FrameLink Express™

User's Manual

Revision History

RA01	Aug-12-2008	J. Egri	Initial Release
RA02	Nov-24-2008	J. Egri	Updated Table 2a for ‘unpacked’ modes and added Tables 2b thru 2e for ‘packed’ modes. Updated ‘Camera Parameters’ dialog to include ‘packed’ option. Updated ‘Statistics’ dialog to include clock_rate, horiz. and vert. fields
RA03	Dec-04-2008	J. Egri	Updated Appendix A.
RA04	June-24-2009	J. Egri	Updated Software Installation to reflect new InstallShield for Windows 64 bit OS.
RA05	July-12-2011	J. Egri	Added Medium mode support. Added PCIe and ExpressCard/34 versions.
RA06	Jan-30-2012	J. Egri	Updated ‘Camera Parameters’ dialog to include ‘TrueSense’ option.
RA07	Oct-25-2012	J. Egri	Added VCE-CLPCIe02 card and features: PoCL, GPIO and PLC.
RA08	Oct-22-2013	J. Egri	Modified PoCL and Statistics dialogs.
RA09	Jan-28-2014	J. Egri	Modified PoCL dialog for dual channel operation and Statistics dialog for PCI Express status.
RA10	Apr-3-2014	J. Egri	Added VCE-CLPCIe03 and VCE-CLPCIe04 cards. Updated Tables 2 – 7 to add Full and Deca modes. Added Table 11 – PCIe x4 connector pinout. Added Card Selector dialog.

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Chapter 1

Introduction

This chapter outlines the key features of the Imperx FrameLink Express series of Camera Link frame grabbers.

VCE-CLEX01

VCE-CLEX02

VCE-CLPCIe01

VCE-CLPCIe02

VCE-CLPCIe03

VCE-CLPCIe04

FrameLink Express

The FrameLink Express frame grabber series includes six models:

Desktop cards:

VCE-CLPCIe01 - a dual-channel, low-profile PCI Express x1 card
- supports two Base or one Medium interface.

VCE-CLPCIe02 - a dual-channel, low-profile PCI Express x1 card with I/O, PLC and PoCL.
- supports two Base or one Medium interface.

VCE-CLPCIe03 - a dual-channel, low-profile PCI Express x4 card with I/O, PLC and PoCL.
- supports two Base or one Medium interface.

VCE-CLPCIe04 - a single-channel, low-profile PCI Express x4 card with I/O, PLC and PoCL.
- supports one Base, Medium, Full or Deca interface.

Laptop cards:

VCE-CLEX01 - a dual-channel ExpressCard/54 card
- supports two Base or one Medium interface.

VCE-CLEX02 - a single-channel ExpressCard/34 card
- supports one Base interface.

The FrameLink Express cards support either one or two Camera Link interfaces. They support single Base, dual Base/single Medium or single Base/Medium/Full/Deca modes. All cards transfer the video data to host memory via a PCI Express x1 or x4 interface. All of the cards share the same software (i.e. application program, libraries and driver). The remaining text in this document makes reference to a dual-channel card but note that the single-channel card is just a one channel version of this same card.

Functionality

- Captures video data from two independent Base Camera Link interfaces or a single Medium/Full/Deca Camera Link interface, formats this data and stores it into local FIFO's.

- Retrieves the formatted data from the FIFO's and transfers it into host memory via an intelligent scatter/gather DMA over the PCI Express interface.

- Provides a full-duplex asynchronous interface (UART) to/from an attached device on each Camera Link serial interface.

- Provides the host processor with the ability to configure the four discrete Camera Control signals on each Camera Link interface.

- VCE-CLPCIe02/03/04 only: Provides a comprehensive Programmable Logic Controller (PLC), I/O circuitry and Power over Camera Link (PoCL).

Interfaces

Camera Link interface

The FrameLink Express provides two CameraLink connectors configured as either two independent 'base' interfaces or a single 'medium', 'full' or 'deca' interface. Each interface requires a single 26 conductor connector/cable.

The base configuration (refer to Figure 2a) consists of multiplexing 28 bits of video data into 4 LVDS data streams. This data consists of 24 bits of pixel data along with 4 pixel qualifier signals: 'frame valid' strobe, 'line valid' strobe, 'data valid' strobe and a spare strobe (for future use). A phased-locked transmit clock is transmitted in parallel with the data streams over a fifth LVDS link. Additionally, four RS-644 LVDS streams are included for general purpose camera control. These 'camera control' signals allow the frame grabber to manipulate discrete controls within an attached camera. A bi-directional asynchronous communications channel between the frame grabber and an attached camera is also provided by means of two RS-644 LVDS pairs.

The 'medium' configuration (refer to figure 2b) uses a second CameraLink connector that provides an additional 28 bits of video data multiplexed into 4 LVDS streams with a fifth LVDS pair for the transmit clock. This data consists of 24 bits of pixel data along with 4 pixel qualifier signals: 'frame valid' strobe, 'line valid' strobe, 'data valid' strobe and a spare strobe (for future use).The four camera control signals and the asynchronous communication channel are unused in this configuration.

The ‘full’ configuration (refer to figure 2c) builds on the medium interface and provides an additional 20 bits of video data multiplexed into 4 LVDS streams with a fifth LVDS pair for the transmit clock. This data consists of 16 bits of pixel data along with 4 pixel qualifier signals: ‘frame valid’ strobe, ‘line valid’ strobe, ‘data valid’ strobe and a spare strobe (for future use).

The ‘deca’ configuration replaces the full interface by “stealing” some of the strobe signals and provides a total of 84 bits of video data multiplexed into 12 LVDS streams and 3 LVDS pair for the transmit clock. This data consists of 80 bits of pixel data along with 4 pixel qualifier signals: ‘frame valid’ strobe, ‘xline valid’ strobe, ‘yline valid’ strobe and a ‘zline valid’ strobe.

PCI Express interface

VCE-CLEX01/VCE-CLEX02:
These cards comply with the ExpressCard/54 and ExpressCard/34 package dimensions, respectively, as defined in the ExpressCard Standard release 1.2. Both cards include a 37mm x 20mm extension area used to house the CameraLink connectors.

VCE-CLPCIe01/VCE-CLPCIe02:
These cards comply with the x1 low-profile PCI Express add-in card dimensions as defined in the PCI Express Card Electromechanical Specification revision 2.0.

VCE-CLPCIe03/VCE-CLPCIe04:
These cards comply with the x4 low-profile PCI Express add-in card dimensions as defined in the PCI Express Card Electromechanical Specification revision 2.0.

The FrameLink Express cards provide a 2.5 or 10.0 GHz PCIe Master/Target interface compliant with the PCI Express Release 1.2 specification. This interface provides a single ‘function’, as defined in the PCI Express specification. The design does not support any memory mapped or I/O mapped peripherals on card. Access to the FrameLink Express’s FIFOs is achieved through DMA operations that move the data from the FIFOs into host memory. The host cannot directly access the contents of the FIFOs. The design supports host access into configuration registers, DMA registers, local registers and CIS data via configuration space accesses.

A functional block diagram of the FrameLink Express card is illustrated in Figure 1.

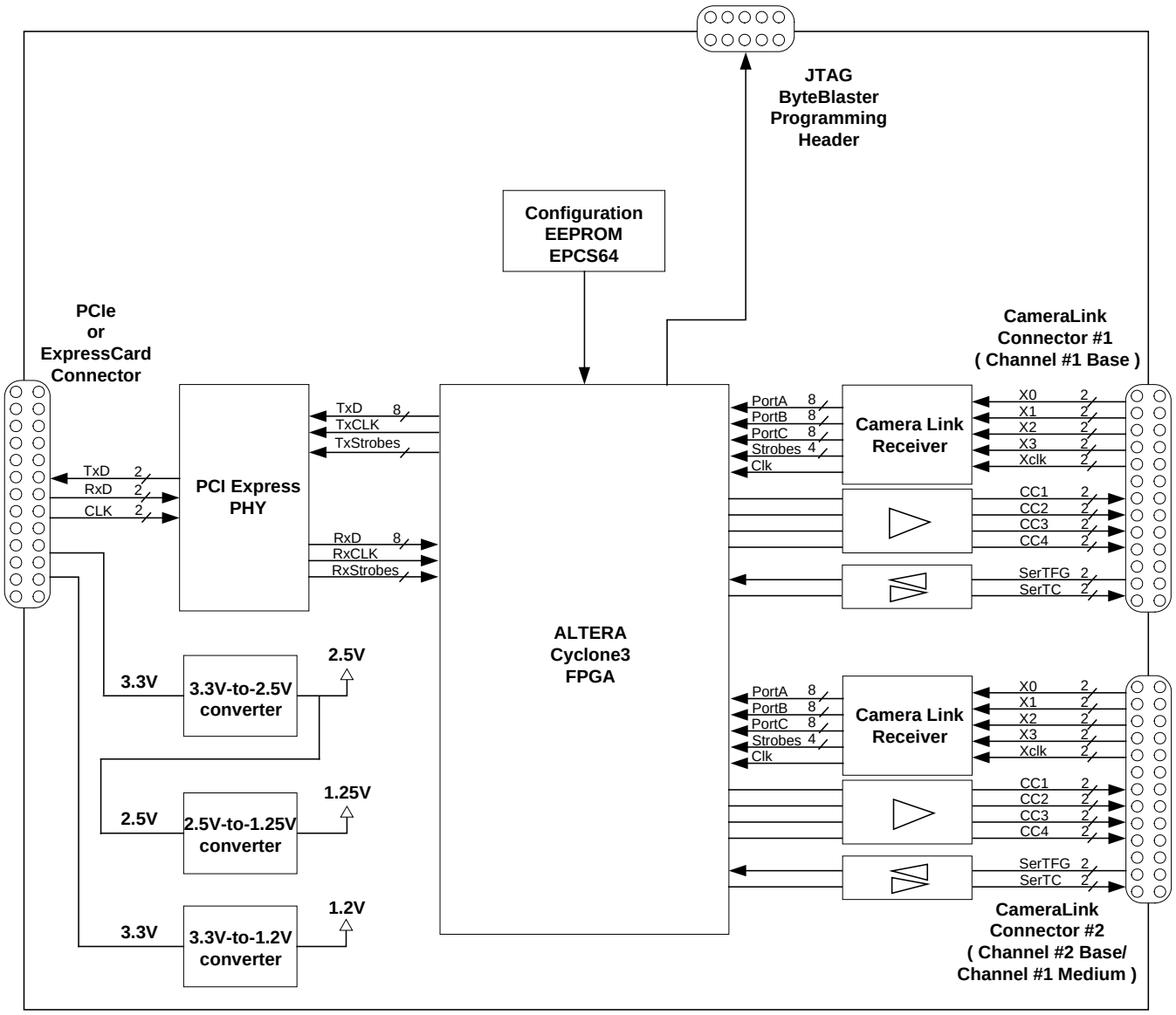


Figure 1 – FrameLink Express Block Diagram

A functional block diagram of the Camera Link interface is illustrated in Figures 2a, 2b and 2c.

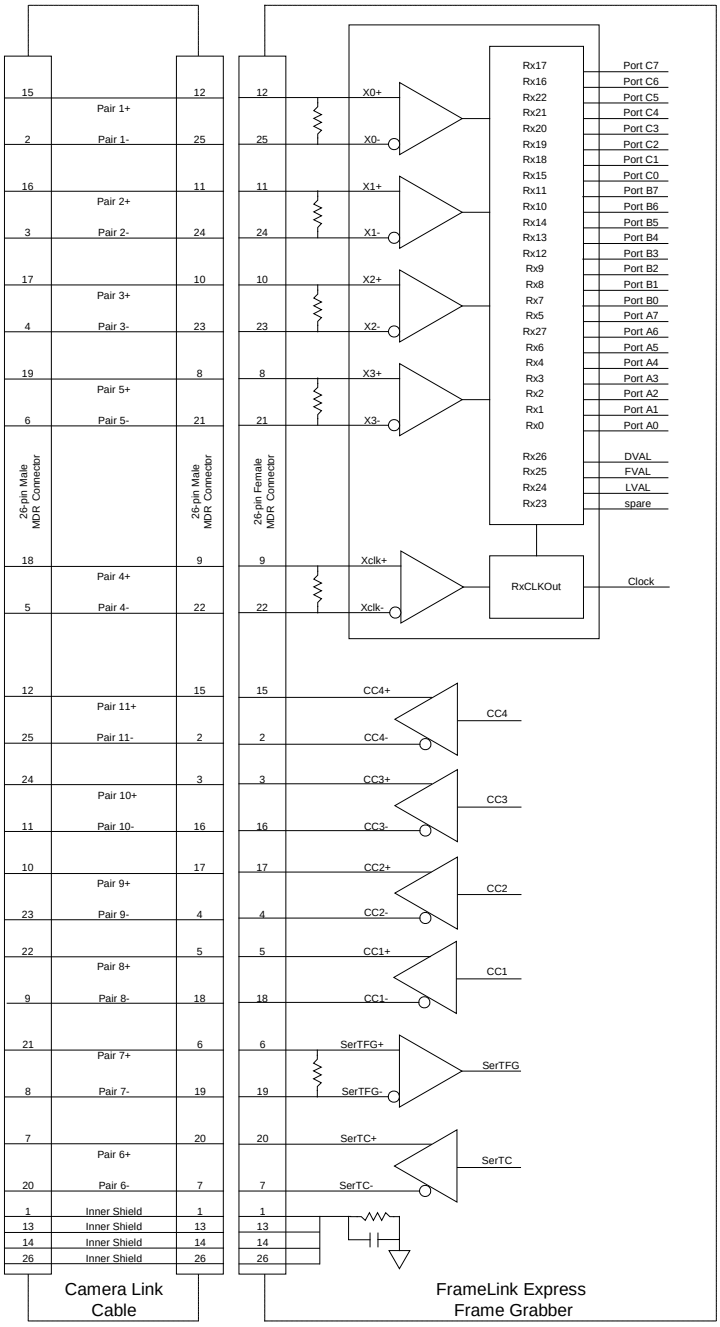


Figure 2a – Base Camera Link Interface (connector #1)

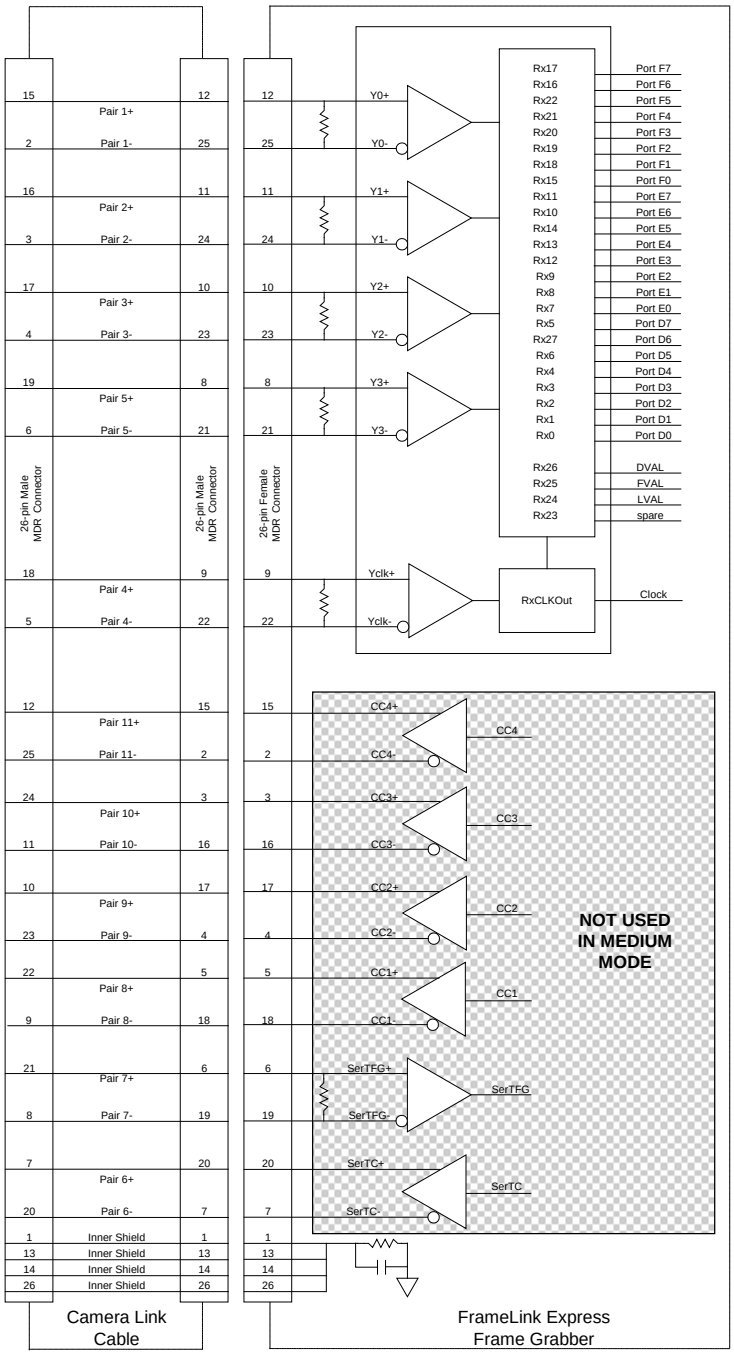


Figure 2b – Medium Camera Link Interface (connector #2)

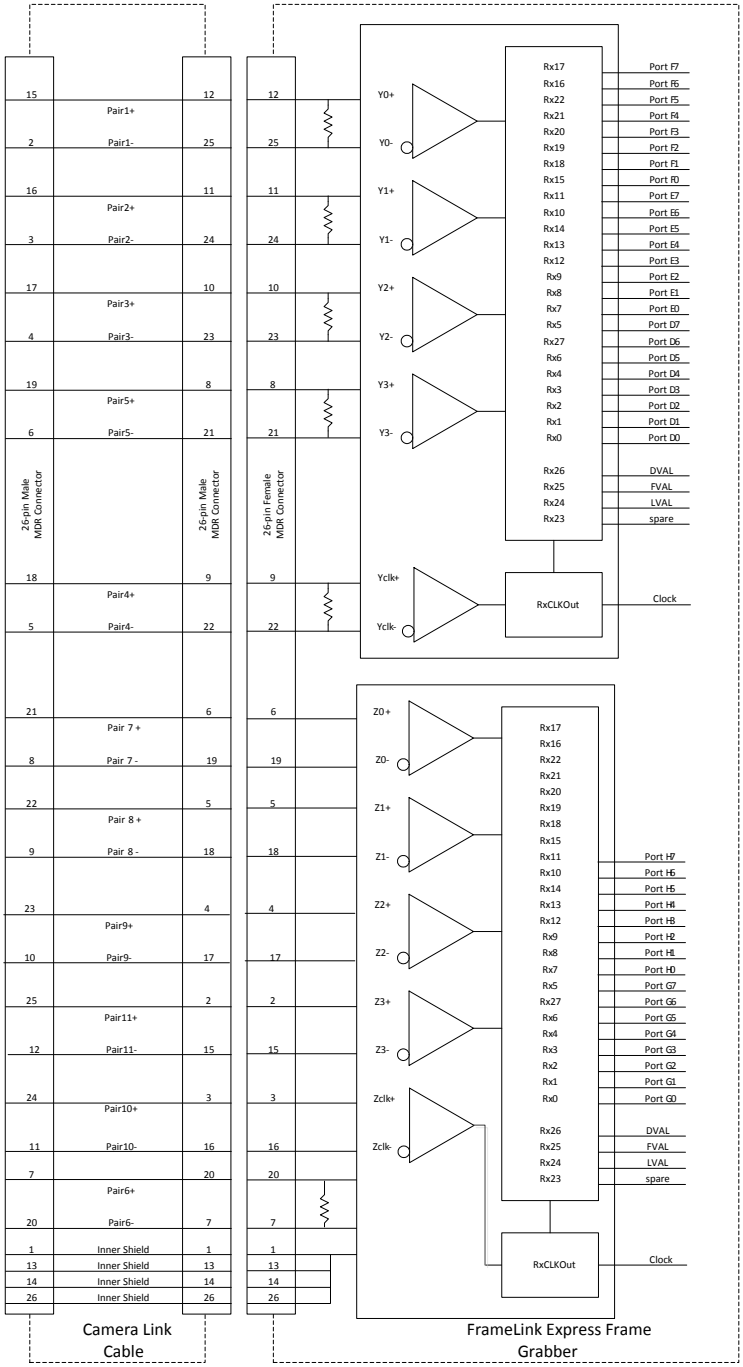


Figure 2c – Full CameraLink Interface (connector #2)

Video Capture

The video capture engine is responsible for receiving video pixel data and qualifiers from the Camera Link transceivers, formatting the data and transferring it into on-board memory. It supports all CameraLink modes as defined in Table 1. Twenty different modes of operation are supported as indicated in the table. The data that it receives from the Camera Link transceivers, per the Camera Link specification, is illustrated in Tables 2, 3, 4 and 5 for Base, Medium, Full and Deca modes, respectively.

The video capture engine translates this data into doublewords (64 bits), as defined in Table 6 and Tables 7a–7l. These tables reflect how the data will appear in host memory. Two options are provided: un-packed and packed. When ‘un-packed’ is selected, the data is formatted per Table 6. When ‘packed’ is selected, the data is formatted per Tables 7a thru 7lj. Packing uses the PCI Express bandwidth more efficiently and conserves memory space.

1x8	2x8	3x8	1x10	2x10	1x12	2x12	1x14	1x16	RGB24	4x8	3x10	4x10	3x12	4x12	RGB30	RGB36	8x8	10x8	8x10	MODE
✓	✓	✓	✓	✓	✓	✓	✓	✓	✓											Base
										✓	✓	✓	✓	✓	✓	✓				Medium
																	✓			Full
																		✓	✓	Deca

Table 1 – CameraLink modes

Port C								Port B								Port A								
c7	c6	c5	C4	c3	c2	c1	c0	b7	b6	b5	b4	b3	b2	b1	b0	a7	a6	a5	a4	a3	a2	a1	a0	MODE
																A7	A6	A5	A4	A3	A2	A1	A0	1x8
								B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	2x8
C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	3x8
														A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x10
B7	B6	B5	B4	B3	B2	B1	B0			B9	B8			A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x10
												A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x12
B7	B6	B5	B4	B3	B2	B1	B0	B11	B10	B9	B8	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x12
										A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x14
								A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x16
BL7	BL6	BL5	BL4	BL3	BL2	BL1	BL0	GR7	GR6	GR5	GR4	GR5	GR2	GR1	GR0	RD7	RD6	RD5	RD4	RD3	RD2	RD1	RD0	RGB24

Table 2 – Image data bit-to-port assignments per the Camera Link specification – Base modes

Port C Port F								Port B Port E								Port A Port D								
c7	c6	c5	c4	c3	c2	c1	c0	b7	b6	b5	b4	b3	b2	b1	b0	a7	a6	a5	a4	a3	a2	a1	a0	
f7	f6	f5	f4	f3	f2	f1	f0	e7	e6	e5	e4	e3	e2	e1	e0	d7	d6	d5	d4	d3	d2	d1	d0	MODE
C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	4x8
																D7	D6	D5	D4	D3	D2	D1	D0	
B7	B6	B5	B4	B3	B2	B1	B0			B9	B8			A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	3x10
						C9	C8	C7	C6	C5	C4	C3	C2	C1	C0									
B7	B6	B5	B4	B3	B2	B1	B0			B9	B8			A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	4x10
		D9	D8			C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	D7	D6	D5	D4	D3	D2	D1	D0	
B7	B6	B5	B4	B3	B2	B1	B0	B11	B10	B9	B8	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	3x12
				C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0									
B7	B6	B5	B4	B3	B2	B1	B0	B11	B10	B9	B8	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	4x12
D11	D10	D9	D8	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	D7	D6	D5	D4	D3	D2	D1	D0	
BL7	BL6	BL5	BL4	BL3	BL2	BL1	BL0			BL9	BL8			RD9	RD8	RD7	RD6	RD5	RD4	RD3	RD2	RD1	RD0	RGB30
						GR9	GR8	GR7	GR6	GR5	GR4	GR3	GR2	GR1	GR0									
BL7	BL6	BL5	BL4	BL3	BL2	BL1	BL0	BL11	BL10	BL9	BL8	RD11	RD10	RD9	RD8	RD7	RD6	RD5	RD4	RD3	RD2	RD1	RD0	RGB36
				GR11	GR10	GR9	GR8	GR7	GR6	GR5	GR4	GR3	GR2	GR1	GR0									

Table 3 – Image data bit-to-port assignments per the Camera Link specification – Medium modes

Port C								Port B								Port A								
Port F								Port E								Port D								
---								Port H								Port G								
c7	c6	c5	c4	c3	c2	c1	c0	b7	b6	b5	b4	b3	b2	b1	b0	a7	a6	a5	a4	a3	a2	a1	a0	
f7	f6	f5	f4	f3	f2	f1	f0	e7	e6	e5	e4	e3	e2	e1	e0	d7	d6	d5	d4	d3	d2	d1	d0	
								h7	h6	h5	h4	h3	h2	h1	h0	g7	g6	g5	g4	g3	g2	g1	g0	MODE
C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	8x8
F7	F6	F5	F4	F3	F2	F1	F0	E7	E6	E5	E4	E3	E2	E1	E0	D7	D6	D5	D4	D3	D2	D1	D0	
								H7	H6	H5	H4	H3	H2	H1	H0	G7	G6	G5	G4	G3	G2	G1	G0	

Table 4 – Image data bit-to-port assignments per the Camera Link specification – Full mode

Port C								Port B								Port A								
Port F								Port E								Port D								
Port I								Port H								Port G								
---								---								Port J								
c7	c6	c5	c4	c3	c2	c1	c0	b7	b6	b5	b4	b3	b2	b1	b0	a7	a6	a5	a4	a3	a2	a1	a0	
f7	f6	f5	f4	f3	f2	f1	f0	e7	e6	e5	e4	e3	e2	e1	e0	d7	d6	d5	d4	d3	d2	d1	d0	
i7	i6	i5	i4	i3	i2	i1	i0	h7	h6	h5	h4	h3	h2	h1	h0	g7	g6	g5	g4	g3	g2	g1	g0	
																j7	j6	j5	j4	j3	j2	j1	j0	MODE
C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	10x8
F7	F6	F5	F4	F3	F2	F1	F0	E7	E6	E5	E4	E3	E2	E1	E0	D7	D6	D5	D4	D3	D2	D1	D0	
I7	I6	I5	I4	I3	I2	I1	I0	H7	H6	H5	H4	H3	H2	H1	H0	G7	G6	G5	G4	G3	G2	G1	G0	
																J7	J6	J5	J4	J3	J2	J1	J0	
C9	C8	C7	C6	C5	C4	C3	C2	B9	B8	B7	B6	B5	B4	B3	B2	A9	A8	A7	A6	A5	A4	A3	A2	8x10
F9	F8	F7	F6	F5	F4	F3	F2	E9	E8	E7	E6	E5	E4	E3	E2	D9	D8	D7	D6	D5	D4	D3	D2	
D1	D0	C1	C0	B1	B0	A1	A0	H9	H8	H7	H6	H5	H4	H3	H2	G9	G8	G7	G6	G5	G4	G3	G2	
																H1	H0	G1	G0	F1	F0	E1	E0	

Table 5 – Image data bit-to-port assignments per the Camera Link specification – Deca modes

Byte4								Byte3								Byte 2								Byte1												
d31	d30	d29	d28	d27	d26	d25	d24	d23	d22	d21	d20	d19	d18	d17	d16	d15	d14	d13	d12	d11	d10	d9	d8	d7	d6	d5	d4	d3	d2	d1	d0	MODE	Base	Med	Full	Deca
A7	A6	A5	A4	A3	A2	A1	A0	A7	A6	A5	A4	A3	A2	A1	A0	A7	A6	A5	A4	A3	A2	A1	A0	A7	A6	A5	A4	A3	A2	A1	A0	1x8	✓			
B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	2x8	✓			
-	-	-	-	-	-	-	-	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	3x8	✓			
D7	D6	D5	D4	D3	D2	D1	D0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	4x8		✓		
-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x10	✓			
-	-	-	-	-	-	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x10	✓			
-	-	-	-	-	-	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	3x10		✓		
-	-	-	-	-	-	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	4x10		✓		
-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x12	✓			
-	-	-	-	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x12	✓			
-	-	-	-	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	3x12		✓		
-	-	-	-	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	4x12		✓		
-	-	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	-	-	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x14	✓			
A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x16	✓			
-	-	-	-	-	-	-	-	RD 7	RD 6	RD 5	RD 4	RD 3	RD 2	RD 1	RD 0	GR 7	GR 6	GR 5	GR 4	GR 3	GR 2	GR 1	GR 0	BL 7	BL 6	BL 5	BL 4	BL 3	BL 2	BL 1	BL 0	RGB24	✓			
-	-	-	-	-	-	GR 9	GR 8	GR 7	GR 6	GR 5	GR 4	GR 3	GR 2	GR 1	GR 0	-	-	-	-	-	-	BL 9	BL 8	BL 7	BL 6	BL 5	BL 4	BL 3	BL 2	BL 1	BL 0	RGB30		✓		
-	-	-	-	GR 11	GR 10	GR 9	GR 8	GR 7	GR 6	GR 5	GR 4	GR 3	GR 2	GR 1	GR 0	-	-	-	-	BL 11	BL 10	BL 9	BL 8	BL 7	BL 6	BL 5	BL 4	BL 3	BL 2	BL 1	BL 0	RGB36		✓		
D7	D6	D5	D4	D3	D2	D1	D0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	8x8			✓	
See Table 7k																																10x8				✓
-	-	-	-	-	-	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	8x10				✓

Byte8								Byte7								Byte6								Byte5												
d63	d62	d61	d60	d59	d58	d57	d56	d55	d54	d53	d52	d51	d50	d49	d48	d47	d46	d45	d44	d43	d42	d41	d40	d39	d38	d37	d36	d35	d34	d33	d32	MODE	Base	Med	Full	Deca
A7	A6	A5	A4	A3	A2	A1	A0	A7	A6	A5	A4	A3	A2	A1	A0	A7	A6	A5	A4	A3	A2	A1	A0	A7	A6	A5	A4	A3	A2	A1	A0	1x8	✓			
B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	2x8	✓			
-	-	-	-	-	-	-	-	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	3x8	✓			
D7	D6	D5	D4	D3	D2	D1	D0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	4x8		✓		
-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x10	✓			
-	-	-	-	-	-	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x10	✓			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	3x10		✓		
-	-	-	-	-	-	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	-	-	-	-	-	-	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	4x10		✓		
-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x12	✓			
-	-	-	-	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x12	✓			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	3x12		✓		
-	-	-	-	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	-	-	-	-	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	4x12		✓		
-	-	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	-	-	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x14	✓			
A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x16	✓			
-	-	-	-	-	-	-	-	RD 7	RD 6	RD 5	RD 4	RD 3	RD 2	RD 1	RD 0	GR 7	GR 6	GR 5	GR 4	GR 3	GR 2	GR 1	GR 0	BL 7	BL 6	BL 5	BL 4	BL 3	BL 2	BL 1	BL 0	RGB24	✓			
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	RD 9	RD 8	RD 7	RD 6	RD 5	RD 4	RD 3	RD 2	RD 1	RD 0	RGB30		✓		
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	RD 11	RD 10	RD 9	RD 8	RD 7	RD 6	RD 5	RD 4	RD 3	RD 2	RD 1	RD 0	RGB36		✓		
H7	H6	H5	H4	H3	H2	H1	H0	G7	G6	G5	G4	G3	G2	G1	G0	F7	F6	F5	F4	F3	F2	F1	F0	E7	E6	E5	E4	E3	E2	E1	E0	8x8			✓	
See Table 7k																																10x8				✓
-	-	-	-	-	-	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	-	-	-	-	-	-	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	8x10				✓

Table 6 – Unpacked pixel mapping into memory

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1																																	1x8 base
DW1				**No packing required Same as Table 6**																													
DW2																																	
DW2																																	
DW3																																	
DW3																																	
DW1																																	2x8 base
DW1				**No packing required Same as Table 6**																													
DW2																																	
DW2																																	
DW3																																	
DW3																																	
DW1	A7	A6	A5	A4	A3	A2	A1	A0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	3x8 base
DW1	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	
DW2	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	C7	C6	C5	C4	C3	C2	C1	C0	
DW2	A7	A6	A5	A4	A3	A2	A1	A0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	
DW3	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	
DW3	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	C7	C6	C5	C4	C3	C2	C1	C0	
DW1																																	4x8 med
DW1				**No packing required Same as Table 6**																													
DW2																																	
DW2																																	
DW3																																	
DW3																																	
DW1																																	8x8 full
DW1				**No packing required Same as Table 6**																													
DW2																																	
DW2																																	
DW3																																	
DW3																																	

Table 7a – Packed pixel mapping into memory – 8 bit modes

d31	d30	d29	d28	d27	d26	d25	d24	d23	d22	d21	d20	d19	d18	d17	d16	d15	d14	d13	d12	d11	d10	d9	d8	d7	d6	d5	D4	d3	d2	d1	d0	
d63	d62	d61	d60	d59	d58	d57	d56	d55	d54	d53	d52	d51	d50	d49	d48	d47	d46	d45	d44	d43	d42	d41	d40	d39	d38	d37	d36	d35	d34	d33	d32	MODE
A1	A0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x10
-	-	-	-	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A9	A8	A7	A6	A5	A4	A3	A2	
B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x10
-	-	-	-	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	B9	B8	B7	B6	B5	B4	B3	B2	
A1	A0	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	3x10
-	-	-	-	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	

Table 7b – Packed pixel mapping into memory – 1x10, 2x10 and 3x10 modes – 6 pixels/DW

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	D1	D0	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	4x10
DW1	C3	C2	C1	C0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	D9	D8	D7	D6	D5	D4	D3	D2	
DW2	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C9	C8	C7	C6	C5	C4	
DW2	-	-	-	-	-	-	-	-	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	

Table 7c – Packed pixel mapping into memory – 4x10 mode – 12 pixels/2 DWs

d31	d30	d29	d28	d27	d26	d25	d24	d23	d22	d21	d20	d19	d18	d17	d16	d15	d14	d13	d12	d11	d10	d9	d8	d7	d6	d5	D4	d3	d2	d1	d0	
d63	d62	d61	d60	d59	d58	d57	d56	d55	d54	d53	d52	d51	d50	d49	d48	d47	d46	d45	d44	d43	d42	d41	d40	d39	d38	d37	d36	d35	d34	d33	d32	MODE
A7	A6	A5	A4	A3	A2	A1	A0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	1x12
-	-	-	-	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	A11	A10	A9	A8	

Table 7d – Packed pixel mapping into memory – 1x12 mode – 5 pixels/DW

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	A7	A6	A5	A4	A3	A2	A1	A0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	2x12
DW1	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	
DW2	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	B11	B10	B9	B8	B7	B6	B5	B4	
DW2	A7	A6	A5	A4	A3	A2	A1	A0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	
DW3	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	
DW3	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	B11	B10	B9	B8	B7	B6	B5	B4	

Table 7e – Packed pixel mapping into memory – 2x12 mode – 16 pixels/3 DWs

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	C7	C6	C5	C4	C3	C2	C1	C0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	3x12
DW1	C3	C2	C1	C0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	C11	C10	C9	C8	
DW2	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	C11	C10	C9	C8	C7	C6	C5	C4	
DW2	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	
DW3	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B11	B10	B9	B8	
DW3	-	-	-	-	-	-	-	-	-	-	-	-	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B11	B10	B9	B8	B7	B6	B5	B4	

Table 7f – Packed pixel mapping into memory – 3x12 mode – 15 pixels/3 DWs

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	C7	C6	C5	C4	C3	C2	C1	C0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	4x12
DW1	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C11	C10	C9	C8	
DW2	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B11	B10	B9	B8	B7	B6	B5	B4	
DW2	C7	C6	C5	C4	C3	C2	C1	C0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	
DW3	B3	B2	B1	B0	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C11	C10	C9	C8	
DW3	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B11	B10	B9	B8	B7	B6	B5	B4	

Table 7g – Packed pixel mapping into memory – 4x12 mode – 16 pixels/3 DWs

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	B7	B6	B5	B4	B3	B2	B1	B0	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	RGB
DW1	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	24
DW2	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	R7	R6	R5	R4	R3	R2	R1	R0	
DW2	B7	B6	B5	B4	B3	B2	B1	B0	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	
DW3	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	
DW3	R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	R7	R6	R5	R4	R3	R2	R1	R0	

Table 7h – Packed pixel mapping into memory – RGB24 mode – 8 pixels/3 DWs

d31	d30	d29	d28	d27	d26	d25	d24	d23	d22	d21	d20	d19	d18	d17	d16	d15	d14	d13	d12	d11	d10	d9	d8	d7	d6	d5	D4	d3	d2	d1	d0	
d63	d62	d61	d60	d59	d58	d57	d56	d55	d54	d53	d52	d51	d50	d49	d48	d47	d46	d45	d44	d43	d42	d41	d40	d39	d38	d37	d36	d35	d34	d33	d32	MODE
-	-	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	RGB
-	-	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	30

Table 7i – Packed pixel mapping into memory – RGB30 mode – 2 pixels/DW

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	R7	R6	R5	R4	R3	R2	R1	R0	G11	G10	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	RGB
DW1	R3	R2	R1	R0	G11	G10	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	R11	R10	R9	R8	36
DW2	G11	G10	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	R11	R10	R9	R8	R7	R6	R5	R4	
DW2	G7	G6	G5	G4	G3	G2	G1	G0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	
DW3	G3	G2	G1	G0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	G11	G10	G9	G8	
DW3	-	-	-	-	-	-	-	-	-	-	-	-	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	G11	G10	G9	G8	G7	G6	G5	G4	

Table 7j – Packed pixel mapping into memory – RGB36 mode – 5 pixels/3 DWs

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	D7	D6	D5	D4	D3	D2	D1	D0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	10x8
DW1	H7	H6	H5	H4	H3	H2	H1	H0	G7	G6	G5	G4	G3	G2	G1	G0	F7	F6	F5	F4	F3	F2	F1	F0	E7	E6	E5	E4	E3	E2	E1	E0	
DW2	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	J7	J6	J5	J4	J3	J2	J1	J0	I7	I6	I5	I4	I3	I2	I1	I0	
DW2	F7	F6	F5	F4	F3	F2	F1	F0	E7	E6	E5	E4	E3	E2	E1	E0	D7	D6	D5	D4	D3	D2	D1	D0	C7	C6	C5	C4	C3	C2	C1	C0	
DW3	J7	J6	J5	J4	J3	J2	J1	J0	I7	I6	I5	I4	I3	I2	I1	I0	H7	H6	H5	H4	H3	H2	H1	H0	G7	G6	G5	G4	G3	G2	G1	G0	
DW3	D7	D6	D5	D4	D3	D2	D1	D0	C7	C6	C5	C4	C3	C2	C1	C0	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	
DW4	H7	H6	H5	H4	H3	H2	H1	H0	G7	G6	G5	G4	G3	G2	G1	G0	F7	F6	F5	F4	F3	F2	F1	F0	E7	E6	E5	E4	E3	E2	E1	E0	
DW4	B7	B6	B5	B4	B3	B2	B1	B0	A7	A6	A5	A4	A3	A2	A1	A0	J7	J6	J5	J4	J3	J2	J1	J0	I7	I6	I5	I4	I3	I2	I1	I0	
DW5	F7	F6	F5	F4	F3	F2	F1	F0	E7	E6	E5	E4	E3	E2	E1	E0	D7	D6	D5	D4	D3	D2	D1	D0	C7	C6	C5	C4	C3	C2	C1	C0	
DW5	J7	J6	J5	J4	J3	J2	J1	J0	I7	I6	I5	I4	I3	I2	I1	I0	H7	H6	H5	H4	H3	H2	H1	H0	G7	G6	G5	G4	G3	G2	G1	G0	

Table 7k – Unpacked pixel mapping into memory – 10x8 mode – 40 pixels/5 DWs

	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	MODE
DW1	D1	D0	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	8x10
DW1	G3	G2	G1	G0	F9	F8	F7	F6	F5	F4	F3	F2	F1	F0	E9	E8	E7	E6	E5	E4	E3	E2	E1	E0	D9	D8	D7	D6	D5	D4	D3	D2	
DW2	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0	G9	G8	G7	G6	G5	G4	
DW2	E7	E6	E5	E4	E3	E2	E1	E0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	
DW3	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	F9	F8	F7	F6	F5	F4	F3	F2	F1	F0	E9	E8	
DW3	D1	D0	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	
DW4	G3	G2	G1	G0	F9	F8	F7	F6	F5	F4	F3	F2	F1	F0	E9	E8	E7	E6	E5	E4	E3	E2	E1	E0	D9	D8	D7	D6	D5	D4	D3	D2	
DW4	B5	B4	B3	B2	B1	B0	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0	G9	G8	G7	G6	G5	G4	
DW5	E7	E6	E5	E4	E3	E2	E1	E0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	B9	B8	B7	B6	
DW5	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0	F9	F8	F7	F6	F5	F4	F3	F2	F1	F0	E9	E8	

Table 7l – Packed pixel mapping into memory – 8x10 mode – 32 pixels/5 DWs

Pixel Buffering The pixel data formatted by the video capture engine is stored into two on-board FIFO memories. This memory serves as an elastic store for formatted video pixel data. The FIFOs are managed by an independent pair of controllers, implemented in the FPGA, supporting concurrent operation. The two FIFOs are utilized in a ping-pong fashion such that while one is being filled with new pixel data, the other is being emptied via DMA into host memory.

