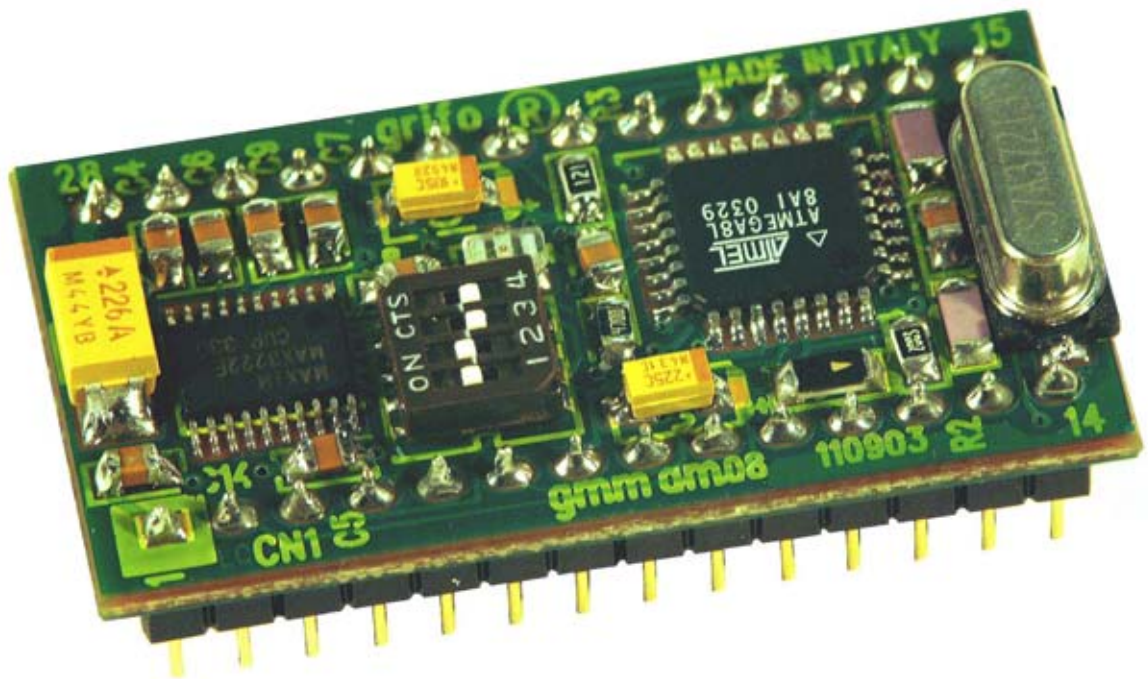


GMM AM328

grifo® Mini Modulo AT mega 328

TECHNICAL MANUAL



grifo®

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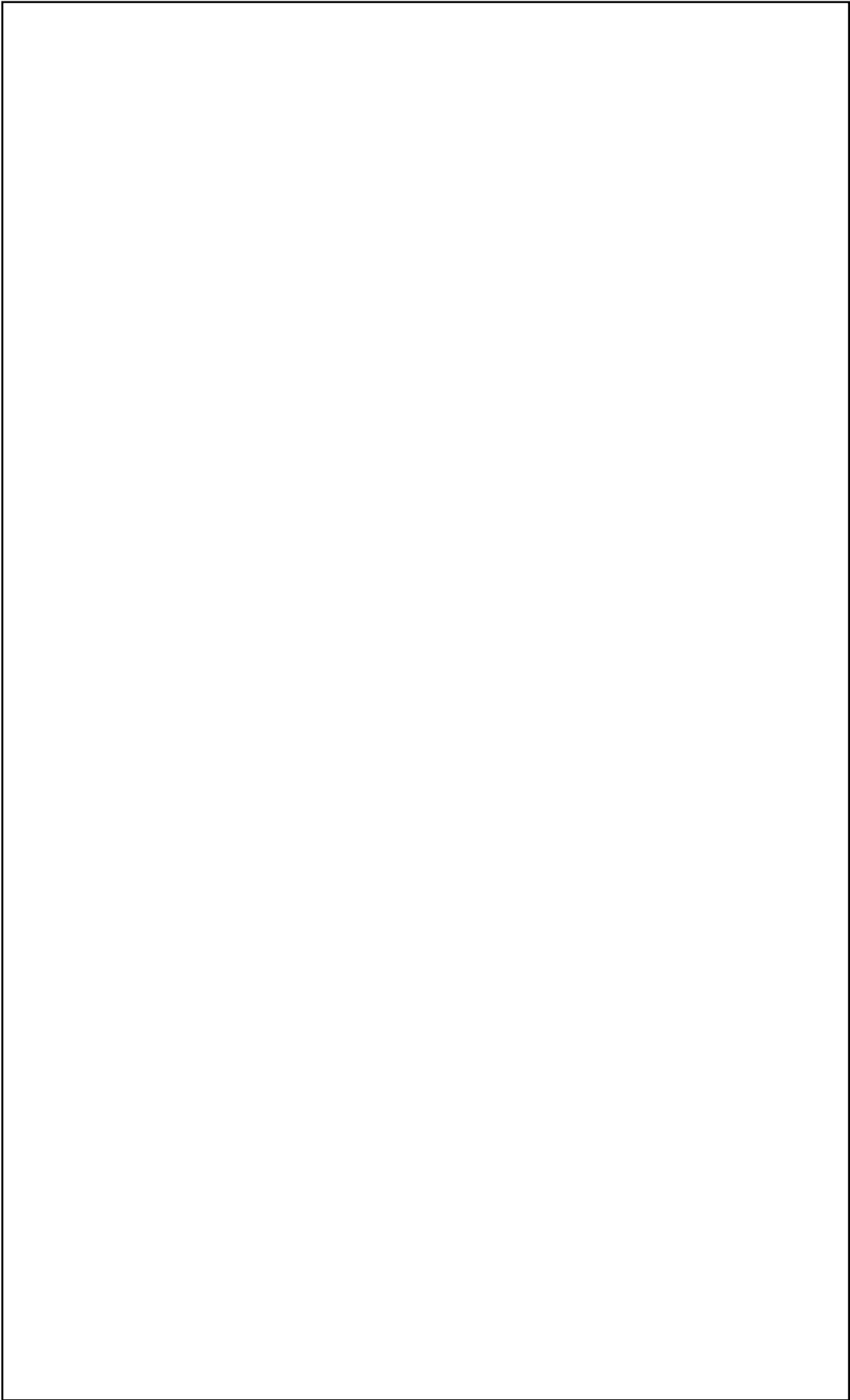
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GMM AM328 Rel. 5.10 Edition 25 June 2011

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GMM AM328

grifo® Mini Modulo AT mega 328

TECHNICAL MANUAL

Standard container with **28 pins** male socket, DIL, **100 mils** pitch, **600 mils** width; very small dimension: **20.7 x 38.7 x 12.8 mm**; single power supply required from **+3.0 Vdc** to **+5.0 Vdc** (the current consumption may vary according to module connections); availability of **Idle Mode** and **Power Down Mode**; **Atmel ATmega 328** microcontroller (AVR RISC) with **7.3728 Mhz** crystal; **32KBytes FLASH** for code, up to **1K Bytes FLASH** for optional **Boot Loader**, **1KBytes EEPROM**, **2K Bytes SRAM** for data; **8 A/D** converter channels with **10 bits** resolution; **18 interrupt** sources; **3 Timers Counters** up to **16 bits**, compare, capture, **PWM**, etc.; programmable **Watch Dog** from **16 ms** up to **2 s**; **23 digital I/O** lines available on connector; hardware serial line with Baud Rate up to **115200 Baud**, **RS 232** buffered or at **TTL** level; **PC BUS** serial interface; **SPI** interface; **Reset** circuitry; 4 ways configuration dip switch; software **I/O** managed status **LED**; internal **FLASH** and **EEPROM** can be managed through **In System Programming**, or when the module is already mounted, by using **ISP** programming; **freeware** software for **PC**, that supports the **ISP** programming to download the generated code, inside on board **FLASH**; wide range of development tools as: **C** compiler (ImageCraft ICC AVR, DDS Micro C), **BASIC** compiler (BASCOM AVR), etc.; long list of demo programs and use examples supplied under source form, duly remarked, for the available development tools.

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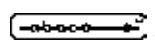
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For specific informations on the components mounted on the card, please refer to the Data Book of the builder or second sources.

SYMBOLS DESCRIPTION

In the manual could appear the following symbols:



Attention: Generic danger



Attention: High voltage



Attention: ESD sensitive device

Trade Marks

 , GPC®, **grifo®** : are trade marks of **grifo®**.

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

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INTRODUCTION

The use of these devices has turned - IN EXCLUSIVE WAY - to specialized personnel.
This device is not a **safe component** as defined in directive **98-37/CE**.



Pins of Mini Module are not provided with any kind of ESD protection. They are connected directly to their respective pins of microcontroller. Mini Module is affected by electrostatic discharges. Personnel who handles Mini Modules is invited to take all necessary precautions to avoid possible damages caused by electrostatic discharges.

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 environment, 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 respect 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.

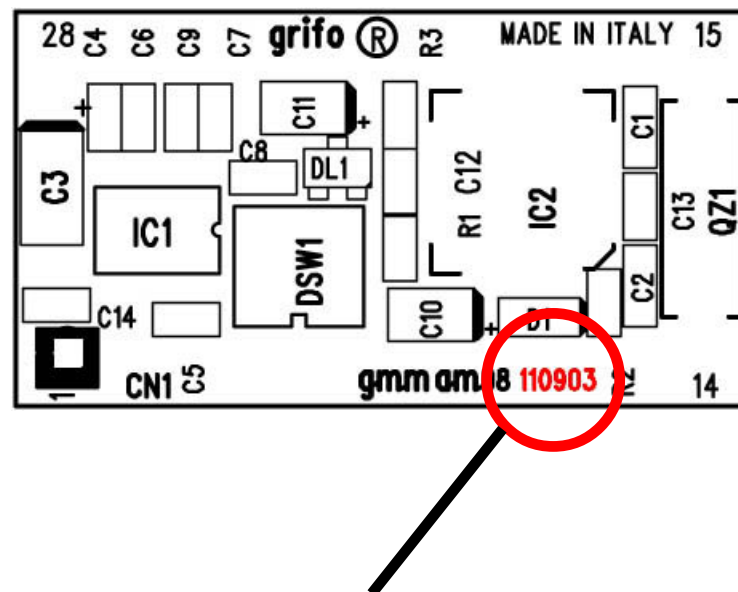
To prevent problems during card utilization, it is a good practice to read carefully all the informations of this manual. After this reading, the user can use the general index and the alphabetical index, respectly at the begining and at the end of the manual, to find information in a faster and more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

CARD VERSION

This handbook make reference to card **GMM AM328** with printed circuit version **110903**.

The validity of the information contained in this manual is subordinated to the printed circuit revision number and so the user must always check the correspondance.

The printed circuit revision number is always printed in several positions of the circuit and following figure shows the easiest to access.



PRINTED CIRCUIT REVISION NUMBER

FIGURE 1: LOCATION OF REVISION NUMBER

GENERAL INFORMATION

GMM AM328 (grifo® Mini Module ATMEL ATmega328) is a module based on microcontroller **Atmel ATmega328**, a powerful and complete system-on-a-chip provided with **CPU**, **internal memory** both for data and for code, **A/D converter**, **watch dog**, **interrupts**, TTL digital I/O lines, a hardware serial line, dedicated **timer/counter** with capture/compare and **PWM** capability, **SPI** interface, **I²C BUS** (**two wires** interface **synchronous** line), etc.

In modules's very small area some components that exploit microcontrollers's performance are already mounted.

In addition to this, component that complete micro's features are installed, like the **reset** circuitry. Possible applications of **GMM AM328** Mini Modules are several.

We remark the employ as **smart intelligent nodes** with local functionalities as PID algorithms for controlling temperatures, motors, valves, etc. or as **decentralized systems** as robots, automation of production line machines, big factory automations.

Finally, **teleacquisition** and **telecontrol** on medium and low distances, **home automation** (lights turning ON/OFF, heating and cooling systems control, supervision of electric devices, security and access control systems).

Last but not least, **didactics**: **GMM AM328** offers a very low cost to learn how a real **AVR RISC** microcontroller works and to develop typical applications for this family.

For this purpose it is likewise interesting the **GMM TST 2** support card.

GMM TST 2 allows to connect immediately a RS 232 interface to communicate to a PC and a reference voltage source for A/D converter.

In addition, it is delivered with a **4x4 matrix keyboard** and a **20x2 LCD backlit display**, allowing to implement easily terminal emulators and to design user interfaces.

GMM TST 2 is also capable to program internal memories using a very comfortable **AVR ISP** programmer, to speed up the internal memories programming and so making the production faster. Multilingual free software made by **LancOS**, and italian brand, can also be used.

It requires only a RS 232 port (for example, on the PC) and a standard serial connection cable to program internal memories of Mini Module installed on **GMM TST 2**.

GMM AM328 is delivered with a Boot Loader preinstalled. This program allows to reprogram Flash and EEPROM through a simple RS 232 serial port (for example, PC COM port).

In any case, there is a short time to market: the user can see a prototype or even a ready product in one week.

Overall features are:

- Standard container with **28 pins** male socket, DIL, **100** mils pitch, **600** mils width
- Very small dimension: **20.7 x 38.7 x 12.8 mm**; single power supply required from **+3.0 Vdc** to **+5.0 Vdc** (the current consumption may vary according to module connections)
- Availability of **Idle Mode** and **Power Down Mode**
- **Atmel ATmega328** microcontroller (AVR RISC) with **7.3728 Mhz** crystal
- **32KBytes FLASH** for code, up to **1K Bytes FLASH** for optional **Boot Loader**, **1K bytes EEPROM**, **2K Bytes SRAM** for data
- **8 A/D** converter channels with **10 bits** resolution
- **18 interrupt** sources; **3 Timers Counters** up to **16** bits, compare, capture, **PWM**, etc.
- Programmable **Watch Dog** from 16 ms up to 2 s
- **23** digital **I/O** lines available on connector

- Hardware serial line with Baud Rate up to **115200 Baud**, **RS 232** buffered or at **TTL** level
- **I²C** BUS serial interface
- **SPI** interface
- **Reset** circuitry
- 4 ways configuration dip switch
- Software **I/O** managed status **LED**
- Internal **FLASH** and **EEPROM** can be managed through **In System Programming**, or when the module is already mounted, by using **ISP** programming
- **Freeware** software for **PC**, that supports the **ISP** programming to download the generated code, inside on board **FLASH**
- Wide range of development tools as: **C** compiler (ImageCraft ICC AVR, DDS Micro C), **BASIC** compiler (BASCOM AVR), etc.
- Long list of demo programs and use examples supplied under source form, duly remarked, for the available development tools.

Here follows a description of the board's functional blocks, with an indication of the operations performed by each one.

To easily locate such section on verify their connections please refer to figure 2.

DIGITAL I/O LINES

The Mini Module **GMM AM328** is provided with 23 TTL digital I/O lines, of the microprocessor Atmel ATmega328, that are all the signals of Ports PB, PD and from PC0 to PC6.

These lines are connected directly to 28 pins connectors with standard **grifo**[®] Mini Module pin out, allowing to be connected directly to several interface cards.

By software it is possible to define and acquire the function and the status of these lines, and also to match them to peripheral devices (like Timer Counter, Interrupt, I²C BUS, SPI, etc.), simply programming some CPU internal registers.

For further information please refer to paragraph CONNECTIONS and PERIPHERAL DEVICES SOFTWARE DESCRIPTION.

A/D CONVERTER

Mini Module **GMM AM328** is provided with an eight channels A/D converter, multiplexed on some signals of port PC, plus signals ADC6 and ADC7 not multiplexed.

Reference voltage can be fetched externally through a pin or internal reference generator can be used.

Range of signals is from 0 to +Vdc POW, analog signals generators must have a low impedance.

Conversion end can be used to trigger an interrupt, if enabled.

Peripheral management is performed by manipulating specific microcontroller internal registers.

For further information please refer to Appendix A or to the comments in our examples.

DIP SWITCH

GMM AM328 Mini Module is provided with an on board dip switch whose purpose is to switch between RS 232 or TTL serial signals.

In fact they decide whether RS 232 signals generated by MAX 3222E or CPU TTL USART signals reach the pins of the socket.

WATCH DOG

Microcontroller ATmega328 is provided with an internal hardware watch dog capable to reset the CPU if the user program cannot retrigger it in less than the selected intervent time.

Intervent time range is rather wide, it is from about 16 ms to 2 s.

SPI INTERFACE

Microcontroller ATMEL ATmega328 can be programmed In-Circuit through its SPI interface, but the same interface is also available to the user.

In fact, other devices provided with the same communication interface can be interconnected to the application.

