



### General Description

The TM-6760 is a miniature, high-resolution monochrome progressive scan CCD camera. The imager resolution is 648 x 484 pixels and the frame rate is 60 and 30 frames per second. The interline transfer CCD permits full vertical and horizontal resolution of high-speed shuttered images. The electronic shutter has speeds up to 1/32,000 sec. and can be reset asynchronously by external pulse control.

The TM-6760 has a patent-pending, PULNiX exclusive, built-in look-up table (LUT). This full dynamic range control function can be set at externally selectable knee slopes to optimize the CCD's full dynamic range in the normal output signal range. It also provides fast 10-bit to 8-bit pre-processing for effective image feature enhancement. The camera has both analog and digital (RS-644) output for interfacing with frame grabbers.

All camera control functions are externally controlled via a user-friendly RS-232C graphical interface provided by PULNiX.

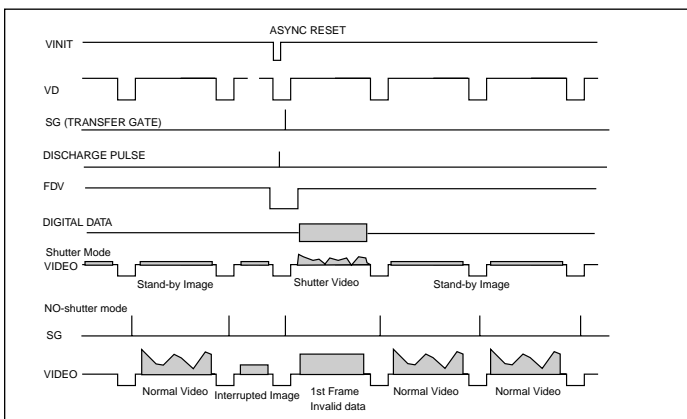
Applications for the TM-6760 include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, gauging, character recognition, documents archiving, and surveillance.

### Asynchronous Reset

The TM-6760's asynchronous reset is flexible and accepts external horizontal drive (HD) for phase locking. When the VINIT pulse is applied, it resets the camera's scanning and purging of the CCD. There are two modes to control the asynchronous reset and shutter speed:

1 External VINIT with pulse width. The duration between pulse edges controls the shutter speed externally.

2 Internal shutter speed control. The speed control varies from 1/125 to 1/32,000 sec. The video signal and FDV starts with internal V reset timing related to shutter speed.



### Product Summary

- High-speed 1/2" progressive scan 648(H) x 484(V) interline transfer CCD imager
- Miniature 44x44x64 mm housing with high-rel connector
- Digital RS-644 (LVDS) output and analog output
- 60 and 30 frames per second (80 frame models available)
- Maximum dynamic range control with PULNiX-exclusive, patent-pending built-in look-up table (Gamma, knee, user parameters)
- Full frame integration, Two-row binning (648x242 pixels) at 120 fps, Partial scan (200 lines, 120 fps).
- Full-frame shutter to 1/32,000 sec.
- Asynchronous reset, no-delay shutter and read-out-inhibit control for multiple camera applications
- RS-232 external control
- Color version (RGB Bayer CFA) is available (TMC-6760)

### Electronic Shutter

The TM-6760 has a substrate drain-type shutter mechanism which provides a superb picture at various speeds without smearing. A built-in manual shutter speed control selects the electronic shutter rate of 1/125 (non-async mode only), 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/8,000, 1/16,000 or 1/32,000 second.

The CCD discharges when discharge pulse is applied via internal shutter control. With a negative pulse to VINIT, the camera resets and purges the CCD charge momentarily. Then it starts integrating for the period of preset shutter control time by either an external pulse width or internal shutter control.

Progressive scanning permits a full 484 lines of vertical resolution, as compared to a conventional CCD camera which captures only half the vertical lines per shutter.

### Integration

The CCD imager of the TM-6760 can be exposed for longer than the normal scan timing of 1/60 sec. This integration feature provides extra sensitivity for dark-environment applications. The progressive-scan imager permits a full frame of resolution in non-interlace format. Integration is achieved by applying INTEG signal to pin #11 of the 12-pin connector or pin #6 of the 31-pin connector, or by feeding VINIT pulse width control up to 3 sec of the pulse width.

