ScR

ELECTRONIC EMERGENCY BLOCK BELL

E2B2

Contents

Revision

Card Type	Issue	Date
89SES1	Prototype	1989
89SES1.M1	First Issue	1990
89SES1.M2	Added carrier de-bounce	1991

1. Introduction

This system replaces the single stroke bell commonly used for the Emergency Block Bell function during a Train Describer failure.

The ‘bell’ is replaced by a speaker enabling multiple tones to be designated to avoid confusion at sites where more than one bell is installed.

Instead of using conventional signalling cable and a 50V pole change circuit the bell communication between signal boxes is via telecoms pairs or transmission system.

Sites installed at time of writing:

Yoker SC (1990) - six systems.
Greenhill SB (1992) - four systems
Glasgow Central Signalling Centre
Motherwell Signalling Centre.

This manual contains enough information to build, install and service the ScR Electronic Emergency Block Bell (E2B2).

2. Implementation

Description

The design remit had very little detail but stated that as a minimum the following features had to be implemented:

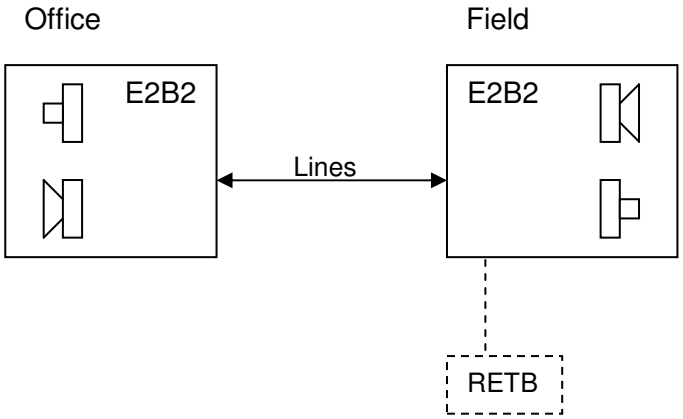
1) Multiple Tones.
2) Interface to radio equipment (i.e. Banavie RETB).
3) The "Bell" was to be a transducer e.g. Speaker.

A single Euro-card (100mm x 160mm) was designed to fulfil the remit with a few additional features to make the system as flexible as possible.

- Selectable tone.
- Two wire PCM compatible.
- Relay contacts - repeat of received push. (connection to radio)
- On board speaker.
- External speaker.
- Carrier Detect on board indication.
- Configurable for shared speaker multi-card system.

Its Working Title is E2B2.

The Basic system configuration is:



Office (multiple system)

The cards occupy a 19" rack with connectors at the rear for lines, bell push and 12VDC. One rack can hold up to six E2B2 cards (systems) and one spare card. The card position sets the transmit direction and tone. On some systems a 12VDC out socket is also incorporated to facilitate local testing.

Field (or single system)

