

DELGEN

X-Graph XG5000 Family Rabbit Single Board Computer with Graphic LCD Interface

User's Manual

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1 Welcome

1.1 Introduction

The X-Graph XG5000 module has all the features of a typical Rabbit Semiconductor RCM module and adds an impressive list of I/O interfaces at a very competitive price. It is available as a stand-alone, self-powered single board computer or as an operating console with a large choice of user configurable character and graphic (QVGA up to VGA) LCD's.

The XG5000 includes a Rabbit 3000A processor running at its max. speed (58.8MHz) with all the required support logic and up to 2Mbyte of local memory. The SBC uses a medium size pcb with components installed on a single side to increase reliability.

Five 34-pin 0.1" expansion headers are available. These headers are used for Rabbit I/O expansion signals, analog inputs, LCD expansion, special XG5000 extensions and buffered I/O signals.

The SBC has on-board connectors for Ethernet, USB, power input, RS485 and RS232C.

Two on-board switched mode power supplies (3.3 and 5 Volt) are standard. The XG5000 can be powered from a DC input ranging from 7 Volt up to 30 Volt. Optional a 5 Volt or 3.3 Volt DC input version is available. The latter one only with a limited range of LCD's. A replaceable Li battery powers the RTC and battery backup sram when no external power is available.

Have a look at the impressive feature list of the X-Graph XG5000 (Max. configuration):

- Universal TFT LCD interface supports QVGA and VGA TFT LCD's and special sizes
- STN B/W or CSTN Color ¼ VGA LCD interface
- Industry standard 16-pin character LCD interface for low cost applications
- Analog touchscreen interface
- MMC and SD slot
- Five 34-pin Industry standard 0.1" boxed male headers
- USB interface (can be used for programming at 1MBaud, no programming cable required)
- 10/100 Ethernet interface
- DC input plug
- 5 high voltage, current-sinking outputs
- 24-channel 10-, 12- or 16-bit ADC
- 1-channel 8- or 12-bit DAC
- RS232C driver included (4 lines, 2 serial ports supported)
- Two serial ports have RS485 buffers
- Low power design with switch mode power supply
- Integrated replaceable Li battery for RTC and SRAM backup
- Keypad interface
- 1-Wire interface
- Extra (7th) async or sync serial port
- RC-5 receiver
- Hardware I2C interface
- PC/AT compatible keyboard interface
- Secured 512 byte eeprom array and 1024 byte flash array

If you are unfamiliar with the Rabbit microcontroller, visit the Rabbit Semiconductor website (www.rabbitsemiconductor.com).

1.1.1 The Next Generation Rabbit SBC with LCD

The XG5000 module is a new generation Rabbit Single Board Computer and Operating Console incorporating features you cannot find in any competitive Rabbit based product.

On top of all standard Rabbit 3000A features the XG5000 includes a universal LCD interface which supports B/W STN or color CSTN QVGA displays and QVGA/VGA TFT displays. The standard Dynamic C graphic libraries are compatible with the B/W LCD. DELGEN adds to this an advanced xGUI graphic library supporting all types of LCD's. This library adds graphic widgets and faster and better text and bitmap control. The TFT LCD interface supports a 8-bit (256 color) and 24-bit (16M colors) color depth for QVGA resolution and 8-bit color depth for VGA resolution. TFT LCD's with SVGA resolution can be supported with a plug-in card.

The unique direct display hardware offers faster drawing speed and faster response to user interactions. The displays are available with or without an analog touchscreen.

The Rabbit 3000A runs at its maximum allowed speed of 58.8MHz, something RCM modules do not offer. The XG5000 module has standard 512 kByte program memory. More memory then ever can be added because the XG5000 supports an MMC/SD slot for memory upgrades up to 4GByte and higher. DELGEN offers a FAT library to read/write files on a FAT formatted SD Card.

Interfaces? The XG5000 has standard a 4-channel RS232C driver, a 10/100 Ethernet, a RS485 driver with DPI connector and Full-Speed USB interface. Forget about the slow download speeds of DynamicC with the XG5000 module. The USB interface supports a 1MBaud download speed, reducing the wait time for large programs to a minimum.

The Rabbit 3000 PWM channels are buffered with high-voltage, current-sinking buffers to directly drive motors.

Analog input and outputs are available in different configurations.

The XG5000 module can be delivered as a pcb-module or with several attractive plastic cases some with IP65 water/dustproof capability. Custom made keyboard panels can also be supplied.

Expansion modules can be easily added because many I/O ports and decoded I/O chip selects are available on standard 0.1" headers.

DELGEN offers a special [custom made X-Graph service](#). This service includes X-Graph modules with selected interfaces, the design and manufacturing of expansion modules, cases and keyboards, and a full software service to implement the user interfaces for your product.

1.1.2 XG5000 Features

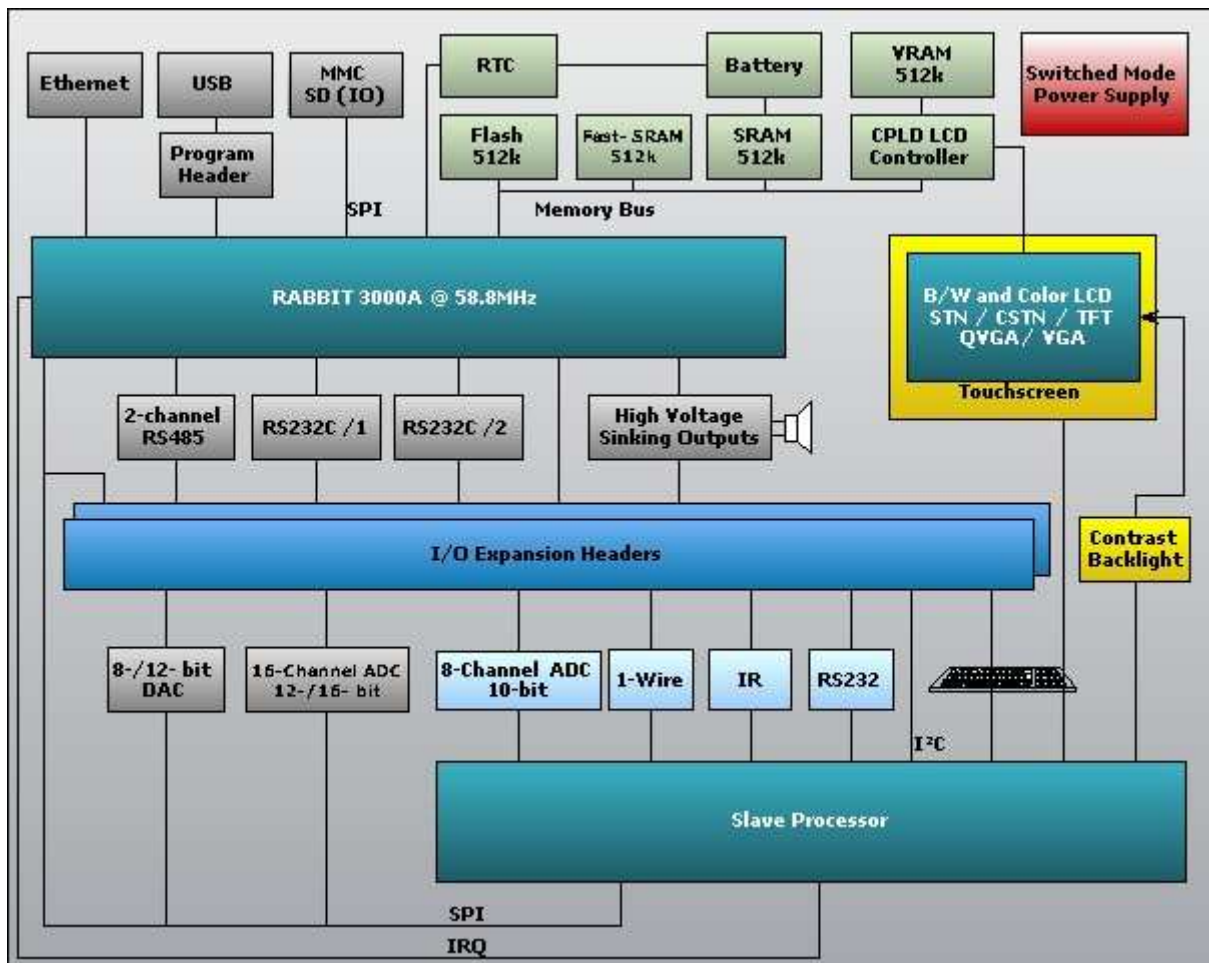


Figure 1: XG5000 features

- Rabbit 3000 running at 58.8MHz
- TFT LCD interface
 - 3.5" QVGA TFT (PDA-style) with led-backlight
 - 4.9" 320x96 TFT (carradio style) with bright CCFL backlight
 - 5.6" 320x234 TFT with led or CCFL backlight
 - 6.4", 8.4", 10.4" VGA TFT with led or CCFL backlight
 - Analog touchscreen
 - 512kByte fast (zero wait-state) display RAM increases drawing speed
 - Direct video page memory access
 - 256 color (8-bit) support uses a one byte/pixel system for very fast drawing speed
 - 16M color (3 bytes/pixel) support optional
- STN 320x240 graphic screen with or without analog touchscreen
 - Color, B/W or Blue/White versions
 - LCD's can be used vertical or horizontal with a selectable viewing angle (3, 6, 9 or 12 o'clock)
 - Two lcd sizes available with viewing areas of 77x58mm or 115x87mm (Color only 115x87)
 - B/W LCD's use a bright white led backlight with software brightness control
 - The Color LCD uses a CCFL backlight
 - Analog touchscreen

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- 512kByte fast (zero wait-state) display RAM increases drawing speed
 - Direct video page memory access
- 16-pin industry standard character LCD interface for cost-effective LCD applications.
- Expanded Memory Interfaces
 - 512 kByte program Flash + 512kByte Fast-SRAM program memory for zero-waitstate operation
 - 128, 256 or 512 kByte battery-backup data SRAM
 - 512 kByte or 1 MByte zero-waitstate video memory for LCD's
 - 512 Bytes of secured EEPROM storage
 - 1024 Bytes of secured Flash storage
 - MMC/SD card interface in SPI mode with support for memory cards up to 4 GByte
 - The SD card slot also supports IO cards as WLAN, Bluetooth, ... (no drivers included)
- Serial Ports
 - Rabbit programming port header (non USB version)
 - RS232C port (RXD/TXD, RTS/CTS or 2xRXD/2xTXD)
 - Two serial ports have RS485 buffers
 - All Rabbit serial ports including 2 free async/sync and HDLC compatible serial channels are available unbuffered on the expansion connector
 - All buffered serial ports signals are also available on an expansion connector
 - Extra serial port on slave processor
 - 1-Wire interface
 - Hardware I2C interface
 - PC/AT keyboard interface
 - RC-5 Remote control receiver
- Buzzer
- 4x4 keypad header
- 8 single ended 10-bit ADC channels (2 channels used for analog touchscreen)
- 16 single ended or 8 differential 12- or 16-bit ADC channels
- 1 channel 8- or 12-bit DAC
- 5 channel high-voltage/high current-sinking output channels. Three channels are directly connected to the Rabbit PWM outputs for direct-motor-drive solutions.
- Power
 - Power-saving dual 3.3/5 Volt design with 5 Volt compatible I/O
 - DC power input
 - Dual SMPS
 - Lithium 3 Volt backup battery included on the module
 - Input voltage range from 7 Volt up to 30 Volt. Versions with 5 Volt and 3.3 Volt input are available.
- Different types of enclosures available
 - board-only version (no enclosure)
 - Different enclosures available matching the selected LCD type (most are available with an IP65 dust/waterproof option)
- Custom-made keyboards available
 - Hardware prepared for a 4x4 keyboard matrix (expandable to any size)
 - Very short turnaround
 - Perfectly matching the X-Graph enclosures
- 10/100 MBit Ethernet port
- USB (!!) Rabbit download port (Port A) with speeds up to 1MBaud
- Expandable
 - Rabbit I/O ports available on 0.1" expansion connectors
 - Standard boxed male headers reducing EMC problems and prevent wrong inserting of expansion boards
 - Female, Male or Angled-Male headers available

- Headers can be installed on component or solder side (custom option)
- All headers are installed on a 0.1" grid. Expansion modules can be easily installed on a test-pcb with a 0.1" copper grid.

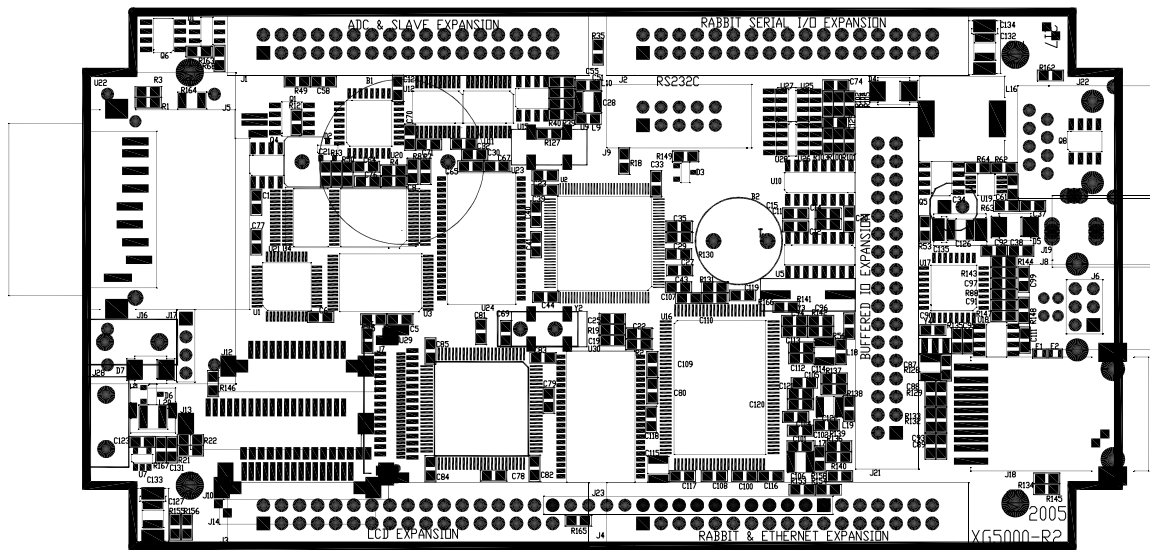


Figure 2: XG5000 PCB layout

1.2 How This Book Is Organized

You can find following chapters in it:

Chapter 1 contains a view on all the information in this book.

Chapter 2 gives helps on getting started with your new X-Graph module.

Chapter 3 describes the features of the XG5000 standard module, the development kit contents and the XG5000 custom design possibilities.

The different LCD and enclosure options are listed in **Chapter 4**.

In **chapter 5** you receive a detailed description of all hardware features including information on custom-made expansion modules.

Chapter 6 gives information on installing and mounting the X-Graph module.

In **chapter 7** we add all available technical information.

Chapter 8 is dedicated to custom-made design products DELGEN is offering.

Several other X-Graph Users Manuals are available. They include information on using the X-Graph modules with a C Compiler, the X-Graph software modules and X-Graph expansion cards.

1.3 More Questions

If you have questions while using your X-Graph module, check first if the information is available in this book. If you cannot find the answer check the information and forum on the X-graph website (www.x-graph.be). Finally you can also contact your local distributor or the X-Graph technical support by e-mail (techsup@x-graph.be).

This manual includes all available documentation on the X-Graph module. It is strongly advised to download and read documentation on the Rabbit processor, and the OP7200 operating console (for X-Graph modules with a B/W LCD installed) available from the Rabbit Semiconductor (www.rabbitsemiconductor.com) website. This manual is complimentary to the documentation found on these websites.

2 Getting Started

Get quickly started by connecting the power supply and installing and running the demo software and development tools.

2.1 Power Supply

2.1.1 Power Input

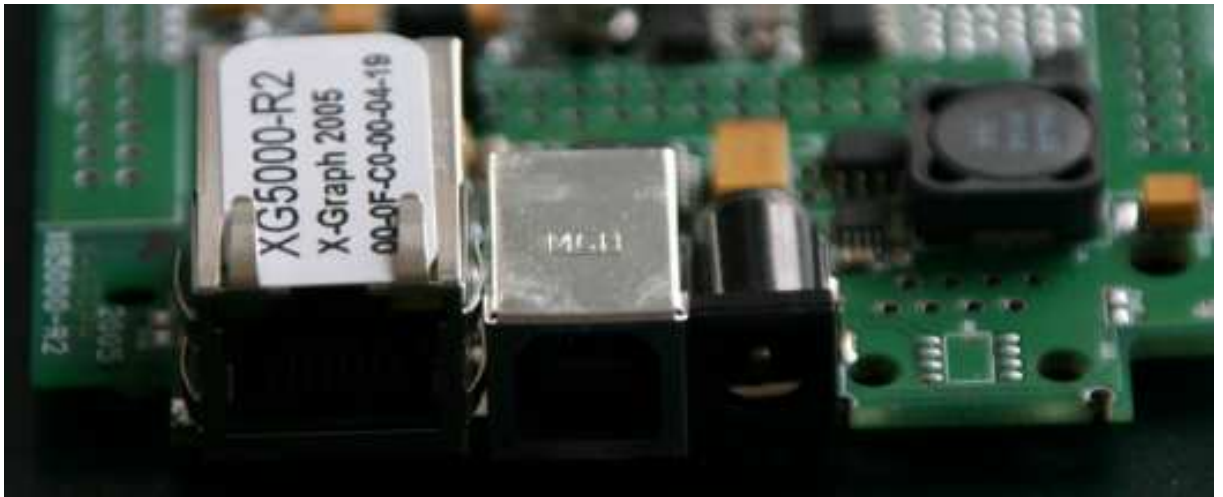


Figure 3: Power input jack

Different power inputs are available. Warning: only use one single input. Connecting several DC inputs will result in damage to the power supplies and/or the module.

The available power inputs are:

- DC Input connector J11
- All five expansion connectors have a power input/output pin
- USB bus powered (option, 500mA max.)
- DPI bus powered (input as slave DPI power unit or output as master DPI power unit)
- Power-over-Ethernet is available with a plug-in board

2.1.2 Power Supply Design Concept

2.1.2.1 Standard Power Supply is Dual Voltage

The XG5000 module has been designed to operate with a dual 3.3/5 Volt power supply. The Rabbit processor and the memory components are powered by 3.3 Volt. The 5 Volt power supply is used for the LCD backlight and most I/O chips (slave processor, ADC, DAC, RS485, RS232C, ...).

