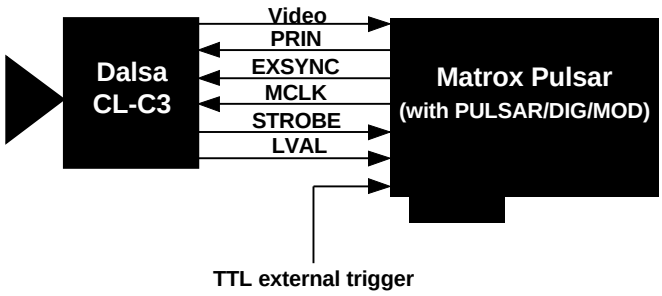
Application Note:
Interfacing non-standard cameras to Matrox Pulsar

DALSA CL-C3-1024A **May 29, 1996**

Camera Interface Overview	• 1000 x 1 x 8-bit • 2 channel digital video output (RS-422) • external sync required • variable line scan rate • exposure control
Camera Interface Details	**Variable line scan rate**  • 1000 x 1 x 8-bit • 2 channel digital video output (RS-422) • DCF configured for 480 lines per virtual frame • line scan rate is variable and is controlled by external trigger signal • Matrox Pulsar receiving TTL external trigger • Matrox Pulsar sending EXPOSURE1 (PRIN), EXPOSURE2 (EXSYNC) and reference clock (MCLK) signals (all RS-422) to camera; the EXPOSURE1 and EXPOSURE2 signals control the exposure time • Matrox Pulsar receiving RS-422 pixel clock (STROBE @ 7.159MHz) and RS-422 vsync (LVAL) signals from camera; the LVAL signal initiates line readout • DCF used: CLC3_LS.DCF • in addition to the DCF, PSG FPGA version 3.01 or newer is required; if this version is not on your release of the MIL driver for Pulsar, the newest version can be found on the BBS or at the FTP site
Cabling Requirements	**Variable line scan rate** • IMG-7W2-TO-5BNC cable required for TTL external trigger source and PULSAR/DIG/MOD required for digital data, syncs and control signals in RS-422 format

Cabling Requirements (Continued)

- the connections between the **OS1** 20-pin dual row connector of the camera and the 68-pin SCSI-2 connector of the PULSAR/DIG/MOD are as follows:

DALSA CL-C3-1024A (20-pin dual row connector - OS1)			**PULSAR/DIG/MOD (68-pin SCSI-2 connector)**	
Pin name	***Pin no.***		***Pin name***	***Pin no.***
AD7+	1	→	DATA7+	10
AD7–	2	→	DATA7–	44
AD6+	3	→	DATA6+	11
AD6–	4	→	DATA6–	45
AD5+	5	→	DATA5+	13
AD5–	6	→	DATA5–	47
AD4+	7	→	DATA4+	14
AD4–	8	→	DATA4–	48
AD3+	9	→	DATA3+	15
AD3–	10	→	DATA3–	49
AD2+	11	→	DATA2+	16
AD2–	12	→	DATA2–	50
AD1+	13	→	DATA1+	19
AD1–	14	→	DATA1–	53
AD0+	15	→	DATA0+	20
AD0–	16	→	DATA0–	54
STROBE+	17	→	CLKIN+	29
STROBE–	18	→	CLIKIN–	63
LVAL+	19	→	HSYNC+	26
LVAL–	20	→	HSYNC–	60

- the connections between the **OS2** 20-pin dual row connector of the camera and the 68-pin SCSI-2 connector of the PULSAR/DIG/MOD are as follows:

DALSA CL-C3-1024A (20-pin dual row connector - OS2)			**PULSAR/DIG/MOD (68-pin SCSI-2 connector)**	
Pin name	***Pin no.***		***Pin name***	***Pin no.***
BD7+	1	→	DATA15+	2
BD7–	2	→	DATA15–	36
BD6+	3	→	DATA14+	3
BD6–	4	→	DATA14–	37
BD5+	5	→	DATA13+	4
BD5–	6	→	DATA13–	38
BD4+	7	→	DATA12+	5
BD4–	8	→	DATA12–	39
BD3+	9	→	DATA11+	6
BD3–	10	→	DATA11–	40
BD2+	11	→	DATA10+	7
BD2–	12	→	DATA10–	41
BD1+	13	→	DATA9+	8
BD1–	14	→	DATA9–	42
BD0+	15	→	DATA8+	9
BD0–	16	→	DATA8–	43

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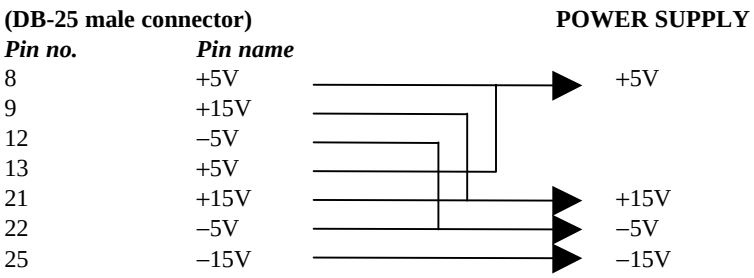
Cabling Requirements (Continued)

