PS351

Power Supply Module

User Manual

Rev. 1.0 E

July 2012

Revision history

Rev. Index	Brief Description of Changes	Board Index	Date of Issue
1.0	Initial version	PS351	July 2012

Contact information

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Notation conventions

Warning, ESD Sensitive Device!

This symbol draws your attention to the information related to electro static sensitivity of your product and its components. To keep product safety and operability it is necessary to handle it with care and follow the ESD safety directions.

Attention!

Information marked by this symbol is essential for human and equipment safety.
Read this information attentively, be watchful.

Note:

This symbol and title marks important information to be read attentively for your own benefit.

Transportation, unpacking, inspection and handling

Please read the manual carefully before unpacking the module or mounting the device into your system. Keep in mind the following:

ESD Sensitive Device!

Electronic modules and their components are sensitive to static electricity. Even a non-perceptible by human being static discharge can be sufficient to destroy or degrade a component's operation! Therefore, all handling operations and inspections of this product must be performed with due care, in order to keep product integrity and operability:

- Preferably, unpack or pack this product only at EOS/ESD safe workplaces. Otherwise, it is important to be electrically discharged before touching the product. This can be done by touching a metal part of your system case with your hand or tool. It is particularly important to observe anti-static precautions when setting jumpers or replacing components.
- If the product contains batteries for RTC or memory back-up, ensure that the module is not placed on conductive surfaces, including anti-static mats or sponges. This can cause short-circuit and result in damage to the battery and other components.
- Store this product in accordance with IEC721 in its protective packaging while it is not used for operational purposes.

Transportation

The module must be transported in individual factory packages consisting of an individual antistatic bag and a cardboard box, in closed vehicles (in heated and airtight compartments of motor, railroad or airborne vehicles) in accordance with IEC721.

Packed modules must be transported pursuant to the cargo transportation rules applicable to this mode of transport.

During loading and unloading work and transportation, packed modules must not be exposed to jerks, falls, shocks and atmospheric precipitation. The stowage of packed modules in a vehicle must exclude their shifting.

Unpacking

The product is carefully packed in an antistatic bag and in a carton box to protect it against possible damage and harmful influence during shipping. Unpack the product indoors only at a temperature not less than +15°C and relative humidity not more than 70%. Please note, that if the product was exposed to the temperatures below 0°C for a long time, it is necessary to keep it at normal conditions for at least 24 hours before unpacking. Do not keep the product close to a heat source.

Following ESD precautions, carefully take the product out of the shipping carton box. Proper handling of the product is critical to ensure correct operation and long-term reliability. When unpacking the product, and whenever handling it thereafter, be sure to hold the module preferably by the front panel, card edges or ejector handles. Avoid touching the components and connectors.

Retain all original packaging at least until the warranty period is over. You may need it for shipments or for storage of the product.

Initial Inspection

Although the product is carefully packaged, it is still possible that shipping damages may occur. Careful inspection of the shipping carton can reveal evidence of damage or rough handling. Should you notice that the package is damaged, please notify the shipping service and the manufacturer as soon as possible. Retain the damaged packing material for inspection.

After unpacking the product, you should inspect it for visible damage that could have occurred during shipping or unpacking. If damage is observed (usually in the form of bent component leads or loose socketed components), contact Fastwel's official distributor from which you have purchased the product for additional instructions. Depending on the severity of the damage, the product may even need to be returned to the factory for repair. DO NOT apply power to the product if it has visible damage. Doing so may cause further, possibly irreparable damage, as well as result in a fire or electric shock hazard.

If the product contains socketed components, they should be inspected to make sure they are seated fully in their sockets.

General rules for product usage

In performing all necessary installation and application operations, please follow only the instructions supplied by the present manual.

In order to keep Fastwel’s warranty, you must not change or modify this product in any way, other than specifically approved by Fastwel or described in this manual.

Technical characteristics of the systems in which this product is installed, such as operating temperature ranges and power supply parameters, should conform to the requirements stated by this document.

Retain all the original packaging, you will need it to pack the product for shipping in warranty cases or for safe storage. Please, pack the product for transportation in the way it was packed by the supplier.

When handling the product, please, remember that the module, its components and connectors require delicate care. Always keep in mind the ESD sensitivity of the product.

1 INTRODUCTION

1.1 PRODUCT DESIGNATION

PS351 power supply module (hereafter referred to as the module) is designed for use in highly reliable self-contained modular computer systems built based on PC/104 or PC/104+ standards with small power consumption.

PS151 power supply module is designed for building modular computer systems based on the MicroPC standard. PS151 module is built on PS351: PS351-02 module is installed on a passive MicroPC format motherboard. Therefore, this Manual includes PS351 module specifications with PS151 design features outlined separately.

The modules are galvanically isolated secondary power supply sources with input voltage range from 10.5 to 36 V and output voltages of +12, +5, and +3.3 V, equipped with a smart power on/off and monitoring system. The smart system is capable of measuring ambient temperature to prevent the module from switching on outside its operating range. The real-time clocks included in the modules enable power control based on a preset schedule and storage of system events in the on-board non-volatile memory. The modules also allow connecting additional (redundant, chemical) power supply sources, which improves durability of the system as a whole.

Basic characteristics of the product:

– Form-factor: PC/104+ for PS-351; MicroPC for PS151

– Input voltage: 10.5-36 VDC

Input/Output galvanic isolation: 1000 V

– Output voltages/currents (power):
  – +12 V / 1.66 A (20 W)
  – +5 V / 6 A (30 W)
  – +3.3 V / 1.5 A (5 W)

– Overload and overheating protection (for 5 V and 12 V stabilizers)

– Uninterruptible power supply function (UPS)[1]

– PowerGood signal

– Smart control system:
  – RS232/RS422 interface with galvanic isolation
  – Programmable DC/DC converters activation/deactivation schedule
  – On-board WDT
  – Integrated temperature sensor
  – Integrated RTC with battery backup
  – System event memory.

[1] The UPS function and power supply to the module via the redundant power connector are not supported in version 1.2 modules.

1.2 VERSIONS, DELIVERY PACKAGE, ORDERING INFORMATION

1.2.1 Versions, ordering information

Versions of PS351 and PS151 modules are listed in Table 1.1. All versions can be coated: when ordering, add "\COATED" option to the device type.

Table 1.1. PS351 and PS151 Versions

Description	Identification	Device type for ordering	Remarks
Power supply module PS351	PS351	PS351-01	On-board control system, PC/104+ connectors, heat spreading plate
		PS351-02	On-board control system
		PS351-03	PC/104+ connectors, heat spreading plate
Power supply module PS151	PS151	PS151-01	MicroPC form-factor, on-board control system

1.2.2 Delivery package

Delivery packages for different PS351 versions are shown in Table 1.2.

Delivery package for PS151 module is shown in Table 1.3.

Table 1.2: Delivery package for PS351 module

Decimal number/PN	Description	Quantity		
		-01	-02	-03
IMES.436634.002, IMES.436634.002-01, IMES.436634.002-02	Power supply module PS351	1	1	1
–	Compact-disc	1	1	1
39-01-4030	Cable for XP15 connector	1	1	1
39-01-4040	Cable for XP14 connector	1	1	1
PHR-2	Cable for XP1 connector	1	1	1
PHR-3	Cable for XP17 connector	1	1	-
PHR-4	Cable for XP2 connector	1	1	-
PHR-5	Cable for XP13, XP18 connectors	2	2	-

Decimal number/PN	Description	Quantity		
		-01	-02	-03
43645-0700	Cable for XP12 connector	1	1	1
SPH-002T-P0.5S	Set of contacts for PHRx connectors	19	19	2
44-47-63111	Contacts for 39-01-40xx connectors	7	7	7
43030-0001	Contacts for 43645-0700 connector	7	7	7
382575-2	Jumper, 2 mm	9	9	-
IMES.467941.023	Installation kit: mounts, nuts, washers	-	1	-

Table 1.3: Delivery package for PS151 module

Decimal number/PN	Description	Quantity
IMES.436634.003 IMES.436634.003-01	Power supply module PS151 Power supply module PS151\Coated	1
–	Compact-disc	1
39-01-4030	Cable for XP15 connector	1
39-01-4040	Cable for XP14 connector	1
PHR-2	Cable for XP1 connector	1
PHR-3	Cable for XP17 connector	1
PHR-4	Cable for XP2 connector	1
PHR-5	Cable for XP13, XP18 connectors	1
PHR-6	Cable for XP8 connector (PS151)	1
SPH-002T-P0.5S	Set of contacts for PHRx connectors	20
44-47-63111	Contacts for 39-01-40xx connectors	7
382575-2	Jumper, 2 mm	10

2 TECHNICAL SPECIFICATIONS

2.1 GENERAL FUNCTIONAL DESCRIPTION

– Form-factor: PS351 – PC/104+ top side connection only
PS151 – MicroPC, edge slot mounted

– Input voltage: 10.5-36 VDC

– Switched off state consumption current (with control system switched on): 5mA

– Typical efficiency: 80%

– Input/Output galvanic isolation: 1000V

– Output voltages/currents *(power):

  – +12 V / 1.66 A (20 W)

  – +5 V / 6 A (30 W)*

  – +3.3 V / 1.5 A (5 W)*

  * total power provided by 3.3 V and 5 V stabilizers: 30 W max.

– Minimum load current: no requirements for +5 V and +12 V channels; +3.3 V – 5% of nominal;

– Output power reduction under high temperature exposure:

  – +5 V without heat spreading plate: 2.3%/°C for temperatures above +55°C;

  – +5 V with heat spreading plate: 2.5%/°C for temperatures above +60°C;

  – +12 V without heat spreading plate: 2.9%/°C for temperatures above +70°C;

  – +12 V with heat spreading plate: 3.4%/°C for temperatures above +75°C;

– Overload and overheating protection (for 5 V and 12 V stabilizers)

– Uninterruptible power supply function (UPS)[2]

– DC/DC converters operating temperature range: -40°C to +85°C (with derating at temperatures above 60°C)

– Control system operating temperature range: -50°C to +85°C

– Cold start: at temperatures below -40°C a heater (external device) enable signal is generated, DC/DC converters are activated when a preset temperature is reached

– External cooler control is temperature dependent

– Galvanic isolation (1000 V, from input and output) of control system's RS232/RS422 (38400 bit/s) interface

– Programmable DC/DC converters activation/deactivation schedule

– Integrated WDT to control the module's DC/DC converters

– Integrated temperature sensor

– Integrated RTC with battery backup capability

– Input and RTC battery voltages monitoring

[2] The UPS function and power supply to the module via the redundant power connector are not supported in version 1.2 modules.

- PowerGood signal generation: all output power supply voltages are monitored
- System events stored in non-volatile memory
- System event signals routed to an auxiliary connector: input voltage drop, switching to power backup etc.
- Switching of system event signals to IRQ5, IRQ6, IRQ10, IRQ11 interrupts of PC/104 connector (PS351 module)
- Switching of system event signals to IRQ3-IRQ7 interrupts of MicroPC connector
- I2C interface connector for connection of an external temperature sensor or a charging unit (if an electrochemical power source with external charging unit is used)
- Dry contact external signal inputs with programmable assignment
- Connector for external LEDs
- Additional connector for supplying of output voltages to loads over a cable (PS351 module)

2.2 POWER REQUIREMENTS

The module can be powered from a power supply source with voltage ranging from +10.5 V to +36 V.

