



BR 1943

DECODER FOR BRITISH RAILWAYS AUTOMATIC WARNING SYSTEM

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1. LIST OF SUPPORTING DOCUMENTS REFERRED TO IN THIS SPECIFICATION

Where this specification requires reference to BR Specifications, British standards and other documents the latest issue shall apply, unless stated otherwise.

1.1 British Railways Board Specifications

BRB/RIA 12	General Specification for Protection of Traction and Rolling Stock Electronic Equipment from Transients and Surges in DC Control Systems.
BRB/RIA 13	General Specification for Electronic Equipment used on Traction and Rolling Stock.
BRB/LUL/RIA 20	Requirements for Vibration and Shock Testing of Equipment for Railway Vehicles.
BR 1942	System Specification for British Railways Automatic Warning System.
TDE/E/78/R/23	Lightweight Harness for Electronic Equipment.
TEE/G/87/R/60	Specification for Electrical Equipment for use on Traction and Rolling Stock.
TDE/G/77/R/71	Codes of Practice for Electrical Equipment for use on Traction and Rolling Stock Parts 1, 3 and 9.
TDE/74/P/74	Internal Cabling for Electronic Equipment (Purchase Specification).
TDE/75/P/7	Procurement Specification for Multi-pole Circular Connectors used on Electronic Equipment.
TDE/76/P/23	Procurement Specification for Reed Relays for Printed Circuit Board Mounting.
TEE/E/80/M/54	General Instructions for Packaging New Electronic Equipment.
TEE/AV/88/R/43	Technical Specification for Interference Testing for Electronic Equipment used on Traction and Rolling Stock.

1.2 British Standard Specifications

BS 4058	Data Processing Problem Definition and Analysis. Part 1. Flow Chart Symbols.
BS 5760	Reliability of Systems, Equipments and Components. Part 2. Guide to the Assessment of Reliability.
BS 6224	Guide to Design Structure Diagrams for Use in Program Design and other Logic Applications.

1.3 Drawings and Other Documentation

G-A30763 BR Drawing of: Resistor Board Assembly. Used for Contact Overload Protection.

G-A3-764 BR Drawing of: Printed Circuit Board. Used for Contact Overload Protection.

Report Number 2 of ORE Committee Number A 118. Office for Research and Experiments of the International Union of Railways, Oudenoord 60, 3513 EV Utrecht, Netherlands.

Defences against Common Mode Failures in Redundancy Systems published by the Safety and Reliability Directorate, United Kingdom Atomic Energy Authority.

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2. DEFINITIONS AND INTRODUCTION

The principles, operation and equipment of the British Railways Automatic Warning System are outlined in BR Specification No 1942.

2.1 Definitions

The following general definitions will be used throughout this Specification, Section 3 expands some of these definitions where they are related directly to the Decoder.

- 2.1.1 AWS or System - British Railways Automatic Warning System.
- 2.1.2 Brake Application - AWS initiated train brake application. The brake application may be either a full service or an emergency application depending on the type of vehicle/operating requirements.

2.1.3

AWS AUDIBLE CAB INDICATION*		LINESIDE SIGNAL	
Indication	Sound	Condition	Aspect/Position
Caution	Horn	Restrictive	Red, Yellow, Double Yellow/On
Clear	Bell	Clear	Green/Off

- 2.1.4 Ready State - Receiver N contact made when running between signals, no audible indication or brake application, the visual indicator may be in either position.
- 2.1.5 Primed State - Receiver S contact made after detecting a permanent magnet, for 1 second or before detecting an electromagnet.
- 2.1.6 Caution Indication - The horn sounding, with delay to allow for acknowledgement before a brake application is initiated.
- 2.1.7 Acknowledgement,) - Operation of the reset switch to
Reset,) reset the system to the Ready
Initialisation) State, in acknowledgement of a
caution indication or on power up.
- 2.1.8 Clear Indication - the bell sounding for a nominal period following which the system automatically restores to the Ready State.

2.1.9 The Engineer shall be the Director of Signal and Telecommunications Engineering, British Railways Board or his appointed representative.

2.2 Introduction

The system is designed to draw the Drivers attention, by means of an audible cab indication, to a lineside signal as the train approaches that signal. The system is intermittent with the receiver on the train only having to respond at each equipped AWS signal. See BR Specification 1942 for further details.

The system comprises two sub-systems:

2.2.1 The Track sub-system consists of two magnets of opposite polarity, mounted in the centre of the track approximately 180 m on the approach side of the signal. The first magnet is a permanent magnet with its South pole uppermost. This is immediately followed by an electromagnet which, when energised, has its North pole uppermost. The power to the electromagnet is switched by the associated signal controls.

