Maintenance News

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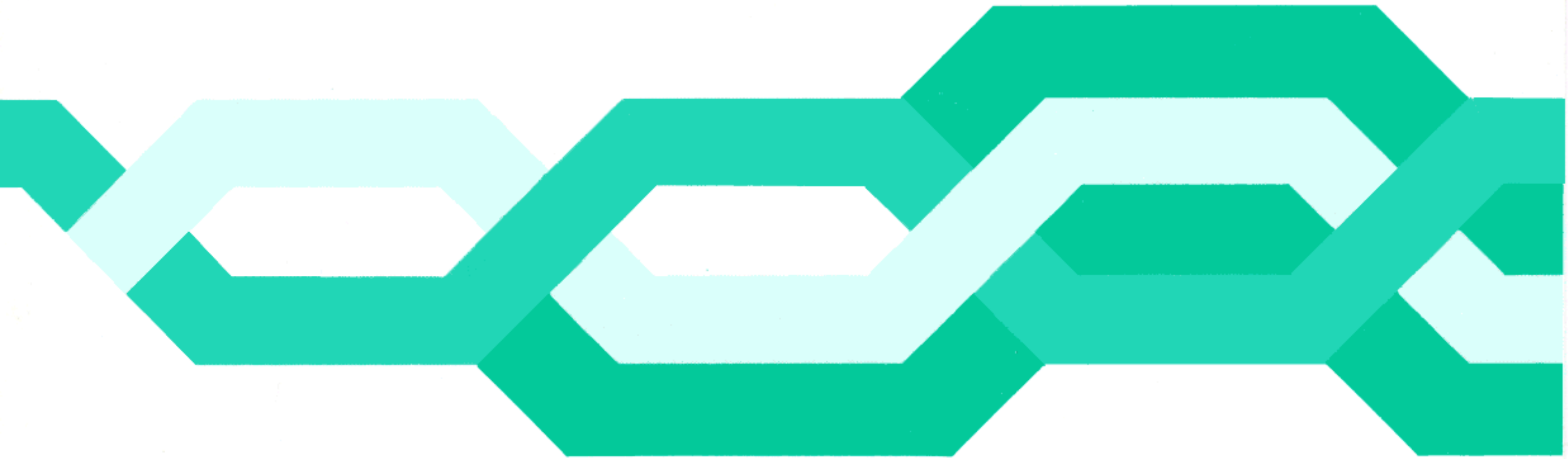

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Editorial

Our first editor Dave Manning, who helped at the birth of *MN* in 1973, laid aside his red pen with issue 10. He retired recently noting with satisfaction that the magazine had survived THQ reorganisation and seemed set for a bright future. We wish the same for him.
Ron Quinney – Editor

The Woodley and Broughton strikes

by **Malcolm Asquith** NWTB/S222

Last June some of the worst thunderstorms in living memory were experienced in north west England, causing two TXE4 exchange isolations. In neither case did the lightning cause any physical damage to buildings, nor could any evidence be found in the vicinity of where a strike to ground might have occurred. But no protection is provided on the MDFs of the exchanges concerned.

Woodley

The worst damage was at Woodley in Manchester South Area. This exchange, which opened in November 1979, has 5600 connections and is co-sited with a Strowger unit. The area is mainly residential with some light industry.

The exchange stopped functioning at about 4 pm on 5 June. The officer in the exchange at the time attempted to restore service but, deciding that this was not immediately possible, sent for help.

By 7 pm it was realised that the situation was worse than first thought. Also, continuing attempts to set up calls from subscribers' lines and incoming junctions were making it very difficult to find faults in the common control equipment. To overcome this 'A' switches and incoming junction relay sets were unplugged from the racks. Outgoing relay sets were left in place as they were not causing problems. This action allowed fuses to be replaced and DC-DC converters to be reset.

The staff on site had by now been joined by others from surrounding TXE4 exchanges and the regional headquarters, and were formed into teams to concentrate on particular tasks. Testing of all 'A' switches began using two matrix testers, one having been borrowed from a nearby exchange.

As all call-office lines were served by the TXE4, they were transferred to the Strowger unit to maintain emergency services. A message was put out on local radio explaining the problem. Repair continued throughout the night and, by Friday morning, much of the common control equipment was functioning. The staff who had been working overnight were taken off duty, and reliefs – including some STC engineers who had been working on the exchange extension – took over. Because it was still not clear when service would be restored, work began on transferring 'E' category circuits onto the Strowger unit.

By 11 am of the next day sufficient progress had been made in restoring common control equipment and testing 'A' switches, so it was decided to try to re-establish some originating service to subscribers. A limited number of 'A' switches were replaced in the racks and traffic was allowed to build up. As a high level of congestion was experienced, full service was still not possible, so the category III preference keys were thrown. By 1 pm all category I and II subscribers had limited service restored and a start was made in re-introducing remaining lines. Then, restoring of incoming service began and by about 9 pm the majority of circuits were restored.

On Saturday, the 'E' category circuits were returned to the TXE4 and finally, on Sunday, the call-office lines were back.

Of the components that failed, most were transistors (CV9507) and diodes (CV8790). Very few reed relay faults were found. In fact the switching matrix was tested later with an STC network analyser and found remarkably fault free.

The majority of faults were on 'A' switches and Markers and, while faulty 'A' switches were in circuit, the Marker faults could not be cleared.

Broughton

Three weeks later, on 25 June, Broughton exchange in Manchester North Area failed during a severe thunderstorm. The damage in this case was not so widespread as that at Woodley. Again the Markers were the most affected but this was not appreciated at first as only deferred alarms were present. After proving that the main control units and pulse generator were working, it was realised that although there were no prompt alarms, only two out of the nine Markers were working. By restricting traffic, delayed dial tone was obtained. Testing the Markers proved that in each case part 55 (P-wire earth buffers) were faulty. Service was restored at 1.30 pm, three hours after the breakdown. As Broughton TXE4 stands alone service could not be provided by transferring lines to another unit as in the case of Woodley.

So, what did we learn from our experiences? We still do not know exactly what the lightning did to the exchanges. Debate still continues as to whether British Telecom lines, power supply or earth were affected. The possibility of a directly-induced electromagnetic field has not been ruled out either. The debate as to what effect gas discharge tube protection on the MDF would have had also continues.

To speed faulting – and restoration of service – the removal or restriction of traffic is necessary. At Woodley, faulty 'A' switches were putting more faults on common control equipment already cleared, so it was necessary to do a 100 per cent check. To speed this up a second matrix tester was obtained, but these are bulky – not to mention the difficulty of obtaining a van in the middle of the night. The original tester became faulty at about the same time as the exchange failure, so also had to be replaced.

Fortunately, both exchanges seem to have settled down and we did not see the residual trouble that we once feared. We still get worried, though, when black clouds gather!

061-863 7121

Isolation: cable

by **Eric Harcourt** NE/T5.1.2

The title of this article appears with unfailing regularity on the list of major service failures of telephone exchanges. Some of the failures are due to mechanical damage to the cable either by British Telecom's, other authorities', or contractors' staff working near a cable route. Other failures are due to poor maintenance, such as lack of attention to cable pressure alarms and so on. But should they cause isolations?

Quite a number of our small exchanges are still served by only one junction cable. When this is damaged, or becomes wet due to ineffective pressurisation, there is little that can be done to restore service other than speedily repair the damage, dry-out the cable or renew a cable length. But there have been other cases where the more detailed report of the isolation showed that partial service had been restored relatively quickly by re-routeing some circuits. As this type of isolation appears to have been increasing recently, this article aims to draw your special attention to the problem.

If an isolation can be speedily remedied by re-routeing, it suggests that the isolation should never have occurred. It indicates that a second cable exists over the whole, or part, of the route and in such cases the circuits should normally be divided between the available routes. Why was this not done?

Three key points

There are probably quite a number of answers to that question, but there are three points which can be considered by Circuit Provision Group (CPG) and by exchange maintenance staff.

☐ Are both the incoming and outgoing circuits on the route split between the available cables? (In one recent case all the incoming circuits were in one cable and all the outgoing in the other.)

☐ Are the outgoing circuits arranged on the grading so that early choice junctions are split over the available cables?

☐ Are new junction cables brought into use as soon as possible, and are early choice junctions re-arranged?

These may seem elementary points but by considering them, and taking appropriate action to correct any anomalies, the incidence of exchange isolation can be reduced and service to our customers improved. If you know of a junction route that needs attention, tell your AEE.

01-432 1306

Datel's new modem 27A

by **Ray Carter** NE/T5.3.2

In October 1980 British Telecom added the Datel 1200 Duplex Service to the range of data communications services. Using the new Modem 27A, full duplex data transmission over a single public switched telephone network (PSTN) connection is possible.

The photograph shows the new-style modem case which houses a single three-card unit. Power is derived from an in-line mains transformer, normally wall mounted.

A technique of four-phase differential modulation is used over two frequency-separated channels – the calling modem transmitting a carrier of 2400 Hz. Data to be transmitted is scrambled by means of a 17-bit shift register. This prevents energy peaks on the line and preserves data transitions for receiver timing recovery. After scrambling, data is then coded into Dibits for modulation.

On connection to line, the modem exercises a 'handshaking' procedure with the distant modem. This involves exchanging answer tones and synchronising patterns. It is important to note that failure of the handshake procedure will result in the automatic disconnection of both modems.

Basically, Modem 27A is a synchronous type but also contains a synchronous-to-asynchronous converter. This means that although the data between modems is

Modem 27A and associated telephone

always isochronous, the modem can be installed to provide one of three discrete data formats between the customers' data terminals. The optional data formats are set by switches and only similarly optioned modems can interwork.
The formats are either:

- 1200 bit/s ± 0.01% synchronous
- 1200 bit/s +1% to −2.5% asynchronous with 9 bit/character
- 1200 bit/s +1% to −2.5% asynchronous with 10 bit/character

Unlike modems 1, 2, 13, 20 and 21, the 27A is code sensitive rather than code transparent. This is because it will only correctly transmit start/stop formatted data when used in the asynchronous mode. To allow for the limits of +1% to −2.5% when in this mode and transmitting contiguous characters, the modem adjusts the data format by deleting up to 1 in 8 stop bits. The removed stop bits are re-inserted by the receiving modem. The signalling rate of the start bit plus information bits within a character (known as the intracharacter signalling rate) is always 1219.05 bit/s, as the length of stop bits is elastic. This overspeed data rate is equivalent to a gross start/stop distortion of 14% Early – an important point when maintenance measurements are being made.

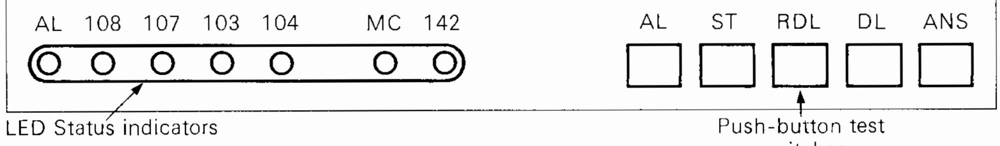


Fig 1 Modem 27A front panel

Table 1 Switches

Marking	Function	Remarks
AL	Puts the local modem into Analogue Loop mode	This loops the transmit to receive at the line side of the modem. The modem uses an internal frequency-changing process to take account of CALL and ANS channels.
ST	Puts the local modem into Self-Test mode.	An internally generated test pattern (1:1 reversals) is scrambled and transmitted to line. Received data is monitored, compared with the internal test pattern and MC indicator flashed for received errors.
RDL	Puts the remote modem into Digital Loop mode.	A handshake procedure conditions the remote modem to apply a Digital Loop (effectively a loop between interchange circuits 103 Transmitted Data and 104 Received Data).
DL	Puts the local modem into Digital Loop mode.	On modems set for asynchronous working the Digital Loop (Local and Remote) DOES NOT include the synchronous to asynchronous converter.
ANS	Puts the local modem into the Answer mode.	Selects the 2400 Hz carrier and 1200 Hz receive filter.

