

G C T R

Grifo[®] C To Rom

USER MANUAL

grifo[®]

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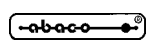
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GCTR

Edition 5.40

Rel. 06 February 2002

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USER MANUAL

GCTR is a complete and powerful software package that allows to develop C application programs taking advantage of its fast, comfortable and efficient development environment and debuggin environment.

It is available for each of the **grifo[®]** cards based on microprocessors of family **Intel 86**.

GCTR can save in FLASHEPROM the code developed in its environments, this makes easier the final update and installation phase, that can be done even on the field.

A wide set of library functions allow to manage immediatly several operator interfaces normally present in most of automation applications.

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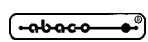
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IMPORTANT

Although all the information contained herein have been carefully verified, **grifo®** assumes no responsibility for errors that might appear in this document, or for damage to things or persons resulting from technical errors, omission and improper use of this manual and of the related software and hardware.

grifo® reserves the right to change the contents and form of this document, as well as the features and specification of its products at any time, without prior notice, to obtain always the best product.

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:

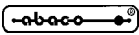


Attention: Generic danger



Attention: High voltage

Trade Marks

, **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.

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.

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.

grifo® gives no warrany that this software may fulfil the user needs, the production does not stop or be without errors or all the eventual errors can be corrected. **grifo®** is not responsible for problems caused by hardware changes of the computers and the operating system that may happen in the meantime.

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SOFTWARE VERSION

The present handbook is reported to the **GCTR** release **3.5** and later. The validity of the bring informations is subordinate to the number of the software release. The user must always verify the correct correspondence among the two denotations. Software release number is printed on the disk labels and is written in the source of some programs, examples, etc.

This manual also contains information about other programs that are part of **GCTR** package: each of these programs has its own release number that will be specified when the explanation will require it.

In case of need for the technical assistance it is essential that the user provides the release number or numbers of the program/s used in addition to a clear and exhaustive description of the problem. For information about **GCTR** releases that can be ordered and the description of the changes made, please refer to chapter “GCTR VERSIONS”.

GENERAL INFORMATION

This manual gives all the software and hardware information to allow the user to take the maximum advantage of **GCTR (Grifo® C To Rom)** features.

This manual uses the following conventions:

Application program: is the program developed by the user; it manages the software part of the system to build.

Control card: is the **grifo®** card used to develop the application program with **GCTR** as software development environment.

GCTR is a complete and powerful software development package that allows to develop C application programs taking advantage of its comfortable development and debugging environments. It is available for all the **grifo®** cards based on family **Intel 86** microprocessors.

GCTR allows to work in a very advanced environment that needs no deep knowledge of the hardware used and has been designed with the goal to simplify and fasten the phases of development, test and installation of the system to make.

The package is made of several subsets independent and not that satisfy the needs of modern programmers, according to their working experiences. In detail, the package includes a **compiler** and **linker**, a **debugger**, a **programmer**, general **utility programs** and **examples** ready for use, in addition to the code needed to **rom** the application program.

C is one of the most appreciated programming languages and, thanks to its modularity, compactness, flexibility and efficiency, is very easy to find great amounts of code already written and often ready for use. This language allows to manage directly the on board hardware, take advantage of several kinds of data structures, manage interrupts easily, use powerful control instructions and exploit all the advantages of a high level programming language.

GCTR uses Borland C compiler, certainly one of the most diffused so certainly well-known by the programmers. This latter is provided only of its essential files; the user has the task to get the complete package to be able to take advantage of all of its tools, library functions, on line and on paper documentation, etc.

Borland C/C++ is development environment for **DOS and/or WINDOWS** programs, so even if its compiler and linker can be used to develop embedded code, its debugger and libraries require the presence of an operating system. **GCTR** provides the missing parts to the programmers who want to use Borland C/C++ to develop programs for and embedded hardware that does not have an operating system.

Both **GCTR** and any program developed using **GCTR** are not subject to any royalty: the user can develop an unlimited number of application programs also in different versions without having to inform **grifo®** about them.

- Complete development environment on ROM for family **I86** CPU's and compatible.
- Programming in **Borland C/C++**.
- On board debugging through Borland **Turbo Debugger**.
- **Source level** remote debugging.
- Short download time of application program to debug (about **6 Kbyte/second**).
- **Start-up code** for ROM storage, to execute the application program after a reset or a power on.
- **Large** memory model is used to have maximum room available for code, data, stack and heap.
- **Floating point** completely available.

- **Library** storable into ROM that provides the most frequently used functions (malloc, free, interrupt, delay, etc.) in the automation field.
- Possibility to use high level console functions (cprintf, cputs, getch, kbhit, etc.) to manage a set of operator panels like **QTP xxx**, **QTP xxxP**, serial terminals or, more simply, **alphanumeric display** and **matrix keyboards**.
- Flexible **locator** for 80x86 microprocessors, preset to generate binary files.
- Ready to operate also matched with application programs that manage **interrupts**, without limits for the response procedures.
- Code can be stored into **EPROM** or **FLASH EPROM**.
- Possibility to use only part of available **SRAM** for data, stack and heap and to keep the remaining for **storing parameters, data logher**, etc.
- Possibility to use only part of available **ROM** for code and to keep the remaining for storing **messages, tables**, etc.
- Use of Borland standard linker and **compiler**.
- **Hardware debugging**.
- Complete management of target board **watch dog** circuit. The user can mantain always connected the watch dog circuit, when required, even during download and debug phases.
- **GCTR** is a **non intrusive** development environment, in fact it does not use interrupts for its own and performs no action in autonomy. One serial line on the debugged board is used during the debugging phase.
- **GCTR** is deterministic: execution times of its functions are constants so it can also be used in real time applications.
- Included there is a specific **installation program** to perform automatically the package configurations.
- No royalties or further costs.
- Provided on **floppy disks**, pre-programmer memory device and with user manual on **CD**.

Considering the natural evolution of software packages, please always refer to the eventual READ.ME file in the work disk or directory. This file reports all the additions, changes and improvements made to all the software package not yet reported in the manual: if this file is present it must be examined, printed and added to this manual.

MINIMUM REQUIREMENTS

Here follows a brief description of all the material (hardware and software) needed to work with **GCTR**.

CONTROL CARD

It is a control card belonging to **grifo**[®] industrial cards listing based on a family I86 microprocessor like: **GPC**[®] **188F**, **GPC**[®] **188D**, **GPC**[®] **884**, **GPC**[®] **883**, etc.

Independently from the requirements of the application to build, the control card must be provided with:

- at least 64KByte of SRAM
- an asynchronous RS 232 serial line
- an EPROM or a FLASH EPROM with one of the following labels:

TDE B xxx	FWR xxx
Ver. ??	Ver. ??
zzM	yyyK zzM

where:

xxx	=	control board code
??	=	program version
yyy	=	size of FLASH EPROM (128K or 256K Byte)
zz	=	control board clock frequency (20M, 26M or 40M)

The above reported list is minimum work structure, in fact the same system can be expanded increasing its potentialities. The control card configuration must be chosen according to the specific needs of the application that must be developed.

Should the control card and **GCTR** be purchased in the same order, the EPROM or FLASH EPROM memory device is provided already installed on the control card. On the label of such device all the information about board code, version of code stored, its size and clock frequency are specified in a form like the one above described.

PERSONAL COMPUTERS

GCTR software package needs a personal computer, from now called **development PC**, with at least the following features:

<i>Personal Computer:</i>	IBM compatible (with CPU \geq 386).
<i>RAM:</i>	At least 8M Bytes.
<i>Operating system:</i>	WINDOWS 3.11, 95, 98, ME..
<i>Monitor:</i>	Colour.
<i>Mass storage:</i>	Floppy disk drive 3" 1/2. Hard Disk with at least 4M Byte of free space.
<i>One Serial port:</i>	COM 1 or 2 in RS 232, compliant to V24 standard (capable to manage 115.2 Kbaud)
<i>Mouse:</i>	Microsoft compatible with its own driver installed.

Another personal computer, from now called **console PC**, is suggested to be able to use directly the demo program provided with **GCTR** and to create a “traditional” user interface. The console PC just needs to have are a keyboard, a monitor, an RS 232 serial line and a serial communication program to perform the tasks of a simple terminal the shows on the monitor data received from the serial port and sends there all the keys pressed on the keyboard.

SERIAL COMMUNICATION CABLE

During the debugging phase, and for the eventual programmin of FLASH EPROM on the control card, it is essential to perform a connection between one of the development PC serial ports and the serial line A of the control card. This connection needs only the transmission, reception and ground signals (RxD, TxD and GND) and must be compliant to the V24 normatives of C.C.I.T.T. A second communication cable may be required between console PC and serial line B of control card if the user wants to use the **GCTR** console. This cable is like the previous described, as reported here:

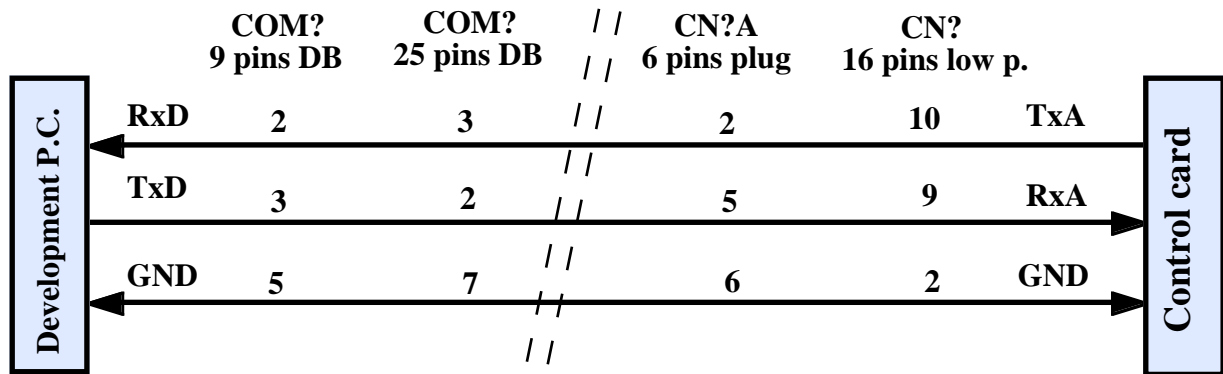


FIGURE 1: SERIAL CONNECTION BETWEEN DEVELOPMENT PC AND CONTROL CARD

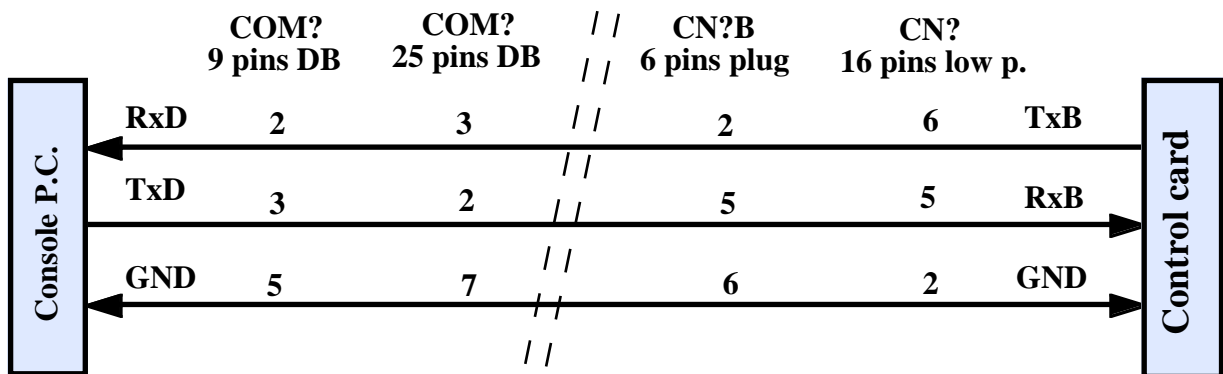


FIGURE 2: SERIAL CONNECTION BETWEEN CONSOLE PC AND CONTROL CARD

The indication **COM?** stands for one of PC serial lines, while the indications **CN? 16 pins low p.** and **CN? 6 pins plug** stand for **grifo®** control card standard connectors, described in the control card technical manual. The table in the following figure shows connectors names and accessories codes (cables, cards, etc.) that **grifo®** can offer to easy and fasten the connection phase. So the user can decide whether to make them in autonomy or purchase them directly from **grifo®**.

CONTROL CARD NAME	CONNECTOR	CODE OF ACCESSORIES FOR SERIAL CONNECTION
GPC® 188F	CN1	FLT 16+16; NCS 01; CCR 25+25 or CCR 25+9
GPC® 188D	CN1	FLT 16+16; NCS 01; CCR 25+25 or CCR 25+9
GPC® 883	CN3A, CN3B	CCR.PLUG25F or CCR.PLUG9F
GPC® 884	CN3A, CN3B	CCR.PLUG25F or CCR.PLUG9F

FIGURE 3: SERIAL CONNECTORS AND CONNECTION ACCESSORIES

WORKING SOFTWARE

In addition to the previously described hardware, **GCTR** needs a software for working to develop and set up the application program. Such software is made by a set of programs and files provided through the distribution disks and can be divided in two main groups as follows:

SOFTWARE TO DEVELOP THE APPLICATION PROGRAM

GCTR is based on Borland C compiler, linker and debugger. These software tools are normally used to generate executable files for standard personal computers with MS DOS or WINDOWS operating system installed. To avoid the potential problems that may arise between different versions of the previously mentioned software packages, **GCTR** provides also the essential parts of compilation, linker and debug packages already installed and configured, ready to use.

This simplifies the use of **GCTR**; it is however essential that the user gets the complete Borland packages to use them regularly, to read their documentation and to be able to use the generic utility tools provided with Borland software package.

Summarizing, the software essential to develop the application program is:

- Software package Borland TURBO C or Borland TURBO C++ or Borland C++ with its own documentation
- Software package Borland TURBO DEBUGGER with its own documentation

Version and type of these software packages are not important for the above described reasons. It is suggested, but not essential, to use a generic communication program capable to manage a classic terminal emulation, with possibility to set through PC the console physical communication protocol. Remarkable for this use are the following famous and diffused programs: CROSS TALK, PROCOMM, BITCOMM, TERMINAL, HYPERTERMINAL, etc. or **GET51** available on **grifo**® CD or website.

SOFTWARE AND FIRMWARE FOR THE CONTROL CARD

GCTR is based on a set of programs and files charged to make the C application program storable in a ROM, despite the compiler has been designed to generate executable codes for system provided with an operating system. This task is performed by libraries, startup code, remote debugging, support programs, utilities, etc. that change according to the features of the control card used and are made and provided by **grifo**®. For further information about software and firmware for control cards, please refer to the paragraph called "DIRECTORY C:\GCTRxxx".

GCTR USER MANUAL

The present manual, that reports all the technical information regarding **GCTR** operating system. In detail it is possible to find hardware connections, commands syntax, libraries description, procedures and support programs, memory organization, etc.

EPROM PROGRAMMER

There is the need for an EPROM programmer to burn the files generated on the development PC and to complete the application. In fact the code already developed, debugged and tested in all its parts, must be stored permanently in a EPROM to install on the control card.

Please remark that the EPROM programmer is needed only if the **GCTR** used is not on FLASH EPROM because in this latter case the burning on the FLASH itself is performed in autonomy by the control card through the development PC and a specific programming firmware (**FWR xxx**) included in **GCTR**.

USE OF GCTR

To use correctly **GCTR** it is essential to perform the operations, both sequential and not, described in the following paragraphs. To verify the correct working of the software package and to obtain a system ready for use in short time, please follow the information reported in the next chapter whose title is "HOW TO START".

INSTALLATION

Please consider the **GCTR** is a software package designed to perform all the operation of the application program creation, of course except debugging, on the development PC, not on the control card, for this reason it is convenient for the user to choose a powerful, fast and secure PC to make the installation.

Here follows the list of operations that the user must perform to install correctly the **GCTR** software package. It is essential to follow the order here specified:

- 1 - Install on the development PC, if not already present, the software package Borland TURBO C or TURBO C++ or C++, following the indication given by the package itself.
This step is optional, but recommended to ease the successive operations of writing and syntactic checking of the application programs to develop.
- 2 - Assure that at least 4 MBytes of free space are available on the development PC's hard disk.
- 3 - Insert the disk 1 "**GCTR xxx**" in the floppy disk drive of the development PC and run the installation program INSTALL.EXE by double-clicking on its icon.
- 4 - Read the informative window showed by the installation program, click on the "Next" button to continue.
- 5 - At this point the installation program checks the hardware and software requirements of the development PC and, if they are enough, installation continues, otherwise the program awarns about the lacks inviting to remove them.
- 6 - Wait for the end of the search for a Borland development environment (I.D.E.) on the development PC hard disk. After the search the possible development environment found is shown, otherwise, in case no C Borland compiler has been installed, the standard editor EDIT.COM is shown. Should the user not appreciate the development environment presented by **GCTR**, it can be modified by specifying the path of the preferred programs in the specific displayed window, or by editing the file GCTR.IDE as described in the paragraph "USER CONFIGURATIONS", even at the end of the installation.
- 7 - Select the serial port to use on the development PC (COM1 or COM2).
- 8 - Select the size of the two memory areas (CODE AREA SIZE and DATA AREA SIZE) that are to be dedicated to **GCTR**, taking care that such sizes are respectively lower than or equal to the amount of EPROM/FLASH EPROM and SRAM installed on the control card.
- 9 - This far the installation program starts to copy the work files to the hard disk. During this phase a specific window shows the name of the file currently being copied and a progress bar indicating the percentage of work already done. Insert the other "**GCTR xxx**" disks when prompted and press a key to continue.
- 10 - Wait for the end of the copy phase, which will be indicated by a window informing about the successful installation; then click on "Next" button to continue.

