

SI-3300RGB MegaCamera™
 3.2 Megapixel, 10-Bit, 40/80MHz
 Progressive Scan Digital Camera



Silicon Imaging is proud to continue its innovation in high-resolution color vision camera. Driven by the growing demand for consumer Digital Still Cameras, CMOS sensors are continuing to break technical barriers and surpass the performance characteristics of CCD's in many photonic, imaging and consumer applications. By utilizing a single highly integrated CMOS device, which incorporates Megapixel sensing areas, timing generation, signal processing and high bandwidth outputs, Silicon Imaging has developed a very compact, low-power, ultra high speed Megapixel digital camera system.

2048 x 1536 Megapixel (3.2MP) - Ultra Resolution

The SI-3300 is an all-digital 1/2" format CMOS camera that delivers 3.2 Million pixels of resolution and is capable of running at over 12 frames/second at its full 2048 x 1536 resolution. The entire package is only 45 x 52 x 50mm (33 x 40mm x 22mm in PCB) and is small enough to be placed on a robot for semiconductor machine vision inspection or placed in an outdoor housing for remote surveillance. It is ideal for live visualization and handheld instrumentation.

10-Bits Sampling – Sub-Pixel Accuracy

The SI-3300 MegaCamera uses 10-Bit digitizers to sample the pixel data. Converting the pixel data directly to digital at the sensor head eliminates pixel-sampling jitter and enables accurate sub-pixel metrology, image analysis and improved live video reconstruction. A programmable clock which ranges from 20–40MHz or up to 80MHz with -H version, allows for trade-offs in speed versus exposure time and lower noise.

Subsampling with Binning – Video Preview

Ideal for high speed preview and focusing, the SI-3300 is capable of generating imagery at over 30 frames per second by reducing the size of the readout image in color subsampling mode. This entire imager is readout by binning 4x4 groups of pixels into 2x2 bayer super pixels with increased sensitivity, less aliasing and faster readout rates. The camera also supports up to 3x binning and 8x subsampling.

1000FPS Windowing and 720/1080P HD Modes

A small region of the imager can be readout at frame rates in excess of 1000fps, with speed increasing with reduced vertical and horizontal settings. At 1920 x 1080 and a 75MHz clock the output rate would be 30fps or 1280x720 at 73MHz will be 60fps. The window size and position can be adaptively changed on frame-by-frame basis.

Automatic Black Level Correction

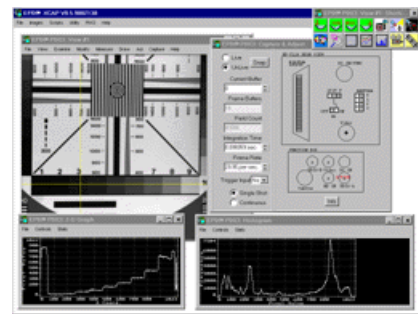
The SI-3300 has automatic black level calibration, which measures the average value pixels from two dark rows of the imager for each of the four colors. The pixels are averaged as if they were light sensitive and passed through the appropriate color gain. This average is then digitally filtered over many frames and compared to minimum and maximum acceptable thresholds for automatic correction.

CameraLink Digital Interface - 57.6K Serial Mode

An industry standard forum has adopted Camera Link, for low cost connectivity and cabling of cameras and frame grabbers at very high speeds. The SI-3300-CL utilizes the high speed CameraLink interface to output 2048 x 1536 10 bit data at 60MHz continuously to a frame grabber and directly into PC memory for further processing. The single cable includes image data, vertical and horizontal synch, LVDS Triggering and 9600 baud Serial communication. For High-Speed communication, the SI-3300 also has a 57.6kb mode for faster register updates. This camera complies with the standard, it is compatible with many popular frame grabber and image processing hardware devices and fiber-optic extender for extended distance transmission.

GigE-Cameralink – Gigabit Ethernet Connectivity

Now you can capture high-speed MegaCamera images to your PC from distance of a 100-meters using CAT-5 wire using the Silicon Imaging [GigE-Cameralink](#) Interface. The GigE-Cameralink captures MegaCamera digital images and transmits them via 10/100/1000 Gigabit Ethernet directly to your PC at speeds over 100MB/sec.



