



UP3-1C12 Education Kit

Reference Manual, Cyclone Edition

Version 01.00

System Level Solutions Inc. (USA)

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About this manual

This is the first publication of the reference manual of the UP3-1C12 (University Program 3) Education Kit published in March, 2005.

How to find the information

- The Adobe Acrobat Find feature allows you to search the contents of a PDF file. Use Ctrl + F to open the Find dialog box. Use Ctrl + N to open to the Go To Page dialog box.
- Thumbnail icons, which provide miniature preview of each page, provide a link to the pages.
- Links allow you to jump to related information.

How to contact SLS

For the most up-to-date information about SLS products, go to the SLS worldwide website at <http://www.slscorp.com>.

TABLE 1. Contact Information

Information Type	E-mail
Product literature services, SLS literature services, Non-technical customer services, Technical support.	support@slscorp.com

Features

The following are some of the features of the UP3-1C12 Board.

- Features an Altera EP1C12Q240 Device and EPCS4 configuration device
- Supports intellectual property based (IP-Based) design both with and without a microprocessor
- USB 1.1 (Full speed & Low speed)
- RS 232 Port
- Parallel port (IEEE 1284)
- PS/2 Port
- VGA port
- IDE (Integrated Drive Electronics)
- 2KBytes of I2C PROM(Expandable)
- 128KBytes of SRAM
- 2MBytes of FLASH
- 8MByte SDRAM
- Supports multiple clocks like CPU clock, USB clock, PCI clock, and IOAPIC clock.
- JTAG and Active Serial download capability
- 5V Santa Cruz Expansion Card Header provides 42 I/Os for the development of additional boards providing various functionalities plus 20 additional user I/O pins are provided giving total of 62 user definable I/O pins
- One user definable 4-bit switch block
- Four user definable push button switches, and one global reset switch
- Four user definable LEDs
- One 16X2 character LCD Module
- I2C Real Time Clock

General Description

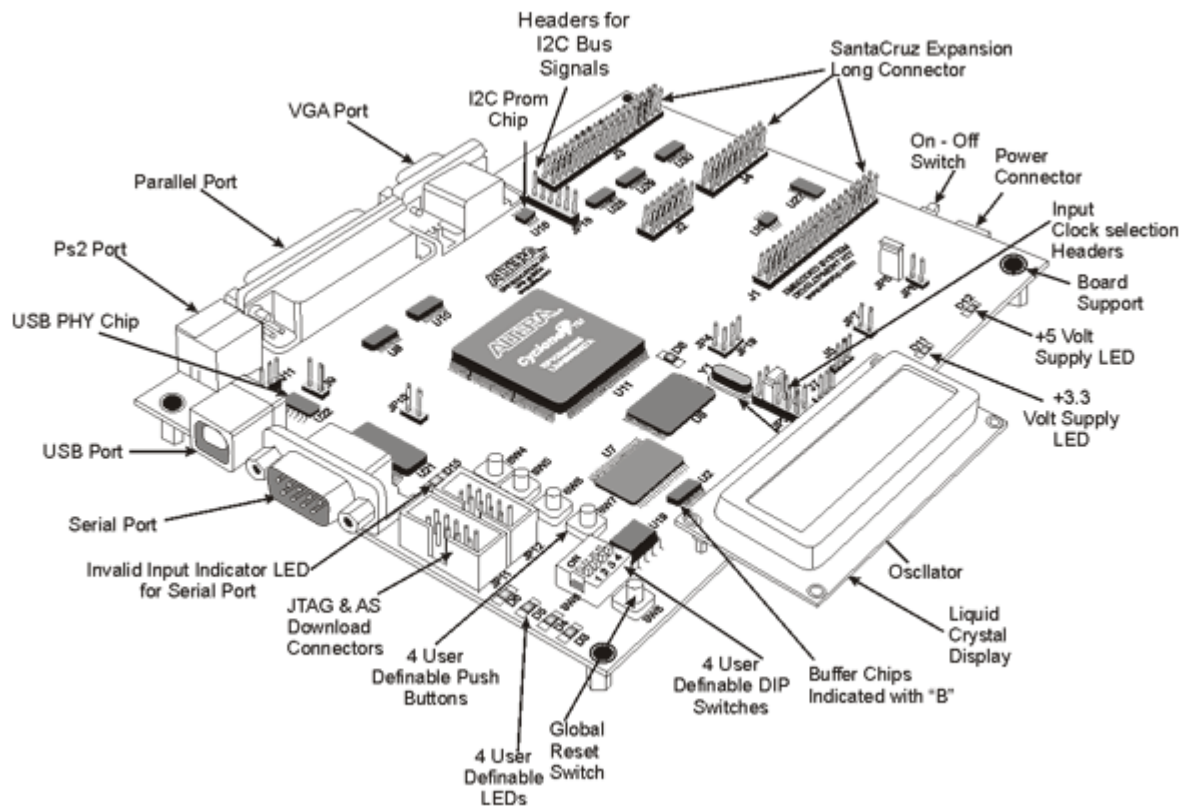
The UP3-1C12 Education Kit provides a powerful educational tool and also a low-cost solution for prototyping and rapidly developing products. The board serves as an excellent means for system prototyping, emulation and hardware as well as software development. The board ships with a powerful Altera Cyclone FPGA providing around 12,000 Logic Elements. It allows hardware design engineer to design, prototype and test IP cores or any hardware design using HDLs like Verilog or VHDL. The entire environment helps to quickly implement any processor as well as any real time operating system on the kit. Along with that one can simulate and test 'C' or assembly code also. The board provides industry standard interconnections, Memory Subsystem, Multiple clocks for system design, JTAG Configuration, expansion headers for greater flexibility, capacity and additional user interface features. Further, the board can be used for DSP applications by interfacing directly to a DSP processor or implementing DSP functions inside the FPGA. In short, it is a dual-purpose kit, which can be used for prototyping and developing VLSI designs as well as designing and developing microprocessor based embedded system designs.

Components

Board Diagram

Figure 1 shows the top view of the board.

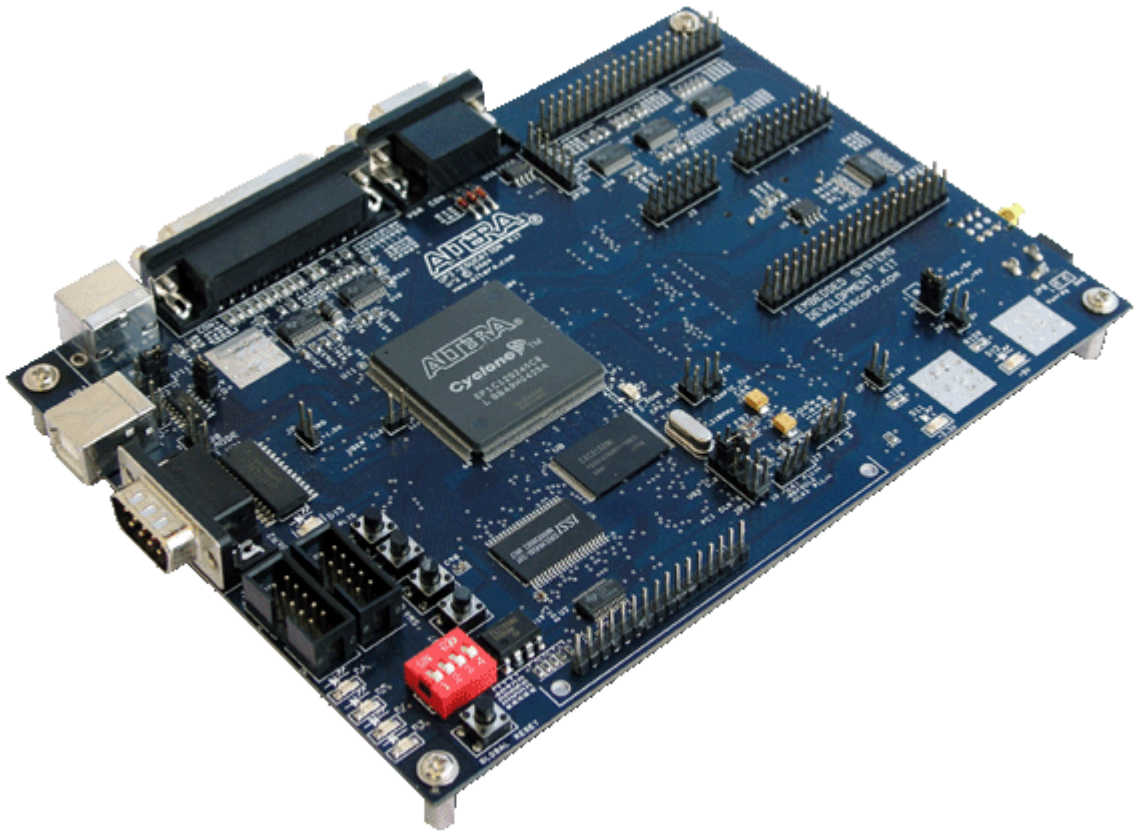
FIGURE 1. UP3-1C12 Board Top View (not to scale)