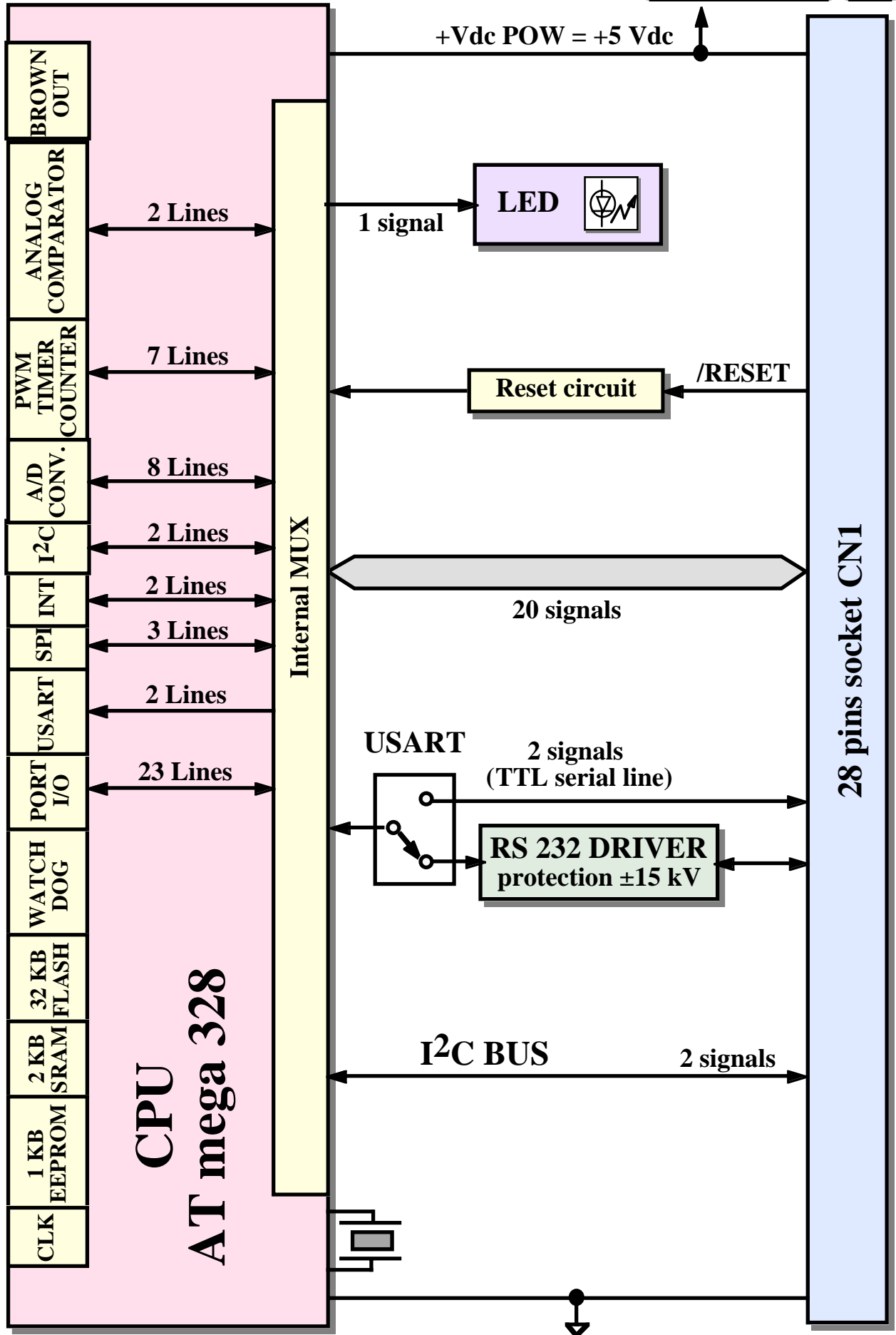


FIGURE 2: BLOCK DIAGRAM

I²C BUS INTERFACE

Standard pin out of 28 pins **grifo**[®] Mini Module connector reserves two pins, 6 and 7, to I²C BUS interface. These signals are provided with a 4.7 k Ω pull-up on the Mini Module board.

GMM AM328 features a hardware I²C BUS interface and is managed through microcontroller internal registers. It can work both as master or slave, in transmission or reception.

This interface allows to connect components featuring the same communication standard to expand locally the potentialities of Mini Module.

For this Mini Module, a rich serie of demo programs that explain how to use A/D and D/A converters, memories, temperature sensors, etc. by a complete and well commented code is available.

Remarkable is the possibility to connect the **grifo**[®] QTP operator panels serie through I²C BUS. QTP are capable to manage alphanumeric and graphic display and several models of keyboards, according to the model selected.

Mini Modules support cards manufactured by **grifo**[®] (like **GMB HR84**) are provided also with a connector dedicated to I²C BUS, to easy the field connections.

SERIAL COMMUNICATION

On **GMM AM328** there is always availability of one hardware serial line that is completely software configurable for physical protocol (baud rate, stop bits number, lenght of character, etc) by simply programming some microprocessor registers as described in the manufacturer documentation or in the appendix of this manual.

The serial lines are connected to CN1 connector at TTL or RS 232 level, thanks to some on board dip switches configuration, so when the card must be connected in a network or at long distance or with other systems that use different electric protocol, the user must provide external drivers (RS 232, RS 422, RS 485, Current loop, etc.).

Please remember that on CN1 connector more than standard receive and transmit signals are available also other I/O signals that can be driven by software; these signals can be used to define the RS 485 line direction, to enable the RS 422 transmit drive or to generate an RS 232 handshake. For example it can be used the **MSI 01** module that converts a TTL serial line in any other electric standards in a pratical and inexpensive way.

Please read SERIAL COMMUNICATION SELECTION paragraph of this manual or contact directly **grifo**[®] technician for further explanation or any other necessary information.

TIMER COUNTER AND PWM

Microcontroller is provided with three Timer/Counter (two featuring eight bits, one featuring sixteen bits) capable to count clock pulses (through a programmable prescaler), level transictions on specific pins and to generate interrupts.

They can also be used in PWM mode, to generatesignals of variable duty cycle and frequency set by software with eight or sixteen bits of resolution.

Typical applications of these signals are motor velocity control, in fact several motor control cards are provided with compatible inputs.

Another application is analog signals generation by simply adding an integrator.

MEMORY DEVICES

The card is provided of 9.5K of memory divided with a maximum of **32K**Bytes FLASH EPROM, **2K**Bytes of internal SRAM and **1K** Bytes EEPROM.

The memory configuration must be chosen considering the application to realize or the specific requirements of the user.

Thanks to on board EEPROM there is the possibility to keep data also when power supply is failed. In this way the card is always able to maintain parameters, logged data, system status and configuration, etc. in each working conditions.

Whenever the amount of memory for data is not sufficient (i.e. for data loghin systems), it is always possible to connect external memory devices (with SRAM, EEPROM, FLASH technologies) through the comfortable and efficient SPI and I²C BUS interface of the card.

The addressing of memory devices is controlled by microcontroller as described in the component data sheet or in APPENDIX A of this manual.

CLOCK

On **GMM AM328** module there is a circuitry that generates a 7.3728 MHz frequency for the microcontroller.

About speed and performances please remind that **GMM AM328** has a RISC microcontroller on board, capable to execute in average one instruction per clock cycle.

So, considering the frequency of quartz installed, execution speed may be almost 7 MIPS.

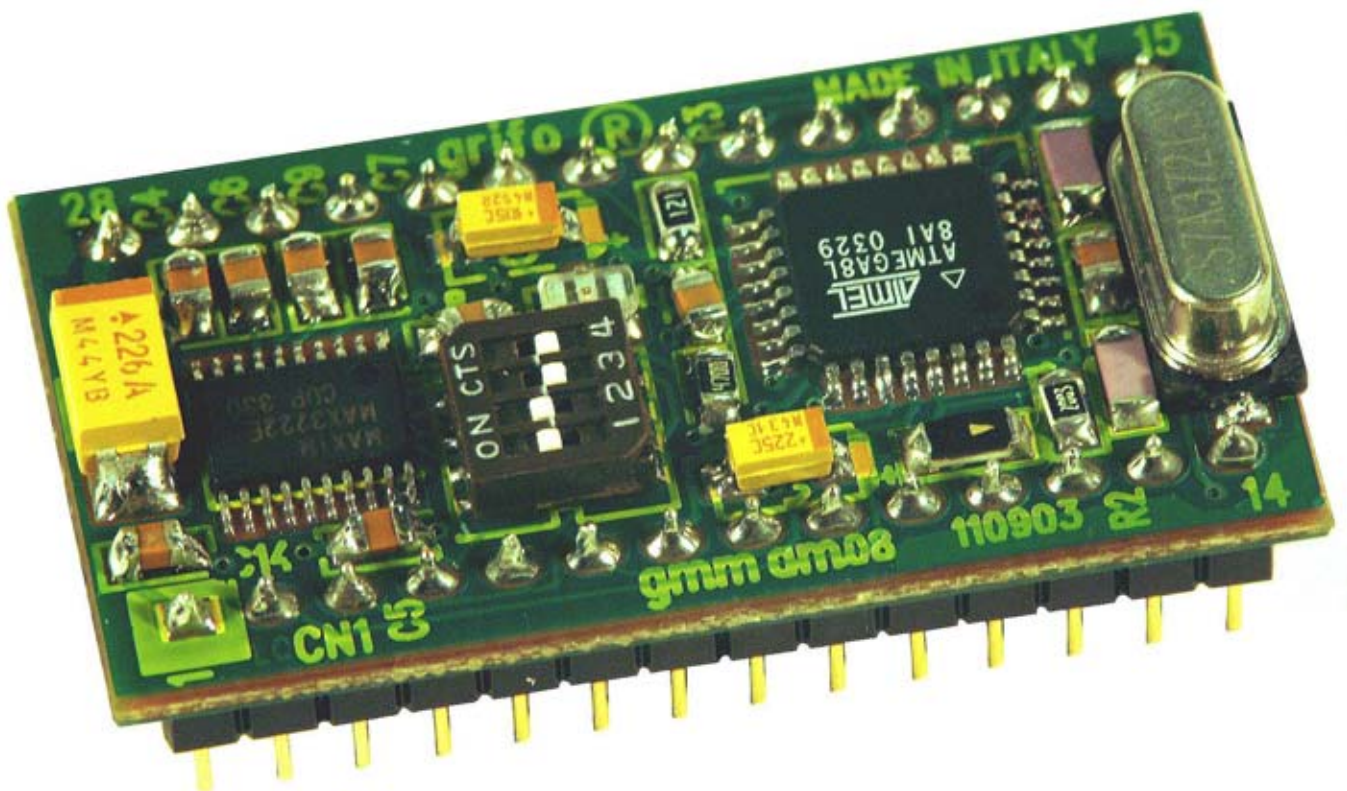


FIGURE 3: PHOTO OF GMM AM328

TECHNICAL FEATURES

GENERAL FEATURES

| | |
|------------------------------------|---|
| Devices: | 23 digital TTL I/O signals 8 A/D converter analog inputs 1 Watch Dog section 3 Programmable Timer/Counters 18 interrupt sources 1 reset circuitry 1 RS 232 serial line through MAX 3222 1 four ways dip switch 1 status LED (red) |
| Memories: | 32 Kbyte FLASH user program up to 1K byte FLASH boot loader 1K Bytes EEPROM user data 2K Bytes SRAM user data |
| CPU: | Atmel ATmega328 |
| Clock frequency: | 7.3728 MHz |
| Counters maximum frequency: | I/O clock frequency |
| Power on time: | 79 ms |
| A/D resolution: | 8 lines at 10 bit |
| A/D conversion time: | 20 μ s |

PHYSICAL FEATURES

| | |
|---------------------------|---|
| Size: | 20.7 x 38.7 x 12.8 mm |
| Weight: | 6.8 g |
| Connectors: | 28 pins male socket DIL |
| Temperature range: | 0÷50 °C |
| Relative humidity: | 20%÷90% (without condense) |

ELECTRIC FEATURES

Power supply voltage: called +Vdc POW, from +3.0 Vdc to +5.0 Vdc

Current consumption at +5.0 V:

| | |
|-------|-----------------------|
| 3 ma | (power down mode) |
| 15 ma | (normal working mode) |
| 18 ma | (highest) |

Current consumption at +3.0 V:

| | |
|-------|-----------------------|
| 2 ma | (power down mode) |
| 9 ma | (normal working mode) |
| 10 ma | (highest) |

Impedance analog signals generators: <10 k Ω

RS 232 protection: ± 15 kVdc

I²C BUS pull-up resistor: 4.7 k Ω

Brown out threshold: 2.7 or 4.0 Vdc with hysteresis

INSTALLATION

In this chapter there are the information for a right installation and correct use of the **GMM AM328** card. In detail there are the locations and functions of each connector, of the user settable dip switches, LEDs, and so on.

VISUAL SIGNALATIONS

GMM AM328 features the LED described in the following table:

| LED | PURPOSE |
|-----|--|
| DL1 | Driven by signal PB.5 , SCK of Mini Module, it can be used as activity LED and can be managed by software. |

FIGURE 4: LED TABLE

The main function of LED is to inform the user about card status, with a simple visual indication and in addition to this, LED makes easier the debug and test operations of the complete system. To recognize the LED location on the card, please refer to figure 8. while for further information please refer to paragraph ACTIVITY LEDS.

CONNECTIONS

The **GMM AM328** module has 1 connector that can be linkeded to other devices or directly to the field, according to system requirements.

In this paragraph there are connector pin out, a short signals description (including the signals direction) and connectors location (see figure 8) that simplify and speed the installation phase. Some additional figures shows the pins functionalities and some of the most frequently used connections.

CN1 - EXTERNAL POWER SUPPLY CONNECTOR

CN1 is a 28 pins, male, dual in line, socket connector with 100 mils pitch and 600 mils width. On CN1 are available all the interfacement signals of the Mini Module as the power supply, the I/O lines, the synchronous and asynchronous communication lines, the on board peripheral devices signals, the operating mode selection lines, etc.

Some pins of this connector have multiple purposes, in fact they can be multiplexed by programming some software registers with several CPU internal devices and the following figure lists all these possible functionalities. So the signals available on CN1 have different types as described in the following CONNECTOR SIGNALS INTERFACEMENT paragraph and they follow grifo® Mini Module standard pin out.

To avoid problems in pin counting and numbers the figure 5 shows the signals directly on the top view of the **GMM AM328**; moreover the serigraph reports the pins number on the four corner of the card both on bottom (solder) and top (component) side.

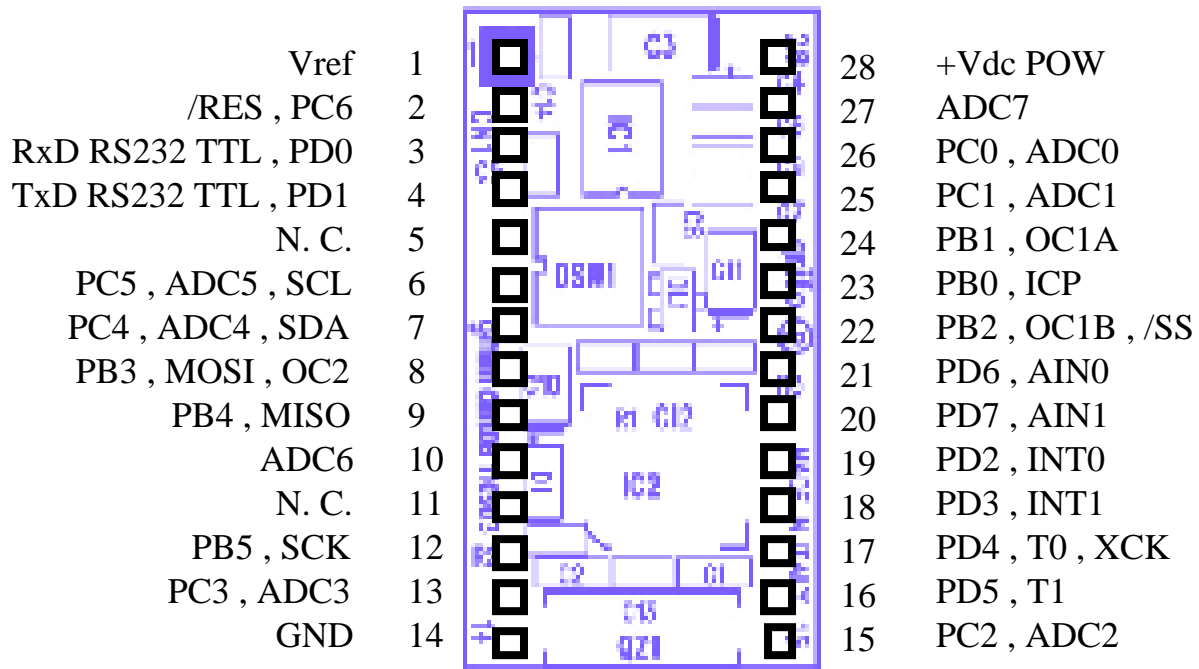


FIGURE 5: CN1 - SOCKET WITH MINI MODULE SIGNALS

Signals description:

| | |
|------------------------|--|
| +Vdc POW | = I - Power supply |
| GND | = - Ground |
| RxD RS232 TTL | = I - Receive Data of RS 232 or TTL line |
| TxD RS232 TTL | = O - Transmit Data of RS 232 or TTL line |
| INT_n | = I - CPU external interrupts (INT0 and INT1) |
| T_n | = I - External inputs for timer 0, 1 and 2 counters |
| /RES | = I - Reset signal of CPU |
| PB0÷7 | = I/O - CPU Port B I/O TTL signals |
| PC0÷6 | = I/O - CPU Port C I/O TTL signals |
| PD0÷7 | = I/O - CPU Port D I/O TTL signals |
| ADC0÷7 | = I - A/D converter analog inputs |
| AIN0÷1 | = I - Analog multiplexer inputs |
| OC_{xy} | = O - Match of Timer 1 (A and B) and Timer 2 compare units |
| ICP | = I - Input capture pin of Timer 1 |
| SDA | = I/O - Data signal of two wires serial synchronous interface (I ² C BUS) |
| SCL | = I - Clock signal of two wires serial synchronous interface (I ² C BUS) |
| SCK | = I - Clock signal of SPI serial synchronous interface |
| MOSI | = I - Data input signal of SPI serial synchronous interface |
| MISO | = I - Data output signal of SPI serial synchronous interface |
| /SS | = I - Slave Select signal of SPI serial synchronous interface |
| Vref | = I - A/D converter reference voltage |
| N. C. | = - No connection |

MINI MODULE CONFIGURATION

On **GMM AM328** module there is a 4 ways dip switch that defines some configurations of the card. In the following figure is reported their list, their position and their functions in all the available connection modes.

The * (asterisk) 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.

To recognize the configuration elements location, please refer to figure 8.