DMA The DMA engine is responsible for reading formatted pixel data from the on-board FIFO memories and transferring them into host memory via the PCI Express interface. An intelligent scatter-gather method is utilized, providing for an efficient use of the PCI Express bandwidth. The use of non-contiguous 4Kbyte buffers provides support for the Windows operating system's memory allocation model.

Serial Interface A bi-directional Universal Asynchronous Receiver Transmitter (UART) is provided for each Camera Link serial interface. It transmits and receives ASYNC formatted characters with 1 Start bit, 8 data bits, no parity and 1 Stop bit. The baud rate of this interface can be configured by the user to be any one of a set of standard bit rates ranging from 4800 to 115.2K bits per second. A software interface to the UART is provided by means of a Camera Link compliant *'clser***.dll'* file.

Camera Control The FrameLink Express card provides four discrete camera control bits per the Camera Link specification for each channel. These bits can be configured by the user via the FrameLink Express application GUI.

FPGA The heart of the FrameLink Express is a dense Field Programmable Gate Array (FPGA). This FPGA implements all of the functions related to video data capture, formatting, storage and DMA. The firmware contents of the FPGA can be upgraded while in the field by following the instruction outlined in Section 3 of this document entitled 'Firmware Upgrade from Web Site'.

What you need to get started

To begin using the FrameLink Express card, you need the following:

- A computer with a PCIe x1 (or x4) slot or a laptop with an ExpressCard/54 (or ExpressCard/34) slot.
- Microsoft Windows 7 or XP software.
- A computer with at least 256M bytes of RAM.
- A CD drive, and a hard disk on which to install the FrameLink Express software.

Inspecting the FrameLink Express package

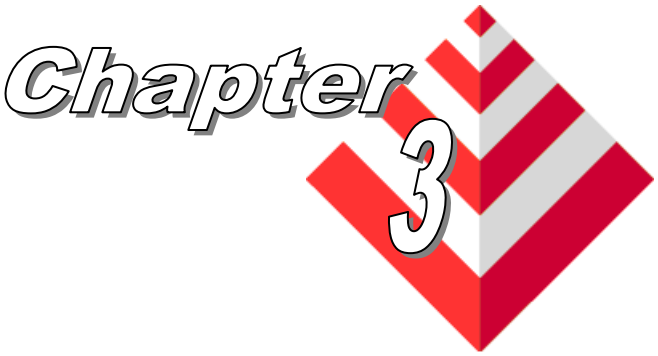
When you unpack your FrameLink Express package, you should visually inspect all of its contents. If something is missing or damaged, contact your Imperx representative.

Package contents
You should have received the following items:

- The FrameLink Express card
- A CD with the FrameLink Express software suite
- A ‘Quick Start’ installation guide

Hardware Installation

Installing the FrameLink Express card is as simple as plugging it into an available PCIe x1 (or x4) slot on your desktop computer's motherboard or a ExpressCard/54 (or ExpressCard/34) slot on your laptop.



Software Installation

This chapter explains how to install the FrameLink Express software.

Software Suite

The FrameLink Express software suite consists of the following files:

Windows application files:
(located in *c:\Program Files\ImperX\FrameLink Express*)

FrameLink_Express.exe	- Area scan application program
VceComEx.exe	- Virtual COM port emulator
FrameLink_Express.chm	- Help file
FrameLinkConsole.exe	- Console program (for debug purposes)
FLExDrvManager.exe	- Driver manager tool (for debug purposes)
Uninstall.exe	- Un-install utility
VCECLB.dll	- FrameLink Express library
clseripx.dll	- CameraLink serial interface library
ippLib.dll	- Intel image processing library
IpxLog.dll	- ImperX logging library
IpxMisc.dll	- ImperX miscellaneous library
IpxMovieMaker.dll	- ImperX movie maker library
DSMovieWriter.ax	- Movie Writer DirectShow filter

Windows driver files:
(located in *c:\Program Files\ImperX\FrameLink Express\drivers*)

/Kernel/ folder	- WinXP/2000/Vista driver files
/DirectShow/ folder	- DirectX driver files
/Halcon/ folder	- Halcon driver files
/Labview/ folder	- Labview driver files

Software Development Kit (SDK) files:
(located in *c:\Program Files\ImperX\FrameLink Express\SDK*)

/bin/ folder	- binaries
/inc/ folder	- include files
/lib/ folder	- libraries
/doc/ folder	- documentation
/examples/ folder	- sample source code

Documentation files:
(located in *c:\Program Files\ImperX\FrameLink Express\Doc*)

FrameLink_Express_Users_Manual.pdf	- User manual document
FrameLink_Express_Datasheet.pdf	- Technical datasheet

LUT Files:
(located in *c:\Program Files\ImperX\FrameLink Express\LUT*)

gamma_45.lut	- Sample lookup table for Gamma_45
gamma_45.xls	- Sample excel file for Gamma_45

CAM Files:
(located in *c:\Program Files\ImperX\FrameLink Express\CAM_Files*)

various folders	- FrameLink Express configuration files for various camera vendors

Note that our FrameLink Express application program was created using our SDK (software developers kit). Our SDK is included in the standard FrameLink Express software suite that comes with the card.

Software Installation from CD

Use the following steps to install the FrameLink Express software supplied on a CD. Note that 'click' refers to the left mouse button.

1. If a version of FrameLink Express was previously installed on this machine, then you must first remove it:

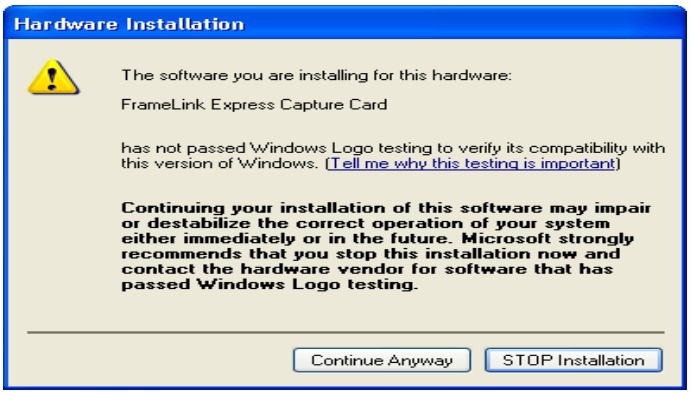
   To remove the application files:

   1.1 Click on *"Start"*
   1.2 Click on *"Settings"***.**
   1.3 Click on *"Control Panel"***.**
   1.4 Double click on *"Add or Remove Programs"***.**
   1.5 Click on *"FrameLink Express"***.**
   1.6 Click on *"Remove"***.**
   1.7 If the 'FrameLink Express – InstallShield Wizard' pops-up then do the following, otherwise go to step 1.8
   Click on *'Remove'*.
   Click *'Next'*.
   Click *'Yes'*.
   Click *'Finish'*.
   1.8 Click on *"Yes"***.**
   1.9 Click on *"Close"*.

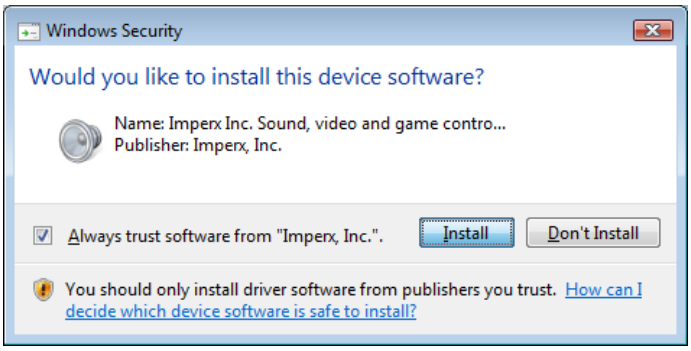
2. After having removed a previous version or if a version of FrameLink Express was NOT previously installed on this machine then:

   The first step is to install the application files:

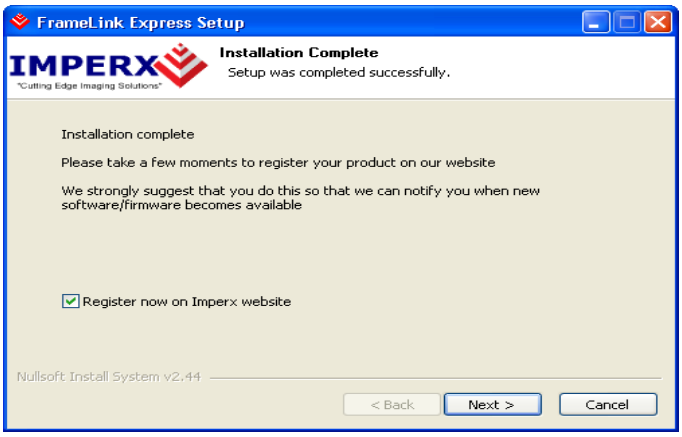
   2.1 Insert the FrameLink Express CD into the appropriate drive; the setup.exe file will run automatically. Note: If it does not start automatically, then click on *"Start"***,** *"Run"***,** enter or browse to *"(CD drive): setup.exe"* and click *"OK"*.
   2.2 Wait for the "FrameLink Express - InstallShield Wizard" screen to appear.
   2.3 Follow the on-screen instructions.
   2.4 For Windows XP 32 bit and Windows XP 64 bit, click "*Continue Anyway*" to continue.



2.5 For Windows Vista 32 bit and Windows Vista 64 bit, select *"Always trust software from Imperx, Inc."* and click on *"Install"* button, when the following message appears:



2.6 When the following message appears, choose if you would like to register online by clicking on *"Register now"* or *"Skip"*.



2.7 Click *"Finish"*. This completes the software installation.

2.8 Reboot your computer.

The next step is to install the driver files:

2.9 Insert the FrameLink Express card into the computer.

2.10 For Windows XP 32 bit and for Windows XP 64 bit:

Wait for the system to prompt you with a "Found New Hardware Wizard" dialog box. Proceed to Step 2.11.

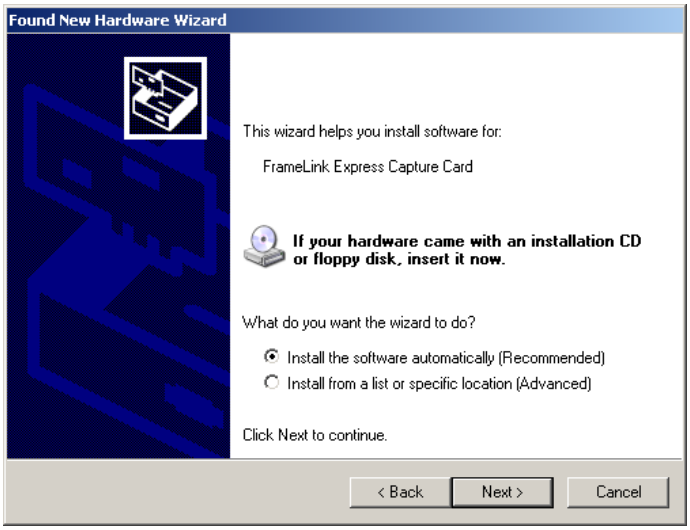
For Windows Vista:

The driver will automatically be installed. Proceed to step 2.16.

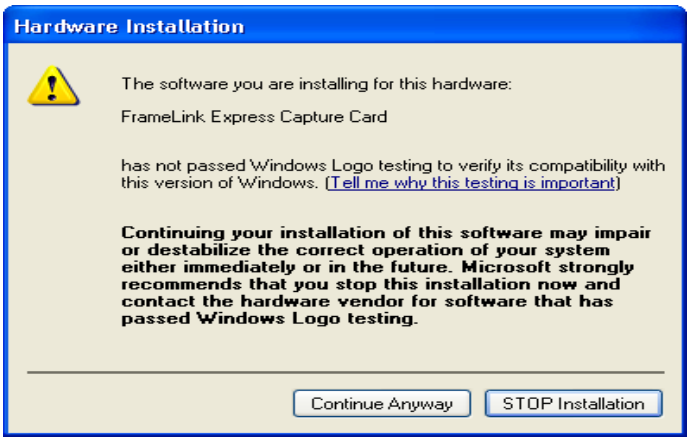
2.11 Under certain conditions, the following message may appear:

If this message appears, click *"No, not this time"*, then click *"Next"*.

2.12 When the following message appears, select *"Install the software automatically (Recommended)"*, then click *"Next"*.



2.13 The following message will appear:



2.14 Click "*Continue Anyway*" to continue.

2.15 When "Click finish to close the wizard" appears, click on "*Finish*".

2.16 This completes the driver installation.

Software Upgrade from Web Site

New application and/or driver software may be released periodically to reflect improvements and/or functionality added to the FrameLink Express. You can retrieve these updates by visiting the download page of our web site at
http://www.imperx.com/frame_grabbers/camera_link/FrameLink_Express_downloads.php

Use the following steps to install newly released application software:

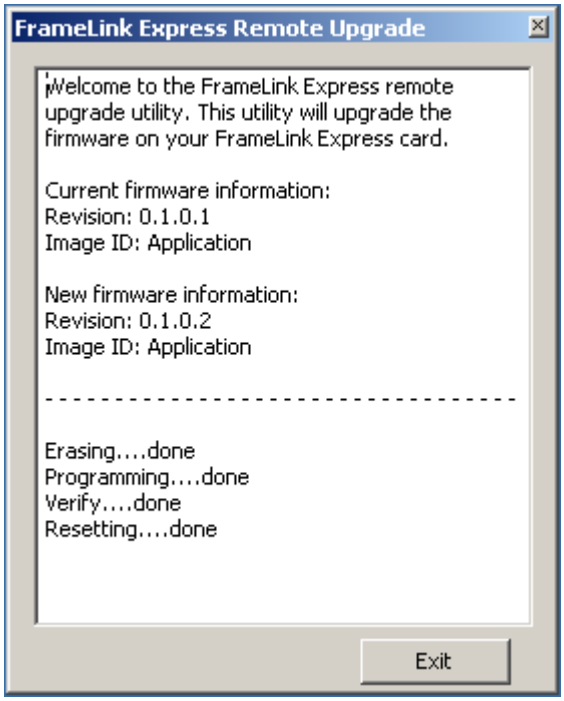
3.1 Uninstall all application files by following the instructions in step 1. of the 'Software Installation from CD' section.
3.2 Download the FrameLink_Express_Installer.exe file from the Imperx web site to a new folder on your PC (we will use the folder C:\new_FrameLink Express as an example).
3.3 Left mouse click on *"Start"*, *"Run"*, enter or browse to *C:\new_FrameLink Express\FrameLink_Express_Installer.exe*.
3.4 Left mouse click on *"Open"*, then *"OK"*.
3.5 Follow the instructions starting from step 2.2 above.

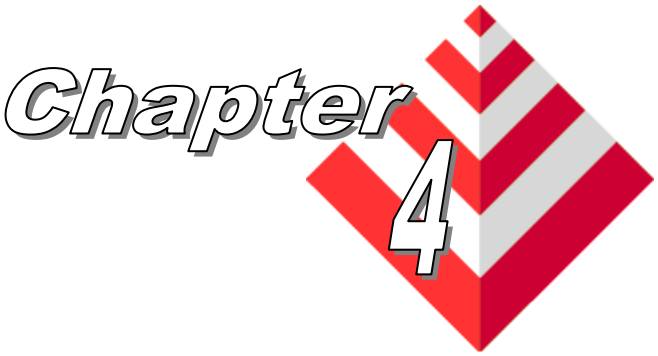
Firmware Upgrade from Web Site

Your newly received FrameLink Express card has been programmed in the factory with the latest firmware prior to shipping. New firmware, however, may be released periodically to reflect improvements and/or added functionality. You can retrieve these updates by visiting the download page of our web site at:
http://www.imperx.com/frame_grabbers/camera_link/FrameLink Express_downloads.php

Use the following steps to install newly released firmware:

1. Download and unzip the firmware Upgrade Utility file to a folder on your PC.
2. Insert the FrameLink Express card into the laptop. Note that if your system has two ExpressCard slots, then you must insert the card into the slot in which it was placed during the original driver installation.
3. If the system prompts you with a “New Hardware Found” dialog box, then you have not previously installed the driver. You must follow the steps outlined in the section above titled “Software Installation from CD” to install the driver.
4. To run the Upgrade Utility simply double click on the icon. **Note: DO NOT POWER DOWN OR REMOVE THE CARD WHILE PROGRAMMING IS IN PROGRESS!**
5. The Upgrade Utility will display the following dialog box:





Using the FrameLink Express

This chapter contains information on how to configure and use the FrameLink Express card.

Running the FrameLink Express Application

The VCECLB_app.exe program supplied with the FrameLink Express card is a stand-alone Windows based application. It provides an easy to use graphical user interface (GUI), allowing the user to configure the FrameLink Express card and to view, record and playback video data received from the CameraLink interface. The application consists of a main window as well as several other dialogs which can be accessed from the main menu or from convenient icons.

Launching Application

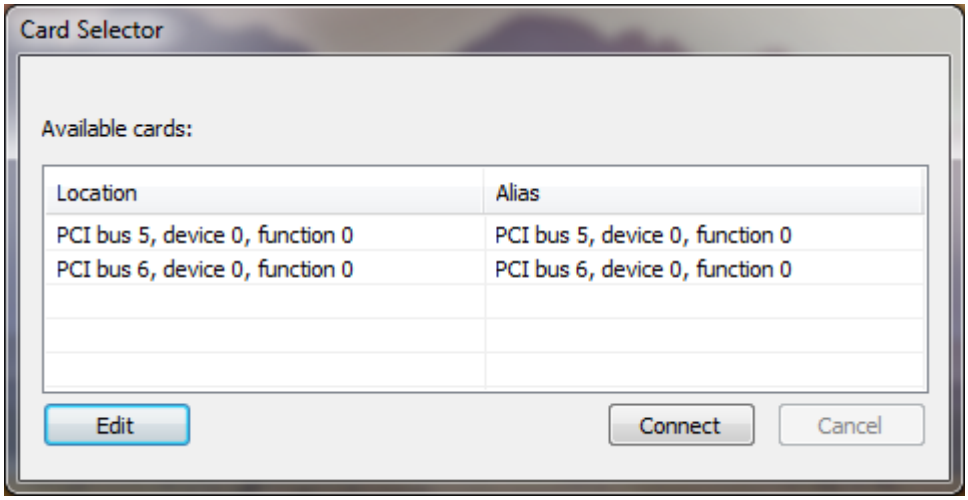
To launch the FrameLink Express application, simply double left mouse click on the 'FrameLink Express' icon on the desktop.

Note

In the remainder of this chapter, references to 'clicking' on objects in the GUI refers to the left mouse button.

Card Selector

After launching the FrameLink Express application, if multiple FrameLink Express cards are installed in the PC then the Card Selector dialog will appear.



Edit

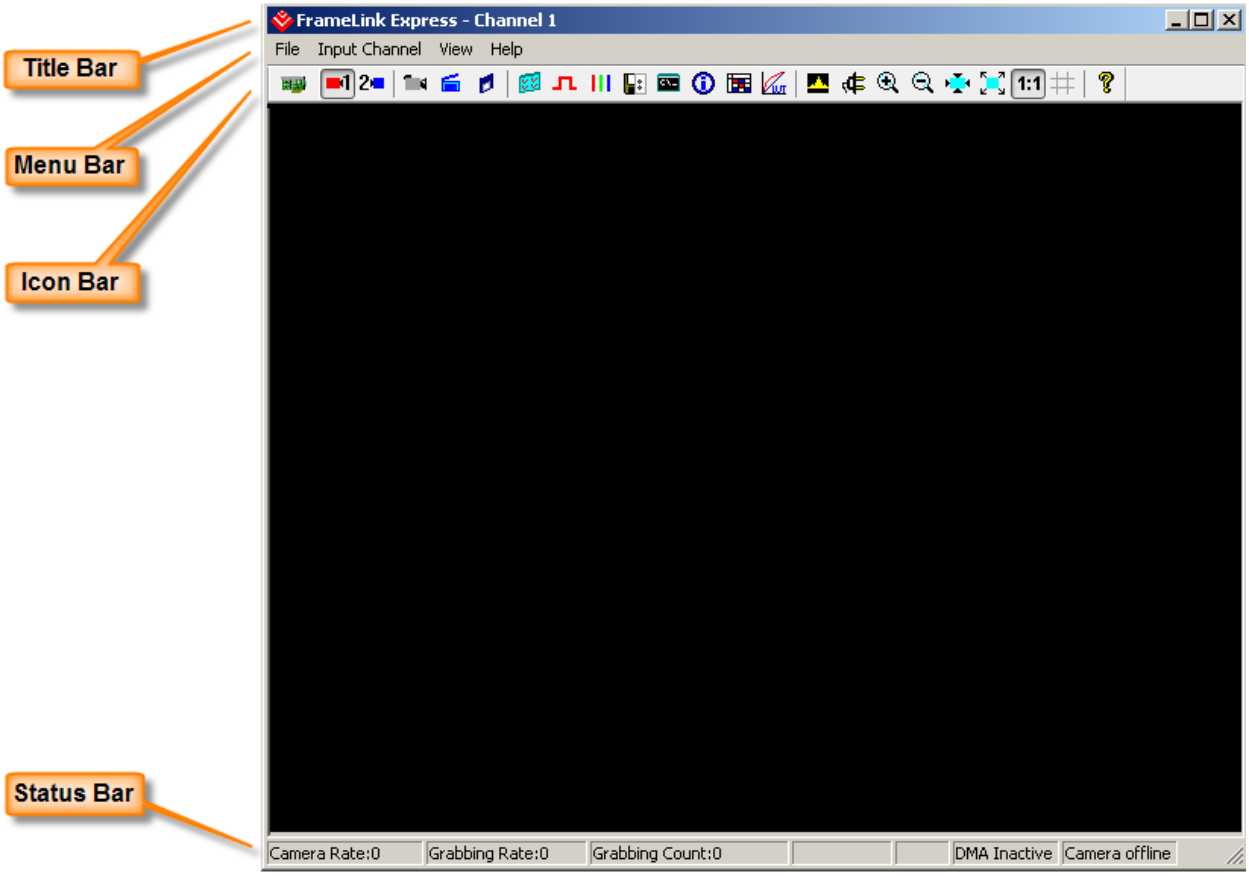
Allows the user to change the 'Alias' name that appears on the Title bar of the main dialog. Select the card you want to rename and click on 'Edit'.

Connect

Select the card you want to use and click on 'Connect'.

Main Window

When the FrameLink Express application is executed, a main window titled ‘FrameLink Express’ will appear. The main window provides the primary area for viewing real-time images received from the camera. This window can be sized and moved to suit your needs. When image viewing is active, the size of this window will be automatically scaled as a function of the camera parameters (i.e. pixels/line and lines/frame) specified in the ‘Camera Parameters’ dialog.



The Main dialog contains a Title bar, a Menu bar, an Icon bar and a Status bar.

Title Bar

The Title bar reflects the name assigned to the Camera Link port that is currently selected. A name of ‘Channel 1’ or ‘Channel 2’ is used as a default. The user can replace this default name by filling in the ‘Alias’ field in the ‘Camera Parameters’ dialog.

Menu Bar

The Menu bar includes a set of pull-down sub-menus as follows:

File Clicking on this item reveals a pull-down menu with two options: ‘Player’ and ‘Exit’.

- **Play Files** This option opens the ‘Player Dialog’ and ‘Player Control’ windows.
- **Exit** Clicking on this option causes the program to terminate.

Input Channel Reveals a pull-down menu allowing the user to select which Camera Link channel to connect to.

View Clicking on this item reveals a pull-down menu with the following options:

- **Card Selector** Causes the ‘Card Selector’ dialog to appear.
- **Camera Parameters** Causes the ‘Camera Parameters’ dialog to appear.
- **CC Control** Causes the ‘CC Control’ dialog to appear. (‘PLC Control’ dialog for the VCE-CLPCIe02/03/04 cards – see Appendic C).
- **RGB Control** Causes the ‘RGB Control’ dialog to appear. This option is only available if ‘Bayer’ or ‘RGB’ is selected in the ‘video type’ field of the ‘Camera Parameters’ dialog.
- **Capture Settings** Causes the ‘Capture Settings’ dialog to appear.
- **Terminal** Causes the ‘Terminal’ dialog to appear.
- **Statistics** Causes the ‘Statistics’ dialog to appear.
- **Hex Pixel Dump** Causes the ‘Hex Pixel Dump’ dialog to appear.

PoCL	Causes the ‘PoCL’ dialog to appear for the VCE-CLPCIe02/03/04 cards.
Lookup Table	Causes the ‘Lookup Table’ dialog to appear.
Histogram	Causes the ‘Histogram’ dialog to appear.
Stretch between markers	Turns the Histogram bit stretching feature on/off.
Colorization	Turns the Histogram colorization feature on/off.
Zoom	Causes the ‘Zoom’ menu to appear.
Grid	Turns the grid on/off.
Toolbar	Causes the toolbar to be displayed.
Status bar	Causes the status bar to be displayed.
Reset dialog position	Causes the screen position of all dialogs to return to their default locations. This is useful when a dialog disappears from the screen as a result of the user having adjusted the screen’s resolution.

Help Clicking on this item reveals a pull-down menu with two options: ‘About’ and ‘Help Manual’.

About	Causes version information to be displayed including release identifiers for the application software, library, driver and firmware. This information should be provided to Imperx technical support personnel during a service call.
Help Manual	Causes an interactive point-and-click style help manual to be displayed. The help manual provides a summary description of all GUI controls and fields.

Icon Bar

The Icon bar contains a set of icons that act as shortcuts into the features located on the Menu bar.

Card Selector

Select **Channel #1**

Select **Channel #2**

Start/stop continuous **Grab**

Snap single frame

Start/stop **Capture** to disk

Open **Camera Parameters** dialog

Open **CC Control** dialog
(**PLC Control** dialog for the VCE-CLPCIe02/03/04).

Open **RGB Control** dialog

Open **Capture Settings** dialog

Open **Terminal** dialog

Open **Statistics** dialog

Open **Hex Pixel Dump** dialog

Enable/disable **Lookup Table** processing

Open **Histogram** dialog

Open **PoCL** dialog (for the VCE-CLPCIe02/03/04).

Zoom In / Zoom Out

Fit to Window

Full Screen

Zoom 1:1

Turn **Grid** on/off

Help

Status Bar

The Status bar reflects the real-time state of the current camera connection.

Camera Rate

Displays the real-time frame rate of the attached camera as measured at the input of the FrameLink Express card.

Grabbing Rate

Displays the real-time rate at which frames are being transferred from the card into host memory.

Grabbing Count

Displays a running count of the total number of frames transferred into system memory. This counter is reset when ‘grabbing’ is stopped.

DMA Status

Displays the real-time status of the DMA process as being either ‘**active**’ or ‘**inactive**’.

‘**Active**’ indicates that the user has commanded the FrameLink Express to acquire video data by clicking on the ‘Start Grab’ button and that the camera is providing valid framing.

‘**Inactive**’ indicates that either the user has commanded the FrameLink Express to stop acquiring video data by clicking on the ‘Stop Grab’ button or that grabbing is enabled but the camera is not providing valid framing.

Camera Status

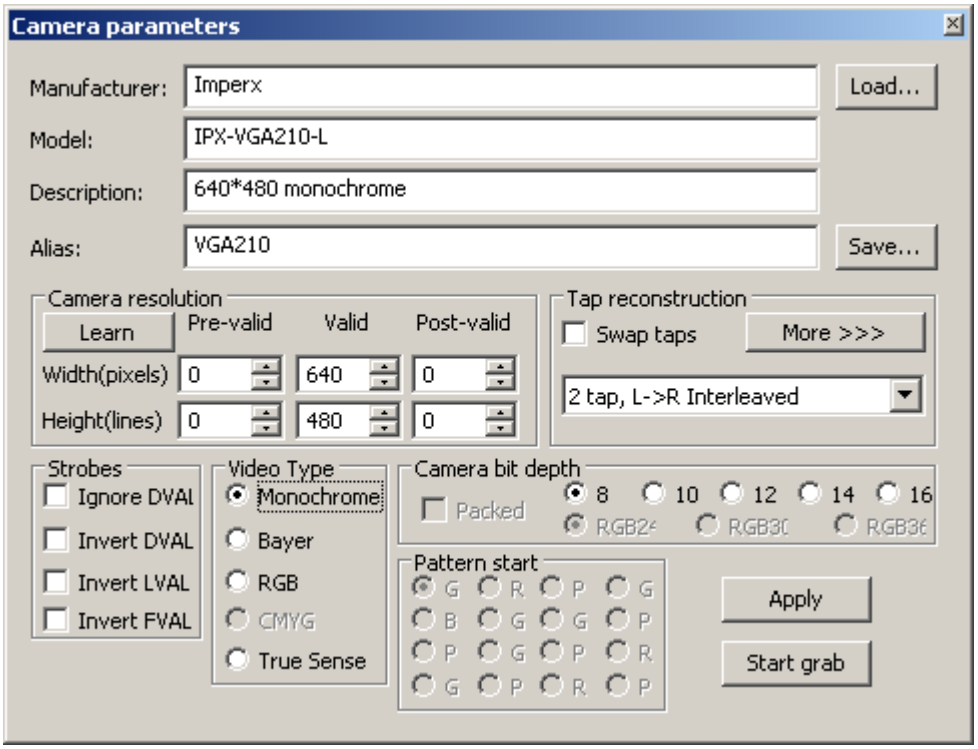
Displays the real-time status of the attached camera as being either ‘**online**’ or ‘**offline**’.

‘**Online**’ indicates that the camera is powered on, attached and providing a video clock via the CameraLink interface.

‘**Offline**’ indicates that the FrameLink Express card is not receiving a video clock from the camera either because the camera is powered off or the CameraLink cable is disconnected.

Camera Parameters Dialog

The Camera Parameters dialog allows the user to configure the FrameLink Express card with the operating parameters of the attached camera. For the FrameLink Express card to be able to properly acquire and display images from an attached camera, the settings entered into this screen must match the parameters of the camera.



Manufacturer
Model
Description

These text fields allow the user to record the vendor and part number of the attached camera. This text, along with all of the other settings, can then be saved as a .CXF file on the PC for later retrieval.

Alias

This is a user defined name for the channel. The text entered into this field will be displayed as the channel name in the Title bar.

Load…

Loads a previously saved camera configuration file. Clicking on this box will cause a Windows 'browse' box to appear. The user can then browse to the folder and file he wishes to open. The program will then open the selected file, parse it and populate the fields in the dialog.

Save…

Saves the current GUI fields as a camera configuration file. Clicking on this box will cause a Windows 'browse' box to appear. The user can then browse to a folder and enter a file name. The program will then create a .CXF file using the values in the dialog's fields and write it to the disk.

Camera Resolution These fields specify the geometry of the attached camera and instructs the FrameLink Express on how to reconstruct a received image.

Width (pixels): These fields specify the total number of pixels per line. The Camera Link standard defines a line as being a series of pixels enveloped by the LVAL strobe and qualified by the DVAL strobe. Cameras generally provide some leading and trailing dummy pixels before and after a set of valid pixels. Most cameras can disqualify these dummy pixels by negating the DVAL signal. For cameras that do not disqualify the dummy pixels, the FrameLink Express has to be told the number of pre-valid, valid and post-valid pixels in order to properly construct an image.

Pre-valid Specifies the number of leading pixels prior to any valid pixels. The FrameLink Express will exclude these pixels from the displayed/captured image.

Valid Specifies the number of valid pixels. The FrameLink Express will include these pixels in the displayed/captured image.

Post-valid Specifies the number of trailing pixels following any valid pixels. The FrameLink Express will exclude these pixels from the displayed/captured image.

Height (lines): These fields specify the total number of lines per frame. The Camera Link standard defines a frame as being a series of lines enveloped by the FVAL strobe. Cameras can sometimes provide some leading and trailing dummy lines before and after a set of valid lines. Most cameras can disqualify these dummy lines by negating the FVAL signal. For cameras that do not disqualify the dummy lines, the FrameLink Express has to be told the number of pre-valid, valid and post-valid lines in order to properly construct an image.

Pre-valid Specifies the number of leading lines prior to any valid lines. The FrameLink Express will exclude these lines from the displayed/captured image.

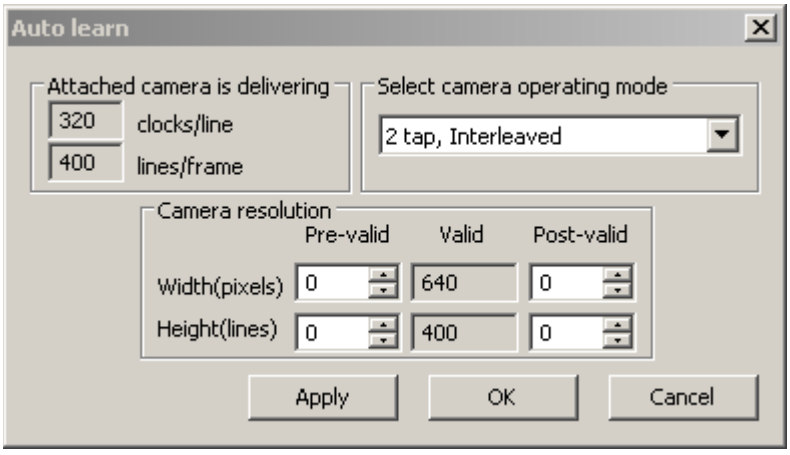
Valid Specifies the number of valid lines. The FrameLink Express will include these lines in the displayed/captured image.

Post-valid Specifies the number of trailing lines following

any valid lines. The FrameLink Express will exclude these lines from the displayed/captured image.

Learn

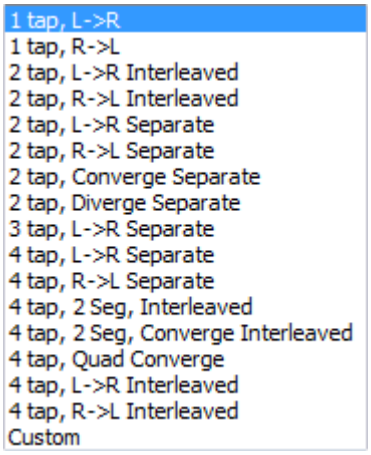
Clicking on this button pops-up the ‘Auto learn’ dialog.



‘Auto learn’ is a unique feature of the FrameLink Express card which assists the user in entering the camera resolution parameters. The FrameLink Express card is continuously measuring the signals it receives from the CameraLink interface and therefore can determine what the cameras resolution is. It measures both the number of CLOCK transitions per LVAL (clocks/line) as well as the number of LVAL transitions per FVAL (lines/frame). It displays these results in the ‘Attached camera is delivering’ fields. The card, however, has no way of knowing how many taps are active and what the camera bit depth is. The user should select the operating mode of the camera and then click the ‘Apply’ button. This will cause the fields in the Camera Resolution group to automatically be populated.

NOTE: If the ‘clocks/line’ field is reporting a value of ‘0’, then the camera may not be providing a DVAL signal on the Camera Link interface. If this is the case then cancel the Auto Learn dialog, select ‘Ignore DVAL’ under Strobes in the Camera Parameters dialog and then click on ‘Learn’ again to re-enter the Auto Learn dialog.

Tap Reconstruction Specifies the number of taps and the pixel ordering provided by the attached camera. The following formats are supported:



Swap taps Instructs the card to interchange the pixel data received from Tap1 and Tap2 of the Camera Link interface. This only applies to Base modes.

More >>> Clicking on this button will cause an animation of the selected tap reconstruction mode to appear.

Strobes Specifies how to treat the Camera Link strobes, where 'DVAL' is data valid, 'LVAL' is line valid and 'FVAL' is frame valid.

Ignore DVAL Instructs the FrameLink Express card to ignore the 'DVAL' signal received from the CameraLink interface. Pixel capture will be qualified with the 'FVAL' and 'LVAL' signals only.

Invert DVAL Instructs the FrameLink Express card to invert the 'DVAL' signal. received from the CameraLink interface prior to processing it.

Invert LVAL Instructs the FrameLink Express card to invert the 'LVAL' signal. received from the CameraLink interface prior to processing it.

Invert FVAL Instructs the FrameLink Express card to invert the 'FVAL' signal received from the CameraLink interface prior to processing it.

Video Type Specifies the video mode as either or monochrome, Bayer or RGB.

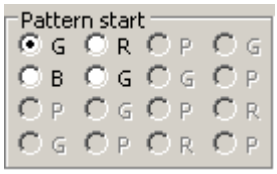
Camera Bit Depth Specifies the number of bits per pixel.

Packed Instructs the card to pack pixels before transferring them to host memory. Packing uses the PCI Express bandwidth more efficiently and conserves memory space. Refer to Tables 5a – 5j.

Pattern Start Specifies the starting pixel in the Bayer or TrueSense pattern as provided by the camera. This selection is typically required when a camera is operated with an 'area of interest' feature enabled.

