



General Description

The TM-1020-15 is a miniature, high-resolution monochrome progressive scan CCD camera. The imager resolution is 1008 x 1018 pixels and the frame rate is 15 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 1/16,000 sec. and can be reset asynchronously by external pulse control. The square imager format with uniform square pixels provides superior image definition in any orientation.

The TM-1020-15 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-422) output for interfacing with frame grabbers.

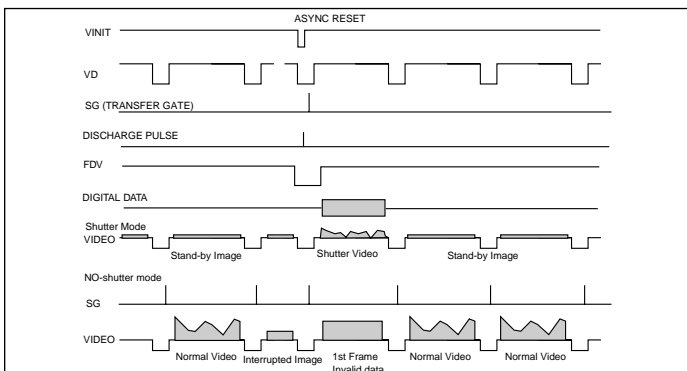
All camera control functions are externally controlled via a user-friendly RS-232C graphical interface provided by PULNiX. The TM-1020-15 has a pixel clock locking phase lock loop (PLL) for multi-camera operation which requires exact data and clock phases from each camera (optional).*

Applications for the TM-1020-15 include machine vision, medical imaging, intelligent transportation systems, high-definition graphics, gauging, character recognition, document archiving, and surveillance.

Asynchronous Reset

The TM-1020-15'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 three 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 with Fast mode. The video has no delay from the reset timing (shutter speed range is 1/2,000 to 1/16,000 sec.)
- 3 Internal shutter speed with Slow mode. The speed control varies from 1/125 to 1/1,000 sec. The video signal starts with internal V reset timing related to shutter speed.



Product Summary

- High-resolution 1" progressive scan 1008(H) x 1018(V) interline transfer CCD imager
- Miniature 44x44x64 mm housing with high-rel connector
- Digital RS-422 (LVDS) output or analog output (RS-644 optional)
- 15 frames per second
- Maximum dynamic range control with PULNiX-exclusive, patent-pending built-in look-up table (Gamma, knee, user parameters)
- Full frame integration, two-row binning (1008 x 508 pixels) at 30 fps.
- Full-frame shutter to 1/16,000 sec.
- Asynchronous reset with external shutter control
- RS-232 external control

Electronic Shutter

The TM-1020-15 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 1/60 (non-async mode only), 1/125, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/8,000, or 1/16,000 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 1018 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-1020-15 can be exposed for longer than the normal scan timing of 1/15 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 1 sec at the pulse width.

* Contact factory for availability

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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 1k x 1k CCD operating at 20MHz 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.

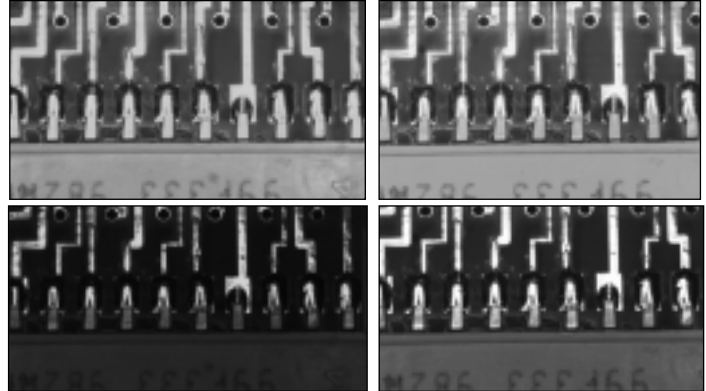
The TM-1020-15 uses a 1" CCD with 9.0 μm x 9.0 μm pixel and two-phase vertical shift register structure. The well capacity is 50,000 electrons. The theoretical dynamic range is 50,000:30 = 1667:1 (64 dB).

