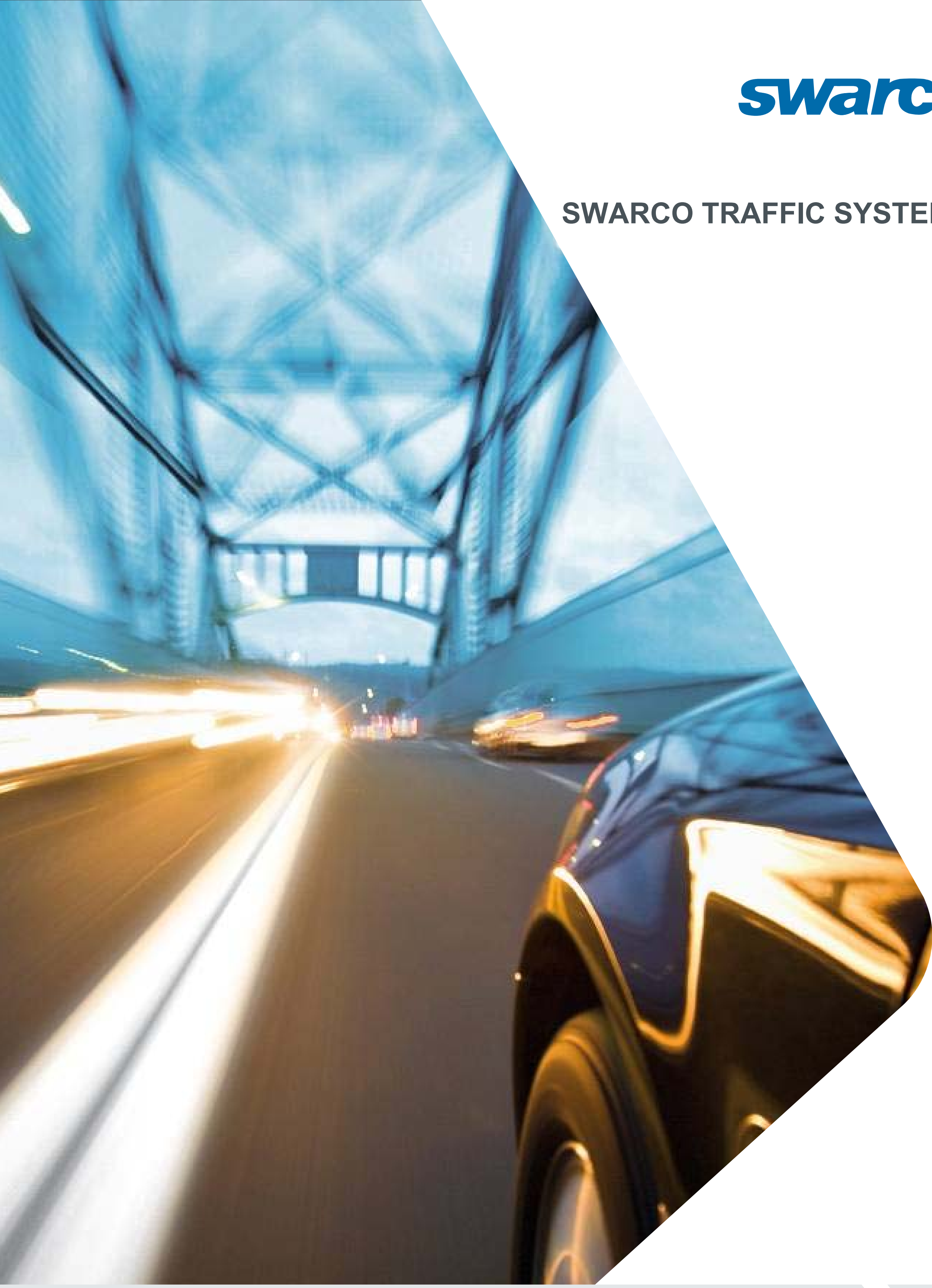
SWARCO TRAFFIC SYSTEMS GMBH



IG946

User Manual

SWARCO I First in Traffic Solutions.

IG946_BE_10

Content

1 Introduction

In this chapter you will find preliminary remarks about the usage of the IG946, as well as explanations about the structure of this manual and the usage of symbols.

1.1 About this manual

On the following pages you will learn how to install and operate the device in an appropriate way.

We attach great importance to the safe, appropriate and effective handling of this device. It is therefore important to read this manual thoroughly before using the device. In the manual you will find important instructions helping you to avoid danger and to prolong the reliability and durability of the device and the accessories.

For your own safety you should read the safety instructions. Follow the instructions closely in order to avoid danger for yourself and others or damage to the device.

If you have any questions about the IG946, which are not answered in this manual, or if you have problems understanding the descriptions, please contact:

SWARCO TRAFFIC SYSTEMS GmbH
Business Unit Detection
Niederkircher Straße 16
54294 Trier
Germany

www.swarco.com/sts-en

1.2 Usage according to regulations

The IG946 is solely designed for the detection of vehicles in road traffic. Any further usage is not appropriate. Do not use the IG946 for any other purpose.

NOTE

The IG946 is especially designed for the usage at traffic light installations and is less suited for precise vehicle classification or speed measurement. For these applications we recommend using detectors from the product range traffic counting or enforcement, e.g. MC3224 (see **www.swarco.com/sts-en/detection**).

For further requirements for the usage according to regulations, see chapter 8.5.

1.3 Label

The IG946 is provided with a type label and a serial number. You will need the indications when talking with the customer service, e. g. ordering accessories or spare parts.

Note here the informations from the labels in order to have them available when needed:

Serial number: ____

Device name: ____

This manual is valid for all devices type IG946. Documentations of optional functionalities are specified in chapter 1.4, if applicable.

CE-Label: 

1.4 Further documentation

- **“Loop installation“, SWARCO TRAFFIC SYSTEMS GmbH**
- **“IG746-IG946-CAN-interface”, SWARCO TRAFFIC SYSTEMS GmbH**

1.5 Symbols

In several places throughout this manual you will find the following symbols stating important safety instructions:

ATTENTION!
This symbol indicates dangers which might cause damage to people or property.

NOTE
This symbol indicates information for installation and function of the device.

1.6 Safety instructions

Read the following safety instructions thoroughly and observe them carefully. They are stated to ensure your own safety and the safety of others and to avoid damage to the device or accessories.

CAUTION!

- Danger of electricity!
  Make sure that no liquid may get inside the device. If this happens, interrupt the power supply to the device at once.
- If you notice any damage, e.g. broken or crushed cables, damaged plugs, enclosures etc., turn off the device at once, interrupt the power supply and make sure that the device cannot accidentally be turned on again.
- The device may only be installed, brought into service and repaired by an electro-technical expert. Inappropriate operation, improper maintenance or not observing the instructions in this manual can lead to danger.
- Any malfunction of the device which may limit the safety of its users or others must be removed immediately. All warning and safety labels on the device must be observed and kept complete and legible.
- The appropriate usage must be observed by all means. For damage resulting from inappropriate usage the manufacturer will not undertake any liability.
- The device must not be used as a safety component in the sense of the European Directive 98/37/EC ("Machinery Directive”). In systems with high risk additional safety measures are necessary.
- The operator of the device must ensure that the chosen means of operation will not cause damage to material or danger to people and that all security and safety installations are present and functioning.
- Before installation and first operation please observe the instructions in the manual.
- The manual must be available at the site of usage at any time. It must be read thoroughly and applied appropriately by the person responsible for the operation, maintenance and service of the device.

NOTE

- Our products are in a constant process of improvement and advancement. Because of this, read the current manual thoroughly before installation and first operation.
- Without prior consent of the manufacturer, no modifications, neither mechanical nor electrical, may be done. Only parts that have the consent of the manufacturer may be used for backfitting or as accessories. Any violations will lead to the termination of conformity and the manufacturer’s warranty. The user will subsequently bear the risk.

2 Product description

2.1 General description

Figure 1: front view of the IG946

The IG946 is an inductive loop detector for the connection of up to 4 induction loops and now offers the functions and outstanding features of the SWARCO TRAFFIC SYSTEMS induction loop detectors in 19“ plug in technology also in a DIN-rail mount version. Additionally it includes a complete overvoltage protection module for the induction loops. This integration minimizes the wiring effort and significantly reduces the required space.

It is functionally compatible with the IG746CAN for rack mounting and was specially developed for traffic control applications and controllers with CAN bus communication.

The detector processes the loops one after the other in a predetermined sequence (multiplex mode); i.e. there is always only one loop switched as inductance L to the LC oscillating circuit of the detector. Since there is always only current flow through one loop, the channels of a detector cannot interfere with each other. The channel reaction times and the cycle time of the detector indicated in the technical data result from the multiplex mode.

If a metallic object is located within the range of action of the connected induction loop, the frequency of the LC oscillator also changes owing to reduction in the loop inductance. This change is determined by the detector evaluation circuit and, if the turn-on threshold is exceeded, a busy signal occurs on the switching outputs of the channel (open collector). Different output functions, e.g. presence signal and pulse signal are possible.

The detection quality is not influenced by the weather. Activating the directional logic generates pulses according to the driving direction on the switching outputs.

The detector is configured via serial interface on the front of the unit. The free PC service software **LoopMaster** provides a convenient operator interface for modifying and displaying all parameters and diagnostic values. The configured parameters are stored in a non-volatile memory (EEPROM).

CAUTION!

The IG946 loop detector is solely designed for use by qualified personnel trained in dealing with traffic detection equipment. Improper use of the IG946 may result in unpredictable behaviour of the systems controlled by the detector.