- 11 - Compile the options of the **GET188** installation window, taking care to select again the development PC serial port (COM1 or COM2), the communication baudrate (115200), the messages language (italian or english), the type of monitor used and user and firm name. After completing click on "Install" button to continue.
- 12 - Read the update notes not yet reported on this manual that are shown in a specific window during this phase. Please remark that such update notes are stored in the file READ.ME and that they can be read and printed also in a second moment.
- 13 - Verify that on the development PC's hard disk the directories C:\TC_GCTR, C:\TD_GCTR and C:\GCTRxxx have been created correctly and that they contain the files described in the following paragraphs.
- 14 - At this point installation is completed.

To complete the explanation, here follows a short description of all the files installed on the development PC; use information are reported in the next chapter.

DIRECTORY C:\TC_GCTR

This directory contains 9 files and/or programs that allow to compile and link the C source of the application program and to obtain the executable file. Documentation about these files can be found in Borland C++, TURBO C, TURBO C++ manuals.

DIRECTORY C:\TD_GCTR

This directory contains 15 files and/or programs that allow to debug the application program under development; please remark that the debugger in the **GCTR** software package is a very powerful symbolic source level debugger capable to manage directly the control board hardware, breakpoint, trace, data structures visualization, etc. in a simple and intuitive mode with a multiple windows representation, pull-down menus, shortcuts, etc. Also for this program, documentation can be found in Borland TURBO DEBUGGER manuals.

DIRECTORY C:\GCTRXXX

After the installation this directory contains 80 files and/or programs that allow to use the whole **GCTR** software package. The user must always work in this directory because the files present allow to access the other directories so that all the operation like editing, compilation, linking, debugging, EPROM image preparation, etc. can be performed.

In detail these files are:

STDEB.OBJ -> These are the startup code used during the linking of the application program for the debug phase and binary image generation; such codes provides to set and to initialize opportunely the hardware being used so that the C main function of application program, may take control of the card. The files change according to the memory configuration chosen at point 8 of installation.

STBIN.OBJ ->

- LCTR_T.LIB -> This is a library file for the control card used during the linking of the application program that allows the executable generated for an operating system to be ROMmed and executed on the control card.
- CL.LIB -> This is the Borland standard library file for the Large memory model; some of its functions have been modified to be used on the control card, also this file is used during the linking phase. For further information please refer to the next chapters.
- EMU, MATL.LIB -> These are the library files that contain the C mathematic procedures in the version with emulated math coprocessor, essential to perform floating point operations and to use the wide range of mathematical functions.
- *.H -> These are the header files where the declarations of Borland functions are stored; they can be included in the main function of the application program according to the rules of Borland documentation.
- LOC.EXE -> This program allows to transform the .EXE executable file obtained after compiling and linking in the corresponding binary image to be used for burning EPROM or FLASH EPROM for the control card.
- EXETOBIN.LOC -> This file contains the transformation parameters for LOC.EXE that specify the memory configuration of the control card. Of course this file changes according to the memory configuration of control card input by the user at point 8 of installation.
- CTODEB.* -> These files are support programs that provides to run sequentially the Borland I.D.E. or the text editor, the compiler, the linker and the debugger for the specified application program.
- CTOBIN.* -> These files are support programs that provides to run sequentially the compiler, the linker and the locator for the specified application program.
- FLASHWR.* -> These files are support programs that allow to program the FLASH EPROM on the control card.
- GCTR.IDE -> This is a text file containing the path of the I.D.E. program or the text editor that must be used during the development of the application program. CTODEB runs the program indicated here.
- TDxxx.IMG -> This is the binary image of the program executable on the control card that is charged to communicate with the TURBO DEBUGGER and so it manages the whole set-up phase of the application program. This file changes according to the memory configuration chosen at point 8 of installation.
- GET188.EXE -> This is the intelligent terminal emulation program used by FLASHWR to program the FLASH EPROM.
- G188HELP.HLP -> On line help file for **GET188**.
- GET188IN -> Installation program for **GET188**.
- GHEX2.COM -> This is an utility program that allows to transform a binary file into the equivalent file in Intel HEX format.
- INSTALL.LOG -> This is a text file containing the list of the installed files.
- UNINSTALL.EXE -> This is the uninstallation program for **GCTR** and can be used to delete the files installed on the development PC.
- *.C -> This is a set of demo programs directly usable on the control card with **GCTR**.
- READ.ME -> This files contains the latest updates not yet reported in this manual.

USE

Here follows the description of how to use **GCTR** software package; please remark that the use procedure has been simplified making it usable by all the user who are programmers capable to use C.

The following steps must be performed to obtain an application program written in C, completely debugged, to be installed on the control card and must be executed in the reported order. To give a complete description both the use modalities under MS-DOS and the modalities under WINDOWS are shown when they happen to be different:

- 1 - Enter in directory C:\GCTRxxx on the development PC's hard disk.
- 2- Check the user configurations and modify them according with used editor and Borland C I.D.E. settings as described in "USER CONFIGURATIONS" paragraph.
- 3 - Run the support program CTODEB:

<i>typing C:\GCTRxxx>CTODEB <filename>.C<ENTER></i>	<i>under MS-DOS</i>
<i>dragging the icon <filename>.C onto the icon of CTODEB</i>	<i>under WINDOWS</i>

this runs the Borland I.D.E. or the editor specified during the installation phase with file <filename>.C as target. In this environment the user must develop the C program according to the rules of the programming language, being careful not to modify the name of the C source file being used; after writing the application program (or the part of it that must be tested) it is convenient, if the user is running an I.D.E., to check the syntax correctness giving the compilation command. It is now possible to exit from the I.D.E. or the text editor, the source is automatically compiled and linked with the specific programs in the directory C:\TC_GCTR. It is essential to check for absence of errors in this phase, if errors are present the execution of CTODEB must be terminated and point 3 must be repeated since the beginning to correct the errors. If compiling and linking complete successfully, the debugger that finds in directory C:\TD_GCTR is automatically run. Now the correct working of the application program must be verified taking advantage of the great potentialities of Borland TURBO DEBUGGER testing it directly on the hardware of control card connected to eventual external electronic and to the development PC.

After terminating the test the user can exit form the debugger and return the control to the development PC operating systtem, because CTODEB terminates when the debugger is terminated. During the execution of this phase the files <filename>.OBJ, <filename>.MAP, <filename>.EXE, <filename>.C, <filename>.BAK are created or modified but only the file <filename>.C is interesting for the user.
- 4 - If the correct working verify shows no problem or error the user can continue to point 3, otherwise must repeat point 3 until the complete verify of all the program parts. Of course the errors found using the debugger must be solved by the user through changes to the source of the application program.
- 5 - After the debugging phase the application program must be saved on the control card. This operation is completely automatic and is performed running the support program CTOBIN:

<i>typing C:\GCTRxxx>CTOBIN <filename>.C<ENTER></i>	<i>under MS-DOS</i>
<i>dragging the icon <filename>.C onto the icon of CTOBIN</i>	<i>under WINDOWS</i>

where <filename>.C is the name of the C source file used at point 3. Also in this point user will have to check for the absence of errors and, at the end, the file <filename>.IMG will have been generated; this file contains the binary image of the code to use for programming (burning) EPROM or FLASH EPROM for the control card. A file called <filename>.ABM is also created in this step.

- 6 - The user must burn EPROM or FLASH EPROM with the file <filename>.IMG. For a detailed description of the execution of these operations, please refer to the paragraphs “EPROM PROGRAMMING” and “FLASH EPROM PROGRAMMING”.
- 7 - Now, if the **GCTR** on EPROM is used, the user must turn off the control card, uninstall the EPROM labelled “**TDE B xxx ...**” and replace it with the one burned at point 6; if the **GCTR** on FLASH EPROM is used the user must turn off the control card, set it to RUN mode (please see paragraph “CHANGES TO AN ALREADY INSTALLED APPLICATION”).
Once the control card is supplied, application program starts automatically.

The user must keep the work files of the application program (sources, includes, macros, etc.) in the directory C:\GCTRxxx; eventually, to simplify the icons dragging when working under WINDOWS, it is possible to copy the support link files CTODEB and CTOBIN on desktop and to use these copies.

EPROM PROGRAMMING

The modalities of use of an EPROM programmer are not subject for this manual, so in this paragraph only **GCTR** related information are provided.

The file <filename>.IMG generated by the CTOBIN support program is a binary file whose size is the same as the size of the selected EPROM during the **GCTR** installation phase; this file must be burned from address 00000H.

If the EPROM programmer being used requires the Intel HEX format the binary file must be transformed into the equivalent Intel HEX file through the program GHEX2.COM. The syntax to use GHEX2 is:

C:\GCTRxxx>GHEX2 <filename>.IMG<ENTER>

it must be type at MS-DOS prompt or in the Start|Execute window of WINDOWS and it generates the file <filename>.HEX featuring extended Intel HEX format.

Should the application program need external data to store in EPROM (configuration data, messages, tables, etc.) they must be stored after the last byte of the previously saved code. As the binary file generated by **GCTR** fills the whole EPROM content, the user has to locate the address of code end as described in the paragraph “RESERVED MEMORY”.

FLASH EPROM PROGRAMMING (FLASH WRITER)

One of the **GCTR** remarkable features is the possibility to manage in autonomy the FLASH EPROM installed on the control card. This feature makes really easier the development of an application, in fact it an external EPROM programmer is not needed any more, it is replaced simply by the development PC connected to the control card through a serial port. The updating, verify and maintenance phases of the software under development may comfortably performed even on the field, for example using a portable PC.

FLASH EPROM management through **GCTR** is a supported operation that allows the user to modify the content of certain FLASH areas using a specific program, starting from some files stored on any of the development PC's drives. These are high level operations and are provided with help messages that support the user across all the phases.

Please remark that to guarantee the integrity of data stored in FLASH EPROM and to assure everytime the presence of program FLASH WRITER, this latter is always written in the last sector of the component and it can be written only by **grifo®**. The user can obtain other FLASH EPROMs for working or to install on a production system by ordering them to **grifo®** using the code **FWR xxx** or **FWR www.512K**, as described in chapter "GCTR VERSIONS".

BOARD CONFIGURATION

To manage correctly FLASH WRITER, the user must perform the following hardware configurations:

- 1 - Connect the serial line A of the control card to the serial line of the development PC chosen during installation using the communication cable described in figure 1.
- 2 - Install the FLASH EPROM labelled "FWR xxx ..." on the specific socket of the control card.
- 3 - Install at least 128KBytes of SRAM on the specific sockets of the control card.
- 4 - Configure the jumpers of the control card according to its hardware configuration and select the DEBUG mode following the indications on the technical manual or figure 4 in this manual.

NOTE: For **GPC® 188F** and **GPC® 188D** do not connect jumpers J16 and J17.

FLASH EPROM AREAS

Referring to figures 5 and 6, only the areas marked with (*) can be modified through the program FLASH WRITER. Here follows a short description of these areas.

- 1 - FLASH WRITER area: it corresponds to the last 16K Bytes of the FLASH and it contains the code of the FLASH management program. The control card always executes this portion of code after a reset or a power on, its first action is to detect whether RUN or DEBUG mode are set and, in consequence, run the program stored in FLASH (RUN mode) or the FLASH WRITER (DEBUG mode). This area cannot be modified by the user in any way in order to avoid wrong situations which would prejudice the control card correct working.
- 2 - Not used area: it may be present in FLASH EPROMs whose sector size is greater than the 16KBytes required by the FLASH WRITER area. Size of this area is variable (for example 0K Bytes for 128Kx8 FLASH and 48KBytes for 512Kx8 FLASH), however it corresponds to an area not usable for any operation.
- 3 - User area: it corresponds the remaining free space on the FLASH except for the two previous areas (for example 112K Bytes for 128Kx8 FLASH, 448K Bytes for 512Kx8 FLASH) and it can contain code and/or data like the application program, configuration data, messages, tables, etc. In RUM mode the control card always starts by executing the code stored at the beginning of this area.

In the user area can be stored one or more binary files located on development PC mass memory devices (floppy disk, hard disk, etc.) that have been generated by **GCTR** or other software packages. These files can be written to FLASH EPROM starting from an user specified address until the last file is writtern or the user area is full. User area cannot be written twice with different data (in such case a FLASH EPROM malfunctioning error is visualized), so user area must first be deleted.

The application program developed with **GCTR** must be always stored at the beginning of the user area to be executed in RUN mode.

For further information about previously described memory areas please refer to the paragraphs "MEMORY ORGANIZATION".

FLASH WRITER EXECUTION

To execute correctly the FLASH EPROM management program, the following steps must be performed; when needed the differences between MS-DOS and WINDOWS are specified:

- 1 - Run **GET188** on the development PC connected to the control card:
typing C:\GCTRxxx>GET188 /T<ENTER> *under MS-DOS*
*double clicking on the icon **FLASHWR*** *under WINDOWS*
and wait for the presentation window to disappear.
- 2 - Prepare the control card as described in the previous paragraph "BOARD CONFIGURATION" then reset or turn off and on the control card to run FLASH WRITER.
- 3 - FLASH WRITER starts showing its version number, size of FLASH, start address of free user area and the first help screen.
- 4 - Read carefully the help screens selecting them with the keys "N" and "P" then continue the execution pressing "ENTER".
- 5 - Select the operation desired by pressing the corresponding numeric key ("0"÷"3") as indicated in the menu.
- 6 - If the write to user area operation is selected (key "0"), the user must insert the name of the file to write in this area. This file must be in binary format (.IMG, .BIN, etc.) and located in the current directory of the current drive. The program checks for the existence of the specified file; if it exists the program continues otherwise request a new file name.
If the file exists, the user must type the segment address from wich the programming of the selected file content must start; the program will prompt automatically the first free address of FLASH that can be confirmed or changed by inserting a new hexadecimal upper case address. FLASH WRITER verifies that the address inserted is included in the user area and, in case it is, it continues, otherwise requires a new address.
If the address is valid the program checks whether the selected file can be completely written into the user area starting from the specified address and, if it is possible, the program continues, otherwise prompts for a confirm to the programming and truncation of the final part that exceeds the user area. If the user confirms the program continues, otherwise the operation is aborted.
The next writing phase is shown by a specific status message that shows the address currently under programming; during this phase the user has just to wait for its completion and verify its result.
The file name requested by the program is in the format <drive>:<name>.<extension> and the drives supported are all the ones of development PC. Should the file to select not to be located in the current directory, the right directory must be selected through the option "File|Change Dir..." of **GET188**.
- 7 - If the user selects to delete the user area (key "1") the confirmation request appears and in case of user confirmation the whole user area of the FLASH is deleted, otherwise the operation is aborted.

In case of confirmation the user has just to wait for the completion of the operation, whose progress is indicated by a serie of dots printed on the monitor, then verify its result.

This operation is normally used to delete the previous content of the FLASH EPROM and so making possible a successive programmation with new files; data elimination is definitive so it must be selected and confirmed extemly carefully.

- 8 - If the help screen representation is selected (key "2"), the help screens are shown to the user as described in step 4.
- 9- If exit operation is selected (key "3"), the FLASH WRITER shows a proper message that informs about the stopped execution and about next possible operations.
- 10 - During the execution of most of the phases it is possible to stop the operation by pressing the "ESC" key that terminates the FLASH WRITER. This key has the same effect of exit operation.
- 11 - During every phase of the program possible malfunctioning are verified (file system access error, FLASH deletion error, FLASH write error, etc.) and in case one of them occurs and informative message appears immediatly.
- 12 - Exit from **GET188** on the development PC pressing at the same time the keys <ALT>+<X> to return the control to the operating system.

CHANGES TO INSTALLED APPLICATION: DEVELOPMENT, EXECUTION

A very common feature requested to any system is the possibility to intervent easily on the application programs to update them, modify them or verify their working when they are operational. **GCTR** responds to this request by providing the possibility to perform these operations of updating, modifying and verifying in a simple and efficent way, always using the only development PC. The technique provided is the possibility to stop the already installed application program execution (EXECUTION mode) and to return to the verify and modification condition described in the paragraph "USE OF GCTR" (DEVELOPMENT mode). Both EXECUTION and DEVELOPMENT mode have already been widely described in the previous paragraphs, so in this paragraph only the passage from one mode to the other is described, in two different versions for **GCTR** in EPROM and in FLASH EPROM.

GCTR in EPROM

- EXECUTION mode is selected by installing on the control card the EPROM containing the application program obtained following the indications in the paragraph "EPROM PROGRAMMING".
- DEVELOPMENT mode is selected by installing on the control card the EPROM labelled "**TDEB xxx ...**" and connecting serial port A of control card to development PC.

GCTR in FLASH EPROM

- EXECUTION mode is selected by setting the control card in DEBUG mode, erasing the user area of FLASH EPROM then storing the application program at the beginning of the user area and setting back the control card to RUN mode.
- DEVELOPMENT mode is selected by setting the control card in DEBUG mode, erasing the user area of FLASH EPROM then storing the TURBO DEBUGGER (file TDxxx.IMG) at the beginning of the usera area and setting back the control card to RUN mode.

The operations of user area deletion and programming must be performed using the FLASH WRITER following the indications given in the paragraph “FLASH EPROM PROGRAMMING”. Both in EXECUTION and DEVELOPMENT modes when the program to save at the beginning of the user area is selected the storing with truncation of the file must be confirmed.

The operative mode selection (RUN/DEBUG) is made positioning a specific jumper, as described in the following table:

CONTROL CARD	RUN DEBUG JUMPER
GPC® 188F	J18
GPC® 188D	J18
GPC® 883	J1
GPC® 884	J1

FIGURE 4: RUN AND DEBUG MODE SELECTION JUMPERS TABLE

Where: jumper not connected -> selects RUN mode
 jumper connected -> selects DEBUG mode

NOTE: Whenever the status of the RUN/DEBUG mode selection jumper is changed the control board must be reset or turned off and then on, because FLASH WRITER checks for its status only at startup.