Power can be supplied via the main power connector (XP14) and the redundant power connector (XP15)[3].

Current consumption in standby mode (the control system is on, DC/DC converters are deactivated, LEDs are off) and in idle mode (the load is disconnected) must not exceed the values shown in Table 2.1.

Table 2.1: Module average current consumption

Module version	I_{in}, mA (U_{in}=10.5 V, DC/DC off, max.)	I_{in}, mA (U_{in}=36 V, DC/DC off, max.)	I_{in}, mA (U_{in}=24 V, DC/DC on, max.)
PS351-01, PS351-02, PS151	5	5	160
PS351-03	-	-	140

2.3 ENVIRONMENTAL

- Operating temperature range for PS351-01, PS351-02, PS151: -50°C to +85°C (-40°C to -50°C for “cold start” mode: control system is on, DC/DC converters are deactivated).
- Operating temperature range for PS351-03: -40°C to +85°C.

2.4 MECHANICAL

- Vibration, acceleration amplitude – 5g
- Single shock, peak acceleration – 100g
- Multiple shock, peak acceleration – 50g

PS151 module’s mechanical characteristics are valid for the module fixed in the mounting cage.

[3] The UPS function and power supply to the module via the redundant power connector are not supported in version 1.2 modules.

2.5 DIMENSIONS AND WEIGHT

Module weight shall not exceed the values shown in Table 2.2.

Table 2.2: Module weight

Module version	Weight, kg, max.
PS351-01, PS351-03	0.350
PS351-02	0.150
PS151	0.180

PS351 module overall and mounting dimensions are shown in Figure 2.1. Overall and mounting dimensions of the heat spreading plate are shown in Appendix A. PS351 module's shipping weight (gross): 490 gr max.

PS151 module overall and mounting dimensions are shown in Figure 2.2. PS151 module's shipping weight (gross): 330 gr max.

The modules are supplied in shipping boxes with overall dimensions of 155 mm x140 mm x 45 mm.

Figure 2.1: Module overall and mounting dimensions: A – side view for PS351-01 and PS351-03 versions; B – side view for PS351-02 version

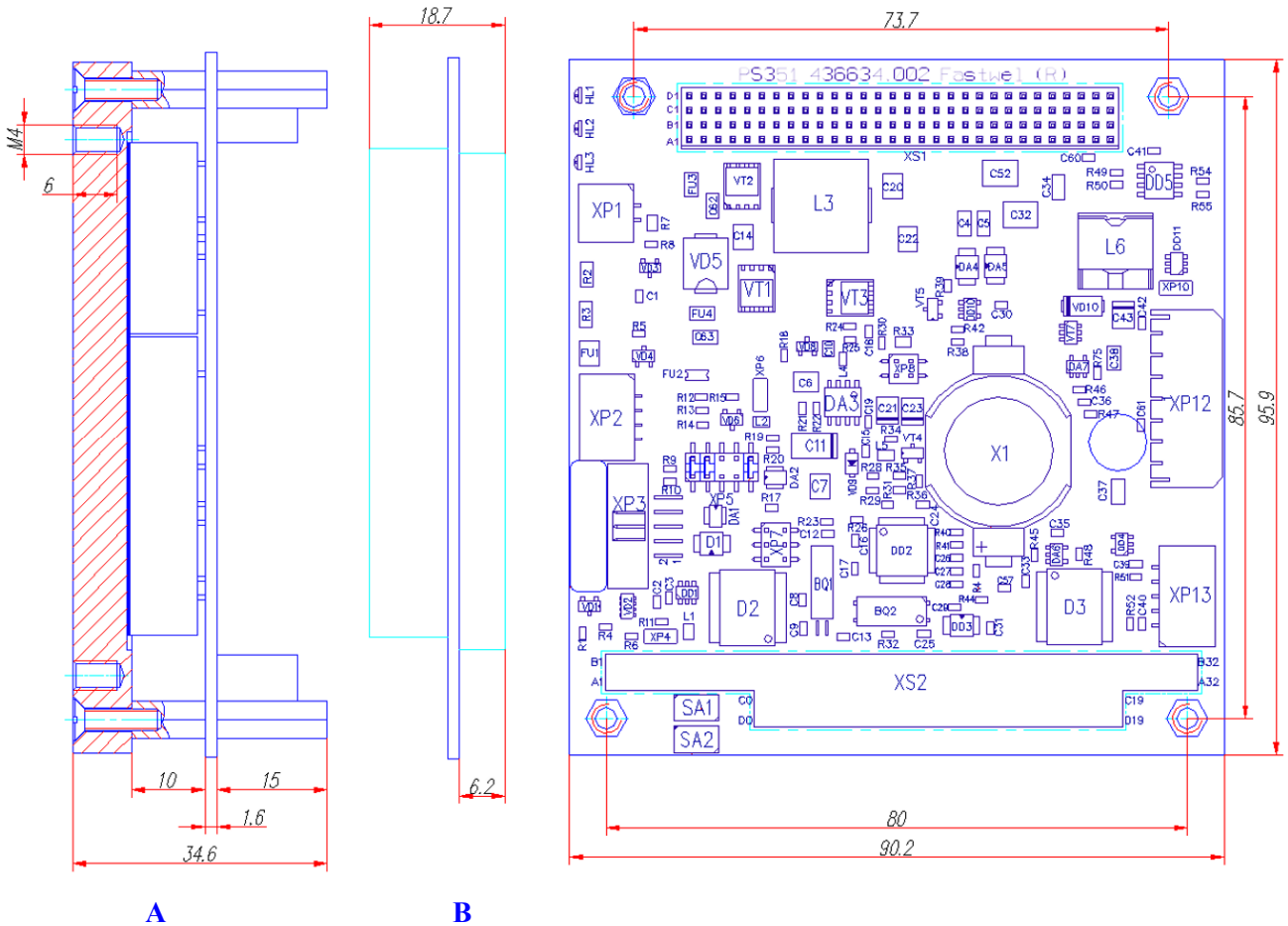
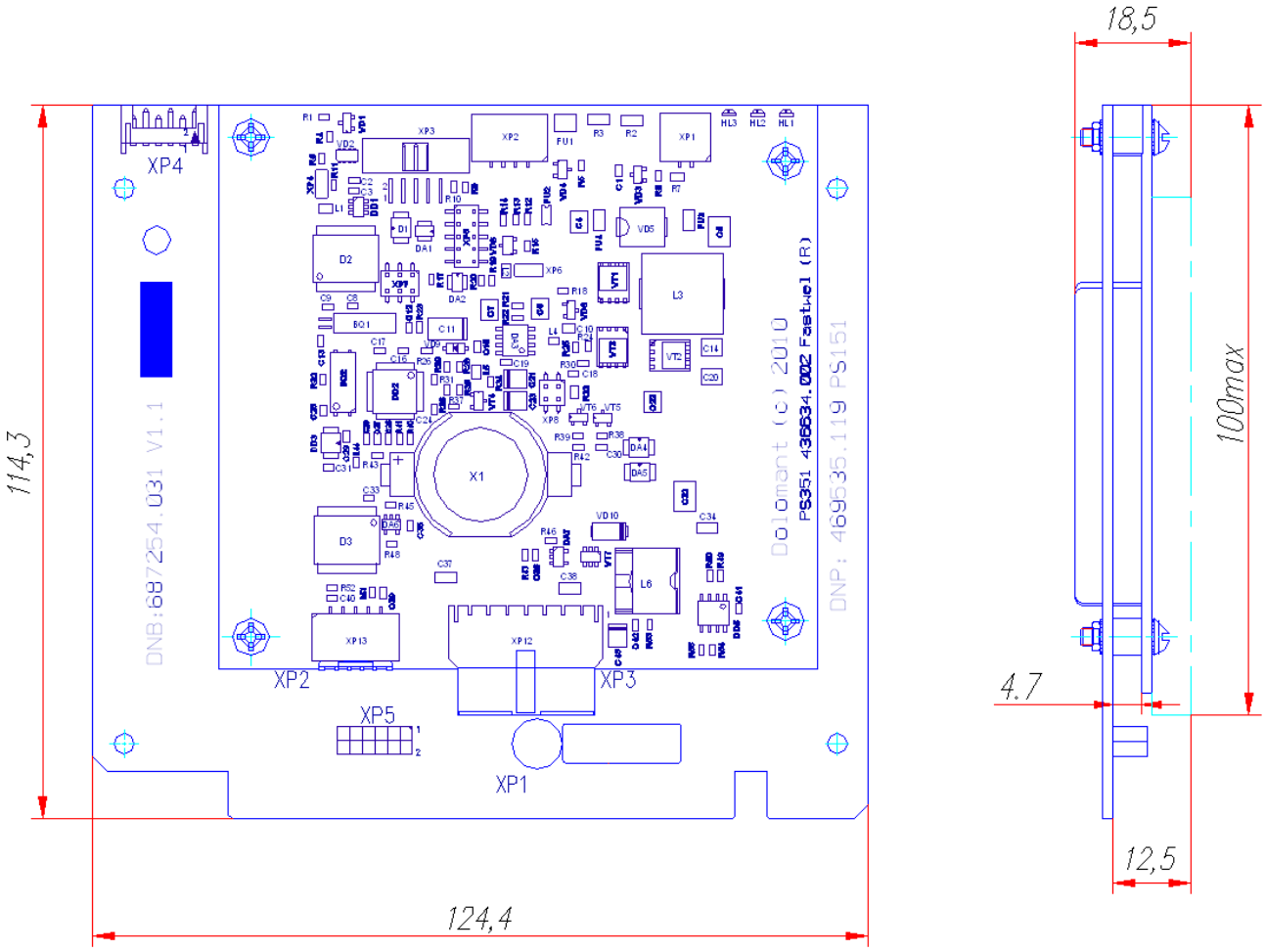


Figure 2.2: PS151 module overall and mounting dimensions



2.6 MTBF

MTBF is 160000 hours.

