INTELLIGENT SENSOR MODULE

ISM 102

User Manual

V 1.10

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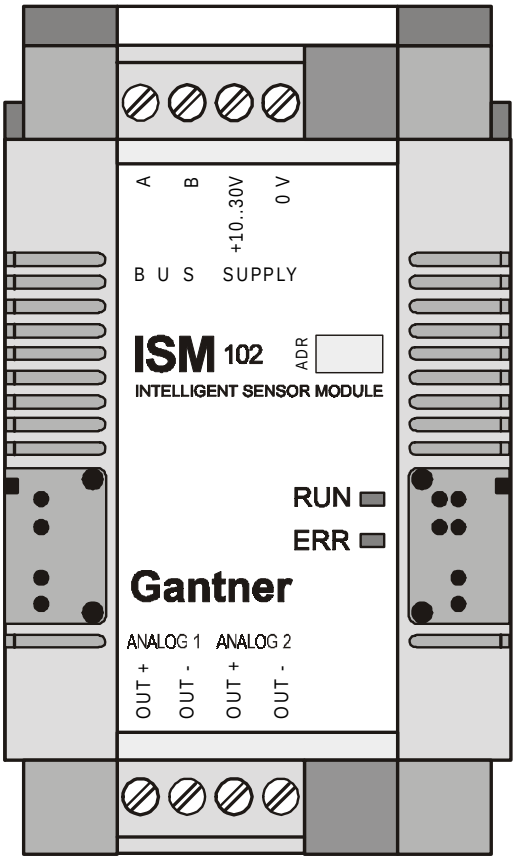
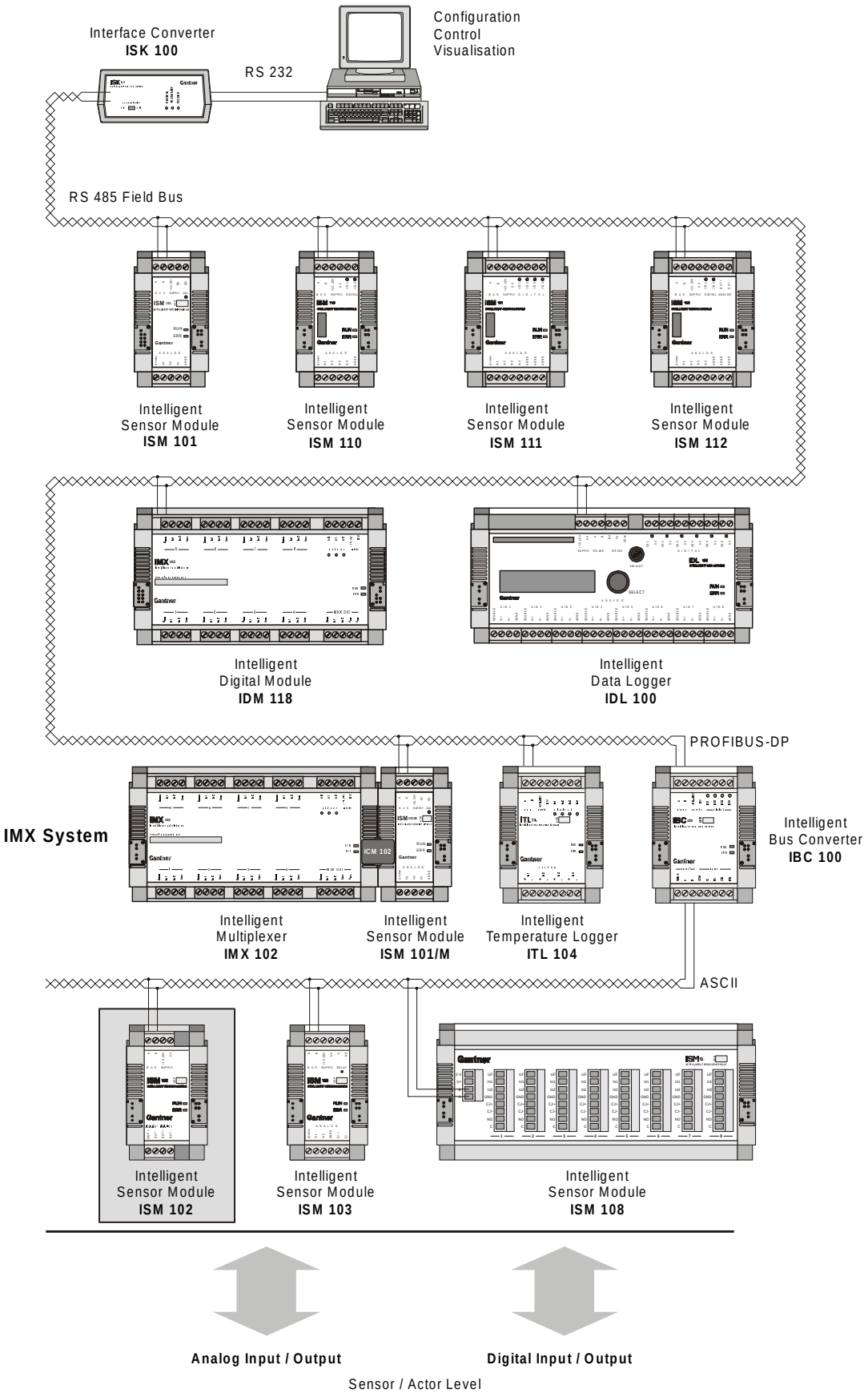
ISM 102



The following persons have cooperated in the development of the ISM-system: Bernd Brugger, Josef Brugger, Reinhold Gantner, Heinz Peter Luef, Ludwig Schwarzhans, Georg Seidlich, Stefan Stocker. This documentation was prepared by Roland Weg.


Interface Converter
ISK 100
RS 232
Configuration
Control
Visualisation
RS 485 Field Bus
Intelligent
Sensor Module
ISM 101
Intelligent
Sensor Module
ISM 110
Intelligent
Sensor Module
ISM 111
Intelligent
Sensor Module
ISM 112
Intelligent
Digital Module
IDM 118
Intelligent
Data Logger
IDL 100
PROFIBUS-DP
IMX System
Intelligent
Bus Converter
IBC 100
Intelligent
Multiplexer
IMX 102
Intelligent
Sensor Module
ISM 101/M
Intelligent
Temperature Logger
ITL 104
ASCII
Intelligent
Sensor Module
ISM 102
Intelligent
Sensor Module
ISM 103
Intelligent
Sensor Module
ISM 108
Analog Input / Output
Digital Input / Output
Sensor / Actor Level

ADVANVED SIGNAL PROCESSING

One of the basic requirements of industrial measurement technology is the efficient, fast, safe, precise and cost-effective processing of a wide variety of sensor signals and status information. The signals must be compatible for their integration into a PLC or PC environment for display, control and monitoring purposes or for control and regulation tasks.

Usually, the output signals of the sensors have to be converted first by transmitters into signals of identical type, afterwards amplified. These analog sensor signals then have to be transmitted together with binary signals to a higher-level central system (PLC, PC) by means of point-to-point wiring. There, analog to digital conversion and the subsequent data processing has to be performed.

The advanced *Intelligent Sensor Modules ISM* by *Gantner Electronic GmbH* combine all these functions in one system. The *Intelligent Sensor Modules ISM* are multi-channel, programmable measurement data transducers with an integrated bus interface. They are designed for flexible, versatile and adaptable applications where measured data has to be collected, prepared, digitized, monitored, controlled and transmitted. A great number of tasks may be performed with only one system, independent of the problem definition. The intended functions of a module may be defined by configuring the module on a PC. Then the configuration can be downloaded to the module by transmission via the bus interface. As a remote, on-site signal pre-processing and networked peripheral piece of equipment, the *Intelligent Sensor Modules ISM* are the ideal link between sensors, process control (PLC) and process visualization (PC).

CHAPTERS

page

TABLE OF CONTENTS

Page

Page

1. GENERAL INTRODUCTORY REMARKS

1.1. About this Manual

This manual contains all important information concerning the function, installation and setup of the *Intelligent Sensor Modules ISM 102*.

Description of the *Configuration Software ICP 100* (*"ICP 100 Lite"* only for *ISM 101* but without PROFIBUS-DP support, *"ICP 100 Standard"* for all Sensor Modules of the series *"100"* but without PROFIBUS-DP support, *"ICP 100 Advanced"* for all Sensor Modules of the series *"100"* with PROFIBUS-DP support and modem communication for *IDL 100*) is available as a separate manual and is supplied together with the *Configuration Software ICP 100*.

1.2. Important Notice

Make sure to use the *Intelligent Sensor Modules ISM 102* exclusively in accordance with the notices, technical data and operating conditions mentioned in this manual. In case of inexpert handling or wrong application possible disturbances, measuring errors, effects on or from other appliances and facilities as well as possible endangering of human lives or tangible assets cannot be excluded!

Therefore if you have not yet worked with the *Intelligent Sensor Modules ISM 102*, this manual should be studied thoroughly. While setting up or operating the appliance or in case service is required always observe the notices given in this manual.

Please note further that there are other special regulations to be observed in case of application in potentially explosive surrounding (EExe, EExi, ...). These are not, however, the subject of this manual, which only explains the general use of the *Intelligent Sensor Modules ISM 102*.

1.3. Contact for Inquiries

In case of inquiries concerning the *Intelligent Sensor Modules ISM 102* please get in touch with your representative / distributor or directly with one of the *Gantner Electronic GmbH* branch offices. The addresses, phone and fax numbers are listed on the inner side of the cover.

2. SYSTEM DESCRIPTION

2.1. System Overview

The *Intelligent Sensor Modules ISM 102* are part of a complete system for the remote acquisition and processing of sensor signals and digital status information. The general abbreviation term for this system of *Intelligent Sensor Modules* is *"ISM".*

Several system types of the *Intelligent Sensor Modules ISM* are available for various applications. Basically, these types differ by the number of their digital and analog inputs/outputs, the number of configurable sensor channels, their display and operating options and by the number of arithmetic functions.

The modules of the series *"100",* which consists of the *IBC 100*, *IDL 100*, *IDM 118*, *ISM 101/M*, *IMX 102*, *ISM 102*, *ISM 110*, *ISM 111*, *ISM 112* and *ITL 104* are freely configurable, multi-channel sensor modules. The on-site data display and module operation can be performed with an *Infrared Remote Control IRC 100*. The *Intelligent Sensor Modules ISM 101* and *ISM 103* as an efficient, freely-configurable, one-channel module, and the *ISM 108* which consists of 8 one-channel Sensor Modules, complete the ISM-series.

2.2. Range of Application

The *Intelligent Sensor Module ISM 102* is a two-channel device for fast and accurate control of up to 2 actors via its 2 analog voltage outputs. Both output channels of the *ISM 102* may be configured via the serial RS 485 interface with the *Configuration Software ICP 100*.

2.3. Performance Features

The performance features of the *Intelligent Sensor Modules ISM 102* are as follows:

Function:

- Monitoring of output values within programmable threshold values
- Detection of communication errors
- Programmable error handling

Outputs:

- 2 analog voltage outputs

Power Supply:

- Power supply: +10 ... +30 VDC
- All connections protected against excess voltage, excess current and wrong connection of polarity
- DC-isolation between power supply, analog outputs and RS 485 bus interface

Display and Operation:

- Status-LED for operation (green) and malfunction (red)

Configuration:

- Configurable with PC-software under Windows 95™ and Windows NT™
- Free configuration of the output channels
- Display of output connection
- Setting of the output limits
- Programmable error handling
- Configuration on file (offline-operation)
- Configuration via bus (online-operation)

Programming:

- Allocation of address, baud rate, data format and protocol via bus
- Automatic search for all connected sensor modules independent of the defined bus parameters

Communication:

- Integrated RS 485 communication interface
- Selectable transmission protocol (ASCII / PROFIBUS / PROFIBUS-DP / MODBUS)
- Simple instruction set

Chassis:

- Compact shape and attractive design
- Fast installation / mounting
- Snap-on mounting on DIN rail 35 mm
- Protection system IP 20
- Detachable terminal strip
- separate Cold Junction Terminal
- Rapid Bus Link Plug

3. INSTALLATION

3.1. Installation / Mounting

The *Intelligent Sensor Modules ISM* of the "*100*" series have a snap-on mounting mechanism for installation onto 35 mm standard profile rails according to DIN EN 50022. The installation position is arbitrary.

Modules can be mounted onto a profile rail by four snap-tabs on the backside of the module. First, push the two bottom snap-tabs into the lock seam of the DIN rail. Afterwards, press the module towards the profile rail until the two top snap-tabs snap in.

In order to remove the module from the profile rail, slide the module sideward off the rail. In case that is not possible, lift the module slightly until the top snap-tabs come off the lock seam, then tilt the module and take it off the profile rail.

3.2. Protective System

The sensor modules have an IP 20 protective system. If required by the conditions of the operating site, the modules have to be installed accordingly, e.g. in a water-resistant or water-proof case, compliant with the regulations of electrical engineering.

3.3. Ambient Temperature

Ambient temperature for the *Intelligent Sensor Module ISM 102* in operation must not exceed the range of -20 °C to +60 °C. The permissible range of storage temperature is between -30°C and +85°C.

3.4. Front Side of Module / Terminal Connection Assignment

Attachment accessories and display elements on the front side of the *ISM 102* are described in the following figure.

