

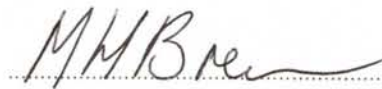
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Guidance Note

SSI Hardware Problems

Endorsement and Authorisation

Endorsed by:



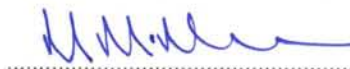
Mark Brewer, Working Group Chair

Authorised by:



Steve Hailes, Steering Group Chair

Accepted for issue by:



Mick McManus, National Standards Manager

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Issue record

Issue	Date	Comments
1	Feb 1998	Original issue
2	April 2001	Updated following issue of additional Technical Investigations etc
3	Dec 2004	Updated following issue of additional Technical Investigations etc
4	March 2011	Update and re-numbering of RT/E/C/17903 Issue 3

Reference documentation

BR 966	British Rail Specification - Relays Miniature Tractive Armatures, Plug-in Type for Railway Signalling Purposes.
BR1937A	British Rail Specification - Surge Protection Equipment for the Solid State Interlocking System Trackside Data Link.
BR1901	British Rail Specification - Solid State Interlocking Line-side Points Module.
Datalink P002	A Handbook for SSI Users - Power Disable Test Causing Aspect Blinking.
Notice Board 080	SSI Data Link Cable: Jointing Kits
RT/LS/CAT005	Typical Circuits
SAO-SSI(MPM)-RP-1, Issue 1	An Investigation into the Effect of Short Power Supply Breaks on SSI MPMS
SSI8150	SSI Software Record; part of RT/E/S17002 'SSI Applications Manual Contents'
SSI8500	Design of SSI Schemes; part of RT/E/S17002 'SSI Applications Manual Contents'

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1 Purpose

This Guidance Note summarises significant SSI hardware problems that have been identified on Network Rail infrastructure as a result of technical investigation, and the resultant changes made. It supersedes RT/E/C/17903 Issue 3. This information will be useful to those wishing to fully understand the reasoning behind a particular change to SSI equipment or its application.

2 Scope

All problems related to hardware and its generic application software currently in use in SSI installations on Network Rail, discovered during investigation by specialist equipment investigation organisations.

This document incorporates brief details of identified problems and provides the following for each situation:

- When the identified problem arose
- What the problem was/is
- What actions were taken to overcome the problem in terms of modifications/or specification changes
- Relevant references

Where further or more detailed information is required, reference should be made to TI Reports and other identified reference material.

NOTE For the purposes of this document, all failures have been reduced to their root cause and categorised as such. The root cause often has little to do with the technical investigation report title, as this is invariably based on the location and end effect of the problem in question.

Guidance on whether any solutions should be applied retrospectively is outside the scope of this document.

3 Definitions

AHC	Active Harmonic Cancellation
APC	Automatic Power Control
ATE	Automatic Test Equipment
AWS	Automatic Warning System
BRT	Racal-BRT
DLI	Data Link Interrogator
DLIT	Data Link Isolation Transformer
DLM	Data Link Module
DSO	Digital Storage Oscilloscope
EPROM	Erasable Programmable Read Only Memory
FIFO	First In First Out Register

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HVI	High Voltage Impulse
IC	Integrated Circuit
ICP	Internal Communications Processor
IDL	Internal Data Link
LDT	Long Distance Terminal
LLL	Long Line Link
MM	Memory Module
MPM	Multi Processor Module
NVRAM	Non-volatile Random Access Memory
PCC	Printed Circuit Card
PCM	Pulse Code Modulation
PDT	Power Disable Test
PM	Point Module
PMUX	Panel Multiplexer
PRBS	Pseudo Random Binary Sequence
REB	Relocatable Equipment Building
RETB	Radio Electronic Token Block
SIGTAN	Signalling Equipment Technical Advice Notice
SM	Signal Module
SPAD	Signal Passed at Danger
SSI	Solid State Interlocking
TC	Track Circuit
TERTS	Telegram Error Rate Tests Set
TFM	Trackside Functional Module
TI	Technical Investigation
T/J	Transformer Rectifier
TOWS	Train Operated Warning System
TT	Technician's Terminal
UPS	Uninterruptible Power Supply
VCB	Vacuum Circuit Breaker
WS	Westinghouse Rail Systems Limited

