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SU320-1.7RT Indium Gallium Arsenide Area Cameras Operation Manual



1.0 General Information

The SU320-1.7RT Indium Gallium Arsenide Near Infrared Camera is a compact and versatile imaging tool. Designed for laboratory or field use, the SU320-1.7RT is temperature stabilized at 18°C and requires no external utilities besides electricity. It's optical sensitivity ranges from 0.9 µm to 1.7 µm, with a quantum efficiency greater than 75% from 1.0 µm to 1.6 µm. The lack of cryogenic liquids or moving parts makes the SU320-1.7RT equally at home in industrial settings as well as in the laboratory.

The SU320-1.7RT is available in two versions: "video" (SU320-1.7RT-V) and "digital" (SU320-1.7RT-D). In the video version, the analog output of the focal plane array (FPA) is digitized using a 12-bit analog-to-digital converter. The digitized image undergoes a pixel-by-pixel 2-point correction (offset and response gain) and bad pixel substitution. The offset is the dark current signal and the response gain is the photoresponse non-uniformity. The digital image is then converted into an analog video stream using a 12-bit digital-to-analog converter with superimposed synchronization signals. The digitized and corrected video signal is simultaneously available in RS422 format.

In the digital version, the user has control over both the exposure time and the scan mode (free-running or triggered) but no image corrections or pixel substitutions are performed. This camera is intended for use in conjunction with a frame grabber board to capture the uncorrected 12-bit digitized image. In addition, the uncorrected digitized signal from the FPA is converted to composite video for direct display on a monitor.

In both versions of the camera, video and digital, the output of the camera is a non-interlaced progressive scan version of the RS-170 (or CCIR) standards. The composite video can be displayed on an RS170 (or CCIR) monitor or recorded with NTSC (or PAL/SECAM) equipment but, strictly speaking, does not adhere to these standards since it is non-interlaced.

A complete order for a SU320-1.7RT includes the following:

1. This manual
2. A SU320-1.7RT camera
3. Universal power supply with cable
4. A 25 mm, f/1.4 C-mount lens
5. A U-mount to C-mount adapter
6. A hard carrying case

2.0 Safety Considerations

- WARNING! For personal safety, the camera power supply must be properly grounded. The power cord provided is equipped with a three-prong plug which mates with a standard three-prong wall receptacle. It is the responsibility and obligation of the user to have the outlet and circuit checked by a qualified electrician to make sure that it is properly grounded. DO NOT CUT OR REMOVE THE THIRD (GROUND) PRONG FROM THE POWER CORD.

- THE USER SHOULD ALSO HAVE THE POLARITY OF THE RECEPTACLE THE CAMERA IS BEING PLUGGED INTO CHECKED FOR THE PROPER POLARITY. IF THE POLARITY IS REVERSED THE SUPPLY WILL POWER UP BUT THE POWER SWITCH LIGHT WILL NOT ILLUMINATE. IF THIS IS THE CASE TURN THE CAMERA'S POWER OFF, REMOVE IT

FROM THE WALL RECEPTACLE AND HAVE THE WIRING CORRECTED.

- The Focal Plane Array is mounted behind a protective BK7 window. When changing lenses or mounting the camera in any optical arrangement, **take care not to scratch this window**

- This device complies with part 15 of the FCC rules. Operation of this device in a residential area may cause unacceptable interference to radio and TV reception requiring the operator to take whatever steps are necessary to correct the interference.

- To minimize the effects of static discharge, digital ground is connected to earth ground through a 1 KΩ resistor.

- The dust cover should remain on the back panel digital interface connector when this port is not in use.

- To prevent fire, shock hazard or damage to the camera, do not expose to rain or excessive moisture. Do not disassemble camera. Do not remove screws or covers. There are no user serviceable parts inside. Removal of any panel will void the warranty.

3.0 Optical Considerations

- The front panel of the camera is threaded for U-mount lenses. This was chosen because of its large diameter (42 mm) and its closeness to the focal plane (6 mm). These features make adaptation to other formats convenient.