Table 2 – Indicators

Label	Function
AL	Indicates when the modem is in the Analogue Loop mode
108	Monitors interchange circuit 108/2 Data Terminal Ready
107	Monitors interchange circuit 107 Data Set Ready
103	Monitors interchange circuit 103 Transmitted Data
104	Monitors interchange circuit 104 Received Data
MC	When the modem is idle, the indicator stays ON to indicate power connected. When in use, the indicator goes OFF after the handshake sequence is complete. When the self-test (ST) facility is used the LED acts as an error indicator.
142	Monitors interchange circuit 142 Test Indicator.

Note : Where LEDs monitor interchange circuits they glow when the circuit is ON (+ 3v to + 15v) and are extinguished when the circuit is OFF (– 3v to – 15v). They also remain extinguished if the circuit is disconnected.

Testing aids built-in

The modem is equipped with press-button switches and light emitting diode (LED) status indicators on the front panel – as shown in Fig 1. The switches and indicators allow use of the in-built test facilities. Details of their functions are given in Tables 1 and 2. Testing procedures are given in *TI E8 B1200.*

Test Equipment

The Datel Tester 11A is used for testing Modem 27A in either synchronous or asynchronous (start/stop) modes of working.

Useful references

- *TI C3 I1731* – Modem 27A Installation Instruction
- *TI E8 B1200* – Modem 27A Maintenance Instruction
- *Technical Guide No 42*

01-357 4968

Planned work

by **Jim Haarer** NE/T5.3.3

Planned work is the term used to describe all *forseen* engineering work on British Telecom equipment and cable. This may be to relocate, modify, investigate poor performance, or to complete permanent repairs.

All planned works originate in the areas, including those initiated by regional and British Telecom headquarters. Each task is formulated by an Originating Officer and agreed in consulation with the Maintenance Officer responsible for the plant concerned. Some planned works will incur a loss of service, so these are submitted to the Regional Network Co-ordination Centre (RNCC) for further study. The aim is to ensure that each planned work is a practicable proposition, incorporates the best engineering methods available in the circumstances, and will cause the minimum loss of service. Subsequent action by the RNCC depends on the scope and nature of the proposed work.

Form A60

If these conditions are met, work involving a loss of service to amplified circuits routed on physical pairs is approved by the RNCC. Form A60 – notice of an out of service – is prepared and issued by the area's Circuit Provision Control (CPC) to all controls concerned on the advice of the originating officer.

The initial treatment of all planned work affecting high frequency (HF) plant is identical to that for audio plant. Temporary re-routes to maintain service on high-capacity coaxial line systems (960 and 2700 circuits) are arranged by the RNCC. Final approval is given to the Originating Officer by the RNCC after consultation with other RNCCs, the National NCC and any necessary RHQ/THQ specialist groups.

Each planned work is examined to ensure that out-of-service requirements are appropriate to the work to be done. All details of re-routes are recorded to prevent double bookings. The NNCC also ensures that the total planned works in progress at any one time does not seriously deplete the national network. Additionally the interests of customers renting special circuits have to be safeguarded – radio and TV, Gas and Electricity control circuits, for example. Finally, a check is made to see if other planned work affecting the same plant during the same period is possible. Requests for A60s to withdraw HF plant from service have to be approved by the NNCC. A60 preparation and distribution is the responsibility of the THQ A60 group.

The SPN

The re-routes mentioned earlier comprise coaxial line systems forming the Service Protection Network (SPN). These line systems are provided as dedicated spare links between major repeater stations. They are brought into use to by-pass faults on normal routes, or to permit work to be undertaken on a traffic-carrying system which otherwise would have required an A60 for an out-of-service during preferred hours. Preferred hours are: midnight Saturday-5pm Sunday and 11pm-midnight Sunday; and on other days, from midnight-6am and 11pm-midnight daily. Patching used to be a manual operation which introduced momentary interruptions (MIs) to service, and for this reason patching was restricted to times within preferred hours. Nowadays nearly all transfers to the SPN are accomplished using high-speed switches operating within a few microseconds. While it is no longer necessary to restrict switching to preferred hours, it has been found more convenient – for SPN booking purposes – and less fallible, to switch at 8am daily.

Useful references

This article has dealt briefly with planned works and the Service Protection Network. Three TIs deal with the subject in detail and should be read by staff undertaking planned work and those wishing to expand their knowledge.

E1 A1457 Foreseen Interruptions to Service and Withdrawal of Plant from Service for Engineering Works
E1 A1510 Service Protection Network – General Description
E1 A1511 The Service Protection Network Operation and Management

01-357 2280

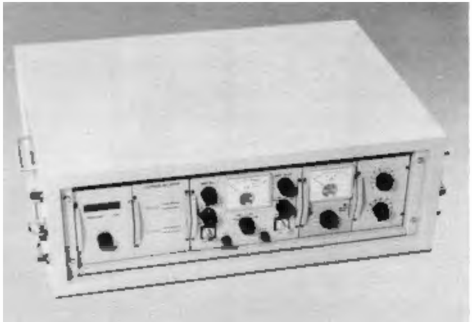
Second harmonic testing of coaxial cables

by **Dave Haffenden** NE/T5.1.2

Occasionally defects occur in coaxial cables which are only brought to light by intermittent variations in pilot level on the associated transmission equipment. This type of defect – known as a high resistance (HR) – normally only occurs in the soldered joints of the older 2.6/9.5 type of coaxial cable, although some trouble has been experienced in the 'back joints' and terminations on 1.2/4.4 type cable. Pulse echo testers can sometimes be used to locate these defects, but the high voltage pulses have a tendency to temporarily 'seal' the defect giving the impression of a good coaxial pair. All 1.2/4.4 and 2.6/9.5 type cables laid since 1970 and most new joints made on existing cables (due to roadworks, length replacement and so on) have used the 'all brazed' jointing technique. This causes little trouble for 'straight' joints – but 'back joints' and terminations are still soldered.

HR joints

These have a very small DC value but they exhibit non-linear characteristics. An oxide layer forms between the conductor and the



Tester 238A

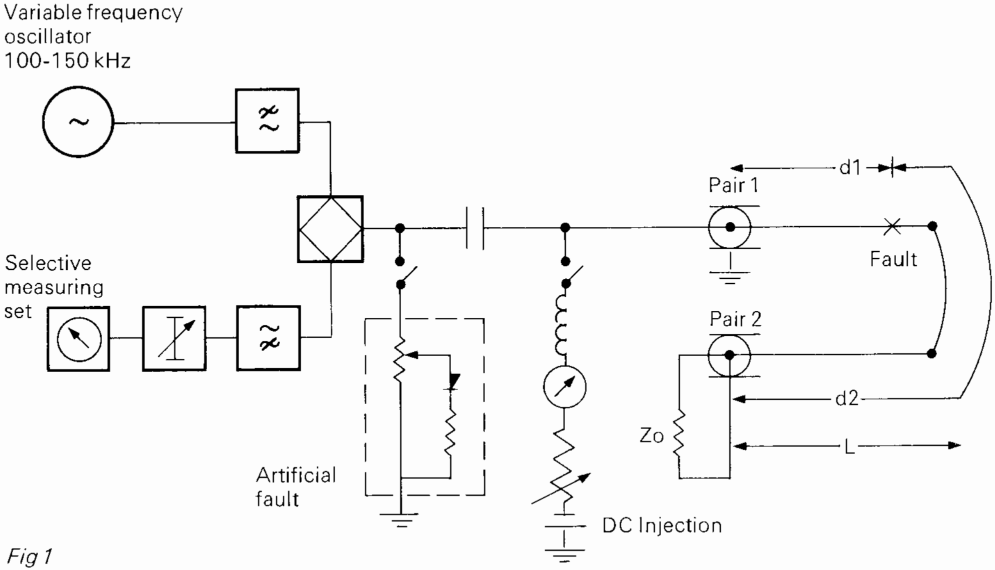


Fig 1

ferrules causing 'diode' action. HR joints can be caused by:

□ bad soldering
□ solder decomposition
□ unsoldered joints – these become apparent later when the copper oxidises
□ cable creepage
□ vibration.

Second harmonic test

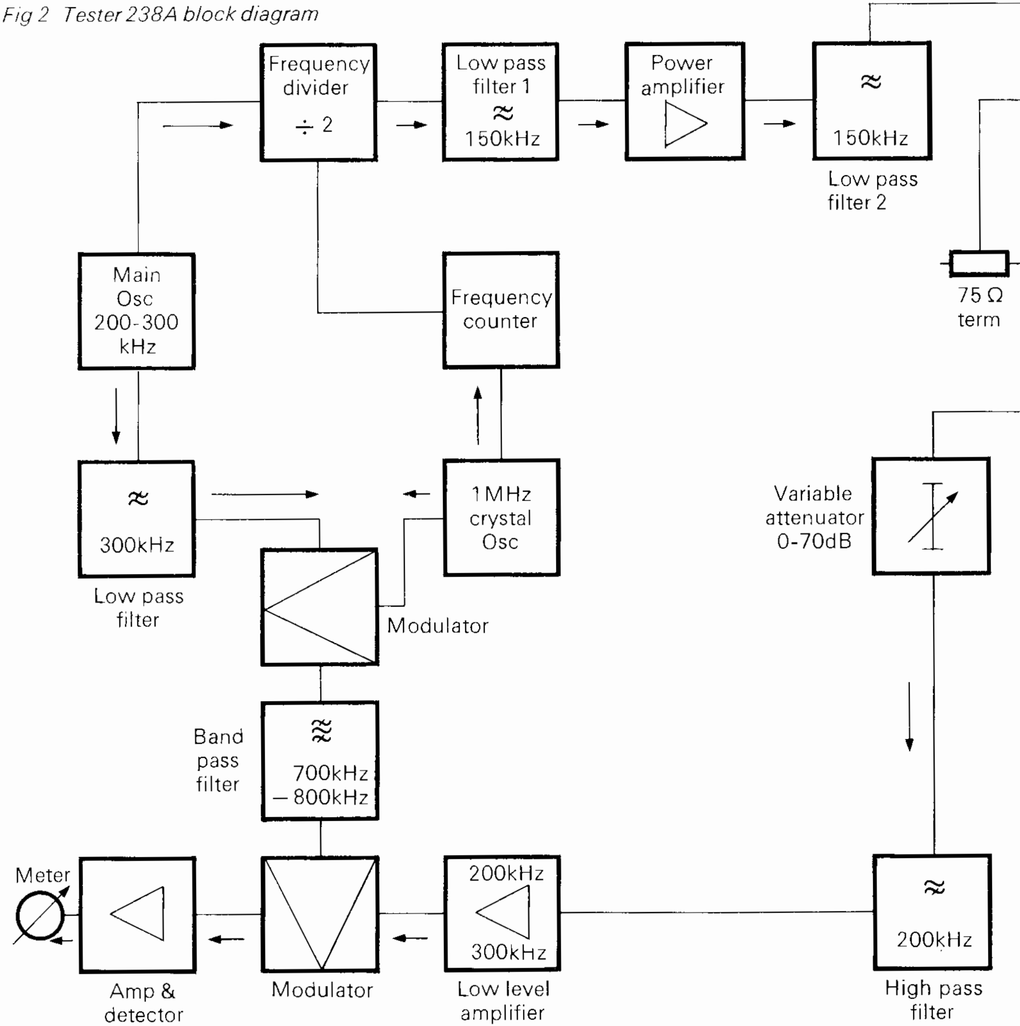
HR joints can be located by the second harmonic test – Fig 1 – which uses the non-linear characteristics of the defects to produce harmonics, the second harmonic being the larger. The output of a variable oscillator is connected through a low-pass filter to the transmit terminals of a hybrid termination. The signal at the receive terminals of the hybrid is connected to a high-pass filter and then to a selective measuring set, tuned to twice the frequency of the sending oscillator. The 'transmit' filter passes only the fundamental frequency of the oscillator, whereas the 'receive' filter passes only the second harmonic generated by the HR fault; other unwanted frequencies are suppressed. The faulty coaxial pair is connected to the 'line' side of the hybrid and is correctly terminated at the far end to prevent signal reflections. An artificial fault – a small diode and variable resistance – is also connected in parallel with the cable to the 'line' terminal of the hybrid. Second harmonics are produced in both the real and the artificial faults. By varying the frequency of the sending oscillator, the second harmonic produced goes in and out of phase. This effect registers as peaks and troughs on the level measuring set. The frequency at which these occur relates to the distance between the 'real' and 'artificial' faults. By noting the frequencies at which the troughs occur the mean frequency interval (MFI) can be determined. This is used to calculate the distance to the fault using the formula

$$\text{Distance} = \frac{V}{4 \times MFI} \text{km.}$$

Where V = Velocity of cable in km/second
MFI = Mean Frequency Interval

The frequency of the peaks – when the harmonics are in phase – can be used but, because they are far less sharp, it is more difficult.

