TM-1300

Progressive Scan High Resolution Camera

Operations Manual

69-0048
Rev. A

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Certifications

UL

CE

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-1300 Operation Manual
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TM-1300 Progressive Scanning High Resolution Camera

Operations Manual

1 INTRODUCTION

1.1 Product Description

Compact and lightweight, the TM-1300 is a state-of-the-art CCD camera with a 2/3 inch 1.3K x 1K progressive scan interline transfer CCD imager.

1.2 Features

- **1.3K x 1K progressive scan interline transfer CCD**

  The advantages of this CCD are:

  - High resolution (1300 x 1030 active pixels) for very high resolution and image quality.
  - Square pixels (6.7 x 6.7 μm for precise dimensional measurement).
  - High speed electronic shutter capability results in high dynamic resolution of moving objects.
  - Progressive scanning eliminates interlace deterioration of image.
  - High sensitivity and low noise at fast scanning.

- **Asynchronous reset**

  The TM-1300 can be reset with an external reset pulse (VINIT). This feature is especially important for capturing moving objects at a precise location in the field of view, for applications such as a conveyer belt, fast event observation, and still picture capturing.

- **Async image capturing**

  The TM-1300 captures an image using async reset and provides continuous video output of the same image.This makes it simpler for an ordinary frame grabber to capture the async reset images.

- **Frame memory and digital output**

  The TM-1300 has a built-in frame grabber and a frame memory. There are two modes of digital output available:

  Direct output mode: 10-bit output without going through an internal frame buffer (direct from the A/D converter via RS-422).

  Memory mode: 8-bit output with the internal frame buffer, to capture the asynchronous image inside of the camera. The 10-bit A/D converter provides 1024 gray levels with maximized signal-to-noise ratio. The output can be real time digital output or captured image (frozen picture).

- **Pixel clock rate**

  The standard pixel clock frequency is 20 MHz.

- **Integration**

  The TM-1300 is capable of capturing high resolution integration images. Integration can last from 1/12 sec. to a few seconds.

- **Analog output (SVGA, BNC)**

  Since the TM-1300 is non-TV format, a frame grabber and computer, special monitor or SVGA monitor must be used to display the video output.

  The TM-1300 outputs analog signals from the SVGA and BNC connectors. The analog signal is processed in the camera for scan conversion in order to output high frame rate video (SVGA). The analog outputs are not recommended to be used for signal processing. While the digital is 10-bit non-interlace, the analog is 8-bit or 8-bit x 3 (SVGA) non-interlace output.

- **A/D reference voltage and dynamic range control**

  The 10-bit A/D converter's reference voltage can be controlled by back panel switches or RS-232C. The high reference and low reference variation provides A/D or signal processing dynamic range to maximize CCD characteristics.

- **Remote RS-232C control**

  The back panel mode switch functions, gain control, shutter speed, A/D reference functions and the data preset are all controllable via RS-232C communication.

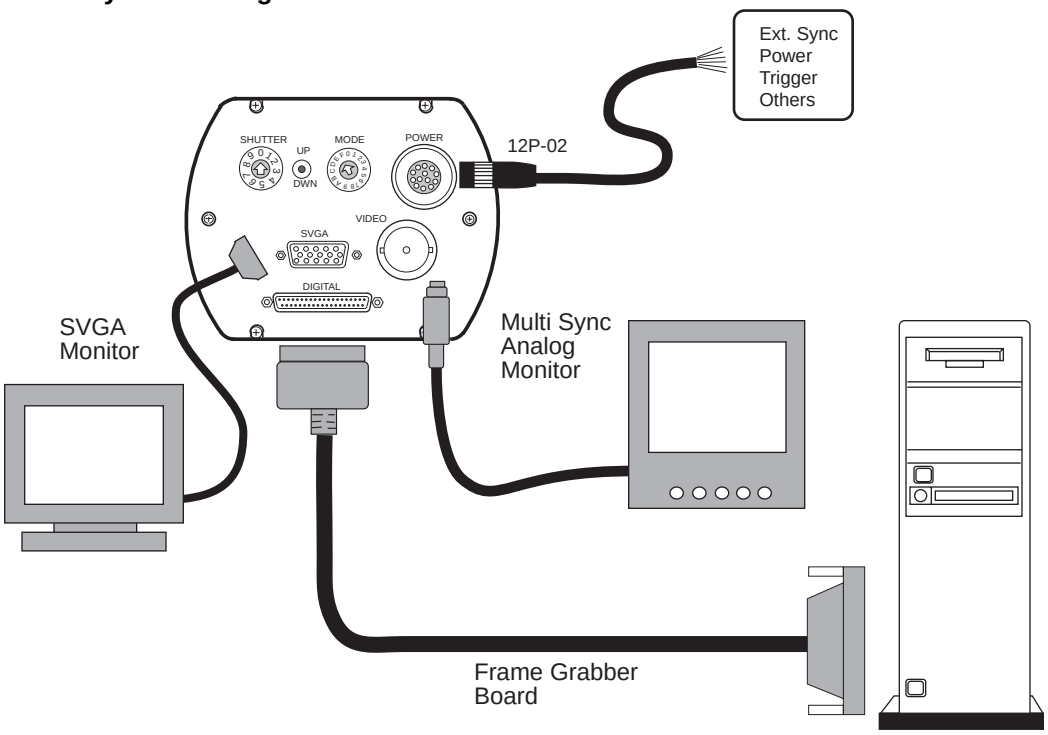
1.3 Functional Options

- Optical Filter Removal (OP3-2)
- Glassless CCD Imager (OP21)
- Internal IR Filter (OP3-1)

1.4 Applications

The versatile TM-1300 meets the needs of a broad range of applications, including high resolution image capturing, machine vision, computer graphics, gauging, avionics, microscopy, medical imaging, character and fine pattern recognition, document reading and high end surveillance.

FIGURE 1. **TM-1300 System Configuration**



Note: Additional cable interface may be required from the frame grabber board manufacturer.

2 INSTALLATION

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

2.1 Getting Started

2.1.1 Unpacking Instructions

It is recommended that the original packing cartons for the cameras and lenses be saved in case there is a need to return or exchange an item.

It is also recommended 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.

- TM-1300 camera
- 30DG-02-40 digital cable
- PD-12P power supply (650mA)
- TM-1300 Data Sheet
- TM-1300 Operations Manual

2.1.3 Accessories

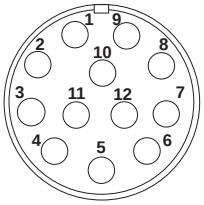
Following is a list of additional accessories or equipment that may be recommended or required for your particular application. Please check with your PULNiX representative prior to the installation of your video system to determine what you might need.

- RS-232 controller cable
- RS-232 controller software

2.2 Camera Setup

2.2.1 Connector Pin Configurations

2.2.1 (a) 12-Pin Connector

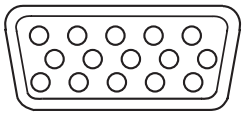


The TM-1300 has a 12-pin connector for power input. Pin #1 is Ground and Pin #2 is +12V DC. The other pins handle a number of other input and output functions as detailed below.

Pin	Description	Pin	Description
1	**GND**	**7**	**Strobe out+**
2	**+12V DC**	**8**	**Strobe out-**
3	**GND**	**9**	**RS-232 TXD**
4	**Video Out**	**10**	**RS-232 RXD**
5	**GND**	**11**	**Integration**
6	**VINIT In**	**12**	**N/C**

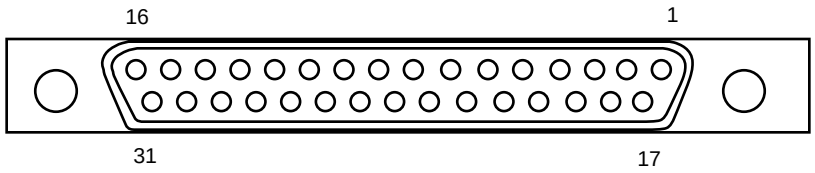
Note: Strobe output is differential but can be used as positive going TTL or negative going TTL.

2.2.1 (b) SVGA Output Connector (15-pin Dsub miniature connector)



2.2.1 (c) Digital Output Connector

An EIA-422 digital output is available from the 31-pin high-rel, micro-miniature connector (Airborn MP221-031-243-2200). The mating connector can be firmly secured to the receptacle for vibration and shock environments. A common D-sub connector was not used to prevent any vibration problems.



Pin	Description	I/O	Pin	Description	I/O
1	CLK+	Out	17	CLK-	Out
2	LDV+	Out	18	LDV-	Out
3	FDV+	Out	19	FDV-	Out
4	GND		20	VINIT	In
5	N/C		21	INTEG	In

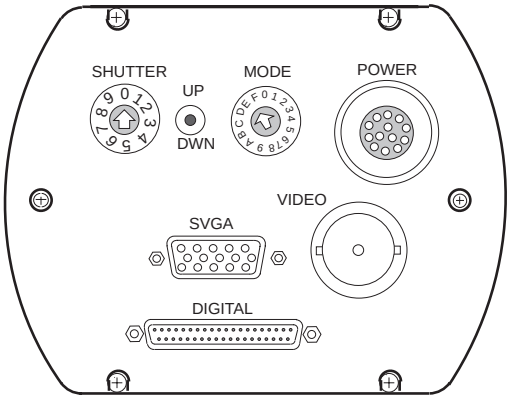
Pin	Description	I/O	Pin	Description	I/O
6	D0+	Out	22	D0-	Out
7	D1+	Out	23	D1-	Out
8	D2+	Out	24	D2-	Out
9	D3+	Out	25	D3-	Out
10	D4+	Out	26	D4-	Out
11	D5+	Out	27	D5-	Out
12	D6+	Out	28	D6-	Out
13	D7+	Out	29	D7-	Out
14	D8+	Out	30	D8-	Out
15	D9+	Out	31	D9-	Out
16	GND	Shield			

2.2.1 (d) Mode Control Switch

Setting	Mode	
O	Normal Mode	
1	MGC gain control	Up/Down (6 to 22 dB)
2	Async / Manual shutter	Up: Manual
		Down: Async
3	Gain selection (9 dB)	Up to set
	Gain selection (12 dB)	Down
4	Gain selection (18 dB)	Up
	Gain selection (22 dB)	Down
5	Image output selection	Up: Direct digital mode
		Digital: 10-bit without memory
		12 frame/sec (20MHz)
		Analog: SVGA/SXGA, 47 frame/sec.
		Down: Memory mode
		Digital: 8-bit through memory, 12frame/sec (20MHz)
		Analog: 12 frame/sec, no-display mode
6	A/D Vref top	Up/Down
7	A/D Vref bottom	Up/Down
8	Freeze (ENINT) enable	Up: Real time
		Down: Freeze
9	Factory default recall	Up/Down: Recall factory default
A	User power up default	Up: Load user default data
	(default page at power up)	Down: Save data (latest data)
B-D	User page storage	Up: Load
		Down: Save
E	Direct shutter	Up/Down (1/39,000 to 1/12 sec., 1H increment)
F	Fast dump	Up: Normal mode
		Down: Fast dump mode

2.2.2 Rear Panel

FIGURE 2. **TM-1300 Rear Panel**



2.2.3 Power Supply and Power Cable Setup

2.2.3 (a) Power Supplies

PULNiX recommends the following power supplies:

K25-12	110V AC/12V DC	2.1A power supply
P-15-12	220V AC/12V DC	2.1A power supply
K50-12	110V AC/12V DC	4.2A power supply
PD-12P	110V AC/12V DC	0.5A power supply

For users providing power through the 12-pin connector, the PD-12P power supply is 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.

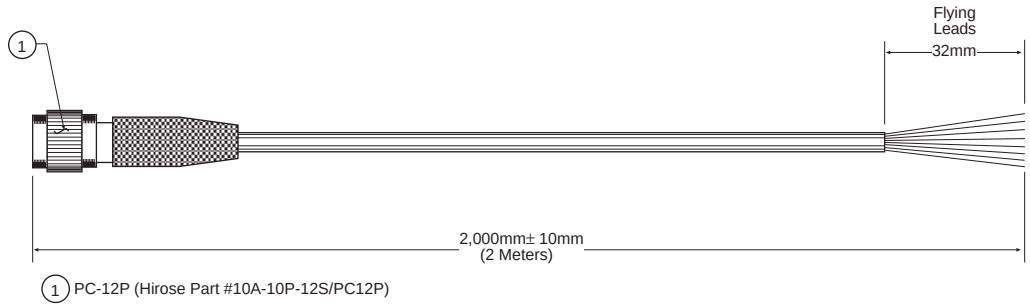
If wiring the PD-12 power supply directly, please note the following:

- Twist the lead ends together and tin solder 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.
- Properly insulate all connections to prevent shorting.

2.2.3 (b) Using PULNiX Power Cables

If you are using PULNiX power cables, such as the 12P-02, KC-10, etc., please refer to the pin-out diagram. The color coded leads use Grey for Ground and Yellow for +12V DC.

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



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.

2.2.3 (c) Using the "K" Series Power Supplies

Attach the 110V line cord to the two terminals marked "AC". Do not plug the cord into a 110V AC socket until later in the procedure. Next, attach the Grey and Yellow leads of the power cable to the Ground and 12V DC terminals respectively. Be sure to replace the plastic terminal guard on the power supply at this time.

Note: 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 DC-12N and PD-12 are recommended.

2.2.3 (d) Building Your Own Power Cables

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

2.2.3 (e) Attaching 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 firmly seated.

The power cord may now be plugged into the 100V AC socket, and the camera powered up.

2.2.4 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.

Users wishing to output the video and input the power and sync to a camera over a single cable can use the PULNiX multi-conductor cables, such as the 12P-02, the KC-10, 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.

2.2.5 Attaching the Camera Lens

The TM-1300 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-1300 camera, first attach a C-mount lens in the lens mount. Be sure that the lens is properly mounted.

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-illuminated image). Obtain the best focus possible at this setting, then loosen the two miniature hex head set screws locking the focus ring in place. Now turn the entire lens and focus ring assembly back and forth until the best image is obtained. Tighten the focus ring set screws. Your backfocus is now set.

2.2.7 Auto Iris Lens Setup

Auto-iris lenses with full video input can be used with the PULNiX TM-1300, although this camera model does not come equipped with auto-iris input.

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 damage could occur to the auto-iris lens 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 output is not supplied, wire the signal (video) on the lens into the terminal 1 Vp to peak 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.

2.2.8 Monitor Display Mode

For monitoring real time video, connect the SVGA output to a SVGA/SXGA computer monitor.

Since the standard frame rate is 12 Hz, it may not be easy to see detail on a monitor. Therefore, the TM-1300 display mode provides scan conversion to 47 frame / sec rate. The analog output of the TM-1300 is more likely to be monitored by oscilloscope for the waveform analysis.

Analog signal monitoring does not take full advantage of the 10-bit signal processing capability. For 10-bit output applications, use the digital output connector.

2.2.9 Connectors and Cables

The digital output connector is optional. Mating connector ordering information is as follows: PULNiX Part No. 15-1623 (Airborn P/N: MP211-031-113-3400)

Straight Backshell (cover): PULNiX Part No.15-1625 (Airborn P/N: MM253-031-000-4300)

Cable assembly: Digital cable 30DG-02 (50-1301-01: 8-bit standard cable) or 30DG-02-40 (50-1224:10-bit cable). Special cable length or specific interface connector to a frame grabber board is available upon request.

12-pin connector and cable: Standard cable is 12P-02 (2m, 8 conductor cable) for power and external controls.

3 OPERATION

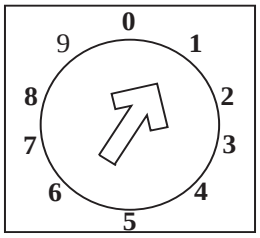
3.1 Modes of Operation

The TM-1300 is designed to accommodate a high resolution, on-line inspection reset mechanism with full frame shutter. It accepts external horizontal sync (HD, TTL Levels) to lock the camera and VINIT pulse for resetting the camera asynchronously. The shutter speed can be controlled by either RS-232 computer commands or internal shutter speed control with a 10-position dial switch on the back panel.

3.1.1 Shutter Control Switch

The TM-1300'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. Do not supply VD if the asynchronous reset is used. Instead, use HD to synchronize the camera to the external device.

