

# **IGLOO PLUS Starter Kit**

User's Guide



#### Actel Corporation, Mountain View, CA 94043

© 2009 Actel Corporation. All rights reserved.

Printed in the United States of America

Part Number: 50200152-0

Release: March 2009

No part of this document may be copied or reproduced in any form or by any means without prior written consent of Actel.

Actel makes no warranties with respect to this documentation and disclaims any implied warranties of merchantability or fitness for a particular purpose. Information in this document is subject to change without notice. Actel assumes no responsibility for any errors that may appear in this document.

This document contains confidential proprietary information that is not to be disclosed to any unauthorized person without prior written consent of Actel Corporation.

#### Trademarks

Actel and the Actel logo are registered trademarks of Actel Corporation.

Adobe and Acrobat Reader are registered trademarks of Adobe Systems, Inc.

All other products or brand names mentioned are trademarks or registered trademarks of their respective holders.



# **Table of Contents**

	Introduction       5         IGLOO PLUS Starter Kit Contents       5
1	Board Components and Settings       7         Board Description
2	FPGA Description15Key Features of AGLP125-CSG28915Power and Ground Pins16Bank I/O Signals17JTAG Pins21Decaps and Ground Post Schematics22
3	Power23Power Modes24Battery25Potentiometer and Voltage-Sweep25Current Measurement26
4	Operation of Board Components29Clock Oscillator29Reset29Flash*Freeze Mode30Push-Button Switches37DIP Switches37User LEDs38User LEDs39I/O Test Pins40OLED41Interface Connector42USB-to-UART Interface43SPI Flash44Low-Cost Programming Stick (LCPS)45
5	Programming
6	IGLOO PLUS Board Demo       51         Demos Included in the Starter Kit       51         Powering Up the Board       51         Getting Started with the IGLOO PLUS Starter Kit Demo Design       51
A	Resources

### 

#### Table of Contents

В	Product Support	57
	Customer Service	. 57
	Actel Customer Technical Support Center	. 57
	Actel Technical Support	. 57
	Website	. 57
	Contacting the Customer Technical Support Center	57
	Index	59



### **IGLOO PLUS Starter Kit Contents**

The RoHS-compliant, environmentally friendly IGLOO® PLUS Starter Kit is packaged in a recyclable cardboard box made from recycled materials. This development kit includes an on-board programmer and demonstrates the ultra-low power of Actel IGLOO PLUS devices. Table 1 lists the contents of the box.

Quantity	Contents
1	IGLOO PLUS board with AGLP125 IGLOO PLUS FPGA
1	Programmer for use with IGLOO PLUS board
1	5 V power supply
2	USB 2.0 high-speed cables
1	Packet of jumpers
1	Actel Libero® Integrated Design Environment (IDE) DVD
1	Quick Start Guide



Figure 1 · IGLOO PLUS Starter Kit Board



# **Board Components and Settings**

This chapter describes the components and settings for the IGLOO PLUS Starter Kit Board.

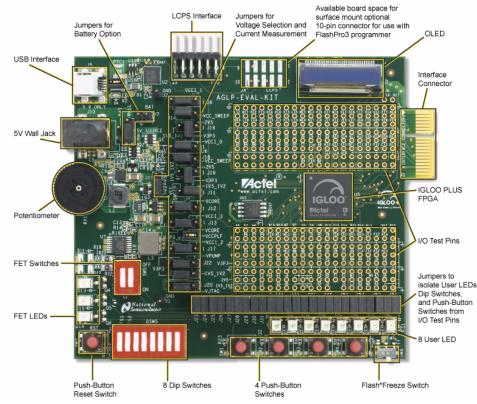
### **Board Description**

The IGLOO PLUS Starter Kit board is intended to provide a low-cost system platform for evaluating IGLOO PLUS (AGLP) technology, such as low power, I/O state preservation during Flash\*Freeze mode, and Schmitt Triggered I/Os. Other advanced features include the ability to use the FPGA I/Os of the Expansion Header as hot-swappable and the Schmitt Triggered FPGA inputs for improved noise immunity.

This evaluation board enables you to measure power consumption (dynamic, static, and Flash\*Freeze modes) with the core operating between 1.2 V and 1.5 V. When using the board in conjunction with Actel's power analysis tools, you will have a clear picture of application power consumption at each stage in your design. In addition, the Libero® Integrated Design Environment (IDE) tool suite now includes power-driven layout (PDL), which can reduce the power consumption of designs up to 30 percent.

The evaluation board has a small form factor, measuring 3.7 inches by 4 inches, and supports an AGLP125 IGLOO PLUS device in the 14 mm  $\times$  14 mm CSG289 package. All components used on the board, such as LEDs, reset ( $\mu$ A range), and oscillator, are low-power components. Also included on the evaluation board is a USB-to-UART interface to allow HyperTerminal on a PC to communicate with the IGLOO PLUS device on the board.

The top of the board has a programming stick header which allows the low-cost programming stick (LCPS) to be attached to the board for programming the IGLOO PLUS AGLP125-CSG289 device (Figure 1-1 on page 7). FPGA I/Os have been wired to test pin pads on the board for debug and expandability.



Note: The clock oscillator for the IGLOO PLUS Starter Kit Board is behind the board. Figure 1-1 · IGLOO PLUS Starter Kit Board



Board Components and Settings

### **IGLOO PLUS Board Stackup**

The IGLOO PLUS board is built on a 10-layer PCB. Figure 1-2 and Figure 1-3 on page 10 show the top (L1) and bottom (L10) silkscreens. The full PCB design layout is provided on the Actel website, on the IGLOO PLUS Starter Kit page: http://www.actel.com/products/hardware/devkits\_boards/iglooplus\_starter.aspx. To view the PCB design layout files, you can use the Allegro Free Physical Viewer, which can be downloaded from the Cadence Allegro Downloads page.

- 1. Top Signal (Figure 1-2 on page 9)
- 2. GND 1
- 3. Signal
- 4. GND 2
- 5. PWR 1
- 6. PWR 2
- 7. GND 3
- 8. Signal
- 9. GND 4
- 10. Bottom Signal (Figure 1-3 on page 10)



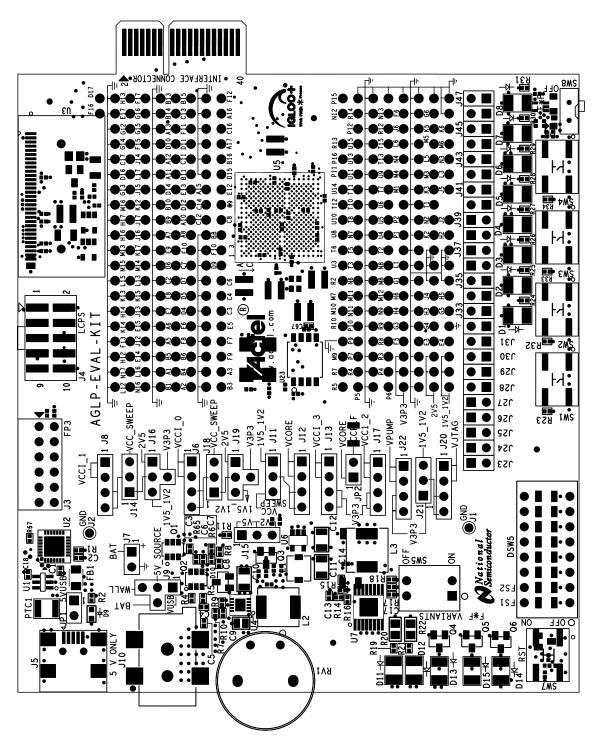


Figure 1-2 · IGLOO PLUS Top Silkscreen (L1)



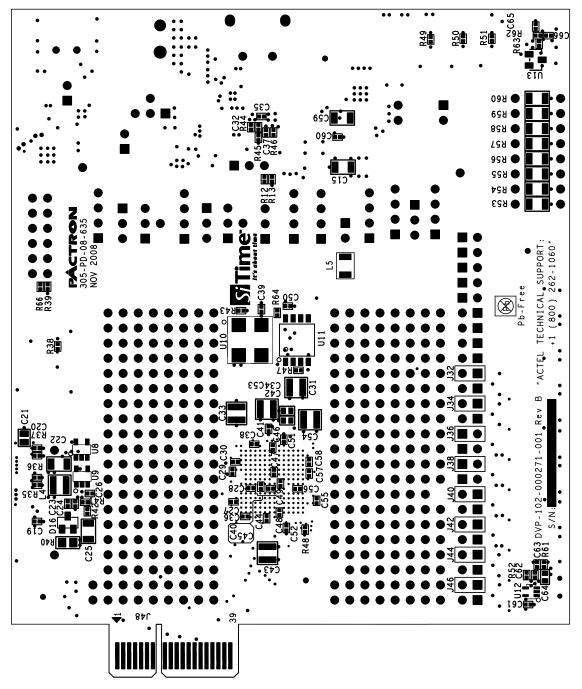


Figure 1-3 · IGLOO PLUS Bottom Silkscreen (L10)

### Connectors, Jumpers, and Switch Settings

Recommended default jumper settings are defined in Table 1-1. The voltage selection jumpers are highlighted in grey. Connect jumpers in the default settings described in Table 1-1 to enable the pre-programmed demo design to function correctly.

Jumper	Default Setting	Comment					
J1		Ground post header					
J2		Ground post header					
J3		LC JTAG header for programmer					
J4		JTAG header					
J5		USB mini receptacle					
J6	Pin 2-3	Remove jumper to disconnect VCCI_0 power					
J7	Remove	Remove jumper to disconnect external battery source					
J8	Pin 2-3	Remove jumper to disconnect VCCI_1 power					
		Select WALL, BAT, VUSB for 5V_SOURCE					
J9	Pin 1-4	Pin 1-4 = VUSB					
J,2	F III 1-4	Pin 2-4 = BAT					
		Pin 3-4 = WALL					
J10		5 V Brick					
	Pin 1-2	Select VCC or VCC_SWEEP for VCORE					
J11		Pin 1-2 = VCC					
		Pin 3-2 = VCC_SWEEP					
J12	Pin 2-3	Current measurement header for VCORE					
J13	Pin 2-3	Current measurement header for VCCI_3					
	Pin 1-2	Select VCC or VCC_SWEEP for VCCI_1					
J14		Pin 1-2 = VCC					
		Pin 3-2 = VCC_SWEEP					
		Select VJTAGENB or 3.3 V					
J15	Pin 3-2	Pin 3-2 = VJTAGENB					
		Pin 1-2 = 3.3 V					
		Select 3.3 V, 1.5 / 1.2 V, or 2.5 V for VCCI_1					
J16	Pin 2-4	Pin 2-4 = 3.3 V					
2		Pin 3-4 = 1.5 V or 1.2 V					
		Pin 1-4 = 2.5 V					
J17	Pin 2-3	Current measurement header for VCCI_2					
		Select VCC or VCC_SWEEP for VCCI_0					
J18	Pin 1-2	Pin 1-2 = VCC					
		Pin 3-2 = VCC_SWEEP					