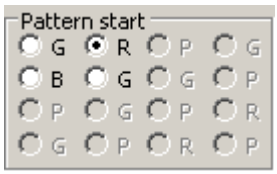
Bayer Patterns For the following examples, assume that 'n = number of pixels/line' and 'm = number of lines' then:

Pattern #1 Use this selection when the camera provides the following pattern:



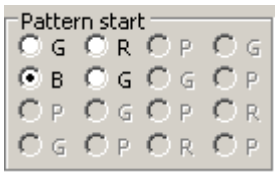
		Pixel						
		1	**2**	**3**	**4**	**…**	**n-1**	**n**
Line	**1**	G	R	G	R		G	R
	2	B	G	B	G		B	G
	3	G	R	G	R		G	R
	4	B	G	B	G		B	G
	:							
	m-1	G	R	G	R		G	R
	m	B	G	B	G		B	G

Pattern #2 Use this selection when the camera provides the following pattern:



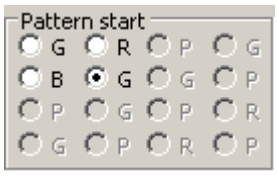
		Pixel						
		1	**2**	**3**	**4**	**…**	**n-1**	**n**
Line	**1**	R	G	R	G		R	G
	2	G	B	G	B		G	B
	3	R	G	R	G		R	G
	4	G	B	G	B		G	B
	:							
	m-1	R	G	R	G		R	G
	m	G	B	G	B		G	B

Pattern #3 Use this selection when the camera provides the following pattern:



		Pixel						
		1	**2**	**3**	**4**	**…**	**n-1**	**n**
Line	**1**	B	G	B	G		B	G
	2	G	R	G	R		G	R
	3	B	G	B	G		B	G
	4	G	R	G	R		G	R
	:							
	m-1	B	G	B	G		B	G
	m	G	R	G	R		G	R

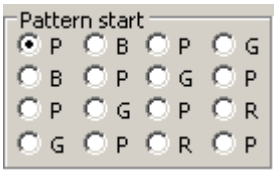
Pattern #4 Use this selection when the camera provides the following pattern:



		Pixel						
		1	**2**	**3**	**4**	**…**	**n-1**	**n**
Line	**1**	G	B	G	B		G	B
	2	R	G	R	G		R	G
	3	G	B	G	B		G	B
	4	R	G	R	G		R	G
	:							
	m-1	G	B	G	B		G	B
	m	R	G	R	G		R	G

TrueSense Patterns

This is similar to the Bayer pattern except that the matrix is 4x4 instead of 2x2. Note that in a TrueSense pattern, in addition to the Green (G), Red (R) and Blue (B) pixels there are also Panchromatic (P) pixels.



Apply

Causes the application to apply the current settings to the FrameLink Express card.

Start/Stop Grab

This button will toggle between **'Start Grab'** and **'Stop Grab'** every time the user clicks on it. Clicking on 'Start Grab' enables the FrameLink Express's DMA engine and causes the main window to display live images received from the camera. Clicking on 'Stop Grab' disables the DMA engine and causes the display to freeze.

Close

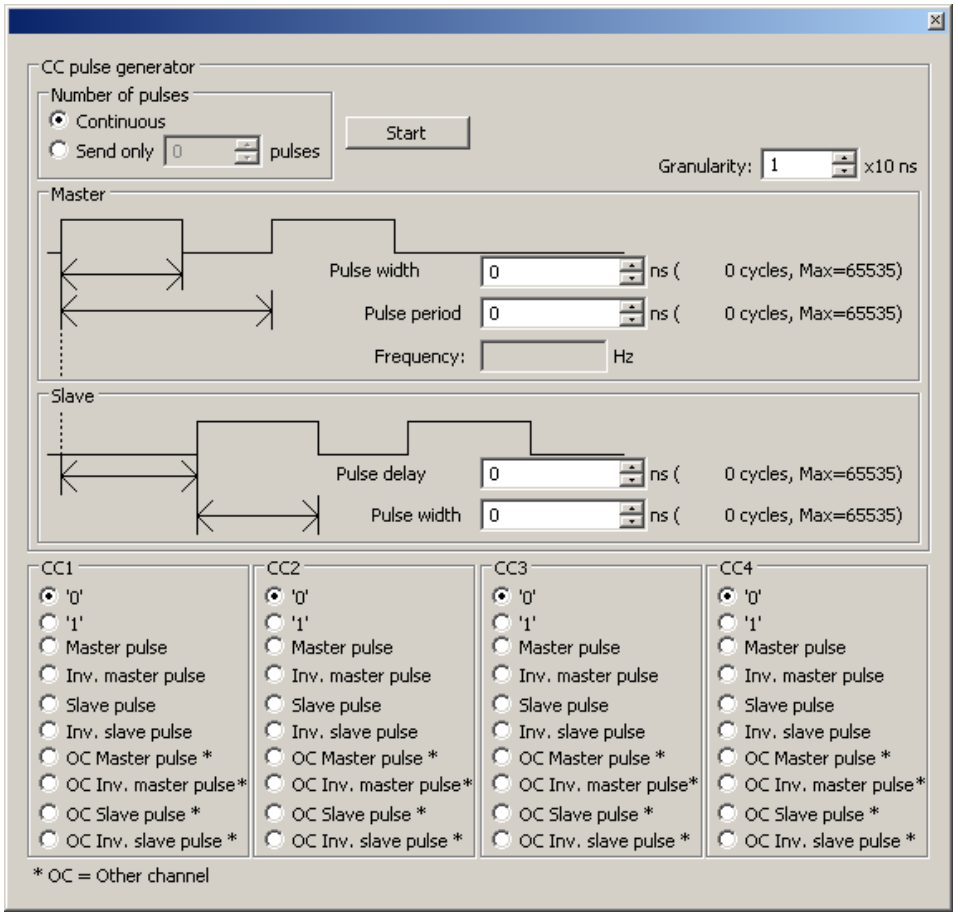
This button will close the Camera Parameters dialog.

CC Control Dialog

The CC Control dialog allows the user to program the FrameLink Express card to generate signals on the Camera Link CC1-CC4 signals. These signals are often used by cameras to control triggering and exposure time via the host computer.

The CC Control dialog is not available on the VCE-CLPCIe02 card. The VCE-CLPCIe02 card uses a Programmable Logic Controller instead (see Appendix C).

The FrameLink Express includes two pulse generators per channel: Master and Slave. Both pulse generator's outputs can be routed to the CC1-CC4 signals of either channel.



Start This button toggles between 'Start' and 'Stop'. Causes both Master and Slave pulse generators to start or stop running.

Number of pulses: Determines how often to send CC pulses:

Continuous Configures the FrameLink Express to send a continuous stream of CC pulses. Clicking on the ‘Start’ button causes the pulses to begin. Clicking on the ‘Stop’ button causes the pulses to cease.

Send only Configures the FrameLink Express to send a programmed number of pulses. Clicking on the ‘Start’ button causes the sequence to begin. The sequence will end after the programmed number of pulses are delivered.

Granularity Sets the granularity of the clock used by the Master and Slave pulse generators. A value of ‘1’ corresponds to a clock period of 10 nSeconds, a value of ‘2’ to 20 nSeconds etc. All master and slave pulse variables (i.e. width, period, etc.) are scaled by this clock granularity.

Master Sets the parameters for the Master pulse generator:

Pulse width Sets the width of the master pulse.

Pulse period Sets the period (repetition rate) of the master pulse.

Slave Sets the parameters for the Slave pulse generator:

Pulse delay Sets the delay between the master and slave pulses.

Pulse width Sets the width of the slave pulse.

CC1 – CC4 Configures the behavior of each of the four CC signals:

‘0’ Drive the selected CC signal to a logic ‘0’.

‘1’ Drive the selected CC signal to a logic ‘1’.

Master pulse Drive the selected CC signal with the output of the master pulse generator.

Inv. master Pulse Drive the selected CC signal with the inverted output of the master pulse generator.

Slave pulse Drive the selected CC signal with the output of the slave pulse generator.

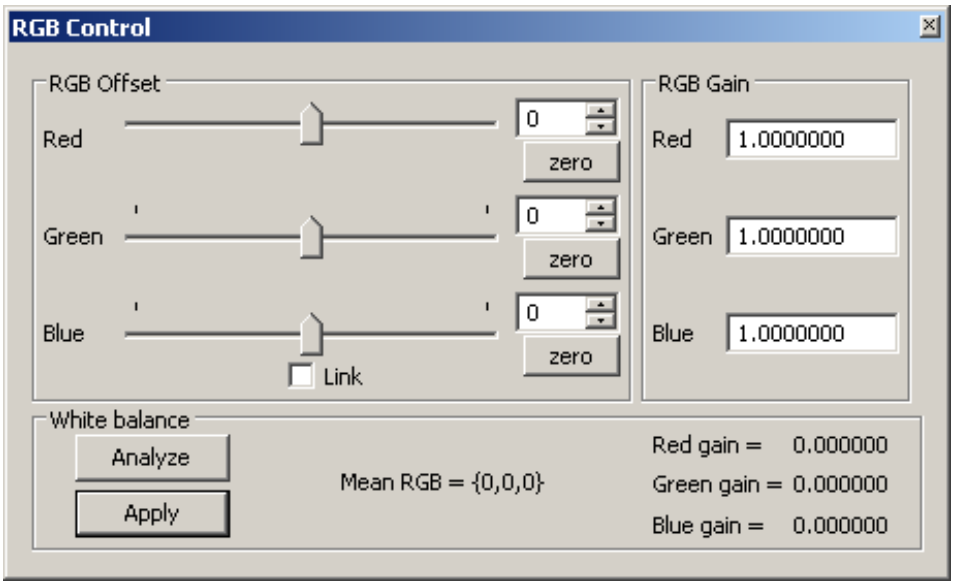
Inv. slave Pulse Drive the selected CC signal with the inverted output of the slave pulse generator.

OC Master pulse Drive the selected CC signal with the output of the other channel’s master pulse generator.

OC Inv. master Pulse	Drive the selected CC signal with the inverted output of the other channel’s master pulse generator.
OC Slave pulse	Drive the selected CC signal with the output of the other channel’s slave pulse generator.
OC Inv. slave Pulse	Drive the selected CC signal with the inverted output of the other channel’s slave pulse generator.

RGB Control Dialog

The RGB Control dialog allows the user to adjust the gain and offset for each of the RGB color components. This option is only available if 'Bayer' or 'RGB' is selected in the 'video type' field of the 'Camera Parameters' dialog.



RGB Offset Specifies the amount of offset to apply to each of the R, G and B components.

RGB Gain Specifies the amount of gain to apply to each of the R, G and B components.

White balance Performs an automatic white balancing procedure.

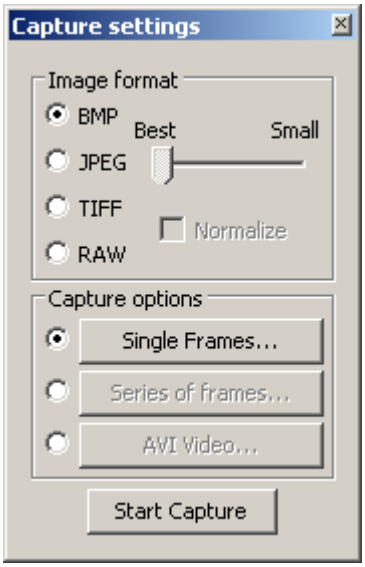
Analyze Instructs the FrameLink Express card to analyze the current image received from the camera and to calculate a set of RGB Gain coefficients that will cause the sample image to be white balanced.

NOTE: Before clicking on 'Analyze', the user should point the camera at a uniform white target.

Apply Instructs the FrameLink Express card to use the calculated RGB Gain coefficients acquired during the 'analyze' procedure and to apply these to the received image prior to display.

Capture Settings Dialog

This dialog gives the user complete control over image storage.



Start/Stop Capture

This button will toggle between **'Start Capture'** and **'Stop Capture'** every time the user clicks on it. Clicking on 'Start Capture' starts the process of recording the images to disk. The options set in the 'Capture Options' field determine what, how and when actual recording is performed. Clicking on 'Stop Capture' causes recording to stop.

Close

This button will hide the Capture Settings Dialog screen. You can invoke it again by either hitting Ctrl-S or by selecting it from the Control Panel pull-down menu.

Image Format

When recording images to disk, this option selects the format, 'BMP', 'JPEG', 'TIFF' or 'RAW', that the image will be saved in. Selecting 'JPEG' activates a compression slider. 'Best' provides the least compression, while 'Small' provides the most compression.

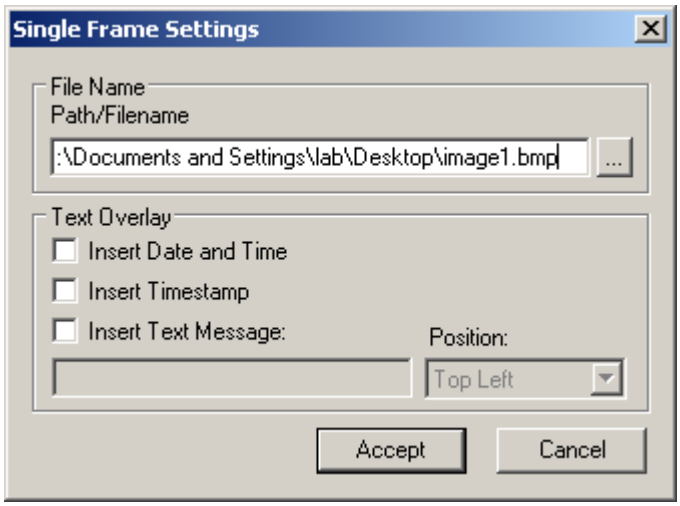
Normalize

Normalize defines the way in which TIFF files are created. Since a TIFF file uses 16 bits to represent each pixel and cameras can produce less than 16 bit pixels, the normalize option is provided. If 'normalize' is disabled, then left pixel padding is used so that 16 bit TIFF data is produced by appending zeros to the MSB bits of the pixel data. For example, for a 12 bit pixel the resultant 16 bit TIFF data is "0,0,0,0,p12, p11….p2,p1" where p12..p1 represent the 12 bit pixel. Left padding is useful when the user wishes to post-process the TIFF data. If 'normalize' is enabled, then right pixel padding is used so that 16 bit TIFF data is

produced by shifting the pixel data left and appending zeros to the LSB bits of the pixel data. For example, for a 12 bit pixel the resultant 16 bit TIFF data is “p12, p11….p2,p1,0,0,0,0”. Right padding is useful when the user wishes to view the TIFF data using a standard TIFF viewer program.

Capture Options Determines how, when and where images are recorded to disk. Three choices are provided: ‘Single Frames’, ‘Series of Frames’ and ‘AVI Video’. Selecting the radio button and then clicking on each option box opens a new dialog providing additional options.

Single Frames Select this option when you wish to record one frame only. Clicking on this button causes the ‘Single Frame Settings’ dialog to open.



Path/Filename This text field allows you to provide a path and filename for the recorded image file. Clicking on the ‘…’ box will cause a Windows ‘browse’ box to appear. The user can then browse to a folder and enter a file name. The filename extension, .BMP or .JPG, will automatically be added depending on the image format chosen and therefore you do not need to include the filename extension.

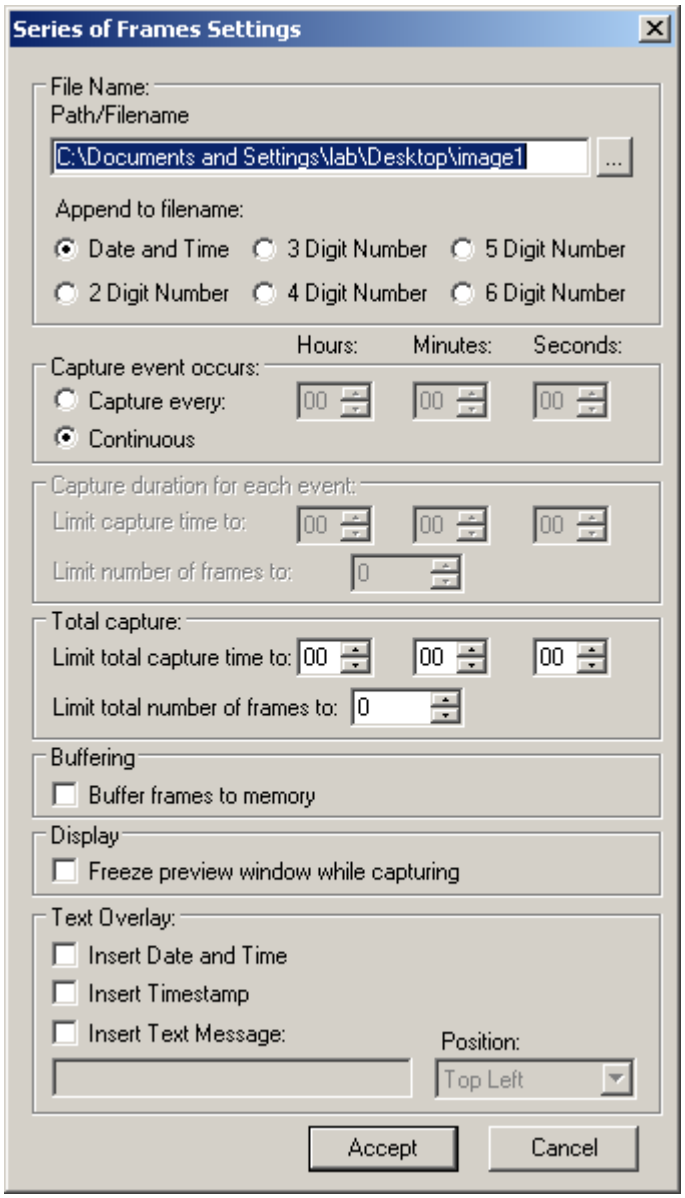
Text Overlay Enabling **‘Insert Date and Time’** automatically overlays the date and time, received from the PC’s operating system, on each image recorded. Date and time formats are the same as those used on your computer. Enabling **‘Insert Timestamp’** automatically overlays an accurate timestamp on each image recorded. The timestamp is a decimal integer value indicating the time, in microseconds, when the card acquired the frame from the attached

camera. Enabling **'Insert Text Message'** allows you to enter a text string to be automatically overlayed on each image recorded. Clicking on **'Position'** causes a pull-down menu to appear which defines the placement position of the date/time/text message within the image. Available options include: Top-Left, Top-Center, Top-Right, Bottom-Left, Bottom-Center and Bottom-Right.

Accept Clicking on this causes the entries made to the various fields to be accepted and then closes the 'Single Frame Settings' dialog window.

Cancel Clicking on this causes the entries made to the various fields to be rejected and then closes the 'Single Frame Settings' dialog window.

Series of Frames Select this option when you wish to record multiple frames. Clicking on this button causes the 'Series of Frames Settings' dialog to open.



Path/Filename This text field allows you to provide a path to a folder where the recorded image files will be saved to. Clicking on the '…' box will cause a Windows 'browse' box to appear. The user can then browse to a folder. The filename will automatically be created based on the choice made in the 'Append to filename' option. The filename extension, .BMP or .JPG, will automatically be added depending on the image format chosen.

Append to filename Allows the user to choose the format of the text filename to be created. Every time a recording file is created, the filename suffix will automatically be updated (for the ‘Date and Time’ option) or incremented (for the ‘N Digit Number’ option).

Date and Time This option will create files named as YYYYMMDDhhmmssnnn where:

Y - year (4 digits)
M - month (2 digits)
D - day (2 digits)
h - hour (2 digits)
m - minute (2 digits)
s - second (2 digits)
n - millisecond (3 digits)

‘N’ Digit Number This option will create numerically named files. The filename starts at 0 and is incremented by one after each frame is captured. If the number of frames captured exceeds the number of digits selected then the filename will continue to increment.

For example:

If ‘2 Digit Number’ is selected then the files will be named as:

‘00.bmp’, ‘01.bmp’ … ‘99.bmp’, ‘100.bmp’, ‘101.bmp’, etc.

If ‘4 Digit Number’ is selected then the files will be named as:

‘0000.bmp’, ‘0001.bmp’ … ‘9999.bmp’, ‘10000.bmp’, ‘10001.bmp’, etc.

Capture event occurs: Allows you to control how often to start capturing images.

Capture every Specifies how often, in time, to start capturing images. Use this feature to take snapshots at regular intervals in order to create a time-lapse series of images. This option is mutually exclusive with the ‘Continuous’ option.

Continuous Specifies that image capture is free-running.

Capture duration for each event: Allows you to control how much to capture with each capture event specified above. Limits can be specified by either time or number of frames, whichever occurs first.

- **Limit capture time to** Allows you to limit the duration of the recording by the amount of time specified.
- **Limit number of frames to** Allows you to limit the duration of the recording by the number of frames specified.

Total capture: Allows you to control how much to capture over all events specified above. Limits can be specified by either time or number of frames, whichever occurs first.

- **Limit total capture time to** Allows you to limit the duration of the total recording by the amount of time specified.
- **Limit total number of frames to** Allows you to limit the duration of the total recording by the number of frames specified

Examples of how to use Capture timers and counters:

Example #1: To capture 5 frames, every 1.5 hours, over a 12 hour period.

Capture event occurs:
Capture every: 01 Hr 30 Min 00 Sec

Capture duration for each event:
Limit number of frames to: 5

Total capture:
Limit total capture time to: 12 Hr 00 Min 00 Sec

Example #2: To capture 5 minutes worth of images, every 15 minutes and not to exceed a total of 250 images.

Capture event occurs:
Capture every: 00 Hr 15 Min 00 Sec

Capture duration for each event:
Limit capture time to: 00 Hr 05 Min 00 Sec

Total capture:
Limit total number of frames to: 250

Example #3: To capture 10 frames, every 1 hour, over a 6 hour period and not to exceed a total of 300 images.

Capture event occurs:
Capture every: 01 Hr 00 Min 00 Sec

Capture duration for each event:
Limit number of frames to: 10

Total capture:
Limit total capture time to: 06 Hr 00 Min 00 Sec
Limit total number of frames to: 300

Example #4: To capture continuously for a period of 2 hours and not to exceed a total of 100 images.

Capture event occurs:
Continuous

Total capture:
Limit total capture time to: 02 Hr 00 Min 00 Sec
Limit total number of frames to: 100

Buffer frames to memory — When selected will store images in system memory during capturing. When capturing is complete, the images in memory will be flushed to the disk drive. Select this option to improve capture performance (i.e. the number of frames per second stored to disk). If this option is not selected, images will be stored directly to disk and therefore capture performance will be limited by the disk's transfer rate.

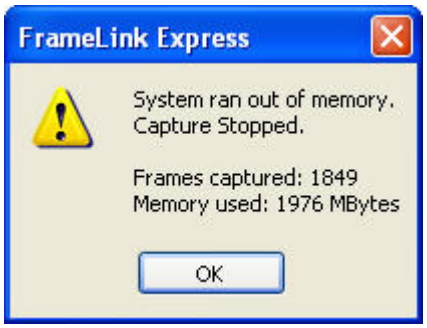
Freeze preview window while capturing — When selected will stop the live image in the main window from updating during capture, otherwise the image will remain live. Selecting this option improves capture performance (i.e. the number of frames per second stored to disk).

Text Overlay — Same as in 'Single Frames'.

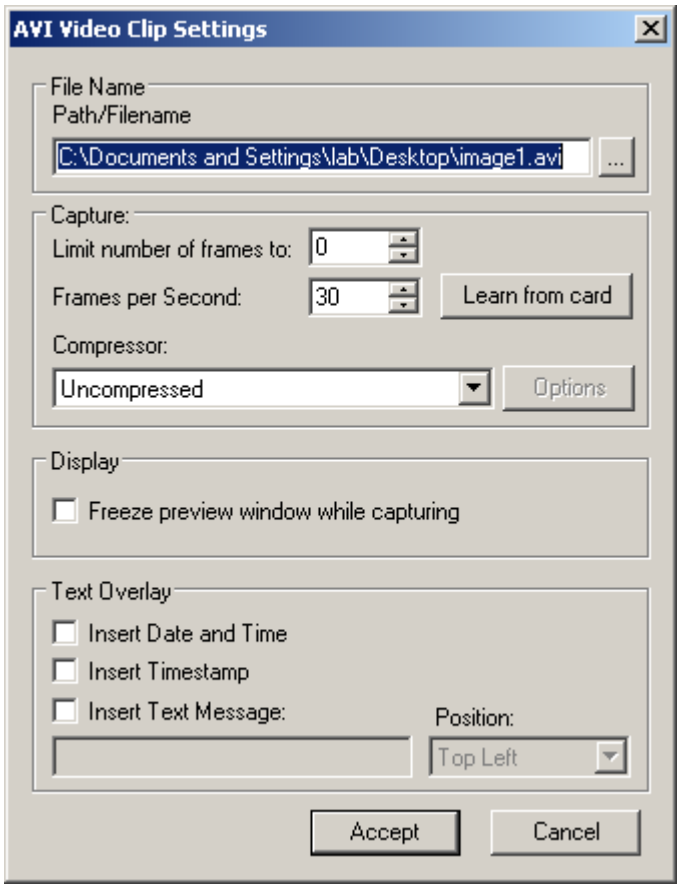
Accept — Same as in 'Single Frames'.

Cancel — Same as in 'Single Frames'.

NOTE: While capturing is in progress, if the host operating system denies the FrameLink Express application's request to allocate more frame buffers in host memory then the following error message will appear.



AVI Video Select this option when you wish to create an AVI movie file. An AVI movie is a series of images assembled into a single AVI file. Clicking on this button causes the 'AVI Video Clip Settings' dialog to open.



Path/Filename Same as in 'Single Frames'.

Limit number of frames to: Allows you to limit the duration of the recording by the number of frames specified.

Frames per Second: Limits the frame rate of the recorded movie.

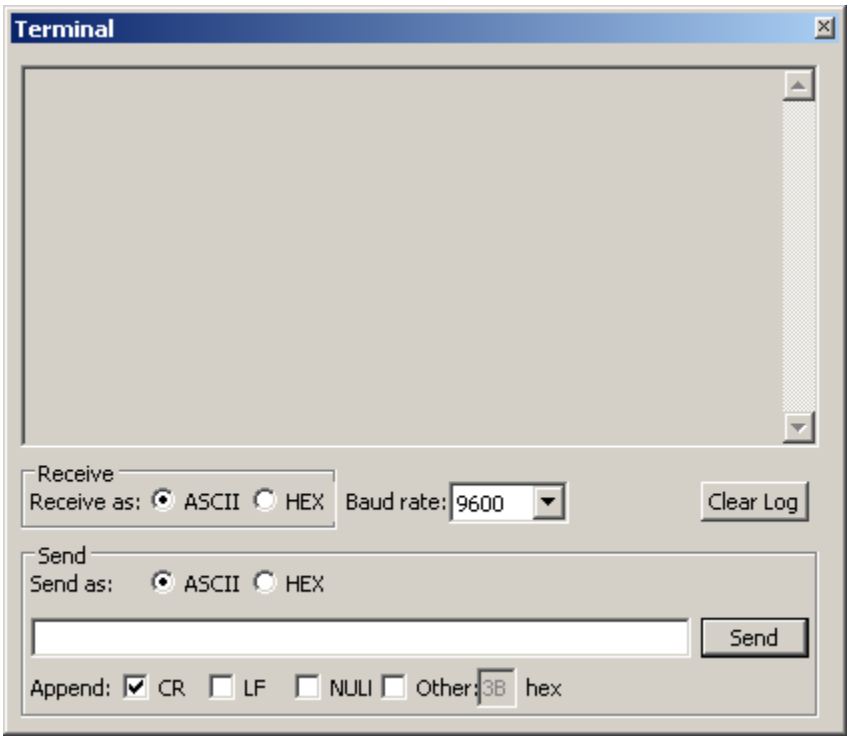
Learn from card Clicking on this button causes the actual frame rate of the attached camera to be read from the card and automatically populated into the 'Frame per Second' field. This option works only if Grabbing is started.

Compressor: Allows you to choose between a variety of compressor implementations and options. This pull-down menu lists several different implementations of AVI compressors. Each has its own set of

	configuration options.
Freeze preview window while capturing	Same as in ‘Series of Frames’.
Text Overlay	Same as in ‘Single Frames’.
Accept	Same as in ‘Single Frames’.
Cancel	Same as in ‘Single Frames’.

Terminal Dialog

The Terminal dialog allows the user to communicate with the attached camera via the Camera Link's serial interface.



Receive as Allows the user to select the format in which he wants received characters to be displayed.

Baud rate Specifies the data transfer speed of the CameraLink's serial interface. Clicking on this box causes a pull-down menu to appear. The user can then select the desired baud rate from among the choices presented, ranging from 9600 to 115,200 bits per second. This setting must match the camera's requirements.

Clear Log Clears the terminal window of all text.

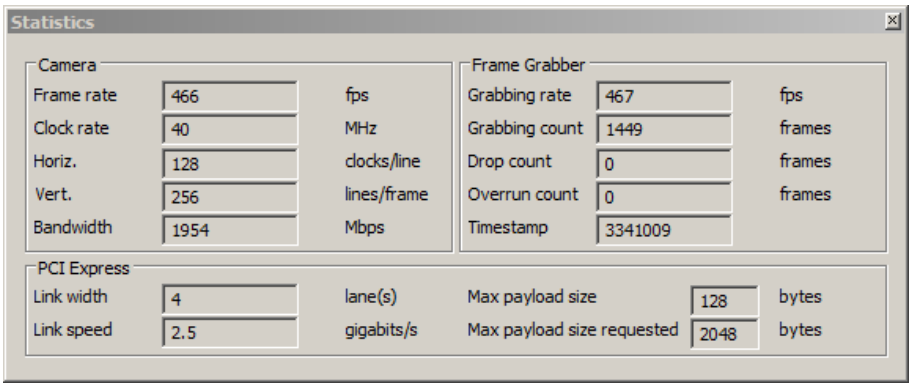
Send as Allows the user to select the format in which he wants transmitted characters to be entered.

Append Specifies which control character should be added to the end of the command that the user entered into the Send line.

Send Causes the command entered into the Send line to be transmitted to the camera.

Statistics Dialog

The Statistics dialog displays real-time status information about the current camera connection.



Camera Displays information related to the attached camera.

Frame rate Displays the real-time frame rate of the attached camera as measured at the input of the FrameLink Express card.

Clock rate Displays the real-time Camera Link clock rate of the attached camera as measured at the input of the FrameLink Express card.

Horiz. Displays the number of clocks/line received from the attached camera as measured at the input of the FrameLink Express card. Note that this value represents the number of pixels/line for single tap mode. For dual tap mode, however, the number of pixels/line is twice the value displayed.

Vert. Displays the number of lines/frame received from the attached camera as measured at the input of the FrameLink Express card.

Bandwidth Displays the computed bandwidth required on the PCI Express interface in order to support the attached camera. Bandwidth is a function of the pixels/line, lines/frame, frame rate, number of taps and bit depth.

Frame grabber Displays information related to the frame grabber.

Grabbing rate Displays the real-time rate at which frames are being transferred from the card into host memory.

Grabbing count Displays a running count of the total number of frames transferred into system memory. This counter is reset when ‘grabbing’ is stopped.

Drop count Displays a running count of the total number of dropped frames. Dropped frames are defined as frames that were received from the camera but due to a lack of host buffers could not be transferred into host memory. It is the host computer’s responsibility to provide the card with pointers into host buffers. If the host computer cannot keep up with the incoming frame rate then the card will drop frames. The primary cause of this is background applications that are competing for the host processors time and preventing it from servicing the FrameLink Express card.

Overrun count Displays a running count of the total number of receiver buffer overruns. Overruns are defined as pixel data that was received from the camera but due to a lack of space, in the card’s on-board receiver FIFOs, had to be discarded. Buffer overruns are an indication that the incoming pixel rate exceeds the bandwidth available on the PCI Express interface.

Timestamp Displays a running timestamp counter. Each frame that is received from the camera and transferred into host memory is time stamped. This field shows the timestamp value for the last frame processed.

PCI Express Displays information related to the PCI Express bus connection.

Link width Displays the number of lanes that are connected between the card and host PC.

Link speed Displays the clock frequency of each lane.

Max payload size Displays the maximum payload size that was granted to the card by the Operating System.

Max payload size requested Displays the payload size that the card requested to be granted to it by the Operating System.

NOTE:

If the *max payload size* granted by the Operating System is less than the *max payload size requested* by the card, then the card’s DMA performance may be compromised. If this is the case, then try increasing the payload size provided by the Operating System by modifying BIOS parameters (if available).

A *max payload size* of 128 Bytes/Packet will limit the DMA throughput to 5.565 Gbps. This is less than the theoretical limit, 6.8 Gbps, for a DECA camera operating with an 85 MHz clock and will result in overruns.

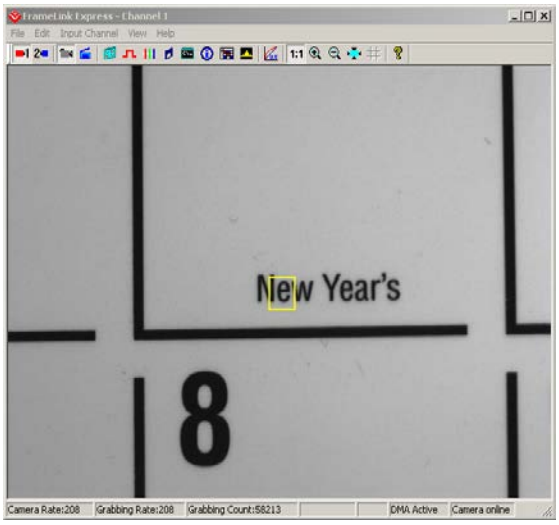
Hex Pixel Dump Window

The Hex Pixel Dump window displays a two-dimensional table of pixel values, plotting row (Y) vs. column (X), for a bounded region of pixels. The hexadecimal value of each pixel is displayed in each cell. For monochrome formatted images, a single grayscale value is displayed per pixel. For Bayer and RGB formatted images, three values representing R, G and B are displayed per pixel. Additionally, the background color of each cell is grayscale encoded for monochrome images or color encoded for Bayer /RGB images.

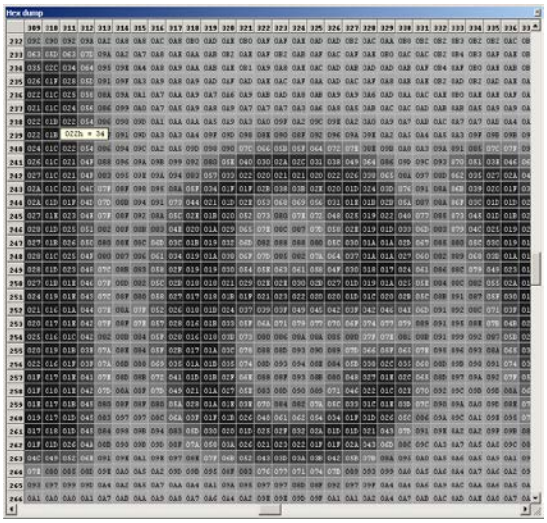
Hovering the mouse over a given pixel reveals both the pixel's hexadecimal and integer values. In the monochrome sample image below, with the mouse positioned at location 311, 239 (X, Y), a box is revealed showing that the value of the pixel at that location is 022 in hexadecimal and 34 in integer.

A yellow square, overlayed on the main image window, shows the position of the bounded region. Horizontal and vertical scroll bars allow the user to move the position of the bounded region of pixels anywhere within the entire frame.

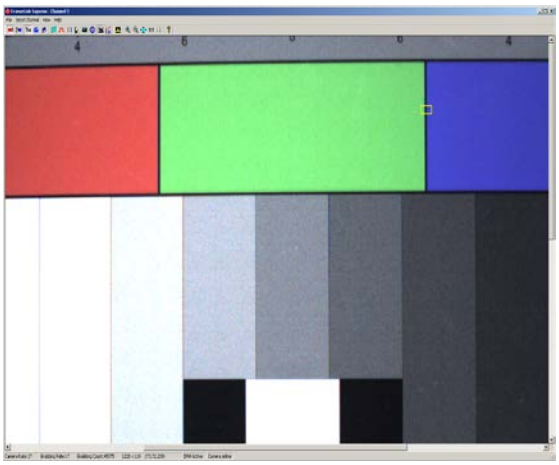
Another method of opening the Hex Pixel Dump window is to drag the mouse over the main image window while holding down the left mouse button. This creates the yellow box that defines the pixel dump's bounded region and automatically open the Hex Pixel Dump window.



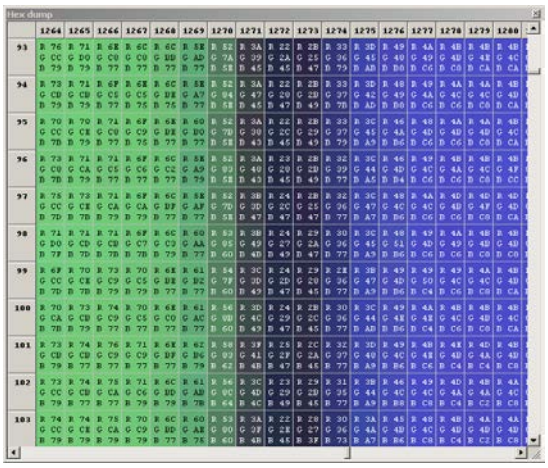
The sample monochrome image.



Hex dump for monochrome image.



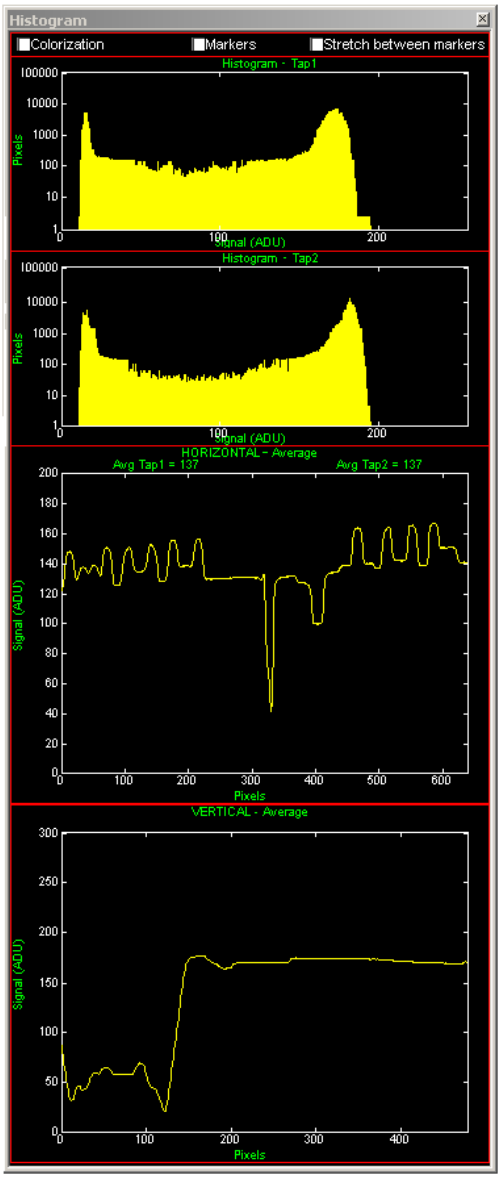
The sample color image.



Hex dump for color image.

Histogram Window

The Histogram window displays three graphs: a histogram plot, a horizontal average plot and a vertical average plot.



Check Boxes

These features affect the way that the pixel data is altered prior to being displayed in the live preview window. For an illustration of how these features work, see ‘Examples of how to use the Histogram’ below.

Colorization

Causes the live preview image to be ‘colorized’. Colorization results in pixels with no value (i.e. 0 decimal) to be displayed as ‘green’ and pixels that are saturated (i.e. 4095 decimal in 12 bit mode) to be displayed as ‘red’. All other pixels (i.e. from 1 to 4094 decimal in12 bit mode) are displayed as normal.

Markers

Turns on two vertical markers, ‘green’ and ‘red’, that move along the X-axis of the Histogram plot. The ‘green’ marker can be moved by dragging it with the left mouse. The ‘red’ marker can be moved by dragging it with the right mouse. The ‘green’ marker defines a lower limit for the pixel value, while the ‘red’ marker defines an upper limit for the pixel value. All pixels with a value less than or equal to the lower limit will be converted to 0, while all pixels with a value greater than or equal to the upper limit will be converted to saturated.

For example: in 12 bit mode, the pixel values range from 0 to 4095 decimal. If the lower marker is set to 1000 then all pixels with a value between 0 and 1000 will converted to 0. If the upper marker is set to 2000 then all pixels with a value between 2000 and 4095 will be converted to 4095.

Stretch between markers

Causes all pixel values lying between the lower marker and the upper marker to be ‘stretched’, in effect causing contrast enhancement. In the example above, the pixels with values between 1001 and 1999 will be ‘stretched’ so that they fill the entire range from 1 to 4094. This means that a pixel value of 1001 will be converted to 1 and a pixel value 1999 will be converted to 4094. All other pixels, values 1002 to 1998, will be scaled linearly to fill in the range.