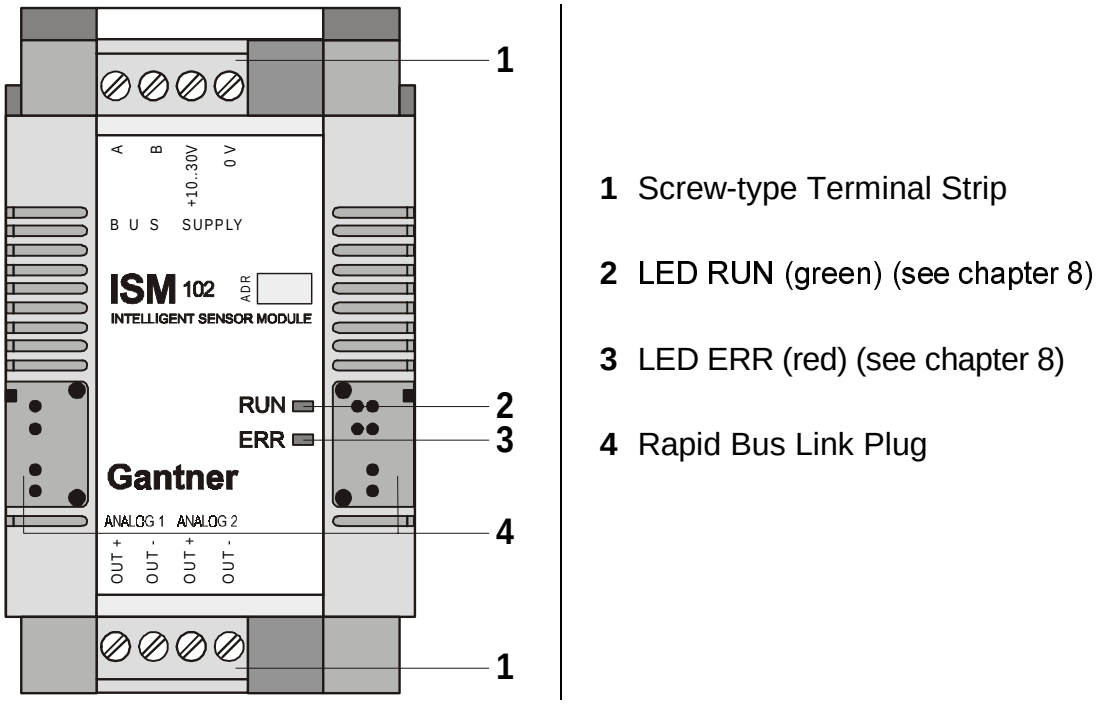


Figure 3.1 Front Side View of ISM 102

Terminal	Identification
A	RS 485-Bus Interface A*
B	RS 485-Bus Interface B*
+10..30 VDC	Voltage Supply +
0 V	Voltage Supply -

Terminal	Identification
OUT +	Analog Output 1
OUT -	Analog Output 1
OUT +	Analog Output 2
OUT -	Analog Output 2

* The terminal designations A and B of all modules of the ISM-series *"100"* are exchanged compared with the PROFIBUS-definitions. Consequently, in multi-vendor systems the bus lines A and B must be exchanged when connecting them to a module of the ISM-series.

Table 3.1 Terminal Assignment

3.5. Connection Technique

- connection technique: plug-in screw-type terminal strip
- nominal cross section: 1.5 mm² unifilar/fine-strand (AWG 16)
- stripped wire length: 6 mm

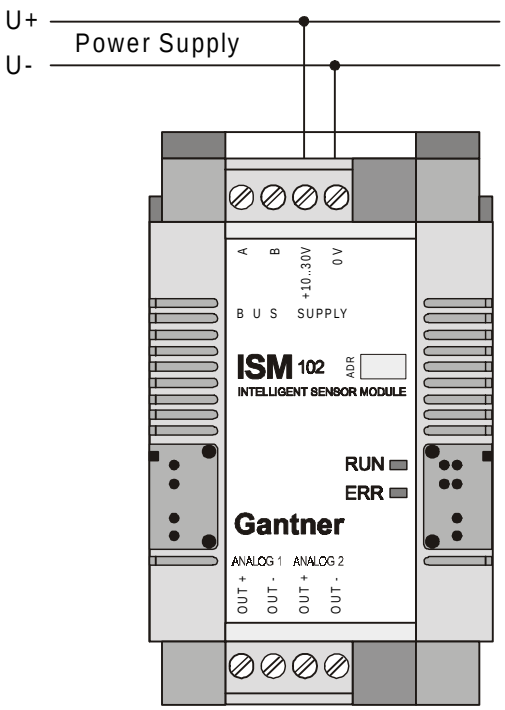
Connecting of wires to the module is performed via screw-type terminals. The terminal screws are part of the terminal strips. All terminal strips are of plug-in type and can be detached from the module. To take the plug-in terminal strips off the module simply use a small screwdriver as a lever to lift the terminal strip.

No more than 2 leads should be connected with one clamp. In this case both leads should have the same conductor cross section. For the precise clamping of stranded wire we recommend the use of wire-end ferrules.

Notice: Connection of wiring respectively the plugging-in and -out of the terminal strip is only allowed with modules in power-off status.

Notice: In order to prevent interference with sensors, signals and modules, shielded cables have to be used for the power supply, bus connection and signal lines.

3.6. Power Supply



Voltage Range
- ❑ +10 ... +30 VDC

Power Input
- ❑ max. 2.0 W

External Fuse
- ❑ max. 1 A

Internal Fuse (reversible)
protection against
- ❑ excess current
- ❑ excess voltage
- ❑ connecting wrong polarity

Figure 3.2 Connection of the Power Supply

Non-regulated DC voltage between +10 and +30 VDC is sufficient for the power supply of the modules. The input is protected against excess voltage, current and polarity connecting error. The power consumption remains approximately constant over the total voltage range, due to the integrated switching regulator.

Due to their low current consumption (max. 50 mA at 10 VDC) the modules can also be remotely supplied via longer lines. Several modules can be supplied in parallel within the permissible voltage range and drop in the lines. If required, the supply lines together with the bus line may be incorporated in one cable.

In order not to overload the module power supply needlessly and to avoid unnecessary line troubles, a separate power supply is recommended for sensors with a large current drain.

The distribution voltage for the *Intelligent Sensor Modules ISM 102* has to be protected by a fuse with maximum 1 A (inert).

3.7. Earthing

The case of the *Intelligent Sensor Modules ISM 102* has to be connected to earth. For this purpose an M3-thread for attaching an earthing wire is located on the backside of the case.

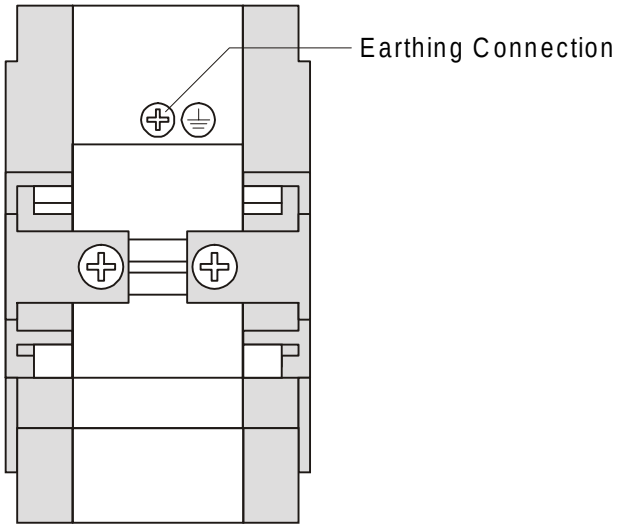


Figure 3.3 Earthing Connection of ISM 102

3.8. Lightning Protection

If the supply, signal, and data lines are installed between several buildings, appropriate protection against lightning must be made, e.g. by:

- Laying the cables in metal tubes which are earthed on both sides
- Laying the cables in concrete cable ducts with fed-through shielding over total cable length
- Using a lightning-protected wire

The lines must be wired with elements protecting against excess voltage at the point where they enter a building, e.g. with varistors or excess voltage conductors filled with an inert gas.

3.9. Bus Connection

In general, the sensor module is connected with the bus by connecting both signal leads A and B of the incoming bus cable and A' and B' of the outgoing bus cable together to one terminal on the module (Figure 3.4).

Alternatively, the bus can also be connected by a "stub cable" (Figure 3.5).

Due to the removable terminal strip, the bus connection to other modules remains in place, even if one module has to be exchanged.

Notice: The stub-cable should be as short as possible, not longer than 30 cm.

Notice: The terminal designations A and B of all modules of the ISM-series *"100"* are exchanged compared with the PROFIBUS-definitions. Consequently, in multi-vendor systems the bus lines A and B must be exchanged when connecting them to a module of the ISM-series.

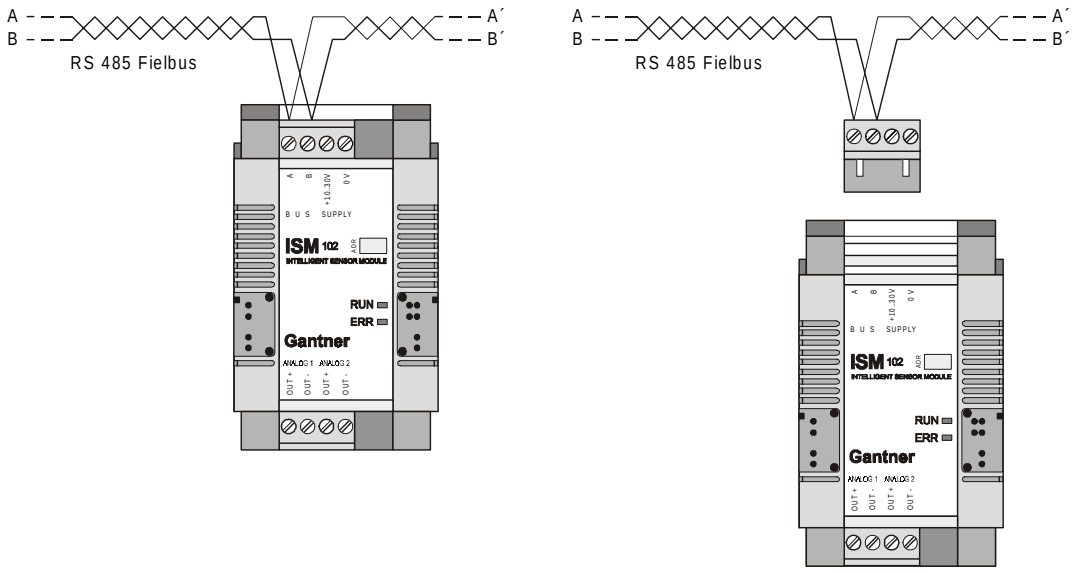


Figure 3.4 Connection of the ISM 102 to the Bus

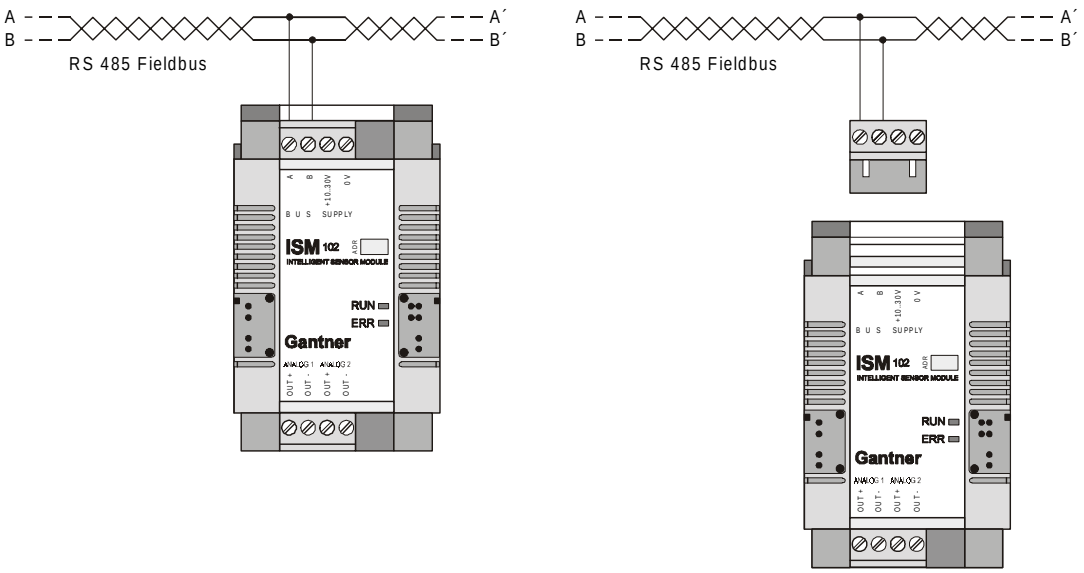


Figure 3.5 Connection of the ISM 102 to the Bus by a Stub Cable

3.10. Rapid Bus Link Plug *ICM 100*

The *Intelligent Sensor Modules ISM* of the series *"100"* have terminals on the left and right side which allow for connecting the bus and power supply from one module to the next with a Rapid Bus Link Plug (type designation: *ICM 100*).

This novel kind of connecting bus and power supply is particularly advantageous if several modules are mounted on one common profile rail side by side. In this case, only the terminal of one module has to be connected.

Furthermore, various modules of the series *"100"* may be connected with the Rapid Bus Link Plug (e.g. *ISM 102* with *ISM 110, ISM 111*, *ISM 112* and *IRK 100*).

Notice: The current flowing through the Rapid Bus Link Plug Jack and the Sensor Module must not exceed the permissible limits. Thus, the power supply should preferably be connected to the middle of several modules and no more than 6 pieces of *ISM 102* modules may be connected via the Rapid Bus Link Plug *ICM 100* in one line.

Notice: The *Intelligent Digital Module IDM 165* has a 230 VAC power supply. This module only allows the connecting of the bus **not** the power supply - via the Rapid Bus Link Plug to the adjacent module.