#### Table 1-1 · Jumper and Connector Settings



### Board Components and Settings

Jumper	Default Setting	Comment					
J19	Pin 2-4	Select 3.3 V, 1.5 / 1.2 V, or 2.5 V for VCCI_0 Pin 2-4 = 3.3 V Pin 3-4 = 1.5 V or 1.2 V Pin 1-4 = 2.5 V					
J20	Pin 2-3	Current measurement header for VJTAG					
J21	Pin 1-2	Select 3.3 V or 1.5 / 1.2 V for VJTAG Pin 1-2 = 3.3 V Pin 2-3 = 1.5 V or 1.2 V					
J22	Pin 2-3	Current measurement header for VPUMP					
J23-J24	Pin 1-2	Remove each jumper to disconnect any of the 2 FET Switches[1:2] from FPG J23 = 3V3_SWITCH1 J24 = 3V3_SWITCH2					
J25-J27	Pin 1-2	Remove each jumper to disconnect any of the 3 FET LEDs from FPGA. J25 = FET_P1 J26 = FET_N J27 = FET_P2					
J28-J35	Pin 1-2	Remove each jumper to disconnect any of the 8 user DIP switches[1:8] from FPGA. J28 = D_SWITCH1 J29 = D_SWITCH2 J30 = D_SWITCH3 J31 = D_SWITCH4 J32 = D_SWITCH4 J33 = D_SWITCH5 J33 = D_SWITCH6 J34 = D_SWITCH7 J35 = D_SWITCH8					

Jumper	Default Setting	Comment					
		Remove each jumper to disconnect any of the 4 push-button switches[1:4] from FPGA.					
126 120	Pin 1-2	J36 = SWITCH1					
J36-J39		J37 = SWITCH2					
		J38 = SWITCH3					
		J39 = SWITCH4					
		Remove each jumper to disconnect any of the 8 user LEDs[1:8] from FPGA.					
		J42 = LED1					
		J41 = LED2					
		J40 = LED3					
J40-J47	Pin 1-2	J47 = LED4					
		J46 = LED5					
		J45 = LED6					
		J44 = LED7					
		J43 = LED8					

Table 1-1 · Jumper and Connector Settings (continued)

#### Table 1-2 · Switch Settings

Switch	Default Setting	Comment		
SW1-SW4		Push-button switches for SWITCH[1:4]		
SW5	CLOSE	Contains DIP switches for 3V3_SWITCH[1:2]		
DSW5	CLOSE	Contains DIP switches for D_SWITCH[1:8]		
SW7		Push-button switch for system reset PBRESET_N		
SW8	OFF	Flash*Freeze: To enable Flash*Freeze mode, SW8 toward ON. In Flash*Freeze mode, current consumption of FPGA goes below 50 μA.		

# **FPGA Description**

Actel

The IGLOO PLUS board is populated with an IGLOO PLUS AGLP125-CSG289 FPGA.

### Key Features of AGLP125-CSG289

- Low power
- 1.2 V to 1.5 V core voltage support for low power
- Supports single-voltage system operation
- \* 5  $\mu$ W power consumption in Flash\*Freeze mode
- Low-power active FPGA operation
- Flash\*Freeze technology enables ultra-low power consumption while maintaining FPGA content
- Configurable hold previous state, tristate, HIGH, or LOW state per I/O in Flash\*Freeze mode
- Easy entry to / exit from ultra-low-power Flash\*Freeze mode
- Reprogrammable flash technology
- In-system programming (ISP) and security
- High-performance routing hierarchy
- Advanced I/O
- Selectable Schmitt trigger inputs
- Clock conditioning circuit (CCC) and PLL
- Embedded memory

Table 2-1 lists specifications for the AGLP125-CSG289 FPGA.

#### Table 2-1 · IGLOO PLUS AGLP125-CSG289 FPGA Features

Feature	Specification				
System Gates	125,000				
Typical Equivalent Macrocells	1,024				
VersaTiles (D-flip-flops)	3,120				
Flash*Freeze Mode (Typical, µW)	16				
RAM kbits (1,024 bits)	36				
4,608-Bit Blocks	8				
FlashROM (bits)	1 K				
Secure (AES) ISP	Yes				
Integrated PLLs in CCCs	1				
VersaNet Globals	18				
I/O Banks	4				
Maximum User I/Os	212				

For further information, refer to the IGLOO PLUS datasheet: http://www.actel.com/documents/IGLOOPLUS\_DS.pdf



**FPGA** Description

### Power and Ground Pins

Figure 2-1 shows the power and ground pins for AGLP125-CSG289.

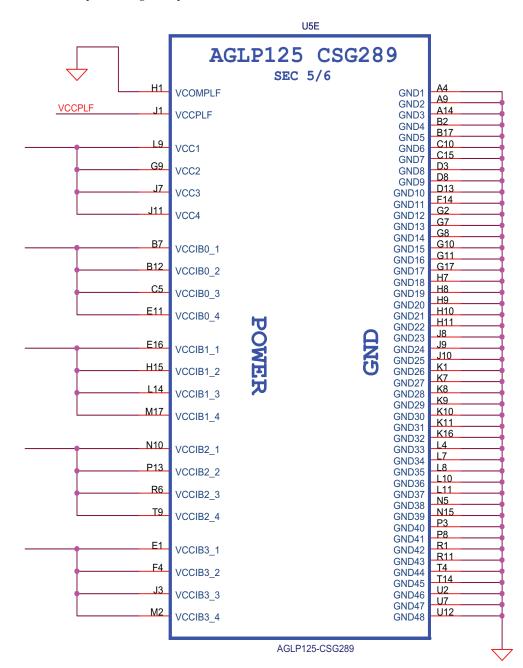


Figure 2-1 · Power and Ground Pins for AGLP125-CSG289



### Bank I/O Signals

Figure 2-2 through Figure 2-5 on page 20 show schematics for the bank I/O signals.

U5A									
			AGLP125	CSG28	9				
O TP105	AGL_B0_PIN_B3	B3		1/6		A11		TP96 O TR	
O TP112	AGL_B0_PIN_D5		IO06RSB0		IO38RSB0			<u>TP116</u> TP	
	AGL_B0_PIN_A3	D5	IO07RSB0		IO39RSB0	B11			
O TP69	AGL_B0_PIN_C4	A3	IO08RSB0	1	IO40RSB0	A12			
		C4	IO09RSB0	I	IO41RSB0	D10		TP124 TP	
	AGL_B0_PIN_D6	D6	IO10RSB0	I	IO42RSB0	A13			
	AGL_B0_PIN_A2	A2	IO11RSB0	I	IO43RSB0	_C11			
	AGL_B0_PIN_E6	E6	IO12RSB0	I	IO44RSB0	B13		<u>TP97</u> TP	
	AGL_B0_PIN_B4	B4	IO13RSB0	1	IO45RSB0	C12		TP89 O TP	
O	AGL_B0_PIN_F7	F7	IO14RSB0	I	IO46RSB0	B14		TP80 O TP	
О <u>ТР106</u>	AGL_B0_PIN_B5	B5	IO15RSB0	1	IO47RSB0	D11		TP78 O TP	
O <sup>TP101</sup>	AGL_B0_PIN_E7	E7	IO16RSB0	I	IO48RSB0	A15		TP118 TP	
O <sup>TP120</sup>	AGL_B0_PIN_C6	C6	IO17RSB0	1	IO49RSB0	B15		TP98 O TP	
O <u>TP72</u>	AGL_B0_PIN_D7	D7	IO18RSB0	1	IO50RSB0	C13		TP111 TP	
	AGL_B0_PIN_A5	A5	IO19RSB0	2	IO51RSB0	F11		TP76 OTP	
O <sup>TP113</sup>	AGL_B0_PIN_F8	F8	IO20RSB0	<b>9</b> 1	IO52RSB0	C14		TP109 TP	GPIO4
	AGL_B0_PIN_B6	B6	IO21RSB0		IO53RSB0	F12		TP103 TP	
O TP114	AGL B0 PIN E8	E8	IO22RSB0	2	IO54RSB0	A16		TP81 OTP	
O TP121	AGL_B0_PIN_C7	C7	IO23RSB0	-	IO55RSB0	D12	AGL_B0_PIN_D12	TP93 () TP	
O TP107	AGL B0 PIN A6	A6	IO24RSB0	1	IO56RSB0	E12	AGL B0 PIN E12	TP92 TP	
	AGL_B0_PIN_F9	F9	IO25RSB0						
O TP115	AGL_B0_PIN_A7	A7	IO26RSB0	GAA0/I	O00RSB0	C2	AGL_B0_PIN_C2	TP102 TP	
O	AGL_B0_PIN_C8	C8	IO27RSB0	GAA1/I	O01RSB0	B1	AGL_B0_PIN_B1	TP22 TP	
207	AGL_B0_PIN_B8	B8	IO28RSB0	GAB0/I	O02RSB0	D4	AGL B0 PIN D4	TP90 TP	
2222	AGL_B0_PIN_F10	F10	IO29RSB0	GAB1/I	O03RSB0	A1	AGL_B0_PIN_A1	TP68 TP	
	AGL_B0_PIN_A8	A8	IO30RSB0		O04RSB0	C3	AGL_B0_PIN_C3	TP83 TP	
2239	AGL_B0_PIN_B9	В9	IO31RSB0		O05RSB0	E5	AGL B0 PIN E5	TP91 O TP	
O TP122	AGL_B0_PIN_E9	E9	1032RSB0		O61RSB0	C16	AGL_B0_PIN_C16		
240	AGL_B0_PIN_C9	C9	1033RSB0		O62RSB0	D15	AGL_B0_PIN_D15		
	AGL_B0_PIN_D9	D9	1033RSB0		059RSB0	D14	AGL_B0_PIN_D14		
2247	AGL B0 PIN A10	A10				E13	AGL B0 PIN E13	TP100 TP	
○ <sup>TP123</sup>	AGL_B0_PIN_E10	E10	IO35RSB0		O60RSB0	A17	AGL_B0_PIN_A17		
236	AGL B0 PIN B10	B10	IO36RSB0		O57RSB0	B16	AGL B0 PIN B16	TP119 TP	
		010	IO37RSB0	GBC1/I	O58RSB0	510		UP IP	

