ERICSSON Review

1

1971

ERICSSON REVIEW

Vol. 48 1971

RESPONSIBLE PUBLISHER: CHR. JACOBÆUS, DR. TECHN.

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: S-126 11 STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $1.80; ONE COPY $0.60

CONTENTS

TELEPHONE TRAFFIC THEORY

TRANSMISSION TECHNIQUE

MISCELLANEOUS

ERICSSON REVIEW

Vol. 48 No. 1 1971

RESPONSIBLE PUBLISHER: CHR. JACOBÆUS, DR. TECHN.

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: S-126 11 STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $1.80; ONE COPY $0.60

CONTENTS

On cover: Testing of line amplifier in L M Ericsson's coaxial cable system for carrier telephony

Applications of Telephone Traffic Theory in Industry and Administration

C. JACOBÆUS, TELEFONAKTIEBOLAGET LM ERICSSON, STOCKHOLM

UDC 519.21:654.15.02
LME 807 8303

At the 6th International Teletraffic Congress (ITC 6) at Munich in September 1970 a number of reviews on general topics were presented by guest lecturers. The present article is a revised version of a paper read by the author, dealing chiefly with the practical aspects of telephone traffic theory.

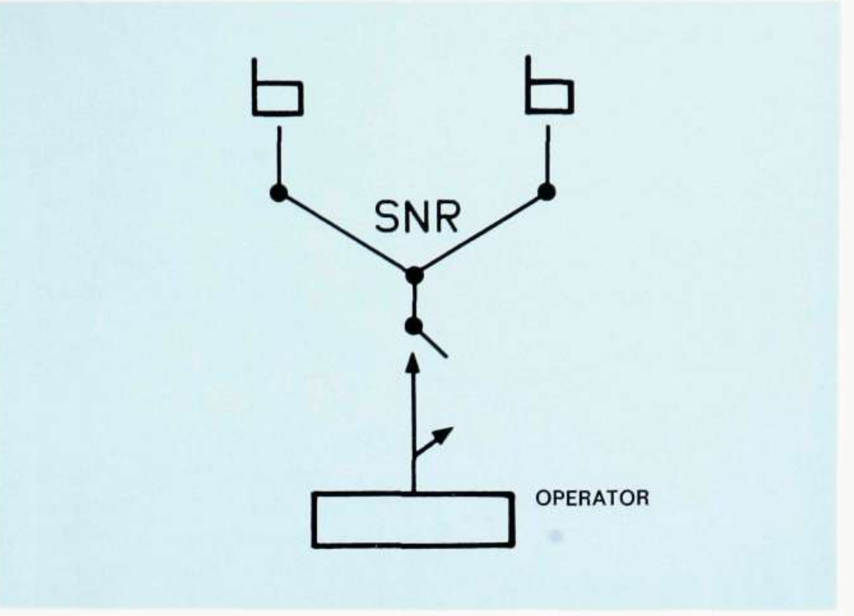
The job of traffic theoreticians, technicians and operations engineers is to achieve better telephone plant. The criterion of this is that the plant is better calculated to fulfil its functions for the subscribers and for the community as a whole. It must provide the service facilities required at a reasonable price. To achieve this aim, theoretical, practical and technical advances must go hand in hand. It may then be advisable to consider more closely the relation between theory on the one hand and technique and administration on the other. This article presents a few examples of the interplay between theory and practice that has existed during the development of telephony. Some perspectives on the future as regards urgent tasks for the traffic researchers are also presented. Finally a few words are said about the inherent limitations of telephone traffic theory.

Manual Exchanges

To start with, we may consider the very simplest form of telephone plant, namely a manual exchange. In order to carry traffic without congestion, the number of cord circuits would theoretically need to amount to half of the number of subscribers. But it was clear, of course, even to the designers of the first switchboards, that so large a number of cord circuits would never be required. It is extremely improbable that all subscribers would wish to ring at the same time. One could therefore be content with a fairly limited number of cord circuits, perhaps usually only 10 % of the number of subscribers, which is a very much more economical solution of the switching problem. This means that the requirement of non-blocking access has been abandoned. During peak traffic periods the subscribers must be prepared not to be immediately served. As is known, this limitation of the service can be kept very low without affecting the economy, and it must be considered very reasonable to accept such a compromise. It may also be mentioned that all types of traffic plant—not only telecommunications—are calculated on the same principles.

The man who finally evolved a scientific theory for this problem was, as we all know, Erlang. It is almost a truism to speak of the enormous importance his work has had, and of the influence he has exercised both on the theoreticians and on the engineers. The Erlang loss formula has been the standard tool in the majority of cases which the engineer meets in practice in industry and administrations. This goes both for the cases for which his formula was designed, i.e. full avaliability groups, and when it is used as a common yardstick for the efficiency we can reach with any type of grouping.

Fig. 1
Manual switchboard



Selector Stages, Gradings

The circuit requirements in the earlier manual exchanges were calculated by some rule of thumb. With the advent of automatic systems, on the other hand, traffic theory came into the picture in a more conscious manner. In the first more advanced automatic systems, the Strowger systems, the designers were faced with the problem of constructing larger exchanges than corresponded to the capacity of the selector. This led to the discovery of the group selector.

If one were to build an exchange for 10,000 lines, it could be done as in fig. 2. Here each selector *GS* has been equipped with 100 *LS*, i.e. one *LS* to every multiple position in *GS*. One may regard each *GS* with its 100 *LS* as a single selector with a capacity of 10,000 lines.

In fig. 3 use has been made of a fundamental discovery, "free (non-numerical) hunting by the group selector". The inventor is unknown but should deserve a place on a level with Strowger. Through this arrangement one can build systems of any size for the same economy. The 101 selectors in fig. 2 correspond to 3 selectors in fig. 3 (with some approximation). The systems are, of course, not equivalent. There is congestion between the selector stages in fig. 3, but this can always be kept within acceptable limits.

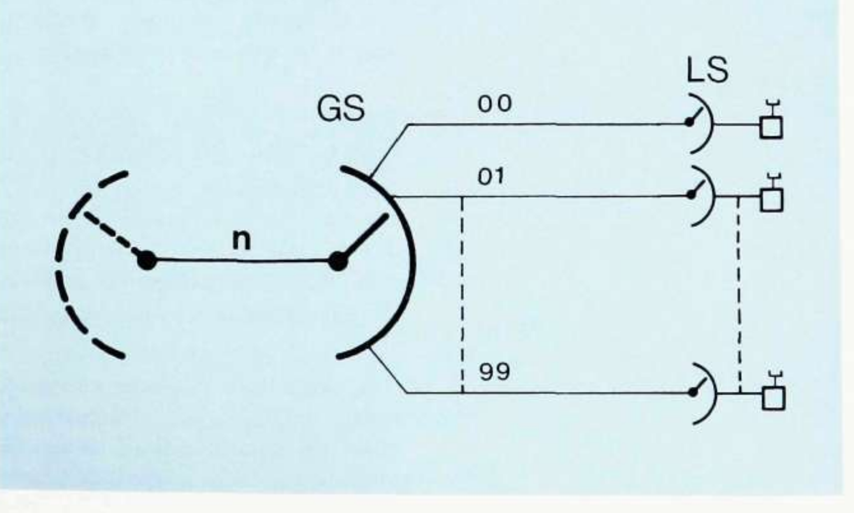
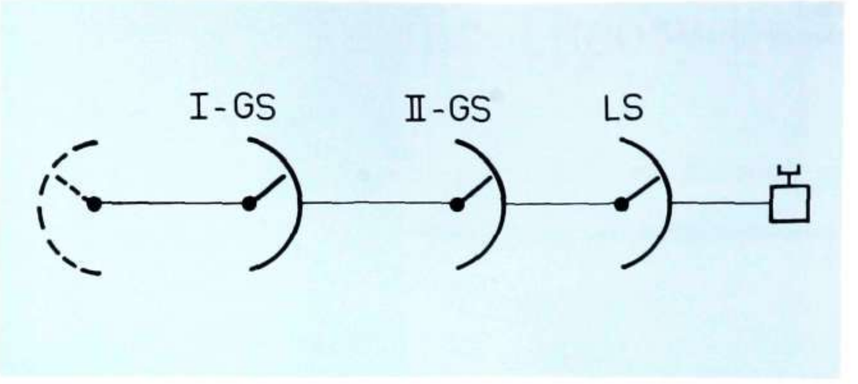


Fig. 2
Non-blocking office for 10,000 lines
GS Group selector
LS Final selector

Fig. 3
Office for 10,000 lines with group selector stages



In their basic form the Strowger systems had selectors with a capacity of 10×10 In the *GS* stages partial multipling (grading) was quite soon introduced. It was realized that the circuit utilization in subsequent selector stages could be improved if the availability could be increased in the gradings. Selectors of Strowger type were built with 20 outlets per decade, and in the motor-driven systems use was also made of a larger hunting capacity. As is known, the gradings have for a long time defied the efforts of the theoreticians to get to grips with the problems in a practical way. Admittedly Erlang, at an early stage, produced simple formulae for his ideal or homogeneous grading. But this grading cannot be realized even with present technique. Measurements on actual gradings also showed great deviations from Erlang's results. Only after the introduction of traffic machines, and later through simulations in computers, has it been possible to chart this wide field. Here, undeniably, the system and selector designers were ahead of the theoreticians.

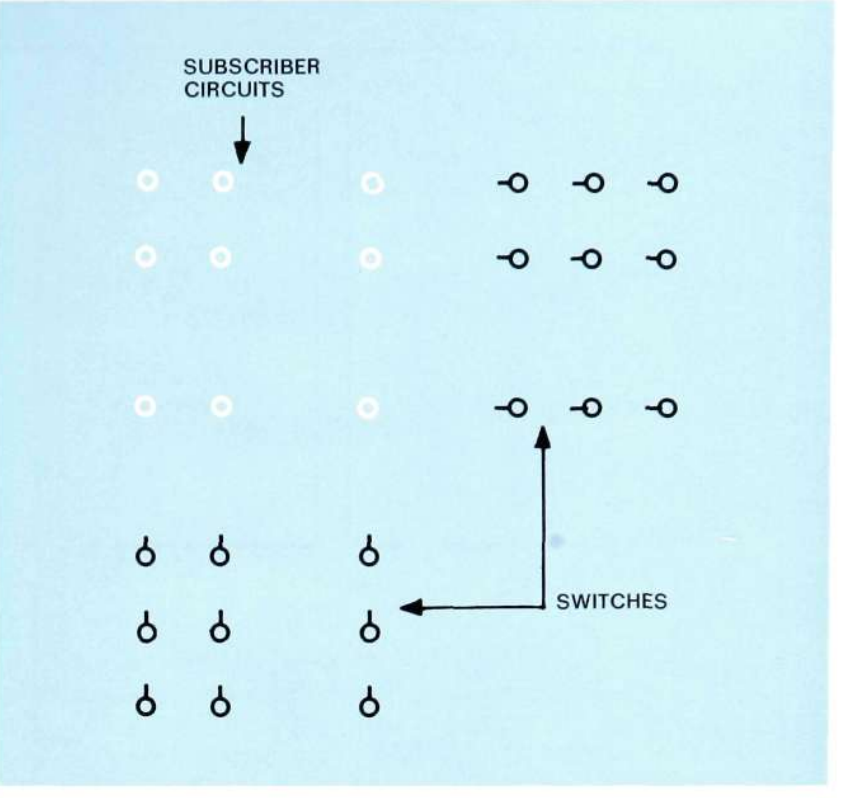
It may perhaps be added that the number of routes in a *GS* stage is not directly dependent on the traffic. A selector with larger capacity in this respect results in a smaller number of *GS* stages in an exchange. As regards the number of routes, the capacity can probably be evaluated in proportion to the logarithm for the number of routes. This could be used for striking a balance between the number of outlets per route and the number of routes when this division can be freely selected within the capacity of the selector. This is the case with some selectors of rotary type, and perhaps also in certain link systems. But, as far as is known, no investigation of this has been published.

When we come to gradings, the theory has had manifest difficulties in guiding the technicians. In the older Strowger and motor-driven systems the designers were tied to a given order of hunting for each selector. Ofter the gradings were arranged in such a way that in the direction of hunting there was increasing multipling of the outgoing circuits. Special rules of thumb existed for this multipling without any deeper theoretical background.

The technicians have tried by various means to raise the capacity of these gradings. One such means was the introduction of mixing selectors. Selectors were placed on the outlets from a *GS* stage which hunts for a free circuit. If there are no free circuits in the selector multiple, it is marked busy. In this way a considerable increase is obtained in the effective hunting capacity. The possibility of calculation for this system came much later, in conjunction with the elaboration of the methods for link systems.

A special kind of grading which is used to advantage when the load on the traffic sources is low is transposition (fig. 4). This is used in concentration stages for subscriber lines. Simple formulae produced for this purpose appear to give a good idea of the traffic-carrying capacity.

Fig. 4
Grading with transposition



In some crossbar switching systems there are link systems with gradings, in which the attempt is made to achieve something similar to Erlang's homogeneous grading by uniform multipling and by hunting for a free outlet from a rotating starting point.

The design of gradings is to a great extent a practical question. It is important that the installation should be simple and that changes caused by reorganization of outside plant and extensions of plant are not too complicated. Otherwise one runs the risk that they will be wrongly done, with inferior traffic handling properties in consequence. The practical simplifications initiated by technicians should be examined by traffic experts.

For calculation of the traffic capacity of gradings there are only in very simple cases any formulae based on a reasonably stringent theory. In the majority of cases it has been considered sufficient to use approximations with some theoretical association. The problem of gradings—as of all other groupings—can in principle be approached by the equations of state method. The systems of equations that have been set up, however, defy all efforts at simple explicit solutions—in fact very large computers are required for this purpose, even for relatively simple cases.

In practice simulation methods are used today, and for the various automatic systems there are tables or manuals prepared on the basis of extensive simulations.

Link Systems

The designers of new telephone systems are now less interested in gradings than before, and various types of link systems now stand in the foreground of their interest. The link systems, like the gradings, have been used for a very long time within telephony without any theoretical basis for their calculation. Examples of link systems from previous times are various types of common control, operators, registers, markers etc. Another is the mixing selectors which

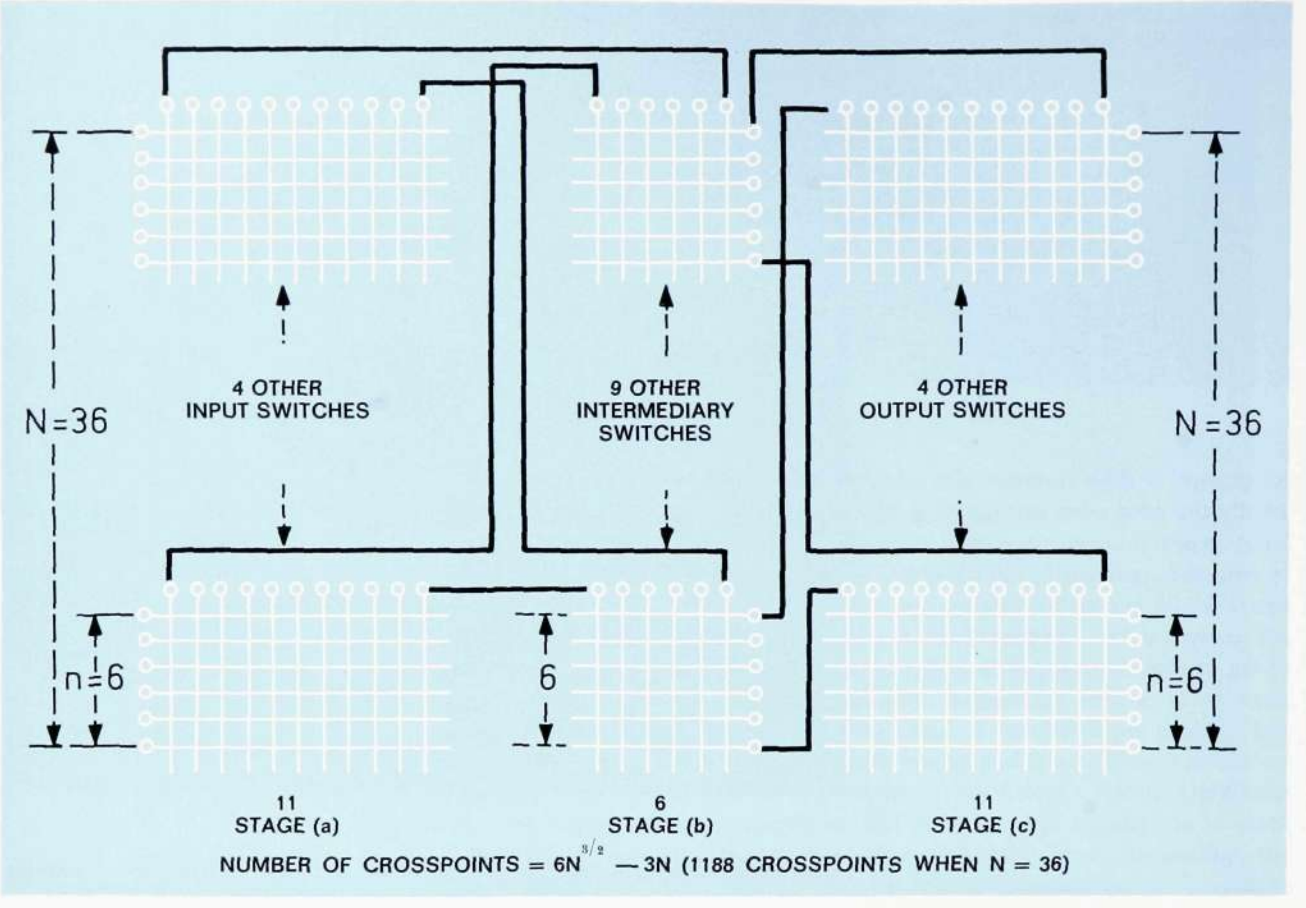


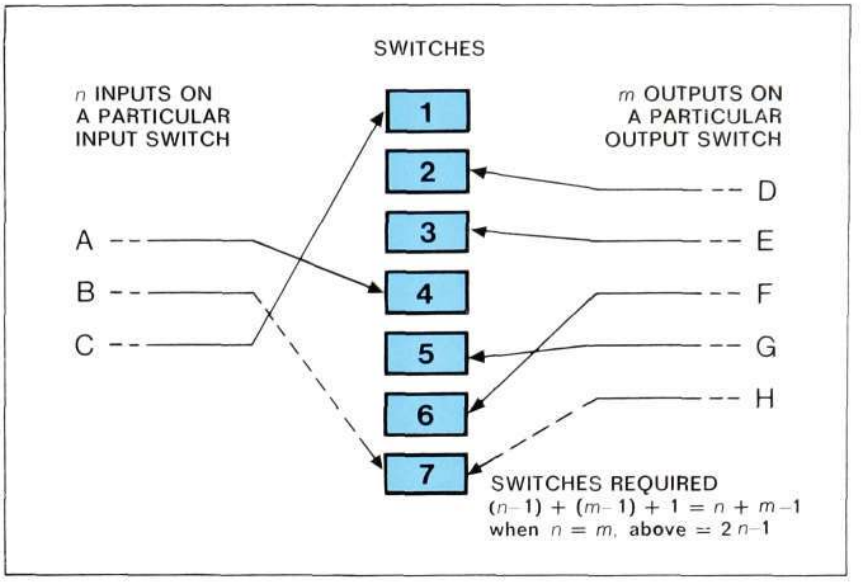
Fig. 5
Three-stage switching array

were connected to the outlets of the *GS* stages to raise the utilization of junction circuits. For link systems I presented in 1950 a system of calculation, which, although approximate, could give very good guidance to designers of selectors and switching systems. This system has since been developed in several respects by other authors. For link systems with large internal congestion, however, as also for multistage link systems, the method is not sufficiently correct if high requirements are placed on accuracy. In practical cases one must have recourse to simulation.

The development of automatic exchanges at many telephone companies appears to be in the direction of link systems in several stages, and with a comparatively small selector capacity. It is the electronic control technique which allows these solutions, which are rather troublesome with relay technique. Studies have been made of how selectors should be dimensioned to attain a minimum of crosspoints. First, however, I would refer to an investigation published by Clos in 1952 concerning non-blocking link systems. Clos investigated in general the principles for the build-up of such link systems.[1] Fig. 5 shows the arrangement for a three-stage system for 36 inlets and 36 outlets.

The principle involved for determining the number of switches required in the intermediary stage is illustrated in fig. 6. The figure is drawn for a specific case from which one can generalize for n inputs on a given size of input switch and m outputs on a given size of output switch. In the figure it is desired to establish a connection from input B to output H. A sufficient number of intermediary switches are required to permit the $(n-1)$ inputs other than B on the particular input switch and the $(m-1)$ outputs other than H on the particular output switch to have connections to separate intermediary switches

Fig. 6
Principle involved for non-blocking systems



plus one more switch for the desired connection between B and H. Thus $n + m - 1$ intermediary switches are required.

The number of crosspoints as function of the number of selector stages will be seen from fig. 7. The lines are practically straight on the double logarithmic scale. The greater the number of lines, the greater should be the number of selector stages. The difference is quite small, however, and it seems as though one could be content with five selector stages in practical cases. But even for 200 inlets and outlets there are roughly 16,000 crosspoints, which shows that the achievement of freedom from congestion even in link systems is expensive. But it is possible that the non-blocking systems could find a wider use in switching systems based on time division multiplex. Large switching systems of this kind, equivalent to 3-stage link systems, are built up roughly

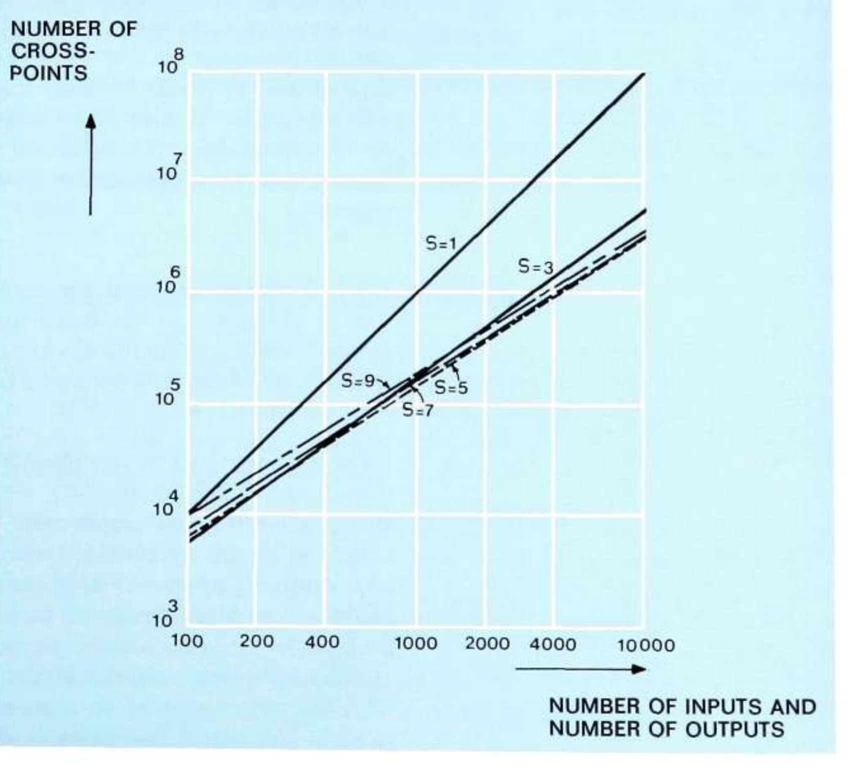


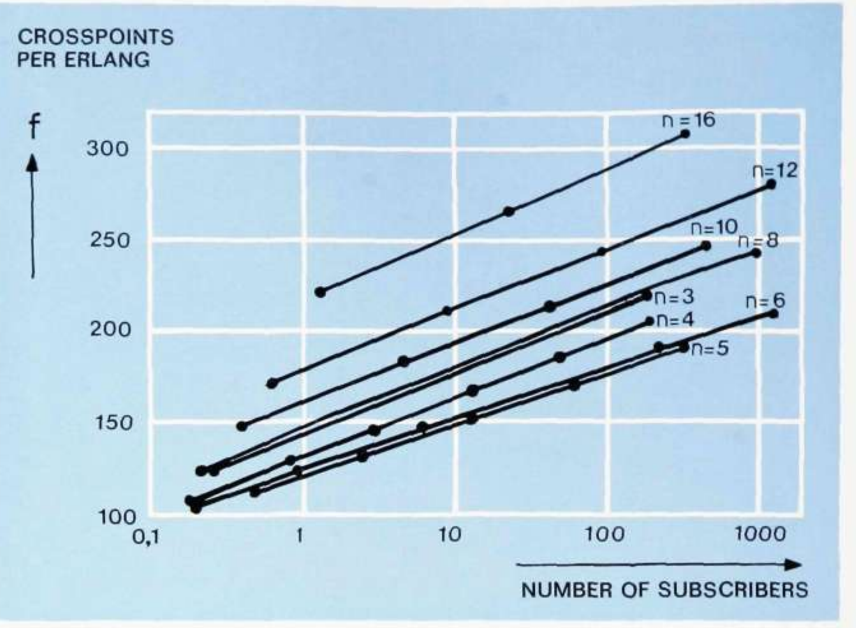
Fig. 7
Crosspoints versus number of inlets (outlets) for different numbers of switching stages

S = Number of switching stages

Fig. 8

Comparison of crosspoints per erlang and switch size of optimum link systems

n = Switch capacity



as shown in fig. 5. The reason why one may here conceive of non-blocking systems is that the extra cost will be fairly moderate, as freedom from congestion involves chiefly an increase in the number of pulse positions, which is not too costly. The systems will be of interest, however, only in cases of heavy loading of the lines, i.e. for large transit centres. The technical realization of these exchanges also lies several years ahead in time.

By way of comparison with the results of Clos, fig. 8—taken from Japanese paper[2]—shows the number of crosspoints/Erlang for different sizes of exchange and switch capacity at a traffic of 0.1 E per circuit with 1 % loss. One sees from the figure that a minimum number of crosspoints is obtained at a switch capacity of 5. For comparison it may be noted that for switch capacity 16 the number of crosspoints is about 70 % greater (at around 10,000 lines). With a switch capacity of 3 the increase is roughly 15 %. Switch size 8 is attractive from many points of view, one reason being that it links up with the binary system and also provides an increase of only about 15 % over optimal size. It should be noted that the cost per crosspoint is rather lower with a larger switch than with a smaller. There is reason to believe that switch size 8 often yields a real optimum. It may be noted that other authors have found a theoretical optimum at a switch size of 2 e (e = base of the natural logarithm).

It will also be seen from the curves that the number of crosspoints/Erlang rises in proportion to the logarithm for the number of lines. This is fairly natural considering that, in a way, systems of this kind materialize a number system in which the switch capacity is the base number.

It has sometimes been discussed whether rather larger gains could be made if occupations in the switching system could be moved so that there was always space for new occupations. In a grading with sequential hunting the outlets which are common to many switches should be kept free for as long as possible. A connection which seizes one of these outlets when such an outlet becomes free would be moved to a prior outlet in the order of hunting, and common to a smaller number of switches. This would bring about a packing effect, which would often make the gradings free from additional congestion, i.e. when the congestion on a given route approaches the congestion of the route at full availability. Systems of this kind are rather difficult to realize.

The gains can, of course, be indicated by the theoreticians if they are faced with the problem.

Considerable research has been devoted to variations of the traffic and their influence on how the systems handle the traffic. One may perhaps say that hitherto this has had fairly little consequence for circuit calculation. This is because, in tender specifications, often no attention is paid to how plant behaves, especially during overload. In future, probably, this must be taken into account to a greater extent, as the general tendency is to utilize the circuits and switching equipment effectively. This makes the plants more sensitive to overload.

Common Control Groups—Queue Problems

Another important aspect of modern telephone systems in which the technicians must call on the aid of the traffic technicians is different forms of common control groups such as markers, number groups and the like, which work on a delay basis. Individual devices in such types of equipment may have a rather high load, which means that many calls using these devices will be delayed.

This can be tolerated, as the mean holding time for the devices is very short. The total waiting time will consequently also be short. The rule for calculation of the capacity of such a system is usually that only a small proportion of the calls (e.g. 1 %) are permitted to wait more than a certain time (e.g. 1 s) to be served. As there are often several interworking devices, and also devices built up of a chain of subdevices, extremely complicated systems may arise. The queue theory provides guidance for technicians in this case. But sometimes the problems are so complicated that simulations are the easiest way to get an answer.

It may be worth pointing out—as another example of the fact that new problems constantly arise—that the data networks now being planned in several European countries will place new requirements on the switching equipment. As the mean holding time per data message is considerably shorter than for telephone calls, there will be greater demands for speed of switching. It may be necessary to adopt new solutions for markers and their construction. Problems also arise in the intermediate storage of data messages. The queue theoreticians will here again have new assignments.

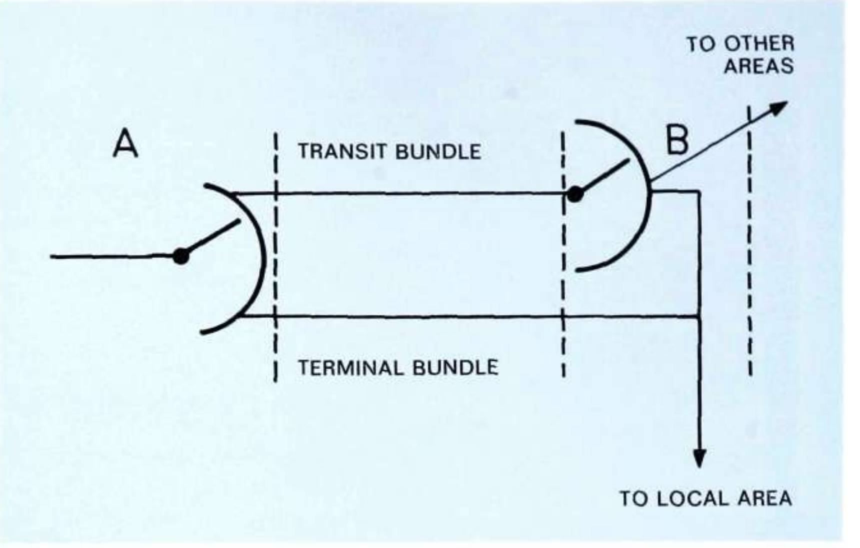
Within the sphere of interest of the manufacturing industry there are other fields in which the traffic technicians must be brought in. Such fields are to some extent power equipments, amplifiers for carrier systems, signalling on a common signalling channel. But these questions will be dealt with in this context.

The Problems for the Administrations

It is perhaps difficult to draw an entirely clear boundary-line between the fields of application of the manufacturers and of administrations. The solutions offered by the manufacturers naturally have an influence on the plant planning by the administration, just as the demand raised by the administrations are a guide to the manufacturers.

The close cooperation between manufacturers and administrations has undoubtedly been of great importance for system developments. The perhaps most important example in this respect is the development of register systems, which eliminated the lack of flexibility of the decadic systems. The groups of circuits between exchanges could be more economically dimensioned. This had an influence also on the optimal size of exchanges and on the suitable location of exchanges. But there is hardly any direct application of traffic theories within this field.

Fig. 9
Divided bundle for transit and terminal traffic

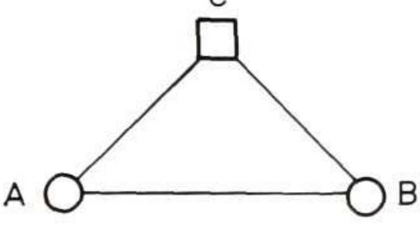


If, however, we go a step farther and introduce systems with alternative routing, we come to a complex of problems which, as is known, has attracted great interest from the theoreticians. In their simplest form the alternative routes consisted of separate bundles for terminal traffic and transit traffic between two exchanges. The terminal traffic bundle, running to subscribers within the terminal exchange area, could be given rather worse transmission characteristics, and in this way a saving on transmission equipment could be attained, as well as a saving of one selector stage. The transit traffic occupies only the transit bundle, while at full occupation of the terminal bundle the terminal traffic can use circuits in the transit bundle. One may say that this is a type of grading (fig. 9). The problem of determining the appropriate number of circuits in each bundle is fairly easy to solve by trial and error.

In fig. 10 we see the well known picture of two exchanges *A* and *B* with connection via exchange *C*. When is it advisable to introduce a direct route between *A* and *B*, and how should it be dimensioned? The overflow traffic is still carried over *C*. In the course of the years much work has been expended on this problem and several methods of solution are available. The configuration of fig. 10 is actually a special case of the more general case illustrated in fig. 11. Here we have a metropolitan network with four transit exchanges *A*, *B*, *C*, *D*, which are interconnected.

A number of terminal exchanges are connected to the transit exchanges. How should a network of this type be optimized? Should alternative routing be allowed between the transit exchanges? Should there be a direct route between the terminal exchanges? How should the terminal exchanges be interconnected? The problem is obviously very complicated but can nevertheless be attacked successfully. It has been demonstrated that considerable gains may be counted on in such metropolitan areas by the consistent application of the tools made available by the theoreticians.

Fig. 10
Alternative routing



It should be noted that the administrations are more directly concerned with operational research than with traffic theory in their planning. The greater part of their investment planning is done on the basis of operational research principles.

Within this sphere, finally, I may merely point to a computation rule of a general nature because it is closely associated with traffic research. This applies to the principle presented by the Danish telephone engineer, Moe. It relates to the distribution of the congestion in a network when the total congestion is given. According to Moe the distribution should be such that, in each part of the network the cost for carrying one additional Erlang is the same. No administration presumably is entirely consistent in this respect, but to some extent Moe's principle has come into use, in that different levels of congestion are often allowed for switching equipment and circuits. One may say that Moe's principle is the old law of marginal utility applied within a technical field.

Future Demands on Traffic Theory

What demands can the telephone engineer make on the traffic theoreticians in the future? What can he reasonably hope for from them in the way of new tools in his work? The answer to these questions is, of course, given by the general development seen within traffic theory: in the first place an increased understanding of the nature of telephone traffic.

Thereby better models for the traffic can be produced, which in turn would bring about a closer adaptation of the plant to the real need. The pattern of subscriber's behaviour needs to be charted. The traffic conditions in small subscriber groups have not been satisfactorily investigated. Small exchanges, line concentrators etc. could or should perhaps be otherwise dimensioned.

One may well say that the computation rules for ordinary switching systems in other respects are satisfactory. The methods available for different groupings permit a choice between alternative technical solutions. The development of simulation technique has given us new means when the pure theory has not led to the goal. The stored-programme-controlled exchanges, however, require further studies in order to discover what alternative forms of structure and interworking between the processors will be most feasible in different cases.

The future development in the field of network structure will be interesting. Additional gains may perhaps be made for the administrations. Hitherto the hierarchial networks have been studied fairly thoroughly, but we now await an attack on more general types of network. Also networks with different busy

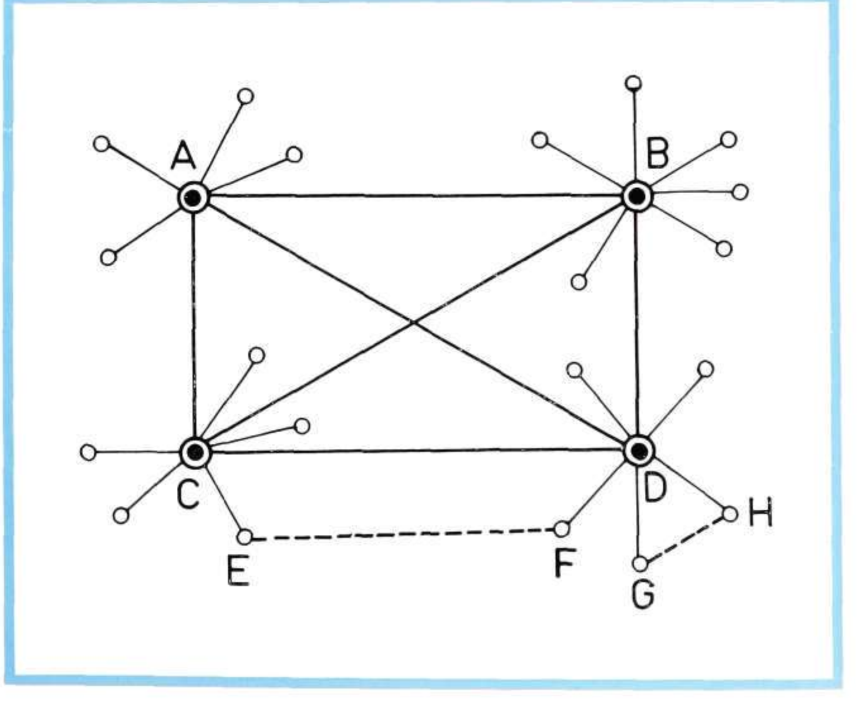


Fig. 11
Network with alternative routing

◉ Transit exchange

○ Terminal exchange

hours for different parts of the network will be created. This is important for satellite systems. Even if the percentual gains may probably be limited, the absolute amounts are likely to be considerable.

It will be apparent that in general there has been continuous and important interplay between theory and practice within telephone engineering. Sometimes theory has lain ahead of the practical applications, in other cases the telephone engineers have with good intuition been able to propose new solutions, the total benefits of which have not become manifest until a corresponding theory was created. Owing to the increased complexity of telephone systems it will be necessary in the future that still more intimate collaboration takes place between theoreticians and engineers.

New systems will grow up in which, in almost every stage of the creation process, contributions are made by both these specialist groups. Many of those in leading positions in industry—and with the ultimate responsibility for its economy—have questioned whether traffic research is not a matter that can be entirely left to universities and colleges. But it will be apparent from the foregoing account that close collaboration between engineers and traffic theoreticians is absolutely essential. The costs of traffic research to manufacturers and administrations have always been fairly moderate in relation to other items in the development budget, and they must be said to have given a very good return in respect of savings in telephone plant.

Some Concluding Remarks

In conclusion a field will be spotlighted which concerns the entire telephone system and which requires the cooperation of the traffic theoreticians. It has not yet been possible satisfactorily to link together congestion, fault rate and transmission parameters. We do not know at present whether we have struck the right balance in our calculations. One may well say that a call rejected owing to congestion must be put on an equal footing with a connection which is lost owing to a technical fault, and that fault rate and congestion are thereby linked together. From the point of view of calculation, however, the comparison is rendered difficult by the fact that the fault rate is usually not constant, i.e. the number of faults is proportional to the traffic, while the number of calls lost through congestion increases with an exponent of the traffic. A model which would allow of mathematical treatment could perhaps nevertheless be found for these conditions. But complications arise through the fact that some types of faults, such as disconnection and crosstalk, cannot be directly compared with calls lost owing to congestion.

When one then brings in the transmission parameters, one faces difficulties of an entirely different order.

An attempt has been made to measure the prolongation of a conversation due to poor transmission, and so to obtain a comparison with the costs for a normal conversation. The method has proved to be unsatisfactory for the reason that misunderstandings owing to poor transmission cannot be evaluated. Probably one must rely on the fact that the practice that has evolved implies a fairly correct and suitable form of calculation. Naturally this means that a change called for by technical developments must often be slowly accepted, as one cannot show it to be warranted by objective methods. As in many other fields, one here runs up against the human system of evaluation, which is bound by custom and is irrational.

We also, of course, come up against the fundamental limitation in our science. We can deal only with what can be converted into economic terms.

The rest is left to human judgement, which is subject to change. As an example, it may happen that in future we may wish to pay more in order to obtain a more natural reproduction of speech at the cost of deteriorated grade of service. Our science then has the task of telling what the savings in the network may be. But we can never state what is right and what is wrong; this must be chiefly a question of judgement. There are many similar examples in other means of communication.

One can naturally expend research efforts on investigating what people are prepared to pay in respect of the grade of service of telephone plant. Such efforts, however, appear rather futile. People cannot so easily decide what they want. Unfortunately a tolerance quickly arises for even quite considerable deteriorations of the service. Purely technically, there may be difficulties also in producing usable alternatives without interference with the equipment. One must therefore have recourse to the general judgement of administrations.

The latter must naturally follow the developments in respect of the telephone network parameters as regards transmission and grade of service. They must be sensitive to subscriber reactions and to expressions of opinion. It is reasonable to suppose that in normal times the trend will be towards a generally improved service. The technical advances will offer the administrations the means, at a reasonable economic sacrifice, of giving subscribers a better quality of service at the same time as telecommunication plants will provide a more diversified range of services.

References

1. CLOS, C.: *A Study of Non-Blocking Switching Networks*. Bell Syst. Tech. J. *32*(1953): 2, pp. 406—424.
2. TAKAGI, K.: *Design of Multi-Stage Link Systems with Optimum Channel Graph*. Rev. Elect. Commun. Lab. *17*(1969): 10, pp. 1205—1226.

New Variant of International and Intercontinental Telephone Exchanges ARM 202

S. ELLSTAM & B. OLSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.722
LME 8305
831
834

The semi-automatic and fully automatic international and intercontinental telephone traffic is rapidly developing. L M Ericsson has supplied and installed telephone exchanges for this purpose since 1959. It is also worthy of mention that most of the important telephone and telex exchanges in the CANTAT, COMPAC and SEACOM intercontinental links are of L M Ericsson type ARM 20 (fig. 1). The international and intercontinental telephone exchanges installed hitherto are characterized by the fact that they are adapted for connection of circuits working either on CCITT signalling scheme No. 4 or No. 5. Today, however, there is a need for connection to a single exchange of circuits operating on both of these signalling systems. Recently, furthermore, CCITT has recommended signalling systems R.2 and No. 5 bis for international circuits, which should also be connectable to the same exchange. To meet these and other new requirements, which will be dealt with below, L M Ericsson has designed a new variant of ARM 202. It is based on conventional technique and on normal construction practice for the ARM exchanges.

An investigation is being made of the possibility at a later date of supplementing ARM 202 with special equipment for connection of circuits with CCITT signalling system No. 6. The results of this investigation can, however, not be reported until the present field tests with the signalling system have been completed.

Chief Characteristics of the ARM Systems

L M Ericsson's system *ARM 20* is one of the geographically most widespread of the modern transit systems on the world market, and manufacture is in progress or planned in twenty countries. Some of the characteristics common to all types of *ARM* exchanges, including the new international variant described below, and which have contributed to the spread of the system, are as follows:

- *Rapidity*, switching time through four partial stages about 700 ms.
- *Full availability*, which ensures the optimum circuit economy, of special value for international exchanges.
- *Alternative routing*, of significance for circuit economy.
- *Good transmission characteristics* with switchable pads and echo suppressors. The link connection principle results in short multiples and thus in low crosstalk and noise levels.
- *Multimetering or toll ticketing* as desired.
- *Two-way selector stages* for two-way circuits, which results in better selector economy and increased accessibility.
- *Low maintenance costs*, 0.6 man-hour per line (incoming and outgoing) and year has been recorded.

Fig. 1

Important telephone and telex exchanges in the CANTAT, COMPAC and SEACOM intercontinental links of L M Ericsson type ARM 20

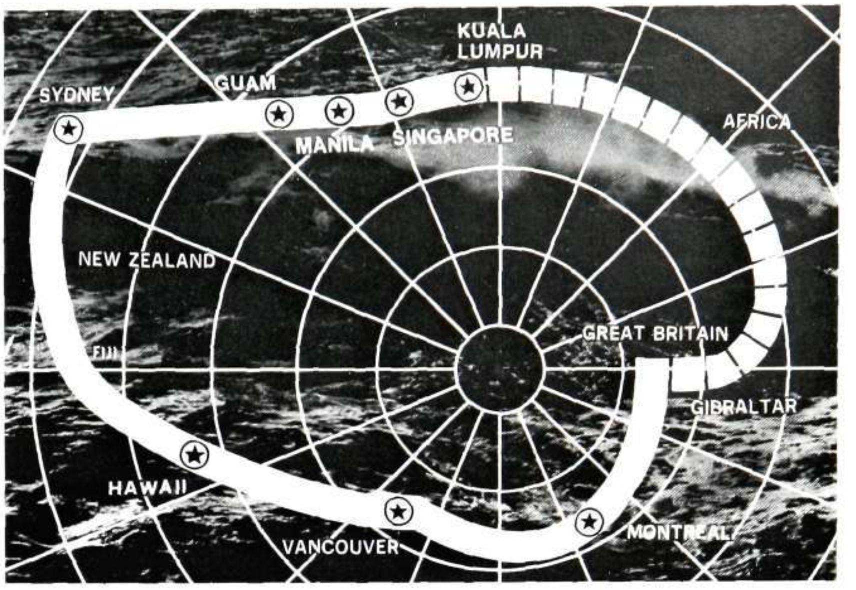
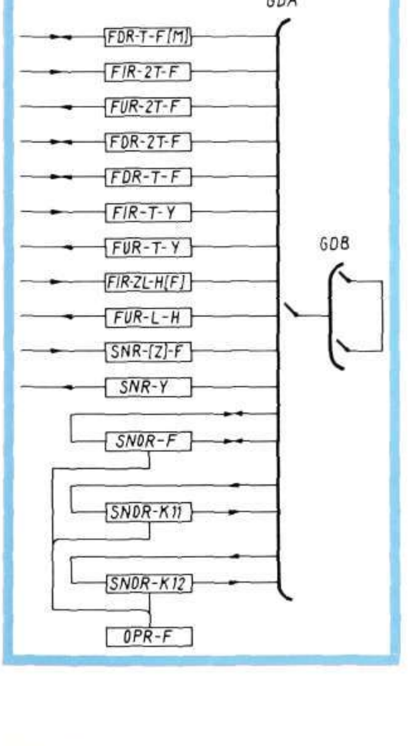


Fig. 2

Line and operator equipment in an international exchange

FDR-T-F(M)	Two-way line equipment for manual international traffic (CCITT no. 1)
FIR-2T-F	Incoming line equipment for fully/semi-automatic international traffic (CCITT no. 4)
FUR-2T-F	Outgoing line equipment for ditto (CCITT no. 4)
FDR-2T-F	Two-way line equipment for ditto (CCITT no. 5, no. 5 bis)
FDR-T-F	Two-way line equipment for ditto (CCITT R.1, R.2). One-way line equipments for system R.2 may be used
FIR-T-Y	Incoming line equipment for traffic from national network
FUR-T-Y	Outgoing line equipment for traffic to national network
FIR-ZL-H(F)	Incoming line equipment for traffic from adjacent local exchange
FUR-L-H	Outgoing line equipment for traffic to adjacent local exchange
SNR-(Z)-F	Incoming line equipment for traffic from adjacent national transit exchange
SNR-Y	Outgoing line equipment for traffic to adjacent national transit exchange
SNOR-F	Operator's line equipment for record calls and demand service for outgoing operator-controlled international traffic etc.
SNOR-K11	Operator's line equipment for reception of K11 calls
SNOR-K12	Operator's line equipment for reception of K12 calls
OPR	Operator's position equipment
GDA, GDB	Two-way group selector stage



Summary of Additional Requirements Placed on the New Variant

The chief new requirements which have appeared in the course of time and which are fulfilled by the new variant of *ARM 202* are summarized below:

- *Circuits with different international signalling systems must be connectable* to the same exchange, as noted above. The various line and operator equipments of interest today are shown in fig. 2. Additional variants may be required for circuits entering the national network.

- *Interworking between circuits with different signalling systems must take* place flexibly without complicated translating units.

- Increased traffic handling capacity in the selector stages to ensure adequate final exchange capacity.

- An international and national exchange must be combinable and thus be served by the same marker arrangement. Having regard to present and future complex signalling requirements the international exchange must be 10-pole, while the national exchange must remain 5-pole. It must also be possible to introduce one or more 5-pole stages for the international traffic to the national network.

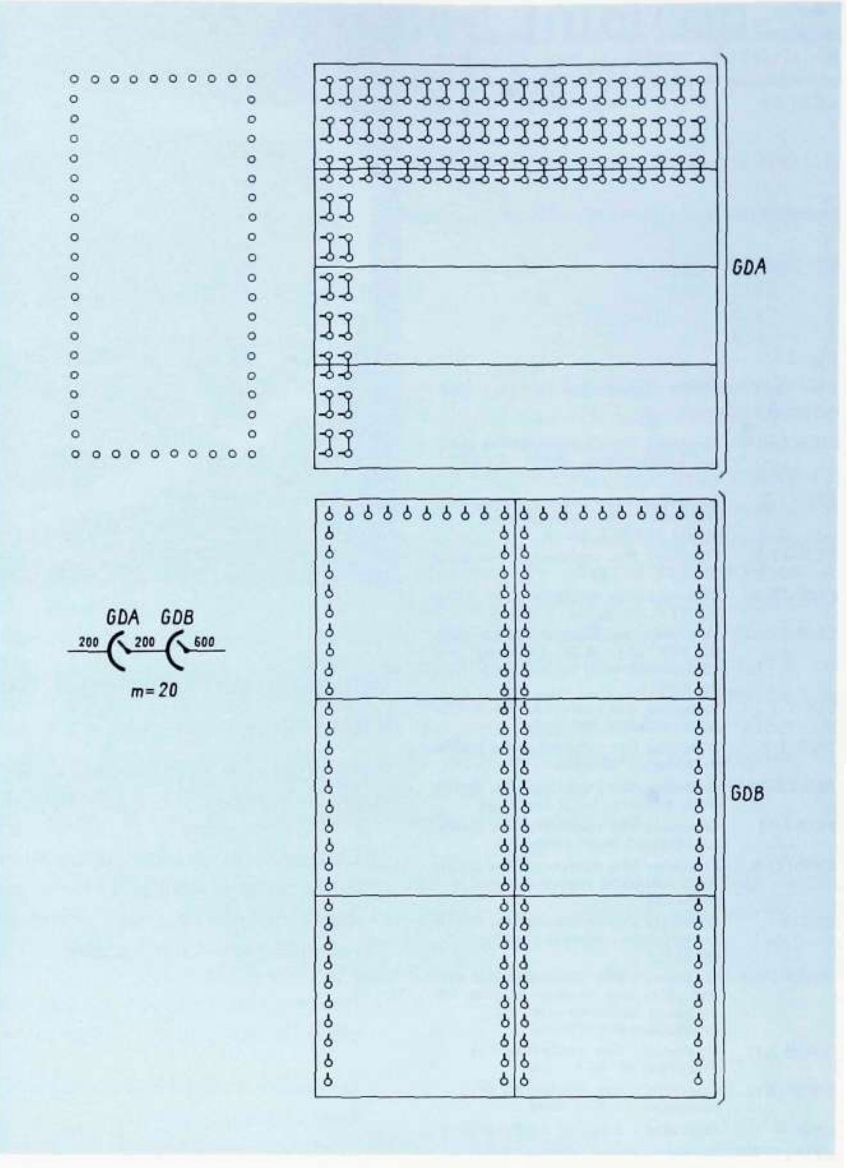
- Facilities for extension of older exchanges should be as simple as possible, without complication of the new equipment.

Chief Characteristics of the New Variant

It has proved desirable to raise the traffic handling capacity in the selector stages and the ultimate capacity of *ARM 202*, which has been made possible through the introduction of a new grouping plan accepting a larger quantity of traffic, built up with 200-line grouping (fig. 3).

It will be seen from the figure that the *A* selectors are built in 200-line groups and that a maximum of 600 links can be connected to eath 200-line group. The *m*-number (the number of verticals accessible in a horizontal row in the *A* selector stage) is 20, and the number of links between the *A* and *B* selectors 200. As there are 10 poles, a 5-bar crossbar switch is used. This means that 20 rows of *B* verticals are required for the links to the *A* selectors.

Fig. 3
Grouping plan for ARM 202 with 10-pole through-connection



Certain data for the new variants of *ARM 202/2* and *202/4* are tabulated below.

Type	Max. number of		Max. number of common control units			
	Circuits	Connections/hour	*REG*	*VM*	*M*	*TB*
ARM 202/2 new variant	4,000*	22,000	200	10	5	20
ARM 202/4 new variant	8,000**	70,000	800	40	20	40

* Two-way and/or one-way
** One-way

It should be noted that the maximum circuit capacity stated in the table for *ARM 202/4* (8,000) relates to a complete exchange unit, but that several such units can be combined to attain the necessary ultimate capacity.

Owing to the new requirements referred to above, new types of line equipment have been designed for the international circuits. The line equipments for the national circuits, on the other hand, are not affected.

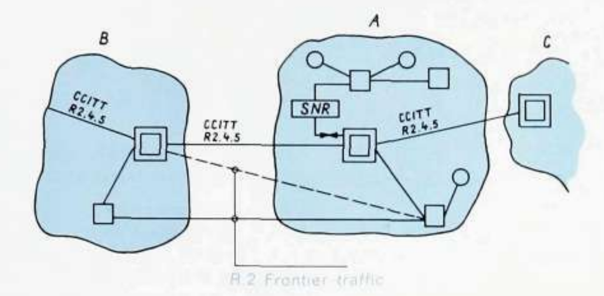


Fig. 4

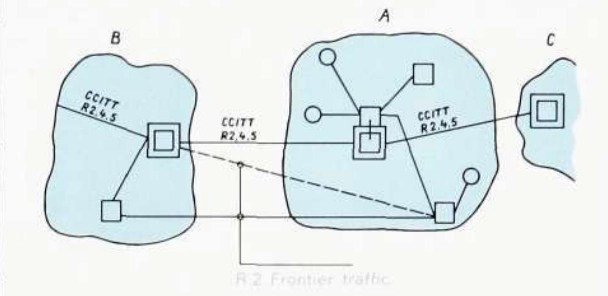


Fig. 5

Fig. 4

Network plan with separate exchanges for international and national traffic

⧈	**International transit exchange**
□	**National transit exchange**
○	**Local exchange**

Fig. 5

Network plan with combined international and national transit exchange

⊞	**Combined international and national transit exchange**

For other symbols see fig. 4

Exchange Network

System *ARM 202* is very flexible and the network can therefore be constructed in the most economical manner for each particular case. Three examples of network configuration are given below.

Fig. 4 shows a network plan with separate exchanges for international and national transit traffic. All traffic between the international and adjacent national exchanges passes through *SNR*. For terminal traffic to remote national exchanges from the 10-pole international exchange it is possible to connect, for example, high usage routes without the use of *SNR*. Frontier traffic with, for example, signalling system R.2 may be carried either via an international or a national exchange in the country of origin to a national exchange in the country of destination.

Fig. 5 shows a network plan for a combined international and national exchange. In an exchange of this kind the marker arrangement in the selector stages can serve both 10-pole international and 5-pole national selector units (fig. 6). With this exchange structure seizure of the translating equipment *SNR* can generally be avoided on traffic from an international to a national circuit. Another advantage is that the same outgoing national routes can serve incoming

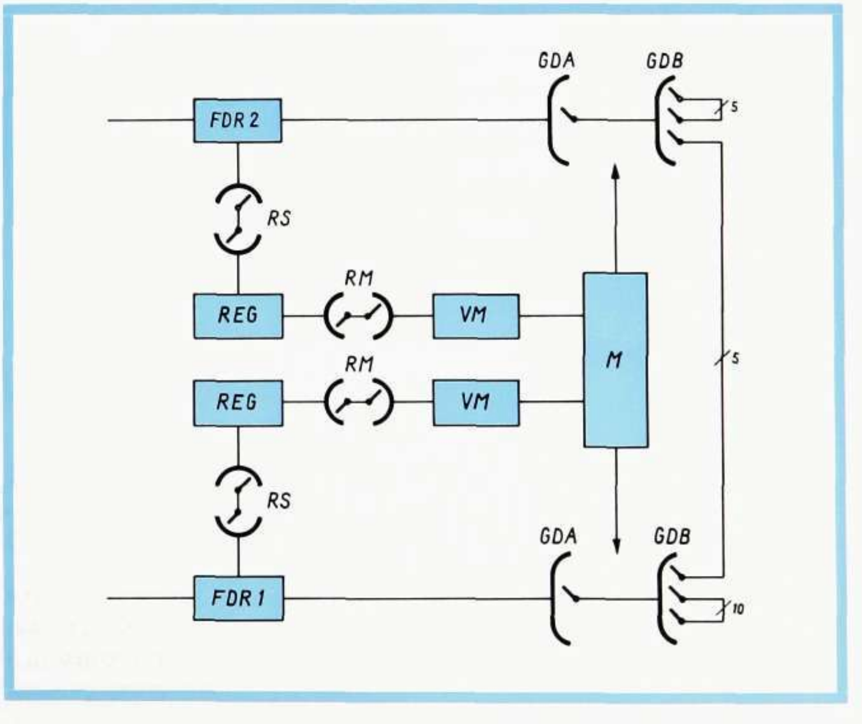


Fig. 6

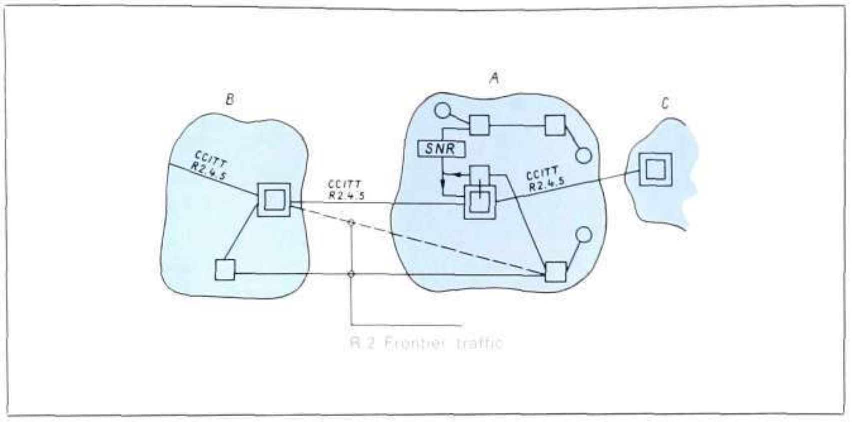
Combined exchange for 10-pole international and 5-pole national selector units

FDR 1	**International line equipment connected to 10-pole selector unit**
FDR 2	**National line equipment connected to 5-pole selector unit**
RS	**Register finder**
REG	**Register**
RM	**Equipment for connection of register to route marker**
VM	**Route marker**
M	**Marker**
GDA, GDB	**Two-way group selector stage**

Fig. 7

Combined international and national transit exchange with connection of other national exchanges in different ways

For symbols see figs. 4 and 5



traffic both from the international and national network. Otherwise this plan incorporates the same features as that in fig. 4.

Fig. 7 is a combination of fig. 4 and fig. 5 and should therefore not require any comments.

Main Principles for Traffic Routing

As already noted, international and national transit exchanges may be either separate or combined. Fig. 8 shows the trunking diagram for a separate exchange and fig. 9 for a combined exchange.

The following points are common to the two types:

- Outgoing international traffic from the national network normally passes through translating equipment *SNR-(Z)-F* for signal translation, international charging and/or settlement of accounts, and connection of an international register. If the local exchange has a large international traffic, however, and it is therefore economically warranted to introduce a direct route to the international exchange, the functions of *SNR-(Z)-F* can be transferred to the national repeater *FIR*, which is connected directly to a 10-pole selector unit.

- Incoming international repeaters are normally placed in a 10-pole selector unit. They must be able to interwork both with outgoing international repeaters and operator's equipment, as well as directly (without translation equipment *SNR-Y*) with the ordinary 5-pole outgoing national repeaters. If there are no echo suppressors in the national network, however, and/or if an operator's services need not be used in the international exchange in the country of destination, incoming international circuits for terminating traffic can be terminated on 5-pole selector units (not shown in the figures).

- Outgoing international circuits are normally connected to 10-pole selector units. For outgoing (non-transit) traffic on circuits with signalling system R.2 the outgoing circuits, however, can be connected to 5-pole selector units not shown in the figures).

- If equipment for assistance operator traffic is required, *SNOR-AO* is connected via register finder *RS*—with or without additional equipment for choice of language—to an incoming international repeater.

- The operators' equipments *SNOR* for *K11* and *K12* traffic are connected to 10-pole selector units. The language marking can be used in such case either for choice of a group of operators or to mark the language to be used by a common group of operators.

Fig. 8

Trunking diagram for separate international and national transit exchange

Fig. 9

Trunking diagram for combined international and national transit exchange

①	*National register arrangement*
②	International register arrangement
FDR 2	Two-way national line equipment
SNR-Y	Translation line equipment
SNR-(Z)-F	Translation line equipment
FUR	*Outgoing national line equipment* (only fig. 8)
FIR	Incoming national line equipment; traffic from, for example, adjacent local exchange
FDR 1	Two-way international line equipment
SNOR	Operator's line equipment
SNOR-AO	Operator's line equipment for incoming assistance operator calls
OPR	Position equipment
RS 1	Register finder
RS 2	Finder for selection of SNOR-AO

The international register arrangement comprises, among other equipment:

REG	Register unit
KM	*Code receiver*
KS	Code sender
AN	Analyser
SS1	Code receiver finder
SS2	Code sender finder

Characteristic of an exchange as in fig. 8 is that the incoming traffic to the international exchange terminating on small national routes and/or with complicated signal configuration is routed via translating equipment *SNR-Y* to the national exchange where, together with other traffic, it is spread throughout the national network. If the incoming traffic represents large routes with simple signalling, on the other hand, the traffic bypasses the adjacent national exchange on direct routes passing normal 5-wire repeaters *FUR* connected to 10-pole selector units.

In a combined exchange as in fig. 9 all national repeaters are connected to 5-pole selector units. Setting up of connections via *SNR-Y* is used in this case only for complicated signalling conditions.

Method of Signalling through the Selector Stage

For international transit traffic through the 10-pole selector units continuous signals are used on 6 separate signal wires. In register position, furthermore, the four open-circuit speech wires are used for signalling. This ensures rapid signalling with a conventional exchange structure.

It should also be pointed out that continuous signalling is most advisable having regard to existing international signalling schemes.

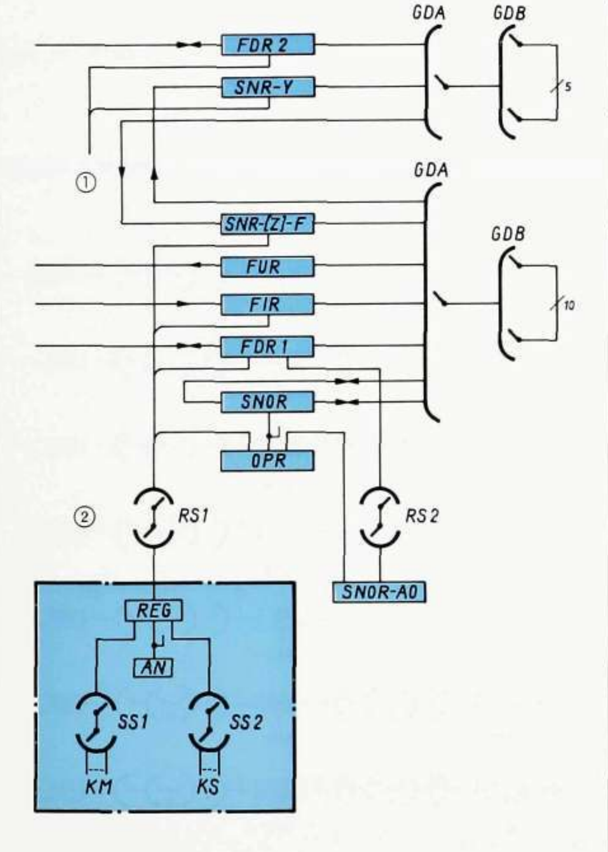


Fig. 8

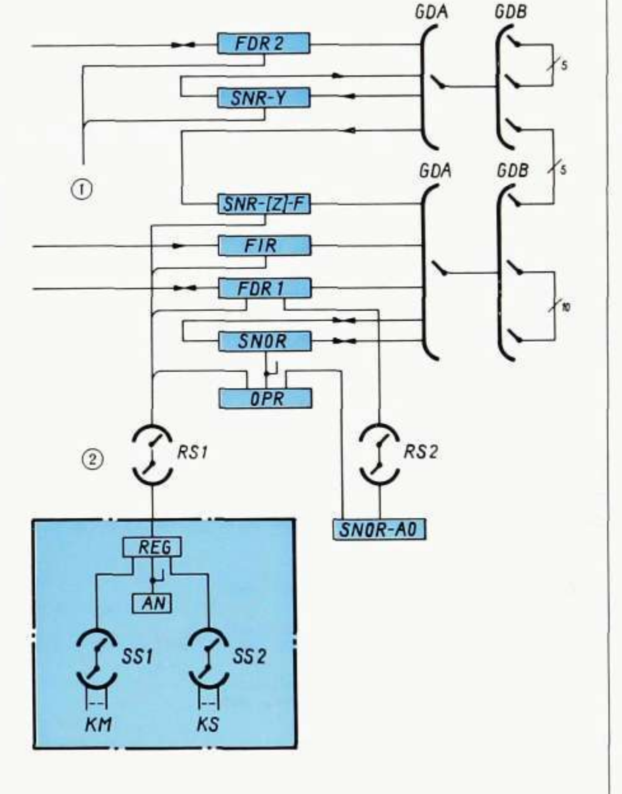


Fig. 9

Through marking of type of traffic, which in the case of terminating traffic is received by the incoming international repeaters, the latter are switched, when required, to the type of Signalling, used for interworking with national repeaters. This has the following advantages:

- In a separate or combined international exchange incoming international repeaters—without connection of translating equipment *SNR*—can interwork with normal national 5-pole outgoing repeaters connected to 10- or 5-pole selector units.

- In a national 5-pole exchange incoming international repeaters of normal design can, when necessary, interwork with existing outgoing repeaters to the national network.

Different traffic situations with the signalling methods applied are shown in fig. 10.

New Register Arrangement, ANA 12

To further increase the flexibility of the system a new register arrangement *ANA 12* has been introduced.

Apart from the increase of the flexibility in respect of traffic routing, new facilities can easily be added. Examples are the use of different register signalling methods. Up to four types of code sender and five types of code receiver, working independently of one another, can thus be connected to the same exchange. When the need arises, therefore, a new signalling system can be introduced by adding new code senders and receivers.

Code senders and receivers contain all logic functions for the respective methods of signalling.

ANA 12 consists of a number of standardized relay sets which, in each

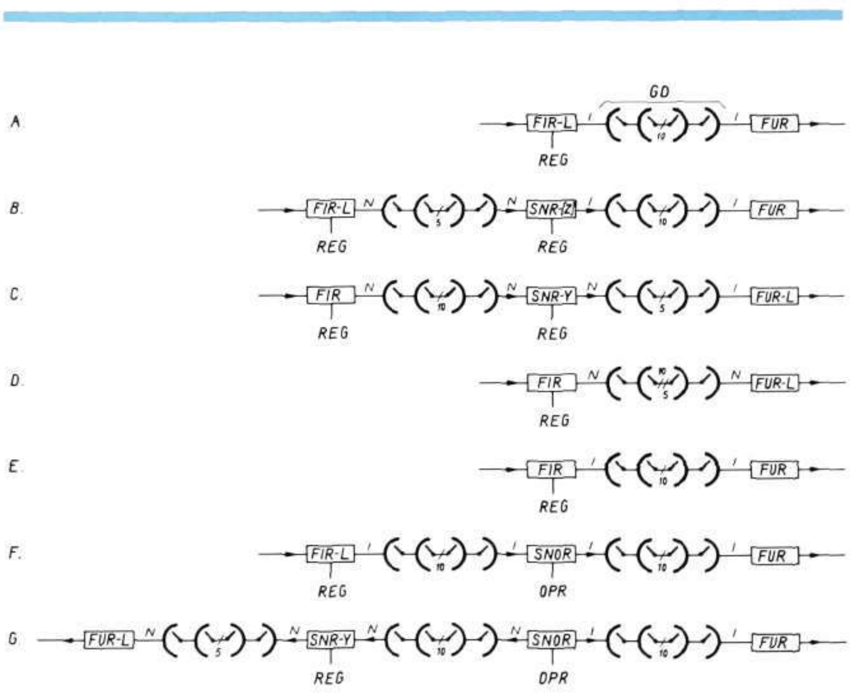


Fig. 10

Signalling methods through the selector stages

I	International signalling through the selector stages
N	National signalling through the selector stages
10	10-pole selector stage GDA, GDB
5	5-pole selector stage GDA, GDB
FIR-L	Incoming national line equipment
FUR-L	Outgoing national line equipment
FIR	Incoming international line equipment
FUR	Outgoing international line equipment
SNR-(Z)	Incoming line equipment with traffic from adjacent national transit exchange
SNR-Y	Outgoing line equipment with traffic to adjacent national transit exchange
SNOR	Operator's line equipment
OPR	Position equipment
REG	Register
GD	Two-way group selector stage

Traffic situations

A, B	Outgoing international traffic from home country
C	Incoming terminating international traffic. Separate international and national transit exchanges
D	Incoming terminating international traffic. Combined international and national transit exchange
E	International transit traffic
F	Outgoing international operator-controlled traffic from home country with demand working
G	Outgoing international operator-controlled traffic from home country for delay working. Separate international and national exchanges

particular case, can be combined as required. When the conditions change and new needs arise, new relay sets can be easily installed.

A coming number of Ericsson Review will contain a description of *ANA 12*.

Charging and Settlement of Accounts

Charging can be done either by multimetering or by toll ticketing.

With inband signalling and multimetering, the latter must be decentralized to the national transit centres, as the metering pulses would disturb speech. Equipment has been designed for this purpose and can be supplemented by a programmer. The latter can switch to different daily rates, and the number of rates and the time of switching can be determined according to the country of destination.

With another type of signalling, which permits the transmission of rate pulses, equipment for multimetering can be centralized at the international exchange. The same facilities as mentioned above for switching of rate are provided also in this case.

Toll ticketing equipment has for a long time been supplied by L M Ericsson. Equipment of normal design can also be used for international traffic and be placed either in the international centre or in the national transit centres. For the settlement of accounts for subscriber-dialled international and intercontinental transit calls the system is designed in accordance with CCITT recommendations.

Either toll ticketing equipment or a simple form of relay and selector equipment can be used for this purpose.

International Maintenance Centre

The new variant is adapted for connection to an international maintenance centre *(IMC)*. This will be further dealt with in a coming number of Ericsson Review.

Older Types of Exchanges

If the traffic handling capacity in an older type of international exchange (with 100-line groups) proves insufficient, *A* and *B* racks can be added by fairly simple means so as to attain the same traffic carrying capacity as for the new variant. If the ultimate capacity of the older exchange is insufficient, a change can be made from 100- to 200-line grouping, so increasing the capacity from 2,000 to 4,000 lines in *ARM 202/2* and from 4,000 to 8,000 lines in *ARM 202/4*.

If a new signalling system is to be introduced in an exchange of older type, this can also be done. As the best solution for this purpose must be decided from case to case, the question is not dealt with in this article.

Concluding Remarks

As will be apparent, the new variant is very flexible and can therefore meet every requirement placed on a modern international exchange. A few examples: the facility for connection of lines with different signalling systems, high traffic carrying capacity, high ultimate capacity, flexible network structure, flexible register arrangement, flexible charging method, settlement of accounts in accordance with CCITT recommendations, and facility for connection to international maintenance centre.

Exchanges Installed and on Order

As seen from the table below, 22 international and intercontinental exchanges *ARM 20*, with a total of 18,800 multiple positions, have been delivered or were on order at November 1, 1970. These exchanges are spread throughout the world.

Country/Town	CCITT signal system no.	Operators	Multiple positions	
			Delivered	On order
Antigua/Clare Hall	5, R.1	x	—	400
Australia/Guam	5	—	200	—
Australia/Sydney	5	—	1,300	—
Barbados/Bridgetown	5, R.1	—	—	300
Canada/Montreal	5	—	400	300
Canada/Vancouver	5	—	200	—
Czechoslovakia/Prague	1, 4	x	—	900
Denmark/Copenhagen	1, 4, 5	x	5,200	200
Finland/Helsinki	1, 4	x	300	—
Jamaica/Kingston	5, R.1	—	—	300
Lebanon/Beirut	4, 5	x	—	300
Malaysia/Kuala Lumpur	5	x	200	100
Netherlands/Rotterdam	1, 4	x	2,800	200
Netherlands Antilles/Curaçao	5	x	—	100
Philippines/Manila (PLDT)	5	x	400	—
Philippines/Manila (RCA)	5	x	—	200
Singapore	5	x	300	100
Trinidad/Port of Spain	5, R.1	—	—	400
Tunisia/Tunis	4, 5	x	—	600
USA/Hawaii	5	—	200	—
Venezuela/Caracas	5	x	600	400
Yugoslavia/Belgrade	1, 4	x	900	1,000

Radio Relay System ZRL 7500

R. JACOBSSON, TELEFONAKTIEBOLAGET L M ERICSSON, MÖLNDAL

UDC 621.396.65
LME 8521
85103

L M Ericsson has developed a radio relay system operating in the 7.5 GHz band. The system meets CCIR recommendations for long-distance circuits. It can transmit up to 960 telephone circuits or television with associated sound-program channel. The system design uses semiconductor techniques throughout. The first system has recently been put into operation on the Kokkola—Kannus route in Finland. The article deals with some of the main features of the system.

General

The *ZRL 7500* radio relay system (fig. 1) operates in the CCIR frequency band 7 125—7 725 MHz. The system has a flexible design which can be adapted in an economical manner for the transmission of different baseband signals.

When transmitting multiplex telephony signals of 120, 300, 600 or 960 circuits each radio-frequency (r.f.) channel can carry sub-baseband service channels for speech, supervisory and control signals.

When transmitting a television signal, black and white or colour, a superposed sound-program channel can be transmitted along with the television signal.

The designation *ZRL 7500-1* denotes the system variant transmitting up to 300 telephone circuits, the designation *ZRL 7500-3* referring to the variant having a higher transmission capacity.

The system design permits each of the above-mentioned transmission alternatives to be realized in an economical manner. It also simplifies expansion or conversion of a system, the same basic units being employed to constitute the three station types: terminal, baseband repeater and i.f. (heterodyne) repeater.

Basic Units

Fig. 2 shows a block diagram of a two-way terminal station. It comprises the basic units of which are made up all stations where the baseband signal is available. At i.f. repeaters the modulator and demodulator units are omitted.

In the modulator the level of the incoming baseband signal—multiplex telephony or television—is adjusted to the input level recommended by the CCIR. The baseband signal is then converted into a frequency-modulated i.f. signal with the 70 MHz centre frequency. To minimize the thermal noise contribution in a frequency-modulated system the baseband signal is first pre-emphasized in accordance with CCIR recommendations. In the case of television transmission the sound-program channel primarily frequency-modulates a 7.5 MHz subcarrier, which is added to the video signal. The modulator also provides for the injection of the continuity pilot which is transmitted along with

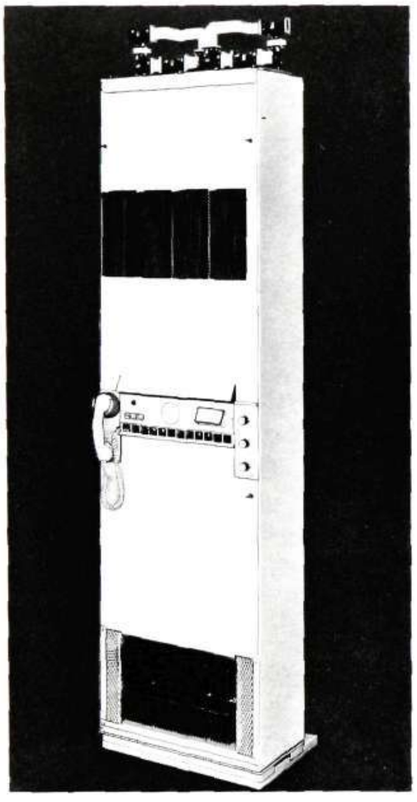


Fig. 1
ZRL 7500
Bay containing complete equipment for four two-way r.f. channels, including r.f. branching equipment, modulators/demodulators, service channel, local and remote supervision as well as protection-switching equipment

Fig. 2
Block diagram of two-way radio terminal

the baseband signal for supervision of the radio link and, where applicable, for protection-channel switching control.

In the transmitter the i.f. signal carrying the information is applied to the up-converter, where it is mixed with an i.f. local-oscillator signal which is 70 MHz below the r.f. output frequency. The service-channel band is added to the transmitter output signal by modulation of the local-oscillator signal. This is done to achieve uniformity of service-channel arrangements at terminals, baseband and i.f. repeaters, the latter having no modulator.

The r.f. branching equipment provides for the separation of transmitted and received r.f. signals in applications where a common antenna is used.

