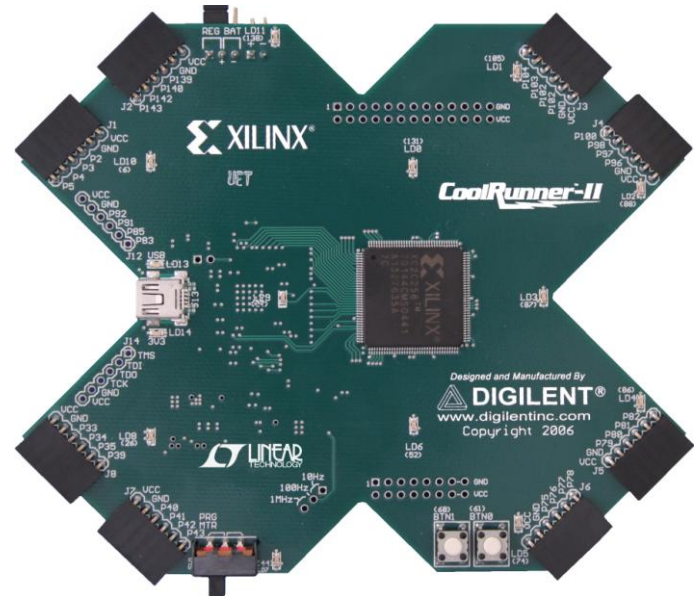


Overview

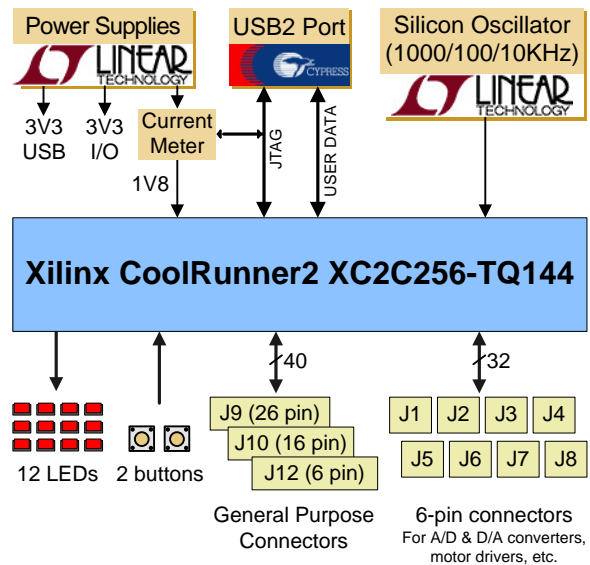
The X-board is a complete circuit development platform for Xilinx's CoolRunner-II CPLD. It provides all essential support circuits for the CoolRunner-II so users can focus on creating and downloading new designs. An on-board USB2 port supplies power to the board and provides a data port for CPLD configuration as well as user data transfers.

More than 75 CPLD signals are routed to expansion connectors so designs can easily be extended. Thirty-two signals are routed to six-pin connectors that can accommodate Digilent's Pmod I/O modules – Pmods are small, low-cost accessory boards offering circuits like A/D and D/A converters, various I/O ports, high-current outputs for motor drive, etc.



X-board features include:

- A 256 macrocell CoolRunner-2 CPLD in a TQ-144 package;
- An on-board USB2 port for JTAG programming and user-data transfers;
- An on-board 16-bit A/D converter to measure real-time CPLD current during board operation (data is sent to the PC for display via the USB cable);
- An user-settable silicon oscillator (1000/100/10 KHz), plus pads for a second crystal oscillator;
- 12 LEDs and two pushbuttons for onboard I/O;



Functional Description

The X-board provides an inexpensive, robust, and easy-to-use platform that anyone can use to gain experience with the latest CPLD devices and modern design methods. It is centered on the CoolRunner-II CPLD, and it contains all needed support circuits so designs can get up and running quickly. The X-Board is ideal introductory platform for experimenting with new designs or learning about CPLDs and CAD tools. The large collection of expansion connectors allow designs to grow beyond the X-Board board, either with user-designed boards or breadboards and/or peripheral

module (Pmod) boards offered by Digilent. (Pmods are inexpensive analog and digital I/O modules that offer A/D conversion, D/A conversion, motor drive, sensor input, and a host of other features).

