PRODUCT MANUAL

eDisplay (OP7200)

¼ VGA Operator Control Panel

User's Manual

019–0116 • 090529–M

OP7200 User's Manual

Part Number 019-0116 • 090529–M • Printed in U.S.A.

Trademarks

Rabbit and Dynamic C are registered trademarks of Digi International Inc.

Rabbit 2000, RabbitCore, and RabbitNet are trademarks of Digi International Inc.

The latest revision of this manual is available on the Rabbit Web site, www.rabbit.com, for free, unregistered download.

Digi International Inc.

www.rabbit.com

TABLE OF CONTENTS

1. INTRODUCTION

The OP7200 intelligent operator interface is a small, high-performance, C-programmable data acquisition and display unit that offers built-in I/O, Ethernet connectivity, and an optional touchscreen. The OP7200 can be used in a control system with RabbitNet™ expansion I/O cards. A Rabbit® 2000 microprocessor operating at 22.1 MHz provides fast data processing.

The OP7200 is designed for panel mounting and is NEMA-4 compatible. The OP7200 incorporates the powerful Rabbit 2000 microprocessor, flash memory, static RAM, industrialized digital I/O ports, RS-232/RS-485 serial ports, a 10/100-compatible Ethernet port, and eight optional A/D converter inputs and touchscreen.

1.1 Features

- Small size: 4.4" × 5.7" × 1.7" (112 mm × 144 mm × 43 mm).
- ¼ VGA LCM display (320 × 240 pixels) with white LED backlight.
- Software-controlled LCD contrast and backlight on/off.
- 9-key keypad.
- LCD controller and SRAM compatible with OP7100.
- 4 status LEDs.
- 24 digital I/O: 16 filtered digital inputs with an input range of ±36 V DC and a switching point of 2.4 V, and 8 sourcing/sinking/tristate high-current outputs (250/350/0 mA).
- Rabbit 2000 microprocessor operating at 22.1 MHz.
- Audible alarm buzzer.
- 128K static RAM and 256K flash memory standard.
- One RJ-45 10/100-compatible Ethernet port with a 10Base-T Ethernet interface.

- Four serial ports (2 RS-232 or 1 RS-232 with RTS/CTS, 1 RS-485 or RabbitNet™ expansion port, and 1 CMOS-compatible programming port).
- Onboard backup battery for real-time clock and SRAM, connection point for external battery included.
- Watchdog.
- External reset input.
- Meets NEMA 4 watertightness specifications when front-panel mounted.
- Optional 8-channel 12-bit A/D converter.
- Optional 4096 × 4096 analog touchscreen.

Two OP7200 models are available. Their standard features are summarized in Table 1.

Table 1. OP7200 Models

Feature	OP7200	OP7210
Microprocessor	Rabbit 2000 running at 22.1 MHz	
Static RAM	128K	
Flash Memory	256K	
RJ-45 Ethernet Connector and Filter Capacitors	Yes	
RabbitCore Module Used	RCM2200	
A/D Converter Inputs	Yes	No
4096 × 4096 Touchscreen	Yes	No

Additional 512K flash/512K SRAM memory options are available for custom orders involving nominal lead times. Contact your Rabbit sales representative or authorized distributor for more information.

Throughout this manual, the term OP7200 refers to the complete series of OP7200 operator interfaces unless other production models are referred to specifically.

Appendix A provides detailed specifications.

Visit our Web site for up-to-date information about additional add-ons and features as they become available. The Web site also has the latest revision of this user's manual.

1.2 Development and Evaluation Tools

1.2.1 Tool Kit

A Tool Kit contains the hardware essentials you will need to use your OP7200. The items in the Tool Kit and their use are as follows.

- ***OP7200 Getting Started*** instructions.
- ***Dynamic C*** CD-ROM, with complete product documentation on disk.
- Programming cable, used to connect your PC serial port to the OP7200.
- Universal AC adapter, 12 V DC, 1 A (includes Canada/Japan/U.S., Australia/N.Z., U.K., and European style plugs).
- Demonstration Board with pushbutton switches and LEDs. The Demonstration Board can be hooked up to the OP7200 to demonstrate the I/O.
- Wire assembly to connect Demonstration Board to OP7200.
- Screwdriver.
- ***Rabbit 2000 Processor Easy Reference*** poster.
- Registration card.

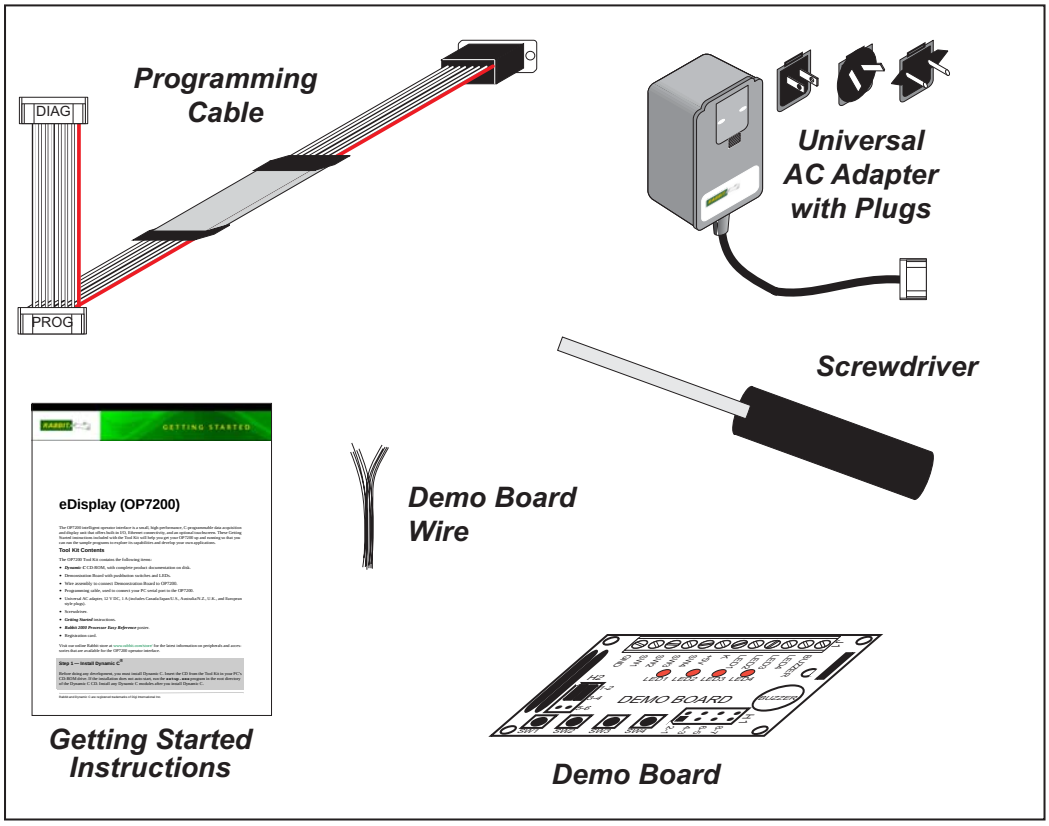


Figure 1. OP7200 Tool Kit

1.2.2 Software

The OP7200 is programmed using version 7.30 or later of Rabbit's Dynamic C. A compatible version is included on the Tool Kit CD-ROM. Dynamic C v. 9.60 includes the popular µC/OS-II real-time operating system, point-to-point protocol (PPP), FAT file system, RabbitWeb, and other select libraries that were previously sold as individual Dynamic C modules.

Rabbit also offers for purchase the Rabbit Embedded Security Pack featuring the Secure Sockets Layer (SSL) and a specific Advanced Encryption Standard (AES) library. In addition to the Web-based technical support included at no extra charge, a one-year telephone-based technical support subscription is also available for purchase. Visit our Web site at www.rabbit.com for further information and complete documentation, or contact your Rabbit sales representative or authorized distributor.

1.3 RabbitNet Peripheral Cards

RabbitNet™ is an SPI serial protocol that uses a robust RS-422 differential signalling interface (twisted-pair differential signaling) to run at a fast 1 Megabit per second serial rate. The OP7200 has one RabbitNet port, which can support one peripheral card. Distances between a master processor unit and peripheral cards can be up to 10 m or 33 ft.

The following low-cost peripheral cards are currently available.

- Digital I/O
- A/D converter
- D/A converter
- Display/Keypad interface
- Relay card

Appendix D provides additional information on RabbitNet peripheral cards and the RabbitNet protocol. Visit our Web site for up-to-date information about additional add-ons and features as they become available.

1.4 CE Compliance

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 µV/m at 10 m (40 dB relative to 1 µV/m) or 300 µV/m	More restrictive emissions requirement: 30 dB µV/m at 10 m or 100 µV/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 OP7200 has been tested and was found to be in conformity with the following applicable immunity and emission standards. The OP7210 is also CE qualified as it is a sub-version of the OP7200. Boards that are CE-compliant have the CE mark.

NOTE: Earlier versions of the OP7200 sold before 2003 that do not have the CE mark are ***not*** CE-compliant.

Immunity

The OP7200 operator control panels meet 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.

Emissions

The OP7200 operator control panels meet the following emission standards emission standards with the Rabbit 2000 spectrum spreader turned on and set to the normal mode. The spectrum spreader is only available with Rev. C or higher of the Rabbit 2000 microprocessor. This microprocessor is used on the OP7200 operator control panels 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.

1.4.1 Design Guidelines

Note the following requirements for incorporating the OP7200 operator control panels into your application to comply with CE requirements.

General

- The power supply provided with the Tool Kit is for development purposes only. It is the customer's responsibility to provide a CE-compliant power supply for the end-product application.
- When connecting the OP7200 to outdoor cables, the customer is responsible for providing CE-approved surge/lightning protection.
- Rabbit recommends placing digital I/O or analog cables that are 3 m or longer in a metal conduit to assist in maintaining CE compliance and to conform to good cable design practices. Rabbit also recommends using properly shielded I/O cables in noisy electromagnetic environments.
- While the OP7200 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 OP7200.
- To meet electromagnetic compatibility requirements, and in particular to prevent misoperation or damage from electrostatic discharges, connect the bezel to a protective ground via a low-impedance path as explained in Section 6.1.

Safety

- For personal safety, all inputs and outputs to and from the OP7200 must not be connected to voltages exceeding SELV levels (42.4 V AC peak, or 60 V DC). Damage to the Rabbit 2000 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.
- The lithium backup battery circuit on the OP7200 has been designed to protect the battery from hazardous conditions such as reverse charging and excessive current flows. Do not disable the safety features of the design.

1.4.2 Interfacing the OP7200 to Other Devices

Since the OP7200 operator control panels are 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. Additional information, tips, and technical assistance are available from your authorized Rabbit distributor, and are also available on our Web site at www.rabbit.com.

2. GETTING STARTED

Chapter 2 explains how to connect the programming cable and power supply to the OP7200.

2.1 Power Supply Connections

1. First prepare the AC adapter for the country where it will be used by selecting the plug. The OP7200 Tool Kit presently includes Canada/Japan/U.S., Australia/N.Z., U.K., and European style plugs. Snap in the top of the plug assembly into the slot at the top of the AC adapter as shown in Figure 2, then press down on the spring-loaded clip below the plug assembly to allow the plug assembly to click into place.

   Connect the bare ends of the power supply to the **+PWR** and **-PWR** positions on pins 1 and 2 of screw terminal header J3 as shown in Figure 2. The polarity of your connections is not important because the power-supply circuit has a full-wave bridge rectifier.

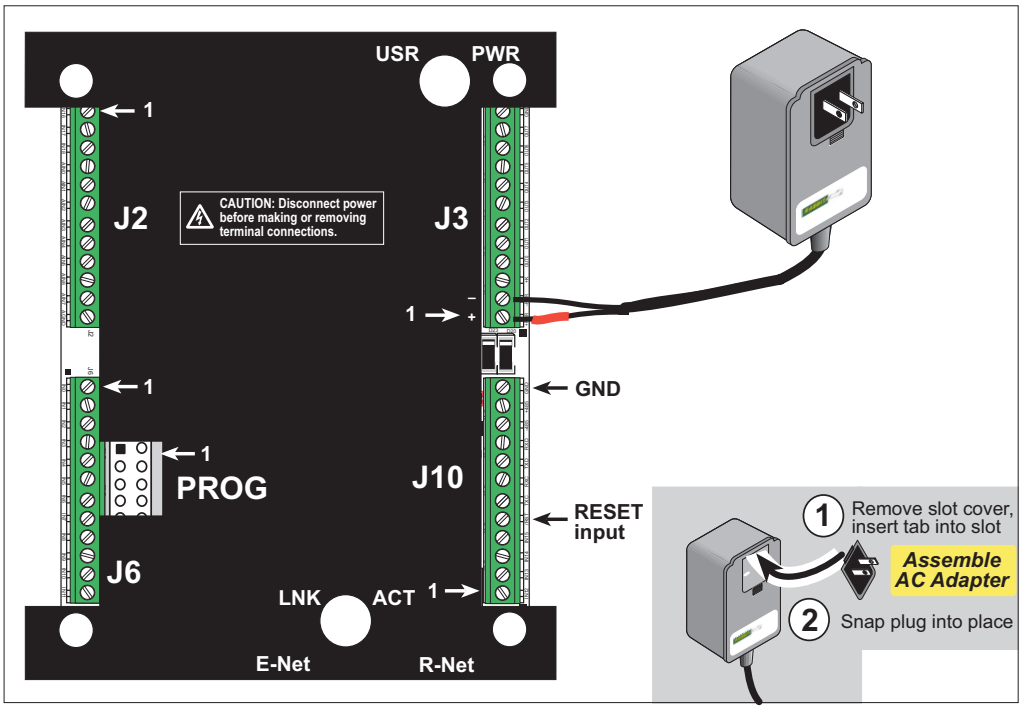


Figure 2. Power Supply Connections

2. Apply power.

Plug in the AC adapter. If you are using your own power supply, it must provide 9 V to 40 V DC or 24 V AC—voltages outside this range could damage the OP7200.

CAUTION: Unplug the power supply while you make or otherwise work with the connections to the screw-terminal headers. This will protect your OP7200 from inadvertent shorts or power spikes.

NOTE: A hardware RESET is done by unplugging the AC adapter, then plugging it back in. You may also reset the OP7200 by grounding the reset input located on pin 5 of screw-terminal header J10.

2.2 Demonstration Program on Power-Up

A repeating sequence of graphics and menus will be displayed on the LCD when power is first applied to the OP7200. Press any of the five keypad buttons immediately below the LCD to select the corresponding demonstration. When you are in a menu demo screen, press the diamond-shaped keypad button in the middle row to enter the menu choice that is highlighted, or press the up and down keys above and below the diamond-shaped keypad button to move around the menu.

Note that the programming cable should ***not*** be connected for this demonstration.

This demonstration will be replaced by a new program when the programming cable is attached and the new program is compiled and run. The demonstration is available for future reference in the Dynamic C **`SAMPLES\OP7200`** directory as **`FUN.C`**.

2.3 Programming Cable Connections

Connect the programming cable to download programs from your PC and to program and debug the OP7200.

> **NOTE:** Use only the programming cable that has a red shrink wrap around the RS-232 level converter (Part No. 101-0513), which is supplied with the OP7200 Tool Kit. Other Rabbit programming cables might not be voltage-compatible or their connector sizes may be different.

Connect the 10-pin **PROG** connector of the programming cable to header J1 on the OP7200's RabbitCore module. Ensure that the colored edge lines up with pin 1 as shown. (Do not use the **DIAG** connector, which is used for monitoring only.) Connect the other end of the programming cable to a COM port on your PC. Make a note of the port to which you connect the cable, as Dynamic C will need to have this parameter configured. Note that COM1 on the PC is the default COM port used by Dynamic C.

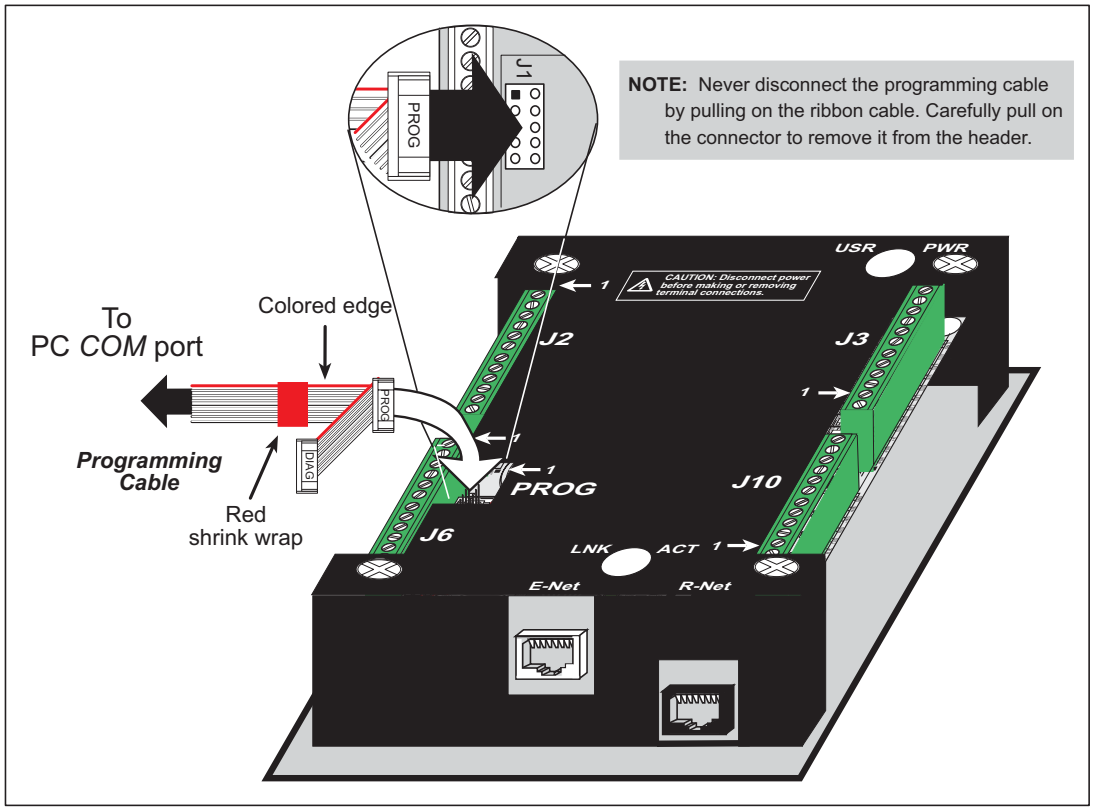


Figure 3. Programming Cable Connections

> **NOTE:** Some PCs now come equipped only with a USB port. It may be possible to use an RS-232/USB converter (Part No. 20-151-0178) with the programming cable supplied with the OP7200 Tool Kit. Note that not all RS-232/USB converters work with Dynamic C.

2.4 Installing Dynamic C

If you have not yet installed Dynamic C version 7.30 (or a later version), do so now by inserting the Dynamic C CD from the OP7200 Tool Kit in your PC's CD-ROM drive. The CD will auto-install unless you have disabled auto-install on your PC.

If the CD does not auto-install, click **Start > Run** from the Windows **Start** button and browse for the Dynamic C **setup.exe** file on your CD drive. Click **OK** to begin the installation once you have selected the **setup.exe** file.

The online documentation is installed along with Dynamic C, and an icon for the documentation menu is placed on the workstation's desktop. Double-click this icon to reach the menu. If the icon is missing, create a new desktop icon that points to **default.htm** in the **docs** folder, found in the Dynamic C installation folder.

The latest versions of all documents are always available for free, unregistered download from our web sites as well.

The ***Dynamic C User's Manual*** provides detailed instructions for the installation of Dynamic C and any future upgrades.

> **NOTE:** If you have an earlier version of Dynamic C already installed, the default installation of the later version will be in a different folder, and a separate icon will appear on your desktop.

2.5 Starting Dynamic C

Once the OP7200 is connected to your PC and to a power source, start Dynamic C by double-clicking the Dynamic C icon on your desktop or in your **Start** menu. Dynamic C uses the serial port specified during installation

If you are using a USB port to connect your PC to the OP7200, choose **Options > Project Options** and check "Use USB to Serial Converter" in "Serial Options" on the **Communications** tab. Click **OK** to save the settings.

Dynamic C assumes, by default, that you are using serial port COM1 on your PC when you are running a program. If you ***are*** using COM1, then Dynamic C should detect the OP7200 and go through a sequence of steps to cold-boot the OP7200 and to compile the BIOS. If the error message "Rabbit Processor Not Detected" appears, you have probably connected to a different PC serial port such as COM2, COM3, or COM4. You can change the serial port used by Dynamic C with the **OPTIONS** menu, then try to get Dynamic C to recognize the OP7200 by selecting **Reset Target/Compile BIOS** on the **Compile** menu or by pressing **<Ctrl-Y>**. Try the different COM ports in the **OPTIONS** menu until you find the one you are connected to. If you still can't get Dynamic C to recognize the target on any port, then the hookup may be wrong or the COM port might not working on your PC.

If you receive the "BIOS successfully compiled …" message after pressing **<Ctrl-Y>** or starting Dynamic C, and this message is followed by a communications error message, it is possible that your PC cannot handle the 115,200 bps baud rate. Try changing the baud rate to 57,600 bps as follows.

- Locate the **Serial Options** dialog in the Dynamic C **Options > Communications** menu. Change the baud rate to 57,600 bps.

2.6 PONG.C

You are now ready to test your set-up by running a sample program.

Find the file **PONG.C**, which is in the Dynamic C **SAMPLES** folder. To run the program, open it with the **File** menu (if it is not still open), then compile and run it by pressing **F9** or by selecting **Run** in the **Run** menu. The **STDIO** window will open on the PC and will display a small square bouncing around in a box.

This program shows that the CPU is working. The sample program described in Section 5.2.3, "Run the PINGME.C Demo," tests the TCP/IP portion of the board.

2.7 Where Do I Go From Here?

NOTE: If you purchased your OP7200 through a distributor or Rabbit partner, contact the distributor or partner first for technical support.

If there are any problems at this point:

- Use the Dynamic C **Help** menu to get further assistance with Dynamic C.
- Check the Rabbit Technical Bulletin Board and forums at www.rabbit.com/support/bb/ and at www.rabbit.com/forums/.
- Use the Technical Support e-mail form at www.rabbit.com/support/.

If the sample program ran fine, you are now ready to go on to explore other OP7200 features and develop your own applications.

The following sample programs illustrate the features and operation of the OP7200.

Basic	Keypad	Touchscreen
BUFFLOCK.C	KP_16KEY.LIB	BTN_16KEY.C
CONTRAST.C	KP_ANALOG.C	BTN_BASICS.C
PRIMITIVES.C	KP_BASIC.C	BTN_KEYBOARD.C
SCROLLING.C	KP_MENU.C	CAL_TOUCHSCREEN.C
TEXT.C		RD_TOUCHSCREEN.C

These sample programs can be used as templates for applications you may wish to develop.

Chapter 3, "Subsystems," provides a description of the OP7200's features, Chapter 4, "Software," describes the Dynamic C software libraries and introduces some sample programs. Chapter 5, "Using the TCP/IP Features," explains the TCP/IP features.

2.8 Remove Battery Tab

The backup battery on the OP7200 has a plastic tab to protect the battery against discharging before the OP7200 is placed into service. Although the battery is located inside the OP7200's protective casing, it is possible to reach the plastic tab using pliers or tweezers from the opening on the side of the OP7200 shown in Figure 4.

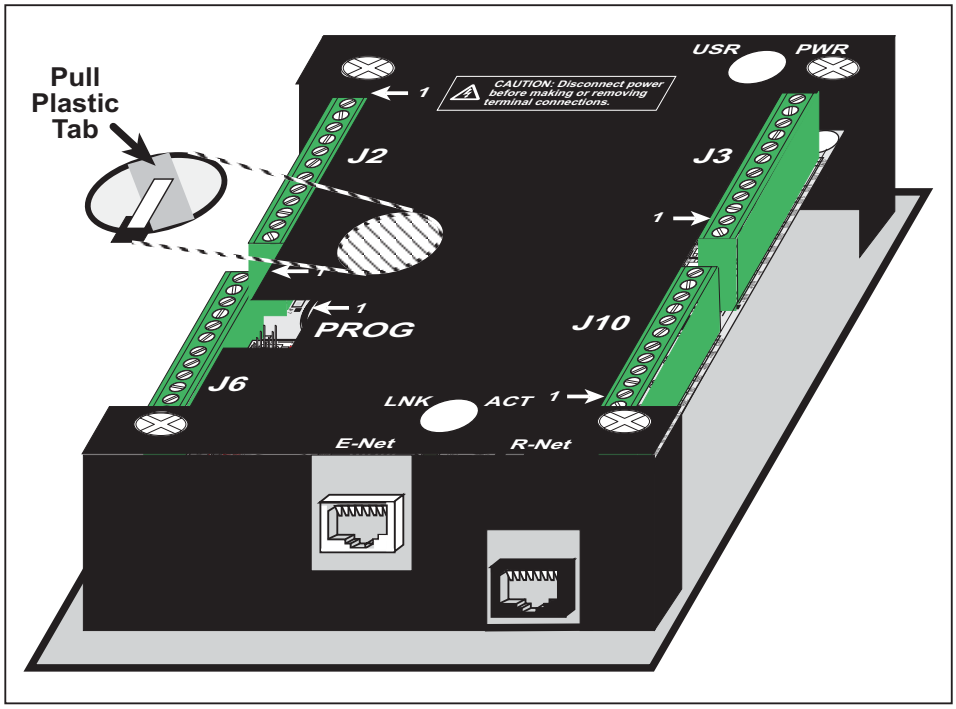


Figure 4. Remove Battery Tab

NOTE: Rabbit recommends that the battery tab not be removed until you are ready to place the OP7200 in normal service with regular power connected to header J3.

The backup battery protects the contents of the SRAM and keeps the real-time clock running when regular power to the OP7200 is interrupted. If you plan to use the real-time clock functionality in your application, you will need to set the real-time clock once you remove the plastic tab. Set the real-time clock using the onscreen prompts in the demonstration program. Alternatively, you may set the real-time clock using the **SETRTCKB.C** sample program from the Dynamic C **SAMPLES\RTCLOCK** folder. The **RTC_TEST.C** sample program in the Dynamic C **SAMPLES\RTCLOCK** folder provides additional examples of how to read and set the real-time clock.

3. SUBSYSTEMS

Chapter 3 describes the principal subsystems for the OP7200.

- Digital I/O
- Analog Features (OP7200 only)
- Serial Communication
- Memory
- Liquid Crystal Display Controller
- Keypad
- OP7200 CPLD

Figure 5 shows these Rabbit-based subsystems designed into the OP7200.

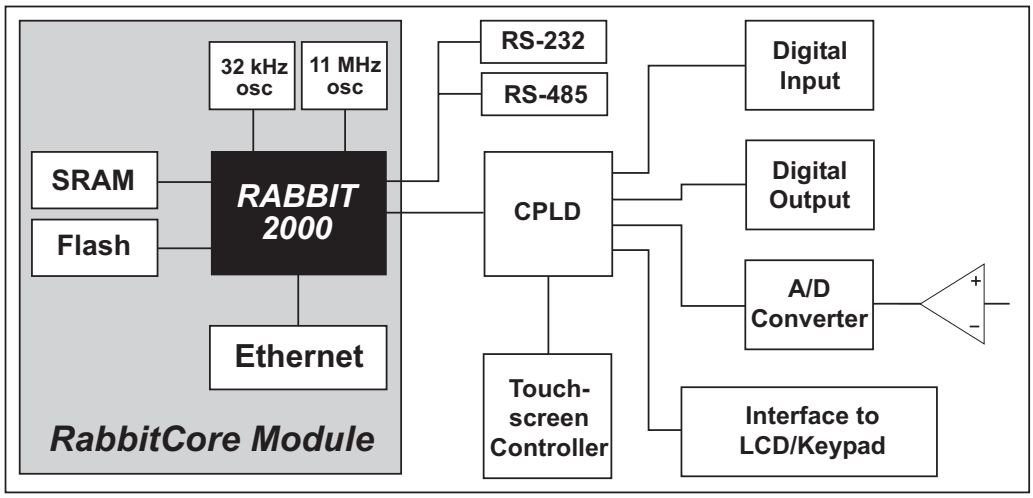


Figure 5. OP7200 Subsystems

The memory and microprocessor are located on the RabbitCore module. The RCM2200 module is used on the OP7200. If you have more than one OP7200 or other Rabbit products built around RabbitCore modules, take care not to swap the RabbitCore modules since they contain system ID block information and calibration constants that are unique to the board they were originally installed on. It is a good idea to save the calibration constants should you need to replace a RabbitCore module in the future. See Section 4.3.8, "Using System Information from the RabbitCore Module," for more information.

3.1 OP7200 Pinouts

The OP7200 pinouts are shown in Figure 6.

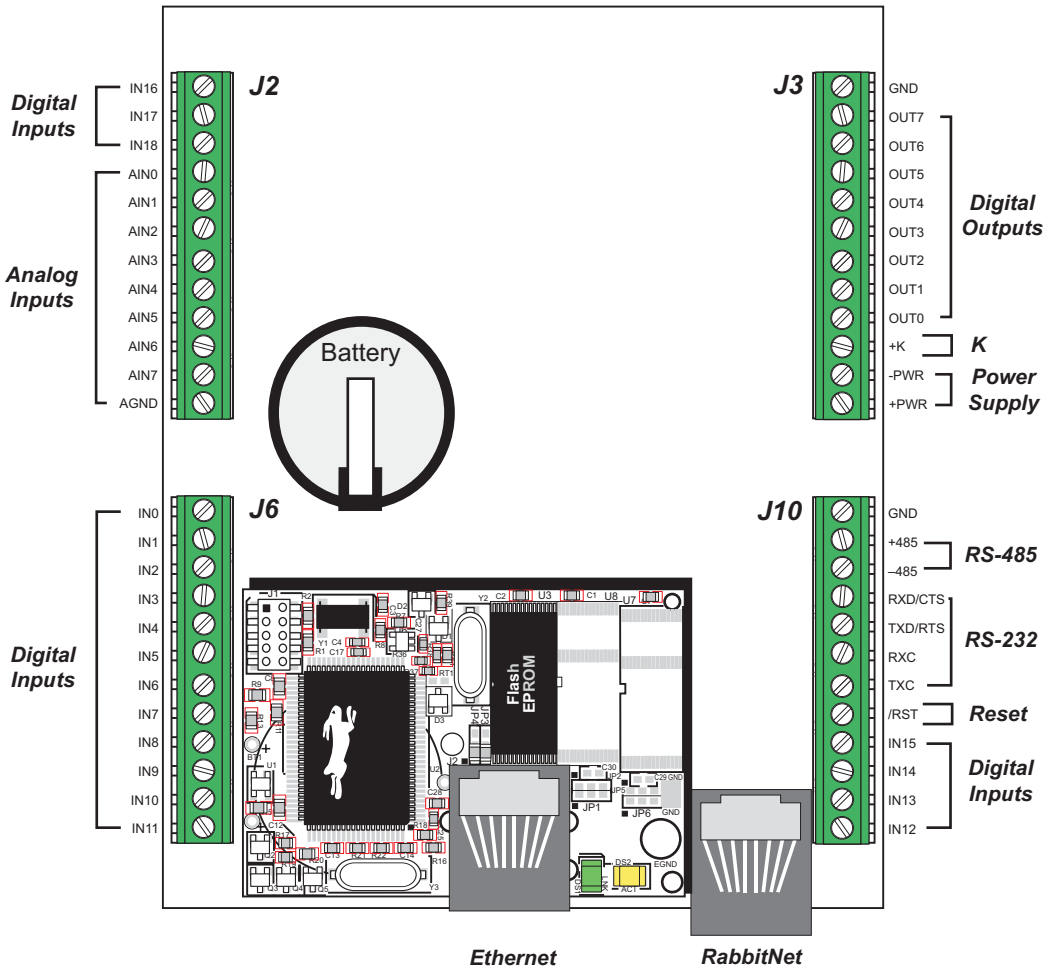


Figure 6. OP7200 Pinouts

NOTE: Screw-terminal header J2 and the associated analog and digital I/O are not available on the OP7210.

3.1.1 Headers and Screw Terminals

Standard OP7200 models are equipped with four 1 × 12 screw terminal strips (J2, J3, J6, and J10), and a 2 × 5 programming header and an RJ-45 Ethernet jack on the RCM2200 RabbitCore module.

The RJ-45 jack labeled ***RabbitNet*** is a serial I/O expansion port for use with RabbitNet I/O cards. The ***RabbitNet*** jack does ***not*** support Ethernet connections. Be careful to connect your Ethernet cable to the jack labeled ***Ethernet***.

3.2 Indicators

3.2.1 LEDs

The OP7200 has two LEDs, **Power Good** and **Microprocessor Bad**.