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4 Signal Module Mk II

4.1 Date:

- 1991

Description:

- The absence of termination resistors on the datalinks between two RETB interlockings and their respective MKII SMs caused anomalous pulses on the current loop interface of the associated RETB interlocking DLM.
- This problem had no direct effect until an outwardly compatible Mk II SM was fitted following a failure. When attempts were made to issue tokens, a relay connected to one of the module outputs pulsed at approximately 1Hz.
- The output changes were requested by the interlocking as replies from the module in question were being lost due to the anomalous pulse problem. The replacement module was fitted with version C2 software, whereas the previous module having version B4. Additional reply turnaround delays in C2 software, to allow for telegram delay for LLL, meant that the module reply was sent slightly later. This caused a gap between the anomalous pulse and the reply precursor with which the reply reception software in the RETB could not cope.
- With B4 software the anomalous pulse still existed but merged with the precursor, which did not adversely affect telegram reception.

Mods/Specification Changes:

- Datalink termination resistors were added for test purposes and were proved to be effective.
- Arrangements were made to have resistors fitted permanently, have the site records changed and check other RETB sites in the region.

References:

- TI Report 91001.

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4.9 Date:

- 1995

Description:

- Intermittent current proving, on signals that were shown to have remained lit, occurred as a result of the combined effects of distortion on the power supply and reduced lamp voltages.
- The problem only affected WS Mk II SMSs, due to slight differences in the current proving threshold values in the ALSTOM and WS modules.
- Power supply distortion was found to cycle through a fairly large range due to the fact that most of the non-linear load appeared to be station lighting.

Mods/Specification Changes: A number of solutions were outlined, all of which would make the site non-standard:

- Exclusive use of ALSTOM modules.
- Lamp voltage derogation from specification to increase the load to be current proved.
- Secondary resistors in the lamp circuit.

A further solution was to reduce or eliminate the power supply distortion by employing one of a number of proposed solutions:

- Reduce common impedance in the affected circuits e.g. fit a new transformer for the signalling supply.
- Filter out or recreate a sine wave using specialist equipment such as a UPS or AHC.

References:

- TI Report 95057.

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- 4.10** Date: 1995
- Description:
- Datalink problems were identified as being caused by surge arrestor units damaged by traction interference.
 - Intermittent current proving bit loss problems on a junction signal were attributed to the combined effects of a power disable test and electrical noise affecting the clock of the triac firing latch circuit of a ALSTOM Mk II SM causing switching to occur at a point other than '0°'.
- Mods/Specification Changes:
- It was recommended that a suitable ALSTOM Mk III SM should be fitted, when available. Until that was the case, a WS Mk II SM would be a good substitute as its circuitry is provided with a tie high resistor on the clock input that was affected by noise in the ALSTOM hardware.
 - An alternative was to fit tie high resistors to ALSTOM Mk II modules.
- References:
- TI Reports 95066 & 95069.
- 4.11** Date: 1996
- Description:
- Four Mk II SMS, manufactured by ALSTOM, were examined following a reported failure as a result of high ambient temperature. One module was found to work satisfactorily, but the various reliability failures observed on site were all confirmed under laboratory conditions.
- Mods/Specification Changes:
- High temperature testing was recommended for units prior to despatch following manufacture or repair and return.
- References:
- TI Report 96002.
- 4.12** Date: 1996
- Description:
- A WS Mk II SM repeatedly disabled its output interface, due to the fitting of additional components intended only to be fitted to Mk II PMs. The output interface disabling only occurred when the module was wired in specific configurations, i.e. with specific outputs unloaded.
 - Additionally, internal damage was identified consistent with poor handling during transit.

