TM-6710/6710CL High-Speed Progressive Scanning CCD Camera

Operation Manual

69-0058
Rev. D

iAi PULNiX®
Imaging Products

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Warranty

Please contact your factory representative for details about the warranty.

Certifications

CE Compliance

The TM-6710/6710CL 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: EN55022:1995 Class A / CISPR 22:1993

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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.

TM-6710/6710CL Operation Manual
Printing: August 30, 2004
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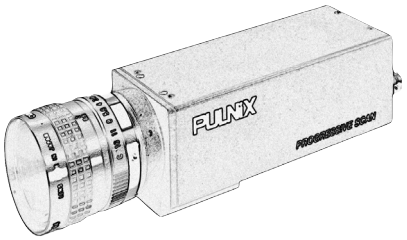
TM-6710/6710CL High-Speed Progressive Scanning CCD Camera

Operation Manual



1 Introduction

1.1 Product Description

The TM-6710* is a high-resolution monochrome CCD camera with “quad speed” 120FPS dual-tap, dual-channel digital output.

1.2 Features

- **Three scanning modes**
  - Non-interlace quad speed scanning (484 active lines at 120Hz or 60Hz (selectable))
  - 200 lines partial scanning (at 236Hz)
  - 100 lines partial scanning (at 300Hz)
- **Full frame electronic shutter**

  The substrate drain electronic shutter captures images at various speeds without any smearing. The electronic shutter works in all there scanning modes except slow speed at partial scanning.
- **1/2" progressive scan interline transfer CCD**

  Advantages include:
  - High resolution (648 H x 484 V) active pixels for very high speed and image quality.
  - Square pixels (9.0 x 9.0 μm). Precise dimensional measurement ability.
  - High speed electronic shutter capability offering high dynamic resolution of moving objects, as well as electronic iris control. This eliminates the need for a mechanical shutter.

*. Unless specifically mentioned, all information in this manual is relevant to both the TM-6710 and TM-6710CL cameras.

- Progressive scan, which eliminates interlace deterioration of the image while offering an easy-to-use computer interface.
- High sensitivity and low noise at fast scanning. Can drive faster than 25 MHz pixel clock rate. Excellent S/N ratio (>45 dB, 8-bit typical). Built-in micro lens.
- Partial scan capability, which allows 100 and 200 lines of partial scan up to 300Hz scanning.

- **Asynchronous reset**

  The TM-6710 captures an image using asynchronous reset. This feature is especially important for applications requiring the capture of images of moving objects at the precise location in the field of view, such as a belt conveyer, fast event observation and still picture capture.

  An asynchronously resettable frame grabber is required to capture the async reset images.

- **Digital output**

  The TM-6710 has a pair of 8-bit A/D converters, and a line buffer that generates 16-bit, 25MHz dual channel digital output. The digital output is standard RS-644 format with LDV, FDV and clock output for standard frame grabbers or Camera Link. The Camera Link model is called the TM-6710CL.

- **RS-232C (or RS-485) control**

  External computer control allows the operator to remotely adjust the following functions: clock speed, shutter, gain, A/D reference and scan format. Camera Link controls the same functions via a Camera Link serial communication.

- **VGA display output**

  Because progressive scan cameras are not in TV format, the display of the video signal can only be achieved by using a frame grabber and computer. The VGA output of the TM-6710 scans the FIFO memory read out at 120Hz at 50.98 MHz pixel clock (or 60 Hz) non-interlace (multiplexed output).

- **Miniaturized, lightweight and rugged**

  All PULNiX cameras are built with the same design principles: Solid state technology; miniaturization; application-specific features such as custom design, remote imagers, special functions for various application needs; and design robust enough even for military applications.

- **Warranty**

  Please contact your factory representative for details about the warranty.

1.3 Applications

Designed for speed and functional versatility, the TM-6710 is ideal for applications such as high speed image capturing, machine vision, computer graphics, gauging, avionics, microscopy, character and fine pattern recognition, document reading and high-end surveillance.

1.4 System Configuration

FIGURE 1. TM-6710 System Configuration

Figure 1 below presents a typical system configuration for the TM-6710 camera. Please see "Power Supply and Power Cable Setup" on page 7 for info on power supplies.

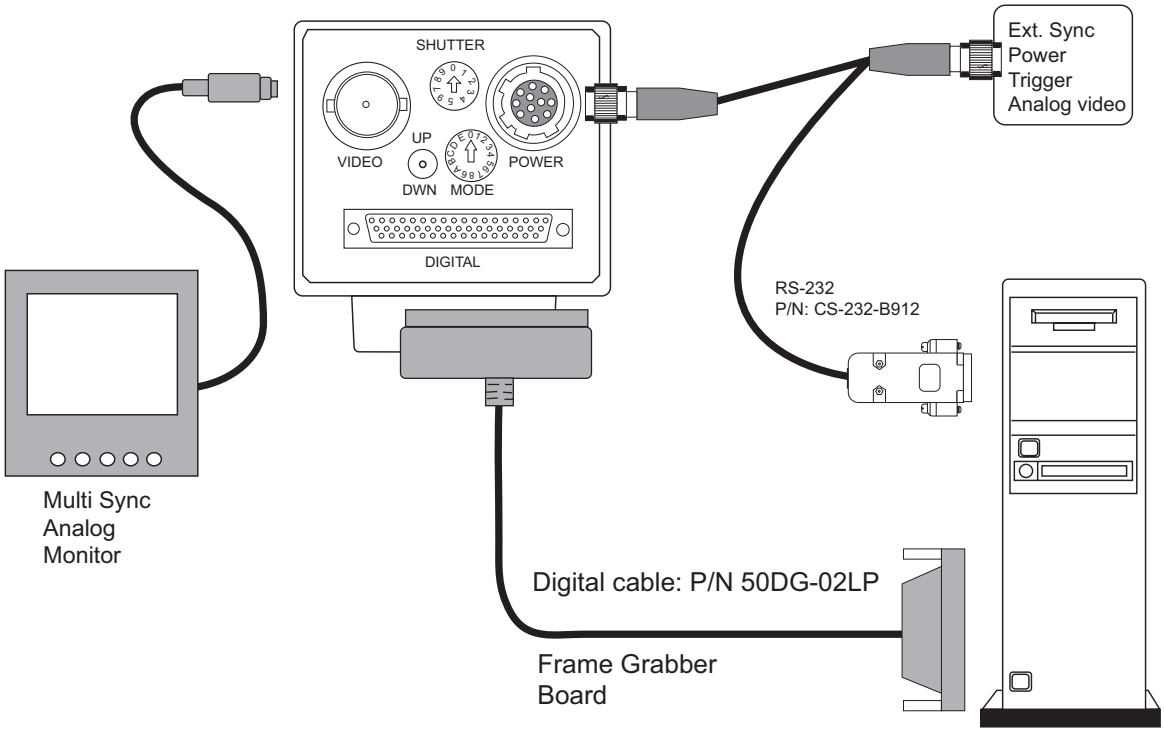
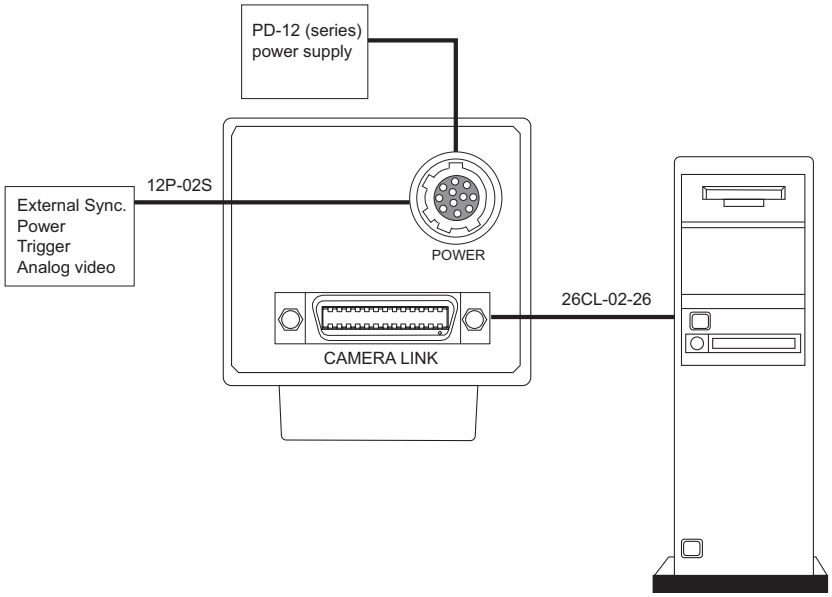


FIGURE 2. TM-6710CL System Configuration

Figure 2 below presents a typical system configuration for the TM-6710CL camera. Please see "Power Supply and Power Cable Setup" on page 7 for information on power supplies.



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 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 works together properly.

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.

- TM-6710 or TM-6710CL camera
- Tripod mount
- TM-6710 /TM-6710CL manual (if ordered)
- Warranty card
- Document information card

2.1.3 Accessories and Options

Following is a list of additional accessories or equipment 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.

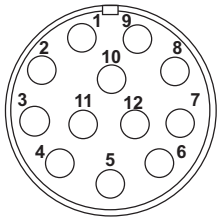
- RS-232 cable (Part #CS-232-B912 for the TM-6710 camera)
- Digital cable (Part #50DG-02LP for the TM-6710 camera. Contact the factory for frame-grabber specific cables.)
- PD-12UUP power supply or PD-12UU power supply with 12P-02S cable
- 26CL-02-16 Camera Link cable (for TM-6710CL camera)

2.2 Camera Setup

2.2.1 Pin Configurations

2.2.1 (a) 12-Pin Connector (TM-6710)

The TM-6710 has a 12-pin connector for power input. Pin #1 is Ground and Pin #2 is +12V DC. The other pins handle a number of other input and output functions, as detailed below.



Pin	Description	Pin	Description
1	GND (Power)	7	VD In
2	+12V DC	8	N/C
3	GND (Analog)	9	HD In
4	Video Out	10	RXD (RS-232)
5	GND (Digital)	11	Integration
6	VINIT In	12	TXD (RS-232)

2.2.1 (b) 12-Pin Connector (TM-6710CL)

The TM-6710CL has a 12-pin connector for power input. Pin #1 is ground and Pin #2 is +12V DC. The pinout table is shown below. For the TM-6710CL, serial communication camera control is done via the Camera Link connector on the rear panel of the camera.

Pin	Description	Pin	Description
1	GND (Power)	7	VD In
2	+12V DC	8	N/C
3	GND (Analog)	9	HD In
4	Video Out	10	RXD*
5	GND (Digital)	11	Integration†
6	VINIT In†	12	TXD*

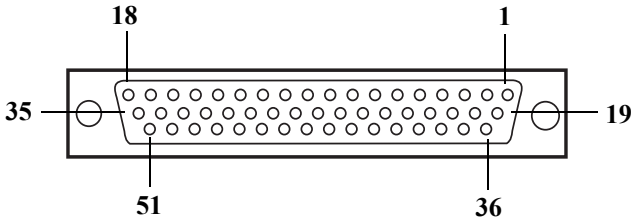
*. Optional TTL serial communications.

†. VINIT and Integration can be controlled via Camera Link. When Camera Link is connected for these uses, do not use the 12-pin connector inputs.

2.2.1 (c) 51-Pin Connector

The TM-6710 has a 51-pin connector for RS-644 digital output (using B channel digital output to configure single channel).

FIGURE 3. 51-Pin Connector



Pin#	Description	Pin#	Description	Pin#	Description
1	A0+	18	CLK+	35	CLK-
2	B0+	19	A0-	36	GND
3	A1+	20	B0-	37	VCC (jumper)
4	B1+	21	A1-	38	VCC (jumper)
5	A2+	22	B1-	39	EXT. HD
6	B2+	23	A2-	40	TXD
7	A3+	24	B2-	41	LPULSE
8	B3+	25	A3-	42	RXD
9	A4+	26	B3-	43	VINIT
10	B4+	27	A4-	44	INTEG
11	A5+	28	B4-	45	EXP-
12	B5+	29	A5-	46	EXP+
13	A6+	30	B5-	47	LDV-
14	B6+	31	A6-	48	LDV+
15	A7+	32	B6-	49	FDV-
16	B7+	33	A7-	50	FDV+
17	GND	34	B7-	51	GND

2.2.1 (d) Camera Link Connector

The TM-6710CL has a 26-pin connector on the rear panel to output Camera Link data. The connector pinout is shown in Figure 4 below.

FIGURE 4. Camera Link Connector

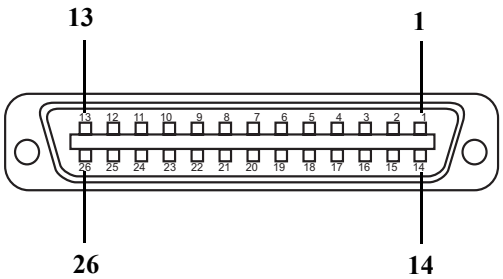


FIGURE 5. MDR 26-Pin Connector (0226-622VC)

MDR 26-Pin Connector (0226-622VC)			
Pin#	**Description**	**Pin#**	**Description**
1	GND (shield)	14	GND (Shield)
2	X0-	15	X0+
3	X1-	16	X1+
4	X2-	17	X2+
5	Xclk-	18	Xclk+
6	X3-	19	X3+
7	SerTC+	20	SerTC-
8	SerTFG-	21	SerTFG+
9	VINIT (CC1-)	22	VINIT (CC1+)
10	INTEG (CC2+)	23	INTEG (CC2-)
11	CC3-	24	CC3+
12	CC4+	25	CC4-
13	GND (shield)	26	GND (Shield)

2.2.2 Power Supply and Power Cable Setup

PULNiX recommends the following power supply:

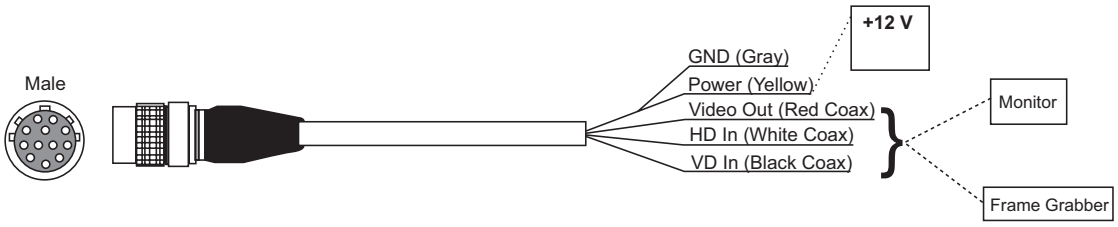
PD-12UUP 110V AC/12V DC 1.2A power supply

If you are providing power through the 12-pin connector, the PD-12UUP power supply is available with the 12-pin mating connector already attached to the leads from the power supply. The PD-12UU power supply can be connected directly to the PULNiX power cable or via a terminal strip. If you choose direct wiring, note the following:

- The lead ends must be twisted together and tin-soldered for strength and electrical continuity.
- Use shrink tubing or a similar insulator to prevent exposed leads from touching.
- 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.

If using PULNiX power cables, such as the 12P-02S, etc., please refer to the pin-out diagram. The color-coded leads use Gray for Ground and Yellow for +12V DC.

FIGURE 6. 12P-02S Power Cable



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.*

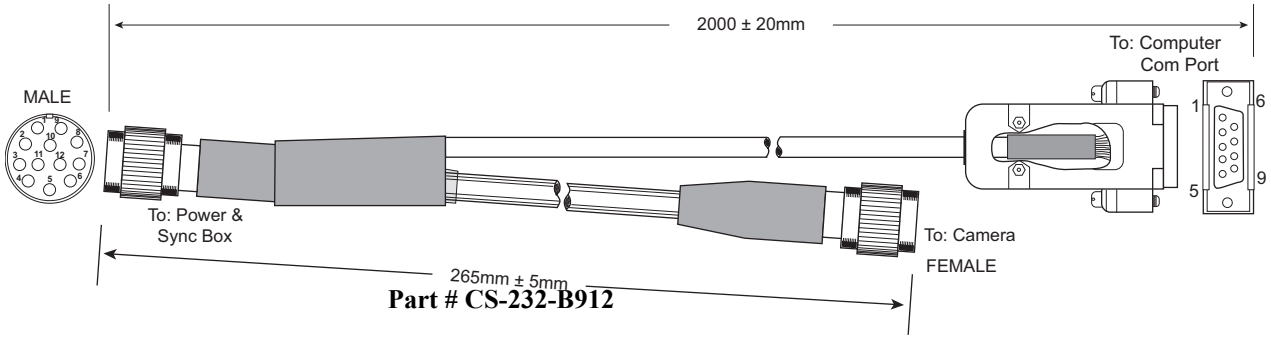
If you are building your own power cables, consult the pin-out for the camera purchased. Connect the Ground and +12V power leads of the PC-12P power connector to Pin #1 and Pin #2, respectively. Remember that power must be DC regulated, and of sufficient current to properly power the camera.

Attach the power cable to the connector. The 12-pin connector is keyed and will only fit in one orientation. Rotate the connector while applying slight pressure until the keyways line up. Press the connector into place until it is firmly seated.

You may now plug the power cord into the 110V AC socket and power up the camera.

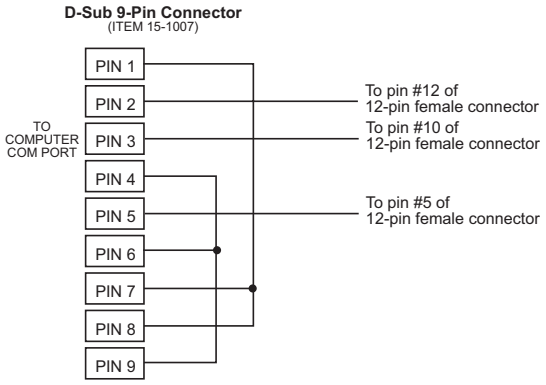
2.2.3 RS-232 Cables and Connectors (TM-6710 only)

FIGURE 7. RS-232 Serial Communication Cable



Part # CS-232-B912

12-Pin Male Connector		12-Pin Female Connector	
Pin#	**Description**	**Pin#**	**Description**
1	GND	1	GND
2	+12V	2	+12V
3	GND	3	GND
4	Video Out	4	Video Out
5	GND	5	GND
6	VINIT	6	VINIT
7	VD In	7	VD In
8	N/C	8	N/C
9	HD In	9	HD In
10	N/C	10	RXD
11	INTEG	11	INTEG
12	N/C	12	TXD



2.2.4 Attaching the Video Output (Analog Output on TM-6710 Only)

Connect a BNC cable to the output from the camera and the input to your system (frame grabber analog input). The input of the system or monitor should be balanced for 75ohms termination.

Standard RG-59 type coaxial cable should carry a full video signal for up to 100 feet.

If you want to output the video, input the power, and sync to a camera over a single cable, you can use a PULNiX multi-conductor cable, such as the 12P-02S. The mini coaxial leads in PULNiX multi-conductor cables are designed for short runs of no longer than 100 feet.

Note: *Make sure that no extraneous wires are visible which could cause a short.*

Note*: For digital output, see Section 3.3.9 on page 23.*

2.2.5 Attaching the Camera Lens

The TM-6710 camera accepts standard C-mount lenses. To attach the C-mount lens to the camera, carefully engage the threads and rotate the lens clockwise until it firmly seats on the mounting ring. Do not force the lens if it does not seat properly. Please note that some lenses with extremely long flangebacks may exceed the mounting depth of the camera.

2.2.6 Back-Focusing the Lens

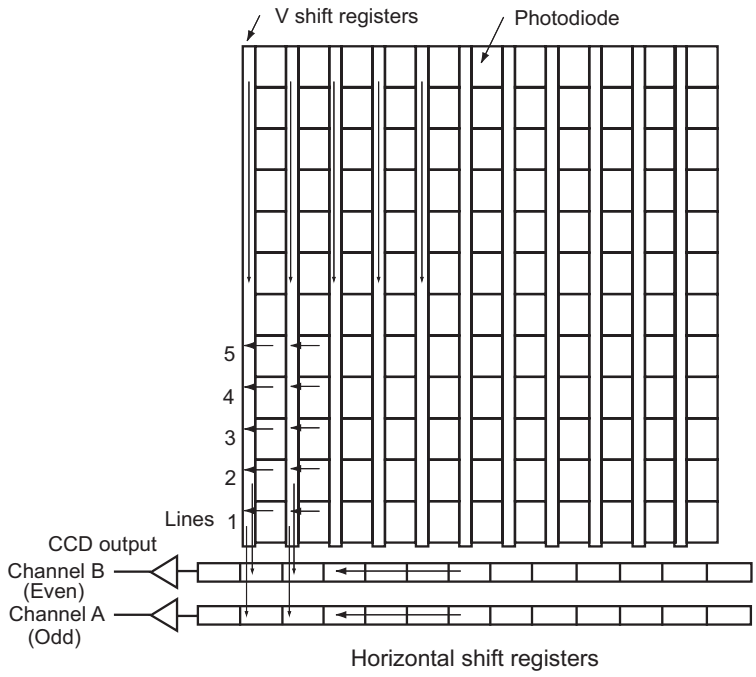
To backfocus the TM-6710 camera, follow the steps below:

1. Attach a C-mount lens in the lens mount. Be sure that the lens is properly mounted.
2. Set the lens focus to infinity (if the lens is a manual iris, set the iris to a high f-stop while still retaining a well-lighted image).
3. Obtain the best focus possible at this setting, then loosen two of the three miniature hex head set screws locking the focus ring in place.
4. Now turn the entire lens and focus ring assembly back and forth until the best image is obtained.
5. Tighten the focus ring set screws. Your backfocus is now set.

3 Operation

3.1 Dual-Tap Video Output

The TM-6710CL uses a dual-tap output for its fast frame readout. At the same horizontal clock cycle, line 1 and all odd lines go to channel A, and line 2 and all even lines go to channel B. Vertical shift registers move twice per horizontal blanking period. Lines are grouped in twos, so that 1 and 2, and 3 and 4, and so on, are output from channel A and B simultaneously.