FEATURES

- 2048 x 1536 Resolution (3.2 Million Pixels)
- 1/2" Imaging Format , 5.2um Square Pixel
- Rolling Shutter, Progressive scan
- 640 x 480 VGA Windowing and Binning at 120fps
- 1280/30P Video Capture (1280x720 @ 30FPS)
- 10 Bits per Pixel, 48MHz Sampling (Nominal)
- 20 ~ 80MHz Programmable Clock (– H Version)
- Programmable Gain, Exposure & Clocks
- Global Reset, External Triggering Option (-T)
- Auto Black Level Calibration
- Color Bayer (RGB) Model
- Custom PCB Version
- C-Mount Precision Mached Housing
- Cameralink (CL) & GigE Remote (GR) Interface

SI-3300 MegaCamera CameraLink Specifications

SI-3300 Sensor:

Active Pixels	2,048H x 1,536V
Optical Format	1/2" (6.83mm x 5.45mm)
Pixel Size (pitch)	3.2 µm x 3.2 µm
Pixel Type	CMOS
Aspect Ratio	1 : 1
Spectral Response	350 ~ 1000 nm
Peak QE	56% Monochrome @ 570nm
Minimum Illumination:	0.3 lux nominal (SNR =1, f# = 2.8, exposure = 100ms, daylight)

CameraLink Frame Grabber Control:

Serial Communication	RS-232 Protocol 9600bps (57.6k)
Signaling	TX & RX (LVDS)
Asynchronous Triggers	LVDS – CC1 (-CL) TTL Trigger-In / Strobe-Out (option)
Region-of-Interest	Programmable Horiz & Vertical
Programmable Modes	Exposure, Gain, Windowing, Clock rates, Auto black, image mirroring.
Gains	Individual RGB Gains

Responsivity	2.1 V/lux-sec
Dark Current @ 25° C	20 e-/sec
Temporal Noise	10 e-
Saturation Charge	40,000 e ⁻
SNR	>43dB (MAX)
Dynamic range	61 dB
Windowing (ROI)	Horizontal & Vertical speed crease
Sub-sampling	Full, 1/2, 1/4, 1/8
Gain MAX	15X, min step size 0.125
Readout Method	Progressive Scan
Black Level	Auto Black Level Calibration
Shutter	Rolling Shutter and Single Frame
Shutter Speed	Variable, 1 to 16383 row times
Horizontal Blanking	244 Clocks/line
Minimum Row Time	548 Clocks (304+ 244 Blanking)
Vertical Blanking	25 Rows (16 min)

A/D Conversion & Sampling Clock Synthesizer

A/D Conversion	Nominal 48Mhz (12fps @ 3.1MP)
Vertical Resolution	10 Bit (Format = 12bit-CL 1-Tap)
Pixel Clock Frequency	20 ~ 60 Mhz Programmable 20 ~ 80 Mhz (-H High-Speed)
Adjustment Method	Serial command Protocol
Mean Black Level	32 Counts

Digital Video Output

Readout Rate	20 ~ 85Mhz x 12bit format	
Readout Format	CL-12 (Duplicated on Ports A, B)	
Frame Rate	48MHz	60MHz
1280 x 1024	30	38
1280 x 720	43	54
640 x 480	110	137
320 x 240	334	417
200 x 200	407	509
160 x 120	654	817
Frame Time (default)	1524 x 1050 rows @48MHz = 30fps	

(R,G,B,G & Global)	Range: 15X, MIN step size 0.125
Setting Timing	Next top of Frame
Ext Clock Sync	Clock in or Clock Out (-X Option)

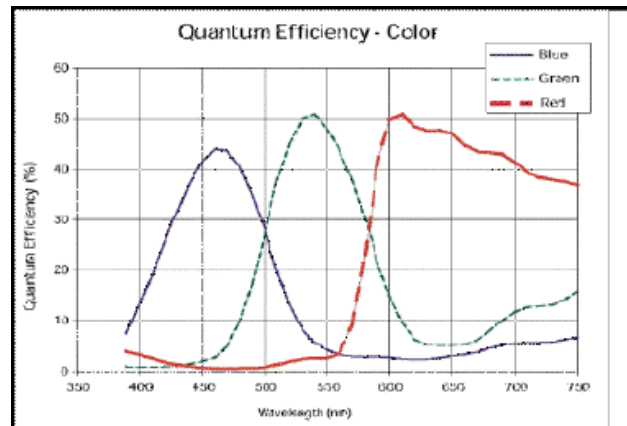
Power

Input Voltage	+5 VDC +/- 10%
Power	2.5 Watts
Power/Trigger Connection	Tajimi RO3-PB3M 3Pin (-CL) Tajimi RO3-PB5M 5Pin (-X)

Mechanical

Lens Mount	C-Mount, 7mm Back focus Adj.
Enclosure Size	45mm W x 52mm H x 50mm L
Weight	12 oz.
Camera Mount	¼" x 20 standard tripod mount
Cable Connector	Cameralink MDR-26

