DIAGRAM NOTES (ISSUE 3)

concerning

NZPO 38743 (ISSUE E)

titled

SUBSCRIBERS LINE SIGNALLING EXTENDER RELAY SET

INDIVIDUAL, 2-PARTY AND PABX EXTENSIONS

An explanation of the above circuitry is covered under the following headings:

PRINTED BY NZPO

OCTOBER 1978

1. GENERAL.

1.1 The diagram shows the circuit of a subscriber's line signalling extender relay set for individual, 2-party and PABX extension lines for use at local or intermediate exchange locations.

1.2 Typical diagrams to be considered in conjunction with this circuit are -

Subscribers line circuit	GBW 10750 or equivalent
Final Selector	GBW 10770 or equivalent.

2. FACILITY SCHEDULE.

Provision is made for -

2.1 Transformer type transmission bridge, which includes a differentially connected relay when used in conjunction with NZPO PABX extension for recall facility.

2.2 Bothway working.

2.3 Pulse repetition with a pulse corrector.

2.4 N.I.R. switching.

2.5 Individual and two party service.

2.6 Extending an uninterrupted start condition, if required, to a common ringing supply equipment.

2.7 Limiting the current from the exchange equipment.

2.8 Ringing return battery or ringing return earth option.

3. OUTLINE CIRCUIT OPERATION.

3.1 Incoming Call. Ringing current is received from an automatic exchange or PABX on the outgoing negative and positive wires and causes ringing current and ringing return to be connected to the incoming negative and positive wires respectively. Where required, an uninterrupted signal is connected to the common ringing supply equipment as a start condition.

When the called party answers, a loop signal is received on the incoming negative and positive wires to trip the local ring current, extend the transmission path and connect a loop to the outgoing negative and positive wires as an answering signal to the automatic exchange or PABX unit.

When the called party clears, the loop signal is disconnected from the incoming negative and positive wires and is repeated to the outgoing negative and positive wires as a release signal to the automatic exchange or PABX unit.

3.2 Calls from a Subscriber or Extension. When a call is originated a loop is connected to the incoming negative and positive wires and this is repeated to the outgoing negative and positive wires to seize the subscriber's line circuit at an automatic exchange or PABX unit.

During dialling, loop disconnect pulses received on the incoming negative and positive wires are corrected to reduce distortion and repeated to the outgoing negative and positive wires to route the call via the automatic exchange or PABX unit.

When the subscriber or extension clears, the loop signal is disconnected from the incoming negative and positive wires and is repeated to the outgoing negative and positive wires as a release signal to the automatic exchange or PABX unit.

On both outgoing and incoming calls, an NZPO PABX extension has inquiry, transfer and operator recall facilities.

4. OPERATION DETAILS.

4.1 Call to an individual subscriber or a PABX extension.

4.1.1 Seizure. Ringing current being applied to the positive and negative wires from the exchange or PABX unit causes relay RR to operate to each alternative half cycle of the ringing current.

Relay RR	operating,
RR 1	operates relay RA,
RR 2	spare.
Relay RA	operating,
RA 1 and RA 2	spare,
RA 3	connects earth via Resistor R 8 to discharge Capacitor C 8 and operate relay RB. Also connects earth to the local ringing supply equipment where required as a start signal.
RA 4	spare.
Relay RB	operating,
RB 1	disconnects Transformer T1 from, and connects a ringing return via Resistor R 6 to, the incoming positive wire (+).
RB 2	disconnects Transformer T1 from, and connects interrupted ringing current via the 200 ohm winding of Relay FB to the incoming negative wire to ring the subscriber or extension. Due to the relatively high impedance of the subscribers

exchange line or extension circuit Relay FB does not operate at this stage.

RB 3 — connects a loop via Resistor R 14 to operate Relay LS. Relay DR, if in circuit, is differentially connected and therefore is not operated at this stage.

RB 4 — connects earth to the local ringing supply equipment where required as a start signal.

