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Engineering Standard – NSW

Category

Signalling

Title

Track Circuits

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About This Standard

This Standard defines the procedures to be followed when carrying out maintenance activities associated with track circuits.

Document History

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Contents

1 GENERAL

Signalling maintainers are responsible for maintaining track circuits for safe and reliable operation. They are to work in accordance with the following maintenance requirements and schedules. As with other vital signalling equipment, signalling maintainers should be on the lookout and check for potential track circuit problems whenever the opportunity permits, as when visiting sites or walking through the section.

Maintenance requirements include four specific tasks:

a) Track circuit examination

b) Recording of track circuit voltages etc. and settings

c) Shunt test

d) Polarity test

Signalling maintainers shall make themselves aware of the equipment manuals and specifications and maintenance procedures for each type of track circuit which they will be required to maintain.

1.1 Track Circuit Examination

The objective of examining track circuits is to find and remove any potential failure conditions and ensure that as far as possible the track circuit will function satisfactorily until the next examination.

Any conditions likely to cause trouble or reduce the reliability of the track circuit shall be dealt with immediately, if practicable, or brought to the notice of the Maintenance Signal Engineer and dealt with as soon as possible.

1.2 Track Circuit Test Records (History Cards)

Track circuit test record cards (history cards) shall be kept near each track relay and tests shall be made and recorded thereon.

Although preferable to have one card per track circuit located in the track relay location, it is permissible to have a second card in the track feed location and the test readings recorded separately for each end of the track circuit on the respective card.

The track circuit history card provides a past record of the performance of the track circuit. Further to highlighting variations that need to be accounted for, observation and comparison of values recorded provides a way of detecting "trends" in performance, allowing problems to be detected before they cause a failure. Gradual consistent variations (e.g.: adjusting Krv upward on a CSEE receiver by a small amount every quarterly visit) indicate the deterioration of some component of the track circuit. The causes of these problems shall be sought out and attended to.

The following shall be treated as separate track circuits and tests and records carried out and kept accordingly:-

pinpoint detectors, centre fed track circuits, common transmitter track circuits, double receiver track circuits and cut section track circuits.

1.3 Shunt Test

Shunt tests using test resistors require two people, one to apply the shunt resistor and the other to observe the contacts of the relay.

Shunt checks, using a train or fixed shunt resistor, may be able to be performed by one person checking that the track relay has dropped when the track is shunted.

The minimum drop shunt resistance value for various types of track circuit is as laid down in TABLE 2.

a) Drop Away Shunt Test

The 'drop shunt' resistance is the highest value of resistance which, when placed across the rails, will cause the relay to drop away (i.e. become de-energised with all front contacts open.)

The drop shunt resistance is measured by aid of a variable shunt device (known as a `shunt box').

When taking the `drop away shunt' measurement the leads of the shunt box are connected across the rails at the relay/receiver end of the track, set at a high value (at which the relay is energised), and then the resistance is decreased until the relay drops away; the 'drop shunt' value is then measured.

The drop away shunt test is repeated three times until consistent results are obtained. This result shall then be recorded on the track circuit history card.

b) Fixed Shunt Test

A `fixed shunt test' is carried out by connecting the specified value fixed shunt across the rails and observing that the track relay drops (de-energises). Special shunt boxes are available for this purpose.

These are fitted with leads and a special set of clamps to minimise rail-lead contact resistance.

For a fixed shunt test the fixed shunt resistor is connected across the rails at all extremities of the track circuit (including within crossovers) and at the mid point of the track circuit. At each point the track relay is observed to drop away.

The value of the fixed shunt resistor will be the figure shown in Table 2, which is the minimum drop away shunt value for the type of track circuit concerned.

c) Fixed Shunt Check

If it is necessary only to check that the track circuit will shunt at one point then a fixed shunt check may be carried out using the fixed shunt resistor described in the fixed shunt test.

d) Train Shunt Check

A final test of proper operation of track circuit is the "train shunt check," carried out to ensure that there is effective rail/wheel contact and that a train is effectively detected during its entire passage over the track circuit.

A train shunt check is required where there is doubt about the conductivity of the rail contact surfaces, for example after rerailing or after an extended period of disuse.

The check is carried out by monitoring the track relay/receiver input voltage, while a train passes over the whole length of the track circuit, and observing that the input voltage does not exceed a maximum 'train shunt' value. The test point and the maximum 'train shunt' value for each type of track circuit are given in the table below:

Table 1.

