# FM3101



# USER MANUAL
# V1.3

# Table of Contents

# ATTENTION!

Do not disassemble the device. Do not touch before unplugging the power supply if the device is damaged, the power supply cables are not isolated or the isolation is damaged.

All wireless data transferring devices produce interference that may affect other devices witch are placed nearby.

The device may be connected only by qualified individuals.

The device must be firmly fastened in the predefined location.

The programming must be performed using a second class PC (with autonomic power supply).

The device is susceptible to water and humidity.

Warning!! May explode, if a wrong accumulator is used.

Any installation and/or handling during a lightning storm is prohibited.

# INSTRUCTIONS OF SAFETY

This document contains information on how to operate "FM3101" safely. BY following these requirements and recommendations you will avoid dangerous situations. You must read these instructions carefully and follow the strictly before operating the device!

The device uses a 10V...30V DC power supply. The nominal voltage is 24V DC. The allowed range of voltage is 10V...30V DC, power – not more than 12 W.

To avoid mechanical damage, it is advised to transport the FM3101 device in an impact-proof package. Before usage, the device should be placed so that its LED indicators are visible, which show what status of operation the device is in.

When connecting the connection (2x10) cables to the vehicle, the appropriate jumpers of the power supply of the vehicle should be disconnected.

Before dismounting the device from the vehicle, the (2x10) connection must be disconnected.

The device is designed to mount in a zone of limited access, which is inaccessible for the operator. All related devices must meet the requirements of standard LST EN 60950-1.

The device FM3101 is not designed as a navigational device for boats.

## LEGAL NOTICE

# SHORT DESCRIPTION

FM3101 is a terminal with GSM and GPS connectivity, which is able to determine the object's coordinates and transfer them via the GSM network. This device is perfectly suitable for applications where location acquirement of remote objects is needed. It is important to mention that FM3101 has additional inputs and outputs, which let you control and monitor other devices on remote objects. 1-Wire® I/O (for Dallas digital thermometer or I-Button reader) is integrated. It also has a RS232 port (possibility to connect any external device for example a barcode reader, RFID reader etc.). Apart from that, the device is fully programmable, so you can load a special Java™ IMlet and perfectly adapt it for your needs.

FM3101 has a rechargeable battery inside and a special controller for power management. Because of this new feature, GPS/GSM unit can operate for some time without external power supply. A special power saving algorithm can be implemented in Java™ IMlet and operation time can be expanded up to 3-5 times.

## 1.1 About the document

This document contains information about the features, architecture, possibilities, mechanical characteristics and data transfer types of the FM3101 device.

## 1.2 Acronyms

PC – Personal Computer.

GPRS – General Packet Radio Service.

GPS – Global Positioning System.

GSM – Global System for Mobile Communications.

SMS – Short Message Service.

RFID – Radio Frequency Identification.

AC/DC – Alternating Current/Direct Current.

## 1.3 Mounting guidelines

The device is mounted in the predefined location in the object by attaching it using a two-sided tape and additionally securing using three plastic 300x4 mm straps. If there is no possibility of mounting the device in the predefined location as written above, alternative mounting methods may be applied, securing the stable position of the device.

# 2 PACKAGE CONTENTS

The FM3101 device is supplied to the customer in a cardboard box containing all the equipment that is necessary for operation. The package contains:

1. The FM3101 device.
2. PC <-> FM3101 cable port 2 (For configuring of the module).
3. PC <-> FM3101 cable port 3 (NMEA -> PC).
4. Input and output power supply cable with a 2x10 connection.
5. CD with the Aplicom User Manual, SDK and the User Manual.
6. GPS and GSM antennas.

Supplements:

1. Temperature sensor TTJ-101 (by order).
2. Voltage regulator GCM-100 (by order).

*Note: the manufacturer does not supply a SIM card in the package, which is necessary for connection to the GSM network! SIM card can be obtained from Your local GSM service provider!*

If any of the components is not in the package, please contact the manufacturer's representative or the vendor. (www.teltoniika.lt)