Fig 2 Tester 238A block diagram



Normally, coaxial pairs can be looped back to the sending end using another pair so enabling tests to be made in both directions around the looped pairs. By combining the two results the term for the velocity of the cable is eliminated, so the distance to the fault becomes

$$\text{Distance} = \frac{2L \times MFI(2)}{MFI(1) + MFI(2)} \text{ km.}$$

Where L = Length of coaxial pair
MFI(1) = MFI for coaxial pair 1
MFI(2) = MFI for coaxial pair 2

Sometimes a fault behaves like two rectifiers back-to-back. In this case, the harmonic level produced by the fault can be enhanced and stabilised with a small DC voltage applied to the coaxial pair. The polarity can be reversed if required during the test.

□ **Tester 238A**

Second harmonic testing can now be done using the Tester 238A shown in the photograph. It has been found by experiment that the best fundamental frequency range for this location technique is 100-150 kHz.

Fig 2 shows the main elements of the tester which is based on the principle described above. It contains a pure sine wave generator, hybrid, attenuator, high-pass filter, amplifier and measuring set. The measuring set has a direct frequency input which is twice that of the sent fundamental frequency. This is modulated with a 1 MHz local oscillator and filtered to produce frequencies in the range 700-800kHz. These are modulated by the incoming received harmonic from the fault, and the resultant signal detected, amplified and displayed on the meter. By this method the measuring set automatically tracks the second harmonic as the fundamental frequency is varied, eliminating an otherwise tedious, manual process. It is a simple and quick operation to identify the number of peaks or troughs in the frequency range and to obtain an accurate measurement of the MFI.

Test limitations

In practice the second harmonic test is accurate to within ±100 m – the nearest joint in most instances. But three conditions must be met to achieve this accuracy:

□ Only one fault should exist on the coaxial pair. This should give a reading of at least 10 dB on the tester to allow the troughs to be easily seen on the meter.

□ The fault must be at least 1.4 km from the testing end, to obtain at least two troughs so that the MFI can be determined. Sometimes it is necessary to transfer the test equipment to the remote end and test from there.

□ The fault must be steady. Otherwise any level variations of the second harmonic produced by the fault will be confused with those of the fundamental frequency which is varied during the location procedure. This would result in a false MFI being calculated.

Tester 238A availability

A small number of testers have been produced and are available for use from regional Service Divisions by area Precision Testing Officers (PTOs). Help in operating the tester can be provided, although training in its use is included in the PTOs Training Course 626 held at BTTC Stone.

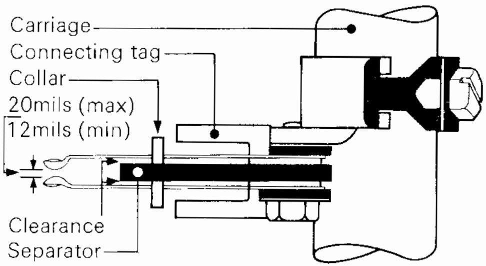
01-432 1310

Wiper-to-bank noise in Strowger exchanges

by **Norman Paine** NE/ES9.3.3

We have received reports that some Strowger exchanges are experiencing noise problems apparently due to poor electrical contact between the wipers and banks of two-motion selectors. Although this can be due to dirty banks it is more often caused by incorrectly adjusted wiper tip gaps. If the gap is too wide the wiper-to-bank pressure is insufficient to ensure a good electrical contact and any slight movement of the wiper on the bank caused by vibration can lead to noise.

Although the wiper tip gap can widen in the period between block routines, the most usual reason is the incorrect adjustment of the tip gaps when the block routine is being applied. This is commonly due to staff not using the correct gauge to set the gap. The correct gap is 12-20 mils and must be checked using the Gauge Feeler No. 2 – as specified in the Maintenance Adjustment and Block Routine TI. No matter how experienced staff may be, it is very difficult to judge the correct tip gap accurately and consistently by eye. This is especially so when the shapes of the wiper tips are subject to manufacturing variations and wear.



Clearance between wiper tips when off the bank

The value of wiper tip gap stated ensures good wiper-to-bank contact as well as maximum wiper and bank life. This has been confirmed by many years of research and measurement in Strowger telephone exchanges. The success of block routines at the recommended periodicities, relies on the correct application of the TI methods, including adherence to the recommended adjustment values. The illustration taken from *TI E6 H5156*, shows the correct gap setting. So it is essential for all staff performing routine work to use the specified tools and gauges when checking and making adjustments to any equipment.
01-432 1346

Modernising telex

by **Dave Nutbeam** NE/ES2.3.1

MN 13 outlined a plan to replace some of the Strowger telex exchanges with stored program control (SPC) exchanges. The first stage of this plan is now under way and we are able to bring you up-to-date.

Since our last article (Spring 1978) the choice of system has been made, and a contract for the first 11 exchanges has been placed with GEC Ltd.

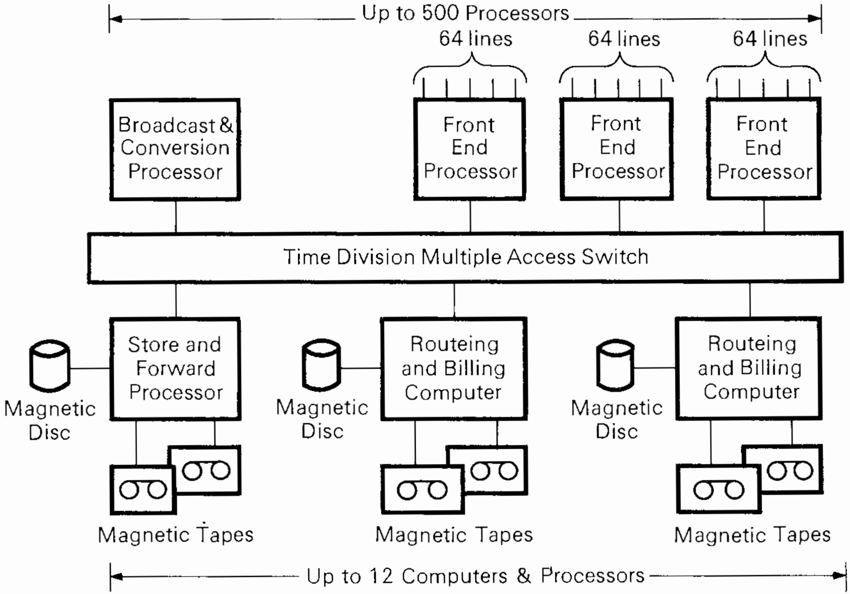
The system was designed by the Canadian Marconi Company – an associate company of GEC – and first used for an international telex gateway exchange in Montreal.

The facilities offered by the exchange are broadly similar to those mentioned in *MN 13* so this article concentrates on the make-up of the exchange and the tasks done by the various parts.

The exchange line cards have ±12v 4-wire interfaces. This transmission method will be used for connection to time-division multiplex (TDM) and voice frequency (VF) equipment located in the same building. For longer distances and for physical customer lines ±12v 4-wire to ±80v 2-wire converters will be provided.

The block diagram shows each Front End Processor (FEP) serving 64 lines. The FEP is microprocessor controlled and looks for call starts, returns proceed to select signals, monitors call clears, and so on. When a call is originated, the FEP receives the selection information and passes it to a Routeing and Billing Computer (RBC) for processing.

The RBC contains a mini-computer which uses information stored on a magnetic disc to identify the called line (or trunk group) and checks that the line is able to receive the call. If all is well the RBC 'introduces' the calling FEP to the called FEP and allows them to 'converse' directly. The RBC then disengages from the connection and is not involved



again in that call until it clears down.

All these communications take place through the Time Division Multiple Access (TDMA) switch. This is a hardware multiplexing device allowing very fast intercommunication between processors, each call being allocated a different time slot through the TDMA.

The FEP also passes data to the RBC for later production of statistical and accounting information. This raw data is recorded on the RBC's magnetic tapes at the beginning and end of each call. The tapes are processed on-site using the exchange hardware to produce formatted statistics on the exchange line-printer and magnetic tape, and an accounting record on magnetic tape.

The other two units shown are the Broadcast and Conversion Processor (BCP) and the Store and Forward Processor (SFP). 'Broadcast' calls are those to several customers simultaneously and are made by keying a special code. When the RBC 'sees' this code it introduces the calling line's FEP to the BCP which sets up the broadcast. The 'conversion' function will be required when a call is made to a customer or trunk circuit working at a different speed or using a different code. These facilities will be provided at a later stage. In this case the RBC automatically directs the call to the BCP which carries out the necessary conversion and relays the data to its destination. The BCP comprises the same hardware as an FEP but with different software.

'Store and Forward' calls – those made to the exchange for onward transmission at a later time – are dealt with by the SFP. The call destination and the message text are recorded on the SFP disc and transmitted at the required time by the SFP. The SFP also records the call details on tape for statistics and accounting. It comprises the same hardware as an RBC but uses different software.

All communications take place via the TDMA switch which is triplicated to reduce to a negligible level the risk of the TDMA causing an exchange failure. The RBC is also crucial to the exchange working and this is safeguarded by providing one RBC more than is required to handle maximum traffic. If one RBC is removed from service the others automatically continue to handle its calls.

FEPs, BCPs and SFPs are not duplicated but spares are held at the exchange. This results in one fault only affecting a maximum of 64 lines or one facility.

Part of the Montreal Gateway Exchange by courtesy of GEC Ltd

Timescale

The first model was installed at British Telecom's Technical Training College at Stone in time for the first training course in January 1981. The first exchange will be brought into service at Sheffield about mid-1982 and it is planned to bring Guildford, Manchester and Birmingham into service in the same year. In 1983 four exchanges will be replaced and these will be followed by the remaining three early in 1984. The strategy for further modernisation for the period beginning 1984 is now being considered.

It's worth mentioning other new developments associated with the SPC programme. These include the 4-wire 12v to 2-wire 80v converter mentioned earlier (Unit Telegraph 52A) ; a new 4-wire Engineering Control Board using smaller plugs and jacks ; and a completely redesigned Test Desk with VDU.

