Extension xG18

Modbus RTU extension module for connection of up to 8 Unipi 1-Wire temperature sensors.

unipi technology

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1 Introduction

What is the Unipi xG18?

The xG18 module is a simple and reliable device for reading data from up to eight Unipi 1-Wire temperature sensors with RJ45 connector. The module provides its data using Modbus RTU protocol through RS-485 serial interface.

A single RJ45 connector is reserved for each sensor (see Chapter 3.3).

> **Caution:** Compatibility is guaranteed only for the original Unipi temperature sensors. The xG18 module is compatible only with DS18B20-based temperature sensors. Sensors for measuring other quantities (humidity, light intensity etc.), or sensors based on a different chip then DS18B20 CANNOT BE USED. Functionality with other 1-Wire temperature sensors, or sensors from other vendors is not guaranteed.

Advantages of xG18

- Affordable method of temperature measurement
- Easy connection of up to 8 temperature sensors
- 1-Wire channels are isolated for increased measurement reliability
- Compatible with any system featuring an RS-485 interface and Modbus RTU support
- Reduces total cable length and increases system reliability
- Suitable for extensive projects
- Up to 32 modules on a single RS- 485 line

2 Communication and configuration

2.1 Communication

2.1.1 1-Wire

Temperature sensors connected to the module communicates via the 1-Wire bus. Compared to the standard 1-Wire bus where multiple sensors are connected to one channel, the xG18 has a separate 1-Wire channel for each sensor. This design increases reliability of temperature measurements and largely eliminates the problem of the bus freezing issue due to an error on a single sensor.

On the xG18, only a single sensor can be connected to a single 1-Wire channel. If multiple sensors are connected to a single channel, the entire channel is marked as invalid. The maximum theoretical cable length for a single channel is 50 meters.

2.1.2 Modbus

Modbus RTU protocol on a RS-485 line is used for communication between the module and control system. The module can be configured (see Chapter 2.2) using DIP switches (HW configuration), or through its Modbus registers (SW configuration). DIP switch configuration offers enough flexibility for most applications, while the Modbus register configuration features wider range of configurable parameters (wider range of addresses and bitrates)

The following parameters can be set using DIP switches:

- Address ..... 1 – 15 (Address 0 = SW configuration from Modbus registers is used)
- Bitrate ..... 9600 / 19200 bps
- Parity ..... none / even

Default communication parameters:

- Number of data bits .. 8 bits (fixed value)
- Modbus address ..... 15 (default value from Modbus register)
- Bitrate ..... 19200 bit/s (default value from Modbus register)
- Parity ..... None (default value from Modbus register)

Built-in RS-485 terminating resistor (120 Ω) can be attached or unattached using the **RS-485-END** switch placed on the left from the RS-485 connector. The resistor is usually attached only on the first and the last device on a RS-485 bus.

2.2 Example of communication parameters configuration

The module can be configured using DIP switches (HW configuration), or through its Modbus registers (SW configuration). Each change of settings requires a device reboot by power cycle or through the use of the Modbus coil 1002 (see Chapter 2.5).

2.2.1 Configuration through DIP switches (HW)

The DIP switches are used to physically adjust communication parameters. This option is suitable for most applications, or if the Modbus register parameters are not known. It is necessary to **unplug and plug back** the power supply to apply changes performed via DIP switches.

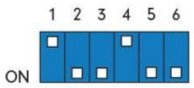
The following table describes configurations options available through the DIP switches:

DIP switch settings				
DIP Switch n.	**Description**	**Meaning**	**ON state**	**OFF state**
1	1	Modbus address	Weight 1	Weight 0
2	2	Modbus address	Weight 2	Weight 0
3	4	Modbus address	Weight 4	Weight 0
4	8	Modbus address	Weight 8	Weight 0
5	9,6 / 19,2	Bitrate	9600 baud	19200 baud
6	N / E	Parity	None	Even

If all **Address switches are set to OFF,** meaning the address is **set to 0,** the **SW configuration** is used - address, bitrate and parity are determined by content of registers 1018 and 1019 (see Chapter 2.4), while DIP switch configuration of bitrate and parity are ignored. For the default factory settings, see Chapter 2.1.2.