The green **Power Good** LED at DS2 indicates when power is applied to the OP7200 and that Vcc is within the proper operating range of 4.5 to 5.5 V. The LED turns off when the OP7200 is being reset.

The red **Microprocessor Bad** LED at DS1 indicates the status of the OP7200. Following reset, DS1 will be ON and will remain ON until turned OFF by Dynamic C. Once the microprocessor comes out of reset and finishes all its internal checks and initializes the system, it should turn DS1 OFF.

The operation of DS1 may be redefined in any manner desired with the caveat that DS1 comes ON after reset. The **USR** label on the dust cover refers to the LED at DS1 and reflects its secondary purpose as a user-defined indicator.

3.2.2 Buzzer

An audible buzzer is turned on and off through the use of a programmed I/O bit defined in software.

3.3 Digital I/O

3.3.1 Digital Inputs

The OP7200 has 19 digital inputs, IN0–IN18, each of which is protected over a range of –36 V to +36 V. The inputs are factory-configured to be pulled up to +5 V, but they can also be pulled down to 0 V in banks of eight by changing a surface-mounted 0 Ω resistor. Figure 7 shows a sample digital input circuit. All 19 inputs are protected against noise spikes by a low-pass filter composed of a 22 kΩ series resistor and a 10 nF capacitor.

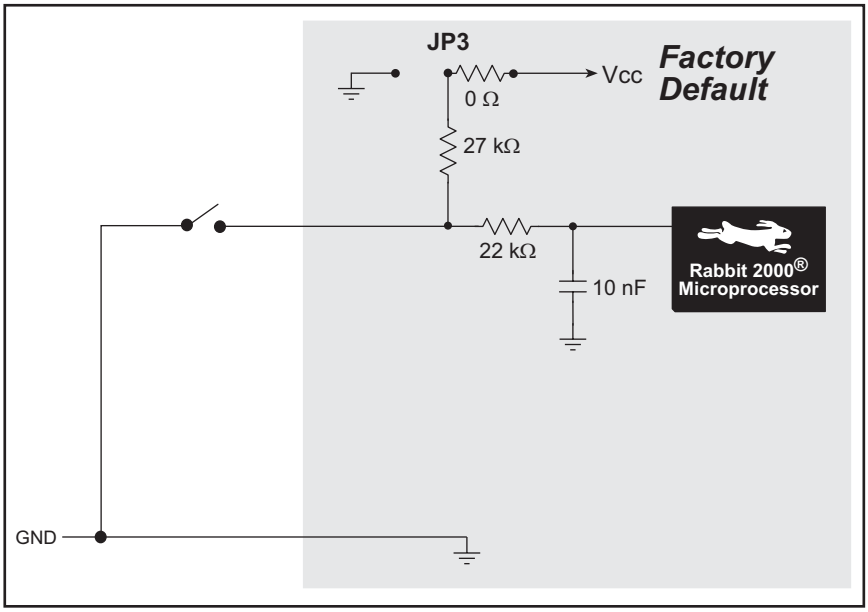


Figure 7. OP7200 Digital Inputs [Pulled Up—Factory Default]

OP7200 series boards can be made to order in volume with the banks of digital inputs pulled down to 0 V. Contact your authorized Rabbit distributor or your Rabbit sales representative for more information.

For IN0–IN7 the actual switching point between a zero and a one is 1.5 V max and 3.5 V min respectively. The range between 1.5 and 3.5 V is undefined. For IN8–IN15 the actual switching point between a zero and a one is 0.8 V max and 2.0 V min respectively. The range between 0.8 and 2.0 V is undefined. For IN16–IN17, which are available only on the OP7200 model, the actual switching point between a zero and a one is 0.8 V max and 3.5 V min respectively. The range between 0.8 V and 3.5 V is undefined.

Therefore, the input voltage must be less than 0.8 V for all the digital inputs as a group to ensure that a zero is being read, and the input voltage must be must be greater than 3.5 V for a one.

IN16–IN18 interface to the A/D converter chip serially with an access time of 100 µs, which is different from the access time of 5 µs for IN0–IN15, which interface in parallel with the Rabbit 2000 microprocessor.

The digital inputs are each fully protected over a range of -36 V to +36 V, and can handle short spikes of ±40 V.

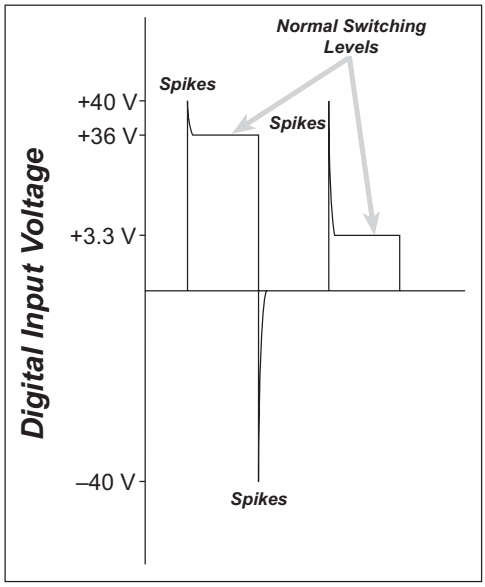


Figure 8. OP7200 Digital Input Protected Range

3.3.2 Digital Outputs

The OP7200 has eight digital outputs, OUT0–OUT7, which are individually configurable with the **`digoutConfig`** or **`digoutTriStateConfig`** software function calls as sinking (up to 350 mA per channel) or as sourcing (up to 250 mA per channel). Figure 9 shows a wiring diagram for using the digital outputs in a sinking or a souring configuration.

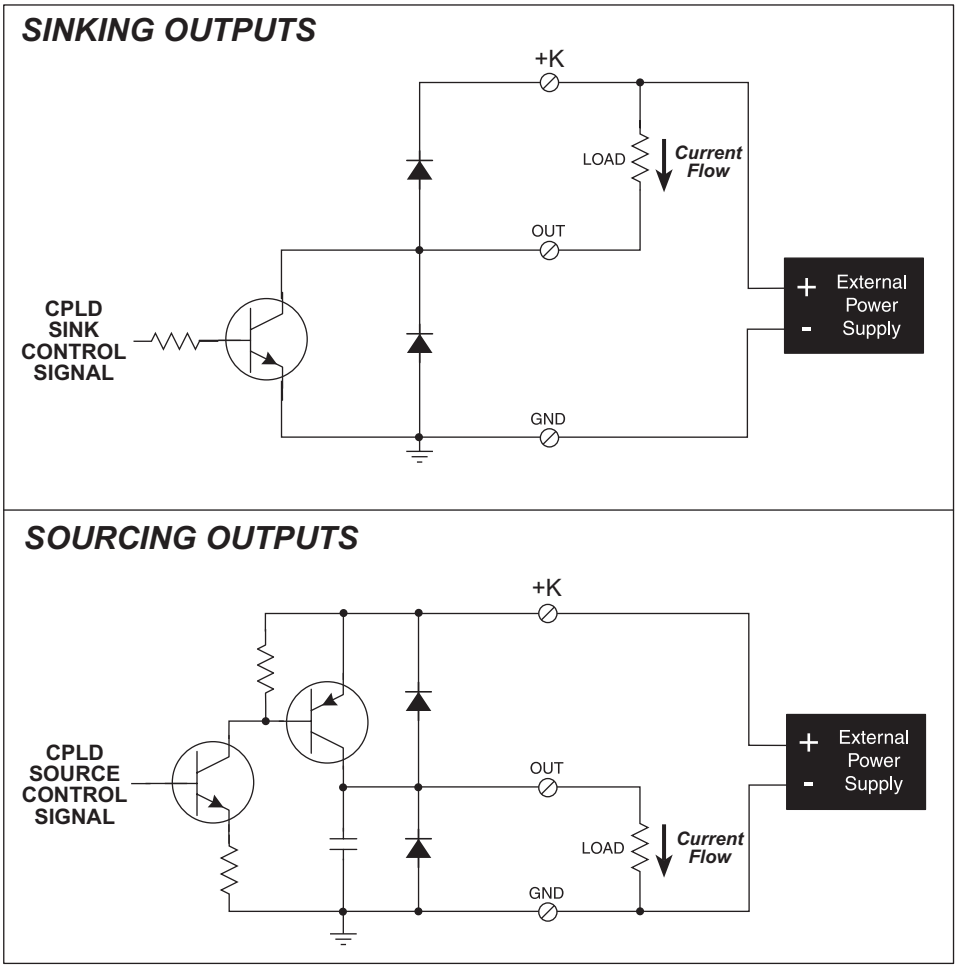


Figure 9. OP7200 Digital Outputs

All the digital outputs are in the high-impedance tristate when the OP7200 is initially powered on or reset. The CPLD (U4) then enables either the sink control or the source control to operate the digital outputs as sinking ***or*** sourcing, and thereby serves as a hardware block to prevent both sinking and sourcing drivers from being activated at the same time in a given channel.

Although the components are not installed, there is provision on the circuit board for the digital outputs to be pulled as a group to Vcc, +K, or to GND through 27 kΩ resistors. In special circumstances, you may need to pull sinking outputs high to either Vcc or +K, or you may need to pull sourcing outputs to GND, for example, when driving low-level logic signals. Pulling the digital outputs up to +K allows the current-sinking outputs to be used as voltage outputs where their upper level is controlled by the voltage of +K. OP7200 series

boards can be made to order in volume with the digital outputs pulled up to Vcc or +K, or pulled down to GND. Contact your authorized Rabbit distributor or your Rabbit sales representative for more information.

+K is an externally supplied voltage of 9–40 V DC used primarily in combination with current sourcing outputs, and should be capable of delivering up to 2 A. Although a connection to a +K supply is not absolutely ***required*** with sinking outputs, it is ***highly recommended*** to protect against current spikes when driving inductive loads.

Connect the positive +K supply to pin 3 of screw-terminal header J3 and the negative side of the supply to pin 12 of screw-terminal header J3. Exercise care to connect this supply correctly because the +K inputs are ***not*** protected against reverse polarity, and serious damage to the OP7200 may result if you connect this supply backwards.

When you are using the same DC power supply as the main power supply for the OP7200 and as the +K power supply, Rabbit recommends that you tie the -PWR connection to ground. Since this step will bypass the reverse-polarity protection afforded by the full-wave bridge rectifier, ensure that the positive leads from the power supply are connected correctly to prevent damage to the OP7200.

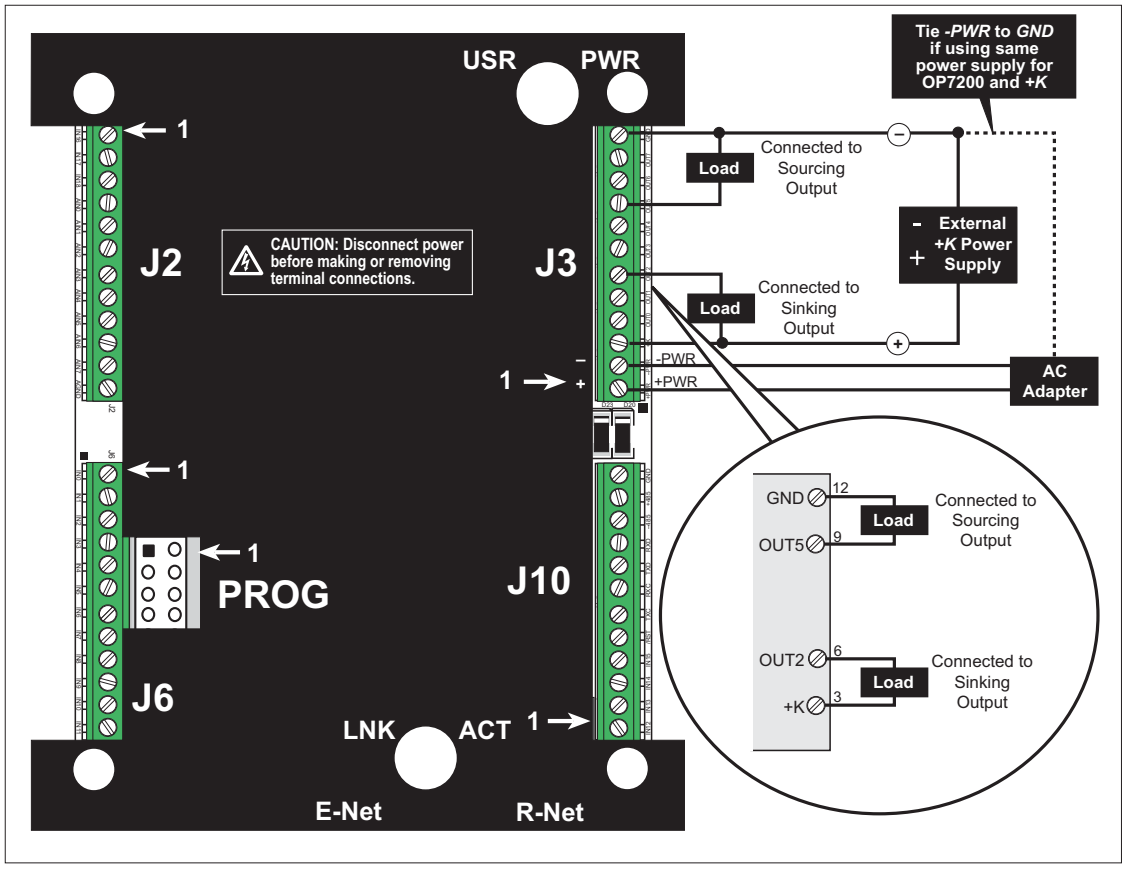


Figure 10. +K, Power Supply, and Sample Load Connections

3.4 Analog Features (OP7200 only)

The single A/D converter used in the OP7200 (the OP7210 does not have analog or touch-screen capabilities) has a resolution of 11 bits (single-ended mode) or 12 bits (differential mode). There are eight channels of A/D conversion, and the OP7200 also has provision for up to four digital inputs. Three of the four digital inputs are available on screw terminal header J2. The fourth digital input serves as a board status bit, and is controlled by a 0 Ω surface-mount resistor R159. The factory default is for R159 to not be installed, which leaves this fourth input pulled up to Vcc.

3.4.1 A/D Converter Inputs

Figure 11 shows a pair of A/D converter input circuits. Each A/D converter input consists of resistors and a capacitor. The resistors form a10:1 attenuator, and the capacitor protects the A/D converter input against electrostatic discharges.

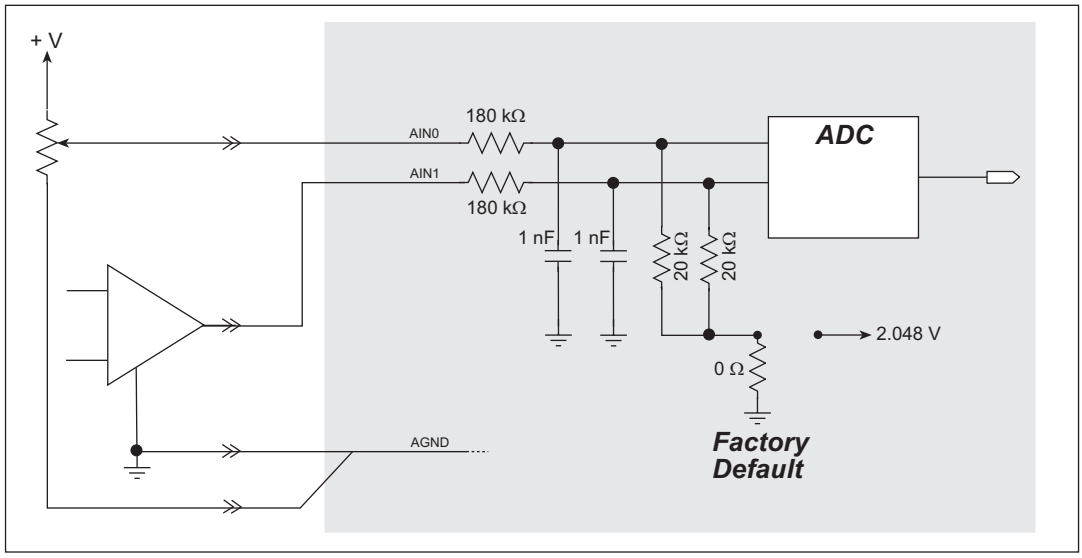


Figure 11. A/D Converter Inputs

The A/D converter chip can make either single-ended or differential measurements depending on the value of the **opmode** parameter in the software function call. Adjacent A/D converter inputs are paired to make differential measurements. The default setup for the OP7200 is to measure only positive voltages for the ranges listed in Table 2.

Table 2. Positive A/D Converter Input Voltage Ranges

Min. Voltage (V)	Max. Voltage (V)	Amplifier Gain	mV per Tick
0.0	+20.0	1	10
0.0	+10.0	2	5
0.0	+5.0	4	2.5
0.0	+4.0	5	2.0
0.0	+2.5	8	1.25
0.0	+2.0	10	1.0
0.0	+1.25	16	0.625
0.0	+1.0	20	0.500

Many other possible ranges are possible by physically changing the resistor values that make up the attenuator circuit.

It is also possible to read a negative voltage by moving the 0 Ω jumper (see Figure 11) on header JP4, JP5, JP6, or JP7 associated with the A/D converter input from analog ground to the 2.048 V reference voltage generated and buffered by the A/D converter. Adjacent input channels are paired so that moving a particular jumper changes both of the paired channels. At the present time Rabbit does not offer the software drivers to work with single-ended negative voltages, but the differential mode described below may be used to measure negative voltages.

Differential measurements require two channels. As the name *differential* implies, the difference in voltage between the two adjacent channels is measured rather than the difference between the input and analog ground. Voltage measurements taken in differential mode have a resolution of 12 bits, with the 12th bit indicating whether the difference is positive or negative.

The A/D converter chip can only accept positive voltages. When the 0 Ω resistor shown in Figure 11 ties the A/D attenuator circuit to analog ground, both differential inputs must be referenced to analog ground, and ***both inputs must be positive with respect to analog ground***.

If a device such as a battery is connected across two channels for a differential measurement, and it is ***not*** referenced to analog ground, then the current from the device will flow through both sets of attenuator resistors as shown in Figure 12. This will generate a negative voltage at one of the inputs, AIN1, which will almost certainly lead to inaccurate A/D conversions.

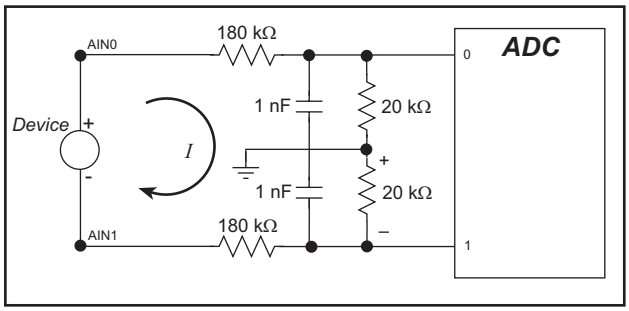


Figure 12. Current Flow from Ungrounded or Floating Source

To make such differential measurements, move the 0 Ω resistor jumper (see Figure 11) associated with the A/D converter inputs (JP4, JP5, JP6, or JP7) from analog ground to the 2.048 V reference voltage. This allows input voltages that are negative with respect to analog ground. Table 3 provides the differential voltage ranges for this setup.

Table 3. Differential Voltage Ranges

Min. Differential Voltage (V)	Max. Differential Voltage (V)	Amplifier Gain	mV per Tick
0	±20.0	×1	10
0	±10.0	×2	5
0	±5.0	×4	2.5
0	±4.0	×5	2.0
0	±2.5	×8	1.25
0	±2.0	×10	1.00
0	±1.25	×16	0.625
0	±1.0	×20	0.500

The input circuit of the OP7200 was designed to use the differential mode in a unique way to support measuring voltages in an equal range above and below ground. This method also requires you to move the 0 Ω jumper (see Figure 11) on the header associated with the A/D converter inputs (JP4, JP5, JP6, or JP7) from analog ground to the 2.048 V reference voltage. The input is connected to the even-numbered channel, and the odd-numbered channel is tied to analog ground. Table 4 provides the bipolar voltage ranges for this setup.

Table 4. Bipolar Voltages

Min. Voltage (V)	Max. Voltage (V)	Amplifier Gain	mV per Tick
-20.0	+20.0	1	10
-10.0	+10.0	2	5
-5.0	+5.0	4	2.5
-4.0	+4.0	5	2.0
-2.5	+2.5	8	1.25
-2.0	+2.0	10	1.00
-1.25	+1.25	16	0.625
-1.0	+1.0	20	0.500

3.4.2 Analog Current Measurements

The A/D converter inputs can also be used with 4–20 mA current sources by measuring the resulting analog voltage drop across a 100 Ω 1% precision resistor placed between the analog input and analog ground as shown in Figure 13.

The single-ended scale of 0–2.56 V with a gain of 8 is used to get an A/D current conversion of 12.5 µA/tick.

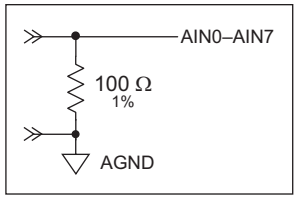


Figure 13. Resistor for 4–20 mA Current Sources

3.4.3 Calibrating the A/D Converter Chip

Manufacturing tolerances for resistors, bias currents, offset voltages, gain, and the like introduce errors into the A/D conversions. Ideally there would be a one-to-one straight-line relationship between the input voltage and the output of the A/D converter, and a graph of such a line would have a slope of 1 and would pass through the (0,0) coordinate. However, the errors arising from manufacturing tolerances introduce a deviation between the applied input voltage and the voltage that is output by the A/D converter. The actual plot of voltage in vs. the voltage out from A/D converter is not actually a straight line. However, a straight line is a very good first-order approximation, and the calibration routines provided for the OP7200 are based on a straight line with a slope of 1 and an offset from (0,0). The calibration routines use two known measurement points on the voltage-in vs. voltage-out line as the basis to calculate calibration constants that will be used to adjust for the slope of the line and the offset from (0,0). The calibration routines typically use input voltage points that are 10% less then the maximum and 10% more than the minimum readings possible for the A/D converter on any given range.

Quality calibration procedures are extremely important in obtaining good A/D converter results. No matter how high a resolution the A/D converter has, it cannot compensate for improper calibration. A/D converter results will never be more accurate than the meter used in the calibration process. Therefore, use the best digital volt and milli-amp meter available that meets or exceeds the accuracy of the A/D converter chip.

3.4.3.1 Modes

The OP7200 A/D converter operates in three different modes:

- the single-ended mode,
- the differential mode, and
- the milli-amp mode

The calibration and read routines provided correspond to these three modes.

3.4.3.2 Calibration Constants

The A/D converter has eight individual input channels, and each channel has eight programmable gains. Additionally, the A/D converter has the capability for adjacent inputs to be paired to make differential measurements with eight different gains, and provision is also made to convert 4–20 mA analog current measurements.

To get the best results form the A/D converter, it is necessary to calibrate each mode for each of its gains. The following table provides a grid for each possible set of calibration constants.

		Mode															
		Single-Ended								mA	Differential						
Gain Code		1	2	4	5	8	10	16	20	4	1	2	4	5	8	10	16	20
Input	0																	
	1																	
	2																	
	3																	
	4																	
	5																	
	6																	
	7																	

For the single-ended mode there are calibration constants for each channel and for each of its gains, for a total of 64 sets of calibration constants. The milli-amp mode covers 4–20 mA (actually 0–25 mA) currents. Separate calibration and read-back routines are provided for this. Since only one range of current measurement is provided, these routines use only one gain (4). One set of calibration constants is provided for each of the eight input channels. The differential-mode routines use a pair of input channels to make measurements. In this case, calibration constants are stored for each pair of channels and for each of the eight gains, for a total of 32 sets of calibration constants.

When a calibration is performed, it fills in one of the squares in the table with a set of calibration constants representing the corresponding mode, channel, and gain. These constants are stored in flash memory, and are thus maintained even when power is been removed from the OP7200. Note that calibration constants are stored for each of the modes. Since A/D converter read routines select the appropriate calibration constants based on the mode, it is possible for software calls to move from one mode to another without recalibration.

3.4.3.3 Calibration Recommendations

It is imperative that you calibrate each of the A/D converter inputs in the same manner as they are to be used in the application. For example, if you will be performing floating differential measurements or differential measurements using a common analog ground, then calibrate the A/D converter in the corresponding manner. The calibration must be done with the attenuator reference selection jumper in the desired position (see Figure 11). If a

calibration is performed and the jumper is subsequently moved, the corresponding input(s) must be recalibrated. The calibration table only holds calibration constants based on mode, channel, and gain. ***Other factors affecting the calibration must be taken into account by calibrating using the same mode and gain setup as in the intended use.***

It is not necessary to fill out the entire calibration table. Only the entries associated with the modes, channels, and gains that you will be using are necessary. This fact can be used to simplify and speed up the calibration process.

Each calibration is normally done at 10% less than the maximum and 10% more than the minimum within a given voltage range defined by the mode, channel, and gain. However, if an application is known to use only portion of a particular range, it is possible to obtain improved accuracy by using calibration points that are 10% less than the expected maximum and 10% greater than the expected minimum.

3.4.3.4 Factory Calibration

Because of the large number of possible calibrations, the factory performs only a rudimentary calibration on the unit. By default, all four of the attenuator reference selection jumpers are in the analog ground position. The factory performs a single-ended calibration on each of the eight channels with a gain of 1 (0–20 V range). The remaining single-ended calibration constants for the other seven gains are approximated and are filled in based on the initial calibration. The milli-amp and differential portions of the table are filled in using typical expected values. All read routines will work properly with these factory-initialized calibration constants, but only the single-ended mode should be expected to return accurate results over a range of 0–20 V until you recalibrate the OP7200 for your use.

Sample programs are provided to illustrate how to read and calibrate the various A/D inputs for the three operating modes.

Mode	Read	Calibrate
Single-Ended, one channel	**ADRD_SE_CH.C**	**ADCAL_SE_CH.C**
Single-Ended, all channels	**ADRD_SE_ALL.C**	**ADCAL_SE_ALL.C**
Milli-Amp	**ADRD_MA_CH.C**	**ADCAL_MA_CH.C**
Differential, analog ground	**ADRD_DIFF_GND.C**	**ADCAL_DIFF_GND.C**
Differential, 2 V reference	**ADRD_DIFF_2V.C**	**ADCAL_DIFF_2V.C**

These sample programs are found in the **ADC** subdirectory in **SAMPLES\OP7200**. See Section 4.3, “Sample Programs,” for more information on these sample programs and how to use them.

3.4.4 Touchscreen

The OP7200 analog touchscreen provides a high-resolution matrix of 4096 × 4096 elements. The touchscreen is mounted to the front of and is the same size as the LCD module. A four-conductor flex cable connects the touchscreen to the OP7200 at connector J13. The inputs from the touchscreen are protected from ESD by ferrite beads, capacitors, and shunt diodes. The ferrite beads and capacitors also serve to eliminate EMI radiating from the cable. Ferrite beads rather than resistors are used in series with the inputs to maintain the most accurate measurement of the touchscreen ***x,y*** position.

A reference voltage is applied across the touchscreen. When the touchscreen is touched, resistances that represent the ***x,y*** position are presented at the input circuit. The touchscreen controller chip U9 converts these resistances into digital form for use by the software.

> **NOTE:** Should you touch two or more different points on the touchscreen simultaneously, the resistance presented to the input circuit will represent some difference between the resistances corresponding to the points. This can lead to a different or an unknown key's value being processed. To prevent this from happening, exercise care to "touch" only one point or position on the touchscreen at a time.

3.4.5 Analog Supply Voltage

The analog section is isolated from digital noise generated by other components by way of a low-pass filter composed of L2, C31, and C32 as shown in the left side of Figure 14. The +V analog power supply powers the A/D converter chip.

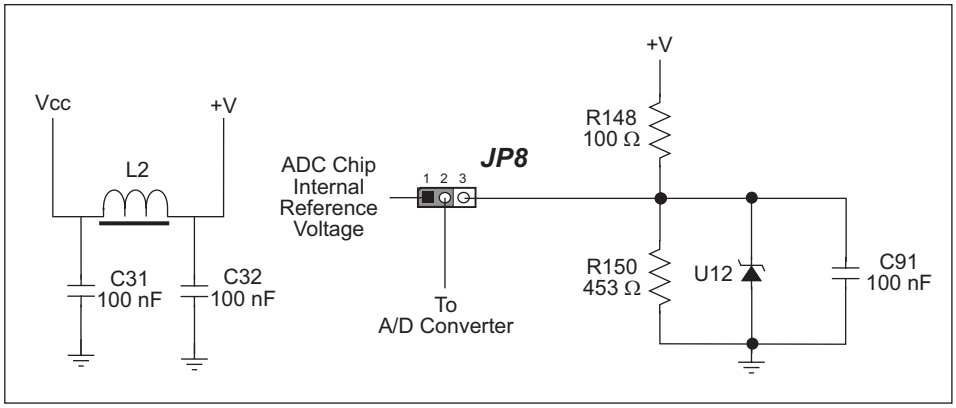


Figure 14. Analog Supply and Voltage Reference Circuits

3.4.6 A/D Converter Reference Voltage (+V)

A reference voltage of 2.048 V is generated by the A/D converter chip. The reference voltage is used by the touchscreen controller chip, and may also be used to bias the input attenuator circuits when bipolar inputs are to be measured. As shown in Figure 14, the factory default is for a surface-mounted 0 Ω resistor to connect pins 1–2 on header JP8. This enables the internal reference voltage of 2.048 V generated by the A/D converter chip.

By connecting pins 2–3 on header JP8 instead, a ratiometric reference can be provided by the divider consisting of R148 and R150. A fixed reference can be configured by removing R150 and installing a zener diode at U12. The zener diode will then set the reference voltage. C91 would be always installed, and provides filtering. None of these components (R148, R150, C91, or U12) is factory-installed.

3.5 Serial Communication

The OP7200 has two RS-232 serial ports, which can be configured as one RS-232 serial channel (with RTS/CTS) or as two RS-232 (3-wire) channels using the **serMode** software function call. Table 5 summarizes the options.

Table 5. Serial Communication Configurations

Software Mode	Serial Port		
	B	C	D
0	RS-485	RS-232, 3-wire	RS-232, 3-wire
1	RS-485	RS-232, 5-wire	CTS/RTS
2	not initialized*	RS-232, 3-wire	RS-232, 3-wire
3	not initialized*	RS-232, 5-wire	CTS/RTS

* Use modes 2 and 3 when Serial Port B is going to used by other libraries such as **PACKET.LIB**.

The OP7200 also has one RS-485 serial channel and a CMOS serial channel that serves as the programming port. When you are using the OP7200 in a RabbitNet network, Serial Port B is configured as a clocked serial port and the RS-485 chip drives the RabbitNet port—the OP7200 then cannot be used for RS-485 serial communication.

All four serial ports operate in an asynchronous mode up to the baud rate of the system clock divided by 32. An asynchronous port can handle 7 or 8 data bits. A 9th bit address scheme, where an additional bit is sent to mark the first byte of a message, is also supported. Serial Port A, the programming port, and Serial Port B can be operated alternately in the clocked serial mode. In this mode, a clock line synchronously clocks the data in or out. Either of the two communicating devices can supply the clock. When the Rabbit provides the clock, the baud rate can be up to ¼ of the system clock frequency, or more than 5.525 Mbps for a 22.1 MHz clock speed.

The OP7200 boards use all four serial ports. Serial Port A is used in the clocked serial mode to provide cold-boot, download, and emulation functions. Serial Port B is used either for RS-485 or for RabbitNet communication, and Serial Ports C and D are used for RS-232 communication. The OP7200 uses an 11.0592 MHz crystal, which is doubled to 22.1184 MHz. At this frequency, the OP7200 supports standard asynchronous baud rates up to a maximum of 230,400 bps.

3.5.1 RS-232

The OP7200 RS-232 serial communication is supported by an RS-232 transceiver. This transceiver provides the voltage output, slew rate, and input voltage immunity required to meet the RS-232 serial communication protocol. Basically, the chip translates the Rabbit 2000's CMOS/TTL signals to RS-232 signal levels. Note that the polarity is reversed in an RS-232 circuit so that a +5 V output becomes approximately -10 V and 0 V is output as +10 V. The RS-232 transceiver also provides the proper line loading for reliable communication.

RS-232 can be used effectively at the OP7200's maximum baud rate for distances of up to 15 m.

If you are planning to use any of the RS-232 serial ports ***and*** the RabbitNet port on the OP7200, initialize the serial port(s) ***before*** you initialize the RabbitNet port. Section 4.5.4 provides some sample code to illustrates the sequence.

3.5.2 RS-485

The OP7200 has one RS-485 serial channel, which is connected to the Rabbit 2000 Serial Port B through an RS-485 transceiver. The half-duplex communication uses an output from the CPLD (U4) to control the transmit enable on the communication line. Using this scheme a strict master/slave relationship must exist between devices to insure that no two devices attempt to drive the bus simultaneously.