01-432 1320

A strategy for improving the repair service

by **Denis Webb** ES5.1.4

In recent years the Repair Service has not been performing as we would wish to see it and considerable customer dissatisfaction has been expressed with this key service. Viewed nationally, the frequency with which plant becomes faulty is too high, the speed of fault clearance is too slow, and there are markedly different local levels of performance.

Jointly, THQ and regions have sought solutions to this situation and identified the underlying causes and 'road blocks' preventing necessary improvements. This appraisal found that the present repair service organisation and staffing arrangements have a number of basic weaknesses hampering efficient operation.

Organisation weaknesses

Repair Service Controls (RSCs) – the heart of repair operations – are organised on a mixture of direct, indirect and filtered systems for receiving customers' fault reports. Additionally, during evening, night and weekend periods fault reports are almost entirely received at Auto-Manual Centres (AMCs). Thus, in over half the reported cases, customers have not had direct access to the organisation responsible for handling fault reports.

Direct access to the organisation which has the responsibility for the speedy and effective clearance of customer-reported faults has fundamental benefits for the customer. But the current organisation of RSC work does not enable all those benefits to be realised.

Staff manning RSCs are the most senior of the combined RSC/field repair force but their background and experience, which play a vital role in diagnostic, fault distribution and control functions, are not particularly suited to speedy and effective RSC reception work. Also, by past agreements, they are confined to RSC work and consequently can become out of touch with recent developments in customer apparatus.

Reliefs for RSC personnel are currently drawn from the field repair force which can result in its depletion during periods of high fault incidence – with undesirable affects on fault clearance capability.

RSC facilities, equipment and accommodation are inadequate to support a first class service. They have evolved by adaptation over a long period – from the days of a test position at the end of a manual exchange multiple, through early automatic own-exchange test desk operations, to the present situation where faults are received and controlled for a territory extending from a few to a large number of exchanges of all types. This has taken place against the background of a very large increase in the size of the telephone system.

A fundamentally important aspect emerging from the appraisal, to be set against these organisational shortcomings, is the undoubted skills and dedication of repair service staff who, as individuals, do a competent job in difficult circumstances. It was clear from the appraisal that the complex nature of the changes needed to achieve an improved, enduring, repair service required a strategic plan setting out the general objectives and means of attainment so that all those involved could contribute to its detailed development and realisation.

The remainder of this article describes the main provisions of the repair service strategy, and the changes proposed to repair service arrangements.

24-hour RSC working

A prime objective of the strategy will be to establish an integrated repair service organisation providing a 24-hour, seven-days-a-week fault repair service which is responsive to customers' needs. This will mean bringing all RSCs within a direct fault reporting organisation. It will not however be practicable to provide an effective answering service at RSCs handling less than 20 000 fault reports a year, so fault reports for these will be taken at suitably located RSCs large enough to support a reception unit. Out-of-normal hours, the repair service organisation and control will fall back to one or more RSCs within a telephone area staffed to deal with this work. The fault clearance levels during out-of-normal hours are not expected to change from those at present and will be dealt with by existing call-out arrangements.

Functional working in RSCs

The strategy proposes that in future work done in RSCs will be functionalised so that staff may use their training and experience to best advantage within a team. Two main functional areas are envisaged

- reception and record work
- diagnostic testing and distribution work.

Reception and record work will be done by Customer Service Officers (CSOs) initially drawn from the telephonist operating force and existing technicians employed on RSC work. This recognition of the aspirations of existing, separately represented, groups within the Business possessing most of the reception function skills – against a background of preserving job opportunities – is seen as a critical element for implementing the strategy's staffing arrangements.

Complementing of CSOs will be based on fault report traffic patterns, so as to achieve the required answering standard of 75 per cent of calls answered within 25 seconds, and on record work based on registered reports. Relief staff to cover normal absences will be provided on a telephone area basis.

The diagnostic testing and fault distribution work will be the responsibility of Technical Officers (TOs) and Senior Technicians (STs).

Complementing will be based on work loads derived from registered fault reports, with the proportions of TOs/STs determined by applying existing criteria. An important provision in the strategy is for RSC STs to spend 13 weeks each year on field technical support work. This should broaden their knowledge of customers' equipment and enable them to keep up-to-date with an increasing variety of customers apparatus. Similarly TOs will spend part of their time on their own non-RSC discipline to refresh their knowledge and skills.

The basic complements of TO/STs in areas will be enlarged to provide relief cover. Broad calculations indicate that the total number of TOs/STs required to implement the strategy will be substantially the same as present. To cover a few situations, when a local excess of complement is identified, introductory arrangement guarantees have been given which will ensure that improved service objectives and system growth will enable a smooth progression to the appropriate staffing levels to be achieved.

The TO/ST provisions taken together with the introduction of CSOs will give a net increase in RSC staff and, because there will be no longer any need to draw on field resources during periods of RSC staff leave, there will also be an effective increase in field fault clearance capability.

Modernisation of RSCs

The section of the strategy dealing with the modernisation of RSCs proposes that these be located in accommodation with a direct fault reporting atmosphere, free from intruding noise and other distractions. Where necessary, expedient measures will be undertaken to ensure lighting, ventilation and noise standards are achieved at existing locations.

It also envisages a series of independent but linked projects which, overall, form an integrated logical system for providing RSCs with modern test, administration and statistical facilities. Each will be subject to field evaluation under normal joint code of practice arrangements with the unions concerned. These will be described more fully in later *MN* articles but a brief introduction is given here for the sake of completeness.

Modular RSC equipment

This consists of three desk-top modules providing test, test access and communication (with improved 151 answering) facilities. Its modularity permits the phased introduction of additional or replacement units associated with other projects with minimum on-site disturbance to RSC staff – see *Desk-top equipment for RSCs* in *MN 8* for a full description. It is now in service at 33 RSCs and a further 86 are scheduled for installation by mid-1983.

Fault analysis system

The optical mark read fault docket and fault analysis system (FAS) project is currently on field trial and employs a specially designed docket which replaces the normal manuscript docket used for progressing fault reports. The progress of a fault and its 'clear' details are recorded at the RSC by a series of marks entered in pre-printed boxes Individual dockets are then batch-posted to centrally located optical readers which produce a tape for computer processing to input into FAS. The FAS consists of a suite of mainframe computer programs capable of producing a range of outputs covering plant and service quality performance statistics including the existing form A51 analysis.

Remote line test equipment

This is a microprocessor controlled system consisting of visual display terminals (VDTs) in RSCs which, using normal quality private circuits, can access remote automatic test equipment in each exchange. The VDT will replace the test and test access modules of the modular equipment. Test results will be displayed on the VDT at the RSC and include

- automatic check for AC mains contact immediately a line is accessed for test purposes
- automatic line insulation tests comprising insulation resistance from line to earth and across the pair, and insulation resistance of any battery contact fault
- more comprehensive line tests consisting of insulation tests as indicated above plus three capacitance tests, A wire to earth, B wire to earth and across the pair
- the system will also provide a local line routiner facility directly operable by the repair service.

Remote line test equipment is expected to be on field trial at two RSCs by April 1981.

Administration system

A further major project under development is an on-line, computer-based RSC administrative system (known as ARSCC), using local mini-computers within the direct control of the repair service. The objective of this project will be to improve the service provided at large RSCs (initially) by enabling reception, diagnosis and distribution staff to 'talk' to the system using VDTs. Supervisory and records duties and certain other associated controls, for example EPMCs, TMCCs, will also have access to the system.

The mini-computer will store fault history and customers' permanent information – equipment and circuitry installed – which will replace the existing A700 series of cards and filing arrangements. There will also be an 'in hand' category of information which will enable RSC staff to hold and track all reports received and assemble them into lists appropriate to the various duties for access as required as work progresses. Statistical counts and returns will be produced automatically. The system will also provide RSC management statistics and an input to FAS. The process of converting RSC customers' permanent records at two RSCs has already begun in preparation for the start of a field trial in November 1981.

The remote line test and administrations will be linked by further development once their viability as separate systems is proven.

Implementation

The detailed implementation of the strategy will be drawn up in consultation with the representatives of those involved in the change. The introduction of full direct reporting within an integrated repair organisation, and changes to RSC staffing and functional working, have already been progressed at national level and await endorsement by the constitutional processes of the unions concerned. Areas have already begun planning for this aspect of the strategy so that implementation delays can be minimised.

Although those involved consider much has been achieved in formulating the strategy it is tinged with the knowledge that the bulk of the work has yet to start. Nevertheless it is clear that the repair service is at the beginning of a period of a radical and highly beneficial series of changes involving substantial investment in capital and staff resources, with the declared intent of making it second to none of the world's telephone administrations within five years.

This is a worthwhile objective deserving the support of all levels in the Business having in mind what it means in terms of staff satisfaction at a job done well and, most importantly, to the quality of the service provided for our customers.

01-432 1390

LTR makes the MOST of its RT13s

by **George Smith** LTR/SV214

A description of the type 13 RT equipment and the plans for it to replace director exchange short holding equipment appeared in *MN 14* in Spring 1979. Here the experiences of LTR staff who install and maintain this equipment are outlined.

LTR has now brought into service more than half the planned 165 type 13 RT installations, and hopes to install the rest by mid-1981. Engineering staff associated with its introduction, have had to overcome many obstacles before reaching the present number of working installations.

Introducing type 13 RTs into service

It soon became obvious that close liaison between installation and maintenance staff would be essential if replacement of working short holding time equipment with RT 13 was to be completed without disrupting service. To achieve this a meeting of interested staff is arranged at each installation about two weeks before change-over to RT 13 equipment. The topics covered include

- spare plug-in unit and component availability
- essential modifications before bringing into service
- change-over method and timing
- known difficulties and advice on action to be taken should such problems be encountered
- reminder to report any unusual defects or difficulties using the A646 procedure.

These on-site exchanges of views have proved effective in assisting a smooth change-over of equipment and will be continued until the installation programme is complete.

Maintenance

The RT 13 equipment is largely self checking with in-built facilities which include

- monitoring live traffic by comparison with a test register
- passing 10 test calls through each register every night
- continuous validity check of the data stored in each translator
- self busying of registers if they are seized incorrectly on 10 successive occasions.

Fault information gathered by the self testing facilities is output on a teleprinter associated with the RT 13 equipment.

Interpretation of the fault print-out varies in complexity. In the case of a faulty integrated circuit (IC) in a translator store it is relatively easy to detect not only which translator is faulty, but to identify the actual IC which is defective. Unfortunately most of the fault print-out information is not so easy to interpret as many print-outs are caused by design anomolies on the RT 13 rack itself. So it requires the expertise of the trained staff to determine which plug-in unit, if any, is faulty.

Having proved the fault to a plug-in unit, the unit is fitted on an outrigger giving access to the printed circuit board (PCB) to allow localisation of a defective component. Some difficulty has been encountered with multi-IC units as it is sometimes extremely difficult to determine which of two ICs is defective. This can lead to unnecessary replacement of working ICs and a reduction in maintenance spares as a result.

To reduce fault liability all components are soldered directly into the PCB without the use of IC holders. As a result removal of components requires an unsoldering operation, which in the case of IC removal can be difficult. But experience has proved that, used with care, the aspirator and soldering iron provided are satisfactory.

Assistance for maintenance staff

The method adopted to give advice and support on all aspects of RT 13 equipment is a series of *Type 13 RT Information Notes*. These are issued to all maintenance staff by LTR Service Division. The notes give advice on stores ordering procedures, modification of outriggers and so on, but the most comprehensive is Note No 7, which gives technical information about known fault conditions. The notes are updated regularly to advise staff of new problems. This information saves the time of maintenance staff as it helps locate certain faults and avoid duplicating detailed work when more obscure fault conditions are met. Copies of *Information Note No 7* have been supplied to THQ and all RHQ Service Divisions. (Enquiries or requests for copies should be made to the appropriate Service Division).

