TMC-6700/1000 Series Progressive Scan CCD Digital Color Camera

Operation Manual

69-0117
Rev. A

PULNiX
Imaging Products

Notice

The material contained in this manual consists of information that is proprietary to PULNiX America, Inc., and may only be used by the purchasers of the product. PULNiX America, Inc. makes no warranty for the use of its product and assumes no responsibility for any errors which may appear or for damages resulting from the use of the information contained herein. PULNiX America, Inc. reserves the right to make changes without notice.

Warranty

All of our solid-state cameras have a full three-year warranty. If any such product proves defective during this warranty period, PULNiX America, Inc. will repair the defective product without charge for parts and labor or will provide a replacement in exchange for the defective product. This warranty shall not apply to any damage, defect or failure caused by improper use or inadequate maintenance and use.

Certifications

CE Compliance

The TMC-6700/1000 series has been certified to conform to the requirements of Council Directive 89/336/EC for electromagnetic compatibility and to comply with the following European Standards:

Immunity: EN500082-2/1995

Emissions: EN55011:1991 Class A / CISPR 11

All PULNiX products bearing the CE mark have been declared to be in conformance with the applicable EEC Council Directives. However, certain factory-installed options or customer-requested modifications may compromise electromagnetic compatibility and prohibit use of the CE mark. Please note that the use of interconnect cables that are not properly grounded and shielded may affect CE compliance.

Contact PULNiX Applications Engineering Department for further information regarding CE compliance.

FCC

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING

Changes or modifications to this unit not expressly approved by the party responsible for FCC compliance could void the user's authority to operate the equipment.

TMC-6700/1000 Series Operation Manual
PULNiX America, Inc.
1330 Orleans Drive
Sunnyvale, CA 94089
Tel: (408) 747-0300
Tel: (800) 445-5444
Fax: (408) 747-0880
E-mail: imaging@jaipulnix.com
www.pulnix.com

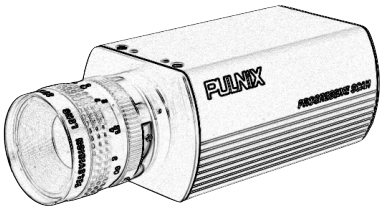
List of Tables

TMC-6700/1000 Series Progressive Scan CCD Digital Color Camera

Operation Manual

Models:

TMC-1000, TMC-1000CL,
TMC-6700, TMC-6700CL



1 Introduction

1.1 Product Description and Applications

The TMC-6700/1000 series* cameras are digital process and output color video cameras which use a 1"(TMC-1000) and 1/2" (TMC-6700) high-resolution progressive scan interline transfer CCD. This camera series is specially designed to capture images in progressive scan (non-interlace) format, producing a full frame of electronic shutter image as well as normal images.

The TMC-6700/1000 series cameras are excellent in applications such as dynamic motion capturing, still-picture storage, on-line inspection, gauging, printing, high-definition graphics and high-resolution surveillance where high-quality color images are required.

1.2 Features

- **RGB primary color 1" (TMC-1000/CL) 1/2" (TMC-6700/CL) progressive scanning interline transfer CCD imager**

  The TMC-1000/6700 series has a color filter array (CFA) called a "Bayer CFA." It comprises a ratio of two green pixels for every one red or blue pixel. This staggered structure results in color that is perceptually true to the human eye. The primary color Bayer CFA progressive scan interline transfer CCD combines excellent resolution (1008 H x 1018 V) and color fidelity with superb electronic shutter capability.

- **Full digital processing using real-time DSPs**

  PULNiX's state-of-the-art DSP technology offers increased speed, greater efficiency and specialization of function.

- **RS-232C external control**

*. Unless specified, all references to the TMC-1000 and TMC-6700 are relevant to the CL versions of those cameras as well.

The built-in Digital Signal Processor (DSP) is controlled via RS-232C communication for remotely adjusting color matrix, white balance, gain, edge enhancement, and other functions.

- **Progressive Scanning**

  The TMC-6700/1000 series uses a state-of-the-art progressive scanning interline transfer CCD, which scans all lines sequentially from top to bottom at one frame rate (15Hz in TMC-1000, 60Hz in TMC-6700). In comparison, conventional "TV-format" scanning captures every other horizontal line (ODD and EVEN lines) at a 60Hz rate per field, completing the scanning with two fields (one frame) at a 30Hz rate. Like a non-interlace computer screen, progressive scanning generates a crisp, stable image without alternating lines and provides full vertical resolution. The interline transfer architecture is essential in generating simultaneous shuttering, as compared with full-frame architecture which requires mechanical shuttering or a strobe light to freeze the object motion.

- **Progressive scan output in 24-bit LVDS Channel Link™* Digital and RGB analog format (TMC-1000 nd TMC-6700 base models only)**

  The digital output is 24-bit LVDS Channel Link output. Channel Link is a transmitter/receiver chipset pair developed by National Semiconductor for high-speed data transmission. Originally designed for flat-panel display technologies, Channel Link lends itself to digital video transmission and has been adopted by PULNiX in their latest cameras. Visit PULNiX's website at www.pulnix.com for information on Channel Link-compatible frame grabbers.

  Channel Link offers two main advantages:

  - Smaller cables

    A Channel Link transmitter converts 28 bits of data into four LVDS parallel data streams. A transmit clock is transmitted with the data over a fifth line. So during every clock cycle, 28 bits of data are transmitted over only 5 LVDS lines.

    As an example, for a 24-bit RGB camera, at least 27 pairs of wires (data and timing) are needed to transfer the data. The required cable, with 54 wires, would be bulky, heavy, and expensive.

    Using Channel Link technology, the same data can be transferred using only 11 conductors (4 data pairs, one clock pair, and a minimum of 1 ground). This provides an 80% reduction in cable width, reducing the connector size and cost, as well as requirements for shielding.

  - Higher data rates

    A Channel Link transmitter can send data rates up to 2.38GB/sec, (depending on the transmitter) more than satisfying what is available with today's camera technology and offering compatibility with the solutions of the future.

- **Camera Link Digital Output**

  Camera Link is a camera-to-frame grabber interface specification based on an implementation of Channel Link technology. The Camera Link standard includes data transmission, hardware (cable connectors), camera control, and asynchronous serial communications, all on a single cable.

- ***Built-in YCrCb 4:4:4 and 4:2:2 converter**

  The TMC-6700/1000 series cameras can output three different digital video outputs: 24-bit RGB, 24-bit 4:4:4 YCrCb, and 16-bit 4:2:2 YCrCb.

- **Full-frame electronic shutter, 1/15 sec. to 1/16,000 sec.**

  The substrate drain-type shutter mechanism provides a clear, crisp image without smearing. Progressive scanning permits a full frame of image resolution (1008 lines TMC-1000; 484 lines

*. Channel Link is a trademark of National Semiconductor.

TMC-6700) per shutter or integration. The user can assign any shutter speed to any of the preset shutter positions.

- **Asynchronous reset and shutter**

  The TMC-6700/1000 series cameras asynchronous reset operates with internal sync or external HD for phase locking. There are three modes to control the asynchronous reset and shutter speed.

- **Integration**

  The CCD imager of the TMC-6700/1000 series can be exposed for longer than one frame duration (1/15 sec. TMC-1000; 1/60 sec. TMC-6700). This feature provides sensitivity for low-light application environments.

- **External Sync Control**

  The TMC-6700/1000 series cameras accept HD and VD inputs from an external sync generator.

- **Anti-smear filter**

  Like all PULNiX color cameras, the TMC-6700/1000 series cameras contain a filter to minimize smear that can result when shooting a very bright object. Smear should only occur under extremely bright and pointed light source conditions.

- **Three-Year Warranty**

  The CCD solid-state image sensor allows the camera to maintain a superior performance level indefinitely while requiring virtually no maintenance. PULNiX backs all of the TMC Series cameras with a three-year warranty.

  Warning: Unscrewing the camera cover or opening the camera in any way without prior written permission will void this warranty.

1.3 Functional Options

Contact factory for information on current options.

1.4 System Configuration

Figure 1(below) presents a typical system configuration for the base model.

FIGURE 1. TMC-6700/1000 (Base models only) Series System Configuration

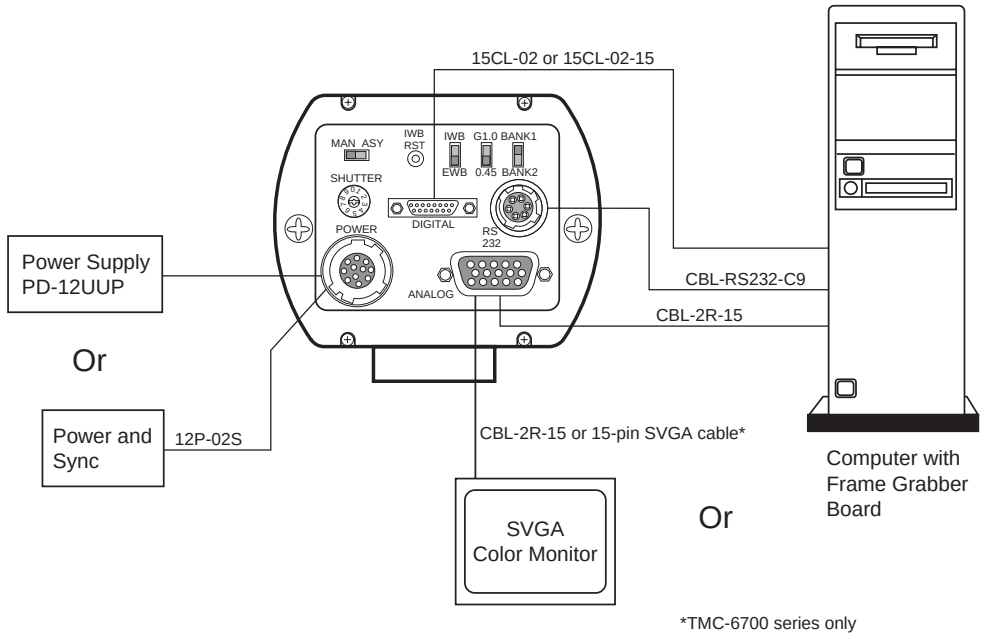
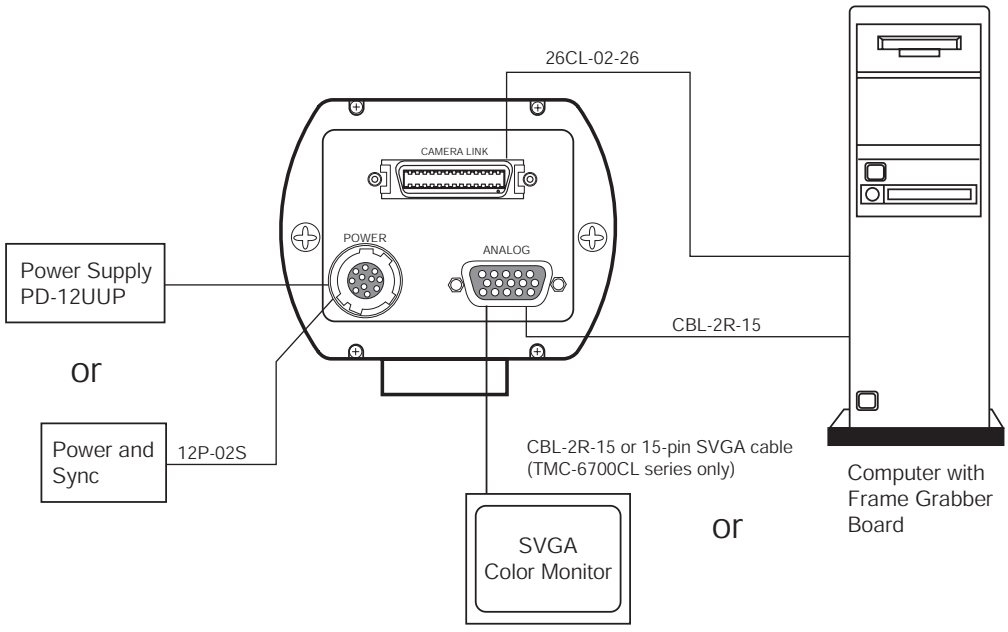