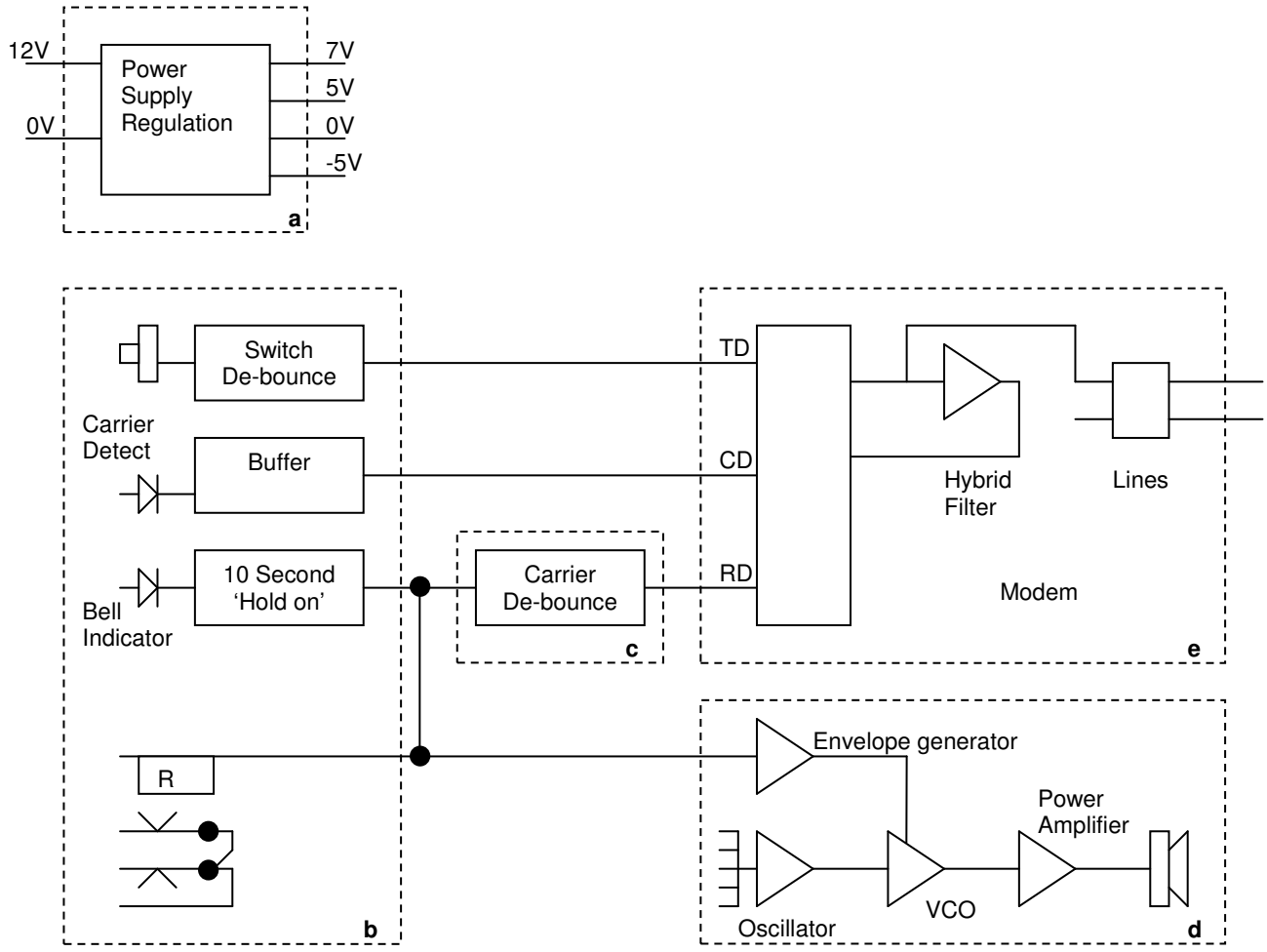
A single Euro-card case is used to house the card. The rear panel has connectors for lines and the 12VDC. Depending on local environment the bell push is mounted on the faceplate or on the operating panel. Transmit direction and tone is configured internally on the card edge connector.

3. Circuit Description

The circuit design consists of the following key areas:

a) Supply regulation.
b) Lamp/relay delay/drive and switch de-bounce.
c) Transmission line de-bounce.
d) Sound generator and speaker drive.
e) Modem (transmission).

Block diagram:



a) Supply regulation

The 12V (12V-15V) supply is fed to a simple Zener regulated emitter follower providing a stable 10V. This is then split to give a +/- 5V using B8, a negative 5V regulator IC.

b) Lamp/relay delay/drive and switch de-bounce

B1A de-bounces the single pole change-over switch. B2A & B, logically corrects and illuminates the Carrier Detect LED. B2D, E & F provides the high current drive for the bell push LED and relay. B3A gives a 10 second delay on the push LED.

c) Transmission line de-bounce

B3B, B1B & B2C prevents short duration carrier loss and line breaks from ringing the bell.

d) Sound generator and speaker drive

The sound generator is formed round the LM13600 (B5) dual transconductance operational amplifier and the LM324 (B4) quad operational amplifier.

B4C and B4D generate the attack/decay control voltage used to envelope the frequency generated by B5A and B4A. The two waveforms are combined in B5B.

The TBA820 (B6) 2 watt audio amplifier in standard configuration drives an 8 ohm 12 watt speaker.

The volume is set by VR1.

e) Modem (transmission)

The EF7910 is a single chip Asynchronous Frequency Shift Keying voiceband modem. It is used in the CCITT V.21 300bps full duplex mode. The transmit and receive carrier (TC/RC) outputs from the EF7910 are fed via a hybrid filter (duplexer) B4B and isolated from the lines by transformer T1.