2.2 Overview of the essential product characteristics

- Vehicle detection with 4 induction loops, detection signals on switching outputs and CAN bus
- CAN bus interface:
    - Specification 2.0A - 11-bit identifier, basic CAN
    - Bit rate: 10 Kbit – 500 Kbit with automatic bit rate recognition
    - Standard function:
      - detection status
      - error status
      - detection edges with holding time and time gap,
        e.g. for determining the occupancy rate for congestion detection
      - complete parameterisation
    - Optional functions:
      - additional single vehicle data when using double loop systems:
        speed, length, driving direction
      - firmware download
- Service interface: 3.5 mm stereo phone socket (TRS) at front
- Wide power supply range: 10 V DC - 38 V DC, nominal voltage 24 V DC
- Wide inductance range: 20 µH - 2000 µH
- One open collector switching output per channel
- Easy and space-saving integration due to DIN-rail mounting
- Maximum modularity by TBUS system: bus system integrated in DIN-rail for power supply, CAN bus interface and detector synchronization
- Complete integrated overvoltage protection for inductive loops, no additional components necessary
- Loop activation in multiplex mode
- Wide adjustment range for the measurement frequency
- Low power consumption
- Convenient operation by means of PC service software LoopMaster via service interface, saving of unit-specific or application-specific parameter sets by means of LoopMaster
- Variable parameterisation allows use in practically all application fields of induction loop technology

- Non-volatile storage of all operating parameters in EEPROM
- Functionally compatible with IG746CAN
- Channel parameters, e.g.:
    - Frequency
    - Sensitivity
    - Measuring time
    - Hold time
    - Channel function (off, presence signal, pulse signals for arrival or departure, continuous signal)
    - Turn-on / turn-off delay
    - Oversampling
- Channel diagnostic values, e.g.:
    - Measuring frequency
    - Loop inductance
    - Error type
- Permanent loop control for immediate detection of induction loop errors
- Automatic compensation of temperature influences and ferrite control
- High interference resistance by means of frequency adjustment, oversampling and possibility of detector synchronization
- Automatic alignment after activation, reset or parameter modification
- Automatic recalibration in case of malfunction
- Directional logic with output on switching output
- Bus classification function with output on switching output and CAN bus
- µ-controller with watchdog and power fail monitoring

3 Installing the IG946

3.1 Installing and start-up of the device

The IG946 is designed for DIN-rail mount (TS35 EN50022). Into the DIN-rail a bus system (TBUS) for power supply, a CAN bus data interface and a synchronization can be integrated. For further information about DIN-rail mounting see chapter 8.3.

Figure 2: IG946 mounted on DIN-rail, including TBUS-bus plug and connector

Wire the device according to the terminal assignment in the appendix (chapter 8.4).

NOTE

When connecting the loops, all feed cables must be twisted up to the terminal clamps of the IG946! Do not use the feed cables parallel to e.g. AC-power supply or communication cables! The loop installation manual by SWARCO TRAFFIC SYSTEMS GmbH must be observed (see **www.swarco.com/sts-en/detection**).

Refer to the technical data for the specification of the supply voltage.

ATTENTION!

When connecting the integrated overvoltage protection of the inductive loops, the DIN-rail must be connected with the protective earth (PE) (see also chapter 8.4.1).

CAUTION!

Incorrect connection of the unit may result in malfunctions or destruction of the unit. SWARCO TRAFFIC SYSTEMS GmbH does not provide any warranty coverage for unit function in case of incorrect installation and cannot be held liable in this case. The general electrotechnical rules must be complied with when connecting the detector.

After switching on the unit for the first time, the detector aligns to the connected loop inductance. Short-circuited or open loop connections are indicated by the **ERR** (ERROR) collective error LED and flashing of the channel LED of the disturbed channel (refer also to section 6.2). The **FCT** (FUNCTION) LED flashes during normal operation with a frequency of 1 Hz.

3.2 Overvoltage protection and loop diagnosis

The detector offers a completely integrated overvoltage protection for the inductive loops. No additional components are necessary.

Before the detectors are installed, the loop values must be checked. The values for loop inductance, ohmic resistance and insulation resistance should be checked and documented

For more information about loop installation see the manual “Loop installation“.

3.3 Notes for installation

The device has a power consumption of approximately 0.7 W. Due to the closed housing (IP40) an uncritical self-heating occurs. Please note, in particular when installing a larger number of IG946 or presence of other heat-generating devices, the following instructions.

When installed in an enclosure or cabinet, a sufficient heat dissipation must be ensured. The ambient temperature surrounding the device and thus the temperature inside this enclosure or cabinet must not exceed the maximum allowable operating temperature of 80°C.

4 Operating the IG946 with LoopMaster

4.1 General

The IG946 is operated via service interface on the front by means of the service software LoopMaster installed on a PC or laptop computer. The detector is connected directly with an USB interface of the PC.

NOTE

- Please use an USB adapter cable with 3.5 mm jack plug. SWARCO TRAFFIC SYSTEMS GMBH label KA_Service_AJ-USB (order number: D.000.604.466).
- Please use only LoopMaster, the preceding program IGBT does not support this detector type.

LoopMaster is available as download from our website

www.swarco.com/sts-en/detection

In LoopMaster the following interface parameters can be set: (**Settings – Communication settings…**):

- COM port
- Baud rate: 4800 Baud (default)

LoopMaster provides an extensive help function, therefore only the most important functions will be described in the following.

4.2 Functionalities

In the parameter and diagnosis windows of LoopMaster the parameter and diagnosis values used in the IG946 are displayed as clear text. There are windows for individual channels, in the IG946 normally 4 , and one detector window. The detector window lists the according values for several channels and / or of the complete device. The data of these values between LoopMaster and IG946 is transferred together with the channel values.

The displayed values in the channel and detector windows are classified into alterable parameter values and unalterable diagnosis values. The entry fields for the alterable parameters are white, the display fields for the diagnosis values are grey.

Besides these windows a terminal window could be activated at the left side of the LoopMaster, which logs the serial communication via service interface.

When the LoopMaster software is started, all channel and detector data are automatically requested and displayed in the according windows, the status bar at the bottom part of the window is updated.

IG946 SN123456 E V1.17 Apr 11 2014

Figure 3: Example for the LoopMaster status bar

The displayed information are used to identify the detector hardware and firmware:

- Detector type, e.g. IG946
- **S**erial **N**umber, e.g. SN123456
- Country code of the service interface output, e.g. E (**E**nglish) or D (German)
- Detector firmware date, e.g. Apr 11 2014 (11.04.2014)
- Version status of the detector firmware, e.g. V1.17 (Version 1.17)

When positioning the mouse cursor on the status bar, these information are displayed in detail.

Indicator and control elements on the front panel

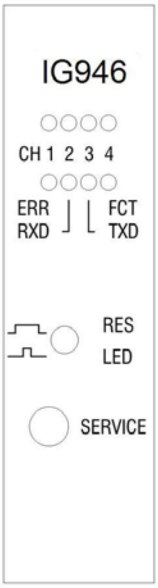


Figure 4: front panel of IG946 with LEDs, pushbutton and service interface

The detector has an LED for each channel to indicate vehicle detection (**CH1**…**CH4**). Furthermore, in case of a malfunction, the LEDs display the cause of the malfunction (e.g. loop open) by means of a predetermined number of LED blinkings (refer to section 6.2). Further functions related to turn-on / off-delay and the directional logic are described later (sections 7.1.6., 7.5.2).

The **ERR** LED is activated in case of a malfunction of at least one channel.

The reception and transmission processes of the CAN bus interface are indicated at the **RXD** and **TXD** LEDs for the reception and transmission direction of the IG946.

The **FCT** LED flashes with a frequency of 1 Hz during normal operation of the detector. With activation of MASTER-SLAVE synchronization, the flashing frequency during normal operation is reduced to 0.5 Hz.

The **RES LED** pushbutton has 3 functions, depending on how long the button is being pushed:

- **LED on / off**: Press button less than 1 sec, all LEDs are deactivated or activated, function can be disabled by means of the parameter setting "LED-turnoff-time = 0"
- **Channel alignment**: Press button 1 – 2 secs, initialisation of all active loop channels
- **Reset**: Press button longer than 3 secs, detector reset and subsequent alignment of all channels

All detector settings are made using the front RS232 interface (labelled: **"SERVICE")**.

6 Alignment and error diagnosis

6.1 Alignment

Alignment is defined as initialisation of a detector channel. In doing so, all settings are configured according to the parameters saved in the EEPROM (e.g. frequency, sensitivity). There must be no extended vehicle passages during the alignment.
If a convoy of vehicles passes during alignment, the IG946 attempts to adjust to the gaps between the vehicles. There are no vehicle detections possible during the alignment. After the alignment, the channel is always in an "undetected" status.

ATTENTION!

When a channel is aligned, vehicles located within the range of action of the induction loop at this point in time are ignored. This means that they are not detected during and directly after the alignment!

In the following events, the IG946 carries out an alignment

- after switching on the supply voltage (**P**ower **O**n **R**eset "POR")
- after the modification of relevant parameters (e.g. sensitivity, frequency, measurement time, channel function) through the service or CAN bus interface
- after operating the RESET button
- reset request via interface
- after an internal RESET (e.g. watchdog or power fail).

After reset, all channels will always be aligned. During a parameter transfer via the service interface by means of LoopMaster or CAN bus, only the selected channels for which at least one parameter has changed are realigned. All other channels continue to operate without any influence on their detection in this case. The alignment takes approx. 1 sec. with an unaffected induction loop and may take longer e.g. with disturbances on the loop. The corresponding channel LED **CH1** ... **CH4** is activated during the alignment and the **FCT** LED also flashes faster (approx. 5 Hz). Once alignment has been successfully completed, the channel LEDs **CH1** ... **CH4** are switched off and used for the indication of the detection status.

6.2 Error detection and troubleshooting

Channel-related errors are indicated at the channel LEDs **CH1** ... **CH4** by blinking repeatedly every 5 secs with a predetermined number of blinkings for each error.