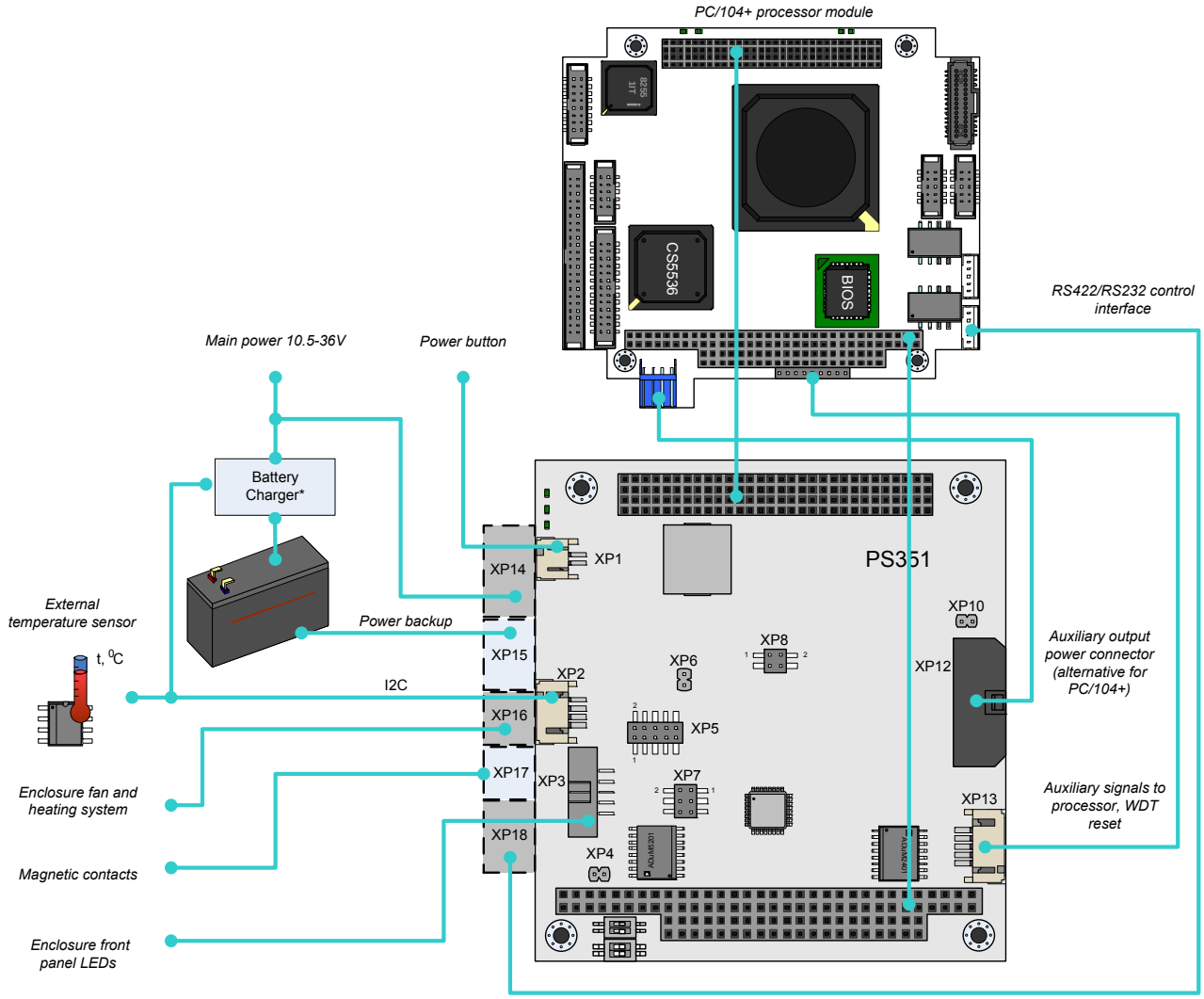
The value is calculated using the Telcordia Issue 1 model, Method I Case 3, for continuous operation at a surface location, in accordance with IEC721 for regions with temperate and cold climate, at ambient temperature 30°C.

3 INTENDED USAGE

Typical connection diagram for the PS351 module as part of a modular computer is shown in Figure 3.1.

Typical connection diagram for the PS151 module differs from the diagram in Figure 3.1 in the manner of load connection: PS151 module output voltage is routed to relevant pins of the edge connector.

Figure 3.1: Typical connection of PS351 power supply module



** The current version of the PS351 firmware does not support connection of additional devices over the I2C bus*

Connectors shown in dashed lines are located on the bottom side of the circuit board

The PS351 power supply module design requires removal of heat from power converters arranged on the bottom side of the board using a heat spreading plate (used in PS351-01, -03 versions) or by attaching the PS351 module to the target device enclosure. Therefore, all modules of the system can only be connected from the top side of the PS351 module.

Input voltage is supplied over the module's XP14 main power connector and XP15 redundant power connector[4]. Each of the inputs is provided with an 8A fuse. The main power connector is additionally provided with an LC filter. The module is supplied via the input at which the voltage is higher.

XP1 connector is provided for connection of the power on/off switch located on the device enclosure.

The module can be used to build a self-contained system or a system with battery power backup[4]. An external charging unit controlled via the I2C bus can be used to charge the battery from main power supply[5] (XP2 connector). The system can be programmed to operate at certain intervals: the module will be switched on/off by a timer to significantly reduce current consumption in standby mode. Besides, the module provides additional signals to control the external fan and heater enabling warming-up of the system enclosure (when the system is switched on at temperatures up from -50°C or as otherwise programmed) or switching on an extra fan (to enhance convection within the enclosure).

The PC/104+ form-factor processor module is supplied via the relevant +5 V and +12 V contacts of stack connectors (the +3.3 V supply channel is low-power and in most cases will be incapable of supplying power to the processor module). Such connection enables building a “rigid” system (all modules are rigidly interconnected by standoffs) and fixing it on the device enclosure using mounting holes of the PS351 heat spreading plate (versions -01 and -03). Where power to the processor module cannot be supplied via the stack connectors, an auxiliary output power connector (XP12) is provided on the PS351 module.

PS151 module output voltage is routed to relevant pins of the edge connector to power all the modules of the system via the backplane. The +3.3 V voltage is not routed to the edge connector, but is applied to the XP4 connector of the motherboard.

The module is controlled over a RS232 or RS422 serial interface (XP18) selected using the XP4 jumper. Control can be effected by either a remote system or the processor module. Drivers of the control system line are provided with galvanic isolation from the input and output voltages.

Power converters activation modes can be selected by means of XP7 jumpers: 6 fixed and 1 programmable mode (i.e. changeable during operation of the module) is available.

For auxiliary signals, an on-board connector is available (XP13 on PS351; on PS151, the signals of the connector are applied to the XP4 connector of the motherboard) enabling the processor to receive the error condition reports with minimum delay:

– CPU_INT signal with programmable assignment,
– LOW_POWER signal (active low signal) at the output of input voltage comparator with programmable threshold,
– POWER_GOOD signal (active high signal) at the output of output power supply voltages supervisor,
– RESET_WDT signal to reset the watchdog timer integrated into PS351.

Additionally, the LOW_POWER and CPU_INT signals can be switched (using microswitches) to the PC/104 connector interrupt request lines IRQ5, IRQ6, IRQ10, IRQ11 (for PS351 module).

For the PS151 module, the CPU_INT signal can be switched to the IRQ3-IRQ7, IRQ9 interrupts of the XP1 edge slot.

The board is provided with LED module status indicators representing voltage presence across the main power connector, across the input of power converters, and presence of POWER_GOOD signal, external fan and heater control signals. The on-board LEDs can be disables by means of jumpers (XP5) to reduce the module’s current consumption or connect additional external LED indicators (XP3) conveniently located on the target device enclosure.

The module is equipped with a connector for two dry contact signals which can be used as “device enclosure open” detection signals or as additional digital inputs.

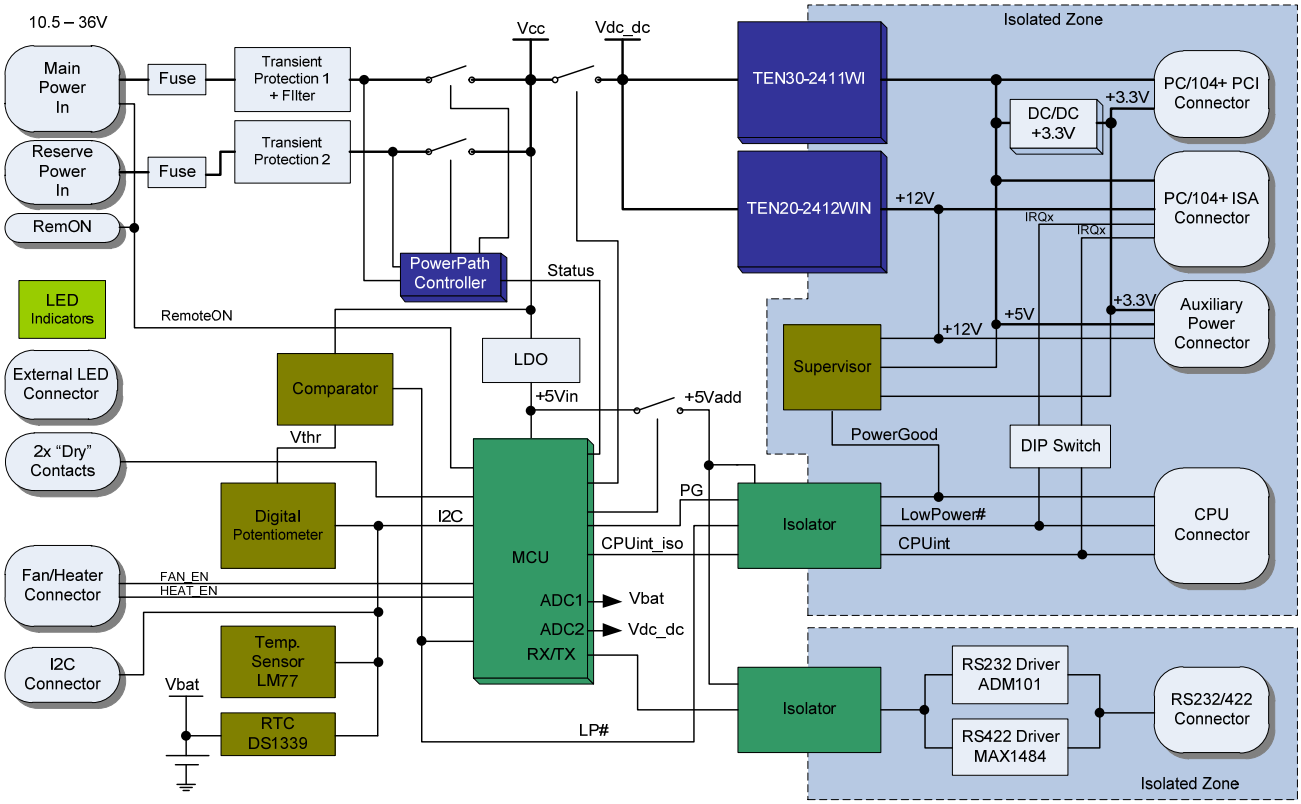
[4] The UPS function and power supply to the module via the redundant power connector are not supported in version 1.2 modules.
[5] Version 3.0 of the firmware does not support connection of external devices over the I2C bus.

4 FUNCTIONAL DESCRIPTION

4.1 BLOCK DIAGRAM AND GENERAL LAYOUT

A block diagram of the module is shown in Figure 4.1.

Figure 4.1: Module block diagram



The module includes the following main functional components:

- Protective elements at the main and redundant power inputs: fuses, TVS diodes;
- Input voltage selection controller: control of MOSFET transistors to minimize losses[6];
- DC/DC power converters with galvanic isolation: TEN30-2411WI for +5 V/30 W and TEN20-2412WIN for +12 V/20 W outputs;
- Low power DC/DC converter from +5 V into +3.3 V/5 W;
- PC/104+ stack connectors with the supply voltages terminated to their contacts (for PS351);
- Output voltage supervisor;
- Galvanic isolator for the CPU_INT, LOW_POWER, POWER_GOOD, WDT_RESET processor signals;
- Microcontroller based control system (MCU) ATmega328P;
- Serial interface drivers with galvanic isolation (RS232 or RS422 can be selected using on-board jumper) for the control system;
- Input voltage level comparator with programmable triggering level;

[6] The UPS function and power supply to the module via the redundant power connector are not supported in version 1.2 modules.

– Digital potentiometer for setting the input voltage comparator triggering level;
– Temperature sensor based on LM77 device with measuring accuracy of 1.5°C;
– Real-time clock RTC based on DS1339 device with battery backup capability;
– Measurements of input voltage and RTC battery voltage are implemented based on an ADC microcontroller.