The output line level is -10dBm. This can be altered easily by changing R30 and R31. Details can be found in the parts list.

The modem (EF7910) integrated circuit was manufactured by Thomson Semiconductors but has now been superseded by the newer EF7911.

f) Options

There are two groups of links on the circuit board. Link 1, pins 1 to 4 select the source for the power amplifier with pins 3 and 4 linked as the default. Link 2, pins 1 and 2 allow for an internal resistor on the bell push lamp (LED). See circuit Diagram 89SES1.M2

Link Allocations

Link	**Setting**	**Function**
LK1	1 to 3	Input from edge connector
	2 to 4	Output to edge connector
	3 to 4	Normal operation (**default**)
LK2	Open	Normal operation (**default**)
	1 to 2	External LED resister

4. Fault Investigation

Introduction

The following gives a background to faulting the system whilst it is in situ, the only tools required are an ear piece and a voltage meter.

On Site Faulting

Appendix 1 is a detailed block diagram showing the configuration of the system. It includes site names, types of power supply, line allocations and interfaces to other systems.

Procedure

1) Ascertain a description of the fault from the signaller.

2) Not receiving bells:

a) Check carrier detect (CD) green LED is lit.

b) CD LED not lit - Check power supply e.g. fuse etc. Replace as required.

Check for tone on telecoms lines - break lines and listen for tone on the incoming side. If there is no tone the fault is either at the remote bell unit or the lines are down. Go to remote end and follow procedure No.3

c) CD LED lit - Check for modulation of incoming tone - ask the signallman at the remote unit to send 16 bells - if there is no modulation the fault is at the remote end. Go to remote end and follow the faulting procedure No3.

If modulation does occur you have a faulty card. Replace card/unit.

3) Not sending bells:

a) Check power supply e.g. fuse etc. Replace as required.

b) Check for tone on telecoms lines -

Break lines and listen for tone on the outgoing side. If there is no tone replace the card/unit.

If there is a tone ask the signaller or assistant to send 16 bells. If no modulation occurs replace the card. If modulation does occur the fault is either at the remote bell unit or the telecoms lines are down. If you have come from the remote end and carried out procedure No.2 then the telecoms lines are faulty, otherwise go to remote end an follow the faulting procedure No.2.

Power supplies

All power supplies in the system have battery backup. There are three types of supplies available for use with the Block Bell, which one is used is dependent on local availability.

1) 110V AC to 12V DC - used where the 110V supply is guaranteed.

2) 50V to 12V DC/DC converter - used where there is an existing 50V battery.

3) 110/240V AC to 12V DC with internal battery - used where the 110V supply is not guaranteed.

Connections

50V DC-DC converter - screw terminals.

Looking at front, left to right -	0V IN (N50) 50V IN (B50) Space 0V OUT (N12) 12V OUT (B12)
110/240V supply -	IEC socket (IN). Cannon 3 pin (OUT).
Cannon -	Pin 2 (12V OUT) Pin 3 (0V OUT)

Apart from changing the fuse, no maintenance can be carried out on these units.

Spares should be held by the local Technician.

Interface

See site appendix for details of links to external systems.

5. Circuit Description

Introduction

This Section presents a detailed description of the card with circuit diagram and overlay provided in appendix 2.

Power Supply

The 12V (12V-15V) supply is fed via D7 to a simple Zener regulated emitter follower providing a stable 10V. This is further split to give a +/- 5V using B8, a negative 5V regulator IC.

Digital Circuit

B1A de-bounces the single pole change-over bell push switch (SW1 is mounted and used only in a test environment). The $\overline{Q}$ output is fed to the TD (Transmit data) input of B7.

B1B is a spare 'D' type flip-flop with all its inputs and outputs brought to the backplane.

B2, an inverting open collector buffer, provides the high current drive for the LED's and relay.

The RD (receive data) output of B7 is de-bounced by B1B and B3B. The $\overline{Q}$ output of B3B prevents the triggering of the bell/relay circuit until it has timed out. This prevents short duration carrier loss or line breaks from ringing the bell. The output of B1B is directed to the analogue circuitry via D8 and to the relay and B3A via a buffer B2D. The relay is a direct repeat of the bell push.