For further information about serial communication lines, please refer to paragraph **SERIAL COMMUNICATION SELECTION**.

| SWITCH | POSITION | PURPOSE | DEF. |
|--------|----------|--|------|
| 1 | ON | Connects signal RxD RS232 TTL , PD0 of socket CN1 to on board RS 232 driver. Used in conjunction with switch 3. | * |
| | OFF | Does not connect signal RxD RS232 TTL , PD0 of socket CN1 to on board RS 232 driver, allowing a direct connection to microcontroller. Used in conjunction with switch 3. | |
| 2 | ON | Connects signal TxD RS232 TTL , PD1 of socket CN1 to on board RS 232 driver. Used in conjunction with switch 4. | * |
| | OFF | Does not connect signal TxD RS232 TTL , PD1 of socket CN1 to on board RS 232 driver, allowing a direct connection to microcontroller. Used in conjunction with switch 4. | |
| 3 | ON | Connects signal RxD RS232 TTL , PD0 of socket CN1 directly to the microcontroller, excluding the on board RS 232 driver. Used in conjunction with switch 1. | * |
| | OFF | Does not connect signal RxD RS232 TTL , PD0 of socket CN1 directly to microcontroller, allowing to use the on board RS 232 driver. Used in conjunction with switch 1. | |
| 4 | ON | Connects signal TxD RS232 TTL , PD1 of socket CN1 directly to the microcontroller, excluding the on board RS 232 driver. Used in conjunction with switch 2. | * |
| | OFF | Does not connect signal TxD RS232 TTL , PD1 of socket CN1 directly to microcontroller, allowing to use the on board RS 232 driver. Used in conjunction with switch 2. | |

FIGURE 6: DSW1 4 WAYS DIP SWITCH TABLE

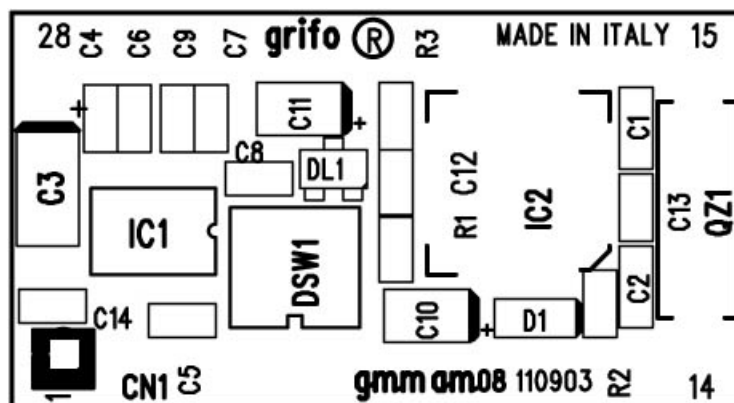


FIGURE 7: COMPONENTS MAP (COMPONENTS SIDE)

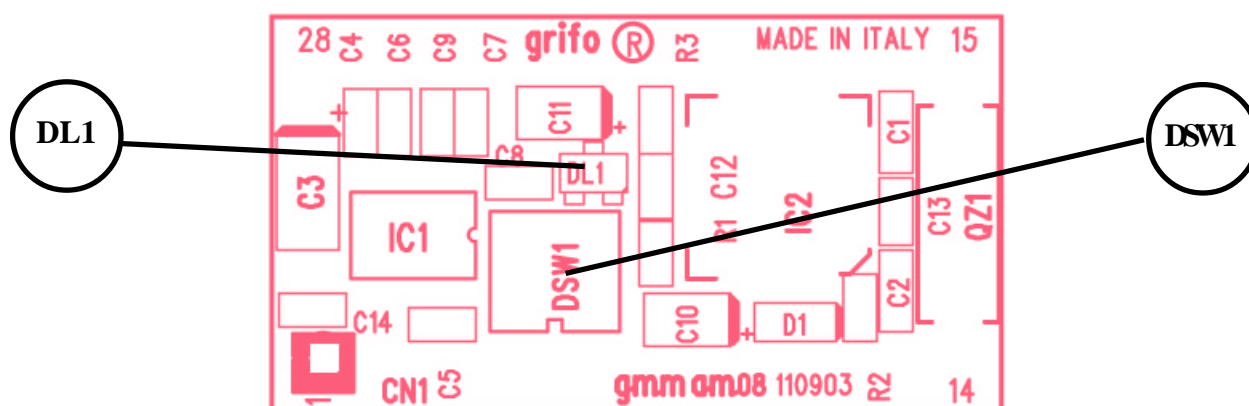


FIGURE 8: LED, DIP SWITCH, ETC. LOCATION

SERIAL COMMUNICATION SELECTION

Serial communication line of **GMM AM328** can be buffered as RS 232 or TTL.

By software, it is possible to define physical communication protocol for the line setting some microcontroller internal registers.

The serial interface has its own group of registers for configuration, and can work in total independence respect to the other peripherals.

Electric protocol is selected by hardware and requires the dip switches to be configured correctly, as described in previous tables; the user can set any configuration in autonomy following the below reported information:

- SERIAL LINE CONFIGURED AS RS 232 (default configuration)

| | | |
|--------|---|-----|
| DSW1.1 | = | ON |
| DSW1.2 | = | ON |
| DSW1.3 | = | OFF |
| DSW1.4 | = | OFF |

- SERIAL LINE CONFIGURED AS TTL

| | | |
|--------|---|-----|
| DSW1.1 | = | OFF |
| DSW1.2 | = | OFF |
| DSW1.3 | = | ON |
| DSW1.4 | = | ON |

Figures 9 and 10 show how to connect a generic external system to both serial lines of **GMM AM328**.

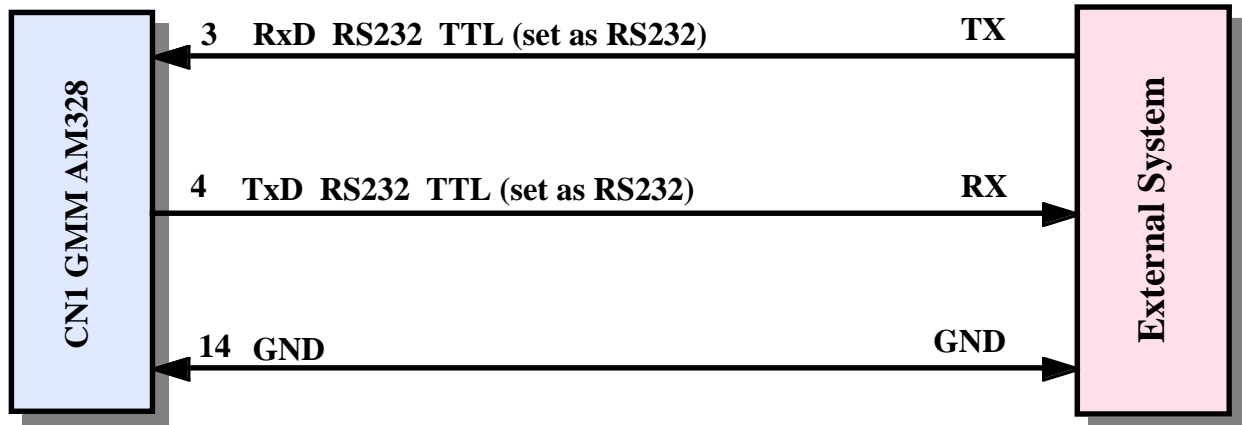


FIGURE 9: EXAMPLE OF RS 232 SERIAL CONNECTION

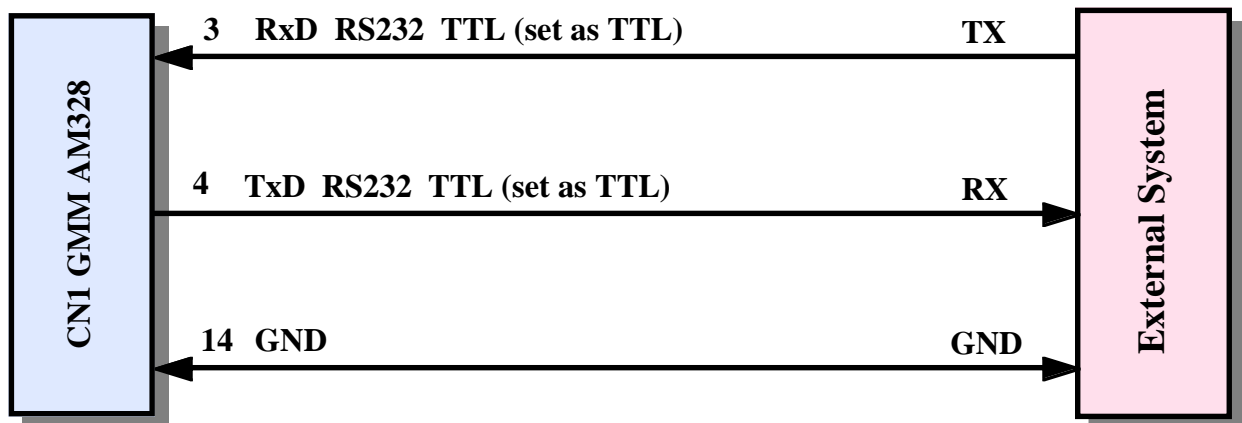


FIGURE 10: EXAMPLE OF TTL SERIAL CONNECTION

CONNECTOR SIGNALS INTERFACEMENT

To prevent possible connecting problems between **GMM AM328** and the external systems, the user has to read carefully the previous paragraph information and he must follow these instructions:

- For RS 232 signals the user must follow the standard specifications of these protocols, defined by specific normatives.
- All TTL signals must follow the rules of this electric standard. The connected digital signals must be always referred to card ground (GND) and then the 0V level corresponds to logic state 0, while the +Vdc POW level corresponds to logic state 1. The connection of these lines to devices of the controlled system (encoders, switches, proximity, electric valves, power relays, etc.) must be performed through proper power interfaces; it is preferable to adopt opto coupled interfaces that ensure an electric insulation between Mini Module electronic and external noisy, typically generated by power electronic.
- The inputs for analog comparator must be connected to signals generators featuring a low impedance in the range from 0 to +Vdc POW, to assure greater stability and precision.
- The inputs for A/D converter must be connected to signals generators featuring a low impedance in the range from 0 to +Vdc POW, to assure greater stability and precision.
- PWM signals generated by Timer Counter and OCM sections are TTL type so they must be buffered to interface the power circuitry. Typical interfaces can be current driver (if PWM signal is still required) or an integrator circuit if analog voltage is required.
- Also I²C BUS and SPI signals are at TTL level, as defined by the same standards; for completeness it is remarked that in a network with several devices and rather long it is better to study the connection lay out and to set properly the output stage, the best operational modes and the programmable bit rate: all these conditions allow communications in any condition. On Mini Module, signals SDA and SCL are pulled-up to +Vdc POW through 4.7 kΩ resistors.

POWER SUPPLY

Mini Module can be supplied by a continuous tension in the range from +3.0 V to +5.0 Vdc called +Vdc POW in this manual.

GMM AM328 design adopted all the circuital and componentistic options that reduce sensibility to noise and reduce consumption, including the possibility to switch the microcontroller to low consumption modes.

In optimal situation, the minimum consumption (in power down mode) is 2 mA, so it can, for example, increase battery life in case of portable applications.

For further information please refer to paragraph ELECTRIC FEATURES.

INTERRUPTS

A remarkable feature of **GMM AM328** card is the powerful interrupt management. Here follows a short description of which devices can generate interrupts and their modalities; for further information about interrupts management please refer to the microprocessor data sheet or APPENDIX A of this manual.

- Pin 19 of CN1 -> Generates an interrupt INT0 of microprocessor.
- Pin 18 of CN1 -> Generates an interrupt INT1 of microprocessor.
- CPU peripherals -> Generate an internal interrupt. In detail the possible microcontroller interrupt sources are: Timer Counter, OCM, USART, analog comparator, A/D converter, I²C BUS, SPI, EEPROM, etc.

An interrupt management section, integrated in microcontroller, allows to enable, disable and mask so the user has the possibility to respond promptly and efficiently to any external event. The microcontroller has an interrupt section that let the user manage the 18 interrupt sources. So the application program has always the possibility to react promptly to every event.

SUPPORT CARDS

GMM AM328 Mini Module can be used as a macro components for some support cards either developed by the user or directly chosen from the **grifo**[®] boards. In the following paragraphs are reported the suggested configuration of the most interesting support cards.

USE WITH GMB HR84 MODULE

Amongst **grifo**[®] cards, **GMB HR84** module is the one designed specifically to provide to 28 pins Mini Modules many interesting features as: 8 optocoupled inputs, 4 relay outputs, mechanical mounting on omega rails and a comfortable wiring through screw terminal connectors. The complete description of the product is available in the relative data sheet and technical manual while in this paragraph are listed the advantages obtained by using this pair of cards:

GMB HR84 allows easily to:

- to supply the Mini Module through on board power supply;
- to have eight TTL I/O signals of microprocessor ports optocoupled NPN and PNP at the same time and visualized through green LEDs; I/O signals are multiplexed with timer inputs, so developed functions like counters are immediatly available;
- to have four TTL I/O signals of microprocessor ports on buffered relays driving and visualized through red LEDs;
- to connect on **PC BUS** and +5 Vdc power supply on a dedicated connector;
- to connect immediatly communication serial line through a comfortable 9 ways DB9 connector;
- to buffer easily TTL USART signals from microprocessor in RS 422, RS 485 or current loop;
- to connect PWM signal through a comfortable standard AMP connector;

The serial connection cable with development PC is the CCR 9+9 R (or in other words a reversed extension cable provided of D9 Female and D9 Male connectors).



FIGURE 11: IMAGE OF GMB HR 84 AND GMM AM328 WITH AND WITHOUT CONTAINER

USE WITH GMM TST2 MODULE

Amongst **grifo®** cards, **GMM TST2** is the one designed specifically to provide a first entry point to 28 and 40 pins Mini Modules, with suitable evaluation purposes.

The complete description of the product is available in the relative data sheet and technical manual, is electric diagram is in appendix B of this manual.

In this paragraph are listed the advantages obtained by using this pair of cards.

The **GMM TST2** allows easily to:

- supply the Mini Module through on board AC, DC power supply;
- connect all the I/O signals of microcontroller ports on comfortable connectors compatible with **I/O ABACO®** standard pin out;
- connect immediately USART serial line through a comfortable 9 pins D type connector;
- set and show the status of 2 microcontroller I/O lines through push button and LEDs with different colours;
- generate audible feed back thanks to active buzzer mounted on board;
- develop in a short time user interface applications by using the on board matrix keyboard with 4x4=16 keys and the backlite LCD display with 2 rows of 20 characters;
- develop easily a support card that satisfy customer requirements starting from the supplied electric diagrams;
- program FLASH and EEPROM using the Boot Loader and in ISP modality.

The following configuration is suggested to use the couple **GMM TST 2 + GMM AM328** in their base version, that is RUN mode with serial line buffered in RS 232:

GMM AM328 configuration

DSW1.1 = ON
DSW1.2 = ON
DSW1.3 = OFF
DSW1.4 = OFF

GMM TST 2 configuration

J1 = 2-3
J2 = 2-3
J3 = not connected
J4 = not connected
J5 = not connected
J6 = not connected
J7 = not connected

The serial connection cable with development PC is the CCR 9+9 E (or in other words an extension cable provided of D9 Female and D9 Male connectors).



FIGURE 12: PHOTO OF GMM TST 2 + GMM AM328 CONNECTED TO AVR ISP

HOW TO START

One of the most interesting features is the possibility to program the content of microcontroller on board FLASH and EEPROM using specific tools manufactured by **grifo®** and Atmel.

Across this chapter we presume that you have a **GMM TST 2** or a **GMB HR84** where to install **GMM AM328**.

For further information please refer the specific manual of **GMB HR84 + GMM AM328**.

A) SERIAL CONNECTION BETWEEN GMM AM328 AND PC

A1) To make the serial connection between **GMM AM328** and a PC, the structure described on figure 13 should be built.

The program delivered to the customer in the Mini Module performs the blink of the on board LED, without using the serial interface. Demo program uses widely such interface, it also provides a section dedicated to it. So it is a good idea to make the serial connection as first thing.

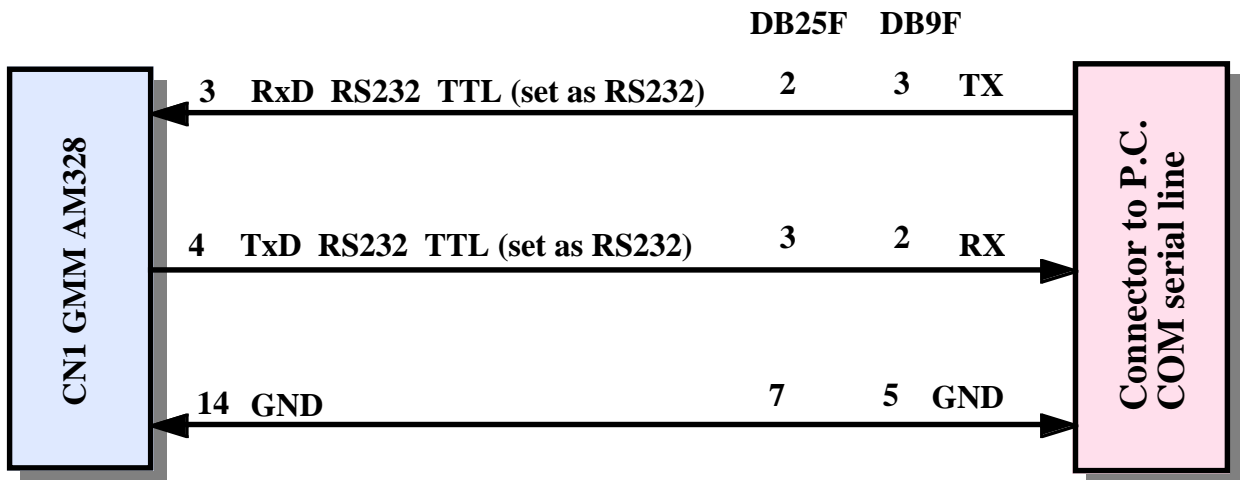


FIGURE 13: RS 232 SERIAL CONNECTION BETWEEN GMM AM328 AND PC

A2) Keep ready for running a terminal emulator on PC, configure it to use the serial port where Mini Module is connected with 19200 baud, 8 data bits, 1 stop bit, no parity. If you are using BASCOM AVR, you may simply open the terminal emulator in its IDE.

