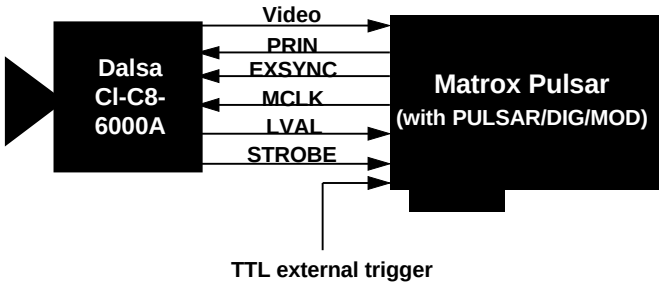
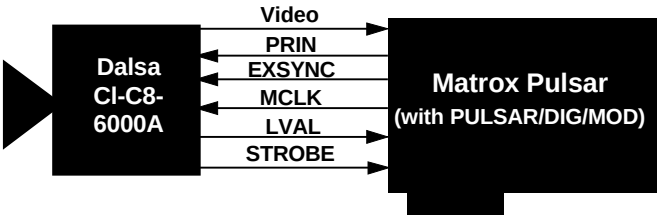
Application Note:
Interfacing non-standard cameras to Matrox Pulsar

DALSA CL-C8-6000A **November 26, 1996**

Camera Interface Overview	• 6000 pixels (3000 x 2 x 8-bit) • Variable line scan rate • Digital video output (RS-422) • Exposure control • 2 modes of operation: variable line scan rate, programmable line scan rate (with programmable exposure control)
Camera Interface Details	**Mode 1: Variable line scan rate**  • 2988 x 2 x 8-bit • 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 RS-422 EXPOSURE 1 (PRIN), EXPOSURE 2 (EXSYNC) and RS-422 reference clock (MCLK) signals to camera; the EXPOSURE2 signal initiates line readout • Matrox Pulsar receiving RS-422 pixel clock (STROBE @ 15 MHz) and RS-422 hsync (LVAL) signals from camera • Exposure control can be changed via INTELLICAM or MIL digitizer control functions. • DCFs used: CLC8DAL.DCF **Mode 2: Programmable line scan rate (with programmable exposure control)**  • 2988 x 2 x 8-bit • Digital video output (RS-422) • DCF configured for 480 lines per virtual frame • Matrox Pulsar sending EXPOSURE 1 (PRIN), RS-422 EXPOSURE2 (EXSYNC) and RS-422 reference clock (MCLK) signals to camera; the EXPOSURE2 signal initiates line readout • Matrox Pulsar receiving RS-422 pixel clock (STROBE @ 15 MHz) and RS-422 hsync (LVAL) signals from camera • Line scan rate and exposure control and can be changed via INTELLICAM or MIL digitizer control functions. • DCFs used: CLC8DEL.DCF

Cabling Requirements

Mode 1: 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
- TTL external trigger source should be connected to the TTL Trigger Input of the IMG-7W2-TO-5BNC cable
- The connections between the 20-pin dual row connector (labeled OS1 and OS2) of the camera and the 68-pin SCSI-2 connector of the PULSAR/DIG/MOD are as follows:

DALSA CL-C8-6000A (20-pin dual row connector - OS1)			**PULSAR/DIG/MOD (PULSAR/CBL/OPEN 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	→	CLKIN-	63
LVAL+	19	→	HSYNC+	26
LVAL-	20	→	HYSNC-	60

DALSA CL-C8-6000A (20-pin dual row connector - OS2)			**PULSAR/DIG/MOD (PLS/CBL/OPEN 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

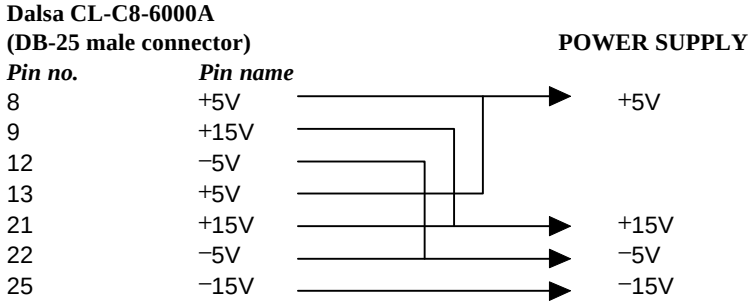
(Pin-out continued)