Certainly the switching between these two operative modes is more comfortable in case of **GCTR** on FLASH EPROM, in fact in this case the only physical intervent on the control card is the different connection of a comfortable jumper.

GCTR on FLASH EPROM is suggestable in the phase of application set-up or however for small productions, while **GCTR** on EPROM is certainly a better choice to produce a great number of systems with a stable application program.

HOW TO START

This chapter describes the operations to perform in order to begin to use **GCTR**.

In detail here is reported the correct sequence of operation with practical use examples. For further information, please refer to the previous chapters, where each operation here explained is described with many more details. Examples reported in this paragraph are reported to a **GCTR** in FLASH EPROM for **GPC® 884** with 128K FLASH EPROM (“**FWR xxx ...**”) and 128 K SRAM.

- 1 - Read all the documentation included in the software package.
- 2 - Install a Borland C programming package.
Example: install Borland C++ Ver. 3.1 following the information and the possibilities of its installation program.
- 3 - Install **GCTR** selecting: the development environment (I.D.E.), the development PC serial port and the configuration for the memories installed on the control card.
Example: confirm the choice of Borland I.D.E. BC.EXE; select COM1 in the serial port request window; set the size for CODE AREA SIZE to 128K Bytes; set the size for DATA AREA SIZE to 128K Bytes; after the copy reselct COM1 in the **GET188** installation window and insert the user personal data.
- 4 - Install the EPROM “**TDE B xxx ...**” or FLASH EPROM “**FWR xxx ...**” on the specific socket of control card and set it to DEVELOPMENT mode.
Example: install FLASH EPROM “**FWR 884 ...**” on socket IC5; connect jumper J1; run FLASHWR on the development PC; supply the control card; cancel the user area with FLASH WRITER on the FLASH EPROM then program it with file TD884.IMG at the beginning of user area (E000H) confirming the truncation; exit from **GET188** pressing <ALT> and <X> at the same time; disconnect jumper J1 and turn off and on the control card.
- 5 - Connect serial line A of control card to the development PC's selected serial port taking care to respect the RS 232 standard in the connection of signals GND, TxD and RxD. For further information about this connection please refer to figure 1 or to control card and PC technical manuals.
Example: build a connection cable that connects respectively pins 2, 3 and 5 of a DB 9 female connector to pins 2, 5 and 6 of a 6 pins male plug connector; connect this cable to CN3A of **GPC® 884** and to connector COM1 of development PC.
- 6 - Connect serial line B of control card to the console PC's one of its serial ports taking care to respect the RS 232 standard in the connection of signals GND, TxD and RxD. For further information about this connection please refer to figure 2 or to control card and PC technical manuals.
Example: build a connection cable that connects respectively pins 2, 3 and 5 of a DB 9 female connector to pins 2, 5 and 6 of a 6 pins male plug connector; connect this cable to CN3A of **GPC® 884** and to connector COM1 of development PC.
- 7 - Run on the console PC a serial communication program and configure the logic communication protocol to 19200 Baud, 8 bit per character, 1 stop bit, no parity on the serial port connected to serial line B of control card.
Example: run the communication program **GET51** (available on the site and/or the CD of **grifo®**); set the above mentioned parameter in the window “Option|Serial port” and activata the communication with the command “Option|Terminal”.

- 8 - Run on the development PC the support program for the debugger with program TEST.C as target file:
typing C:\GCTRxxx>CTODEB TEST.C<ENTER> *under MS-DOS*
dragging the icon of file TEST.C on the icon CTODEB *under WINDOWS*
 verify that the selected I.D.E. program is run and that it opens file TEST.C.
 This latter is the classical program that prints to the console the prime numbers lower than 100, its purpose is merely didactical and demonstrative.
 Example: Run the support program for debugger as above noted.
- 9 - If Borland I.D.E. is used, continue reading from here, otherwise jump to step 12.
 Configure Borland I.D.E. selecting the signalation of all warnings and the use of large model.
 Example: Select the option "All" in the window "Display Warnings" visualized with the command "Option|Compiler|Messages"; select the option "Large" in the window "Model" visualized through the command "Options|Compiler|Code generation"; save these settings with the command "Options|Save" and confirming with "OK".
- 10 - Examine the program TEST.C without changing it using the editor commands then run the compilation using the specific command of Borland I.D.E.
 Example: scroll the program source with arrow keys; verify the potentialities of edit and search menus commands without changing the program; compile the program selection the option "Compile|Compile".
- 11 - Correct the error signaled during the compilation: at row 48 the source contains a typing error, that is an "s" has been omitted so the string "flag[i]" should have been "flags[i]". After having added the missing letter compilation must be repeated and if there are no errors compilation must be repeated.
 Example: move to row 48, where the compiler has found an error, and add the missing "s"; repeat the compilation described at step 9.
- 12 - After having verified and corrected the syntax of TEST.C exit from I.D.E., check for errors absence during the next phases of compiling and linking, wait for TURBO DEBUGGER to run and confirm the program transmission through the serial line, as requested by the specific pop-up window.
 Example: perform the above described operations confirming by keyboard pressing <ENTER> or by mouse clicking on key "Yes" when the message "Program out of date, send over link?" appears.
- 13 - Wait for the transmission phase to end and the source of TEST.C to appear on the monitor, select the execution command "Run|Run". Doing so, on the console PC's monitor the list of the prime numbers included in the range 1 to 100 will appear, it is possible to verify the correctness and completeness of the list.
 The user should immediately note the absence of prime number 1: program TEST.C has a functional error that must be located.
 Example: perform the above described operations.
- 14 - Stop the program execution by pressing <CTRL>+<BREAK>, close the CPU window that appears with <ALT>+<F3>, reload the program with the command "Run|Program Reset", place the cursor at the end of the prime numbers determination cycle (row 61) then give command "Run|Go To Cursor". The program is executed up to the numbers representation cycle, now the boolean vector flags[] already contains the status matched to the first 100 numbers. The command "Data|Add watch", specifying the variable "flags", pops up a window that shows its content; it is easy to verify that the vector has the correct value for index 1 so the absence found at step 13 is due to an error during representation. Executing the code step by step by command "Run|Trace Into" it is immediate to see that the starting index is wrong, in fact the first prime number printed has index 2.

Example: perform the above described operations.

- 15 - To correct the starting index exit from TURBO DEBUGGER with command “File|Quit” and repeat step 8, correct row 63 with “i=1” and repeat steps 10 and 12. Now also prime number 1 will be printed to the console PC so the program has been completely tested and verified.

Example: perform the above described operations.

- 16 - The program, completely tested, obtained in the previous step now can be stored to EPROM or FLASH EPROM on the control card to make it run automatically at power on, even without the development PC connected. To do this, first run on the development PC the support program that generates a binary image of the executable:

typing *C:\GCTRxxx>CTOBIN TEST.C<ENTER>*

under MS-DOS

dragging the icon of file TEST.C on the icon CTOBIN

under WINDOWS

to create the file TEST.IMG in the work directory.

Example: run the support program as above indicated

- 17 - Now the control card must be set in EXECUTION mode:

in case of **GCTR** on EPROM, file TEST.IMG must be used to burn an empty EPROM whose size is equal to the size indicated at step 3 through an EPROM programmer connected to the development PC;

in case of **GCTR** on FLASH EPROM control card must be turned off, set to DEBUG mode, the program **GET188** must be run on the development PC:

typing *C:\GCTRxxx>GET188 /T<ENTER>*

under MS-DOS

double clicking on the icon FLASHWR

under WINDOWS

turn on control card, wait for program FLASH WRITER to start, confirm the execution pressing <ENTER>, select the user area deletion (pressing <1>) and confirm the operation pressing <Y>, wait for the end of the deletion and press a key to return to FWR main menu, here select the write user area option (pressing <0>), type the name of the file to store in the area C:TEST.IMG<ENTER>, confirm the programming address pressing <ENTER>, confirm programming with truncation pressing <Y>, wait for the end of programming and press a key to return to the main menu, select the option to exit form FWR pressing <3>, exit from **GET188** pressing <Alt>+<X>.

In both cases after the programming operation has been completed the development PC is not needed any more and can also be disconnected from the control card.

Example: perform the above described operations considering that for **GPC® 884** the DEBUG mode is set connecting jumper J1 and that when programming the address to confirm is E000.

- 18 - Turn off the control card and set it to EXECUTION mode which:

in case of **GCTR** on EPROM, means to replace the EPROM on the control card with the one obtained at step 17;

in case of **GCTR** on FLASH EPROM means to set the control card in RUN mode, disconnecting the specific jumper.

Example: turn off **GPC® 884** and disconnect jumper J1.

- 19 - Turn on the control card and check that the application program starts automatically, that is check that on the console PC all the prime numbers between 1 and 100 are represented.

So the creation of the first application program is terminated.

Example: perform the above instructions.

DESCRIPTION OF GCTR

Here follow some general information about **GCTR** that the user must use during the development of the application program to take the best advantage of the control card features.

Of course the different features of different hardware are shown separately.

START-UP CODE

By start-up code we mean that piece of code always executed by the control card immediately after a reset or a power on that is charged to set up all the conditions needed for the next phases. The main operations performed by start-up code are listed below:

- 1 - Sets the control card for selected memory size
- 2 - Sets the I/O configuration
- 3 - Disables the circuiteries that can influence the program execution like internal watch dog, interrupts, DMA, etc.
- 4 - Retrigger ther external watch dog circuit
- 5 - Initializes an oportune stack for working
- 6 - Resets the global variables area
- 7 - Initializes the floating point emulator
- 8 - Copies the initialized data area from EPROM or FLASH EPROM to SRAM
- 9 - Installs an handler for interrupt 21H to intercept and refer eventual unexpected system callls
- 10 - Jumps to the firsr instruction of main in C application program

GCTR start-up code is essential for any Capplication program and can't be replaced with Borland standard start-up code because this latter is based on an execution under MS-DOS or WINDOWS operating system. Such code must be used also during the development phase of the application program infact **TURBO DEBUGGER** can execute it even if the control card hasn't been reset or turned off and on.

The start-up code specific for the selected memory configuration is provided already compiled in the files **STDEB.OBJ**, **STBIN.OBJ** and are automatically linked to the application program through **CTODEB** and **CTOBIN**.

ADDRESSING OF HARDWARE STRUCTURES IN I/O

The start-up code which is always executed before the main function of C application program is also charged to set and initialize the microprocessor register used to manage I/O (**RELOC**, **PACS**).

A setting common for all the control cards is to set the I/O internal microprocessor addresses starting from **FF00H** and to set the I/O addresses of on-board peripherals starting from the values reported in **APPENDIX C** of this manual.

These addresses, especially the peripherals addresses, must be used directly by the user in the C application program and are also used by the **ROMed** libraries provided with **GCTR**; so they can't be changed for any reason.

LOCATOR

The **GCTR** locator allows to locate code and data anywhere in the control card conventional memory space. It works on standard executable files (.EXE) and on .MAP files generated by the Borland C/C++ creating a binary file that can be burned on EPROM or used to program a FLASH EPROM. It may also create a file in Intel OMF absolut format if needed, such file is used by most of the emulators. Allocation commands are in an human readable format; they indicate the files that the locator must use, the ROM addresses, the SRAM addresses of the segments and the memory areas available. Such commands must not be provided by the user infact they are already written in the file EXETOBIN.LOC during the **GCTR** installation.

Locator performs cross verifies during allocation. It checks for ROM overflows, code overlappings, SRAM and ROM overlappings, missing correspondances between .EXE and .MAP files, the complete program allocation, etc. After it has worked locator prints the amount of ROM used, both as percentage and as number of bytes currently used.

Locator generates an absolute .MAP file, with extension .ABM, that reports the addresses of all public functions and data structures; it has the same format of .MAP file generated by Borland linker with addresses changed.

FLOATING POINT

GCTR provides fast and precise floating point support with typical C mathematic and trigonometric functions. For **grifo**® control cards not provided with mathematic coprocessor, Borland C/C++ mathematic management means a floating point software emulation.

Mathematic errors are managed by a specific ROMed function that exits from application program execution and returns an unique error code, to provide the user information about what happened. There is an example program, called DEMOFP.C, specific to show the use modalities of all the functions available.

HARDWARE BREAKPOINT

In the application program DEVELOPMENT and debug mode, the user can employ two breakpoints that provide the possibility to take the control of the control card execution even when the application program has jumped into an infinite loop or other not predicted situations.

The first breakpoint is the classic one, activable through development PC keyboard by pressing <CTRL>+<BREAK>, it is a software interrupt matched to the reception interrupt of serial line A on the control card.

The second is a real hardware breakpoint matched to Not Maskable Interrupt (/NMI) of control card. This interrupt can be activated by pressing simply a button that connects /NMI signal (available on the control card connectors) to the ground. Differently from the first breakpoint, this one can't be disactivated by software, it is always active so it is always usable. Another difference between these two breakpoints is that the first one stops the application program execution, while the second one exits from program execution so this must be reloaded for eventual next debug phases. Of course no breakpoint is available and/or activated during EXECUTION mode of application program.

MEMORY ORGANIZATION

Basically, all C programs use three fundamental memory areas: **code** area, **data** area, **stack** and **heap** area, while the control card features two kind of memories: **ROM** (EPROM or FLASH EPROM) which is read-only and **SRAM**, readable and writeable. **GCTR** charges to organize all the memory installed on the control card to make it available to the application program in the way the user has chosen. During installa phase, in fact, **GCTR** ask for the size of code area (in EPROM or FLASH EPROM) and data+stack+heap area (in SRAM) and self-configures automatically with the selections input by the user; for this reason it is not essential to worry about the hardware configuration during the work but it is enough to respect the indications provided in this paragraph, limiting to use only the allowed areas.

The **grifo**® control cards based on microprocessors of family I86, it is possible to set size and addresses of memory devices by software through programming a set of microprocessor internal registers and the eventual on board MMU circuitry. **GCTR** sets these registers (UMCS, MPCS, MMCS, LMCS, MMU) in the start-up code which is also configured during the installation. Control card always runs star-up code after a reset or a power on so the correct memory configuration is always guaranteed in the operating phase. If the memory needs of an application program change it is enough to reinstall **GCTR** and recompile the application program without any further modification. The following figures show the possible memory configurations supported by **GCTR**:

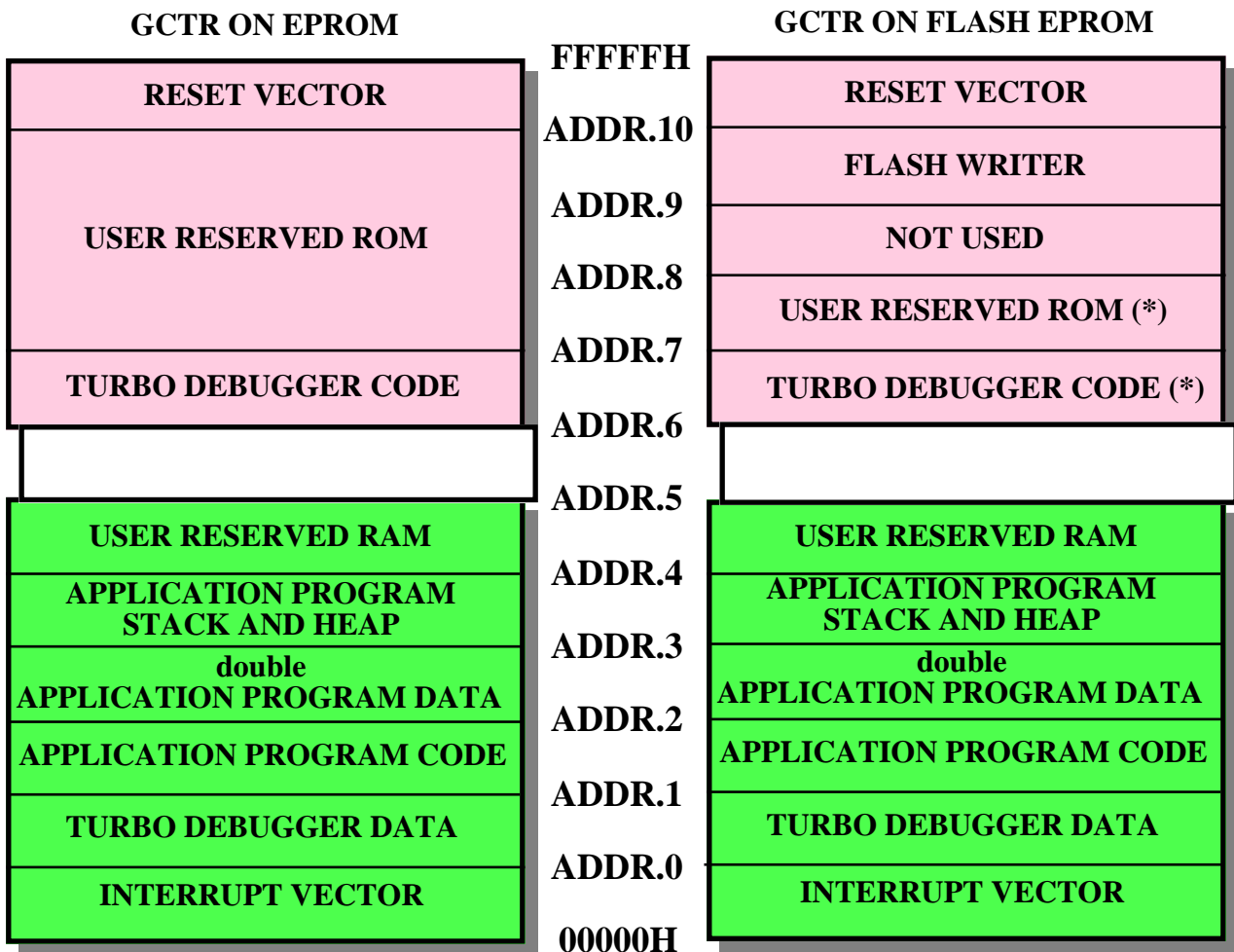


FIGURE 5: MEMORY CONFIGURATION IN DEVELOPMENT MODE

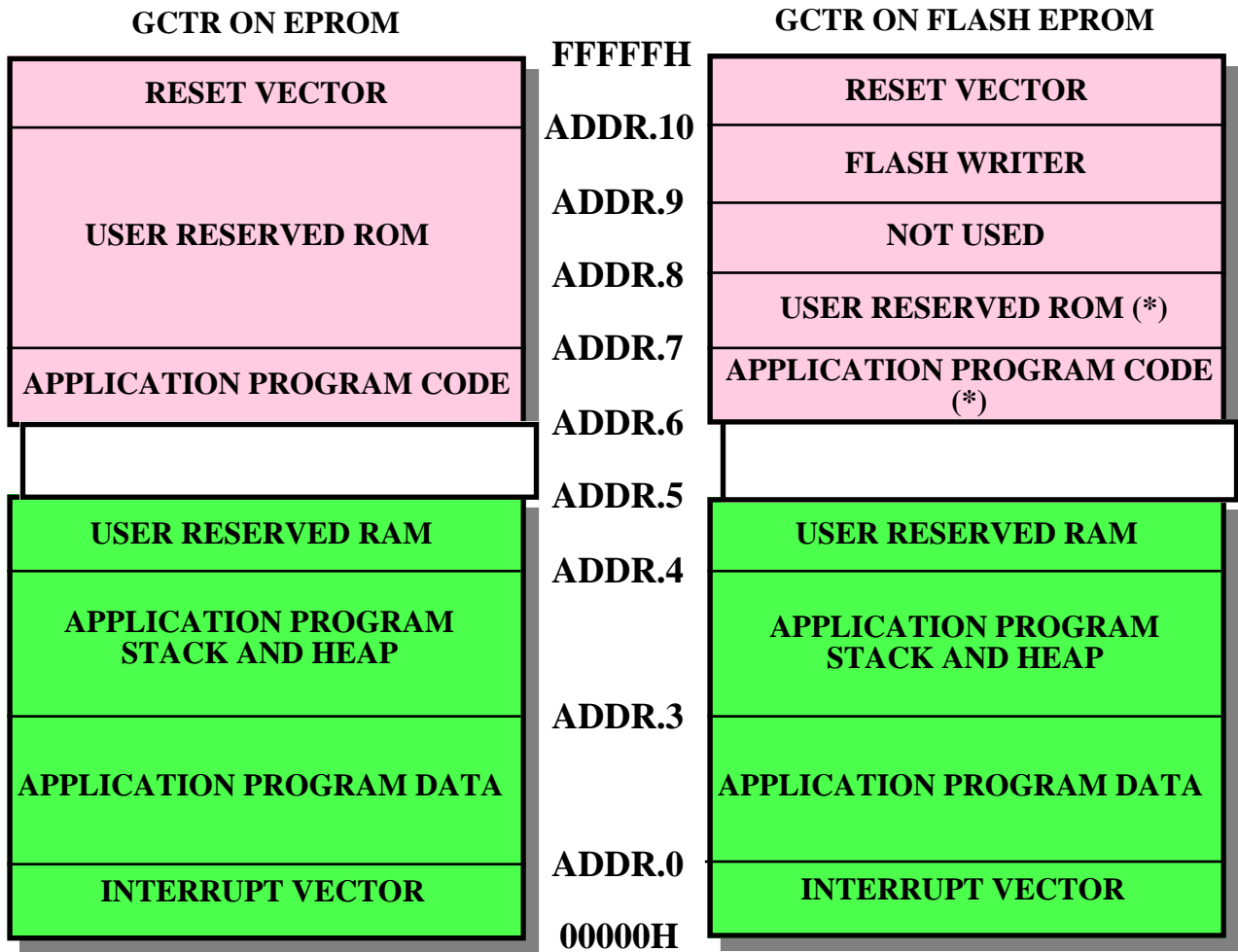


FIGURE 6: MEMORY CONFIGURATION IN EXECUTION MODE

The values of the addresses reported in figures 5 and 6 change according to the memory configuration installed on the control card and the memory area sizes set during the installation phase, as described in the following tables.

Size of DATA area set during installation	ADDR.0	ADDR.1	ADDR.2	ADDR.3	ADDR.4
64 Kbyte	00400H	00FC0H	?????H	?????H	10000H
128 Kbyte	00400H	00FC0H	?????H	?????H	20000H
256 Kbyte	00400H	00FC0H	?????H	?????H	40000H
512 Kbyte	00400H	00FC0H	?????H	?????H	80000H

FIGURE 7: SRAM MEMORY ADDRESSES VALUES SET DURING INSTALLATION

Configuration SRAM on card	ADDR.5
128 Kbyte	10000H
256 Kbyte	20000H
512 Kbyte	80000H

FIGURE 8: SRAM MEMORY ADDRESSES VALUES OF CONTROL CARD CONFIGURATION

Size of CODE area set during installation	ADDR.6	ADDR.7	ADDR.8	ADDR.9	ADDR.10
128 KByte	E0000H	?????H	FC000H	FC000H	FFFF0H
256 Kbyte	C0000H	?????H	F8000H	FC000H	FFFF0H
512 Kbyte	80000H	?????H	F0000H	FC000H	FFFF0H

FIGURE 9: ROM MEMORY ADDRESSES VALUES SET DURING INSTALLATION

Configuration ROM on card	ADDR.6
128 Kbyte	E0000H
256 Kbyte	C0000H
512 Kbyte	80000H

FIGURE 10: ROM MEMORY ADDRESSES VALUES OF CONTROL CARD CONFIGURATION

Wherever there is an undefined address (?????H) an exact value cannot be specified because the area size change according to the size of the application program under development and can be decided only by the user.

MEMORY USE NOTES

- Information about both data area and code area size of application program can be found in the files <filename>.MAP and <filename>.ABM which are generated by **GCTR** during its normal work.
- The **user area**, referred to by paragraph "FLASH EPROM PROGRAMMING", is the FLASH EPROM area delimited between the addresses ADDR.6 and ADDR.8, as denoted by the *, which indicates the areas that the user can modify using FLASH WRITER.
- For **GCTR** on FLASH EPROM the choice to have an area not used whose size depends on the memory size is due to the physical organization of the FLASH used. In fact this latter is divided into 8 sectors of equal size, for safety reasons it has been decided to protect the last sector making it unusable. This safety decision reduces the user area of an amount of memory acceptable.
- **GCTR** uses **large** memory model to provide the maximum dimension for all the areas of application program. Anyhow please remind that the DGROUPE segment can't exceed the 64K inclusive, as described in Borland C documentation.

- As described on figure 5 the TURBO DEBUGGER doubles the data area of application program saved on RAM, for an internal use. Summarizing on control card must be installed the following SRAM size: 0FC0H + application code + application data + application data + stack and heap + possible reserved memory.
- In DEVELOPMENT mode **GCTR** uses really much more RAM than those required in EXECUTION mode, in fact in the first condition TURBO DEBUGGER saves on RAM even other different areas of application program under development. For simplicity, security and cost reduction reasons it is possible to use a control card with the highest SRAM configuration during program generation (DEVELOPMENT mode) and after in production (EXECUTION mode) it is possible to use the only necessary configuration.

RESERVED MEMORY

One of the most common requirements during the development of industrial automation application programs is the availability of reserved memory areas, completely manageable by the user, where DMA transfers can be performed, data acquired from the field or parameters tables and/or messages can be stored, etc.

GCTR allows to have reserved memory areas both in SRAM and in ROM by simply installing on the control card enough memory for the application program plus the reserved space and installing **GCTR** specifying data and code area sizes enough for the application program only. Doing so, all the memory amount installed on the control card but not declared is automatically reserved. More in detail, **GCTR** never accesses in autonomy SRAM in the range ADDR.4÷ADDR.5 and ROM in the range ADDR.7÷ADDR.10 in case EPROM is used or in the range ADDR.7÷ADDR.8 in case FLASH EPROM is used.

For example, if the user needs 256 KBytes of SRAM to save data transferred through DMA and 50÷100 KBytes of SRAM for data+stack and heap area of application program, then control card will have to be configured with 512 KBytes of SRAM and **GCTR** will have to be installed specifying 256 KBytes for data area. Doing so, **GCTR** and the application program will never access addresses greater than or equal to ADDR.4 = 40000H and, starting from this address, the user will comfortably manage the DMA transfers.

If the user needs to save 10 Kbytes of messages in four different languages (totalizing 40 KBytes) in ROM and the application program size is 50 KBytes, then the control card will have to be configured with 128 KBytes of EPROM or FLASH EPROM, **GCTR** will have to be installed with 128 KBytes of code area and messages will be storable starting from F0000H. This address has been chosen 14 KBytes after ADDR.7 = EC800H to let the application program grow in size without having to move the messages.

To get information about size of code and data areas used by the application programs developed with **GCTR**, to sum to size of reserved areas, to install correctly the package and select the right quantity of memory installed on the control card, the user can examine the file .ABM generated by the support program CTOBIN. This file in fact contains the list of all application program segments specifying their size in bytes.

Should the available configurations not be able to satisfy the application program requirements, please contact **grifo**® directly.

CONSOLE MANAGEMENT

The development system **GCTR** is charged to manage a set of operator interfaces that can be used through C high level instructions dedicated to console management.

Operator interfacement has always been one of the worst problems of application programs, so availability of tools ready-to-use to ease the solution of this problem surely simplifies the user work and reduces the development time.

The console device managed through **GCTR** may be matched to hardware devices to use as operation interface, like printers, serial terminals, alphanumeric displays, status LEDs, matrix keyboards, etc. These devices can both be manufactured by **grifo**[®] (e.g. **QTP xxx**, **QTP xxxP**, **KDx x24**, **DEB 01**, **IAC 01**, etc.) and manufactured by third parts.

Console management is made by the application program through specific C high level instructions (cputs(), cprintf(), cscanf(), etc.) that call as many functions included in library CL.LIB; currently are available several functions that allow to activate status LEDs with attributes and to print and/or read both numeric and alphanumeric data, even formatted, on all hardware devices supported. For a detailed description of console functions please refer to "APPENDIX B" of this manual, where definitions, parameters description and use example are reported for each function.

Normally to manage correctly **GCTR** console the following operations must be performed in sequence:

- a) initialize the hardware device used to be able to connect the eventual console system connected (operation essential only for serial systems);
- b) select the hardware device to use as input;
- c) select the hardware device to use as output;
- d) use the selected devices with high level instructions;

It is immediate to see that a **GCTR** application program can manage even more than one input and output devices, provided that they all have been initialized and that the device to be used has been selected, also if a different device has been previously selected. The distinction between input and output devices allows to use different hardware system for these purposes, allowing, for example, to read data from a serial port and to print them on a parallel printer.

CONSOLE HARDWARE DEVICES

GCTR libraries are designed to manage a set of hardware console devices that can be used for input and/or output operations and that use some resources of the control card, as indicated below:

Hardware console device	I/O	Resources of control card used
Serial terminals, QTP xxx , P.C., etc	I/O	Serial line A
Serial terminals, QTP xxx , P.C., etc	I/O	Serial line B
External display and keyboard (KDx x24)	I/O	16 I/O digital lines
Display, keyboard and LEDs (QTP xxP)	I/O	16 I/O digital lines
Parallel printer (IAC 01 , DEB 01)	O	16 I/O digital lines

FIGURE 11: CONSOLE HARDWARE DEVICES

The devices that use 16 digital I/O lines are provided with a standard connector and can be connected directly to the control card, following the indications of figure 12, the connector also provides power supply. Should the interfaces manufactured by **grifo®** not fulfil the user needs it is possible to build own operator interfaces following the indications in “APPENDIX A” where the electric diagrams of some interfaces are reported.

CONTROL CARD	CONNECTOR	CONNECSION CABLE
GPC® 188F	CN2	FLAT 20+20
GPC® 188D	CN2	FLAT 20+20
GPC® 883	CN5	FLAT 20+20
GPC® 884	CN5	FLAT 26+20

FIGURE 12: CONSOLE DEVICES CONNECTIONS

For further information about console devices nominated in this paragraph and their possible configurations and potentialities, please refer to the specific documentation available on **grifo®** website or CD.

CONSOLE PREDEFINED SYMBOLS

GCTR provides an header file called GCLIBD.H that includes the definition of a set of symbols that must be used for high level management of console device:

QTP16P	->	Identifies the hardware console device QTP 16P	(*)
QTP24P	->	Identifies the hardware console device QTP 24P	(*)
KDxx24	->	Identifies the hardware console device KDx x24	(*)
SER0	->	Identifies the hardware console device serial port B	
SER1	->	Identifies the hardware console device serial port A	
PRINTER	->	Identifies the hardware console device parallel printer	
LCD20x2	->	Identifies a 20 characters by 2 rows LCD display	(#)
LCD20x4	->	Identifies a 20 characters by 4 rows LCD display	(#)
LCD40x2	->	Identifies a 40 characters by 2 rows LCD display	(#)
VFD20x2	->	Identifies a 20 characters by 2 rows fluorescent display	(#)

In the same file are present, in addition to these symbols, the prototypes of all the library functions for console management available to the user; these latter are widely described in “APPENDIX B”. Please remark that the symbols can be used directly as parameters for the library functions and that symbols marked with (*) must be ORed with symbols marked with (#) to define completely the console device used. No other symbols combination is allowed, they may cause a console libraries malfunction.

For further information about the use of predefined symbols please refer to the specific demonstration program called DEMOCONS.C which can manage all the console devices supported by **GCTR**.

MATRIX KEYBOARD

Here follow the tables with codes returned by **GCTR** when a key on the console device matrix keyboard is pressed. To make the description as generic as possible the keys are identified through their position in the matrix, that is through the signals of row and column available on the keyboard connector. The tables on figures 13, 14 and 15 and the electric diagrams on figures A2, A4 and A5 allow to know the key codes both for standard keyboards and for user-made keyboards.

PIN CN2 KDX x24	8	7	6	5	9	10
4	F = 70	E = 69	D = 68	C = 67	J = 74	N = 78
3	CR = 13	9 = 57	6 = 54	3 = 51	I = 73	M = 77
2	0 = 48	8 = 56	5 = 53	2 = 50	H = 72	L = 76
1	A = 65	7 = 55	4 = 52	1 = 49	G = 71	K = 75

FIGURE 13: KEY CODES OF KDX x24

PIN CN3 QTP 16P	8	7	6	5
4	D = 68	C = 67	B = 66	A = 65
3	# = 35	9 = 57	6 = 54	3 = 51
2	0 = 48	8 = 56	5 = 53	2 = 50
1	* = 42	7 = 55	4 = 52	1 = 49

FIGURE 14: KEY CODES OF QTP 16P

PIN CN3 QTP 24P	6	5	4	3	2	1
10	7 = 55	CR = 13	6 = 54	L = 76	H = 72	D = 68
9	ESC = 27	0 = 48	4 = 52	K = 75	G = 71	C = 67
8	5 = 53	9 = 57	3 = 51	J = 74	F = 70	B = 66
7	1 = 49	8 = 56	2 = 50	I = 73	E = 69	A = 65

FIGURE 15: KEY CODES OF QTP 24P

When the hardware device used as input is one of the above mentioned matrix keyboards, in addition to the 16 I/O lines also CPU Timer 2 and its interrupt are used. This latter is used to perform a periodic scanning of keyboard to detect eventual key pressures and to provide the typical debouncing and autorepeat features. In detail **GCTR** sets:

debouncing time = 20 msec
 autorepeat time = 100 msec
 first autorepeat delay = 500 msec
 keyboard buffer size = 5 keys

The autorepeat management starts to save a key code in the buffer once every 100 msec, if that key has been pressed for more than 500 msec, and stops saving when the key is released. The code of every key pressed is saved in the buffer, which is a FIFO, here it is ready to be read by the library functions; pressing more than 3 keys without any read from the buffer means the loss of these extra characters because there is no physical space where to store them.

CONSOLE COMMANDS

This paragraph shows all the command sequences that can be used to take advantage of the main console device hardware features. **GCTR** shows on the display all the characters having a code included in the range **32÷255 (20÷FF Hex)**; if it is sent a code not included in this range and this latter is not a command, the code is ignored. The character is printed in the current cursor position, this latter will move one position to the right; if the cursor is in the last position (bottom right corner) it will be moved to Home position (top left corner).

For each command a double description is reported: a mnemonic description, based on ASCII characters, and the numeric description, both in decimal and hexadecimal form. These commands are compliant to **ADDS View-Point** standard, so all the command sequences start with character **ESC**, corresponding to decimal code 27 (**0x1B**). Of course, the effect of each command depends on the kind of hardware console peripheral used, so, for example, all the listed commands will be managed correctly by **QTP xx** or **QTP xxP** but will not be managed by a printer or a serial terminal that is not **ADDS View-Point** compliant.

Please remark that for some of the commands listed here below there are library functions which perform exactly the same action: for further information refer to **APPENDIX C** of this manual.

CURSOR LEFT

Code: 21
Hex code: 0x15
Mnemonic: NACK

The cursor is shifted of one position to the left without modifying the display contents. If the cursor is in Home position, it will be placed in the last position of the last row of the display.

CURSOR RIGHT

Code: 6
Hex code: 0x06
Mnemonic: ACK

The cursor is shifted of one position to the right. If the cursor is placed in the last position of the last row, it will be moved to the Home position.

CURSOR DOWN

Code: **10**
Hex code: **0x0A**
Mnemonic: **LF**

The cursor will be moved to the line below but it will remain in the same column. If the cursor is in the last display line, it will be moved to the first display line.

CURSOR UP

Code: **26**
Hex code: **0x1A**
Mnemonic: **SUB**

The cursor will be moved to the line above but it will remain in the same column. If the cursor is in the first display line, it will be moved to the last display line.

HOME

Code: **1**
Hex code: **0x01**
Mnemonic: **SOH**

The cursor is moved to Home position i.e first line, first column of the display, or on the other hand the up, left corner

CARRIAGE RETURN

Code: **13**
Hex code: **0x0D**
Mnemonic: **CR**

The cursor is moved to the beginning of the line where it was located.

CARRIAGE RETURN+LINE FEED

Code: **29**
Hex code: **0x1D**
Mnemonic: **GS**

The cursor is moved to the beginning of line above the one where it was located. If the cursor is at the last display line, it will be moved to the beginning of the first line i.e Home position.

ALPHANUMERIC CURSOR PLACEMENT

Code: 27 89 r c
Hex code: 0x1B 59 r c
Mnemonic: ESC Y ASCII(r) ASCII(c)

The cursor is moved to the absolute position indicated by "r" and "c".

These codes are the row and column values of the position, plus a constant offset of **32 (20 Hex)**.

If, for example, the user wants to place the cursor at Home position (line 0, column 0), the following byte sequence must be sent:

27 89 32 32.

If row and/or column values are not compatible to the installed display, the command is ignored.

BACKSPACE

Code: 8
Hex code: 0x08
Mnemonic: BS

This command moves the cursor one character position to the left and it erase the contents of the reached cell.

If the cursor is in Home position, it will be erased the last character of the last row of the display.

CLEAR PAGE

Code: 12
Hex code: 0x0C
Mnemonic: FF

This command clears all data on the display and it moves the cursor to Home position.

CLEAR LINE

Code: 25
Hex code: 0x19
Mnemonic: EM

This command erases all characters displayed on the current line and it moves the cursor to the first column of the said line.

CLEAR END OF LINE

Code: 27 75
Hex code: 0x1B 0x4B
Mnemonic: ESC K

This command erases all characters displayed from the current cursor position to the end of line inclusive. The cursor mantains the previous position.

If, for example, the cursor is at the beginning of a display line, the complete line will be erased.

CLEAR END OF PAGE

Code: 27 107
Hex code: 0x1B 0x6B
Mnemonic: ESC k

This command erases all characters displayed from the current cursor position to the end of display inclusive. The cursor maintains the previous position.

If, for example, the cursor is at Home position, the complete display will be erased.

CURSOR OFF

Code: 27 80
Hex code: 0x1B 0x50
Mnemonic: ESC P

The cursor is not active and it is not more visible.

STATIC CURSOR ON

Code: 27 79
Hex code: 0x1B 0x4F
Mnemonic: ESC O

The cursor is activated so it is visible. Now it is a not blinking line placed under the char.

NOTE: This command is not available when **fluorescent display 20x4** is used.

BLINKING CURSOR ON

Code: 27 77
Hex code: 0x1B 0x4D
Mnemonic: ESC M

The cursor is activated so it is visible. Now it is a blinking line placed under the char.

LEDS ACTIVATION

Code: 27 50 n.LED Attr.
Hex code: 0x1B 0x32 n.LED Attr.
Mnemonic: ESC 2 ASCII(n.LED) ASCII(Attr.)

The LED shown in "n.LED" is setted with the attribute specified in "Attr.". The LEDs numbers are included in **0÷15** range as shwon in figure B1.

The available attributes are as follows:

0	(00 Hex)	->	Not enabled LED
255	(FF Hex)	->	Enabled LED
85	(55Hex)	->	Blinking LED

For example if you wish to enable LED n.5 with blinking attribute, the following sequence has to be sent:

27 50 5 85

If the parameters LED number or attribute are not valid, the command is ignored.

LEDS ACTIVATION WITH MASK

Code: 27 52 mask1 mask2 mask3
Hex code: 0x1B 0x34 mask1 mask2 mask3
Menomonic: ESC 4 ASCII(mask1) ASCII(mask2) ASCII(mask3)

All the LEDs available on the console system (like **QTP 24, QTP 24P, QTP 22, QTP G28**, etc.) are contemporarily managed as indicated in "mask1", "mask2" and "mask3" with the following corrispondence:

mask1 (bit 0 ...7)	->	LED 0 ... LED 7
mask2 (bit 0 ...7)	->	LED 8 ... LED 15
mask3	->	(No function, manteined for compatibility)

If a bit is placed at 0 logic state, the correpondent LED is turned off (disabled), viceversa it will be turned on (enabled) if the correspondent bit is at 1 state.

If there are some LEDs having the blinking attribute, this latter will be disabled.

LEDs numbers range from **0 to 15** and are assigned like in figure B1.

NOTE: The "mask3" must be always sent even if it has no meaning, for a correct management of all the terminal's LEDs.

LIBRARIES

Libraries can be used when programming with **GCTR** like with any other C compiler. The package delivers four library files:

LCTR_T.LIB	to make the code ROMable;
CL.LIB	which is the Borland TURBO C++ standard library with console functions, timing functions and date and time management functions modified;
MATHL.LIB	allows to use the wide set of Borland C mathematic functions;
EMU.LIB	to perform floating point operations with a math coprocessor software emulation when this latter is not available on the control card.

Suffix or prefix L present in many library names indicate the memory model used by **GCTR**. This latter is **Large** model because it is the best choice to take the maximum advantage of the memory configuration on the control card.

The user can freely intervene on the libraries but only changing them in fact the support programs CTODEB and CTOBIN, that perform link phase, can't use other files different from those above listed. However new library functions can be added to standard library CL.LIB without restrictions. The modification and/or addition modalities are the typical ones of the used Borland package, managed by dedicated program TLIB. When the source code of the library functions that must be modified or added is available it can be alternatively used the include technique: the source files will be simply "inserted" inside the application program used with CTODEB and CTOBIN.

Using the library functions means to include its specific header files (*.H) where function prototypes and eventual data structures are declared. The complete set of .H files is stored in the work directory of **GCTR** during the installation and the user should include only the ones needed.

In "APPENDIX B" of this manual the list of library functions ROMed and/or modified is present; in the list also function's needed header file name is specified. The library functions provided replace the standard functions with the same name so can be used directly in the applications program developed by the user.

The source file of libraries is not included in **GCTR** package but can be requested directly to grifo® if this is essential. Several demonstration programs that use library functions are provided, to make them immediately usable.

Remarkable is the possibility to manage directly the console redirected to the serial port of control card, in fact this feature provides the user a minimum interface like the one usually available for Borland C++ on PC without any effort. To take full advantage of this feature the user will have to configure the console PC as previously described.

EXTERNAL WATCH DOG

GCTR performs autonomously the periodic retrigger of external watch dog circuit available on each control card. In this way the customer that develops an application that uses external watch dog can restfully connect this circuit and he has not to perform retrigger when **GCTR** is executed (start up code, TURBO DEBUGGER, library function with a long execution time). Naturally when the application program developed by the user is executed, the periodic retrigger of watch dog circuit must be performed by the same program, to avoid circuit intervention and consequent card reset. To spare unwanted retrigger, if watch dog circuit intervenes when application program is executed, you must always:

- restart communication with TURBO DEBUGGER through a keyboard breakpoint <CTRL>+<BREAK>;
- exit from TURBO DEBUGGER on development P.C.;
- reset or resupply power to control card;
- restart normal application program development.

USER CONFIGURATIONS

As described in the previous paragraph, **GCTR** features a range of configurations that allow the user to define the development package functionalities. For completeness in this paragraph all these configurations are described, defining for each one meaning and setting modalities.

- **EDITOR:** this is the editor by which the user writes and/or modifies the source of application program when uses CTODEB. It is suggestable to use the editor integrated in Borland C I.D.E. because it provides features like color coding, syntax check, an on line help about C, etc. The choice of the editor is made during the installation phase or modifying the ASCII file GCTR.IDE where the editor complete pathname is stored.
- **Borland C I.D.E.:** if the Borland C I.D.E. has been selected as editor of GCTR and the user wants to take advantage of its application program syntax check feature (command Compile), I.D.E. itself must be configured for the memory model and warning level desired. This means to select manually the Large memory model in the compilers options and to activate all alarm messages (All) in messages options. These configurations must be performed through the specific I.D.E. modalities, as described in its own documentation, and saved to make them permanent (refer to example at step 9 of "HOW TO START" chapter).
- **CODE AREA SIZE:** this is the size of memory area used by **GCTR** to store the application program code. It can set only during installation phase.
- **DATA AREA SIZE:** this is the size of memory area used by **GCTR** to store data, stack and heap of application program. It can set only during installation phase.
- **Development PC serial port:** this is the development PC serial line connected to the control card used to debug and store to FLASH EPROM the application program. It can set only during installation phase.

DIFFERENCES AMONGST BORLAND C++, TURBO C OR C++ AND GCTR

The differences are due to the fact that the first three have been developed for PC hardware platforms where also an operating system exists while the control card where the last one works does not have this structure.

- 1 - The standard start-up code must be replaced with a specific one capable to work from EPROM or FLASH EPROM even when the operating system is absent (for further information please refer to the paragraph "START UP CODE").

- 2 - Some library functions related to date and time cannot be used. In detail the functions to set and get the current date and time have been changed to manage the hardware real time clock (RTC) on the control card while the functions based on “system ticks” cannot be modified and so used.
- 3 - Library functions related to PC hardware peripherals (files on hard disk or floppy disk, mass memories, monitor, graphic, printer, serial communication, etc.) cannot be used on the control card.
- 4 - The library functions related to the console cannot be used on their original form because they use operating system calls, so they have been modified to redirect their data flow on one of the hardware devices supported, as described in the paragraph “CONSOLE MANAGEMENT”.
- 5 - An application program developed with **GCTR** enters an infinite loop when it terminates because the control cannot be returned to an operating system that does not exist on the control card. The termination conditions of an application program are the classical ones like an error during execution, the reaching of main function end, a call to INT 21H, the function “exit()”, etc.
- 6 - Timing of generated code are constant. The absence of MS-DOS or WINDOWS operating systems and their interrupts warrants unchangeable execution times of generated code, consequently the possibility to fix in advance and to measure with certainty program performances.
- 7 - The program generated by linker must be transformed in its memory utilization before being executed. This transformation is called allocation and is performed by a specific program described in the paragraph “LOCATOR”.
- 8 - In DEVELOPMENT mode of application program the serial line A on the control card is always used by TURBO DEBUGGER and so is not available for the application program. Developing PC programs the debug is performed using monitor and keyboard which are not completely dedicated and so can continue to perform console tasks.

Further differences can be easily encountered during the debug phase and opportunely managed while for further information about the changes to the libraries please refer to the paragraph about libraries and to “APPENDIX B”.

DEMO PROGRAMS

GCTR is delivered with a set of examples that show the employ modalities of the development package and allow to take advantage of the control board resources in the least time possible. Here follows the list of these demo programs with a short description:

C:\GCTRxxx\DEMOCONS.C

Demo for the management of all console hardware devices through library functions.

C:\GCTRxxx\DEMOFP.C

Demo for the management of the main mathematical functions on floating point variables.

C:\GCTRxxx\DEMORIT.C

Demo for the management of the time delays functions.

C:\GCTRxxx\DEMORTC.C

Demo for the library functions that manage date and time through real time clock.

C:\GCTRxxx\IRQxxx.C

Demo for the management of interrupt generated by hardware peripherals of **GPC® xxx** control card.

C:\GCTRxxx\PRxxx.C

Demo for the management of all hardware sections of **GPC® xxx** control card.

C:\GCTRxxx\TEST.C

Program to learn the **GCTR** use modalities, used in the chapter "HOW TO START".

C:\GCTRxxx\DEB01*.C

Demo programs for **DEB 01** didactic board management, connected to **GPC® xxx** control card, in all its sections.

Of course all these programs are provided in source form, are well documented and are structured to be used directly by the user. This latter will be able whether to use part of these examples (for examples the functions) without any change orto examine the source text and modify it according to the needs.

VERSIONS OF GCTR

The following basic versions of the software package are available:

GCTR xxx

Development environment for control card **GPC® xxx** in EPROM.

FGCTR xxx

Development environment for control card **GPC® xxx** in FLASH EPROM size 128K Byte.

FGCTR xxx.512K

Development environment for control card **GPC® xxx** in FLASH EPROM size 512K Byte.

FWR xxx

FLASH EPROM size 128 KByte for control card **GPC® xxx**, with FLASH WRITER programmed in the first sector.

FWR xxx.512K

FLASH EPROM size 512 KByte for control card **GPC® xxx**, with FLASH WRITER programmed in the first sector.

The five above reported signatures fit for the card with basic clock frequency (20 MHz for **GPC® 188F/D** and 26 MHz for **GPC® 884, GPC® 884**); if the user wants to use **GCTR** with higher clock frequencies, specific versions identified with suffix .xxM must be ordered (for example .40M for **GPC® 884** at 40 MHz). Please remark that the above reported signatures can be used directly to make orders.

Like every software and firmware, also **GCTR** is continuously changed and improved to satisfy completely the new requirements of the users and correct the eventual problems. Here follows a brief description of the changes made to the development package according to the version number:

- Ver. 1.0 -> First version.
- Ver. 1.1 -> Added installation program.
- Ver. 2.0 -> Added complete management for floating point.
- Ver. 3.1 -> Added FLASH EPROM management; employed large memory model; added management of **GPC® 884**.
- Ver. 3.2 -> Improved start-up code setting.
- Ver. 3.3 -> Added selection of control card memory amount; added hardware breakpoint management.
- Ver. 3.4 -> Improved library functions; added serial port selection on development PC; increased warning level; added utilization from WINDOWS 3.1, 95, 98, ME.
- Ver. 3.5 -> Added external watch dog retrigger; improved demo programs; added management of **GPC® 883**.

Any eventual improvement or addition the user thinks may be interesting can be suggested contacting **grifo®** directly.

BIBLIOGRAPHY

Here follows a list of manuals and technical notes to which user can refer to obtain further information that simplify the use of **GCTR**:

Title	Author/s
The C programming language	Brian W. Kernighan and Dennis M. Ritchie
BORLAND C++ - User Guide	Borland
BORLAND C++ - Programming Guide	Borland
TURBO DEBUGGER - User Guide	Borland
BORLAND C++ - Libraries	Borland

To get all the updated versions of such manuals, example application programs, special writing, etc. please refer to the specific internet sites.



APPENDIX A: ELECTRIC DIAGRAMS

This appendix shows some of the console hardware managed by GCTR electric diagrams. Each of the se interfaces can be produced in autonomy or can be ordered directly from grifo®.