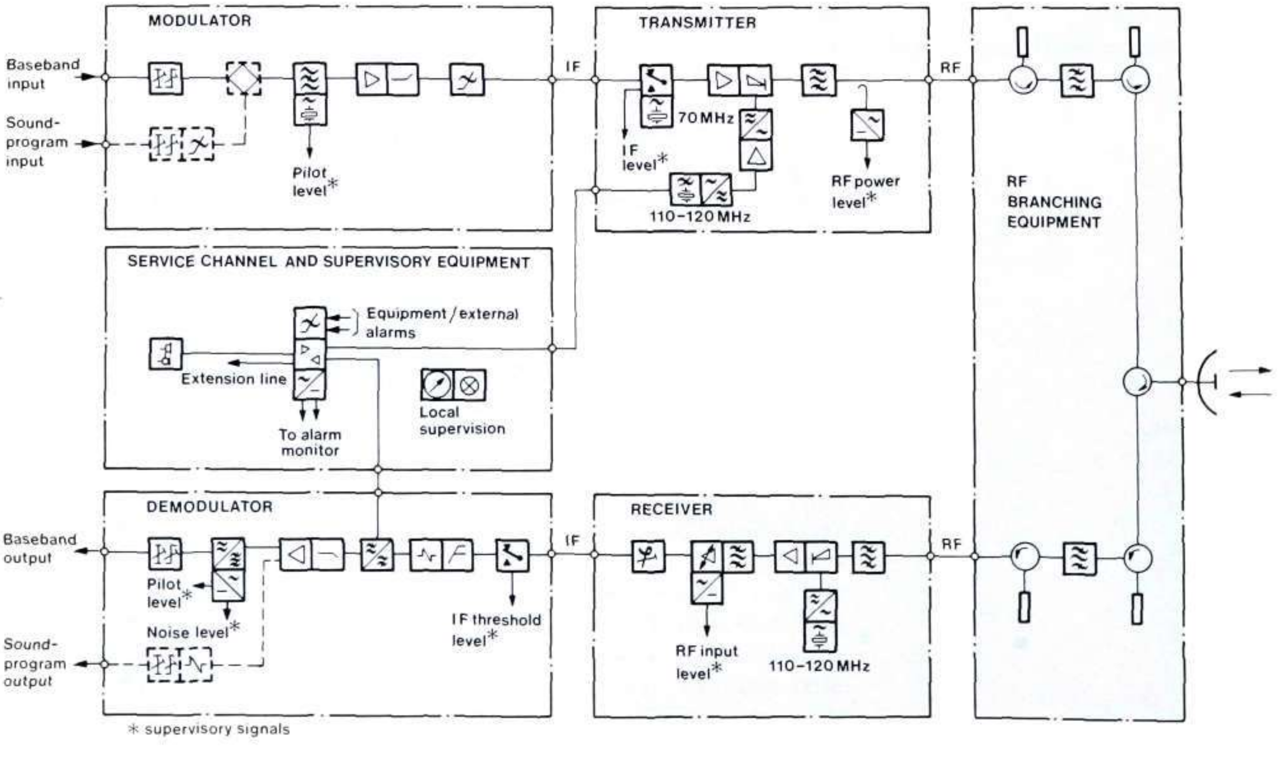
The received r.f. signal is fed via the branching equipment to the receiver. After filtering, the incoming r.f. signal is mixed with a local-oscillator signal which, like its counterpart in the transmitter, lies 70 MHz below the r.f. signal. The 70 MHz i.f. signal thus obtained is amplified in an a.g.c.-controlled amplifier. Group-delay variations, which essentially originate from the r.f. filters, are equalized before the signal is applied to the demodulator.

In the demodulator the baseband signal is recovered and de-emphasized. The service-channel traffic or the program channel is branched off and the baseband signal is applied to the output at the prescribed levels. A pilot/noise detector for supervisory and control function can be connected to the demodulator.

In addition to the above-mentioned basic units, the system comprises service-channel and supervisory facilities as well as a power supply and bay equipment.

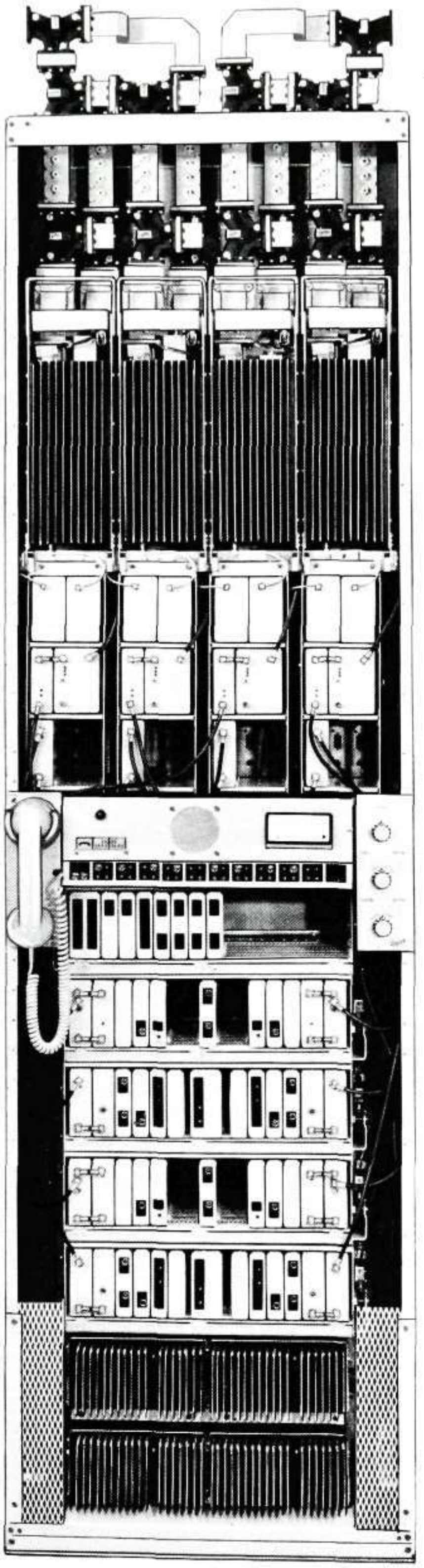
Modular Design

The system's adaptibility to different transmission capacities and station types is a result of the modular design employed. Each of the main constituent parts is a mechanical unit assembled from plug-in units having basic dimensions and module sizes corresponding with those of Ericsson's M4 construction practice for carrier telephone equipment.



This modular design philosophy has also been adopted for the r.f. units, which have been engineered in a construction practice suited to the high frequencies involved.

This construction practice, R4, is exemplified in fig. 3 showing a bay containing the equipment for four two-way channels. The bay, which is shown with the dust covers removed, is assembled on site by joining two side members



BASIC UNITS	HEAT DISSIPATION
RF Branching equipment	
Transceiver blocks	140 W
Transceiver shelves	132 W
Supervisory shelf	5 W
Service-channel shelf	8 W
Modulator shelf	22 W
Demodulator shelf	35 W
Modulator shelf	22 W
Demodulator shelf	35 W
Power packs	69 W
Power packs	63 W

Fig. 3
Terminal bay arrangement with four radio channels

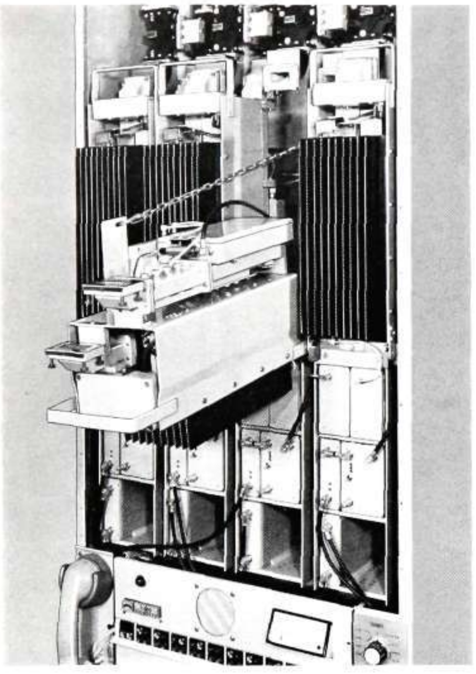


Fig. 4
Upper half of the bay with one transceiver assembly folded down

with top and bottom members with screwed fittings. The pre-fabricated bay cabling distributes power as well as test and alarm signals; however, this cabling does not carry signals in the transmission path.

At the bottom of the bay are four power packs, one for each radio channel. Certain sections of the bay equipment which are shared by two or more channels, e.g. the service-channel equipment, are powered from two power packs.

Modulator and demodulator shelves are placed alternately above the power shelves. In the bay arrangement shown in fig. 3 the four modulator units and four demodulator units have been combined into pairs, each pair occupying one shelf. This disposition is suitable for applications where two channels operate in a 1 + 1 baseband protection arrangement, e.g. on routes where severe fading conditions are encountered. For single-channel operating, 1 + 0, there is a shelf variant containing one modulator and one demodulator for one two-way channel. The same bay cabling is used in either case.

The service-channel shelf is placed above the modulator/demodulator shelves and comes in different versions for terminals and i.f. repeaters.

The supervisory shelf provides a maintenance strip including alarm lamps associated with the various sections of each channel set, as well as recorder outlets. The front cover of the shelf accommodates the bay alarm lamp as well as the push buttons for the service telephone. The built-in indicating instrument is arranged to give a standard scale deflection and its selector switches are mounted on a separate panel connected directly to the bay cabling. The supervisory shelf includes logic circuits for local and remote supervision. The shelf can be removed from its mounting position and disconnected without involving interruption to traffic.

In the upper half of the bay a vertical apparatus design is used for each channel set. The crystal oscillators for the transmit and receive local oscillator chains as well as the i.f. units associated with the modulators and demodulators are accommodated in the lower shelf. The other functional units making up the transmitter and receiver for one channel are assembled into a hinged block which can be folded down—see fig. 4. The branching equipment consisting of circulators, waveguide filters and waveguide connectors are easily accessible at the top of the bay.

All parts are accessible from the bay front, so that the bay can be installed against a wall or back to back.

Electrical Design

The radio relay system employs only silicon semiconductor devices as active components.

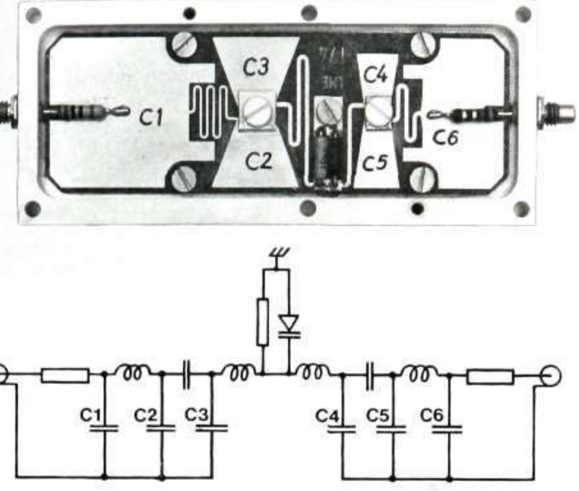
One of the substantial advantages of semiconductor devices is their modest power requirements. In radio relay systems a low primary-power consumption is frequently of vital importance, especially in the case of out-of-the-way station sites, where the installation and operating costs for the primary-power source may form a considerable part of the station cost. In addition, semiconductor techniques promote compactness of design with consequent savings in station space.

The predominant advantage of semiconductor devices, however, is their valuable contribution to the achievement of high reliability in the radio relay equipment. The concept of reliability does not merely mean that a system is free from component parts requiring more or less frequent replacement. Reliability in a wider sense implies that the system parameters are not degraded under the influence of environmental conditions and time.

The semiconductor devices as well as the passive components used in the system operate at loads lying well below their maximum permissible values (derating).

With regard to the compactness characterizing the construction practice employed when designing the *ZRL 7500* bay a great deal of attention has been given to thermal conditions. The system maintains its specified perform-

Fig. 5
Frequency doubler 470 to 940 MHz, in strip-line design



ance at ambient temperatures between −5 °C and +45 °C. As far as the components are concerned this means that even those semiconductor devices with the greatest dissipation have junction temperatures below 140 °C even at the maximum ambient temperature. From the point of view of reliability this must be considered a conservative limit. In this connection it should also be mentioned that the equipment requires no forced air cooling.

The apparatus design, using printed-board assemblies in shielding cases, contributes to reliability in that the functional units are protected from dust and mechanical damage.

The r.f. apparatus units of the system are engineered in the strip-line design. Fig. 5 illustrates this design with a frequency doubler which is included in the local oscillator chains of transmitter and receiver. Strip-line techniques are also employed in Ericsson constructions for military and space applications. These design techniques permit weight- and space-saving constructions to be accomplished, as appears from fig. 6, which shows the system's transmitter assembly.

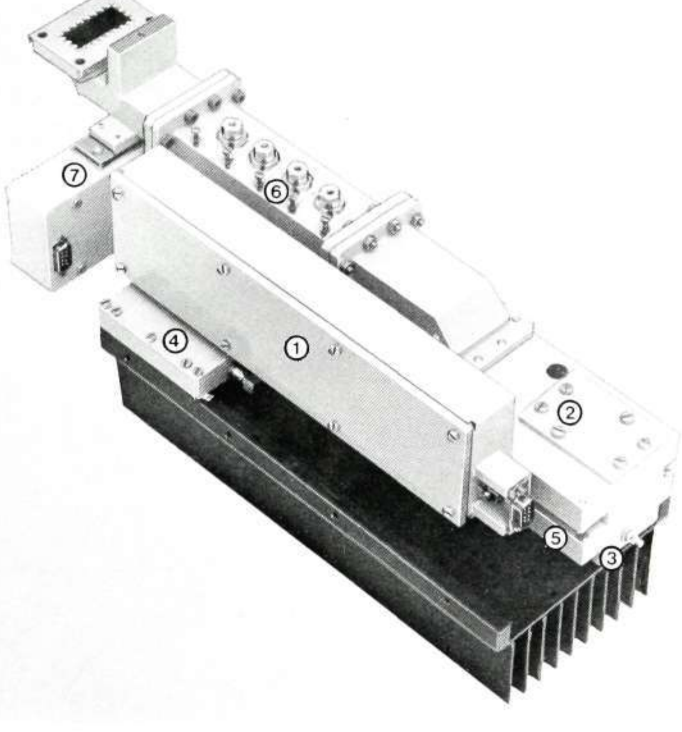
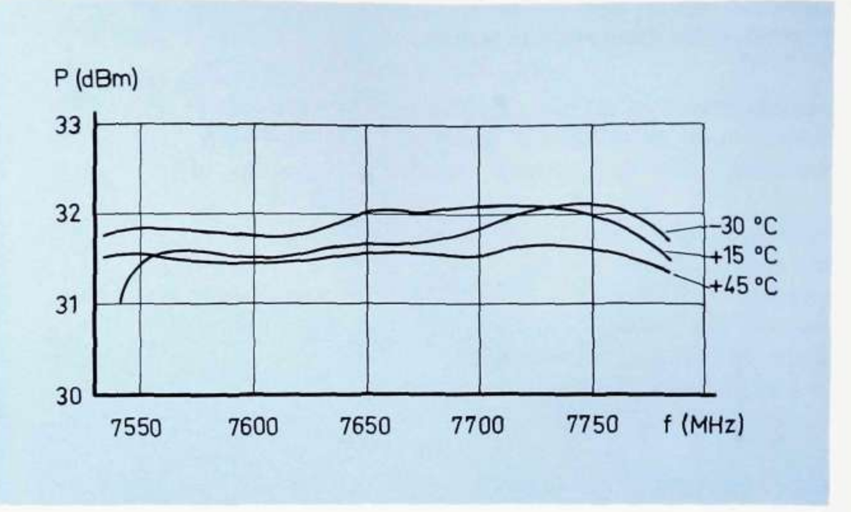


Fig. 6
ZRL 7500-1
Transmitter assembly

1. IF amplifier
2. Up-converter
3. Frequency multiplier x2
4. Power amplifier
5. Frequency multiplier x8
6. RF filter
7. Power measuring unit

Fig. 7
ZRL 7500-1
Output power from the transmit local oscillator chain as a function of the bay's ambient temperature. The oscillator chain covers the 7575-7725 MHz frequency band



In radio relay systems reliability considerations are the primary motive for introducing strip-line technique.

The use of this technique and a filter design appropriate for this technique permits wideband designs to be achieved, thus obviating mechanical constructions that might jeopardize the stability of the apparatus units. This is illustrated in fig. 7, which shows that the output power from the transmit local oscillator chain varies by less than 1 dB when the bay's ambient temperature fluctuates between −30°C and +45°C. The units constituting the local oscillator chain are wideband. They can be connected to different crystal oscillators for channel frequencies in the 7 575—7 725 MHz band without re-tuning. An additional advantage of this wideband design is that the number of spares variants can be kept down.

Long-term stability of the transmit and receive local oscillator chains is ensured by crystal oscillators using crystal units inclosed in an oven. The transmit oscillator arrangement includes modulation circuits for the service channel, but otherwise the basic oscillators in the transmit and receive paths are identical. Measurements (fig. 8) carried out over a period of more than a year show that frequency stability is maintained within the tolerance limits with ample margins.

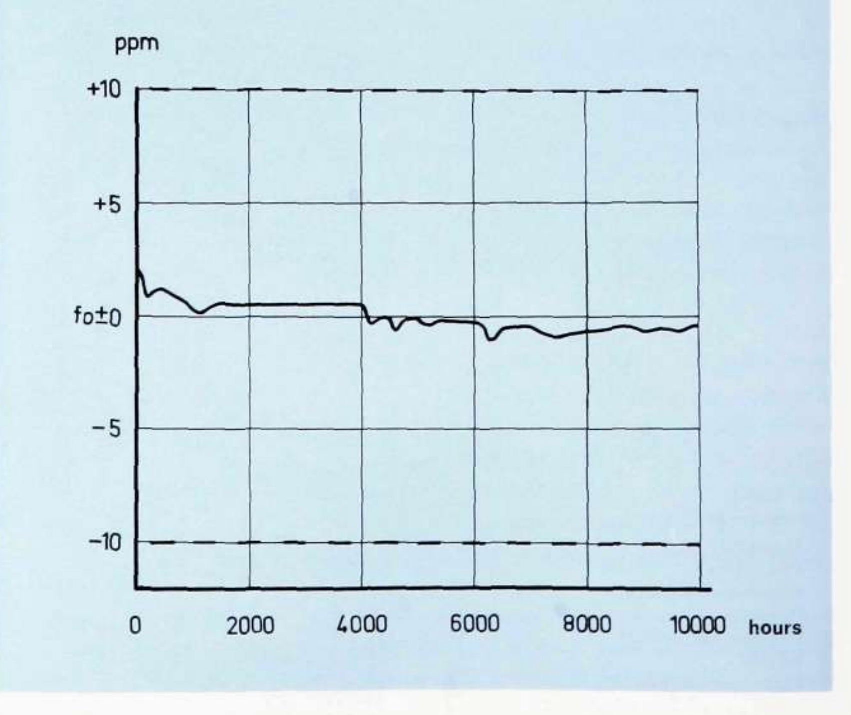


Fig. 8
ZRL 7500
Local-oscillator frequency stability. The discontinuities correspond to short-duration power failures

Noise Performance

An essential part of the CCIR recommendations for long-distance circuits is concerned with the maximum allowable noise contribution from the transmission equipment.

The noise contribution from the radio relay system can be divided into thermal receiver noise, basic noise, intermodulation noise and interference noise.

A high transmitter output power and a low receiver noise factor, i.e. a high system value, as well as low attenuation in the branching equipment are the qualities that give the *ZRL 7500* radio relay system its low thermal noise. Other parameters that influence the thermal noise in a complete radio relay link are hop length, antenna size and antenna feeder length. The high system value offers the user great liberty in the choice of these parameters and facilitates economical station siting.

The basic noise in the radio equipment bay is mainly produced by the modulator/demodulator units and the local oscillator chains in transmitter and receiver. Since in long-haul applications using i.f. repeaters the number of transmitters and receivers exceeds that of modulators and demodulators, it is essential that the basic noise contributed by the local oscillator chains should be as low as possible. The *ZRL 7500* employs crystal oscillators designed specially for low noise. The frequency of oscillation lies within the 110—120 MHz range, which means that a frequency multiplication by 64 is required to obtain the r.f. output frequency of the local oscillator chain. The *ZRL 7500-3* employs a continuously adjustable narrow-band filter in the local oscillator chain in order to ensure a low noise contribution even at high modulation frequencies.

Intermodulation noise is caused by amplitude and phase nonlinearities in the transmission path and increases with load. Wideband limiters, high return loss in conjunction with controlled group delay characteristics give the

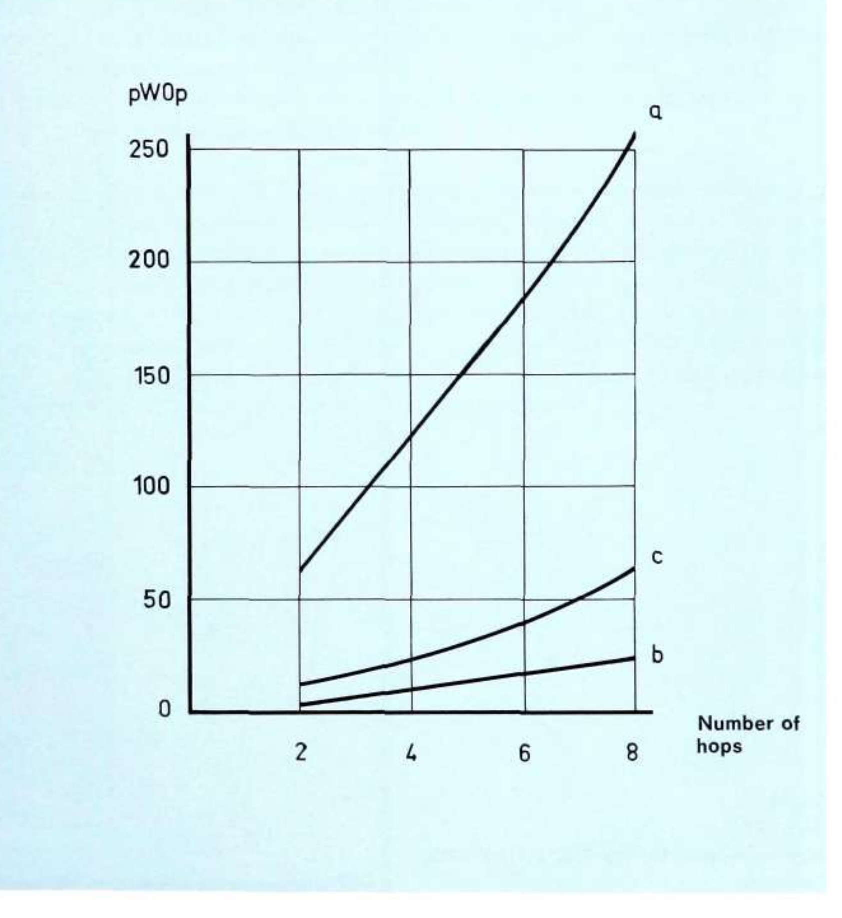


Fig. 9
ZRL 7500-1
Multi-hop link using i.f. repeaters. Noise contribution in 1 248 kHz measuring slot

a. Basic noise and thermal receiver noise; r.f. input level -40 dBm.
b. Intermodulation noise in 300-cct system at nominal load, +9.8 dBm0, busy hour.
c. Intermodulation noise at 5 dB excess white-noise load, +14.8 dBm0.

ZRL 7500 its very low intermodulation figure. Another feature conducive to low intermodulation distortion is a continuously adjustable electronic group-delay equalizer following the receiver i.f. amplifier.

Finally, interference noise is suppressed by the selectivity of the r.f. and i.f. filters and, with the channel arrangement employed, is usually quite negligible.

A quantitative summary of the system's noise performance is given in fig. 9. It shows the results from measurements made on an eight-hop link using i.f. repeaters. These measurements were made in a laboratory where the bays had been interconnected by means of attenuators. The path loss corresponds to hop lengths of 47 km, 3 m parabolic antennæ and 100 m antenna waveguides per hop. For six hops the CCIR allows 840 pW0p. This requirement is met by the *ZRL 7500* system even at 6 dB fading per hop. It should also be observed that intermodulation is low even at 5 dB excess level.

Maintenance

High reliability and the modular design using interchangeable units of the plug-in type conduce to low maintenance costs.

Maintenance tests during routine station visits can largely be carried out using the bay's built-in indicating instrument, whose test points are shown in fig. 10. For each of the four r.f. channels there are seventeen level test points which can be checked with the instrument. The test points are decoupled from the transmission path. In addition, test points correspondingly protected against short circuits and designed for tests by means of external selective test equipment are located on the front side of the functional units incorporated in the modulator and demodulator assemblies.

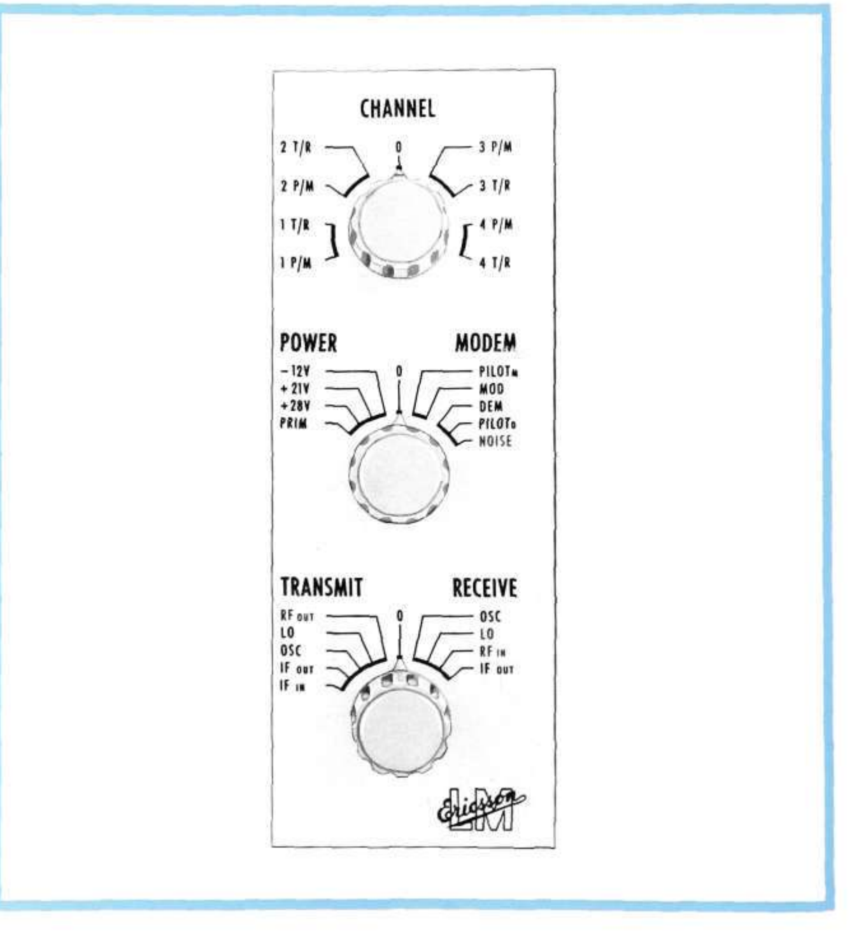
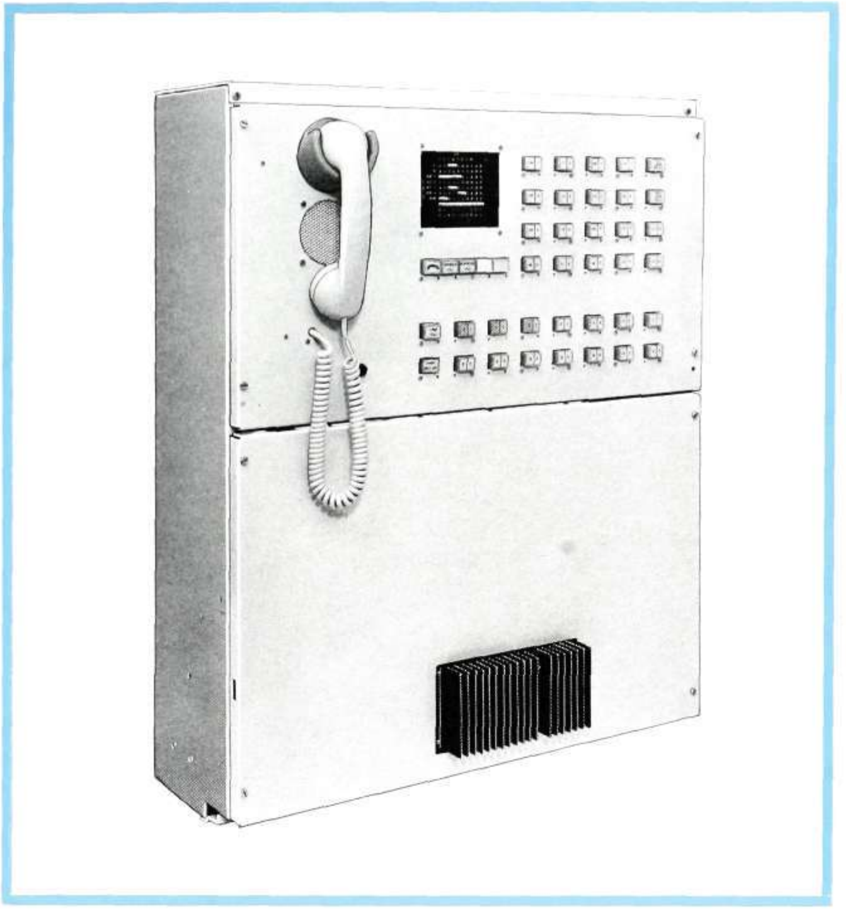


Fig. 10
ZRL 7500
Selector switches for the built-in indicating instrument

Fig. 11
ZRZ 10-01
Remote control and supervisory equipment for radio relay systems. Supervisory cabinet for control stations



The alarm system built into the radio equipment bay responds to deviations from preset tolerance limits, ten alarm points being provided for each r.f. channel. Local alarm indication is provided by the bay alarm lamp. In addition, the front panel of the supervisory shelf includes lamps indicating the operating conditions of each r.f. channel's five basic units: modulator, transmitter, receiver, demodulator and power pack.

Each radio equipment bay has mounting space for remote alarm transmitters. Alarm information is transmitted in the form of frequency-modulated v.f. telegrams in the service-channel band, where each bay included in the radio link has its own frequency. To each alarm transmitter can be connected 40 alarm points, 15 of which can be used for external alarms, e.g. burglar alarm, failure of aircraft warning beacons on masts, etc. The remote control and supervisory equipment for a control station is housed in a cabinet engineered in the M4 construction practice as shown in fig. 11.

TECHNICAL DATA

	ZRL 7500-1 TELEPHONY, 300 ccts	ZRL 7500-3		
		TELEPHONY, 960 ccts	TELEVISION + SOUND	
General				
Radio frequency range	7125-7425/7425-7725 MHz	7125-7425/7425-7725 MHz		
Channel arrangement	CCIR Rec. 385	CCIR Rec. 385 or 386-1		
Type of modulation	frequency modulation (FM)	frequency modulation (FM)		
Frequency deviation	200 kHz r.m.s.	200 kHz r.m.s.	8 MHz p-p	
Pre-emphasis	CCIR Rec. 275-1	CCIR Rec. 275-1	CCIR Rec. 405	
Type of repeater	IF or baseband	IF or baseband		
System value	≥ 145	≥ 139	≥ 148	
Bay capacity	4 two-way r.f. channel sets	4 two-way r.f. channels sets		
Baseband Data			VIDEO	SOUND
Frequency range	60-1364 kHz	60-4287 kHz	10 Hz-6 MHz	30 Hz - 15 kHz
Impedance	75 Ω unbal.	75 Ω unbal.	75 Ω unbal.	600 Ω bal.
Input level	≥ -42 dBr	≥ -45 dBr	≥ 0.7 V p-p	≥ +9 dBr
Output level	≤ -18 dBr	≤ -20 dBr	≤ 1.4 V p-p	≤ +15 dBr
Level adjustment range	15 dB	15 dB	15 dB	±3 dB
Continuity pilot	1499 kHz	4715 or 8500 kHz	8500 or 9023 kHz	
Subcarrier	—	—	—	7500 kHz
Transmitter				
IF centre frequency	70 MHz	70 MHz	70 MHz	
Output power	+25 dBm	+28 dBm	+28 dBm	
Frequency stability	better than 10^{-5}	better than 10^{-5}	better than 10^{-5}	
Receiver				
Noise figure	≤ 9.5 dB	≤ 8.5 dB	≤ 8.5 dB	
Freq. stability local osc.	better than 10^{-5}	better than 10^{-5}	better than 10^{-5}	
AGC range	50 dB	45 dB	45 dB	
IF centre frequency	70 MHz	70 MHz	70 MHz	
Antenna and Branching Equip.				
VSWR, bay input/output	< 1.08	< 1.08	< 1.08	
Number of T/R on common antenna	3-4	3	3	
Protection Arrangements				
Baseband switching	combiner/switch	combiner/switch	—	
IF switching	—	single- or multi-line switching		
Switching criteria	pilot and noise level	pilot and noise level		
Service Channels				
Omnibus voice circuit	0.3-3.4 kHz	0.3-3.4 kHz		
Supervisory circuit	4.6-6.4 kHz	4.6-6.4 kHz		
Control circuit	—	8.6-11.7 kHz		
Express voice circuit	—	12.6-15.7 kHz		
Power Supply				
Voltage	-24 or -48 V +20 %, -15 %	-24 or -48 V +20 %, -15 %	-24 or -48 V +20 %, -15 %	
Power consumption				
Terminal, single two-way chan.	125 W	135 W	135 W	
Same incl. service channels	140 W	150 W	150 W	
Environmental Conditions				
Ambient temperature				
With specified performance	-5 to +45°C	-5 to +45°C	-5 to +45°C	
Operating	-25 to +55°C	-25 to +55°C	-25 to +55°C	
Cooling	no forced air cooling	no forced air cooling	no forced air cooling	
Humidity	95 %	95 %	95 %	
Dimensions				
Bay proper	2140×598×313 mm	2140×598×313 mm	2140×598×313 mm	
Bay incl. branching equipment	2350×598×313 mm	2350×598×313 mm	2350×598×313 mm	
Weight				
Fully equipped bay (4 sets)	255 kg	265 kg	265 kg	

35-Watt Mixer Amplifier from L M Ericsson Telemateriel AB

B. MAGNUSSON, L M ERICSSON TELEMATERIEL AB, STOCKHOLM-TYRESÖ

UDC 621.375.4
LME 7524

With the mixer amplifier ZGA 311 L M Ericsson Telemateriel AB introduces a fully transistorized voice frequency 35 W amplifier for use within industry, schools, small hotels, hospitals and public address systems.

The amplifier is made in two types—with and without built-in FM radio—and with, in each case, a relay for connection of a separate public address microphone. With this microphone a programme can be temporarily interrupted for issue of a public announcement. The amplifier fulfils in every respect the requirements of class 1 of the Swedish National Committee of the International Electrotechnical Commission (SEN) standards.

Mechanical Design

The amplifier is built up on a separate chassis and is of robust construction with aluminium alloy sides. The sides are black enamelled and the front panel, upper and lower cover plates grey enamelled. In the cover plates there are rows of rectangular holes for cooling of the power transistors by air flow (Fig. 1). The upper cover plate is bent so as to constitute also the rear panel of the amplifier. On the rear panel there are symbols showing the connections for the various programme sources and, beside these symbols, the characteristic data of the various inputs (Fig. 2). The lower cover plate has rubber studs to permit stacking of amplifiers one on the other. The front panel is marked with international symbols for identification of switches, keys and volume and tone control (Fig. 3).

On the front panel there are push-buttons for selection of programme and sliding potentiometers for adjustment of volume and tone control, so that the emplifier is very easily operated. For control of the output level the amplifier has a volume unit (VU) meter. In the mains switch there is a built-in neon lamp for indicating that the amplifier is switched on.

Electrical Design

Both from mechanical and electrical points of view the amplifier may be divided into a preamplifier, driver stage and power stage (Fig. 4).

Preamplifier

The preamplifier, like the driver stage, is made up on a printed circuit board, which permits mechanical fitting and soldering of the components and eliminates the risk of faulty connections.

Fig. 1
Mixer amplifier ZGA 311, viewed from front

Connectors and microphone transformers are also placed directly on the printed circuit board, so that all connections from input connector up to the power transistors are in the form of printed circuits with the exception of the circuit between the preamplifier board and driver stage.

The output voltage of the preamplifier is limited by a limiter circuit which enters into operation when the output voltage reaches 1.2 V (the voltage for full power output) and therefore causes no change in the amplifier dynamics. This circuit thus constitutes an effective protection against overdriving of the amplifier

Driver Stage

Apart from the supplementary pair of transistors which drive the output stage transistors, the driver stage contains transistor circuits which protect the power transistors against temperature-dependent changes of the emitter currents, and a circuit which controls the balancing of the current through the power transistors.

For protection against overloading of the power transistors there is a transistor circuit which, at a given maximum current (e.g. on shortcircuiting of the secondary winding of the output transformer), cuts off the driver stage and thus limits the current in the power stage.

Fig. 2 (left)
ZGA 311, rear

Fig. 3 (right)
ZGA 311—front panel with symbols

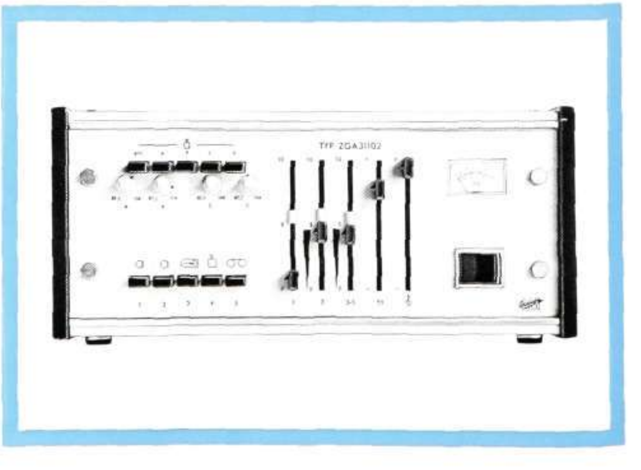
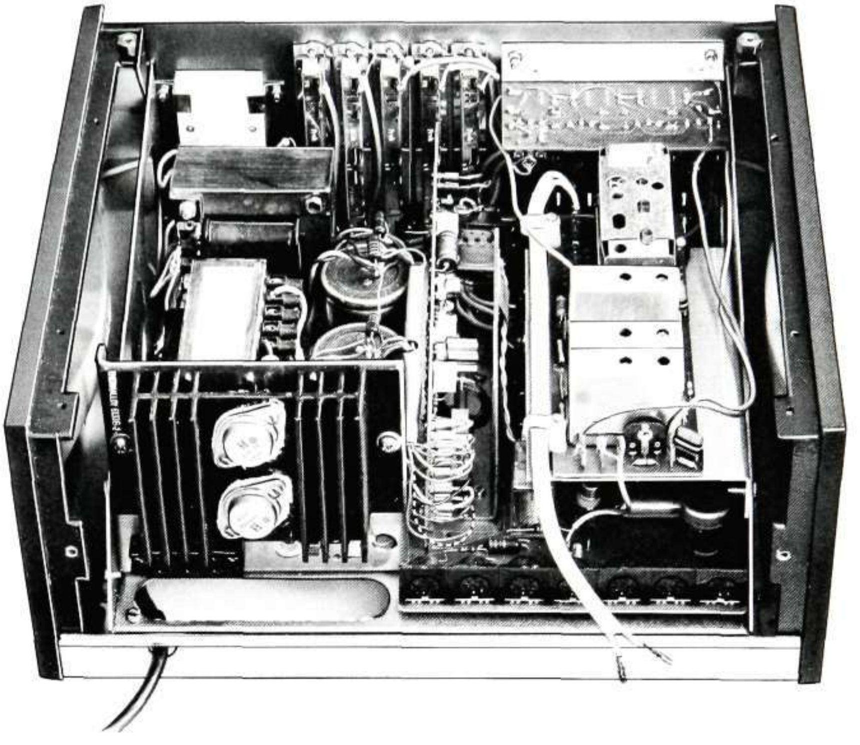


Fig. 4
ZGA 311 with cover plate removed



To protect the power transistors of the amplifier during no-load operation, among other purposes, the amplifier has a high negative feedback which varies with the load. An unloaded output consequently signifies maximal negative feedback and thus protection against overloading of the power transistors.

Power Stage

The power stage consists of two series-connected power transistors in single-ended push-pull connection with the emitter/collector junction connected to the primary side of the output transformer via a 5000 μF capacitor. From this feed point the driver stage is also given its negative feedback, the purpose of which is to reduce the distortion and make the output voltage independent of changes of load.

The power transistors are fed with signal voltages, opposed in phase, from the complementary pair of transistors in the driver stage.

Power Supply

The amplifier has a mains transformer with tappings for 110, 120, 220 and 240 V (50—60 Hz), a silicon rectifier and stabilizing circuits.

The amplifier output and driver stages are fed with +32 and −32 V (to earth). Preamplifier and FM unit are fed with +12 V (tapped from +32 V), which is stabilized by a series transistor and zener diode.

The mains transformer is protected by a thermal fuse, which is also the sole fuse in the amplifier apart from the tubular wire fuse protecting the 32 V circuit to the output connector of the amplifier.

Built-in FM Radio

One type of the amplifier has a built-in FM radio with frequency range 87.5-104 MHz. The radio unit is a tuner and consists of a HF section (tuning), intermediate frequency section 10.7 MHz and ratio detector. From the ratio detector the low frequency signal is switched to the radio input of the amplifier. The radio is tuned to the transmitters by means of capacitance diodes. By varying a DC voltage across the diodes the capacitance is changed, and thus the resonant frequency in the diode circuit.

The HF and mixer stages contain two field effect transistors (FET) which ensure low cross modulation and low noise. The aerial circuit is tuned by a capacitance diode, which ensures high selectivity in relation to adjacent frequencies and low oscillator radiation.

On the front of the amplifier there are knobs for tuning of four stations, which are connected with push-buttons placed above the tuning knobs. To ensure reliable tuning irrespective of frequency deviations in the local oscillator of the radio there is automatic frequency control (AFC). The AFC consists of a voltage generated in the ratio detector of the receiver and is positive or negative depending on the deviation of the local oscillator from resonant frequency. The frequency deviations have now been converted to voltage variations, and the voltages can be fed to the capacitance diodes and thus reset the local oscillator to the correct frequency.

Inputs

The amplifier has inputs for two microphones, radio, gramophone and tape recorder, and line input (Fig. 5). All inputs have DIN standard connectors.

The microphone inputs are connected direct to the microphone transformers and are designed for 200-ohm microphones. The microphone inputs have separate preamplifiers with separate volume controls, which permits mixing.

Fig. 5
Block schematic of ZGA 311

1, 2 Microphone inputs
3 Gramophone input
4 Radio input
5 Tape recorder input
6 Line output
7 Line input with public address relay
8 Loudspeaker output

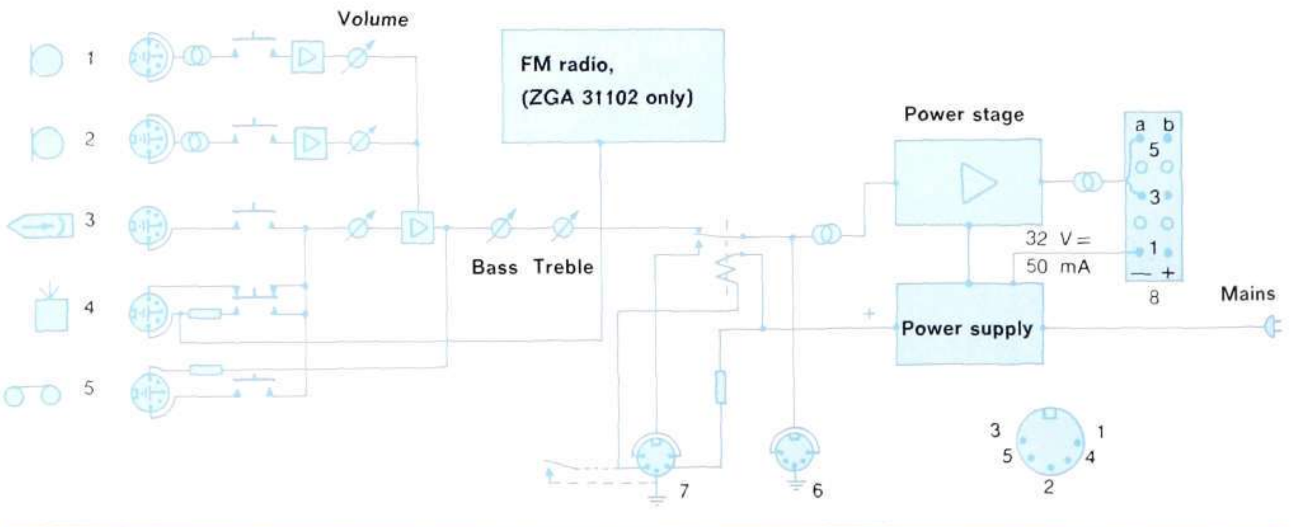
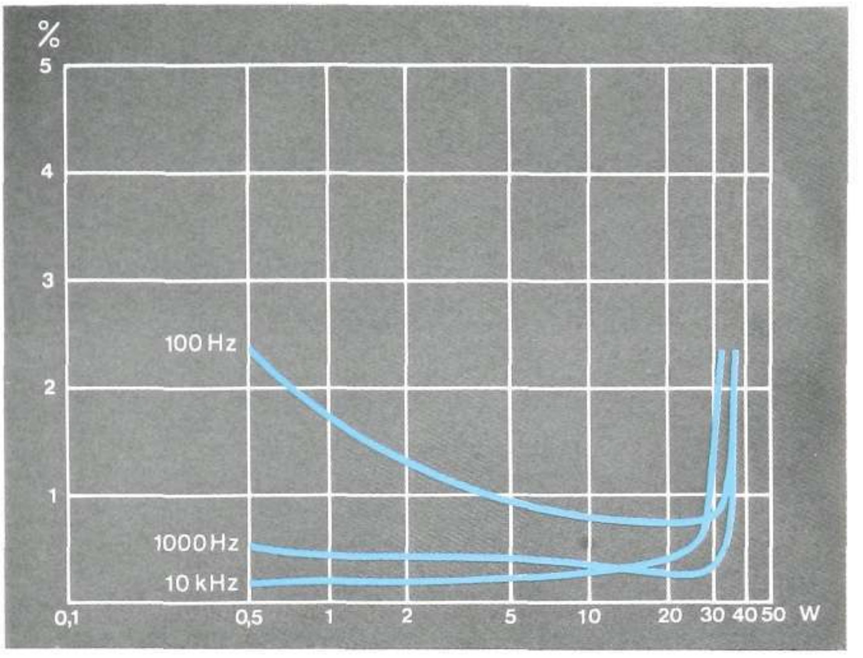


Fig. 6
Distortion curve



The other inputs, except the line inputs, have a common preamplifier and volume control. This means that *one* of these programme sources can be mixed with the two microphone inputs.

The 1.2 V/600-ohm line input is directly connected to the power stage via a public address relay. The relay is operated from the same input by short-circuiting of terminals 2 and 5. This means that, on operation of the relay, this input has priority over other inputs and is therefore especially well suited for the issue of announcements. Terminal 4 has voltage for feed of a microphone with built-in preamplifier (1.2 V/600 ohms).

Outputs

The amplifier has low as well as high impedance loudspeaker outputs. The output transformer has four secondary windings. Parallel connection of two of these windings gives an impedance of 4 ohms, and series connection 16 ohms.

The two other windings form the high impedance output. Parallel connection gives 50 V/70 ohms output and series connection 100 V/285 ohms. The amplifier is delivered wired for 4 ohms and 50 V.

For connection of an extra power stage the amplifier has a 1.2 V/600 ohms line output.

Interconnection of the line outputs in two separate amplifiers allows parallel connection. The output connector has ±32 V/50 mA for relay operation and similar purposes.

Electrical Data

The output power is 35 W sinusoidal (continuous operation) with less than 2.5 % harmonics (distortion) within the frequency range 50-15,000 Hz. Measurements have been made at frequencies of 100, 1,000 and 10,000 Hz and load of 70 ohms on the 50 V output (Fig. 6). The reduction of the distortion with rising output power, especially at low frequencies, is due to the simultaneous rise of the negative feedback.

With the aid of the tone controls the frequency response can be made flat from 20 to 20,000 Hz with deviation ±1.5 dB.

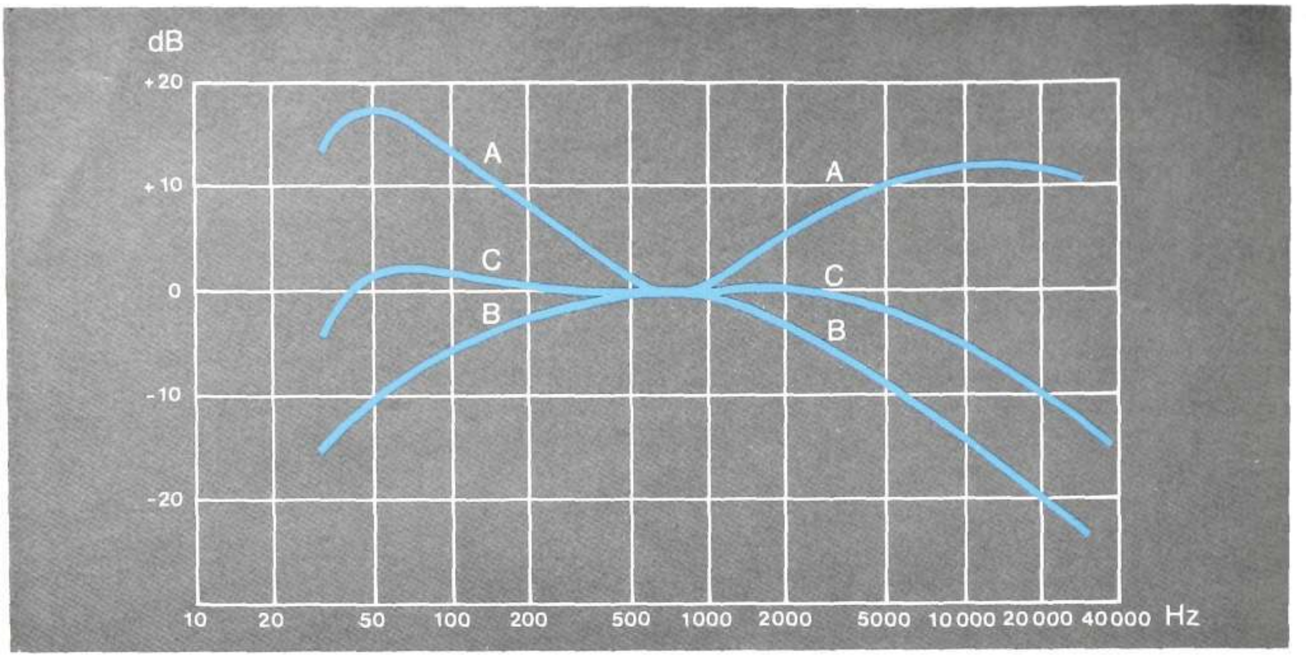


Fig. 7
Frequency response for radio input
Effect of bass and treble controls
A Maximum
B Minimum
C *Mid-position*
0 dB = 10 V output voltage

Fig. 7, curve C, shows the frequency response with the tone controls in mid-position, and curves A and B the effect of the tone controls on the frequency.

With short-circuited input the noise signal for microphone and gramophone is 60 dB and for the radio and tape recorder inputs 65 dB below the max. useful signal. All measurements are "unweighted", which means that they are linear and that no correction has been made for the physiological characteristics of the ear.

Other technical data are presented below.

ZGA 31101

Dimensions	145×325×290 mm (height×width×depth)
Power	35 W (sinusoidal)
Outputs	Loudspeaker, 50 V/70 ohms, 100 V/285 ohms and 4 and 16 ohms. Line, 1.2 V/600 ohms, symmetric
Frequency range	20—20,000 Hz ±1.5 dB
Distortion	<2 % (50—15,000 Hz)
Noise level	-60 dB (microphone input)
Tone control	Bass $^{+15}_{-10}$ dB at 50 Hz Treble $^{+11}_{-15}$ dB at 10,000 Hz
Inputs	Mike, 0.2 mV/200 ohms, symmetric Gram., dynamic, 5 mV/5 kohms Gram., crystal 0.5 V/500 kohms Radio, 50 mV/100 kohms Tape, recording, 10 mV/100 kohms Tape, playback, 50 mV/100 kohms Line, 1.2 V/600 ohms, symmetric, and ±32 V for feed of microphone preamplifier and control of built-in public address relay
Mains voltage	110, 120, 220 and 240 V, 50 Hz
Max. power consumption	60 VA
Weight	9.2 kg

ZGA 31102

Built-in FM radio with AFC	
Frequency range	87.5—104 MHz
Other data	As for ZGA 31101
Weight	9.5 kg

Applications

Thanks to its well devised construction the amplifier can be used within the most differing fields. Industry, schools, hospitals, small hotels and public address systems have already been mentioned as typical.

Within industry the amplifier with radio can be used for "music while you work" and at the same time, with the aid of the public address relay, provides a simple and cheap public address system.

In schools the amplifier can be used in several contexts. In auditoria and music rooms its mixing facilities are highly appreciated. The two microphone inputs can be used, for example, by the school choir with music tape-recorded on the third mixable input. These mixing facilities have proved well to cover the needs of schools.

Large gymnasia are often divisible into two sections by a folding partition. For such purposes an individual amplifier is required per section; when the entire gymnasium is used, the two amplifiers can be connected in parallel and operated from one of the amplifier positions. Fig. 8 shows how this problem can be solved with two standard switches and without external relays.

The amplifier has proved especially suitable for hospitals, where, owing to the risk of disturbances from electronically transmitted medical measurements, the level at which transmission of telecommunication signals may take place has been limited to max. 14 V. At full power one of the loudspeaker outputs carries max. 12 V and thus fulfils the requirements posed. This signal voltage can be connected directly to pillow-speakers without an intermediate transformer. The distribution to the higher power loudspeakers in day-rooms and the like is done at zero level, 1.2 V/600 ohms. These loudspeakers are provided with built-in 1—5 W amplifiers to permit the low power transmission.

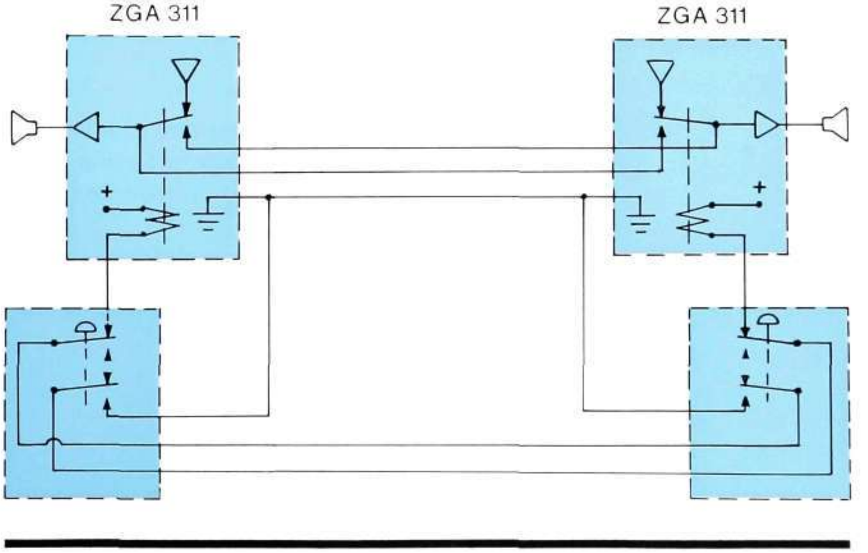


Fig. 8
Circuit diagram showing equipment for gymnasium divided into two sections

Fig. 9

Block schematic of sound distribution system for hospitals etc.

① To central aerial
② To bed panel
③ For loudspeakers in day-rooms and the like
④ Central programme for internal studio
⑤ Microphone for announcements
⑥ Local programme

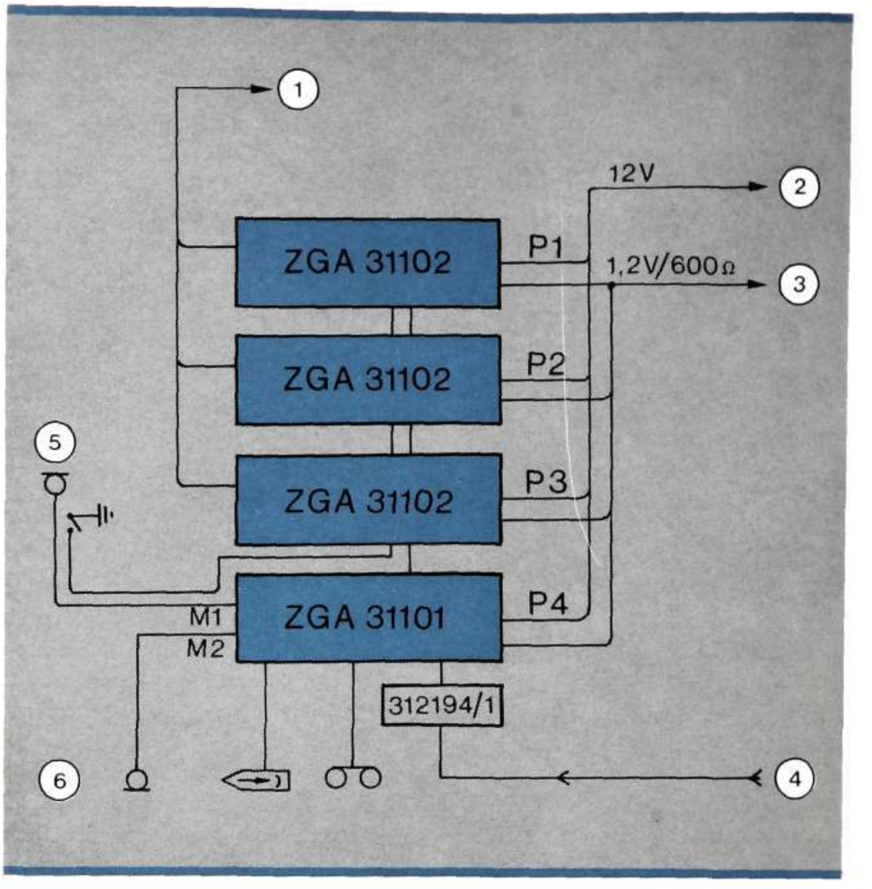


Fig. 9 shows a sound distribution system for hospitals, in which three amplifiers *with* radio and one *without* radio are placed on each floor for serving the general wards. Amplifiers P1, P2 and P3 are used for three radio programmes and amplifier P4 for locally produced programmes. One of the programme sources—microphone, gramophone, tape recorder—or a programme produced from the hospital studio can be connected to amplifier P4. For announcements within the wards there is a microphone connected to P4. When this microphone is switched on, the public address relay in amplifiers P1, P2 and P3 interrupts the programme in progress and the announcement is delivered on all programme channels.

ZGA 311 is characterized by flexibility and combination facilities. The mixing facility means that the amplifier can be used in simple mixer desks—parallel connection of the line outputs of two amplifiers gives six mixable inputs.

Three amplifiers with built-in FM radio receivers provide a complete central unit for sound radio programmes, and with two amplifiers stereo programmes can be distributed in music rooms and the like.

ERICSSON News

from All Quarters of the World

120,000 New Subscriber Lines for Bogotá and Medellín

L M Ericsson has received from the telephone administrations of the two largest cities in Colombia—Bogotá and Medellín—orders for equipment for telephone exchanges to a total value of 60 Mkr, covering more than 120,000 subscriber lines.

In keen competition with American and Japanese manufacturers LME was awarded a contract by the Bogotá Telephone Administration, Empresa de Teléfonos de Bogotá (ETB), for the delivery of 12 new telephone exchanges and equipment for extension of another 10 exchanges for local traffic. The Bogotá telephone network will thereby be extended by 92,200 subscriber lines.

The contract, which includes the right of option to switching equipment for an additional 51,400 subscriber lines, covers also four new local transit exchanges and equipment for interworking between LME exchanges of different systems.

Colombian technicians employed at the Ericsson subsidiary, Ericsson de Colombia S.A. (EDC), will install the equipment. Some thirty Colombian engineers from ETB will receive special training at L M Ericsson's International Training Centre in Stockholm during a period of about one year in order later to be able to handle the maintenance of the new equipment.

The Medellín Telephone Administration, Empresas Públicas de Medellín, has ordered equipment for the extension of 12 telephone exchanges by, in all, an additional 28,200 subscriber lines. It is planned that the equipment shall be installed by 1973.

Of some 700,000 lines installed or on contract for the whole of Colombia, L M Ericsson is the supplier of around 540,000 lines.

The Ericsson Group has sold telephone exchanges and other telecommunication equipments to Colombia since 1932. In 1943 a subsidiary company, Ericsson de Colombia S.A., was formed, which is responsible for sales within the country. Another member of the Ericsson Group is the cable manufacturing company, Fábricas Colombianas de Materiales Eléctricos Facomec S.A.

From the signing of the contract between LME and ETB for 92,200 subscriber lines and four tandem exchanges for Bogotá. (From left) Antonio Diaz, Colombian Minister of Communications, Valdemar Henriksson, President of EDC, Miguel Mejia Borda, President of ETB, and Alvaro Camargo, Financial Director of ETB.

Contract with Singapore for more than 200 Million Kronor

The Singapore Telephone Board (STB) has decided to introduce L M Ericsson's crossbar system for extension of its public telephone exchanges during the seventies.

A contract has therefore been signed between STB and a newly formed local company, Telephone Industries of Singapore Private Ltd. (TIS), which is owned jointly by STB and LME. The contract covers the delivery of equipments from TIS, made on licence from LME, to a value of more than 200 million kronor during the coming ten-year period.

The factory being built for this purpose is expected to be completed by the beginning of 1972 and will turn out automatic equipments for public and private branch exchanges, and also telephone sets.

Since 1964 LME has delivered 11 telephone exchanges for altogether 121,000 lines to STB, and the recent agreement may therefore be regarded as a broadening of the existing relations.

Swedish Telecommunications Administration Orders Another Computer-Controlled Telephone Exchange

From the Swedish Telecommunications Administration L M Ericsson has received an order for an additional large trunk exchange. The exchange will be situated in Gothenburg and built in accordance with L M Ericsson's modern computer-controlled system with code switches. Two large exchanges of the same type for the Stockholm area were ordered at the beginning of the year.

The amount of the order is around 17 million kronor.

(Cont.)

The exchange, which will be opened during the second half of 1974, will carry trunk traffic to and from certain local exchanges within the Gothenburg area and will serve as transit exchange for traffic via Gothenburg. It will interwork with and supplement the present Gothenburg trunk exchange, which is expected to have attained its full capacity within the next few years.

Third Large Order from Saudi Arabia

L M Ericsson has received a new order from Saudi Arabia covering automatic telephone exchanges, line plant, cable and telephone sets. The amount of the order exceeds 37.5 million kronor and the equipment is intended entirely for extension of the telephone network in the capital city of Riyad.

This is the third large order received by L M Ericsson from Saudi Arabia. The company has 76,600 lines in operation or under installation in the country, the Telephone Administration of which has standardized its equipment in accordance with L M Ericsson's system.

PABX's to U. S. A.

The ERGA Division of L M Ericsson has received large orders for PABX's for American customers to a value of 13.5 million kronor. The delivery will take place during 1971.

New Share Issue by Ericsson do Brazil

Ericsson do Brasil Comércio e Industria S.A. (EDB), a fully owned subsidiary of L M Ericsson, with a share capital of 60 million cruzeirios, has issued 20 million new shares at a nominal value of one cruzeiro.

Of the new issue 19 million shares have been placed with Brazilian shareholders, who thereby will hold 24 % of the share capital. One million of the shares have been reserved for employees of the company.

The shares in EDB have been introduced on the stock exchanges in São Paulo, Rio de Janeiro, Belo Horizonte and Pôrto Alegre.

The new issue is in line with L M Ericsson's policy to enable nationals, whenever possible, to invest in the company's expansion of its operations in their countries.

Group Interim Report for Jan. – Sept. 1970

"Group order bookings during the first nine months of 1970 amounted to 2930 Mkr, an increase of 28 % over the corresponding period of 1969", states the Ericsson Group Interim Report. Of the total orders 64 % were from European countries (Sweden 25 %), 23 % from Latin America, and 13 % from the remainder of the world.

Group sales amounted to 2062 Mkr and exceeded the figure for the corresponding period of 1969 (1844 Mkr) by 12 %. The rate of increase was highest within Europe (apart from Sweden) and Latin America.

Expenditure rose by 20 % over the same period in 1969. Contributory factors were the considerable rise in salaries and wages within several of the Group companies as a result of new labour market contracts, and the reinforcement of the resources principally within the technical and production departments required for product development and to meet the increased volume. For the whole of 1970, compared with 1969, the rate of increase of expenditure was expected to be lower than the 9-month figure.

The result prior to special adjustments and income taxes for the whole of 1970 is expected to be close to the figure for 1969.

The number of Group employees has risen since the beginning of the year from 53,600 to 59,300, of whom 2560 in Swedish and 3140 in foreign companies of the Group.

In November 1970, to finance the expanding foreign activities of the Group, the parent company raised a 15-year 9 1/4 % loan of 30 million US $ and a 5-year 8 3/4 % loan of 15 million US $ on the European capital market. The loans were negotiated by a consortium headed by Stockholms Enskilda Bank, S.G. Warburg & Co., Svenska Handelsbanken, Crédit Lyonnais and Credito Italiano.

Ericsson Technics

Ericsson Technics No. 4/1970 was issued at the end of last year, and the 26th Volume of the journal is thus complete. Abstracts from nos. 1 and 2 were contained in Ericsson Review No. 3, 1970, and a brief review of nos. 3 and 4, each containing three papers, is given below.

The first paper in no. 3/1970, *PLUTO, a Data Base Management System*, by S. Sem-Sandberg, describes the file and storage structures and the procedures for data definition and data base creation.

In the second paper, *Optimization of Electrical Networks with Respect to Tolerance Costs*, G. Kjellström presents a method for optimization of tolerance costs and hitting probabilities in a tolerance region when the component values of electrical networks are allowed to deviate at random from their nominal values.

No. 3 terminates with *Amplitude Distribution of a Linearly Filtered PN-Sequence*, in which I. Ingemarsson assumes that a linearly filtered binary PN-sequence of maximal length often has noise-like properties. The moments of such a signal, and thus the amplitude distribution of the PN-sequence, are derived.

The first paper in no. 4, *On the Design of Adaptive Wiener Filters*, by T. Ericsson, describes a class of variable filters for minimization of a mean square error. The existence of simple adjustment algorithms is pointed out, and a method for efficient filter design is proposed. The theory

The U.S. Ambassador to Sweden, Mr Jerome Holland, and his wife, visited LME at Midsommarkransen for a few hours last autumn. In the photograph, taken in a production department, is seen (from left) Ambassador Holland, Vice-President Arne Mohlin, and Isak Silton, machine operator.

L M Ericsson was recently visited by the Governor of the State of Goiás, Brazil, Dr Leonino di Ramos Caiado. The photograph from the Exhibition Room shows (from left) Torsten Lindstedt, LME, Dr Caiado, Arne Stein, LME, Sven Gunnar Friberg, LME, Dr Júlio Cezar Montenegro, Director of Companhia Telefônica de Fortaleza, and Juan Arpa, LME.

may be regarded as an extension of the theory of automatic equalizers.

In *On the Extent of Routine Measurements in Telephone Plant. An Operational Research Approach*, A. Elldin discusses the possibilities of estimating the optimal extent of routine measurements in telephone plant. Using the general scheme of operational research, a definition is given of the working conditions which must be established before the problem can be solved. It is found that the service criterion, extensions steps, forecasting methods and measuring method are all interdependent.

M. E. Fakhr El Din, in the last paper in no. 4, *Comparison between Measured and Calculated Values in a Link System with Overflow Facility*, which is also his doctoral thesis, reports the measurement with a special equipment of the traffic and congestion in a group selector with overflow. The measured values have been systematically compared by means of different methods of calculation. The results showed that the observed traffic distributions varied considerably, which implies that more frequent and more lengthy measurements are generally required than was earlier considered necessary.

From the LME 1970 Gold Medallist Festival at the Stockholm City Hall. (From left) President Björn Lundvall, Mrs Astrid Kronqvist, Vice-Chairman of the Board Erik Boheman, Arne Wrette, Erik Olsson and Helmer Angelgård.
Oldest in the service of the company among the male medallists was Mr Anglegård with nearly 43 years of employment, and among the female medallists Mrs Kronqvist with 37 1/2 years.

Señorita Elsa Triana acted as hostess for L M Ericsson's Colombian manufacturing company at "VIII Feria Internacional de Bogotá 1970". The exhibition, which is held every second year, was visited by 1.2 million persons.

Engbert Brandsma In Memoriam

Engbert Brandsma, President of LME's Dutch subsidiary, Ericsson Telefoonmaatschappij (ETM), died in Amsterdam on November 17, 1970, at the age of 63.

After taking a M.Sc. degree at Delft in 1931, followed by a period with the Dutch PTT, he joined the Ericsson Group after the end of the war. To become better acquainted with the Group and its products, Bert Brandsma spent a large part of the year 1947 in Stockholm. During that time he got to know LME well and made many friends within the company. He also learnt Swedish, which greatly facilitated his future work and contacts with LME.

On his return to Holland Bert Brandsma became head of the Telephone Exchange Division at ETM at the Hague and in 1966 was appointed Vice-President of the Company. On July 1, 1967, he succeeded J. Badon Ghijben as President.

Bert Brandsma's time as head of the Telephone Exchange Division of ETM coincided with a period of intense development and modernization of the Rotterdam Telephone network, which had traditionally been LME's predominant market in Holland. LME's crossbar switching technique was introduced at a very early stage, and in 1950 the first 4-wire crossbar switching transit exchange was cut over in Rotterdam.

Bert Brandsma took an extremely active part in the elaboration and adaptation of the new technique, and his abilities as technician, in personnel management and as salesman were used to the full.

Apart from his abilities in the working sphere, Bert Brandsma had also an abundant measure of purely personal qualities. His friendly and subtle humour left its mark on his dealings with people both at work and outside, and he made many personal friends in the Dutch PTT, among customers, and not least at LME, where a large number of people had the benefit of working with him.

Bert Brandsma's many friends join with his wife and relatives in their sorrow at his departure.

New Subsidiary in Spain

Casten Cramér

For sales on the Spanish private market the Group has formed still another subsidiary company in Spain under the name L M Ericsson S.A. The Head of this company is Mr Casten Cramér.

New President of SIELTE

Pietro Paci

The Vice-President of L M Ericsson's subsidiary company SIELTE, Soc. per Az., in Italy, Pietro Paci, was appointed President of the company at the meeting of the Board on September 30, 1970. He succeeds the late Dr Aldo d'Arrigo.

New Head of Telephone Cable Division

Gösta Mattsson

Mr Gösta Mattsson has been appointed Head of The Telephone Cable Division in succession to Nils Eklöv, who resigned from this appointment at the year end. Mr Mattsson has at the same time been appointed Vice-President of the company.

Mr Eklöv will remain in service for one year as from January 1 for special assignments.

New President of LME, Holland

Clas-Ivar Schultz

The Vice-President of LME's Dutch subsidiary, Ericsson Telefoonmaatschappij N.V. (ETM), Clas-Ivar Schultz, has been appointed President in succession to the late Engbert Brandsma.

At the same time the Head of the Telephone Exchange Division of ETM, Adrianus van Bruggen, has been appointed Vice-President.

Associated and co-operating enterprises and technical offices

EUROPE

DENMARK

L M Ericsson A/S *DK-2000 København F*, Finsensvej 78, tel: (01) 34 6868, tgm: ericsson, telex: 9020 "ERICSSON KH"

GNT AUTOMATIC A/S *DK-2860 Søborg*, Telefonvej 6, tel: (01) 69 5188, tgm: nortelmatic, telex: 5264, "GNT AUTOMATIC KH"

Dansk Signal Industri A/S *DK-2650 Hvidovre*, Stamholmen 175, Avedøre Holme, tel: (01) 49 0333, tgm: signaler københavn, telex: 6503, "6503 DSI DK"

FINLAND

O/Y L M Ericsson A/B *Helsinki 13*, P.O.B. 13018, tel: (90) 121 41 tgm: ericsons, telex: 12546, "LME SF"

FRANCE

Société Française des Téléphones Ericsson
F-92 Colombes, 36, Boulevard de la Finlande, tel: Paris (1) 781 3535, tgm: ericsson colombes, telex: 62179, "ERICSSON CLOMB"

F-75-Paris 17e, 147, rue de Courcelles, tel: Paris (1) 227 9530, tgm: eric paris, telex: 29276, "ERICSSON PARIS"

Etablissements Ferrer-Auran, *13 Marseille*, 2, *Rue Estelle*, tel: 20 6940, tgm: etabferrer, telex: 42579, "RINGMARS"

GREAT BRITAIN

Swedish Ericsson Company Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Telecommunications Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Production Control (Ericsson) Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: productrol, telex: 935979, "SWEDERIC LDN"

Centrum Rentals Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: celefon, telex 935979 "SWEDERIC LDN"

IRELAND

L M Ericsson Ltd. *Dublin 2*, 32, Upper Mount Street, tel: (01) 619 31, tgm: ericsson, telex, 5310, "LMEEI"

ITALY

FATME, Soc. per Az. *1-00100 Roma*, C. P. 4025 Appio, tel: (06) 4694, tgm: fatme, telex: 61327, "61327 FATME"

SETEMER, Soc. per Az. *1-00198 Roma*, Via G. Paisiello 43, tel: (06) 86 8854, tgm: setemer

SIELTE, Soc. per Az. *I-00100 Roma*, C.P. 5100, tel: (06) 577 8041, tgm: sielte, telex: 61225, "61225 SIELTE"

NETHERLANDS

Ericsson Telefoonmaatschappij N.V. *Rijen (N.Br.)*, P. O. B. 8, tel: (01612) 3131, tgm: erictel, telex: 54114, "ETMRY NL"

Voorburg 2110, P. O. B. 60, tel: (070) 81 4501, tgm: erictel den haag, telex: 31109, "ERICTEL DEN HAAG"

NORWAY

A/S Elektrisk Bureau *Oslo 3*, *P.B.* 5055 Maj, tel: (02) 46 1820, tgm: teleb, telex: 11723, "TELEB N"

A/S Industrikontroll *Oslo 6*, Grensevejen 86/88, 3. etg., tel: (02) 68 7200, tgm: indtroll

A/S Norsk Kabelfabrik *Drammen*, P.O.B. 369, tel: (02) 83 7650, tgm: kabel, telex: 18149, "KABEL N".

