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PRODUCT MANUAL


# OP7100

**Serial Graphic Display**

## User's Manual

019–0065 • 070831–O

# OP7100 User's Manual

Part Number 019-0065 • 070831-O • Printed in U.S.A.



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# TABLE OF CONTENTS

# ABOUT THIS MANUAL

This manual provides instructions for installing, testing, configuring, and interconnecting the Rabbit Semiconductor OP7100 touchscreen operator interface. Instructions are also provided for using Dynamic C functions.

## Assumptions

Assumptions are made regarding the user's knowledge and experience in the following areas.

- Ability to design and engineer the target system that interfaces with the OP7100.
- Understanding the basics of operating a software program and editing files under Windows on a PC.
- Knowledge of the basics of C programming.

For a full treatment of C, refer to the following texts.

***The C Programming Language*** by Kernighan and Ritchie

and/or

***C: A Reference Manual*** by Harbison and Steel

- Knowledge of basic assembly language and architecture for the Z180 microprocessor.

For documentation from Zilog, refer to the following texts.

***Z180 MPU User's Manual***
***Z180 Serial Communication Controllers***
***Z80 Microprocessor Family User's Manual***

## Acronyms

Table 1 lists and defines the acronyms that may be used in this manual.

***Table 1. Acronyms***

| Acronym | Meaning |
|---|---|
| EPROM | Erasable Programmable Read-Only Memory |
| EEPROM | Electronically Erasable Programmable Read-Only Memory |
| LCD | Liquid Crystal Display |
| LED | Light-Emitting Diode |
| NMI | Nonmaskable Interrupt |
| PIO | Parallel Input/Output Circuit<br>(Individually Programmable Input/Output) |
| PRT | Programmable Reload Timer |
| RAM | Random Access Memory |
| RTC | Real-Time Clock |
| SIB | Serial Interface Board |
| SRAM | Static Random Access Memory |
| UART | Universal Asynchronous Receiver Transmitter |

## Icons

Table 2 displays and defines icons that may be used in this manual.

***Table 2. Icons***

| Icon | Meaning | Icon | Meaning |
|---|---|---|---|
|  | Refer to or see |  | Note |
|  | Please contact | Tip | Tip |
|  | Caution |  | High Voltage |
|  | Factory Default | | |

## Conventions

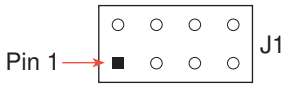
Table 3 lists and defines the typographical conventions that may be used in this manual.

***Table 3. Typographical Conventions***

| Example | Description |
|---|---|
| **`while`** | Courier font (bold) indicates a program, a fragment of a program, or a Dynamic C keyword or phrase. |
| `// IN-01…` | Program comments are written in Courier font, plain face. |
| *Italics* | Indicates that something should be typed instead of the italicized words (e.g., in place of *filename*, type a file's name). |
| **Edit** | Sans serif font (bold) signifies a menu or menu selection. |
| . . . | An ellipsis indicates that (1) irrelevant program text is omitted for brevity or that (2) preceding program text may be repeated indefinitely. |
| [ ] | Brackets in a C function's definition or program segment indicate that the enclosed directive is optional. |
| < > | Angle brackets occasionally enclose classes of terms. |
| a \| b \| c | A vertical bar indicates that a choice should be made from among the items listed. |

### *Pin Number 1*

A black square indicates pin 1 of all headers.




### *Measurements*

All diagram and graphic measurements are in inches followed by millimeters enclosed in parenthesis.

# CHAPTER 1: OVERVIEW

Chapter 1 provides an overview and a brief description of the OP7100 features.

# Introduction

The OP7100 is a serial graphic display in a compact, easy to integrate module. The OP7100 features an LCD that has a white background with blue images. The LCD has pixel graphics and provides two-color (monochrome) displays. Five standard fonts are included in the supplied software. Additional custom fonts are easily created to meet the needs of an application.

The OP7100 can operate with Rabbit Semiconductor single-board computers or other serial displays over an RS-485 network. The OP7100 also supports RS-232 communication.

The OP7100 display terminal uses display technologies that require minimal mounting depth and offer maximum viewing angles. The memory allows up to 25 application-screen bitmaps (240 × 320) to be stored without compression in a 256K flash EPROM. A further 256K is available for the application in a second flash EPROM.