# 3  MAIN FEATURES

- ✓ Track your remote objects (trucks, cars) quickly and easily.
- ✓ The device supports the following GSM bearers:
    - o EDGE class 6 (up to 177,4 kbps).
    - o GPRS class 10 (up to 85,6 kbps).
    - o HSCSD (up to 43,2 kbps).
    - o CSD (up to 14,4 kbps).
    - o SMS (text/data).
    - o USSD (data).
- ✓ As a lot of connection types are supported, you can choose one according to price, reliability, speed or ease of use.
- ✓ Dual-band:
    - o European (and Asian) version - 900 MHz / 1800 MHz.
    - o American version - 850 MHz / 1900 MHz.
- ✓ The aluminum case of the device is very robust and perfectly suitable for installation into harsh environment such as cars, trucks, boats or other moving objects.
- ✓ Internal rechargeable battery with charge controller.
- ✓ FM3101 has 3 digital inputs, 3 digital outputs and 3 analogue inputs, which could be used for performing of various tasks on remote objects, such as monitoring fuel tank level, engine status, or controlling truck door etc.
- ✓ FM3101 has 1-Wire® I/O protocol integrated for temperature measuring or key identification.
- ✓ FM 3101 has RS232 port which could be used foe external peripheral data acquisition.
- ✓ FM3101 is an open architecture device, which is fully programmable, so if you want to perform a very special task, you can adapt the device for your needs by writing your own Java™ IMlet or asking our technical staff to make it for you. TCP/IP and UDP stacks are integrated.
- ✓ AutoPIN feature enters the PIN code each time the device is turned on, while SIM card is still protected with the code.
- ✓ 3 LED indicators: "Power", "Status" and "Navigate".
- ✓ An advanced solution for a very reasonable price.
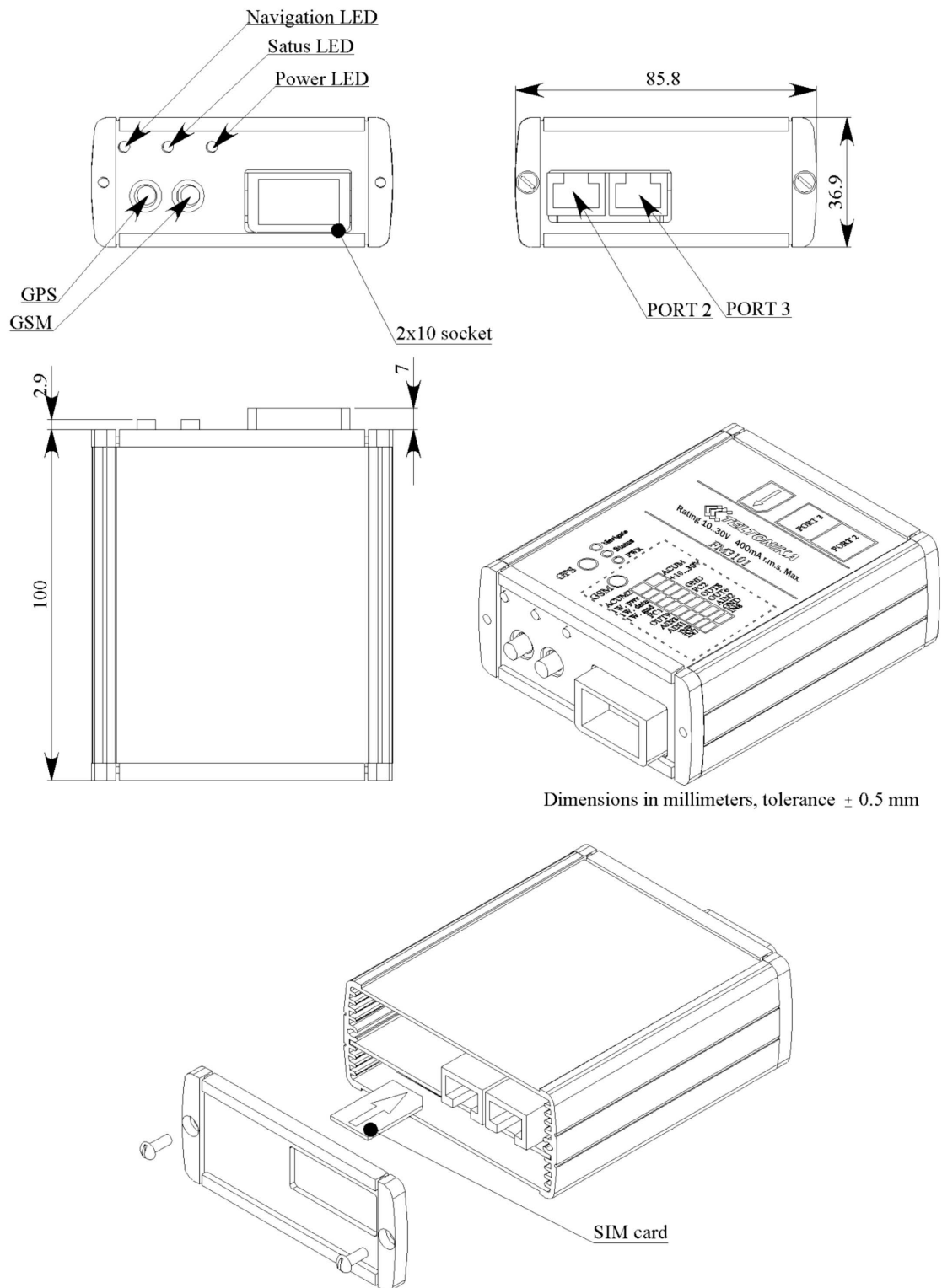
# 4 MECHANICAL FEATURES



Figure 1. FM3101 drawing & spec (Dimensions in millimeters, tolerance 0,5 mm)

| Part name | Physical specification |
|---|---|
| Navigation LED | LED |
| Status LED | LED |
| Power LED | LED |
| GSM | GSM antenna connector SMA |
| GPS | GPS antenna connector SMA |
| Socket 2×10 | Tyco Multi-Lock I/O MK-II C-175975 |
| SIM | GSM SIM card socket |
| PORT 2 | RJ45 8 pin socket |
| PORT 3 | RJ45 8 pin socket |

| Technical details |
|---|
| Power supply 10...30 V DC |
| 12W Max |
| Energy consumption: |
| GPRS: $=$ 400 mA r.m.s Max., |
| Nominal: $=$ 100 mA r.m.s.. |
| Operation temperature: |
| -25°C ... +55°C |
| Storage temperature: |
| -40°C ... +70°C |
| Relative humidity 5 ... 95% |

When GPS signal is not received, the Navigation LED is blinking as follows:
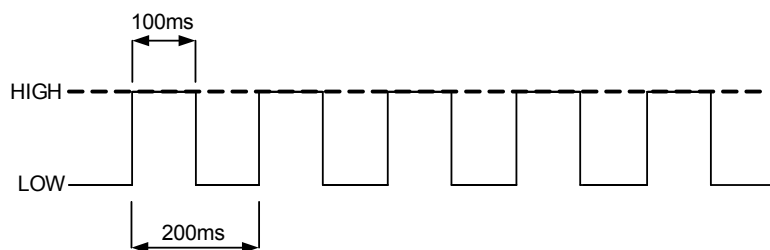