The OP7200 can be used in an RS-485 multidrop network spanning up to 1200 m (4000 ft), and there can be as many as 32 attached devices. Connect the 485+ to 485+ and 485– to 485– using single twisted-pair wires as shown in Figure 15. Note that a common ground is recommended.

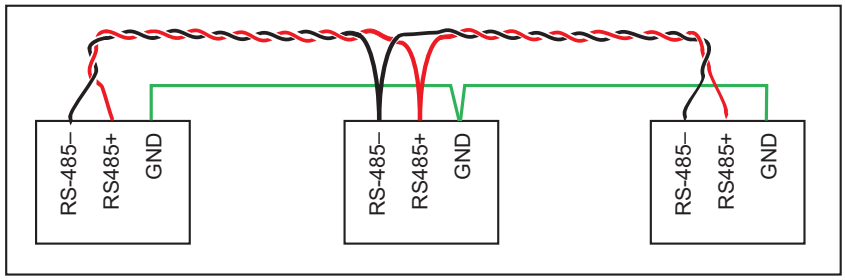


Figure 15. OP7200 Multidrop Network

The OP7200 comes with a 220 Ω termination resistor and two 681 Ω bias resistors installed and enabled with jumpers across pins 1–2 and 4–6 on header J8, as shown in Figure 16.

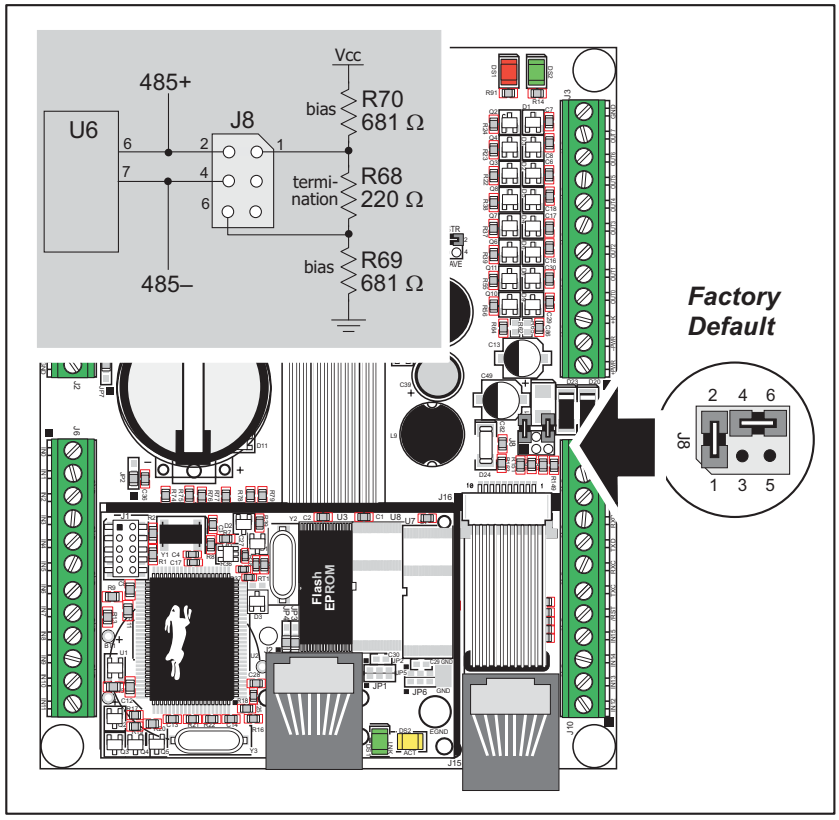


Figure 16. RS-485 Termination and Bias Resistors

For best performance, the termination resistors in a multidrop network should be enabled only on the end nodes of the network, but ***not*** on the intervening nodes. Jumpers on boards whose termination resistors are not enabled may be stored across pins 1–3 and 5–6 of header J8.

NOTE: Remove the back cover from the OP7200 to access the bias and termination resistor jumpers on header J8.

3.5.3 RabbitNet Port

The RJ-45 jack labeled ***RabbitNet*** is a serial I/O expansion port for use with RabbitNet I/O cards. The ***RabbitNet*** jack does ***not*** support Ethernet connections. There is also no provision for the OP7200 to supply power to any RabbitNet peripheral cards.

When you are using the OP7200 in a RabbitNet network, Serial Port B is configured as a clocked serial port and the RS-485 chip drives the RabbitNet port—the OP7200 then cannot be used for RS-485 serial communication.

If you are planning to use any of the RS-232 serial ports ***and*** the RabbitNet port on the OP7200, initialize the serial port(s) ***before*** you initialize the RabbitNet port. Section 4.5.4 provides some sample code to illustrates the sequence.

In principle, the OP7200 can operate either as a master controller with RabbitNet expansion I/O, or it can operate as a slave operator interface in a RabbitNet network. Jumper settings on header JP10 are used to configure the OP7200 for master or slave operation as shown in Appendix A.3, "Jumper Configurations." The factory default is for the OP7200 to be configured as a RabbitNet master.

At the present time, Dynamic C does not support the operation of the OP7200 as a slave, and so the OP7200 is restricted to being used as a master.

Appendix D provides additional information about the RabbitNet system.

3.5.4 Ethernet Port

Figure 17 shows the pinout for the Ethernet port (J2 on the OP7200's RabbitCore module). Note that there are two standards for numbering the pins on this connector—the convention used here, and numbering in reverse to that shown. Regardless of the numbering convention followed, the pin positions relative to the spring tab position (located at the bottom of the RJ-45 jack in Figure 17) are always absolute, and the RJ-45 connector will work properly with off-the-shelf Ethernet cables.

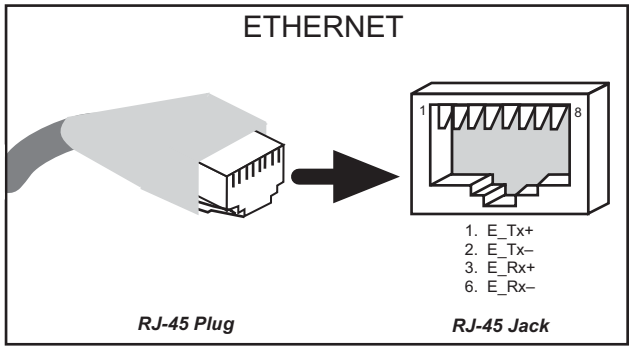


Figure 17. RJ-45 Ethernet Port Pinout

RJ-45 pinouts are sometimes numbered opposite to the way shown in Figure 17.

Two LEDs are placed next to the RJ-45 Ethernet jack, one to indicate a live Ethernet link (**LNK**) and one to indicate Ethernet activity (**ACT**).

The transformer/connector assembly ground is connected to the OP7200's RabbitCore module printed circuit board digital ground via a 0 Ω resistor "jumper," R29, as shown in Figure 18.

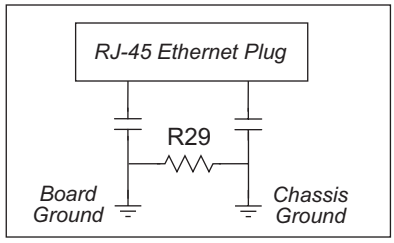


Figure 18. Isolation Resistor R29

The factory default is for the 0 Ω resistor "jumper" at R29 to be installed. In high-noise environments, remove R29 and ground the transformer/connector assembly directly through the chassis ground by using the EGND terminal on the RabbitCore module. This will be especially helpful to minimize ESD and/or EMI problems.

3.5.5 Programming Port

The RabbitCore module on the OP7200 has a 10-pin programming header. The programming port uses the Rabbit 2000's Serial Port A for communication. Dynamic C uses the programming port to download and debug programs.

The programming port is also used for the following operations.

- Cold-boot the Rabbit 2000 on the RabbitCore module after a reset.
- Remotely download and debug a program over an Ethernet connection using the RabbitLink EG2110.
- Fast copy designated portions of flash memory from one Rabbit-based board (the master) to another (the slave) using the Rabbit Cloning Board.

Alternate Uses of the Serial Programming Port

All three clocked Serial Port A signals are available as

- a synchronous serial port
- an asynchronous serial port, with the clock line usable as a general CMOS input

The serial programming port may also be used as a serial port via the **DIAG** connector on the serial programming cable.

In addition to Serial Port A, the Rabbit 2000 startup-mode (SMODE0, SMODE1), status, and reset pins are available on the serial programming port.

The two startup mode pins determine what happens after a reset—the Rabbit 2000 is either cold-booted or the program begins executing at address 0x0000.

The status pin is used by Dynamic C to determine whether a Rabbit microprocessor is present. The status output has three different programmable functions:

1. It can be driven low on the first op code fetch cycle.
2. It can be driven low during an interrupt acknowledge cycle.
3. It can also serve as a general-purpose CMOS output.

The /RESET_IN pin is an external input that is used to reset the Rabbit 2000 and the onboard peripheral circuits on the RabbitCore module. The serial programming port can be used to force a hard reset on the RabbitCore module by asserting the /RESET_IN signal. The green **Power Good** LED goes off momentarily during a reset.

Refer to the ***Rabbit 2000 Microprocessor User's Manual*** for more information.

3.6 Memory

3.6.1 SRAM

The OP7200's RabbitCore module is designed to accept 128K to 512K of SRAM packaged in an SOIC case. The standard OP7200's RabbitCore modules come with 128K of SRAM.

3.6.2 Flash Memory

The OP7200 is also designed to accept 128K to 512K of flash memory. The standard OP7200's RabbitCore modules comes with one 256K flash memory.

> **NOTE:** Rabbit recommends that any customer applications should not be constrained by the sector size of the flash memory since it may be necessary to change the sector size in the future.

A Flash Memory Bank Select jumper configuration option based on 0 Ω surface-mounted resistors exists at header JP2 on the RabbitCore module. This option, used in conjunction with some configuration macros, allows Dynamic C to compile two different co-resident programs for the upper and lower halves of the 256K program flash in such a way that both programs start at logical address 0000. This is useful for applications that require a resident download manager and a separate downloaded program. See Technical Note 218, ***Implementing a Serial Download Manager for a 256K Flash***, for details.

3.7 Liquid Crystal Display Controller

The LCD module controller chip provides support for the LCD module. The controller chip is attached to the data bus on the OP7200's RabbitCore module, and is mapped to the I/O address space. This interface is composed of eight data bits, one address line, and three control lines (/IORD, /IOWR, and /LCDM-CS).

The interface from the LCD controller to the LCD module is unidirectional. Data flow from the controller chip to the LCD module. A number of control lines are provided for this function, but not all of them are used for a particular LCD module. The controller continually reads the SRAM (which is included on the LCD controller chip used after January,2006) for data placed there by the microprocessor and refreshes the display periodically.

Other functions support the LCD module to adjust its contrast and to turn the white LED backlight on and off. A variable resistor between two of the LCD module's terminals sets the contrast. U5 is a digitally controlled potentiometer that is controlled by software. Once the value is set, the value will be maintained. A single programmed I/O bit is used to turn the LED backlight on or off. Since this bit does not have enough drive current to light the LED directly, it is buffered by the FET Q1.

The controller chip used in OP7200's sold before 2006 supported either 32K or 64K of SRAM. These OP7200s were designed using a dual-footprint SRAM to accept either one 32K or one 128K SRAM. The 128K part was standard. The full 64K supported by the controller is available with the 128K SRAM, plus an additional 64K can be swapped in and out by using the programmed I/O bit VA16. Pins 1–2 on header JP9 are normally connected by a 0 Ω surface-mounted resistor, but pins 2–3 should be connected instead for video SRAM paging with I/O bit VA16.

OP7200 units sold after January, 2006, have a new LCD controller chip because the previously used LCD controller chip is no longer available. The new LCD controller chip has 32K of internal SRAM. Figure 19 shows the area of the OP7200 that changed to accommodate the new LCD controller chip. The new LCD controller is not 100% code-compatible with the old chip—Section 4.1.2.1 explains how to handle programs developed using versions of Dynamic C before v. 9.40.

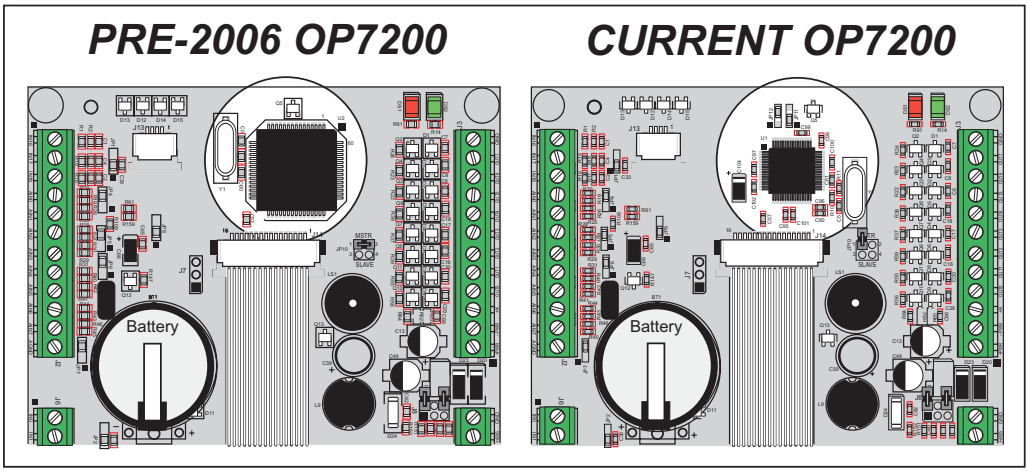
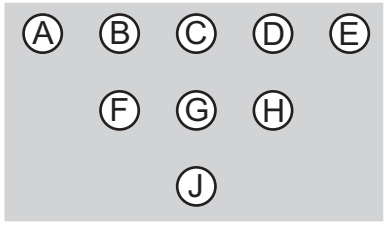


Figure 19. How to Identify Pre-2006 OP7200 Boards

3.8 Keypad

The OP7200 is equipped with a nine-position keypad. The keypad is attached to the front bezel with an adhesive backing and is connected through J16 to the OP7200 printed-circuit board with a flex cable. Only 7 of the 10 conductors in the cable are used at the present time. The extra lines are reserved for an expanded keypad or LED indicators. The interface to the keypad is through programmed I/O bits composed of four scan rows of three keys each. Driving a particular scan line (/KB–S0:3) low will read back a zero on the keypad data lines (/PB0:2–K0:2) associated with the three keys on the selected row. Diodes D16–D19 prevent feedback, allowing the software to read the keypad even when multiple keys are pressed simultaneously. Resistors R138–R141 and capacitors C79–C81 and C83 form a low-pass filter to protect against ESD damage. These same circuits help to eliminate EMI from being radiated from the keypad or its flex cable. R149, R151–R152, and C82–C84 perform a similar function for the keypad data lines. The tri-state receiver chip U13 connects the key data to the microprocessor data bus at the appropriate time when directed by the control signals /IORD and /PE5-IO-CS1. Note that only the low-order three bits of the data bus are connected. The software must mask off the high 5 bits since they are undefined.

Figure 20 shows how the keypad is encoded with respect the scan and data lines. For example, if /KB–S2 is asserted low, then keys D, H, and E are read back on data lines K0, K1, and K2 respectively. A zero read on the data lines indicates that the key is pressed and a one indicates that it is not. Ones are always read back on data lines that are not assigned to any particular key. Once the values read from the keypad remain constant for a length of time, the read can be assumed to be valid.



	/PB0–K0	/PB1–K1	/PB2–K2
/KB–S0	B	F	
/KB–S1	C	G	J
/KB–S2	D	H	E
/KB–S3	A		

Figure 20. OP7200 Keypad Encoding

3.9 OP7200 CPLD

All the random logic used to control the OP7200 is contained within a single ComPlex Logic Device (CPLD). The AMD ATF1500A contains 32 macrocells and is packaged in a 44-pin TQFP. This device contains decoding and a number of I/O bits that can be set to high or low to control various functions of the OP7200.

The CPLD interfaces to the address and data bus on the RabbitCore module, and is write-only. Two chip select lines, /PE4 and /PE5, are used to enable the device. /PE4 and /PE5 are configured in software as I/O strobes, and set the base address used by the CPLD. /PE4 is used when selecting one of the sixteen I/O control bits associated with the eight driver circuits. /PE5 is used with the remainder of the controls. The control bits within the CPLD normally can be set and reset independently of one another. The SINK and SOURCE outputs are different in that both the SINK and SOURCE outputs for a particular driver cannot be asserted simultaneously. If either the SINK or SOURCE output is asserted, and the software tries to set the other, the operation is ignored and the bit will not be set. The purpose of this interlock is to prevent damage to the driver circuit by not allowing both current sourcing and sinking to be enabled simultaneously.

Table 6. CPLD Parameters

/PE5	/PE4	A3–0	D0	Signal	Function
1	0	0000	1	SINK0	Enable Sink Output 0
1	0	0000	0	SINK0	Disable Sink Output 0
1	0	0001	1	SINK1	Enable Sink Output 1
1	0	0001	0	SINK1	Disable Sink Output1
1	0	0010	1	SINK2	Enable Sink Output 2
1	0	0010	0	SINK2	Disable Sink Output 2
1	0	0011	1	SINK3	Enable Sink Output 3
1	0	0011	0	SINK3	Disable Sink Output 3
1	0	0100	1	SINK4	Enable Sink Output 4
1	0	0100	0	SINK4	Disable Sink Output 4
1	0	0101	1	SINK5	Enable Sink Output 5
1	0	0101	0	SINK5	Disable Sink Output 5
1	0	0110	1	SINK6	Enable Sink Output 6
1	0	0110	0	SINK6	Disable Sink Output 6
1	0	0111	1	SINK7	Enable Sink Output 7
1	0	0111	0	SINK7	Disable Sink Output 7
1	0	1000	1	SOURCE0	Enable Source Output 0
1	0	1000	0	SOURCE0	Disable Source Output 0
1	0	1001	1	SOURCE1	Enable Source Output 1
1	0	1001	0	SOURCE1	Disable Source Output 1
1	0	1010	1	SOURCE2	Enable Source Output 2
1	0	1010	0	SOURCE2	Disable Source Output 2

Table 6. CPLD Parameters (continued)

/PE5	/PE4	A3–0	D0	Signal	Function
1	0	1011	1	SOURCE3	Enable Source Output 3
1	0	1011	0	SOURCE3	Disable Source Output 3
1	0	1100	1	SOURCE4	Enable Source Output 4
1	0	1100	0	SOURCE4	Disable Source Output 4
1	0	1101	1	SOURCE5	Enable Source Output 5
1	0	1001	0	SOURCE5	Disable Source Output 5
1	0	1110	1	SOURCE6	Enable Source Output 6
1	0	1110	0	SOURCE6	Disable Source Output 6
1	0	1111	1	SOURCE7	Enable Source Output 7
1	0	1111	0	SOURCE7	Disable Source Output 7
0	1	0000	1	/KB-S0	Assert Keypad Scan Line S0
0	1	0000	0	/KB-S0	Deassert Keypad Scan Line S0
0	1	0001	1	/KB-S1	Assert Keypad Scan Line S1
0	1	0001	0	/KB-S1	Deassert Keypad Scan Line S1
0	1	0010	1	/KB-S2	Assert Keypad Scan Line S2
0	1	0010	0	/KB-S2	Deassert Keypad Scan Line S2
0	1	0011	1	/KB-S3	Assert Keypad Scan Line S3
0	1	0011	0	/KB-S3	Deassert Keypad Scan Line S3
0	1	0100	1	BKLT-ON	Turn On the LCDM Backlight
0	1	0100	0	BKLT-ON	Turn Off the LCDM Backlight
0	1	0101	1	RS485-EN	Enable the 485 Transmitter
0	1	0101	0	RS485-EN	Disable the 485 Transmitter
0	1	0110	1	ALARM	Turn On the Buzzer
0	1	0110	0	ALARM	Turn Off the Buzzer
0	1	0111	1	VA16	Assert the VA16 Address Line/RabbitNet CS
0	1	0111	0	VA16	Deassert the VA16 Address Line/RabbitNet CS
0	1	1000	1	/CS	Assert X9015 Chip Select
0	1	1000	0	/CS	Deassert X9015 Chip Select
0	1	1001	1	U_D	Set X9015 to Count Up
0	1	1001	0	U_D	Set X9015 to Count Down
0	1	1010	*	INC	Increment the X9015 Counter
0	1	1011	*	NA	Reserved
0	1	1100	*	NA	Reserved
0	1	1101	*	NA	Reserved
0	1	1110	*	NA	Reserved
0	1	1111	*	NA	Reserved

3.10 Programming Cable

The programming cable is used to connect the programming port of the RabbitCore module to a PC serial COM port. The programming cable converts the RS-232 voltage levels used by the PC serial port to the TTL voltage levels used by the Rabbit 2000.

When the **PROG** connector on the programming cable is connected to the RabbitCore module's programming header, programs can be downloaded and debugged over the serial interface.

The **DIAG** connector of the programming cable may be used on the programming header of the RabbitCore module with the module operating in the Run Mode. This allows the programming port to be used as a regular serial port.

3.10.1 Changing Between Program Mode and Run Mode

The OP7200 is automatically in Program Mode when the **PROG** connector on the programming cable is attached to the RabbitCore module, and is automatically in Run Mode when no programming cable is attached. When the Rabbit 2000 is reset, the operating mode is determined by the status of the SMODE pins. When the programming cable's **PROG** connector is attached, the SMODE pins are pulled high, placing the Rabbit 2000 in the Program Mode. When the programming cable's **PROG** connector is not attached, the SMODE pins are pulled low, causing the Rabbit 2000 to operate in the Run Mode.

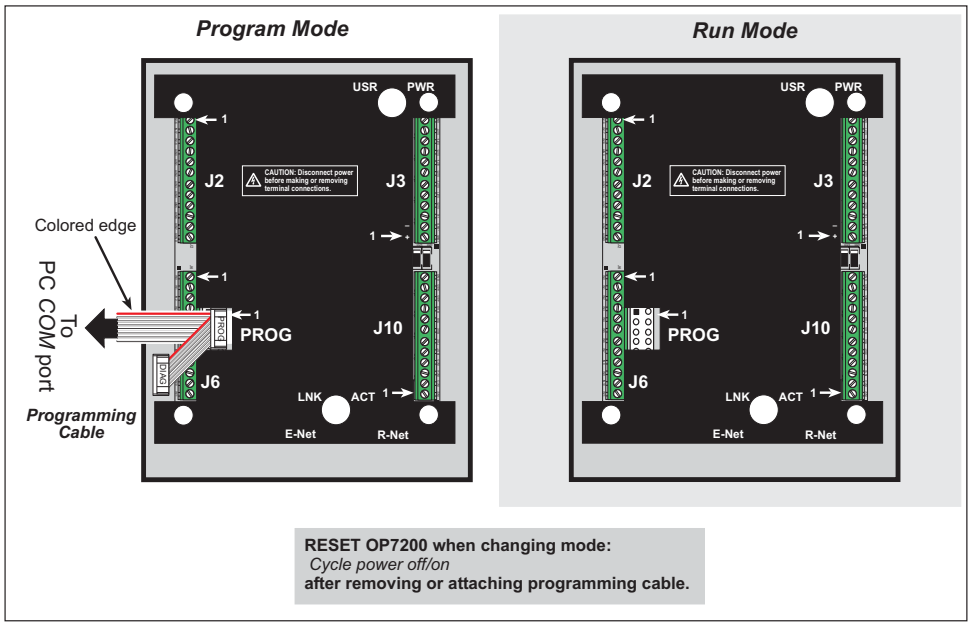


Figure 21. OP7200 Program Mode and Run Mode Set-Up

A program can be run in either mode, but can only be downloaded and debugged when the OP7200 is in the Program Mode.

Refer to the ***Rabbit 2000 Microprocessor User's Manual*** for more information on the programming port and the programming cable.

3.11 Other Hardware

3.11.1 Spectrum Spreader

OP7200 operator control panels that carry the CE mark on their RabbitCore module have a Rabbit 2000 microprocessor that features a spectrum spreader, which helps to mitigate EMI problems. By default, the spectrum spreader is on automatically for OP7200 operator control panels that carry the CE mark when used with Dynamic C 7.30 or later versions, but the spectrum spreader may also be turned off or set to a stronger setting. The means for doing so is through a simple global macro as shown below.

1. Select the "Defines" tab from the Dynamic C **Options > Project Options** menu.
2. Normal spreading is the default, and usually no entry is needed. If you need to specify normal spreading, add the line

   ```
   ENABLE_SPREADER=1
   ```

   For strong spreading, add the line

   ```
   ENABLE_SPREADER=2
   ```

   To disable the spectrum spreader, add the line

   ```
   ENABLE_SPREADER=0
   ```

   NOTE: The strong spectrum-spreading setting is not needed for the OP7200.
3. Click **OK** to save the macro. The spectrum spreader will now remain off whenever you are in the project file where you defined the macro.

There is no spectrum spreader functionality for OP7200 operator control panels that do not carry the CE mark on their RabbitCore module or when using any OP7200 with a version of Dynamic C prior to 7.30.

4. SOFTWARE

Dynamic C is an integrated development system for writing embedded software. It runs on an IBM-compatible PC and is designed for use with single-board computers and other devices based on the Rabbit microprocessor.

Chapter 4 provides the libraries, function calls, and sample programs related to the OP7200.

4.1 Running Dynamic C

You have a choice of doing your software development in the flash memory or in the static RAM included on the OP7200. The flash memory and SRAM options are selected with the **Options > Compiler** menu.

The advantage of working in RAM is to save wear on the flash memory, which is limited to about 100,000 write cycles. The disadvantage is that the code and data might not both fit in RAM.

NOTE: An application can be developed in RAM, but cannot run standalone from RAM after the programming cable is disconnected. Standalone applications can only run from flash memory.

NOTE: Do not depend on the flash memory sector size or type. Due to the volatility of the flash memory market, the OP7200 and Dynamic C were designed to accommodate flash devices with various sector sizes.

OP7200s that are special-ordered with 512K flash/512K SRAM memory options have two 256K flash memories. By default, Dynamic C will use only the first flash memory for program code in these OP7200s. Uncomment the **USE_2NDFLASH_CODE** macro within the **RABBITBIOS.C** file in the Dynamic C **BIOS** folder to allow the second flash memory to hold any program code that is in excess of the available memory in the first flash.

Developing software with Dynamic C is simple. Users can write, compile, and test C and assembly code without leaving the Dynamic C development environment. Debugging occurs while the application runs on the target. Alternatively, users can compile a program to an image file for later loading. Dynamic C runs on PCs under Windows 98 or later. Programs can be downloaded at baud rates of up to 460,800 bps after the program compiles.

Dynamic C has a number of standard features.

- Full-feature source and/or assembly-level debugger, no in-circuit emulator required.
- Royalty-free TCP/IP stack with source code and most common protocols.
- Hundreds of functions in source-code libraries and sample programs:
  - ▶ Exceptionally fast support for floating-point arithmetic and transcendental functions.
  - ▶ RS-232 and RS-485 serial communication.
  - ▶ Analog and digital I/O drivers.
  - ▶ I^2C, SPI, GPS, file system.
  - ▶ LCD display and keypad drivers.
- Powerful language extensions for cooperative or preemptive multitasking
- Loader utility program to load binary images into Rabbit targets in the absence of Dynamic C.
- Provision for customers to create their own source code libraries and augment on-line help by creating "function description" block comments using a special format for library functions.
- Standard debugging features:
  - ▶ Breakpoints—Set breakpoints that can disable interrupts.
  - ▶ Single-stepping—Step into or over functions at a source or machine code level, µC/OS-II aware.
  - ▶ Code disassembly—The disassembly window displays addresses, opcodes, mnemonics, and machine cycle times. Switch between debugging at machine-code level and source-code level by simply opening or closing the disassembly window.
  - ▶ Watch expressions—Watch expressions are compiled when defined, so complex expressions including function calls may be placed into watch expressions. Watch expressions can be updated with or without stopping program execution.
  - ▶ Register window—All processor registers and flags are displayed. The contents of general registers may be modified in the window by the user.
  - ▶ Stack window—shows the contents of the top of the stack.
  - ▶ Hex memory dump—displays the contents of memory at any address.
  - ▶ **STDIO** window—`printf` outputs to this window and keyboard input on the host PC can be detected for debugging purposes. `printf` output may also be sent to a serial port or file.

4.1.1 Upgrading Dynamic C

4.1.1.1 Patches and Bug Fixes

Dynamic C patches that focus on bug fixes are available from time to time. Check the Web site www.rabbit.com/support/ for the latest patches, workarounds, and bug fixes.

The default installation of a patch or bug fix is to install the file in a directory (folder) different from that of the original Dynamic C installation. Rabbit recommends using a different directory so that you can verify the operation of the patch without overwriting the existing Dynamic C installation. If you have made any changes to the BIOS or to libraries, or if you have programs in the old directory (folder), make these same changes to the BIOS or libraries in the new directory containing the patch. Do ***not*** simply copy over an entire file since you may overwrite a bug fix; of course, you may copy over any programs you have written. Once you are sure the new patch works entirely to your satisfaction, you may retire the existing installation, but keep it available to handle legacy applications.

4.1.1.2 Upgrades

Dynamic C installations are designed for use with the board they are included with, and are included at no charge as part of our low-cost kits. Dynamic C is a complete software development system, but does not include all the Dynamic C features. Rabbit also offers add-on Dynamic C modules containing the popular µC/OS-II real-time operating system, as well as PPP, Advanced Encryption Standard (AES), and other select libraries. In addition to the Web-based technical support included at no extra charge, a one-year telephone-based technical support module is also available for purchase.

NOTE: Dynamic C RabbitSys cannot be used with the OP7200.

4.1.2 Accessing and Downloading Dynamic C Libraries

The libraries needed to run the OP7200 are available on the CD included with the Development Kit. Upgrades may be downloaded from www.rabbit.com/support/downloads/ on our Web site. You may need to download upgraded or additional libraries to run selected RabbitNet peripheral boards or to use an OP7200 purchased after January, 2006, with a Dynamic C release prior to v. 9.40.

When downloading the libraries from the Web site, click on the product-specific links until you reach the links for the OP7200 download you require. You will be able to either run the download directly from the Web site, or you may choose to save it to run later.

Once you run the download, InstallShield will install the additional or upgraded software. A readme file associated with the installation will then guide you to add to, replace, or edit Dynamic C libraries or sample programs.

You will be able to use the revamped Dynamic C installation with the OP7200 and you will continue to be able to use this upgraded installation with all the other Rabbit products you were able to use before.

4.1.2.1 New LCD Controller Chip

OP7200 units sold after January, 2006, have a new LCD controller chip because the previously used LCD controller chip is no longer available. The new LCD controller is not 100% code-compatible with the old chip, and therefore changes were made to the LCD drivers. The updated drivers for the OP7200 are included in Dynamic C v. 9.40 and later, and are backward-compatible for use with the old LCD controller chip.

If you are using a program developed with an earlier version of Dynamic C, you will need to replace the existing Dynamic C **SED1335F.LIB** library in your Dynamic C installation in the **LIB\DISPLAYS\GRAPHIC\320x240** folder. Once you have the new **SED1335F.LIB** library, you will have to recompile your program.

The new **SED1335F.LIB** library is available for download from our Web site at www.rabbit.com/support/downloads/downloads_prod.shtml, and has been tested for compatibility with Dynamic C versions 7.33 and later.

The changes to the **SED1335F.LIB** library will improve the OP7200 screen update time by a factor of four. Otherwise, the form, fit, and function of the OP7200 are not affected by the changes.

4.2 Font and Bitmap Converter

The Font and Bitmap Converter is a utility included with Dynamic C to convert Windows fonts and monochrome bitmaps to a library file format compatible with Dynamic C applications and Rabbit's graphic displays. These library files may be added to applications with the statement **#use LIBRARYFILENAME.LIB** or by cutting and pasting from the library file directly into the application. Remember to enter **LIBRARYFILENAME.LIB** into **LIB.DIR**, which is located in the Dynamic C directory if you **#use LIBRARYFILENAME.LIB**.

To start the Font and Bitmap Converter, use the Windows **Start > Run** menu or Windows Explorer to launch **fbmcnvtr.exe** from the root folder where Dynamic C is installed. Click on **Help** in the Font and Bitmap Converter utility to get complete use information about the utility.

4.3 Sample Programs

Sample programs are provided in the Dynamic C **SAMPLES** folder. The sample program **PONG.C** demonstrates the output to the **STDIO** window. The various directories in the **SAMPLES** folder contain specific sample programs that illustrate the use of the corresponding Dynamic C libraries.

The **SAMPLES\OP7200** folder provides sample programs specific to the OP7200. Each sample program has comments that describe the purpose and function of the program. Follow the instructions at the beginning of the sample program.