Figure 1-1 illustrates the standard OP7100 board layout.

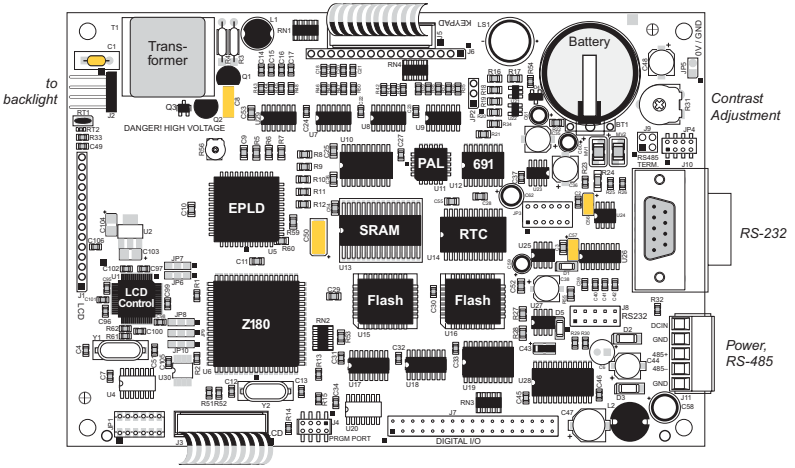



***Figure 1-1. OP7100 Board Layout***

# Features

The OP7100 includes the following features.

- 240 × 320 ¼ VGA LCD (with touchscreen on OP7100 only)
- jumper-selectable background—positive (blue images on white background) or negative (white images on blue background)
- software-controlled cold-cathode fluorescent backlighting
- software-controlled contrast is enabled/disabled with jumper settting
- temperature compensation for LCD contrast changes with temperature
- RS-485 and RS-232 serial communication up to 57,600 bps
- 8 CMOS/TTL-level digital inputs and 8 CMOS/TTL-level digital outputs
- 18.432 MHz clock with Z180 microprocessor, 9.216 MHz LCD controller
- 256K flash EPROM for program, 256K flash EPROM for screen bitmaps
- switching voltage regulator

Appendix B provides detailed specifications for the OP7100.

The OP7100 also includes battery-backed RAM (128K) and a battery-backed real-time clock a watchdog timer, and power-failure interrupt.

## *Options*

The OP7100 series of serial displays has two versions. Table 1-1 lists their standard features.

***Table 1-1. OP7100 Series Features***

| Model | Features |
|---|---|
| OP7100 | Serial graphic display, touchscreen, blue and white screen, ¼VGA LCD with bezel mount, software contrast control |
| OP7110 | OP7100 with no touchscreen, manual contrast control |

Either model may be used in either a portrait or a landscape orientation by using the corresponding software library.

For ordering information, call your Rabbit Semiconuctor Sales Representative.

## Development and Evaluation Tools

The OP7100 is supported by a Tool Kit that include everything you need to start development with the OP7100.

The Tool Kit includes these items.

- Serial cable
- 24 V DC power supply capable of delivering 1.1 A
- User's manual with schematics

An optional Serial Interface Board (SIB) is available to program the OP7100 when a second RS-232 serial port is needed by the application being developed.

For ordering information, call your Rabbit Semiconductor Sales Representative.

### *Software*

The OP7100 is programmed using Rabbit Semiconductor's Dynamic C, an integrated development environment that includes an editor, a C compiler, and a debugger. Library functions provide an easy and robust interface to the OP7100.

Rabbit Semiconductor's Dynamic C reference manuals provide complete software descriptions and programming instructions.

## CE Compliance

The OP7100 has been tested and was found to be in conformity with applicable EN immunity and emission standards. Note the following requirements for incorporating the OP7100 into your application to comply with CE requirements.

- The power supply provided with the Tool Kit is for development purpose only. It is the customer's responsibility to provide a CE compliant power supply for their end-product application.
- The OP7100 has been tested to meet the following 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.
- The OP7100 has been tested to meet the EN55022 Class A emissions standard with ferrite RFI suppressors on the I/O cables. Additional shielding or filtering may be needed to meet Class B emissions standards.