Channel errors	Number of channel LED blinkings
Short-circuit loop	1
Open loop, loop broken	2
Frequency not adjustable	3
Disturbance	4
reserved	5
Error in other channel of the directional logic	6
Maximum loop alignment duration exceeded	7

Table 1: list of channel errors with allocation of the number of flashes to the channel LED

These errors are displayed in the channel windows in the LoopMaster as "channel error" diagnostic parameters (refer also to section 7.3.2). Furthermore, the **ERR** collective error LED indicates an error status with at least one channel.

In case of a short-circuited or open loop, the alignment algorithm detects that the connected inductance (induction loop + feed cable!) is outside the permissible range (refer to section 8.1). The error cause is to be found and eliminated.

If the selected frequency range cannot be set, the connected inductance (loop inductance plus inductance of feed cable) lies outside the recommended range (refer to section 8.1). To solve this problem, set another frequency range (section 7.1.2).

The error message "Disturbance" indicates external interferences during alignment. This causes longer alignment times (more than approx. 2 secs. per channel). The external interferences must be determined and eliminated in order to ensure the correct detector function. Otherwise, misdetections may occur, i.e. the according channel switches even without loop attenuation. The external inferences may be caused by electromagnetic fields or pulses in the environment of the induction loop or feed cable. Selecting another frequency range may solve this problem. Furthermore, the channel can be interference-suppressed using the oversampling procedure (section 7.1.7).

If the disturbances are caused by other identical loop detectors, the interference can be eliminated by synchronising the detectors by means of the synchronization leads of the terminal strip (section 7.5.3).

The duration of the channel alignment is restricted to the set duration using the "maximum loop alignment duration" parameter. The error message "maximum loop alignment duration exceeded" is generated if this time is exceeded.

On activating the function "Directional logic (switching output)" (refer to sections 7.1.8 and 7.5.2), both channels are necessary for correct operation. Consequently, in case of a failure of one channel, e.g. loop open, the other channel of the directional logic is also deactivated with the error "Error in other channel of the directional logic".

After troubleshooting, an alignment of all channels or a reset of the IG946 with subsequent alignment of all channels can be initiated using the pushbutton on the front panel in order to restore correct functionality.

If the channel flag "Automatic recalibration in case of channel error" (refer to section 7.1.8) is activated (factory setting: deactivated), a cyclical alignment is performed in case of a channel error. At the latest 1 min. after troubleshooting, the channel faults will automatically be removed in this case.

In this case also, a vehicle located within the range of action of the loop at the time of troubleshooting will be ignored.

7 Parameters and functionality

The parameters are divided into

- Channel-related parameters (sensitivity, channel function, etc.), these can be configured separately for each channel
- Device parameters (e.g. synchronization), these are settings which apply to the entire device (refer to section 7.2)

In addition to the user-adjustable parameters, the IG946 also supplies diagnostic data, which can be displayed in the LoopMaster. These values cannot be directly modified but result from the parameters (e.g. frequency from configured frequency range), are determined during operation (e.g. last amplitude) or result from the unit operating status (e.g. channel status, RESET counter). It is to be noted that all displayed data show the current status of the detector at the time of parameter request (LoopMaster menu item: "Read from device“).

ATTENTION!

The user must take care that the configured parameters ensure a logical and reliable detector function.

7.1 Significance of the channel parameters

The channel parameters comprise all channel-specific settings. After the data transfer to the detector, the detector checks all parameters for modification in comparison to the current settings. An alignment is only performed if at least one of the channel parameters has changed and the modified values are stored non-volatile in the EEPROM.

7.1.1 Sensitivity / measuring time:

The sensitivity determines the response threshold for vehicle detection and is defined as the frequency change Δf in relation to the alignment frequency f_0. A high sensitivity determines a low turn-on threshold and therefore high response sensitivity. The sensitivity should not be set higher than absolutely necessary, as otherwise detection may be affected if external interferences occur (e.g. power supply lines in the loop area, poor quality loops, coupling of other detectors).

To a large extend, the sensitivity and measuring time can be configured independently from one another. Consequently, a suitable combination can be found for practically any application (classification detector, gate/barrier detector, bicycle detector).

The control response (refer to **Control** flag in section 7.1.8) influences the maximum adjustable sensitivity. In "Regulation with observance of hold time", the maximum sensitivity is limited in comparison to "permanent regulation" so that more prolonged hold times can be observed even under unfavourable conditions.

The sensitivity is restricted by the measuring time. The maximum sensitivity level can therefore only be achieved from a specific measuring time onwards. The IG946 device automatically limits the sensitivity at a predetermined measuring time.

Measuring time	**Permanent regulation (factory setting)**	**Regulation with observance of hold time**
[ms]	**max. sensitivity $\Delta f / f_0$ [%]**	**max. sensitivity $\Delta f / f_0$ [%]**
2.5	0.060	0.100
5,0	**0.020**	0.035
7.5	0.012	0.020
10.0	0.012	0.020
12.5	0.007	0.012
15.0	0.007	0.012
20.0 - 45.0	0.007	0.007

Table 2: measuring time – maximum sensitivity allocation depending on control, factory setting (bold)

Disturbed or deactivated channels are automatically set to the shortest measuring time (2.5 ms). The parameterised measuring time remains stored in the EEPROM.

Measuring times of more than 20 ms are currently not required, but remain reserved for future implementation of higher sensitivities.

The factory settings for sensitivity (0.020 %), measuring time (7.5 ms) and regulation (permanent regulation) are default values for a reliable vehicle detection at traffic light installations.

Other settings are required under certain circumstances for other applications, e.g.:

Application	**Sensitivity [%]**	**Measuring time [ms]**	**Comment**
Bicycle detection	0.012 - 0.007	7.5 – 12.5	permanent regulation recommended
Speed measurement by analysis of the switching outputs	0.060 – 0.020	2.5 – 5.0	permanent regulation recommended
Car/HGV detection at barriers	0.100 – 0.020	10.0 – 20.0	Regulation with observance of hold time required

Table 3: examples of configuration of sensitivity, measuring time, control

Some pre-defined application settings using the recommended parameters are avaialable in the LoopMaster menu "Parameter" - "Load detector preset ...".

7.1.2 Frequency range

The loop frequency of each channel can be set to one of four frequency ranges.

Frequency level	Frequency range [kHz]
‘0’	30 - 44
‘1’	**45 - 64**
‘2’	65 - 84
‘3’	85 - 110

Table 4: frequency levels and ranges, factory setting (bold)

This can contribute to interference suppression during operation of several detectors interconnected by means of loops and / or a loop feed cable (see **Instructions for setting the frequency for several detectors**).

With a known frequency of external interference sources, interference suppression can likewise be achieved by selecting an appropriate frequency range. The channel is faulty, if the selected frequency range cannot be set (refer also to section 6.2).

The oscillator of the IG946 is designed in such way that, when using loops with inductances within the recommended range, all frequency ranges can be used (refer to section 8.1).

Instructions for setting the frequency for several detectors

Because of the loop control in multiplex mode, the channels of the detector cannot interfere with each other. Thus, the user must only pay attention that the interconnected channels of several detectors have a sufficiently large frequency gap.

An interconnection of detector channels can be the result when the distance between inductive loops is too small and / or when they share the same loop feed cable. The smaller the distance between the loops and the longer the channels e.g. because they are lead through a shared feed cable, the larger is the interconnection.

ATTENTION!

Please observe that the interconnected detectors must work with different frequencies and that additionally the synchronization function must be activated (see chapter 7.5.3).

The difference of measurement frequencies should be approx. 5 - 10 kHz and is normally achieved when different frequency ranges are chosen for several detectors. The channel diagnosis value Frequency shows the current measurement frequency (see chapter 7.3.5). This can be used to control the above mentioned minimum frequency gap when the same frequency ranges are set for several detectors.

7.1.3 Smoothing of measured values

The smoothing of measured values is used to suppress noise. This can be caused by other detectors, but also from external noise sources such as AC power supplies, communication lines, etc. in the field of induction loops or their leads.

The duration of the measured value smoothing is parameterized in 10ms increments. The number of measurement values used for the arithmetic averaging is calculated automatically for each channel:

Number of smoothed values = duration smoothing of values / cycle time

The current cycle time is displayed as a detector diagnostic value in LoopMaster (see Section 7.4.3).

When setting the smoothing of measured values it is important to note that vehicles with the shortest adopted occupancy time should still be detected. A rule of thumb is.

Duration smoothing of values < 2 x minimum occupancy time

This ensures that the averaging with unchanged sensitivity adjustment has only a small influence on the amplitude of the vehicle. At the same time interfering signals that are significantly shorter in general than the minimum occupancy time, are effectively suppressed.

Example:
Motorcycles (shortest to be detected vehicle!) should be detected without affecting through the averaging safely up to a maximum speed of v_{max} = 70 km / h. An assumed vehicle length l_{min} = 1.0 m and v_{max} results in an occupancy time t_O of

$$t_O = (l_{min} \times 3{,}6) / v_{max} = 0{,}051 \text{ s} = 51 \text{ ms}$$

The factory setting of the measuring value smoothing (100ms) meets these requirements:

100 ms < 2 x 51 ms

In order to obtain a sufficient number of measurements for averaging, it is recommended to set the sum of the channel measurement time (cycle time) and the measured value smoothing as follows:

Duration smoothing of values > 3 x cycle time

The measured value smoothing is available at firmware versions greater than 1.05.

7.1.4 Hold time

The hold time is initiated during each detection. If the hold time elapses without the channel becoming free, the channel will be reset. If a vehicle is still on the loop at this point in time, this vehicle will be ignored. If the vehicle leaves the loop afterwards, the further detection behaviour will depend on the configured regulation (refer to section 7.1.8).

With "Permanent regulation", detection is initially less sensitive and is subsequently gradually readjusted to the original sensitivity. In "Regulation with observance of hold time", the original sensitivity is achieved approx. 4 secs after leaving the loop if no further detections occur during this period.

With static hold time (infinite hold time), external interferences may result in shortening of the actually achievable hold time. Setting a finite hold time generally ensures reliable operation in these cases.