- A wide variety of lenses and lens adapters are available from Sensors Unlimited. In general, indium gallium arsenide focal plane arrays are compatible with conventional glass optics. For limitations and recommendations, please contact your sales representative.

- Adapters to a number of flat-field spectrographs are available from Sensors Unlimited or the spectrograph manufacturer. Contact your sales representative for more information.

4. EMI Warning

Exposures to high levels of electromagnetic interference or static discharge may distort the image or cause the camera to lock up in which case no image will be produced. Simply turn off the camera at the power supply, wait 10 seconds, and then restore power

5. Cleaning

Turn the camera power supply off and disconnect the power cord. The camera and power supply housing may be wiped clean with a small amount of water or alcohol on a soft cloth.

6. Principles of Operation

The SU320-1.7RT cameras incorporate Sensors Unlimited's SU320-1.7T1 indium gallium arsenide (InGaAs) focal plane arrays (FPAs). This FPA has 320x240, 40 µm pixels and a single, progressive scan readout. The camera frame sequence consists of an exposure followed by digitization.

The exposure "rolls" through the camera. At the start of the integration, the first row (top of the monitor, bottom of the FPA) becomes active. After one line time, the second line becomes active. Each subsequent line becomes active after a delay of an additional line time. After the integration time, the first line goes inactive. After a line time, the second line goes inactive, and so forth.

In the SU320-1.7RT, the frame rate is 60 Hz (50 Hz for "CCIRni"). Strictly speaking, the SU320-1.7RT is not RS170-compatible (or CCIR). However, as discussed below, the line timing is the same as that used for "television" so the video output can be displayed or recorded with conventional NTSC (or PAL/SECAM) equipment.

The SU320-1.7RT-D features 8 user-selectable exposure times ranging from 2 line times through 256 line times (see Section 6.0). In addition, the camera may be operated in either continuous or triggered scan mode. The output image (both analog and digital) is the uncorrected image from the FPA.

In the SU320-1.7RT-V, the 2-point correction depends on exposure time. In this version, only a single exposure time is available (16.27 msec for RS170 and 16.38 msec for CCIRni). Since video

monitors can display only 8-bits of information, the FPA image is both corrected and amplified 4x so that the most sensitive portion of the image is displayed on the screen. The SU320-1.7RT-V operates only in free-running, continuous scan mode.

Camera Operation

SU320-1.7RT Back Panel Connections

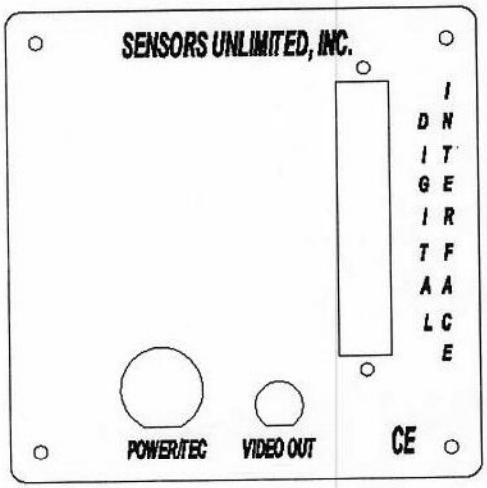


Figure 1: SU320-1.7RT-V back panel

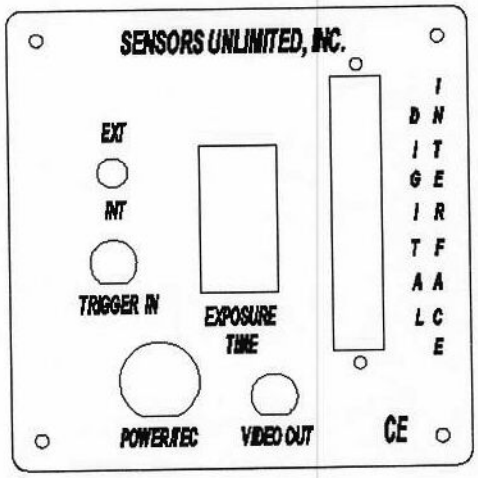


Figure 2: SU320-1.7RT-D back panel

POWER/TEC Connection to universal power supply.

