DIAGRAM NOTES (ISSUE 1)

concerning

NZPO 29613, ISSUE E

titled

AUTOMATIC CALLING EQUIPMENT

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

PRINTED BY NZPO
MAY 1973

1. GENERAL

1.1 This diagram shows the circuit of the "A.C.E." (Automatic Calling Equipment) which originates test calls to any pre-set test number. A test is made for continuity and polarity of trunks used, tripping of ringing, constant check of circuit continuity, etc., so assisting in the finding of intermittent faults and giving an indication of the grade of service.

2. FACILITY SCHEDULE

The following facilities are provided:

2.1 The P-wire is checked for any busy condition.

2.2 If the selector to be used is free the polarity of the A & B legs is checked. If faulty the "continuity" light glows.

2.3 Pre-set trains of pulses are sent forward at 10 p.p.s. with a minimum 200 m/s inter-digital pause.

2.4 A "continuity" lamp gives indication of a continuity or P-wire fault on any selector or trunk used.

2.5 Ringing tripped after two complete ringing cycles.

2.6 An "unanswered polarity" lamp gives an indication of faulty polarity of the speech pair right through to the final selector or relay set.

2.7 Checks reversal of polarity when the final selector or relay set answers. Non-receipt of this reversal gives a "C.S.A. Polarity" lamp.

2.8 If these are satisfactory a called sub clear condition is set up and a check that restoration of polarity has occurred. Non-receipt of this restoration gives "C.S. Clear Polarity" lamp.

2.9 Releasing of selector train and a check that this has occurred.

2.10 Continuous monitoring of continuity and holding of all equipment up to the stage the faulty trunk was picked if disconnection occurs.

2.11 Indication of the progress of the call by digit display lamps.

2.12 Provides its own source of pulses.

2.13 Enables any number of digits from 2-6 to be dialled.

2.14 Indicates number of effective calls on a call count meter.

2.15 Provides an optional delay between seizure and dialling to permit the junction hunter to drive when used in a D.S.R. exchange, or register hunter when used from an I/W relay set.

2.16 Introduces a $2\frac{1}{2}$ second delay between the releasing of the first stage and reseizure for the next call to obtain a better spread of calls.

2.17 Allows selection of a 2nd hundred number when used directly from a final selector.

2.18 Cancels the answer polarity test when used from a D.S.R. or line circuit in a D.S.R. exchange where no reversal is passed beyond the transmission bridge.

2.19 In conjunction with an adapter circuit, can be used from a group selector routiner, using the routiner control and access circuit to provide a means of distributing calls over the gradings.

3. OUTLINE CIRCUIT OPERATIONS

3.1 Setting up of Tester. The test number to be dialled should be set up on the rotary switches SW1-SW6. Any unwanted digits should be set to D.C. (Digit Cancel). For all testing where a delay is required after seizure (e.g., D.S.R. junction or register hunters) a test link should be inserted in TJC 7 and 8. Where no delay is required insert the test link in TJC 8 and 9. The tester is connected to the desired selector via a 6-way cord and to the desired test number via a way-line, I.D.F. or any convenient connecting point by a 2-way cord. Battery and earth is also connected via a cord.

3.2 Circuit Operation. If, on plugging in, the busy lamp glows, the start key may be thrown and when the selector comes free the A.C.E. will start its operation. If the selector is already free, throwing the start key will cause the pre-set number to be dialled (progress of the digits being shown by lamp) and various tests will be applied. The test number will continue being dialled, circuit tested, selectors released and the cycle repeated until a fault occurs or the start key is restored. If a fault condition occurs the tester will hold all the selectors up to the fault and give an indication of the fault by means of lamps. Before the start key is thrown the test number to be dialled should be set up on the rotary switches SW1 - SW6.

4. OPERATIONAL DETAILS

4.1 Initial operation of tester. On plugging in the tester to a selector relay PB is applied to the P-wire of the selector and if the selector is busy PB will operate to the P-wire earth. If the selector is free the start key KS is operated and the loop of relay LT is applied to the line circuit. If, however, a line circuit is seized an earth will come back on the M1-lead to operate relay LS. An earth also comes back on the M'-lead and via LS 1 will operate the ST relay.