Either the 5 Volt can be supplied from an external source (option), or the on-board SMPS can be used (standard).

This 5 Volt SMPS allows a non-regulated voltage input range from 7 up to 30 Volt and can supply about 1.5Amps of total power to the module and expansion modules.

Warning: All I/O lines on the I/O expansion headers are 5 Volt tolerant EXCEPT for the LCD I/O lines which are only 3.3 Volt tolerant. Higher input voltages may damage the module and void your warranty.

2.1.2.2 Single 3.3 Volt Power Supply Version

A single 3.3 Volt power supply version is also available. Either the 3.3 Volt can be supplied from an external source (option), or the on-board SMPS can be used which needs a minimum 5 Volt DC input voltage.

For external powered 3.3 Volt modules an optional secondary SMPS booster can be installed to power the white-led backlight of some LCD modules (power limit applies).

Note: all pre-R4 XG5000 standard modules are configured as single 3.3 Volt power supply versions. These boards do NOT have the 5 Volt power supply hardware and can not be reconfigured as a dual 3.3/5 Volt version. All currently shipped XG5000 standard modules (-R4 and higher) have the 5 Volt SMPS installed by default. This change was required to support the newest LCD generation which uses 5 Volt LED backlights.

Important: the following section is only valid for single 3.3 Volt versions. It does NOT apply any more to all post-R4 standard modules.

Some LCD options require high-current CCFL backlights. If the on-board CCFL adaptor is used with these LCD's the input voltage range is reduced to either 5Volt +/-10% (standard) or 9Volt up to 14.4Volt (option).

Carefully check the CCFL convertor version BEFORE applying power. The CCFL convertor marked CXA-L10A is the 5 Volt version, the one with the CXA-L10L marking is the 12Volt version.

An optional CCFL convertor expansion board is available which removes this input voltage range reduction. This expansion board includes a 5Volt SMPS and allows for an input voltage range from 7 up to 35 Volt.

Warning: The Rabbit 3000 and Asix I/O lines on the I/O expansion headers are 5 Volt tolerant. All other I/O lines only accept 3.3 Volt input signals. Higher input voltages may damage the module and void warranty.

2.1.3 Voltage Selection

On most systems the module DC input will be used to power the system. It requires a 2.1mm matching connector.

IMPORTANT: Make sure the polarity of the AC/DC adaptor is correct. The inner contact should be the + input, the outer contact the ground.

A reverse polarity protection is included on the module. This will short the external power supply in case an inverse power polarity is detected.

Note that reversing the polarity can destroy the protection diode, the external power supply, the XG5000 module and void your warranty.

Carefully measure the power dissipation (temperature) when using the on-board SMPS to power your expansion boards. The maximum power output of the SMPS is 1.5Amp and a current limiter is build in the system. Note that the effective current limiter value is dependant on the input voltage. An input voltage of appr. 12 Volt will get you the maximum current output.

All five expansion connectors have a pin directly connected to the power input rail. If the DC input plug is not used, one of these can be used as a power input. All other pins,

including the DC input plug, will carry the input voltage connected to the selected power input pin.

Check the expansion connector pin table in chapter 3 for correct pin numbers.

WARNING: Connecting a voltage higher than 3.3V on any other pin will destroy your module and void your warranty. Observe carefully the pin number and location of the power pins before applying power. Some pins are 5 Volt tolerant, check chapter 3 for a complete list.

A Li battery is used to power the RTC and battery backup SRAM. The battery voltage is available on an expansion connector pin. If a battery is installed the output voltage on this pin can be used to power battery backup devices. Note that if the main power is absent, this pin is current limited by a 10kOhm resistor and the voltage might drop to 2Volt. Current consumption on this pin should be in the uAmp range.

If no battery is installed on the module, this pin can be used to feed a battery backup voltage to the module. This voltage should be fed through a reverse polarity protection diode and current limiting resistor of 10kOhm (see the XG5000 schematic for an example).

All expansion connectors also include a 3.3 Volt pin and most connectors a 5 Volt pin. On a standard XG5000 module these are output pins available to power electronics on expansion boards.

But, the module can also be powered via one of these 3.3 or 5 Volt pins. The selected pin is then acting as a voltage input pin but only if the module is custom designed for this. The standard module has two SMPS installed and does NOT accept an external 3.3 or 5 Volt input.

2.1.4 Backup Battery

A battery holder is installed on the board for an industry standard CR2025 Lithium battery. This battery is used to keep the RTC running and the contents of the SRAM unchangeable while the power supply is not available.

The battery is user-replaceable, and is fitted in a battery holder. To replace the battery, lift up the old battery and insert the new one into the battery holder with the + side facing up.

Note that the SRAM contents and the RTC settings will be lost if the battery is replaced with no power applied to the X-Graph. Exercise care if you replace the battery while external power is applied to the X-Graph.

CAUTION: There is an explosion danger if the battery is short-circuited, recharged, or replaced incorrectly. Replace the battery only with the same type or an equivalent type recommended by the battery manufacturer. Dispose of used batteries according to the battery manufacturer's instructions.

2.1.5 Current Calculation

Total typical current: 100 mA (12 Volt input, no expansion cards, no LCD)

Standby typical current from Li battery: 6uA

2.1.6 USB Bus Powered

The XG5000 module can be powered directly from a USB bus. Configured like this, the module can be used as a slave USB device. Only one cable is required for power and communication with a PC.

The USB standard limits the maximum current used by each USB device to 500mA which is well within the power requirements of the XG5000 module. If you connect a USB device to a passive hub, the limit is 100mA in which case the X-Graph module will not operate.

Note that the larger LCD's, some MMC/SD cards and additional I/O cards might result in a total power consumption larger than the maximum 500mA. Carefully check your design before operating the module on a USB connection.

WARNING: the USB Bus powered modules are available as a factory option. The standard modules can not be used in this mode. Contact DELGEN for test samples or instructions how to convert a standard module to a USB Bus powered module.

2.1.7 DPI Bus Powered or Power

On XG5000 modules fitted with a DPI bus connector, the module can either be powered by the DPI bus (power slave mode), or supply power to the DPI bus (power master mode). Observe the DPI bus power conventions and make sure only one power master exists on a single DPI segment.

The DPI power pins are directly connected to the power input rail of the board. The DC input can be used as a DPI power master.

2.2 Demonstration Program on Power-Up

A demo program is installed on delivery. Check the DC samples directory for the source code. See the 'X-Graph and Dynamic C' manual for information on how to install the included samples and libraries.

This sample program demonstrates the GUI features of the XG5000 and start the xgConsole. Just connect a terminal emulator to a serial port (RS232C, DPI, USB, Ethernet) to get connected and start entering X-Graph console commands. Refer to the 'xgConsole Users Manual' for more information on the xgConsole mode.

The 'X-Graph Ethernet Firmware Upgrade' utility is also installed. You can load your custom firmware via the Ethernet port to the Flash memory. No need to connect any development tools or interfaces.

2.3 Using Dynamic C or WinIDE with the X-Graph Module

Refer to the 'X-Graph and Dynamic C' and 'X-Graph and Softools Rabbit WinIDE' manuals for a description on how to use Dynamic C or Softools WinIDE with the X-Graph module.

3 XG5000 Standard Module / Custom Module

Learn about the different XG5000 configurations, the X-Graph custom design service and the development kit.

3.1 Development Kit

The XG5000 development kits (XG5000DK)

What's included in the development kit:

- XG5000 Standard Module
- A 128Mbyte SDCard, just to try the unlimited XG5000 memory expansion
- Your choice of LCD
- A quality plastic X-Graph enclosure fitting the selected LCD
- An AC/DC adaptor with europlug (only for EC deliveries)
- An RS232C cable with matching male dSub-9 connector
- 4 male boxed expansion headers (J1, J2, J4 and J21)
- 4 female boxed expansion headers
- 1 male and female boxed expansion header (J3)
- 2 pin male jumper and pin-header for enabling programming mode
- USB cable
- The latest libraries and documentation can be downloaded from our website (www.x-graph.be)

Possible LCD options:

- XG5000DK: no LCD included
- XG5000DKH4X16: 4x16 character LCD
- XG5000DKB36: B/W 3.6" QVGA LCD
- XG5000DKL57A: Blue/White 5.7" QVGA LCD with touchscreen
- XG5000DKC57A: Color STN 5.7" QVGA LCD with touchscreen
- XG5000DKT56A: 5.6" QVGA TFT LCD with touchscreen
- XG5000DKT104A: 10.4" VGA TFT LCD with touchscreen

Refer to chapter 4 to get more information on the available LCD options.

The module can be operated without purchasing any development software by using its standard xgConsole control firmware. Refer to 'xgConsole Users Manual' for more information.

But, to develop user programs for your new X-Graph development kit, you will need to purchase some development software.

If you don't own it yet, you will need a copy of the DynamicC compiler. It's available online from the Rabbit Semiconductor website (www.rabbitsemiconductor.com). Different versions are available, but the standard compiler (DynamicC Individual License) will do fine. There is no need to buy any of the available options to operate the XG5000. Rabbit Semiconductor regularly offers a 'DynamicC Promotional Bundle' including libraries for SSL, FAT, RabbitWeb, PPP, SNMP and AES. Unless you need one of these functions, you don't need to purchase the bundle (don't mind FAT, it's included free-of charge with all X-Graph products).

Refer the 'X-Graph and Dynamic C' and the X-Graph software library manuals to get more info on the free libraries included with the X-Graph modules.

DELGEN also supports the Softools WinIDE (www.softools.com) ANSI C compiler on its X-Graph modules. Refer to the 'X-Graph and Softools Rabbit WinIDE' manual for more information on the Softools compiler.

For fast and intuitive GUI development DELGEN advises to use the xgGUI (X-Graph GUI) development package (refer to chapter 'xgGUI Users Manual').

With the Softools compiler an alternative GUI development environment can be used.

The easyGUI (www.easygui.com) pc program integrates with minimal changes with the Softools compiler. Note that to use the easyGUI generate C code with DynamicC several changes are need to be made in the easyGUI generated code.

3.2 Standard Module

The XG5000 module can be manufactured in almost an unlimited number of versions. To reduce production costs and increase stock availability DELGEN offers a single XG5000 'Standard' module. For any purchase of up to 100pcs, we advise to use this standard module. Custom designs can be made for any quantity, but price increases will apply for lower then 100pcs quantities.

3.2.1 What's included

Refer to chapter 5 to get a complete detailed overview of all the possible hardware options of the XG5000. Below is a list of the features included in the XG5000 Standard Module. Also refer to the table in section 3.3 for a complete overview.

- Rabbit 3000A running at 58.8MHz (Epson precision oscillator)
 - 512kByte Flash program memory
 - 512kByte Fast-SRAM program & data memory
 - 512kByte Fast-SRAM video memory (doubles as extra data memory)
 - Epson high-precision and low-power 32.768kHz oscillator
 - Li battery for RTC backup
 - SDCard socket
 - 10/100 Ethernet interface with RJ connector and indicator leds
 - USB interface
 - 4-line RS232C driver
 - RS485 driver and DPI connector
 - ULN2003 high voltage, high current driver
 - Buzzer
 - RC-5 receiver input
 - Alternate UART or PS/2 keyboard interface inputs
 - 1-Wire input/output
 - 8-channel 10-bit ADC
 - Dual 3.3/5 Volt SMPS with 2.1mm DC input plug (up to 30V input)
 - CCFL convertor (for CCFL backlight LCD's)
 - 2 pin male jumper and pin-header for enabling programming mode
-
- Depending on your order an LCD with or without touchscreen is included and the matching connectors and backlight options are installed on the XG5000.

A cable set is available for the standard module (included in every development kit):

- 10-pin male boxed expansion header for RS232C cable
- 4 pcs of 34-pin male boxed expansion headers
- 4 pcs of matching 34-pin female boxed expansion headers
- 1 pcs of 10-pin male boxed expansion header (J3)
- 1 pcs of matching 10-pin female boxed expansion header

A matching AC/DC adaptor and SDCards are available as options.

3.2.2 What's not included

Note that the following features are NOT included in the standard module. This is a limited list, refer to section 3.3 for a complete overview.

- Second RS485 driver and the RS485 resistor options
- USB bus-power system
- Rabbit programming socket (USB is standard)
- Touchscreen connector (unless your order includes a touchscreen LCD)
- 1-Wire protection diode
- extra (8 or 16) ADC inputs
- DAC output

3.3 Custom Designs

The XG5000 can be delivered with any user selection of interfaces installed. DELGEN will consider any purchase of 100pcs or more as a custom design without additional costs.

For lower quantities we advise to use the standard module. On request additional interfaces can be added to the standard module for a reasonable extra cost. A full custom design for small quantities (1 to 99pcs) is possible, but will cost extra.

Below is a complete list of all XG5000 features. Refer to chapter 5 for a complete detailed description of all hardware features.

To get a quote on a custom design you can send a copy of below list with the items you require indicated to DELGEN.

Column 1 has * indicators if the feature is installed on the standard module.

Column 2 contains a short description of the feature.

Column 3 contains an indication of the features size or configuration in the standard module version.

Column 4 can be used to fill in the required size or configuration for custom designs.

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XG5000 Hardware Features			
Description	Default	Custom value	
Processor			
* Rabbit 3000A			
25MHz or 50MHz clock (only with Ethernet, not with TFT)			
Rabbit oscillator (typ. 11/22MHz, max. 29MHz)			
* Epson precision oscillator (any clock possible up to 58.8MHz)	58.8MHz		
Epson precision oscillator 50MHz (only with Ethernet)			
Standard RTC 32.768kHz oscillator (no battery backup)			
* Epson precision RTC 32.768kHz oscillator			
* Li CR2025 replaceable backup battery			
* Flash program memory	512kByte		
* Fast SRAM program memory (required for clock > 29MHz)	512kByte		
Battery-Backup SRAM data memory (128k, 256k or 512k)			
Rabbit programming header (not with USB)			
Ethernet			
* 10/100 Ethernet Port			
* Ethernet RJ connector with indicator leds			
Connector (Ethernet & USB) shield connect to logic gnd			
Memory & I/O Expansion			
* SDCard socket			
Serial Port Buffers			
* USB Port (includes Rabbit programming mode)			
USB connector inserted line connected to Rabbit PE1 pin			
USB powered system (max. 500mA)			
* RS232C buffer (4 lines)			
2x5 boxed male header to connect dSub-9 cable			
RS485 buffer A on Rabbit SerC (not with RS232C buffer)			
RS485 buffer B on Rabbit SerD (not with RS232C buffer)			
* RS485 buffer A on Rabbit SerE			
RS485 buffer B on Rabbit SerF (Note: max. 2 RS485 buffers can be installed)			
120Ohm end resistor on RS485 Buffer A			
120Ohm end resistor on RS485 Buffer B			
680Ohm polarizing resistors on RS485 Buffer A			
680Ohm polarizing resistors on RS485 Buffer B			
* DPI Connector (only with RS485 Buffer A installed)			
High Voltage / High Current outputs			
* ULN2003 (5 lines available) (required for CCFL and buzzer)			
* Buzzer (ULN2003 required)			
ADC & DAC			
8-channel ADC			

	16-channel ADC		
	Resolution of ADC (12 or 16 bit)		
	1-channel DAC (indicate resolution = 8 or 12 bit)		
	ADC and DAC powered by local 3.3Volt		
	ADC and DAC powered by external power supply (max 5V)		
*	Analog ground connected to signal ground (indicate required resistor value, standard is 0 Ohm)		
	Slave processor options (Note: 8-channel ADC, RC-5 receiver, 1-Wire interface, extra serial port or PS/2 keyboard interface, I2C interface, configurable I/O ports, eeprom, flash area are standard on the XG5000 module)		
	1-Wire protection diode		
	4 pin 0.1" angled touchscreen header		
	4 pin 1mm FFC touchscreen header horizontal		
	4 pin 1mm FFC touchscreen header vertical		
	Power supply		
	NO SMPS installed (3.3Volt is externally supplied)		
*	3.3 Volt SMPS with current protection		
*	5 Volt SMPS with current protection		
*	2.1 mm DC input plug		
*	Reverse polarization protection diode		
*	Maximum input voltage up to 30V		
	Maximum input voltage up to 16V		
	LCD Interface		
	Universal character LCD interface (replaces J3 and J4)		
	5 Volt boost-up SMPS for white-led backlights		
*	100-pin CPLD for LCD interface or user CPLD program		
*	Fast-SRAM video memory (512k or 1M)	512kByte	
	24-bit TFT color interface		
	3.6" B/W QVGA LCD FFC connector		
	3.6" B/W QVGA LCD FFC connector type 2		
	5.7" B/W QVGA LCD FFC connector		
	5.7" 16-pin CSTN QVGA Color LCD FFC connector		
	5.7" 15-pin CSTN QVGA Color LCD connector		
	32-pin TFT FFC connector		
	LCD 2x17 male boxed expansion connector (can not be combined with above FFC connectors)		
	Idem but female boxed connector		
	CCFL convertor (required for CSTN and TFT LCD's)		
	One CCFL connector (bottom pcb)		
	Two CCFL connectors (VGA TFT required) (bottom pcb)		
	Expansion headers		
	J1		
	J2		

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<input type="checkbox"/>	J3		
<input type="checkbox"/>	J4		
<input type="checkbox"/>	J21		
<input type="checkbox"/>	Gender of connectors (male or female)		
<input type="checkbox"/>	Boxed, non-boxed, raised or angled (only male)		
<input type="checkbox"/>	Installed on component side or bottom side		
<input type="checkbox"/>	Note: combined installs are also possible, indicate separately		
<input type="checkbox"/>			
<input type="checkbox"/>	XG5000 Plug-in Cards		
<input type="checkbox"/>	3.5" QVGA TFT LCD expansion card (J3)		
<input type="checkbox"/>	4.9" 320x96 TFT LCD with CCFL expansion card (J3)		
<input type="checkbox"/>	Plug-in pcb with 34 screw terminals = 1 for every pin on the expansion headers. Can be used on all 5 exp. headers.		
<input type="checkbox"/>	I/O port connectors: high-voltage outputs, dual d-Sub9, dual DPI, DC input, USB and Ethernet (J21)		
<input type="checkbox"/>	Dual CCFL convertor with on-board 5Volt SMPS (J3)		
<input type="checkbox"/>	Parallel port (pc-style, uses J4)		
<input type="checkbox"/>	PS/2 keyboard connector, IR RC-5 receiver, 1-Wire temperature sensor, Audio in/out (J1)		
<input type="checkbox"/>	PS/2 keyboard connector, IR RC-5 receiver (J1)		
<input type="checkbox"/>	Mono Audio output and input (uses J1)		
<input type="checkbox"/>	Two DMX512 connectors (RS485 chips required, J21)		
<input type="checkbox"/>	56k fax/modem (J4, J2)		
<input type="checkbox"/>	ISDN fax/modem (J4, J2)		
<input type="checkbox"/>	GSM + GPRS modem (J4, J2)		
<input type="checkbox"/>	GPS (J4, J2) (can be combined with modems)		
<input type="checkbox"/>	I2C Smartcardreader		
<input type="checkbox"/>	8 Opto-Isolated inputs on X-Graph serial expansion (can be expanded to any size: 16, 24,)		
<input type="checkbox"/>	8 Opto-Isolated outputs on X-Graph serial expansion (can be expanded to any size: 16, 24,)		
<input type="checkbox"/>	Compact Flash interface internal (J2, J4)		
<input type="checkbox"/>	Compact Flash interface external cold-swap (J2, J4)		
<input type="checkbox"/>	Dual-card Compact Flash interface (J2, J4)		
<input type="checkbox"/>	Hot-swap compact Flash interface, 2.5" hard disc interface, 5Volt SMPS, USB2.0 HDD-PC interface (uses J2 and J4)		
<input type="checkbox"/>	JTAG-Rabbit connector to reprogram the CPLD (uses J3)		
<input type="checkbox"/>	PoE (Power of Ethernet) adaptor (J21)		
<input type="checkbox"/>			

Table 1: XG5000 Hardware Features

4 LCD Versions & XG5000 Enclosures

In this chapter you will find all technical information on the LCD displays available with the XG5000. A number of LCD's are considered standard and are usually available from stock for sample quantities. Also several non-standard and custom design LCD's can be interfaced with the XG5000.