3.2 Rear Panel

FIGURE 8. Rear Panel Layout (TM-6710)

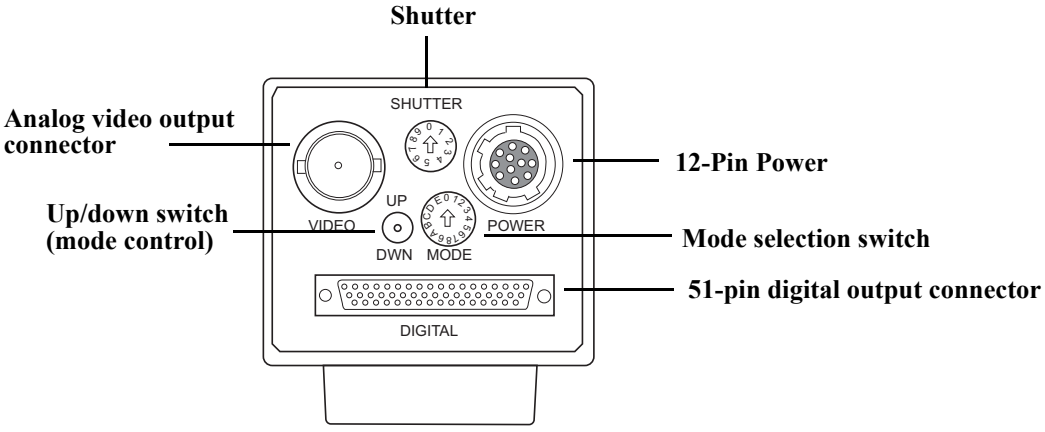
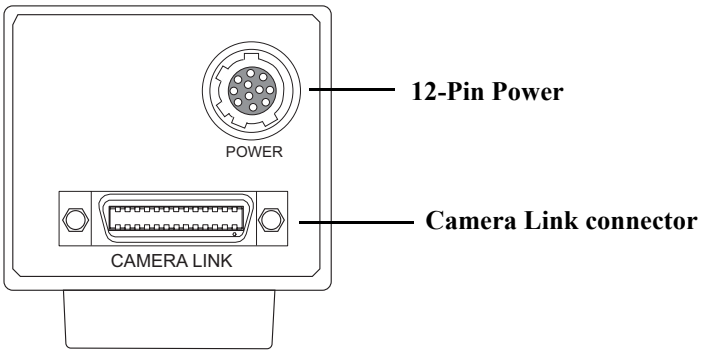


FIGURE 9. Rear Panel Layout (TM-6710CL)



3.2.1 Mode Control Switches (TM-6710)

Mode	Control Switch	Up/Down Switch	
0	Normal mode		
1	Gain control (A/B)	up - increase gain of Ch. A down - decrease gain of Ch. A	
2	Gain (A/B) fine tune	up - increase gain of Ch. A down - decrease gain of Ch. A, while decrease/increase gain of Ch. B, at 5:1 ration	
3	Main Vref control	up - increase gain of Ch. A down -decrease A/D voltage reference of Ch. A & Ch. B	
4	Vref balance control	up - increase gain of Ch. A down - increase/decrease A/D voltage reference of Ch. A, while decrease/increase gain of Ch. B	
5	Gain selection	up: 9dB	down: 12dB
6	Gain selection	up: 18dB	down: 22dB
7	Clock selection	up: 120Hz	down: 60Hz
8	Async/Manual shutter	up: Manual	down: Async
9	Factory set recall	up/down - recall only	
A	Power up (recall or save)	up: recall	down: save
B-C	User page storage (store user settings)	up: recall	down: save
D	Direct shutter	up - increase manual shutter speed down - decrease manual shutter speed	
E	Partial scan	up: 100 lines	down:
F	Partial scan	up: normal scan	down: 200 lines

3.3 Modes of Operation

3.3.1 Shutter Operation

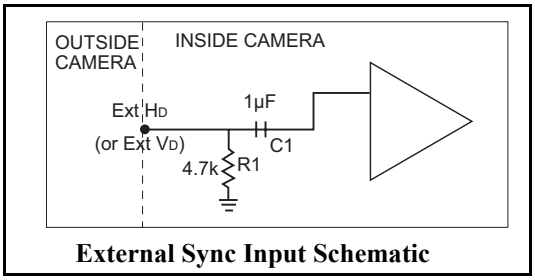
The TM-6710 has a substrate drain electronic shutter mechanism which provides a superb picture at various speeds without smearing. Manual shutter speed control can be selected at 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/8,000, 1/16,000 or 1/32,000 sec. rate.

Note: *Some slow speed shutter rates will not apply to partial scanning.*

3.3.2 External Synchronization

The TM-6710 can take external HD and VD for phase locking. The internal PLL will take external HD and lock with the CCD HD. (The CCD HD frequency is half of the analog video output HD.)

Example: Ext. HD = 30.49KHz, VD will be 120Hz and Master Clock will be 50.98MHz.



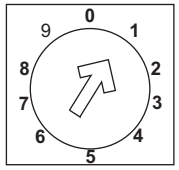
External Sync Input Schematic

The internal sync generator will take external VD to generate internal VD. External VD frequency should be the same as the frame rate.

3.3.3 Asynchronous Reset with Shutter

To activate the asynchronous reset mode, use the Mode control switch on the back panel of the camera (TM-6710). The asynchronous trigger input (VINIT) is applied to pin #6 of the 12-pin connector (TM-6710) or pins #9 and #22 of the Camera Link connector (TM-6710CL).

The TM-6710's asynchronous reset is flexible and takes external HD for phase locking. Applying a VINIT pulse resets the camera's scanning and purging of the CCD. When async reset pulse (VINIT) is applied to High state (+5V) with dial switch select from 1 to 9, the TM-6710's asynchronous camera discharges the photo charges into the substrate drain although the camera is still running on its sync timing and only outputs captured video. When the negative going reset pulse is applied, the camera will latch the falling edge to its next horizontal drive and reset vertical sync timing immediately. Then it starts integrating for the period of shutter control set by either an external pulse width pulse or internal shutter control. Therefore the horizontal phase will not be interrupted. The TM-6710 asynchronous camera will output one frame of shuttered video after reset.



Shutter Control Switch

TABLE 1. Shutter Control

Set	Manual Mode		Async Reset Mode	
0	No Shutter (1/120)		No Shutter (1/120)	
1	1/250	128H	1/32,000	1.0H
2	1/500	64H	1/16,000	2.0H
3	1/1,000	32H	1/12,000	3.0H
4	1/2,000	16H	1/8,000	4.0H
5	1/4,000	8.0H	1/4,000	8.0H
6	1/8,000	4.0H	1/2,000	16H
7	1/12,000	3.0H	1/1,000	32H
8	1/16,000	2.0H	1/500	64H
9	1/32,000	1.0H	Shutter determined by pulse width	

There are three modes to control the asynchronous reset and shutter speed:

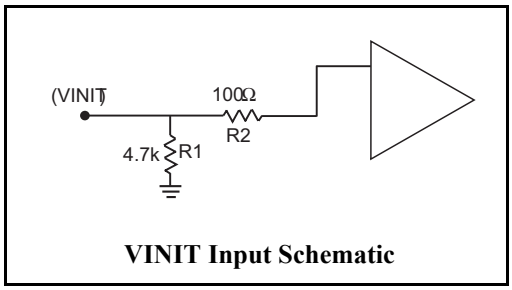
- External Pulse Width Control Mode

- Internal Fast Reset Mode
- Internal Slow Reset Mode

Mode 0:	Normal Mode
Async Mode 1-4:	Fast Mode
Async Mode: 5-8:	Slow Mode
Async Mode 9:	External pulse width control mode

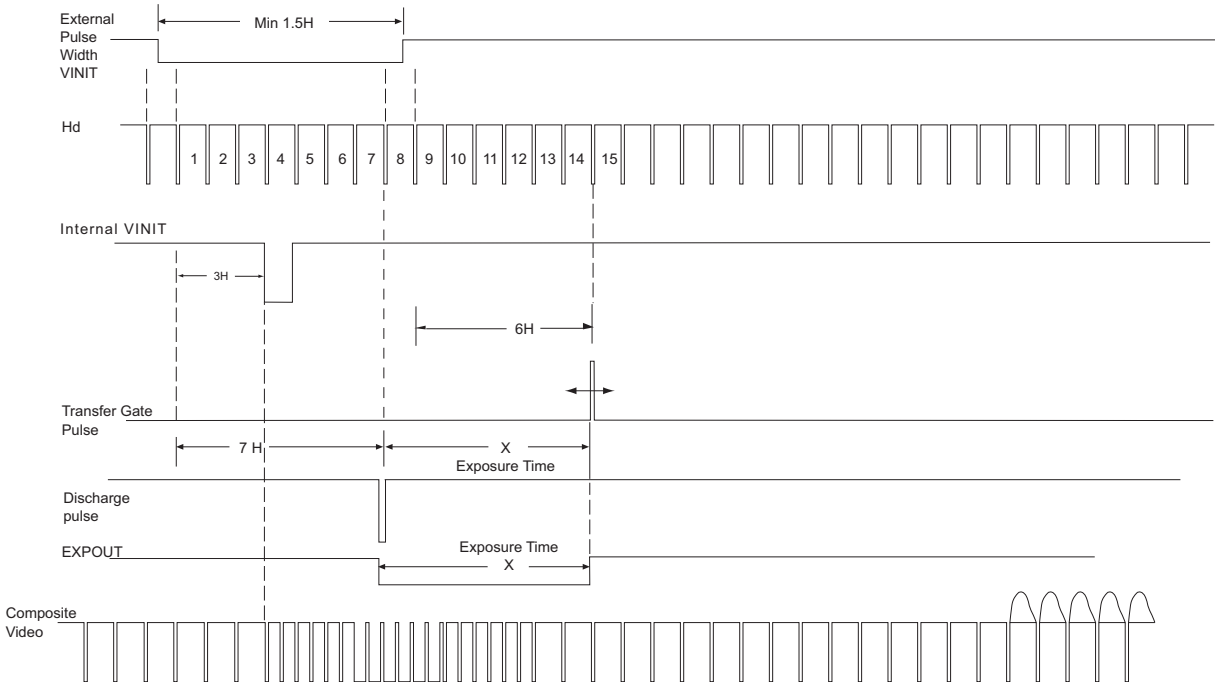
3.3.3 (a) External Pulse Width Control Mode

The TM-6710 can be reset with external reset pulse (VINIT). Set the dial switch to "9." Apply a pulse-width control VINIT signal generated from an external event trigger to the camera. The internal reset pulse will be latched to Hd and at 5th HD timing from the external pulse leading edge (negative going edge). The CCD discharge pulse will be generated to clear the images. The internal VINIT will be generated at the following edge (positive going edge) of the external pulse, resetting the internal timing including the video sync. The shutter speed is the same as the external pulse width, but the integration delays 5H from the leading edge. For the immediate reset option, please contact PULNiX.



VINIT Input Schematic

FIGURE 10. External Pulse Width Mode



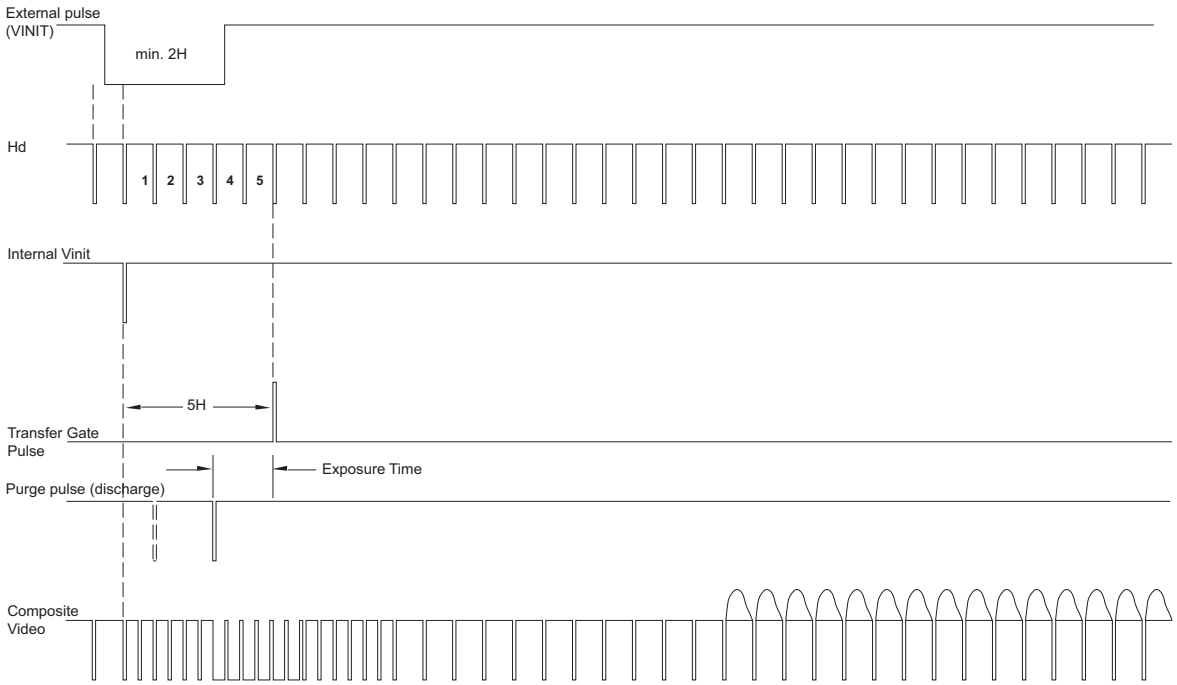
For the progressive format, one frame of video output will start from the rising edge of the pulse width control. At async mode with external pulse input high, the video output will be disabled as the camera continues discharging the CCD image, providing black video only.