With long hold times, oversampling should be activated in all events (refer to section 7.1.7) and "Regulation with observance of hold time" should be selected, as this ideally maintains the set hold time regardless of the detuning caused by the vehicle.

The channel alignments initiated by exceeded hold times are displayed in the channel diagnostic value in the LoopMaster (refer to section 7.3.3). Unusually high counter values indicate in the case of traffic light installations e.g. that hold times are too short (e.g. traffic light cycle 2 min. > hold time 1 min.). External interferences may likewise result in higher counter values, as the detector resets the resulting "hanging" after the hold time has elapsed with a realignment.

7.1.5 Channel function

The channel function determines the behaviour of the switching outputs (open collector) as well as the detection status in the CAN protocol during vehicle detection. The CAN protocol does not support the functions "Pulse on entry / exit”. The channel can furthermore be deactivated (output corresponds to loop not occupied) or be set to a permanent busy signal for testing processing units (e.g. traffic light installation controller)

On setting the presence signal, the switching output remains activated during loop occupation. With pulse signals, it is possible to select between pulse when the vehicle drives onto the loop (entry) or pulse when leaving the loop (exit). The pulse length is approx. 100 ms. without activation of the turn-off delay.

7.1.6 Turn-on / turn-off delay

The turn-on delay defers the activation signal (for presence and pulse) by the set time. No occupied signal is issued if the loop becomes free again during the turn-on delay. Consequently, the turn-on delay can also be used for interference suppression of channels with misdetections. Whether this measure results in reliable operation depends on the individual case.

The turn-off delay extends the presence signal after the loop becomes free by the set time. With pulse signals, the turn-off delay is used to adjust the pulse length. The total duration of the pulse in this case is the sum of the set time plus approx. 100 ms.

When the directional logic is activated, the turn-off delay serves for jumpering between the first and second attenuated loop. This is used to implement a directional logic for vehicles that cannot simultaneously attenuate both loops (e.g. bicycles and motorcycles).

The turn-on delay is indicated by the channel LED with a flashing frequency of approx. 8 Hz and the turn-off delay with a flashing frequency of approx. 16 Hz.

7.1.7 Oversampling

By activating oversampling x2 (alternatively x4, x8, x16), 2 (or 4, 8, 16) measurements are summarized, thus achieving a higher interference resistance. The reaction time of the channel is doubled by activating oversampling (or 4x, 8x, 16x) as long as:

> **Channel reaction time = cycle time x channel oversampling factor**
> (for cycle time, refer to section 7.4.3, oversampling factor = 1 (off), 2 ,4, 8, 16)

With an undetected channel, this means e.g. that the loop must be occupied longer than the reaction time in order to activate the switching output of the channel.

7.1.8 Channel flags

The channel flags are used to configure the following binary channel parameters:

- Automatic recalibration in case of channel error (for functionality, refer to section 6.2)
- Contact position of the switching outputs
- Contact position in case of an error
- Regulation
- Classification function (amplitude at individual loop)
- CAN option positive and negative edge
- Directional logic (switching output)

The **contact position of the switching outputs** (open collector) can be influenced in the following manner:

- Normally Open (NO): open collector HIGH when loop not occupied (factory setting),
- Normally Closed (NC): open collector LOW when loop not occupied

On detection (loop occupied), the output switches to the respective other position.

The **contact position in case of an error** in the channel can be adjusted as follows:

- Switching output as loop unoccupied
- Switching output as loop occupied (factory setting)

The **regulation** flag allows selection between

- Permanent regulation
- Regulation with observance of hold time

and ensures the reliable functionality of detection under different application conditions. When used in traffic light installations, the factory setting **permanent regulation** reliably prevents "hanging" of channels when conditions are not ideal. Since only short hold times are necessary in this case - the factory setting is 5 min. for example - the effective slight reduction of the attenuation measurement values with this control algorithm does not have any significant influence.

During **regulation with observance of hold time,** the set hold times incl. the static hold time (refer also to section 7.1.4) are observed, when no external interferences occure. The hold time is independent of attenuation in this case, since in contrast to the other setting there is no reduction of the amplitude during detection.

If external interferences are to be expected, permanent regulation should be selected in which minor faults are corrected. However, the set hold time is attenuation-dependent in this case and can therefore only be observed if there is an adequate attenuation.

If hold times of more than approx. 1 h are required, or in gate/barrier applications, regulation with observance of hold time should be selected. As described in section 7.1.1, the maximum achievable sensitivities with identical measuring time are somewhat limited in this setting in order to ensure reliable function with regard to the hold time.

The following channel flags are used for deactivation / activation of special functions described in further detail in the sections indicated:

- Classification function (amplitude at an individual loop): section 7.5.1
- CAN option positive and negative edge: section 7.5.4
- Directional logic (switching output): section 7.5.2

7.1.9 Extended channel flags

The extended channel flags are used to configure additional binary channel parameters:

- Boost function activated / deactivated

The **boost function** causes an automatic increase of sensitivity after the detection of the vehicle limited to the maximum sensitivity. Thus also parts of a vehicle with low detuning amplitudes, e.g. poles of trailers, can be reliably detected. After the vehicle has left the loop, the sensitivity returns to the value originally set. In pulse mode, this function is disabled. The boost function is available at firmware versions greater than 1.05.
In addition, here the current loop configuration is indicated, a modification of this factory setting is not possible.

- Double loop function (v, l, dir.): on / off

In the default configuration of the IG946 the four channels are configured as single loop. In this setting, the determination of vehicle speed v, vehicle length l and the driving direction are not possible. To realize this, the optional double loop configuration of the detector and the connection of a double loop system are required. The output of the additional vehicle data (v, l, direction) is done via the CAN bus and the service interface.

7.1.10 Maximum loop alignment duration

Under unfavourable application conditions, the alignment duration of a channel may be considerably longer as a result of external interferences. This parameter limits the alignment duration per channel to the indicated value and sets the channel to fault, in order to prevent unreliable detection behaviour. This function is deactivated with the value 0. On activating the function "Automatic recalibration in case of channel error", a new alignment attempt is cyclically initiated.

7.2 Significance of the device parameters

The device parameters are settings that affect several or all channels of the detector and are transmitted together with the channel data between the LoopMaster and the detector.

7.2.1 Language service interface

The text output of the service interface can be set to the desired language. Please note that the language of LoopMaster will not be influenced.

7.2.2 CAN bus address

This parameter is used to assign the CAN bus address. The address is part of the CAN ID in the CAN protocol.

For hardware addressing, a 4-pole DIP switch is located behind the removable front panel. With switch 2 – 4 hardware addresses can be set from 0 to 7:

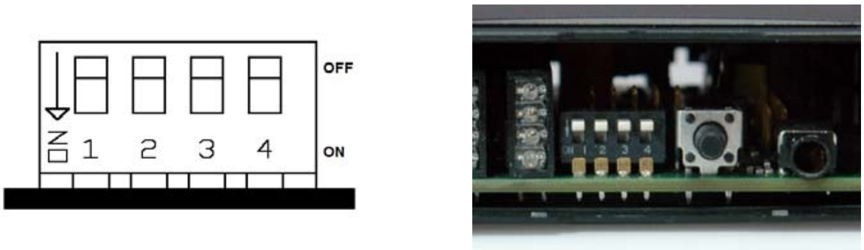


Figure 5: Switches for CAN bus termination and hardware address

DIP switch				CAN-Adresse
1	**2 (LSB)**	**3**	**4 (MSB)**	
Termination see chapter 7.5.4	OFF	OFF	OFF	0 (Werkseinstellung)
	ON	OFF	OFF	1
	OFF	**ON**	OFF	2
	ON	**ON**	OFF	3
	OFF	OFF	**ON**	4
	ON	OFF	**ON**	5
	OFF	**ON**	**ON**	6
	ON	**ON**	**ON**	7

Table 5: Function of switches for CAN bus hardware address

The factory setting switches 2 – 4 OFF (address 0) deactivates the hardware address.

ATTENTION!

The DIL-switches may only be set when the device is not connected to power supply. To do so, unplug all connections of the device and take it out of the DIN-rail.

To remove the front panel: Push apart slightly, the housing at the long side of the front panel and loosen the panel at the 4 fixation points.

With at least one address switch in position ON, the hardware address is activated. A modification using LoopMaster is not possible in this case, but the transferred address is nevertheless saved in the EEPROM. On deactivation of the hardware address, the last saved address will be used.

The address 0 disables the CAN bus function, the valid addresses are 1 – 63.

The hardware addressing can be deactivated by means of a device flag (section 7.2.3).

NOTE

In the factory setting for the hardware address (DIP switch 2 - 4 OFF: address 0) the CAN bus address must be activated by LoopMaster.

CAN bus addresses greater than 7 must also be configured with LoopMaster. Then the hardware address (DIL switch 2 - 4 OFF) or the hardware addressing must be deactivated!

7.2.3 Device flags

The following settings can be configured:

- Detector synchronization: MASTER / SLAVE
- Hardware address for CAN-bus: ENABLED / DISABLED

If several detectors are to be synchronised with one another in order to avoid their mutual interaction, the MASTER setting must be configured here for **just one** detector. Further information concerning **synchronization** can be found in section 7.5.3.

The hardware address can be disabled by the setting "**Hardware address for CAN-bus: DISABLED**". The already saved EEPROM address is used in this case, or a new address can be defined by means of the parameter "CAN bus address". With modification of this flag, a detector reset is performed.

7.2.4 LED turn-off time

To reduce power consumption, after the LED turn-off time has elapsed, the LEDs are switched off. Briefly pressing the pushbutton or communicating via the service interface reactivates the LEDs. The value 0 deactivates the turn-off function (factory setting).

7.3 Significance of the channel diagnostic values

These values are generated for each channel from the detector during operation. The values indicated apply for the time of parameter request and are to be updated if necessary by parameter request from the detector.

7.3.1 Channel status

The channel status contains the following binary data:

- Channel occupied: current detection status (detection yes / no)
- Channel error: current error status (error yes / no)
- Channel error history (since POR): channel was previously disturbed (yes / no).