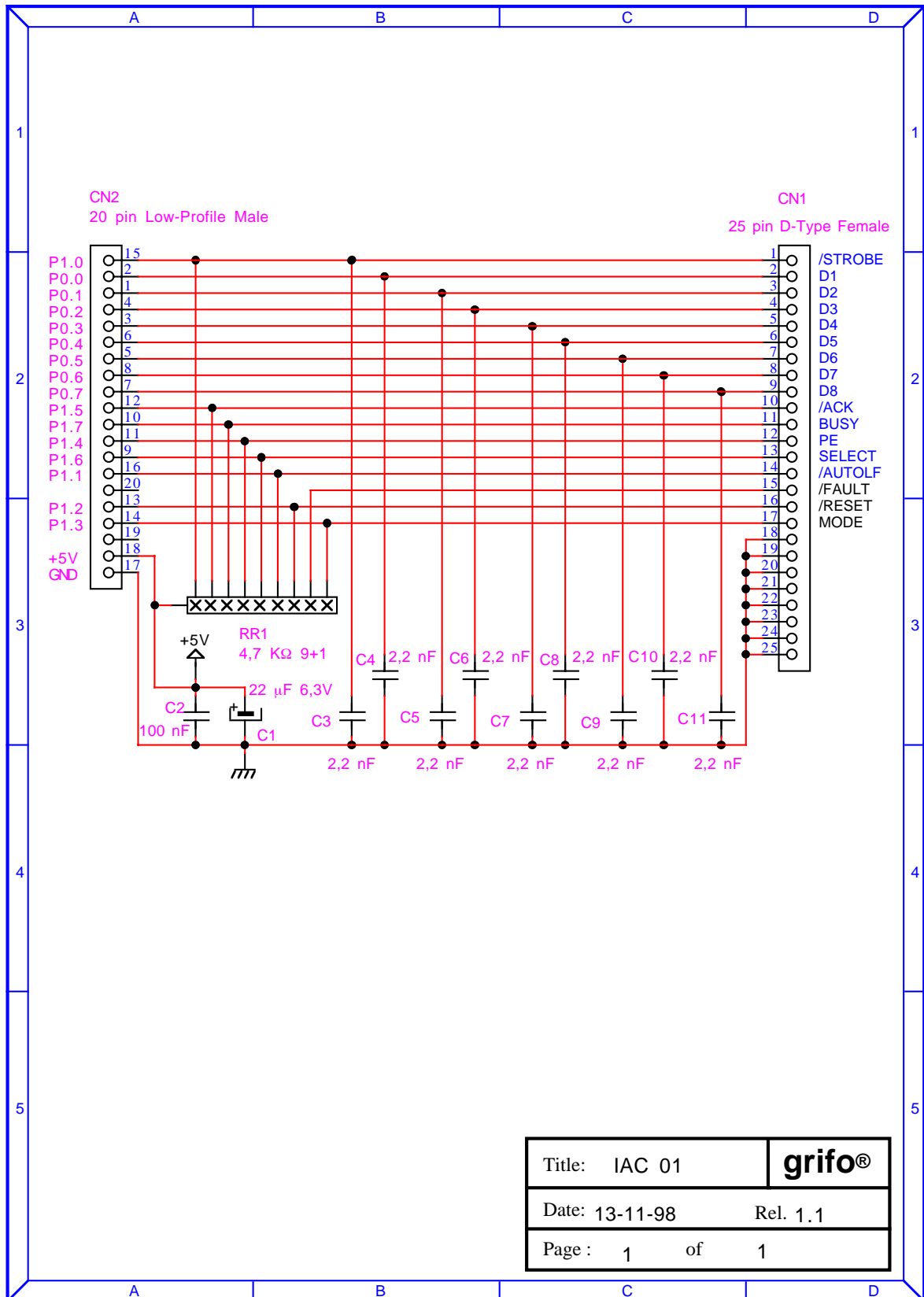
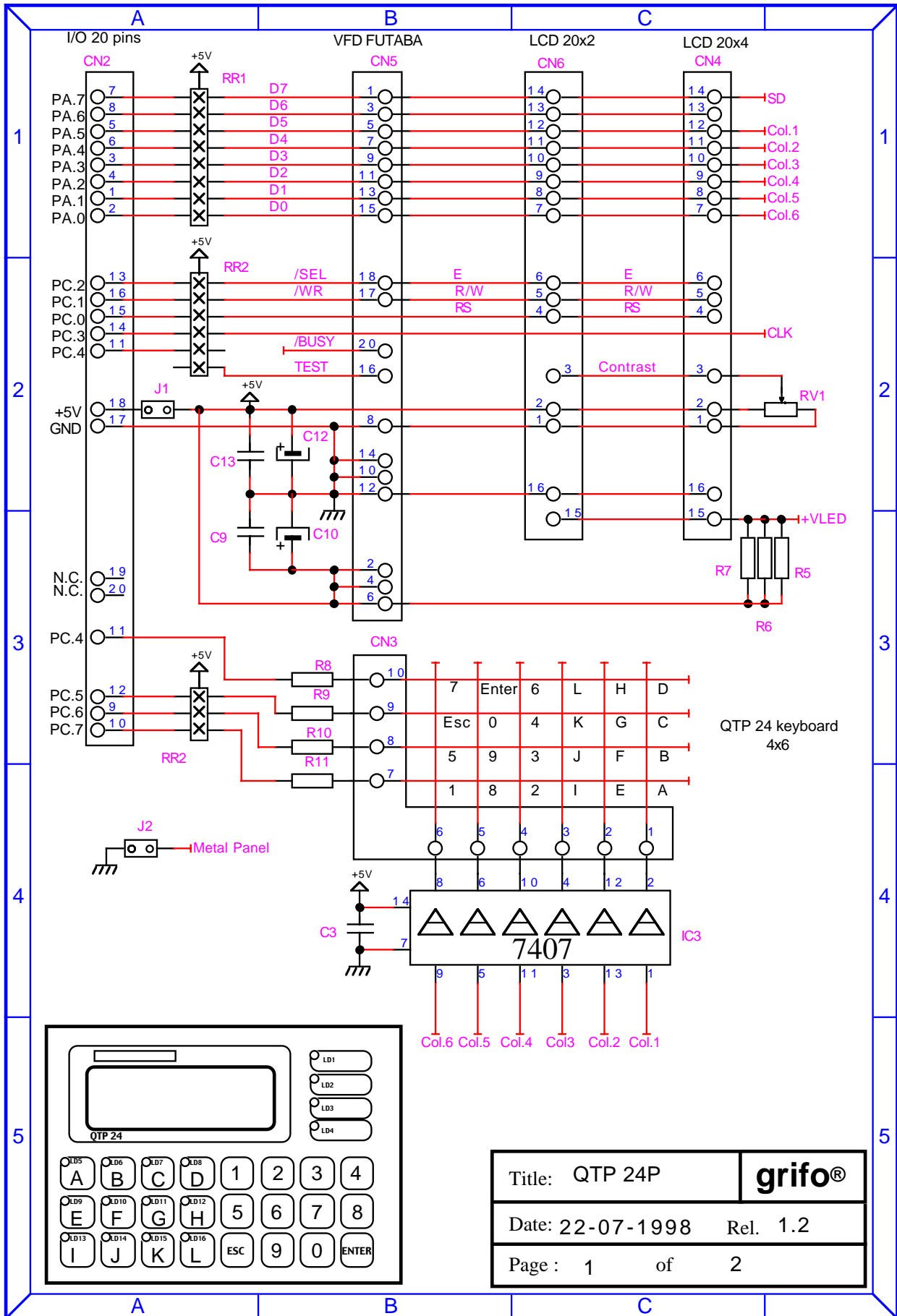


FIGURE A1: IAC 01 ELECTRIC DIAGRAM



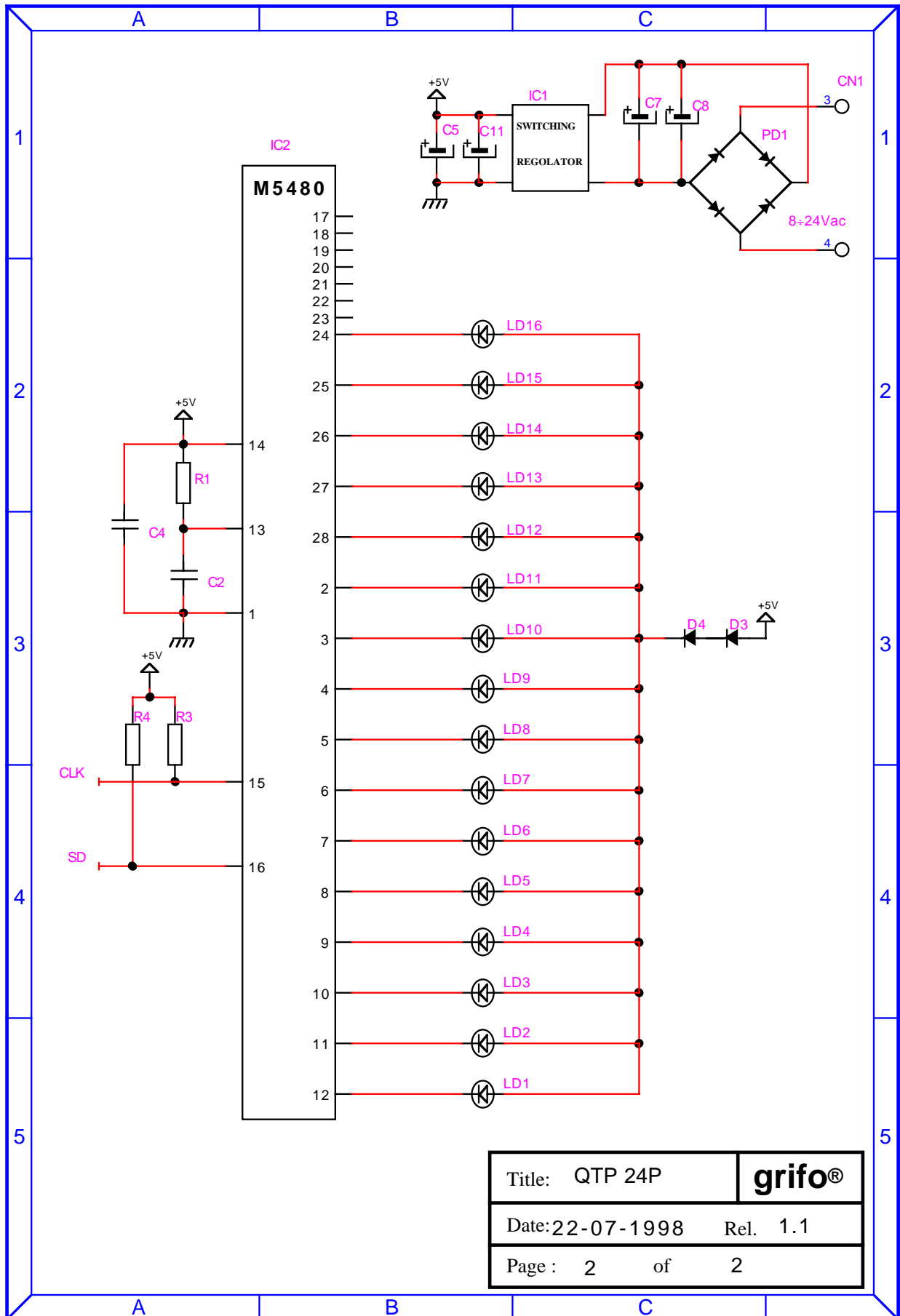
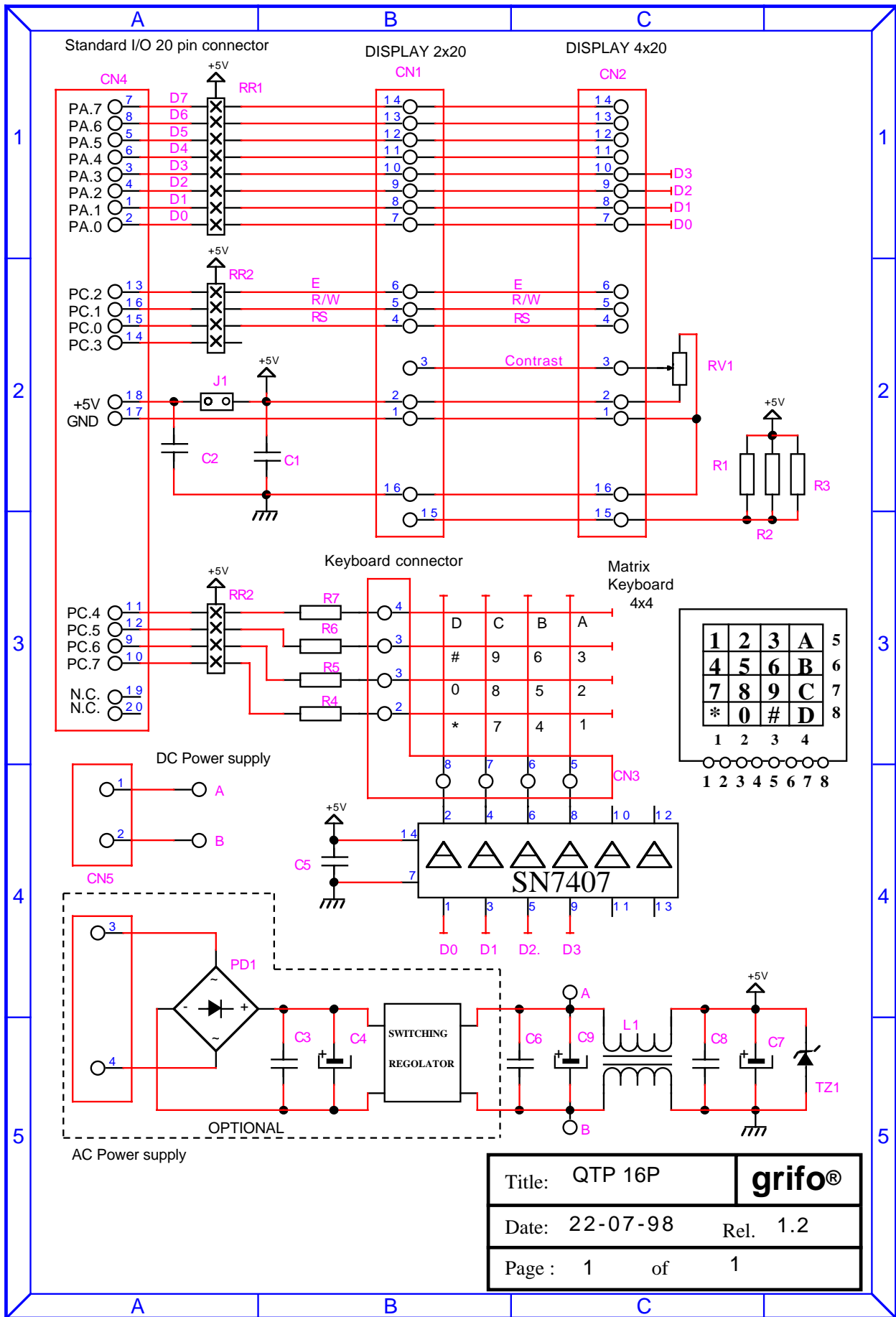


FIGURE A3: QTP 24P ELECTRIC DIAGRAM (2 OF 2)



Title: QTP 16P	grifo®
Date: 22-07-98	Rel. 1.2
Page : 1	of 1

FIGURE A4: QTP 16P ELECTRIC DIAGRAM



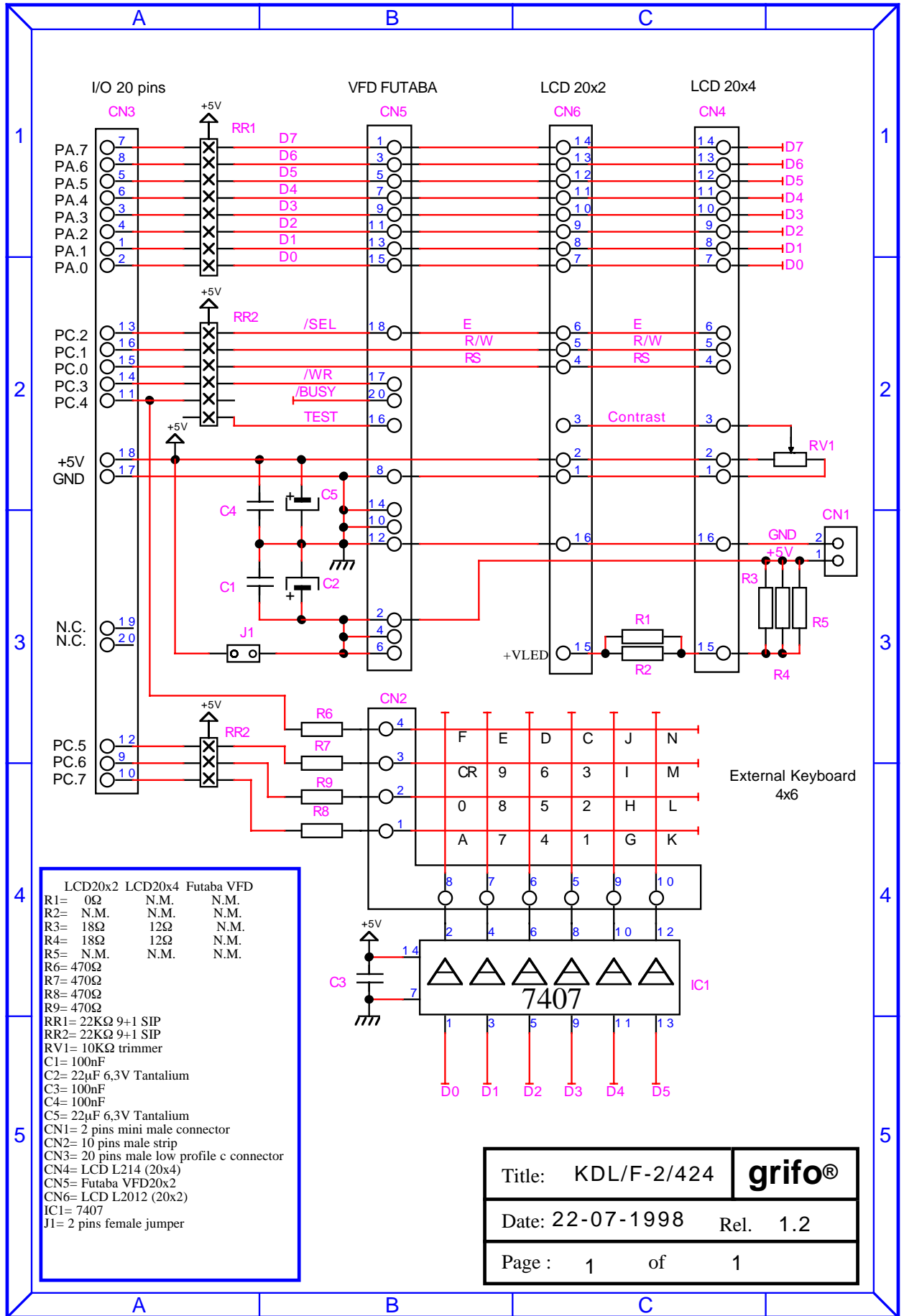


FIGURE A5: KDX x24 ELECTRIC DIAGRAM



APPENDIX B: LIBRARY FUNCTIONS CHANGED

CALLOC

Definition:

```
#include <ALLOC.H>
void* calloc(unsigned int items, unsigned int size);
```

Library:

LCTR_T.LIB

Description:

Function calloc allocates a memory area and resets it. The amount of memory allocated by a call to this function corresponds to items*size bytes, must be lower than 64K Bytes and is allocated in the heap area.

Example:

```
struct zoo*park1;
park1=calloc(105,sizeof(struct zoo));
```

Parameters returned:

Function calloc returns a pointer to the memory allocated if it works successfully or a NULL pointer in case of error. The pointer returned is NULL also when available memory is insufficient to fulfil completely the request.

CLREOL

Definition:

```
#include <CONIO.H>
void clreol(void);
```

Library:

CL.LIB

Description:

Function clreol deletes all the characters from current cursor position to the end of the line without moving the cursor position. If a serial line has been selected as output console device it will receive the ADDS View-Point codes for this action.

Example:

```
integer i;
cputs("Insert number of pieces=");
clreol();
scanf("%d",&i);
```

Parameters returned:

Function clreol returns nothing.

CLRSCR

Definition:

```
#include <CONIO.H>
void clrscr(void);
```

Library:

CL.LIB

Description:

Function clrscr deletes all the characters on the screen and locates the cursor to Home position (the top left corner). If a serial line has been selected as output console device it will receive the ADDS View-Point codes for this action.