FIGURE 2. TMC-6700CL/1000CL (Camera Link models only) Series System Configuration



- **Power supply**

  Use the optional PD-series power supply or use cable 12P-02S (optional) that connects to the camera's 12-pin Hirose connectors on one end and has flying heads for power and sync signals on the other end.

- **Display monitor**

  Use cable CBL-2R-15 (optional) or a 15-pin SVGA cable to connect to an SVGA color monitor.

- **Digital output**

  Use cable 15CL-02 (optional) to connect the camera to a Channel Link™-input frame grabber, or use cable 15CL-02-15 (optional) connect the camera to a TTL-input frame grabber. (TMC-6700 series only)

- **Analog output**

  Use cable CBL-2R-15 (optional) to connect the camera to an analog frame grabber.

- **Serial communication**

  Use cable CBL-RS232-C9 (optional) to connect the camera to a PC for setup.

2 Installation

The following instructions are provided to help you to set up your video camera system quickly and easily. We suggest that you read through these instructions prior to unpacking and setting up your camera system.

2.1 Getting Started

2.1.1 Unpacking Instructions

We recommend that you save the original packing cartons for the cameras and lenses in case you need to return or exchange an item. We also recommend that any equipment being sent to another location for field installation be bench-tested to assure that everything is fully operational as a system.

2.1.2 Components List

Please begin by checking your order against the Components List (below) to assure that you have received everything as ordered, and that nothing has been overlooked in the packing materials. If any item is missing, please contact your PULNiX representative immediately.

- TMC-6700 or 1000 series camera
- TMC-6700 or 1000 data sheet
- TMC-6700/1000 series operation manual
- TMC-6700/1000 series software manual

2.1.3 Accessories and Options

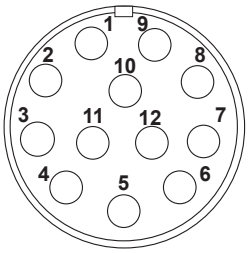
Following is a list of additional accessories and options that may be recommended or required for your particular application. Please check with your PULNiX representative prior to the installation of your video system to determine what you might need.

- Direct Channel Link cable: 15CL-02-15 (base TMC-1000 and TMC-6700 only).
- RS-232 controller set: CS-232C (base only)
- RGB cable: CBL-2R-15
- Power supply and power cables: please refer to Section 2.2.2 on page 9.

2.2 Camera Setup

2.2.1 Connector Pin Configurations

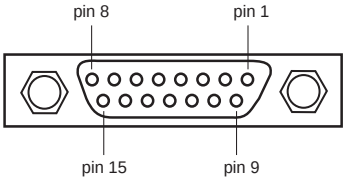
2.2.1 (a) 12-Pin Connector



The TMC-6700/1000 series has a 12-pin connector (PC-12P) on the rear panel for power input and integration control.

Pin	Description	Pin	Description
1	GND	7	VD In
2	+12V DC	8	GND
3	GND	9	HD In
4	N/C	s10	N/C
5	GND	11	Integ Cont
6	Vinit	12	GND

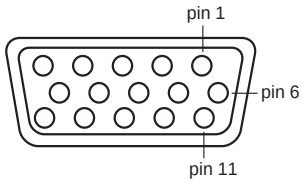
2.2.1 (b) 15-Pin Digital Connector (base only)



The TMC-6700/1000 series has a 15-pin digital connector (MP221-015-243-2200) on the rear panel to output 24-bit digital video and other digital sync signals via Channel Link™.

Pin	Description	Pin	Description
1	CH CLK+	9	CH CLK-
2	CH0+	10	CH0-
3	CH1+	11	CH1-
4	CH2+	12	CH2-
5	CH3+	13	CH3-
6	D_VINIT+	14	D_VINIT-
7	D_INTEG+	15	D_INTEG-
8	GND		

2.2.1 (c) 15-pin SVGA Output Connector (base only)

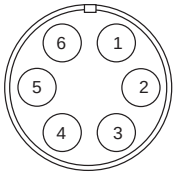


The analog RGB output connector is a high-density D-Sub 15-pin connector.

TABLE 1. 15-Pin SVGA Output Connector Configuration

Pin	Description	Pin	Description
1	Red	9	N/C
2	Green	10	N/C
3	Blue	11	GND
4	GND	12	N/C
5	GND	13	H Sync
6	Red GND	14	V Sync
7	Green GND	15	N/C
8	Blue GND		

2.2.1 (d) 6-Pin Connector (base only)



The TMC-6700/1000 series has a 6-pin connector for RS-232C communication. A mating 6-pin connector (PC-6P) can be obtained from PULNiX.

TABLE 2. 6-Pin Connector Pinout Configuration

	Standard
Pin	**Description**
1	RS-232 RX
2	RS-232 TX
3	reserved
4	GND
5	GND
6	GND

2.2.1 (e) 26-Pin CL Connector Pinout (CL Models)

The TMC-1000/6700 series has a 26-pin MDR26 connector (3M part number 10226-6212VC) on the rear panel to output Camera Link data. The connector pin-out is shown in Table 3 below.

TABLE 3. 26-Pin CL Connector Pinout Configuration

Camera Link Connector MDR 26-Pin Connector 10226-6212VC

Pin #	Description	I/O	Pin #	Description	I/O
1	GND		14	GND	(Shield)
2	Tx OUT 0-	Out	15	Tx OUT 0+	Out
3	Tx OUT 1-	Out	16	Tx OUT 1+	Out
4	Tx OUT 2-	Out	17	Tx OUT 2+	Out

TABLE 3. 26-Pin CL Connector Pinout Configuration (Continued)

Camera Link Connector MDR 26-Pin Connector 10226-6212VC					
Pin #	**Description**	**I/O**	**Pin #**	**Description**	**I/O**
5	Tx CLK OUT -	Out	18	Tx CLK OUT +	Out
6	Tx OUT 3 -	Out	19	Tx OUT 3+	Out
7	SerTC+	In	20	SerTC -	In
8	SerTFG-	Out	21	SerTFG+	Out
9	VINIT - (CC1-)	In	22	VINIT + (CC1+)	In
10	INTEG + (CC2+)	In	23	INTEG- (CC2-)	In
11	N/C		24	N/C	
12	N/C		25	N/C	
13	GND		26	GND	

2.2.2 Power Supply and Power Cable Setup

2.2.2 (a) Power Supplies

The TMC-6700/1000 series requires 12V DC. Power is obtained through the 12-pin connector located at the rear of the camera. PULNiX recommends the following power supplies:

K25-12	110V AC/12V DC	2.1A power supply
K50-12	110V AC/12V DC	4.2A power supply
PD-12UU	110V AC/12V DC	0.5A power supply
PD-12UUP	12-pin connector	US plug
PD-12UE	110V AC/12V DC	0.5A European power supply
PD-12UEP	12-pin connector	European plug

For users providing power through the 12-pin connector, the PD-12P, PD-12UUP, and PD-12UEP power supplies are available with the 12-pin mating connector already attached to the leads from the power supply. The PD-12 power supply can be connected to the PULNiX power cable via a terminal strip or directly.

When wiring the PD-12 power supply directly, please note the following:

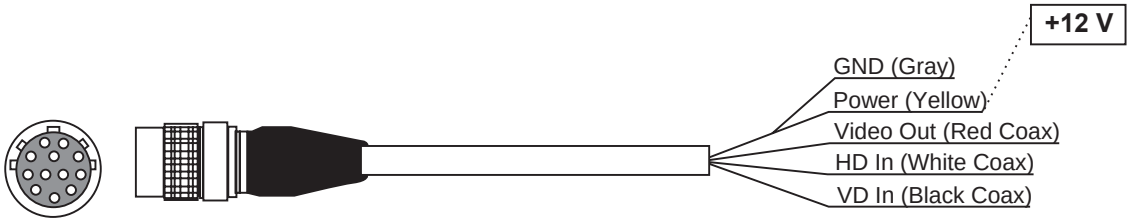
- The lead ends must be twisted together and tin-soldered for strength and electrical continuity.
- Shrink tubing or a similar insulator should be used to prevent exposed leads from touching and shorting.
- The +12V lead is marked with a red stripe or white lettering; be sure not to reverse the leads.
- All connections must be properly insulated to prevent shorting.

2.2.2 (b) PULNiX Power Cables

If you are using PULNiX power cables, such as the 12P-02S, please refer to the12-pin connector pin-out diagram in Section 2.2.1 on page 7. The cable pin-out diagram is shown below in Figure 3. The color-coded leads use Gray for Ground and Yellow for +12V DC.

WARNING: When applying power to the camera, using one of the 12-P series cables, make sure that none of the exposed leads on the multiple conductor cables are touching, as this may cause damage to the camera.