To run a sample program, open it with the **File** menu (if it is not still open), then compile and run it by pressing **F9** or by selecting **Run** in the **Run** menu. The OP7200 must be in **Program** mode (see Section 3.10) and must be connected to a PC using the programming cable as described in Section 2.3.

More complete information on Dynamic C is provided in the ***Dynamic C User's Manual***.

4.3.1 General OP7200 Sample Programs

The following sample programs are found in the **SAMPLES\OP7200** directory.

- **BOARD_ID.C**—Detects the model of the board you are using and displays the information in the **STDIO** window.
- **FUN.C**—Demonstrates the features of the OP7200. A variable customer-supplied 0–10 V DC power supply is recommended to demonstrate the analog input section.

4.3.2 Digital I/O

The following sample programs are found in the **IO** subdirectory in **SAMPLES\OP7200**.

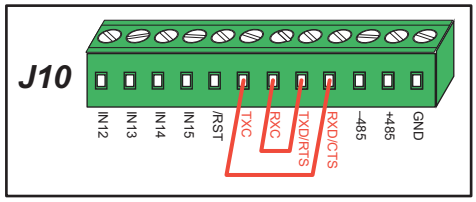
- **BUZZER.C**—Demonstrates the use of the OP7200 buzzer.
- **DIGIN.C**—Demonstrates the use of the digital inputs. Using the Demonstration Board, you can see an input channel toggle from HIGH to LOW when pressing a pushbutton on the Demonstration Board.
- **DIGOUT.C**—Demonstrates the use of the high-current outputs configured as either sinking or sourcing outputs. Using the Demonstration Board, you can see an LED toggle on/off via a high-current output.
- **LED.C**—Toggles the LEDs on the OP7200.
- **PWM.C**—Demonstrates the use of Timer B to generate a 42 Hz PWM signal on digital output OUT0. The PWM duty cycle may be adjusted from 1 to 99%. Connect +K to +PWR (pins 1 and 3 on screw-terminal header J3) to run this sample program.
- **TRISTATE.C**—Demonstrates the use of the high-current outputs configured as sinking, sourcing, or tristate outputs. Using the Demonstration Board, you can see a bank of channels toggle the corresponding LEDs on/off via the high-current outputs.

4.3.3 Serial Communication

The following sample programs are found in the **RS232** subdirectory in **SAMPLES\OP7200**.

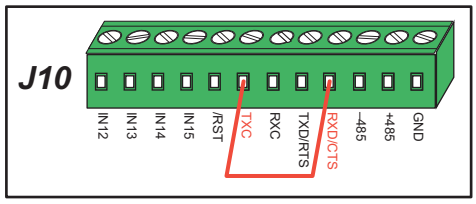
- **PUTS.C**—This program transmits and then receives an ASCII string on Serial Ports C and D. The serial data received are displayed in the **STDIO** window.

  To set up the OP7200, you will need to tie TxC and RxD together on the screw-terminal header at J10, and you will also tie TxD and RxC together as shown in the diagram.



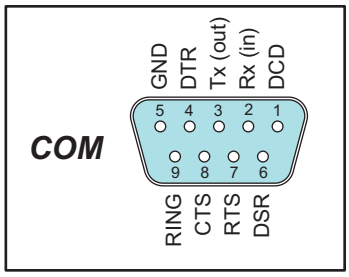
- **RELAYCHR.C**—This program echoes characters to or from a serial utility such as HyperTerminal or Tera Term.

  To set up the OP7200, you will need to tie TxC and RxD together on the screw-terminal header at J10.



  Then connect your PC COM port to screw-terminal header J10 as follows.

  - ▶ PC Tx to RxC on J10
  - ▶ PC Rx to TxD on J10
  - ▶ PC GND to GND on J10



  Set up HyperTerminal or Tera Term as follows: 19200 bps, 8 data bits, no parity, 1 stop bit, and no flow control. Here are a few additional settings if you are using Tera Term.

  - ▶ Disable **Local Echo** in the **Terminal** setup
  - ▶ Enable the receive and line feed options (**CR + LF**) under **New line** in the **Terminal** setup

  Now when you type characters in the HyperTerminal or Tera Term window, they will appear in the window because they are being echoed back by the sample program.

Two sample programs, **MASTER.C** and **SLAVE.C**, are available in the **RS485** subdirectory in **SAMPLES\OP7200** to illustrate RS-485 master/slave communication. To run these sample programs, you will need a second Rabbit-based system with RS-485—another Rabbit single-board computer or OP7200 may be used as long as you use the master or slave sample program associated with that board.

The RS-485 connections between the slave and master devices are as follows.

- RS485+ to RS485+
- RS485– to RS485–
- GND to GND

- **MASTER.C**—This program demonstrates a simple RS-485 transmission of lower case letters to a slave. The slave will send back converted upper case letters back to the master OP7200 and display them in the **STDIO** window. Use **SLAVE.C** to program the slave.
- **SLAVE.C**—This program demonstrates a simple RS-485 transmission of lower case letters to a master OP7200. The slave will send back converted upper case letters back to the master OP7200 and display them in the **STDIO** window. Use **MASTER.C** to program the master OP7200.

4.3.4 A/D Converter Inputs

The following sample programs are found in the **ADC** subdirectory in **SAMPLES\OP7200**.

- **ADCAL_DIFF_2V.C**—Demonstrates how to recalibrate an A/D input channel being used for a differential input with the input attenuator tied to the 2 V reference voltage.
- **ADCAL_DIFF_GND.C**—Demonstrates how to recalibrate an A/D input channel being used for a differential input with the input attenuator tied to analog ground.
- **ADCAL_MA_CH.C**—Demonstrates how to recalibrate an A/D input channel being used to convert analog current measurements to generate the calibration constants for that channel.
- **ADCAL_SE_ALL.C**—Demonstrates how to recalibrate all single-ended A/D input channels for a given gain.
- **ADCAL_SE_CH.C**—Demonstrates how to recalibrate one single-ended A/D input channels to generate the calibration constants for that channel.

  NOTE: The above sample programs will overwrite the calibration constants set at the factory.
- **ADRD_DIFF_2V.C**—Demonstrates how to read an A/D input channel being used for a differential input with the input attenuator tied to the 2 V reference voltage.
- **ADRD_DIFF_GND.C**—Demonstrates how to read an A/D input channel being used for a differential input with the input attenuator tied to analog ground.
- **ADRD_MA_CH.C**—Demonstrates how to read an A/D input channel being used to convert analog current measurements using previously defined calibration constants for that channel.
- **ADRD_SE_ALL.C**—Demonstrates how to read all single-ended A/D input channels using previously defined calibration constants.
- **ADRD_SE_CH.C**—Demonstrates how to read one single-ended A/D input channels using previously defined calibration constants.

4.3.5 Graphic Display

The following sample program is found in the **LCD_BASIC** subdirectory in **SAMPLES\OP7200**.

- **BUFFLOCK.C**—Demonstrates how to improve LCD performance by using the **glBuffLock** and **glBuffUnlock** functions.
- **CONTRAST.C**—Demonstrates how to adjust the contrast on the LCD.
- **PRIMITIVES.C**—Demonstrates the primitive graphic functions to draw lines, circles, polygons, and bitmaps.
- **SCROLLING.C**—Demonstrates the scrolling features of the **GRAPHIC.LIB** library.
- **TEXT.C**—Demonstrates the text features of the **GRAPHIC.LIB** library.

4.3.6 Keypad

The following sample programs are found in the **LCD_KEYPAD** subdirectory in **SAMPLES\OP7200**.

- **KP_16KEY.C**—Demonstrates using 9-key keypad instead of touchscreen to control virtual keypad.
- **KP_ANALOG.C**—Demonstrates using 9-key keypad instead of touchscreen to control virtual keypad.
- **KP_BASIC.C**—Demonstrates the keypad functions.
- **KP_MENU.C**—Demonstrates how to implement a menu system using the **GLMENU.LIB** library.

4.3.7 Touchscreen (OP7200 only)

The following sample program is found in the **LCD_TOUCHSCREEN** subdirectory in **SAMPLES\OP7200**.

- **BTN_16KEY.C**—Demonstrates the use of a virtual keypad for data entry.
- **BTN_BASICS.C**—Demonstrates the basic functionality of the touchscreen buttons.
- **BTN_KEYBOARD.C**—Demonstrates the use of a virtual keypad for data entry.
- **CAL_TOUCHSCREEN.C**—Demonstrates how to recalibrate the touchscreen coordinates.
- **RD_TOUCHSCREEN.C**—Demonstrates how to read the touchscreen in debounced or real-time modes.
- **TSCUST16KEY.LIB**—Sample library demonstrating how to make custom keysets using **GLTOUCHSCREEN.LIB**.
- **TSCUSTKEYBOARD.LIB**—Sample library demonstrating how to make custom keysets using **GLTOUCHSCREEN.LIB** functions.

4.3.8 Using System Information from the RabbitCore Module

Calibration constants for the A/D converter are stored in the simulated EEPROM area of the flash memory. You may find it useful to retrieve the calibration constants and save them for future use, for example, if you should need to replace the RabbitCore module on the OP7200.

The following sample programs, found in the **Calib_Save_Retrieve** subdirectory in **SAMPLES\OP7200**, illustrate how to save or retrieve the calibration constants. Note that both sample programs prompt you to use a serial number for the OP7200. This serial number can be any 5-digit number of your choice, and will be unique to a particular OP7200. Do ***not*** use the MAC address on the bar code label of the RabbitCore module attached to the OP7200 since you may at some later time use that particular RabbitCore module on another OP7200, and the previously saved calibration data would no longer apply.

- **SAVECALIB.C**—This program demonstrates how to save your analog calibration coefficients using a serial port and a PC serial utility such as Tera Term.

  NOTE: Use the sample program **GETCALIB.C** to retrieve the data and rewrite it to the single-board computer.

- **GETCALIB.C**—This program demonstrates how to retrieve your analog calibration data to rewrite it back to the simulated EEPROM in flash with using a serial utility such as Tera Term.

  NOTE: Calibration data must be saved previously in a file by the sample program **SAVECALIB.C**.

  NOTE: In addition to loading the calibration constants on the replacement RabbitCore module, you will also have to add the product information for the OP7200 to the ID block associated with the RabbitCore module. The sample program **WRITE_IDBLOCK.C**, available on the our Web site at www.rabbit.com/support/feature_downloads.shtml, provides specific instructions and an example.

Two sample programs are available to show how to get information on ID and user blocks, and how to clear the contents in the user block. These sample programs are in the Dynamic C **SAMPLES\USERBLOCK** folder.

- **USERBLOCK_INFO.C**—This program reports on the size and capabilities of the ID and user blocks. It will report the version of the ID block, the size of the ID and user blocks, the size of the user blocks reserved for calibration constants, whether the ID or user blocks are mirrored, and the total amount of flash memory used by the ID and user blocks.

- **USERBLOCK_CLEAR.C**—This program clears the contents of the user block. Note that it does not clear the calibration constants or the system ID block.

  When you run this sample program in the Program Mode, there is a 300 ms timer delay after each **writeUserBlock()** call to allow Dynamic C and the OP7200 to exchange a debug packet in order to inform the debug kernel that the OP7200 is still "alive." The timer delay is not necessary in the Run Mode with **nodebug** or when single-stepping.

4.4 OP7200 Libraries

The following library folders contain the libraries whose function calls are used to develop applications for the OP7200.

- **OP7200**—libraries associated with features specific to the OP7200. The functions in the **OP72xx.LIB** library are described in Section 4.5, "OP7200 Function APIs.".
- **DISPLAYS**—libraries associated with the LCD display. The **GLMENU.LIB** library provides function calls to display menus on the OP7200 LCD display.
- **KEYPADS**—libraries associated with the keypad. The **KEYPAD9.LIB** library provides function calls to keypad menus for the OP7200 keypad.
- **TOUCHSCREENS**—libraries associated with the touchscreen. The **GLTOUCHSCREEN.LIB** library allows you to link adjacent pixel locations on the LCD to create a button. The button can then be translated by the touchscreen when pressed. The **TS_R4096.LIB** library in the **TouchScreens** directory provides low-level touchscreen function calls.
- **RABBITNET**—libraries associated with the RabbitNet network. The **RN_CFG_OP72.LIB** library is used to configure the OP7200 for use as a master with RabbitNet peripheral cards. The function calls in the **RNET.LIB** library are used to set up the RabbitNet network, and are described in Appendix D. Each RabbitNet I/O card also has its own library in this folder, and these function calls are described in the user's manual for each I/O card.

Call the libraries you intend to use in the following order.

```
#use "OP72xx.LIB"
#use "GLMENU.LIB"
#use "KEYPAD9.LIB"
#use "RN_CFG_OP72.LIB"
#use "NET.LIB"
```

Finally, call the library or libraries associated with the RabbitNet I/O card(s) in your RabbitNet system, for example, **#use "RNET_DIO.LIB"** for the RabbitNet digital I/O card

Other generic functions applicable to all devices based on the Rabbit 2000 microprocessor are described in the ***Dynamic C Function Reference Manual***.

4.5 OP7200 Function APIs

4.5.1 Board Initialization

```
void brdInit (void);
```

Call this function at the beginning of your program. This function initializes the system I/O ports and loads all the A/D converter calibration constants from flash memory into SRAM for use by your program. This function will turn off LED DS1 (Microprocessor Bad) to indicate that the initialization was successful.

The ports are initialized according to Table A-3.

4.5.2 Digital I/O

void digOutConfig(char outputMode);

This functions is used to configure the high-current outputs as either a sinking or a sourcing type output. Note that **brdInit** must be executed before calling this function.

PARAMETERS

outputMode is an 8-bit parameter where each bit corresponds to a high-current output:

Bit 7 = OUT7
Bit 6 = OUT6
Bit 5 = OUT5
Bit 4 = OUT4
Bit 3 = OUT3
Bit 2 = OUT2
Bit 1 = OUT1
Bit 0 = OUT0

To set the outputs, set the corresponding bit to one of the following states:

0 = Sinking type circuit
1 = Sourcing type circuit

EXAMPLE

```
digOutConfig(0x81);
        // OUT0 and OUT7 are sourcing, OUT1-OUNT6 are sinking
```

SEE ALSO

brdInit, digIn, digOut, triStateConfig, digOutTriState

void digOut(int channel, int state);

Sets the state of a digital output (OUT0–OUT7).

The output channel is set to the state that is specified. If the output is configured as sinking, set to 0 for the driver to be sinking, or set to 1 for the driver to be OFF (high-impedance state). If the output is configured as sourcing, set to 0 for the driver to be OFF (high-impedance state), or set to 1 for the driver to be sourcing.

Remember to call **brdInit** and **digOutConfig** before executing this function.

A runtime error will occur for the following conditions:

1. **channel** or **state** out of range.
2. **brdInit** or **digOutConfig** was not executed before executing **digOut**.
3. Your tried to use a channel configured as a tri-state output.

PARAMETERS

channel is the output channel number (0–7).

state is the output value (0 or 1).

SEE ALSO

brdInit, digOutConfig, triStateConfig, digOutTriState

void digTriStateConfig(char triState);

Allows a given channel to be configured as a tristate type output. When a channel is configured as a tristate output, then **digOutTriState** can be used to control that channel.

A run-time error will occur for the following conditions:

1. **digOut** is disabled from controlling any channel that is configured as a tristate output.
2. **brdInit** was not executed before executing **digTriStateConfig**.

PARAMETER

triState is an 8-bit parameter where each bit corresponds to a high-current output:

Bit 7 = OUT7
Bit 6 = OUT6
Bit 5 = OUT5
Bit 4 = OUT4
Bit 3 = OUT3
Bit 2 = OUT2
Bit 1 = OUT1
Bit 0 = OUT0

To set the outputs, set the corresponding bit to one of the following states:

0 = tristate operation disabled
1 = tristate operation enabled

EXAMPLE

```
digTriStateConfig(0x02);  // OUT1 tristate is enabled,
                          // Out0, OUT2-OUNT7 tristate are disabled
```

SEE ALSO

brdInit, digIn, digOutConfig, digOut, digOutTriState

void digOutTriState(int channel, int state);

Sets the state of a digital output channel (OUT0–OUT7).

This function is intended to control a given channel as a tristate output, for example:

0 = Active low state (GND potential)
1 = Active High state (+K potential)
2 = High-Impedance state.

Since switching from one state to another has some software overhead, the switching delay should be less than 1 µs.

A run-time error will occur for the following conditions:

1. **channel** or **state** out of range.
2. **brdInit** or **digTriStateConfig** was not executed before executing **digOutTriState**.
3. Your tried to use a channel that is not configured as a tristate output.

PARAMETERS

channel is the output channel number (0–7).

state is set to one of the following output states.

0 = Active Low.
1 = Active High
2 = High-Impedance state.

SEE ALSO

brdInit, digIn, digOutConfig, digOut, triStateConfig

int digIn(int channel);

Reads the state of an input channel (IN0–IN18 for OP7200, IN0–IN15 for OP7210).

A run-time error will occur for the following conditions:

1. **channel** out of range.
2. **brdInit** was not executed before executing **digIn**.

PARAMETER

channel is the input channel number (0–18 or 0–15)

RETURN VALUE

The logic state of the input (0 or 1).

SEE ALSO

brdInit, digOut

4.5.3 LEDs

`void ledOut(int led, int value)`

Turns LED DS1 (Microprocessor Bad) on or off.

> **NOTE:** Once the **`brdInit`** function executes, then the Microprocessor Bad indicator is available for other use in the application.

PARAMETERS

`led` is the LED to control

0 = LED DS1 (Microprocessor Bad indicator)

`value` is used to control whether the LED is on or off

0 = OFF
1 = ON

SEE ALSO

`brdInit`

4.5.4 Serial Communication

Library files included with Dynamic C provide a full range of serial communication support. The **RS232.LIB** library provides a set of circular-buffer-based serial functions. The **PACKET.LIB** library provides packet-based serial functions where packets can be delimited by the 9th bit, by transmission gaps, or with user-defined special characters. Both libraries provide blocking functions, which do not return until they are finished transmitting or receiving, and nonblocking functions, which must be called repeatedly until they are finished. For more information, see the ***Dynamic C Function Reference Manual*** and Technical Note 213, ***Rabbit 2000 Serial Port Software***.

If you are planning to use any of the RS-232 serial ports ***and*** the RabbitNet port on the OP7200, initialize the serial port(s) ***before*** you initialize the RabbitNet port. The following sample code illustrates this sequence.

```
// Initialize Serial Port C, set baud rate to 19200
serCopen(19200);
serCwrFlush();
serCrdFlush();

// Initialize Serial Port D, set baud rate to 19200
serDopen(19200);
serDwrFlush();
serDrdFlush();

// Set serial mode...must be done after serXopen function(s)
and before Rabbitnet initialization
serMode(0);

// Initialize RabbitNet port
rn_init(RN_PORTS, 1);
```

Use the following function calls with the OP7200. Note that Serial Port B is used for both RS-485 and the RabbitNet port, so that RS-485 is no longer available once you have configured Serial Port B as a RabbitNet port.

int serMode(int mode);

User interface to set up OP7200 serial communication lines. Call this function after **serXOpen()**.

Whether you are opening one or multiple serial ports, this function must be executed after executing the last **serXOpen** function AND before you start using any of the serial ports. This function is non-reentrant.

If Mode 1 or Mode 3 is selected, CTS/RTS flow control is exercised using the **serCflowcontrolOn** and **serCflowcontrolOff** functions from the **RS232.LIB** library.

PARAMETER

mode is the defined serial port configuration.

Mode	Serial Port		
	B	C	D
0	RS-485	RS-232, 3-wire	RS-232, 3-wire
1	RS-485	RS-232, 5-wire	CTS/RTS
2	not initialized*	RS-232, 3-wire	RS-232, 3-wire
3	not initialized*	RS-232, 5-wire	CTS/RTS

* Use modes 2 and 3 when Serial Port B is going to used by other libraries such as **PACKET.LIB**.

RETURN VALUE

0 if valid mode, 1 if not.

SEE ALSO

ser485Tx, ser485Rx

void ser485Tx(void);

Enables the RS-485 transmitter. Transmitted data get echo'ed back into the receive data buffer. These echo'ed data could be used to know when to disable the transmitter by using one of the following methods:

Byte mode—disable the transmitter after the same byte that is transmitted is detected in the receive data buffer.

Block data mode—disable the transmitter after the same number of bytes transmitted is detected in the receive data buffer.

serMode() must be executed before running this function.

SEE ALSO

serMode, ser485Rx

void ser485Rx(void);

Disables the RS-485 transmitter. This puts the OP7200 in listen mode, which allows it to receive data from the RS-485 interface. **serMode()** must be executed before running this function.

SEE ALSO

serMode, ser485Tx

4.5.5 A/D Converter Inputs (OP7200 only)

```
unsigned int anaIn(int channel, int opmode,
   int gaincode);
```

Reads the state of an analog input channel.

PARAMETERS

`channel` is the analog input channel number (0 to 7) corresponding to AIN0–AIN7:

`channel`	Single-Ended Input	Differential Input
0	+AIN0	+AIN0 -AIN1
1	+AIN1	—
2	+AIN2	+AIN2 -AIN3
3	+AIN3	—
4	+AIN4	+AIN4 -AIN5
5	+AIN5	—
6	+AIN6	+AIN6 -AIN7
7	+AIN7	—

`opmode` is the mode of operation:

`0` = **`SE_MODE`**—single-ended input line
`1` = **`DIFF_MODE`**—differential input line
`2` = **`mAMP_MODE`**—4–20 mA input line

`gaincode` is the gain code of 0 to 7 for both single-ended and differential measurements:

Gain Code	Macro	Gain
0	`GAIN_X1`	×1
1	`GAIN_X2`	×2
2	`GAIN_X4`	×4
3	`GAIN_X5`	×5
4	`GAIN_X8`	×8
5	`GAIN_X10`	×10
6	`GAIN_X16`	×16
7	`GAIN_X20`	×20

RETURN VALUE

A value corresponding to the voltage on the analog input channel, which will be:

0–2047 for 11-bit A/D conversions (signed 12th bit)

SEE ALSO

`anaInVolts, anaInCalib, brdInit, anaInmAmps, anaInDiff`

```
int anaInCalib(int channel, int opmode,
   int gaincode, int value1, float volts1,
   int value2, float volts2);
```

Calibrates the response of the A/D converter channel as a linear function using the two conversion points provided. Four values are calculated and placed into global table **_adcCalib** to be stored later into using the function **anaInEEWr()**. Each channel will have the following information:

a linear constant,

a voltage offset,

a calculation gain code used to calculate calibrations, and

a user gain code to set voltage range (defaults to the calculation gain code).

PARAMETERS

channel is the analog input channel number (0 to 7) corresponding to AIN0–AIN7:

channel	Single-Ended Input	Differential Input
0	+AIN0	+AIN0 -AIN1
1	+AIN1	—
2	+AIN2	+AIN2 -AIN3
3	+AIN3	—
4	+AIN4	+AIN4 -AIN5
5	+AIN5	—
6	+AIN6	+AIN6 -AIN7
7	+AIN7	—

opmode is the mode of operation:

0 = **SE_MODE**—single-ended input line

1 = **DIFF_MODE**—differential input line

2 = **mAMP_MODE**—4–20 mA input line

gaincode is the gain code of 0 to 7 for both single-ended and differential measurements:

Gain Code	Macro	Gain
0	GAIN_X1	×1
1	GAIN_X2	×2
2	GAIN_X4	×4
3	GAIN_X5	×5
4	GAIN_X8	×8
5	GAIN_X10	×10
6	GAIN_X16	×16
7	GAIN_X20	×20

value1 is the first A/D converter channel value (0–2047).

volts1 is the voltage or current corresponding to the first A/D converter channel value.

value2 is the second A/D converter channel value (0–2047).

volts2 is the voltage or current corresponding to the first A/D converter channel value.

RETURN VALUE

0 if successful.

-1 if not able to make calibration constants.

SEE ALSO

anaIn, anaInVolts, brdInit, anaInmAmps, anaInDiff, anaInEERd, anaInEEWr

`float anaInVolts(int channel, int gaincode);`

Reads the state of a single-ended analog input channel and uses the previously set calibration constants to convert the reading to volts.

PARAMETERS

`channel` is the analog input channel number (0 to 7) corresponding to AIN0–AIN7:

`channel`	Single-Ended Input
0	+AIN0
1	+AIN1
2	+AIN2
3	+AIN3
4	+AIN4
5	+AIN5
6	+AIN6
7	+AIN7

`gaincode` is the gain code of 0 to 7 for both single-ended and differential measurements:

Gain Code	Macro	Gain	Voltage Range
0	`GAIN_X1`	×1	0–20 V
1	`GAIN_X2`	×2	0–10 V
2	`GAIN_X4`	×4	0–5 V
3	`GAIN_X5`	×5	0–4 V
4	`GAIN_X8`	×8	0–2.5 V
5	`GAIN_X10`	×10	0–2 V
6	`GAIN_X16`	×16	0–1.25 V
7	`GAIN_X20`	×20	0–1 V

RETURN VALUE

A voltage value corresponding to the voltage on the analog input channel.

SEE ALSO

`anaInCalib, anaIn, brdInit, anaInmAmps, anaInDiff`

```
float anaInDiff(unsigned int channel,
   unsigned int gaincode);
```

Reads the state of a differential analog input channel and uses the previously set calibration constants to convert it to volts.

PARAMETERS

`channel` is the channel number (0, 2, 4, 6):

Channel	Differential Input Lines
0	+AIN0 -AIN1
2	+AIN2 -AIN3
4	+AIN4 -AIN5
6	+AIN6 -AIN7

`gaincode` is the gain code of 0 to 7:

Gain Code	Macro	Gain	Voltage Range
0	`GAIN_X1`	×1	-20 to 20 V
1	`GAIN_X2`	×2	-10 to 10 V
2	`GAIN_X4`	×4	-5 to 5 V
3	`GAIN_X5`	×5	-4 to 4 V
4	`GAIN_X8`	×8	-2.5 to 2.5 V
5	`GAIN_X10`	×10	-2 to 2 V
6	`GAIN_X16`	×16	-1.25 to 1.25 V
7	`GAIN_X20`	×20	-1 to 1V

RETURN VALUE

A voltage value corresponding to the voltage on the analog input channel.

SEE ALSO

`brdInit, anaInCalib, anaIn, anaInVolts, anaInmAmps`

`int anaInmAmps(unsigned int channel);`

Reads the state of an analog input channel and uses the previously set calibration constants to convert it to current.

PARAMETER

`channel` is 0–7:

Channel	4–20 mA Input Lines
0	AIN0
1	AIN1
2	AIN2
3	AIN3
4	AIN4
5	AIN5
6	AIN6
7	AIN7

RETURN VALUE

A current value between 4–20 mA (0.004 and 0.020 A) corresponding to the current on the analog input channel.

SEE ALSO

`brdInit, anaInCalib, anaIn, anaInVolts, anaInDiff`

int anaInEERd(unsigned int channel, int opmode, unsigned int gaincode);

Reads the calibration constants, gain, and offset for an input based on its designated channel code position into global table **_adcCalib**. The constants are stored in the top 1K of the reserved user block memory area. Use the sample program **USERBLOCKINFOR.C** in **SAMPLES\OP7200** to get the addresses reserved for the calibration data constants and the addresses available for use by your program.

NOTE: This function cannot be run in RAM.

PARAMETERS

channel is the analog input channel number (0 to 7) corresponding to AIN0–AIN7:

channel	Single-Ended Input	Differential Input
0	+AIN0	+AIN0 -AIN1
1	+AIN1	—
2	+AIN2	+AIN2 -AIN3
3	+AIN3	—
4	+AIN4	+AIN4 -AIN5
5	+AIN5	—
6	+AIN6	+AIN6 -AIN7
7	+AIN7	—
-1	**ALL_CHANNELS**	**ALL_CHANNELS**

opmode is the mode of operation:

0 = **SE_MODE**—single-ended input line
1 = **DIFF_MODE**—differential input line
2 = **mAMP_MODE**—4–20 mA input line

gaincode is the gain code of 0 to 7 for both single-ended and differential measurements:

Gain Code	Macro	Gain
0	**GAIN_X1**	×1
1	**GAIN_X2**	×2
2	**GAIN_X4**	×4
3	**GAIN_X5**	×5
4	**GAIN_X8**	×8
5	**GAIN_X10**	×10
6	**GAIN_X16**	×16
7	**GAIN_X20**	×20

RETURN VALUE

0 if successful.

-1 if address is invalid or out of range.

SEE ALSO

`anaInEEWr, anaInCalib, brdInit`

int anaInEEWr(unsigned int channel, int opmode, unsigned int gaincode);

Writes the calibration constants, gain, and offset for an input based on its designated channel code position from global table **_adcCalib**. The constants are stored in the top 1K of the reserved user block memory area. Use the sample program **USERBLOCKINFOR.C** in **SAMPLES\OP7200** to get the addresses reserved for the calibration data constants and the addresses available for use by your program.

NOTE: This function cannot be run in RAM.

channel is the analog input channel number (0 to 7) corresponding to AIN0–AIN7:

channel	Single-Ended Input	Differential Input
0	+AIN0	+AIN0 -AIN1
1	+AIN1	—
2	+AIN2	+AIN2 -AIN3
3	+AIN3	—
4	+AIN4	+AIN4 -AIN5
5	+AIN5	—
6	+AIN6	+AIN6 -AIN7
7	+AIN7	—
-1	ALL_CHANNELS	ALL_CHANNELS

opmode is the mode of operation:

0 = **SE_MODE**—single-ended input line
1 = **DIFF_MODE**—differential input line
2 = **mAMP_MODE**—4–20 mA input line

gaincode is the gain code of 0 to 7 for both single-ended and differential measurements:

Gain Code	Macro	Gain
0	GAIN_X1	×1
1	GAIN_X2	×2
2	GAIN_X4	×4
3	GAIN_X5	×5
4	GAIN_X8	×8
5	GAIN_X10	×10
6	GAIN_X16	×16
7	GAIN_X20	×20

RETURN VALUE

0 if successful.

-1 if address is invalid or out of range.

SEE ALSO

`anaInEERd, brdInit`

4.5.6 Graphic Display Functions

4.5.6.1 On-Screen Menus

The **GLMENU.LIB** library in the **LIB\DISPLAYS\GRAPHIC** directory provides function calls to display menus on the OP7200 LCD display. When *x* and *y* coordinates on the display screen are specified, *x* can range from 0 to 319, and *y* can range from 0 to 239. These numbers represent pixels counted from the top left corner of the display.

```
int glMenuInit(windowMenu *menu, fontInfo *pFont,
   int border, int shadow, char **menu_options,
   char* title, maxOptDisplayed);
```

Initializes a menu structure with the required parameters to automatically build and display a text menu when the **glMenu** function is executed.

PARAMETERS

menu is a pointer to the **windowMenu** descriptor

pFont is a pointer to the **fontInfo** descriptor

border describes the menu border options:

0 = **NO_BORDER**, no border drawn

1 = **SINGLE_LINE**, draw a single-line border around the text menu

2 = **DOUBLE_LINE**, draw a double-line border around the text menu

shadow describes the menu shadow options:

0 = **NO_SHADOW**, no shadowing provided

1 = **SHADOWING**, shadowing is provided on the menu

menu_options is a pointer to the list of menu options—here is an example of a list of options for the menu system:

```
// Menu options........set as needed for your application
const char *main_menu [] =
     {
     "1.Increase Menu size",
     "2.Decrease Menu size",
     "3.Backlight menu",
     ""
     };
```

It is possible to insert or delete menu options. The highlight bar is set up to start with the first menu option and stop at the last menu option in the menu.

When adding or deleting menu options you must match up the case statements to the menu option number.

title is the menu title

ASCII string = title

null string = no title

maxOptDisplayed indicates the maximum number of options to be displayed by the menu:

-1 = forces all options to be displayed

>0 = menu box will only display the number of options indicated, which will require the user to use the scroll keys to bring an option into the menu box view area for the selection

RETURN VALUE

0 = success

-1 = **border** parameter value is invalid

SEE ALSO

glMenu, glMenuClear, glRefreshMenu

int glMenu(windowMenu *mPtr, int *state, int x, int y);

Displays a menu on the LCD display and get the menu options from the user.

> **NOTE:** This function will display an error message on the LCD if the menu width or height exceeds the LCD display boundaries.

PARAMETERS

mPtr is a pointer to structure that contains the information for the menu

state is a pointer to the menu control parameter. The **state** parameters are as follows:

0 = **MENU_INIT**, initialize and display menu

1 = **MENU_NO_CHANGE**, return to selected option, no changes to menu or highlight bar.

2 = **MENU_REFRESH**, display the last image of the menu, including the location of the highlight bar.

x is the *x* coordinate of where the text menu is to start

y is the *y* coordinate of where the text menu is to start

RETURN VALUE

0 = no option is selected

>0 = option the user has selected

-1 = menu has exceeded LCD screen width

-2 = menu has exceeded LCD screen height

SEE ALSO

glMenuInit, glMenuClear, glRefreshMenu

void glRefreshMenu(windowMenu *mPtr);

Refreshes the menu indicated by the **WindowMenu** pointer.

