C-Programmable Controller

PK2100 Series

The PK2100 Series of C-programmable controllers is based on the Zilog Z180 microprocessor. The PK2100 includes analog, digital, serial, and high-current switching interfaces. The standard PK2100 includes a rugged enclosure with 2x20 LCD and 2x6 tactile keypad. The PK2100 also has a PLCBus™ expansion port, allowing you to connect several Z-World expansion boards (such as the XP8100 or XP8300) if you need extra I/O.

The following PK2100 Series controllers are available:

PK2100	With enclosure, 2x20 LCD, and 2x6 keypad. Operates at 24V nominal.
PK2110	With enclosure, 2x20 LCD, and 2x6 keypad. Operates at 12V nominal.
PK2120	No enclosure, LCD, or keypad. Operates at 24V nominal.
PK2130	No enclosure, LCD, or keypad. Operates at 12V nominal.

The following PK2100 Series options are available:

- 9.216 MHz clock upgrade. (6.144 MHz standard)
- 128K flash (32K EPROM standard)
- 128K or 512K RAM (32K standard)
- Backlit LCD (with PK2100 or PK2110)

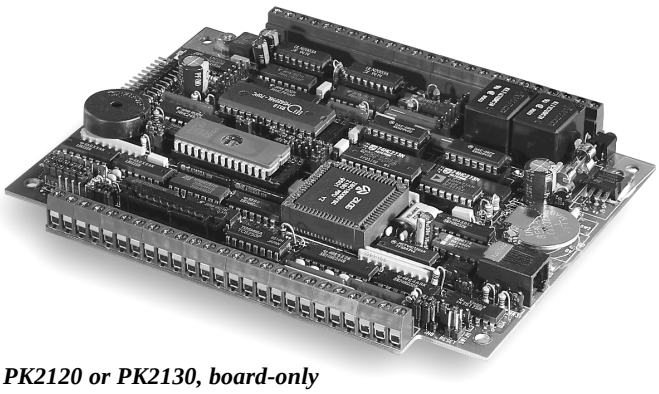
Features

- Battery-backed static RAM, up to 512K bytes.
- EPROM, up to 512K bytes, or flash memory to 256K bytes.
- Battery-backed real-time clock (RTC).
- Lithium backup battery, rated at 560 mA-hours. Sustains the RTC and RAM for about 4 years [35,000 hours].
- Watchdog timer.
- Power failure warning interrupt.
- EEPROM, standard 512 bytes, for calibration constants.
- 2 × 20 LCD. Other displays can be installed on special order.
- 2 × 6 keypad, 2 rows of 6 keys, for a total of 12 keys.
- Beeper with high- and low-volume.

Specifications

Board Size	5.5″ × 6.82″ × 0.78″.
Enclosure Size	5.5″ × 7.0″ × 1.6″.
Operating Temp.	–40°C to +70°C. With LCD, 0°C to 50°C.
Humidity	5% to 95% non-condensing.
Input Power	18–35VDC, 220 mA, linear supply [24V]
Processor	Z180
Clock	6.144 MHz [9.216 MHz optional]
Power Consumption	5.5W

PK2100 or PK2110, with enclosure, LCD, and keypad



PK2120 or PK2130, board-only

The Interface

A PK2100 Series controller has the following as its interface:

1 Six universal inputs. Universal inputs can be used as

(A) digital inputs with a single logic threshold.

(B) digital inputs with two logic thresholds. Z-World software returns a digital 1 when the input voltage is above a high threshold, a 0 when voltage is below a low threshold, and reports ‘no change’ otherwise.

(C) analog inputs (with Z-World software).

The universal inputs accept 0–10V with 10-bit resolution, and are protected against overloads in the range ±48 volts.

2 One high-gain differential analog input. Normally, the high-gain input range is 0–1 volt with 10-bit resolution.

If you don’t use the high-gain channel, a seventh universal input is available.

3 Seven protected digital inputs, with a 2.5V logic hreshold. Three of the inputs also function as counter inputs.

4 Two counter channels capable of counting pulses at up to 600 kHz or more. The counters use DMA hardware.

5 Two on-board relays, rated for 3A at 48V.

6 Ten high-current outputs that can sink approximately up to 500 mA at voltages up to 48V (when used individually).

7 One analog output (DAC) that can be either a 0–10V voltage output or 0–20 mA current output. A second analog voltage output (UEXP) is available when the universal inputs have a fixed hardware threshold. The DACs have 10-bit resolution.

8 An RS422/RS485 serial port and an RS232 serial port with two handshaking lines that operate up to 38,400 baud. The RS485 port can also function as a second RS232 port.

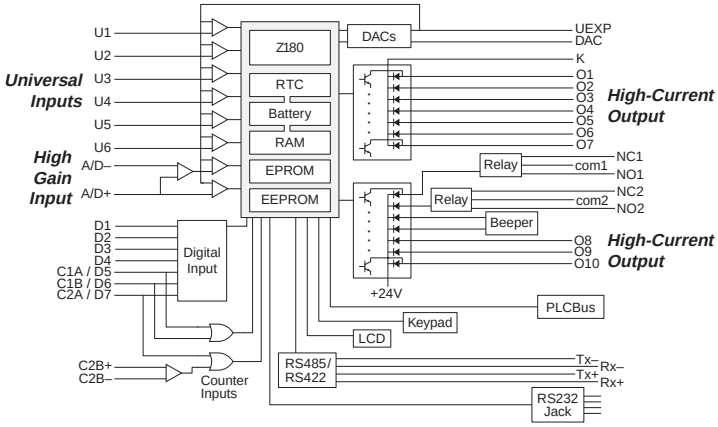
9 A 26-pin expansion bus port for PLCBus devices.

The Terminals

There are two connectors on the sides of the unit: a RJ12 "phone jack" for the RS232 port, and a 26-pin connector for the expansion bus. There are 50 screw terminals used for input, output, and power connections:

Signal	Meaning
+10V Ref	Output from U11, analog reference voltage.
+5V	Output from 5V regulator
GND	Ground
U1–U6	Universal inputs
D1–D7	Digital inputs
C1A, C1B	Counter 1 inputs
C2A	Counter 2 input
C2B+, C2B–	Counter 2 inputs, differential
TX–,TX+	RS485 Transmit
RX–, RX+	RS485 receive
+24V	External power
K	Protection for high-current outputs O1–O7
O1–O10	High-current outputs
A/D–	Negative side of high-gain input
A/D+	(1) Positive side of high-gain input, or (2) the seventh universal input
DAC	DAC output, 0–20 mA or 0–10 volts.
UEXP	Internal DAC, output is 0–10V.
NC, COM, NO	Relay contacts for relays 1 and 2

Figure 1. PK2100 Block Diagram



Universal Inputs

There are six universal inputs and a high-gain input. A seventh universal input is available if you do not use the high-gain channel. Each input channel has a comparator that yields a 1 when the input is greater than a threshold, and 0 otherwise.

You can (1) choose a fixed hardware threshold (1.6V) or (2) use the internal DAC to generate a threshold. Z-World software compares against 1 or 2 thresholds for digital input; it uses successive approximation to make analog readings.

Channel 5 (labelled U6) can be 4-20 mA current loop if you connect pins 7 and 8 of H5.

High-Gain Analog Input

This input is useful for devices requiring higher input sensitivity, for example, thermistors or RTDs in a bridge. The input range is 0–1.0V with 10-bit resolution. The gain at the plus and minus inputs is 10 when jumper H7 is installed. If H7 is removed, then the gain of the plus input becomes higher: 11. The calibration gain and offsets are stored in the EEPROM.

To change the gain, change R5, R11, and possibly RP5. If the gain is increased significantly, it is necessary to use an operational amplifier with a more stable offset voltage than the LM324. The LM1014 is suitable for gains up to 100 or more.

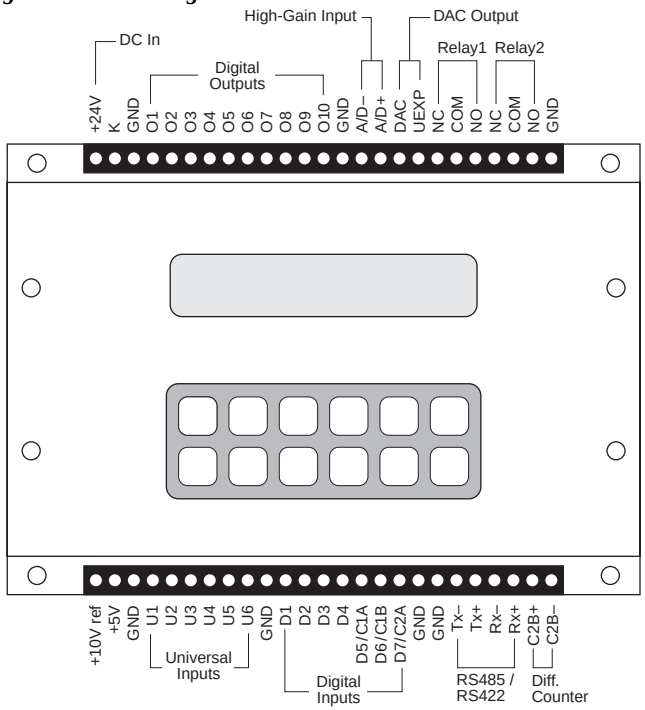
Digital Inputs

The 7 digital inputs accept an input voltage with a digital threshold at approximately 2.5 volts. The inputs are protected against overload over the range of –48 to +48 volts.

Counter Inputs

Three of the digital inputs also serve as counter inputs. There is, in addition, a special differential counter input.

Figure 2. PK2100 Signals



The counters sense negative edges. The differential receiver input can be used as a digital input by attaching one side of it to the desired threshold voltage. It can be used as a true differential input for such devices as inductive pickups. An internal jumper can connect the signal CKA1 which is controlled by the serial port hardware. It can be set to various speeds from 600 kHz down to 300 Hz. The counters use the DMA channels of the Z180. The maximum counting speed is approximately 600 kHz.

The capabilities of the counter are summarized as follows:

1 Measure the time at which a negative edge occurs with a precision of a few microseconds.

2 Measure the width of a pulse.

3 Count negative-going edges for each of two channels.

Analog Output

One analog output (named DAC) is provided. The output can be either a 0–10V voltage output or a 0–20 mA current output suitable for driving 4–20 mA current loops. It will drive 20 mA up to 470 ohms. The resolution is 10 bits.

Another 10-bit analog output channel (UEXP) is available if it is not used to provide reference voltage for the universal inputs. UEXP is not identical to the first DAC channel.

High-Current Outputs

There are 10 high-current outputs O1–O10. Outputs O1–O7 use a common connector ("K") for the protective diodes. Diodes for O8–O10 use the on-board power supply directly.

The driver used is the ULN2003 (Texas Instruments). Each driver chip can dissipate a maximum of 1.25 watts when the ambient temperature is 60°C. The maximum current is approximately 150 mA per output if all outputs are turned on at the same time continuously. The maximum current for any single output is 500 mA.

Relay Outputs

There are two SPDT relays rated at 3A, 48 volts. The three contacts for each relay have terminals (NC, NO, COM on the terminal strips).

Battery-Backed Real-Time Clock

The real-time clock stores a representation of time and date, and runs independently. The RTC can be programmed to interrupt the processor periodically through the INT2 interrupt line. Please refer to the Toshiba TC8250 data book for detail.

The Serial Ports

The Z180 has two independent, full-duplex asynchronous serial channels, with a separate baud rate generator for each channel. The baud rate can be divided down from the microprocessor clock, or from an external clock for either or both channels.

The serial ports have a multiprocessor communications feature that can be enabled. When enabled, an extra bit is included in the transmitted character (where the parity bit would normally go). Receiving processors can be programmed to ignore all received characters except those with the extra multiprocessing bits enabled. This provides a 1-byte attention message that can wake up a processor without the processor having to monitor (intelligently) all traffic on a shared communications link.

The serial ports can be polled or interrupt-driven. Normal serial options are available: 7 or 8 data bits, 1 or 2 stop bits, odd, even or no parity, and parity, overrun, and framing error detection.

Port 0

Port 0 is RS232; its connector is the RJ12 jack. It has CTS and RTS handshaking lines. Port 0 is constrained by hardware to have the CTS (clear to send) pulled low by the RS232 device with which it is communicating.

Port 1

Port 1 is RS485 normally, with transmit and receive lines on the screw terminals. You can use port 1 as an RS232 port, but it has no CTS/RTS handshaking.

LCD

The 2×20 LCD used with the PK2100 can come from one of several vendors. All the LCDs are identical in operation, electrical connections, and dimension. They may differ in timing.

Refer to any of the LCD manufacturers' data sheets for information regarding LCD operations.

The LCD connector is a 2×7 header, P2.

Keypad

To read the 2×6 matrix keypad, you "drive" the row or rows you wish to sample, then read the columns. Any or all keys may be sensed.

Beeper

The on-board beeper has two volume levels. Alternately send 1 then 0 to make it oscillate.

Heat Sinking

A PK2100 Series controller has two power supply regulators. The aluminum enclosure provides the heat sink. In the board-only version, the mounting rails provide the heat sink. The +5V regulator dissipates the most heat and transfers heat to the case or side rails via two mounting "pem" nuts. Maximum heat dissipation by this regulator is 10W when the ambient temperature is 50°C. Power dissipation is given by the formula:

$P = (V_{IN} - 5) \times (I + 0.15)$

V_{IN} = input voltage

I = current, in amperes, drawn from +5V supply by external accessories on bus or from VCC terminal.

Environmental Temperature Constraints

No special precautions are necessary over the range of 0–50°C (32–122°F). For operation at temperatures much below 0°C, the PK2100 should be equipped with a low temperature LCD. The heating effect of the power dissipated by the unit (about 5 watts) may be sufficient to keep the temperature above 0°C, depending on the insulating capability of the enclosure

used. The LCD unit is specified for a maximum operating temperature of 50°C. Except for the LCD, which fades at higher temperatures, the PK2100 can be expected to operate at 60°C, or more, without problem.

Expansion Bus

The PLCBus,™ is a general purpose expansion bus for Z-World controllers. Multiple expansion boards may be daisy-chained together and connected to a Z-World controller to form an extended system. For details, refer to the PLCBus data sheet.

Power Failure Interrupts

The following events occur when power fails:

1 The power-failure NMI (non-maskable interrupt) is triggered when the unregulated DC input voltage falls below approximately 15.6 volts. [7.8V on 12V systems]

2 A system reset is triggered when the regulated +5V supply falls below 4.5 volts. The reset remains enabled as the voltage falls further. At some point, the chip select for the SRAM is forced high (for standby mode). The time/date clock and SRAM are switched to the lithium backup battery when VCC falls below the battery voltage of approximately 3 volts.

The 12-Volt PK2100

The following are changes for the 12-volt PK2100. R40 and U12 are absent on the 12V board, and R9 is 14K, not 22K.

- The connector labeled "+10V ref" is +7 volts.
- The connector labeled "+24V" is +12 volts.
- DAC output (either channel) is not 0–10V, but 0–7V.
- Universal input range (any) is not 0–10V, but 0–7V.
- The high-gain channel is not 0–1V, but 0–0.7V.
- Relay coil voltage is 12V. Relay rating is 5A/120V.

Certain EEPROM constants are changed.

Programming

Developers program a PK2100 Series controller by connecting it to the serial port of an IBM PC running Z-World's Dynamic C development system. Serial communication for programming takes place at 19,200 baud or at 38,400 baud. While a program is undergoing development, the controller normally remains connected to the PC and Dynamic C.

Initial PK2100 Setup

When the PK2100 powers up, it consults its board jumpers, the keypad if any, and the contents of the EEPROM to determine its mode of operation. The modes of operation are the following:

- Run a program stored in battery-backed RAM.
- Prepare for Dynamic C programming at 19.2K baud.
- Prepare for Dynamic C programming at 38.4K baud.

If your controller has a keypad, you can use it to select the operation mode. If the keypad is not available, or you want to override the keypad, you can use jumper block J4.

Jumpers and Headers

Figures 4–7 below show important headers.

