EG1

ELECTRONICS GUIDELINES NO. 1
REED F.D.M. SYSTEMS

REGIONAL SIGNAL AND
TELECOMMUNICATIONS
ENGINEER'S OFFICE
BRITISH RAILWAYS
(WESTERN REGION)
WESTERN TOWER
READING

READING

ELECTRONICS GUIDELINES NO.1

PART A

Issue 3

Electronics Section
Electronics Lab.
READING CP. 14

Ref: 14/G13-300/PAW

January 1985

Notes on the design requirements for Reed F.D.M. Systems

These notes are designed to supplement the Type RR Frequency-Multiplex system handbook, and to emphasise particularly important design points. They should be read in conjunction with signalling standards E10000/14/1-6.

Contents

Figures

1. Principles of Reed Systems

Reed systems are used to economise on cable cores. Each channel is allocated a discrete frequency within the range from 380Hz to 890Hz, and filters are provided at the receiver and the transmitter to ensure that each channel responds only to its own transmitter.

The filters use two mechanically-tuned reeds which are accurately tuned by the manufacturer, and are selective to within 1Hz. In the event of physical damage, which might cause one reed to vibrate at some other frequency, the unit is designed to fail safely. In all 53 frequencies can be used as different channels on the same system for vital functions, each frequency being identified by a discrete channel (f) number. A further 12 frequencies may be used on non-vital systems. An additional 16 frequencies are available for vital functions in a.c. electrified territory.

A vital function is defined as one directly relating to safety operation of signalling; and if one such function is present in a system the whole system must be treated as a vital system.

Reed systems can be relatively expensive. Care should be taken to ensure that a viable cost saving is achieved over the use of physical cable pairs, especially if carrying vital circuits, before any such reed system is embarked upon.

2. Design

2.1 Requirement of the line

The Reed system does not require a matched transmission line, but particular care has to be taken in the design of the line circuit in view of the fact that audio-frequency a.c. signals are used in transmission. In systems which are used for the transmission of vital signalling functions the integrity of the line must be secured at the same high level as that of the individual functions.

In the following sections the term Multicore cable refers to cored signalling cable.

2.2 Sectionalising the line

The purpose of sectionalising the line is to reduce unwanted interference. This can arise from crosstalk with other reed systems, interference from 50Hz power supplies and intermodulation of the reed signal with interference signals.

Line amplifiers and line isolation transformers are used to sectionalise the line, and normally these are alternated in vital systems. Two amplifiers may be used consecutively if necessary, but two transformers are never used consecutively as they would load the line excessively.

Both units contain transformers which completely block any spurious d.c. and reduce 50Hz signals considerably.

Between sectionalising points the line should have a loop resistance of less than 200 ohms.

/Continued 3

At intermediate locations where the cable breaks, the jumpering should be wired with twisted-pair cable (yellow-blue wire twisted together) and not laced in with the rest of the location jumpering.

For vital systems in multicore cable, the line must be sectionalised at intervals of not more than 2 km, to minimise crosstalk. Where overhead line is used it must be sectionalised at intervals of not more than 10 km.

2.3 Choosing the Cores

Where multicore cable is used the following rules have to be observed :-

(a) The cable should be of a type in which successive layers of cores are laid with opposite directions of rotation (i.e. not Unilay).

(b) The outer layer should be used wherever possible (i.e. cores 28 to 48 in a 48 core cable, cores 8 to 19 in a 19 core cable).

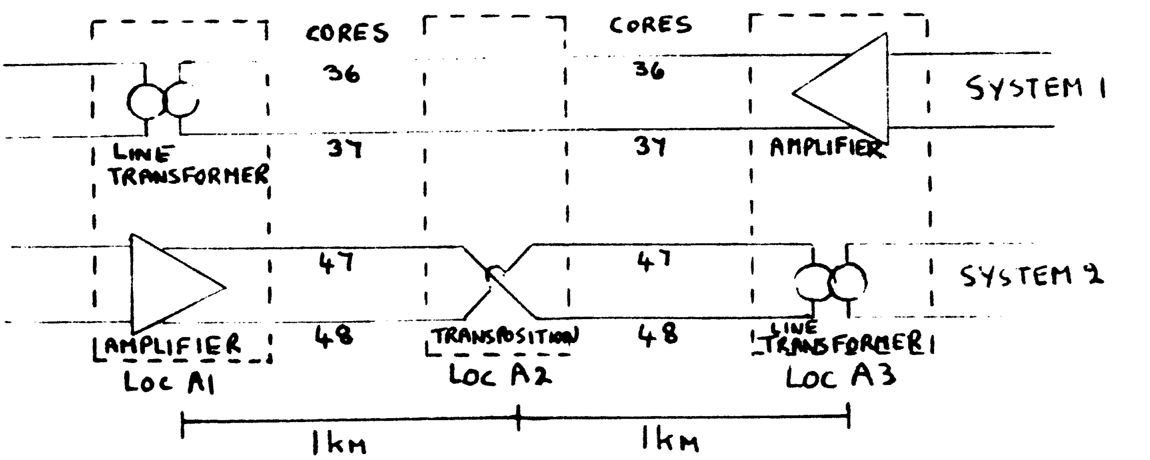
(c) In no case must two cores in different layers be used as a transmission line pair of a system (e.g. in a 48 core cable, cores 28 and 29 would be suitable, but not cores 28 and 27).

(d) If two systems use the same cable, it is necessary to select core pairs which are directly opposite each other (e.g. System 1, cores 47 and 48: System 2, cores 36 and 37). In a 48 core cable there are eleven such combinations in the outer layer. If four systems use the same cable, the systems should be separated as far as possible (e.g. System 1, cores 47 & 48: System 2, cores 36 & 37: System 3, cores 31 & 32: System 4, cores 41 & 42).

For details of cable layouts see Fig 3.

2.4 Transposition

This should be effected wherever more than one vital reed system shares the same pole-route or multicore cable. On pole-routes a standard scheme of transposition is used. In multicore cables each alternate system requires to be transposed at its midpoint. A typical example is shown below where two systems are located in a 48 core cable.



/Continued 4

The transposition point should be as near the mid-point as possible, and in any case not more than 400m from the mid-point. Thus any crosstalk voltage induced by one system to another is cancelled out in the other half-section.

Where the two systems run in the same cable for a long distance, System 1 and System 2 are alternately transposed in each section.

2.5 Lightning Protection

For non-vital systems in multicore cable, surge divertors may be used. These provide a low resistance path to earth for surges. Unfortunately this has the same effect as an earth fault on a cable, which is dangerous in a vital system.

Where there are several vital systems in a cable, earth faults can cause dangerous increases in crosstalk levels, particularly when there is more than one fault simultaneously. No lightning protection should therefore be applied to a vital system in multicore cable.

On overhead pole-routes the danger from crosstalk is reduced, but lightning protection should not be applied if more than four systems share the same route.

2.6 Power Supplies

Transmitters and receivers require d.c. power supplies at 12v. There are two types of 12v d.c. power supply; the RR9131 (rated at 5amp) and the RR9121 (rated at 0.6amp). The RR9121 can be used in locations and interlocking with a small number of units (see E10000/14/4). Line amplifiers require a 24v a.c. supply which is obtained from the RR9210 transformer unit.

Where there is equipment belonging to several systems at a particular site, separate supply units must be provided for each system, so that transmitters and receivers belonging to different systems are never fed from the same supply unit.

When a type RR9131 power unit is used to feed all the units on a particular system, the units should be fed from up to six connections, each spur feeding not more than twelve units. The RR9131 power unit has three parallel outputs, enabling two spurs to be fed off each output as necessary.

To ensure that the maximum voltage levels are not exceeded on vital systems, reed power supply units must be fed from an a.c. supply, the frequency of which is constant at 50Hz ± 3% (48.5Hz to 51.5Hz). Special care must therefore be taken in the design of standby power supplies.

2.7 Spacing of Line Amplifiers and Line Isolating Transformers

A typical non-vital system in multicore cable will have line amplifiers every 10 kms. A vital system in multicore cable will have alternate line amplifiers and line-isolating transformers every 2 kms. Additional line amplifiers are provided, or substituted for isolating transformers according to the following rules :-

/Continued 5

(1) Terminations of systems

An amplifier must always be provided at the termination of the system.