The "Channel error history (since POR):" flag is reset in case of a **P**ower **O**n **R**eset (abbreviation: POR, i.e. reset on switching on the supply voltage).

7.3.2 Channel error

In case of a disturbed channel, the channel error shows the error cause detected by the detector during the alignment (see section 6.2).

7.3.3 Alignment counter and hold time exceedance

This value indicates the alignment processes performed since the last POR. These can be alignment processes initiated by parameter modification, RESET conditions or alignments caused by error conditions during loop operation. This information may therefore contribute to error detection, since unreliably operating loop channels and units can be detected here.

The number of hold time exceedances is indicated in a separate counter and is also included in the number of (total) alignments. The number of hold time exceedances should be 0 with correct parameterisation of the hold time. High values may occur because e.g. the hold time set for request loops is shorter than the cycle time of the traffic light installation.

These values can be reset using the LoopMaster menu item: "Reset counter".

7.3.4 Inductance

The inductance of the inductive loop (including feed cable!) is indicated in µH with a resolution of 10 µH. The inductance is determined with an accuracy of +/- 20 % within the recommended inductance range.

7.3.5 Frequency

The frequency indicated here in kHz lies within the set frequency range and is e.g. used to control the frequency gap to channels of other detectors (see instructions for setting the frequency with several detectors in chapter 7.1.2).

7.3.6 Turn-on and classification threshold, maximum and last amplitude

All these values are displayed in the unit [%] and can therefore be directly related to one another and to sensitivity [%]:

- sensitivity (e.g. factory setting: 0.020 %) always corresponds to
  turn-on threshold (e.g. factory setting: 0.020 %)
- Last amplitude 1.000 %,
  i.e. the last vehicle had a maximum detuning value 50 times greater than the factory setting for sensitivity and turn-on threshold.

If the value exceeds resp. falls below the **turn-on threshold** the "channel occupied" resp. "channel not occupied" message is issued on the channel LED, switching output and in the detection status of the CAN protocol.

The **classification switching threshold** is a second switching threshold above the turn-on threshold for channels 1 and 2. If exceeded, the classification output channel 3 or 4 is set (refer also to section 7.5.1).

By comparison with the turn-on threshold and/ or the sensitivity, the **maximum amplitude (maximum attenuation** since the last alignment) allows the conclusion whether the set sensitivity is sufficient. Depending on the application, the following rule of thumb applies:

maximum attenuation > 10 .... 100 x turn-on threshold.

The **last amplitude** indicates the maximum value of the last loop attenuation. If this value exceeds the value of the maximum attenuation the following applies:

maximum attenuation = last amplitude.

These values can be reset using the LoopMaster menu item: "Reset counter".

7.3.7 Alignment cause

The alignment cause indicates the reasons for the numbers indicated in the alignment counter and hold time exceedance:

- **Mesurement out of range**:
  Cause e.g. for a following channel fault, loop open or short-circuited
- **Error in other channel: system alignment**:
  The alignment was initiated by the channel linked to this channel by means of directional logic. Both loops form a loop system.
- **Hold time exceedance:**
  An alignment was performed for the channel as a result of elapse of the hold time and the hold time exceedance counter increased.
- **Operation (interfaces, switch)**:
  The alignment was initiated by the user by pressing the reset pushbutton or by parameter modification by means of the LoopMaster or CAN bus interface.
- **Synchronization**: An alignment was initiated by a modification in synchronization (refer to section 7.5.3).

This value can be reset using the LoopMaster menu item: "Reset counter".

7.4 Significance of the device diagnostic values

These values are generated by the detector during operation. The values displayed are valid for the time of parameter request. If necessary, they are to be updated with a parameter request from the detector.

7.4.1 CAN bus bit rate

The bit rate of the IG946 is automatically determined based on the bit rate predetermined by the connected CAN-MASTER (e.g.: traffic light installation controller). Consequently, no setting of the bit rate is provided.

7.4.2 Reset counter, reset cause

The value reset cause indicates in bit-coded form the reason for the reset, the reset counter indicates the number of resets since the last POR. These values can be reset using the LoopMaster menu item "Reset counter".

7.4.3 Cycle time

The cycle time in ms is the sum of the total measuring times of all channels (section 7.1.1):

Cycle time = **measuring time, channel 1**
+ measuring time, channel 2
+ measuring time, channel 3
+ measuring time, channel 4.

The reaction time of the individual channels can be determined using the cycle time (refer to section 7.1.7).

When the synchronization function is activated, the cycle time is the sum of the accordingly longest channel measurement times of all synchronized detectors.

7.5 Description of the special functions

7.5.1 Classification function

7.5.1.1 General

By means of the classification function the vehicle types are distinguished based on their attenuation amplitudes on the individual loops. Only loop channels 1 and 2 may be used for this function. Channels 3 and 4 must be deactivated, since the allocated switching outputs are used by channel 1 and 2 for the classification results.

With the IG946, the classification data are additionally transferred in the CAN bus protocol (negative edge telegram, type 2):

- Bus and car-related: byte 7 = 1
- Not bus and HGV-related[1] byte 7 = 0

A second classification switching threshold above the turn-on threshold is defined for the classification function. If the turn-on threshold is exceeded, the output of channel 1 or 2 switches, if the classification switching threshold is exceeded, additionally channel 3 or 4 switches. If the value falls below the turn-on threshold, channels 1 and 3 respectively 2 and 4 are deactivated. Channels 3 and 4 may therefore only maximally be activated once per vehicle passage.

For the classification function, the measuring time and oversampling must under certain circumstances be adapted in order to guarantee an adequate reaction time (refer to section 7.1.7) with regard to the amplitude analysis. A few examples of these parameters are presented in the following table as a function of the maximum vehicle speed v_{max} for bus classification (bus length > 8 m):

v_{max} [km/h]	Sensitivity [%]	Measuring time [ms.]	Oversampling
50	0,1 - 0,020*	7,5*	x1 - x2*
100	0,1 - 0,035	5,0	x1 - x2*
70	0,1	2,5	x1 - x4

Table 6: recommended settings for measuring time, sensitivity and oversampling

*: factory setting

The classification function is primarily intended for performing bus classification with a special loop (approx. 10 m x 2.5 m). Buses generally cause greater attenuation on this loop in flowing traffic than a convoy of cars with a normal distance between vehicles. The loop must not be laid in a congestion area, as a line of 3 stationary cars might otherwise be classified as a bus.

[1] HGV: **H**eavy **G**oods **V**ehicles

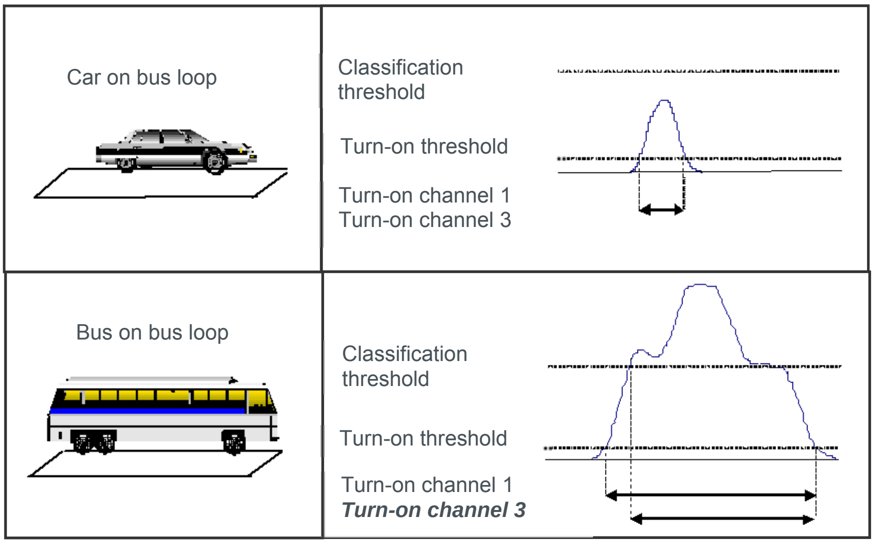


Figure 6: bus classification with a special loop

When using standard loops (length 1 m - 2.5 m), this function may also be used for differentiation by car-related/HGV-related vehicles. In this case though, heavily attenuatiing vehicle types (e.g. buses) are classified as car-related and weakly attenuatiing vehicles (e.g. motorcycles) are classified as HGV-related.

7.5.1.2 Learning the classification threshold

The classification function is activated by setting the corresponding channel flag (refer to section 7.1.8). In this case, the classification switching threshold is initially set to a default value (15x turn-on threshold). When the classification function is deactivated, the classification switching threshold is not indicated in the LoopMaster.

In order to determine the desired classification switching threshold, a maximum of 5 vehicles of a vehicle type with the higher attenuation amplitude is required afterwards, i.e. buses for bus classification or cars for car-related/ HGV-related classification.

The determination of the classification switching threshold for the next vehicle passing is activated by means of the terminal window of the LoopMaster using the command sequence

‘**K’ - ‘1’ - ‘1’ - CR** for channel 1 and **‘K’ - ‘2’- ‘1’ - CR** for channel 2

i.e. the maximum detuning (amplitude) for this vehicle is determined. Determination of the amplitude is displayed in the terminal window of the LoopMaster by the output

"**Ampl.classif. channel 1: 1 of 5 vehicles"** and "**Ampl.classif. channel 2: 1 of 5 vehicles"**

.   .
.   .
.   .

"**Ampl.classif. channel 1: 5 of 5 vehicles"** and "**Ampl.classif. channel 2: 5 of 5 vehicles"**

A new command sequence can subsequently be immediately entered.

Activation can be cancelled with the command sequences

‘K’ - ‘1’ - ‘0’ - CR for channel 1 and **‘K’ - ‘2’- ‘0’ - CR** for channel 2

before the vehicle passing to be assessed. An intermediate RESET or alignment of the channel resets the classification switching threshold to the initial status (5 vehicles, classification switching threshold = 15x turn-on threshold).