A/S Telesystemer *Oslo 6*, Tvetenveien 32, *Bryn*, tel: (02) 68 7200, tgm: telesystemer, telex: 16900, "ALARM N"

POLAND

Telefonaktiebolaget L M Ericsson, Technical Office *Warszawa*, Ul. Nowy Swiat 42, tel: 26 4926, tgm: tellme, telex: 813710, "813710 TELLME PL"

PORTUGAL

Sociedade Ericsson de Portugal Lda. *Lisboa 1*, Rua Filipe Folque 7, 1°, tel: 56 3212, tgm: ericsson

SPAIN

Cia Española Ericsson, S.A. *Getafe*, Paseo Felipe Calleja 6, tel: 295 2100, tgm: ericsson, telex: 22666, "ERIGE E"

SWEDEN

Telefonaktiebolaget L M Ericsson, *S-126 11 Stockholm 32*, tel: (08) 19 0000, tgm: telefonbolaget, telex: 17440, "LME S"

Bjurhagens Fabriker AB *S-212 15 Malmö*, Fack, tel: (040) 93 4770

AB Rifa *S-161 30 Bromma 11*, tel: (08) 26 2600, tgm: elrifa, telex: 10308, "ELRIFA STH"

L M Ericsson Instruktionsteknik AB *S-117 47 Stockholm 44*, tel: (08) 68 0870, tgm: instruktec

L M Ericsson Telemateriel AB *S-135 01 Stockholm-Tyresö 1*, Fack, tel: (08) 712 0000 tgm: ellem, telex: 1275, "1275 TELERGA S"

Sieverts Kabelverk AB *S-172 87 Sundbyberg*, tel: (08) 28 2860, tgm: sievertsfabrik, telex: 1676, "SIEVKAB STH"

Svenska Radio AB *S 102 20 Stockholm 12*, tel: (08) 22 31 40, tgm: svenskradio, telex: 10094 "SRA S"

AB Transvertex *S-140 11 Vårby*, Fittja industriområde, tel: (08) 710 0935

SWITZERLAND

Ericsson A.G. *8061 Zurich*, Postfach, tel: (051) 41 6608, tgm: telericsson, telex: 52669, "ERIC CH"

TURKEY

Ericsson Türk Ticaret Ltd. Sirketi *Ankara*, Rumeli Han, Ziya Gökalp Cad. tel: 12 3170, tgm: ellem

WEST GERMANY

Deutsche Ericsson G.m.b.H. Telematerial, *4 Düsseldorf 1*, Postfach 2628, tel: (0211) 35 3594, tgm: eric-tel telex: 8587912, "ERIC D"

Ericsson Centrum G.m.b.H. *3 Hannover*, Dornierstrasse 10, Postfach, tel: (0511) 63 1018, tgm: ericen, telex: 0922913, "ERICE D"

ASIA

INDIA

Ericsson Telephone Sales Corporation AB
Calcutta 22, P.O.B. 2324, tel: (032) 45 4494, tgm: inderic

New Delhi 49, L25, South Extension Part II, tel: (011) 62 6505, tgm: inderic

INDONESIA

Ericsson Telephone Sales Corporation AB
Djakarta, P.O.B. 2443, tel: (07) 463 97, tgm: javeric, telex: 4414 "JAVERIC DKT 4414"

Bandung, Djalan Ir. H. Djuanda 151, tel: (082) 820 94, tgm: javeric

IRAQ

Telefonaktiebolaget L M Ericsson, Installation Branch *Baghdad* P.O.B. 2388, Alwiyah, tel: 947 14, tgm: ellemco

KUWAIT

Telefonaktiebolaget L M Ericsson, Technical Office *Kuwait, State of Kuwait*, P.O.B. SAFAT No. 5979, tel: 200 74, tgm: erictel

LEBANON

Société Libanaise des Téléphones Ericsson *Beyrouth* B.P. 8148, tel: 25 2627, tgm: ellem, telex: 876, "ELLEM BERYT"

MALAYSIA

Ericsson Talipon SDN BHD *Petaling Jaya*, P.O.B. No 9, tel: Kuala Lumpur (03) 56 1523, tgm: kuleric, telex: 265 "ERICMAL KL"

Telecommunication Manufacturers (Malaysia) SDN BHD *Petaling Jaya*, P.O.B. 9, tel: Kuala Lumpur (03) 56 1523, tgm: kuleric, telex: 265, "ERICMAL KL"

PAKISTAN

L M Ericsson Telephone Company, Technical Office *Karachi*, P.O.B. 7398, tel: (90) 51 6112, tgm: ericsson

SINGAPORE

Telephone Industries of Singapore Private Ltd. *Singapore 1*, P.O.B. 3079, tel: 98 1155, tgm: telsin

THAILAND

Ericsson Telephone Corp. Far East AB *Bangkok*, P.O.B. 824, tel: (02) 580 41, tgm: ericsson, telex: 2274, "THAIERIC"

AFRICA

ALGERIA

Société Algérienne des Téléphones Ericsson *El Biar (Algers)*, 4, rue Mouloud Hadjen, tel: 78 2692, tgm: eric alger

EGYPT (UAR)

Telefonaktiebolaget L M Ericsson, Technical Office Egypt Branch *Cairo* P.O.B. 2084, tel: (02) 465 83, tgm: ericgypt, telex: 2009, "ELLEME UN"

ETHIOPIA, SUDAN

Telefonaktiebolaget L M Ericsson, Technical Office *Addis Ababa*, P.O.B. 3366, tel: (01) 492 60, tgm: ericsson, telex: 21090 "MOSFIRM ADDIS"

LIBYA

Telefonaktiebolaget L M Ericsson Technical Office *Tripoli*, P.O.B. 3002, tel: 361 93, tgm: ericsson

MALAWI

Ericsson Telephone Sales Corporation AB *Blantyre*, P.O.B. 431, tel: 300 95, tgm: ericofon

MOROCCO

Société Marocaine des Téléphones Ericsson *Casablanca*, 87, Rue Karatchi, tel: 788 75, tgm: ericsson

TUNISIA

Telefonaktiebolaget L M Ericsson, Technical Office, *Tunis*, Boite Postale 780, tel: (01) 24 0520, tgm: ericsson, telex: 695, "ERICSSON TUNIS".

ZAMBIA

Ericsson Telephone Sales Corporation AB *Lusaka*, P.O.B. 2762, tel: (146) 744 42, tgm: ericofon

Ndola, P.O.B. 2256, tel: (143) 3885, tgm: ericofon

AMERICA

ARGENTINE

Cia Ericsson S.A.C.I. *Buenos Aires* Casilla de Correo 3550, tel: 33 2071, tgm: ericsson, telex: 0122196, "CATEL BA"

Cia Argentina de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Cia Entrerriana de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Industrias Eléctricas de Quilmes S.A. *Quilmes FNGR*, 12 de Octubre 1090, tel: 253 2775, tgm: indelqui buenosaires, telex: 0122196, "CATEL BA"

BRAZIL

Ericsson do Brasil Comércio e Indústria S.A. *São Paulo*, C.P. 5677, tel: 298 0437, tgm: ericsson, telex: 021817, "ERICSSON SPO"

Fios e Cabos Plasticos do Brasil S.A. (FICAP) *Rio de Janeiro*, caixa postal: 1828, tel: 29 0185, tgm: ficap, telex: 031563, "FICAP RIO"

CANADA

L M Ericsson Limited *Montreal 381, Quebec*, 2300 Laurentian Boulevard St. Laurent, tel: (514) 331 3310, tgm: caneric, telex: 05-267682, (TWX) 610-421-3311, "CANERIC MTL"

CENTRAL AMERICA

Telefonaktiebolaget L M Ericsson, Oficina Tecnica de Centroamérica y Panama *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson

CHILE

Cia Ericsson de Chile S.A. *Santiago*, Casilla 10143, tel: (04) 825 55, tgm: ericsson, telex: SGO 389, "ERICHILE SGO389"

COLOMBIA

Ericsson de Colombia S.A. *Bogotá*, Apartado Aéreo 4052, tel: (92) 41 1100, tgm: ericsson, telex: 044507, "ERICSSON BOG"

Fábricas Colombianas de Materiales Eléctricos Fácomec S.A. *Cali*, Apartado Aéreo 4534, tel: 42 1061, tgm: facomec, telex: 55673, "FACOMEC CLO"

COSTA RICA

Telefonaktiebolaget L M Ericsson, Technical Office *San José*, Apartado 10073, tel: 21 1466, tgm: ericsson

ECUADOR

Teléfonos Ericsson C.A.
Quito, Casilla 2138, tel: 52 4000, tgm: ericsson

Guayaquil, Casilla 376, tel: 52 6900, tgm: ericsson

Cont. on next page

Associated and co-operating enterprises and technical offices (Cont. from preceding page)

MEXICO

Teléfonos Ericsson S.A. *Mexico D.F.*, Apartado Postal 9958, tel: (25) 46 4640, tgm: coeric, telex: 01772485, "ERICSSON MEX" PARA COERIC

Latinoamericana de Cables S.A. de C.V. *Mexico 12 D.F.*, Apartado Postal 12737, tel: (2) 549 3650, tgm: latincasa, telex: 01772485, "ERICSSON MEX" PARA LATINCASA

Teleindustria, S.A. de C.V. *Mexico 1, D.F.*, Apartado Postal 1062, tel: (2) 546 4640, Factory: (2) 576 3166, tgm: ericsson, telex: 01772485, "ERICSSON MEX"

Telemontaje, S.A. de C.V. *Mexico 1, D.F.*, Apartado Postal 1062, tel: (2) 576 4044, tgm: ericssonmexicodf, telex: 01772485, "ERICSSON MEX" PARA TELEMONTAJE

PERU

Cia Ericsson S.A. *Lima*, Apartado 2982, tel: 31 1005, tgm: ericsson, telex: 3540202, "ERICSSON 3540202"

Soc. Telefónica del Perú, S. A. *Arequipa*, Apartado 112-1012, tel: 6060 tgm: telefonica

EL SALVADOR

Telefonaktiebolaget L M Ericsson, Technical Office *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson

URUGUAY

Cia Ericsson S.A. *Montevideo*, Casilla de Correo 575, tel: 926 11, tgm: ericsson, telex: 398228, "ROULEMENT UY" PARA MELANDER

USA

The Ericsson Corporation *New York, N.Y. 10017*, 100 Park Avenue, tel: (212) 685 4030, tgm: erictel, telex: 620484, "ERICTEC 620484"

Ericsson Centrum Inc. *New York, N.Y. 10016*, 16, East 40th Street, tel: (212) 679 1000, tgm: erictel, telex: 620149, "ETELSAC 620149"

VENEZUELA

Cia Anónima Ericsson *Caracas*, Apartado 70516, tel: (02) 34 4661, tgm: ericsson, telex: 22734, "22734 ERIC VEN"

Alambres y Cables Venezolanos C.A. (ALCAVEL) *Caracas*, Apartado del Este 62107, tel: (02) 33 9791, tgm: alcave, telex: 845, "ALCAVE VE"

AUSTRALIA & OCEANIA

AUSTRALIA

L M Ericsson Pty Ltd.
Broadmeadows, Victoria 3047, P.O.B. 41, tel: (03) 309 2244, tgm: ericmel, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: ericsyd, telex: AA 21358 "ERICSYD"

Port Moresby, Territory of Papua and New Guinea, P.O.B. 1367, Boroko, tel: 569 65, tgm: ericpor

Teleric Pty. Ltd.
Broadmeadows, Victoria 3047, P.O.B. 41, tel: (03) 309 2244, tgm: teleric, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: teleric, telex: AA 21358, "ERICSYD"

Conqueror Cables Pty. Limited *Dee Why, N.S.W. 2099*, P.O.B. 69, tel: (02) 98 0364, tgm concab sydney

A.E.E. Capacitors Pty. Ltd. *Preston, Victoria 3072*, 202 Bell Street, P.O.B. 95, tel: (03) 480 1211, tgm: engiquip melbourne

Representatives

EUROPE

AUSTRIA

Telecom Handelsgesellschaft m.b. H. *1160 Wien*, Postfach 98, tel: (0222) 43 5956, tgm: teleric, telex: 75976), "75976 TELECOM A"

BELGIUM

Allumage Lumière S.A. *Bruxelles 7*, 128-130 Chaussée de Mons, tel: 22 9870, tgm: allumalux, telex: 21582, "ALLUMALUX BRU"

GREECE

Angelos Cotzias *Athens*, 18, Odos Omirou, tel: (021) 62 6031, tgm: cotziasan, telex: 215252, "215252 CTS GR"

ICELAND

Johan Rönning H/F *Reykjavik*, P.O.B. 5300, tel: 254 00, tgm: rönning, telex: 2040, "ROENNG IS"

SPAIN

TRANSA Transacciones Canarias S.A.

Las Palmas de Gran Canarias, Tomas Morales 38, tel: 21 8508, tgm: transa, telex: 824, "MAVAC LPE"

Santa Cruz de Tenerife, Sabino Berthelot, 3, tel: 24 5897, tgm: transa

YUGOSLAVIA

Merkantile Inozemna Zastupstva *Zagreb* pošt pretinac 23, tel: (041) 41 6655, tgm: merkantile, telex: 21139, "21139 YU MERTIL"

Beograd, Ul. 7. jula br. 18, tel: (011) 62 1773, tgm: merkantile, telex: 11506, "YU MERKAN"

ASIA

BAHRAIN & TRUCIAL STATES

Yusuf Bin Ahmed Kanoo *Bahrain, Arabian Gulf*, tel: 40 8188, tgm: kanoo, telex: BHN 215

BURMA

Myanma Export Import Corp., Agency Div. *Rangoon*, P.O.B. 404, tel: 146 18, tgm: myanimport

CAMBODIA

Comin Khmere S.A. *Phnom-Penh*, P.O.B. 625, tel: 233 34, tgm: engineer

CYPRUS

S.A. Petrides & Sons Ltd. *Nicosia*, P.O.B. 1122, tel. 627 88, tgm: armature, telex: 2308, "ARMATURE"

HONG KONG AND MACAO

Swedish Trading Co. Ltd. *Hong-Kong*, P.O.B. 108, tel: 23 1091, tgm: swedetrade

IRAN

Irano Swedish Company AB *Teheran*, Khiabane Sevom Esfand 29, tel: 31 4160, tgm: iranoswede

JORDAN

The Arab Trading & Development Co. Ltd. *Amman*, P.O.B. 6141, tel: 259 81, tgm: aradeve

KUWAIT

Morad Yousuf Behbehani *Kuwait, State of Kuwait*, P.O.B. 146, tel: 270 71, tgm: barakat, telex: 048, "BEHBEHANI KUWAIT"

LEBANON

Swedish Levant Trading (Elié B. Hèlou) *Beyrouth*, P.O.B. 931, tel: 23 1624, tgm, skefko

PAKISTAN

Panasian Marketing Service Ltd. *Karachi*, P.O.B. 3941, tel: (90) 51 2051, Ext. 53, tgm: panasian

PHILIPPINES

USIPHIL Inc. *Manila*, P.O.B. 125, tel: 89 2061, tgm: usiphil, telex: PN 3550, "USIPHIL"

SAUDI ARABIA

Engineering Projects & Products Co. Ltd. (Eppco)

Riyadh, P.O.B. 987, tel: 222 22, tgm: eppcol

Yeddah, P.O.B. 1502, tel: 4567, tgm: eppcol

Dammam, P.O.B. 450, tel: 222 22, tgm: eppcol

SYRIA

Constantin Georgiades *Damas*, P.O.B. 2398, tel: 266 73, tgm: georgiades

TAIWAN

Trans-Eurasia Enterprise, Ltd. *Taipei*, P.O.B. 3880, tel: 51 7038, tgm: esbtrading

REPUBLIC OF VIETNAM

Vo Tuyen Dien-Thoai Vietnam *Saigon*, P.O.B. 1049, tel: 226 60, tgm: telerad

International Business Representative *Saigon*, 26—28, Hai Ba Trung Street, tel: 226 60, tgm: ibur

AFRICA

ETHIOPIA

Mosvold Company (Ethiopia) Ltd. *Addis Ababa*, P.O.B. 1371, tel: (01) 101 00, tgm: mosvold, telex: 21090, "MOSFIRM ADDIS"

GHANA

R.T. Briscoe Ltd. *Accra*, P.O.B. 1635, tel: 669 03, tgm: briscoe, telex: 295, "BRISCOE ACCRA"

LIBERIA

Post & Communications Telephone Exchange *Monrovia*, Corner Ashmun & Lynch Streets, tel: 222 22, tgm: radiolibe

LIBYA

ADECO African Development & Engineering Co *Tripoli*, P.O.B. 2390, tel: 339 06, tgm: adeco

MOZAMBIQUE

J. Martins Marques & Ca. Lda *Lourenço Marques*, P.O.B. 2409, tel: 5953, tgm: marquesco

SOUTH AFRICA
SOUTHWEST AFRICA

Dryden Communications (Pty.) Ltd. *Johannesburg, South Africa*, P.O.B. 2440, tel: 838 5454

SUDAN

El Rahad Trading Corporation *Khartoum*, P.O.B. 866, tel: 776 95, tgm: suconto, telex: BHN 251

AMERICA

BAHAMA ISLANDS

Anglo American Electrical Company Ltd. *Freeport, Grand Bahama*, P.O.B. 104

BOLIVIA

Prat Ltda *La Paz*, Casilla 4790, tel: 277 12, tgm: prat

COSTA RICA

Tropical Commission Co. Ltd. *San José*, Apartado 661, tel: 22 5511, tgm: troco

DOMINICAN REPUBLIC

Humberto Garcia, C. por A. *Santo Domingo*, Apartado 771, tel: 3645, tgm: gartier

GUATEMALA

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: (021) 622 57, tgm: nilspira

GUYANA

General Supplies Agency *Georgetown*, P.O.B. 375, tgm: benwlks

HONDURAS

Quinchón Leon y Cia *Teguicigalpa*, Apartado 85, tel: 251 71, tgm: quinchon

NETHERLANDS ANTILLES

S.E.L. Maduro & Sons Inc. *Willemstad, Curaçao* P.O.B. 304, tel: 130 00, tgm: madurosons, telex: CU 92

NICARAGUA

Roberto Teran G. *Managua*, Apartado 689, tel: 224 00, tgm: roteran

PANAMA

Sonitel, S.A. *Panama 5, R.P.*, Apartado 4349, tel: 64 3600, tgm: sonitel, telex: 368674, "368674 SONITEL"

PARAGUAY

S.A. Comercial e Industrial H. Petersen *Asunción*, Casilla 592, tel: 9868, tgm: pargtrade

EL SALVADOR

Dada-Dada & Co. *San Salvador* Apartado 274, tel: 21 7940, tgm: dada

SURINAM

W.E. van Romondt's Trading Company Ltd. *Paramaribo*, tel: 2831, tgm: vanromondt

TRINIDAD, W.I.

Leon J. Aché Ltd. *Port-of-Spain*, 100 Frederic Street, tel: 323 57, tgm: achegram

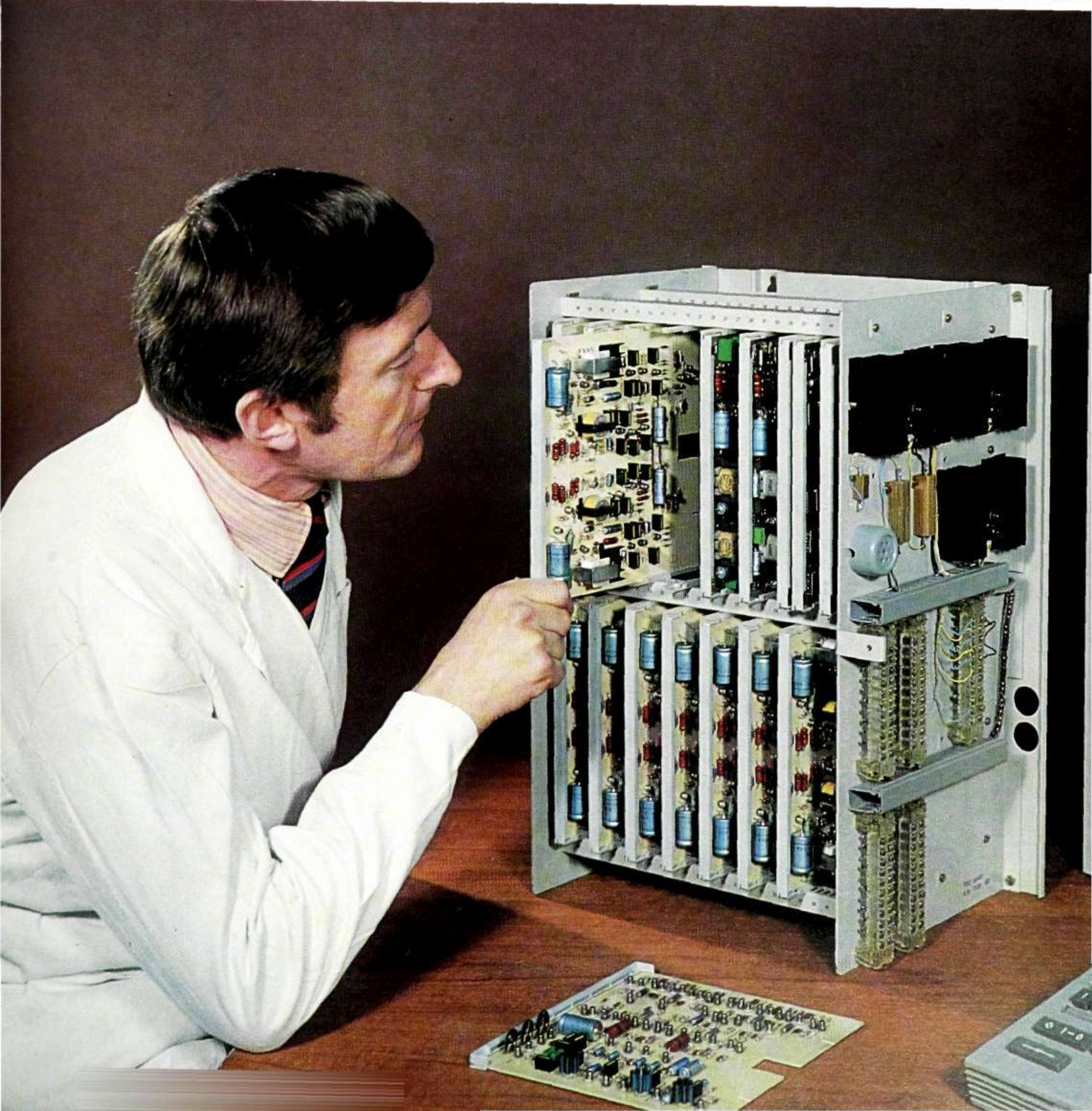
AUSTRALIA & OCEANIA

NEW ZEALAND

ASEA Electric (NZ) Ltd. *Wellington C. 1.*, P.O.B. 3239, tel: 706 14 tgm: asea, telex: 3431, "ASEAWELL NZ 3431"

ERICSSON Review

2
1971



ERICSSON REVIEW

Vol. 48 No. 2 1971

RESPONSIBLE PUBLISHER: CHR. JACOBÆUS, DR. TECHN.

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: S-126 11 STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $1.80; ONE COPY $0.60

CONTENTS

On cover: Fully solide state TDM (Time Division Multiplex) Intercom Exchange ASE 432 for 20 extensions from L M Ericsson Telemateriel AB

Jutland Telephone Company's Experience of L M Ericsson Rural Exchanges ARK 522

G. PETERSEN, CHR. NEERGÅRD-PETERSEN & K. VESTERGÅRD, JUTLAND TELEPHONE CO, AARHUS

UDC 621.395.722(489)
LME 8354

The Jutland Telephone Company (JTAS) has a large telephone network with several hundred rural exchanges. Rural automatic exchanges in Jutland were earlier to a large extent of LM Ericsson type ARK 521. A new type, ARK 522, which is superior to ARK 521 especially from the points of view of installation and extension, was however introduced in the network in 1968. This article presents the Administration's experience of ARK 522 from different points of view.

Operating Area, Subscriber Distribution, and Growth of Automatization

The operating area of the Jutland Telephone Company comprises Jutland with surrounding islands as far south as the Kolding, Grindsted and Ribe zones.

The total extent of the area is 25,550 km² and the population 1.95 million. On December 31, 1970, the number of subscribers was 391,000, distributed over the following exchanges:

146,000 subs. connected to	30 exchanges of type *ARF10+ARM 20*
2,300 ,, ,, ,,	1 exchange ,, ,, *ARF 10+ARM 50*
56,000 ,, ,, ,,	10 exchanges ,, ,, *ARF 10*
10,100 ,, ,, ,,	13 exchanges ,, ,, *ARK 521+ARM 50*
2,500 ,, ,, ,,	3 exchanges ,, ,, *ARK 522+ARM 50*
29,700 ,, ,, ,,	96 exchanges ,, ,, *ARK 521*
51,400 ,, ,, ,,	177 exchanges ,, ,, *ARK 522*
21,500 ,, ,, ,,	27 exchanges with registers, other makes, crossbar
27,100 ,, ,, ,,	113 exchanges without registers, other makes, crossbar
44,400 ,, ,, ,,	221 manual rural exchanges

It is expected that the 221 manual rural exchanges will be replaced by 171 automatic rural exchanges type *ARK 522* before the middle of 1974. There will thus be a total of 348 exchanges *ARK 522* serving about 120,000 subscribers by the middle of 1974.

With few exceptions all exchanges were manually served before the automatization of the Aarhus area in 1953. Rural automatization based on *ARK 521* started with the opening of the Øster Hurup exchange in December 1962, and in September 1968 the Administration went over to *ARK 522*.

By the time of the completion of the automatization in 1974 the Administration will have crossbar exchanges throughout the network.

Network Structure

The Jutland network is built up around four district centres, under which there are a number of zone centres.

The zone centres contain registers for a number of terminal exchanges. According to the network planning principle adopted hitherto they have in many cases served also as transit point for one or more group centres.

One function of the group centre is, on traffic engineering grounds, to serve as transit point for a number of terminal exchanges. Another function, from the line engineering aspect, is to serve as register point for a number of remote terminal exchanges where the maximum loop resistance of the rural circuits (2000 ohms combined with 20 I.P.S. dial) would not suffice for connection to a zone centre without the use of unreasonably large conductors (> 0.9 mm).

Especially owing to the rapid development of carrier technique this network structure is being changed. Group centres which, on traffic engineering grounds, are warranted as transit points are being successively connected direct to a district centre and thus become zone centres. Group centres which, on the other hand, were only warranted on account of the high loop resistance become terminal exchanges, which, with other terminal exchanges in the area, are connected on carrier direct to a zone centre.

Fig. 1 shows the Give group area with the Give group centre connected to the Vejle zone centre before the conversion of the Give exchange from group to zone centre. Fig. 2 shows the conditions after the conversion, with a main route between Give and Kolding and a direct (high-usage) route between Give and Vejle.

Fig. 1 (left)

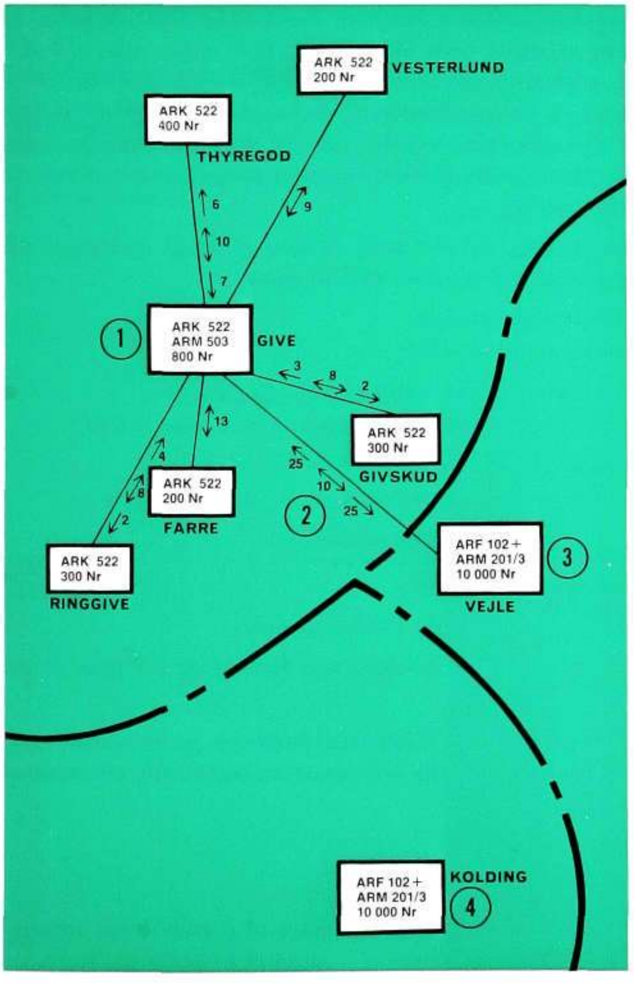
Prior to the conversion of the Give exchange to Zone centre

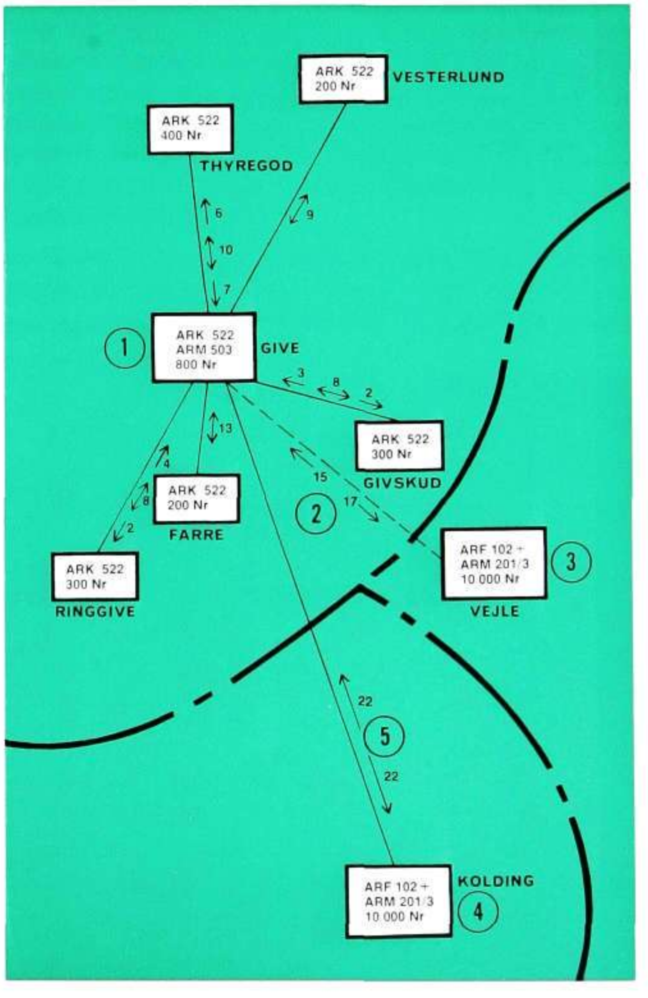
① Group centre
② Carrier
③ Zone centre
④ District centre

Fig. 2 (right)

After the conversion of the Give exchange to Zone centre

① Zone centre
② Carrier
③ Zone centre
④ District centre
⑤ Carrier
--- Direct route (high usage route)





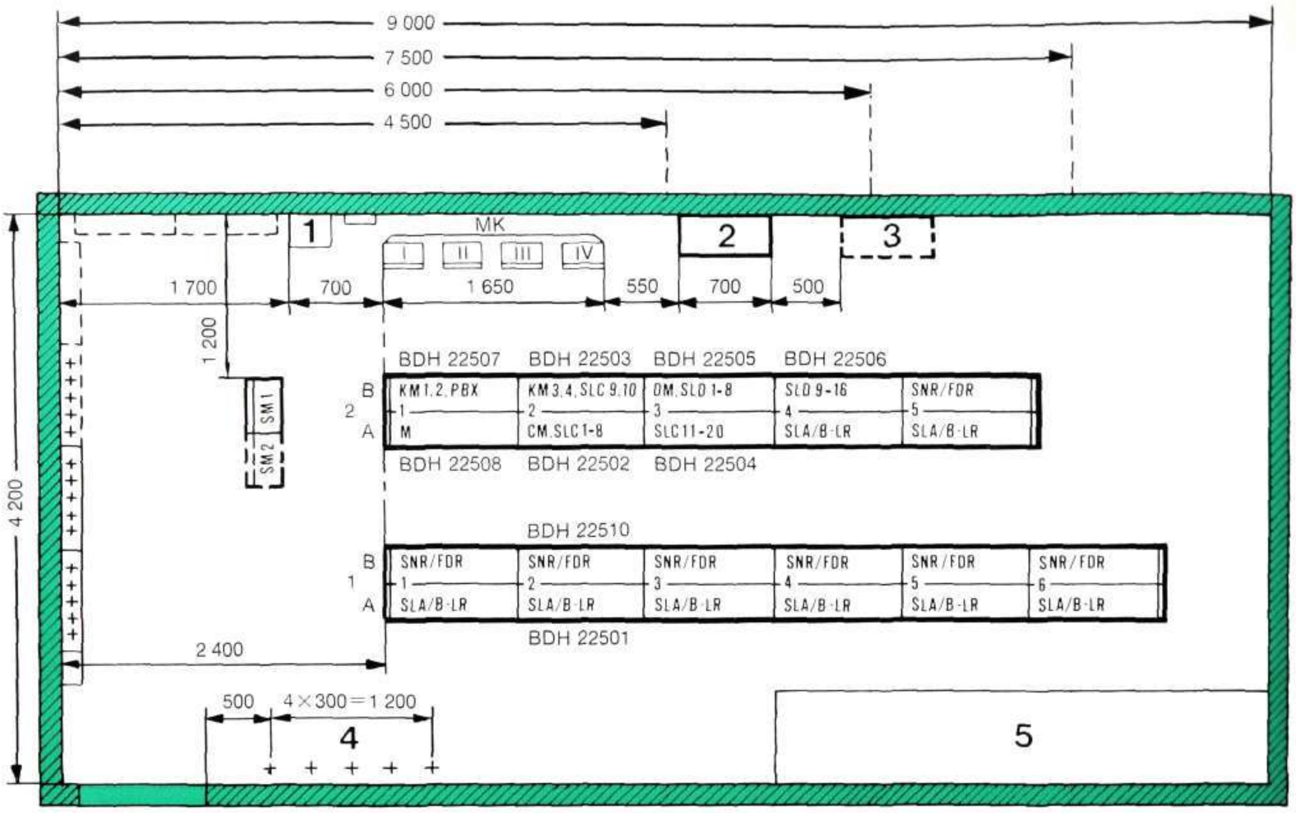


Fig. 3
Small type of exchange building

Rack height: 2700 mm
Rack width: 961 mm
Ceiling heigh: 3350 mm
1 Metering equipment
2 *Coin-box equipment*
3 Coin-box equipment
4 Carrier equipment
5 Power

Extension Policy and Rules for Switch Calculation

Since the start of automatization it has been the Administration's policy to extend the capacity in as small steps as possible. This means that the Administration does not work with optimum economy if one considers solely the operating and first costs of existing automatic exchanges. The capital released through adoption of this principle, however, can be used for automatization of manual exchanges, which in the present situation outweighs the aforementioned economic disadvantages.

For calculating the number of switching devices in rural exchanges the following rules are employed in more than 95% of cases:

- Exchanges < 800 lines: single markers
  Exchanges ≥ 800 lines: double markers
- Exchanges < 400 lines and without direct circuits: single *KM*
  Exchanges ≥ 400 lines and/or with direct circuit: min. 2, max. 3 *KM*
- Exchanges < 500 lines: no local registers
  Exchanges ≥ 500 lines: min. 2 local registers
- Number of $SNR = 2 + \dfrac{\text{number of subscribers}}{50}$
- Extensions are made in steps of entire 100-line groups
- The number of repeaters and the grouping are decided on the basis of the measured traffic.

These rules mean that continuous traffic measurements in individual rural exchanges are superfluous and that only occasional measurements are required at lengthy intervals.

Buildings and Savings

The rural exchanges are housed in buildings made of prefabricated concrete units on a cast foundation.

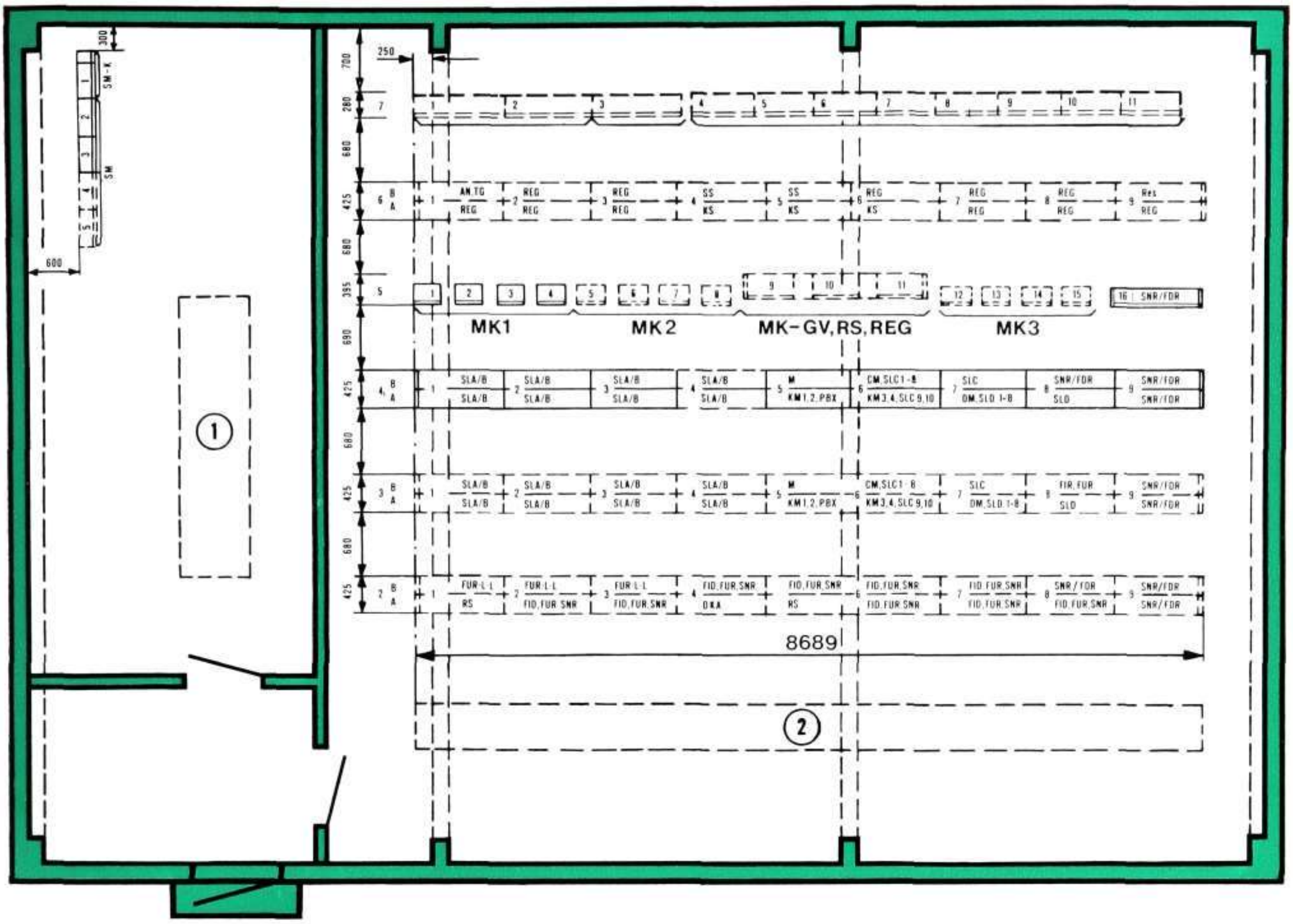


Fig. 4
Large type of exchange building
Rack height: 2700 mm
Ceiling height: 3420 mm
Ceiling height under beam: 3000 mm
① Main distribution
② Carrier equipment

The buildings are of two types. The smaller type (fig. 3) ranges from 4.2×4.5 to 4.2×9.0 m and is used for exchanges which, within the foreseeable future, are not expected to have a capacity greater than 1600 subscribers. The larger type ranges from 9.25×13.75 m to 9.25×18.25 m and is used for larger rural exchanges (twin exchanges) and for rural exchanges which are expected to be combined with transit exchanges. Fig. 4 shows a building with twin exchanges, the dimensions being 9.25×13.75 m.

The Administration regards the design of *ARK 522* with 100% plug-and-jack connection as an important rationalization measure — both for the installation of new exchanges and especially for the extension of existing exchanges.

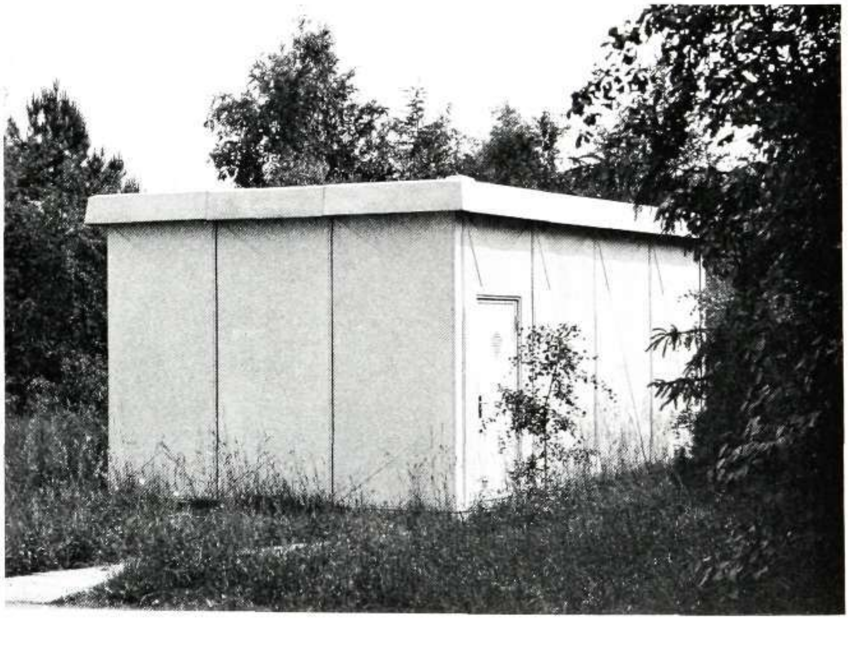


Fig. 5
Rural exchange building 4.2×6.0 m

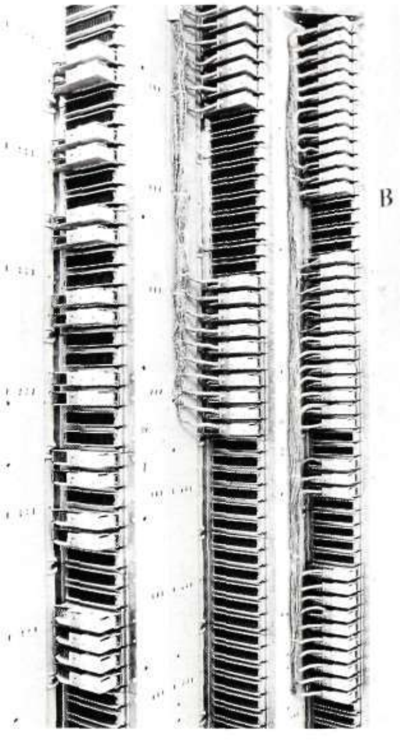


Fig. 6
I.D.F. with plug-and-jack connection

It is a great advantage in particular that the I.D.F. is based on plug-and-jack connections (fig. 6). Earlier an alteration of the grouping had to be done by soldering, often at a very rapid pace during an entire night or even an entire week-end. With *ARK 522*, on the other hand, the entire rewiring of the *BDH* intermediate distribution frame is done in a very short time.

The standardized grading patterns and plug-in, factory-made grading cables of the *ARK 522* exchanges fit the Administration's extension and switch calculation policy like a glove. It is the Administration's experience that the time spent on extension and alteration work, both in the drawing office and in the field, is usually 25% less for *ARK 522* than for *ARK 521* with its fixed cabling. This is most marked in conjunction with the introduction of a *D*-stage, when the saving of time exceeds 45%.

In economic analyses it should also be noted that up to 25% of the installation and testing work can be done in a central workshop, so that fairly considerable savings are made compared with decentralized exchange installation.

Fault Rate

The fault statistics for 111 exchanges *ARK 522* with a total of 51,800 subscribers show for the first six months of 1970 an average fault rate of 15 per 1000 subscribers and year. The exchanges are, however, new and experience shows that the fault rate diminishes after a certain run-in period.

Present Maintenance Method

The present maintenance method is based chiefly on subscribers' complaints and routine tests.

Of the number of faults repaired 36% have derived from subscribers' complaints, 45% from routine tests, 7% from fault alarms, 7% from test calls from a superior zone centre, and 5% from fault reports from other exchanges.

Supervision by Traffic Route Tester (TRT)

JTAS' nationwide test traffic programme includes also tests of incoming traffic to *ARK 522* rural exchanges. The tests are carried out with *TRT* from a zone centre to an answer tone generator in the *ARK 522* rural exchanges.

These traffic route testers have been modified to comply with JTAS' principle of automatic shifting between the *B* groups instead of using push-buttons, so that calls from 10 *A*-numbers can be automatically obtained to max. 200 *B*-numbers.

Routine Tests in the Exchange

Test of Metering

The metering is tested as often as once a quarter by manual means, as JTAS considers that even if the probability of metering faults is very small, a fault is all the more serious when it occurs.

Every link circuit is tested for local rate based on Karlsson metering and every repeater is tested for the rate on direct routes and the rate from the superior exchange.

As aid to the repairman the subscriber's meter of the test number has been connected in parallel with a bell which tinkles every time a metering pulse is received. By means of a stop-watch the repairman can check the time between each two bell signals, i.e. can check the rate.

The test is carried out during normal working hours when the exchanges are carrying traffic and — for an exchange with 500 subscribers, 12 cord circuits, 7 *FUR* and 10 *FDR* — takes about 5 hours. Adding 1 hour for travel, the tests take a total of 24 hours per year.

The rate determination at the zone centre is tested in the zone centre with the automatic rate tester, so that at the rural exchange it is necessary merely to check that the meter pulse transmission was correct.

Test of Traffic Routes

The outgoing traffic from the Administration's rural exchanges has been kept continuously under observation by means of regular visits to the exchanges and through a systematic, nationwide test call procedure. The travelling inspectors carry out the tests with ordinary telephone sets.

Calls are made to the zone centre in the home area, followed by calls to zone centres in others areas. Each rural exchange is visited twice during an 18-weeks period and the results constitute a part of the maintenance reports issued by the Telephone Administration in Denmark every 14th day and every 18th week.

Fault Alarms

Certain fault alarms from the exchanges are today transmitted to a superior exchange. Only two categories of alarm are issued, major and minor alarm.

Planned Maintenance Method

The present method, with lengthy periodical tests and subscribers' complaints as the basis for fault repair, is expensive. Measures for changing this procedure must therefore be taken.

The *ARK 522* system has been designed with a view to the adoption of controlled corrective maintenance. This, in conjunction with certain alterations in the present maintenance method, will mean that the Administration can reduce routine tests and can detect and repair faults before they are reported by subscribers.

The organization of the planned new method is outlined below.

Centralized Supervision

Test of Metering

The Administration plans in most cases to connect a line from the rural exchange to the traffic route tester at its zone centre on a separate pair of wires. When the length of circuit makes this uneconomical, or when there is no circuit available for the purpose, it is the Administration's intention instead to connect a so-called satellite equipment at the rural exchange, adapted for interworking with the *TRT*.

If a separate pair of wires is used, the metering pulses are transferred to a special discriminating selector in the *TRT* at the zone centre, which processes the pulses and reports the result in the normal way.

Using satellite equipment, the metering pulses can instead be transmitted by voice frequency on a set-up test connection.

With these two methods considerable savings can be made, since the manual metering test procedure can be avoided.

Testing of Incoming and Outgoing Traffic

If a line in a rural exchange *ARK 522* has been connected as test number in the *TRT* of the associated zone centre, there is nothing to prevent automatic testing from it of outgoing and incoming traffic at the rural exchange.

This can be done even if a satellite equipment is provided instead at the rural exchange. This equipment is called from *TRT* by dialling of the test number. The satellite equipment closes a loop to an *A* test number in *ARK 522* and dial tone is sent from there via the satellite equipment to *TRT*. *TRT* then transmits the desired number, at voice frequency, which is converted in the satellite equipment into dial pulses.

In this way it is possible automatically to test all outgoing routes from *ARK 522*, and also internal traffic.

Incoming traffic is tested in the normal way.

Built-in Supervisory Equipment

Service Alarm System

JTAS will also make use of the service alarm equipment. The service alarm unit *DLNR* is standard equipment in the rural exchanges. This equipment is designed for continuous supervision of the quality of operation. It consists in principle of a store (zeroable counters and relay chairs), which counts the number of failed connections in relation to the total number of attempted connections. If the fault rate exceeds a predetermined level, an alarm is issued to the superior exchange. Both major and minor alarms can be issued. The equipment is zeroed when a predetermined number of connections have been recorded.

Equipment for Fault Tracing

Analysis Counters

ARK 522 has ten non-zeroable analysis counters placed on the M.D.F.

The first seven counters provide a rough picture of various fault conditions, while counters 8 and 9 provide information for evaluation, for example, of subscribers' complaints concerning the absence of dial tone owing to a shortage of circuits. Counter 9 is used also for counting the number of occupations of local registers. The tenth counter shows that a fuse relay has operated.

The use of a "counter box" permits a more exact analysis, as up to 40 points in the exchange can then be supervised.

By means of special arrangements this counter box in a large exchange with two markers can be so connected that on one occasion it checks one half of the exchange and on the other the other half.

Unit for Directing Calls (DKS)

In order to be able to test a specific device during fault tracing, a unit for directing calls can be used for selecting a given switching path through the selector stages.

Summary

The *ARK 522* rural exchange is flexible from the network planning aspect, is simple as regards switch calculations, can be extended in small steps, can be installed and extended by rational centralized methods with a great saving of costs, can be quickly graded and the grading pattern can be quickly altered, has a low fault rate, and offers the means of controlled corrective maintenance. The latter involves great savings, as all manual testing of rural exchanges is then unnecessary. Visits to rural exchanges need be made only when the built-in supervisory equipment or the test traffic indicate that a fault exists.

All-Electronic Intercom Exchange ASE 432 — a New Step in the Development of Intercom Telephony

L. SKOOG, LM ERICSSON TELEMATERIEL AB, STOCKHOLM-TYRESÖ

UDC 621.395.345
621.395.2
LME 83024 837

The article briefly describes a recently developed intercom exchange. The exchange is based on the time-division multiplex principle and is all-electronic. The properties of the intercom system and the principles of time-division multiplex are described.

Some important switching processes are presented, as well as the mechanical structure of the exchange.

Fundamental innovations have been introduced in the course of the years within the field of loudspeaking intercom systems. A typical example is the voice-controlled two-way amplifier or, as it is often called, the duplex amplifier. Natural voice control has eliminated the need for manual switching of the direction of speech, which many considered troublesome.

The exchange is one of the series of modern exchanges making up the *AVF 404* system. The intercom stations for this system are available in a number of types for different needs and can be used with all exchanges. This means that already installed stations can be retained when changing to a larger exchange.

Apart from minor modifications the centralized two-way amplifier is identical to the well-known *AVF 404* amplifier.

The popularity of the intercom is based chiefly on the following characteristics:

- Quick contact — direct access is obtained by pushing one or a couple of buttons
- Connection is normally obtained directly without any action being required by the called party. This means that conversation can be conducted at a fairly large distance from the intercom instrument
- The called party can prevent direct access by pushing a special button — privacy condition
- Quick, simple communication — results in short conversations and quick messages — rational work. Average conversation time less than 30 seconds
- Low operating cost — high reliability.

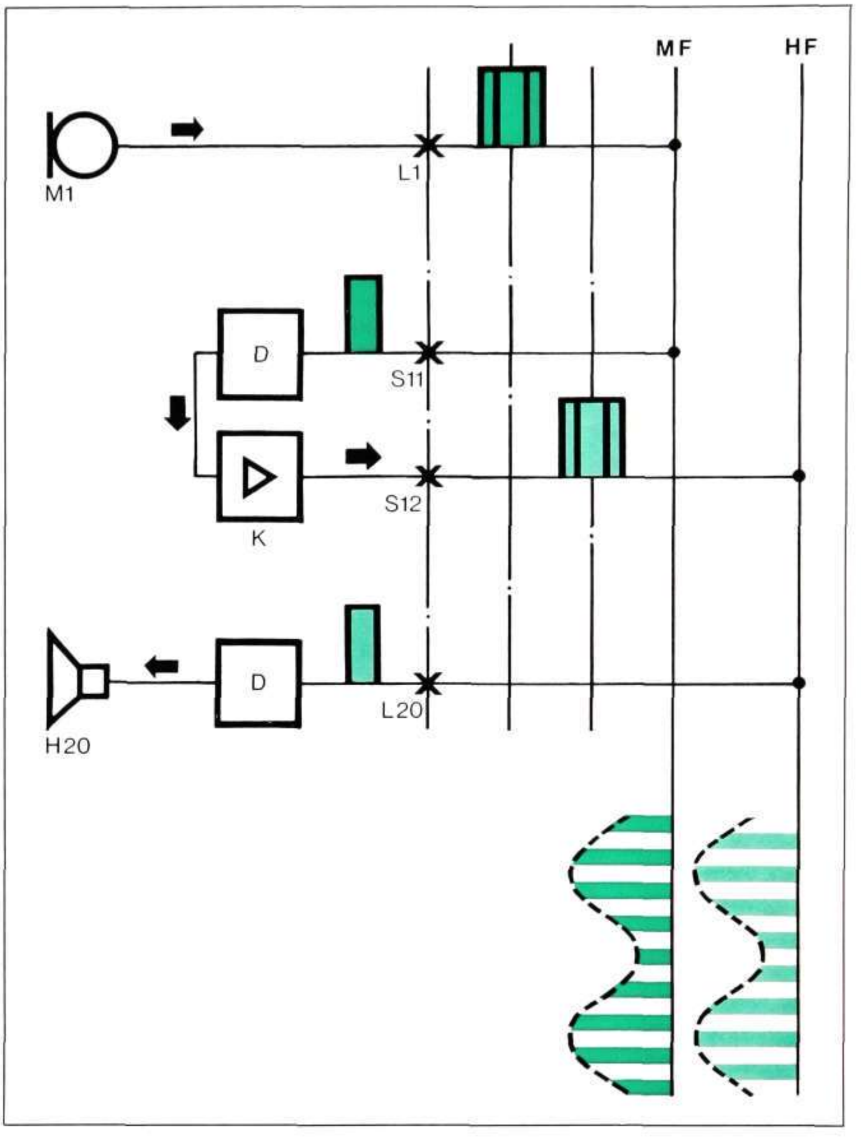
The electronic exchange *ASE 432* offers additional advantages:

- Silent operation permits installation of the exchange in ordinary office rooms
- Small dimensions
- Low weight
- Low installation cost — one-man job

Fig. 1

One-way connection

M	Microphone
H	Loudspeaker
D	Demodulator
K	Amplifier
MF, HF	Microphone and loudspeaker highways
	Electronic switches—L for lines, S for connecting circuits—actuated in time positions marked by colours
	Natural speech
	Pulsed speech on MF and HF in different time positions



- Use of plug-in printed circuit boards provides great flexibility and permits simple extension of the system by plugging-in of additional boards
- Quick service through change of printed circuit boards and centralized repair of faulty boards.

Principle of Time-Division, Multiplex and Transmission of Speech

The intercom stations are connected on four wires to the exchange, with one pair for the microphone and one pair for the loudspeaker. The speech switching network can therefore be built up on a four-wire basis with one-way connections.

Every extension line can be connected via individual electronic line switches to two common circuits known as highways. The microphone circuits are connected to one highway — the microphone highway — and the loudspeaker circuits to the other highway — the loudspeaker highway.

The inputs and outputs to and from the channels of the two-way amplifiers are also connected to microphone highway and loudspeaker highway via individual connecting circuit switches.

The connection from a microphone (e.g. *M1*, fig. 1) to a loudspeaker (*H20*, fig. 1) is established by periodical closure of the respective line switches *L1*, *L20* and connecting circuit switches (*S11*, *S12*) during very short intervals of time. Brief samples of the incoming natural speech (black arrow) are thus transmitted in the form of amplitude-modulated pulses (green broad pulse) to the microphone highway *MF*. The pulses are then taken to a demodulator via the connecting circuit switch *S11*, which closes for a shorter time than the width of the pulse. The function of the demodulator is to fill out the gaps between the pulses so that natural speech is again obtained (black arrow). The demodulation to natural speech permits the use of the normal duplex amplifier. The signal is taken to the input of an amplifier. On the amplifier output the natural speech is again modulated by connecting circuit switch *S12* and the resulting pulses are taken to the loudspeaker highway *HF*. This modulation takes place in a different time position than that for contacts *L1* and *S11*. The output pulses are therefore indicated in a different time position (light green broad pulse).

Both on modulation and transition an amplitude-modulated pulse is subjected to different influences which may give rise to time errors or disturbances. The switch through which the pulse is transmitted to the demodulator is therefore closed for a shorter time than the width of the pulse, so that imperfections at the start and end of the pulse can be eliminated. The amplitude-modulated pulses in the loudspeaker highway are connected via the individual switch *L20* of the loudspeaker circuit to the demodulator. After demodulation natural speech is extended to the loudspeaker.

Fig. 2 shows the principle of the two directions of conversation with time positions for a two-way connection. The common highways *MF* and *HF* are utilized on the time sharing principle, the basic period containing 16 consecutive time positions, each corresponding to a one-way circuit. Eight two-way connections can be carried simultaneously on the highways.

Each time position has a pulse width of 4 μs. The sampling interval is thus 64 μs and the sampling frequency close to 16 kHz, which can be simply filtered out from the natural speech.

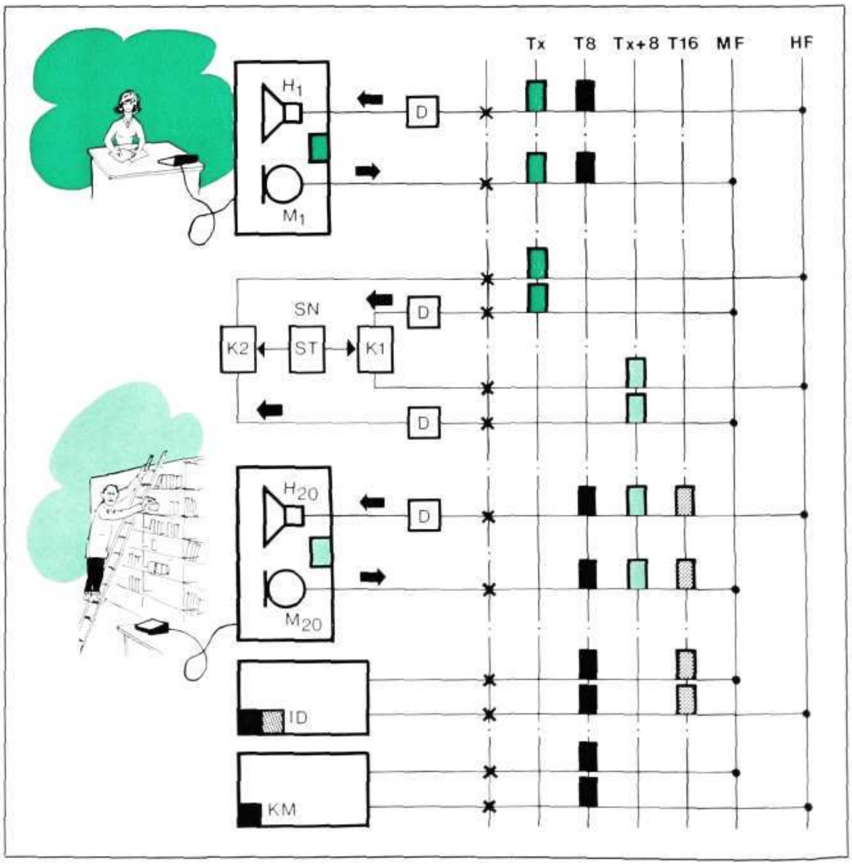


Fig. 2

Two-way connection

Notations as in fig. 1, and in addition:

- T Time position
- ID Identifiers in T8 and T16
- KM Number code receiver in T8
- ST Voice control devices which regulate the duplex amplifier K1, K2 according to the direction of speech

The diagram shows how line and *ID* switches are actuated in different time positions.

The process can be followed by means of the pulses marked by colours:

- during conversation (Tx and Tx + 8)
- for line scanning and reception of number code (T8) and for test condition of called *extension line* (*T16*)

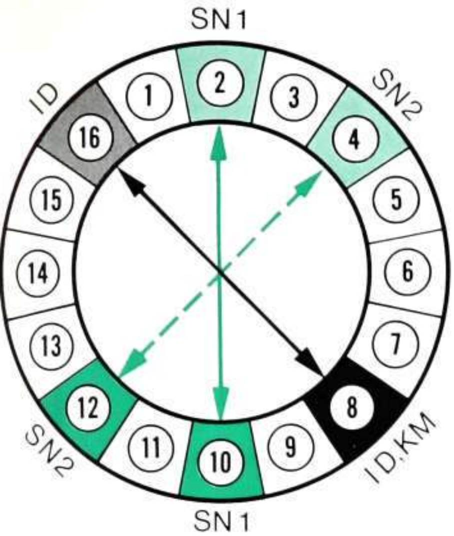


Fig. 3

Utilization of time positions in ASE 432

1—16 Consecutive time positions
SN Connecting circuit with voice-controlled duplex amplifier which is connected to the
- caller in Tx (x = 1—7)
- called party in Tx + 8

ID Identifier—connected in T8 and T16
KM Number code receiver—connected in T8

In larger exchanges a larger number of connecting circuits are connected in free time positions.

SN, ID and KM have fixed time positions and the extension line switches are allotted some of them. Cf. fig. 2.

In the time positions of the connecting circuits ID scans the information in the memory.

Exchange *ASE 432* has equipment for 20 extensions and 2 connecting circuits, each connecting circuit having two time positions (fig. 3). A further two positions are required for the central control devices — the identifier *ID* and the number code receiver *KM*. The remaining 10 times positions are intended for larger exchanges with a larger number of connecting circuits. The exchange also has a central memory equipment *REG*.

The switches to be actuated in the various time positions are tested cyclically. Every time a time position *T8* is passed, *ID* and one of the extensions are connected to the highways so that a call can be detected.

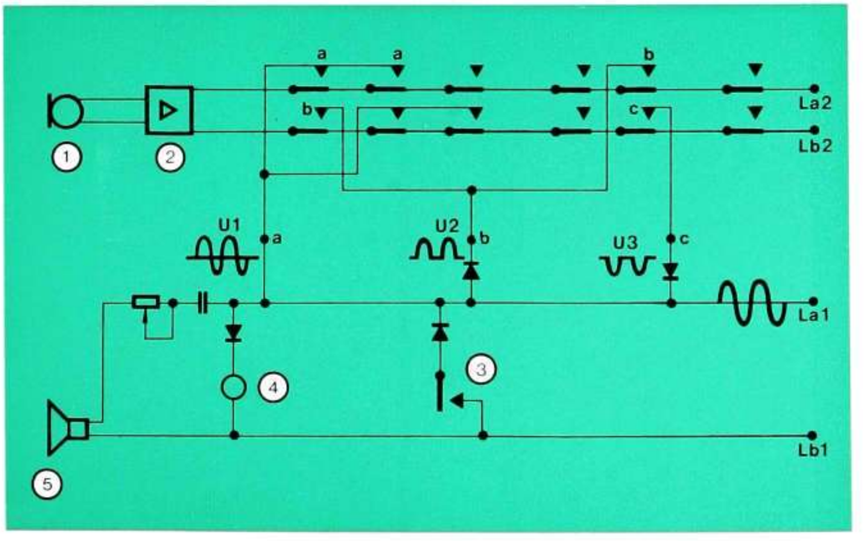
Keying Procedure

A call is made by keying the number of the wanted extension. Both the calling and called extension lines are thereby normally seized. Loudspeaker circuit *La1* has +30 V and is connected by means of diodes to the two microphone circuits in 12 combinations (see fig. 4 with table) for numbers 1—9, 0 and two buttons for special facilities. The combinations are so chosen that there is always +30 V on the microphone circuit, which indicates a call.

When, in time position *T8* (fig. 2), *ID* encounters a call, the line scanning stops. *KM* is connected in parallel with *ID* and a voice frequency is superimposed on *La1*. *KM* detects the number code. At the same time *ID* in *T16* tests the condition of the wanted extension line. A free connecting circuit *SN* is seized and data for both extensions are registered in the memory *REG*, which thereafter controls the connection of the line switches of the two extensions in both time positions of *SN*. Including test of called line condition, a connection takes about 20 ms (0.02 s) to set up.

Switching Procedure

Called extension free. The first call tone is sent to both loudspeakers from *ID*, after which *ID* and *KM* are released for new calls. With the *privacy button* in normal position *SN* transmits call tones until the called party presses the talk button and the call is put through. If the privacy button is up, a diode is connected across the loudspeaker circuit and connection is established automatically without action by the called party. The called party can thus answer the call without being in the immediate vicinity of the instrument.



Comb. No.	1	2	3	4	5	6	7	8	9	0	11	12
La2	a	a	-	c	c	-	a	a	b	b	b	b
Lb2	-	b	b	b	a	a	a	c	c	-	a	b

Fig. 4

Extension station

The diagram shows microphone and pre-amplifier, loudspeaker, call lamp and privacy button, and the principle for initiation of call and number code marking.

The code combinations transmitted via the microphone circuits La2 and Lb2 on pressing of a number button will be seen from the table:

— no tone
a full-wave tone
b positive half-wave tone
c negative half-wave tone

Signal a or b is always issued on one of the microphone circuits. Indicates a call.

Digits 1—9, 0 are transmitted when the corresponding button is pressed.

If the call is initiated by combination 12, it goes to extension numbers 11—19, 10. Combination 11 is used for special facilities.

① Microphone
② Amplifier
③ Privacy button
④ Call lamp
⑤ Loudspeaker

Fig. 5

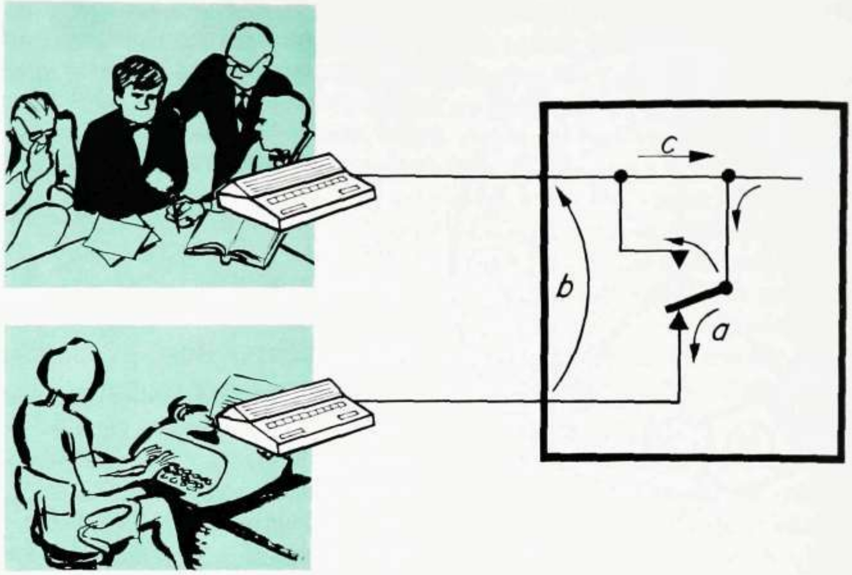
Secretary connection

a When a fingertip switch on the executive's station is actuated, incoming calls are automatically put through to the secretary.

b Only the secretary can override the privacy and call the executive under such conditions.

c Outgoing calls can still be made from the executive's station.

No special cable is required between executive and secretary.



Called line engaged. The line switches of the called party are already allotted the time position of another connecting circuit and must not be actuated by the new call in such a way as to disturb the conversation. *SN* sends seven busy tones to the calling party and then clears the connection.

Congestion tone. If no *SN* is free, *ID* in *T8* sends a special congestion tone to the calling party before clearing the line.

Priority. If the wanted extension or all *SN* are engaged, an extension with priority can make use of this facility by pressing his talk button. A discreet "hurry-up" tone is then sent to the conversing extensions.

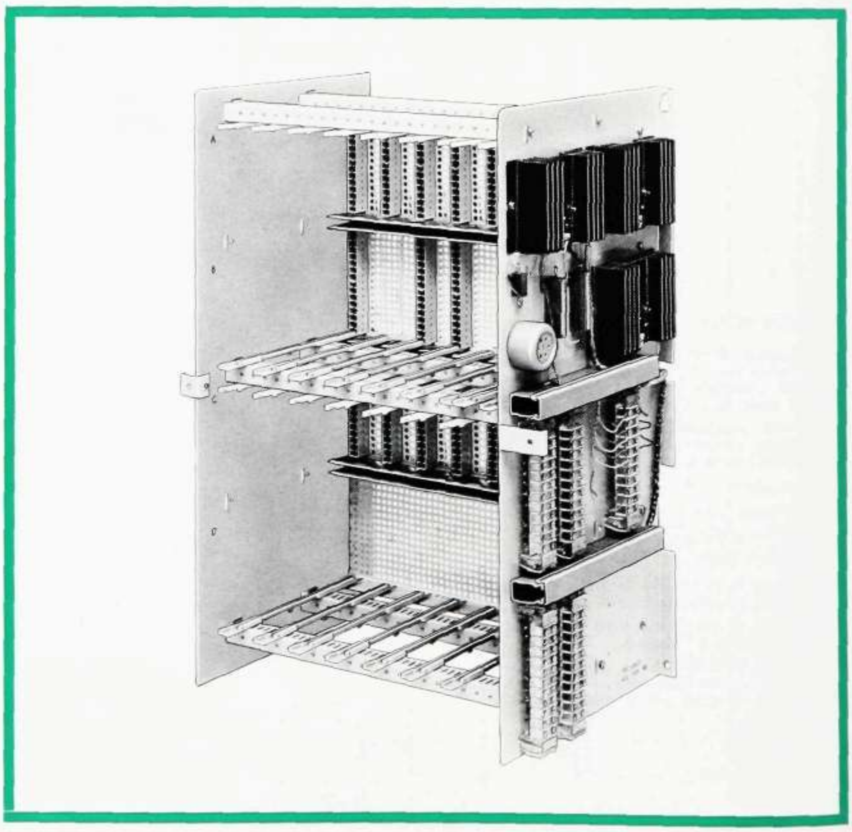


Fig. 6
Rack BDC 604

Clearing of a call takes place automatically or when either of the conversing parties presses his clearing button. A call which cannot be set up is cleared after a short time.

Secretary connection. An executive who wishes to remain undisturbed can press his secretary button. This is indicated in the exchange and calls to the executive are then put through direct to his secretary. The latter can override the privacy and call the executive if necessary (fig. 5).

Feed Voltages

All voltages are stabilized and distributed from the exchange to the microphone amplifiers and microphone circuits of the extension stations. During conversation the call lamps are lit on the stations supplied via the loudspeaker circuits.

Mechanical Features

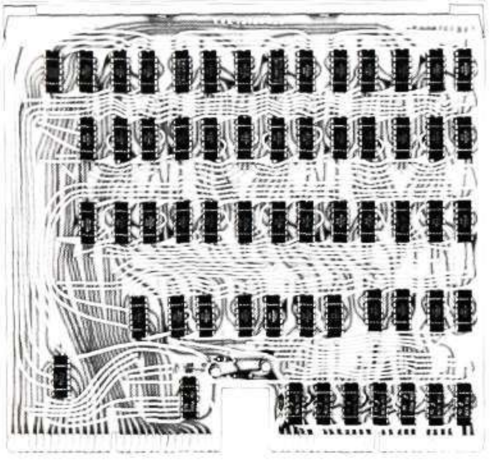
The rack *BDC 604* (fig. 6) is constructed on a modular system which permits vertical and horizontal variations. Between two side walls there are spacers with slots for the guides of the printed circuit boards. The spacers can be arranged for different widths of board. In *ASE 432* all boards are of the same size.

The printed circuit boards are connected to the cabling via L M Ericsson's connectors mounted on an earth plate. On one side of the rack there are terminal blocks for termination of the extension lines. The terminal blocks can also be used for cross-connections.

Fig. 7
Extension stations and exchange ASE 432 (cover removed)

Fig. 8

Memory board (REG) containing 60 integrated circuits



A test jack and the power transistors for the voltage feed of the exchange are also placed on the side of the rack. The rack is protected by a grey-enamelled aluminium cover.

A complete exchange system (fig. 7) contains extension stations, mains power unit and rack with max. 16 printed circuit boards. There are six types of boards, four of which for the basic equipment. These are the identifier board (*IDE*), the memory board (*REG*), the number code receiver board (*KME*) and the stabilization board for internal voltages (*STB*). An optional number of line boards may be added (1-10 *LDE*, each with equipment for two extensions) and one or two connection circuit boards (*SNE*).

Some printed circuit boards are equipped chiefly with integrated circuits. The memory board (fig. 8) is made up of 60 integrated circuits. Other printed circuit boards are equipped solely with discrete components e.g. the line boards (fig. 9).

Technical Data

Operating voltage, 48 DC (4 A), can be taken optionally from a battery or mains power unit.

Line data. The extension stations can be connected via max. 240-ohm line resistance.

Current feed to lamps and microphone preamplifiers of extension stations is connected centrally in the exchange with transistors.

Busy tone consists of seven rapid tones at a frequency of about 445 Hz. Pulse-off and pulse-on times about 1/4 s each.

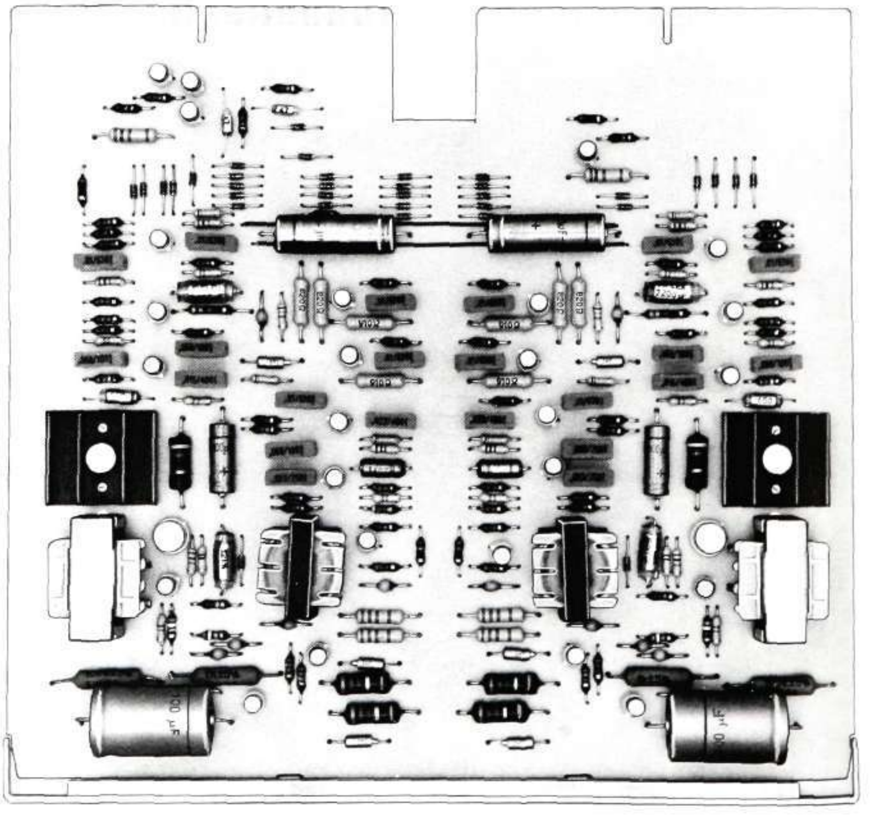


Fig. 9

Line board containing equipment for two extensions

Call tone consists of one 1/2 s tone and, with normal position of privacy button, is repeated about every fifth second.

Congestion tone consists of four tones of 1/4 s length with 3/4 s silent period.

Dimensions 55×39×30 cm.

Weight approx. 19 kg.

Summary

The new intercom exchange is all-electronic, made up of printed circuit boards, and is of low weight. It is of small volume and is silent. It can thus be placed in ordinary office rooms. It is entirely in line with L M Ericsson's other modern intercom exchanges within system *AVF 404*.

The use of time-division multiplex provides a flexible system which permits the use of identical printed circuit boards for exchanges of different sizes.

For the customer the new exchange technique offers convenient means of extension of the system, small space requirement for the exchange, quicker installation, quick and effective service, high reliability and low operating costs.

New, Flexible Register Arrangement ANA 12 for Transit Exchanges Type ARM

S. ELLSTAM & B. OLSSON, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.344
LME 834

The register is an extremely vital part of a conventional telephone exchange. Especially in national, international and intercontinental transit exchanges the design of the register is of great importance. It should be based on the building block principle to allow for the simultaneous use of several signalling systems. Extensions or alterations of the signalling systems must be simple to perform at any time. There must also be simple means for the introduction of new facilities such as storage of the A number, addition of digits to the B number, etc. The functions which are dependent on the traffic routing should be concentrated to a few devices so as to facilitate changes in the traffic routing. This article will describe how these demands, among others, are fulfilled by the register arrangement ANA 12 for national, international and intercontinental transit exchanges of ARM type.

Basic Principles of System Structure

The register arrangement is divided into a number of units (devices), which are allotted well defined functions. Such functions, which are dependent on the traffic conditions, have been concentrated to special relay sets. In this way it has been possible to standardize the basic equipment of the register and to give every customer a well tested register arrangement.

The signalling and its logic are concentrated to special code receivers *KM* and code senders *KS* (fig. 1). Up to five entirely independent groups of *KM* and four groups of *KS* can be connected to the register arrangement. This ensures that a sufficient number of different signalling systems can be handled in *ANA 12* and that new systems can be simply introduced at any time.

For storage of the *A* number an *ANM/ATT* can be added, and for prolongation of the *B* number by the international code digits an *EMA* is required.

One analyser *AN* is required for up to 24 registers, and in this analyser are concentrated the functions which are dependent on the traffic routing. The necessary reconnections can be made on easily accessible strapping fields in these analysers.

Functions of the Various Devices

Register REG

Before entering into a detailed description of the individual relay sets in *REG*, a brief account will be given of the function of the entire register.

It stores all information relating to the register arrangement originating from

- incoming circuits (*FIR* etc.)
- originating exchange (via *KM*)
- marker arrangement (*VM*)
- analyser (*AN*)
- subsequent exchanges (via *KS*)

After carrying out its own analysis or receiving a request signal, it distributes the stored information to the device concerned at a specific point of time.

The register *REG* contains the following relay sets:

INT stores indications of origin, traffic routing information from preceding exchange, *A*-subscriber category, language digit for operator-controlled international traffic, and end-of-selection signals from *KS*. Sends end-of-selection signals to *FIR* and supplementary signals which may be required for special types of traffic.

MAG stores the *B* number and contains also functions for tests, seizure, supervision and interworking with *AN* and *KS*.

VMS receives and stores prefix information from *MAG*, receives route selection information from *VM* and initiates calls to *KS*.

EMA is a supplementary relay set used for extension of *B*-number storage, e.g. on international calls.

ANM is a supplementary relay set for *A*-number storage when toll ticketing takes place at a superior national transit centre. For international centres with toll ticketing an *ANM* is always required.

