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SPECIAL MAINTENANCE INSTRUCTION No. RDSO/2010/EL/SMI/ 263 (Rev.'0'), Dated. 27.07.10

1.0 Objective:

Instructions for development of testing set up of Gate Unit of Traction Converter for three phase electric locomotives.

2.0 Introduction:

- 2.1 The Gate Units (GUs), type GVA 587 A01 are designed for triggering Gate Turn Off (GTO) thyristors fitted in traction converters of three phase electric locomotives. The GU supplies the turn on pulse and controlled continuous gate current to keep the thyristors in conductive state; and the turn off pulse and negative continuous gate voltage for keeping the GTO in permanently blocked condition. The GU supply is electrically isolated by a transformer while the signaling circuits are isolated using optical fibre cables. The GU essentially consists of a clocked current source and a switching transistor that switches the gate of GTO during ON period. During turn OFF period, the circuit generates the powerful, fast rise current pulse required for a reliable GTO turn off, using the capacitor turn-off principle. Electrolytic capacitors charged to -15 volt (w.r.t cathode voltage) are abruptly switched to the gate of GTO. To ensure the blocking ability of the GTO, the field effect transistors remain turned on till the next turn ON command. Typical photograph of Gate unit used in traction converter is shown in fig. 1 below.



Fig.1

- 2.2 There have been several failure cases of Gate units. Failure investigation suggests that the failures are mainly in electrolytic capacitors after a period of 5-6 years and in fibre optic transmitter (QFBR1478C, component A151). The failure of gate unit

sometimes results in failure of GTO and isolation of traction converter. In view of this the testing of gate units is very important for improving the reliability of three phase electric locomotives. This SMI intends to issue instructions through which electric loco sheds shall be able to develop testing jig for testing of GUs and shall be able to test GUs.

3.0 Testing Set up: The following test equipments shall be required for testing:

1. Gate Unit Transmitter Receiver Test Set (GUSET);
2. four channel oscilloscope;
3. current probe (100 A-DC);
4. Optic fibre cable of approximately 20 cm length with connector at both the ends (2 Nos.);
5. Gate Unit Power Supply(GUSP);
6. 110 VDC supply source; and
7. dB meter.

3.1 The details of GUSET is given in Annexure-I. This can either be made locally in electric loco sheds or can be got manufactured from suitable source.

3.2 All the other items except GUSP are either bought out item or available in shed. The GUSP is same used in three phase locomotive for providing supply to GUs and can be used from standard spares.

4.0 Testing procedure:

- Connect all the above equipments as per following connections diagram (fig.2).

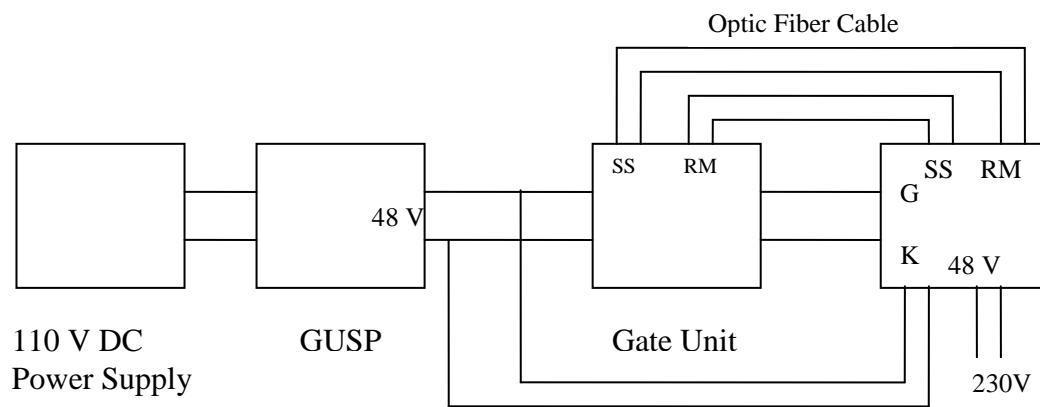


Fig.2

- Turn ON the unit. Control pulse of approximately 350-Hz to be provided from GUSET to gate unit.
- Connect the oscilloscope to RM, SS, GK terminals and through current probe for GK current.
- Observe the following parameters for healthy GU:
 - a. SS and RM pulse should be opposite to each other i.e. when SS is ON, RM should be OFF.
 - b. GK voltage magnitude shall be within the limits of -14 to -16.5 volts.
 - c. Minimum ON time shall be 85 micro seconds $\pm 5\%$.
 - d. Minimum OFF time shall be 110 micro seconds $\pm 5\%$.
 - e. Optical power at the input of the receiver shall be > -18 dBm.

- f. Optical transmitter output at the end of the standard optic fibre cable shall be >-16 dBm.
 - g. There should not be any distortion in any of the waveform.
 - h. Observe if RM, GK current or GK voltage waveform is missing intermittently or permanently. If any waveform other than SS, which is output of the Guset, is missing, the gate unit is defective.
- Typical waveforms of RM, SS, GK voltage and Gate current are given in Part-5 of Volume F-4 (Suppliers Documentation-Traction converter-Procedure for short tests on Gate Unit).
 - The voltage waveform across G-K terminals with GTO/Diode connected across G-K terminal is given in following figures. The waveform across G-K terminal (pink colour) should terminate up to zero from $-16V$.