Track Circuit Type	Test Point	Measure Units	Maximum Train Shunt or O/C Feed Value
DC-Shelf	Relay Coil	$_{V}$DC	<30% of D.A. test value
DC-Plug in	$^{R}1^{R}2$	$_{V}$DC	<30% of D.A. test value
AC	Control terminals	$_{V}$AC	<30% of D.A. test value
CSEE UM 71	Receiver $^{R}1^{R}2$	mV^{AC} with filter	<90 mV
ML TI 21	Receiver R+R-	mV^{AC} with filter	(mV x GAIN) <100 mV
WB&S FS2500	Receiver monitor	mV^{AC}	<400 mV
J/S	Receiver terminals C+/C1 (RVT-600) 3/C1 (BRT-CA2)	VDC with integrator	<100 Volts

Note: This check is best carried out with a Digital Multimeter with an analog bar display, set to a fixed voltage range (not auto - ranging).

The D.A. test value is, for shelf relays, the drop away value shown on the manufacturer's or workshop's test label on the relay, and for plug-in relays is the standard drop away value for that type of relay as shown in the Relays Equipment Manual.

The track circuit shall be disconnected and booked out of use if maximum "train shunt" value is exceeded under train shunt conditions.

Notwithstanding the specified maximum 'train shunt' values, test readings above ten percent of the D.A. test value or above one third of the other values specified in the table above, are to be further investigated and immediately reported to the Maintenance Signal Engineer.

1.4 Polarity Test

Rail voltage polarities shall be checked using a voltmeter (and pulse integrator where applicable) to ensure that there is polarity reversal across all insulated rail joints between adjacent track circuits of the same type, namely 50Hz AC to 50Hz AC, DC to DC, impulse to impulse.

The existence of like polarities on these track circuits is acceptable only at a track feed to track feed interface, or with cut tracks where the track relay directly cuts the adjacent feed.

Polarity reversal does not apply to audio frequency track circuits.

Track circuit polarities must not be reversed without the approval of a Signal Engineer.

The Signal Engineer shall be advised of incorrect polarities between track circuits as soon as possible. The condition of the insulated rail joints shall be checked to ensure they are not liable to breakdown before the situation is corrected to the instructions of a Signal Engineer.

The Signal Engineer shall consult with the ARTC General Manager ISP or nominated Signalling representative, as necessary, to determine design solutions.

1.5 Track Circuit Adjustment

On installation, adjust track circuits and complete all entries shown on the track circuit history card.

a) Adjust track circuits with the track bonding (rail bonds, series bonds, parallel bonds, impedance bond side leads) and rail connections in good condition with low resistance.

Track circuit feed voltages shall not be increased to compensate for open circuit or high resistance bonding - in electrified areas high track feed voltages could increase the probability of circulating currents through traction tie in bonding or earth’s.

b) Adjust and drop away shunt test track circuits preferably in dry ballast conditions. Track circuits adjusted in wet or poor ballast conditions shall be drop away shunt tested again when the track has dried out, or the ballast conditions improved, to ensure correct shunting.

- The signalling maintainer is to keep informed of planned works or activities which could change track or ballast conditions and affect the proper adjustment of the track circuit and its ability to operate reliably and safely.
- Minor adjustments should be carried out first and the Maintenance Signal Engineer is to be promptly informed.
- Should large adjustment or adjustment for unaccountable reason be required, the Maintenance Signal Engineer shall be immediately contacted for instructions.

c) Whenever the track circuit is readjusted, measure and record all track circuit voltage readings; carry out a fixed shunt test at all extremities and observe the relay pick up and drop away correctly. Also carry out a drop away shunt test at the relay/receiver end; if the variable shunt box is not on hand the drop away shunt test shall be performed as soon as practical.

- In exceptional circumstances, if it is necessary to temporarily readjust a track circuit to compensate excessively wet or poor ballast conditions, an entry to that effect shall be made on the track circuit history card.

- The Maintenance Signal Engineer shall be promptly advised and shall suitably record such advice. The suitably accredited signalling maintainer must regularly monitor the track circuit and the track must be readjusted immediately the ballast conditions have improved; the Maintenance Signal Engineer shall ensure the timely correction of the adjustment.

1.6 Interference/Repairs to Track Circuit Wires

Whenever two or more track circuit wires are disconnected and reconnected or repairs are made to two or more broken wires to or from track circuit equipment, ensure that the track relay has picked up and carry out a fixed shunt check or train shunt check to ensure that it drops away correctly. Where applicable, carry out a polarity reversal test between the affected track circuit and adjacent track circuits if there is any possibility of the track circuit polarity being altered.

1.7 New or Rusty Rails (refer also to SMP 26)

After rerailing, where rail surfaces are not clean (bright and shiny) or when the rail surface is rusted after a period of disuse, carry out a train shunt check to ensure that a train is effectively detected over the complete length of the track circuit.

