GPC® R/T168

General Purpose Controller
Relays or Transistors; 16 Inputs, 8 Outputs

TECHNICAL MANUAL

grifo®
ITALIAN TECHNOLOGY

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GPC® R/T168 Edition 5.00 *Rel. 07 February 2001*

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GPC® R/T168

General Purpose Controller
Relays or Transistors; 16 Inputs, 8 Outputs

TECHNICAL MANUAL

ABACO® Block **M Serie** size 22.5x82x90 mm. **Housing** for **Omega rail** DIN 46277-1 and DIN 46277-3 types.
Available in 3 different versions with the following CPUs:

GPC® R/T168	with **Atmel 89C52** 22MHz, 32K external SRAM
GPC® R/T168A	with **Atmel 89S8252** 22MHz; 8K internal FLASH; 2K internal EEPROM; 32K external SRAM
GPC® R/T168P	with **Philips 89C51Rx2** 22MHz; from 16K to 64K internal FLASH; from 512 bytes to 1K internal SRAM; 32K external SRAM; serial ISP Flash programming through RS 232

Total addressable memory is **96K** divided in: 32K static **RAM** soldered; 64K **Flash EPROM** inside the microcontroller; code compatible with family **51** µP; **Real Time Clock** with 256 Byte of internal SRAM; **Back up** circuitry for RTC and SRAM, through **LITHIUM** battery; Real Time Clock output for /INT management or frequency output; **16** NPN digital **input** lines, galvanically isolated: 8 of them are connected to the microcontroller and 8 are connected to **PCF8575** that generates INT ad whenever inputs change; **8 output relays** 5A; **4 A/D** lines and one **8 bit D/A** through **PCF 8591**; I/O connections through **quick release screw terminal connectors**; **3 timer counter** resolution16 bits; serial lines in **RS232**, or in RS422, RS485 or Current-Loop; supply of the galvanically isolated section: **+24 Vdc**; supply of the on board logic: **5Vdc** or **10÷40 Vdc** or **8÷24Vac**; supply protection through **TransZorb™**; wide range of development software available like **C compilers**, **Assembler**, **BXC51**, **MCS BASIC 52**, **HTC 51**, **BASCOM 8051**, **PASCAL**, **CMX**, etc.

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For specific informations on the components mounted on the card, please refer to the Data Book of the builder or second sources.

SYMBOLS DESCRIPTION

In the manual could appear the following symbols:

Attention: Generic danger

Attention: High voltage

Trade Marks

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Other Product and Company names listed, are trade marks of their respective companies.

GENERAL INDEX

FIGURES INDEX

INTRODUCTION

The use of these devices has turned - IN EXCLUSIVE WAY - to specialized personnel.

The purpose of this handbook is to give the necessary information to the cognizant and sure use of the products. They are the result of a continual and systematic elaboration of data and technical tests saved and validated from the manufacturer, related to the inside modes of certainty and quality of the information.

The reported data are destined- IN EXCLUSIVE WAY- to specialized users, that can interact with the devices in safety conditions for the persons, for the machine and for the enviroment, impersonating an elementary diagnostic of breakdowns and of malfunction conditions by performing simple functional verify operations , in the height respect of the actual safety and health norms.

The informations for the installation, the assemblage, the dismantlement, the handling, the adjustment, the reparation and the contingent accessories, devices etc. installation are destined - and then executable - always and in exclusive way from specialized warned and educated personnel, or directly from the TECHNICAL AUTHORIZED ASSISTANCE, in the height respect of the manufacturer recommendations and the actual safety and health norms.

The devices can't be used outside a box. The user must always insert the cards in a container that rispect the actual safety normative. The protection of this container is not threshold to the only atmospheric agents, but specially to mechanic, electric, magnetic, etc. ones.

To be on good terms with the products, is necessary guarantee legibility and conservation of the manual, also for future references. In case of deterioration or more easily for technical updates, consult the AUTHORIZED TECHNICAL ASSISTANCE directly.

To prevent problems during card utilization, it is a good practice to read carefully all the informations of this manual. After this reading, the user can use the general index and the alphabetical index, respectly at the begining and at the end of the manual, to find information in a faster and more easy way.

CARD VERSION

The present handbook is reported to the card release:

- **GPC® R168** version **220400** and later;
- **GPC® T168** version **110500** and later;

The validity of the bring informations is subordinate to the number of the card release. The user must always verify the correct correspondence among the two denotations. On the card the release number is present in more points both board printed diagram (serigraph) and printed circuit (for example near battery BT1 on the solder side); firmware version is written on the CPU or it can be obtained through the specific serial command.

GENERAL FEATURES

GPC® R168 and **GPC® T168** (**G**eneral **P**urpose **C**ontroller **R**elays/**T**ransistors **16** input, **8** output) boards are powerful low cost modules capable to work in autonomy as intelligent peripherals and/or as remote controlled devices in a network of telecontrol and/or acquisition. They belong to M serie CPU cards, their size is 22.5x82x90 mm.
GPC® R168 and **GPC® T168** boards are provided with plastic container for direct mounting on standard Omega rails type DIN 46277-1 and DIN 46277-3. Thanks to the low cost of this CPU serie, it is possible to successfully solve, also all those small automation problems, which have a limited cost budget. Using the wide range of developing software tools, available for the **GPC® R168** and **GPC® T168** such as **BASCOM 8051** or the very comfortable Intel **MCS BASIC-52** to use in match with **BXC51**, and so on, it is possible to complete the applications in a very short time and with minimum investments. The cards are provided with comfortable connectors that simplify the connection with field signals, requiring no further modules and further cost. Moreover these connectors reduce times when possible up date and assistance phases must be performed.

- **ABACO®** Block **M Serie** size 22.5x82x90 mm
- **Housing** for **Omega rail** DIN 46277-1 and DIN 46277-3 types
- Available in 3 different versions with the following CPUs:
  - **GPC® R/T168** with **Atmel 89C52** 22MHz, 32K external SRAM
  - **GPC® R/T168A** with **Atmel 89S8252** 22MHz; 8K internal FLASH; 2K internal EEPROM; 32K external SRAM
  - **GPC® R/T168P** with **Philips 89C51Rx2** 22MHz; from 16K to 64K internal FLASH; from 512 bytes to 1K internal SRAM; 32K external SRAM; serial ISP Flash programming through RS 232
- Total addressable memory is **96K** divided in: 32K static **RAM** soldered; 64K **Flash EPROM** inside the microcontroller
- Code compatible with family **51** µP
- **Real Time Clock** with 256 Byte of internal RAM
- **Back up** circuitry for RTC and RAM, through **LITHIUM** battery
- Real Time Clock output for /INT management or frequency output
- **16** NPN digital **input** lines, galvanically isolated; 8 of them are connected to the microcontroller and 8 are connected to **PCF8575** that generates INT ad whenever inputs change
- **8 output relays** 5A
- **4 A/D** lines and one **8 bit D/A** through **PCF 8591**
- I/O connections through **quick release screw terminal connectors**
- **3 timer counter** resolution16 bits
- Serial lines in **RS232**, or in RS422, RS485 or Current-Loop
- Supply of the galvanically isolated section: **+24 Vdc**
- Supply of the on board logic: **5Vdc** or **10÷40 Vdc** or **8÷24Vac**
- Supply protection through **TransZorb™**
- Wide range of development software available like **C compilers**, **Assembler**, **BXC51**, **MCS BASIC 52**, **HTC 51**, **BASCOM 8051**, **PASCAL**, **CMX**, etc.

The following pages describe each section of the card in a more detailed mode and figures 1 and 2 illustrate the sections interconnections.

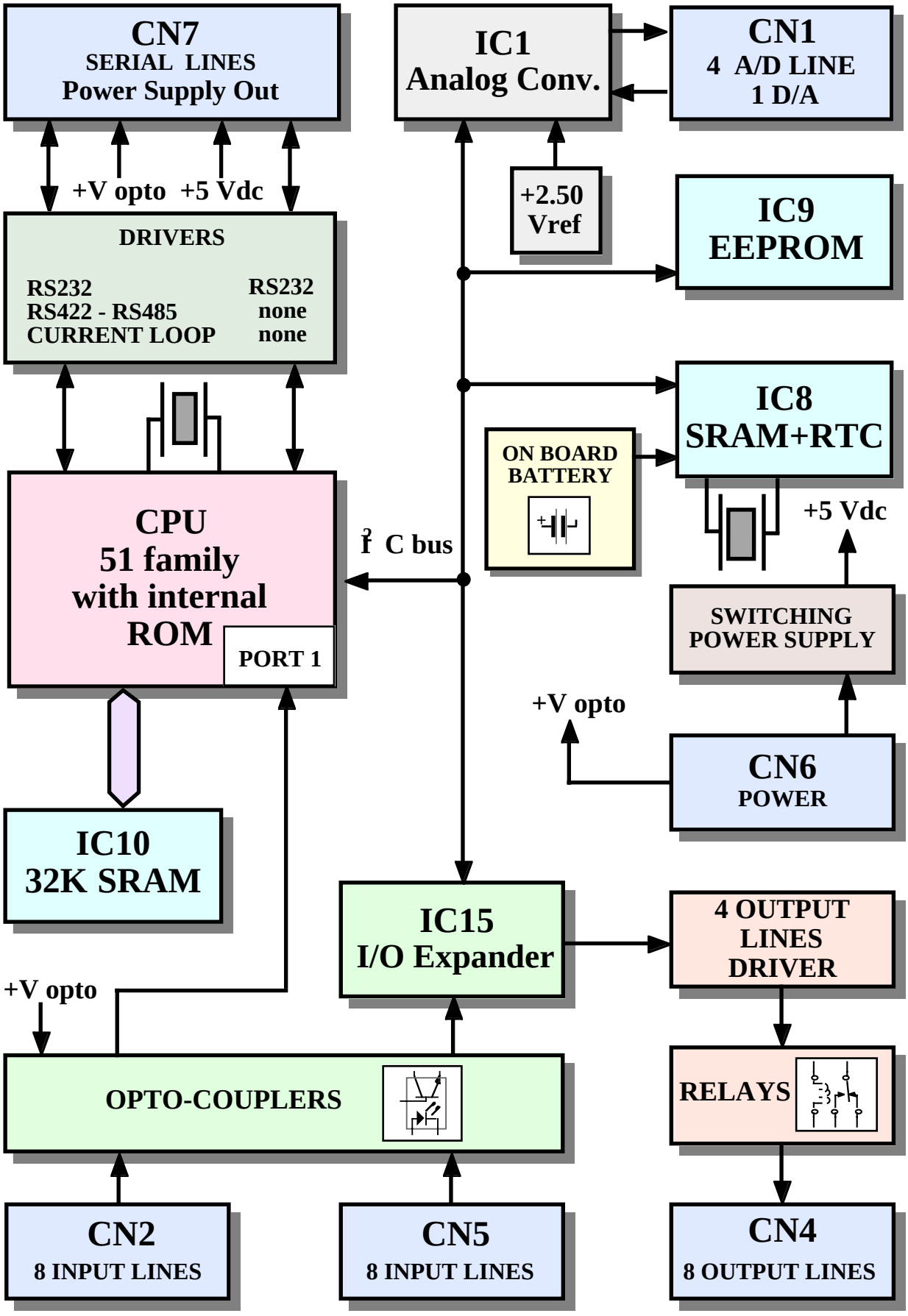


FIGURE 1: GPC® R168 BLOCK DIAGRAM

CPU

The **GPC® R/T168** are designed to use all the microprocessors characterized by a family 51 compliant pin out. Such 8 bit microprocessors are provided with an internal FLASH EPROM sized at least 8 KBytes up to 64 KBytes, are widely diffused all over the world and have an extended instruction set, fast execution time,fast data handling,an efficient interrupt management, several hardware peripherals integrated.
Here follows a list of the main features of these CPU's:

- µP AT89C52 manufactured by ATMEL:
  - 12 clock pulses per machine cycle;
  - 256 bytes internal SRAM;
  - 8 KBytes internal FLASH EPROM;
  - 2 interrupt priority levels and 6 interrupt sources;
  - 1 synchronous/asynchronous serial line;

- µP AT89S8252 manufactured by ATMEL:
  - 12 clock pulses per machine cycle;
  - 256 bytes internal SRAM;
  - 8 KBytes internal FLASH EPROM;
  - 2 KBytes internal EEPROM;
  - 2 interrupt priority levels and 6 interrupt sources;
  - 1 synchronous/asynchronous serial line;

- µP AT89C51RB2/ RC2/ RD2 manufactured by PHILIPS:
  - 6 or12 clocks system cycle;
  - 16K/32K/64K Bytes internal FLASH EPROM;
  - 512 or 1K Bytes internal SRAM;
  - 4 interrupt priority levels and 7 interrupt sources;
  - 1 syncronous/asyncronous serial line;
  - ISP and IAP programming;

By default, **GPC® R/T168** are provided with AT89C52.
For further information on the listed microprocessor, please refer to specific documentation of the manufacturing company.

POWER SUPPLY

One of the most important features of **GPC® R/T168** is its on board power supply circuitery; the card can be powered in two different ways: +5 Vdc (without power supply section) or 10÷24Vac (switching section). The power supply circuit generates the necessary voltages for the card, starting from all the standard industrial source like mains, power transformer, battery, solar cell, etc. The User must provide also a 24 Vdc voltage for the optocoupled section. The power supply type must be specified at the moment of the order. The power supply circuit was designed for reducing the consumption (the microprocessor power down and idle mode is available) and for increasing the electrical noise immunity.
Remember that on board there is a protection circuit aganist voltage peaks by **TransZorb™**.

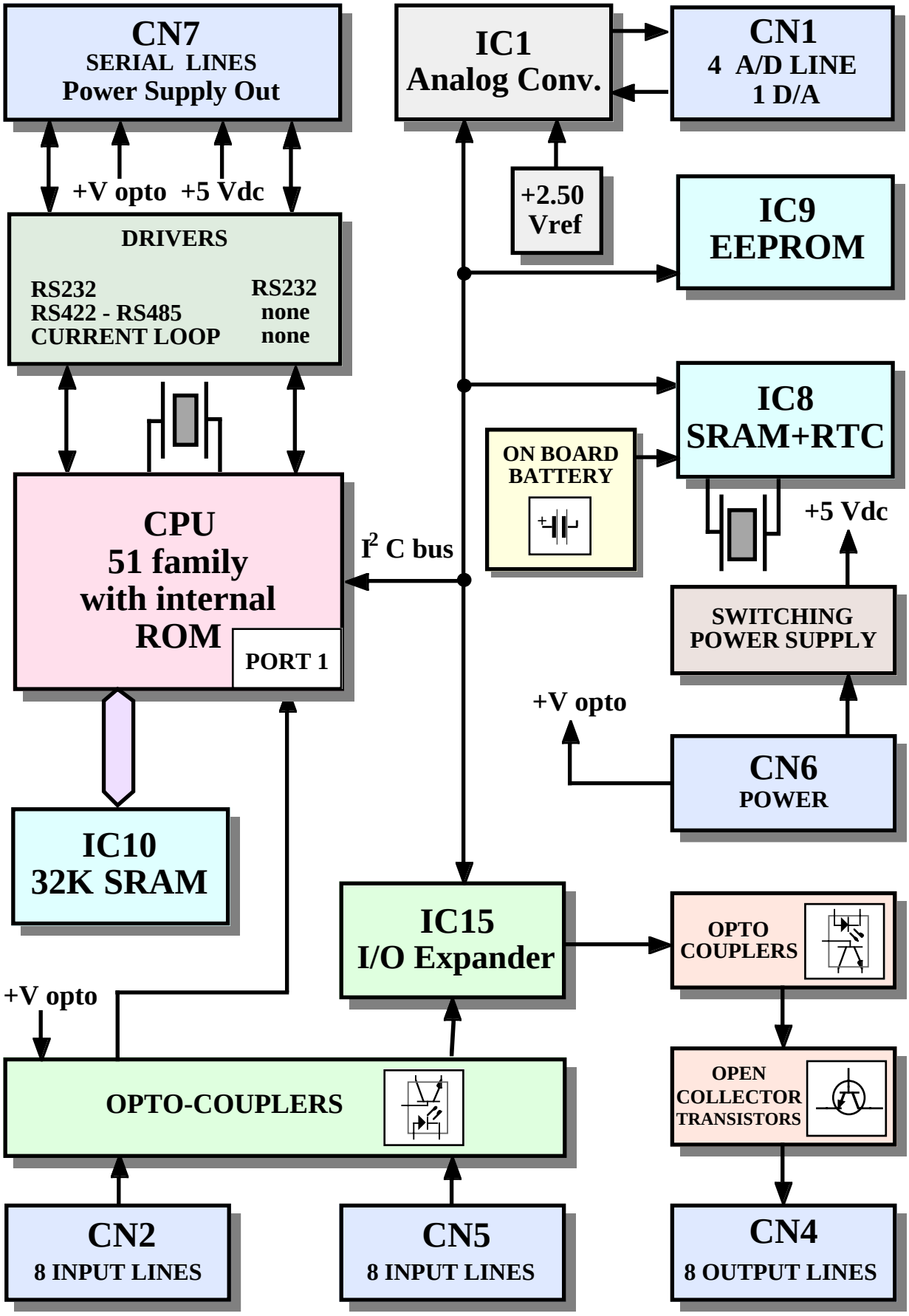


FIGURE 2: GPC® T168 BLOCK DIAGRAM

CLOCK DEVICES

On **GPC® R/T168** there are two separate circuits with crystal to generate the clock signal for the microprocessor (22.1184 MHz) and the clock signal for Real Time Clock (32.768 KHz). The choice of using two circuits and two separated crystals, has the advantage to change the microprocessor working speed (when best performances are required) without additional changes in software, firmware, etc.

MEMORY DEVICES AND REAL TIME CLOCK

The total memory amount that the card can support can be up to 1280 Bytes of serial external memory plus 32 KBytes of external SRAM. Serial external memory can at most 256 Bytes of SRAM plus 1024 Bytes of serial EEPROM. Through these devices the card is always able to maintain parameters, system status and configuration, etc. without using expensive external UPS.

- **Real Time Clock:** The IC 8 SRAM module, is provided with on board lithium battery and with Real Time Clock which manages time (hours, minutes, seconds) and date (day, month, year, day of the week). With the on board back up circuit there is the possibility to keep the 256 SRAM+RTC data, also when power supply is failed; The back up circuit is based on an internal LITHIUM battery.

- **Serial EEPROM:** With the IC9 EEPROM module (range 512÷1024 bytes), there is the possibility to keep data also when power supply failed without using the SRAM backup drastically increasing the data safety. This component has a default size of 512 bytes but can be required with 1024 Bytes.

- **SRAM:** The 32 KBytes SRAM module, soldered on IC10, is very useful to store the remarkable amount of data coming from the A/D converter, or the serial line or to make a data logger.

For further information about peripheral device please refer to the technical documentation of the manufacturing company.

RELAYS OUTPUT

This section has 8 normally open 5 A relays output lines, available on a comfortable screw terminal quick release connector. These components are buffered by a specific driver and managed through 16 TTL programmable signals provided by IC15; 8 of its signals are used for relays outputs, the remaining 8 signals are used for optocoupled inputs.

TRANSISTOR OUTPUT

This section has 8 NPN open collector 4A (non continuous) Darlington transistors output lines, provided with back EMF protection diode, available on a comfortable screw terminal quick release connector. These components are optocoupled and managed through 16 TTL programmable signals provided by IC15; 8 of its signals are used for relays outputs, the remaining 8 signals are used for optocoupled inputs.

INPUT SECTION

GPC® R/T168 cards are provided with 16 NPN optocoupled inputs; 8 inputs are acquired directly by the microprocessor (Port 1), the remaining 8 inputs are acquired through PCF8575 soldered on IC15 and implementing a serial protocol. This device is capable to trigger an interrupt whenever one if its inputs changes, this allows the microprocessor to save time because it must not poll countinuosly these 8 signals, it is enough to wait for the interrupt.
The inputs are available on a comfortable screw terminal quick release connector.

A/D AND D/A CONVERTER

GPC® R/T168 cards are provided with a A/D and D/A converter, implemented through **IC1**: this peripheral is capable to acquire 4 channels and to drive 1 channel with a maximum resolution of 8 bits.By software it is possible to decide wich channel to activate through **I²C-BUS** serial communication. The analog signals connectable are in the range 0÷2.5V.

SERIAL COMMUNICATION SELECTION

GPC® R/T168 cards are provided with two serial lines, one software and one hardware completely software settable, both as communication protocol and speed. These settings are performed by programming on board microprocessor's internal registers, so for further information please refer to manufacturers documentation.
By hardware the two serial lines can work only as RS 232. Other communication protocols can be implemented only by the hardware serial line losing the possibility to use the software serial line. Other protocols implementable are current loop, RS 485 and RS 422, in this latter case the communication can be implemented as Full Duplex or Half Duplex.

GPC® R168 TECHNICAL FEATURES

GPC® R168 GENERAL FEATURES

On board resources:
16 NPN optocoupled digital inputs
8 normally open 5 A relays digital outputs
4 A/D converter signals
1 D/A converter signal
1 real time clock
2 RS 232 serial lines or one RS 422-485 or Current Loop

Memory addressable:
IC 8: serial 256 Bytes RTC+SRAM
IC 9: serial EEPROM from 512 Bytes to 1 KBytes
IC10: SRAM 32 KBytes

CPU:

Atmel AT89C52	8 KBytes Flash-Eprom
Atmel AT89S8252	8 KBytes Flash-Eprom
Philips P89C51RB2	16 KBytes Flash-Eprom
Philips P89C51RC2	32 KBytes Flash-Eprom
Philips P89C51RD2	64 Kbytes Flash-Eprom

CPU clock frequence: 22.1184 MHz

RTC clock frequence: 32.768 KHz

A/D converter general features:
- **Resolution:** 8 bit
- **Conversion time:** 90 µsec

D/A converter general features:
- **Resolution:** 8 bit
- **Conversion time:** 90 µsec

GPC® R168 PHYSICAL FEATURES

Size (W x H x D):
109 x 104 x 22.5 mm
109 x 115 x 22.5 mm (included container for Ω rails)

Mounting: Ω rails type DIN 46277-1 and DIN 46277-3

Weight: 196 g (basic version)

Connectors:

CN1:	7 pins quick release 90° pitch 3.5 mm
CN2:	9 pins quick release 90° pitch 3.5 mm
CN4:	11 pins quick release 90° pitch 5 mm
CN5:	9 pins quick release 90° pitch 3.5 mm
CN6:	4 pins quick release 90° pitch 3.5 mm
CN7:	4+4 pins AMP Mod II 90°

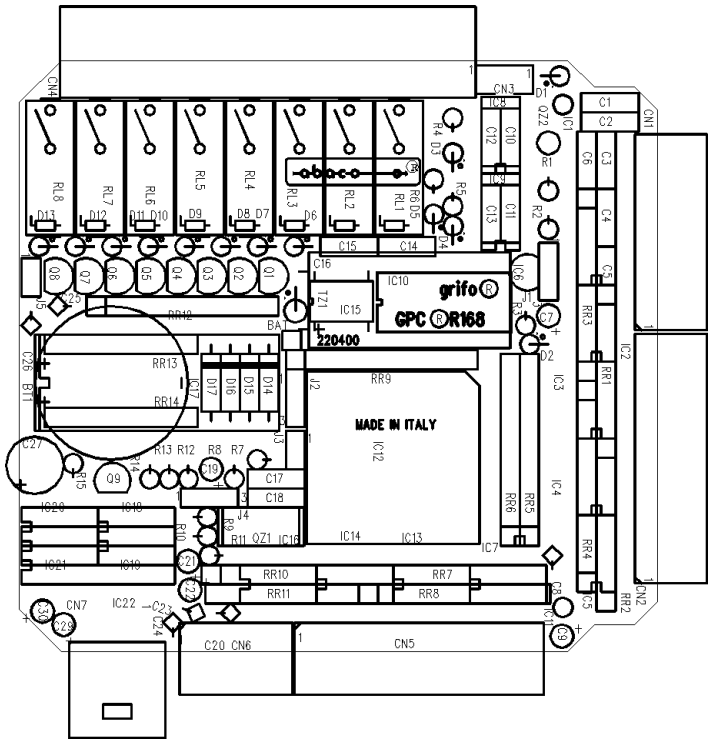


FIGURE 3: GPC® R168 (COMPONENT SIDE) COMPONENTS MAP

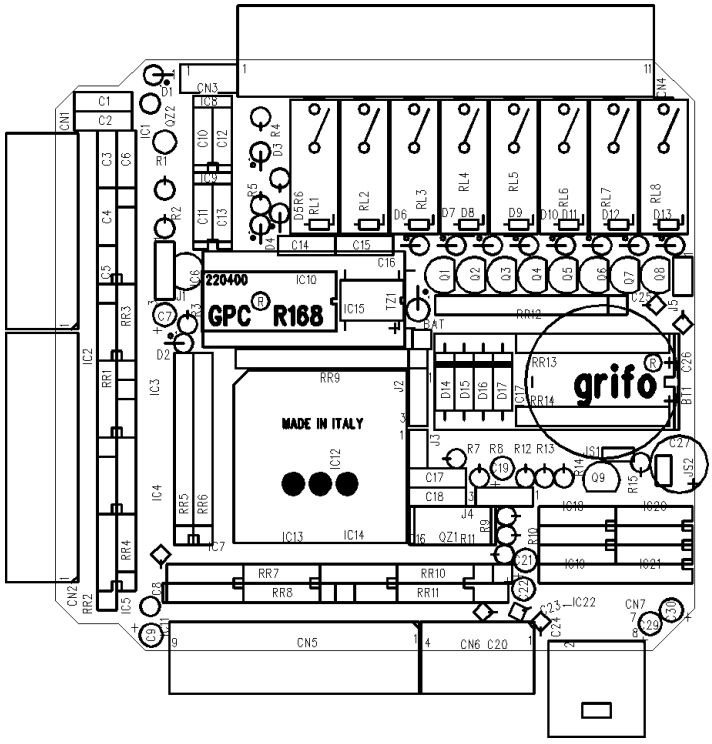


FIGURE 4: GPC® R168 (SOLDER SIDE) COMPONENTS MAP

Temperature range: from 0 to 50 Centigrad degreeses

Relative humidity: 20% up to 90% (without condensing)

GPC® R168 ELECTRIC FEATURES

Version without power supply

Power supply voltage:	+5 Vdc	(control logic)
	+24 Vdc	(+V opto)

Version with switching power supply

Input power supply voltage:	10÷40 Vdc o 8÷24 Vac	(control logic)
	24 Vdc	(+V opto)
Output power supply voltage:	+5 Vdc; 550 mA	
	+Vopto 100 mA	
Current consumption:	450 mA max	(+5 Vdc)
	37 mA max	(+V opto)
Relays maximum current:	5A	
Relays maximum voltage:	30 Vdc / 250 Vac	
NPN inputs minimum current:	1 mA	
Back up current:	3,5 µA	
On board back up battery:	3 V; 180 mAh; mod. CR 2032	

A/D converter electric features:

Voltage range:	0÷2.5Vdc
Input impedance:	not specified

D/A converter electric features:

Voltage range:	0÷2.5Vdc
Load acceptable:	10K

RS422-485 termination network:	Line termination resistor	=	120 Ω
	Positive pull up resistor	=	3,3 KΩ
	Negative pull down resistor	=	3,3 KΩ

GPC® T168 TECHNICAL FEATURES

GPC® T168 GENERAL FEATURES

On board resources:
16 NPN optocoupled digital inputs
8 open collector darlington NPN transistors digital outputs, with back EMF protection diode
4 A/D converter signals
1 D/A converter signal
1 real time clock
2 RS 232 serial lines or one RS 422-485 or Current Loop

Memory addressable:
IC 8: serial 256 Bytes RTC+SRAM
IC 9: serial EEPROM from 512 Bytes to 1 KBytes
IC10: SRAM 32 KBytes

CPU:

Atmel AT89C52	8 KBytes Flash-Eprom
Atmel AT89S8252	8 KBytes Flash-Eprom
Philips P89C51RB2	16 KBytes Flash-Eprom
Philips P89C51RC2	32 KBytes Flash-Eprom
Philips P89C51RD2	64 Kbytes Flash-Eprom

CPU clock frequence: 22.1184 MHz

RTC clock frequence: 32.768 KHz

A/D converter general features:
- **Resolution:** 8 bit
- **Conversion time:** 90 µsec

D/A converter general features:
- **Resolution:** 8 bit
- **Conversion time:** 90 µsec

GPC® T168 PHYSICAL FEATURES

Size (W x H x D):
109 x 104 x 22.5 mm
109 x 115 x 22.5 mm (included container for Ω rails)

Mounting: Ω rails type DIN 46277-1 and DIN 46277-3

Weight: 181 g (basic version)

Connectors:

CN1:	7 pins quick release 90° pitch 3.5 mm
CN2:	9 pins quick release 90° pitch 3.5 mm
CN4:	11 pins quick release 90° pitch 5 mm
CN5:	9 pins quick release 90° pitch 3.5 mm
CN6:	4 pins quick release 90° pitch 3.5 mm
CN7:	4+4 pins AMP Mod II 90°

Temperature range: from 0 to 50 Centigrad degreeses

Relative humidity: 20% up to 90% (without condensing)

GPC® T168 ELECTRIC FEATURES

Version without power supply

Power supply voltage:	+5 Vdc	(control logic)
	+24 Vdc	(+V opto)

Version with switching power supply

Input power supply voltage:	10÷40 Vdc o 8÷24 Vac	(control logic)
	24 Vdc	(+V opto)
Output power supply voltage:	+5 Vdc; 550 mA	
	+Vopto 100 mA	
Current consumption:	106 mA max	(+5 Vdc)
	37 mA max	(+V opto)
Transistors maximum current:	4A (not contiguous)	(*)
Transistors maximum voltage:	45 Vdc	(*)
Transistors maximum power:	1.25 W	(*)
NPN inputs minimum current:	1 mA	
Back up current:	3,5 µA	
On board back up battery:	3 V; 180 mAh; mod. CR 2032	

A/D converter electric features:

Voltage range:	0÷2.5Vdc
Input impedance:	not specified

D/A converter electric features:

Voltage range:	0÷2.5Vdc
Load acceptable:	10K

RS422-485 termination network:	Line termination resistor	=	120 Ω
	Positive pull up resistor	=	3,3 KΩ
	Negative pull down resistor	=	3,3 KΩ

(*) These values are referred to a working temperature of 20 °C

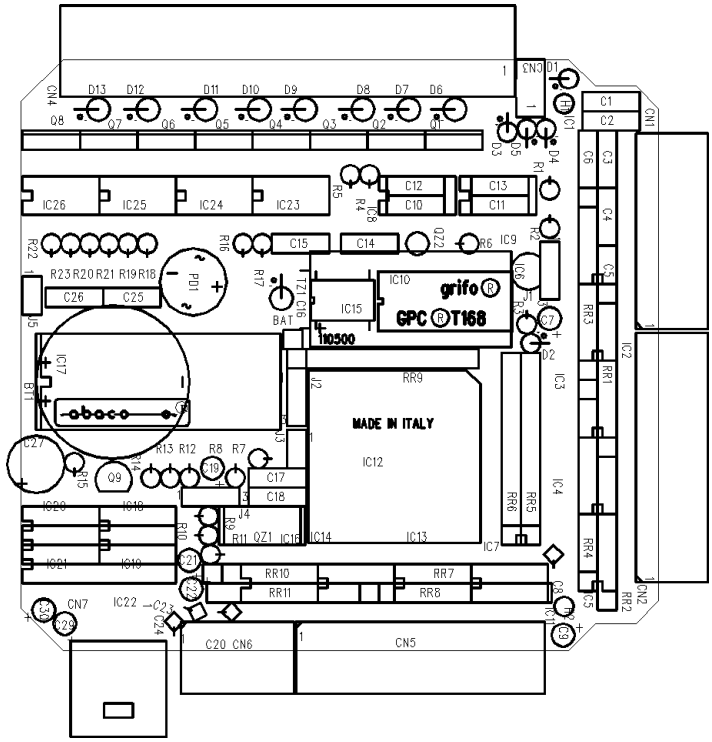


FIGURE 5: GPC® T168 (COMPONENT SIDE) COMPONENTS MAP

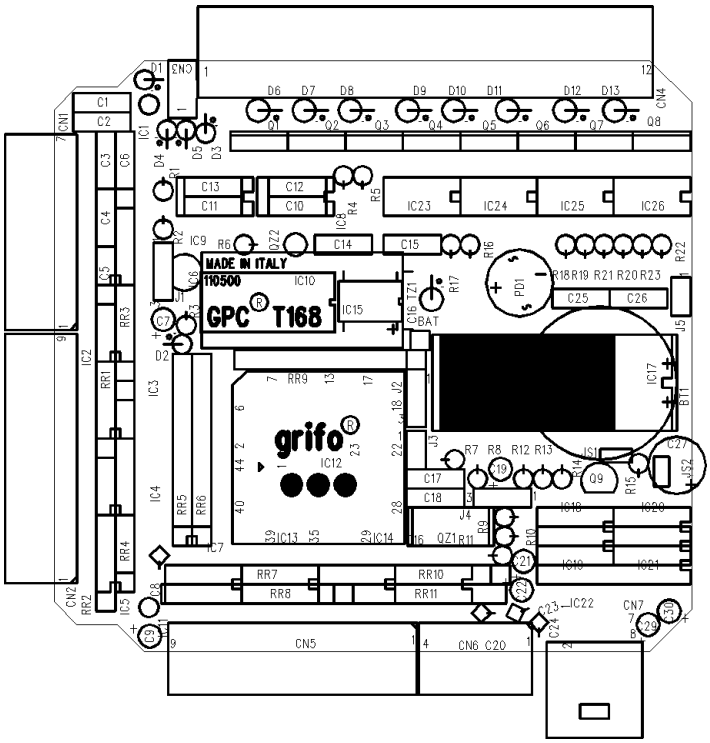


FIGURE 6: GPC® T168 (SOLDER SIDE) COMPONENTS MAP

INSTALLATION

In this chapter there are the information for a right installation and correct use of the card. The User can find the location and functions of each connector, jumper installed on **GPC® R/T168** and some explanatory diagrams.

CONNECTIONS

The **GPC® R/T168** modules have 6 connectors that can be linked to other devices or directly to the field, according to system requirements. In this paragraph there are connectors pin out, a short signals description (including the signals direction) and connectors location. To easily locate them please refer to figures 8 and 9, while for further information about the connections please refer to the following figures.

CN6 - POWER SUPPLY CONNECTOR

CN6 is a 4 pins, quick release, screw terminal connector 3.5 mm pitch. CN6 is used to power the card when on **GPC® R168** or **GPC® T168** there is the switching power supply section and to supply the optocouplers.
Please remark that for a correct working of the board these two tension must be galvanically isolaed.

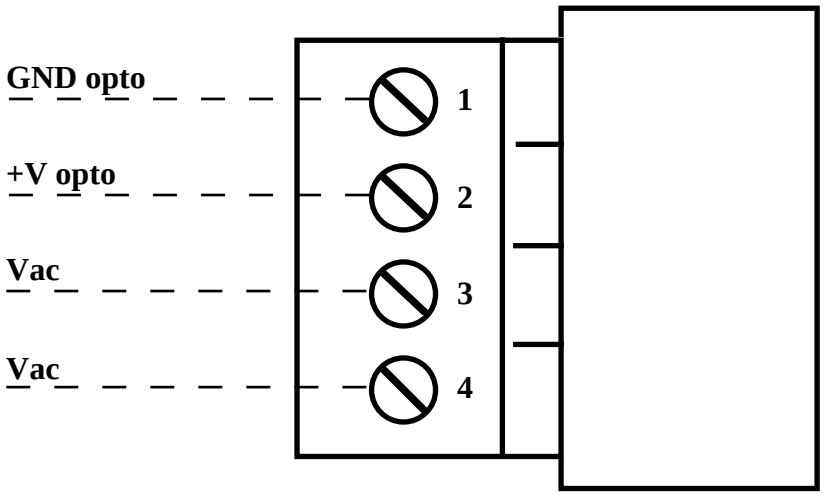


FIGURE 7: CN6 - POWER SUPPLY CONNETTOR

Signals description:

+V opto = I - +V opto power supply.
GND opto = - +V opto ground signal.
Vac = I - Control logic power supply line (+10÷40 Vdc or 10÷24Vac).
Vac = I - Control logic power supply line (+10÷40 Vdc or 10÷24Va)c.

For further information please refer to the paragraph “POWER SUPPLY VOLTAGES”

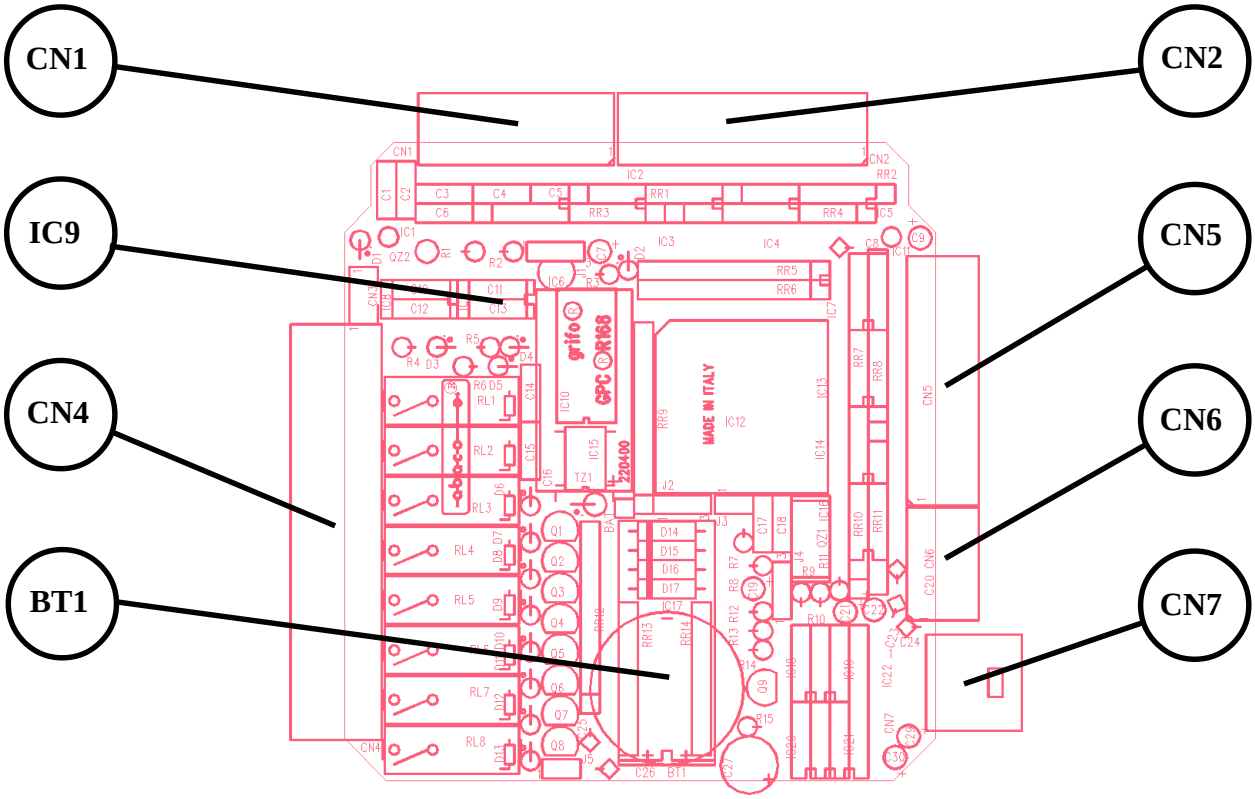


FIGURE 8: GPC® R168 CONNECTORS, ETC. LOCATION

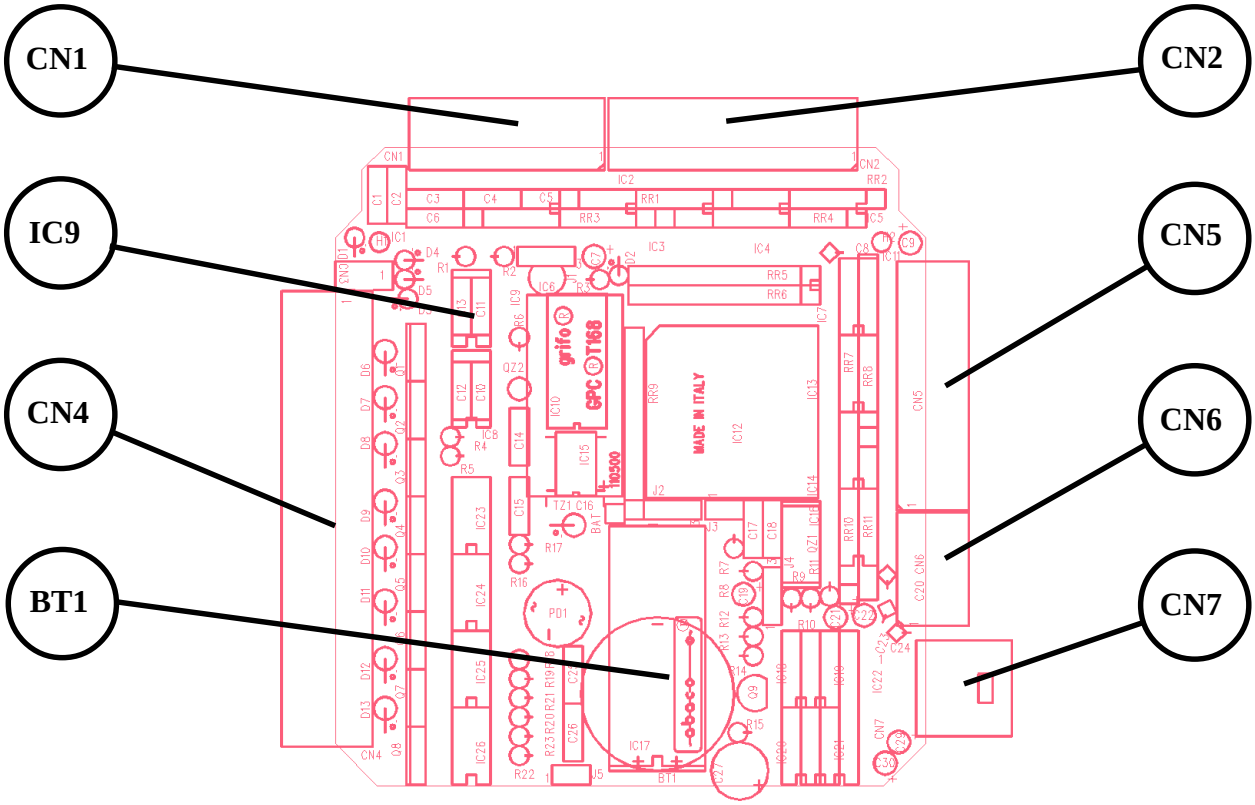


FIGURE 9: GPC® T168 CONNECTORS, ETC. LOCATION

CN7 - POWER SUPPLY AND SERIAL LINES CONNECTOR

CN7 is a 4+4 pins AMP Mod II type connector with 2.54 mm pitch.
If the **GPC® R168** or **GPC® T168** has the switching power section mounted, trough CN7 the user can draw the two galvanically isolated voltages and can use them for external loads supply.
In the other case (switching not present) trough CN7 the user must give the two voltages (+5 Vdc and +Vopto) for card power supply. Also, on CN7 connector are available the buffered signals for RS 232, RS 422, RS 485 or Current Loop serial line communication, all CCITT normatives compliant. All the signals are placed in order to reduce interference and electrical noise. The female connector can be ordered directly to **grifo®** (code **CKS.AMP8**) or to AMP (connector P/N: 280365; pins as loose pieces P/N:182206-2).

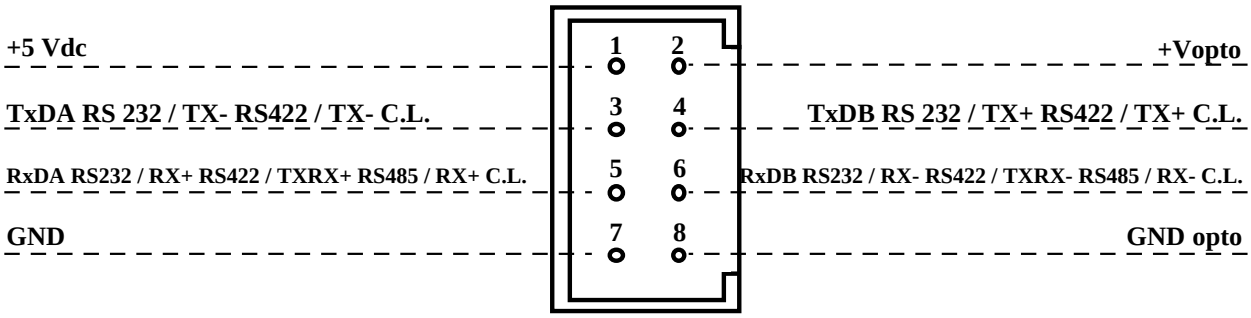


FIGURE 10: CN7 - POWER SUPPLY AND SERIAL LINES CONNECTOR

Signals description:

RxDA/B RS 232 = I - Receive Data of RS 232 serial line.
TxDA/B RS 232 = O - Transmit Data of RS 232 serial line.
RX- RS 422 = I - Receive Data Negative of RS 422 serial line.
RX+ RS 422 = I - Receive Data Positive of RS 422 serial line.
TX- RS 422 = O - Transmit Data Negativ of RS 422 serial line.
TX+ RS 422 = O - Transmit Data Positive of RS 422 serial line.
TXRX- RS 485 = I/O - Transmit Receive Data Negative of RS 485 serial line.
TXRX+ RS 485 = I/O - Transmit Receive Data Positive of RS 485 serial line.
RX- C.L. = I - Receive Data Negative of Current Loop serial line.
RX+ C.L. = I - Receive Data Positive of Current Loop serial line.
TX- C.L. = O - Transmit Data Negative of Current Loop serial line.
TX+ C.L. = O - Transmit Data Positive of Current Loop serial line.
+5 Vdc = I/O - Positive terminal of +5 Vdc power supply.
GND = - +5 Vdc ground.
+V opto = I/O - Positive terminal of +V opto power supply.
GND opto = - +V opto ground.

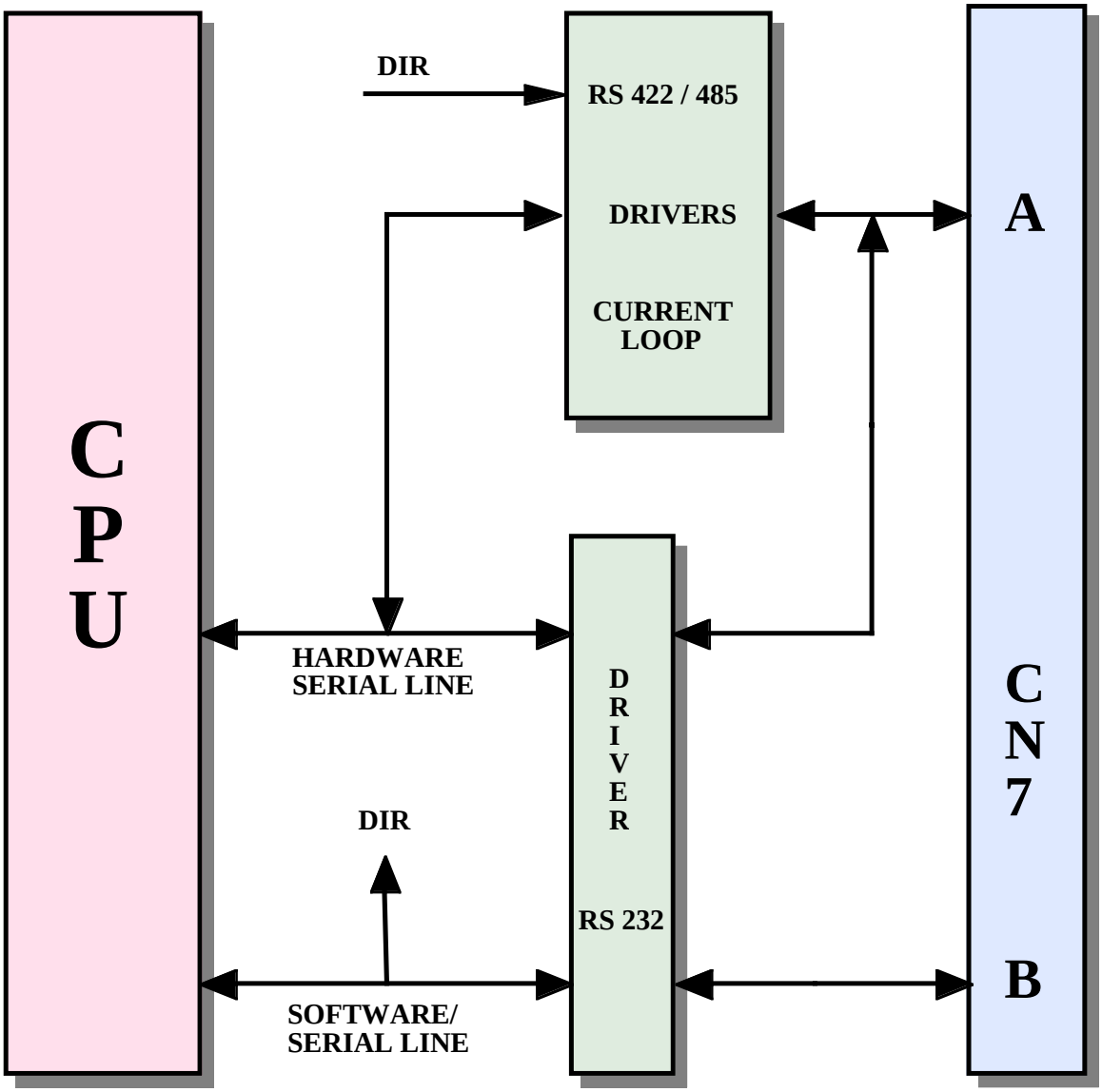


FIGURE 11: SERIAL COMMUNICATION DIAGRAM

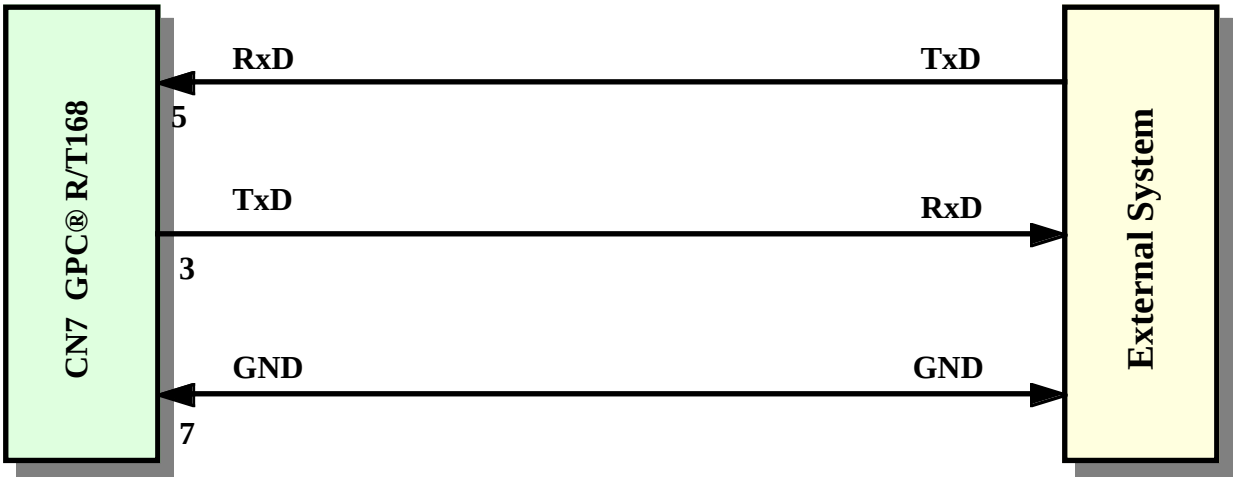


FIGURE 12: RS 232 POINT TO POINT CONNECTION EXAMPLE

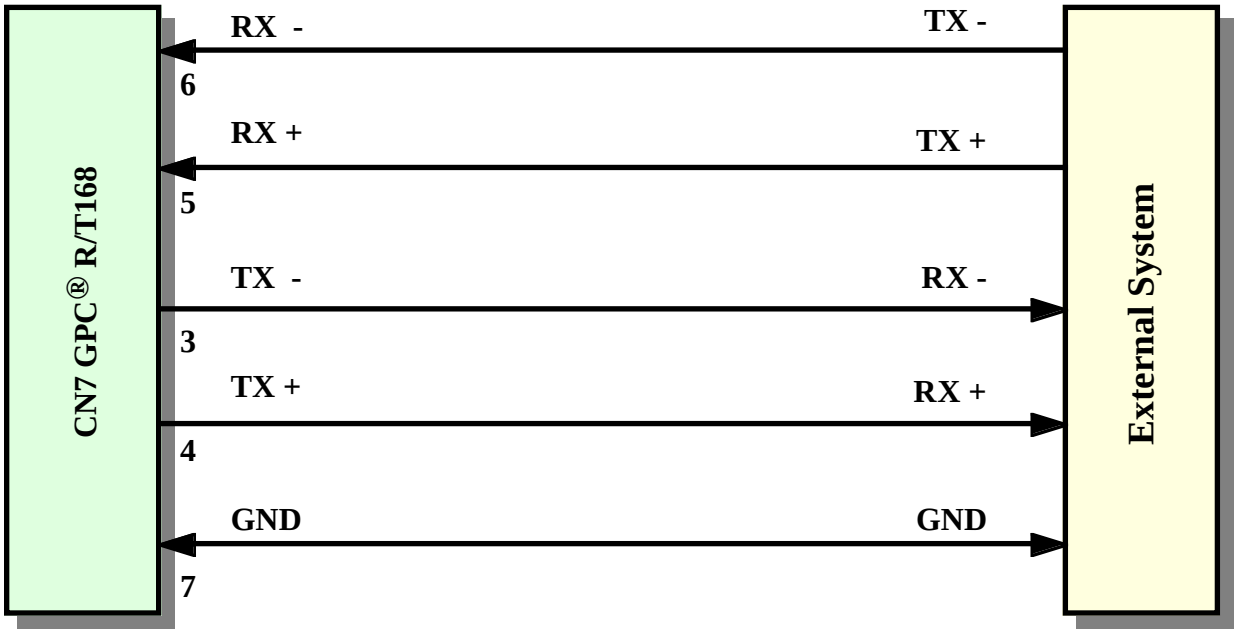


FIGURE 13: RS 422 POINT TO POINT CONNECTION EXAMPLE

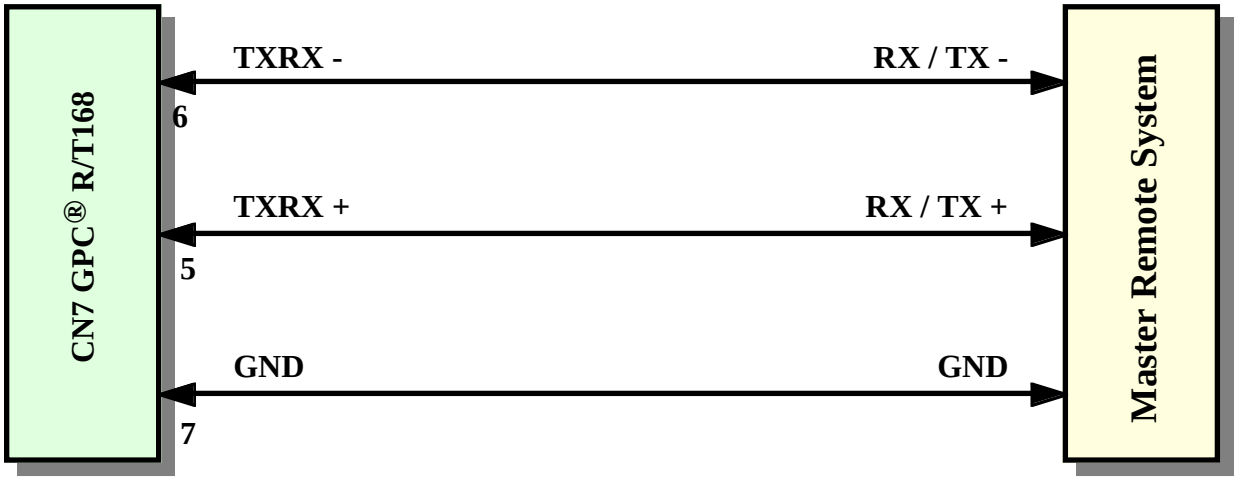


FIGURE 14: RS 485 POINT TO POINT CONNECTION EXAMPLE

NOTE

There can be two serial lines, one software and one hardware, only in RS 232, in all other cases there is only one serial line.

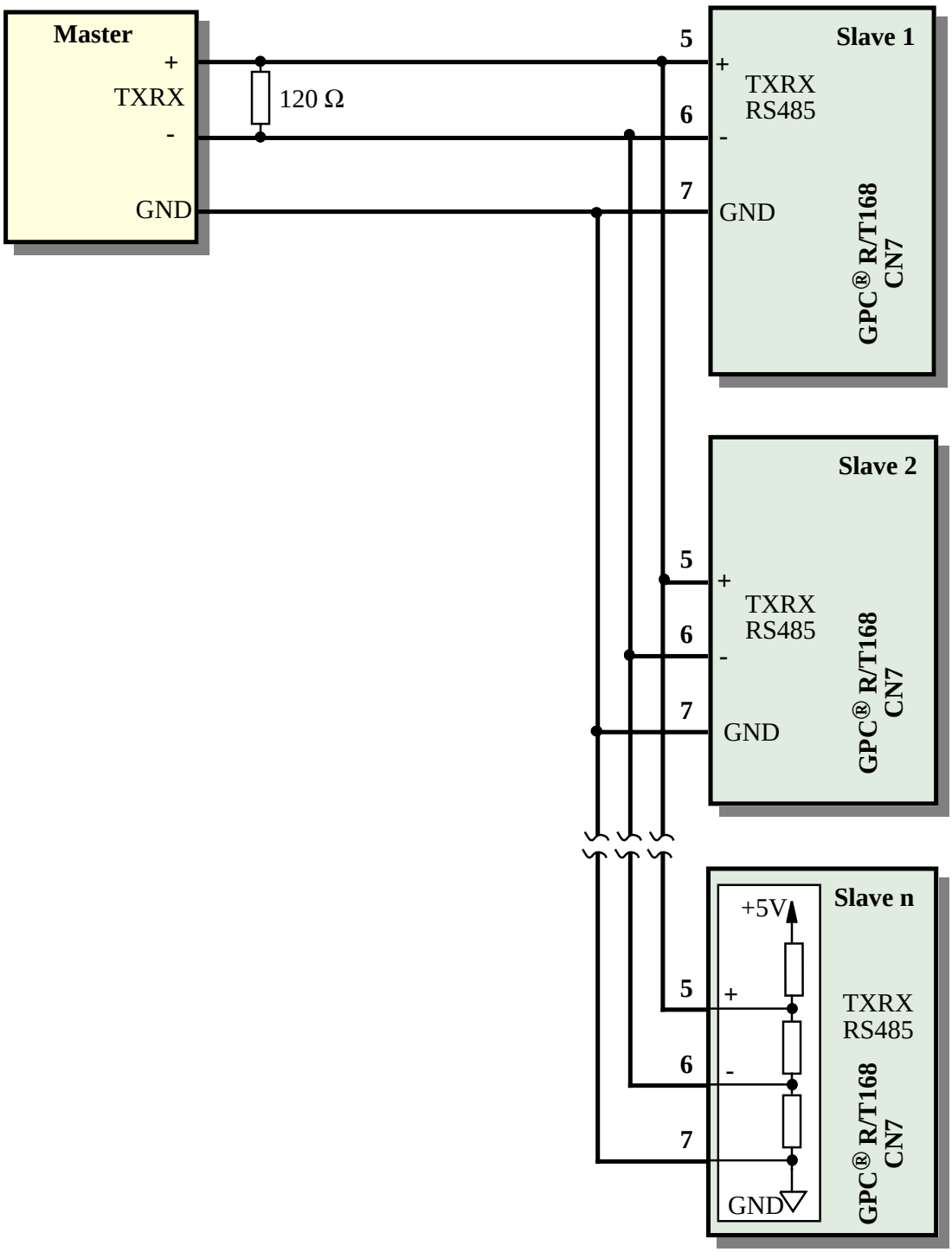


FIGURE 15: RS 485 NETWORK CONNECTION EXAMPLE

Please remark that in a RS 485 network two forcing resistors must be connected across the net and two termination resistors (120 Ω)must be placed at its extrems, respectevely near the Master unit and the Slave unit at the greatest distance from the Master.
Forcing and terminating circuitry is installed on **GPC® R/T168** board. It can be enabled or disabled through specific jumers, as explained later.
The termination resistor on the Master unit must be connected only if it not already provided through other devices (for example several RS 232-RS 485 converters).
For further informations please refer to TEXAS INSTRUMENTS Data-Book , "*RS 422 and RS 485 Interface Cicuits*", the introduction about RS 422-485.

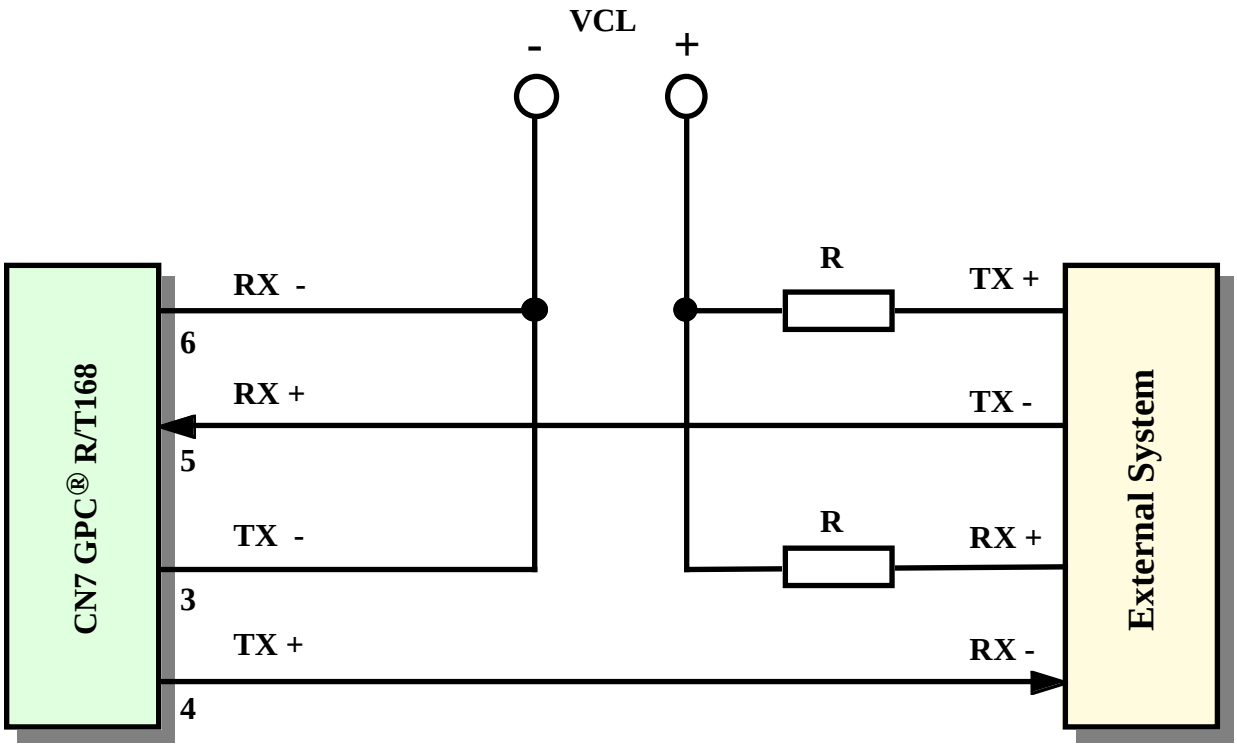


FIGURE 16: 4 WIRES CURRENT LOOP POINT TO POINT CONNECTION EXAMPLE

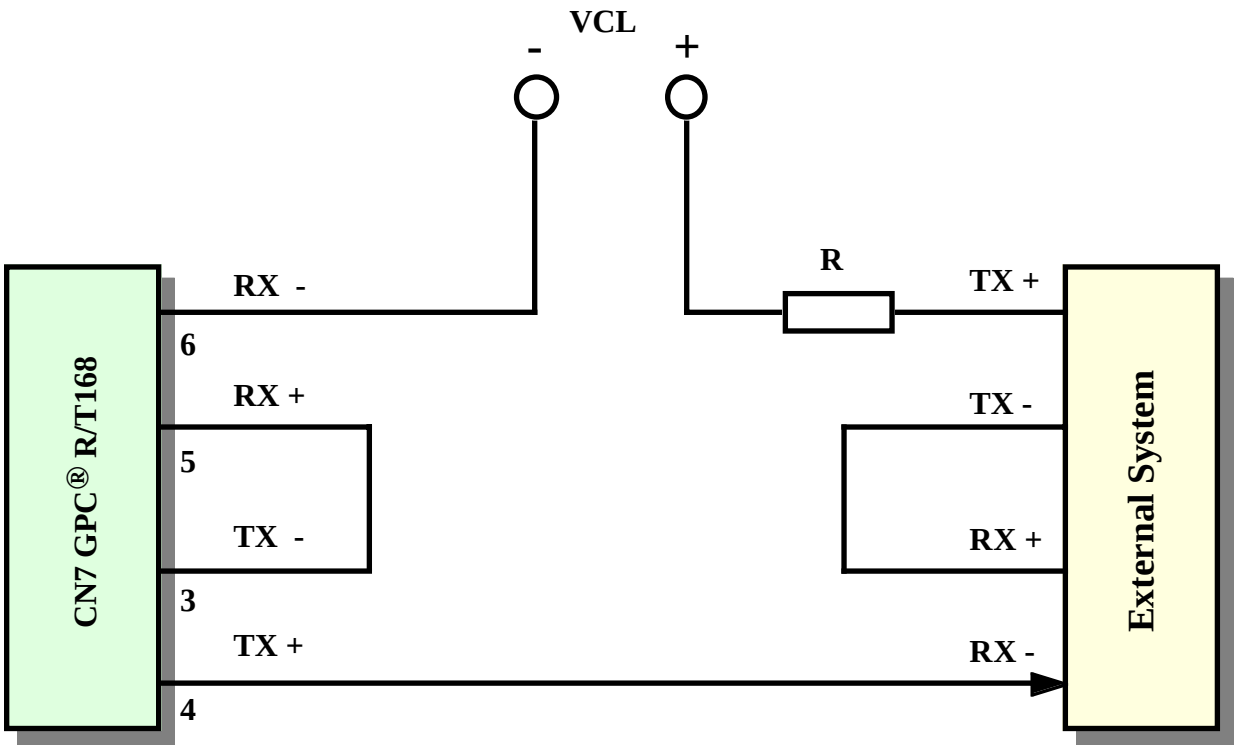


FIGURE 17: 2 WIRES CURRENT LOOP POINT TO POINT CONNECTION EXAMPLE

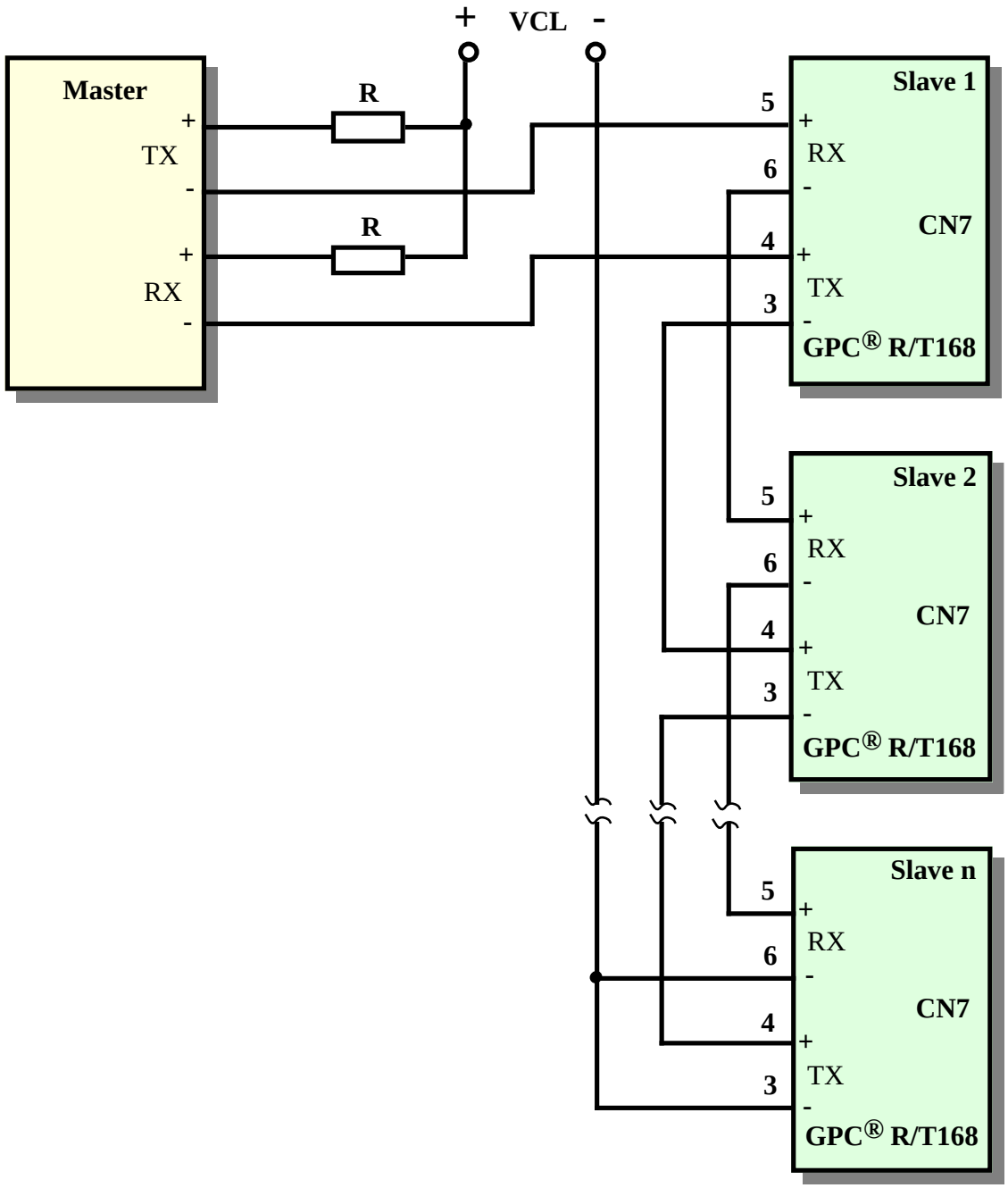


FIGURE 18: PASSIVE CURRENT LOOP NETWORK CONNECTION EXAMPLE

Possible Current Loop connections are two: 2 wires and 4 wires. These connections are shown in figures 17 and 18 where it is possible to see the voltage for **VCL** and the resistances for current limitation (**R**). The supply voltage varies in compliance with the number of connected devices and voltage drop on the connection cable.
The choice of the values for these components must be done cosidering that:
- circulation of a **20 mA** current must be guaranteed;
- potential drop on each transmitter is about **2.35 V** with a 20 mA current;
- potential drop on each receiver is about **2.52 V** with a 20 mA current;
- in case of shortciruit each transmitter must dissipate at most **125 mW**;
- in case of shortciruit each receiver must dissipate at most **90 mW**.

For further info please refer to HEWLETT-PACKARD Data Book, (**HCPL 4100** and **4200** devices).

CN2 - CONNECTOR FOR OPTOCOUPLED INPUTS

CN2 is a 9 pins, quick release, screw terminal connector.
CN2 is used to connect the 8 out of 16 optocoupled NPN input signals that the CPU manages directly through port 1.
On the connector is also available the optocoupled inputs power supply ground signal.

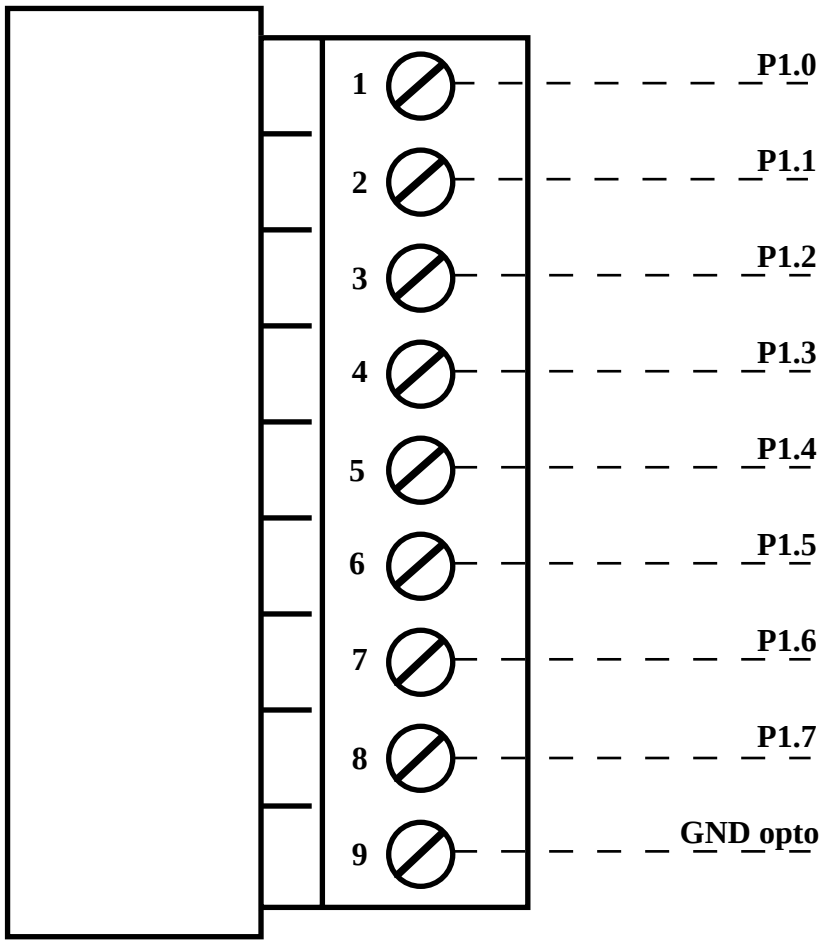


FIGURE 19: CN2 - CONNECTOR FOR OPTOCOUPLED INPUTS

Signals description:

P1.0÷P1.7 = I - Open collector NPN input, connected to CPU port 1 pins.
GND opto = - Opto ground.

CN5 - CONNECTOR FOR OPTOCOUPLED INPUTS

CN5 is a 9 pins, quick release, screw terminal connector.
CN5 is used to connect the 8 out of 16 optocoupled NPN input signals that the device installed on IC15manages directly through its port 0. Such device can communicate to the CPU through **I²cBUS** protocol to simplify the software management (for further information please refer to chapter "PERIPHERAL DEVICES SOFTWARE DESCRIPTION").
On the connector is also available the optocoupled inputs power supply ground signal.

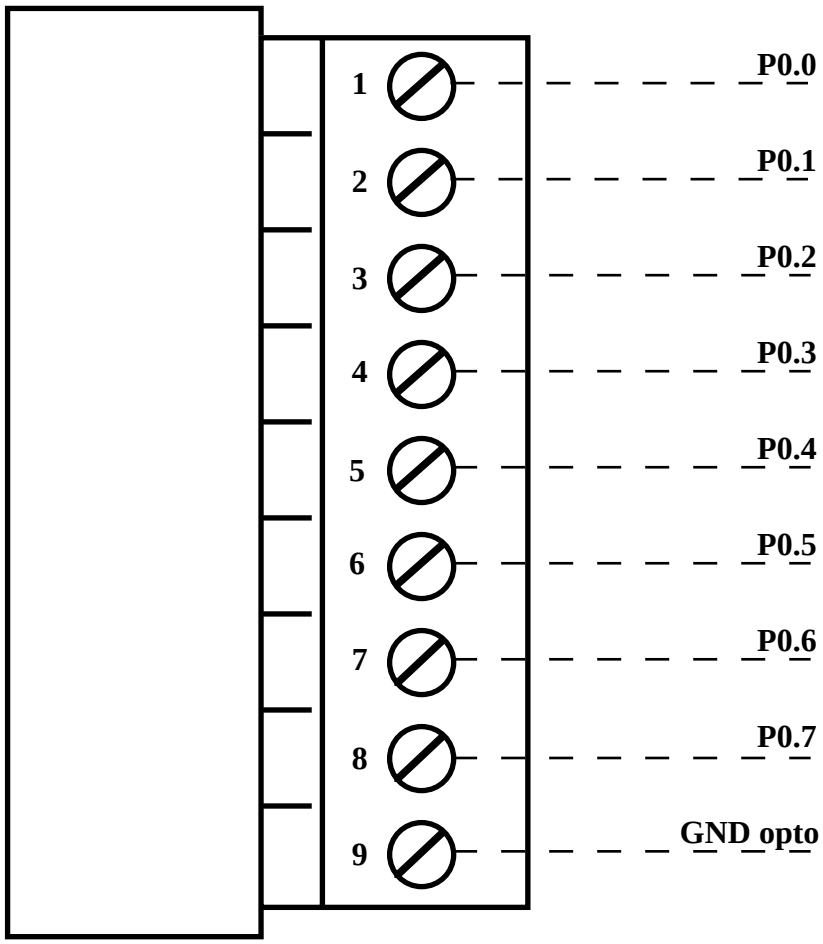


FIGURE 20: CN5 - CONNECTOR FOR OPTOCOUPLED INPUTS

Signals description:

P0.0÷P0.7 = I - Open collector NPN input, connected to IC15 port 0 pins.
GND opto = - Opto ground.

The inputs available on the board are optocoupled, provided with a low-pass filter to warrant a certain degree of internal electronic protection against noise coming from external world. The inputs are suitable for **NPN** type drivers, to connect them to **PNP** drivers yuo should interpose a **PBI 01** module. The 9 inputs section circuitery is shown in the diagram below.
Optocouplers power supply may be granted by connector CN6.

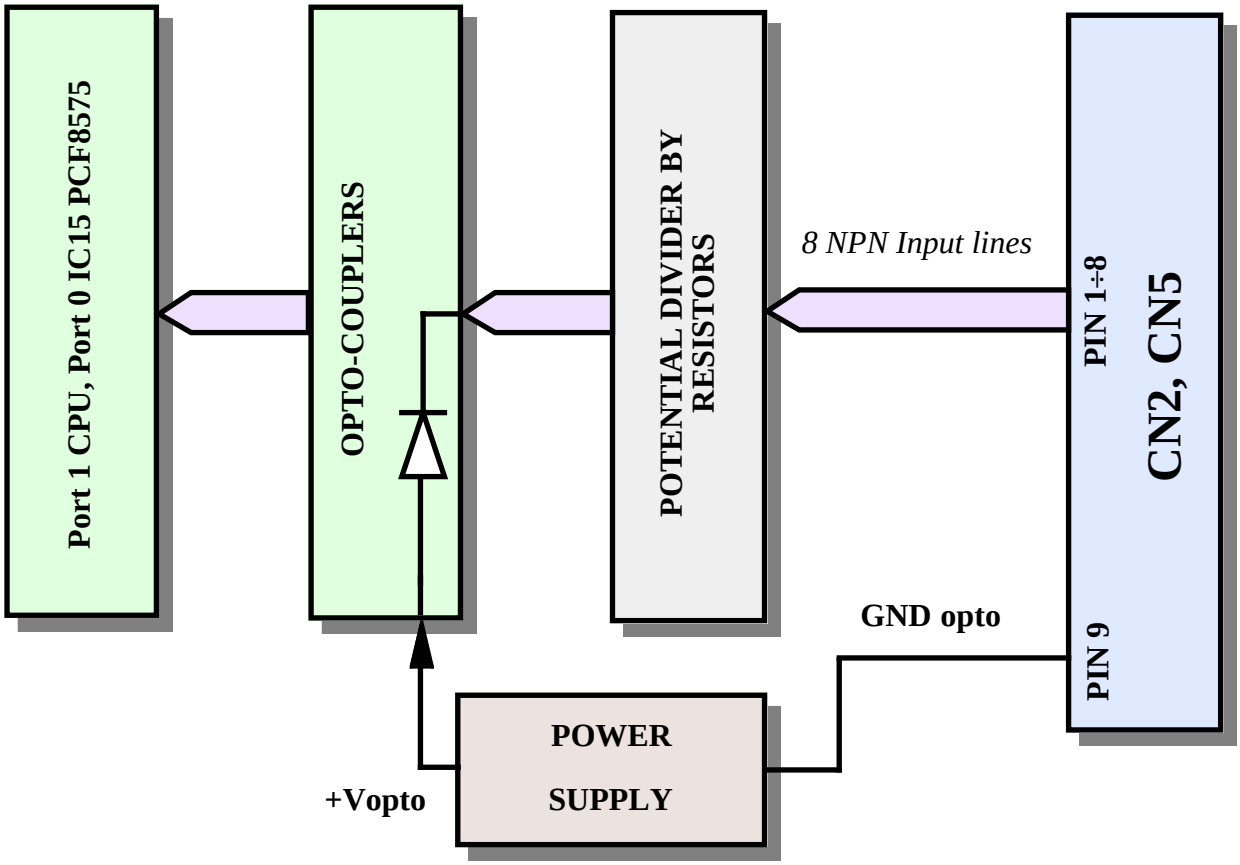


FIGURE 21: OPTOCOUPLED INPUTS BLOCK DIAGRAM

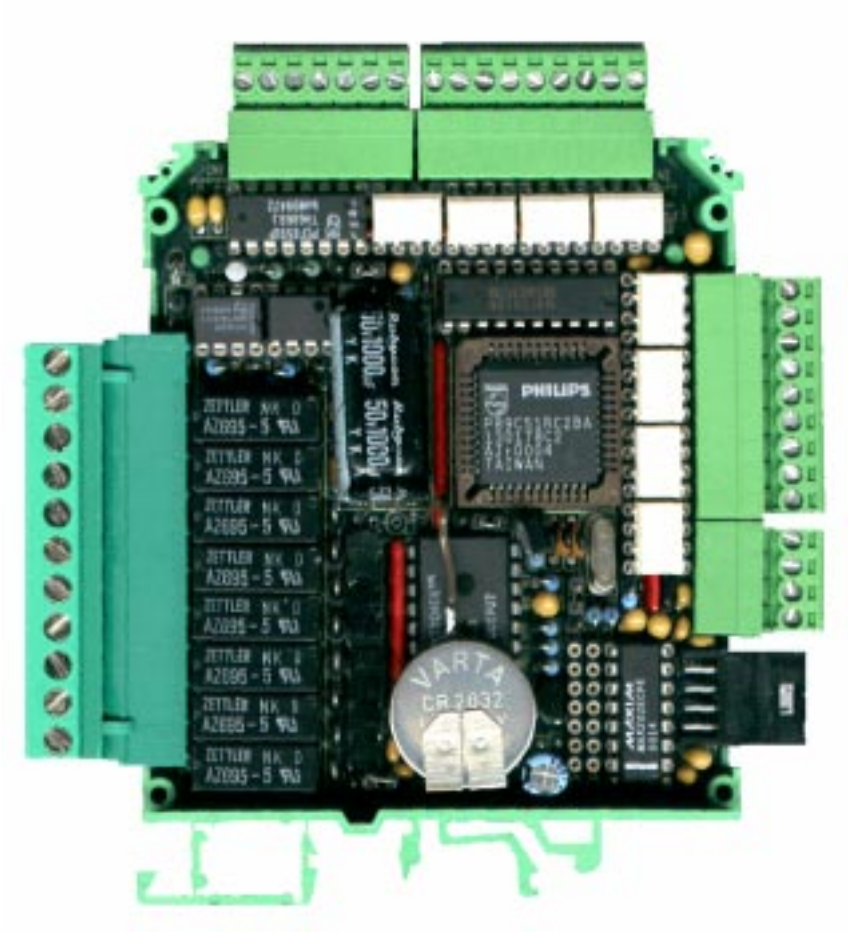


FIGURE 22: GPC® R168 CARD PHOTO

CN4 - RELAY OUTPUTS CONNECTOR

CN4 is a 11 pins, quick release screw terminal connector. On CN4 are available the normally open 8 relays outputs and their relative commons. The maximum external load for each line is **5 A** with a maximum tension or **30 Vdc** or **250 Vac**.
The outputs are managed through port 1 of IC15, opportunaly buffered, carefully selected to simplify the software management (for further information please refer to the chapter "PERIPHERAL DEVICES SOFTWARE DESCRIPTION").

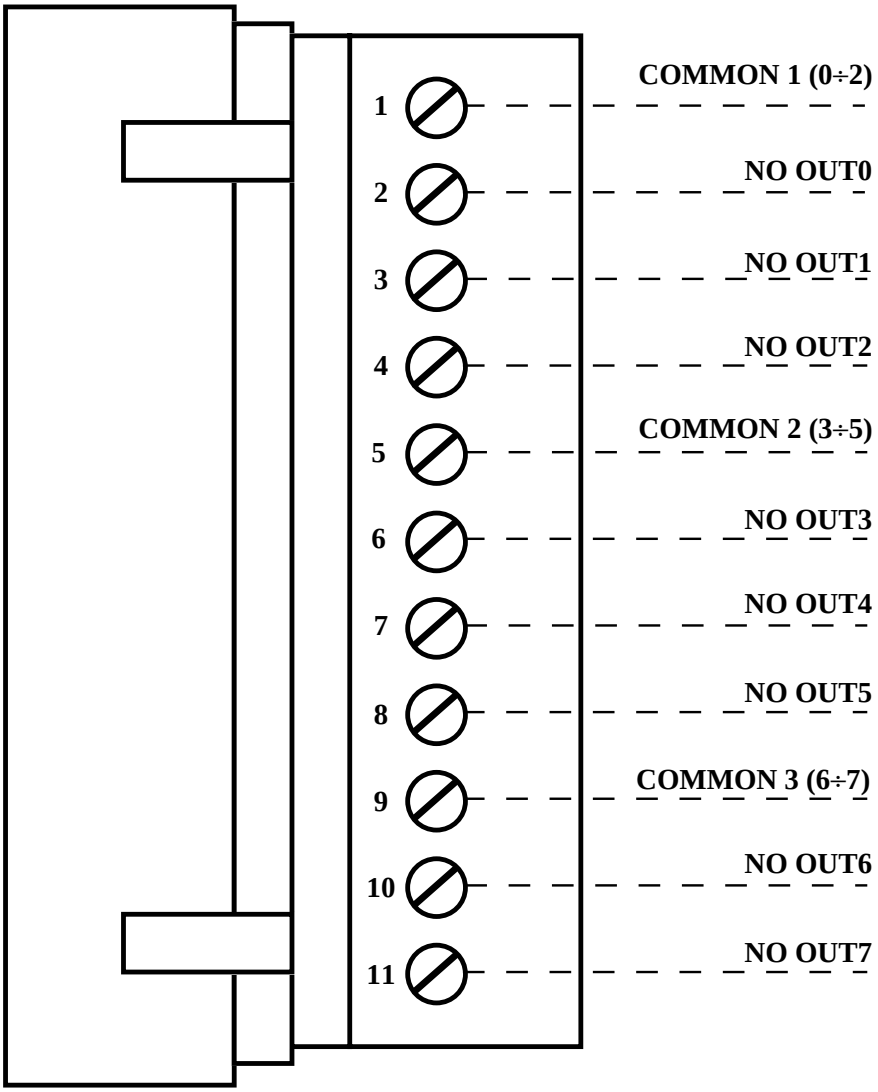


FIGURE 23: CN4 - RELAY OUTPUTS CONNECTOR

Signals description:

NO OUT n (P1.x) = O - n-th relay normally open contact, driven through pin P1.x of device installed on IC15.
COMMON n (m÷p) = - Common contacts of the relays from m to p.

The relays are driven through 8 PNP transistrors that are driven through pins of the device installed on IC15.

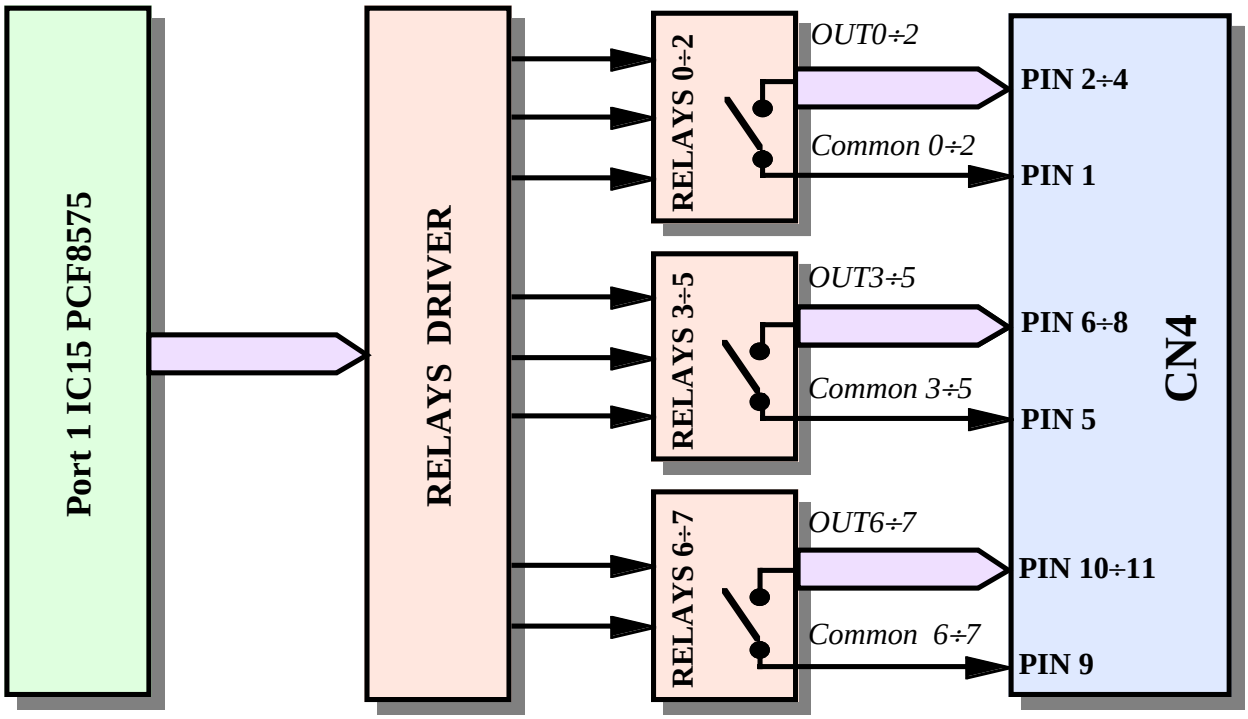


FIGURE 24: RELAY OUTPUTS DIAGRAM

CN8 - TRANSISTOR OUTPUTS CONNECTOR

CN8 is a 6 pins, quick release, screw terminal connector.
On CN8 are available the 8 open collector Darlington NPN transistor outputs and their relative commons (emitter). The maximum external load for each line is **4 A** not continuative with **45 Vdc**. The transistors, being without heat sink,can drive in continuative way a resistive load that absorbs at most **600 mA** with a maximum voltage of **45 Vdc** only if the working temperature is 20° C. All the signals are provided with a back EMF protection diode which suppresses eventual inductive voltages when loads like power relays, solenoids etc. are driven. In this case the load supply must be connected to the +VL signal. The outputs are managed through a set of IC15 I/O pins, appropriately buffered, carefully selected to simplify the software management (for further informations please refer to the chapter "PERIPHERAL DEVICES SOFTWARE DESCRIPTION".

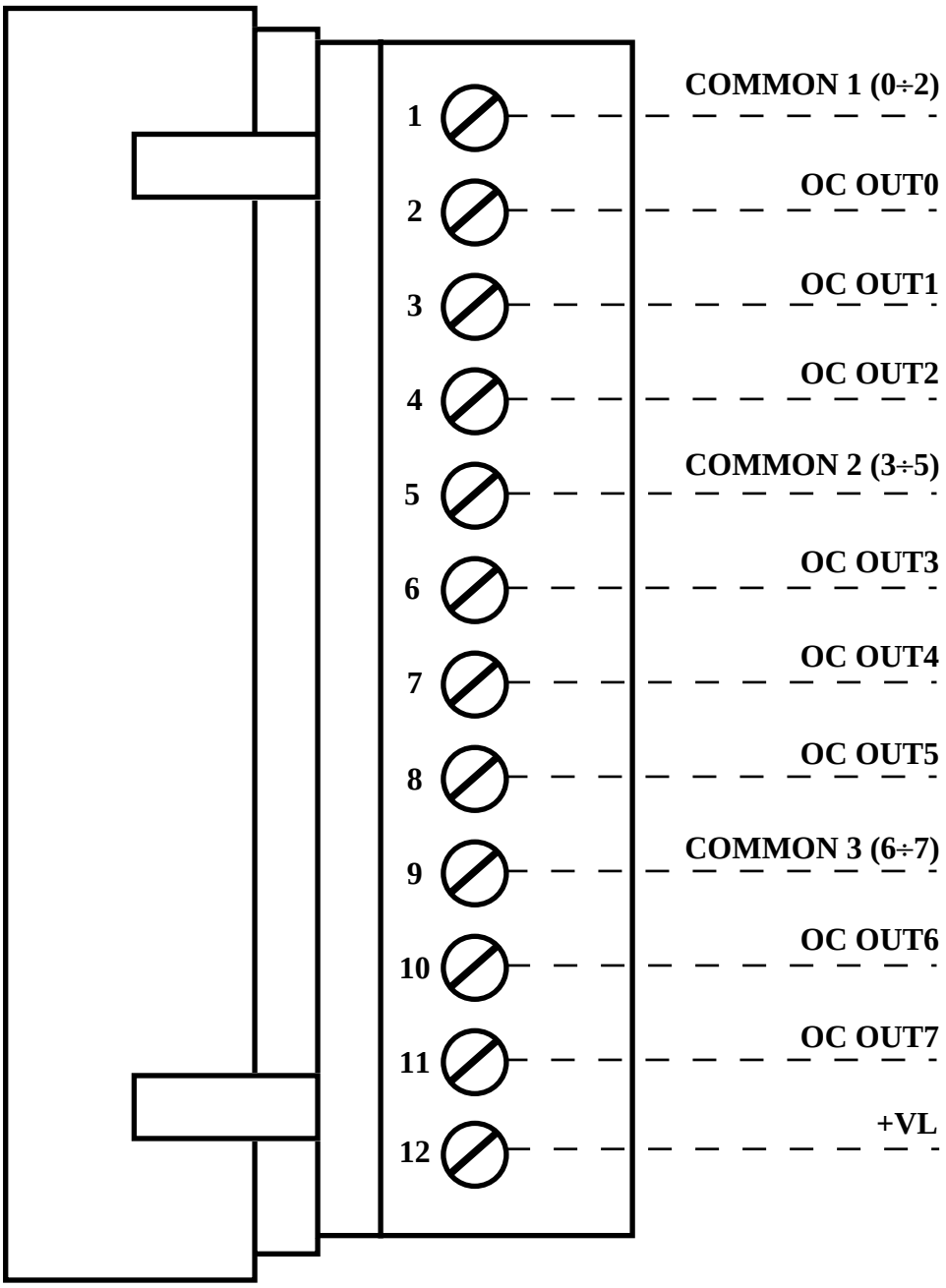


FIGURE 25: CN4 - TRANSISTOR OUTPUTS CONNECTOR

Signals description:

OC OUT n (P1.x) = O -Open collector contact of n-th NPN transistor, driven by pin P1.x of device installed on IC15.
COMMON n (m÷p) = - Common emitter of transistors from m to p..
+VL = I - Back EMF protection diodes power supply (power supply of load).

Each transistor output line is optocoupled to warrant a great isolation between internal electronics and the external world.
The final stage of such outputs is made by an **NPN** Darlington transistor in Open Collector provided with back EMF protection diode, the emitters are connected in groups of three, three and two elements, allowing to connect up to three different tensions to be driven.

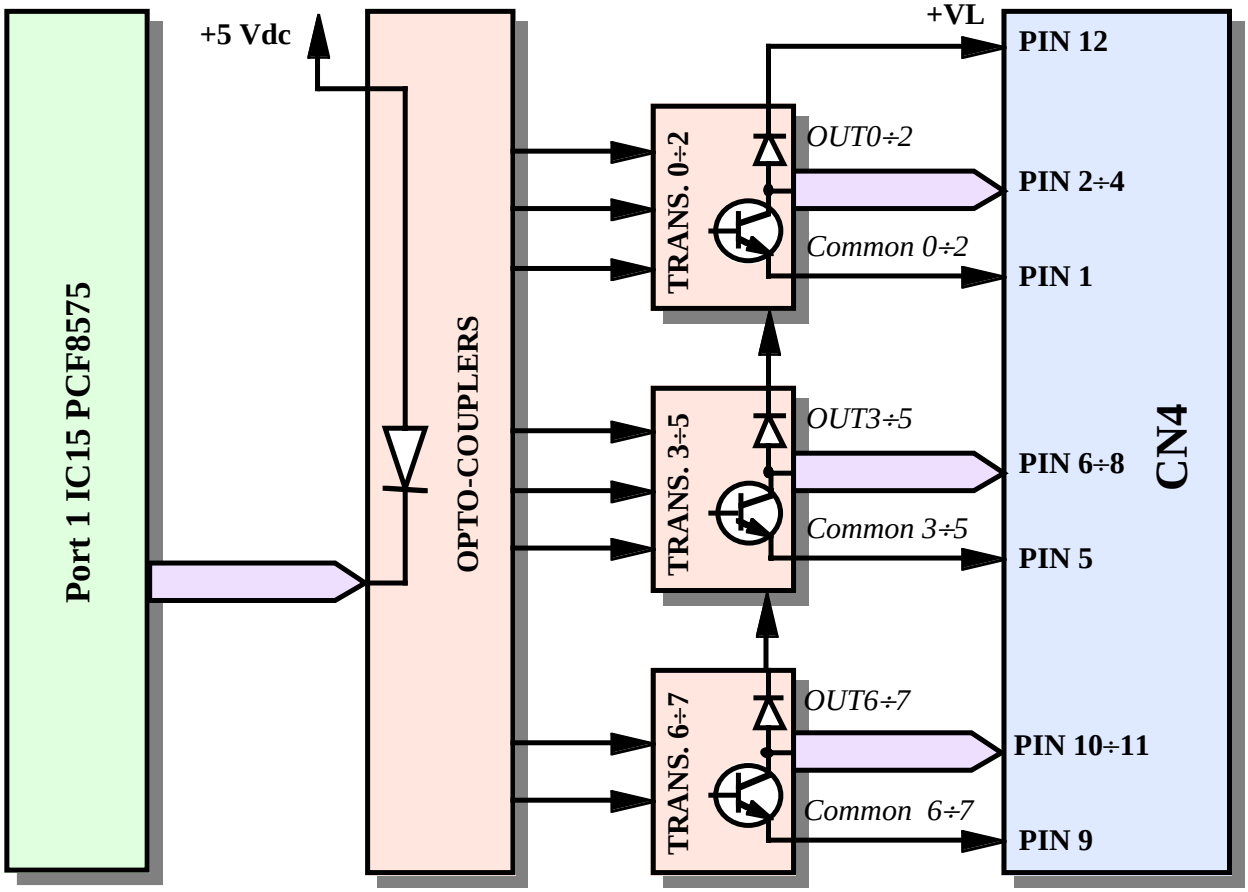


FIGURE 26: TRANSISTOR OUTPUTS BLOCK DIAGRAM

CN1 - A/D AND D/A CONVERTER CONNECTOR

CN1 is a 7 pins screw terminal quick release connector.
CN1 allows to connect the analog signals available on **GPC® R/T168** (4 input signals for the A/D converter, one output signal for the D/A converter and two power supply lines for eventual external loads). The conversion management is performed by reading the analog converter registers connected to the microprocessor through **I²cBUS** as described in the chapter "PERIPHERAL DEVICES SOFTWARE DESCRIPTION".