When GPS signal is received, the Navigation LED is blinking as follows:
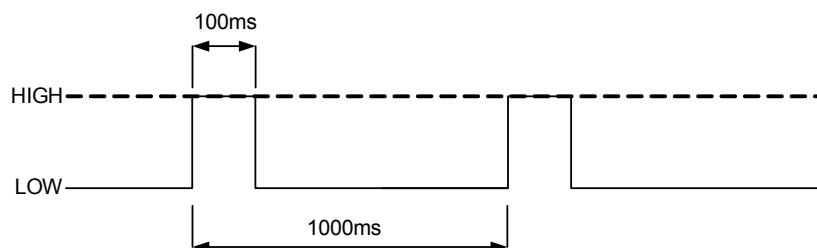


When Navigation LED is off, that means a short circuit is GPS antenna or connector.
Power LED means that device is switched on.
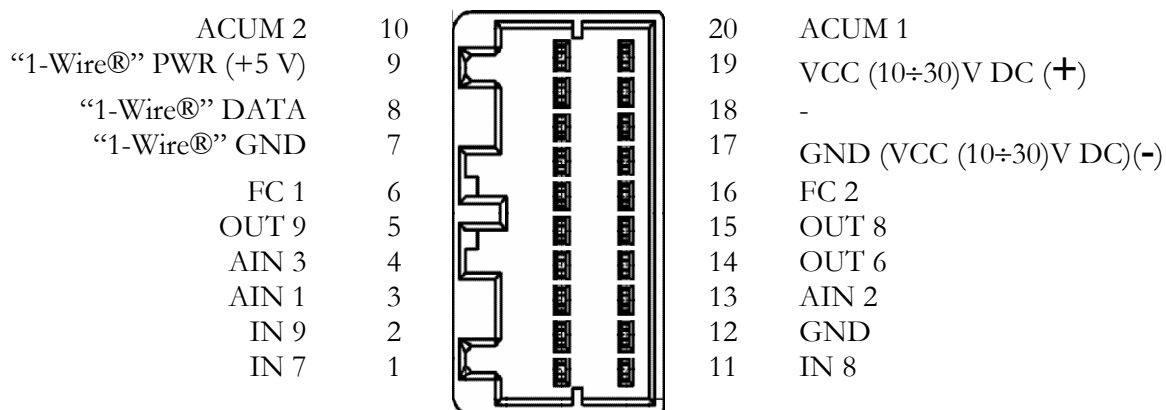
# 5 CONNECTION & PINOUT

## 5.1 Socket 2×10

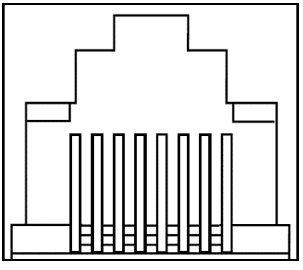| | | | | |
|---|---|---|---|---|
| ACUM 2 | 10 | | 20 | ACUM 1 |
| "1-Wire®" PWR (+5 V) | 9 | | 19 | VCC (10÷30)V DC (+) |
| "1-Wire®" DATA | 8 | | 18 | - |
| "1-Wire®" GND | 7 | | 17 | GND (VCC (10÷30)V DC)(-) |
| FC 1 | 6 | | 16 | FC 2 |
| OUT 9 | 5 | | 15 | OUT 8 |
| AIN 3 | 4 | | 14 | OUT 6 |
| AIN 1 | 3 | | 13 | AIN 2 |
| IN 9 | 2 | | 12 | GND |
| IN 7 | 1 | | 11 | IN 8 |

Figure 2. 2×10 socket pinout

| Pin Nr. | Pin Name | Description |
|---|---|---|
| *1* | *2* | *3* |
| 1 | IN 7 | Digital input, channel 7. * |
| 2 | IN 9 | Digital input, channel 9. * |
| 3 | AIN 1 | Analog input, channel 2. Input range: 0-10V DC ** |
| 4 | AIN 3 | Analog input, channel 3. Input range: 0-10V DC ** |
| 5 | OUT 9 | Digital output. Channel 9. Open collector output. Max. ⎓ 500mA. |
| 6 | FC 1 | Fuel Counter (Quick counter digital input, channel 1) |
| 7 | "1-Wire®" GND | Digital output Channel 7, used for Dallas 1-Wire® devices GND (purpose: output could be OFF-ON-OFF to reset device) |
| 9 | "1-Wire®" PWR (+5 V) | + 5 V output (not only) for Dallas 1-Wire® devices. (max 100mA) |
| 10 | ACUM 2 | This pin is used connected with pin ACUM 1. Function of those pins is to disconnect the internal accumulator during shipment or storage. When ACUM 1 and ACUM 2 are connected, the internal accumulator is on, while disconnected - the internal accumulator is off. |
| 11 | IN 8 | Digital input, channel 8. * |
| 12 | GND | Ground pin. |

| 1 | 2 | 3 |
|---|---|---|
| 13 | AIN 2 | Analog input, channel 2. Input range: 0-10V DC ** |
| 14 | OUT 6 | Digital output. Channel 6. Open collector output. Max ⎓ 500mA. |
| 15 | OUT 8 | Digital output. Channel 8. Open collector output. Max ⎓ 500mA. |
| 17 | GND | Ground pin. (10÷30)V DC ( - ) |
| 18 | - | - |
| 19 | + (10÷30) V | Power supply for module. Power supply range (10...30) V DC<br>Energy consumption: GPRS: ⎓ 400 mA r.m.s Max., Nominal: ⎓ 100 mA r.m.s.. |
| 20 | ACUM 1 | This pin is used connected with pin ACUM 2. Function of those pins is to disconnect the internal accumulator during shipment or storage. When ACUM 1 and ACUM 2 are connected, the internal accumulator is on; while disconnected, the internal accumulator is off. |