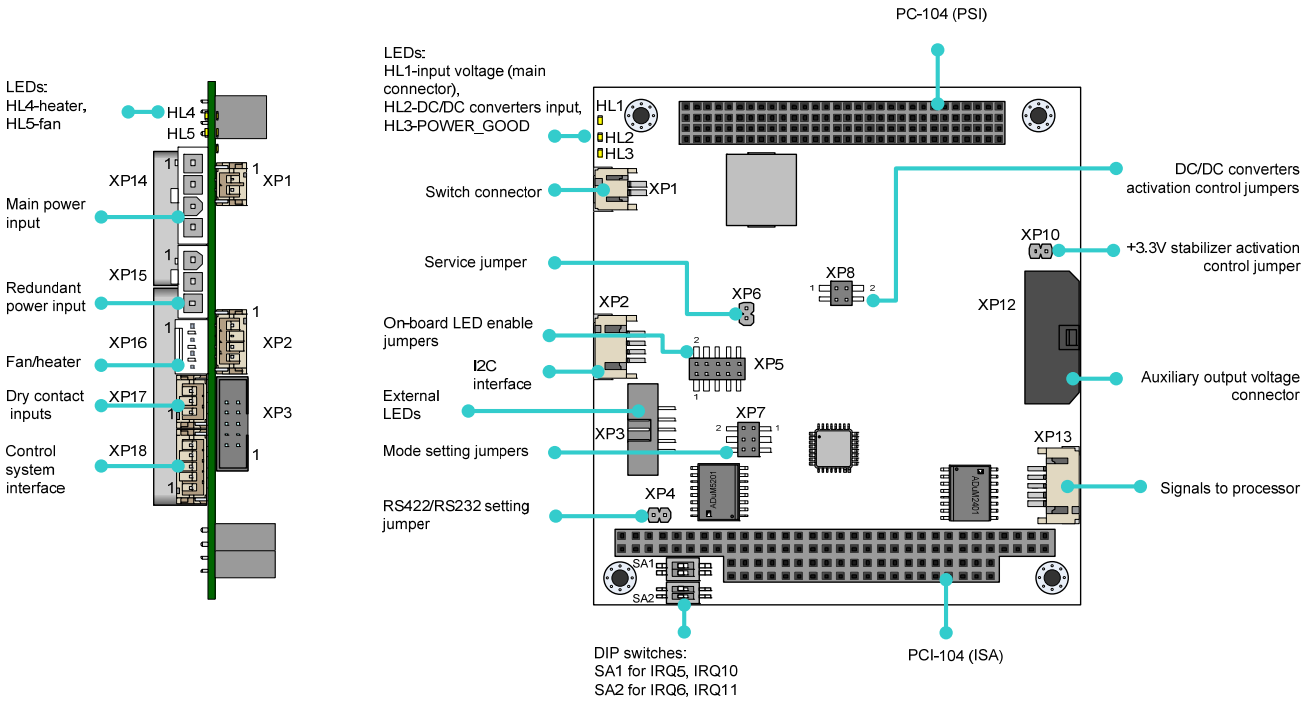
Output voltages in PS-151 module (except +3.3V) are terminated to an edge slot; signals to processor and the +3.3V voltage are terminated to a connector (XP4) on the motherboard.

When voltage is applied to the module's main power connector, the on-board controller is activated and initialization of peripheral devices takes place, after which the controller switches into the sleep mode. It can wake up to switch the module into a preset mode only when there is high level in Remote EN signal line. If there is no need to use this signal, a jumper can be installed on the XP8 connector of the board, between contacts 3 and 4, thus enabling the module to activate the DC/DC converters directly upon connection of the minimum input voltage. For detailed information, see the «*Configuration jumpers*» paragraph.

Layout of main components and connectors on the top side and the module side view are shown in Fig. 4.2.

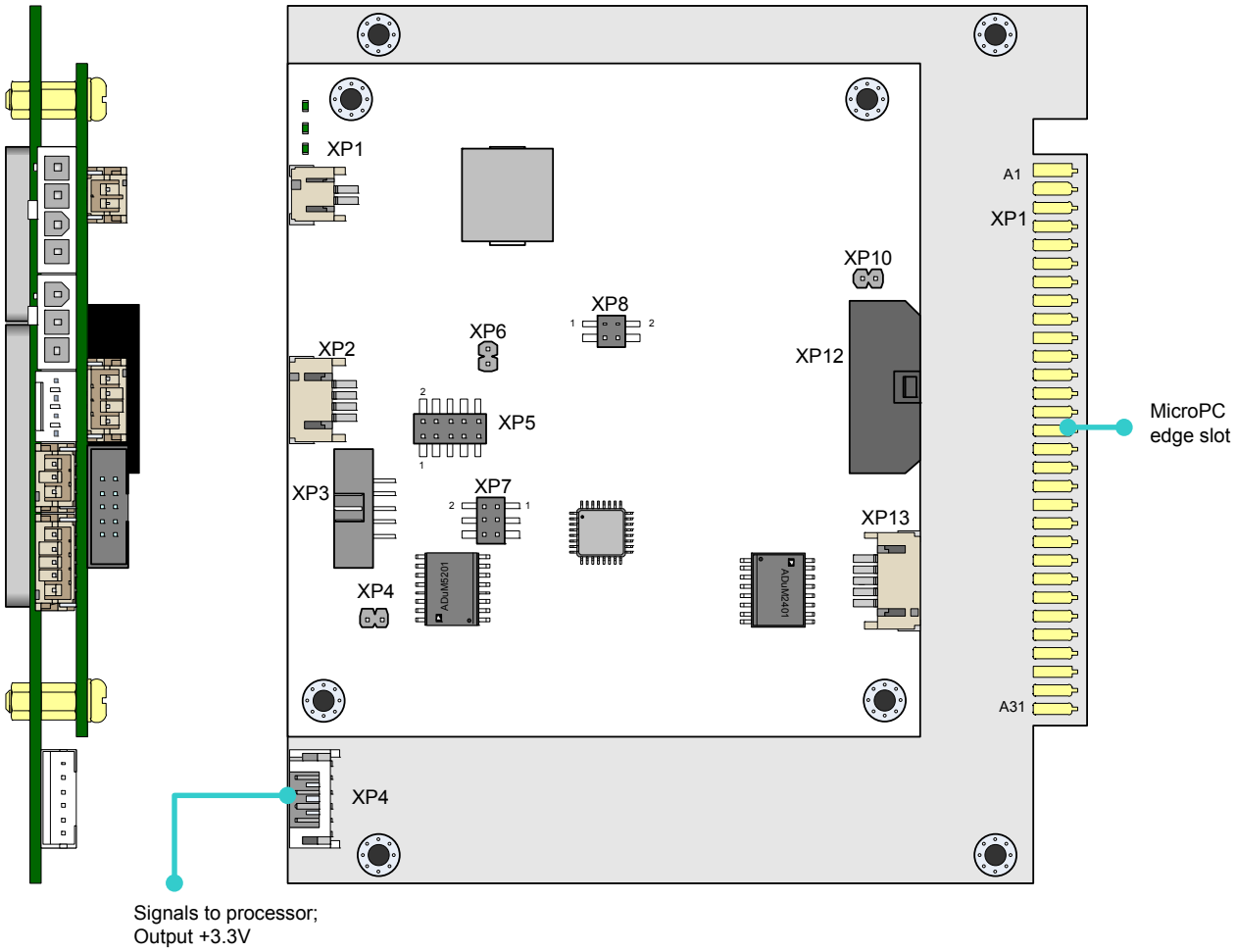
Layout of main components and connectors of the PS151 module is shown in Fig. 4.3.

Figure 4.2: PS351 module connectors and main components layout



PS351-03 modules are not equipped with a control system and any of the following components: HL3-HL5, XP2, XP4, XP6, XP7, XP13, XP16-XP18, SA1, SA2.

Figure 4.3: PS151 module connectors and main components layout



4.2 INTERFACES AND CONNECTORS

4.2.1 Main power connector

Main input voltage is supplied over the XP14 connector. XP14 connector contacts designation is shown in Table 4.1.

The input is protected by a 0458 008 (Littelfuse) fuse rated to 8 A.

It is recommended to use 39-01-4040 (Molex) connector and 44-47-63111 (Molex) contacts of the module's delivery package as a mating part.

Figure 4.4: XP14 main power connector

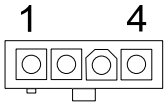


Table 4.1: XP14 connector contacts designation

Pin	Signal
1	–
2	Vin +
3	GND_in
4	Remote EN

Remote EN signal is used for remote activation/deactivation of the module. To improve noise protection of the module a Schmitt trigger is provided at its input: To activate the module, supply voltage exceeding 3.05 V to its input, to deactivate the module, supply voltage less than 2.15 V to its input (over the entire temperature range). Voltage at Remote EN input 36 V max.

To activate PS351-03 module to the Remote_EN signal, an activation signal must be supplied. The corresponding level can be supplied either to XP14 connector or to XP1 connector.

4.2.2 Redundant power connector [7]

Redundant input voltage is supplied over the XP15 connector. The module is powered from a source, backup or main, with a higher voltage (switching threshold can vary depending on the load current and input voltage due to series resistance of power transistors and inductance resistance of the filter at the main power input, but will not exceed 0.5 V). If both voltages are equal, the load is shared; i.e. power from both input power sources is supplied simultaneously. XP15 connector contacts designation is shown in Table 4.2.

It is recommended to use 39-01-4030 (Molex) connector and 44-47-63111 (Molex) contacts of the module's delivery package as a mating part.

The input is protected by a 0458 008 (Littelfuse) fuse rated to 8 A.

[7] The UPS function and power supply to the module via the redundant power connector are not supported in version 1.2 modules.

Figure 4.5: XP14 main power connector

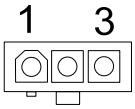


Table 4.2: XP15 connector contacts designation

Pin	Signal
1	Vin_reserv +
2	GND_in
3	GND_in

4.2.3 Power on/off switch connector

XP1 connector is provided for connection of the power on/off button. Power supply voltage (after voltages from the main and redundant power supply are combined – Vcc_dc/dc; not recommended for supplying power to any external circuits) and Remote EN signal are terminated to this connector. XP1 connector contacts designation is shown in Table 4.3.

It is recommended to use PHR-2 (JST) connector and SPH-002T-P0.5S (JST) contacts of the module's delivery package as a mating part.

Figure 4.6: XP1 switch connector

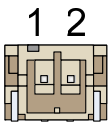


Table 4.3: XP1 connector contacts designation

Pin	Signal
1	Vcc_dc/dc
2	Remote EN

4.2.4 I2C[8] interface connector

Use the XP2 connector to connect additional devices (a charger, an external temperature sender) to the module. XP2 connector contacts designation is shown in Table 4.4.

TVS-diodes are provided at signal lines to protect the I2C interface from external noise and static voltage.
It is recommended to use PHR-4 (JST) connector and SPH-002T-P0.5S (JST) contacts of the module's delivery package as a mating part

[8] A function for connection of external devices is not implemented in modules of versions 1.2 and 1.3.

Figure 4.7: XP2 connector for I2C interface

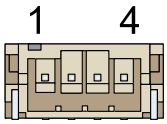


Table 4.4: XP2 connector contacts designation

Pin	Signal
1	+5V
2	SDA
3	SCL
4	GND_in

4.2.5 Fan and heater control signals connector

Use XP16 connector for connection of additional elements to the power supply module: a heating element and a fan, which ensure activation at low temperatures (warming up the casing of a device containing the PS351 module). PS351 module can also activate the fan when temperature inside the device casing exceeds preset temperature that improves air circulation inside the device casing. XP16 connector contacts designation is shown in Table 4.5.