When the async reset pulse (VINIT) is applied to High state (+5V) with the dial switch set from1 to 9, the TM-1300 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 will immediately reset the vertical sync timing. The maximum delay is 80.645μsec. (1H). Then the camera will start integrating for the period of shutter control set by either computer control or internal shutter control. Therefore the horizontal phase will not be interrupted. The TM-1300 asynchronous camera will output one full frame of shuttered video after reset.



Shutter Control Switch

TABLE 1. Shutter Control Settings

Set	Manual Shutter Mode	Async Reset Mode	
0	No Shutter (1/12)	No Shutter (1/12)	
1	1/50	1.5H	1/39,000
2	1/100	2.5H	1/9,500
3	1/200	4.5H	1/5,500
4	1/400	8.5H	1/3,000
5	1/1,500	16.5H	1/1,500
6	1/3,000	32.5H	1/400
7	1/5,500	64.5H	1/200
8	1/10,000	64.5H	1/245
9	1/39,000	256.5H	1/50

Mode 0: Normal Mode
Mode 1-4: Fast Mode
Mode 5-9: Slow Mode

3.1.1 (a) Direct Shutter Control Mode

For Direct Shutter Control Mode, set the dial switch to “E”. When the up/down switch on the back plate is used, the shutter increments or decrements by 1H from the current setting. By controlling through RS-232C, the exact shutter speed can be programmed by feeding H number from 1H (actual shutter speed is 0.5H) to 1000H. The back plate control status can be read with RS-232C control and saved into customer pages (page A is the power up default; whenever power is switched on, page A status is loaded). This shutter control can be applied to both manual and async shutter modes. As shown in Table1 (above), the shutter speeds are inversed in manual and async modes.

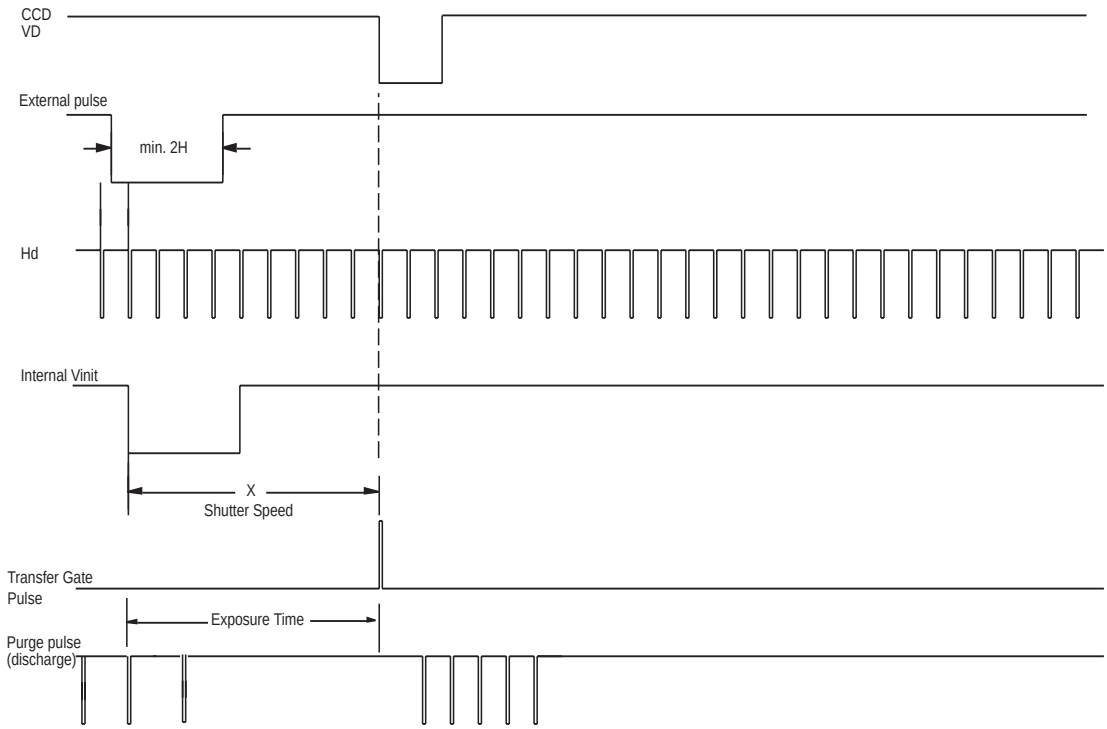
At async shutter, the internal VINIT is generated at the leading edge (negative going edge) of the external trigger pulse. Internal timing, including the video sync, is reset. The shutter speed is the same as in manual shutter mode. One frame of video output will start at the completion of the exposure time (approx. 243μsec.).

In Memory Output mode, the camera will output the same video from memory when VINIT is kept high (5V) and update the image upon receiving the next trigger pulse. In Direct mode, with external pulse input high, the video output is disabled as the camera keeps discharging the CCD image and provides only black video. Therefore, if the direct digital output mode is chosen, the video output is only one frame and then black video with sync.

3.1.1 (b) Internal Reset Mode

For Internal Reset Mode, set the 10-position dial switch from “1” to “9”. When this 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 4. **Internal Reset Mode**



3.1.2 Asynchronous Shutter

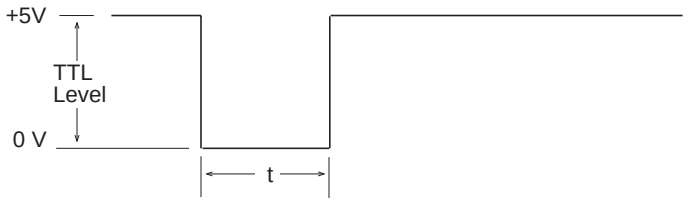
For Async Shutter mode, select mode control switch #2 and press the up/down switch down. When the negative going reset pulse VINIT is applied to pin 6 of the 12-pin connector, the camera will latch the falling edge to its next horizontal drive and immediately reset the vertical sync timing. Therefore, the horizontal pulse phase will not be interrupted.

The TM-1300 asynchronous camera outputs a full frame of shuttered video in progressive scanning format from a frame buffer. The frame buffer is updated with each new image captured upon receiving the next negative reset pulse. Since the internal frame buffer is designed to capture asynchronously triggered images and output them as continuous video, an ordinary frame grabber can be used with the TM-1300 (some frame grabber boards cannot accept disrupted sync).

The scan converted analog output is continuous sync without interruption at the trigger point. Therefore, a computer monitor can display steady images without losing sync or jumping images.

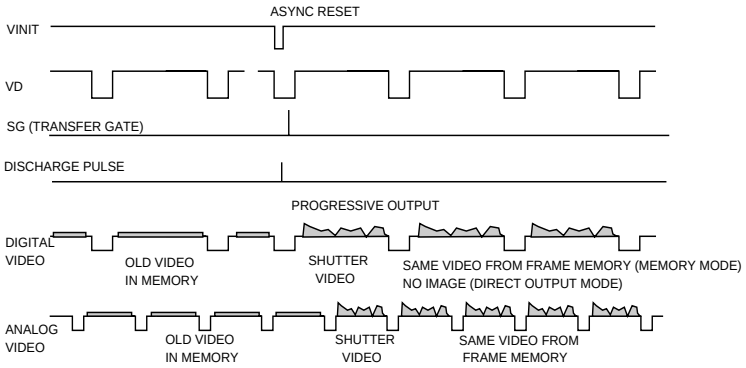
Note: All trigger input signals should have a pulse width of 160μsmin. (2H) 80ms 1000H max. for the camera to function properly.

FIGURE 5. **VINIT (Vertical Initialization) Trigger Specification**



	Min	Max
t	24H	1000H

FIGURE 6. **Asynchronous Shutter**



3.1.3 Frame Memory (Memory Output Mode)

The TM-1300 has a built-in frame memory which outputs progressive scanning images at a 12 Hz rate (12 frames per sec). This feature provides the following advantages:

1. Asynchronously captured images are output as standard continuous video signals so that a monitor or frame grabber can display or process without a special asynchronous video grabber.
2. Integration video is continuously output until the next capture. Normally, a camera cannot output the video signal during the integration, and the periodic integration causes a blinking video signal. The TM-1300 memory keeps the stored image until the next image is completed so that there is no blank interval during integration.
3. Digital format of the video output can be used as a direct interface with the computer. The format is progressive.