This feature is especially important in capturing moving objects at the precise location of the field of view, such as belt conveyer, fast event observation and still picture capturing.

3.3.3 (b) Internal Fast Reset Mode

The video signal has no delay from the reset timing. Shutter speed range is 1/8,000 to 1/31,000 sec. Select a dial switch setting from "1" to "4." When the fast reset mode is selected, the camera resets with internal VINIT timing, which is latched to HD, and video output is also synchronized with internal VINIT timing without further delay. The shutter speed is controlled by the dial switch.

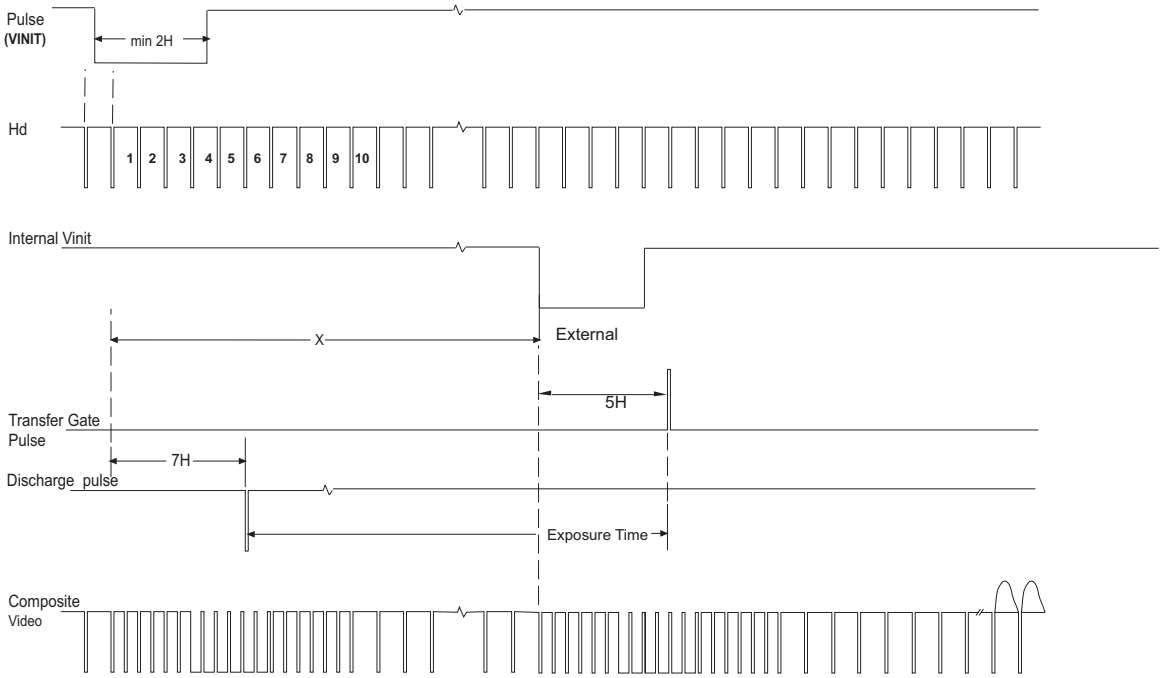
FIGURE 11. Internal Fast Reset Mode



3.3.3 (c) Internal Slow Reset Mode

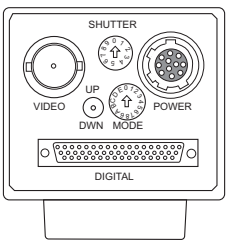
The speed control ranges from 1/120 to 1/4,000 sec. With the internal slow reset mode selected, the camera operates the reset and shutter in the same way as the external pulse width control mode. When the external VINIT pulse is applied, internal VINIT is latched to HD and the second internal VINIT signal is delayed to set up the shutter speed period. The shutter speed is controlled by the dial switch from "5" to "8." Video output timing starts right after the internal VINIT. For the timing of the delayed internal reset, LPULSE output of the 51-pin connector can be used.

FIGURE 12. Internal Slow Reset Mode



3.3.4 Partial Scan Mode

A key advantage of the TM-6710 is the partial scan mode, which provides up to 300Hz frame rate output. 200 line partial scan is output at 236Hz. 100 line partial scan is output at 300Hz.



Normal mode:	F	UP	120 Hz progressive scan
200 line scan:	F	DWN	236 Hz progressive scan
100 line scan:	E	UP	300 Hz progressive scan

3.3.5 Integration

Integration is activated by keeping INTEG control as active low. Integ is #11 of the 12-pin connector for the TM-6710, (TTL) and #10 and 23 of the Camera Link connector for the TM-6710CL (LVDS). During low, the TM-6710 series keeps integrating and, upon the rising edge of the INTEG control pulse, outputs the frame. During integration, the signal processing keeps optical black levels as the reference black video to clamp video levels. This has the result of cancelling out thermal noise during the integration period.

3.3.6 Progressive Scanning

The TM-6710 uses a state-of-the-art CCD called a “Progressive scanning interline transfer CCD” which scans all lines sequentially from top to bottom at one frame rate 120 Hz or (60 Hz) with dual channel output. Like a non-interlace computer screen, it generates a stable crisp image without alternating lines and provides full vertical TV resolution of 484 active lines. The interline transfer architecture is also important to generate simultaneous shuttering. This is different from full frame transfer architecture which requires a mechanical shutter or strobe light in order to freeze the object motion.

The TM-6710 outputs the progressive scanned image with an electronic shutter in two different formats:

1. **Progressive scanning quad speed output (normal mode)**

   Straightforward signal output equivalent to non-interlace VGA format (120 Hz). This is real-time CCD output through Camera Link, digital RS-644 output, and normal analog video processing into 75ohms 1Vp-p output format.

2. **Partial scanning output (Rear switch.... 100 lines,.... 200 lines) TM-6710 only**

   By setting the switch to 100 line partial scan, the TM-6710 outputs 100 lines of video. It repeats the same rate with the fast dump blanking. The asynchronous reset and electronic shutter functions are maintained at each partial scan. When 200 line partial scan is selected, 200 lines of video are output. The partial scan maintains the same resolution as full progressive scan, although with a narrower field of view. It also maintains the same image center between partial scan and normal images.

3.3.7 RS-232C (or Optional RS-485) Control and Camera Link Serial Communication

The TM-6710’s built-in microcomputer chip (CPU) can be controlled by an external RS-232C interface. The internal CPU controls TM-6710 operation mode and DSP parameter changes. Contact PULNiX for the TM-6710 software diskette. Camera Link control is implemented via Camera Link serial communication. We recommend that you use PULNiX control software (.dll), part number 69-0062.

3.3.7 (a) RS-232C Communication Default Condition

Parity: None

Data: 8-bit

STOP: 1-bit

Baud rage: 9600 bps

If other communication conditions are required, please contact PULNiX.

3.3.7 (b) RS-232C Control Commands

External RS-232C (or optional RS-485) computer control allows the operator to remotely adjust the following functions: clock speed, shutter, gain, A/D reference and scan format. The control commands are detailed below.

Note: *RS-232 control will override the rear panel switch control. (TM-6710 only)*

The TM-6710 command package begins with "." (Start of Text = 3AH), and is then followed by the Command Code (C.C...one alphabet), Command option parameter and CR (End of Text = 0DH) to end.

When a packet is received by the TM-6710 (ETX:03H is detected), it reads the internal packet of the receiver buffer. If it is the correct packet, then it processes the parameters based on the command. When the process is completed, it sends a completion signal (AK packet). If an error is detected, a No-go signal (NK packet) is sent back and it disregards the packet signal in the buffer. When an NK packet is sent from the TM-6710, the host must correct the error and resend the packet.

Example: Executing manual shutter control #2.

The C.C. packet is sent as follows:

":", "S", "M", "2", CR
3AH, 53H, 4DH, 32H, 0DH
where "S".....Shutter control command mode

"M".....Manual mode

The TM-6710 will send back

":",ACK,CR	or	":",NAK,CR
3AH, 06H, 0DH		3AH,15H,0DH

Command S

Function: Shutter control command. Shutter mode selection and shutter speed setting.

1. **Manual Shutter Mode**
   ":", "SM", "0" - "9", CR
   3AH, 53H, 4DH, 30H - 39H or 53H, 0DH

Enables manual shutter operation. Select 0 through 9 shutter speed. This overrides the back panel setting. When "S" code is selected, the back panel shutter switch is activated for speed selection.

2. **Async Shutter Mode**
   ":", "SA", "0" - "9", CR
   3AH, 53H, 41H, 30H - 39H, 0DH
3. **Direct Shutter Mode**
   ":", "SX", "1A0", CR
   3AH, 53H, 58H, 31H, 41H, 30H, 0DH

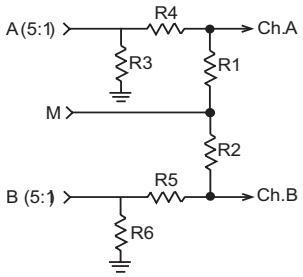
This selects a mode for external shutter speed control. Hexadecimal shutter number (3 digit) follows "SX" command (e.g., "080" = 128H, shutter speed = 4.1msec). It moves the shutter discharge pulse at every 1H (32 µsec.) period from 254 (no shutter) to 1H (max. speed).

Command G

Function: A/D pre-amp gain control.

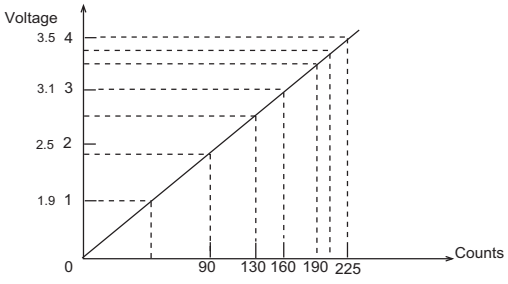
The "GM" command controls the gains of the A channel and the B channel. The "GA" and "GB" commands fine tune the gain of the A and B channels respectively, to achieve balance. The ratio is about 5:1.

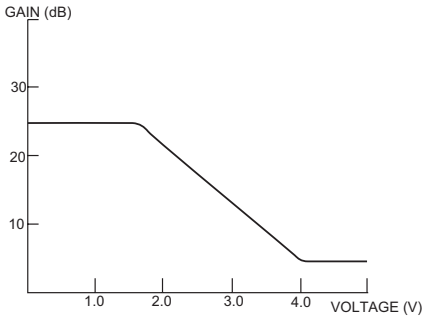
Examples:



":", "GM", "D2", CR
D2 = gain 210
3AH, 47H, 46H, 46H, 0DH

":", "GA", "12", CR
3AH, 47H, 31H, 32H, 0DH
Gain control value 18





Command V

Function: A/D reference voltage control. In the default gain setting there is no shutter. The A/D reference voltage bottom is preset to 0.45V. The controllable range of the reference voltage (Vref1,

Vref2) is between 1V and 0.2V. The controllable range of the reference top voltage (Vtop) is between 1.5V and 3V.