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.

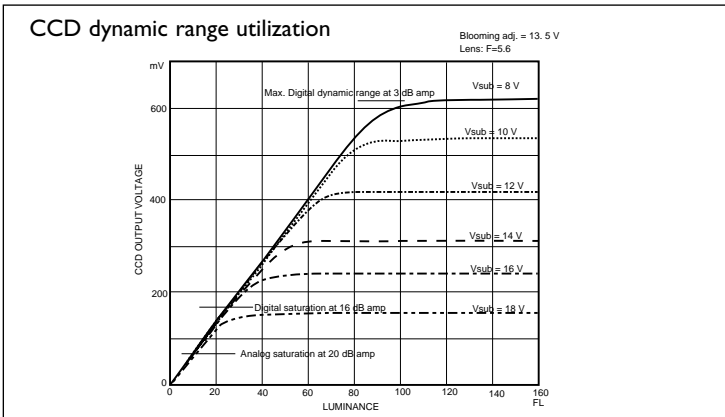
(maximum level... saturation point) are set to 10-bit A/D input so that the full dynamic range of the CCD is utilized at 10-bit references as the input and the LUT output is converted into 8-bit to adjust the gamma correction.

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.



Programmable LUT and Knee Control (patent pending)

The TM-1020-15 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

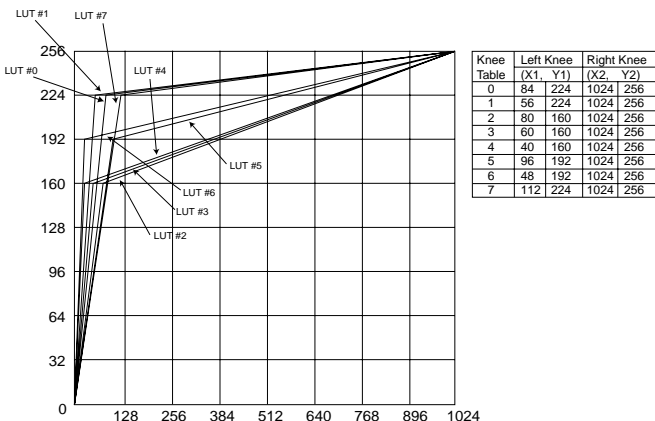
Scan Mode

Full Progressive Scan

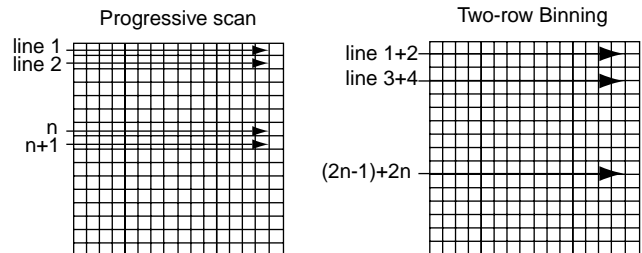
Normal scanning mode for the TM-1020-15 is 1008 x 1018 pixels. The standard speed with single-channel output is 15 frames/sec at the pixel clock of 20 MHz. Unlike an interlace scan camera, the TM-1020-15 reads every line from top to bottom, resulting in all lines being obtained per captured image frame with electronic shutter.

Two-Row Binning

This is a standard feature in the TM-1020-15. The camera scans two rows together and outputs 1008 (H) x 508 (V) pixels at 30 frames per second. Two-row binning is typically implemented to increase the frame rate.



Note: The second knee point on the built-in LUT defaults to position (1024, 256). To reposition this point, click on it and drag it to a new location.