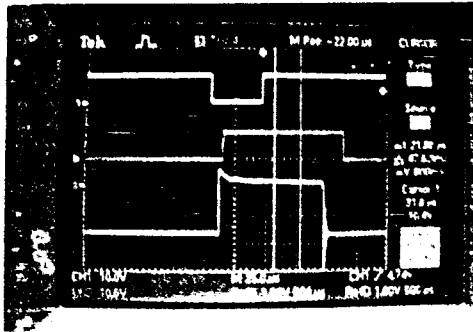


Fig. A: Waveform of Healthy Gate Unit

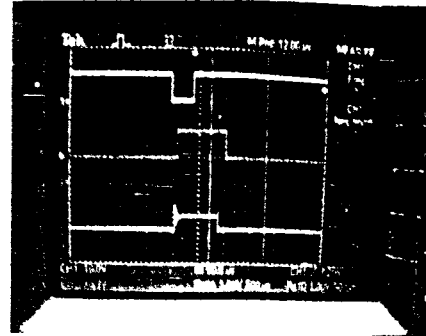


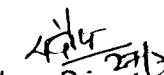
Fig. B: Waveform of Defective Gate Unit

5.0 Application to:

WAP5, WAP7, WAG9 and WAG9H locomotives.

6.0 Agency of implementation:

All sheds, workshops holding & maintaining WAP5, WAP7, WAG9 and WAG9H locomotives.

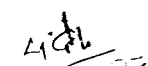

 (Sandeep Srivastava)
 for Director General (Elect)

End: Nil

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| <ol style="list-style-type: none"> 1. Secretary (Elec. Engg./RS), Railway Board, Rail Bhawan, New Delhi-110 001. 2. Chief Electrical Engineer (D&D), Chittaranjan Locomotive Works, Chittaranjan(W.B) 3. Sr. DEE (TRS), Electric Loco Shed, East Central Railway, Gomoh-828 401 4. Sr. DEE (RS), Electric Loco Shed, Northern Railway, Ghaziabad-201 001 5. Sr. DEE (TRS), Electric Loco Shed, Central Railway, Ajni, Nagpur-440 008 6. Sr. DEE (TRS), Electric Loco Shed, South Central Rly., Lallaguda, Secunderabad 500071 7. Sr. DEE (TRS), Electric Loco Shed, West Central Railway, Tuglakabad, New Delhi-110044 8. Sr. DEE (TRS), Electric Loco Shed, South East Central Rly., Bhilai, Durg-490 025 | <p>: For kind inf. Please</p>
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 for Director General (Elect)

Gate Unit Transmitter Receiver Test Set (GUSET):

- 1.0 The testing set mainly transmits and receives signals necessary for turn on and turn off GTOs and is commonly known as Gate Unit Transmitter and Receiver Test Set (**GUSET**). GUSET consists of a function generator to provide optical firing pulse via optical fibre cable and the feedback is monitored via optical receiver. GUSET also consists of a diode so that it is possible to measure pertinent switch on and continuous current as well as gate-cathode voltage so that it can be compared with the standard output parameters to check healthiness of the gate unit. The technical requirement of GUSET is given in following paragraphs:
- 1.1 GUSET shall operate on standard 230 V single phase AC supply suitably stepped down to required supply voltage for operation of function generator. However, necessary provision shall also be made on GUSET to operate it on input from standard GUSP with 48 V, 16 KHz square wave power output. GUSET shall be provided with a rechargeable internal battery of suitable capacity, which allows the feedback section to be operative even when a voltage supply for GUSET is not available. Necessary provision for charging of battery shall be made on the GUSET with a changeover switch to operate GUSET on battery as well as on 230 V AC supply. Mode of operation shall be indicated by LED indication. Necessary supply to the GU shall be fed only through standard GUSP used in three phase electric locomotives.
- 1.2 Suitable function generator to operate at the frequency of 350 Hz with facility to select desired duty cycle down to minimal time interval with the help of soft touch push switches shall be provided on the GUSET. It shall be possible to generate minimum ON and OFF pulses of 25 microseconds. Variation in duty cycle shall not affect the frequency of the pulse. It shall be possible to invert the pulse and to generate continuous ON signal pulse through soft touch push switches mounted on the unit.

GUSET shall be able to generate following control signals (SS) to be transmitted to GU. The amplitude of the control signal must lie within the range of 9 to 15 V.

Light :	Switch ON GU	$SS \leq 0.5 \text{ V}$
No Light	Switch OFF GU	$SS \approx 9 \text{ V}$

- 1.3 Provision shall be made on the GUSET to monitor this signal through LED indication. The control signal shall be transmitted to GU via Avago make optical transmitter QFBR1478 or HFBR1412 mounted on the GUSET suitable for connection with optic fiber cable with ST Bayonet connector. Separate test points to monitor electrical equivalent of this signal on Oscilloscope shall be provided on GUSET.
- 1.4 Feedback signal (RM) from GU shall be received by GUSET via Avago optical receiver type QFBR2478 or HFBR2412 suitable for connecting ST bayonet optical cable connector. Electrical equivalent of this signal RM shall be made available on the GUSET to monitor on oscilloscope. For the feedback signal RM, the following magnitude holds.

RM active	$RM \leq 0.5 \text{ V}$
RM passive	$RM \approx 4 \text{ V}$

Optical interrogation shall be possible through LED indication mounted on the GUSET.

- 1.5 It shall be possible to load the gate unit using a diode type MUR 3020PT (30 A, 200V) which shall be mounted with suitable heat sink inside the GUSET. Necessary arrangement of sockets shall be made on the test unit to connect this diode to gate unit. Terminal "G" must be connected to gate and terminal "K" must be connected to cathode of the gate unit. It shall be possible to measure signal characteristics of the switch ON pulse and continuous current with a current probe in the gate connection. Accordingly the gate cathode voltage shall also be measured on the oscilloscope.

The basic block diagram of GUSET is as shown in figure-3:

