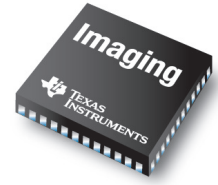


Analog Front End Imaging Guide



Analog Front End Imaging Guide

→ Analog Front Ends – Imaging

TI Covers the Image Capture Spectrum

TI's product line covers a broad spectrum of image capture applications with diverse requirements. Portfolio offerings, application support, product quality and manufacturing excellence allow you to customize imaging systems for specific applications with confidence. TI's imaging products are optimized to work together, yet also allow you to mix-and-match with third-party components when required. Use the guides and information featured in this brochure to make the best selections for your needs.

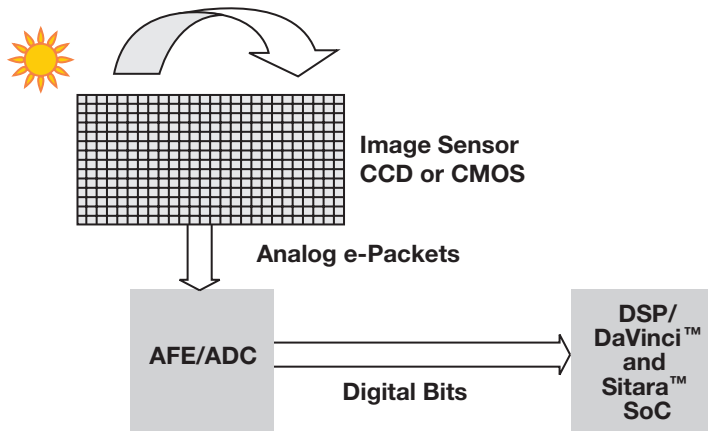


Image sensor and imaging AFE/ADC

Image Sensor:

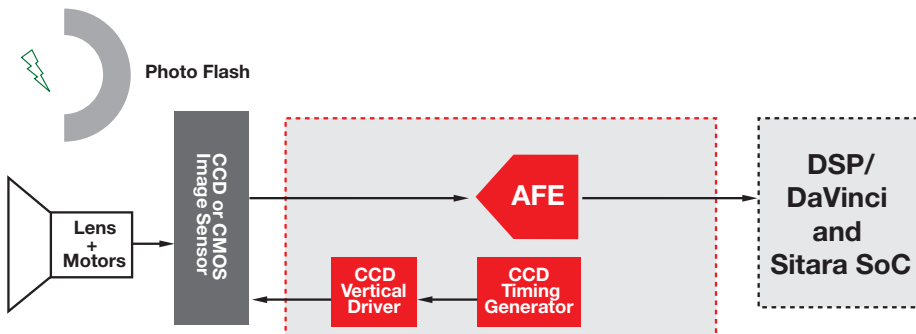
Converts photons to electrons stored in the pixel

- CCD output requires correlated double sampling (CDS)
- CMOS output requires sample and hold (S/H)

Imaging AFE/ADC:

Conditions and digitizes sensor output

- Samples and conditions the sensor output (CDS or S/H)
- Digitizes the signal for DSP
- Optional AFE sensor support functions
 - Provides CMOS-level timing signals for sensor operation
 - Provides voltage level-shifting for CCD vertical drivers



Typical imaging block diagram

TI's AFE supports a wide variety of third-party CCD image sensors from VGA through 14MP. The Imaging AFE accepts the analog sensor output, provides signal conditioning and digitizes the signal in the ADC. The digitized signal is easily interfaced to a broad range of DSPs, including TI's DaVinci™ and Sitara™ processors with integrated image pipe for enhanced video and image processing.

Image Sensors

→ Selecting an Image Sensor

TI offers a number of different image sensors. Many are optimized to support specific applications. Selecting the correct image sensor depends on several variables: resolution, responsivity, dynamic range, output characteristics and speed.

Image Sensor Selection Guidelines

Selection Criteria	Description	Guidelines
Resolution	Number of pixels determines the quantity of detail(s) that will be resolved.	For an area array: number of rows x the number of pixel columns. For a linear array: number of pixels in a row
Responsivity	Ability of a pixel to convert a photon signal to an electrical signal: mV/lux or mV/watt.	For constant sensor area: larger pixels capture more photons and show higher responsivity while smaller pixels provide more resolution.
Dynamic Range	Ability to capture bright and dark elements of a scene SNR = 20 log (maximum signal/noise).	30dB for useable image quality, 40dB for better image quality, +45dB for best image quality.
Output	Output type and number: CCDs use CDS, CMOS use S/H.	Match type and number of sensor output channels to AFE number input type.
Speed	Rate at which pixels are read units = MHz or MSPS.	Area sensor = resolution x frame rate, linear sensor = resolution x line rate.