(2) Between two amplifiers in the section:

If more than 25 transmitters would have occurred in any section, an additional line amplifier should be introduced to bring the number below 25.

If more than 17 receivers would have been connected on the output of an amplifier, an additional line-amplifier should be introduced to bring the number below 17.

(3) Between line-amplifier and transformer in section:

If more than four transmitters would have occurred on a transformer input, the transformer should be replaced by a line amplifier.

If more than four receivers would have been connected across the output of a transformer, the transformer should be replaced by a line amplifier.

(4) Penultimate sectionalising point:

The nearest sectionalising point to the terminal line amplifier should always have a line amplifier rather than a transformer.

(5) Intermediate Transmitters and Receivers:

A sectionalising point should be provided at the same location as intermediate transmitters and receivers where this is possible.

2.8 Rack Layout

Fig 1 illustrates a typical interlocking rack layout. Because of the dangers of crosstalk, power supply wiring, switching circuits and the line itself must be as short as is reasonably practicable.

The rack layout is very important and should be decided before details of the wiring are drawn. This is essential in order to ensure the most direct route for transmission lines and power supplies.

Each individual system will have detail differences from other systems, but the following points should be noted :-

(1) The 24 a.c. supply transformer should be mounted next to the line amplifier.

(2) The 12v d.c. supply unit should be mounted at the opposite end of the system layout to ensure a direct wiring route.

(3) The reed-follower relays are mounted alongside each individual receiver.

/Continued 6

(4) In vital systems, 930-style relays are mounted alongside each individual transmitter. In non vital systems, special 4-relay units are mounted with each group of four transmitters.

(5) No frequency is allocated to more than one system on any particular rack.

2.9 Provision for Modifications

If there is sufficient room on a relay rack it would be advantageous to leave a few spaces between systems for future modifications. When modifications are carried out it is very important to keep all lines as short as is reasonably practicable even if this means re-routing them.

It should be remembered that all reed wiring is distinctly colour-coded and is not laced or placed in trunking. This ensures that the various lines are kept reasonably short, and are easily identifiable, as well as minimising interference effects.

2.10 Location wiring

The principles described in Sections 2.8 and 2.9 should also be applied to locations to keep all lines as direct as is reasonably possible. Reed equipment should be mounted as far as possible from other equipment. It is permissible to dispense with a separate repeat relay for each transmitter if the controlling relay is on the same mini-rack and the wiring is run direct. It may also be possible to use a RR9121 power supply unit (12v d.c.) if the load is small. However each system must use a separate power supply unit.

As far as possible, the reed equipment should be mounted on a separate mini-rack or in a separate cupboard, and links should be provided to isolate the line each side of the location. The links should be located on the equipment rack, rather than using cable cupboard links. The line can easily be identified as it will be run in yellow-blue twisted wire and not tied in with the rest of the wiring.

2.11 Telecommunications Cables

Paired telecommunication cable is suitable for use with both vital and non-vital systems. Where paired cable is used for vital systems, the restrictions relating to sectionalisation distance (2KM), and transposition, do not apply.

The loop resistance between sectionalising points should not exceed 200 ohms.

Loaded pairs are not suitable for use with Reed systems.

/........7

3. Block Schematic : SL/ESD/300 Drawing

An example of a typical block schematic is shown in figure 2. This drawing is designed to provide a complete picture of a reed system for design, commissioning, and also for technicians use when the system is operational.

Each design will be drawn up by the Electronic Systems Design section, upon receipt of scheme details, at an early stage in the work. The negative will be filed by that section on completion.

Attached Figs. 1 to 3.

SYSTEM 1 CONTROL SYSTEM (VITAL)

SYSTEM 2 INDICATION SYSTEM

SYSTEM 3 CONTROL SYSTEM (NON - VITAL)

SYSTEM 4 INDICATION SYSTEM

A - B B24T RR9210	LINE AMPLIFIER RR8102 TRANSMITTER SYSTEM 1	TX f RR1000	TX ※1 SWITCHING RELAY	TX f RR1000	TX ※1 SWITCHING RELAY	TX f RR1000	TX ※1 SWITCHING RELAY	TX f RR1000	TX ※1 SWITCHING RELAY	TX f RR1000	TX ※1 SWITCHING RELAY	TX f RR1000	TX ※1 SWITCHING RELAY
								B12J RR9121		TX f RR1000	TX ※1 SWITCHING RELAY	TX f RR1000	TX ※1 SWITCHING RELAY

B12J RR9121	Rx f RR2003	32M10	Rx f RR2003	32M10	Rx f RR2003	32M10	Rx f RR2003	32M10	Rx f RR2003	32M10	LINE AMPLIFIER RR8102 (RECEIVER) SYSTEM 2	B - A B24T RR9210

A - C B24T RR9210	LINE AMPLIFIER RR8102 (TRANSMITTER) SYSTEM 3	Tx f RR1000	Tx f RR1000	Tx ** SWITCHING RELAYS	Tx f RR1000	Tx f RR1000	Tx f RR1000	Tx f RR1000	Tx ** SWITCHING RELAYS	Tx f RR1000	Tx f RR1000	B12J RR9121

	B12J RR9121	32M10	Rx f RR2003	32M10	RX f RR2003	32M10	Rx f RR2003	RR8102 LINE AMPLIFIER SYSTEM 4 (RECEIVER)	C - A B24T RR9210

※1 930 STYLE

** RELAY UNIT PIN CODE 144

Revisions

PAW	30-7-85	AJW	28/9/79
REDRAWN		CHECKED	

British Railways Western Region
Chief Signal and Telecommunications Engineer

British Rail

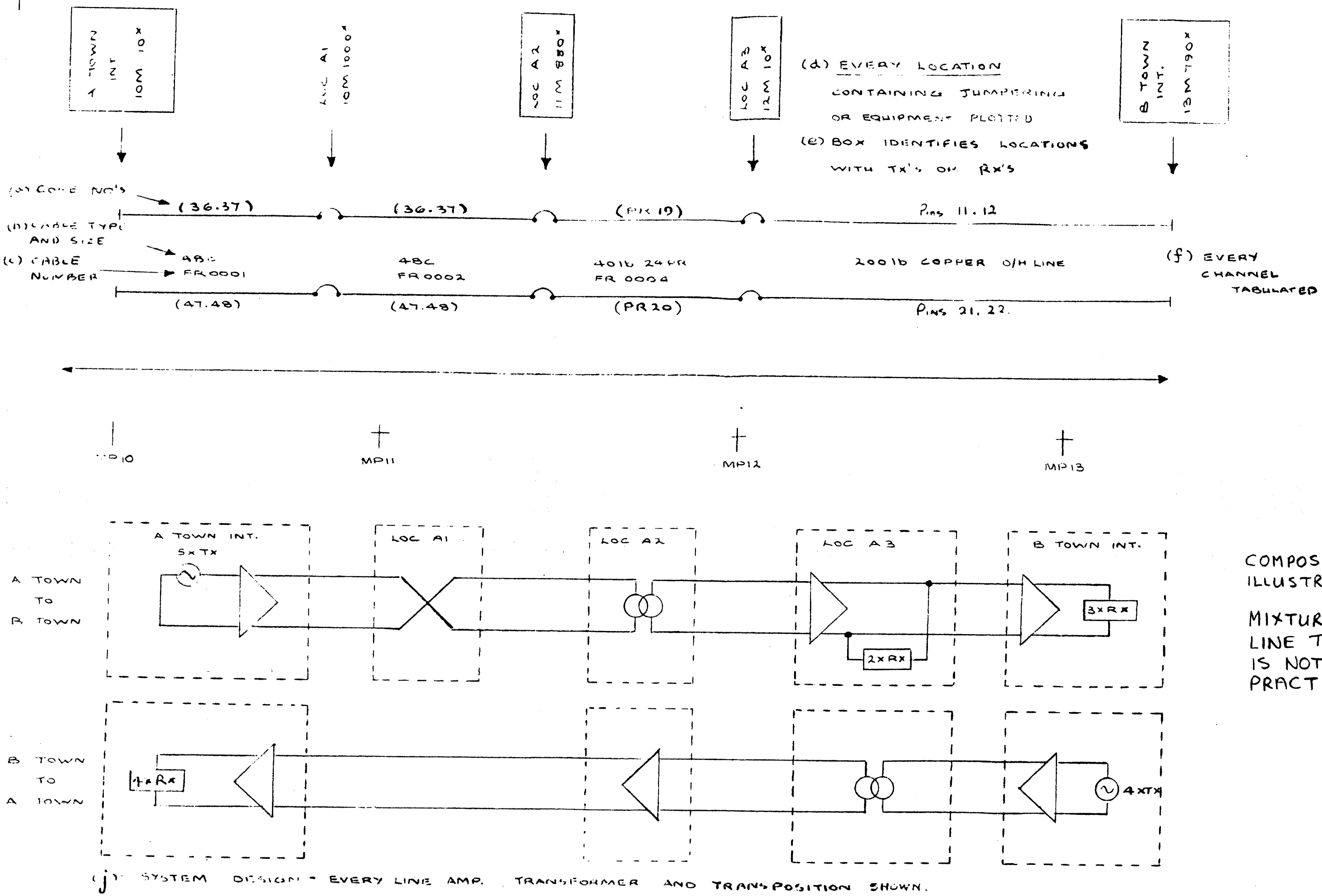
FIG. 1.
TYPICAL LAYOUT OF 4 REED SYSTEMS ON INTERLOCKING RACK

FOR F. KERR
Chief S & T Engineer

No FIG 1.