PARAMETER

mPtr is a **windowMenu** descriptor pointer

RETURN VALUE

None.

SEE ALSO

glMenuInit, glMenu, glMenuClear

glMenuClear(windowMenu *mPtr);

Clears the menu indicated by the **WindowMenu** descriptor pointer.

PARAMETER

mPtr is a **windowMenu** descriptor pointer

RETURN VALUE

None.

SEE ALSO

glRefreshMenu, glMenu, glMenuInit

4.5.6.2 Graphic Drawing Routines

The **GRAPHIC.LIB** library in the **DISPLAYS\GRAPHIC** directory provides function calls for primitive graphic drawing routines such as lines, circles, and polygons.

void glInit(void);

Initializes the display devices, clears the screen. This function call must be made prior to any other graphic function calls.

SEE ALSO

glDispOnOFF, glBacklight, glSetContrast, glPlotDot, glBlock, glPlotPolygon, glPlotCircle, glHScroll, glVScroll, glXFontInit, glPrintf, glPutChar, glSetBrushType, glBuffLock, glBuffUnlock, glPlotLine

void glBuffLock(void);

Increments LCD screen-locking counter. Graphics calls are recorded in the LCD memory buffer, and are not transferred to the LCD if the counter is non-zero.

> **NOTE:** Functions **glBuffLock()** and **glBuffUnlock()** can be nested up to a level of 255, but be sure to balance the calls. It is not a requirement to use these procedures, but a set of **glBuffLock()** and **glBuffUnlock()** bracketing a set of related graphics calls significantly speeds up the rendering.

SEE ALSO

glBuffUnlock, glSwap

void glBuffUnlock(void);

Decrements LCD screen-locking counter. The contents of the LCD buffer are transferred to the LCD if the counter goes to zero.

SEE ALSO

glBuffLock, glSwap

void glSwap(void);

Checks the LCD screen-locking counter. The contents of the LCD buffer are transferred to the LCD if the counter is zero.

SEE ALSO

glBuffLock, glBuffUnlock

void glFillScreen(int pattern);

Fills the LCD display screen with a pattern.

PARAMETER

pattern

0xFF = all black

0x00 = all white

anything else = vertical stripes

SEE ALSO

glBlock, glBlankScreen, glPlotPolygon, glPlotCircle

void glBlankScreen(void);

Blanks (sets to white) the LCD display screen.

SEE ALSO

glFillScreen, glBlock, glPlotPolygon, glPlotCircle

void glSetBrushType(int type);

Sets the drawing method (or color) of pixels drawn by subsequent graphics calls.

PARAMETER

type is the value can be one of the following macros:

PIXBLACK draws black pixels

PIXWHITE draws white pixels

PIXXOR draws old pixel XOR'ed with the new pixel

SEE ALSO

glGetBrushType

void glGetBrushType(void);

Gets the current method (or color) of pixels drawn by subsequent graphics calls.

RETURN VALUE

The current brush type.

SEE ALSO

`glSetBrushType`

void glPlotDot(int x, int y);

Draws a single pixel in the LCD buffer, and on the LCD if the buffer is unlocked.

If the coordinates are outside the LCD display area, the dot will not be plotted.

PARAMETERS

`x` is the *x* coordinate of the dot

`y` is the *y* coordinate of the dot

SEE ALSO

`glPlotline, glPlotPolygon, glPlotCircle`

void glPlotLine(int x0, int y0, int x1, int y1);

Draws a line in the LCD buffer, and on the LCD if the buffer is unlocked.

Any portion of the line that is beyond the LCD display area will be clipped.

PARAMETERS

`x0` is the *x* coordinate of one endpoint of the line

`y0` is the *y* coordinate of one endpoint of the line

`x1` is the *x* coordinate of the other endpoint of the line

`y1` is the *y* coordinate of the other endpoint of the line

SEE ALSO

`glPlotDot, glPlotPolygon, glPlotCircle`

void glBlock(int x, int y, int bmWidth, int bmHeight);

Draws a rectangular block in the page buffer, and on the LCD if the buffer is unlocked.

Any portion of the block that is outside the LCD display area will be clipped.

PARAMETER

x is the *x* coordinate of the upper left corner of the block

y is the *y* coordinate of the left top corner of the block

bmWidth is the width of the block

bmHeight is the height of the block

SEE ALSO

glFillScreen, glBlankScreen, glPlotPolygon, glPlotCircle

void glPlotPolygon(int n, int x1, int y1, int x2, int y2, ...);

Plots the outline of a polygon in the LCD page buffer, and on the LCD if the buffer is unlocked.

Any portion of the polygon that is outside the LCD display area will be clipped. The function will also return, doing nothing, if there are less than 3 vertices.

PARAMETERS

n is the number of vertices

x1 is the *x* coordinate of the first vertex

y1 is the *y* coordinate of the first vertex

x2 is the *x* coordinate of the second vertex

y2 is the *y* coordinate of the second vertex

... coordinates of additional vertices

SEE ALSO

glPlotVPolygon, glFillPolygon, glFillVPolygon

void glFillPolygon(int n, int x1, int y1, int x2, int y2, ...);

Draws a filled polygon in the LCD page buffer, and on the LCD if the buffer is unlocked.

Any portion of the polygon that is outside the LCD display area will be clipped. The function will also return, doing nothing, if there are less than 3 vertices.

PARAMETERS

n is the number of vertices

x1 is the *x* coordinate of the first vertex

y1 is the *y* coordinate of the first vertex

x2 is the *x* coordinate of the second vertex

y2 is the *y* coordinate of the second vertex

... coordinates of additional vertices

SEE ALSO

glFillVPolygon, glPlotPolygon, glPlotVPolygon

void glPlotVPolygon(int n, int *pFirstCoord);

Plots the outline of a polygon in the LCD page buffer, and on the LCD if the buffer is unlocked.

Any portion of the polygon that is outside the LCD display area will be clipped. The function will also return, doing nothing, if there are less than 3 vertices.

PARAMETERS

n is the number of vertices

pFirstCoord is a pointer to an array of vertex coordinates **x1,y1**, **x2,y2**, **x3,y3**, **...**

SEE ALSO

glPlotPolygon, glFillPolygon, glFillVPolygon

void glFillVPolygon(int n, int *pFirstCoord);

Draws a filled polygon in the LCD page buffer, and on the LCD if the buffer is unlocked.

Any portion of the polygon that is outside the LCD display area will be clipped. The function will also return, doing nothing, if there are less than 3 vertices.

PARAMETERS

n is the number of vertices

pFirstCoord is a pointer to an array of vertex coordinates **x1,y1**, **x2,y2**, **x3,y3**, **...**

SEE ALSO

glFillPolygon, glPlotPolygon, glPlotVPolygon

void glPlotCircle(int xc, int yc, int rad);

Draws a circle in the LCD page buffer, and on the LCD if the buffer is unlocked.

Any portion of the circle that is outside the LCD display area will be clipped.

PARAMETERS

xc is the *x* coordinate of the center of the circle

yc is the *y* coordinate of the center of the circle

rad is the radius of the circle (in pixels)

SEE ALSO

glFillCircle, glPlotPolygon, glFillPolygon

void glFillCircle(int xc, int yc, int rad);

Draws a filled circle in the LCD page buffer, and on the LCD if the buffer is unlocked.

Any portion of the circle that is outside the LCD display area will be clipped.

PARAMETERS

xc is the *x* coordinate of the center of the circle

yc is the *y* coordinate of the center of the circle

rad is the radius of the circle (in pixels)

SEE ALSO

glPlotCircle, glPlotPolygon, glFillPolygon

void glXFontInit(fontInfo *pInfo, char pixWidth, char pixHeight, unsigned startChar, unsigned endChar, unsigned long xmemBuffer);

Initializes the font descriptor structure, where the font is stored in **xmem**. Each font character's bitmap is column-major and byte-aligned.

PARAMETERS

pInfo is a pointer to the font descriptor to be initialized

pixWidth is the width of each font item (in pixels)

pixHeight is the height of each font item (in pixels)

startChar is the value of the first printable character in the font character set

endChar is the value of the last printable character in the font character set

xmemBuffer is an **xmem** address of the pointer to a linear array of font bitmaps

SEE ALSO

glPrinf

void glPrintf(int x, int y, fontInfo *pInfo, char *fmt, ...);

Prints a formatted string (much like **printf**) on the LCD screen. Only the character codes that exist in the font set are printed, all others are skipped over. For example, **'\b'**, **'\t'**, **'\n'**, and **'\r'** (ASCII backspace, tab, new line, and carriage return, respectively) will be printed if they exist in the font set, but will not have any effect as control characters.

Any portion of the bitmap character that is outside the LCD display area will be clipped.

PARAMETERS

x is the *x* coordinate (column) of the upper left corner of the text

y is the *y* coordinate (row) of the left top corner of the text

pInfo is a pointer to the window frame descriptor

fmt is a formatted string

... is a formatted string of conversion parameter(s)

EXAMPLE

```
glprintf(0,0, &fi12x16, "Test %d\n", count);
```

SEE ALSO

glXFontInit

void glSetPfStep(int stepX, int stepY);

Sets the **glPrintf()** printing step direction. The *x* and *y* step directions are independent signed values. The actual step increments depend on the height and width of the font being displayed, which are multiplied by the step values.

Use **glGetPfStep()** to examine the current *x* and *y* printing step direction.

PARAMETERS

stepX is the **glPrintf** *x* step value

stepY is the **glPrintf** *y* step value

SEE ALSO

glGetPfStep

void glGetPfStep(void);

Gets the current **glPrintf()** printing step direction. Each step direction is independent of the other, and is treated as an 8-bit signed value. The actual step increments depends on the height and width of the font being displayed, which are multiplied by the step values.

Use **glSetPfStep()** to control the *x* and *y* printing step direction.

RETURN VALUE

The *x* step is returned in the MSB, and the *y* step is returned in the LSB of the integer result.

SEE ALSO

glSetPfStep

unsigned long glFontCharAddr(fontInfo *pInfo, char letter);

Returns the **xmem** address of a character from the specified font set.

PARAMETERS

pInfo is the **xmem** address of the bitmap font set

latter is an ASCII character

RETURN VALUE

The **xmem** address of the bitmap character font, column-major and byte-aligned.

SEE ALSO

glPutFont, glPrintf

void glPutFont(int x, int y, fontInfo *pInfo, char code);

Puts an entry from the font table to the page buffer, and on the LCD if the buffer is unlocked. Each font character's bitmap is column-major and byte-aligned.

Any portion of the bitmap character that is outside the LCD display area will be clipped.

PARAMETERS

x is the *x* coordinate (column) of the upper left corner of the text

y is the *y* coordinate (row) of the left top corner of the text

pInfo is a pointer to the window frame descriptor

code is the ASCII character to display

SEE ALSO

glFontCharAddr, glPrintf

void glPutChar(char ch, char *ptr, int *cnt, glPutCharInst *pInst)

Provides an interface between the **STDIO** string handling functions and the graphic library. The **STDIO** string formatting function will call this function, one character at a time, until the entire formatted string has been parsed.

Any portion of the bitmap character that is outside the LCD display area will be clipped.

PARAMETERS

ch is the character to be displayed on the LCD

ptr is not used, and is a place holder due to the **STDIO** string functions

cnt is not used, and is a place holder due to the **STDIO** string functions

pInfo is a pointer to the window frame descriptor

SEE ALSO

glPrintf, glPutFont

int TextWindowFrame(windowFrame *window, fontInfo *pFont, int x, int y, int winWidth, int winHeight)

Defines a text-only display window. This function provides a way to display characters within the text window only using character row and column coordinates.

The text window feature provides end-of-line wrapping and clipping after the character in the last column and row is displayed.

> **NOTE:** Be sure to execute the **TextWindowFrame** function before using any of the text-only functions (**TextGotoXY**, **TextPutChar**, **TextPrintf**, **TextCursorLocation**).

PARAMETERS

window is a pointer to the window frame

pFont is a pointer to the window frame descriptor

x is the *x* coordinate of where the text window frame is to start

y is the *y* coordinate where the text window frame is to start

winWidth is the width of the text window frame

winHeight is the height of the text window frame

RETURN VALUE

0 = window frame was successfully created

-1 = *x* coordinate + width has exceeded the display boundary

-2 = *y* coordinate + height has exceeded the display boundary

SEE ALSO

TextPutChar, TextPrintf, TextCursorLocation, TextGotoXY

void TextGotoXY(windowFrame *window, int col, int row);

Sets the cursor location on the display of where to display the next character. The display location is based on the height and width of the character to be displayed.

> **NOTE:** Be sure to execute the **TextWindowFrame** function before using any of the text-only functions (**TextGotoXY**, **TextPutChar**, **TextPrintf**, **TextCursorLocation**).

PARAMETERS

window is a pointer to the window frame

col is the character column location

row is the character row location

SEE ALSO

TextPutChar, TextPrintf, TextWindowFrame, TextCursorLocation

```
void TextCursorLocation(windowFrame *window,
   int *col, int *row);
```

Gets the current cursor location that was set by one of the graphic text functions.

> **NOTE:** Be sure to execute the **TextWindowFrame** function before using any of the text-only functions (**TextGotoXY**, **TextPutChar**, **TextPrintf**, **TextCursorLocation**).

PARAMETERS

window is a pointer to the window frame

col is a pointer to the cursor column variable

row is a pointer to the cursor row variable

RETURN VALUE

lower word = cursor row location

upper word = cursor column location

SEE ALSO

TextGotoXY, TextPrintf, TextWindowFrame, TextPutChar

```
void TextPutChar(struct windowFrame *window,
   char ch);
```

Displays a character on the display where the cursor is currently pointing. If any portion of the bitmap character is outside the LCD display area, the character will not to be displayed.

> **NOTE:** Be sure to execute the **TextWindowFrame** function before using any of the text-only functions (**TextGotoXY**, **TextPutChar**, **TextPrintf**, **TextCursorLocation**).

PARAMETERS

window is a pointer to the window frame

ch is the character to be displayed on the LCD

SEE ALSO

TextGotoXY, TextPrintf, TextWindowFrame, TextCursorLocation

void TextPrintf(struct windowFrame *window, char *fmt, ...);

This function prints a formatted string (much like **printf**) on the LCD screen. Only printable characters in the font set are printed; escape sequences **'\r'** and **'\n'** are also recognized. All other escape sequences will be skipped over. For example, nothing will be displayed for **'\b'** and **'t'**.

The text window feature provides end-of-line wrapping and clipping after the character in the last column and row is displayed.

> **NOTE:** Be sure to execute the **TextWindowFrame** function before using any of the text-only functions (**TextGotoXY**, **TextPutChar**, **TextPrintf**, **TextCursorLocation**).

PARAMETERS

window is a pointer to the window frame

fmt is a formatted string

... formatted-string conversion parameter(s)

EXAMPLE

```
TextPrintf(&TextWindow, "Test %d\n", count);
```

SEE ALSO

TextGotoXY, TextPutChar, TextWindowFrame, TextCursorLocation

void glLeft1(int left, int top, int cols, int rows);

Scrolls byte-aligned window left one pixel, right column filled by current pixel type (color).

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

cols is the number of columns in the window, must be evenly divisible by 8

rows is the number of rows in the window

SEE ALSO

glHScroll, glRight1

void glRight1(int left, int top, int cols, int rows);

Scrolls byte-aligned window right one pixel, left column filled by current pixel type (color).

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

cols is the number of columns in the window, must be evenly divisible by 8

rows is the number of rows in the window

SEE ALSO

glHScroll, glLeft1

void glHScroll(int left, int top, int cols, int rows, int nPix);

Scrolls right or left within the defined window by **nPix** number of pixels. The opposite edge of the scrolled window will be filled in with white pixels. The window must be byte-aligned.

Parameters will be verified for the following:

1. The **left** and **column** parameters will be verified that they are evenly divisible by 8. If not, they will be changed to be a value that is a multiple of 8.
2. Parameters will be checked to verify that the scrolling area is valid. The minimum scrolling area is a width of 8 pixels and a height of one row.

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

cols is the number of columns in the window, must be evenly divisible by 8

rows is the number of rows in the window

nPix is the number of pixels to scroll within the defined window (negative value to scroll left)

SEE ALSO

`glVScroll`

void glUp1(int left, int top, int cols, int rows);

Scrolls byte-aligned window up one pixel, bottom row filled by current pixel type (color).

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

cols is the number of columns in the window, must be evenly divisible by 8

rows is the number of rows in the window

SEE ALSO

`glVScroll, glDown1`

void glDown1(int left, int top, int cols, int rows);

Scrolls byte-aligned window down one pixel, top row filled by current pixel type (color).

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

cols is the number of columns in the window, must be evenly divisible by 8

rows is the number of rows in the window

SEE ALSO

`glVScroll, glUp1`

void glVScroll(int left, int top, int cols, int rows, int nPix);

Scrolls up or down within the defined window by **nPix** number of pixels. The opposite edge of the scrolled window will be filled in with white pixels. The window must be byte-aligned.

Parameters will be verified for the following:

1. The **left** and **column** parameters will be verified that they are evenly divisible by 8. If not, they will be changed to be a value that is a multiple of 8.
2. Parameters will be checked to verify that the scrolling area is valid. The minimum scrolling area is a width of 8 pixels and a height of one row.

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

cols is the number of columns in the window, must be evenly divisible by 8

rows is the number of rows in the window

nPix is the number of pixels to scroll within the defined window (negative value to scroll up)

SEE ALSO

glHScroll

void glXPutBitmap(int left, int top, int width, int height, unsigned long bitmap);

Draws bitmap in the specified space. The data for the bitmap are stored in **xmem**. This function automatically calls **glXPutFastmap** if the bitmap is byte-aligned (left edge and width are each evenly divisible by 8).

Any portion of a bitmap image or character that is outside the LCD display area will be clipped.

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

width is the width of the bitmap

height is the height of the bitmap

bitmap is the address of the bitmap in **xmem**

SEE ALSO

glXPutFastmap, glPrintf

void glXPutFastmap(int left, int top, int width, int height, unsigned long bitmap);

Draws bitmap in the specified space. The data for the bitmap are stored in **xmem**. This is like **glXPutBitmap**, except that it's faster. The restriction is that the bitmap must be byte-aligned.

Any portion of a bitmap image or character that is outside the LCD display area will be clipped.

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

width is the width of the bitmap

height is the height of the bitmap

bitmap is the address of the bitmap in **xmem**

SEE ALSO

glXPutBitmap, glPrintf

void glXGetBitmap(int x, int y, int bmWidth, int bmHeight, unsigned long xBm);

Gets a bitmap from the LCD page buffer and stores it in **xmem** RAM. This function automatically calls **glXGetFastmap** if the bitmap is byte-aligned (left edge and width are each evenly divisible by 8).

PARAMETERS

x is the *x* coordinate of the left edge of the bitmap (in pixels)

y is the *y* coordinate of the top edge of the bitmap (in pixels)

bmWidth is the width of the bitmap (in pixels)

bmHeight is the height of the bitmap (in pixels)

xBm is the address of the bitmap in **xmem** RAM

SEE ALSO

glXPutFastmap, glPrintf

void glXGetFastmap(int left, int top, int width, int height, unsigned long xmemptr);

Draws bitmap in the specified space. The data for the bitmap are stored in **xmem**. This is like **glXPutBitmap**, except that it's faster. The restriction is that the bitmap must be byte-aligned.

Any portion of a bitmap image or character that is outside the LCD display area will be clipped.

PARAMETERS

left is the upper left corner of bitmap, must be evenly divisible by 8

top is the left top corner of the bitmap

width is the width of the bitmap

height is the height of the bitmap

xmemptr is the address of the bitmap in **xmem**

SEE ALSO

glXPutBitmap, glPrintf

void TextBorderInit(windowFrame *wPtr, int border, char *title);

Initializes the window frame structure with the border and title information. The **TextWindowFrame** function must be executed before running this function.

PARAMETERS

WindowFrame is a pointer to the window frame descriptor

border is the border style:

SINGLE_LINE—single-line border around the text window

DOUBLE_LINE—double-line border around the text window

title is a pointer to the title:

1. If a **NULL** string is detected, then no title is written to the text menu
2. If a string is detected, then it will be written to the top of the text menu box as the centered title

SEE ALSO

TextBorder, TextGotoXY, TextPutChar, TextWindowFrame,TextCursorLocation

void TextBorder(windowFrame *wPtr);

Displays the border for a given window frame. The **TextBorderInit** function must be executed before running this function.

This function will automatically adjust the text window parameters to accommodate the space taken by the text border. This adjustment will only occur once after the **TextBorderInit** function executes.

PARAMETER

wPtr is a pointer to the window frame descriptor

SEE ALSO

TextBorderInit, TextGotoXY, TextPutChar, TextWindowFrame, TextCursorLocation

void TextWinClear(windowFrame *wPtr);

Clears the entire area within the specified text window.

PARAMETER

wPtr is a pointer to the window frame descriptor

SEE ALSO

TextGotoXY, TextPrintf, TextWindowFrame, TextCursorLocation

int TextMaxChars(windowFrame *wPtr);

Returns the maximum number of characters that can be displayed within the text window. The **TextWindowFrame** function must be executed before running this function.

PARAMETER

wPtr is a pointer to the window frame descriptor

RETURN VALUE

The maximum number of characters that can be displayed within the text window.

SEE ALSO

TextGotoXY, TextPrintf, TextWindowFrame, TextCursorLocation

4.5.6.3 LCD Screen Control

The **SED1335F.LIB** library in the **DISPLAYS\GRAPHIC\320x240** directory provides low-level drivers for the SED1335F graphic chip.

> **NOTE:** Remember to call **glInit** from **GRAPHIC.LIB** before calling any of the functions described in this section.

void glAnimation(int OnOff);

Enables/disables the graphic animation mode. The animation mode is defaulted OFF when the graphic driver is executed.

> **NOTE:** The animation mode is intended to be used for special effects only. Raster lines may appear in your display image when this mode is turned on.

PARAMETER

0 = animation mode disabled
1 = animation mode enabled

SEE ALSO

GRAPHIC.LIB

void glRealtime(int OnOff);

Enables/disables the real-time mode for the **glPlotDot** function. The **glPlotDot** real-time mode is defaulted OFF when the graphic driver is executed.

PARAMETER

0 = real-time mode disabled
1 = real-time mode enabled

SEE ALSO

glPlotDot, GRAPHIC.LIB

void glBackLight(int onOff);

Turns the backlight on or off. The backlight is off by default when the OP7200 powers up.

PARAMETER

0 = backlight off
1 = backlight on

SEE ALSO

glSetContrast

void glSetContrast(int contrast);

Sets the LCD display contrast.

PARAMETER

contrast represents the contrast level (0 to 31 for low to high contrast), with a typical setting of 20.

SEE ALSO

glBacklight

void glDispOnOff(int onOff);

This function is not supported at the present time.

4.5.7 Keypad Functions

The **KEYPAD9.LIB** library in the **Keypads** directory provides function calls to keypad menus for the OP7200 keypad.

```
void keyInit(void);
```

Initializes keypad process

```
void keyConfig(char cRaw, char cPress,
   char cRelease, char cCntHold, char cSpdLo,
   char cCntLo, char cSpdHi);
```

Assigns each key with key press and release codes, and hold and repeat ticks for auto repeat and debouncing.

PARAMETERS

cRaw is a raw key code index.

3 × 4 keypad matrix with raw key code index assignments (in brackets):

[0]	[1]	[2]	[3]	[4]
	[5]	[6]	[7]	
		[8]		

User Keypad Interface

cPress is a key press code

An 8-bit value is returned when a key is pressed.
0 = Unused.

See **keypadDef()** for default press codes.

cRelease is a key release code.

An 8-bit value is returned when a key is pressed.
0 = Unused.

cCntHold is a hold tick.

How long to hold before repeating.
0 = No Repeat.

cSpdLo is a low-speed repeat tick.

How many times to repeat.
0 = None.

cCntLo is a low-speed hold tick.

How long to hold before going to high-speed repeat.
0 = Slow Only.

cSpdHi is a high-speed repeat tick.

How many times to repeat after low speed repeat.
0 = None.

RETURN VALUE

None.

SEE ALSO

keyProcess, keyGet, keypadDef

void keyProcess(void);

Scans and processes keypad data for key assignment, debouncing, press and release, and repeat.

NOTE: This function is also able to process an 8 × 8 matrix keypad.

RETURN VALUE

None

SEE ALSO

keyConfig, keyGet, keypadDef

char keyGet(void);

Get next keypress

RETURN VALUE

The next keypress, or 0 if none

SEE ALSO

keyConfig, keyProcess, keypadDef

void keypadDef();

Configures the physical layout of the keypad with the desired ASCII return key codes.

Keypad physical mapping 3 × 4

[B]	[+]	[U]	[-]	[S]
	[L]	[E]	[R]	
		[D]		

where

'E' represents the ENTER key
‘+’ represents Page Up
‘-’ represents Page Down
'D' represents Scroll Down
'U' represents Scroll Up
'L' represents Scroll Left
'R' represents Scroll Right
'S' represents Space
‘B’ represents Backspace

Example: Do the following for the above physical vs. ASCII return key codes.

```
keyConfig ( 6,'E',0, 0, 0, 0, 0 );
keyConfig ( 3,'-',0, 0, 0, 0, 0 );
keyConfig ( 1,'+',0, 0, 0, 0, 0 );
keyConfig ( 8,'D',0, 0, 0, 0, 0 );
keyConfig ( 2,'U',0, 0, 0, 0, 0 );
keyConfig ( 5,'L',0, 0, 0, 0, 0 );
keyConfig ( 7,'R',0, 0, 0, 0, 0 );
keyConfig ( 0,'B',0, 0, 0, 0, 0 );
keyConfig ( 4,'S',0, 0, 0, 0, 0 );
```

Characters are returned upon keypress with no repeat.

RETURN VALUE

None.

SEE ALSO

`keyConfig, keyGet, keyProcess`

void keyScan(char *pcKeys);

Writes "1" to each row and reads the value. The position of a keypress is indicated by a zero value in a bit position.

PARAMETER

`*pcKeys` is the address of the value read.

RETURN VALUE

None.

SEE ALSO

`keyConfig, keyGet, keypadDef, keyProcess`

4.6 Touchscreen (OP7200 only)

The **GLTOUCHSCREEN.LIB** library in the **TouchScreens** directory allows the user to link adjacent pixel locations on the LCD to create a button. The button can then be translated by the touchscreen when pressed.When *x* and *y* coordinates on the display screen are specified, *x* can range from 0 to 319, and *y* can range from 0 to 239. These numbers represent pixels from the top left corner of the display.

unsigned long btnInit(int MaxButtons);

Initializes the **GLTOUCHSCREEN.LIB** library, must be called at power-up before any other **GLTOUCHSCREEN.LIB** library functions can be used. This function allocates **xmem** SRAM for the storage of the button parameters.

PARAMETER

MaxButtons is the number of buttons to initialize

RETURN VALUE

The unsigned long memory location of the **BtnData** area

SEE ALSO

btnCreateText, btnCreateBitmap, btnRecall, btnStore, btnDisplay, btnDisplayLevel, btnClear, btnClearLevel, btnAttributes, btnMsgBox, btnDisplayText, btnClearRegion

int btnStore(unsigned long xmemPtr, int BtnID);

Stores the **btnData** structure in **xmem** SRAM. This function is normally called by **btnCreateText** or by **btnCreateBmp**.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

BtnID is the button ID number of wherethe structure will be stored

RETURN VALUE

1 when completed

SEE ALSO

btnRecall, btnInit, btnCreateText, btnCreateBitmap

int btnRecall(unsigned long xmemPtr, int BtnID);

Retrieves a **btnData** structure that was stored in **xmem** SRAM. This is function is normally called by the other functions as needed.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

BtnID is the button ID number to retrieve from **xmem**

RETURN VALUE

1 when completed

SEE ALSO

btnStore, btnInit, btnDisplay, btnDisplayLevel, btnClear, btnClearLevel

```
int btnCreateText(unsigned long xmemPtr, int BtnID,
   int xStart, int yStart,int xSize, int ySize, char
   Attribs, char Level, fontInfo *bFont, char
   *Text);
```

Creates a button with a text label.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

BtnID is the button ID number of the button being created

xStart is the coordinate of the starting horizontal pixel

yStart is the coordinate of the starting vertical pixel

xSize is the horizontal size of the button

ySize is the vertical size of the button

Attribs are the button attributes:

bit 0: 1 = oval shaped, 0 = square shaped
bit 1 to 7 (reserved).

Level is the level to associate the button with (buttons with the same level can be displayed together using the function **btnDisplayLevel**, or they can be removed together using the function **btnClearLevel**.)

bFont is a pointer to the font descriptor

Text is a pointer to the text to display centered in the button

RETURN VALUE

1 when completed

EXAMPLE

The text displayed can be multiline by inserting '\n' within the text:

"Hello\nfrom\nZ-World" will produce

SEE ALSO

btnCreateBitmap, btnInit, btnDisplay, btnDisplayLevel, btnClear, btnClearLevel

```
int btnCreateBitmap(unsigned long xmemPtr,
   int BtnID, int xStart, int yStart, char Attribs,
   char Level, unsigned long bmp, int bmpWidth,
   int bmpHeight);
```

Creates a button with a bitmap.

PARAMETERS

`xmemPtr` is the **`xmem`** address of the pointer to an array of button descriptors

`BtnID` is the button ID number of the button being created

`xStart` is the coordinate of the starting horizontal pixel

`yStart` is the coordinate of the starting vertical pixel

`Attribs` are the button attributes:

bit 0: 1 = oval shaped, 0 = square shaped
bit 1: 1 = beep when pressed, 0 = disable beep
bit 2 to 7 (reserved).

`Level` is the level to associate the button with (buttons with the same level can be displayed together using the function **`btnDisplayLevel`**, or they can be removed together using the function **`btnClearLevel`**.)

`bmp` is a pointer to the bitmap to use

`bmpWidth` is the horizontal size of the bitmap

`bmpHeight` is the vertical size of the bitmap

RETURN VALUE

1 when completed

NOTE: The button will be the bitmap size + 16 pixels, and will be centered with 8 pixels on each side, and 8 pixels each, top and bottom.

SEE ALSO

`btnCreateText, btnDisplay, btnClear, btnDisplayLevel, btnClearLevel, btnInit`

```
int btnDisplayText(int xStart, int yStart,
   int xSize, int ySize, fontInfo *pInfo,
   char *Text);
```

Displays text on the LCD. The text will be centered automatically both horizontally and vertically. '\n' within the text will give you the capability for multiline text. For example,

"Hello\nfrom\nZ-World" will produce

PARAMETERS

xStart is the coordinate of the starting horizontal pixel

yStart is the coordinate of the starting vertical pixel

xSize is the width of the display area in pixels

ySize is the height of the display area in pixels

pInfo is a pointer to the font descriptor

Text is a pointer to the text to be displayed

RETURN VALUE

1 when completed

SEE ALSO

btnMsgBox, btnDisplay

```
int btnClearRegion(int xStart, int yStart,
   int xSize, int ySize);
```

Blanks a region of the LCD. Do ***not*** use this function call to remove buttons—if you use this function to remove a button from the LCD, the button will still be enabled. Instead, use **btnClear** or **btnClearLevel** to remove buttons from the LCD.

PARAMETERS

xStart is the pixel coordinate of the starting horizontal pixel

yStart is the pixel coordinate of the starting vertical pixel

xSize is the width of the display area in pixels

ySize is the height of the display area in pixels

RETURN VALUE

1 when completed

SEE ALSO

btnClear, btnClearLevel

int btnMsgBox(int xStart, int yStart, int xSize, int ySize, fontInfo *pInfo, char *Text, int Frame, int Invert);

Displays a message or text box on the LCD. The box can be square or oval-framed, and it can be inverted. The text will be centered automatically both horizontally and vertically. '\n' within the text will give you the capability of multiline text. For example,

"Hello\nfrom\nZ-World" will produce

PARAMETERS

xStart is the pixel coordinate of the starting horizontal pixel

yStart is the pixel coordinate of the starting vertical pixel

xSize is the width of the box in pixels

ySize is the height of the box in pixels

pInfo is a pointer to the font descriptor

Text is a pointer to the text to be displayed

Frame is the frame type (1 = oval, 0 = square)

Invert inverts the selection (0 = normal display, 1 = inverted display)

RETURN VALUE

1 when completed

SEE ALSO

btnDisplayText

int btnDisplay(unsigned long xmemPtr, int BtnID);

Displays a predefined button on the LCD. The attributes, the text/bitmap displayed, and the location of the button are predefined by either **btnCreateText** or **btnCreateBmp**. Once the button is displayed, the touchscreen will monitor it for presses. Call **btnClear** to remove the button.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

BtnID is the button ID number of the button to display

RETURN VALUE

1 when completed

SEE ALSO

btnDisplayLevel, btnClearLevel, btnClear

int btnDisplayLevel(unsigned long xmemPtr, char Level);

Displays predefined buttons having the same level setting. The level is defined by either **btnCreateText** or **btnCreateBmp**. **btnDisplayLevel** allows you to display a group of buttons with a single function call.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

Level is the button level to display

RETURN VALUE

1 when completed

SEE ALSO

btnClearLevel, btnDisplay, btnClear

int btnClear(unsigned long xmemPtr, int BtnID);

Removes a button displayed on the LCD.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

BtnID is the button ID number of the button to remove

RETURN VALUE

1 when completed

SEE ALSO

btnDisplayLevel, btnDisplay, btnClearLevel

int btnClearLevel(unsigned long xmemPtr, char Level);

Removes a group of buttons having the same level. This function is called as many times as necessary until **BTN_SUCCESS** is returned.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

Level is the button level to remove; use **BTN_ALL_L** to remove all the buttons

RETURN VALUE

BTN_SUCCESS when completed, otherwise **BTN_PENDING**

SEE ALSO

btnDisplayLevel, btnDisplay, btnClear

```
int btnAttributes(unsigned long xmemPtr, int btn,
   int RepeatCntrl,int InitRepeatDelay,
   int RepeatDelay, int BuzzerCntrl);
```

Sets the button attributes for the action to be taken when the button is pressed.

