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No. EL/11.5.5/1

Dated: 07/02/2017

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- South East Central Railway, Bilaspur-495 004
- South Central Railway, HQs Office, Rail Nilayam, Secunderabad-500 071
- South Eastern Railway, Garden Reach, Kolkata- 700 043
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### Modification Sheet No. RDSO/2017/EL/MS/0458 (Rev.0)

#### 1.0 Title

Adoption of IGBT type speed sensors in locomotives with GTO based traction converter.

#### 2.0 Object

It has been the experience of Indian Railways that the performance of speeds sensors in the locomotives with IGBT based traction converters is satisfactory. While on the other hand, in spite of the fact that a number of reliability improvement measures have been taken, the speed sensors being used in the locomotives with GTO based converters is not up to the mark. The objective of this Modification Sheet is to evolve methods so as to use speed sensors used in the IGBT based traction in locomotives with GTO traction converter as well. For this purpose, the AS-PERI card (type XV A987 C22) used in the ALG rack needs modification, in order to adopt IGBT type sensors.

#### 3.0 Existing Arrangement

##### Locomotives with GTO based traction converter

The originally used Wiegand sensors in GTO locomotives were passive type, which did not require any power supply. Wiegand sensors were connected to sub-D connectors in

AS-PERI card (XV A987 C22). There are 4 channels (connectors X5, X11, X17, and X25) in an AS-PERI card. In WAG9, three channels are used and one is spare (only one channel each of the speed sensor is connected). In WAP5, all the 4 connectors are used, as both the channels of the speed sensor are connected. As the wiegand sensors do not need power supply the connectors do not have any provision for tapping the DC power supply from the electronic rack.

Subsequently, Hall Effect sensors were developed. These are the modern type of sensors and need external power supply and for the same reason these are also known as active sensors. As there was no provision in the AS-PERI card to derive control power supply, the sensors were provided with internal power supply fed from 110V DC battery. These types of sensors are provided in locomotives with GTO based traction converters utilizing MICAS S2 electronics. Each of these speed sensors has two output channels and both are identical. The signal output contains the direction information also which means in one direction of rotation of the motor the pulses have positive polarity and for opposite rotation the pulses have negative polarity. These are illustrated below:

Reverse Direction

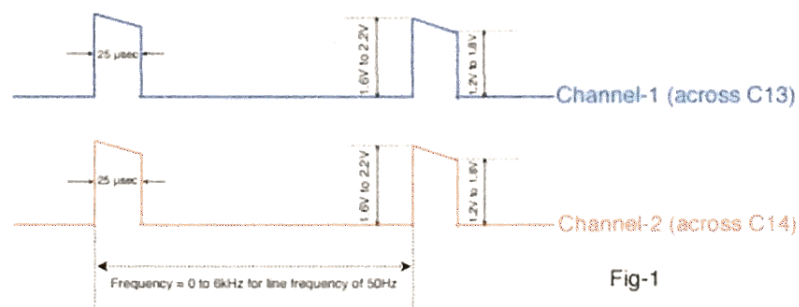


Fig-1

Forward Direction

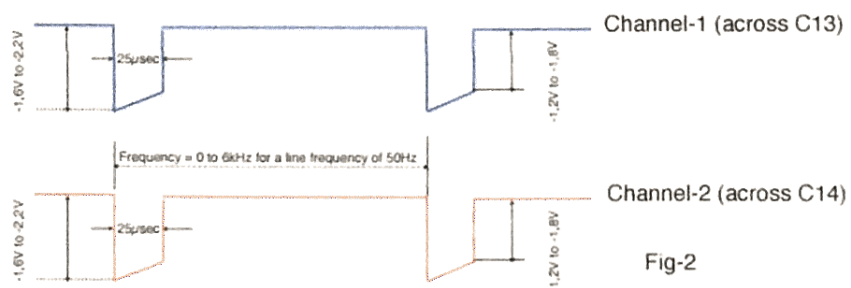


Fig-2

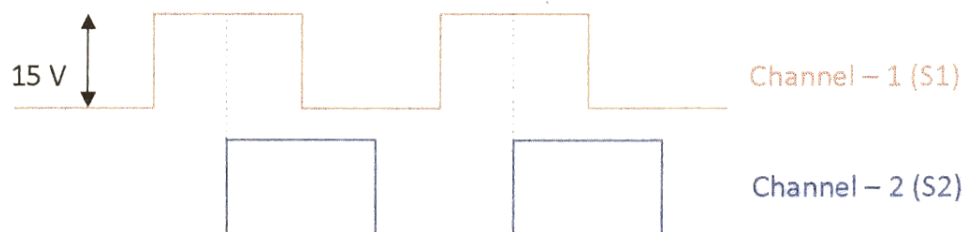
Fig. – 1 Pulse pattern of speed sensors in GTO based traction converter