Each standard LCD fits an X-Graph enclosure. Technical information on these is also available in this chapter.

4.1 Standard Graphic LCD Versions

The XG5000 has 8 different connectors to allow several different types of LCDs to be connected. It is perfectly possible to design a low-cost version of your project with a small cost-effective LCD, or even no LCD. More expensive version(s) can be offered to your customer with more expensive larger LCD's without the need of complicated application software changes.

4.1.1 3.6" QVGA B/W & Blue/White LCD

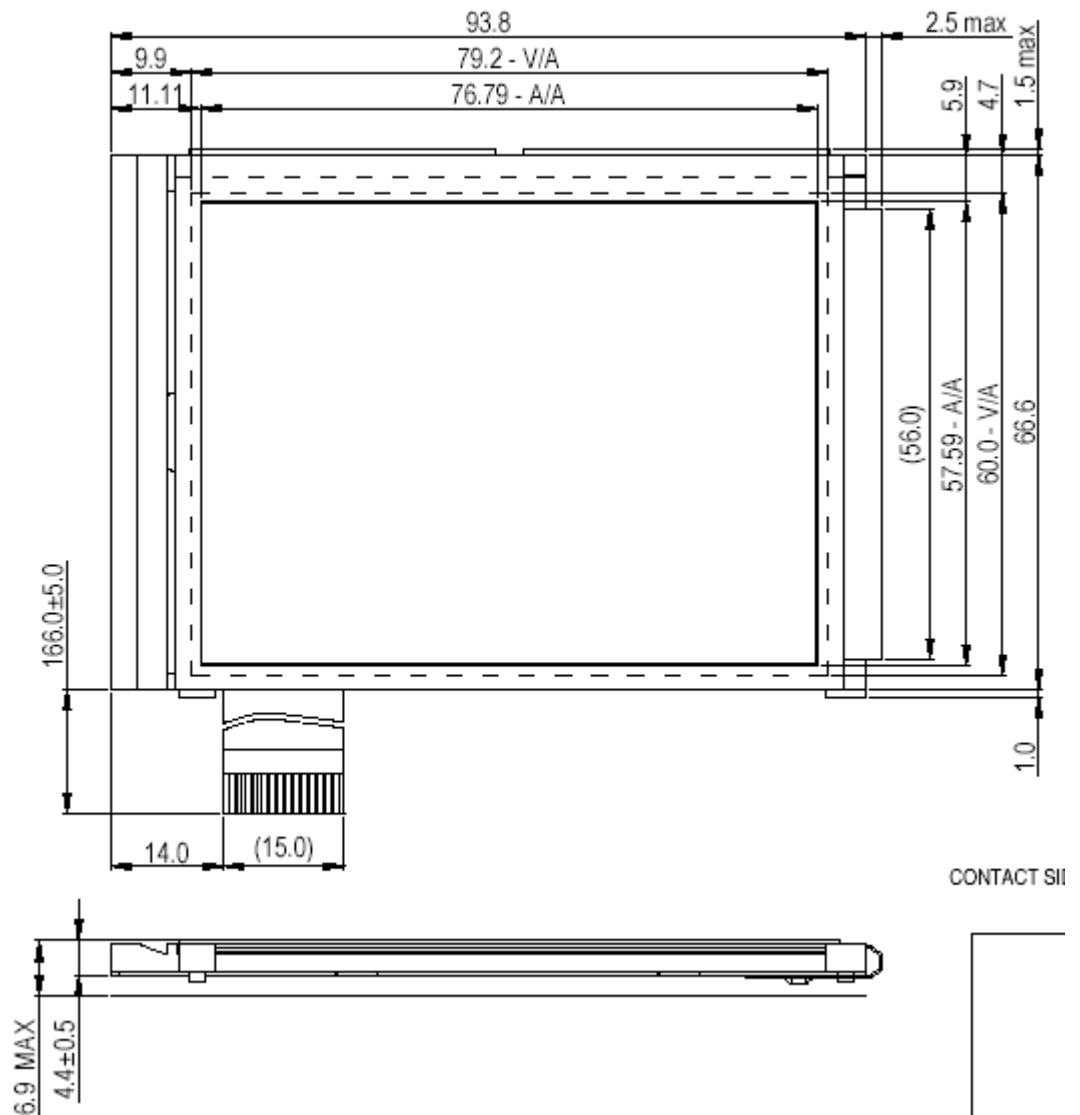


Figure 4: Mechanical Drawing of 3.6" B/W LCD

Backlight: white leds (10000 hours lifetime to 50% brightness)

Typical Brightness: 7 cd/m² (5 cd/m² with touchscreen)

Typical power consumption LCD: 20mA @ 3.3 Volt

Typical power consumption backlight: 75mA @ 5 Volt

Uses XG5000 connector: J12 = 14-pin 1mm FFC

Touchscreen: available

Enclosure: All

Available versions (call DELGEN for more info):

- B/W or Blue/White
- Any viewing angle
- Transmissive, Reflective, Negative

Standard: B/W 6 o'clock transmissive positive without touchscreen

4.1.2 5.7" QVGA B/W & Blue/White LCD

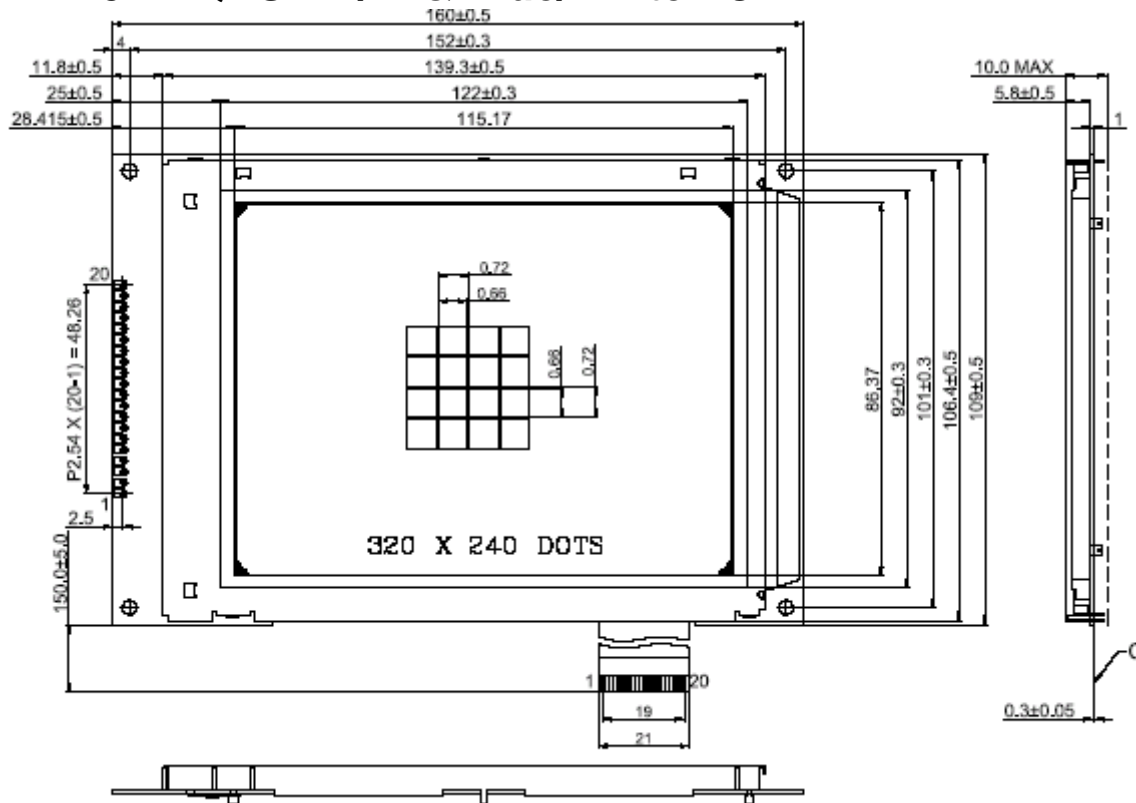


Figure 5: Mechanical Drawing of 5.7" B/W LCD

Backlight: white leds (10000 hours lifetime to 50% brightness)
 Typical Brightness B/W: 150 cd/m² (130 cd/m² with touchscreen)
 Typical Brightness Blue/White: 140 cd/m² (120 cd/m² with touchscreen)
 Typical power consumption LCD: 50mA @ 3.3 Volt
 Typical power cons. backlight: 140mA @ 5 Volt (7 leds), 180mA @ 5V (10 leds)
 Uses XG5000 connector: J13 = 20-pin 1mm FFC
 Touchscreen: available
 Enclosure: All except Standard and Standard XL

Available versions (call DELGEN for more info):

- B/W or Blue/White
- Any viewing angle
- Transmissive, Reflective, Negative
- 7 leds or 10 leds backlight

Standard: Blue/White 6 o'clock negative with or without touchscreen and 7 leds backlight

4.1.3 5.7" QVGA CSTN Color LCD Type 16

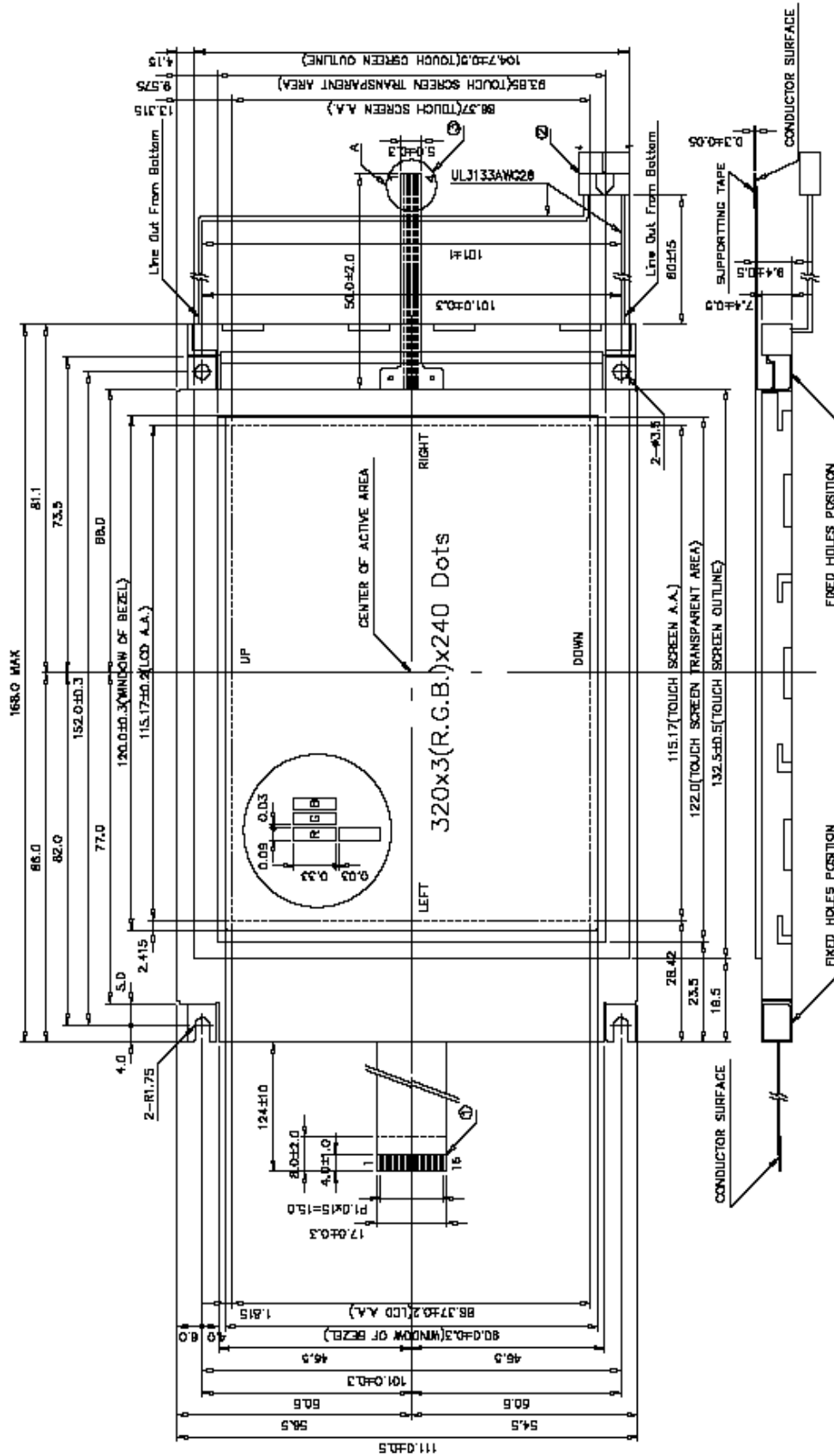


Figure 6: Mechanical Drawing of 5.7" CSTN LCD (Type 16)

Backlight: CCFL (20000 hours lifetime to 50% brightness)
Typical Brightness: 80 cd/m² (65 cd/m² with touchscreen)
Typical power consumption LCD: 29mA @ 3.3 Volt
Typical power consumption backlight: 510mA @ 5 Volt
Uses XG5000 connector: J14 = 16-pin 1mm FFC
Touchscreen: available
Enclosure: All except Standard and Standard XL

Available versions (call DELGEN for more info):

- with or without touchscreen

Standard: not available as standard LCD

DELGEN does not recommend this LCD for new designs. The Type 15 (next paragraph) is a price compatible replacement with a sturdier enclosure, better connection cable and higher brightness.

The Type 16 LCD is only recommended for new designs which require a mechanical compatibility with the standard 5.7" B/W LCD (4.1.2).

4.1.4 5.7" QVGA CSTN Color LCD Type 15

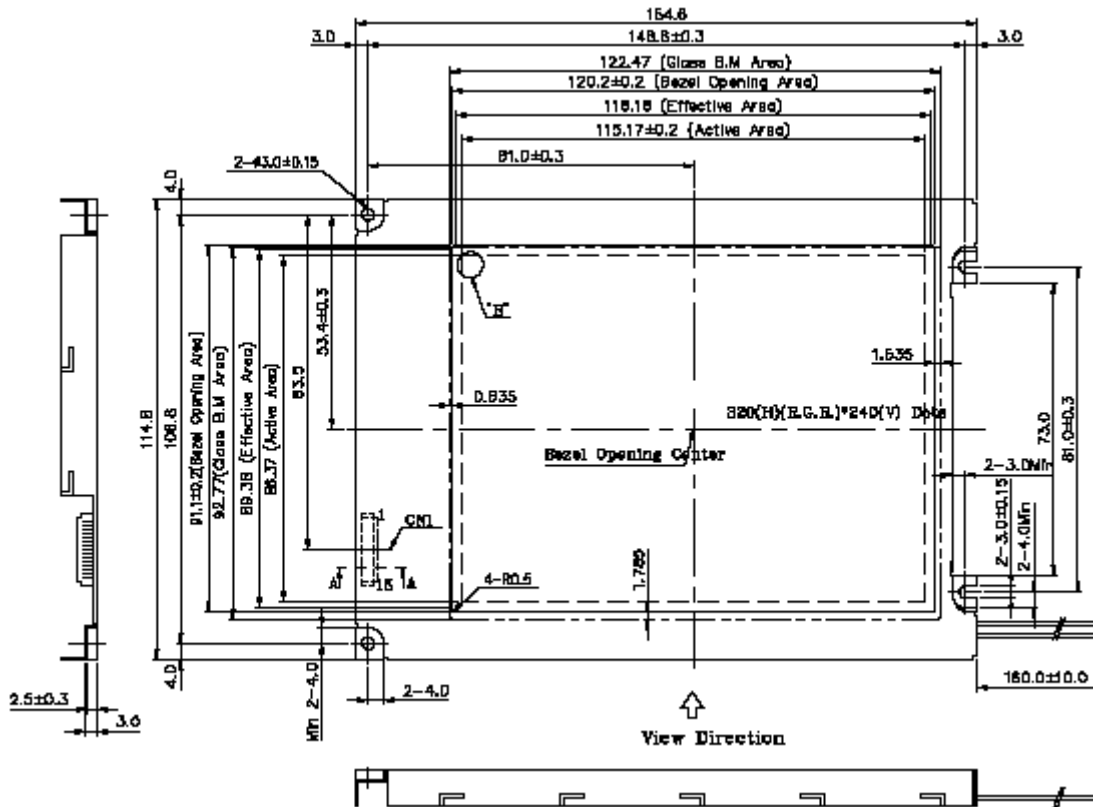


Figure 7: Mechanical Drawing of 5.7" CSTN LCD (Type 15)

- Backlight: CCFL (40000 hour lifetime to 50% brightness)
- Backlight: LED (10000 hour lifetime to 50% brightness)
- Typical Brightness CCFL: 180 cd/ m2 (140 cd/m2 with touchscreen)
- Typical Brightness LED: 70 cd/ m2 (60 cd/m2 with touchscreen)
- Typical power consumption LCD: 50mA @ 3.3 Volt
- Typical power consumption backlight: 510mA @ 5 Volt (CCFL) / 200mA (LED)
- Uses XG5000 connector: J15 = 15-pin 1.25mm X-Graph cable
- Touchscreen: available
- Enclosure: All except Standard and Standard XL

Available versions (call DELGEN for more info):

- with or without touchscreen

Standard: CSTN 6 o'clock with or without touchscreen with CCFL backlight

DELGEN does not recommend this LCD for new XG5000 designs. The 320x234 TFT LCD offers more colors, better contrast and a better viewing angle for an almost identical price.