UP3-1C12 Education Kit

This section contains a brief overview of the important components on the UP3-1C12 Board. Figure 2 shows the snapshot of the same.

FIGURE 2. UP3-1C12 Board Components



The Cyclone EP1C12Q240 Device

U11 is an ALTERA Cyclone EP1C12Q240 Device in a 240-pin PQFP package. Table 2 lists the Cyclone device features.

TABLE 2. Cyclone EP1C12Q240 Device features

Logic Elements	12060
RAM Blocks	52
Total RAM Bits	239616
PLLS	2
User I/Os	173*

* 173 pins are for the PQFP package used on this UP3-1C12 board.

FPGA uses SRAM cells to store configuration data. Since SRAM memory is volatile configuration, the data must be downloaded into Cyclone FPGA each time the device powers up. There are three methods to configure the device - Active serial configuration, Passive serial configuration and JTAG based configuration. The UP3-1C12 board supports the following two modes: Active Serial Mode and JTAG Mode.

Active Serial Mode:

Active serial configuration is carried out through serial configuration device EPCS4. Serial configuration devices provide a serial interface to access configuration data. During device configuration, Cyclone FPGA read configuration data via the serial interface, decompresses data if necessary, and program their SRAM cells. This scheme is referred to as an AS configuration scheme because the FPGA controls the configuration interface. The Quartus II software automatically generates **.pof** files that can be downloaded into the configuration device using Byte-Blaster II or USB Blaster Cable for Active serial configuration.

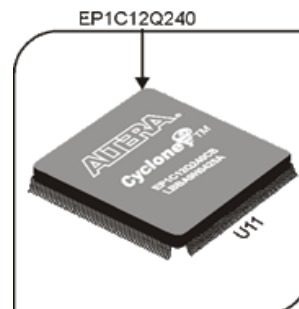
JTAG Mode:

JTAG (Joint Test Action Group) has developed a specification for boundary-scan testing. This boundary-scan test (BST) architecture offers the capability to efficiently test components on printed circuit boards (PCBs) with tight lead spacing. The BST architecture can test pin connections without using physical test probes and capture functional data while a device is operating normally. The user can also use the JTAG circuitry to shift configuration data into Cyclone FPGA. The Quartus II software automatically generates **.sof** files that can be downloaded using Byte-Blaster II or USB Blaster Cable for JTAG configuration.

Cyclone is designed such that JTAG instructions have precedence over any device operating modes. So JTAG configuration can take place without waiting for other configuration to complete (e.g., configuration using serial or enhanced configuration devices). If the user attempts for the JTAG configuration in Cyclone FPGA during non-JTAG configuration, the non- JTAG configuration will be terminated and the JTAG configuration will be initiated.

Passive configuration mode has not been supported on this board. This board does not support multiple devices using Active Serial mode.

FIGURE 3. EP1C12Q240 Cyclone FPGA



Serial Configuration Device

U15 is a serial configuration device (EPCS4) for the **Cyclone FPGA** on UP3-1C12 board. Serial configuration devices are flash memory devices with a serial interface that can store configuration data for a Cyclone device and reload the data into the device upon power-up or re-configuration. With the new data-decompression feature in the Cyclone FPGA family, designers can use smaller serial configuration device to configure larger Cyclone FPGA.

Active Serial & JTAG:

On UP3-1C12 board AS configuration scheme is combined with JTAG-based configuration. The MSE (Mode Select Enable) pins are tied low to select the Active Serial Configuration mode. This setup uses two 10-pin download cable headers on the board. The first header (**JP11**) programs the serial configuration device in-system via the AS programming interface, and the second header (**JP12**) configures the Cyclone FPGA directly via the JTAG interface. If you try configuring the device using both schemes simultaneously, JTAG configuration takes precedence and AS configuration will be terminated..

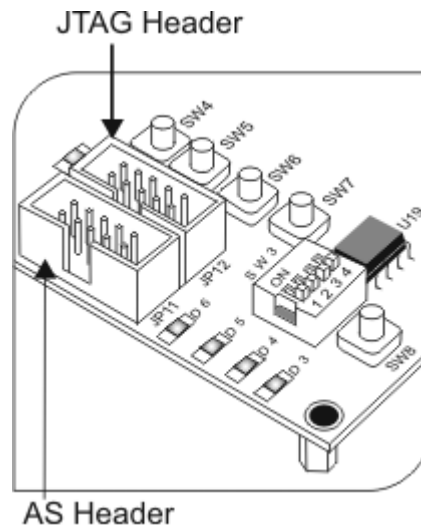
TABLE 3. Header JP12

Header JP12 Pin No.	Signal	FPGA (U11) Pin No
1	TCK	147
2	GND	---
3	TDO	149
4	+3.3V	---
5	TMS	148
6	+3.3V	---
7	NC	---
8	NC	---
9	TDI	155
10	GND	---

TABLE 4. Header JP11

Header (JP11) Pin No.	Signal	EPCS4 (U15) Pin No.	FPGA (U11) Pin No.
1	DCLK	6	36
2	GND	---	---
3	CONF_DONE	---	145
4	+3.3V	---	---
5	CONFIG#	---	25
6	CE#	---	32
7	DATA	2	25
8	CSO#	1	24
9	ASDO	5	37
10	GND	---	---

FIGURE 4. Active Serial & JTAG Header



Flash Memory Device

U8 is a 2Mbyte of Flash memory connected to the Cyclone device.

The U8 is a 16,777,216-bit, 3.0-V read-only electrically erasable and programmable flash memory organized as 2,097,152 words x 8 bits or as 1,048,576 words x 16 bits. The U8 features commands for Read, Program and Erase operations to allow easy interfacing with microprocessors. The Program and Erase operations are automatically executed in the chip. Table 5 shows the Flash signal description and its connection with FPGA.