J660

A3 RR 888/1



A TOWN TO B TOWN			
POSITION OF RX	POSITION OF TX	CHAN. NO.	FREQ

B TOWN TO A TOWN			

COMPOSITE DRAWING FOR ILLUSTRATION PURPOSES

MIXTURE OF TRANSMISSION LINE TYPES WITHIN SYSTEMS IS NOT RECOMMENDED IN PRACTICE

NOTE ADDED 30-7-85

[redacted]

h) SCALE DEPENDS ON AMOUNT OF DETAIL TO BE SHOWN

FIG 2: TYPICAL BLOCK DIAGRAM (PRODUCED BY ELECTRONIC SYSTEMS SECTION)

C.B.N.	13.3.78	CRS	13.3.78.
DRAWN		CHECKED	

British Railways Western Region
Chief Signal and Telecommunications Engineer

A TOWN TO B TOWN
REED SYSTEMS
(M) VITAL OR NON VITAL

British Ra

g) NUMBER ALLOCATED BY ELECTRONICS SECTION

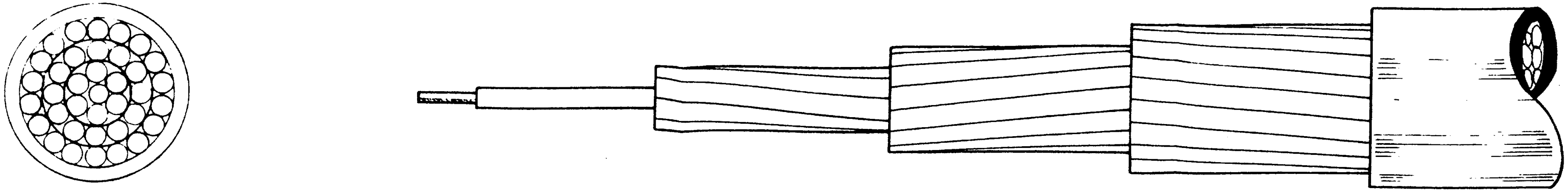
Chief S & T Engine

No SL/ESD/300/

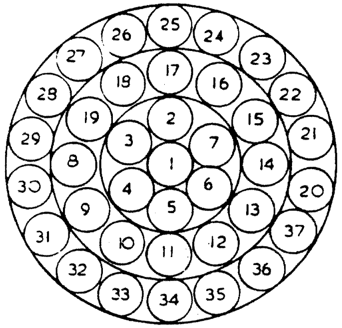
A

J660

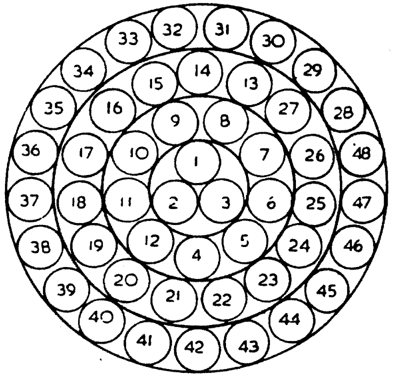
A3 B.R. 888



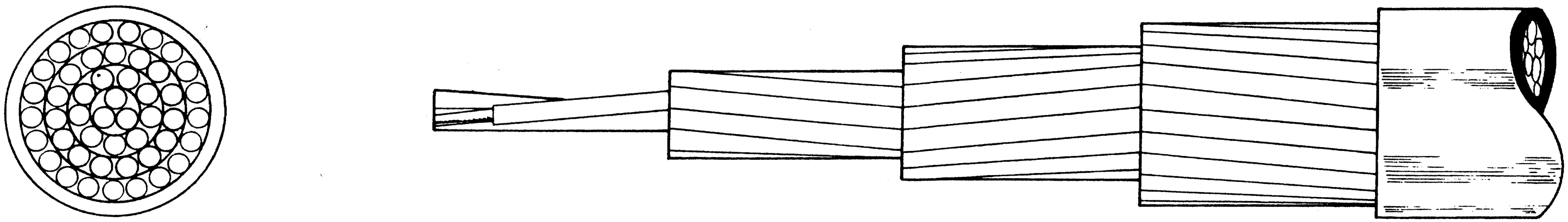
37C 1/1.53 P.C.P



7/19/37 CORE



3/12/48 CORE



48C 1/1.53 P.C.P

Revisions	
ISSUE 1	27-1-77

British Railways Western Region
Chief Signal and Telecommunications Engineer

British Rail

MAKE UP & LAY OF P.C.P CABLES.

FOR A.R. BROWN
Chief S & T Engineer

No. CB.3000/207

N/S	J.C.	1-2-77	Rac.	27-1-77
	DRAWN		TRACED	

A3 B.R. 888/16

ELECTRONICS GUIDELINES NO.1

Part B
Issue 3.

Electronics Section
Electronics Lab
READING CP. 14
January 1985

Ref: 14/G13-300/PAW

REED F.D.M. SYSTEMS - NOTES FOR THE GUIDANCE OF INSTALLERS

Reed Systems are used to economise on cable cores. A particular frequency is allocated to each circuit function and very accurate reed filters are used at either end of the line to make sure that each receiver responds only to its own transmitter. In this way many differrent circuits can be transmitted over one pair of wires. Audible frequencies are used throughout and although special cable is not strictly required, particular care must be taken when wiring reed systems.

The main dangers are that one reed system will interfere with another reed system or that electrical interference will occur due to relay switching at 50 Hz a.c. interference. These effects can increase dangerously when there is an earth fault on any part of the reed line.

IMPORTANT POINTS (See Figs 1 to 4)

(1) The normal methods of lacing wires in parallel runs should not be followed when wiring reed systems. Instead, wires should be run by the most direct route and colour-coded so that they may be easily identified. They should not be tied together, and for example where several systems are wired in one interlocking, each system line should follow a different route.

(2) Fig 1 illustrates the requirements for wiring transmitters, and the example given are applicable to non vital systems. In the case of Vital systems individual 930 style relays will be provided for switching each transmitter (see Note on Fig 1) but the wiring requirements are the same.

(3) Fig 2 illustrates the requirements for wiring receivers, and these requirements apply equally to both vital and non-vital systems.

(4) Transmission Lines
In every location where the cable is jumpered, or where amplifiers or line isolation transformers are fitted, YELLOW/BLUE twisted wire must be used and this should not be laced in with the main wiring run. Wiring from rack to cable bays in inter-lockings should be run with 2-core screened cable directly NOT through Belling-Lee style terminal strips. All screens should be earthed (at one end of the cable only) to a central earth point in the cable bay. In the case of non-vital systems this will be at the lightning protection box, which will be mounted on an earthed bar or frame.

Particular care should be taken to ensure that lines are free from earth, or the possibility of earth e.g. rubbing on iron-work.

Cont.../...

IMPORTANT POINTS Cont.

(5) Fig 3 illustrates the wiring for an intermediate Line Amplifier in an interlocking with intermediate transmitters and receivers. In locations the incoming and outgoing lines would be in yellow-blue twisted wire instead of screened cable. If there are no intermediate transmitters, the line would be taken direct to terminals 1 and 6 on the line amplifier (Yellow to terminal 1 on locations) and the Belling-Lee connecting block will not be required.