2.2.3 Vehicle sub-system consists of:- a receiver, usually mounted on the vehicle bogie, which detects the track magnets and is a latched bi-stable device; a decoder (relay unit) to process the signals from the receiver and control the audible and visual indications, the brake application and reset (acknowledgement) signals; clear (bell) and caution (horn) audible indications, a visual indicator; a reset switch; emergency isolating switch; a power supply and in some cases an air supply; an interlock between the systems and traction control.

2.3 System Operations

The track permanent magnet primes the vehicle sub-system and then if an energised track electromagnet is not detected within 1 second a caution indication is given in the vehicle cab. If the lineside signal is clear the track electromagnet is energised and, providing that this is detected within 1 second of the receiver detecting a permanent magnet, then a clear indication is given in the vehicle cab.

At a restrictive signal the electromagnet is de-energised. When the permanent magnet is detected the receiver N contact breaks and S contact makes, the indicator is set to display or remain at all black and the initial (1 second) delay commences. The system is now in the Primed state. When this delay has elapsed the caution indication (horn) sounds in the cab and the reset (acknowledgement) response delay commences. This delay is usually 3 seconds. If no acknowledgement is made then when the reset response delay elapses the brake is applied. A caution indication is acknowledged by pressing and releasing the reset switch which sets the indicator to display black and yellow, resets the receiver to its N contact, silences the horn and prevents or cancels a brake application; at which point the vehicle sub-system is restored to the Ready state.

At a clear signal the electromagnet is energised. From the Primed state, providing the electromagnet is detected within the initial (1 second) delay period, the clear indication (bell) sounds for [second at the end of which time the vehicle sub-system automatically restores to the Ready state.

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3. FUNCTIONAL REQUIREMENTS

This section designates the Decoder inputs, outputs and timers and it defines the system processes and states and the allowed transitions between states.

The functional requirements of the Decoder are derived from the principles of the system and an analysis of the existing system. BR Specification 1942 give details of the principles and of the existing system.

The basic architecture and variations for the vehicle sub-system are shown in Fig 3.1. It will be necessary in all instances where the Decoder is fitted retrospectively to alter the existing decoder Junction Box wiring accordingly.

The terminal allocation of the existing Junction Box, modified to accept the Decoder, is shown in Fig 3.2.

The functional requirements for the vehicle sub-system are specified below and in the flow chart Fig 3.4.

Standard Boolean logic symbols and terminology are used throughout the specification. The terms high or 1 and low or 0 refer to the presence or absence respectively of the input and output signals that are specified in Section 4.

The Decoder shall be designed such that it can be configured to either interface with the existing peripheral equipment or directly control an electronic horn/bell tone generator, provide the reset response delay and control the brake.

In the first instance the Decoder shall control the horn, reset response delay and the brake through either an EP valve or auxiliary relay unit from output P12. In the second instance the Decoder shall control the electronic horn tone generator directly from output P12a and provide a voltage free contact across P5 and P16 with a delayed release (reset response delay T2) to control the brake.

3.1 Decoder Input, Output and Timer Designations

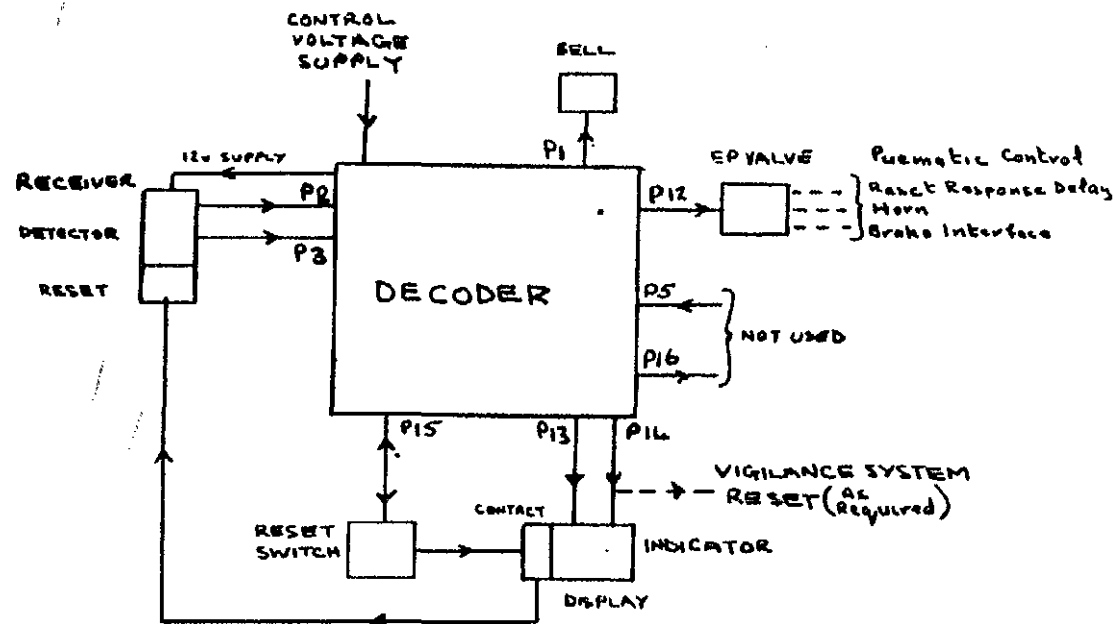
The input and output designations follow the existing Junction Box terminal numbering system modified for the Decoder (see Fig 3.2) with which they will be required to interface.