Spectral Response Curve (RGB Model Only)



Command	Clock Rate MHz	SI-3300 Frame Rate						
		2048 x 1536	1600 x 1200	1920x1080	1280x720	640 x 480	320 x 240	128 x 128
lc306886	20	5	8	8	17	40	122	148
lc30b689	25	7	10	10	21	50	152	185
lc37cb8f	30	8	13	12	25	60	182	222
lc35d40b	35	9	15	14	29	70	213	259
lc306882	40	11	17	16	33	80	243	296
lc35e709	45	12	19	18	37	90	274	333
lc36a20f	48	13	20	19	40	96	292	355
lc34b689	50	13	21	20	41	100	304	370
lc34b688	55	15	23	22	45	110	334	407
lc36cb8f	60	16	25	24	50	120	365	444
lc367307	65	17	27	26	54	130	395	481
lc36ee0f	70	19	29	28	58	140	426	518
lc36f88f	73	19	30	29	60	147	446	542
lc34ae05	75	20	31	30	62	150	456	555

SI-3300 Register Programming

0x00	Chip Version	0x8421 0x8431	
0x01	Row Start	0x000C (12)	(First row to be read out + 12)
		0x0014	(First column to be read out + 14)

0x02	Column Start	(20)	Register value must be an even number.												
0x03	Window Height	0x03FF (1023)	Window height (number of rows - 1) Min = 0x0002.												
0x04	Window Width	0x04FF (1279)	Window width (number of columns - 1) Register value must be an odd number. Min = 0x0003												
0x05	Horizontal Blanking	0x0013 (19)	Number of extra row blanking clocks + 19 Row Blanking = 244 clocks + (Regx05 -19)												
0x06	Vertical Blanking	0x0019 (25)	Number of extra rows added into the vertical blanking period. Typically used to slow down frame rate and allow time for register updates between images.												
0x09	Exposure	0x0419 (1049)	Number of rows of integration												
0x0C	Shutter Delay (Short Exposure)	0x0000 (0)	Number of master clocks times 4 that the sensor waits before asserting the reset for a given row.												
0x1E	Subsampling & Snapshot Mode	0x80xx (x8000)	0 0 (do not change) 1 0 (do not change) 2 Column Skip 4—default is 0 (disable), 1 = enable. 3 Row Skip 4—default is 0 (disable), 1 = enable. 4 Column Skip 8—default is 0 (disable), 1 = enable. 5 Row Skip 8—default is 0 (disable), 1 = enable. 6 0 (do not change). 7 0 (do not change). 8 Snapshot Mode—default is 0 (continuous mode). 1 = enable Snapshot TRIGGER can come from CC-1 or from serial interface command.												
0x20	Subsampling 2 & Scan Reversal	0x11xx (0x1104)	0 No bad frames: 0 (default) = only good frames, 1 = all frames 1 0 (do not change) 2 1 (do not change) 3 Column skip2: 0= normal readout (default), 1= skip by 2 4 Row skip2: 0 = normal readout (default), 1= skip by 2 5 0 (do not change) 6 0 (do not change) 7 Flip Row: 0 = normal, 1= Scan reversal 8 1 (do not change)												
0x2B	Green1 Gain	0x0008 (8) 1x gain.	<table border="1"> <thead> <tr> <th>Gain</th> <th>Increments</th> <th>Settings</th> </tr> </thead> <tbody> <tr> <td>1.000 to 4.000</td> <td>0.125</td> <td>0x08 to 0x20</td> </tr> <tr> <td>4.25 to 8.00</td> <td>0.25</td> <td>0x51 to 0x60</td> </tr> <tr> <td>9.0 to 15.0</td> <td>1.0</td> <td>0x61 to 0x67</td> </tr> </tbody> </table>	Gain	Increments	Settings	1.000 to 4.000	0.125	0x08 to 0x20	4.25 to 8.00	0.25	0x51 to 0x60	9.0 to 15.0	1.0	0x61 to 0x67
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4.25 to 8.00	0.25	0x51 to 0x60													
9.0 to 15.0	1.0	0x61 to 0x67													
0x2C	Blue Gain	0x0008 (8) 1x gain.													
0x2D	Red Gain	0x0008 (8) 1x gain.													
0x2E	Green2 Gain	0x0008 (8) 1x gain.													
0x35	Global Gain	0x0008 (8) 1x gain.	This register can be used to set all four gains at once. When read, it will return the value stored in Reg0x2B.												