Relay LS — operating,

LS 1 — prepares a hold circuit for Relay FB.

LS 2 — is ineffective at this stage.

4.1.2 Called Party Answers. When the subscriber or extension answers, a loop signal is received on the incoming negative and positive wires, the resulting rise in current via the 200 ohm winding of Relay FB (due to the reduced impedance of the line circuit) is sufficient to permit the early make Contact FB 3 x to operate and complete a local circuit for the complete operation of Relay FB.

Relay FB — operating,

FB 1 — releases relay RB and connects Capacitor C 8 to the 1300 ohms winding of relay FB.

FB 2 — disconnects shunt resistors R 9 A to C from relay RA to ensure fast release of relay RA.

FB 3 x — completes an operating circuit for relay FB via its 1300 ohms winding.

FB 4 — releases relay RR (if operated at this stage) and disconnects it from the outgoing negative wire. Also completes a loop across the positive and negative wires, thereby tripping the ringing from the exchange or PABX unit.

FB 5 — releases relay RA (if operated at this stage) and operates relay BB.

Relay BB — operating,

BB 1 — applies battery to PL lead to switch on N.I.R. if equipped.

BB 2 and 3 — are ineffective at this stage.

BB 4 — spare.

Relay RB	releasing,
RB 1	disconnects the ringing return via Resistor R 6 from, and connects Transformer T1 to, the incoming positive wire (+).
RB 2	disconnects the ringing current via the 200 ohm winding of Relay FB from, and connects Transformer T1 to, the incoming negative wire (-).
RB 3	disconnects a loop via Resistor R 14 from the incoming negative and positive wires to extend the battery feed and complete the speech transmission path. Relay LS remains held operated to the subscriber's exchange line or the extension instrument loop (Relay DR which is differentially connected remains unoperated at this stage).
RB 4	disconnect an earth from the ringer start lead (where required) and completes an alternative hold circuit for Relay FB controlled by Contact LS 2.
Relay RR	releasing (if operated at this stage),
RR 1	disconnects original operating circuit for relay RA.
RR 2	spare.
Relay RA	releasing (if operated at this stage),
RA 1, RA 2 and RA 4	are spare,
RA 3	disconnects original operating circuit for relay RB.

Relays LS, FB and BB are now held operated and conversation may proceed.

4.1.3 Release. When the subscriber or extension clears, the loop is disconnected from the incoming negative and positive wires to release Relay LS.

Relay LS	releasing,
LS 1) LS 2)	operates relay CD, disconnects earth from Capacitor C 1 and the 1300 ohm winding of relay FB. Capacitor C 1 charges via relay FB and after a delay the relay releases. Contact LS 2 also operates relay A and discharges Capacitors C 7 and C 8 in series with resistor R 3.

Relay CD	operating,
CD 1	short circuits T 1 winding,
CD 2	disconnects the battery from the N.I.R. if equipped,
CD 3	spare.
Relay A	operating,
A 1	disconnects a loop from the outgoing negative and positive wires as a clearing supervisory signal.
Relay FB	releasing slowly (see contacts LS 1 and LS 2 above),
FB 1	disconnects relay FB from, and connects relay RB to, Capacitor C 8.
FB 2	connects shunt resistors R 9 A to C to relay RA.
FB 3 x	is ineffective at this stage.
FB 4	connects relay RR to the outgoing negative wire (via capacitor C 5) to prepare for a subsequent call to the subscriber or extension.
FB 5	releases relay BB.
Relay BB	releasing,
BB 1	is ineffective at this stage,
BB 2	releases relay CD.
BB 3	disconnects earth from relay A and Capacitors C 1 and C 2 which now charges via the relay and Resistor R 3. After a short delay Relay A releases.
BB 4	spare.
Relay A	releasing (see Contact BB 2 above).
A 1	prepares a loop circuit to the automatic exchange or PABX unit.
Relay CD	releasing,
CD 1	removes short circuit from T1 winding,

CD 2	prepares a circuit to connect battery to the N.I.R. if equipped on subsequent calls.
CD 3	spare.