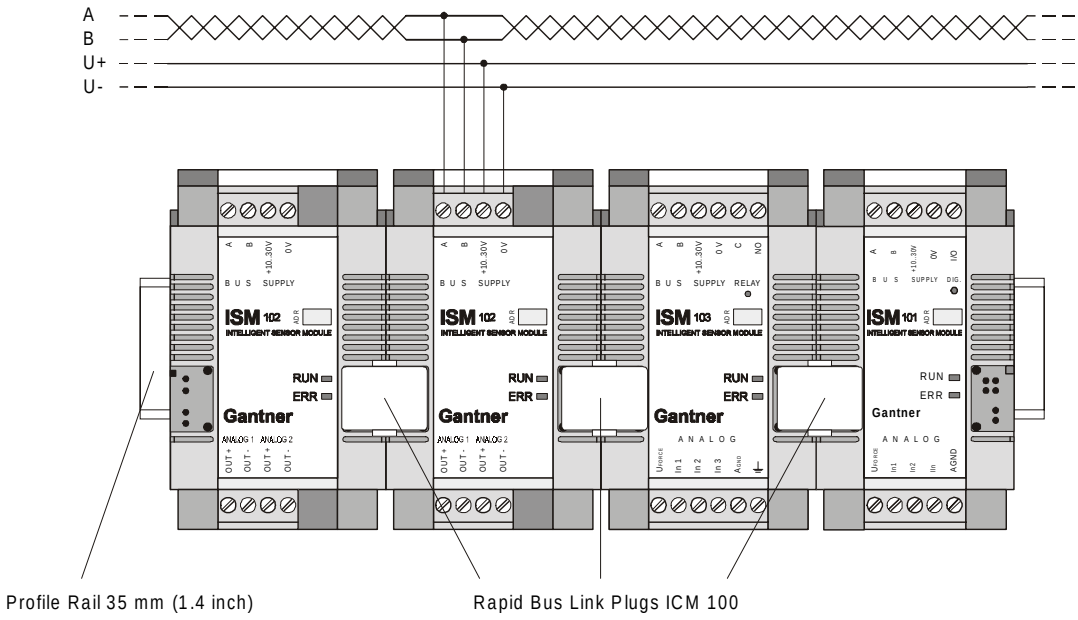


Figure 3.6 Connection of four ISM 102 by Rapid Bus Link Plugs ICM 100

3.11. DC-Isolation

The power supply, bus interface and the analog signal inputs are DC-isolated from each other. This can schematically be described as follows:

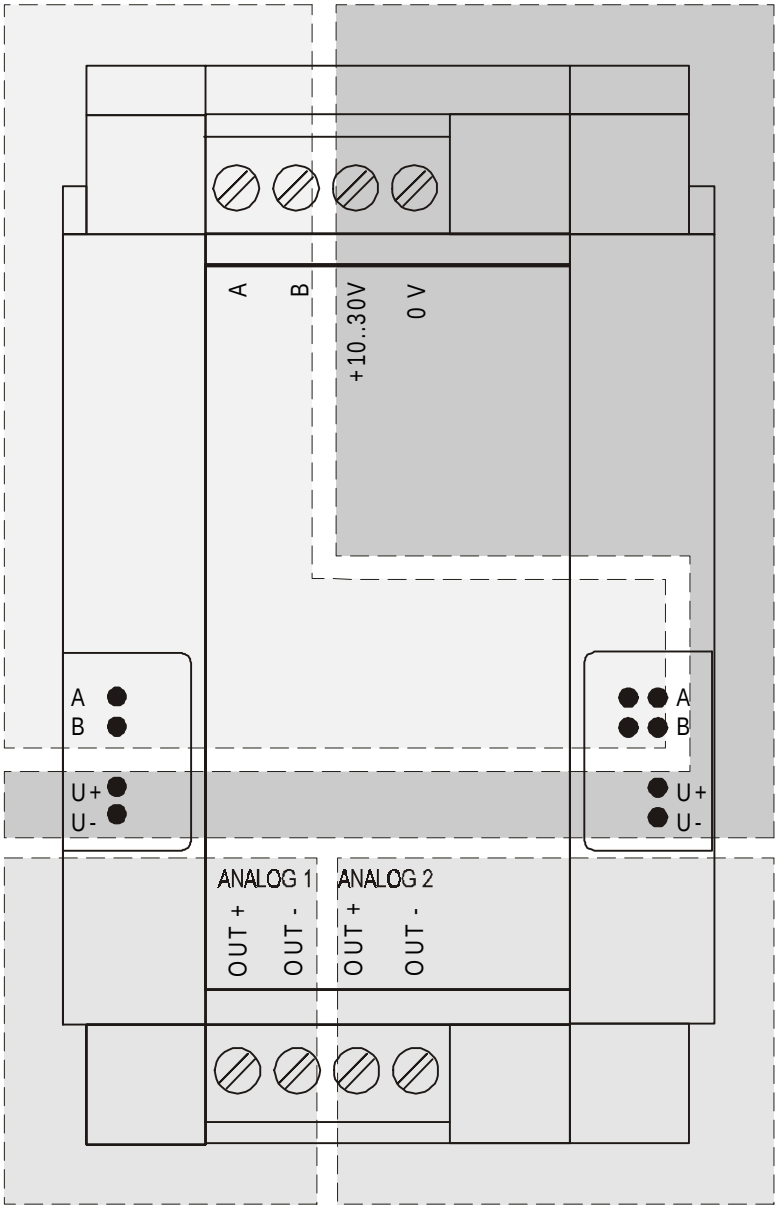


Figure 3.8 DC Isolation of the ISM 102 (Schematic)

4. STRUCTURE OF THE BUS TOPOLOGY

The *Intelligent Sensor Modules ISM 102* may be connected to a communication bus via an integrated RS 485 interface in the module. The bus topology is characterised by the following features:

- ***Bus Interface:***
  RS 485, half duplex

- ***Bus Topology:***
  line pattern, terminated at both ends by the characteristic impedance, stub cable length to user is max. 30 cm.

- ***Bus Medium:***
  shielded, twisted pair cable

- ***Transmission Speed:***
  ASCII-protocol: 4.800 / 9.600 / 19.200 / 38.400 bit/s
  PROFIBUS-protocol: 4.800 / 9.600 / 19.200 / 38.400 bit/s
  PROFIBUS-DP-protocol: 9,6 / 19,2 / 500 kbit/s
  MODBUS-protocol: 4.800 / 9.600 / 19.200 / 38.400 bit/s

- ***Line Length:***
  depends on the transmission speed, max. 1.2 km per bus segment, max. 4.8 km via a physical bus string using 3 repeaters.

- ***Number of Bus Users:***
  max. 32 bus users per bus segment, max. 127 bus users via a physical bus string.

4.1. Bus Interface

The bus interface in the sensor modules is an RS 485 interface. Compared to the traditional RS 232 connections, there are several advantages, such as the capacity for a larger number of users, higher transmission speed, less susceptibility to interference and increased line length (which is a frequent requirement).

4.2. Bus Structure

The bus structure is a line structure where each bus segment will be terminated with characteristic impedance on both ends. Branches can be set up by means of a bi-directional signal amplifier, so-called repeaters. Other types of branches are not permitted (no tree topology). The max. stub-length to a user must not exceed 30 cm.

The following figures show a few examples of possible bus topology set-ups. The meanings of the symbols are as follows:

- ☐ : bus user
- ▢ : repeater
- ■ : bus termination

Figure 4.1 Simple Line Structure

Figure 4.2 Extended Line Structure

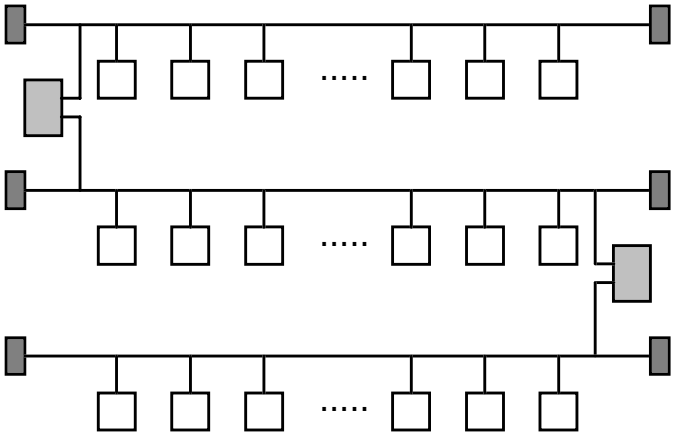
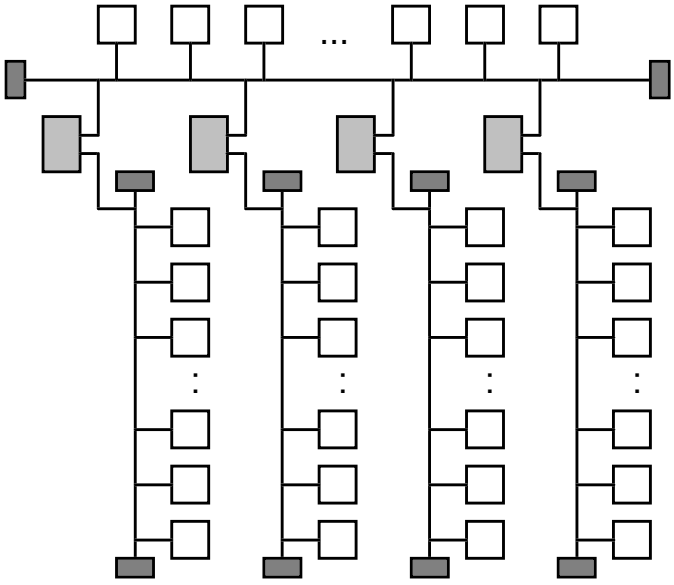


Figure 4.3 Line Structure with Branches



4.3. Number of Users

The RS 485-interface permits simultaneous connection and operation of a maximum of 32 bus users per bus segment. Further bus segments can be set up via bi-directional repeaters, and thus the number of bus users can be increased to a max. of 127.

4.4. Transmission Speed and Line Length

The transmission speed of the *Intelligent Sensor Modules* can be adjusted for each bus protocol. The permissible line length decreases with increasing transmission speed. At transmission speeds below 93,75 kbit/s, line length may go up to 1,200 m per bus segment; at 500 kbit/s the line length is 600 m per bus segment (specifications according to USA-standard EIA RS 422-A). Thus, at lower baud rates and with 3 repeaters, topologies with a dimension of max. 4.8 km may be set up.

Transmission Speed	Line Length	
	without Repeater	with 3 Repeaters
≤ 93.75 kbit/s	max. 1.200 m	max. 4.800 m
500 kbit/s	max. 600 m	max. 2.400m

Table 4.1 Relationship Between Transmission Speed and Line Length

Notice: These specifications refer to bus cables with a conductor cross section of 0.22 mm² and a permissible signal attenuation of max. 6 dB across the total length. According to previous experience, the line length can be twice as long if a two-wire line with a conductor cross section of at least 0.5 mm² is used.

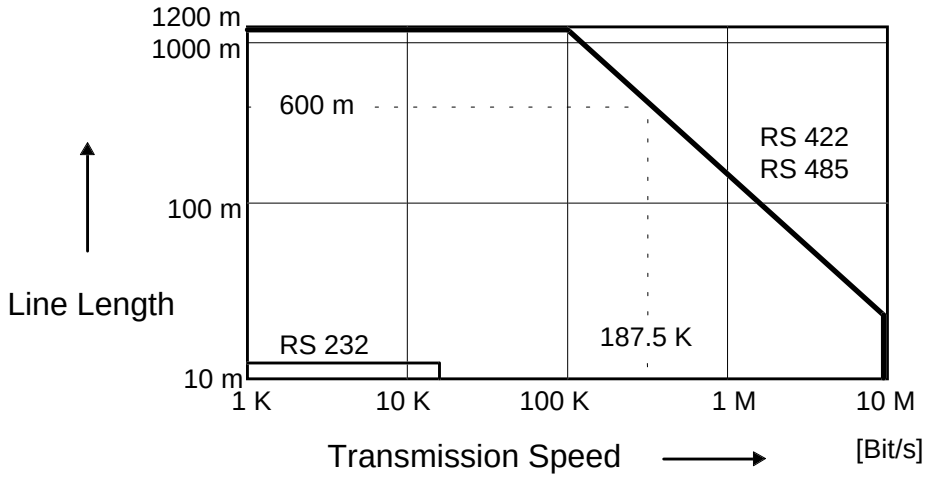


Figure 4.4 Relationship Between Transmission Speed and Line Length

4.5. Bus Cable

For setting up a bus topology, a shielded twisted pair with at least two leads and the following electric characteristic values must be used:

- Characteristic Impedance : 100 ... 130 Ω at f > 100 kHz
- Operating Capacity : max. 60 pF/m
- Conductor Cross Section : min. 0.22 mm² (AWG 24)
- Attenuation : max. 6 dB Across the Total Length

4.6. Bus Plug

For the installation of the bus cable and bus interface, 9-channel D-subminiature plugs and sockets are used. The pin assignment for the RS 485 connection according to PROFIBUS is given in Table 4.2.

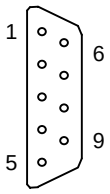
Plug	Pin	RS 485 Notation	Signal	Identification
 DB 9	1	-	Shield	Shield, Protective Ground
	2	-	RP	Reserved for Power
	3	B / B´	RxD/TxD-P	Receive/Transmit-Data-P
	4	-	CNTR-P	Control-P
	5	C / C´	DGND	Data Ground
	6	-	VP	Voltage Plus
	7	-	RP	Reserved for Power
	8	A / A´	RxD/TxD-N	Receive/Transmit-Data-N
	9	-	CNTR-N	Control-N

Table 4.2 Pin Assignment D-Subminiature Plug According to PROFIBUS

The signal leads A and B (and Shield) are mandatory for a (shielded) connection. Additional signal leads may be installed if required.