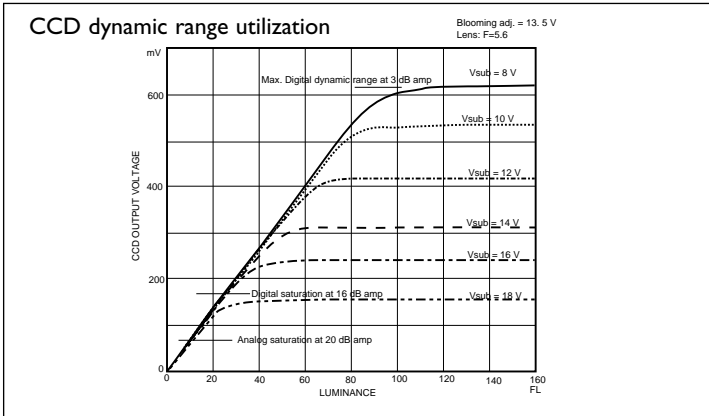
# TM-6760 Progressive Scan High-Resolution Shutter Camera

## Dynamic Range Control

Typical interline transfer CCDs have fixed noise levels based on dark current (thermal or KT noise), pattern noise, and operating clock speed. Typically for a VGA format CCD operating at 25MHz pixel clock, the noise level is around 30 electrons. The maximum capacity of the CCD charges is limited by the well capacity at saturation. The range is limited by the structure and the pixel size.

The TM-6760 uses a 1/2" CCD with 9.0 μm x 9.0 μm pixel and two-phase vertical shift register structure. The well capacity is 50,000 electrons. The theoretical dynamic range is 50,000:30 = 1667:1 (64 dB).

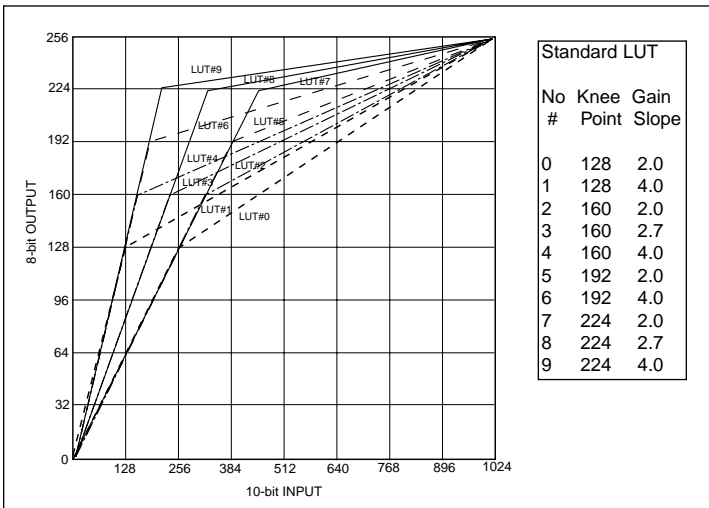
A typical CCD camera does not use the full dynamic range due to the nominal gain and the output specification such as RS-170. The typical CCD camera has its gain set at 16 to 22 dB and the RS-170 video level is 714 mV. Using 20 dB gain for the calculation, CCD output is limited to 714/10 = 71.4 mV. Since the CCD's saturation voltage is 400 mV to 500 mV, it uses less than 1/5 of the full dynamic range.



Machine vision and outdoor applications cannot afford to miss image information behind the saturation, which is why the dynamic range adaptation is critical.

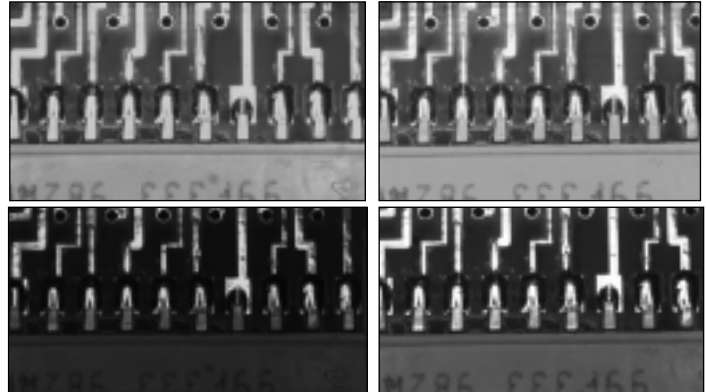
## Programmable LUT and Knee Control (patent pending)

The TM-6760 has a built-in LUT (look-up table) for dynamic range control.



At a specific gain setting, the offset (minimum level... dark point) and A/D reference top voltage (maximum level... saturation point) are set to 10-bit A/D input so that the full dynamic range of the CCD is utilized at 10-bit references as the input and the LUT output is converted into 8-bit to adjust the gamma correction.

