TM-75/76 High-Resolution CCD Camera

Operation Manual

69-0088
Rev. A

PULNiX
Imaging Products

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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 TM-75/76 camera 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: EN50082-2/1995
Emissions: EN55011/EN61326-1, Class A

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.

TM-75/76 Operation Manual
Printing:June 27, 2001
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REGISTERED TO ISO-9001
FILE #A3942

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TM-75/76 High-Resolution CCD Camera

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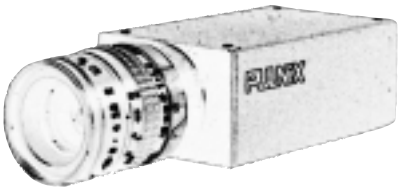


1 Introduction

1.1 Product Description

The TM-75 is specifically designed to be a replacement for SONY's XC-75 camera. It is an inexpensive yet high-quality camera that meets a variety of application requirements. This miniaturized high-resolution camera features an advanced Hyper-HAD* interline transfer 1/2" CCD imager, and offers many standard and optional features at a very affordable price. A CCIR-format model, the TM-76, is also available.

1.2 Features

- **Variable electronic shutter**

  The substrate drain-type shutter mechanism provides a superb picture at various speeds without smearing. The electronic shutter rate can be adjusted from 1/60 to 1/10,000 (1/29,100 in some operating modes) in discrete steps.

- **Miniaturized and lightweight**

  The use of a CCD image sensor in the video camera module and mini C-mount lenses make it possible to produce a very compact, lightweight and robust camera small enough to operate just like a remoted head.

- **High sensitivity**

  The TM-75/76 camera is one of the most low-light sensitive 1/2" CCD cameras available today. This feature is especially important when using the faster shutter speeds. It requires only 1.0 lux of minimum illumination and 0.5 lux minimum illumination at maximum gain. In general, this allows the use of a higher lens F-value while providing a greater field depth and sharper images.

- **Reset-restart and external trigger mode**

*. Hyper-HAD is a trademark of SONY Corporation.

The camera can be reset at random timing to restart. It will also take an external trigger signal to control shutter and reset timing for asynchronous image capturing.

- **Low lag/high resistance to image burning**

  Because the CCD is highly resistant to image burning, the camera may be exposed to bright objects for a long period of time. Because a "smear" phenomenon may occur when shooting a very bright object, an infrared cutoff filter is standard to obtain a clear picture.

- **AGC/MGC selection, manual gain control and gamma adjustment**

  These adjustments, which are particularly important in vision system applications, are adjustable via internal switches.

- **Genlock circuit**

  A genlock circuit is built in to accept external sync for applications in which external sync is required.

- **High resistance to magnetic field and vibration/mechanical shock**

  The CCD imager's rugged design allows it to withstand strong vibration and shock with little or no noise appearing in the picture. Since the TM-75/76 is not influenced by a magnetic field, it will produce stable images even when placed next to objects such as electric furnaces, welding machines or NMR scanners.

- **Quick start-up and low power consumption**

  Image capture can begin within a fraction of a second after turning on the camera. The power consumption is only 2.3W, 190mA @12V.

- **Camera mounting flexibility**

  The TM-75/76 has tapped M3 holes on the top and bottom. A tripod mount is available as an optional accessory.

- **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 TM series cameras with a three-year warranty.

Warning: Unscrewing the camera cover or opening the camera in any way will void this warranty unless prior written approval is obtained from the factory.

1.3 Functional Options

- Optical Filter Removal (OP3-2) (TM-75/76 comes with an IR cut filter as standard equipment).
- Glassless CCD Imager (OP21)
- DC Coupled (OP72)
- NIR CCD

1.4 Applications

The miniature size of the TM-75/76 camera eliminates the need for a remoted imager camera in all but the most confined spaces. This camera fits easily, both physically and functionally, into all types of machine vision, automated inspection, and related applications. Other uses include remotely piloted vehicles, miniature inspection devices, surveillance, microscopes, and medical equipment.

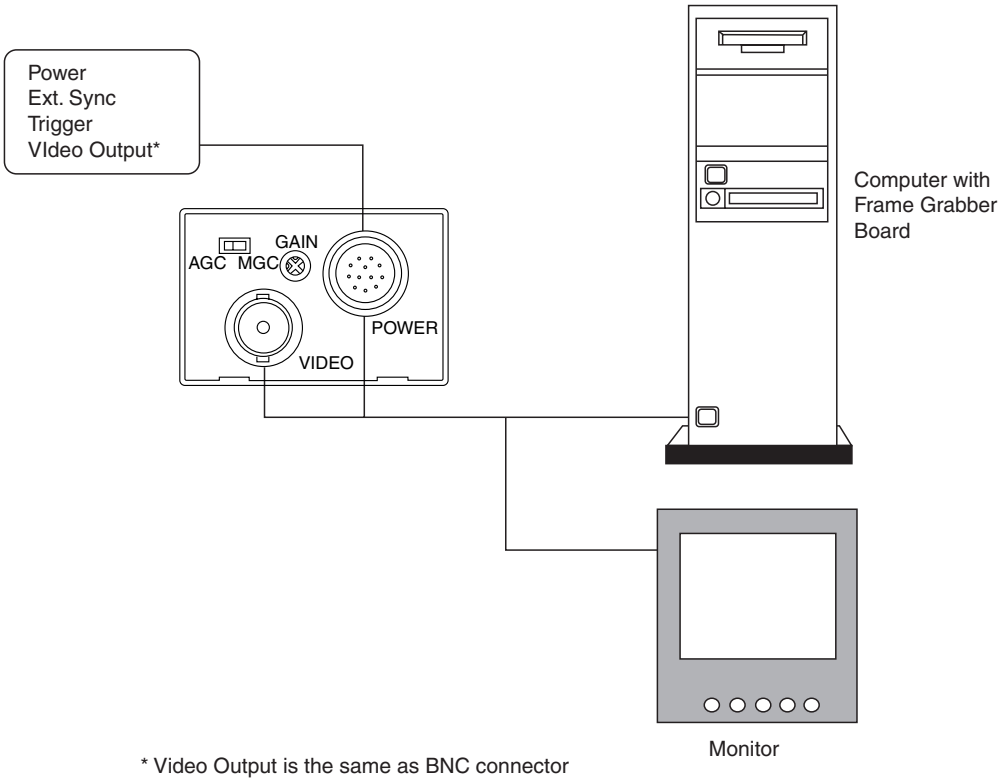
1.5 Interfacing to Frame Grabbers

The TM-75/76 camera can be connected to a frame grabber using either the 12-pin connector or the BNC connector on the rear panel of the camera.

1.6 System Configuration

Figure 1 (below) presents a typical system configuration for the TM-75.

FIGURE 1. TM-75/76 System Configuration



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 before 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 you bench-test any equipment being sent to another location for field installation 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.

- TM-75/76 camera
- TM-75/76 data sheet
- TM-75/76 operation manual (if ordered)

2.1.3 Accessories

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 before installing your video system to determine what you might need.

- Power Cable: 12P-02S Interface Cable
- Power Supply: PD-12UU, PD-12UE, and K series
- Tripod mount: 32-2000 (AT-34)

2.2 Camera Setup

2.2.1 Connector Pin Configurations

The TM-75/76 has a 12-pin connector for power input. In general, Pin #1 is Ground and Pin #2 is +12V DC. The other pins handle a number of other input and output functions, as shown in the table below.

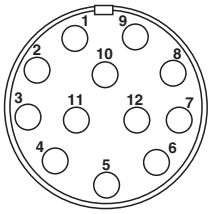


TABLE 1. 12-Pin Connector Configuration

Pin	Description	Pin	Description
1	GND (power)	7	VD Input
2	+12V DC	8	GND
3	GND (analog)	9	TRIG Input
4	Video Out	10	N/C
5	GND (digital)	11	N/C
6	HD Input	12	GND (digital)

Note: External sync and trigger

2.2.2 Power Supply and Power Cable

2.2.2 (a) Power Supplies

PULNiX recommends the following power supplies:

K25-12	110V AC/12V DC	2.1A power supply (OEM type)
K50-12	110V AC/12V DC	4.2A power supply (OEM type)
PD-12UU	100-240V AC/12V DC	1.2A universal voltage power supply, US plug
PD-12UUP	PD-12UU with12-pin connector	US plug
PD-12UE	PD-12UU	European plug
PD-12UEP	PD-12UU with 12-pin connector	European plug

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 to the PULNiX power cable via a terminal strip or directly.

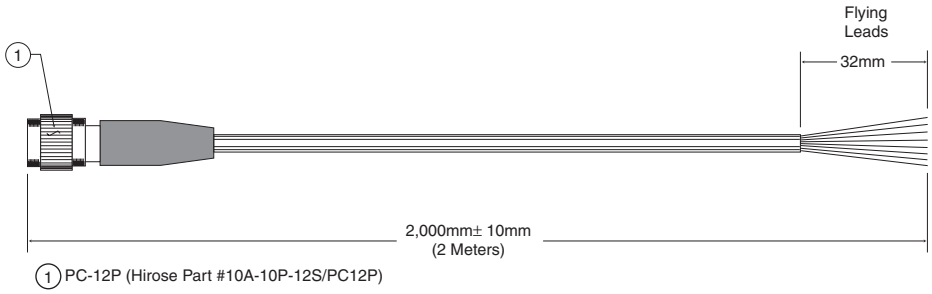
When wiring the PD-12UU power supply directly, please note the following:

- 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.
- 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 the appropriate pin-out diagram. The color coded leads use Gray for Ground and Yellow for +12V DC.