VIDEO OUT BNC connector for supplying composite video to monitor or video recorder. Use of a 75Ω cable is recommended.

DIGITAL INTERFACE DB37-S connector for transmitting the 12-bit RS422 digital image to a frame grabber board.

(SU320-1.7RT-D only)

EXPOSURE TIME 16-position thumb-wheel switch for selecting the exposure time. The upper 8 positions (8-to-F) repeat the lower 8 positions (0-to-7). This switch must be set to 0 for exposure time control through digital interface.

INT/EXT Trigger mode selection switch. INT corresponds to free-running video. In the EXT position, the camera waits for a trigger before capturing a single frame.

TRIGGER IN BNC connector for applying the external trigger. Use of a 50Ω cable is recommended.

Connecting the Components

The SU320-1.7RT camera is shipped as two major units; a camera body and a power supply together with a power cable. Power is provided from the universal power supply via the 12-pin Hirose connector on the back panel. This supplies power both for the camera functions and for the thermoelectric cooler in the focal plane array. The power supply can accept 95-240 VAC, 47-63 Hz. The camera must be plugged into a properly wired three-prong wall receptacle. See Section 2.0 Safety Considerations on page 1 of this manual for more information.

When first applying power to the camera, the red "TEC UNLOCK" indicator will light for several seconds. The temperature control circuitry is set to hold the focal plane array at 18°C. Should, for any reason, this is not possible, the "TEC UNLOCK" indicator on the power supply will not extinguish. There are a number of reasons that this might occur. The most likely is that the camera is being operated at an ambient temperature greater than that rated (40°). Another possibility is that the camera is operated in an enclosed environment that limits the ability of the case to radiate heat. ***If the cooler unlocked indicator remains lit after these conditions have been remedied, disconnect power and contact the factory.***

If the ***DIGITAL INTERFACE*** port is not used, the dust cover should be kept in place. If the ***VIDEO***

OUT connection is not used, it should be terminated into 75Ω.

Setting the Exposure Time (SU320-1.7RT-D only)

The back panel thumb-wheel switch is used to select the exposure time as listed in Table 1. The exposure time can also be changed by setting a binary number (0-7) on the Digital Interface using TTL level signals. **In order to control the exposure time using the digital interface, the thumb-wheel switch must be set to position 0**. The Exposure time can be changed at any time.

Switch Position	Line Times	Exposure Time (msec) (RS170)	Exposure Time (msec) (CCIR)
0 , 8	2	0.127	0.128
1 , 9	4	0.254	0.256
2 , A	8	0.508	0.512
3 , B	16	1.107	1.024
4 , C	32	2.034	2.048
5 , D	64	4.068	4.096
6 , E	128	8.135	8.230
7 , F	256	16.27	16.38

Table 1: Exposure time settings

Video Display

The video output format of the SU320-1.7RT is non-interlaced progressive scan. The timing is such that the image can be directly displayed on a standard video monitor, captured with a video-input frame grabber board, or recorded with a VCR. The video output is nominally 1 V peak to peak with 714mV of video and 286 mV of sync. Use of a 75Ω coaxial cable with a 75Ω termination is recommended for connection between ***VIDEO OUT*** on the camera back panel to the display device.

Digital Interface

The SU320-1.7RT is fundamentally a digital camera. The analog output of the focal plane array is digitized using a 12 bit analog-to-digital converter. The digitized image is passed through a digital-to-analog converter and converted into composite video. At the same time, the digitized image is available at the ***DIGITAL INTERFACE*** port in RS422 format.

The ***DIGITAL INTERFACE*** is intended to allow connection of the SU320-1.7RT to a digital input frame grabber board. The RS422 digital video signal, together with a pixel clock (A2DCLK), horizontal synchronization signal (HSYNC), and vertical synchronization signal (FLDINDEX) are available at the DB37-S connector. Figure 3 indicates the pin assignments on the DB37-S.