3.1.3 (a) Activating Frame Memory

1. Asynchronous reset mode

Select switch #2 of the back panel for async.When External VINIT is high (5V), the TM-1300 expects the async pulse input. It resets at the negative going pulse edge and captures the frame regardless of the shutter speed. The video output is kept disabled as the CCD is discharged continuously during VINIT high. When the first VINIT pulse comes in, it resets the timing and

captures the image (Fig. 5). The captured image is kept until the next pulse is applied for the next image. If the switch is at normal mode (manual shutter mode), the video output is real time with manual shutter.

2. **Integration**

   Activate EN INT (Enable Integration) of mode selection #8 by pushing down the switch then input INTEG control (#11 of 12-pin connector or #21 of 31-pin connector) as active low (TTL). When it is low, the TM-1300 keeps integrating and, upon the rising edge of the INTEG control pulse, it captures the frame and keeps it until next end of integration. When EN INT is high (open), video output is in real time without freezing and one frame of the integrated image appears upon ending of INTEG control pulse (during INTEG control low, it keeps the previous image but when INTEG is high it only holds one frame). FDV (Field) Data Valid) is disabled during the integration and the vertical pulse starts when the image is output.

3.1.3 (b) Progressive Scanning

The TM-1300 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 (12 Hz). Like a non-interlace computer screen, it generates a stable crisp image without alternating lines and provides full vertical TV resolution of 1000 lines (a monitor display may not be able to show 1000 lines due to monitor resolution and interlace scanning of the analog output). 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-1300 outputs the progressive scanned image with an electronic shutter in two different formats:

1. **Progressive scanning digital output**

   The CCD signal goes through A/D converters. The frame memory is capable of capturing async and integration video without having special frame grabbers. 10-bit digital output is available from 31-pin connector with EIA-422 format (20 MHz clock rate).

2. **Non-interlace scan analog output**

   The TM-1300 outputs non-interlace video for SVGA monitor display. The digital output of 31-pin connector is also at 12 Hz with a 20 MHz pixel clock (progressive scan).

3.1.4 Video Output

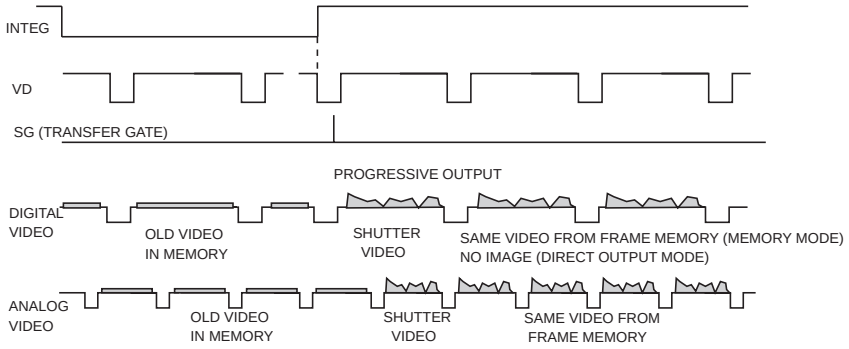
3.1.4 (a) Async Reset Image Capture

With built-in memory, an image can be captured when VINIT pulse is applied. The captured image will be continuously scanned out until the next VINIT pulse occurs. (Ref. Figure 3, pg. 11).

3.1.4 (b) Built-in Memory for Integration Image Capture

With the Freeze Enable with mode #8 (push down), set the integration control (pin #11) to low for integration. Integrated video can be captured once integration control goes back to high. Upon rising edge of integration, the image is transfered (SG) 9H later.

FIGURE 7. **Integrated Image Capture Timing**



3.1.4 (c) Continuous Sync Output

When async reset is applied, video sync is also reset asynchronously. This phenomenon causes video picture rolling or bouncing on the monitor. With this feature, a continuous output (no more bouncing or rolling pictures) will be achieved at async reset.

3.1.5 Mode Control Functions

3.1.5 (a) 0. Normal Mode

The camera outputs real time normal video signal without electronic shutter or asynchronous functions. The shutter speed is 1/12 sec.

3.1.5 (b) 1. MGC Gain Control

CDS amplifier gain can be controlled by the up/down switch. The minimum gain is 6dB and the maximum gain is 24dB (factory set is 18 dB at power on).

3.1.5 (c) 2. Async / Manual Shutter Selection

The electronic shutter mode is selected by up (manual) and down (async) switch. When it is in manual mode, the shutter speed is programmed by the shutter speed switch. When the async shutter is selected, the shutter timing works with VINIT (async reset pulse). If VINIT is kept high, it keeps discharging the CCD. When negative going pulse comes in, it resets the timing and captures a image, holding it until the next pulse comes. The async shutter speed is also selected by the shutter selection switch but exposure times are inverted from manual shutter times.

3.1.5 (d) 3. and 4. Gain Selection

Fixed specific gain is recalled by selecting 3 or 4 and pressing up/down switch up or down.

3 - up9 dB

3 - down12 dB

4 - up16 dB

4 - down22 dB

3.1.5 (e) 5. Image Output Format Selection

The TM-1300 has three output connectors. The digital output is 10-bit or 8-bit from 31-pin connector and the analog outputs are SVGA format (DB-15 connector) and composite video (BNC connector) with sync.

When Image Selection (mode #5) is selected by pushing the switch up, the Direct Digital Output mode is selected. This bypasses the memory buffer (cannot grab and freeze video images), and 10-bit 12 frame/sec digital output is generated. The analog output is scan-converted to SVGA speed (47 frame/sec).

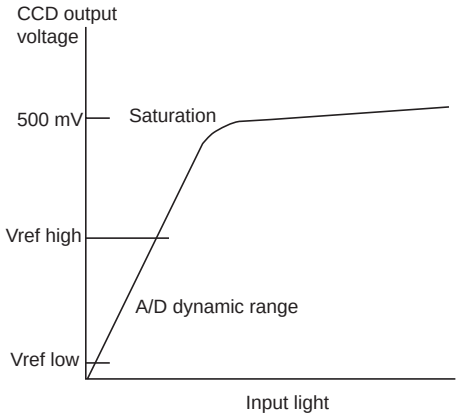
When the switch is down, Memory mode is selected. The digital signal goes through the memory buffer for grabbing images and the output is 8-bit. The frame rate of both digital and analog is 12 frame/sec. (no SVGA output).

3.1.5 (f) 6. and 7. A/D Reference Voltage Control

The CCD output itself has over 60 dB of dynamic range. However, the signal normally used to display or capture does not have such a wide range. For instance, if the amp gain is set at 12 dB (4X) and the display is 100 IRE in which saturation is 714 mV, the actual signal from the CCD is 714/4 = 178 mV. This is 1/3 of the imager saturation. By adjusting Vref, the full dynamic range at a specific gain can be obtained.

When low light and high sensitivity is required, the reference can be set to the narrow range so that the small signal can be digitally amplified and the gray level can be shifted to the middle region for easy observation and processing. The input signal to A/D is from 2.2 V to 3.7 V. The typical factory set is VL = 2.2 V and VH = 3.2 V.

FIGURE 8. **A/D Dynamic Range**



3.1.5 (g) 8. Freeze (ENINT) Enable

The internal frame buffer can freeze the image by selecting this function. When the up/down switch is pushed up, it is a real time image. When it is down, it freezes the final image. This freeze mode is also used for integration control. At freeze mode, the TM-1300 can be used to integrate (log exposure) by controlling INTEG control input on 12-pin connector (pin #11). It keeps integrating as long as the pin #11 is low and grabs an image when the integration is over.

3.1.5 (h) 9. Factory Default Recall

When mode 9 is selected at power up, camera starts with the factory set parameter. When camera is already powered, select the switch #9 and press up/down switch up to recall factory default. (User cannot change this parameter)

3.1.5 (i) A. User Default Page

This page is a default page for camera start up. When camera is powered up, it starts operating with the parameters stored in page #A except switch positions of #9 (factory set), #B through #D (user set specific pages).The last changes during optimization should be stored in page #A so that the default will be recalled upon next power up.

3.1.5 (j) B. through D. User Pages

User can store specific parameters in pages from B through F.

3.1.5 (k) E. Direct Shutter

This mode accepts shutter control by every 1H (80μsec) increment (up) or decrement (down) for 1/12 sec to 1/39,000 sec. If RS-232C is connected, the exact shutter control number (1H to 1000H) is applied.