Ensure rail surfaces are clean for sections of track even as short as the wheel base of a single bogie when that section of track is located within a vehicle wheel base of an insulated rail joint between adjacent track circuits.

Whenever there is replacement of rails in points or at blockjoints, or in tuned loops, or where short sections of rail are replaced in the vicinity of the clearance point between converging tracks and near the interface between adjacent track circuits, or where glued insulated joints are installed, then the signalling maintainer is to be in attendance and ensure that the rail surfaces are clean before the track circuit is restored into use.

In certain areas of plain track the attendance of the signalling maintainer may not be necessary for the replacement of short sections of rails where the requirements of section 1.5 *(Guidelines for the use of temporary rail bonds)* of SMP 26, (Rerailing – Precautions to be taken) have been met and with the agreement of the Maintenance Signal Engineer.

In these cases, the civil engineering staff are to grind the surface of the rail to clean off any protective coating, rust or other contamination and provide a shiny metallic surface for good electrical contact with the wheels. Alternatively restoration of the track circuit is to wait until the passage of trains has cleaned the rail surface to ensure shunting.

Inspections during maintenance visits and more frequently where necessary are to be made of sections of track where rust or other contaminants are likely to accumulate on the rails of track circuited lines e.g. sidings and entry to sidings, refuges, branch lines.

Whenever signalling maintainers become aware of rails that are rusty or otherwise contaminated such that the track circuit would not detect the presence of trains that run on the track, they shall book out of use the affected signals and/or points and immediately advise the Maintenance Signal Engineer of the details. Potential problem sections of track are also to be reported to the Maintenance Signal Engineer.

When the rails of a points turnout are rusted on the turnout lead but not on the straight and there is the possibility that power operated points could be operated with a train still foul on the turnout, the points and signal for the move through the turnout are to be disconnected and booked out of use.

Where the rusty rails of a track circuit are on a double ended turnout (crossover) operated from an adjacent ground frame, or on a turnout with catchpoint operated from an adjacent ground frame, then the ground frame release may be left connected.

Where the rusty rails of a track circuit are on a single ended turnout connecting to a running line with track circuited controlled signals, and the turnout points and a turnout signal are operated from a ground frame which is not in a position where the operator can easily observe the clearance point, then the release switch is to be disconnected and booked out of use.

Signalling Maintainers are to identify and maintain a register of sections of line on their areas which are likely to have rust build up and cause loss of train detection. They are to ensure that the potential for this is minimised and that if it is likely to occur it will be detected and protected against. They are to be alert for changes in the type, frequency and tonnage of traffic over the lines.

Maintenance Signal Engineer are to specify any change needed to the general requirements stipulated under Network rule NGE 220.

Maintenance Signal Engineers are to advise the ARTC GM ISP or nominated Signalling representative of any more stringent requirements for ensuring track circuits do not fail to detect trains because of rusty rail and/or light weight trains and/or infrequent services.

The general requirement period of 72 hours nominated in Network rule NSG 220 must be reduced by the Maintenance Signal Engineer after consultation with the ARTC GM ISP or nominated Signalling representative where conditions would not provide for reliable train detection over this period. For example, reductions might be to 48 hours for non electrified main line areas and to 24 hours for non electrified branch line areas.

Where a lesser period or longer (due to the provision of impulse track circuits, etc) is required for specific sections, the Maintenance Signal Engineer is to advise this as an exception to these general requirements.

The decision on the integrity of the track circuits relative to the potential loss of train detection due to rusty rails needs to be determined on site.

Relevant factors include rust causing environments (humidity, rainfall, temperature), rail susceptibility to rusting, axle loading, number of axles per train, speed of short light trains, maximum time period between trains and the frequency of trains, gross tonnage, wheel profile/rail profile interaction, variance between trains of the wheel trace on the rail, long lengths of straight track allowing smooth rolling of wheels on rails, and fitted brake shoes that might dislodge rust (transferred from the rail) building up on the wheel surfaces. Track circuits also vary in their relative vulnerability to the thickness of rust, those with higher track voltages being less vulnerable.

Where adverse conditions exist and/or an infrequent or light weight traffic service runs, measures such as five second slow pick-up track repeat relays or impulse track circuits may be necessary. These issues need to be referred to the ARTC GM ISP or nominated Signalling representative.

NOTE: The application of the "72 hour rule" was designed for main line operations or frequently use lines where the rail head surface was already clean and free of contaminants (bright shine) and maintained in that condition by the normal timetabled running and where the line was intermittently closed for periods of less than 72 hours.

The application of running one short train over a section of track circuited line once every 72 hours does not allow adequate cleaning of the rail head surface and over an extended period of time, allows a slow buildup of rust and other contaminants to accumulate, resulting in the subsequent intermittent loss of track circuit shunt.