FIGURE 5. Flash Memory Devices

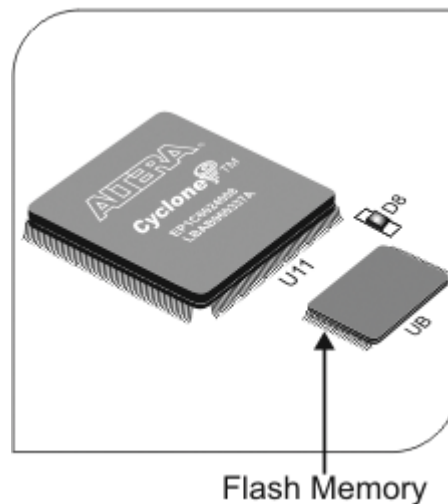


TABLE 5. Flash Signal Description

Flash Pin	Signal Name	FPGA Pin No.	Description
1	A15	76	Address Line
2	A14	75	Address Line
3	A13	74	Address Line
4	A12	68	Address Line
5	A11	67	Address Line
6	A10	66	Address Line
7	A9	65	Address Line
8	A8	64	Address Line
9	A19	78	Address Line
10	NC	---	Not Connected
11	WE#	79	Write Enable Signal
12	RESET	----	System Reset
13	NC	----	Not Connected
14	NC	----	Not Connected
15	RY/BY#	126	Ready/Busy Signal
16	A18	125	Address Line
17	A17	82	Address Line
18	A7	63	Address Line
19	A6	83	Address Line
20	A5	84	Address Line
21	A4	85	Address Line
22	A3	86	Address Line
23	A2	87	Address Line
24	A1	88	Address Line
25	A0	93	Address Line
26	CE#	117	Chip Enable Signal
27	VSS	---	GND
28	OE#	118	O/P Enable Signal
29	DQ0	94	Data Line
30	DQ8	95	Data Line

TABLE 5. Flash Signal Description

Flash Pin	Signal Name	FPGA Pin No.	Description
31	DQ1	133	Data Line
32	DQ9	132	Data Line
33	DQ2	98	Data Line
34	DQ10	99	Data Line
35	DQ3	100	Data Line
36	DQ11	101	Data Line
37	VDD	---	Data Line
38	DQ4	128	Data Line
39	DQ12	127	Data Line
40	DQ5	104	Data Line
41	DQ13	105	Data Line
42	DQ6	106	Data Line
43	DQ14	107	Data Line
44	DQ7	113	Data Line
45	DQ15/A-1	114	Data Line / Address Line
46	VSS	---	GND
47	BYTE	115	Word / Byte
48	A16	77	Address Line

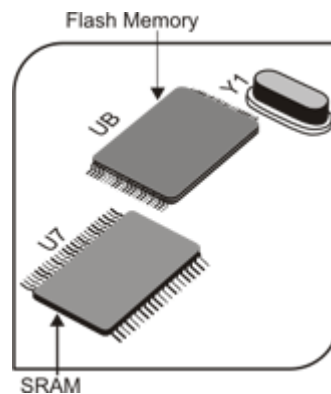
SRAM Device U7 is the 128KBytes asynchronous SRAM device. It is a high speed, 1,048,576-bit static RAM organized as 65,536 words by 16 bits. It is fabricated using the ISSI's high performance CMOS technology. This highly reliable process coupled with innovative circuit design techniques, yields access times as fast as 10 ns with low power consumption. Table 6 describes signals and pin connections of SRAM..

TABLE 6. Pin Out for SRAM

SRAM Pin No.	Signal Name	FPGA Pin No.	Description
1	AD-15	76	Address Line
2	AD-14	75	Address Line
3	AD-13	74	Address Line
4	AD-12	68	Address Line
5	AD-11	67	Address Line
6	CE_n	116	
7	DQ-00	94	Data Line
8	DQ-01	133	Data Line
9	DQ-02	98	Data Line
10	DQ-03	100	Data Line
11	VCC	---	Supply
12	GND	---	GND
13	DQ-04	128	Data Line
14	DQ-05	104	Data Line
15	DQ-06	106	Data Line
16	DQ-07	113	Data Line
17	WE_n	79	Write Enable Input
18	AD-10	66	Address Line
19	AD-09	65	Address Line
20	AD-08	64	Address Line
21	AD-07	63	Address Line
22	NC	---	Not Connected
23	NC	---	Not Connected
24	AD-06	83	Address Line
25	AD-05	84	Address Line

TABLE 6. Pin Out for SRAM

SRAM Pin No.	Signal Name	FPGA Pin No.	Description
26	AD-04	85	Address Line
27	AD-03	86	Address Line
28	NC	---	Not Connected
29	DQ-08	95	Data Line
30	DQ-09	132	Data Line
31	DQ-10	99	Data Line
32	DQ-11	101	Data Line
33	VCC	---	Supply
34	GND	---	GND
35	DQ-12	127	Data Line
36	DQ-13	105	Data Line
37	DQ-14	107	Data Line
38	DQ-15	114	Data Line
39	LB_n	77	Lower Byte Control
40	UB_n	82	Upper Byte Control
41	OE_n	118	Output Enable Input
42	AD-02	87	Address Line
43	AD-01	88	Address Line
44	AD-00	93	Address Line

FIGURE 6. SRAM Device

SDRAM Device

U6 is a 8MByte Synchronous Dynamic RAM. It is organized as 1,048,576 bits X 16-bit X 4-bank for improved performance. The synchronous DRAMs achieve high speed data transfer using pipeline architecture. All the input and output signals refer to the rising edge of the clock input. Figure 7 below shows the pin configuration of the SDRAM and the Figure 8 shows the SDRAM device. Table 7 gives the pin description for the same.

TABLE 7. SDRAM Pin Configuration

SDRAM Pin No.	Signal Name	FPGA Pin No.	Description
1	VDD	---	Supply
2	DQ-00	94	Data Line
3	VDDQ	---	Supply
4	DQ-01	133	Data Line
5	DQ-02	98	Data Line
6	GNDQ	-	GND
7	DQ-03	100	Data Line
8	DQ-04	128	Data Line
9	VDDQ	---	Supply
10	DQ-05	104	Data Line
11	DQ-06	106	Data Line
12	GNDQ	---	GND
13	DQ-07	113	Data Line
14	VDD	---	Supply
15	LDQM	77	Lower Byte, I/O Mask
16	WE_n	79	Write Enable Input
17	CAS_n	75	Column Address Strobe
18	RAS_n	76	Row Address Strobe
19	CE_n	119	Chip Enable Input
20	BA0	68	Bank Select Address
21	BA1	74	Bank Select Address
22	AD-10	66	Address Line
23	AD-00	93	Address Line
24	AD-01	88	Address Line

TABLE 7. SDRAM Pin Configuration

SDRAM Pin No.	Signal Name	FPGA Pin No.	Description
25	AD-02	87	Address Line
26	AD-03	86	Address Line
27	VDD	---	Supply
28	GND	---	GND
29	AD-04	85	Address Line
30	AD-05	84	Address Line
31	AD-06	83	Address Line
32	AD-07	63	Address Line
33	AD-08	64	Address Line
34	AD-09	65	Address Line
35	AD-11	67	Address Line
36	NC	---	No Connection
37	CKE	115	Clock Enable
38	CLK	11	SDRAM Clock
39	UDQM	82	Upper Byte, I/O Mask
40	NC	---	No Connection
41	GND	---	GND
42	DQ-08	95	Data Line
43	VDDQ	---	Supply
44	DQ-09	132	Data Line
45	DQ-10	99	Data Line
46	GNDQ	---	GND
47	DQ-11	101	Data Line
48	DQ-12	127	Data Line
49	VDDQ	---	Supply
50	DQ-13	105	Data Line
51	DQ-14	107	Data Line
52	GNDQ	---	GND
53	DQ-15	114	Data Line
54	GND	---	GND