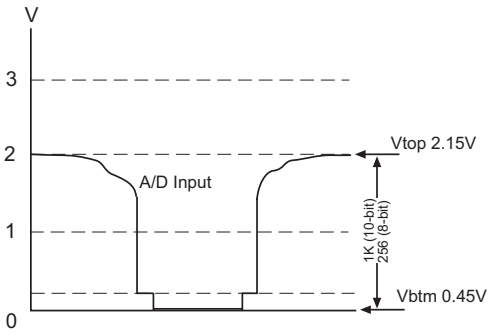


Figure 1

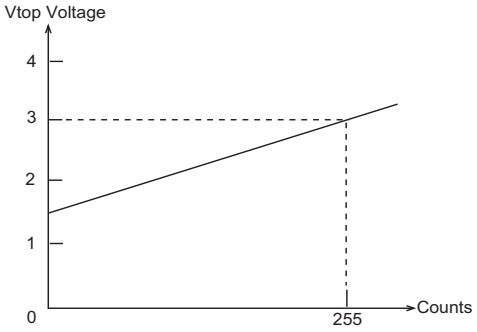


Figure 2

Examples:

“:”, “VT”, “7E”, CR
7EH = Vref top: 126
3AH, 56H, 37H, 45H, 36H, 0DH

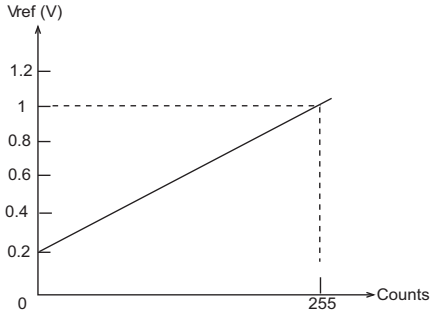


Figure 3

Command W

Function: Write data to the selected pages or calibration data table.

Saving to page (from 0 through 6):

“:”, “W”, “P” - “6”, CR
3AH, 57H, 41H - 36H, 0DH
(Page 0 is factory use only)

Saving the current gain setting to User Table (A) with the “WU” command:

“:”, “W”, “U”, “A”, CR
3AH, 57H, 55H, 41H, 0DH

Command L

Function: Select and read a memory page and set the preprogrammed data. This loads the data from the preset page location or preset gain table.

“:”, “L”, “P” - “6”, CR
3AH, 4CH, 50H - 36H, 0DH

Command R

Function: Output data values of camera memory (PULNiX software is available).

1. **Report from RAM "R R" command.** Reads out the current setting. The response format from the camera is:
   ":", ASK, "RR",[data] (12 x 2 bytes ASCII), CR
2. **Report from pages "RP 0-6" command.** Camera responds**:**
   ":", ASK, "P", "0-6" (page), (12 x 2 bytes ASCII), CR
3. **Report from user calibration table "R U", "A-D" command.** Camera response is:
   ":", ACK, "U", "A-D", [data] 5 x 2 bytes (first five value above twelve value)
4. **Report from factory set "R S", "A-D" command.** Camera response is:
   ":", ACK, "S", "A-D", [data] 5 x 2 bytes (first five value above twelve value)

1	2	3	4	5	6	7	8	9	10	11
8	8	8	8	8	8	8	8	8	8	16

1. Main Gain (ch. A and ch. B)
2. Ch. A fine tune gain
3. Ch. B fine tune gain
4. Ch. A video voltage reference
5. Ch. B video voltage reference
6. Reserved
7. Video voltage reference top
8. Reserved
9. Function flag
10. Shutter dial switch valve
11. Normal shutter value

Function Flag Description

Bit	7	6	5	4	3	2	1	0

Bit	Description		
0	Clock Selection	1- 60 Hz	0- 120 Hz
1	Sync Output	1- "One Shot"	0- Continuous
2	Shutter	1- On	0- Off
3	Shutter Control	1- Direct	0- Normal
4	Async Mode	1- Pulse Width	0- Normal
5	Shutter Mode	1- Async	0- Normal
6	Partial Scan 0	11- 120 Hz	01-200 Lines
7	Partial Scan 1	10- 100 Lines	11- N/A

For detailed parameters, please contact PULNiX.

Command C

Pixel Clock Speed (frame rate 120/60Hz)

Clock/2: ":", "C", "1", CR
3AH, 43H, 31H, 0DH

Master Clock: ":", "C", "0", CR
3AH, 43H, 30H, 0DH

Note: *When RS-232C is active, back plate switches are overwritten and do not function. In order to activate back plate switches, power off and power up again.*

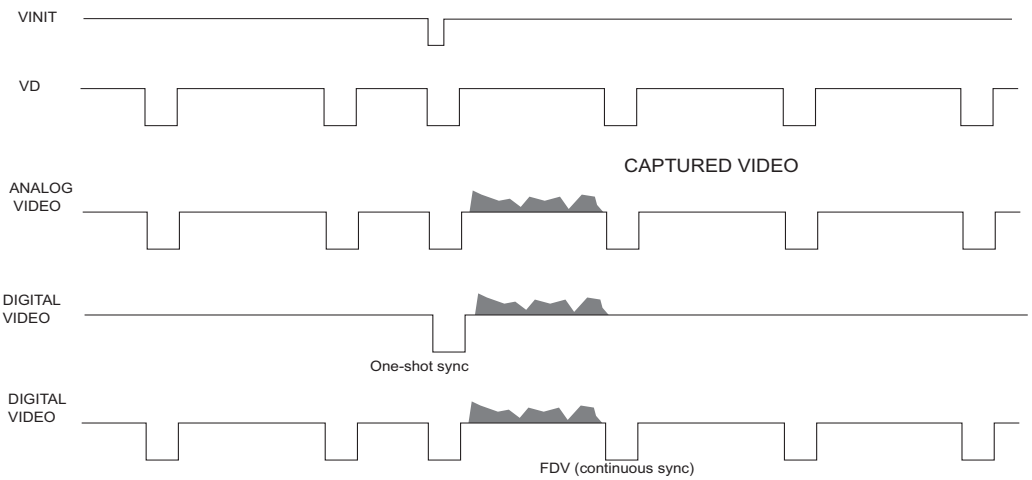
TABLE 2. RS-232C Control Commands Summary Table

1st CHAR		2nd CHAR	3rd CHAR	Response	Functions
"S"	(Shutter)	"M" (Manual)	"0" - "9" Mode	ACK	Manual shutter mode
		"A" (Async)	"0" - "8" Mode	ACK	Async shutter mode
			"9" (Pulse width)	ACK	Pulse width mode
"G"	(Gain)	"M" (Main)	"00" - "FF"	ACK	Main CH Gain Control
		"A" (Fine A CH)	"00" - "FF"	ACK	CH1 Gain Fine Tuning
		"B" (Fine B CH)	"00" - "FF"	ACK	CH2 Gain Fine Tuning
"V"	(A/D Vref)	"A" (CH1)	"00" - "FF"	ACK	CH1 Vref Fine Tuning
		"B" (CH2)	"00" - "FF"	ACK	CH2 Vref Fine Tuning
		"T" (Top)	"00" - "FF"	ACK	Vtop voltage setting
		"L" (BTM/Vsub)	"00" - "FF"	ACK	Vbottom - Vsub setting
"W"	(Write)	"P" (Page)	"0" - "6"	ACK	Write to P EPROM
		"U" (User)	"A" - "D"	ACK	Write to U EPROM
		"S" (System)	"A" - "D"	ACK	Write to S EPROM
"L"	(Load)	"P" (Page)	"0" - "6"	ACK	Load from P EPROM
		"U" (User)	"A" - "D"	ACK	Load from U EPROM
		"S" (System)	"A" - "D"	ACK	Load from S EPROM
"R"	(Report)	"R" (Current)		ACK	ACK + "RR"+12x2 bytes
		"P" (Page)	"0" - "6"	ACK	ACK + "P"+{"9" - "F"}+ 12x2 bytes
		"U" (User)	"A" - "D"	ACK	ACK + "U"+{"9" - "F"}+ 5x2 bytes
		"S" (System)	"A" - "D"	ACK	ACK + "S"+{"9" - "F"}+ 5x2 bytes
		"X" (Execute)		ACK	Set camera with loaded data
		"D" (Date)		DATE	Report program date
"C"	(Clock)	"0" (120Hz)		ACK	Using master clock
		"1" (60Hz)		ACK	Using half of master clock
"N"	(Partial Scan)	"0" (Normal)		ACK	Normal scan
		"1" (200 lines)		ACK	200 line scan
		"2" (100 lines)			100 line scan
"O"	(Async sync out)	"0" (Continuous)		ACK	Continuous sync out in Async Mode.
		"1" (One Shot)			One sync with on VINIT.

3.3.8 Video Output

3.3.8 (a) Async Reset Image Capture

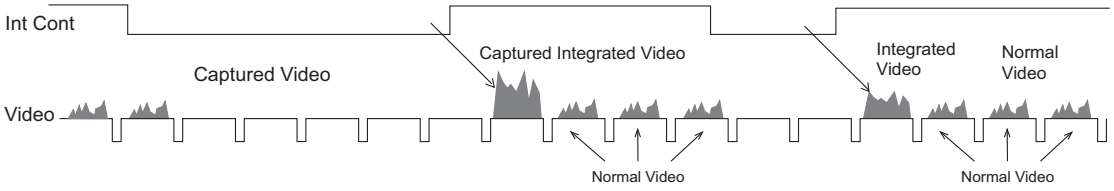
FIGURE 13. Async Reset Image Capture



3.3.8 (b) Integration Image Capture

Set the integration control (pin #11) to low for integration. Integrated video can be captured once integration control goes back to high.

FIGURE 14. Integrated Image Capture



3.3.9 Timing

3.3.9 (a) Digital Video

Differential line-driven, 2 x 8-bit parallel signal with EIA-644 format. 100ohms output termination impedance. Output from 51-pin connector. Mating connector: Airborne MQ3130511130000. Please consult digital cable information, e.g., 50DG-02LP 2m cable. The TM-6710CL uses the 26CL-02-26 Camera Link cable.

3.3.9 (b) Line Data Valid

Differential line-driven signal with EIA-644 format. It is active high (+ side is higher than - side) during the transfer of each line of data.....horizontal line readout.

3.3.9 (c) Frame Data Valid

Differential line-driven signal with EIA-644 format. It is active high during the transfer of each frame data. During integration, both LDV and FDV are kept high and restart upon the completion of integration.

3.3.9 (d) Pixel Clock

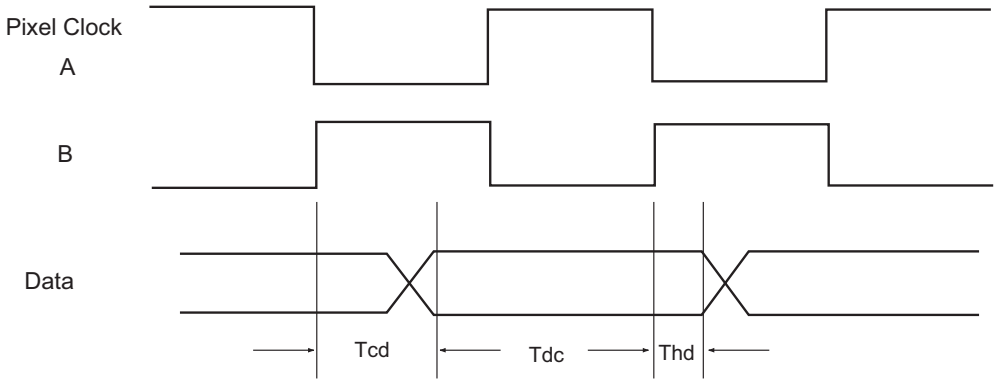
Differential line-driven signal with EIA-644 format. The master clock frequency is 50.98MHz (or 40.068MHz).