Are CPLD signals short- and ESD protected?

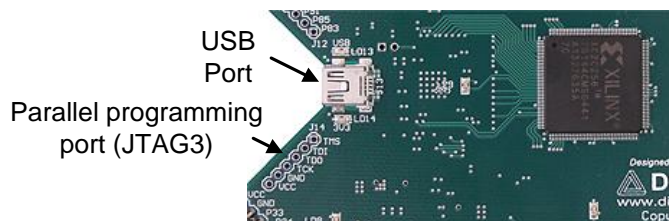
All CPLD pins are protected against damage from ESD and short-circuit connections, ensuring a long operating life in any environment. The X-Board works seamlessly with all versions of the Xilinx ISE tools, including the free WebPack tools. It ships with a USB cable that can supply power to the board as well as provide a programming and data interchange port, so designs can be implemented immediately without the need for any additional hardware.

Device Configuration

The CPLD on the X-Board must be configured (or programmed) by the user before it will perform any functions. Configuration files can be created from schematics or HDL source files using the free WebPack CAD software from Xilinx. Configuration files can be transferred to the X-Board using a USB cable and Digilent's Adept software, or using a parallel programming cable and Xilinx's iMPACT software. Once configured, the CPLD will retain its state indefinitely.

When the X-Board is powered on, the most recently loaded CPLD configuration will be available immediately. A new configuration can be loaded at any time, and as soon as a new configuration is loaded, it will define the CPLD's behavior.

To configure the CPLD using Digilent's Adept software, attach a USB cable to a host PC and to the X-Board. Start Adept, and allow it to auto-detect the USB device on the X-Board. When the CPLD has been detected, you will see a graphic of the CPLD and a pull-down text box where a configuration file can be selected. Select the desired .jed CPLD configuration file, and then right-click on the graphic of the CPLD and select "Program".



X-Meter

The X-Board includes an on-board current meter that continuously measures CPLD core current. The X-Meter is built around the Linear Technology LTC2480 16-bit sigma-delta converter. The LTC2480 uses an SPI port to send sample data to the PC, and the SPI port shares the same pins as the JTAG programming port. Switch 1 (SW1) selects between the X-Meter and JTAG programming port.

The X-meter is a PC-based current measurement application developed for the X-board. The X-board, based on Xilinx's CoolRunner2 CPLD, contains a Linear Technology LTC2480 A/D converter specifically for measuring current and temperature. The X-meter acquires data from the LTC2480 using the USB2 port on the X-board, and displays the data on a PC.

To install the X-meter software, simply run the X-Meter.exe application. Prior to installing the X-meter, ensure Digilent's Adept Suite v1.7 (or higher) is installed on the computer.

To use the X-Meter, connect an X-Board to the PC, set SW1 to "Meter", and ensure JP1 is set to REG. Start the X-Meter application from the Windows Start menu, and click the "Start" button in X-Meter.



The X-Meter will acquire one temperature and nine current samples every 2 seconds, and transfer the samples to a data buffer on the PC via the USB cable. X-meter plots the data in a waveform graph, and shows the most recent, maximum, and minimum data obtained. To change the scale of the plotted waveform, click the desired amperage/division radio button.

Temperature data is only displayed when the “enable” check box under “Temperature Measurement” is checked.

The “Stop” button causes the X-meter to stop acquiring new data, and the “Clear” button stops data acquisition, purges the data buffers, and clears the waveform display.

To save the data values in the buffer to a CSV (Comma Separated Value) file, click the “Save Buffer As...” button and specify a filename (note the temperature values will only be saved if the “Enable” checkbox under “Temperature Measurement” is checked).

Power Supplies

The X-Board can be powered from its integral USB port, or from an external supply attached at connector JP3. Jumper JP2 selects whether the board uses USB power or external power.

Linear regulator...

If USB power is used...