**\* Input is inverted.**
**\*\* N12i module have input divider of 4.08, that meant if input equals to 10V, then N12i will receive 2,45V**

## 5.2    PORT 2 & PORT 3

| RJ-45 socket | PORT 2 | | PORT 3 | |
|---|---|---|---|---|
| | Pin Nr. | Description | Pin Nr. | Description |
| | 1 | - | 1 | - |
| | 2 | TXD_GPS | 2 | - |
| | 3 | - | 3 | - |
| | 4 | GND | 4 | GND |
| | 5 | RXD2 | 5 | RXD3 |
| | 6 | TXD2 | 6 | TXD3 |
| | 7 | CTS2 | 7 | RTS3 |
| 8 7 6 5 4 3 2 1 | 8 | RTS2 | 8 | - |

> ➢ Port 2. Connected to N12i port 2. This port can be used as system port (M2M protocol to configure N12) with cable 1/2 and as GPS NMEA 0183 output with cable PORT 3.

> ➢ Port 3. Connected to N12i Port 3. This port is controlled by Java application on the N12i module.

# 6  INTERNAL ARCHITECTURE

APLICOM 12i modem is equipped with J2ME virtual Java™ Machine. This platform can be used for different user applications. For further documentation of APLICOM 12 modem, please contact APLICOM corp. (www.aplicom.com ).

FM3101 has special power management schematics and MCU to control power. It can charge the internal battery and turn on or off all peripheral devices for a desired period of time. PORT3 is used for APLICOM 12i modem power control. Command set can be found in chapter 8.1.
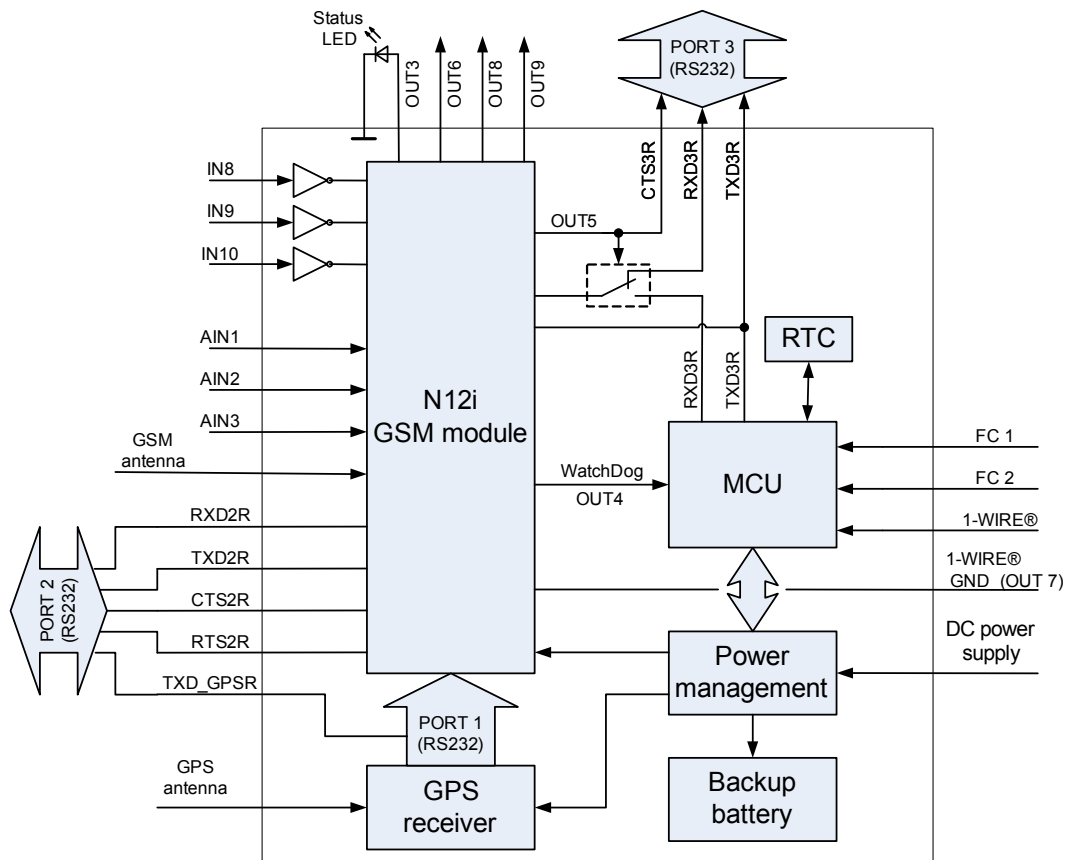


Figure 3. Internal architecture

* When OUT5 is HIGH, then N12i module is connected to external PORT3, in other case to MCU.

* Watchdog is monitoring the N12i OUT 4 pin, if it has not changed in 20 min, it restarts N12i. If after the first restart there is no change, second restart is executed after 1 hour, the same with the third etc. It is recommended to change the status of N12i OUT4 every half minute.

## 6.1 Rechargeable battery

In FM3101 is used rechargeable battery of 250 mAh capacitance. It is able to supply power if there is no external power supply, (life time depends on how frequently data is transmitted). Its lifetime is more than 1000 charge – discharge cycles.