FIGURE 3. 12P-02S Interface Cable (optional)



12P-02S Interface Cable

Pin#	Lead Color	Function	Pin#	Lead Color	Function
1	Gray	GND	7	Black coax signal	VD IN
2	Yellow	+12V DC	8	White shield	GND
3	Red shield	GND	9	White coax signal	HD IN
4	Red coax signal	N/C	10	Brown	N/C
5	Orange shield	GND	11	Blue	INTEG CONT
6	Orange coax signal	VINIT	12	Black shield	GND

Note: *Make sure that the unused leads are not touching and that there is no possibility that the leads could short due to exposed wires.*

2.2.2 (c) Building Your Own Power Cable

Please refer to the 12-pin connector (PC-12P) pin-out in Section 2.2.1 on page 7. Connect the Ground lead to Pin #1, and the +12V DC (0.5A) lead to Pin #2 of the 12-pin connector.

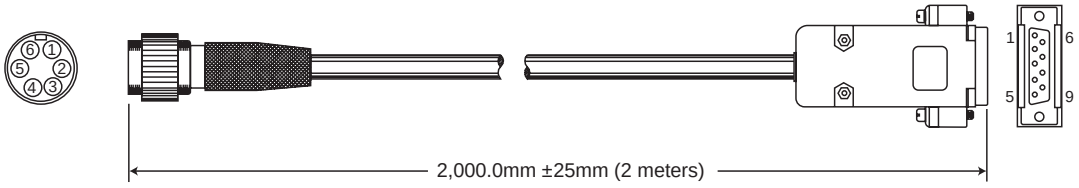
2.2.2 (d) Attaching the Power Cable to the Connector

The 12-pin connector is keyed and will fit in only one orientation. Follow these directions to properly attach the power cable to the camera connector:

1. Rotate the connector while applying slight pressure until the keyway lines up.
2. Press the connector into place until it is firmly seated.
3. Plug the power cord into the 110V AC socket. This will power up the camera.

2.2.3 RS-232C Cosmmunication Cable and Connector

FIGURE 4. CBL-RS232-9 Cable



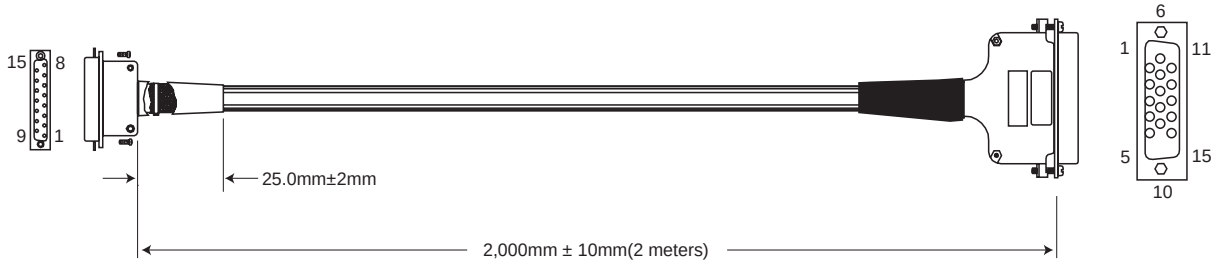
The RS-232 controller set CS-232C includes CBL-RS232-9 interface cable, software diskette, and a quick-start card. The TMC-6700/1000 series camera's built-in DSP chip can be controlled by an external RS-232C interface. The camera settings can be programmed or changed using the communication cable and software. Please refer to the software manual for details on the graphical user interface.

2.2.4 Digital Output Cables

The selection of an appropriate digital output cable depends on whether you are using a Channel Link frame grabber or a non-Channel Link frame grabber. PULNiX offers two digital output cables. The Channel Link/TTL Adapter cable (15CL-02) provides 24 bit TTL output for use with a non-Channel Link frame grabber. The Direct Channel Link cable (15CL-02-15) should be used with a Channel Link frame grabber. Please check PULNiX's website (www.pulnix.com) for a list of compatible Channel Link frame grabbers.

2.2.4 (a) Direct Channel Link Cable

FIGURE 5. Direct Channel Link Cable (15CL-02-15) (base only)

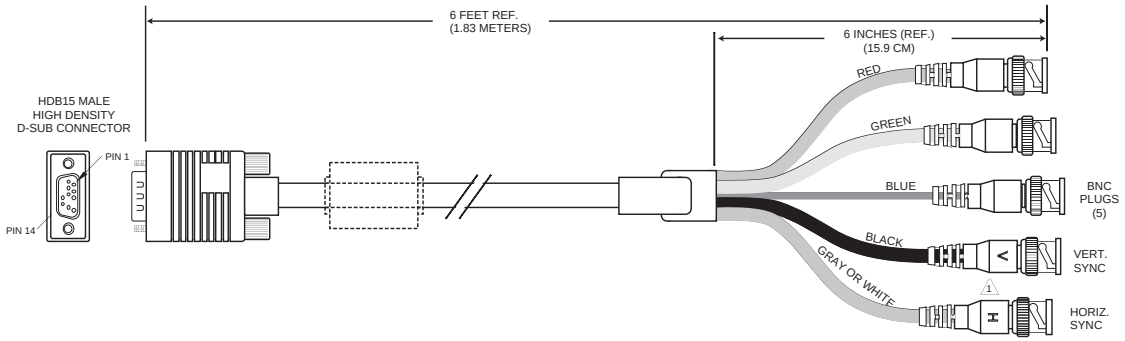


This cable is for use with Channel Link frame grabbers. It has a 15-pin Airborne connector on the camera end and a 15-pin high-density, D-sub connector on the frame-grabber end.

Not all Channel Link frame grabbers have a 15-pin input connector, in which case a custom adapter cable will be needed. The pin assignment for the digital connector is show in Section 2.2.1 (b on page 7. Contact your PULNiX representative if you need assistance.

2.2.5 Analog Output Cable (CBL-2R-15)

FIGURE 6. Analog Output Cable (CBL-2R-15)

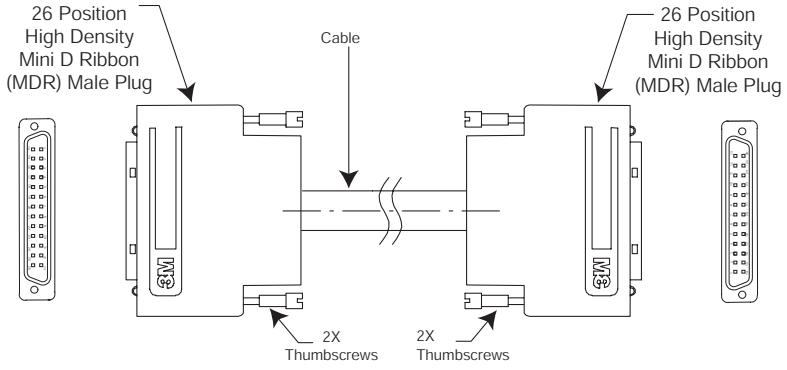


The RGB analog cable has a 15-pin high-density D-sub connector on the camera end, and five BNC connectors on the frame-grabber end.

Not all frame grabbers have BNC analog input connectors, in which case a custom adapter cable will be needed. Contact your PULNiX representative if you need assistance.

2.2.6 Camera Link Cable (Camera Link models only)

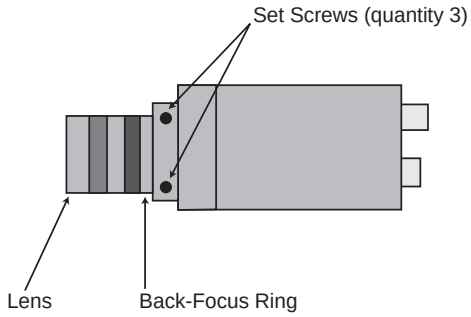
The MDR26 cable assembly (26CL-02-26) from 3M (part number 10226-6212VC) has been standardized as the Camera Link cable. This cable has the 26-pin MDR26 connector on both ends. This is a straight-through cable. The pin-out configuration is shown in Table 3 on page 8.



2.2.7 Back-Focusing the Lens

Follow these directions to back-focus the TMC-6700/1000 series camera.

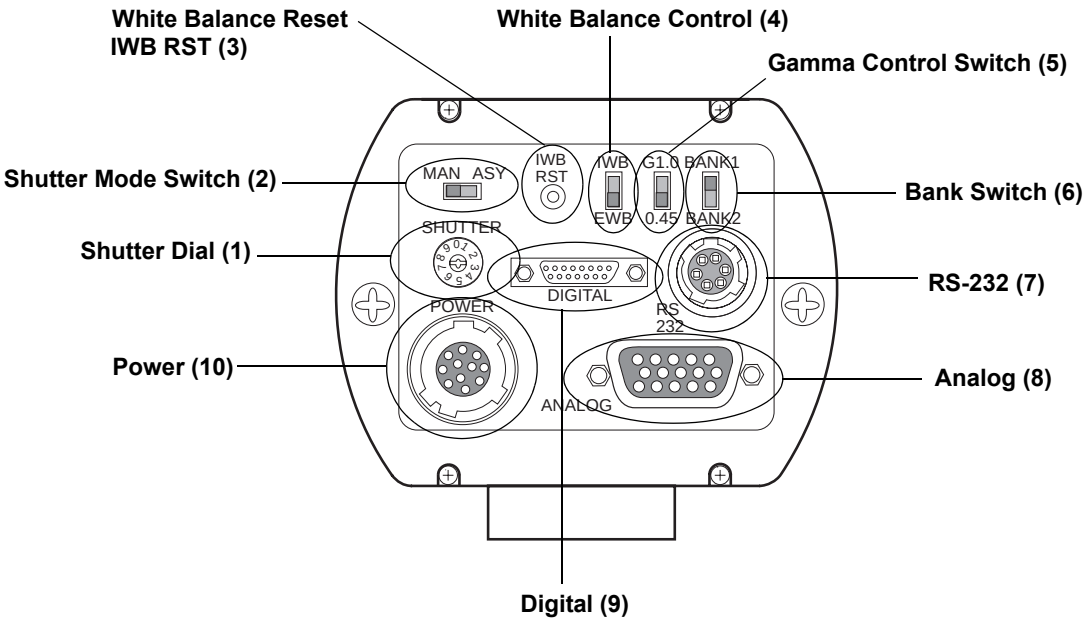
1. Attach a C-mount lens to the camera. Be sure that the lens is properly mounted.
2. Loosen the three miniature set screws holding the focus ring.
3. Set the lens focus to infinity.
4. Point the camera at a distant object and turn the focus ring to obtain the best possible focus.
5. Tighten the focus-ring set screws. Your back-focus is now set.