After 5 vehicles have been assessed in this manner, the classification switching threshold is stored non-volatilely in an EEPROM as the mean of the 5 amplitudes minus approx. 25%. Determination of the threshold is displayed in the terminal window of the LoopMaster by the output

"Channel 1:threshold was determined!" and **"Channel 2:threshold was determined!"**

The classification switching threshold can be checked in the channel window.

The classification switching threshold only influences activation of the outputs of channel 3 and 4; channel 1 and 2 remain unaffected.

Only the presence signal is permissible as the channel function for channel 1 and 2; turn-on and turn-off delays are not permissible.

The classification quality is solely influenced by the classification switching threshold. Care should be taken when determining the latter that the vehicles do not pass over the loop diagonally or shifted. The classification switching threshold can be verified after determination using the channel diagnostic value "last amplitude". For buses, the last amplitude must lie above the classification switching threshold, for all other vehicles (particularly in case of convoys of cars), below the classification switching threshold.

The determination of the classification switching threshold can be restarted at any time using the command sequences

‘K’ - ‘1’ - ‘3’ - CR for channel 1 and **‘K’ - ‘2’- ‘3’ - CR** for channel 2

The next vehicle will be used, in a similar manner as with the command sequence ‘K’ - ‘1’ / ’2’ - ‘1’, for threshold determination. The values of the current determination are lost in the process. The current, non-volatile value in the EEPROM remains unchanged until amplitude is finally determined.. This command sequence must also be entered e.g. after switching off the supply voltage or after a reset during determination of the classification switching threshold.

In order to reduce the number of vehicles for threshold determination, the command sequences

‘K’ - ‘1’ - ‘2’ - CR for channel 1 and **‘K’ - ‘2’- ‘2’ - CR** for channel 2

can be used. After the following vehicle, the threshold is determined as described and is acknowledged with the output described above. At least 3 vehicles should be used however to determine the classification switching threshold.

After the classification switching threshold is determined, the settings for frequency, measuring time and channel function must not be modified, otherwise the determined classification switching threshold will not be valid anymore. If these parameters are modified, the classification switching threshold will automatically be reset to the default value and must be redetermined.

7.5.2 Directional logic

The functionality directional logic is used to detect the driving direction of vehicles. In this case, two loops arranged in a row are grouped into a loop system (channel 1 and 2 and channel 3 and 4). For direction detection, when both loops are occupied at the same time, the switching output of the loop which was passed last is activated. The channel function establishes whether a presence or pulse signal is used on the switching output.

In order to likewise create a directional logic for vehicles that cannot simultaneously occupy both loops (e.g. bicycles), the turn-off delay can be used to artificially extend the busy signal of the first occupied loop. The turn-off delay applies also to the activated switching output (second occupied loop), i.e. the presence signal is extended by the turn-off delay. Please note that the time gap between the vehicles must be longer than the turn-off delay set.

The first loop occupied is indicated by flashing (frequency 4 Hz) of the corresponding channel LED. Flashing of the directional logic is dominant over the flashing of the turn-off delay.

A turn-on delay is not permissible with the directional logic.

The directional logic is activated and deactivated using the corresponding channel flag. Since a double loop function is involved, it is sufficient to parameterise the respective 1st channel of the loop system, i.e. channel 1 and 3. The setting is automatically adopted for the 2nd channel. If a loop fault occurs in one of the loops of a directional logic, the other loop will also be faulty (channel error "Error in other channel of the directional logic").

The following figures show the function of the directional logic for a single vehicle and in convoy traffic for the driving direction from loop 1 to loop 2. The function is equivalent for the other driving direction and channels 3 and 4. For vehicle convoys, the distance between the vehicles must amount to at least one loop length plus the distance between the loops. Consequently, loops as short as possible (< 1 m) and with a small distance (< 1 m) should be used for a directional logic.

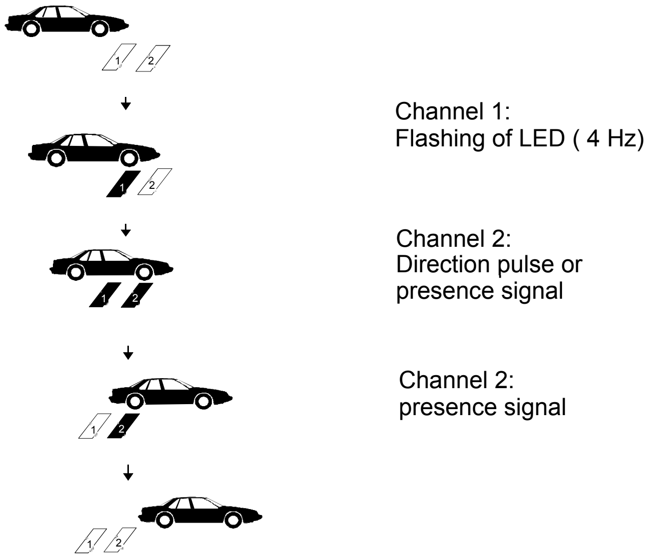


Figure 7: directional logic for single vehicle

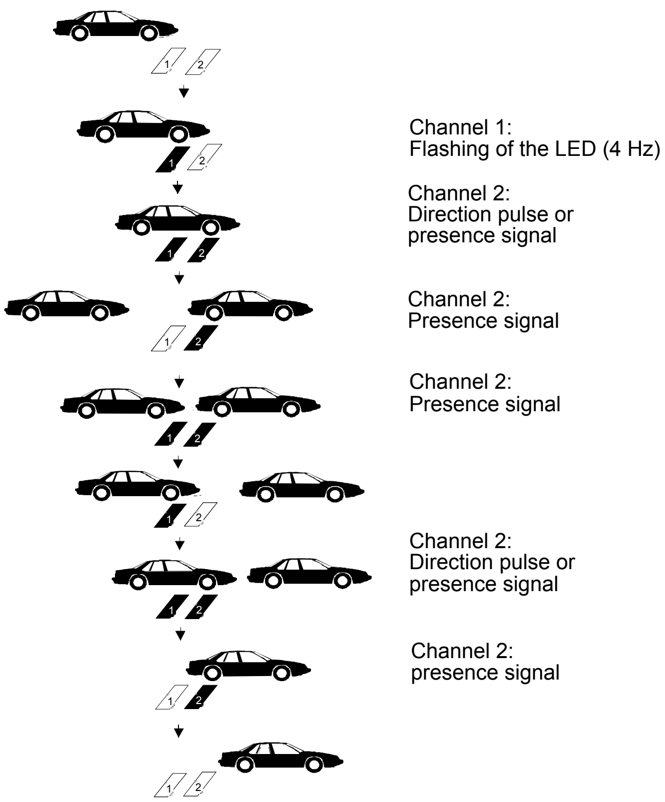


Figure 8: directional logic for convoy traffic

7.5.3 Synchronization

The synchronization function can be used to minimize or eliminate e.g. false detection on several detectors interconnected by means of a loop feed cable or directly by loops, if the setting of different frequency ranges alone (refer to section 7.1.2) does not show any result. The synchronization function makes sure that the same channel is respectively measured at all connected units at any given time.
When connecting the induction loops please note: Do not connect induction loops with a small distance between them to channels with the same channel number. Different channel measuring times are automatically taken into account as the longest measuring time of the respective channel group determines the total measuring time of this channel. If the systems are particularly interconnected, different frequency ranges must additionally be configured.
To activate the synchronization first the bus system TBUS, which can be integrated in the DIN-rail, must be installed (see chapter 0). The synchronization line of the detectors, as well as the power supply and the CAN bus data interface are then connected with each other via this bus system. At the middle connection of the TBUS terminal (clamp 3) the synchronization line can be connected with further devices such as detectors with identical synchronization methods installed e.g. in a rack (e.g. IG746). Please note that the maximum number of devices is 30, the maximum length of connection 1 m.

In addition, exactly one detector must be defined as MASTER. All other units must remain in the factory setting SLAVE.

CAUTION!

Configuration of several MASTERs is not allowed!
For SLAVE detectors, that are already synchronized with a MASTER, the activation of the MASTER function will automatically be prevented.

The MASTER-SLAVE function is a device parameter and is to be found in the corresponding LoopMaster parameter window. The setting is transmitted to the detector by the command "Write to device..." and by selecting a channel.

When the MASTER-SLAVE setting is changed, no RESET is executed on the IG946 and therefore no interruption of the CAN communication occurs. The start and the end of the SLAVE-synchronization is performed as part of an alignment of all channels of the SLAVE units if:

- a MASTER is activated when synchronization is not yet activated (start of synchronization)
- the MASTER executes a reset (start of synchronization)
- the MASTER is deactivated while synchronization is activated (end of synchronization)

Once all detectors have finished the initialisation of synchronization and the channel alignment, all FCT LEDs flash synchronously with a frequency of 0.5 Hz; that of the MASTER however flashes inversely to the SLAVE detektors.

7.5.4 Notes concerning the CAN bus function

For specifications of CAN bus see the technical data (section 8.1), the protocol description is available on request.

The CAN bus protocol transmits all functions of the switching outputs (detection and error status) and furthermore provides further data contents, e.g.:

- time stamp of the detection status, resolution 10 ms
- error type in case of a channel fault
- detection edges with occupation time and time gap, resolution 10 ms
- optional: in a double loop system: additionally vehicle speed, vehicle length and driving direction;
  with single loop: bus classification
- all parameter and diagnostic values, alignment and reset triggering

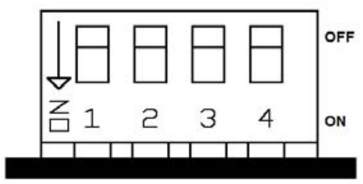
A firmware download via the CAN bus interface is already available; the firmware download protocol description for implementation in a controller is available on request.

NOTE

Use of the CAN bus functionality of the IG946 considerably simplifies wiring and operation and, at the same time, improves functionality.