The term "Infrequently used lines" appears in a number of safeworking documents and for signalling purposes "infrequently used lines" when applied to light engines or equivalent, refers to track circuited lines that have had less than 6 trains (approx equivalent to 8 car passenger set in length) or 5000 tonnes traverse them at or near line speed in a 24 hour period.

The action of a train travelling at or near line speed especially freight trains has a "scrubbing effect" on the top of the rail head keeping it free from contaminants and rust. However there is a difference between the behavior of a light engine & an electric train on the track circuits on "infrequently used lines", the electric train because of the large traction current drawn, will break down contaminants on the rail head allowing the track circuit to shunt. This may result in a different safeworking requirement for electric rolling stock and light engines or the equivalent when applied to a tracked circuited line that comes under the category of an "Infrequently used lines".

1.8 Excessive sanding of the Track by Locomotives

When excessive sanding of tracks occurs in track circuited areas the effective shunting of track circuits could be affected.

Any case of excessive sanding is to be immediately brought to the attention of the Maintenance Signal Engineer, and also to the attention of the driver and/or nearest signaller. The Train control staff are to be requested to issue a 'Genl' telegram to report the instance of excessive sanding.

Any instances of trains failing to shunt track circuits, intermittently or otherwise due to sand on the rail head, are to be immediately reported to the Maintenance Signal Engineer and fully investigated.

1.9 Precaution to be taken when inserting track circuit receivers

It is critical that CSEE receivers, especially, be plugged into their correct rack positions. The misallocation of a receiver by one module space can have unsafe consequences, with the permanent energisation of the track relay.

2 TRACK CIRCUIT CYCLIC MAINTENANCE

2.1 One Monthly Check of Double Rail 50Hz track circuits in electrified areas.

Test 50Hz AC double rail track circuits in electrified areas on a monthly basis as follows, and record the results on the monthly check card.

a) Track relay coil voltage, unoccupied

b) Current in each rail, relay end, for balance

c) Current in each rail, feed end, for balance

d) Current in each cable of impedance bond side lead, up rail, for balance

e) Current in each cable of impedance bond side lead, down rail, for balance

f) Voltage drop across side lead connection to the up rail

g) Voltage drop across side lead connection to the down rail

The track relay coil voltage should be roughly one volt under normal unoccupied conditions.

The current in each rail at the one location should be equal or within 0.5 amp as measured on an induction meter.

Investigate unbalance (unequal) current readings and advise the Maintenance Signal Engineer without delay.

The currents measured in each cable of a side lead pair of cables should be equal, or within 10%. Uneven current sharing indicates a high resistance side lead or connection.

The voltage drop across a side lead connection to the rail should be less than 10 millivolts ac. Investigate changes in values significantly different to previous readings.

2.2 Regular Check of Parallel Bonds

Parallel bonds on track circuits extending over points to a clearance point on another line, shall be inspected on each occasion the set of points or the track circuit is maintained and whenever suitably accredited signalling maintainers are working in the vicinity of the points.

Where the track relay is connected such that open circuit or high resistance parallel bonds would fail the track circuit, then the inspections need only be carried out on the normal rostered maintenance visit to the track circuit.

To deter theft of copper traction bonds used for parallel bonding, maintenance staff should consider converting vulnerable bonds to aluminum or encase them in concrete filled surface conduits.

Staff must be vigilant when visiting locations where parallel bonding is provided to ensure bonding has not been damaged/removed by track machines, vandals or copper thieves.

2.3 Rostered Maintenance Visits

Specific attention and visual inspection shall be given, and necessary action taken on the following items:

a) Connections to the rails and the condition of cables for:

- track circuit leads
- series and parallel bonds
- mechanical fishplate bonds
- sparkgaps
- electrolysis bonds.
- impedance bond side leads
- traction tie-in leads
- emergency jumper bonds

The voltage drop across impedance bond side lead connections to the bond and to the rail shall be checked to be low resistance, ie less than 10 millivolts.

b) Connections to air-cored inductors, tuning units, compensating capacitors and their connections.

c) Cable fasteners to rails and sleepers (including clip/cleating arrangements on concrete sleepers).

d) Insulated rail joints:

- deterioration
- rail burning/burring over
- steel scale.
- clear of ballast and metallic items.

Use an induction meter to detect leakage through the insulated joints.