FIGURE 7. SDRAM Pin Configuration

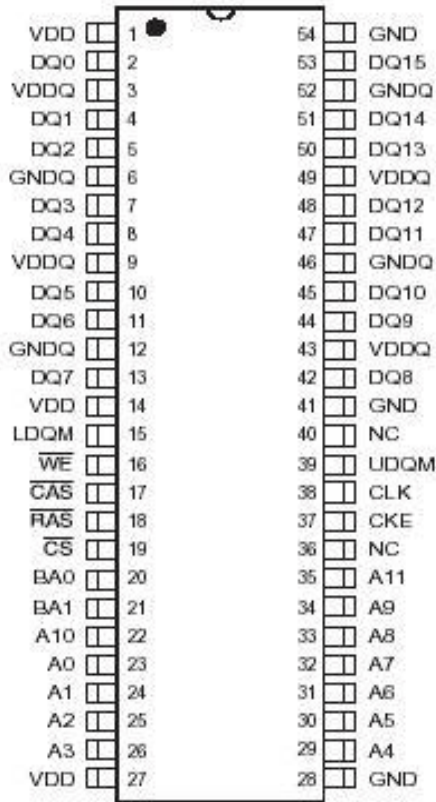
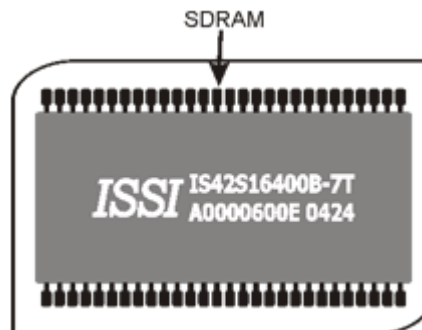


FIGURE 8. SDRAM Device



Liquid Crystal Display

U1 is a 16X2 character Liquid Crystal Display. Here 16X2 represents 2 display lines with 16 characters per line. The display contains 2 internal byte wide registers, one for the command and second for characters to be displayed. It also contains user programmed RAM area that can be programmed to generate any desired character that can be formed using a dot matrix.

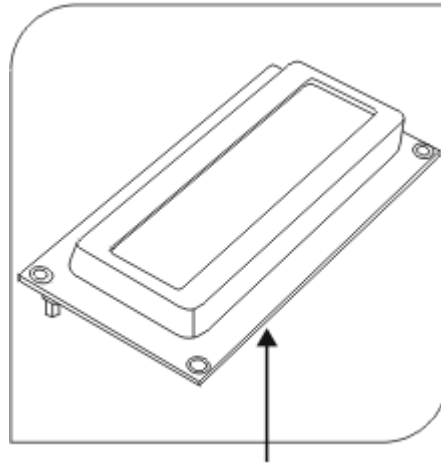
TABLE 8. Liquid Crystal Display Signal Description

LCD Pin No.	Signal Name	FPGA Pin No.	Description
1	VSS	---	GND
2	VDO	---	+5 V
3	VO	---	Contrast Setting
4	RS(Register select)	108	All these
5	R/W (Read/Write)	73	All of these signals are level shifted and then connected to the FPGA pins
6	E(Enable signal)	50	
7	DB0	94	
8	DB1	133	
9	DB2	98	
10	DB3	100	
11	DB4	128	
12	DB5	104	
13	DB6	106	
14	DB7	113	
15	LED+	---	+5V
16	LED-	---	GND

Table 8 gives full description about the signals and pin connection of the LCD.

Notes: It should be noted that the address lines of the SRAM, FLASH and SDRAM Memories are shared. Also the data lines of the SRAM, FLASH, SDRAM Memories and LCD are shared.

FIGURE 9. LCD



Liquid Crystal Display

TABLE 9. LCD Instruction Table

Instruction	CODE										Execute Time (max)
	R S	R/W	D 7	D 6	D 5	D 4	D 3	D 2	D1	D0	
Clear Display	0	0	0	0	0	0	0	0	0	1	1.64mS
Cursor at Home	0	0	0	0	0	0	0	0	1	-	1.64mS
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	40uS
Display On/Off Control	0	0	0	0	0	0	1	D	C	B	40uS
Cursor/ Display Shift	0	0	0	0	0	1	S/C	R/L	-	-	40uS
function set	0	0	0	0	1	D L	N	F	-	-	40uS
CGRAM address set	0	0	0	0	ACG					40uS	
DDRAM address set	0	0	1	ADD					40uS		
Busy Flag/ Address Read	0	1	B F	AC					40uS		
CGRAM / DDRAM Data Write	1	0	Write Data					40uS			
CGRAM / DDRAM Data Read	1	1	Read Data					40uS			

TABLE 10. LCD Instruction Table

SYMBOLS	DESCRIPTION	SYMBOLS	DESCRIPTION
I/D = 1	Increment	D/L = 0	4 Bit
I/D = 0	Decrement	N = 1	1/16 Duty
S = 1	With Display Shift	N = 0	1/8 Duty, 1/11 Duty
S/C = 1	Display Shift	F = 1	5 X 10 dots
S/C = 0	Cursor Movement	F = 0	5 X 7 dots
R/L = 1	Shift to the right	BF = 1	Internal Operation is being performed
R/L = 0	Shift to the left	BF = 0	New Instruction acceptable
D/L = 1	8 Bit		

The above execution time is for $f_{osc} = 250\text{KHz}$. However, when frequency changes, execution time also changes. When $f_{osc} = 270\text{KHz}$, then new execution time will be $40\mu\text{S} \times (250/270) = 37\mu\text{S}$.

LCD Initialization:

Normally LCD itself executes internal reset operations at power up. But if the power supply condition is not satisfied, the internal reset circuit would not operate properly. It is better to provide initialization sequence by instruction.

Initializing by instruction

The Initialization command sequence for the LCD is as follows: POWER ON - 15msec Delay - Function Set - 4.1msec Delay - Function Set - 100microsec - Function Set - 5msec Delay - Function Set - Display OFF - Display ON - Entry Mode Set.

LCD on UP3-1C12 board is of $N = 1$ (1/16 Duty) and $F = 0$ (5X7 dots). After this sequence, LCD is ready for operation.

TABLE 11. LCD Instruction Table

INSTRUCTION	DESCRIPTION
Clear Display	Clears all display and returns the cursor to the home position (Address 0).
Cursor at Home	Returns the cursor to the home position (Address 0). Also returns the display being shifted to the original position. DDRAM contents remain unchanged.
Entry Mode Set	Sets the cursor move direction and specifies or not to shift the display. These operations are performed during data write and read.
Display On / Off Control	Sets On/Off of all display(D), cursor On/Off(C), and blink of cursor position character(B).
Cursor / Display Shift	Moves the cursor and shifts the display without changing DDRAM contents.
Function Set	Sets interface data length(DL), number of display lines(L) and character font(F).
CGRAM Address Set	Sets the CGRAM address. CGRAM data is sent and received after this setting.
DDRAM Address Set	Sets the DDRAM address. DDRAM data is sent and received after this setting.
Busy Flag / Address Read	Reads Busy flag(FB) indicating internal operation is being performed and reads address counter contents.
CGRAM / DDRAM Data Write	Writes data into DDRAM or CGRAM
CGRAM / DDRAM Data Read	Reads data from DDRAM or CGRAM

Table 12 gives full description about the shared signals and pin connections of the same.