## 6.2 1-Wire® devices

One of the FM3101 features is realized 1-Wire data protocol, which enables connection of thermometer (DS1820, DS18S20 and DS18B20) and I-Buttons DS1990A reading.
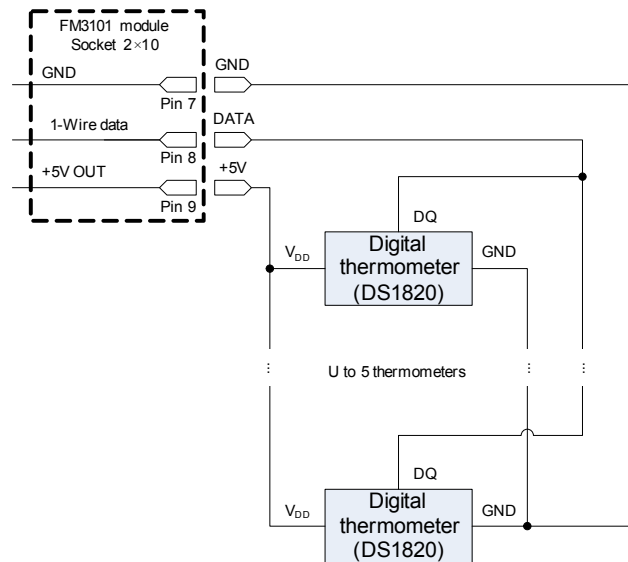
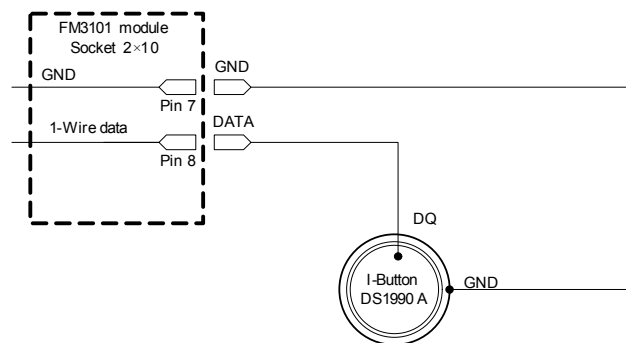Figure 5. Digital thermometers DS1820 connection scheme

Figure 6. Digital key "I-Button" DS1990A connection scheme

# 7  ACCESSORIES

JSC Teltonika offers accessories to simplify adjusting of sensors with FM3101 analogue inputs and temperature measurement.

## 7.1    Voltage adjuster GCM-001

While maximal voltage of analogue FM3101 input is 2.8 Volts, some of the sensors output voltage is higher. The voltage adjuster GCM-001, that is proportionally converting voltage, was created for that purpose.
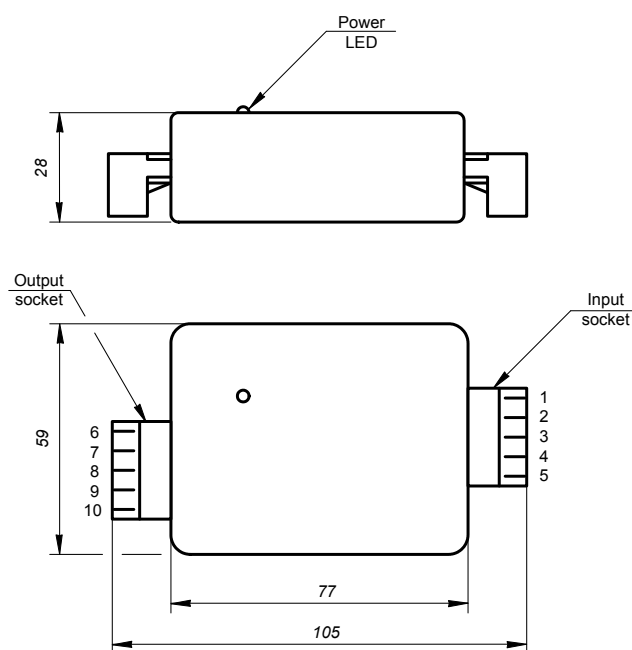


Dimensions in millimeters, tolerance ±1mm

Figure 7. GCM-001 dimensions & spec.

It has three independent channels, so it is possible to adjust three sensors in one device. Also the device has a +5 Volts output, which could be useful for some sensors.

Main features:

Supply voltage (Vpp) DC +10 ÷ 30 V.

Input voltage range (0 ÷ 27 Volts).

Output voltage range (0 ÷ 2.8 Volts).