Example:

```
clrscr();
cputs("Help screen: select item with arrow keys");
cputs("      :                :                :");
```

Parameters returned:

Function clrscr returns nothing.

CPRINTF

Definition:

```
#include <CONIO.H>
int cprintf(const char *format [,argument,.....]);
```

Library:

CL.LIB

Description:

Function cprintf manages the formatted representation (feature of the famous function printf) to the selected output console hardware device; the device must be selected and/or initialized previously. All formats can be used to create the constant format and for further information please refer to C programming manual.

Example:

```
integer i;
float d[100];
cprintf("Index= %d Value= %f \r\n",i,d[i]);
```

Parameters returned:

Function cprintf return the number of charactes printed.

CPUTS

Definition:

```
#include <CONIO.H>
int cputs(const char *str);
```

Library:

CL.LIB

Description:

Function cputs manages a string representation to the selected output console hardware device; the device must be selected and/or initialized previously. String str must be terminated with null character and the function does not represent CR or LF characters.

Example:

```
cputs("Produzione arrestata");
```

Parameters returned:

Function cputs returns the represented character code.

CSCANF

Definition:

```
#include <CONIO.H>
int cscanf(const char *format [,address,.....]);
```

Library:

CL.LIB

Description:

Function scanf manages the formatted input (feature of the famous function scanf) from selected input console hardware device: the device must be selected and/or initialized previously. All formats can be used to create the constant format and for further information please refer to C programming manual.

Example:

```
integer i;
float d;
cscanf("%d %f",&i,&d);
```

Parameters returned:

Function cscanf returns the number of values correctly acquired.

DELAY

Definition:

```
#include <DOS.H>
void delay(unsigned int milliseconds);
```

Library:

CL.LIB

Description:

Function delay performs a calibrated delay whose lasting is determined by parameter milliseconds and is expressed in milliseconds.

Example:

```
outp(PA,0x01);      // Activates output for 50 msec
delay(50);
outp(PA,0x00);
```

Parameters returned:

Function delay returns nothing.

DISABLE

Definition:

```
#include <DOS.H>
void _disable(void);
```

Library:

LCTR_T.LIB

Description:

Function _disable disables the microprocessor interrupt management bit, which finds in the flags register.

Example:

```
_disable();
```

Parameters returned:

Function _disable returns nothing.

DELLINE

Definition:

```
#include <CONIO.H>
void delline(void);
```

Library:

CL.LIB

Description:

Function `delline` deletes the line where the cursor finds, then the cursor is located at the beginning of the line. If a serial line has been selected as output console device it will receive the ADDS View-Point codes for this action.

Example:

```
integer i;
delline();
cputs("Input number of pieces=");
cscanf("%d",&i);
```

Parameters returned:

Function `delline` returns nothing.

DOS_GETDATE

Definition:

```
#include <DOS.H>
void _dos_getdate(struct dosdate_t *datep);
```

Library:

CL.LIB

Description:

Function `_dos_getdate` fetches current date from Real Time Clock on the control card and stores it to the structured variable `datep`. This latter must be a pointer to the type `dosdate_t`, declared in the header `DOS.H`, that contains four variables: `day` (unsigned char), `month` (unsigned char), `year` (unsigned int) and `dayofweek` (unsigned char).

Example:

```
struct dosdate_t dd;
_dos_getdate(&dd);
cprintf("Current date: %2d/%2d/%2d", dd.day, dd.month, dd.year);
```

Parameters returned:

Function `_dos_getdate` returns nothing.

DOS_GETTIME

Definition:

```
#include <DOS.H>
void _dos_gettime(struct dostime_t *timep);
```

Library:

CL.LIB

Description:

Function `_dos_gettime` fetches current time from Real Time Clock of control card and stores it in the structured variable `timep`. This latter must be a pointer to a variable of type `dostime_t`, declared in header file `DOS.H`, that contains four variables `hour`, `minute`, `second`, `hsecond` (all unsigned char). Control card RTC does not manage hundreds of seconds (structure member `hsecond`), so its value is always zero.

Example:

```
struct dostime_t tt;
_dos_getdate(&tt);
cprintf("Current time: %2d:%2d:%2d", tt.hour, tt.minute, tt.second);
```

Parameters returned:

Function `_dos_gettime` returns nothing.

DOS_GETVECT

Definition:

```
#include <DOS.H>
void interrupt (*_dos_getvect(unsigned int intnum)) ();
```

Library:

LCTR_T.LIB

Description:

Function `_dos_getvect` fetches the address of response routine of interrupt specified by `intnum` from the memory area reserved to interrupt vectors in a safe way (disabling interrupts themselves). Intel86 microprocessors family can manage 256 different interrupts, numbered from `0x00` to `0xFF`, whose vectors are stored sequentially in the first kilobyte of memory from `0x0000` to `0x0400`.

Example:

```
void interrupt(*oldfunc) (__CPPARGS);
oldfunc=_dos_getvect(5);
```

Parameters returned:

The far address (one word for segment and one word for offset) of the specified interrupt response procedure is returned by this function.

DOS SETDATE

Definition:

```
#include <DOS.H>
unsigned char _dos_setdate(struct dosdate_t *datep);
```

Library:

CL.LIB

Description:

Function `_dos_setdate` sets on Real Time Clock of control card the date stored in the structured variable `datep`. This latter must be a pointer to the type `dosdate_t`, declared in the header `DOS.H`, that contains four variables: `day` (unsigned char), `month` (unsigned char), `year` (unsigned int) and `dayofweek` (unsigned char).

Example:

```
struct dosdate_t dd;
dd.day=1;           // Sets RTC to beginning of century
dd.month=1;
dd.year=0;
_dos_setdate(&dd);
```

Parameters returned:

Function `_dos_setdate` always returns 0 to indicate that setting has been succesful.

DOS SETTIME

Definition:

```
#include <DOS.H>
unsigned char _dos_settime(struct dostime_t *timep);
```

Library:

CL.LIB

Description:

Function `_dos_settime` sets on Real Time Clock of control card the time stored in the structured variable `timep`. This latter must be a pointer to a variable of type `dostime_t`, declared in header file `DOS.H`, that contains four variables `hour`, `minute`, `second`, `hsecond` (all unsigned char). Control card RTC does not manage hundreds of seconds (structure member `hsecond`), so it is not evaluated by the function.

Example:

```
struct dostime_t tt;
tt.hour=tt.minute=tt.second=1;           // Sets RTC to beginning of day
_dos_setdate(&tt);
```

Parameters returned:

Function `_dos_settime` always returns 0 to indicate that setting has been succesful.

DOS SETVECT

Definition:

```
#include <DOS.H>
void _dos_setvect(unsigned int intnum, void interrupt far(*isr) ());
```

Library:

LCTR_T.LIB

Description:

Function `_dos_setvect` sets the address for the response procedure to interrupt specified by `intnum` into the memory area reserved to interrupt vectors in a safe way (disabling interrupts themselves). Intel86 microprocessors family can manage 256 different interrupts, numbered from 0x00 to 0xFF, whose vectors are stored sequentially in the first kilobyte of memory from 0x0000 to 0x0400.

Example:

```
_dos_setvect(5,intris);
void interrupt intris(void)
{
}
```

Parameters returned:

Function `_dos_setvect` returns nothing.

ENABLE

Definition:

```
#include <DOS.H>
void _enable(void);
```

Library:

LCTR_T.LIB

Description:

Function `_enable` enables the microprocessor interrupt management bit, which finds in the flags register.

Example:

```
_enable();
```

Parameters returned:

Function `_enable` returns nothing.

EXIT

Definition:

```
#include <STDLIB.H>
void _exit(int value);
```

Library:

LCTR_T.LIB

Description:

Function `_exit` is different from the common C `exit()` function because it does not to MS-DOS or WINDOWS operating system but simply it stores the exit code to variable `_exit_status`, enables interrupts and enters an infinite loop. Function `exit` can be used with profit during debug phase, in fact setting a breakpoint on it and getting the exit code it is always possible to determine the cause of program execution termination even it has not been explicitly called from application program. To perform this check with TURBO DEBUGGER a breakpoint must be set on the label `_exit` then execute single steps (F8) when this is reached up to the infinite loop of `_abort` procedure; at this point it is possible to inspect the value stored in variable `_exit_status`.

Here follows the correspondance between exit causes and respective numeric exit codes:

Normal return from main	->	0x80
NULL pointer assignment	->	0x81
Stack overflow	->	0x82
Call to INT 21H of operating system	->	0x83
Floating point emulator not initialized	->	0x90
Division by 0	->	0x91
Division overflow	->	0x92

Example:

```
exit(0);
```

Parameters returned:

Function `_exit` returns nothing and function itself does not return to the caller.

FAR FREE

Definition:

```
#include <ALLOC.H>
void far_free(void far *block);
```

Library:

LCTR_T.LIB

Description:

Function far_free frees the memory previously allocated by function far_malloc. It is equivalent to function free in large memory model and releases memory only if the variable block has a valid value.

Example:

```
int huge *array;
array=far_malloc(50000L * sizeof(int));
:
:
far_free(array);
```

Parameters returned:

Function far_free returns nothing.

FAR MALLOC

Definition:

```
#include <ALLOC.H>
void far *far_malloc(unsigned long nbytes);
```

Library:

LCTR_T.LIB

Description:

Function far_malloc allocates and so keeps reserved a memory block of size nbytes Bytes in heap memory area. This function can allocate all the memory available and is particularly interesting to manage large arrays.

As this function returns a far pointer, far_malloc does not have the 64 KBytes limit characteristic of function malloc which works with small model.

Example:

```
float matrix far *array;
array=far_malloc(80000L * sizeof(float));
```

Parameters returned:

Function far_malloc returns a far pointer to memory successfully allocated or a NULL pointer in case of errors. The pointer returned is NULL also if free available memory is insufficient to fulfil the request.

FREE**Definition:**

```
#include <ALLOC.H>
void free(void *block);
```

Library:

LCTR_T.LIB

Description:

Function free releases memory previously allocated with function malloc. If the memory indicated by block has never been allocated or is released twice, unpredictable results may happen.

Example:

```
char *buffer;
buffer=malloc(10000);
:           :
free(buffer);
```

Parameters returned:

Function free returns nothing.

GETCH , GETCHE**Definition:**

```
#include <CONIO.H>
int getch(void);
int getche(void);
```

Library:

CL.LIB

Description:

Functions getch and getche manage the acquisition of character from the selected input console hardware device; the device will have to be previously selected and/or initialized. Acquisition suspends the execution of calling program and, in case of getche, echo of input character to output console device is made.

Example:

```
unsigned char scelta;
if getch()=='S'
    scelta=getche();
```

Parameters returned:

Functions getch and getche return the first available character from input console.

GETDATE

Definition:

```
#include <DOS.H>
void getdate(struct date *datep);
```

Library:

CL.LIB

Description:

Function getdate fetches current date from Real Time Clock on the control card and stores it to the structured variable datep. This latter must be a pointer to the type date, declared in the header file DOS.H, that contains three variables: da_day (char), da_month (char), da_year (int).

Example:

```
struct date d;
getdate(&d);
printf("Current date: %2d/%2d/%2d", d.da_day, d.da_mon, d.da_year);
```

Parameters returned:

Function getdate returns nothing.

GETTIME

Definition:

```
#include <DOS.H>
void gettime(struct time *timep);
```

Library:

CL.LIB

Description:

Function gettime fetches current time form Real Time Clock of control card and stores it in the structured variable timep. This latter must be a pointer to a variable of type time, declared in header file DOS.H, that contains four variables ti_hour, ti_min, ti_sec, ti_hsec (all char). Control card RTC does not manage hundreds of seconds (structure member ti_hsec), so its value is always zero.

Example:

```
struct time t;
gettime(&t);
cprintf("Current time: %2d:%2d:%2d", t.ti_hour, t.ti_min, t.ti_sec);
```

Parameters returned:

Function gettime returns nothing.

GOTOXY

Definition:

```
#include <CONIO.H>
void gotoxy(int x, int y);
```

Library:

CL.LIB

Description:

Function gotoxy moves the cursor to the position specified by the input parameters x and y, which correspond to row or column of console. If a serial line has been selected as output console device it will receive the ADDS View-Point codes for this action. If the indicated coordinates are not suitable for the selected console the function will do nothing.

Example:

```
int npz;
gotoxy(2,5);
printf("Number of pieces produced=%d",npz).
```

Parameters returned:

Function gotoxy returns nothing.

KBHIT

Definition:

```
#include <CONIO.H>
int kbhit(void);
```

Library:

CL.LIB

Description:

Function kbhit manages checks whether a character is available for selected input console hardware device; the device will have to be selected and/or initialized previously. The function checks for a character available without suspending the program execution.

Example:

```
while (!kbhit()); // Wait for a key
```

Parameters returned:

Function kbhit returns a value different from 0 if a character is available and viceversa.

LEDBLINKSTATUS

Definition:

```
#include <GCLIBD.H>
unsigned int ledblinkstatus(void);
```

Library:

CL.LIB

Description:

Function ledblinkstatus returns the blinking status of LEDs that the console hardware device connected may eventually have (**QTP 24** and **QTP 24P**); the device will have to be selected and/or initialized previously.

Example:

```
unsigned int blink;
blink=ledblinkstatus();
```

Parameters returned:

Function ledblinkstatus returns a 16 bit word whose least significant bit (bit 0) corresponds to LED0 and most significant bit (bit 15) corresponds to LED15, as indicated in figure B1. If a bit in the word returned is set (1) the corresponding LED is blinking and viceversa.

LEDSTATUS

Definition:

```
#include <GCLIBD.H>
unsigned int ledstatus(void);
```

Library:

CL.LIB

Description:

Function ledstatus returns the activation status of LEDs that the console hardware device connected may eventually have (**QTP 24** and **QTP 24P**); the device will have to be selected and/or initialized previously.

Example:

```
unsigned int led;
led=ledstatus();
```

Parameters returned:

Function ledstatus returns a 16 bit word whose least significant bit (bit 0) corresponds to LED0 and most significant bit (bit 15) corresponds to LED15, as indicated in figure B1. If a bit in the word returned is set (1) the corresponding LED is on or blinking and viceversa.

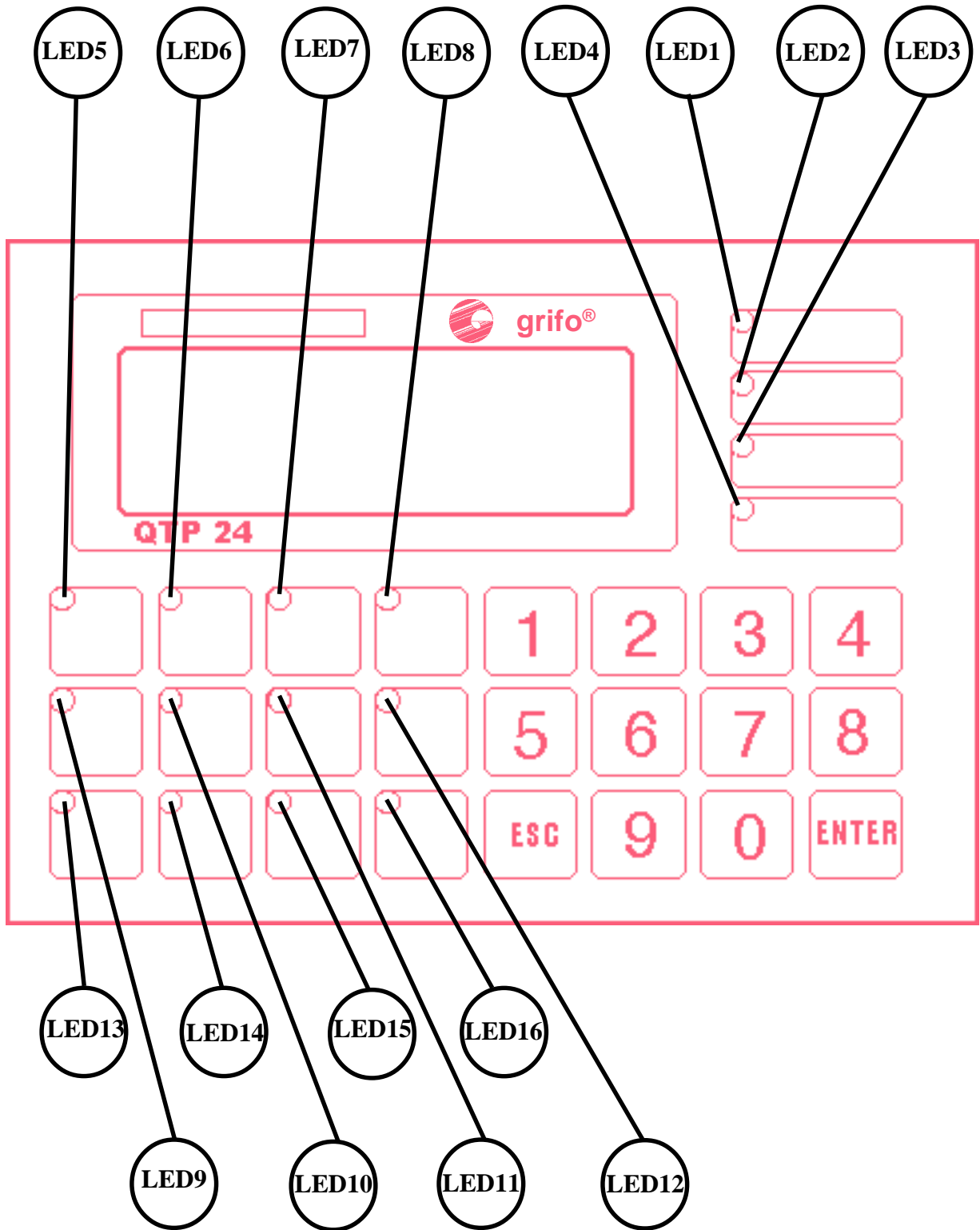


FIGURE B1: LEDs NUMERATION ON QTP 24 AND QTP 24P

MALLOC

Definition:

```
#include <ALLOC.H>
void *malloc(unsigned int nbytes);
```

Library:

LCTR_T.LIB

Description:

Function malloc allocates and so keeps reserved a memory block of size nbytes Bytes in heap memory area. This function can allocate all the memory available up to 64 KBytes.