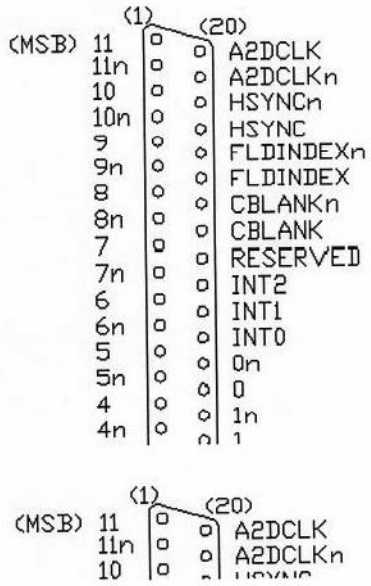


Figure 3: DIGITAL INTERFACE pin assignment

The key timing considerations for interfacing the SU320-1.7RT to a frame grabber board are shown in Figure 4. The roles of the various synchronization signals are summarized below:

A2DCLK

A2DCLK is the pixel clock. The A2DCLK frequency is approximately 6.01 MHz with one clock cycle per pixel. A2DCLK is HIGH for 30% of the clock period. This allows the video signal to settle to 12-bit precision before digitization. A2DCLK is continuous and does not stop during the blanking times.

FLDINDEX

FLDINDEX indicates the start of a frame. For interfacing to a frame grabber board, it serves as the vertical synchronization signal.

The SU320-1.7RT has a progressive scan video output. In progressive scan, there is one field per frame. FLDINDEX occurs at the start of the frame (Figure 5).

The FLDINDEX pulse is 10.5 µsec wide and is coincident with the beginning of the vertical synchronization interval of the composite synchronization signal. The first line of video starts 17 television lines after the FLDINDEX pulse has occurred (47 lines for CCIRni). Active video is read out for 240 lines and there are 320 valid pixels during the time that CBLANK is HIGH.

HSYNC

HSYNC is available to provide the continuous horizontal synchronization signal required by many frame grabber boards. The first pixel of valid video occurs on the 31st A2DCLK pulse following HSYNC. There are 240 pixels of valid video per line.

CSYNC

CSYNC is composite television synchronization. The CSYNC interval is made up of four distinct sections. The first three lines of the field one sync interval are vertical equalization pulses. The next three lines form the vertical synchronization interval followed by another three lines of equalization pulses. The remaining 11 lines are standard horizontal synchronization and there is no video information during this time

CBLANK

CBLANK is the composite of horizontal blanking and vertical blanking in the television timing system. In Field 1, CBLANK is held low for the first 20 line television-blanking interval. It is also held low during the 10.5-to-11.2 µsec horizontal blanking interval. This signal is used as the valid data interval. There are 320 valid pixels while CBLANK is high. The SU320-1.7RT horizontal blanking interval is 10.8 µsec.

Figure 4: Timing of SU320-1.7RT-RS170ni

Triggered Operation (SU320-1.7RT-D only)

When the ***INT/EXT*** switch is in the EXT position, the camera waits for a trigger pulse before initiating a single scan of the FPA. The ***TRIGGER*** input requires TTL-level signals with the normal state a TTL low (< 0.8V). The trigger pulse must remain in the TTL high state (>2.4V) for a minimum of 200 µsec but no longer than 10 msec. Use of a 50Ω coaxial cable is recommended.

The camera detects a low-to-high transition. The delay between detecting a trigger and initiating a scan is 1 line time (63.6 µsec for RS170ni, 64 µsec for CCIRni). The exposure time is set by the position of the thumb wheel switch.

In the trigger mode, valid readouts occur immediately after the first FLDINDEX after the rising edge of the trigger pulse. There are no back-porch lines.

The camera readout following the first trigger pulse after powering up the camera, changing from internal to external mode or changing integration time does not contain valid data. Also, in order to receive valid data the time between triggers must be a minimum of 2/60 sec for RS170ni or 2/50 sec for CCIRni.