Where an insulated joint between track circuits is in need of repair, check for correct polarity reversal as a precautionary measure

e) Point rodding, signal wires and debris such as spent drink cans or detonator cases coming into contact with rails and crossing noses.

f) Electric traction bonds or other cables being installed clear of, and insulated from, rails to which they are not bonded.

g) Rusty rails, sand or other contamination which could affect train shunts (on the contact surface of the rail).

h) Rail fasteners or Pandrol clips clear of fishplate bolts at insulated joints, and clip and chair insulation pads on concrete-sleepered track. Rail fasteners and rail bonds clear of steel structure on bridges.

i) General condition of ballast.

j) Lightning protection equipment.

k) The d.c. voltage drop across all stanchion spark gaps shall be tested to ensure that they are open circuit. A voltage reading over three volts would indicate a satisfactory open circuit spark gap.

l) Relay track coil voltage on 50Hz A.C D.R track circuits (Record the voltage at the track receiver/relay and check against the last recorded value.) - 1 monthly (Passenger lines)

Relay track coil voltage on 50Hz A.C S.R track circuits - 2 monthly (Freight only lines)
Relay track coil voltage on D.C. track circuits

Receiver Input voltage on jointless and impulse type track circuits. - 3 monthly

m) Rail current balance for 50Hz track circuits in electric traction areas, double rail passenger - 1 monthly, double rail freight only - 2 monthly, single rail - 3 monthly. - 3 monthly

n) Track relay pick up and drop away operation where practical, when the track circuit is shunted by a train. - 3 monthly

o) On D.C. track circuits, battery condition, battery voltage, electrolyte level, and on primary batteries the battery drain current. Record electrical readings and compare with track circuit battery record card and battery life expectancy.

If the reading shows a variation from the last recorded value which is large enough that it cannot be accounted for by normal variations in ballast conditions, then further investigation and tests (see 2.5) shall be carried out. Severe degradation of performance of the track circuit outside normal behaviour or known symptoms of failure must be reported to the Maintenance Signal Engineer who shall arrange investigation.

In the case of double rail 50Hz AC track circuits, the current balance shall be determined by measuring the signalling current in both rails, at both the feed and relay ends of the track, using an Induction meter. This test is not highly accurate, due to variations induced by traction current harmonics; the test does give a convenient indication of unbalance in the rail currents, and any difference greater than 0.5 amps may be considered significant.

While there should not be stray 50Hz currents emanating from balanced double rail track circuits this is not the case with single rail 50Hz track circuits, where close tie in bonding between the traction rails of parallel tracks provides an alternate low resistance path for stray 50Hz track circuit currents. It may not then be unusual to measure unbalanced 50Hz currents in single rail track circuits.

Measuring rail current balance using a meter that is not 50Hz frequency selective may not be an accurate indicator because of traction harmonics flowing in the traction rail. Differences between the rail currents measured on an induction meter of greater than 1.25 amps on single rail 50Hz track circuits should be further investigated by checking other track circuits in the vicinity.

2.4 Traction Bonding (Refer also to SMP 27)

Where a fault condition causes AC track circuit currents to circulate via traction tie-in bonds or earths, etc through other track circuits (or where a fault condition causes AC currents in the DC traction supply) then a potentially unsafe condition can occur if a high resistance track circuit condition arises. All cases of open circuit or high resistance rail bonds, series bonds, impedance bond side leads, and their connections, shall be rectified promptly. Emergency jumper bonds, in good condition and correctly applied, should be utilised as required but replaced by permanent bonds as soon as possible. Any case where AC rail current unbalance is detected shall be immediately reported to the Signal Engineer, and the cause found and rectified without delay.

Signalling maintainers must ensure that track circuit bonding is in good condition, that open circuit bonds are immediately replaced, that high resistance connections are immediately rectified and that deteriorated bonding is programmed for timely renewal. The Signal Engineer shall check that bonding requirements are met.

2.5 Annual and Two Yearly Maintenance Visits

In addition to the inspection and tests which are carried out on a normally rostered maintenance visit (see paragraph 2.3), the following tests shall be carried out at intervals not exceeding 12 months.

a) Check rail voltage polarities using a voltmeter to ensure that there is the required polarity reversal across all insulated rail joints between adjacent track circuits at all extremities. Ensure the checks are carried out while relevant power supply locations are operating on the ‘Normal’ supply. Advise any discrepancies to the Maintenance Signal Engineer.

b) Open and examine impedance bonds installed in the four foot with part below top of sleeper level. (see Paragraph 2.7)

In addition to the above, the following inspections and tests shall be carried out at intervals not exceeding two years.

i) Measure all voltage readings indicated on track circuit history cards according to the methods prescribed for the type of track circuit under test and fill the results out on a new line on the card and compare with previous results.

ii) Carry out a fixed shunt test, with the appropriate resistance value for the type of track circuit concerned, see Table 2 at all extremities of the track circuit including in points turnouts and crossovers and especially where connected by parallel bonding. Record details on the history card.