B3A gives a 10-second 'on' time set by R6/C6. The Q output is sent to B2E and B2F. B2F drives the bell push LED via R5 (R5 can be de-selected by shorting pins 1 & 2 on link 2 if the LED has a built in resistor) and B2E repeats the indication on the card using LED2 (yellow).

The CD (carrier detect) output of B7 is used to illuminate LED1 (green) a 'Carrier present' LED via B2A and B2B.

Modem (transmission)

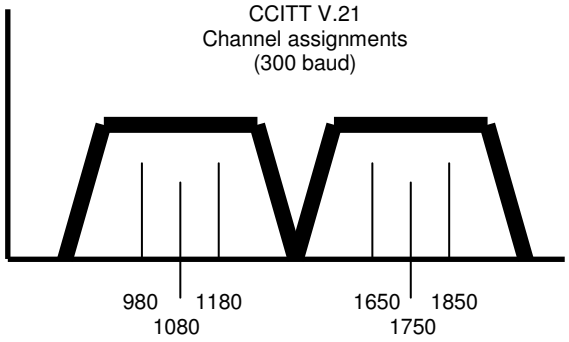
The EF7910 (B7) is a single chip Asynchronous Frequency Shift Keying voiceband modem. Audio frequency tones received from the lines are sampled by an 11-bit analogue to digital converter and tones transmitted are generated by an 11-bit digital to analogue converter. The shape of the sine-wave is governed by data stored in an internal ROM and frequency stability is assured by a quartz crystal. Even the filtering is performed within the chip, therefore no setting-up adjustments are required to be made.

There are five control lines with which to set up any of nine normal operating configurations. All but one of these lines are hard wired on the card, the other is available on the backplane. Selection is therefore done by pulling this control pin High or Low for 'answer' or 'originate' mode.

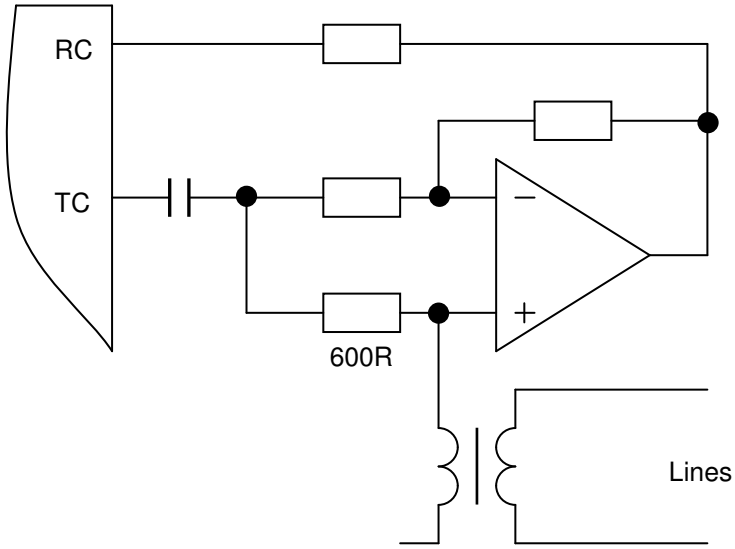
Frequency assignments for the various standards are shown below. The highlighted lines are those used.

Mode	**Data Rate**	**Duplex**	**Tx Frequency**		**Rx Frequency**		**Answer tone Freq.**
	Baud		**Space**	**Mark**	**Space**	**Mark**	
			Hz	**Hz**	**Hz.**	**Hz**	**Hz**
Bell 103 Originate	300	Full	1070	1270	2025	2225	
Bell 103 Answer	300	Full	2025	2225	1070	1270	2225
CCITT V.21 Originate	300	Full	1180	980	1850	1650	
CCITT V.21 Answer	300	Full	1850	1650	1180	980	2100
CCITT V.23 mode 1	600	Half	1700	1300	1700	1300	2100
CCITT V.23 mode 2	1200	Half	2100	1300	2100	1300	2100
Bell 202	1200	Half	2200	1200	2200	1200	2025
CCITT V.23 back	75		450	390	450	390	
Bell 202 back	5						

The centre frequencies for V.21 are 1080Hz and 1750Hz.



The Transmit carrier appears on the TC output of the EF7910 at a level of about -3dBm into 600R. It is desirable to provide some degree of separation between transmitted and received signals, and this can be achieved simply with an op-amp duplexer as shown below.