Service-affecting problems

A number of serious design defects have been encountered which in some cases, resulted in complete failure of the RT 13 equipment, preventing any calls originating from an exchange for a period of time. There have been at least 20 cases in LTR when outgoing service has been affected in this manner. The duration of this condition has varied from one minute to several hours depending whether the exchange was staffed at the time the fault occurred.

Many weeks of investigation by LTR staff – in association with THQ and the manufacturer (PYE/TMC) – has led to a number of circuit modifications which have overcome most design weaknesses. Investigations will continue until all 'known' problems are resolved.

Benefits

Despite the problems mentioned customers served by exchanges fitted with RT 13 equipment generally experience a markedly improved service. This improvement is shown in the service observation results which measure the number of local calls which fail due to British Telecom plant (TSO, TIP3). A similar improvement is also being observed by the measurement analysis centres (MACs) which are operating in some LTR areas.

It is reasonable to expect more customers will benefit from fewer plant failures as the number of RT 13 installations increase and the design problems are overcome.

One RT 13 facility which has proved to be of particular benefit to LTR, is the ability to 'key-in' a new route translation, or change an existing translation quicker than it takes to alter the translation field wiring of a single Strowger director. This is significant at a time when LTR is involved in major route re-arrangements due to the final stages of the Sector Switching Centres (SSCs) programme including the closure of some Strowger tandem exchanges.

The facility which locks an RT 13 register out of service if it is incorrectly seized on 10 successive occasions, is proving to be very useful in detecting certain Strowger equipment faults. Exchange staff keep a simple record of the registers which have 'locked-out', and can see if those registers are seized by a common part of the first code selector to register grading arrangement. If this is so investigation of the Strowger equipment usually reveals a fault condition. A large percentage of register lock-outs particularly in the early months of RT 13 service, are caused by Strowger fault conditions. The more common faults found in this way are:

- ☐ 'A' digit hunter wipers touching adjacent brush feeds on late choice outlets.
- ☐ 'A' digit hunter bank outlet or distribution frame wiring disconnected.
- ☐ First Code Selector LSA (or equivalent) relay out of adjustment.

Early difficulties with the type 13 RT equipment unfortunately delayed the introduction of a system which gives very good service when working properly.

LTR is now looking forward to completing the RT 13 installation programme, and benefit from the contribution that LTR staff have made towards making the RT 13 a more reliable system.

01-587 8565

Don't plan a service interruption

by **Eric Harcourt** NE/T5.1.2

Construction and maintenance work on the trunk and junction network is unavoidable and in some cases, will lead to foreseeable interruptions to service. If the work involves individual traffic circuits its effect is easily minimised by contacting the circuit control and 'busying' the circuit. Other work affects large groups of both private and public circuits and special measures are necessary to minimise the effect of the interruption. These measures are covered by the procedures detailed in *TI E1 A1457*.

The article 'Planned Work', elsewhere in this issue, briefly describes the procedures involved. This may result in plans to re-route large groups of circuits – for example Regulated Line Systems (RLS) – over the Service Protection Network (SPN) or over spare line plant.

If the interruption of RLSs can be avoided by re-routeing, the National Network Co-ordination Centre (NNCC) issues details of the re-routes required and, provided these are implemented and the planned work carried out during the agreed time, our customers will be unaware of it. If re-routeing is not feasible, the NNCC authorises the issue of an A60 advice which is distributed to all group and circuit controls responsible for circuits that are liable to be interrupted.

Usually this procedure works satisfactorily, and most planned works proceed with little service interruption, *but it is not infallible.* There are several points along the path at which a small error can upset the whole plan. For example, a mis-quoted, or badly written, cable name or number can result in an incorrect cable being cleared of traffic – an error which perhaps only the originating officer will recognise. Another hazard is that of starting the work before the agreed time, something which the officer responsible for the execution of the work should ensure never happens.

A further hazard exists with the setting-up of the re-route circuit and switching of traffic. If for any reason the officer responsible for diverting the system is unable to complete this before the agreed starting time for the planned work, it is imperative that the work be delayed. To this end that officer must contact a responsible transmission maintenance officer before the work is allowed to start in order to verify that the systems have been re-routed. In the case of work on external cables this will be the nominated cable control.

If the planned work is on external cables there are two other points to emphasise.

□ If the work involves interrupting a cable, check by tone testing with oscillator, probe and amplifier that the correct cable is about to be interrupted.

□ If work involves some other authority – a roadworks contractor for example, stress the importance that work should not begin near the cables before the agreed time.

Foreseeable interruptions are acceptable, they need careful planning, *but don't plan a service interruption.*

01-432 1306

London's sector switching centres – SSCs

by **Derek Bull** LTR/SV312

The Sector Plan resulted from the study carried out in 1963-65 by the London Trunk and Junction Task Force. A Sector Switching Centre (SSC) in each of the seven outer areas of the London Charge Group (LCG) – which would have been difficult to accommodate in central London – was planned to cater for the growth forecast for trunk switching.

At present six SSCs are fully operational

Ilford – East Area
Ealing – West Area
Woodgreen – North Area
Colindale – North West Area
Kingston – South West Area
Eltham – South East Area

The first unit to be brought into service at Croydon SSC (South Area) will be the tandem in mid-1981.

From the service viewpoint, decentralisation of trunk switching units has given GMs in outer areas much closer control of their trunk service, and allowed partial modernisation of the trunk network – giving scope for improvements in quality of service and productivity.

With SSCs available as locations for tandem units, greater flexibility in switching within director area traffic has been achieved. Also with Trunk Maintenance Control Centres (TMCCs) and Auto-Manual Centres (AMCs) located in close proximity the GMs control of local service, private circuit and operator service has also improved.

Switching units

Each SSC has discrete switching units for incoming trunk, outgoing trunk, and tandem traffic.

The switchblock is of proprietary design realised using TXK1 crossbar switching principles and is manufactured and installed by both Plessey and GEC. The register translator function is achieved using the stored program control (SPC) techniques of the GEC Mk1C processor. The peripheral relay groups AC9, AC11, and so on are generally of standard design adapted to conform to TXK1 mounting requirements.

The TXK1 equipment practice uses double-sided racks with equipment mounte on hinged shelves and protected against dust by transparent covers. The crossbar switch is of Plessey design with 10 inlets and up to 28 outlets. The relays are either RE type (a derivative of the PO 3000-type) or comb operated 501/502, with a small number of standard PO types.

In general connections are wire wrapped. The SPC equipment uses discrete components mounted on printed circuit boards assembled on plug-in units. The program and translator stores are hard-wirec which means that the procedure for changin the program or routeing information involve:

re-threading wire through a series of magnetic cores.

Maintenance

Only the peripheral relay sets in the units warrant a similar maintenance approach to that evolved for Strowger – such as regular night routining with prompt attention to service-affecting faults.

It is within the routeing and switching parts of the system that equipment design has most radically influenced the maintenance approach and affected staffing levels.

The SSCs employ a unique combination of electronic register translators and crossbar switches. The Mk1C SPC has shown itself to be extremely reliable and requires little maintenance attention – it includes numerous self-checking facilities including systematic translation checks. Compared with its Strowger counterpart, the crossbar switch is a simple device requiring no lubrication, no regular adjustment, and no automatic routining.

Every call set-up is subjected to a number of tests by the SPC/crossbar control equipment culminating in a continuity/reversal test before being switched through. Failure of any test results in a second attempt over a different route path being initiated automatically, without the customer being aware that a fault has been encountered. Details of the failure, state of the call, equipment involved and so on, are printed-out on teleprinters to enable patterns to be detected and remedial action taken. Its second attempt feature means that the switching equipment is fault tolerant, so faults need not be dealt with as they arise. A number of incidents are allowed to occur, enabling patterns to be detected, before remedial action is taken.

The accent is therefore on corrective rather than preventive maintenance with staff employed mainly on analysing information to identify faulty items of equipment.

Maintenance aids

A well equipped diagnostic room is provided with each switching unit.

The most useful aid is an Equipment Monitor which accepts fault information on live traffic for print-out on associated teleprinters. There are also Out of Service detectors which identify any working crossbar switch outlet which has not been in use over a twenty-four hour period. A Busy Display panel shows when Router Controls and Office/Junction Markers are in use or are busied out. A Service Measuring Circuit monitors the performance in the switchblock. An alarm is given when a pre-set ratio of 'total seizures' to 'total effective calls' is exceeded, or an imbalance occurs in the number of effective calls handled by the two parts of the Main Router. An automatic Call Trace Equipment is also available to display call path information automatically from a known outgoing or incoming circuit.

Print-out

The majority of print-out produced by the Equipment Monitor is associated with:

- Peripheral relay groups, and is generated by routiners running at night. Each report gives details of a fault within a specific relay group.
- The switchblock and the common control equipment, and gives details of all failed attempts (first and second) to set up a call across the unit. Priority is normally given to the clearance of routiner generated print-outs as relay groups do not benefit from the second attempt feature.

Analysis of the print-out

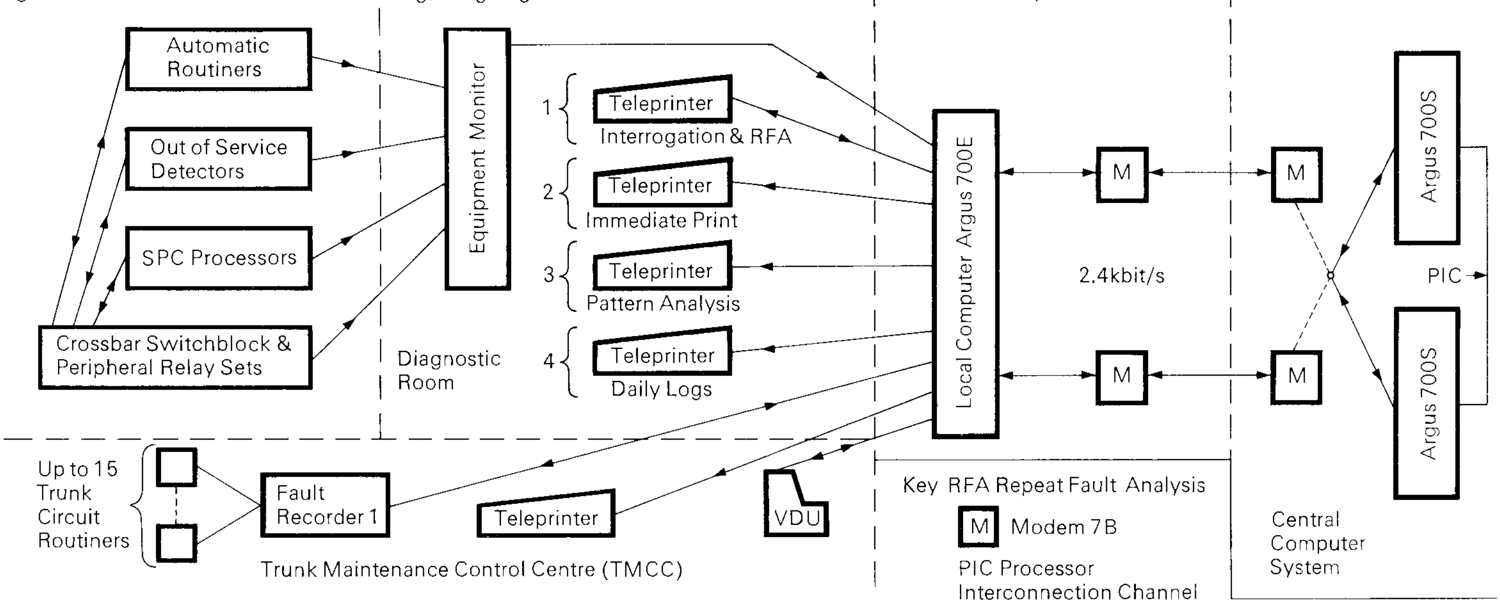
The original GEC design relied on the Service Measuring Circuit alarms to alert maintenance action. But British Telecom were not content to rely on this approach and specified that information relating to all call failures should be recorded. A considerable amount of analysis is involved with this approach and computer assistance has been used. Initially a batch processing scheme was operated using a data processing centre but recently a Ferranti on-line computer system, developed to British Telecom specification, has been brought into use and is now undergoing final acceptance tests.