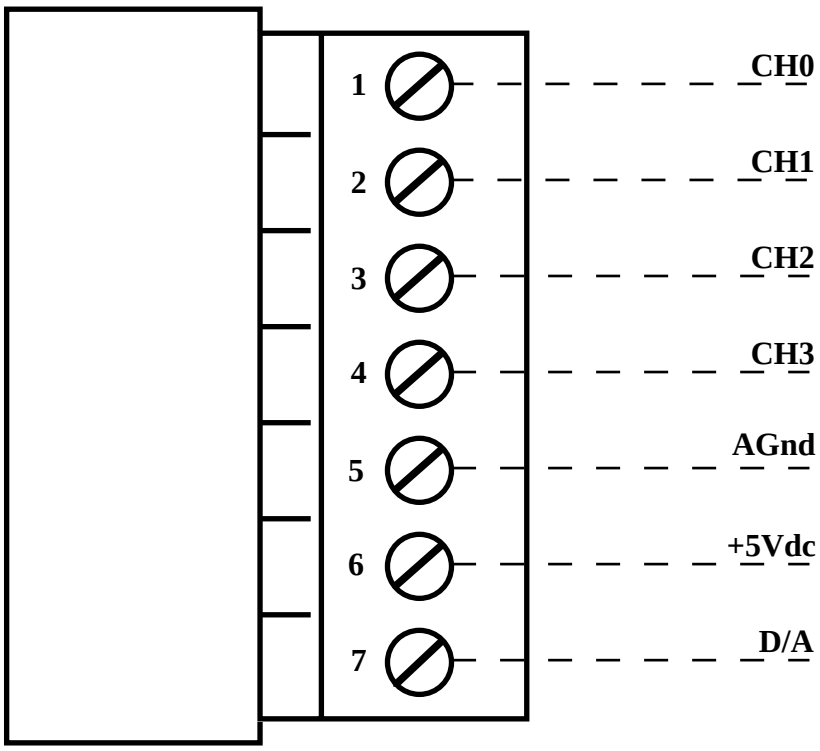


FIGURE 27: CN1 - A/D AND D/A CONVERTER CONNECTOR

Signals descrption:

CHx	= I	- x-th input signal of A/D converter.
D/A	= O	- Analog output signal of D/A converter.
+5 Vdc	= O	- +5 Vdc power supply.
AGND	=	- Analog ground.

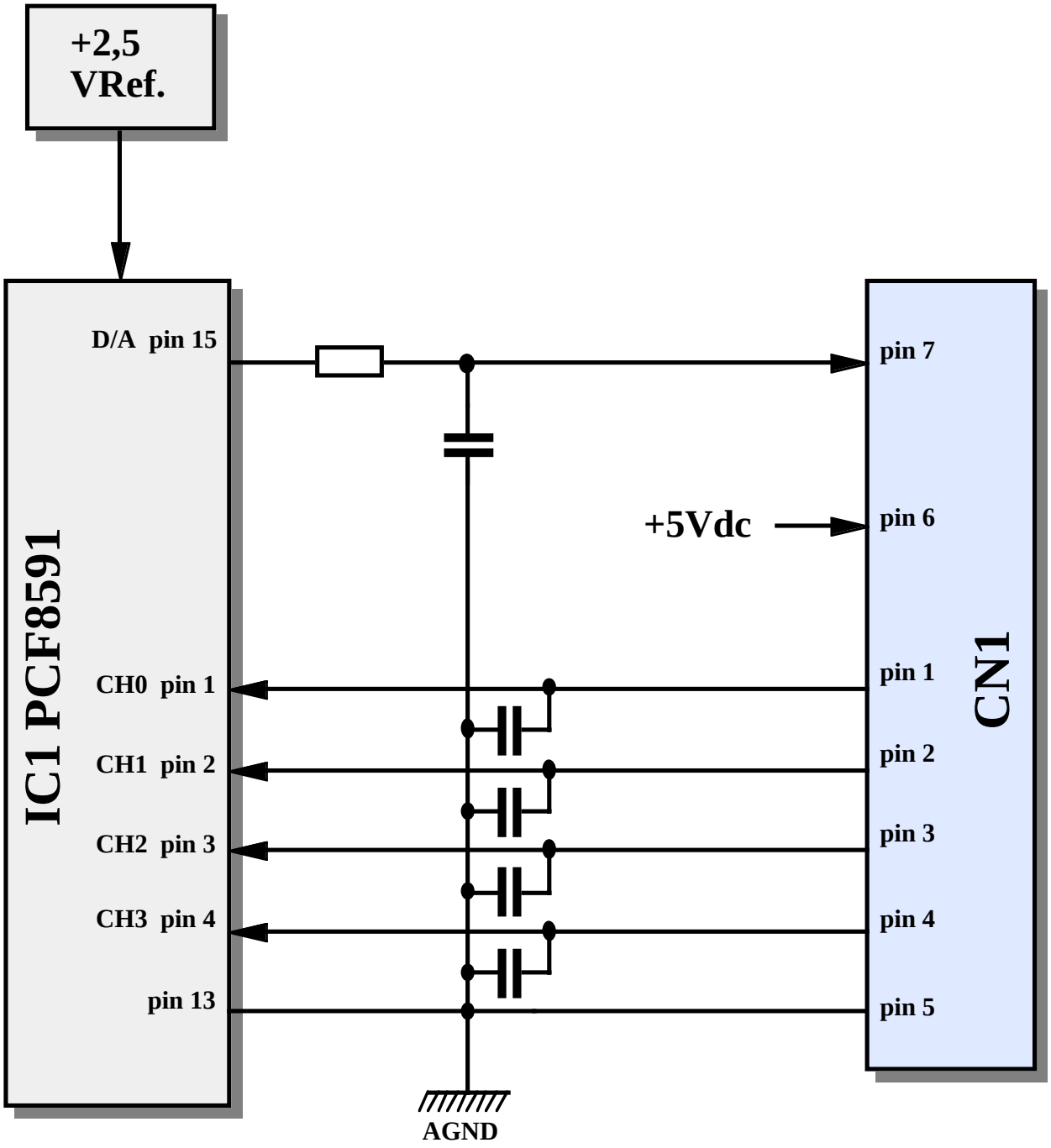


FIGURE 28: A/D INPUT AND D/A CONVERTER OUTPUT BLOCK DIAGRAM

INTERRUPTS

A remarkable feature of **GPC® R/T168** cards is the powerful interrupt management.
Here follows a short description of which devices can geneate interrupts and their modalities; for further information about interrputs management please refer to the microprocessor data sheet.

- CPU peripherals -> Possible interrupt sources are: Timer/Counter 0÷2; serial lines 0, 1; external interrupts 0÷5; internal watch dog, ecc.
  In particular TIMER 2, available on PORT 1, connector CN2.

NOTE: for further information about these interrputs management please refer to the microprocessor data sheet.

- On board sources -> Generate an interrupt on pin /INT0 (P3.2) of microcontroller (see jumper J2). Interrupt sources are two; IC8 (RTC) that can feature a programmable time base and IC15 (I/O expander) that can send an interrupt whenever one of its inputs changes.

- External sources -> On connector CN2 PORT 1 is available. It has several functions bound to TIMER 2.

BACK UP

On **GPC® R/T168** is provided with a Lithium battery, called BT1, that keeps data on SRAM+RTC also when power supply fails. With jumper J5 the User can connect or disconnect the Back Up whenever it is needed, so the battery life time is increased. To easily locate the battery please refer to figures 8 and 9.

I/O CONNECTION

To prevent possible connecting problems between **GPC® R/T168** and the external systems, the User has to read carefully the previous paragraph information and he must follow these instrunctions:

- For RS 232, RS 422, RS 485 and current loop signals the user must follow the standard rules of each one of these protocols;

- The analog input (A/D Converter) must be connected to signals within the ranges: 0÷2.5 V. Please remark that such input, available on connector CN1, is provided with a low pass filter that warrants a greater stability of the signal acquired

- To the optocoupled input signals only the contacts to be acquired must be connected. Such contacts (relays, swithces; etc.) must connect or must not connect the input signal INx to GND opto.
  For logic signals correspondace, the open contact corresponds to logic state **1**, while the closed contact corresponds to logic state **0**. Correspondance is compliant to the NPN normative.

- The relays output signals, available only on **GPC® R168**, must be connected directly to the load to be driven (power relays, etc.). The boards provides the normally open contact, for which maximum current is **5A** with a tension that can be as high as **30 Vdc** or **250 Vac**.
  To give the chance to drive different loads with different supplies, three different COMMON contacts are available, that connect three different groups of relays.

- The Darlington NPN output signals, available only on **GPC® T168**, must be connected directly to the load to be driven (power relays, etc.). The boards provides the Open Collector output line, for which maximum current is **4A not continuative** with a tension that can be as high as **+45 Vdc**.
  The transistors, being without heat sink,can drive in continuative way a resistive load that absorbs at most **600 mA** with a maximum voltage as high as **24 Vdc** only if the work temperature is 20° C.

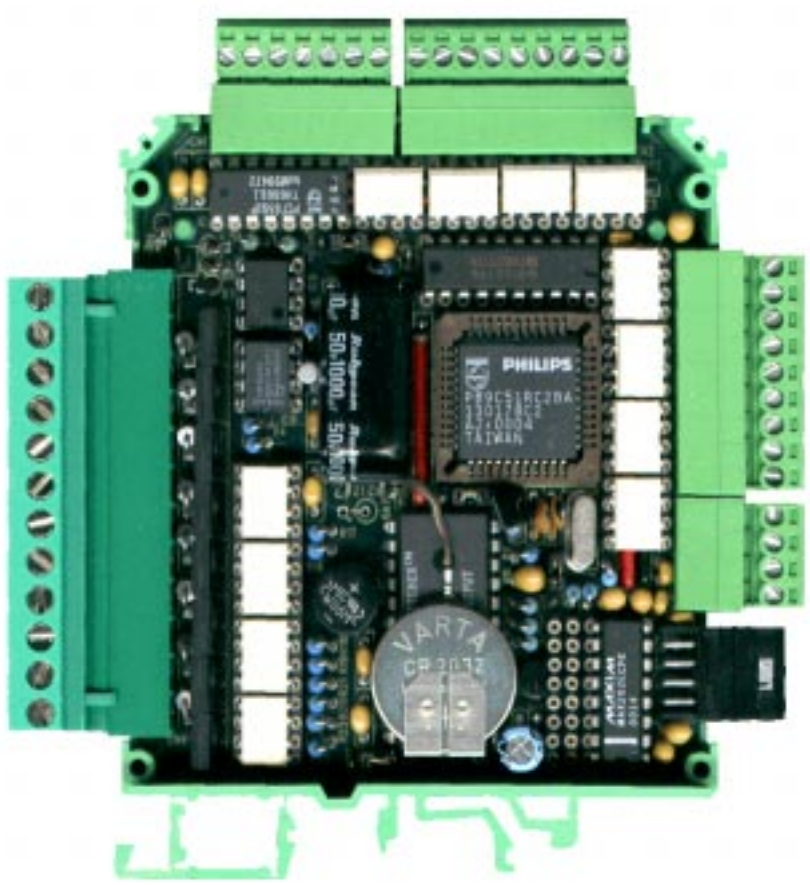


FIGURE 29: GPC® T168 CARD PHOTO

POWER SUPPLY

One of the most important features of **GPC® R/T168** is its on board power supply circuitery; the card can be powered in two different ways to let the User solve easier the problem to supply the board in any working condition:

Without switching power supply (default):

+V opto: Supplies the optocouplers of the board's input section; it must be +24 Vdc and must be provided through pins 1 and 2 of CN6 or pins 2 and 8 of CN7.

+5 Vdc: Supplies the control logic and the board's output section: it must be +5 Vdc ± 5% and must be provided through pins 1 and 7 of CN7.

*With switching power supply (option **.SW**):*

+V opto: Supplies the optocouplers of the board's input section; it must be +24 Vdc and must be provided through pins 1 and 2 of CN6 or pins 2 and 8 of CN7.

Vac: Supplies the control logic and the board's output section through the on board switching power supply: it must be 10÷40 Vdc or 8÷24 Vac and must be provided through pins 3 and 4 of CN6. The power supply circuit generates the necessary voltages for the card, starting from all the standard industrial source like mains, power transformer, battery, solar cell, etc. It is possible to supply external loads with the +5 Vdc tension available on pins 1 and 7 of CN7.
Please remark that the on board switching supply section is provided with its own diode bridge, so if the supply is continuous tension the ground digital signal (GND) doesn't have the same potential of the ground signal available on CN6.

To warrant the maximum electrical noise immunity and so the correct board's functions, power supply voltages must be galvanically isolated, to assure this condition even starting from mains supply the power supply **EXPS-2** can be ordered.

The power supply type must be specified at the moment of the order and can be installed only by **grifo®** technicians. The power supply circuit was designed for reducing the consumption (the microprocessor power down and idle mode is available) and for increasing the electrical noise immunity. On board there is a protection circuit aganist voltage peaks by **TransZorb™**.

SOLDER JUMPERS

The default setting of the solder jumpers, named **JSxx**, is performed with a small track on the solder side, so if this setting must be changed, first cut the default connection track with a sharp cutter and then connect the required position with a low power solder .

JUMPERS

On **GPC® R/T168** there are 7 jumpers, two of them are solder jumpers, for card configuration. Connecting these jumpers, the user can define for example the memory type and size, the peripheral devices functionality and so on. Below there is the jumpers list, location and function:

JUMPERS	N. PINS	PURPOSE
J1	3	Enables Philips chip ISP programming.
J2	3	Selects whether to use INT0 as RxB or as interrupt source.
J3	2	Enables Philips chip ISP programming.
J4	3	Selects directionality and activation modality of RS 422, RS 485 serial line.
J5	2	It connects the on board battery BT1 to RTC IC8.
JS1, JS2	2	Connect the termination and forcing circuitery to RS 422, RS 485.

FIGURE 30: JUMPERS SUMMARIZING TABLE

The following tables describe all the right connections of **GPC® R/T168** jumpers with their relative functions. To recognize these valid connections, please refer to the board printed diagram (serigraph) or to figures 3÷6 of this manual, where the pins numeration is listed; for recognizing jumpers location, please refer to figures 33÷36. The "*" used in the following tables, denotes the default connection, or on the other hand the connection set up at the end of testing phase, that is the configuration the user receives.

2 PINS JUMPERS

JUMPERS	CONNECTION	PURPOSE	DEF.
J3	not connected	Does not enable ISP programming for Philips microcontrollers serie 89c51Rx2.	*
	connected	Enables ISP programming for Philips microcontrollers serie 89c51Rx2.	
J5	not connected	Does not connect on board battery BT1 to RTC IC8.	*
	connected	Connects on board battery BT1 to RTC IC8.	
JS1, JS2	not connected	Do not connect the termination and forcing circuitery to reception line of RS 422 or RS 485 serial line.	*
	connected	Connect the termination and forcing circuitery to reception line of RS 422 or RS 485 serial line.	

FIGURE 31: 2 PINS JUMPERS TABLE

3 PINS JUMPERS

JUMPERS	CONNECTION	PURPOSE	DEF.
J1	position 1-2	Enables ISP programming for Philips microcontrollers serie 89c51Rx2.	
	position 2-3	Does not enable ISP programming for Philips microcontrollers serie 89c51Rx2.	*
J2	position 1-2	Connects microcontroller INT0 pin to on board interrupt sources.	
	position 2-3	Connects INT0 to RxB of software serial.	*
J4	position 1-2	Selects serial line communication as RS 485 (2 wires half duplex).	
	position 2-3	Selects serial line communication as RS 422 (4 wires full duplex or half duplex).	*