3 Operation

3.1 Camera Rear Panel-Base Only

FIGURE 7. TMC-6700/1000 Series Rear Panel

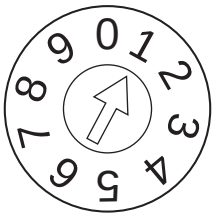


3.1.1 Shutter Mode Switch

The Shutter Mode Switch selects between Manual (MAN) Shutter Mode and Asynchronous (ASY) Shutter Mode. Table 4, “Shutter Speed Control Settings (Factory Default),” on page 15 lists shutter speeds for Manual and Async Modes. When Async (ASY) Mode is selected, live image data is not sent out except with Asynchronous Reset. See Figure 9 on page 20 for more information.

3.1.2 Shutter Speed Control Dial

Shutter speed can be selected by switching the shutter dial to the appropriate setting (0 through 9). In the factory default value, the settings correspond to the shutter speeds as follows in Table 4 on page 15. Each position can have any shutter speed by assigning a value to the proper register address, using the RS-232 software control.



Note: In order to avoid video problems, make sure that you turn the shutter-speed control dial quickly. If you turn the dial too slowly, the shutter may not expose for the proper period of time, resulting in either no video or bright video. If this happens, push the IWB RST switch on the rear panel or repeat the dial change at a faster speed.

TABLE 4. Shutter Speed Control Settings (Factory Default)

Position	Manual (MAN) Shutter		Async (ASY) Shutter	
0	no shutter		no shutter with VINIT reset	
1	256H	1/60	1.0H	1/16,000
2	128H	1/125	2.0H	1/8,000
3	64H	1/250	4.0H	1/4,000
4	32H	1/500	8.0H	1/2,000
5	16H	1/1,000	16H	1/1,000
6	8H	1/2,000	32H	1/500
7	4H	1/4,000	64H	1/250
8	2H	1/8,000	128H	1/125
9	1H	1/16,000	Pulse Width Control	

3.1.3 White Balance Control Switch

The IWB/EWB switch selects between Internal White Balance (IWB) mode and External White Balance (EWB) mode. When the IWB RST button is pressed, white balance is calibrated. When the IWB RST button is released, the last calibration value is held internally. EWB preset values can only be changed via RS-232C control.

3.1.4 IWB Reset Button

When held down, the IWB reset button calibrates the white balance so that the selected object appears to be white. After it is released, the camera maintains the last white balance values.

3.1.5 Gamma Control Switch

The gamma control switch selects between gamma 1.0 and gamma 0.45.

3.1.6 Bank Switch

The camera features four memory banks that store camera configuration parameters such as shutter speed, color matrix, white balance, gain, and edge enhancement. The first two banks, Bank1 and Bank2, can be selected via the Bank Switch on the back panel of the camera. Bank3 and Bank4 can be selected via RS-232C control. This feature allows easy switching between different camera-control parameters as application needs change. Please refer to Section 4.1.2 on page 22.

3.2 Camera Rear Panel Switches and Connectors

The following two charts list and describe the features of the camera rear panel illustrated in Figure 7. Table 5 on page 16 contains information on the switches on the rear panel and Table 6 on page 17 contains information on connectors on the rear panel.

TABLE 5. Camera Rear Panel Switches

#	Switch	Mode	Description	Action
1	Shutter dial	0 to 9 positions, Manual (MAN) Mode	Shutter speed control dial for manual shutter mode	Please refer to Table 4 on page 15 for shutter speeds.
		0 to 9 positions. Asynchronous (ASY) Reset Mode	Shutter speed control dial for asynchronous shutter mode.	
2	Shutter Mode Switch	MAN	Manual Shutter Mode	Camera continuously outputs video at 15FPS.
		ASY	Asynchronous Shutter Mode	Camera resets on Vinit signal: pin 6 of 12-pin connector.
3	White Balance Reset IWB RST	Held down	White Balance Reset switch	Calibrates the white balance so that the selected object appears to be white.
		Released		Camera maintains the last white balance values and holds the calibration internally.
4	White Balance Control	IWB	Internal White Balance	Selects Internal White Balance mode. In the IWB mode, when the IWB reset RST button is pushed, the camera internally adjusts R and B white balance so that the white object is viewed as white under particular light conditions.
		EWB	External White Balance	Selects External White Balance mode. When EWB mode is set, the external WB-R and WB-B offsets are loaded from RAM. EWB preset values can be changed via RS-232C only, i.e, WB-R and WB-B offsets in RAM can be updated by software.
5	Gamma Control Switch	G1.0	Gamma 1.0	Selects Gamma 1.0
		G0.45	Gamma 0.45	Selects Gamma 0.45
6	Bank Switch	Bank1	Bank1 selection switch	Selects Bank1 camera parameter set.
		Bank2	Bank2 selection switch	Selects Bank2 camera parameter set NOTE: Bank3 and Bank4 can be selected via RS-232C control.

TABLE 6. Camera Rear Panel Connectors

#	Connector	Type	Cable Needed	Cable Information
7	RS-232	6-pin female connector	CBL-RS232-C9	Connect PC to the camera using the RS-232C control cable (CBL-RS232-C9). This cable is a part of the communication kit (CS-232C).
8	Analog	15-pin High Density D-sub female connector	CBL-2R-15	If you are using a monitor or frame grabber that needs Red, Green, Blue, Vertical Sync, and Horizontal Sync, then use the RGB analog cable (CBL-2R-15).
9	Digital	15-pin female Airborne connector	15CL-02 or 15CL-02-15	Use the Channel Link/TTL adapter cable (15CL-02) if you are using a non-Channel Link frame grabber that needs TTL input. Use the Direct Channel Link cable (15CL-02-15) if you are using a Channel Link frame grabber.
10	Power/Sync	12-pin Hirose male connector	12P-02S cable or PD-12P power supply	Connect a 12V DC power supply (K25-12V or PD-12) using power cable 12P-02S* or connect power supply PD-12P.

*See Figure 3 on page 10 for Sync, VD, HD, and VINIT pinout.

3.3 Color Balance Adjustment

3.3.1 White Balance

Internal WB and External WB modes are available either via the rear panel switch or through RS-232 software control. In internal WB mode when the IWB Reset Button is pushed, the TMC-6700/1000 series internally adjusts R and B white balance so that the white object is viewed as white under the particular light conditions. When external WB mode is set, the external WB-R and WB-B offset are loaded from RAM. WB-R and WB-B offsets in RAM can be updated by software.

3.3.2 Camera Gain

The TMC-6700/1000 series supports VCA (Voltage Controlled Amplifier) gain control and DSP (Digital Signal Processing) gain control. DSP gain is supplementary control for users requiring fine tuning.

3.3.3 Color Matrix

Color matrixing is an operation designed to improve the color rendition and color saturation of the image. The matrixing corrects the spectral sensitivities of the image sensor for the chromaticities of the display. This significantly improves the subjective quality of the image, since it allows the tone and color reproduction to be optimized, which also improves the apparent contrast and sharpness of the system.

The mathematical transformation is a linear-space 3 x 3 matrix operation, as shown below.

$$\begin{bmatrix} Ro \\ Go \\ Bo \end{bmatrix} = \begin{bmatrix} 1.75 & -0.25 & -0.5 \\ -0.1875 & 1.3125 & -0.125 \\ -0.125 & -0.5 & -1.625 \end{bmatrix} \begin{bmatrix} Ri \\ Gi \\ Bi \end{bmatrix}$$

The coefficients have been optimized for the spectral sensitivities of a Bayer CFA (color filter array). For camera systems, a linear-space color correction matrix is used. The coefficients are programmable through the serial interface.

3.3.4 User-Programmable Functions

3.3.4 (a) Edge Enhancement (Sharpness)

Edge enhancement is set by RS-232 control. Horizontal, vertical, and both H and V enhancement are selectable. The DSP mathematically manipulates the horizontal and vertical edge information to sharpen the image. The intensity of the enhancement can be set by Edge Enhancement Level.

3.3.4 (b) Gamma Selection

You can toggle between 0.45 (default) and 1.0 (linear output) by either the switch on the rear panel or RS-232 control.

3.3.4 (c) Shutter Selection

The TMC-6700/1000 series provides manual shutter and asynchronous shutter with external trigger (VINIT). Each mode is selectable up to 1/16,000 sec. By selecting the shutter dial setting (0 to 9), the preset shutter duration is loaded from RAM.

The TMC-6700/1000 series also supports Direct shutter mode. In Direct shutter mode, the user can control any exposed line count within the shutter time range.

3.3.4 (d) RGB to YCrCb Conversion

The TMC-6700/1000 series can output three different digital video outputs, 24-bit RGB, 24-bit 4:4:4 YCrCb, and 16-bit 4:2:2 YCrCb. Output can be selected by software interface *only.*

YCrCb conversion is expressed in the following formula:

Y = 0.257R + 0.504G + 0.098B + 16
Cr = 0.439R + 0.368G - 0.071B + 128
Cb = -0.148R - 0.291G + 0.439B + 128

3.3.4 (e) User Parameter Saving and Loading

User parameters can be stored in EEPROM. However, the user has no direct read/write access to the EEPROM. RS-232 software permits read/write of the parameters to RAM. Four RAM banks are available; if the user needs to save the data permanently into EEPROM, then all of the data in the four

RAM banks can be saved by the EEPROM save command (Section 4.2.3, “Save RAM Data Into EEPROM,” on page 24).

3.3.4 (f) Black Level Control

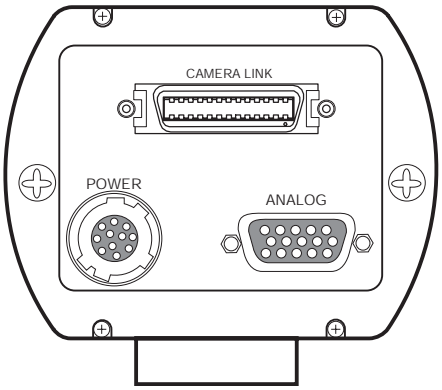
The TMC-6700/1000’s DSP has independent red, green and blue offset controls, and black level control. The user can calibrate these under specific lighting conditions by using the RS-232 control.