Board Dimensions

Figures 8 (next page) shows part locations and labels. Figure 9 (page 6) shows board dimensions, mounting hole locations and sizes, all the jumpers and headers, pin 1 positions for important headers, and the positions of resistors that affect the universal inputs and the high-gain input. Mounting holes are (0.225, 0.7) from the extreme corners of the board. Resistors R5, R11, and resistor pack RP5 affect the high-gain channel. Resistor R28 (5.1 kΩ) is part of a resistor divider that gives the optional fixed hardware reference voltage for the universal inputs.

Maximum height of components above the board is 0.65″ approximately. Overall height is 0.78″ approximately.

Figure 10 (page 6) shows the size of the aluminum enclosure and the location of the PLCBus port and phone jack.

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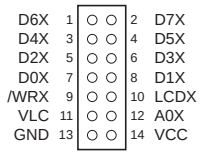

Figure 4. P2, LCD Connector

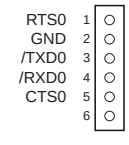

Figure 5. JP1, Phone Jack

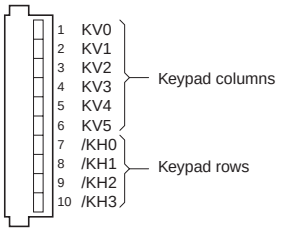

Figure 6. K1, Keypad Connector

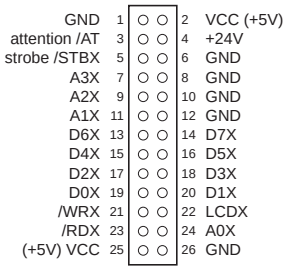

Figure 7. P1, PLCBus connector

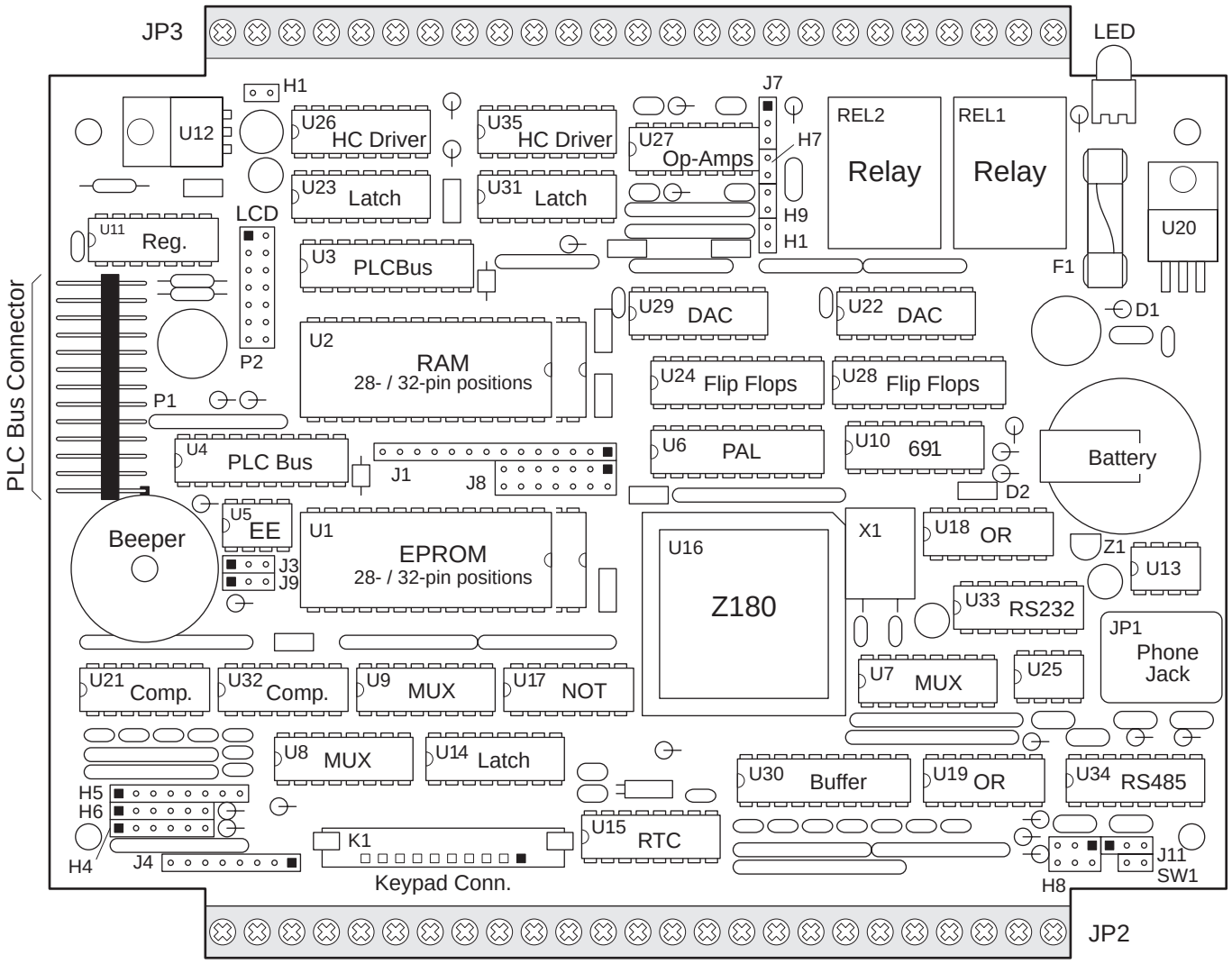

Figure 8. Parts Locations

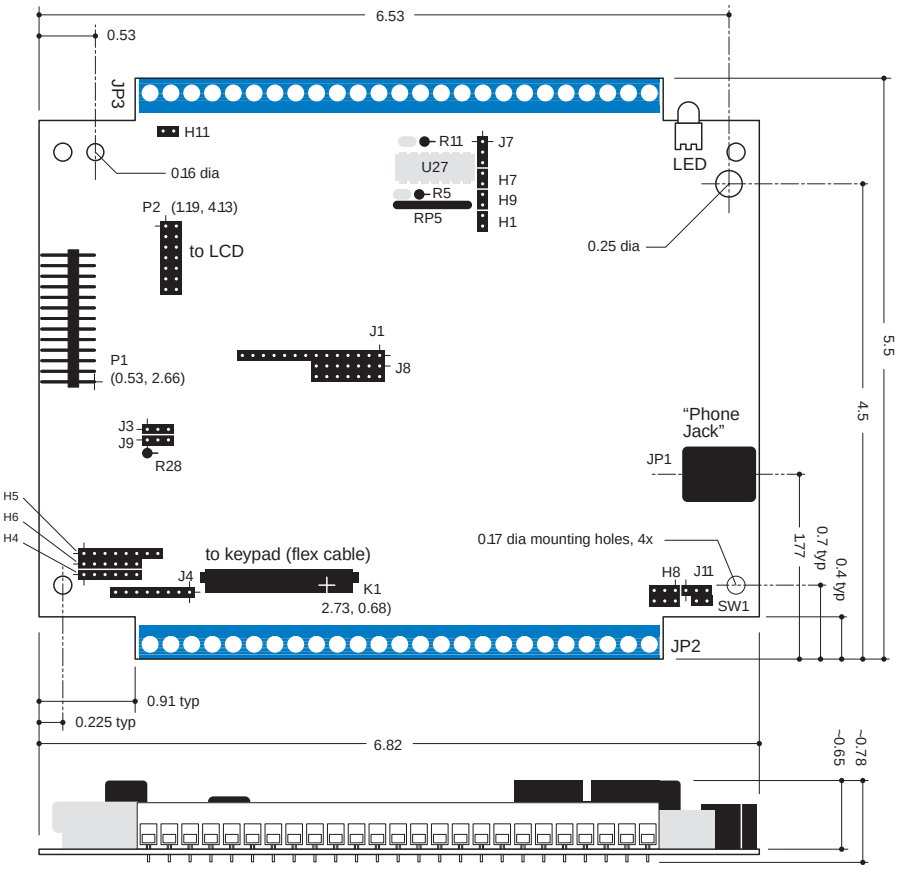

Figure 9. Board Dimensions

Figure 10. Enclosure Dimensions