- A3) Supply **GMM TST 2** or **GMB HR84**. LED of Mini Module should start blinking about twice per second.



| PROGRAMS FOR MINI MODULES AND MINI BLOCKS | | | | | | | | | | | | | |
|---|-----|-----|--------|-----------------|-------------|-------------------|------------------|-----------|------------|---------------|---|--------|--|
| BOARD TYPE | GET | ASM | Ladder | Abaco® Link BUS | BASIC CBZ80 | BASIC BASCOM 8051 | BASIC BASCOM AVR | PIC BASIC | BASIC VARI | MCS® Basic 52 | C | PASCAL | CPU / BLOCK TYPE |
| MISCELL. | - | - | - | - | - | ● | - | - | - | - | - | - | - |
| CAN GM0 | ● | - | - | - | - | ● | - | - | - | - | ● | - | Atmel T89C51cc03 - 8051 Code |
| CAN GM1 | ● | - | - | - | - | ● | - | - | - | - | ● | - | Atmel T89C51cc01 - 8051 Code |
| CAN GM2 | ● | - | - | - | - | ● | - | - | - | - | ● | - | Atmel T89C51cc02 - 8051 Code |
| GMM 5115 | ● | - | - | - | - | ● | - | - | - | - | ● | - | Atmel T89C5115 - 8051 Code |
| GMM 876 | ● | - | - | - | - | - | - | ● | - | - | - | - | Microchip PIC16F876A - PIC 14 Code |
| GMM 932 | ● | - | - | - | - | ● | - | - | - | - | - | - | PHILIPS P89LPC932 - 8051 Code |
| GMM AC2 | ● | - | - | - | - | ● | - | - | - | - | ● | - | Atmel T89C51AC2 - 8051 Code |
| GMM AM08 | ● | - | - | - | - | - | ● | - | - | - | - | - | Atmel ATmega08 - AVR Code |
| GMM AM32 | ● | - | - | - | - | - | ● | - | - | - | - | - | Atmel ATmega32 - AVR Code |
| GMB HR84 | ● | - | - | - | - | ● | ● | ● | - | - | ● | - | Mini Block 8 input opto 4 output relè |
| GMB HR168 | ● | - | - | - | - | ● | - | - | - | - | ● | - | Mini Block 16 input opto 8 output relè |




FIGURE 14: EXAMPLES TABLE

B) FLASH REPROGRAMMING

Mini Module programming is performed using the Boot Loader preprogrammed in the Flash of Mini Module itself.

Such program allows to create a communication between Mini Module and the PC, and to use it to send a .hex file to code memory and/or EEPROM memory area of microcontroller.

Boot Loader does not allow to program configuration bits and security fuses of microcontroller, this can be done using ISP programming (please refer to appendix B of this manual).

The portion of Flash memory taken by the Boot Loader is 2 KBytes, this means that the last block of 1 KWord at the end of the memory is reserved to Boot Loader and is not available for user application any more.

Boot Loader communicates through PC serial port installing a specific utility (that can be downloaded for free from our website www.grifo.com or can be found in our CD) called AVRBootloaderGrifo.exe. This utility allows to select the serial port to use and to select the files to program memories of Mini Module.

For some applications, use of an ISP programmer may be the only chance. Please refer to appendix B for more information about ISP programming.

Combo box called "Com Port" allows to select the serial port to use for communication with Mini Module.

Checking the checkbox "Application Code" the file whose name is written in the text box on the right will be stored in Flash of Mini Module. To choose the file press the "Browse" button.

Checkbox "EEPROM Code" performs the same operation described above, but writes to EEPROM.

There is also the possibility to use AVRBootloaderGrifo from DOS window, commands prompt, a command line or as an external tool of an IDE.

Option for command line are:

| | |
|-----------------------------|---|
| /com1 , /com2 , ... , /com9 | Number of serial port used for communication. Serial ports from COM1 to COM9 are supported |
| /f <FLASHProgram> | Indicates the complete pathname of the .HEX file to write in microcontroller FLASH memory |
| /e <EEPROMProgram> | Indicates the complete pathname of the .HEX file to write in microcontroller EEPROM memory |

For example:

AVRBootloaderGrifo.exe /com2 /f C:\Projects\MotorControl\Main.hex

opens a connection on serial port COM2 to the Boot Loader and sends the file Main.hex located in folder C:\Projects\MotorControl\.

To integrate AVRBootloaderGrifo.exe in a IDE, for example the one of BASCOM AVR (described at point C) the user must:

- 1) Open the window of menu Options | Programmer
 - 2) In the text box Programmer choose "External Programmer"
 - 3) Click the tab Other
 - 4) In text box Program insert the complete pathname of AVRBootloaderGrifo.exe pressing Browse
 - 5) In text box Parameters insert command line parameter for AVRBootloaderGrifo
- Please remaind that the string {file} in the above mentioned text box is automatically replaces by BASCOM AVR with the name of .hex file just generated.
- Please refer to BASCOM AVR documentation for further information.

- B1) Find on CD **grifo®** and save to a comfortable position on your hard drive the demo program "d_am328u1.hex". It can be found starting from main page following the path: English | Examples tables | Mini Modules and Mini Block examples | GMM AM328 (please refer to figure 14). You may want to remove the read-only attribute.
- B2) Connect the Mini Module to PC serial port making the connection described at point A. Close the terminal emulator.
- B3) Indicate in combo box "Com Port" the serial port connected at the previous point.
- B4) Check the check box "Application Code" and press the button "Browse" on the right, then select the file previously saved at point B1.
- B5) Uncheck the check box "EEPROM Code", if checked.
- B6) Press the button "Synch to Bootloader..." or the key combination Alt+S on the PC, then reset the Mini Module or turn off and then on its supply. The file is downloaded into the Mini Module. If this does not happen, and the program should indicate a "No response from target bootloader", try to repeat the operation decreasing the time between pressure of button on the PC and reset of Mini Module. If the problem persists, check cable and connection.
- B7) When operation is completed the program reports its status. In case of problems, check cable and connection.
- B8) Start the terminal emulator configured like in point A2 and verify that the application program just downloaded is executed in internal Flash.

**FIGURE 15: BOOT LOADER UTILITY**

C) GENERATING DEMO EXECUTABLE CODE

- C1) Install on the hard disk of the development P.C. the software environment selected to develop the application program. As described in the chapter SOFTWARE DESCRIPTION there are many different software tools that satisfy any customers requirements but here we remind only the most diffused as the BASCOM AVR, ICC AVR, etc.
- C2) On grifo® CD in addition to file with the executable code of the demo program, described at point B2, there are also the source files of the same. These have an extension that identifies the used software development tools (for example d_am08u1.bas for BASCOM AVR or d_am328u1.c for ICC AVR) and they are properly organized inside demo programs tables available on CD, together with possible definition file (for example: d_am328u1.prj for ICC AVR). Once these files have been located they must be copied in a comfortable folder on the hard disk of development PC.
- C3) Compile the source file by using the selected software tools: the file d_am08u1.hex must be obtained equal to those available on grifo® CD and already used at points B. This operation is very different according to the programming environment selected, so here follow the details:

C3 Bascom AVR) Ricompilation using BASCOM AVR.

C3 Bascom AVR a) In BASCOM IDE, load the program source with menu File | Open:

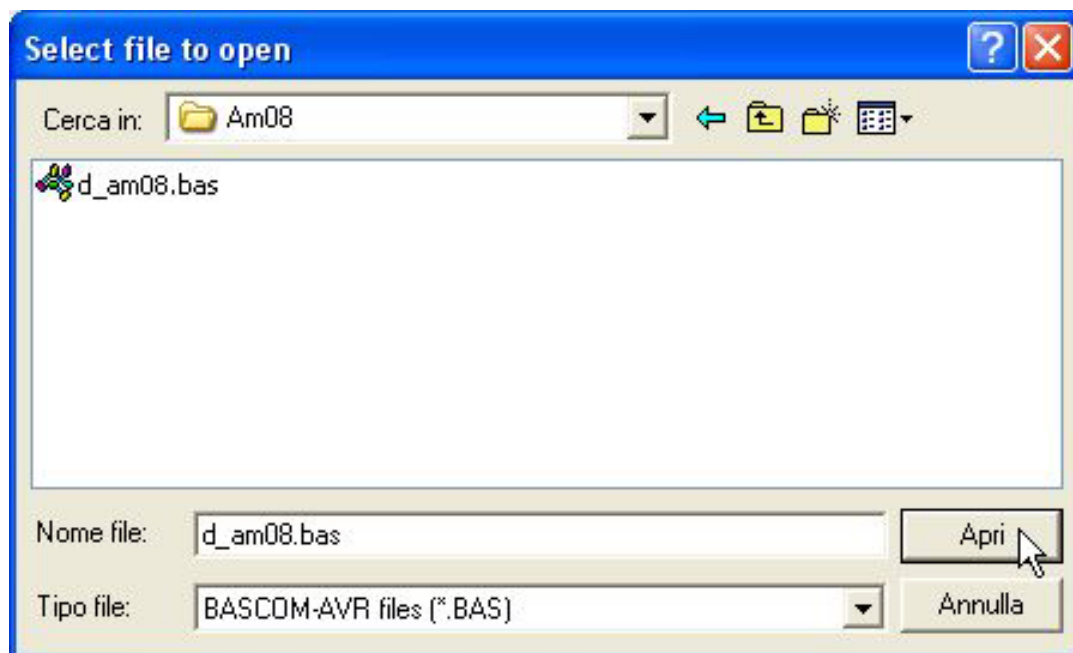


FIGURE 16: LOADING A SOURCE FILE WITH BASCOM AVR

C3 Bascom AVR b) From menu Options | Compiler | Chip set the value 64 for HW Stack, 32 for Soft Stack, 64 for Framesize, as suggested also in the source code, and press OK. Such values must be considered minimal and must be increased if required:

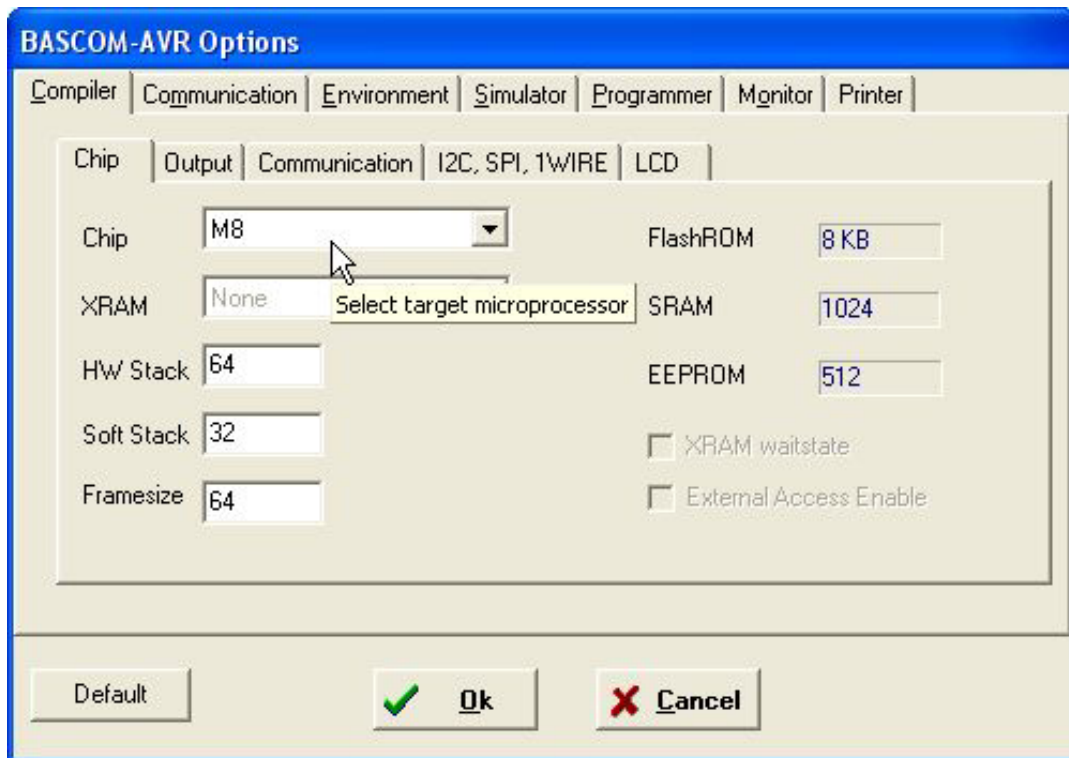


FIGURE 17: CONFIGURATION OF COMPILER BASCOM AVR

C3 Bascom AVR c) Compile the source file by pressing the button with the icon of an integrated circuit.

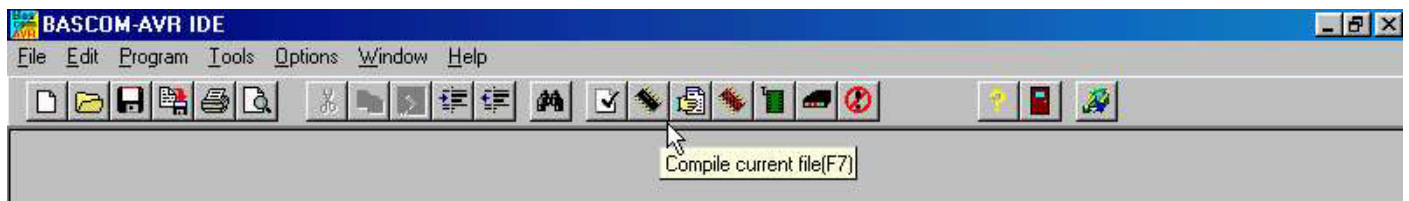


FIGURE 18: COMPILE WITH BASCOM AVR

C3 ICC AVR) Ricompilation with ICC AVR.

C3 ICC AVR a) In standard editor, load the project file d_am328u1.prj using the menu Project | Open....

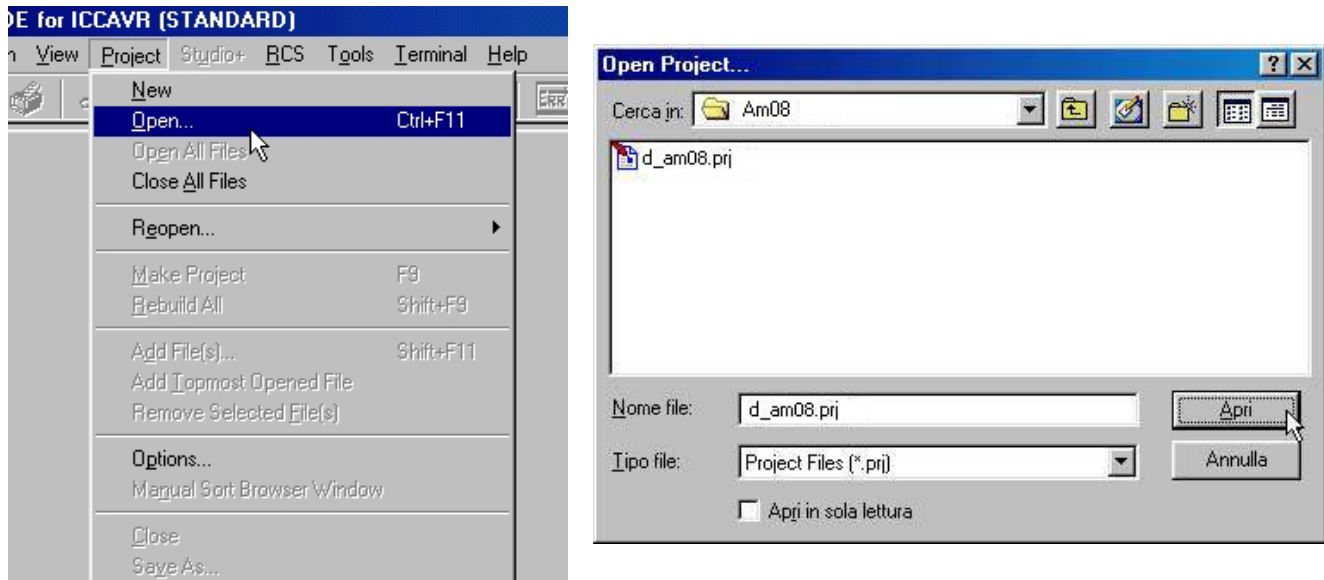


FIGURE 19: LOADING PROJECT FILE WITH ICC AVR

C3 ICC AVR b) Compile the project using the menu Project | Make project:

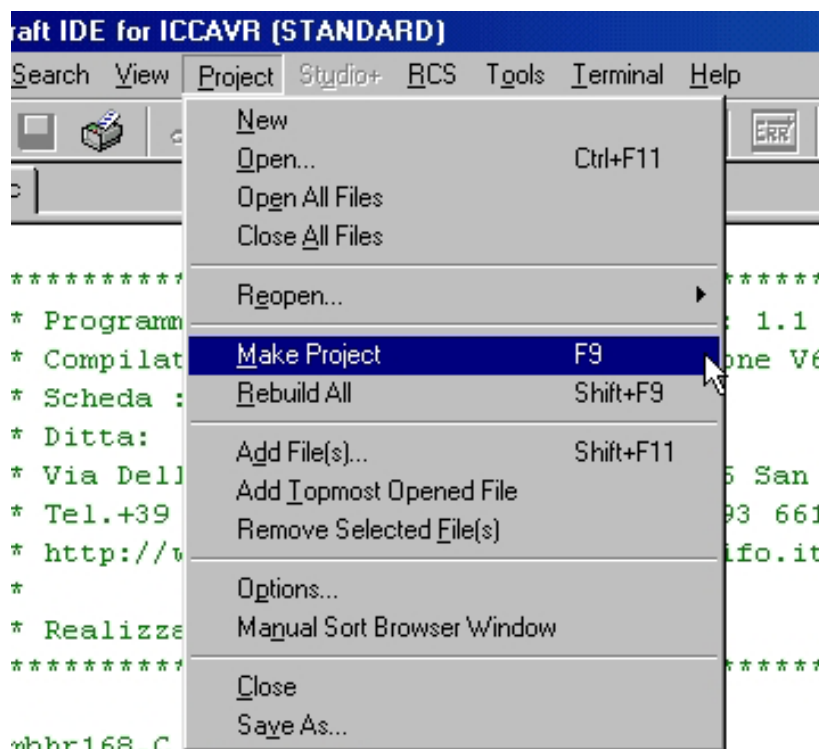


FIGURE 20: COMPILATION WITH ICC AVR

C4) Program the compiled file into FLASH memory of **GMM AM328** repeting the steps of point B.

D) *FINAL APPLICATION*

D1) Close the Boot Loader PC utility.

When during execution of the steps above described a problem or a malfunction is found, we suggest to read and repeat again all the steps carefully and if malfunction persists please contact directly **grifo®** technician.