4 Camera Timing Charts

Model: TM-6710/6710CL Operation Mode: 60 Frames/Second

Master Clock: 50.98_MHz, M= 19.62_ nsec
Pixel Clock: 12.75_MHz, P= 78.46_ nsec

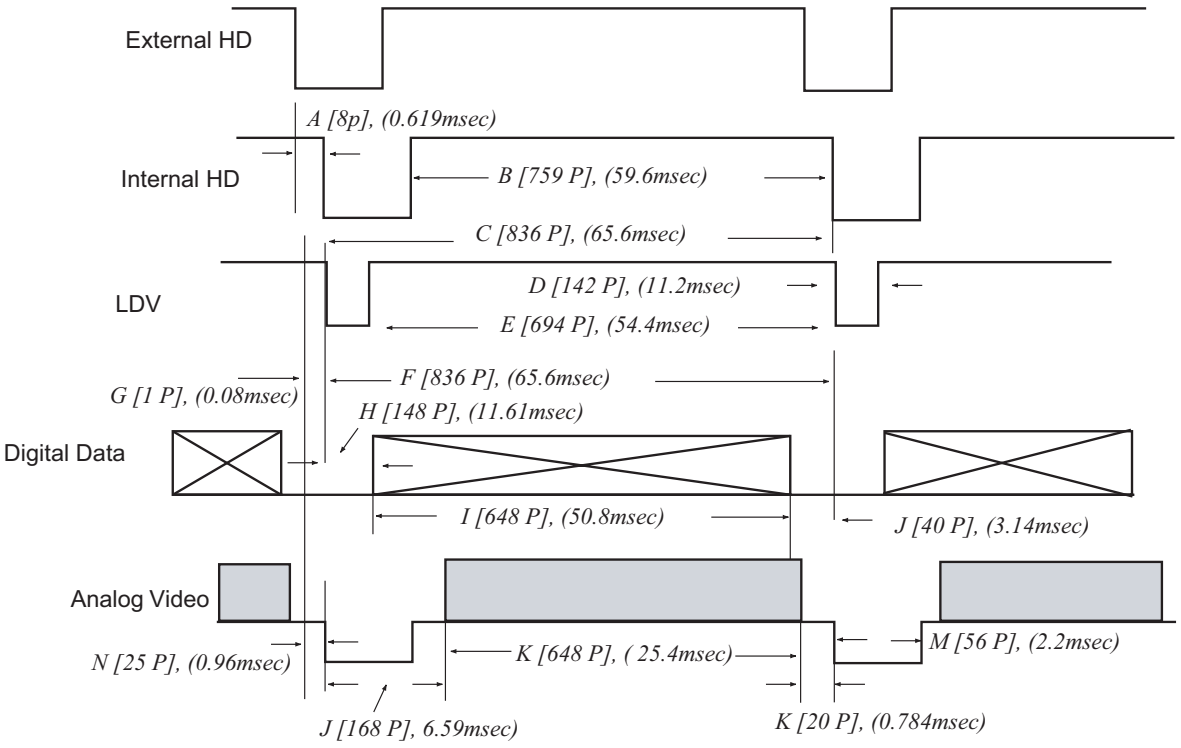
1. Pixel Clock and Digital Data



Tcd: Clock to Data Ready
Tdc: Data Ready to Next Clock
Thd: Data Hold Time

Tcd = 6.7_nsec, Tdc = 71.7_nsec, Thd= 2.3_ nsec.

2. Horizontal Signals fHD = [15.24 KHz]
tHD = [65.6 msec]



Camera Timing Charts

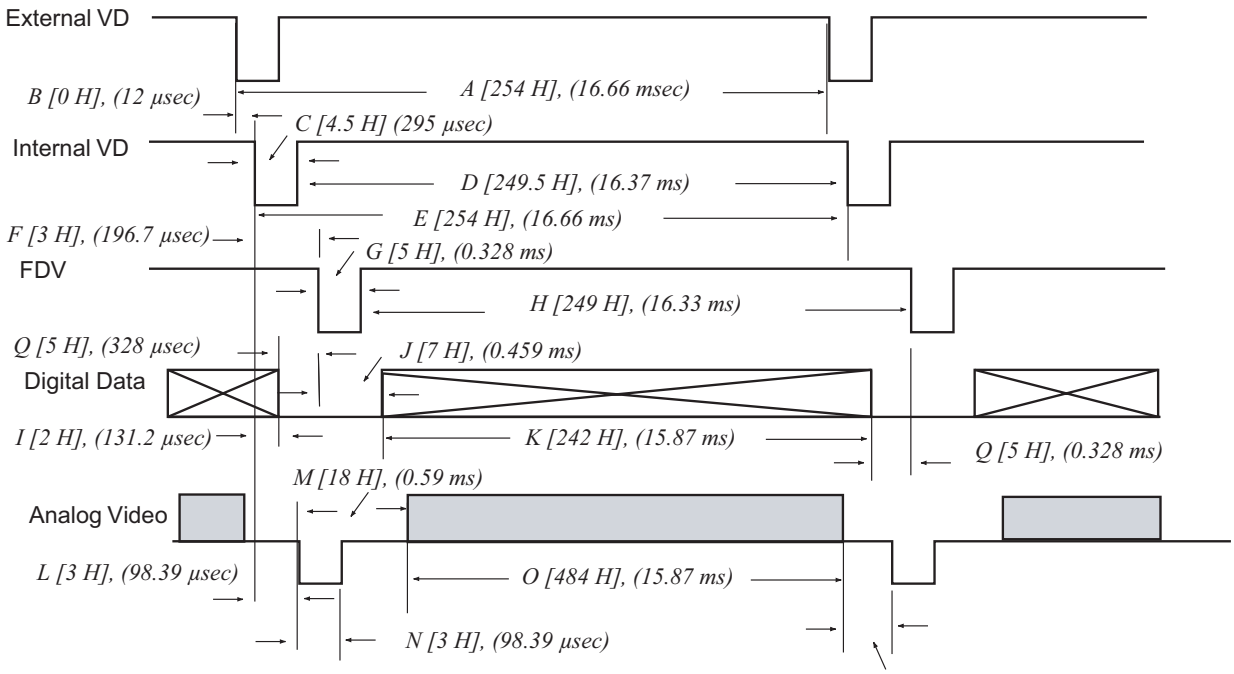
Model: TM-6710/6710CL

Operation Mode: 60 Frames/Second

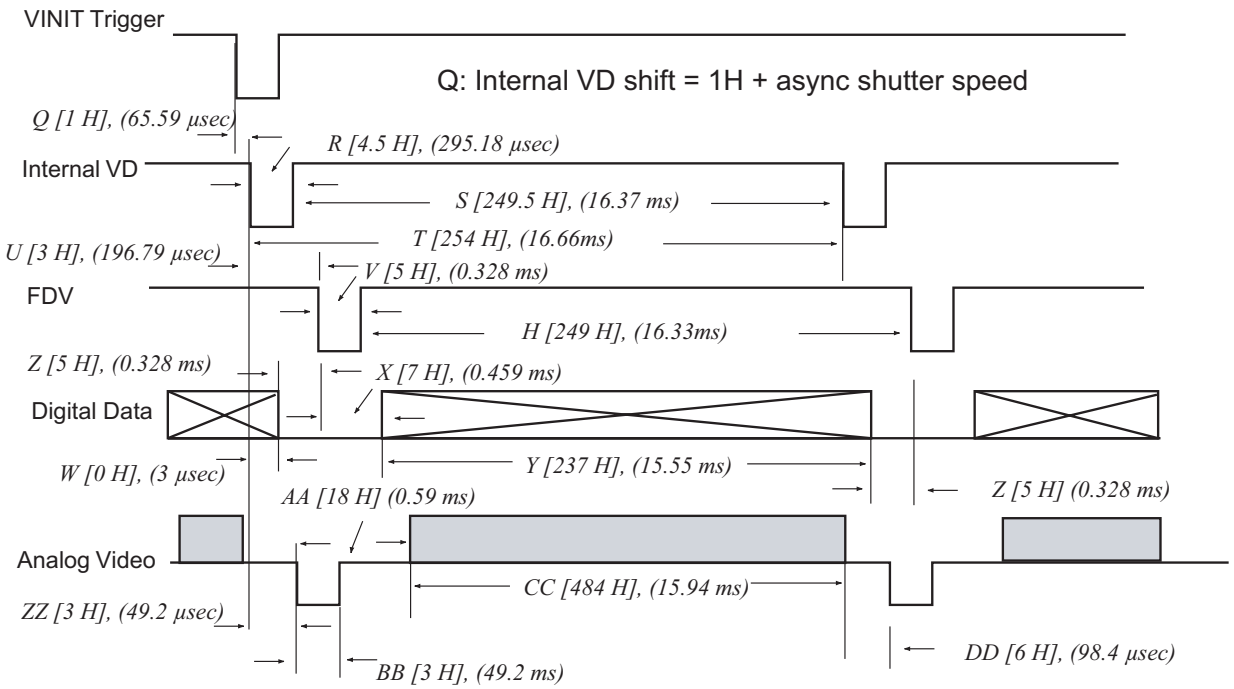
Master Clock: 50.98_MHz, M= 19.62_ nsec
Pixel Clock: 12.75_MHz, P= 78.46_ nsec

Horizontal Frequency: 15.245_KHz
1H = 65.595_ µsec Digital
1H = 32.8_ µsec Analog