FIGURE 2. 12P-02S Interface Cable (optional)



12P-02S Interface Cable					
Pin#	**Lead Color**	**Function**	**Pin#**	**Lead Color**	**Function**
1	Gray	GND	7	Black coax	VD Input
2	Yellow	+12V DC	8	White coax shield	GND
3	Red coax shield	GND	9	White coax	TRIG Input
4	Red coax	Video	10	Brown	N/C
5	Orange coax shield	GND	11	Blue	N/C
6	Orange coax	HD Input	12	Black coax 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) "K" Series Power Supplies

The "K" series power supplies are designed primarily for OEM users who will be mounting the power supply inside a protective enclosure. For use in exposed situations, the PD-12UU series power supplies are recommended. Follow the directions below to connect a "K" series power supply.

1. Attach the 110V line cord to the two terminals marked "AC." Do not plug the cord into a 110V AC socket until you have completed steps 2 and 3.
2. Attach the Gray and Yellow leads of the power cable to the Ground and 12V DC terminals, respectively.
3. Replace the plastic terminal guard on the power supply.

2.2.2 (d) Building Your Own Power Cable

Consult the pin-out for the camera purchased. Connect the Ground and +12V power leads of the PD-12UUP power connector to Pin #1 and Pin #2, respectively (power must be DC regulated, and of sufficient current to properly power the camera).

2.2.2 (e) Attaching the Power Cable to the Connector

The 12-pin connector is keyed and will only fit in 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 keyways line up.
2. Press the connector into place until firmly seated.

3. Plug the power cord into the 110V AC socket (or the proper AC line). This will power the camera up.

2.2.3 Attaching the Video Output

Most users utilize the BNC connector for video output from the camera. Connect the output from the camera to the input of your monitor, VCR, or switching device. The input of the monitor should be balanced for 75Ω termination. Standard RG-59 type coaxial cable should carry a full video signal for up to 500 feet.

To output the video and input the power and sync to a camera over a single cable, use the PULNiX multi-conductor cables, such as the 12P-02S, etc. 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.*

2.2.4 Attaching the Camera Lens

The TM-75/76 camera accepts 1/2" or larger format size 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.

2.2.5 Auto-Iris Lens Setup

Auto-iris lenses with full video input can be used with the PULNiX TM-75, although this camera model does not come equipped with auto-iris output.

Note: *Make sure that the power is removed from the camera before connecting or disconnecting the auto-iris lens. There is a small chance that the auto-iris lens could be damaged by plugging or unplugging it while the camera is powered up.*

Power down the camera before installing the auto-iris lens. To install the auto-iris lens in a PULNiX camera for which the auto-iris input is not supplied, wire the signal (video) on the lens into the terminal 1 Vp-p video output on the camera.

Point the camera at a light area and then quickly towards a darker area. If everything is working properly, the iris should adjust for the light change.

2.2.6 Monitor Display Mode

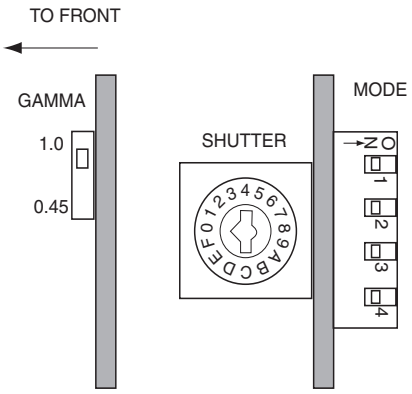
For monitoring real-time video, connect the video output to a video monitor or other device.

3 Operation

3.1 Mode Switches

3.1.1 Mode Selection

NO	Mode	Switch		Function
		OFF	ON	
1	Cyclic/Async	Cyclic	Async	Select continuous sync or async
2	FRM/FLD	Frame	Field	Frame mode and Field mode
3	F1	OFF	ON	Function selection for Trigger mode
4	F2	VD	R-R	External VD or R-R mode selection



Factory Set is:
Gamma=1.0

Mode switch	ON/OFF	Mode
1	OFF	Cyclic
2	OFF	Frame mode
3	OFF	No TRIG mode
4	OFF	External HD, VD Mode

Shutter = 0 No shutter

3.1.2 Internal Shutter Speed Control

TABLE 2. Shutter Speed Control and Function

Mode SW	Rotary SW	Shutter Speed		Trigger
F1	NO.	Second	H lines	
OFF	0	No shutter		
OFF	1	1/60	261.5	
OFF	2	1/100	157.5	
OFF	3	1/120	130.5	
OFF	4	1/250	62.5	
OFF	5	1/500	31.5	
OFF	6	1/1,000	15.5	
OFF	7	1/1,500	10.5	
OFF	8	1/2,000	7.5	
OFF	9	1/2,800	5.5	
OFF	A	1/3,500	4.5	
OFF	B	1/4,500	3.5	
OFF	C	1/6,000	2.5	
OFF	D	1/10,000	1.5	
OFF	E	1/29,000	0.5	
ON	D	Snapshot[a]	Variable >0	Positive
ON	E	RR Position	Variable >0.5	Positive
ON	F	RR Width	Variable >2.5	Positive

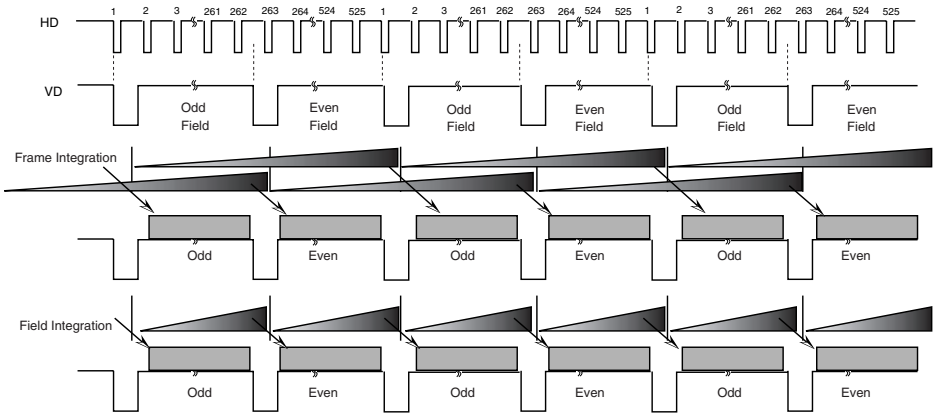
a. Snapshot mode is similar to Donpisha mode.

Note: In order to enable Reset-Restart sync pulse, F2 function selection must be ON. Normal external VD is detected automatically when F2 is OFF. In this mode, if there is no external VD, internal VD is automatically generated.

3.1.3 Field and Frame Modes

The standard factory setting for the TM-75/76 camera is FRAME MODE. The field and frame integration mode is selectable using the #2 switch of the mode switch inside the camera. The frame integration is used to separate all CCD pixels. The exposure of Odd and Even fields generates the full frame image shown in Figure 3, “Field/Frame Diagram,” on page 10.

FIGURE 3. Field/Frame Diagram



3.1.3 (a) Field Mode

In Field mode, two horizontal rows are scanned simultaneously. At each interlace scan, the scanned pairs are changed. Thus the sensitivity of the CCD is doubled for one field of integration. When compared to Frame mode, in which each horizontal row is scanned separately, Field mode obtains the same sensitivity in half the time period. The field integration is done by combining two pixel rows (binning) together and each pair alternates as interlace scan is generated. Row 1 is binned with row 2, and row 3 is binned with row 4. In Field 2, row 2 is binned with row 3, row 4 with row 5, and so on. The field mode is very effective in shutter mode since the pixel sensitivity is doubled for field integration (1/60 sec) and equals with frame mode (one row at 1/30 sec). Since shutter mode is only one field output per shutter and darker than normal image, two-row binning is effective. This mode also reduces interlace moire when a sharp horizontal pattern is observed.

Moire is unnoticeable because of alternating two-row scanning. The vertical resolution in Field mode is not as good as that in Frame mode, but it is sufficient to view the full vertical resolution of the TV format.

Note: *1. Since only one field are output in the Field mode, it cannot provide full frame resolution in strobe lighting applications.*
2. The TM-76(CCIR) is 1/50 sec. for Field and 1/25 sec. for Frame mode.

3.1.3 (b) Frame Mode

In Frame mode, each horizontal row is scanned as interlace scanning. The integration of each pixel is one frame period. In Frame mode, vertical pixel resolution is good, and the exact location is obtained. In comparison with Field mode, however, Frame mode has the disadvantage of showing vertical Moire. Frame mode should be used in applications that need strobe lighting, because full frame resolution is achieved in this mode. For higher pixel definition such as gauging and sub-pixel interpolation, Frame mode operation is recommended.

3.2 Operating Modes

Besides normal operation, the TM-75/76 supports the following versatile operations that can be selected:

- **Standard Interlace Mode**

  Field integration Mode
  Frame Integration Mode
- **External Sync Mode**
- **Interlace Scan Mode**
- **Non-interlace Scan Mode**
- **Reset-Restart Mode with Electronic Shutter**

  Trigger Width Mode
  Trigger Position Mode
  Snapshot Mode (Donpisha Mode)

3.2.1 Standard Interlace Mode

See Section 5, “Operation Mode,” for setting and operation of modes.

3.2.1 (a) Field Mode and Frame Mode

The field and frame integration mode is selectable. The frame integration is used to separate all CCD pixels and the exposure of Odd and Even fields generate the full frame image shown in the figure below.

3.2.1 (b) Field Mode Binning

The field integration is done by combining two pixel rows (binning) together, each pair alternating as interlace scan is generated. Row 1 is binned with row 2, and row 3 is binned with row 4. In Field 2, row 2 is binned with row 3, row 4 with row 5, and so on.