Threshold temperatures for setting fan and heater activation signals are programmed in the PS351 non-volatile memory. To operate the module with temperature control, set the required mode of operation. See guidelines for programming of thresholds and operation modes in the «*Programming of modules*» section of this Manual.

Input voltage (main and redundant power supply voltages after combination) through a 2 A fuse, type 0466.002.NR (Littelfuse), and external fan and heater activation control signals are terminated to this connector.

It is recommended to use 22-01-2045 (Molex) connector and 08-50-0114 (Molex) contacts as a mating part.

Figure 4.8: XP16 connector for connection of external fan/heater

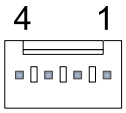


Table 4.5: XP16 connector contacts designation

Pin	Signal	Active level
1	Vcc_dc/dc	-
2	FAN_EN	“1”
3	HEAT_EN	“1”
4	GND_in	-

4.2.6 Dry contacts

Dry contact inputs are routed to the XP17 connector. Each input is connected with the internal supply voltage of +5 V over a 100 kohm resistor. XP17 connector contacts designation is shown in Table 4.6.

Depending on the configuration programmed in the EEPROM (see "*Programming of modules*"), the signals can be used to store events in the non-volatile memory or to generate CPU_INT signal (see "*Connector for additional signals (PS351 module)*" or "*Connector for additional signals (PS151 module)*").

It is recommended to use PHR-3 (JST) connector and SPH-002T-P0.5S (JST) contacts of the module's delivery package as a mating part.

Figure 4.9: XP17 connector for dry contact input signals

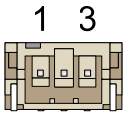


Table 4.6: XP17 connector contacts designation

Pin	Signal
1	DRY1
2	DRY2
3	GND_in

4.2.7 External LEDs

External LEDs can be connected to the XP3 connector. External LEDs duplicate the HL1-HL5 on-board LEDs. Simultaneous connection of external and on-board LEDs is not recommended. XP3 connector contacts designation is shown in Table 4.7.

The module's external LEDs can be disconnected using jumpers of the XP5 connector (jumpers removed). External LEDs (for example, module front panel LEDs) are connected to the XP3 connector. Table 4.7 also includes ratings of current-limiting resistors for each LED, which must be taken into account when selecting LEDs for the external indication.

It is recommended to use 2040-3102 (Leotronics) header as a mating part.

Figure 4.10: XP3 connectors for external LEDs

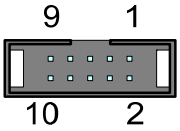


Table 4.7: External LEDs XP3 connector contacts designation

Pin	Signal	Current-limiting resistor	Remarks
1	Vled_heat+	-	External heating element activation LED. Heater ON – LED is lit. Power to the LED from on-board +5 V stabilized source.
2	Vled_heat-	680	
3	Vled_fan+	-	External fan activation LED. Fan ON – LED is lit. Power to the LED from on-board +5 V stabilized source.
4	Vled_fan-	680	
5	V_pwr_on+	-	DC/DC converters activation. Power is connected to isolated DC/DC converters – LED is lit. Power to the LED from the combined input voltage; varies from -10.5 V to +36 V.
6	V_pwr_on-	6.8 kohm	
7	V+	-	Main or backup input power LED. Main power connector voltage ON – LED is lit. Power to the LED from the main input voltage connector; varies from -10.5 V to +36 V.
8	V–	6.8 kohm	
9	V_pg+	-	"Power Good"[9] signal LED – PG signal indicator for XP13 connector. Output voltages within preset range – LED is lit. Power to the LED from on-board +5 V stabilized source.
10	V_pg-	2.2 kohm	

4.2.8 Control interface

For interaction with the PS-351 module on-board controller (operation mode setting, reading data), an RS232 or RS422 serial interface with galvanic isolation is used. The control interfaces are selected using the XP4 jumper:

- RS232 (RX and TX lines) – jumper removed
- RS422 – jumper installed.

XP18 connector contacts designation is shown in Table 4.8.

A peculiarity of the RS232 interface driver is using logic signal levels of ±4.2V (ADM101E device installed; for more information on the logic levels depending on temperature and load see the manufacturer's web-site at www.analog.com).

When the RS422 interface is used, a matching resistor in the PS351 transmitter line is not installed.

It is recommended to use PHR-5 (JST) connector and SPH-002T-P0.5S (JST) contacts of the module's delivery package as a mating part.

[9] The indicator will not work correctly on the module with 1.3 PCB version when the module is deactivated using the Remote_EN signal. In this mode, the LED is not used and it is recommended to disconnect it by removing the XP5 jumper (between contacts 9-10).

Figure 4.11: Control interface XP18 connector

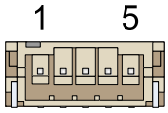


Table 4.8: Control interface XP18 connector contacts designation

Pin	RS232	RS422
1	-	RX+
2	-	RX-
3	TX	TX+
4	RX	TX-
5	GND_iso	GND_iso

Note:

GND_iso signal is galvanically isolated from GND_in (module's input voltage) and GND (module's output voltage reference level).

4.2.9 PC-104 connector (ISA; PS351 module)

Stabilized power +5 V and +12 V is terminated to the corresponding pins of the PC/104 – XS2 connector. XS2 connector contacts designation is shown in Table 4.9.

Additionally, LOW_POWER (inverted when connected to corresponding pin of the XS2 connector; active high) and CPU_INT signals to the processor can be switched to the connector's interrupt lines IRQ5, IRQ6, IRQ10 and IRQ11. An interrupt line for signals output are selected using the SA1 and SA2 jumpers.

Table 4.9: XS2 (PC-104, ISA) connector contacts designation

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	–	B1	GND	C0	GND	D0	GND
A2	–	B2	–	C1	–	D1	–
A3	–	B3	+5V	C2	–	D2	–
A4	–	B4	–	C3	–	D3	IRQ10
A5	–	B5	–	C4	–	D4	IRQ11
A6	–	B6	–	C5	–	D5	–
A7	–	B7	–	C6	–	D6	–
A8	–	B8	–	C7	–	D7	–
A9	–	B9	+12V	C8	–	D8	–
A10	–	B10	GND	C9	–	D9	–
A11	–	B11	–	C10	–	D10	–
A12	–	B12	–	C11	–	D11	–
A13	–	B13	–	C12	–	D12	–
A14	–	B14	–	C13	–	D13	–
A15	–	B15	–	C14	–	D14	–
A16	–	B16	–	C15	–	D15	–
A17	–	B17	–	C16	–	D16	+5V
A18	–	B18	–	C17	–	D17	–
A19	–	B19	–				
A20	–	B20	–				
A21	–	B21	–				
A22	–	B22	IRQ6				
A23	–	B23	IRQ5				
A24	–	B24	–				
A25	–	B25	–				
A26	–	B26	–				
A27	–	B27	–				
A28	–	B28	–				
A29	–	B29	+5V				
A30	–	B30	–				
A31	–	B31	GND				
A32	GND	B32	GND				

4.2.10 PCI-104 (PCI; PS351 module) connector

Stabilized power +5 V, +12 V, and +3.3 V is terminated to the corresponding pins of the PCI/104 – XS1 connector. XS1 connector contacts designation is shown in Table 4.10.

Table 4.10: XS1 (PCI-104, PCI) connector contacts designation

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	GND	B1	–	C1	+5V	D1	–
A2	–	B2	–	C2	–	D2	+5V
A3	–	B3	GND	C3	–	D3	–
A4	–	B4	–	C4	GND	D4	–
A5	GND	B5	–	C5	–	D5	GND
A6	–	B6	–	C6	–	D6	–
A7	–	B7	–	C7	GND	D7	–
A8	+3.3V	B8	–	C8	–	D8	+3.3V
A9	–	B9	GND	C9	–	D9	–
A10	GND	B10	–	C10	+3.3V	D10	–
A11	–	B11	+3.3V	C11	–	D11	GND
A12	+3.3V	B12	–	C12	GND	D12	–
A13	–	B13	GND	C13	–	D13	+3.3V
A14	GND	B14	–	C14	+3.3V	D14	–
A15	–	B15	+3.3V	C15	–	D15	GND
A16	–	B16	–	C16	GND	D16	–
A17	+3.3V	B17	–	C17	–	D17	+3.3V
A18	–	B18	GND	C18	–	D18	–
A19	–	B19	–	C19	–	D19	–
A20	GND	B20	–	C20	–	D20	GND
A21	–	B21	+5V	C21	–	D21	–
A22	+5V	B22	–	C22	GND	D22	–
A23	–	B23	GND	C23	–	D23	–
A24	GND	B24	–	C24	+5V	D24	–
A25	–	B25	–	C25	–	D25	GND
A26	+5V	B26	–	C26	GND	D26	–
A27	–	B27	+5V	C27	–	D27	GND
A28	GND	B28	–	C28	+5V	D28	–
A29	+12V	B29	–	C29	–	D29	–
A30	–	B30	–	C30	–	D30	GND

4.2.11 Auxiliary output voltage connector

Stabilized voltage is terminated to the stack connectors as per the PC/104+ specification and to the additional on-board connector XP12. XP12 connector contacts designation is shown in Table 4.11.

In cases where the +3.3 V voltage is not used it is recommended to deactivate the DC/DC converter by removing the XP10 jumper (for more details see the "*Configuration jumpers*" section).

It is recommended to use 43645-0700 (Molex) connector and 43030-0001 (Molex) contacts of the module's delivery package as a mating part.

Figure 4.12: Auxiliary output power connector XP12

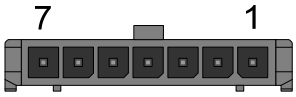


Table 4.11: XP12 connector contacts designation

Pin	Designation
1	+3.3 V
2	+12 V
3	GND
4	GND
5	GND
6	+5 V
7	+5 V

4.2.12 Connector for additional signals (PS351 module)

On-board XP13 connector is installed to connect additional signals of the PS351 module (LOW_POWER#, WDT_RESET, CPU_INT, POWER_GOOD) to processor input/output signals (GPIO of processor module). XP13 connector contacts designation is shown in Table 4.12.

LOW_POWER# signal is in inactive high state; when the input voltage drops below a predefined threshold (such threshold is preset in the non-volatile memory of the PS351 module integrated controller, see the "*Programming of modules*" section) the signal changes to low.

RESET_WDT signal enables resetting the WDT implemented in the PS351 module: the timer is reset on leading and trailing edge of the signal. The integrated WDT enables short-time deactivation (duration of deactivation is programmed in the integrated memory EEPROM) of the integrated DC/DC converters (i.e., powering off the processor module).

CPU_INT signal is configurable, its designation and active level are preset in the internal registers of the module's controller (see the "*Programming of modules*" section).

POWER_GOOD (PG) signal is generated by PS351 module if corresponding voltage levels are present at all three DC/DC converters. The maximum threshold voltage (over the entire temperature range): 4.67 V for a channel with nominal voltage of +5 V; not less than 3.02 V for a channel with nominal voltage of +3.3 V (if the corresponding converter is enabled using the XP10 jumper); 10.82 V for a channel with nominal voltage of 12 V. The PG signal delay after all voltages are set up is less than 280 ms (typical delay is 200 ms).