The TFT LCD does not use more video memory. If this is an issue, the CSTN LCD is a valid option.

On XG4x00 modules the CSTN LCD requires considerable less display refresh time. The overall execution speed of the XG4x00 is 20% higher on a CSTN LCD system compared to a TFT LCD system. This is not an issue on the XG5000 due to its superior CPLD LCD control design.

4.1.5 3.5" QVGA TFT Color LCD

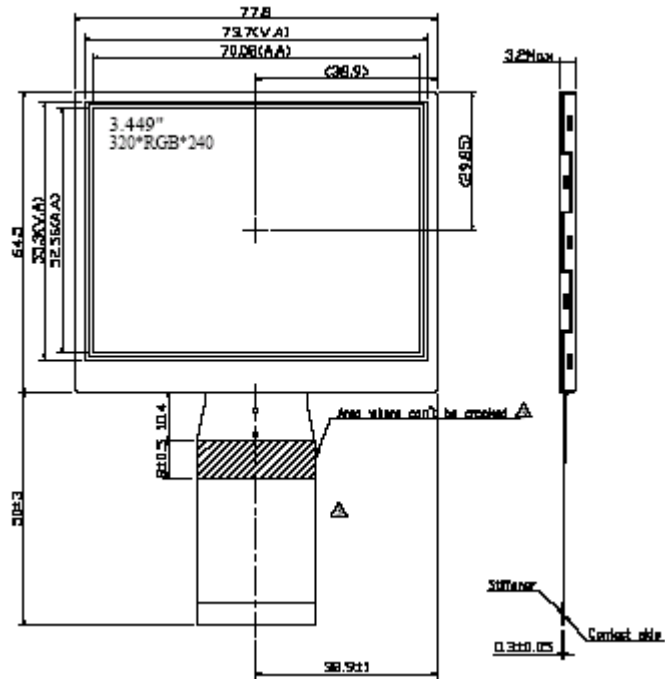


Figure 8: Mechanical Drawing of 3.5" TFT LCD

Backlight: white leds
 Typical Brightness: tbf
 Typical power consumption LCD: tbf mA @ 3.3 Volt
 Typical power consumption backlight: tbf mA @ 7.5 Volt
 Uses XG5000 connector: J3 expansion connector with plug-in board
 Touchscreen: available
 Enclosure: All

Available versions (call DELGEN for more info).

This new 3.5" QVGA TFT LCD requires a XG5000 plug-in card. The development of this I/O card is currently delayed. If you need up to date availability information contact DELGEN.

4.1.6 5.6" 320x232 TFT Color LCD

Backlight: CCFL (30000 hour lifetime to 50% brightness)
Backlight: LED (25000 hour lifetime to 50% brightness)
Typical CCFL Brightness: 500 cd/m² (400 cd/m² with touchscreen)
Typical LED Brightness: 320 cd/m² (250 cd/m² with touchscreen)
Typical power consumption LCD: 150 mA @ 3.3 Volt
Typical power consumption backlight: 510 mA @ 5 Volt (CCFL) / 420 mA (LED)
Uses XG5000 connector: J29 = 32 pin 0.5mm FFC cable
Touchscreen: available
Enclosure: All except Standard

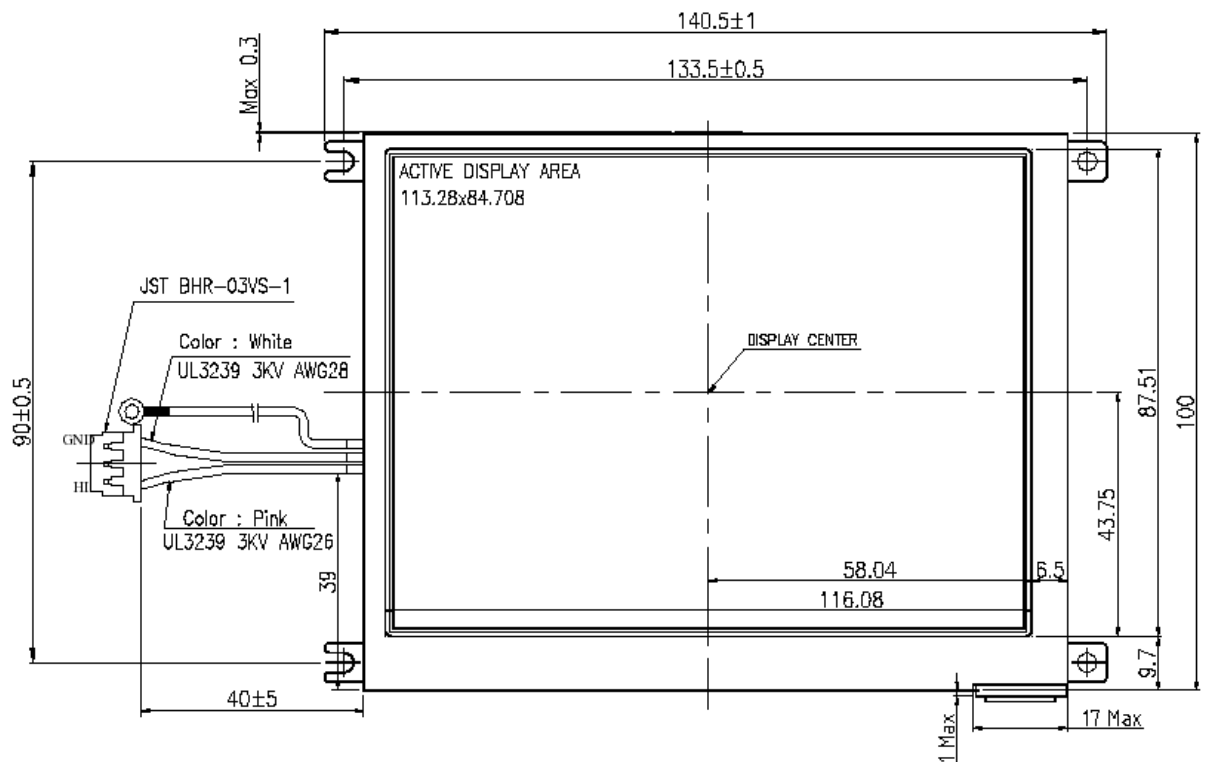


Figure 9: Mechanical Drawing of 5.6" TFT LCD

Available versions (call DELGEN for more info):

- with or without touchscreen
- with or without 4 screw connections
- 256 color or 16M color version
- white-led or CCFL backlight

Standard: with or without touchscreen and without screw connections, 256 colors, white-led backlight

This LCD is a very cost effective TFT solution matching the XG5000 perfectly.

4.1.7 6.4" VGA TFT Color LCD

The 6.4" and 10.4" TFT LCD's have very similar specs and all use the same XG5000 interface. The 6.4" and 10.4" version are the XG5000 standard versions. The 8.4" version is available on request (also technical info).

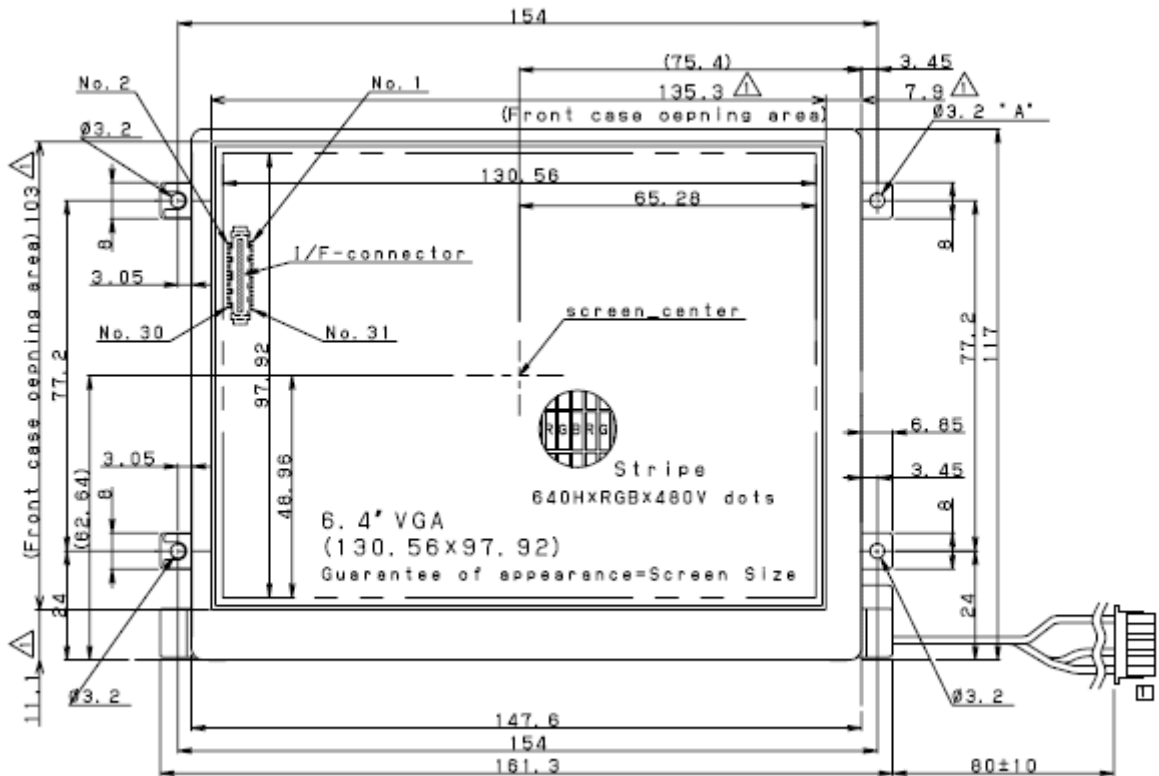


Figure 10: Mechanical Drawing of 6.4" TFT LCD

- Backlight: Two CCFL lamps (50000 hour lifetime to 50% brightness)
- Typical Brightness: 350 cd/m² (280 cd/m² with touchscreen)
- Typical power consumption LCD: 350mA @ 3.3 Volt
- Typical power consumption backlight: 800mA @ 5 Volt, 320mA @ 12 Volt
(for each active CCFL convertor)
- Uses XG5000 connector: J29 = 32-pin 0.5mm FFC with X-Graph adaptor cable
- Touchscreen: available
- Enclosure 6.4: All except Standard and Standard XL
- Enclosure 10.4: Exclusive and Desktop XL

Available versions (call DELGEN for more info):

- with or without touchscreen

Standard: without touchscreen

4.1.8 10.4" VGA TFT Color LCD

The 6.4" and 10.4" TFT LCD's have very similar specs and all use the same XG5000 interface. The 6.4" and 10.4" version are the XG5000 standard versions. The 8.4" version is available on request (also technical info).

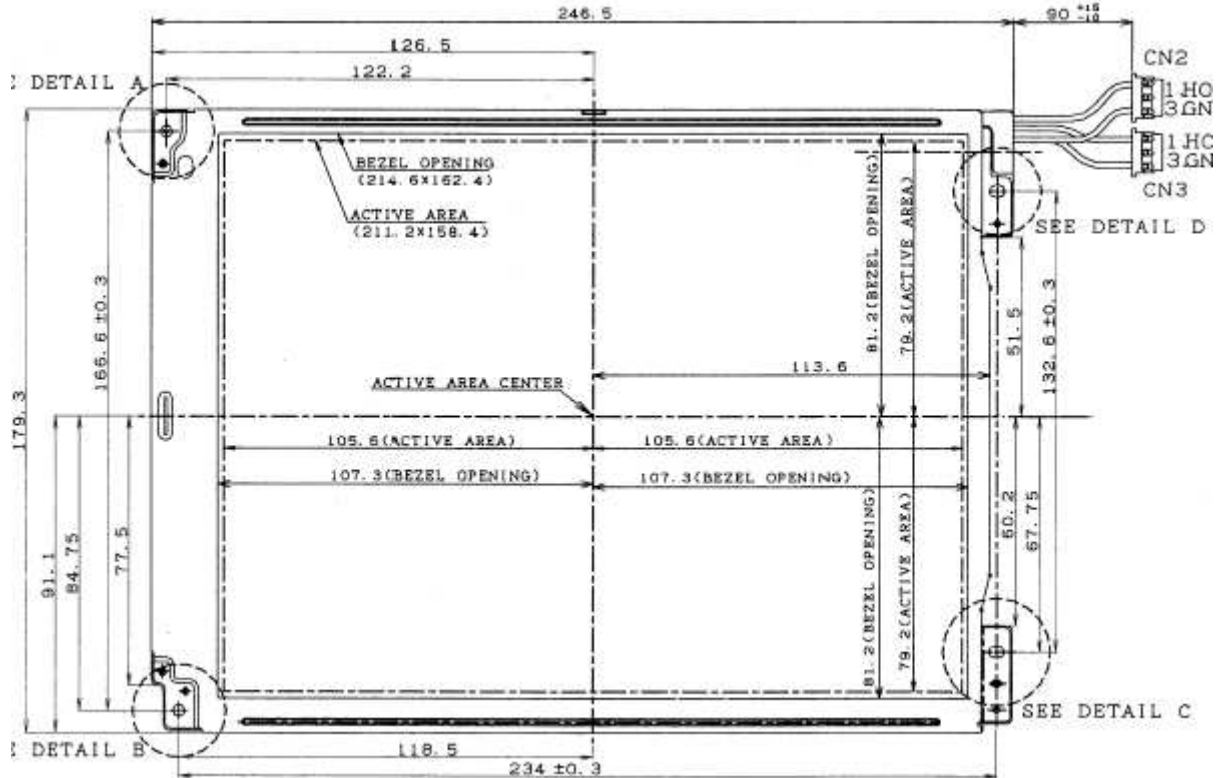


Figure 11: Mechanical Drawing of 10.4" TFT LCD

Backlight: Two CCFL lamps (50000 hour lifetime to 50% brightness)
 Typical Brightness: 450 cd/m² (350 cd/m² with touchscreen)
 Typical power consumption LCD: 350mA @ 3.3 Volt
 Typical power consumption backlight: 800mA @ 5 Volt, 320mA @ 12 Volt
 (for each active CCFL convertor)
 Uses XG5000 connector: J29 = 30-pin 0.5mm FFC with X-Graph adaptor cable
 Touchscreen: available
 Enclosure 6.4: All except Standard and Standard XL
 Enclosure 10.4: Exclusive and Desktop XL

Available versions (call DELGEN for more info):

- with or without touchscreen

Standard: without touchscreen

4.2 Custom LCD Design

Because the XG5000 uses a reprogrammable CPLD to generate all required LCD signals, and because all the signals are available on a 0.1" expansion header, the XG5000 can be interfaced to almost any size and type of LCD.

If your application needs a non-standard LCD, contact DELGEN with full details of your applications LCD requirements. We will find a solution for your problem.

Any size or style of STN LCD can be interfaced, either B/W or color, any viewing angle or backlight system. Sizes as small as 128x32 dots up to VGA or no problem. TFT LCDs can be interface for sizes up to VGA resolution with the standard hardware. SVGA resolution is possible with a high-speed CPLD upgrade.

4.3 Character LCD Versions

Several industry-standard 3.3Volt compatible character LCD modules can be connected to J23 (replaces J3 and J4).

A non-limited list of available CLCD's (contact DELGEN about availability):

- 1 line x 16 characters @ 60x6.5mm (40 or 120mA backlight)
- 1 line x 16 characters @ 95x9.6mm (190 mA backlight)
- 2 lines x 16 characters @ 56x11.5mm (20 or 90mA backlight)
- 4 lines x 16 characters @ 56x20.8mm (220 mA backlight)
- 2 lines x 20 characters @ 119x19mm (270 mA backlight)
- 4 lines x 20 characters @ 55x17.5mm (150 mA backlight)
- 4 lines x 20 characters @ 70x20.8mm (260 mA backlight)
- 4 lines x 20 characters @ 119x38mm (770 mA backlight)

(dimensions are character size, glass size is larger)

Available versions:

- Negative or positive
- Green, white or blue backlight

Enclosures: all

Standard: depends on stock, contact DELGEN for availability.

4.4 Enclosures

All XG5000 modules are available with matching high quality modern plastic enclosures. Several standard enclosures are available and custom designed enclosures can be manufactured.

4.4.1 Standard Enclosure



Figure 12: Standard Enclosure

The XG5000 Standard enclosure perfectly fits the pcb-board. The removable side panels are milled to fit the XG5000 I/O connectors on one side (Ethernet, USB, DC input and DPI) and the SDCard slot on the opposite side.

This enclosure is available in two colors, white (RAL9002) with gray sidepanels (RAL7032) or black (RAL9005), and two heights. The slim version can fit the PCB and several LCD types. The higher version can be used for the XG5000 including plug-in boards. This version can also have a dSub-9 connection.

There are two types of wall brackets available, either a standard bracket or a DIN Rail type. Or non-slip foot stickers can be attached.



Figure 13: Standard Enclosure Options

This enclosure fits all character LCD's, the 3.6" B/W and 3.5" TFT (high enclosure version) displays. There is some space available for custom keyboards.