The following table describes an example of DIP switches set to Modbus address 6 and bitrate of 9600 bps with no parity.

DIP switch n.	State	Result
1	OFF	Address 6
2	ON	
3	ON	
4	OFF	
5	ON	9600 baud
6	ON	Parity None



2.2.2 Configuration through Modbus RS-485 (SW)

SW configuration of communication parameters through Modbus registers is defined by the following rules:

- Register 1019 is used to set the device's Modbus address. The value is entered as a decimal number.
- Register 1018 is used to set the device's bitrate. The first 13 bits of the register are reserved for the bitrate settings. Bit 0 has the lowest priority, bit 12 has the highest. Bitrate values are listed in Chapter 2.4.
- Bit 13 and 14 of the register 1018 are used to set parity. See Chapter 2.4 for more info.

After applying changes to the mentioned registers, the SW configuration must be saved, and the module must be rebooted. Follow the following below:

- To save changes, the **coil 1003** must be set to log. 1. Without this step, the new configuration will be overwritten by the previous configuration during the module's restart.
- The last step is to reboot the device to load the configuration, either by unplugging and plugging back the power supply, or by setting the coil 1002 to log. 1. Without the reboot, the new configuration will not be used.

A table containing detailed description of all available registers and coils is available in Chapters 2.4 and 2.5 respectively.

In the Mervis IDE, this configuration is significantly easier, as all parameters can be set directly in the device's properties.

2.3 Reading of temperature values

2.3.1 Reading values

Measured temperature values in °C are available on registers 1 – 8. The register numbers correspond with 1-Wire channel numbers. Measured temperatures are represented on the Modbus register as integer values – the temperature is rounded to two decimal number and multiplied by 100.

Example: Measured temperature 25,32°C is represented on Modbus register as integer number 2532.

Upon connecting the power supply or rebooting the module, the default value for each unused channel is -32768 (After transformation to temperature in Mervis IDE, the value is -327.68).

2.3.2 Validity of values

Register 9 is a crucial one, as its lowermost 8 bits express validity (TRUE/FALSE) of values in registers 1 to 8.

- The least significant bit (LSB) at 0 express validity of channel 1 or register 1 respectively.
- The most significant bit (MSB) at position 7 express validity of channel 8 or register 8 respectively.

If a sensor is unplugged, its **last recorded value is reported** in the register, while the validity bit of the channel will change to FALSE.

2.3.3 Measurement period

Registers 1010 and 1017 represent another read/write registers. Each contains a pause interval between measurements expressed in seconds (default period is 2s) for certain channel. Register 1010's value is applied for channel 1, while the channel 8's pause interval is determined by register 1017.

2.3.4 Channel state indication

Channel state is indicated by the corresponding LED or through Modbus (register 9, see Chapter 2.4).

LED functions for channel state indication:

1. OFF – no sensor connected
2. On for 750 ms, off for the rest of the set interval – measurement in progress – valid state
3. On for 950 ms, off for 50 ms – invalid state
    - Corrupted data – the bus is too long/too much interference/damaged sensor
    - Unsupported sensor is connected
    - Multiple sensors are connected to the channel
    - In this state, measure attempts will be repeated each 1s until a first valid measurement. The interval entered in the register is used afterwards.
4. On for 50 ms, off for 950 ms – short circuit on the bus

