

(Minor changes to the previous edition are indicated by ◆ placed before the relevant paragraphs)

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1. Scope

This Specification is written to comply with Engineering Standard 1-202 in defining the requirements for the servicing of all styles of 10 KHz Delta Track Circuit Units, also known to as 'Delta Units', which are used extensively in the signalling system on the London Underground.

The specification hierarchy which supports these requirements is detailed in Attachment 3 to the Specification.

2. References

The text of this document cites other documents that provide information or guidance. These are listed in Attachment 1.

References to British Standards or standards in other standards systems shall be taken to include the words 'or equivalent'.

3. Abbreviations

The following abbreviations are used in this document (if from a published source this is indicated):

CPS	Critical Parameter or Setting
DCN	Design Change Notice
IMR	Interlocking Machine Room
LU	London Underground
OEM	Original Equipment Manufacturer
OSC	Oscillator
P/S	Power Supply
WSL	Westinghouse Signals Limited

4. Definitions

The Client – The Client is the Infracore representative responsible for administering the contract under which the servicing work is being performed.

The Contractor – The Contractor refers to the organisation responsible for the delivery of serviced equipment.

5. Introduction

This specification has been written to detail the servicing requirements of all styles of 10 KHz Delta Track Circuit Units, hereafter referred to as 'Delta Units', which are used in the signalling system on the London Underground.

The Delta Unit is classified as an item of safety signalling equipment which means that it is used in applications involved with the safe movement of trains. It is a mandatory requirement that a unit that has been serviced shall have a functional performance, a safety integrity, a reliability, an expected service life in its installed condition and a shelf life equivalent to that of a new unit.

Any failure condition which causes the unit to behave as though it is energised, when the conditions required to energise it are not present is classed as a 'wrong-side' failure. Wrong-side failures are investigated exhaustively to establish the cause of the failure. Investigations into wrong-side failures will examine materials, processes and the history of servicing operations to establish the exact cause of the event and to ensure that no other items are likely to suffer a similar failure. An occurrence of a wrong-side failure, or a misoperation showing a tendency towards a wrong-side failure, even if no accident or damage is caused, can be extremely costly to investigate and could result in the need to change many units in service.

Items supplied for servicing will be complete units which may be in working order or may have failed in service. The failure mode of items will vary, ranging from causes such as simple electronic component failure to items which have suffered severe damage. In the latter case there will be an element of salvage involved in the servicing process. The equipment will be supplied in an 'as found' condition after being removed from its working position on the railway.

Delta Units are generally left in service until they fail. Under circumstances of systemic failing of electronic components an upgrading programme may be instituted which will involve replacing a designated component, or components. Any work performed as part of such a programme will be deemed to have been performed to the requirements of this Specification, including all aspects of testing and certification.

6. Usage of item

A Delta Track Circuit is a normally de-energised one designed to detect the presence of trains or vehicles. This is a different concept from the normal track circuit which detects the absence of a train or vehicle. The running rails form part of the Delta circuit which is completed by the axles and wheels of the train.

The circuit operates at nominally 10 KHz which obviates the use of insulated rail joints (block-joints) and has no appreciable effect on the normal track circuit.

A Delta Unit is connected to the track at a point a safe distance past a boundary to which the tracklocking of a route extends. The safe distance is calculated to comprise the maximum length of any train which will traverse the route, and allowance for the pick-up distance of the Delta Unit and a safety margin.

7. Equipment design outline

The operating principles of all styles are the same. The differences between styles arise to cover differing mechanical arrangements, different circuits resulting in slight differences in performance parameters and different relays being used as the output device.

A power oscillator operating at nominally 10 KHz is connected across the running rails at the desired detection point. This unit must be placed within a few feet of the connection to the rails. A series tuned circuit is used to effect the connection thus offering a high impedance to the normal track circuit operating frequencies of $33\frac{1}{3}$ Hz or 125 Hz. With the track clear only small leakage currents flow and the voltage at the output transformer secondary is therefore low. Due to the relatively high impedance of the running rails at the 10 KHz operating frequency of the Delta Unit, the influence of an approaching axle is constrained to a range in the order of 5' to 40'. Within this range 10 KHz current will flow through the axle to complete the output circuit and allow an output voltage to be produced by the output transformer. The output voltage is passed to the receiver unit where it is rectified and used to energise the output relay.

Style A is the original design which was replaced by later design as improved semiconductor components became available. However, Style A units remain in service to this day.

Style B units have separate power oscillator and receiver units which may be up to 3200' apart. This development allows the receiver unit and the output relay to be housed in a relay room or IMR allowing better site maintenance access.

Style C units utilise a constant voltage power input transformer and silicon transistors and are therefore less likely to suffer from the effects caused by operation at high temperatures.

Style D units utilise a constant voltage power input transformer which stabilises the oscillator output. This provides a more stable operating distance at which trains are detected.

8. Applicability

This specification applies to the following items.

Item	Stores List No.
10 KHz Delta Unit – Style A – Power Supply and Oscillator – $33\frac{1}{3}$ Hz	830/9857
10 KHz Delta Unit – Style A – Power Supply and Oscillator – 125 Hz	830/9881
10 KHz Delta Unit – Style A – Receiver	830-S-7
10 KHz Delta Unit – Style B – Power Supply and Oscillator	830/9858
10 KHz Delta Unit – Style B – Receiver Amplifier	830/9883
10 KHz Delta Unit – Style C – Power Supply and Oscillator	830/9884
10 KHz Delta Unit – Style C – Receiver Amplifier	830/9530
10 KHz Delta Unit – Style D – Power Supply and Oscillator – $33\frac{1}{3}$ Hz	830/9882
10 KHz Delta Unit – Style D – Power Supply and Oscillator – 125 Hz	830/9859
10 KHz Delta Unit – Style D – Receiver Amplifier	830/9672

9. Critical functions

Critical Functions of Delta Units are defined to be:

High Integrity Operation: The equipment has not been designed to full fail-safe standards although A.C. operation has been employed throughout before rectifying the output signal to energise a D.C. output relay. However, the units are utilised in safety signalling applications where high reliability and high integrity are expected properties of the equipment.

10. Operating parameters

The Operating parameters of the various styles are as given below. Where no differentiation is made within a heading, that parameter applies to all styles.

10.1 Operating voltage

Style A units shall operate to meet the required sections of their relevant Test Specification when supplied with 80 – 100 V A.C.

Styles B, C and D units shall operate to meet the required sections of their relevant Test Specification when supplied with 80 – 110 V A.C.

10.2 Power supply frequency

Units shall be supplied with A.C. power at a frequency as defined in Table 1 below.

Unit type	Power supply frequency (Hz)
Style A 33 $\frac{1}{3}$ Hz	32.0 – 34.0
Style A 125 Hz	121.0 – 127.0
Style B	120.0 – 125.0
Style C	120.0 – 125.0
Style D 33 $\frac{1}{3}$ Hz	32.0 – 34.0
Style D 125 Hz	121.0 – 127.0

Table 1 Power Supply Frequency ranges

10.3 Operating temperature

The units shall operate fully when subjected to Operating Temperature ranges defined in Table 2 below.

Unit type	Operating Temperature ranges (°C)
Style A	-5.0 – 45.0
Style B	-5.0 – 45.0
Style C	-5.0 – 45.0
Style D	-5.0 – 55.0

Table 2 Operating Temperature ranges