4.7. Bus Termination at the *ISM 102*

In order to avoid signal reflections on the bus, each bus segment has to be terminated at its physical beginning and at its end with the characteristic impedance. A terminating resistor R_t is installed

between the bus leads A and B for this purpose. In addition, the bus lead A is connected via a pull-up resistor R_u to potential (VP) and the bus lead B is connected via a pull-down resistor R_d to ground (DataGround). These resistors provide a defined quiescent potential in case there is no data transmission on the bus. This quiescent potential is level *high*.

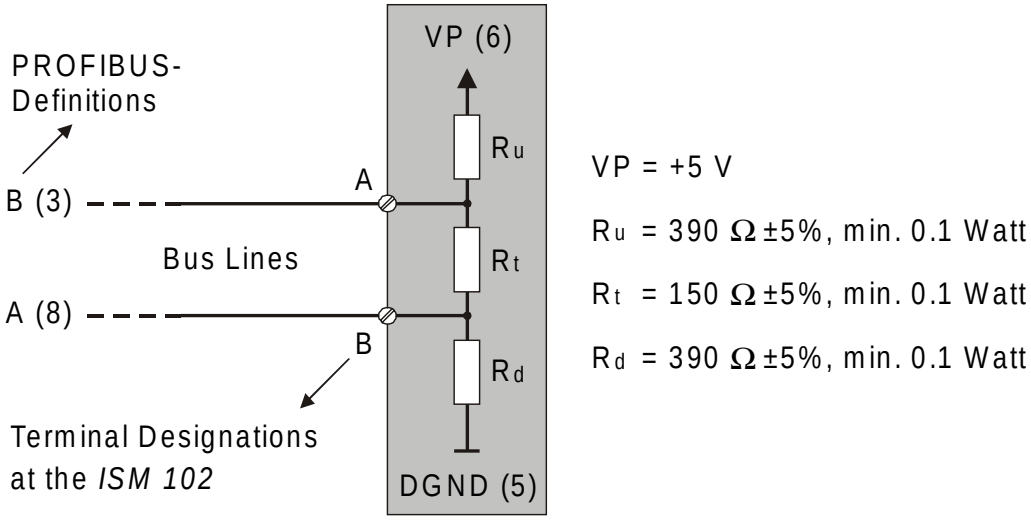


Figure 4.5 Bus Termination

Notice: The terminal designations A and B of all modules of the ISM series *"100"* are interchanged compared to the PROFIBUS-definitions. Consequently, in multi-vendor systems the bus lines A and B must be exchanged when connecting them to a module of the ISM-series.

Notice: The numbers in parentheses in Figure 4.5 indicate the pin number for the connection to the 9-channel D-subminiature plug.

The bus termination can either be made with external resistors and a separate power supply according to Fig. 4.5 and independent of the module. In this case we recommend using the indicated resistors for the bus termination.

As an alternative, the bus termination is connected with the bus users at the beginning and at the end of a bus line. Most of the RS 485 connections of controllers, computers, repeaters, interface converters, etc. offer this option.

Also, the *Intelligent Sensor Module* of the *"100"* series offers this possibility. Via the bus termination plug *IBT 100* which is available as accessory and installed at the right port on the front side of the module, the bus termination may be connected to the module. Two jumpers, which connect the bus with the bus termination in the module, are integrated in the bus termination plug.

Notice: Instead of the bus termination plug *IBT 100*, also separate jumpers may be used for the bus termination. In this case, it is mandatory that the jumper clips are installed as indicated below, and that the bus leads or the bus termination are not short-circuited by mistake.

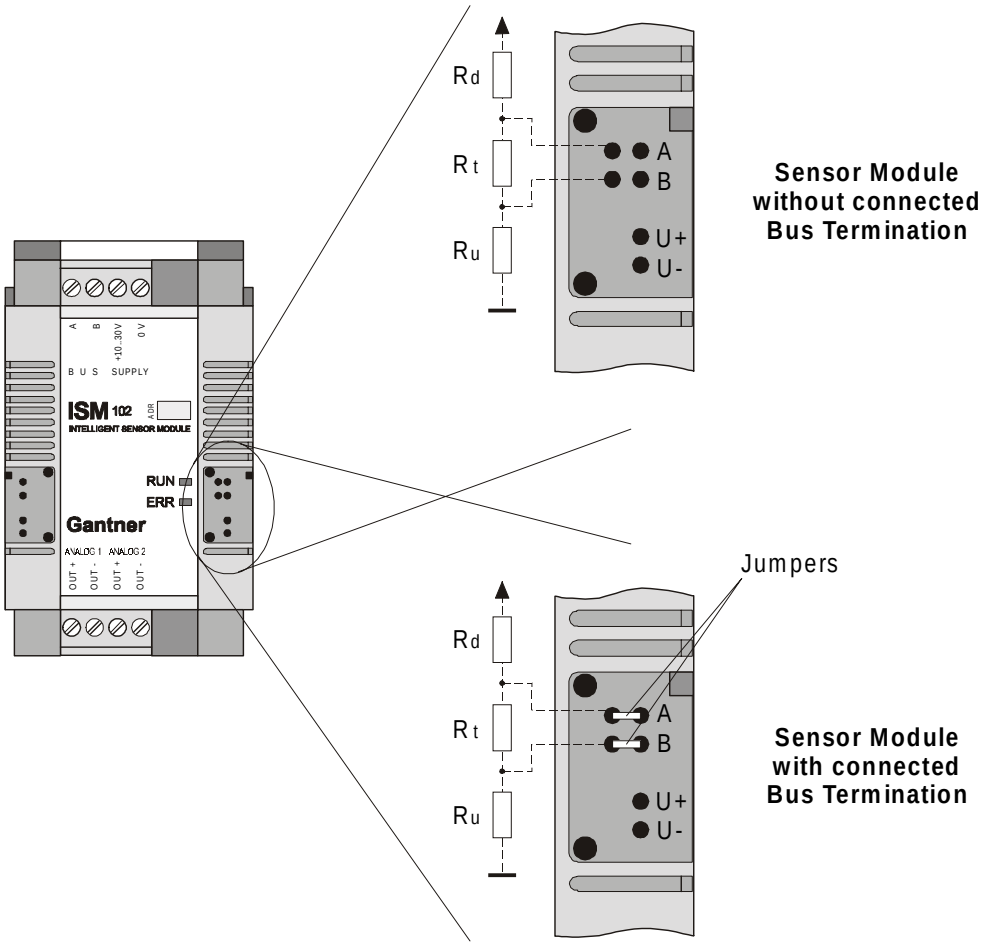


Figure 4.6 Bus Termination at the ISM 102

4.8. Shielding

In case of increased interference, such as in industrial areas, we recommend shielding of power supply, bus, and signal cables.

There are varying experiences and recommendations concerning the best way to connect shielding. In general, the shield should be connected to the protective earthing (not DataGround!) at each bus connection. If necessary, the shield should also be applied along the course of the cable several times.

For shorter distances, e.g. with stub cables, the interference response is often improved if the shielding is only applied to the stub cable exit.

Bus users such as controllers (PLCs), computers (PCs), repeaters and interface converters (ISK), etc., generally feature the possibility of applying the shield directly to the appliance or to separate shield rails. Shield rails offer the advantage of preventing possible interfering signals from reaching the appliance. The shields which are connected to protective earthing conduct interference signals off before reaching the module.

The *Intelligent Sensor Modules ISM 102* do not have a direct shield connection at the module. Here the shield of the bus cable can be connected to earth e.g. by so-called shield clamps.

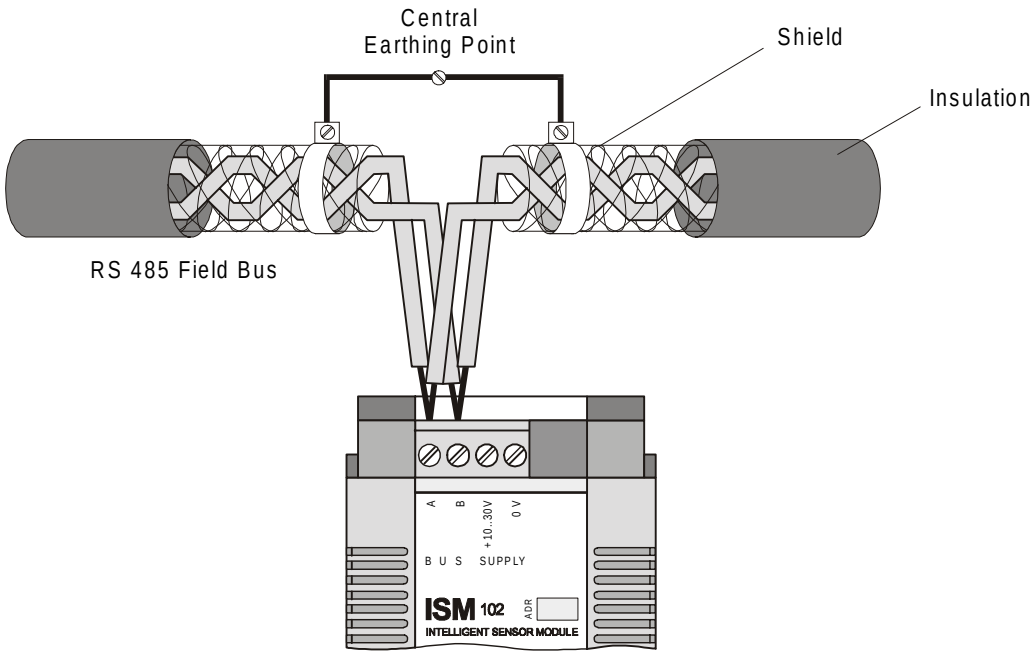


Figure 4.7 Earthing of the Bus Line Shield at the ISM 102

Notice: The shielding screen must not be connected to the ground (0V) of the power supply!

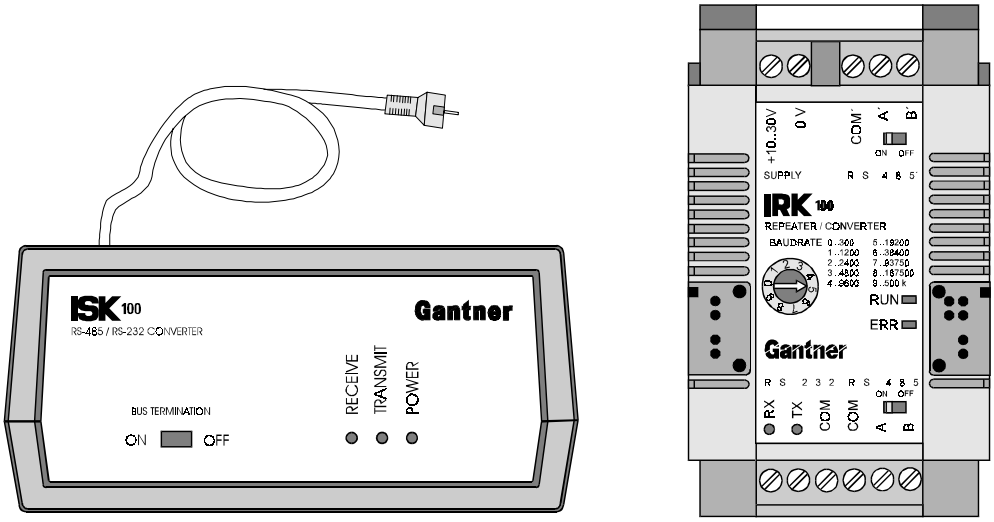
Notice: The shielding screen should always be connected to earth with a large surface and low-inductance.

4.9. PC Bus Connection

The bus interface of the sensor module is based on the RS 485-standard. Since most hosts are "only" equipped with RS 232-interfaces, an interface converter or a plug-in board with RS 485 drivers is required for conversion purposes.

Gantner Electronic GmbH offers a compact interface converter, called *ISK 100,* with an integrated power supply and automatic baud rate detection. The power supply, bus connection and a separate 24 VDC-output are DC-isolated. Therefore, the interface converter *ISK 100* is also applicable as a power supply for remote applications. Additionally, the interface converter *ISK 100* features the option of connecting the required bus termination via a switch. The converter is designed to be used as a desk device.

Another module *IRK 100* from *Gantner Electronic GmbH* is available which may be used as an RS 485-repeater or RS 485/RS 232-converter. The baud rate can be adjusted at the *IRK 100.* Also, for this module the required bus termination may be connected with a switch. The Repeater/ Converter *IRK 100* has a snap-on mounting mechanism for the installation on standard profile rails (DIN rail) 35 mm according to DIN EN 50022.



Interface Converter ISK 100 ***Repeater/Converter IRK 100***

Figure 4.8 Interface Converters ISK 100 and IRK 100

4.10. Equipotential Connecting of Modules

The potential difference between all data related connections DGND within the network must not exceed ±7 Volt. If this cannot be guaranteed, all modules have to be equipotentially connected. For most of the connections this means that the minus connection of the power supply has to be fed-through as a compensating line from connection to connection. Since the *Intelligent Sensor Modules* of the "100" series have a power supply that is DC-isolated from the bus, the *ISM 102* does not need to be equipotentially connected.

4.11. Adjustment of Address and Baud Rate

Before a controller (PLC) or computer (PC) can exchange data with a sensor module via the bus, address and baud rate for the sensor module have to be defined. The following points must be taken into consideration:

- ❑ All devices have to be adjusted to the same baud rate.
- ❑ The same address must not appear twice in the bus topology.