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Mods/Specification Changes: It was recommended that:

- WS Mk II SMs exhibiting repeatable output interface disabling problems, with a serial number between E91100001 and E91249230 should be returned to WS together with full details of the problem.
- WS modify their PCC ATE program to carry out checks for additional components and that they introduce a test where the module is tested with the outputs unloaded in both the production and repair areas.
- WS inspect modules received for repair within the serial number range for the presence of additional components.
- Test procedures employed by the Technical Investigation Group are modified with the addition of an open circuit output test.

References:

- TI Report 96011.

4.13 Date:

Description:

- 1996
- Loss of external contact detection was observed on a Mk II SM following de-energisation of an AWS electro-inductor. Site investigation indicated that this was as a result of electrical noise coupling into the contact detection circuitry and invalidating the PRBS signal - though the failure could not be reproduced.
- The problem was thought to have been exacerbated by poor contact alignment in the controlling relay.

Mods/Specification Changes:

- It was known that other sites were similarly configured and that no problems were reported from these sites - it was recommended that should further problems occur a design change be considered at other sites.
- In view of design changes at the site in question, it was recommended that the relay controlling the electro-inductor be abolished.

References:

- TI Report 96178.

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4.14 Date:

Description:

- 1997
- An ALSTOM Mk II SM and specification BR941A relay were tested following an alleged wrong side lamp proving failure of a fibre optic route indicator using 55W halogen lamps.
- No problems were found with the Signal Module.
- The relay, used as a UECR, was found to have a diode failed open circuit in the bridge rectifier, resulting in a volt drop across R1 – R2 far higher than the specified maximum.
- The component failure was found to be due to the use of the BR941A relay in an unsuitable application where the current through the relay was too high.

Mods/Specification It was recommended that:

Changes:

- Similar applications of BR941A relays for proving fibre optic route indicators should be modified retrospectively. Suggested solutions were:
- connection of a 47Ω 50W resistor in parallel with each relay's R1–R2 terminals, in accordance with BRB Standard Free Wired Interlocking Typical Circuits BRS-SW67-28A (this resistor is now also shown in Typical Circuit T28410);
- alternatively, replace the BR941A relay with a relay designed to provide current proving for fibre optic route indicators, such as WS QECX11. It is not known whether this relay has been type approved. This should be undertaken before use.

References:

- TI Report 97140
- BRS-SW67
- Typical Circuits RT/LS/CAT005

4.15 Date:

Description:

- 1997 - 2004
- Four WS Mk II SMs manufactured between 1989 week 26 and 1990 week 34 were found to contain earth faults on washers insulating a 5V regulator from the module chassis.
- Another WS Mk II SM was found to contain a number of loose small metallic objects.

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Mods/Specification It was recommended that:

Changes:

- WS investigate the effectiveness of insulation between the 5V regulators and the chassis.
- Location tests following shutdown or output interface disabling of SMs should include earth testing of the a.c. busbars.
- Risk assessment be undertaken. This determined that the level of risk from these earth faults was acceptable, without considering routine busbar earth testing.

References:

- TI Reports 97177, 04045 & 04217

4.16 Date:

- 1997

Description:

- An ALSTOM Mk II SM was returned for investigation following a report that a signal was out when it should have been showing red.
- Site investigation determined the signal to be dimly lit. This was attributed to a defective signal lamp transformer, which led to the SM going into its red-retained state during site investigation.
- Further examination found a defective resistor within the module, which would have extinguished the red lamp and prevented current proving. This may have been a progressive failure. Also found were a 28mm length of wire within the module case and handling damage to the PCB.

Mods/Specification It was recommended that:

Changes:

- Manufacturers and service agents must ensure that quality assurance procedures protect modules from damage during assembly and disassembly.
- They must also ensure that loose objects are not left inside the equipment.