Histogram

Plots the histogram of the current frame displayed in the image window as a function of pixel frequency (Y-axis) vs. pixel value (X-axis). The range of the pixel value, in the X-axis, depends on the bit depth of the camera. For example, the range is 256 for 8 bits, 1024 for 10 bits, etc. The pixel frequency represents the total number of pixels with a given pixel value. Two histogram plots are provided with the upper plot representing CameraLink tap #1 and the lower representing tap #2.

Horizontal Average

Plots the average value of the current frame displayed in the image window as a function of average pixel value (Y-axis) vs. horizontal position (X-axis). The average value for all pixels in a given column of the image is plotted on the Y-axis. The range of the horizontal positions, in the X-axis, depends on the number of columns in the frame.
For example, in the sample illustration, the range of the X-axis is 640 indicating that there are 640 pixels/line in the sample image. In this example, the average of all of the pixels in column number 400 is 100.

A single plot represents both taps. The averages for each tap, however, is listed at the top of the plot.

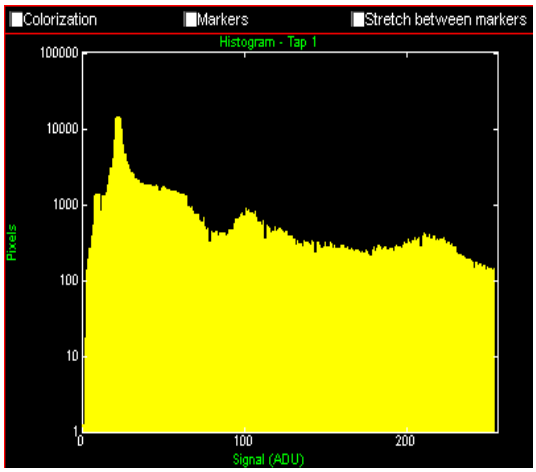
Vertical Average

Plots the average value of the current frame in the image window as a function of average pixel value (Y-axis) vs. vertical position (X-axis). The average value for all pixels in a given row of the image is plotted on the Y-axis. The range of the vertical positions, in the X-axis, depends on the number of rows in the frame. For example, in the sample illustration, the range of the X-axis is 480 indicating that there are 480 lines/frame in the sample image. In this example, the average of all of the pixels in row number 100 is 50.

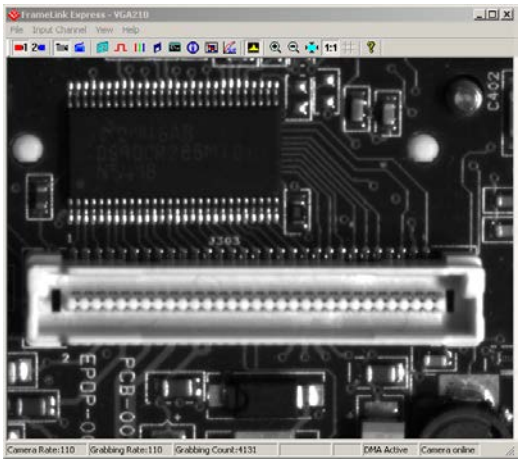
Examples of how to use the Histogram

The examples below illustrate the effect that colorization, markers and stretching have on an image. These examples are based on a single tap image with a bit depth of 8 bits.

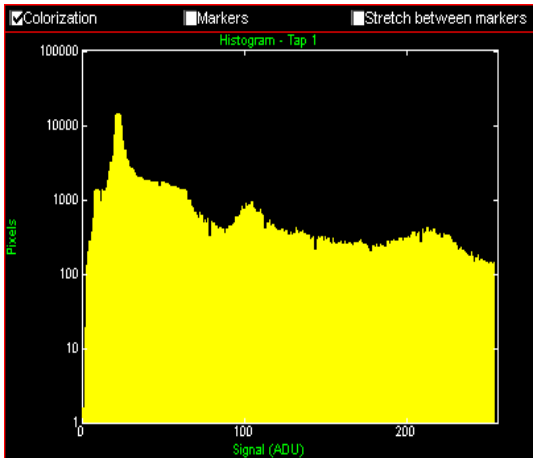
Example using 'Colorization':



The histogram shows the distribution for the sample image.

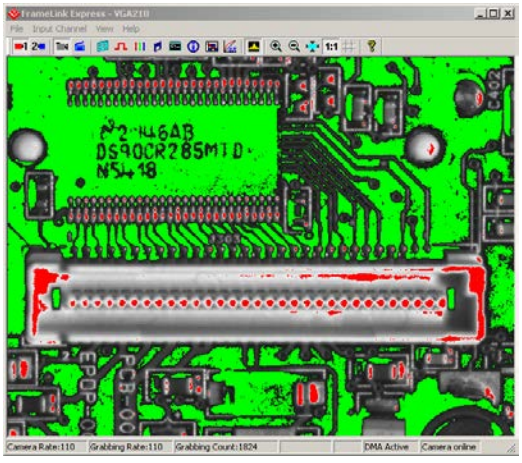


This is the original sample image.



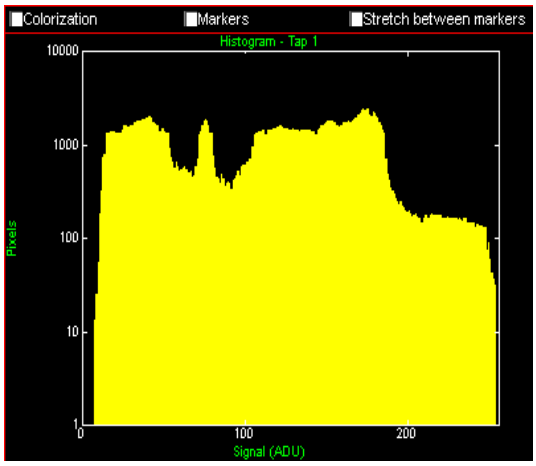
The histogram 'colorization' is turned on.

This causes all pixels with a value of 0 (black) to be converted to green and with a value of 255 (white) to be converted to red.



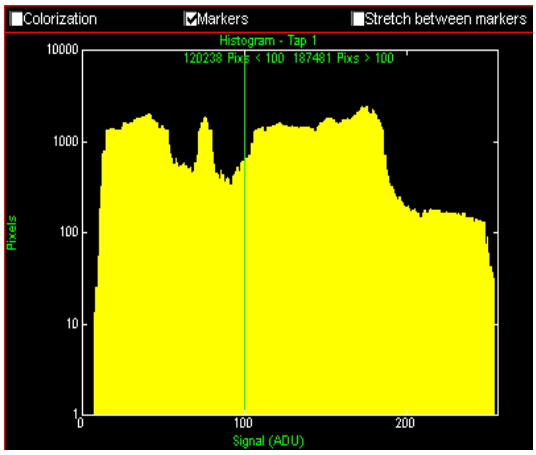
Resultant colorized image.

Example using ‘Markers’ (for single thresholding):



The histogram shows the distribution for the sample image.

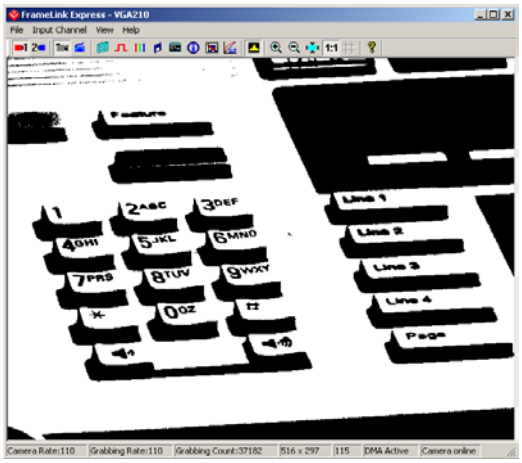
This is the original sample image.



The histogram ‘markers’ are turned on.

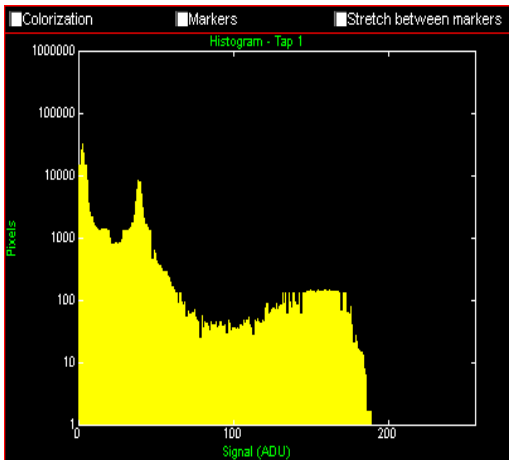
Both the lower limit marker (green) and upper limit marker (red) are set to the same pixel value of 100.

This causes all pixels with a value less than 100 to be converted to black and with a value greater than 100 to be converted to white.



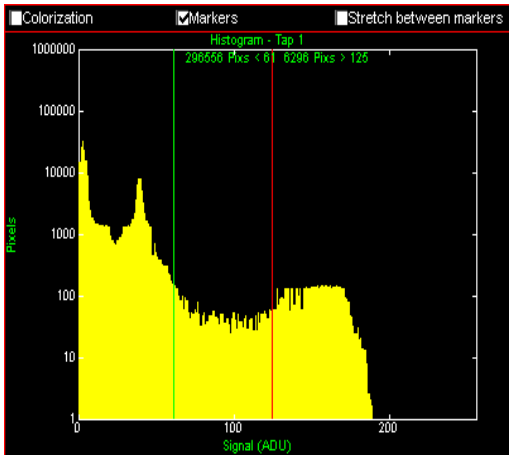
Resultant black & white image with all grayscale removed.

Example using ‘Markers’ (for double thresholding):



The histogram shows the distribution for the sample image.

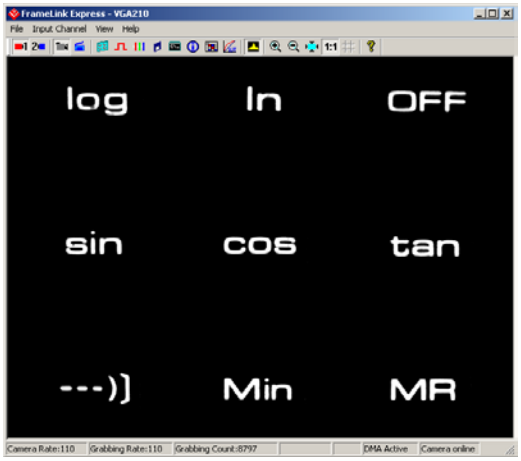
This is the original sample image.



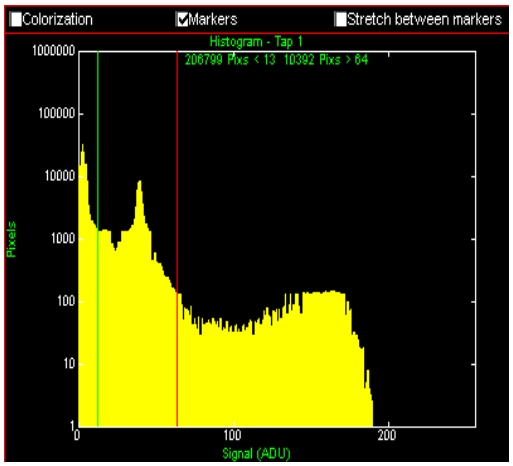
The histogram ‘markers’ are turned on.

The lower limit marker (green) is set to 61 and upper limit marker (red) is set to 125.

This causes all pixels with a value less than 61 to be converted to black and with a value greater than 125 to be converted to white.



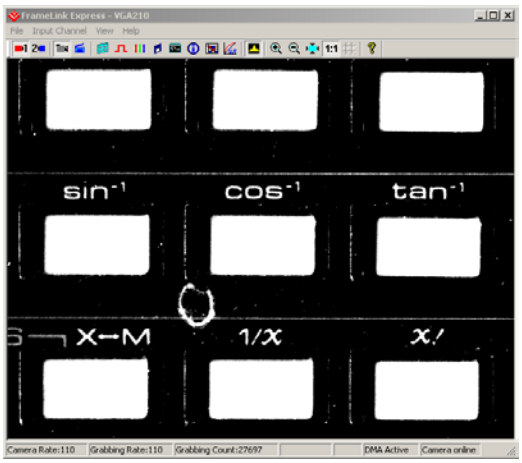
Resultant image.



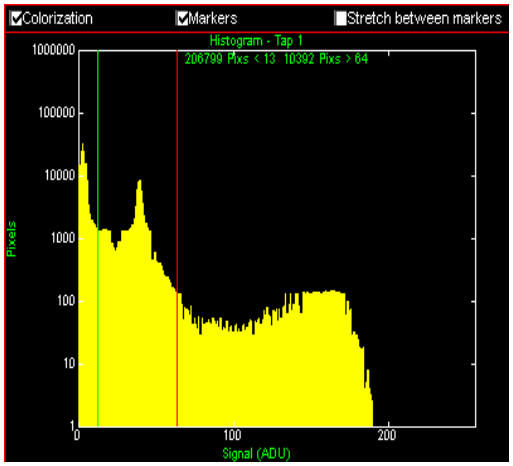
The histogram ‘markers’ are turned on.

The lower limit marker (green) is set to 13 and upper limit marker (red) is set to 64.

This causes all pixels with a value less than 13 to be converted to black and with a value greater than 64 to be converted to white.



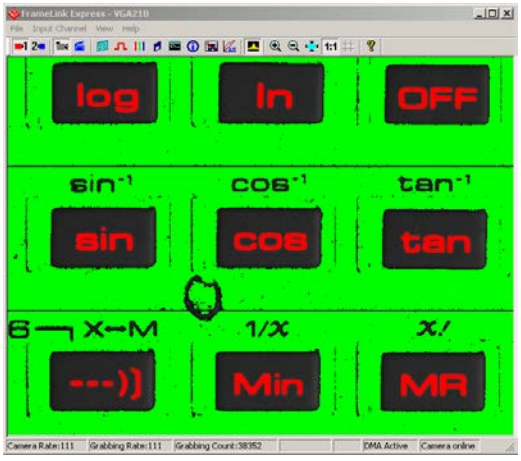
Resultant image.



The histogram ‘colorization’ and ‘markers’ are turned on.

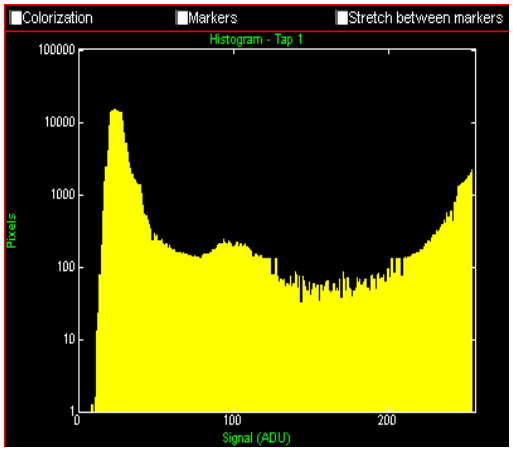
The lower limit marker (green) is set to 13 and upper limit marker (red) is set to 64.

This causes all pixels with a value less than 13 to be converted to green and with a value greater than 64 to be converted to red.

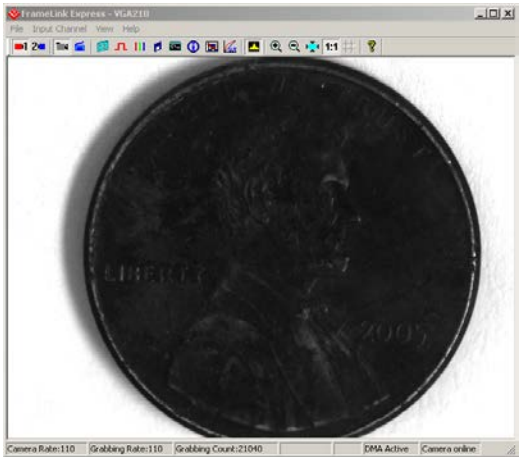


Resultant image.

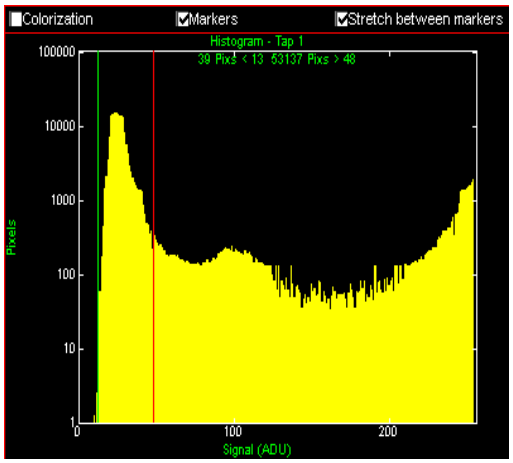
Example using ‘Stretch between markers’ (for contrast enhancement):



The histogram shows the distribution for the sample image.



This is the original sample image.



The histogram ‘Markers’ and ‘Stretch’ are turned on.

The lower limit marker (green) is set to 13 and the upper limit marker (red) is set to 48.

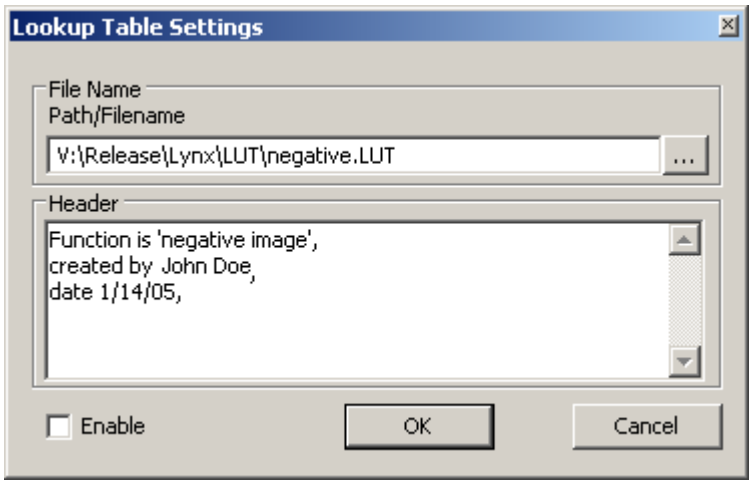
This causes all pixels between 13 and 48 to be stretched, all pixels with a value less than 13 to be converted to black and with a value greater than 48 to be converted to white.

Resultant contrast enhanced image.

Lookup Table Dialog

The Lookup Table dialog allows the user to select and enable a lookup table transfer function. The lookup table feature allows the user to modify and transform the original video data into any arbitrary value. Any 12-bit value can be transformed into any other 12-bit value. This is useful for Gamma correction, digital gain/offset, thresh-holding, etc. Refer to Appendix B for details on how to create a Lookup Table.

Note: A Gamma45 lookup table will be loaded by the application program by default.



Path/Filename This text field allows you to provide a path and filename for the lookup table file to be opened. Clicking on the '…' box will cause a Windows 'browse' box to appear. The user can then browse to a folder and enter a file name. The filename extension, **.lut**, will automatically be added and therefore you do not need to include the filename extension.

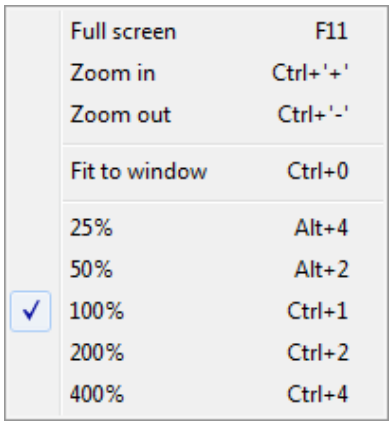
Header This text window displays the header read from the LUT file. For example, in the negative.lut file illustrated in Appendix C, the header window would list the following:

```
Function is 'negative image',
created by John Doe,
date 1/14/05,
```

Enable Causes lookup table processing to be performed on received images using the selected lookup table file. The resultant image will be displayed in the main image window.

Zoom Menu

The Zoom menu allows the user to select various zooming and scaling functions. The zoom menu can be invoked via the View item on the Menu bar or by right clicking the mouse over the image window.



Full screen Causes the displayed image to be scaled to fill the entire screen. In this mode, all menu bars will be hidden. The user can hit the ‘F11’ key or the icon from the icon bar as shortcuts. Pressing ‘F11’ again or ‘ESC’ exits this mode.

Zoom in Causes the displayed image zoom to be increased. The user can hit the ‘Ctrl’ and ‘+’ keys or the icon from the icon bar as shortcuts.

Zoom out Causes the displayed image zoom to be decreased. The user can hit the ‘Ctrl’ and ‘-‘ keys or the icon from the icon bar as shortcuts.

Fit to window Causes the displayed image to be scaled to fill the entire image window. The user can change the image window by dragging its sides or corners. Note that the Fit to Window function will maintain the aspect ratio of the original image.

25% Causes the displayed image to be 25% of the original image. This scaling factor will also be applied to the saved image files.

50% Causes the displayed image to be 50% of the original image. This scaling factor will also be applied to the saved image files.

100% Causes the displayed image to be 100% of the original image. This scaling factor will also be applied to the saved image files.

200% Causes the displayed image to be 200% of the original image. This scaling factor will also be applied to the saved image files.

400% Causes the displayed image to be 400% of the original image. This scaling factor will also be applied to the saved image files.

Player Control

Clicking on the ‘Play Files’ item under the ‘File’ pull-down menu at the top of the FrameLink Express main window causes two windows to appear: the ‘Player Control’ and ‘Player Dialog’ windows. These windows can be moved anywhere around the screen to suit your needs.

The Player Control window is used to select the pre-recorded image or movie files that you wish to view.

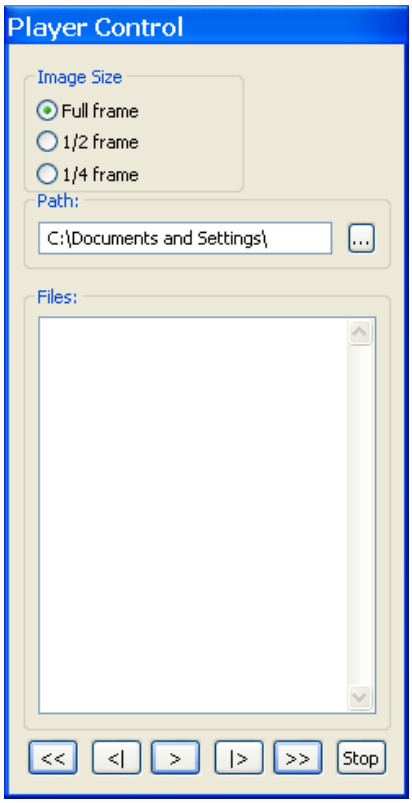
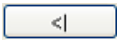


Image Size Determines the size of the Player Dialog window and the playback image. Changing from one scale to another automatically updates the Player Dialog window and image size.

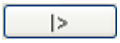
Path This text field allows you to enter the name of the folder or directory containing the image or movie files. Clicking on the ‘…’ box will cause a Windows ‘browse’ box to appear.

Files This box lists all of the image or movie files that are in the folder selected under ‘Path’.

Rewind  Displays the first image in the series.

Step Backwards  Displays the previous frame or image. Use this button to back through individual frames of an AVI Movie. Play must be paused for this button to work on AVI Movies.

Play  Begins playing the AVI movie. If you are viewing JPEG or BMP images, clicking this button displays a series of images (one after another) starting from the current file selected in the Player Control dialog.

Step Forward  Displays the next frame or image. Use this button to advance through individual frames of an AVI Movie. Play must be paused for this button to work on AVI Movies.

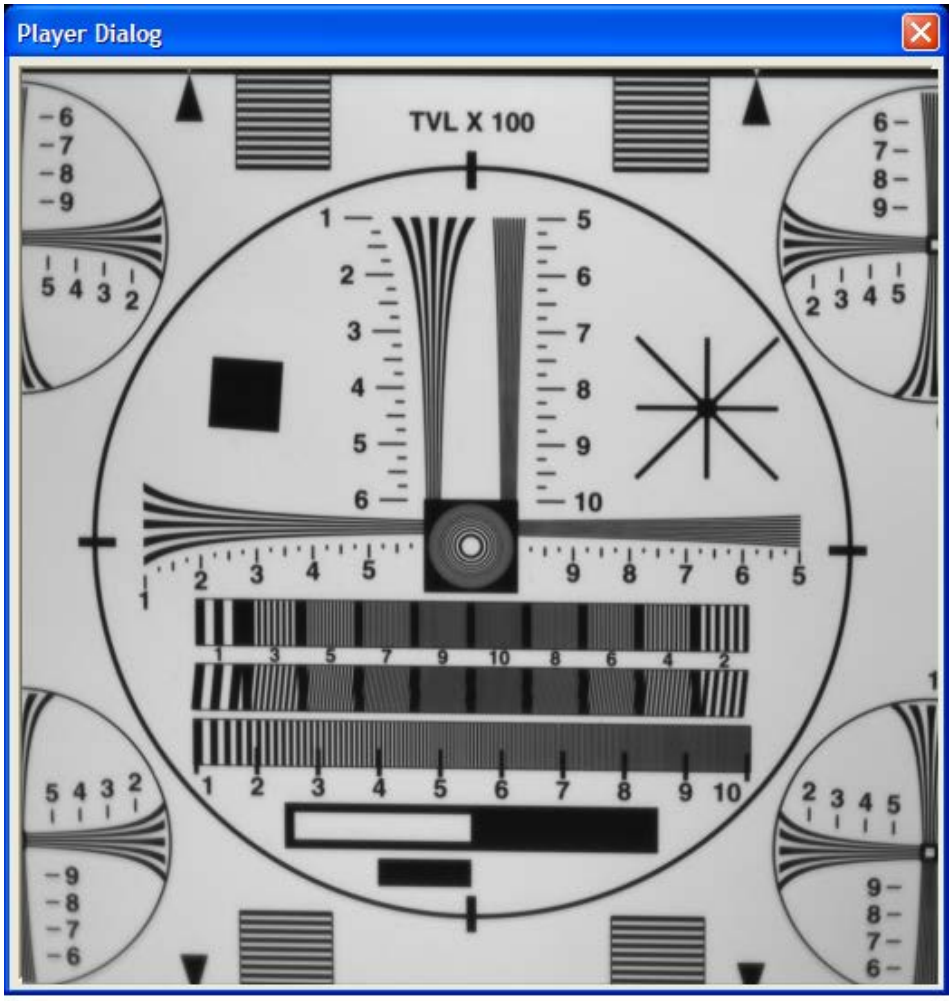
Fast Forward  Displays the last image in the series.

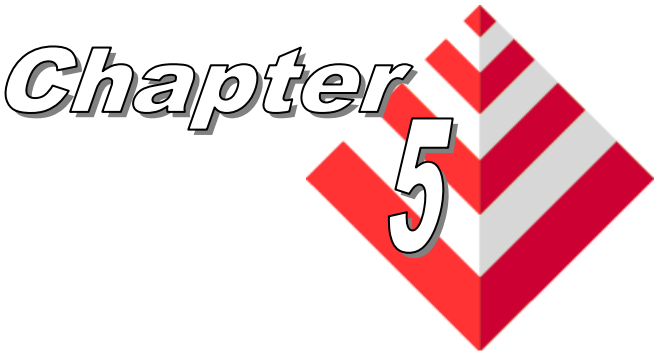
Stop  Halts current playback.

Player Dialog

The Player Dialog window appears when the user selects the ‘Play Files’ item under the ‘File’ pull-down menu at the top of the FrameLink Express main window. The Player Dialog window provides the primary area for viewing playback of pre-recorded images or movies. This window can be moved anywhere around the screen to suit your needs.

The size of the window (and image) is determined by the size of the image file selected in the ‘Player Control’ window and can be scaled using the ‘Image Size’ option. For example, if the user selects an image file that was produced by a 640x480 resolution camera, then the ‘Full frame’ window size will be 640x480. In this example, selecting ‘½ frame’ produces a window size of 320x240 and selecting ‘¼ frame’ produces a size of 160x120.





Electrical Interfaces

This chapter contains information on the FrameLink Express’s connectors.

Camera Link Connector

The CameraLink connectors are shielded, right angle, through hole, 26 position, female, SDR (shrunk delta ribbon) style connectors. Two such connectors are provided on the card. The first connector is used for a Channel #1 Base configuration while the second is used for either a Channel #2 Base or Channel #1 Medium/Full/Deca configuration. Note that in the Channel #1 Medium configuration, the second connector's CC[4:1] and SerTC/SerTFG signals are unused.

Pin #	Cable name	Signal name
1	Inner Shield	Inner Shield
2	PAIR11-	CC4-
3	PAIR10+	CC3+
4	PAIR9-	CC2-
5	PAIR8+	CC1+
6	PAIR7+	SerTFG+
7	PAIR6-	SerTC-
8	PAIR5+	X3+
9	PAIR4+	Xclk+
10	PAIR3+	X2+
11	PAIR2+	X1+
12	PAIR1+	X0+
13	Inner Shield	Inner Shield
14	Inner Shield	Inner Shield
15	PAIR11+	CC4+
16	PAIR10-	CC3-
17	PAIR9+	CC2+
18	PAIR8-	CC1-
19	PAIR7-	SerTFG-
20	PAIR6+	SerTC+
21	PAIR5-	X3-
22	PAIR4-	Xclk-
23	PAIR3-	X2-
24	PAIR2-	X1-
25	PAIR1-	X0-
26	Inner Shield	Inner Shield

Table 8 – Camera Link Connector Pin-out

Note that the Camera Link connector pin-out for the frame grabber is 180 degrees rotated from the pin-out for the camera.

ExpressCard Connector (VCE-CLEX01/CLEX02 only)

The ExpressCard connector is a surface mount, right angle, 26 position, female connector.

Pin #	Signal name	In/Out	Note
1	GND		
2	USBD-	I/O	not used
3	USBD+	I/O	not used
4	CPUSB#	O	not used
5	reserved		
6	reserved		
7	SMBCLK	I/O	not used
8	SMBDATA	I/O	not used
9	+1.5V		
10	+1.5V		
11	WAKE#	O	3
12	3.3VAUX		5
13	PERST#	I	4
14	+3.3V		
15	+3.3V		
16	CLKREQ#	O	2
17	CPPE#	O	1
18	REFCLK-	I	
19	REFCLK+	I	
20	GND		
21	PERn0	O	
22	PERp0	O	
23	GND		
24	PETn0	I	
25	PETp0	I	
26	GND		

Table 9 – ExpressCard Connector Pin-out

Notes:

1 – CPPE# indicates to the host that the card has been inserted.

2 – CLKREQ# indicates to the host that the card is requesting that the REFCLK be provided. This is a Power Management function and is not implemented on the FrameLink Express.

3 – WAKE# is used to notify the host that it should re-apply power to the card. This is a Power Management function and is not implemented on the FrameLink Express.

4 – PERST# is a reset signal driven by the host to reset the card.

5 – 3.3VAUX is used to power the WAKE# circuitry. This is a Power Management function and is not implemented on the FrameLink Express.

PCIe x1 Connector (VCE-CLPCIe01/CLPCIe02 only)

The PCIe x1 connector is a vertical, edge-finger, two-sided, 36 position connector. Side B is on the primary (component) side and Side A is on the secondary (solder) side. Both pins A1 and B1 are closet to the I/O bracket.

	Side B				Side A		
Pin #	**Signal name**	**In/Out**	**Note**	**Pin #**	**Signal name**	**In/Out**	**Note**
B1	+12V			**A1**	PRSNT1#		5
B2	+12V			**A2**	+12V		
B3	+12V			**A3**	+12V		
B4	GND			**A4**	GND		
B5	SMBCLK	I	1	**A5**	JTAG_TCK		2
B6	SMBDAT	I/O	1	**A6**	JTAG_TDI		2
B7	GND			**A7**	JTAG_TDO		2
B8	+3.3V			**A8**	JTAG_TMS		2
B9	JTAG_TRST#	I	2	**A9**	+3.3V		
B10	3.3Vaux		3	**A10**	+3.3V		
B11	WAKE#	O	2	**A11**	PERST#	I	6
B12	reserved			**A12**	GND		
B13	GND			**A13**	REFCLK+	I	
B14	PETp0	I	7	**A14**	REFCLK-	I	
B15	PETn0	I	7	**A15**	GND		
B16	GND			**A16**	PERp0	O	7
B17	PRSNT2#_x1		5	**A17**	PERn0	O	7
B18	GND			**A18**	GND		

Table 10 – PCIe x1 Connector Pin-out

Notes:

1 – The SMB Bus is not implemented.

2 – The JTAG interface is not implemented.

3 – 3.3Vaux is used to power the WAKE# circuitry. This is a Power Management function and is not implemented.

4 – WAKE# is used to notify the host that it should re-apply power to the card. This is a Power Management function and is not implemented.

5 – PRSNT1# is tied to PRSNT2#_x1 and is used by the host to sense card insertion/removal.

6 – PERST# is a reset signal driven by the host to reset the card.

7 – Direction for transmit and receive signals are relative to the host.

PCIe x4 Connector (VCE-CLPCIe03/CLPCIe04 only)

The PCIe x4 connector is a vertical, edge-finger, two-sided, 64 position connector. Side B is on the primary (component) side and Side A is on the secondary (solder) side. Both pins A1 and B1 are closet to the I/O bracket.

	Side B				Side A		
Pin #	**Signal name**	**In/Out**	**Note**	**Pin #**	**Signal name**	**In/Out**	**Note**
B1	+12V			**A1**	PRSNT1#	O	5
B2	+12V			**A2**	+12V		
B3	+12V			**A3**	+12V		
B4	GND			**A4**	GND		
B5	SMBCLK	I	1	**A5**	JTAG_TCK		2
B6	SMBDAT	I/O	1	**A6**	JTAG_TDI		2
B7	GND			**A7**	JTAG_TDO		2
B8	+3.3V			**A8**	JTAG_TMS		2
B9	JTAG_TRST#	I	2	**A9**	+3.3V		
B10	3.3Vaux		3	**A10**	+3.3V		
B11	WAKE#	O	2	**A11**	PERST#	I	6
B12	reserved			**A12**	GND		
B13	GND			**A13**	REFCLK+	I	
B14	PETp0	I	7	**A14**	REFCLK-	I	
B15	PETn0	I	7	**A15**	GND		
B16	GND			**A16**	PERp0	O	7
B17	PRSNT2#_x1		5	**A17**	PERn0	O	7
B18	GND			**A18**	GND		
B19	PETp1	I	7	**A19**	reserved		
B20	PETn1	I	7	**A20**	GND		
B21	GND			**A21**	PERp1	O	7
B22	GND			**A22**	PERn1	O	7
B23	PETp2	I	7	**A23**	GND		
B24	PETn2	I	7	**A24**	GND		
B25	GND			**A25**	PERp2	O	7
B26	GND			**A26**	PERn2	O	7
B27	PETp3	I	7	**A27**	GND		
B28	PETn3	I	7	**A28**	GND		
B29	GND			**A29**	PERp3	O	7
B30	reserved			**A30**	PERn3	O	7
B31	PRSNT2#_x4		5	**A31**	GND		
B32	GND	O	5	**A32**	reserved		

Table 11 – PCIe x4 Connector Pin-out

Notes:

1 – The SMB Bus is not implemented.

2 – The JTAG interface is not implemented.

3 – 3.3Vaux is used to power the WAKE# circuitry. This is a Power Management function and is not implemented.

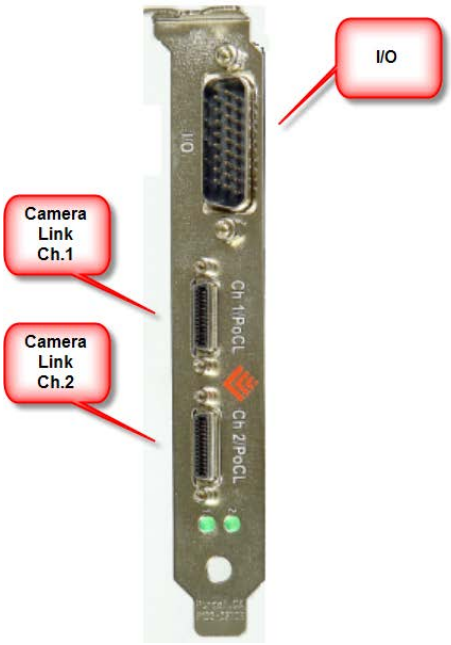
4 – WAKE# is used to notify the host that it should re-apply power to the card. This is a Power Management function and is not implemented.
5 – PRSNT1# is tied to PRSNT2#_x4 and is used by the host to sense card insertion/removal.
6 – PERST# is a reset signal driven by the host to reset the card.
7 – Direction for transmit and receive signals are relative to the host.

I/O Connector (VCE-CLPCIe02/03/04 only)

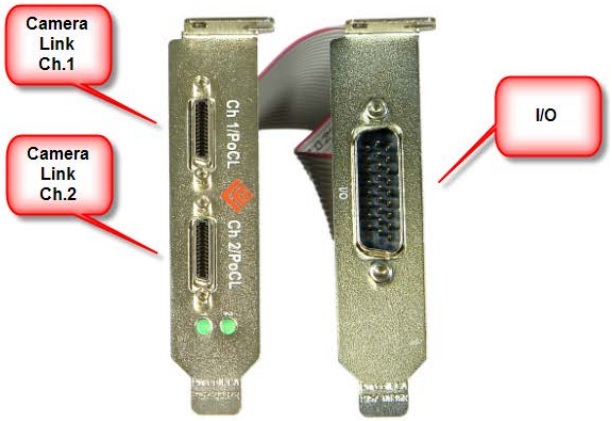
The I/O connector consists of an internal board mounted 26 pin header and an external bracket mounted HDD-26 jack. A cable assembly connects the internal and external connectors. The pin assignments of the internal and external connectors are one-to-one (i.e. pin#1 of the internal connector is connected to pin#1 of the external connector). The external connector can be mounted on either a full-height bracket or a half-height bracket. Use of the half-height bracket requires an adjacent PC expansion slot.

Pin #	Signal Name	Pin #	Signal Name
1	IN1+	2	OUT1+
3	IN1-	4	OUT1-
5	IN2+	6	OUT2+
7	IN2-	8	OUT2-
9	IN3+	10	OUT3+
11	IN3-	12	OUT3-
13	IN4+	14	OUT4+
15	IN4-	16	OUT4-
17	RXD1	18	TXD1
19	RXD2	20	TXD2
21	Ext_VCC1	22	Ext_VCC3
23	Ext_VCC2	24	Ext_VCC4
25	GND	26	GND

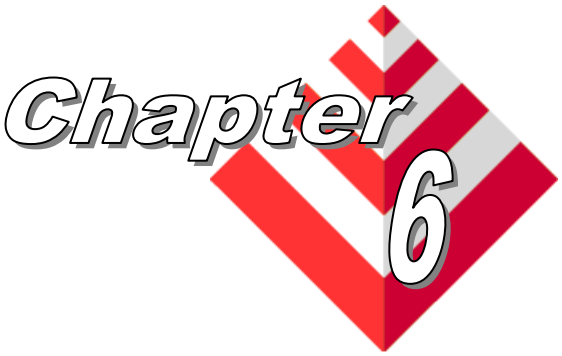
Table 12 – I/O Connector Pin-out



Full-height bracket



Half-height bracket



Specifications

Video Source

Camera Link interface (Base configuration using a single SDR26 connector or Medium/Full/Deca configurations using two SDR26 connectors).

Base modes supported:
1x8, 2x8, 3x8, 1x10, 2x10, 1x12, 2x12, 1x14, 1x16 and RGB24

Medium modes supported: all Base modes plus
4x8, 3x10, 4x10, 3x12, 4x12, RGB30 and RGB36.