3.2.2 Cyclic (Continuous) Shutter Mode

With rotary switch shutter control, the TM-75/76 operates at the internally predefined shutter speeds. Each field output is exposed for the same period. The shutter control varies the substrate discharge timing. The duration between the shutter pulse and transfer gate timing (9.5H from VD leading edge for EIA, 14.5H for CCIR) decides the exposure time. The following four cyclic shutter modes are available:

- High-Speed Cyclic Shutter mode
- Trigger Position Reset/Restart Shutter mode
- Trigger Width Reset/Restart Shutter mode
- Snapshot Reset/Restart Shutter mode

Contact PULNiX for timing charts of various cyclic shutter modes.

3.2.3 External Sync Mode

TM-75/76 accepts standard RS-170 external sync, which is defined as horizontal sync (HD) and vertical sync (VD). The phase-locked loop jitter is designed to be the minimum (< 5ns) in this category using the latest PLL chip. The wide capture range enables the camera to operate at an extended temperature range (optional) of -35°C to 65°C. HD and VD input is TTL level and the input impedance is 75Ω.

3.2.4 Reset-Restart Mode

The camera can be reset asynchronously using EXT VD. In this mode, the camera needs multiple VD pulses to output valid images, depending on whether it is set to Field or Frame mode. Usually, the first field (Field mode) or the first frame (Frame mode) are garbage because of previous signal residuals prior to reset. A frame grabber has to know which frame or field to capture. External HD also must be applied for this operation.

3.2.5 External Shutter Control

The shutter speed or exposure can be controlled with external pulse (TRIG) in this mode. In combination with Reset-Restart Pulse (EXT VD), the camera can be externally controlled for image-capture timing as well as for exposure time.

This is an excellent application for capturing multiple images (two fields of images) of indexing objects under various lighting or brightness conditions. When Frame mode is selected, the full vertical resolution is achieved by taking two fields of shutter images, whether or not you are using an electronic shutter.

3.2.6 Non-Interlace Operation

With non-interlace external sync, the camera operates at non-interlace scanning. External VD for TM-75 must be generated at integer of 262H ± 8H (Standard interlace is 262.5 H). For the TM-76, it must be 312H ±8H, and the interlace scan is 312.5H.

4 TM-75/76 External Signals

This section explains how the external signals (HD and VD) and shutter trigger signal (TRIG) must be fed in External sync (HD, VD sync) and Reset-Restart operation.

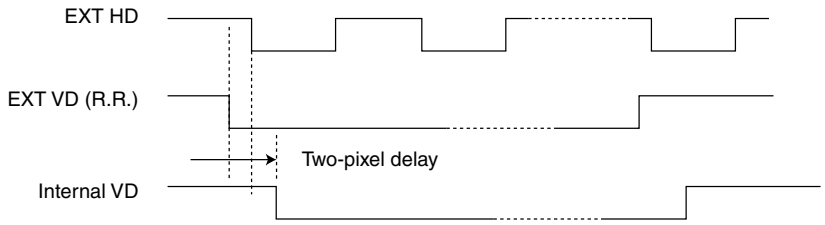
4.1 External HD

When external HD is supplied to pin #6 of the 12-pin connector, the TM-75/76 automatically switches the clock to phase-lock to the external clock via HD PLL (phase lock loop). The PLL detects the leading edge of external HD and Phase compare with the internal HD. Then PLL circuit generates internal clock to phase-lock with the external clock. Therefore, the leading edges of both external and internal HD are in exactly the same position. The PLL capture range is ±5% of fHD (=15.734KHz: EIA, 15.625: CCIR). It is, however, advisable to stay within ±1% of fHD frequency to assure the best PLL jitter characteristics. Without the presence of external HD, the TM-75/76 maintains the internal sync. The input impedance of external HD and VD is 75Ω at factory set. A high-impedance option is also available.

4.2 External VD

The TM-75/76 interface circuit deliberately delays external VD by two pixel clock (14 nsec) to ensure the stable reset of VD in relation to external HD.

FIGURE 4. External Vd Delay Timing



For HD, VD external sync operation, apply VD to pin #7 of the 12-pin connector. The input impedance is 75Ω. The VD reset range is from 244H to 1023.5H. For normal RS-170 operation, the VD must be interlace scan at 262.5H (59.94 Hz = 16.7 msec). At 525H, it generates one full frame timing. The integer (i.e. 262) reset makes non-interlace sync operation. Half H number (i.e. 262.5) makes interlace scanning.

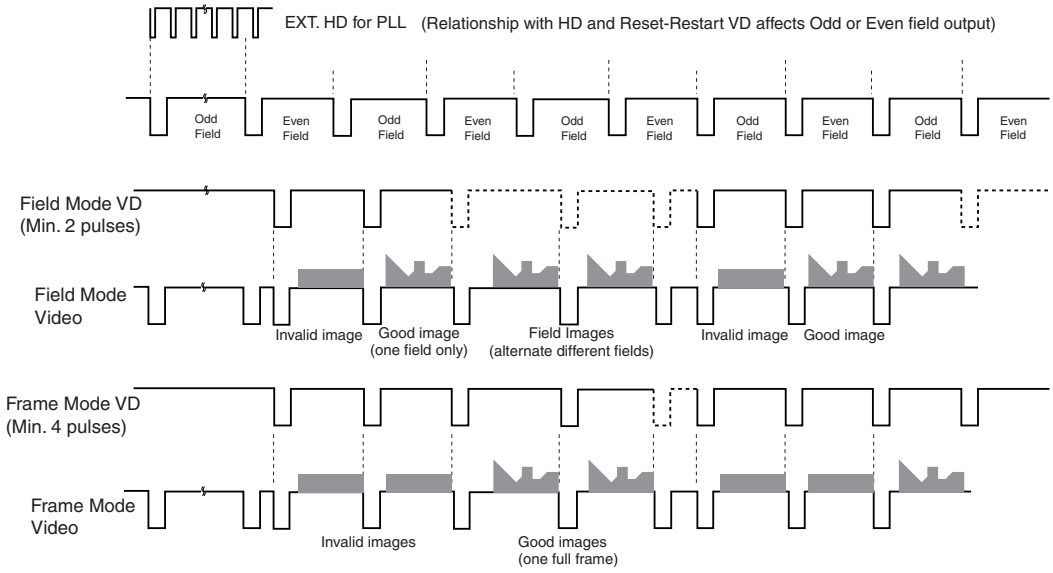
Note: The TM-76 vertical scan is 625H. VD is defined as 312.5H (50Hz).

4.3 Reset-Restart VD

For Reset-Restart VD operation, VD is asynchronous in relation to any previous VD. Depending on field or frame mode, however, once the first VD is asynchronously set, consecutive VD must be generated to obtain proper images. I n general, the first field in field mode or the first frame in frame mode is not usable because they are previous images prior to reset. A frame grabber has to know which frame or field to capture. External HD must be applied for this operation.

For External HD, VD sync mode or Reset-Restart mode selection, please refer to Section 3.1.1, “Mode Selection,” on page 8. Mode switch F2 must be set to ON for R-R mode and keep it OFF for normal HD, VD external sync mode.

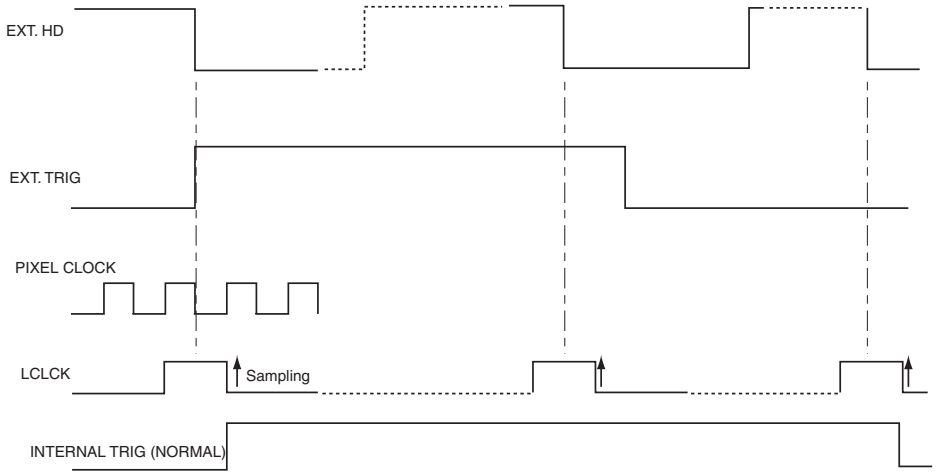
FIGURE 5. HD and Reset-Restart (VD) Relationship



4.4 External Trigger (TRIG) and Internal Sampling Clock

To ensure stable operation without the influence of jitter, the TM-75/76 samples shutter trigger pulse (TRIG) by internal sampling clock (LCLK) and detects the low to high level change of TRIG. The sampling occurs only at HD leading edge timing to generate the internal TRIG as shown below. Therefore, the external TRIG pulse must be wider than 1H (64 µsec) for pulse width and pulse position shutter control. All trigger pulse modes must work with Reset-Restart VD, which is described in Section 5, “Operation Mode,” The TRIG input is pin #9 of the12-pin connector and the input impedance is 100Ω.

FIGURE 6. External Trigger Timing



4.5 Trigger Pulse for Pulse-Width Shutter Control

In pulse width shutter control mode, the leading edge and trailing edge of TRIG must be synchronized with external HD. The duration must be longer than 1H. If TRIG does not meet these conditions, the exposure time may vary depending on the trigger position in one field to another field.