Example: Sensor Selection for Security Application

Resolution: select desired number of pixels

Pixel number:	Horizontal pixels	x	Vertical pixels	=	Total pixels
For NTSC:	658	x	496	=	326 Kpixels
Your application:	_____	x	_____	=	_____

Responsivity: select desired response to light

	Fair	Good	Better	Best
	CMOS with integrated ADC	CCD with RBG filters	CCD with CMYG filters or CMOS sensor with external AFE	Black and white CCD
Your application:	_____	_____	_____	_____

Dynamic Range: select desired range of response

	Fair	Good	Better	Best
	CMOS with integrated ADC	CCD with 10- to 12-bit AFE	CCD with 14-bit AFE, or CMOS with external AFE	CCD with 16-bit AFE
Your application:	_____	_____	_____	_____

Speed: calculate the data output rate

Pixel number:	Horizontal pixels	x	Vertical pixels	x	Frame rate	=	Pixels/S (MHz)
For NTSC:	658	x	496	x	60	=	20MSPS
Your application:	_____	x	_____	x	_____	=	_____

Brochure Legend

Code	Description
ADC	Analog-to-Digital Converter
AFE	Analog Front-End
CCD	Charge-Coupled Device
CDS	Correlated Double Sampling
CMOS	Complementary metal-oxide semiconductor
dB	Decibels
DSP	Digital Signal Processor
EMCCD	Electron Multiplier CCD
FS	Full Scale
NTSC	Analog television standard established by the National Television System Committee
SNR	Signal-to-Noise Ratio
SoC	System on Chip
WDR	Wide Dynamic Range
x	Times, or to multiply by

Image Sensors

→ Selecting the Correct Imaging AFE

TI designs different AFEs optimized for particular applications. To select the correct AFE, several properties must be identified: AFE-input channels, sensor output type (CCD or CMOS), pixel samples per second, number of bits output, SNR and gain.

Imaging AFE Selection Guidelines

Selection Criteria	Description	Guidelines
AFE channels	Analog inputs to AFE(s).	Total number of AFE channels must equal total number of sensor outputs. Any combination of single-channel and multi-channel AFEs may be used.
Sample rate (MSPS)	Sampling rate for each AFE channel in terms of pixels-per-second.	Area sensors: MSPS ~ sensor resolution (in MP) x frame rate (fps). Linear sensors: MSPS ~ pixel resolution x line rate.
Bits output	The bits output is based on the number of bits desired in the final result.	TAFE bits = number of bits desired in final application +2 to 4-bits.
SNR	Signal-to-noise ratio.	AFE SNR = sensor SNR +6 to 10dB. If sensor SNR not known, then AFE SNR = sensor DR + 10dB.
Gain	Amplify input signal to use entire ADC range.	Highest AFE gain = AFE FS/smallest expected sensor output signal (white).

Example: AFE Selection for Security Application

Resolution: select desired number of pixels

Pixel number: Horizontal pixels x Vertical pixels x Frame rate = Pixels/S (MHz)

For NTSC: 658 x 496 x 60 = 20MSPS

Your application: _____ x _____ x _____ = _____

Bits output: select desired response to light

Bits output: Bits in final image after processing + 2 to 4-bits = ADC output bits

For NTSC: 8 + 2 to 4 = 10 to 12-bits

Your application: _____ + 2 to 4 = _____

SNR: required SNR for the AFE

SNR: Sensor SNR or dynamic range + 6 to 10dB = AFE SNR(dB)

For CCD sensor: 60dB + 6 to 10dB = 66 to 70dB

Your application: _____ + 6 to 10dB _____ _____

Gain: calculate the minimum gain required

Minimum gain: AFE full-scale input Minimum sensor output for white = Gain(dB)

For example: 1.0V FS input 0.1V = 10V/V or 20dB

Your application: _____ _____ = _____ V/V or 20 Log (V/V)

Quality Assurance

TI recognizes the importance of advancing industry standards and is committed to working on regulatory as well as U.S. and international voluntary standards. As an active member of numerous global industry associations and with a strong commitment to the environment, TI has emerged as a leader with its Lead (Pb)-Free programs. An initiative begun in the 1980s to find alternative materials for products has resulted in the majority of TI products being available Pb-Free and green.