Instead when execution of all the steps above described is right, the user has realized his first application program that coincides with demo of **GMM AM328**.

At this point it is possible to modify the source of the demo/s program according to application requirements and test the obtained program with the steps above listed (successive to B and C) in cyclic mode, until the developed application program is completely well running.

When this focus is reached the developmnet PC can be eliminated.

Remember to reconfigure USART of Mini Module, if required.



SOFTWARE DESCRIPTION

A wide selection of software development tools can be obtained, allowing use of the module 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 the mounted microprocessor, or for the AVR family, can be used.

Software packages purchased from **grifo®** are always provided with example programs that show how to use each section of the board and a complete use documentation.

Remarkable are:

BASCOM AVR

It is a powerfull new integrated development environment for AVR microcontroller. The toolset incorporates an editor, optimising BASIC compiler, assembler and HEX creator. The BASIC compiler produces very tight AVR machine code by virtue of the fact it translates the BASIC source into actually run timeassembly code wich is optimised to run as fast as possible. The target AVR microcontroller therefore runs true assembly code rather than tokenised code wich is found in many other BASIC compilers. It is also provided with integrated simulator for source level debugging and optional external libraries to drive or simulate several external devices (likebadge readers, PS/2 keyboards, graphic and alphanumeric displays, etc.).

ICC AVR PRO

Cross compiler for C source program. It is a powerfull software tool that includes editor, ANSI C compiler, assembler, linker, library management program and project manager included in an easy to use integrated development environment for Windows and other P.C. operating systems. Library sources, floating point, integration with AVR studio, on line help and ANSI terminal emulator for target communication are provided too.

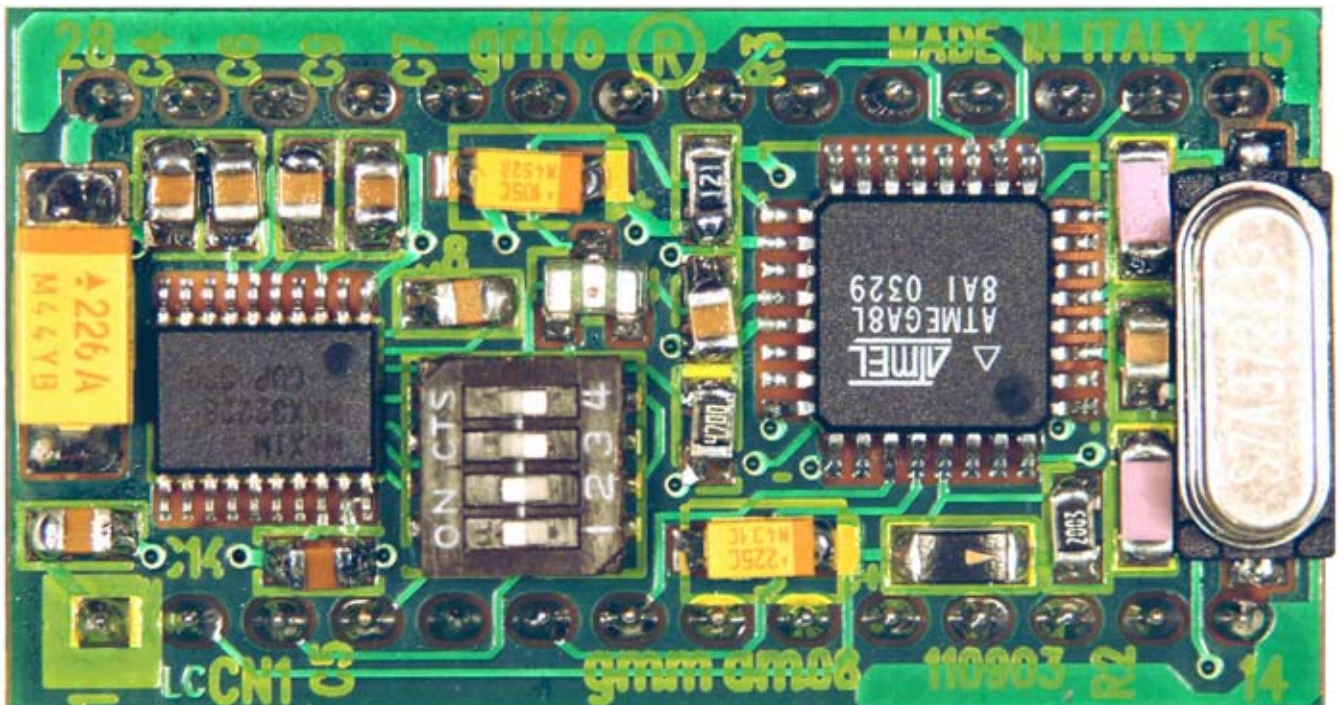
DDS MICRO C AVR

Low cost ross compiler for C source program. It is a powerful software tool that includes editor, C compiler (integer), assembler, optimizer, source linker and library in one easy to use integrated development environment. There are also included the library sources and many utilities programs. The default IDE can be replaced by a new one named **Micro IDE**, that is more powerfull, for Windows operating system and provided of many utility functions.

AVR Studio

It is a development tool for AVR family of microcontroller that fully control execution of program on AVR in circuit emulator or on the built in AVR instruction set simulator. AVR Studio supports source level execution of assembly and C programs generated by external compilers and assemblers. The tolls is based on a set of windows for source, watch, registers, memory, peripherals, message and processor that enable the user to have full control of the status of every element in the execution target. It also features an "application builder" to easy the generation of code to initialise all hardware peripherals (USART, SPI, Port, ADC, ect.) starting from a graphic interface.

Using JTAG interface several debugging problems are solved, increasing the possibility to eliminate bugs and drastically reducing the time required to obtain the final application completely debugged.



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PERIPHERAL DEVICES SOFTWARE DESCRIPTION

Below there is a specific description of the software managements of the on board peripheral devices. Whenever the reported documentation is not sufficient, please search a more detailed description of the devices in manufacturing company data sheets. Furthermore in this chapter the microprocessor internal peripheral devices are not described so if their programming is necessary, please refer to appendix A of this manual.

In the following paragraphs the **D7÷D0** and **.0÷7** indications denote the eight bits of the combination involved in I/O operations.

ACTIVITY LEDS

The **GMM AM328** allows software management of activity or status LED DL1, through an I/O line of the microcontroller, with the following correspondence:

| | | |
|----------------|----|----------------|
| PB5 = 0 | -> | DL1 ON |
| PB5 = 1 | -> | DL1 OFF |

It is important to remind that PB5 is connected to CN1 at pin 12.

The signal PB5 is set high by the microcontroller after reset or power on, so during these phases LED is OFF.

CPU INTERNAL PERIPHERALS

Registers description and purpose for all internal peripherals (Analog COMPARATOR, A/D CONVERTER, Timer Counters, USART, I²C BUS, SPI, OCM, etc.) is available in the proper data sheet and user manual of the manufacturer.

Please refer to chapter BIBLIOGRAPHY and to appendix A of this manual to easily locate such documentation.

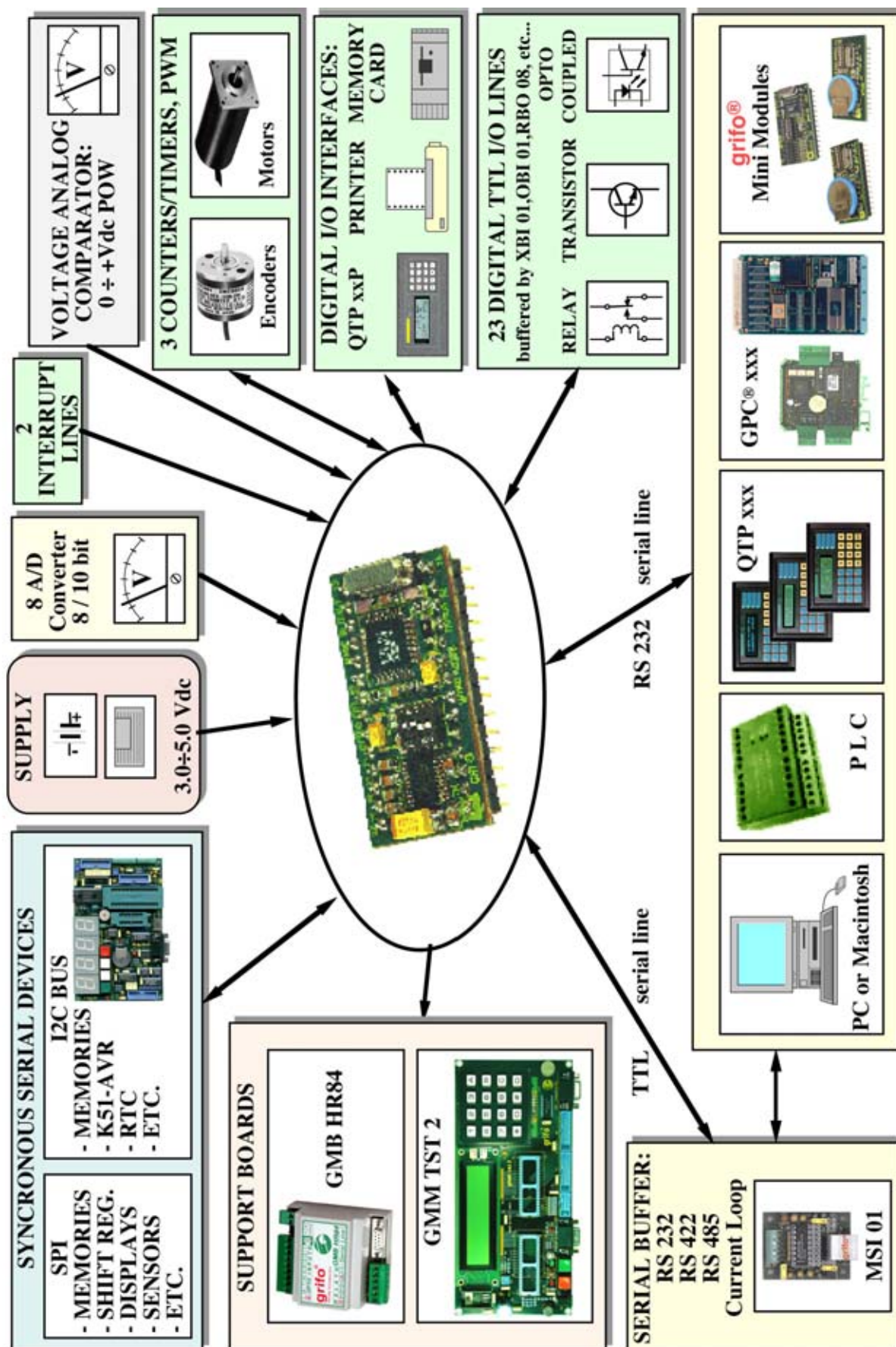


FIGURE 22: POSSIBLE CONNECTIONS DIAGRAM

BIBLIOGRAPHY

In this chapter there is a complete list of technical books, where the user can find all the necessary documentations on the components mounted on **GMM AM328**.

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

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

Manual NATIONAL SEMICONDUCTOR: *Linear Databook - Volume 1*

For further information and upgrades please refer to specific internet web pages of the manufacturing companies.

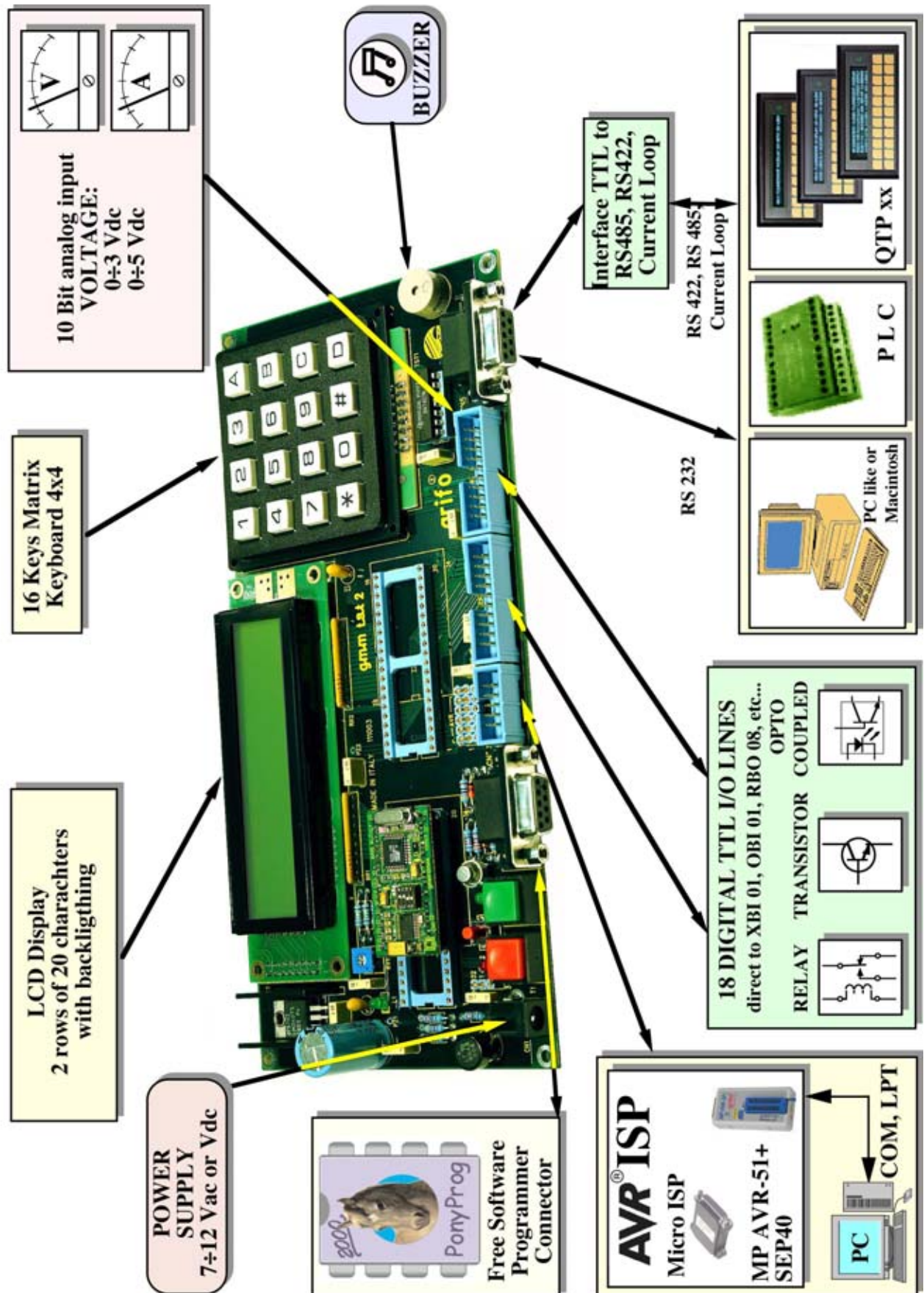


FIGURE 23: POSSIBLE CONNECTIONS DIAGRAM OF GMM TST 2 AND GMM AM328

APPENDIX A: DATA SHEET

grifo® provides a completely free technical documentation service to make available data sheets of on board components, through its web site. In this chapter the user found the complete and ready to use links and URLs to these information, together with the first pages of the same documents. To use our technical documentation service just connect to our site www.grifo.com and click its icon.

ATmega328

Link: Home | Technical documentation Service | ATMEL | Data-Sheet ATmega328

URL: <http://www.grifo.com/PRESS/DOC/Atmel/ATmega328.pdf>

Features

- High Performance, Low Power AVR® 8-Bit Microcontroller
- Advanced RISC Architecture
 - 131 Powerful Instructions – Most Single Clock Cycle Execution
 - 32 x 8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 20 MIPS Throughput at 20 MHz
 - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
 - 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory
 - 256/512/1K Bytes EEPROM
 - 512/1K/1K/2K Bytes Internal SRAM
 - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
 - Data retention: 20 years at 85°C/100 years at 25°C⁽¹⁾
 - Optional Boot Code Section with Independent Lock Bits
 - In-System Programming by On-chip Boot Program
 - True Read-While-Write Operation
 - Programming Lock for Software Security
- Peripheral Features
 - Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
 - One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode
 - Real Time Counter with Separate Oscillator
 - Six PWM Channels
 - 8-channel 10-bit ADC in TQFP and QFN/MLF package
 - Temperature Measurement
 - 6-channel 10-bit ADC in PDIP Package
 - Temperature Measurement
 - Programmable Serial USART
 - Master/Slave SPI Serial Interface
 - Byte-oriented 2-wire Serial Interface (Philips I²C compatible)
 - Programmable Watchdog Timer with Separate On-chip Oscillator
 - On-chip Analog Comparator
 - Interrupt and Wake-up on Pin Change
- Special Microcontroller Features
 - Power-on Reset and Programmable Brown-out Detection
 - Internal Calibrated Oscillator
 - External and Internal Interrupt Sources
 - Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and Packages
 - 23 Programmable I/O Lines
 - 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF
- Operating Voltage:
 - 1.8 - 5.5V
- Temperature Range:
 - -40°C to 85°C
- Speed Grade:
 - 0 - 4 MHz @ 1.8 - 5.5V, 0 - 10 MHz @ 2.7 - 5.5V, 0 - 20 MHz @ 4.5 - 5.5V
- Power Consumption at 1 MHz, 1.8V, 25°C
 - Active Mode: 0.2 mA
 - Power-down Mode: 0.1 µA
 - Power-save Mode: 0.75 µA (Including 32 kHz RTC)



8-bit AVR®
Microcontroller
with 4/8/16/32K
Bytes In-System
Programmable
Flash

ATmega48A
ATmega48PA
ATmega88A
ATmega88PA
ATmega168A
ATmega168PA
ATmega328
ATmega328P

Rev. 8271C-AVR-08/10



ATmega48A/48PA/88A/88PA/168A/168PA/328/328P

1. Pin Configurations

Figure 1-1. Pinout ATmega48A/48PA/88A/88PA/168A/168PA/328/328P

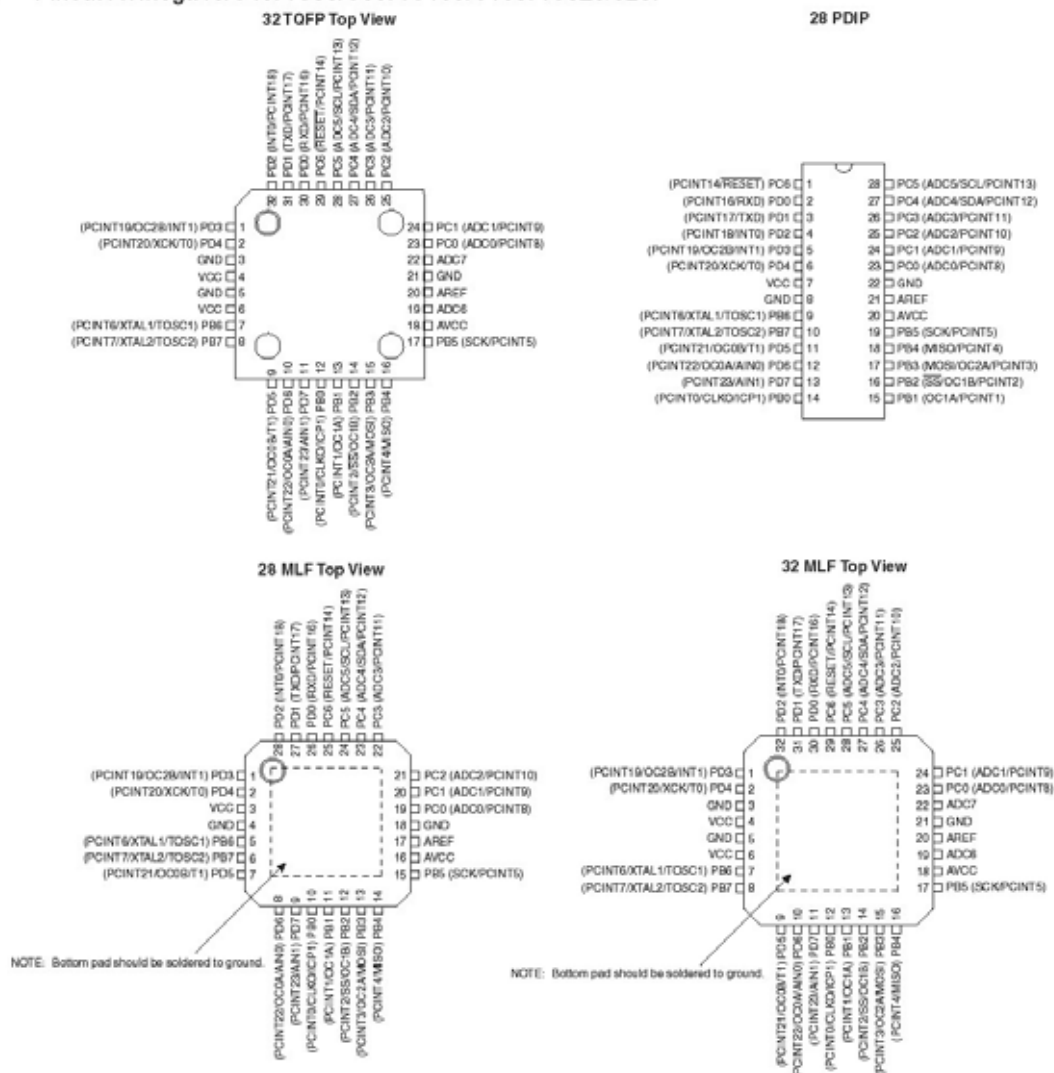


Table 1-1. 32UFBGA - Pinout ATmega48A/48PA/88A/88PA/168A/168PA

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|-----|-----|-----|-----|------|------|
| A | PD2 | PD1 | PC6 | PC4 | PC2 | PC1 |
| B | PD3 | PD4 | PD0 | PC5 | PC3 | PC0 |
| C | GND | GND | | | ADC7 | GND |
| D | VDD | VDD | | | AREF | ADC6 |
| E | PB6 | PD6 | PB0 | PB2 | AVDD | PB5 |
| F | PB7 | PD5 | PD7 | PB1 | PB3 | PB4 |

APPENDIX B: ISP PROGRAMMING WITH GMM TST 2

In this appendix the user can find specific instructions to program Mini Module **GMM AM328** installed on a **GMM TST 2** using an external ISP programmer.

This method to program Mini Module on board Flash and EEPROM can be considered and alternative to the one explained in section "B" of chapter "How to start" of manual.

Content of other sections in above mentioned chapter are still valid anyway.

ISP programming allows also to change the value of configuration bits and security fuses, in addition to the programming of whole Flash and EEPROM content.

The Boot Loader does not allow to program the whole content of Flash, because the Boot Loader itself resides in a Flash area which becomes protected.

Also, configuration bits, that enable the Boot Loader itself, and security fuses are out of the range programmable by the Boot Loader and must be programmed in ISP mode.

If you think it is more convenient to use a Boot Loader on RS 232 serial line, refer to above mentioned chapter.

For more information on how to connect a PC serial port to **GMM TST 2** (or even to Mini Module as stand-alone) to test the program, refer to section "A" of chapter "How to start" of manual.

For further information on how to develop and debug the firmware, refer to section "C" of chapter "How to start" of manual.

Programmers that can be used with **GMM TST 2** are:

- **grifo® MP AVR-51+** ; **grifo® UEP 49**
- Equinox EPSILON5
- ATMEL AVR ISP
- PonyProg

Information here reported are completed with direct connection diagrams (at page B-3 and B-5) that allow the user to build an ISP support hardware or to embed ISP support in user application.

A) COMMON OPERATIONS FOR ALL PROGRAMMERS

A1) Programming of Mini Module on a **GMM TST 2** board is performed through a specific connector of the card and, if required, an interface adapter between the programmer and the connector itself.

The two **grifo®** programmers that can be interfaced with **GMM TST 2**, that is **UEP 49** and **MP AVR-51+**, use a specific interface for each one of them, whose diagram is shown in figures B-1 and B-2. On the left side of the figures there is the list of **GMM TST 2** CN7 connector's ways that must be connected to corresponding pins on programmer's connector indicated by the arrow.

Programmers AVR ISP and Equinox EPSILON5 do not require any specific interface.

A2) Insert **GMM AM328** in one of the 40 ways socket of **GMM TST 2** aligned to the bottom, as indicated by serigraph and shown in figure 12 of manual.

A3) Locate on **grifo®** CD and save to a comfortable position on the hard disk of the PC the file called "d_am08u1.hex" following the path: English | Example Tables | Mini Module and Mini Block examples | GMM AM328 (please refer to figure 14 of manual).

Next sections described a detailed configuration specific for each programmer.

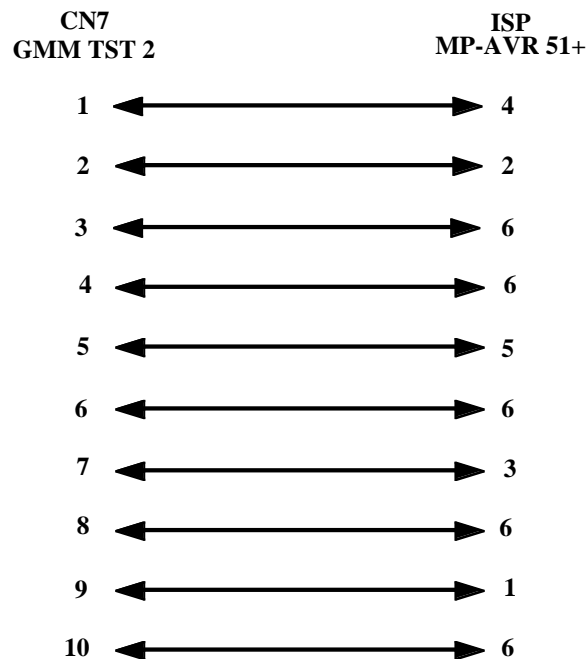


FIGURE B-1: DIAGRAM OF INTERFACE BETWEEN GMM TST 2 AND MP AVR-51+

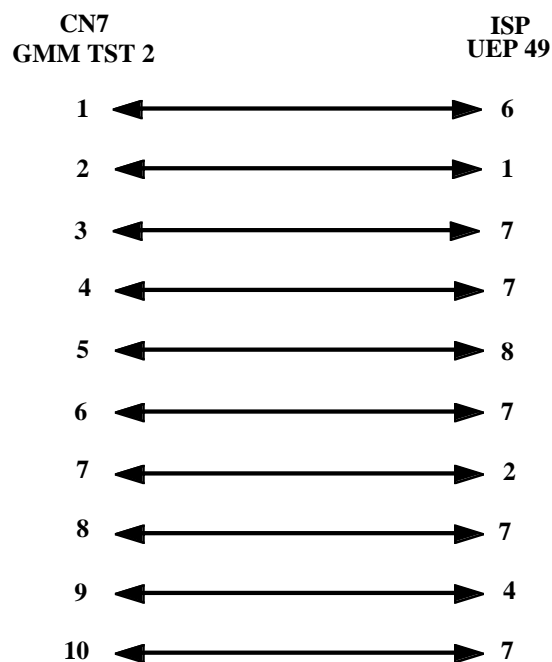


FIGURE B-2: DIAGRAM OF INTERFACE BETWEEN GMM TST 2 AND UEP 49

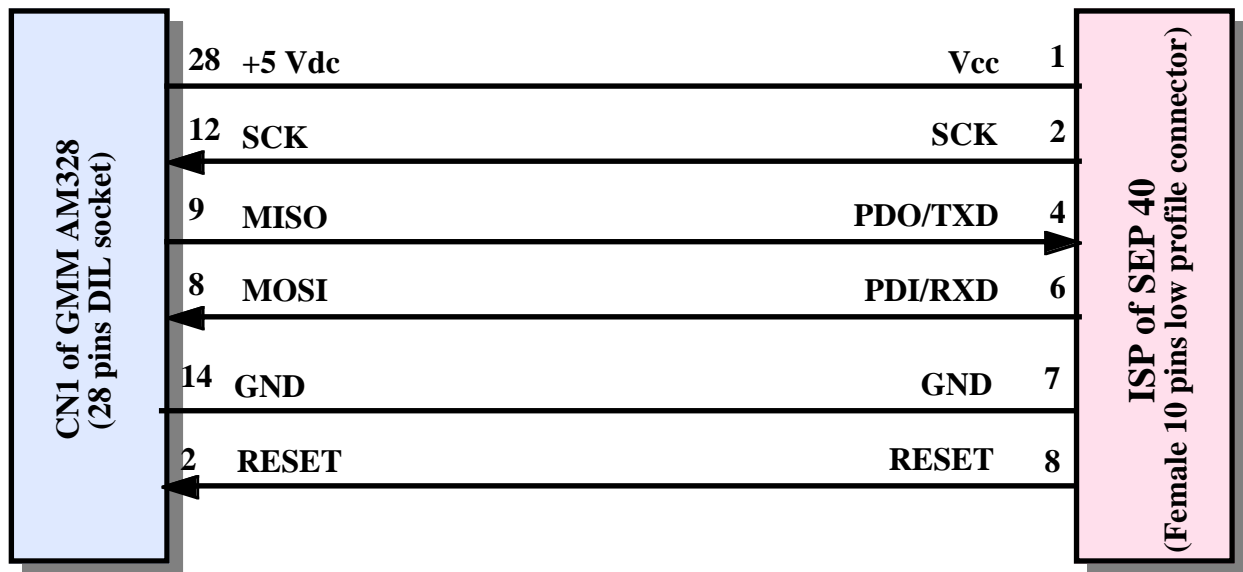


FIGURE B-3: DIRECT CONNECTION BETWEEN GMM AM328 AND SEP 40

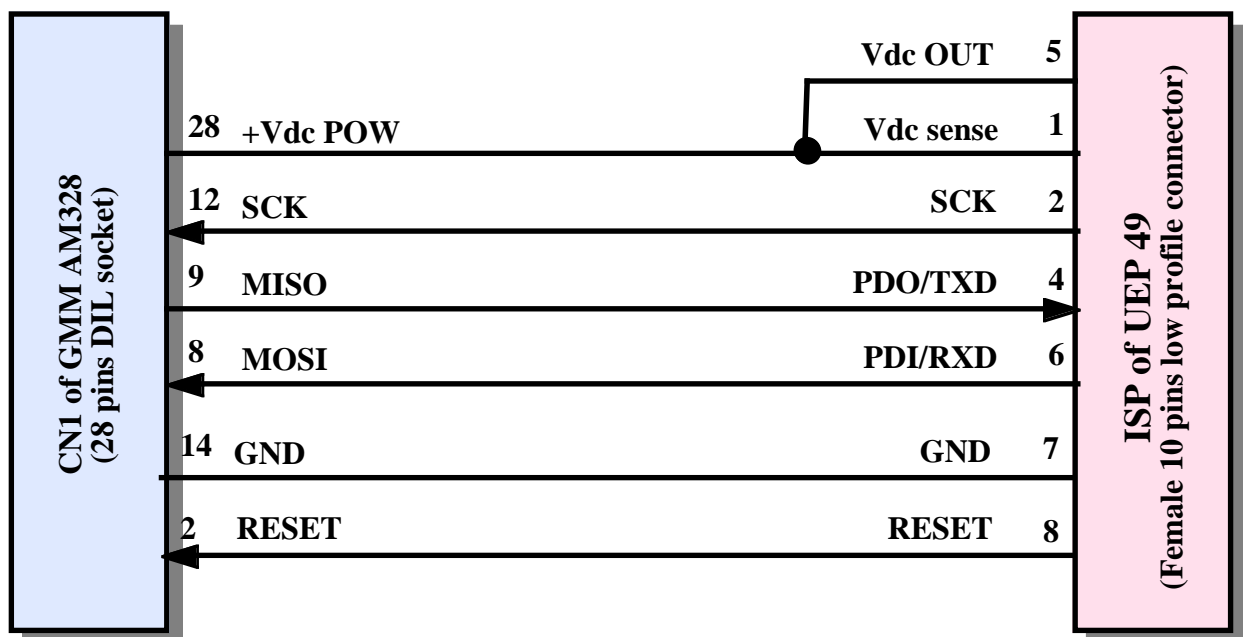


FIGURE B-4: DIRECT CONNECTION BETWEEN GMM AM328 AND UEP 49

B) PROGRAMMING USING grifo® MP-AVR 51+ ; grifo® UEP 49

B1) Instructions for installing, connecting to PC and using the programmer are delivered with the programmer itself. The control program for all grifo® programmers is called PG4UW and will be indicated by that name from now on.

B2) Connect the programmer to **GMM TST 2** using the interface described at point A1.

B3) Insert module in socket Z1 or Z2 of **GMM TST 2** using the interface and the instructions described at point A2, then turn on power supply of **GMM TST 2** and configure it as if a AVR ISP programmer should be used (see the manual of **GMM TST 2**).

B4) Select ATmega328 ISP as the component to program in specific menu of PG4UW, as indicated in figure B-5.

B5) Load the file previously saved on point A4) by pressing the button "Load".

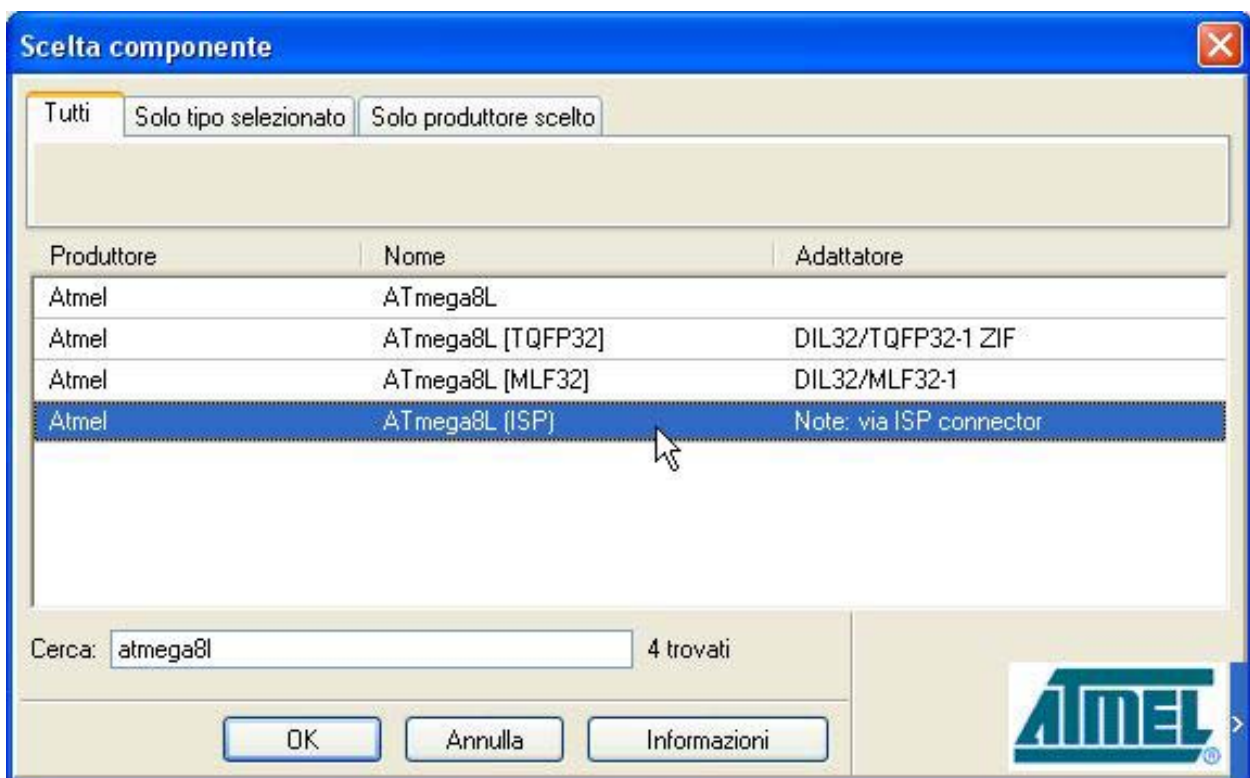


FIGURE B-5: COMPONENT SELECTION USING PG4UW

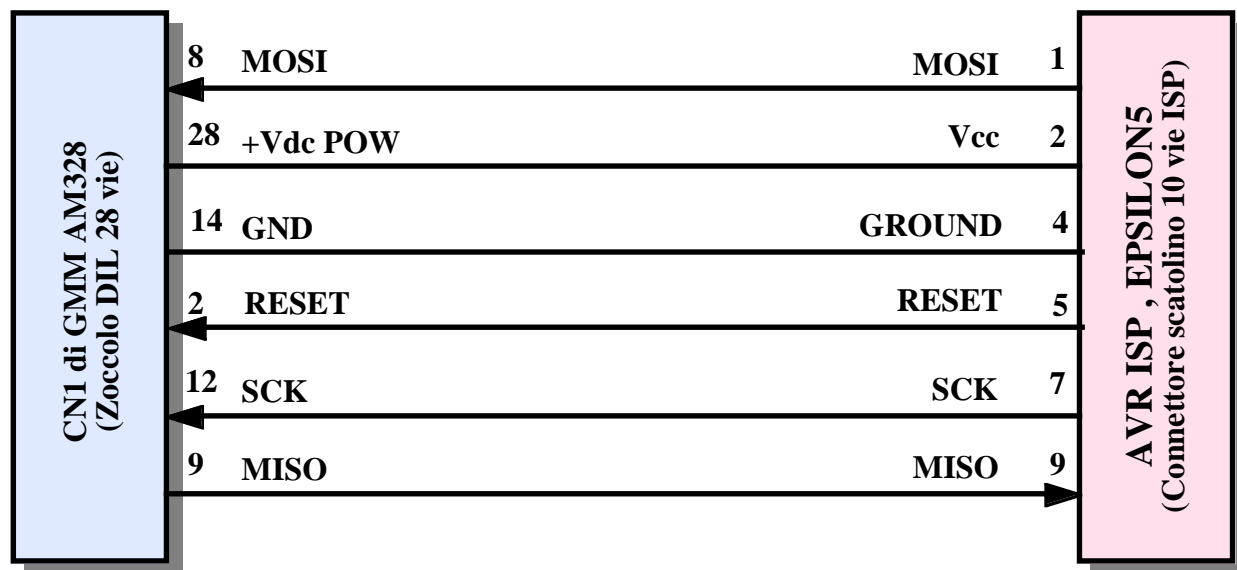


FIGURE B-6: DIRECT CONNECTION BETWEEN GMM AM328 AND EPSILON5 OR AVR ISP

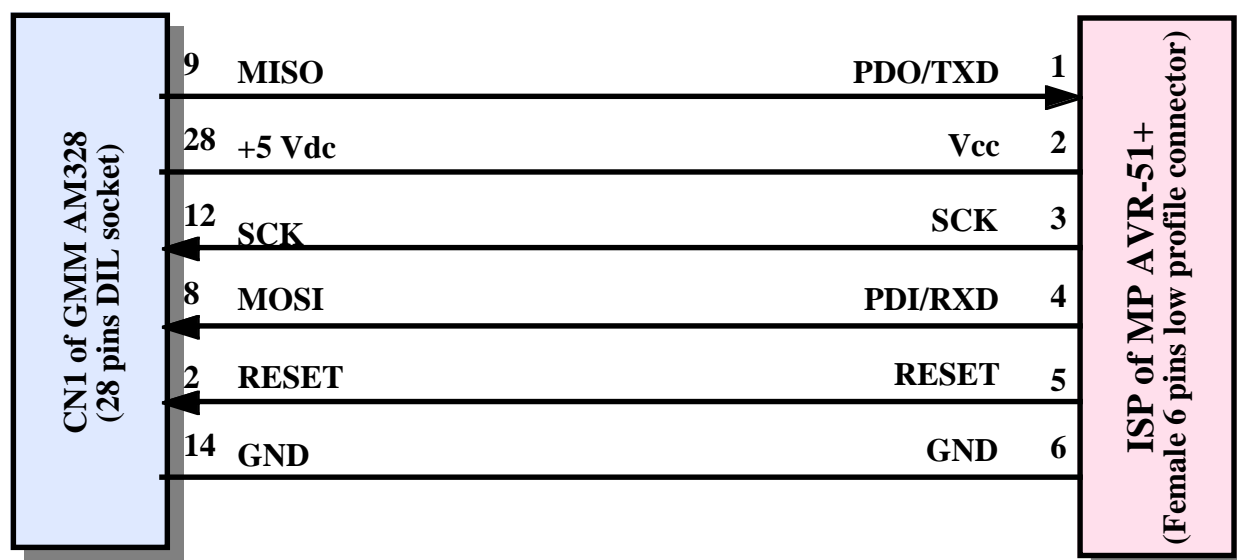


FIGURE B-7: DIRECT CONNECTION BETWEEN GMM AM328 AND MP AVR-51+

- B6) Configure the component using the menu Device options | View/Edit options and security. The component must be configured as indicated in figure B-8, that is the configuration required to make the demo program d_am328u1.hex work. Quartz and start-up time options must be configured like in the figure. Other settings are not important. Of course, the user can perform any other configuration required by his/her application.
- B7) Configure the programmer using the menu Device options | Operating options. Programmer must be configured as indicated in figure B-9.
- B8) Start the programming operation, pressing the "Program" button.
- B9) During the programming operation, a progress bar advances until the operation is completed. Eventual errors are promptly indicated.

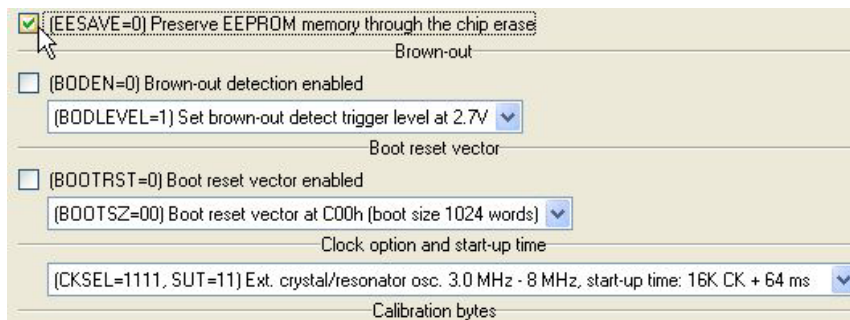


FIGURE B-8: COMPONENT CONFIGURATION USING PG4UW

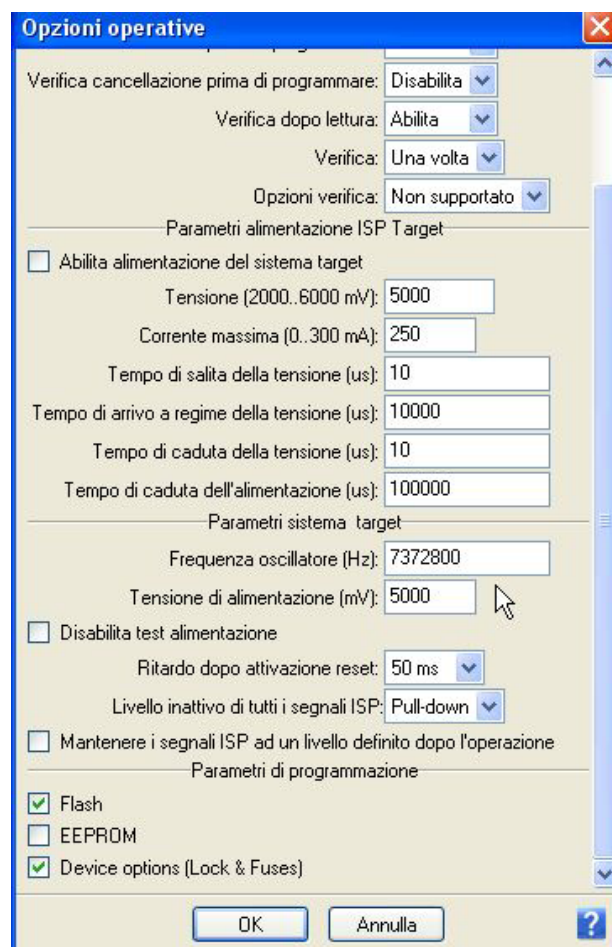


FIGURE B-9: PROGRAMMER CONFIGURATION USING PG4UW

C) PROGRAMMING USING EQUINOX EPSILON5

C1) Programming of Mini Module on a **GMM TST 2** board is performed through a specific connector of the card. First of all, programmer Equinox EPSILON5 must be physically configured to connect to **GMM TST 2**. To perform such configuration:

- Connect the 10 ways flat cable to connector "J7-ATMEL10" of EPSILON5
- Connect jumper J9 of EPSILON5

for further information please refer to manual of EPSILON5.

C2) After configuring and closing the EPSILON5, its control program must be installed. This program's name is EQTools, and will be called this way from now on. For further information about installing the program and connecting EPSILON5 to the PC, please refer to manual of EPSILON5.

C3) Connect the programmer to connector CN7 of **GMM TST 2**.

C4) Insert module in socket Z1 or Z2 of **GMM TST 2** using the interface and the instructions described at points A2 and A3, then turn on power supply of **GMM TST 2** as described in the manual of **GMM TST 2**.

C5) To use Equinox EPSILON5 connected to the PC (instead of stand-alone), it is required to open a project file (extension EDS). This can be done creating a new one from start screen of EQTools, using specific menus and buttons or loading an existing project file. For further information about project file management, please refer to manual of EQTools.

C6) Who creates a new project, must be sure to perform the settings shown in figure B-10. Who opens an existing project must be sure that these settings have already been performed. These settings assure that:

- The project is programmed correctly by EPSILON5
- Target device is ATmega8L
- File programmed on the target is d_am08u1.hex
- Target component configuration is correct

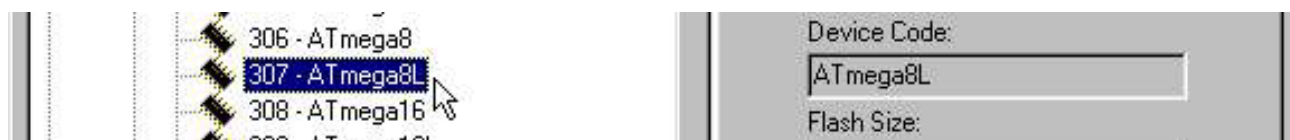
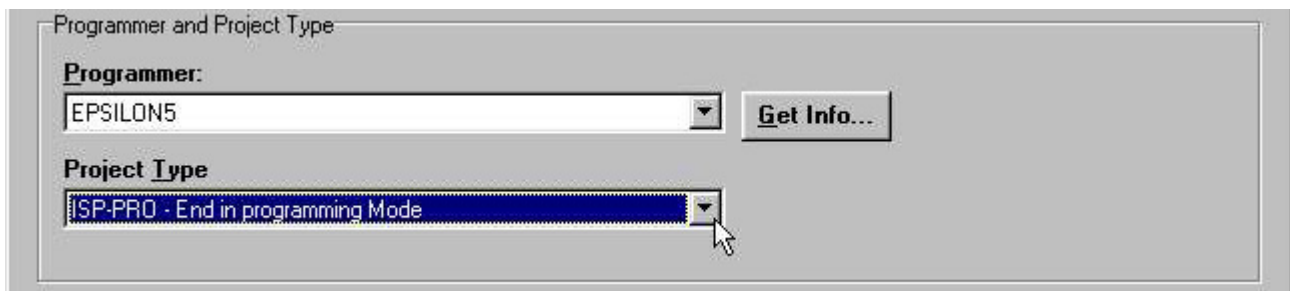
for further information about configuring a project, please refer to EQTools documentation.

C7) Who creates a new project, must also indicate to use it as "Test EDS" mode. To enable and perform Flash write operation the user must move back to Flash menu, put the check sign on "Edit Menu" checkbox and press button "Write".

C8) Window "Write Block to Flash" shows a summar of some current settings to verify them. If they are correct, pressing OK starts the memory writing procedure.

C9) Current status of programming is indicated by a progress bar, when programming completes a message indicates the operation final result.

C10) To perform configuration bits write operation it is required to move back to Fuses menu, and press button "Write" in frame "Target Fuses".



| Fuses | PC Fuse State | Target Fuse State | Description |
|----------|------------------|-------------------|---------------------------------------|
| CKSEL0 | 1 - UNPROGRAMMED | ? | Clock Select 0 |
| CKSEL1 | 1 - UNPROGRAMMED | ? | Clock Select 1 |
| CKSEL2 | 1 - UNPROGRAMMED | ? | Clock Select 2 |
| CKSEL3 | 1 - UNPROGRAMMED | ? | Clock Select 3 |
| SUT0 | 1 - UNPROGRAMMED | ? | Select Start Up Time 0 |
| SUT1 | 1 - UNPROGRAMMED | ? | Select Start Up Time 1 |
| BODEN | 1 - UNPROGRAMMED | ? | Brown out Detector - ENABLE |
| BODLEVEL | 1 - UNPROGRAMMED | ? | Brownout Level - select trip volta... |
| BOOTSZ0 | 0 - PROGRAMMED | ? | Boot Size 0 |
| BOOTSZ1 | 0 - PROGRAMMED | ? | Boot Size 1 |
| EESAVE | 0 - PROGRAMMED | ? | Preserve EEPROM during ERAS... |
| CKOPT | 1 - UNPROGRAMMED | ? | Clock Oscillator Options |

FIGURE B-10: PROJECT CONFIGURATION USING EQTOOLS

D) *PROGRAMMING USING ATMEL AVR ISP*

- D1) Control program of **AVR ISP** is **AVR STUDIO**, version 4 or greater. Latest version can be downloaded from Atmel website www.atmel.com. You may download it and install it following the instructions on screen.
- D2) Configure **AVR ISP** to use the 10 ways flat cable and connect it to connector CN7 of **GMM TST 2**, connect **AVR ISP** to PC serial port (please refer to instructions at points A2 and A3), configure **GMM TST 2** to program through **AVR ISP** and supply it (please refer to **GMM TST 2** manual).
- D3) Run **AVR STUDIO**. AVR ISP control program can be run by pressing the button with AVR chip as icon.
- D4) Select as CPU ATmega328, like in figure B-11.
- D5) Load the file previously saved on point A3 by pressing the button "Load".
- D6) Configure CPU as indicated in images of figure B-12.
- D7) Configure the programmer to check signature, erase device and reprogram with verify Flash memory and configuration bits, like indicated in figure B-13.
- D8) Perform the programming sequence by pressing button "Start" indicated in figure B-13.