TABLE 12. Shared Lines on the UP3-1C12 board

FPGA Pin No.	Signal Name			
	SRAM	SDRAM	FLASH	LCD
11	---	SDRAM CLK	---	---
63	AD-07	AD-07	AD-07	---
64	AD-08	AD-08	AD-08	---
65	AD-09	AD-09	AD-09	---
66	AD-10	AD-10	AD-10	---
67	AD-11	AD-11	AD-11	---
68	AD-12	BA0	AD-12	---
74	AD-13	BA1	AD-13	---
75	AD-14	CAS	AD-14	---
76	AD-15	RAS	AD-15	---
77	LB	LDQM	AD-16	---
78	---	---	AD-19	---
79	WE_n	WE_n	WE_n	---
126	---	---	RY/BY_n	---
125	---	---	AD-18	---
82	UB	UDQM	AD-17	---
83	AD-06	AD-06	AD-06	---
84	AD-05	AD-05	AD-05	---
85	AD-04	AD-04	AD-04	---
86	AD-03	AD-03	AD-03	---
87	AD-02	AD-02	AD-02	---
88	AD-01	AD-01	AD-01	---
93	AD-00	AD-00	AD-00	---
94	DQ-00	DQ-00	DQ-00	DQ-00
95	DQ-08	DQ-08	DQ-08	---
133	DQ-01	DQ-01	DQ-01	DQ-01
132	DQ-09	DQ-09	DQ-09	---
98	DQ-02	DQ-02	DQ-02	DQ-02

TABLE 12. Shared Lines on the UP3-1C12 board

FPGA Pin No.	Signal Name			
	SRAM	SDRAM	FLASH	LCD
99	DQ-10	DQ-10	DQ-10	---
100	DQ-03	DQ-03	DQ-03	DQ-03
101	DQ-11	DQ-11	DQ-11	---
128	DQ-04	DQ-04	DQ-04	DQ-04
127	DQ-12	DQ-12	DQ-12	---
104	DQ-05	DQ-05	DQ-05	DQ-05
105	DQ-13	DQ-13	DQ-13	---
106	DQ-06	DQ-06	DQ-06	DQ-06
107	DQ-14	DQ-14	DQ-14	---
113	DQ-07	DQ-07	DQ-07	DQ-07
114	DQ-15/A-1	DQ-15/A-1	DQ-15/A-1	---
115	---	CKE	BYTE_n	---
116	CE_n	---	---	---
117	-	---	CE_n	---
118	OE_n	---	OE_n	---
119	-	CE_n	---	---

Expansion Prototype Connector

Headers J1, J2, J3 and J4 collectively form the standard-footprint called SantaCruz Expansion Headers. These are mechanically stable connections that can be used as an interface to a special function daughter card.

The expansion prototype connector interface includes

- 62 general purpose I/O pins for prototyping (All 62 I/O pins connect to user I/O pins on the Cyclone device)
- PCI Clock available on the J4 connector from master clock chip
- User clock available on the J4 connector from FPGA
- An Active LOW Power On Reset signal
- Five regulated 3.3V power-supply pins (1A total max load)
- One regulated 5V power-supply pin. (1A total max load)
- Numerous ground connections

The output logic level on the expansion prototype connector pins is 5 Volts. There are two types of Santa Cruz headers: Short-expansion header and long-expansion header. The short-expansion header is formed on UP3-1C12 by J2, J3 & J4 connectors, which are 14 pins, 40pins and 20pins respectively. The J1 header contains additional user-definable I/O pins.

The UP3-1C12 Kit expansion prototype connector provides 62 I/O pins (5 Volts tolerant) for expansion purposes. Here all 62 I/O lines are level shifted using bus switches. Figure 10 shows the Santa Cruz connector.

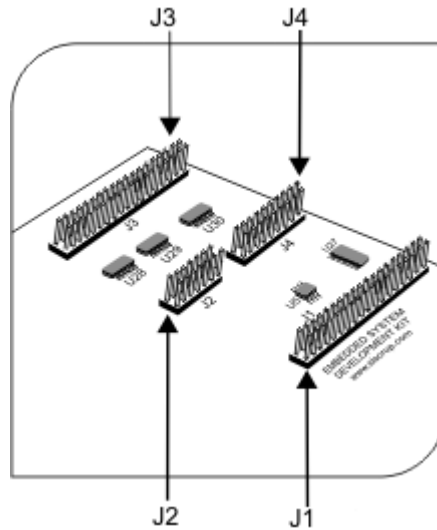
FIGURE 10. Santa Cruz Connector

Figure 11, Figure 12, Figure 13 & Figure 14 show the pin description of the connectors J1, J2, J3 & J4 respectively.

FIGURE 11. Expansion Prototype Connector-J1

FPGA Pin#	Connector Pin#		Connector Pin#	FPGA Pin#
Gnd	1	●	2	Gnd
138	3	●	4	139
140	5	●	6	141
143	7	●	8	156
158	9	●	10	159
160	11	●	12	161
gnd	13	●	14	gnd
162	15	●	16	163
164	17	●	18	165
166	19	●	20	167
NC	21	●	22	NC
NC	23	●	24	NC
NC	25	●	26	NC
gnd	27	●	28	gnd
137	29	●	30	136
135	31	●	32	134
NC	33	●	34	NC
NC	35	●	36	NC
NC	37	●	38	NC
gnd	39	●	40	gnd

FIGURE 12. Expansion Prototype Connector-J2

FPGA Pin#	Connector Pin#		Connector Pin#	FPGA Pin#
Grnd	1	●	2	+5V
NC	3	●	4	186
195	5	●	6	186
194	7	●	8	184
193	9	●	10	183
188	11	●	12	182
187	13	●	14	181

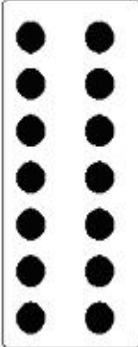
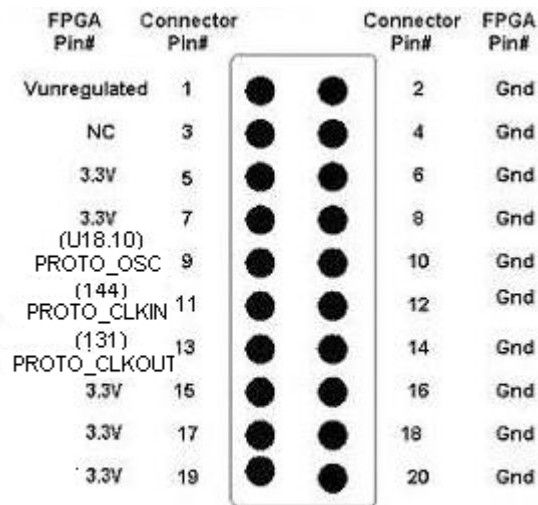


FIGURE 13. Expansion Prototype Connector-J3

FPGA Pin#	Connector Pin#	Connector Pin#	Connector Pin#	FPGA Pin#
Reset-Shift	1	●	●	2 Gnd
217	3	●	●	4 169
216	5	●	●	6 219
215	7	●	●	8 218
206	9	●	●	10 168
207	11	●	●	12 222
208	13	●	●	14 223
213	15	●	●	16 224
214	17	●	●	18 226
Gnd	19	●	●	20 NC
180	21	●	●	22 Gnd
200	23	●	●	24 Gnd
201	25	●	●	26 Gnd
202	27	●	●	28 196
175	29	●	●	30 Gnd
177	31	●	●	32 197
203	33	●	●	34 179*
176	35	●	●	36 178
174	37	●	●	38 124
173	39	●	●	40 Gnd

* should be kept NC for standard Santa Cruz connector

FIGURE 14. Expansion Prototype Connector-J4

In the Figure 14,

- Connector Pin J4.9 has a PCI clock coming from the board clock chip
- Connector Pin J4.11 has a clock coming from the FPGA pin
- Connector Pin J4.13 has a clock coming out of the Prototype card to the FPGA

IDE

J3 on Santa-Cruz connector can be used as IDE interface connector. Hard Drive and CD ROM Drive usually connect to the computer through an Integrated Drive Electronics (**IDE**) interface. Essentially, an IDE interface is a standard way for a storage device to connect to a computer.

Table 13 gives the pin connections of IDE.