FIGURE 32: 3 PINS JUMPERS TABLE

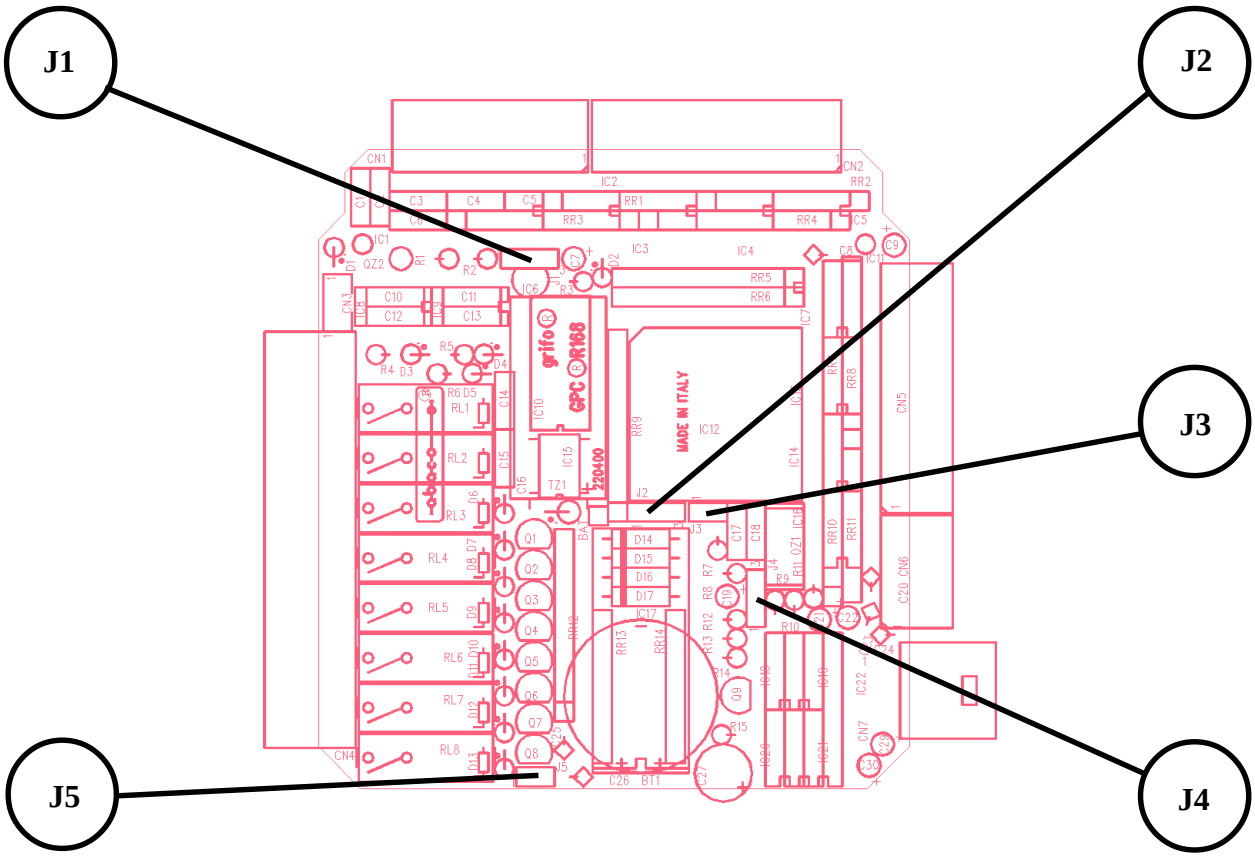


FIGURE 33: GPC® R168 JUMPERS LOCATION ON COMPONENT SIDE

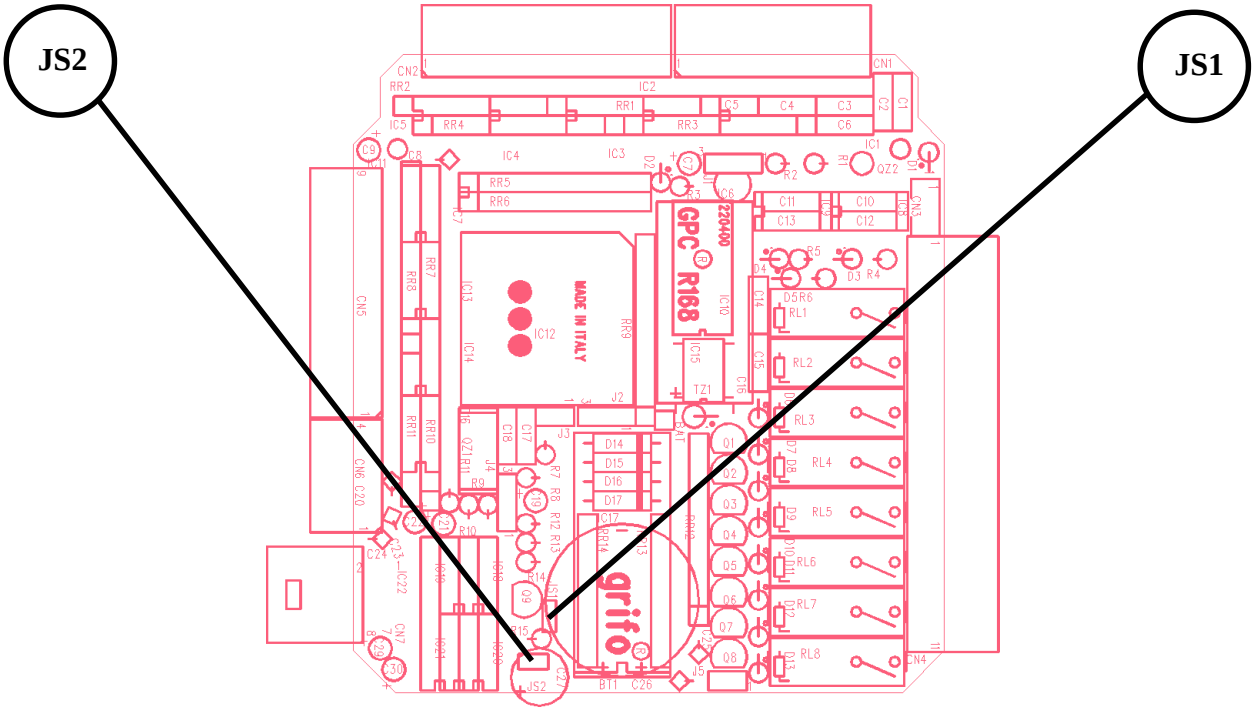


FIGURE 34: GPC® R168 JUMPERS LOCATION ON SOLDER SIDE

MEMORY SELECTION

Le **GPC® R/T168** can manage up to 99936 bytes of memory in several configurations. For the details of the possible configurations please refer to the following table:

IC	DEVICE	SIZE
12	AT89C52	8 KBytes (FLASH EPROM) 256 Bytes (SRAM)
	AT89s8252	8 KBytes (FLASH EPROM) 2 KBytes (EEPROM) 256 Bytes (SRAM)
	P89c51Rx2	16/32/64 KBytes (FLASH EPROM) 512/1 KBytes (SRAM)
8	SRAM+RTC	256 Bytes
9	EEPROM	512÷1 KBytes
10	SRAM	32 KBytes

FIGURE 35: MEMORY SELECTION TABLE

GPC® R/T168 is delivered in its default configuration with microprocessor AT89C52, 32 KBytes of SRAM from **0000H** to **7FFFH**, SRAM+RTC device installed and 512 bytes of EEPROM; every different configuration can be performed by the user in autonomy (except for EEPROM IC9) or required in ordering phase. Below are reported the codes for the memory options available:

.EE08 -> 1K serial EEPROM

For further informations and prices of the opions please contact **grifo®**,while to easily locate memory devices please refer to figures 8 and 9.

SERIAL COMMUNICATION SELECTION

GPC® R/T168 serial line can be buffered as RS 232, RS 422, RS 485 or Current Loop. By hardware can be selected which one of these electric standards is used, through jumpers connection and drivers installation. By software the serial line can be programmed to operate with all the standard physical protocols, in fact the bits per character, parity, stop bits and baud rates can be decided by setting opportunes CPU internal registers. In the following paragraphs there are all the informations on serial communication configurations.
Some devices needed for RS 422, RS 485 and Current Loop configurations are not mounted on the board in standard configuration; this is why each fist non-standard (non-RS 232) serial configuration must be always performed by **grifo®** technicians. This far the User can change in autonomy the configuration following the informations below:

- SERIAL LINE A (hardware) IN RS 232 (default configuration)

			IC22	= driver MAX 202
J2	=	don't care	IC19	= no device
J4	=	don't care	IC21	= no device
JS1, JS2	=	not connected	IC18	= no device
			IC20	= no device

- SERIAL LINE B (software) ONLY RS 232 (default configuration)

			IC22	= driver MAX 202
J2	=	2-3	IC19	= no device
J4	=	don't care	IC21	= no device
JS1, JS2	=	not connected	IC18	= no device
			IC20	= no device

- SERIAL LINE IN CURRENT LOOP (option **.CLOOP**)

			IC22	= no device
J2	=	don't care	IC19	= no device
J4	=	don't care	IC21	= no device
JS1, JS2	=	not connected	IC18	= driver HP 4100
			IC20	= driver HP 4200

Please remark that Current Loop serial interface is passive, so it must be connected an active Current Loop serial line, that is a line provided with its own power supply. Current Loop interface can be employed to make both point-to-point and multi-point connections through a 2-wires or a 4-wires connection.

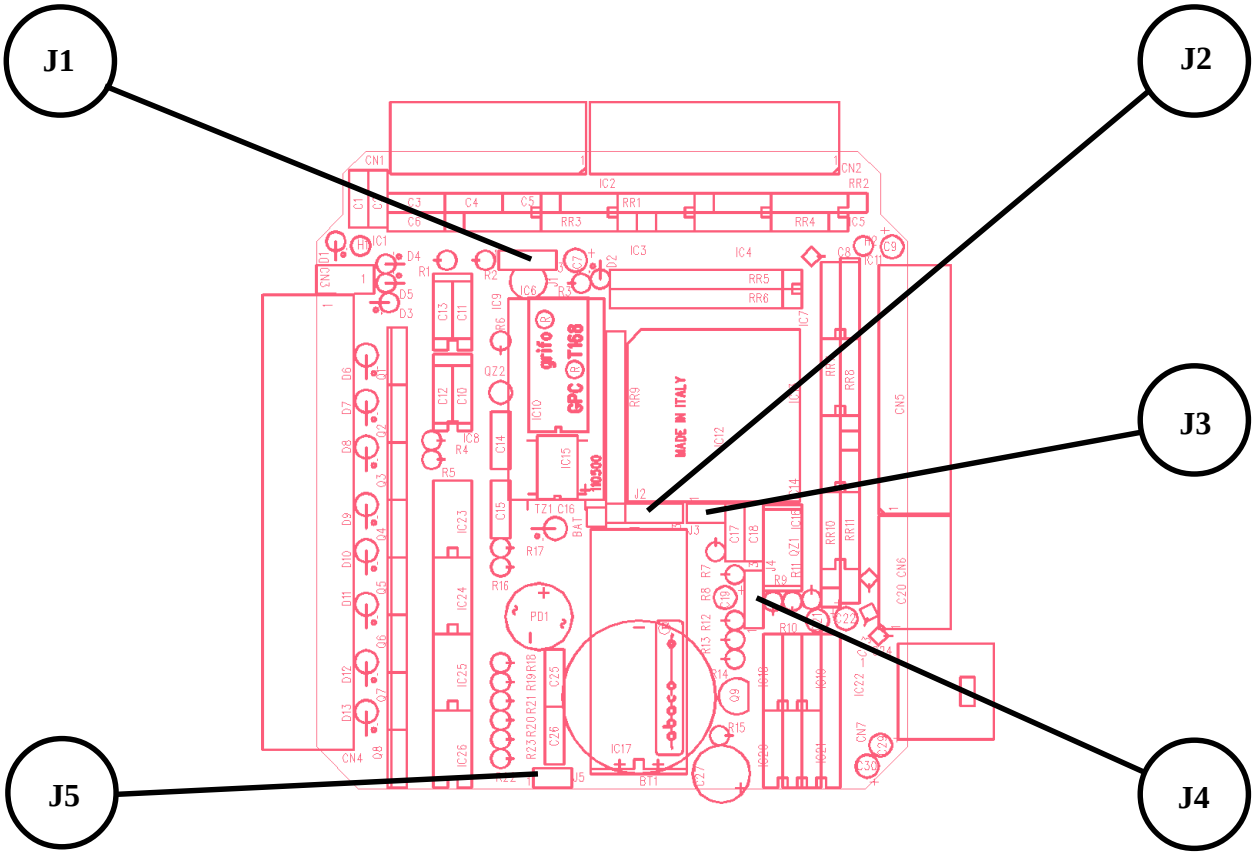


FIGURE 36: GPC® T168 JUMPERS LOCATION ON COMPONENT SIDE

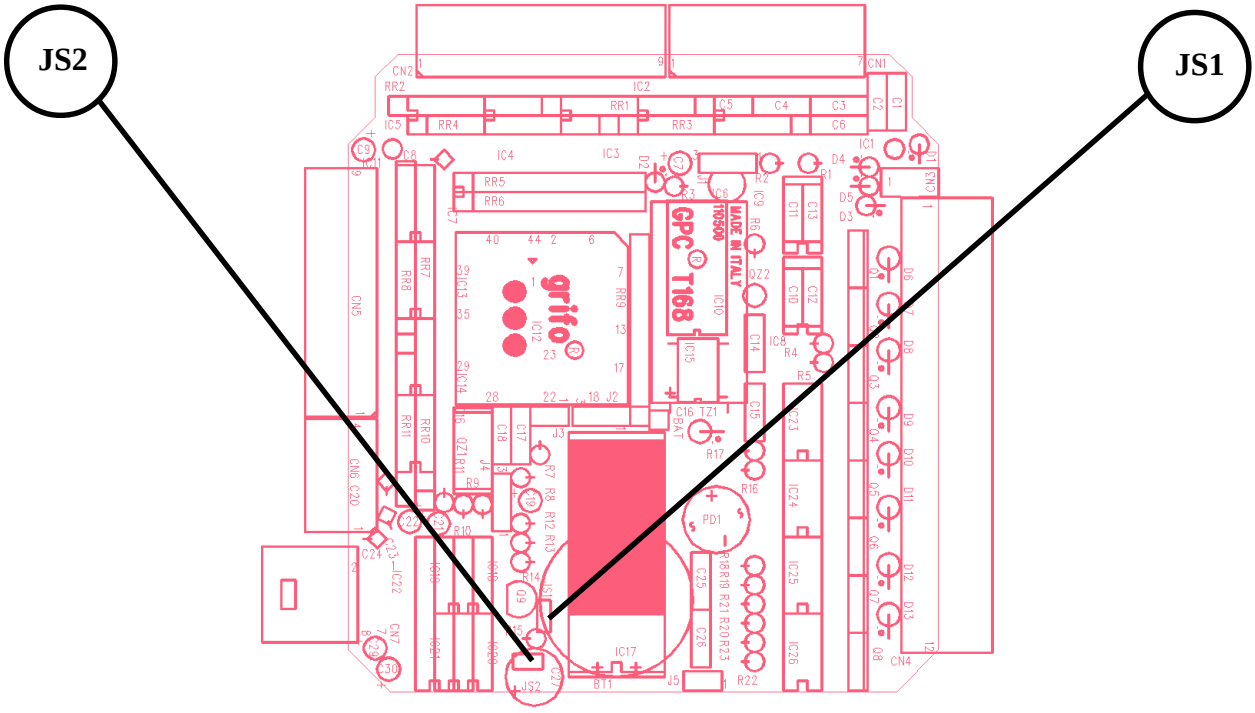


FIGURE 37: GPC® T168 JUMPERS LOCATION ON SOLDER SIDE

- SERIAL LINE IN RS 485 (option **.RS 485**)

			IC22	= no device
J2	=	don't care	IC19	= no device
J4	=	position 1-2	IC21	= driver MAX 483 or SN 75176
JS1, JS2	=	(*1)	IC18	= no device
			IC20	= no device

In this modality the signals to use are pins 5 and 6 of connector CN7, that become transmission or reception lines according to the status of signal P3.3, managed by software, as follows:

P3.3= low level	= logic state 0	->	transmitter enabled
P3.3= high level	= logic state 1	->	transmitter disabled

This kind of serial communication can be used for multi-point connections, in addition it is possible to listen to own transmission, so the User is allowed to verify the succes of transmission. In fact, any conflict on the linecan be recognized by testing the received character after each transmission.

(*1) If using the RS 422 or RS 485 serial line, it is possible to connect the terminating and forcing circuit on the line by using JS1 and JS2. This circuit must be always connected in case of point-to-point connections, while in case of multi-point connections it must be connected olny in the farest boards, that is on the edges of the commmunication line.

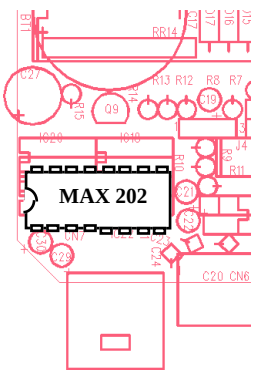
- SERIAL LINE IN RS 422 (option **.RS 422**)

			IC22	= no device
J2	=	don't care	IC19	= driver MAX 483 or SN 75176
J4	=	position 2-3	IC21	= driver MAX 483 or SN 75176
JS1, JS2	=	(*1)	IC18	= no device
			IC20	= no device

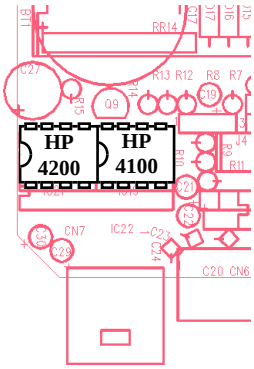
Status of signal P3.3, which is software managed, allows to enable or disable the transmitter as follows:

P3.3= low level	= logic state 0	->	transmitter enabled
P3.3= high level	= logic state 1	->	transmitter disabled

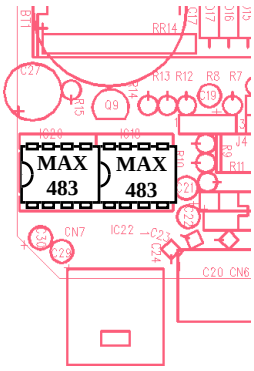
In point-to-point connections, signal P3.3 can be always kept low (trasnmitter always enabled), while in multi-point connections transmitter must be enabled only when a transmission is requested.



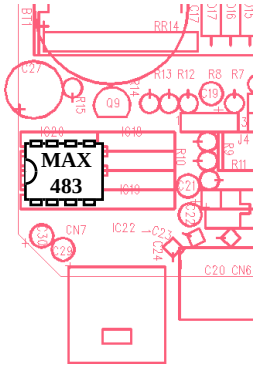
Serial in RS 232



Serial in Current-Loop



Serial in RS 422



Serial in RS 485

FIGURE 38: SERIAL COMMUNICATION DRIVERS LOCATION

IN SYSTEM PROGRAMMING (ISP)

One of the most important features of **GPC® R/T 168** is the possibility to employ the new microprocessors PHILIPS 89CRx2 that support in system programming, this means that the CPU FLASH can be programmed directly on the board, without any need to remove the CPU. Here follows the steps to perform for ISP:

1) develop the application program usign a software tools capable to generate executable code
2) connect jumpers J3 and J1 in position 1-2
3) connect serial line A in RS 232 to a personal computer COM port
4) supply the board, program the microprocessor internal FLASH EPROM using the specific software tool provided by PHILIPS: **WINISP**.
5) remove power supply to the board
6) connect J3 and J1 in position 2-3 to enable the microprocessor internal EPROM
7) supply the board again: the application program is now executed from internal EPROM.

ISP reduces the total cost of the application, in fact it allows to do without EPROMs, EPROM programmer, FLASH EPROM, etc.
For further information about ISP programming please refer to the specific technical documentation by PHILIPS.

RESET AND WATCH DOG

On **GPC® R/T168** there is a watch dog circuit (not all the microprocessors are provided with it) that is really efficient and easy to use. The most important features of such circuitery are:

- astable mode;
- intervention time tipically programmable;
- retrigger by software;

In astable mode when intervention time is elapsed the circuit becomes active, it stays active till the end of reset time and after it is again deactivated.
Please remark that another reset source, in addition to the eventual watch dog circuit, is power on circuitery.

SOFTWARE

A wide selection of software development tools can be obtained, allowing use of the **GPC® R/T168** card as a system for its own development, both in assembler and in other high level languages; in this way the user can easily develop all the requested application programs in a very short time. Generally all software packages available for the51 microprocessors family can be used.

MICRO/ASM-51: macro cross assembler available for MS-DOS operating system in "ABSOLUTE" and "RELOCATABLE" version. In this "RELOCATABLE" version is supplied with a linker and a library manager.

MICRO/C-51: integer cross compiler for source files in standard ANSI C, available also for MS-DOS operating system. It produces a source assembly file compatible with MICRO/ASM-51 or with Intel macro relocatable assembler MCS 51.

MICRO/SLD-51: source level debugger and simulator. It is executed on P.C. without any additional hardware and it allows loading of HEX and SYMBOLIC files, breakpoint setting, instruction execution in trace mode, registers and memory dump, etc.

HI-TECH C: cross compiler for C source program. It is a powerful software tool that includes editor, C compiler, assembler, optimizer, linker, library, and remote symbolic debugger, in one easy to use integrated development environment.

BASCOM 8051: cross compiler for BASIC source program. It is a powerful software tool that includes editor, BASIC compiler and simulator included in an easy to use integrated development environment for Windows. Many memory models, data types and direct use of hardware resource instructions are available.

DDS MICRO C 51: low cost ross compiler for C source program. It is a powerful software tool that includes editor, C compiler (integer), assembler, optimizer, linker, library, and remote debugger, in one easy to use integrated development environment. There are also included the library sources and many utilities programs.

ADDRESSING

INTRODUCTION

In this chapter all the information related to the software programming of the board will be given. Such information include the software management of all the section.

ON BOARD RESOURCES ADDRESSING

The on board devices are addressed in two modes: the classic 16 bit parallel bus for FLASH EPROM and SRAM and the devices connected to the two-wires serial **I²C-BUS**.
These latter devices have the addresses reported in the following paragraph and cannot be reallocated to any other address. The devices connected to **I²C-BUS** are managed by the microcontroller through two generic I/O lines, clock signal (SCL, P3.5 pin 17) and data signal (SDA, P3.4 pin 16).