If the track fails to shunt at the minimum drop shunt value specified for that type of track circuit, then a drop away shunt test shall be conducted and the Signal Engineer shall be informed immediately. The track circuit shall not be left operating in an unsafe condition.

iii) In the case of compensated track circuits, record the rail-rail voltage at each capacitor connection for comparison with previous results.

iv) Remove the track feed fuse and observe the track relay de-energise properly and check the track relay/receiver input voltage measures near zero and does not exceed the maximum O/C Feed values specified in the Table 1.

Notwithstanding the specified maximum "O/C Feed" value, test readings above ten percent of the D.A. test value or above one third of the other values specified in the Table 1 are to be further investigated and immediately reported to the Signal Engineer.

On D.C. track circuits, open circuiting of the track feed is important in determining whether there is any galvanic action (battery effect) between the rails or residual magnetism in the relay. All cases where a D.C. track relay does not de-energise normally with the track feed disconnected shall be promptly reported to the Signal Engineer.

On AC vane relays supply to the local coil will also need to be opened.

On audio frequency track circuits the transmitter for the track adjacent to the receiver will also have to have the supply fuse removed unless a frequency selective voltmeter is used.

v) Insulation test track circuit leads from the location to the bootleg riser, bond or tuning unit, and record values, every two years for non PVC insulated cables and every four years for PVC insulated PVC sheathed cables.

If the track circuit readings show variations from the last recorded values which are large enough that they cannot be accounted for by normal variations in ballast condition, then further investigation shall be carried out. Severe degradation of performance of the track circuit outside normal behaviour or known symptoms of failure shall be reported to the Maintenance Signal Engineer for investigation.

2.6 Other Circumstances Requiring Testing

The inspections and tests required on maintenance visits shall also be carried out whenever there are changes which could affect the adjustment or polarity of the track circuits, including:

a) when the track circuit is newly installed

b) in the case of 50Hz AC track circuits and DC track circuits with shelf relays, when a relay change has been carried out. Carry out a fixed shunt check at the relay and measure the relay voltage before and during the fixed shunt check. Compare the values with previous values, the track relay workshop test values, and the normally required values. Assess the need for readjustment.

c) after any of the following equipment items forming part of the track circuit has been changed, eg: transformer, resistor, impedance bond, capacitor, transmitter, receiver, tuning unit, matching unit, shielding unit. Carry out a fixed shunt check at the relay end and measure the relay/receiver voltage before and during the fixed shunt check. Compare the values with the previous values, the track relay workshop test values and the normally expected values. Assess the need for readjustment.

d) after track work such as relaying or ballast cleaning which can affect the adjustment of the track circuit. Carry out a fixed shunt check at the relay end and measure the relay/receiver voltage before and during the fixed shunt check. Compare the values with the previous values, the track relay workshop test values and the normally required values. Assess the need for readjustment

e) when track circuit readjustment is required proceed as stipulated in Paragraph 1.5. When a track circuit is readjusted a drop away shunt test is also required as well as a fixed shunt test at all extremities.

f) as required, when investigating "no cause found" failures, etc.

g) whenever both track circuit feed wires and relay wires are disconnected and reconnected, carry out polarity tests between adjacent track circuits requiring polarity reversal.

h) whenever track circuit feed wires or relay wires have been reconnected, or a 50Hz track feed transformer has been changed, the track relay must be observed to pick up correctly to ensure that there has been no change to the circuit polarity.

i) whenever the polarity of power supply transformers or wiring feeding the track circuits is subject to change, carry out polarity tests between adjacent track circuits requiring polarity reversal which are fed from different power supplies.

j) when a mishap has occurred in which the signalling arrangements are being questioned, under the direction of the investigating Signal Engineer.

2.7 Impedance Bonds - Annual Maintenance

The removable lids of fully enclosed impedance bonds installed in the track below top of sleeper level shall be removed and the bond examined at intervals not exceeding twelve (12) months.

The set screws securing the yoke to the laminated core and all terminal studs shall be kept tight. The windings shall be examined to ensure that the insulation is not displaced and that the coil leads are not fractured. The bond shall be examined to see that it is clean and dry and the case is not cracked. When replacing the lids of bonds installed in the four foot it is essential that the sealing of the connection inlets and hemp lid packing or gasket will effectively exclude the entry of water or other foreign matter.

The set screws or bolts securing the lid shall be kept in good order and the wooden packing, where provided, maintained in position.

Siemens DD131 impedance bonds are provided with a dip stick plug to facilitate checking for the accumulation of moisture. In addition to the yearly examination this plug shall be removed frequently and any water detected shall be removed and the necessary attention given to the sealing of the connection inlets and lid gasket.