ATT with *A*-number storage is used instead of *ANM* at national centres with toll ticketing equipment. For international centres an international *ATT* is used without *A*-number storage for settlements with other countries. If toll ticketing is required for international calls, an *ANM* of normal type is added.

Analyser AN

As indicated by its name, *AN* carries out the necessary analyses. One analyser can serve up to 24 *REG*.

The analyser *AN* consits of the following units:

IDR identifies the calling register and, after selection of one register in case of simultaneous calls from several such devices, connects this register to *TSA*. To reduce the switching time for a waiting register, *IDR* identifies such a register at the same time as *TSA* serves preceding calls.

TSA stores the prefix from *VMS* and the subsequent three digits from *MAG*. If additional digits are required, a supplementary unit must be added. *TSA* analyses stored digits and sends to *MAG* a signal which decides the starting point for *calling of VM*.

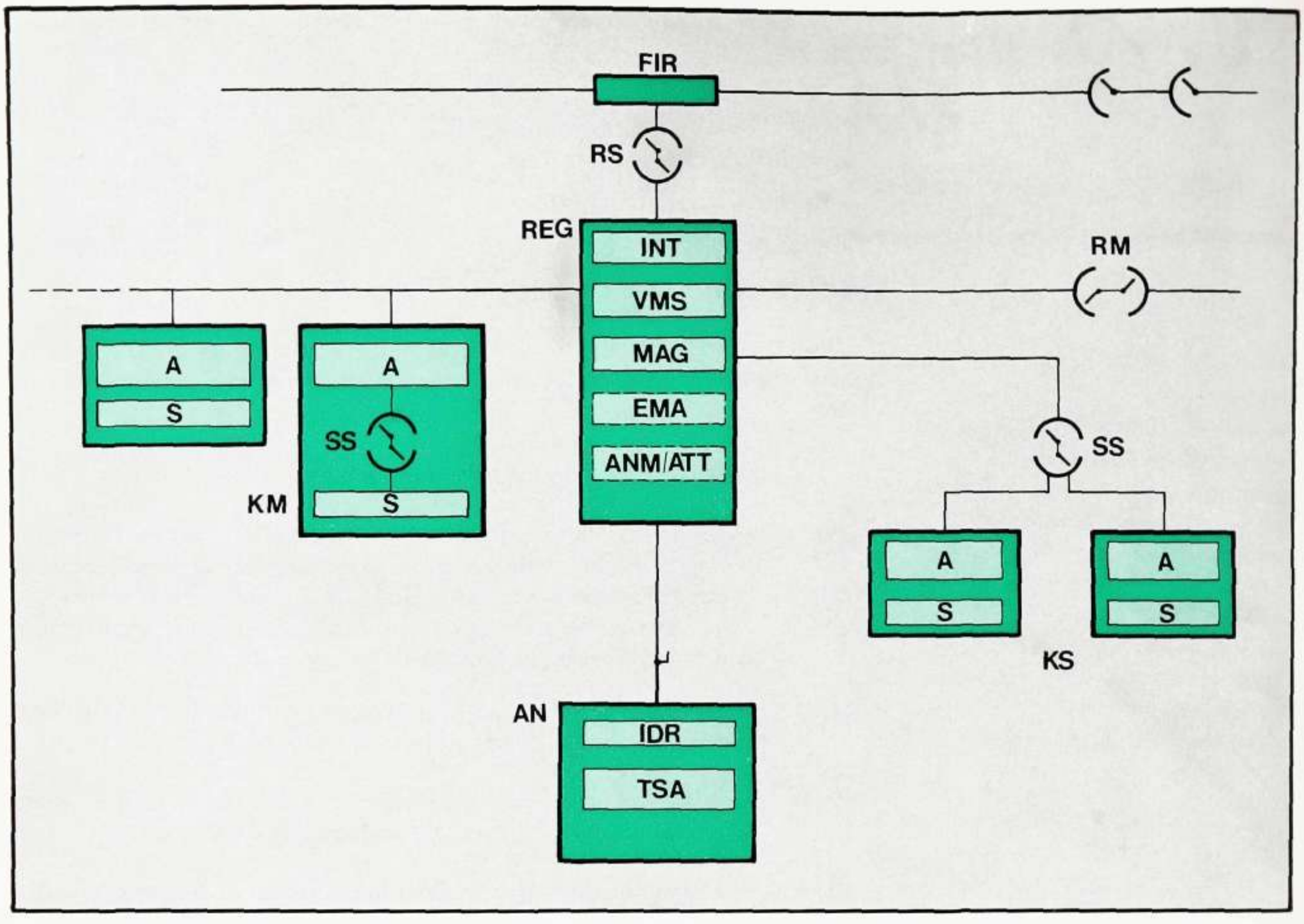


Fig. 1

Block schematic of ARM register arrangement, ANA 12

FIR Line equipment
RS Register finder
REG Register
A A-unit
S S-unit
KM Code receiver
AN Analyser
SS Sender finder
KS Code sender
RM Equiqment for connection of register to route marker

Code Receiver KM

As noted, five types of code receiver can be connected to the register arrangement (two are shown in fig. 1). *KM* contains two types of equipment, the *A-unit* and *S-unit*. The *A-unit* is directly connected to the register. The connection between the *A-unit* and the *S-unit* can either be arranged directly or via a finder *SS*. The two units have the following functions:

A-unit Different types are provided for different signalling systems of the calling *FIR* such as decadic pulsing, *MFC* etc. The correct type of *A-unit* is connected via *REG* to the speech wires of this *FIR*. For decadic pulsing the *A-unit* repeats the *FIR* signals to the *S-unit*, but for *MFC* signalling makes a direct through-connection. After recoding in the *S-unit* the result is transmitted to *REG* via the *A-unit*, which directs the information to the correct store.

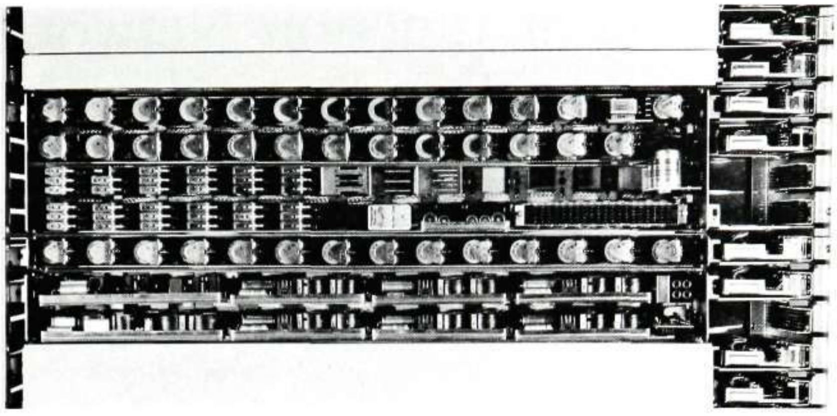
S-unit Also available in variant types matched to the register signalling systems; performs the recoding of information received.

Code Sender KS

Up to four types of code senders *KS* can be connected (two *KS* shown in fig. 1). A maximum of three types of *KS* can be connected to the same group of *SS* finders. If four *KS* groups are to be connected, a second *SS* group is required. One *KS* consists of two units with the following functions:

A-unit receives information from *REG* concerning the type of call, e.g. ordinary call from *KS*, switch-over from other *KS*, or test call. It

Fig. 2
ANA 12, code receiver equipment



stores information concerning the type of traffic and indicates, for example, which digit should be transmitted as first digit in the forward direction.

S-unit sends information in the forward direction in accordance with the signalling scheme of the outgoing line. For *MFC* or similar signalling it also receives signals in the backward direction.

Register Finder RS

Finder with 20-pole through-connection which connects *FIR* to *REG*.

Finder SS

10- or 20-pole finder which connects *REG* to *KS* or the *A-unit* in *KM* to its *S-unit*.

Summary

As a result of the well devised building block principle, a flexible register arrangement is obtained with a limited number of types of relay set, which however cover all requirements of different markets. In view of the uncertainty of future developments this choice of register arrangement permits simple addition or limited replacement of equipment when new system requirements and/or types of traffic arise.

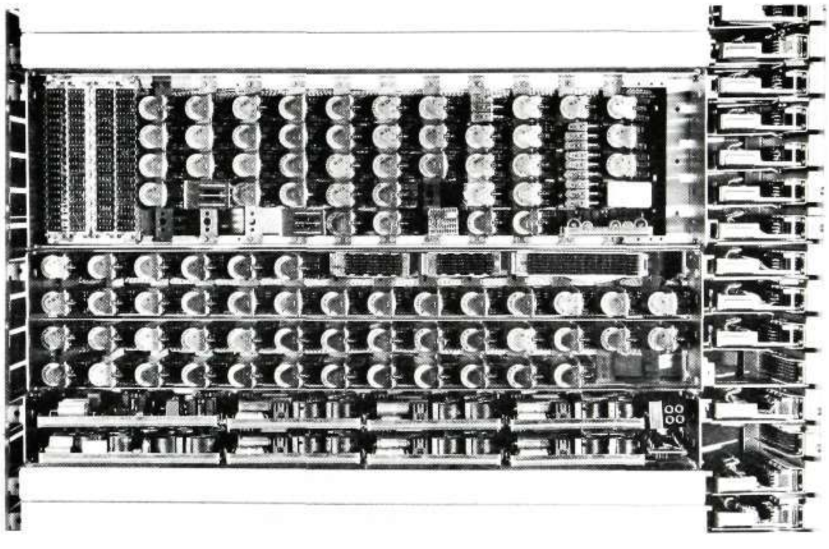


Fig. 3
ANA 12, code sender equipment

Planning of Junction Network with Non-Coincident Busy Hours

Y. RAPP, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.74 : 621.395.31
LME 83035 8073
8231

*In contradistinction to the planning of junction networks with coincident busy hours, which is done with the aid of a single value for the offered traffic between each pair of exchanges, the planning of a network with non-coincident busy hours has to be done with the aid of a traffic profile indicating the traffic during a number of time intervals.**

This involves a complication of the problem to such an extent that it is not possible to solve it by traditional methods.

Admittedly an algorithm for exact solution can be developed. But on account of the complicated nature of the problem a considerable calculation time is required on computers available at present.

For this reason an approximate method is presented in this paper, which seems to have an accuracy sufficient for practical applications.

A comprehensive account of the subject has been given in Ericsson Technics No. 1, 1971.

Coincident Busy Hours

In a network with coincident busy hours, in which the offered traffic between each pair of exchanges may be sufficiently described by a single value valid for one and the same busy hour, the planning is done as is known, by a successive treatment of triangles consisting of one high usage route and two tandem routes.

Fig. 1 shows such a triangle where i and j are exchanges and λ a tandem-stage.

The number of high usage circuits is obtained with good accuracy by the following approximate formula

$$F_n(A) = \varepsilon\eta \tag{1}$$

where

$F_n(A) = A \mid E_n(A) - E_{n+1}(A) \mid$ = improvement function

A = offered traffic between the exchanges i and j

n = number of high usage circuits

ε = cost ratio between incremental costs for high usage circuits (i—j) and tandem circuits (i—λ—j)

η = efficiency of incremental tandem (marginal utility)

$\varepsilon\eta$ = improvement factor

Comprehensive calculations on computer has shown[1,2] that

$$\eta = 1 - 0.3(1 - \varepsilon^2) \tag{2}$$

is a good approximation.

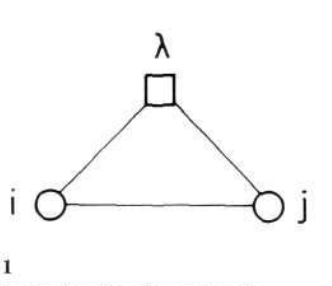


Fig. 1
A triangle in a junction network

i, j Exchanges
λ Tandem stage
ij First choice route
$i\lambda j$ Second choice route

* Extension of a paper "Planning of Junction Network with Non-Coincident Busy Hours" presented at the Sixth International Teletraffic Congress in Munich, September 9—15, 1970.

After having calculated the number of high usage circuits between all exchanges in the network in this way, the traffic rejected to the tandem routes can be calculated and the number of tandem circuits established with the aid of formulae loaned from traffic theory.

From the data regarding the state on the tandem routes it is possible to improve the result obtained with the approximate formulae (1) and (2) by using more sophisticated methods.[1–3]

Non-Coincident Busy Hours

In a network with non-coincident busy hours the traffic between each pair of exchanges has to be defined by a number of data, a *traffic profile*

$$|A| = |A^{(1)}, A^{(2)}, \ldots, A^{(\nu)}| \qquad (3)$$

valid for different time intervals, $t = 1, 2, \ldots, \nu$, in order to arrive at an optimal layout.

For any given number of high usage circuits between the exchanges it is possible to calculate for each tandem route a traffic profile

$$|M| = |M^{(1)}, M^{(2)}, \ldots, M^{(\nu)}| \qquad (4)$$

The maximum traffic, $\max_t |M|$, attained at a specific time interval t, is evidently decisive for determination of the number of tandem circuits. With known costs for high usage and tandem circuits, together with preassigned values for the permissible traffic losses, it is possible to determine the cost of the network for any preassigned number of high usage circuits.

But the inverse problem, viz. to determine the number of high usage circuits in such a way that the cost of the network is as small as possible, meets with difficulties. This because the specific time interval during which the maximum traffic on a tandem route will occur depends on the number of high usage circuits—which it is our task to determine.

Expressed in another way, one may say that the cost of the network cannot generally be expressed as a derivable function of the number of high usage circuits.

Numerical Example 1

Before going further, the nature of the problem will be elucidated by a simple numerical example.

Say that the traffic between three exchanges i, j, λ in fig. 1, of which λ contains a tandem stage is given during two time intervals $t = 1$, $t = 2$ according to table 1.

Table 1. Traffic profile between 3 exchanges

Traffic	Time interval t	
	$t = 1$	$t = 2$
A_{ij}	12	7
$A_{i\lambda}$, $A_{\lambda j}$	15	18

For simplicity it has been assumed that the traffic profiles for the tandem routes $i\lambda$, λj are identical.

Table 2. Traffic offered to the tandem routes

n = number of high usage circuits

Offered traffic	Time interval
$15+12\ E_n(12)$	$t=1$
$18+7\ E_n(7)$	$t=2$

A calculation shows that the traffic offered to the tandem routes according to table 2 is greatest during the time interval $t = 1$ as long as $n \leq 10$ and greatest during the time interval $t = 2$ as long as $n \geq 11$. From a table over the improvement function, $F_n(A)$, one finds that $n = 9$ as long as

$$F_9(12) = 0.7020 \leq \varepsilon\eta < 0.7468 = F_8(12)$$

and that $n = 12$ as long as

$$F_{12}(7) = 0.08896 \leq \varepsilon\eta < 0.1445 = F_{11}(7)$$

Comparing the incremental cost for $n = 10$ and $n = 11$ one finds them to be equal when $\varepsilon\eta = 0.289$.

From the above it is seen that the number of high usage junctions is determined according to table 3 for different values of the improvement factor ($\varepsilon\eta$).

Table 3. Number of high usage circuits for different values of the improvement factor $\varepsilon\eta$

Improvement factor, $\varepsilon\eta$	Number of high usage circuits, n
$\varepsilon\eta < 0.1445$	from $F_n(7) = \varepsilon\eta$
$0.1445 \leq \varepsilon\eta < 0.289$	$n = 11$
$0.289 \leq \varepsilon\eta < 0.702$	$n = 10$
$0.702 \leq \varepsilon\eta$	from $F_n(12) = \varepsilon\eta$

Fig. 2

Number of high usage juctions, n, as a function of the improvement factor, $\varepsilon\eta$, for traffic profiles on high usage and junction routes according to the example in table 1

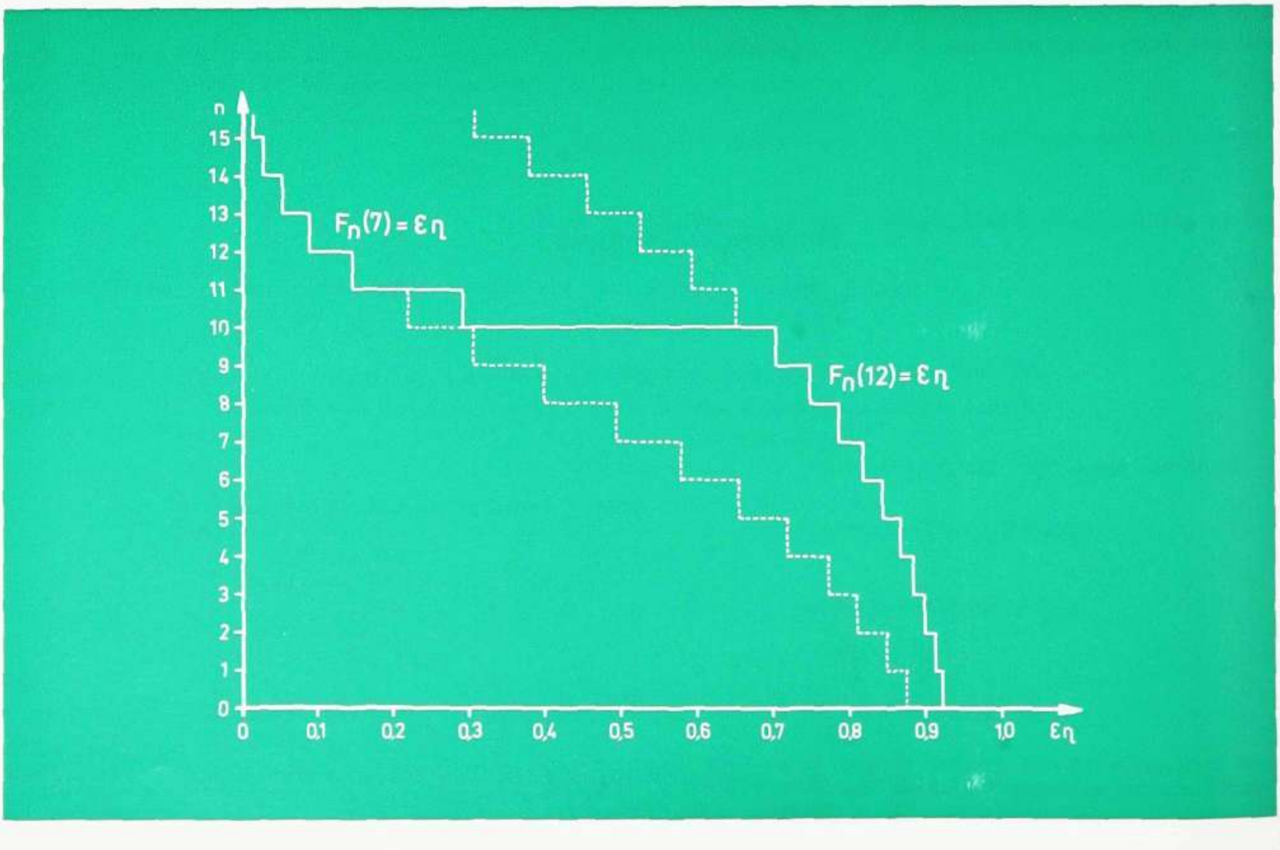


Fig. 2 summarizes the result of the calculations.

The example shows clearly that the number of high usage circuits cannot be determined in the usual way on the basis of a single value for the traffic between the exchanges. The absolute value of the traffic rejected to the tandem routes during different time intervals and for different numbers of high usage circuits must also be taken into account.

A Step towards an Exact Solution

The analysis above suggests the following algorithm for solving a problem of this simple kind when the improvement factor $(\varepsilon\eta)$ is given from the outset.

- Determine an interval (n_0, n_0+1) for the number of high usage junctions within which the traffic offered to the tandem routes intersects for the time intervals $t=1$ and $t=2$ respectively. (If no intersection point exists the traffic at one of the time intervals is dominant and the problem is solved in the usual way, cf. eq. (1).)
- Calculate $F_{n_0-1}(A^{(1)})$ and $F_{n_0+2}(A^{(2)})$ $\qquad (A^{(1)} > A^{(2)})$
- If $\varepsilon\eta \geq F_{n_0-1}(A^{(1)})$ calculate n from $F_n(A^{(1)}) = \varepsilon\eta$
- If $\varepsilon\eta < F_{n_0+2}(A^{(2)})$ calculate n from $F_n(A^{(2)}) = \varepsilon\eta$
- If none of these inequalities is fulfilled, calculate the cost for $n = n_0$ and $n = n_0 + 1$ and select the value for n which gives the lowest cost.

The described algorithm may be extended to be valid for several time intervals[4] (up to 24 for international circuits).

With several time intervals and many exchanges, however, this becomes a painstaking task. Furthermore, the complicated nature of the algorithm and the iterative process contained therein will lead to long running time on an electronic computer.

Therefore it seems worthwhile to look for an approximate method for the determination of the number of high usage circuits with an accuracy sufficient for practical applications.

In the next paragraph a proposal for such a solution is presented.

Approximate Formulae for Determination of the Number of High Usage Circuits

In order to calculate the number of high usage circuits the *time-dependent traffic* between two exchanges i and j

$$|A_{ij}| = A_{ij}^{(1)}, A_{ij}^{(2)}, \ldots, A_{ij}^{(\nu)}| \tag{5}$$

is replaced by a fictive *time-independent traffic*, $\bar{A}_{ij}$, according to the following heuristic formula

$$\bar{A}_{ij} = \frac{1}{2}\left|\max_t |A_{ij} + A_{i\lambda}^0| + \max_t |A_{ij} + A_{\lambda j}^0| - \max_t |A_{i\lambda}^0| - \max_t |A_{\lambda j}^0|\right| \tag{6}$$

where $|A_{i\lambda}^0|$ and $|A_{\lambda j}^0|$ are the traffics rejected to the tandem routes $i\lambda$ and λj, respectively, from all high usage routes except the route ij.

Using the value for the fictive traffic obtained from eq. (6) the number of high usage circuits, n_{ij}, is calculated from the formula

$$\boxed{F_{n_{ij}}(\overline{A}_{ij}) = \varepsilon\eta} \tag{7}$$

Calculation of a Junction Network

With the aid of eqs. (6) and (7) the number of high usage circuits in the multiexchange area is calculated iteratively in the following way:

- Put $n_{ij} = 0$ for all high usage circuits and calculate $|A^0_{i\lambda}|$ and $|A^0_{\lambda j}|$
- Calculate $\overline{A}_{ij}$ and n_{ij} from eqs. (6) and (7)
- Adjust the values for $|A^0_{i\lambda}|$ and $|A^0_{\lambda j}|$
- Repeat the calculations using again eqs. (6) and (7).

After determination of the number of high usage circuits in this way the maximum traffic (mean and variance) on the tandem routes is calculated, whereafter the number of circuits is determined with the help of formulae borrowed from the congestion theory[1–3] and a preassigned value for the permissible traffic losses.

Considerations Underlying the Formula for the Fictive Traffic, Eq. (6)

The construction of the heuristic formula for the fictive traffic, eq. (6), is based on the following considerations:

- For coincident busy hours $\overline{A}_{ij} = A_{ij}$ must be valid
- For entirely time separated traffic $(\overline{A}_{ij} = 0)$ must be valid as long as $A_{ij} \leq \min |A^0_{i\lambda}, A^0_{\lambda j}|$
- The type of formula chosen should probably have a certain similarity to the expression for the necessary traffic handling capacity in a simple symmetrical network.[4]

Numerical Example 2

The traffic profile between three exchanges is given in table 4 and one wishes to determine the fictive time-independent traffic, $\overline{A}_{ij}$ and the number of high usage circuits, n_{ij}, for an improvement factor $\varepsilon\eta = 0.4$

Table 4. Traffic profile for three exchanges

Traffic	Time interval t		
	t'	t''	t'''
$\vert A_{ij}\vert$	24	5	3
$\vert A^0_{i\lambda}\vert$	18	32	17
$\vert A^0_{\lambda j}\vert$	29	6	46

One obtains

$$\max_t |A_{ij} + A^0_{i\lambda}| = 24 + 18 = 42 \qquad t = t'$$

$$\max_t |A_{ij} + A^0_{\lambda j}| = 24 + 29 = 53 \qquad t = t'$$

$$\max_t |A^0_{i\lambda}| = 32 \qquad t = t''$$

$$\max_t |A^0_{\lambda j}| = 46 \qquad t = t'''$$

Eq. (6) gives

$$\bar{A}_{ij} = \frac{1}{2}(42 + 53 - 32 - 46) = 8.5$$

If the improvement factor is $\varepsilon\eta = 0.4$, one obtains from eq. (7) $F_n(8.5) = 0.4$ and $n = 10$.

A check made by calculation of the cost for different numbers of high usage junctions ($n_{ij} = 0, 1, 2, \ldots$) gave the result shown in table 5.

Table 5. Check of the numerical example
Grade of service on the tandem routes $E_{i\lambda} = E_{\lambda j} = 0.005$

Variance to mean ratios on the tandem routes	Optimum numbers of high usage circuits	Cost penalty in percent for $n = 10$
1	9	0.3
2	7	0.9

In the next paragraph an account of a computerized numerical check of the proposed approximate method will be given.

Numerical Check of the Proposed Approximate Method

A check of the cost penalty resulting from the use of the proposed approximate method for planning of junction networks with non-coincident busy hours has been made with triplets of random numbers satisfying the following constraints:

$$2 \leq \max_t |A_{ij}| \leq 50$$

$$10 \leq \max_t |A^0_{i\lambda}|, \ \max_t |A^0_{\lambda j}| \leq 100$$

$$\max_t |A_{ij}| \leq \max_t |A^0_{i\lambda}|, \ \max_t |A^0_{\lambda j}|$$

$$A_{ij}, A^0_{i\lambda}, A^0_{\lambda j} \geq 1$$

$$E_{i\lambda}, E_{\lambda j} = 0.005$$

At the same time random number for the variance to mean ratio on the tandem routes were generated fulfilling the condition

$$1 \leq \frac{V^0_{i\lambda}}{A^0_{i\lambda}}, \ \frac{V^0_{\lambda j}}{A^0_{\lambda j}} \leq 3$$

to be used for the check of the result obtained from the approximate formulae (6) and (7).

The result of the check is summarized in table 6.

Table 6. Cost penalty in percent for the approximate formula (4.3)

ε = cost ratio between high usage and tandem circuits

k = cost ratio between tandem circuits

Percentile 99 % = upper limit of cost increase for 99 % of examined 2000 triplets of random numbers examined for each value of ε and k

Total of cases tested: $2000 \cdot 3 \cdot 9 = 54{,}000$

Mean error in the determination of number of high usage circuits +1.2
standard deviation $\sigma = 3.4$

ε	$k = 1$			$k = 1.5$			$k = 2$		
	Mean value	Max value	Percentile 99 %	Mean value	Max value	Percentile 99 %	Mean value	Max value	Percentile 99 %
0.30	0.16	2.97	1.80	0.20	3.38	2.30	0.26	4.46	2.70
0.35	0.14	3.50	1.50	0.19	3.93	1.90	0.28	4.42	2.40
0.40	0.13	3.57	1.60	0.20	3.98	1.70	0.30	4.56	2.20
0.45	0.15	3.59	1.70	0.22	3.94	1.90	0.31	4.54	2.30
0.50	0.21	3.78	1.60	0.24	4.60	2.20	0.32	5.25	2.80
0.55	0.27	3.61	1.90	0.28	4.36	2.50	0.33	5.73	3.20
0.60	0.31	4.08	2.30	0.32	5.02	2.90	0.34	6.61	3.50
0.65	0.35	3.69	2.70	0.35	5.82	3.20	0.36	7.39	3.80
0.70	0.37	4.44	3.10	0.37	6.52	3.20	0.37	8.05	3.90

As seen, the mean cost penalty for the 54,000 cases examined does not exceed 0.5 %.

In this context it may be of interest to note that other methods for calculating the number of high usage circuits, for instance proceeding from the maximum, mean or minimum value for the offered traffic and using eq. (1), give a considerably lower accuracy.

A calculation under simplified assumptions embracing 5000 triplets of random numbers for the traffic on the high usage and tandem routes, during three different time intervals gave the result shown in table 7.

Table 7. *Cost penalty in percent resulting from the use of different approximative* methods for determination of the number of high usage circuits

Cost ratio $\varepsilon = 0.5$, $k = 1$

Marginal utility $\eta = 0.8$

No regard to the variance of the traffic on the tandem routes

No. of tandem circuits $= L(1/\eta \cdot A)$, a linear function of the offered traffic

Cost penalty	Proposed method eqs. (6) and (7)	Traffic on high usage route		
		max	mean	min
Mean value	0.1	3	1	2
Max value	1	30	11	27

From the table it is seen that a determination of the number of high usage circuits on the basis of the maximum value of the offered traffic between the exchanges gives the worst result.

References

1. Rapp, Y.: *Planning of Junction Network in a Multi-Exchange Area. I. General Principles.* Ericsson Tech. *20*(1964): 1, pp. 77—130.
2. Rapp, Y.: *Planning of Junction Network in a Multi-Exchange Area. II. Extensions of Principles and Applications.* Ericsson Tech. *21*(1965): 2, pp. 187—240.
3. Wallström, B.: *Methods for Optimizing Alternative Routing Networks.* Ericsson Tech. 25(1969): 1, pp. 3—28.
4. Rapp, Y.: *Planning of Junction Networks with Non-Coincident Busy Hours.* Ericsson Tech. *27*(1971): 1, pp. 3—23.

ERICSSON *News*

from All Quarters of the World

Telecommunications Package from LM Ericsson in New Swedish Parliament

King Gustav Adolf is shown the voting system by Mr Erkki Mikkelinen during his visit to the new parliament.

There are many impressive features in the new parliament building at Sergels Torg, not least the telecommunications equipment, which is the most extensive of its kind in Sweden. Thanks to meticulous planning, the suppliers, L M Ericsson Telemateriel AB, were able to install the whole of the equipment in as short a time as 15 months. A computer had to be used for planning of the main item, the voting system.

The complete "package" consists of a score of telecommunications systems, of which the voting system is the largest item and, like many of the other systems, is tailored for its purpose.

Contacts between the Swedish parliament and L M Ericsson are of old date. In the early thirties L M Ericsson delivered the first voting system and in 1966 a second voting system to the Swedish parliament.

The new voting system for the single-chamber parliament and its 350 members collects, records, distributes and photographs the results of every vote. The members can throughout follow the voting on a panel behind the speaker's chair. After automatic counting of the votes the result is displayed via TV cameras and a large screen projector on a screen above the voting panel and on a small panel on the speaker's desk, as well as on all TV monitors in the podium and outside the chamber. At the same time a panel showing the vote cast by each member and identifying the question voted on is automatically photographed. The voting system is, of course, provided with extensive alarm and control equipments to avoid breakdowns to the greatest possible extent. 30,000 m of cable was used for the voting system alone.

Apart from the large voting system L M Ericsson's "telecommunications package" contains many types of equipment, among which a sound distribution system through which speech is relayed from microphones to 507 loudspeakers in the chamber and by radio the 536 loudspeakers in the members' rooms and elsewhere.

(cont. p. 76)

From the chamber, where Tage Erlander, senior member of parliament, bids the members welcome to the new single-chamber parliament at its opening on January 11, 1971.

Large Order from Swedish Telecommunications Administration

The Swedish Telecommunications Administration has ordered from L M Ericsson equipment for extension and modernization of the long-distance network to a value of about 80 million kronor. The order comprises carrier equipment for 135 repeater stations, 50 of which are new stations.

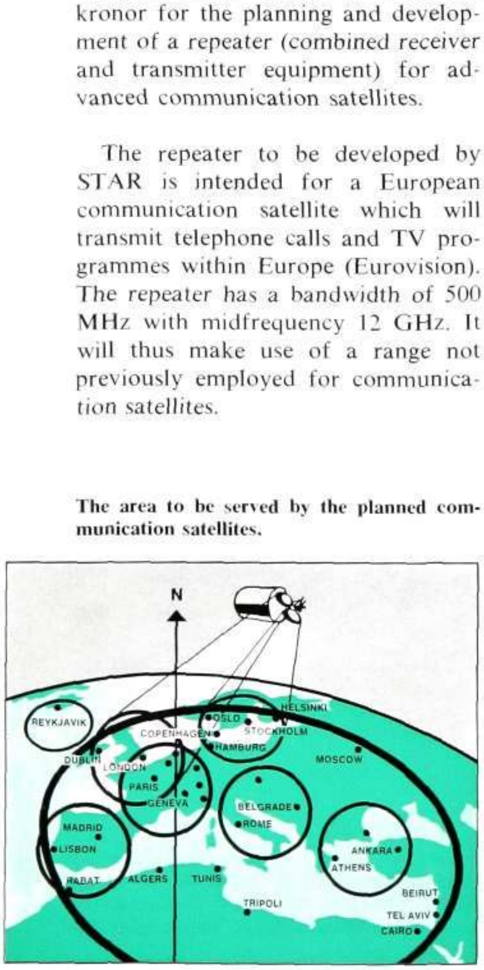
The equipment on order will be delivered over a three-year period starting at the end of this year. The equipment was designed to specifications drawn up jointly by the Administration and L M Ericsson.

Two Important ESRO Assignments for Space Group

The electronics enterprises within the STAR consortium (Satellite for Telecommunications Applications and Research) have received from ESRO (European Space Research Organization) an order valued at 8 million kronor for the planning and development of a repeater (combined receiver and transmitter equipment) for advanced communication satellites.

The repeater to be developed by STAR is intended for a European communication satellite which will transmit telephone calls and TV programmes within Europe (Eurovision). The repeater has a bandwidth of 500 MHz with midfrequency 12 GHz. It will thus make use of a range not previously employed for communication satellites.

The area to be served by the planned communication satellites.



The STAR consortium was created in January this year to develop equipment for advanced telecommunication satellites. L M Ericsson is Swedish member of the consortium, on which there are eight other European enterprises from seven countries.

A first step has now been taken towards the realization of a European telecommunication system with satellites. ESRO have commissioned STAR to investigate the technical problems that must be solved for the effective and economical development of a complete telecommunication system for Europe, consisting of satellites and ground stations.

It is expected that the investigations will be completed during 1971. The system will be based on a very advanced satellite technique, using an entirely new frequency range (12—13 GHz). It is planned that the satellite system shall be brought into use during 1978 and that it will transmit part of the telephone traffic between the European capitals and will also be used for international European TV transmissions within Eurovision.

L M Ericsson's new factory at Kuala Lumpur, Malaysia.

Opening of L M Ericsson Factory in Malaysia

A new L M Ericsson factory for telecommunications material, especially automatic telephone exchange equipment, has been opened in the Malaysian capital, Kuala Lumpur. The opening ceremony was presided over by the Prime Minister, Tun Abdul Razak, in the presence of, among others, the Ministers of Industry and Communications and around 300 other prominent guests.

The factory will initially employ about 150 persons, apart from some 40 employees of L M Ericsson's sales company in Malaysia. The head of the factory and the sales company is Allan Uvhagen.

The factory in Kuala Lumpur is the 26th foreign production unit of the Ericsson Group. Under a general agreement drawn up in 1967 L M Ericsson will deliver during the 5-year period 1967—1972 equipment for public telephone exchanges for 110,000 subscriber lines in Malaysia. The decision to build the new factory was made after a new general agreement had been drawn up in December 1969, comprising equipment for an additional 150,000 subscriber lines for installation during the period 1972—1979.

New Order from Kuwait

L M Ericsson has received from Kuwait an order for telephone exchange equipment to a value of 13.7 million kronor. The order comprises equipment for extension of four existing telephone exchanges. All material on the order will be delivered from L M Ericsson's factories in Sweden.

The new order implies that L M Ericsson retains its leading position as supplier of telecommunications equipment in Kuwait. Its products were introduced in Kuwait as late as 1966, despite which, after implementation of the new order, LME will have delivered equipment for althogether 88,000 of the roughly 128,000 subscriber lines which are then expected to be in operation in the country. Kuwait has a very high telephone density and is rapidly approaching European levels. Within a year or so it is expected to have reached a density of 20 telephones per 100 inhabitants, roughly the same figure as for West Germany. The entire telephone system in the country is automatic.

On December 2, 1970, L M Ericsson's main plant in Stockholm was visited by the French Ambassador, M. P. Francfort, who is here seen with Mr C.-H. Ström, L M Ericsson.

In March L M Ericsson was visited by representatives of the Dutch PTT. (From left) Fred Sundkvist, Vice President of L M Ericsson, A. van Bruggen, Vice President of Ericsson Telefoonmaatschappij, H. Reinoud, Director General of the Dutch PTT, and Björn Lundvall, President of L M Ericsson.

In the last week of February an "Electronic Components" exhibition was held at the US Trade Center in Stockholm. The US Ambassador, Jerome Holland, is seen with Dr Chr. Jacobæus, Technical Director of L M Ericsson, at the opening ceremony.

The South Korean Ambassador, H. E. Droon Bong Kang, trying out an old model of a telephone set during his visit to Midsommarkransen on Feb. 17, 1971.

L M Ericsson's new office building, "Centro Ericsson", in São Paulo, Brazil, has now been completed. It at present houses some 700 persons but can accommodate roughly twice this number. ➤

L M Ericsson's intercom telephones, Centrum and Dirivox, are now made also with jacaranda casing. This elegant variant of the two models has been very highly appreciated especially in the USA, which is L M Ericsson's largest export market for intercom telephones. Each model is provided with a handset.

Licence Agreement with National Semiconductor Corporation

L M Ericsson's subsidiary AB Rifa, which in recent times has been very active within the field of integrated circuits, has taken further measures to quickly establish itself as a large-scale manufacturer. A licence agreement has been signed with National Semiconductor Corporation, Santa Clara, USA, under which Rifa will have access to know-how and designs of bipolar digital integrated circuits. Factory buildings totalling more than 5,000 m² are being erected at Bollmora and Solna for the purpose. Full-scale production of monolithic integrated circuits is expected to start before the end of 1971.

Telecommunications Equipments for Hospitals

L M Ericsson Telemateriel AB are at present working on a number of telecommunications systems for large hospitals. The Karolinska Hospital in Stockholm will soon have available the first stage, comprising 1890 lines, of Sweden's largest intercom system. When fully extended it will comprise 5,400 lines.

The Jakobsberg Hospital has recently been opened with an extensive telecommunications package from L M Ericsson, and for the Central Skövde Hospital telecommunications equipment has been ordered comprising, among other items, intercom, visual nurse call and paging systems, sound distribution equipment including radio and sound amplifiers, master clock with electronic control equipment, and fire and burglar equipment.

Ericsson Technics

Ericsson Technics No. 1, 1971, which was recently issued, contains two papers.

In the first, by Y. Rapp, *Planning of Junction Network with Non-Coincident Busy Hours*, a heuristic method is presented for planning of junction networks when the traffic between the exchanges is defined by traffic profiles with non-coincident busy hours.

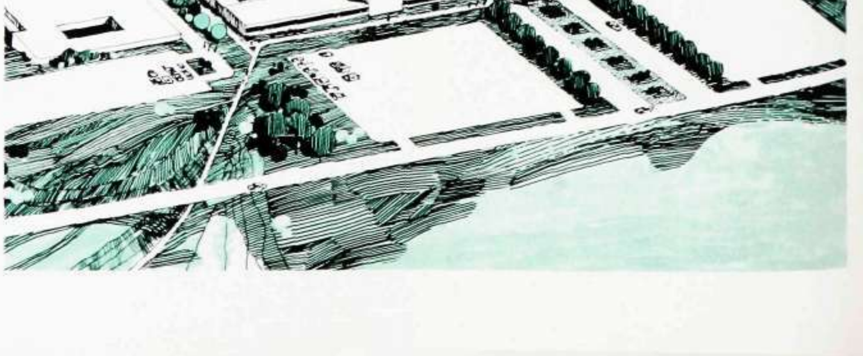
The second paper, by S. Hellström, *The Frequency Change Due to Small Component Variations in Passive RC Twin-T Filters with π Rad Phase Shift*, presents expressions for frequency and attenuation as functions of the component values, after which the effect of small variations in the latter on the frequency is shown. The derivations are made with regard to applications in hybrid circuits.

Telecommunications package . . . (Cont. from page 73)

Communication on all floors and with all modern aids has been the aim in the design of the telecommunications equipment for the new parliament building. In whatever room or corridor a member happens to be, he will be accessible on intercom, PAX or paging system. The work in the chamber can be followed on internal TV both inside and outside the chamber. A system for simultaneous interpretation in five foreign languages as well as Swedish is also installed, as also a system for exact time indication on about 300 clocks.

The value of the system delivered by L M Ericsson Telemateriel AB amounts to some 5 million kronor. The project has been in the hands of a special project group within the company under the leadership of Erkki Mikkelinen.

Central Skövde Hospital, the first stage of which is expected to be completed in 1973.



Associated and co-operating enterprises and technical offices

EUROPE

DENMARK

L M Ericsson A/S *DK-2000 København F*, Finsensvej 78, tel: (01) 34 6868, tgm: ericsson, telex: 9020 "ERICSSON KH"

GNT AUTOMATIC A/S *DK-2860 Søborg*, Telefonvej 6, tel: (01) 69 5188, tgm: nortelmatic, telex: 5264, "GNT AUTOMATIC KH"

Dansk Signal Industri A/S *DK-2650 Hvidovre*, Stamholmen 175, Avedøre Holme, tel: (01) 49 0333, tgm: signaler københavn, telex: 6503, "6503 DSI DK"

FINLAND

O/Y L M Ericsson A/B *Helsinki 13*, P.O.B. 13018, tel: (90) 121 41 tgm: ericsons, telex: 12546, "LME SF"

FRANCE

Société Française des Téléphones Ericsson
F-92 Colombes, 36, Boulevard de la Finlande, tel: Paris (1) 781 3535, tgm: ericsson colombes, telex: 62179, "ERICSSON CLOMB"

F-75-Paris 17e, 147, rue de Courcelles, tel: Paris (1) 227 9530, tgm: eric paris, telex: 29276, "ERICSSON PARIS"

Etablissements Ferrer-Auran, *13 Marseille*, 2, Rue Estelle, tel: 20 6940, tgm: etabferrer, telex: 42579, "RINGMARS"

GREAT BRITAIN

Swedish Ericsson Company Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Telecommunications Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Production Control (Ericsson) Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: productrol, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Rentals Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: celefon, telex: 935979 "SWEDERIC LDN"

IRELAND

L M Ericsson Ltd. *Dublin 2*, 32, Upper Mount Street, tel: (01) 619 31, tgm: ericsson, telex, 5310, "LMI EI"

ITALY

FATME, Soc. per Az. *1-00100 Roma*, C. P. 4025 Appio, tel: (06) 4694, tgm: fatme, telex: 61327, "61327 FATME"

SETEMER, Soc. per Az. *1-00198 Roma*, Via G. Paisiello 43, tel: (06) 86 8854, tgm: setemer

SIELTE, Soc. per Az. *I-00100 Roma*, C.P. 5100, tel: (06) 577 8041, tgm: sielte, telex: 61225, "61225 SIELTE"

NETHERLANDS

Ericsson Telefoonmaatschappij N.V. *Rijen (N.Br.)*, P. O. B. 8, tel: (01612) 3131, tgm: erictel, telex: 54114, "ETMRY NL"

Voorburg 2110, P. O. B. 60, tel: (070) 81 4501, tgm: erictel den haag, telex: 31109, "ERICTEL DEN HAAG"

NORWAY

A/S Elektrisk Bureau *Oslo 3, P.B.* 5055 Maj, tel: (02) 46 1820, tgm: teleb, telex: 11723, "TELEB N"

A/S Industrikontroll *Oslo 6*, Grensevejen 86/88, 3. etg., tel: (02) 68 7200, tgm: indtroll

A/S Norsk Kabelfabrik *Drammen*, P.O.B. 369, tel: (02) 83 7650, tgm: kabel, telex: 18149, "KABEL N".

A/S Telesystemer *Oslo 6*, Tvetenveien 32, Bryn, tel: (02) 68 7200, tgm: telesystemer, telex: 16900, "ALARM N"

POLAND

Telefonaktiebolaget L M Ericsson, Technical Office *Warszawa*, Ul. Nowy Swiat 42, tel: 26 4926, tgm: tellme, telex: 813710, "813710 TELLME PL"

PORTUGAL

Sociedade Ericsson de Portugal Lda. *Lisboa 1*, Rua Filipe Folque 7, 1°, tel: 56 3212, tgm: ericsson

SPAIN

Industrias de Telecomunicación, S.A. *Getafe*, Paseo Felipe Calleja 6, tel: 295 2100, tgm: ericsson, telex: 22666, "ERIGE E"

L M Ericsson, S.A. *Getafe*, Paseo Felipe Calleja 6, tel: 295 2100, tgm: ericsson, telex: 22666, "ERIGE E" PARA LES

SWEDEN

Telefonaktiebolaget L M Ericsson, *S-126 11 Stockholm 32*, tel: (08) 19 0000, tgm, telefonbolaget, telex: 17440, "LME S"

ELLEMTEL Utvecklings Aktiebolag *S-127 25 Skärholmen* Box 249, tel: (08) 97 0220

Bjurhagens Fabrikers AB *S-212 15 Malmö*, Fack, tel: (040) 93 4770

AB Rifa *S-161 30 Bromma 11*, tel: (08) 26 2600, tgm: elrifa, telex: 10308, "ELRIFA STH"

L M Ericsson Instruktionsteknik AB *S-117 47 Stockholm 44*, tel: (08) 68 0870, tgm: instruktec

L M Ericsson Telemateriel AB *S-135 01 Stockholm-Tyresö 1*, Fack, tel: (08) 712 0000 tgm: ellem, telex: 1275, "1275 TELERGA S"

Sieverts Kabelverk AB *S-172 87 Sundbyberg*, tel: (08) 28 2860, tgm: sievertsfabrik, telex: 1676, "SIEVKAB STH"

Svenska Radio AB *S 102 20 Stockholm 12*, tel: (08) 22 31 40, tgm: svenskradio, telex: 10094 "SRA S"

AB Thorsman & Co. *S-611 01 Nyköping 1*, Box 149, tel: (0155) 810 00, tgm: thorsmanco

AB Transvertex *S-140 11 Vårby*, Fittja industriområde, tel: (08) 710 0935

SWITZERLAND

Ericsson A.G. *8061 Zurich*, Postfach, tel: (051) 41 6608, tgm: telericsson, telex: 52669, "ERIC CH"

TURKEY

Ericsson Türk Ticaret Ltd. Sirketi *Ankara*, Rumeli Han, Ziya Gökalp Cad. tel: 12 3170, tgm: ellem

WEST GERMANY

Deutsche Ericsson G.m.b.H. Telematerial, *4 Düsseldorf 1*, Postfach 2628, tel: (0211) 35 3594, tgm: eric-tel: telex: 8587912, "ERIC D"

Ericsson Centrum G.m.b.H. *3 Hannover*, Dornierstrasse 10, Postfach, tel: (0511) 63 1018, tgm: ericen, telex: 0922913, "ERICE D"

ASIA

INDIA

Ericsson India Private Limited *Calcutta*, P.O.B. 2324, tel: (032) 45 4494, tgm: inderic

New Delhi 16, L25, South Extension Part II, tel: (011) 62 6505, tgm: inderic

INDONESIA

Ericsson Telephone Sales Corporation AB
Djakarta, P.O.B. 2443, tel: (07) 463 97, tgm: javeric, telex: 4414 "JAVERIC DKT 4414"

Bandung, Djalan Ir. H. Djuanda 151, tel: (082) 820 94, tgm: javeric

IRAQ

Telefonaktiebolaget L M Ericsson, Installation Branch *Baghdad* P.O.B. 2388, Alwiyah, tel: 947 14, tgm: ellemco

KUWAIT

Telefonaktiebolaget L M Ericsson, Technical Office *Kuwait, State of Kuwait*, P.O.B. SAFAT No. 5979, tel: 200 74, tgm: erictel

LEBANON

Société Libanaise des Téléphones Ericsson *Beyrouth* B.P. 8148, tel: 25 2627, tgm: ellem, telex: LE 20876, "ELLEM"

MALAYSIA

Ericsson Talipon SDN BHD *Petaling Jaya*, P.O.B. No 9, tel: Kuala Lumpur (03) 56 1523, tgm: kuleric, telex: 265 "ERICMAL KL"

Telecommunication Manufacturers (Malaysia) SDN BHD *Petaling Jaya*, P.O.B. 9, tel: Kuala Lumpur (03) 56 1523, tgm: kuleric, telex: 265, "ERICMAL KL"

PAKISTAN

L M Ericsson Telephone Company, Technical Office *Karachi*, P.O.B. 7398, tel: (90) 51 6112, tgm: ericsson

SINGAPORE

Telephone Industries of Singapore Private Ltd. *Singapore 1*, P.O.B. 3079, tel: 98 1155, tgm: telsin

THAILAND

Ericsson Telephone Corp. Far East AB *Bangkok*, P.O.B. 824, tel: (02) 580 41, tgm: ericsson, telex: 2274, "THAIERIC"

AFRICA

ALGERIA

Société Algérienne des Téléphones Ericsson *El Biar (Algers)*, 4, rue Mouloud Hadjen, tel: 78 2692, tgm: eric alger

EGYPT (UAR)

Telefonaktiebolaget L M Ericsson, Technical Office Egypt Branch *Cairo* P.O.B. 2084, tel: (02) 465 83, tgm: ericgypt, telex: 2009, "ELLEME UN"

ETHIOPIA, SUDAN

Telefonaktiebolaget L M Ericsson, Technical Office *Addis Ababa*, P.O.B. 3366, tel: (01) 492 60, tgm: ericsson, telex: 21090 "MOSFIRM ADDIS"

MALAWI

Ericsson Telephone Sales Corporation AB *Blantyre*, P.O.B. 431, tel: 300 95, tgm: ericofon

MOROCCO

Société Marocaine des Téléphones Ericsson *Casablanca*, 87, Rue Karatchi, tel: 788 75, tgm: ericsson

TUNISIA

Telefonaktiebolaget L M Ericsson, Technical Office, *Tunis*, Boite Postale 780, tel: (01) 24 0520, tgm: ericsson, telex: 695, "ERICSSON TUNIS".

ZAMBIA

Ericsson Telephone Sales Corporation AB
Lusaka, P.O.B. 2762, tel: (146) 744 42, tgm: ericofon

Ndola, P.O.B. 2256, tel: (143) 3885, tgm: ericofon

AMERICA

ARGENTINE

Cía Ericsson S.A.C.I. *Buenos Aires* Casilla de Correo 3550, tel: 33 2071, tgm: ericsson, telex: 0122196, "CATEL BA"

Cía Argentina de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Cía Entrerriana de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Industrias Eléctricas de Quilmes S.A. *Quilmes FNGR*, 12 de Octubre 1090, tel: 253 2775, tgm: indelqui buenosaires, telex: 0122196, "CATEL BA"

BRAZIL

Ericsson do Brasil Comércio e Indústria S.A. *São Paulo*, C.P. 5677, tel: 221 9477, tgm: ericsson, telex: 021817, "ERICSSON SPO"

Fios e Cabos Plasticos do Brasil S.A. (FICAP) *Rio de Janeiro*, caixa postal: 1828, tel: 29 0185, tgm: ficap, telex: 031563, "FICAP RIO"

CANADA

L M Ericsson Limited *Montreal 381, Quebec*, 2300 Laurentian Boulevard St. Laurent, tel: (514) 331 3310, tgm: caneric, telex: 05-267682, (TWX) 610-421-3311, "CANERIC MTL"

CENTRAL AMERICA

Telefonaktiebolaget L M Ericsson, Oficina Tecnica de Centroamérica *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson, telex: 20087, "ERICSAL 20087"

CHILE

Cía Ericsson de Chile S.A. *Santiago*, Casilla 10143, tel: (04) 825 55, tgm: ericsson, telex: SGO 389, "ERICHILE SGO389"

COLOMBIA

Ericsson de Colombia S.A. *Bogotá*, Apartado Aéreo 4052, tel: (92) 41 1100, tgm: ericsson, telex: 044507, "ERICSSON BOG"

Fábricas Colombianas de Materiales Eléctricos Fácomec S.A. *Cali*, Apartado Aéreo 4534, tel: 42 1061, tgm: facomec, telex: 55673, "FACOMEC CLO"

COSTA RICA

Telefonaktiebolaget L M Ericsson, Technical Office *San José*, Apartado 10073, tel: 21 1466, tgm: ericsson

ECUADOR

Teléfonos Ericsson C.A.
Quito, Casilla 2138, tel: 52 4000, tgm: ericsson

Guayaquil, Casilla 376, tel: 52 6900, tgm: ericsson

Cont. on next page

Associated and co-operating enterprises and technical offices (Cont. from preceding page)

MEXICO

Teléfonos Ericsson S.A. *Mexico D.F.*, Apartado Postal 9958, tel: (25) 46 4640, tgm: coeric, telex: 01772485, "ERICSSON MEX" PARA COERIC

Latinoamericana de Cables S.A. de C.V. *Mexico 12 D.F.*, Apartado Postal 12737, tel: (2) 549 3650, tgm: latincasa, telex: 01772485, "ERICSSON MEX" PARA LATINCASA

Teleindustria, S.A. de C.V. *Mexico 1, D.F.*, Apartado Postal 1062, tel: (2) 546 4640, Factory: (2) 576 3166, tgm: ericsson, telex: 01772485, "ERICSSON MEX"

Telemontaje, S.A. de C.V. *Mexico 1, D.F.*, Apartado Postal 1062, tel: (2) 576 4044, tgm: ericssonmexicodf, telex: 01772485, "ERICSSON MEX" PARA TELEMONTAJE

PANAMA

Telefonaktiebolaget L M Ericsson, Oficina Técnica de Panamá *Panama 5, R.P.* Apartado 4349, tel: 64 3600, tgm: ericsson, telex: 368674 "368674 SONITEL"

PERU

Cia Ericsson S.A. *Lima*, Apartado 2982, tel: 31 1005, tgm: ericsson, telex: 3540202, "ERICSSON 3540202"

Soc. Telefónica del Perú, S. A. *Arequipa*, Apartado 112-1012, tel: 6060 tgm: telefonica

EL SALVADOR

Telefonaktiebolaget L M Ericsson, Technical Office *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson

URUGUAY

Cía Ericsson S.A. *Montevideo*, Casilla de Correo 575, tel: 926 11, tgm: ericsson, telex: 398228, "ROULEMENT UY" PARA MELANDER

USA

The Ericsson Corporation *New York, N.Y. 10017*, 100 Park Avenue, tel: (212) 685 4030, tgm: erictel, telex: 620484, "ERICTEC 620484"

Ericsson Centrum Inc. *New York, N.Y. 10016*, 16, East 40th Street, tel: (212) 679 1000, tgm: erictel, telex: 620149, "ETELSAC 620149"

VENEZUELA

Cía Anónima Ericsson *Caracas*, Apartado 70516, tel: (02) 34 4661, tgm: ericsson, telex: 22734, "22734 ERIC VEN"

Alambres y Cables Venezolanos C.A. (ALCAVEL) *Caracas*, Apartado del Este 62107, tel: (02) 33 9791, tgm: alcave, telex: 845, "ALCAVE VE"

AUSTRALIA & OCEANIA

AUSTRALIA

L M Ericsson Pty Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: ericmel, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: ericsyd, telex: AA 21358 "ERICSYD"

Port Moresby, Territory of Papua and New Guinea, P.O.B. 5602 Boroko, tel: 565 66, tgm: ericpor, telex: 153

Teleric Pty. Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: teleric, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: teleric, telex: AA 21358, "ERICSYD"

Conqueror Cables Pty. Limited *Dee Why, N.S.W. 2099*, P.O.B. 69, tel: (02) 98 0364, tgm concab sydney

A.E.E. Capacitors Pty. Ltd. *Preston, Victoria 3072*, 202 Bell Street, P.O.B. 95, tel: (03) 480 1211, tgm: engiquip melbourne

Representatives

EUROPE

AUSTRIA

Telecom Handelsgesellschaft m.b. H. *1160 Wien*, Postfach 98, tel: (0222) 43 5956, tgm: teleric, telex: 75976), "75976 TELECOM A"

BELGIUM

Allumage Lumière S.A. *Bruxelles 7*, 128-130 Chaussée de Mons, tel: 22 9870, tgm: allumalux, telex: 21582, "ALLUMALUX BRU"

GREECE

Angelos Cotzias *Athens*, 18, Odos Omirou, tel: (021) 62 6031, tgm: cotziasan, telex: 215252, "215252 CTS GR"

ICELAND

Johan Rönning *Reykjavik*, P.O.B. 5300, tel: 254 00, tgm: rönning, telex: 2040, "ROENNG IS"

SPAIN

TRANSA Transacciones Canarias S.A.

Las Palmas de Gran Canarias, Tomas Morales 38, tel: 21 8508, tgm: transa, telex: 95024, "MAVAC E"

Santa Cruz de Tenerife, Sabino Berthelot, 3, tel: 24 2596, tgm: transa, telex: 95024, "MAVAC E"

YUGOSLAVIA

Merkantile Inozemna Zastupstva Zagreb pošt pretinac 23, tel: (041) 41 6655, tgm: merkantile, telex: 21139, "21139 YU MERTIL"

Beograd, Ul. 7. jula br. 18, tel: (011) 62 1773, tgm: merkantile, telex: 11506, "YU MERKAN"

ASIA

BAHRAIN & TRUCIAL STATES

Yusuf Bin Ahmed Kanoo *Bahrain, Arabian Gulf*, tel: 40 8188, tgm: kanoo, telex: BHN 215

BURMA

Myanma Export Import Corp., Agency Div. *Rangoon*, P.O.B. 404, tel: 146 18, tgm: myanimport

CAMBODIA

Comin Khmere S.A. *Phnom-Penh*, P.O.B. 625, tel: 233 34, tgm: engineer

CYPRUS

S.A. Petrides & Sons Ltd. *Nicosia*, P.O.B. 4522, tel. 627 88, tgm: armature, telex: 2308, "ARMATURE"

HONG KONG AND MACAO

Swedish Trading Co. Ltd. *Hong-Kong*, P.O.B. 108, tel: 23 1091, tgm: swedetrade

IRAN

Irano Swedish Company AB *Teheran*, Khiabane Sevom Esfand 29, tel: 31 4160, tgm: iranoswede

JORDAN

The Arab Trading & Development Co. Ltd. *Amman*, P.O.B. 6141, tel: 259 81, tgm: aradeve

KUWAIT

Morad Yousuf Behbehani *Kuwait, State of Kuwait*, P.O.B. 146, tel: 270 71, tgm: barakat, telex: 048, "BEHBEHANI KUWAIT"

LEBANON

Swedish Levant Trading (Elié B. Hélou) *Beyrouth*, P.O.B. 931, tel: 23 1624, tgm, skefko

PAKISTAN

Panasian Marketing Service Ltd. *Karachi*, P.O.B. 3941, tel: (90) 51 2051, Ext. 53, tgm: panasian

PHILIPPINES

USI Asia Industries, *Makati, Rizal*, P.O.B. 1322, tel: 87 7011, tgm: usi asia, telex: 7222233, "7222233 AII PH"

SAUDI ARABIA

Engineering Projects & Products Co. Ltd. (Eppco)

Riyadh, P.O.B. 987, tel: 222 22, tgm: eppcol

Yeddah, P.O.B. 1502, tel: 4567, tgm: eppcol

Dammam, P.O.B. 450, tel: 222 22, tgm: eppcol

SYRIA

Constantin Georgiades *Damas*, P.O.B. 2398, tel: 266 73, tgm: georgiades

TAIWAN

Trans-Eurasia Enterprise, Ltd. *Taipei*, P.O.B. 3880, tel: 51 7038, tgm: esbtrading

REPUBLIC OF VIETNAM

Vo Tuyen Dien-Thoai Vietnam *Saigon*, P.O.B. 1049, tel: 226 60, tgm: telerad

International Business Representative *Saigon*, 26—28, Hai Ba Trung Street, tel: 226 60, tgm: ibur

AFRICA

ETHIOPIA

Mosvold Company (Ethiopia) Ltd. *Addis Ababa*, P.O.B. 1371, tel: (01) 101 00, tgm: mosvold, telex: 21090, "MOSFIRM ADDIS"

GHANA

R.T. Briscoe Ltd. *Accra*, P.O.B. 1635, tel: 669 03, tgm: briscoe, telex: 295, "BRISCOE ACCRA"

KENYA, TANZANIA, UGANDA

The Old East African Trading Co. Ltd. *Nairobi, Kenya*, P.O.B. 30013, tel: 271 61, tgm: broche, telex: 22261, "OLDEAST NAIROBI"

LIBERIA

Post & Communications Telephone Exchange *Monrovia*, Corner Ashmun & Lynch Streets, tel: 222 22, tgm: radiolibe

LIBYA

ADECO African Development & Engineering Co *Tripoli*, P.O.B. 2390, tel: 339 06, tgm: adeco

MOZAMBIQUE

J. Martins Marques & Ca. Lda *Lourenço Marques*, P.O.B. 2409, tel: 5953, tgm: marquesco

SOUTH AFRICA
SOUTHWEST AFRICA

Dryden Communications (Pty.) Ltd. *Johannesburg, South Africa*, P.O.B. 2440, tel: 838 5454

SUDAN

El Rahad Trading Corporation *Khartoum*, P.O.B. 866, tel: 776 95, tgm: suconto, telex: BHN 251

AMERICA

BAHAMA ISLANDS

Anglo American Electrical Company Ltd. *Freeport, Grand Bahama*, P.O.B. 104

BOLIVIA

Prat Ltda *La Paz*, Casilla 4790, tel: 277 12, tgm: prat

COSTA RICA

Tropical Commission Co. Ltd. *San José*, Apartado 661, tel: 22 5511, tgm: troco

DOMINICAN REPUBLIC

Humberto Garcia, C. por A. *Santo Domingo*, Apartado 771, tel: 3645, tgm: gartler

GUATEMALA

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: (021) 622 57, tgm: nilspira

GUYANA

General Supplies Agency *Georgetown*, P.O.B. 375, tgm: benwiks

HONDURAS

Quinchón Leon y Cia *Teguicigalpa*, Apartado 85, tel: 251 71, tgm: quinchon

NETHERLANDS ANTILLES

S.E.L. Maduro & Sons Inc. *Willemstad, Curaçao* P.O.B. 304, tel: 130 00, tgm: madurosons, telex: CU 92

NICARAGUA

Roberto Teran G. *Managua*, Apartado 689, tel: 224 00, tgm: roteran

PANAMA

Sonitel, S.A. *Panama 5, R.P.*, Apartado 4349, tel: 64 3600, tgm: sonitel, telex: 368674, "368674 SONITEL"

PARAGUAY

S.A. Comercial e Industrial H. Petersen *Asunción*, Casilla 592, tel: 9868, tgm: pargtrade

EL SALVADOR

Dada-Dada & Co. *San Salvador* Apartado 274, tel: 21 7940, tgm: dada

SURINAM

W.E. van Romondt's Trading Company Ltd. *Paramaribo*, tel: 2831, tgm: vanromondt

TRINIDAD, W.I.

Leon J. Aché Ltd. *Port-of-Spain*, 100 Frederic Street, tel: 323 57, tgm: achegram

AUSTRALIA & OCEANIA

NEW ZEALAND

ASEA Electric (NZ) Ltd. *Wellington C. 1.*, P.O.B. 3239, tel: 706 14 tgm: asea, telex: 3431, "ASEAWELL NZ 3431"

ERICSSON Review

3
1971

ERICSSON REVIEW

Vol. 48 No. 3 1971

RESPONSIBLE PUBLISHER: CHR. JACOBÆUS, DR. TECHN.

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: S-126 11 STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $1.80; ONE COPY $0.60

CONTENTS

On cover: A vote beeing taken in the single-chamber Swedish parliament.

International Telephone Switching Centres for the Caribbean Islands

J. W. C. ORMSBY, CABLE AND WIRELESS LTD., LONDON

UDC 621.395.722(729)
LME 8303 834

Orders have recently been placed with L M Ericsson by Cable and Wireless Ltd. for international telephone switching centres in Antigua, Barbados and Jamaica, and on behalf of the Trinidad and Tobago External Telecommunications Co. also in Trinidad. These centres will form a transit network which will provide fourteen Caribbean countries (including Guyana) with an automatic and semiautomatic international telephone service. This article outlines the development of the network and briefly describes the L M Ericsson equipment which will be used for the switching centres.

Introduction

The islands of the West Indies lie in a 2,000 mile sweep from Florida, U.S.A., to Venezuela, dividing the Gulf of Mexico and the Caribbean Sea from the Atlantic Ocean (Fig. 1). If you enjoy variety, you will find it here—in geography and climate, in language and culture, in status and political affiliation. Exactly how many thousand islands, islets and cays there are in the chain probably no one knows, but the estimated land area of 93,000 square miles and a population of 24 million is sub-divided into some 22 separate republics or states of distinct political status, for 13 of which Cable and Wireless (West Indies) Ltd., or one of the associated companies of the Cable and Wireless Group, has the responsibility for the overseas telephone service.

During the past 10 years, Cable and Wireless have been constructing wideband radio and submarine telephone cable systems to provide high quality overseas communications for the islands and which, in 1969, saw the North and South American sub-continents linked together by facilities wholly or in part owned and operated by Cable and Wireless. The story of the construction of these systems is a fascinating one—of construction teams driving roads through tropical rain forests to build radio stations high on mountain peaks, of cable-ships of the Cable and Wireless fleet edging their way through coral reefs to lay the shore ends of submarine cables on exotic beaches. It is a continuing story too, for in three locations (Barbados, Jamaica and Trinidad) ground stations are being constructed to work to the INTELSAT communications satellites, while new radio and cable systems are being planned to extend and supplement the network.

Long Distance Telephone Service

But one problem remains—to establish a modern telephone network which will provide the highest standard of service for the islands while making the most economic use of these costly transmission facilities. Initially the network was set up on a manual circuit basis with two manual transit centres in Barbados and Antigua, but with one or two isolated semi-automatic routes. The service thus provided, requiring an operator in both the country of origin and that of destination, is wasteful of operator time and circuit utilization and gives and inferior service by modern standards. In the longer term it was recognised that an automatic switched network capable of handling both semi-automatic and automatic (International Subscriber Dialling—ISD) traffic was required, both as a service to a subscriber and as a means of making optimum use of the transmission network. The switched network should be designed to facilitate ISD not only inter-island, but also between the islands and the U.S.A., Canada, Europe and other points in the international network. It was also necessary to ensure that costs to the individual national network were kept as low as possible, while providing an overseas service to full international standards.

In consultation with other operating agencies and administrations in the Caribbean area, it was established that the islands should be included in World Numbering Plan Zone 1. This zone, which covers the U.S.A. and Canada, was chosen because of the convenience which would thereby be gained when ISD to and from the North American network was to be established. Zone 1 is a 10-digit integrated numbering plan, the first three digits being the Area Code, and it was therefore necessary to develop an integrated 7-digit plan for the Caribbean. This was done with the exclusion of Cuba, which elected to join Zone 5, and the inclusion of Bermuda. Each national network, which may have a 4-, 5-, 6-, or 7-digit plan for internal use, has exchange codes assigned to build the number out to 7 digits, which will uniquely define any subscriber within the entire Caribbean network.

Switching Philosophy

The next stage was to establish the technical details of the switching equipment. A switching network was evolved comprising four international tele-

Fig. 1

Wideband communications systems in the Caribbean

Underlined C & W or associated company responsible for overseas communications
(Rep) Independent Republics
(US) Associated with or territory of USA
(Br) Associated states of UK, Commonwealth nations, colonies and territories
(Fr) Overseas Depts of France
(Du) Dutch Antilles

Wideband radio and cable
C & W and associated companies
Others

Earth station (opens)
C & W and associated companies
Others

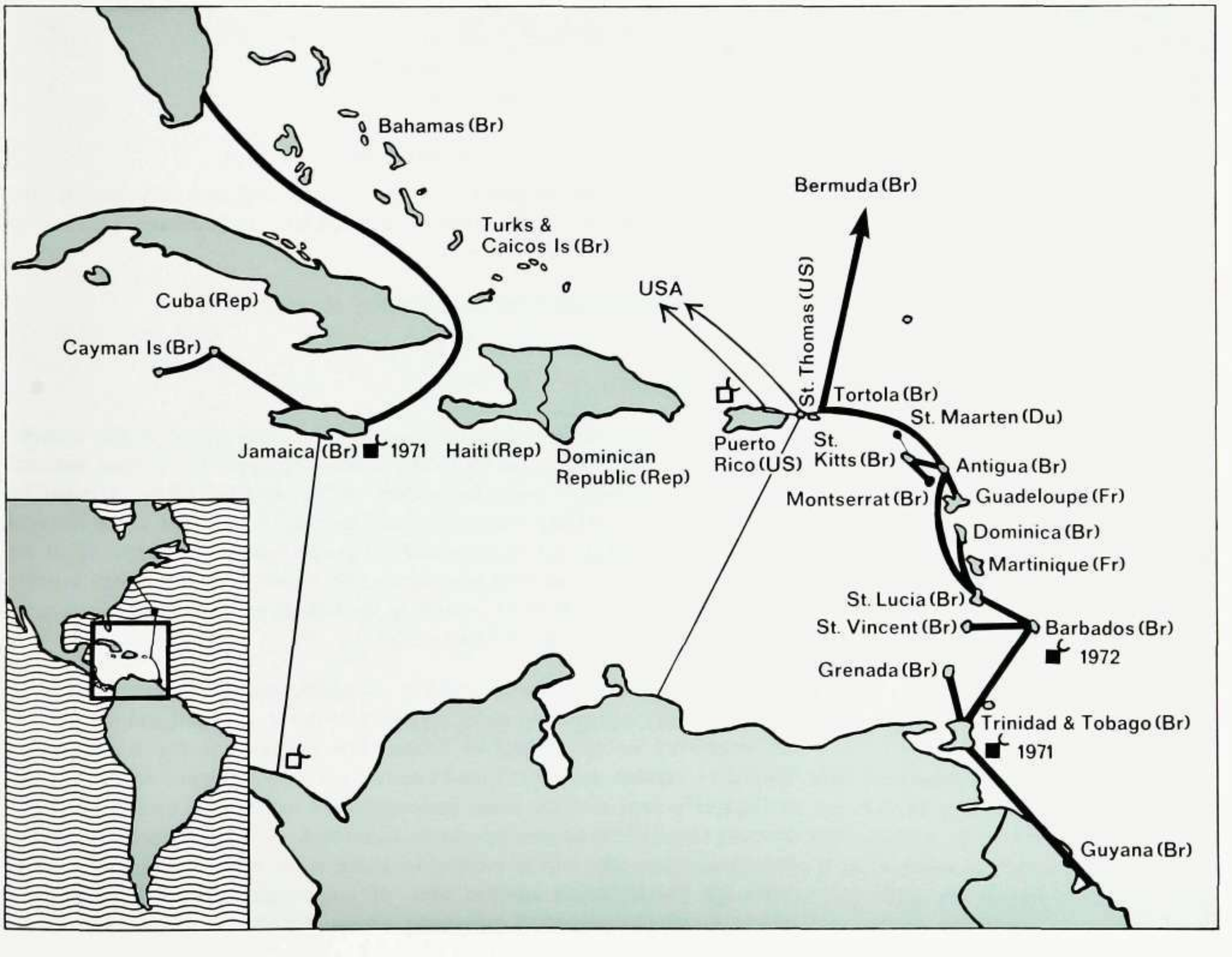
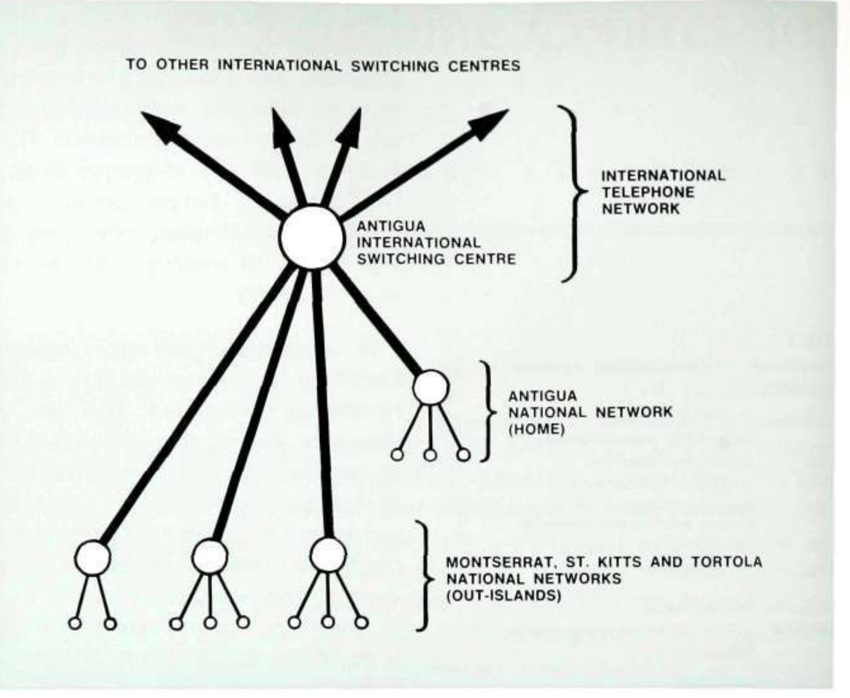


Fig. 2
National networks for which the Antigua international telephone switching centre serves as gateway



phone switching centres located in key locations in the system—Antigua, Barbados, Jamaica and Trinidad. Each centre will act as the gateway for the country in which it is situated—the "home" network—and for a number of neighbouring networks which would share the same centre as their gateway—the "out-island" networks. For example, the Antigua international switching centre will serve the following territories for which Cable and Wireless is the overseas operating agency (Fig. 2):

Antigua	"home"
Montserrat	"out-island"
St. Kitts	"out-island"
Tortola	"out-island"

In addition to acting as gateway to the international switched network, the centres will also switch traffic between "out-islands", and between "out-island" and the "home" networks.

The advantages of this network philosophy are as follows:

Circuit Economy

Traffic from a number of territories is combined into heavy traffic streams, thereby permitting better use of transmission facilities. If all four national systems in the example given had direct circuits to the U.S.A., it might be estimated that a total of 20 circuits would be required to give an on-demand service. However, because of the statistical at randomness of traffic, if all the traffic from the four countries is combined by a switching centre into a single group of circuits, a total of 12 circuits to the U.S.A. will suffice. On an overall network basis, such savings are appreciable.

Further economies can be achieved by automatic alternative routing, whereby some routes are equipped to carry only part of the traffic load and the remainder overflows on to alternative routes. For example, if the traffic routes Trinidad—London and Barbados—London are only equipped to carry 80 % of the traffic load, and the peaks are overflowed to Antigua, then the peaks of demand from all three centres can be combined. And since statistical studies show that the peaks will not coincide, there is an overall saving of circuits from the Caribbean to London and, of course an increased flexibility to relieve localised congestion caused by excess demand or equipment failure.

Signalling Conversion

Problems of signalling system compatibility between national networks are avoided, since all connections between national networks are via international switching centres. Additionally, greater flexibility is achieved since changes in methods of working (for example, the change from impulse dialling to multi-frequency signalling following the replacement in the national network of step-by-step exchange equipment by common control) only affect the trunks between that national network and its gateway international switching centre and do not necessitate changes in other national networks.

CCITT Recommendations specify the signalling systems to be used for international telephony. For automatic working CCITT No. 5 is the most common, with others such as CCITT R1 (otherwise known as North American MF/SF) and R2 (Berne MFC) approved for regional use. Any switching centre requiring connection to the international network must provide for at least one, and more likely two or three of these signalling systems, which can be very costly and quite uneconomic for small national networks.

The switching centres are therefore required to provide signalling conversion so that between a national network and the international switching centre a single, simple signalling system can be used, with the facilities and flexibility of the CCITT systems concentrated in the international switching centres. The Caribbean national switching centres will, in fact, be provided initially with CCITT No. 5, R.1, and the North American SF signalling, while for the connection between the international centres and the national networks the signalling system chosen can be the most appropriate for the current state of development of that national network. For example, handspeed multi-frequency (MF) from operators' keysenders may be used in one direction and impulse dialling for feeding directly into the step-by-step national system in the other. A further requirement is that it should be possible to introduce new signalling systems, such as CCITT No. 5 bis, with only minimal changes in the existing equipment (for example, no replacement of major items of common equipment). In fact, it is planned that CCITT-R2 be introduced in Jamaica within the next two years.

Centralisation Facilities

With the growth of the international telephone service, the complexity of traffic routing increases and the need for sophisticated testing and observation facilities develops. An international switching centre provides a suitable location to concentrate these facilities, and to provide equipment and expertise on a scale which would be quite uneconomic in an individual country with a comparatively small demand for international telephony, as is the case in the Caribbean Islands. With each international switching centre, therefore, is integrated an international maintenance centre (IMC) to provide maintenance and operational supervision of the international circuits.