It is recommended to use PHR-5 (JST) connector and SPH-002T-P0.5S (JST) contacts of the module's delivery package as a mating part.

Figure 4.13: Connector for additional signals of the PS351 module (XP13)

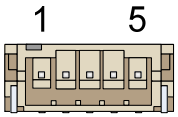


Table 4.12: XP13 connector contacts designation for PS351 module

Pin	Designation	Direction
1	CPU_INT	Output
2	LOW_POWER#	Output
3	PG	Output
4	RESET_WDT	Input
5	GND	-

4.2.13 Connector for additional signals (PS151 module)

PS151 module's motherboard has the XP4 connector, to which signals from the PS351 module's XP13 connector and +3.3 V (DC/DC converter for +3.3 V is enabled using the XP10 jumper on-board PS351-02) are routed.

XP4 connector contacts designation for PS151 module is shown in Table 4.13.

Figure 4.14: Connector for additional signals of the PS151 module (XP4)

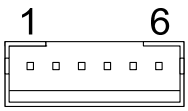


Table 4.13: XP4 connector contacts designation for PS151 module

Pin	Designation	Direction
1	POWER_GOOD	Output
2	RESET_WDT	Input
3	CPU_INT	Output
4	LOW_POWER	Output
5	GND	-
6	+3.3V	Output

4.2.14 MicroPC edge slot (PS151 module)

The +5 V and +12 V output voltages and the interrupt lines of the PS151 module are terminated to the corresponding contacts of the XP1 edge slot. Contacts designation for the slot is shown in Table 4.14.

CPU_INT signal of the PS351 module can be switched to the interrupt lines using the XP5 jumpers (see the "*Configuration jumpers*" section). It is not recommended to switch the CPU_INT signal to several interrupts simultaneously.

Table 4.14: XP1 connector contacts designation for PS151 module

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
A1	–	A17	–	B1	GND	B17	–
A2	–	A18	–	B2	–	B18	–
A3	–	A19	–	B3	+5V	B19	–
A4	–	A20	–	B4	IRQ9	B20	–
A5	–	A21	–	B5	–	B21	IRQ7
A6	–	A22	–	B6	–	B22	IRQ6
A7	–	A23	–	B7	–	B23	IRQ5
A8	–	A24	–	B8	–	B24	IRQ4
A9	–	A25	–	B9	+12V	B25	IRQ3
A10	–	A26	–	B10	GND	B26	–
A11	–	A27	–	B11	–	B27	–
A12	–	A28	–	B12	–	B28	–
A13	–	A29	–	B13	–	B29	+5V
A14	–	A30	–	B14	–	B30	–
A15	–	A31	–	B15	–	B31	GND
A16	–	–	–	B16	–	–	–

4.2.15 LED indication

5 angled LEDs HL1-HL5 are installed on-board. Designation of the LEDs is shown in Table 4.15.

Table 4.15: LED indication of the module

LED	Designation
HL1	Indication of voltage across the main or backup power connector
HL2	Indication of voltage across the inputs of DC/DC converters
HL3	Power Good signal indication: Lit, if output voltages exceed the preset range[10]
HL4	External heater enable signal indication: Lit, if the activation signal (Heat_EN) is set to high.
HL5	External fan enable signal indication: Lit, if the activation signal (Fan_EN) is set to high.

[10] The indicator will not work correctly on the module with 1.3 PCB version when the module is deactivated using the Remote_EN signal. In this mode, the LED is not used and it is recommended to disconnect it by removing the XP5 jumper (between contacts 9-10).

4.3 PROGRAMMING OF MODULES

4.3.1 Modes of operation

Modes of operation for the modules can be selected by means of the XP7 jumpers. A mode number can be set using the binary system, by proper positioning of the jumpers (see the "*Configuration jumpers*" paragraph). The jumpers allow selecting between 8 (0…7) modes of operation, where the mode with number 7 is programmatically configurable: with these jumper settings, the active mode of operation is read from the configuration register in the non-volatile memory (see the "*Configuration registers*" paragraph).

Table 4.16 shows a list of possible modes of operation of the module: modes from 0 through 6 can be set using the on-board jumpers, while setting the jumpers to mode 7 enables programmatic selection of the modes. The table also shows the functionality utilized to control the module operation:

– "Off timeout" – the module will be switched off on expiry of the timeout (0x08 register) after the Remote EN signal state changes to "low";

– "ACK" – the module will be switched off upon expiry of the timeout (0x08 register) after the Remote EN signal state changes to "low" or upon confirmation from the processor of readiness to turn power off (change of the RESET_WDT signal from "low" to "high" or vice versa); switch-off instructions are sent to the processor using the CPU_INT signal (0x22 register);

– "WDT" – using the timer for deactivation with further activation of the DC/DC converters; the timer interval and deactivation duration for the module can be programmed in the EEPROM (0x02 and 0x06 registers respectively);

– "LOG" – storing events in the non-volatile memory;

- "Temperature" – if switching on is performed at a temperature below the preset value (0x0E register), the heating element enable signal is generated (HEAT_EN), then after 2 minutes, the fan enable signal is generated (FAN_EN; to enhance the convective heat transfer inside the enclosure). The module switches on after the ambient temperature inside the enclosure reaches the preset value. If, on timeout expiry (0x1E register), the preset temperature is not achieved, then emergency activation of the DC/DC converters occurs (at temperatures below 40°C operation of the DC/DC converters cannot be guaranteed). If temperature inside the enclosure exceeds the maximum value (0x10 register), the fan enable signal (FAN_EN) is generated to enhance convection in the enclosure;

– "Schedule" – the module will be switched on or off according to the time settings stored in the registers (switching on: 0x28 – hours register, 0x29 – minutes register; switching off: 0x2A – hours register, 0x2B – minutes register). Prior to switching off, at a time preset in the register (0x08), the CPU_INT signal is set to active state (0x22 register). When operating in scheduled modes, the CPU_INT signal will send a system shutdown warning signal only.

When the external Remote EN signal (XP14 or XP1 connector) is set to high, it causes the module to switch to active state: the switching on/off is controlled according to the mode set by means of the jumpers. When the XP8 is removed from contacts 3-4, the control system switches to active mode regardless of the Remote EN signal state on the external connectors.

Table 4.16: Modes of operation

Mode number (hex)	Off timeout	ACK	WDT	LOG	Temperature	Schedule
0x00	-	-	-	-	-	-
0x01	-	-	+	-	-	-
0x02	+	-	+	-	-	-
0x03	+	+	+	-	-	-
0x04	+	-	-	-	-	-
0x05	+	+	-	-	-	-
0x06	+	+	+	+	-	-
0x07	-	-	-	+	-	-
0x08	-	-	+	+	-	-
0x09	+	-	+	+	-	-
0x0A	+	-	-	+	-	-
0x0B	+	+	-	+	-	-
0x0C	-	-	-	-	+	-
0x0D	-	-	+	-	+	-
0x0E	+	-	+	-	+	-
0x0F	+	+	+	-	+	-
0x10	+	-	-	-	+	-
0x11	+	+	-	-	+	-
0x12	-	-	-	+	+	-
0x13	-	-	+	+	+	-
0x14	+	-	+	+	+	-
0x15	+	+	+	+	+	-
0x16	+	-	-	+	+	-
0x17	+	+	-	+	+	-
0x18 (24)	+	-	-	+	-	+
0x19	+	-	+	+	-	+
0x1A	+	-	-	+	+	+
0x1B	+	-	+	+	+	+

4.3.2 Data transfer protocol

Serial control interface parameters:

– Exchange rate: 38400 baud/sec
– Data bits: 8
– Parity: none
– Stop bits: 1

The power supply module control via the serial interface is implemented using ASCII coded instructions. Each instruction must end with the CR character (code 0x0D). If an instruction received by the module is true, the power supply module returns a value in accordance with the instruction transmitted. If the instruction is true, but there is an error in its arguments (values being set, register address), then the “INVALID COMMAND” string is returned. Unsupported commands will not be processed by the PS351 module.

The described protocol for interfacing with the module enables its programming by means of any common terminal application (e.g. Putty, Hyper Terminal etc.) available in various operating systems.

When the module’s power supply is switched on, a message similar to one below is transmitted over the control interface:

PS351control program. V.3.0 Nov 29 2010 15:28:31

MODE=7 J.T.=0000161D

EPCT=00000031

ONCT=00000025

The message includes: the firmware version (*V.3.0*), firmware compilation date and time (*Nov 29 2010 15:28:31*), operation mode set (*MODE=7*), total operation time of the module (*J.T.=0000161D)*, total number of connections of the module to the power supply voltage (*PCT=00000031)*, total number of DC/DC converters activation events (*ONCT=00000025*).

4.3.3 Instructions set and system events

Table 4.17 represents a list of instructions for the module. To enable the programmed settings (after reprogramming the EEPROM settings) it is required to disconnect the module from the input supply voltage for a few seconds or to execute the RBT and RST instructions.

Table 4.17: Module instructions set

Instruction	Description	Returned value
INF?	Returns the firmware version of the PS351 module, date of its compilation, current operating mode, and total operation time of PS351 in seconds (in hexadecimal format), number of connections of the module to the input power, number of DC/DC converters activation events, time left before power off when operating in the scheduled mode	Depends of the firmware version. Example: PS351 control program. V.1.0 Mar 11 2010 15:27:40 MODE=7 J.T.=000001F8 EPCT=00000003 ONCT=00000003
INSF	Reading the event register. After the instruction in executed, the CPU_INT signal becomes inactive; the event register is reset.	**INF**=YYYY where *YY* = register hexadecimal value (0000..01FF); Bit 8 – WDT triggering

Instruction	Description	Returned value
		Bit 7 – DRY2 signal 0->1 change Bit 6 – DRY1 signal 0->1 change Bit 5 – RESERV_ON signal 0->1 change Bit 4 – REMOTE_EN signal 0->1 change Bit 3 – DRY2 signal 1->0 change Bit 2 – DRY1 signal 1->0 change Bit 1 – RESERV_ON signal 1->0 change Bit 0 – REMOTE_EN signal 1->0 change
ADREAD	Reading the input voltage comparator potentiometer position. To convert the threshold coded values into voltages, the 4.2 formula is applied.	**ADREAD=***YY* where *YY* = potentiometer hexadecimal value (00..FF)
ADC6	Measuring the input voltage level. To convert the coded values into voltages, the 4.1 formula is applied. *Note:* voltage is measured at DC/DC converters input, which may differ from the power input voltage by 0.5V max. (see the "*Main power connector*" and "*Redundant power connector* " paragraphs)	**ADC6=***YYY* where *YYY* = input voltage hexadecimal value (0…1023)
ADC7	Reading the on-board battery voltage level. To convert the coded values into voltages, the 4.3 formula is applied.	**ADC7=***YYY* where *YYY* = battery voltage hexadecimal value (0…1023)
EEREAD*XX* where *XX* = register address in the non-volatile memory in hexadecimal format (00...FF)	Reading configuration register byte at *XX* address	**EEREAD***XX*=*YY* where *YY* = register hexadecimal value (00..FF)
EEWRITE*XXYY* where *XX* = register address in the non-volatile memory in hexadecimal format (00...FF); YY = value written to the register (00...FF)	Writing *YY* value to the configuration register at *XX* address	**EEWRITE***XX OK*
DSREAD*XX* where *XX* = register address in the	Reading from the *XX* register of the real-time clock device (DS1339)	**DSREAD***XX*=*YY* where *YY* = register