3.1.5 (l) F. Fast Dump

One of the unique features of the TM-1300 is the capability of fast dump charges kept inside of the CCD’s vertical shift registers prior to image integration in async reset mode. This feature reduces vertical smear lines from a point light source during fast shutter conditions. The lower side smear, however, cannot be reduced due to the CCD structure.

FIGURE 9. **Normal Mode vs. Fast Dump Mode**

Normal Mode Fast Dump Mode

3.1.6 Digital Output Pulses

3.1.6 (a) Digital Video

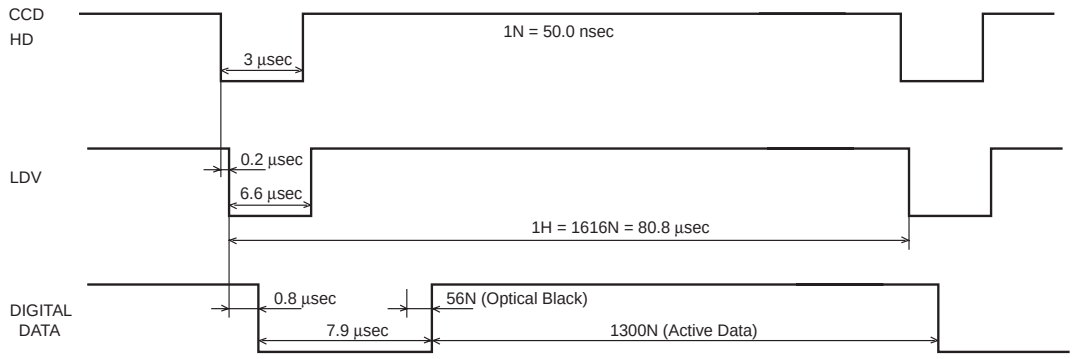
Differential line-driven, 10-bit parallel signal with EIA-422 format. 100Ω output termination impedance. Output from 31-pin connector. The mating connector: Airborne MP211-031-113-4300

Please consult PULNiX digital cable information: 50-1224, 30DG-02-40 (10-bit), 2m cable

3.1.6 (b) Line Data Valid (preliminary)

Differential line-driven signal with EIA-422 format. It is active high (+ side is higher than - side) during the transfer of each line of data.....Horizontal line read out.

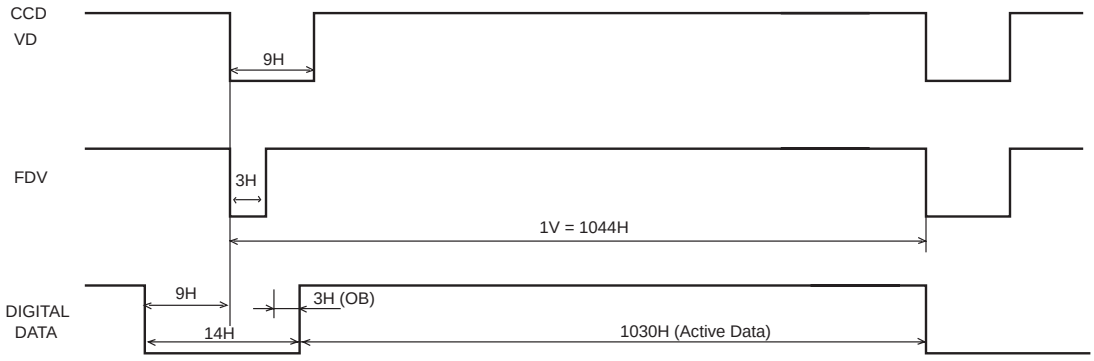
FIGURE 10. **Line Data Valid**



3.1.6 (c) Frame Data Valid (preliminary)

Differential line-driven signal with EIA-422 format. It is active high during the transfer of each frame data. During integration, both LDV and FDV are kept low and restart upon the completion of integration.

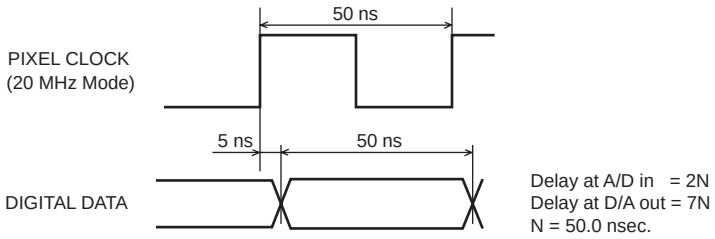
FIGURE 11. **Frame Data Valid**



3.1.6 (d) Pixel Clock

Differential line-driven signal with EIA-422 format. The frequency is 20.0 MHz (standard)

FIGURE 12. **Pixel Clock**



3.1.7 TM-1300 RS-232C Control

The TM-1300's built-in microcomputer chip (CPU) can be controlled by an external RS-232C interface. The internal CPU controls TM-1300 operation mode and DSP parameter changes. Contact PULNiX for the TM-1300 software diskette.

3.1.7 (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.

Note: The TM-1300 protocol requires no handshaking.

3.1.7 (b) RS-232C Command

The TM-1300 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-1300 (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 TM-1300, 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-1300 will send back

":",ACK,CR or ":",NAK,CR
3/ahm06H,0DH 3AH,15H,0DH

3.1.7 (c) 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., "1A0" = 416H, shutter speed = (1050-416) = 634H = 50 msec.). It moves the shutter discharge pulse at every 1H (80 μsec.) period from 0 (no shutter) to 1024 H.

3.1.7 (d) Command F

Function: Changes memory mode between Freeze and Free-run modes.

Freeze Mode: ":", "F", "1", CR
3AH, 46H, 31H, 0DH

Free-run Mode: ":", "F", "0", CR
3AH, 46H, 30H, 0DH

3.1.7 (e) Command G

Function: A/D pre-amp gain control. (The effective range is from 64H to D2H).

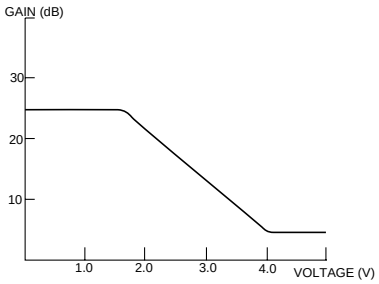
The first value next to "G" command is A channel. The second value is B channel.

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

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

It changes the gain by hexadecimal 2 digit.

VO = 2/255 x SET VALUE +2.0V
Value: 0 to 255
VO = D/A output voltage



3.1.7 (f) Command V

Function: A/D reference voltage control. In default gain setting, no shutter. The effective range of A/D bottom reference voltage is from 64H to 87H. The effective range of A/D top reference voltage is from 82H to FFH.

The first value next to “V” command is Vref top. The second value is Vref bottom.

“:”, “V”, “7E”, “64”, CR
7EH = Vref top: 126
4H = Vref bottom: 100
3AH, 56H, 37H, 45H, 36H, 34H, 0DH

3.1.7 (g) Command W

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

Saving to page (from 9 through F):

“:”, “W”, “A” - “F”, CR
3AH, 57H, 41H - 46H, 0DH
(Page 9 is factory use only)

Saving to calibration table “WU” command:

“WU” + [data string 32, byte]
See EEPROM partition table

3.1.7 (h) Command L

Function: Select and read a memory page and set the preprogrammed data. This loads the data.

“:”, “L”, “A” - “F”, CR
3AH, 4CH, 41H - 46H, 0DH

3.1.7 (i) 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] (6 bytes aSCII), CR
2. **Report from pages “RP 9-F” command.** Camera responds**:**
   “:”, ASK, “P”, “9-F” (page), (6 bytes ASCII), CR

3. **Report from user calibration table "R U", "A-D" command.** Camera response is:
   ":", ACK, "U", "A-D", [data] 6 bytes
4. **Report from factory set "R S", "A-D" command.** Camera response is:
   ":", ACK, "S", "A-D", [data] 6 bytes

For detailed parameters, please contact PULNiX.

3.1.7 (j) Command D

Fast Dump mode:	":", "D", "1", CR
	3AH, 44H, 31H, 0DH
Normal mode:	":", "F", "0", CR
	3AH, 44H, 30H, 0DH

3.1.7 (k) Command C

Gain control.

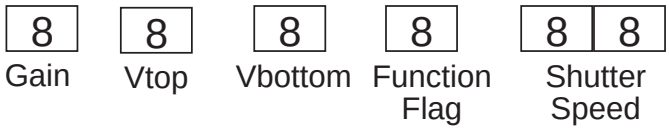
Direct mode:	":", "C", "1", CR
	3AH, 43H, 31H, 0DH
Memory mode:	":", "C", "0", CR
	3AH, 43H, 30H, 0DH

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.