The look-up table has two knee points (variable gamma selection) that allow the 10 bits to be segmented into three regions. The look-up table selection can be made either by variable knee curve or by direct input of the knee coordinates.



Linear image: When PCB surface is visible, metal trace is saturated. If the metal surface appears, then the plastic surface is too dark.

Knee-controlled image: The upper is LUT#6, the lower is #7. Both show the full dynamic range with different effects.

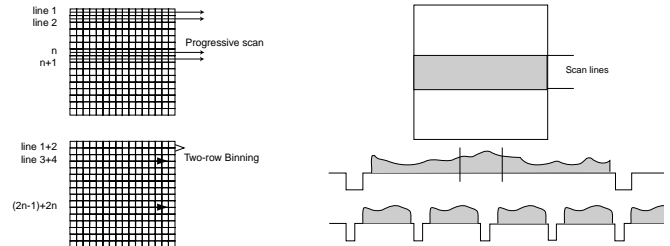
## Scan Mode

### Full Progressive Scan

Normal scanning mode for the TM-6760 is VGA (648 x 484 pixels). The standard speed with single-channel output is 60 frames/sec at the pixel clock of 25 MHz\*. Unlike an interlace scan camera, the TM-6760 reads every line from top to bottom, resulting in all lines being obtained per captured image frame with electronic shutter.

### Two-Row Binning

This is a standard feature in the TM-6760. The camera scans two rows together and outputs 648 (H) x 242 (V) pixels at 120 frames per second. Two-row binning is typically implemented to increase the frame rate.



### Partial Scan

Partial Scan is preset at 200 lines at the image center. By selecting this mode it scans every 200 lines at 120 fps frame rate. since it is at the image center, the optical axis can remain the same as full field-of-view scanning.

\* The TM-6760 also operates at 30 fps (12.5MHz pixel clock) and all clock timings are half of 60 fps.

# TM-6760 Progressive Scan High-Resolution Shutter Camera

## External Sync

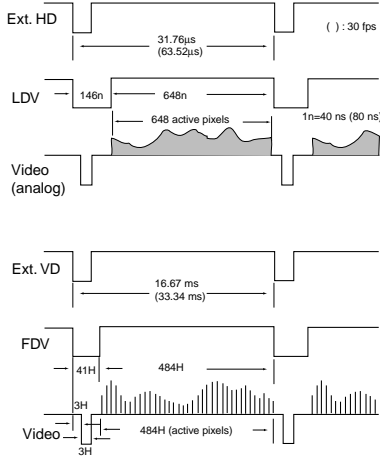
The TM-6760 accepts an external sync. of standard HD and VD at TTL level for general locking to a system sync. and clock. The external sync. is only available for 60-frame mode. The frequency requirement is as follows:

$$f_{HD} = 31.486 \text{ KHz} / 15.743 \text{ KHz} \pm 5\%$$

$$f_{VD} = 60.00 \text{ Hz} / 30.0 \text{ Hz} \pm 5\%$$

(Internal Master clock = 50.0 MHz / 25.0 MHz,  
Pixel clock = 25.0 MHz / 12.5 MHz)

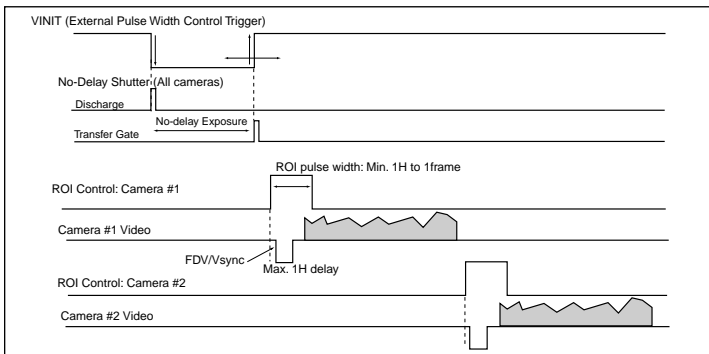
Please contact PULNiX for TM-6760 timing charts.



## No-delay Shutter and Read-out-inhibit

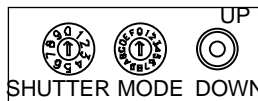
For multiple-camera applications such as 2D or 3D measurement and multi-angle inspection, simultaneous image capturing at an exact shutter timing for all cameras is a critical requirement. The TM-6760's **async pulse width control mode** provides no-delay shutter as standard. Regardless of internal pulse timing, it discharges at VINIT's leading edge and transfers charges at the trailing edge of the pulse. Even though each camera runs with slightly different H and data clock timing, image capturing is exactly simultaneous.