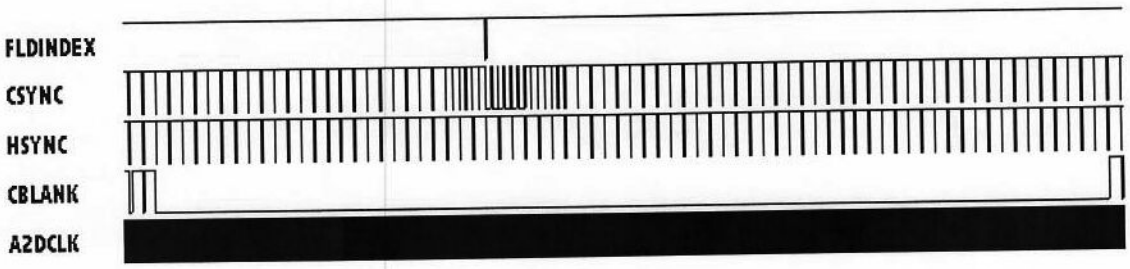
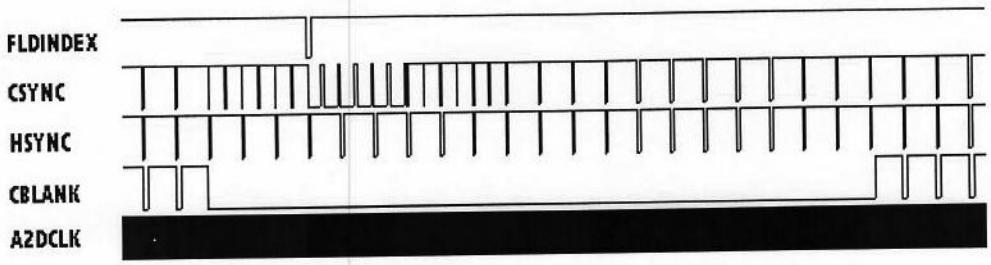


Figure 5: Timing of SU320-1.7RT-CCIRni



Appendix A: Specifications

SU320-1.7RT-V and SU320-1.7RT-D

Focal Plane Array Format	320 x 240 Pixels
Pixel Pitch	40 µm
Optical Fill Factor	100%
Exposure Mode	Ripple
Spectral Response	0.9 µm to 1.7 µm
Quantum Efficiency	> 75% from 1.0 µm to 1.6 µm
Mean Detectivity, $D^*(\lambda_{pk})$[1]	> 10^{12} cm–√Hz/W
Uniformity[2]	> 98%
Full Well Capacity	> 10 million electrons
Digitization	12 bit
Electronic Readout Noise	2,000 equivalent photoelectrons
Pixel Rate	6.1 MHz
FPA Temperature	18°C
Lens Mount	U- and C-mount
LxWxH (cm), Weight (kg)	15.85 x 10.32 x 10.32, 1.1
Power Requirements	95-240VAC, 47-63 Hz
Current Rating	1.2A
Temperature: Operating	0°C to 40°C
Storage	-10°C to 60°C
Humidity: Operating	Less than 95%
1. Storage	Non-condensing

2. λ_{pk} = 1.55 µm, exposure time = 16.3 msec, no lens

The percentage of pixels with D*>50% of the mean value

SU320-1.7RT-V only

Scan Mode	Continuous
Exposure Time	16.27 msec (RS170ni), 16.38 msec (CCIRni)
Image Correction	pixel-by-pixel offset and gain
Digital Output Format	12 bit corrected
Video Output Format	Progressive Scan
Frame Rate	30 Hz (RS170ni) 25 Hz (CCIRni)
Image Display	Frame Grabber Board and/or Video Monitor