All relays have now released and the circuit is free for further calls.

4.2 Call from a Subscriber or Extension.

4.2.1 Seizure. When a subscriber or extension originates a call, a loop on the incoming negative (-) and positive wires (+) operates relay LS (on NZPO PABX extension). Relay LS is in series with Relay DR but as that relay is differentially connected it does not operate at this stage.

Relay LS	operating,
LS 1	is ineffective at this stage.
LS 2	operates Relay FB and prevents irregular operation of Relay A when Contact BB 3 operates.
Relay FB	operating,
FB 1	disconnects relay RB from, and connects the 1300 ohms winding of relay FB to Capacitor C 8 (see Design Details).
FB 2	is ineffective at this stage.
FB 3 x	is ineffective at this stage.
FB 4	disconnects relay RR from the outgoing negative wire (via Capacitor C 5) to avoid shunting the transmission path and connects the secondary winding of transformer to the outgoing negative and positive wires to seize the subscribers line circuit at the exchange or PABX unit.
FB 5	operates relay BB.
Relay BB	operating,
BB 1	applies battery to PL lead to switch on N.I.R. if equipped,
BB 2	prepares an operating circuit for relay CD,
BB 3	prepares an operating circuit for relay A,
BB 4	spare.

The calling party is now connected to the exchange or to the PABX unit and dial tone is received. The calling party now dials and relay LS functions under the control of the received pulses.

Relay LS	releasing to a disconnect pulse,
LS 1) LS 2)	operates relay CD, disconnects earth from the 1300 ohm winding of relay FB which due to its own release lag and the effect of the shunt Capacitor C 1 in series with resistor R 2, remains operated during dialling. Contact LS 2 operates relay A and discharges Capacitors C 1 and C 2 in series with resistor R 3.
Relay A	operating,
A 1	transmits a "break" pulse to the outgoing negative and positive wires.
Relay CD	operating and remains operated until after the end of the digit.
CD 1	places a short circuit across T1 winding to provide a non-inductive path for the pulse currents.
CD 2	disconnects the battery from the N.I.R. if equipped.
CD 3	spare.
Relay LS	operating to a loop pulse or at the end of a digit.
LS 1) LS 2)	releases relay CD, re-energise relay FB to hold that relay and discharge Capacitor C 8. Contact LS 2 also disconnects earth from relay A and Capacitors C 1 and C 2, the latter now charging in series with the relay and resistor R 3. After a short delay relay A releases.
Relay A	releasing to a loop pulse or at the end of a digit transmits a "make" pulse or maintains a holding loop to the outgoing negative (-1) and positive (+1) wires.
Relay CD	releasing removes the short circuit from the T1 winding.

This permits the calling party to receive any tone present on the line - e.g., overflow or number unobtainable tone. The same process is repeated for each digit dialled. At the completion of the last digit dialled a tone, indicating the condition of the called line is returned

to the calling party. When the called answers, conversation can take place.

4.2.2 Release. The release proceeds as explained in section 4.1.3.

4.3 NZPO PABX Extension Recall Facility. The extension telephone is provided with a non-locking key which when operated connects an earth to the negative wire. On receipt of this signal, relay LS, previously operated in series with relay DR to the extension loop, now holds in series with the battery connected winding of the differentially connected relay DR which also operates.

Relay DR	operating,
DR 1	connects earth to the outgoing negative wire.

When the extension key is released, the earth is disconnected and relay LS remains held to the loop but the differentially connected relay DR releases.

4.4 Call to a 2-Party Subscriber.

4.4.1 Seizure (X Party). Ringing current being applied to the negative wire from the exchange causes relay RR to operate to each alternative half cycle of the ringing current.