FIGURE 7. Proper Pulse Width Control

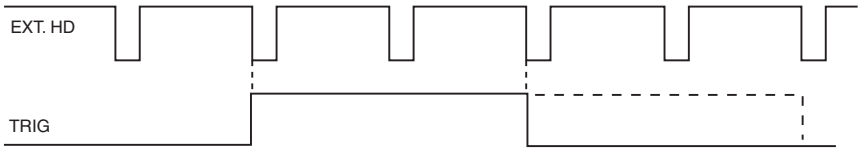
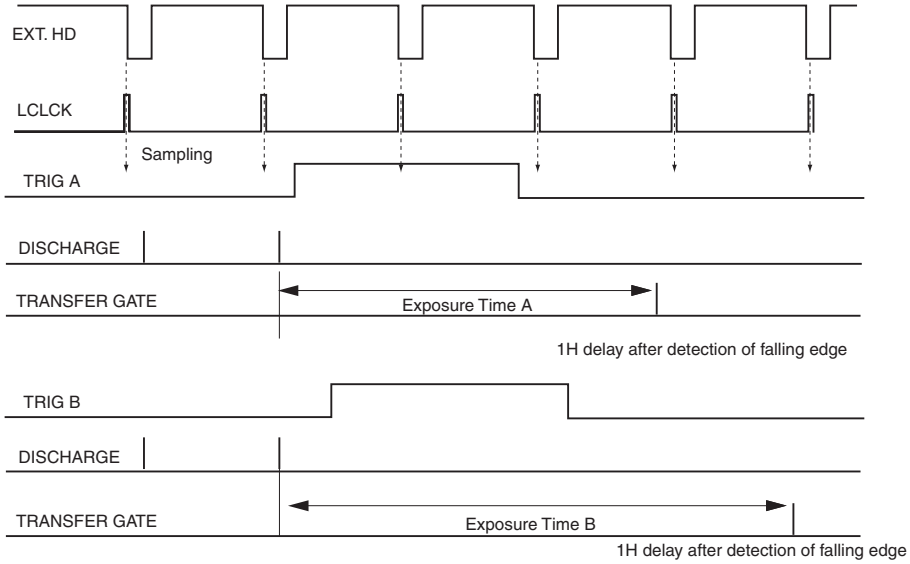


FIGURE 8. Improper Pulse Timing for Width Control



4.6 Trigger Pulse for Snapshot Shutter Control (Donpisha Mode... No Delay Shutter)

For snapshot mode (Donpisha shutter), the TRIG pulse width can be wider than just 2 pixel clocks wide (>150nsec) since this mode only requires pixel clock data strobing. The internal TRIG is generated at any random point and stays high until transfer gate pulse is completed.

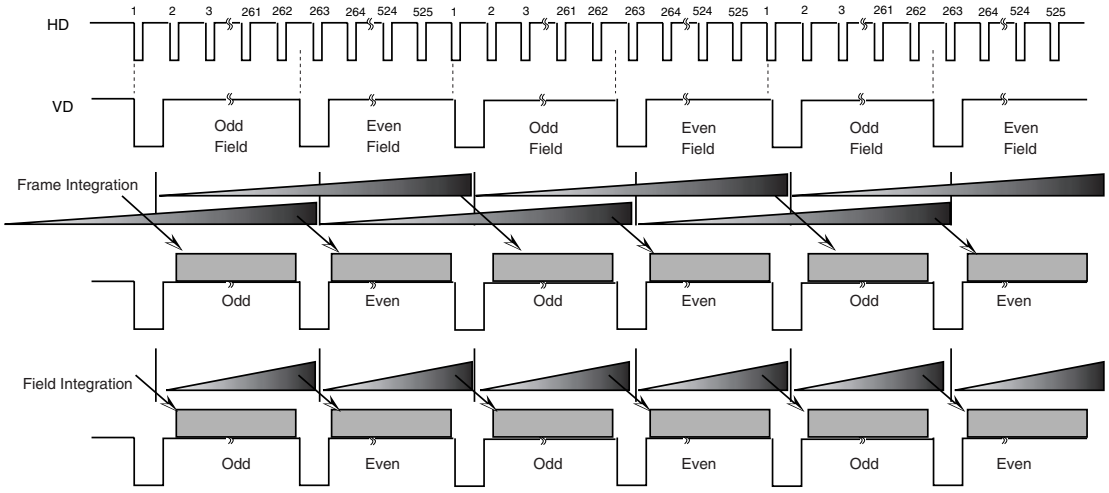
5 Operation Mode

5.1 No Shutter Cyclic (Continuous Sync) Operation

In Cyclic operation mode, the camera generates its own synchronization signal by itself. It continuously (cyclically) transfers photo charge at every VD (Vreset) in internal or external HD, VD sync mode.

Since no discharge occurs, the one full frame (1/30 sec or 1/25 sec) is the exposure time for both fields in frame accumulation mode. In frame mode, single shot strobing or LED flash can generate a full frame resolution with frame (two fields) image capturing. In field mode, the accumulation is for 1/60 or 1/50 sec but by taking two fields (one frame) full frame resolution can be achieved. However, strobe lighting only generates one field image.

FIGURE 9. No Shutter Field/Frame Integration



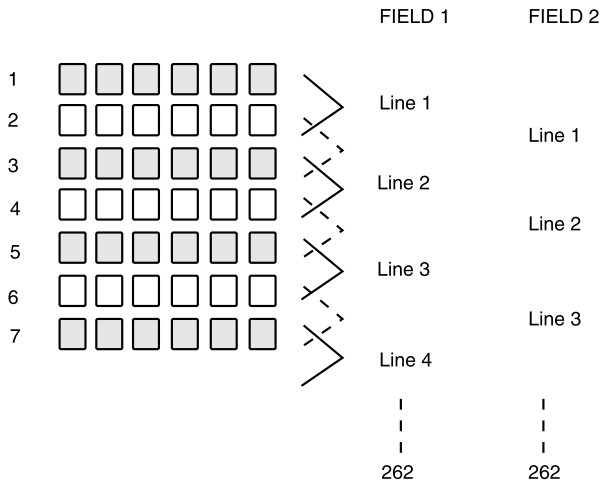
5.2 High-Speed Continuous (Cyclic) Shutter

5.2.1 Field Mode Integration

Field mode integration is implemented by scanning two rows together (binning) and each pair alternates as interlace scan is generated. In Field 1, row 1 is binned with row 2, row 3 with row 4,and so on.

In Field 2, the pairs change to row 2 and 3, 4 and 5 and so on. This field mode accumulation is effective for electronic shutter applications as it generates twice as sensitive an image as frame mode. The electronic shutter output is always one field image per shutter.

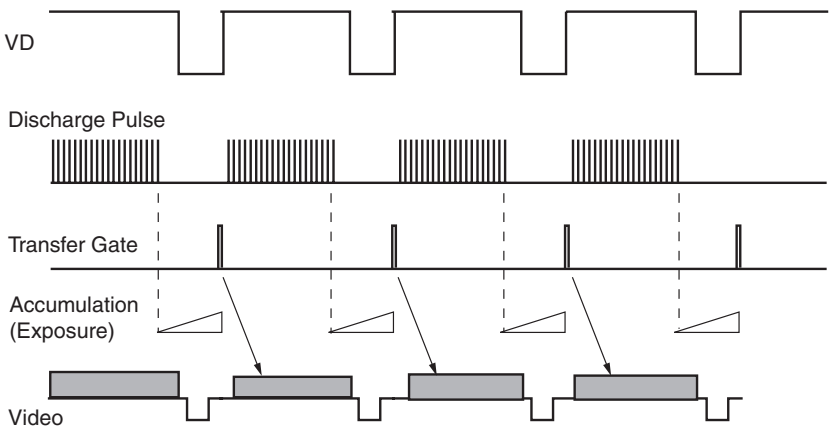
FIGURE 10. Field Mode Integration



5.2.2 Continuous Shutter

In this shutter mode, the camera generates its own sync signal and continuously (cyclically) carries out the internal shutter operation set by rotary switch. The discharge and transfer repeats in every field at a predefined shutter speed. The discharge pulses occur in every horizontal line (in blanking) and stop at a predefined shutter timing in one field. The duration between the last discharge and transfer determines the exposure time.

FIGURE 11. Continuous Shutter Timing



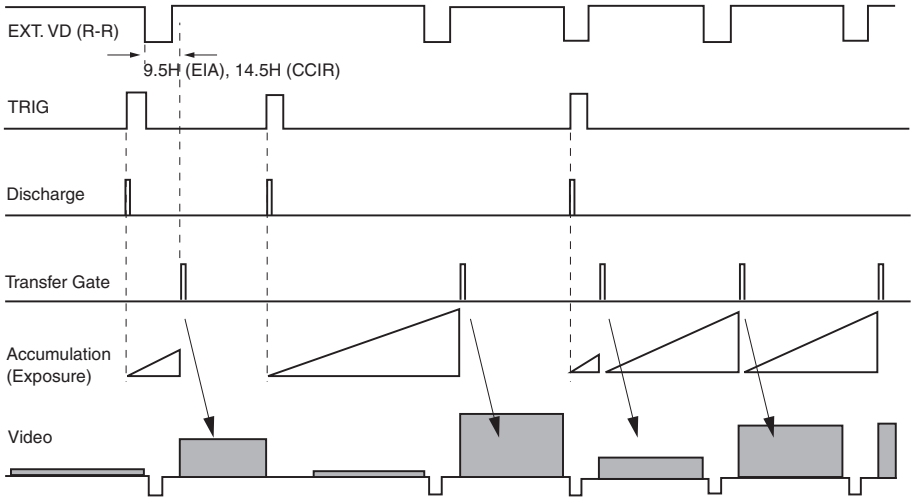
5.3 Snapshot Reset-Restart Shutter (Donpisha Shutter)