Full modes supported: all Medium modes plus
8x8

Decal modes supported: all Full modes plus
8x10 and 10x8

Camera Link clock rates from 20 MHz to 85 MHz.

Color filters supported: Monochrome, Bayer and TrueSense.

UART serial interface, for camera configuration and monitoring, formatted as: no parity, 8 data bits, 1 stop bit and baud rates from 9600 to 115,200 bps.

Four discrete LVDS differential outputs, CC[4:1], for camera control.

Physical Dimensions

VCE-CLPCIe01 : 84mm x 69mm (3.3 x 2.7 in).
VCE-CLPCIe02/03/04 : 168mm x 69mm (6.6 x 2.7 in).
ExpressCard/54 : 108mm x 54mm x 18mm (4.3 x 2.1 x .7 in).
ExpressCard/34 : 108mm x 34mm x 18mm (4.3 x 1.3 x .7 in).

Weight

VCE-CLPCIe01 : 45.0 grams (1.59 oz)
VCE-CLPCIe02/03/04 : 110.0 grams (3.88 oz)
ExpressCard/54 : 53.6 grams (1.91 oz)
ExpressCard/34 : 35.9 grams (1.27 oz)

Electrical Characteristics	Operating voltage:	3.3V +/- 5%
	Operating current:	500mA
Operating Environment	Operating temperature:	0°C to 65°C
	Relative humidity:	90% non-condensing
Regulatory	FCC 15 part B, CE, RoHS	

Appendix A

Serial Communications

The FrameLink Express provides a Camera Link compliant serial communications channel. This is an ASYNC interface operating at a user selectable BAUD rate (set via the Camera Parameters dialog), with 1 start bit, 8 data bits, 1 stop bit, no parity and no handshake.

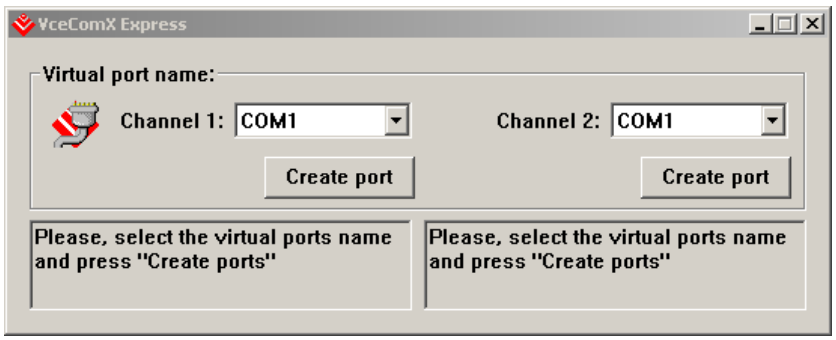
Clseripx.dll

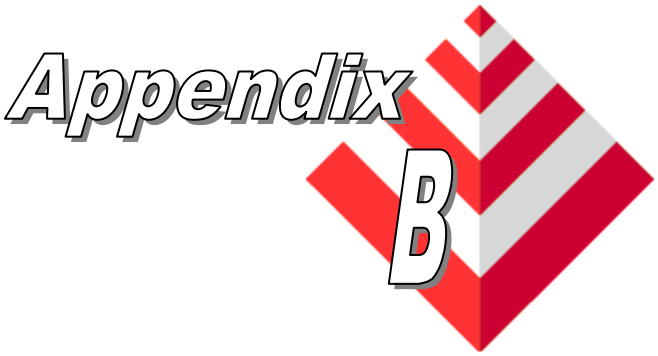
Any standard camera configuration software can access this serial interface by using the FrameLink Express's clseripx.dll file (located in the c:/WINDOWS/system32 folder for WinXP or c:/WINNT/system32 folder for Win2000). The clseripx.dll is fully compliant with v1.2 of the Camera Link specification.

COM port emulation

Alternatively, if the camera configuration software does not provide an interface to the Camera Link clser***.dll but only supports standard COM ports, then the user can invoke our VceComEX.exe COM port emulator. This software will emulate a PC COM port allowing any terminal emulator or camera configuration tool to access the FrameLink Express serial interface.

To create a virtual COM port, simply run the VceComEX.exe program. Then select the port number from the pull-down list and click on 'Create Port'. You can now begin using the virtual COM port in you terminal or camera configuration software. **NOTE: You must not exit the VceComEX program while it is in use.** When you are done using the COM port, then click on 'Delete Port' and 'Exit'.





Creating Look Up Tables

This appendix provides a reference on how to create a lookup table using both an ASCII editor and an Excel spreadsheet.

Overview

The Lookup Table file can be created using any standard ASCII text editor or by using Microsoft Excel. Additionally, any spreadsheet or mathematical program capable of generating a comma delimited file can be used.

Using an ASCII text editor

A custom LUT (lookup table) can be prepared using any ASCII text editor. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, the file must be renamed to include the .lut extension. The .lut file has three main sections: ‘Header’, ‘Options’ and ‘Table’.

Header Section

The ‘Header’ section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated in a comma.

Options Section

The ‘Options’ section includes a ‘Depth=x’ parameter where x indicates the pixel bit depth of 8, 10, 12, 14 or 16 bits. If the ‘Options’ section is omitted, then the bit depth will default to 12 bits.

Note: The Options Section and Depth parameter are only available in software versions 1.4.0.211 or higher. In previous versions of the software, the LUT is fixed to operate in 12 bit mode with 4096 entries in the table.

Table Section

The ‘Table’ section of the file contains an array of 256, 1024, 4096, 16384 or 65536 lines (for bit depths of 8, 10, 12, 14 or 16 respectively) with each line containing an input value followed by a comma and an output value. The input values represent incoming pixels and the output values represent what each incoming pixel should be converted into as an output pixel.

LUT Format

```
-- Look Up Table input file example,
-- lines beginning with two dashes are comments,
-- and are ignored by parser,
:Header,
Function is 'negative image' for 12-bit pixels,
created by John Doe,
date 1/14/05,
:Options
-- the Depth token can be set to 8, 10, 12, 14 or 16
Depth=12
:Table,
--input output,
0,4095
1,4094
2,4093
3,4092
4,4091
:
4095,0
```

Using Microsoft Excel

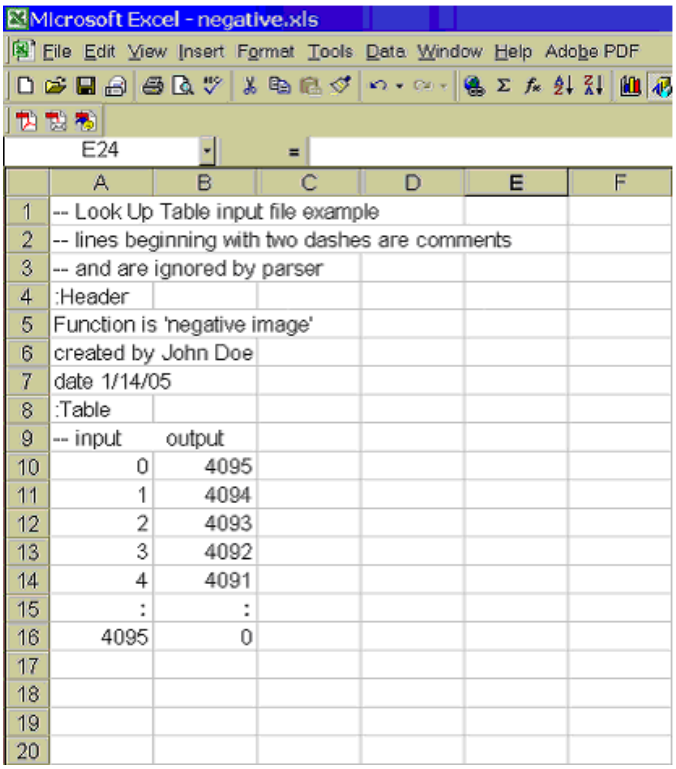
The .LUT file can be created in Excel as follows:

1 - create the spreadsheet as shown below (note that since the ":Options" line is missing, the bit depth will default to 12 bits and therefore 4096 rows are required in the table).

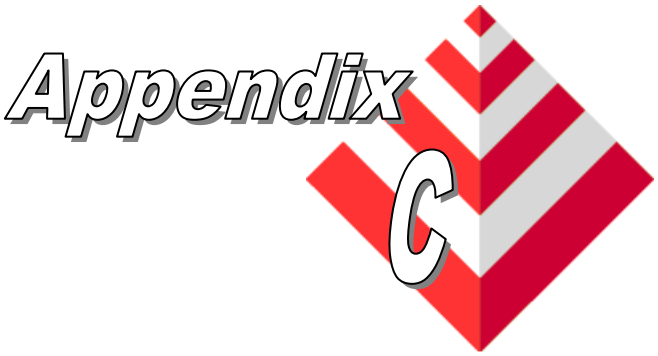
2 - add the necessary equations into the output cells to generate the transfer function required.

3 - save the file as a .csv (comma delimited format).

4 - rename the .csv file to an extension of .lut.



	A	B	C	D	E	F
1	-- Look Up Table input file example					
2	-- lines beginning with two dashes are comments					
3	-- and are ignored by parser					
4	:Header					
5	Function is 'negative image'					
6	created by John Doe					
7	date 1/14/05					
8	:Table					
9	-- input	output				
10	0	4095				
11	1	4094				
12	2	4093				
13	3	4092				
14	4	4091				
15	:	:				
16	4095	0				
17						
18						
19						
20						



Programmable Logic Controller

This appendix applies to the VCE-CLPCIe02 card only and provides a reference on how to use the PLC functionality provided by the FrameLink Express.

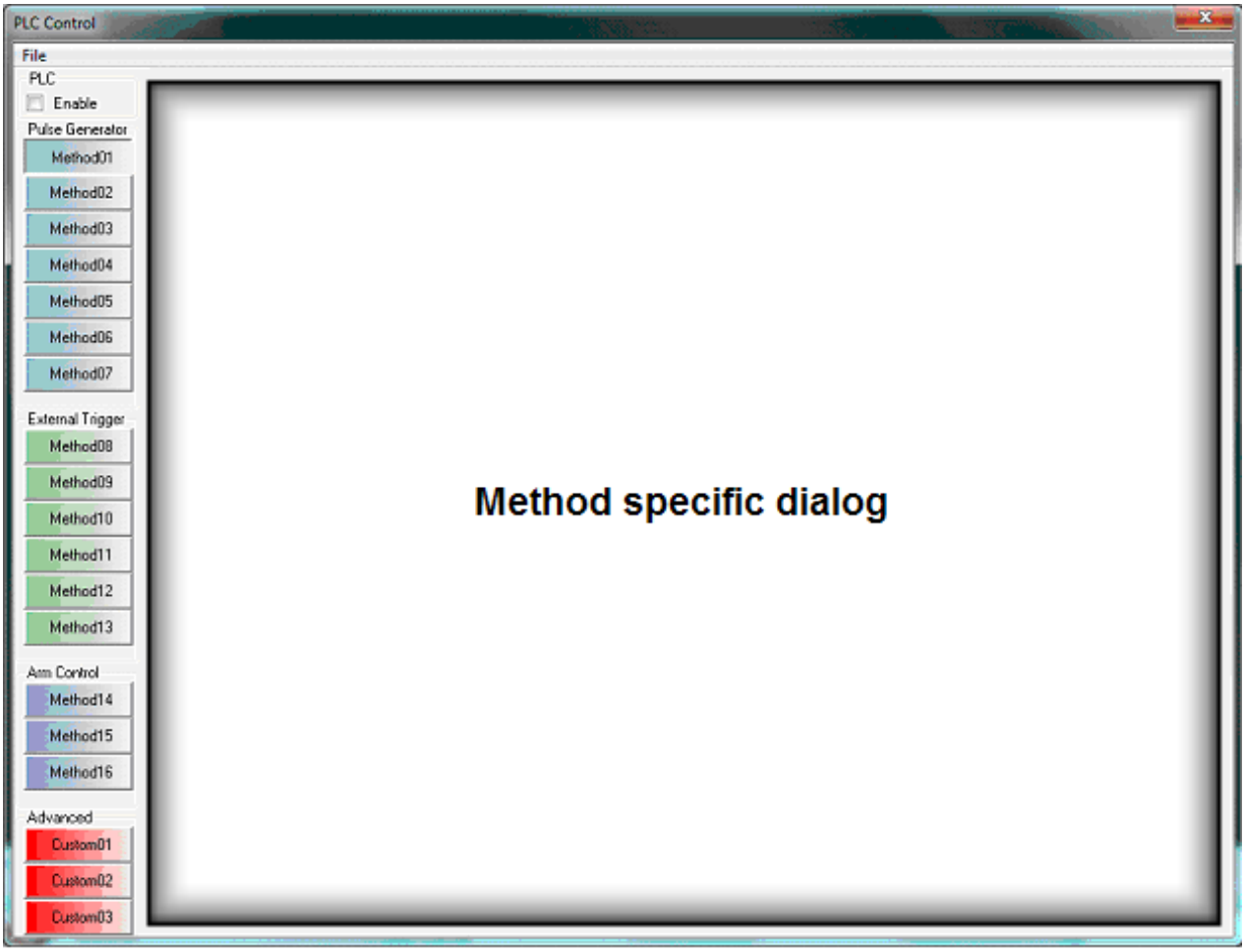
Overview

The PLC provides a comprehensive set of programmable functional blocks which allow the user to create arbitrary waveforms. These waveforms are typically used for:

- Triggering an attached camera
- Providing exposure signals to an attached camera
- Triggering an external lighting device
- Arm'ing the frame grabber to capture images

Common Dialog

The common PLC dialog includes a “File” pull-down menu, “Enable” check box, a list of “pre-defined” methods (Method01 – Method16), a list of “custom” methods (Custom01 – Custom03) and an area for the method specific dialog.



File

Clicking on this item reveals a pull-down menu, which allows the user to “load” or “save” PLC configurations files. The files are text files with a .plc extension and follow an XML-like structure.

Load

Loads a previously saved PLC configuration file. Clicking on this box will cause a Windows “browse” box to appear. The user can then browse to the folder and file he wishes to open. The program will then open the selected file, parse it and populate the fields in all methods of the PLC dialogs.

Save

Saves the current configuration for all methods as a PLC configuration file. Clicking on this box will cause a Windows “browse” box to appear. The user can then browse to a folder and enter a file name. The program will then create a .PLC file using the values in all methods of the PLC dialogs and write it to the disk.

Enable

The procedure is for the user to select a given method, configure its fields and then check the **Enable** box. Checking the **Enable** box causes the contents of the GUIs fields to be transferred into the hardware and the PLC to start operating. While **Enable** is checked, the GUI’s fields are rendered un-editable and the user is prevented from switching to a different method. Un-checking the **Enable** box stops the PLC’s operation and places the GUI back into the edit mode.

Methods list

Selecting a given method, displays the GUI for that method and allows it’s fields to be edited.

Predefined Methods

The PLC can be programmed by a novice user via a set of predefined “methods”. Sixteen methods are provided allowing the user to program the PLC for many of the most common use cases. The methods abstract the underlying details of programming the PLC’s functional blocks and provide an easy to use interface.

Custom Methods

The PLC can also be programmed by an experienced user via an advanced set of custom methods. The custom method GUIs provide access “under-the-hood” to each of the PLC’s functional blocks allowing the user to create his own method. The ability to create three custom methods is provided. The methods created can be saved for later recall and use.

Predefined Methods

The pre-defined methods are separated into three groups: Pulse Generator, External Trigger and Arm Control.

Pulse Generator

These methods produce free-running, periodic, asynchronous pulses. The pulses can be routed to the GPIO OUT[4:1] signals or the Camera Link's CC[4:1] signals. The OUT or CC signals can be connected to a camera that supports an external triggering capability.

External Trigger

These methods produce pulses that are synchronized and controlled by an external input. The external input is received via the GPIO IN[4:1] signals. The pulses produced by these methods can then be routed to the GPIO OUT[4:1] or the Camera Link's CC[4:1] signals. The OUT or CC signals can be connected to a camera that supports an external triggering capability.

Arm Control

These methods are used to "arm" the frame grabber's capture engine and to qualify when it acquires images from the camera. This is useful when the attached camera does not support an external trigger (i.e. it always provides free-running images) yet the user wants to synchronize frame capture via an external signal. The arm methods use an external input received via the GPIO IN[4:1] signals to determine when and how to capture images from the camera.

Method #1

Method #1 programs the PLC to produce a free-running, periodic pulse. The pulse can then be routed to a GPIO OUT[4:1] or CL CC[4:1] output.

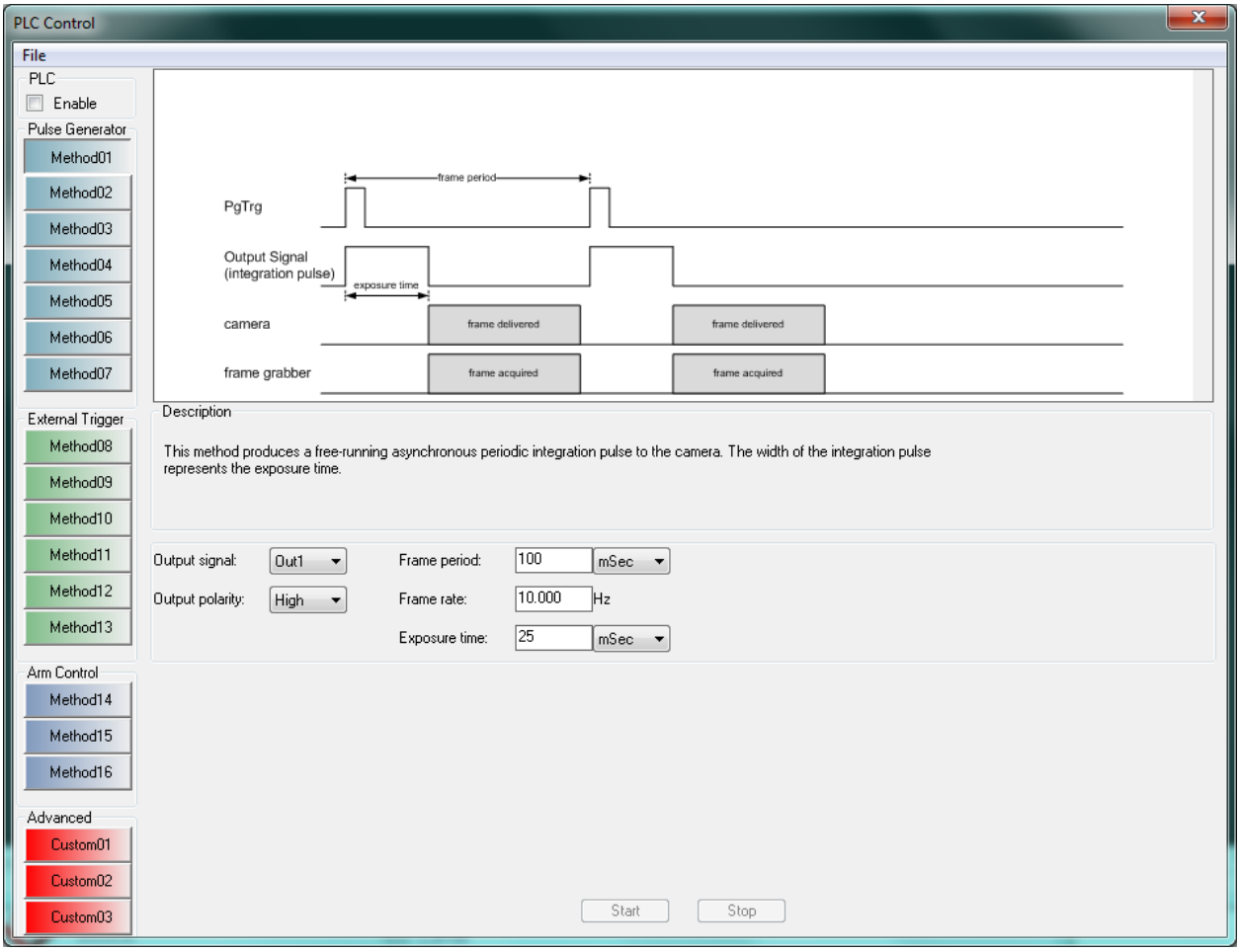


Figure C.1 – PLC Method #1

Method #2

Method #2 programs the PLC to produce two free-running, periodic pulses. The pulses can then be routed to a GPIO OUT[4:1] or CL CC[4:1] output.

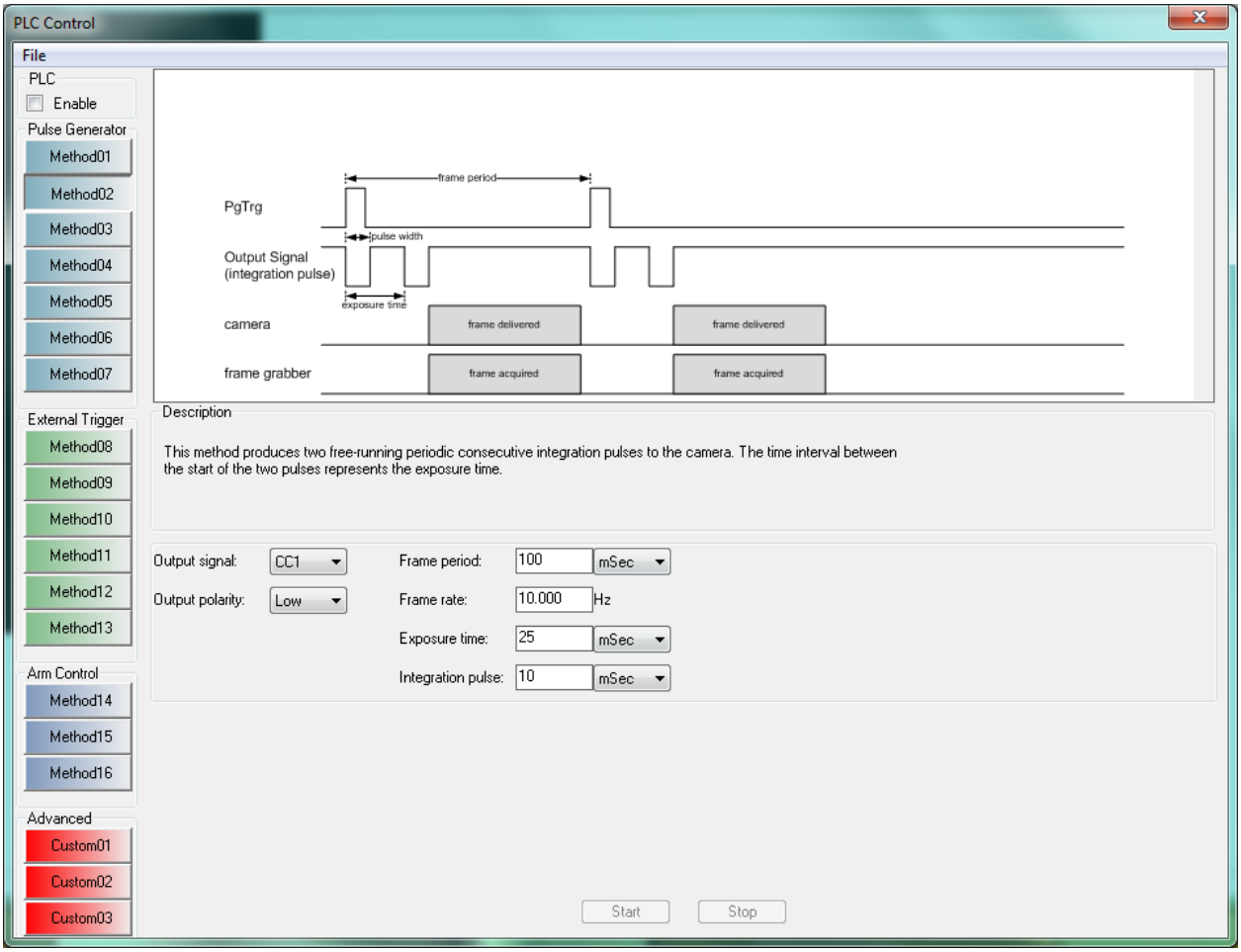


Figure C.2 – PLC Method #2

Method #3

Method #3 programs the PLC to produce two free-running, periodic pulses. The pulses can then be routed to the GPIO OUT[4:1] or CL CC[4:1] outputs.

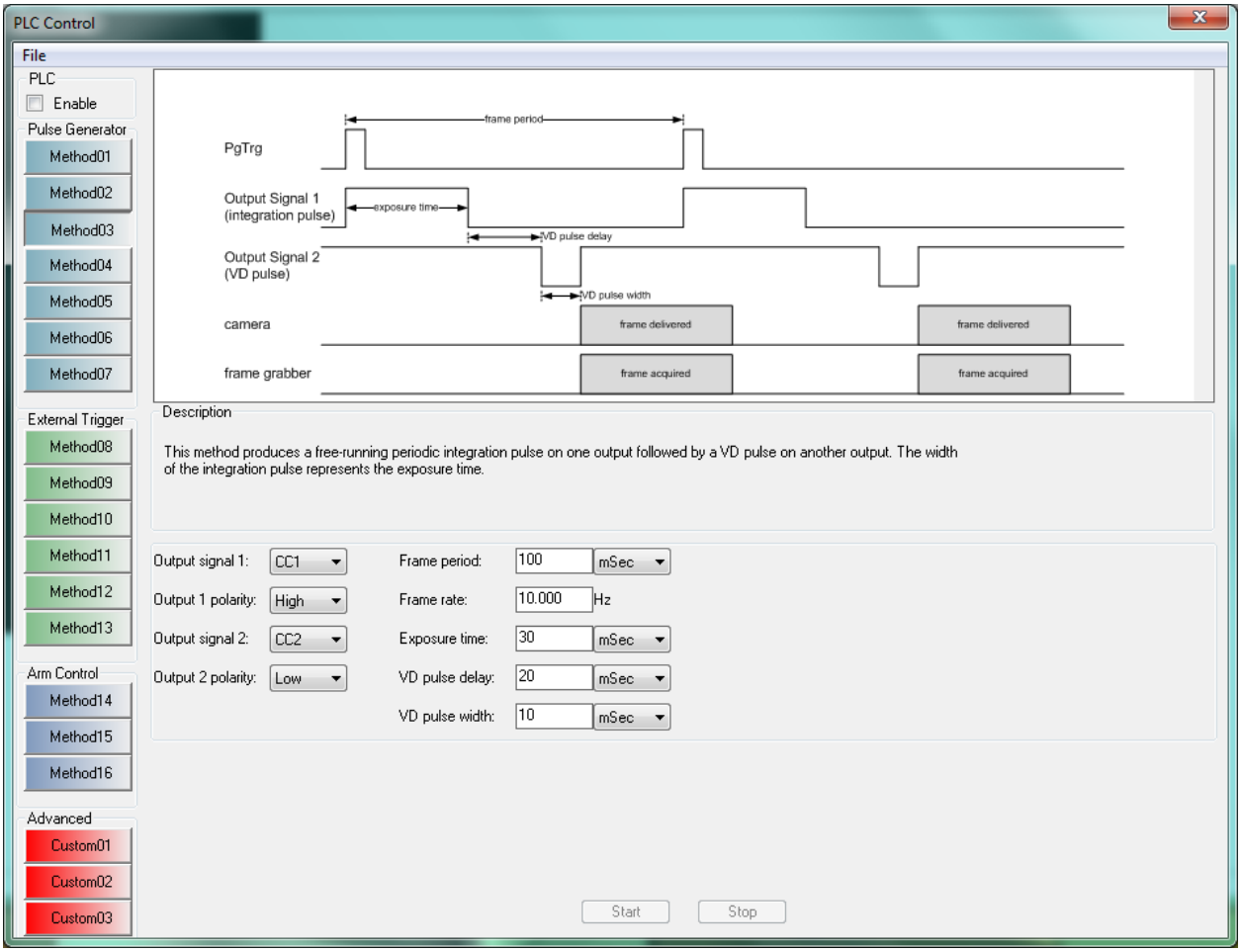


Figure C.3 – PLC Method #3

Method #4

Method #4 programs the PLC to produce two free-running, periodic pulses. The pulses can then be routed to the GPIO OUT[4:1] or CL CC[4:1] outputs.

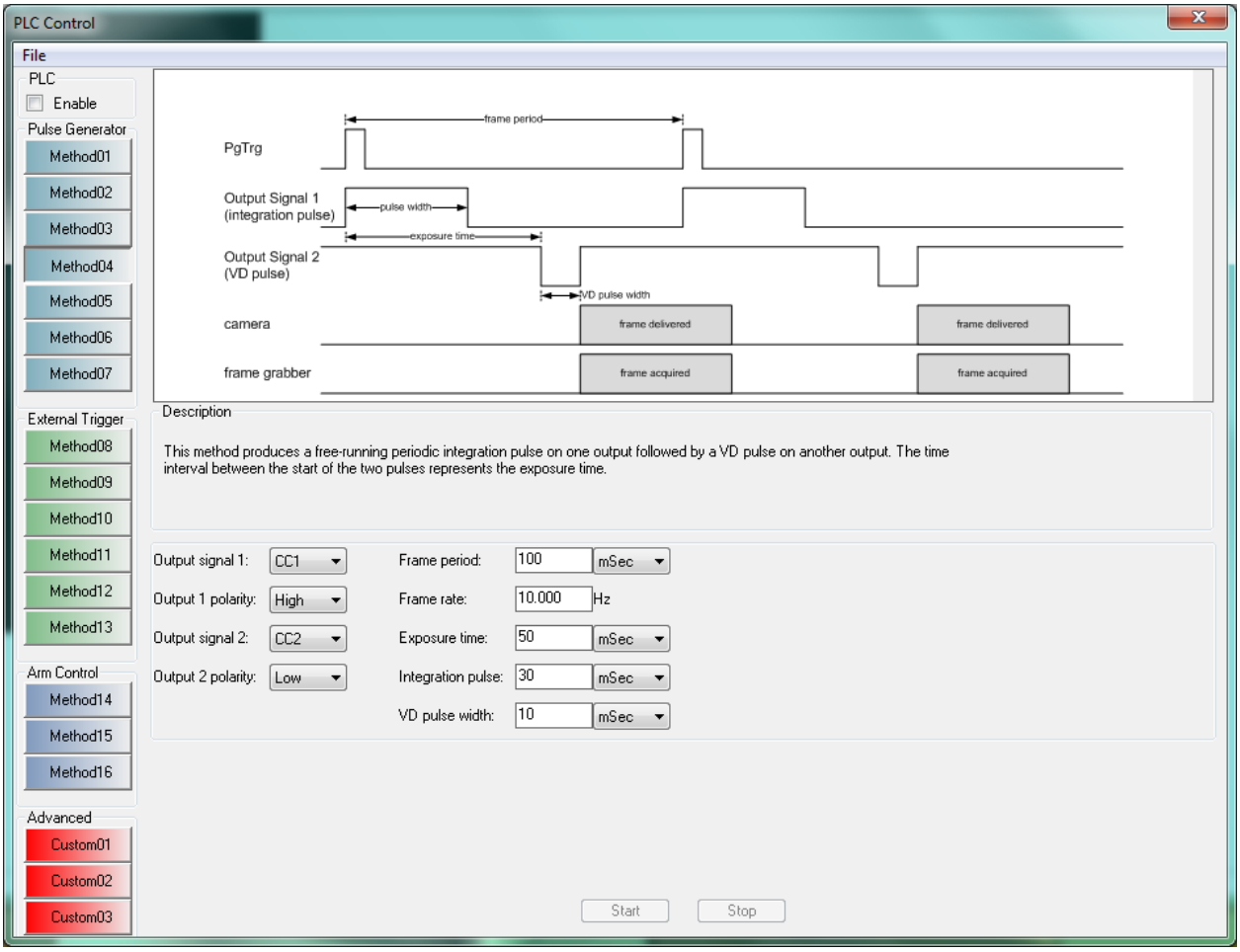


Figure C.4 – PLC Method #4

Method #5

Method #5 programs the PLC to produce a programmable number of periodic pulses. The pulse train is started by the receipt of an external trigger via a GPIO IN[4:1] input. The pulse produced can then be routed to a GPIO OUT[4:1] or CL CC[4:1] output. A debounce or deglitch filter can be applied to the input signal.

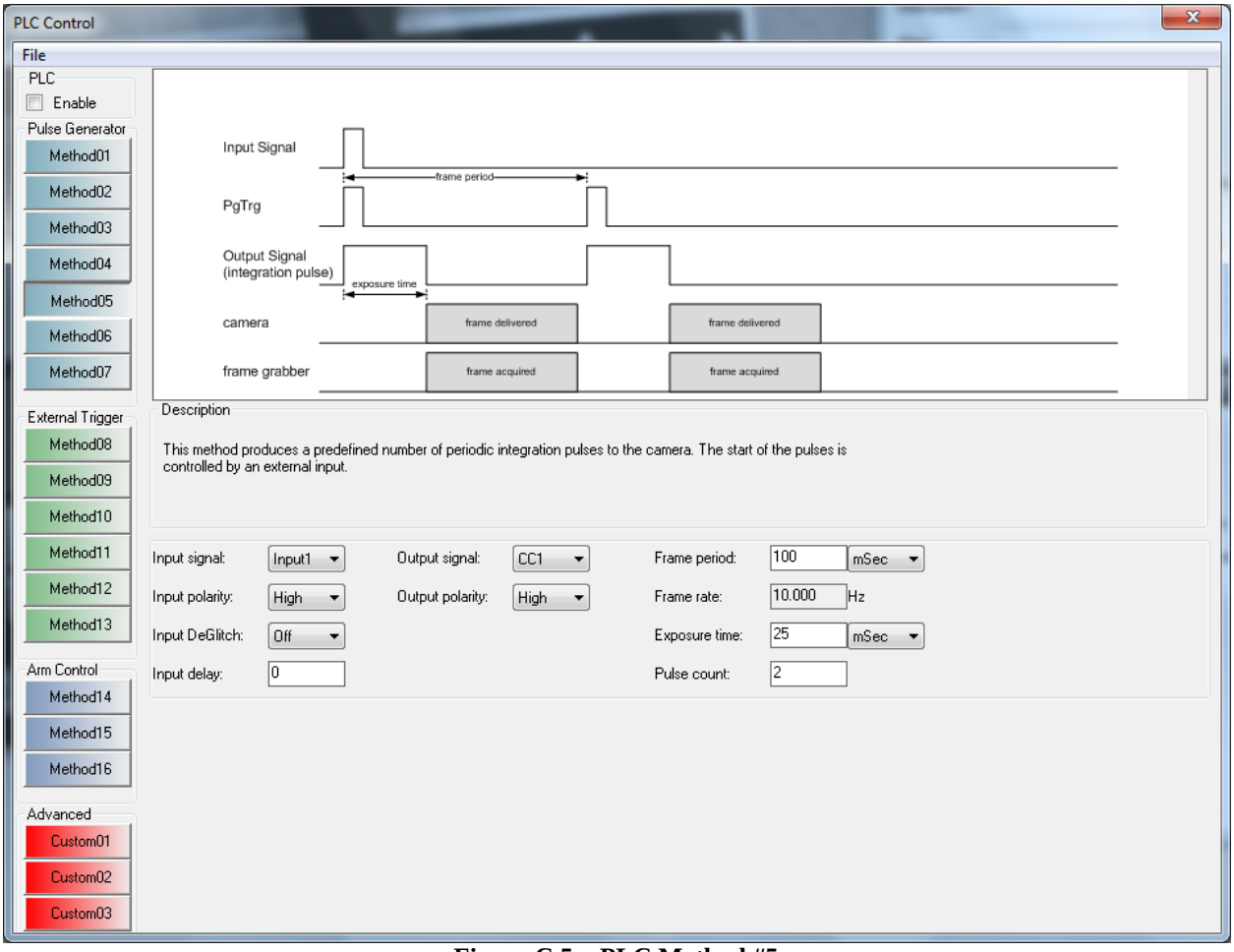


Figure C.5 – PLC Method #5

Method #6

Method #6 programs the PLC to produce a periodic pulse qualified by an external trigger. The pulse train is started/stopped by the presence/absence of an external trigger via a GPIO IN[4:1] input. The pulse produced can then be routed to a GPIO OUT[4:1] or CL CC[4:1] output.
A debounce or deglitch filter can be applied to the input signal.

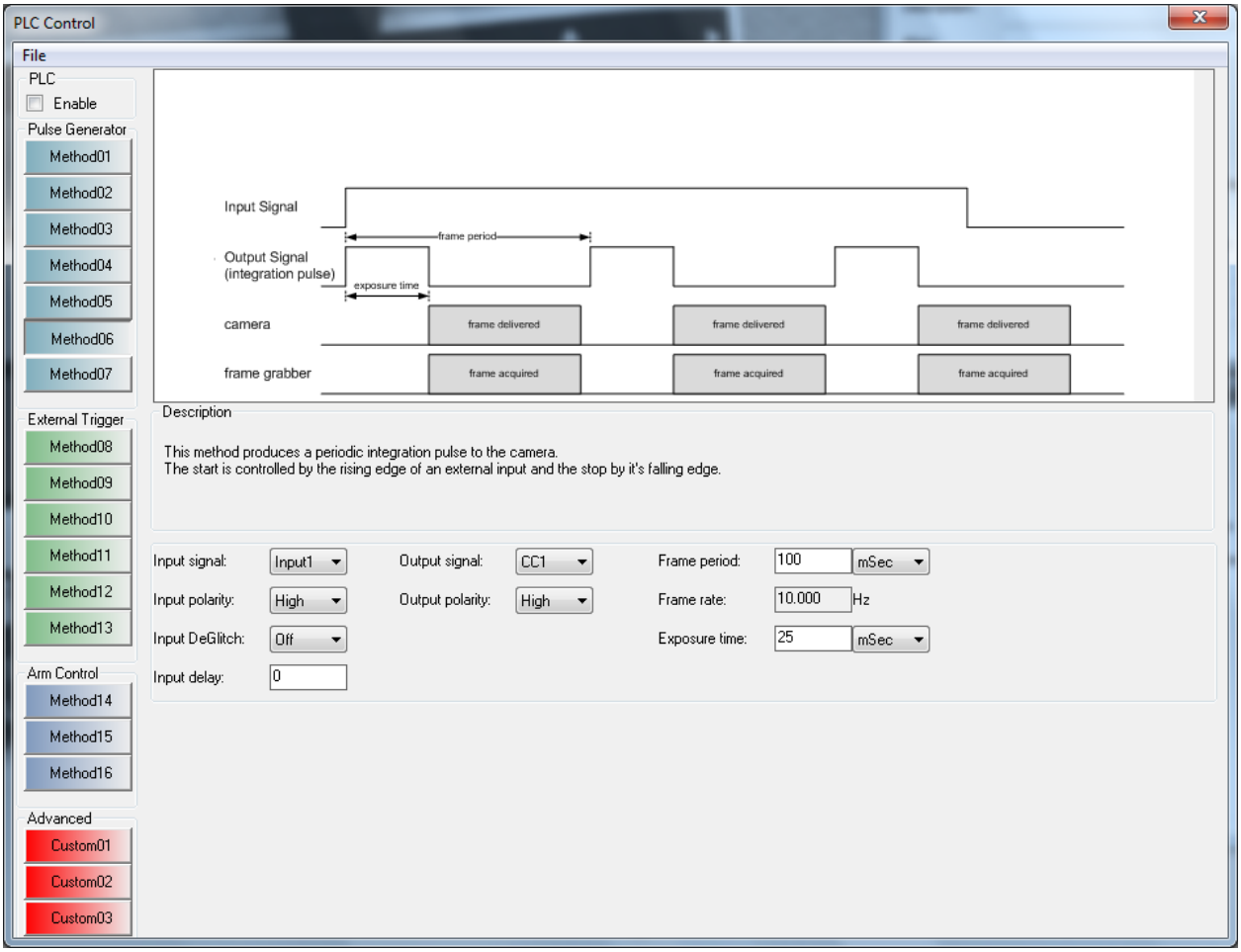


Figure C.6 – PLC Method #6

Method #7

Method #7 programs the PLC to produce a periodic pulse qualified by two external triggers. The pulse train is started by the receipt of the first signal and stopped by the receipt of the second signal. The external trigger signals are received via a GPIO IN[4:1] input. The pulse produced can then be routed to a GPIO OUT[4:1] or CL CC[4:1] output. A debounce or deglitch filter can be applied to the input signals.