The impedance of the line is matched by the 600R resistor (R30), and the network introduces a 6dB loss between the transmitter and receiver. In practice, the line is unlikely to match the resistor perfectly and may be quite reactive; however this should not matter greatly.

The sensitivity of the receiver is very high, the modem will accept signals between 0dBm and -48dBm, although the carrier detect pin will not turn on unless the level exceeds -43dBm.

A matching transformer provides the electrical isolation and coupling to the lines. ZD1 and ZD2 suppress short spikes or surges on the lines.

Note: For -13dBm R30 = 1k2 R31 = 36K
For -20dBm R30 = 3k6 R31 = 91K

Analogue Circuit

The Trigger (from D8) is differentiated by C13/R27, giving a short spike that is amplified by B4C and used to charge C12 'the Attack'. A discharge path is provided by R24, the 'decay'. This results in an envelope with a fast attack and a slow decay. B4D buffers this signal and is used to drive the LED and the VCA (Voltage Controlled Amplifier) via R20.

The VCO (Voltage Controlled Oscillator) is based around one half of B5 (B5A), a dual transconductance amplifier. Current from pin 5 charges C11 until it reaches the threshold of Schmitt trigger, B4A. When this occurs the output at pin 1 switches and the capacitor begins to charge in the opposite direction until it reaches the opposite threshold and switches again. A triangle wave is therefore produced at the capacitor buffered by B5A (pin 8). The frequency of operation is set by the current into pin 1. This is provided by the selection of resistors R36 to R42.

The oscillator frequency is de-coupled by C10 and connected to B5B which is configured as a VCA. The gain of the amplifier is set by the current into R14 controlled by the current flowing into pin 16 from the envelope circuitry, via R20. The signal is buffered by B5B and the volume is set by VR1.

The signal can now travel one of two paths depending on whether the signal is to be sent to the backplane or to the power amplifier.

In normal operation the signal is passed to B6 (a low frequency class B power amplifier) via C8, R11 and link 1 pins 3 & 4. R10 lowers the input impedance, R9/C5 sets the gain, C4 the ripple rejection, C2 the bandwidth, C1/R7 forms the bootstrap and C23 de-couples the signal from the speaker. The output of B6 is also available on the backplane for the option of an external speaker.

6. Edge Connector Allocation

	c		**a**	
	0V	**1**	0V	
		2		
	12V	**3**	12V	
		4		
	MC0	**5**	5V	
	MC0	**6**	10V	
	TONE 1	**7**	10V	
	TONE 2	**8**	10V	
	TONE 3	**9**	10V	
	TONE 4	**10**	10V	
	TONE 5	**11**	10V	
	TONE 6	**12**	10V	
	SOT	**13**	10V	
		14		
	MIX I/O	**15**		
	5V	**16**		
	PRESET	**17**	CLEAR	
	DATA	**18**	CLOCK	
	Q	**19**	Q bar	
		20		
	0V	**21**	EXT. SPK	
	RLY NO	**22**	RLY NO	
	RLY COM	**23**	RLY COM	
	RLY NC	**24**	RLY NC	
	SW NO	**25**	SW NO	
	SW COM	**26**	SW COM	
	SW NC	**27**	SW NC	
	12V	**28**	12V	
	PUSH LAMP	**29**	PUSH LAMP	
	LINE a	**30**	LINE a	
	LINE b	**31**	LINE b	
		32		

7. Integrated Circuit power supply pins

IC No.	Part No.	SUPPLY PIN NUMBERS				PACKAGE SIZE
		0V	5V	10V	12V	
74HCT74	B1		7	14		14
7406	B2		7	14		14
74HCT123	B3		7	14		14
LM324	B4	11		4		14
LM13600	B5	6		11		16
TBA810	B6	4			6	8
EF7910	B7	4	9,22	2		28-0.6"
LM320T5	B8	3	2	1		3-SIL