*Wag9*

This encoding of direction is further decoded in the existing AS-PERI card and given to ALG electronics as speed pulse and direction signal, both TTL level. All the GTO locomotives, having a population base of around 700 are presently provided with this type of sensor, replacing the Weigand type.

### **Locomotives with IGBT based traction converter**

IGBT based traction converters have been developed, with multi-sourcing. The presently manufactured locomotives use IGBT converters. IGBT converters use the standard format active speed sensor, in which, it receives control power supply from the rack, and the speed signal is in the form of two, 90° phase shifted square pulses, mostly open collector type. The phase lag (90°) between these pulses will determine the direction of rotation of the motor, which is resolved by the converter electronics, unlike in the case of existing active sensors for the GTO converter. This means, in one direction, if pulse A lags pulse B by 90°, in the opposite direction, pulse B will lag pulse A by 90°. Also, it provides only one signal channel, as both the pulses together becomes one channel. These are illustrated below:



**Fig. – 2 Pulse pattern of speed sensors in IGBT based traction converter**

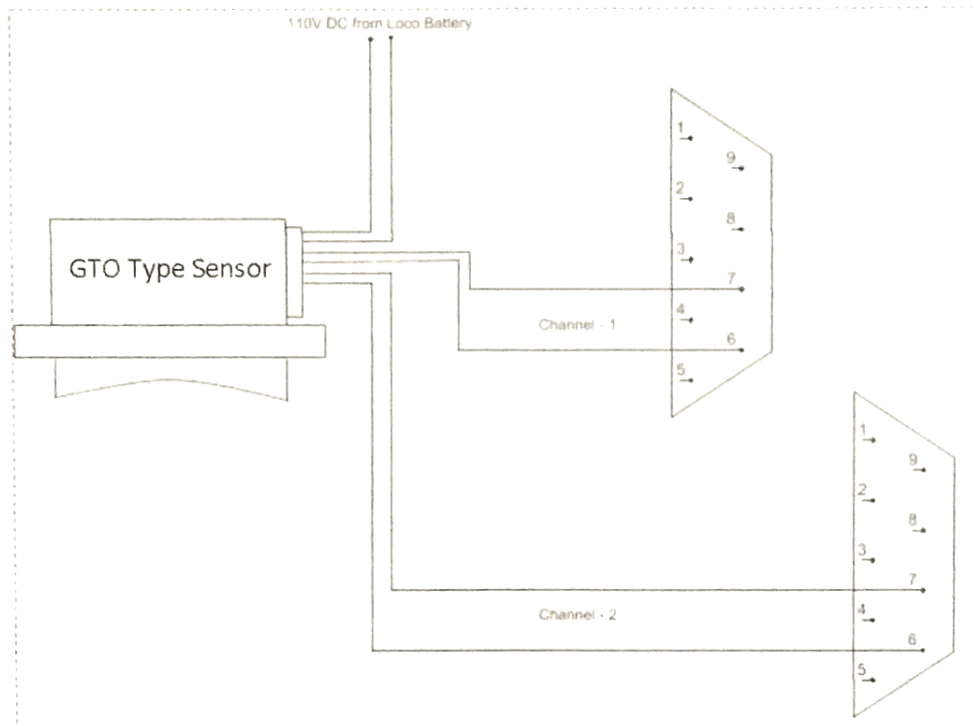
#### **4.0 Modified Arrangement for using IGBT type speed sensors in Locomotives with GTO based traction converters**

The details of the proposed modifications are explained in the subsequent sections:

##### **a. Arrangement in GTO type Sensor**

The connection arrangement for the existing GTO type sensors is given in Fig-1. There are three cables entering in the sensor, one for 110V DC power supply and other two are signal channels. Each signal channel is terminated on a 9-pin sub-D connector (Gimota). In WAG9 locomotive, only one channel needs to be connected to the AS-PERI card. In WAP5 locomotive, both the channels are connected. The AS-PERI card supports connection of four sensor signals through front connectors designated as X25, X17, X11 and X5. With the modified AS-PERI card in the ALG rack, no modification is needed in the sensor side wiring. However, within the modified AS-PERI card, the selector switch of IGBT/GTO has to be switched to 'GTO' type.