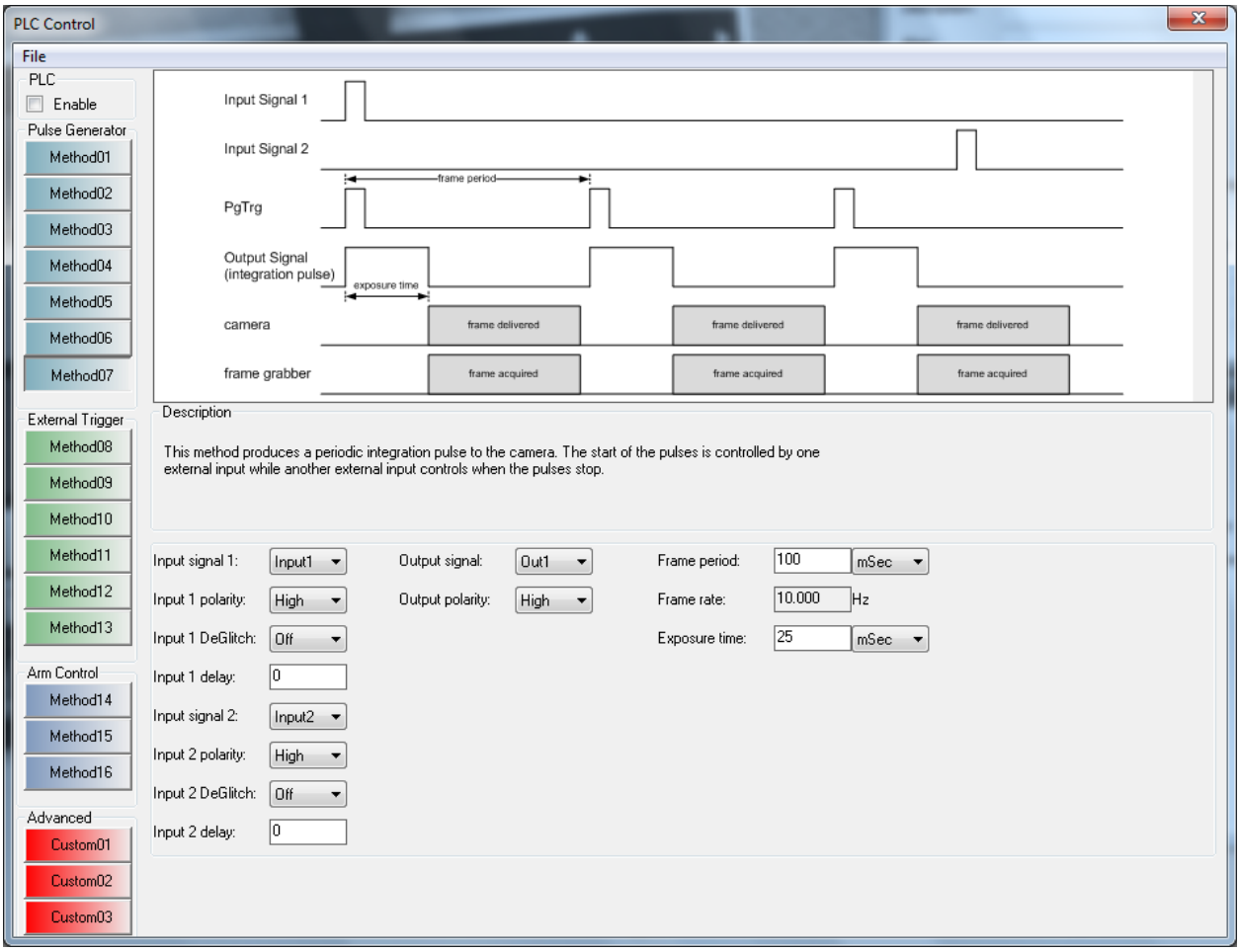


Figure C.7 – PLC Method #7

Method #8

Method #8 programs the PLC to route an external trigger signal to an output. The external trigger signal is received via a GPIO IN[4:1] input and then routed to a GPIO OUT[4:1] or CL CC[4:1] output. A debounce or deglitch filter can be applied to the input signal.

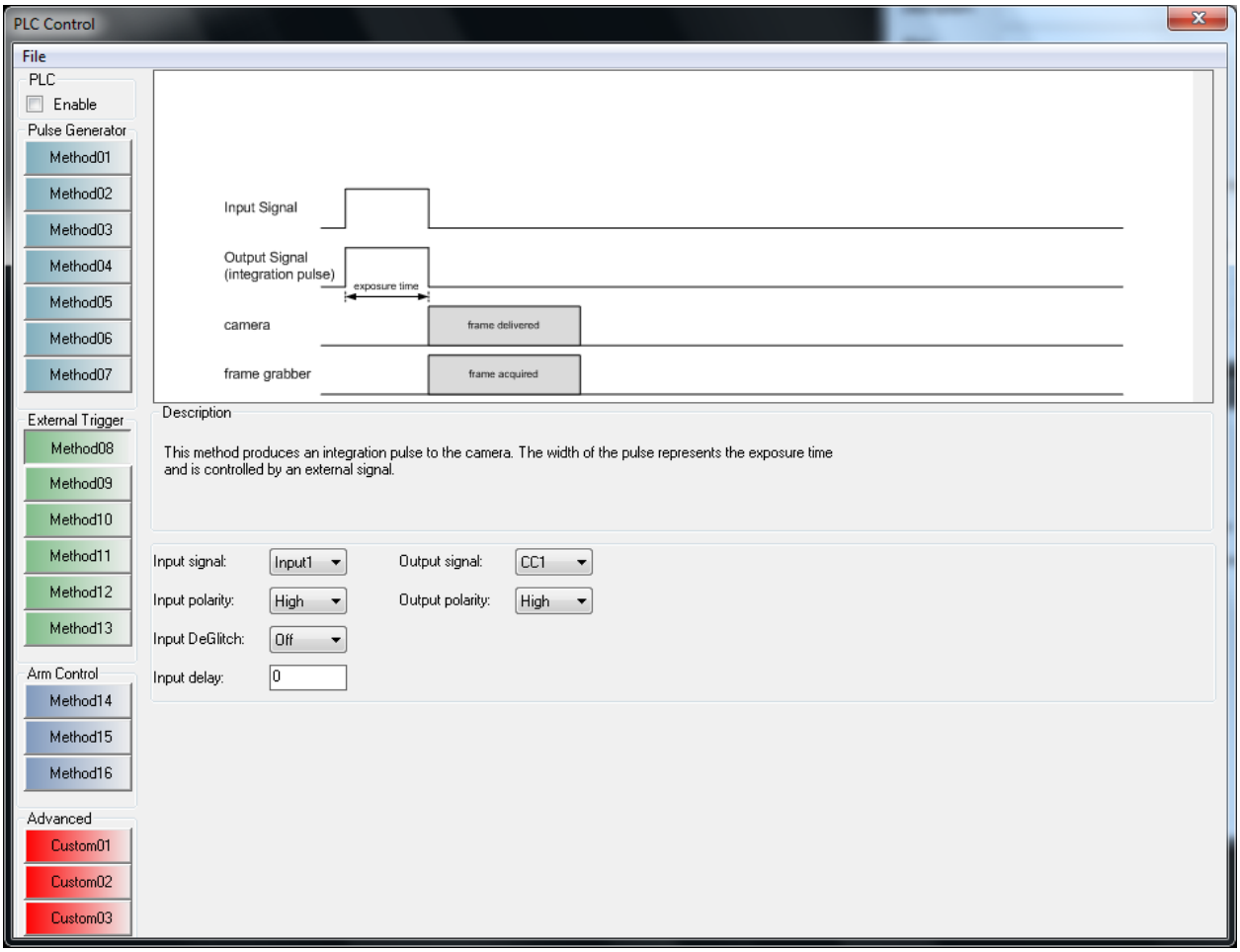


Figure C.8 – PLC Method #8

Method #9

Method #9 programs the PLC to route an external trigger signal to an output. The external trigger signal is received via a GPIO IN[4:1] input, is stretched by a programmable amount of time and then routed to a GPIO OUT[4:1] or CL CC[4:1] output. A debounce or deglitch filter can be applied to the input signal.

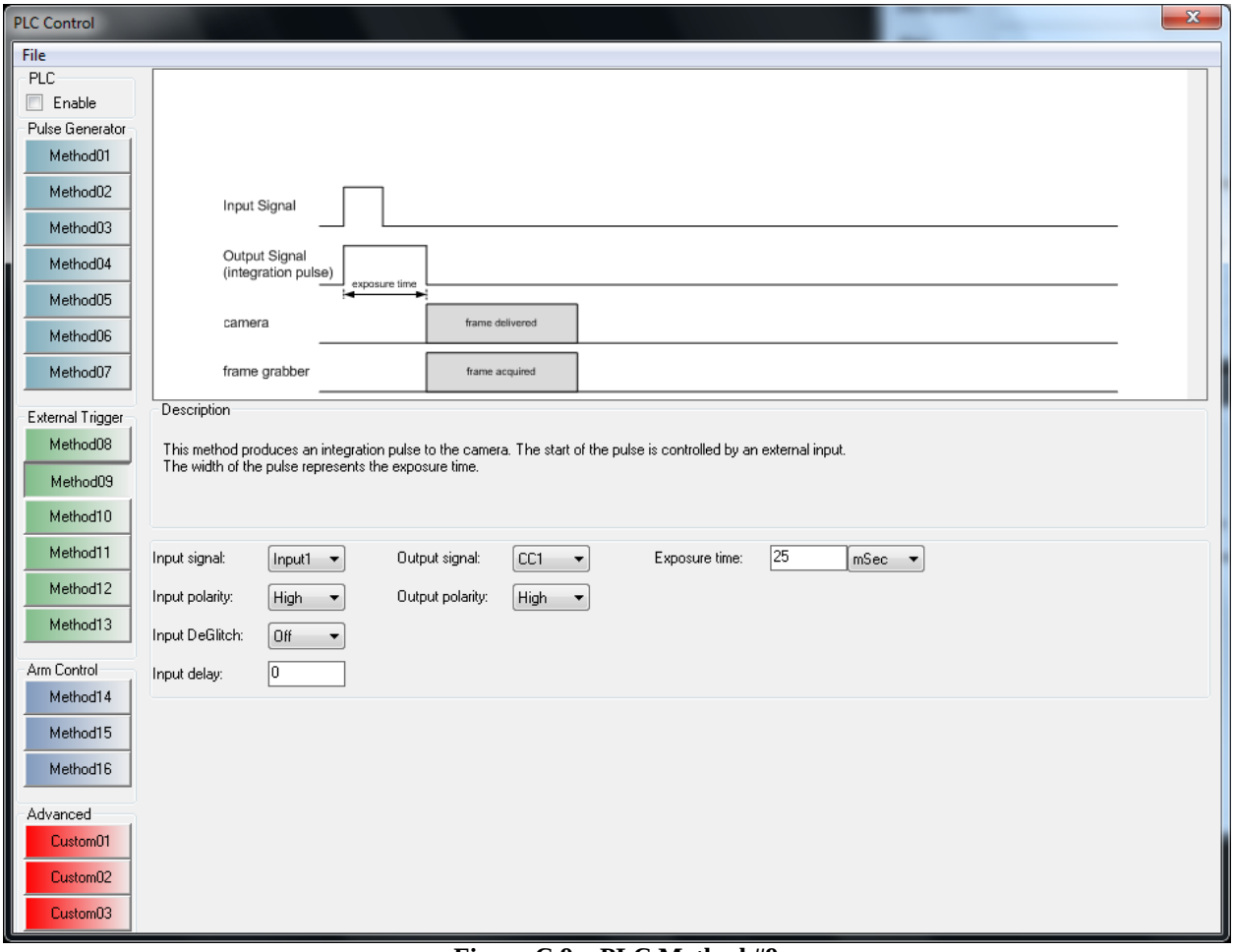


Figure C.9 – PLC Method #9

Method #10

Method #10 programs the PLC to route an external trigger signal to an output. The external trigger signal is received via a GPIO IN[4:1] input, is delayed and stretched by a programmable amount of time and then routed to a GPIO OUT[4:1] or CL CC[4:1] output. A debounce or deglitch filter can be applied to the input signal.

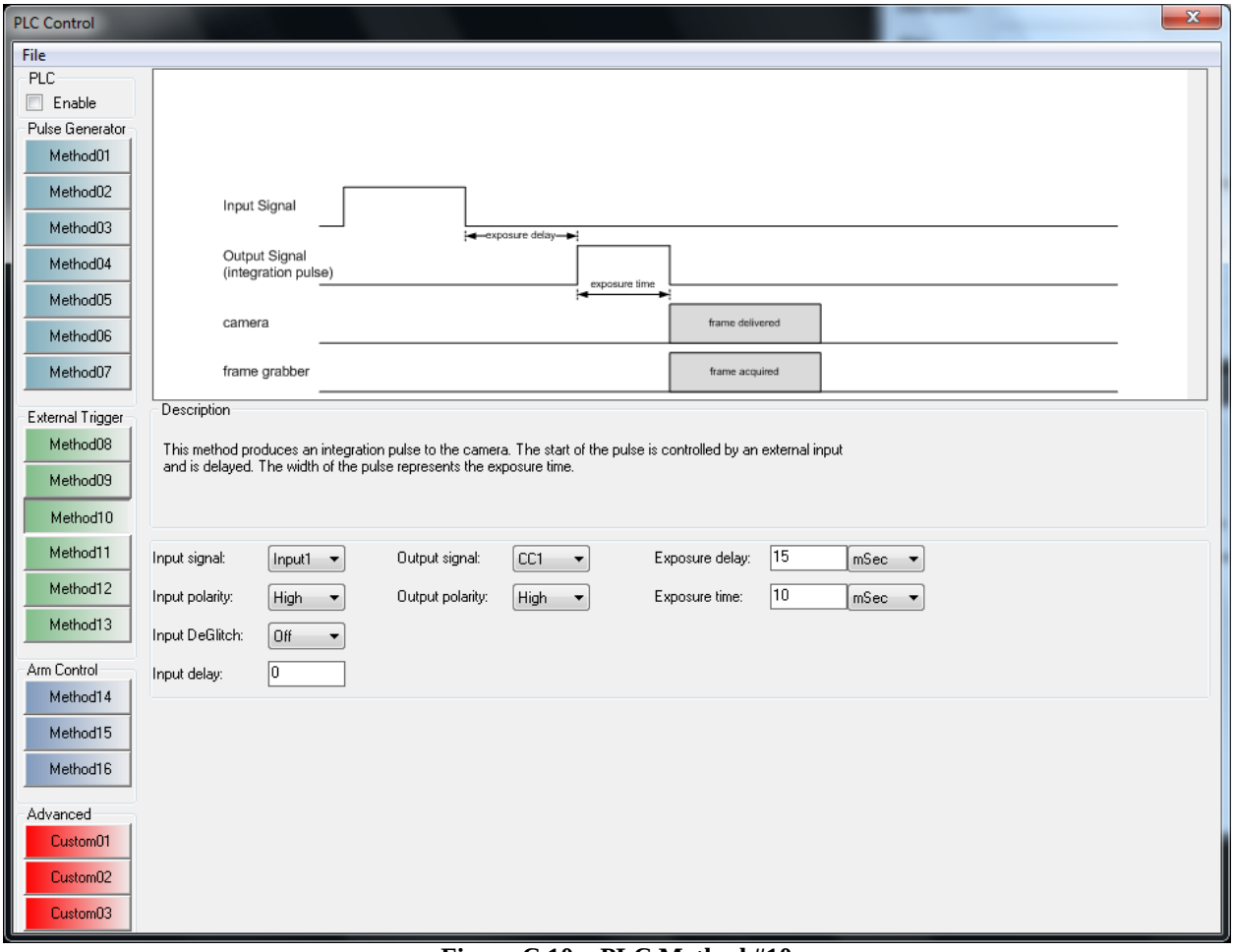


Figure C.10 – PLC Method #10

Method #11

Method #11 programs the PLC to produce two programmable pulses. The pulse train is started by the receipt of an external trigger via a GPIO IN[4:1] input. The pulse produced can then be routed to a GPIO OUT[4:1] or CL CC[4:1] output. A debounce or deglitch filter can be applied to the input signal.

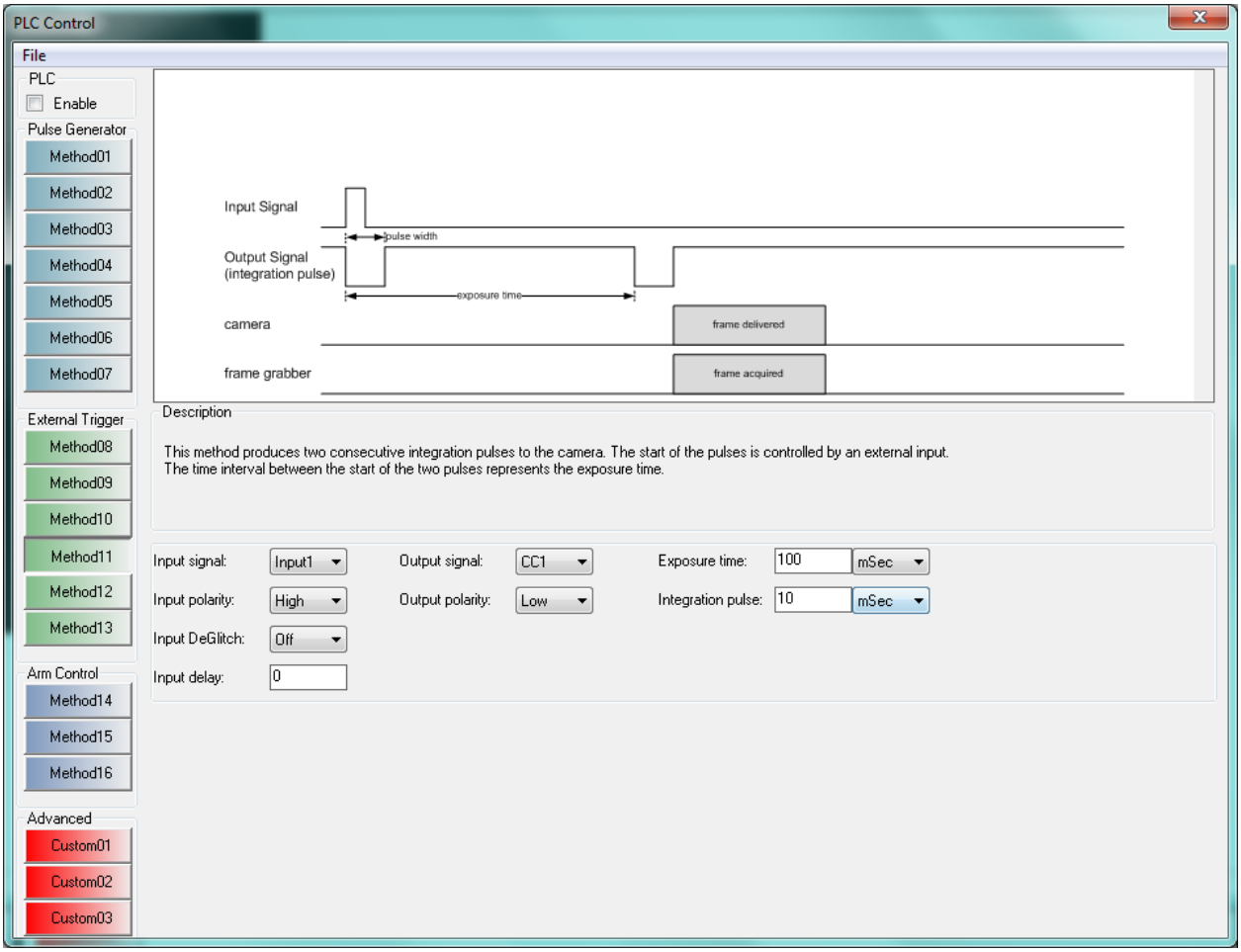


Figure C.11 – PLC Method #11

Method #12

Method #12 programs the PLC to produce two programmable pulses. The pulse train is started by the receipt of an external trigger via a GPIO IN[4:1] input. The pulses produced can then be routed to the GPIO OUT[4:1] or CL CC[4:1] outputs. A debounce or deglitch filter can be applied to the input signal.

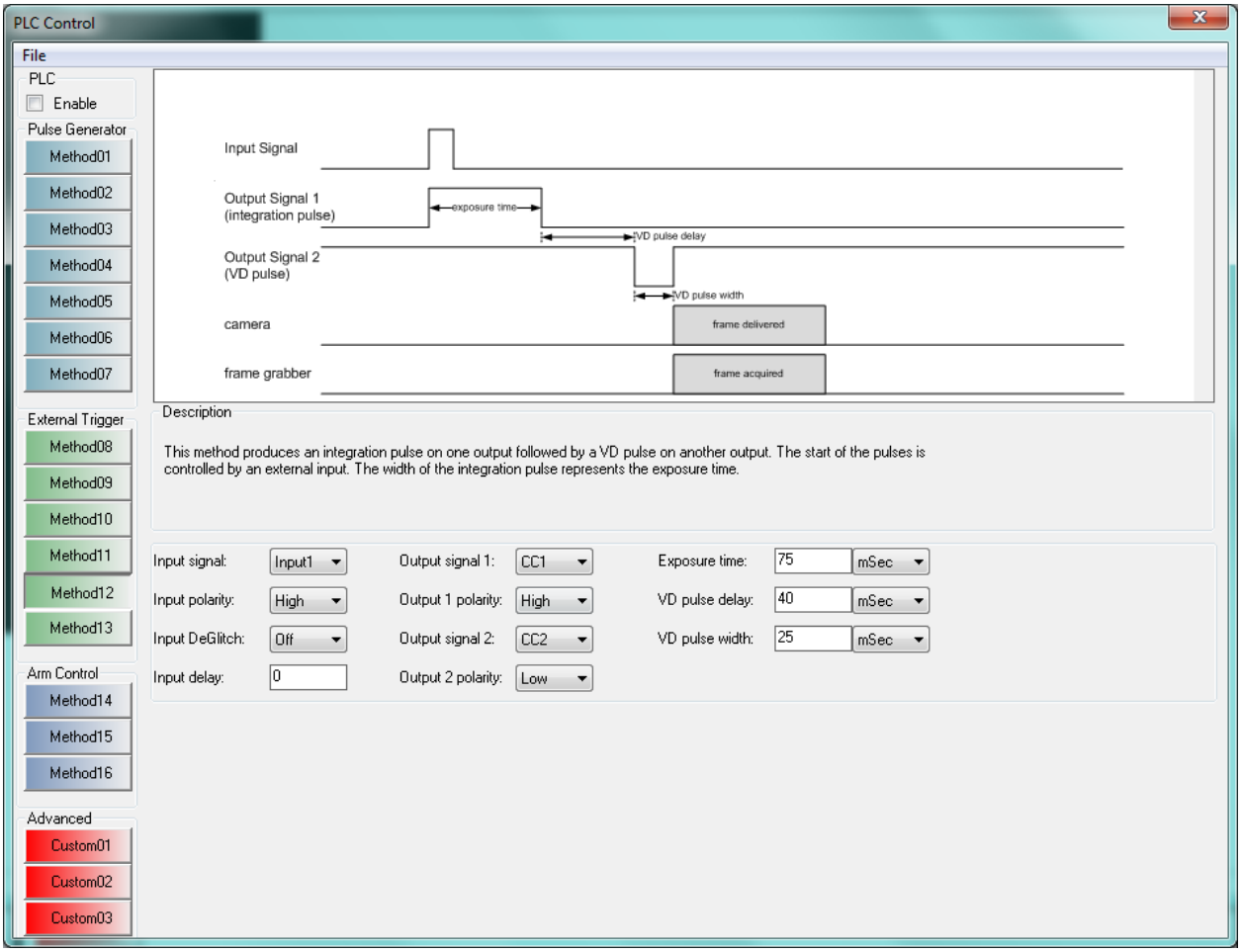


Figure C.12 – PLC Method #12

Method #13

Method #13 programs the PLC to produce two programmable pulses. The pulse train is started by the receipt of an external trigger via a GPIO IN[4:1] input. The pulses produced can then be routed to the GPIO OUT[4:1] or CL CC[4:1] outputs. A debounce or deglitch filter can be applied to the input signal.

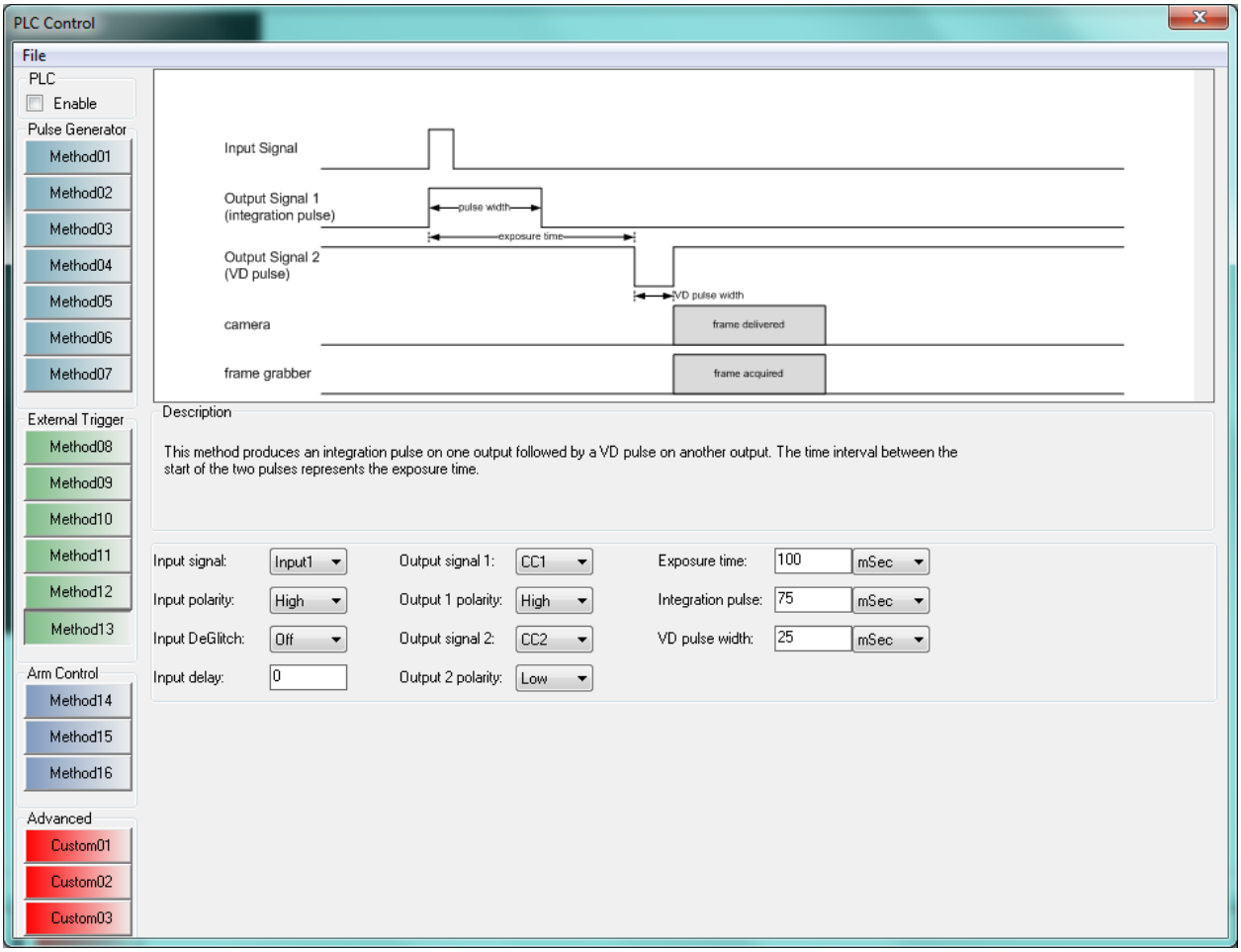


Figure C.13 – PLC Method #13

Method #14

Method #14 programs the PLC to wait for the receipt of an external trigger signal and then to "arm" the frame grabber's capture engine to acquire a single frame. The external trigger signal is received via a GPIO IN[4:1] input, is stretched by a programmable amount of time and then routed to a GPIO OUT[4:1] or CL CC[4:1] output. A debounce or deglitch filter can be applied to the input signal.

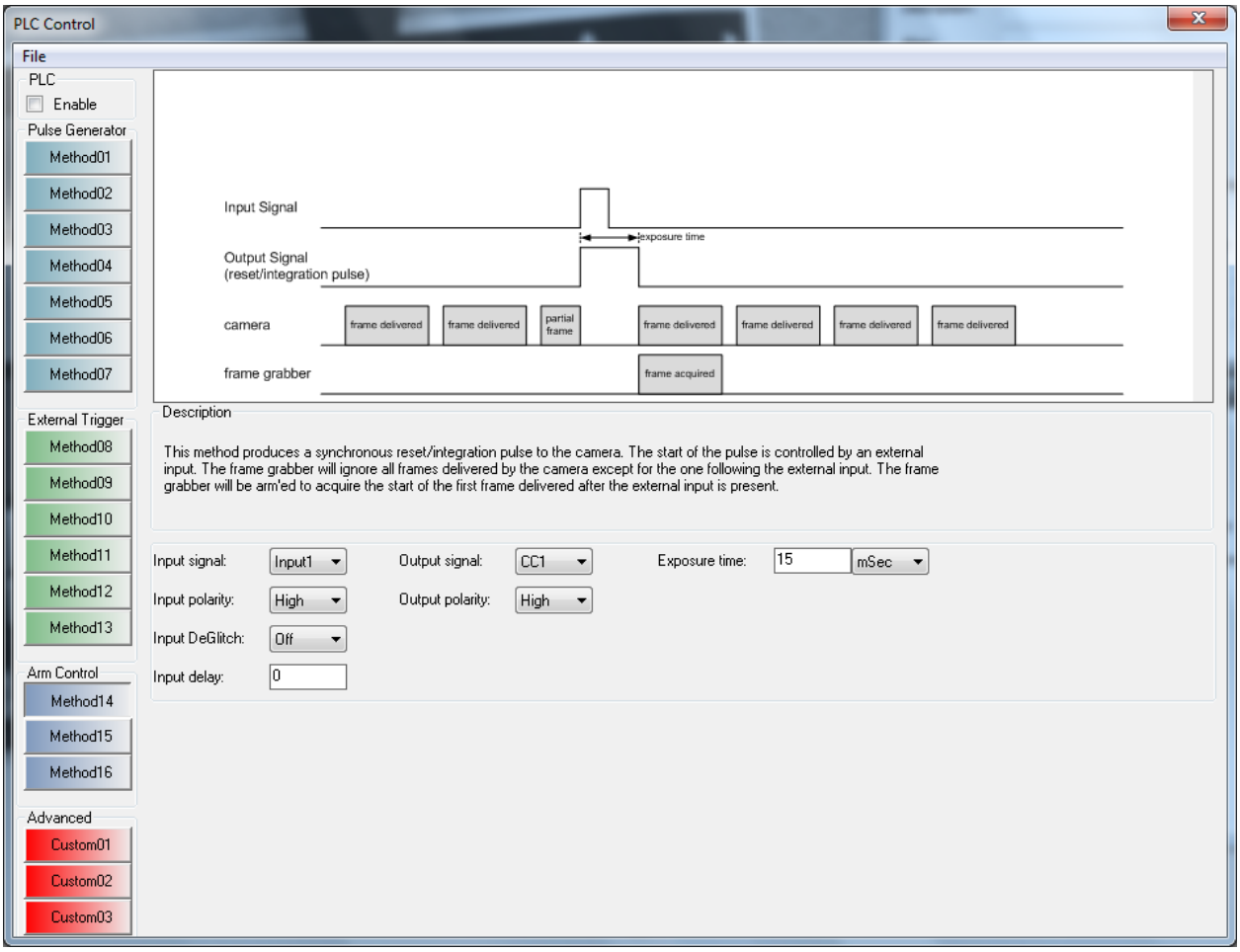


Figure C.14 – PLC Method #14

Method #15

Method #15 programs the PLC to wait for the receipt of an external trigger signal and then to "arm" the frame grabber's capture engine to acquire a programmable number of frames. The external trigger signal is received via a GPIO IN[4:1] input. A debounce or deglitch filter can be applied to the input signal.

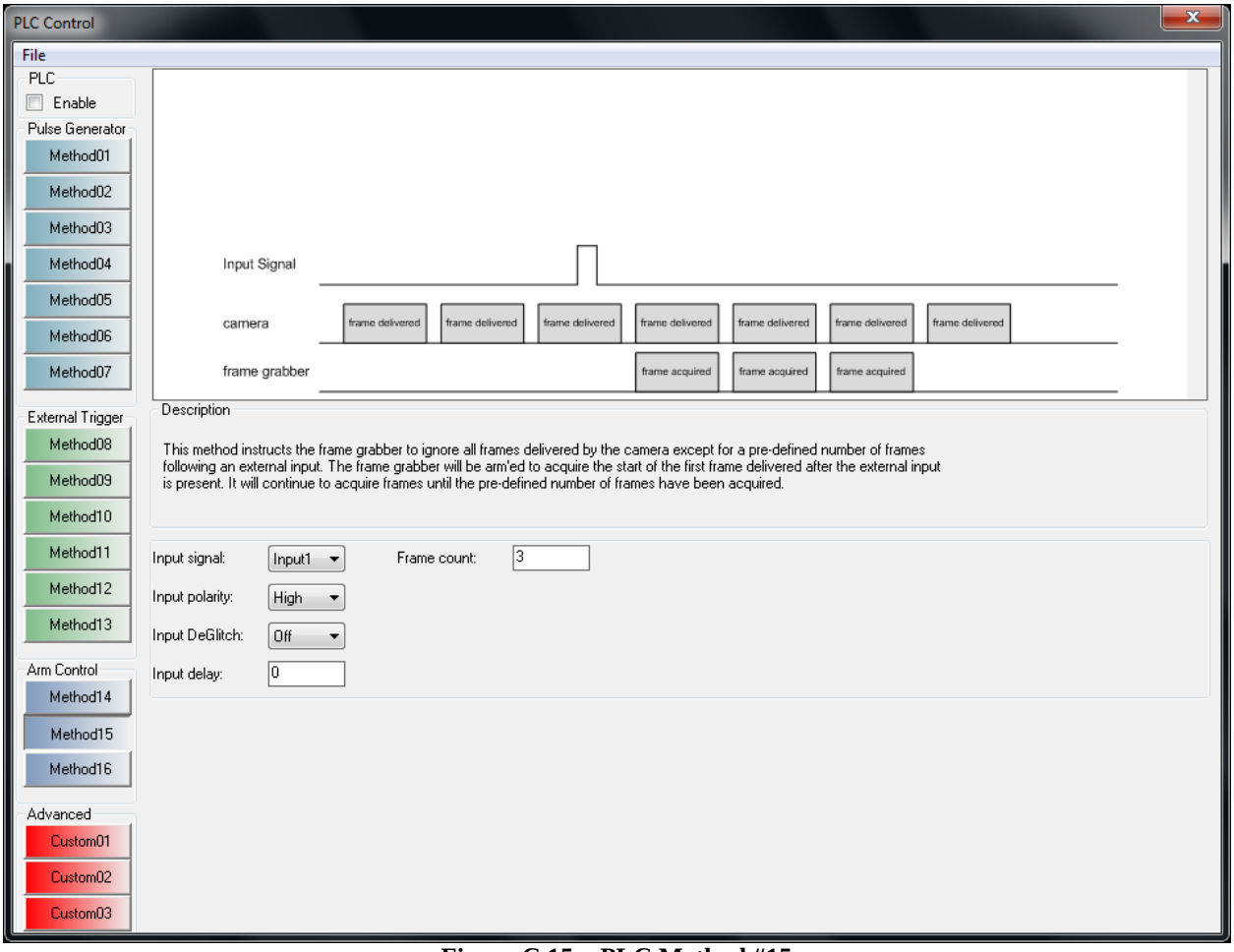


Figure C.15 – PLC Method #15

Method #16

Method #16 programs the PLC to wait for the receipt of an external trigger signal and then to "arm" the frame grabber's capture engine to acquire frames. The frame acquisition is started/stopped by the presence/absence of an external trigger via a GPIO IN[4:1] input. A debounce or deglitch filter can be applied to the input signal.

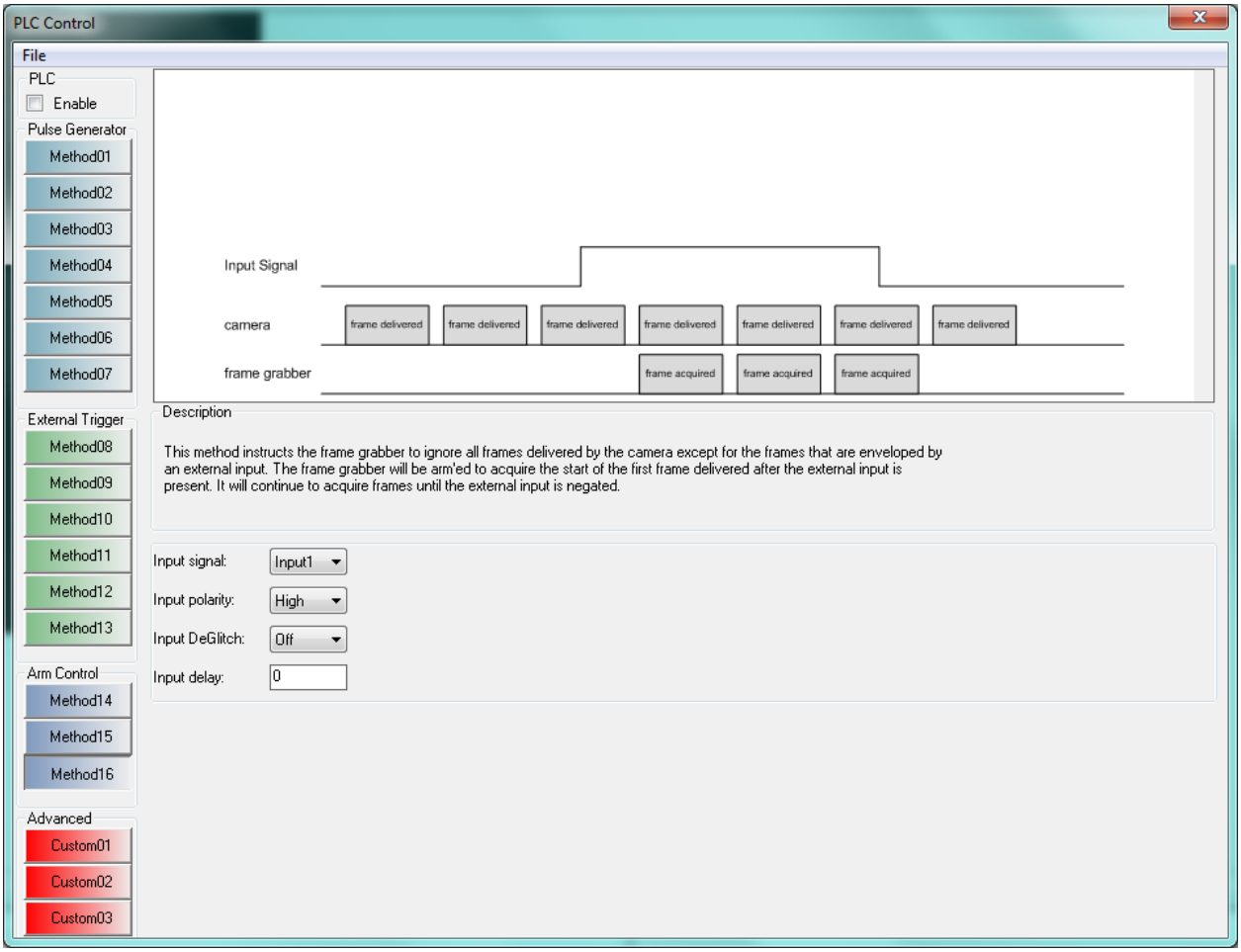


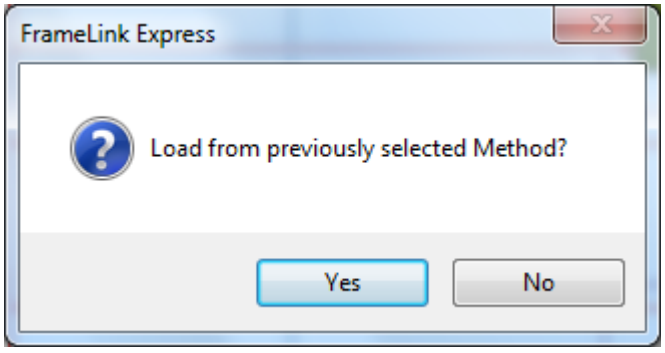
Figure C.16 – PLC Method #16

Custom Methods

The custom methods allow users to program the PLC directly by providing access to each of its functional blocks. The ability to create three custom methods is provided. After creation, the custom methods can be saved for later use. Creating a custom method requires configuring the following PLC functional blocks:

Block Diagram	Illustrates the PLC's functional blocks and their interconnect.
Input Block	Configures the polarity and filtering of the GPIO IN[4:1] inputs.
PG Block	Configures the Pulse Generator function.
Mstr/Slv Block	Configures the generation of the Master and Slave pulses.
Strobe Block	Configures the generation of the STROBE output signal.
Output Block	Configures the generation of the GPIO OUT[4:1] output signals.
CC Block	Configures the generation of the CL CC[4:1] output signals.
Arm Block	Configures the generation of the ARM signal to be used by the frame grabber's acquisition engine.