The TM-6760 also has read-out-inhibit control (ROI) to control the vertical clock start (**Async Shutter #9**). When ROI is low, V-clock is stopped and the transferred charges remain in the vertical shift registers, which works like CCD memory. When ROI is high, it clocks out the CCD data. This helps a single frame grabber process multiple images in pipeline processing (sequential process).



## Mode Switches

Various modes can be implemented with the rear panel-mode selection switch and Up/Down switch as well as RS-232

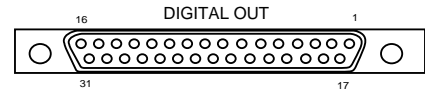


external control. When RS-232 is connected, the command overwrites the rear panel switch settings.

Mode Switch	Up/Down Switch	Functions
0 Switch Disabled	Switch Disabled	None
1 Set Gain	Up / Down	Change gain
2 Set Vtop (A/D)	Up / Down	Change A/D ref. top
3 Set Vbottom (A/D)	Up / Down	Change A/D ref bottom
4 Gain Selection #1	Up: 9dB, Down: 12dB	Lower gain selection
5 Gain Selection #2	Up: 18dB, Down: 22dB	Higher gain selection
6 Linear LUT	Up	Back to linear table
7 Knee Selection	Up / Down (Scroll)	Scroll 10 different LUTs
8 Async Reset Mode	Up: Normal, Dwn: Async	Async and normal shutter
9 Factory Default Recall	Up / Down: Recall	Factory setting
A Power up Setting	Up: Recall, Dwn: Save	Power up page setting
B User Page Storage#1	Up: Recall, Dwn: Save	User page storage setting
C User Page Storage#2	Up: Recall, Dwn: Save	User page storage setting
D Direct Shutter Control	Up / Down	Shutter speed increment by 1H
E Scan Format2	Up: Optional, Dwn: Binning	Two-row binning selection
F Scan Format1	Up: Normal, Dwn: Optional	Custom option scanning

## Connector and Pin Configurations

### Digital Output Connector



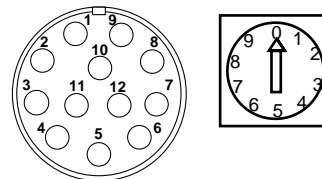
### 31-Pin Connector (MP211-031-243-2200)

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 (TTL)	In
				[INTEG (TTL)	In]
5	EXT HD (TTL)	in	21	EXT VD (TTL)	In]
	[EXT CLK+	In]		[EXT CLK-	In]
6	INTEG/ROI (TTL)	In	22	N/C	
	[HD+	In]		[HD-	In]
7	N/C		23	GND	
	[Vinit+/(VD+)	In]		[Vinit-/(VD-)	In]
8	D0+	Out	24	D0-	Out
9	D1+	Out	25	D1-	Out
10	D2+	Out	26	D2-	Out
11	D3+	Out	27	D3-	Out
12	D4+	Out	28	D4-	Out
13	D5+	Out	29	D5-	Out
14	D6+	Out	30	D6-	Out
15	D7+	Out	31	D7-	Out
16	GND				

**Note:** CLK: data clock, LDV: Line data valid, FDV: Frame data valid, INTEG: Integration control, EXT CLK: external pixel clock, [ ]: Differential input option

### 12-Pin Connector

1 GND (power)	7 VD in
2 +12V	8 GND
3 GND (analog)	9 HD in
4 Video out	10 RXD(RS232)
5 GND (digital)	11 INTEG/ROI
6 VINIT in	12 TXD(RS232)



### Shutter Control Switch

	Manual	Async
0	no shutter (1/60)	no shutter (1/60)
1	1/125	1/32,000
2	1/250	1/16,000
3	1/500	1/8,000
4	1/1,000	1/4,000
5	1/2,000	1/2,000
6	1/4,000	1/1,000
7	1/8,000	1/500
8	1/16,000	1/250
9	1/32,000	Ext. pulse width control