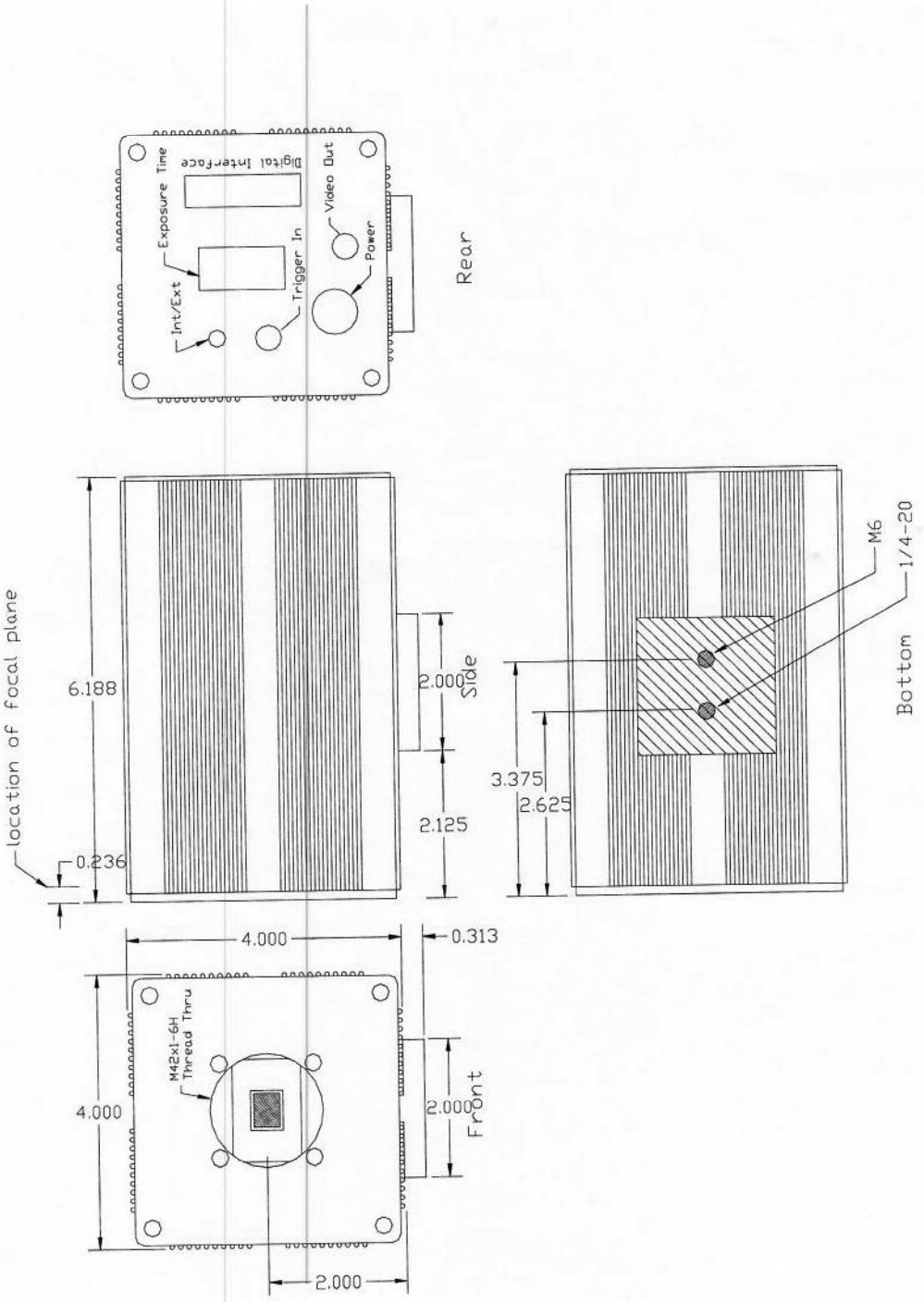
SU320-1.7RT-D only

Scan Mode	Continuous or Triggered

Exposure Times	127 µsec to 16.3 msec in 8 steps (RS170ni) 128 µsec to 16.4 msec in 8 steps (CCIRni)
Trigger Jitter	< 64 µsec
Digital Output Format	12 bit uncorrected
Video Output Format	Progressive Scan
Frame Rate	60 Hz (RS170ni) 50 Hz (CCIRni)
Image Display	Frame Grabber Board and/or Video Monitor

Appendix B: Mechanical Drawings

(all dimensions in inches)



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