Since Rabbit Semiconductor products are connected to other devices, good EMC prac-tices should be taken to ensure compliance. CE compliance is eventually the responsibility of the integrator. For more information on tips and technical assistance, visit our Web site at www.rabbit.com/products/ce_certification/, or contact your local authorized Rabbit Semiconductor distributor.

# CHAPTER 2: GETTING STARTED

Chapter 2 provides instructions for connecting the OP7100 to a host PC and running a sample program.

# Initial OP7100 Setup

## *Parts Required*

- 24 V unregulated DC power supply capable of delivering up to 1.1 A
- Serial cable

The necessary parts are supplied with the Tool Kit.

## *Setting Up the OP7100*

1. Remove the green power connector shown in Figure 2-1 from the back of the OP7100.
2. Attach the bare leads from the power supply to the terminals on the power connector as shown in Figure 2-1.
3. Plug the connector back into the power connection header at the back of the OP7100. Watch the polarity of the connection so that the banded wire from the power supply goes to DCIN as shown in Figure 2-1.

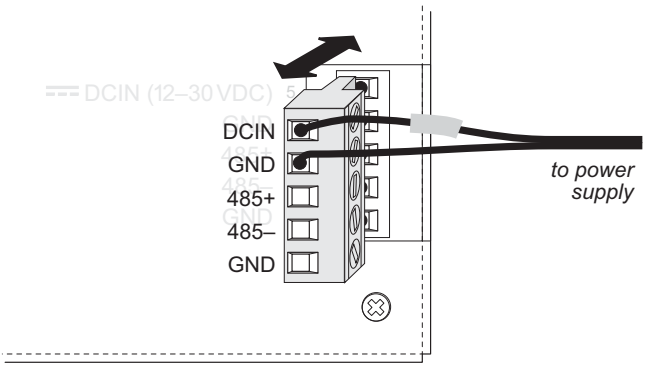



***Figure 2-1. OP7100 Power Supply Connections***

> Be careful to connect the power supply wires to the correct screw terminals on header J8. The OP7100 may be destroyed if the power supply is connected to the ***wrong*** screw terminal. A protective diode prevents damage to the OP7100 if the power supply polarity is reversed.

4. Plug the power supply into a wall outlet. The display should now light up with the demonstration screens shown in Figure 2-2.

