DELGEN

X-Graph Software Module

xgBUS Users Manual

Version 1.0 – August 16, 2007

If you have any remarks on this document, please report them to DELGEN.

Printed in Luxembourg.
Document Nr: XGBUS-001

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1 Welcome

1.1 Introduction

The xgBUS is a very low cost X-Graph expansion system. xgBUS devices expand the X-Graph modules with additional I/O functions. The serial communication protocol is universal and data transfers are unbuffered at TTL-level.

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 has all the xgBUS hardware related info.

Refer to **Chapter 3** for info on the xgBUS Dynamic C software library functions.

In **chapter 4** you receive a detailed description of all currently available xgBUS devices.

1.3 More Questions

If you have questions while using your X-Graph module or one of the X-Graph Software Modules, check first if the information is available in this book of the other X-Graph Users Manuals. 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 information on the X-Graph modules. It is strongly advised to download and read documentation on the Rabbit processor from the Rabbit Semiconductor (www.rabbitsemiconductor.com) website.

This manual is complimentary to the documentation found on these websites.

2 xgBUS Hardware

xgBUS devices are daisy-chained and there is no limit to the number of installed devices. No hub is required. Multiple xgBUS chains can be connected to one X-Graph module.

2.1 xgBUS Connections and Protocol

Every xgBUS device must include two boxed male 5x2 IDC headers, an input and output connection. Devices are interconnected with a short flatcable. The total length of the cables is only limited by the required communication speed. As communication is at TTL levels, a longer cable length will introduce slew rates and require a reduced communication speed.

2.1.1 The xgBUS signals

Pin 1: OE = output enable
Pin 2: LD = load
Pin 3: CLK = clock
Pin 4: GP0 = general purpose 0
Pin 5: STR = strobe
Pin 6: GP1 = general purpose 1
Pin 7: TXD = serial input stream (input header), output stream (output header)
Pin 8: RXD = serial output stream (input header), input stream (output header)
Pin 9: VCC = X-Graph module power supply, typically 3.3Volt, can be 5Volt
Pin 10: GND = ground

All pins of the input and output header are connected one-by-one.

xgBUS devices use a serial bus to read and write data. The data transmitted by the X-Graph module is routed through all devices and returns to the X-Graph module. To accomplish this the very last xgBUS device in the chain must have a jumper installed on pins 7 and 8.

The xgBUS can be used in two operation modi (see next section). Devices of both modi can be used in one chain.

2.1.2 Mode A Examples

Some examples will clarify the basic operation of Mode A devices. Typical simple TTL based devices using a 74HC4094 or 74HC165 shift register.

In our first example the xgBUS has 3 devices installed. Each device includes an 8-bit shift register. All devices are output only, thus the concept is easy to understand. The X-Graph module transmits 3 bytes to fill the all 3 shift registers. Then the X-Graph module toggles the STR (strobe) line which loads the contents of the shift registers in the xgBUS devices output registers. You just added 24 output lines to your X-Graph module.

As a second example imagine an xgBUS chain with 3 input devices. The X-Graph module will first toggle the LD (load) line. The input devices will latch their input lines to the shift register. Then the X-Graph module starts a 3 byte receive sequence to read the 3 shift registers. The X-Graph module does not shift data out. But the first device shifts data out to the TXD pin of its output header. That signal is routed to the TXD pin of the input header of the second device, etc.. The third device has a jumper installed on pin 7 (TXD) and pin 8 (RXD) of its output header. I.e. the output signal of the third shift register is routed to pin 8 of all headers and passes directly to the RXD pin of the X-Graph module.

A final example demonstrates the use of both input and output xgBUS devices in one chain: the first device is output, the second and third device are input. The principle for the input devices is identical to our second example. Only for this example the X-Graph module also transmits data to fill the shift register of the output device.

It's important to understand that the first byte transmitted will end up in the last device of the chain. Also the first byte received will be the data from the last device in the chain. Data is written and read no matter whether the device is output or input. One just has to neglect read data from an output device and write random data to input devices.

The OE pin can be used to enable or disable the output lines of the output devices.

Both general purpose lines (GP0 and GP1) can be used as gp's or as chip select lines for SPI xgBUS devices.