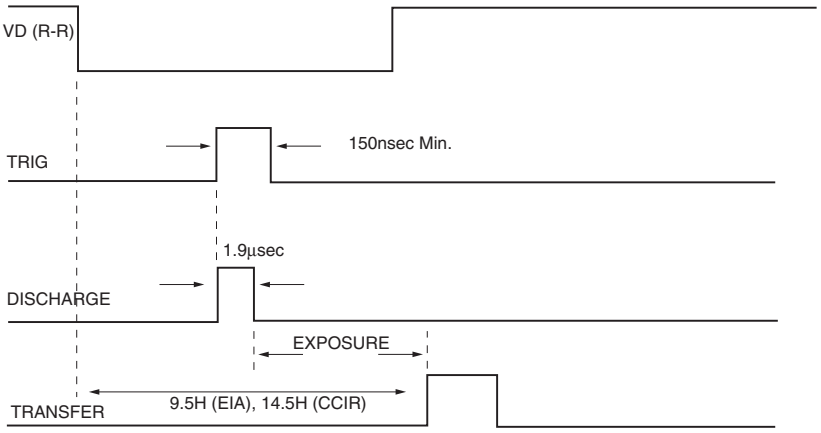
In this mode the shutter trigger pulse (TRIG) should be 150 nsec (two pixel clock) or wider. Snapshot mode is similar to Pulse Position mode. However the leading edge of TRIG pulse in snapshot mode immediately produces discharge pulse without delay (means Donpisha= no delay) and starts exposure, which enables very high speed shutter up to over 1/1,000,000 sec (1 µsec exposure). It can, in theory, go to a 70 nsec exposure time.

The transfer (read out) occurs at 9.5H (TM-76 is 14.5H) line from VD (R-R VD) leading edge.

TRIG pulse timing can be anywhere. However, when the pulse is generated during active video period, white noise of the pulse location may appear (faster than 1/1000 sec shutter is inside Vertical blank period and no noise will be seen).

FIGURE 12. Donpisha Timing





5.4 Pulse Position Reset-Restart Shutter

The shutter trigger pulse (TRIG) is required to be wider than 1H (>70 µsec) for this operation. Like continuous shutter mode, the last discharge pulse occurs as external shutter control. The position is determined at 1H after the detection of the TRIG pulse edge. The transfer (read out) occurs at 9.5H (14.5H for the TM-76) from reset-restart VD leading edge. The minimum exposure time is 0.5H (34.4 µsec). Because the shutter operation is synchronized with an internal horizontal clock, a stable exposure time is assured even though TRIG is applied with minor variation relative to the HD timing. In order to avoid flickering between each field exposure, it is advisable to synchronize the TRIG with reset-restart VD. If one frame (two fields) of shutter images are required, the TRIG pulse must be synchronous to the interlace scanning relationship.

FIGURE 13. Pulse Position Reset-Restart Timing

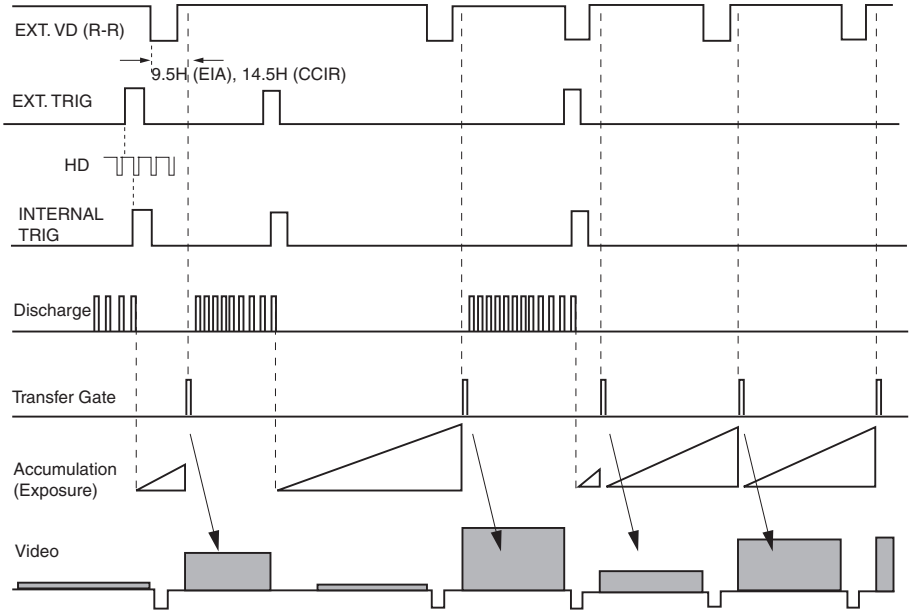


FIGURE 14. Pulse Position Odd Field Timing

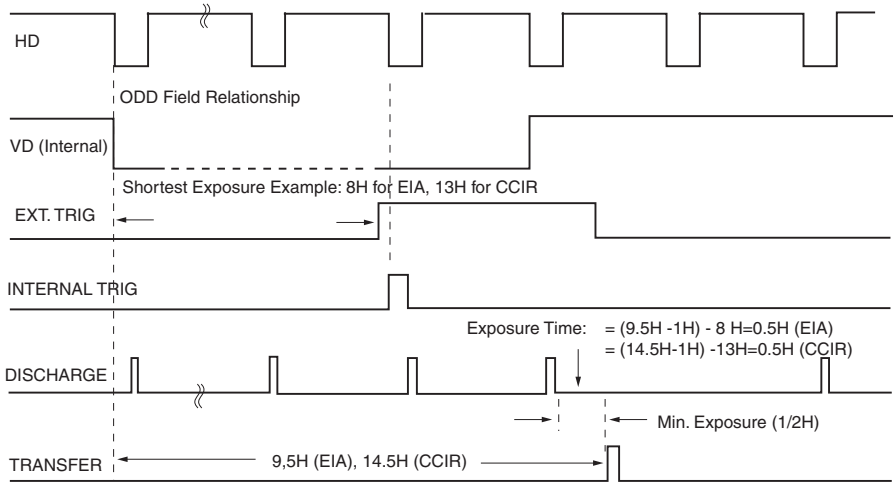
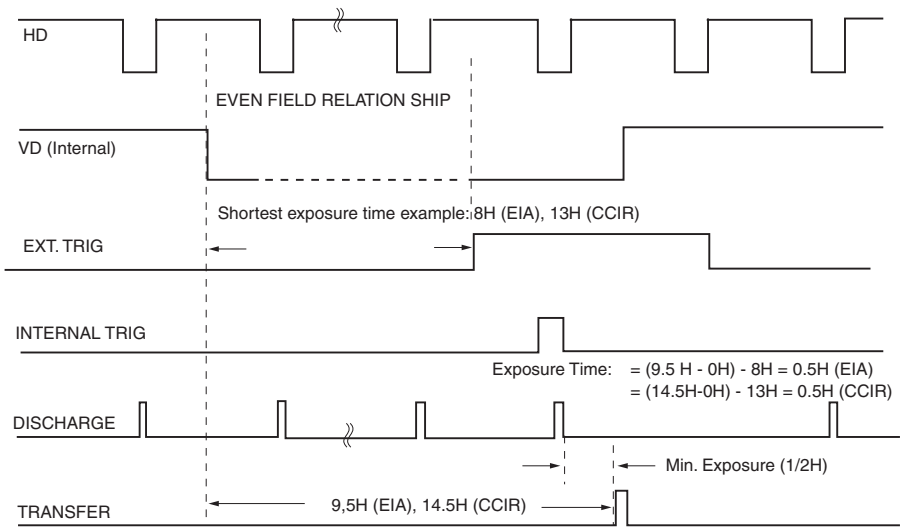


FIGURE 15. Position Shutter Even Field Timing



5.5 Pulse Width Control Reset-Restart Shutter

The shutter Trigger (TRIG) pulse is required to be wider than 1H (70µsec). The minimum exposure time in this mode is 2.5H (1/6200 sec). In this mode, the position of TRIG does not have to be synchronized with Reset-Restart VD (Ext. VD) and it can be asynchronous trigger with moving object. The exposure is set by rising edge and falling edge of TRIG pulse, which can be any timing (asynchronous). The video output is, however, synchronous with R-R VD. Since the vertical shift register must wait for completion of TRIG and next VD, only one field of image is valid after TRIG pulse. If continuous shutter control is required with pulse width control, the TRIG falling edge must be within 9.5 H (14.5H for TM-76) from each VD leading edge. To avoid any image flickering between odd and even field, the TRIG pulse is required to synchronize with HD and Reset-Restart VD.