3.1.1 There are 3 input signals:-

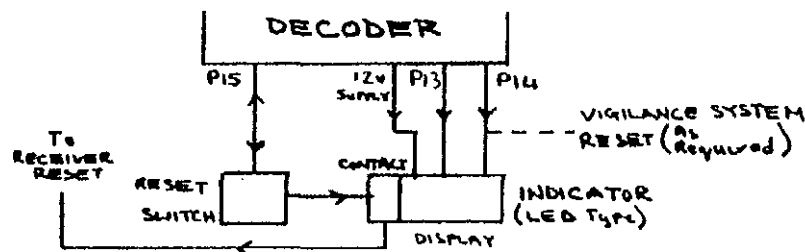
<u>Description</u>	<u>Designation</u>	<u>Cross Ref</u>
Receiver N Contact	P2 (N)	) 4.3.1
Receiver S Contact	P3 (S)	)
Reset (Switch N/O Contacts (1/3))	P15	4.3.3

Note: P15 shall be configured as alternately an input and an output during the Reset process, see 3.1.5 and Fig 3.3.

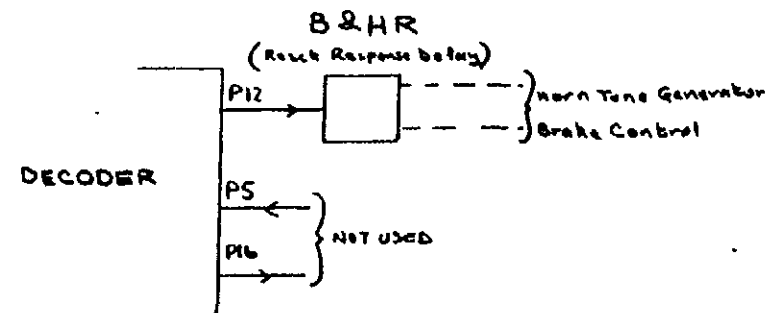
VARIATIONS : RESET RESPONSE DELAY; BRAKE CONTROL;
HORN CONTROL.