BD1-	14	→	DATA9-	42
BD0+	15	→	DATA8+	9
BD0-	16	→	DATA8-	43
not connected	17			
not connected	18			
not connected	19			
not connected	20			

- 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-C8-6000A (DB-25 male connector)			**PULSAR/DIG/MOD (PLS/CBL/OPEN 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			**PLS/CBL/OPEN**	
GROUND			GROUND	46
GROUND			GROUND	68

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



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

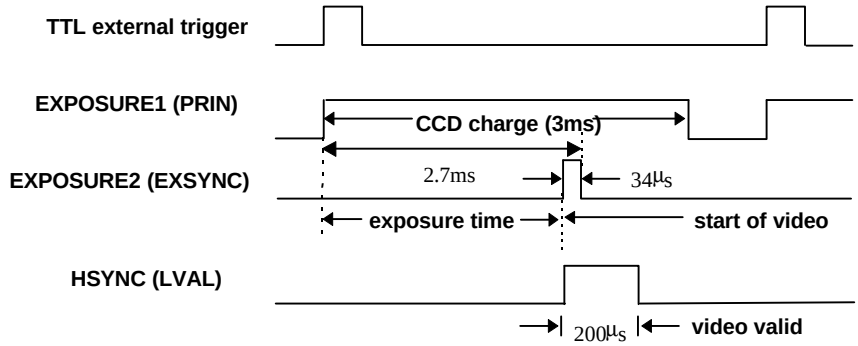
Mode 2: Programmable periodic line scan rate (programmable exposure control)

- All connections except IMG-7W2-TO-5BNC cable (no TTL external trigger) are as in Mode 1: *variable line scan rate*

Special Considerations

Mode 1: Variable line scan rate

- The line scan rate is variable and is controlled by the external trigger signal.
- 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.



- The time between the arrival of the rising edge of EXPOSURE1 and the rising edge of 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

The above are 16-bit registers that have been split in two: the low byte and the high byte. Here, the timer for the EXPOSURE1 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.

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 sum of the exposure time, the maximum possible delay between the EXPOSURE2 pulse and the LVAL pulse, and the width of the LVAL pulse (the line transfer time).

The maximum possible delay between the EXPOSURE2 pulse and the LVAL pulse is calculated to be 6.4µs (4µs + 11 MCLK + 4 MCLK + 400ns or 4µs + 0.73µs + 0.26µs + 400ns = 5.39µs maximum). The line transfer time is 199.9µs (2988 pixels times at a clock rate of 15 MHz).

So to summarize:

CTRL_T1START = CTRL_SET1CNT, i.e., CTRL_T1STARTL = CTRL_SET1CNTL and CTRL_T1STARTH = CTRL_SET1CNTH

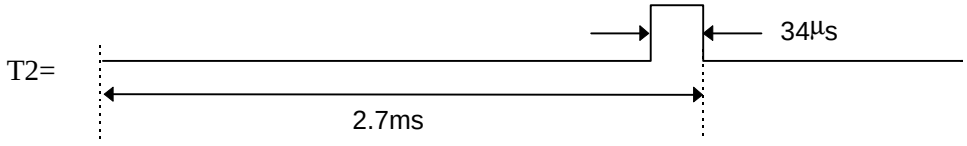
EXPOSURE TIME = CTRL_SET2CNT -CTRL_T2START

CTRL_SET1CNT > exposure time + maximum delay between EXPOSURE2 and LVAL pulses (5.39µs) + line transfer time (199.9µs)

Remember that each 16-bit register is split into a low and 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 registers are set in the following way:

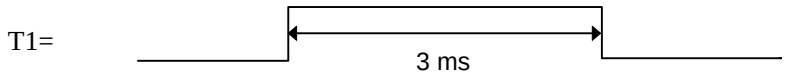
T2 user clock 14.31MHz (clock source select)

