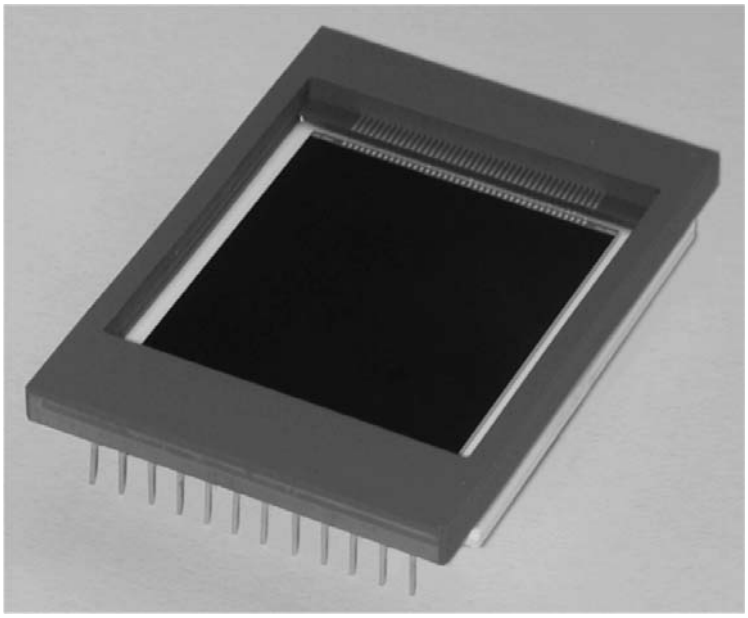
e2v technologies

CCD42-40 Ceramic AIMO Back Illuminated Compact Package High Performance CCD Sensor

FEATURES

- 2048 by 2048 pixel format
- 13.5 μm square pixels
- Image area 27.6 x 27.6 mm
- Back Illuminated format for high quantum efficiency
- Full-frame operation
- Symmetrical anti-static gate protection
- Very low noise output amplifiers
- Dual responsivity output amplifiers
- Gated dump drain on output register
- 100% active area
- New compact footprint package
- Advanced inverted mode operation (AIMO)



APPLICATIONS

- Scientific Imaging
- Microscopy
- Medical Imaging

INTRODUCTION

This version of the CCD42 family of CCD sensors has full-frame architecture. Back illumination technology, in combination with extremely low noise amplifiers, makes the device well suited to the most demanding applications requiring a high dynamic range. To improve the sensitivity further, the CCD is manufactured without anti-blooming structures.

There are two low noise amplifiers in the readout register, one at each end. Charge can be made to transfer through either or both amplifiers by making the appropriate R∅ connections. The readout register has a gate controlled dump drain to allow fast dumping of unwanted data.

The register is designed to accommodate four image pixels of charge and a summing well is provided capable of holding six image pixels of charge. The output amplifier has a feature to enable the responsivity to be reduced, allowing the reading of such large charge packets.

The advanced inverted mode operation (AIMO) gives a 100-times reduction in dark current with minimal full-well reduction and is suitable for use at Peltier temperatures.

Other variants of the CCD42-40 available are front illuminated format and non-inverted mode. In common with all e2v technologies CCD Sensors, the front illuminated CCD42-40 can be supplied with a fibre-optic window or taper, or with a phosphor coating.

Designers are advised to consult e2v technologies should they be considering using CCD sensors in abnormal environments or if they require customised packaging.

TYPICAL PERFORMANCE

(Low noise mode)

Maximum readout frequency	3	MHz
Output amplifier responsivity	4.5	$\mu V/e^-$
Peak signal	100	ke^-/pixel
Dynamic range (at 20 kHz)	33 333:1	
Spectral range	200 - 1060	nm
Readout noise (at 20 kHz)	3	e^- rms

GENERAL DATA

Format

Image area	27.6 x 27.6	mm
Active pixels (H)	2048	
(V)	2048 + 4	
Pixel size	13.5 x 13.5	μm
Number of output amplifiers	2	
number of underscan (serial) pixels	50	
Fill factor	100	%

Package

Package size	37.0 x 51.7	mm
Number of pins	24	
Inter-pin spacing	2.54	mm
Inter-row spacing across sensor	45.72	mm
Window material	removable glass	
Package type	ceramic DIL array	