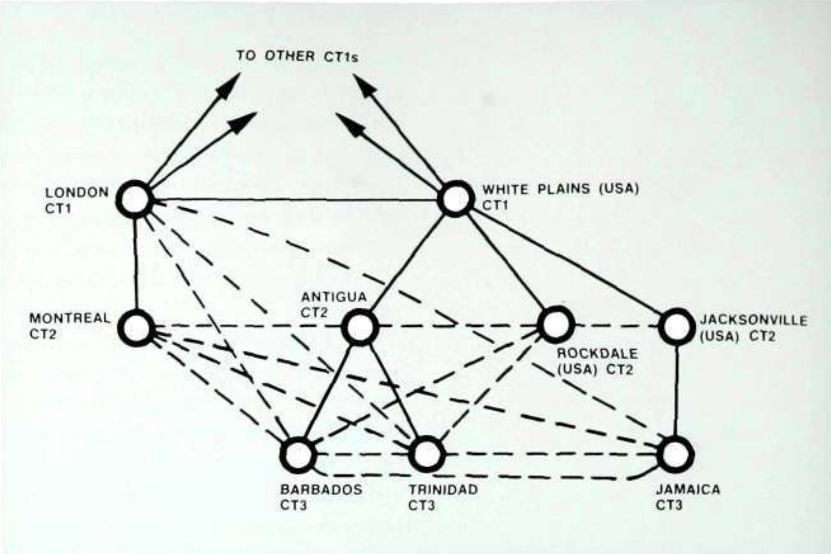
Routing Plan

In an automatic switched network with alternative routing, it is necessary that a carefully devised routing plan be evolved if abortive routing ("ring-around-the-roses") is to be avoided. For example, if in the earlier example Trinidad had overflowed its peak traffic for London to Barbados and Barbados had done similarly to Trinidad a call might get routed back and forth between Barbados and Trinidad without getting anywhere. In international

Fig. 3

Caribbean theoretical final routing plan

——— Theoretical Final Routes
– – – Typical Direct Routes ("Low-loss" or "High-usage")



telephony there are further complications, such as the requirement that two satellite circuits should not be connected in tandem, the special routing agreements, for example, within the Commonwealth, and economic considerations related to the very high cost of international circuits.

Within the Caribbean, therefore, it has been found necessary to follow the ITU World Routing Plan as contained in the CCITT White Book.[1] In this plan each international switching centre is allocated a "transit centre" category: CT1, CT2 or CT3. All CT1s are—in theory—interconnected with CT2s and CT3s. Figure 3 shows a greatly simplified version of the plan as it applies to the Caribbean. Theoretical final-last choice-routes are the "back-bone" of the routing plan, but one or more of them will only be realized when justified by increasing traffic demands.

Direct routes may join switching centres with large mutual traffic, and such routes may be "high-usage"—to carry, say, 80 per cent of offered traffic with the remaining 20 per cent overflowing—or "low-loss" to carry all offered traffic without overflow. A "low-loss" direct route becomes the Actual Final Route for the traffic offered to it, and it is not necessary to resort to the Theoretical Final Route. Any proposed routing must be compared against this theoretical routing plan to determine if it is permissible with respect to existing or planned equipment.

In fact, during the early years of the network's growth it is unlikely that the Antigua-White Plains route will be provided, as all traffic will be carried on Actual Final Routes to Rockdale and Montreal. Special rules are also laid down which, for example, govern the conditions under which Barbados may be used as a transit point for traffic between Antigua and Jamaica.

Technical Description

From the foregoing it will be apparent that the technical requirements for the switching equipment are very stringent. In addition to the normal requirements for 4-wire transit exchanges, these centres must provide all the facilities of an international transit centre according to CCITT specifications and be fully compatible with the Bell System. This involves interworking between a wide variety of signalling systems, accepting and processing a number of different signalling formats and providing testing facilities of considerable sophistication.

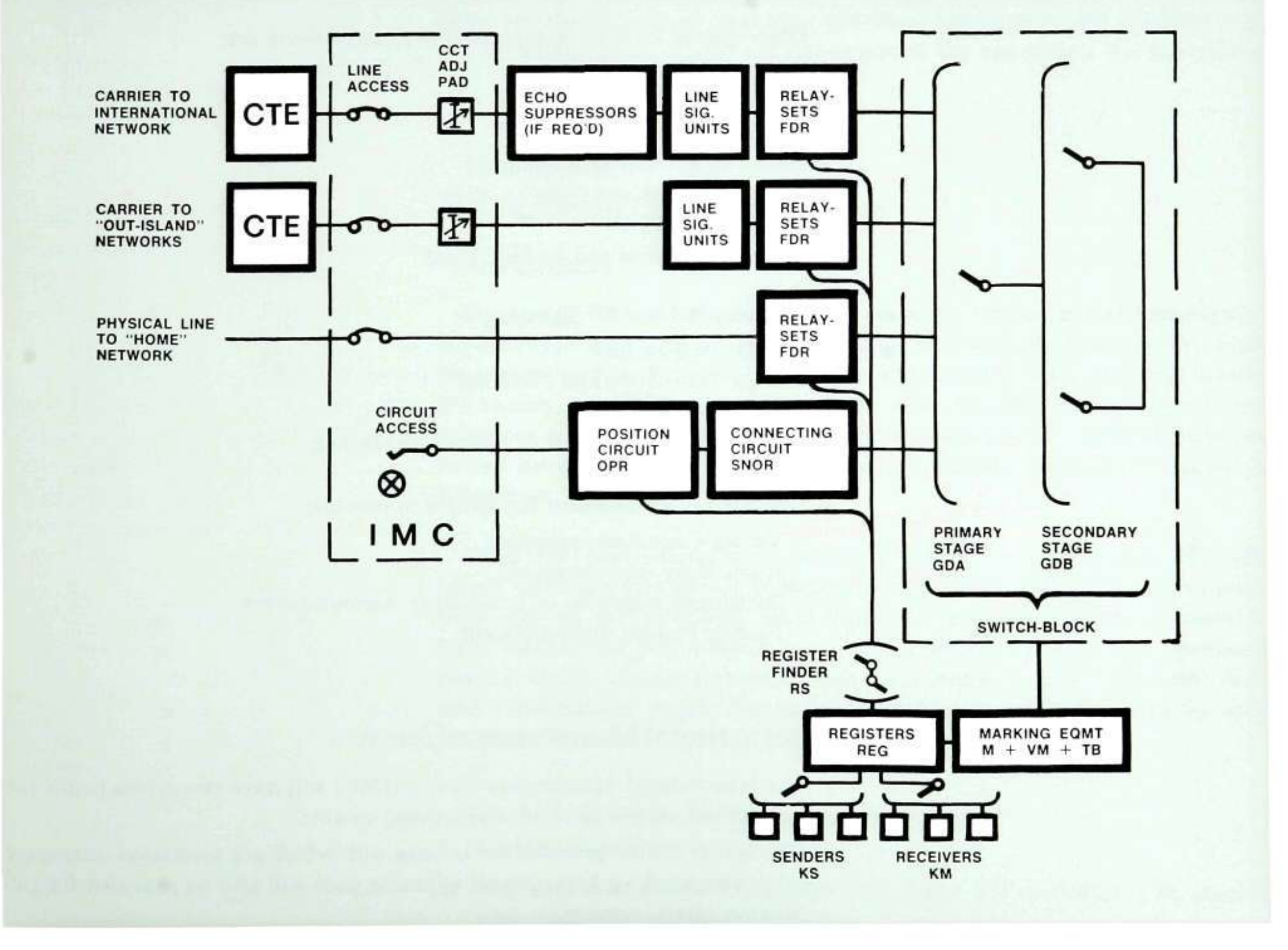
It was fortunate that at the same time that Cable and Wireless Ltd. were planning this network, L M Ericsson were developing the new international variant of the *ARM 20* crossbar system[2]. Close co-operation between engineers of the two companies has resulted in a technical proposal for these centres which meets the present technical requirements and also incorporates considerable flexibility for adding new facilities at minimum costs in the future. In particular, in the matter of signalling flexibility and IMC facilities the co-operation between Operating Administration and manufacturer has been most rewarding.

Switching Equipment

Figure 4 shows a simplified block diagram of the *ARM 20*. The crossbar switches are arranged in blocks of 200 connections to both-way relay sets, the same connection being used for incoming and outgoing calls.

An incoming call is detected by the relay set *FDR* which calls for a register *REG* via a register finder *RS*. The register selects and appropriate receiver *KM* for the signalling system used on the circuit, and receives and stores the incoming numerical information. When sufficient digits have been received to determine the outgoing route, the register connects to the Marking equipment *M + VM + TB*. This locates the incoming relay set, selects a free relay set on the outgoing route required and establishes connection in the crossbar switch-block from the Primary Stage *GDA* to which the incoming relay is connected, via Secondary Stages *GDB* to the Primary Stage of the free relay set on the outgoing route. Connection is from *FDR-GDA-GDB-GDB-GDA-FDR*, as shown in fig. 5 A.

Fig. 4
Trunking diagram for international switching centres



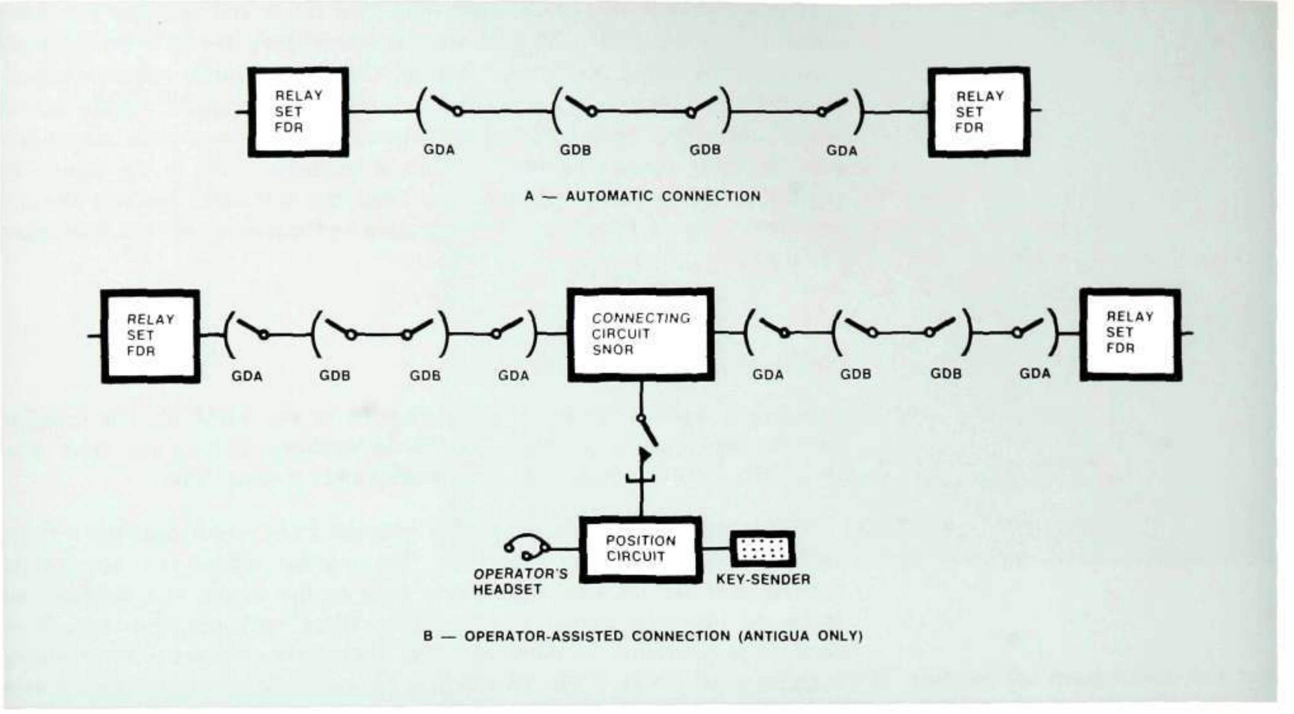


Fig. 5
Trunking diagram for connections

The register then selects a sender *KS* appropriate to the signalling system of the outgoing route and transmits the numerical information forward, making any necessary changes in the signalling format. Alternative routing is provided, so that if all the circuits of the required route are busy, up to four alternative routes can be tried.

Other special features incorporated in the equipment are:

- Extendable Digit Capacity
- Extendable Digit Examination
- Pad Switching
- Incoming R.1 and SF Signalling[3]
  KP2, Code 11 and Code 12 (R.1)
  Prefix digits (SF)
  Proceed-to-send and/or Dial Tone
- Outgoing R.1 and SF Signalling[3]
  Variable digit spill
  Digit Translation and Prefixing
  Stop/Go Working
  Delay Dial, Wink Start or Immediate Dialling
- Recorded Announcement Equipment to provide:
  Vacant Code Announcement
  Route Busy Announcement
  Switching Congestion or Irregularity Announcement
  Facility Failure Announcement

International Maintenance Centre

The International Maintenance Centre (IMC) will have two access points for setting up and maintenance of international circuits.

- *Line access* will be provided by U-links with which are associated occupancy lamps and blocking keys. Circuit adjusting pads will also be provided for circuits via carrier systems.

- *Circuit access* will be provided via the switching equipment so that all the equipment proper to a particular circuit (e.g. signalling unit, relay set, echo suppressor) can be included in tests towards line.

A wide range of test equipment, including digital level measuring sets, impulse noise counters, multi-channel ultraviolet recorders (for recording signalling) and special test sets for particular signalling systems, will be provided. Some test equipment will be mounted on central test consoles, some rack mounted and some on trolleys or portable. There will also be specialised test equipment for the switching equipment, including an automatic exchange tester.

The IMC will also be provided with traffic meters and statistic counters, switching equipment fault print-out (CENTRALOGRAPH), and a wide range of equipment and service alarms. Provision is being made so that at a future date a Call Data Recording Equipment (CDRE) can be added which will give a permanent record, for example on punched card or magnetic tape, of every call through the switching centre. With a suitable data processor, this could give statistics for traffic planning and international accounting purposes.

The following Test Codes will be available:

- 100 600 Ohm Termination (4-wire)
- 101 IMC Test Trunk
- 102 1000 Hz Reference Tone
- 103 Supervisory and Signalling Test Termination

Physically, each IMC will consist of a rectangular room approximately 20 feet by 24 feet with the long walls being formed by equipment racks. One wall will consist of test boards with U-link panels for line access. The other wall will be Supervision Boards, with alarms, traffic meters, fault print-out units, etc. On the central floor area will stand one or more test consoles, with the automatic circuit access and test trunks to the test boards for line access.

International Operating Centres

"Out-islands"

In general, the existing international operating centres in the "out-islands" are cord-type sleeve-controlled switchboards with manual circuits to the existing manual switching centres in Barbados and Antigua. Some operating centres are already equipped with semi-automatic relay sets and selectors so that the operators can dial outgoing calls from the switchboard and incoming calls can be fed directly into the selector train of the national network for access to subscribers.

When the new international switching centres are operational, all "out-island" operating centres will be equipped with this facility and operating positions will be provided with multi-frequency (MF) push-button keysenders. Each push-button will connect two voice frequency tones to the operator's position circuit and six frecuencies will be provided to give 15 possible two-tone combinations. Single frequency (2,600 Hz) line signalling will be used for supervisory signals.

The chief advantages of keysending over dialling are:

1. Keysending is faster than dialling.
2. The additional combinations over and above the numericals can provide additional information.

Table 1 gives the signal code which will be used, which it will be noted uses the same frequency combinations as CCITT No. 5 and R1 signalling but the significance of the KP signals is modified. The KP1 prefix will be used to indicate a call to a subscriber within World Numbering Zone 1 (U.S.A., Canada, and Caribbean), and for subscribers within the Caribbean area the operator will key the following sequence:

KP1 + (7 digits) + ST

The seven digits will consist of a two, three, or four digit exchange code followed by a five, four, or three digit subscriber's number. For calls to the U.S. or Canada, the operator will key the following:

KP1 + (3-digit Area Code) + (7 digits) + ST

Similarly, operators in the U.S. or Canada requiring a Caribbean subscriber will key the three digit Area Code for the Caribbean (809) followed by the same seven digits which a Caribbean operator would key for that subscriber. Further information of the Zone 1 numbering plan will be found in Ref. 2.

For calls to outside Zone 1, the "out-island" operator keys:

KP2
\+
(Country Code)
\+
(Language digit)
\+
(National number of required subscriber)
\+
ST

For example, for a call to the London number 01-242 4433 the operator would key:

KP2 + 44 + 2 + 1-242-4433 + ST
where 44 is Country Code for England
2 is English Language digit
1-242-4433 is the National significant number (as in most European countries the initial digit "0" of the national number is deleted in the international code).

Fig. 6 shows a block schematic of an "out-island" operating centre. Subscribers requiring an overseas call dial the access code for the overseas operator and the call is routed via an assistance relay set to the switchboard suite. The operator answers with one of her cord circuits and her position circuit. When the calling subscriber has given the number of the required subscriber, the operator selects an outgoing circuit to the international switching centre and keys into the ISC register the MF sequence. When the called subscriber answers, she can leave the cord circuit connection set up and answer other calls with other cord circuits and her position circuit.

Calls incoming from the international switching centre will use decadic (10 i.p.s.) dialling to step the selectors in the national network to reach the required subscriber. (Of course, if the national network is common control, it is possible for incoming calls to use MF signalling also.) If an incoming call requires operator assistance the international switching centre register will send an access code (either "0" or "1X1" where X is a digit indicating the type of assistance required) which routes that the call to the incoming international assistance operator. The operator can complete such calls to subscribers by connecting to an outgoing line to the national selectors, and if the national network is step-by-step she will, of course, use her dial for this purpose.

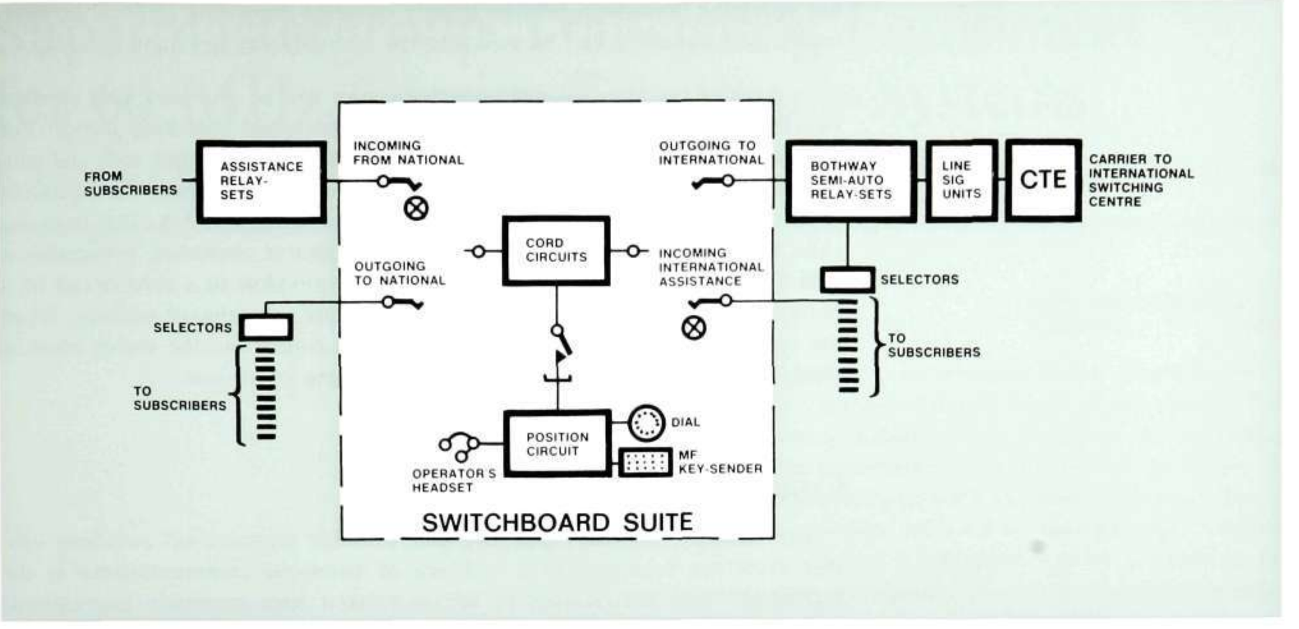


Fig. 6
"Out-island" international operating centre

If for any reason it is not possible to fix MF keysenders to "out-island" switchboards, the international switching centres will accept dialling but special prefix codes are required to compensate for the lack of KP1, KP2, and the special combinations "Code 11" and "Code 12" which are required to reach assistance operators in some countries.

Table 1
"Out-island" MF Keysender Signalling Code

Signal	Frequency Combination (Hz)
1	700 + 900
2	700 + 1,100
3	900 + 1,100
4	700 + 1,300
5	900 + 1,300
6	1,100 + 1,300
7	700 + 1,500
8	900 + 1,500
9	1,100 + 1,500
0	1,300 + 1,500
KP1 (Zone I Prefix)	1,100 + 1,700
KP2 (Non-Zone I Prefix)	1,300 + 1,700
Code 11 (Inward Operator)	700 + 1,700
Code 12 (Delay Operator)	900 + 1,700
ST (End-of-pulsing)	1,500 + 1,700

"Home"

The present arrangements are that the "home" international operating centres in Barbados, Jamaica and Trinidad will be operated by the respective local administrations, which are members of the Continental Telephone System. The facilities available to operators will be identical to those in the "out-islands", but operating procedures may be slightly different depending on local arrangements. MF signalling will be used into the international switching centres.

In Antigua the international operating centre will be provided with cordless switchboards associated directly with the international switching centre. For calls which require automatic connection (i.e. all types of transit call, and calls incoming to "home" which do not require operator assistance) the operation is as described earlier, and the trunking as shown in Fig. 5 A. For outgoing calls, and transit or incoming calls requiring operator assistance, connection is first made to an operator's connecting circuit (equivalent to a cord circuit on a cord-type board), of which there are up to six per switchboard position. When the operator keys the sequence for the onward connection the switch block is used for a second time. Fig. 5 B shows the trunking in this case.

Conclusion

The Antigua, Barbados, Jamaica and Trinidad international switching centres mark the beginning of a new era of telephone communications in the Caribbean. The introduction of an on-demand semi-automatic international service, to be followed in the not too distant future by ISD, will open new horizons for subscribers, and provide a service for visitors equal to that to which they are accustomed in the U.S., Canada or Europe. But communications is a rapidly advancing technology and, as new techniques are evolved, it will be necessary to modify the world-wide telephone network and to revise the World Routing Plan. In particular, the use of satellites for telephony is a young art and developments such as demand assignment can be anticipated. The Caribbean international switching centres are of an advanced design by one of the most experienced telephone manufacturers in the world, and will provide the facilities and flexibility to meet these challenges for many years to come.

References

1. CCITT IVth Plenary Assembly. White book. Geneva 1969.
2. Ellstam, S. & Olsson, B.: *New Variant of International and Intercontinental Telephone Exchanges ARM 202*. Ericsson Rev. *48*(1971): 1, pp. 14—22.
3. *Notes on Distance Dialing*. AT&T, New York 1968.

Supermastergroup Translating Equipment for 60 MHz Carrier Telephone Systems

P. ECHARTI, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.44:621.376
LME 8421 7544

The present article describes L M Ericsson's terminal multiplexing equipment for assembling 12 batches of 900 telephone channels into a 10,800-channel line group and vice versa. This frequency translation can be carried out according to two different modulation plans recommended by the CCITT, as shown in fig. 1. Plan 1 is applicable to those long-distance networks which are based upon the use of basic supermastergroups made up of mastergroups, whereas Plan 2 is applicable to those cases where a 900-channel batch is made up of assemblies of 15 supergroups which are obtained from 960-channel line groups by omission of supergroup 1.

To achieve the flexibility that is desirable in systems handling such large numbers of channels, supplementary equipment is required for through connection, direct through connection and branching of batches of channels. L M Ericsson has also developed such equipment, which can be used as required with regard to the two modulation plans.

The multiplexing equipment needed to implement either alternative modulation plan is accommodated in one bay using shelves and shelf stacks as basic functional building blocks. The equipment is fully transistorized and engineered in the M4 construction practice.

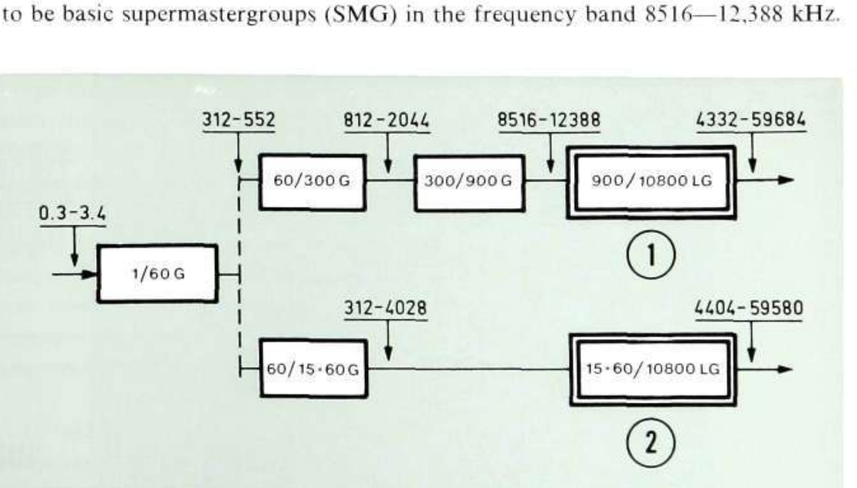
The equipment complies with CCITT recommendations by an ample margin and has been developed in consultation with the Swedish Telecommunications Administration, which at an early stage worked out the basic principles for 10,800-circuit systems for use in the Swedish coaxial cable network.

Equipment according to Plan 1

Electrical Design

Modulation Plan

Modulation Plan 1 recommended by the CCITT presupposes all 900-channel batches at the input of the send path and at the output of the receive path to be basic supermastergroups (SMG) in the frequency band 8516—12,388 kHz.



Modulation stages for the formation of 10,800-channel line groups according to CCITT modulation Plans 1 and 2

Frequencies in kHz

1/60G	Channel and group translating equipment
60/300G	Supergroup translating equipment producing basic mastergroups
60/15 × 60G	Supergroup translating equipment producing basic 15-supergroup assemblies
300/900G	Mastergroup translating equipment producing basic supermastergroups
900/10,800LG	Supermastergroup translating equipment producing 10,800-channel line group, Plan 1
15 × 60/10,800LG	15-supergroup translating equipment producing 10,800-channel line group, Plan 2

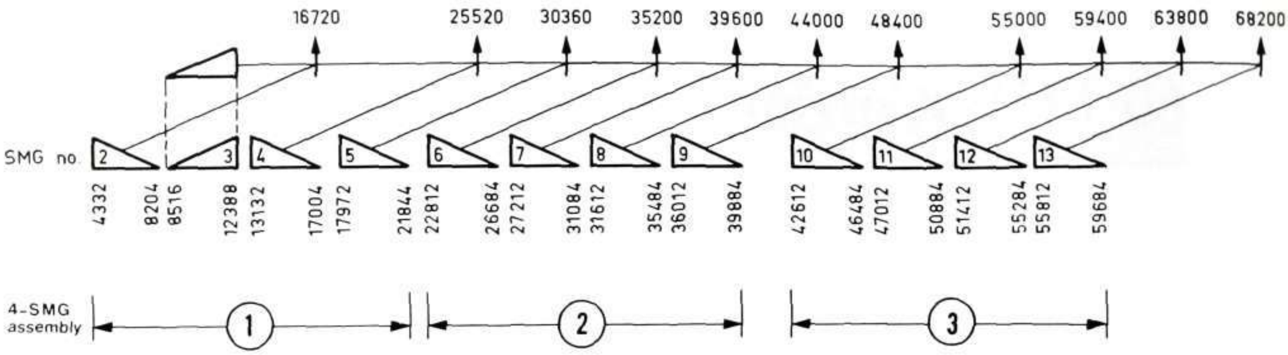


Fig. 2

Modulation plan for assembling twelve basic supermastergroups into a 10,800-channel line group (CCITT Plan 1)

Fig. 3

Block diagram of supermastergroup translating equipment for forming a 10,800-channel line group according to CCITT Plan 1

A SMG translating shelf stack, SMG's 2 – 5
B 4-SMG combining and separating shelf
C Pilot receiving shelf 1552
D Built-in carrier generating equipment (see fig. 4 a-c)
F Fault location test points
M Maintenance test points
2 – 13 Inputs and outputs for SMG's
Frequencies in kHz
× Not included for SMG 3

Graphical symbols

- cable equalizer
- hybrid transformer
- distributor
- low-pass filter
- band-pass filter
- rectifier
- amplifier
- (de)modulator
- selector
- level control

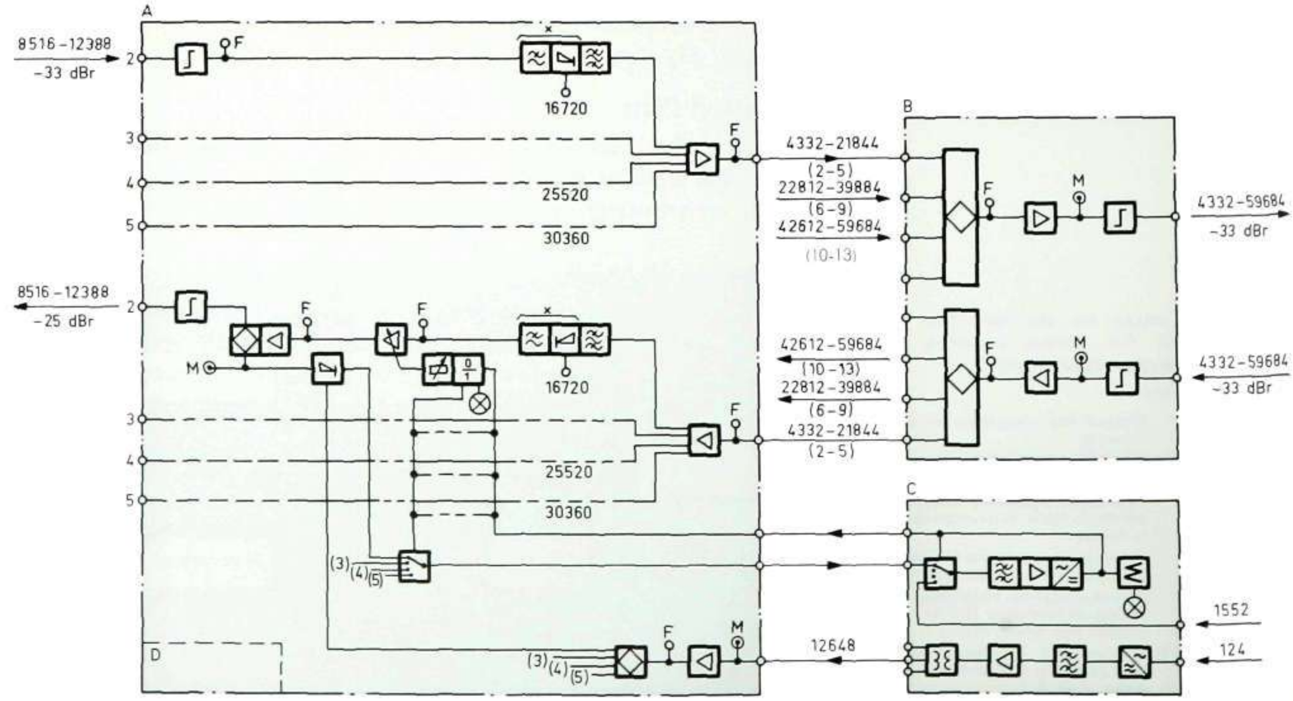
The line frequency band, which comprises 12 supermastergroups, is divided into three frequency blocks of four supermastergroups each, comprising Nos. 2—5, 6—9 and 10—13 respectively. Such a frequency block is termed a 4-supermastergroup assembly (4-SMG). This division is conducive to system flexibility, making it possible, for example, to through connect 4-supermastergroup assemblies at line frequencies, i.e. without demodulation to the basic frequency band. The equipment for direct through connection is described later in this article.

All the carrier frequencies for modulation and demodulation, eleven in all, are multiples of 440 or 2200 kHz. These two basic frequencies correspond with master frequencies already being used in current 12 MHz systems.

The modulation plan for assembling 12 basic supermastergroups into a 10,800-channel line group according to Plan 1 is shown in fig. 2.

Block Diagram

A block diagram of the main equipment is shown in fig. 3. The equipment consists of three basic building blocks: the SMG translating shelf stack, the 4-SMG combining and separating shelf and the pilot receiving shelf for regulation and supervision shared by all the supermastergroups.



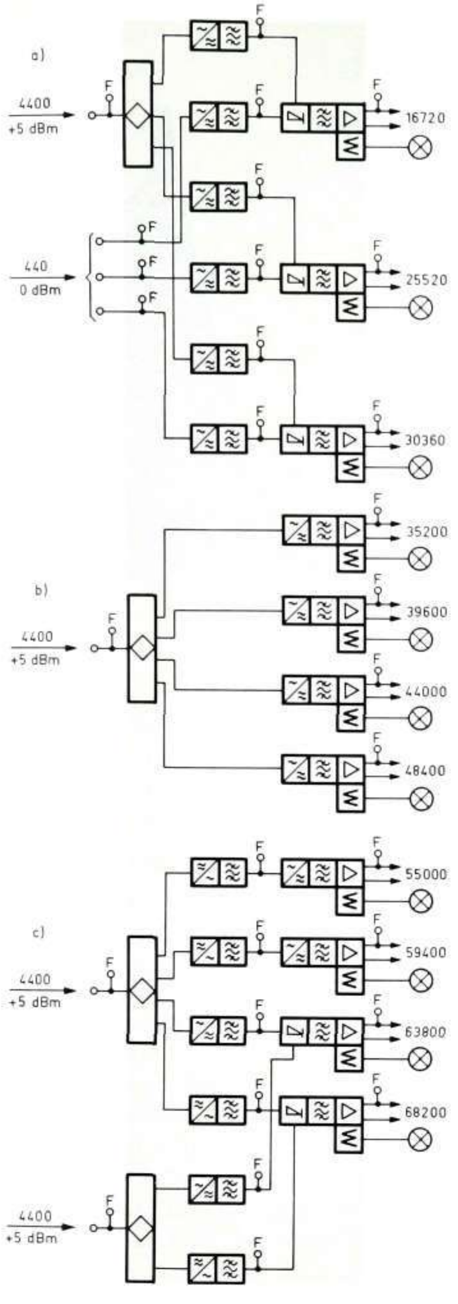


Fig. 4

Block diagram of carrier generating equipment built into SMG translating equipment for

a) SMG's 2–5
b) SMG's 6–9
c) SMG's 10–13
Frequencies in kHz
For Plan 2 the 16,720 kHz carrier is omitted

Graphical symbols

frequency multiplier
frequency divider
level limit indicator

The SMG translating equipment for 12 basic supermastergroups comprises three shelf stacks each providing equipment for assembling 4 basic supermastergroups into a 4-SMG assembly and vice versa. In addition, each such shelf stack includes the carrier generating equipment required for the modulation and demodulation involved. Block diagrams for these carrier generating equipments are shown in fig. 4.

The 4-SMG combining and separating shelf in the send path combines the three 4-SMG assemblies from the SMG translating shelf stacks into a 10,800-channel line group. In the receive path the process is reversed. The accessibility of 4-SMG assemblies thus obtained, permitting direct through connection of these blocks at line frequencies, contributes greatly to the achievement of system flexibility.

The CCITT has recommended the following relative levels at the equipment input and output points: at SMG distribution frames −33 dBr in the send path and −25 dBr in the receive path, at line link interconnection points −33 dBr, send and receive. The impedance at all these points is 75 ohms, unbalanced to earth.

To ensure reliability in service, the built-in carrier generating equipment has been arranged in such a way that a failure in one of the functional units containing active components can affect no more than one supermastergroup. As previously mentioned, the basic frequencies for carrier generation are 440 and 2200 kHz. These frequencies are derived from the 2500 kHz master frequency, which is generated in the centralized frequency generating equipment of the station concerned.

Modulator Unit

For each basic supermastergroup a modulator unit, consisting of a low-pass filter, the modulator proper and a band-pass filter, is provided in the send path. An exception to this is SMG No. 3, which retains its basic frequency band also when placed in the line frequency spectrum. Therefore, only a band-pass filter is required for this supermastergroup. The demodulators in the receive path use the same basic design as the modulators in the send path.

In all cases one and the same wideband, double-balanced transistor circuit is used which at its input substantially suppresses the carrier leak and greatly attenuates the modulating signal applied to the (de)modulator input.

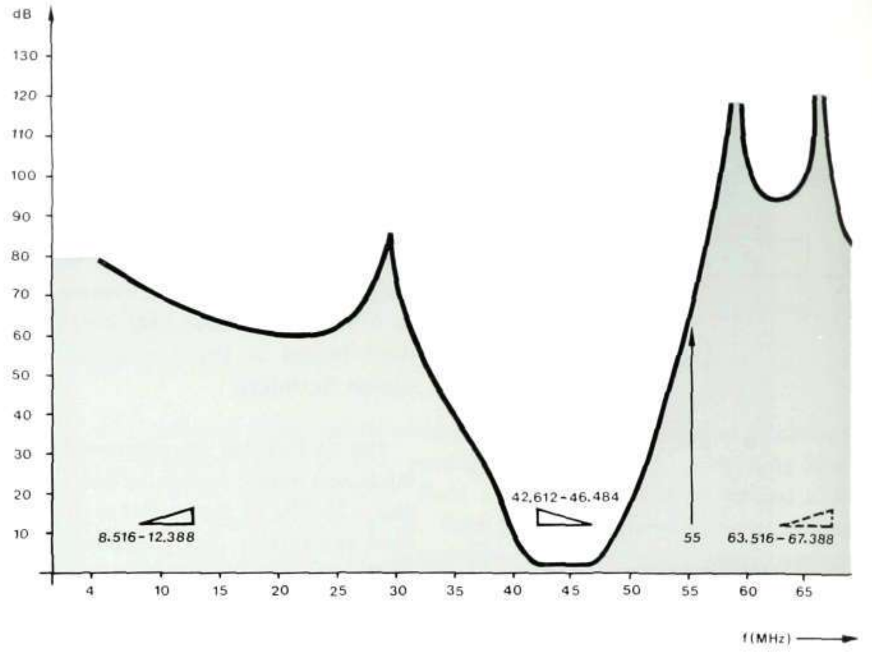
The low-pass filters are a simple coil-type design serving to suppress interference frequencies, including thermal noise, which, owing to the frequency range they occupy after modulation, may enter the traffic band. In the receive path the filters further suppress the carrier leak and greatly attenuate the undesired upper sideband received from the demodulator as well as other higher-order noise products.

The band-pass filters are calculated partly by the working-parameter (insertion-loss) method and partly by the image-parameter method. To achieve low losses in the coils, those used for supermastergroups 5 and upwards are designed as air-core coils provided with small ferrite trimming screws for alignment purposes.

In making this calculation, consideration has also been given to the circuit's stray capacitances and its line inductance. Thus it has proved feasible to reproduce computer-calculated loss and impedance values in practice.

Fig. 5

Typical attenuation characteristic for a band-pass filter (SMG 10)



The composite attenuation inserted in the stop band by an air-core-coil filter is shown in fig. 5, and the over-all loss characteristic in the pass band for the complete unit in fig. 6.

The band-pass filters for supermastergroups 2—4 use a ferrite-coil design.

SMG Combiner and Separator

To combine four supermastergroups into a 4-SMG assembly in the send path and to split a 4-SMG assembly into four supermastergroups for application to the demodulators in the receive path, use is made of active circuits. These are based on very low input and output impedances in conjunction with series resistances for matching the 75-ohm impedance. Thus a high attenuation is achieved between the four inputs or outputs respectively to which the modulators and demodulators are connected. At the same time mutual coupling between modulator/demodulator units is minimized. The combiner and separator are designed for such a wide range of frequencies that the same unit can be used for the different frequency bands of all three 4-SMG assemblies. In this way losses in combining and separating the supermastergroups are minimized, which is also advantageous with regard to the transmission level.

The level at the interconnection point between the SMG translating equipment and the 4-SMG combining and separating equipment is – 37 dBr in both directions of transmission.

Wideband Amplifier

To compensate for losses in the combining and separating equipment in-

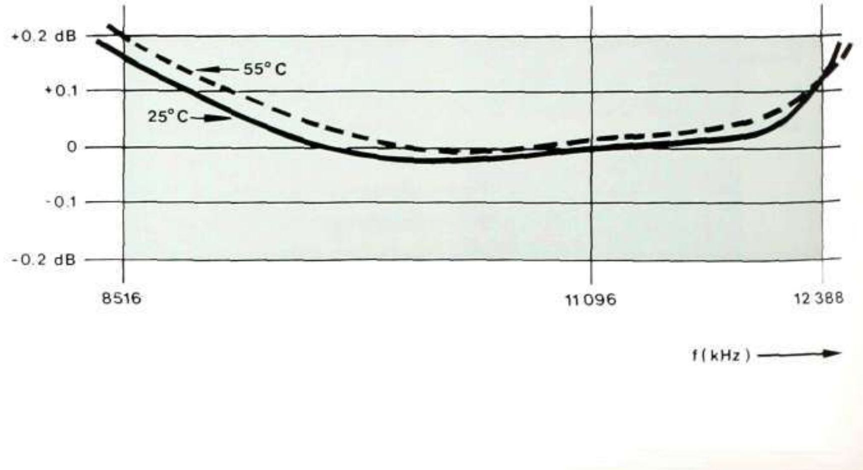


Fig. 6

Over-all loss characteristic for a complete SMG modulator unit, referred to the pilot frequency

troduced by the 4-SMG combining or separating hybrid, in this case passive, by the test hybrid and the station cable equalizer, a wideband amplifier has been inserted in each direction of transmission.

The line group amplifier is a three-stage feedback circuit with electronically adjusted output impedance. The amplifier gain can be varied in several steps, which means that the amplifier can be used for other applications, e.g. in branching and direct through-connection equipment.

Station Cable Equalizer

A new equalizing network has been developed to compensate for the attenuation slope introduced by a station cable up to 25 m long between the line side of the equipment and the line link interconnection point. The loss introduced by the cable employed is about 0.1 dB per metre at 60 MHz. The equalizer can be adjusted as required by the actual loss conditions in each particular case in steps of 0.5 dB, corresponding to a cable length of 5 m.

Frequency Generation

The carrier frequencies required for the modulation and demodulation involved between the basic supermastergroup band and the line frequency allocation according to fig. 2 are generated locally in the SMG translating shelf stacks concerned.

This carrier generation is effected by means of frequency multipliers, frequency dividers and modulators. Each of these units is followed by a very narrow-band pass filter, which has been designed as an LC circuit. Here too, the inductors used for frequencies from about 20 MHz and upwards are air-core coils. The signal frequency selected by the filter is then amplified to the desired carrier level. The amplifier has two outlets feeding the modulator and demodulator concerned. The basic circuit is arranged so as to achieve a high attenuation between the two outlets, thus assisting to keep crosstalk between the send and receive paths at a sufficiently low level.

The carrier amplifier outputs are provided with built-in supervisory arrangements. An alarm is given if the carrier level drops by more than 2—3 dB below its nominal value.

The frequencies required for the operation of the SMG translating equipment in a 60 MHz system are:

- basic frequencies 440 and 4400 kHz for carrier generation
- basic frequency 124 kHz for generation of the 12,648 kHz carrier in the pilot receiving shelf
- pilot frequency 1552 kHz for the centralized pilot receiver
- frequency comparison pilot 4200 kHz.

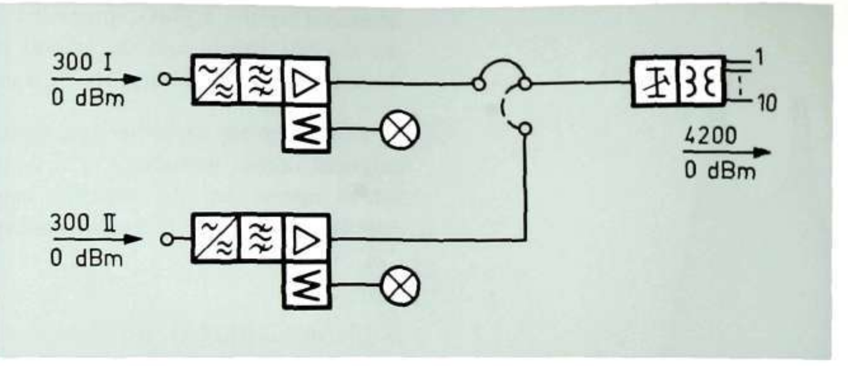
All these frequencies are generated in the centralized frequency generating equipment common to the whole station; this common frequency supply can feed several other 60 MHz systems.

For further details concerning frequency generation, reference should be made to an article in the 1st issue of Ericsson Review, 1967.[1] The basic frequency generating equipment described in that article has subsequently been supplemented with frequency doubling equipment 2200 to 4400 kHz with appurtenant distribution equipment. Furthermore, equipment for generation of the 4200 kHz frequency comparison pilot as shown in fig. 7 has been added.

The frequency comparison pilot is distributed direct from the common frequency supply since, being a pilot belonging to the h.f. line, it has a consider-

Fig. 7
Block diagram of generating equipment for 4200 kHz frequency comparison pilot

I = regular set
II = standby set
Frequencies in kHz



ably smaller number of injection points than other frequencies that are distributed. No automatic changeover arrangements are required for this frequency, changeover being effected by means of U-links. The pilot level at the output of the amplifier is supervised by a level limit indicator, which initiates an alarm in the event of a level drop of 2—3 dB.

Frequency Checking

The common frequency supply of the station includes frequency checking equipment (fig. 8) for synchronization of

a) the two 2500 kHz master oscillators (working and standby) with each other, or
b) each of the master oscillators against an external frequency standard.

For this purpose the 4200 kHz frequency comparison pilot mentioned in the preceding section is applied to the input of the frequency checking equipment.

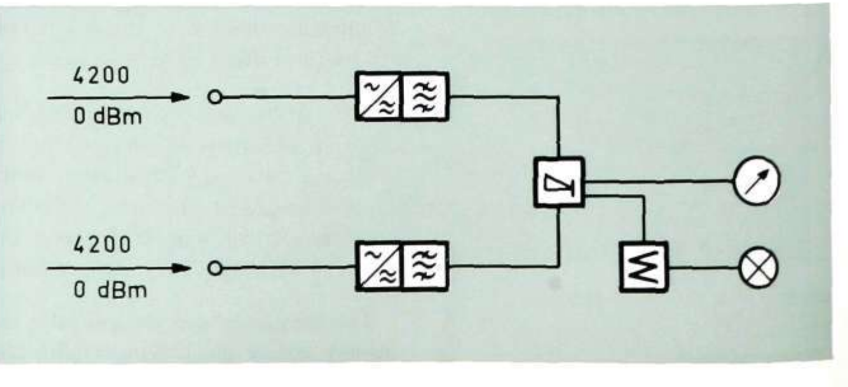
This equipment uses the beat method, i.e. it indicates the difference frequency between the two input frequencies as a pulsating d.c. current. The duration of one beat can be read from an indicating instrument by means of a stop watch. Both pilot frequencies are passed through a 4200 to 12,600 kHz multiplier, so that comparison is effected at 12,600 kHz. By using the 12,600 kHz as comparison frequency a convenient beat reading is produced on the indicating instrument. Thus a frequency stability of $\pm 10^{-8}$ corresponds to a beat duration of 8 seconds. The frequency checking equipment can be provided with facility for continuous supervision of the two frequencies being compared, so that an alarm is given as soon as the difference between the two frequencies exceeds the guaranteed accuracy limits.

Test Points

Two kinds of test points are provided, namely maintenance test points and fault location test points.

Fig. 8
Block diagram of frequency checking equipment

Frequencies in kHz



Maintenance test points, denoted by M in the block diagrams, are provided at all outputs. These test points are short-circuit proof, i.e. a short circuit at the test point does not noticeably affect the transmission path. Nor is the level at a maintenance test point affected by possible poor impedance matching in the transmission path. The impedance at these test points is generally 75 ohms. They consist of coaxial sockets located in a maintenance strip below the apparatus units.

Fault location test points, in the block diagrams denoted by F, are provided to enable any faults to be located to a certain unit by logical fault location. They are designed as bridging test points. Those intended for the higher frequencies are provided with series resistors, permitting measurements to be carried out using an instrument having an impedance of 75 ohms. These fault location test points are coaxial and are located at the front of the apparatus units concerned.

Level Regulation and Supervision

The transmission of batches of channels over long distances, with through connection over several line sections, frequently involves the accumulation of certain residual level errors which are not constant over the entire line frequency band. The SMG translating equipment therefore includes facilities for regulation of any such residual level errors in the basic SMG band and for supervision of SMG reference pilots, as shown in fig. 3. This equipment is controlled by a centralized pilot receiver accommodated in the same bay frame as the SMG translating equipment.

At the point where the supermastergroup is formed the 11,096 kHz reference pilot is injected into the SMG band, to be picked off in the receive path at the point where the basic supermastergroups have been recovered from the line frequency spectrum. After filtering and modulation with 12,648 kHz the frequency 1552 kHz is obtained, which can be used as reference frequency for both automatic regulation and supervision of the supermastergroup concerned by means of the centralized 1552 kHz pilot receiver.

The gain regulating function is provided by a thermistor-controlled amplifier for each supermastergroup, which is inserted directly after the demodulator.

The pilot receiving shelf includes generating equipment for the 12,648 kHz carrier required to convert the 11,096 kHz pilot into 1552 kHz.

A more detailed description of the level regulating equipment and its operating principles has been given in the 3rd issue of Ericsson Review, 1966.[2]

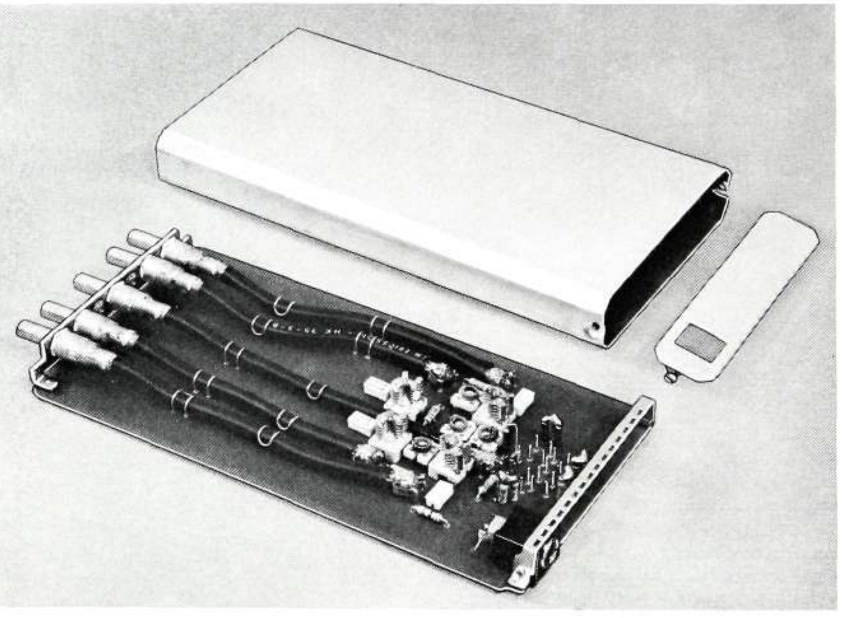
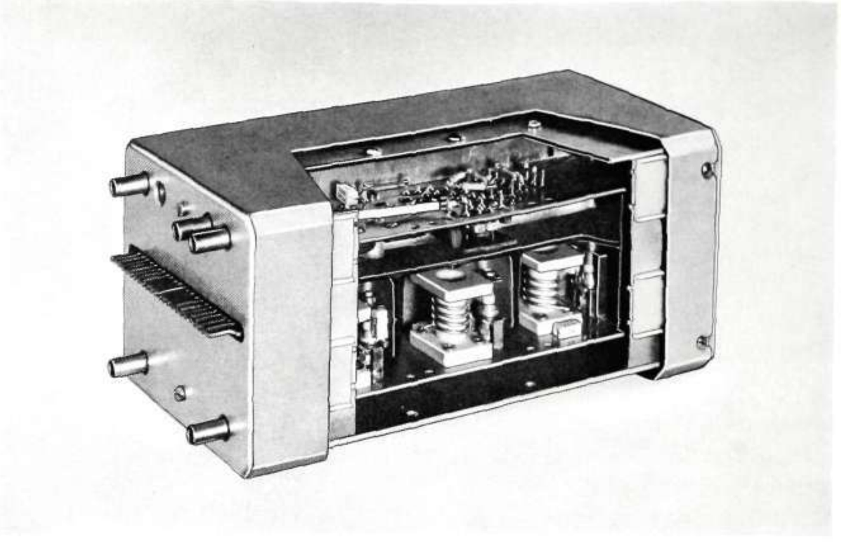


Fig. 9
Hybrid unit 4—60 MHz in M4 design

Fig. 10

Apparatus construction for filter designs using air-core coils. Cut-away view of the SMG-5 modulator unit



Mechanical Construction

Apparatus Units

The mechanical construction is entirely based on the M4 construction practice described in the 3rd issue of Ericsson Review, 1966.[3]

All the apparatus units are of the plug-in type. The components are assembled on printed-wiring boards, which are enclosed by aluminium cases providing good electrical shielding as well as protection from mechanical damage. During the design work, the M4 mechanical design has proved fully capable of application even at frequencies up to 100 MHz. An example of a unit operating at such high frequencies is the passive combiner/separator (fig. 9), which handles all 10,800 circuits.

A special mechanical design was developed for those apparatus units which contain filters using air-core coils. This design provides the electrical shielding required to prevent leakage of the powerful magnetic field from the air-core coils to adjacent apparatus units and vice versa. The mechanical unit consists of a cast light-metal box, which is well insulated from the outer case. The

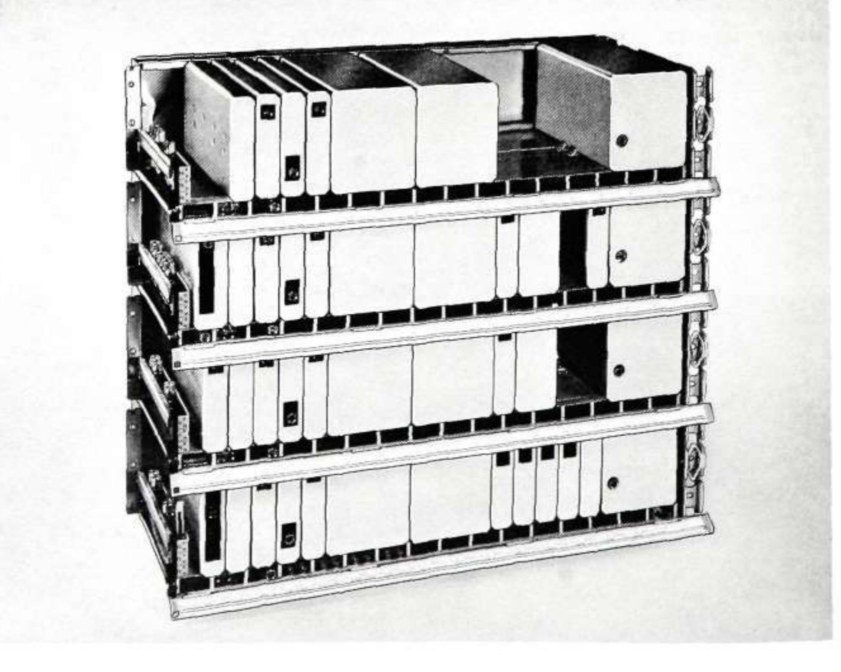


Fig. 11

Shelf stack for translating four basic supermastergroups into an assembly of SMG's 6—9. Covers for shelf maintenance strips are open, giving access to test points. Connections to station cabling are made at the left-hand side of the shelf stack

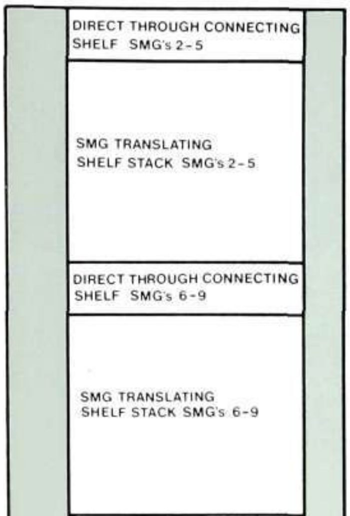


Fig. 12

Bay layout for supermastergroup translating equipment according to CCITT Plan 1

inner box accommodates up to four printed-wiring boards, two of which can be equipped with air-core coils and the rest with other active and passive components. This design offers great flexibility, which permits it to suit a variety of applications. Fig. 10 shows an apparatus unit engineered in this manner.

Another version of the cast box has been used for assembling the 60 MHz line group amplifier as well as the active combiner and separator.

Bay Arrangement

All the functional electrical equipment required for frequency translation, regulation and power supply has been assembled into shelves and shelf stacks, which constitute the so-called basic building blocks of which stations are made up. An illustration of such a building block is given in fig. 11, which shows the shelf stack for assembling four basic supermastergroups into an assembly of supermastergroups 6—9.

A bay arrangement for assembling twelve basic supermastergroups into a 10,800-channel line group and vice versa is shown in fig. 12. This bay can also be equipped with shelves for direct through connection of 4-SMG assemblies, in which case the corresponding SMG translating shelf stack is omitted.

The internal bay cabling is mainly accommodated in the right-hand bay upright, the connection of the station cabling being arranged in the left-hand bay upright.

To ensure continuity of operation the bay has been provided with two power packs. In the event of a failure in one of these, the load is automatically switched to the other.

Equipment according to Plan 2

Electrical Design

Modulation Plan

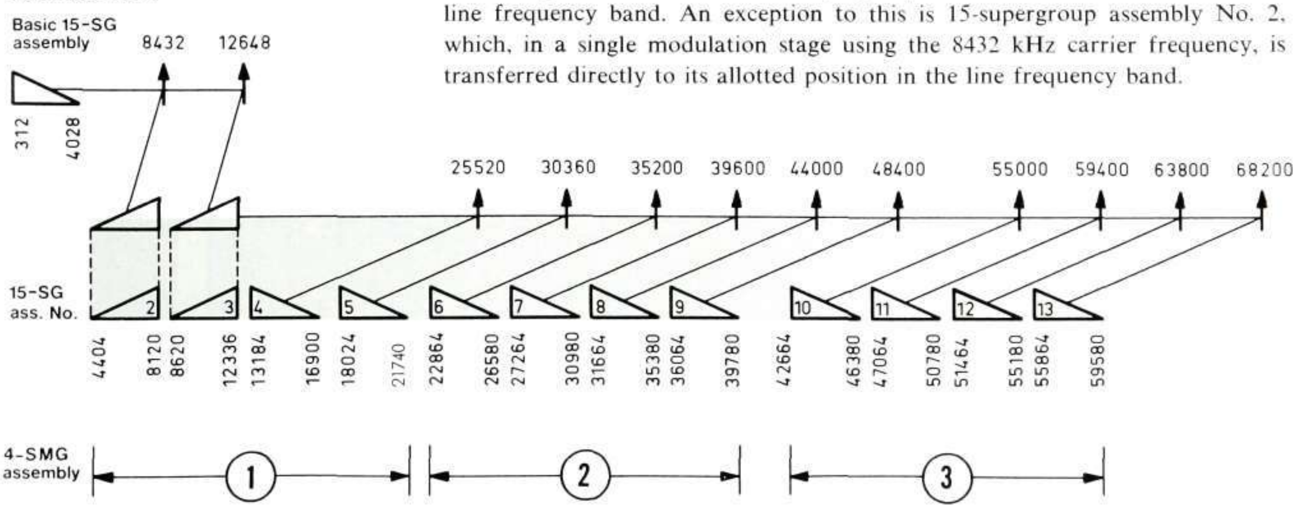
The frequency allocation of Plan 1 described in the first part of this article is based on the use of basic supermastergroups occupying the 8516—12,388 kHz frequency band. The 900-channel batches according to CCITT Plan 2, however, are assemblies of 15 supergroups located in the basic 312—4028 kHz range. The relevant modulation plan is shown in fig. 13.

The basic 15-supergroup assembly, in a first modulation stage, is caused to modulate the 12,648 kHz carrier, thereby producing the 8620—12,366 kHz band of 15-supergroup assembly No. 3, which corresponds to the basic supermastergroup band. The No. 3 band is subsequently applied to a second modulation stage, where the No. 3 15-supergroup assemblies are translated into the line frequency band. An exception to this is 15-supergroup assembly No. 2, which, in a single modulation stage using the 8432 kHz carrier frequency, is transferred directly to its allotted position in the line frequency band.

Fig. 13

Modulation plan for assembling twelve 15-SG assemblies into a 10,800-channel line group (CCITT Plan 2)

Frequencies in kHz



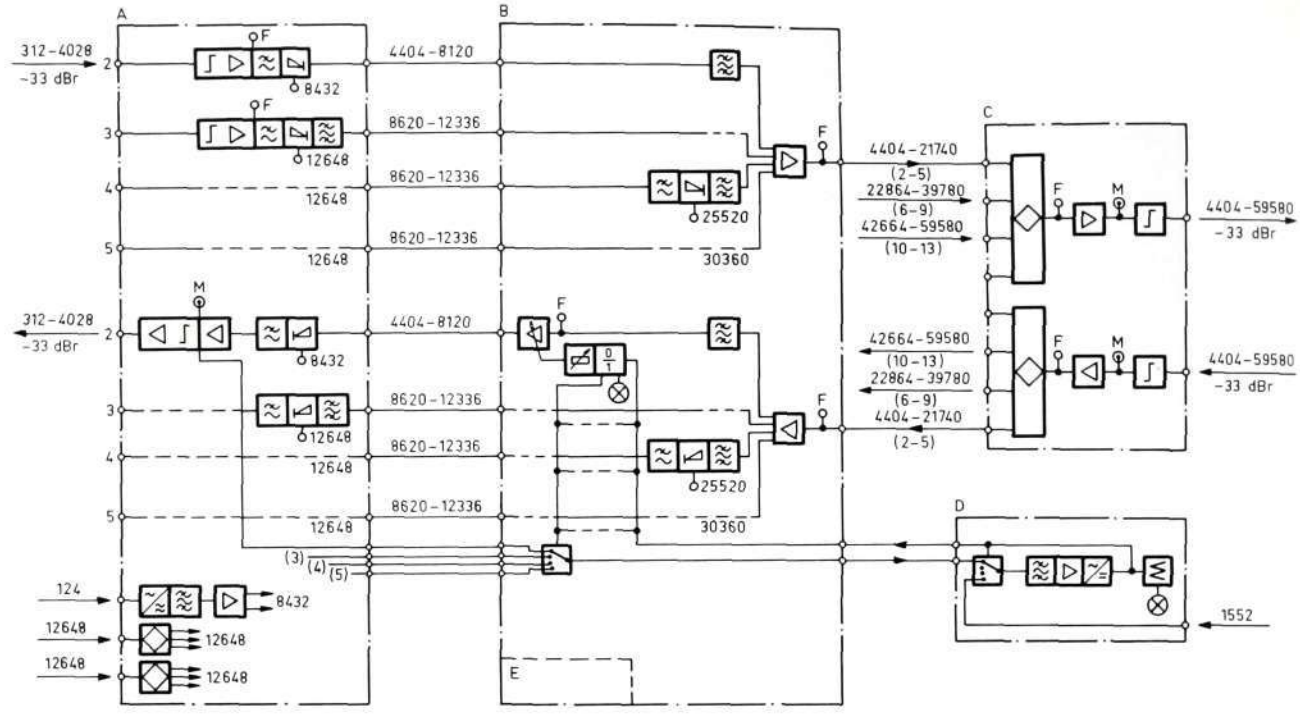


Fig. 14

Block diagram of 15-supergroup translating equipment for forming a 10,800-channel line group according to CCITT Plan 2

A 15-SG modulating shelf stack
B SMG translating shelf stacks, 15-SG assemblies 2–5
C 4-SMG combining and separating shelf
D Pilot receiving shelf 1552
E Built-in carrier generating equipment (see fig. 4 a–c)
F Fault location test points
M Maintenance test points
2–13 Inputs and outputs for 15-SG assemblies
Frequencies in kHz

Graphical symbol

[ʃ ▷] active cable equalizer

A comparison between the line frequency allocations for Plan 1 and Plan 2 shows that the bandwidth required for a 15-supergroup assembly according to Plan 2 is less than that required for the supermastergroup of Plan 1. The Plan-2 band consequently lies within the limits of the Plan-1 band, which means that the second modulation stage can use the same supermastergroup translating shelf stack as the equipment according to Plan 1. Only 15-supergroup assembly No. 2 necessitates a modification, since the modulation for supermastergroup 2 according to Plan 1 cannot be used in Plan 2.

Also the line frequency band of Plan 2 is divided into three 4-SMG assemblies, so that the same system flexibility is achieved as in Plan 1.

The carrier frequencies for the first modulation stage, 8432 kHz and 12,648 kHz, have been chosen such that the carrier leaks in the line frequency band will always fall in the gaps between two 15-supergroup assemblies.

Block Diagram

The block diagram of the multiplexing equipment according to CCITT Plan 2 differs only slightly from that of Plan 1. As will be seen from fig. 14, a modulation stage has been added for transferring the basic 15-supergroup assemblies to the No. 3 position. This equipment is interconnected in both directions of transmission with the next modulation stage, where the 15-supergroup assem-

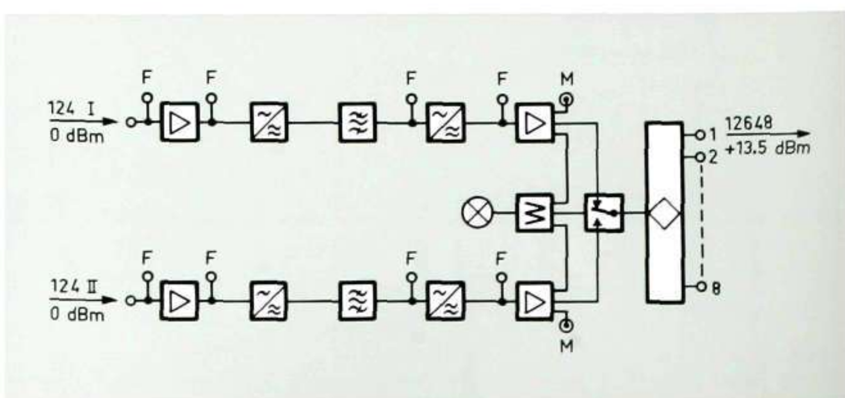


Fig. 15

Block diagram of carrier generating equipment 12,648

I = regular set
II = standby set
Frequencies in kHz

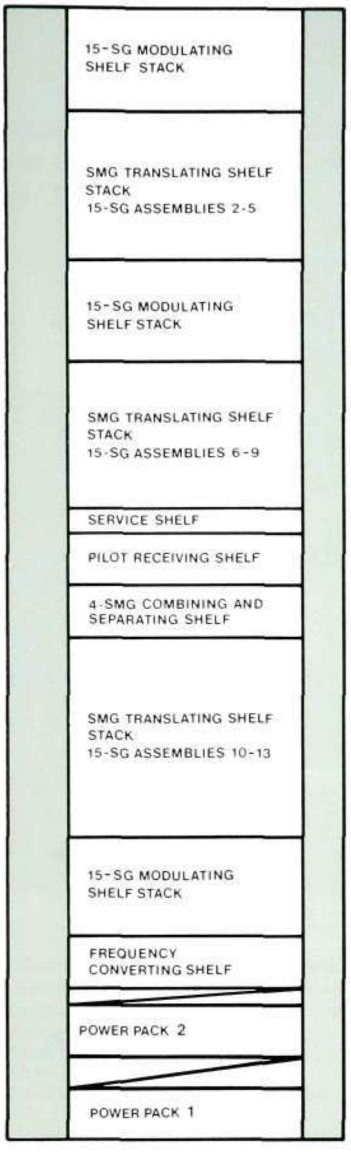


Fig. 16
Bay layout for 15-SG translating equipment according to CCITT Plan 2

blies are translated to their respective positions in the line frequency band. The reference pilot for regulation and supervision is picked off at the output of the A-stage receive path. Since at this point the pilot has a frequency of 1552 kHz, it can be directly applied to the 1552 kHz pilot receiver common to all the basic 15-supergroup assemblies. This also means that no modulator — and thus no carrier — is needed for pilot modulation. For this reason, the pilot receiving shelf has no carrier supply.

The generating equipment for the 15-supergroup carrier frequencies is also decentralized and built into the shelf stacks where these frequencies are to be used. An exception to this rule is the 12,648 kHz carrier. In a complete 15-supergroup translating bay this frequency is needed in 11 modulators and as many demodulators. The bay has therefore been provided with a special shelf for the generation of this frequency, as shown in fig. 15. Since $11 \times 900 = 9900$ telephone circuits depend on this carrier, the active part of this generating equipment has been duplicated to ensure continuity of operation. In the event of a failure in the working equipment a changeover switch will connect the standby equipment into circuit and at the same time initiate an alarm. The carrier is distributed via passive hybrids to the modulators for 15-supergroup assemblies 3—5, 6—9 and 10—13.

The 8432 kHz carrier is required for 15-supergroup assembly No. 2 only and is therefore generated in the shelf stack concerned.

The requisite basic frequencies are generated in the same way as in the equipment previously described, i.e. in the common frequency supply of the station.

The levels at the equipment input and output points in the send and receive paths are −33 dBr, the impedance at these points being 75 ohms, unbalanced to earth.

Modulator Units 12,648 and 8432 kHz

These units are designed as active transistor modulators. For the filters a design using ferrite coils has been employed. The composite-attenuation characteristic in the filter stop-band range has been shaped such that the send and receive filters together with the low-pass filters provide adequate protection against crosstalk between 15-supergroup assemblies. No additional filters are therefore required for through connection of 15-supergroup assemblies.

In addition, active station cable equalizers are included in the modulator units to compensate for the attenuation slope introduced by the cabling between the 15-supergroup distribution frame and the 15-supergroup translating bay. Equalization is provided in such a manner that the sum of the frequency-dependent loss introduced by the cable and the gain introduced by the equalizer is zero. The corresponding equalizers inserted in the receive path are designed as separate units each of which is provided with a pilot outlet for connection to the pilot receiver as well as a short-circuit-proof maintenance test point.

Mechanical Construction

All the apparatus units shown schematically in figs. 14 and 15 are assembled into shelves and shelf stacks, which are accommodated in one bay frame as shown in fig. 16. The station cabling is connected to the left-hand side of the bay.

Two power packs are placed at the bottom of the bay, one acting as regular supply, the other as standby.

Technical Data	*Plan 1*	*Plan 2*
Frequency ranges		
Basic 900-channel batch	8516—12,388 kHz	312–4028 kHz
10,800-channel line group	4332—59,684 kHz	4404—59,580 kHz
15-SG assembly No. 3	—	8620—12,336 kHz
Nominal interconnection levels		
Basic 900-channel batch		
Send path	– 33 dBr	– 33 dBr
Receive path	– 25 dBr	– 33 dBr
10,800-channel line group		
Send path	– 33 dBr	– 33 dBr
Receive path	– 33 dBr	– 33 dBr
Maximum cable length for which equalization is provided at SMGDF and line sides	25/25 m	50/25 m
Nominal impedances		
All inputs and outputs at SMGDF and line sides	75 ohms unbal.	75 ohms unbal.
Attenuation distortion		
in 900-channel band, send and receive, referred to:		
attenuation at 11,096 kHz	$< \pm 0.5$ dB	—
attenuation at 1552 kHz	—	$< \pm 1.0$ dB
Level regulation range		
for 900-channel batches in receive path	± 4 dB	± 4 dB
Carrier leak		
measured at send-path output	≤ -50 dBm0	≤ -50 dBm0
Attenuation of intelligible crosstalk		
referred to nominal level for all combinations of near-end and far-end crosstalk	$>$ 85 dB	$>$ 85 dB
Noise		
per telephone circuit, psophometrically weighted, in looped equipment loaded with white noise at – 15 dBm0 per circuit	$\leq$ 50 pW0p	$\leq$ 80 pW0p
Power consumption		
for fully equipped bay	c. 130 W	c. 170 W

Supplementary Equipment

In long-distance networks, which may consist of many branches with numerous small and large stations, severe demands are imposed on the flexibility of a carrier system of the capacity described in this article, if it is to solve traffic problems in a technically as well as economically attractive manner.

To meet the flexibility requirement, supplementary facilities have been developed which permit the separate handling of one or more individual super-

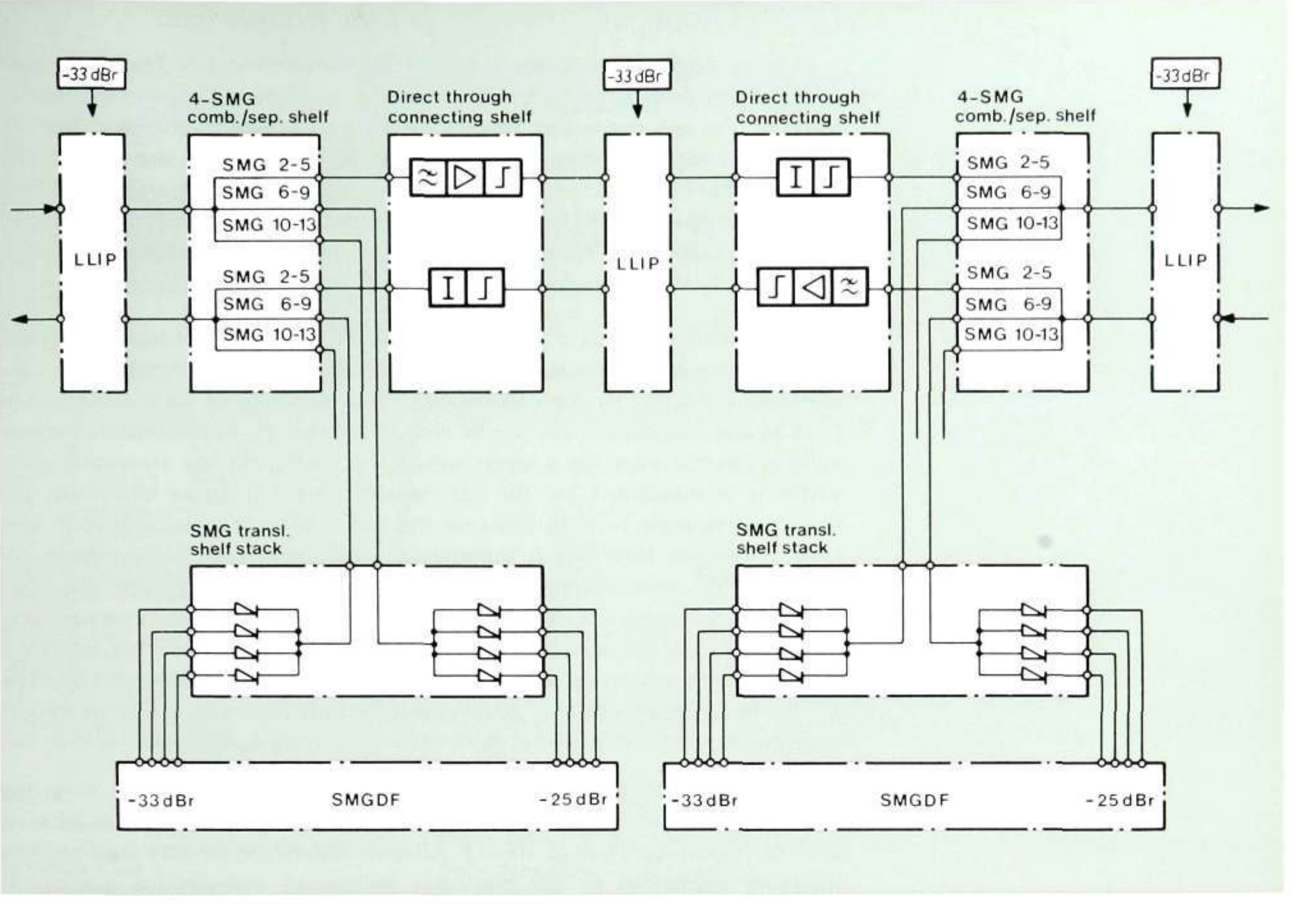


Fig. 17

Block diagram for direct through connection at line frequencies in a 60 MHz system. The example refers to Plan 1 and shows the direct through connection of SMG's 2—5.

LLIP = Line link interconnection point
SMGDF = Supermastergroup distribution frame

mastergroups or 15-supergroup assemblies. This also facilitates interconnection between existing smaller-capacity carrier systems and the 60 MHz system.

The supplementary equipment serves for:

- through connection of one SMG or 15-SG assembly
- direct through connection of four SMG's or 15-SG assemblies
- branching of SMG's or 15-SG assemblies Nos. 2 and 3.

Through Connection in the Basic Frequency Band

The smallest batch of channels employed as a flexibility group in this equipment is the supermastergroup or 15-supergroup assembly. When through connecting such a batch from one 60 MHz system to another, or from a 60 MHz system to a 12 MHz system, any channel vestiges outside the through-connected band should be suppressed to ensure that crosstalk between different batches of channels is minimized. The attenuation needed for this purpose is obtained by means of a through-connection filter, which is connected to the SMG or 15-SG point at the output of the receive path before through connection to the other system.

To allow for noise components produced by the modulators in a frequency range that exceeds 100 MHz, the stop-band attenuation characteristic of the filter has been shaped so as to fulfil the requirements for crosstalk protection, even if certain assistance from modulator filters preceding and following the through-connection filter is not taken into account.