Table 4.3 shows the setting variants of the bus parameters for the *Intelligent Sensor Modules*:

Bus Parameters	ASCII-/PROFIBUS-Protocol	PROFIBUS-DP-Protocol	MODBUS-Protocol
Address	1 127	1 126	1 127
Baud Rate	4,800 bits/s	-	4,800 bits/s
	9,600 bits/s	9,6 kbits/s	9,600 bits/s
	19,200 bits/s	19,2 kbits/s	19,200 bits/s
	38,400 bits/s	-	38,400 bits/s
	-	500 kbits/s	-

Table 4.3 Setting Variants of Address and Baud Rate for the Intelligent Sensor Modules

If no other specifications are delivered with the sensor modules, default factory setting of parameters are: address 1, baud rate 38,400 bits/s and ASCII/PROFIBUS-protocol with data format 8E1.

It is a prerequisite for the adjustment of the bus parameters via bus that there should never be two or more sensor modules having the same address on the bus. In such a case, those sensor modules having the same address, the bus connection must be disconnected or the supply voltage must be interrupted for the duration of the new adjustment.

The adjustment or modification of the bus parameters via bus is always performed with the *Configuration Software ICP 100*. The values are accepted as soon as the data transmission via bus has been completed successfully. The procedure is described in the manual for the *Configuration Software ICP 100*.

Notice: The address 0 cannot be assigned to the sensor modules. It is reserved for the PC in case of transmission via PROFIBUS.

Notice: The address 127 is reserved for broadcast transmission in the PROFIBUS-DP-protocol and is used only in this case by the PROFIBUS-DP-master.

5. SIGNAL PROCESSING

5.1. Analog Outputs

The analog outputs can be used for controlling actors or for regulating purposes. The output is defined as a voltage output and can be set via the RS 485 interface by means of the *Configuration Software ICP 100*:

The analog output will be assigned by a D/A-converter with a resolution of 14 bit. He is dc decoupled from the remaining device by an optocoupler.

Notice: When connecting an actor to an analog output it is necessary to take care that this actor does not exceed the maximal burden of 1.2 kΩ of the output.

5.2. Internal Processing

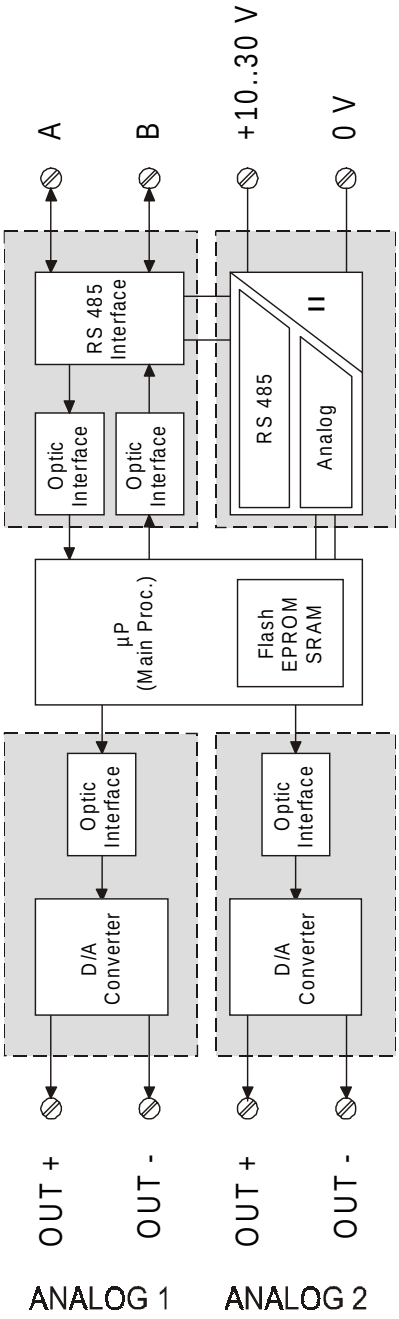


Figure 5.1 Functional Diagram of the ISM 102

5.3. Measurement Rate

The D/A-converters update the output signal at a rate of 1 kHz.

6. FUNCTIONAL DESCRIPTION

6.1. Analog Output Variable

The *Intelligent Sensor Modules ISM 102* have 2 output variables which can be used to control various actuators. The Analog Output Variables have the function of a voltage output. The limit values for the voltage range can be set between -10 and +10 VDC by means of the *Configuration Software ICP 100*.

The output values are set via the serial interface, e.g. from a PC. For each variable various settings like the transformation between the source values and the output values, a startup value, the type of response in case the output range is exceeded and the error handling at a communication timeout can be determined. The variable set-ups are carried out by means of the *Configuration Software ICP 100*.

Output of Analog Signals:

Connection Scheme ***Circuit***

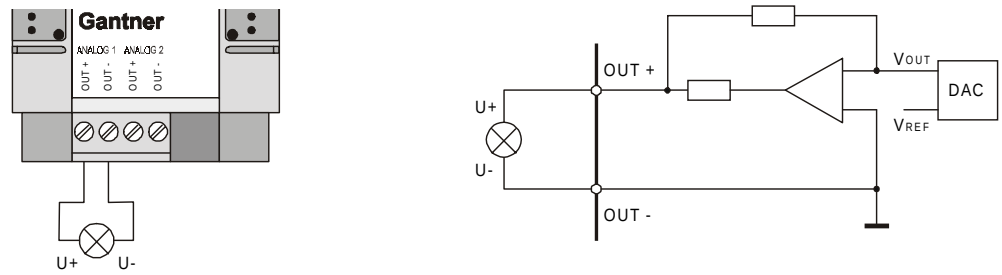


Figure 6.1 Analog Signal Output

With the analog signal output the value, which is assigned to the Analog Output Variable, will be transformed into a voltage value, according to the definition, and output. Thus the lowest defined value corresponds to the lower limit value of the measuring range (≥ -10 VDC) and the highest defined value corresponds to the upper limit value of the measuring range (max. +10 VDC). The values between these two points will be calculated by the *Intelligent Sensor Module ISM 102* based on a linear characteristic.

The actualizing rate of the output values is 1 kHz where as the swing-in rate of the output will be 2 ms to 0.012 % of the set value.

6.2. Error Handling

The *Intelligent Sensor Modules ISM 102* are able to independently detect if the output values exceed the defined output range and if the communication is interrupt. The user can preset a certain module response for the occurrence of these errors via the *Configuration Software ICP 100*.

By default, the limit value of the measurement range is returned in case of an error or defect.

7. SETUP AND TEST

7.1. Before Connecting to the Power Supply

Before connecting the power supply with the Sensor Module, make a final check of the device as to its appropriate installation and correct voltage adjustment. It is absolutely essential that the Sensor Modules be connected to earth according to the regulations, and that the voltage supply does not exceed the specified +30 VDC for all sensor modules.

7.2. After Connecting to the Power Supply

After the voltage supply is connected, the sensor module displays the current operating state on the two LEDs at the front of the device. The meanings of the LEDs are given in Table 8.1 on the next page.

7.3. Configuration of the Sensor Module

Before starting operation, the Sensor Module has to be programmed and configured as to its specific application. In most cases the programming has already been performed in the factory before delivery (see status of RUN-LED and ERR-LED, Table 8.1). The configuration has to be carried out by the user with the *Configuration Software ICP 100* on a PC. This procedure is described in detail in the corresponding manual for the *Configuration Software*.

RUN (green LED)	ERR (red LED)	Indication
off	off	The supplied voltage has been selected too low or the power supply cannot supply the required power.
flashes	off	Data from the Sensor Module is being retrieved by a master system via bus.
	flashes	There is a sensor error detected by the module. Possible causes may be: 1. wrong configuration, 2. line break or short-circuit, 3. measured value too large or too small, 4. DAC-communication error.
on	off	The supply voltage has been connected correctly. There is no error. Data transmission to the module via bus is not active.
	on	There is a sensor error detected by the module. Possible causes may be: 1. wrong configuration, 2. line break or short-circuit, 3. measured value too large or too small, 4. DAC-communication error.
short off	short on	A software error has occurred the sensor module via bus to a control system or to a PC.

Table 7.1 Meaning of the LEDs (Flash Frequency, Approx. 1Hz)

8. COMMUNICATION

8.1. General

There are 3 possible protocol combinations that can be used with the *Intelligent Sensor Module ISM 102*. The firmware software, that is loaded into the *ISM 102*, determines the used protocols.

- PROFIBUS-DP / ASCII-Gantner / PROFIBUS Layer 2
  Software identification: **P**x.xx

- MODBUS-RTU / ASCII-Gantner / PROFIBUS Layer 2
  Software identification: **R**y.yy

- LOCAL-BUS / ASCII-Gantner / PROFIBUS Layer 2
  Software identification: **F**z.zz

The LOCAL-BUS protocol is a binary protocol which has been defined by Gantner Electronic®. It is used in combination with an *Intelligent Bus Converter IBC 100* (Concentrator) in test bed systems. The protocol is not public.

8.2. ASCII-Protocol

8.2.1. Instruction Set

Check Sum	Request Telegram	Response with Orderly Performence	Response in Case of Error
Read Device Identification			
With	# aa V cc <cr>	> v..v cc <cr>	NAK
Without	$ aa V <cr>	= v..v <cr>	NAK
Read Device Information			
With	# aa S cc <cr>	> s..s cc <cr>	NAK
Without	$ aa S <cr>	= s..s <cr>	NAK
Read Status Information			
With	# aa Z cc <cr>	> z..z cc <cr>	NAK
Without	$ aa Z <cr>	= z..z <cr>	NAK
Read Variable Information			
With	# aa B kk cc <cr>	> b..b cc <cr>	NAK
Without	$ aa B kk <cr>	= b..b <cr>	NAK
Read Data From a Variable			
With	# aa R kk cc <cr>	> d..d cc <cr>	NAK
Without	$ aa R kk <cr>	= d..d <cr>	NAK
Write Data to a Variable			
With	# aa W kk d..d cc <cr>	ACK	NAK
Without	$ aa W kk d..d <cr>	ACK	NAK

Table 8.1 Instruction set in ASCII-protocol

Char	Meaning	Length	Range
#	Start delimiter for request telegram with check sum	1	ASCII "#"
>	Start delimiter for response telegram with check sum	1	ASCII ">"
$	Start delimiter for request telegram without check sum	1	ASCII "$"
=	Start delimiter for response telegram without check sum	1	ASCII "="
<cr>	End delimiter (carriage return)	1	*hex* 0D
ACK	Positive acknowledge	1	*hex* 06
NAK	Negative acknowledge	1	*hex* 15
aa	Destination address	2	ASCII "01".."7F"
cc	Check sum	2	ASCII "00".."FF"
kk	Variable number	2	ASCII "01".."02"
v..v	Device identification	26	ASCII - String
s..s	Device information	27	ASCII - String
z..z	Status information	4	ASCII - String
b..b	Variable information	29	ASCII - String
d..d	Variable value	max. 8	ASCII - String

Table 8.2 Explanation of command characters in ASCII-protocol

8.2.2. Instruction Parameters

Device Identification (v...v)			Length = 26 Char
<Vendor Name>	ASCII	("Gantner_")	8 Char
<Model Name>	ASCII	("ISM-102_")	8 Char
<HW Version>	ASCII	("xy.yy")	5 Char
<SW Version>	ASCII	("xy.yy")	5 Char

x = " P" ... PROFIBUS-DP / ASCII-Gantner / PROFIBUS Layer 2 prog.
x = " R" ... MODBUS-RTU / ASCII-Gantner / PROFIBUS Layer 2 prog.
x = " F" ... LOCAL-BUS / ASCII-Gantner / PROFIBUS Layer 2 prog.
y.yy ..... Version

Device Information (s...s)		Length = 23 Char
<Location>	ASCII	16 Char
<Serial Number>	ASCII	6 Char
<Number of Variables>	ASCII	1 Char

Status Information (z...z)		Length = 6 Char
<Variable Status>	ASCII	4 Char
<Module Status>	ASCII	2 Char

	Variable 1		Variable 2		
<variable st.> =	K16..K13	K12..K9	K8..K5	K4..K1	= *hex* 0XYZ
	0	X	Y	Z	*ASCII* "0XYZ"
<module st.> =	M8 M7 M6 M5		M4 M3 M2 M1		= *hex* XY
	X		Y		*ASCII* "XY"

If the bit Kn in the variable status is set it indicates that an error has occured in the corresponding variable. A variable error is given when the measuring value is outside of the linearization, e.g. in consequence of a sensor break down or of a short circuit of transmission.

If the bit Mn in the module status is set it indicates that an error has occured in the sensor module. Valid is:

K1 = 1: Over Range Channel 1 K9 = 1: Over Range Channel 2
K2 = 1: Under Range Channel 1 K10 = 1: Under Range Channel 2
M4 = 1: Configuration Error

Variable Information (b...b)		Length = 25 Char
<Variable Type>	ASCII	1 Char
<Variable Name>	ASCII	16 Char
<Data Format>	ASCII	1 Char
<Field Length>	ASCII	1 Char
<Decimals>	ASCII	1 Char
<Unit>	ASCII	4 Char
<Host Input>	ASCII	1 Char

Coding <Variable Type>:
ASCII "A": Analog Output Variable (AO)

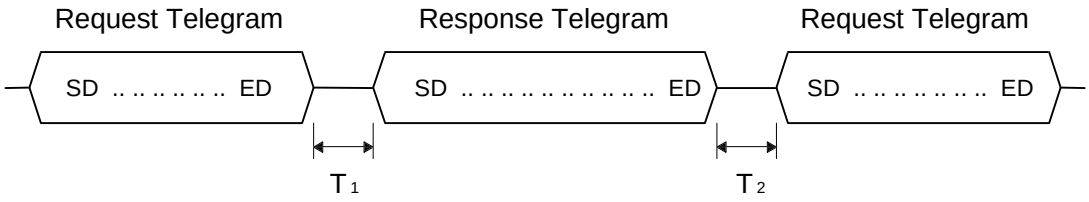
Coding <Data Format>:
ASCII "2": INTEGER

Coding <Host Input>:
ASCII "1": host input is possible (analog output)

8.3. PROFIBUS-Protocol

8.3.1. Transmission Sequence

In the PROFIBUS- or PROFIBUS-DP-protocol the data are transmitted from and to the sensor module by means of the following sequence:



T_1: Time Between Request-Telegram and Corresponding Response-Telegram

T_2: Time Between Response-Telegram and Next Request-Telegram

The minimum and maximum occurring values for T_1 and T_2 and the adjustment range may be taken from the following Table 8.3 for PROFIBUS and Table 8.3 for PROFIBUS-DP.