Jeumont Schneider CIT 1400 impedance bonds can suffer from loose back nuts so particular attention should be given to any loose terminations. The construction of this bond brings out each half of the winding externally for traction connections. To prevent a possible cause for unbalanced traction return a good solid connection must be maintained between the two centre copper bars. Inspect this connection to ensure that the two bus bars form a good connection.

Impedance bonds with removable lids installed outside the track on stands and impedance bonds with fixed lids are not required to have the lids removed for examination of the bonds.

On MJS and ABW 1000 amps per rail impedance bonds the condition of the connections is to be examined for looseness or any signs of oxidistion.

On 2000 Amps per rail impedance bonds there is an additional box mounted on the rear of the bond containing either capacitors (2000R and 2000RAF) or a transformer (2000P). The lid on the box is to be removed and a check made for any loose or imperfect connections.

Signalling maintainers must also ensure that whenever a refurbished impedance bond is being installed, an internal inspection is carried out to ensure that it has suffered no damage or deterioration during transport or storage.

On yearly inspections of resonated bonds the Capacitor voltage is to be measured and recorded on the respective impedance bond capacitor history card. Variation in the voltage compared to previous records is to be investigated.

TABLE 2 Drop Away Minimum Shunt Values

Track Circuit Type		Minimum Value of Drop Away Shunt (ohms)
DC track circuits 4 ohms -	DC shelf	0.15 ohms
	BTIB	0.25 ohms
	QTI	0.25 ohms
DC track circuits 9 ohms -		0.5 ohms
Jeumont Schneider impulse track (Double rail) (1xBRTCA2-Rx)		0.25 ohms
Jeumont Schneider impulse track (Double rail) (2xRVT600-Rx)		0.25 ohms
Jeumont Schneider impulse track (Double rail) (1xRVT600-Rx)		0.5 ohms
Jeumont Schneider impulse track (Single rail) (Normal/TV-TH1)		0.5 ohms
Jeumont Schneider impulse track (Single rail) (TV-THD2 or TV-LV)		0.25 ohms
AC track resistor fed - Signal Branch (Single rail)		0.25 ohms
AC track resistor fed - WBS single rail		0.5 ohms
AC track Resonant impedance bond		0.25 ohms
AC track AAR standards Double rail		0.06 ohms
CSEE jointless track		0.15 ohms
ML jointless track		0.5 ohms (0.15 ohms within loop)
WBS jointless track		0.5 ohms (0.15 ohms within loop)
USS Microtrax		0.25 ohms

TABLE 3. TRACK CIRCUIT HISTORY CARD 50 Hz AC TRACK CIRCUIT

LENGTH: ___________________m DOUBLE RAIL ☐ TRACK: __________________________

NUMBER OF IMPEDANCE BONDS ❖__________ SINGLE RAIL ☐

IMPEDANCE BOND TYPE ❖__________________

TRACK FEED TYPE *	
STORE 37 (100VA)	
STORE 45 (200VA)	
STORE 47 (200VA)	
W.B.S. (220VA)	

RELAY TYPE *	
VT1	
G.R.S	
KYOSAN	
McK&H/WBS	

TEST SHUNT *		
WBS S.R.	0.5 Ω	
SIG.BCH S.R.	0.25 Ω	
D.R. (RESONATED BOND)	0.25 Ω	
D.R. (STANDARD BOND)	0.06 Ω	

CHANGE OF RELAYS				
DATE	SERIAL No.	P.U. VOLTS	COMP. VOLTS	D.A. VOLTS

❖ Where applicable

*PLACE CROSS AGAINST APPROVED TYPE

DATE	FEED END				RELAY END							CHECKS				Ballast Conditions	Signature Of Testing Officer
	Mains Supply Voltage (V)	Secondary Voltage (V)	Current (A)	Track[2] Voltage (V) UP DN	Rail Current[1] (A) UP DN	Track[2] Voltage (V) UP DN	Relay Volts (V) Cont	Relay Volts (V) Local	Zero Feed (mV) Cont	Zero Feed (mV) Local	Drop Shunt (Ω)	Phase Check (OK)	Test Shunt (Ω)	Bonds/Rail Connections (Y/N)	Spark Gaps (Y/N)		

(1) CHECK RAIL CURRENTS ARE WITHIN 0.5A

(2) RECORD VOLTAGE EACH RAIL TO NEUTRAL ON DOUBLE RAIL ELECTRIFIED TRACKS

TRACK CIRCUIT HISTORY CARD **DC TRACK CIRCUIT**

LENGTH: ________________________________m TRACK: _________________________

POS. RAIL (UP/DN): _______________________

Date	(√) New Battery	Feed End				Relay End				Drop Shunt	Fixed Shunt Test	Ballast Conditions	Signature Of Testing Officer
		Mains Supply✶ (V)	DC Supply (V)	Feed Resistance (Ω)	Volts on Track Terminals	Volts on Track Terminals (V)			Polarity (OK)		(Ω)		
						Unoccupied	With Shunt On	Zero Feed					