PARAMETERS

`xmemPtr` is the **`xmem`** address of the pointer to an array of button descriptors

`btn` is the button ID number

`RepeatCntrl` sets repeat enable/disable (0 = repeat off, 1 = repeat on)

`InitRepeatDelay` sets the initial delay in milliseconds for the repeat when the repeat is enabled

`RepeatDelay` sets the repeat delay in milliseconds between repeats

`BuzzerCntrl` enables/disables the buzzer sound when the button is pressed (0 = buzzer off, 1 = buzzer on)

RETURN VALUE

1 when completed

.

```
int btnSearchXY(unsigned long xmemPtr, int x, int y);
```

Searches the list of buttons in use for a button that matches the *x*,*y* coordinates from the touchscreen.

PARAMETERS

`xmemPtr` is the **`xmem`** address of the pointer to an array of button descriptors

`x` is the *x* coordinate of the location on the touchscreen

`y` is the *y* coordinate of the location on the touchscreen

RETURN VALUE

The button ID of the button corresponding to the button being pressed. If no such button is found, the function returns a negative number.

SEE ALSO

`btnVerifyXY, btnGet`

int btnVerifyXY(unsigned long xmemPtr, int btn, int x, int y);

Searches the list of buttons in use for a button that matches the *x,y* coordinates from the touchscreen.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

btn is the button ID code of the button to be verified

x is the *x* coordinate of the location on the touchscreen

y is the *y* coordinate of the location on the touchscreen

RETURN VALUE

The button ID of the button corresponding to the button being verified. If the button is not the correct button, the function returns a negative number.

SEE ALSO

btnSearchXY, btnGet

int btnGet(unsigned long xmemPtr);

Checks the touchscreen *x,y* coordinates against a given set of buttons being displayed to look for a match. If a match is found, then the button ID code for the button will be returned.

PARAMETERS

xmemPtr is the **xmem** address of the pointer to an array of button descriptors

RETURN VALUE

The button ID code of the button corresponding to the button being pressed. If no such button is found, the function returns a negative number.

SEE ALSO

btnSearchXY, btnVerifyXY

The **TS_R4096.LIB** library in the **TouchScreens** directory provides low-level touch-screen function calls.

int TsCalib(int x1, int y1, int x2, int y2);

Calibrates the touchscreen as a linear function using the two sets of *x,y* coordinates provided. Gain and offset constants are calculated and placed into the global table **_adcCalibTS**.

PARAMETERS

x1 is the *x* coordinate of the upper left-hand corner of the touchscreen

y1 is the *y* coordinate of the upper left-hand corner of the touchscreen

x2 is the *x* coordinate of the lower right-hand corner of the touchscreen

y2 is the *y* coordinate of the lower right-hand corner of the touchscreen

RETURN VALUE

0 if sucessful
-1 if not able to make calibration constants

SEE ALSO

TsCalibEERd, TsCalibEEWr, TsXYvector, brdInit

int TsCalibEERd(void);

Reads the calibration constants, gain, and offset from the simulated EEPROM in flash. The constants are stored in the top 1K of the reserved user block memory area. Use the sample program **USERBLOCKINFOR.C** in **SAMPLES\OP7200** to get the addresses reserved for the calibration data constants and the addresses available for use by your application program.

RETURN VALUE

0 if sucessful
-1 if invalid address or range

SEE ALSO

TsCalib, TsCalibEEWr, TsXYvector, brdInit

int TsCalibEEWr(void);

Writes the calibration constants, gain, and offset to the simulated EEPROM in flash. The constants are stored in the top 1K of the reserved user block memory area. Use the sample program **USERBLOCKINFOR.C** in **SAMPLES\OP7200** to get the addresses reserved for the calibration data constants and the addresses available for use by your application program.

RETURN VALUE

0 if sucessful
-1 if invalid address or range

SEE ALSO

TsCalib, TsCalibEERd, TsXYvector, brdInit

void TsXYvector(int *xkey, int *ykey, int mode);

Reads the current *x,y* coordinates of the touchscreen

PARAMETERS

xkey is a pointer to the *x* coordinate

ykey is a pointer to the *y* coordinate

mode is the mode of operation:

0 (**RAW_MODE**)—raw mode, returns touchscreen *x, y* coordinate's true raw data value

1 (**CAL_MODE**)—calibration mode, returns touchscreen *x, y* coordinates as normalized data values to match the LCD display resolution

SEE ALSO

TsActive, TsScanState, TsXYBuffer, brdInit

int TsActive(void);

This function returns the status of whether the touchscreen is being pressed or touched.

RETURN VALUE

0—touchscreen is not being pressed
1—touchscreen is being pressed

SEE ALSO

TsXYvector, TsScanState, TsXYBuffer, brdInit

void TsScanState(void);

This function processes the current state of the touchscreen. The results can then be read with the **TsXYBuffer** function, which will return one of the following.

1. The current *x,y* location of where the touchscreen is being pressed
2. A value indicating that the touchscreen press has ended
3. A value of -1 to indicate no activity has occurred

NOTE: When this function is called, the information should be processed before calling this function again to avoid losing the information.

SEE ALSO

TsXYvector, TsActive, TsXYBuffer, brdInit

long TsXYBuffer(void);

This function returns either the *x,y* coordinates or the touchscreen **BTN_RELEASE** status code that was processed by the **TsScanState** function.

RETURN VALUE

The *x* coordinate is returned in the MSB, and the *y* coordinate is returned in the LSB of the long integer value.

SEE ALSO

TsXYvector, TsActive, TsScanState, brdInit

4.7 RabbitNet Port

The function calls described in this section are used to configure the OP7200 for use with RabbitNet peripheral boards. The user's manual for the specific peripheral board you are using contains additional function calls related to the RabbitNet protocol and the individual peripheral board.

Add the following lines at the start of your program.

```
#define RN_MAX_DEV 10  // max number of devices
#define RN_MAX_DATA 16 // max number of data bytes in any transaction
#define RN_MAX_PORT 1  // max number of serial ports
```

Set the following bits in **RNSTATUSABORT** to abort transmitting data after the status byte is returned. This does not affect the status byte and still can be interpreted. Set any bit combination to abort:

bit 7—device busy is hard-coded into driver
bit 5—identifies router or slave
bits 4,3,2—peripheral-board-specific bits
bit 1—command rejected
bit 0—watchdog timeout

```
#define RNSTATUSABORT 0x80
     // hard-coded driver default to abort if the peripheral board is busy
```

void rn_sp_info();

Provides **rn_init()** with the serial port control information needed for OP7200 series controllers.

RETURN VALUE

None.

void rn_sp_close(int port);

Deactivates the OP7200 RabbitNet port as a clocked serial port and restores the RS-485 driver for RS-485 communication. This call is also used by **rn_init()**.

PARAMETERS

portnum = 0

RETURN VALUE

None

void rn_sp_enable(int portnum);

This is a macro that enables or asserts the OP7200 RabbitNet port select prior to data transfer.

PARAMETERS

portnum = 0

RETURN VALUE

None

void rn_sp_disable(int portnum);

This is a macro that disables or deasserts the OP7200 RabbitNet port select to invalidate data transfer.

PARAMETERS

portnum = 0

RETURN VALUE

None.

5. USING THE TCP/IP FEATURES

Chapter 5 discusses using the TCP/IP features on the OP7200 boards.

5.1 TCP/IP Connections

Before proceeding you will need to have the following items.

- If you don't have an Ethernet connection, you will need to install a 10Base-T Ethernet card (available from your favorite computer supplier) in your PC.
- Two RJ-45 straight-through Ethernet cables and a hub, or an RJ-45 crossover Ethernet cable.

The Ethernet cables and Ethernet hub are available from Rabbit in a TCP/IP tool kit. More information is available at www.rabbit.com.

1. Connect the AC adapter and the programming cable as shown in Chapter 2, "Getting Started."
2. Ethernet Connections

- If you do not have access to an Ethernet network, use a crossover Ethernet cable to connect the OP7200 to a PC that at least has a 10Base-T Ethernet card.
- If you have an Ethernet connection, use a straight-through Ethernet cable to establish an Ethernet connection to the OP7200 from an Ethernet hub. These connections are shown in Figure 22.

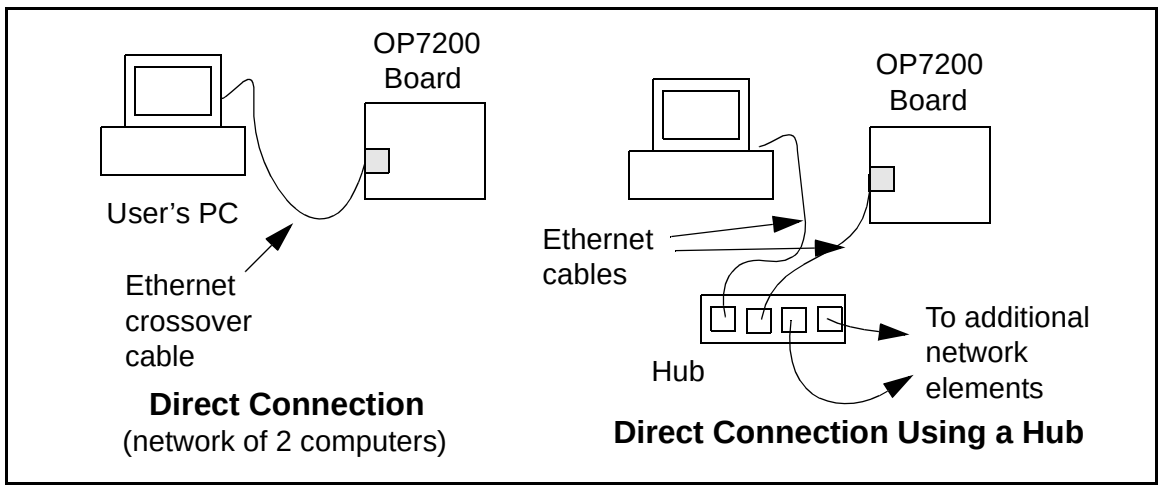


Figure 22. Ethernet Connections

3. Apply Power

Plug in the AC adapter. The OP7200 is now ready to be used.

> **NOTE:** A hardware RESET is accomplished by unplugging the AC adapter, then plugging it back in, or by momentarily grounding the board reset input at pin 5 on screw-terminal header J10.
>
> When the PROG connector of the programming cable connects the OP7200 to your PC, and Dynamic C is running, a RESET occurs when you press **<Ctrl-Y>**.

The green **LNK** light on the OP7200 RabbitCore module is on when the OP7200 is properly connected either to an Ethernet hub or to an active Ethernet card. The orange **ACT** light flashes each time a packet is received.

5.2 TCP/IP Sample Programs

We have provided a number of sample programs demonstrating various uses of TCP/IP for networking embedded systems. These programs require that you connect your PC and the OP7200 together on the same network. This network can be a local private network (preferred for initial experimentation and debugging), or a connection via the Internet.

5.2.1 How to Set IP Addresses in the Sample Programs

Most of the sample programs such as shown in the example below use macros to define the IP address assigned to the board and the IP address of the gateway, if there is a gateway.

```
#define MY_IP_ADDRESS "10.10.6.170"
#define MY_NETMASK "255.255.255.0"
#define MY_GATEWAY "10.10.6.1"
#define MY_NAMESERVER "10.10.6.1"
```

In order to do a direct connection, the following IP addresses can be used for the OP7200:

```
#define MY_IP_ADDRESS "10.1.1.2"
#define MY_NETMASK "255.255.255.0"
// #define MY_GATEWAY "10.10.6.1"
// #define MY_NAMESERVER "10.10.6.1"
```

In this case, the gateway and nameserver are not used, and are commented out. The IP address of the board is defined to be **10.1.1.2**. The IP address of you PC can be defined as **10.1.1.1**.

IP Addresses After Dynamic C 7.30

With the introduction of Dynamic C 7.30 we have taken steps to make it easier to run many of our sample programs. Instead of the **MY_IP_ADDRESS** and other macros, you will see a **TCPCONFIG** macro. This macro tells Dynamic C to select your configuration from a list of default configurations. You will have three choices when you encounter a sample program with the **TCPCONFIG** macro.

1. You can replace the **TCPCONFIG** macro with individual **MY_IP_ADDRESS**, **MY_NETMASK**, **MY_GATEWAY**, and **MY_NAMESERVER** macros in each program.
2. You can leave **TCPCONFIG** at the usual default of 1, which will set the IP configurations to **10.10.6.100**, the netmask to **255.255.255.0**, and the nameserver and gateway to **10.10.6.1**. If you would like to change the default values, for example, to use an IP address of **10.1.1.2** for the RCM3200 board, and **10.1.1.1** for your PC, you can edit the values in the section that directly follows the "General Configuration" comment in the **TCP_CONFIG.LIB** library. You will find this library in the **LIB\TCPIP** directory.
3. You can create a **CUSTOM_CONFIG.LIB** library and use a **TCPCONFIG** value greater than 100. Instructions for doing this are at the beginning of the **TCP_CONFIG.LIB** file.

There are some other "standard" configurations for **TCPCONFIG** that let you select different features such as DHCP. Their values are documented at the top of the **TCP_CONFIG.LIB** library. More information is available in the ***Dynamic C TCP/IP User's Manual***.

5.2.2 How to Set Up Your Computer for Direct Connect

Follow these instructions to set up your PC or notebook. Check with your administrator if you are unable to change the settings as described here since you may need administrator privileges. The instructions are specifically for Windows 2000, but the interface is similar for other versions of Windows.

> **TIP:** If you are using a PC that is already on a network, you will disconnect the PC from that network to run these sample programs. Write down the existing settings before changing them to facilitate restoring them when you are finished with the sample programs and are ready to reconnect your PC to the network.

1. Go to the control panel (**Start > Settings > Control Panel**), and double-click the Network icon.
2. Select the network interface card used for the Ethernet interface you intend to use (e.g., **TCP/IP Xircom Credit Card Network Adapter**) and click on the "Properties" button. Depending on which version of Windows your PC is running, you may have to select the "Local Area Connection" first, and then click on the "Properties" button to bring up the Ethernet interface dialog. Then "Configure" your interface card for a "10Base-T Half-Duplex" or an "Auto-Negotiation" connection on the "Advanced" tab.

   NOTE: Your network interface card will likely have a different name.

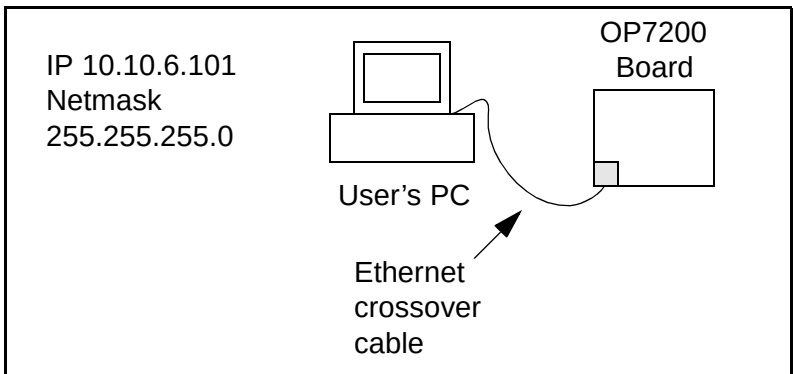
3. Now select the **IP Address** tab, and check **Specify an IP Address**, or select TCP/IP and click on "Properties" to assign an IP address to your computer (this will disable "obtain an IP address automatically"):

   IP Address : 10.10.6.101

   Netmask : 255.255.255.0

   Default gateway : 10.10.6.1

4. Click **<OK>** or **<Close>** to exit the various dialog boxes.



Direct Connection PC to OP7200 Board

5.2.3 Run the PINGME.C Demo

Connect the crossover cable from your computer's Ethernet port to the OP7200's RJ-45 Ethernet connector. Open this sample program from the **SAMPLES\TCPIP\ICMP** folder, compile the program, and start it running under Dynamic C. When the program starts running, the green **LNK** light on the OP7200 should be on to indicate an Ethernet connection is made. (Note: If the **LNK** light does not light, you may not have a crossover cable, or if you are using a hub perhaps the power is off on the hub.)

The next step is to ping the board from your PC. This can be done by bringing up the MS-DOS window and running the ping program:

```
ping 10.10.6.100
```

or by **Start > Run**

and typing the command

```
ping 10.10.6.100
```

Notice that the orange **ACT** light flashes on the OP7200 while the ping is taking place, and indicates the transfer of data. The ping routine will ping the board four times and write a summary message on the screen describing the operation.

5.2.4 Running More Demo Programs With a Direct Connection

The sample programs discussed in this section use the Demonstration Board from the OP7200 Tool Kit to illustrate their operation. Appendix C, “Demonstration Board Connections,” contains diagrams of typical connections between the OP7200 and the Demonstration Board used to run these sample programs.

The program **FLASH_XML.C** (**SAMPLES\OP7200\TCPIP**) runs a Web server that has a Web page with a Macromedia Flash movie. You will need the Macromedia Flash plug-in installed on your browser to use this sample program.

The program **SMPTP.C** (**SAMPLES\OP7200\TCPIP**) uses the SMTP library to send an e-mail when a switch on the Demonstration Board is pressed.

The program **SSI.C** (**SAMPLES\OP7200\TCPIP**) demonstrates how to make the OP7200 a Web server. This program allows you to turn the LEDs on an attached Demonstration Board from the Tool Kit on and off from a remote Web browser. LED1 and LED2 on the Demonstration Board will match those on the Web page. As long as you have not modified the **TCPCONFIG 1** macro in the sample program, enter the following server address in your Web browser to bring up the Web page served by the sample program.

http://10.10.6.100

Otherwise use the TCP/IP settings you entered in the **TCP_CONFIG.LIB** library.

The sample program **TELNET.C** (**SAMPLES\OP7200\TCPIP**) allows you to communicate with the OP7200 using the Telnet protocol. This program takes anything that comes in on a port and sends it out Serial Port B. It uses digital input IN0 to indicate that the TCP/IP connection should be closed and high-current output OUT0 to indicate that there is an active connection.You may change the digital input and output to suit your application needs.

Follow the instructions included with the sample program. Run the Telnet program on your PC (**Start > Run** `telnet 10.10.6.100`). As long as you have not modified the **TCPCONFIG 1** macro in the sample program, the IP address is 10.10.6.100 as shown; otherwise use the TCP/IP settings you entered in the **TCP_CONFIG.LIB** library. Each character you type will be printed in Dynamic C's **STDIO** window, indicating that the board is receiving the characters typed via TCP/IP.

5.3 Where Do I Go From Here?

NOTE: If you purchased your OP7200 through a distributor or Rabbit partner, contact the distributor or partner first for technical support.

If there are any problems at this point:

- Use the Dynamic C **Help** menu to get further assistance with Dynamic C.
- Check the Rabbit Technical Bulletin Board and forums at www.rabbit.com/support/bb/ and at www.rabbit.com/forums/.
- Use the Technical Support e-mail form at www.rabbit.com/support/.

If the sample programs ran fine, you are now ready to go on.

Additional sample programs are described in the ***Dynamic C TCP/IP User's Manual***.

Refer to the ***Dynamic C TCP/IP User's Manual*** to develop your own applications. ***An Introduction to TCP/IP*** provides background information on TCP/IP, and is available on our Web site.

6. INSTALLATION, MOUNTING, AND CARE GUIDELINES

Chapter 6 describes some considerations for mounting the OP7200 in a panel, and includes detailed mounting instructions, protective grounding instructions, and care guidelines for cleaning the screen overlay.

6.1 Grounding

CAUTION: Many of the OP7200 ICs are sensitive to static. Use extra caution when handling units in high-static areas.

To meet electromagnetic compatibility requirements, and in particular to prevent misoperation or damage from electrostatic discharges, the bezel must be connected to a protective ground via a low-impedance path.

A protective building ground is recommended once the OP7200 is installed at the location where it will be used. In addition to providing protection against an unexpected electric shock, the connection to building ground also mitigates any problems from external electrostatic discharges and transients, and dampens any RF emissions.

The metal case is already connected electrically to the bezel, and so does not require a separate ground connection.

The recommended way to connect an OP7200 to a building ground is to mount the unit in a metal panel that is already grounded. Use a wire with a size of at least 20AWG (0.5 mm^2), preferably stranded, to establish a connection between one of the screws holding the back cover in place and the protective building ground. This wire should be as short as possible to keep its impedance low.

There is an electrical connection between the OP7200 bezel/casing and the connections marked GND or AGND on the OP7200 headers. This connection is the return for the I/O signals, and should not be used for a protective ground connection.

6.2 Installation Guidelines

When possible, following these guidelines when mounting an OP7200.

1. Leave sufficient ventilation space, at least 1" (2 cm) around the unit on all sides.
2. Do not install the OP7200 directly above machinery that radiates a lot of heat (for example, heaters, transformers, and high-power resistors).
3. Leave at least 8" (20 cm) distance from electric power lines and even more from high-voltage devices.
4. When installing the OP7200 near devices with strong electrical or magnetic fields (such as solenoids), allow a least 3" (8 cm), more if necessary.

The OP7200 has strong environmental resistance and high reliability, but you can maximize system 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

6.3 Mounting Instructions

The OP7200 comes with a gasket attached to the bezel. When properly mounted in a panel, the OP7200 bezel/gasket are designed to meet NEMA 4 specifications for water resistance.

Since the OP7200 employs an LCD display, the viewing angle must be considered when mounting the display. The viewing angle is affected by the software-controlled contrast. Install the OP7200 at a height and angle that makes it easy for the operator to see the screen.

6.3.1 Bezel-Mount Installation

This section describes and illustrates how to bezel-mount the OP7200. Follow these steps for bezel-mount installation.

1. Cut a mounting hole in the mounting panel in accordance with the recommended dimensions in Figure 23, then use the bezel faceplate to mount the OP7200 onto the panel.

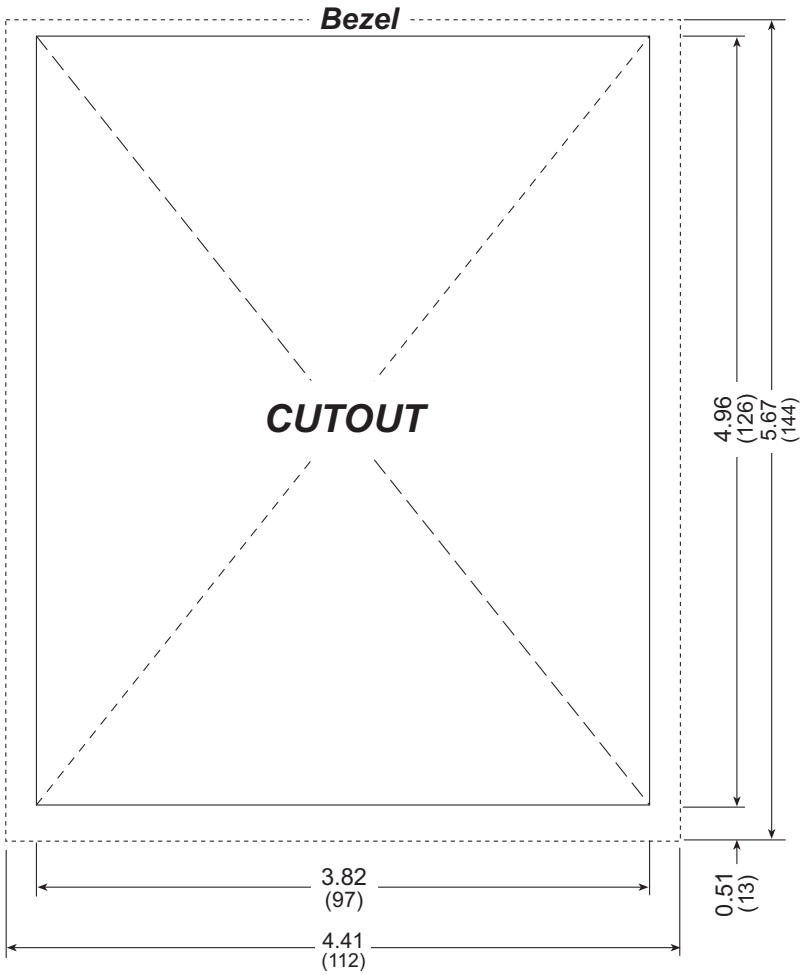


Figure 23. Recommended Cutout Dimensions

2. Remove the OP7200 back cover. Set the screws and back cover aside since the back cover will be re-attached after the OP7200 is inserted through the cutout.
3. Carefully insert the OP7200.
4. Fasten the unit to the panel with the back cover and the four 4-40 screws that attach the back cover to the OP7200. If your panel is more than 0.1" (2.5 mm) thick, you will need to supply longer 4-40 screws.

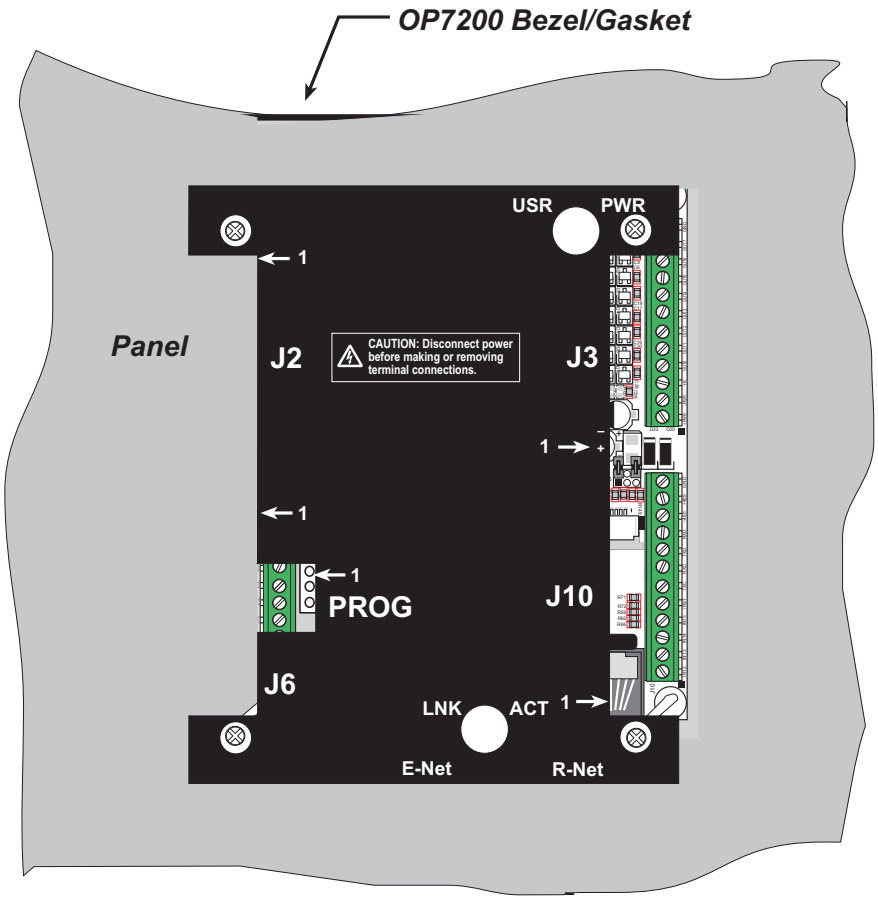


Figure 24. OP7200 Mounted in Panel (rear view)

Carefully tighten the screws until the gasket is compressed by the bezel faceplate.

Do not tighten each screw fully before moving on to the next screw. Apply only one or two turns to each screw in sequence until all are tightened manually as far as they can be so that the gasket is compressed by the bezel faceplate.

6.4 Care Guidelines

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 grade of VM&P naphta, Windex®, or 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 OP7200 is exposed to the hot sun or elevated temperatures.

APPENDIX A. SPECIFICATIONS

Appendix A provides the specifications for the OP7200.

A.1 Electrical and Mechanical Specifications

Figure A-1 shows the mechanical dimensions for the OP7200.

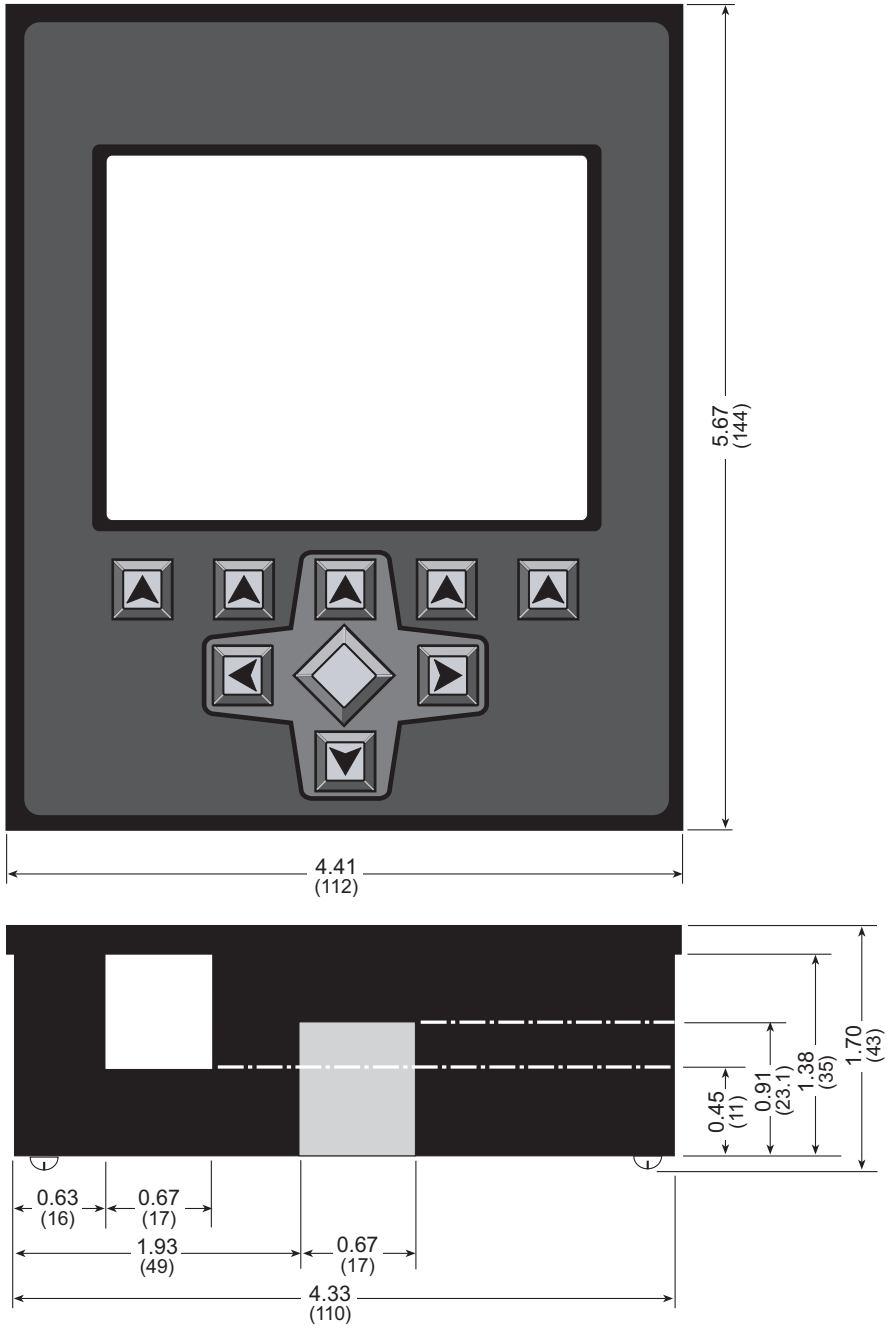


Figure A-1. OP7200 Dimensions

NOTE: All measurements are in inches followed by millimeters enclosed in parentheses.