3.3.4 (g) RS-232 External Communication

The TMC-6700/1000 series is capable of being controlled by external communication via RS-232. This communication overrules the preset data in the memory pages and the back panel switch settings. Please refer to Section 4 on page 22 for detailed instructions.

3.4 Camera Link Rear Panel

FIGURE 8. Camera Link Rear Panel



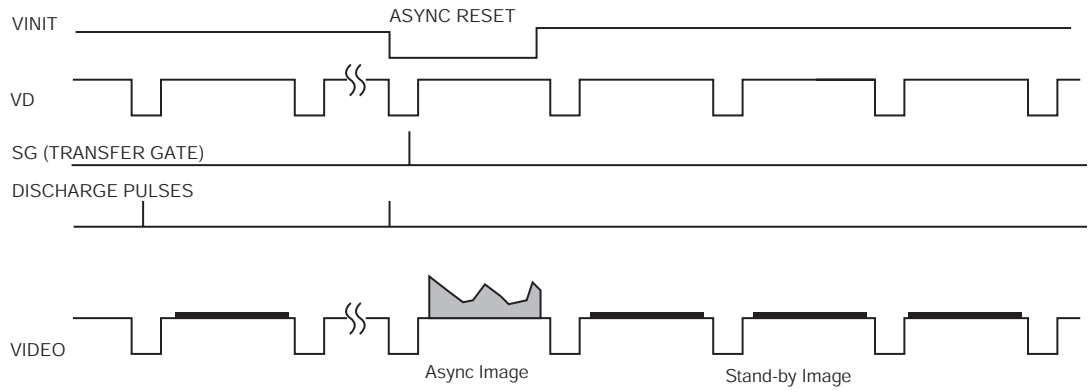
3.5 Asynchronous Reset Full Frame Shutter Camera Operation

The TMC-6700/1000 series is designed to accommodate an ON-LINE inspection reset mechanism with full frame shutter. The shutter speed can be controlled by either an external pulse width or internal shutter speed control.

3.5.1 Asynchronous Shutter

For the asynchronous shutter mode, async mode needs to be selected either from the rear panel (ASY) or by RS-232. When the negative reset pulse (VINIT) is applied, the camera will latch the falling edge to its next horizontal drive and immediately reset the vertical sync timing (Figure 9, “Asynchronous Reset,” on page 20). The TMC-6700/1000 series asynchronous cameras output a full frame of shuttered video in progressive format.

FIGURE 9. Asynchronous Reset



3.5.2 Asynchronous Reset and Shutter Speed

The TMC-6700/1000 series asynchronous reset operates with internal sync or external HD for phase locking. When VINIT pulse is applied, it resets the camera's scanning and purges the CCD. There are three modes to control the asynchronous reset and shutter speed:

- External VINIT with pulse width control
- Internal shutter speed with fast mode
- Internal shutter speed with slow mode

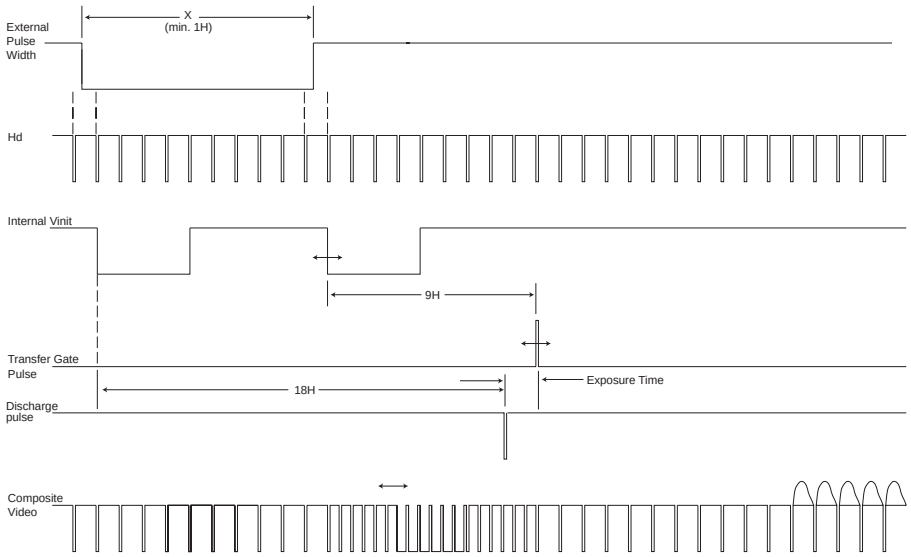
3.5.2 (a) External Pulse Width Control Mode

To select the external pulse width control mode, set the shutter dial switch to "9." Apply a VINIT signal with controlling pulse width, which can be generated from an external event trigger to the camera. The internal reset pulse will latch to HD. The duration from the first VINIT pulse leading edge to rising edge, X, controls the shutter speed as follows:

Shutter speed ts = X (1H resolution)
1H = 63.5 μsec.

Min. pulse width = 1H

FIGURE 10. External Pulse Width Control



3.5.2 (b) Long Integration

With pulse-width control, long integration is possible up to a few seconds besides integration control (pin #11 of the 12-pin connector).

3.5.2 (c) Internal Fast Reset Mode (1H~8H, or 1/16,000~1/2,000)

When fast reset mode is selected, the camera resets with internal VINIT timing which is latched to HD. Video output is also synchronized with internal VINIT timing without further delay. The shutter speed is controlled by the shutter dial.

3.5.2 (d) Internal Slow Reset Mode (9H~1048H, or >1/2,000~1/15)

With the Internal Slow Reset mode selected, the camera operates the reset and shutter by the same means as the wide pulse width control mode. When external VINIT pulse is applied, internal VINIT is latched to HD and the second internal VINIT signal is generated to set up the shutter speed period. Video output timing starts right after the second internal VINIT.

4 TMC-6700/1000 Series RS-232C Control*

4.1 RS-232C Control Introduction

The TMC-1000's DSP parameters and operation mode can be controlled by an external RS-232C interface. The camera features four memory banks that store camera configuration parameters such as shutter speed, color matrix, white balance, gain, and edge enhancement. The first two banks, Bank1 and Bank2, can be selected via the Bank Switch on the back panel of the camera. Bank3 and Bank4 can be selected via RS-232C control. This feature allows easy switching between different camera-control parameters as application needs change. Each time the camera is turned on, saved data is loaded from EEPROM to RAM Bank1.

The RS-232C control software does not have direct access to the EEPROM. Users can program the EEPROM via the RAM banks. For instance, in order to change the gain value, it is necessary to access the RAM address that holds the gain parameter to send new data to it. The RAM address is shown in Section 6.3, "TMC-6700/1000 Series Control Parameter Address Map," on page 36. Section 4.1.3 through Section 4.2.4 explains the following:

- how to set the RAM bank
- how to get the current RAM bank number
- how to save into and load from EEPROM.

Section 4.2.5 and Section 4.3.10 show how to write and read new camera parameters to and from the RAM bank.

4.1.1 RS-232C Communication Defaults

Parity	:	None
Data	:	8-bit
Stop	:	1-bit
Baud rate	:	9600 bps

If other communication conditions are required, please contact PULNiX.

4.1.2 RS-232C Command

The TMC-6700/1000 series command packet is in 8-bit binary code. When a packet is received by the TMC-1000, it reads the internal packet of the received buffer. If it is the correct packet, then it processes the parameters based on the commands detailed in Section 4.2.

4.1.3 RAM Memory Map

Each of four user's RAM banks is mapped in the Appendix, Section 6.3, "TMC-6700/1000 Series Control Parameter Address Map," on page 36.

*. Note: for information on the GUI software, see the TMC-1000/6700 camera control software manual.

4.2 Basic Command Code

4.2.1 Set/Refresh RAM Bank

Function: Set or refresh the RAM bank.

Four user's RAM banks are available from Bank 1 to Bank 4. Typical situations in which you may want to use this command are when you want to change to another RAM bank, and when you want to reflect changes after sending the shutter command, WB command, etc.

TX Command Code

MSB							LSB
7	6	5	4	3	2	1	0
1	0	1	0	D3	D2	D1	D0

D3	0 : Override Rear Panel Flag Off 1 : Override Rear Panel Flag On
D2:0	Ram Bank Number -1 (0, 1, 2 or 3) Ex: Bank 1: 00

If the "Override Rear Panel" flag is on, the rear panel settings are overwritten by the software settings. If the flag is off, the rear panel settings reflect on the image.

***Note**: The rear panel setting gets priority. Once you change any rear panel setting on the back of the camera, the parameters reflect the new rear panel setting.*

Example: Set RAM bank 1 with override panel flag on. The command code packet is sent as follows:

10101000 (BIN) or 168 (DEC)

4.2.2 Get RAM Bank

Function: Get the number of the RAM bank currently being used.

The current RAM bank number is returned from the camera in response to the following command code:

TX Command Code

MSB							LSB
7	6	5	4	3	2	1	0
1	1	1	0	X	X	X	X

Bits 3 to 0 are no-care bits. The camera responds as the following 8-bit binary data:

RX Response Code

MSB							LSB
7	6	5	4	3	2	1	0
0	0	0	0	D3	D2	D1	D0

D3	Rear Panel Override Flag
D2:0	Ram Bank Number -1 (0, 1, 2 or 3)

D3 is the rear panel override flag, indicating whether the software or the rear panel has priority regarding parameter control.

Note: Once any rear panel switch is changed, rear panel control will take priority, and the configuration of all the rear panel switch settings will apply to the current image:

4.2.3 Save RAM Data Into EEPROM

Function: Save all four RAM data banks into EEPROM.

All of the data in the four RAM banks can be saved into EEPROM by sending the following command code:

TX Command Code

MSB							LSB
7	6	5	4	3	2	1	0
1	0	0	0	1	0	1	0

4.2.4 Load RAM Data From EEPROM

Function: Load config data from EEPROM to all four RAM banks.

Data saved in EEPROM can be loaded from EEPROM into four RAM banks by sending the following command code:

TX Command Code

MSB							LSB
7	6	5	4	3	2	1	0
1	1	0	0	0	0	0	0

4.2.5 Write 1 Byte Into RAM Bank

Function: Write 1 byte of data into the location of a specific address in a RAM bank.

After the RAM bank is selected, new 8-bit data can be written to the desired location of a specific address by sending the following command code:

TX Command Code 1

MSB							LSB
7	6	5	4	3	2	1	0
0	1	A5	A4	A3	A2	A1	A0

A5:0	RAM address

TX Command Code 2

MSB							LSB
7	6	5	4	3	2	1	0

D0	D1	D2	D3	D4	D5	D6	D7

D7:0 8-bit data to update

The first command code specifies the RAM address to write. The RAM address is shown in the Appendix, Section 6.3, "TMC-6700/1000 Series Control Parameter Address Map," on page 36. The second command code specifies the new 8-bit data to overwrite.