As mentioned in the preceding chapter, no additional filtering is required for Plan-2 equipment, since adequate attenuation of noise components in the stop band concerned is provided by the filters incorporated in the modulators and demodulators using the 8432 and 12,648 kHz carrier frequencies.

Direct Through Connection at Line Frequencies

In those applications where only part of the received line frequency band is to be terminated, considerable savings in multiplexing equipment can be made by through connecting batches of channels at line frequencies. The line frequency bands according to both alternative CCITT plans are divided into three assemblies of four supermastergroups alt. 15-supergroup assemblies, Nos. 2—5, 6—9 and 10—13. The gaps between these 3600-channel batches are so large that economical filters can be used to separate the batches from each other directly at line frequencies, if desired.

Consequently, if such a 3600-channel batch is directly through connected, no translating equipment is required. Fig. 17 exemplifies this by showing schematically the direct through connection of an assembly of supermastergroups 2—5 at line frequencies. As will be seen, the direct through-connection equipment is inserted after the 4-supermastergroup combining and separating shelf, where it is substituted for the supermastergroup translating equipment for supermastergroups 2—5. In this case the direct through-connecting shelf contains a low-pass filter which transmits supermastergroups 2—5 (about 4—20 MHz) and effectively suppresses all the others. The level at the line link interconnection point is − 33 dBr. In the system to which the 4-supermastergroup assembly is to be through connected the send equipment of the other terminal's direct through-connecting shelf only consists of a station cable equalizer. The 4-supermastergroup assembly is subsequently combined with the other two 4-supermastergroup assemblies in the 4-SMG combining equipment.

In the case of an assembly consisting of supermastergroups 6—9 the through-connection filter consists of a band-pass filter; a high-pass filter is used for supermastergroups 10—13. All three filters use air-core coils and are therefore engineered in the previously mentioned well-shielded mechanical design.

One filter with associated amplifier and equalizer is mounted in a shelf which is placed in the supermastergroup translating bay either at a predetermined position or at that of the supermastergroup translating shelf stack for which it is substituted.

Branching

Supermastergroups or 15-supergroup assemblies Nos. 2 and 3 in a 60 MHz line group coincide with their counterparts in a 12 MHz system. The branching equipment for extraction of these batches directly from the line frequency band has been developed to facilitate in this respect the interconnection of 60 MHz systems with existing 12 MHz systems, so that the batches Nos. 2 and 3 can either be terminated or directly through connected via a 12 MHz line link.

The branching equipment mainly consists of a low-pass/high-pass filter combination. The high-pass filter effectively suppresses the frequency band of the batches Nos. 2 and 3 previously extracted from the line group so that this frequency band can be employed for the injection of two other 900-channel batches to permit communication with the next station. In the receive path the same procedure applies. The equipment comprises station cable equalizers at all inputs and outputs as well as amplifiers to adjust the output levels to the desired value. One set of equipment is required for each direction of transmission, each set requiring one shelf.

Since the 900-channel batches are extracted directly from the line frequency band, i.e. without first splitting up the line group into 3600-channel batches, as in the direct through-connection equipment described in the preceding section, no supermastergroup translating bay is needed. The branching shelf is therefore not restricted to a certain bay for its accommodation. A block dia-

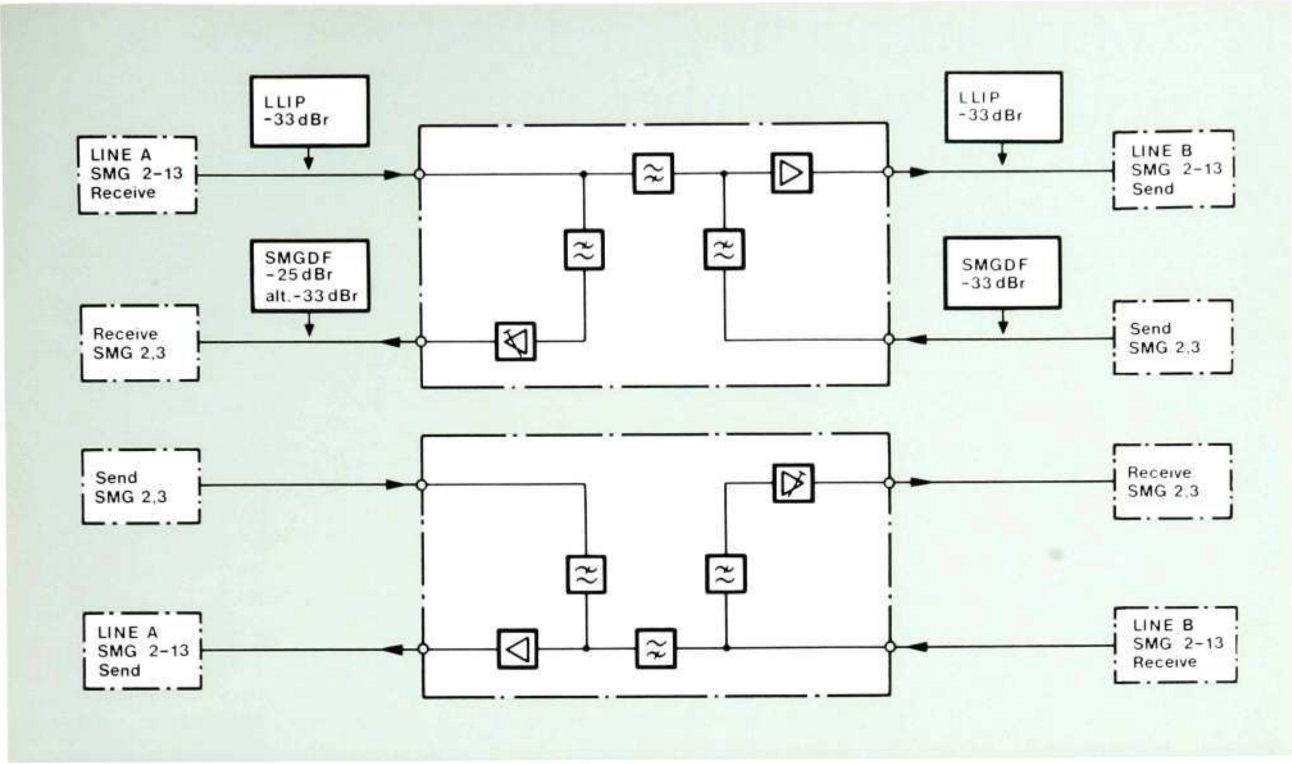


Fig. 18

Block diagram for branching in a 60 MHz system. The example shows the branching of SMG's 2 and 3.

[≈] **High-pass filter**

gram showing the basic operating principle for the branching equipment in both directions of transmission is shown in fig. 18.

Summary

The rapidly increasing need for long-distance telephone circuits, particularly marked in highly industrialized countries, has induced L M Ericsson to develop multiplexing equipment capable of transmitting up to 10,800 simultaneous telephone conversations on one pair of coaxial tubes.

It is now possible to offer a degree of transmission-medium utilization four times as high as with the present maximum of 2700 conversations.

To achieve the high degree of flexibility required in transmission systems involving such large numbers of circuits, special equipment has been developed for the through connection of individual 900-channel batches after demodulation to the basic frequency band as well as for the direct through connection of 3600-channel batches and for branching supermastergroups or 15-supergroup assemblies Nos. 2 and 3 by direct line filtration.

With regard to differences in the network-design principles employed by different countries, L M Ericsson has developed multiplexing equipments for each of the two modulation plans recommended by the CCITT. Each of these complete sets of multiplexing equipment can be housed in a standardized bay frame engineered in accordance with L M Ericsson's well-known and tried construction practice for transmission equipment, M4.

References

1. TANGEN, N. & ZEIPEL, K.-G.: *Centralized Fundamental and Pilot Frequency Generating Equipment for Carrier Terminals.* Ericsson Rev. *44*(1967): 1, pp. 34—52.
2. ASARNOJ, R. & RASK, B.: *Channel and Group Translating Equipment.* Ericsson Rev. *43*(1966): 3, pp. 102—124.
3. AXELSON, K.: *The M4 Method of Construction Used in Mechanical Design.* Ericsson Rev. *43*(1966): 3, pp. 83—93.

Telecommunications Simplify the Work of the Swedish Single-Chamber Parliament

E. MIKKELINEN, T. ANDERSSON & R. BIRKSJÖ, L M ERICSSON TELEMATERIEL AB, STOCKHOLM – TYRESÖ

UDC 621.39:725.11
65493
LME 86
825
837
8543
8524
4166

This article briefly describes the telecommunications equipments in the new Swedish single-chamber parliament, where the goal has been as far as possible to simplify the work for the individual member of parliament.

The telecommunications system is not an end in itself. Its function is to take over important routines so that the parliamentary work can be conducted as effectively as possible. The time is long past when members of parliament voted by a show of hands. The first electrical voting system was delivered by L M Ericsson to the Swedish parliament in 1932 and greatly facilitated the work of the members.

In the new single-chamber parliament at Sergels Torg in Stockholm a further step has been taken. Not only is there an electrical voting system, which helps the members to conduct their business more effectively, but also a score or so of telecommunications systems, all more or less integrated with one another, which simplify the work for the members.

L M Ericsson Telemateriel AB was commissioned by the Swedish parliament to make up and deliver this extensive telecommunications package, at a cost of some 5 million kronor. A specially appointed project group within L M Ericsson Telemateriel AB completed the whole job in as short a time as 15 months. The telecommunications package is accommodated in the three houses which make up the parliament building and comprises chiefly the following individual systems:

- Voting system
- Voting signalling and paging system with more than 350 stations
- Sound distribution system with more than 1000 loudspeakers
- Amplifier equipment for the hard-of-hearing, with tape recording (party rooms and lecture rooms)
- Magnetic loops for the hard-of-hearing (plenary chamber)
- TV installation with cameras which are automatically directed at the member who is holding the floor
- Stenographers' tape recording equipment
- Member's microphone equipment
- Simultaneous interpretation equipment for five foreign languages
- Projector equipment
- Timer system for control of times for members' replies etc.

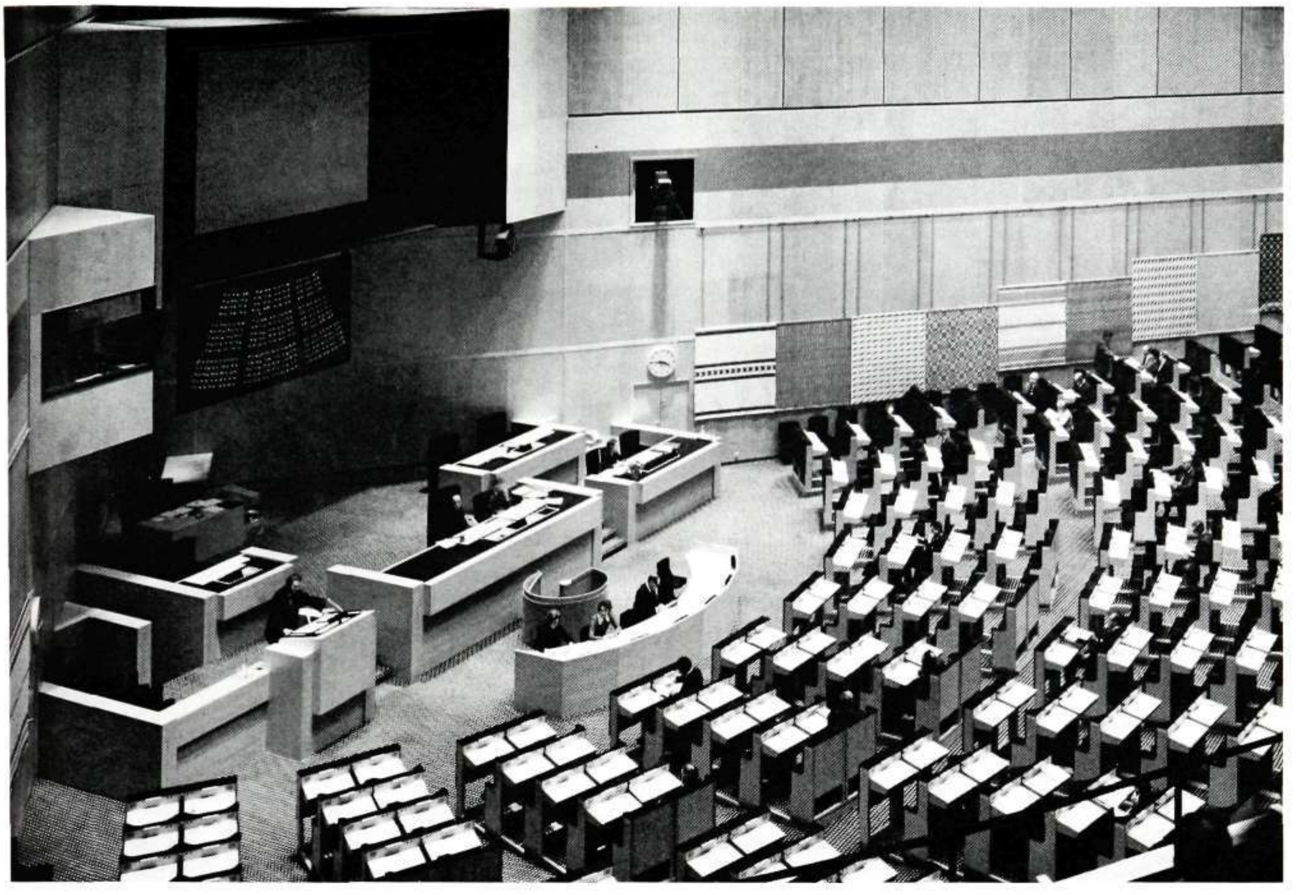


Fig. 1

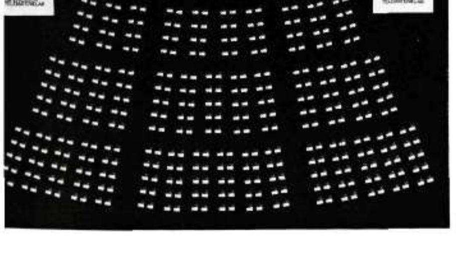
Plenary chamber viewed from visitors' gallery. (Left) Control room, in the rear above the podium the 3.5×4.5 m projector screen, thereunder the voting panel and the moving TV cameras.

- Optical paging equipment in plenary chamber
- Door signal system with attendant calling signal
- Loop paging with pocket size receivers
- Intercom system with ten speech channels and at present about 250 stations
- P.A.X.
- Emergency telephones in some 20 lifts
- Fire protection system with smoke and thermal detectors
- Smoke-detector-controlled door magnets which, on a fire risk, automatically close doors between corridors etc.
- Control system for switching-off of fans and closing of dampers in event of a fire risk (via smoke detectors in ventilation ducts)
- Electronic master clock for exact time indications on more than 300 clocks
- Controls for the technician in the control room

Some of the systems are described below. A standardized technique has been used in all systems, including those tailored to suit their particular purpose.

Fig. 2

Voting panel



Quick Voting System

The function of the voting system is to collect, record, photograph and distribute the result of every division.

Fig. 3
Speaker's podium; on the left of the Speaker is the Secretary. From the podium the Speaker leads the work in the plenary chamber with the technician's aid. In front of him he has a TV monitor on which the member addressing the chamber at the moment is seen. Below it is a panel which shows the voting result.

During voting the system is controlled from the Speaker's desk. Connection and disconnection of the system is done by the Secretary; and the Speaker, who sits on his right, need only operate three buttons during the actual voting procedure.

When voting can start, the Speaker presses the VOTE button and, after members have voted, the VOTING ENDED button. He presses the RESTORE button when the result of the vote is no longer needed. At the technician's position in the control room above the podium there are also buttons corresponding to those used by the Speaker and Secretary.

The 350 members of the chamber sit at pairs of benches and have in front of them a control panel containing a loudspeaker, reading lamp, three indication lamps and four voting buttons: AYE (green), NO (red), ABSTAIN (orange) and CORRECT (white). When the speaker presses the VOTE button, the lamp in the CORRECT button lights as a sign that voting can start. If the member wishes to record an *aye* vote he presses the green button, a *no* the red button, and to *abstain* the orange button. When one of these buttons is pressed, a lamp in the button lights as acknowledgement and the white lamp goes out. If the member wishes to correct his vote (which he can do any number of times until the voting has been terminated by the Speaker), he first presses the white CORRECTION button and then the button for the vote he wishes to give.

Voting Panel

The members can follow the voting throughout on a voting panel above the podium. During debates the panel is raised up and concealed by a film screen, but during a vote it is automatically lowered. The panel has the form of the plenary chamber, each member been represented by four lamps, a green for AYE, a red for NO, an orange for ABSTAIN and a white for ABSENT. The white lamps are lit by the Speaker after the end of voting.

Recording of Result of Vote

After a division the votes are automatically counted and sorted in the central equipment of the voting system. After only six seconds the result is shown by the TV cameras and a large-screen projector on a 3.5×4.5 m screen above the

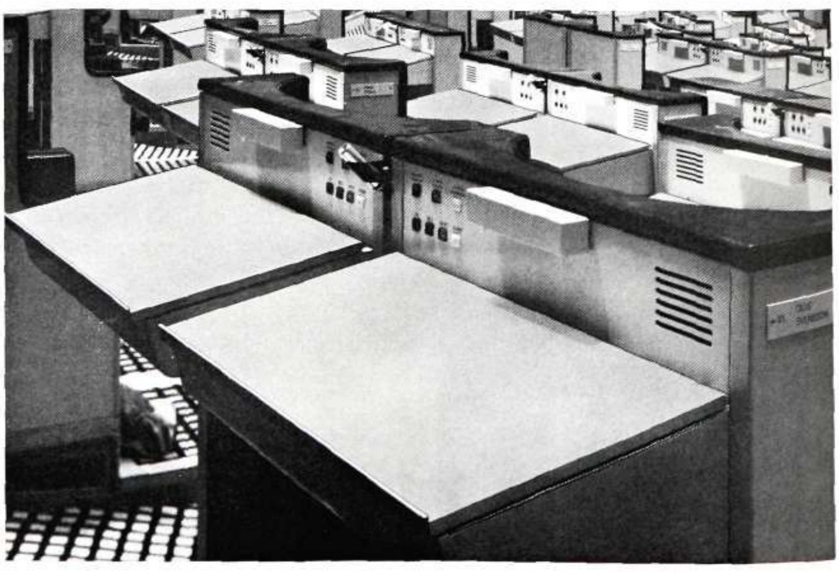
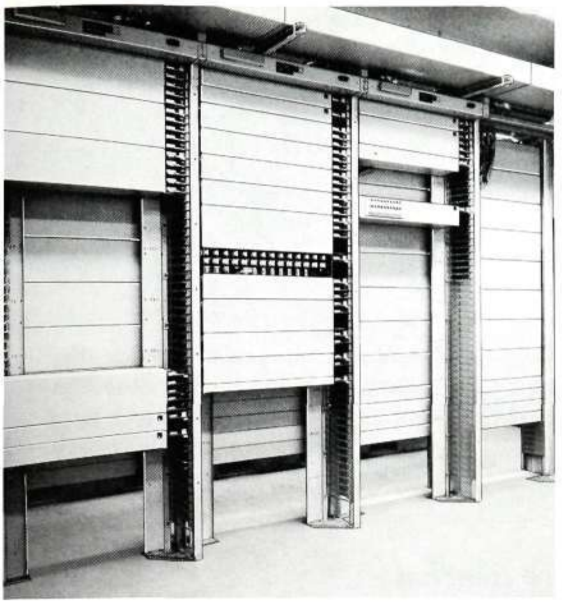


Fig. 4
The members of parliament sit at pairs of benches with black leather upholstery. In front of them they have a control panel, loudspeaker and microphone.



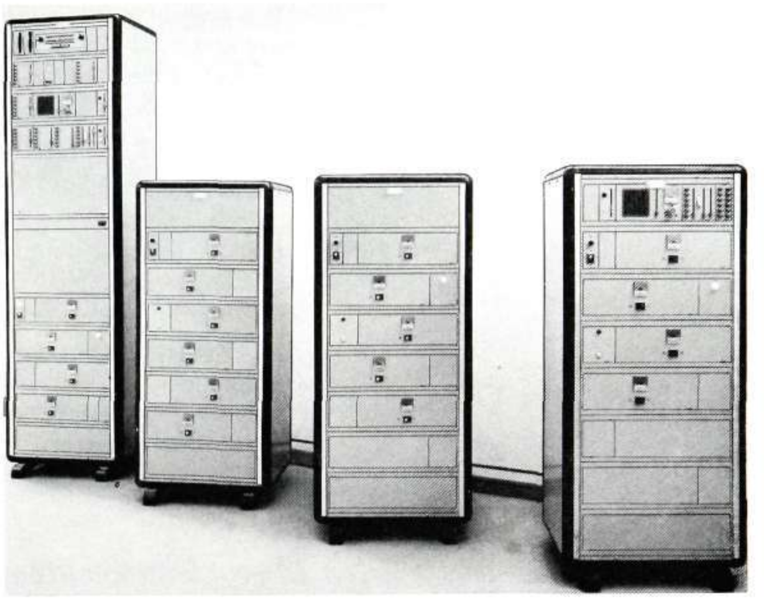


Fig. 5 (left)
Central equipment of voting system.

Fig. 6 (right)
Part of the central equipment for sound distribution. The plant delivers a total of more than 5000 W.

podium, on a miniature result panel on the Speaker's desk, and on all TV monitors on the podium and outside the chamber. The total AYE, NO, ABSTAIN and ABSENT votes can thus be read at these various points.

Automatic Photographing of Record Panel

Immediately after every division a panel showing the vote cast by each member is automatically photographed by two electrical Hasselblad cameras in parallel operation. This panel is placed in a room close to the central equipment and contains lamps which indicate the vote of each member, alphabetical and numerical indicators showing the date, question number, committee designation, vote number etc. Two cameras are used in order to ensure that at least one negative is obtained in the event of failure of a camera or destruction of a negative, e.g. during its development. The cameras are connected to a counter equipment which counts the number of photographs taken. When only two exposures remain on the reel, a warning lamp lights. When only one exposure remains, the Secretary's clerk is informed of the fact through an optical signal on his panel. If the entire film has been exposed, an END OF REEL lamp lights. Development and enlargement are done in a darkroom close to the central equipment.

Reliability Tests

The voting system includes more than 6000 lamps. In view of the high requirement of reliability there must be efficient means of tracing faults in lamps and other components. Checking of lamps and counting circuits is done automatically during every vote.

By means of three routine tests, which can be started by the technician, the system can be automatically tested before a sitting. The first test checks all lamps on the members' benches and on voting and record panels. The second test checks the lamps on the miniature result panel. In the third test a number of divisions with different numbers of AYE votes are simulated for check of the counting circuit. A similar test is made also for NO, ABSTAIN and ABSENT votes.

If a fault is found in these tests, the test is stopped and the technician receives an optical fault indication. In the first and second tests an indication is also given of the location of the fault. In the third test a red lamp lights in the faulty relay unit in the central equipment if the fault is a short, and a white lamp in the case of an open. Apart from these indications there is an extensive fault location panel in the central equipment.

Sound Distribution

In order that members may distinctly hear what is being said wherever they are in the chamber, including podium and gallery, there is a sound distribution system which distributes the speech via microphones and amplifiers to a large number of loudspeakers.

Microphones in Members' Benches

Microphones are provided on the rostrum, at the Speaker's, Secretary's and Secretary's clerk's positions and — a new feature in the single-chamber parliament — also in the members' benches. Every pair of benches has a permanent microphone placed between them for joint use by the two members. The microphone is switched on by the technician in the control room above the podium. For this purpose he has push-buttons, one for each pair of benches. The buttons are arranged fanwise and their positions correspond to the positions of the benches in the chamber, so facilitating the work of the technician. When the Speaker calls a member, the technician presses the button for the latter's microphone. The MICROPHONE ON lamp on the member's panel then lights as a sign that he can start speaking. At the same time a given number of loudspeakers in the surrounding members' benches are automatically switched off to prevent acoustic feedback.

Warning Signal Indicates End of Time for a Members' Reply

When the Speaker calls a member to make a speech or a brief reply, he starts a digital clock. The time allowed is counted down to a second, being shown by illuminated digits on screens on the Speaker's desk and on the rostrum.

For members' replies the time is limited to three, six or ten minutes. When 30 seconds of the time remains, the member is warned of the fact by flashing of a yellow lamp on his panel. At the end of the reply time the lamp glows steadily. There is a corresponding lamp on the Speaker's desk.

Stenographers

The telecommunications equipment has, however, not taken over all functions. There are still stenographers, though not so many as before. They sit at a semicircular table below the Speaker's chair. They work for five minutes at a time, one at a time. After every spell of duty the stenographer goes down to the floor below, where there are two tape recorders which continuously record every 5-minute period of the debate. The tape recorders work with 10-second overlap. The stenographer receives from the tape recorder operator his 5-minute tape for a playback check. He can then immediately make the final transcription. As an extra precaution there is a long-playing tape recorder which continuously records the day's debate.

Fig. 7
Room loudspeaker

More than 1000 Loudspeakers

In the plenary chamber there are more than 500 loudspeakers, 405 of which in the members' benches, 125 in the visitors' gallery and the remainder on the podium etc. All loudspeakers are recessed. Debates in the plenary chamber are relayed through these loudspeakers and a central radio equipment to the roughly 600 loudspeakers in the members' rooms and to a tape recording room. The room loudspeakers can also receive channels P1, P2 and P3 of the Swedish Broadcasting Corporation. Pushbuttons for setting to the desired programme and volume make the loudspeakers very easy to handle.

Facilities for the Hard-of-Hearing

Magnetic loops for the hard-of-hearing are placed in the floors of the plenary chamber and visitors' gallery for wireless transmission to portable receivers.

Direct Transmission to Swedish Broadcasting Corporation

The sound distribution system can be used for relaying debates via the public telephone network directly to the Ministry for Foreign Affairs, the large Stockholm newspapers, the Central News Agency and the Swedish Broadcasting Corporation. The latter can thus both tape-record and directly broadcast parliamentary debates via L M Ericsson's sound distribution system. A corresponding connection can also be made to the simultaneous interpretation system.

Five Languages

A simultaneous interpretation system is installed for five foreign languages. The transmission to the listening positions is by magnetic loop. Foreign visitors can thus hear debates in their own languages in the plenary chamber and in the visitors' gallery through the use of small portable receivers. Five of the booths allotted to the foreign press are equipped for use by interpreters, with space for two interpreters in each. Sixty portable receivers have been supplied for the system.

The Prime Minister and the Speaker Can Issue General Announcements

In critical situations the Prime Minister and the Speaker can deliver a general announcement from special microphones, i.e. deliver a message to all of the roughly 1500 loudspeakers in the sound distribution system of the new parliament. All other programmes are then interrupted automatically.

Audible Signals and Red Lamps Call Members to Vote

Communication on all floors and with all modern aids has been the aim in the design of the telecommunications equipment for the new parliament building. Wherever a member happens to be in the many rooms and corridors of the building, he must be accessible at any time. There are several paging systems, of which the voting signalling system is the largest, with about 350 stations at all imaginable positions within the building. It is practically only in the sauna that a member is left undisturbed.

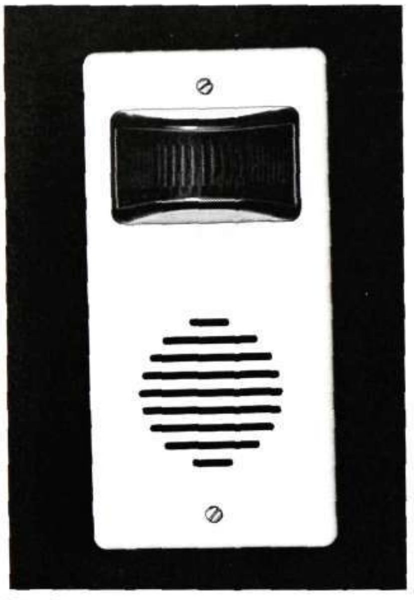


Fig. 8
Paging station

The paging apparatus has a red lamp and a built-in loudspeaker. When voting is to take place, the lamp flashes during the intervals between regular audible signals sent through the loudspeaker. The system is switched on from the podium. The members then have two minutes to reach their positions in the plenary chamber.

The voting signal system is integrated with the sound distributions system. This means that a call to a division is issued through the 600 room loudspeakers. The loudspeakers have a red lamp for visual indication as well. A radio programme is automatically interrupted when a call to a division is signalled.

Individual Paging

A steady red light on the room loudspeaker signifies that a paging call has been set up from the telephone switchboard and that the person should contact the operator.

Future Plans

The voting signal system is prepared for four other types of warning signal within the parliament building. These warnings could be used, for example, for summoning members to the day's sitting, for fire alarm or air raid alarm.

Loop Paging

If a person is expecting an important message and must be immediately available, he can collect a loop paging unit from the attendant's counter in the foyer of the plenary chamber. At present there are 20 such receivers, each with its call signal, and not much larger than a packet of cigaretts. They can therefore easily be carried in a coat pocket. When a receiver is collected, the attendant notifies the switchboard operator of the name of the recipient and the number of the receiver. Paging signals can then be set up by the operator on a special console. The receivers batteries ar charged, while not in use, in special charging cells in the attendant's counter. The system can be successively extended to comprise 500 receivers.

Fig. 9
Dirivox intercom telephone instruments are provided in most of the offices in the new parliament building.

Intercom

For loudspeaking internal communication between certain parts of the building, e.g. offices, there is an intercom system with at present about 250 stations. Ten conversations can be conducted at a time. The exchange is of type *AKD 461* and can be extended by some hundreds of additional stations.

Exact Time

An electronic master clock of *Mobatron* type controls roughly 300 clocks throughout the building. The master clock has three subequipments which control corridor bells, room clocks, etc. in the three houses. One subequipment also controls a timer which is used during speeches and replies in the chamber.

TV System

A closed circuit TV system is installed for distribution programmes within the parliament building. This system enables the work in the chamber to be followed both within and outside the chamber. Within the chamber this is done by large-screen projection on the projector screen and on the TV monitors on the podium, outside the plenary chamber on a number of TV receivers.

Key Function of the Technician

The TV equipment is operated by the technician in the control room which, during a sitting, has at least one man in attendance. Guided by the Speaker he controls all the technical functions required for the work in the chamber.

A Whole Battery of Cameras

Fixed cameras are directed at the rostrum and Speaker's chair. Two cameras below the TV projector screen are directed automatically at the member who holds the floor, being remote-controlled via the microphone in his bench. This is done as soon as the technician has switched on the member's microphone. The technician adjusts the zoom setting of the camera to give the desired picture.

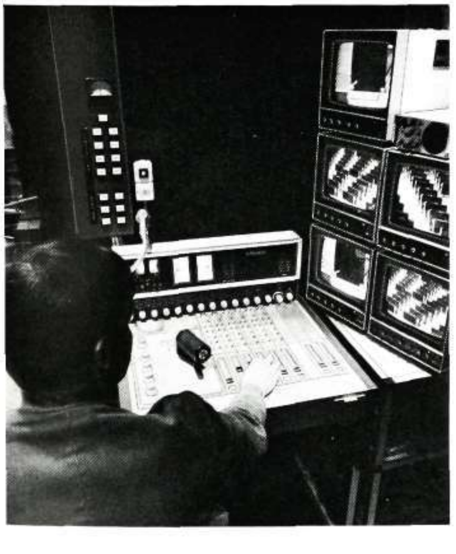
Two document cameras are installed on the podium. With these a member who is addressing the chamber can show diagrams, sketches etc. on the 3.5×4.5 m TV projector screen above the podium. In the central equipment there is also a camera for the result panel. With this camera the result of every vote is shown on the TV projector screen. A large-screen projector is used for projection of the image on this screen.

Apart from this facility for TV reproduction there is an equipment for showing of films on a 4.3×5.3 m film projector screen which, when in use, is lowered to a position in front of the TV projector screen. A 16 mm sound film projector and a slide projector are used for projection of the image on the film projector screen.

The projectors have TV scanners to permit transmission of the picture to the TV equipment outside the plenary chamber. Via a HF generator the picture produced in the plenary chamber can be transmitted to a special aerial array. This makes it possible to receive on ordinary domestic receivers the plenary chamber programme on channel 6 of all receivers connected to the aerial system. In the foyer of the plenary chamber there are, for example, four TV receivers from which the work in the chamber can be followed. There are TV receivers in the reading room adjoining the foyer. Wherever there are TV receivers, a member can see what is going on in the chamber. It is the technician's job to see that nothing is missed.

Fig. 10

The technician at the control desk for supervision of sound and picture. (Right) The five vision control monitors for the TV installation.



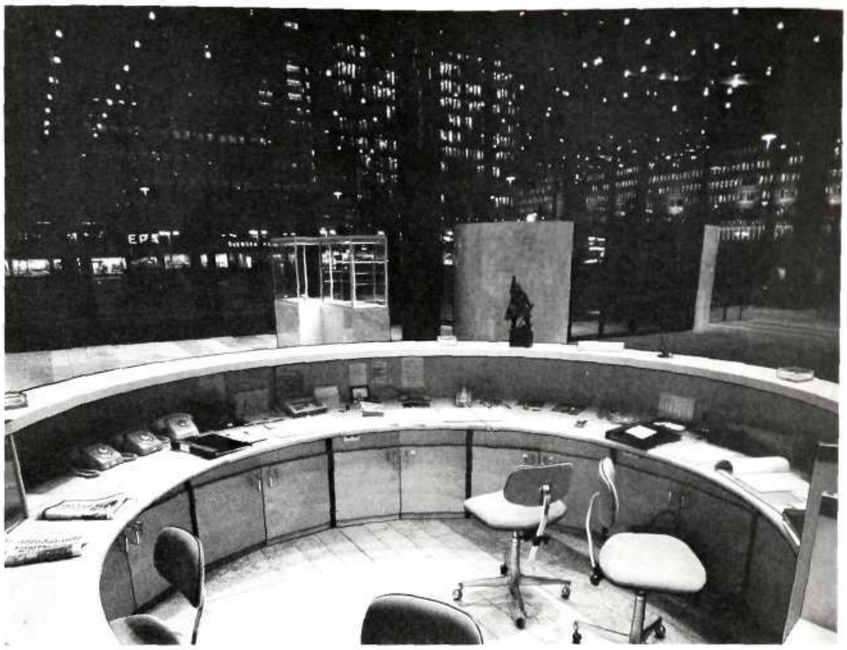
With his equipment in the control room the technician can also distribute the closed circuit TV programme directly to the Swedish Broadcasting Corporation, and he can also distribute Swedish Broadcasting Corporation programmes TV 1 and TV 2 to the plenary chamber monitors and to the large-screen projector if, during a debate for example, the chamber wishes to see any of these programmes. The podium monitors can be switched off if no picture is desired on them. The voting results are, however, shown on these monitors even if they are switched off.

A Few Words about the Technique

Most of the systems are both electrically and mechanically integrated. To save space, to ensure a natural function and the best utilization of the tele-

Fig. 11

Reception office at the entry to the parliament building at Sergels Torg, with all-round-the-clock attendance. The emergency telephones for the lifts, among other equipment, are connected to this point.



communications package, several equipments and functions have been combined within a single casing, on common panels or apparatus, and in common apparatus rooms.

Ordinary telephone technique has been used as far as possible. The central equipment of the voting system is made up chiefly of telephone relays mounted in easily handled units. These are placed on racks of type *BDH* and connected to the rack cabling by plug and jack. The equipment is supplied from a fully automatic power supply equipment of L M Ericsson's type *BMK 42203* for 48 V.

All outgoing circuits from the central equipment to panels are connected to the cabling via intermediate distribution frames. It is therefore easy to make any necessary changes. The cabling consists chiefly of *EKKX* cable.

The three houses of the parliament building have their separate power supply rooms for the sound distribution equipment. The total maximum power is 5100 W.

On the technical floor there is a programme rack *VAB 1410* and a power supply room. The programme rack contains three individual programme units, a TV sound unit and public address relay equipment for the general announcement microphone of the Prime Minister and Speaker. The rack contains four output stages of 100 W each.

One building has four power supply racks *VAB 1603* to which 350 room loudspeakers, among other equipment, are connected. The programme feed comes from equipment in the second building. The sound distribution in the third building works on the same principles.

* * *

The telecommunications equipment for the Swedish parliament is the most extensive delivered hitherto by L M Ericsson Telemateriel AB. It is a good example of how different telecommunications systems can be integrated on this scale. Several similar projects are planned. The Chilean parliament recently put into use a voting system supplied by L M Ericsson Telemateriel AB, very similar in size and extent to that in the Swedish parliament.

International Maintenance Centre, IMC

A. SÖDERBERG, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.722
658.58
LME 1540

This article describes L M Ericsson's equipment for an International Maintenance Centre (IMC), from which international circuits can be supervised and measured either fully automatically, semi-automatically or manually, and the international switching equipment can be supervised and tested. The equipment complies with CCITT recommendations. As supervision and testing of the switching equipment have already been described in Ericsson Review No. 3, 1970,[1] these aspects will be only briefly dealt with in the present article.

Why Is IMC Required?

A well equipped IMC is required because

- the semi- and fully automatic international traffic is increasing very quickly
- the circuits are usually long and very expensive
- an interruption of international service involves heavy losses for administrations
- high requirements are placed on the quality of transmission.

For these reasons effective facilities are required for supervision, measurement and testing of circuits and international switching equipments. A condition for smooth international collaboration is standardization of the necessary equipments and methods. CCITT have drawn up recommendations for this purpose. For quick tracing of faults, furthermore, the maintenance of circuits and switching equipment must be coordinated.

CCITT Recommendations

CCITT have recommended that *IMC* should in principle comprise the following functions:

☐ *ISMC* (*I*nternational *S*witching *M*aintenance *C*entre), with the necessary testing and supervisory equipment.

☐ *ITMC* (*I*nternational *T*ransmission *M*aintenance *C*entre), with equipment for supervision, testing and measurement of circuits.

☐ *ISCC* (*I*nternational *S*ervice *C*oordination *C*entre), for administrative coordination of switching and circuit maintenance. No special equipment is required for this purpose.

L M Ericsson's equipment naturally complies with these recommendations and has also been divided into independent functional units which can be combined in an optional manner. Checking of the signalling functions, for example, according to CCITT recommendations can be done either in *ISMC* or *ITMC* at the administration's choice. In the following account the supervisory desk for such checks is described with reference to *ITMC*.

Under certain circumstances, e.g. at small exchanges, it may be advisable not to divide up *IMC* as above, but to organize the entire work around a single maintenance centre. This can be easily done owing to the modular construction of the equipment. Every administration can build up *IMC* according to its local requirements.

The following description is based on a division into *ISMC*, *ITMC* and *ISCC*, but the equipment described will be the same if the three are combined.

International Switching Maintenance Centre, ISMC

Equipment Requirements

ISMC is equipped with

- An observation desk with lamps and counters for supervision of the switching equipment
- A control panel for traffic measurements
- A CENTRALOGRAPH for recording of faults
- A relay rack with supervisory and traffic measuring equipment.

In a separate room are placed the observation desk, control panel for traffic measurements, and the CENTRALOGRAPH, whereas relay racks and *test equipments for exchange and tariff tests* are placed adjoining the switchroom.

Survey of functions

The functions of the various equipments are briefly as follows:

- ☐ *The observation equipment* issues an alarm if the fault rate in a group of switches exceeds a preset value. Tracing of faulty units can then be done by connection of analysis counters individual to each unit in the group.
- ☐ *The traffic measuring equipment* contains erlang meters and statistical counters in a number sufficient for accurate measurement of the traffic.
- ☐ The *CENTRALOGRAPH* records faulty connections. It is connected to route markers and markers, and a record is made if the switching processes in the units are not completed within the preset supervisory times. From the centralograph record the switching units and switching path used on the connection through the selector stages can be identified and a detailed statement of the cause of the fault is obtained, which greatly facilitates fault tracing.
- ☐ *Equipments* for testing of switching functions and metering.

In tests of the switching equipment the line signalling functions are checked by, for example, measurement of the line signals from the incoming line relay sets and checking the signal sequence. By transmission of marginal signals, furthermore, a check is obtained that the line signalling equipments tied to the relay sets function within the tolerance ranges prescribed for the signalling scheme. The outgoing relay sets are also tested. In conjunction with these tests a satisfactory check is obtained also that the exchange registers are functioning satisfactorily.

In tariff tests a check is made of the metering pulse interval from the line relay sets and that the length of the metering pulse is correct. In conjunction therewith a check is also obtained that the tariff determining equipment in the route marker is functioning correctly.

International Transmission Maintenance Centre, ITMC

Equipment Requirements

The *ITMC* equipment includes

- Supervisory desk with lamps, counters and keys for continuous supervision of the circuits
- Test desk with instrumentation for qualified manual or semiautomatic transmission and signalling measurements
- Automatic transmission measuring equipment, *ATME*, with control panel and input and output devices
- Jack rack for connection of the circuits to the test desk
- Relay rack with equipment for connection of line relay sets to the supervisory desk, for connection of instruments to the test desk, for code answering, for fully automatic measuring devices, and for setting up of connections.

ATME can be excluded at small exchanges.

Supervisory desk, test desk, control panel and input and output devices for *ATME* and jack rack are placed in a separate room, while the remaining equipment is placed in the switchroom.

Supervisory Desk

Capacity

The capacity of the supervisory desk can be adapted to the following requirements:

20 groups with 20 circuits per group
40 groups with 40 circuits per group
60 groups with 40 circuits per group

Types of Fault

In the supervisory desk the signalling sequence on the circuits and occupation and clearing are supervised.

Faults arising on the circuits are divided into two types:

Type A A fault which can be definitely related to the circuit and which prevents its use. On the occurrence of such a fault the circuit is blocked automatically.

Type B A fault which cannot be definitely related to the circuit and which is of a temporary nature. The circuit is not blocked automatically and can be used for traffic.

Supervisory Principles

The desk lamps and counters are controlled by signals, sent from the line relay sets, which indicate an abnormal occurence, for example the absence of a line signal or failure of clearing.

In the supervisory desk the circuits are divided into groups of max. 40 each. If a fault occurs in such a group, it is indicated on a lamp if of *type A* and on a counter if of *type B*. A lamp or a counter is common to the entire group.

By throwing of a key the group can be directed to individual lamps and counters per circuit to discover which circuit or circuits are faulty.

To analyse a fault on a circuit, the circuit is connected with a key to lamps. A lit lamp indicates the phase of the signalling process in which the fault occurred.

Miscellaneous Functions

If one or more circuits in a group are manually blocked, a common group lamp lights. The circuits are connected by keys to individual lamps which indicate manually blocked circuits.

An alarm for a large number of blocked circuits on a route is indicated on a lamp. The alarm limit depends on the size of the route and can be preset. If all circuits on the route are occupied and/or blocked, another lamp lights. If this condition has lasted during a presetable time per route, a special lamp lights and remains lit until a key has been actuated and the blocking condition on the route has ceased.

A call can be made from the desk to and received from an interworking *IMC*.

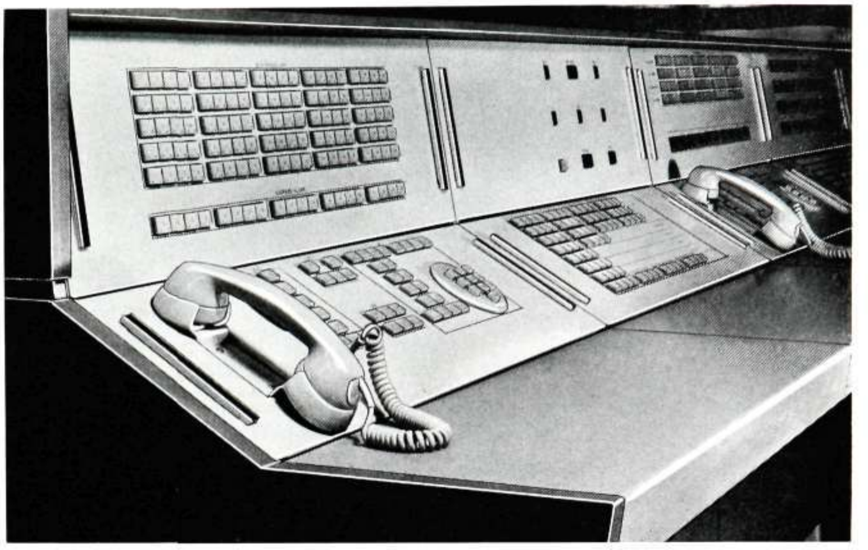
Test Desk and ATME

Capacity and Equipment of Test Desk

The test desk is shown in fig. 1. The number of desks required will depend on the number of circuits and on the maintenance requirement. By way of guidance for normal maintenance requirements, one desk can serve 300—500 circuits.

The instruments are placed on the vertical panel of the desk and keys with built-in lamps for operation and supervision on the horizontal panel. The keys control relays for connection and disconnection of the desired instrument and carry symbols for the respective instruments.

Fig. 1
Desk of the type used as test desk but without instruments



Access for Measurement of Circuits

In accordance with CCITT recommendations L M Ericsson have designed the international switching centre type *ARM* and *ITMC* so that the circuits are accessible for measurement as follows:

☐ On the exchange side of the relay sets (circuit access) in order that the relay sets may be included in measurements. The desk is furnished with normal telephone operator's equipment and the connections are set up from a keyset by individual selection through the ordinary selector stages of the *ARM* exchange.

☐ On the line side of the relay sets (line access) to permit measurements of the circuit alone.

Junction circuits run from jacks in a jack rack to the test desk. At the time of measurement the desired circuits are connected with plug-ended cords to the jack rack. Connection can be made with the exchange side, line side, or in parallel across the line for monitoring. The jacks are normally strapped with U-links, which are removed when connection is to be made to the exchange or line side.

Connected to these jacks are buttons and jacks for blocking of the circuits. If an echo suppressor is used, a button for blocking of it is added.

Different Types of Measurements

The following measurements can be made from test desk and *ATME:*

☐ *Fully automatic*, with *ATME* (*A*utomatic *T*ransmission *M*easuring *E*quipment). CCITT have issued recommendations concerning international circuits and, in accordance therewith, L M Ericsson have designed *ATME 1* and delivered such equipment to several administrations. CCITT have, however, issued new recommendations and L M Ericsson are therefore developing a new variant, *ATME 2*.

Attenuation and noise measurements are made and the result is written on punched cards, punched tape, teleprinter etc., according to the customers' desires.

The measuring equipments and principles used by L M Ericsson in *ATME 1* were described in Ericsson Review No. 3, 1963.[2]

- ☐ *Semiautomatic* with connection to the desired circuit from a keyset and individual selection through the *ARM* exchange; measurement with automatic measuring devices in the test desk and at the remote end. Tones are sent in both directions and detected on the receiving sides. Lamps on the test desk indicate whether the circuit equivalent is within a given tolerance (± 4 dB from nominal according to CCITT's measuring method No. 2). L M Ericsson's equipment is designed for this measuring method.

- ☐ *Manual*, which may be divided into

  - Manual connection of the circuits to the test desk via the jack rack. Line access is applied for this purpose, whereby the switching equipment is excluded from the measurement. The line is also brought into the test desk at the remote end and is thus accessible for manual measurements at both ends.

  - Pushbutton connection and individual selection of circuit to a code answer unit at the remote exchange. The code answer unit may be designed, for example, in accordance with code 100 for noise measurement or code 102 for attenuation measurement. Measurements are then made after connection of the necessary instruments on the test desk.

  - Pushbutton connection and individual selection of circuit to interworking *ITMC*. The circuit is then accessible for manual measurement at both ends.

For carrying out manual measurements with line access, up to eight circuits can be connected to the test desk. No circuit need be blocked until a measurement is to be made on it. If the measurements are carried out with different types of instruments, two circuits can be measured simultaneously. The instruments can be connected to the exchange side, line side, or in parallel across the line.

Instrumentation

The instruments which will be in greatest use are permanently installed in the desks. Separate instruments can be easily connected. The choice of instruments is based on the existing types of circuits.

The general requirements for transmission measurements are:

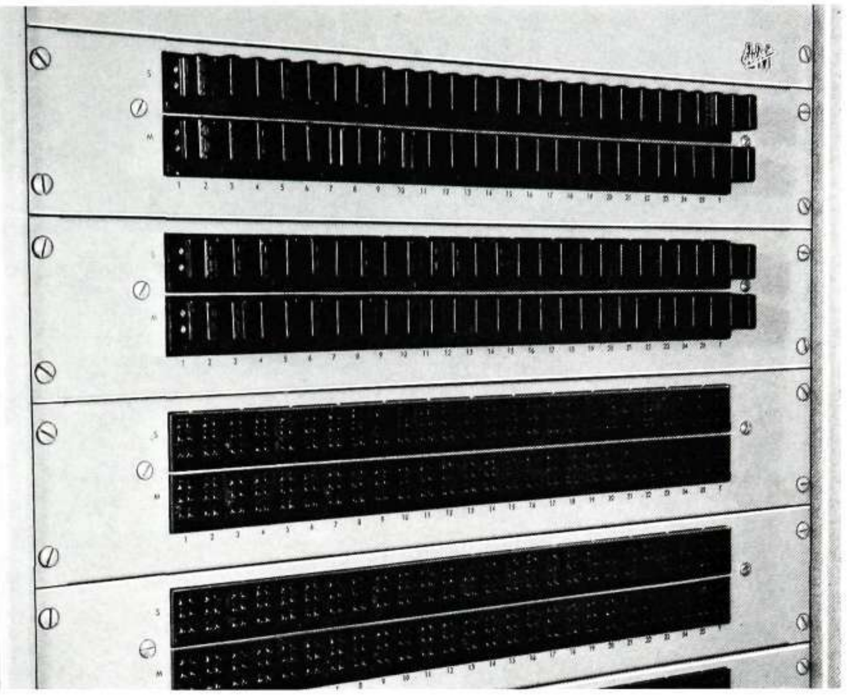
- Level meter
- Variable oscillator
- Frequency meter
- Psophometer.

Oscillators with fixed levels for 800 and 1000 Hz are connected in the test desk.

The general requirements for signal measurements are:

- Channel writers
- Tone receivers
- Code receivers

Fig. 2
Part of jack rack with and without U-links



- Tone generators
- Instruments for checking of signals.

L M Ericsson have designed an instrument for checking of signals adapted to signalling systems 4 and 5. The instrument fulfils the CCITT recommendation Q 138 and Q 164, and the signals can be transmitted and received for measurement. The instrument is also adapted for measurement of the length of DC signals irrespective of signalling system.

Jack Rack

One jack rack accommodates 150—200 circuits.

The jacks have gold-plated terminals for optimal contact performance.

Part of a jack rack with U-links is shown in fig. 2.

International Service Coordination Centre, ISCC

In *ISCC* the reports from *ISMC* and *ITMC* must be coordinated and analysed and fault reports from interworking exchanges received. As already mentioned, *ISCC* has only administrative functions, so that no special equipment is required.

Schematic Survey

Fig. 3 illustrates schematically the equipments in *ISMC* and *ITMC* and their connection to the circuits and the international switching equipment.

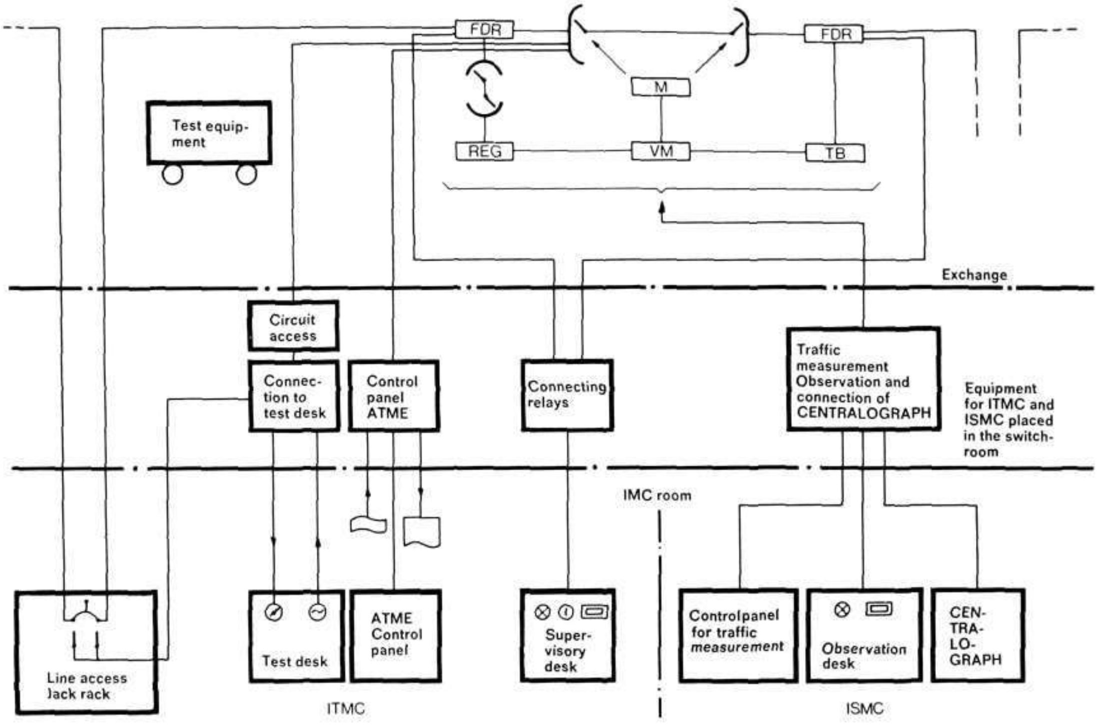


Fig. 3
IMC, block schematic

Summary

High requirements are placed on the quality of transmission and on effective utilization of the very expensive international circuits. It is therefore extremely important that circuits and international switching equipment can be supervised, tested and measured in an effective and uniform way in accordance with CCITT recommendations. The *IMC* equipment described in this article fulfils these requirements in all respects. The observation equipment facilitates switching maintenance to a great extent and permits a system of rational, controlled corrective maintenance, whereas *ATME* offers convenient and effective means for automatic measurement of the transmission characteristics of the circuit.

Thanks to the small variations of level and the insignificant noise caused by the *ARM* exchange the circuits can be conveniently connected for different types of measurements by individual selection, the connection being set up through the ordinary selector stages of the exchange. The modular design of *IMC*, furthermore, allows an administration to adapt the *IMC* to exactly suit its local requirements.

References

1. ERIKSSON, V.: *Equipment for Maintenance of ARM 20 and ARM 50 Automatic Telephone Exchanges.* Ericsson Rev. *47*(1970): 3, pp. 99—108.
2. KARL, H.: *Automatic Transmission Measuring Equipment for Telephone Circuits. 2. Measurement of Attenuation and Noise.* Ericsson Rev. *40*(1963): 3, pp. 78—86.

ERICSSON News from All Quarters of the World

Centralized Maintenance Again the Main Theme at This Year's Maintenance Conference.

In the last week of May telephone engineers from many parts of the world gathered in Stockholm for the twelfth time since 1956 at L M Ericsson's 1971 Maintenance Conference.

This year's conference was directed chiefly to the Spanish-speaking countries in South and Central America and Mexico. From Europe there came representatives from Spain and Portugal and, from Sweden, as usual, the Swedish Telecommunications Administration and LME people working on the markets concerned.

There were altogether 73 delegates representing 13 countries and 24 administrations.

In the cycle of three conferences, of which this was the last, the chief interest — as in the past two years — was in centralized maintenance, in which data processing has increasingly entered into the picture, and the new maintenance aspects initiated by the increasingly advanced switching technique.

The first week of the conference was spent in Sweden and, apart from a full programme of lectures, time was found also for a visit of study to the AKE exchange in Tumba, L M Ericsson's Erga Division in Bollmora, L M Ericsson's International Training Centre, and the Swedish Telecommunications Administration in Västerås, where a visit was made to the new maintenance centre.

The second week of the conference was for the first time arranged outside Scandinavia, in the Rotterdam District in Holland. Through the kind courtesy of the Dutch PTT a series of very interesting lectures and visits had been arranged. Visits were made to, among other places, the International Maintenance Centre and the PTT Training School in Rotterdam, the Dr Neher Laboratory in Leidschendam, and the AKE Exchange at Waalhaven.

Mr Björn Lundvall, President of L M Ericsson, delivering the opening address at the 1971 Maintenance Conference.

Ericsson Group Results during First Half Year 1971

For the second year in succession the Ericsson Group presented in mid-August 1971 a report of its activities during the first half of the year.

Order bookings during the period amounted to 2,274 Mkr, an increase of 24% over 1970 (1,833 Mkr).

Orders from Swedish customers amountaed to 25%, other European customers 44%, Latin America 21%, and other markets 10%.

Group sales, which in 1970 amounted to 3,160 Mkr, were 1,647 Mkr during the first six months of 1971, a rise of 20% over the figure for the same period of 1970 (1,371 Mkr). Within Sweden the rise of sales was only 7%. On foreign markets deliveries to European customers rose particularly sharply, accounting for nearly two-thirds of the entire increase during the period.

Group income prior to special adjustments and income taxes amounted to 183.9 Mkr (201.8 Mkr), corresponding to 11.2% of sales (14.7%).

Despite increased production resources, with an attendant rise of sales of 20%, the estimated sales figure has not been attained. Salary and wage increases in Sweden during the latter part of 1970 and during 1971 have had a great impact, and it has not been possible to compensate for them through rationalization and increased productivity, so that production costs and overheads have risen greatly.

The increased engagement in technical development, as also the allocation of technical development work to several of the group's foreign producers, has also involved an extra strain both in respect of personnel and costs.

The number of employees rose since the beginning of the year from 61,900 to 65,300, 700 of whom in the Swedish sector and 2,700 in foreign companies.

From the signing of the contract for São José dos Campos, Brazil. (From left) Ovidio Barradas, Technical Director of CTB, General José de Siqueira Menezes, President of CTB, Geraldo Nóbrega and Knut Albertsson, Director of EDB, Delson Siffert and Helvécio Gilson, Operations Directors of CTB, and Sales Leite, Financial Director of CTB.

Two Large Orders Totalling 185 Mkr from Brazil

L M Ericsson's Brazilian subsidiary, Ericsson do Brasil, has received two large orders for equipment for extension of the telephone networks of two Brazilian cities. The value of the orders exceeds 185 Mkr. One of the orders, for the São Paulo network, amounts to more than 135 Mkr, the largest individual order ever received within the Ericsson Group. The second order, for about 50 Mkr, is for equipment for extension of the Belo Horizonte network, the third city of Brazil with 1.3 million inhabitants.

The order for São Paulo is the third large order received by Ericsson do Brasil (EDB) from the largest Brazilian Telecommunications Administration, Companhia Telefônica Brasileira (CTB), for extension of the telephone network in this rapidly expanding city. The telephone network of São Paulo has been radically modernized since 1965 on the basis of L M Ericsson's crossbar system.

All equipment under the two contracts will be manufactured at Ericsson do Brasil's factory in São José dos Campos outside São Paulo.

Only two days after signing of the contract the first truckload of equipment left EDB's factory. The photograph was taken during an all-day visit to EDB's factory and offices by the management of CTB on May 13 this year.

Italy Orders Its First Computer-controlled Telephone Exchange

Through its subsidiary FATME in Italy, L M Ericsson has received an order from the government administration Societá Italiana per l'Esercizio (SIP) for a very large computer-controlled automatic trunk exchange. This is the first computer-controlled exchange to be installed in the highly developed Italian telephone network and is therefore a milestone in the expansion of the network.

The exchange will serve the Naples district, providing full- and semiautomatic facilities between Naples and other areas throughout Italy. It will be built in steps, the first of which is expected to be completed in 1974. The exchange has a contracted final capacity of 9,000 trunk and similar lines.

In a computer-controlled exchange the entire intelligence work in the connection of calls is done by computers, which in principle correspond to the brains of the operators in a manual exchange. They can carry out the most advanced operations required in a complicated trunk network. The computers used in this type of exchanges were designed and are manufactured by L M Ericsson.

The first L M Ericsson telephone exchange in Italy was delivered in 1925. On January 1, 1971, there were more than 1.2 million subscriber lines of Ericsson local exchange equipment in operation in the Italian network and orders were on hand for another 125,000 lines.

The Ericsson subsidiary, FATME, started operations in 1923, and with its roughly 3,500 employees is now Rome's largest industrial enterprise. Together with SIELTE, Ericsson's other subsidiary in Rome, an installation and sales company, the Group employs around 7,000 persons in Italy.

Order for 16 Mkr from El Salvador

From the Telephone Administration of El Salvador, ANTEL, L M Ericsson has received an order for telecommunications equipment valued at more than 16 million kronor. The order is for equipment for extension of the El Salvador telephone network and comprises, among other items, telephone exchange equipment, telex equipment, telephone sets, and transmission equipment including cable, outside plant and multiplex equipment. Within the framework of the agreement L M Ericsson will also train a number of technicians from the El Salvador Telephone Administration. The deliveries will be made in the course of next year.

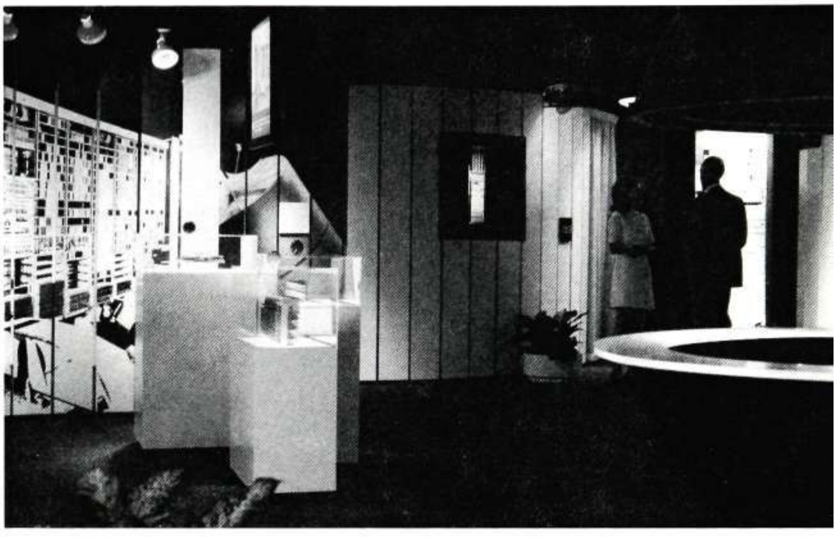
New PABX Orders for the United States

LME's French subsidiary (Société Française des Téléphones Ericsson) has received an order amounting to about 13 Mkr for PABX type CP 100 for the U.S. market. The deliveries will be made during 1971 and 1972.

On June 24 this year L M Ericsson's head factory was visited by Francisco Lozano Valcárcel, President of the Colombian telephone company Empresa National de Telecomunicaciones. He is seen with L M Ericsson's Vice President, Arne Stein, inspecting the collection of historical telephone sets. ►

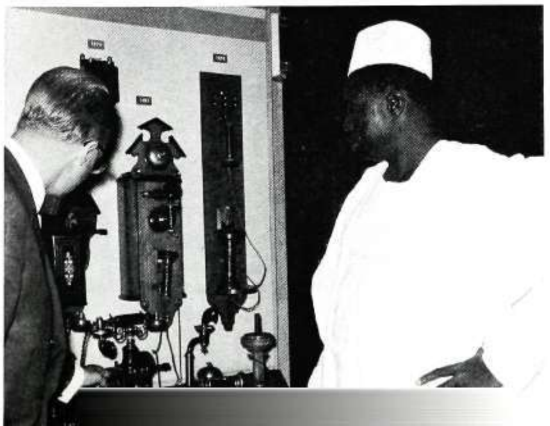
The Malaysian Minister of Commerce and Industry, Enche Khir Johari, signing his name in the visitors' book during a visit to L M Ericsson in June this year.

A space exhibition "TELECOM-71" was arranged in conjunction with "The Second World Administrative Radio Conference for Space Telecommunication" in Geneva in June. The photograph shows a part of L M Ericsson's well visited stand. ►



In mid-June L M Ericsson was visited by representatives from RENFE (Red Nacional de Ferrocarriles Españoles). (From left) Ricardo Navarro, Francisco Lozano Vicente, head of RENFE, Antonio Debesa and, from L M Ericsson, Torsten Lindstedt and Vice President Chr. Jacobæus. ►

The Minister of Communications of Niger, Issa Ibrahim, during his visit to Midsommarkransen on June 2, 1971.



Mr Goh Seng Kim, Director of the Singapore Telecoms Department, visited L M Ericsson in Stockholm on his return journey from a lengthy stay in the U.S.A. He is seen with Mr Khoo Teng Lake, Head of Telephone Industries of Singapore Private Ltd., and H. Augustinsson, L M Ericsson. ▼

At the beginning of May delegates from the Executives Meeting of the Swedish Telecommunications Administration visited the Telephone Cable Division of L M Ericsson. The delegates were informed about the production processes in the factory. The photograph shows them studying a set of paper-wrapping machines for local cable. (From left) Per Ahlström, L M Ericsson, Torsten Larsson, Operations Director, and Nils Roos, Administrative Director, of the Administration, and Nils Eriksson and Yngve Åkesson, L M Ericsson.

This year, as earlier, L M Ericsson took part in the space and aircraft exhibition in Paris, which is held every second year. Apart from airborne radar, pulse doppler radar for anti-aircraft use and laser rangefinders were shown this year.

AB ASEA LME Automation – a Newly Formed Computer Company

ASEA and L M Ericsson have concluded an agreement to form a joint company AB ASEA LME Automation for development and marketing of computer-based process and production control systems within industry, electric power distribution, and mechanical handling.

The coordination of the two companies' activities within these fields is aimed at strengthening their competitivity and their ability to meet the requirements of customers both in Sweden and on export markets. The company starts with a staff consisting of some 150 engineers from ASEA and L M Ericsson and experience from some seventy complete computer projects within a large number of fields.

ASEA LME Automation will take over the contracts and orders which ASEA and L M Ericsson already have on hand. The latter will be subcontractors to the new company for equipment supplies. The new company will be subcontractor to ASEA and L M Ericsson for process and production control systems.

Of the shares in the new company 60% are held by ASEA and 40% by L M Ericsson. ASEA and L M Ericsson are represented on the board in proportion to their shareholdings. Hans Wallgren of ASEA has been appointed President and Bo Jender of L M Ericsson Vice President of the company.

L M Ericsson Markets New CRT Display Terminals

L M Ericsson has concluded an agreement with the U.S. Control Data Corporation under which LME's newly formed Data Communication Department will market CDC's new CRT display terminals 710 in all Scandinavian countries.

L M Ericsson has recently received an order from the National Swedish Office for Administrative Rationalization and Economy for a large number of these terminals for its central personal records file. The amount of the order is 2 Mkr.

CRT display terminals of this type are used, among other purposes, by airlines for bookings and by banks for quick reading of, for example, balances on accounts.

CRT display terminal

Retirement

Vice President Knut Styrén retired at the beginning of this year on reaching pensionable age.

During the coming year Mr Styrén will remain in the company's service as consultant on Group questions.

New Head of Facomec

Fredrik Croneborg has been appointed President of the Group's Colombian cable works. Fábricas Colombianas de Materiales Eléctricos Facomec S.A., as from May 1, 1971.

He succeeds Olof Irgens, who has been transferred to other work within the Group.

The Ericsson Group

Subsidiaries, associated companies and technical offices

EUROPE

DENMARK

L M Ericsson A/S *DK-2600 Glostrup*, Kirkebjerg Allé 86, tel: (01) 96 6133, tgm: ericsson københavn, telex: 9020 "ERICSSON KH"

GNT Automatic A/S *DK-2860 Søborg*, Telefonvej 6, tel: (01) 69 5188, tgm: nortelmatic, telex: 5264, "GNT AUTOMATIC KH"

Dansk Signal Industri A/S *DK-2650 Hvidovre*, Stamholmen 175, Avedøre Holme, tel: (01) 49 0333, tgm: signaler københavn, telex: 6503, "6503 DSI DK"

FINLAND

O/Y L M Ericsson A/B *SF-02420 Jorvas*, tel: (90) 2991, tgm: ericssons, telex: 12546, "LME SF"

FRANCE

Société Française des Téléphones Ericsson
F-92 Colombes, 36, Boulevard de la Finlande, tel: Paris (1) 781 3535, tgm: ericsson colombes, telex: 62179, "ERICSSON CLOMB"

F-75-Paris 17e, 147, rue de Courcelles, tel: Paris (1) 227 9530, tgm: eric paris, telex: 29276, "ERICSSON PARIS"

Etablissements Ferrer-Auran S.A. *13 Marseille, (10ème)*, 88, Avenue de la Capelette, tel: (91) 47 4851, telex: 42579, "RINGMARS"

GREAT BRITAIN

Swedish Ericsson Company Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Telecommunications Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Production Control (Ericsson) Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: productrol, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Rentals Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: celefon, telex: 935979 "SWEDERIC LDN"

IRELAND

L M Ericsson Ltd. *Dublin 2*, 32, Upper Mount Street, tel: (01) 619 31, tgm: ericsson, telex, 5310, "LMI EI"

ITALY

FATME, Soc. per Az. *I-00100 Roma*, C. P. 4025 Appio, tel: (06) 4694, tgm: fatme, telex: 61327, "61327 FATME"

SETEMER, Soc. per Az. *I-00198 Roma*, Via G. Paisiello 43, tel: (06) 86 8854, tgm: setemer

SIELTE, Soc. per Az. *I-00100 Roma*, C.P. 5100, tel: (06) 577 8041, tgm: sielte, telex: 61225, "61225 SIELTE"

NETHERLANDS

Ericsson Telefoonmaatschappij N.V. *Rijen (N.Br.)*, P. O. B. 8, tel: (01612) 3131, tgm: erictel, telex: 54114, "ETMRY NL"

Voorburg 2110, P. O. B. 60, tel: (070) 81 4501, tgm: erictel den haag, telex: 31109, "ERICTEL DEN HAAG"

NORWAY

A/S Elektrisk Bureau *Oslo 3, P.B.* 5055 Maj, tel: (02) 46 1820, tgm: teleb, telex: 11723, "TELEB N"

A/S Industrikontroll *Oslo 6*, Grensevejen 86/88, 3. etg., tel: (02) 68 7200, tgm: indtroll

A/S Norsk Kabelfabrik *Drammen*, P.O.B. 369, tel: (02) 83 7650, tgm: kabel, telex: 18149, "KABEL N".

A/S Telesystemer *Oslo 6*, Tvetenveien 32, Bryn, tel: (02) 68 7200, tgm: telesystemer, telex: 16900, "ALARM N"

POLAND

Telefonaktiebolaget L M Ericsson, Technical Office *Warszawa*, Ul. Nowy Swiat 42, tel: 26 4926, tgm: tellme, telex: 813710, "813710 TELLME PL"

PORTUGAL

Sociedade Ericsson de Portugal Lda. *Lisboa 1*, Rua Filipe Folque 7, 1°, tel: 56 3212, tgm: ericsson

SPAIN

Industrias de Telecomunicación, S.A. *Getafe*, Paseo Felipe Calleja 6, tel: 295 2100, tgm: ericsson, telex: 22666, "ERIGE E"

L M Ericsson, S.A. *Madrid 5*, Bernadino Obregón 25, tel: 467 8700, telex: 23333, "23333 ERICOFON"

SWEDEN

Telefonaktiebolaget L M Ericsson, *S-126 11 Stockholm 32*, tel: (08) 19 0000, tgm, telefonbolaget, telex: 17440, "LME S"

ELLEMTEL Utvecklings Aktiebolag *S-127 25 Skärholmen* Box 249, tel: (08) 97 0220

Bjurhagens Fabrikers AB *S-212 15 Malmö*, Fack, tel: (040) 93 4770

AB Rifa *S-161 11 Bromma 11*, tel: (08) 26 2600, tgm: elrifa, telex: 10308, "ELRIFA STH"

L M Ericsson Instruktionsteknik AB *S-117 47 Stockholm 44*, tel: (08) 68 0870, tgm: instruktec

L M Ericsson Telemateriel AB *S-135 01 Stockholm-Tyresö 1*, Fack, tel: (08) 712 0000 tgm: ellem, telex: 1275, "1275 TELERGA S"

Sieverts Kabelverk AB *S-172 87 Sundbyberg*, tel: (08) 28 2860, tgm: sievertsfabrik, telex: 1676, "SIEVKAB STH"

Svenska Radio AB *S 102 20 Stockholm 12*, tel: (08) 22 31 40, tgm: svenskradio, telex: 10094 "SRA S"

AB Thorsman & Co. *S-611 01 Nyköping 1*, Box 149, tel: (0155) 810 00, tgm: thorsmanco

AB Transvertex *S-145 53 Norsborg*, Fittja industriområde, tel: (08) 710 0935

SWITZERLAND

Ericsson A.G. *8061 Zurich*, Postfach, tel: (051) 41 6608, tgm: telericsson, telex: 52669, "ERIC CH"

TURKEY

Ericsson Türk Ticaret Ltd. Sirketi *Ankara*, Rumeli Han, Ziya Gökalp Cad. tel: 12 3170, tgm: ellem

WEST GERMANY

Deutsche Ericsson G.m.b.H. Telematerial, *4 Düsseldorf 1*, Postfach 2628, tel: (0211) 35 3594, tgm: erictel: telex: 8587912, "ERIC D"

Ericsson Centrum G.m.b.H. 3 *Hannover*, Dornierstrasse 10, Postfach, tel: (0511) 63 1018, tgm: ericen, telex: 0922913, "ERICE D"

ASIA

INDIA

Ericsson India Limited
Calcutta, P.O.B. 2324, tel: (032) 45 4494, tgm: inderic

New Delhi 16, L25, South Extension Part II, tel: (011) 62 6505, tgm: inderic

INDONESIA

Ericsson Telephone Sales Corporation AB
Djakarta, P.O.B. 2443, tel: (07) 463 97, tgm: javeric, telex: 4414 "JAVERIC DKT 4414"

Bandung, Djalan Ir. H. Djuanda 151, tel: (082) 820 94, tgm: javeric

IRAQ

Telefonaktiebolaget L M Ericsson, Iraq Branch *Baghdad* P.O.B. 2388, Alwiyah, tel: 947 14, tgm: ellemco

KUWAIT

Telefonaktiebolaget L M Ericsson, Technical Office *Kuwait, State of Kuwait*, P.O.B. SAFAT No. 5979, tel: 200 74, tgm: erictel

LEBANON

Société Libanaise des Téléphones Ericsson *Beyrouth* B.P. 8148, tel: 25 2627, tgm: ellem, telex: LE 20876, "ELLEM"

MALAYSIA

Ericsson Talipon SDN BHD *Shah Alam, Selangor, Batu Tiga Industrial Estate*, P.O.B. 28, Tel: Kuala Lumpur 36 1821, tgm: kuleric, telex: 265, "ERICMAL KL"

Telecommunication Manufacturers (Malaysia) SDN BHD *Shah Alam, Selangor, Batu Tiga Industrial Estate*, P.O.B. 28, tel: Kuala Lumpur 36 1821, tgm: kuleric, telex: 265, "ERICMAL KL"

PAKISTAN

L M Ericsson Telephone Company, Technical Office *Karachi*, P.O.B. 7398, tel: (90) 51 6112, tgm: ericsson

SINGAPORE

Telephone Industries of Singapore Private Ltd. *Singapore 1*, P.O.B. 3079, tel: 98 1155, tgm: telsin

THAILAND

Ericsson Telephone Corp. Far East AB *Bangkok*, P.O.B. 824, tel: (02) 580 41, tgm: ericsson, telex: 2274, "THAIERIC"

AFRICA

ALGERIA

Société Algérienne des Téléphones Ericsson *El Biar (Algers)*, 4, rue Mouloud Hadjen, tel: 78 2692, tgm: eric alger

EGYPT (UAR)

Telefonaktiebolaget L M Ericsson, Technical Office Egypt Branch *Cairo* P.O.B. 2084, tel: (02) 465 83, tgm: ericgypt, telex: 2009, "ELLEME UN"

ETHIOPIA, SUDAN

Telefonaktiebolaget L M Ericsson, Technical Office *Addis Ababa*, P.O.B. 3366, tel: (01) 492 60, tgm: ericsson, telex: 21090 "MOSFIRM ADDIS"

MOROCCO

Société Marocaine des Téléphones Ericsson *Casablanca*, 87, Rue Karatchi, tel: 788 75, tgm: ericsson

TUNISIA

Telefonaktiebolaget L M Ericsson, Technical Office, *Tunis*, Boite Postale 780, tel: (01) 24 0520, tgm: ericsson, telex: 695, "ERICSSON TUNIS".