4.2 Selector Busy

Relay PB Operates

- PB1 locks relay PB to P-wire earth
- PB2 prevents application of relay LT to line until the selector is free
- PB3 ineffective
- PB4 lights the "busy" lamp
- PB5 ineffective

Start Key Thrown (KS)

- KS1 prepares to apply the loop of relay LT.
- KS2 prepares for operation of relay St.

KS3 prepare for operation of relay ST and leaves PB holding via PB1 to P-wire eth.

KS4 supplies an earth for the lamp display

KS5 spare

It should be noted that the tester should not be plugged in with the start key thrown but the start key may be operated after plugging in while there is a busy condition on the selector.

4.3 Selector Free. When the selector becomes free, earth is removed from the P-wire and relay PB releases.

Relay PB releasing.

PB1 removes the holding circuit for relay PB

PB2 applies LT relay loop to line and if the polarity is correct LT relay will operate

PB3 ineffective

PB4 extinguishes the "Busy" lamp

PB5 ineffective

Relay LT operates

LT1 completes an operate circuit for relay ST to P-wire eth

LT2 ineffective

LT3 ineffective

LT4 ineffective

Relay ST operates

ST1 connects PF relay to P-wire to provide a continuous monitor of the trunks through to the final selector. Relay PF does not operate, being held short circuited by the earth on the P-wire.

ST2 ineffective

ST3 provides a holding earth for ST

ST4 operates relay SA via T5 bank and TJA 5 and 6 or steps dmT via T5 bank, TJA 6 and 7 and T4 bank, which eliminates the 2.5 second delay (ref. par. 3.1)

ST5 prepares a slow stepping circuit for dmT

ST6 removes the homing earth from T4 bank

Relay SA operates

SA1 starts IG self-interrupting at 10 p.p.s.

Relay IG pulsing

The S3 earth is applied via S3 position 1, SA1, IG1 normal through the 1500 ohm winding of IG to battery and also through the parallel path via the capacitors and the 500 ohm winding of IG to battery.

However, the coils are differentially connected so that the two currents are mutually opposing and the initial flux in the 1500 ohm coil is very low while the 500 ohm coil flux is very high. This is because the capacitors appear as a short circuit in the uncharged state. As the capacitors become charged the flux increases in the 1500 ohm winding and drops in the 500 ohm winding until after a definite period relay IG will operate.

Relay IG operating

IG1 Breaks the circuit from the S3 earth to the capacitors and the IG relay and energizes dmS.

IG2 breaks, but is masked.

The reactive circuit now discharges through the 1500 ohm and 500 ohm windings in series, with the two coils no longer working in opposition. This will allow the capacitors to discharge (much faster than the charging time) until IG relay finally releases.

The choice of the 500 ohm and 1500 ohm coils will largely determine the make/break ratio 66/33 while the capacitance largely determines the pulse frequency (10 p.p.s.).

When relay IG releases the cycle will restart.

Relay IG releases

IG1 starts the cycle over again and steps dmS

IG2 makes ineffectively at this stage due to the short at T2 bank

dmS will continue stepping.

At step 2 dmS will step around to position 23 via its interrupter, IG1 and the S3 wiper to earth. At step 23 dmS will pause while ZA operates via S2 bank to the PF2 earth and relay V operates via ZA2 to the same earth. dmS is then energised via its interrupter, V3, S3 arc to earth. On releasing at position 24 dmS will step as before via IG1 contacts to the home position.

Relay ZA operating

ZA1 removes possible ST5 eth from drive magnet T when relay V operates.

ZA2 provides operate circuit for relay V to PF2 earth.

Relay V — operating

V1 — prepares an operate circuit for dmT

V2 — releases ZA relay

V3 — provides circuit for dmS from 23 to 24 dmS then continues to step at 10 p.p.s. under control of IG.

Relay ZA — releasing

ZA1 — energises dmT

ZA2 — releases relay V

Relay V — releasing

V1 — releases dmT stepping onto position 2

V2 — does not reoperate ZA as dmS has stepped S2 wiper on to position 24

V3 — allows 1G to pulse and step dmS continuously

This first cycle of dmS allows time for a junction or register hunter to drive and seize. dmS continues to rotate at 10 p.p.s. pausing at position 23 to operate ZA and V as above on each sweep.

dmT on Step 2

T1) T2) — prepares a circuit to transmit IG2 pulses on the + and - wires and LT relay is disconnected.

T3 — provides holding for SA relay during sending of the six digits.