On-line computer scheme

Two Ferranti Argus 700 S computers (main and standby) have been installed at North West Area's SSC, complete with peripheral storage and environmental control equipment, to act as the hub of the system. They are connected via data links to each of the SSCs where a Ferranti Argus 700 E computer is provided to serve the incoming trunk, outgoing trunk, and tandem switching units. The TMCC in each SSC is also served by the computer system which sorts and prints-out fault reports produced by the trunk circuit routiner fault recorder.

Fig 1 shows the basic computer system interface with the exchange maintenance

Fig 1



equipment. Input from the exchange equipment is taken in the form of reports from the equipment monitors, fault recorders and, using manual entry, from interrogation teleprinters or the VDU.

Processed information is presented via teleprinters in each diagnostic room or the TMCC as appropriate. On receipt of information from the computer, further analysis may be necessary to pin-point a particular fault. To help staff with fault location in the switching area and SPC, a series of diagnostic cards have been produced by THQ. These cards, which are referred to in computer print-out, give circuit elements and contacts most likely to be the location of faults in certain situations. They also indicate further tests or corrective measures required.

The majority of call set-up reports are switchblock related and may be 'time out' or 'loop check' in nature, depending on whether the failure is detected while setting-up the path through the exchange or during the subsequent loop check. These reports are stored in the central computer system at North West Area's SSC for up to 14 days and only reported to maintenance staff if a pre-set number (five, eight or 10 reports) refer to the same group of equipment.

Reports related to SPCs are printed locally in each SSC immediately the faults occur as well as the information being transmitted to the central complex. The central computer stores these reports for up to seven days and checks daily for faults which have been reported twice or more. Such recurring faults are reported as Recurrent Fault Action (RFA) reports.

Reports produced by routiners running at night are assembled by the central computer and presented each morning in routiner related blocks listed in access order. A record of these reports is also retained in the central computer for up to seven days so that RFA analysis can take place.

Counts of all fault types are maintained in the central computer and facilities are provided for the report files to be interrogated at any time in addition to automatic daily logging of reports.

Staffing the SSCs

Staffing levels derived from *TI E1 G1035* have proved adequate. A typical unit has six TOs and three T2As – this is approximately one-third of the staff required for an equivalent Strowger unit.

Management structure

The maintenance management structure typically comprises an EE in charge of the complex, with AEEs covering

- incoming trunk unit (and pcm)
- outgoing trunk unit
- tandem unit (and AMC)
- TMCC (and area fault control)
- repeater station and power

Role of the unit manager

The AEE is responsible for the maintenance of a switching unit. He has overall control and directs maintenance effort using such information as TSO results, night routining results, equipment fault pattern analyses, traffic meter readings and computer print-out statistics.

The AEE also assigns responsibility for the completion of precautionary and preventive routines (time-out checks, alarm tests, relay inspections) within defined areas of the unit. But staff do move across areas of responsibility when repairing faults or conducting special investigations.

The AEE's aim is for a compromise between the flexibility required to apply effort to the maximum advantage, the need for staff to gain experience in particular work areas, and the need to hold staff accountable for work performed.

The EE's role

Normally the staff in a unit work as a team – with their own AEE – but the EE views the total SSC performance to ensure that staff are most effectively deployed throughout the SSC and that activities are co-ordinated between the units – Switching, TMCC, Repeater Station, and so on.

Because the SSC affects – and is affected by – local performance, close liaison with maintenance sections throughout the area has also brought benefits. This has been particularly so with those responsible for local exchange maintenance.

Performance

At present, SSCs switch about 35 per cent of the trunk traffic into and out of the London Charge Group.

Despite having to contend with a variety of design modifications, and integration of extensions soon after opening, SSCs have significantly improved London's STD performance – this at much reduced staffing levels – a creditable achievement.

01-735 9737

Optical fibre line systems' maintenance

by **Eric Harcourt** NE/T5.1.2 and **Norman Rolfe** NE/T5.1.1

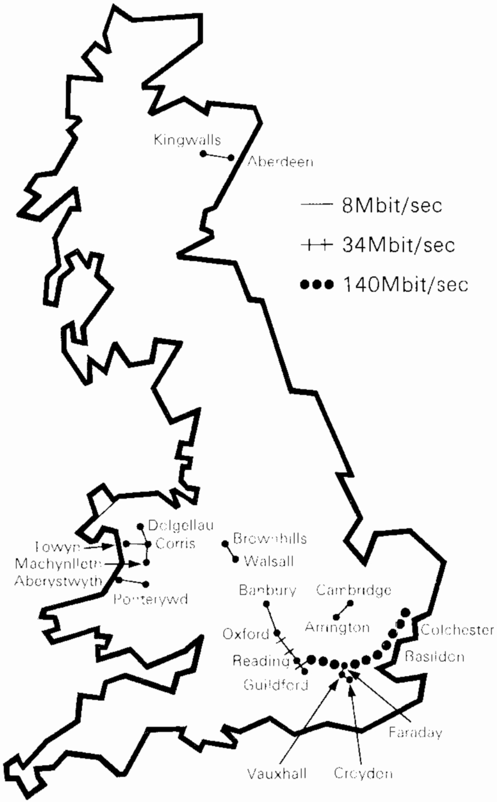
The use of light as a means of conveying information to a remote point is not new. The beacon fires of the Middle Ages and the sending of morse code messages by flashing lamp signals are just two systems which come to mind. The use of light as a carrier of information in a telecommunications transmission network was not, however, possible until the 1960s. At that time the development and introduction of digital transmission systems using pulse code modulation (PCM) provided a means of coverting analogue signals into a coded form suitable for transmission as flashes of light. About the same time, the development of the laser reached the stage at which the electromagnetic radiation fell within the visual spectrum. These two developments opened the door for an optical transmission system.

A transmission system which uses light as the carrier of information is very similar to the morse signalling mentioned above. This similarity led to the examination of the possibility of direct, line-of-sight transmission through the atmosphere – but rain and other conditions severely attenuated the signal and demonstrated the need for some means of guiding the light beam. The use of lenses and mirrors mounted at intervals inside a tube was considered, but the breakthrough came in 1970 when the Corning Glass Works, in USA, announced that they had produced a fibre of glass having a loss of 20 dB/km. Subsequent work in Britain, the USA, and other countries resulted in the development of low-loss fibres, having an attenuation of less than 3 dB/km at a wavelength of 850nm, and the packaging of these fibres into cables.

Proprietary systems ordered

To gain experience in planning, installing, operating and maintaining optical fibre systems, and to give British industry an opportunity to demonstrate its ability to manufacture and install such systems, British Telecom has ordered 15 optical fibre transmission systems working at 8, 34 or 140 Mbit/sec. Six of these systems – known as Proprietary Optical Line Systems (POLS1) – are being installed in the trunk network and nine in junction network during 1980/82. The routes chosen are shown on the map. Contracts have been placed for both equipment and cables and require two of the equipment manufacturers to engage a cable manufacturer as a sub-contractor. This is a departure from British Telecom's normal practice of placing separate contracts for cable and equipment. Although the original intention was for the cable to be laid and jointed by contract labour, it has subsequently been agreed with staff associations and the contractors, that most of the cable installation and jointing work will be undertaken by British Telecom staff.

In the specifications for POLS1 systems, British Telecom has specified only the bare essentials of the system and the safety requirements, leaving the contractors considerable latitude in the detailed ways in which they meet the total system requirements. This means that each contractor may adopt a different method to achieve the objective.



Routes for Proprietary Optical Line Systems

Standard being developed

In the external field this has resulted in variations in the design of the optical fibres, in the make-up of the cables, and in the types of joint closure used. Different fibre jointing techniques are also being used by each cable sub-contractor and, as most of the fibre jointing is being carried out by staff, arrangements have been made for jointers to receive initial training at cable sub-contractors. Also, a small nucleus of maintenance jointers will be trained in the techniques used on the cables installed in their areas. But British Telecom is also developing methods of fibre jointing with the objective that, eventually, only one method will be used for jointing new fibres installed in the network. Where possible this standard jointing, and a standard British Telecom sheath closure, will be used for maintenance jointing on the POLS1 cables.

Power feed and supervisories

All POLS1 cables will be polyethylene sheathed containing eight optical fibres. Those installed in the trunk network, and two of those installed in the junction network, will require intermediate regenerators, most of which will be housed in repeater cases in jointing chambers. Power feed for these regenerators ,and supervisory/ speaker circuits, will be routed over metallic conductors, usually included within the same cable sheath as the optic fibres but, exceptionally, may be routed in a separate metallic conductor cable. The power feeding systems will supply 50mA DC at either 75-0-75 volts to 250-0-250 volts. Both systems are inherently safe but the systems will be disconnected before jointing work is carried out on power feed conductors. As a further safeguard special current detector test sets are being introduced to enable jointers to verify that the power feed system has been disconnected. Faulty regenerators will be changed by external staff with the co-operation of internal staff.

Speaker and supervisory facilities are broadly similar to those provided on coaxial digital systems with the added facility of an advance warning of laser failure. This enables optical devices to be replaced at convenient times with the minimum effect on traffic.

Standard digital test equipment at terminals will monitor system performance. Optical testers will measure optical output and, using back-scatter techniques, locate optical fibre faults. Existing techniques will be used to locate power feeding faults. Although expected to be highly reliable, each system is being duplicated as a precaution. The spare systems will be continually monitored to ensure readiness for service and to give a more detailed knowledge of system performance. In the longer term digital service protection network (SPN) facilities will safeguard service provided on 140 Mbit/sec optical fibre line systems.

The line terminal equipment is broadly similar to digital line systems using metallic cables. The obvious difference is the electro-optical interface devices and its realisation in TEP1(E) equipment practice (see elsewhere in this issue). Launch devices will be light emitting diodes (LEDs) at 8 Mbit/sec and lasers at 34 and 140 Mbit/sec. Receive devices will be PIN-FET photo-diode modules.

Repair

Having faulted to card or regenerator level, these will be sent to Area Repair Centres (ARCs) for repair although it is hoped that replacement of optical devices can be effected at terminal stations. In view of the small quantity of equipment and lack of experience associated with POLS1, three ARCs have been nominated – each dealing with a particular manufacturer's equipment. This will optimise the use of test equipment and the experience gained. As more equipment is installed more ARCs will become involved in the repair of faulty items.

01-432 1371: NE/T5.1.1
01-432 1306: NE/T5.1.2

Channel Islands restoration plans

by **Bob Hart** NE/T5.3.3

When a ship's half-ton anchor, with 100 m of chain attached, wraps itself around a submarine cable, service is likely to be interrupted! That is just what happened last November to a cable serving the Channel Islands. But six months previously, plans had been agreed to cope with such an emergency.