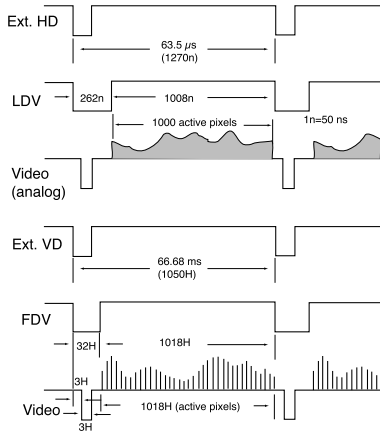
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External Sync

The TM-1020-15 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 15-frame mode. The frequency requirement is as follows:

$f_{HD} = 15.75 \text{ KHz} \pm 5\%$
 $f_{VD} = 15.00 \text{ Hz} \pm 5\%$
 (Internal Master clock = 40.0 MHz,
 Pixel clock = 20.0 MHz)

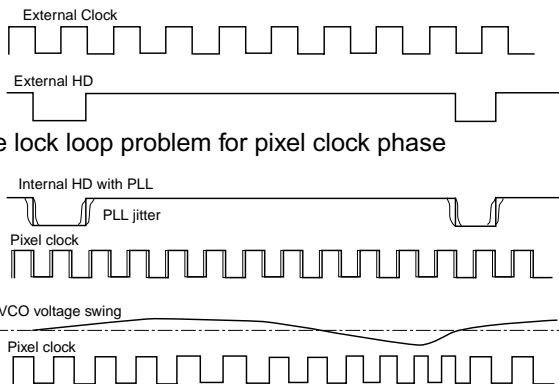
Please contact PULNiX for TM-1020-15 timing charts.



Pixel Clock Locking(optional)*

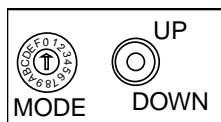
For multiple-camera applications such as 2D or 3D measurement, a parallel digital data input capability is important. The high resolution and precision measurement require that camera data be consistent and free from phase lock loop (PLL) jitter. This is especially important for digital output multiplexing.

The TM-1020-15 has an optional capability for pixel clock locking. It takes RS-422 (differential) external clock and H and V reset sync (TTL or RS-422). By doing this, each camera's digital data is in-phase with the pixel clock (data clock) for multiplexing or parallel input to a frame grabber.



Mode Switches

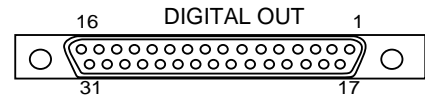
Various modes can be implemented with the rear panel-mode selection switch and Up/Down switch as well as RS-232 external control. When RS-232 is connected, the command over-rites the rear panel switch settings.



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

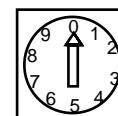
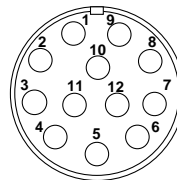
Digital Output Connector



31-Pin Connector (MP211-031-113-4300)					
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
5	EXT HD (TTL)	in	21	[INTEG (TTL)	In]
6	[EXT CLK+	In]	22	EXT VD (TTL)	In]
7	INTEG/ROI (TTL)	In	23	[EXT CLK-	In]
8	[HD+	In]	24	N/C	
9	N/C		25	[HD-	In]
10	[Vinit+/(VD+)	In]	26	GND	
11	D0+	Out	27	[Vinit-/(VD-)	In]
12	D1+	Out	28	D0-	Out
13	D2+	Out	29	D1-	Out
14	D3+	Out	30	D2-	Out
15	D4+	Out	31	D3-	Out
16	D5+	Out		D4-	Out
	D6+	Out		D5-	Out
	D7+	Out		D6-	Out
	GND			D7-	Out

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 (1/15)	no shutter (1/15)
1	1/60	1/16,000
2	1/125	1/8,000
3	1/250	1/4,000
4	1/500	1/2,000
5	1/1,000	1/1,000
6	1/2,000	1/500
7	1/4,000	1/250
8	1/8,000	1/125
9	1/16,000	Ext. pulse width control