3. External Reset Timing



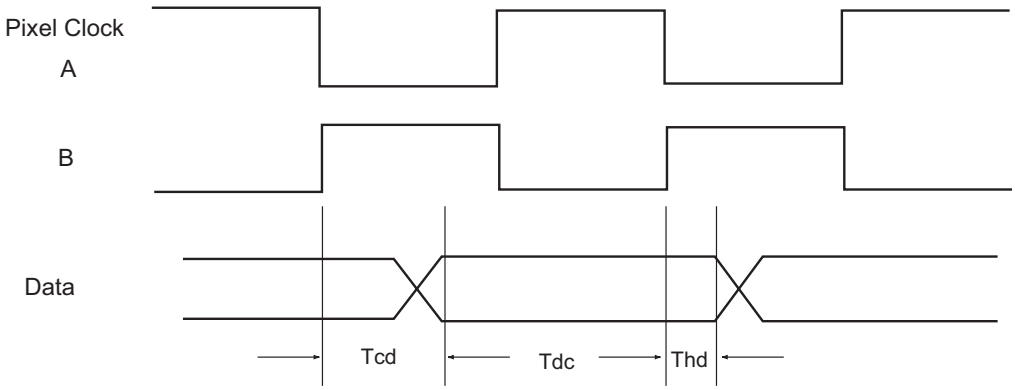
4. Async Reset Timing



Model: TM-6710/6710CL Operation Mode: 120 Frames/Second

Master Clock: 50.98_MHz, M= 19.62_ nsec
Pixel Clock: 25.49_MHz, P= 39.23_nsec

1. Pixel Clock and Digital Data

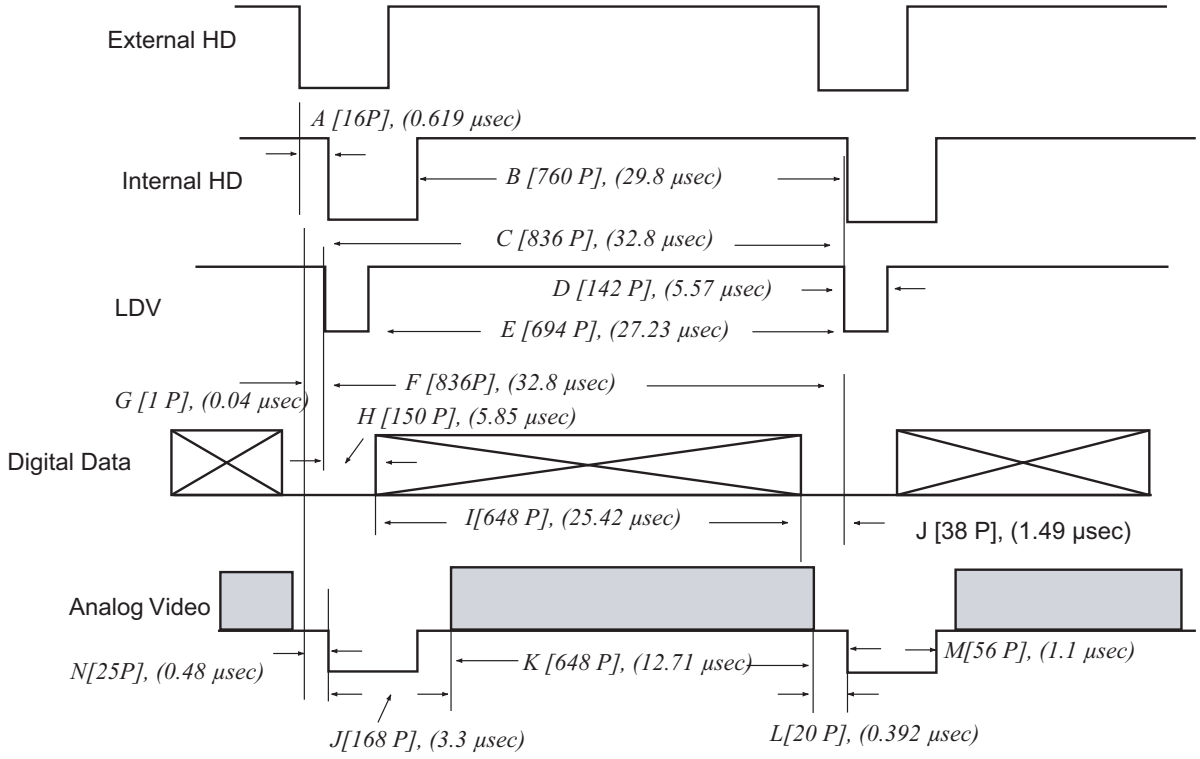


Tcd: Clock to Data Ready
Tdc: Data Ready to Next Clock
Thd: Data Hold Time

Tcd = 6.9_nsec, Tdc = 32.3_nsec, Thd= 2.6_ nsec.

2. Horizontal Signals

fHD = [30.49 KHz]
tHD = [32.8 µsec]



Camera Timing Charts

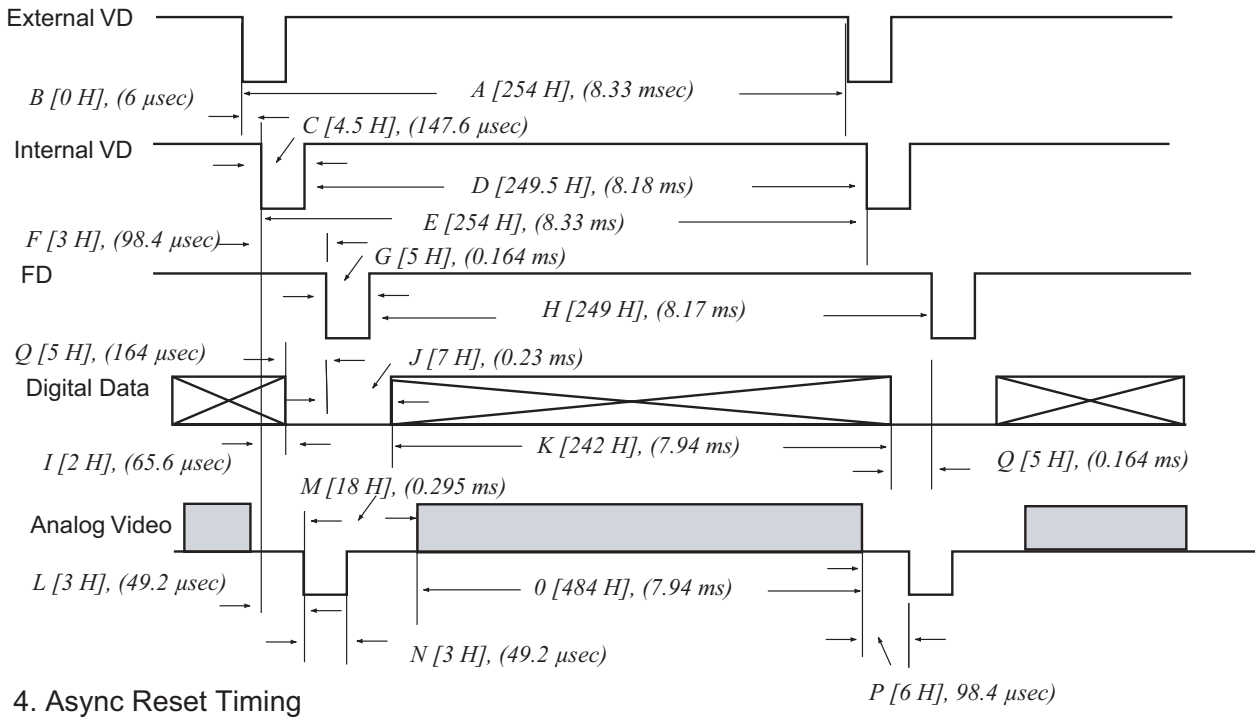
Model: TM-6710/6710CL

Operation Mode: 120 Frames/Second

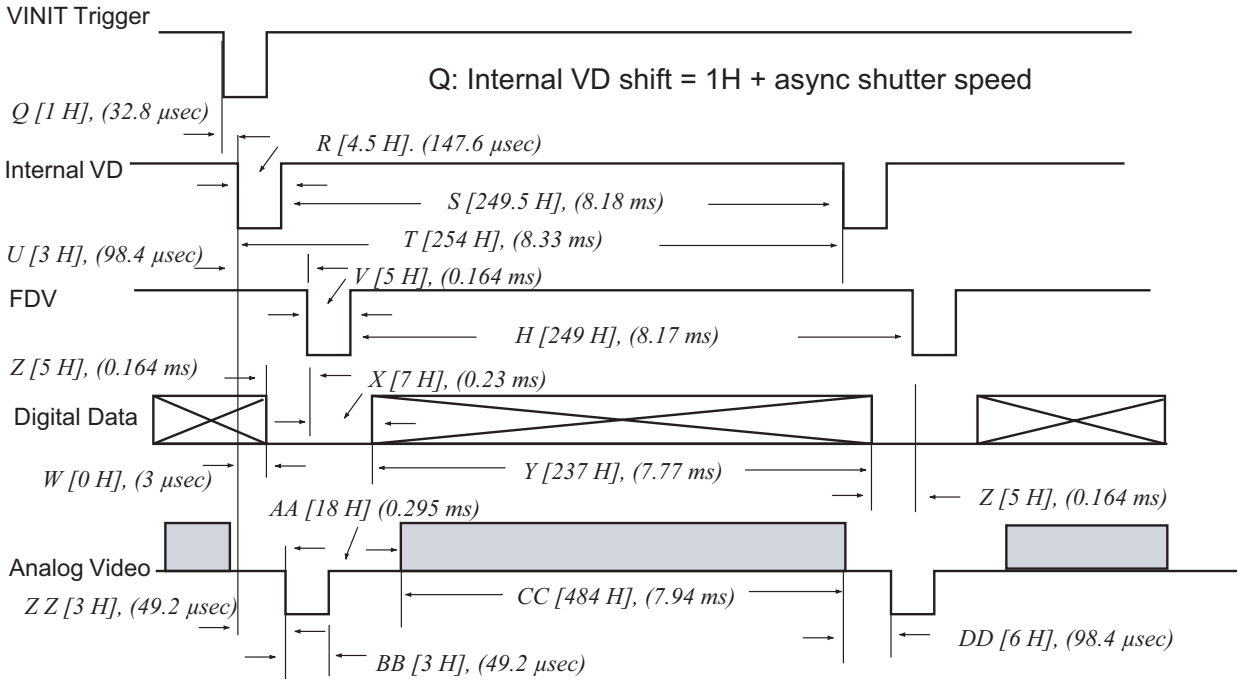
Master Clock: 50.98_HMz, M= 19.62_ nsec
Pixel Clock: 25.49_MHz, P= 39.23_ nsec

Horizontal Frequency: 30.49_KHz
1H = 32.8_ µsec Digital
1H = 16.4_ µsec Analog

3. External Reset Timing



4. Async Reset Timing



5 Troubleshooting

5.1 Problems and Solutions

Following are troubleshooting tips for common problems. Generally, 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 connected and operational.

- Power supplies
- Power cables
- Main power source
- Shutter control
- Async mode
- Lens
- Proper level setting as Camera Link CC1 and CC2

5.1.2 Symptom: Dark Video

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

- Shutter selection
- Iris opening on the lens
- Proper power (DC level)

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: RS-232 Non-Communication

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

- Cable connection
- Proper serial port selection
- Camera has power
- Proper Camera Link DLL selection (for TM-6710CL)

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:	JAI PULNiX Inc. Sales Department 1330 Orleans Drive Sunnyvale, CA 94089 ATTN: Video Applications
Web Site:	www.pulnix.com

6 Appendix

6.1 Specifications

TABLE 3. Specifications Table

Imager	1/2" progressive scan interline transfer CCD with on-chip microlens
Pixels	648 (H) x 484 (V)
Pixel size	9.0 (H) x 9.0 (V) µm
Output sensitivity	12µV/e-
Micro lens	Standard
Scanning	525 lines at 120Hz/60Hz
Sync output	HD =60.98KHz±5%, VD=120Hz±5% (at 50.980MHz) HD=47.94KHz±5%, VD=96Hz±5% (at 40.068MHz) (optional)
Ext. sync input Ext. HD = HD output/2	HD=30.49KHz±5%, (at 50.980MHz) HD=23.97KHz±5% (at 40.068MHz) Vertical async. reset or Vertical async. reset or VD=120Hz±5% VD=96Hz±5%
Pixel clock	50.98 MHz / 25.49 MHz (or 40.068 MHz / 20.034 MHz (optional))
TV resolution	500 (H) x 484 (V)
Min. illumination	4 lux at normal speed (120 frame/sec.)
S/N ratio	45 dB min., AGC = off
Video output	8-bit digital output via RS-644 (8-bit x 2 dual or single channel) Output clock: 25.49 MHz for dual channel output Analog 1.0 Vp-p composite video, 75ohms, sync negative, non-interlace
Display mode video	Analog only fHD = 30.49 KHz, fVD = 60 Hz (60 Hz mode)
AGC	OFF (AGC ON is a factory option)
MGC	Manual gain adjustable (6 dB to 26 dB)
Gamma	1.0 (0.45 is a factory option)
Lens mount	C-mount
Power requirement	12V DC 520±50 mA (normal), 1.2A (surge)
Power cable	12P-02S (not required if camera is used with PD-12UUP)
Power supply	PD-12UUP
Operating temp.	- 10°C to +50°C
Vibration & Shock	Vibration: 7 Grms (10Hz to 2000Hz), Shock: 70G
Dimensions	39.6mm x 46.3mm x 136.6mm (1.56" x 1.82" x 5.30")
Weight	252 grams (9.2 oz.)