For all your Lead (Pb)-Free questions, visit www.ti.com/quality



Analog Front End Imaging Guide

→ Selection Tables

PhotoFlash Capacitor Chargers

Device	V _{CC}	V _{MIN}	V _{MAX}	Peak Current (A) (min)	Peak Current (A)	Power Switch (V)	IGBT Driver	Over Voltage Shutdown	Thermal Monitor	Thermal Shutdown	Package	Price*
TPS65520A	5	1.8	12	0.95	1.8	50	X	X	X		10-MSOP-PowerPAD™ 16-QFN	4.95
TPS65560	3	1.6	12	0.9	1.8	50	X	X		X	16-QFN	0.85
TPS65561	3	1.6	12	1.1	2.2	50	X	X	X		16-QFN	0.95
TPS61050 LED Driver	5.5	2.5	5.5	—	1.2				X	X	10-SON, 12-DSBGA	1.90

AFE and Support Chips

Device	Description	AFE	TG	VD	SNR (dB)	Bits Out	MSPS (MHz)	Pd (mW)	VS (V)	DNL (±LSB)	INL (±LSB)	Gain (dB)	Package	Price*
Single-Channel AFEs														
VSP2582	Single Ch., 12b, 36MSPS	X	—	—	78	12	36	85	2.7 to 3.3	0.5	2	−9 to 35	36-QFN	3.20
VSP2560	Single Ch., 10b, 36MSPS, 2 8-Bit DACs	X	—	—	78	10	36	86	2.7 to 3.3	0.5	0.5	−9 to 44	48-QFP	3.85
VSP2562	Single Ch., 12b, 36MSPS, 2 8-Bit DACs	X	—	—	78	12	36	86	2.7 to 3.3	0.5	2	−9 to 44	48-QFP	5.65
VSP2566	Single Ch., 16b, 36MSPS, 2 8-Bit DACs	X	—	—	78	16	36	86	2.7 to 3.3	2	32	−9 to 44	48-QFP	9.40
VSP8244	Single Ch., 14b, 50MSPS	X	X	X	80	14	50	140	2.7 to 3.3	0.5	12	0 to 51	98-BGA MicroStar Junior™	**
VSP01M02	Single Channel, 12b, 36MSPS	X	X	X	78	12	36	139	2.7 to 3.3	1	2	−9 to 44	100-BGA	7.25
VSP01M01	Single Channel, 10b, 36MSPS	X	X	X	78	10	36	139	2.7 to 3.6	0.5	1	−9 to 44	100-BGA	6.25
VSP8133	Single Ch., 14b, 50MSPS	X	X	X	80	14	50	140	2.7 to 3.3	0.5	12	0 to 51	64-QFN	**
Multi-Channel AFEs														
VSP2254	2 Ch., 14b, 36MSPS	X	—	—	75	14	36	210	3.0 to 3.3	2	8	0	96-BGA Monostar	17.25
VSP2590	2 Ch., 16b, 41MSPS	X	—	—	75	16	41	290	2.7 to 3.3	0.8	32	−3 to 5	159-NFBGA	18.00
AFE for Line Sensor														
VSP5010	2 Ch., 12b, 31MSPS	X	—	—	78	12	30	290	3 to 3.6	0.5	2	0 to 24	64-LQFP	**
VSP7502	4 Ch., 16b, 54MSPS, LVDS Output	X	X	—	78	16	54	400	1.8V core, 3.3V I/O	1	32	0 to 40	159-NFBGA	**

Vertical Drivers

Device	Description	Drivers	Drive Voltage	E- Shutter Control	Price*
VSP1900	CCD Vertical Clock Driver	3-Level Drivers x 5, 2-Level Drivers x 3	H = 11 to 15 V, L = −5 to −9 V	X	7.90

*Suggested resale price in U.S. dollars in quantities of 1,000. **Please contact your local TI representative for pricing information. [Preview products are listed in bold blue.](#)

Packaging

Pin/Package	Package Symbolization	Length (mm)	Width (mm)	Area (mm ²)	Pitch Lead (mm)	Package Height (mm)+
36-QFN	RHN	6.3	6.3	39.7	0.5	0.9
48-QFN	PT	7	7	49	0.5	1.4
64-QFN	RGC	9	9	84	0.5	1.0
64-LQFP	PM	10	10	100	0.5	1.6
80-TQFP	PFC	12	12	144	0.5	1.2
96-BGA Monostar	GSJ	9	9	81	0.8	1.2
98-BGA MicroStar Junior™	ZRC	6	9	54	0.65	1
100-BGA	ZWD	7	7	49	0.65	1.2
159-NFBGA	ZWV	8	8	64	0.5	1.2

For additional packages, visit www.ti.com/packaging



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Phone	International	+91-80-41381665
	Domestic	<u>Toll-Free Number</u>
Note: Toll-free numbers do not support mobile and IP phones.		
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	India	1-800-425-7888
	Indonesia	001-803-8861-1006
	Korea	080-551-2804
	Malaysia	1-800-80-3973
	New Zealand	0800-446-934
	Philippines	1-800-765-7404
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