AGLP125-CSG289

Figure 2-2 · Bank 0 I/O Signals for AGLP125-CSG289



#### FPGA Description

		U5	В	
		AGLP125	CSG289	
} GPIOA_2 >>		SEC	2/6	
} GPIOA_4 >>	TPO TP38 G13	IO64RSB1	GBA2/IO63RSB1	E14 AGL B1 PIN E14 TP39 TP
	TPOTP45 D16	IO66RSB1	GBB2/IO65RSB1	E15 AGL B1_PIN_E15_TP104 TP
} GPIOA_6 >>	TPOC17C17	IO68RSB1	GBC2/IO67RSB1	F13 AGL B1_PIN_F13_TP42 TP
} GPIOA_8 >>	TPO G14	IO69RSB1	GCA0/IO84RSB1	H14 AGL_B1_PIN_H14 TP226
GPIOA_10 >>	TPO	IO70RSB1	GCA1/IO83RSB1	J17 AGL_B1_PIN_J17 TP29 TP
GPIOA_12 >>	TPO			H16AGL_B1_PIN_H16TP2101
GPIOA_16 >>	TPO	IO71RSB1	GCA2/IO85RSB1	J16 AGL_B1_PIN_J16_TP48 TP
GPIOA_18	1FU +	IO72RSB1	GCB0/IO82RSB1	
GPIOA_20 >>	TPO TP46 E17	IO73RSB1	GCB1/IO81RSB1	J13 AGL B1 PIN J13 TP223
	TPO TP17 H13	IO74RSB1	GCB2/IO86RSB1	J12 AGL_B1_PIN_J12 TP43 TP
GPIOA_22	TPO	1075RSB1	GCC0/IO80RSB1	<u>H17 AGL_B1_PIN_H17 TP208</u> 01
GPIOA_24	TPO TP28 G16	IO76RSB1	GCC1/IO79RSB1	H12 AGL_B1_PIN_H12 TP142T
GPIOA_26	TPO	IO76RSB1 IO77RSB1 IO78RSB1	GCC2/IO87RSB1	K17 AGL_B1_PIN_K17 TP162 T
GPIOA_28	TPO TP32 G15	IO78RSB1	GDA0/IO104RSB1	M14 AGL B1_PIN_M14_TP20 TP
GPIOA_30 >>	TPOK12			<u>M13 AGL_B1_PIN_M13 TP183</u> 01
GPIOA_32 >>	TPO <sup>TP23</sup> J15	IO88RSB1	GDA1/IO103RSB1	N16 AGL B1 PIN N16 TP50 TP
GPIOA_34 >>	TP(	IO89RSB1	GDB0/IO102RSB1	<b>U</b>
GPIOA_36	TPO	IO90RSB1	GDB1/IO101RSB1	L13 AGL_B1_PIN_L13 TP24 TP
	TPOTP35	IO91RSB1	GDC0/IO100RSB1	N17 AGL B1 PIN N17 TP31 TP
	TPOTP49 AGL_B1_PIN_L16 L16	IO92RSB1	GDC1/IO99RSB1	L12 AGL_B1_PIN_L12 TP19 TP
	TPOTP21 AGL_B1_PIN_K15 K15	IO93RSB1		
	TPOTP34 AGL B1 PIN K13 K13	IO94RSB1		
	TPOTP16 AGL_B1_PIN_K14_K14_	IO95RSB1		
	TPOTP30 AGL B1 PIN M16 M16	IO96RSB1		
	TPOTP18 AGL_B1_PIN_M15_M15	IO97RSB1		
	TPOTP41 AGL B1 PIN L15 L15	IO98RSB1		

AGLP125-CSG289

Figure 2-3 · Bank 1 I/O Signals for AGLP125-CSG289



		U5C					
	AGLP1	25 C	SG289				
		SEC 3/6		Т8	AGL B2 PIN T8		OTP156
	IO108RSB2		IO139RSB2	T7	AGL_B2_PIN_T7	TP	OTP176
	IO109RSB2		IO140RSB2		AGL_B2_PIN_R8	TP	OTP167
PACER_RES# C R15	IO110RSB2		IO141RSB2	R8	AGL B2 PIN U6	TP	OTP155
<u> </u>	IO111RSB2		IO142RSB2	_U6		TP	OTP135
TPOTP163 AGL B2 PIN P12 P12	IO112RSB2		IO143RSB2	T6	AGL_B2_PIN_T6		
TPOTP170 AGL B2 PIN M12 M12	IO113RSB2		IO144RSB2	N8	AGL_B2_PIN_N8		
TPOTP161 AGL_B2_PIN_R14R14	IO114RSB2		IO145RSB2	R7	AGL_B2_PIN_R7		OTP175
TPO	IO115RSB2		IO146RSB2	U5	AGL_B2_PIN_U5	ТР	O <sup>TP174</sup>
TPOTP141 AGL_B2_PIN_R13 R13	IO116RSB2		IO147RSB2	T5	AGL_B2_PIN_T5	тр	O <sup>TP152</sup>
TPOTP160 AGL_B2_PIN_U15 U15	IO117RSB2		IO148RSB2	N7	AGL_B2_PIN_N7		OTP154
TPOTP181 AGL B2 PIN R12 R12	IO118RSB2		IO149RSB2	U4	AGL B2 PIN U4	10	OTP125
TPOTP150 AGL_B2_PIN_N11N11	IO119RSB2		IO150RSB2	R5	AGL_B2_PIN_R5	1P	OTP134
TPOTP139 AGL_B2_PIN_U14 U14	IO120RSB2		IO151RSB2	U3	AGL_B2_PIN_U3	TP	OTP287
TPOTP131 AGL_B2_PIN_M11 M11	IO121RSB2		IO152RSB2	P7	AGL_B2_PIN_P7	TP	- TP153
TPOTP179 AGL_B2_PIN_T13 T13	IO122RSB2		IO153RSB2	ТЗ	AGL_B2_PIN_T3	TP	OTP153
TPOTP159 AGL B2 PIN_U13 U13	IO123RSB2	Z	IO154RSB2	P6	AGL_B2_PIN_P6	TP	
TPO	IO124RSB2	A	IO155RSB2	R4	AGL_B2_PIN_R4	TP	
TPO	IO125RSB2	р	IO156RSB2	N6	AGL B2 PIN N6	TP	OTP151
TPO	IO126RSB2		IO157RSB2	P5	AGL_B2_PIN_P5	TP	OTP145
TPO TP178 AGL B2 PIN_T11	IO127RSB2		IO158RSB2	R3	AGL_B2_PIN_R3	TP164	
TPOAGL_B2_PIN_M100M1000M100M100M1000_M100M100M1000M1000_M1000_M100M100	IO128RSB2		IO159RSB2	M7	AGL_B2_PIN_M7	TP132	
TPO TP158 AGL B2 PIN_U11 U11	IO129RSB2		IO160RSB2	P4	AGL_B2_PIN_P4	TP144	
TPO TP169 AGL B2 PIN R10 R10	IO129RSB2			M8	AGL B2 PIN M8	TP171	
TPO TP157 AGL B2 PIN T10 T10			IO161RSB2				
TPOTP147 AGL B2 PIN P9 P9	IO131RSB2						
TPOTP137 AGL B2 PIN_U10U10	IO132RSB2			P15	AGL_B2_PIN_P15	TP143	
	IO133RSB2		GDA2/IO105RSB2	N13	AGL_B2_PIN_N13	TP182	
	IO134RSB2		GDB2/IO106RSB2		AGL B2 PIN P16	U TP	
TPOTP129 AGL B2 PIN M9 M9	IO135RSB2		GDC2/IO107RSB2	P16			
TPOTP177 AGL B2 PIN U9 U9	IO136RSB2		GEA2/IO164RSB2	R2	AGL_B2_PIN_R2	O TP	
TPOTP149 AGL B2 PIN N9 N9	IO137RSB2		FF/GEB2/IO163RSB2	U1			00_FF [6]
TPOTP136 AGL_B2_PIN_U8 U8	IO138RSB2		GEC2/IO162RSB2	T2	AGL_B2_PIN_T2		
			289				

AGLP125-CSG289

Figure 2-4 · Bank 2 I/O Signals for AGLP125-CSG289



#### FPGA Description

			U5D				
		AGLP125		G289			
AGL_B3_PIN_P2	P2_	IO171RSB3	2 4/6	GAA2/IO211RSB3	E4	AGL_B3_PIN_E4	
AGL_B3_PIN_M4	M4	IO172RSB3		GAB2/IO209RSB3	F5	AGL_B3_PIN_F5	O TP
AGL_B3_PIN_L5	L5_	IO173RSB3		GAC2/IO207RSB3	E3	AGL_B3_PIN_E3	TP218 TP
AGL_B3_PIN_P1	P1_	IO174RSB3		GEA0/IO165RSB3	N4	AGL_B3_PIN_N4	
AGL_B3_PIN_K5	K5	IO175RSB3		GEA1/IO166RSB3	T1	AGL_B3_PIN_T1	TP227 TP
AGL_B3_PIN_M3	M3	IO176RSB3		GEB0/IO167RSB3	M5	AGL_B3_PIN_M5	TP248TP
AGL_B3_PIN_K6	<u>K6</u>	IO177RSB3		GEB1/IO168RSB3	M6 .	AGL_B3_PIN_M6	TP215 () TP
AGL_B3_PIN_N2	N2	IO178RSB3		GEC0/IO169RSB3	N3	AGL_B3_PIN_N3	TP214 O TP
	K4	IO179RSB3		GEC1/IO170RSB3	L6	AGL_B3_PIN_L6	TP249 () TP
	N1	IO180RSB3		GFA0/IO189RSB3	К2	AGL_B3_PIN_K2	TP209 O TP
AGL_B3_PIN_J6	J6	IO181RSB3		GFA1/IO190RSB3	J2	AGL_B3_PIN_J2	TP224 () TP
AGL_B3_PIN_L3	L3	IO182RSB3		GFA2/IO188RSB3	L1	AGL_B3_PIN_L1	TP225 () TP
AGL_B3_PIN_J5	J5	IO183RSB3		GFB0/IO191RSB3	H2	AGL_B3_PIN_H2	TP241 () TP
	M1	IO184RSB3	n	GFB1/IO192RSB3	H6	AGL_B3_PIN_H6	TP206 () TP
AGL_B3_PIN_J4	J4	IO185RSB3	4	GFB2/IO187RSB3	К3	AGL_B3_PIN_K3	TP213 () TP
AGL_B3_PIN_H3	H3	IO195RSB3	BANK	GFC0/IO193RSB3	G1	AGL_B3_PIN_G1	TP242 O TP
	F2	IO196RSB3		GFC1/IO194RSB3	_F1		——————————————————————————————————————
AGL_B3_PIN_H4	H4	IO197RSB3		GFC2/IO186RSB3	L2		
AGL_B3_PIN_G3	G3	IO198RSB3					
AGL_B3_PIN_H5	H5	IO199RSB3					
	E2	IO200RSB3					
AGL_B3_PIN_G5	G5	IO201RSB3					
	F3	IO202RSB3					
AGL_B3_PIN_G4	G4	IO203RSB3					
	D1	IO204RSB3					
	D2	IO205RSB3					
AGL B3 PIN G6	G6	IO206RSB3					
AGL B3 PIN F6	F6	IO208RSB3					
	C1	IO210RSB3					
			405 0000		•		

AGLP125-CSG289

Figure 2-5 · Bank 3 I/O Signals for AGLP125-CSG289



### **JTAG Pins**

The AGLP125-CSG289 has advanced I/O features such as JTAG pins for IEEE 1149.1 JTAG Boundary Scan Test. These pins are utilized during programming of the FPGA (Figure 2-6). Low-power flash devices have a separate bank for these dedicated JTAG pins. The JTAG pins can be run at any voltage from 1.5 V to 3.3 V (nominal). V<sub>CC</sub> must also be powered for the JTAG state machine to operate, even if the device is in bypass mode; V<sub>JTAG</sub> alone is insufficient. Both V<sub>JTAG</sub> and V<sub>CC</sub> to the part must be supplied to allow JTAG signals to transition the device. Isolating the JTAG power supply in a separate I/O bank gives greater flexibility in supply selection and simplifies power supply and PCB design. If the JTAG interface is neither used or planned for use, the V<sub>JTAG</sub> pin together with the TRST pin could be tied to GND.