Protocol	Baud Rate	T_1	T_{2min}	T_{2max}
Adjustable		No	No	Yes
PROFIBUS	4,800 bit/s 9,600 bit/s 19,200 bit/s 38,400 bit/s	1.5 CT (16 BT)	3 CT	Arbitrary

Table 8.3 Values and Adjustment Range for the T_1 and T_2 (PROFIBUS)
CT: Character Time: 1 CT = Character Length [bit] / Baud Rate [bit/s]
BT: Bit-Time: 11 BT = 1CT

Protocol	Baud rate	T_{1min}	T_{1max}	T_{2min}	T_{2max}
Adjustable		Yes	Yes	No	Yes
PROFIBUS-DP	9.6 kbit/s 19.2 kbit/s 500 kbit/s	1 CT	5.5 CT (60 BT)	3 CT	10 ms to 650 s

Table 8.4 Values and Adjustment Range for the Times T_1 and T_2 (PROFIBUS-DP)
CT: Character Time: 1 CT = Character Length [bit] / Baud Rate [bit/s]
BT: Bit-Time: 11 BT = 1CT

Notice: The values for T_{1min} and T_{2max} and the response of the sensor module in case the time T_{2max} is exceeded (communication timeout, see also chapter 6.2, error handling) can be adjusted by means of the *Configuration Software*. The default values for the times are set to:

T_1 = 1.5 CT (for PROFIBUS-protocol)
T_{1min} = 1 CT (for PROFIBUS-DP-protocol)
T_{2max} = 3 CT

8.3.2. Telegram Format

For data transmission via PROFIBUS and PROFIBUS-DP the following telegram formats are relevant for the *Intelligent Sensor Module*:

Formats with fixed information section length without data field:

SD1	DA	SA	FC	FCS	ED

Formats with variable information section length with data field:

SD2	LE	LEr	SD2	DA	SA	FC	DataUnit	FCS	ED

For PROFIBUS and PROFIBUS-DP various telegrams differ by varying Start-Delimiters (SD). They can also be called SD1- and SD2- telegrams in this context. The telegram formats are valid both for request and response telegrams. However, a request telegram does not necessarily have to be followed by a response telegram of the same format. In addition, there is a telegram which consists of only one character and is used as an either positive or negative acknow-ledgement, according to the kind of request.

Short Acknowledgement:

SC

SD: *Start-Delimiter (length = 1 byte):*
The Start-Delimiter SD marks the beginning of a telegram. It has the following values in the PROFIBUS-protocol:

Telegram Format	Request Telegram	Response Telegram	Data Field Length
SD1	hex 10	hex 10	0
SD2	hex 68	hex 68	1 ... 246 (32)

Table 8.5 Start-Delimiter (SD) in the PROFIBUS-Protocol

LE: *Length (Length = 1 Byte):*
The Length LE defines the length of the telegram with variable data field length (SD2-telegram) and comprises the characters from DA to DataUnit. Thus it corresponds to the length of DataUnit+3 and can assume values between 4 and 249. In the PROFIBUS-DP-protocol the maximum length of the data field is generally limited to 32 bytes.

LEr: *Length-Repeated (Length = 1 Byte):*
The Length-Repeated LEr corresponds to the specification Length LE. It is stated again in the telegram for data protection control purposes.

DA: *Destination-Address (Length = 1 Byte):*
The Destination-Address DA defines the address of the communication partner to whom the data should be transmitted or from whom data is requested. Destination-Address can assume values from 0 to 127 in the PROFIBUS-protocol and 0 to 126 in the PROFIBUS-DP-protocol (address 127 is reserved for the Global Control Command). It is stated here as a hexadecimal value (hex 00 .. 7F or 7E).

SA: *Source-Address (Length = 1 Byte):*
The Source-Address SA defines the address of your own appliance and is communicated to the communication partner with the telegram. Source-Address can assume values from 0 to 127 and 0 to 126 in the PROFIBUS-DP-protocol (*hex* 00 .. 7F or 7E).

FC: *Frame-Control (Length = 1 Byte):*
The Frame-Control FC defines the type of telegram (request or response telegram), the type of station (passive or active station), the type of data transmission (send and/or request data, with or without acknowledgement, etc.) and the telegram acknowledgement (successful or unsuccessful transmission). For the complete

listing, coding and meaning of the Frame-Control see the PROFIBUS-Norm DIN 19245, part 1 and part 3 or EN 50170.

ReqDataUnit: *Request-Data-Unit (Length = 0 ... n Byte):*
The Request-Data-Unit marks a data field in the request telegram which contains the data for the communication partner with the DA address.

ResDataUnit: *Response-Data-Unit (Length = 0 ... n Byte):*
The Response-Data-Unit marks a data field in the response telegram which contains the data for the calling communication partner.

FCS: *Frame-Check-Sequence (Length = 1 Byte):*
The Frame-Check-Sequence FCS defines the check sum of the telegram. In the PROFIBUS- and PROFIBUS-DP-protocol this is the sum of the ASCII-values from DA to DataUnit *modulo* 256: CheckSum_PROFIBUS = [DA+SA+FC+DataUnit] mod 256. The value is stated as a hexadecimal value (*hex* 00 .. FF).

ED: *End-Delimiter (Length = 1 Byte):*
The End-Delimiter ED defines the end of the telegrams. In the PROFIBUS- and PROFIBUS-DP-protocol it has the value *hex* 16.

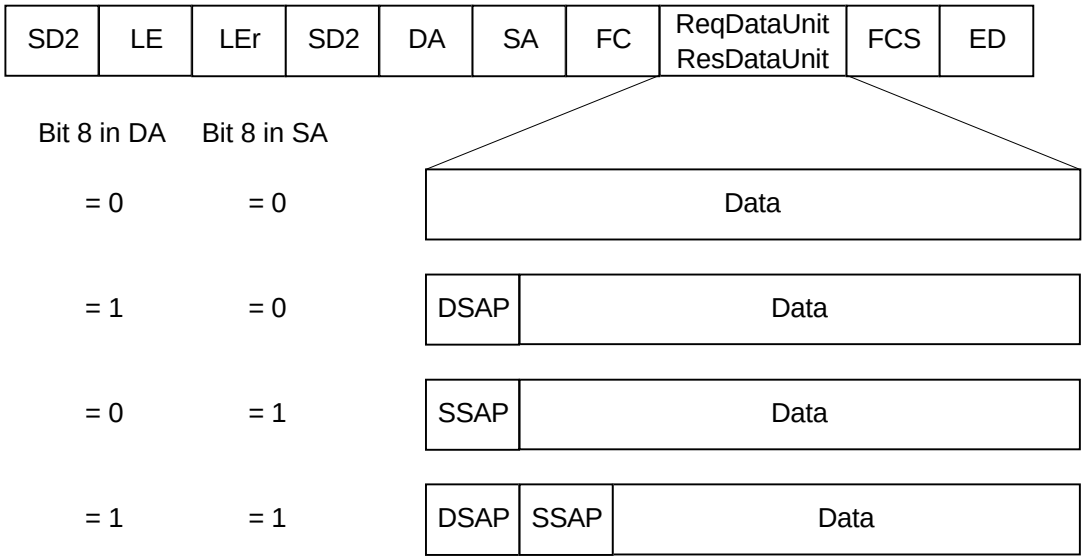
SC: *Short-Acknowledgement-Frame (Length = 1 Byte):*

The Short-Acknowledgement-Frame SC defines a telegram that can be sent back to the communication partner as an acknowledgement. With SDA-requests it can be used as a positive receive acknowledgement. With SRD-requests it can be returned as a negative acknowledgement.

8.3.3. Instruction Set

Layer 2-Access in PROFIBUS- and PROFIBUS-DP-Protocol:
With PROFIBUS each bus user owns a so-called "service access points" (SAPs), via which he can exchange data with communication partners. With the *Intelligent Sensor Modules* the SAPs are used for identifying (addressing) the various data and commands of the sensor module. By specifying the DSAP-number (DSAP: Destination SAP) in the data field of the request telegram the sensor module can be informed as to which data should be transmitted or which function the sensor module should carry out. The sensor module can also be programmed to send data back to its own SAP (SSAP: Source SAP).

Request/Response Telegram (Example SD2-Telegram):



A DSAP- or SSAP-entry is marked by setting the highest bit in the address byte of either the Destination-Address (DA) or Source-Address (SA). The entry itself is carried out in the first or the second position in the ReqDataUnit data field.

The DSAP- and SSAP-entries in the request telegram also appear in the response telegram, where DA, SA, DSAP and SSAP in the response telegram correspond to SA, DA, SSAP and DSAP in the request telegram!

If no address expansion is carried out in the request telegram, the orders are carried out via the Default-SAP. The Default-SAP has the number 0. It does not have to be indicated separately in the telegram.

DSAP and SSAP entries are only possible with telegrams with data field (SD2 telegrams).

PROFIBUS - Layer 2 Commands			
DSAP	**Service**	**Data to Module (ReqDataUnit)**	**Data from Module (ResDataUnit)**
Read Device Identification			
0	Ident	No Data	<Ident>
Read status information			
10	SRD	No Data	<Status>
Read device information			
11	SRD	No Data	<Ginfo>
Read channel information			
12	SRD	<Channel Number>	<Kinfo>

Table 8.6 PROFIBUS - Layer 2 - Commands

Notice: If more data is sent in the ReqDataUnit than required, it will be ignored.

PROFIBUS-DP - Commands			
DSAP	**Service**	**Data to Module (ReqDataUnit)**	**Data from Module (ResDataUnit)**
Transfer of Input and Output Data (Data_Exchange)			
0	SRD	<Outp_Data>	SC
Check Configuration Data (Chk_Cfg)			
62	SRD	<Cfg_Data>	SC
Send Parameter Data (Set_Prm)			
61	SRD	<Profibus_DP_Parameter>	SC
Read Diagnostic Data (Slave_Diag)			
60	SRD		<Diag_Data>
Read-out Configuration Data (Get_Cfg)			
59	SRD		<Cfg_Data>
Control Commands (Global_Control)			
58	SDN	<Control_Command>	
Read Outputs (RD_Outp)			
57	SRD		<Outp_Data>
Read Inputs (RD Inp)			
56	SRD		SC

Table 8.7 PROFIBUS-DP - Commands

Notice: If more data is sent in the ReqDataUnit than required, it will be ignored.

The <Profibus_DP_Parameter> are comprised of: Stations_Status, WD_Fact1, WD_Fact2, Min_Tsdr, Ident_Hi, Ident_Lo und Group_Ident. For a more detailed description see the PROFIBUS-DP-Standard DIN 19245, part 1 and part 3 or EN 50170.

8.3.4. Instruction Parameters

PROFIBUS:

<Ident> Device Identification	Length = 30 Byte

<Length Vendor Name> ..... Binary (Hex 08) ..... 1 Byte
<Length Model Name> ..... Binary (Hex 08) ..... 1 Byte
<Length HW Version> ..... Binary (Hex 05) ..... 1 Byte
<Length SW Version> ..... Binary (Hex 05) ..... 1 Byte
<Vendor Name> ..... ASCII ("Gantner_") ..... 8 Byte
<Model Name> ..... ASCII ("ISM-102_") ..... 8 Byte
<HW Version> ..... ASCII ("Hy.yy") ..... 5 Byte
<SW Version> ..... ASCII ("xy.yy") ..... 5 Byte

x = " P" ... PROFIBUS-DP / ASCII-Gantner / PROFIBUS Layer 2 prog.
x = " R" ... MODBUS-RTU / ASCII-Gantner / PROFIBUS Layer 2 prog.
x = " F" ... LOCAL-BUS / ASCII-Gantner / PROFIBUS Layer 2 prog.
y.yy ..... Version

<Ginfo> Device Information	Length = 22 Byte

<Location> ..... ASCII ..... 16 Byte
<Serial Number> ..... ASCII ..... 6 Byte

<Status> Status Information	Length = 6 Byte

<Variable Status> ..... ASCII ..... 4 Char
<Module Status> ..... ASCII ..... 2 Char

	Variable 1		Variable 2		
<variable st.> =	K16..K13	K12..K9	K8..K5	K4..K1	= *hex* 0XYZ
	0	X	Y	Z	*ASCII* "0XYZ"
<module st.> =	M8 M7 M6 M5		M4 M3 M2 M1		= *hex* XY
	X		Y		*ASCII* "XY"

If the bit Kn in the variable status is set it indicates that an error has occured in the corresponding variable. A variable error is given when the measuring value is outside of the linearization, e.g. in consequence of a sensor break down or of a short circuit of transmission.