(6) It is impossible to illustrate every combination, but the general principle of keeping wiring runs as short as is reasonably possible should always be adopted.

Fig 4 illustrates the general wiring requirements for locations.

COLOUR CODING OF WIRING					R.S. Components Cat No.
(1)	12V D.C. Supply	+	Red)	Twisted	356-763
		-	Black)		356-729
(2)	Transmitter Switch	A4	Red)	Twisted	356-763
		D4	Red)		356-763
(3)	Transmitter Link (A2 to D2)		Red		356-763
(4)	Receiver to Reed Follower Relay				
		R1 to A1	Brown)	Twisted	356-741
		R4 to D1	Pink)		356-965
(5)	Relay Link (R2 to R3)		Grey)		356-943
(6)	Reciever Link (D2 to A3)		Yellow)		356-785
(7)	Transmission Line	A	Yellow)	Twisted	356-785
		D	Blue)		356-735

Twin Screened PVC 1 Pair 0.7mm Tinned Copper
To BR Spec. 890 6/162850

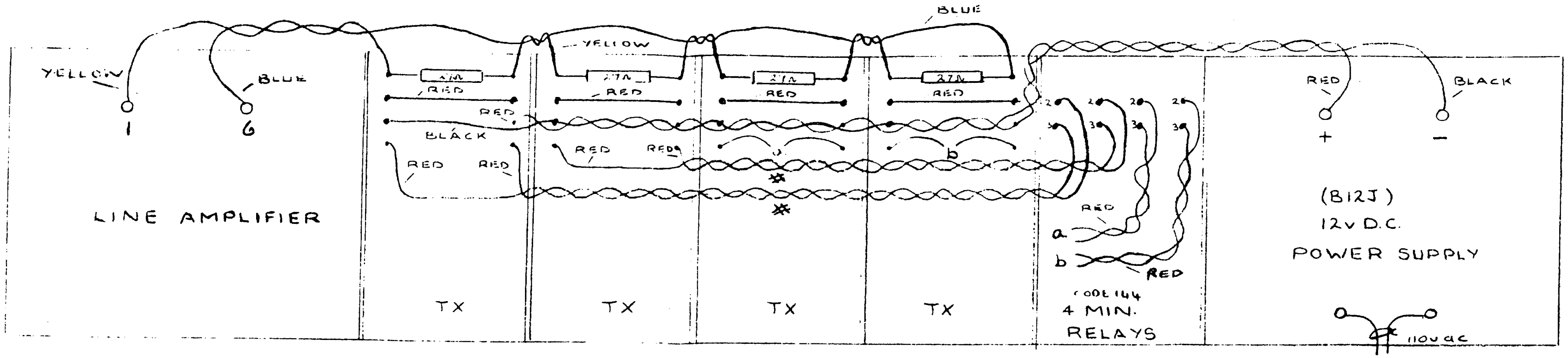
COMPONENTS (Misc)

Transmitter Resistor	27 ohm 1 watt	133-560

COLOUR CODING OF UNITS

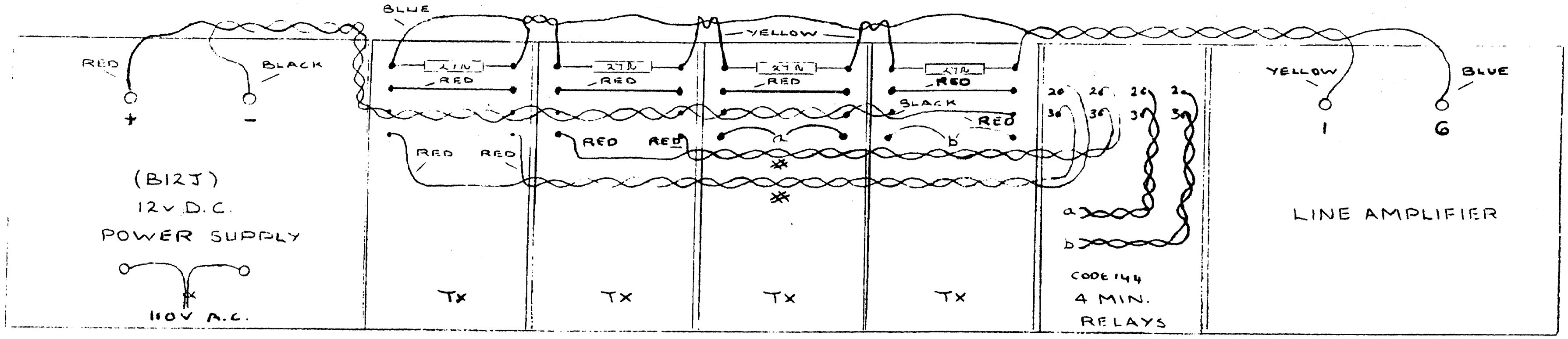
TRANSMITTERS	-	Blue Label
RECEIVERS	-	Yellow Label

Figs 1 to 4 attached.



TYPICAL WIRING LAYOUT WITH LINE AMPLIFIER ON LEFT OF Tx's (REAR VIEW)

REFER TO PRINTS FOR PARTICULAR LAYOUT.



TYPICAL WIRING LAYOUT WITH LINE AMPLIFIER ON RIGHT OF Tx's (REAR VIEW)

REFER TO PRINTS FOR PARTICULAR LAYOUT.

MINIATURE RELAY UNIT MAY BE POSITIONED AT EITHER END OR IN THE MIDDLE OF THE GROUP OF FOUR TRANSMITTERS.

* SWITCHING CIRCUIT (RED RED TWISTED) TO BE AS DIRECT AS POSSIBLE. FOR VITAL CIRCUITS 930 RELAY WILL BE MOUNTED NEXT TO TRANSMITTER ALTERNATELY ACROSS RACK

LINE AMPLIFIERS AND POWER SUPPLY UNITS TO BE MOUNTED WITH TERMINALS ON WIRING SIDE OF RACK

Revisions
NOTE ADDED 30-7-85

C B N	9 6 78	PAW	15-8-78
DRAWN		CHECKED	

British Railways Western Region
Chief Signal and Telecommunications Engineer

British Ra

SKETCH FOR INSTALLER'S USE

4 TRANSMITTERS IN NON-VITAL SYSTEM

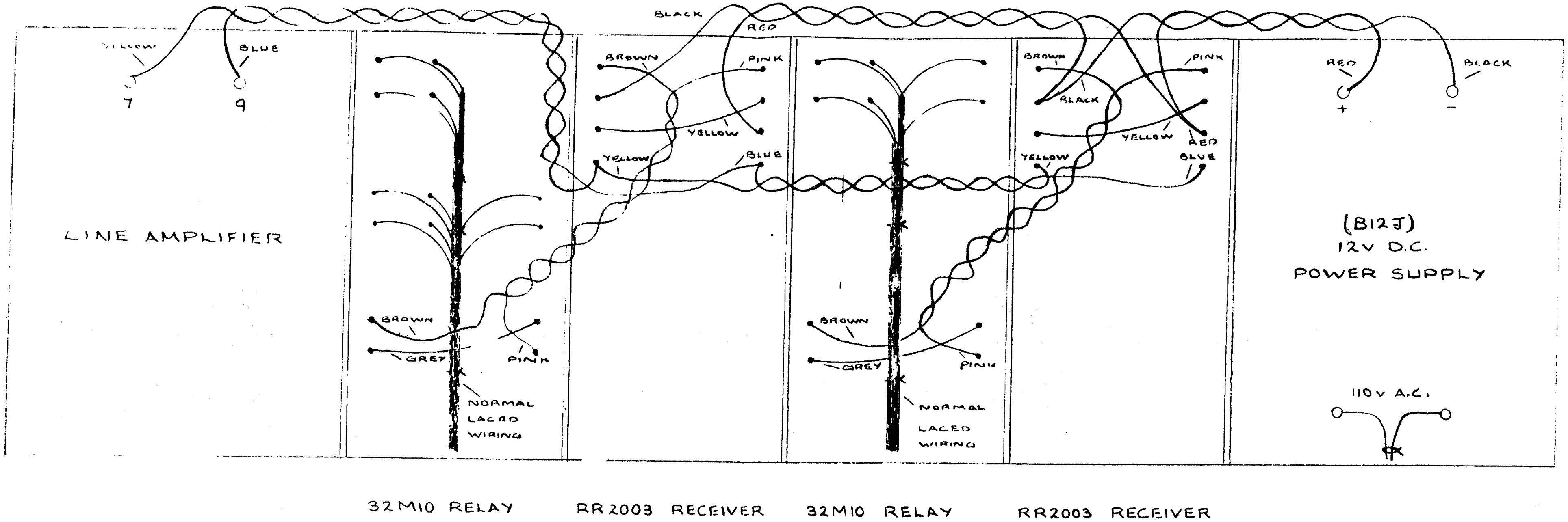
FOR F. KE
Chief S & T Engi

No FIG 1

A

J660

A3 B.R. 8



TYPICAL LAYOUT WITH LINE AMPLIFIER ON LEFT OF Rx's (REAR VIEW)
UNITS MAY BE TRANSPOSED IN PRACTICE (REFER TO PRINTS FOR PARTICULAR LAYOUT)

TYPICAL WIRING LAYOUT AND COLOUR CODING OF REED SYSTEMS.