2.4 List of Modbus registers

Register address	R/W	Data type	Description			Bit position	Category
0	R	Bit field	Master Watchdog				Advanced
			MWD enabled			0	Advanced
			MWD restart detected			1	Advanced
1	R	INT	Temperatures: T = reg/100 In two's complement, negative temp. values are signed integer (16 bit)	CH1			Basic
2	R	INT		CH2			Basic
3	R	INT		CH3			Basic
4	R	INT		CH4			Basic
5	R	INT		CH5			Basic
6	R	INT		CH6			Basic
7	R	INT		CH7			Basic
8	R	INT		CH8			Basic
9	R	Bit field	A bitmask determining validity of the temp. value	CH1		0	Basic
				CH2		1	
				CH3		2	
				CH4		3	
				CH5		4	
				CH6		5	
				CH7		6	
				CH8		7	
1000	R	Word	Firmware version				Expert
1003	R	Word	Firmware ID				Expert
1004	R	Word	Firmware ID				Expert
1005 - 1006	R	DWord	Serial number of the circuit board				Expert
1008	R/W	Word	Master Watchdog (MWD) time limit (1ms)				Advanced
1010	R/W	INT	Interval of measurement	CH1	in seconds		Basic
1011				CH2			Basic
1012				CH3			Basic
1013				CH4			Basic
1014				CH5			Basic
1015				CH6			Basic
1016				CH7			Basic
1017				CH8			Basic
1018	R/W	Bit field	RS-485 configuration				Advanced
			Bitrate (see Chapter 2.6 for more info)			0 - 12	
			Parity – 0 = off, 1 = on			13	
			Parity – 0 = even, 1 = odd			14	
1019	R/W	Bit field	Modbus address configuration (1-255)				Advanced

2.5 List of Modbus coils

Coil address	R/W	Description	Category
1000	R	MWD reset indication	Advanced
1002	R/W	MCU reset	Advanced
1003	R/W	Save the current config and load it during start-up	Advanced

2.6 Supplemental information for the Modbus tables

2.6.1 Bit order for table in chapter 2.4

Bit order
0 – LSB
15 – MSB

2.6.2 Bitrate configuration in register 1018

Bitrate configuration	
Value	Bitrate [bps]
10	1200
11	2400
12	4800
13	9600
14	19200
15	38400
4097	57600
4098	115200

For more info, please visit the **KB – Unipi Knowledge Base**.

3 Description of connectors and LED indicators

3.1 Description of connectors

Label	Meaning
+24 V	Positive pole of the power supply connector
GND	Negative pole of the power supply connector
⏚	Grounding screw connector
Channel 1 to 8	1-Wire sensor RJ45 connector, see Chapter 3.3
RS485-A / RS485-B	RS-485 screw terminals
DIP switch 1 – 6	Configuration of communication parameters, see Chapter 2.1
RS485-END DIP switch	Attachment of the built-in RS-485 terminating resistor

3.2 Description of LED indicators

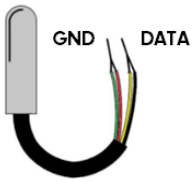
The xG18 features 11 LEDs for indication of channel states, traffic on the RS-485 bus and power supply. Functions of the individual LEDs are described in the following table:

LED label	Modes	Meaning	Color
1 ... 8	LED is blinking	State of channel 1 ... 8	Green
RS485 RX	Indication of receiving data	Traffic on the bus	Green
RS485 TX	Indication of transmitting data	Traffic on the bus	Green
PWR	Glowing LED	Device is powered	Red

See Chapter 2.3.1 for the description of channel state indication.

3.3 Connecting a 1-Wire sensor with a RJ45 connector

The 1-Wire bus is designed to read data from connected sensors – only temperature sensors in the xG18's case. It is recommended to use only original Unipi 1-Wire sensors.



The sensors are connected via RJ45 connectors. Connection scheme is described in the following chapters.

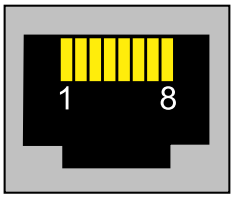
Sensors can be connected only in a so-called parasite mode, in which the Vcc and GND wires must be interconnected.

Note: It is not possible to connect multiple sensors per channel. This limitation also prevents the usage of RJ45 1-Wire hubs, such as the Unipi 1-Wire 8-port hub.

3.3.1 Description of xG18's RJ45 connectors

The table and picture below depict a RJ45 connector of the xG18 module and describe functionality of its individual pins.