Table A-1 lists the electrical, mechanical, and environmental specifications for the OP7200.

Table A-1. OP7200 Specifications

Feature	OP7200	OP7210
Microprocessor	Rabbit® 2000 at 22.1 MHz	
Ethernet Port	10/100-compatible with 10Base-T interface, RJ-45	
Flash Memory	256K	
SRAM	128K	
Backup Battery	Socketed 3 V lithium coin type, 265 mA·h	
Keypad/Display	¼ VGA (320 × 240 pixels) with programmable white LED backlight, black on white display, transflective FSTN LCD, 6 o'clock viewing angle; 9-key keypad	
Touchscreen	4096 × 4096 resistive touchscreen	No
LEDs	4: Power On, Microprocessor Error, Ethernet Link, Ethernet Activity	
Digital Inputs	19: protected to ±36 V DC	16: protected to ±36 V DC
Digital Outputs	8: individually configurable in software to sink up to 350 mA each, 36 V DC max., or source up to 250 mA each, 40 V DC max.	
Analog Inputs	8 single-ended or 4 differential, 200 kΩ input impedance, 1.5 ksamples/s sampling rate • software-controlled ranges: 0–1 V, 2 V, 5 V 10 V, 20 V DC (11-bit single-ended, 12-bit differential)	None
Connectors	Four 12-position screw-terminal headers, 0.1" pitch	Three 12-position screw-terminal headers, 0.1" pitch
Serial Ports	4 serial ports: • two RS-232 or one RS-232 (with CTS/RTS) • one RS-485 with onboard network termination and bias resistors or one RS-422 SPI master port • one 5 V CMOS-compatible programming port	
Serial Rate	Max. burst rate = CLK/32, Max. sustained rate = CLK/64	
Real-Time Clock	Yes	
Timers	Five 8-bit timers (four cascadable from the first), one 10-bit timer with 2 match registers	
Watchdog/Supervisor	Yes	
Power	9–40 V DC or 22–26 V AC, 4 W max.	
Temperature	Operating Range: -10°C to +65°C Storage Range: –30°C to +80°C	
Humidity	20% to 70%, noncondensing	
Unit Size	4.41" × 5.67" × 1.70" (112 mm × 144 mm × 43 mm)	

A.1.1 Physical Mounting

Figure A-2 shows position information to assist with interfacing other boards with the OP7200.

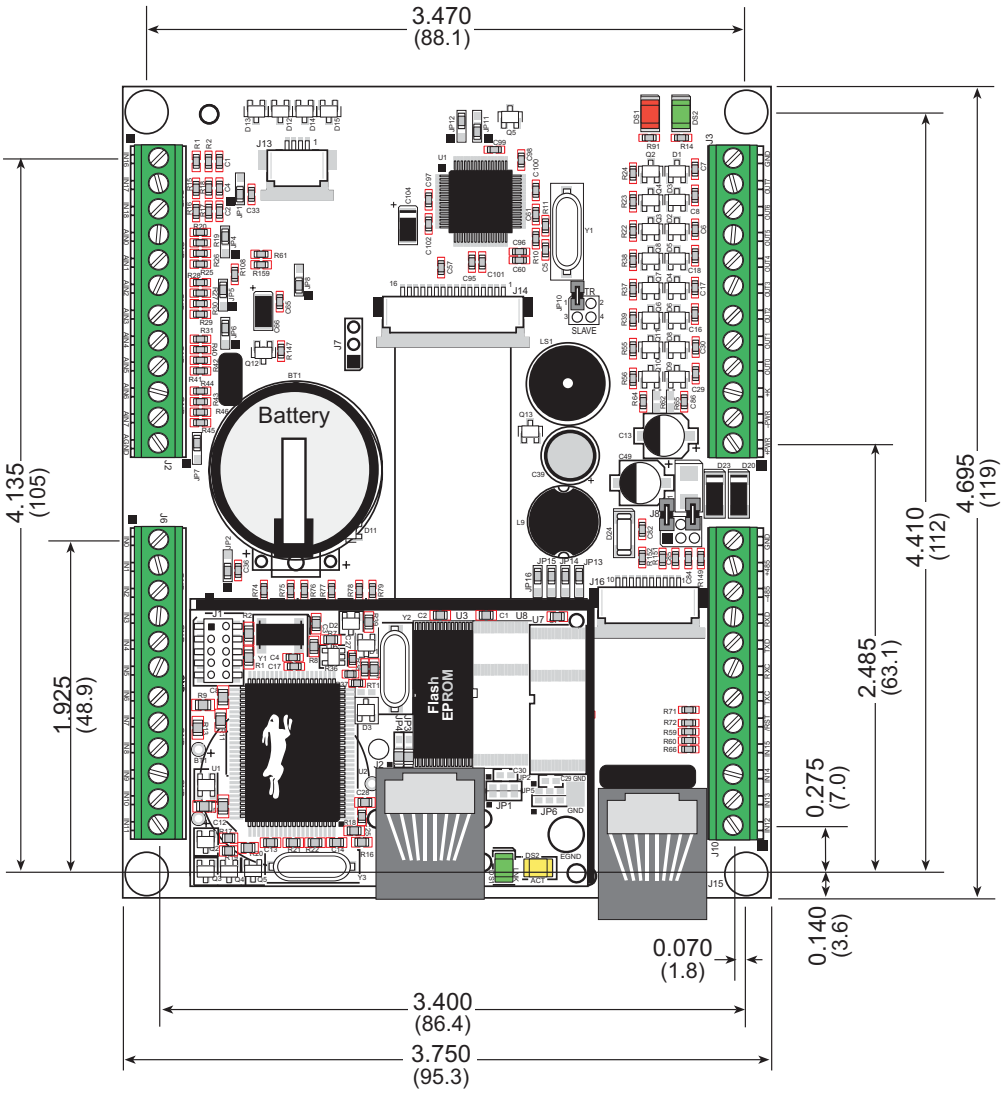


Figure A-2. User Board Footprint for OP7200

A.2 Conformal Coating

The areas around the crystal oscillator and the battery backup circuit on the OP7200's RabbitCore module have had the Dow Corning silicone-based 1-2620 conformal coating applied. The conformally coated areas are shown in Figure A-3. The conformal coating protects these high-impedance circuits from the effects of moisture and contaminants over time, and helps to maintain the accuracy of the real-time clock.

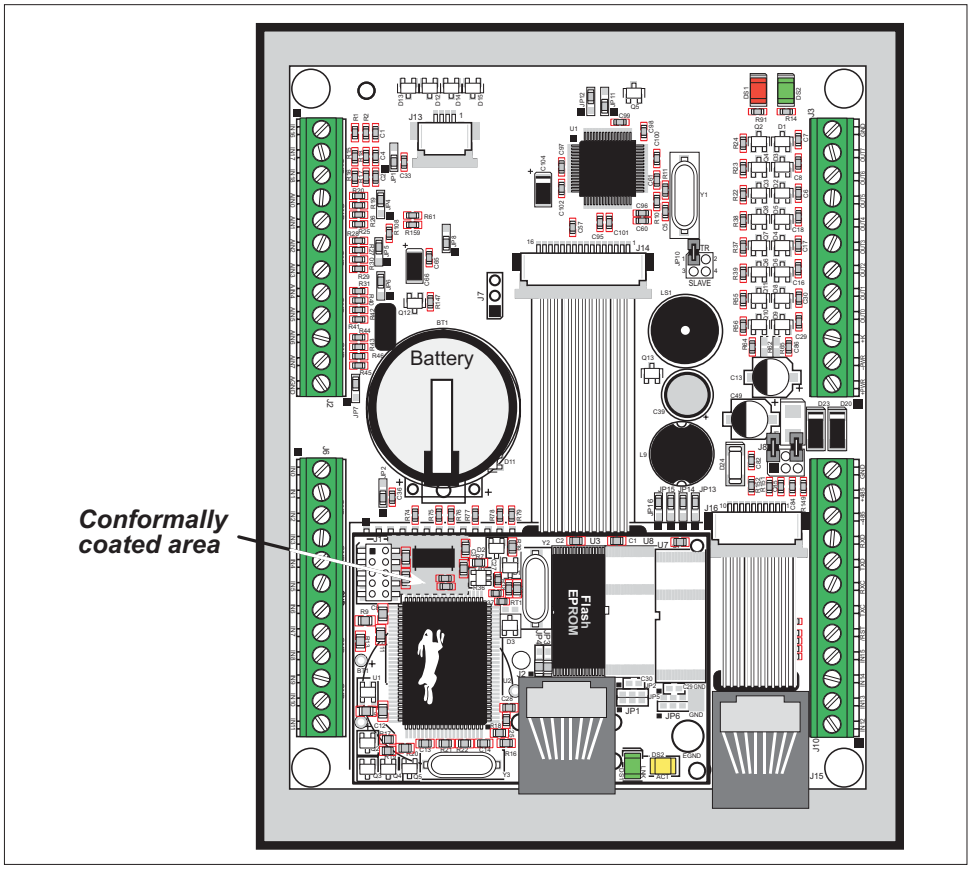


Figure A-3. OP7200's RabbitCore Module Areas Receiving Conformal Coating

Any components in the conformally coated area may be replaced using standard soldering procedures for surface-mounted components. A new conformal coating should then be applied to offer continuing protection against the effects of moisture and contaminants.

NOTE: For more information on conformal coatings, refer to Rabbit Technical Note 303, ***Conformal Coatings***.

A.3 Jumper Configurations

Figure A-4 shows the header and jumper locations used to configure the various OP7200 options.

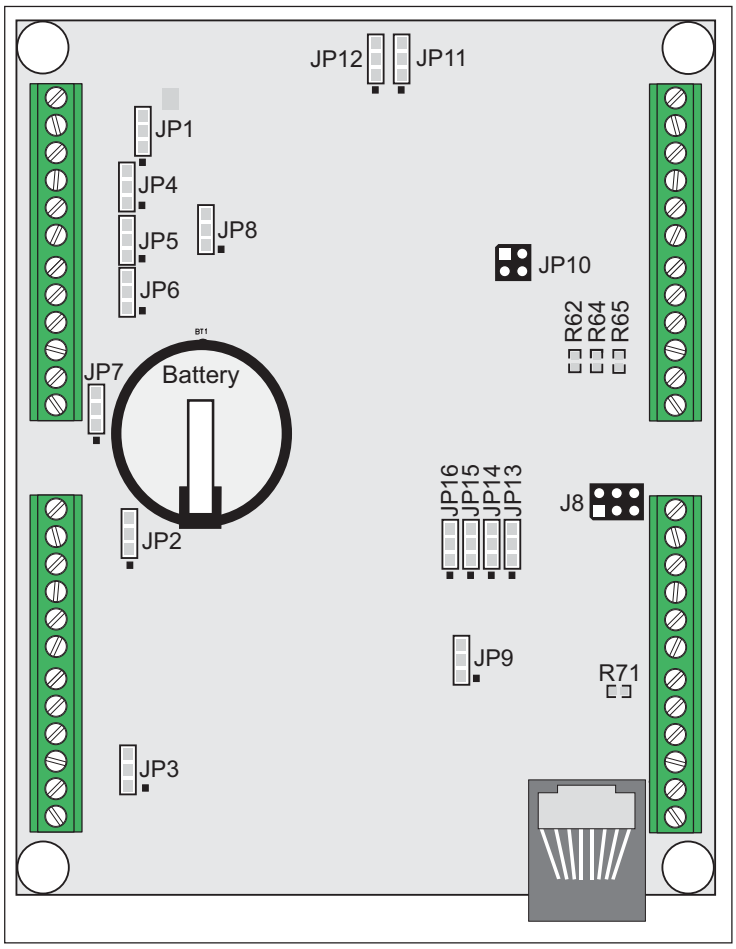


Figure A-4. Location of OP7200 Configurable Positions (RabbitCore module is not shown)

Table A-2 lists the configuration options. 0 Ω surface mount resistors are used for all the positions except JP10 and J8, which use standard pluggable jumpers.

Table A-2. OP7200 Jumper Configurations

Header	Description	Pins Connected		Factory Default
JP1	IN16–IN18	1–2	Pulled up to Vcc	×
		2–3	Pulled down	
JP2	IN00–IN07	1–2	Pulled up to Vcc	×
		2–3	Pulled down	

Table A-2. OP7200 Jumper Configurations (continued)

Header	Description	Pins Connected		Factory Default
JP3	IN8–IN15	1–2	Pulled up to Vcc	✕
		2–3	Pulled down	
JP4	AIN0–AIN1	1–2	Tied to 2.048 V	
		2–3	Tied to analog ground	✕
JP5	AIN2–AIN3	1–2	Tied to 2.048 V	
		2–3	Tied to analog ground	✕
JP6	AIN4–AIN5	1–2	Tied to 2.048 V	
		2–3	Tied to analog ground	✕
JP7	AIN6–AIN7	1–2	Tied to 2.048 V	
		2–3	Tied to analog ground	✕
JP8	Analog Reference Voltage	1–2	Based on A/D converter chip	✕
		2–3	Based on ratiometric or ext. reference	
JP9	LCD Controller I/O bit VA16	1–2	VA16 not used	✕
		2–3	VA16 used—additional 64K video SRAM	
JP10	RabbitNet Master/Slave Control	1–2	Reserved for future use	
		3–4	Reserved for future use	
		n.c.	OP7200 in “master” role	✕
JP11	LCD Oscillator	1–2		
		2–3	OSC/4	✕
JP12	LCD Oscillator	1–2		
		2–3	OSC/4	✕
JP13	Board ID Bit 0 (LSB)	1–2	Pulled up to Vcc	
		2–3	Pulled down	✕

Table A-2. OP7200 Jumper Configurations (continued)

Header	Description	Pins Connected		Factory Default
JP14	Board ID Bit 1	1–2	Pulled up to Vcc	
		2–3	Pulled down	✕
JP15	Board ID Bit 2	1–2	Pulled up to Vcc	
		2–3	Pulled down	✕
JP16	Board ID Bit 3 (MSB)	1–2	Pulled up to Vcc	
		2–3	Pulled down	✕
J8	RS-485 Bias and Termination Resistors	1–2 4–6	Bias and termination resistors connected	✕
		1–3 5–6	Bias and termination resistors ***not*** connected (parking position for jumpers)	
—	OUT0–OUT7	R64	Pulled up to Vcc	✕
		R65	Pulled up to +K	
		R62	Pulled down	
—	IN15 or Vcc on J10:4	—	IN15 on J10:4	✕
		R71	Vcc on J10:4	

NOTE: Jumper positions JP11–JP16 were introduced in January, 2006, to accommodate a new LCD controller chip. See Section 4.1.2.1 for additional information.

A.4 Use of Rabbit 2000 Parallel Ports

Figure A-5 shows the Rabbit 2000 parallel ports.

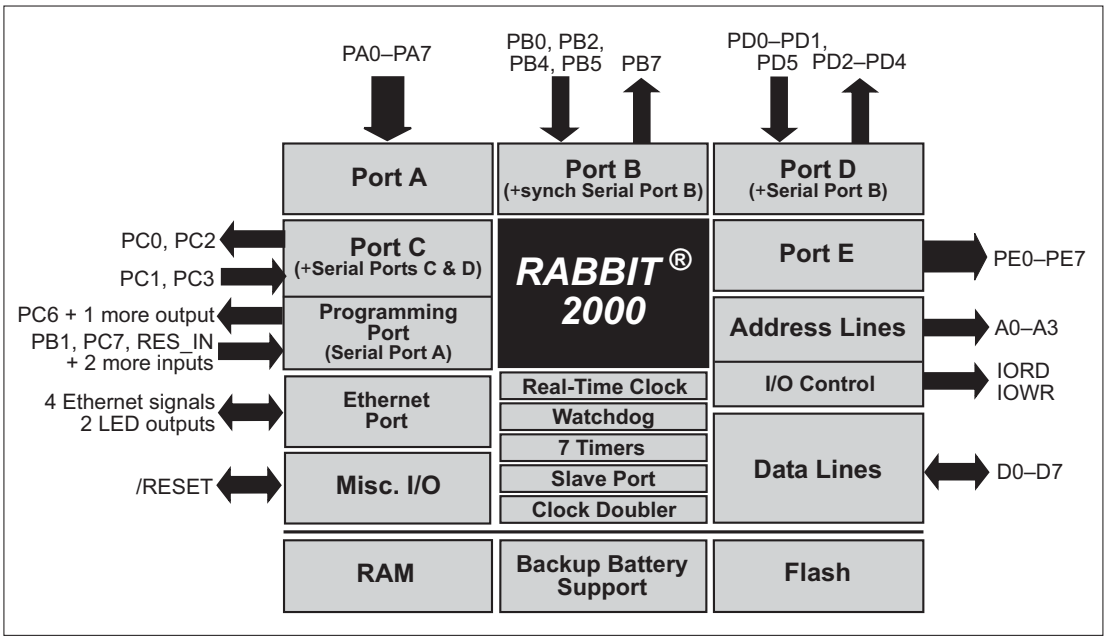


Figure A-5. OP7200 Rabbit-Based Subsystems

Table A-3 lists the Rabbit 2000 parallel ports and their use in the OP7200.

Table A-3. Use of Rabbit 2000 Parallel Ports

Port	I/O	Signal	Notes
PA0	Input	IN00	Pulled up to Vcc
PA1	Input	IN01	Pulled up to Vcc
PA2	Input	IN02	Pulled up to Vcc
PA3	Input	IN03	Pulled up to Vcc
PA4	Input	IN04	Pulled up to Vcc
PA5	Input	IN05	Pulled up to Vcc
PA6	Input	IN06	Pulled up to Vcc
PA7	Input	IN07	Pulled up to Vcc
PB0	Input	SS_CLK	Pulled up to Vcc
PB1	Input	Programming Port Clock	Pulled up to Vcc
PB2	Input	SS_CS	Pulled up to Vcc
PB3	Input	SS_Mode	Pulled up to Vcc
PB4	Input	Touchscreen status	Pulled up to Vcc
PB5	Input	ADC_SD0	Pulled up to Vcc
PB6	Output	Not Used	High
PB7	Output	Microprocessor Bad LED	High

Table A-3. Use of Rabbit 2000 Parallel Ports (continued)

Port	I/O	Signal		Notes
PC0	Output	RTS/TXD RS-232	Serial Port D	Inactive high
PC1	Input	CTS/RXD RS-232		Inactive high
PC2	Output	TXC RS-232	Serial Port C	Inactive high
PC3	Input	RXC RS-232		Inactive high
PC4	Output	Realtek Reset		Initialized by **sock_init**
PC5	Input	Realtek INT0		Pulled up to Vcc
PC6	Output	TXA Programming Port	Serial Port A	Inactive high
PC7	Input	RXA Programming Port		Inactive high
PD0	Input	Realtek CLK		Initialized by **sock_init**
PD1	Input	Realtek SD0		Initialized by **sock_init**
PD2	Output	Not Used		High
PD3	Output	ADC and Touchscreen Chip Select		High
PD4	Output	ATXB RS-485	Serial Port B	Inactive high
PD5	Input	ARXB RS-485		Inactive high
PD6	Output	Not Used		High
PD7	Output	Not Used		High
PE0	Output	ADC and Touchscreen Serial Clock		High
PE1	Output	ADC and Touchscreen Data In		High
PE2	Output	Realtek IORB Strobe		Initialized by **sock_init**
PE3	Output	Realtek SDI Line		Initialized by **sock_init**
PE4	Output	CPLD Chip Select 0		High
PE5	Output	CPLD Chip Select 1		High
PE6	Output	Realtek I/O Write		Initialized by **sock_init**
PE7	Output	SED1335 Chip Select		High

A.5 I/O Address Assignments

Table A-4 lists the external I/O address assignments.

Table A-4. Display and Keypad I/O Addresses

External Address	Signal Name	Function
PBDR (Write) PB7 Port Pin 0 = LED off, 1 = LED on	**PB7-Up_Good**	LCD indicator
PBDR (Read) PB5 serial data from device	**PB5_ADC_SDO**	Data from A/D converter or touchscreen
PDDR (Write) PD3 0 = ADC chip selected, 1 = touchscreen chip selected	**/PD3_ADC_CS**	CS for A/D converter or touchscreen
PEDR (Write) PE0 clock data to device on 0/1 trans.	**PE0_ADC_SK**	CLK for A/D converter or touchscreen
PEDR (Write) PE1 serial data to the device	**PE1_ADC_SDI**	Data to A/D converter or touchscreen
PBDR (Read) PB4 0 = touchscreen active, 1 = touchscreen not active	**/PB4_TSC_PIRQ**	Touchscreen status
PADR (Read) PA0–PA7 port pins	**IN0–IN7**	Digital inputs IN0–IN7
0x8000 (Read) D0–D7 data lines	**IN8–IN15**	Digital inputs IN8–IN15
0x8000–0x8007 (Write) 0 = driver enabled, 1 = driver disabled	**SINK0–SINK7**	Sinking driver control lines
0x8008–0x800F (Write) 0 = driver enabled, 1 = driver disabled	**SOURCE0–SOURCE7**	Sourcing driver control lines
0xA000 (Read) Data line D5, 0 = key active, 1 = no active keys	**K0**	Keypad row 0
0xA000 (Read) Data line D6, 0 = key active, 1 = no active keys	**K1**	Keypad row 1
0xA000 (Read) Data line D7, 0 = key active, 1 = no active keys	**K2**	Keypad row 2
0xA000 (Write) 1 = assert key scan line, 0 = deassert key scan line	**/KB-S0**	Keypad column 0
0xA001 (Write) 1 = assert key scan line, 0 = deassert key scan line	**/KB-S1**	Keypad column 1
0xA002 (Write) 1 = assert key scan line, 0 = deassert key scan line	**/KB-S2**	Keypad column 2
0xA003 (Write) 1 = assert key scan line, 0 = deassert key scan line	**/KB-S3**	Keypad column 3

Table A-4. Display and Keypad I/O Addresses (continued)

External Address	Signal Name	Function
0xA004 (Write) 1 = backlight on, 0 = backlight off	**BKLT-ON**	Backlight on/off control
0xA005 (Write) 1 = Xmit on, 0 = Xmit off	**RS-485EN**	RS-485 transmitter control
0xA006 (Write) 1 = buzzer on, 0 = buzzer off	**ALARM**	Buzzer on/off control
0xA007 (Write) 1 = assert LCD address A16, 0 = deassert LCD address A16	**VA16**	LCD address line A16
0xA008 (Write) 1 = assert X9013 chip select, 0 = deassert X9013 chip select	**/CS**	Contrast control chip select
0xA009 (Write) 1 = set X9013 to count up, 0 = set X9013 to count down	**U_D**	Contrast control count mode
0xA00A (Write) increment X9013 counter when accessed, data = don't care	**INC**	Contrast control CLK line
0xA00B–0xA00F	Reserved	Not used
0xE000 (W/R) command data byte	**/PE7-LCDM-CS**	SED1335 command register
0xE001 (W/R) data register byte	**/PE7-LCDM-CS**	SED1335 data register

APPENDIX B. POWER SUPPLY

Appendix B describes the power circuitry provided on the OP7200.

B.1 Power Supplies

Power is supplied to the OP7200 via pins 1 and 2 of screw-terminal header J3. The OP7200 is protected against reverse polarity by a full-wave bridge rectifier as shown in Figure B-1. The full-wave bridge rectifier also allows the OP7200 to be powered from 24 V AC.

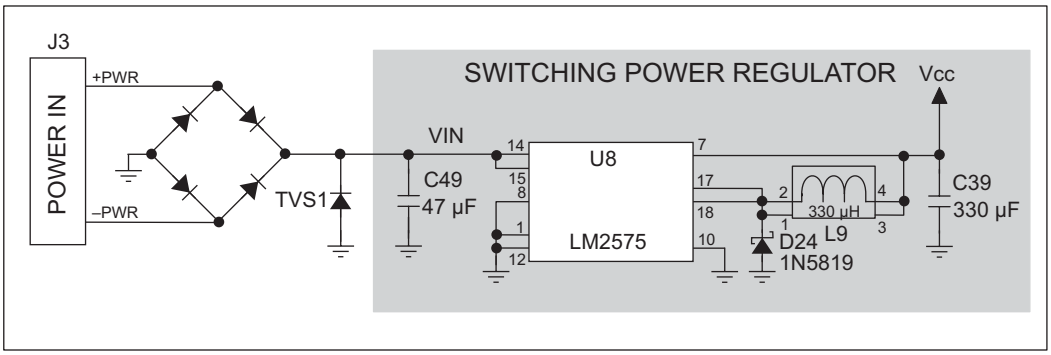


Figure B-1. OP7200 Power Supply

The input voltage range is from 9 V to 40 V DC. A switching power regulator is used to provide a Vcc of +5 V for the OP7200 logic circuits. Vcc is can be made accessible to the user by installing a 0 Ω resistor at R71. Vcc will then be available instead of digital input IN15 on pin 4 of screw-terminal header J10.

The OP7200 can alternatively be powered by 24 V AC. In this case the full-wave bridge rectifier produces approximately 30 V DC at the input of the switching regulator. Although a significant drop will be measured at the input to the switching regulator, the voltage will never drop below +9 V DC. As long as the minimum input level is maintained at the input to the regulator, Vcc will be held at +5 V DC.

There is provision on the printed-circuit board for a transorb to be installed at TVS1 in parallel with C49 to provide suppression for positive noise pulses above 51 V. This part is only needed when the OP7200 will be used in industrial environments where a clean source of power cannot be guaranteed, and is not part of the normal factory build.

B.1.1 Power for Analog Circuits

Power to the analog circuits is provided by way of a single-stage low-pass filter, which isolates the analog section from digital noise generated by the other components. The analog power voltage +V powers the A/D converter chip, the touchscreen controller, and the reference circuit. The maximum current draw on +V is less than 10 mA. +V is not accessible to the user.

B.1.2 Grounds

There are three grounds, one digital ground on screw-terminal headers J3 (pin 12) and J10 (pin 12), and an analog ground on screw-terminal header J2 (pin 12). The digital and analog grounds share a single split ground plane on the printed-circuit board. Keeping the grounds separate isolates the noise of the digital section from the analog circuits, providing for improved performance of the A/D converter chip and the touchscreen controller.

The analog ground is connected at a single point to the digital ground by a single copper bridge to eliminate the possibility of ground loops. Analog ground should be used as the return path for inputs connected to the A/D converter chip via pins 4–11 of screw-terminal header J2.

B.1.3 RabbitNet Power Supplies

There is no provision on the OP7200 to supply power to any RabbitNet peripheral cards that together with the OP7200 make up a RabbitNet LAN.

B.2 Batteries and External Battery Connections

The SRAM and the real-time clock have battery backup. Power to the SRAM and the real-time clock (VRAM) on the OP7200's RabbitCore module is provided by two different sources, depending on whether the main part of the OP7200 is powered or not. When the OP7200 is powered normally, and Vcc is within operating limits, the SRAM and the real-time clock are powered from Vcc. If power to the board is lost or falls below 4.63 V, the VRAM and real-time clock power will come from the battery. The reset generator circuit controls the source of power by way of its **/RESET** output signal.

A replaceable 265 mA·h lithium battery provides power to the real-time clock and SRAM when external power is removed from the circuit board. The drain on the battery is typically less than 10 µA when there is no external power applied to the OP7200, and so the expected shelf life of the battery is

$$\frac{265\ \text{mA}\cdot\text{h}}{10\ \mu\text{A}} = 3.0\ \text{years}.$$

The drain on the battery is typically less than 4 µA when external power ***is*** applied, and so the expected battery in-service life is

$$\frac{265\ \text{mA}\cdot\text{h}}{4\ \mu\text{A}} = 7.5\ \text{years}.$$

B.2.1 Replacing the Backup Battery

The battery is user-replaceable, and is fitted in a battery holder. To replace the battery, lift up on the spring clip and slide out the old battery. Use only a Panasonic BR2330 or equivalent replacement battery, and insert it into the battery holder with the + side facing up.

NOTE: The SRAM contents and the real-time clock settings will be lost if the battery is replaced with no power applied to the OP7200. Exercise care if you replace the battery while external power is applied to the OP7200.

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.

B.2.2 External Battery

As an alternative to preserving the SRAM contents and the real-time clock settings while changing the backup battery, you may connect an external battery temporarily at header J7. The pins on header J7 have ground on the ends and positive in the center to allow the external battery to be connected without the potential of reversing its polarity. Connect the positive terminal of the external battery to pin 2 and the negative terminal to either pin 1 or pin 3 of header J7.

The onboard battery does not have to be removed as it is protected against overvoltage by resistors R80–R81. By having both batteries connected, either can be replaced from time to time without losing the data stored in the SRAM and the real-time clock. The external battery should be no more than 6.3 V.

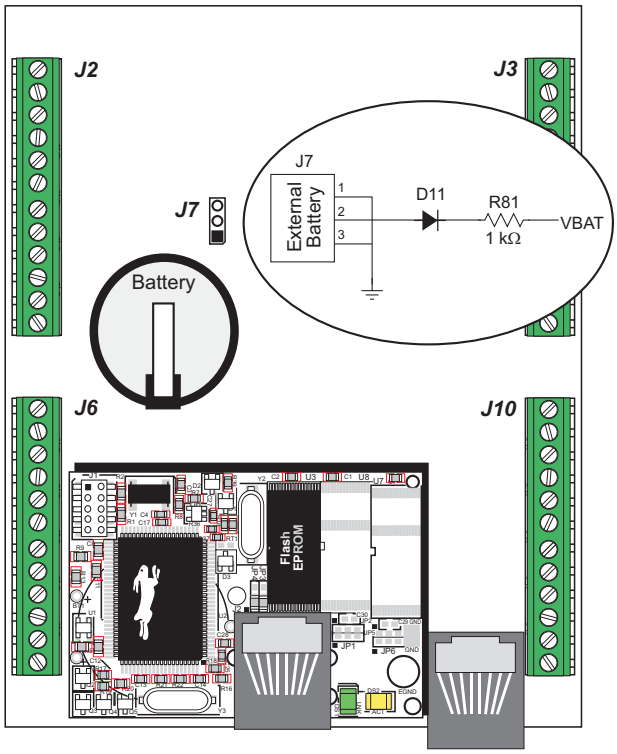


Figure B-2. OP7200 External Battery Connections

B.2.3 Battery-Backup Circuit

Figure B-3 shows the battery-backup circuit located on the OP7200's RabbitCore module.

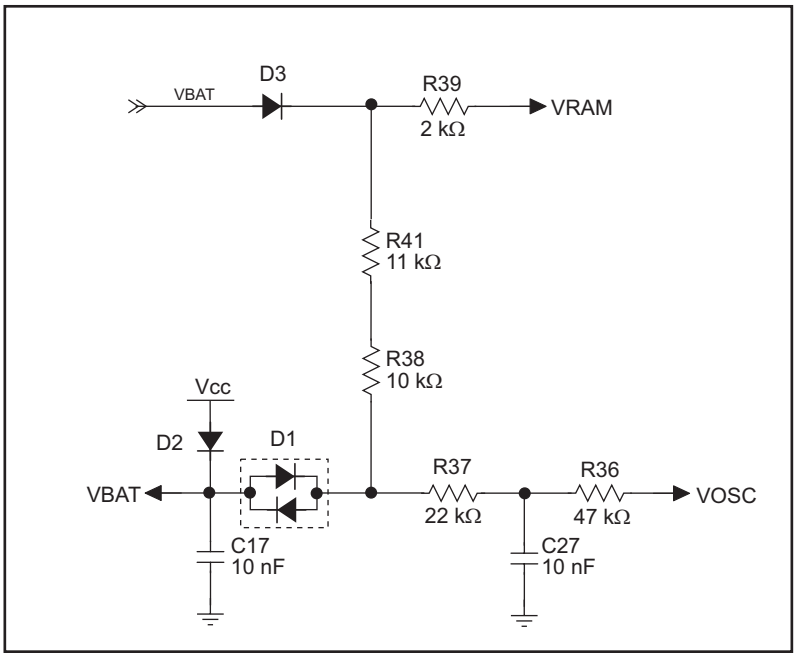


Figure B-3. OP7200 Backup Battery Circuit

The battery-backup circuit serves three purposes:

- It reduces the battery voltage to the SRAM and to the real-time clock, thereby limiting the current consumed by the real-time clock and lengthening the battery life.
- It ensures that current can flow only ***out*** of the battery to prevent charging the battery.
- A voltage, VOSC, is supplied to U6, which keeps the 32.768 kHz oscillator working when the voltage begins to drop.

VRAM and Vcc are nearly equal (<100 mV, typically 10 mV) when power is supplied to the OP7200.

B.2.4 Power to VRAM Switch

The VRAM switch on the OP7200's RabbitCore module, shown in Figure B-4, allows the battery backup to provide power when the external power goes off. The switch provides an isolation between Vcc and the battery when Vcc goes low. This prevents the Vcc line from draining the battery.

