

# SP-11-xxx40 Compact Line Scan Camera

DALSA's newest, smallest camera sets new standards in performance and value. Once more DALSA raises the bar by bundling an unmatched feature set into a compact package.

## Features

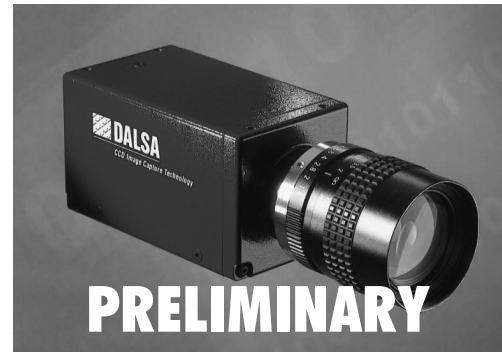
- Small form factor (50mm x 50mm x 88mm, <300g)
- 512, 1024, or 2048 x 1 resolution, 14µm square pixels
- 8-bit output from 10-bit digitizer
- 40MHz data rate, LVDS, CE-compliant
- Exposure control and antiblooming
- External clock detection powers down internal clock source when external clock is detected
- Test pattern generation to aid in system debug
- Free run mode—camera will operate without any external control signals
- User-selectable features:
  - 1x2 horizontal binning
  - four gain settings
  - data rate (clock divide by 1 or 2)
- Single 12V input model (SP-12) also available

## Description

The SP-11 cameras use DALSA's newest compact modular architecture. Within the SP-11 camera, driver circuits provide bias voltages and clocks to the CCD image sensor, timing circuits generate internal timing, and A/D circuits process the video and digitize it for output.

### Sensor

The SP-11 cameras use DALSA's IL-CC line scan sensors. The sensors' photoelements have a photosensitive area of 14µm x 14µm and a center to center spacing of 14µm. Figure 3 shows a block diagram of the IL-CC sensor. See the IL-CC datasheet (document number 03-36-00125) for more details.



**Table 1. SP-11 Configurations**

Specification	0512	1024	2048
Pixel Pitch	14µm x 14µm		
Aperture 14µm x	7.2mm	14.4mm	28.8mm
Lens Mount	C-mount	C-mount	F-mount
Max. Line Rate:	70.4kHz	36.8kHz	18.8kHz
Data Format	1x8 bits, EIA-644 (LVDS)		
Data Rate	40MHz		
CE Compliance	Yes		

**Example Configuration: SP-11-01K40**



## Operation

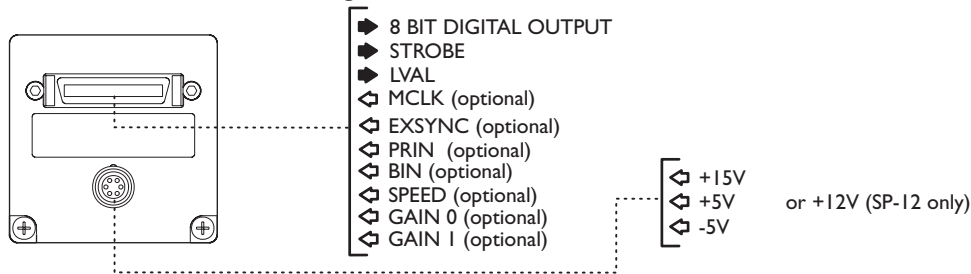
### Power Supplies

Cameras meet all performance specifications using standard switching supplies, although well-regulated linear supplies provide optimum performance. The standard SP-11 requires three input voltages (±5V, +15V), but a single supply model (SP-12, 12V input) is also available.

### Optical Interface

The SP-11 cameras provide an adapter for C-mount or F-mount (35mm Nikon-compatible) lenses, depending on sensor resolution. The mount threads into an opening in the camera's front plate, and is optically aligned to provide the proper distance between lens and sensor.

**Figure 1. Camera Interface**



**Electrical Interface**

All connectors are on the camera rear plate. The standard SP-11 uses Hirose HR10A series 6-pin circular connector for power and a MDR36 (mini D-shell) for data and control signals. Data, clocking, and control signals use the EIA-644 (LVDS) standard for data transmission.

**Input Control Signals**

Control signals are differential, requiring complements denoted with a "B" suffix (e.g. BIN, BINB). All inputs are optional and default to logic high.