LINE AMPLIFIERS AND POWER SUPPLY UNITS TO BE MOUNTED WITH TERMINALS ON WIRING SIDE OF RACK

Revisions
NOTES ADDED 30-7-85

C.B.N.	7.6.78	PAW	18.5.78
DRAWN		CHECKED	

British Railways Western Region
Chief Signal and Telecommunications Engineer

British Rail

SKETCH FOR INSTALLER'S USE

2 RECEIVERS IN VITAL SYSTEM

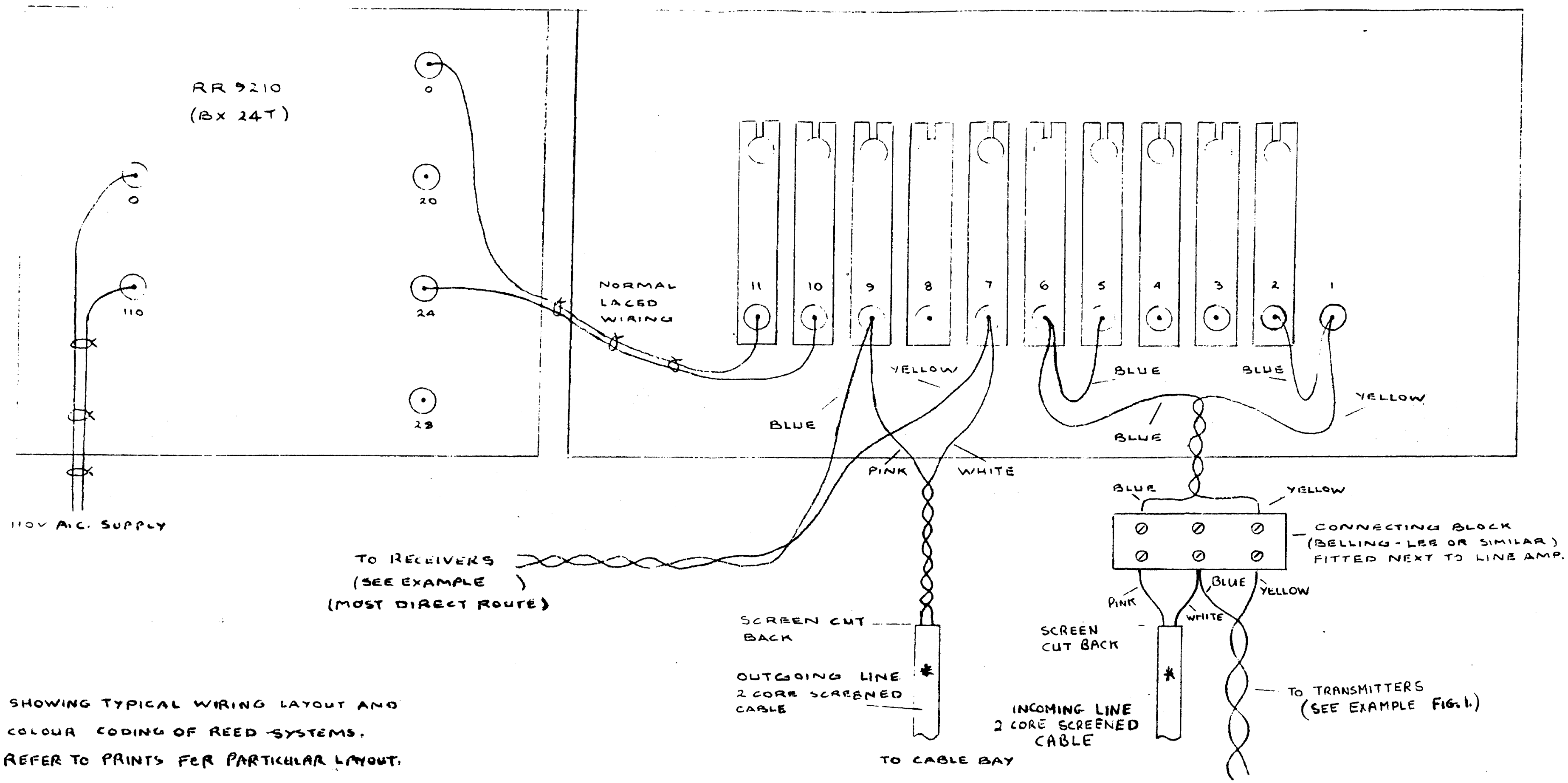
Chief S & T Engineer

No FIG 2

A

A3 B.R. 888/18

60



SHOWING TYPICAL WIRING LAYOUT AND COLOUR CODING OF REED SYSTEMS.
REFER TO PRINTS FOR PARTICULAR LAYOUT.

ALL SCREENS TO BE EARTHED TO A CENTRAL POINT. IN CABLE BAY.

* 2 CORE SCREENED CABLE MAY HAVE BLACK/WHITE COLOURED INNER INSULATION DEPENDING UPON MANUFACTURER.

Revisions

British Railways Western Region
Chief Signal and Telecommunications Engineer

British Rail

SKETCH FOR INSTALLER'S USE

INTERMEDIATE LINE AMP. IN INTERLOCKING WITH INTERMEDIATE TRANSMITTERS AND RECEIVERS

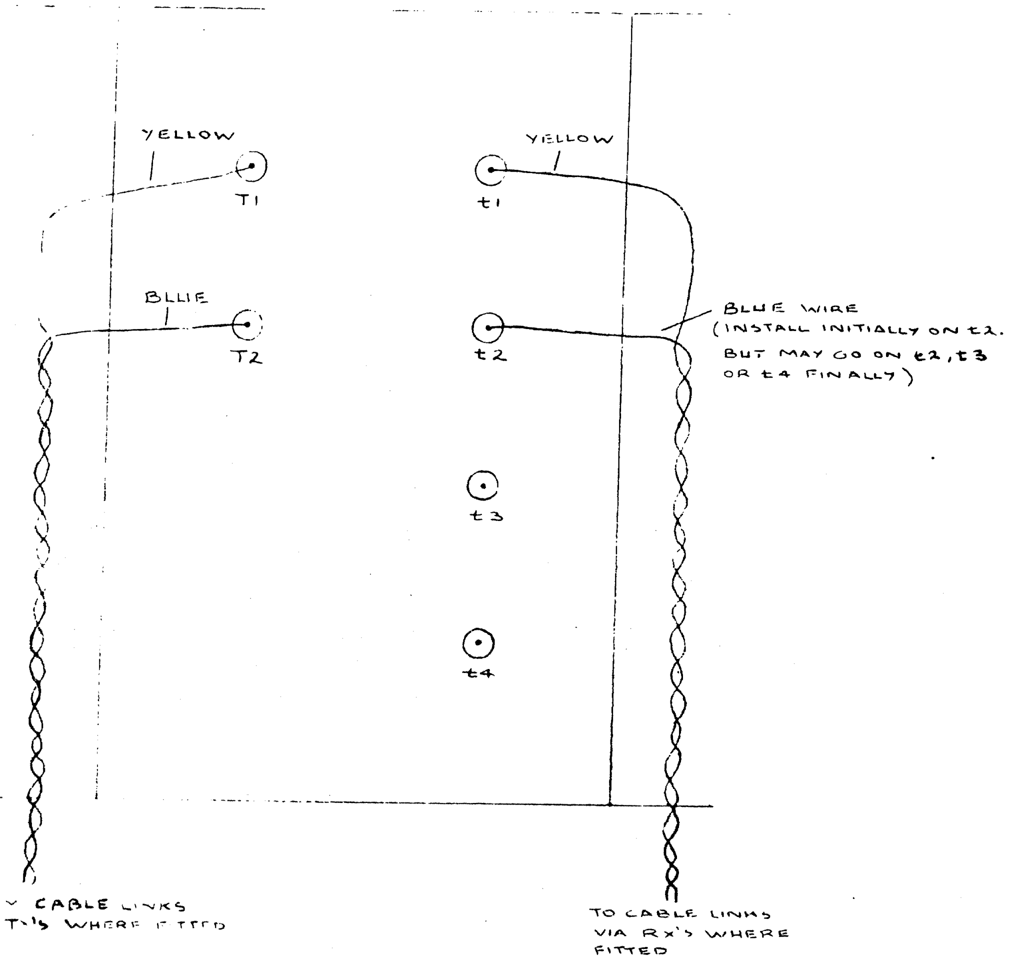
C.B.N	16.6.78	PAW	15.5.78
DRAWN		CHECKED	