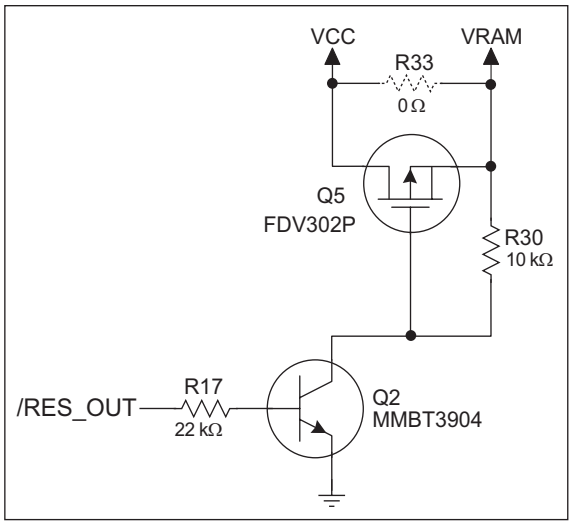


Figure B-4. VRAM Switch

Field-effect transistor Q5 is needed to provide a very small voltage drop between Vcc and VRAM (<100 mV, typically 10 mV) so that the board components powered by Vcc will not have a significantly different voltage than VRAM.

When the OP7200 is ***not*** in reset, the **/RES_OUT** line will be high. This turns on Q2, causing its collector to go low. This turns on Q5, allowing VRAM to nearly equal Vcc.

When the OP7200 ***is*** in reset, the **/RES_OUT** line will go low. This turns off Q2 and Q5, providing an isolation between Vcc and VRAM.

B.2.5 Reset Generator

The OP7200's RabbitCore module uses a reset generator on the module, U1, to reset the Rabbit 2000 microprocessor when the voltage drops below the voltage necessary for reliable operation. The reset occurs between 4.50 V and 4.75 V, typically 4.63 V.

B.3 Chip Select Circuit

Figure B-5 shows a schematic of the chip select circuit on the OP7200's RabbitCore module.

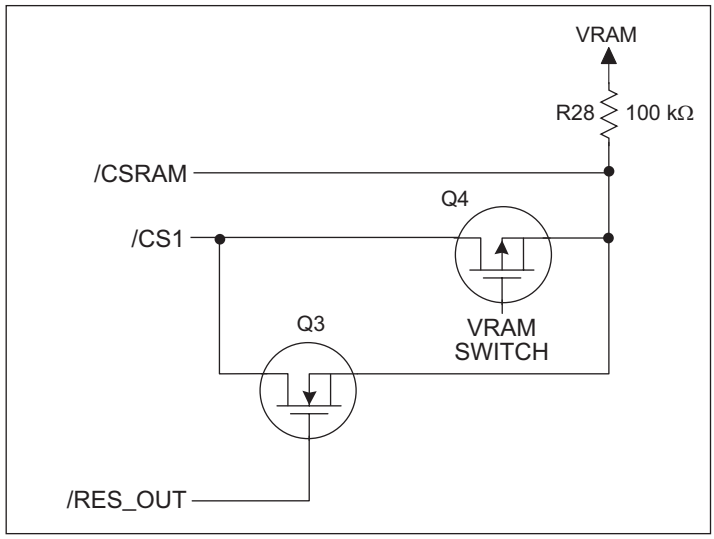


Figure B-5. Chip Select Circuit

The current drain on the battery in a battery-backed circuit must be kept at a minimum. When the OP7200 is not powered, the battery keeps the SRAM memory contents and the real-time clock (RTC) going. The SRAM has a powerdown mode that greatly reduces power consumption. This powerdown mode is activated by raising the chip select (CS) signal line. Normally the SRAM requires Vcc to operate. However, only 2 V is required for data retention in powerdown mode. Thus, when power is removed from the circuit, the battery voltage needs to be provided to both the SRAM power pin and to the CS signal line. The CS control circuit accomplishes this task for the SRAM's chip select signal line.

In a powered-up condition, the CS control circuit must allow the processor's chip select signal /CS1 to control the SRAM's CS signal /CSRAM. So, with power applied, /CSRAM must be the same signal as /CS1, and with power removed, /CSRAM must be held high (but only needs to be battery voltage high). Q3 and Q4 are MOSFET transistors with complementary polarity. They are both turned on when power is applied to the circuit. They allow the CS signal to pass from the processor to the SRAM so that the processor can periodically access the SRAM. When power is removed from the circuit, the transistors will turn off and isolate /CSRAM from the processor. The isolated /CSRAM line has a 100 kΩ pullup resistor to VRAM (R28). This pullup resistor keeps /CSRAM at the VRAM voltage level (which under no power condition is the backup battery's regulated voltage at a little more than 2 V).

Transistors Q3 and Q4 are of opposite polarity so that a rail-to-rail voltage can be passed. When the /CS1 voltage is low, Q3 will conduct. When the /CS1 voltage is high, Q4 conducts. It takes time for the transistors to turn on, creating a propagation delay. This propagation delay is typically very small, about 10 ns to 15 ns.

APPENDIX C. DEMONSTRATION BOARD CONNECTIONS

Appendix C shows how to connect the Demonstration Board to the OP7200.

C.1 Connecting Demonstration Board

Before running sample programs based on the Demonstration Board, you will have to connect the Demonstration Board from the OP7200 Tool Kit to the OP7200 board. Proceed as follows.

1. Use the wires included in the OP7200 Tool Kit to connect header J1 on the Demonstration Board to the OP7200. The connections are shown in Figure C-1 for sample program **`DIGIN.C`**, in Figure C-2 for sample program **`DIGOUT.C`**, and in Figure C-3 for the **`OP7200\TCPIP`** TCP/IP sample programs.
2. Make sure that your OP7200 is connected to your PC and that the power supply is connected to the OP7200 and plugged in as described in Chapter 2, “Getting Started.”

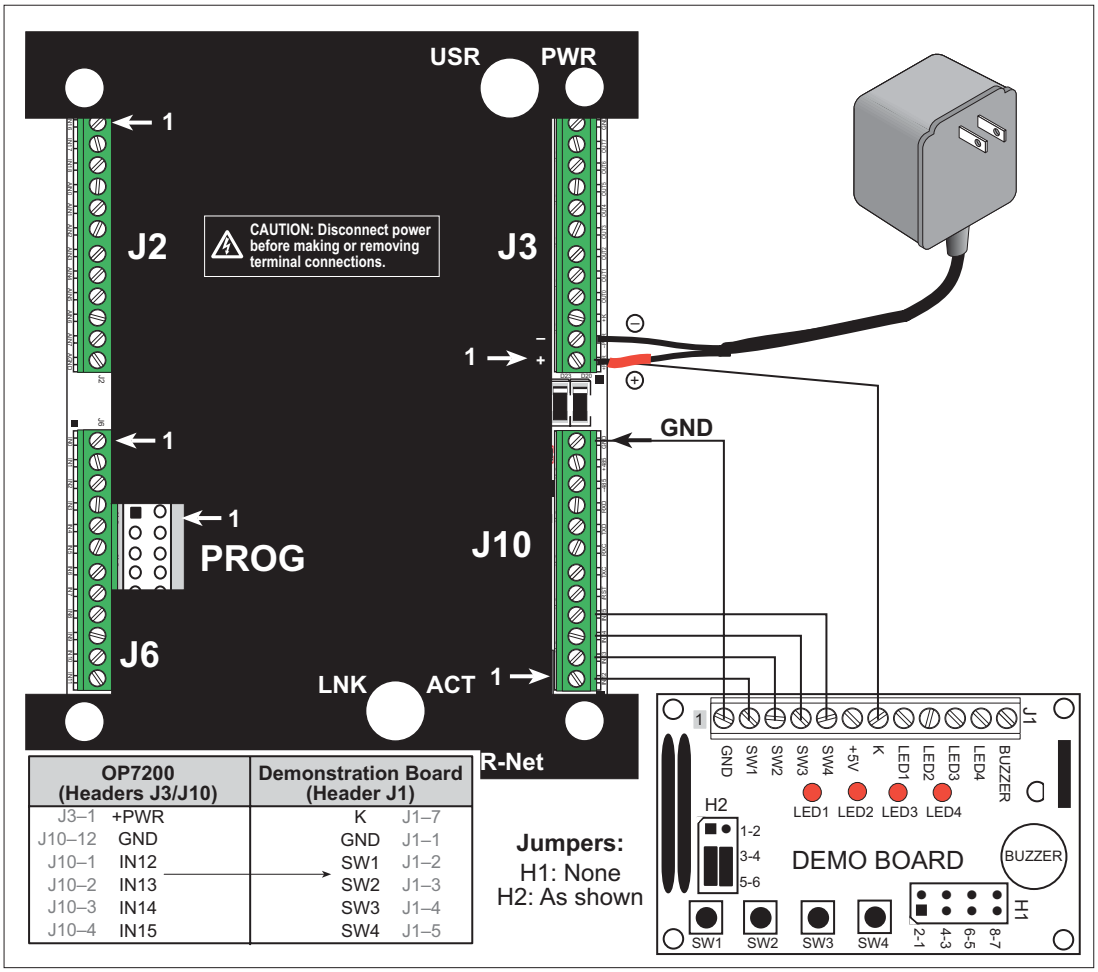


Figure C-1. Connections Between OP7200 and Demonstration Board for `DIGIN.C` Sample Program

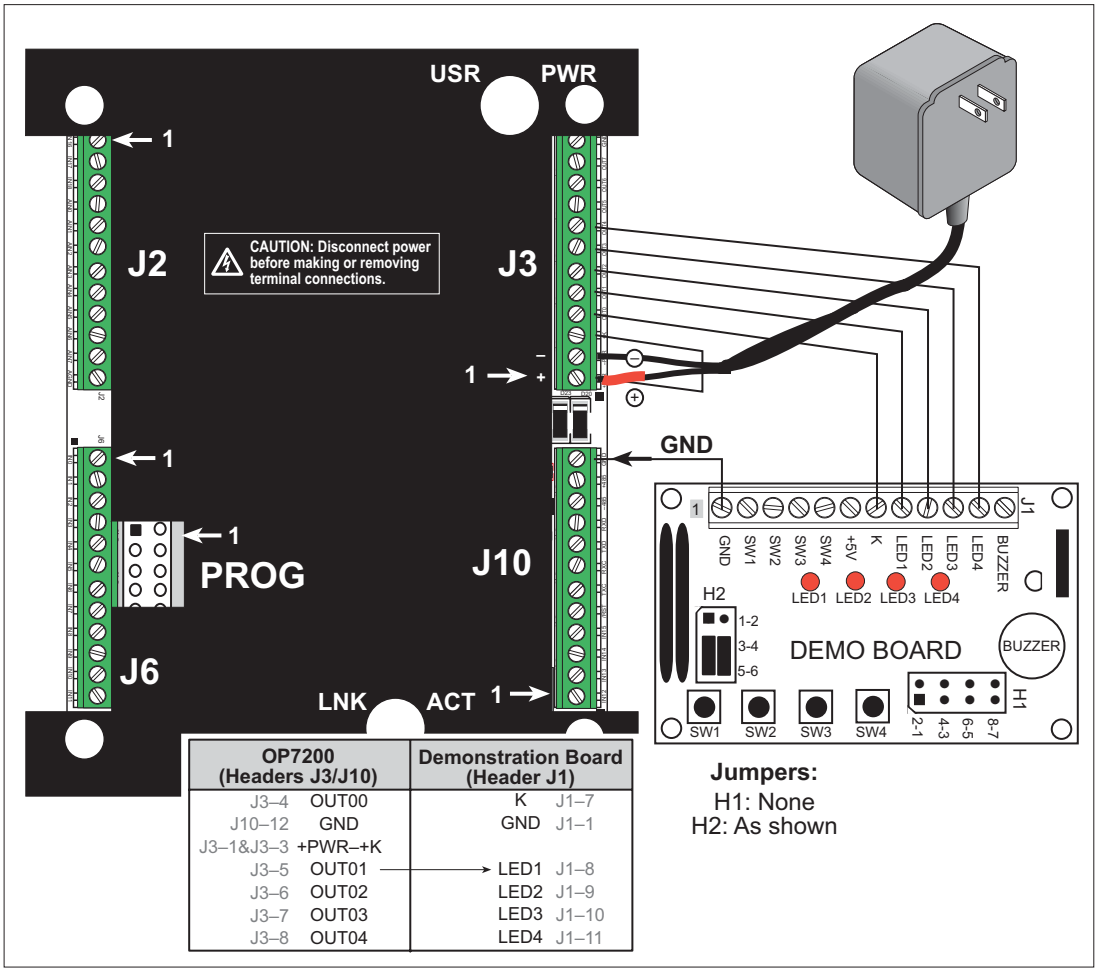
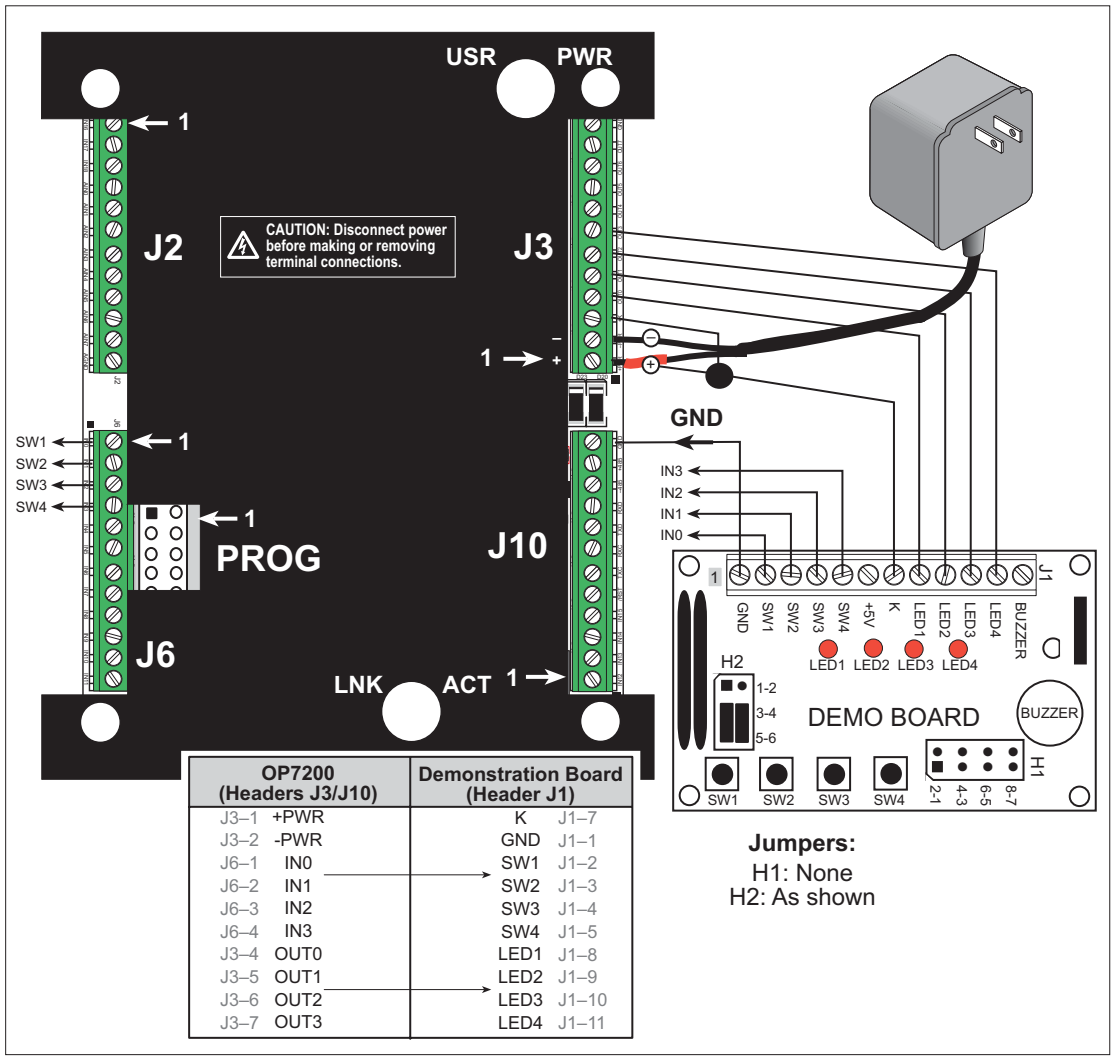


Figure C-2. Connections Between OP7200 and Demonstration Board for `DIGOUT.C` Sample Program



OP7200 (Headers J3/J10)		Demonstration Board (Header J1)	
J3–1	+PWR	K	J1–7
J3–2	-PWR	GND	J1–1
J6–1	IN0	SW1	J1–2
J6–2	IN1	SW2	J1–3
J6–3	IN2	SW3	J1–4
J6–4	IN3	SW4	J1–5
J3–4	OUT0	LED1	J1–8
J3–5	OUT1	LED2	J1–9
J3–6	OUT2	LED3	J1–10
J3–7	OUT3	LED4	J1–11

Figure C-3. Connections Between OP7200 and Demonstration Board for TCP/IP Sample Programs

APPENDIX D. RABBITNET

D.1 General RabbitNet Description

RabbitNet is a high-speed synchronous protocol developed by Rabbit to connect peripheral cards to a master and to allow them to communicate with each other.

D.1.1 RabbitNet Connections

All RabbitNet connections are made point to point. A RabbitNet master port can only be connected directly to a peripheral card, and the number of peripheral cards is limited by the number of available RabbitNet ports on the master.

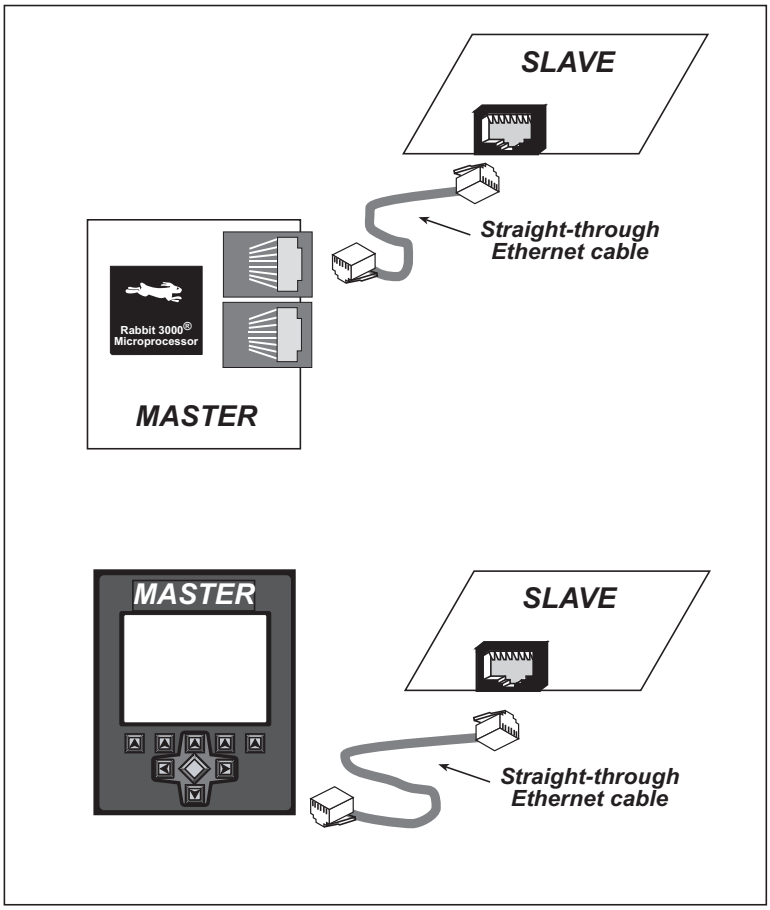


Figure D-1. Connecting Peripheral Cards to a Master

Use a straight-through Ethernet cable to connect the master to slave peripheral cards, unless you are using a device such as the OP7200 that could be used either as a master or a slave. In this case you would use a crossover cable to connect an OP7200 that is being used as a slave (note that Dynamic C does not support the operation of the OP7200 as a slave at the present time).

Distances between a master unit and peripheral cards can be up to 10 m or 33 ft.

D.1.2 RabbitNet Peripheral Cards

- Digital I/O

  24 inputs, 16 push/pull outputs, 4 channels of 10-bit A/D conversion with ranges of 0 to 10 V, 0 to 1 V, and -0.25 to +0.25 V. The following connectors are used:

  Signal = 0.1" friction-lock connectors
  Power = 0.156" friction-lock connectors
  RabbitNet = RJ-45 connector

- A/D converter

  8 channels of programmable-gain 12-bit A/D conversion, configurable as current measurement and differential-input pairs. 2.5 V reference voltage is available on the connector. The following connectors are used:

  Signal = 0.1" friction-lock connectors
  Power = 0.156" friction-lock connectors
  RabbitNet = RJ-45 connector

- D/A converter

  8 channels of 0–10 V 12-bit D/A conversion. The following connectors are used:

  Signal = 0.1" friction-lock connectors
  Power = 0.156" friction-lock connectors
  RabbitNet = RJ-45 connector

- Display/Keypad interface

  allows you to connect your own keypad with up to 64 keys and one character liquid crystal display from 1 × 8 to 4 × 40 characters with or without backlight using standard 1 × 16 or 2 × 8 connectors. The following connectors are used:

  Signal = 0.1" headers or sockets
  Power = 0.156" friction-lock connectors
  RabbitNet = RJ-45 connector

- Relay card

  6 relays rated at 250 V AC, 1200 V·A or 100 V DC up to 240 W. The following connectors are used:

  Relay contacts = screw-terminal connectors
  Power = 0.156" friction-lock connectors
  RabbitNet = RJ-45 connector

Visit our Web site for up-to-date information about additional cards and features as they become available. The Web site also has the latest revision of this user's manual.

D.2 Physical Implementation

There are four signaling functions associated with a RabbitNet connection. From the master's point of view, the transmit function carries information and commands to the peripheral board. The receive function is used to read back information sent to the master by the peripheral board. A clock is used to synchronize data going between the two devices at high speed. The master is the source of this clock. A slave select (SS) function originates at the master, and when detected by a peripheral board causes it to become selected and respond to commands received from the master.

The signals themselves are differential RS-422, which are series-terminated at the source. With this type of termination, the maximum frequency is limited by the round-trip delay time of the cable. Although a peripheral board could theoretically be up to 45 m (150 ft) from the master for a data rate of 1 MHz, Rabbit recommends a practical limit of 10 m (33 ft).

Connections between peripheral boards and masters are done using standard 8-conductor Ethernet cables. Masters and peripheral cards are equipped with RJ-45 8-pin female connectors. The cables are nonpolarized in that they may be swapped end for end without affecting any functionality.

D.2.1 Control and Routing

Control starts at the master when the master asserts the slave select signal (SS). Then it simultaneously sends a serial command and clock. The first byte of a command contains the address of the peripheral card if more than one peripheral card is connected.

A peripheral card assumes it is selected as soon as it receives the select signal. For direct master-to-peripheral-card connections, this is as soon as the master asserts the select signal. The connection is established once the select signal reaches the addressed slave. At this point communication between the master and the selected peripheral card is established, and data can flow in both directions simultaneously. The connection is maintained so long as the master asserts the select signal.

D.3 Function Calls

The function calls described in this section are used with all RabbitNet peripheral boards, and are available in the **RNET.LIB** library in the Dynamic C **RABBITNET** folder.

If you are planning to use any of the RS-232 serial ports ***and*** the RabbitNet port on the OP7200, initialize the serial port(s) ***before*** you initialize the RabbitNet port. The following sample code illustrates this sequence.

```
// Initialize Serial Port C, set baud rate to 19200
serCopen(19200);
serCwrFlush();
serCrdFlush();

// Initialize Serial Port D, set baud rate to 19200
serDopen(19200);
serDwrFlush();
serDrdFlush();

// Set serial mode...must be done after serXopen function(s)
and before Rabbitnet initialization
serMode(0);

// Initialize RabbitNet port
rn_init(RN_PORTS, 1);
```

int rn_init(char portflag, char servicetype);

Resets, initializes, or disables a specified RabbitNet port on the master single-board computer. During initialization, the network is enumerated and relevant tables are filled in. If the port is already initialized, calling this function forces a re-enumeration of all devices on that port.

Call this function first before using other RabbitNet functions.

PARAMETERS

portflag is a bit that represents a RabbitNet port on the master single-board computer (from 0 to the maximum number of ports). A set bit requires a service. If **portflag** = 0x03, both RabbitNet ports 0 and 1 will need to be serviced.

servicetype enables or disables each RabbitNet port as set by the port flags.

0 = disable port
1 = enable port

RETURN VALUE

0

int rn_device(char pna);

Returns an address index to device information from a given physical node address. This function will check device information to determine that the peripheral board is connected to a master.

PARAMETER

pna is the physical node address, indicated as a byte.

7,6—Port number
5,4,3—Level 1 downstream port
2,1,0—Level 2 downstream port

RETURN VALUE

Pointer to device information. -1 indicates that the peripheral board either cannot be identified or is not connected to the master.

SEE ALSO

rn_find

int rn_find(rn_search *srch);

Locates the first active device that matches the search criteria.

PARAMETER

srch is the search criteria structure **rn_search:**

```
unsigned int flags;     // status flags see MATCH macros below
unsigned int ports;     // port bitmask
char productid;         // product id
char productrev;        // product rev
char coderev;           // code rev
long serialnum;         // serial number
```

Use a maximum of 3 macros for the search criteria:

```
RN_MATCH_PORT          // match port bitmask
RN_MATCH_PNA           // match physical node address
RN_MATCH_HANDLE        // match instance (reg 3)
RN_MATCH_PRDID         // match id/version (reg 1)
RN_MATCH_PRDREV        // match product revision
RN_MATCH_CODEREV       // match code revision
RN_MATCH_SN            // match serial number
```

For example:

```
rn_search newdev;
newdev.flags = RN_MATCH_PORT|RN_MATCH_SN;
newdev.ports = 0x03; //search ports 0 and 1
newdev.serialnum = E3446C01L;
handle = rn_find(&newdev);
```

RETURN VALUE

Returns the handle of the first device matching the criteria. 0 indicates no such devices were found.

SEE ALSO

rn_device

```
int rn_echo(int handle, char sendecho,
   char *recdata);
```

The peripheral board sends back the character the master sent. This function will check device information to determine that the peripheral board is connected to a master.

PARAMETERS

`handle` is an address index to device information. Use **`rn_device()`** or **`rn_find()`** to establish the handle.

`sendecho` is the character to echo back.

`recdata` is a pointer to the return address of the character from the device.

RETURN VALUE

The status byte from the previous command. -1 means that device information indicates the peripheral board is not connected to the master.

```
int rn_write(int handle, int regno, char *data,
   int datalen);
```

Writes a string to the specified device and register. Waits for results. This function will check device information to determine that the peripheral board is connected to a master.

PARAMETERS

`handle` is an address index to device information. Use **`rn_device()`** or **`rn_find()`** to establish the handle.

`regno` is the command register number as designated by each device.

`data` is a pointer to the address of the string to write to the device.

`datalen` is the number of bytes to write (0–15).

> **NOTE:** A data length of 0 will transmit the one-byte command register number.

RETURN VALUE

The status byte from the previous command. -1 means that device information indicates the peripheral board is not connected to the master, and -2 means that the data length was greater than 15.

SEE ALSO

`rn_read`

int rn_read(int handle, int regno, char *recdata, int datalen);

Reads a string from the specified device and register. Waits for results. This function will check device information to determine that the peripheral board is connected to a master.

PARAMETERS

handle is an address index to device information. Use **rn_device()** or **rn_find()** to establish the handle.

regno is the command register number as designated by each device.

recdata is a pointer to the address of the string to read from the device.

datalen is the number of bytes to read (0–15).

NOTE: A data length of 0 will transmit the one-byte command register number.

RETURN VALUE

The status byte from the previous command. -1 means that device information indicates the peripheral board is not connected to the master, and -2 means that the data length was greater than 15.

SEE ALSO

rn_write

int rn_reset(int handle, int resettype);

Sends a reset sequence to the specified peripheral board. The reset takes approximately 25 ms before the peripheral board will once again execute the application. Allow 1.5 seconds after the reset has completed before accessing the peripheral board. This function will check peripheral board information to determine that the peripheral board is connected to a master.

PARAMETERS

handle is an address index to device information. Use **rn_device()** or **rn_find()** to establish the handle.

resettype describes the type of reset.

0 = hard reset—equivalent to power-up. All logic is reset.
1 = soft reset—only the microprocessor logic is reset.

RETURN VALUE

The status byte from the previous command. -1 means that device information indicates the peripheral board is not connected to the master.

int rn_sw_wdt(int handle, float timeout);

Sets software watchdog timeout period. Call this function prior to enabling the software watchdog timer. This function will check device information to determine that the peripheral board is connected to a master.

PARAMETERS

handle is an address index to device information. Use **rn_device()** or **rn_find()** to establish the handle.

timeout is a timeout period from 0.025 to 6.375 seconds in increments of 0.025 seconds. Entering a zero value will disable the software watchdog timer.

RETURN VALUE

The status byte from the previous command. -1 means that device information indicates the peripheral board is not connected to the master.

int rn_enable_wdt(int handle, int wdttype);

Enables the hardware and/or software watchdog timers on a peripheral board. The software on the peripheral board will keep the hardware watchdog timer updated, but will hard reset if the time expires. The hardware watchdog cannot be disabled except by a hard reset on the peripheral board. The software watchdog timer must be updated by software on the master. The peripheral board will soft reset if the timeout set by **rn_sw_wdt()** expires. This function will check device information to determine that the peripheral board is connected to a master.

PARAMETERS

handle is an address index to device information. Use **rn_device()** or **rn_find()** to establish the handle.

wdttype

0 enables both hardware and software watchdog timers
1 enables hardware watchdog timer
2 enables software watchdog timer

RETURN VALUE

The status byte from the previous command. -1 means that device information indicates the peripheral board is not connected to the master.

SEE ALSO

rn_hitwd, rn_sw_wdt

int rn_hitwd(int handle, char *count);

Hits software watchdog. Set the timeout period and enable the software watchdog prior to using this function. This function will check device information to determine that the peripheral board is connected to a master.

PARAMETERS

handle is an address index to device information. Use **rn_device()** or **rn_find()** to establish the handle.

count is a pointer to return the present count of the software watchdog timer. The equivalent time left in seconds can be determined from **count** × 0.025 seconds.

RETURN VALUE

The status byte from the previous command. -1 means that device information indicates the peripheral board is not connected to the master.

SEE ALSO

rn_enable_wdt, rn_sw_wdt

int rn_rst_status(int handle, char *retdata);

Reads the status of which reset occurred and whether any watchdogs are enabled.

PARAMETERS

handle is an address index to device information. Use **rn_device()** or **rn_find()** to establish the handle.

retdata is a pointer to the return address of the communication byte. A set bit indicates which error occurred. This register is cleared when read.

7—HW reset has occurred
6—SW reset has occurred
5—HW watchdog enabled
4—SW watchdog enabled
3,2,1,0—Reserved

RETURN VALUE

The status byte from the previous command.

```
int rn_comm_status(int handle, char *retdata);
```

PARAMETERS

handle is an address index to device information. Use **rn_device()** or **rn_find()** to establish the handle.

retdata is a pointer to the return address of the communication byte. A set bit indicates which error occurred. This register is cleared when read.

7—Data available and waiting to be processed MOSI (master out, slave in)
6—Write collision MISO (master in, slave out)
5—Overrun MOSI (master out, slave in)
4—Mode fault, device detected hardware fault
3—Data compare error detected by device
2,1,0—Reserved

RETURN VALUE

The status byte from the previous command.

D.3.1 Status Byte

Unless otherwise specified, functions returning a status byte will have the following format for each designated bit.

7	6	5	4	3	2	1	0	
×	×							00 = Reserved 01 = Ready 02 = Busy 03 = Device not connected
		×						0 = Device 1 = Hub
			×					Reserved for devices
				×				Reserved for devices
					×			Reserved for devices
						×		0 = Last command accepted 1 = Last command unexecuted
							×	0 = Not expired 1 = HW or SW watchdog timer expired*

* Use the function **rn_rst_status()** to determine which timer expired.

INDEX

K

L

M

O

P

R

S

T

U

SCHEMATICS

090-0120 RCM2200 Schematic

www.rabbit.com/documentation/schemat/090-0120.pdf

090-0138 OP7200 Schematic

www.rabbit.com/documentation/schemat/090-0138.pdf

090-0042 Demonstration Board Schematic

www.rabbit.com/documentation/schemat/090-0042.pdf

090-0128 Programming Cable Schematic

www.rabbit.com/documentation/schemat/090-0128.pdf

You may use the URL information provided above to access the latest schematics directly.