Example:

```
unsigned char *tmp;
tmp=malloc(8000);
```

Parameters returned:

Function malloc returns a far pointer to memory succesfully allocated or a NULL pointer in case of errors. The pointer returned is NULL also if free available memory is insufficient to fulfil completely the request.

PUTCH

Definition:

```
#include <CONIO.H>
int putch(int ch);
```

Library:

CL.LIB

Description:

Function putch manages a single character representation to the selected output console hardware device; the device must be selected and/or initialized previously.

Example:

```
putch('\r');
```

Parameters returned:

Function putch returns the represented character.

QTPLED

Definition:

```
#include <GCLIBD.H>
void qtpled(unsigned char nled, unsigned char attr);
```

Library:

CL.LIB

Description:

Function qtpled gives the LED indicated in nled the attribute specified by attr on the connected console hardware device (**QTP 24** and **QTP 24P**); the device must be selected and/or initialized previously. LEDs numbers are included in the range 0÷15, as shown in figure B1, while the attributes can be:

0	(00 Hex)	->	LED Off
255	(FF Hex)	->	LED On
85	(55 Hex)	->	LED blinking

If parameters are not valid, the function does nothing.

Example:

```
qtpled(5, 85);           // Sets LED5 blinking
```

Parameters returned:

Function qtpled returns nothing.

SERIN

Definition:

```
#include <GCLIBD.H>
unsigned char serIn(unsigned char nser);
```

Library:

CL.LIB

Description:

Function serIn manages a character reception from serial line nser; serial line must be initialized previously. The function can use one of the control card serial lines according to the parameter nser: 0 -> serial B and 1 -> serial A. It waits for character reception suspending the program.

Example:

```
unsigned char rx[10];
for (i=0; i<5; i++)
    rx[i]=serIn(0);           // Cycle to receive 5 chr from serial B
```

Parameters returned:

Function serIn returns the character code received.

SEROUT

Definition:

```
#include <GCLIBD.H>
void serOut(unsigned char nser, unsigned char c);
```

Library:

CL.LIB

Description:

Function serOut manages the single character c transmission to serial line indicated by nser; the serial line must be initialized previously. The function can use one of the control card serial lines according to the parameter nser: 0 -> serial B and 1 -> serial A.

Example:

```
unsigned char tx[10];
for (i=0; i<5; i++)
    serOut(0, tx[i]);      // Cycle to send 5 chr on serial B
```

Parameters returned:

Function serOut returns nothing.

SERSTATUS

Definition:

```
#include <GCLIBD.H>
unsigned char serStatus(unsigned char nser);
```

Library:

CL.LIB

Description:

Function serStatus checks for a character reception from serial line nser; the serial line must be initialized previously. The function can use one of the control card serial lines according to the parameter nser: 0 -> serial B and 1 -> serial A and does not suspend program execution.

Example:

```
unsigned char rx;
if (serStatus(0))      // If character received from serial B
    rx=serin(0);      // fetch it
```

Parameters returned:

Function serStatus returns a value different from 0 if a character has been received and viceversa.

SETIN

Definition:

```
#include <GCLIBD.H>
unsigned int setIn(unsigned int device);
```

Library:

CL.LIB

Description:

Function setIn allows to select the input console hardware device and prepares it for the future operations performed by other console functions. The input parameter device specifies the console connected to control card and must be defined as described in paragraph “CONSOLE PREDEFINED SYMBOLS”.

Example:

```
unsigned int devin;
devin=QTP16P | LCD20x4;           // Set as console QTP 16P with display LCD 20x4
setIn(devin);
```

Parameters returned:

Function setIn returns 0 in case of invalid device and viceversa.

SETOUT

Definition:

```
#include <GCLIBD.H>
unsigned int setOut(unsigned int device);
```

Library:

CL.LIB

Description:

Function setOut allows to select the output console hardware device and prepares it for the future operations performed by other console functions. The input parameter device specifies the console connected to control card and must be defined as described in paragraph “CONSOLE PREDEFINED SYMBOLS”.

Example:

```
unsigned int devout;
devout=SER0;                // Set as console serial B
setOut(devout);
```

Parameters returned:

Function setOut returns 0 in case of invalid device and viceversa.

SETSERIAL

Definition:

```
#include <GCLIBD.H>
```

```
void setSerial(unsigned char nser, unsigned long baud, unsigned char bitxchr, unsigned char parity,  
              unsigned char stopbit);
```

Library:

CL.LIB

Description:

Function setSerial manages initialization of serial line indicated by nser, to prepare it to work with successive console functions. The five input parameters are:

nser	serial port to initialize	0 -> serial B 1 -> serial A
baud	baud rate	50÷115200
bitxchr	bit per character	5÷8
parity	parity bit management	0 -> no parity 1 -> odd parity 2 -> even parity
stop bit	number of stop bit	1 or 2

According to the control card used the values acceptable for the above parameters may vary; the user must find the valid ones on the control card technical manual and use them to call the function correctly. Hardware and/or software handshakes management is never enabled by this function.

Example:

```
setSerial(0, 19200, 8, 0, 1);      // Initializes serial B  
serOut(0, 65);
```

Parameters returned:

Function setSerial returns nothing.

SETDATE

Definition:

```
#include <DOS.H>
void setdate(struct date *datep);
```

Library:

CL.LIB

Description:

Function setdate sets current date of Real Time Clock on the control card from structured variable datep. This latter must be a pointer to the type date, declared in the header file DOS.H, that contains three variables: da_day (char), da_month (char), da_year (int).

Example:

```
struct date d;
d.da_day=1;           // Sets RTC to beginning of century
d.da_mon=1;
d.da_year=0;
setdate(&d);
```

Parameters returned:

Function setdate returns nothing.

SETTIME

Definition:

```
#include <DOS.H>
void settime(struct time *timep);
```

Library:

CL.LIB

Description:

Function settime sets current time of Real Time Clock on the control card from structured variable timep. This latter must be a pointer to a variable of type time, declared in header file DOS.H, that contains four variables ti_hour, ti_min, ti_sec, ti_hsec (all char). Control card RTC does not manage hundreds of seconds (structure member ti_hsec), so it can be ignored.

Example:

```
struct time t;
t.ti_hour= t.ti_min= t.ti_sec= 1; // Sets RTC to beginning of the day
settime(&t);
```

Parameters returned:

Function settime returns nothing.

SLEEP

Definition:

```
#include <DOS.H>
void sleep(unsigned int seconds);
```

Library:

CL.LIB

Description:

Function sleep performs a calibrated delay whose duration is specified in seconds by the input parameter seconds.

Example:

```
outp(PA,0x02);          // Activates output for 5 sec
sleep(5);
outp(PA,0x00);
```

Parameters returned:

Function sleep returns nothing.

STRDATE

Definition:

```
#include <TIME.H>
char *_strdate(char *buf);
```

Library:

CL.LIB

Description:

Function _strdate converts current date from Real Time Clock on the control card into a string that stores in the buffer buf. The string generated is terminated by the classic null character and features the American notation MM/DD/YY where MM, DD and YY are two figures numbers for month, day and year. So the buffer buf must be at least 9 characters long.

Example:

```
char datebuf[9];
_strdate(datebuf);
cprintf("Date: %s",datebuf);
```

Parameters returned:

Function _strdate returns buf, that is the address from where the string has been stored.

STRTIME

Definition:

```
#include <TIME.H>
char *_strtime(char *buf);
```

Library:

CL.LIB

Description:

Function `_strtime` converts current time from Real Time Clock on the control card into a string that stores in the buffer `buf`. The string generated is terminated by the classic null character and features the notation HH:MM:SS where HH, MM and SS are two figures numbers for hours, minutes and seconds. So the buffer `buf` must be at least 9 characters long.

Example:

```
char timebuf[9];
_strtime(timebuf);
printf("Time: %s",timebuf);
```

Parameters returned:

Function `_strtime` returns `buf`, that is the address from where the string has been stored.

WHEREX

Definition:

```
#include <CONIO.H>
int wherex(void);
```

Library:

CL.LIB

Description:

Function `wherex` returns current orizontal position `x` (column) of cursor on console display.

Example:

```
int col, row;
col=wherex();           // Move cursor 5 chars forward
row=wherey();
gotoxy(col+5,row);
```

Parameters returned:

Function `wherex` returns the column where the cursor finds, the range of this value changes according to which console is selected.

WHEREY

Definition:

```
#include <CONIO.H>
int wherey(void);
```

Library:

CL.LIB

Description:

Function wherey returns current vertical position y (row) of cursor on console display.

Example:

```
int col, row;
col=wherex();           // Move cursor 3 chars down
row=wherey();
gotoxy(col,row+3);
```

Parameters returned:

Function wherey returns the row where the cursor finds, the range of this value changes according to which console is selected.

APPENDIX C: I/O ADDRESSES

DEVICE	REG.	ADDRESS	R/W	PURPOSE
ABACO® I/O BUS	IOBUS	F000H÷F0FFH	R/W	ABACO® I/O BUS addresses
RUN/DEB.	RUNDEB	F100H	R	Register for configuration jumper acquisition
Real Time Clock	SEC1	F100H	R/W	Data register for seconds units
	SEC10	F101H	R/W	Data register for seconds decines
	MIN1	F102H	R/W	Data register for minutes units
	MIN10	F103H	R/W	Data register for minutes decines
	HOU1	F104H	R/W	Data register for hours units
	HOU10	F105H	R/W	Data register for hours decines and AM/PM
	DAY1	F106H	R/W	Data register for day units
	DAY10	F107H	R/W	Data register for day decines
	MON1	F108H	R/W	Data register for month units
	MON10	F109H	R/W	Data register for month decines
	YEA1	F10AH	R/W	Data register for year units
	YEA10	F10BH	R/W	Data register for year decines
	WEE	F10CH	R/W	Data register for week day
	REGD	F10DH	R/W	Control register D
	REGE	F10EH	R/W	Control register E
REGF	F10FH	R/W	Control register F	
W. DOG	RWD	F600H	R/W	Register for watch dog retrigger

FIGURE C1: I/O REGISTERS ADDRESSES ON GPC® 884

DEVICE	REG.	ADDRESS	R/W	PURPOSE
W.DOG	RWD	F000H	R/W	Watch Dog retrigger
EEPROM	RE2	F000H	R/W	EEPROM serial access
MMU	MMU	F000H	R/W	MMU memory paging
LD3,4	LED	F000H	R/W	Activity LEDs management register
BT1	BAT	F000H	R	Battery status acquisition register
SCC 85C30	RSB	F080H	R/W	Serial line B status register
	RDB	F081H	R/W	Serial line B data register
	RSA	F082H	R/W	Serial line A status register
	RDA	F083H	R/W	Serial line A data register
DMA	DMA	F100H	R/W	Disable DMA request register
A/D LM12458	IRL0÷7	F180H÷F18EH (even)	R/W	Sequencer instruction register low 0÷7
	IRH0÷7	F181H÷F18FH (odd)	R/W	Sequencer instruction register high 0÷7
	CNTL	F190H	R/W	Configuration register low
	CNTH	F191H	R/W	Configuration register high
	INTENL	F192H	R/W	Interrupt abilitation register low
	INTENH	F193H	R/W	Interrupt abilitation register high
	INTSTL	F194H	R	Interrupt status register low
	INTSTH	F195H	R	Interrupt status register high
	TMRL	F196H	R/W	Timer register low
	TMRH	F197H	R/W	Timer register high
	FIFOL	F198H	R	Conversions to FIFO register low
	FIFOH	F199H	R	Conversions to FIFO register high
	LIMSTL	F19AH	R	Limits status register low
	LIMSTH	F19BH	R	Limits status register high

FIGURE C2: I/O REGISTERS ADDRESSES ON GPC® 188F (1 OF 2)

DEVICE	REG.	ADDRESS	R/W	PURPOSE
PPI 82C55	PA	F200H	R/W	Port A data register
	PB	F201H	R/W	Port B data register
	PC	F202H	R/W	Port C data register
	RC	F203H	R/W	Control and command register
RTC 62421	S1	F280H	R/W	Units of seconds data register
	S10	F281H	R/W	Decines of seconds data register
	MI1	F282H	R/W	Units of minutes data register
	MI10	F283H	R/W	Decines of minutes data register
	H1	F284H	R/W	Units of hours data register
	H10	F285H	R/W	Decines of hours data register; AM/PM
	D1	F286H	R/W	Units of day data register
	D10	F287H	R/W	Decines of day data register
	MO1	F288H	R/W	Units of month data register
	MO10	F289H	R/W	Decines of month data register
	Y1	F28AH	R/W	Units of year data register
	Y10	F28BH	R/W	Decines of year data register
	W	F28CH	R/W	Day of week data register
	REGD	F28DH	R/W	D control and status register
	REGE	F28EH	R/W	E control and status register
	REGF	F28FH	R/W	F control and status register
WRITE PROTECT	WRP	F300H	W	SRAM write protection register
DIP SWITCH	DSW1	F300H	R	Dip Switch acquisition register

FIGURE C3: I/O REGISTERS ADDRESSES ON GPC® 188F (2 OF 2)

DEVICE	REG.	ADDRESS	R/W	PURPOSE
W.DOG	RWD	F000H	R	Watch Dog retrigger
EEPROM	RE2	F000H	R/W	EEPROM serial access
SCC 85C30	RSB	F080H	R/W	Serial line B status register
	RDB	F081H	R/W	Serial line B data register
	RSA	F082H	R/W	Serial line A status register
	RDA	F083H	R/W	Serial line A data register
DMA	DMA	F100H	R/W	Disable DMA request register
ABACO [®] I/O BUS	IOBUS	F180H÷F1FFH	R/W	Addresses for ABACO [®] I/O BUS management.
PPI 82C55	PA	F200H	R/W	Port A data register
	PB	F201H	R/W	Port B data register
	PC	F202H	R/W	Port C data register
	RC	F203H	R/W	Control and command register

FIGURE C4: I/O REGISTERS ADDRESSES ON GPC[®] 188D (1 OF 2)

DEVICE	REG.	ADDRESS	R/W	PURPOSE
RTC 72421	S1	F280H	R/W	Units of seconds data register
	S10	F281H	R/W	Decines of seconds data register
	MI1	F282H	R/W	Units of minutes data register
	MI10	F283H	R/W	Decines of minutes data register
	H1	F284H	R/W	Units of hours data register
	H10	F285H	R/W	Decines of hours data register; AM/PM
	D1	F286H	R/W	Units of day data register
	D10	F287H	R/W	Decines of day data register
	MO1	F288H	R/W	Units of month data register
	MO10	F289H	R/W	Decines of month data register
	Y1	F28AH	R/W	Units of year data register
	Y10	F28BH	R/W	Decines of year data register
	W	F28CH	R/W	Day of week data register
	REGD	F28DH	R/W	D control and status register
	REGE	F28EH	R/W	E control and status register
REGF	F28FH	R/W	F control and status register	
WR PROT	WRP	F300H	W	SRAM write protection register
DIP SWITCH	DSW1	F300H	R	Dip Switch acquisition register
LEDS	LED	F340H	W	Register to manage activity LEDs

FIGURE C5: I/O REGISTERS ADDRESSES ON GPC® 188D (2 OF 2)

DEVICE	REG.	ADDRESS	R/W	PURPOSE
ABACO® I/O BUS	I/O BUS	F000H÷F0FFH	R/W	Addresses for ABACO® I/O BUS management.
RUN / DEB.	RUNDEB	F100H	R	Units of seconds data register
RTC 62421	SEC1	F100H	R/W	Decines of seconds data register
	SEC10	F101H	R/W	Units of minutes data register
	MIN1	F102H	R/W	Decines of minutes data register
	MIN10	F103H	R/W	Units of hours data register
	HOU1	F104H	R/W	Decines of hours data register; AM/PM
	HOU10	F105H	R/W	Units of day data register
	DAY1	F106H	R/W	Decines of day data register
	DAY10	F107H	R/W	Units of month data register
	MON1	F108H	R/W	Decines of month data register
	MON10	F109H	R/W	Units of year data register
	YEA1	F10AH	R/W	Decines of year data register
	YEA10	F10BH	R/W	Day of week data register
	WEE	F10CH	R/W	D control and status register
	REGD	F10DH	R/W	E control and status register
	REGE	F10EH	R/W	F control and status register
	REGF	F10FH	R/W	Registro di controllo F
A/D MAX197	DASCTRL	F500H	W	A/D converter control register
	DASL	F500H	R	A/D converter low data register
	DASH	F501H	R	A/D converter high data register
PPI 82C55	PA	F540H	R/W	Port A data register
	PB	F541H	R/W	Port B data register
	PC	F542H	R/W	Port C data register
	RC	F543H	R/W	Control and command register
W. DOG	RWD	F580H	R/W	Watch Dog retrigger register
DIP SWITCH	DSW1	F5C0H	R	Dip switch acquisition register
UART CAN SJA 1000	CAN	F600H÷F67FH	R/W	Registers to manage UART CAN SJA 1000 in BasicCAN or PeliCAN modalities (registers are the same reported in the component data sheet, plus an <u>offset</u> of F600H)

FIGURE C6: I/O REGISTERS ADDRESSES ON GPC® 883

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