To avoid reflections and undefined states on the bus lines, **both ends** of the CAN bus have to be terminated **one-time** with a termination resistance of **120 Ω**.

To terminate the CAN bus at the detector, a 4-pole DIP switch is located behind the front panel which can be removed:



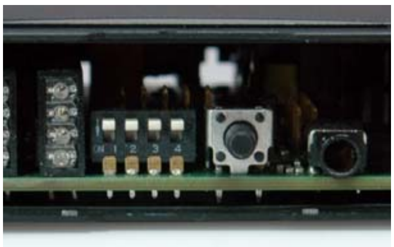


Figure 9: Switch for termination of CAN bus interface

Nr.	Function switch OFF	Function switch ON
1	termination resistance 120 Ω **deactivated**	termination resistance 120 Ω **activated**
2 – 4	Hardware address, see chapter 7.2.2	

Table 7: Function of switch for termination of CAN bus interface

NOTE

In the factory setting switch 1 is in position OFF, i.e. the CAN bus is not terminated by this detector. Activate the termination one-time on the detector at the end of the CAN bus line!

If no detector is present on the end of a CAN bus, but e.g. a traffic light installation controller, also here the described termination has to be conducted!

ATTENTION!

The DIL-switches may only be set when the device is not connected to power supply. To do so, unplug all connections of the device and take it out of the DIN-rail

To remove the front panel: Push apart slightly, the housing at the long side of the front panel and loosen the panel at the 4 fixation points.

8 Appendix

8.1 Technical data

Technical data	
Supply voltage	nominal voltage 24 V DC, range: 10 V DC - 38 V DC
Power consumption	max. 0.7 W at 24 V DC
Loop inductance	allowed range: 20 µH - 2000 µH recommended range: 80 µH – 250 µH 1)
Sensitivity	0,5 % - 0,007 % (frequency change $\Delta f/f_0$ in %)
Loop frequency	30 kHz – 110 kHz
Measuring time	2,5 ms - 20 ms
Hold time	2 s - 12 h, ∞
CAN- Interface	vendor specific telegram definition, specification 2.0A - 11-Bit Identifier, Basic-CAN, bitrate: 10 kBit – 500 kBit, termination resistor 120 □ (adjustable via switch), connection see chapter 8.4.2 and 0
Service interface (at front, “SERVICE“)	USB adapter cable with 3.5 mm stereo phone connector (TRS), label: KA_Service_AJ-USB order number: D.000.604.466
Switching outputs	switching output per channel: Open Collector (not potential free) U_{max} = 38 V DC, I_{max} = 50 mA DC, P_{tot} = 125 mW $I_c \leq$ 50 mA: $U_{cesat} \leq$ 0,4 V
Pulse duration	approx. 100 ms for pulse- and direction signal
Cycle time / reaction time	10 ms ... 80 ms / 10 ms ... 1280 ms, depends on settings of measurement period (2,5 … 20 ms) and oversampling (x1 … x16)
Velocity for vehicle acquisition 2)	with measurement period 2.5 ms and oversampling x2: 200 km/h with measurement period 7.5 ms and oversampling x1: 140 km/h with measurement period 7.5 ms and oversampling x2: 70 km/h
Device protection	Power supply, CAN: suppression-diode loop inputs: gas filled surge arrester, glow lamp, galvanic isolation with transformer
Dimensions	height: 99 mm, length: 114.5 mm, width: 22.5 mm
Operating / storage temperature	-25°C to +80°C / -40°C bis +80°C
Relative humitidy	maximum 95 %, noncondensing
Protection class	III (low voltage < 60 V DC)
Housing	Plastic housing polyamide (PA), IP protection class: 40, flammability classification acc. UL 94: V-0
Mounting	DIN-rail mounting (TS35 EN50022), to be installed in housing or cabinet with IP54 necessary(pollution degree 2)
Connection terminal	see chapter 8.4
Weight	approx. 130 g

1) The inductance of an inductive loop with a circumference of about 5 m to 10 m and 2 to 4 turns and a feed cable up to about 50 m is within the recommended range.

2) Assumption: minimum length of the vehicle about 2 m, the speed limit increases with longer vehicles

8.2 Dimensions and housing layout

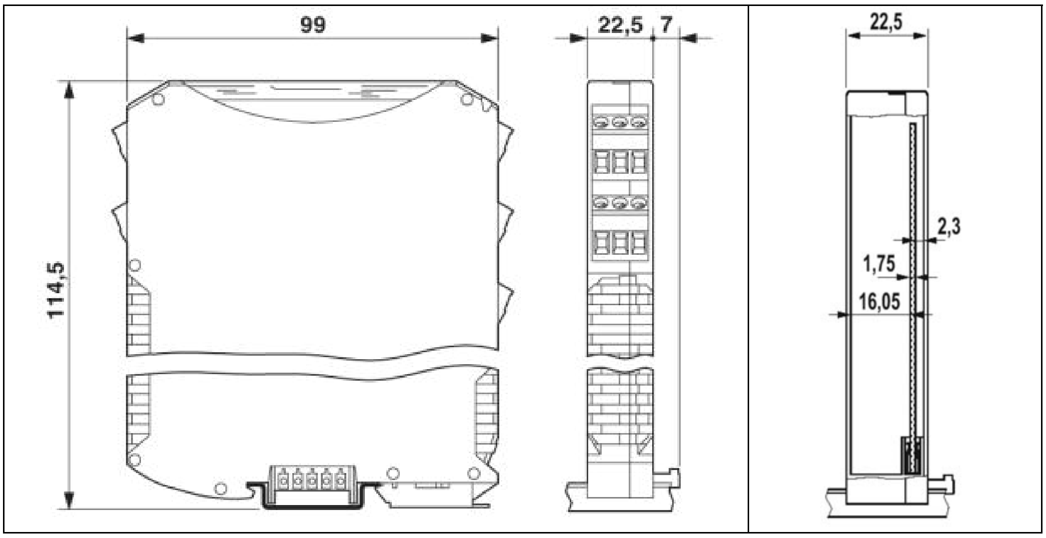


Figure 10: Dimensions (all measurements in mm)

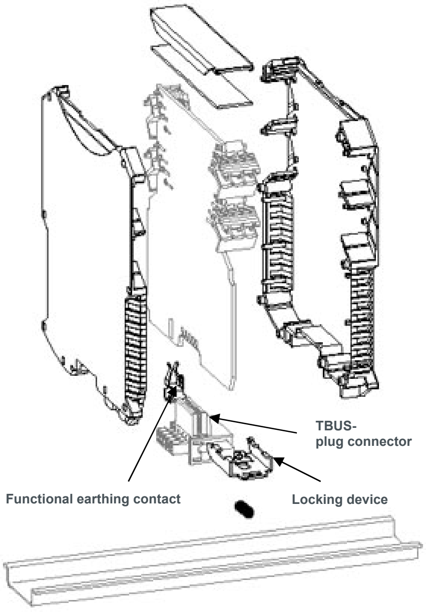


Figure 11: Housing layout

8.3 Mounting and dismounting

The device can be mounted on the DIN-rail by inserting it into the upper brim of the rail and then pressing it down until the locking mechanism at the back snaps into place.
When using a TBUS bus system, the according slots for the TBUS bus connector at the back of the device must be observed.
Afterwards, the correct position must be checked.

To dismount the device, e.g. a suited screwdriver can be placed in the slot at the bottom side of the locking mechanism at the back and then pressed down until the device can be slightly tilted up and taken out.

8.4 Pin assignment

8.4.1 Overvoltage protection of inductive loops

The overvoltage protection of the inductive loops (functional earth) is done via the contact integrated at the back and the DIN-rail. The DIN-rail must be permanently and with low impedance connected with the earth potential (PE).

8.4.2 Connection terminals on top and bottom side

In order to wire individual devices with supply voltage and CAN bus, use the top front connection terminal (several devices: see following chapter).

The Open Collector switching outputs are connected with the upper rear connector terminal, the inductive loops with the connectors at the bottom.

Terminal type: Terminal with screw connection, 4-pole, black,
Conductor cross section (flexible with conductor sleeve): 0.25 – 2.5 mm2
(AWG 24 - 14), included in delivery

Position terminal	Function
top – front	Supply voltage 24 V DC and CAN data bus
top – back	Open Collector switching outputs channels 1 - 4
bottom – front	Induction loops channel 1 and 2
bottom– back	Induction loops channel 3 and 4

Table 8: Overview pin assignment at the top and the bottom

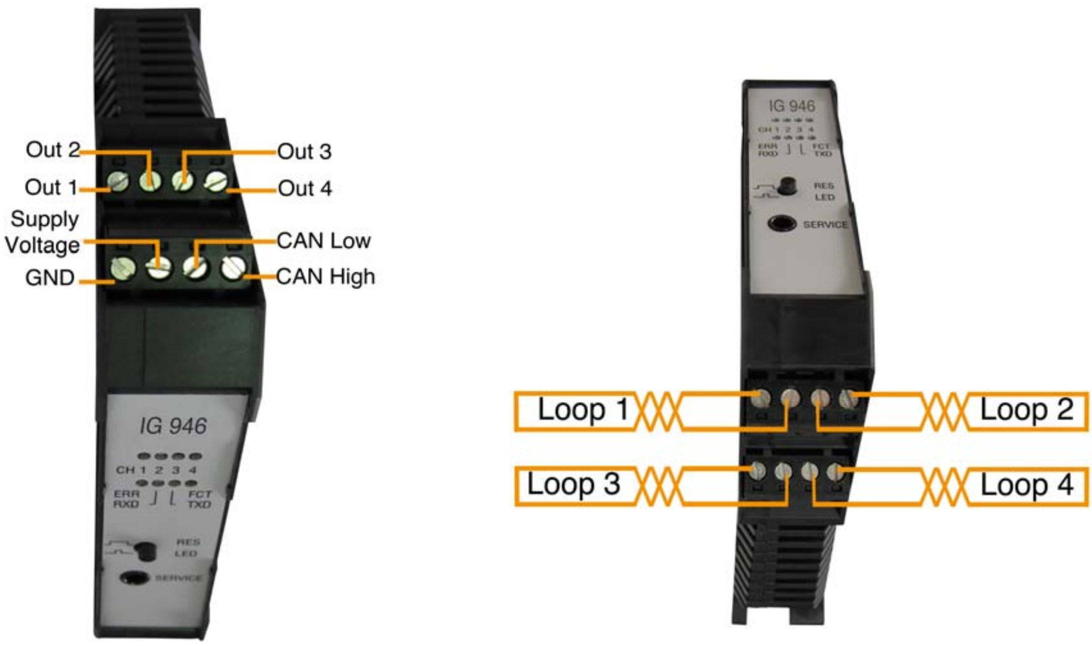
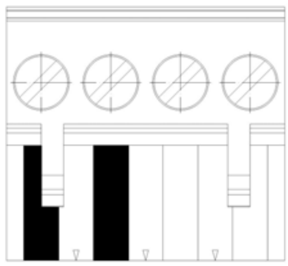