Part numbers are:

- Slim White/Grey version: B1065365
- Slim Black version: B1065369
- High White/Grey version: B1060365
- High Black version: B1060369
- Grey wall bracket: B1360028
- Black wall bracket: B1360029
- Grey DIN rail clip: B1300017
- Black DIN rail clip: B1300019
- 4 pcs of foot stickers: A9207150

4.4.2 Standard XL Enclosure

The XG5000 Standard XL enclosure is an enlarged version of the standard enclosure. The pcb-board is installed on one side of the enclosure. One removable side panel is milled to fit the XG5000 I/O connectors (Ethernet, USB, DC input and DPI).

This larger version gives you more space for expansion boards and keypads. It's available with the same options as the Standard enclosure.

This enclosure fits all character LCD's, the 3.6" B/W, 3.5" TFT and 5.6" TFT. There is some space available for custom keyboards.

Part numbers are:

- Slim White/Grey version: B1075365
- Slim Black version: B1075369
- Grey wall bracket: B1370028
- Black wall bracket: B1370029
- Grey DIN rail clip: B1300017
- Black DIN rail clip: B1300019
- 4 pcs of foot stickers: A9207150

4.4.3 Desktop Enclosure

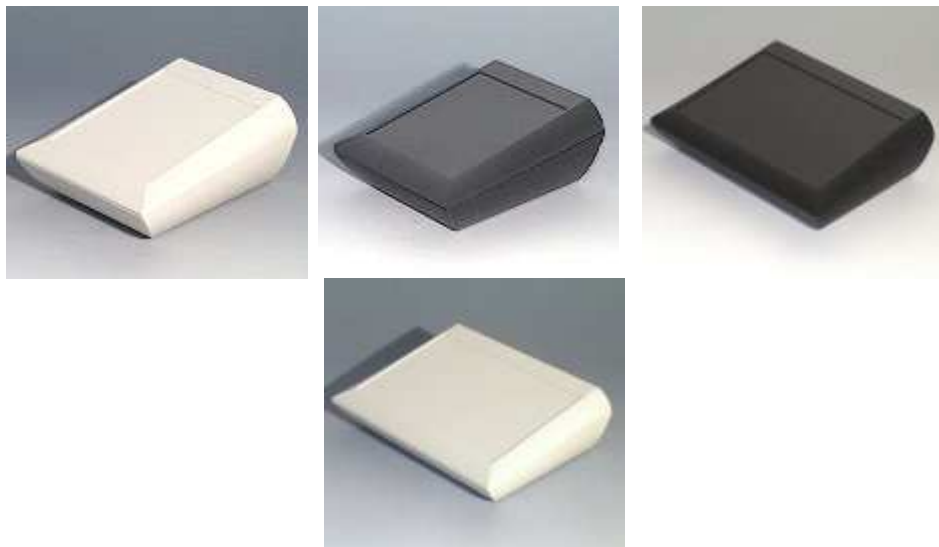


Figure 14: Desktop Enclosure

This is a three part enclosure for table top and wall-mounted applications. The operating area is ergonomically sloped by 10° and the top area has a recessed area for optional membrane keyboards. There is a version with or without a battery compartment (9Volt or 4x1.5Volt). And the enclosure is available in white (RAL9002) or black (RAL9005)

There are two orientation versions: vertical or horizontal. Thus an LCD can be fitted in landscape or portrait mode.

The XG5000 is installed either on the rear side of the LCD or on the bottom of the enclosure. All I/O connectors are available via milled openings on the rear side (if desk mounted).

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There is a wall bracket available and several battery options. Either 4 AA batteries, or 1 or 2 9Volt batteries can be installed to either power the backup memory of the XG5000 or fully power the unit (limited power, depends on LCD type used).

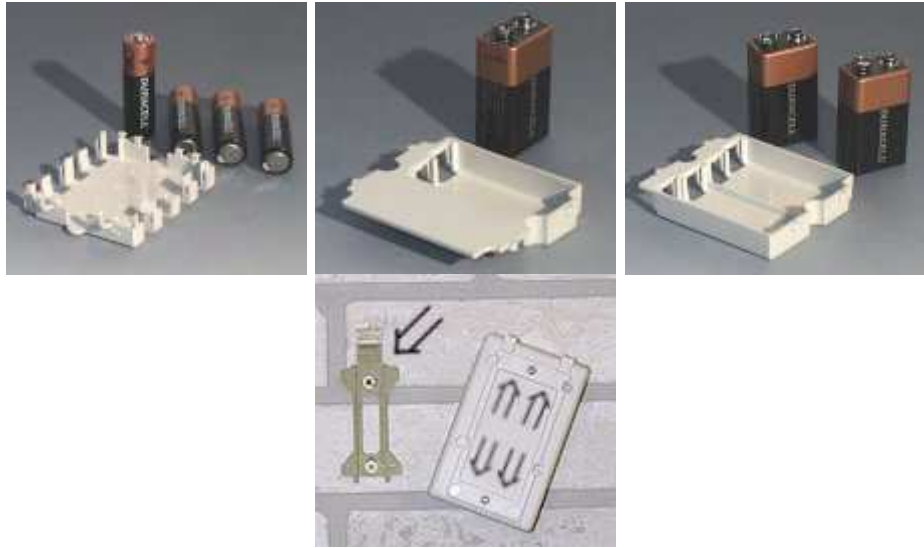


Figure 15: Standard Enclosure Options

This enclosure fits all character LCD's, the 3.6" B/W, 5.7" B/W, 5.7" CSTN, 3.5" TFT and 5.6" TFT. There is enough space for expansion cards and an optional keypad

Part numbers are:

- Horizontal white version: A0620107
- Idem with battery compartment: A0620117
- Horizontal black version: A0620109
- Idem with battery compartment: A0620119
- Vertical white version: A0612107
- Vertical black version: A0612109
- Wall suspension element: B1350048
- Battery holder for 2x 9Volt batteries: A9174002
- Battery holder for 1x 9Volt battery: A9174003
- Battery holder for 4x AA batteries: A9174004
- Set of battery clips for 4xAA batteries: A9161001
- Set of battery clips for 1x9Volt battery: A9174006

4.4.4 Desktop XL Enclosure

The XL version of the desktop enclosure also fits the larger TFT screens (up to 10.4"). It has all the benefits of the Desktop enclosure and is available in a horizontal white or black version (no battery compartment).

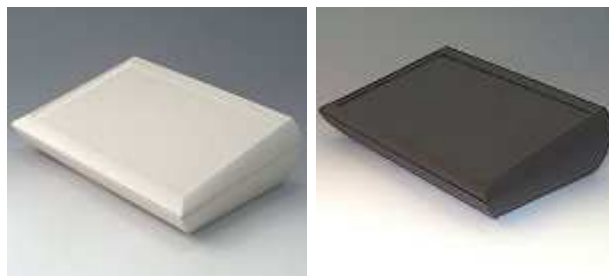


Figure 16: Desktop XL Enclosure

This enclosure can of course also be used for all smaller LCD's. It offers a lot of space for expansion cards and connectors.

Part numbers are:

- White version: A0629107
- Black version: A0629109
- Wall suspension element: B1360048

4.4.5 Smart Enclosure

The modern design Smart enclosure (white RAL9002) is intended to be used with the 5.6"/5.7" LCDs and the 6.4" TFT LCD, but it can also be used with the character LCD's and 3.5"/3.6" LCD's. There is enough space to add custom keyboard designs.



Figure 17: Smart Enclosure

It's available with two different types of optional covers, foot stickers and a 9 Volt battery compartment.

The white cover covers the complete LCD, the plexi cover can be used to cover the LCD while keeping it readable.

This enclosure is intended to be wall mounted but it could be installed on a desktop surface with the foot stickers.



Figure 18: Smart Enclosure Options

Two types of batteries can be installed in the battery compartment. Two AAA batteries can be used for backup or a single 9Volt battery can be used for full XG5000 operation (limited power, depends on LCD type used).

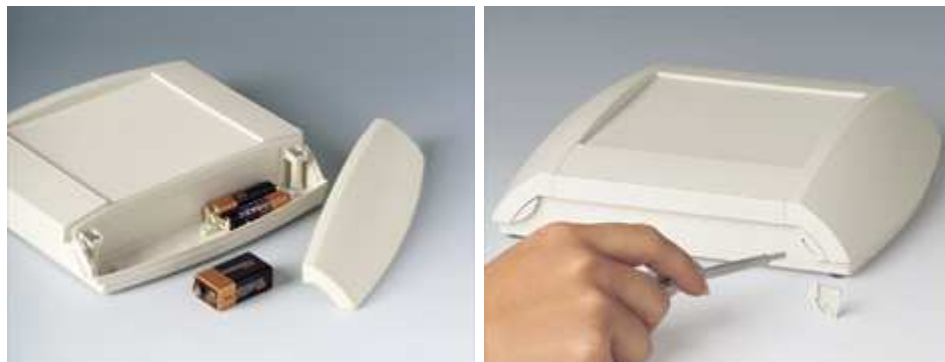


Figure 19: Smart Enclosure Batteries / Mounting

Space is available in this enclosure to add plug-in and/or expansion boards. Both side panels can be easily removed to access connectors and they can be locked. Connectors can be installed on the wall-side or on the top and bottom sides. A special I/O board needs to be designed for this.

Standard the XG5000 board is mounted on the reverse side of the LCD and all connectors are available in the enclosure. This gives you the option to have all cables on the top, bottom or rear side. The easily removable side panels can be used to access optional connectors on I/O boards.

Part numbers are:

- White case: A9094107
- White cover: A9194127
- Transparent cover: A9194121
- 4 pcs of feet: A9212330

4.4.6 Exclusive Enclosure

The large 8.4" and 10.4" TFT LCDs fit the XG5000 Exclusive enclosure. This enclosure can of course also be used with any other type of LCD. It has a lot of space for plug-in cards and electronics, and for custom keyboards. It's available with many options including a card reader upgrade.



Figure 20: Exclusive Enclosure

The white (RAL9002) enclosure consists of a base module and a cover. Other options can be attached to either base module or cover.

Three different base modules are available: standard, standard including a hinge system for the cover and a third version including the hinge and a keylock. Both hinge versions can be used to quickly open the enclosure.



Figure 21: Exclusive Enclosure Base Modules

Two white covers are available (slim or tall), a transparent cover which must be combined with an alu front panel, a simple alu front panel, and a special profiled alu front panel.

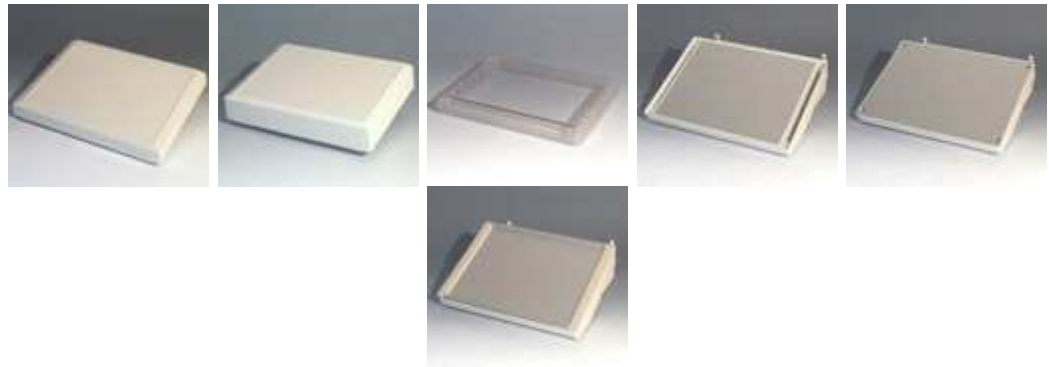


Figure 22: Exclusive Enclosure Covers

The bottom compartment can be used to install a magnetic cardreader with a special cover plate and mounting plate. DELGEN can deliver matching magnetic cardreaders with a serial port interface.

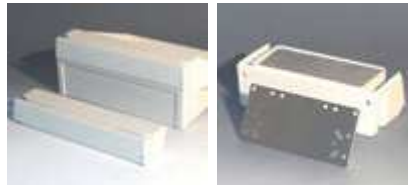


Figure 23: Exclusive Enclosure Cardreader



Figure 24: Exclusive Enclosure Wall Bracket

Due to the many different options we suggest to contact us for your specific requirements. This enclosure can be tailored to fit your application, including custom designed keypads.

No specific part numbers are available, only custom designs.

4.4.7 Other Enclosures

If your application requires a custom enclosure or a different style of standard enclosure, contact DELGEN for help.

A custom enclosure can be made with other 'standard' available enclosures, or a real custom designed enclosure can be designed for your application.

All enclosures can be painted per your request. Any color or combination of colors is available.

Below are some pictures of other 'standard' enclosures which can fit some versions of the XG5000. Options like batteries, card readers, keypads, are possible.



Figure 25: Examples of other enclosures

Custom enclosures can also be designed by DELGEN. Any form factor or material, on your request, can be used.

5 Hardware Specification

Learn more about all hardware features of the X-Graph module. Discover all special functions and find out how to build expansion boards.

5.1 Clock Speed

5.1.1 RTC

The Rabbit processor requires a 32.768kHz oscillator for its RTC and for the initial communication protocol with Dynamic C. To prevent the known problems with this oscillator, see Tech Notes on the Rabbit Semiconductor website, the X-Graph module is equipped with an external oscillator module.

This prevents any oscillation startup problems, removes all influence of external contamination, greatly increases the accuracy of the real time clock and reduces standby current.

If a battery backup of the RTC is not required (time and date are lost on power loss), this special external oscillator can be removed from the module to reduce costs (only for custom designs). An alternative 32kHz oscillator is available for these boards to allow bootstrapping. Also this clock prevents the startup problems and influences for external contamination, but it doesn't support battery backup.

5.1.2 Rabbit Processor Clock

On the XG5000 module the Rabbit is typically clocked at 58.8MHz. Other clock speeds are available on request. A lower clock speed will result in a reduced performance, but also in a lower current consumption. A clock lower than 29MHz also reduces cost (less memory components needed), which could be important for custom designs. Note that the VGA TFT systems require a minimum clock of 50MHz.

The XG5000 uses a high precision Epson clock oscillator. This reduces all contamination, accuracy and drift problems known from the RCM modules. The Rabbit 3000A internal oscillator is normally not used on the XG5000 standard module. Note that (only for custom designs) the Epson clock oscillator is one-time programmable to any required frequency.

To reduce clock instabilities the Rabbit 3000A clock doubler and clock spreader are not used unless on customer request for low cost custom designs. Both systems tighten the requirements on the external memory bus. Using both the doubler and spreader in combination with the internal oscillator would limit the maximum operation frequency to about 30 MHz.

For custom designs different clock speeds can be considered, some examples:

- With the standard 58.8MHz oscillator you get maximum performance. 50MHz is the min. clock for VGA TFT systems.
- A 11.0592MHz crystal gives a maximum speed of 22MHz. The Rabbit 3000A internal clock divider can be used to switch the processor in several low speed power saving modes.
- A 14.112MHz crystal or 56.448MHz oscillator could be used to get perfect matching audio frequencies (44100Hz, 22050Hz).
- The Ethernet chip on the XG5000 has a 25MHz oscillator, which can also be used for the Rabbit on low-cost systems (saves a second oscillator and reduces EMI). Note that this system cannot be used on VGA TFT systems.

- A 25MHz Epson oscillator can also clock the Rabbit and Ethernet chip parallel. Slightly more expensive than the previous situation, but this allows the Rabbit to run at 50MHz. Still not compatible with the VGA TFT system.
- Any lower frequency crystal can be installed for low-power applications. For proper STN LCD operation the clock speed should not be lower than 11MHz.

Selected clock speeds should be multiples of 115200 to allow exact timing of the high-speed serial channels.

5.2 Memory

The XG5000 module has a unique memory organization to get the maximum possible performance and remain compatible with DynamicC. Several enhancements have been made compared to RCM modules.

5.2.1 Memory Organization

5.2.1.1 Memory Devices

The XG5000 allows zero waitstate program memory operation for speeds up to 58.8MHz.

- Program and data memory:
 - Flash: 512 kByte, 45 nsec access time. The flash memory is used to store the application program during power off. Programs are never executed from Flash. Once the module is booted, the flash memory is not used anymore unless your application needs it to store data in it (flash file system or user ID block).
 - Fast SRAM: 512 kByte, 15 nsec access time min. (modules might have 10 or 8 nsec devices installed). After booting the program runs with zero-waitstates from this memory. Also all user data is stored in this memory, unless the memory is completely used. Only then, DynamicC will start using part of the video memory or the slower battery-backup SRAM (if installed).
- Battery backup SRAM: 128, 256 or 512 kByte, 55nsec access time. This type of memory can be used to store non-volatile data (DynamicC feature) or user data, which does not fit the Fast SRAM (unusual situation in DynamicC programs). The bb-SRAM is not installed on the standard XG5000 module. It's available on custom modules. For 58.8MHz systems this memory requires two waitstates.
- Video memory: 512 kByte or 1 MByte, 8nsec access time (10 or 15 on custom designs). This memory is installed on all standard modules. It is used as additional data memory and for storing the display buffer. For 58.8MHz systems it has full read/write capability using zero waitstates.

5.2.1.2 Rabbit Memory Quadrant Allocation

A Rabbit 3000A can control 6MByte of physical memory, but only 1MByte is indirectly accessible. The MMU divides this 1Mbyte of memory space in four 256kByte quadrants. On the XG5000 the following quadrant configuration is used. This list includes the memory mapping used by DynamicC and the XG5000 libraries.

- CS0/OE0/WE0: 512kByte Flash: this memory is never mapped during normal program execution. During booting the BIOS maps this memory temporarily to Q0/Q1, and makes a copy to the 512kByte fast-sram. Then the program restarts from the fast-sram. This is a system supported by DynamicC to allow zero-wait state program execution on fast Rabbit 3000A systems.