Most applications will use an EXSYNC input to control line rate, but the SP-11 can operate in "free-run mode" in which it outputs data without requiring any inputs.

**Table 2. EXSYNC and PRIN**

EXSYNC and PRIN are used together, as outlined below.

EXSYNC	PRIN	Camera Operation
Supplied from external source (Min 300Hz)	Disabled or unconnected (high)	Edge Mode: EXSYNC falling edge triggers line readout. Camera integrates incident light from the falling edge of EXSYNC to the next falling edge of EXSYNC.
Supplied from external source (Min 300Hz)	Enabled (low)	Level Mode: EXSYNC falling edge triggers line readout. Camera integrates incident light while EXSYNC is high (from rising edge of EXSYNC to falling edge of EXSYNC). While EXSYNC is low, the camera does not integrate incident light.
Unconnected*	Disabled or unconnected (high)	Free Run Mode: Camera operates at maximum line rate until it receives an EXSYNC edge. No exposure control.
Unconnected*	Enabled (low)	Free Run Mode: Camera operates at maximum line rate until it receives an EXSYNC edge. Each line is only exposed for ~400ns.

\* Free run is disabled when the camera receives an EXSYNC edge. The camera will not free run again until it is powered off and on again.

**Table 3. Control Signals**

These control inputs can be used independently of each other.

MCLK	Unconnected	Internal MCLK controls pixel rate (40MHz)	
	Supplied externally	MCLK controls pixel rate (maximum 40MHz)	
SPEED	Unconnected or High	Pixel rate = MCLK rate	
	Low	Pixel rate = MCLK/2	
BIN	Unconnected or High	No binning	
	Low	Camera combines the charge collected by two horizontally adjacent pixels.	
GAIN		GAIN1 High or Unconnected	GAIN1 Low
	GAIN0 High or Unconnected	8x (default)	4x
	GAIN0 Low	2x	1x

**Output Signals**

These signals indicate when data is valid, allowing you to clock the data from the camera to your acquisition system:


Clocking Signal	Indicates
LVAL (high)	Outputting valid line
STROBE (rising edge)	Valid data

**Digital Data**

The SP-11 digitizes to 10 bits and outputs the most significant 8 bits in LVDS format on a MDR36 connector.

After the end of each valid line, the camera outputs two isolation pixels and four test pattern pixels. These pixels alternate between 10101010 and 01010101 (eg. 170, 85, 170, 85).

**Figure 2. SP-11 Connector Pinouts**

Power Connector	Pin	Signal	Current	
	1	+5V	680mA	<b>Camera meets all performance specifications using standard switching power supplies.</b>  <b>Voltage Input Tolerance:</b> $\pm 250\text{mV}$ on all supplies.
	2	+5V		
	3	+15	80mA	
	4	-5V	80mA	
	5	GND		
	6	GND		

**Control & Data Connector**

	<b>All data and control signals use EIA-644 (LVDS) format.</b>		
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**Mating Part:** 3M 10136-6000EC series