4.2.6 Read 1 Byte From RAM Bank

Function: Read 1 byte of data from the location of a specific address in the RAM bank.

8-bit data saved in the RAM bank can be read by sending the following command:

TX Command Code

MSB							LSB
7	6	5	4	3	2	1	0
0	0	A5	A4	A3	A2	A1	A0

A5:0RAM Address

R X Response Code

MSB							LSB
7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0

D7:0 8-bit data received from the camera

The command code to transmit specifies the address of the location from which to read the data. Please refer to the RAM address map (Section 6.3, "TMC-6700/1000 Series Control Parameter Address Map," on page 36). If the address is accepted by the camera, the camera sends the data stored in the address.

4.3 Camera Control

4.3.1 VCA Gain

Saved address: 1
Representation: 8-bit normal binary
Value: 80~100

Write Example: (Write VCA 25 to address 1)
Tx1 01000001
Tx2 10011000 *
Tx3 Refresh RAM Bank

Read Example: (Read address 1, and receive 67)
Tx1 00000001
Rx1 11000010 *

***Note:** The byte order of the ADC offset, VCA gain and ADC Ref. Top is opposite to that which is actually seen. For instance, if the user needs to write 48 (00110000 in binary code) as the new VCA gain, the code for 48 must be sent (00001100).*

***Note**: The particular RAM bank may be set prior to write or read. The image will not be updated until you set (refresh) the RAM bank after the write or read operation.*

4.3.2 ADC Offset

Saved address: 2
Representation: 8-bit normal binary
Value: 220~240

Write Example: (Write ADC offset 34 to address 2)

Tx1	01000010
Tx2	01000100 *
Tx3	Refresh RAM Bank

***Note:** The byte order of the ADC offset, VCA gain and ADC reference data is opposite to that which is actually seen. Unlike all other data, ADC offset, ADC Ref. Top and VCA gain have the opposite byte order. For instance, if the user needs to write 48 (00110100 in binary code) as the new ADC offset, the code for 52 must be sent (00101100).*

4.3.3 ADC Ref. Top

Saved address: 3
Representation: 8-bit normal binary
Value: 0~255

Write Example: (Write ADC ref top 25 to address 3)

Tx1	01000011 (address 3, write)
Tx2	10011000 *
Tx3	Refresh RAM Bank

Read Example: (Read address 3, and receive 67)

Tx1	00000011 (address 3, read)
Rx1	11000010 *

***Note:** The byte order of the ADC offset, VCA gain and ADC Ref. Top is opposite to that which is actually seen. For instance, if the user needs to write 48 (00110000 in binary code) as the new VCA gain, the code for 48 must be sent (00001100).*

***Note**: The particular RAM bank may be set prior to write or read. The image will not be updated until you set (refresh) the RAM bank after the write or read operation.*

4.3.4 White Balance

The white balance mode is saved in address 6 in RAM. If the internal WB mode is set, then the TMC-6700/1000 series internally accumulates R and B white balance. If the external WB mode is set, then the external WB-R and WB-B offset are loaded from address 2B (hex) and 2A (hex) respectively. WB-R and WB-B offsets can be updated by accessing addresses 2B and 2A (hex). WB-R and WB-B in these addresses are 2's complement representation.

Address 6

MSB							LSB
7	6	5	4	3	2	1	0
Y1	Y0	EL1	EL0	EM1	EM0	W1	W0

Y1:0	RGB to YCrCb Conversion Mode (0: RGB, 1: 4:4:4 YCrCb, 2: 4:2:2 YCrCb)
EL1:0	Edge enhancement level (0: max enh. level, 3: min. enh. level)
EM1:0	Edge enhancement mode (0: Bypass, 1: H, 2: V, 3: H&V)
W1	Hold when Int. WB is selected (0: Reset, 1: Hold)
W0	White balance mode (0: Int. WB, 1: Ext. WB)

Example 1
Set Internal Autotracking WB (RGB, Edg Enh Bypass)

Tx1	01000110 (address 6, write)
Tx2	00000010
Tx3	Refresh RAM Bank

Example 2
Set External WB (RGB, H Edge, level 2)

Tx1	01000110 (address 6, write)
Tx2	00100100 (Ex WB, H Edge, level 2, RGB)

Set External WB-R (-30) and WB-B (-20)

Tx3	01101010 (address 0 x 2A)
Tx4	11101100 (WB-B, -20)
Tx5	01101011 (address 0 x 2B)
Tx6	11100010 (WB-R, -30)
Tx7	Refresh RAM Bank

4.3.5 Edge Enhancement

The Edge Enhancement mode is saved in address 6 (please refer to Section 4.3.4 on page 27). The TMC-6700/1000 series supports Bypass, Horizontal Enh (H), Vertical Enh (V) and H&V mode. Please refer to Section 4.3.4, "White Balance," on page 27.

Example

Set V Enh and level 3 (RGB, Int. WB)

Tx1	01000110 (address 6, write)
Tx2	00111000
Tx3	Refresh RAM Bank

4.3.6 RGB to YCrCb Conversion

RGB to YCrCb Conversion mode is saved in address 6. The TMC-6700/1000 series supports RGB, 4:4:4 YCrCb and 4:2:2 YCrCb. Please refer to Section 4.3.4, “White Balance,” on page 27.

Example
Set 4:2:2 YCrCb (Edge Enh Bypass, Int. WB)

Tx1	01000110 (address 6, write)
Tx2	10000000
Tx3	Refresh RAM Bank

4.3.7 Shutter

Shutter mode is saved in address 7 in the RAM bank.

In Normal shutter mode (DS=0), Manual and Async can be selected. The shutter speed can be changed by setting the proper value on the Shutter Dial (0 through 9). If a value is set on the Shutter Dial, then the preset values for this dial are loaded from different locations of the address in RAM.

Address 7

MSB							LSB
7	6	5	4	3	2	1	0
X	G	DS	AS	D3	D2	D1	D0

G	Gamma Conversion Mode (0: off (1.0), 1: on (0.45))
DS	Direct Shutter Flag (0: Normal Shutter, 1: Direct Shutter)
AS	Async Shutter Flag (0: Manual, 1: Async)
D3:0	Shutter Dial (0 to 9)

In Direct Shutter mode (DS=1), Manual and Async mode can be selected. In Direct Shutter mode, the Shutter Dial has no effect; the preset shutter speed value is loaded from address A, B (hex) or 3E, 3F (Hex) (Async). Users can upload the Direct Shutter preset value by accessing these direct shutter preset addresses.

In order to convert the exposing line count (H) to direct shutter speed, the following formula is applied:

Direct Shutter Manual:
Shutter Speed = 1049 (dec) - n ------>TMC-1000
524 (dec) - n ------>TMC-6700
Direct Shutter Async:
Shutter Speed = 8-n when n=1H~8H

n-1 when n=9H~1048H----> TMC-1000
when n is exposing line count. when n=9H-523 ----> TMC-6700

Example 1
Set Normal Manual Shutter Dial 5 (Gamma on)

Tx1	01000111 (address 7, write)
Tx2	01000101
Tx3	Refresh RAM Bank

Example 2
Set Direct Shutter Async mode (n=1030H, Gamma on)

Tx1	01000111 (Address 7)
Tx2	01110000 (Shutter Mode)
Tx3	01111110 (Address 3E)
Tx4	00000101 (Direct Shutter LSB)
Tx5	01111111 (Address 3F)
Tx6	00000100 (Direct Shutter MSB)
Tx7	Refresh RAM Bank

4.3.8 Gamma Conversion

The Gamma Conversion mode is saved in address 7. The TMC-6700/1000 series supports 1.0 Gamma mode and 0.45 Gamma mode. Please refer to Section 4.3.6, “RGB to YCrCb Conversion,” on page 28.

Example
Set Gamma on (0.45) (Normal Async Dial 5)

Tx1	01000111 (Address 7)
Tx2	01000101 (Gamma mode)
Tx3	Refresh RAM Bank

4.3.9 Color Matrix

Color Matrix data are saved in the RAM address from 1E to 26 (hex). As discussed in Section 3.3.3, “Color Matrix,” on page 17, the Color Matrix has 9 coefficients of floating point value. Each (RR, RG,....BB) is converted into 8-bit 2’s complement representation by first multiplying 32, then extracting the integer, and finally 2’s complementing the negative number.

Example
Write Default Matrix

CMTX= [1.75 -0.25 -0.5
-0.1875 1.3125 -0.125
-0.125 -0.5 1.625]

Tx1	01011110 (Address of BB)
Tx2	00110100
Tx3	01011111 (Address of BG)
Tx4	11110000
Tx5	01100000 (Address of BR)

Tx6	11111100
Tx7	01100001 (Address of GB)
Tx8	11111100
Tx9	01100010 (Address of GG)
Tx10	00101010
Tx11	01100011 (Address of GR)
Tx12	11111010
Tx13	01100100 (Address of RB)
Tx14	11110000
Tx15	01100101 (Address of RG)
Tx16	11111000
Tx17	01100110 (Address of RR)
Tx18	00111000
Tx19	Refresh RAM Bank

4.3.10 Black Level Reference

Saved address:	27, 28, 29 (hex)
Representation:	8-bit 2's complementary binary
Value:	-128~127

Example: Update new Black Level offset values (Rof=-10, Gof=-20, and Bof=-10)

Tx1	01100111 (Address of B offset)
Tx2	11110110
Tx3	01101000 (Address of G offset)
Tx4	11101100
Tx5	01101001 (Address of R offset)
Tx6	11110110
Tx7	Refresh RAM Bank

5 Troubleshooting

5.1 Problems and Solutions

Following are troubleshooting tips for common problems. In general, problems can easily be solved by following these instructions. If the following remedies fail to offer a solution to your problems, please contact a PULNiX representative.

5.1.1 Symptom: No Video

Remedies: Check that the following are properly operational.

- Power supplies
- Power cables
- Main power source
- Shutter mode switch (Please refer to the note under Section 3.1.1 on page 14.)
- Shutter speed control dial (Please refer to the note under Section 3.1.2 on page 14.)
- Lens

5.1.2 Symptom: Dark Video

Remedies: Check that the following are properly connected and operational.