Pin number	Function
5,8	GND
6,7	Data
1,2,3,4	Unused

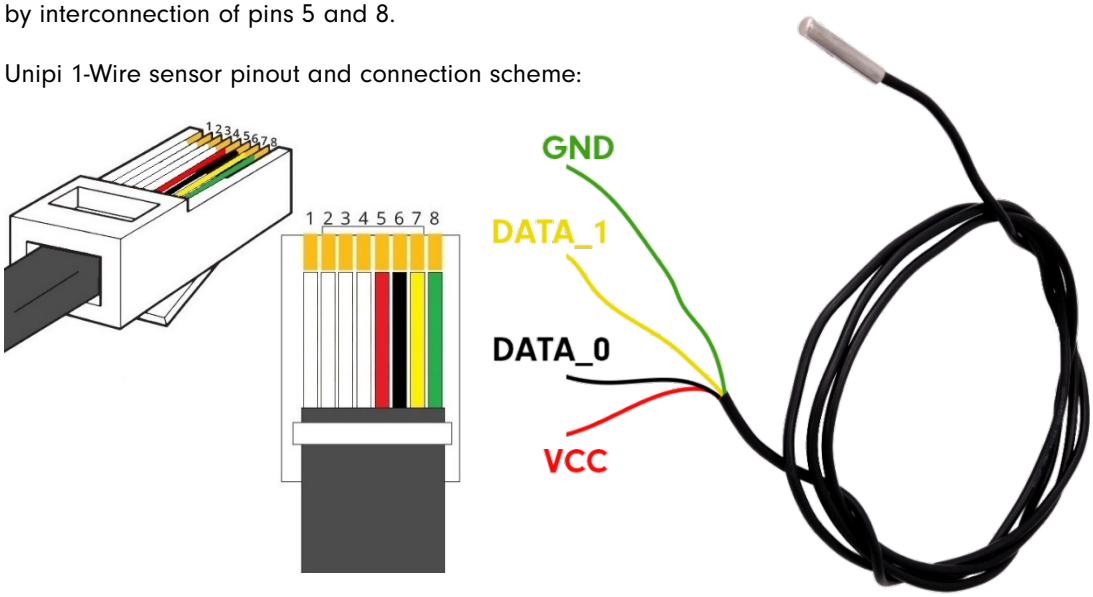


3.3.2 Unipi 1-Wire temperature sensors with RJ45 connector

Unipi 1-wire temperature sensors with RJ485 connector are designed for direct connection. It's not needed to do any modification.

When connected to xG18, the parasite mode on these sensors is already handled by the inner wiring by interconnection of pins 5 and 8.

Unipi 1-Wire sensor pinout and connection scheme:

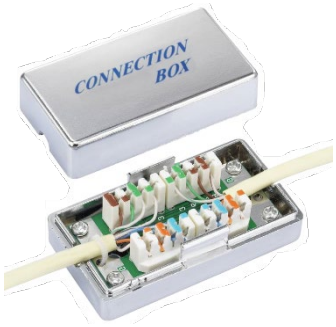


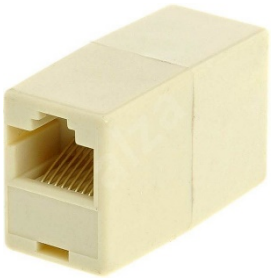
Note: Unipi 1-wire temperature sensors with RJ485 connector contains two data cables, DATA_0 and DATA_1 (pins 6 and 7 - see schematic and picture above), which are interconnected inside of the senor right on the measuring element. This wiring makes most sense in the standard bus connection with multiple sensors on the bus, especially with the Unipi controllers. Both data lines are also interconnected in the xG18 to avoid unconnected data line in case of a non-standard connection causing possible interference.