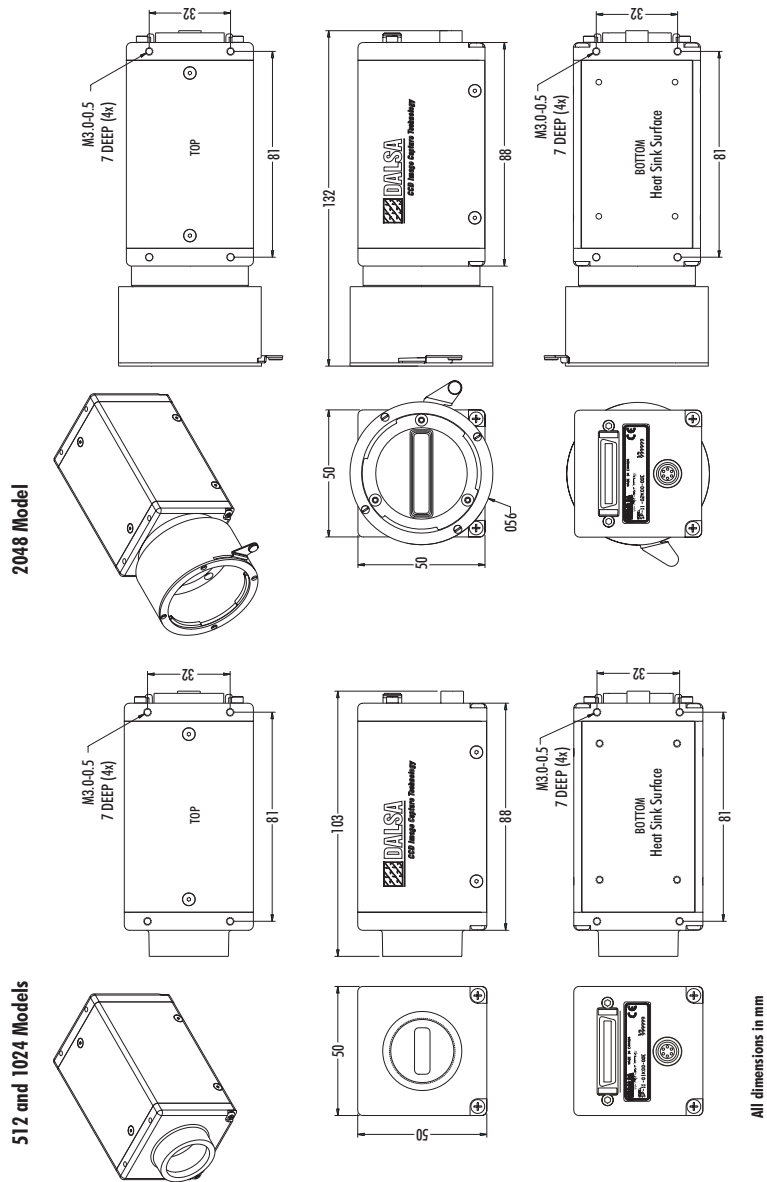
**Cable:** 26AWG 100W shielded twisted pair

Pin	Signal	Pin	Signal	Description	Default
1	SPEED	19	SPEEDB	Controls data rate	40MHz
2	GAIN0	20	GAIN0B	Controls gain	High
3	Future use	21	Future use	Not used: Do not connect	
4	GAIN1	22	GAIN1B	Controls gain	High
5	MCLK	23	MCLKB	Controls master clock frequency	40MHz
6	PRIN	24	PRINB	Exposure control	Disabled
7	EXSYNC	25	EXSYNCB	Controls line rate/exposure time	Free run
8	BIN	26	BINB	Controls pixel binning (summing)	Disabled
9	D7	27	D7B	} Data bits	
10	D6	28	D6B		
11	D5	29	D5B		
12	D4	30	D4B		
13	D3	31	D3B		
14	D2	32	D2B		
15	D1	33	D1B		
16	D0	34	D0B		
17	STROBE	35	STROBEB	} Outputs Pixel clock; data valid on rising edge Pixel data valid during logic high state	
18	LVAL	36	LVALB		

**Notes on Operation (for full detail, see the Camera User's Manual)**

- All control signals are OPTIONAL and default to logic high state when unconnected.
- Long unterminated cables can act as antennae, causing spurious inputs. DALSA recommends tying unused inputs to known states using differential drivers or resistive networks.
- Max. operating temperature is 50°C ambient.
- Free run is disabled when the camera receives an EXSYNC edge. The camera will not free run again until it is powered off and on again.