VJTAG is the ability to switch between 3.3 V and 1.5 V / 1.2 V source using jumper J21. Four-pin headers could be used for current measurement of the  $V_{\text{ITAG}}$  and  $V_{\text{PUMP}}$  rails.

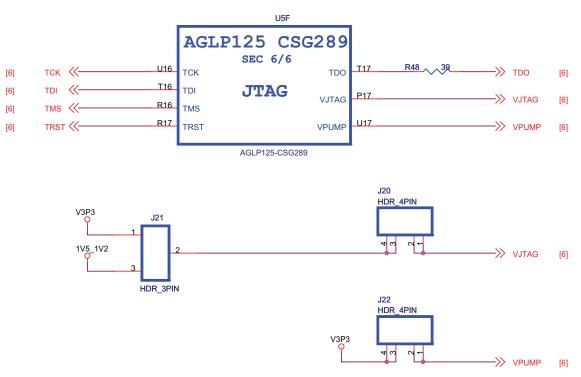


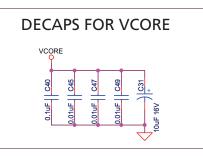
Figure 2-6 · JTAG Pins

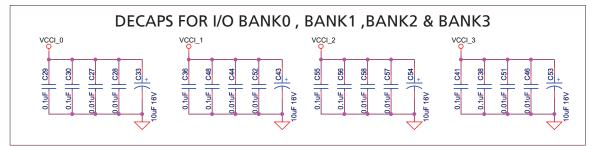


**FPGA** Description

### **Decaps and Ground Post Schematics**

The schematics for the decaps and ground post are shown in Figure 2-7.





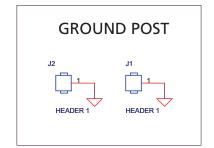


Figure 2-7 · Schematics for Decaps and Ground Post



# 3

The IGLOO PLUS development board is powered through an external voltage power brick or USB. The board does not switch seamlessly between the power brick and USB, so the 4-pin header and jumper must be used to select the desired power source. In the USB option, the in-rush current meets the USB specifications (see Figure 3-1). The power brick option is provided in applications when 100% of the total I/Os are utilized and USB power is insufficient. A green LED next to the USB jack is ON whenever the USB power supply is connected.

The development board has an input of a 5 V supply from the power brick or USB. Protection diodes are used to protect against negative voltage. Three voltage rails are provided, as shown in Table 3-1 (3.3 V, 2.5 V, and 1.5 V).

The regulator can be switched between the 1.5 V and 1.2 V rail because the FPGA core functions at 1.2 V, but is programmed at 1.5 V.

Regulator	Current Rating
3.3 V	2 A
2.5V	1 A
1.5 V / 1.2 V	500 mA

Table 3-1 · Power Regulator Current Ratings

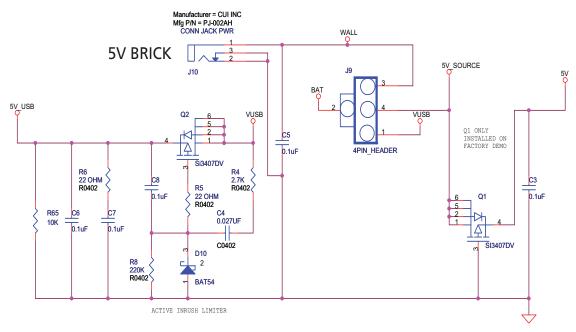


Figure 3-1 · USB Active Inrush Limiter

### **Power Modes**

Power

In addition to the board, the IGLOO PLUS FPGA offers power advantages. Some key power advantages of the IGLOO PLUS FPGAs are as follows:

- Flash\*Freeze technology enables easy entry and exit from the static low power mode, where IGLOO consumes as little as 5  $\mu$ W while retaining the contents of the system memory and data registers.
- Sleep (and shutdown) mode allows the IGLOO PLUS FPGA core power supply (or all power supplies) to be powered down when functionally is not required, while the rest of the system remains powered.
- The user low static ICC macro (ULSICC) reduces IGLOO PLUS FPGA dynamic and static power consumption. The ULSICC macro, when enabled, disables the FlashROM, reducing the overall power of the device.

Table 3-2 gives a summary of the power modes available with IGLOO PLUS devices in general and is extracted from the "Actel's Flash\*Freeze Technology and Low Power Modes" chapter of the *IGLOO PLUS FPGA Fabric User's Guide*..

Mode		V <sub>CC</sub>	V <sub>CCI</sub>	Core	Clocks	ULSICC Macro	To Enter Mode	To Resume Operation	Trigger
Active		On	On	On	On	N/A	Initiate clock	None	_
	Idle	On	On	On	Off	N/A	Stop clock	Initiate clock	External
Static	Flash*Freeze Type 1	On	On	On	On*	N/A	Assert FF pin	Deassert FF pin	External
	Flash*Freeze Type 2	On	On	On	On*	Used to enter Flash*Freeze mode	Assert FF pin and LSICC	Deassert FF pin	External
Sleep		On	Off	Off	Off	N/A	Shut down V <sub>CC</sub>	Turn on V <sub>CC</sub> supply	External
Shutdown		Off	Off	Off	Off	N/A	Shut down V <sub>CC</sub> and V <sub>CCI</sub> supplies	Turn on V <sub>CC</sub> and V <sub>CCI</sub> supplies	External

Table 3-2 · Power Modes

\* External clocks can be left toggling while the device is in Flash\*Freeze mode. Clocks generated by the embedded PLL will be turned off automatically.



### Battery

In addition to the power brick and USB, this board provides the option to power-up via battery. No battery casing is provided on the board. Jumpers should be set correctly to select the option of either powering through a wall/USB or through batteries hooked up externally. To provide a 3 V input source from battery, two AA Alkaline cells may be used. A 2-pin jumper for VBAT and GND must be provided to the input of the main regulator to give the option of either powering through a wall/USB or powering through batteries hooked up externally.

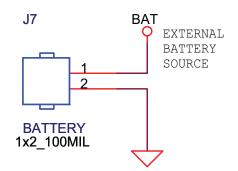


Figure 3-2 · Battery Header and Power Input Schematics

### Potentiometer and Voltage-Sweep

A potentiometer is located on the left hand side of the board to provide the voltage-sweep function to sweep  $V_{CC}$  (Figure 3-3). One primary function of the potentiometer is to show battery operation on the IGLOO PLUS device and how the FPGA can operate successfully even if  $V_{CC}$  experiences a drop in voltage. You can measure the lowest possible  $V_{CC}$  for battery operations. When using the potentiometer, you should also monitor the  $V_{CC}$  via current measurement headers (Figure 3-4 on page 26) to make sure it does not go beyond the specified value.

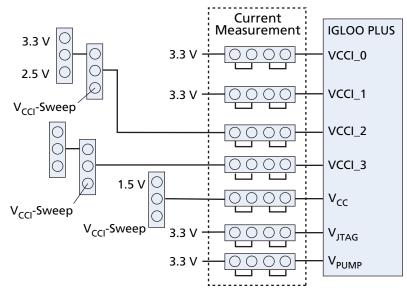


Figure 3-3 · Current Measurement Headers

### 

#### Power

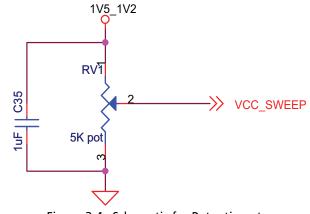
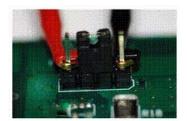


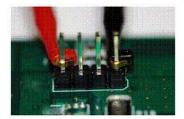
Figure 3-4 · Schematic for Potentiometer

### **Current Measurement**

Once the IGLOO PLUS evaluation board is powered up, you can evaluate power consumption using the current measurement four-pin headers on the board (Figure 3-5). Current measurement can be made without powering down the board.



Set the multimeter to measure current and attach the probes to pins 1 and 4 when the board is in normal operation.



Remove jumper from pins 2-3 for current measurement without powering down.

#### Figure 3-5 · Current Measurement 4-Pin Headers

Four-pin headers are used for current measurement of the rails shown in Figure 3-6 on page 27. All banks are separated and two of the banks have an option to power-up though a 3.3 V or 2.5 V source, as shown in Figure 3-7 on page 28. Voltage sources can be selected using jumpers or can be selected to sweep between 1.2 V and 1.5 V using the potentiometer on the development board.



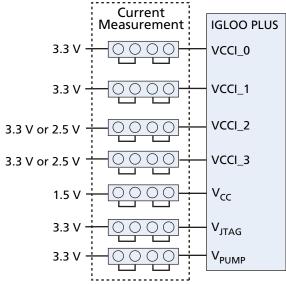
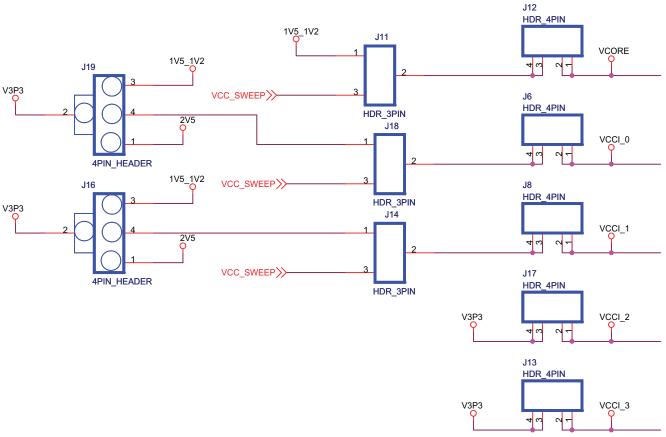


Figure 3-6 · Current Measurement Headers for Power Rails

#### Power



The schematic in Figure 3-7 shows the options for power-up.

Figure 3-7 · Power-Up Options



## **Operation of Board Components**

This chapter describes operation of the IGLOO PLUS evaluation board.

### **Clock Oscillator**

One 20 MHz clock oscillator with 50 PPM is provided on the board. This clock oscillator is connected to the FPGA to provide a system or reference clock. The PLL can be configured and instantiated in the FPGA to generate a wide range of clock frequencies.

### Reference

For more information, refer to the IGLOO PLUS Starter Kit website page: http://www.actel.com/products/hardware/devkits\_boards/iglooplus\_starter.aspx.

### **Schematic**

Figure 4-1 shows the schematic for the clock oscillator.

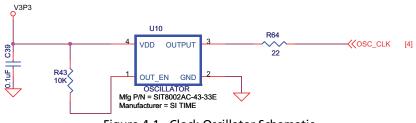


Figure 4-1 · Clock Oscillator Schematic

### Reset

An RC type push-button reset switch to the FPGA is provided on-board. The Schmitt Trigger chip (U13), however, is NOT populated. An on-board Schmitt Trigger chip is not required because Schmitt Trigger is one of the many advanced I/O features of the IGLOO PLUS FPGA family. To improve noise immunity, ensure that the Schmitt Trigger option for this reset input pin is enabled in the FPGA design. If the IGLOO PLUS FPGA is swapped out with a device that does not have the advance Schmitt Trigger I/O feature, the Schmitt Trigger chip (U13) should be populated.