TABLE 13. IDE

FPGA Pin No.	Signal	IDE Pin No. (S.C. J3)		Signal	FPGA Pin No.
---	RESET#	1	2	GND	---
217	D7	3	4	D8	169
216	D6	5	6	D9	219
215	D5	7	8	D10	218
206	D4	9	10	D11	168
207	D3	11	12	D12	222
208	D2	13	14	D13	223
213	D1	15	16	D14	224
214	D0	17	18	D15	225
---	GND	19	20	NC	---
180	DMARQ	21	22	GND	---
200	WE#	23	24	GND	---
201	OE#	25	26	GND	---
202	IORDY	27	28	CSEL	196
175	DMACK	29	30	GND	
177	INTRQ	31	32	IOCS16	197
203	A0	33	34	PDIAG	179
176	A1	35	36	A2	178
174	CS0#	37	38	CSI	124
173	DASP#	39	40	GND	---

Serial Port Connector

SER2 is the standard DB-9 Serial connector. It has all 9-pin connections to the FPGA, a FULL Modem interface. This connector is typically used for communication with a host computer using a standard serial cable connected to (for example) a COM port. **U21** is a level translator for interfacing the SER2, Full Modem serial port, with the FPGA.

Figure 15 shows Serial Port connector. Table 14 shows the pin description of the Serial Port connector.

FIGURE 15. Serial Port Connector

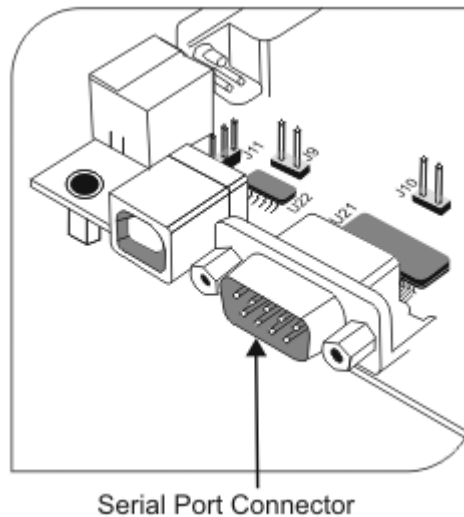


TABLE 14. Pin Description for Serial Port

FPGA Pin No.	DB-9 (SER2) Pin No.	Description	U21 (MAX 3243) Pin No.
---	1	DCD-232 LEVEL	4 RSIN1
---	2	RX-232 LEVEL	6 RSIN2
---	3	TX-232 LEVEL	9 RSOUT1
---	4	DTR-232 LEVEL	10 RSOUT2
---	5	GND-232 LEVEL	25 GND
---	6	DSR-232 LEVEL	5 RSIN2
---	7	RTS-232 LEVEL	11 RSOUT3
---	8	CTS-232 LEVEL	7 RSIN4
---	9	RI-232 LEVEL	8 RSIN5
39	---	DCD-TTL LEVEL	19 TTLOUT1
42	---	RX-TTL LEVEL	17 TTLOUT3
47	---	TX-TTL LEVEL	14 TLIN1
46	---	DTR-TTL LEVEL	13 TTLIN2
---	---	GND-TTL LEVEL	25 GND
41	---	DSR-TTL LEVEL	18 TTLOUT2
45	---	RTS-TTL LEVEL	12 TTLIN3
43	---	CTS-TTL LEVEL	16 TLOUT4
44	---	RI-TTL LEVEL	15 TTLOUT5

I2C Bus

I2C is a two-wire, bi-directional serial bus that provides a simple and efficient method of data exchange between devices. It is most suitable for short distance communication between many devices. I2C standard is a true multi-master bus, which includes collision detection, and arbitration that prevents data corruption if two or more masters attempt to control the bus simultaneously.

It is the most widely used bus, which allows the connection of many types of ICs that are used in a number of different applications. It provides an interface between microprocessor and peripheral devices without wiring full address, data and control.

Two I2C buses have been provided on the UP3-1C12 board in which one I2C hooks up with memory (I2C EEPROM) and other to I2C RTC. Both are 5V operative. These two buses are

1. Fast I2C Bus: 400Kbps, I2C EEPROM is on this bus
2. Normal I2C Bus: 100Kbps, I2C RTC is on this bus

TABLE 15. I2C EEPROM Signal Assignments

Header Pin No.	Signal	FPGA Pin No.
---	A0	---
---	A1	---
---	A2	---
---	GND	---
JP18.3	SDA	21
JP18.2	SCL	20
---	WP	---
---	VCC	---

I2C Memory (EEPROM)

U16 is a 16 Kbits I2C EEPROM. The I2C interface lines of this I2C Memory are also shared on the headers to add more I2C devices on the bus.

Notes for the I2C EEPROM Interface:

1. Address lines A0, A1, A2 are shoted to GND
2. SDA and SCL lines are pulled high through 5.6K resistors
3. Write Protect pin is left floating, not to write protect the memory
4. The Write Protect (WP) pin can be tied HIGH with 5.6K resistor to write protect the entire memory.

I2C RTC

U5 is a Real Time Clock chip on I2C bus. The TIMEKEEPER RAM is a low power Serial TIMEKEEPER with a built-in 32.768kHz oscillator (external crystal controlled). Eight bytes of the RAM are used for the clock/calendar function and are configured in binary coded decimal (BCD) format. Addresses and data are transferred serially via a two-line bi-directional bus. The built-in address register is incremented automatically after each WRITE or READ data byte. The clock has a built-in power sense circuit that detects power failures and automatically switches to the battery supply during power failures. The energy needed to sustain the RAM and clock operations can be supplied from a small lithium coin cell. Typical data retention time is in excess of 5 years with a 50mA/h 3V lithium cell.

Notes for the I2C RTC Interface:

1. On UP3-1C12 board the RTC is battery backed with 3 V lithium cell.

2. 32.768 KHz crystal is used for the RTC.
3. FT/OUT pin is taken out on the header at **JP13.1** for frequency test.
4. Clock, Data and FT/OUT lines are pulled up through 5.6K resistors.

TABLE 16. RTC Pin Configuration

U5-RTC Pin No.	Header Pin No.	Signal	FPGA Pin No.
1	---	OSCI	---
2	---	OSCO	---
3	---	VBAT	---
4	---	GND	---
5	JP18.4	SDA	121
6	JP18.5	SCL	120
7	JP13.1	FT/OUT	---
8	---	VCC	---

Headers for I2C bus (JP18)

Signals for both the I2C buses are taken out as headers. These headers can be used to connect additional I2C slaves or can be used for debugging purpose for existing I2C slaves (RTC and EEPROM).

TABLE 17. Headers for I2C Bus

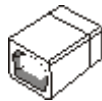
JP18 Pin No.	Signal Description
1	VCC +5 Volt
2	SCL - I2C Bus on which I2C EEPROM is connected
3	SDA - I2C Bus on which I2C EEPROM is connected
4	SDA - I2C Bus on which I2C RTC is connected
5	SCL - I2C Bus on which I2C RTC is connected
6	GND

USB

USB is a cable bus that supports data exchange between a host computer and a wide range of simultaneously accessible peripherals. The attached peripherals share USB bandwidth through a host-detached while the host and other peripherals are in operation.

The USB transfers signal and power over a four-wire cable as shown in the figure below. The signaling occurs over two wires on each point-to-point segment.

B Type Connector



The figure beside shows B-Type connector (**J12** on the UP3-1C12 board). This connector requires a transceiver (PHY-chip) in order to communicate with FPGA. Table 17 shows pin connections of the B-type connector and Table 18 describes the configuration jumpers.

PHY-Chip

U22 is the PHY Chip (1T11A), which act as the interface between FPGA pins and the two differential lines of the USB Interface. It converts the differential line interface of the USB to the three transmit and three receive signals as shown in the Figure 16.