Selecting any of the custom methods results in the following pop-up message. Clicking on **Yes** causes the PLC functional blocks to be preloaded with the contents of the previously selected method.



Block Diagram

The Block Diagram dialog illustrates the PLC's functional blocks and their interconnect. It is used for illustrative purposes only.

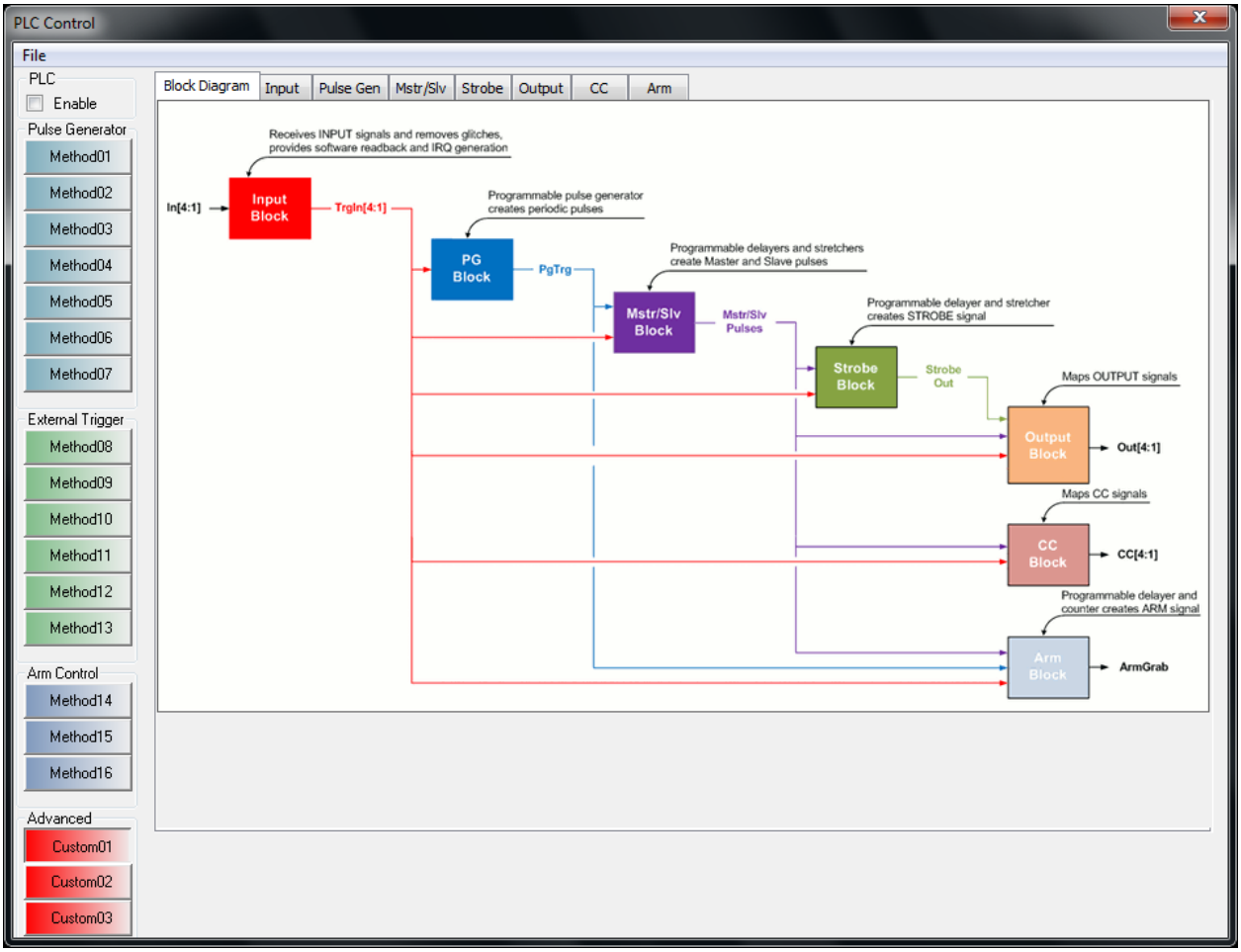


Figure C.17 – PLC Block Diagram

Input

The Input dialog allows the user to select the polarity of the GPIO IN[4:1] input signals and to apply a debounce or deglitch filter.

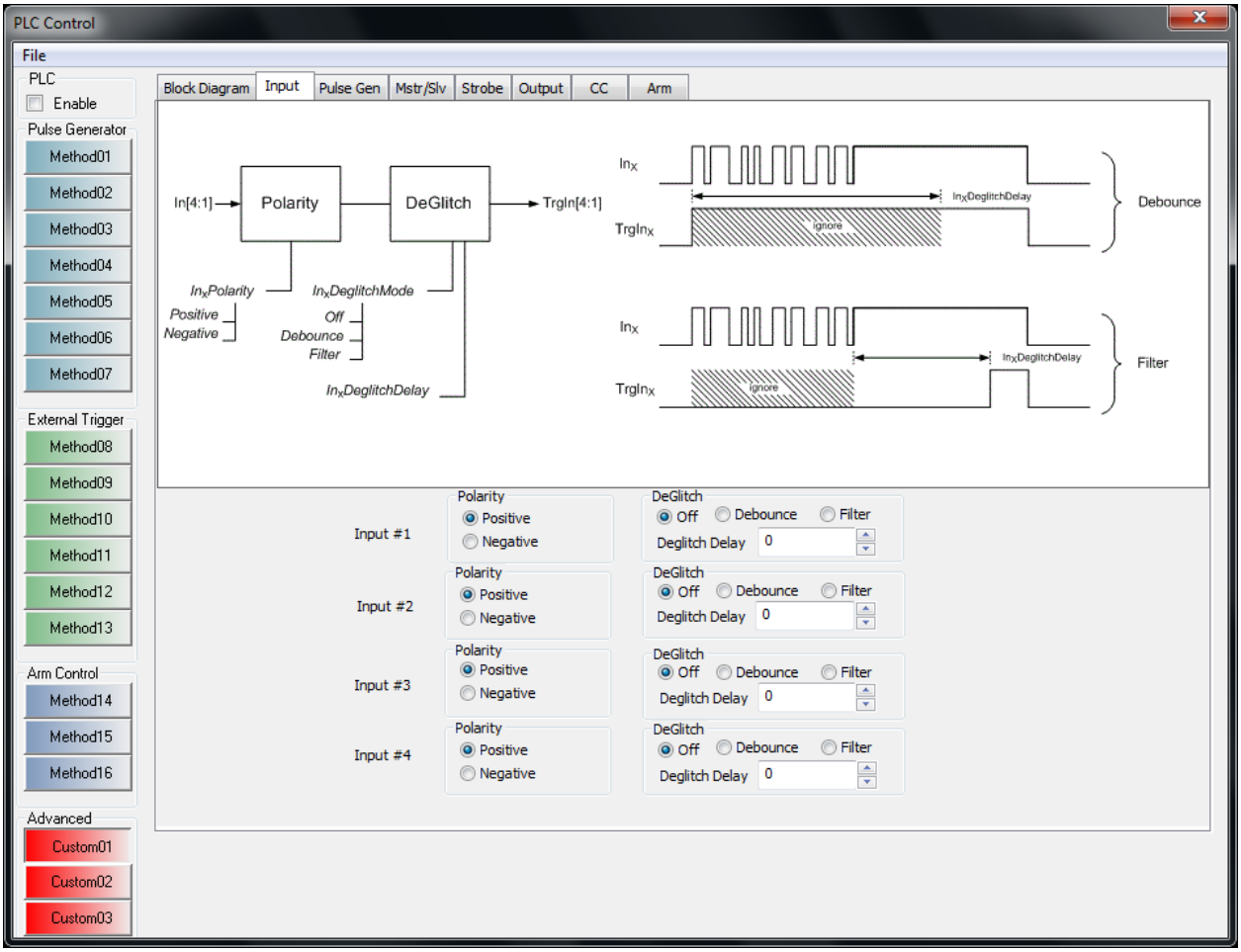


Figure C.18 – PLC Input block

Polarity Selects the polarity of the GPIO IN[4:1] input signal. Selecting **Negative** will invert the signal.

DeGlitch Selects the mode of operation of the deglitch circuit.

Off Turns off the deglitch circuit. Deglitch is not required if the input signal is stable. Deglitch is required if the input signal contains any spurious glitches (i.e. contact bounce in a mechanical switch).

Debounce	This selection will cause the trigger to immediately assert with the active edge of the input signal. Any subsequent edges in the input signal will be ignored for a period of time set by the **DeglitchDelay**.	
Filter	This selection will cause the trigger to be asserted only after the input signal has been stable for a period of time set by the **DeglitchDelay**.	
Deglitch Delay	In **Debounce** mode:	Determines the amount of the time that the input signal is ignored.
	In **Filter** mode:	Determines the amount of time that the input signal has to be stable and glitch-free.

Pulse Gen

The Pulse Gen dialog allows the user to configure the pulse generator using the following parameters:

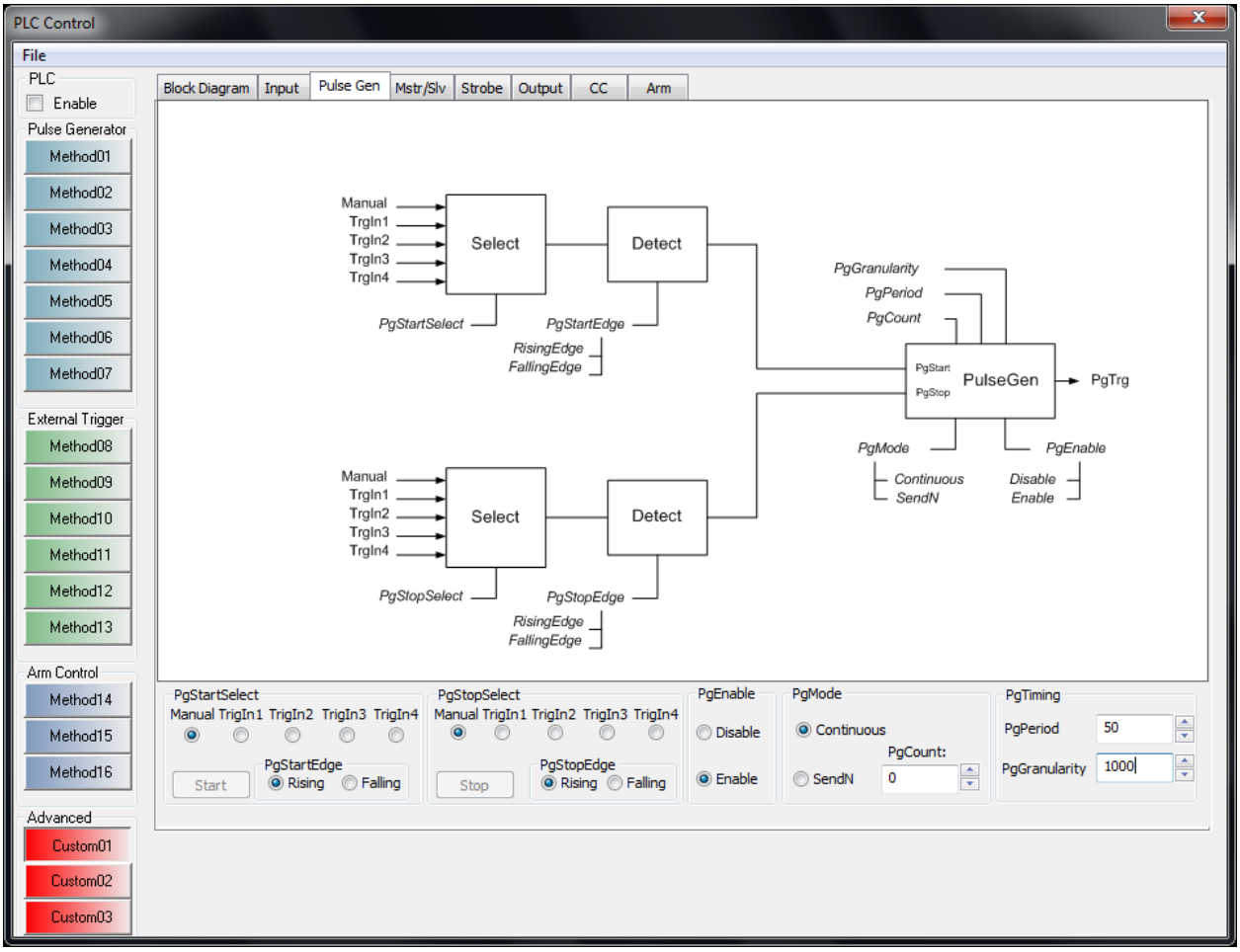


Figure C.19 – PLC Pulse Generator block

PgStartSelect Selects the source signal that will start the pulse generator. If **Manual** is selected, then the **Start** button is used. **TrgIn[4:1]** refers to the trigger signals generated by the Input block.

PgStartEdge Selects the active edge of the start source as either **Rising** or **Falling**.

PgStopSelect Selects the source signal that will stop the pulse generator. If **Manual** is selected, then the **Stop** button is used. **TrgIn[4:1]** refers to the trigger signals generated by the Input block.

PgStopEdge — Selects the active edge of the stop source as either **Rising** or **Falling**.

PgEnable — Enables/disables the operation of the Pulse Generator.

PgMode — Selects the mode of operation of the Pulse Generator.

- Continuous — The Pulse Generator will provide a continuous train of pulses.
- SendN — The Pulse Generator will only provide N pulses and then automatically stop. The value N is set in the **PgCount** field.

PgCount — Determines the number of pulses to produce when **PgMode** = **SendN**.

PgPeriod — Determines the period of the pulses produced by the Pulse Generator. The units/increment of the period is determined by the **PgGranularity** field.

PgGranularity — Determines the clock multiplication factor to be used for the **PgPeriod** field. The reference clock is 100 MHz, so a **PgGranularity** of 1 results in the **PgPeriod** to be in units of 10 nSeconds.

For example: if **PgGranularity** is set to 10 and **PgPeriod** is set to 5, then the Pulse Generator will produce a signal with a period of 500 nSeconds.

Mstr/Slv

The Mstr/Slv dialog allows the user to configure a set of Master and Slave pulses using the following parameters:

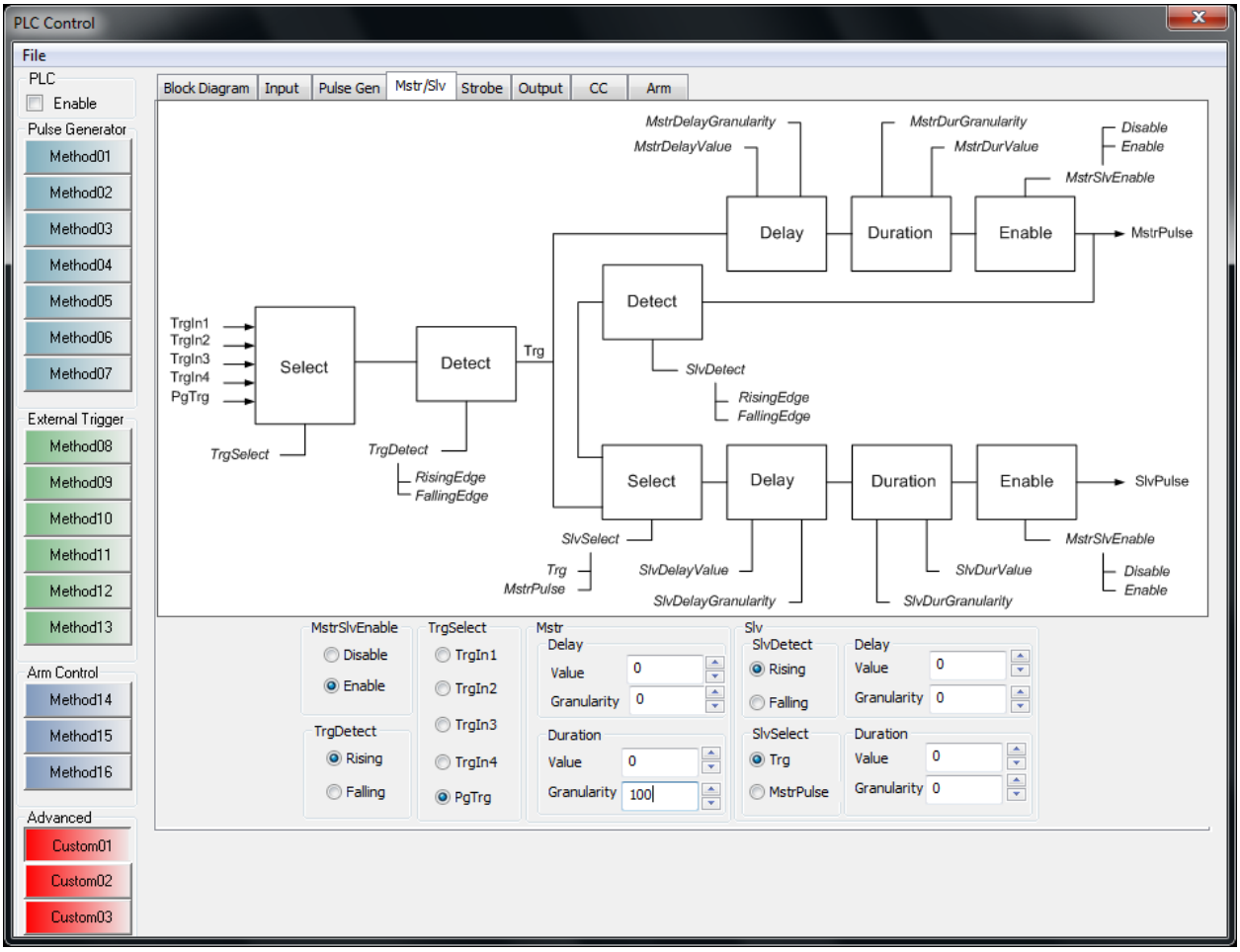


Figure C.20 – PLC Master/Slave block

MstrSlvEnable Enables/disables the generation of the Master and Slave pulses.

TrgSelect Selects the source signal that will be used to generate the Master and Slave pulses. **TrgIn[4:1]** refers to the trigger signals generated by the Input block. **PgTrg** refers to the trigger signals generated by the PG block.

TrgDetect Selects the active edge of the selected source signal as either **Rising** or **Falling**.

Mstr	These parameters control the generation of the Master pulse.	
	Delay Value	Determines how much the Master pulse will be delayed from the selected source signal. The units/increment of the delay is determined by the **DelayGranularity** field.
	Delay Granularity	Determines the clock multiplication factor to be used for the **DelayValue** field. The reference clock is 100 MHz, so a **DelayGranularity** of 1 results in the **DelayValue** to be in units of 10 nSeconds.
	Duration Value	Determines the width of the generated Master pulse. The units/increment of the duration is determined by the **DurationGranularity** field.
	Duration Granularity	Determines the clock multiplication factor to be used for the **DurationValue** field. The reference clock is 100 MHz, so a **DurationGranularity** of 1 results in the **DurationValue** to be in units of 10 nSeconds.
Slv	These parameters control the generation of the Slave pulse.	
	Slv Detect	Selects the active edge of the Master pulse, as either **Rising** or **Falling**, to be used to drive the creation of the Slave pulse.
	Slv Select	Selects the source signal that will be used to generate the Slave pulse. Either the Master pulse or the results of the TrgDetect block can be used as the source of the Slave pulse.
	Delay Value	Determines how much the Slave pulse will be delayed from the selected source signal. The units/increment of the delay is determined by the **DelayGranularity** field.
	Delay Granularity	Determines the clock multiplication factor to be used for the **DelayValue** field. The reference clock is 100 MHz, so a **DelayGranularity** of 1 results in the **DelayValue** to be in units of 10 nSeconds.
	Duration Value	Determines the width of the generated Slave pulse. The units/increment of the duration is determined by the **DurationGranularity** field.
	Duration Granularity	Determines the clock multiplication factor to be used for the **DurationValue** field. The reference clock is 100 MHz, so a

DurationGranularity of 1 results in the **DurationValue** to be in units of 10 nSeconds.

Strobe

The Strobe dialog allows the user to configure the generation of a Strobe pulse. The Strobe pulse can then be routed to a GPIO OUT[4:1] output signal.

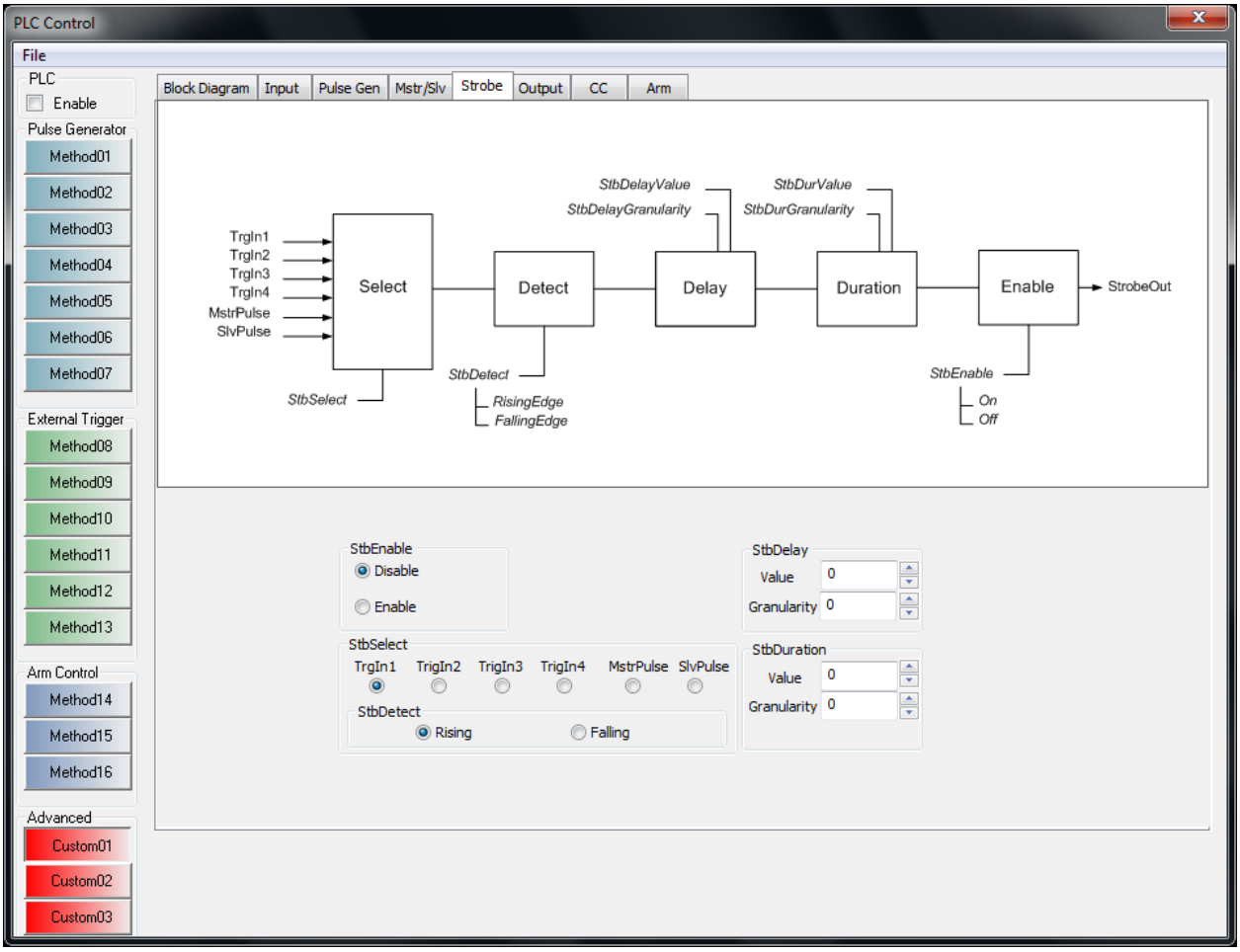


Figure C.21 – PLC Strobe block

StbEnable — Enables/disables the generation of the Strobe pulse.

StbSelect — Selects the source signal that will be used to generate the Strobe pulse. **TrgIn[4:1]** refers to the trigger signals generated by the Input block. **MstrPulse** and **SlvPulse** refers to the pulses generated by the Mstr/Slv block.

StbDetect — Selects the active edge of the selected source signal as either **Rising** or **Falling**.

StbDelay Value	Determines how much the Strobe pulse will be delayed from the selected source signal. The units/increment of the delay is determined by the **StbDelayGranularity** field.
StbDelay Granularity	Determines the clock multiplication factor to be used for the **StbDelayValue** field. The reference clock is 100 MHz, so a **StbDelayGranularity** of 1 results in the **StbDelayValue** to be in units of 10 nSeconds.
StbDuration Value	Determines the width of the generated Strobe pulse. The units/increment of the duration is determined by the **StbDurationGranularity** field.
StbDuration Granularity	Determines the clock multiplication factor to be used for the **StbDurationValue** field. The reference clock is 100 MHz, so a **StbDurationGranularity** of 1 results in the **StbDurationValue** to be in units of 10 nSeconds.

Output

The Output dialog allows the user to select the source and polarity of the GPIO OUT[4:1] output signals.

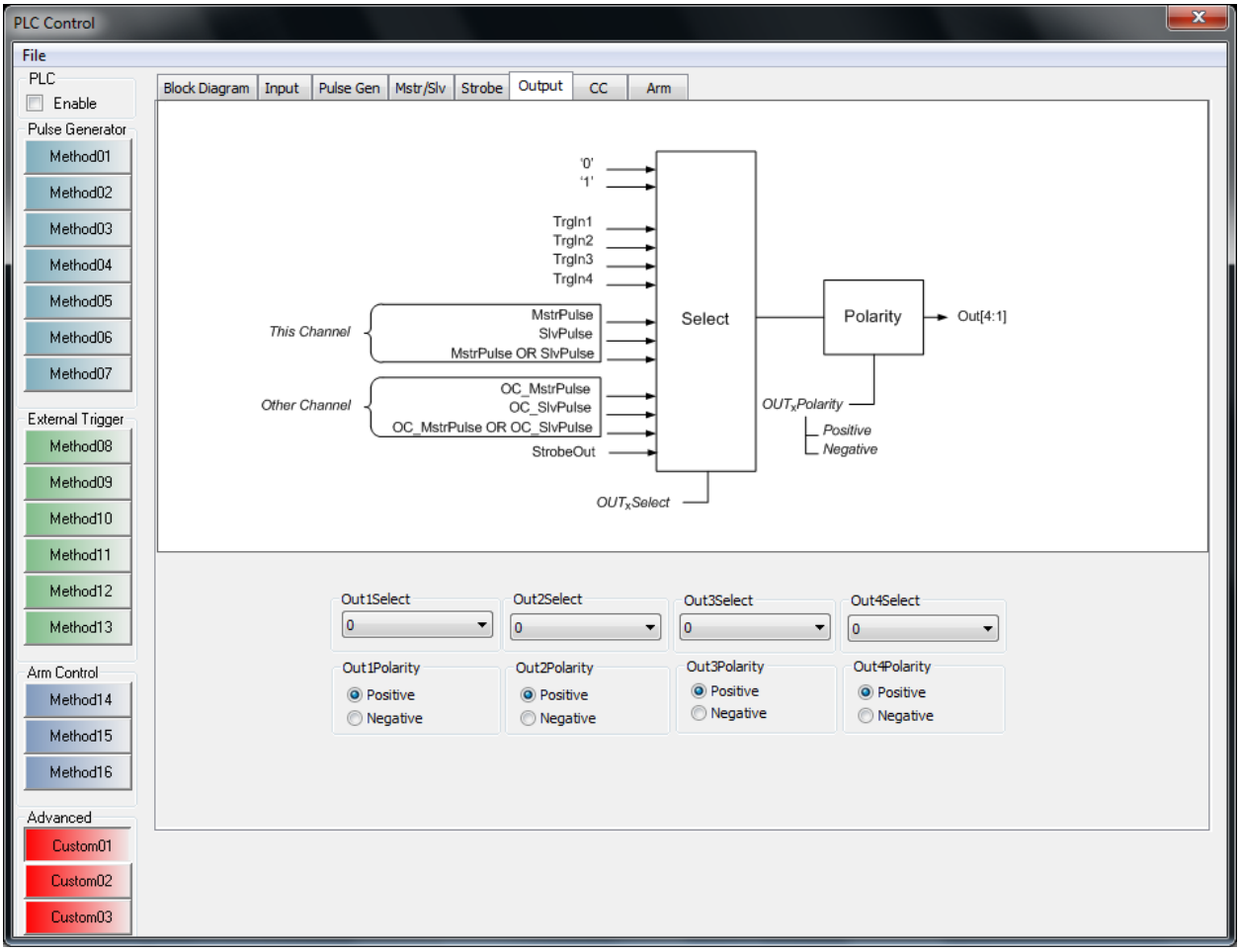


Figure C.22 – PLC Output block

Out$_x$Select Selects the source signal that will be routed to the OUT signal. **TrgIn[4:1]** refers to the trigger signals generated by the Input block. **MstrPulse** and **SlvPulse** refers to the pulses generated by the Mstr/Slv block. "This Channel" refers to pulses created by the PLC attached to the current channel, while "Other Channel" refers to pulses created by the other channel's PLC. **StrobeOut** refers to the pulse created by the Strobe block.

Out$_x$Polarity Selects the polarity of the output signal. Selecting **Negative** will invert the selected source signal.

CC

The CC dialog allows the user to select the source and polarity of the Camera Link CC[4:1] output signals.

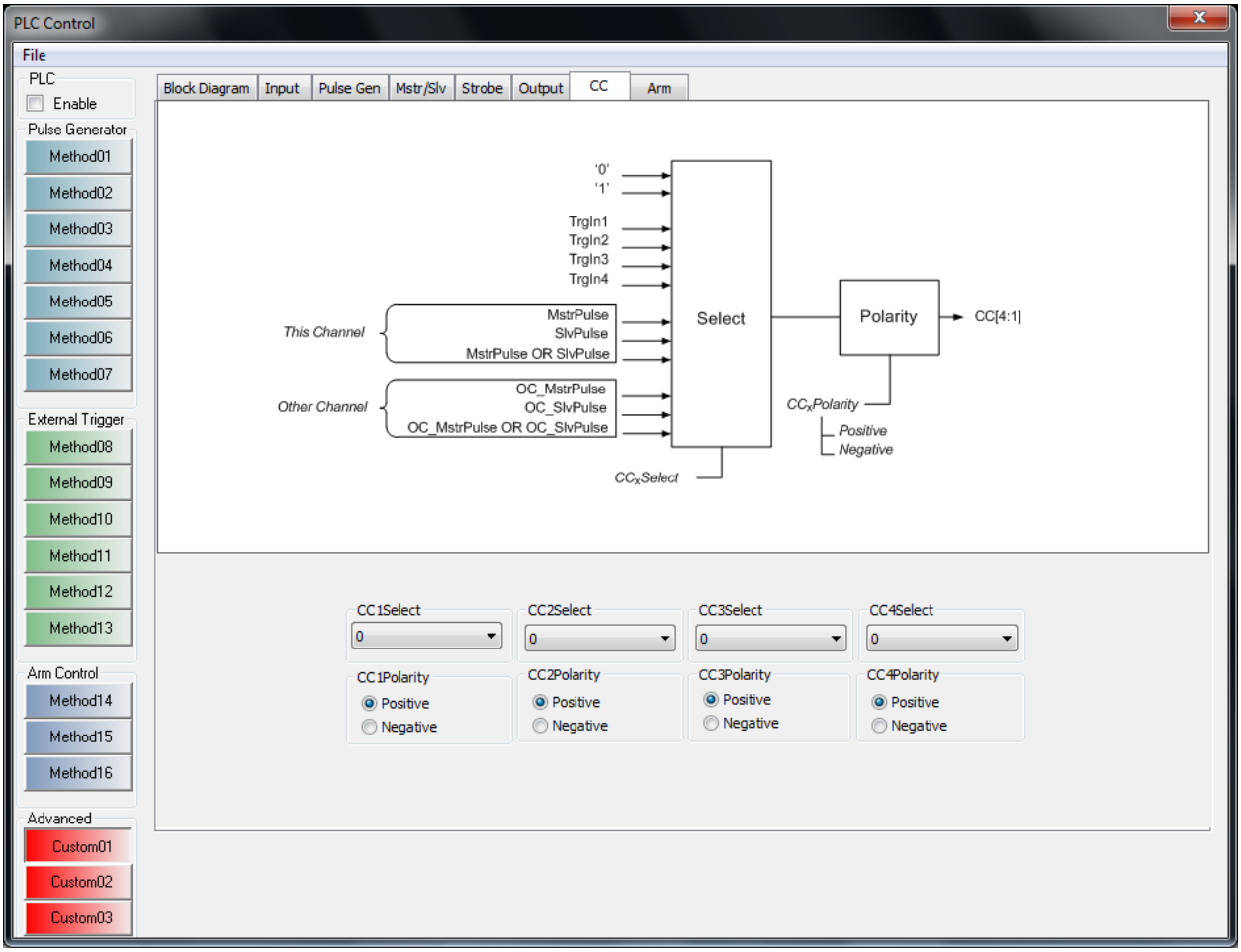


Figure C.22 – PLC CC block

$CC_xSelect$ Selects the source signal that will be routed to the Camera Link CC signal. **TrgIn[4:1]** refers to the trigger signals generated by the Input block. **MstrPulse** and **SlvPulse** refers to the pulses generated by the Mstr/Slv block. “This Channel” refers to pulses created by the PLC attached to the current channel, while “Other Channel” refers to pulses created by the other channel’s PLC. This is useful when you want to have one channel’s PLC drive the CC signals on both Camera Link channels (i.e. to synchronize two cameras).

$CC_xPolarity$ Selects the polarity of the CC signal. Selecting **Negative** will invert the selected source signal.

Arm

The Arm dialog allows the user to configure the generation of an ArmGrab signal. The ArmGrab signal is used by the grabber's capture engine to qualify the acquisition of frames. The capture engine will acquire frames, from the Camera Link interface, as long as the ArmGrab signal is asserted.

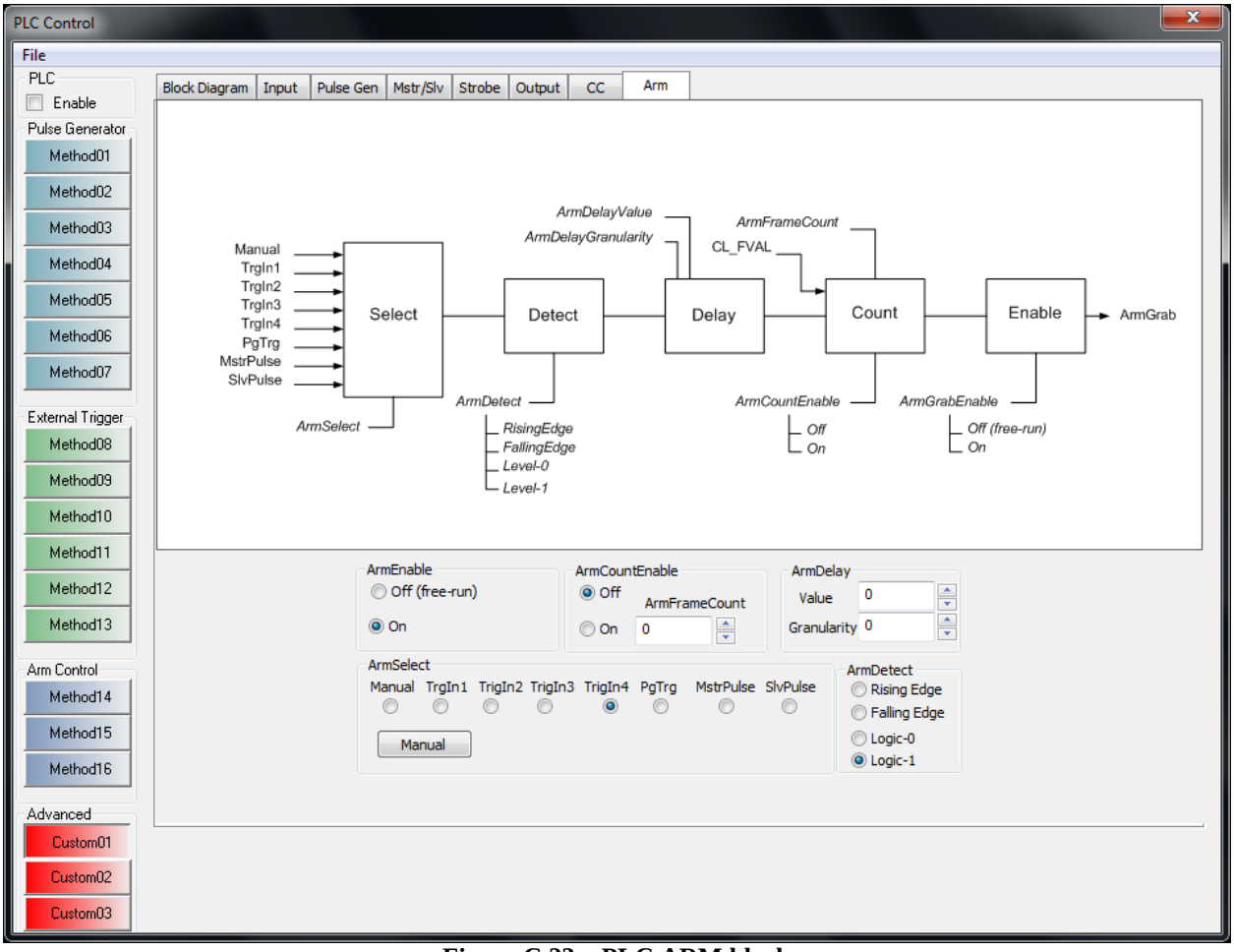
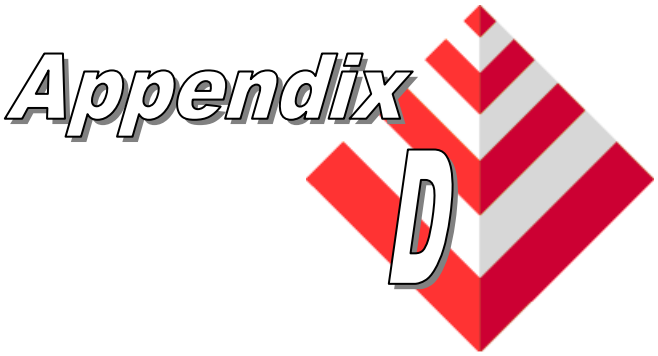


Figure C.23 – PLC ARM block

ArmEnable Enables/disables the operation of the 'arm' function. Selecting **Off** returns the grabber into the free-running mode.