# TM-6760 Progressive Scan High-Resolution Shutter Camera

## SPECIFICATIONS

<b>Imager</b>	1/2" progressive scan interline transfer CCD
<b>Active Area</b>	6.16mm x 4.36mm
<b>Active Pixels</b>	648 (H) x 484 (V)
<b>Cell size</b>	9.0 $\mu\text{m}$ x 9.0 $\mu\text{m}$
<b>Display Mode (Active Pixels)</b>	648 (H) x 484 (V) @ 60 Hz (VGA output) 648 (H) x 242 (V) @ 120Hz (two-row binning)
<b>Sync</b>	Internal/external auto switch HD/VD, 4.0 Vp-p impedance 4.7K $\Omega$ VD=60 / 30 Hz $\pm$ 5%, non-interlace, HD=31.48 / 15.74 kHz $\pm$ 5%
<b>Data clock output</b>	25.00 / 12.5 MHz
<b>Resolution</b>	Digital: 648 (H) x 484 (V), Analog: over 500 TV lines (H) x 484 TV lines (V)
<b>S/N ratio</b>	50dB min. (AGC off)
<b>Min. illumination</b>	1.0 lux, f=1.4 without IR cut filter (no shutter) Sensitivity: 11.5 $\mu\text{V/e-}$
<b>Video output</b>	Analog: 714mV, 75 $\Omega$ (900 mV white clip) Digital output: 8-bit RS-644 Camera Link (See Camera Link data sheet)

<b>AGC</b>	OFF
<b>Gamma</b>	Programmable LUT(1.0 std.)
<b>Lens mount</b>	C-mount (use > 1/2" format lenses)
<b>Power req.</b>	12V DC $\pm$ 10%, 400 mA (current measured at 25 $^{\circ}$ )
<b>Operating temp.</b>	-10 $^{\circ}$ C to 45 $^{\circ}$ C*
<b>Vibration</b>	7Grms (10 Hz to 2000 Hz) Random
<b>Shock</b>	70G
<b>Size (W x H x L)</b>	44mm x 44mm x 64mm (1.73" x 1.73" x 2.51")
<b>Weight</b>	133 grams, 4.7 oz (without tripod)

MUST BE ORDERED SEPARATELY	
<b>Optional Functions</b>	Adjustable back-focus front end, 80 fps, pixel clock locking
<b>Optional accessories I/O</b>	30DG-02 digital output cable CS-232E serial communication kit
<b>Power cable</b>	12P-02S
<b>Power supply</b>	PD-12UUP series (includes power connector)

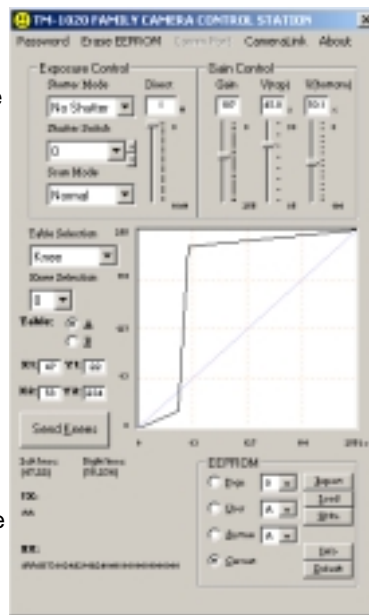
\* Image quality will degrade with increasing temperature.

## Graphical User Interface

A user-friendly graphical user interface (GUI) is provided in the CS-232E kit. This interface allows users to control the following functions of the TM-6760 camera:

- **Shutter control for manual async. and pulse width control**
- **Gain control**
- **A/D reference voltages control for Vtop and Vbottom**
- **Save settings**
- **Load settings**
- **Report settings**
- **LUT setting and graphic display**
- **Scanning mode selection and Option selections**

Camera parameters can be uploaded from the PC to the camera. Once these parameters are stored in EEPROMs, an instantaneous change from one setting to another can be done with a delay of few frames in between.

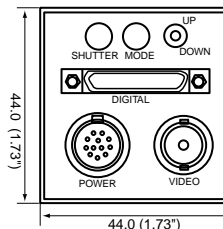
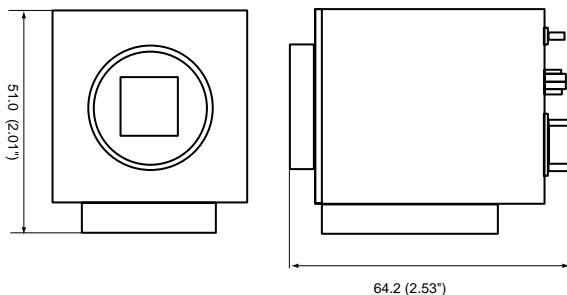


## Serial Communication Kit

The serial communication kit CS-232E consists of serial cable RS-232B-12, a software disk, and a quick-start guide. The RS-232B-12 cable has a 12-pin connector on the camera end, and a 9-pin D-sub connector (RS-232) and a 12-pin connector (power and sync signals) on the other end.

AccuPIXEL Series TM-6760

71-0079 Rev. C



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