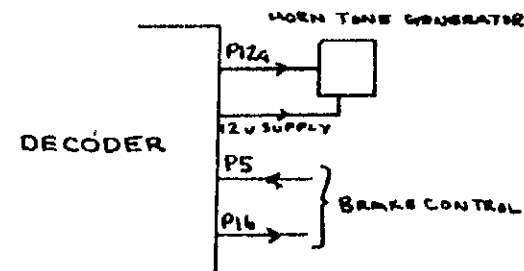
BASIC SYSTEM



VARIATION - ALTERNATIVE INDICATOR SEE 4.4.1



VARIATION 1



VARIATION 2 (SEE 3.1.4)
DIRECT CONTROL OF HORN AND BRAKE

BR AUTOMATIC WARNING SYSTEM VEHICLE SUB-SYSTEM BASIC ARCHITECTURE AND VARIATIONS

P1	CLEAR INDICATION (BELL) OUTPUT
P2	RECEIVER N INPUT
P3	RECEIVER S INPUT
P4	LINKING FROM INDICATOR CONTACT (P5)
P5	VOLTAGE FREE CONTACT FOR BRAKE CONTROL
P6	(SYSTEM 40 V NEGATIVE (FROM PSU) (RECEIVER RESET COIL SUPPLY NEGATIVE
P7	40 V POSITIVE FEED TO RESET SWITCH N/O CONTACT
P8	CONTROL VOLTAGE SUPPLY POSITIVE
P9	SYSTEM 12 V NEGATIVE LOOPING TO PERIPHERALS
P10	CONTROL VOLTAGE SUPPLY NEGATIVE (SYSTEM 12 V POSITIVE (FROM PSU)
P11	(12 V POSITIVE FEED TO RECEIVER AND, WHEN (FITTED, TONE GENERATOR AND LED INDICATOR
P12	(EP VALVE OR BRAKE CONTROL RELAY 1 OUTPUT (OF TONE GENERATOR HORN OUTPUT
P13	INDICATOR B OUTPUT
P14	(INDICATOR Y OUTPUT (VIGILANCE SYSTEM RESET (WHEN REQUIRED) OUTPUT
P15	RESET SWITCH INPUT/OUTPUT
P16	VOLTAGE FREE CONTROL FOR BRAKE CONTROL

NOTE: 12 V (P9) AND 40 V (P6) NEGATIVE TERMINALS ON SOME VEHICLES ARE COMMON.

JUNCTION BOX TERMINAL ALLOCATIONS

FIG 3.2

3.1.2 There are 6 output signals:-

<u>Description</u>	<u>Designation</u>	<u>Cross Ref</u>
Indicator B Coil	P13	) 4.4.1
Indicator Y Coil	P14	)
*EP Valve or Brake Control Relay 1	P12	(3.2.7 & (4.4.3
Bell	P1	4.4.2
Reset (Switch N/C Contacts (1/2))	P15	4.4.4
Brake Control Voltage Free Contact	P5 and P16	4.4.3.2

This output shall be alternatively designated:-

Horn Drive	P12a	(3.1.4 (3.2.7.1 & (4.4.6
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Note: P15 shall be configured as alternately an input and an output during the Reset process, see 3.1.5 and Fig 3.3.

3.1.3 There are 4 timers:-

<u>Description</u>	<u>Designation</u>	<u>Cross Ref</u>
Initial Delay	T1	)
Reset (or Acknowledgement)	T2	)
Response Delay		) 3.4
Bell Output Duration	T3	)
Reset Enable Delay	T4	)

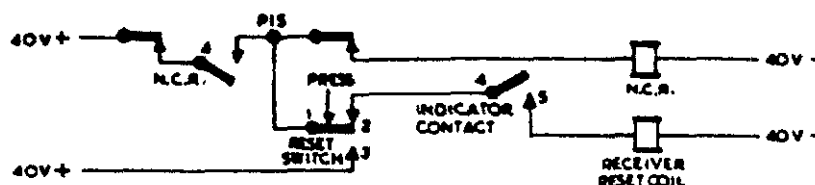
3.1.4 Variations

In the existing system the horn control, reset response delay T2 and the brake control interface is carried out either pneumatically via the EP valve or by one of two auxiliary relay units. These units are controlled from output P12. The Decoder shall be designed such that it can be configured to interface with either the existing EP valve and auxiliary relay unit or to control the horn directly, provide the reset response delay (T2 timing) and a voltage free contact for the brake control.

3.1.5 Reset Input and Output

The system reset shall only be enabled after a caution indication has been given and it shall be disabled once the system has been reset.

The Decoder reset process shall be primed when the reset switch is pressed and shall be completed when the reset switch is released. A common connection P15 is used for both the input signal, to prime the reset process when the switch is pressed, and for the output signal to reset the receiver when the switch is subsequently released, this is illustrated in Fig 3.3 below. The sequencing of this is shown in Fig 3.4.



This extract from the existing relay system illustrates the use of P15 for alternately the Reset input and output signals. The NCR is shown de-energised. Pressing the switch connects the supply via P15 to energise the NCR, subsequently releasing the switch feeds out 40 volts over the NCR contact (now made) via P15 to the reset coil (the NCR also controls the indicator).

FIG 3.3 : ILLUSTRATION OF THE FUNCTION OF P15

The reset switch is a two position changeover switch biased such that its contacts 1 and 2 are normally closed.

When the Decoder reset process is primed the Indicator 'Y' output P14 shall be set high and the reset output P15 set high. Releasing the reset switch feeds the signal from P15 over the now made Indicator contact and via Junction Box terminal P4 to the receiver reset coil.