- the connections between the DB-25 connector on the rear panel of the camera and the 68-pin SCSI-2 connector of the PULSAR/DIG/MOD are as follows:

DALSA CL-C3-1024A (DB-25 male connector)			PULSAR/DIG/MOD (68-pin SCSI-2 connector)	
Pin name	***Pin no.***		***Pin name***	***Pin no.***
MCLK+	6	←	CLKOUT+	24
MCLK–	19	←	CLKOUT–	58
EXSYNC+	17	←	EXPOSURE2+	28
EXSYNC–	4	←	EXPOSURE2–	62
PRIN+	5	←	EXPOSURE1+	30
PRIN–	18	←	EXPOSURE1–	64
GROUND	7		GROUND	1
GROUND	11		GROUND	12
GROUND	20		GROUND	34
GROUND	24		GROUND	35
POWER SUPPLY GROUND			GROUND	46
POWER SUPPLY GROUND			GROUND	68

NOTE: it is very important that all the GROUNDs of the camera be connected together to the POWER SUPPLY GROUND, which in turn must be connected to the GROUND of the Pulsar

- the connections between the DB-25 connector on the rear panel of the camera and the power supply are as follows:



- TTL external trigger source should be connected to the TTL Trigger Input of the IMG-7W2-TO-5BNC cable

Special Considerations

Variable line scan rate

- PSG FPGA version 3.01 or newer is required
- the line rate is variable and is controlled by the external trigger signal
- virtual frame size is 1000 x 1 x 480, with 4 lines of vertical blanking; therefore an effective 480 lines out of every 484 lines are acquired

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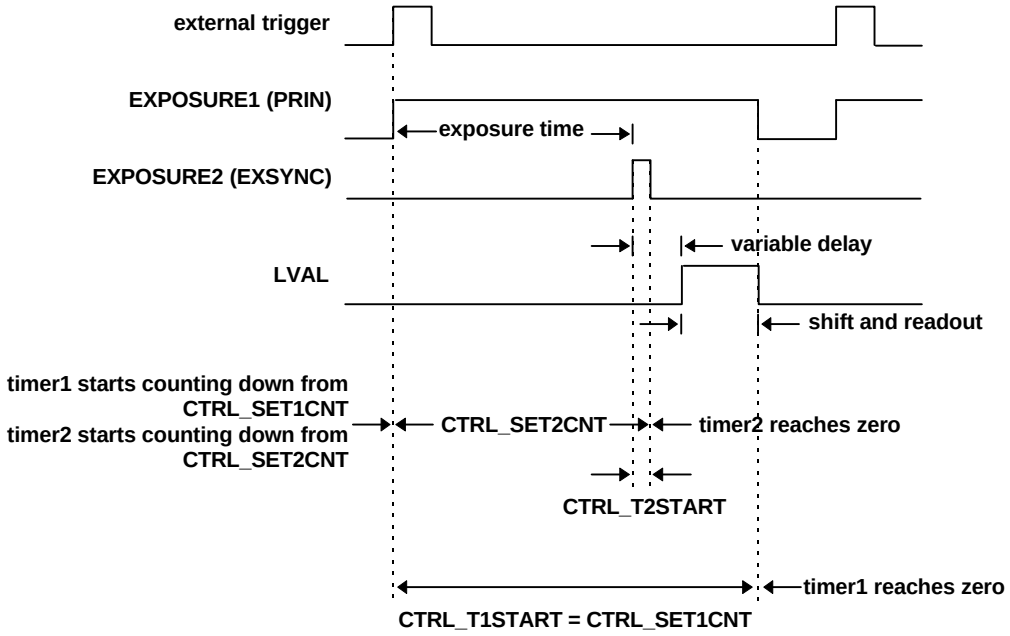
Special Considerations

- once it has received the external signal to trigger, the Pulsar sends the RS-422 EXPOSURE1 (PRIN) signal to the camera to initiate exposure. The Pulsar will send the RS-422 EXPOSURE2 (EXSYNC) signal to the camera following a delay that is equal to the desired exposure time. A short (variable) delay after receiving the EXPOSURE2 pulse, the camera sends the RS-422 LVAL signal to the Pulsar to initiate line readout



- the time between the arrival of the EXPOSURE1 and EXPOSURE2 signals is the exposure time. In order to select the exposure time, the registers that control the width and the deployment time of each of the EXPOSURE1 and EXPOSURE2 pulses must be set in the DCF at the hardware register level. A hardware register editor is provided by running Intellicam with the *-hwreg* option (specifically by running *INTELCAM -hwreg*). An additional menu item, "HW REGISTER EDITOR", appears on the main menu screen. The following registers are used to define the exposure timings:

EXPOSURE1:	CTRL_SET1CNTL	EXPOSURE2:	CTRL_SET2CNTL
	CTRL_SET1CNTH		CTRL_SET2CNTH
	CTRL_T1STARTL		CTRL_T2STARTL
	CTRL_T1STARTH		CTRL_T2STARTH

These are 16-bit registers that have been split in two: the low byte and the high byte. Here, the timers for the EXPOSURE1 and EXPOSURE2 pulses both start as soon as the external trigger signal is received by the Pulsar. CTRL_SET1CNT controls the amount of time that is set on the timer for EXPOSURE1 (timer1); the timer starts at this value and counts down to zero. CTRL_T1START is the width of the EXPOSURE1 pulse and also controls the time at which the EXPOSURE1 pulse is sent.