References:

- TI Report 97183

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4.17 Date:

Description:

- 1998
- The exit signal to North Pole Depot was reported to be causing reliability problems, possibly as a result of Eurostar trains switching from 25kV overhead traction to 750V third rail whilst on the move.
- An unattended monitoring exercise was undertaken to continuously monitor various parameters of the SM and datalink.
- As part of the test the resident ALSTOM Mk II SM was replaced by a ALSTOM Mk III SM for several days, eliminating module related failures.

Mods/Specification It was recommended that:

Changes:

- The Mk II signal module is replaced by a 'good' example of the same type, or a WS Mk II module, or a Mk III module, and maintenance staff informed of the importance of this change.
- A datalink survey be undertaken to find underlying problems with this datalink.

References:

- TI Report 98008

4.18 Date:

Description:

- 1999
- A Mk II WS SM was sent for investigation following erroneous reports on the Technician's Terminal on consecutive days of a signal lamp out.
- The fault was found to be a known failure of d.c. blocking capacitors in a current proving circuit.

Mods/Specification It was recommended that:

Changes:

- Testing should be carried out on a sample basis to gauge the scale of the current proving problem.

References:

- TI Report 99002
- 4.20 below

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- 4.19** Date: 1999
- Description:
- During correlation & location checks a ALSTOM Mk II SM was found to have an earth fault.
 - Investigations determined the earth fault to be as a result of the PSU filter case penetrating solder resist and short circuiting to a PCB track passing beneath the filter.
 - This was the result of the omission of an insulator pad at manufacture of the module.

Mods/Specification It was recommended that:

Changes:

- ALSTOM check for the presence of the PSU filter unit insulator when modules are returned for repair.
- Location tests following shutdown or output interface disabling should include an earth test of the a.c. busbars prior to the changing of any module, even though not required by GK/RT0171.

References:

- TI Report 99028

- 4.20** Date: 2000
- Description:
- Investigation of two WS Mk II SMs following reports of unusual behaviour led to the discovery that both had faults in the current proving circuit.
 - The modules had high current proving threshold that could lead to intermittent right-side failures, especially where SL35 lamps are running on a reduced supply voltage.
 - The fault was found to be a known failure of d.c. blocking capacitors in a current proving circuit.

Mods/Specification It was recommended that:

Changes:

- Testing should be carried out on a sample basis to gauge the scale of the current proving problem.

References:

- TI Reports 00251 & 00265
- 4.18 above

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- 4.21** Date: 2002
- Description:
- Following a lightning strike it was noted that a signal module was not operating correctly.
 - It was noted that output 3 should have been connected to a red retaining feed, however the wiring diagram showed it connected to the protected source supply instead. Pin analysis showed that the wiring followed the diagram.
 - Such wiring faults can lead to a reduction in reliability, rupturing of the main BX110 fuse or internal damage to the TFM.
- Mods/Specification It was recommended that:
- Changes:
- Drawings and wiring for the location concerned must be corrected, and checks must be made on the rest of the scheme.
 - It may be helpful to designers if SSI8500 included more typical circuit configuration examples, particularly an example where output 3 was configured for retained aspect operation.
- References:
- TI Report 02148
- Date: 2004-6
- Description:
- Due to faulty 6821 PIAs, two Mk II SMs could not accept particular address lines being set to '1'.
- Mods/Specification Changes:
- Failure of the 6821 PIA is not considered common, but note that the SM could not receive data and would OID when installed at affected addresses.
- References:
- TI Reports 04234 & 06122
- 4.22** Date: 2008
- Description:
- Investigation of an ALSTOM Mk II SM manufactured in 1988 found evidence of age related degradation to an opto-coupler in an input circuit. This type of opto-coupler is also used in Point Modules.
 - It was noted that BR1900 requires SSI equipment to have a useful life of not less than 20 years, and this module had probably spent roughly this length of time in service. Manufacturers data for the opto-coupler noted degraded performance over time.