For security reasons, three separate submarine cables are used to provide service to the Channel Islands. They are capable of carrying 120 circuits (two supergroups), 480 circuits (eight supergroups) and 1380 circuits (23 supergroups) respectively. Even so, on two occasions, complete isolation has occurred when all three cables were damaged.

THQ's National Network Co-ordination Centre (NNCC) has drawn up plans to meet such emergencies. Because of the different numbers of circuits carried by each cable, the plans include methods for overcoming any combination of cable failure. They also take account of the need to make the best use of all remaining circuits after a failure, and to provide fair proportions of circuits between Jersey, Guernsey and the mainland.

In May 1980, the NNCC co-operated with Jersey States Telecomms Board (JSTB), States Telecommunication Board Guernsey (STBG) and THQ Main Network Operations, in preparing a book containing five plans covering failure of each or all cables. In November, the 23 supergroup cable was damaged by the anchor – tearing about 400 m of the cable. So one of the emergency plans was used – requiring the re-arrangement of three supergroups, six groups and 17 private circuits. Most of this work had to be done by JSTB staff. Although some congestion was experienced – to be expected when only 600 of the original 1980 circuits were available – no isolations were reported, nor complaints from customers concerning loss of service.

After this event, both JSTB and STBG confirmed that the new plans were vital for the speedy restoration of service and they should be retained for use in any future failure.

A sixth plan has since been prepared involving the use of a 15 supergroup radio link in such an emergency.

Footnote: A group comprises 12 speech-band circuits; a supergroup is five groups – or 60 circuits.

01-357 2643

New equipment practice –TEP1E

by **The Editor**

A new equipment practice – known as TEP1E – has been designed to cater for modern telecommunications equipment. It will rationalise the layout of mixed transmission and switching equipment, and harmonise with the latest European standards.

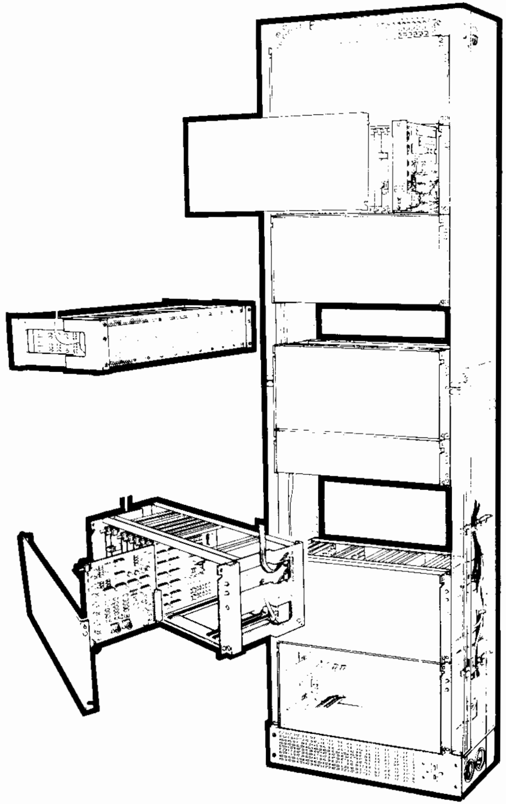
It is a single-sided rack occupying a floor space of 600mm (width) by 260mm (depth) and 2600mm (height). Other heights will be available. The rack has a basic module size of 2.54mm, convenient for accommodating electronic integrated circuits and connectors mainly 2.54mm pitch. Ventilation is by convection and racks may be assembled in suites on a back-to-back basis.

Shelf arrangement

The shelf is the basic unit of equipment and is constructed using a height-module of 30.48mm – equivalent to twelve 2.54mm basic modules. Single, four and eight module shelves are generally preferred, but multi-shelf equipment can be provided.

Printed circuit cards 195mm by 100mm and 195mm by 222mm for use with the four and eight module single shelves, respectively, are inserted into the shelves and connected to the back-plane by IEC 130/14 type conectors with coaxial inserts fitted as required.

Back-planes can be wired, or of printed circuit construction, connection to shelves



The New Equipment Practice

being made by plugs which mate with sockets mounted directly on the back-plane. The method of construction allows the shelf to be assembled and tested as a self-contained unit – installation merely entails screwing the shelf to the rack and plugging in the connecting cables.

Rack construction

The main strength members of both rack and shelves are made from chrome steel. Plastic covered aluminium is used for all external surfaces. Both materials are self-finished and require no additional protection.

Cabling

Cabling to and from the rack can be overhead or underfloor and cables are converged within the rack in a wiring space on either side of the shelves. During installation, access to the wiring space is obtained by removing rack covers.

Power cables are terminated on fuses at the rack top and feeds to individual shelves are run in the wiring space down the rack. Mains sockets for test equipment and so on are provided at the base of the rack.

Other facilities

Alarm facilities are provided at the top of each rack and on equipment shelves as required. Lamps and circuitry at the rack-top indicate a fault on the rack and operate the station alarm. Shelf-mounted alarm lamps and switches indicate faulty shelves. Additional alarms can be positioned under the shelf covers if required.

01-739 3464 ext 7695

Digital transmission –the basic PCM system

by **George Clark** NE/T5.1.4

The digital network in *MN 15* introduced readers to the new integrated digital switching and transmission network. The digital hierarchy – as it is known – is based upon the primary rate of 2048 kbit/s. Other internationally approved levels are 8448 kbit/s, 34 368 kbit/s and 139 264 kbit/s. Here we look again at the digital hierarchy, then at the basic PCM system. Elsewhere in this issue are related articles on *Optical fibre line systems* and the *New equipment practice* – others will be published later.

The digital hierarchy

First, let us look at Fig 1 to see how the digital hierarchy is built up. An important design feature is the standardisation of all electrical characteristics of the interfaces between equipment. This ensures that digital multiplex equipment can be fully inter-connected irrespective of manufacturer.

Digital line and radio systems and other digital equipment which have input and output ports operating with these recognised digital rates and electrical interfaces can also be used in conjunction with the standard multiplexing units. Many line and radio systems operate at various line speeds and circuit capacities, but all have input and output ports that operate at one of the approved hierarchical levels. Some systems will combine a number of standard hierarchical levels within the terminal equipment, to provide a larger transmission capacity.

Planning aspects

The most important factors to be considered when selecting a digital transmission system that will be best suited to the conditions on a particular route are the :

- number and predicted growth of circuits
- route length
- local geographical and network conditions.

In general, the route length and growth rate affect the optimum system capacity to be used. The local geographical and network conditions will influence the choice of media ; that is, metallic cables, optical fibre cables or microwave radio.

Transmission systems are available for operation at each level in the digital hierarchy, giving capacities for telephony from 30 circuits to 1920 circuits and operating at digit rates from 2 Mbit/s to 140 Mbit/s. Digital transmission systems can use metal conductor cables – both symmetrical pair and coaxial pair types – microwave radio, and optical fibre cables. The system capacity and transmission media can therefore be chosen to provide the most economic solution for virtually all network requirements.

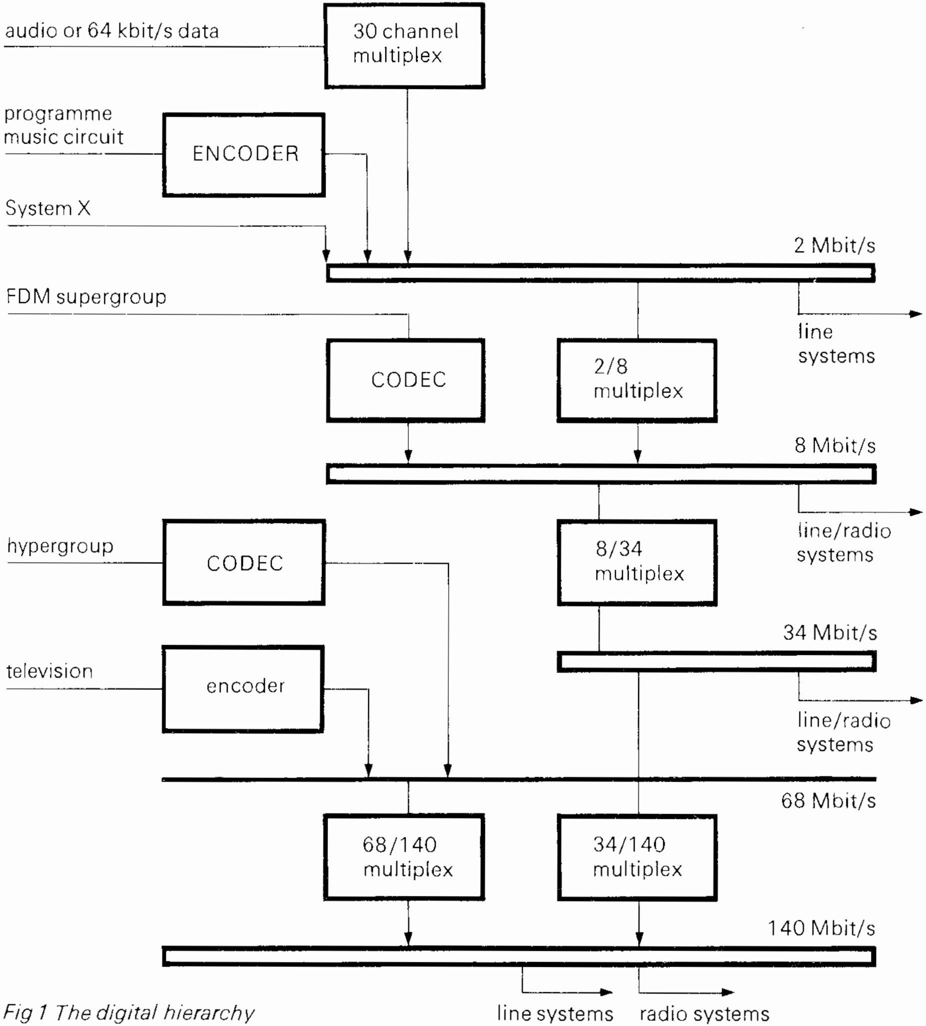


Fig 1 The digital hierarchy

Basic PCM system

Britain has been producing PCM systems since the late 1960s and a third generation design will be introduced into the British Telecom network from 1982 onwards. Of the two earlier designs some 7000 are at present in use. The new design is made up of three parts, the multiplex, line, and signalling sub-systems (Fig 2):

□ **The multiplex sub-system (primary multiplex)** – where signals in analogue or digital form are multiplexed together in time division to provide a 2048 kbit/s composite digital signal. The equipment will provide

- 30 telephone circuits together with signalling information
- 31 data channels at 64 kbit/s
- two monophonic or one stereophonic 15 kHz sound programme circuits
- a combination of these services to suit local circumstances

□ **The line sub-system** – consists of regeneration and line terminating equipment, including power feed facilities.

Cable aspects

With single-cable working, a maximum of between 25 per cent and 40 per cent of the pairs in an existing telephone cable – depending on its construction and size – can generally be used to carry 2 Mbit/s systems. This gives an increase in total cable capacity of between eight and 12 times compared with that obtained by using 4-wire audio transmission.