Chief S & T Engineer

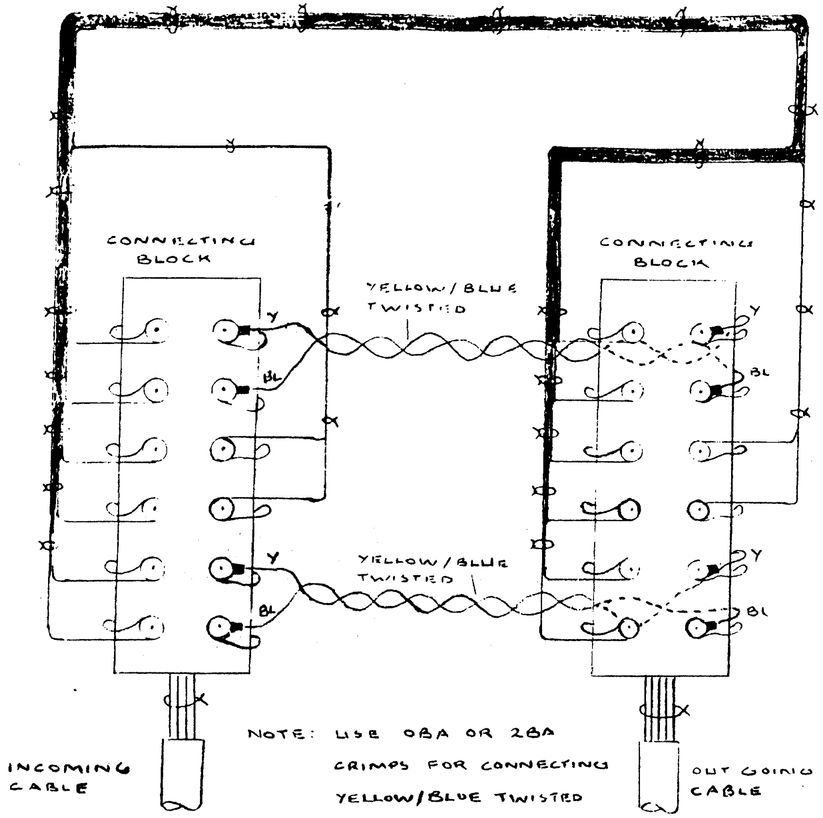
No FIG 3

J660

A3 B.R. 888/18



LINE TRANSFORMER IN INTERMEDIATE LOCATION.



TYPICAL 12 CORE JUMPERING LAYOUT WITH TWO F.D.M. SYSTEMS

SHOWING TYPICAL WIRING LAYOUT AND COLOUR CODING OF REED SYSTEMS. REFER TO PRINTS FOR PARTICULAR LAYOUT.

Revisions			
C.B.N	5.7.78	PAW	18-8-78
DRAWN		CHECKED	

British Railways Western Region
Chief Signal and Telecommunications Engineer

British Rail

SKETCH FOR INSTALLER'S USE

Chief S & T Engineer

WIRING OF LINE TRANSFORMER AND LAYOUT OF TYPICAL 12 CORE JUMPERING

No FIG 4

A3 B.R. 888/18

ELECTRONIC GUIDELINES NO. 1

PART C

Issue 2 Ref: 14/G13-300/PAW

Electronics Section
Electronics Lab.
READING CP 14

October, 1985

Notes to assist in the commissioning of Reed F.D.M. Systems

These notes cover the procedures that are required on site when Type RR systems are being commissioned. They should be read in conjunction with parts A and B.

Contents

Figures

...CONT'D...

1. <u>Line Tests</u>

Normal cable testing techniques should be used to ensure that the line, be it either overhead or multicore, is free from earths and high resistance joints.

Loop resistance between sectionalising points should be measured using an Avo EA113 Transistorised Multimeter.

Slotted links with their associated nuts and washers are used for line connections at interlockings and locations. It is necessary to carry out the cable continuity and insulation testing <u>before</u> the links are coupled through. Units should not be plugged in, or connections made to line amplifiers and isolation transformers until these line tests have been completed.

All location jumpering must be checked to ensure that the cable detail conforms to the requirements of the design as set out in the TR/300 drawing for the system, and that the wiring has been completed in accordance with Part B of these guidelines.

At this stage it is important to ensure that good telephone (or a suitable alternative) communication is available between each relay room and location where Reed equipment is sited, as this is absolutely essential for the setting up of the Reed systems.

2. <u>Preliminary Tests</u>

Before plugging in the units, check the wiring of the Reed system. Note in particular that the correct polarities have been observed on the plugboards for the power supply connections. <u>This is most important as incorrect polarity will damage or destroy the amplifiers</u>.

Ensure that the number of plugboards connected to one supply does not exceed the number scheduled.

Receiver outputs (A1, D1) are connected to a Reed follower relay plugboard, terminals R1 and R4, with a permanent link between R2 and R3, <u>carefully</u> check that this circuit is complete, before mounting the Reed follower relay, type 32M10.

<u>It is most important that receiver output circuits are complete</u>, and if it is found necessary to switch Reed follower relays directly from local test panel to facilitate internal signalling testing, then a 1500 ohm 1 watt resistor <u>must</u> be connected across the output terminals A1 and D1 of each affected receiver, and care taken to ensure that the d.c. test supply is <u>not</u> connected to any receiver.

Check that all plugboards have the correct pin code.

...CONT'D...

It is important at this stage of testing that, following the tests detailed above, any corrective work is carried out. All such work must be re-checked before proceeding with the following stages of commissioning.

3. Testing the Units

After satisfactorily carrying out the preliminary testing, and having mounted the follower relays as detailed under item 2, the transmitters and receivers may be plugged in and the power switched on.

Check that the a.c. supplies to line amplifiers, and the d.c. supplies to transmitters and receivers are within the specified tolerance.

Check that all line amplifiers are working and that they are set to 100% (1:1) and that isolation transformers are on the 1:1 tap.

Switch on each transmitter by temporarily strapping the contacts of the associated switching relay (connected to terminals A4 and D4) and check that each output is between 0.59 and 0.75 volts a.c. If the voltage is lower than 0.59 volts, change the amplifier portion before suspecting the filter.

Record the output level of each transmitter.

Ensure after testing that each transmitter is switched off.

4. Setting Up the System

The object of setting up the system is to ensure that each Reed receiver is operated within the optimum input voltage level of 270mV to 350mV.

When a small system is to be set up, it is in order to switch on one channel at a time and measure the input voltage to a particular receiver, but on larger systems it is essential to switch on all channels which are normally energised. Consequently, to obtain an individual channel level it is necessary to use, the appropriate receiver filter and a filter adaptor. The reading obtained corresponding to the optimum input level should be between 110mV and 150mV.

4.1 System Level Adjustment

System levels may be adjusted by the following:-

(i) Line Amplifier

By changing the feedback tap and, if finer adjustment is necessary, by adding suitable resistance in series with the input circuit. Suitable resistors are metal oxide or high stability type, 1 watt with a range of values between 68 and 820 ohms.

...CONT'D...

(ii) Isolating Transformers

By changing the tap on the secondary winding.