Instruction	Description	Returned value
DS1339U real-time clock device (00...FF)		hexadecimal value (00..FF)
DSWRITE*XXYY* where *XX* = register address in the DS1339U real-time device (00...FF); YY = value written to the register (00...FF)	Writing *YY* value to the *XX* register of the RTC device. **It is recommended to use this instruction applying special care as it can change the RTC built-in algorithm.** **It is further recommended to use this instruction only for writing to the registers of the device with addresses from 0x00 through 0x06 (time and date setting; see the device description at www.maxim-ic.com) and to the 0x0F register (bit 7 – Oscillator Stop Flag).**	**DSWRITE***XX OK*
LMREAD*XX* where *XX* = register address in the LM77 temperature sensor (00...FF)	Reading *XX* register in the temperature sensor (see the LM77 device description at www.national.com)	**LMREAD***XX*=*YY* where *YY* = register hexadecimal value (00..FF)
LOG?	Reading the “events” table from the PS351 non-volatile memory by 16 values in a line (the lines are separated by the LF+CR character); there is a space character between each byte	**Stored events table broken into lines**
LOG2	Reading the “events” table from the PS351 non-volatile memory; there is a space character between each byte	**Stored events table**
TM?	Reading time values from the RTC (the instruction is only available in the modes with events storing and scheduled operation enabled, see Table 4.16)	**DD:MO:YY Wd HH:MI:SS** where *DD* = day, MO = month, YY = year, Wd = weekday, HH = hours, MI = minutes, SS = seconds
TP?	Measuring of temperature (the instruction is only available in the modes with temperature control enabled, see Table 4.16)	**T=YYY^{0}C,** where YYY = temperature value (e.g., +27)
SDS	Setting default configuration (Table 4.19); to validate these settings it is required to disconnect the input supply voltage for a few seconds or to execute the RBT or RST instruction	**SDS OK**
RST	PS351 control system reset causing replacement of settings: after the instruction is executed it is required to deactivate the Remote EN signal for a short time	**RST OK**

Instruction	Description	Returned value
RBT	PS351 control system reset causing replacement of settings: the control system will reboot disabling the DC/DC converters after an interval set in the 0x26 register	**RBT OK**
TGE	Enable/disable output of information on events that have occurred, via the control interface. Only information related to the events allowed to be stored in the on-board EEPROM will be transferred (0x1A register). For example, in case of an error during output voltage setting the "EV-T 1C" message will be transmitted over the control interface, where the last two characters represent the event identifier in accordance with Table 4.18. When the module power is switched on, the output is initially disabled.	**TGE OK**
TGO	Enable/disable data transfer over the control interface: when data transfer is enabled, PS351 returns values of instructions; when data transfer is disabled the PS351 module's transmitter is turned off with only the receiver remaining operational. When the module power is switched on, data transfer is initially enabled.	**TGO OK – when data transfer is enabled** **No response – when data transfer is disabled**

Note:

When measuring the input voltage using the ADC6 instruction, voltage across the DC/DC converters input is measured after it passes through the MOSFET transistors and the filter inductance included in the input circuit, which reduces the voltage across the DC/DC converters input depending on the current consumption and temperature, but not more than by 0.5 V.

Events are stored in circular memory sized to 50 events. Each event takes 7 bytes of the non-volatile memory. Address of the current free storage location is written to the 0x01 address of the EEPROM (see the "*Configuration registers*" paragraph). During reading the events table using the LOG? and LOG2 instructions the non-volatile memory is read starting from the zero address, while a space character (0x20) is transmitted between each byte. Memory storage structure for an event is as follows:

Address shift	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Assignment	Day	Month	Year	Hours	Minutes	Seconds	Identifier

Table 4.18 describes assignments of event identifiers in the non-volatile memory of the PS351 module.

Table 4.18: Event identifiers

Identifier	Assignment
0x00	Supply voltage across the input below preset level (0x0C register)
0x01	Change of the Remote EN signal state into active or power-on button pressed to close contacts
0x02	Change of the Remote EN signal state into inactive or power-on button pressed to open contacts
0x03	DC/DC converters activated
0x04	DC/DC converters deactivated
0x05	Voltage across the RTC battery below preset level (0x16 register)
0x06	DC/DC converters deactivated upon WDT timeout
0x07	Voltage across the RTC battery above preset level (0x18 register)
0x08	Voltage across the input above preset level (0x0D register)
0x09	Change of the RESET_WDT signal from high to low
0x0A	Control system supply voltage above 4.375V threshold
0x0B	Control system supply voltage below 4.375V threshold
0x0C	I2C interface error (at that, error number will be written to the seconds position in the non-volatile memory)
0x0D	Change of the RESET_WDT signal from low to high
0x0E	Temperature above maximum threshold value (0x10 register)
0x0F	Temperature below maximum threshold value (0x10 register)
0x10	Current temperature below minimum preset value (0x0E register)
0x11	Current temperature above minimum preset value (0x0E register)
0x12	Switched to redundant power connector
0x13	Switched to main power connector
0x14	Change of the DRY1 line from high to low

Identifier	Assignment
0x15	Change of the DRY1 line from low to high
0x16	Change of the DRY2 line from high to low
0x17	Change of the DRY2 line from low to high
0x18	Interrupt from RTC device
0x19	Scheduled power on
0x1A	Scheduled power off
0x1B	POWER_GOOD signal set to active state (output voltages established)
0x1C	POWER_GOOD signal set to inactive state (failure to establish output voltages)

4.3.4 Configuration registers

The module's configuration is stored in the non-volatile memory (EEPROM) of the control system microcontroller. Table 4.19 lists the assignments of the registers.

Table 4.19: PS351 power supply module configuration registers

Address	Number of bytes	Description	Default value
0x00	1	Mode number	0x07
0x01	1	Address of free storage location in the events table	0
0x02	4	Watchdog timer (WDT) timeout (msec)	5 min (0x000493E0)
0x06	2	System powered-off duration at WDT triggering (msec)	5 sec (0x1388)
0x08	4	Power-off timeout if switching off with timeout (after Remote EN changes into inactive state) (msec)	60 sec (0x0000EA60)
0x0C	1	Input voltage comparator lower threshold (to change LOW_POWER# signal into active state)	22V (0x9C)
0x0D	1	Supply voltage comparator upper threshold (to change LOW_POWER# signal into inactive state)	24V (0xAA)
0x0E	2	Minimum operating temperature with 0.5°C steps	-40°C (0xFFB0)
0x10	2	Maximum operating temperature with 0.5°C steps	85°C (0x00AA)
0x12	4	Total PS351 power supply module operating time in seconds (updated on PS351 power on/off)	0
0x16	2	Lowest voltage value across RTC battery (000…3FF) causing the 0x05 event logging; a formula (4.3) is applied for calculations	2V (0x024A)
0x18	2	Highest voltage value across RTC battery (000…3FF) causing the 0x07 event logging; a formula (4.3) is applied for calculations	2.5V (0x02DB)
0x1A	4	Register for flags permitting writing of events to non-volatile memory: bit number corresponds to the event identifier number in Table 4.18; 1 – event storage allowed, 0 – event storage not allowed	0xFFFFFFFF
0x1E	4	Max. timeout (msec) for module warming-up to the minimum operating temperature; on timeout expiry, emergency activation of the DC/DC converters occurs	30 min (0x001B7740)
0x22	1	CPU_INT signal configuration: Bit 7: 0 – duplication of input signals (Remote EN or RESERV_ON or DRY1 or DRY2); 1 – CPU_INT changes to active state when states of said inputs change; Bit 6: not used; Bit 5: not used; Bit 4: 0 – DRY2 will not generate CPU_INT signal;	0x02

Address	Number of bytes	Description	Default value
		1 – DRY2 will generate CPU_INT signal; Bit 3: 0 – DRY1 will not generate CPU_INT signal; 1 – DRY1 will generate CPU_INT signal; Bit 2: 0 – RESERV_ON will not generate CPU_INT signal; 1 – RESERV_ON will generate CPU_INT signal; Bit 1: 0 – REMOTE EN will not generate CPU_INT signal; 1 – REMOTE_EN will generate CPU_INT signal; Bit 0: 0 – CPU_INT active low; 1 – CPU_INT active high; CPU_INT signal reset to inactive state will occur when module state is read using "INS?" or "INSF" instructions	
0x24	1	Time for which CPU_INT signal remains inactive with Bit 7 set to low in 0x22 register	255 msec (0xFF)
0x25	1	Not used	0xFF
0x26	2	Control system controller reboot timeout (msec) accompanied by disabling the DC/DC converters and loss of voltage at the module output	65535 msec (0xFFFF)
0x28	1	DC/DC converters activation time – hours; binary-decimal format (0x00..0x24)	8 hr (0x08)
0x29	1	DC/DC converters activation time – minutes; binary-decimal format (0x00..0x59)	0 min (0x00)
0x2A	1	DC/DC converters deactivation time – hours; binary-decimal format (0x00..0x24)	17 hr (0x17)
0x2B	1	DC/DC converters deactivation time – min; binary-decimal format (0x00..0x59)	0 min (0x00)
0x2C	4	A counter for the number of connections of the module to input power	0
0x30	4	A counter for the number of DC/DC converters activation events	0

Note:

In the table above:

RESERV ON – signal of switching to redundant power supply (active high – power supply via the redundant power connector)

DRY1, DRY2 – dry contact input signals

When reading the input voltage level using the ADC6 instruction, the value is returned as an ADC code (CODE_VIN=0x000…0x3FF) that can be converted into volts using the formula (4.1):

$$Uin = CODE\_VIN \cdot 0.035 \quad (4.1)$$

Comparator input power supply voltage decrease threshold is set using codes (CODE_VTHR=0x00..0xFF) and can be converted into input voltage using the formula (4.2):

$$Uthr = CODE\_VTHR \cdot 0.141 \quad (4.2)$$

To convert the RTC battery voltage code (CODE_VBAT=0x000…0x3FF) into volts the formula (4.3) is used:

$$Ubat = CODE\_VBAT \cdot 0.00341 \quad (4.3)$$

4.3.5 Programming examples

The module can be programmed using virtually any terminal application (e.g. Putty, Hyper Terminal etc.) capable of sending and receiving ASCII coded serial port instructions.

The programming examples below are shown for a terminal application run on a PC with the parameters of the serial port to which the module is connected preconfigured by the user as described in the "*Data transfer protocol*" paragraph of this Manual. The module must be connected to the corresponding port of the user PC over a null-modem cable, the XP4 jumper not installed on the module, the module is in active mode: REMOTE EN signal is active or XP8 (1-2) jumper is removed or XP6 jumper is installed.

Using the XP7 jumpers of the PS351 module, the 0x07 operation mode can be set to enable changing the module's operation mode programmatically.