FIGURE 13. **TM-1300 Camera Control Commands**

	START: ":"			END: "CR"
	1st	2nd	3rd	Response
1	"S" (Shutter)	"M" (Manual) "A" (Async) "X" (Direct)	"0" - "9" (1/60 - 1/16000) "0" - "8" (1/125 - 1/16000) "9" (Pulse Width Mode) "000" - "400" (Hex) (lines)	ACK
2	"G" (Gain)	"00" - "FF"		ACK
3	"V" (A/D Vref)	"00" - "FF" (Top)	"00" - "FF" (Bottom)	ACK
4	"W" (Write)	"P" (Page) "U" (User) "S" (System)	"9" - "F" "A" - "D" "A" - "D"	ACK
5	"L" (Load)	"P" (Page) "U" (User) "S" (System)	"9" - "F" "A" - "D" "A" - "D"	ACK
6	"R" (Report)	"R" (Current) "P" (Page) "U" (User) "S" (System) "X" (Execute)	 "9" - "F" "A" - "D" "A" - "D"	ACK + "RR" + 6bytes ACK + "P" + ("9" - "F") + 6bytes ACK + "U" + ("A" - "D") + 6bytes ACK + "S" + ("A" - "D") + 6bytes ACK
7	"F" (Freeze)	"0" (Real Time) "1" (Freeze)		ACK
8	"C" (Digital out)	"0" (Direct) "1" (Memory)		ACK
9	"D" (Fast Dump)	"0" (Normal) "1" (Fast Dump)		ACK

The 6 bytes of Report Response contain:



8 Function Flag bits contain:

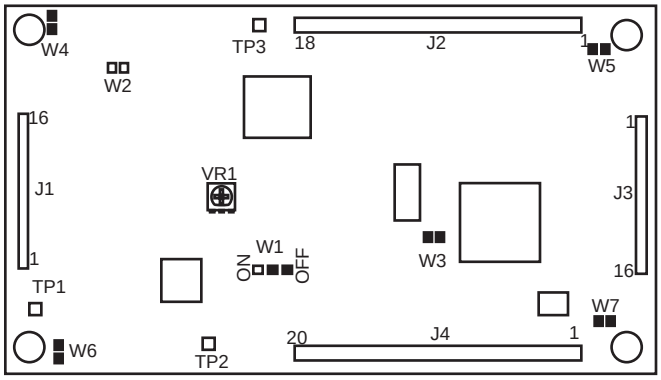
Bit 7	**N/A**	
Bit 6	**Freeze Flag**	**1/0**
Bit 5	**Async Mode Flag**	**1/0**
Bit 4	**N/A**	
Bit 3	**Direct Shutter Flag**	**1/0**
Bit 2	**No Shutter Flag**	**1/0**
Bit 1	**Fast Dump Flag**	**1/0**
Bit 0	**Digital Output Mode Flag**	**1/0**

3.2 Board Layout and Adjustment

3.2.1 Signal Board (Top Side)

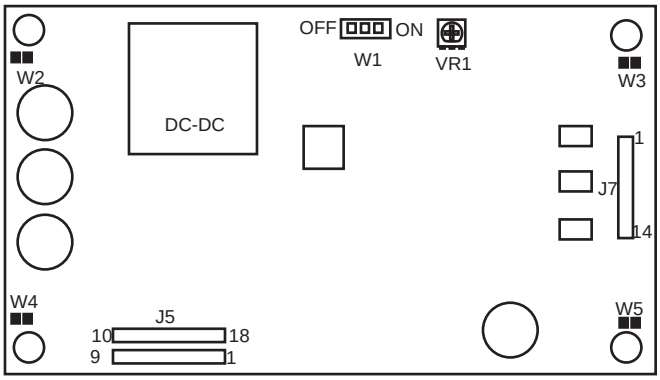
Preset		
VR1	AGC Max	1.5 V (22 dB)
Jumpers		
W1	Gamma	Set to 1.0 (OFF)
W2	Clk enable	Open
W3	Not used	
W4-W7		for chassis GND

FIGURE 14. **Signal Board (top side)**



3.2.2 Power Board (Bottom Board, Top Side)

FIGURE 15. **Power Board**



3.2.3 Power Board (Bottom Board, Top Side)

Jumpers

W1	Analog Gamma	OFF for Gamma 1
W2-W5		for chassis GND
W6	RS-422 power option	Open for (4.0V)

Select internal jumper W7 through W11 (back side) for power supply optimization.

Potentiometer

VR1	PED	Set pedestal at 50 mV of video (analog)

3.2.4 Memory Board (Middle Board, Bottom Side)

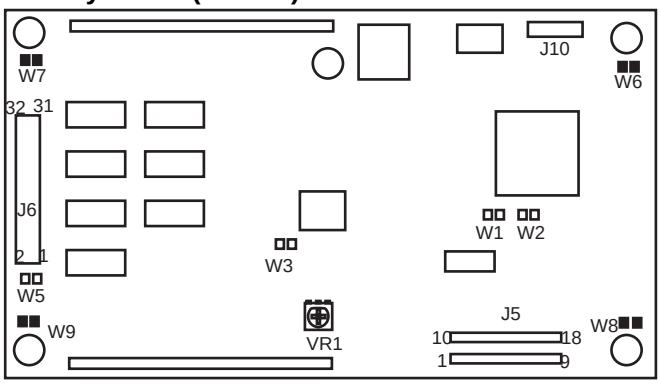
Preset

VR1	D/A reference	TBD (Vin = V out)

Jumpers

W1	DL	Download (Open)
W2	ER	(Open)
W3	D/A reference	Close for Preset Vout
W4	Clk selection	Close to left for internal clock
W5	Clk selection	Close to left for internal clock
W4-W7		Chassis GND

FIGURE 16. **Memory Board (bottom)**



4 TROUBLESHOOTING

4.1 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.