FIGURE 16. USB PHY Chip interface diagram

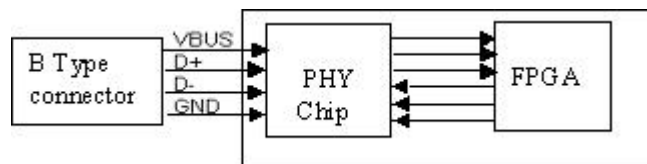


TABLE 18. Connection table B Type Connector to PHY Chip to FPGA

B-Type Connector Pin no.	Signal	PHY Chip Pin No.	Signal	FPGA Pin No.
---	---	1	Mode	---
---	---	2	OE	16
---	---	3	RCV	17
---	---	4	VP	18
---	---	5	VM	19
---	---	6	SUSPEND	---
J12.4	GND	7	GND	---
J12.1	NC	8	NC	---
---	---	9	SPEED	---
J12.2	D-	10	D-	---
J12.3	D+	11	D+	---
---	---	12	VPO	15
---	---	13	VMO/FSEO	14
---	---	14	VCC	---

TABLE 19. USB Configuration Jumpers

Jumper	Speed Select	
	Low Speed	Full Speed
JP8 (MODE)	Short 2-3	Short 2-3
JP9 (D+)	Open	Short 1-2
JP10 (D-)	Short 1-2	Open
JP11(SPEED)	Short 2-3	Short 1-2

PS/2 Connector

JP1 is a PS/2 Connector. The PS/2 interface allows the connectivity to a PS/2 device. The connector is a female 6-pin mini din type.

FIGURE 17. PS/2 Connector

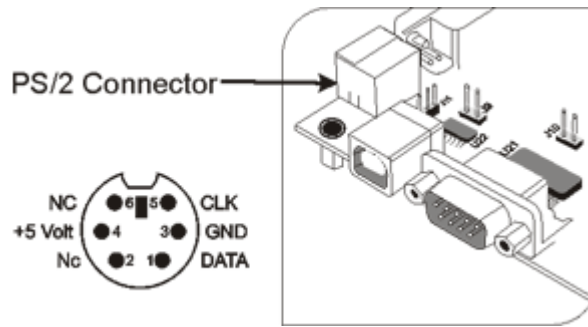


TABLE 20. PS/2 Signal Description

PS/2 Pin #	Signal	FPGA Pin No.	Description
1	DATA	13	PS/2 Device Data
2 & 6	NC	---	---
3	GND	---	---
4	+5 V	---	PS/2 Device Supply
5	CLK	12	PS/2 Device Clock

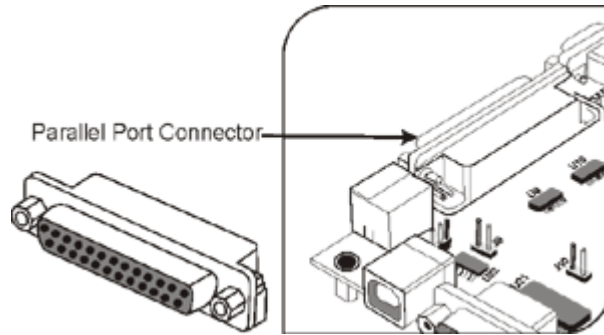
Parallel Port

CON1 is a standard DB25 Female parallel port connector.

TABLE 21. Parallel Port Signal Description

Parallel Port Pin No.	Signal	FPGA Pin No.
1	C0	8
2	D0	6
3	D1	1
4	D2	5
5	D3	3
6	D4	240
7	D5	238
8	D6	237
9	D7	239
10	S6	236
11	S7	235
12	S5	234
13	S4	233
14	C1	7
15	S3	2
16	+5 V	---
17	C3	4
18	GND	---
19	GND	---
20	GND	---
21	GND	---
22	GND	---
23	GND	---
24	GND	---
25	GND	---

FIGURE 18. Parallel Port Connector



VGA Port

UP3-1C12 board has a standard VGA connector. It contains 5 active signals. Two signals - compatible with TTL logic levels - horizontal sync and vertical sync, are used for synchronization of the video. Three analog signals with 0.7 to 1.0 volt peak-to-peak level are used to control the color.

The color signals are Red, Green, and Blue. They are often collectively referred to as the RGB signals. By changing the analog level of the three RGB signals, all other colors are produced.

FIGURE 19. VGA Port

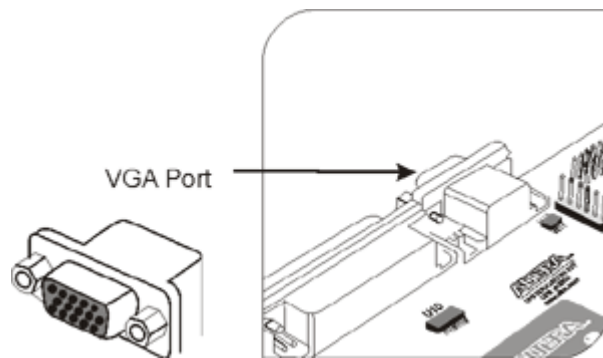


TABLE 22. VGA Port Pin Configuration

VGA Pin No.	VGA Interface	FPGA Pin No.
1	Red	228
2	Green	122
3	Blue	170
4	NC	---
5	NC	---
6	GND	---
7	GND	---
8	GND	---
9	NC	---
10	GND	---
11	GND	---
12	NC	---
13	H_sync	227
14	V_sync	226
15	NC	---

Push Button Switches

SW4, SW5, SW6 and SW7 are momentary-contact push-button switches and are used to provide stimulus to designs in the Cyclone device. Each switch is connected to the Cyclone general-purpose I/O pin with pull-up resistor. The Cyclone device pin will see logic '0' when each switch is pressed.

FIGURE 20. Push Button Switches

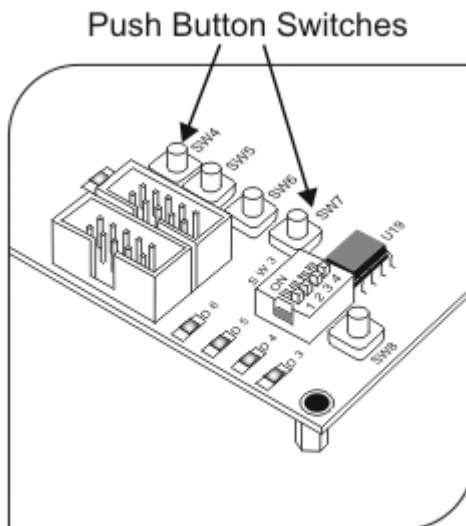


TABLE 23. Push Button Switches Pin Out Table

Button	SW4	SW5	SW6	SW7
FPGA Pin No.	48	49	57	62

SW8 is a global reset switch connected to the RESET IC. The RESET IC pin RESETIN# will see logic '0' when SW8 is pressed. The output of this RESET IC (RESET# Active LOW) is connected to the FPGA pin **U11.23**. Hence the Cyclone device pin will see logic '0' when SW8 is pressed.

Dip Switches

SW3 is a block of four switches. Each switch is connected to the Cyclone general-purpose I/O pin with pull-up resistor. The Cyclone device pin will see logic '0' when switch is in ON condition.