#### **Operation of Board Components**

#### **Schematic**

Figure 4-2 shows the schematic for reset.

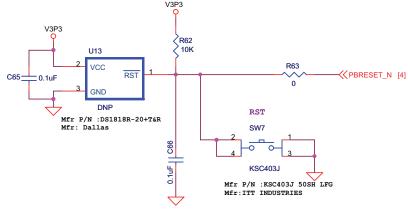


Figure 4-2 · Reset Schematic

### Flash\*Freeze Mode

The IGLOO PLUS device has an ultra-low-power static mode, called Flash\*Freeze mode, which retains all SRAM and register information and can still quickly return to normal operation (Figure 4-3).

Flash\*Freeze technology enables the user to quickly (within 1 µs) enter and exit Flash\*Freeze mode by activating the Flash\*Freeze pin while all power supplies are kept at their original values. I/Os, global I/Os, and clocks can still be driven and can be toggling without impact on power consumption, and the device retains all core registers, SRAM information, and I/O states. I/Os can be individually configured to either hold their previous state or can be tristated during Flash\*Freeze mode.

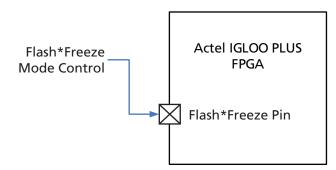


Figure 4-3 · Flash\*Freeze Mode Control

There are two ways to use Flash\*Freeze mode. In Flash\*Freeze type 1, entering and exiting the mode is exclusively controlled by the assertion and deassertion of the FF pin. This enables an external processor or human interface device to directly control Flash\*Freeze mode. In Flash\*Freeze mode type 2, entering and exiting the mode is controlled by both the FF pin AND user-defined logic. Flash\*Freeze management IP can be used in type 2 mode for clock and data management while entering and exiting Flash\*Freeze mode.

For more information and detailed usage of Flash\*Freeze modes, refer to the "Actel's Flash\*Freeze Technology and Low Power Modes" chapter of the *IGLOO PLUS FPGA Fabric User's Guide*.



#### Flash\*Freeze Types

Type 1: Control by dedicated Flash\*Freeze Pin.

Type 2: Control by dedicated Flash\*Freeze Pin and Internal Logic.

#### Flash\*Freeze Type 1: Control by Dedicated Flash\*Freeze Pin

Flash\*Freeze type 1 is intended for systems where either the device will be reset upon exiting Flash\*Freeze mode, or data and clock are managed externally. The device enters Flash\*Freeze mode 1 µs after the dedicated FF pin is asserted (active low), and returns to normal operation when the FF pin is deasserted (high). In this mode, FF pin assertion or deassertion is the only condition that determines entering or exiting Flash\*Freeze mode (Figure 4-4). An INBUF\_FF I/ O buffer macro must be used to identify the Flash\*Freeze input in your design.

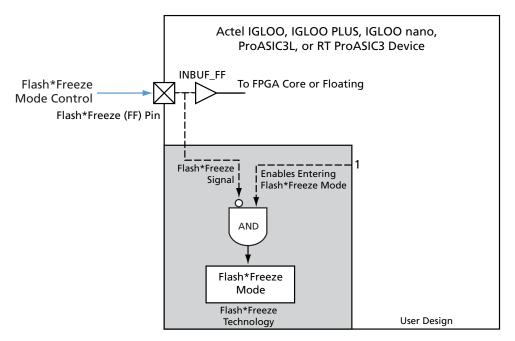


Figure 4-4 · Flash\*Freeze Mode Type 1 – Controlled by the Flash\*Freeze Pin

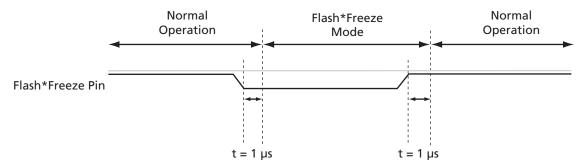


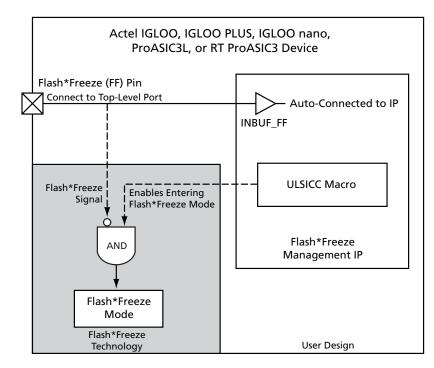
Figure 4-5 · Flash\*Freeze Mode Type 1 – Timing Diagram

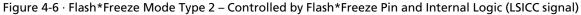
IGLOO PLUS Starter Kit User's Guide

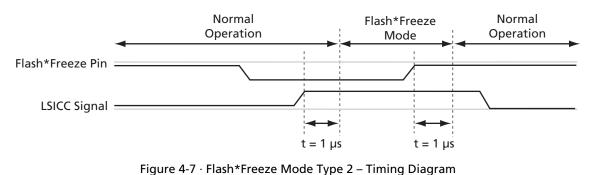
#### Flash\*Freeze Type 2: Control by Dedicated Flash\*Freeze Pin and Internal Logic

The device can be made to enter Flash\*Freeze mode by activating the FF pin together with Actel's Flash\*Freeze management IP core or user-defined control logic (Figure 4-6) within the FPGA core. This method enables the design to perform important activities before allowing the device to enter Flash\*Freeze mode, such as transitioning into a safe state, completing the processing of a critical event. Designers are encouraged to take advantage of Actel's Flash\*Freeze Management IP to handle clean entry and exit of Flash\*Freeze mode. The device will only enter Flash\*Freeze mode when the Flash\*Freeze pin is asserted (active low) and the User Low Static ICC (ULSICC) macro input signal, called the LSICC signal, is asserted (high). One condition is not sufficient to enter Flash\*Freeze mode type 2; both the FF pin and LSICC signal must be asserted.

Figure 4-7 shows the timing diagram for entering and exiting Flash\*Freeze mode type 2. After exiting Flash\*Freeze mode type 2 by deasserting the Flash\*Freeze pin, the LSICC signal must be deasserted by the user design. This will prevent entering Flash\*Freeze mode by asserting the Flash\*Freeze pin only. Refer to Table 4-1 on page 33 for Flash\*Freeze (FF) pin and LSICC signal assertion and deassertion values.







Signal	Assertion Value	Deassertion Value
Flash*Freeze (FF) pin	Low	High
LSICC signal	High	Low

Table 4-1 · Flash\*Freeze Mode Type 1 and Type 2 – Signal Assertion and Deassertion Values

Notes:

1. The Flash\*Freeze (FF) pin is an active-Low signal, and LSICC is an active-High signal.

2. The LSICC signal is used only in Flash\*Freeze mode type 2.

### IGLOO PLUS I/O State in Flash\*Freeze Mode

In IGLOO PLUS devices, users have multiple options in how to configure I/Os during Flash\*Freeze mode:

- 1. Hold the previous state.
- 2. Set I/O pad to weak pull-up or pull-down.
- 3. Tristate I/O pads.

The I/O configuration must be configured by the user in the I/O Attribute Editor or in a PDC constraint file, and can be done on a pin-by-pin basis. The output hold feature will hold the output in the last registered state, using the I/O pad weak pull-up or pull-down resistor when the FF pin is asserted. When inputs are configured with the hold feature enabled, the FPGA core side of the input will hold the last valid state of the input pad before the device entered Flash\*Freeze mode. The input pad can be driven to any value, configured as tristate, or configured with the weak pull-up or pull-down I/O pad feature during Flash\*Freeze mode, without affecting the hold state. If the weak pull-up or pull-down feature is used without the output hold feature, the input and output pads will maintain the configured weak pull-up or pull-down status during Flash\*Freeze mode and normal operation. If a fixed weak pull-up or pull-down is defined on an output buffer or as bidirectional in output mode, and a hold state is also defined for the same pin, the pin will be configured in hold state mode during Flash\*Freeze mode and normal operation, the pin will be configured with the predefined weak pull-up or pull-down. Any I/Os that do not use the hold state or I/O pad weak pull-up or pull-down features will be tristated during Flash\*Freeze mode and the FPGA core will be driven high by inputs. Inputs that are tristated during Flash\*Freeze mode may be left floating without any reliability concern or impact to power consumption.

Table 4-2 shows the I/O pad state based on the configuration and buffer type.

Buffer Type	Hold State	I/O Pad Weak Pull-Up/-Down	I/O Pad State in Flash*Freeze Mode
Input	Enabled	Enabled	Weak pull-up/pull-down <sup>1</sup>
	Disabled	Enabled	Weak pull-up/pull-down <sup>2</sup>
	Enabled	Disabled	Tristate <sup>1</sup>
	Disabled	Disabled	Tristate <sup>2</sup>

Notes:

1. Internal core logic driven by this input buffer will be set to the value this I/O had when entering Flash\*Freeze mode.

- 2. Internal core logic driven by this input buffer will be tied High as long as the device is in Flash\*Freeze mode.
- 3. For bidirectional buffers: Internal core logic driven by the input portion of the bidirectional buffer will be set to the hold state.

#### **Operation of Board Components**

Buffer Type		Hold State	I/O Pad Weak Pull-Up/-Down	I/O Pad State in Flash*Freeze Mode
Output		Enabled	"Don't care"	Weak pull to hold state
		Disabled	Enabled	Weak pull-up/pull-down
		Disabled	Disabled	Tristate
Bidirectional / Tristate Buffer		Enabled	Enabled	Weak pull-up/pull-down <sup>1</sup>
	E = 0	Disabled	Enabled	Weak pull-up/pull-down <sup>2</sup>
	(input/tristate)	Enabled	Disabled	Tristate <sup>1</sup>
		Disabled	Disabled	Tristate <sup>2</sup>
		Enabled	"Don't care"	Weak pull to hold state <sup>3</sup>
	E = 1 (output)	Disabled	Enabled	Weak pull-up/pull-down
		Disabled	Disabled	Tristate

Table 4-2 · IGLOO PLUS Flash\*Freeze Mode (type 1 and type 2)—I/O Pad State (continued)

Notes:

- 1. Internal core logic driven by this input buffer will be set to the value this I/O had when entering Flash\*Freeze mode.
- 2. Internal core logic driven by this input buffer will be tied High as long as the device is in Flash\*Freeze mode.
- 3. For bidirectional buffers: Internal core logic driven by the input portion of the bidirectional buffer will be set to the hold state.

#### Flash\*Freeze Switch

An F\*F switch is provided on the board for designs that utilize the Flash\*Freeze technology. Setting the F\*F switch to FF\_ON will enable the Flash\*Freeze mode of the IGLOO PLUS device. Since the Schmitt Trigger chip (U12) is NOT populated on-board for the F\*F switch, the Schmitt Trigger feature should be enabled in the FPGA design for the Flash\*Freeze input to enhance noise immunity (Figure 4-8). The Schmitt Trigger is an advanced I/O feature of the IGLOO PLUS FPGA family. If the IGLOO PLUS FPGA is swapped out with a device that does not have the advanced Schmitt Trigger I/O feature, the Schmitt Trigger chip (U12) should be populated.