Adjusting of the voltage is executed by choosing the right divisor (placing jumper on one of the four positions) and by twisting amplifier's potentiometer after precise adjusting. (Please see the fig.8.).
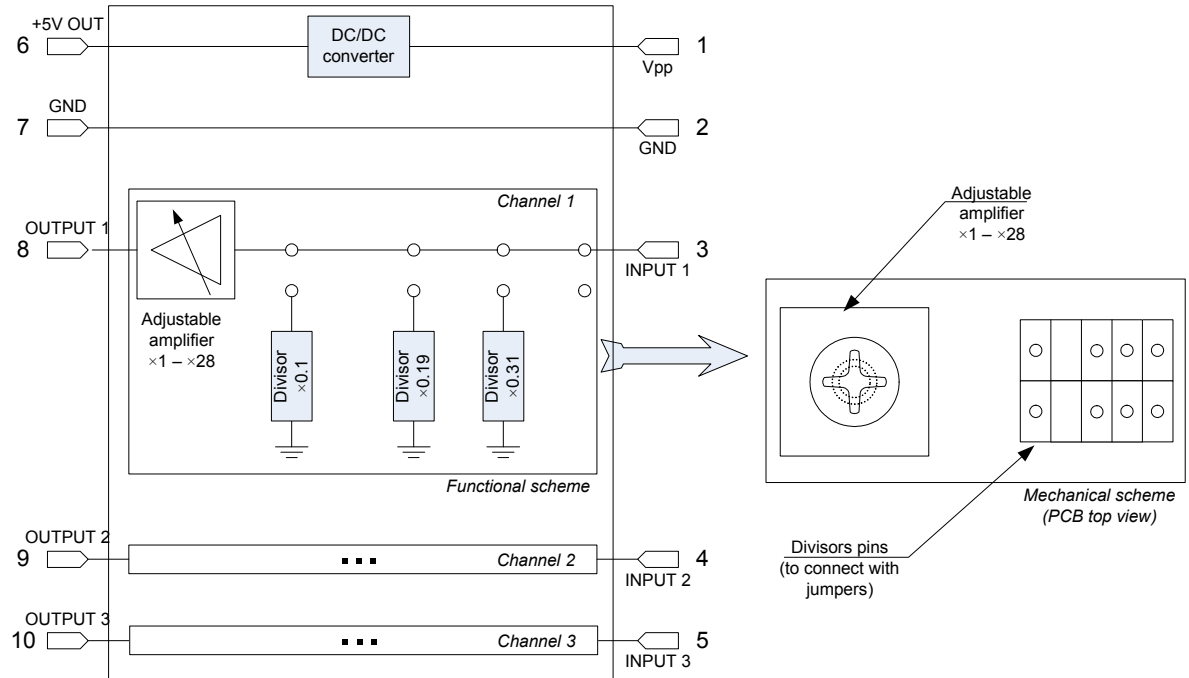


Figure 8. GCM-001 functional and mechanical adjusting scheme

### 7.1.1 Sample of using GCM-001 for tank fuel level measuring

A fuel tank level sensor exists in most of the cars, which shows the approximate fuel level in the driver's indicator panel. It is possible to connect FM3101 through GCM-001 voltage adjuster to get online fuel level data from the remote object (if sensor returns analogue signal proportional to fuel level)
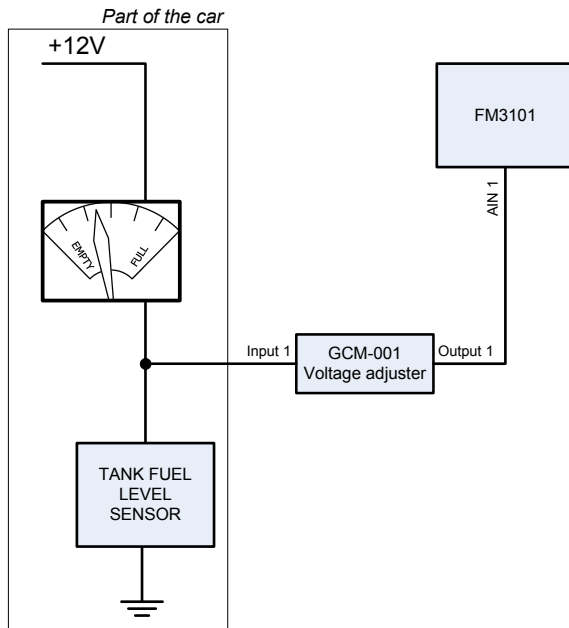
Fig.9 describes the connection scheme to the FM3101. After the connection to the tank fuel level sensor please calibrate GCM-001 (adjust so, that if the tank is full, the voltage on output 1 would be 2.8 Volts). FM3101 will register this parameter and be able to inform the user about its value.

Figure 9. GCM-001 connection to fuel sensor scheme

## 7.2  Sample of using two VZO8(4) fuel meters
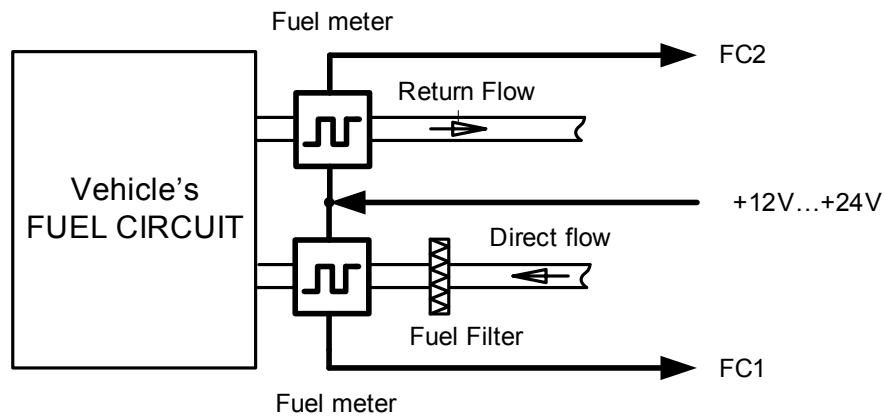


Figure 10. VZO8(4) fuel meters connection scheme

Fig 10 describes the connection scheme to the FM3101. Here two VZO8(4) meters are used, where one is mounted on the direct flow pipe and the other on the return flow pipe. Data from both meters are sent to the FM3101. Then FM3101 calculates FC1-FC2. This difference is fuel consumption. Filter should be used on the direct flow pipe to prevent any damage caused by impurities in the liquid. The filter mounted in the meter inlet is only a safety filter and it is too small to act as a strainer.