(iii) In specific circumstances by fitting an output attenuator (sheet 8).

System channel levels are adjusted by working progressively away from the relay room. A system may be divided into sections, each section being terminated with either a line amplifier or an isolation transformer.

4.2 Typical Indication System

A typical indication system is shown in fig.1.
Adjustment of the amplifiers at the relay room, and at location A will alter the received levels from the transmitters in section 2 (and the signals from the transmitters in the following sections). Similarly, adjustment of the amplifier at location B will alter the received levels from the transmitters in section 3 etc. It is possible therefore to adjust progressively the received levels from the transmitters in each section until the system is complete and all receiver levels are correctly set.
It is important to keep the gain of both line amplifiers and isolating transformers as low as possible i.e. to compensate for the losses in the previous line section, and this is particularly important in long systems where there may be many sections between the farthest field unit and the relay room.

It is convenient to switch on in the field, at the farthest location, the mid-frequency transmitter, and to check the signal level, section by section back to the relay room. This will enable each line amplifier and isolation transformer to be checked, and the overall line attenuation to be measured. Any line faults that may not have been revealed during the tests covered under item 1 should also become apparent at this stage.

4.3 Setting Up (Indication System)

The mid-frequency transmitter at the farthest field location may be switched on to serve a a pilot channel for the system during the setting up.

Adjust the amplifier at the relay room and the amplifier at location A, so that the received levels at the relay room from the transmitters at location A are correct. Each of the transmitters may be switched on in turn and the receiver filter (as measured on the receiver filter adaptor) lies between 110 and 150mV.

Record the measured level for each channel.

Check the d.c. voltage across each operated Reed Follower relay lies between 10.5 and 20 volts. A high reading (50 volts) will be observed if the follower relay circuit is incomplete; as previously stated, this condition must not be allowed to persist. A significantly lower reading would suggest a receiver amplifier fault, and this should be changed.

Record the measured voltage for each receiver.

Ensure that each receiver operates correctly, when the appropriate transmitter is switched on and off again, and that the background signal, when the transmitter is switched off, causes no appreciable d.c. voltage (i.e. max. of 0.2 volts) across the follower relay.

Follow a similar procedure for all other sections progressively i.e. line amplifier at location B to be adjusted for correct received levels from transmitters at location B etc., until the system is complete and all receiver levels are set. Individual channel levels in each section should lie between 270 and 350mV.

When a fairly large system has to be set up, all channels which are normally energised should be switched on with at least one in every six functions at a particular location being energised.

4.4 Typical Control System

A typical control system is shown in fig.2.
Adjustment of the amplifiers at the relay room, and at location A will alter the input levels to the receivers in section 2, and the following sections. Similarly, adjustment of the amplifier at location B will alter the input to the receivers in section 3 etc. It is possible therefore to adjust progressively the input levels to the receivers in each section until the system is complete and all receiver levels are correctly set.
It is important to keep the gain of both line amplifiers and isolating transformers as low as possible i.e. to compensate for the losses in the previous line section, and this is particularly important in long systems where there may be many sections between the farthest field unit and the relay room.

It is convenient to switch on in the relay room, one of the transmitters feeding out to the farthest field location and check the levels, section by section to this location. This will enable each line amplifier and isolation transformer to be checked, and the overall line attenuation to be measured. Any line faults that may not have been revealed during the tests covered under item 1 should also become apparent at this stage.

4.5 Setting Up (Control System)

The transmitter feeding the farthest field location may be switched on to serve as a pilot channel for the system during the setting up.

Adjust the amplifier at the relay room and the amplifier at location A, so that the input levels to the receivers at location A are correct. Each of the transmitters may be switched on in turn and the receiver levels measured. Ensure that the output from the receiver filter (as measured on the receiver filter adaptor) lies between 110 and 150mV.

Record the measured level for each channel.

Check the d.c. voltage across each operated Reed follower relay lies between 10.5 and 20 volts. A high reading (50 volts) will be observed if the follower relay circuit is incomplete; as previously stated, this condition must not be allowed to persist. A significantly lower reading would suggest a receiver amplifier fault, and this should be changed.

Record the measured voltage for each receiver.

Ensure that each receiver operates correctly, when the appropriate transmitter is switched on and off again, and that the background signal, when the transmitter is switched of, causes no appreciable d.c. voltage (i.e. max of 0.2 volts) across the follower relay.

Follow a similar procedure for all other sections progressively i.e. line amplifier at location B to be adjusted so that the input levels to the receivers at location B are correct etc., until the system is complete and all receivers are correctly set. Individual line levels in each section should lie between 270 and 350mV.

When a fairly large system has to be set up, all channels which are normally energised should be switched on with at least one in every six functions at a particular location being fed.

4.6 Complex Systems

Systems of more complex design are illustrated in figs. 3 and 4.

In these examples, only a small number of channels operate throughout the total length of the system, whereas a much larger number of channels are used over shorter distances (sheet 11).
It will be apparent from inspection of these diagrams that any adjustments carried out, to control the line levels of channels operating over short distances, will affect also the levels of those channels working over longer distances, and vice-versa.
The methods by which line levels may be adjusted, have been described under item 4.1, and the effects of adjustment to line amplifiers and line isolation transformers have been described similarly under items 4.2 and 4.4.

The signal levels of the channels operating between intermediate locations, will be at a higher level initially than those channels working over longer distances. Therefore the inclusion of additional resistance to the input of line amplifiers (4.1.i.) at intermediate locations (in order to control the levels over the shorter distance), could require unacceptably high amplifier gain settings at other locations, so as to enable the "longer distance" channels to be set correctly. As previously stated (4.2 and 4.4.) it is important to keep the gain of both line amplifiers and line isolation transformers as low as possible, and therefore the following method of setting up is recommended.

(i) Set up the system following the procedure previously described under items 4.2 and 4.5, so that the received levels of those channels operating over the full distance, between the relay room and the farthest field location, are correctly set.

(ii) By means of suitable transmitter output attenuators* (sheet 8), adjust the received levels of those channels operating from intermediate locations to the relay room (fig.3.), or from the relay room to intermediate locations (fig.4.), so that they are set correctly.

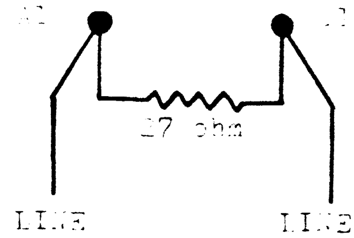
(iii) Follow the same procedure as described above (ii), to adjust the received levels of the channels operating between intermediate locations.

It is important to measure (and record), the output level of each transmitter (item 3) across a normal load resistance of 27 ohms, to ensure that the oputput lies within specified tolerances (item 5. E.), before any additional attenuator resistor is fitted. The output level across the combined load resistance (R + 27) ohms, together with the level across the line resistance (27 ohms), should also be recorded after the attenuator has been fitted.

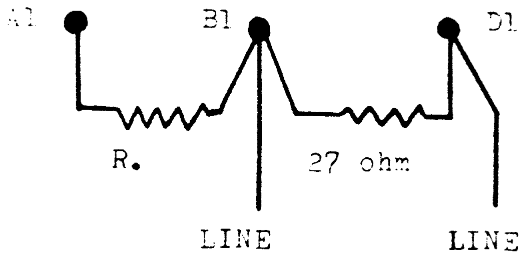
* The value of the line resistance is not altered by this method of adjustment, and therefore the levels set up in (i) will not be appreciably affected.

Transmitter Output Attenuator

In specific circumstances (4.6) the transmitter output may be reduced by the inclusion of an additional resistor between the transmitter output and the normal load resistance.
Attenuation of the output by approximately 3 to 6db may be obtained, with resistance values from 10 ohms to 27 ohms.
Resistors should be Metal Oxide or High Stability type 1 watt.

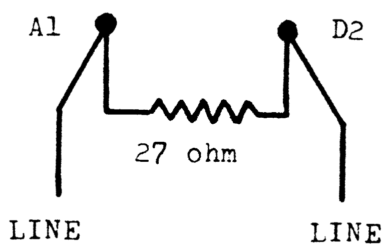


Normal Method of Tx Termination.



Tx Termination for Attenuated Output.

Approximate attenuation	Value of R.(ohms)
2.7db	10
3.2db	12
3.8bb	15
4.4db	18
5.2db	22
6 db	27



Method of Tx Termination for 6db Attenuated output from RR1002 Tx Amplifiers

...CONT'D...