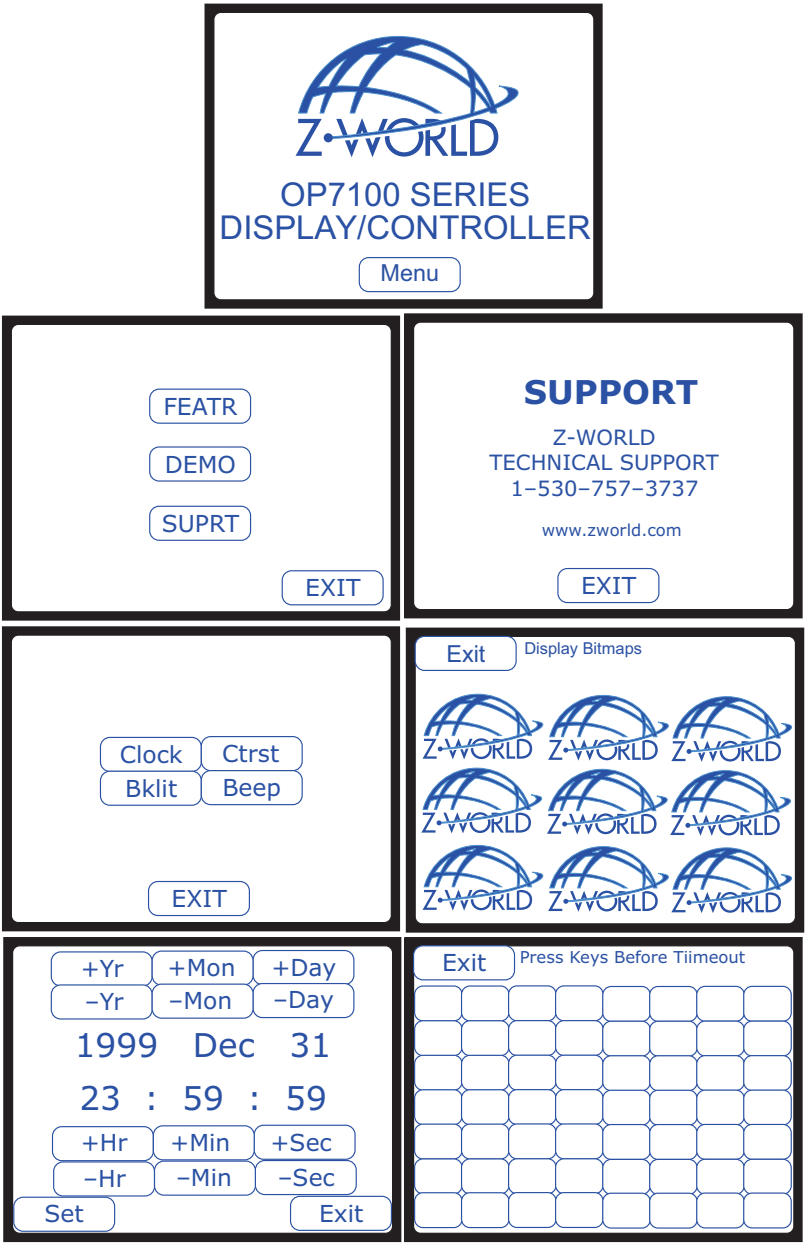



*Figure 2-2. OP7100 Demo Screens*

## Connecting the OP7100 to a Host PC

1. Unplug any power supply connected to the OP7100 and remove the back cover from the OP7100 assembly. The back cover is attached with the two screws shown in Figure 2-3.

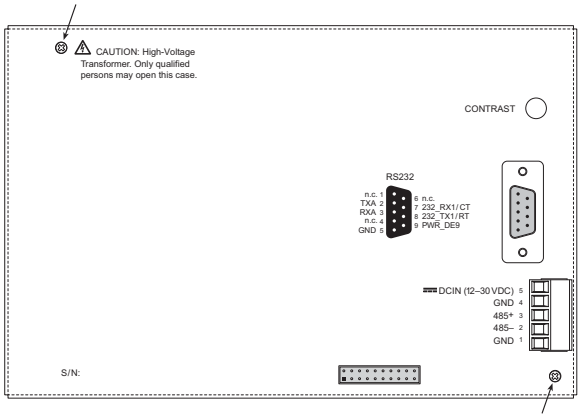



***Figure 2-3. OP7100 Back Cover***

2. Establish a serial communication link. A PC "communicates" with the OP7100 via Serial Port 0 or the Clocked Serial Input/Output port on the OP7100's Z180 microprocessor. There are two options for the serial communication link.

   **Option 1** (via optional SIB)—Connect an RJ-12 cable between the PC and the SIB. An RJ-12 to DB9 adapter is included for DB9 PC COM ports. Remove any jumpers that may be installed on the OP7100's header J4 and plug the SIB's 8-pin connector onto header J4 as shown in Figure 2-4. Make sure that pin 1 on the ribbon cable connector (on the striped side) matches up with pin 1 on J4 (indicated by a small white circle next to the header).

   **Option 2** (directly)—Place a jumper across pins 1–2 of header J4 on the OP7100 as shown in Figure 2-5. Connect the PC COM port to the DB9 jack on the OP7100, header J7, using the DB9 to DB9 serial cable supplied with the Tool Kit.