TRACK FEED TYPE	
	PRIMARY BATTERY
	CHRGR + SEC.BATT
	SOLAR
	STR.70 + PR.BATT
	STORE 72
	TR 17
	DC (AC IMMUNE)

RELAY TYPE		TEST SHUNT
DC SHELF	4 Ω	0.15 Ω
BT 1B	4 Ω	0.25 Ω
QT1	4 Ω	0.25 Ω
QTM1	4 Ω	0.25 Ω
QT1	9 Ω	0.5 Ω
QTA1	9 Ω	0.5 Ω

✶ Place X against appropriate type

TRACK CIRCUIT HISTORY CARD **WB & S FS2500 TRACK CIRCUITS**

TRACK: ___________________________

LENGTH: __________________________________m

FREQUENCY: ______________________________Hz

Tx OUTPUT LEVEL: _________________________% HI/LO

IMPEDANCE BONDS	
RESONATED	Y/N
RES.CAP.	nFFG
CAP.VOLTS	V

DATE	TRANSMITTER END					DPU*				RECEIVER END										0.15 Ω Shunt Check	Ballast Condition	Signature Of Testing Officer
	Tx Serial No.	TU Input (V)	TU T1/T2 (V)	PSU Serial No.	DC (V)	DPU Serial No.	Amp Serial No.	Amp Gain (Hi/Lo)	Rx Input Current (mA)	Rx Serial No.	TU T1/T2 (V)	Rx Input (V)	Monitor Volts Unoc-cupied (mV)	Monitor Volts With Shunt On (mV)	Monitor Volts Zero Feed (mV)	Rx Sens	Drop Shunt (Ω)	PSU Serial No.	DC (V)	(OK)		

* For Tracks with Intermediate Receivers Only

TRACK CIRCUIT HISTORY CARD **WB & S FS2500 TRACK CIRCUITS**

TRACK: ___________________________

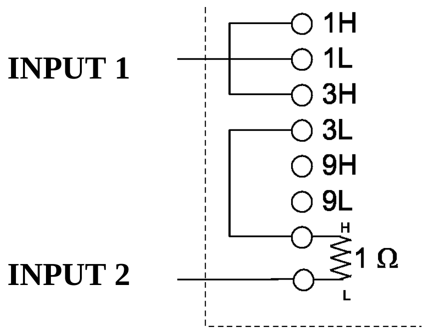
LENGTH: __________________________________m

FREQUENCY: ______________________________Hz

Tx OUTPUT LEVEL: _________________________% HI/LO

DATE	TRANSMITTER END					RECEIVER END										0.15 Ω Shunt Check	Ballast Condition	Signature Of Testing Officer
	Tx Serial No.	TU Input	TU T1/T2	PSU Serial No.	DC Volts	Rx Serial No.	TU T1/T2	Rx Input	Monitor Volts			Gain Setting	Drop Shunt Value	PSU Serial No.	DC Volts			
									Unoc-cupied	With Shunt On	Zero Feed							
		(V)	(V)		(V)		(V)	(V)	(mV)	(mV)	(mV)		(Ω)		(V)	(OK)		

DATE	TRANSMITTER END					RECEIVER END										0.15 Ω Shunt Check	Ballast Condition	Signature Of Testing Officer
	Tx Serial No.	TU Input (V)	TU T1/T2 (V)	PSU Serial No.	DC Volts (V)	Rx Serial No.	TU T1/T2 (V)	Rx Input (V)	Monitor Volts Unoc-cupied (mV)	With Shunt On (mV)	Zero Feed (mV)	Gain Setting	Drop Shunt Value (Ω)	PSU Serial No.	DC Volts (V)	(OK)		



TYPICAL CONNECTION FOR THE GAIN = 2

GAIN	INPUT WIRING			
	1 Ω H to	Input 1	Bridge	Bridge
1	1L	1H		
2	3L	1L	1H – 3H	
3	3L	3H		
4	3L	1H	1L – 3H	
5	9L	1L	1H – 3L	3H – 9H
6	9L	3L	3H – 9H	
7	9L	1H	1L – 3L	3H – 9H
8	9L	1L	1H – 9H	
9	9L	9H		
10	9L	1H	1L – 9H	
11	9L	1L	1H – 3H	3L – 9H
12	9L	3H	3L – 9H	
13	9L	1H	1L – 3H	3L – 9H

INPUT 2 is always connected to 1 Ω Low.