5. TAKING MEASUREMENTS

The instruments required for taking measurements during commissioning are listed below:-

A. Line Measurements ;
Avo EA113 Transistorised Multimeter

B. D.C. Supply ;
Avo Model 8

C. A.C. to Power Units ;
Avo Model 8

D. A.C. to Line Amplifiers ;
Avo Model 8

E. Transmitter Output ;
Avo EA113 Transistorised Multimeter

F. Receiver Filter Output ;
Avo EA113 Transistorised Multimeter

G. Receiver Output and Reed Follower Relay Input ;
Avo Model 8

H. Receiver Background Output ;
Avo Model 8

MEASUREMENTS

A. Line Measurements

Measurement of line voltage on the input and output of line amplifiers and line transformers should be measured using the A.C. voltage ranges of an Avo EA113 Transistorised Multimeter.

It is advisable to monitor the point of measurement with a portable oscilloscope e.g. Telequipment D32 or similar, in order to ensure that the voltage being measured is the true Reed signal, and also to provide an additional reference reading.

The meter range used will depend upon the number of channels energised, e.g. with one channel only, the 1 volt a.c. range should be used as the line voltage will lie between approximately 300mV and 650mV*. If a large system is being set up, then the meter range will need to be set higher to 3 Volts, or possibly 10 volts due to the larger number of channels energised.

* Prior to setting up.

...CONT'D...

B. D.C. Supply

The D.C. supply to transmitters and receivers should be measured on the 25-volt (or 30-volt) range of the Model 8 Avometer, and should read between 12 and 13.4 volts.

C. A.C. to Power Supply Units

The A.C. supply to power supply units should be measured on the 250-volt (or 300-volt) range of the Model 8 Avometer. The reading should be between 100 and 115 volts.

D. A.C. Supply to Line Amplifiers

The A.C. supply to line amplifiers should be measured on amplifier terminals 10 and 11, using the 100-volt (or 30-volt) range of the Model 8 Avometer. This reading should lie between 22 and 26 volts.

E. Transmitter Output

Measurements should always be made across the line resistor (27-ohms) which is associated with the transmitter, and is mounted directly behind the plugboard. Using the 1 volt A.C. range of the EA113 transistorised multimeter, the reading should lie between 0.59 and 0.68 volts A.C. when the D.C. input to the transmitter on terminals D3 and A3 is 12 volts. If the D.C.input voltage is above 12 volts the A.C. output will rise correspondingly to give an upper limit of 0.75 volts A.C. with 13.5 volts D.C. input.

It should be noted that the reading across the line resistor is not appreciably affected by other channels which may be operating in the same system.

F. Receiver Filter Output

Receiver input levels measured at the output terminals of the filter adaptor, should be taken on the 0.3 volt A.C. range of the EA113 transitorised multimeter. The reading should lie between 110 and 150mV.

G. Receiver Output and Follower Relay Input

Reed follower relay voltage should be measured on the 25-volt (or 30-volt) D.C. range of the Model 8 Avometer, across terminals A1 and D1 of the receiver plugboard. The reading should lie between 10.5 and 20 volts. The D.C. input volts to the follower relay should also be measured on terminals R1 and R4 of the relay plugboard. Both readings should be identical.

H. Receiver Background Output

'Background' is the signal which can pass through the Reed filter from the line when the corresponding transmitter is switched off. It arises from the effect of all other frequencies that are present in the same system, and from cross-talk from other systems. It is measured in the same way as receiver output (2.5 or 3 volt range of the Avo 8) and will be varying D.C. voltage well below 0.2 volts.

...CONT'D...

Fig.3

Detail of Reed Equipment Locations.

Tx Location		Rx Location
R (7 Tx)		K (2 Rx)
		J (1 Rx)
		G (1 Rx)
	Relay Room	(3 Rx)
P (2 Tx)		J (1 Rx)
		E (1 Rx)
K (1 Tx)		E (1 Rx)
J (3 Tx)		E (2 Rx)
	Relay Room	(1 Rx)
G (1 Tx)	Relay Room	(1 Rx)
E (6 Tx)		C (1 Rx)
	Relay Room	(5 Rx)
C (1 TX)		B (1 Rx)
	Relay Room	(1 Rx-spare)

Fig.4

Detail of Reed Equipment Locations.

Tx Location	Rx Location
Relay Room 4 (Tx)	G (1 Rx)
	R (3 Rx)
A (1 Tx)	C (1 Rx)
B (3 Tx)	C (1 Rx)
	K (1 Rx)
	N (1 Rx)
C (2 Tx)	E (2 Rx)
E (2 Tx)	H (1 Rx)
	J (1 Rx)
J (1 Tx)	P (1 Rx)
K (2 Tx)	R (2 Tx)

FIG 1

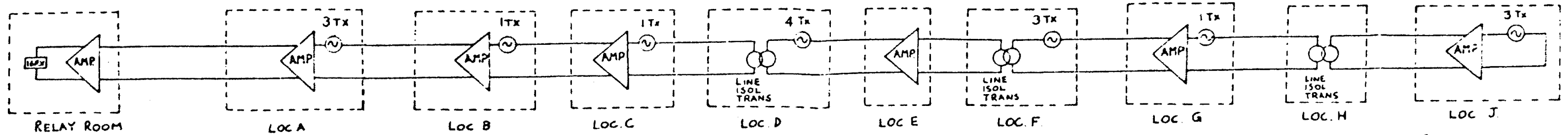


FIG 2

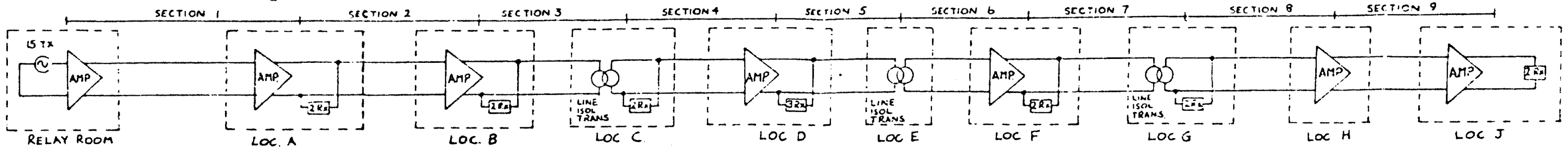


FIG 3

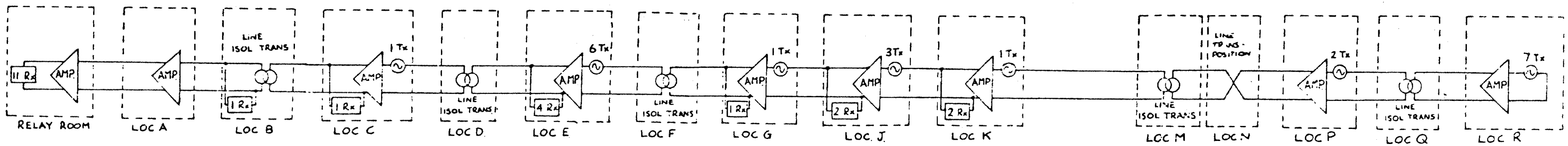
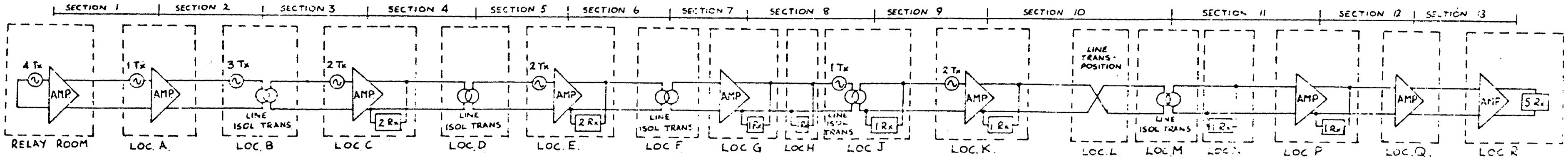


FIG 4



AMENDMENT SERIAL				

FIG.S 1-4

COMMISSIONING GUIDELINES

BRITISH RAILWAYS WESTERN REG.
SIGNAL & TELECOMMUNICATION
ENGINEERING DEPT READING

TR 300