3.1.6 Junction Box Terminal Designations

The existing Junction Box terminal designations, not covered in 3.1.1 and 3.1.2 above are (see Fig 3.2):-

<u>Existing Description</u>	<u>Designation</u>	<u>Cross Ref</u>
Indicator Contact/Reset Coil Connection	P4	3.1.5
40 V dc Negative Supply	P6	5
40 V dc Positive Feed to Reset Switch Terminal (3)	P7	5
12 V dc Negative Supply and Negative Looping for Peripherals	P9	
12 V dc Positive Supply and 12 V Feed to Receiver and where required the Tone Generator and Indicator	P11	5

3.2 System Process and State Definitions

These definitions supplement the general definitions of Section 2.

3.2.1 Power Off, in this state there is no power to the system and consequently there will be no inputs to and there shall be no outputs from the Decoder.

- 3.2.2 Power Up, all outputs shall be set low, the valid receiver inputs are P2(N) XOR P3(S) the reset input P15 shall be enabled.
- 3.2.3 System Initialisation and Reset/Acknowledgement process. At Power Up this process shall initialise the system to the Ready State. After a caution indication has been given it shall reset the systems to the Ready state. The reset input P15 shall only be enabled on power up and after a caution indication has been given. It shall be disabled once a valid input has been received at P15 and output P14 has been set high before output P15 is set high.
- 3.2.4 Ready; in this state output P12 shall be set high, outputs (P12a), P14 and P15 set low and the brake contact P5/P16 made, the valid receiver inputs are P2.P3 and the system is waiting for the receiver inputs to change to P3.P2.
- 3.2.5 Primed, this state shall be initiated by a receiver input transition from P2.P3 to P3.P2, time T1 shall commence and output P13 shall be set high. The system now waits for either time T1 to elapse (to give a caution indication) or the receiver input to change to P2.P3 before time T1 elapses (to give a clear indication).
- 3.2.6 Clear Indication process, shall be initiated by the receiver transition from P3.P2 to P2.P3 before time T1 has elapsed. The bell output P1 shall be set high and time T3 shall commence. When time T3 has elapsed outputs P1 and P13 shall be set low and the system shall restore to the Ready state.
- 3.2.7 Caution Indication process, shall be initiated when time T1 has elapsed, time T4 shall commence and outputs P12 and P13 shall be set low. In this state the horn sounds.

This process shall also be initiated directly whenever the receiver inputs P2 and P3 are invalid.

Reset input P15 shall be enabled when time T4 elapses.

3.2.7.1 Alternative Caution Indication Process

The Decoder shall be capable of being configured to interface directly with the horn tone generator and brake. In these circumstances the function of the Caution Indication process shall be:-

When time T1 has elapsed outputs P12a shall be set high, P13 shall be set low and times T2 and T4 shall commence.

Reset input P15 shall be enabled when time T4 elapses.

The brake control contact P5/P16 shall be opened when time T2 elapses.

3.2.8 Timers, the flow chart Fig 3.4 and this specification only indicate where a timing commences and is tested for elapsing. The design of the Decoder shall ensure that a timer is reset at point in a process stage before it is called.

3.3 Transition Between Processes and States

The transition between processes and states shall be sequenced as shown by the system flow chart Fig 3.4.

3.4 System Timings

There are four timings associated with the system and these shall be provided by the Decoder.

Timing T2 will only be used when the Decoder is configured to interface directly with the brake see 3.2.7.1.

3.4.1 Initial delay T1. This is the period after a permanent magnet has been detected to allow for an electromagnet to be detected.

If T1 elapses before an electromagnet is detected then a caution indication shall be initiated.

If an electromagnet is detected before T1 has elapsed then a clear indication shall be initiated and T1 shall be cancelled or reset.

$T1 = 1 \text{ seconds} \pm 0.1 \text{ S}$

3.4.2 Reset (or Acknowledgement) Response delay T2. This is the period from the caution indicator starting to sound in which to allow for the driver to reset, before a brake application is initiated. It shall be possible to configure the Decoder to provide one of two timings. The timing shall be selected by means of a fixed link within the unit.

$T2 = 2 \text{ seconds} \pm 0.1 \text{ S}$

or

$T2 = 3 \text{ seconds} \pm 0.1 \text{ S}$

3.4.3 Bell Output T3. When required at a clear indication the bell signal shall be high and present for this period, see 4.4.2.

$T3 = 0.5 \text{ seconds} \pm 0.05 \text{ S}$

3.4.4 Reset Enable delay T4. This delay allows the peripherals to respond and a caution indication to commence before reset input P15 is enabled.

$T4 = 0.15 \text{ seconds} \pm 0.02 \text{ S}$

Note: With the existing relay decoder delay T4 is inherent due to the relay characteristics.