T4 — ineffective

T5 — gives marking of S4 bank via setting of SW1

T6 — gives a lamp indication that the 1st digit is to be dialled and will remain lit during dialling of this digit.

dmS Pulsing Around

S1 — the first two pulses will be masked to ensure capacitance, inductance stabilisation for pulses to 10 p.p.s. On position 3 IG2 is unmasked and the rest of the pulses up to the next 10 may be sent out as required until being further masked by straps on the S1 bank or operation of relay SZ at contacts SZ2. This gives an ample inter-digital pause for rest of dmS drive.

S2 — operates ZA and V relays on step 23 and gives a holding earth for SZ relay when it operates.

S3 — allows appropriate stepping of dmS.

S4 — completes the circuit for SZ relay when pre-set position of SW1 is reached via T5 bank to ST4 earth.

Relay SZ operates

SZ1 provides self holding until the 23rd step to PF2 earth via S2 bank.

SZ2 masks any further pulses from being sent out to the selectors.

When dmS reaches position 23 relays ZA and V will operate as before resulting in one more step of dmT ready for the next digit. At T6 the 1st digit lamp will extinguish and the 2nd will light. This process continues with dmT taking another step for each revolution of dmS. If, however, less than 6 digits are required (with a minimum of 2) then the SW switches corresponding to these will be switched to D.C. When dmT then steps onto these D.C. marked banks relay DC will operate.

Relay DC operates

DC1 provides a self drive circuit for dmT over T4 bank through the SW switch, T5 bank to ST4 earth dmT will step over each unwanted digit and will stop on position 8.

DC2 will stop dmS on the home position.

DC3 removes the holding circuit for relay SA.

Relay SA releases

SA1 breaks the pulsing circuit for IG relay.

4.4 Disconnection on P-wire. Throughout the setting up of the call relay PF monitors the P-wire. If at some stage a disconnection occurs in the +, -, or P-wire the PF relay will operate to the HA/HB relays now on the P-wire up to the last successfully connected selector.

Relay PF operates.

PF1 operates PFA relay in series with the other winding of PF.

PF2 removes the earth from the S2 bank halting progress of the call and lights the "trunk fault" lamp. The appropriate digit lamp will also remain lit.

Relay PFA operates.

PFA1 operates relay AL.

PFA2 puts a full earth on the P-wire to give a fast holding guard on all selectors.

Relay AL operates.

AL1 locks relay AL.

AL2 applies an additional holding and last guard earth on the P-wire.

AL3 removes the drive circuit for dmT.

AL4 lights the "fault" lamp and energises the alarm buzzer.

AL5 will release SA if it is operated and dmS will drive to position 23.

AL6 ineffective.

The call can now be traced and the fault localised.

When the fault alarm is to be released the alarm reset key (KRS) is operated.

KRS1 releases the alarm relay AL.

KRS2 releases relays PFA and PF.

Relay AL releasing.

AL1 removes locking from AL relay.

AL2 removes the last guard earth.

AL3 replaces possible drive circuit for dmT.

AL4 extinguishes the "fault" lamp.

AL5 reoperates relay SA.

AL6 ineffective.

Relay PF releases.

PF1 releases relay PFA.

PF2 extinguishes the "trunk fault" lamp and replaces the earth on the S2 wiper.

Relay PFA releases.

PFA1 removes possible operate circuit for relay AL.

PFA2 removes the holding earth from the P-wire.

To restart the tester the "start" key KS should be released then the "alarm reset" key should be released before the "start" key is reoperated.

4.5 Line Polarity Check. After the six digits have been sent dmT will be stepped onto position 8.

T1) T2) will place the LT relay loop back onto the + and - leads and will operate relay LT.

T3 will release relay SA.

T4 ineffective.

T5 will start energising the thermal relay TH.

T6 will light the ring lamp.

At this time the test number should receive ringing which will be passed via the 2-wire cord through TJD and will operate relay AC.

4.6 Ringing.

Relay AC operates.

AC1 steps dmT via T5 to ST4 earth.

Relay AC releases in the silent period between rings then reoperates to the second burst of ringing and steps dmT again. These two short bursts constitute one ringing cycle. On the second cycle dmT will take two more steps to position 12 and at T5 the thermal relay TH will lose its operate circuit. At T6 the "ring lamp" will be extinguished and the "unanswered polarity" lamp will light momentarily.

4.7 Incomplete ringing received. If, however, the two complete ringing cycles were not received within 50 ± 10 secs then the thermal relay TH will operate and will operate the alarm relay AL via TH1. AL relay operates and at AL6 disconnects the thermal relay.

4.8 Unanswered Polarity Check. Relay LT now checks the + and - leads for the correct polarity. If the correct polarity is received LT relay will remain operated and the ST4 earth via T5 will operate relay ZA.

Relay ZA operates.

ZA1 removes possible drive circuit for dmT.

ZA2 operates V relay to ST4 earth.

Relay V operates.

V1 prepares an operate circuit for dmT.

V2 releases ZA relay.

V3 ineifective.

Relay ZA releases.

ZA1 applies an earth to step dmT to position 13.

ZA2 releases V relay.

Relay V releases

V1 releases dmT.

V2 reapplies ZA relay but will not reoperate ZA as dmT has stepped on

V3 ineffective.

If, however, a reversal of polarity was found LT relay would release.

Relay LT releases.

LT1 ineffective.

LT2 ineffective.

LT3 prevents the operation of ZA relay so dmT will not step on

LT4 operates the alarm relay AL.

The "unanswered polarity" lamp will remain lit.

Relay AL operates.

AL1 locks the alarm relay AL.

AL2 guards the P-wire.

AL3 removes any possible drive circuit for dmT.

AL4 operates the alarm light and buzzer.

AL5 ineffective.

AL6 ineffective.

The releasing of the alarm is as previously described in par. 4.4.

4.9 Ring Trip. With dmT on position 13 relay RT will operate to ST4 earth via T5.

Relay RT operates.

RT1 locks relay RT.

RT2 operates ZA relay to ST4 earth via T5.

RT3 ineffective.

RT4 places relay TR and rectifier across the called line and trips the ringing, operating relay TR in series with D in the final selector.

Relay TR operates.

TR1 operates relay TRA.

Relay TRA operates.

TRA1 effective on next step of dmT.

TRA2 lights the "ring tripped" lamp.

The ZA and V relays operate and release as previously described to step dmT to position 14.

T1 Holds the short circuit around LT relay.

T2 ineffective.

T3 desensitises relay PF by the 100 ohm earth from AL5 so that the metering sequence from the final selector does not operate PF.

T4 ineffective

T5 will apply the ST4 earth to operate and release ZA and V so stepping dmT to position 15.

T6 lights the "waiting CSA" lamp.

If relay TR does not operate or operates only momentarily (dis. barretter in the final or similar cause) dmT will not step past the T5, 14, 15 16 common. The ST4 earth will operate the AL alarm relay via the unoperated TRA1 contact.

The alarm may be reset as previously described in par. 4.4.

4.10 C.S.A. Polarity Test. Relays ZA and V will interact to step dmT on to position 16 where at T1 and T2 relay LT is reversed and applied to the A and B legs, testing for the operation of D in the final and polarity reversal at the A relay.

dmT continues to step to position 17 lighting the "CSA polarity" lamp. If there is no reversal LT relay will not operate and ST4 earth via LT2 will bring in an alarm. If relay LT does operate, relays ZA and V will step dmT on to position 18 then 19.

T1)
T2) reverts LT relay back to normal.

T3 removes the 100 ohm desensitising earth from around the PF relay.

T4 ineffective.

T5 applies the ST4 earth to the other coil of the differentially wound RT relay and so releases it.

T6 ineffective.

Relay RT releases.

RT1 removes the holding circuit for RT.

RT2 applies the ST4 earth to operate ZA and V relays to step dmT on to position 20.

RT3 removes the circuit for the other coil of RT.

RT4 removes the TR loop from the final selector releasing TR and also D in the final selector whereby the A and B legs polarity is reversed back to normal.

Relay LT will now reoperate.

Relay TR releases.

TR1 releases TRA relay.

Relay TRA releases.

TRA1 ineffective.

TRA2 extinguishes the "ring Tripped" lamp.

4.11 C.S. Clear Polarity

Relay LT operates.

LT1 ineffective.

LT2 ineffective.

LT3 ineffective.

LT4 prevents an alarm condition when the T switch steps onto position 21. Relays ZA and V will step the T switch onto position 21.

T1)
T2) Leaves LT across A and B legs.

T3 applies an earth to start operating the thermal relay TH.

T4 ineffective.

T5 provided the called sub has cleared and the polarity is correct the ST4 earth is extended to operate relays ZA and V so stepping dmT to position 22.

T6 lights the "C.S. clear polarity" lamp.

If the polarity has not reverted back to normal at the called sub release, Relay LT will not operate and at LT4 will operate the alarm relay AL.

On position 22 at

T1)
T2) condition unchanged.

T3 continues operating the thermal Relay TH.

T4 ineffective.

T5 operates Relay CO.

T6 lights the "release" lamp.

Relay CO operating.

CO1 removes the monitoring Relay PF from the P-wire and operates Relay PB.

CO2 provides holding for CO Relay.

CO3 prepares to connect ST4 earth via PB5 to step dmT to position 23.

Relay PB operating.

PB1 locks Relay PB.

PB2 prepares to disconnect Relay LT.

PB3 ineffective.

PB4 lights the "busy" lamp.

PB5 completes the drive for dmT at T5 after one step.

4.12 Release. The releasing of the calling selectors now begins and at step 23.

T1) removes the LT Relay and leaves an open circuit on the
T2) A and B legs.

T3 is still operating the thermal Relay TH.

T4 prepares a circuit from ST4 earth to step dmT to position 24 when PB relay releases.

T5 passes the above earth via PB5 when PB releases.

As the release of the selectors takes place the earth will be removed from the P-wire and relay PB will slowly release dmT will take another step as already described.

Relay PB releases.

PB1 ineffective.

PB2 ineffective.

PB3 ineffective

PB4 extinguishes the busy lamp

PB5 steps dmT to 24

At step 24 a 2.5 second delay is introduced in the stepping of dmT by driving dmS one revolution.

T1)
T2) ineffective

T3 continues to operate Relay TH.

T4 ineffective.

T5 will operate relay SA to ST4 earth.

T6 the "release" lamp will remain lit.

Relay SA operating.

SA1 will start IG pulsing and step dmS.

dmS will drive around one revolution as previously described and at step 23 will operate and release relays ZA and V to step dmT onto position 25. This 2.5 second delay ensures sufficient time for all selectors and associated equipment to release. This 2.5 seconds also gives the tested equipment a chance to be seized by subs so that the tester may seize and test other equipment thus giving a better coverage of testing.

On step 25 the tester is completely reset back to the normal condition.

T1)
T2) ineffective

T3 shunts down ST Relay releases TH

T4 will when ST releases, drive dmT home.

T5 operates the call count meter and releases Relay SA to stop IG pulsing.

T6 provides a point of access via an adapter circuit to routiner access equipment at step 25.

Relay ST releases.

ST1 ineffective

ST2 ineffective

ST3 ineffective

ST4 releases Relay CO and CCM.

ST5 ineffective

ST6 steps dmT to home position.

If the selectors had not cleared within 50 ± 10 secs TH Relay would have operated and brought in an alarm condition. With dmT back in the home position the selector will restart the cycle again.

4.13 Key Functions. By Operating Key KSH 2nd hundred calls may be made to the final selector under test via TSA 10 and 11 to operate WS Relay in the final selector.

Key KPC should be operated when the tester is used via a D.S.R. or line circuit in a D.S.R. exchange as no polarity reversal will be passed back beyond the transmission bridge.

Key KCO leaves the alarm lamp in the circuit but disconnects the buzzer.

Key KIT gives a permanent circuit for the pulsing Relay IG and drive of dmS so that the pulses at TJB may be tested.

5. CIRCUIT DESIGN NOTES.

5.1 Diodes D1 and D2 allow Relay LT to operate only to the wanted polarity.

Diode D3 prevents slugging of Relays on the P-wire.

Diode D4 enables Relay AC to operate to ringing.

Diode D5 prevents ZA and V relays from pulsing to the RT relay holding earth from ST4.

Diode D6 ensures Relay TR only operates if the correct polarity is received from the final selector.

Resistor R1 and Capacitor C8 simulate a subscribers dial and spark quench.

Atmite Rx1 and Rx2 quench Relays SZ and SA respectively to protect the arcs over which they operate. Lamp LP2 "Call Trap Busy" gives an indication that the call trap is busy when used with the access adapter on dmT 25.

The maximum current drain for this circuit is 1 amp.

END OF DIAGRAM NOTES