- Shutter mode switch (Please refer to the note under Section 3.1.1 on page 14.)
- Iris opening on the lens

5.1.3 Symptom: Non-synchronized Video

Remedies: Check that the following are properly connected and operational.

- Proper mode output
- Frame grabber software camera selection

5.1.4 Symptom: Bright Video

Remedies: Check that the following are properly connected and operational.

- Shutter speed control dial (Please refer to the note under Section 3.1.2 on page 14.)
- IWB RST switch

5.2 Information and Support Resources

For further information and support:

Phone:	(408) 747-0300
	(800) 445-5444
	(800) 3-PULNIX (24-hour message access)
Fax:	(408) 747-0660
E-mail:	imaging@jaipulnix.com
Mail:	PULNiX America, Inc.
	Sales Department
	1330 Orleans Drive
	Sunnyvale, CA 94089
	ATTN: Video Applications
Web Site:	www.pulnix.com

6 Appendix

6.1 Specifications

6.1.1 Product Specifications

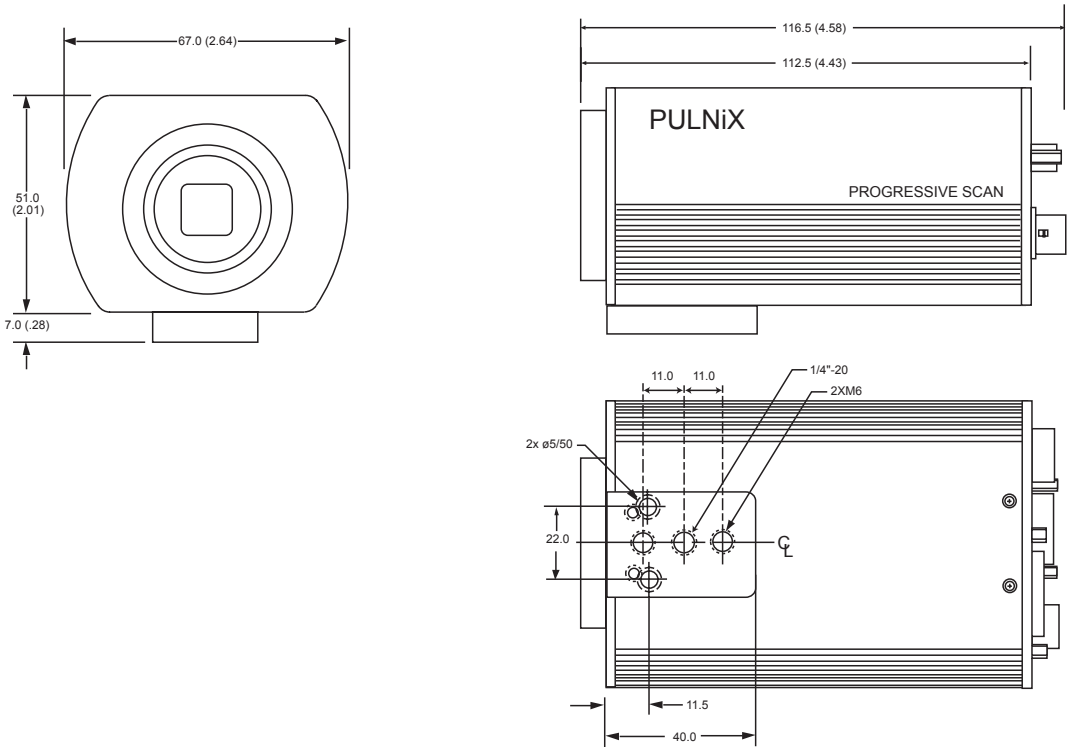
TABLE 7. TMC-6700/1000 Series Product Specifications Table

	TMC-1000/1000CL	TMC-6700/6700CL
Imager	1” progressive scanning interline transfer CCD	1/2” progressive scanning interline transfer CCD
Pixels	1008 (H) x 1018 (V)	648 (H) x 484 (V)
Cell size	9.0µm x 9.0µm	
Color filter	Bayer Primary RGB color filter	
Scanning	Progressive, 1050 lines @ 15Hz	Progressive, 525 lines @ 60Hz
Sync	Internal/external auto switch HD/VD, 4.0 Vp-p impedance 4.7k¾ VD = 15Hz ±5% HD = 15.75KHz ±3%	Internal/external auto switch HD/VD, 4.0 Vp-p impedance 4.7k¾ VD = 60Hz ±5% HD = 31.47KHz ±3%
Data clock output	20.034MHz	25.49MHz
Resolution	Digital: 1006 (H) x 1016 (V)	Digital: 646 (H) x 482 (V)
S/N Ratio	50dB min., 56dB typical	
Min. illumination	10 lux, f = 1.4 9AGC off); Sensitivity: 10µV/e-	
Video output	Digital: 24-bit LVDS Channel Link™* Camera Link (TMC-1000CL/6700CL only) Analog: 0.66 Vp-p 75¾ RGB video	
Gamma	0.45 or 1.0 (0.45 standard)	
Lens mount	C-mount	
Power requirement	12V DC 450±50mA	
Operating temp.	-10°C to 50°C	
Shock	Shock: 70G, 10-11msec	
Vibration	Vibration: 7Grms, 10-2000Hz	
Size (W x H x L)	51mm x 67mm x 116.5 mm (2.01" x 2.64" x 4.58")	
Weight	374g (13.2 oz.) without tripod mount	
Power cable	12P-02S	
Power supply options	PD-12UP, PD-12UU	
Accessories	Channel link/TTL Adapter cable: 15CL-02 Direct Channel Link cable: 15CL-02-15 Power supply for 15CL-02: PD-5 RS-232 controller set: CS-232C RGB cable: CBL-2R-15	

*Channel Link™ is a National Semiconductor trademark.

6.1.2 Physical Dimensions

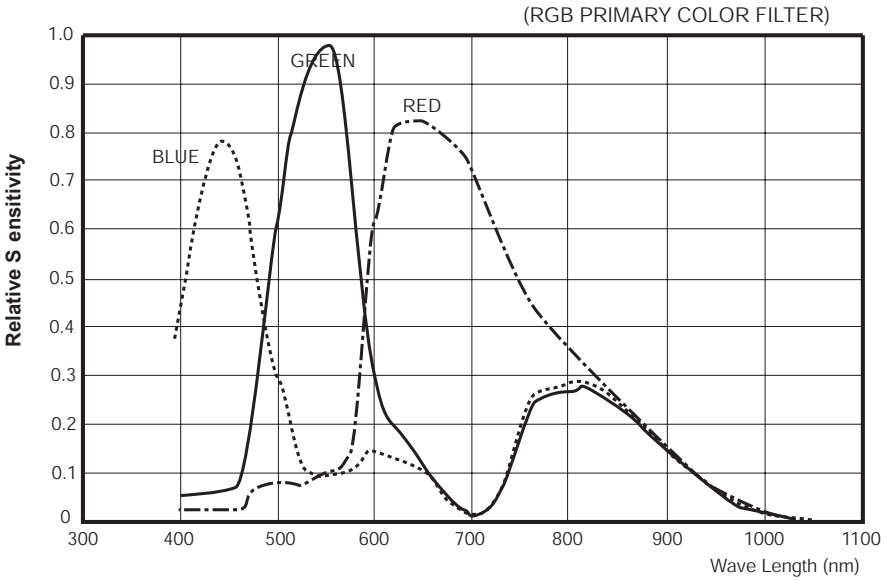
FIGURE 11. TMC-6700/1000 Series Physical Dimensions



6.2 Imager Color Filters

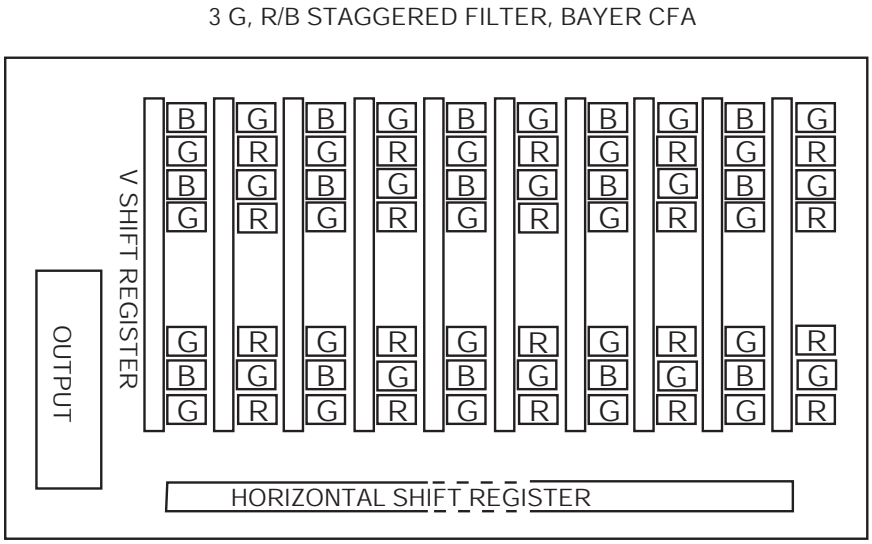
6.2.1 Spectral Response with Complementary Mosaic Filter