SI-3300 READOUT MODES

There are three operating modes for the SI-3300 cameras: Continuous, Frame Snapshot and Genlock modes. Each has its own characteristics shown below

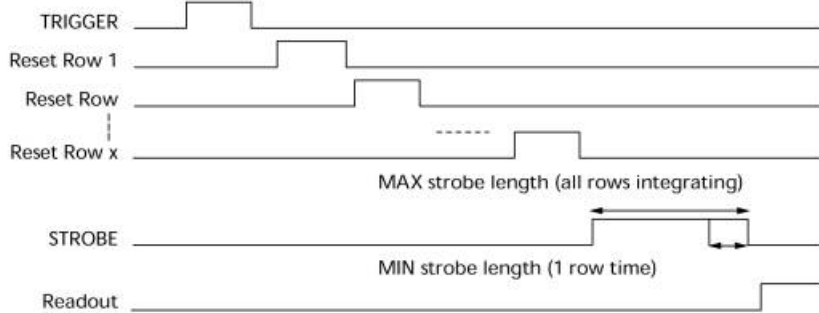
"c"	Continuous Electronic Rolling Shutter Operation. Return to ERS after an "f" or "g"
"f"	Arm single frame capture. Trigger frame capture & readout if already armed. In Frame snapshot there are 2 methods of Readout <ul style="list-style-type: none"> Rolling Shutter Readout - Reg21 = x0000 Global Reset Readout - Reg21 = x0003 (-T Model)
"g"	Enter Genlock Mode. Use "c" to return to continuous (supported by -H model)

Continuous, Electronic Rolling Shutter (ERS) – "c" Mode

Continuous, rolling shutter mode is the default mode of operation of the camera. The exposure is determined by the delay between two scans of the pixel array and controlled with the shutter width registers, Reg0x08 and Reg0x09. The shutter width is measured in row times. The first scan (shutter) resets each row of pixels in turn, starting the exposure. The second scan (read) stops the exposure by transferring the accumulated charge from each row of pixels to sample/hold capacitors at the foot of the columns and reads the (digitized) values out. When each scan reaches the bottom of the array there follows a blanking period (controlled by the user) after which the scan automatically restarts at the top of the array. Read out is therefore continuous.

Frame Snapshot Mode, with ERS – “f” Mode with ERS

The snapshot mode allows capture of a single frame initiated by an external trigger using CC-1, TTL-Trigger (-T option) or software command ('f <cr>'), with the capability of controlling a flash using the Strobe_Out signal. Each of the rows in the shutter will be reset, as shown in Figure. Just as for continuous mode the exposure is determined by the delay between the scans. However, before the start of the frame, the sensor waits for a trigger before starting the scan. The first (shutter) scan does not start until a rising edge on the TRIGGER signal is seen. The second scan then follows after the shutter width delay. After the end of the frame, the sensor waits for another trigger before restarting the scan. The maximum snapshot rate is limited to half the continuous readout rate. Note that the exposure (shutter width) is still determined electronically.



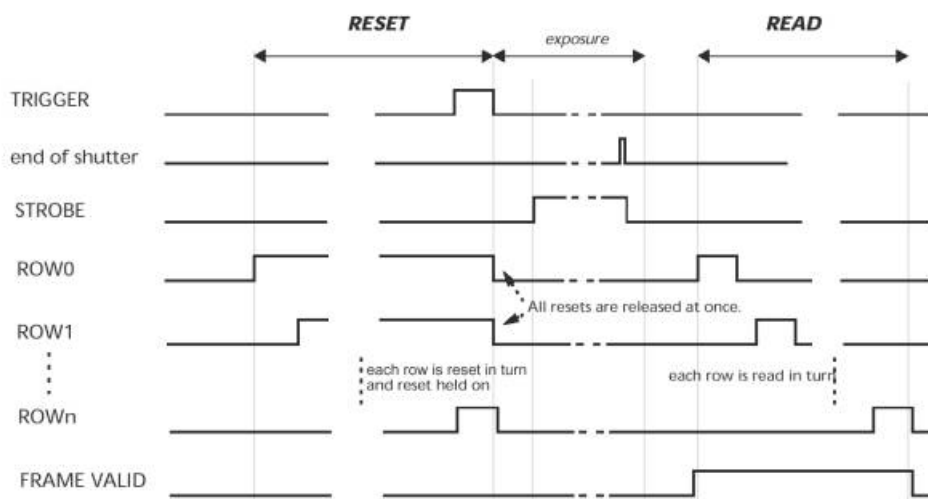
To return to Continuous ERS Readout mode, send a 'c' command.