Considerably greater use can be achieved if systems are operated on separate go and return cables. New designs of cables, specifically suitable for 2 Mbit/s systems, are now available. These have a screen between

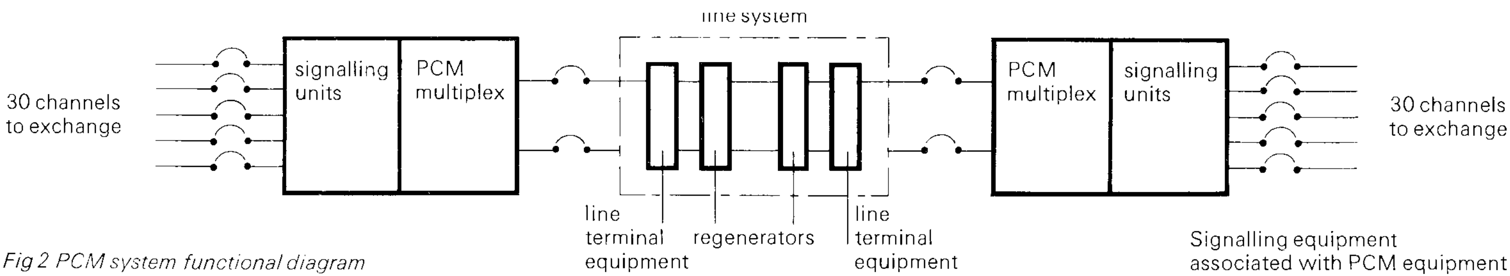


Fig 2 PCM system functional diagram

the pairs for the different directions of transmission and, apart from a few pairs required for supervisory purposes, 100 per cent use can be obtained.

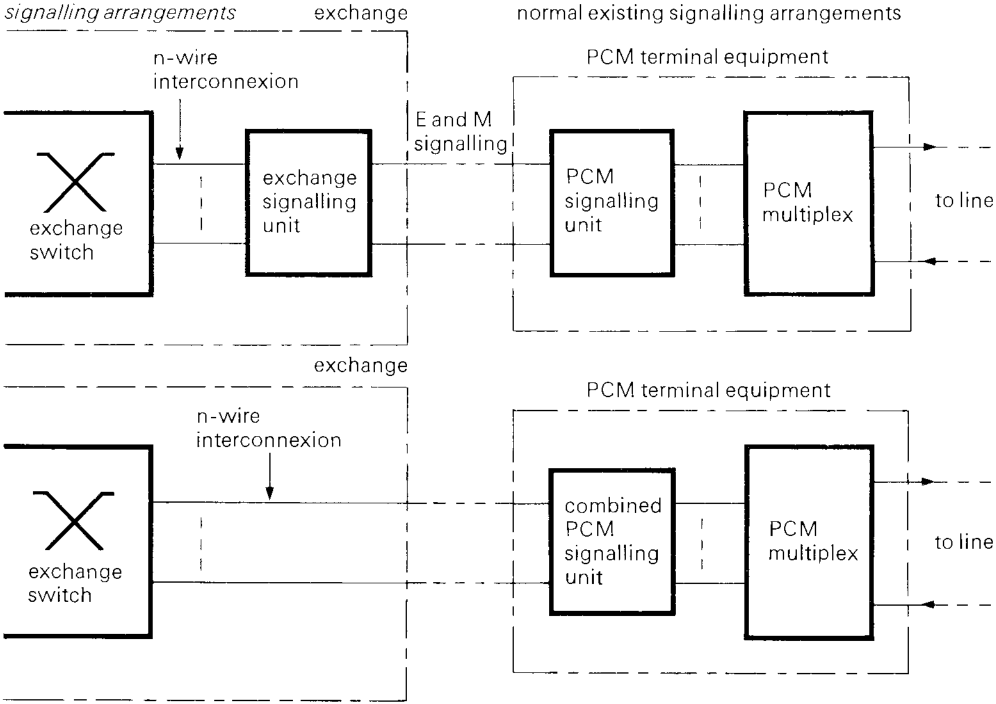
Line terminating equipment

The line terminal equipment forms the system interface with the primary multiplex equipment and the interface conditions are in accordance with international recommendations. The terminal equipment is rack mounted and includes units for providing signal transmission, receive signal regeneration, power feeding, system supervision and engineers' speaker facilities.

Regeneration

Dependent regenerative repeater units are housed in equipment cases, usually located in underground jointing boxes at intervals along a route. Power for the repeaters is supplied from the power feed point over the phantom circuits derived from two pairs. The repeater re-times and re-generates the high density bipolar (HDB3) coded signal received from the preceding line, and then re-transmits an undistorted signal to line. The repeater has automatic equalisation

Fig 3 Simplification of signalling arrangements



built in, which caters for line section losses of up to 37dB at 1 MHz. The maximum spacing that this loss permits depends on the characteristics of the cable used. Typically, a nominal spacing of 1.83 km for 0.63 mm conductor cables is used, the repeaters being sited at loading coil points. For 0.9 mm conductor cables, the spacing may be typically 2.5 km and, for 1.27 mm conductor cables, typically up to 4 km, if it is not required to site the repeaters at loading coil points.

□ The signalling sub-system

Signalling sub-systems are available to meet a wide variety of signalling situations met in a network – see Fig 3. Signalling units (SUs) are available to interface with any kind of channel associated signalling, to interface with both 4W and 2W audio circuits and to provide loss or gain in the audio paths. In general all signalling units are physically interchangeable. Signalling information is transmitted in channel time slot 16 of the PCM system.

Further information

Related articles on the higher-order digital systems and on digital radio will feature in our next issue.

01-432 1328

Maintenance thoughts on new coin boxes

by **Maurice Bradley** LTR/SV4.3.1

Most people are aware that a new generation of microprocessor controlled payphones will be progressively replacing the pay-on-answer (POA) boxes. But few of those who have been involved with the maintenance of electro-mechanical POA boxes will mourn their passing.

For introductory purposes, the new range of payphones are divided into three tiers.

- Tier 1 is the Blue Payphone, a name most of us are now familiar with. For engineers it is more correctly coded Coin Telephone 22A (CT 22A) and on trial now. A production model to follow will be coded CT22B. Both are primarily for high revenue sites.
- Tier 2 is a re-designed, cheaper version of Tier 1, and will be used for ordinary public call offices (PCOs) and renters' installations.
- Tier 3 is a portable, table-top instrument with reduced facilities compared with Tier 1 and 2 – ideal for hotels, restaurants and similar establishments.

Another item in the new range is the Debit Card Payphone – intended to accept specially designed credit cards.

Tier 1 and the Debit Card Payphone are powered from external supplies whereas Tiers 2 and 3 will be powered from the telephone line. All require the services of Subscriber's Private Meter (SPM) equipment at the exchange but dispense with the need for a Coin and Fee Checking (CFC) relay set.

The approach to fault finding and clearance is going to be very different from the POA coin box. Instead of coin acceptors, pulser units, runways and so on, the faultsman's language will be Central Processor Units (CPU), Speech and Interface (S and I) boards, Power Supply Units (PSU), credit displays, edge connectors and the like. Faultsmen will have a diagnostic kit to help them and, by using the diagnostic testing facilities built-in the CT22, they will be able to approach their task in a truly professional manner.

Care necessary

The recommended methods of handling this equipment – particularly the printed circuit boards – are different from the accustomed practices of faultsmen. For example circuit boards with edge connectors must be extracted and inserted only when absolutely necessary. They must be handled with extreme care, always carried in anti-static bags, and provided with adequate protective covering.

In time faultsmen will need to become expert in the facilities, and capable of recognizing the causes of the more common types of failure. This equipment should help create pride in the work, which most found difficult when working with POA apparatus.

Faultsmen will still meet all the old situations and conditions that do little to help their task – kiosk windows broken or missing, customers anxious to use the box being worked on, noisy railway stations, bustling airport buildings – and many others. This is an exciting challenge which faultsmen will be facing if British Telecom is to seize this opportunity to provide the type of PCO service the public demand. A first class maintenance effort is necessary even though these processor-controlled payphones are remarkably advanced machines. They must not be taken for granted. After working on a box, a faultsman must run through the facility test schedule and satisfy himself that all is as it should be. This includes a check to ensure that both the ear and mouthpieces are correctly fastened with rivets.

Another point to remember is that most members of the public will initially find the new PCOs very strange and some may not be able to understand the instructions. Maintenance staff may be called upon by frustrated customers to explain, and this should be done in a way that will inspire confidence. No doubt some customers will expect to get coins refunded when they are not entitled to them. But the new call office mechanism does not give change, it only returns those coins not used during the call. For example, if a user puts one 50p piece into store, makes a call to the value of 10p, then hangs up, the machine will claim the whole of the 50p. But if at the end of the call, and before hanging up, the user inserts a further 10p piece, the payphone will claim the 10p piece and return the 50p to the user when the handset is replaced.

Points to remember

Maintenance staff need to fully understand

- payphone facilities
- methods of fault diagnosis – using the diagnostic kit when necessary
- correct handling of electronic printed circuit boards (PCBs) – both in and out of the machine.

There will be much for faultsman to learn during the early days of the new equipment. It will be very important when new problems or difficulties are found that help should be sought. They should also pass on promptly the lessons which have been learned to the right people. Engineering groups at RHQ and THQ will be keen to give help and information to field staff to resolve problems as they arise. Developments in public call offices will give British Telecom a good opportunity to improve the public image of this important service – at the same time giving staff the chance to work with equipment using present day technology.

01-587 7038

Computer aid to exchange maintenance

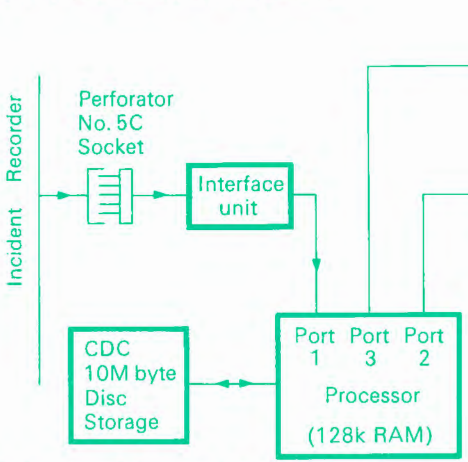
by **Bob Morris** MSS 2.4.3

A micro-computer scheme has been developed to analyse the complex print-out from TXK4 transit exchange incident recorders. Fig 1 shows the arrangement by which this is achieved. It should be noted that no alteration to the exchange is needed to take advantage of this on-line computing facility, apart from a 'black box' interface unit which converts the Murray teleprinter code to ASCII computer code. The new scheme is known as Computer Analysis of Incident Recorder Output (CAIRO).

Programming is now nearing completion, and the first micro-computer was brought into use in Cambridge Transit Switching Centre (TSC) early this year with the help of Cambridge Area. A 'second opinion' computer is operating in Glasgow TSC. Application is foreseen in at least 15 other large TSCs in the UK. Micro-computer aid for fault analysis in other common control exchange systems is being examined. Some common control systems have their Recorder/Monitor outputs analysed centrally by batch processing on mainframe computers, the turnround of the analysed data taking from one to two weeks. This compares with a few minutes by local micro-computer. This quicker faulting capacity means

- faster fault clearance, resulting in
- better exchange equipment utilisation
- reduced maintenance costs – less tedious manual analysis
- improved service to customers

Fig 1 Typical Hardware Configuration



- advantage in network management

Considerable financial savings are expected from Cambridge and Glasgow over the first 10 years but the main advantage is to have an immediate fault analysis at the TSC, which is at the 'centre of the wheel' of GSCs. The staff at the TSC can inform GSCs of trouble observed on a given route, as seen from the computer at the 'centre'. The micro-computer gives 24-hours, seven-days-a-week, surveillance.

The hardware consists of the micro-computer, which is about the same shape and size as a desk-type draw cabinet, a VDU, and a hard-copy printer.

Such a micro-computer system, connected on-line to Cambridge TSC, has been demonstrated to senior staff at THQ, boards and regions.

Maintenance of the system software will be the responsibility of THQ. Maintenance and repair of hardware is envisaged as being undertaken by British Telecom staff.

01-357 2747

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Say what you like, but the Editor may tone comments down if he decides to publish.
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