FIGURE 16. Pulse Width Shutter: Asynchronous Timing

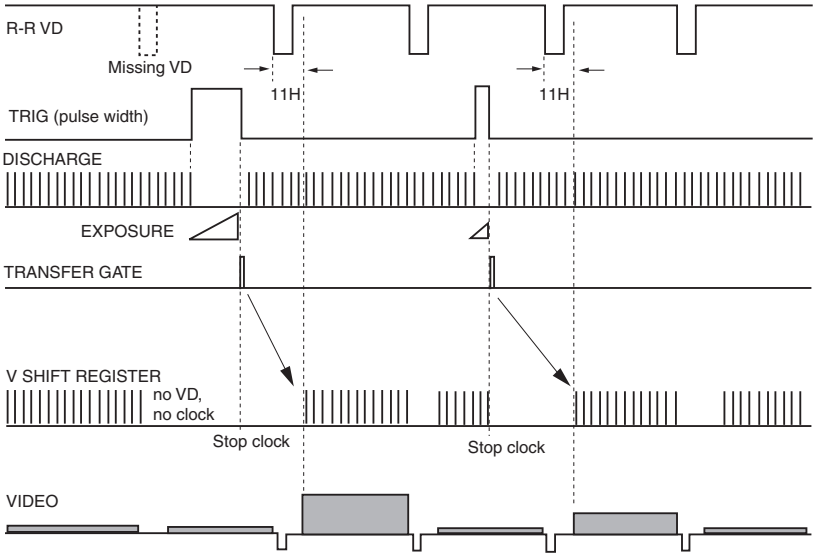
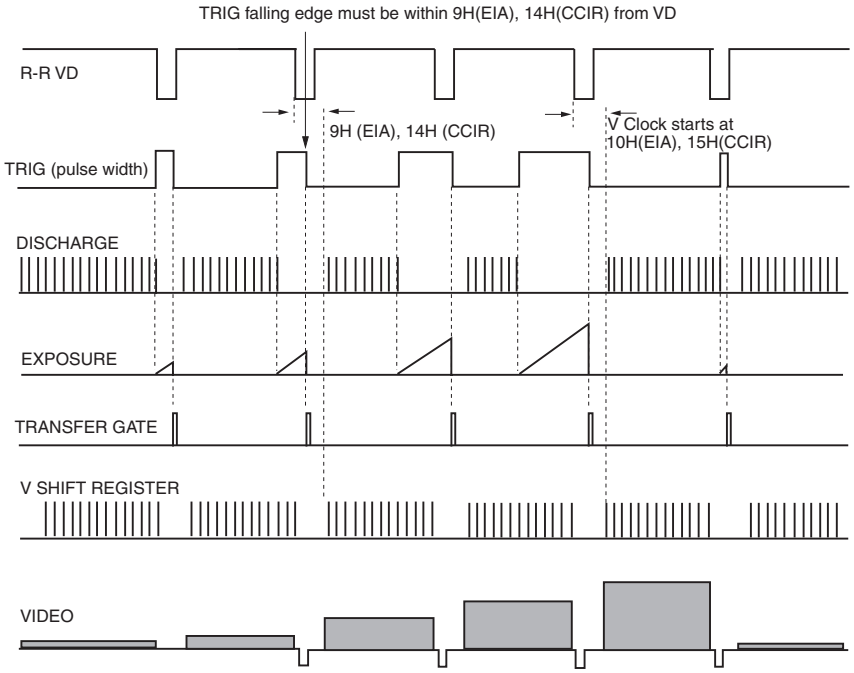


FIGURE 17. Pulse Width Shutter: Continuous Timing



6 Troubleshooting

6.1 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.

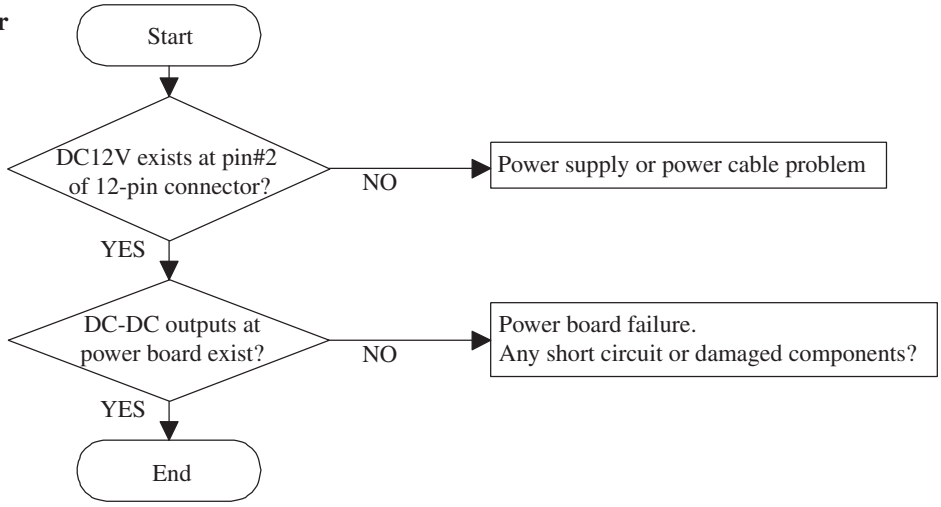
6.1.1 Symptom: No Video

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

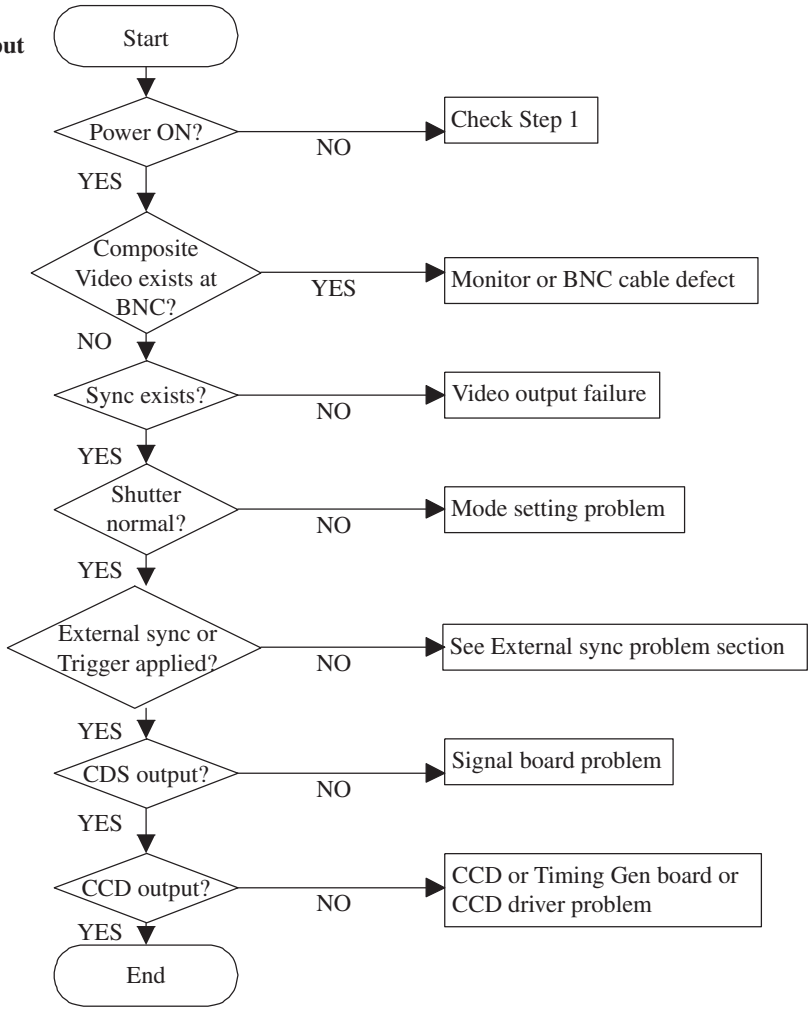
- Power supplies
- Power cables
- Main power source
- Shutter control
- Async mode
- Lens