P3.4 <-> DATA signal (SDA)
P3.5 -> CLOCK signal (SCL)

I²C-BUS PERIPHERALS MAPPING

All the devices interfacing through protocol **I²C-BUS** have an unchangeable internal code (A6, A5, A4, A3), many of these devices may have from one to three pins associated to three address signals (A2, A1, A0), so it is possible to connect together several devices having the same internal code. Here we report the device name, its purpose and slave address:

DEVICE	IC	FUNCTION	I²C-BUS SLAVE ADDRESS Bit 7 6 5 4 3 2 1 0 A6 A5 A4 A3 A2 A1 A0 W/R
PCF8575	IC15	16 I/O Expander	0 1 0 0 0 0 0 X
PCF8591	IC1	4 A/D, 1 D/A	1 0 0 1 0 0 0 X
PCF8583	IC8	RTC + 256 bytes RAM	1 0 1 0 0 0 0 X
24c04 or 24c08	IC9	EEPROM 512÷1024bytes	1 0 1 0 1 0 0 X

FIGURE 39: I²C-BUS PERIPHERALS ADRESSING TABLE

Letter "X" indicates that the component can be read and written, it must be indicated because there are components that can be only read or only written, in these caseW/R will be 0 for writeable, 1 for readable. The software description of the components indicated int the table is contained in the chapter “PERIPHERAL DEVICES SOFTWARE DESCRIPTION”.

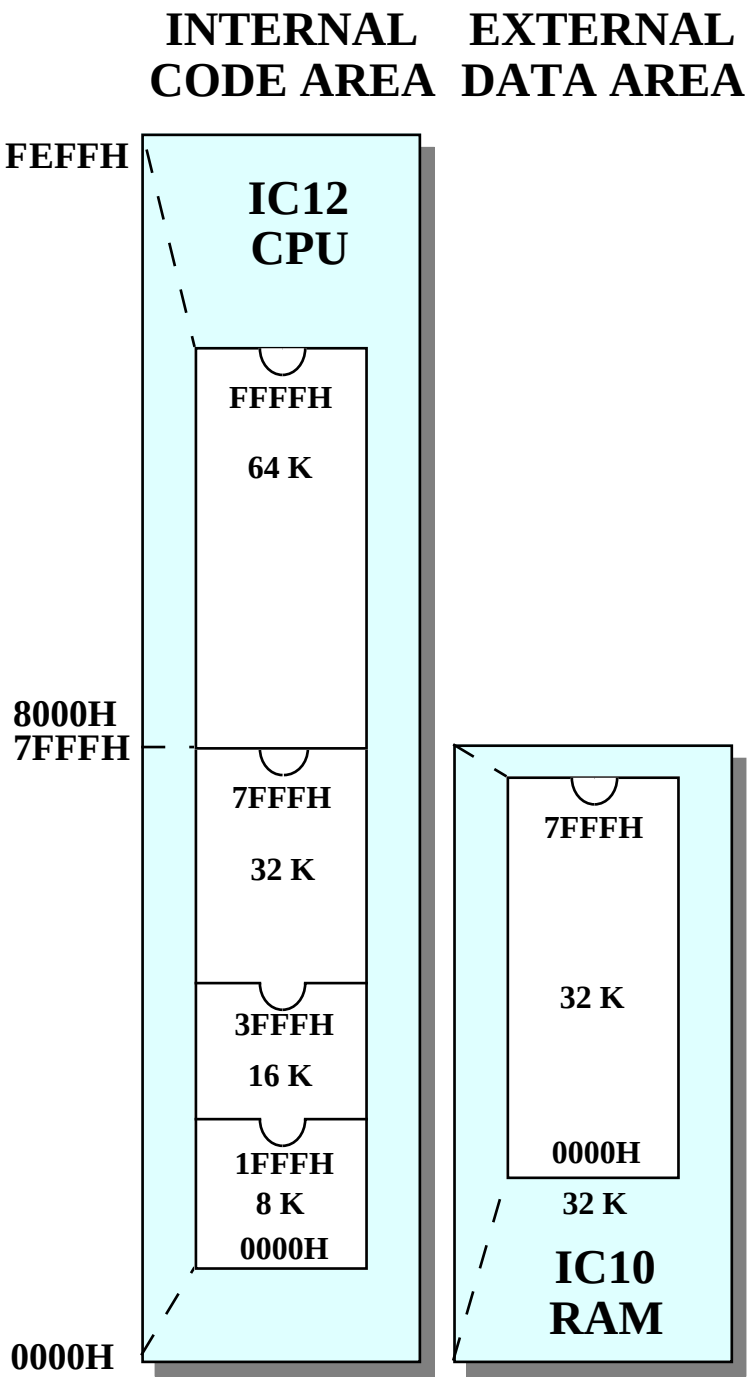


FIGURE 40: MEMORY ADDRESSING TABLE

The previuos paragraph reported the allocation addresses of all the perpherals, in this chapter is reported the detailed description of purpose and meaning of their registers (to correctly understand the following information please refer to the **I²C-BUS** addressing table). Should the present documentation be insufficent please refer to manufacturer documentation. For furhter information about programming the CPU sections please refer to the CPU manufacturer documentation.

BACKED SRAM + RTC

For further information about the **PCF8583** serial module (IC8), please refer to the manifacturer documentation, because it contains several registers. This paragraph does not give detailed software information because the management of this device is complicated and requires a deep knowledge of the device itself, anyway the user can take advantage of the specific high level procedures contained in the examples. The component contains 256 registers, from 0 to 0FH the timer or clock registers are present, remaining addresses from 10H to FFH correspond to backed memory locations, please refer also to jumper J5 description.

Slave Address	**reading**	**writing**
PCF8583	A1H	A0H

We would want to remark that if this device is not installed on IC8 the maximum eeprom size for IC4 is 2048 byte (24c16), when IC8 is installed the maximmum eeprom size is 1024 byte (24c08). To write to a memory location use the followint sequence:
Slave address writing+ register num. (0÷FFH) + data to write
To read from a memory location use the followint sequence:
Slave address writing+ register num. (0÷FFH)
Slave address reading + data to read

SERIAL EEPROM

The management modalities of serial EEPROM installed on IC9 is the same of SRAM+RTC, only the slave addresses change as they are bound to eeprom size. Infact the eeprom that can be installed are: 24c01 (0÷7FH byte), 24c02 (0÷FFH byte), 24c04 (0÷1FFH byte), 24c08 (0÷3FFH byte), 24c16 (0÷7FFH byte) this latter can be installed only if SRAM+RTC is not installed on IC8. Examining the sequence given for SRAM+RTC we can see that available registers range from 0 to FFH, so up to model 24c02there are no differences except for the slave address, please remark that if **slave address is even a writing operation is performed, if odd a reading operation is performed**.

Slave Address	**reading**	**writing**	**register n°**	**memory**
24c01	A9H	A8H	0÷7FH	128 byte
24c02	A9H	A8H	0÷FFH	256 byte

Of course 24c01 does not have valid registers in the range 80H÷FFH.
8 bit are not enough to manage the biggest eeprom, to reach the address 1024 (24c08 1FFH) 10 bit are essential, so the first 8 bit will be set as register number, most significant 2 bit will be A0 and A1, please see figure 39.

Slave Address	reading	writing	register n°	memory
24c04	A9H÷ABH	A8H÷AAH	0÷FFH	512 byte
24c08	A9H÷AEH	A8H÷AFH	0÷FFH	1024 byte

While with a 24c16 the slave address is:

Slave Address	reading	writing	register n°	memory
24c16	A0H÷AEH	A1H÷AFH	0÷FFH	2048 byte

Here it is evident that this eeprom is in conflict with SRAM+RTC, because they have the same slave address (A0H).

4 A/D AND 1 D/A

The IC **PCF8591** installed on IC1, allows to aquire 4 analog input channels and to drive one analog output with 8 bit of resolution, all the signals are in the range da 0÷2.5Vdc. Through **I²C-BUS** writing to this peripheral the control register is accessed, the next byte in writing is the eventual value for the analog output,while in reading the first byte returns the value of the conversion on the channel previously requested, the second byte indicates the value of the conversion on the channel requested. The first operation is to set the control register,to easily understand the bits of control register please refer to figure 41.
There it is shown that bit 7 and bit 3 have no meaning and must be kept at logic level zero, bit 6 if 1 activates the analog input, bit 5 and 4 configure the 4 analog channels in 4 different modes:

- 4 channels single polarity
- 3 differential channels on ch3
- 2 channels single polarity and 1 differential channel
- 2 differential channels.

Bit 2 if 1 allows to switch automatically to the next channel to convert, while bits 1 and 0 select the channel convert, so only this latter two bits will be changed to acquire all the channels without following an automatic sequence.

Slave Address	reading	writing
PCF8591	91H	90H

In the following example the device will be configured with D/A enabled, 4 channells single polarity: point to channell 0, control register 40H.
Writing: **90H, 40H, data for D/A**
Reading: **91H, data previous A/D channel, data channel 0 chosen by control register**

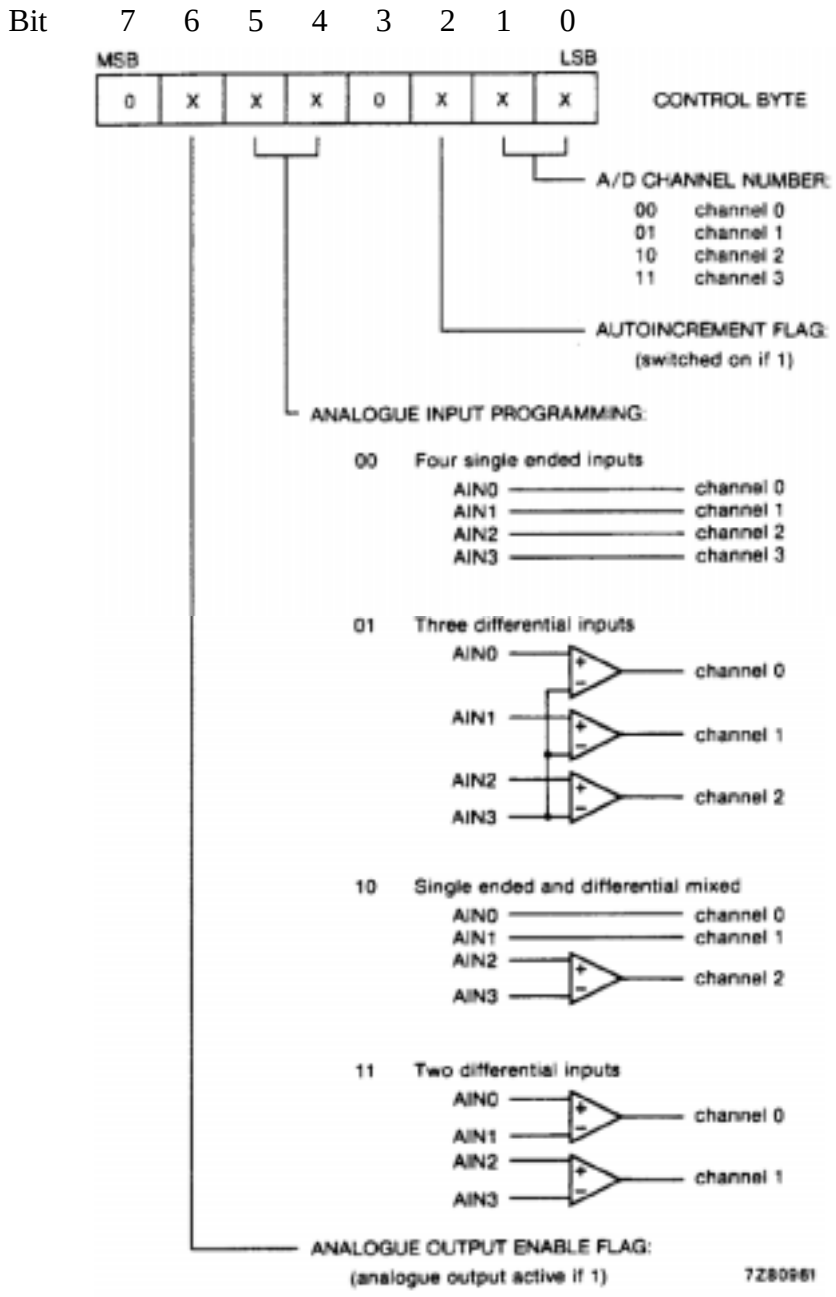


FIGURE 41: A/D AND D/A CONTROL REGISTERS

For further information please refer to manufacturer documentation.

I/O EXPANDER

This peripheral is managed through **I²C-BUS**, the component is installed in IC15, this allows to drive eight digital TTL signals in input or in output. Management is easy, when a read operation is performed (Slave Address W/R=1 + data) they are set as input, while to perfrorm a write operation (Slave Address W/R=0 + data) they are set as output, to set the lines back to input first they must be connected to a logic level high then a read operation will set then ad input, please remark that after the power on all lines are set as input. A remarkable feature of this component is the ability to trigger an interrupt whenever a inputs change logic level (see jumper J2), thanks to this feature it is not essential to read continuously inputs, it is enough to manage the interrupts and to acquire the lines.

Slave Address	reading	writing
PCF8575	41H	40H

For furhter information please refer to the manifacturer documentation.
PORT 0 is used as input to read the 8 optocoupled inputs on CN5, while PORT 1 is used as output for relays or transistor outputs on CN4.

DIGITAL INPUTS

Acquisition of optocoupled inputs (CN2) is performed through 8 microcontroller lines (PORT 1), while the remaining 8 lines (CN5) are managed through PORT 0 of IC15 (**PCF8575**).
To acquire CN2, the microcontroller must read its PORT 1, while to acquire CN5 an **I²C-BUS** sequence must be started to read PORT 0 of IC15, as in the following example:

Slave address read + data to read
Read: **41H, PORT0**

Please remark that this latter device generater an interrupt whenever a logic input changes its status (see jumper J2). When an NPN input is actived (contact closed to GND opto), the corresponding line is at logic level low (logic 0), viceversa an input is disactived (contact open) puts the corresponding line to logic level low (logic 1).

DIGITAL OUTPUTS

The eight NPN relays or transistor outputs are set through PORT1 of IC15 (**PCF8575**), managed in **I²C-BUS**, as in the following exampl:

Slave address write + data to write
write: **40H, PORT0, PORT1**

To avoid confilcts between optocouplers input circuit and PORT 0, this latter must be always set to FFH (255), this prevents problems that may verify when PORT 0 is used as input. In this case the user can take advantage of the specific high level language procedures provided in the examples.
When an I/O line is set to logic state low (logic 0), the corresponding output is actived (transitor conducing or relay contact connected to is common), viceversa when a line is set to logic state high (logic 1) the corresponding output is disactived (transistor not conducing or relay contact open).
When a power on occours, I/O lines are set to logic 1, so the relays or transistors are disactived.

CPU PERIPHERALS

For further information about CPU internal peripherals registers and their purpose (Timer Counter, interrupts controller, serial line, I/O ports , etc) please refer to manufacturer documentation.

BIBLIOGRAPHY

Here follows a list of manuals and technical notes that the User can read to acquire more informations about **GPC® R/T168** board.

Manual TEXAS INSTRUMENTS: *The TTL Data Book - SN54/74 Families*
Manual TEXAS INSTRUMENTS: *RS-422 and RS-485 Interface Circuits*

Manual MAXIM: *New Releases Data Book - Volume 4*

Manual XICOR: *Data Book*

Manual PHILIPS: *IC1, IC8,IC9, IC15 - I^2C bus*

Manual ATMEL: *Microcontroller - AT89 series*

Manual PHILIPS: *80C51 - Based 8-Bit Microcontrollers*

Manual TOSHIBA: *Photo Couplers - Data Book*

Manual MOTOROLA: *Bipolar Power Transistor Data*

Technical notes: *LM2825N*

Please connect to the manifactures Web sites to get the latest version of all manuals and data sheets.

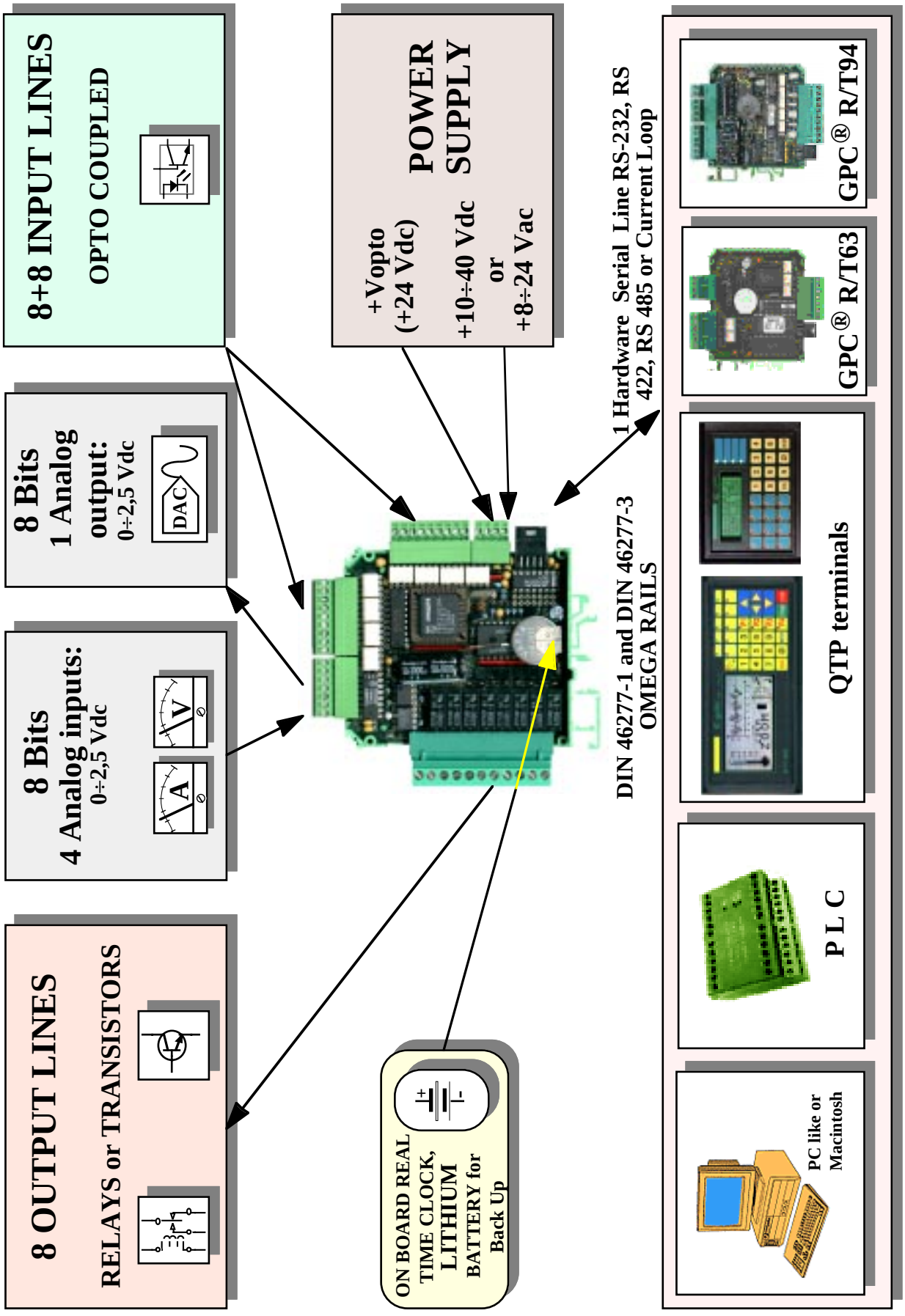


FIGURE 42: POSSIBLE CONNECTIONS DIAGRAM

APPENDIX A: ALPHABETICAL INDEX

D

G

I

J

L

M

N

O

P

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S

T

W