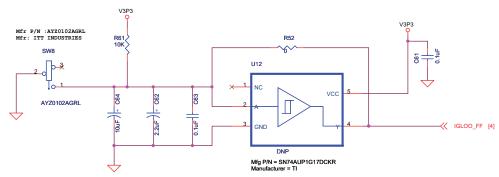


Figure 4-8 · Flash\*Freeze Schematic, Schmitt Triggered

Some features on this board are included to demonstrate the Flash\*Freeze variants of the IGLOO PLUS FPGA. I/Os can be individually configured to either hold their previous state or be tristated during Flash\*Freeze mode. Alternatively, they can be set to a certain state (high or low) using weak pull-up or pull-down I/O attribute configurations. These Flash\*Freeze variants can be demonstrated by configuring the I/Os in Designer and using switches as inputs to control the FET LEDs. Refer to the demo design, which provides additional details on demonstrating these Flash\*Freeze variants ("IGLOO PLUS Board Demo" on page 51).



### Flash\*Freeze Variant Dip Switch

Two regular DIP switches are located on the board, next to the FET LEDs (Figure 4-9). The DIP switches can be programmed to help debug or demonstrate the Flash\*Freeze variants. Refer to the demo design that demonstrates the Flash\*Freeze variants with these switches.

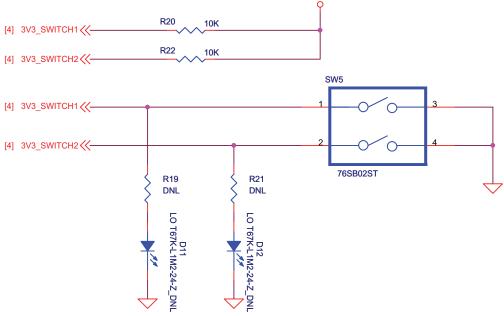
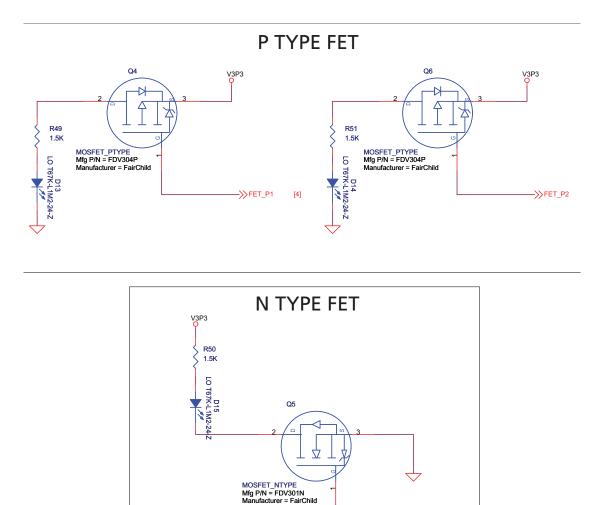


Figure 4-9 · Two I/Os Controlled via DIP Switch Toggling High or Low



### Flash\*Freeze Variant FET LEDs

These FET LEDs can be used for debugging, such as for viewing the state of I/Os in Flash\*Freeze mode. These LEDs can be activated (ON) before entering Flash\*Freeze mode, and have the ability to remain activated (ON) in Flash\*Freeze mode. In low-power or Flash\*Freeze mode, the FET LEDs can continue to function normally. There is one N-Type FET LED and two P-Type FET LEDs on the board (Figure 4-10). Refer to "Demo 4 – Flash\*Freeze Variant: Configuration Settings of Demo Design" on page 52, which will help demonstrate the Flash\*Freeze variants.





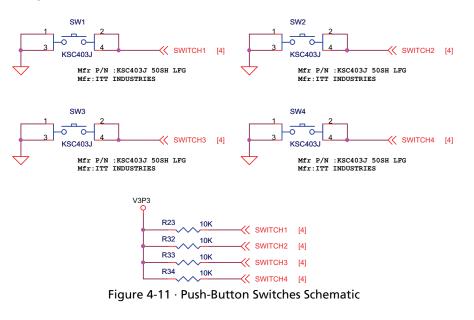
FET\_N <<-

[4]



# **Push-Button Switches**

Four active low push-button switches are provided on the board for debug purposes. You can remove the corresponding jumpers to detach or isolate any of the four push-button test switches from the FPGA I/O. Schematics are shown in Figure 4-11 and Figure 4-12.



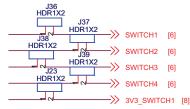


Figure 4-12 · Jumper Header Schematic for Push-Button Switches

# **Actel**°

#### **Operation of Board Components**

# **DIP Switches**

A DIP switch pack (8 switches) is provided on the board (Figure 4-11 and Figure 4-12). You can remove the corresponding jumpers to detach or isolate any of the eight DIP Switches from the FPGA I/Os.

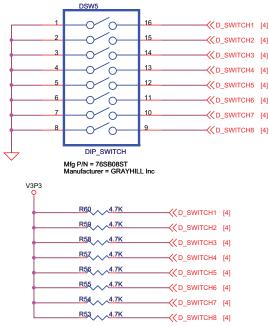


Figure 4-13 · DIP Switches Schematic

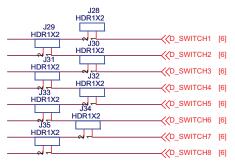
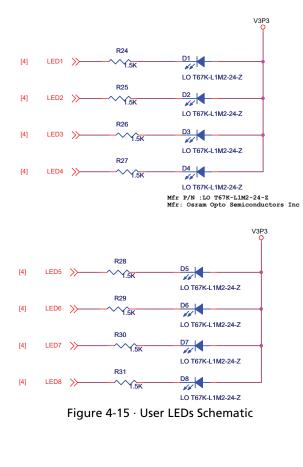


Figure 4-14 · Jumper Header Schematic for DIP Switches



## **User LEDs**

Eight active low debug LEDs are provided on the board (Figure 4-15 and Figure 4-16). You can remove the corresponding jumpers from the  $8 \times 2$  headers to detach or isolate any of the eight LEDs from the FPGA I/Os.



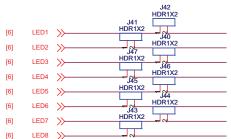


Figure 4-16 · Jumper Header Schematic for User LEDs



## I/O Test Pins

All IGLOO PLUS FPGA I/Os are available on headers located on the top and bottom of the device (Figure 4-17 and Figure 4-18). These test pins are multiples of 100 mils apart, so developers can easily attach headers and place an extension card on top with an off-the-shelf breadboard for a low-cost solution for integration. In order to use I/Os assigned to the LEDs, DIP Switches, and push-button switches, the 2-pin jumper on their path must be removed first to disconnect the assignment.

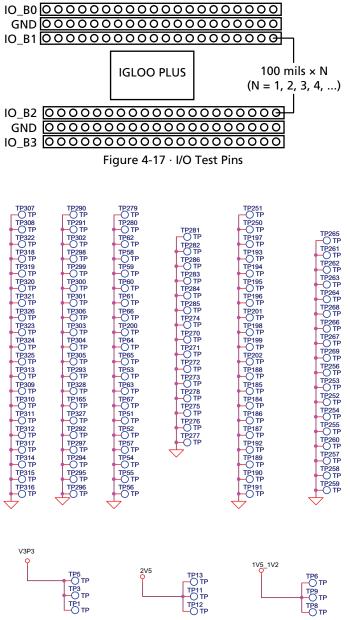


Figure 4-18 · I/O Test Pins Schematic



# OLED

A 96  $\times$  16 pixel low-power blue organic light emitting diode (OLED) is available on the board above the IGLOO PLUS FPGA (Figure 4-19). The OLED features a serial I2C interface, and is capable of displaying sharp images or text. The demo design included in this kit contains a roulette game that uses the OLED for display and the push-button switch for game control.

Additional OLED info is available at the IGLOO PLUS Starter Kit website page:

http://www.actel.com/products/hardware/devkits\_boards/iglooplus\_starter.aspx.

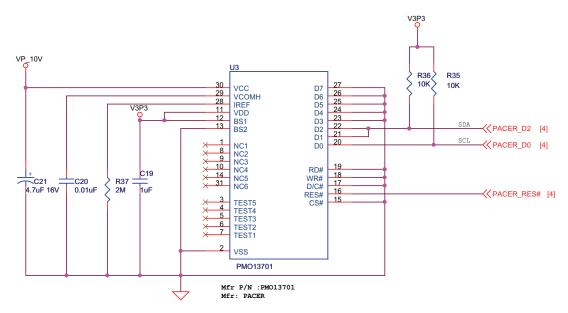


Figure 4-19 · OLED Display Schematic



# **Interface Connector**

A standard interface connector on the board can be used to connect additional daughter cards, some of which are developed by partners and third party vendors (Figure 4-20). The interface possibilities are numerous, such as flash and SRAM memory interfaces, keyboard interfaces for embedded applications, LCD interfaces, and motor control interfaces. GPIOA\_1, GPIOA\_2, GPIOA\_4, and GPIOA\_31 pins can be used for critical signals, such as clock and reset, because proper series termination has been provided on these signal lines.

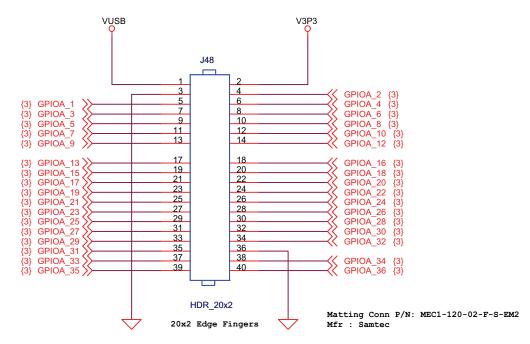




Figure 4-20 · Interface Connector Schematic



## **USB-to-UART** Interface

Included on the starter kit board is a USB-to-UART interface with ESD protection. This interface includes an integrated USB-to-UART bridge controller to provide a standard UART connection with the IGLOO PLUS FPGA. Any standard UART controller can be implemented in the IGLOO PLUS FPGA to allow access with this interface. In addition, Actel IP catalog includes various UART controllers, specifically CoreUART, which can be instantiated in the FPGA design with an embedded processor. CoreUART controller supports both asynchronous and synchronous modes with configurable parameters for various applications.

One application of the USB-to-UART interface is to allow for Hyper-terminal on a PC to communicate with the IGLOO PLUS FPGA. HyperTerminal is a serial communications application program that can be installed in the Windows® operating system. A basic HyperTerminal program is usually distributed with Windows. With an USB driver properly installed, and correct COM port and communication settings selected, you can use the HyperTerminal program to communicate with a design running in the IGLOO PLUS FPGA device.

Information on the USB-to-UART bridge datasheet and device drivers are available at the IGLOO PLUS Starter Kit website page: http://www.actel.com/products/hardware/devkits\_boards/iglooplus\_starter.aspx.