6.2 Troubleshooting Flowchart

1. No Power

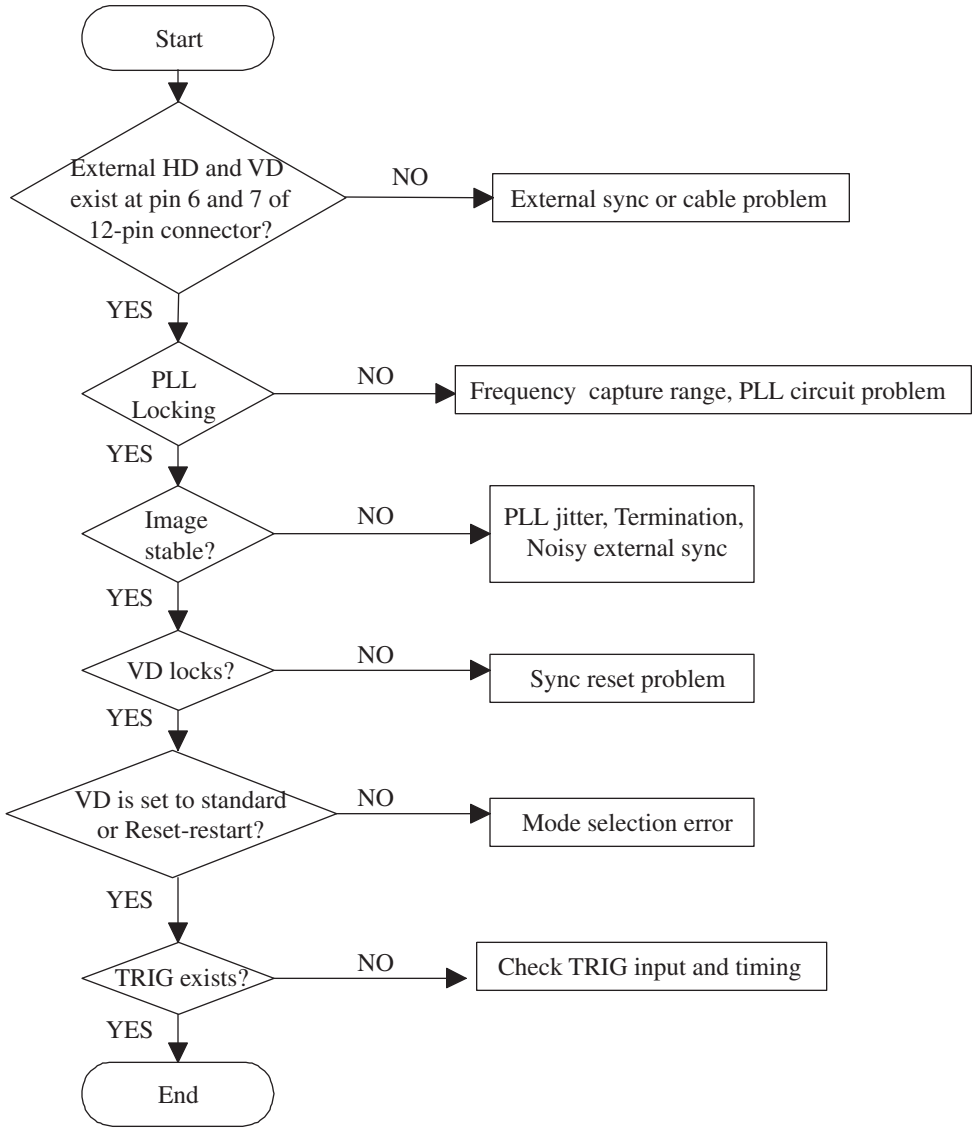


2. No Video Output



6.3 Troubleshooting Flowchart 2

3. External Sync Problem



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

7 Appendix

7.1 Specifications

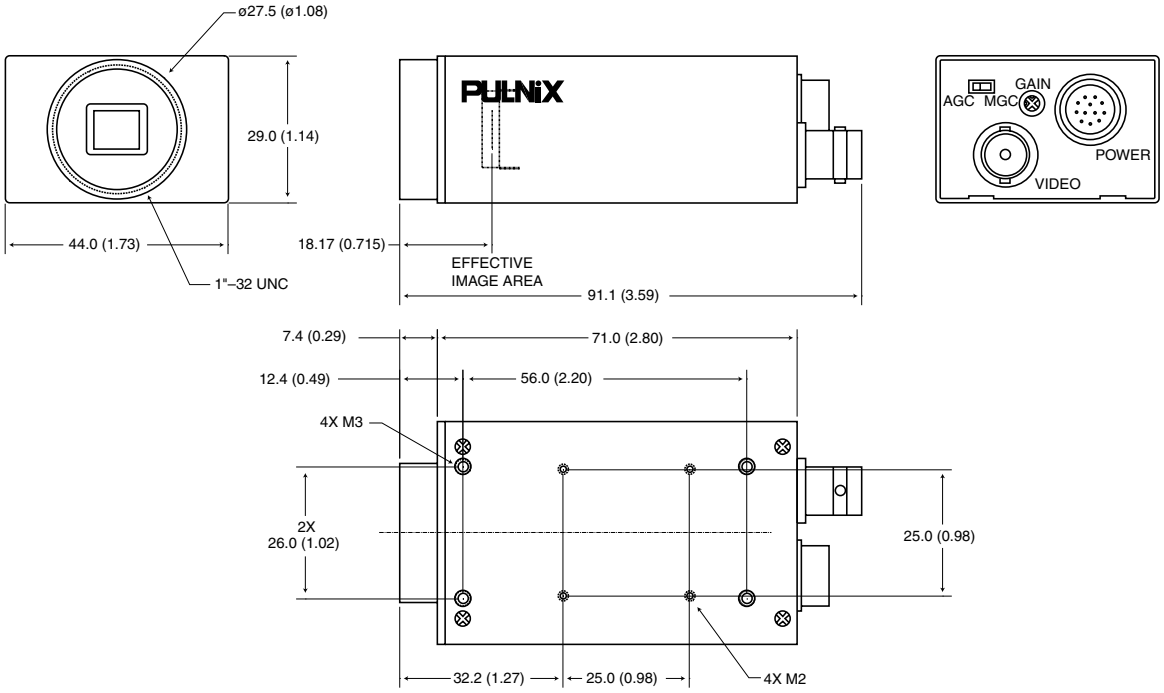
7.1.1 Product Specifications

TABLE 3. TM-75/76 Product Specifications Table

Model	TM-75(EIA)	TM-76(CCIR)
Imager	1/2" Interline transfer CCD, HAD type	
Pixels	768(H) x 494 (V)	752 (H) x 582 (V)
Cell size	8.4µm x 9.8µm	8.6µm x 8.3µm
Scanning	525 lines EIA	625 lines CCIR
Sync	Internal/External auto switch fH=15.734 KHz ±5%, fV=59.94 Hz ±5%	Internal/External auto switch fH=15.625 KHz ±5%, fV=50.00 Hz ±5%
Pixel clock	14.318 MHz	14.1875 MHz
TV resolution	570(H) x 350(V)	560(H) x 420(V)
S/N Ratio	56dB min. AGC off	
Min. illumination	0.5 lux (F=1.4)	
Video output	1.0 Vp-p composite video, 75Ω	
AGC	ON/OFF	
Gamma	Default: 1.0 (linear) or 0.45	
Lens mount	C-mount	
Power requirement	190 mA, 11-15V	
Operating temp.	-10°C to +50°C	
Vibration & Shock	Random Vibration: 7Grms/10-2000 Hz, Shock: 70G	
Size	29.0mm x 44.0mm x 62.3mm 1.14" x 1.73" x 2.45"	
Weight	104grms (3.7 oz.)	
Power cable	12P-02S (optional)	
Power supply	K25-12V, PD-12UE, PD-12U, PD-12UEP, PD-12UUP or PD-12UU	
Functional options	Optical Filter Removal (3-2); DC Coupled (7-2); Glassless CCD Imager (21); NIR CCD; Adjustable backfocus front end	
Accessories	See current price list.	

7.1.2 Physical Dimensions

FIGURE 18. Physical Dimensions

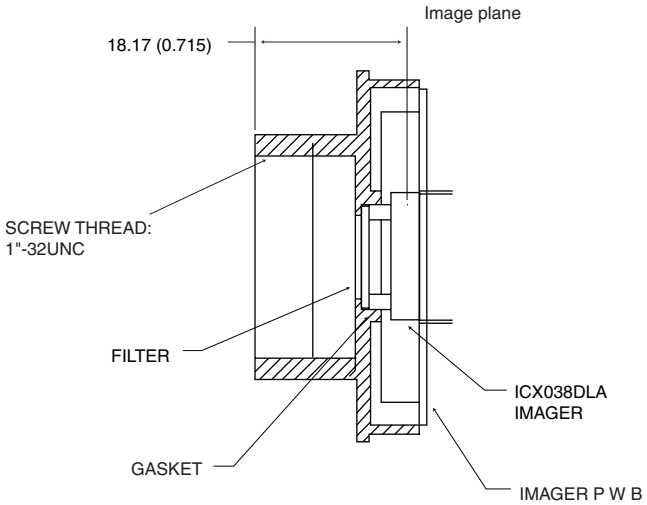


7.1.3 C-Mount Specifications

The TM-75/76 lens mount is standard C-mount.

7.1.3 (a) Front End Detail

FIGURE 19. Front End Detail

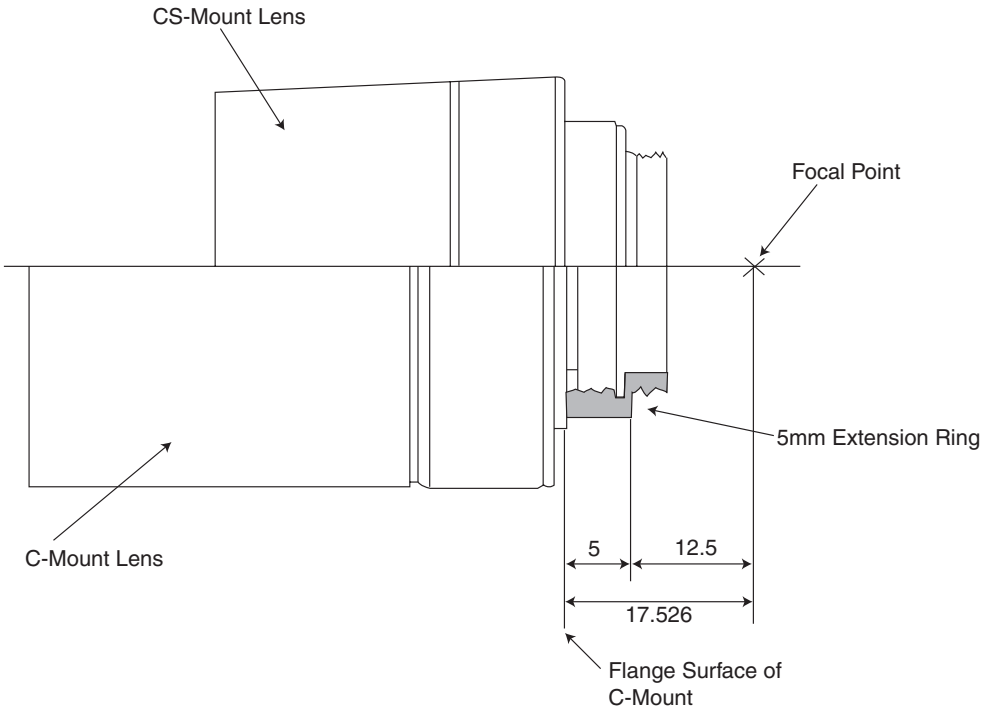


7.1.3 (b) C-Mount Custom Options

There are two custom options available, as follows:

- **CS-Mount Front End**

FIGURE 20. Combination With "CS-Mount" Camera



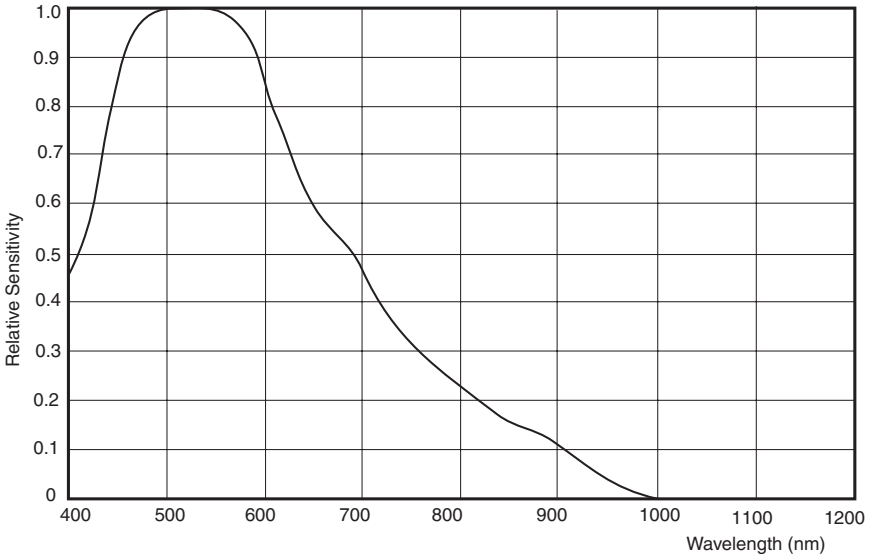
The flange-back length of the CS-Mount is 12.5mm versus 17.526 of the C-Mount. The shorter flange-back length of the CS-Mount allows room for the stripe filter incorporated in the color camera. Additionally, the shorter flange-back length allows for reduction of the effective diameter of the first lens and reduces the number of lens elements. The common C-Mount lens is completely compatible with a CS-Mount camera when a 5mm extension ring is inserted between the lens and the camera.

- **Backfocus adjustable front end**

For close-up and specific backfocus requirements, this front end comes with an adjustable C-mount ring.

7.2 Spectral Response

FIGURE 21. Spectral Response



7.2.1 Timing

FIGURE 22. TM-75 Timing Chart

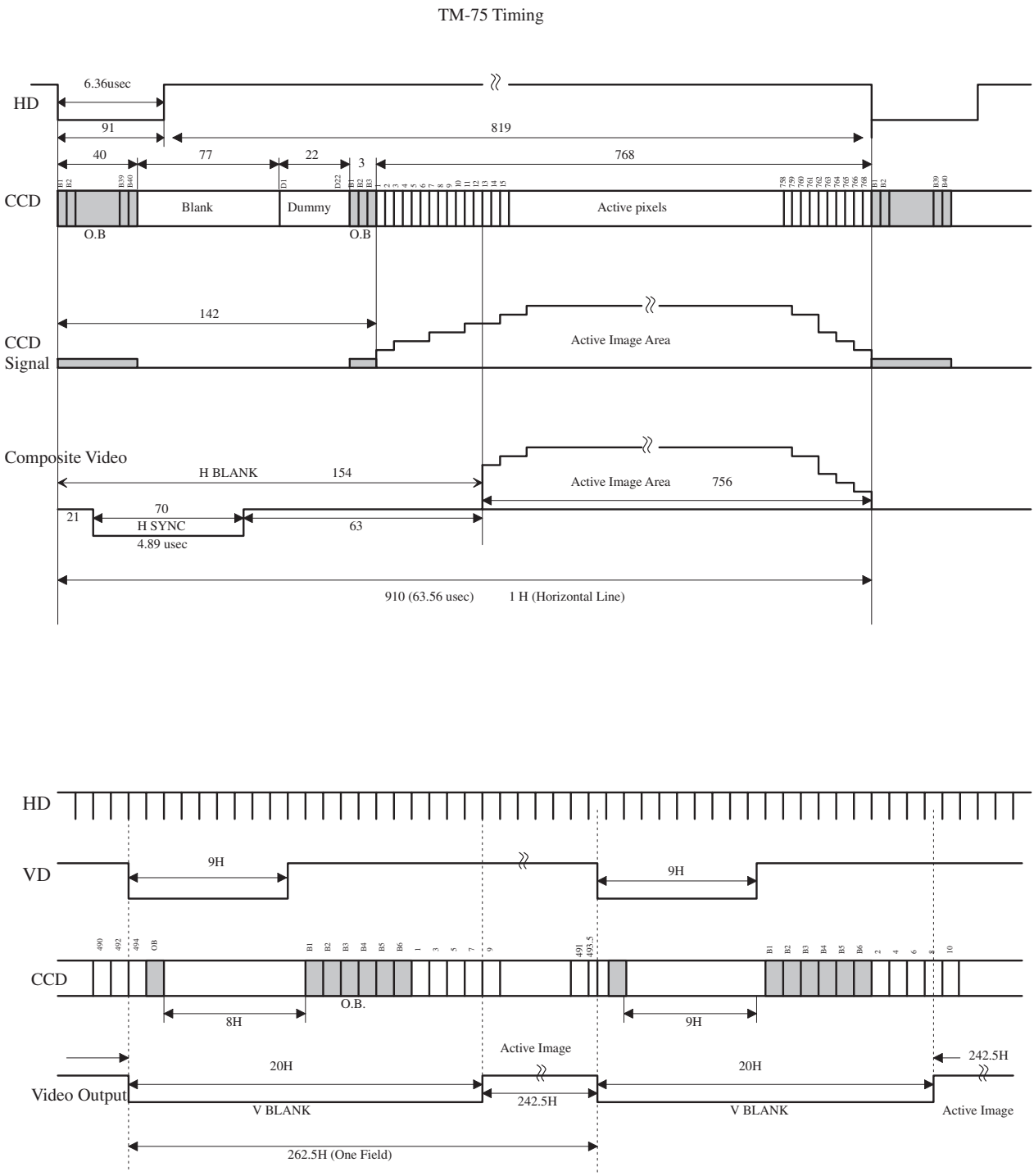
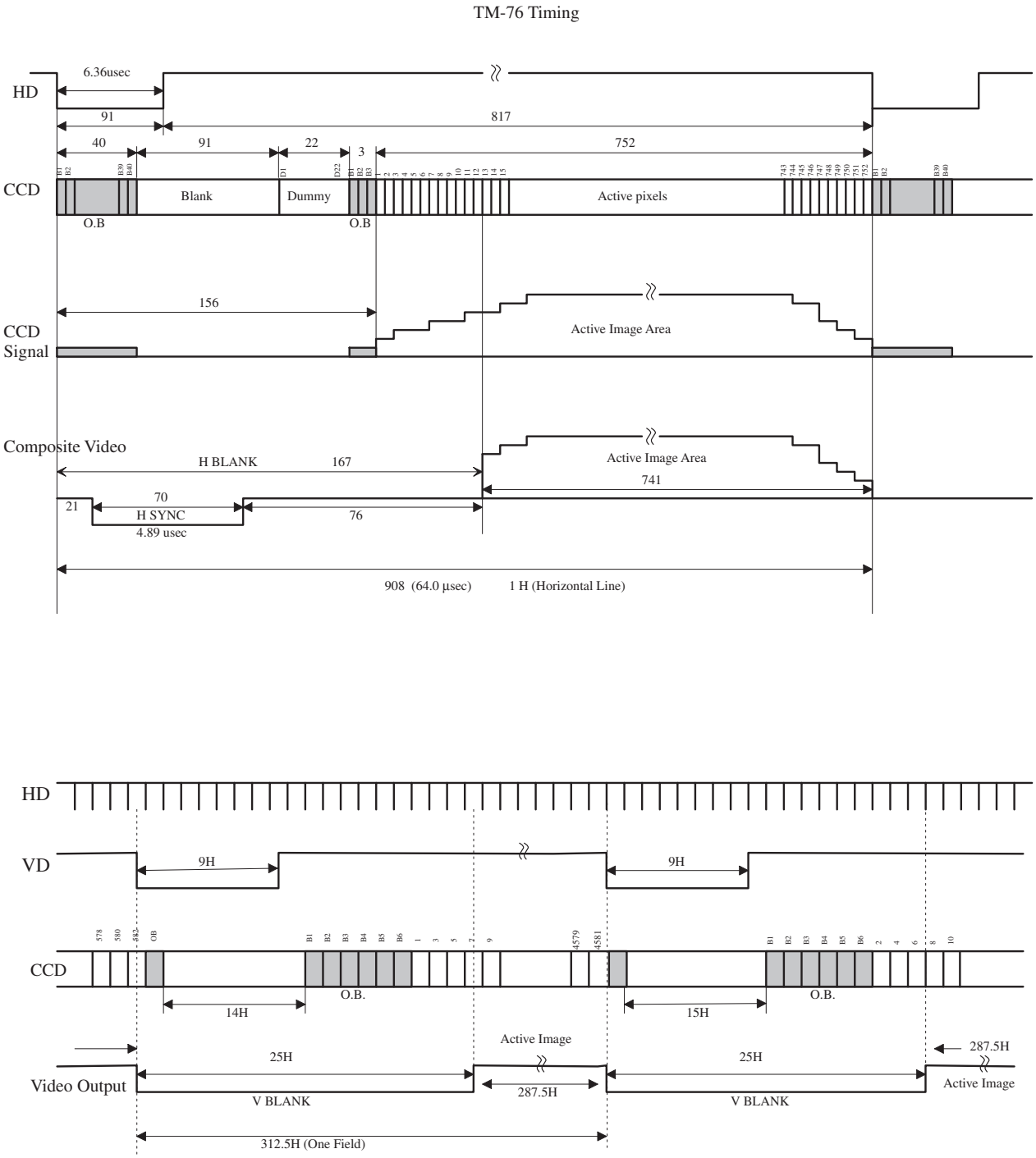
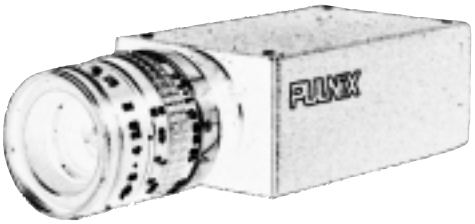


FIGURE 23. TM-76 Timing Chart



Appendix



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