## 7.3    Temperature sensor TTJ-101

To simplify the mounting of the thermometer in the object, it is placed on PCB and inserted into the box. Integrator of the system should solder the FM3101 wires to PCB and place the sensor wherever he wants to measure the temperature.
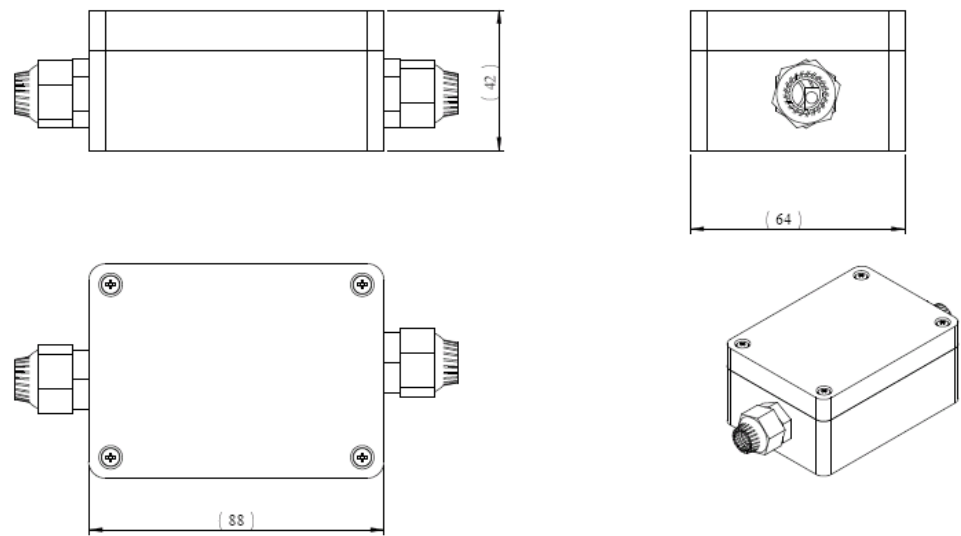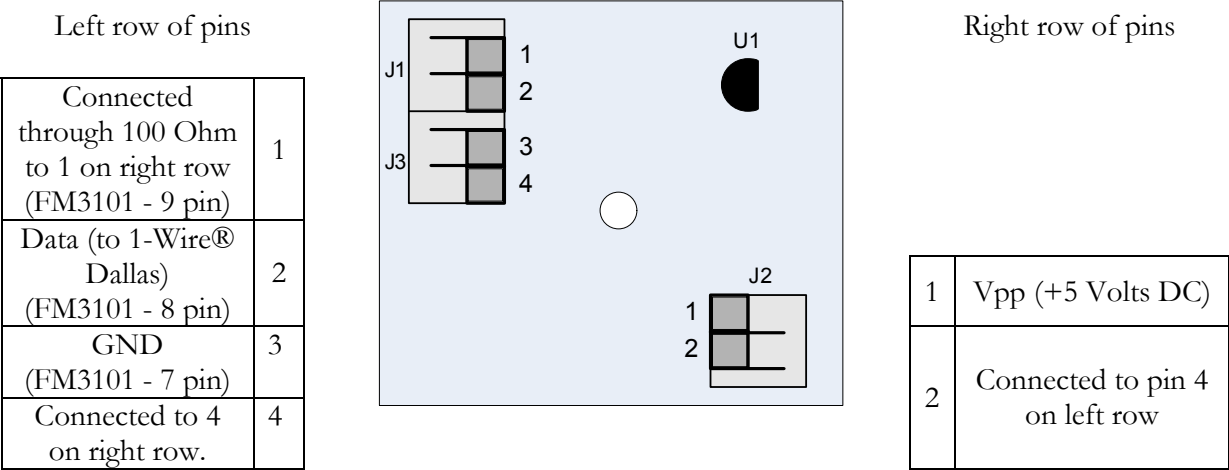


Dimensions in millimeters, tolerance ±1mm

Figure 11. TTJ-101 dimensions & spec.

In TTJ-100, Dallas digital thermometer DS1820 is used. It is possible to connect up to five thermometers parallel and measure the temperature in 5 places in the object (see chapter 6.1.1). The picture bellow describes pinout of the TTJ-100.

Left row of pins

| Connected through 100 Ohm to 1 on right row (FM3101 - 9 pin) | 1 |
|---|---|
| Data (to 1-Wire® Dallas) (FM3101 - 8 pin) | 2 |
| GND (FM3101 - 7 pin) | 3 |
| Connected to 4 on right row. | 4 |



Right row of pins

| 1 | Vpp (+5 Volts DC) |
|---|---|
| 2 | Connected to pin 4 on left row |

# 8 COMMUNICATION PROTOCOLS

For communication between APLICOM 12i modem, MCU, GPS module and RFID receiver, the ModBus protocol is applied. All of the possible commands are described in tables below.

## 8.1 Power management command set

| Name | Code | Parameter | Description | Answer | Description |
|------|------|-----------|-------------|--------|-------------|
| Get power supply state | 0x06 | - | - | 1 symbol. - 0, 1, 2, 3, 4<br>2 symbols – last charge time (min) | 0 – external power supply OK, battery charged<br>1 – battery is charging<br>2 – power supply is from battery<br>3 – accumulator discharged<br>4 – charge error |
| Enter power save state | 0x07 | 0-59 | Time in minutes | - | N12i module and GPS are switched off for defined time period. |
| Get power supply voltage | 0x09 | - | - | 0-29000 | Power supply voltage in mV* |
| Get battery voltage | 0x0A | - | - | 0-10000 | Battery voltage in mV |
| Get battery charge current | 0x0B | - | - | 0-1294 | Battery charge current in mA |
| Get status of GPS antenna power supply | 0x0D | - | - | 0, 1, 2 | 0 – normal state<br>1 – short circuit<br>2 – not plugged |
| Temperature of battery | 0x0E | - | - | 1 byte | Temperature in $^0$C |
| Battery charge ON/OFF | 0x11 | 0-1 | - | - | 0 – Battery charge ON<br>1 – Battery charge OFF |
| Power down mode | 0x20 | - | - | - | If module has no external voltage supply, switches the module off. |

* - Real voltage on the power supply is higher than the answers of the command 0x09 by 0.7 Volts. It is because of the protection diode on the power supply pin.