If the bit Mn in the module status is set it indicates that an error has occured in the sensor module. Valid is:

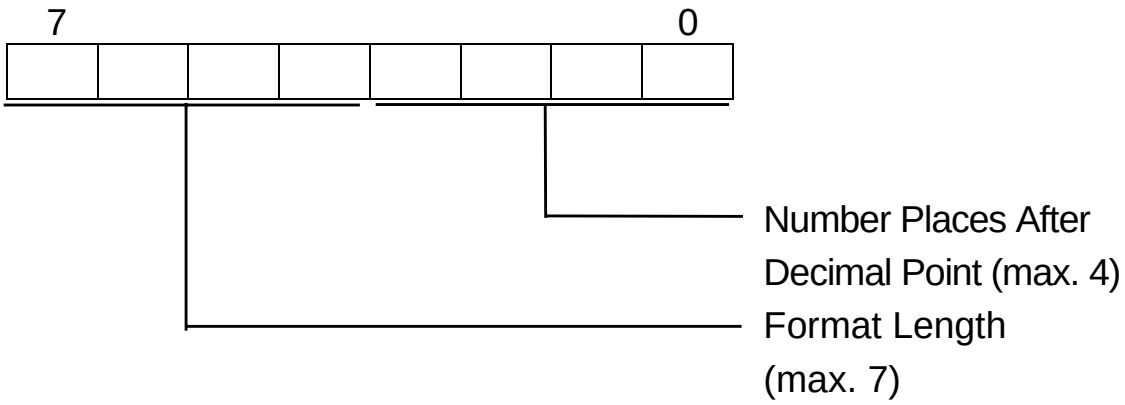
K1 = 1: Over Range Channel 1 K9 = 1: Over Range Channel 2
K2 = 1: Under Range Channel 1 K10 = 1: Under Range Channel 2
M4 = 1: Configuration Error

<Kinfo> Channel Information		Length = 22 Byte
<Channel Definition>	Binary	1 Byte
<Variable Name>	ASCII	16 Byte
<Data Format>	Binary	1 Byte
<Unit>	ASCII	4 Byte
<Data Direction>	Binary	1 Byte

Coding <Channel Definition>:

1010 Analog Output

Coding <Data Format>:



The *ISM 102* only allows the use of integer-format.

Coding <Data Direction>:

00000000 Read
00000001 Write
00000010 Read / Write
00000011 Empty (not present on PROFIBUS-DP bus)

PROFIBUS-DP:

<Outp_Data> Output Data	Length = 2 or 4 Byte*

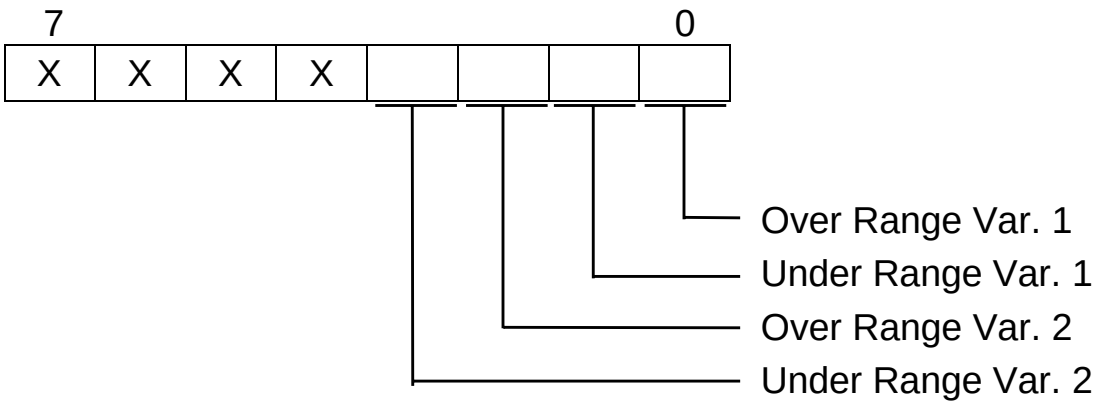
<Data> .....Binary ..... 1 Integer
<Data> .....Binary ..... 1 Integer

* ... depending on number of variables (1 or 2)

<Diag_Data> Diagnostic Data	Length = 8 Byte

<Station Status 1> .....Binary .....1 Byte
<Station Status 2> .....Binary .....1 Byte
<Station Status 3> .....Binary .....1 Byte
<Master Address>.....Binary .....1 Byte
<Ident. Number High>.....Binary ("67H") .....1 Byte
<Ident. Number Low> .....Binary ("80H") .....1 Byte
<Device Header> .....Binary .....1 Byte
<Device Diagnostics> .....Binary .....1 Byte

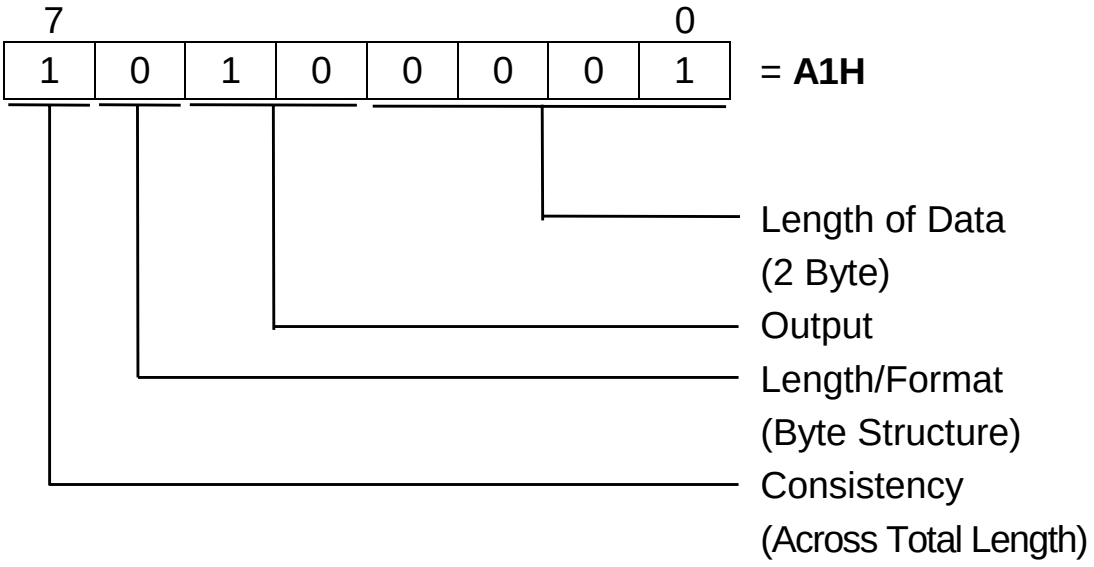
Coding < Device Diagnostics >:



<Cfg_Data> Configuration Data	Length = 1 or 2 Byte*

* ... depending on number of variables (1 or 2)

Coding <Cfg_Data>:



<Control_Command> Command	Length = 2 Byte

<Control Command> ..... Binary ..... 1 Byte
<Group Select> ..... Binary ..... 1 Byte

Broadcast or Multicast Command, No Answer

<Inp_Data_RD> Input Data	Length = 1 Byte

<SC> ..... Binary (E5 Hex) ..... 1 Byte

Corresponding to a negative acknowledgement, since the *ISM 102* provides no input data.

<Outp_Data_RD> Output Data	Length = 2 or 4 Byte*

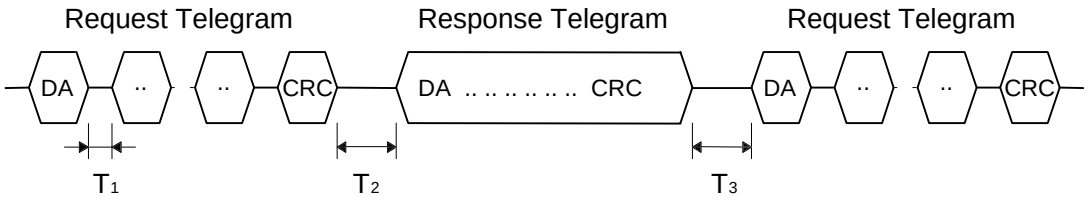
<Data> .....Binary ..... 1 Integer
<Data> .....Binary ..... 1 Integer

* ... depending on number of variables (1 or 2)

8.4. MODBUS-Protocol

8.4.1. Transmission Sequence

In the MODBUS-protocol the data is transmitted from and to the sensor module by means of the following sequence:



T_1: Time Between two Characters

T_2: Time Between Request-Telegram and Corresponding Response-Telegram

T_3: Time Between Response-Telegram and Next Request-Telegram

The minimum and maximum occurring values for T_1, T_2 and T_3 and the adjustment range may be taken from the following Table 8.8.

Protocol	Baud Rate	T_{1min}	T_{1max}	T_{2min}	T_{2max}	T_{3min}	T_{3max}
Adjustable		No	No	Yes	No	No	No
MODBUS	4.800 bit/s 9.600 bit/s 19.200 bit/s 38.400 bit/s	0	150 ms	1 ms	80 ms	3.5 CT	610 sec

Table 8.8 Values and Adjustment Range for the Times T_1, T_2 and T_3
CT: Character Time: 1 CT = Character Length [bit] / Baud Rate [bit/s]

Notice: In the MODBUS-protocol T_{2max} amounts at least 12 msec.

The values for T_{2min} and T_{3max} and the response of the sensor module in case the time T_{3max} is exceeded (communication timeout, see also chapter 6.2, error handling) can be adjusted by means of the *Configuration Software*. The default values for the times are set to:

T_{2min} = 1 CT

T_{3max} = 60 sec

8.4.2. Telegram Format

Request Telegram

> 3,5 CT	1 Byte	1 Byte	n Byte	2 Byte

Response Telegram

> 3,5 CT	1 Byte	1 Byte	n Byte	2 Byte

The request and response telegrams in the RTU-mode used by the sensor modules start with an idle-interval of at least 3.5 character lengths. The most simple to perform this is by waiting for at least 4 character-times after receiving the last character of a telegram. The telegrams have no Start-Delimiter and no End-Delimiter. The first field after this idle-interval is the ISM-address (ADR) followed by the function number (FNR) and the function parameters or data respectively. At the end, the telegrams contain a check sum (CRC) with the length of 16 bits. The check sum is calculated from the whole telegram without regard to the CRC itself. The CRC-polynomial term is: $u^{15} + u^{13} + 1$. The start value is *hex* FFFF.

8.4.3. Instruction Set

With the MODBUS-protocol the data is read and written via multiple register access. The following register access is defined for communication with the sensor modules:

Function Number	Function
03 Hex	Read Holding Register (Read/Write Register)
04 Hex	Read Input Register (Read-Only Register)
06 hex	Preset Single Register
08 hex	Diagnostics
10 Hex	Preset Multiple Register

Table 8.9 MODBUS Commands Supported by the ISM 102

Read Holding Register

Description:

Using this command, input/output registers (read/write registers) can be read. The *Intelligent Sensor Module ISM 102* only uses input-registers.

Request Telegram

ADR	FNR	REGSTA		REGNUM		CRC	
	03	**00**	**00**	**00**	**01**	MSB	LSB

Response Telegram

ADR	FNR	BYTNUM	D0	D1	CRC	
	03	**02**			MSB	LSB

ADR ..... ISM Address (*hex* 00..7F)
FNR ..... Function Number (*hex* 03)
REGSTA ..... Address of First Register to be Read (*hex* 0000)
REGNUM .... Number of Registers to be Read (*hex* 0001)
BYTNUM ..... Number of Data-Bytes (max. 2) (*hex* 02)
D0 – D1 ..... Data-Bytes (max. 64) (2 Bytes Fixed, Corresp. to Integer)
CRC ..... Check Sum

CRC Polynomial: $u^{15} + u^{13} + 1$
CRC Start Value: *hex* FFFF

Read Input Register

Description:

Using this command, input registers (read only registers) can be read.

Request Telegram

ADR	FNR	REGSTA		REGNUM		CRC	
	04	MSB	LSB	MSB	LSB	MSB	LSB

Response Telegram

ADR	FNR	BYTNUM	D0	D1	...	Dn	CRC	
	04						MSB	LSB

ADR .....ISM Address (*hex* 00..7F)
FNR .....Function Number (*hex* 04)
REGSTA .....Address of First Register to be Read (*hex* 0000)
REGNUM ....Number of Registers to be Read (*hex* 0001)
BYTNUM .....Number of Data-Bytes (max. 2) (*hex* 02)
D0 – D1 .....Data-Bytes (max. 2) (2 Bytes Fixed, Corresp. to Integer)
CRC .....Check Sum

CRC Polynomial: $u^{15} + u^{13} + 1$
CRC Start Value: *hex* FFFF

Read Single Register

Description:

With this command a single register can be written.

Request Telegram

ADR	FNR	REGADR		DATA		CRC	
	06	MSB	LSB	MSB	LSB	MSB	LSB

Response Telegram

ADR	FNR	REGADR		DATA		CRC	
	06	MSB	LSB	MSB	LSB	MSB	LSB

ADR ..... ISM Address (*hex* 00..7F)
FNR ..... Function Number (*hex* 06)
REGADR .... Address of the Register to be Written
DATA ..... Data Word (*hex* 000..FFFF)
CRC ..... Check Sum

CRC Polynomial: $u^{15} + u^{13} + 1$
CRC Start Value: *hex* FFFF

Diagnostics

Description:

With this command a diagnostic telegram will be sent to the sensor module. If the telegram has been received in correct form, the module will return this telegram unchanged (echo telegram).