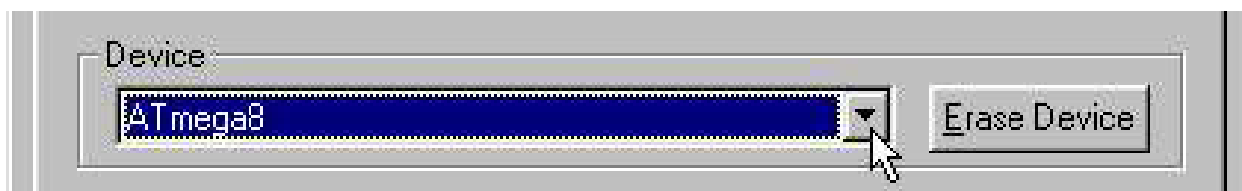


FIGURE B-11: CPU SELECTION USING AVR STUDIO

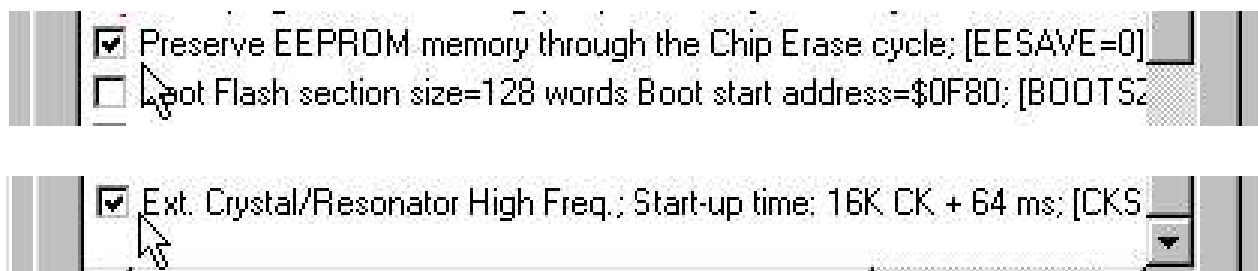


FIGURE B-12: CPU CONFIGURATION USING AVR STUDIO

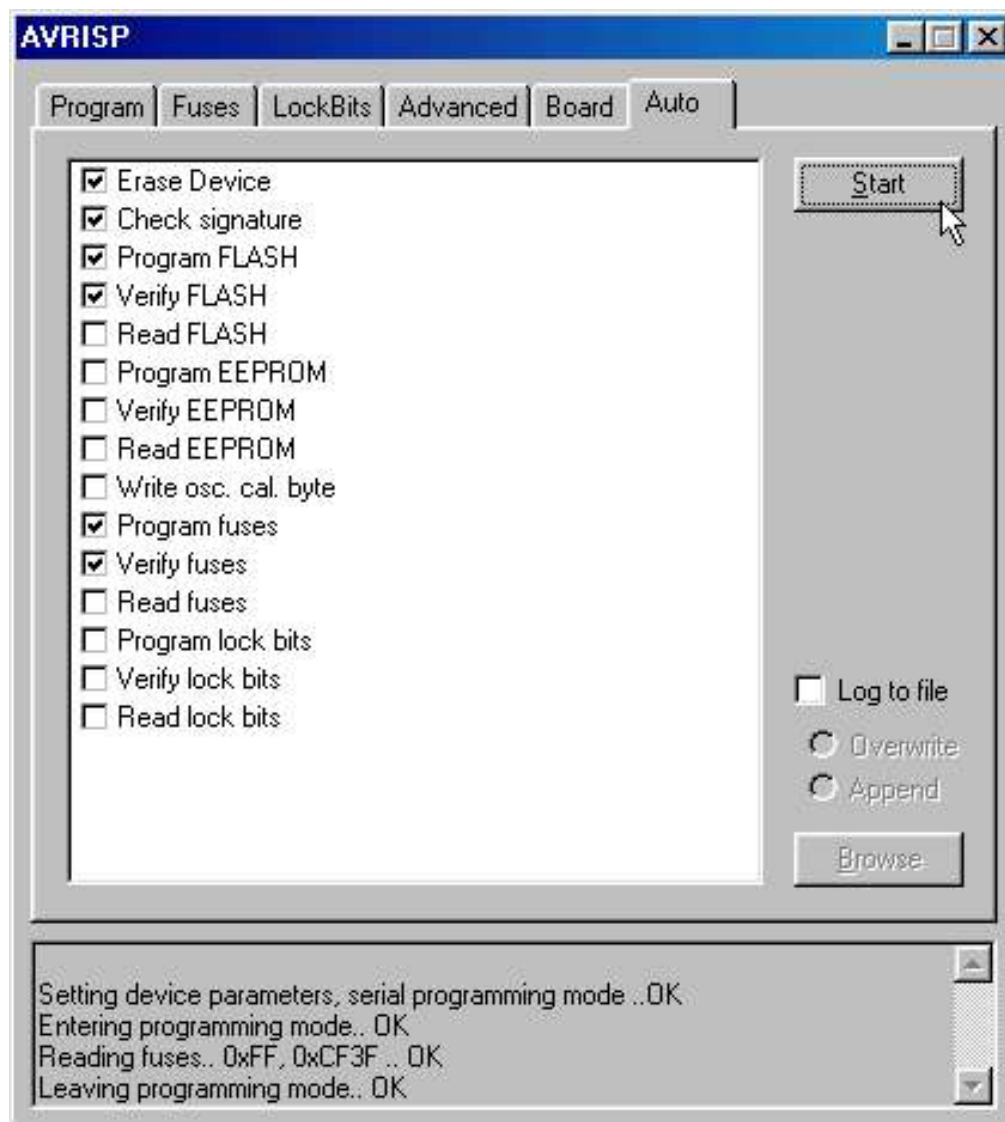


FIGURE B-13: AVR ISP CONFIGURATION USING AVR STUDIO

D) PROGRAMMING USING PONY PROG

- E1) Pony Prog is a software that allows to program **GMM AM328** on a **GMM TST 2** simply connecting PC serial port to connector CN6. Version 2.06c supports Atmel ATmega328, you may download it from www.lancos.com and install it following the instructions on screen.
- E2) Connect CN6 of **GMM TST 2** to PC serial port, configure **GMM TST 2** to program through **Pony Prog** and supply it (please refer to **GMM TST 2** manual).
- E3) Run **Pony Prog** and perform calibration through menu Setp | Calibration.
- E4) Select communication library SI Prog API through menu Setup | Communication setup.
- E5) Select "AVR micro" and "ATmega328" from the specific list boxes (see figure B-15).
- E6) Open the file "d_am328u1.hex" previously saved:
- E7) Configure the CPU to keep the EEPROM content while erasing and use an high frequency external quartz, as indicated in figure B-16.
- E8) Configure the programmer to perform ID check, erase the device and reprogram with verify FLASH and configuration bits.
- E9) Perform the programming pressing the button indicated in figure B-17 and be sure that the message "Program Succesful" appears at the end of the programming phases (which may last up to tenth of seconds).



FIGURE B-14: LOGO OF PONY PROG



FIGURE B-15: CPU SELECTION WITH PONY PROG



FIGURE B-16: CPU CONFIGURATION WITH PONY PROG

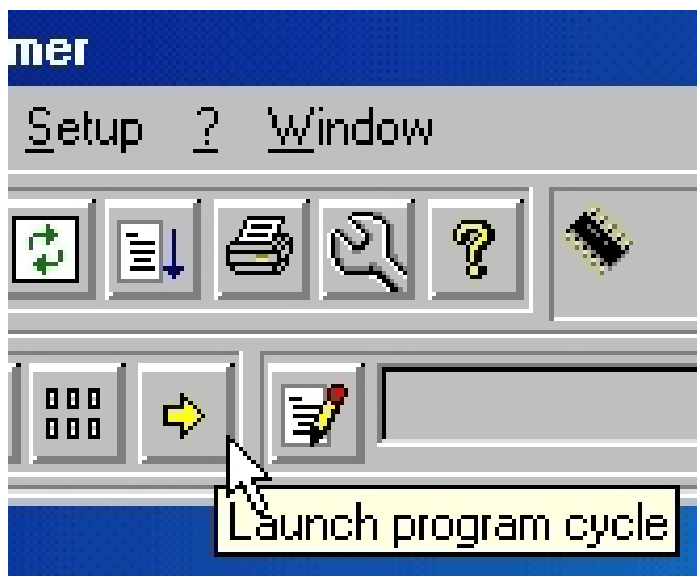


FIGURE B-17: PROGRAMMING USING PONY PROG

APPENDIX C: GMM TST2 ELECTRIC DIAGRAM

In this appendix are reported the electric diagram of **GMM TST2** support card that shows the connection modes for Mini Module signals. Detailed information on the board are available in the relative technical manual and the user can use them freely, for example to develop his own card that use the **GMM AM328** as a macro component.

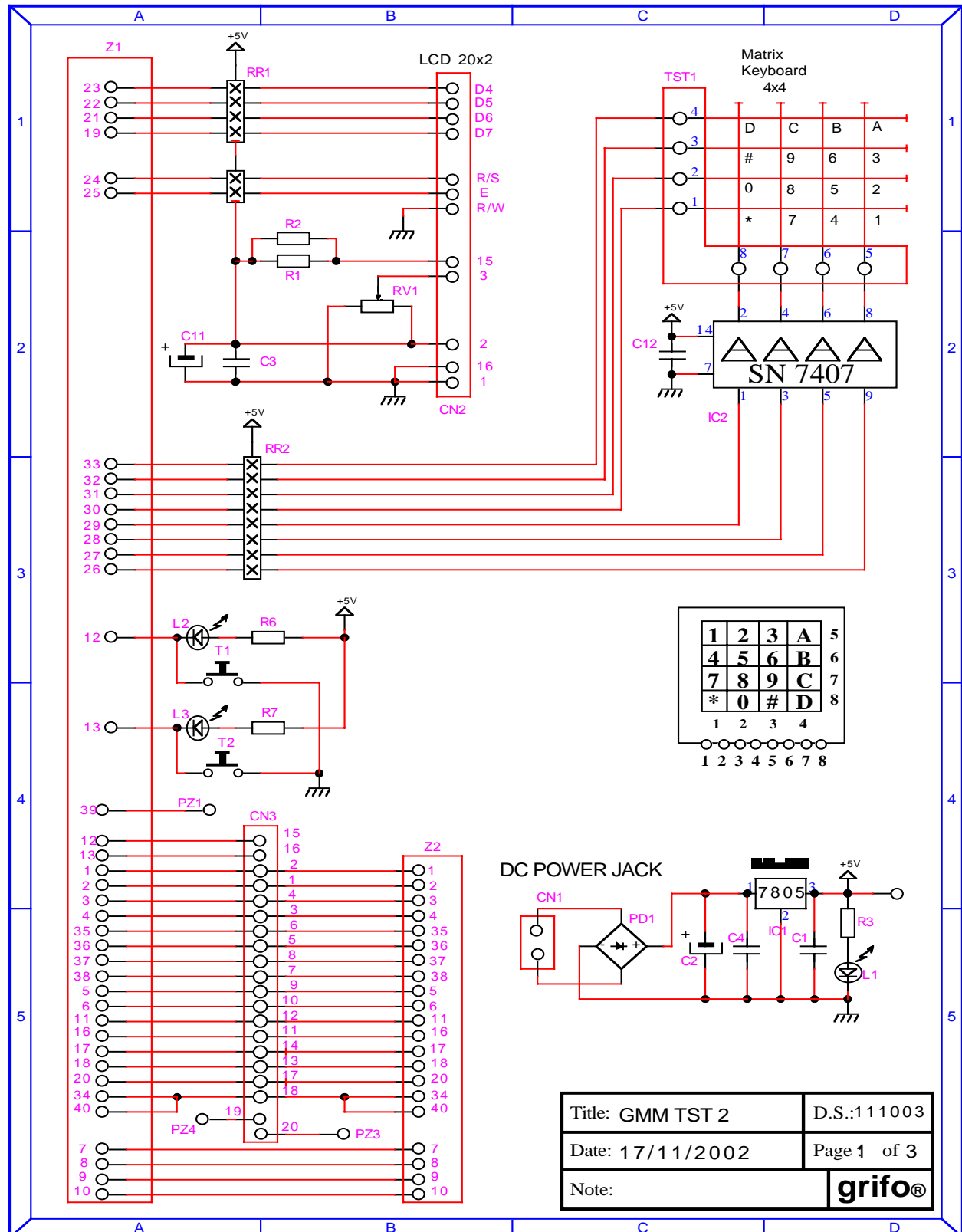


FIGURE C-1: GMM TST 2 ELECTRIC DIAGRAM (1 OF 3)

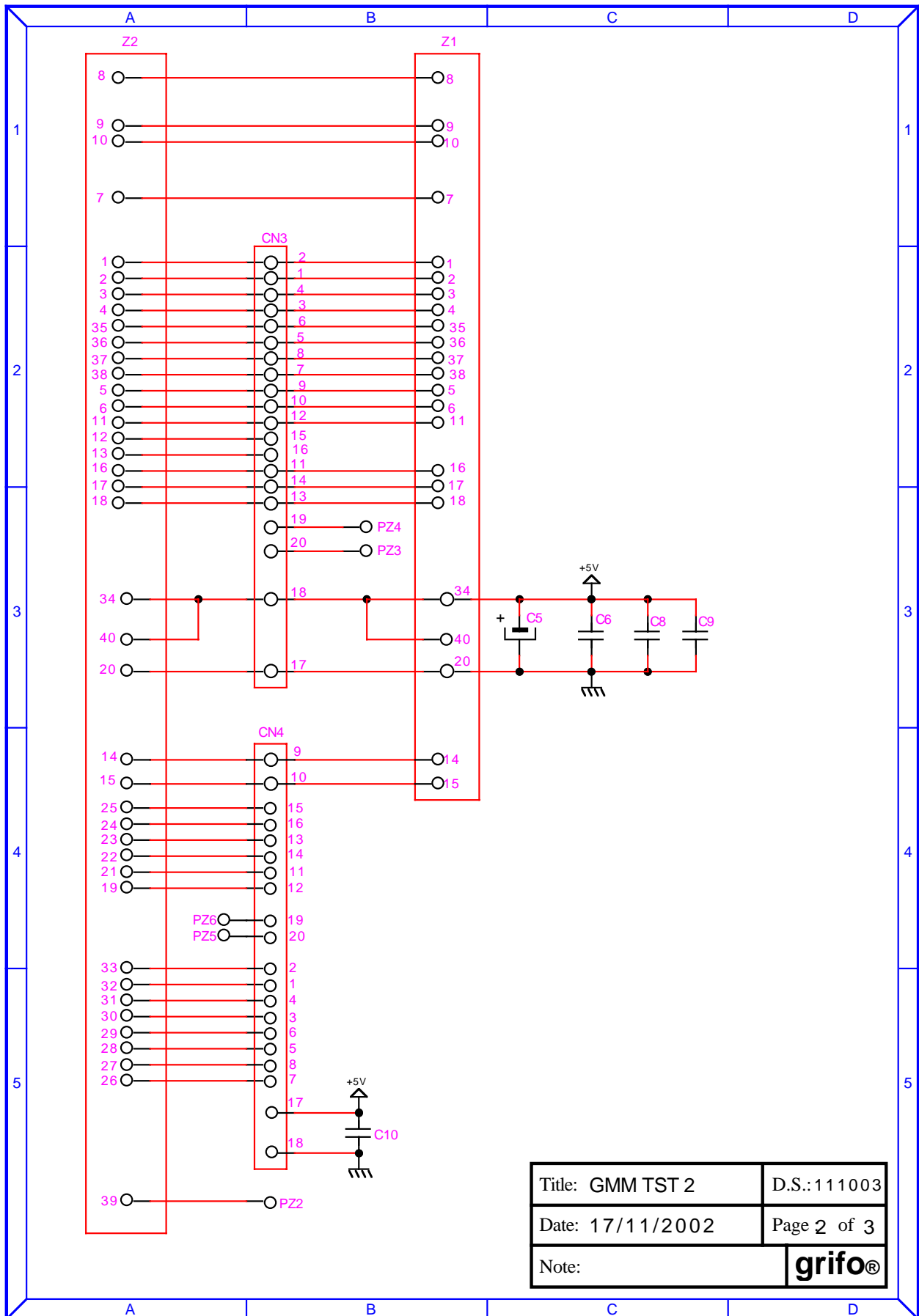


FIGURE C-2: GMM TST 2 ELECTRIC DIAGRAM (2 OF 3)

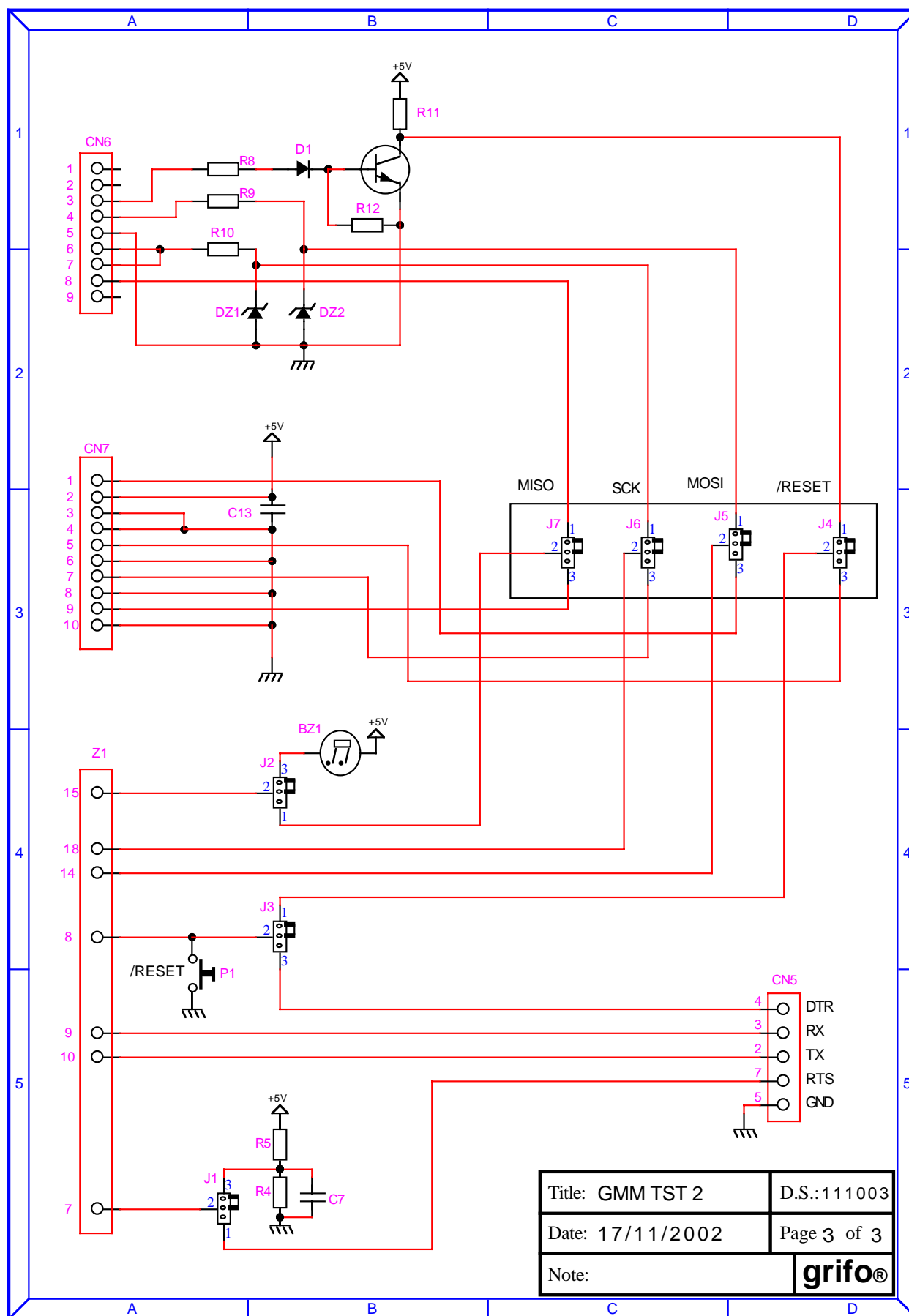


FIGURE C-3: GMM TST 2 ELECTRIC DIAGRAM (3 OF 3)

APPENDIX D: ALPHABETICAL INDEX

SYMBOLS**+VDC POW 13, 18****A****A/D CONVERSION TIME 10****A/D CONVERTER 6, 10, 13, 18****A/D RESOLUTION 10****ANALOG COMPARATOR 13, 18****AVR ISP B-7****AVRBOOTLOADERGRIFO 26****B****BASCOM AVR 28, 32****BIBLIOGRAPHY 36****BROWN OUT 11****C****CARD VERSION 3****CLOCK 9****CLOCK FREQUENCY 10****COUNTERS MAXIMUM FREQUENCY 10****CURRENT CONSUMPTION 11****CURRENT LOOP 8****D****DIGITAL I/O 6, 10, 13****DIP SWITCH 6, 10, 16****DL1 34****DSW1 16****E****EEPROM 9, 10****EPROM 9****F****FLASH 9, 10****G****GMB HR84 20****GMM TST 2 22, B-1, C-1**

II²C BUS 8, 11, 13, 18

ICC AVR 30, 32

IMPEDANCE ANALOG SIGNALS GENERATORS 11

INT0 19

INT1 19

INTERRUPT 10, 19

L

LED 10, 12, 34

M

MPAVR-51+ B-1, B-3

MSI 01 8

O

OCM 18

P

POWER ON TIME 10

POWER SUPPLY 18

POWER SUPPLY 11

R

RELATIVE HUMIDITY 10

RESET 10

RS 232 8, 10, 13, 14, 16, 18

RS 422 8

RS 485 8

S

SIZE 10

SPI 6, 13, 18

SRAM 9, 10

T

TEMPERATURE RANGE 10

TIMER/COUNTER 8, 10, 13, 18

TTL 8, 13, 14, 16, 18

U

UEP 49 B-1, B-3

W**WATCH DOG 6, 10****WEIGHT 10**