8. Parts List

Part number	Part		Part number	Part
R1	Not used		C1 C20 C22	100uF 25V
R2 R4 R5	220R		C2	470pF
R3 R18	4K7		C3	220nF
R6 R23	560K		C4 C6	47uF 16V
R7	56R		C5	100uF 25V
R8	1R		C7 C23	220uF 16V
R9 R35	120R		C8	1uF 50V
R10 R19 R33	10K		C9	22uF 35V
R11 R22	100K		C10 C12	1uF 50V
R12	22K		C11	100nF
R13 R25	2M2		C13 C24	47nF
R14 R17 R26 R27	47K		C14	2.2nF
R15 R16	1K		C15	100nF
R20 R34	15K		C16	2.2uF 50V
R21	680R		C17	47pF
R24	180K		C18 C21	220uF 25V
R28	100R		C19	2.2uF 50V
R29	1M		CD	100nF x 4
R30	600R		B1	74HCT74 Dual D flip-flop
R31 R32	22K		B2	7406 Hex inverter
R36	SOT 27K		B3	74HCT123 Dual monostable
R37	SOT 33K		B4	LM324N Quad op-amp
R38	SOT 39K		B5	LM13600N Dual transconductance op-amp
R39	SOT 47K		B6	TBA820M 2 watt power amp
R40	SOT 56K		B7	EF7910 FSK modem
R41	SOT 75K		B8	LM320T-5.0 Negative 5V regulator
R42	SOT		Q1	BD135 NPN
RV1	4K7		ZD1, ZD2	SA12
RP1	10K		ZD3	BZY88C11
			D1 D7 D8	1N4004
TV41	Heatsinks		D2	1N4148
	Shorting Links		D3 D4 D5 D6	BAW62
	Card Handle		LED1	GREEN
	Edge Connector		LED2	YELLOW
89SES1.M2	Card		LED3	RED
	Push Button		XT1	2.4576MHz
	Push Button LED		RLY	Siemens V23040-A0001-B201 SPCO
	Fuse Holder		T1	1:1 600R
	Fuse		S1	6V Buzzer
	Nut & Bolts		S2	8R 10Watt
	Case		SW1	Not used

For -13dBm R30 = 1k2 R31 = 36K
For -20dBm R30 = 3k6 R31 = 91K

9. Site Appendix

Example – Yoker IECC

Card Frame and Tone Allocation

Card Position	Tone	Resistor	Value	12V Bus	0V Bus	Site
10	1.66KHz	R36	27K	303	103	Banavie
23	1.35KHz	R37	33K	309	109	Motherwell
36	1.10KHz	R38	39K	316	116	Sighthill
49	850Hz	R39	47K	322	122	Cen Union
62	600Hz	R40	56K	329	129	Cen Argyle
75	400Hz	R41	75K	335	135	Cowlairs
80	Reserved for future use			338	138	

Card Frame DC connections

Function	Cannon Female	Cannon Male	Switch	Bus Bar
12V	2	2		100
0V	3	3		300
12V in			2	
12V out			1	

Lines

Function	4 Way Ringlock
Line a	a
Line b	b

110V to 12V Klippon Terminations

Klippon	Function
1	BX110
2	NX110
3	Earth
4	B12
5	N12

Card Edge Connector and Klippon Block Terminations

	c		**a**	
	0V	**1**	0V	
		2		
	12V	**3**	12V	
		4		
	MC0	**5**	5V	
	MC0	**6**	10V	
	TONE 1	**7**	10V	
	TONE 2	**8**	10V	
	TONE 3	**9**	10V	
	TONE 4	**10**	10V	
	TONE 5	**11**	10V	
	TONE 6	**12**	10V	
	SOT	**13**	10V	
		14		
	MIX I/O	**15**		
	5V	**16**		
	PRESET	**17**	CLEAR	
	DATA	**18**	CLOCK	
	Q	**19**	Q bar	
		20		
Orange Klippon Block	0V	**21**	EXT. SPK	**Orange Klippon Block**
1	RLY NO	**22**	RLY NO	**2**
3	RLY COM	**23**	RLY COM	**4**
5	RLY NC	**24**	RLY NC	**6**
7	SW NO	**25**	SW NO	**8**
9	SW COM	**26**	SW COM	**10**
11	SW NC	**27**	SW NC	**12**
13	12V	**28**	12V	**14**
15	PUSH LAMP	**29**	PUSH LAMP	**16**
17	LINE a	**30**	LINE a	**18**
19	LINE b	**31**	LINE b	**20**
		32		

Bell Push cable allocations.