3. The OP7100 is now ready for programming. The power supply may be plugged in and turned on.

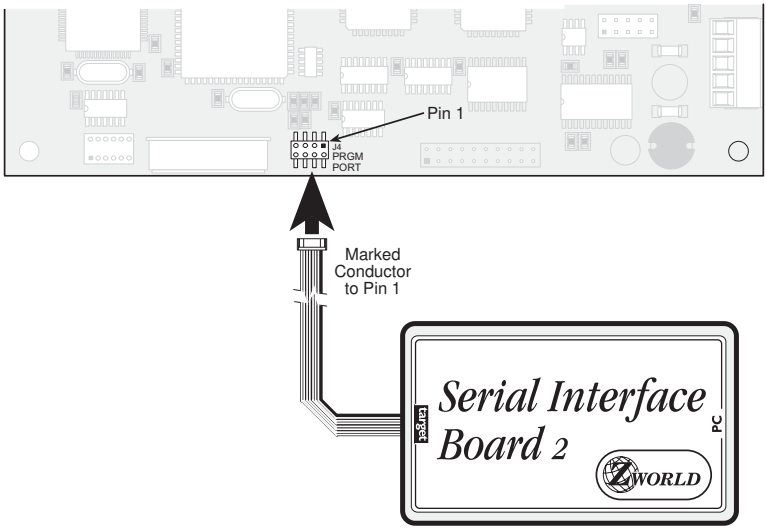



***Figure 2-4. SIB Programming Connection***

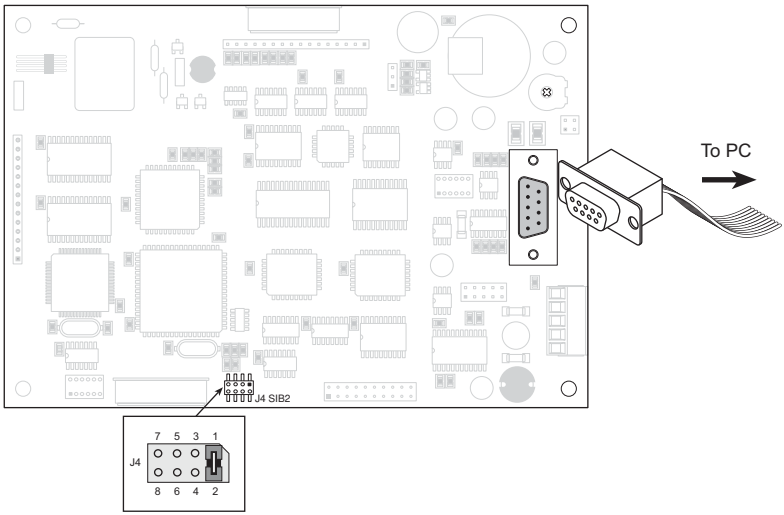



***Figure 2-5. Direct Programming Connection***

Option 2 uses an RS-232 serial port to program the OP7100. If this serial port is needed in your application, use the SIB as described in Option 1.

See Chapter 3, “Hardware,” for more information on the serial ports.

## Running Dynamic C

Double-click the Dynamic C icon to start the software. Note that the PC attempts to communicate with the OP7100 each time Dynamic C is started. No error messages are displayed once communication is established.

The communication rate, port, and protocol are all selected by choosing **Serial Options** from Dynamic C's **OPTIONS** menu. The SIB and the OP7100 both set their baud rate automatically to match the communication rate set on the host PC using Dynamic C (9600 bps, 19,200 bps, 28,800 bps, or 57,600 bps). To begin, adjust the communications rate to 19,200 bps.

Make sure that the PC serial port used to connect the serial cable (COM1 or COM2) is the one selected in the Dynamic C **OPTIONS** menu. Select the 1-stop-bit protocol.

See Appendix A, "Troubleshooting," if an error message such as **Target Not Responding** or **Communication Error** appears.

Once the necessary changes have been made to establish communication between the host PC and the OP7100, use the Dynamic C shortcut **<Ctrl Y>** to reset the controller and initiate communication.

At this point, the LCD should be blank and the backlight should be off. Once communication is established, load the sample program **DEFDEMOL.C** in the Dynamic C **SAMPLES\QVGA** subdirectory. Compile and run the program by pressing **F9** or by selecting **Run** from the **Run** menu.

The OP7100 should now alternately display the large font (17x × 35h) and the small font (6w × 8h). The fonts should scroll across the display.

Compiling and running this sample program will overwrite the demonstration program shown in Figure 2-3.

# CHAPTER 3: HARDWARE

Chapter 3 describes how to use the OP7100. Sections are included to describe the following features.

- Subsystems Overview
- Power Management
- Liquid Crystal Display
- Keyboard Interface
- Digital I/O
- Serial Communication

# OP7100 Subsystems Overview

The OP7100 consists of several subsystems, including a computing module, serial communication channels, lquid crystal display (LCD), a buzzer, and a keypad interface. Figure 3-1 provides a block diagram of the OP7100.