**Figure 3. Mechanical Dimensions**



**Table 4. SP-11 Performance Specifications**

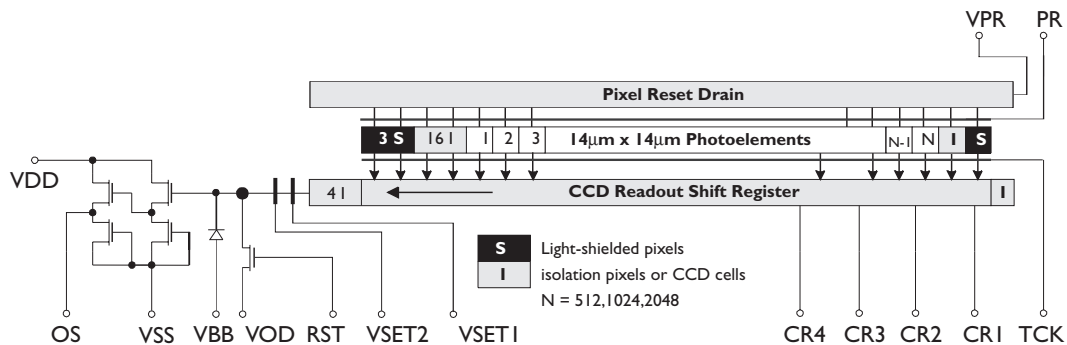
Calibration Conditions	Units	Setting	Range		Notes			
			Min.	Max.				
Data Rate	MHz	40	40	40				
Line Rate	kHz	3.5	3.5	3.5				
Saturation Output Amplitude	DN	246	240	254				
Saturation Light Intensity	$\mu\text{W}/\text{cm}^2$	21			2			
Responsivity	$\text{DN}/(\text{nJ}/\text{cm}^2)$	40	39	41				
+15 Input Voltage	Volts	15.0	14.9	15.1				
+5 Input Voltage	Volts	5.0	4.9	5.1				
-5 Input Voltage	Volts	-5.0	-5.1	-4.9				
Ambient Temperature	$^{\circ}\text{C}$	25	22	28				
Calibration Mode		Default			4			
Operating Ranges		Units	Min.	Max.				
Data Rate		MHz	20	40				
Line Rate 2048 resolution		kHz	0.3	18.8				
Line Rate 1024 resolution		kHz	0.3	36.8				
Line Rate 0152 resolution		kHz	0.3	70.4				
Temperature		$^{\circ}\text{C}$	0	50				
+15 Input Voltage		Volts	14.5	15.5				
+5 Input Voltage		Volts	4.75	5.25				
-5 Input Voltage		Volts	-5.25	-4.75				
Responsivity		$\text{DN}/(\text{nJ}/\text{cm}^2)$	5	40	5			
Nominal Gain Range			1x	8x	5			
Specification	Units	Min Gain			Max Gain		Notes	
		Min.	Typ.	Max.	Min.	Typ.		Max.
Saturation Output Amplitude	DN			255		255		
Photoresponse Non Uniformity (PRNU)								
PRNU, Exposure Control Disabled, Global	DN		6	14		7	16	1
PRNU, Exposure Control Enabled, Global	DN		9	18		16	28	1,6
PRNU, Exposure Control Disabled, Local	DN		4	9		5	10	1
PRNU, Exposure Control Enabled, Local	DN		7	14		12	20	1,6
Fixed Pattern Noise (FPN)								
FPN, Exposure Control Disabled, Global	DN		0.6	2		3	7	
FPN, Exposure Control Enabled, Global	DN		5	10		11	18	6
DC Offset, Exposure Control Disabled	DN		4			6		
DC Offset, Exposure Control Enabled	DN		12			24		
Random Noise, pk-pk	DN		2	3		7	12	7
Random Noise, rms	DN		0.5	0.6		1.3	2	7
Dynamic Range	Ratio		480			180		7
Noise Equivalent Exposure (NEE)	$\text{pJ}/\text{cm}^2$		100			32.5		7
Saturation Equivalent Exposure (SEE)	$\text{nJ}/\text{cm}^2$		48.4			6		7
Supply current +15V	mA		65	80		65	80	
Supply current +5V	mA		600	680		600	680	3
Supply current -5V	mA		65	80		65	80	

Notes: see next page.

**Notes to Table 4: SP-11 Performance Specifications:**

- Performance specification values achieved under calibration conditions. Performance values also achieved over specified temperature range.
- All measurements exclude first and last pixel.
- No performance measurements performed for External Clock, Minimum speed with internal clock, or binning modes. Functional operation verified only.
  1. Measured at 50% of Saturation Output Amplitude.
  2. Tungsten halogen light source, black body color temperature 3200K, with 750nm cutoff filter.
  3. LVDS output signals terminated.
  4. Default operating mode: Max. Speed (40MHz), High gain (8x), Exposure Control Disabled, Binning Off, Internal MCLK.
  5. Intermediate Responsivity settings available of 10 DN/(n)/cm<sup>2</sup> at 2x gain and 20 DN/(n)/cm<sup>2</sup> at 4x gain selectable through user control but not tested.
  6. ECE performance results for maximum values are taken at 10 DN/(n)/cm<sup>2</sup> or 2x gain setting.
  7. Exposure Control disabled (ECD).

**Figure 4. IL-CC Sensor Block Diagram**



**ISO 9001** DALSA maintains a registered quality system meeting the ISO 9001 standard.