4.1.1 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

4.1.2 Symptom: Dark Video

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

- Shutter selection
- Iris opening on the lens

4.1.3 Symptom: Non-synchronized Video

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

- Proper mode output
- Frame grabber software camera selection

4.1.4 Symptom: RS-232 Non-communication

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

- Cable connection
- Proper serial port selection
- Camera has power

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

5 APPENDIX

5.1 Specifications

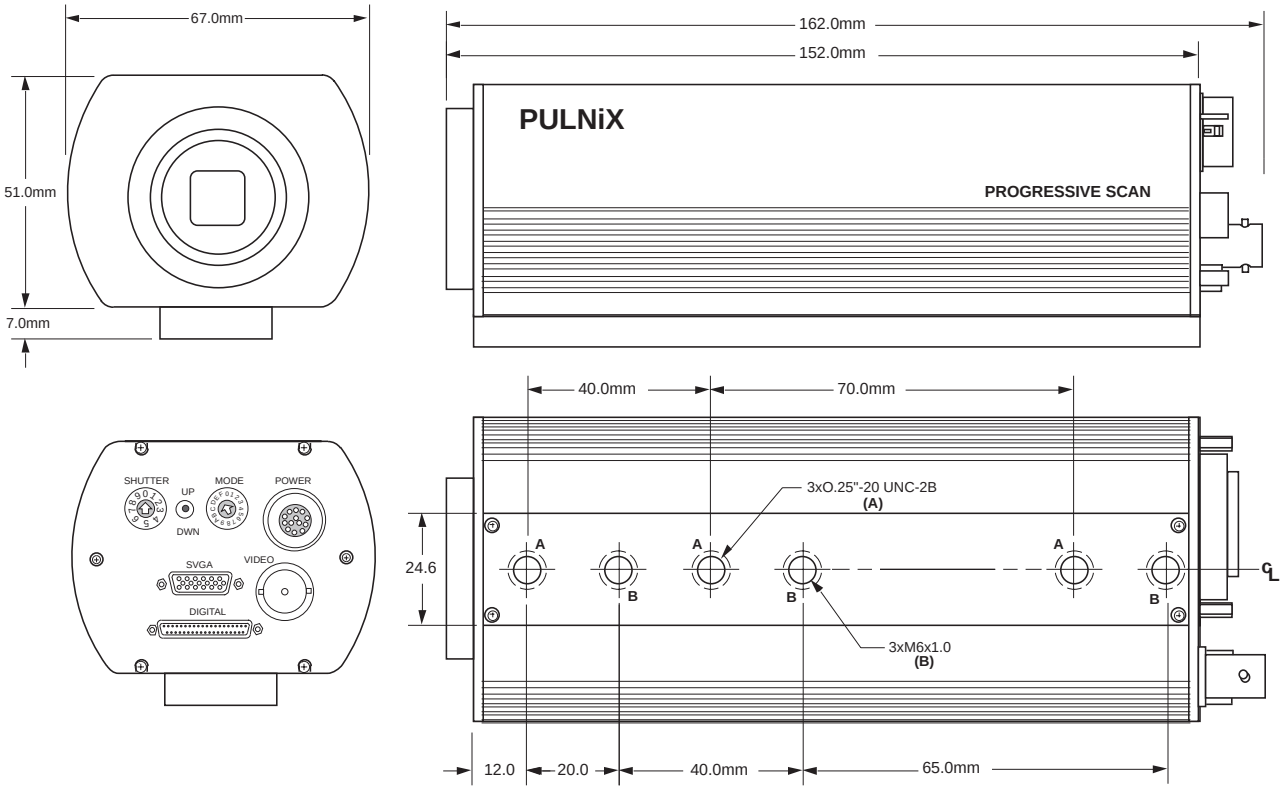
5.1.1 Product Specifications

TABLE 2. **Product Specifications Table**

Imager	2/3" progressive scan interline transfer CCD
Pixels	1360 (H) x 1034 (V)
Cell size	6.7 (H) x 6.7 (V)
Photosensitive Pixels	1300 (H) x 1034 (V)
Output sensitivity	10 μV/e-
Micro lens	Built-in
Blemish	Point Defect Cluster Column no major defect 0 0
Scanning	1044 lines 12 Hz (15Hz, TM-1300-15)
Sync	Internal only fHD = 12.4 KHz (15.50 KHz Tm-1300-15) fHD = 11.9 Hz (14.9 Hz TM-1300-15)
Pixel clock	20.0 MHz, (25.0 MHz TM-1300-15)
TV resolution	Analog:> 700(H) x 800(V) Digital: 1300(H) x 1030(V)
Video output - Analog	1.0 Vp-p composite video, 75Ω, sync negative SVGA: 1.0 Vp-p Video only RGB channels, Sync: TTL
Video output - Digital	10-bit / 8-bit RS-422 differential output Data clock = 20.0 MHz (25.0 MHz, TM-1300-150
TV resolution	Analog only, fHD = 49.5KHz, fVD = 47 Hz, non-interlace
S/N ratio	50dB minimum; 56dB typical
AGC	Not available
MGC	Manual gain adjustable (9 dB to 22 dB)
Gamma	1.0 (0.45 optional)
Lens mount	C-mount, 2/3" lens format
Power requirement	12 V DC 650 mA (700 mA for driving RS-422)
Operating temp.	-10°C to 50°C
Vibration & Shock	Vibration: 7G (20 - 2000MHz), Shock: 70G
Size	51mm(H) x 67mm(W) x 162mm(L) 2.01" x 2.64" x 6.38"
Weight	45 kg. (1.1 lb)
Power cable	12P-02
Digital cable	30DG-02 (std) or 30DG-02-40 (10-bit cable supplied with TM-1300-10)
Power supply	K25-12V or PD-12 (PD-12 supplied)

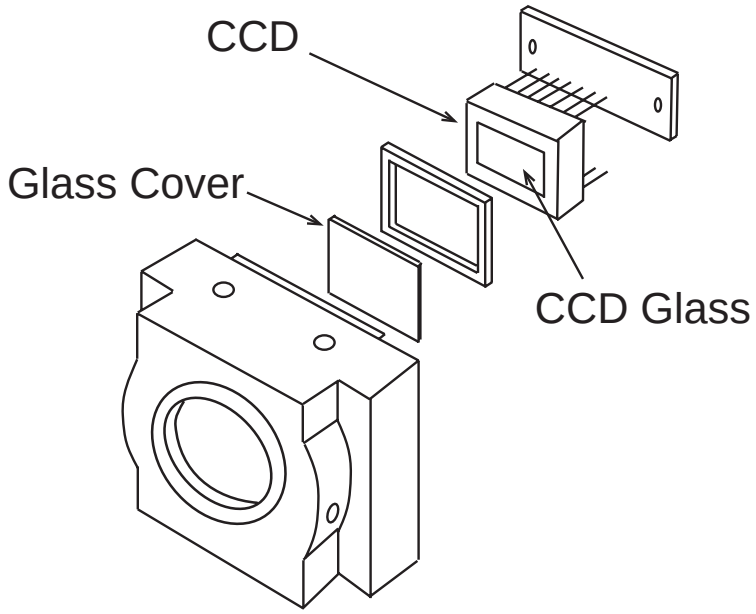
5.1.2 Physical Dimensions

FIGURE 17. **Physical Dimensions**



5.1.3 Glass Specifications

FIGURE 18. **Camera Front End - Glass Specifications**



CCD Glass (BK-7) 0.75mm thickness
Refractive Index = 1.5

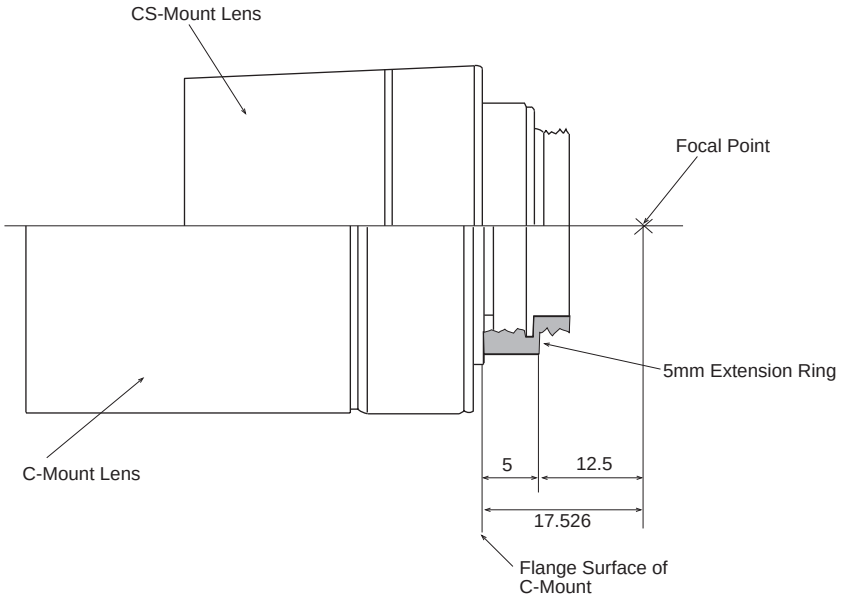
Glass Cover (BD-65) 1.0mm thickness
Refractive Index = 1.51

5.1.4 C-Mount Specifications

FIGURE 19. **C-Mount**

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.