## 8.2 Event counter command set

| Name | Code | Parameter | Description | Answer | Description |
|------|------|-----------|-------------|--------|-------------|
| Read counter "FC1-FC2" | 0x17 | - | - | Unsigned long 4byte | When MCU gets request -> it returns FC1-FC2 answer and resets both counters |

## 8.3  "1-WIRE®" command set

| Name | Code | Parameter | Description | Answer | Description |
|---|---|---|---|---|---|
| Calculate existing sensors | 0x14 | Sensor number | | Number of sensors, 1 symbol | Returns the number of connected sensors |
| Read sensor data | 0x15 | | | Temperature, 2 symbols | If the answer is 0xF000, an error in temperature read |
| Sensors initialize | 0x16 | | | Number of sensors; 1 symbol | Calculating sensors, and attaching ID (0, 1, 2, 3, 4) |
| Get_I-Button | 0x26 | | Gets I-Button ID | 8 bytes | I-Button present: :01\|26\|01\|id\|id\|id\|id\|id\|id\|crc(ib)\| lrc<br>No I-Button: :01\|26\|00\|00\|00\|00\|00\|00\|00\|00\| lrc<br>I-Button read error: :01\|26\|11\|11\|11\|11\|11\|11\|11\|11\| lrc |

For more detail information about the thermometer, please see "Dallas Semiconductors" digital thermometer DS1820, DS18S20 and DS18B20 specifications.

For more detail information about the thermometer, please see "Dallas Semiconductors" I-Button DS1990A specification.

## 8.4  Firmware command set

| Name | Code | Parameter | Description | Answer | Description |
|---|---|---|---|---|---|
| Get Firmware | 0x27 | - | - | 4byte | String "0102" means the version V1.2 |

## 8.5  Watchdog command set

| Name | Code | Parameter | Description | Answer | Description |
|---|---|---|---|---|---|
| Watchdog_enable | 0x18 | 1 | 1 byte | 1 | Enables watchdog |
| Watchdog_disable | 0x18 | 0 | 1 byte | 0 | Disable watchdog |

Watchdog is monitoring the N12i OUT 4 pin, if it has not changed in 20 min, it restarts N12i. If after the first restart there is no change, second restart is executed after 1 hour, the same with the third etc. It is recommended to change the status of N12i OUT4 every half minute.

## 8.6 Real Time Clock command set

| Name | Code | Parameter | Description | Answer | Description |
|---|---|---|---|---|---|
| Set_time | 0x22 | 7 bytes<br><br>:01\|22\|ss\|mm\|hh\|dwdw\|dmdm\|mm\|yy\|LRC | Setting the time | 7 bytes<br><br>:01\|22\|ss\|mm\|hh\|dwdw\|dmdm\|mm\|yy\|crc(t)\|LRS | Set RTC time |
| Set_RTC_CR | 0x23 | 2 bytes<br><br>:01\|23\|cr1cr1\|cr2cr2\|LRC | Setting the control register | 2 bytes<br><br>:01\|23\|cr1cr1\|cr2cr2\|crc(t)\|LRS | Set RTC Control Register 1/2 |
| Read_RTC_CR | 0x24 | - | Get CR value | 2 bytes<br><br>:01\|24\|cr1cr1\|cr2cr2\|crc(t)\|LRC | Read RTC Control Register 1/2 |
| Read_RTC | 0x25 | - | Get time value | 7 bytes<br><br>:01\|25\|ss\|mm\|hh\|dwdw\|dmdm\|mm\|yy\|crc(t)\|LRC | Read time from RTC |

CR (Control Register) – RTC (RS5C338A) management registers
For more detail information about RTC, please see "Ricoh" RS5C338A datasheet.
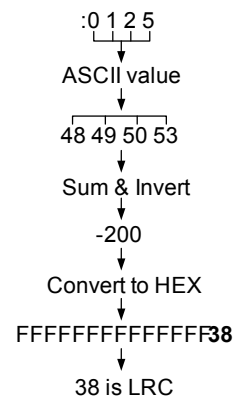

## 8.7 LRC calculation example

Id: 01
Function: 25
Modbus: 0125(LRC)




Finally Modbus command will be :012538

:0 1 2 5
↓
ASCII value
↓
48 49 50 53
↓
Sum & Invert
↓
-200
↓
Convert to HEX
↓
FFFFFFFFFFFFFF**38**
↓
38 is LRC

# TECHNICAL SUPPORT

If you encounter any problems when using our products, please contact our technical support by writing an e-mail to support@teltonika.lt . We will be pleased to help you.

If you are interested in other products from Teltonika, please visit our website www.teltonika.com, where you will find our newest products.

If you are interested in product pricing or want to order our products with different antennas, connectors or built-in programs, please contact our sales department by writing an e-mail to sales@teltonika.lt

The supervision of the device is undemanding.

# 9 CHANGES LOG SHEET

| Nr. | Date | New version number | Comments |
|-----|------|-------------------|----------|
| 1. | June 8, 2006 | 1.1 | Corrected pinout, changed figure 2 |
| 2. | July 11, 2006 | 1.2 | Safety instructions updated, fig. 4.1 edited. |
| 3. | November 24, 2006 | 1.3 | Updated FM3101 architecture, command set, added LRC calculation example. |