2.2 Operation modi and Functionality

Two xgBUS operation modi are available:
- Mode A: simple shift register system using STR/LOAD/OE
- Mode B: SPI style devices using chip selects (GP0/GP1 or a CS-expansion device)

Mode A devices typically use TTL shift registers to build output or input lines (74HC4094 or 74HC165). These lines can be buffered and/or optical separated. Multiple TTL shift registers can be installed on one xgBUS device. A device is not limited to one 8-bit shift register.
The output or input lines can also be used to add ADC or DAC channels. But several serial bus based ADC and DAC chips are available which can be used with Mode B.

Mode B devices use an SPI communication protocol. The OE/LD/STR lines are not used. The CLK/TXD/RXD lines are use in spi mode: SPI_CLK / MOSI / MISO. Each SPI device also requires a CS line. One or both general purpose lines (GP0 / GP1) can be used for this. If more the two SPI devices need to be added one can use two solutions. Either a CS expansion xgBUS device must be added. Or multiple xgBUS's can be used, with for example separated GPx lines.

The number of xgBUS's implemented on one X-Graph module is only limited by the available I/O lines.

Typical Mode B devices are ADC and DAC channel devices. But also a SDCard reader, a DPI bug controller, a CFCard interface, modem, etc... are possible devices.

Mode A devices continuously drive the RXD pin which is not compatible with the SPI protocol. All xgBUS Mode B devices must implement a switch to connect the MISO pin to the xgBUS RXD line. If only Mode B devices are used on an xgBUS, this switch is not required.

2.3 XG5000 & XG4x00 Implementation

The XG4x00 has on-board an xgBUS connector (J9). XGRAPH.LIB includes all macro's for this connector.

On the XG5000 any combination of available I/O pins can be used to implement an xgBUS. This module lacks a direct xgBUS connector, but it can easily be implemented with a plug-in board (available in the near future from DELGEN).
XGRAPH.LIB includes macro's for the following xgBUS XG5000 implementation. These macro's can always be overruled.

Pin 1 = OE = PE0 = J2.17
Pin 2 = LD = PE1 = J2.20 (Also used for optional USBDET line)
Pin 3 = CLK = SPI CLK = J2.1
Pin 4 = GP0 = PD4 = J2.7 (Also used for optional ADC CS)
Pin 5 = STR = PE5 = J2.19
Pin 6 = GP1 = PD7 = J2.27 (Also used for optional RS485 DE2)
Pin 7 = TXD = SPI MOSI = J2.4
Pin 8 = RXD = PD5 = ALT_RXB = J2.10 (Also used for optional DAC CS)
Pin 9 = VCC = 3.3Volt = J2.32
Pin 10 = GND = ground = J2.31

As indicated some pins are reserved for optional features. The standard XG5000 has none of these features installed. On custom versions some of the indicated pins might not be available. Other pins can be selected on J2 (PortG for example).

The XG5000 uses one of the Rabbit 3000 serial ports as an on-board SPI bus. This serial bus is connected to the slave processor and other pheriperals. The same SPI bus can be used for the xgBUS. Because Mode A xgBUS devices continuously drive the MISO pin, which is not compatible with the SPI protocol. That is the reason why the xgBUS uses the alternate Serial Port RXD pin.

3 xgBUS Library

XGBUS.LIB includes xgBUS Mode A support functions. xgBUS Mode B devices use the SPI communication protocol and require specific functions. DELGEN will release specific software support with all future Mode B DELGEN xgBUS devices.

void xgbus_init(void);
Initializes all I/O lines used by the xgBUS based on the xgBUS I/O line macro's defined in XGRAPH.LIB. Custom versions can adapt the macro's. For multiple xgBUS configurations this function can be used as an init example.

PARAMETERS
None

RETURN VALUE
None

void xgbus_tick(void);
This functions should be called each time an xgBUS Mode A device needs to be written or read.
The function uses two global arrays for output and input data. The length of these arrays should match the number of xgBUS devices and can be set with the XGBUS_MAX_DEVICE macro (defaults to 4).
char xgBusDataOut[XGBUS_MAX_DEVICE];
char xgBusDataIn[XGBUS_MAX_DEVICE];
To write data to an output device set the value in xgBusDataOut for the correct device. The output data is written with every call to xgbus_tick().
Input data is read with every call to xgbus_tick() and is available in the xgBusDataIn array.

Remember that the entry 0 is the data for the last device in the xgBUS chain.

PARAMETERS
None

RETURN VALUE
None

4 xgBUS Modules

t.b.f.

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Change List

1.0

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