*W. Reddy*



**Fig. – 3 Existing arrangement of speed sensor interface with ALG rake**

**b. Arrangement in IGBT type Sensor used in GTO based traction converter with MICAS-S2 locomotives**

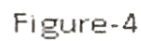
Modifications in the locomotive wiring shall be required if IGBT type sensors are to be used in the GTO based traction converter. For this purpose modification in the following shall be required.

- In the existing IGBT type sensor, two cables are used, one carries the sensor output pulses S1 and S2, which are open collector quadrature phase shifted pulses and terminated on a 5 pin circular connector (ITT Cannon).
- The power supply to the sensor is given at 15V DC and terminated on a three pin circular connector (ITT Cannon).
- In IGBT based converters, the 15V DC power supply need for the speed sensor directly comes from the converter electronic rack. However, for the modified arrangement in GTO based converter, the AS-PERI card to be modified such that the DC power supply need for the speed sensor will come from the modified AS-PERI card.
- For this purpose, in the modified AS-PERI card, 15V DC power supply shall be made available across pin No. 1 & pin No. 5 of the front connectors X25, X17, X11 & X5 using an isolated DC-DC converter of 5 VDC/15 V DC within the board, one for each channel. The 5V DC shall be derived from the backplane of ALG rack. The isolated DC/DC converter ensures that any problem on the sensor side or wiring does not affect the modified AS-PERI card.
- As two cable looms are to be derived from the same 9-pin connector, a special double entry gland type 9-pin sub-D shall be used. This is a special connector

*Wing*



The schematic is given below in Fig. 4 below.



The complete modified arrangement has been shown in Fig. 5 below



~~Wrey~~

## 5.0 Special Note

The modified AS-PERI card shall be such that it can be used with both GTO type and IGBT type speed sensor. There shall be a switch available for each channel which will facilitate switch over the operation from GTO type to IGBT type and vice versa. This way the modified AS-PERI can work on both GTO type as well as IGBT type speed sensor simultaneously. This facility will enable only to replace the defective GTO type speed sensor in the loco with IGBT type speed sensor and the locomotive will be able to operate with a mix of GTO and IGBT type of speed sensor.

## 6.0 Modification Instructions

- A. Removal of the existing AS-PERI card,
- B. Installation of modified As PERI card,
- C. Removal of the existing GTO type speed sensors,
- D. Installation of the IGBT type speed sensors,
- E. Laying of  $2 \times 1 \text{ mm}^2$ , for each speed sensor, from TB3 in SB panel to the ALG rake. This is used to supply 15 V from the AS-PERI card to the speed sensor,
- F. In this modified arrangement, out of the two twisted pairs ( $2 \times 1 \text{ mm}^2$ ) coming from the sensor plate to the AS-PERI card, one pair will become dummy. The speed sensor signals will be carried by only one twisted pair.

## 7.0 Material required per loco

- A. Modified AS-PERI cards – two numbers, one for each ALG rake,
- B. Set of  $2 \times 1 \text{ mm}^2$  control cables – from SB1 to ALG1 rake for 3 speed sensors in bogie – 1 and from SB2 to ALG2 rake for 3 speed sensors in bogie – 2.

## 8.0 Application to class of locomotives:

WAG-9H, WAG-9, WAP-7 and WAP-5 class of locomotives with GTO based traction converter.

## 9.0 Agency of Implementation:

- I. All Electric Loco sheds holding 3-Phase electric locomotive.
- II. POH workshop to ensure modified arrangement during POH of locomotive

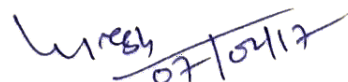


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Encl: Nil