Request Telegram

ADR	FNR	SUBFCT		DATA		CRC	
	08	**00**	**00**	**A5**	**37**	MSB	LSB

Response Telegram

ADR	FNR	SUBFCT		DATA		CRC	
	08	**00**	**00**	**A5**	**37**	MSB	LSB

ADR .....ISM Address (*hex* 00..7F)
FNR .....Function Number (*hex* 08)
SUBFCT .....Sub-Function Number (*hex* 0000)
DATA .....Data-Word (*hex* A537)
CRC .....Check Sum

CRC Polynomial: $u^{15} + u^{13} + 1$
CRC Start Value: *hex* FFFF

Preset Multiple Registers

Description:

With this command a large, continuous field of registers can be written.

request telegram

ADR	FNR	REGSTA		REGNUM		BYTNUM	D0	D1	...	Dn	CRC	
	10	MSB	LSB	MSB	LSB						MSB	LSB

response telegram

ADR	FNR	REGSTA		REGNUM		CRC	
	10	MSB	LSB	MSB	LSB	MSB	LSB

ADR ..... ISM address (*hex* 00..7F)
FNR ..... function number (*hex* 10)
REGSTA ..... address of the first register to be written
REGNUM .... number of registers to be written
BYTNUM ..... number of databytes (max. 64)
D0 - Dn ..... databytes (max. 64)
CRC ..... check sum

CRC polynom: $u^{15} + u^{13} + 1$
CRC start value: *hex* FFFF

8.4.4. Register Contents

Register	Type	Content	Range
Variable Values in Integer Format			
0000	ro/rw	Variable 1 Integ. Value	-32768 ... 32767
0001	ro/rw	Variable 2 Integ. Value	-32768 ... 32767

Register	Type	Content	Length
Variable Information			
0080	ro	Variable 1, Decimals	2 Byte
0081	ro	Variable 2, Decimals	2 Byte

Register	Type	Content	Length
Device Information			
0300..	ro	Number of Variables	2 Byte

Register	Type	Content	Length
Status Information			
0500..	ro	Variable Status	2 Byte
0501..	ro	Module Status	2 Byte

	Variable 1		Variable 2		
<variable st.> =	K16..K13	K12..K9	K8..K5	K4..K1	= *hex* 0XYZ
	0	X	Y	Z	*ASCII* "0XYZ"
<module st.> =	M8 M7 M6 M5		M4 M3 M2 M1		= *hex* XY
	X		Y		*ASCII* "XY"

If the bit Kn in the variable status is set it indicates that an error has occured in the corresponding variable. A variable error is given when the measuring value is outside of the linearization, e.g. in consequence of a sensor break down or of a short circuit of transmission.

If the bit Mn in the module status is set it indicates that an error has occured in the sensor module. Valid is:

K1 = 1: Over Range Channel 1 K9 = 1: Over Range Channel 2
K2 = 1: Under Range Channel 1 K10 = 1: Over Range Channel 2
M4 = 1: Configuration Error

9 SPECIFICATIONS

9.1. Power Supply

- Voltage Range: +10 .. 30 VDC
- Power Input: max. 2.0 W
- External Fuse: max. 1.0 A
- Internal Fuse: Integrated, Reversible Protection Against Excess Voltage, Excess Current and Wrong Polarity Connection
- Current Rating: max. 1.0 A via Rapid Bus Link Plug

9.2. Signal Processing

- D/A-Conversion: up to 16 bit
- Update Rate: 1 kHz

9.3. Analog Output (2 per Module)

- Function: Voltage Output
- Output Range: adjustable from -10 up to +10 VDC
- D/A-conversion: up to 16 Bit
- Accuracy: 0.01 %
- Resolution: 314 µV/Bit
- Swing-In Time: 2 ms to 0.012 %

9.4. Data-Interface:

- Base: RS 485, Shielded Twisted Pair Line
- DC-Isolation: 500 V
- Data Formats: 8N1 / 8E1 / 8O1 / 8N2
- Protocols: ASCII; PROFIBUS According to DIN 19245, Part 1; PROFIBUS-DP According To DIN 19245, Part 3 (EN 50170); MODBUS-RTU According to Reference Guide PI-MBUS-300 Rev. D
- Baud Rate ASCII: 4,800 / 9,600 / 19,200 / 38,400 bit/s
  PROFIBUS: 4,800 / 9,600 / 19,200 / 38,400 bit/s
  PROFIBUS-DP: 9.6 / 19.2 / 500 kbit/s
  MODBUS: 4,800 / 9,600 / 19,200 / 38,400 bit/s

9.5. Operating Conditions:

- Perm. Ambient Temp.: -20 to +60 °C
- Storage Temperature: -30 to +85 °C
- Moisture: 0 to 95 % at +50 °C, Non-Condensing
- Shock: IEC 68-2-27: 50g/8ms Halfsinus
- Vibration: IEC 68-2-6: 10mm/3g

9.6. Electromagnetic Compatibility:

The *Intelligent Sensor Module ISM 102* meets the protection requirements of the EMC-guidelines 89/336/EEC. EN50081-1:92/-2:93 (interference emission) and EN50082-1:92/-2:95 (interference immunity) for industrial and residential areas. The stricter requirements have been applied. At present, further standards concerning CE-marking are not relevant for the *ISM 102*.

The *ISM 102* is Labelled with the CE-Sign.
Meaning of the Evaluation Criteria:

A: During tests no functional impairment below documented minimal operating quality

B: After tests no functional impairment below documented minimal operating quality

Minimum Operating Quality

The minimum operating quality of the digital module *ISM 102* is specified through the following criteria:

- Continuous test value recording, -processing and -transmission
- No unintentional change of status outputs
- No unintentional change of status/ counter impulse in the digital inputs

Specifications for the Electromagnetic Compatibility:

Interference Emission	Range	Requirements	Standard	EC.	Result
Radio Noise Voltage	150 kHz .... 0.5 MHz	66...56Q dB(µV) 56...46M dB(µV)	EN 55022 (Class B)	-	Meets Req.
	0.5 MHz ..... 5 MHz	56Q dB(µV) 46M dB(µV)			
	5 MHz ..... 30 MHz	60Q dB(µV) 50M dB(µV)			
Radio Noise Field Strength	30 MHz .... 230 MHz	10m: 30 dB(µV/m)	EN 55022 (Class B)	-	Meets Req.
	230 MHz .. 1000 MHz	10m: 37 dB(µV/m)			
Interference Immunity	**Range**	**Requirements**	**Standard**		**Result**
Coupling HF-Voltage	0.15.....80 MHz 80% AM (1 kHz)	10 Veff	ENV 50141:93	A	Meets Req.
Interference HF-Fields	80.....1000 MHz 80% AM (1 kHz)	10 V/m	ENV 50140:93	A	Meets Req.
Interference HF-Fields	(900 ± 5) MHz 50% ED (200 Hz)	10 V/m	ENV 50204: ...	A	Meets Req.
Interference HF-Fields	Power Engineering Rel. Impulsive Damped	30 A/m - 50 Hz 300 A/m - 6.4/16 µs 30 A/m - 0.1....1 MHz	EN 61000-4 – 8:93 EN 61000-4 - 9:93 EN 61000-4-10:93	A	---
Fast Transients, Unbalanced	Power Supply Data Line Signal Line	±2.0 kV / 5 kHz / Direct ±2.0 kV / 5 kHz / Cap. ±2.0 kV / 5 kHz / Cap.	EN 61000-4 - 4:95	B	Meets Req.
Electrostatic Discharge	Chassis Terminals Front Plate	±4 kV Contact Disch. ±8 kV Air Discharge (Direct and Indirect)	EN 61000-4 - 2:95	B	Meets Req.

S: Peak Value, Q: Quasi-Peak, M: Average Value, EC: Evaluation Criterion

Permissible Loss of Minimum Operating Quality

A permissible loss of minimal operating quality is given under the following conditions:

- A release of the watchdog or a reset with an automatic restart without any loss of data or change of the operating mode.

- Influences during test value recording, -processing and -transmission if they are short, sporadic and self-recovering (e.g. short interrupt of test value updating, checksum error, delayed answer, timeout,...)

9.7. Chassis:

Material:	Al and ABS
Dimensions:	w 55 x h 90 x d 83 mm w 2.2 x h 3.5 x d 3.3 inch
Weight:	Approx. 280 g
Protective System:	IP 20
Type of Installation:	Snap-On Mounting
Mounting Rail:	35 mm acc. to DIN EN 50022
Connection Tech.:	Plug-In Screw-Type Terminals
Nom. Cross Section:	max. 1.5mm² (AWG 16), Unifilar/Fine-Strand
Strip Length:	6 mm (0.2 inch)

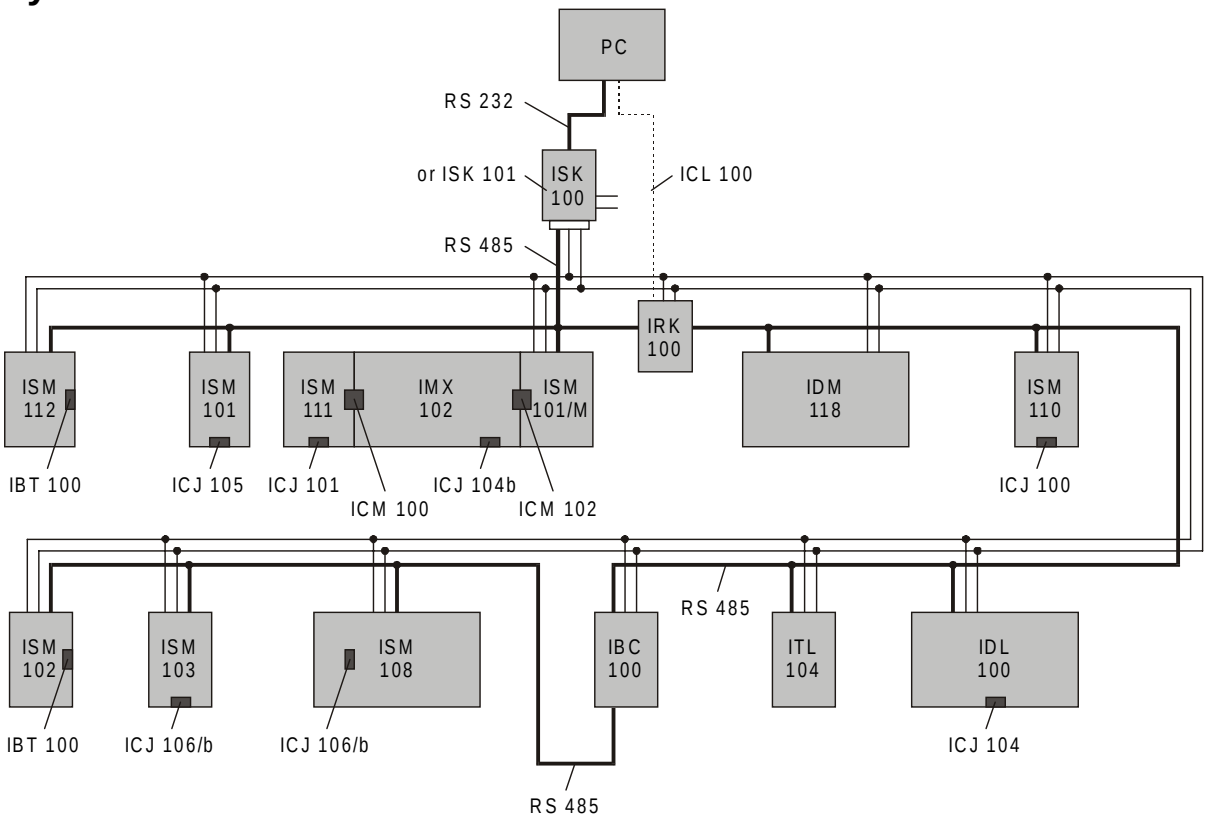
9.8. Accessories:

The *ISM* system offers a wide range of accessories which allows the user to install the *Intelligent Sensor Module* quickly and easily in his applications. In addition, components are available in order to set up locally far-reaching bus structures and connect a large number of sensor modules with each other. A PC can be connected directly to a bus via an interface converter, so the entire system can quickly be set up by means of the *Configuration Software ICP 100.*

In Following Accessories are Available:

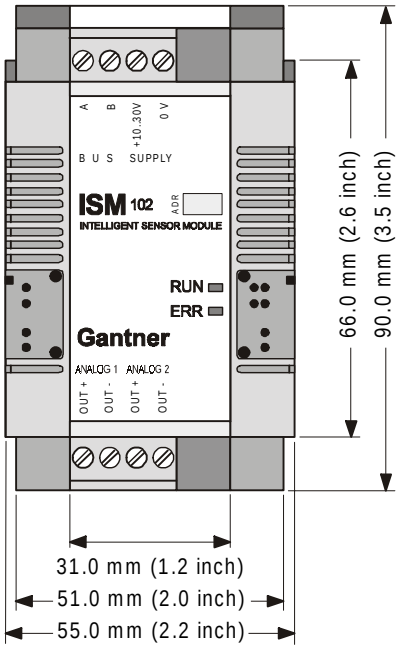
- *ISK 100:* *Interface Converter and Power Supply*
- *ISK 101:* *Compact Interface Converter in Plug Housing*
- *IRK 100:* *Repeater/Converter*
- *IBT 100:* *Bus Termination Plug*
- *ICM 100:* *Rapid Bus Link Plug*
- *ICL 100:* *Converter-Connecting Wire*
- *ICP 100 Lite:* *Configuration Software for the ISM 101 without PROFIBUS-DP-support*
- *ICP 100 Standard:* *Configuration Software for all Sensor Modules of the series "100", without PROFIBUS-DP-support*
- *ICP 100 Advanced:* *Configuration Software for all Sensor Modules of the series "100", with PROFIBUS-DP-support*

System Structure:



10. DRAWINGS AND DIMENSIONS

10.1. Front View



10.2. Side View