- CS2/OE1/WE1: 512kByte of fast-sram. This memory is used for program execution and data storage. Mapped to Q0/Q1.
- CS1/OE1/WE1 (XG5000) / CS0/OE1/WE1 (XG5001): 512kByte of video memory (Q2/Q3). The memory not used by the video memory map (depends on color depth and LCD resolution) can be used as data memory. The video memory is located at the lower address region (0x80000 and up), data memory for DynamicC grows top down (0xBFFFF and down). Care should be taken both areas do not overwrite each other
- CS1/OE1/WE1 (XG5001): 512kByte of battery-backup sram. This memory is not mapped to a quadrant by default in an XG5000 standard setup. To access this memory it needs to be mapped to Q2 and/or Q3. It's important to remap the video memory again to Q2/Q3 once the memory access to the bb-sram is not needed anymore. Due to DynamicC compatibility reasons the physical location of this chip requires a different memory setup for the XG5000/XG5001. But this requires no special actions for programmers because the DynamicC BIOS automatically handles the configuration.

5.2.1.3 Root memory, MMU and Physical Memory

The Rabbit processor can only access 64kByte of memory directly. It does have an on-board MMU to access 1Mbyte of memory indirectly. The physical memory interface has enough I/O lines reserved to connect a maximum of 6MByte memory. How to manage this in software?

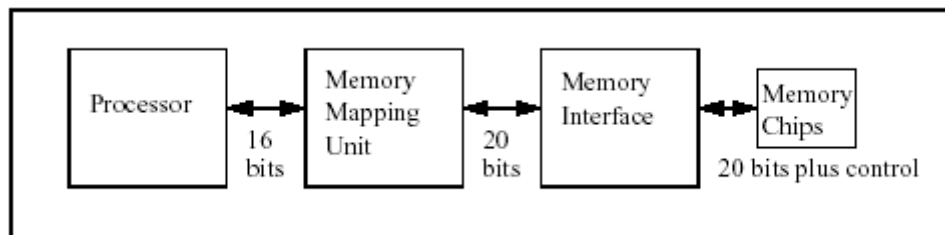


Figure 26: Rabbit MMU

The 64kByte of directly accessible memory is divided in 4kByte chunks. The top 8kByte is always used as a window in the full 1MByte physical memory map. The Rabbit processor has some easy and fast instructions to handle this window. The C Compiler uses this 'xmem' window to access the program memory automatically. A programmer does not need to worry about program size because the full 512kByte of program memory can be accessed almost directly and the compiler handles all overhead. If a program needs to use this window to access the physical memory, the program itself can not be running in this window. This type of program is called a 'root' memory program.

The remaining 56kByte of directly accessible memory is divided in 3 regions by controlling some Rabbit I/O registers. Each region is another window mapped in the physical memory. But these windows don't have an easy system to change the mapping on-the-fly, as the top 8Kbyte window has. The DynamicC BIOS uses the easy approach, and does not support any window remapping. The windows are mapped to physical hardware based on the available hardware.

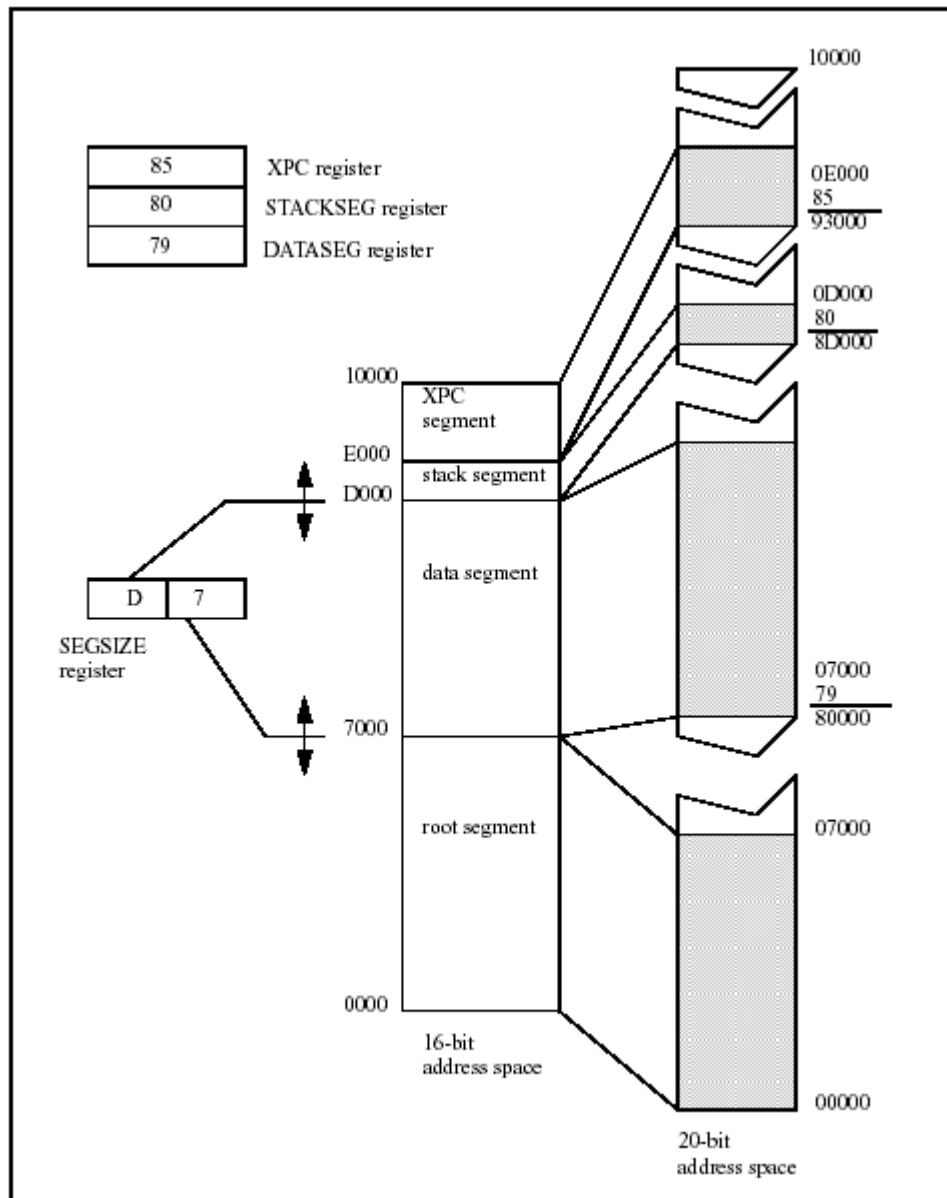


Figure 27: Rabbit MMU Example Configuration

For the X-Graph modules the root window starts at address 0 and its size is standard 44kByte. This window is used to store root memory programs and root data. How much memory is assigned to root memory and root data can be defined in the BIOS with a macro. The Rabbit processor also can use a trick called 'separate instruction and data spaces' to almost double the amount of root memory/data space. But we don't encourage you to use I&D unless you really run out of root memory space.

The second window is normally not used by DynamicC in the X-Graph hardware configuration. DELGEN has implement an innovative feature with this 'not-used' window, i.e. far variables, far pointers and far arithmetic. This windows size is 8kByte. The xgRAM library uses it to give full C style access to all available RAM without the need for far pointers or far arithmetic. This is a new amazing system which gives the programmer full access to all the available ram memory without the need for xmem2root and root2xmem functions. C style type checking works with xgRAM and it is compatible with almost all Dynamic C library functions. Check the 'xgRAM Users Manual' to learn more.

The third window with (4kByte size) is the DynamicC stack window. This size normally fits most DynamicC programs and only needs to be enlarged in very special cases.

This describes how DynamicC uses the 4 available windows, a root program may reconfigure the window mapping I/O registers and use the windows as needed. DELGEN does only encourage users with a very good knowledge of the Rabbit memory system to try window remapping.

5.2.1.4 Accessing more than 20kByte Data Memory

Most users think the Rabbit processor memory model is complicated. Actually, for most applications it's not.

A programmer can just write an application of up to 512kByte program memory size without special actions. To put code in the root memory, a special keyword needs to be used. Because root memory is a limited, you should have a very good reason to use it. Note that many low-level DynamicC libraries use root memory. You might run out of root code memory due to the inclusion of too many DynamicC libraries.

The root code memory is also used to store all users constants !! Try to limit the use of constants and replace them by either xmem constants or use the xgRAM library to access far constants.

Normally 20kByte of root data space is available. This is used to store all global variables of the program. By default DynamicC stores all local variables (of functions) on the stack. The number of local variables is only limited by the stack size (standard is 4kByte). For global variables, global structs and global data arrays, one can use the available root data space. If the 20Kbyte of available space is not sufficient there are several solutions.

The first solution would be increasing the root data space (setting in the BIOS). This will decrease the root program space. Interrupt routines and many DynamicC libraries require root program space. Thus the amount of data space which can be 'stolen' here is limited.

The second solution would be using 'separate instruction & data space'. This will open an extra +/- 16kByte of root data space, but it comes at a speed penalty, an increase of program memory (application dependant) and a decrease of available program memory on fast-sram systems (X-Graph modules).

The third solution is just using the remaining available SRAM memory to store data. On an X-Graph module there is a lot of free available SRAM memory. There is all the memory not used for program execution and root programs in the program fast-sram. Also all the memory in the video memory chip which is not used for the video memory map can be used as data memory.

The main problem many first-time DynamicC users encounter, is how to access all this extra ram memory. It can NOT be accessed with standard C style commands. DynamicC includes a set of library functions to read/write 'extended' data memory. It generally involves copying a chunk of extended data memory to a root memory data buffer before using it. For example one can store an array of 512 elements of a 123 byte struct (62976 bytes) easily in extended memory. To do this you should allocated the amount of needed extended memory, then create a single struct variable in root memory, fill this element with data and copy it to the correct array element in extended memory. To read a struct you'll need to copy the correct element first to a root struct. Got it...., if not check the examples included with DynamicC (the examples on extended memory access).

But the easiest and most ANSI-C compatible solution is using the DELGEN xgRAM library. This library uses a Rabbit hardware window to access all the available SRAM with the standard C style variables (see previous section). No need for xallocs or xmem

calculations. Check the 'xgRAM Users Manual' for more info and start writing DynamicC programs without complicated and buggy xmem2root/root2xmem logic.

On the XG5001 there is an additional 512kByte bb-sram chip. This chip is not mapped to any quadrant. Lets use an example to explain how this memory can be used. Say you want to store the same array of data (512 elements of a 123 byte struct).

- Map Q2/Q3 to the bb-sram. Of course the video memory is not mapped anymore to Q2/Q3. So any extended data memory variable stored in the video memory chip can not be accessed anymore. Also the video memory can not be read or written anymore, but the video display will work as normal.
- Define a region where to store the array. Don't use the DynamicC functions for this, just use a direct physical address.
- Read or write the array with either the xmem2root/root2xmem logic of with the xgRAM library functions.
- Finally don't forget to remap Q2/Q3 to the video memory.

There is an example in the XG5000 samples directory to demonstrate this principle.

5.2.1.5 Dynamic C X-Graph Memory Map

The following memory maps are based on the default X-Graph and BIOS settings. The size of several regions can be adapted and memory space can be reserved for additional DynamicC features (debugging, file system,).

The memory map is not valid for separate I&D mode.

Dynamic C uses data spaces always top-down.

The DC9.50 column indicates only the changes (if any) included in DC9.50 and higher. Also DC9.50 reserves the first 13 bytes of each xalloc region for a configuration table.

Start	Size	Type	Usage	DC9.50 and higher
0x00000	0x6000	RAM	Root code	The unused space is available for xalloc
0x06000	0x3e00	RAM	Root data	
0x09E00	0x0100	RAM	Internal Interrupt Vector Table	
0x09F00	0x0100	RAM	External Interrupt Vector Table	
0x0A000		RAM		Unknown 512 bytes
0X0A000		RAM	Xmem code (the unused space is available for xalloc)	Start = 0x0C200
0x7BFE0	0x0020	RAM	32 bytes unknown	
0X7C000	0x1000	RAM	Stack space	
0x7D000	0x0FE0	RAM	Reserved for stack	
0x7DFE0	0x0020	RAM	Reserved	
0x7E000	0x1000	RAM	Reserved	
0x7F000	0x1000	RAM	Flash buffer	
0x80000	0x40000	RAM	Optional available for xalloc	
0xBF000	0x1000	RAM	"bb-sram" window for root data	
0xC0000	0x40000	Flash	Top 256kByte of Flash	

Table 2: XG5000 Standard Memory Map

5.2.2 MMC/SD(IO) Slot

The XG5000 has standard a Secure Digital card socket. This slot is compatible with MMC (Multimedia card) and SD (Secure Digital) memory and I/O cards. These cards are accessed with an SPI interface. DELGEN provides a low-level driver to access SD memory cards. Also check the 'xgFAT Users Manual' for more information on the X-Graph FAT file system which can be used with the XG5000 SD card socket

Examples of SDIO cards are GPS, GPRS, Bluetooth, WLAN, ... cards. Of course suitable SD(IO) drivers have to be written. DELGEN organizes a forum for exchanging these drivers.

Cards should use a polling system for card and write-protect detection. The slots card detection and write-protect switches are not connected, because they tend to be unreliable on most cards.

SD Cards do not have a reset line and rely on a power on detection for reset. Practical tests indicate that in some situations with some brands of cards a software reset is needed. A mosfet is installed on the XG5000 to allow the cards to be reset.

NOTE: High Power level cards (up to 250 mA) should preferable not be used. Most MMC/SD cards do not use this power level.

5.2.3 EEPROM

The X-Graph module has a 512 byte EEPROM area available in the Atmel slave processor. It can be read or written on byte level and can be used to store configuration information.

Dynamic C and Rabbit modules do offer a user data area in the ID-Block stored in Flash. The X-Graph module also offers this. But the EEPROM area is much faster and easier to access.

5.2.4 Secure Flash

The X-Graph module has a 1024 byte secure Flash area available in the Atmel slave processor. This area uses 64 byte blocks, but the software supports byte level read/writes. It can be used to store configuration or ID information which does not change often. The flash supports 10.000 rewrites for each 64 byte block.

Dynamic C and Rabbit modules do offer an ID-Block stored in Flash. The X-Graph module also includes this. But the XG5000 secure flash area is impossible to erase by simple DynamicC commands and it's impossible to erase during Rabbit firmware upgrades or DynamicC bugs, making it much more secure.

DELGEN provides support to remove the ID-Block feature from the Flash and store all ID-Block data in this secure flash area. This makes available an extra 32kByte of Flash and removes any occasional erasure problems of the ID blocks due to bugs in some DynamicC versions.

Read the 'xgBIOS Users Manual' to get more info on this subject.

5.3 I/O Expansion

The standard Rabbit RCM modules are very small modules offering I/O expansion on 2 mm pitch headers.

The X-Graph module is slightly larger but it uses industry standard 2.54 mm (0.1") headers for I/O expansion because they are much better available and easier to use for through-hole designs. Standard boxed male headers are used to reduce EMC problems and wrong insertion errors. All I/O expansion connectors are installed on a 0.1" grid which makes it easy to use the XG5000 with development pcb boards.

5.3.1 I/O pins

Many Rabbit I/O ports, buffered I/O ports, LCD and ADC lines are available on the I/O expansion headers. Cheap through-hole I/O boards can be designed to offer custom-made I/O functions. These boards can be easily installed on the 2.54 mm headers of the X-Graph module.

DELGEN offers a design service for such I/O cards. Contact us if you need more information. Several I/O boards are already available (ref. To the 'X-Graph Expansion Cards' manual) and several more are being designed.

For a list of available I/O port pins see the description of the I/O expansion headers J1, J2, J3, J4 and J21. Several installation options are available for the I/O expansion headers. They can be installed on the component or solder side of the pcb. Either female or male connectors are available in boxed and standard versions. Male connectors are also available in raised and angled versions. The XG5000 development kit is delivered with a set of female boxed and male boxed headers. Users can solder the proper connectors for their applications.

For more info of the signals mentioned in below tables and marked 'Rabbit 3000 xxxxx', refer to the Rabbit 3000 datasheet (www.rabbitsemiconductor.com).

IMPORTANT: Power supply pins.

Several I/O pins are connected to the +V, +5V or +3.3V power rails. For custom modules the voltage on these pins might be different. A custom module with a +5Volt input level will have all +V pins set to +5Volt. More important, a custom module with a +3.3Volt input level will have both the +V and +5V pins set to +3.3Volt.

On pre-R4 XG5000 modules some power supply pins have different voltage levels. This is clearly marked in below tables.

5.3.1.1 J1: Analog & Slave header

This header is used for the analog input/outputs and the slave processor expansion lines.

- 16 lines are reserved for the 16 optional analog inputs (12- or 16-bit).
- 1 line is reserved for the optional 8- or 12-bit DAC output.
- The power pins: analog ground, analog power input, ground, +3.3Volt, +V
- The slave processor expansion lines:
 - 8 analog inputs (10-bit), reconfigurable as I/O pins and I2C interface
 - 4 I/O lines with optional specific interface connections

All slave I/O lines can be software configured to be either input, output, input with pull-up or special function.

Pin	Signal name	Function
1	1WIRE	Slave I/O or 1-Wire
2	GND	Ground
3	ATM TXD	Slave I/O or RS TXD or PS2 keyboard CLK
4	+V	+V Power rail
5	ATM RXD	Slave I/O or RS RXD or PS2 keyboard Data
6	+5V (pre-R4: +3.3V)	+5V Power Supply
7	RC5 Receive	Slave I/O or RC-5 Receive
8	AGND	Analog Ground (R35 connects AGND-GND)
9	AIN6	Slave I/O or SDA or ADC-6
10	AIN7	Slave I/O or SCL or ADC-7
11	AIN5	Slave I/O or ADC-5
12	AIN1	ADC-1
13	AIN3	Slave I/O or Touchscreen or ADC-3
14	AIN2	Slave I/O or Touchscreen or ADC-2
15	AIN4	Slave I/O or ADC-4
16	AIN0	ADC-0
17	AIN22	ADC Channel 22
18	AIN23	ADC Channel 23
19	AIN20	ADC Channel 20
20	AIN21	ADC Channel 21
21	AIN18	ADC Channel 18
22	AIN19	ADC Channel 19
23	AIN16	ADC Channel 16
24	AIN17	ADC Channel 17
25	AIN14	ADC Channel 14
26	AIN15	ADC Channel 15
27	AIN12	ADC Channel 12
28	AIN13	ADC Channel 13
29	AIN10	ADC Channel 10
30	AIN11	ADC Channel 11
31	AIN8	ADC Channel 8
32	AIN9	ADC Channel 9
33	+5V (pre-R4: ADCP)	+5V Power Supply (pre-R4: ADC Alternate Power Input)
34	DAC0	DAC output

Table 3: J1 Analog & Slave Expansion Header

5.3.1.2 J2: Rabbit I/O header

Many Rabbit I/O pins are available on this header. More are available on J3 and J4. All Rabbit serial port I/O pins are connected to this header. Note that these are the directly connected digital versions, not the buffered versions. For some serial ports there might be buffers on-board, be careful when using the digital lines in this case.