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- Mods/Specification Changes:
- Investigation test procedures required modification to include assessment of actual input resistance thresholds to gain further data.
 - Consideration should be given to establishing the level of testing by servicing agents for input degradation.
 - Consideration should be given to requiring servicing agents to replace opto-couplers in TFMs that have been in service for more than 20 years.
- References:
- 09024
- Date:
- 2009
- Description:
- Several WSL Mk II Mod State 16 WSL Mod State X SMs with firmware D1 were tested, some evidently had the had the resistor mod and low current proving thresholds, whereas others had high current proving thresholds typical of SMs with the original resistor values.
- Mods/Specification Changes:
- WSL note that the current sense resistors were changed at WSL Mod State W from 4k7 to 5k1, and firmware D1 was also installed, inconsistencies would be investigated.
- References:
- TI Report 09060

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5.3 Date:

Description:

- 1998
- It was first observed at MVAIR that ALSTOM Mk III SMs would intermittently report loss of current proving. The problem was associated with interference from Track Circuit Actuators (TCAs) fitted to passing trains, in the presence of Insulated Block Joints (IBJs). It was found that interference on current paths could cause both right- and wrong-side failures.
- Failures caused by interference on current paths and power supply were reproduced under laboratory conditions for both the ALSTOM Mk III and WSL Mk IIIA SMs, but could not be reproduced for Mk II SMs.
- ALSTOM devised a modification in the form of an externally mounted 1 μ F de-coupling capacitor fitted between affected current return paths and earth.
- Analysis indicated that open circuit failure of the external capacitor would not be revealed except by further right-or wrong-side failures caused by interference, and short circuit failure in the presence of another earth fault could cause wrong-side failure of current proving indications.

Mods/Specification It was recommended that:
Changes:

- Retrofitting Mk III modules to replace Mk II modules in existing schemes be re-considered (since these will not have the external capacitor).
- An a.c. busbar earth testing programme, or capacitor monitoring programme, be implemented at sites fitted with external capacitors.
- Mk III modules be modified for compatibility with established systems such as TCA, without the addition of external components. This has been implemented in the ALSTOM Mk IV SM.

References:

- TI Report 98154
- 5.4 below
- 5.6 below
- 5.10 below

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5.4 Date:

Description:

- 1998
- Investigations were carried out into unreliability of lamp proving at Princes Risborough on the Chiltern Lines where the current proving bit on a ALSTOM Mk III SM was being lost, producing a right-side failure, when the location ATP equipment was powered on.
- The problem was traced to 55 kHz interference introduced on to the 110 V a.c. power supply by ATP power supply cards.
- Only ALSTOM Mk III SMs were affected by this problem, not WS Mk IIIA or ALSTOM Mk II modules, and only pre-'1998 modification' ATP power supply cards caused the problem.

Mods/Specification It was recommended that:

Changes:

- Replacement of Mk II SMs with ALSTOM Mk III SMs be precluded on schemes with ATP.
- All ATP power supply cards producing interference be removed from Network Rail infrastructure.
- The EMC performance of the ALSTOM Mk III SM be verified.

References:

- TI Report 98155
- 5.3 above
- 5.6 below
- 5.10 below

5.5 Date:

Description:

- 1998
- Investigations were carried out into the reliability of ALSTOM Mk III SMs on the Woking - Surbiton scheme following repeated failures of modules driving extra strength AWS magnets.
- SMs repeatedly shut down outputs, some rupturing power fuses or security fuses.
- The failures were caused by the inability of the output triac to reliably switch off the extra strength AWS electro-inductor load. The failures occurred on ALSTOM Mk II and some Mk III SMs, but not on WS SMs.
- The power fuse rupture problem was exacerbated by the poor inrush performance of the Howells 3A T/J, which was non-compliant with BR865.