Banavie - West workstation No.1

Function	Ringlock	Molex	Bell Push	Core Colour
Cathode	a	6	X2	Red
Anode	b	5	X1	Black
SW NC	c	4	22	Yellow
SW COM	d	3	13	Green
		1	21	
SW NO	e	2	14	Blue

Molex - pins 1 & 3 looped

Electronic Emergency Block Bell

Motherwell - East workstation No.2

Function	Ringlock	Molex	Bell Push	Core Colour
Cathode	a	6	X2	Red
Anode	b	5	X1	Black
Sw NC	c	4	22	Yellow
Sw COM	d	3	13	Green
		1	21	
Sw NO	e	2	14	Blue

Molex - pins 1 & 3 looped

Sighthill - East workstation No.3

Function	Ringlock	Molex	Bell Push	Core Colour
Cathode	a	12	X2	Red
Anode	b	11	X1	Black
Sw NC	c	10	22	Yellow
Sw COM	d	7	13	Green
		9	21	
Sw NO	e	8	14	Blue

Molex - pins 7 & 9 looped

Central Union Line - East workstation No.4

Function	Ringlock	Molex	Bell Push	Core Colour
Cathode	a	18	X2	Red
Anode	b	17	X1	Black
Sw NC	c	16	22	Yellow
Sw COM	d	13	13	Green
		15	21	
Sw NO	e	14	14	Blue

Molex - pins 13 & 15 looped

Central Argyle Line - East workstation No.5

Function	Ringlock	Molex	Bell Push	Core Colour
Cathode	a	24	X2	Red
Anode	b	23	X1	Black
Sw NC	c	22	22	Yellow
Sw COM	d	19	13	Green
		21	21	
Sw NO	e	20	14	Blue

Molex - pins 19 & 21 looped

Cowlairs - East workstation No.6

Function	Ringlock	Molex	Bell Push	Core Colour
Cathode	a	30	X2	Red
Anode	b	29	X1	Black
Sw NC	c	28	22	Yellow
Sw COM	d	25	13	Green
		27	21	
Sw NO	e	26	14	Blue

Molex - pins 25 & 27 looped

Electronic Emergency Block Bell

Field Unit wirings.

Function	8 Way Ringlock	4 Way Ringlock	Bell Push	Cannon Connector	Core Colour
Cathode	a		X2		Black
Anode	b		X1		Red
Sw NC	c		22		Blue
Sw COM	d		13		Brown
			21		
Sw NO	e		14		Green
Line A		a			Black
Line B		b			Red
12V DC				2	Yellow
0V DC				3	White

Push - 13 & 21 Looped

All field units use frequency F2.

Line allocations - Telecomms.

Fringe Box		Yoker
Banavie/Craigendoran	CCTV Cub T17, 19 V4 L64 Pr1 V3 L32 Pr7	V16 L32 Pr7 V14 L3 Pr3 West WS Pr3
Motherwell	Panel to V1 TB1 Pr12 V14 Tie Pair V15 L8 Pr6 or 7 V14 L43 Pr2	V10 L36 Pr2 V14 L6 Pr6 East WS Pr6
Sighthill	Panel to Location SB1/1Tc Pr83 LHS	V10 L50 Pr2 V14 L6 Pr 5 East WS Pr5
Central Union	Panel 5 Pr12 V2rear L31 Pr7	V14 L6 Pr3 to V12 L2 Pr7 East WS Pr7
Central Argyle	Panel 6 Pr11 V2rear L46 Pr2	V14 L6 Pr3 to V12 L17 Pr2 East WS Pr2
Cowlairs	Panel-V1 L? Pr? V3 L3 Pr9 Old RR	V11 L4 Pr2 V14 L6 Pr4 East WS Pr4

Power supplies

Two 50V to 12V DC-DC converters have been installed at Glasgow Central.

Four 110V/240V AC to 12V DC battery backed supplies have been installed at Cowlairs, Craigendoran, Sighthill and Motherwell. Under power failure conditions battery life is greater 24 hours.

Banavie Radio Interface

The Radio interface is situated in the CCTV cubicle in Craigendoran Relay Room. The interface consists of a block bell card mounted in a 19" card frame with a ribbon cable going to an orange klippon block.

Terminals 2 & 3 are the relay contacts used to repeat the bell on to Banavie.

Terminals 7, 9, & 11 are wired to change over contacts on the XR relay which is operated by the radio link from Banavie. This repeats the bell on to Yoker.

Terminals 17 & 19 are the lines to the telecoms IDF.

Please refer to drawing No. C93/E4/1 for wiring details.