Lines marked 'Free I/O line' are not used on the board and free to use on expansion boards. Some of these lines have an alternate function, indicated after the ` / `. These alternate functions are not installed on the standard board, but might be installed on custom designs, making the pin unavailable for free use.

Pins with only a function indicator (not marked as 'Free I/O line') are used on the standard board. They can be made available as Free I/O lines if the function is not installed on custom designs.

Pins used for 'High Voltage outputs' are connected to the on-board ULN2003 driver. If the ULN2003 outputs are not required they can be freely uses as input or output. Side effect will be the ULN2003 output toggling on I/O port changes.

Pin	Signal name	Function
1	SPI SCK	PB0: SPI clock
2	SPI MISO	PC4 / RXB: SPI Data receive
3	PG0	Free I/O line
4	SPI MOSI	PC4 / TXB: SPI Data transmit
5	PG2 / RS485 TXD	RS485 Txd
6	PG1	Free I/O line
7	PD4	Free I/O line / ADC CS
8	PG3 / RS485 RXD	RS485 Rxd
9	VRAM	Battery backup power output (/ input)
10	PD5	Free I/O line / DAC CS
11	IORD	Rabbit 3000 IORD
12	RESET	Rabbit 3000 Reset
13	PG4	Free I/O line
14	IOWR	Rabbit 3000 IOWR
15	PG6	Free I/O line
16	PG5	Free I/O line
17	PE0	Free I/O line
18	PG7	Free I/O line
19	PE5	Free I/O line
20	PE1	Free I/O line / USB DET (R162 installed)
21	RS232 RXD	PC3 / RXC: Primary RS232C Receive
22	RESETIN	Board Reset input, active low
23	RS232 TXD	PC2 / TXC: Primary RS232C Transmit
24	RS232 RTS	PC0 / TXD: Secondary RS232C Transmit
25	PE7	High Voltage output 2
26	RS232 CTS	PC1 / RXD: Secondary RS232C Receive
27	PD7	Free I/O line / RS485 DE2
28	PE6	Buzzer / High Voltage output 0
29	Not connected	
30	PD6 / DE1	RS485 DE1
31	GND	Ground
32	+3.3V	+3.3V Power Supply
33	+V	+V Power rail
34	+V	+V Power rail

Table 4: J2 Rabbit I/O Expansion Header

5.3.1.3 J3: LCD expansion, Rabbit I/O header

The header is intended to be used for LCD plug in cards to support LCD's which can not be handled with the on-board connectors. It carries all lines directly related to control an LCD, routed via the CPLD.

NOTE: the XG5000 can be used without an LCD, but with the CPLD installed. The CPLD is user programmable and can be used to build a custom interface using the I/O lines connected to this header. If you need help on this, contact DELGEN.

The 10 MSB pins of this header can be accessed with a 2x5 header. These pins carry some Rabbit I/O pins and the pins required to reprogram the CPLD (JTAG interface).

Pin	Signal name	Function
1	+5V (pre-R4: +V)	+5V Power Supply (pre-R4: +V Power rail)
2	+LCD	+LCD backlight power supply (typically +5Volt)
3	MACH12	LCD I/O line 12
4	PWM	LCD PWM control line from slave processor
5	MACH11	LCD I/O line 11
6	MACH10	LCD I/O line 10
7	MACH9	LCD I/O line 9
8	MACH8	LCD I/O line 8
9	MACH7	LCD I/O line 7
10	MACH6	LCD I/O line 6
11	MACH5	LCD I/O line 5
12	MACH4	LCD I/O line 4
13	MACH3	LCD I/O line 3
14	MACH2	LCD I/O line 2
15	MACH1	LCD I/O line 1
16	MACH0	LCD I/O line 0
17	DD5	LCD Databus 5
18	DD6	LCD Databus 6
19	DD4	LCD Databus 4
20	DD7	LCD Databus 7
21	DD3	LCD Databus 3
22	DD2	LCD Databus 2
23	DD1	LCD Databus 1
24	DD0	LCD Databus 0
25	TMS2	CPLD JTAG TMS
26	TCK2	CPLD JTAG TCK
27	+3.3V	+3.3V Power Supply
28	TDI2	CPLD JTAG TDI
29	TDO2	CPLD JTAG TDO
30	PF0	Free I/O line
31	PF1	Free I/O line
32	PF2	Free I/O line
33	PF3	Free I/O line
34	GND	Ground

Table 5: J3 LCD & Rabbit I/O Expansion Header

5.3.1.4 J4: Rabbit & ASIX I/O header

J4 includes the Rabbit I/O address and databus and one Rabbit I/O line. These lines can also be used as standard I/O lines, but care should be taken to keep the ports in I/O bus mode because the Ethernet chip requires this. Unless of course your application does not need the Ethernet chip.

The Ethernet chip, nickname 'Asix', has a number of programmable I/O lines. These are also routed to this header, adding an extra 17 I/O lines to the board. The Asix designers intended these lines to be used to implement a pc-style parallel port. Imagine an Asix chip in a printer. On the XG5000 you can use the lines to easily implement a printer port.

All the lines are also programmable and can be used as standard I/O lines. Check the X-Graph examples directory in Dynamic C.

Pin	Signal name	Function
1	PA5	Rabbit IO Databus 5
2	PA4	Rabbit IO Databus 4
3	PA7	Rabbit IO Databus 7
4	PA3	Rabbit IO Databus 3
5	PA6	Rabbit IO Databus 6
6	PA2	Rabbit IO Databus 2
7	PB7	Rabbit IO Addressbus 5
8	PA1	Rabbit IO Databus 1
9	PB6	Rabbit IO Addressbus 4
10	PA0	Rabbit IO Databus 0
11	PB5	Rabbit IO Addressbus 3
12	PF0	Free I/O line
13	PERR	Free Asix I/O line
14	PB3	Rabbit IO Addressbus 1
15	PSLCTIN	Free Asix I/O line
16	PB2	Rabbit IO Addressbus 0
17	PINIT	Free Asix I/O line
18	LPB4	Rabbit IO Addressbus 2 (not with CLCD)
19	PATFD	Free Asix I/O line
20	+3.3V	+3.3V Power Supply
21	PSTRB	Free Asix I/O line
22	GND	Ground
23	PBUSY	Free Asix I/O line
24	PACK	Free Asix I/O line
25	PPE	Free Asix I/O line
26	PSLCT	Free Asix I/O line
27	PPD7	Free Asix I/O line
28	PPD6	Free Asix I/O line
29	PPD5	Free Asix I/O line
30	PPD4	Free Asix I/O line
31	PPD3	Free Asix I/O line
32	PPD2	Free Asix I/O line
33	PPD1	Free Asix I/O line
34	PPD0	Free Asix I/O line

Table 6: J4 Asix & Rabbit I/O Expansion Header

5.3.1.5 J21: Buffered I/O header

The output signals of all on-board buffers, voltage translators and interfaces are available on J21.

A custom version of the XG5000 can be delivered without the standard plugs (DC input, USB, Ethernet) because all the signals are also available on J21. Such a custom XG5000 can be plugged in an expansion board, which has all the connectors fitting the applications housing.

Note that the Ethernet signals are digital levels, which require an Asix compatible transformer.

Pin	Signal name	Function
1	TPIN+	Ethernet positive input
2	TPIN-	Ethernet negative input
3	TPOUT+	Ethernet positive output
4	CT	Ethernet centertap
5	TPOUT-	Ethernet negative output
6	+3.3V	+3.3V Power Supply
7	+3.3V	+3.3V Power Supply
8	PROG RXD	Rabbit programming receive
9	SMODE	Rabbit SMODE pin
10	RESETIN	Board reset in (programming needed)
11	PTXD	Rabbit programming transmit
12	USB+	USB positive line
13	USB-	USB negative line
14	VBUS	USB power input line
15	USB RTS	USB chip RTS line
16	USB CTS	USB chip CTS line
17	GND	Ground
18	DRS TXD	RS232C Txd (PC2)
19	DRS RXD	RS232C Rxd (PC3)
20	DRS CTS	RS232C CTS (PC1)
21	DRS RTS	RS232C RTS (PC0)
22	GND	Ground
23	+V	+V Power rail
24	+V	+V Power rail
25	HVOUT2	High Voltage Output 2 (PE7)
26	HVOUT0	High Voltage Output 0 (PE6)
27	HVOUT3	High Voltage Output 3 (PF5)
28	HVOUT1	High Voltage Output 1 (PF7)
29	HVOUT4	High Voltage Output 4 (PF4)
30	HVPROT	High Voltage Protection Diode Input
31	RS485 A 2	RS485 Port 2 'A' (PC0/1 or PG6/7)
32	RS485 B 2	RS485 Port 2 'B'
33	RS485 A 1	RS485 Port 1 'A' (PC2/3 or PG2/3)
34	RS485 B 1	RS485 Port 1 'B'

Table 7: J21 Buffered I/O Expansion Header

5.3.1.6 J23: Character LCD header

J23 shares pins with J3 and J4, which cannot be installed once J23 is installed.

J23 uses the industry standard 16-pin connection of character LCD's. Many character LCD's of different manufacturers fit this connector.

Note that only 3.3V compatible character LCD's can be used. Also mind the contrast voltage and backlight voltage required for a character LCD. These might require adjustments on the contrast resistor divider and/or secondary SMPS output voltage.

Pin	Signal name	Function
1	GND	Ground
2	+3.3V	+3.3V Power Supply
3	Contrast +V	Contrast voltage (fixed resistor divider used)
4	PB2	RS
5	PB3	R/W
6	PF0	E
7	PA0	DB0
8	PA1	DB1
9	PA2	DB2
10	PA3	DB3
11	PA4	DB4
12	PA5	DB5
13	PA6	DB6
14	PA7	DB7
15	Backlight +V	Anode
16	Ground	Cathode

Table 8: J23 Character LCD Header

5.4 Interrupts

In a real time system it is very important to understand which interrupts occur and how long it takes to execute the interrupt routines.

5.4.1 Periodic Interrupt

This level 1 interrupt is enforced by Dynamic C. It reenables interrupts very fast thus allowing level 1, 2 and 3 interrupt to occur. But it does interrupt the main program every 488 μ sec. Generally this interrupt requires about 2% of the CPU time (@ 25 MHz), about 1% @ 58.8MHz.

5.4.2 LCD Interrupt

The XG5000 LCD control system does not require an interrupt. The XG1000/XG3000/XG4000 do need an interrupt. This makes the XG5000 LCD interface faster compared to the other X-Graph products.

5.4.3 Serial Bus Interrupts

Most serial busses will require an interrupt for receiving data. Otherwise bytes might be lost at higher communication speeds. Preferable use level 1 and for very critical serial busses level 2 interrupts. Each level 2 interrupt will prevent the periodic interrupt from occurring. This can lock up Dynamic C and make the RTC run slower.

An example of a serial bus library with level 2 interrupts can be found in the DMX512.lib library ('xgDMX512 Users Manual').

5.5 Integrated I/O

The X-Graph module offers standard more interfaces than many other available Rabbit based single board computer. The Dynamic C libraries support most interfaces. DELGEN delivers some extra libraries for the X-Graph specific functions.

5.5.1 Network

The Ethernet connector has two build-in led indicators. They are connected to the LINK and ACT led outputs of the Asix network chip.

Yellow led: on = full duplex connection detected, off = half duplex connection detected. When in half duplex and a collision occurs, the led will blink at 0.67Hz.

Green led: on = link detected, off = no link. When a link is detected the led will blink at 0.67Hz during line activity.

An Asix network controller is used (identically to the RCM3200 module). It is 100% compatible with the Dynamic C version 7.32 and higher network libraries.

5.5.2 Touchscreen & LCD

Refer to chapter 4 for learning about the different available XG5000 LCD's. A short description of the hardware/software interface of the 4 standard LCD controllers is given below.

5.5.2.1 Character LCD (CLCD)

A 16-pin character LCD connector shares pins with J3 and J4. Both of these cannot be installed when a CLCD connector is installed.

Character LCD's use a simple 8-bit interface. Rabbit PortA is connected to the CLCD databus. Further 3 Rabbit I/O pins (PB2, PB3, PF0) are used. Note that to control a CLCD the Rabbit Secondary I/O bus must be disabled. On the XG5000 this bus is enabled, a requirement for the Ethernet chip. To send command and/or data to a CLCD, you need to disable the bus, send the commands/data, and reenable the bus.

A small CLCD library is included with the XG5000, which handles all this and offers a few functions to control the CLCD ('X-Graph and Dynamic C' manual).

5.5.2.2 B/W QVGA Display

The STN LCD interface uses the on-board CLCD to generate all LCD signals automatically. No Rabbit CPU time or interrupt is required to refresh the LCD. A linear video memory map is stored in the video SRAM and is continuously read by the CPLD. Due to the advanced XG5000 LCD interface the Rabbit 3000 has continuously access to

the video sram = 100% of the available bandwidth. This results in the fastest possible drawing and refresh speed.

DELGEN includes with the XG5000 libraries a low level driver for this display. This driver integrates perfectly in the GRAPHIC.LIB library included with Dynamic C. No changes to this Dynamic C library are required.

The LCD uses up to 32kByte chunk of RAM as display buffer. By default it is located at 0x80000. This is in the lower region of the video SRAM.

5.5.2.3 CSTN QVGA Color Display

The CSTN LCD interface uses the on-board CLCD to generate all LCD signals automatically. No Rabbit CPU time or interrupt is required to refresh the LCD. A linear video memory map is stored in the video SRAM and is continuously read by the CPLD. Due to the advanced XG5000 LCD interface the Rabbit 3000 has continuously access to the video sram = 100% of the available bandwidth. This results in the fastest possible drawing and refresh speed.

DELGEN includes with the XG5000 libraries a low level driver for this display. The GRAPHIC.LIB library included with Dynamic C cannot be used because it does not support color. A complete set of X-Graph GUI ('xgGUI Users Manual') libraries is included with the XG5000.

The driver uses up to 64kByte chunk of RAM as display buffer. By default it is located at 0x80000. This is in the lower region of the video SRAM.

5.5.2.4 TFT LCD

The TFT LCD interface uses the on-board CLCD to generate all TFT signals automatically. No Rabbit CPU time or interrupt is required to refresh the LCD. A linear video memory map is stored in the video SRAM and is continuously read by the CPLD. Due to the advanced XG5000 LCD interface the Rabbit 3000 has continuously access to the video sram = 100% of the available bandwidth. This results in the fastest possible drawing and refresh speed.

The standard system can handle TFT LCD's of up to VGA resolution in 8-bit color mode (256 colors). Optional a 24-bit color mode (16M colors) can be installed for QVGA resolutions. SVGA resolution is available as an option. Note that 24-bit color support is possible, but most LCD's only support 18-bit.

DELGEN includes with all XG5000 modules its enhanced xgGUI set of libraries. The drawing speed of these libs is considerable faster compared to the GRAPHIC.LIB functions because no bit manipulations are needed. Correct BMP files (8-bit or 24-bit) can be directly imported without conversion. Even GIF or JPG files could be used, given a proper decoder is used.

Check the 'xgGUI Users Manual' to get more information on the xgGUI libs.

5.5.2.5 Analog Touchscreen

The slave processor manages the analog touchscreen by using two channels of the on-board ADC. Touchscreen actions are pushed in an event buffer, which is read by the Rabbit-Slave interface software driver.

5.5.3 Serial Interfaces

The Rabbit microcontroller includes six serial channels. Five channels are pre-assigned on the XG5000 module and the required hardware interfaces are integrated on the module.

5.5.3.1 USB

An FTDI FT232R chip is used to interface a USB1.1 compliant connector to serial port A on the Rabbit. This connection is required for debugging but it can also be used for applications.

Handshaking is available with the RTS and CTS lines. Both lines are available on the J21 connector and can be routed on an external I/O board to any available I/O line. The DTR line is connected to the Reset line of the board, a debugging requirement.

The standard Dynamic C libraries, RS232.LIB and MODEM.LIB, can be used with this port. The necessary macro's are available in XGRAPH.LIB.

If the USB hardware is not installed, header J6 can be used to connect a Rabbit programming cable.

5.5.3.2 RS232C and Modem

A RS232C communication interface with RTS/CTS handshaking is connected to Rabbit serial port C. The module includes a RS232C 4-channel level shifter with ESD protection. The 4 level shifted RS lines are available on I/O expansion headers J9 and J21. This port is fully compatible with the DC libraries RS232.LIB and MODEM.LIB.

When the RTS/CTS handshake lines are not used, they offer a secondary level shifted serial channel. Both lines can double as a RXD/TXD pair connected to the Rabbit 3000A serial port D pins.

J9 is a 2x5 pin boxed header, which can be connected to a standard RS232C cable and male dSub-9 connector (included with development kit). The port can be used to directly interface any general-purpose serial device, which normally connects to a pc. To use this port for connecting the XG5000 to a PC, a null-modem cable is required. This is for example needed for the xgConsole mode ('xgConsole Users Manual').

Pin	Signal Name	Function
1	Not connected	
2	Not connected	
3	RXD	Received Data
4	RTS	Ready To Send
5	TXD	Transmitted Data
6	CTS	Clear To Send
7	Not connected	
8	Not connected	
9	GND	Ground
10	Not connected	

Table 9: J9 RS232 Header

5.5.3.3 RS485

Two RS485 drivers can be installed on the XG5000. They can be configured to use Serial Port C, D, E or F. Of course serial port C and D can only be used if the RS232C level shifter is not installed.

The XG5000 standard module has one RS485 driver installed, connected to serial port F. The Dynamic C RS485 libraries can be used and the XGRAPH.LIB includes the required macros and support functions for the Dynamic C libs.

A 110 Ohm terminating resistor can be installed and the RS485 + and – lines can have a 680 Ohm pull-up/down resistor. Both of these are custom options, not installed on the standard module.

The RS485 signals are available on I/O expansion header J21.