When timer1 reaches the value set for CTRL_T1START, the EXPOSURE1 signal being sent to the camera goes high. When timer1 reaches zero, the EXPOSURE1 signal goes low. The EXPOSURE1 signal should be sent immediately to the camera upon arrival of an external trigger signal to indicate that exposure should begin, therefore CTRL_SET1CNT and CTRL_T1START must be set equal to each other; this is accomplished by setting CTRL_SET1CNTL equal to CTRL_T1STARTL and CTRL_SET1CNTH equal to CTRL_T1STARTH. The Pulsar indicates to the camera that exposure should stop by sending the EXPOSURE2 pulse. For a given setting of CTRL_SET2CNT, which is the time set on the timer for EXPOSURE2 (timer2), the time at which the EXPOSURE2 pulse is sent is controlled by CTRL_T2START, the width of the EXPOSURE2 pulse. Timer2 starts counting down from CTRL_SET2CNT; when it reaches the value set for CTRL_T2START, the EXPOSURE2 signal being sent to the camera goes high. When timer2 reaches zero, the EXPOSURE2 signal goes low. Since both timers start at the same time, the exposure time is then CTRL_SET2CNT – CTRL_T2START. Finally, it should be noted that the EXPOSURE1 pulse must remain high until the LVAL pulse goes low; therefore the time set on timer1 (CTRL_SET1CNT) must be greater than the exposure time, plus the maximum possible delay between the EXPOSURE2 pulse and the LVAL pulse, plus the width of the LVAL pulse (the line transfer time). The maximum possible delay between the EXPOSURE2 pulse and the LVAL pulse is taken to be 8.9µs (64 pixel times at a clock rate of 7.159 MHz); the line transfer time is 71.5µs (512 pixel times, since there are two outputs, at a clock rate of 7.159 MHz).
So to summarize:

CTRL_T1START = CTRL_SET1CNT, i.e., CTRL_T1STARTL = CTRL_SET1CNTL
and CTRL_T1STARTH = CTRL_SET1CNTH
EXPOSURE TIME = CTRL_SET2CNT – CTRL_T2START
CTRL_SET1CNT > exposure time + maximum delay between EXPOSURE2 and LVAL pulses (8.9µs or 64 pixels) + line transfer time (71.5µs or 512 pixels)

Remember that each 16-bit register is split into a low byte and a high byte. These values must be in pixels and must be set in hexadecimal; the value of each 16-bit register can vary between 0 (0000 in Hex) and 65 535 (FFFF in Hex). The default time set on timer1 as well as the default width of the EXPOSURE1 pulse is 6400 pixels, which in hexadecimal is 1900 (Here the low byte corresponds to 0H and the high byte to 19H). The default time set on timer2 is 6144 pixels (1800H) and the default width of the EXPOSURE2 pulse is 256 pixels (100H). The default exposure time is therefore 6144 – 256 = 5888 pixels, which at a clock rate of 7.159MHz corresponds to 0.82ms. The registers are set in the following way:

CTRL_SET1CNTL	0H	CTRL_SET2CNTL	0H
CTRL_SET1CNTH	19H	CTRL_SET2CNTH	18H
CTRL_T1STARTL	0H	CTRL_T2STARTL	0H
CTRL_T1STARTH	19H	CTRL_T2STARTH	1H

When computing the hardware registers, the following question may be asked: "Some registers have been manually edited. Ok to overwrite them all? (y/n)". Answer "no" to this question and to all questions that follow.

IMPORTANT! These instructions must be followed very carefully*; the only registers that should be modified are those mentioned above*. Please consult Matrox Imaging Applications at (514) 822-6061 if assistance is required.

- the maximum trigger rate is the reciprocal of the width of the EXPOSURE1 pulse, or in other words, it is the reciprocal of the sum of the exposure time and 80.4µs. This last number is the sum of the maximum delay between the EXPOSURE2 and LVAL pulses (taken to be 8.9µs) and the line transfer time (71.5µs). The default max trigger rate is 1.1kHz

- an RS-422 external trigger input may also be used once the following connections between the 68-pin SCSI-2 connector of the PULSAR/DIG/MOD and the external trigger source are made:

PULSAR/DIG/MOD (68-pin SCSI-2 connector)			**External trigger source**
Pin name	***Pin no.***		***Pin name***
TRIGGER+	27	←	"RS-422 TRIGGER+"
TRIGGER-	61	←	"RS-422 TRIGGER-"

- use Matrox Intellicam in order to modify the DCF for an RS-422 external trigger input. Consult the Matrox Intellicam User Guide for more information

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