3.3.3 Modifying length of Unipi 1-Wire sensor with RJ45 connector

It is recommended to use one of the options below to shorten or extend the Unipi 1-Wire sensor's cable:

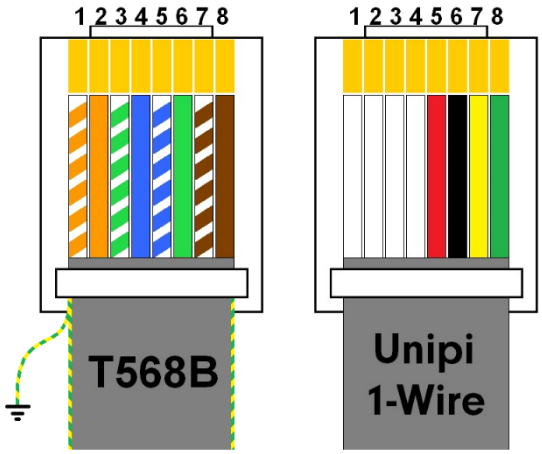
1. Crimp the shortened cable with a suitable RJ45 connector.
2. To extend the sensor's cable use one of the following methods:
    a. Connection box in case of cutting off one the RJ45 connector and connect another UTP cable.
    b. RJ45 8P8C coupler in case of connecting a standard UTP patch cord.





Note: In case of long extensions cable use shielded FTP cable and shielded Connection box or RJ45 coupler. The xG18 is equipped with shielded RJ45 connector. Shielding of the FTP cable should be connected directly to xG18 via shielded RJ45 connector (the shielding is connected to the ground via the xG18 grounding terminal and further to the installation ground) on the FTP cable or to the installation ground terminal inside the installation box.

The connection is made by 1:1 pin to correspond with the picture below. We recommend using shielded FTP cable for longer distances or in distribution boxes affected by interference. Following the rules described in this chapter is necessary to retain compatibility with Unipi 1-Wire sensors, as well as with other Unipi 1-Wire devices.



3.3.4 Connection of common DS18B20 1-Wire sensor

DS18B20-based sensors have three wires – Vcc, Data and GND. To connect such sensor to the xG18, it is needed to wire the sensor to the RJ45 connector. To maintain compatibility with other Unipi 1-Wire sensors it is recommended to follow the pinout described in the table below. Colors of wires can be different from the colors of Unipi sensors. Make sure to check the product's documentation for wire labels.

Note: This connection also applies to special DS18B20-based temperature sensors offered by Unipi, such as sump sensors, tank sensors or pipeline sensors.

Wire	RJ45 pin number
Vcc	5
GND	8
Data	6

You can use the module even in installation with only two-wires. As the xG18 use the 1-Wire sensors in parasite mode, it is possible switch the sensor to parasite mode by to interconnecting Vcc and GND wires directly in the sensor. At the xG18 side the GND wire should be connected to the RJ45 connector's pin 8, and the Data wire to pin 6.