FIGURE 20. **Combination With "CS-Mount" Camera**



5.1.5 Front End Detail

FIGURE 21. **TM-1300 Imager Location**

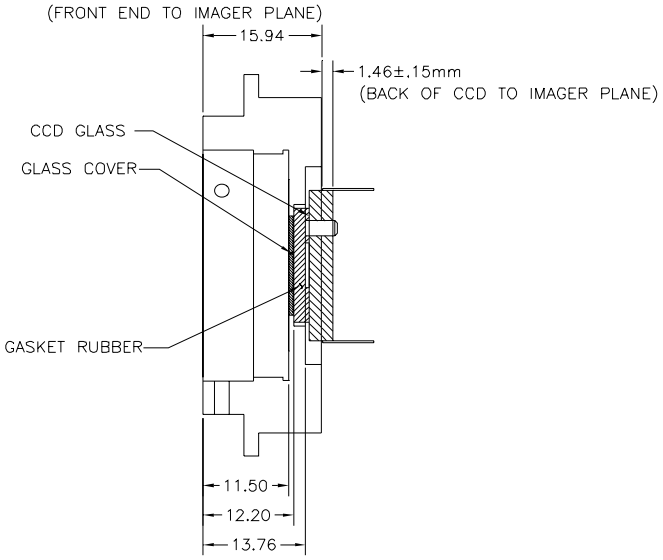
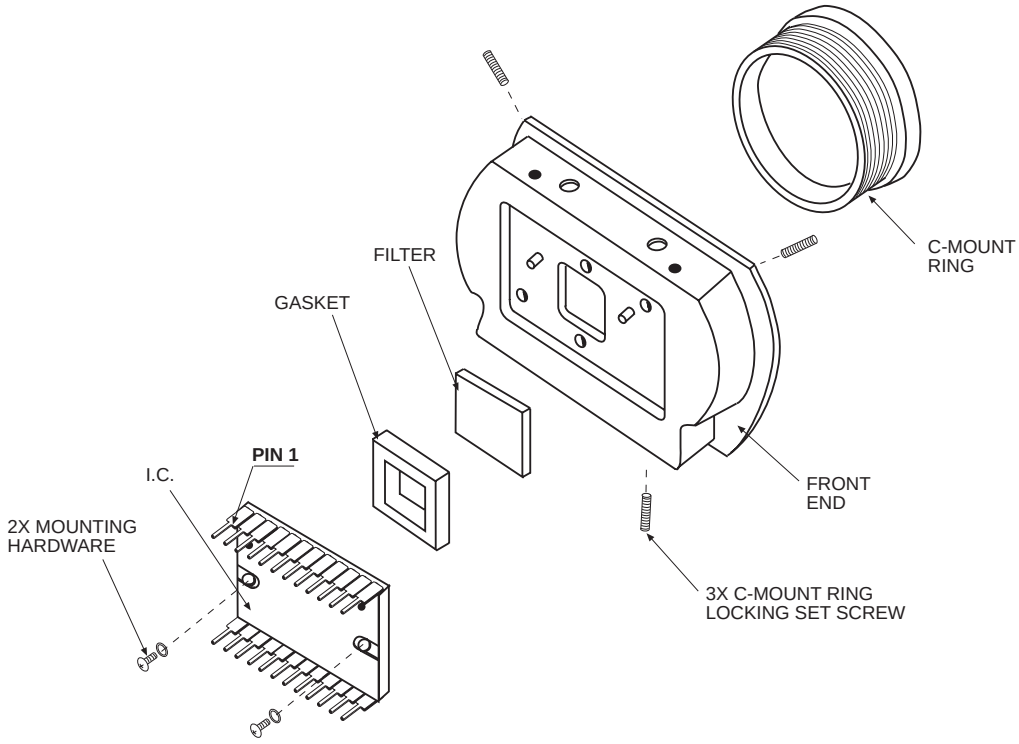
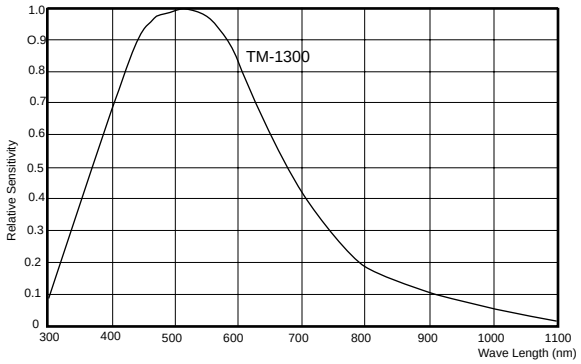


FIGURE 22. **Front End Assembly**



5.2 Spectral Response

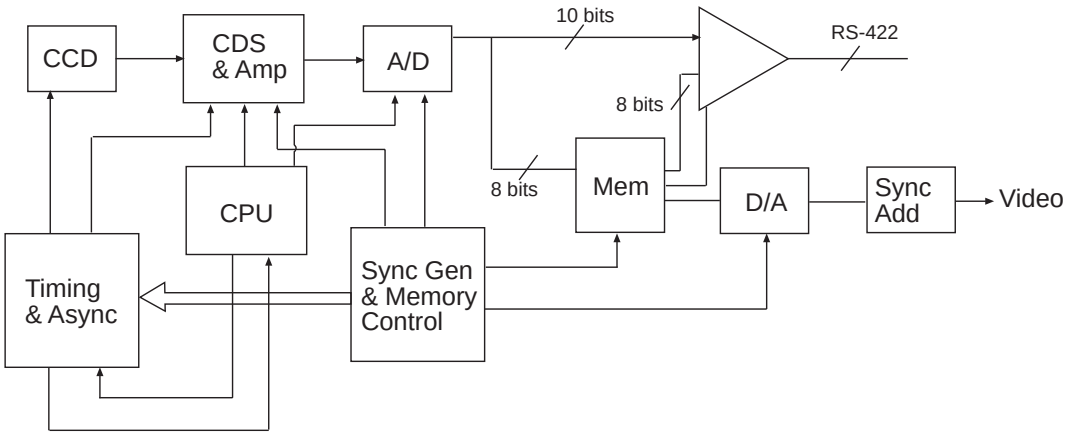
FIGURE 23. **Spectral Response**



TM-1300 SPECTRAL RESPONSE

5.3 Block Diagram

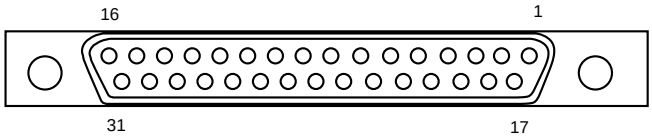
FIGURE 24. **TM-1300 Block Diagram**



5.4 Digital Cable Assembly

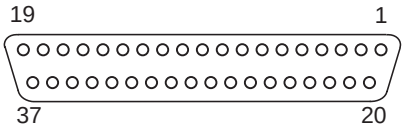
5.4.1 TM-1300 31-Pin Connector

30DG-02-10 (10-bit cable), P/N 50-1301-10 for TM-1300 full function cable



Pin	Signal	Cable	Pin	Signal	Cable
1	CLK+	OR 1 RED	17	CLK-	OR 1 BLUE
2	LDV+	GRY 1 RED	18	LDV-	GRY 1 BLUE
3	FDV+	WHT 1 RED	19	FDV-	WHT 1 BLUE
4	GND	YLW 1 RED	20	VINIT	YLW 1 BLUE
5	N/C	PINK 1 RED	21	INTEG	PINK 1 BLUE
6	D0+	OR 2 RED	22	D0-	OR 2 BLUE
7	D1+	WHT 2 RED	23	D1-	GRY 2 BLUE
8	D2+	WHT 2 RED	24	D2-	WHT 2 BLUE
9	D3+	YLW 2 RED	25	D3-	YLW 2 BLUE
10	D4+	PINK 2 RED	26	D4-	PINK 2 BLUE
11	D5+	OR 3 RED	27	D5-	OR 3 BLUE
12	D6+	GRY 3 RED	28	D6+	GRY 3 BLUE
13	D7+	WHT 3 RED	29	D7-	WHT 3 BLUE
14	D8+	YLW 3 RED	30	D8-	YLW 3 BLUE
15	D9+	PINK 3 RED	31	D9-	PINK 3 BLUE
16	GND	SHIELD			

5.4.2 37-Pin D-Sub Connector Pin Configuration



Pin	Signal	Cable	Pin	Signal	Cable
1	CLK+	OR 1 RED	20	CLK-	OR 1 BLUE
2	LDV+	GRY 1 RED	21	LDV-	GRY 1 BLUE
3	FDV+	WHT 1 RED	22	FDV-	WHT 1 BLUE
4	N/C		23	N/C	
5	N/C		24	N/C	
6	D0+	OR 2 RED	25	D0-	OR 2 BLUE
7	D1+	GRY 2 RED	26	D1-	GRY 2 BLUE
8	D2+	WHT 2 RED	27	D2-	WHT 2 BLUE
9	D3+	YLW 2 RED	28	D3-	YLW 2 BLUE
10	D4+	PINK 2 RED	29	D4-	PINK 2 BLUE
11	D5+	OR 3 RED	30	D5-	OR 3 BLUE
12	D6+	GRY 3 RED	31	D4-	GRY 3 BLUE
13	D7+	WHT 3 RED	32	D6-	WHT 3 BLUE
14	D8+	YLW 3 RED	33	D7-	YLW 3 BLUE
15	D9+	PINK 3 RED	34	D8-	PINK 3 BLUE
16	GND	YLW 1 RED	35	GND	SHIELD
17	VINIT	YLW 1 BLUE	36	N/C	
18	N/C		37	INTEG	PINK 1 BLUE
19	N/C				

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