The USB-to-UART schematic is shown in Figure 4-21.

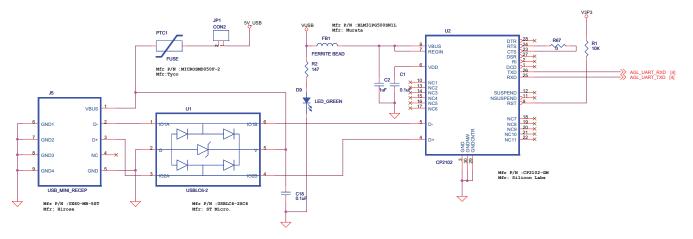


Figure 4-21 · USB-to-UART Interface Schematic

#### **Operation of Board Components**

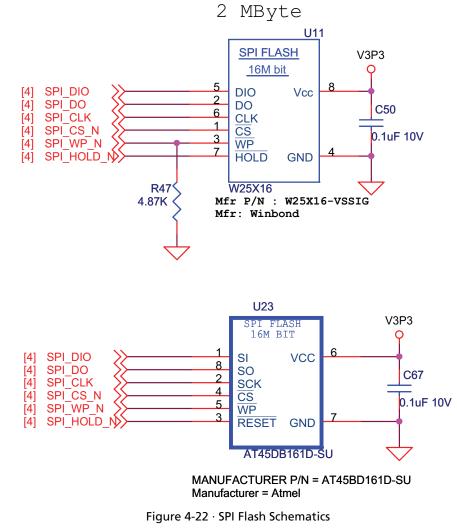


## **SPI** Flash

One 2 Mbyte SPI flash is available on the board and can be used by CoreABC-type applications for access of additional memory. The flash interface, serial peripheral interface bus (SPI), is a synchronous serial data link standard that is used to access the flash memory. Some advantages of the SPI interface are full duplex communication and higher throughput than I2C. In the schematics shown in Figure 4-22, either the Winbond or Atmel 2 Mbyte SPI flash will be populated on-board.

Winbond and Atmel SPI flash datasheets are available at the IGLOO PLUS Starter Kit website page:

http://www.actel.com/products/hardware/devkits\_boards/iglooplus\_starter.aspx.



Note: Either the Winbond or Atmel SPI flash will be populated on the board.

# Low-Cost Programming Stick (LCPS)

## Interface

The development board can be programmed by the low-cost programming stick (LCPS) or via a 10-pin FP3 header (Figure 4-24). Regardless of the programming dongle used, IGLOO PLUS is programmed the same way as IGLOO nano, ProASIC3, and Fusion FPGA devices. The LCPS is a special version for the FlashPro3 programming circuitry that is compatible with FlashPro3 and the generic FlashPro programming software. The LCPS, like the IGLOO PLUS board, is RoHS-compliant and is completely lead (Pb) free. To use the LCPS with the FlashPro software, all you need to do is to select the FlashPro3 from the list of programmer types. The LCPS behaves exactly as if it were a regular encased FlashPro3 programmer. The 12-pin female connector socket is designed to interface to the 12-pin right-angle male header on the IGLOO PLUS kit. One of the pins is a special VJTAGENB signal that goes high when programming is taking place and returns to a low level when programming has completed. This signal is connected to the FET on the 1.5 V regulator circuit. The IGLOO PLUS board uses this signal to effect a change in the value of V<sub>CC</sub> from 1.2 V to 1.5 V, which is required for programming all IGLOO PLUS devices.

You do not need to have the LCPS connected to the IGLOO PLUS board to operate it, after the FPGA has been programmed. The LCPS must be connected to the Actel IGLOO PLUS board only when programming the AGLP125-CSG289.

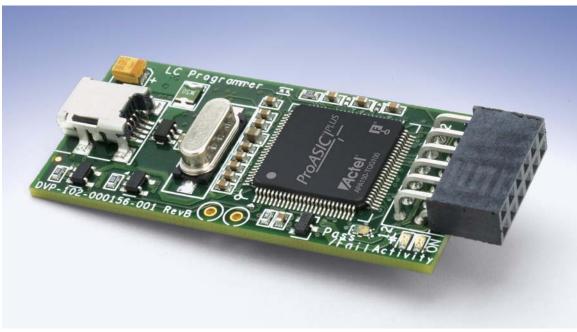


Figure 4-23 · Low-Cost Programming Stick (LCPS)

Note: The LCPS supplied with this kit is intended for use with the IGLOO PLUS Starter Kit. An LCPS supplied for other kits, although electrically and functionally equivalent, may not connect seamlessly with the IGLOO PLUS Starter Kit board.



#### **Operation of Board Components**

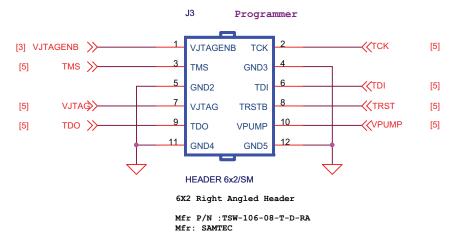


Figure 4-24 · FPGA Programming Headers Schematic

## **LCPS Stackup**

The LCPS is built on a four-layer PCB with the layers arranged in the following stackup:

- 1. Top signal layer (Figure 4)
- 2. Ground plane
- 3. Power plane
- 4. Bottom signal layer (Figure 4-26 on page 48)

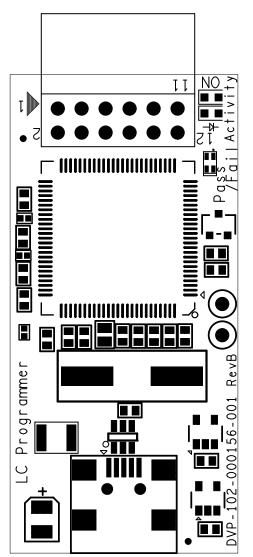


Figure 4-25 · Low-Cost Programming Stick – Top Silkscreen



#### **Operation of Board Components**

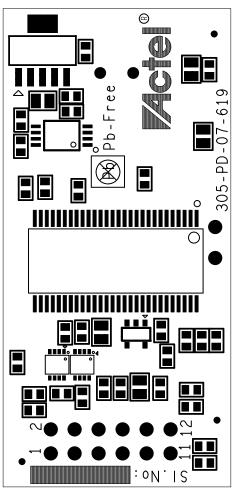


Figure 4-26 · Low-Cost Programming Stick – Bottom Silkscreen



#### To program a design into the IGLOO PLUS evaluation board:

- 1. To program a design into the IGLOO PLUS evaluation board, attach the LCPS board to the IGLOO PLUS evaluation board.
- 2. Attach a USB cable to the LCPS. This allows a programming data file, in programming database format (\*.pdb) or STAPL format (\*.stp), to be downloaded via the FlashPro software to the Actel IGLOO PLUS device fitted to the board.
- 3. A separate USB connection is required for the IGLOO PLUS Board if no other power source (power brick) is attached to the IGLOO PLUS board.
- 4. When using the FlashPro software, the programmer to select is the FlashPro3. The LCPS is functionally equivalent to a FlashPro programmer but designed specifically for use with the IGLOO PLUS Starter Kit.
- 5. Alternatively, an option (10-pin FP3 header) is provided to program the FPGA with a FlashPro3 instead (Figure 5-1).

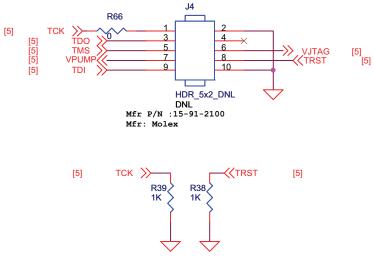


Figure 5-1 · Schematic of JTAG header for Programming Directly with a FlashPro3



The IGLOO PLUS FPGA is pre-programmed with a simple demo to quickly get you started. This demo design will provide a quick overview as well as a quick check of this board.

# Demos Included in the Starter Kit

There are a few demos included in this starter kit, such as a binary counter to light up the 8 user LEDs. These 8 LEDs retain their count value in Flash\*Freeze mode and restart counting from that value after exiting Flash\*Freeze mode. During Flash\*Freeze mode, the active LEDs will be weakly ON, since they are driven by the weak hold state resistors. Flash\*Freeze variants can be demonstrated using the F\*F switches and FET LEDs.

The IGLOO PLUS demo design RTL and design files are available at the IGLOO PLUS Starter Kit website page: http://www.actel.com/products/hardware/devkits\_boards/iglooplus\_starter.aspx. Refer to the *Quick Start Guide* available on the website to run the demo.

# Powering Up the Board

- 1. Before running the demos, refer to Table 1-1 on page 11 to check the default jumper and board settings.
- 2. The board is powered from the USB connection and no external power supply is required.
  - A 5 V wall-jack connector could be used when USB cable is not available.
  - The board does not switch seamlessly between the power brick and USB, so the power source 4-pin header and jumper must be used to select the desired power source.
- 3. Once the USB cable is attached securely, verify the green LED next to the USB jack is ON.

# Getting Started with the IGLOO PLUS Starter Kit Demo Design

## **Demo 1 – IGLOO PLUS Counter**

- 1. Before starting Demo 1, check the jumper settings and set all switches to the OFF or CLOSE position. Ensure the F\*F switch is in the OFF position.
- 2. Power-on the IGLOO PLUS Starter Kit board using the power supply or USB cable included in the starter kit.
- 3. Press and release the System Reset button to reset the IGLOO PLUS FPGA.
- 4. Observe that LED D1 is ON during Reset.
- 5. The LEDs D[3:8] represent a binary counter which counts up from 000000 to 111111 and loops back. After reset, LEDs D[3:8] should restart counting from zero.

LED	Description
LED D1	On during reset
LED D2	On when any push-button is pressed or DIP switch is in the open position
LED D3	Binary Counter[5]
LED D4	Binary Counter[4]
LED D5	Binary Counter[3]
LED D6	Binary Counter[2]
LED D7	Binary Counter[1]
LED D8	Binary Counter[0]

#### Table 6-1 · LED[8:1]

IGLOO PLUS Starter Kit User's Guide



IGLOO PLUS Board Demo

#### **Demo 2 – OLED Interface Demonstration**

This demo includes a simple Roulette game provided by Avnet Memec that demonstrates control and operation of the OLED display.

- 1. Press SW1 to begin a bet and press SW1 again to stop at the number you want to bet on.
- 2. Once you have selected your number, press SW2 to spin. Your results will display in the OLED.
- 3. Continue with steps 1 and 2 to bet and play again.

#### **Demo 3 – Simple Flash\*Freeze Demonstration**

This demonstrates the IGLOO PLUS FPGA's ability to save power while holding internal logic state during Flash\*Freeze mode.

- 1. Enter Flash\*Freeze mode by switching the F\*F switch to ON.
  - In Flash\*Freeze mode, observe the LEDs D[1:8] retain the last state they were driven to when Flash\*Freeze mode was asserted. They may be weakly ON, since they are driven by the weak hold state resistors.
  - The OLED will remain on, since it is self-powered.
  - See Demo 4 below for the settings and states of LEDs D[13:15] during Flash\*Freeze mode.
- 2. Exit Flash\*Freeze mode by switching the F\*F switch to OFF.
  - After exiting Flash\*Freeze mode, LEDs D[3:8] resume counting from the count value prior to entering Flash\*Freeze mode.
- 3. To measure power of the FPGA core during and after Flash\*Freeze mode, simply remove jumper J12 and use a multimeter capable of reading µA current across J12.