FIGURE 15. TM-6710 Physical Dimensions

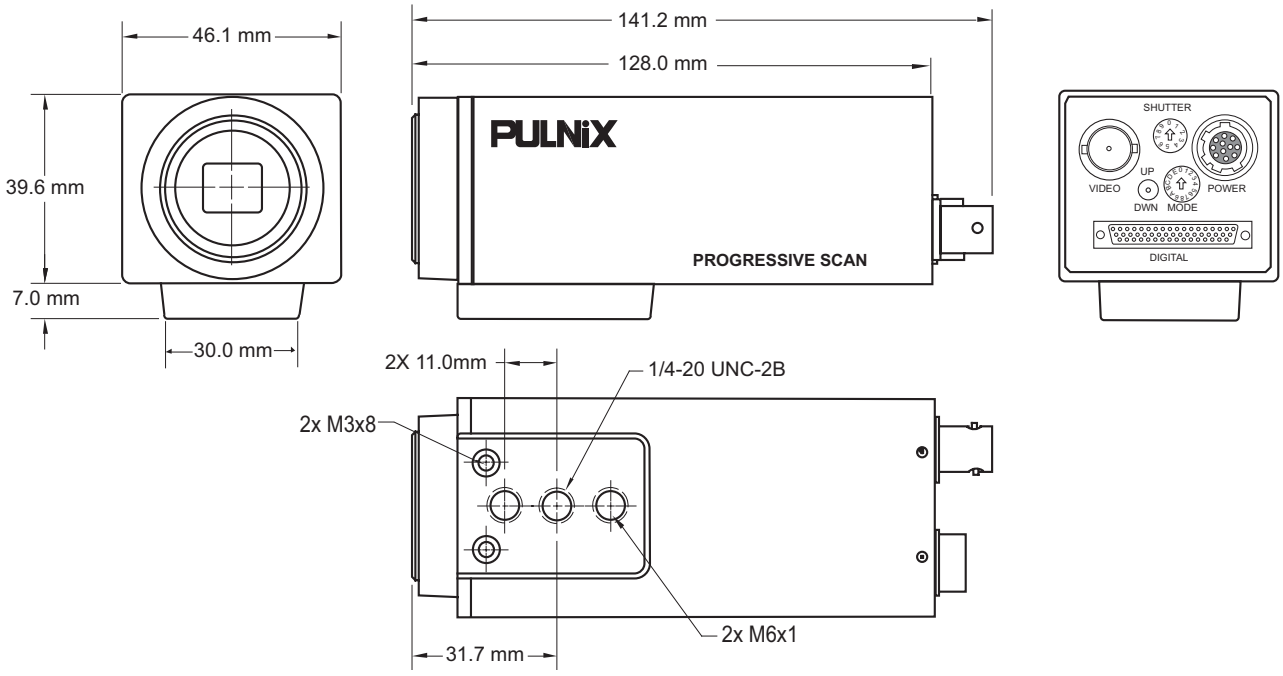


FIGURE 16. TM-6710CL Physical Dimensions

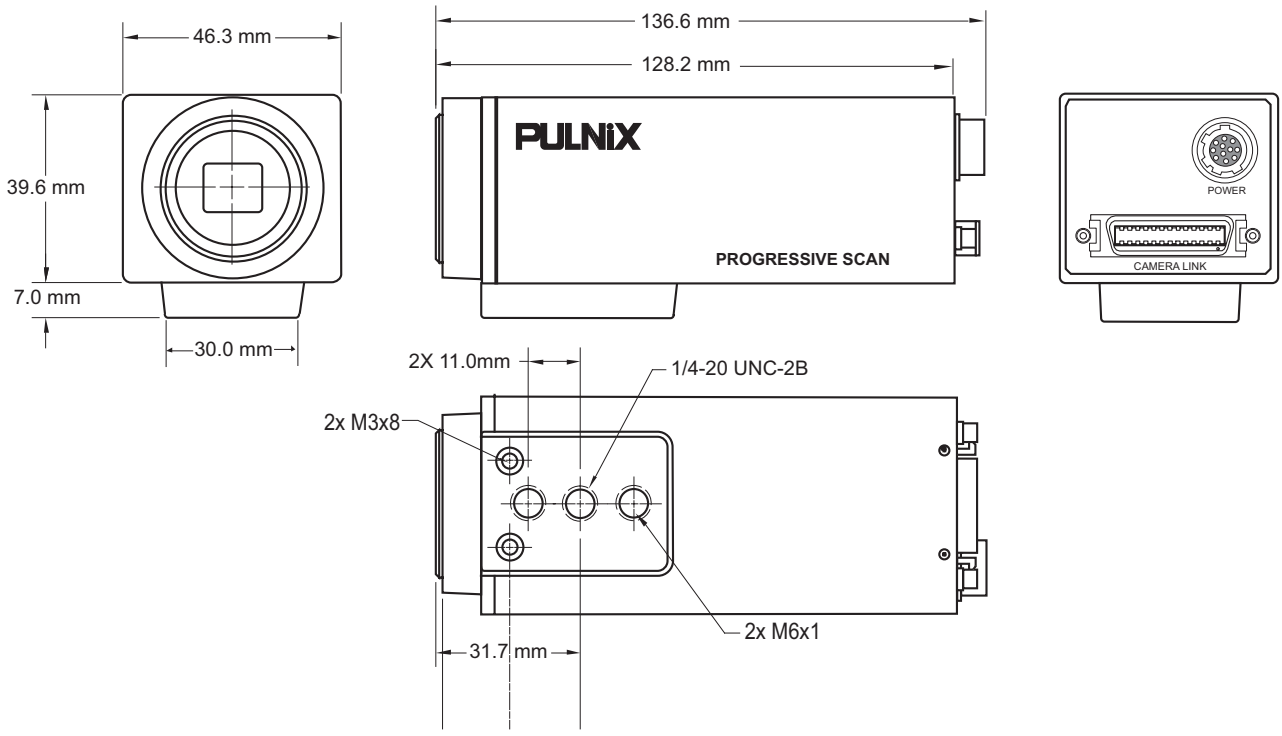


FIGURE 17. Glass Specifications

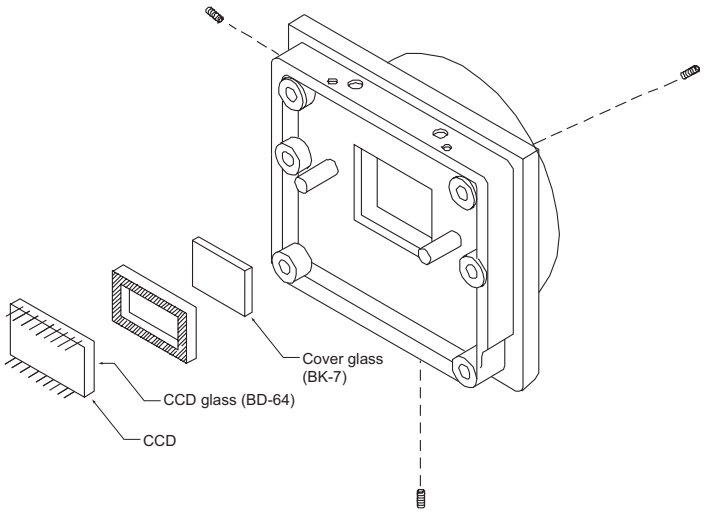
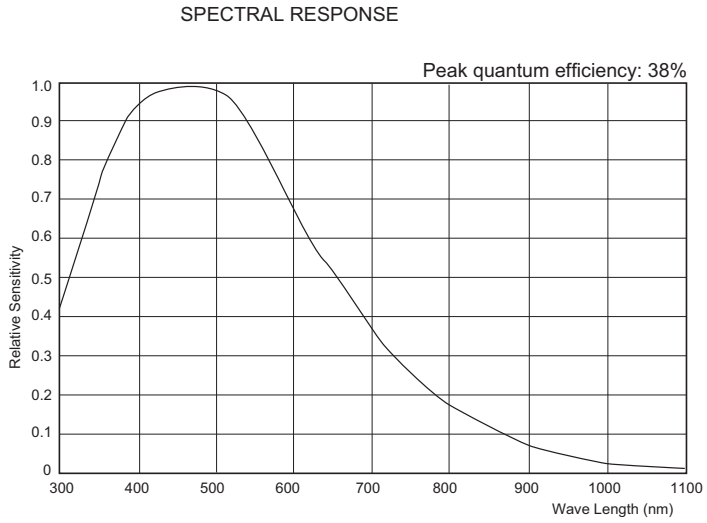


FIGURE 18. TM-6710 Spectral Response



6.2 Block Diagrams

FIGURE 19. TM-6710 Block Diagram

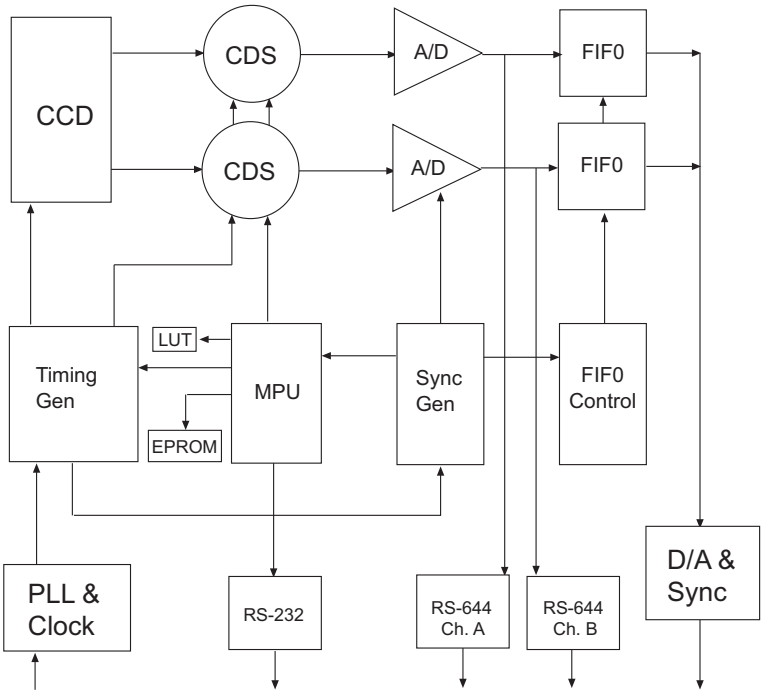
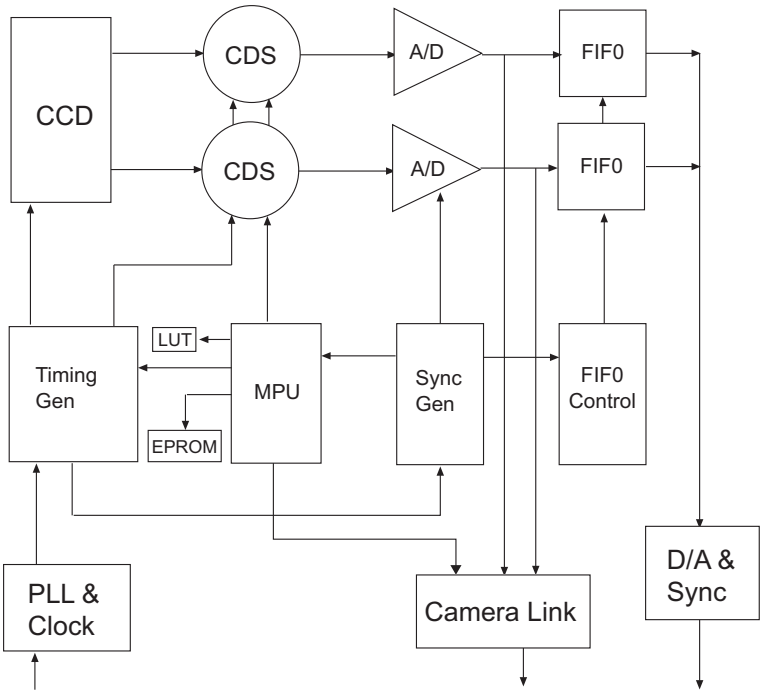


FIGURE 20. TM-6710CL Block Diagram



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