On the standard module is a DPI connector installed (refer to the 'DPI Users Manual'). A DPI bus is a low-cost multi-master-slave communication bus. It uses a RS485 driver, a simple DPI protocol and the bus also includes pins for power distribution. The XG5000 module can either source or sink power on the DPI bus. A standard 8-pin RJ connector is used with UTP cables.

5.5.4 Analog Expansion

Expansion Header J1 includes the analog input and output channels. A single analog ground pin is available.

The XG5000 module has several ADC/DAC options. Standard an 8-channel ADC with a 10-bit resolution is included (slave processor based). Note that analog input 2 and 3 are not available if a touchscreen is installed. Channels 6 and 7 double as a hardware I2C interface. All ADC lines can be reconfigured as standard I/O lines.

Optional one or two ADC chips can be installed, with either a 12-bit or 16-bit resolution. The also optional DAC is available in an 8-bit or 12-bit version.

The different versions are pin compatible. Drivers for both the ADC and DAC are available in the XGRAPH.LIB library.

5.5.5 Buzzer

A small buzzer is installed on the XG5000 board. The Rabbit drives the buzzer directly. Software support is included in XGRAPH.LIB library.

5.5.6 High Voltage / High Current Outputs

5 high voltage / high current outputs are available on expansion connector J5. A ULN2003 driver chip is used for these outputs. This chip can withstand input voltages up to 50V and sink up to 300mA. Please observe the ULN2003 specification for the limited total power dissipation when using all outputs simultaneously.

Each output can either sink 300mA or be high-impedant. The 5 channels are connected to 5 outputs of the Rabbit 3000: PE6 (shared with the buzzer), PF7, PE7, PF5 and PF4. PF4, PF5 and PF7 can be used by the PWM module of the Rabbit 3000. This allows direct control of PWM driven motors.

When driving inductive loads the HVPROT line should be connected to the positive voltage of those loads. The ULN2003 build-in protection diode will prevent damage to

the ULN2003. Inductive loads will generate a reverse voltage when switched off, the energy is absorbed by the protection diode. Typical inductive loads are motors and triacs (not the triacs themselves but the loads connected to the triacs).

5.5.7 I/O Slave Processor

The X-Graph module includes a slave processor for internal hardware management. It also offers some of the most interesting hardware interfaces of the X-Graph module without putting a software load on the Rabbit microcontroller.

The Slave processor is connected to the Rabbit processor with the on-board SPI bus and a single handshake line. A driver is included in the XGRAPH.LIB to handle the low-level communication protocol. Several functions are available to easily control the slave processor features without worrying about this protocol.

The slave processor firmware is user upgradeable. Either new firmware to solve bugs or patches can be installed by the user. Or specific application dependant firmware can be developed by DELGEN or the user. For example the slave processor communication protocol could be changed to allow fast control of one single feature.

12 slave processor I/O pins are directly available on J1. All of these pins are by default configured as general purpose I/O pins. They can be individually configured input or output. Each pin has a programmable pull-up resistor (on or off). All pins also have special functions, which can be enabled individually.

On overview of the pin configurations:

J1 Pin	Signal name	Default	Function 1	Function 2	Function 3
1	1WIRE	I/O pin	1-Wire		Keypad 1
3	ATM TXD	I/O pin	RS232 Txd	PS2 keyboard Data	Keypad 2
5	ATM RXD	I/O pin	RS232 Rxd	PS2 keyboard Clk	Keypad 3
7	RC5 Receive	I/O pin	RC-5 Input		Keypad 4
9	AIN6	I/O pin	ADC-6	I2C SDA	Keypad A
10	AIN7	I/O pin	ADC-7	I2C SCL	
11	AIN5	I/O pin	ADC-5		Keypad B
12	AIN1	ADC-1			
13	AIN3	I/O pin	ADC-3	Touchscreen	Keypad C
14	AIN2	I/O pin	ADC-2	Touchscreen	
15	AIN4	I/O pin	ADC-4		Keypad D
16	AIN0	ADC-0			

Table 10: Slave Processor Configurable Pins

The ADC interface is already described, the remaining interfaces are:

5.5.7.1 PC/AT Keyboard with PS2 Connector

Two slave processor pins can be configured to accept the standard PC/AT keyboard protocol.

The slave processor handles the communication with the keyboard and transmits key pressures to the Rabbit processor. Commands can be send to the keyboard.

A plug-in board is available from DELGEN, which includes a standard PS/2 keyboard connector and a RC-5 receiver. (Pre-R4 XG5000 modules only work with +3.3Volt compatible PS/2 keyboards).

This specific interface is interesting for applications, which need a lot of user input and want to use off-the-shelf cheap full-size keyboard. Also cheap barcode readers can easily be installed.

5.5.7.2 I²C interface

The slave processor also includes a hardware I²C bus driver. Two of the ADC channels can be reconfigured.

The slave processor can be configured as a I2C slave or master. It can handle multi-master setups. The interface is fully configurable and works with speeds up to the max. I2C speed, i.e. 400kHz.

All communication is handled by the slave processor. Data and commands are transferred to the Rabbit processor via the slave processor communication protocol.

5.5.7.3 Dallas 1-Wire

The time-critical Dallas 1-Wire protocol is also supported by the slave processor. This bus can be used to communicate with Dallas 1-Wire or i-Button devices, typically used for temperature and pressure measurements.

All 1-Wire commands are available. The interface can auto-detect 1-Wire devices and report there ID. Data can be send and received.

The interface can be delivered with a DS9502P protection diode (option). It can handle standard 1-Wire and bus-powered high-power 1-Wire devices.

5.5.7.4 IR Remote Control

A single pin of the slave processor can be configured as a remote control input pin. The standard slave processor firmware includes a driver to support the Philips RC-5 protocol.

5.5.7.5 Keypad Expander

A 4x4 matrix keyboard can be connected to the slave processor. The keyboard should be connected to a single row of 8-pins of connector J1 (odd numbered pins 1 up to 15).

All lines not used by the keypad can still maintain there standard or other alternate functions. Rows will be assigned a pull-up resistor automatically. Columns are considered the keypad output lines.

5.5.7.6 RS232C Port

Two slave processor lines can also be configured as a fully programmable UART. The functionality of this UART includes features not offered by the Rabbit serial ports. It requires no Rabbit CPU power and can include configurable receive and transmit buffers.

Features:

- Full Duplex operation
- High resolution baudrate generator

- 5, 6, 7, 8 or 9 databus
- 1 or 2 stopbits
- Hardware odd or even parity generator
- Data overrun detection
- Framing error detection
- Hardware noise filtering
- Multi-processor mode
- Three different interrupts assure correct and fast full-duplex operation

This interface can be used to control a serial device without loading the Rabbit processor.

5.6 Programming the Hardware

The XG5000 slave processor and CPLD firmware are both upgradeable.

5.6.1 Slave Processor

A Rabbit function is included in XGSLAVE.LIB to load new firmware in the slave processor.

New slave processor firmware will be made available by DELGEN to solve bugs, add patches or new features. With the included function it's very easy to safely upgrade the firmware in a life system.

Specific user application dependant slave processor firmware can be developed by DELGEN on request. Or users can contact DELGEN on how to develop such firmware. This could be required if the slave processor needs to handle a single interface system at a speed not attainable with the default communication protocol.

The slave processor can be directly programmed via its bootstrap mode pins connected to the Rabbit processor. DELGEN strongly discourages bootstrapping the slave processor. It does include some internal hardware management firmware, which is not open source. By erasing the slave processor memory (via bootstrap), the hardware management firmware will be removed and make the XG5000 stop working and void your warranty.

5.6.2 CPLD

Also the on-board CPLD can be reprogrammed. The required signals (JTAG port) are available on connector J3. For the programming software and instructions we refer to the Lattice website (www.latticesemi.com).

The XG5000 is delivered with a CPLD firmware matching the included LCD. By reprogramming the CPLD the LCD will become unusable and on systems without battery backup sram, the Rabbit will not boot anymore. This will also void your warranty. The CPLD LCD firmware is a DELGEN trademark and not available as open source. It will never be distributed to any customer.

Although, on systems without an LCD, or for customers wishing to develop their own LCD interface, the CPLD can be reprogrammed.

Systems without LCD have 21 CPLD signals directly connected to J3. Any logical function could be build in the CPLD to generate application dependent signals on these lines.

Contact DELGEN if you need help with the development of such applications.

6 Installation

This section provides some considerations for mounting the X-Graph.

6.1 Reliability Considerations

The X-Graph has strong environmental resistance and high reliability, but you can maximize the systems reliability by avoiding or eliminating the following conditions at the installation site:

- Abrupt temperature changes and condensation
- Ambient temperatures exceeding a range of 0°C to 50°C
- Relative humidity exceeding a range of 20% to 70%
- Strong magnetism or high voltage
- Corrosive gasses
- Direct vibration or shock
- Excessive iron dust or salt
- Spray from harsh chemicals
- Strong magnetic fields
- High voltage lines

6.2 Mechanical Installation

The mechanical dimensions are described in chapter 7. The board is intended to be used in an X-Graph Standard enclosure. It can be mounted in any type of X-Graph or non X-Graph enclosure using the 4 mounting holes.

6.3 Installation Guidelines

Please notice the following advises for incorporating the X-Graph into your application to comply with the CE requirements, described in chapter 7.

The customer should provide a CE-compliant power supply adapter for the end-product application.

- When connecting the X-Graph to outdoor cables, the customer is responsible for providing CE-approved surge/lightening protection.
- DELGEN recommends using shielded cables in noisy electromagnetic environments.
- While the X-Graph meets the EN61000-4-2 (ESD) requirements in that it can withstand contact discharges of ± 4 kV and air discharges of ± 8 kV, it is the responsibility of the end-user to use proper ESD precautions to prevent ESD damage when installing or servicing the X-Graph.
- Damage to the Rabbit 3000 microprocessor may result if voltages outside the design range of 0 V to 5.5 V DC are applied directly to any of its digital inputs.
- Since the X-Graph is designed to be connected to other devices, good EMC practices should be followed to ensure compliance. CE compliance is ultimately the responsibility of the integrator.
- If it becomes necessary to clean the screen overlay, use a mild detergent, then rinse with lukewarm water using a clean sponge or a soft cloth. Dry thoroughly with a chamois or a moist cellulose sponge to prevent water spots. Do not use abrasives, which will scratch the hard coating on the overlay. Fresh paint splashes, grease, and smeared glazing compounds can be removed by rubbing gently with a isopropyl alcohol. Never use gasoline, acetone, carbon tetrachloride, or highly alkaline cleaners. Rinse afterwards with lukewarm water as described above. Cleaning is not recommended when the X-Graph is exposed to the hot sun or elevated temperatures.

7 Technical Information

7.1 CE Compliance

Electrical equipment is generally divided into two classes.

Class A	Class B
Digital equipment meant for light industrial use	Digital equipment meant for home use
Less restrictive emissions requirement: less than 40 dB $\mu\text{V}/\text{m}$ at 10 m (40 dB relative to 1 $\mu\text{V}/\text{m}$) or 300 $\mu\text{V}/\text{m}$	More restrictive emissions requirement: 30 dB $\mu\text{V}/\text{m}$ at 10 m or 100 $\mu\text{V}/\text{m}$

These limits apply over the range of 30–230 MHz. The limits are 7 dB higher for frequencies above 230 MHz. Although the test range goes to 1 GHz, the emissions from Rabbit-based systems at frequencies above 300 MHz are generally well below background noise levels.

The X-Graph has been tested and was found to be in conformity with the following applicable immunity and emission standards. The X-Graph is also CE qualified. Boards that are CE-compliant have the CE mark.

7.1.1 Immunity

The X-Graph meets the following EN55024/1998 immunity standards.

- EN61000-4-2 (ESD)
- EN61000-4-3 (Radiated Immunity)
- EN61000-4-4 (EFT)
- EN61000-4-6 (Conducted Immunity)

Additional shielding or filtering may be required for a heavy industrial environment.

7.1.2 Emissions

The X-Graph meets the following emission standards emission standards with the Rabbit spectrum spreader turned off.

This microprocessor is used on the X-Graph that carry the CE mark.

- EN55022:1998 Class B
- FCC Part 15 Class B

Your results may vary, depending on your application, so additional shielding or filtering may be needed to maintain the Class B emission qualification.

7.2 Mechanical Dimensions

All dimensions are in inches.

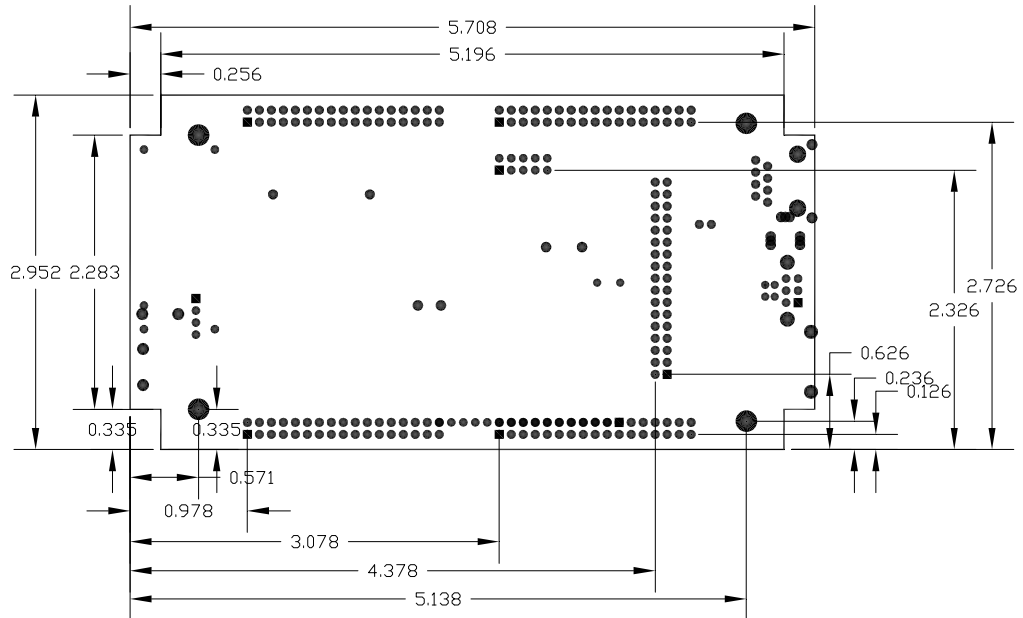


Figure 28: Global board and connector dimensions

7.3 Electrical Schematics

The latest electrical schematics can be downloaded from the X-Graph website www.x-graph.be.

8 Custom Made Designs

8.1 Mechanical Enclosures

The X-Graph can be delivered without an enclosure as a separate module or build in one of several X-Graph enclosures (chapter 4).

Custom-made aluminum or plastic enclosures can be provided. Contact DELGEN for more information.

It is possible to modify existing enclosures and/or openings can be milled. Keypads can be integrated in existing or custom enclosures.

Enclosures can also be painted in any RAL color.

8.2 Keypads

The X-graph can be delivered with an analog touchscreen. The combination of a display and touchscreen provides the possibility to develop the most configurable user interface one can imagine.

Your X-Graph module also has a keypad extension connector fitting a 4x4 keypad (larger available as option). Part of our total custom design service, DELGEN can provide custom-made self-adhesive keypad which perfectly fit the selected enclosures and customer requirements.

8.3 I/O Expansion Cards

As described in chapter 5, the X-Graph module has several expansion connectors. By adding plug-in cards the functionality can be increased. DELGEN can develop and deliver any type of plug-in card with a very short turnaround.

8.4 X-Graph PCB Changes

For any order of 100pcs or higher DELGEN can make changes to the standard X-Graph pcb. We can integrate extra I/O functions, remove not necessary functions, add or remove connectors ... And we can adapt the size of the pcb to fit your enclosure perfectly.

8.5 Software Development

8.5.1 Use X-Graph with Dynamic C

Program development for the Rabbit processor on the X-Graph module is possible with all available Rabbit development tools. This includes the Z-World Dynamic C compiler and Softools WinIDE C Compiler.

Registered X-Graph users will receive the necessary specific X-Graph DC libraries required to support the additional hardware features. DELGEN is working continuously on new and improved libraries. Registered users will receive these libraries for free for an unlimited time. Please check the 'X-Graph and Dynamic C' manual.

8.5.2 xgConsole & xgBASIC

The X-Graph module is delivered with the xgConsole/xgBASIC firmware pre-installed. This firmware supports medium-level commands to control most hardware including the graphic display on the X-Graph module. You can use the RS232C and Ethernet ports as a terminal window.

With the xgConsole there is no need to purchase a C compiler or to spend hundreds of hours of 'C' development time.

8.5.3 Custom Made GUI

If you feel uncomfortable with Dynamic C and/or do not have the necessary resources to development software, DELGEN can develop the GUI and all support software for your application. Just contact (custom@xgraph.be) us and add a complete software requirement specification, so we can send you a quote.

DELGEN has many years experience with embedded applications and software development. We also know perfectly the capabilities of the Rabbit processor and our X-Graph module. So we should be the best informed people to develop software for your X-Graph based applications.

Warranty

DELGEN warrants that the product delivered hereunder shall conform to the applicable DELGEN datasheet or mutually agreed upon specifications and shall be free from defects in material and workmanship under normal use and service for a period of 1 year from the applicable date of invoice. Products which are "samples", "design verification units", and/or "prototypes" are sold "AS IS," "WITH ALL FAULTS," and without a warranty. If, during such warranty period, (1) DELGEN is notified promptly in writing upon discovery of any defect in the goods, including a detailed description of such defect; (2) such goods are returned to DELGEN, DDP DELGEN's facility accompanied by DELGEN's Returned Material Authorization form; and (3) DELGEN's examination of such goods discloses to DELGEN's satisfaction that such goods are defective and such defects are not caused by accident, abuse, misuse, neglect, alteration, improper installation, repair, improper testing, or use contrary to any instructions issued by DELGEN, DELGEN shall (at its sole option) either repair, replace, or credit Buyer the purchase price of such goods. No goods may be returned to DELGEN without DELGEN's Returned Material Authorization form. Prior to any return of goods by Buyer pursuant to this Section, Buyer shall afford DELGEN the opportunity to inspect such goods at Buyer's location, and any such goods so inspected shall not be returned to DELGEN without its prior written consent.

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If you have any questions, call +32-475-60.64.33, or write to the DELGEN office at 241, route de Longwy, LU-1941 Luxembourg, GD-Luxembourg.

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Change List

1.0

Initial release