#### **Demo 4 – Flash\*Freeze Variant: Configuration Settings of Demo Design**

One feature of the IGLOO PLUS FPGA family is the ability to hold input and output states during Flash\*Freeze mode. This demonstration will showcase this feature by displaying the result of various input and output hold configurations.

In this portion of the design, two inputs named FET Switch 1 and FET Switch 2 are used to drive different logic values into the FPGA. FET Switch 1 directly drives FET LED D13 and FET Switch 2 directly drives FET LED D14 and FET LED D15. FET switches are used on this board to provide the required current to drive the LEDs when the FPGA is in Flash\*Freeze mode. FETs are not required to enter Flash\*Freeze mode or to take advantage of the I/O hold state feature. The FPGA configurations of the inputs and outputs of this circuit are described in Table 6-2 and Table 6-3 on page 53.

Name	I/O Hold	Internal Weak Resister Pull	Description
FET Switch 1	Enabled	Down	Drives FET LED D13 directly
FET Switch 2	Disabled	Down	Drives FET LED D14 and D15 directly

#### Table 6-2 · FET Input Configuration in Demo Design

#### Getting Started with the IGLOO PLUS Starter Kit Demo Design

When HOLD is disabled at the output buffer, the output will depend on the resister pull-up or pull-down direction in Flash\*Freeze mode. If HOLD is enabled at the output buffer, then the output will depend on the state right before entering Flash\*Freeze mode.

FET LED	I/O Hold	Internal Weak Resister Pull	Description
FET LED D13	Enabled	Down	Р-Туре
FET LED D14	Disabled	Down	Р-Туре
FET LED D15	Disabled	Up	N-Type

Table 6-3 · FET Output Configuration in Demo Design

1. Similar to Demo 1, before starting Demo 4, check the jumper settings and set all switches to the OFF or CLOSED position. Ensure the F\*F switch is in the OFF position.

2. Power-on the IGLOO PLUS Starter Kit board using the power supply or USB cable included in the starter kit.

- 3. Press and release the System Reset button (SW7) to reset the IGLOO PLUS FPGA.
  - Observe that LED D1 is ON during Reset.
- 4. Example A: Set both FET Switches [2:1] to the CLOSE position.
  - Based on the logic in this demo design, both P-Type FET LEDs D13 and D14 should be ON and N-Type FET LED D15 should be OFF. Refer to the board schematic for reference on the FET LED connections.
  - Enable Flash\*Freeze mode by setting the F\*F Switch to ON.

After entering Flash\*Freeze mode, observe that P-Type FET LED D13 stays ON because the HOLD state for this output configuration was enabled.

Also observe that P-Type FET LED D14 is ON due to the pull-down resister configuration.

N-Type FET LED D15 turns ON due to the pull-up resister configuration.

Toggle the FET Switches back and forth.

Observe that the LEDs are unaffected, because the device is in Flash\*Freeze mode. The inputs are not able to pass data into the device.

Return the FET Switches [2:1] back to the CLOSE position

- Disable Flash\*Freeze mode by setting the F\*F Switch to OFF.
- After exiting the Flash\*Freeze mode, observe that N-Type FET LED D15 turns OFF.
- 5. Example B: Set both FET Switches [2:1] to the OPEN position
  - Based on the logic in this demo design, both P-type FET LEDs D13 and D14 should be OFF and N-type FET LED D15 should be ON.
  - Enable Flash\*Freeze mode by setting the F\*F Switch to ON.

After entering Flash\*Freeze mode, observe that P-Type FET LED D13 remains OFF because the HOLD state for this output configuration was enabled.

Also observe that P-Type FET LED D14 turns ON due to the pull-down resister configuration.

N-Type FET LED D15 is ON due to the pull-up resister configuration.

• Disable Flash\*Freeze mode by setting the F\*F to OFF.

After exiting the Flash\*Freeze mode, observe that P-Type FET LED D14 turns OFF.

The FET Truth Table (Table 6-4) shows the Flash\*Freeze variants based on the FET I/O HOLD and resister pull configured for this demo design. For the output FET LEDs, NORMAL represents the LED state before entering and after exiting Flash\*Freeze mode, while F\*F Mode represents the LED state during Flash\*Freeze mode.

Input		Output						
FET Switch 1	FET Switch 2	P-Type FET LED D13 (active low): HOLD		P-Type FET LED D14 (active low): Pull-down		N-Type FET LED D15 (active high): Pull-up		
		NORMAL	F*F Mode	Normal	F*F Mode	Normal	F*F Mode	
CLOSE (0)	CLOSE (0)	ON (0)	ON (0)	ON (0)	ON (0)	OFF (0)	ON (1)	
CLOSE (0)	OPEN (1)	ON (0)	ON (0)	OFF (1)	ON (0)	ON (1)	ON (1)	
OPEN (1)	CLOSE (0)	OFF (1)	OFF (1)	ON (0)	ON (0)	OFF (0)	ON (1)	
OPEN (1)	OPEN (1)	OFF (1)	OFF (1)	OFF (1)	ON (0)	ON (1)	ON (1)	

Table	6-4	FET	Truth	Table
Tuble	•		matri	iubic



# Resources



#### **IGLOO PLUS Starter Kit**

http://www.actel.com/products/hardware/devkits\_boards/iglooplus\_starter.aspx

#### **IGLOO PLUS Overview**

http://www.actel.com/products/iglooplus/default.aspx

#### IGLOO PLUS Datasheet http://www.actel.com/documents/IGLOOPLUS\_DS.pdf

#### IGLOO PLUS FPGA Fabric User's Guide http://www.actel.com/documents/IGLOOPLUS\_UG.pdf

Libero IDE Design Software http://www.actel.com/products/software/libero/default.aspx



Actel backs its products with various support services including Customer Service, a Customer Technical Support Center, a web site, an FTP site, electronic mail, and worldwide sales offices. This appendix contains information about contacting Actel and using these support services.

# **Customer Service**

Contact Customer Service for non-technical product support, such as product pricing, product upgrades, update information, order status, and authorization.

From Northeast and North Central U.S.A., call **650.318.4480** From Southeast and Southwest U.S.A., call **650.318.4480** From South Central U.S.A., call **650.318.4434** From Northwest U.S.A., call **650.318.4434** From Canada, call **650.318.4480** From Europe, call **650.318.4252** or +44 (0) **1276 401 500** From Japan, call **650.318.4743** From the rest of the world, call **650.318.4743** Fax, from anywhere in the world **650.318.8044** 

# Actel Customer Technical Support Center

Actel staffs its Customer Technical Support Center with highly skilled engineers who can help answer your hardware, software, and design questions. The Customer Technical Support Center spends a great deal of time creating application notes and answers to FAQs. So, before you contact us, please visit our online resources. It is very likely we have already answered your questions.

# **Actel Technical Support**

Visit the Actel Customer Support website (www.actel.com/custsup/search.html) for more information and support. Many answers available on the searchable web resource include diagrams, illustrations, and links to other resources on the Actel web site.

# Website

You can browse a variety of technical and non-technical information on Actel's home page, at www.actel.com.

# **Contacting the Customer Technical Support Center**

Highly skilled engineers staff the Technical Support Center from 7:00 A.M. to 6:00 P.M., Pacific Time, Monday through Friday. Several ways of contacting the Center follow:

#### Website

You can submit a case online to Technical Support at www.actel.com/mycases.

## Email

You can communicate your technical questions to our email address and receive answers back by email, fax, or phone. Also, if you have design problems, you can email your design files to receive assistance. We constantly monitor the email

IGLOO PLUS Starter Kit User's Guide



account throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request.

The technical support email address is tech@actel.com.

#### Phone

Our Technical Support Center answers all calls. The center retrieves information, such as your name, company name, phone number and your question, and then issues a case number. The Center then forwards the information to a queue where the first available application engineer receives the data and returns your call. The phone hours are from 7:00 A.M. to 6:00 P.M., Pacific Time, Monday through Friday. The Technical Support numbers are:

#### 650.318.4460 800.262.1060

Customers needing assistance outside the US time zones can either contact technical support via email (tech@actel.com) or contact a local sales office. Sales office listings can be found at www.actel.com/contact/offices/index.html.

# POWER MATTERS

# Index

## Α

Actel electronic mail 57 telephone 58 web-based technical support 57 website 57

## В

```
board
bottom silkscreen 10
description 7
stackup 8
top silkscreen 9
```

## С

contacting Actel customer service 57 electronic mail 57 telephone 58 web-based technical support 57 contents 5 current measurement 26 customer service 57

## D

demo Flash\*Freeze variant configuration settings of demo design 52 IGLOO PLUS counter 51 OLED interface 52 simple Flash\*Freeze demonstration 52 DIP switches 38

## F

Flash\*Freeze mode control 30 switch 34

## Η

hardware components 7

#### I

I/O test pins 40 IGLOO PLUS Starter Kit board photograph 5

IGLOO PLUS Starter Kit User's Guide

## J

jumper settings 11 jumpers settings 11

## L

LCPS 45 bottom silkscreen 48 stackup 47 top silkscreen 47 LEDs 39 low-cost programming stick (LCPS) 45

## Ρ

product support 57–58 customer service 57 electronic mail 57 technical support 57 telephone 58 website 57 programming 49 push-button switches 37

## R

resources 55

## S

schematic battery header 25 clock oscillator 29 DIP switches 38 Flash\*Freeze 34 FPGA programming headers 46 I/O test pins 40 power input 25 push-button switches 37 reset 30 test LEDs 39 USB-to-UART 43 switches DIP 38 push-button 37 settings 11

## Т

technical support 57

Index



submit case online 57

#### U

USB-to-UART interface 43 User LEDs 39

# W

web-based technical support 57



Actel is the leader in low-power and mixed-signal FPGAs and offers the most comprehensive portfolio of system and power management solutions. Power Matters. Learn more at www.actel.com.

Actel Corporation • 2061 Stierlin Court • Mountain View, CA 94043 • USA Phone 650.318.4200 • Fax 650.318.4600 • Customer Service: 650.318.1010 • Customer Applications Center: 800.262.1060 Actel Europe Ltd. • River Court, Meadows Business Park • Station Approach, Blackwater • Camberley Surrey GU17 9AB • United Kingdom Phone +44 (0) 1276 609 300 • Fax +44 (0) 1276 607 540 Actel Japan • EXOS Ebisu Building 4F • 1-24-14 Ebisu Shibuya-ku • Tokyo 150 • Japan Phone +81.03.3445.7671 • Fax +81.03.3445.7668 • www.jp.actel.com Actel Hong Kong • Room 2107, China Resources Building • 26 Harbour Road • Wanchai • Hong Kong

Actel Hong Kong • Room 2107, China Resources Building • 26 Harbour Road • Wanchai • Hong Kong Phone +852 2185 6460 • Fax +852 2185 6488 • www.actel.com.cn