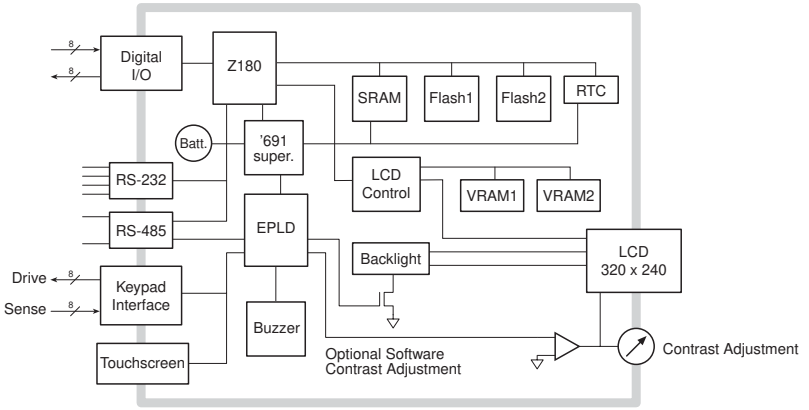



***Figure 3-1. OP7100 Block Diagram***

## *Computing Module*

The OP7100 computing module consists of a Zilog Z180 microprocessor, 128K of battery-backed static RAM, and 512K of flash EPROM. The computing module operates in tandem with a real-time clock and a watchdog timer/microprocessor supervisor.

The Z180 CPU runs at 18.432 MHz, and the LCD controller runs at 9.216 MHz.

The watchdog timer/microprocessor chip provides a watchdog timer function, power-failure detection, RAM protection, and battery backup.

The real-time clock provides time and date information to applications running on the OP7100.

The EEPROM is simulated in flash EPROM for consistency with Rabbit Semiconductor controllers whose software libraries rely on exchanging information with the EEPROM. The simulated EEPROM in the OP7100 is unused at the present time, but addresses 0 and 1 are reserved for furture use. Do not use these addresses in your application.

## Power Management

The OP7100 was designed to operate from a 12 V to 30 V DC source, and consumes about 4.5 W with the backlight on, 1.5 W with the backlight off. To allow for a surge current when the OP7100 is first turned on, the power supply used must be able to handle at least four times this power (for example, 800 mA at 24 V).

The OP7100 power supply is converted internally to supply three voltages.

1. A switching regulator outputs VCC (+ 5 V).
2. A linear regulator outputs VEE (approximately –20 V).
3. A high-voltage section supplies 300 V rms to drive the cold-cathode fluorescent backlight. The backlight can be turned on or off under software control whereby a high on the gate of Q3 enables Q1 and Q2 to oscillate, and a low turns off Q3, stopping the oscillation of Q1 and Q2.

Figure 3-2 shows these internal power supplies in a block diagram

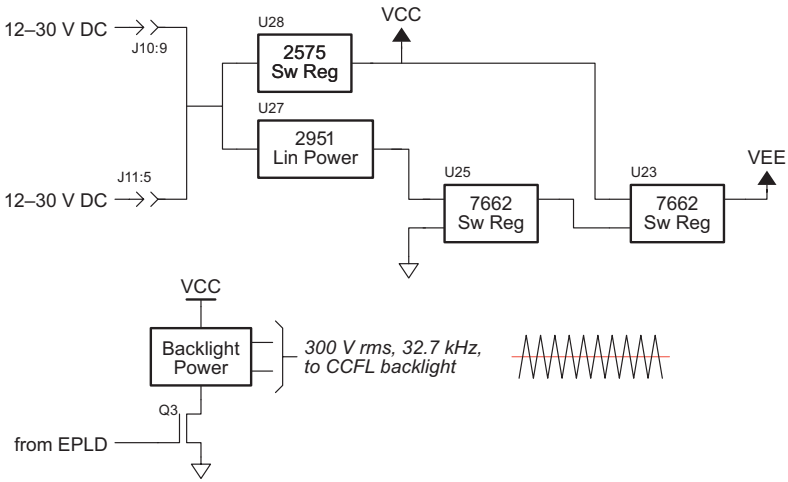



***Figure 3-2. Block Diagram of OP7100 Internal Power Regulators***

The DC input source can also be brought out on pin 9 of header J10, the DE-9 connector, by installing a 0 Ω resistor at R32. This option allows power to be supplied to a serial device connected to the OP7100 as long as the serial device's RS-232 port can handle the DC input on pin 9.

Be sure to use a power supply with sufficient capacity (for example, 1.1 A at 24 V) to handle surges when the OP7100 and any devices connected to it are first turned on.