ZAMBIA

Ericsson Telephone Sales Corporation AB
Lusaka, P.O.B. 2762, tel: (146) 744 42, tgm: ericofon

Ndola, P.O.B. 2256, tel: (143) 3885, tgm: ericofon

AMERICA

ARGENTINE

Cia Ericsson S.A.C.I. *Buenos Aires* Casilla de Correo 3550, tel: 33 2071, tgm: ericsson, telex: 0122196, "CATEL BA"

Cia Argentina de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Cia Entrerriana de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Industrias Eléctricas de Quilmes S.A. *Quilmes FNGR*, 12 de Octubre 1090, tel: 253 2775, tgm: indelqui buenosaires, telex: 0122196, "CATEL BA"

BRAZIL

Ericsson do Brasil Comércio e Indústria S.A.
São Paulo, Rua da Coroa 500, tel: 298 2322 tgm: ericsson, telex: 021817, "ERICSSON SPO"

Rio de Janeiro, Caixa Postal 3601-ZC-00, tel: 221 4777, tgm: ericsson, telex: 031839, "ERICSSON RIO"

Fios e Cabos Plásticos do Brasil S.A. (FICAP) *Rio de Janeiro*, caixa postal: 1828, tel: 29 0185, tgm: ficap, telex: 031485, "FICAP RIO"

CANADA

L M Ericsson Limited *Montreal 381, Quebec*, 2300 Laurentian Boulevard St. Laurent, tel: (514) 331 3310, tgm: caneric, telex: 05-267682, (TWX) 610-421-3311, "CANERIC MTL"

CENTRAL AMERICA

Telefonaktiebolaget L M Ericsson, Oficina Tecnica de Centroamérica *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson, telex: 20087, "ERICSAL 20087"

CHILE

Cia Ericsson de Chile S.A. *Santiago*, Casilla 10143, tel: (04) 825 55, tgm: ericsson, telex: SGO 389, "ERICHILE SGO389"

COLOMBIA

Ericsson de Colombia S.A. *Bogotá*, Apartado Aéreo 4052, tel: (92) 41 1100, tgm: ericsson, telex: 044507, "ERICSSON BOG"

Fábricas Colombianas de Materiales Eléctricos Fácomec S.A. *Cali*, Apartado Aéreo 4534, tel: 42 1061, tgm: facomec, telex: 55673, "FACOMEC CLO"

COSTA RICA

Telefonaktiebolaget L M Ericsson, Technical Office *San José*, Apartado 10073, tel: 21 1466, tgm: ericsson, telex: 283, "283 LME-CR"

ECUADOR

Teléfonos Ericsson C.A.
Quito, Casilla 2138, tel: 52 4000, tgm: ericsson

Guayaquil, Casilla 376, tel: 30 0900 tgm: ericsson

Cont. on next page

Subsidiaries, associated companies and technical offices (*Cont. from preceding page*)

MEXICO

Teléfonos Ericsson S.A. *Mexico D.F.*, Apartado Postal 9958, tel: 566 8955 tgm: coeric, telex: 01772485, "ERICSSON MEX" PARA COERIC

Latinoamericana de Cables S.A. de C.V. *Mexico 12 D.F.*, Apartado Postal 12737, tel: 549 3650, tgm: latincasa, telex: 01772485, "ERICSSON MEX" PARA LATINCASA

Teleindustria, S.A. *Mexico 1, D.F.*, Apartado Postal 1062, tel: 565 7033 tgm: ericsson, telex: 01772485, "ERICSSON MEX"

Telemontaje, S.A. de C.V. *Mexico 1, D.F.*, Apartado Postal 1062, tel: 576 4044, tgm: ericssonmexicodf, telex: 01772485, "ERICSSON MEX" PARA TELEMONTAJE

PANAMA

Telefonaktiebolaget L M Ericsson, Oficina Técnica de Panamá *Panama 5, R.P.* Apartado 4349, tel: 64 3600, tgm: ericsson, telex: 368674 "368674 SONITEL"

PERU

Cia Ericsson S.A. *Lima*, Apartado 2982, tel: 31 1005, tgm: ericsson, telex: 3540202, "ERICSSON 3540202"

Soc. Telefónica del Perú, S. A. *Arequipa*, Apartado 112-1012, tel: 6060 tgm: telefonica

EL SALVADOR

Telefonaktiebolaget L M Ericsson, Technical Office *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson

URUGUAY

Cia Ericsson S.A. *Montevideo*, Casilla de Correo 575, tel: 926 11, tgm: ericsson, telex: 398228, "ROULEMENT UY" PARA MELANDER

USA

The Ericsson Corporation *New York, N.Y. 10017*, 100 Park Avenue, tel: (212) 685 4030, tgm: erictel, telex: 620484, "ERICTEC 620484"

Ericsson Centrum Inc. *New York, N.Y. 10016, 16*, East 40th Street, tel: (212) 679 1000, tgm: erictel, telex: 620149, "ETELSAC 620149"

VENEZUELA

Cia Anónima Ericsson *Caracas*, Apartado 70516, tel: (02) 34 4661, tgm: ericsson, telex: 22734, "22734 ERIC VEN"

Alambres y Cables Venezolanos C.A. (ALCAVEL) *Caracas*, Apartado del Este 62107, tel: (02) 33 9791, tgm: alcave, telex: 845, "ALCAVE VE"

AUSTRALIA & OCEANIA

AUSTRALIA

L M Ericsson Pty Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: ericmel, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: ericsyd, telex: AA 21358 "ERICSYD"

Boroko, Territory of Papua and New Guinea, P.O.B. 5602, tel: Port Moresby 565 66, tgm: ericpor, telex: Port Moresby 153

Teleric Pty. Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: teleric, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: teleric, telex: AA 21358, "ERICSYD"

Conqueror Cables Pty. Limited *Dee Why, N.S.W. 2099*, P.O.B. 69, tel: (02) 98 0364, tgm concab sydney

A.E.E. Capacitors Pty. Ltd. *Preston, Victoria 3072*, 202 Bell Street, P.O.B. 95, tel: (03) 480 1211, tgm: engiquip melbourne

Representatives

EUROPE

AUSTRIA

Telecom Handelsgesellschaft m.b. H. *1160 Wien*, Postfach 98, tel: (0222) 43 5956, tgm: teleric, telex: 75976), "75976 TELECOM A"

BELGIUM

Allumage Lumière S.A. *Bruxelles 7*, 128-130 Chaussée de Mons, tel: 22 9870, tgm: allumalux, telex: 21582, "ALLUMALUX BRU"

GREECE

Angelos Cotzias *Athens*, 18, Odos Omirou, tel: (021) 62 6031, tgm: cotziasan, telex: 215252, "215252 CTS GR"

ICELAND

Johan Rönning *Reykjavik*, P.O.B. 5300, tel: 254 00, tgm: rönning, telex: 2040, "ROENNG IS"

SPAIN

TRANSA Transacciones Canarias S.A.

Las Palmas de Gran Canarias, Tomas Morales 38, tel: 21 8508, tgm: transa, telex: 95024, "MAVAC E"

Santa Cruz de Tenerife, Sabino Berthelot, 3, tel: 24 2596, tgm: transa, telex: 95024, "MAVAC E"

YUGOSLAVIA

Merkantile Inozemna Zastupstva *Zagreb* pošt pretinac 23, tel: (041) 41 6655, tgm: merkantile, telex: 21139, "21139 YU MERTIL"

Beograd, Ul. 7. Jula br. 18, tel: (011) 62 1773, tgm: merkantile, telex: 11506, "YU MERKAN"

ASIA

BAHRAIN & TRUCIAL STATES

Yusuf Bin Ahmed Kanoo *Bahrain, Arabian Gulf*, tel: 40 8188, tgm: kanoo, telex: BHN 215

BURMA

Myanma Export Import Corp., Agency Div. *Rangoon*, P.O.B. 404, tel: 146 18, tgm: myanimport

CAMBODIA

Comin Khmere S.A. *Phnom-Penh*, P.O.B. 625, tel: 233 34, tgm: engineer

CYPRUS

S.A. Petrides & Sons Ltd. *Nicosia*, P.O.B. 4522, tel. 627 88, tgm: armature, telex: 2308, "ARMATURE"

HONG KONG AND MACAO

Swedish Trading Co. Ltd. *Hong-Kong*, P.O.B. 108, tel: 23 1091, tgm: swedetrade

IRAN

Irano Swedish Company AB *Teheran*, Khiabane Sevom Esfand 29, tel: 31 4160, tgm: iranoswede

JORDAN

The Arab Trading & Development Co. Ltd. *Amman*, P.O.B. 6141, tel: 259 81, tgm: aradeve

KUWAIT

Morad Yousuf Behbehani *Kuwait, State of Kuwait*, P.O.B. 146, tel: 270 71, tgm: barakat, telex: 048, "BEHBEHANI KUWAIT"

LEBANON

Swedish Levant Trading *Beyrouth*, P.O.B. 931, tel: 23 1624, tgm: skefko

PAKISTAN

Panasian Marketing Service Ltd. *Karachi*, P.O.B. 3941, tel: (90) 51 2051, Ext. 53, tgm: panasian

PHILIPPINES

USI Asia Industries, *Makati, Rizal*, P.O.B. 1322, tel: 87 7011, tgm: usi asia, telex: 7222233, "7222233 AII PH"

SAUDI ARABIA

Engineering Projects & Products Co. Ltd. (Eppco)

Riyadh, P.O.B. 987, tel: 222 22, tgm: eppcol

Yeddah, P.O.B. 1502, tel: 4567, tgm: eppcol

Dammam, P.O.B. 450, tel: 222 22, tgm: eppcol

SYRIA

Constantin Georgiades *Damas*, P.O.B. 2398, tel: 266 73, tgm: georgiades

TAIWAN

Trans-Eurasia Enterprise, Ltd. *Taipei*, P.O.B. 3880, tel: 51 7038, tgm: esbtrading

REPUBLIC OF VIETNAM

Vo Tuyen Dien-Thoai Vietnam *Saigon*, P.O.B. 1049, tel: 226 60, tgm: telerad

International Business Representative *Saigon*, 26—28, Hai Ba Trung Street, tel: 226 60, tgm: ibur

AFRICA

ETHIOPIA

Mosvold Company (Ethiopia) Ltd. *Addis Ababa*, P.O.B. 1371, tel: (01) 101 00, tgm: mosvold, telex: 21090, "MOSFIRM ADDIS"

KENYA, TANZANIA, UGANDA

The Old East African Trading Co. Ltd. *Nairobi, Kenya*, P.O.B. 30013, tel: 271 61, tgm: broche, telex: 22261, "OLDEAST NAIROBI"

LIBERIA

Liberian Telecommunications Authority *Monrovia*, Corner Ashmun & Lynch Streets, tel: 222 22, tgm: radiolibe

LIBYA

ADECO African Development & Engineering Co *Tripoli*, P.O.B. 2390, tel: 339 06, tgm: adeco

MALAWI

Business Machines Ltd., *Limbe*, P.O.B. 5557, tel: Blantyre 504 03, tgm:falt

MOZAMBIQUE

J. Martins Marques & Ca. Lda *Lourenço Marques*, P.O.B. 2409, tel: 5953, tgm: marquesco

NIGERIA

Communications Associates of Nigeria Ltd. (Comsac), *Yaba (Lagos)*, P.M.B. 1069, tel: Lagos 442 74, tgm: comdec lagos

SOUTH AFRICA
SOUTHWEST AFRICA

Dryden Communications (Pty.) Ltd. *Johannesburg, South Africa*, P.O.B. 2440, tel: 838 5454

SUDAN

El Rahad Trading Corporation *Khartoum*, P.O.B. 866, tel: 776 95, tgm: suconto, telex: BHN 251

AMERICA

BAHAMA ISLANDS

Anglo American Electrical Company Ltd. *Freeport, Grand Bahama*, P.O.B. 104

BOLIVIA

Prat Ltda *La Paz*, Casilla 4790, tel: 277 12, tgm: prat

COSTA RICA

Tropical Commission Co. Ltd. *San José*, Apartado 661, tel: 22 5511, tgm: troco

DOMINICAN REPUBLIC

Humberto Garcia, C. por A. *Santo Domingo*, Apartado 771, tel: 3645, tgm: gartler

GUATEMALA

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: (021) 622 57, tgm: nilspira

GUYANA

General Supplies Agency *Georgetown*, P.O.B. 375, tgm: benwiks

HONDURAS

Quinchón Leon y Cia *Teguicigalpa*, Apartado 85, tel: 251 71, tgm: quinchon

NETHERLANDS ANTILLES

S.E.L. Maduro & Sons Inc. Merchandise Dept. *Willemstad, Curaçao* P.O.B. 304, tel: 130 00, tgm: madurosons, telex: CU 92

NICARAGUA

Roberto Teran G. *Managua*, Apartado 689, tel: 224 00, tgm: roteran

PANAMA

Sonitel, S.A. *Panama 5, R.P.*, Apartado 4349, tel: 64 3600, tgm: sonitel, telex: 368674, "368674 SONITEL"

PARAGUAY

S.A. Comercial e Industrial H. Petersen *Asunción*, Casilla 592, tel: 9868, tgm: pargtrade

EL SALVADOR

Dada-Dada & Co. *San Salvador* Apartado 274, tel: 21 7940, tgm: dada

SURINAM

W.E. van Romondt's Trading Company Ltd. *Paramaribo*, tel: 2831, tgm: vanromondt

TRINIDAD, W.I.

Leon J. Aché Ltd. *Port-of-Spain*, 100 Frederic Street, tel: 323 57, tgm: achegram

AUSTRALIA & OCEANIA

NEW ZEALAND

ASEA Electric (NZ) Ltd. *Wellington C. 1.*, P.O.B. 3239, tel: 706 14 tgm: asea, telex: 3431, "ASEAWELL NZ 3431"

SÄTHERLUND & KROOK

ERICSSON Review

4
1971

ERICSSON REVIEW

Vol. 48 No. 4 1971

RESPONSIBLE PUBLISHER: CHR. JACOBÆUS, DR. TECHN.

EDITOR: SIGVARD EKLUND, DHS

EDITOR'S OFFICE: S-12611 STOCKHOLM 32

SUBSCRIPTIONS: ONE YEAR $1.80; ONE COPY $0.60

CONTENTS

On cover: Installation of L M Ericsson crossbar exchange at Medellín, Colombia.

Maintenance of L M Ericsson's Automatic Crossbar Exchanges in Tunisia

A. LAOUYANE, HEAD OF TELEPHONE EXCHANGE DIVISION, PTT, TUNISIA

UDC 621.395.722.004.5
LME 1540 038

Ericsson Review No. 4, 1967, contained an article on the maintenance of ARF telephone exchanges in Tunis. Since then several new crossbar exchanges ARF, ARM and ARK have been put into operation in different Tunisian towns. The PTT has therefore acquired a sufficient experience of all types of L M Ericsson's crossbar exchanges to be able to testify to the rational and staff-saving maintenance methods adopted at these exchanges, which are entirely based on L M Ericsson's maintenance philosophy. The operational results have been consistently followed up. This article throws further light on these questions and on the maintenance organization, training etc.

Network Structure

Tunisia is divided into eight zones, of which six are fully or partly automatic. In each zone there are a number of group centres in which metering of outgoing trunk calls takes place for the terminal exchanges which they serve.

The terminal exchanges are of types *ARF* or *ARK* and the group centres of types *ARF + ARM* or *ARK 523*. The zone centre is an *ARM* exchange.

By the end of 1972 the Tunisian telephone network will comprise:

	Total
23 local exchanges *ARF*	56,200 lines
10 transit exchanges *ARM*	2,780 multiple positions
5 manual trunk exchanges *AFA*	136 positions
1 manual international exchange *AFA*	16 positions
1 manual information centre	16 positions
72 rural exchanges *ARK*	3,730 lines
1 international exchange *ARM*	800 multiple positions

Maintenance Organization

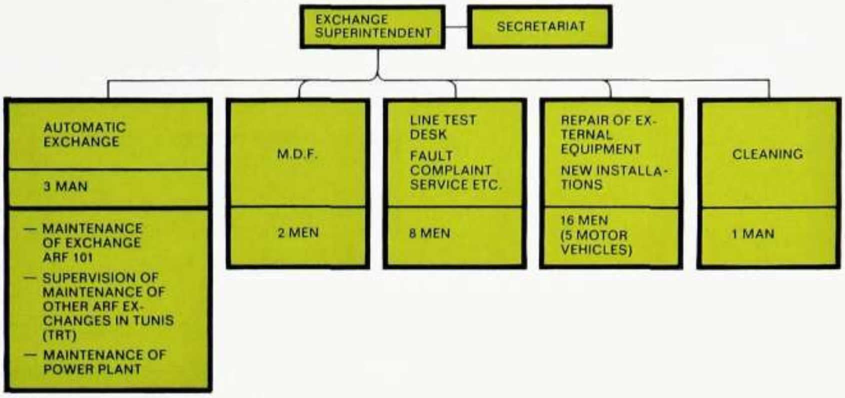
The country is divided into maintenance districts which coincide with the zones. For each district there is a superintendent who is in charge of certain maintenance groups, viz.

- maintenance group for *ARF* (1—2 technicians)
- maintenance group for *ARM* (1 technician)
- maintenance group for *ARK* (1 technician)
- maintenance group for *AFA*, manual (1—2 technicians)

For *ARF* exchanges this form of organizations is not adopted in the capital, as the exchanges there have a large capacity (over 4,000 lines) and require permanent maintenance staff at each exchange. The suburban exchanges (1,000—2,000 lines per exchange), on the other hand, are handled by a mobile maintenance group.

Fig. 1

Organizational chart for maintenance of ARF 101 at Carthage, 15,000 lines, including supervision of other ARF exchanges in Tunis by means of a traffic route tester.



Every *ARM* exchange is maintained by a technician who, according to the size and importance of the exchange, works full-time or half-time. An *ARM* specialist supervises the maintenance of all *ARM* exchanges in the country.

The *ARK* exchanges are connected to superior transit exchanges *ARM* which function as maintenance centres. At present there are three such centres, in Tunis, Sousse and Sfax, but by the end of 1972 there will be some 10 such centres. At each maintenance centre there is a mobile team of 1—2 technicians for complete maintenance of junction circuits, *ARK* exchanges, subscriber lines and telephone sets.

Figs. 1, 2 and 3 show the organizational chart for maintenance of an *ARF* exchange, a zone and the entire network.

Maintenance Philosophy

The change from rotary to crossbar switch systems has necessitated a complete reorganization of the maintenance methods. A training programme for technicians has been carried out in intimate cooperation with L M Ericsson since 1960, and the result has been excellent.

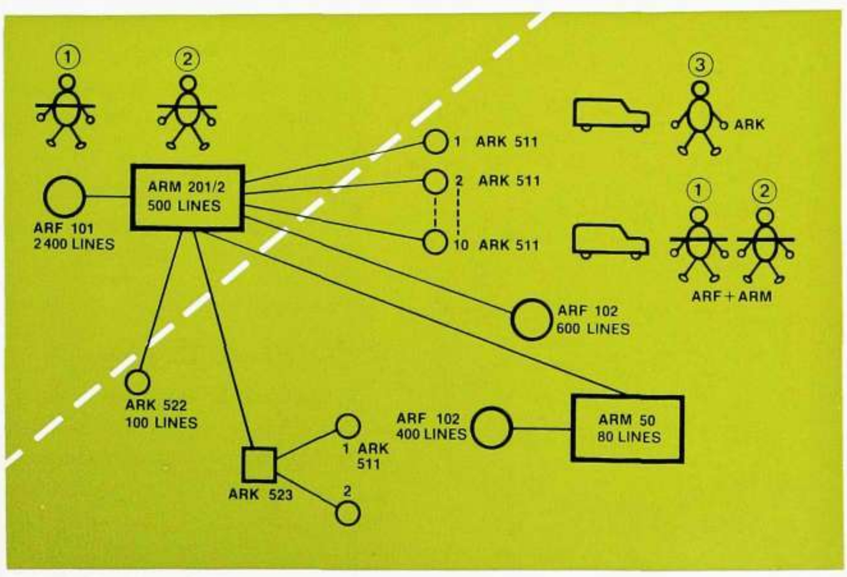


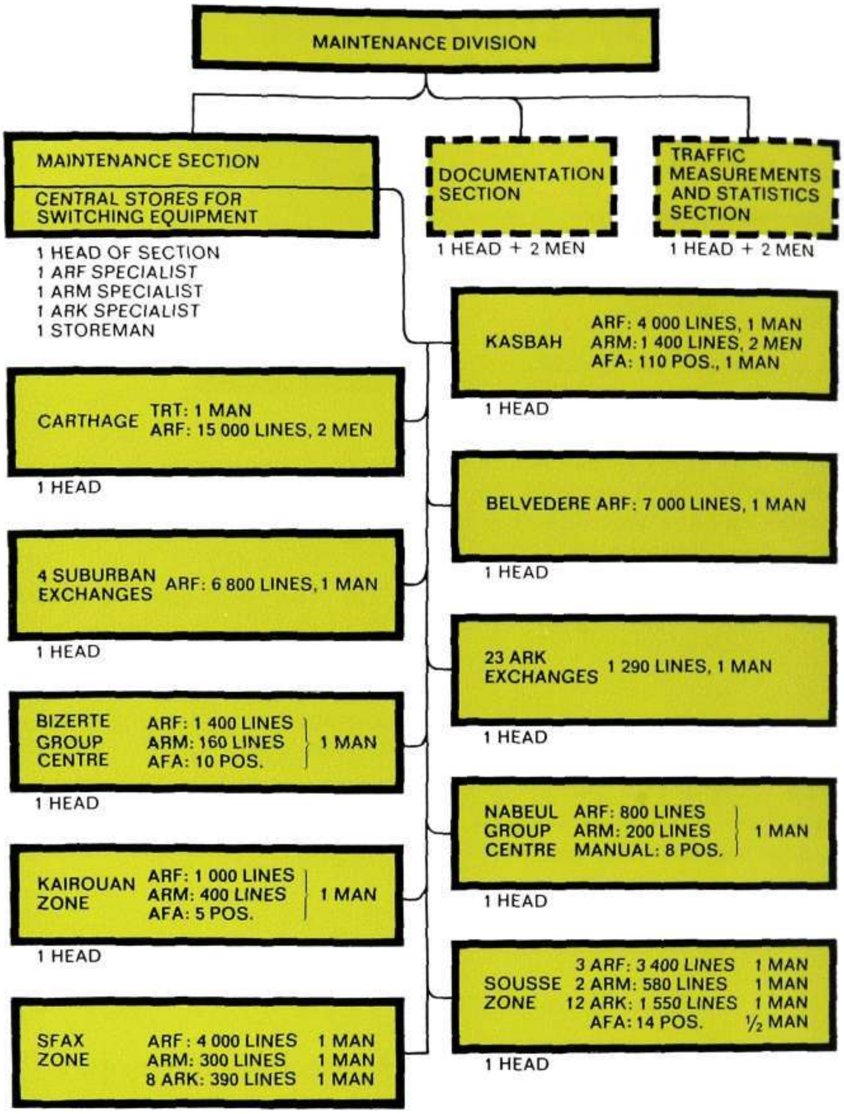
Fig. 2

Sketch of maintenance organization, Sousse zone

Full-time

Half-time

Fig. 3
Organizational chart for maintenance of entire Tunisian network



The maintenance methods naturally follow L M Ericsson's recommendations but have been adapted to local conditions. The following principles are strictly followed:

- do not touch the equipment until the supervisory equipments issue a signal that action is necessary,
- avoid unnecessary routine testing of switching devices, but take measures to establish the functional quality of the exchange from the subscribers' point of view,
- preventive maintenance should be done only in exceptional cases,
- keep the exchange rooms free from dust and therefore do not let the staff enter the rooms unnecessarily.

Maintenance Routines

On the basis of these principles detailed maintenance instructions have been prepared. These contain precise directions concerning the measures to be taken every day, once a week, once a month, once a quarter, and once a year. This maintenance routine has shown very good results with a minimum of staff. Tunisian technicians have been responsible for exchange maintenance over a period of 10 years and have done their work effectively.

Training

The rapid expansion of the Tunisian automatic telephone network requires continuous training, comprising maintenance methods, technique and installation of exchanges *ARF*, *ARM* and *ARK*. The maintenance and testing staff have received special training at L M Ericsson. The PTT in cooperation with L M Ericsson and SIDA (Swedish International Development Authority) has trained different classes of fitters and assistant testers at the PTT Vocational School at Tunis. This latter training has been in the charge of PTT foremen with the assistance of L M Ericsson experts.

The various forms of training have produced excellent results, to the mutual satisfaction of all parties.

Maintenance of ARF Exchanges

Maintenance Equipments

The following maintenance equipments are used:

- Traffic route testers *TRT* with code answering equipments for remote testing are used for checking the functional quality of exchanges and for automatic tracing of faults.
- Control registers
- Supervisory and alarm equipments
- Test and fault tracing equipments consisting of:
  SL-GV tester
  manual *SR* tester
  manual register tester
  subscriber line tester *AEP*
- Traffic measuring equipment
- Statistics counters

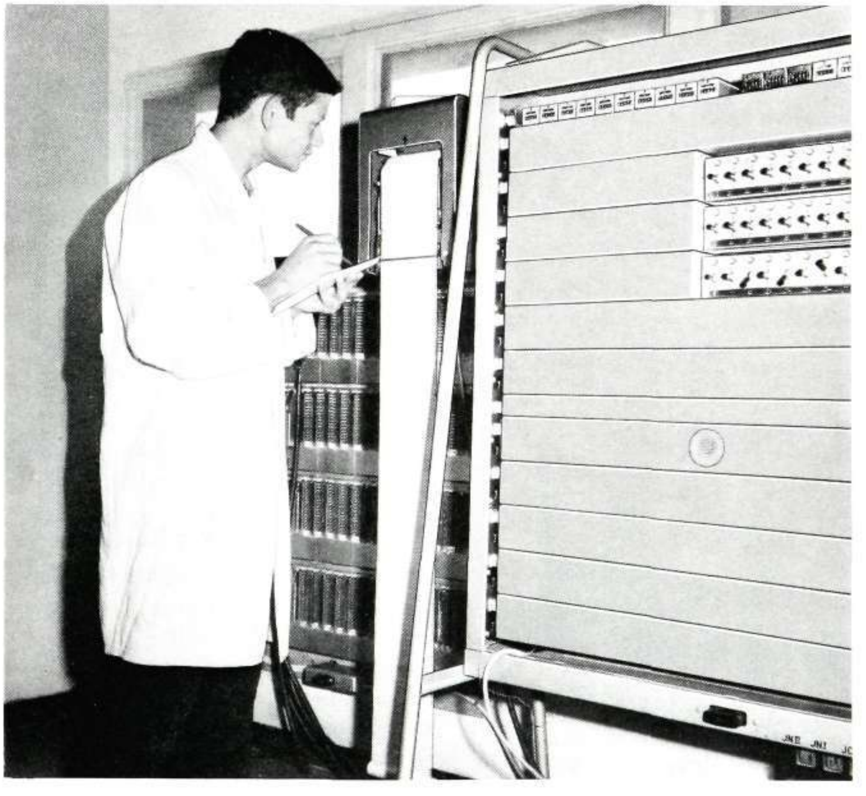


Fig. 4
Traffic route tester with CENTRALOGRAPH

Operational Results

The *ARF 101* exchanges were put into operation during 1961—1964 and the most recent exchange has thus been in operation for more than 7 years. The quality of the material, the competence of the Tunisian technicians, and the maintenance methods in use, have each contributed to a very satisfactory overall result. Visitors to the PTT have difficulty in understanding that certain exchanges have been in operation for 10 years, as they are still in such perfect mechanical and functional state.

The fault statistics show an average of 349 faults per annum counted on 40,400 lines, corresponding to 8.7 faults per 1,000 lines and year.

The fault distribution per category of device is as follows:

Switches	18%
Relays	62%
Other devices	20%

Subscriber Growth

In 1965 there were 25,000 subscribers connected to *ARF* exchanges, and 32,000 in 1970. The average increase has been 5.2% per annum. Fig. 5 shows the growth from 1965 onwards.

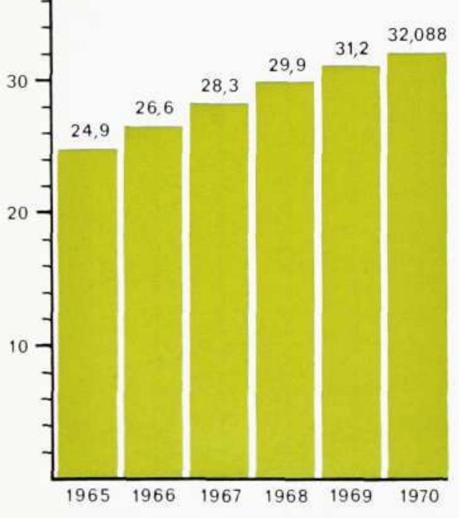
Existing exchanges are being extended by 5,200 lines to cover the need during a 5-year period. Automatization in the remainder of the country is continuing and 12 *new* exchanges *ARF 101* and *ARF 102* with a total capacity of 10,600 lines will be installed by the end of 1972. When these two programmes have been completed, the capacity of *ARF* lines will be 56,200.

Maintenance of ARM Exchanges

ARM Network

The second main group of exchanges maintained by the PTT technicians consists of the *ARM* exchanges in Tunis, Bizerte, Sousse and Sfax, which are transit exchanges in zones 01, 02, 03 and 04. These exchanges were finally taken over during 1967. The *ARM* network is to be considerably extended and, by the end of 1972, seven new exchanges *ARM 201, ARM 202* or *ARM 501* will have been installed, as shown in fig. 6.

Fig. 5
Subscriber growth in Tunisia



Maintenance Equipments

The following maintenance equipments will be used:

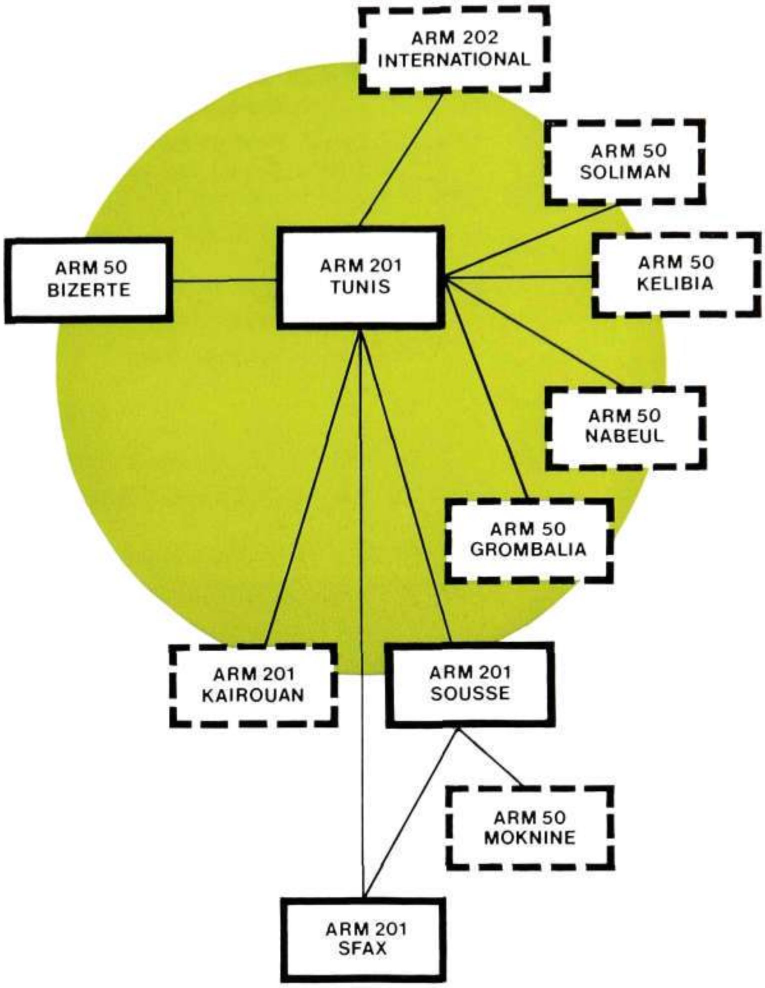
- Centralographs, which provide a coded record on a chart when route markers *VM* and markers *M* fail to complete their switching processes within the specified times.
- Alarms of three degrees of urgency
- Automatic exchange testers
- Statistics counters

As reported below the fault rate is low, but it is very important that faults are immediately signalled and located. This is because disturbances in an *ARM* exchange have more serious consequences than in an *ARF* exchange. This has warranted the use of an equipment which permits supervision of the functional

Fig. 6
ARM network in Tunis at the end of 1972

Existing exchanges

New exchanges



quality of the exchange and rapid fault location. In view of the extension of the *ARM* network it has been found desirable to centralize supervision and testing of the *ARM* exchanges, which necessitates the following additional equipment:

- automatic transmission measurement equipment, *ATME*
- use of *TRT* for trunk traffic through installation of automatic code answerers in remote exchanges
- observation desk in separate room together with CENTRALOGRAPH equipment for large *ARM* exchanges, so permitting effective service supervision without the staff needing to enter the *ARM* equipment rooms.

Operational Results

The results of operation of the *ARM* exchanges have proved to be as satisfactory as those of the *ARF* exchanges. The PTT has thus been able to establish that *ARM* exchanges function very effectively as two- or four-wire transit centres when correctly engineered.

The service quality is very satisfactory, with a fault rate of 0.1%—0.25%, as appears from the figures below from real test traffic:

Tunis	↔	Sousse	0.20%
Tunis	↔	Sfax	0.10%
Tunis	↔	Bizerte	0.25%
Sousse	↔	Sfax	0.25%

The number of faults per rack and year averages 0.86. For *ARM 201* in Sousse, for example, there were 0.74 faults per rack and year in 1970; and through the experience that has been gained, and after the addition of service supervision equipment, the PTT counts on reducing this figure still further. It should be emphasized that the figure is below the normally permissible, i.e. 1 fault per rack and year.

The distribution of these faults by categories of device is as follows:

Switches	8%
Relays	68%
Other devices	24%

Maintenance of ARK Exchanges

Testing Routines

The technicians at the superior *ARM* exchange daily test and supervise the *ARK* exchanges, including the *FDR* relay sets, by systematically making calls to the automatic code answerers *PNR*. The results of these tests are passed on to the mobile maintenance group, which locates and repairs faults in the *ARK* exchanges.

The remote supervision of the *ARK* exchanges is done by means of centralized alarm in the *ARM* exchange. The introduction of equipment for remote-controlled subscriber-line measurement is also planned. At present the mobile maintenance group carries out tests from the local *MDF* in the *ARK* exchanges.

Operational Results

The *ARK* exchanges show an average of 14 faults per 1000 subscribers and year, which is very satisfactory if one considers that the number of racks per 1000 subscribers is very high in an *ARK* exchange. The distribution of the faults is roughly the same as in *ARM* exchanges.

The fault rate on subscriber lines, on the other hand, is fairly high, namely 3 faults per subscriber and year (line plus telephone set). This is because the subscriber networks for the small exchanges, in the suburbs of large towns, consist entirely of overhead lines.

It costs the PTT more to repair faults in *ARK* than in *ARF* exchanges, as the travel distances are of an order of 10—30 km.

Owing to the high fault rate on subscriber lines the PTT is planning a quick change from overhead lines to cable or radio links. The *ARK* exchanges in the Cap-Bon area, for instance, will be served by 0.9 mm loaded cable. The *ARK* exchanges in Kairouan will be served by radio links, as flooding is frequent in this area.

From the PTT's experience of *ARK* exchanges the following conclusions may be drawn:

- *ARK 511* is suited for sparsely populated districts (low number of lines and low traffic per line).
- *ARK 521* is suited for exchanges of 100—400 subscribers (medium traffic).
- *ARK 523*, in addition to the normal functions of *ARK 521*, also serves trunk transit functions as group centre with low traffic. Experience shows

that this type of exchange is not fully satisfactory and that independent four-wire transit stage exchanges are preferable. This is the reason why the group centres which are being automatized will be equipped with *ARM 50* or *ARM 20* depending on the size of the exchange (see *ARM* network).

The small local terminal exchanges will be equipped with *ARK 511* or *ARK 522* (improved *ARK 521*).

After the completion of Plan No. 3 (at the end of 1972) the *ARK* network will comprise 96 exchanges with altogether 6,520 lines.

Summary

The author hopes that he has been able to give an idea of the Tunisian experience as regards development and maintenance of crossbar exchanges. In the attainment of these results the Tunisian PTT has benefited by experience from other countries, especially the Scandinavian countries, where our technical study groups have received all desirable assistance.

The PTT actively follows up this experience in intimate cooperation with L M Ericsson and with the aid of SIDA. Tunisia is proud, within the scope of technical cooperation, to be able now to send technicians to friendly countries to assist in the installation and maintenance of crossbar exchanges.

Strategy for Structure and Maintenance of Modern Telecommunications Transmission Networks

E. A. ERICSSON & P. A. HALLBERG, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.45.004.5
LME 847
83035
1540

Modern transistorized transmission systems are characterized by very high reliability, and the life of the equipments may be estimated at several hundred years. Breakdowns may nevertheless occur in the large batches of circuits, usually as a result of mechanical damage to cables, and lead to interruptions of traffic which call for very quick action so as to be as short as possible.

Increased reliability can be attained in different ways:

- *Large batches of circuits can be divided between independent routes so that only part of the traffic is interrupted on breakdown of one of the routes.*
- *Important batches of circuits are automatically or manually switched to alternative transmission paths.*

Faults in individual items of apparatus are remedied by replacing them by standby units as quickly as possible. The article "Method for estimation of spare parts requirement for transmission systems"[1] shows how the quantity of standby equipment can be optimized.

The present article discusses the strategy for the structure and maintenance of complicated telecommunications transmission networks.

Introduction

Modern transistorized broad-band transmission systems are extremely reliable, but as certain equipments serve a large number of circuits — at present up to 10,800 — faults may result in serious interruptions of service, particularly if the fault consists of a broken cable serving several such systems. A breakdown on an important route results in serious congestion which quickly spreads throughout large areas and causes chaos in the telephone service.

Fig. 1 shows in simplified form the modulation stages in the 60 MHz systems recommended by CCITT. Disturbance of an individual circuit has little effect, but the greater the number of circuits served by a set of equipment, the shorter will be the tolerable interruption time, which should preferably be negligible in the case of 10,800 circuits.

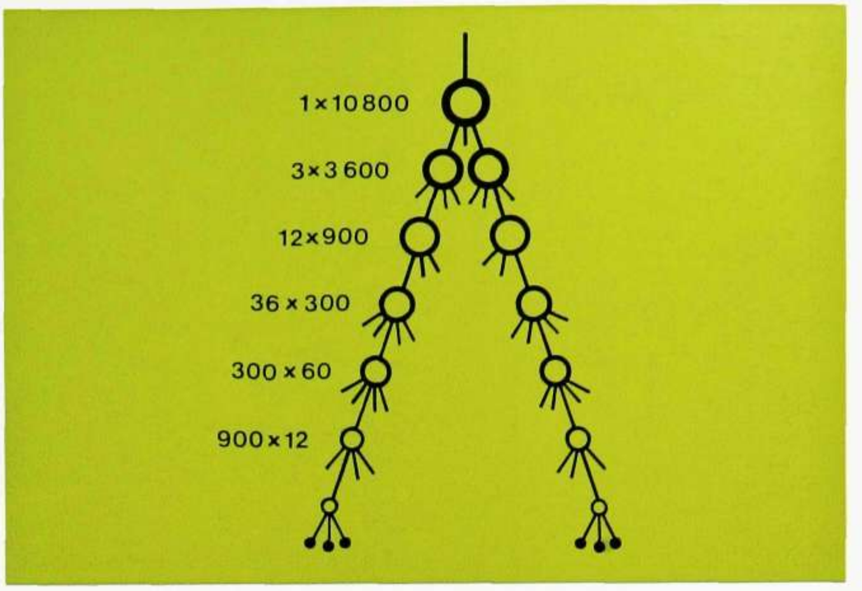
Problems of this kind have been thoroughly discussed at the maintenance conferences arranged by L M Ericsson in Stockholm in the last few years. It has been established that the vast majority of faults originate not from the equipment but from adverse conditions encountered in line transmission, such as fading on radio links or cutting of cables by excavators. As repair of the fault may take several hours or even days, it is necessary to arrange for standby routes so that a normal handling of the traffic can be maintained.

Fig. 1

Modulation stages in 60 MHz system according to CCITT Plan 1. In Plan 2 there are *no* mastergroups.

The figure shows the number of groups, supergroups, etc.

Modulation stage



Network Structure

For this reason, modern long-distance networks are often given a mesh-shaped structure. Thus the telecommunications traffic between two important towns can be divided up between at least two routes (Fig. 2) so as to avoid total breakdown in the event of a fault on one route. However, this involves the risk of congestion occurring, especially during busy hours, and the effects of this may spread far into the otherwise serviceable network. This method may imply additional costs if through connections must be made in lower modulation stages.

It is therefore necessary to create suitable standby routes in the telecommunication network to which basic groups, supergroups, mastergroups and supermastergroups or even entire line groups can be connected in the event of a fault. The additional capacity required both to create standby routes and to cater for normal traffic growth can be obtained by reconstruction of the line systems. By converting from 4 MHz to 12 MHz systems or from 12 MHz to 60 MHz systems, the circuit capacity of the existing cable network can be increased three and four times respectively.

Even if adequate standby route capacity is available, this will not suffice to avoid traffic chaos unless the switching is effected quickly and preferably

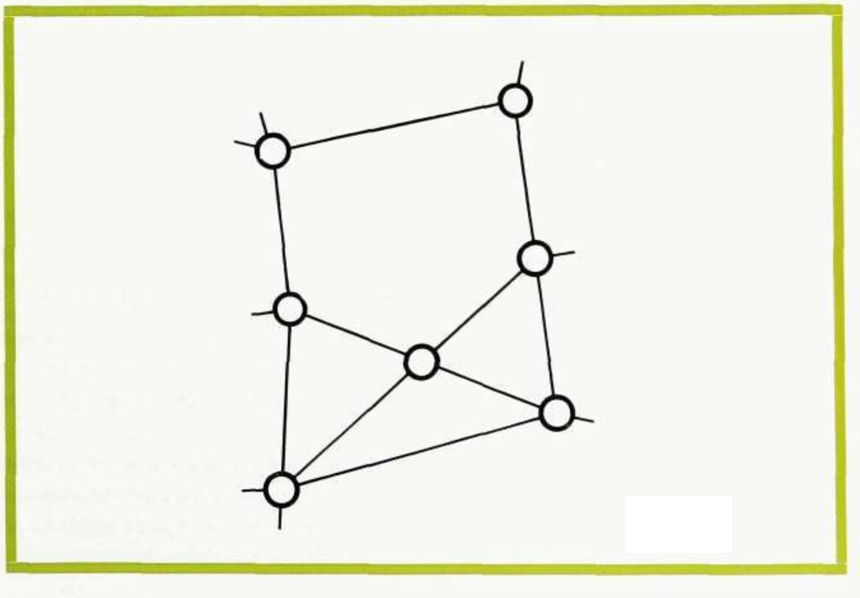


Fig. 2

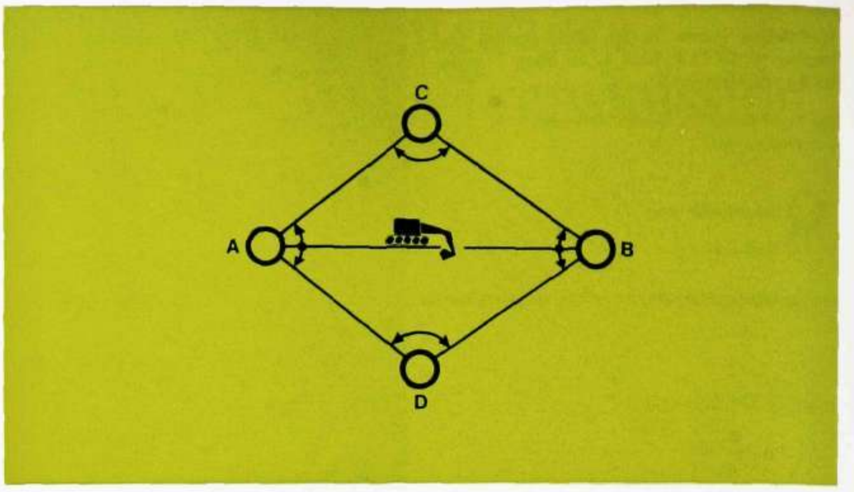
Mesh-shaped network structure

Repeater stations

One or more h.f. lines

Fig. 3
Standby routes

In case of fault on route A-B switching is effected to standby routes connected in tandem at C and D.



automatically. In view of the cost of the necessary electronic equipment, switching to standby routes should be done only in the higher modulation stages. For the Swedish network of 12 and 60 MHz systems, accordingly, automatic switching on a supermastergroup basis is being discussed.

Fig. 3 illustrates a situation with a cable fault on the route A—B. The hypergroups on the interrupted route may, for example, be switched via spare routes A—C—B and A—D—B. If adequate capacity is available, fixed through connections can be arranged at stations C and D. The pilots can then control instantaneous switching to the standby routes at A and B. An exclusive standby system of this kind requires a 100% increase of the system capacity. As a rule so large a surplus capacity is not available. The standby facility must therefore be shared by more than one separate route. However, this method involves instantaneous switching at several points in the event of a failure.

Successful switching to standby routes requires rapid detection and signalling of faults and a good survey of the state of operation in large parts of the network. These points are dealt with below and in greater detail in a coming article.

For small routes, modern trunk exchanges usually provide alternative routing facilities for traffic reasons. This provision in itself goes a long way towards dealing with interruptions.

How a long distance network is to be modelled so as to be reliable and easy to maintain depends on a number of factors such as population density, topography, traffic volume, system technique employed, etc. The optimum solution must be decided in each particular case.

Maintenance Organization

For coordination of the maintenance in a large complicated transmission network the network is divided into a number of sufficiently large maintenance areas, each with a supervisory *operating centre* as shown in Fig. 4.

Since modern transmission equipment is very stable, it is unnecessary to carry out frequent routine measurements. And as the risk of equipment faults is small but the fault rate tends to increase with the presence of staff in the stations these should be left unattended as far as possible.

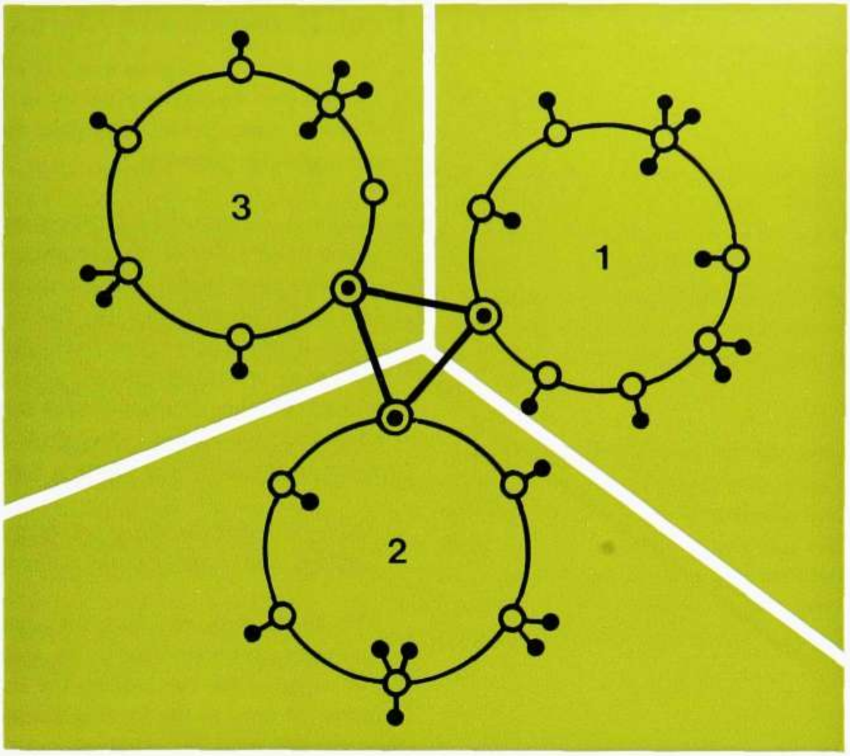
Fig. 4

The network is divided into maintenance areas (1, 2, 3 . . .)

◉ Operating centre

○ Important supervised stations connected to reporting loop

● Secondary stations with branch line from the reporting loop.



Equipment faults are remedied chiefly by replacing defective plug-in units by standby units, which must be available. The stockholding of standby units is dealt with in another article in this issue.

Alarms from unattended stations must be reported to an operating centre or superior repeater station. The necessary maintenance and repair work is directed from the operating centres.

The control of switching equipments for nationwide long-distance networks must be centralized to a *main operating centre* since alternative routing may extend throughout the country. This is because only a central control equipment can locate an arbitrary fault in the long-distance network and initiate all requisite switching operations at the stations concerned. This implies that the necessary details about the fault are promptly supplied and that accurate information about the routing of the individual batches of circuits and about the standby routes at the disposal of the operating centre is available. The handling of such large amounts of data necessitates the use of modern computers, particularly since the time of interruption should be as short as possible.

From the operating centres additional data required are reported to the main operating centre so that the latter can survey the situation in the entire country. This is necessary when the national network also carries international traffic which is supervised by an international maintenance centre in accordance with CCITT recommendations. In some countries the main operating centre may be used for the international supervision.

It should be pointed out that the strategy outlined necessitates equipments of high reliability and stability. Where older types of electron tube equipments are in service, regular routine measurements will be required and the station must be manned. It may prove profitable, however, to replace older equipment by modern equipment so that the station can be unattended, with simultaneous increase of reliability.

Fault Detection and Alarms

- A pilot alarm is used to indicate an interruption or excessive deviation from the nominal hypergroup levels in the various hypergroup links — at least down to supergroups. The gain regulation should usually be automatically controlled by the pilots.

- Faults in the lowest modulation stages involve a loss of at most 12 circuits, which hardly affects the operating stability of the long distance network but increases the congestion on a route and may cause total stoppage on small routes. On grounds of cost, alarms can hardly be introduced for the lowest stages of the transmission network. Such disturbances will, however, be observed at switching centres, since defective circuits are normally blocked and the number of unsuccessful calls increases. An abnormal increase of the congestion on certain routes gives rise to additional indications. If the fault is not in the switching centre a report is delivered to the operating centre.

- Alarm is issued in the event of a fault in the power supply or carrier generation, and of other faults at the station concerned.

The alarm data required for control of automatic hypergroup switching equipments are transmitted to the main operating centre, whereas alarms which are of significance for judging the state of operation at a repeater station are transmitted only to the local operating centre. The transmission path used for this purpose must be extremely reliable so that transmission is possible even in the case of circuit interruption. This can be achieved by making each individual station accessible via two independent routes, as indicated in Fig. 4, less important stations being connected to superior stations via a single route.

As already mentioned, faults on individual circuits are indicated at the switching centres. However, the fault may be located in the transmission equipment. Close cooperation between switching and transmission technicians is therefore desirable. For this reason many administrations have common operating centres for switching and transmission maintenance.

Automatic Transmission Measurement

The indications referred to in the foregoing give a good idea of the state of operating in the higher modulation stages, but no information about noise and level deviations on individual circuits. This information is received if the operating centres are equipped with automatic transmission measuring equipment *ATME*, with which the characteriscs of each circuit in the entire maintenance area are automatically tested on a routine basis in accordance with a predetermined programme. Excessive deviations from nominal attenuation values and too high noise levels are recorded on fault cards. The equipment has been earlier described in Ericsson Review.[2, 3]

It should be noted that *ATME* can also be used for special tests on disturbed routes to supplement other information.

Level Deviations

Each circuit is allotted a nominal transmission loss which is so determined that circuits can be connected in tandem at random without singing or troublesome echo arising on connections without echo suppressors, despite inevitable deviations from the nominal transmission loss in the circuits used.

If on a connection we have n circuits in series, each with s dB standard deviation, the total deviation of transmission loss for $2 \times 1\%$ of the calls will be

$$\triangle \geq \pm 2.33 \cdot s \cdot \sqrt{n} \text{ dB}$$

Consequently, even if CCITT's objectives for traffic handling and transmission maintenance of international circuits are achieved (i.e. $n \leq 12$, $s \leq 1$ dB), there may be deviations of transmission loss from the mean value of $> \pm 8$ dB. The mean value is $n \cdot 0.5$ dB, i.e. 6 dB when $n = 12$. However, only a few poor circuits in a connection will suffice for the deviations of transmission loss to become appreciably larger. There is accordingly every reason to attempt to limit the variations in transmission loss and, with modern equipment, this is technically feasible.

If the variations in transmission loss can be further reduced by adequate maintenance, e.g. regular ATME measurements, it should be possible to reduce the nominal loss increment of 0.5 dB between the four-wire interconnection points which must now be inserted per circuit in view of echo delays and risk of singing. This would imply that the mean value of the average transmission loss on complex connections, measured between the four-wire points, may approximate to 0 dB instead of being dependent on the number of circuits connected in series, as in the above case.

Subscriber Complaints

Subscriber complaints concerning defective quality of service are often so diffuse that they are seldom of any help, especially as the connection has already been cleared. The service supervision of the long distance network, therefore, should be based chiefly on observations made within the maintenance organization.

Priorities

If several faults occur simultaneously, the main operating centre must be able quickly to decide how available resources should be used so that the traffic disturbance is limited and chaos avoided. Action to be taken in a given situation should naturally be planned in advance, and priority should be allotted to the various routes depending on their importance from the traffic handling point of view. One should also know

- the number of circuits in operation per route
- the geographical direction of the route
- what standby routes are in use
- what standby routes are available for a particular case of disturbance

Priorities may also be needed for the insertion of standby units. There may be an interruption on an important route or batch of circuits, but the necessary standby unit is lacking. In such a case equipment must be borrowed from routes with low priority to reduce the disturbance of traffic as far as possible.

The computer with register may be of great value for the allotment of priorities and other planning measures. It may also be an advantage later to equip the operating centres with computers so as to reduce the duties of the supervisory personnel. Suitable programmes can be used to give the personnel information about the action required.

Summary

A brief account has been given of points of view as to how a reliable, complicated broad-band long distance network should be planned so as to be able to organize effective maintenance with a high degree of preparedness. So far it has been possible to apply some of these procedures only to a small extent, but they will become of great urgency when new, increasingly broad-band systems are added to the long distance networks to deal with the quickly growing long distance traffic. Emphasis has been placed on the importance of standby routes with controlled hypergroup switching equipment and on the function of the operating centres in transmission networks. The freedom from maintenance of modern transmission systems has also been stressed, as well as the value of close cooperation between transmission and switching personnel to maintain the desired quality of operation.

References

1. TIGERMAN, B.: *Method for Estimation of Spare Parts Requirement for Transmission Systems*. Ericsson Rev. *48*(1971): 4, pp: 141—152.
2. SÖDERBERG, A.: *International Maintenance Centre, IMC*. Ericsson Rev. *48*(1971): 3, pp: 113—120.
3. KARL, H.: *Automatic Transmission Measuring Equipment for Telephone Circuits*. Ericsson Rev. *40*(1963): 3, pp: 78—86.

Method for Estimation of Spare Parts Requirement for Transmission Systems

B. TIGERMAN, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.395.45.002.69
LME 15411
847
7025

This article presents in brief form a method for calculation of the optimum number of spare units for a carrier transmission system. The system model is based on a maintenance routine under which, when a failure occurs, the defective units are replaced by spare units, which must be available.

From the known inherent reliability of individual units and their number in operation the required number of spares is calculated in such a way that the probability of a lack of replacement units during a given period (shortage risk) will be below a predicted value.

The units are divided into apparatus groups with differing degrees of importance according to the number of channels transmitted. The shortage risk is optimized having regard to the economic losses from interruption of traffic and is distributed among units of different degree of importance according to Erlang's loss formula.

The practical calculation is carried out on a computer, the result being presented in the form of a list of the necessary spare units. At the same time information is received concerning the probability that a given spare unit will be lacking during the period when spare units are required. The procedure is a routine in the project and tendering stage, performed as a service to L M Ericsson customers.

The article is a revision of papers previously presented at L M Ericsson's maintenance conferences. Another article in this issue illustrates problems of network structure and maintenance within transmission technique.)*

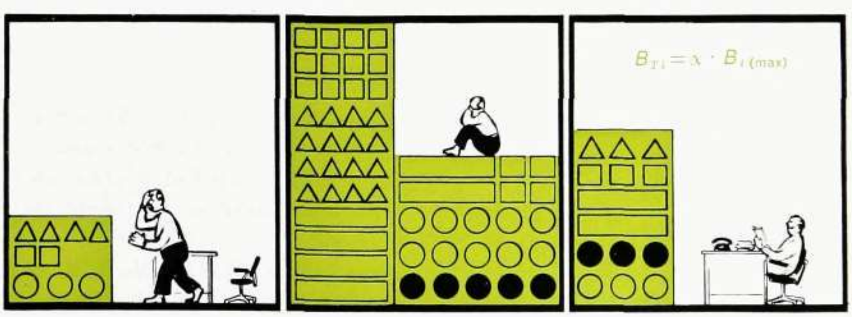
Despite their high inherent reliability the modern transistorized transmission systems can only fulfil the ever-increasing demands for availability by means of external redundancy, i.e. the replacement of defective apparatus units by

*) Strategy for network structure and maintenance of modern telecommunications transmission networks, pp. 134—140

Too small or wrongly planned holding of spares causes insecurity.

A large holding of spares admittedly provides security but is expensive.

L M Ericsson's optimization method leads to optimal security at a reasonable cost.



spares. In this way the "operational reliability" of the system can be increased from the level conditioned by the apparatus design to that desired from the availability aspect.

Hitherto the calculation of the required quantities and types of spare parts have been based on empirical rules and an intuitive judgment of the situation, but the rapidity of development of transmission technique and the requirements of increased availability and economic optimization necessitate more refined methods of calculation.

The method developed by L M Ericsson implies that one seeks for the minimum total cost for the holding of spares and the loss of traffic caused by a shortage of spares. At the same time the inconvenience to the public in the form of increased congestion brought about by stoppages of traffic must be taken into account.

The method is based on system reliability studies. The same difficulties are therefore encountered as in general reliability calculations: a relatively well developed theory but little knowledge of the failure rate and length of life of the apparatus units within the reliability block. By taking into account the properties of modern transmission systems and the maintenance routines applied, however, a practically usable method of calculation can be developed.

For this purpose transmission equipments are divided into "apparatus groups" comprising units with the "same degree of importance" and the individual failures of which disturb the same number of channels. The reliability requirements can then be distributed proportionally over the units of the apparatus group. These should as far as possible be equivalent from the reliability aspect, as it is the weakest link that decides the availability of the system.

Between different apparatus groups the reliability requirements are distributed in proportion to the traffic congestion caused by failures of a permanent nature, owing to a shortage of spares for apparatus groups, in relation to the requirements in the highest apparatus group which serves most channels. The number of required spare units is then calculated per type group, i.e. a set of identical units, and by subsequent adjustment can be adapted to the desired cost limits with minimized shortage risks.

Factors Affecting the Holding of Spares

The holding of spares is a direct consequence of the desired reliability "G" and is affected by the following factors:

Within the system

- Primary or inherent reliability "R" for individual units
- Number of units of the same type.

Outside the system

- Consequences of failures due to shortage of spares having regard to traffic and other economic losses.
- Time required to procure new units.
- Local conditions (climate, maintenance routines, cost of holding spares etc.)
- Special requirements, such as reactions of the public to disturbances on important routes.

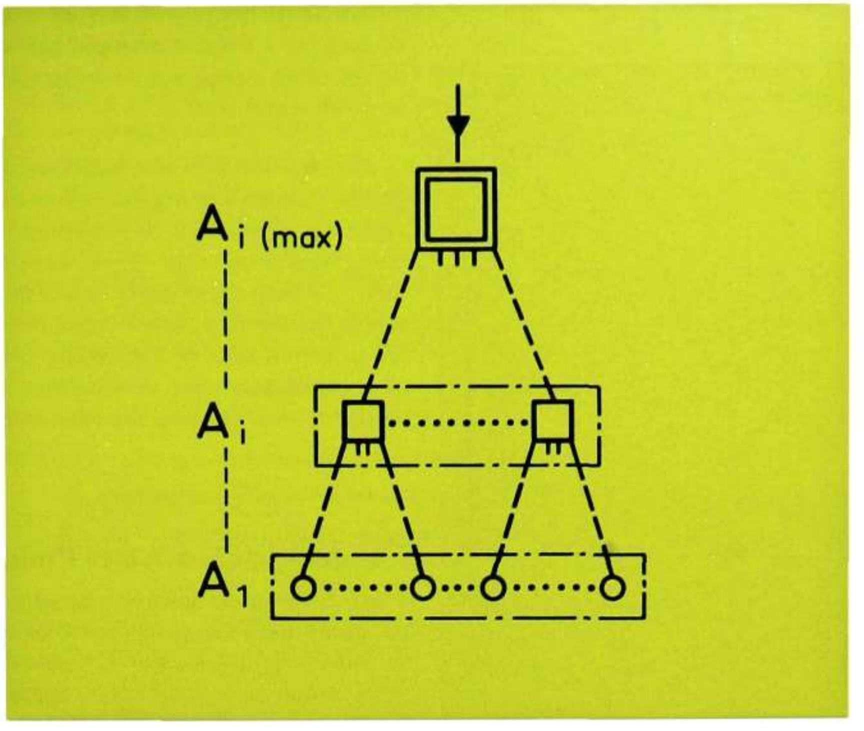
Fig. 1

System pyramid with apparatus groups A_i serving "i" channels each.

The total number of units per apparatus group is

$$S_i = \sum_1^n \left(M_{Ti}\right)_n$$

where $(M_{Ti})_n$ is the number of identical units in the type groups $(Ti)_n$ forming part of A_i



System Model

The calculations can be greatly simplified, without their value for practical use being appreciably lessened, by means of a system model based on the following assumptions:

- The transmission system is built up in pyramid form and consists of individual mechanical and electrical functional units (Fig. 1).
- The units are grouped into "apparatus groups" according to number of channels transmitted, with the largest number of channels in the top group.
- Each apparatus group contains one or more "type groups" consisting of one or more identical units.
- The loss of "i" channels is caused only by failures in units within the respective apparatus groups A_i.
- When a failure occurs the defective unit is replaced by a spare. The replacement time depends on the maintenance routines adopted but has no effect on the calculations.
- Failures which can be remedied by insertion of spares are regarded as non-existent from the point of view of holding of spares.
- If spares are lacking, failures due to shortage occur.
- The shortage risk B_i (t) is the probability that during a period t one or more units in an apparatus group A_i for i channels will be defective without possibility of replacement by spares.
- In the calculation of the reliability G attention is paid solely to failures due to shortage and not to every occurring apparatus failues which could be remedied by replacement by spares.

It is also assumed

- that the equipments are in their "best period"
- that the length of life of the apparatuses is exponentially distributed (constant failure rate)
- that attention is paid solely to failures occurring under normal conditions, which disturb operation
- that failures in different units are independent of one another.

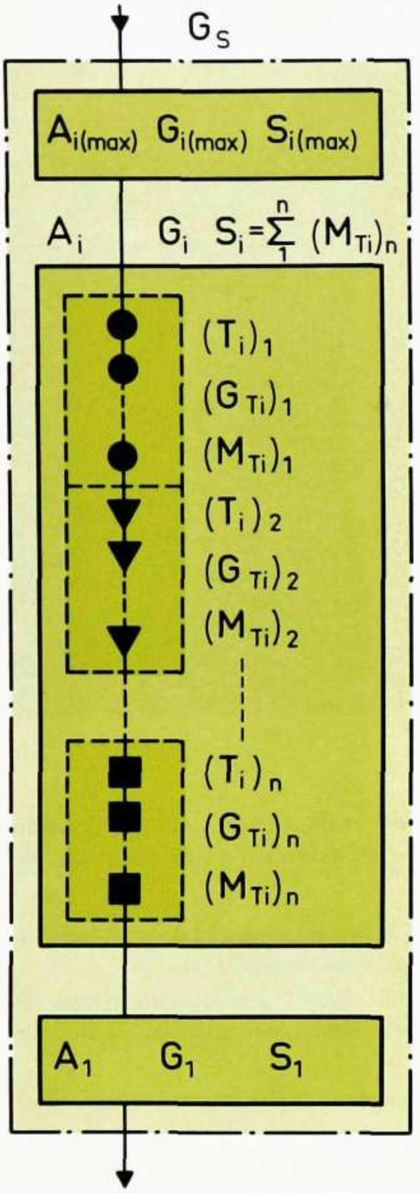


Fig. 2

Division of system (— · — frame) among apparatus groups A_i (—— frame) and type groups T_i (- - - - frame).

G_s, G_i, G_{Ti} = **Reliabilities**
S_i = **Total number of units per A_i**
M_{Ti} = **Number of identical units per T_i**

The model has proved very advantageous for practical calculations and can be used for a shelf, shelf stack, bay, connection between two terminals etc. up to the entire equipment complex within a spare parts stockkeeping area with its maintenance centre.

This is possible as the individual functional units form part of "apparatus groups" comprising a given number of channels which are affected solely by apparatus failures within the group. Each apparatus group consists of one or more type groups, i.e. sets of identical units (see fig. 2). It should be noted that it is only the number of channels affected from the transmission aspect that is the common factor for units within an apparatus group. The apparatus group corresponds to a reliability block, but need not necessarily be identical to a modulation stage or frequency block, since the apparatuses within them do not necessarily affect the same number of channels.

Fundamental Idea and Philosophy

The method of calculation is based on the fact that all units within an apparatus group have the same *degree of importance* from the transmission aspect; the reliability requirement G^* can then be distributed proportionally over all units within the group. Each apparatus group within the described system model has an inherent reliability R which is determined by the number of units and their design, the operating conditions, and the numbers and types of components used. Without change of design the reliability can be increased from R to G^* solely through the introduction of external redundancy in the form of spares.

Owing to the proportional distribution of the reliability requirements the redundancy necessary for type groups, consisting of identical units, in an apparatus group can be easily calculated.

Two basic problems, however, arise in the determination of the reliability requirement for individual apparatus groups:

— the absolute requirement per apparatus group

— the relation between the requirements for different apparatus groups within the system.

By answering the latter problem first, guidance can be obtained for answering the first.

Reliability Requirements for the Apparatus Groups

In principle the reliability requirements for apparatus groups having different degrees of importance can be chosen at option and independently of one another without affecting the actual calculation of the necessary spares within an apparatus group.

As regards the degree of importance, however, two basic facts should be observed, viz.

— the degree of importance of an apparatus group increases with the number of channels affected by shortage-caused failures

— the degree of importance is a function of the local traffic conditions.

But it is not only the absolute number of channels transmitted that determines the degree of importance. Units serving the same number of channels may have different degrees of importance depending on the traffic routes for which they are used.

Within a system, however, there is a certain relation from the traffic point of view between the reliability requirements for apparatus groups of different degrees of importance. Failures due to shortages in different apparatus groups have different consequences in respect of congestion and other problems. An exact calculation of the relations between the shortage risk in apparatus groups with different degrees of importance is thus a function of a number of different factors, which are difficult to define mathematically. For our purpose, however, we may assume that these relations can be based on the relation between congestions. As a result we obtain in accordance with ANNEX 1:

$$B_i = \frac{1}{E_{-i}} \cdot B_{i(max)}$$

With B_i = shortage risk for apparatus group A_i for i channels

E_{-i} = congestion caused by loss of i channels

$B_{i(max)}$ = shortage risk for apparatus group $A_{i(max)}$ with maximum number of channels, i.e. risk of total breakdown of the system.

The value $B_{i(max)}$ can be determined by economic optimization. This is because the expected losses F_F and the costs of spare units C_R are both functions of the shortage risk $B_{i(max)}$, but with opposite trends (see ANNEX 2). By minimization of the sum $F_F + C_R$, accordingly, an expression is obtained for the minimum economic losses of the administration having regard to the risks of breakdown. After certain approximations $B_{i\ max}$ can then be calculated to be

$$B_{i(max)} \approx \frac{\overline{C}}{\overline{L} \cdot \tau}$$

with $\overline{C}$ = mean value of costs per unit in apparatus group $A_{i(max)}$

$\overline{L}$ = mean value of the economic losses of the administration per hour

τ = duration of breakdown, i.e. the time until a new unit can be procured (in hours).

In the optimization procedure attention has been paid solely to the economic interests of the administration. The value of B obtained from the equation, however, can be used as basic value for further estimation of the shortage risk having regard to the concrete reliability requirements, as the transmission equipment must be regarded as a part of the public telecommunications system. Having regard to the "interests of the public" and/or "special reliability requirements" the calculated value of B may need to be adjusted. The adjustment is best made by means of a multiplication factor, $K < 1$, i.e. $B^*_{i(max)} = K \cdot B_{i(max)}$.

The value of K can unfortunately be obtained only by estimation from case to case. Calculations carried out for a number of practical applications, however, show that the following values of K can approximately be used in practice:

$K_H \approx 1$ for "high" permissible shortage risk ("small" holding of spares)

$K_M \approx 0.1$ for "medium" permissible shortage risk ("moderate" holding of spares)

$K_L \approx 0.01$ for "low" permissible shortage risk ("large" holding of spares)

In spite of the necessity for the use of estimation factors, the resulting value of $B^*_{i(max)}$ proves to be sufficiently accurate for calculation of the requirement of spares.

Reliability Requirement for Type Group

As already mentioned, an apparatus group may contain one or more units of one or more different types. As all units have the same degree of impor-

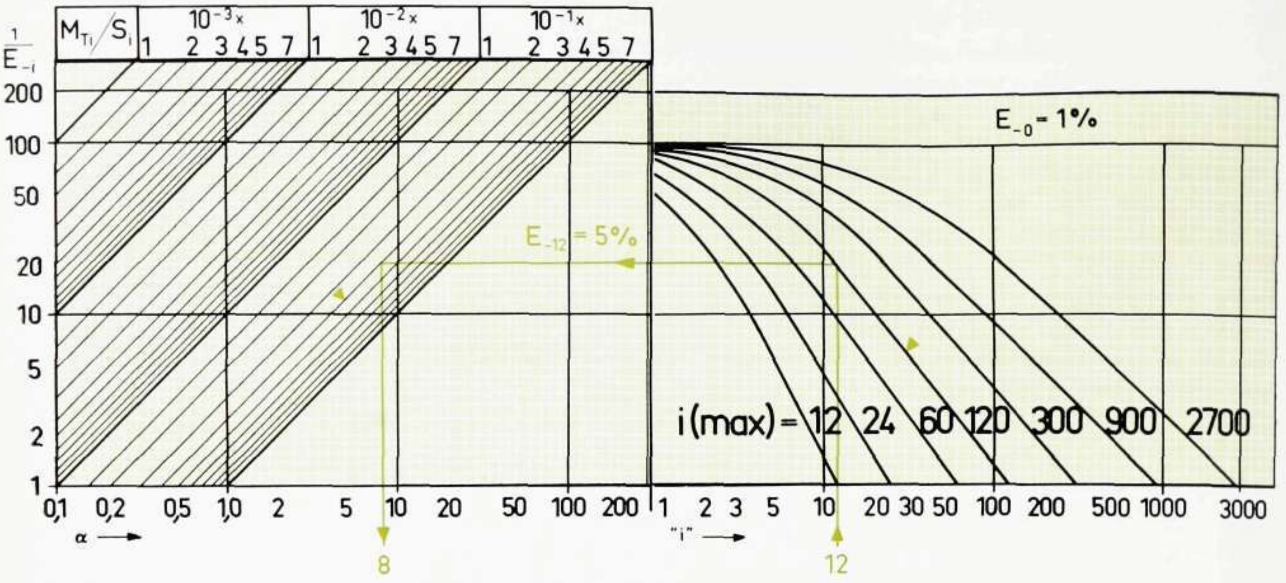


Fig. 3

Nomogram for calculation of α

Parameters:

M_{Ti} = number of units in type group T_i

S_i = total number of units in apparatus group A_i serving i channels

E_{-0} = congestion in faultless system

E_{-i} = congestion in the system if apparatus group A_i for i channels fails.

Example of calculation:

Input data: $i(\max) = 120$ channels
$B^*_{120} = 5 \times 10^{-4}$
$S_{12} = 10$ units
$(M_{12})_1 = 4$ units of type "12–1".

which gives $\frac{(M_{12})_1}{S_{12}} = 4 \times 10^{-1}$

Following the green lines from $i = 12$ one gets $\alpha = 8$

As $B_{Ti} = \alpha \cdot B_{i(\max)}$, then
$(B^*_{12})_1 = 8 \cdot B^*_{120} = 4 \times 10^{-3}$

The horizontal green line indicates that the system congestion increases to 5% when 12 of 120 channels fail.

tance, the reliability can be simply calculated by means of the multiplication law for independent events. The results will then be in accordance with ANNEX 3:

$$B^*_{Ti} \approx \alpha B^*_{i\,(\max)} \quad \text{with} \quad \alpha = \frac{M_{Ti}}{E_{-i} S_i}$$

Here

B^*_{Ti} = the shortage risk requirement for type group T_i within apparatus group A_i for i channels

M_{Ti} = a number of identical units in type group T_i

S_i = number of units (of different types) within apparatus group A_i ($S_i = \Sigma M_{Ti}$)

E_{-i} = congestion caused by loss of i channels.

The value of α can suitably be determined from a nomogram with parameters in accordance with Fig. 3 so that the reliability requirement for a type group, i.e. a set of identical units, can easily be obtained as function of $B^*_{i\ \max}$. The expression has become simple thanks to the apparatus group principle. In other words, it permits the same reliability requirement for a number of units of the same degree of importance within the system.

Calculation of Spare Parts Requirement per Type Group

If for a type group we have $N = M + \varrho$ units with M in operation and ϱ spare, ϱ must be determined so that the probability of $\varrho + 1$ or more units of N being defective during a period t for which the spares are calculated is equal to or less than the permissible probability of failures for the type group, i.e. the shortage risk requirement $B_{Ti}^* = 1 - G_{Ti}^*$. This also implies that the shortage risk is less than the shortage risk requirement.

Mathematically the probability of shortage is expressed as

$$B(\varrho, t) = \sum_{k=\varrho+1}^{N} \binom{N}{k} [Q(t)]^k \cdot [R(t)]^{N-k}$$

With exponentially distributed length of life (i.e. constant failure rate λ) the primary inherent reliability will be $R(t) = 1 - Q(t) = e^{-\lambda t}$

The shortage risk formula can be transformed to

$$B(\varrho,t)=\sum_{k=\varrho+1}^{\varrho+M}\binom{\varrho+M}{k}\left[1-e^{-\lambda t}\right]^{k}\cdot\left[e^{-\lambda t}\right]^{\varrho+M-k}$$

In the formula M and λ are known parameters and, for a specific spare parts holding period "t", ϱ must be calculated so that $B(\varrho, t) \leq B^*$ is fulfilled. This can fairly simply be done by means of families of curves, but even better with a computer program. In the formula $B(\varrho, t)$ is a discrete function with ϱ as integral variable. The integral value of ϱ which should be chosen to fulfil the requirement, however, may imply heavy overdimensioning (in some cases the shortage risk will be 10^2-10^3 times less than the requirement). It is therefore logical to change the requirement to $B^* \simeq B$ and possibly choose the next lower value of ϱ with slightly increased shortage risk in consequence.

Check of Resulting Shortage Risk and Subsequent Adjustment

The reliability of the system is $G_s = \prod_i G_i$, whereas for its shortage risk one obtains $B_s \simeq \sum_i B_i \simeq \sum_i \sum_i B_{Ti}$ as in practice $\sum B_i \ll 1$. By calculating the shortage risks associated with a given spare parts holding one obtains a survey of "weak" apparatus groups in the system. By an insignificant increase in the number of certain spare units, considerable improvements in the reliability of the system can be achieved at a reasonable cost. An adaptation of the quantities of spares to the desired cost limits can also be attained through subsequent adjustment.

Calculation Procedure

This comprises six steps viz.

1. Survey and analysis of input data in accordance with check list.
2. Preparation of "apparatus list" for apparatus and type groups.
3. Determination of $B^*_{i\,(\max)}$ from input data.
4. Determination of B^*_{Ti} as function of $B^*_{i\,(\max)}$.
5. Calculation of required number of spare units of different kinds.
6. Check of the resulting shortage risk and subsequent adjustment if necessary.

The calculation procedure has been programmed for data processing so that, after feed-in of input data, one obtains a list of the necessary spare units.

Summary Example of Calculation

For a project comprising two systems ZAX 120T according to Fig. 4, the spare parts requirement for 1 year is to be calculated. The following input data are available:

Route	A—D	A—B	A—C	B—C
Number of channels	36 (120)	24 (60)	24 (60)	—
Intermediate repeaters	1 (120)	3 (120)	—	3 (60)
	Max. number of channels within brackets.			
Type of line plant:	Solely overhead lines with small capacity reserve.			
Degree of importance:	Low. Circuits of local character.			
Spare parts holding:	Centrally at A, spare units checked and reordered once a year. No special requirements.			
Procurement period:	Approx. 6 weeks (~ 1000 h)			
Traffic:	Automatic.			

Fig. 4
System layout from example of calculation

A-D Terminal exchanges with spare parts and maintenance centre at A.
24 (60) Channels in operation with ultimate capacity within brackets.
O Intermediate repeaters for h.f. lines

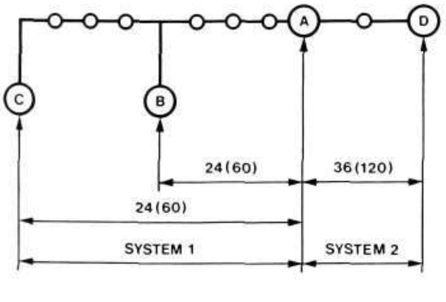


Table 1a

TABLE 1A

SPARE PARTS FOR PROJECT TF128**
STATIONS: A.B.C.D.   SPARES HOLDING CENTER IN STATION A .