External power sources are routed through the Linear regulator

The voltage input to the power jack is routed to the four 6-pin expansion connectors and to a LM1117 voltage regulator that produces the 3.3V supply for the board. The 2.5V and 1.2V supplies required by the FPGA are produced by post-regulating the 3.3V supply. Total board current is dependant on FPGA configuration, clock frequency, and external connections. In test circuits with roughly 20K gates routed, a 50MHz clock source, and all LEDs illuminated, about 200mA of current is drawn from the 1.2V supply, 50mA from the 2.5V supply, and 100mA from the 3.3V supply. Required current will increase if larger circuits are configured in the FPGA, and if peripheral boards are attached.

The X-Board uses a four layer PCB, with the inner layers dedicated to VCC and GND planes. The CPLD and the other ICs on the board all have a large complement of bypass capacitors placed as close as possible to each VCC pin. The Linear regulators, together with good power supply routing and ample bypass capacitors result in a very clean, low-noise power supply.

Oscillators

The X-Board board includes an user-settable silicon oscillator that produces a 1MHz, 100KHz, or 10KHz clock signal based on the position of the clock select jumper at J11 (J11 is labeled on the underside of the board). This primary oscillator output, labeled “PCLK” in the schematic, is connected to the GCLK2 pin of the CPLD (at P38) so that it can be routed to the internal clock management macro (**expand**). Pads for a standard SMT oscillator are also provided at IC4.

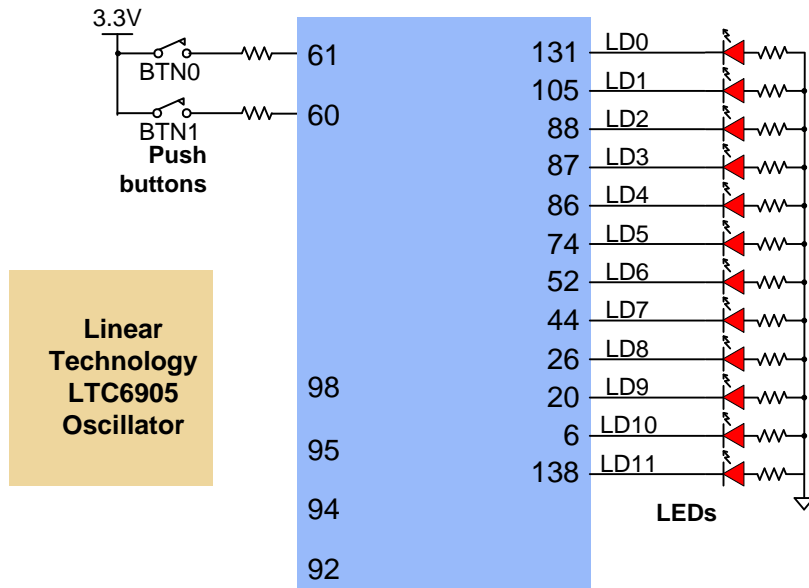
Need a bit more...

User I/O

The Basys board includes several Input and Output devices, and several data ports so that many designs can be implemented without the need for any other components.

Pushbuttons

Four pushbuttons and eight slide switches are provided for circuit inputs. Pushbutton inputs are normally low, and they are driven high only when the pushbutton is pressed. Slide switches generate constant high or low inputs depending on their position. Pushbutton and slide switch inputs use a series resistor for protection against short circuits (a short circuit would occur if an FPGA pin assigned to a pushbutton or slide switch was inadvertently defined as an output).