Frame Snapshot Mode with Global Reset - “f” mode (with Reg21 = x0003) - T Model

0x21	Global Reset or ERS Readout Mode	0x0000 (ERS)	Set to x0003 for Global Reset Snapshot mode - Release all pixels from reset simultaneously (use with flash & mechanical shutter. x0000: for ERS.
		or 0x0003 (GR)	Default Mode is continuous ERS Note: Global reset requires model SI3300-T with external trigger cable.

A further enhancement to the snapshot capability is a global reset mode that enables all pixels to start exposure to the scene simultaneously. Global reset mode is selected by Reg0x21 to x0003 (x0000 is Rolling Shutter).

Global reset mode has to operate with a mechanical shutter to terminate the exposure time or with a strobe with minimum ambient light. Using the global reset feature changes the behavior of the row reset controls. Instead of pulsing, the resets are held on. As the shutter pointer moves through the rows the resets are turned on one by one. When all of the rows have been reset, the exposure is started by releasing them all together. Exposure is terminated when an external mechanical shutter cuts off the light. Row read out is performed after the exposure is terminated. The strobe can be used to control flash and/or a mechanical shutter to end the exposure of the array prior to readout.



To enter Snapshot mode with global Reset:

```
ly210003 <cr>    Global Reset Mode
f <cr>           Frame Snapshot Mode
```

The snapshot is initiated with the CC-1 Trigger, TTL-Trigger (-T option) signal or “f” frame request command, as in ERS snapshot mode. The array is reset row by row before the sensor waits for the trigger. All of the rows are held in reset until a rising edge is detected on the

TRIGGER input, whereupon they are all released at once. At this point every row in the array starts to integrate at the same time. Integration is terminated and the readout started when the internal shutter counter is equal to the shutter width register ([Reg0x08, Reg0x09]). The first active row is read out after the preamble (5 rows), the calibration rows (18 rows) and the dark rows (24 rows), allowing 47 row times for the mechanical shutter to be closed. (Default values).

To return to Continuous ERS, set Reg21 to ERS Readout (x0000) and a "c"

ly210000 <cr> Rolling Shutter Mode

c <cr> Continuous Readout

Genlock Mode for Stereo Capture – 'g' command (-H Model)

For stereo and synchronized multi-camera applications the SI-3300-H models supports a Genlock feature.

In normal Frame Snapshot mode, an image can be captured for two cameras simultaneously by triggering the cameras at the same time. However, this method limits the maximum frame rate to half speed as the exposure and readout do not overlap and require two frame times per image captured. The first frame time is for Reset and begin exposure. The second frame time for Readout and completion of exposure. The Genlock mode provides the highest frame rate synchronization possible by allowing overlapping exposure and readout, just like continuous ERS, while being synchronized to a triggering timebase.

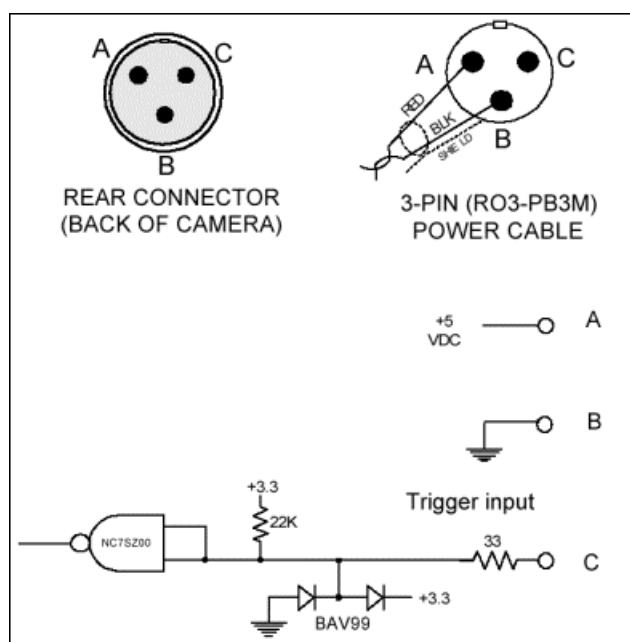
Sending a 'g' command arms the camera for Genlock Mode. Each CC-1 trigger causes the camera to initiate a frame readout. The camera is left in an armed state, continuing exposure and can be re-triggered at anytime. New CC-1 triggers can occur immediately after the completion of the current frame readout cycle. Note: The first frame is improperly exposed and should not be used.

The exposure time should be set to the full frame time for consistent exposures throughout the image. However, variable exposure times can be used if the Genlock trigger rate matches the normal Frame_Time set by image height and Vertical Blanking.

The mode is exited by sending a 'c' command.



3-PIN POWER & TRIGGER INPUT WIRING (-T)



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