Relay RR	
RR 1	operates relay RA,
RR 2	spare.
Relay RA	operating,
RA 1	prepares to extend continuous ringing to the negative wire to ring the "X" subscriber's bell.
RA 2	spare.
RA 3	connects earth via resistor R 8 to discharge C 8 and operate relay RB. Also connects earth to the local ringing supply equipment where required as a start signal.
RA 4	spare.
Relay RB	operating,
RB 1	disconnects transformer T1 from, and connects a ringing return via Resistor R 6 to, the positive wire.
RB 2	disconnects transformer T1 from, and connects continuous ringing via the 200 ohm winding of

relay FB to the negative wire to ring the "X" party subscriber's bell.

RB 3 — connects a loop via resistor R 14 to operate relay LS.

RB 4 — connects an additional earth to the local ringing supply equipment where required as a start signal.

Relay LS — operating,

LS 1 — prepares a hold circuit for relay FB.

LS 2 — is ineffective at this stage.

During the silent period of the incoming ring the exchange, relay RA is released and contact RA 1 connects an earth to the negative wire via the 200 ohm winding of relay FB.

4.4.2 Called Party Answers. When the subscriber answers, a loop signal is received on the incoming negative and positive wires, the resulting rise in current via the 200 ohm winding of Relay FB (due to the reduced impedance of the line circuit) is sufficient to permit the early make Contact FB 3 x to operate and complete a local circuit for the complete operation of Relay FB.

Relay FB — operating,

FB 1 — releases relay RB and connects Capacitor C 8 to the 1300 ohms winding of relay FB,

FB 2 — disconnects shunt resistors R 9 A to C from relay RA to ensure fast release of relay RA.

FB 3 x — completes an operating circuit for relay FB via its 1300 ohms winding.

FB 4 — releases relay RR (if operated at this stage) and disconnect it from the negative wire. Also completes a loop across the positive and negative wires, thereby tripping the ringing from the exchange.

FB 5 — releases relay RA (if operated at this stage) and operates relay BB.

Relay RA — releasing (if operated),

RA 1 — disconnects continuous ringing from the negative wire and connects an earth to the 200 ohm winding of relay FB.

RA 2 and RA 4 — spare,

RA 3	disconnects original operating circuit for relay RB.
Relay BB	operating,
BB 1	applies battery to PL lead to switch on N.I.R. if equipped.
BB 2 and BB 3	are ineffective at this stage.
BB 4	disconnects relay RS from the positive wires.
Relay RB	releasing,
RB 1	disconnects the ringing return via Resistor R 6 from, and connects Transformer T1 to, the incoming positive wire (+).
RB 2	disconnects the earth via the 200 ohm winding of relay FB from, and connects Transformer T1 to, the incoming negative wire (-).
RB 3	disconnects a loop via Resistor R 14 from the incoming negative and positive wires to extend the battery feed and complete the speech transmission path. Relay LS remains held operated to the subscribers exchange line.
RB 4	disconnect an earth from the ringer start lead (where required) and completes an alternative hold circuit for Relay FB controlled by Contact LS 2.

Relays LS, BB and FB are now held operated and conversation may proceed.

4.4.3 Seizure (Y Party). Ringing current being applied to the positive wire from the exchange causes relay RS to operate to each alternative half cycle of the ringing current.

Relay RS	operating,
RS 1	operates relay RC,
RS 2	spare.
Relay RC	operating,
RC 1	prepares to extend continuous ringing to the positive wire to ring the "Y" subscriber's bell.
RC 2	connects continuous ringing current via the 200 ohm winding of relay FB to the positive wire to ring the subscriber's bell. Due to the relatively high impedance of the subscriber exchange line relay FB does not operate at this stage.

RC 3 — connects earth via resistor R 8 to discharge C 8 and operates relay RB. Also connects earth to the local ringing supply equipment where required as a start signal.

RC 4 — connects a ringing return via resistor R 6 to the negative wire.