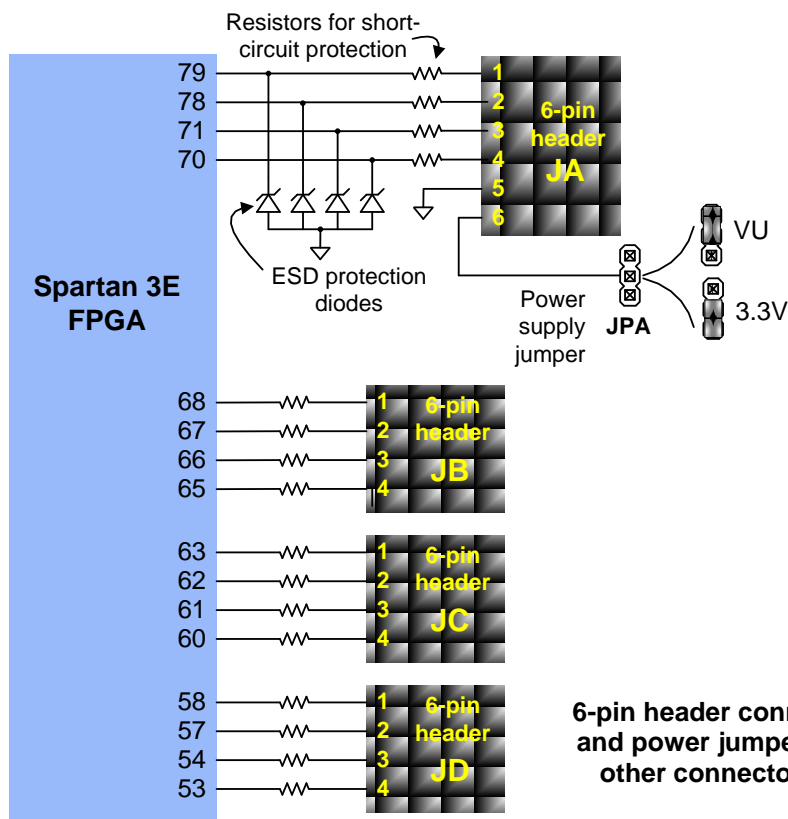
LEDs

Eight LEDs are provided for circuit outputs. LED anodes are driven from the FPGA via 390-ohm resistors, so a logic '1' output will illuminate them with 3-4ma of drive current. A ninth LED is provided as a power-on LED, and a tenth LED indicates FPGA programming status.

6-pin header connectors

The Basys board provides four 6-pin peripheral module connectors. Each connector provides Vdd, GND, and four unique FPGA signals.

Several 6-pin module boards that can attach to this connector are available from Digilent, including speaker boards, H-bridge boards, sensor boards, etc. Please see www.digilentinc.com for more information.



6-pin header connector circuit diagram. ESD diodes and power jumper shown for JA are present for the other connectors but omitted from the drawing.

CPLD

The pinout for the Spartan 3E-100 FPGA in the VQ100 package is shown in the table below.



Basys FPGA Pin Assignments									
Pin	Function	Pin	Function	Pin	Function	Pin	Function	Pin	Function
1	PROG_B	21	V_{AUX}	41	VGA-HS	61	JC-3	81	GND
2	LD7	22	CC	42	MODE1/C	62	JC-2	82	3V3
3	LD6	23	CG	43	MODE0/C	63	JC-1	83	SPI-SS
4	LD5	24	CB	44	DO	64	GND	84	CLK2
5	LD4	25	3V3	45	3V3	65	JB-4	85	PS2C
6	V_{INT}	26	AN4	46	V_{AUX}	66	JB-3	86	PS2D
7	GND	27	AN3	47	VGA-G	67	JB-2	87	GND
8	3V3	28	V_{INT}	48	VGA-B	68	JB-1	88	SW7
9	LD3	29	GND	49	VGA-R	69	BTN0	89	SW6
10	LD2	30	BTN1	50	CCLK	70	JA-4	90	SW5
11	BTN3	31	3V3	51	V_{AUX}	71	JA-3	91	SW4
12	LD1	32	AN2	52	GND	72	GND	92	SW3
13	BTN2	33	AN1	53	JD-4	73	3V3	93	GND
14	GND	34	SPI-MOSI	54	JD-3	74	V_{AUX}	94	SW2
15	LD0	35	SPI-MISO	55	3V3	75	TMS	95	SW1
16	CE	36	CLK1	56	V_{INT}	76	TDO	96	V_{AUX}
17	CD	37	GND	57	JD-2	77	TCK	97	3V3
18	DP	38	SPI-SCK	58	JD-1	78	JA2	98	SW0
19	GND	39	MODE2	59	GND	79	JA1	99	TMS-EN
20	3V3	40	VGA-VS	60	JC-4	80	V_{INT}	100	TDI