FIGURE 21. Dip Switches

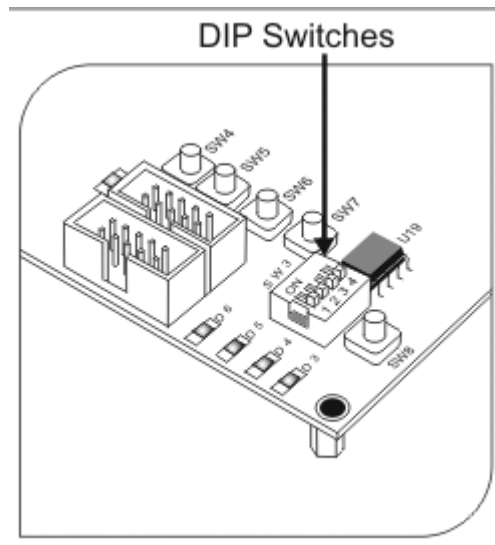


TABLE 24. Dip Switches Pin Out Table

Switch	SW 3.1	SW 3.2	SW 3.3	SW 3.4
FPGA Pin No.	58	59	60	61

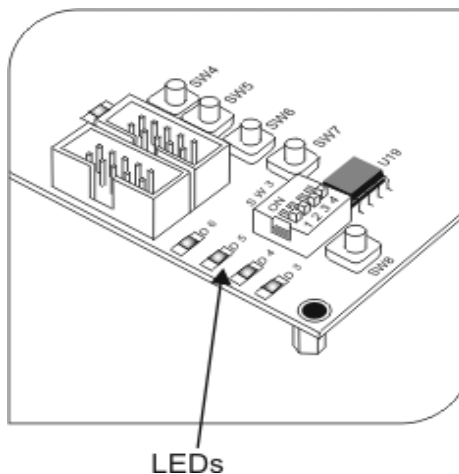
LEDs

D3, D4, D5 and **D6** are four individual LEDs connected to the Cyclone device general purpose I/O with current limiting resistors. All of them are active high driven (Common Cathode Configuration). All the LEDs will glow when there is logic '1' at the corresponding FPGA pins.

TABLE 25. LED Pin Out Table

LED	D3	D4	D5	D6
FPGA Pin No.	56	55	54	53

FIGURE 22. LEDs



D8 is Configuration Done LED that indicates successful completion of the downloading process. The CONFIG_DONE pin (**U11.145**) of the Cyclone device controls this LED.

D15 is INVALID connection indicator LED that indicates faulty/no connection of the serial cable at the serial port (SER2). If invalid voltage (non RS232 standard voltage) appears at any receive lines of the MAX 3243 chip (U21) then the INVALID LED will glow. U21.21 pin controls this LED.

Power Supply Circuitry

The UP3-1C12 board is powered with number of different regulated supply voltages as mentioned below:

1. +1.5 Volts for Cyclone core supply
2. +3.3 Volts for Cyclone I/O ring supply
3. +5 Volts for 5-volts operative devices on the board

The board accepts +9 Volt unregulated/regulated supply from external source (with center-terminal positive supply).

Debug headers provided for the power supply on the board are described in Table 26.

TABLE 26. Headers on the board

Header	Purpose
JP6	+5 V regulated supply
JP7	+3.3 V regulated supply
JP8	Unregulated input voltage to the board
JP10	+1.5 V regulated supply

Power Supply Configuration Jumper

The board is provided with jumper setting for input supply to the board. Jumper pins **JP5.2** and **JP5.3** are shorted when input supply from external source is +9 volt regulated/unregulated, which is the default setting on the board. Jumper pins **JP5.1** and **JP5.2** are shorted when input supply from external source is +5 volt regulated. The second setting is useful when the 5 Volt regulator chip is not stuffed on the board. Be careful while using this option, since in this mode, all the +5 V operative devices are directly fed this supply. Hence if the supply is not proper (+5 V regulated) then this may damage the +5 V operative devices on the board when this option is used.

Clock Circuitry

This development board supports number of IP blocks requiring different frequencies. The UP3-1C12 board provides multiple clocks. **U18** is a Master clock chip (**PI6C106**) which provides different clocks on the board. The clock chip uses 14.318 MHz crystal (**Y1**) for its inbuilt oscillator. Table 28 gives pin description of the clock chip.

JP3 is a 10-pin header for configuring the input clock to the Cyclone device at CLK1 or CLK3 pins. **J7** is a 3-pin header for configuring the CPU clock outputs of the clock chip.

1. PCI clock (33.33 MHz)
2. USB clock (48 MHz)
3. IOAPIC clock (14.318 MHz) and
4. CPU clock (100 MHz / 66.66 MHz).

Table 27 describes jumper setting for CLK1, table 28 describes jumper setting for CLK3 and table 29 is for CPU clock select setting. Table 30 describes details of other clock headers. Table 31 describes the external clock input that can be adjusted by the user.

TABLE 27. Jumper Setting for Clock Input to the FPGA at CLK1

CLK1	Jumper Setting	FPGA Pin No.
USBCLK (U18.14) 48 MHz	Short JP3.4-JP3.3	29
REF0CLK (U18.28) 14.318 MHz	Short JP3.4-JP3.6	29

TABLE 28. Jumper Setting for Clock Input to the FPGA at CLK3

CLK3	Jumper Setting	FPGA Pin No.
PCICLK_E (U18.5)33.33 MHz	Short JP3.8 & JP3.7	152
REF0CLK (U18.28) 14.318 MHz	Short JP3.8 & JP3.6	152

TABLE 29. CPU Clock Select Setting

CPU Clock	Jumper Setting	FPGA Pin No.
66 MHz	Short J 7.1 & J 7.2	153
100 MHz	Short J 7.2 & J 7.3	153

TABLE 30. Other Clock Header

Header	Signal
JP 4.1	CPUCLK2 (U18.22) (100MHz) as per Jumper Setting
JP 19.1	IOAPIC (U 18.26) (14.318 MHz)

It is strongly recommended to disable the clocks, if not in use, using CPU_STOP and PCI_STOP signals to disable the CPU clocks and PCI clocks respectively. Short JP5.1 and JP5.2 to stop the PCI Clock. Drive U11.123 (FPGA) pin low to stop the CPU Clock.

Note: JP4.1 and JP19.1 gives Clock outputs on Headers only. These pins are not connected to any FPGA pins.

TABLE 31. External Clock Input

Header	Signal	FPGA Pin No.
JP 2.2	USER CLOCK	38

Reset Circuitry

U19 is an integrated-circuit supply-voltage supervisor. The supply-voltage supervisor monitors the supply for under voltage conditions at the SENSE input. During power up, the RESET output becomes active (low) when VCC attains a value approaching 1 V. As VCC approaches 3 V (assuming that SENSE is above VT+), the delay-timer function activates a time delay, after which outputs RESET and RESET# goes inactive. When an under voltage condition occurs during normal operation, outputs RESET and RESET# goes active. To ensure that a complete reset occurs, the reset outputs remain active for a fixed time delay even after the voltage at the SENSE input exceeds the positive-going threshold value.

TABLE 32. Reset Signal Assignment

U19 Reset IC Pin No.	Signal	FPGA Pin No.
5	RESET#	23

Appendix

Clocking Chip Pin Configuration

Clock Chip Pin No.	Signal	Connection
1	GND1	Board ground
2	X1	Crystal Y 1.1
3	X2	Crystal Y 1.2
4	GND2	Board ground
5	PCICLK F	Clock setting Jumper JP 3.7
6	PCICLK F	NC
7	PCICLK0	Cyclone CLK0 (U 11.28)
8	PCICLK1	NC
9	VDD2	+3.3 Volt Supply
10	PCICLK2	Santa Cruz Connector J4.9
11	PCICLK3	NC
12	PCICLK4 / SEL100/66#	CPU clock select jumper J7.2
13	VDD3	+3.3 Volt Supply
14	48 MHz	Clock Setting Jumper JP 3.3
15	GND3	Board ground
16	SPREAD#	Tied high +3.3 Volt
17	PD#	Tied high +3.3 Volt
18	CPU_STOP#	Cyclone U 11.123 (Drive this pin low to stop the CPU clock)
19	PCI_STOP#	J5.2 (JP5.1 = GND, JP5.2=PCI_STOP, JP5.3=VCC)
20	GND	Board ground
21	VDDL	+3.3 Volt Supply
22	CPUCLK2	Clock header JP 4.1
23	CPUCLK1	NC
24	CPUCLK0	Cyclone CLK2 (U 11. 153)
25	VDDL	+3.3 Volt Supply
26	IOAPIC	Clock header JP 19.1
27	VDD1	+3.3 Volt Supply
28	REF0	Clock setting Jumper JP3.6