Relay RB — operating,

RB 1 — disconnects transformer T1 from, and connects continuous ringing via the 200 ohm winding of relay FB to the positive wire to ring the "Y" party subscriber's bell.

RB 2 — disconnects transformer T1 from, and connects a ringing return via Resistor R 6, to the negative wire.

RB 3 — connects a loop via resistor R 14 to operate relay LS.

RB 4 — connects an additional earth to the local ringing supply equipment where required as a start signal.

Relay LS — operating,

LS 1 — prepares a hold circuit for relay FB.

LS 2 — is ineffective at this stage.

During the silent period of the incoming ring from the exchange, relay RA is released and contact RA 1 connects an earth to the negative wire via the 200 ohm winding of relay FB.

4.4.4 Called Party Answers. When the subscriber answers, a loop signal is received on the incoming negative and positive wires, the resulting rise in current via the 200 ohm winding of Relay FB (due to the reduced impedance of the line circuit) is sufficient to permit the early make Contact FB 3 x to operate and complete a local circuit for the complete operation of Relay FB.

Relay FB — operating,

FB 1 — releases relay RB and connects Capacitor C 8 to the 1300 ohms winding of relay FB.

FB 2 — disconnects shunt resistors R 9 A to C from relay RC to ensure fast release of relay RC.

FB 3 x — completes an operating circuit for relay FB via its 1300 ohms winding.

FB 4	disconnects relay RR from the negative wire. Also completes a loop across the positive and negative wires, thereby tripping the ringing from the exchange.
FB 5	releases relay RC (if operated at this stage) and operates relay BB.
Relay RC	releasing (if operated),
RC 1	disconnects continuous ringing from the positive wire and connects an earth to the 200 ohm winding of relay FB.
RC 2	connects contact RC 1 earth via the 200 ohm winding of relay FB to the negative wire.
RC 3	disconnects original operating circuit for relay RB.
RC 4	connects ring return to the positive wire.
Relay BB	operating,
BB 1	applies battery to PL lead to switch on N.I.R. if equipped.
BB 2 and BB 3	are ineffective at this stage.
BB 4	releases relay RS (if operated at this stage) and disconnects it from the positive wire.
Relay RB	releasing,
RB 1	disconnects the ringing return via Resistor R 6 from, and connects Transformer T1 to, the incoming positive wire (+).
RB 2	disconnects the circuit via the 200 ohm winding of Relay FB from, and connects Transformer T1 to, the incoming negative wire (-).
RB 3	disconnects a loop via Resistor R 14 from the incoming negative and positive wires to extend the battery feed and complete the speech transmission path. Relay LS remains held operated to the subscribers exchange line.
RB 4	disconnect an earth from the ringer start lead (where required) and completes an alternative hold circuit for relay FB controlled by Contact LS 2.

Relay RS	releasing (if operated at this stage),
RS 1	disconnects original operating circuit for relay RC.
RS 2	spare.

Relays LS, BB and FB are now held operated and conversation may proceed.

4.4.5 Release (X and Y Parties). The release proceeds as explained in Section 4.1.4.

4.5 Call from a 2-Party Subscriber. The call proceeds as explained in Section 4.2.

5. CIRCUIT DESIGN DETAILS.

The following relays have special features or functions:

Relay FB	has a front end slug, the resulting operating lag ensuring that Relay FB does not operate prematurely to a surge, via the 200 ohm line winding, when connected to line. Its release lag, also assisted by the shunt Capacitor C8 and series Resistor R2, ensures that the relay will remain operated on its 1300 ohm winding during pulsing of Contacts LS1 and LS 2 under dialling conditions. The relay, which is provided with an early make contact (x action), is designed such that the x action will operate under ring trip conditions over the maximum line loop resistance of 2000 ohms in series with the ring return Resistor R6 and the subscriber's or extension telephone of 300 ohms impedance. Once operated, the x action completes a local circuit via the 1300 ohm winding in order to fully operate the remaining contacts.
Relays RA, RB and LS or RC, RB and LS	have a combined operate lag greater than the maximum out of sequence that can occur between Contact FB and Contact FB 3 (x action) releasing to ensure that relays RA, RB and LS or relays RC, RB and LS cannot be operated by a follow-on call until Contact FB 3 has released otherwise premature ring trip conditions could take place due to Contact LS 1 re-energising relay FB via Contact FB 3, (see Design Details for Resistor R 8).
Relay RB	is shunted by Capacitor C8 and Resistor R 2 to provide a release lag in order that the relay will remain operated during the normal periodic interruptions of automatic ringing current during which relay RA or RC is released. This avoids intermittent connexion of a ringer start signal

(where required) and also irregular interruptions of the interrupted ringing supply fed via Relay FB to the subscriber's line or extension.

Relay DR — is differentially connected to ensure it will not operate to loop conditions or loop/disconnect pulsing on the incoming negative and positive wires but can operate to earthed leg signalling required for NZPO PABX extension recall facility.

Relay CD — is made slow to release by a heel end slug to guard all pulse disconnection periods.

Relays RA and RC — have two methods of release -

(a) is made slow to release by a shunt resistor to ensure that the correct ringing period is applied to the subscriber's line on 2-party condition.

(b) is made fast release for ring trip condition (FB 5 contact).

Contacts not previously fully explained -

Contact RB 3 pre-operates Relay LS via Resistor R 14 on incoming calls to reduce the acoustic shock effect under ring trip conditions.

Pulse distortion corrector. The extension of line limits permitted by using this unit on a subscriber's line has been achieved by the introduction of an additional pulse repetition stage with a consequent increase in positive pulse distortion. To offset this increase, Relay A, Capacitors C1 and C2 A & B Resistor R 3 have been provided as a pulse corrector.

Capacitors C1 and C2 are normally charged via Relay A. When a break pulse is received, contact LS 2 releases and operates Relay A and discharges Capacitors C1 and C2 Contact A1 repeats the break pulse to the forward equipment. When a make pulse is received, Contact LS 2 operates and disconnects earth from Relay A and Capacitor C1 and C2. The capacitor now charges via Relay A thereby delaying its release and thus ensuring at Contact A1 the repetition of a break pulse of adequate duration.

Resistors -

Resistor R2 limits the charging current of Capacitor C8 during the pulsing of Contacts LS 1 and LS 2 as dialling takes place in order to protect Contact FB 1.

Resistor R8 in conjunction with the high impedance winding of Relay RB and Capacitor C8 ensures that the relay obtains its required operate lag performance (see Design Details for Relays RA, RB and LS).

Resistor R10 is provided to reduce the line current so that relay A in the exchange is not over saturated, thereby prevent pulse distortion.

Resistor R14 limits the current to that necessary only for the correct operation of Relay LS.

Resistor R15 provides a discharge circuit for capacitor C6, this prevents mal-operation of relay RR on completion of a call.

Capacitor C5 is provided to permit speech voltages to bypass Resistor R10.

Diodes are used for the following reasons:

D1 - D4 to permit relay RR and RS to operate to ringing conditions.

D7 - D6 to block resistors R 9 A to C from contacts RR 1 and RS 1 earth during the operation of relays RA and RC.

D8 (Ref. Note 1.9 of schematic) to block the ring start lead from LS1 earth during conversation.

D5 to block contact RB 4 earth from capacitor C8.

R 1 non-linear resistor is provided to reduce sparking on the contacts operating or releasing relay CD.

Current Drain

Normal: Nil

Signalling: 180 mA

Talking: 270 mA

Design Line Limits

To Exchange: Dependent on the exit resistance limit of the particular parent exchange equipment to which the extender is connected.

To Subscriber: 2000 ohms loop conductor resistance

leakage - 50,000 ohms

END