SUPPOSED SHORTAGE RISK FOR UNITS CONCERNING 240 CHANNELS = .50 PER THOUSAND

SPARE PARTS FOR 1 YEARS PERIOD

U N I T	NUMBER OF UNITS IN SERVICE	AS SPARES	U N I T	NUMBER OF UNITS IN SERVICE	AS SPARES
BMN 90441 DC CONV.	5	2	BMN 90443 DIST.POW.	3	2
ZGC 10120 LIN.AMP.	7	2	ZGC 10121	5	2
ZHC 40601 HYBRID	5	0	ZHC 40801	10	0
ZHC 40804/1	5	0	ZHC 40804/3	5	0
ZHC 40806 DISTR.	4	0	ZHC 40834 LG HYB	1	0
ZHD 40601	2	0	ZHD 40804	5	0
ZHD 40807	10	0	ZHE 23103	1	0
ZHE 23105	1	0	ZHE 40601 TRANSF.	5	0
ZHH 10108/2	1	0	ZHH 10117 AMPL.	7	0
ZHH 10118/1	8	2	ZHH 40801	13	1
ZHH 40803	3	1	ZHK 10118 FILT.	4	0
ZHK 40602/1	4	0	ZHK 40602/2	4	0
ZHK 40602/3	4	0	ZHK 40603	4	1
ZHK 40604/1	4	0	ZHK 40604/2	4	0
ZHK 40604/3	4	0	ZHK 40604/4	4	0
ZHK 40606/1	4	1	ZHK 40606/2	4	1
ZHK 40606/3	4	1	ZHK 40606/4	4	1
ZHK 40606/5	4	1	ZHK 40808/2	2	0
ZHK 40808/3	2	0	ZHK 40812	4	0
ZHM 40601 F.CONV.	4	1	ZHM 40602 F.DIV.	4	1
ZHM 40804/1 H.G.	4	0	ZHM 40804/2	8	0
ZHM 41601 P.OSC.	1	1	ZHM 41605 M.OSC.	4	1
ZHP 40601 3G SEND	14	0	ZHP 40603/1 MODEM	4	0
ZHP 40603/2	4	0	ZHP 40603/3	4	0
ZHP 40603/4	2	0			

cont.

The apparatus list for the project comprises 8 apparatus groups with altogether 326 apparatus units of 63 different types.

From projected traffic data and the costs of the "highest" apparatus group (for $2 \times 120 = 240$ channels) and a replacement period of 6 weeks we get $B_{i(\max)} \sim 5.3 \cdot 10^{-3}$. Counting on a medium shortage risk and $K_M = 0.1$, $B^*_{i(\max)} \sim 5 \cdot 10^{-4}$.

After feed-in of input data into a computer one obtains a list comprising all apparatuses with data of the number in operation and spare. Table 1a shows the first sheet of such a list. One also obtains a summary list (table 1b) for each apparatus group, with data of units in operation and spare, and the shortage risks per apparatus group and for the entire system. Apparatus group 0 comprises apparatuses such as alarm units and certain pilot units in which defects do not directly cause traffic interruptions but require action to be taken.

Table 1b

TABLE 1B

S U M M A R Y

	TOT.NR OF UNITS IN SERVICE	AS SPARES	OBTAINED SHORTAGE RISK
UNITS CONCERNING 240 CHANNELS	53	10	.0046184
UNITS CONCERNING 120 CHANNELS	64	11	.0123633
UNITS CONCERNING 60 CHANNELS	31	0	.0097170
UNITS CONCERNING 6 CHANNELS	32	0	.0123735
UNITS CONCERNING 80 CHANNELS	12	0	.0042019
UNITS CONCERNING 48 CHANNELS	16	4	.0008503
UNITS CONCERNING 12 CHANNELS	42	0	.0390214
UNITS CONCERNING 3 CHANNELS	56	1	.0309639
T O T A L	326	26	.1091708

CONCLUSION: WITH A 8.0 % (IN NUMBER) OF SPARES, THE OVER-ALL RISK
DURING A 1.0 YEARS PERIOD THAT A NEEDED SPARE OF ANY
TYPE IS NOT AVAILABLE WOULD BE 109.2 PER THOUSAND, OR
1 : 9.

Table 2a

Apparatus group A_i	Probability of shortage-caused failures, %			
	Without spares	With spares		
		Small holding	Moderate holding	Large holding
A240	15.0	1.6	0.5	0.002
A120	17.5	2.6	1.2	0.01
A80	0.4	0.4	0.4	0.4
A60	1.0	1.0	1.0	1.0
A48	7.4	7.4	0.1	0.1
A12	3.9	3.9	3.9	1.1
A3	23.6	23.6	3.1	0.3
A0	1.2	1.2	1.2	1.2
Total	~66	~37	~11	~4

Shortage-caused failures = failures of a permanent nature owing to shortage of spare units

Small holding of spares, i.e. high shortage risk K = 1
Moderate holding of spares, i.e. average shortage risk K = 0.1
Large holding of spares, i.e. small shortage risk K = 0.01

To illustrate the influence of the factor K in $B^*_{i(\max)} = K \cdot B_{i(\max)}$ the calculations have also been made for high and low shortage risk with $K = 1$ and 0.01 respectively. The result is shown in table 2a.

From table 2b it will be seen that, by subsequent adjustment with slightly increased costs of spare parts holding, one can greatly increase the system reliability G_s. For a medium shortage risk G_s is increased during one year of operation from 0.89 to 0.94 through increase of the number of spare units from 8 to 8.3%. The cost for spare units will be 6.5% of the total cost and 9% of the apparatus cost. The calculations also show that it does not pay to count on a low permissible shortage risk with many times greater costs for holding of spares, which leads only to a moderate improvement of $G_s = 0.96$.

Even with a high permissible shortage risk, subsequent adjustment results in an improvement from $G_s = 0.63$ to 0.82, with the holding costs for spares reduced by more than half.

The calculated requirement of spares is fairly large, but is due to the fact that the two systems are only partially equipped, i.e. there are only small numbers of certain apparatus types, and that the number of spare units must be an integer.

Table 2b

Shortage risk	Spares in % of apparatuses in operation	System reliability	Remarks
150.10^{-3}	0	0.34*	No spares
5.10^{-3}	3.4 (3.7)	0.63 (0.82)	High shortage risk 1)
5.10^{-4}	8.0 (8.3)	0.89 (0.94)	Medium ,, ,, 2)
5.10^{-5}	16.0	0.96	Low ,, ,,

* Inherent system reliability
The values within brackets show the result of subsequent adjustment comprising
1) + 1 spare in A3
2) + 2 spares in A12, —1 spare in A240.

Summary

A method has been described with which the number of necessary spare units can be calculated as function of their failure rate and "degree of importance" in the system.

Although, in order to simplify the calculations, certain approximations, assumptions and estimates (permissible shortage risk) have been made, the method yields satisfactory results in practical calculations.

Adapted for data processing the method is used today by L M Ericsson's Long Distance Division as routine procedure for the calculation of the necessary spare units for carrier equipment. The number of spares can be calculated on the basis either a) of the desired costs for the spare parts stock or b) the maximum permissible shortage risk for spare units, or c) a set of spares which constitutes an economic optimum for the administration.

By subsequent adjustment of the number of spare units and renewed checks of the calculations it is also possible at a fairly low cost to raise the "system reliability".

The cost of the optimal spare parts holding according to the method is the price one must pay for attaining the desired system reliability. If the spare parts holding is reduced, one must accept a higher shortage risk level, with the increased losses of traffic and disadvantages resulting from shortage-caused failures.

By means of data processing, however, one can quickly carry out calculations for alternative shortage risks and give the customer a survey of the consequences from the reliability aspect, which makes it easier for him to arrive at a decision.

Finally it may be mentioned that an increase of system reliability and availability through the holding of spare units is part of the general strategy for network structure, planning and maintenance in modern transmission systems.

ANNEX 1

Distribution of the Shortage Risk Between Different Apparatus Groups

In a given system with "a" channels and traffic volume A erlangs, and with undiminished system capacity, the congestion is $E_{\cdot 0}$. As a result of a shortage-caused failure in an apparatus group for "i" channels the congestion is $E_{\cdot i}$. The probability that this will not occur is equal to the reliability for the apparatus group, i.e. G_i. The probability of congestion $E_{\cdot i}$ is therefore equal to $1 - G_i = B_i$, i.e. to the shortage risk.

Every shortage-caused failure has its consequences. By introducing the concept "loss coefficient" K_F, as product of the shortage risk and the consequences of the shortage-caused failure (i.e. the congestion), the reliability requirement for each apparatus group can be calculated with reference to another apparatus group within the system and the concrete traffic conditions.

The loss coefficient can by definition be written $K_F = B_i^* . E_{\cdot i}$ with $B_i^* =$ max. permissible shortage risk or $G_i^* = 1 - B_i^* =$ min. desired reliability.

Through the use of the loss coefficient, accordingly, all apparatus groups have been normalized. This is because there is no reason to select different loss coefficients for different apparatus groups!. In other words we can write $K_F(i)$ = constant, i.e. independent of i. We may for example, write $B_i \cdot E_{-i} = B_j \cdot E_{-j} = \ldots$, from which follows $B_i = B_j \cdot \frac{E_{-j}}{E_{-i}}$ etc. with $i, j \ldots$ corresponding to the number of channels affected by shortage-caused failures.

The higher the congestion due to a shortage-caused failure, the lower will be the permissible shortage risk, and this can be utilized for distribution of the shortage risk requirements among the apparatus groups.

From the reliability aspect the total breakdown of the system is the most critical event. This occurs as a result of a shortage-caused failure in the "highest apparatus group" $A_{i(\max)}$ and causes total congestion, i.e. $E_{-i(\max)} = 1$. Thus $B_i = B_{i(\max)} \cdot 1/E_{-i}$, where E_{-i} is the congestion of the system on loss of "i" channels and can easily be obtained from Erlang tables.

The shortage risk for an apparatus group A_i can thus be calculated as function of $B_{i(\max)}$ i.e. the risk of total breakdown of the system.

ANNEX 2

Estimate of the Risk of Total Breakdown of the System

In order to be able to determine optimal $B_{i(\max)}$ we must attempt to find a functional relation between the shortage risk for the highest apparatus group and the economical losses which the customer may suffer as a result of the shortage-caused failure. The calculation should be based on input data which are available in most cases in practice.

To obtain the desired simplicity for practical calculations, certain approximations must be adopted. This may be considered permissible, as input data as well contain fairly wide margins of uncertainty. A usable result, however, can be achieved through the following considerations.

A breakdown caused by a shortage-caused failure has a duration (i.e. the time until a new unit has been procured) of τ [h], whereas every hour of interrupted service causes the administration a mean economic loss of $\overline{L}$ \$ h, determined by the costs of traffic losses and taking into consideration possible rerouting or postponing of traffic.

The real economic losses of the administration during the period of interrupted service will then be $\overline{L} \cdot \tau$ dollars.

The probability of occurrence of the shortage-caused error is equal to $B_{i(\max)}$. This means that expected losses will be $F_F = B_{i(\max)} \overline{L} \tau$. In order that the shortage risk $B_{i(\max)}$ shall not be exceeded, however, a reserve of ϱ units is required at a cost of C_R dollars.

Both F_F and C_R are functions of B, but with opposite trends. Reduction of B gives a lower F_F, but more spare units are then required, which increases C_R. We therefore seek the minimum for

$$\Delta C(B) = F_F + C_R = \overline{L} \cdot \tau \cdot B + \overline{C} \cdot \varrho(B)$$

where ϱ is the required number of spare units and C the mean cost per unit in the highest apparatus group.

For optimization it should be possible explicitly to determine $\varrho = \varrho(B)$. This is difficult, as the functional relation between B and ϱ is complicated, as appears from the formula $B = B(\varrho, t)$ under "Calculation of spare parts requirement per type group."

As the number of spare units ϱ is always a positive integer, the difference ratio instead of the derivative can be used for optimization of B. As, within our field of usage, $B(\varrho + 1) \ll B(\varrho)$, the "optimal" shortage risk can be approximated, through calculations not shown here, as

$$B \simeq \frac{\overline{C}}{\overline{L} \cdot \tau}$$

Optimal $B_{i(\max)}$ for the highest channel group is thus determined by numerical values which are known or can be estimated.

For determination of the mean cost per spare units one should know the number of spare units ϱ_{Ti} and their costs C_{Ti} and calculate the mean value $\overline{C}_c$ $\frac{\sum C_{Ti}\varrho_{Ti}}{\sum \varrho_{Ti}}$, but this is impossible as ϱ_{Ti} is unknown and must be determined after calculation of optimal $B_{i(\max)}$.

The assumption is therefore made that the spare units requirement per apparatus group is approximately proportional to the number of units in operation, which gives

$$\overline{C} = \frac{\sum C_{Ti} M_{Ti}}{\sum M_{Ti}}$$

The mean value of the losses per hour $\overline{L}$ should be known through analyses of the profitability of the system. Otherwise the value can be calculated from the traffic data in a specific case. The procurement period τ is dependent on the delivery period and local conditions, and its value should be possible to determine.

ANNEX 3

Reliability Requirements for Type Group

The desired reliability for an apparatus group is $G_i{}^*$. An apparatus group contains S_i different units of the same degree of importance divided into a number of type groups T_i. Each type group consists of M_{Ti} identical apparatuses for which a reliability $G_{Ti}{}^*$ is desired.

Hence

$$G_{Ti}^* = (G_i^*)^{\frac{M_{Ti}}{S_i}}$$

and with, in general, $G = 1 \text{-} B$ and $B \ll 1$

$$G_{Ti}^* = (1 - B_i^*)^{\frac{M_{Ti}}{S_i}} \approx 1 - B_i^* \cdot \frac{M_{Ti}}{S_i}$$

$$B_{Ti}^* = 1 - G_{Ti}^* \approx B_i^* \frac{M_{Ti}}{S_i} = \frac{M_{Ti}}{E_{-i} S_i} \cdot B_{i(\max)}^* = \alpha \cdot B_{i(\max)}^*$$

with $$\alpha = \frac{M_{Ti}}{E_{-i} \cdot S_i}$$

Diesel Generating Set for Telecommunication Equipments

L-E NORSTRÖM, TELEFONAKTIEBOLAGET L M ERICSSON, STOCKHOLM

UDC 621.311.4:621.395.722
621.311.8
LME 781 7824

L M Ericsson's power supply systems with storage batteries for telecommunication equipments were described in Ericsson Review No. 4, 1968.[1] *These power supply systems often include a diesel generating set which serves as standby in the event of mains failure. The diesel can also serve as primary power source in the absence of mains. As for all other power supply equipment very high requirements are placed on reliability, which in the present case applies especially to perfect starting and supervision of the operation of the diesel generating set. L M Ericsson have therefore developed the necessary control and supervisory units made up entirely of electronic components and reed relays, mounted on plug-in printed circuit boards, which ensures the highest possible reliability. For the same reason self-regulating brushless generators are mainly used. Careful attention has been paid in the design to simple installation and maintenance of the diesel generating sets, which of course comply with CCITT recommendations. This article describes the diesel generating set with its control equipments.*

Economic Aspects

For large telecommunication equipments which require an adequate power standby in the event of mains failure the standby power units is often cheaper than large storage batteries and also takes up less space. In telecommunication equipments with standby power unit, furthermore, lighting, air conditioning, conveyors for trunk exchanges and similar equipments operated off AC are entirely unaffected by a loss of mains power.

Alternative Forms of Operation

L M Ericsson can today offer a complete series of diesel generating sets for the power supply of telecommunication equipments in sizes from 1 kVA for the following forms of operation:

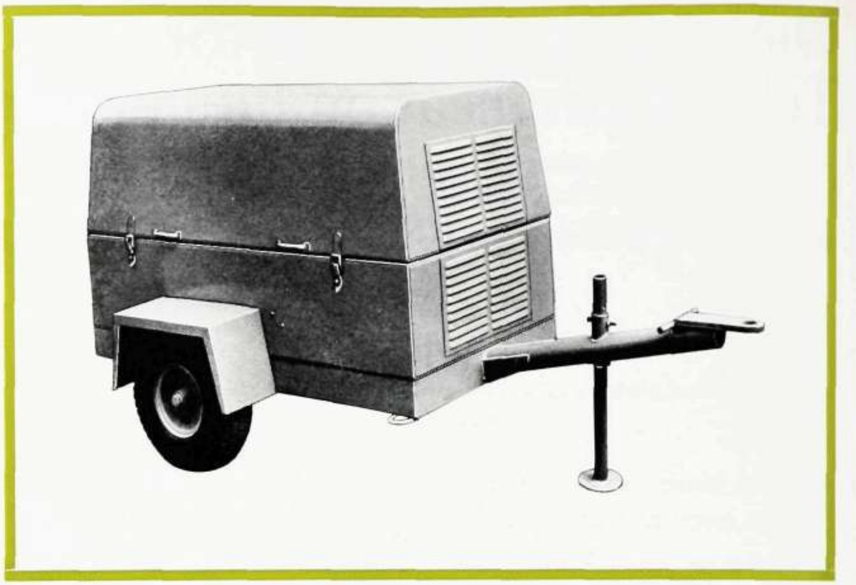
- ☐ Individual or parallel operation
- ☐ Intermittent or continuous operation
- ☐ Automatic or manual operation
- ☐ Stationary or mobile/portable use

The control equipment can be used for diesel engines and generators of most makes.

The mobile units are portable in the smallest size, while the large units are mounted on trailors. They are generally designed for manual operation.

Fig. 1

Mobile diesel generating set, 5 kVA, 220 V, 50 Hz. Generator and diesel engine as shown in fig. 7



Control Equipment

General

The control equipment consists of operating and supervisory unit, contactors for switching on and off of the primary power, measuring instruments for checking of voltage, current, frequency, oil pressure and engine temperature, and equipment for synchronization in parallel operation.

In a diesel generating set used as standby unit (for intermittent operation) the control equipment is used for starting of the diesel engine on mains failure, advanced supervision of the diesel generating set and stopping of the diesel engine on return of the mains voltage.

In the absence of a mains supply the diesel generating set is used as primary power source and is usually divided into two or three units which are switched on alternately by the control equipment.

A simplified form can be supplied for individually operating diesel generating sets between 1 and 20 kVA.

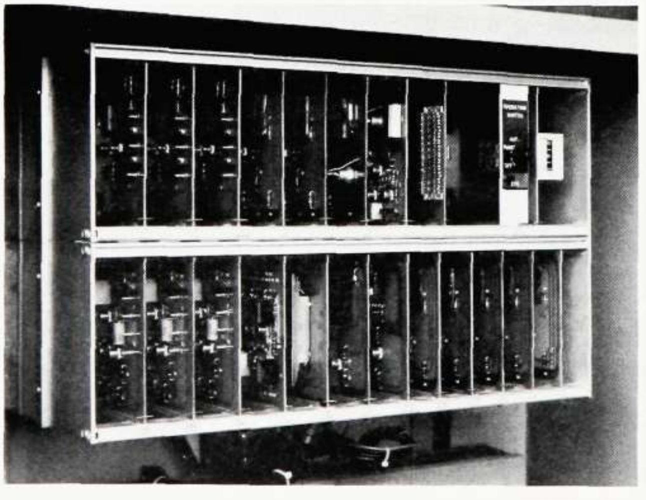
The operating and supervisory unit is made up of electronic components and reed relays mounted on plug-in printed circuit boards. This guarantees the maximum possible reliability. See figs. 2 and 3.

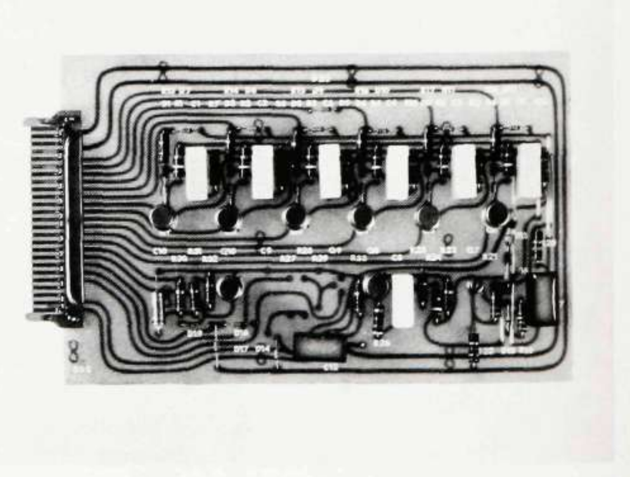
Fig. 2 (left)

Printed circuit rack for operating and supervisory equipment

Fig. 3 (right)

Printed circuit board (202). Thyristor memory for storage of fault signals, blocking of the diesel generating set and issue of alarm





The voltage of the control equipment has been put at 24 V. A lower voltage would involve an increased risk of contact faults. Starting motors of the required sizes are series-produced for this voltage. The control circuit is insulated on a two-pole basis. The frame is not used as return conductor, as this might give rise to uncontrollable galvanic currents.

A 5 A thyristor rectifier has been placed in the operating and supervisory unit for charging of the starting battery. The rectifier is equipped with a constant voltage and a constant current regulator. Regulation takes place through change of the trigger-phase angle in the rectifier connection. The rectifier is equipped with automatic operating charge, which implies that its charging voltage is raised every time the standby set is started. When the charging current has fallen to about 50% of the rated current, the rectifier automatically returns from operating charge to floating charge.

The control equipment as a whole has been so designed that its functional reliability is unaffected by the vibrations or transients which may arise on starting and operation of the diesel generating set.

Intermittent Individual Operation

For intermittent individual operation the diesel generating set is used as standby unit (Fig. 4).

- ☐ The control equipment senses the incoming mains voltage and a mains monitor *(251)* delivers a start impulse on single-, two- or three-phase voltage drop or on failure. The impulse can be delayed (2—80 s) in delay circuit *(208)* for elimination of unwarranted starting caused by brief disturbances of the mains supply.

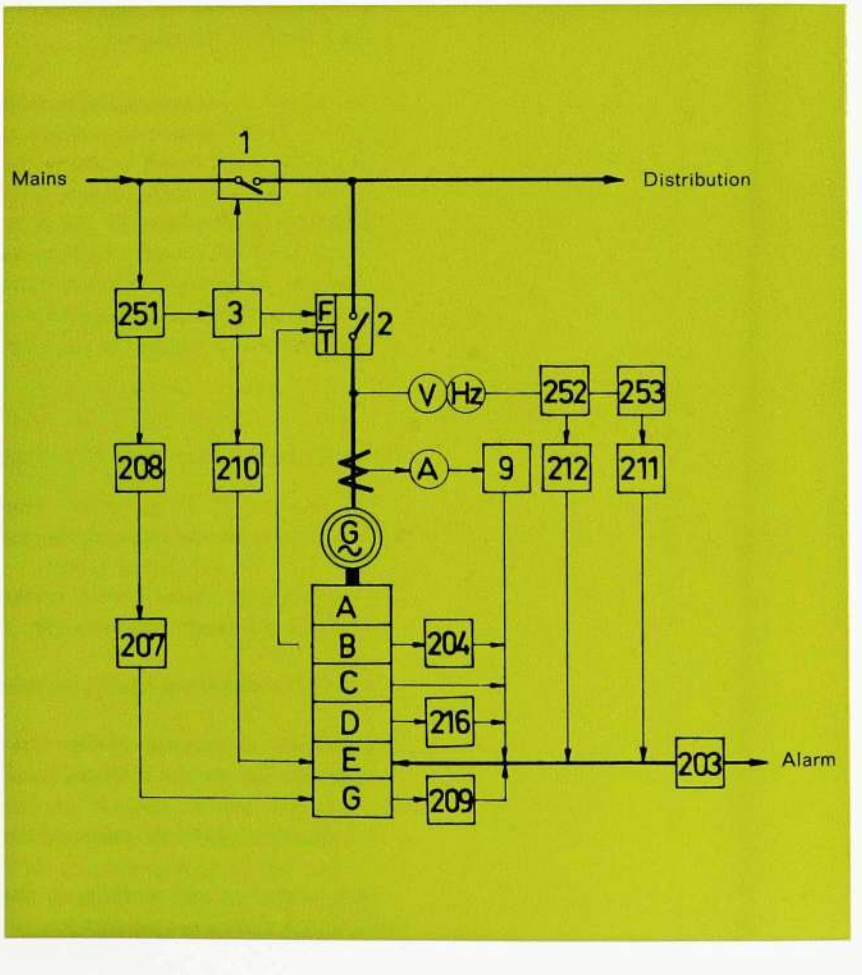


Fig. 4

Block schematic for diesel generating set for intermittent individual operation

A Diesel engine
B Speed detector
C Temperature detector
D Oil pressure detector
E Stop magnet
F Off circuit
G Starting motor
T On circuit
1 Mains circuit-breaker
2 Generator circuit-breaker
3 Delay circuit
9 Thermal overcurrent relay
203 Alarm unit
204 Frequency supervision
207 Start impulsing
208 Start delay
209 Start supervision
210 Cooling control
211, 212, 216 Delay circuits
251 Main supervision
252, 253 Generator voltage supervision

☐ The start impulse goes via unit *(207)* directly to the starting motor. A normal start is completed within about 6 s.

☐ In order that the reliability of starting shall not be jeopardized by oxidization of the main contacts of the start motor, unfavourable tooth engagement or non-engagement, the incoming start impulse is converted into a 5 s on — 5 s off impulse train. This is repeated until a speed counter establishes that the crankshaft has started to rotate. The impulse train then changes to a single long start impulse, which guarantees the most reliable possible starting in minimum time.

☐ The start is supervised by a delay circuit *(209)*, which, if starting has not taken place within about 25 s (presettable), blocks the diesel generating set and issues an alarm.

☐ Closing of the generator circuit-breaker *(2)* takes place, when about 95% of the nominal speed has been attained, through the transmission of an impulse from the speed counter. The load is then connected at the most favourable possible time, i.e. when the diesel engine is under acceleration and the fuel pump regulator provides a maximum fuel supply.

☐ When the mains voltage returns, it must first be approved by the mains monitor *(251)*. Via a delay circuit *(3)* a resetting impulse is then transmitted which can be preset between relatively wide limits (0.5—10 min). The mains supply, therefore, has time to become properly stabilized before the diesel generating set stops.

☐ After the circuit-breakers *(1* and *2)* have shifted and the load has been reconnected to the mains, a stop impulse is delivered. A delay circuit *(210)*, however, causes the engine to idle for about 80 s before it stops. During the idling period the necessary cooling of the engine takes place, so avoiding a harmful rise of heat.

☐ An alarm is issued, without stopping of the diesel generating set, on a failure of the operating voltage and at low fuel level. For all other faults (8 types) which result in alarm the diesel generating set is stopped.

☐ The generator contactor *(2)* is mechanically locked in operated position, which prevents release of the contactor on a short-circuit in the distribution network. After the fuse in the short-circuited mains unit has disconnected the shorted circuit, the voltage rises again to nominal level and the generator can continue to supply the remainder of the network.

Intermittent Parallel Operation

The reasons for using several smaller diesel generating sets instead of one large set as standby in intermittent parallel operation are as follows:

☐ Possibility of lower initial investment for equipments where the future power requirement will be larger.

☐ Possibility of having ½—⅔ of the standby power intact if one set drops out.

☐ Possibility of using a smaller type of engine produced in large series, with adequate service and availability of spare parts.

☐ Possibility of standardization of the diesel generating sets.

The number of sets working in parallel, however, should not be more than three, which allows simple circuitry (fig. 5).

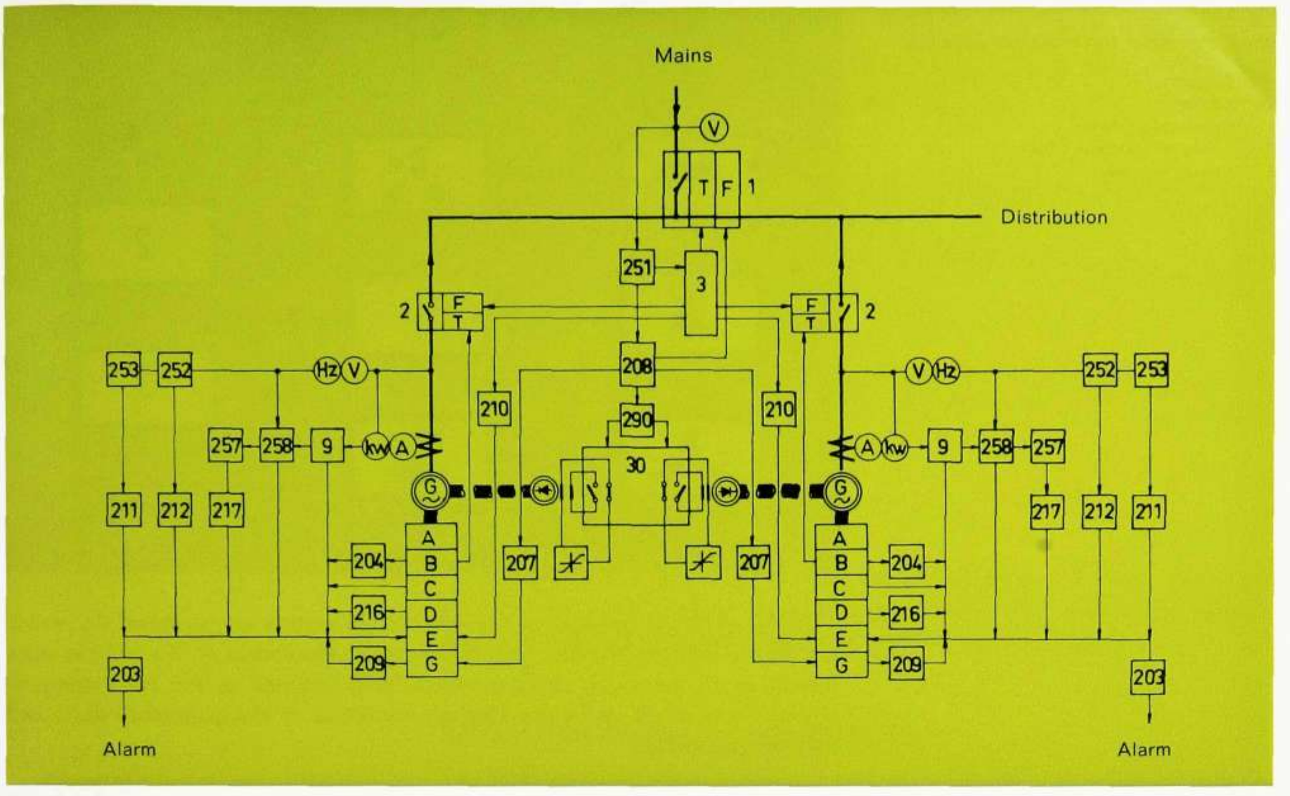


Fig. 5

Block schematic for diesel generating set for intermittent parallel operation

A	Diesel engine
B	Speed detector
C	Temperature detector
D	Oil pressure detector
E	Stop magnet
F	Off circuit
G	Starting motor
T	On circuit
1	Mains circuit-breaker
2	Generator circuit-breaker
3	Delay circuit
9	Thermal overcurrent relay
30	Short-circuiting of exciter field
203	Alarm unit
204	Frequency supervision
207	Start impulsing
208	Start delay
209	Start supervision
210	Cooling control
211, 212, 216, 217	Delay circuits
251	Mains supervision
252, 253	Generator voltage supervision
257	Short-circuit protector
258	Reverse power protector
290	Demagnetization unit

Apart from the components required for intermittent individual operation the control equipment contains the following supervisory and protective equipment needed for parallel operation:

☐ kW meter for checking the power output, permitting manual adjustment to attain a uniform active power distribution between the engines.

☐ Speed setting motors on the diesels to permit manual phasing and final adjustment of the active power distribution.

☐ Reverse power protector *(258)* which prevents drag of a faulty diesel generating set the engine of which for some reason does not deliver active power.

☐ Lamp or zero voltmeter for manual phasing.

Automatic synchronization of generators can be done in many ways. L M Ericsson have chosen a method which offers considerable advantages:

☐ High reliability

☐ All diesel generating sets are synchronized simultaneously and immediately deliver full power

☐ Synchronization takes place in a short time

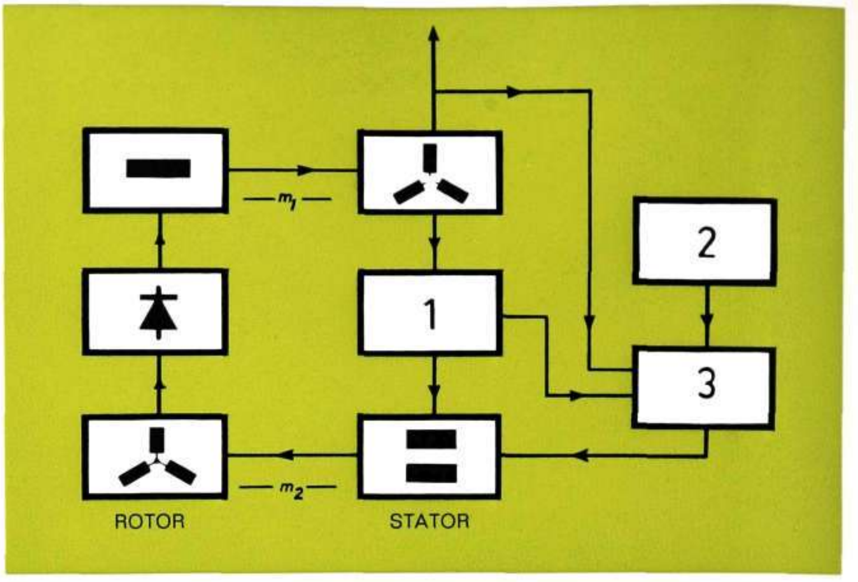
☐ Use of uncomplicated equipment.

To attain these advantages a self-synchronization method has been employed, implying that all parallel-operating diesel generating sets are started on mains failure. Simultaneously with the starting impulse the field windings of the generators are short-circuited so that they are prevented from taking up voltage. The short-circuiting of the fields is delayed 30—35 s, during which any faulty set is disconnected by the start supervision unit *(209)* and is prevented from starting after 25 s.

Fig. 6

Block schematic for brushless generator

- m_1 Generator
- m_2 Exciter
- 1 Compounding device
- 2 Setting of reference voltage
- 3 Voltage regulator



At 90—95% or nominal revolutions the generators are switched on, which for normal starting at room temperature takes place after 4—6 s. At the same instant as all generator circuit-breakers have operated or the field short-circuiting delay of 30—35 s has elapsed, excitation of the generators starts and they take up voltage.

When the field short-circuit has ceased, the phase displacement between the generators is entirely arbitrary. As the voltage rises from nearly zero, the equalization currents, and so the synchronizing forces, are moderate.

When, after 2—3 s, the voltage has attained its nominal value, the diesels operate synchronously.

Continuous Operation

Three diesel generating sets are normally used in cases when there is no mains supply. Each set is run for 24 hours, after which the next set is switched on, and so on in a continuous cycle. The equipment consists of individually operating sets of earlier described type but with minor deviations in components. Each set has its control equipment of the same type as described under "Intermittent individual operation", but the mains monitors are replaced by a programmer for distribution of the operation between the sets, and there are no mains contactors.

Manual Operation

Control equipment for manual operations is limited to supervision of the engine temperature, lubricating oil pressure and overload, and is thus of very simple type.

Diesel Engines

Direct-injection high-speed engines are usually used for L M Ericsson diesel generating sets. In intermittent operation the engines are used in the range 1500—3000 r.p.m. and in continuous operation in the range 1000—1500 r.p.m., which is in accordance with CCITT recommendations.[2] The engines are normally equipped with mechanical speed regulator, but may also be equipped with a hydraulic regulator.

Generators

Self-regulating, brushless, compounded revolving field generators, the principle of which is shown in fig. 6, are almost exclusively used in L M Ericsson's diesel generating sets.

The generator consists of a revolving field engine and a three-phase revolving armature exciter, the armature current of which is supplied to the field winding of the main engine directly through rotating silicon diodes. The poles of the main engine, the armature of the exciter and the rotating diodes are placed on a common shaft.

Radio interference suppression corresponds to suppression level N according to VDE 0875, which also corresponds to the requirements of CISPR publication No. 7, 1966.

Distortion Matching

To eliminate the unfavourable effect on the generator voltage of the distortion arising in conjunction with generator excitation by thyristor rectifiers, generators adapted to such distortion are supplied when necessary.

Load Control and Load Limitation

L M Ericsson's control system for automatic operation of rectifiers includes the following arrangements for operation with diesel generating sets (see Ericsson Review No. 3, 1969).[3]

- ☐ On a mains failure the entire rectifier load is switched off.
- ☐ After starting of the diesel generating set the rectifiers are reconnected in a number of steps. This avoids peak loads on connection of the diesel generating set.
- ☐ The rectifier power can be limited according to the number of diesel generating sets in operation.

Fig. 7
Standby power unit 5 kVA at cos $\varphi = 0.8$, 220 V, 1-phase, 50 Hz, 1000 r.p.m.
Engine: Petter PH 2
Generator: A. van Kaick WKB 30/3—6 TS

Tests

It has proved that any faults in a diesel usually occur during the first 25—50 hours of operation. All diesel generating sets are therefore given a trial run before delivery for 50 hours at full load.

Thereafter follows a complete functional check comprising all monitors, delay circuits and regulators.

A complete test record comprising data from long-time tests and other functional checks is supplied with every diesel generating set delivered.

After testing, the first service is carried out and the engines are conserved with a special oil which prevents corrosion up to the time of putting into operation.

Installation

In the design of the diesel generating sets emphasis has been placed on ease of installation without need of special knowledge or special tools. In fact a telephone exchange installer can easily do this with simple hand tools owing to the following points among others:

- ☐ No cast foundation is required. The engine and generator are flanged together and elastically suspended in a frame in such a way that the entire unit can be set up directly on a normal floor.
- ☐ The exhaust system is so designed that the only action needed at the time of installation is to connect the fixed pipe by simple means to the vibrationless silencer flange (cf. fig. 7).
- ☐ In the case of a water-cooled engine the radiator is fixed in front of the engine and the necessary piping to it is already installed. A different arrangement would require considerable installation work.
- ☐ An armoured hose with couplings is delivered for connection between the day-tank placed on the floor-stand and the engine. The day-tank has a hand pump with hose for filling of fuel oil from a drum or the like.
- ☐ The control unit cabinet is placed on a frame above the generator and all necessary cabling for control and supervision is made up in the factory. The electrical installation thus comprises merely connection of power cables and a few control and alarm circuits.

Summary

These diesel generating sets are available in all sizes and for alternative forms of operation required for different telecommunication equipments. They comply in every respect with CCITT recommendations.

The control and supervisory unit is made up of electronic components and reed relays, a guarantee of the highest possible reliability. Measures for reliable starting have been taken and all important functions are supervised. Maintenance and fault repair are facilitated through the 10 types of alarm.

Self-regulating, brushless compound generators are used. They are specially adapted for interworking with thyristor rectifiers.

Installation of the diesel generating sets is extremely simple.

References

1. LJUNGBLOM, Å.: *L M Ericsson Power Supply Systems for Telecommunication Equipments.* Ericsson Rev. *45*(1968): 4, pp. 142—162.
2. CCITT. *Primary Sources of Energy*, chapter 2.2.
3. WOLPERT, T.: *L M Ericsson's Thyristor-controlled Rectifiers for Power Supplies.* Ericsson Rev. *46*(1969): 3, pp. 84—101.

ERICSSON News

from All Quarters of the World

Opening of the New Finnish Factory

At the beginning of September 1971 O/Y L M Ericsson A/B moved into its new plant at Jorvas, west of Helsinki.

The total area of the plant is about 35,000 m², of which about 26,000 m² factory space. It employs some 800 persons. Of the factory staff, comprising today about 500 persons, more than half are engaged on the manufacture of relay sets for automatic telephone exchanges, racks for switching equipment, and piece-parts for different types of telephone sets and line equipment.

Telephone sets account for a large proportion of the capacity of the factory. During 1972 the Jorvas factory will produce 170,000 telephone sets and the estimate for 1973 is 200,000 telephone sets, all for the Finnish market.

Apart from the company's own requirements, transmitter insets will be manufactured for other companies of the Group. Certain special apparatus, e.g. 3-coin boxes, will also be produced.

At the year-end 1971 it is expected that a department for manufacture of high quality industrial plastics will start operation. It will produce, in the first place, all visible parts of the telephone set. It will also accept orders from Group companies.

The development of O/Y L M Ericsson A/B has been closely associated with the expansion of Finnish telephone plant. The rate of growth of telephony in Finland since the end of the sixties has increased year by year and in 1970 was 8.1%. According to official forecasts this rate of expansion will continue throughout the seventies. The telephone density is at present 25.2 telephone sets per 100 inhabitants.

In the competition within the telecommunications field L M Ericsson's Finnish company, in the same way as the parent company, will concentrate its efforts to a large extent on improved technical service. The Technical Development Department of the company has started to accept design assignments also within data processing. Within the course of three years the department expects to employ some 100 persons and, of course, will cooperate intimately with corresponding functions within the parent company and other subsidiaries.

The new factory of the Ericsson Group at Jorvas, Finland.

Interim Report for Nine Months Ended Sept. 30, 1971

The telecommunications networks in several of the Group's most important markets have kept expanding at a high rate and sales efforts have produced good results, it is stated in the recently presented interim report for the first 9 months of 1971.

Order bookings during the period amounted to 3239 mkr, exceeding by 11% the corresponding figure for 1970 (2930 mkr).

Orders from Swedish customers remained at the same level as during the corresponding period of last year. The strong growth of the Group on the European market outside Sweden continued and orders within this area rose by 26%. Of the total orders received 22% came from Sweden, 45% from the remainder of Europe, 23% from Latin America and 10% from other markets.

The backlog of orders, which at the beginning of the year amounted to 3.6 thousand million kronor, rose to nearly 4.4 thousand million.

Group sales totalled 2488 mkr, exceeding by 21% the corresponding figure for 1970 (2062 mkr). Within Sweden the increase was 9%. Sales to customers outside Sweden rose from 1500 mkr to 1876 mkr (25%). The rate of increase was especially high in Europe and in Australia.

The substantially enlarged capacity of Ericsson plants in Sweden and abroad, undertaken in response to the sharp rise of orders in previous years, has begun to pay off in greatly increased production.

The number of Group employees has risen since the beginning of the year from 61,900 to 66,300.

Group income prior to special adjustments and income taxes amounted to 271.1 mkr (277.8 mkr), corresponding to 10.9% of sales (13.5%). The latest collective agreements in Sweden have resulted in very heavy rises of wages, which were particularly noticeable during late 1970 and in the current year. Despite continuing rationalization of production and other productivity raising measures it has not been possible to offset the wage increases. As rather more than 60% of the Group's production still takes place at Swedish factories, this is bound to react on the consolidated earnings. Competition on the world

(cont. on page 164)

Gathered around the millionth L M Ericsson crossbar switch are seen (from left) Mr Bertil Bjurel, Director General of the Swedish Telecommunications Administration, Mr Nils Palmgren, Dr Christian Jacobæus, Executive Vice President, and Mr Björn Lundvall, President of L M Ericsson.

One Million Crossbar Switches from L M Ericsson, Sweden

In September 1971 L M Ericsson in Sweden produced its millionth crossbar switch, which represents an important milestone in the production of automatic telephone exchange equipment by the Swedish company. Apart from these million Swedish-made crossbar switches, around half a million L M Ericsson crossbar switches have been produced outside Sweden.

Automatic telephone exchanges are the main basis for L M Ericsson's operations. Crossbar has been the most significant switching technique for a long time. L M Ericsson have played an internationally leading role in the development of the modern crossbar systems which today dominate world telecommunications. A considerable number of telephone administrations abroad have in recent years accepted L M Ericsson's crossbar system as standard.

The prototype of the crossbar switch of today was presented by the Swedish engineers G. A. Betulander and Nils Palmgren as early as 1919. The first automatic telephone exchange based on this technique was opened by the Telecommunications Administration in Sundsvall in 1926.

In cooperation with the Administration L M Ericsson conducted intensive development work during the forties with a view to modernization of the crossbar switch. Swedish contributions within telephone traffic theory, by among others Dr Christian Jacobaeus, created the means for economic application of the crossbar switching technique. The first automatic telephone exchange with crossbar switches made by L M Ericsson was opened in Helsinki in 1950.

The crossbar system today comprises a complete series of automatic — national, international and intercontinental — systems for telephony and telex designed to interwork with other systems on the world market. Continuous development work is in progress both as regards systems and components, and L M Ericsson expect that the crossbar system will continue to occupy a leading position in the future as well.

(cont. on page 164)

Death of Marc Wallenberg

Statement by the Board of Telefonaktiebolaget L M Ericsson at its meeting on November 26, 1971:

"Marc Wallenberg Jr has passed away. His death has been a severe loss to the board and to the company. His extensive knowledge of the financial world and his wide and solid international relations have been of invaluable service to the company. Especially in recent years, when the rapid expansion of the parent company and its subsidiaries resulted in heavy capital requirements, his initiative and cooperation in the financing of the Group on the international capital market have been of extreme value.

From his own international experience and operations he was able to bring up many important points of view concerning the work of the company on the foreign market.

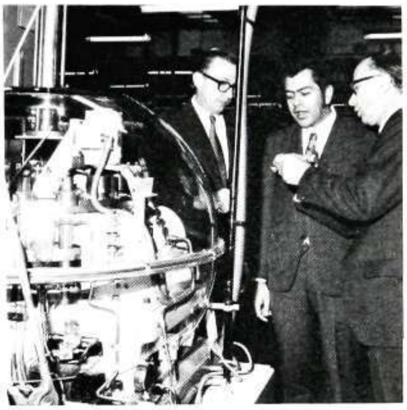
He strongly supported the company's localization policy and, through his many contacts with Swedish government agencies and local authorities, he could give opinions on new localization undertakings which were of great value. One of his guiding principles was the desirability and necessity of creating employment opportunities at places where employment was threatened.

The board has lost a friend and a person with exceptional human qualities. Marc Wallenberg's warm personality was expressed in a constant interest in the people working for the company. He always had a thought for and was ready to help those who were faced with problems of different kinds. He participated in the work of the board with an ardent interest, stamped by a strong belief in the prospects and capacity of the company. He showed consideration and attention to the views of other people but never concealed his own opinion.

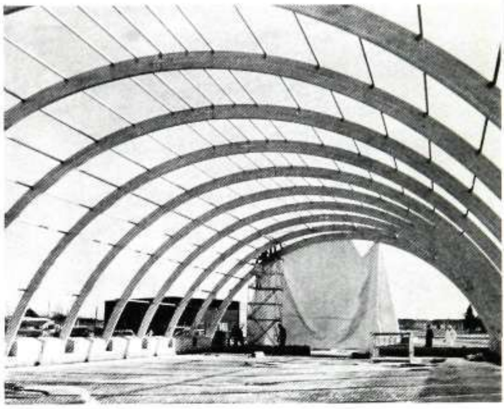
The board pays homage to the memory of the person and the achievements of Marc Wallenberg Jr."

In August this year the Dutch subsidiary of the Group, Ericsson Telefoonmaatschappij N.V., celebrated its 50-years jubilee, one feature of which was an "Open Day". The photograph shows (centre) President Björn Lundvall in conversation with (right) the Director General of the Netherlands PTT, H. Reinoud, and (left) H. J. Wijers, also from the PTT.

In mid-September L M Ericsson's head factory at Midsommarkransen was visited by the Mexican Ambassador, Sr Guillermi Calderón. He is seen here with (left) Harold Mohlström and (right) Sture Edsman, L M Ericsson.

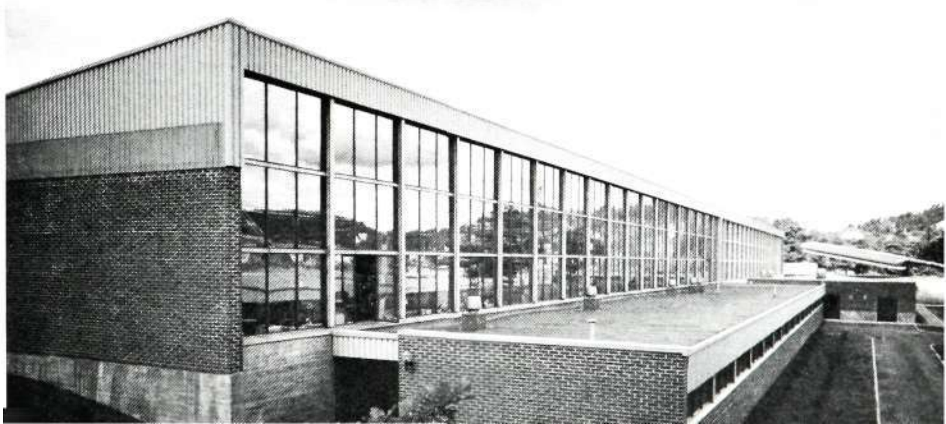


The plastic hall (far right) was set up at the beginning of 1971 to increase the warehouse space at L M Ericsson's factory in Visby. A third stage of the factory with 3,200 m² floor space is to be completed during 1972, thus bringing the entire factory area up to 22,000 m².



The Irish Minister of Posts and Telegraphs called on L M Ericsson during his visit to Sweden in October. (From left) Irish Secretary of State, Frank Coleman, C.-H. Ström, L M Ericsson, the Irish Minister, Gerhard Collins, and Sture Edsman, L M Ericsson.

During the spring of 1971 the Norwegian subsidiary of the Group, A/S Elektrisk Bureau, opened its new factory at Hisöy. The total plant area is about 10,000 m² and it employs more than 400 persons.



Telecenter - New Permanent LME Exhibition

L M Ericsson Telemateriel AB have opened an elegant permanent exhibition room close to the company's regional office at Sveavägen 159, Stockholm. The exhibition has been given the name Telecenter. Within a space of 315 m^2 a pleasant environment has been created around the products of the sales company comprising intercom telephones, paging systems, hotel signalling systems, centralograph, fire and burglary protection etc. All products exhibited are shown in operation.

150 km Power and Telecommunication Lines for New Large Airport at Sturup

An area of about 3500 acres, apart from approach roads, has been reserved for the large new airport at Sturup, which will replace the Bulltofta Airport at Malmö. Rather more than half of this area will be used in the first stage.

The laying of the 150 km of power and telecommunication lines is being done by L M Ericsson's Network Division. The length of the cable trenches will be about 15 km, and 19 km of cable conduit will be required. The cables are drawn through the conduit with motor-driven cable winches operated via radio transmitters.

One million crossbar switches . . . (cont. from p. 162)

The production of the millionth crossbar switch was celebrated at the Karlskrona factory, where the manufacture of this switch has taken place since 1955. A limited series of "jubileum switches" ha been manufactured, of which one was presented to one of its initiators, the 84-year-old Nils Palmgren, and one to the Director General of the Telecommunications Administration, Bertil Bjurel. The presentation was made at a simple ceremony in the exhibition room at Midsommarkransen.

The Telecommunications Administration, which started to manufacture crossbar switches on an industrial scale as early as the twenties, also celebrated the production of its millionth crossbar switch at the Nynäshamn factory at roughly the same time as L M Ericsson.

Interim Report . . . (cont. from p. 161)

market permits increases of prices only to a small extent.

Operating expenses rose by 26% compared with the same period of 1970.

With deliveries now more evenly distributed over the year, it is expected that 1971 sales will exceed those of 1970 by 12—15%. Income for the year prior to special adjustments and taxes is expected to be rather lower than for 1970.

Investments in property, machinery and inventories during the period amounted to 266 mkr (167 mkr).

The liquidity of the Group was affected by the present expansion which, among other things, has required considerable amounts for the build up of subsidiaries abroad, investments in fixed assets, long-term suppliers' credits and increase of goods in stock.

First Transatlantic Video Telephone Call

On December 3 the first transatlantic video telephone call was exchanged today between the new telesatellite station at Tanum, Bohuslän, and the COMSAT building in Washington. For this call, which was transmitted via the INTELSAT IV telesatellite, the video telephones had been designed and manufactured by L M Ericsson.

At the video telephone at Tanum was the Chairman of the Board of the Tanum Station and the Director General of the Danish PTT, Gunnar Pedersen. At the other end, in the USA, was Dr Joseph V. Charyk, Head of COMSAT (Communication Satellite Corporation).

The first transatlantic video telephone call was used for showing to the proud grandparents in Sweden a 2-month-old baby born in the USA. The child, a daughter of an attaché at the Swedish Embassy in Washington, could be admired at Tanum by its grandparents from Västervik.

The video-audio circuit was two-way. One TV channel in each direction was used for the picture; the sound was transmitted on a telephony channel. The picture quality complied with the European public TV standard, which implied that a typed document in front of the video telephone at Tanum could be read in Washington and vice versa.

The conversation was transmitted via INTELSAT IV to Etam Earth Station outside Washington and thence by radio link to the COMSAT building.

Subsidiaries, associated companies and technical offices

EUROPE

DENMARK

L M Ericsson A/S *DK-2600 Glostrup*, Kirkebjerg Allé 86, tel: (01) 96 6133, tgm: ericsson københavn, telex: 19020 "ERICSSON KH"

GNT Automatic A/S *DK-2860 Søborg*, Telefonvej 6, tel: (01) 69 5188, tgm: nortelmatic, telex: 5264, "GNT AUTOMATIC KH"

Dansk Signal Industri A/S *DK-2650 Hvidovre*, Stamholmen 175, Avedøre Holme, tel: (01) 49 0333, tgm: signaler københavn, telex: 6503, "6503 DSI DK"

FINLAND

O/Y L M Ericsson A/B *SF-02420 Jorvas*, tel: (90) 2991, tgm: ericssons, telex: 12546, "LME SF"

FRANCE

Société Française des Téléphones Ericsson
F-92 Colombes, 36, Boulevard de la Finlande, tel: Paris (1) 781 3535, tgm: ericsson colombes, telex: 62179, "ERICSSON CLOMB"

F-75-Paris 17e, 147, rue de Courcelles, tel: Paris (1) 227 9530, tgm: eric paris, telex: 29276, "ERICSSON PARIS"

Etablissements Ferrer-Auran S.A. *13 Marseille, (10ème)*, 88, Avenue de la Capelette, tel: (91) 47 4851, telex: 42579, "RINGMARS"

GREAT BRITAIN

Swedish Ericsson Company Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Telecommunications Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: teleric, telex: 935979, "SWEDERIC LDN"

Production Control (Ericsson) Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: productrol, telex: 935979, "SWEDERIC LDN"

Swedish Ericsson Rentals Ltd. *Morden, Surrey*, Crown House, London Road, tel: (01) 542 1001, tgm: celefon, telex: 935979 "SWEDERIC LDN"

IRELAND

L M Ericsson Ltd. *Dublin 2*, 32, Upper Mount Street, tel: (01) 619 31, tgm: ericsson, telex, 5310, "LMI EI"

ITALY

FATME, Soc. per Az. *1-00100 Roma*, C. P. 4025 Appio, tel: (06) 4694, tgm: fatme, telex: 61327, "61327 FATME"

SETEMER, Soc. per Az. *1-00198 Roma*, Via G. Paisiello 43, tel: (06) 86 8854, tgm: setemer

SIELTE, Soc. per Az. *I-00100 Roma*, C.P. 5100, tel: (06) 577 8041, tgm: sielte, telex: 61225, "61225 SIELTE"

NETHERLANDS

Ericsson Telefoonmaatschappij N.V. *Rijen (N.Br.)*, P. O. B. 8, tel: (01612) 3131, tgm: erictel, telex: 54114, "ETMRY NL"

Voorburg 2110, P. O. B. 60, tel: (070) 81 4501, tgm: erictel den haag, telex: 31109, "ERICTEL DEN HAAG"

NORWAY

A/S Elektrisk Bureau *Oslo 3, P.B.* 5055 Maj, tel: (02) 46 1820, tgm: teleb, telex: 11723, "TELEB N"

A/S Industrikontroll *Oslo 6*, Grensevejen 86/88, 3. etg., tel: (02) 68 7200, tgm: indtroll

A/S Norsk Kabelfabrik *Drammen*, P.O.B. 369, tel: (02) 83 7650, tgm: kabel, telex: 18149, "KABEL N".

A/S Telesystemer *Oslo 6*, Tvetenveien 32, Bryn, tel: (02) 68 7200, tgm: telesystemer, telex: 16900, "ALARM N"

POLAND

Telefonaktiebolaget L M Ericsson, Technical Office *Warszawa*, Ul. Nowy Swiat 42, tel: 26 4926, tgm: tellme, telex: 813710, "813710 TELLME PL"

PORTUGAL

Sociedade Ericsson de Portugal Lda. *Lisboa 1*, Rua Filipe Folque 7, 1°, tel: 56 3212, tgm: ericsson

SPAIN

Industrias de Telecomunicación, S.A. *Getafe*, Paseo Felipe Calleja 6, tel: 295 2100, tgm: ericsson, telex: 22666, "ERIGE E"

L M Ericsson, S.A. *Madrid 5*, Bernadino Obregón 25, tel: 467 8700, tgm: ericofon, telex: 23333, "23333 LMESA E"

SWEDEN

Telefonaktiebolaget L M Ericsson, *S-126 11 Stockholm 32*, tel: (08) 19 0000, tgm, telefonbolaget, telex: 17440, "LME S"

ELLEMTEL Utvecklings Aktiebolag *S-127 25 Skärholmen* Box 249, tel: (08) 97 0220

Bjurhagens Fabrikers AB *S-212 15 Malmö*, Fack, tel: (040) 93 4770

AB Rifa *S-161 11 Bromma 11*, tel: (08) 26 2600, tgm: elrifa, telex: 10308, "ELRIFA STH"

L M Ericsson Instruktionsteknik AB *S-117 47 Stockholm 44*, tel: (08) 68 0870, tgm: instruktec

L M Ericsson Telemateriel AB *S-135 01 Stockholm-Tyresö 1*, Fack, tel: (08) 712 0000 tgm: ellem, telex: 10920, "LMSBO/S"

Sieverts Kabelverk AB *S-172 87 Sundbyberg*, tel: (08) 28 2860, tgm: sievertsfabrik, telex: 1676, "SIEVKAB STH"

Svenska Radio AB *S 102 20 Stockholm 12*, tel: (08) 22 31 40, tgm: svenskradio, telex: 10094 "SRA S"

AB Thorsman & Co. *S-611 01 Nyköping 1*, Box 149, tel: (0155) 810 00, tgm: thorsmanco

AB Transvertex *S-145 53 Norsborg*, Fittja industriområde, tel: (08) 710 0935

SWITZERLAND

Ericsson A.G. *8061 Zurich*, Postfach, tel: (051) 41 6608, tgm: telericsson, telex: 52669, "ERIC CH"

TURKEY

Ericsson Türk Ticaret Ltd. *Sirketi Ankara*, Rumeli Han, Ziya Gökalp Cad. tel: 12 3170, tgm: ellem

WEST GERMANY

Deutsche Ericsson G.m.b.H. Telematerial, *4 Düsseldorf 1*, Postfach 2628, tel: (0211) 35 3594, tgm: erictel: telex: 8587912, "ERIC D"

Ericsson Centrum G.m.b.H. *3 Hannover*, Dornierstrasse 10, Postfach, tel: (0511) 63 1018, tgm: ericen, telex: 0922913, "ERICE D"

ASIA

INDIA

Ericsson India Limited *Calcutta*, P.O.B. 2324, tel: (032) 45 4494, tgm: inderic

New Delhi 16, L25, South Extension Part II, tel: (011) 62 6505, tgm: inderic

INDONESIA

Ericsson Telephone Sales Corporation AB
Djakarta, P.O.B. 2443, tel: (07) 463 97, tgm: javeric, telex: 4414 "JAVERIC DKT 4414"

Bandung, Djalan Ir. H. Djuanda 151, tel: (082) 820 94, tgm: javeric

IRAQ

Telefonaktiebolaget L M Ericsson, Iraq Branch *Baghdad* P.O.B. 2388, Alwiyah, tel: 947 14, tgm: ellemco

KUWAIT

Telefonaktiebolaget L M Ericsson, Technical Office *Kuwait, State of Kuwait*, P.O.B. SAFAT No. 5979, tel: 200 74, tgm: erictel

LEBANON

Société Libanaise des Téléphones Ericsson *Beyrouth* B.P. 8148, tel: 25 2627, tgm: ellem, telex: LE 20876, "ELLEM"

MALAYSIA

Ericsson Talipon SDN BHD *Shah Alam, Selangor, Batu Tiga Industrial Estate*, P.O.B. 28, Tel: Kuala Lumpur 36 1821, tgm: kuleric, telex: 265, "ERICMAL KL"

Telecommunication Manufacturers (Malaysia) SDN BHD *Shah Alam, Selangor, Batu Tiga Industrial Estate*, P.O.B. 28, tel: Kuala Lumpur 36 1821, tgm: kuleric, telex: 265, "ERICMAL KL"

PAKISTAN

L M Ericsson Telephone Company, Technical Office *Karachi*, P.O.B. 7398, tel: (90) 51 6112, tgm: ericsson

SINGAPORE

Telephone Industries of Singapore Private Ltd. *Singapore 1*, P.O.B. 3079, tel: 98 1155, tgm: telsin, telex: 21727 "TELSIN RS 21727"

THAILAND

Ericsson Telephone Corp. Far East AB *Bangkok*, P.O.B. 824, tel: (02) 580 41, tgm: ericsson, telex: 2274, "THAIERIC"

AFRICA

ALGERIA

Société Algérienne des Téléphones Ericsson *El Biar (Algers)*, 4, rue Mouloud Hadjen, tel: 78 2692, tgm: eric alger

A. R. EGYPT

Telefonaktiebolaget L M Ericsson, Technical Office Egypt Branch *Cairo* P.O.B. 2084, tel: (02) 465 83, tgm: ericgypt, telex: 2009, "ELLEME UN"

ETHIOPIA, SUDAN

Telefonaktiebolaget L M Ericsson, Technical Office *Addis Ababa*, P.O.B. 3366, tel: (01) 492 60, tgm: ericsson, telex: 21090 "MOSFIRM ADDIS"

MOROCCO

Société Marocaine des Téléphones Ericsson *Casablanca*, 87, Rue Karatchi, tel: 788 75, tgm: ericsson

TUNISIA

Telefonaktiebolaget L M Ericsson, Technical Office, *Tunis*, Boite Postale 780, tel: (01) 24 0520, tgm: ericsson, telex: 695, "ERICSSON TUNIS".

ZAMBIA

Ericsson Telephone Sales Corporation AB
Lusaka, P.O.B. 2762, tel: (146) 744 42, tgm: ericofon

Ndola, P.O.B. 2256, tel: (143) 3885, tgm: ericofon

AMERICA

ARGENTINE

Cia Ericsson S.A.C.I. *Buenos Aires* Casilla de Correo 3550, tel: 33 2071, tgm: ericsson, telex: 0122196, "CATEL BA"

Cia Argentina de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Cia Entrerriana de Teléfonos S.A. *Buenos Aires*, Belgrano 894, tel: 33 2076, tgm: catel, telex: 0122196, "CATEL BA"

Industrias Eléctricas de Quilmes S.A. *Quilmes FNGR*, 12 de Octubre 1090, tel: 253 2775, tgm: indelqui buenosaires, telex: 0122196, "CATEL BA"

BRAZIL

Ericsson do Brasil Comércio e Indústria S.A.
São Paulo, Rua da Coroa 500, tel: 298 2322 tgm: ericsson, telex: 021817, "ERICSSON SPO"

Rio de Janeiro, Caixa Postal 3601-ZC-00, tel: 221 4777, tgm: ericsson, telex: 031839, "ERICSSON RIO"

Fios e Cabos Plásticos do Brasil S.A. (FICAP) *Rio de Janeiro*, caixa postal: 1828, tel: 29 0185, tgm: ficap, telex: 031485, "FICAP RIO"

CANADA

L M Ericsson Limited *Montreal 381, Quebec*, 2300 Laurentian Boulevard St. Laurent, tel: (514) 331 3310, tgm: caneric, telex: 05-267682, (TWX) 610-421-3311, "CANERIC MTL"

CENTRAL AMERICA

Telefonaktiebolaget L M Ericsson, Oficina Tecnica de Centroamérica *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson, telex: 20087, "ERICSAL 20087"

CHILE

Cia Ericsson de Chile S.A. *Santiago*, Casilla 10143, tel: (04) 825 55, tgm: ericsson, telex: SGO 389, "ERICHILE SGO389"

COLOMBIA

Ericsson de Colombia S.A. *Bogotá*, Apartado Aéreo 4052, tel: (92) 41 1100, tgm: ericsson, telex: 044507, "ERICSSON BOG"

Fábricas Colombianas de Materiales Eléctricos Fácomec S.A. *Cali*, Apartado Aéreo 4534, tel: 42 1061, tgm: facomec, telex: 55673, "FACOMEC CLO"

COSTA RICA

Telefonaktiebolaget L M Ericsson, Technical Office *San José*, Apartado 10073, tel: 21 1466, tgm: ericsson, telex: 283, "283 LME-CR"

ECUADOR

Teléfonos Ericsson C.A.
Quito, Casilla 2138, tel: 52 4000, tgm: ericsson

Guayaquil, Casilla 376, tel: 30 0900 tgm: ericsson

Cont. on next page

Subsidiaries, associated companies and technical offices (*Cont. from preceding page*)

MEXICO

Teléfonos Ericsson S.A. *Mexico D.F.*, Apartado Postal M-9958, tel: 566 8955 tgm: coeric, telex: 017234, "ERICSSON TLA" PARA COERIC

Latinoamericana de Cables S.A. de C.V. *Mexico 12 D.F.*, Apartado Postal 12737, tel: 549 0844 tgm: latincasa, telex: 017234, "ERICSSON TLA" PARA LATINCASA

Teleindustria, S.A. *Mexico 1, D.F.*, Apartado Postal 1062, tel: 565 7033 tgm: ericsson, telex: 017234 "ERICSSON TLA"

Telemontaje, S.A. de C.V. *Mexico 1, D.F.*, Apartado Postal 1062, tel: 576 4044, tgm: ericssonmexicodf, telex: 017234, "ERICSSON TLA" PARA TELEMONTAJE

PANAMA

Telefonaktiebolaget L M Ericsson, Oficina Técnica de Panamá *Panama 5, R.P.* Apartado 4349, tel: 64 3600, tgm: ericsson, telex: 368674 "368674 SONITEL"

PERU

Cia Ericsson S.A. *Lima*, Apartado 2982, tel: 31 1005, tgm: ericsson, telex: 3540202, "ERICSSON 3540202"

Soc. Telefónica del Perú, S. A. *Arequipa*, Apartado 112-1012, tel: 6060 tgm: telefonica

EL SALVADOR

Telefonaktiebolaget L M Ericsson, Technical Office *San Salvador*, Apartado 188, tel: 21 7640, tgm: ericsson

URUGUAY

Cia Ericsson S.A. *Montevideo, Casilla de Correo* 575, tel: 926 11, tgm: ericsson, telex: 398228, "ROULEMENT UY" PARA MELANDER

USA

The Ericsson Corporation *New York, N.Y. 10017*, 100 Park Avenue, tel: (212) 685 4030, tgm: erictel, telex: 620484, "ERICTEC 620484"

Ericsson Centrum Inc. *New York, N.Y. 10016*, 16, East 40th Street, tel: (212) 679 1000, tgm: erictel, telex: 620149, "ETELSAC 620149"

VENEZUELA

Cia Anónima Ericsson *Caracas*, Apartado 70516, tel: (02) 34 4661, tgm: ericsson, telex: 22734, "22734 ERIC VEN"

Alambres y Cables Venezolanos C.A. (ALCAVEL) *Caracas*, Apartado del Este 62107, tel: (02) 33 9791, tgm: alcave, telex: 845, "ALCAVE VE"

AUSTRALIA & OCEANIA

AUSTRALIA

L M Ericsson Pty Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: ericmel, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: ericsyd, telex: AA 21358 "ERICSYD"

Boroko, Territory of Papua and New Guinea, P.O.B. 5602, tel: Port Moresby 565 66, tgm: ericpor, telex: Port Moresby 153

Teleric Pty. Ltd. *Broadmeadows, Victoria 3047*, P.O.B. 41, tel: (03) 309 2244, tgm: teleric, telex: AA 30555, "ERICMEL"

Rushcutters Bay N.S.W. 2011, 134 Barcom Avenue, tel: (02) 31 0941, tgm: teleric, telex: AA 21358, "ERICSYD"

Conqueror Cables Pty. Limited *Dee Why, N.S.W. 2099*, P.O.B. 69, tel: (02) 98 0364, tgm concab sydney

A.E.E. Capacitors Pty. Ltd. *Preston, Victoria 3072*, 202 Bell Street, P.O.B. 95, tel: (03) 480 1211, tgm: engiquip melbourne

Representatives

EUROPE

AUSTRIA

Electro-Diesel Handelsaktiengesellschaft, Abteilung Telecom *1160 Wien*, Postfach 98, tel: (0222) 43 5956, tgm: teleric, telex: 75976, "75976 TELECOM A"

BELGIUM

Allumage Lumière S.A. *Bruxelles 7*, 128-130 Chaussée de Mons, tel: 22 9870, tgm: allumalux, telex: 21582, "ALLUMALUX BRU"

GREECE

Angelos Cotzias *Athens*, 18, Odos Omirou, tel: (021) 62 6031, tgm: cotziasan, telex: 215252, "215252 CTS GR"

ICELAND

Johan Rönning *Reykjavik*, P.O.B. 5300, tel: 254 00, tgm: rönning, telex: 2040, "ROENNG IS"

SPAIN

TRANSA Transacciones Canarias S.A.

Las Palmas de Gran Canarias, Tomas Morales 38, tel: 21 8508, tgm: transa, telex: 95024, "MAVAC E"

Santa Cruz de Tenerife, Sabino Berthelot, 3, tel: 24 2596, tgm: transa, telex: 95024, "MAVAC E"

YUGOSLAVIA

Merkantile Inozemna Zastupstva *Zagreb* pošt pretinac 23, tel: (041) 41 6655, tgm: merkantile, telex: 21139, "21139 YU MERTIL"

Beograd, Ul. 7. Jula br. 18, tel: (011) 62 1773, tgm: merkantile, telex: 11506, "YU MERKAN"

ASIA

BAHRAIN & TRUCIAL STATES

Yusuf Bin Ahmed Kanoo *Bahrain, Arabian Gulf*, tel: 40 8188, tgm: kanoo, telex: BHN 215

BURMA

Myanma Export Import Corp., Agency Div. *Rangoon*, P.O.B. 404, tel: 146 18, tgm: myanimport

CAMBODIA

Comin Khmere S.A. *Phnom-Penh*, P.O.B. 625, tel: 233 34, tgm: engineer

CYPRUS

S.A. Petrides & Sons Ltd. *Nicosia*, P.O.B. 4522, tel. 627 88, tgm: armature, telex: 2308, "ARMATURE"

HONG KONG AND MACAO

Swedish Trading Co. Ltd. *Hong-Kong*, P.O.B. 108, tel: 23 1091, tgm: swedetrade

IRAN

Irano Swedish Company A. B. *Teheran*, Khiabane Sevom Esfand 29, tel: 31 4160, tgm: iranoswede

JORDAN

The Arab Trading & Development Co. Ltd. *Amman*, P.O.B. 6141, tel: 259 81, tgm: aradeve

KUWAIT

Morad Yousuf Behbehani *Kuwait, State of Kuwait*, P.O.B. 146, tel: 270 71, tgm: barakat, telex: 2048, "BEHBEHANI KUWAIT"

LEBANON

Swedish Levant Trading *Beyrouth*, P.O.B. 931, tel: 23 1624, tgm: skefko

PAKISTAN

Panasian Marketing Service Ltd. *Karachi*, P.O.B. 3941, tel: (90) 51 2051, Ext. 53, tgm: panasian

PHILIPPINES

USI Asia Industries, *Makati, Rizal*, P.O.B. 1322, tel: 87 7011, tgm: usi asia, telex: 7222233, "7222233 AII PH"

SAUDI ARABIA

Engineering Projects & Products Co. Ltd. (Eppco)

Riyadh, P.O.B. 987, tel: 222 22, tgm: eppcol

Yeddah, P.O.B. 1502, tel: 4567, tgm: eppcol

Dammam, P.O.B. 450, tel: 222 22, tgm: eppcol

SYRIA

Constantin Georgiades *Damas*, P.O.B. 2398, tel: 266 73, tgm: georgiades

TAIWAN

Trans-Eurasia Enterprise, Ltd. *Taipei*, P.O.B. 3880, tel: 51 7038, tgm: esbtrading

REPUBLIC OF VIETNAM

Vo Tuyen Dien-Thoai Vietnam *Saigon*, P.O.B. 1049, tel: 226 60, tgm: telerad

International Business Representative *Saigon*, 26—28, Hai Ba Trung Street, tel: 226 60, tgm: ibur

AFRICA

ETHIOPIA

Mosvold Company (Ethiopia) Ltd. *Addis Ababa*, P.O.B. 1371, tel: (01) 101 00, tgm: mosvold, telex: 21090, "MOSFIRM ADDIS"

KENYA, TANZANIA, UGANDA

The Old East African Trading Co. Ltd. *Nairobi, Kenya*, P.O.B. 30013, tel: 271 61, tgm: broche, telex: 22261, "OLDEAST NAIROBI"

LIBERIA

Liberian Telecommunications Authority *Monrovia*, Corner Ashmun & Lynch Streets, tel: 222 22, tgm: radiolibe

LIBYA

ADECO African Development & Engineering Co *Tripoli*, P.O.B. 2390, tel: 339 06, tgm: adeco

MALAWI

Business Machines Ltd., *Limbe*, P.O.B. 5557, tel: Blantyre 504 03, tgm: falt

MOZAMBIQUE

J. Martins Marques & Ca. Lda *Lourenco Marques*, P.O.B. 2409, tel: 24953, tgm: marquesco

NIGERIA

Communications Associates of Nigeria Ltd. (Comsac), *Yaba (Lagos)*, P.M.B. 1069, tel: Lagos 442 74, tgm: comdec lagos

SOUTH AFRICA
SOUTHWEST AFRICA

Dryden Communications (Pty.) Ltd. *Johannesburg, South Africa*, P.O.B. 2440, tel: 838 5454

SUDAN

El Rahad Trading Corporation *Khartoum*, P.O.B. 866, tel: 776 95, tgm: suconto, telex: BHN 251

ZAIRE

I.P.T.C. (Zaire) Ltd. *Kinshasa*, P.O.B. 8922, tel: 253 45, tgm: induexpan, telex: 327, "IPTC KIN"

AMERICA

BAHAMA ISLANDS

Anglo American Electrical Company Ltd. *Freeport, Grand Bahama*, P.O.B. 104

BOLIVIA

Prat Ltda *La Paz*, Casilla 4790, tel: 277 12, tgm: prat

COSTA RICA

Tropical Commission Co. Ltd. *San José*, Apartado 661, tel: 22 5511, tgm: troco

DOMINICAN REPUBLIC

Humberto Garcia, C. por A. *Santo Domingo*, Apartado 771, tel: 3645, tgm: gartier

GUATEMALA

Nils Pira *Ciudad de Guatemala*, Apartado 36, tel: (021) 622 57, tgm: nilspira

GUYANA

General Supplies Agency *Georgetown*, P.O.B. 375, tgm: benwlks

HONDURAS

Quinchón Leon y Cia *Teguicigalpa*, Apartado 85, tel: 251 71, tgm: quinchon

NETHERLANDS ANTILLES

S.E.L. Maduro & Sons Inc. Merchandise Dept. *Willemstad, Curaçao* P.O.B. 304, tel: 130 00, tgm: madurosons, telex: CU 92

NICARAGUA

Roberto Teran G. *Managua*, Apartado 689, tel: 224 00, tgm: roteran

PANAMA

Sonitel, S.A. *Panama 5, R.P.*, Apartado 4349, tel: 64 3600, tgm: sonitel, telex: 368674, "368674 SONITEL"

Mr. Tore Korch *Panama 5, R.P.*, Apartado 4349, tel: 64 36 00, tgm: sonitel, telex: 36 86 74, "36 86 74 SONITEL" FOR MR KORCH

PARAGUAY

S.A. Comercial e Industrial H. Petersen *Asunción*, Casilla 592, tel: 9868, tgm: pargtrade

EL SALVADOR

Dada-Dada & Co. *San Salvador* Apartado 274, tel: 21 7940, tgm: dada

SURINAM

W.E. van Romondt's Trading Company Ltd. *Paramaribo*, tel: 2831, tgm: vanromondt

TRINIDAD, W.I.

Leon J. Aché Ltd. *Port-of-Spain*, 100 Frederic Street, tel: 323 57, tgm: achegram

AUSTRALIA & OCEANIA

NEW ZEALAND

ASEA Electric (NZ) Ltd. *Wellington C. 1.*, P.O.B. 3239, tel: 706 14 tgm: asea, telex: 3431, "ASEAWELL NZ 3431"

SATHERLUND & KROOK