ArmSelect Selects the source signal that will be used to generate the ArmGrab signal. If **Manual** is selected, then the **Manual** button is used. **TrgIn[4:1]** refers to the trigger signals generated by the Input block. **PgTrg** refers to the trigger signal generated by the PG block. **MstrPulse** and **SlvPulse** refers to the pulses generated by the Mstr/Slv block.

ArmDetect	Selects the active edge of the selected source signal as either **Rising** or **Falling**.
ArmDelay Value	Determines how much the ArmGrab signal will be delayed from the selected source signal. The units/increment of the delay is determined by the **ArmDelayGranularity** field.
ArmDelay Granularity	Determines the clock multiplication factor to be used for the **ArmDelayValue** field. The reference clock is 100 MHz, so a **ArmDelayGranularity** of 1 results in the **ArmDelayValue** to be in units of 10 nSeconds.
ArmCount Enable	If set to **On**, causes the ArmGrab signal to be active for a limited number of frames as determined by the **ArmFrameCount** field.
ArmFrame Count	Determines the number of frames that the ArmGrabsignal will be active for when **ArmCountEnable** = **On**.



Power Over CameraLink (PoCL)

This appendix applies to the VCE-CLPCIe02 card only and provides a reference on how to use the PoCL functionality provided by the FrameLink Express.

Overview

The FrameLink Express design is fully compliant with the Power Over Camera Link standard as specified in Annex E of the Camera Link specification version 1.2.

Power Over Camera Link describes an extension to the Camera Link standard to allow a camera to be powered by the frame grabber via the Camera Link cable. This allows a single cable solution to provide power and data, useful in low cost applications. Power is supplied to the camera by redefining the four “Inner Shield” wires in a Camera Link cable as two power lines and two power returns. This means that PoCL continues to use the existing Camera Link connectors, allowing backwards compatibility with existing equipment. All existing signals and functions available to a conventional (non-PoCL) system are still available in a PoCL system. The FrameLink Express implements the SafePower protocol to protect systems in the event of an accidental mix of PoCL and conventional Camera Link products.

Compatibility

The FrameLink Express is considered a “Switchable PoCL frame grabber”, where the 12V can be switched to ground to allow the frame grabber to operate with both PoCL and conventional Camera Link cameras, as opposed to a “Dedicated PoCL frame grabber” which is dedicated to PoCL operation and therefore always supplies 12V.

Voltage

The FrameLink Express supplies 12V DC ±1V to pins and 1 and 26 on the Camera Link connector.

Power

The FrameLink Express is capable of supplying 4W over the full voltage. The FrameLink Express ties together pin 1 to pin 26, and pin 13 to pin 14, on the Camera Link connector.

Comment: This helps ensure that the power is equally split between the four power lines in the cable.

Over-Current Protection

In the event of a conventional Camera Link cable or camera being plugged into a PoCL frame grabber, the power output from the frame grabber would get shorted to ground. Therefore, the FrameLink Express implements an over-current protection circuit to limit the transient power in the event of a power-ground short.

SafePower

SafePower is a protocol to prevent the frame grabber from attempting to supply power to a conventional cable or camera.

The FrameLink Express meets the following SafePower requirements:

- It senses that a PoCL camera and cable are connected before applying power. It can do this by sensing the camera's nominal 10kΩ input resistance "Rs", in which case it shall use a sense current of 52μA ± 10%.

  Comment: The 10kΩ / 52μA combination, with a total tolerance of 15%, gives a sensed voltage of 0.44V to 0.6V after allowing for the RC time constant of 0.57s from the 57μF maximum capacitance "Cs" with the 10kΩ input resistance. Note that if a conventional camera or cable is connected, the sensed voltage will be near zero.

- Once power has been applied to a PoCL camera, the FrameLink Express monitors the Camera Link XCLK clock pair. If the clock is not present within a specified time of the frame grabber supplying power, or if at any time the clock stops for more than a specified time, the frame grabber shall remove power from the camera.

  Comment: This causes power to be removed if the camera or cable is unplugged, and prevents the risk of a short should a user unplug a powered PoCL camera, and plug in a conventional camera in its place. It also allows the state machine controlling SafePower to return to its "Sense" state ready to detect a new camera.

- Once power has been applied to a PoCL camera, the FrameLink Express monitors the voltage on pins 1 and 26 on the Camera Link connector. If this voltage drops to a level for more than 20ms indicating that the OCP has tripped, the frame grabber shall remove power from the camera.

- If the FrameLink Express senses that a conventional Camera Link camera or cable is connected, it shall connect its PoCL power lines to ground.

Comment: This allows them to operate as inner shield wires.

- Once the PoCL power lines have been connected to ground for a conventional camera, the FrameLink Express monitors the Camera Link XCLK clock pair. If the clock is not present within a specified time of the frame grabber supplying power, or if at any time the clock stops for more than 1s, the frame grabber shall disconnect the PoCL power lines from ground.

  Comment: This allows the state machine controlling SafePower to return to its "Sense" state ready to detect a new camera.

Disable Mode

The FrameLink Express allows the user to place the card into a "PoCL Disable" mode where its PoCL power lines are always connected to ground. This allows for legacy conventional cameras with very long clock startup or clock disconnection times, in case any operational problems result from the action of the PoCL sense circuit.

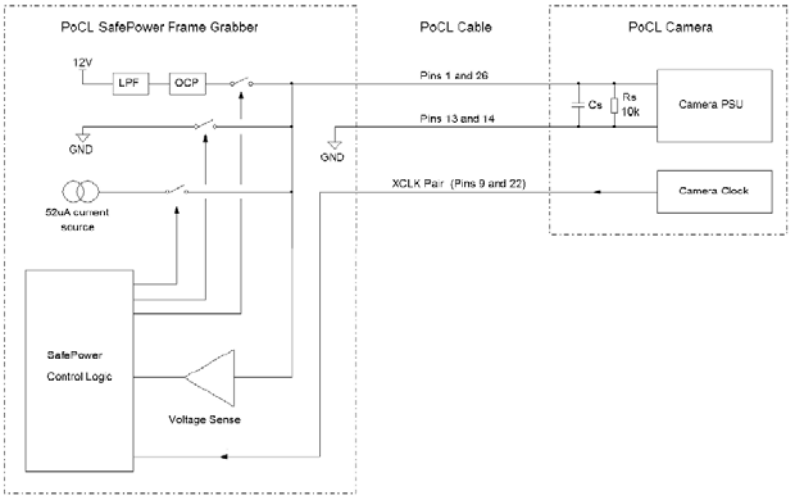


Figure D.1 – PoCL Block Diagram

Notes:

LPF = Power supply low pass filter.
OCP = Over current protection circuit.
PSU = Power supply unit.
SafePower Control Logic = SafePower protection protocol.
Rs = Camera sense resistor for SafePower.
Cs = Camera input capacitance for SafePower.

LEDs

Two LED indicators are provided, one per channel, on the IO bracket to indicate that the FrameLink Express is supplying power to the camera.

PoCL Dialog

The PoCL dialog allows the user to enable PoCL operation. It also provides status which reflects the current state of the PoCL State Machine as well as the VSense (voltage sensing) circuitry. Support for both Camera Link ports (i.e. connectors) is provided.

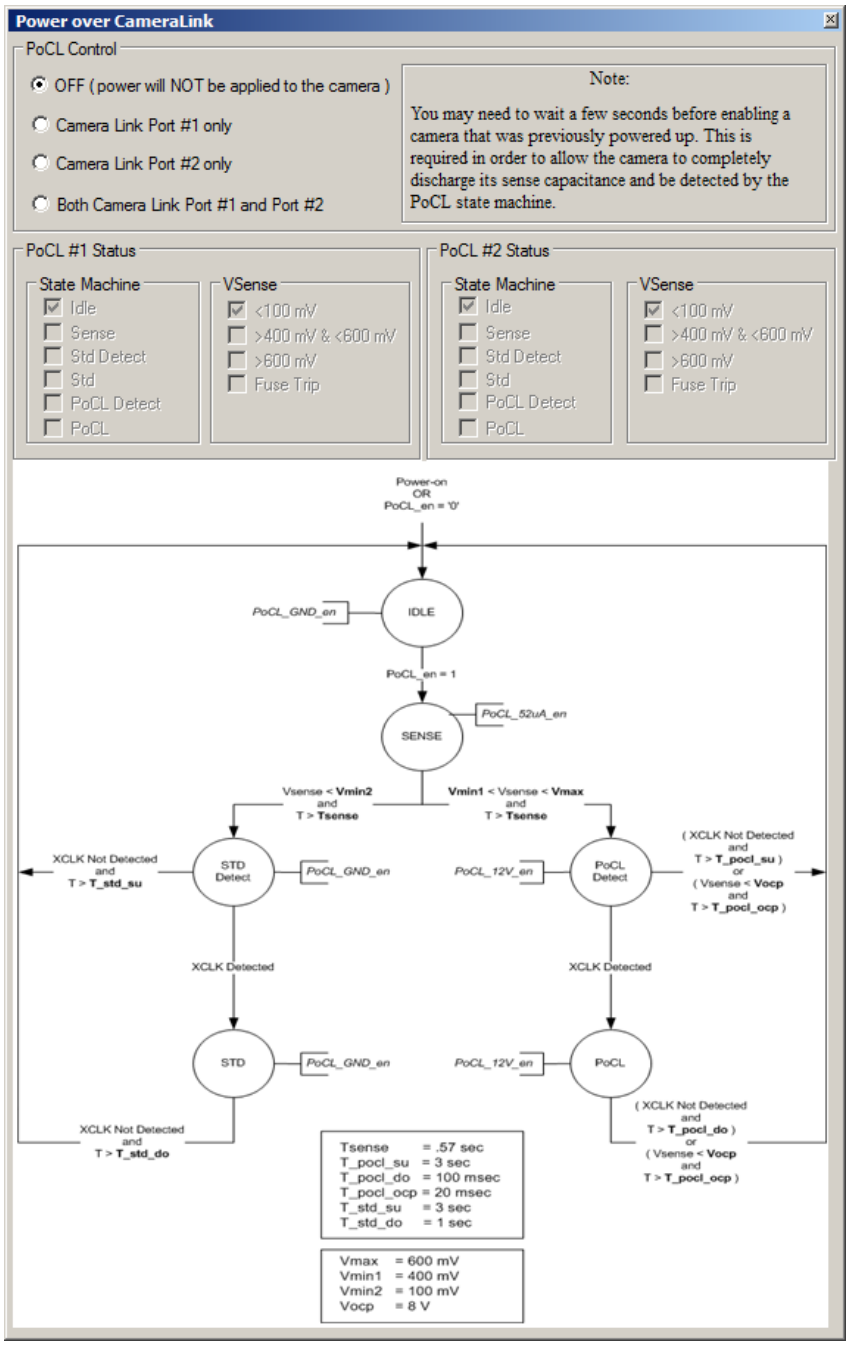


Figure D.2 – PoCL Safe Power state machine

PoCL Control

Off	Turns off both PoCL state machines. Power will not be applied to the camera. Use this for cameras that are not PoCL compliant.
Port #1	Turns on the state machine for Camera Link connector #1 only.
Port #2	Turns on the state machine for Camera Link connector #2 only.
Both	Turns on the state machine for both Camera Link port #1 and port #2 simultaneously. This is required when connecting to a PoCL compliant camera that expects power from both camera link connectors.

PoCL Status

State Machine	Displays the current state of the PoCL state machine. Refer to the state diagram for more information.
VSense	Displays the voltages measured by the PoCL voltage sensing circuitry. Refer to the state diagram for more information.

Appendix E

General Purpose Input/Output

This appendix applies to the VCE-CLPCIe02 card only and provides a reference on how to use the GPIO functionality provided by the FrameLink Express.

Overview

The FrameLink Express design includes an I/O capability which supports four inputs and four outputs. These signals are shared between the two channels and are connected to the PLC of each channel. Each channel's PLC can sink the inputs and source the outputs. The outputs are logical-or'ed between the two channels. Support for a variety of electrical interfaces is provided. Selection of which electrical interface signaling type to use is set via switches on the VCE-CLPCIe02 daughter-card.

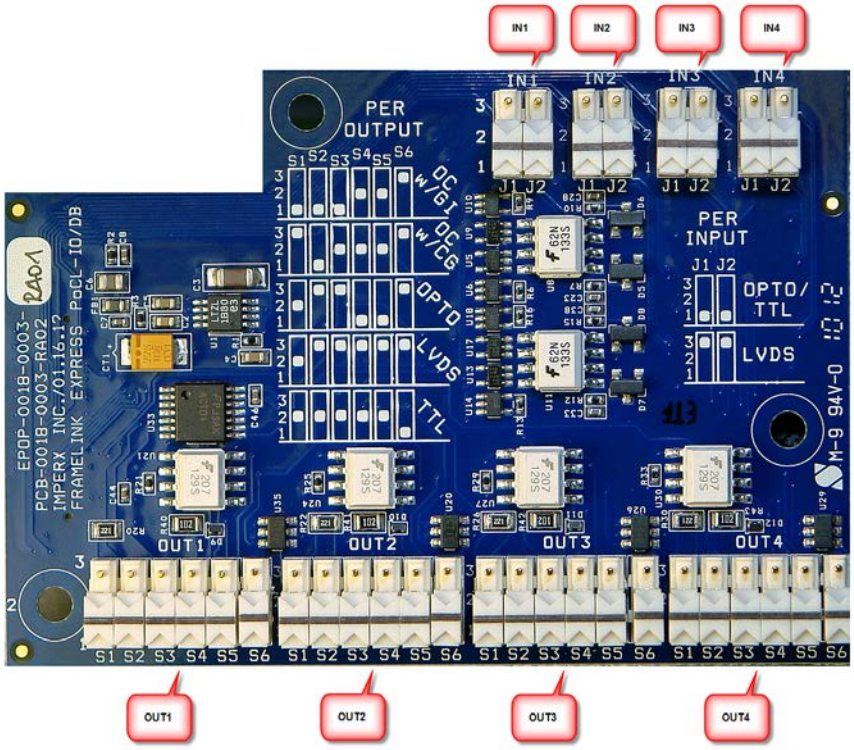


Figure E.1 – VCE-CLPCIe02 Daughter-card GPIO Switches

Inputs

The FrameLink Express design supports three input signaling types:

- Opto-coupled
- LVDS
- TTL

Each of the four inputs, IN[4:1], can be independently configured as one of these three signaling types. The configuration is made by setting switches J1 and J2 on the daughter-card.

Signaling	J1	J2
Opto-coupled	1	1
LVDS	3	3
TTL	1	1

Table E.1 – GPIO IN[4:1] switch settings

Outputs

The FrameLink Express design supports five output signaling types:

- Open-collector with Galvanic Isolation (OC w/GI)
- Open-collector with Common Ground (OC w/CG)
- Opto-coupled
- LVDS
- TTL

Each of the four outputs, OUT[4:1], can be independently configured as one of these five signaling types. The configuration is made by setting switches S1 thru S6 on the daughter-card.

Signaling	S1	S2	S3	S4	S5	S6
OC w/GI	1	1	1	2	2	3
OC w/CG	3	1	2	2	2	3
Opto-coupled	2	3	3	1	1	3
LVDS	2	3	3	3	3	3
TTL	2	2	2	2	2	1

Table E.2 – GPIO OUT[4:1] switch settings

General Purpose Input Circuit

The input circuit can be configured, via switches J1 and J2, to accept external sources which provide opto-coupled, LVDS or TTL signaling.

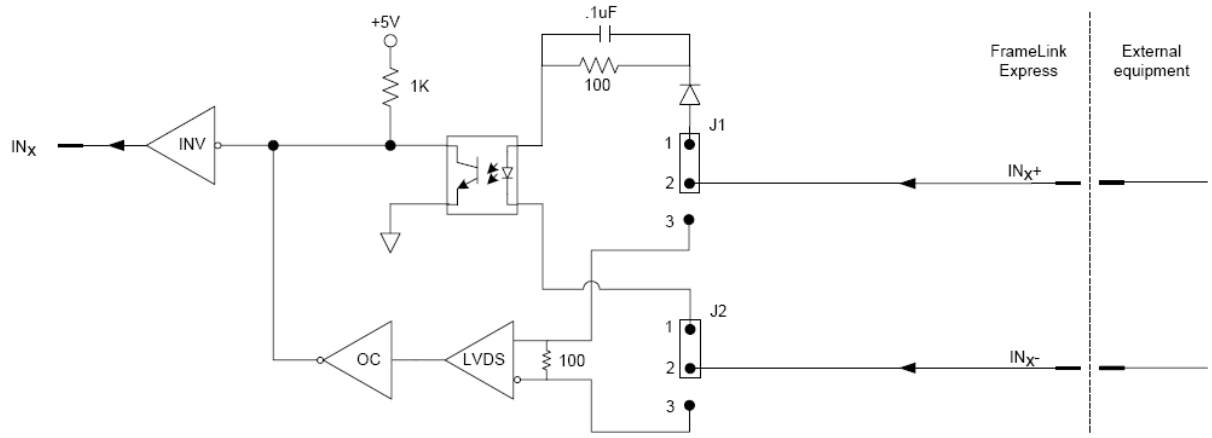


Figure E.2 – General Purpose Input Circuit

Opto-coupled Input Circuit

This configuration accepts an external source which is electrically isolated from the FrameLink Express card. The user must supply a current limited LED voltage on the IN+ pin and must sink the LED's current on the IN- pin.

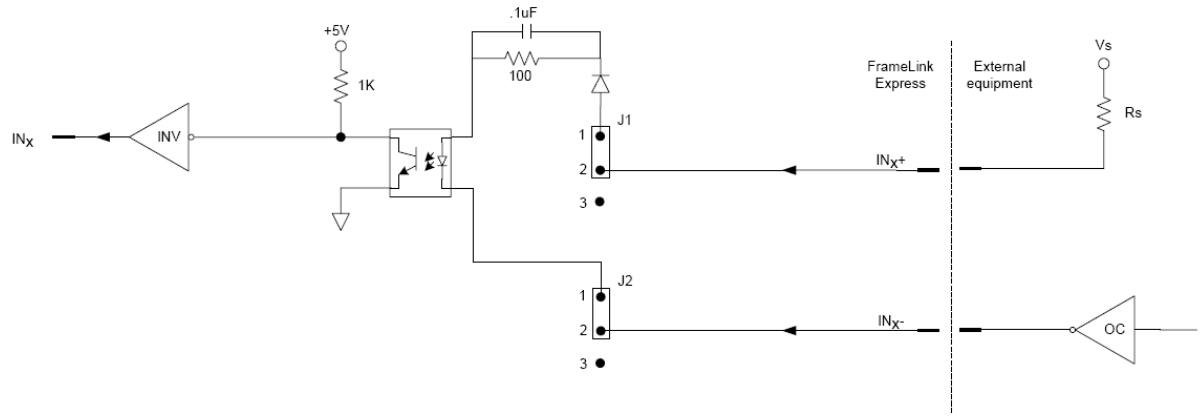


Figure E.4 – Opto-coupled Input Circuit

LVDS Input Circuit

This configuration accepts an external source which provides differential LVDS signaling. The FrameLink Express's LVDS receiver is terminated via a 100 Ohm parallel resistor.

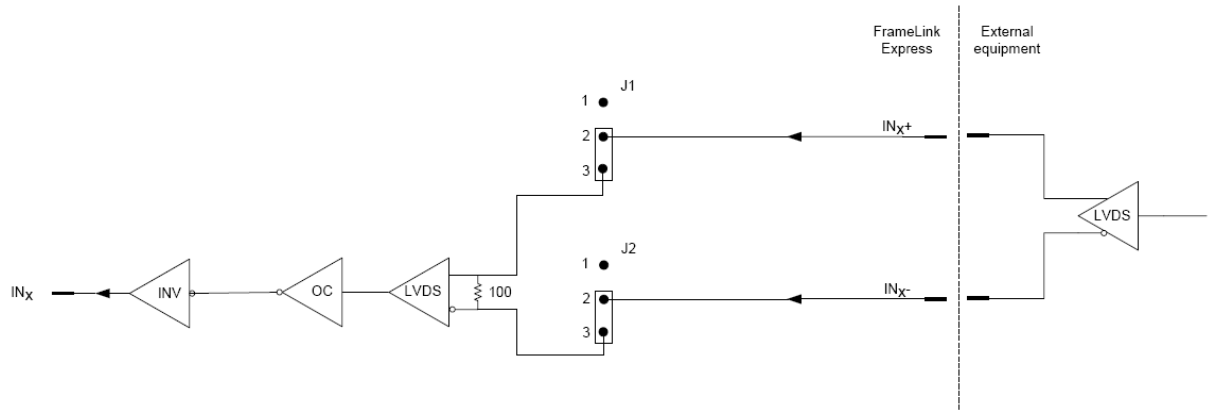


Figure E.5 – LVDS Input Circuit

This configuration accepts an external source which provides single ended TTL signaling.

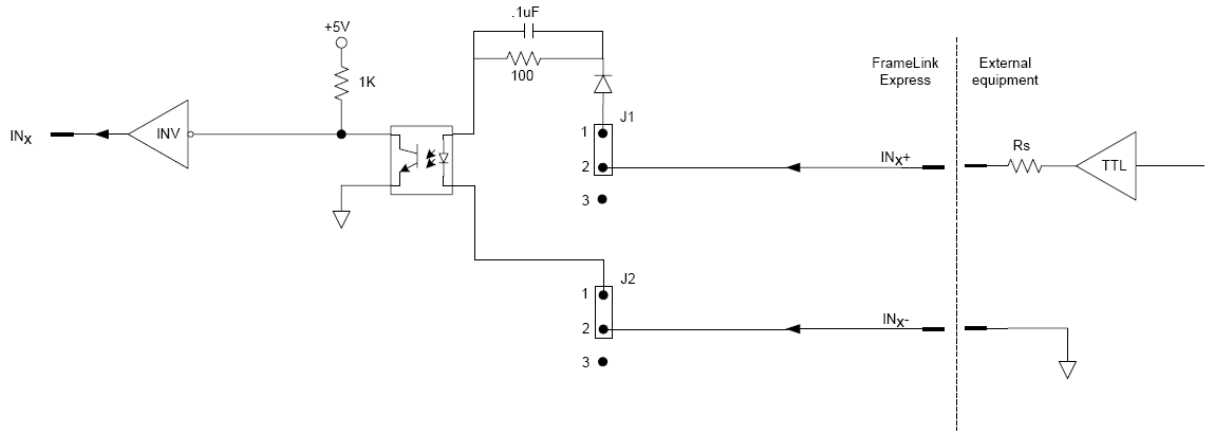


Figure E.6 – TTL Input Circuit

General Purpose Output Circuit

The output circuit can be configured, via switches S1 through S6, to provide open-collector with galvanic isolation, open-collector with common ground, opto-coupled, LVDS or TTL signaling.

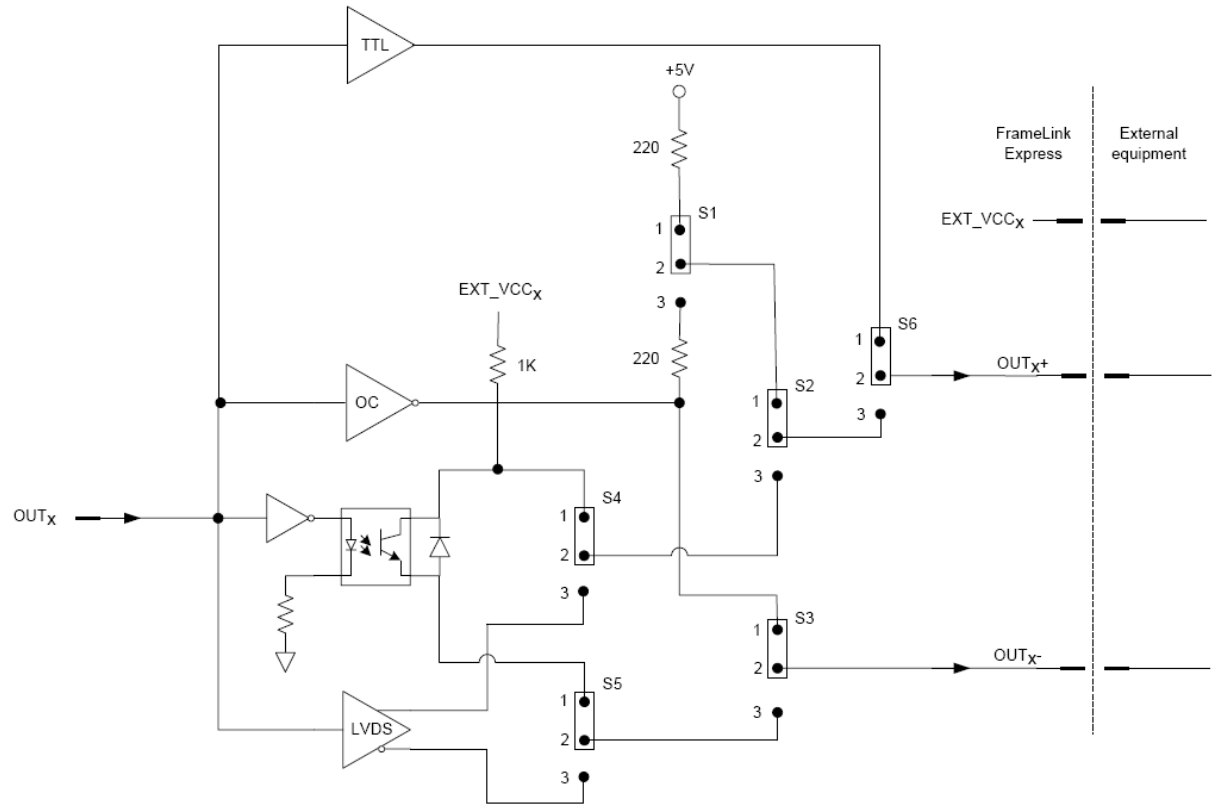


Figure E.3 – General Purpose Output Circuit

Open Collector using Galvanic Isolation Output Circuit

This configuration drives a user's opto-coupled device configured for galvanic isolation between the Framelink Express and the user. The power for the user's LED is supplied by the board's +5V through a 220 Ohm resistor. The open-collector driver will sink the current from the LED.

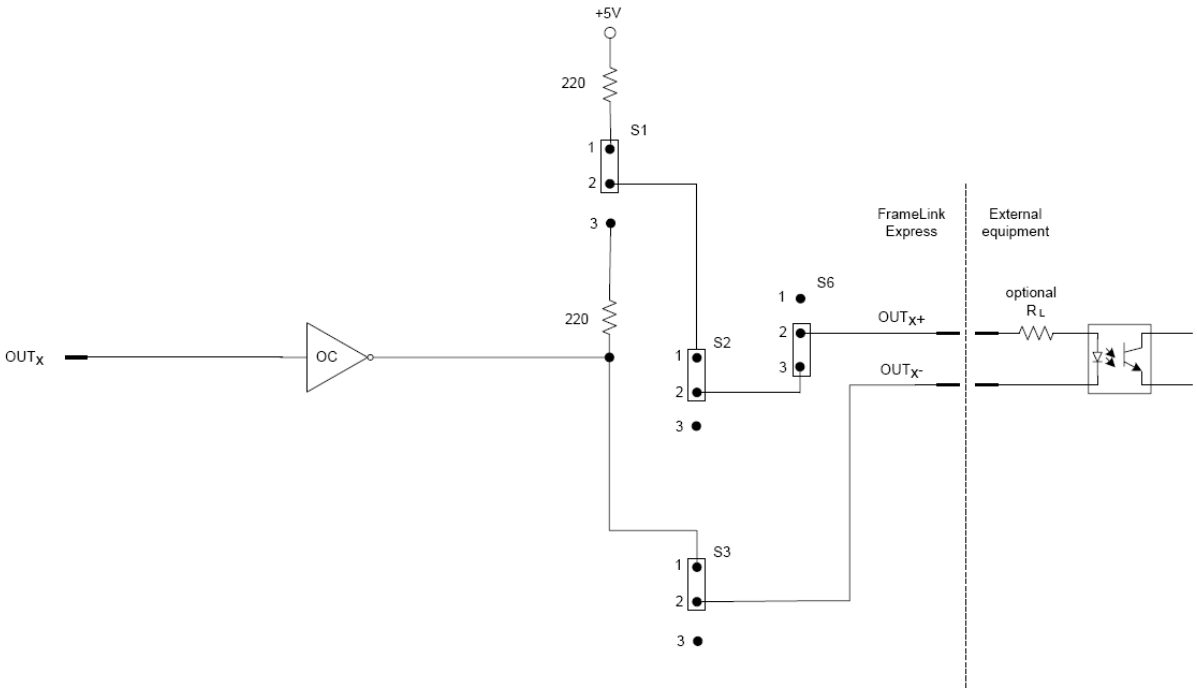


Figure E.7 – Open Collector using Galvanic Isolation Output Circuit

Open Collector using Common Ground Output Circuit

This configuration drives a user's opto-coupled device configured for a common ground between the Framelink Express and the user. The user must supply the +5V for his LED and the two systems must have their grounds connected. The open-collector driver will sink the current from the LED.

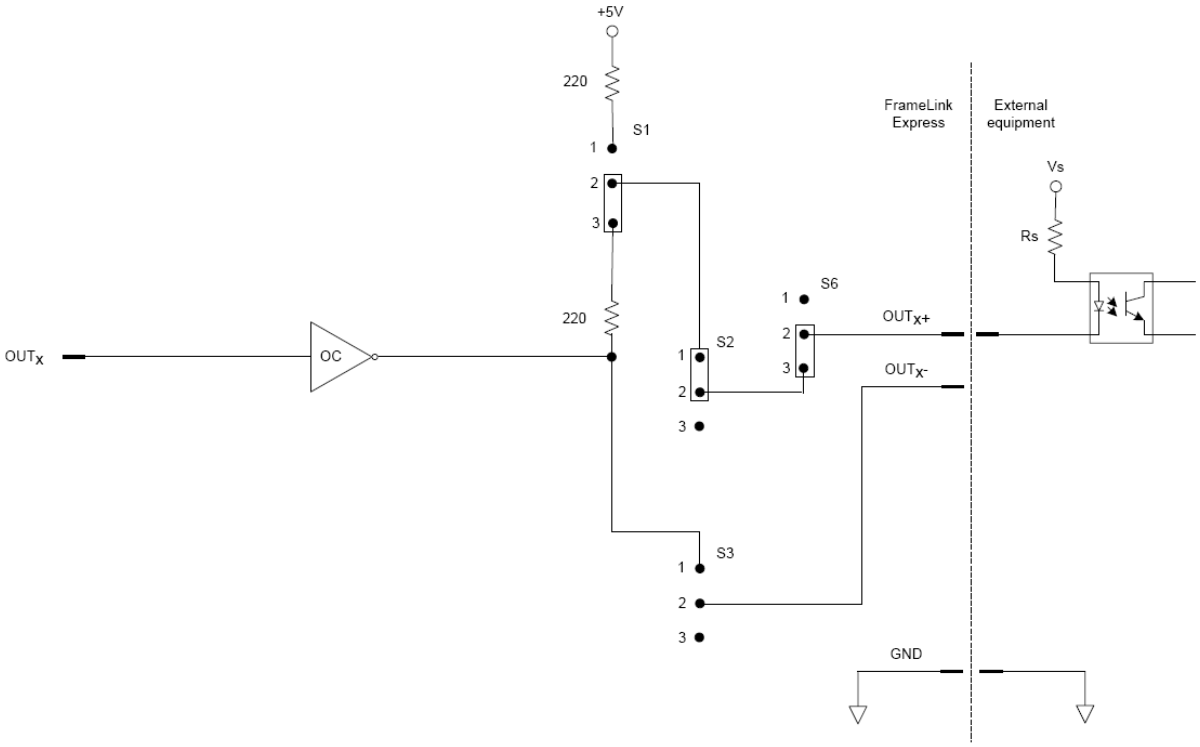


Figure E.8 – Open Collector using Common Ground Output Circuit

Opto-Isolated Output Circuit

This configuration drives a user's receiver configured for galvanic isolation between the Framelink Express and the user. The Framelink Express output is opto-coupled and provides an isolated NPN transistor switch. The user must supply the voltage required by his receiver via the EXT_VCC pin and must also connect the ground required by his receiver to the OUT- pin.

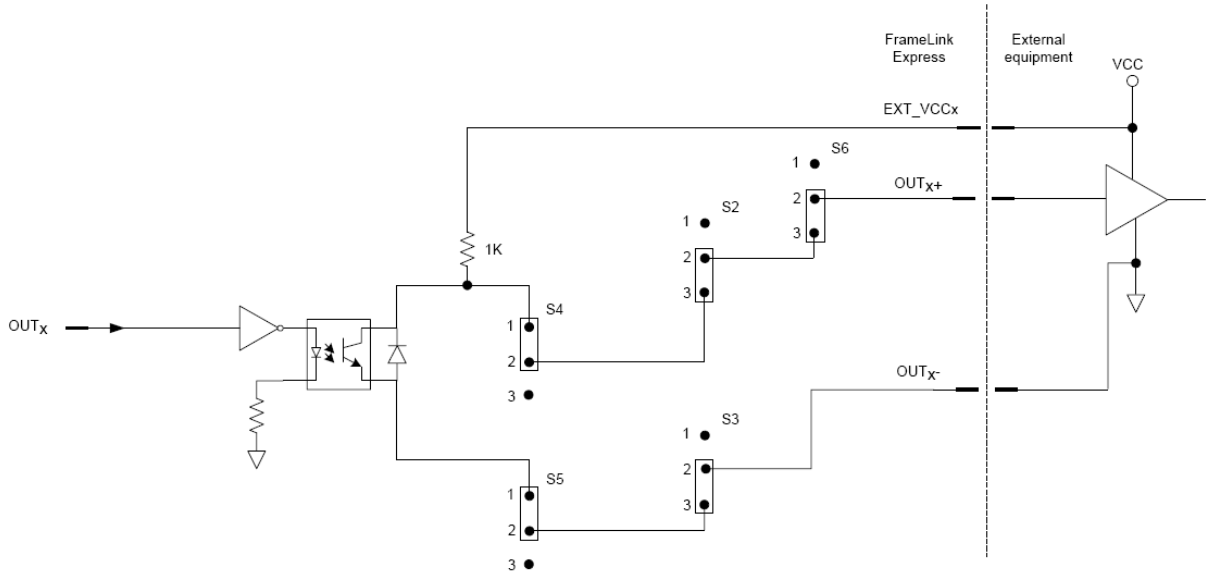


Figure E.9 – Opto-coupled Output Circuit

LVDS Output Circuit

This configuration drives a user's differential LVDS receiver. The user's LVDS receiver should be terminated via a 100 Ohm parallel resistor.

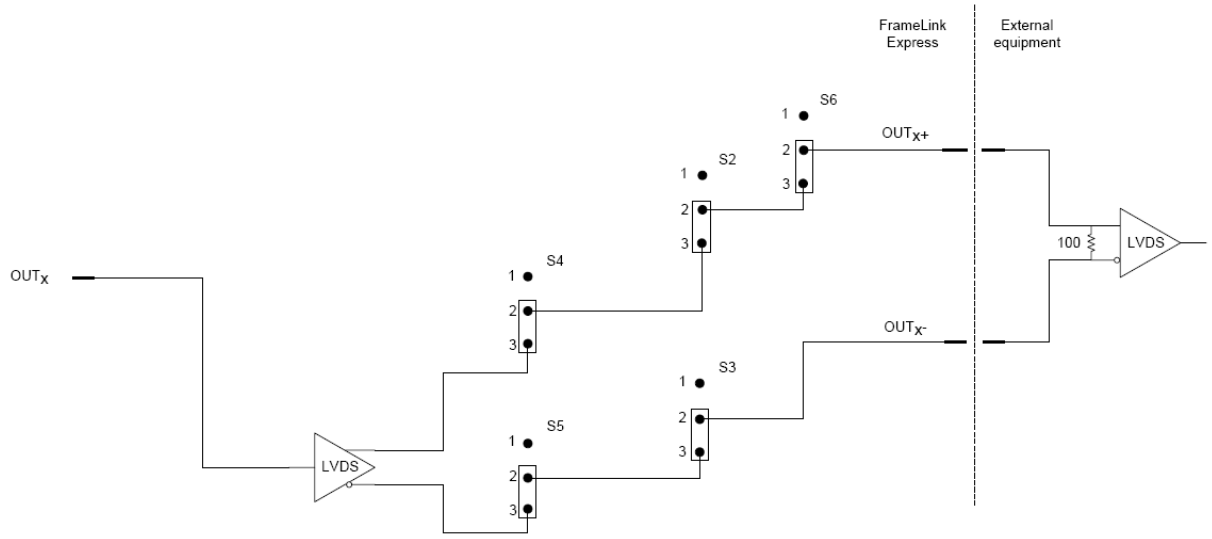


Figure E.10 – LVDS Output Circuit

TTL Output Circuit

This configuration drives a user's single-ended TTL receiver. The two systems must have their grounds connected.

Figure E.11 – TTL Output Circuit

Input		
	Opto-coupled	Input current: logic-0: 250 uA (max) logic-1: 6.3 mA (min) to 15 mA (max)
		Input voltage threshold: logic-0: 1.0 V (max) logic-1: 3.5 V (min)
	LVDS	100 ohm differential termination
		Input current: -20 uA (min) to +20 uA (max)
		Input voltage: common mode: -5 V (min) to +5 V (max) differential threshold: -200 mV (min) to 200 mV (max)
	TTL	Use 330 Ohm series resistor (Rs)
		Input voltage threshold: logic-0: 1.0 V (max) logic-1: 3.5 V (min)

Table E.3 – Input electrical specifications

Output		
	Open-collector with galvanic isolation	Vout: 30V (max) pull-up Vol: 0.7V (max) @ 30mA
	Open-collector with common ground	Vout: 30V (max) pull-up
		Vol: 0.7V (max) @ 30mA
	Opto-coupled	ExtVCC: 5V(min), 15V (max)
		Internal Rp: 1.00 KOhm
		Vol: 0.4V (max) @ 2mA
	LVDS	Output voltage (loaded to 100 ohm): differential: 250 mV (min) to 450 mV (max) common mode: 1.125 V (min) to 1.375 V (max) logic-0: 0.9 V (min) logic-1: 1.6 V (max)
	TTL	Output voltage: logic-0: 0.55 V (max) at -32 mA logic-1: 3.8 V (min) at 32 mA

Table E.4 – Output electrical specifications