Figure 12: Pin assignment at the top and the bottom

NOTE

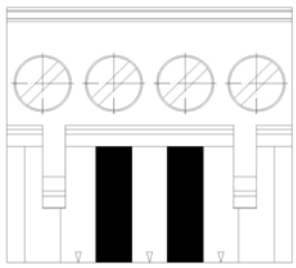
The terminals and connectors have a coding to prevent incorrect connections and thus a possible damage to the unit!

The following figure shows the coding of the terminals. The position of the coding of the connector on the board is oppositely.

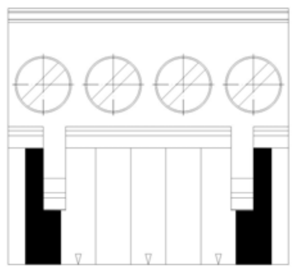


Supply voltage and CAN bus,
connector top – front

Open Collector switching outputs,
connector top – back



Induction loops channel 1 and 2,
connector bottom – front



Induction loops channel 1 and 2,
connector bottom – back

Figure 13: Coding of terminal clamps (black: position of coding profiles)

8.4.3 DIN-rail bus system TBUS

The TBUS bus system which can be integrated in the DIN-rail significantly reduces the effort for wiring several devices. With the bus system the synchronization lines, the CAN data bus and the supply voltage (+ 24 V DC) can be comfortably through-wired. Doing so, the bus connection establishes “itself” within the device grid: snap the bus connector onto the DIN-rail – latch the module – finished.

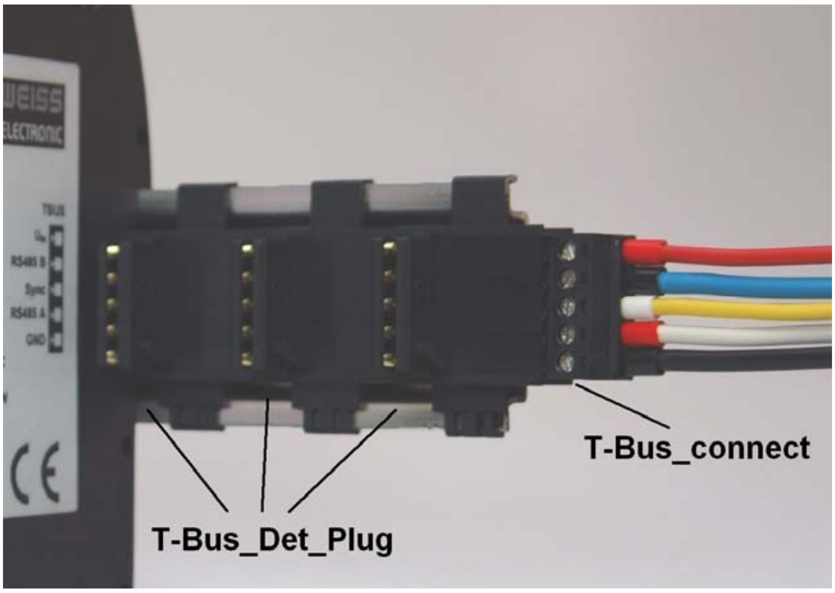


Figure 14: TBUS with bus connector and plug connector

The TBUS bus system includes the bus connectors and a plug connector at the right side where the CAN data bus, the synchronization line (to external detectors) and the supply voltage can be connected:

- Bus connector, 5-pole, black,
  SWARCO TRAFFIC SYSTEMS GMBH article: T-BUS_Det_Plug
  (order no.:D.000.604.507).

- Plug with screw connection, 5-pole, black, Conductor cross section (flexible with conductor sleeve) 0.14 – 1.5 mm2 (AWG 26 - 16),
  SWARCO TRAFFIC SYSTEMS GMBH article: T-BUS_connect
  (order no.: D.000.604.534)

Clamp no. / color Figure 14	Function
5 (top) / red	+ 24 V DC
4 / blue	CAN HIGH
3 / yellow	Synchronization
2 / white	CAN LOW
1 (bottom) / black	GND

Table 9: Pin assignment of the TBUS plug (front view)

Alternatively, for the connection at the TBUS at the side, the supply voltage and the CAN data bus can also be connected via the 4-pole connecting plug at the front top of one device.

The connection of the synchronization with external detectors with identical synchronization method which are not connected with the TBUS can only be done via the plug T-BUS_connect at the side (max. length approx. 1 m). Doing so, the reference potentials GND of the supply voltages of the different detector types must also be connected with each other, if necessary.

8.4.4 Pin assignment service interface (3.5 mm stereo jack plug, TRS)

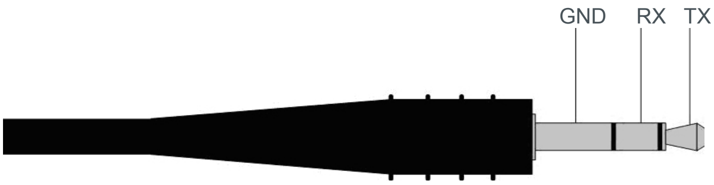


Figure 15: Pin assignment 3.5 mm jack plug

8.5 Requirements for the usage according to regulations

According to DIN EN 60950

The basic insulation of the device requires an exclusive connection of low voltage supply and switching voltages **below 60 V DC**. In addition, the power supplies used for the safe isolation must assure double or reinforced insulation between mains circuits and output voltage.

In compliance with the underlying pollution degree 2 the installation in an enclosure or control panel with at least IP54 is required.

If the device is to be exposed surges above the overvoltage category II, then additional surge protection have to be installed.

According to EN 50293

The length of all connected wires, except induction loops and CAN bus interface, is limited to 3 meters.

Requirements according to ETSI EN 300330-1

For the antenna factor (loop area A in m^2 multiplied by the number of loops turns N) applies:

$$N * A \leq 60 \, m^2$$

Product class 2:	
max. length / width	30 m
area	< 30 m^2
number of turns	≥ 1

Product class 3:	
area	> 30 m^2 <= 60 m^2
number of turns	1

In order to meet the recommended inductance range as well as possible, the following number of loop turns in dependence of the loop area are recommended:

Product class according EN 300300-1	**Area**	**Number of turns**	**L_{loop} [µH]**
2	(1 – 3) m^2	6	100 - 300
	(3 – 5) m^2	5	80 – 260
	(5 – 10) m^2	4	160 – 320
	(10 – 15) m^2	3	180 – 280
	(15 – 30) m^2	2	80 – 180
3	(30 – 60) m^2	1	40 - 100

Installation of loops

For the installation of the inductive loops the documentation “Loop Installation” by SWARCO TRAFFIC SYSTEMS GmbH applies.

8.6 EC Declaration of Conformity

EG-Konformitätserklärung
EC-Declaration of Conformity

Hersteller / manufacturer:	Swarco Traffic Systems GmbH
Adresse / address:	Niederkircher Str. 16
	54294 Trier

erklärt, dass das Produkt / declares that the product

Typ / type:	Induktiver Schleifendetektor / inductive loop detector
Modell / model:	IG946
Verwendungszweck / intended use:	Fahrzeugdetektion / vehicle detection

bei bestimmungsmäßiger Verwendung den grundlegenden Anforderungen gemäß Artikel 3 der R&TTE-Richtlinie 1999/5/EG entspricht und dass die folgenden Normen angewandt wurden:
complies with the essential requirements of Article 3 of the R&TTE 1999/5/EC Directive, if used for its intended use and that the following standards has been applied:

1 Sicherheit / Gesundheit (Artikel 3.1.a der R&TTE-Richtlinie)
safety / health (Article 3.1.a of the R&TTE Directive)

Angewandte Norm(en) / Applied standard(s):	IEC 60950-1	2005 (2nd Edition)/A1:2009
	EN 60950-1	2006/A11:2009/A1:2010/A12:2011

2 Elektromagnetische Verträglichkeit (Artikel 3.1.b der R&TTE-Richtlinie)
electromagnetic compatibility (Article 3.1.b of the R&TTE Directive)

Angewandte Norm(en) / Applied standard(s):	EN 50293	
	ETSI EN 301 489-1	V1.9.2
	ETSI EN 301 489-3	V1.4.1

3 Effiziente Nutzung des Funkfrequenzspektrums (Artikel 3.2 der R&TTE-Richtlinie)
efficient use of the radio frequency spectrum (Article 3.2 of the R&TTE Directive)

Angewandte Norm(en) / Applied standard(s):	ETSI EN 300 330-1	V1.7.1
	ETSI EN 300 330-2	V1.5.1

Trier, 08.05.2013

(Ort und Datum der Konformitätserklärung)
(Place and date of the declaration of conformity)

(Geschäftsführer: Dr.-Ing. Gerhard Ploss)
(managing director)

(ppa. Markus Donell)
(authorised officer)

032QM06

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