* Contact factory for availability

TM-1020-15 Progressive Scan High-Resolution Shutter Camera

SPECIFICATIONS

Imager	1" progressive scan interline transfer CCD
Active Area	9.1 mm x 9.2 mm
Active Pixel	1008 (H) x 1018 (V)
Cell size	9.0 μ m x 9.0 μ m
Display Modes (Active Pixels)	1008 (H) x 1018 (V) @ 15 Hz; 1008 x 508 @ 30Hz (two-row binning)
Sync	Internal/external auto switch HD/VD, 4.0 Vp-p impedance 4.7K Ω VD=15 Hz \pm 5%, non-interlace, HD=15.75kHz \pm 5%
Data clock output	20.000 MHz
Resolution	Digital: 1008 (H) x 1018 (V), Analog: over 700 TV lines (H) x 800 TV lines (V)
S/N ratio	50dB min.
Min. illumination	1.0 lux, f=1.4 without IR cut filter (no shutter) Sensitivity: 10 μ V/e-
Video output	Analog: 1.0 Vp-p composite video, 75 Ω Digital output: 8-bit Digital Camera Link
AGC	OFF

Gamma	Programmable LUT(1.0 std.)
Lens mount	C-mount (use 1" format lenses)
Power req.	12V DC, 400-500 mA (current measured at 25°)
Operating temp	-10°C to 45°C*
Vibration	7Grms (10 Hz to 2000 Hz) Random
Shock	70G
Size (W x H x L)	44mm x 44mm x 64mm (1.73" x 1.73" x 2.51")
Weight	149 grams, 4.7 oz without tripod

MUST BE ORDERED SEPARATELY

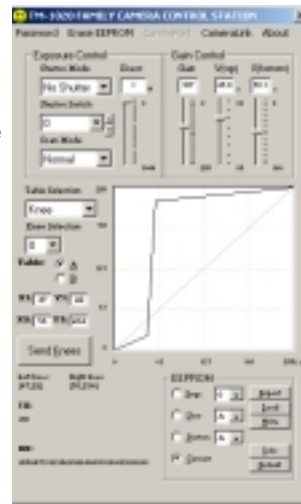
Optional Functions	RS-644 output, adjustable back-focus front end, pixel clock locking
Optional accessories I/O	30DG-02 digital output cable CS-232E serial communications kit 12P-02S
Power cable	PD-12UUP series (includes power connector)
Power supply	

* 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-1020-15 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.

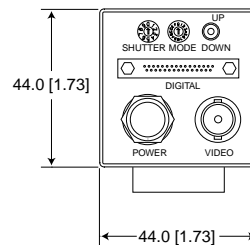
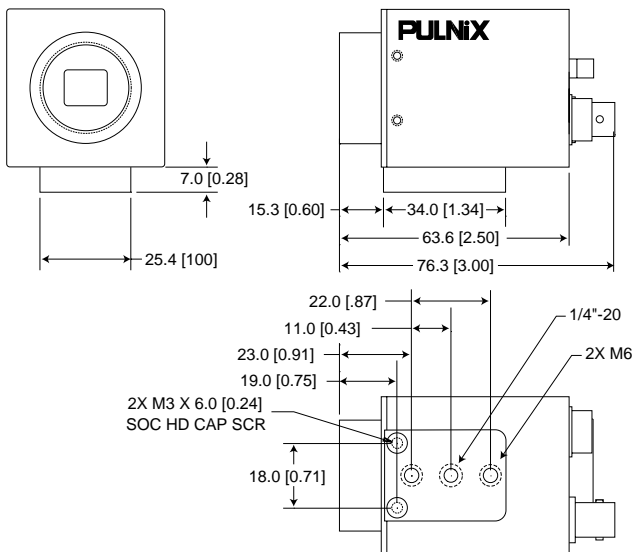
Serial Communication Kit

The serial communication kit CS-232E consists of a serial cable (RS-232B-12), a software disk, and a quick-start guide. The RS-232B-12 cable has three connectors. 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.

TM-1020-15

AccuPiXEL Series

71-0042 Rev. C 10/25/2002



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