Time and date setting

DSWRITE0213 //13 hours
DSWRITE0145 //45 minutes
DSWRITE0000 //00 seconds
DSWRITE0301 //weekday: Monday
DSWRITE0407 // 7 February 2011
DSWRITE0502
DSWRITE0611
TM? // checking the settings applied

Setting operating temperature range, temperature controller operation mode, and scheduled operation

EEWRITE0ED8 *//minimum temperature -20°C*
EEWRITE0FFF
EEWRITE1078 *// maximum temperature +60°C*
EEWRITE1100
EEWRITE1EC0 *// warming-up time 10 minutes*
EEWRITE1F27
EEWRITE2009
EEWRITE2100
EEWRITE02A0 *// WDT interval – 15 minutes*
EEWRITE03BB
EEWRITE040D
EEWRITE0500
EEWRITE2823 *//power-on time 23.00*
EEWRITE2900
EEWRITE2A23 *//power-off time 23.30*
EEWRITE2B30
EEWRITE08C0 *//power-off timeout 2 minutes*
EEWRITE09D4
EEWRITE0A01
EEWRITE0B00
EEWRITE001B *//mode: temperature control, WDT on, schedule*
EEWRITE2610 *//reboot interval 10 seconds*
EEWRITE2727
RBT *//reboot; new mode will activate in 10 seconds*

CPU_INT signal configuration, timeout power-off

EEWRITE0004 *//mode: timeout power-off*
EEWRITE08E0 *//power-off timeout 5 minutes*
EEWRITE0993
EEWRITE0A04
EEWRITE0B00
EEWRITE2287 *// control signals state change monitoring: Remote EN, Reserv ON*
// active high
INSF *//event register reset*
EEWRITE2610 *//reboot interval 10 seconds*
EEWRITE2727
RBT *//reboot; new mode will activate in 10 seconds*

Setting input voltage comparator thresholds and events storage parameters

EEWRITE0007 *//mode with storing events in the non-volatile memory*
……..//time setting (see above, where required)
EEWRITE0C78 *//input voltage comparator triggering on voltage decrease to 17V*
// operating input voltage 18V
EEWRITE0D7D *//LOW_POWER signal deactivation at input voltage of 17.5V*
//setting of the events storage register in memory: DC/DC activated/deactivated, LowPower change,
//I2C error, switching to redundant power supply and back, PowerGood change
EEWRITE1A19
EEWRITE1B11
EEWRITE1C0C
EEWRITE1D18
EEWRITE2610 *//reboot interval 10 seconds*
EEWRITE2727
RBT *//reboot; new mode will activate in 10 seconds*

4.4 CONFIGURATION JUMPERS

Table 4.20 provides designations of the PS351 module on-board jumpers.
Table 4.21 provides designations of the PS151 module motherboard jumpers.
Table 4.22 provides designations of the PS351 module on-board DIP switches.

Table 4.20: Designations of PS351 module on-board jumpers

Jumper	Description
XP4	Selecting control interface operation mode: installed – RS422, removed – RS232
XP5	On-board LEDs enable jumper (if a corresponding jumper is installed, its associated LED is enabled): ***1-2*** – HL2 (DC/DC converters enabled), ***3-4*** – HL1 (input voltage on the main or redundant power connector), 5-6 – HL5 (external fan enable signal), 7-8 – HL4 (external heater enable signal), ***9-10*** – HL3 (POWER_GOOD signal; the LED is lit, if all DC/DC converters are on)
XP6	Service jumper: installed – control system transceiver is always on, removed – transceiver is controlled by on-board controller
XP7	Operation mode setting: 1-2 – bit 2, 3-4 – bit 1, 5-6 – bit 0. An operation mode is set using a binary index number: jumper installed – 1, jumper removed – 0
XP8	DC/DC converters activation control jumpers: 1-2 – DC/DC converters activation bypassing the on-board controller: installed – module power-on on Remote EN signal, not installed – module power-on controlled by the on-board control system, 3-4 – using Remote EN for remote activation: installed – used, removed – not used (control system in active mode)
XP10	+3.3V converter activation control: installed – converter on, removed – converter off

Note:

Factory installed jumpers are shown in bold italics. For PS351-03 version, XP5 jumpers are installed across 1-2 and 3-4 contacts.

When the XP6 jumper is installed, the control system drivers are always on, which leads to an increase in current consumption in the inactive mode, but allows receiving system events messages from the module and sending control instructions to the module. It is not recommended to install the jumper when the module is in the normal operation mode.

Table 4.21: Designations of PS151 module jumpers

Jumper	Description
XP5	Connection of the CPU_INT signal to the interrupt lines on the XP1 edge slot: 1-2 – IRQ9, 3-4 – IRQ7, 5-6 – IRQ6, 7-8 – IRQ5, 9-10 – IRQ4, 11-12 – IRQ3

Note:

There are no factory installed XP5 jumpers on the PS151 module.

Figure 4.15: SA1 and SA2 DIP switches

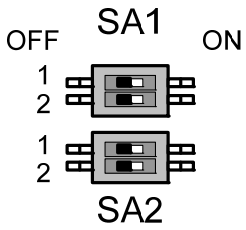


Table 4.22: Designations of PS351 module on-board switches

Reference designator	Designation
SA1	Switching of the CPU_INT signal to the interrupt lines of the XS2 connector: SA1.1 – IRQ10 (OFF), SA1.2 – IRQ5 (OFF)
SA2	Switching of the inverted LOW_POWER signal to the interrupt lines of the XS2 connector: SA1.1 – IRQ6 (OFF), SA1.2 – IRQ11 (OFF)

Note:

In the Designation column above, factory preset positions of the switches are shown in brackets.
ON – the signal is switched to a corresponding interrupt line.
OFF – the signal is not switched to an interrupt line.

Attention!

Switching of jumpers and DIP switches must be done only with the power supply voltage disconnected from the board.

It is not recommended to switch one signal to two interrupts simultaneously.

4.5 ELECTRICAL PARAMETERS

Electrical parameters of the main signals used by the module are shown in Table 4.23. Signal levels, unless otherwise specified, are relative to the GND_iso contact under normal climatic conditions.

Main parameters of DC/DC converters are shown in Table 4.24. To evaluate additional parameters of DC/DC converters, documentation covering the modules (TEN30-2411WI and TEN20-2412WIN) produced by TracoPower (www.tracopower.com) included in the product can be used. The minimum load for the 3.3V converter is 5%; if the 3.3V voltage is not used, it is recommended to disable the converter by removing the XP10 jumper.

Typical efficiency of the power supply module is 85% (at rated output power per channel, Uin = 24V, and under normal climatic conditions).

Transient deviation of the output voltage in each channel under the transition input voltage (12...24V) and during switching from the main to backup power supply does not exceed 2% of the rated voltage of the corresponding channel.

Input consumption current during activation of DC/DC converters (setting up the Remote_EN signal into active level) does not exceed double steady state input current at maximum output power.

The module's output voltages setting up time after setting of the Remote_EN signal does not exceed 180 milliseconds.

Accuracy of temperature measurement is 1.5 ^{0}C (for more details see the documentation for the LM77 device, National Semiconductor). Where temperatures are changing, note that temperature is measured at the module's board and this temperature may differ from the ambient temperature.

Accuracy of DC/DC converters input and RTC device battery voltage measurement does not exceed 4%.

Table 4.23: Electrical parameters of main signals

Pin (signal)	Parameter	Value	Remarks
Remote EN	Vt+, V	3.1	Threshold voltage for switching to active state
	Vt-, V	2	Threshold voltage for switching to inactive state
	Vmax, V	36	Maximum voltage across contact
FAN_EN HEAT_EN	Vout_h, V	4.2	Maximum high level at Iout=0. A 200 ohm series resistor is installed at outputs for short-circuit protection
	Vout_l, V	0.9	Maximum low level at Iout=0
	Iout, mA	8	Maximum output current at Uout=2.5V
DRY1, DRY2	Vmax, V	5	Maximum operating input voltage. Inputs are connected over a 100 kohm resistor to the 5V on-board voltage; additional +36V voltage protection
	Vin_h, V	3	Minimum input voltage of high level
	Vin_l, V	1.5	Maximum input voltage of low level

Pin (signal)	Parameter	Value	Remarks
TX	Vout, V	4.2	Typical level of logic states at the transmitter output (for more information see description of ADM101 at www.analog.com)
POWER_GOOD	Vout_h, V	4.6	Maximum high level at Iout=0. A 200 ohm resistor is installed at output. Relative to GND
	Vout_l, V	0.4	Maximum high level at Iout=0
	Iout, mA	10	Maximum output current at Uout=2.5V
RESET_WDT	Vin_h, V	2	Minimum input voltage of high level. On the module, connected over a 100 kohm resistor to the +5V voltage. Relative to GND
	Vin_l, V	0.8	Maximum input voltage of low level
	Tmin, µs	1.2	Minimum duration
LOW_POWER, CPU_INT	Vout_h, V	4.9	Maximum high level at Iout=0. A 200 ohm resistor is installed at output. Relative to GND
	Vout_l, V	0.1	Maximum high level at Iout=0.
	Iout, mA	10	Maximum output current at Uout=2.5V

Table 4.24: Main parameters of DC/DC converters

Rated output voltage of a channel, V	Rated output power of a channel, W	Steady state deviation, max., V (PS351/PS151)	Steady state deviation in the entire temperature range, max., V (PS351/PS151)	Double amplitude of output voltage ripple[1], max., mV	Transient deviation[2], mV
5	30[3]	±0.08/±0.1	±0.13/±0.15	75	200
12	20	±0.12/±0.18	±0.3	75	200
3.3	5[3]	±0.11	±0.16	75	50

Note:

1. Double amplitude of ripple is measured at nominal load per channel within the 20 MHz bandwidth at the capacitor of the relevant output.
2. Transient deviation in each channel during measurement of current in the load from Inom to 0.75*Inom and from 0.75*Inom to Inom.
3. Total output power in the +5 V and +3.3 V channels – 30 W max.

5 USAGE AND OPERATION GUIDELINES

The module should be used in the treatment and conditions, established by this manual.

Connecting (disconnecting) cables to the interface connectors and input power connectors of the board should be made when power is switched off from the XP14 and XP15 connectors.

It is permitted to connect and disconnect PC/104, PC/104+ and MicroPC expansion modules only when the board is switched off!

6 THE MANUFACTURER'S GUARANTEES

Fastwel Co. Ltd. (Fastwel), warrants that its standard hardware products will be free from defects in materials and workmanship under normal use and service for the currently established warranty period. Fastwel's only responsibility under this warranty is, at its option, to replace or repair any defective component part of such products free of charge.

Fastwel neither assumes nor authorizes any other liability in connection with the sale, installation or use of its products. Fastwel shall have no liability for direct or consequential damages of any kind arising out of sale, delay in delivery, installation, or use of its products.

If a product should fail through Fastwel's fault during the warranty period, it will be repaired free of charge. For out of warranty repairs, the customer will be invoiced for repair charges at current standard labor and materials rates.

Warranty period for Fastwel products is 36 months since the date of purchase.

The warranty set forth above does not extend to and shall not apply to:

1. Products, including software, which have been repaired or altered by other than Fastwel personnel, unless Buyer has properly altered or repaired the products in accordance with procedures previously approved in writing by Fastwel.
2. Products, which have been subject to power, supply reversal, misuse, neglect, accident, or improper installation.

Returning a product for repair

1. Apply to Fastwel company or to any of the Fastwel's official representatives for the Product Return Authorization.
2. Attach a failure inspection report with a product to be returned in the form, accepted by customer, with a description of the failure circumstances and symptoms.
3. Carefully package the product in the antistatic bag, in which the product had been supplied. Failure to package in antistatic material will VOID all warranties. Then package the product in a safe container for shipping.
4. The customer pays for shipping the product to Fastwel or to an official Fastwel representative or dealer.

APPENDIX A

Heat spreading plate mounting dimensions: