CIRCUIT OPERATION AND DESCRIPTION

OF THE RATIONALISED CLASS 50

CU 1 CONTROL SYSTEM

ON-VEHICLE TESTING OF CU1

ON REFURBISHED CLASS 50

LOCOS

The rationalised CU1 is best described when considered in two separate circuits.

The first circuit containing the transformers CT1, CT2, CT3 and CT4, bridge rectifiers B1, B2, B3 and B4 and also the filter networks providing outputs for the ammeters A1, A2 and a reset signal for the control circuit, is mounted within the frame of the CU1, and is hard wired.

The three bridge rectifiers B1, B2 and B3 select the greatest traction motor current. This greatest current flows through three 100Ω resistors R3, R4 and R5. If the traction motor current is 100 A then a volt-drop of one volt will exist across each resistor. The voltage that appears across R4 is used as a reset signal for the control system. This reset signal is proportional to the greatest current and therefore the control system will automatically limit the current if a pair of motors are isolated.

The summation transformer CT4, provides a current proportional to the average traction motor currents, this signal is used to drive the cab ammeters via the calibration potentiometers RP1 and RP2.

The second circuit consists of the electronic control system, and is housed within a metal box, which is mounted in the CU1 frame. This control circuit carries its own power supply which is derived from the locomotive 110 V d.c. supply. Inputs and outputs to the control circuit are gained via a 37 way plug mounted on the side of the box.

The circuit contains two operational amplifiers A1 and A2, A1 being the output amplifier which provides an output voltage of 7-37 V d.c. w.r.t. 0 Volts which is used to control the main generator KV10.

Seven inputs are taken from various points on the locomotive and are summed by the amplifier A1 and thus the output is derived.

DRIVERS CONTROL

The drivers control setting is derived from a 1 kΩ potentiometer mechanically connected to the power handle and electrically connected between centre zero and the negative rail thus giving a negative input to the control circuit. This negative input signal is fed via input resistors onto the summing junction of A1 where it opposes the fixed positive voltage setting. Therefore the summing junction becomes less positive and because the amplifier is connected in the inverting mode the output begins to rise from 7 volts. If the drivers control were to be moved from position 1 to position 7 quickly, then the output of A1 may rise rapidly which could cause engine hunting. To prevent this the negative signal from the drivers control is also fed via a differentiator circuit to A2. The differentiator circuit will only provide an output when its input has a fast rate of rise from the drivers control. The negative output from this circuit is inverted by A2 whose output will rise from centre zero to its positive rail and then decay slowly thus opposing the negative signal at the summing junction of A1.

POWER DELAY RELAY

When the drivers control is in the 'off' position then a 110 V d.c. feed is applied to pin C on the 37 way connector. This turns on the light emitting diode and thus the transistor of the opto-isolator, OP3, this sets a high positive voltage at the summing junction of A1 which ensures that its output is at minimum, e.g. 7 volts, when the driver opens the control handle. With the 110 V feed on pin C capacitor C1 will change so that when the feed is removed the positive signal remains at the summing junction until capacitor C1 discharges.

FCR

With a 110 V d.c. feed on pin J of the 37 way connector the light emitting diode of OP2 is on and therefore the transistor conducts. This supplies a positive feed to the summing junction of A1 reducing its output to approx. 12 volts. This is to ensure that when field divert is taken the generator becomes unloaded, and will thus prevent excessive overloads of the engine.

FDC1
3

This provides the only other negative input to appear at the summing junction of A1 and is termed the 'field divert' fixed setting signal.

When 110 V d.c. is applied to pin m on the 37 way connector the transistor of OP1 is switched 'on' placing a negative voltage of 5.6 volts to the summing junction of A1. This signal ensures that field diversion can take place, even if the drivers control setting corresponds to a current lower than that of the operating value of the field divert relay.

DCCT RESET SIGNAL

This reset signal is derived from R4 which is sited in the frame of the CU1. One volt across R4 is proportional to 100 A of traction motor current. When the driver first demands power the reset signal will be high due to high starting currents, as the train begins to accelerate the traction motor current will fall thus reducing the reset signal therefore allowing the output of A1 to rise. The reset signal is fed to the summing junction of A1 via pin k on the connector.

LOAD LIMIT POTENTIOMETER

This potentiometer is controlled by the engine speed and gives a positive reset signal when the engine becomes fully loaded. This signal is capable of opposing all setting signals, and is connected to the summing junction of A1 via pin h on the connector.

PRINCIPLE CHANGES FROM ORIGINAL TO RATIONALISED CU1

1. Discrete amplifiers CA1 and CA2 replaced by integrated circuit operational amplifiers contained in one control module with power supply and feedback components.

2. Power supply for amplifiers reduced from 22-0-22 V to 18-0-18 V to suit new integrated circuit amplifiers.

3. Power supply zener diodes reduced in rating. (Original supply also supplied slow speed control pcb CU11, this is not necessary on refurbished locos).

4. Connections between loco wiring and CU1 via 2 circular multipole quick release connectors.

5. Only calibration pots. for the cab ammeters remain available for setting up on the loco. These pots to be single turn sealed units with locking device.

6. All access to fitting CU1, fitting control module, and testing and setting up will be from main corridor side of control cubicle.

7. Redundant components for wheelslip protection, and slow speed control have been deleted.

8. Opto-isolators used to replace relays as interface between loco control functions and amplifier control circuit.

INTRODUCTION

The CU1 control unit has been rebuilt to a rationalised design so that it may be fitted to the refurbished locomotives at Doncaster Works.

The following functions will not be present on the rationalised system:-

Slow speed control
Wheelslip detection (already provided by WS1-3)
Drivers Current Limit Potentiometers
Dynamic Brake Potentiometer
Air operated potentiometer

The CU1 has now been separated into two functional parts:-

(1) Electronic Control Module in separate box with circular multipole connector;

(2) Main frame containing transformers, rectifiers and fittings for providing the Traction Motor current feedback signal to the electronic control unit, and also the drive for the cab ammeters.

The external adjustments required on the CU1 when fitted on the locomotive have been reduced to the two calibration potentiometers for the cab ammeters.

Connection of the CU1 to the locomotive terminal bar is via 2 circular multipole connectors, one for the electronic control module and one for the main CU1 frame.

These two connectors are polarised so that they cannot be cross connected.

The new unit has integrated circuit amplifiers to replace the CA1 and CA2 amplifiers on the original CU1. These new amplifiers and their associated input and feedback components and power supply are on one printed circuit board which is contained in the electronic control module. This module can be tested separately from the rest of the CU1 equipment in a similar manner to the original CA1 and 2 amplifiers.

TESTING PROCEDURES

This specification is intended for use when carrying out routine tests on the control system and for fault finding.

Section 3 covers on vehicle setting up instructions and Section 4 details testing of the contact module separately with a mains driven test box and also testing of a complete CU1 with control module.

The instructions are written on the assumption that maintenance depots will not carry out any repair work on the CU1 but will use test gear to determine whether or not it is working correctly. A faulty unit will be replaced by a spare and the faulty unit will be returned to the electronic repair facility at the Technical Centre at Derby.

ON - VEHICLE TESTING

3.1 Equipment required.

AVO meter model 8
200R 0.5A variable resistor

Note: All meter connections are on CU1 terminal bar unless otherwise stated.

3.2 Power Supply Check

3.2.1 Start engine and using an AVO check that the auxiliary supply voltage (approx 110 V) is present between P40 (+ve) and NC3 (-ve).

3.2.2 Check that the electronics power supply is present at the following terminals.

KC5 (+ve) to N (-ve) - 5.1 V ± 0.4 V

29 (+ve) to N (-ve) - 23 V ± 1.3 V

PR (+ve) to N (-ve) - 41 V ± 2.5 V

Note: The 110 V supply is present on the CU1 when the loco auxiliary supply is on. The 110 V supply is not present on the KV10 until the power handle is moved away from position 0.

3.3 Power Delay Function Check

3.3.1 Isolate all traction motors and manually close and retain FR relay, close AWS switch, select FOR or REV. Connect AVO (100 V d.c. range) between terminals GF13 (+ve) and NC3 (-ve). With the engine running the AVO should read between 6 and 8 volts.

3.3.2 Move master handle to position 1. After a delay of approximately 4 seconds the voltage should begin to rise smoothly to 36-38 volts, in approximately 8 seconds.

Return power handle to '0' position and reading should return to between 6 and 8 volts.

This tests the CU1 output.

3.3.3 Connect the AVO to terminals 2 (+ve) and 3 (-ve) on the main generator KV10. The voltage should be zero.

Move power handle to position 1 and reading should rise to between 4 and 8 volts after an approximately 0.5 second delay and continue to rise smoothly to 85-100 volts (10-15 V below aux. gen. volts), in approximately 8 seconds.

This tests the main generator KV10.

Return power handle to 0, and master controller to E0.

3.4 Drivers Current Setting Check

3.4.1 With motors isolated, and engine running, manually close and retain FR relay.
Connect an AVO (d.c. volts) to 29 (+ve) and 30 (-ve). This will monitor the voltage on the drivers current setting potentiometer.

3.4.2 In cab 1 select FOR or REV the meter should read less than 2 volts.

3.4.3 Move power handle in cab 1 to position 7, meter should read approx 15 volts.

3.4.4 Repeat tests 3.4.1 to 3.4.3 inclusive from cab 2.

3.4.5 Return power handle to 0 and master controller to E0.

3.5 Field Divert Setting Signal Check

3.5.1 Select FOR or REV. Connect the AVO to GF13 (+ve) and NC3 (-ve). Disconnect wire H from GFC1.

3.5.2 Manually operate FDC 1/3 relay and the meter reading should rise to 36-38 volts. Reconnect wire H. (Field Reversion Terminal M C.U.1)

3.6 Load Limiting Potentiometer

3.6.1 Connect an AVO (d.c. volts) between LR (+ve) and 29 (-ve). The reading should be less than 2 V.

3.6.2 Manually operate one of the wheelslip relays WS1 - 3 (This will unload engine thus causing LLP to move).

3.6.3 The meter reading should rise smoothly to 18 volts.

3.6.4 Release the relay and the meter reading should fall to below 2 volts again.

3.7 DCCT Circuit

3.7.1 With the engine shut off and battery isolating switch off, connect a variable resistor (0.5A rating) of 200 ohms or more in series with an AVO (on 1 A a.c. range) between terminals AD and DC1 (on DCCT 1).

3.7.2 Close BIS and depress Fuel Sample test button.

Adjust the variable resistor to give a reading of 0.4A on the AVO.

The cab ammeters should both read 800A. If not, adjust RP1 for cab 1 ammeter or RP2 for cab 2 ammeter until the correct readings are obtain

3.7.3 Connect an AVO (d.c. volts) between R14 (+ve) and 29 (-ve). The reading should be 8 V (the TM current feed back signal).

3.7.4 Repeat 3.7.2 and 3.7.3 with resistor and AVO connected across AD and DC2. (Cab ammeters should not require re-adjusting if set up in (3.7.2).

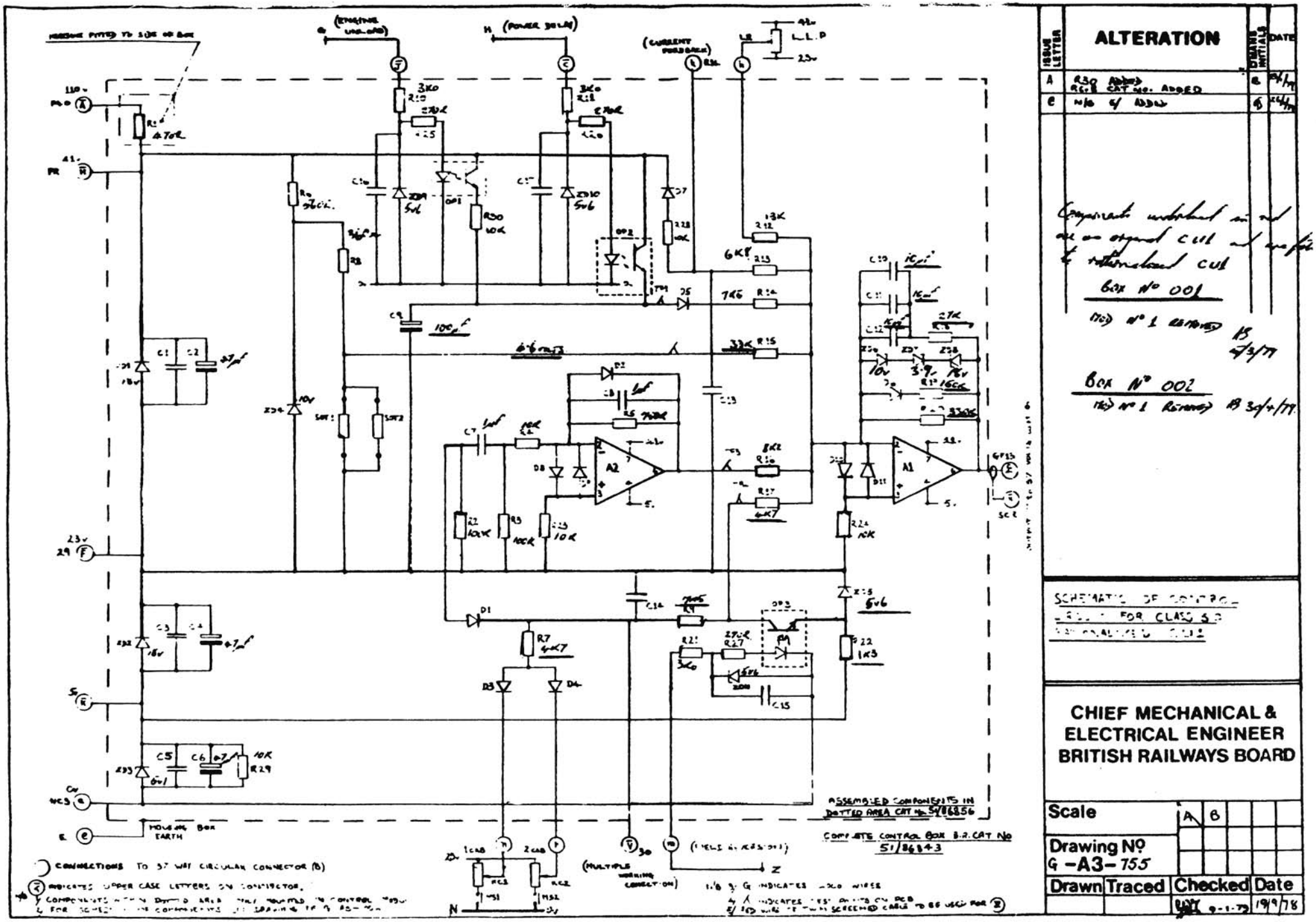
3.7.5 Repeat 3.7.2 and 3.7.3 with resistor and AVO oconnected across AD and DC3. (Cab ammeters should not require re-adjusting if set up in 3.7.2)

3.8 FDC3/3

With engine running and master controller in FOR or RFV, select notch 1. Connect AVO to GF13 (+ve) and NC3(-ve). When reading reaches 36-38 volts, manually operate FDC3/3 and check that the reading falls to approximately 7 volts and rises again when contactor is released.

Set power handle to 0 and master controller to E0. Stop engine.

3.9 Should any of the preceeding tests not meet the specification then the CU1 must be suspect. The CU1 control module may be removed from the frame and tested separately, or the complete CU1 may be removed and tested.



RATIONALISED CU1 UNIT

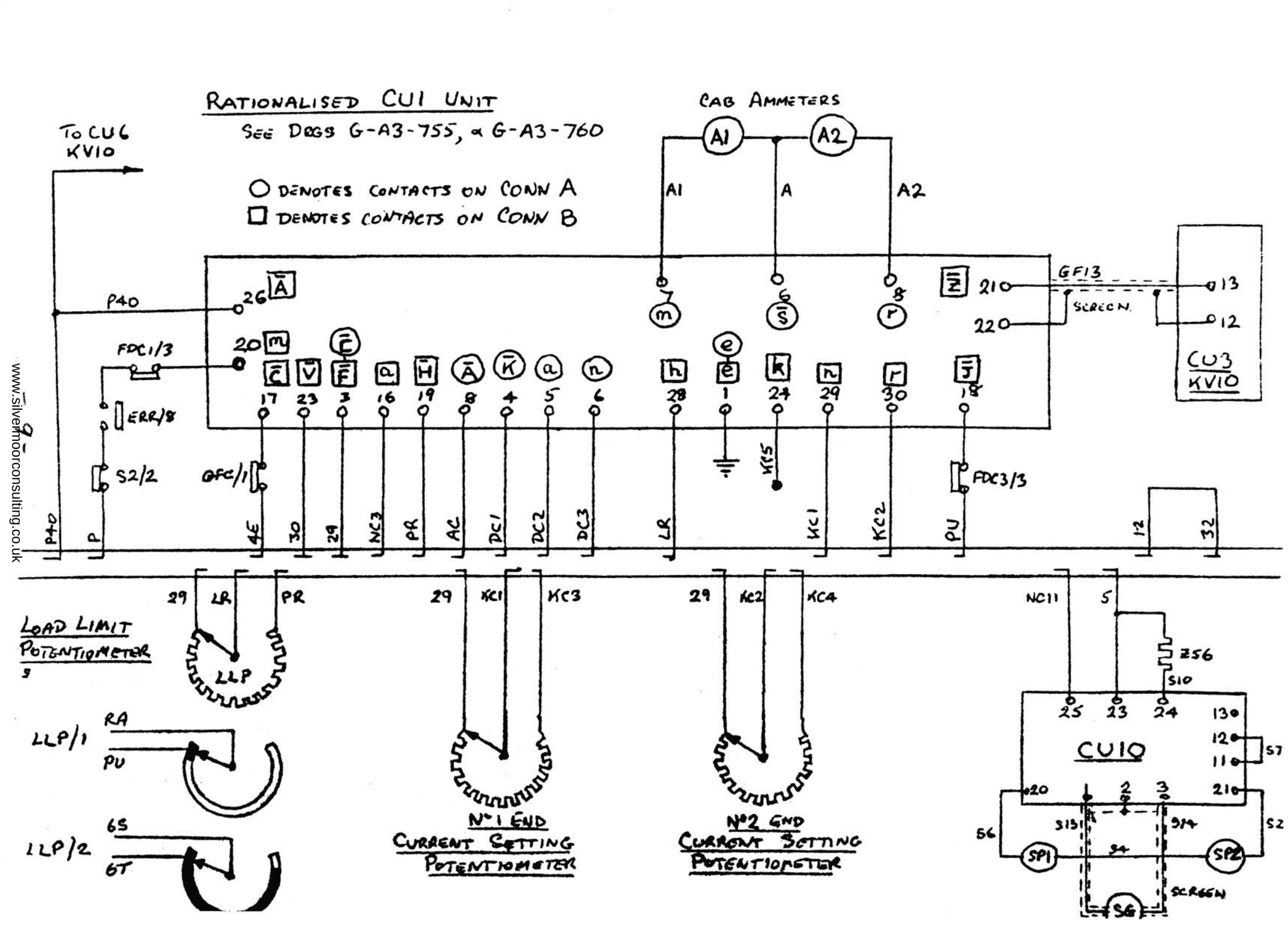
SEE DRGS G-A3-755, & G-A3-760

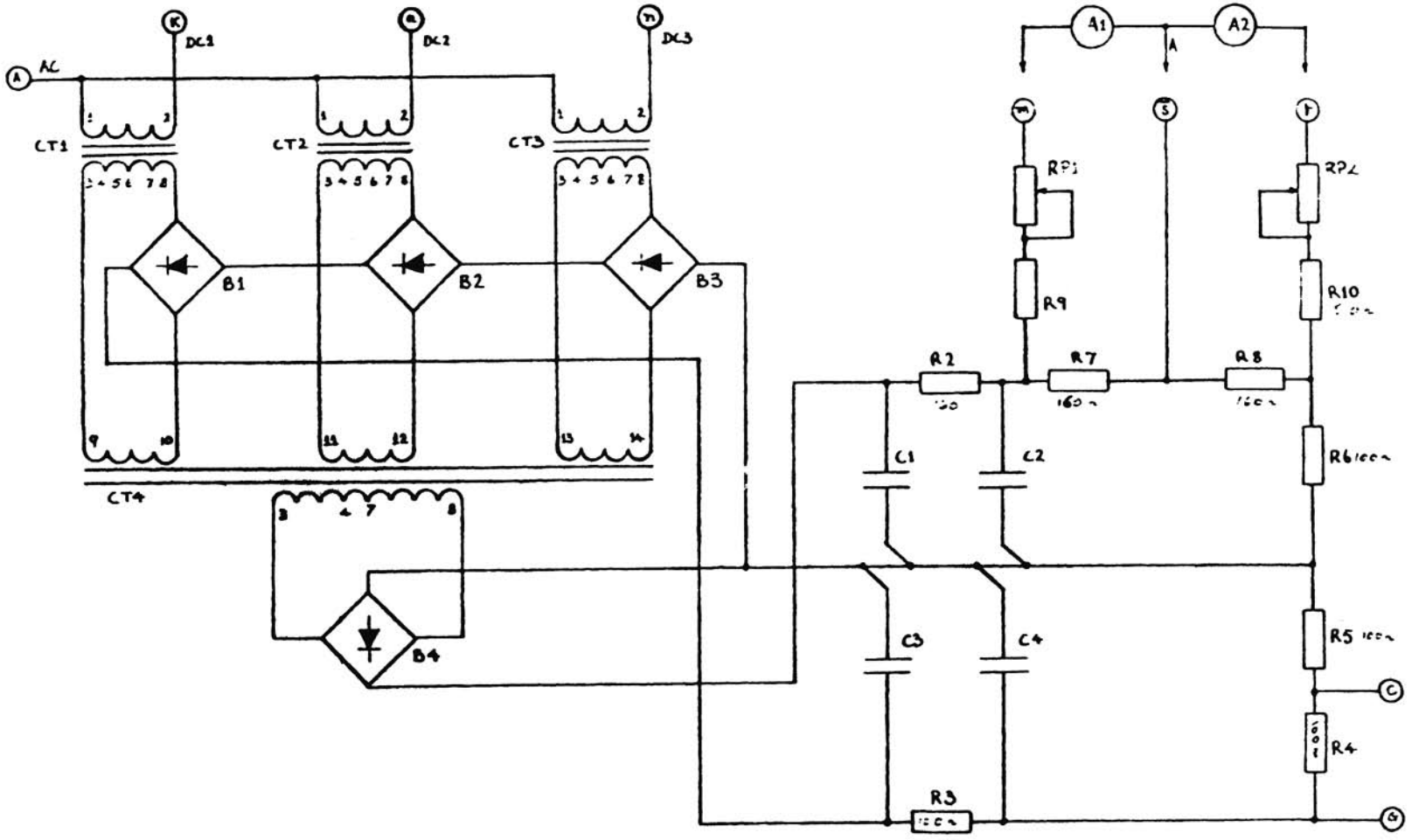
TO CU6 KV10

○ DENOTES CONTACTS ON CONN A

□ DENOTES CONTACTS ON CONN B

CAB AMMETERS





○ CONNECTIONS TO FIXED CONNECTOR MOUNTED TO FRAME OF CU1

ISSUE LETTER	ALTERATION	DMANS INITIALS	DATE

CHIEF MECHANICAL & ELECTRICAL ENGINEER BRITISH RAILWAYS BOARD

Scale							
Drawing No -A3-							
Drawn	Traced	Checked	Date				