4 Installation and connection

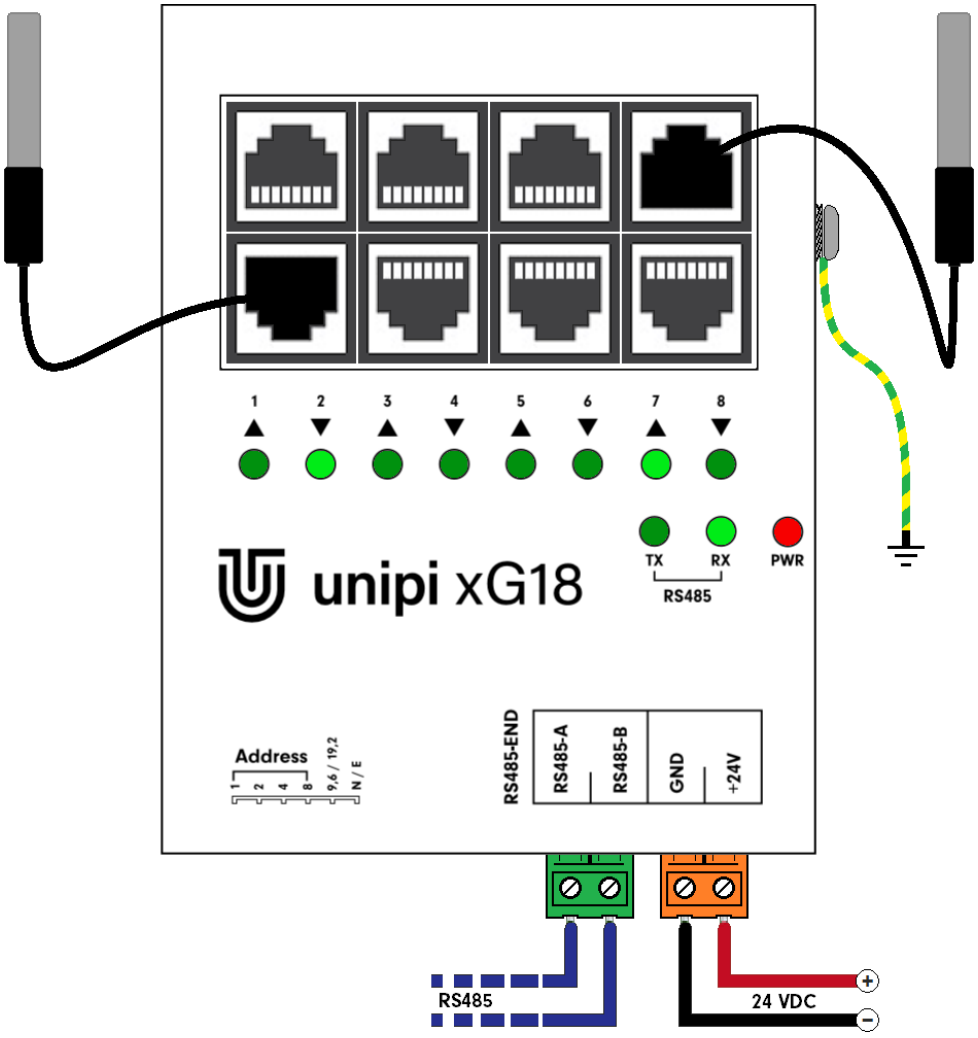
The module is designed to be installed vertically onto a DIN rai. Connect all wires according to the corresponding tables (see Chapter 3).

Installation guide:

1. Attach DIN rail holder using screws to the back side of the module.
2. Configure communication parameters using DIP switches.
3. Clip-on the module onto DIN rail.
4. Connect grounding using tooth washer and screw.
5. Connect temperature sensors to the RJ45 connector.
6. Connect RS-485 communication line using pluggable screw terminal (green).
7. Connect power supply using pluggable screw terminal (orange).

The correct connection is also depicted on the following picture:

- Power supply – red + black
- RS-485 – purple
- Ground – yellow/black
- Temperature sensors – black



5 Technical parameters

5.1 Power supply

Power supply	
Rated voltage - SELV	5 – 24 VDC
Reverse polarity protection	YES
Power consumption	Max. 0,2 W

5.2 RS-485 interface

RS-485	
Galvanic isolation	NO
Overvoltage protection	YES, Max. 24 V
Terminating resistor	Built-in attachable 120 Ω

5.3 1-Wire interface

1-Wire	
Number of channels	8
Sensors per channel	1
Sensors mode	Parasite – 2 wires per sensor
Supported sensors	DS18B20

5.4 Operating and storage conditions

Operating and storage conditions	
Storage temperature	-25 °C ... +75 °C
Storage humidity	10 % ... 95 %, non-condensing, nonaggressive
Operating temperature	-25 °C ... +75 °C
Operating humidity	10 % ... 95 %, non-condensing, nonaggressive
Construction	Aluminum box
Installation	DIN rail – 35 mm (EN 50022)
Protection	IP 20
Power supply/RS-485 connector	Pluggable screw terminals
Sensor connector	RJ-45
Power/RS-485 wire gauge	Max. 2,5 mm²
Dimensions	72 x 91 x 22 mm (š, v, h)
Weight	110 g