FIGURE 12. Spectral Response



6.2.2 Bayer Primary Color Filter

FIGURE 13. Bayer Primary Color Filter Diagram



6.3 TMC-6700/1000 Series Control Parameter Address Map

FPGA RAM				EIA-232 Control	
Dec Addr.	Hex Addr.	Bin Addr.	Parameter	Dec Index	Hex Index
0	000	000000000	none	0	000
8	008	000001000	VCA gain	1	001
16	010	000010000	ADC offset	2	002
24	018	000011000	ADC reference top	3	003
32	020	000100000		4	004
40	028	000101000		5	005
48	030	000110000	WB, edge enh. mode/level, ycc	6	006
56	038	000111000	shutter dial/mode, gamma	7	007
64	040	001000000		8	008
72	048	001001000		9	009
80	050	001010000	direct shutter manual LSB	10	00A
88	058	001011000	direct shutter manual MSB	11	00B
96	060	001100000	preset shutter manual 9 LSB	12	00C
104	068	001101000	preset shutter manual 9 MSB	13	00D
112	070	001110000	preset shutter manual 8 LSB	14	OOE
120	078	001111000	preset shutter manual 8 MSB	15	00F
128	080	010000000	preset shutter manual 7 LSB	16	010
136	088	010001000	preset shutter manual 7 MSB	17	011
144	090	010010000	preset shutter manual 6 LSB	18	012
152	098	010011000	preset shutter manual 6 MSB	19	013
160	0A0	010100000	preset shutter manual 5 LSB	20	014
168	0A8	010101000	preset shutter manual 5 MSB	21	015
176	0B0	010110000	preset shutter manual 4 LSB	22	016
184	0B8	010111000	preset shutter manual 4 MSB	23	017
192	0C0	011000000	preset shutter manual 3 LSB	24	018
200	0C8	011001000	preset shutter manual 3 MSB	25	019
208	0D0	011010000	preset shutter manual 2 LSB	26	01A
216	0D8	011011000	preset shutter manual 2 MSB	27	01B
224	0E0	011100000	preset shutter manual 1 LSB	28	01C
232	0E8	011101000	preset shutter manual 1 MSB	29	01D
240	0F0	011110000	color matrix BB	30	01E
248	0F8	011111000	color matrix BG	31	01F
256	100	100000000	color matrix BR	32	020
264	108	100001000	color matrix GB	33	021
272	110	100010000	color matrix GG	34	022
280	118	100011000	color matrix GR	35	023
288	120	100100000	color matrix RB	36	024
296	128	100101000	color matrix RG	37	025
304	130	100110000	color matrix RR	38	026
312	138	100111000	black level offset B	39	027
320	140	101000000	black level offset G	40	028
328	148	101001000	black level offset R	41	029
336	150	101010000	white balance offset B	42	02A
344	158	101011000	white balance offset R	43	02B
352	160	101100000	DSP gain	44	02C
360	168	101101000		45	02D
368	170	101110000	preset shutter async 8 LSB	46	02E
376	178	101111000	preset shutter async 8 MSB	47	02F
384	180	110000000	preset shutter async 7 LSB	48	030
392	188	110001000	preset shutter async 7 MSB	49	031
400	190	110010000	preset shutter async 6 LSB	50	032
408	198	110011000	preset shutter async 6 MSB	51	033
416	1A0	110100000	preset shutter async 5 LSB	52	034
424	1A8	110101000	preset shutter async 5 MSB	53	035
434	1B0	110110000	preset shutter async 4 LSB	54	036
440	1B8	110111000	preset shutter async 4 MSB	55	037
448	1C0	111000000	preset shutter async 3 LSB	56	038
456	1C8	111001000	preset shutter async 3 MSB	57	039
464	1D0	111010000	preset shutter async 2 LSB	58	03A
472	1D8	111011000	preset shutter async 2 MSB	59	03B
480	1E0	111100000	preset shutter async 1 LSB	60	03C
488	1E8	111101000	preset shutter async 1 MSB	61	03D
496	1F0	111110000	direct shutter async LSB	62	03E
504	1F8	111111000	direct shutter async MSB	63	03F

6.4 Digital Output Wave Forms

FIGURE 14. Line Data Valid (TMC-1000/1000CL)

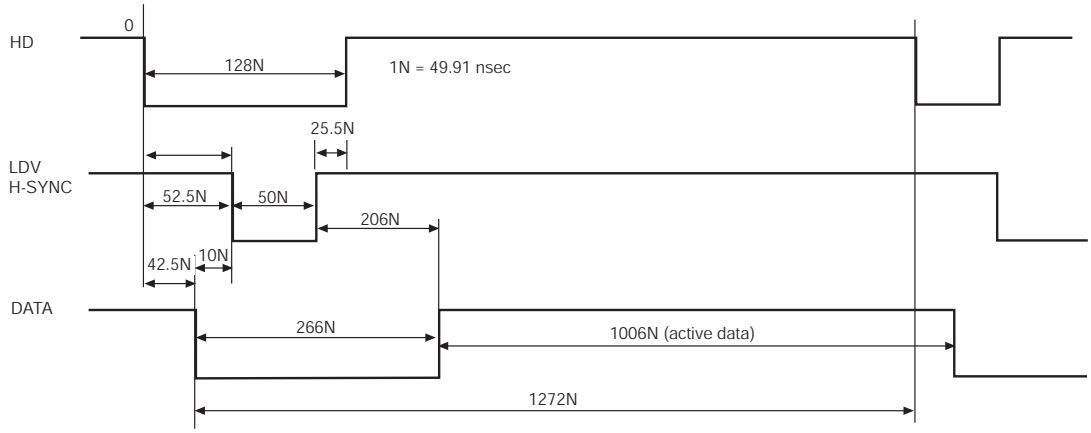


FIGURE 15. Frame Data Valid (TMC-1000/1000CL)

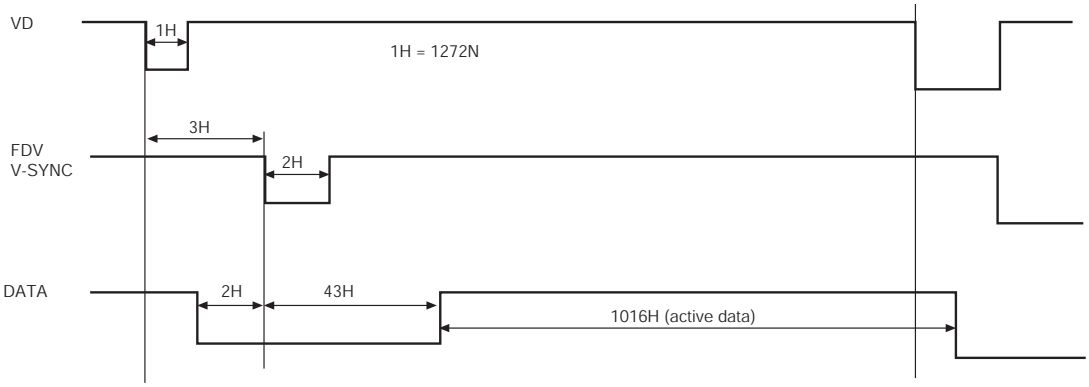


FIGURE 16. Line Data Valid (TMC-6700/6700CL)

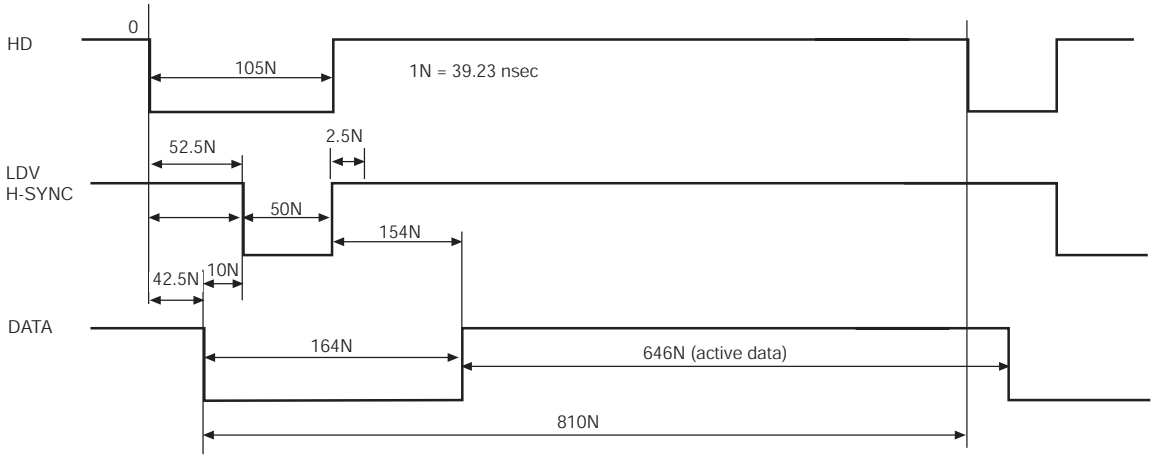
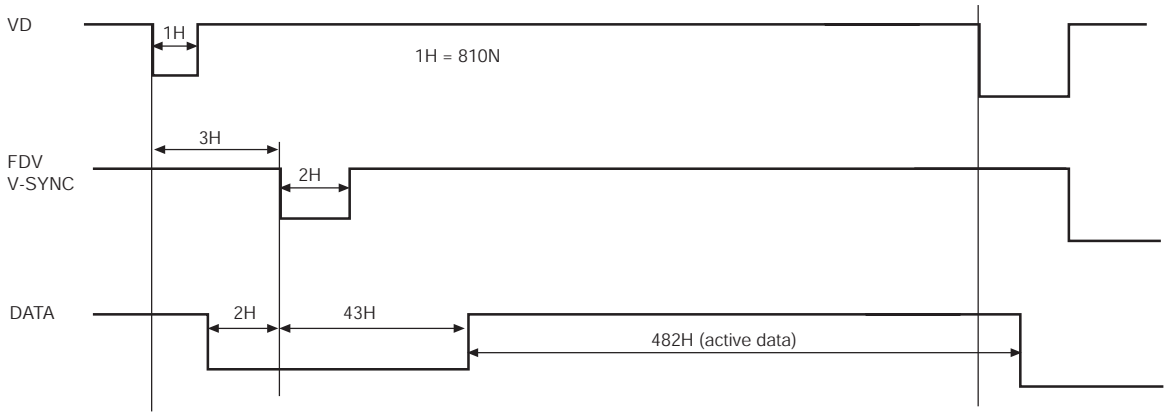
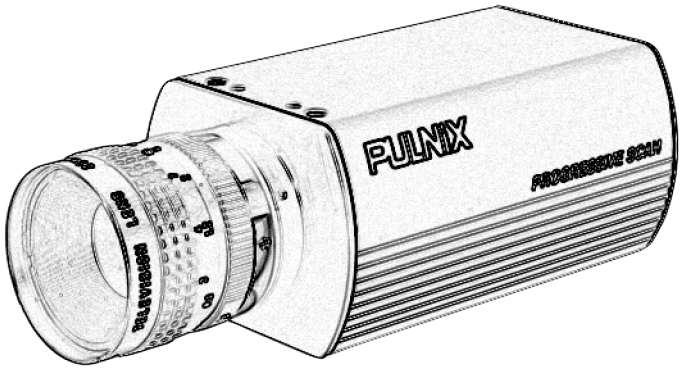


FIGURE 17. Frame Data Valid (TMC-7600/6700CL)





PULNiX

Imaging Products

www.pulnix.com

PULNiX America, Inc.
1330 Orleans Drive
Sunnyvale, CA 94089

Tel: 408-747-0300
Tel: 800-445-5444
Fax: 408-747-0660

Email: imaging@jaipulnix.com

69-0117
Rev. A