	Hex	Decimal equivalent x user clock period
CTRL_ SET2CNTL	DA	39130 x (69.9ns) = 2.7ms
CTRL_ SET2CNTH	98	
CTRL_T2STARTL	E8	488 x (69.9ns) = 34µs
CTRL_T2STARTH	1	



T1 user clock 14.31MHz (clock source select)

	Hex	Decimal equivalent x user clock period
CTRL_ SET1CNTL	CA	42954 x (69.9ns) = 3 ms
CTRL_ SET1CNTH	A7	
CTRL_T1STARTL	CA	42954 x (69.9ns) = 3 ms
CTRL_T1STARTH	A7	



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 default exposure time for this DCF is 2.7 ms
- For this DCF, the minimum line scan rate is 3.1ms. The line scan rate can be increased by changing the RS-422 external trigger (for this DCF, the period of the external trigger can be equal to or more than 3.1 ms).
- Use Matrox Intellicam in order to modify the DCF for RS-422 external trigger input. Consult the Matrox Intellicam User Guide for more information.
- Contact your local sales representative or Matrox Sales Office, or contact Matrox Imaging Applications at 514-822-6061 for assistance (if required).

Mode 2: Programmable line scan rate (with programmable exposure control)

- The time between the arrival of the rising edge of EXPOSURE1 and rising edge of 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 or by programming the line scan rate for this DCF. A line scan rate programmed higher than the default will cause no problem, to an upper limit of approximately 4.8KHz.
- The default line scan rate is 3.1 ms (322 Hz).
- The default exposure time for this DCF is 2.7 ms
- Remember that each 16-bit register is split into a low and 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 registers are set in the following way : (continued next page)

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DALSA CL-C8-6000A

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T2 user clock 14.31MHz (clock source select)

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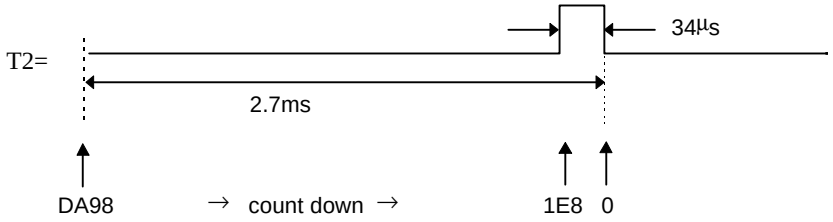
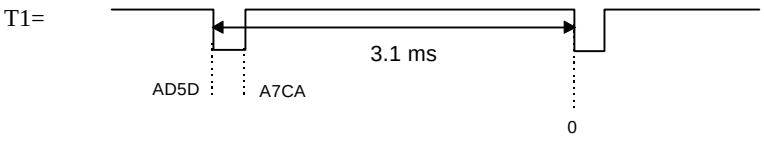
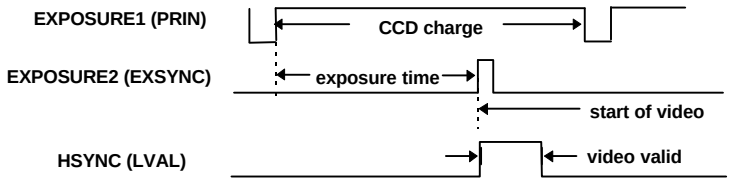
CTRL_T2STARTH	1	



T1 user clock 14.31MHz (clock source select)

	Hex	Decimal equivilant x user clock period
CTRL_ SET1CNTL	5D	44381 x (69.9ns) = 3.1 ms
CTRL_ SET1CNTH	AD	
CTRL_T1STARTL	CA	42954 x (69.9ns) = 3 ms
CTRL_T1STARTH	A7	





The DCF(s) mentioned in this application note can be found on the MIL and MIL-Lite CD, or our FTP site (ftp.matrox.com). The information furnished by Matrox Electronics System, Ltd. is believed to be accurate and reliable. Please verify all interface connections with camera documentation or manual. Contact your local sales representative or Matrox Sales office or Matrox Imaging Applications at 514-822-6061 for assistance.

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