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PERFORMANCE

	Min	Typical	Max	
Peak charge storage (see note 1)	80k	100k	-	e^-/pixel
Peak output voltage (unbinned)	-	450	-	mV
Dark signal at 293 K (see notes 2 and 3)	-	250	500	e^-/pixel/s
Dynamic range (see note 4)	-	33 333:1	-	
Charge transfer efficiency (see note 5):				
parallel	99.999	99.9999	-	%
serial	99.999	99.9993	-	%
Output amplifier responsivity:				
low noise mode (see note 3)	3.0	4.5	6.0	$\mu V/e^-$
high signal mode	-	1.5	-	$\mu V/e^-$
Readout noise at 253 K:				
low noise mode (see notes 3 and 6)	-	3.0	4.5	rms e^-/pixel
high signal mode	-	6.0	-	rms e^-/pixel
Maximum readout frequency (see note 7)	-	20	3000	kHz
Dark signal non-uniformity at 293 K (std. deviation) (see notes 3 and 8)	-	60	125	e^-/pixel/s
Output node capacity (see note 9)	-	1,000,000	-	e^-

Spectral Response at 253 K

Wavelength (nm)	Minimum Response (QE)			Maximum Response Non-uniformity (1σ)	
	Basic Process Mid-band Coated	Basic Process Broadband Coated	Basic Process Uncoated		
350	15	25	10	5	%
400	40	55	25	3	%
500	85	75	55	3	%
650	85	75	50	3	%
900	30	30	30	5	%

The uncoated process is suitable for soft X-ray and EUV applications.

ELECTRICAL INTERFACE CHARACTERISTICS

Electrode capacitances (measured at mid-clock level)

	Min	Typical	Max	
I∅/I∅ interphase	-	18	-	nF
I∅/SS	-	33	-	nF
R∅/R∅ interphase	-	80	-	pF
R∅/(SS + DG + OD)	-	150	-	pF
Output impedance at typical operating conditions	-	350	-	Ω

NOTES

1. Signal level at which resolution begins to degrade.
2. Measured between 253 and 293 K typically. The typical average (background) dark signal at any temperature T (kelvin) between 230 K and 300 K may be estimated from:
   $$Q_d/Q_{d0} = 1.14\text{x}10^6T^3e^{-9080/T}$$
   where Q_{d0} is the dark signal at 293 K.
3. Test carried out at e2v technologies on all sensors.
4. Dynamic range is the ratio of full-well capacity to readout noise measured at 253 K and 20 kHz readout frequency.
5. CCD characterisation measurements made using charge generated by X-ray photons of known energy.
6. Measured using a dual-slope integrator technique (i.e. correlated double sampling) with a 20 μs integration period.
7. Readout above 3 MHz can be achieved but performance to the parameters given cannot be guaranteed.
8. Measured between 253 and 293 K, excluding white defects.
9. With output circuit configured in low responsivity/high capacity mode (OG2 high).

BLEMISH SPECIFICATION

Traps Pixels where charge is temporarily held. Traps are counted if they have a capacity greater than 200 e^- at 253 K.

Slipped columns Are counted if they have an amplitude greater than 200 e^-.

Black spots Are counted when they have a signal level of less than 80% of the local mean at a signal level of approximately half full-well.

White spots Are counted when they have a generation rate 125 times the specified maximum dark signal generation rate (measured between 253 and 293 K). The typical temperature dependence of white spot blemishes is given by:

$$Q_d / Q_{d0} = 122T^3 e^{-6400/T}$$

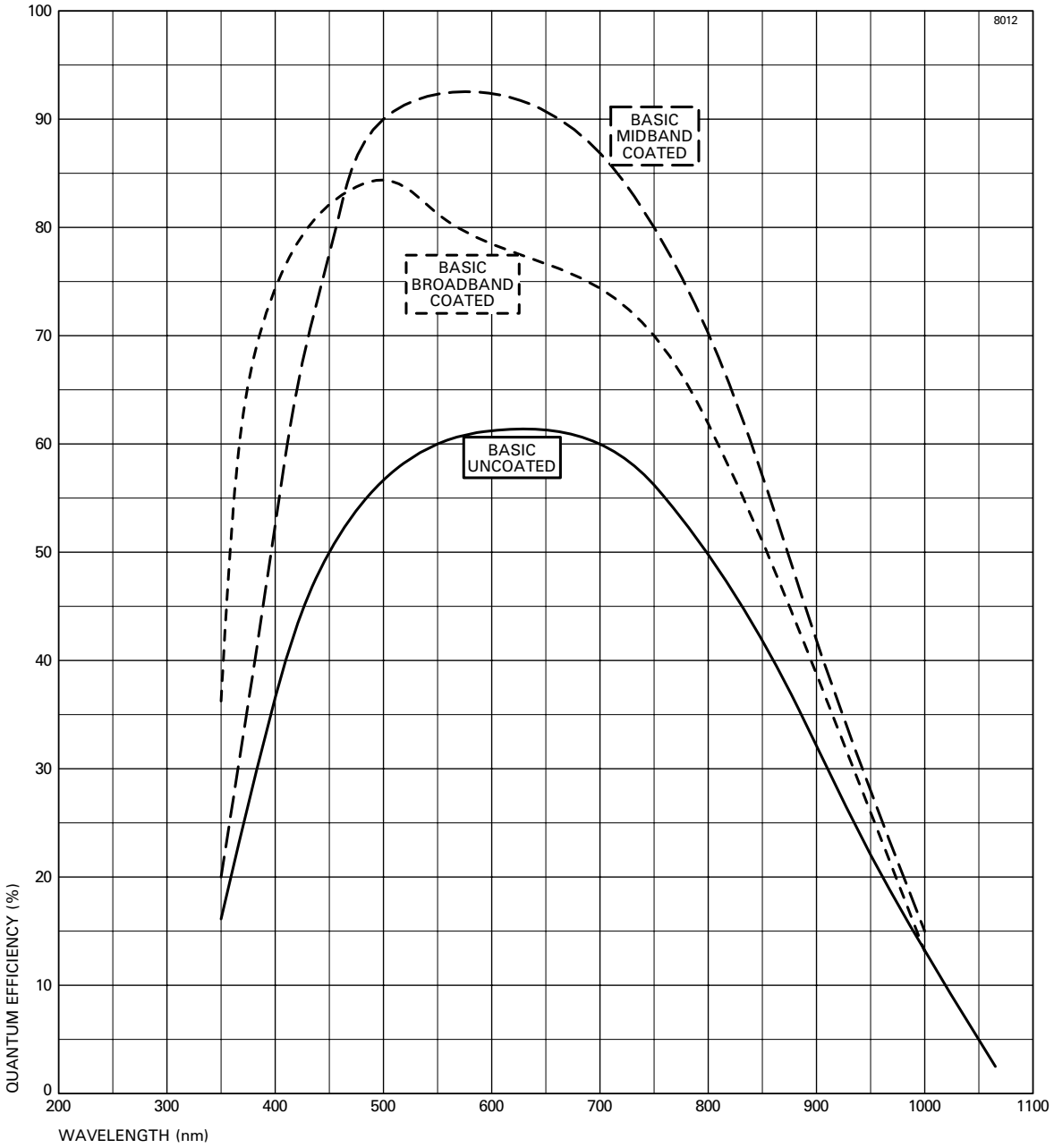
Column defects A column which contains at least 50 white or 50 black defects.

GRADE	0	1	2
Column defects; black or white	0	3	6
Black spots	100	150	250
Traps >200 e^-	10	20	30
White spots	100	150	200

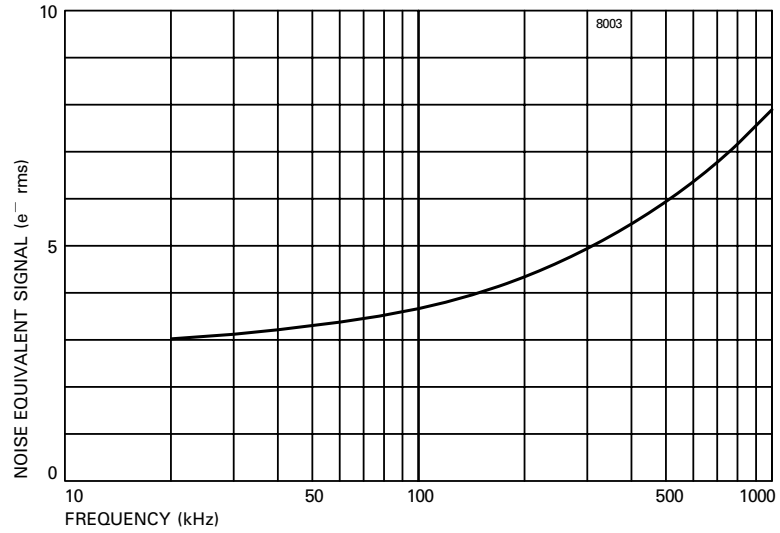
Grade 5 Devices which are fully functional, with image quality below that of grade 2, and which may not meet all other performance parameters.

Note The effect of temperature on defects is that traps will be observed less at higher temperatures but more may appear below 253 K. The amplitude of white spots and columns will decrease rapidly with temperature.

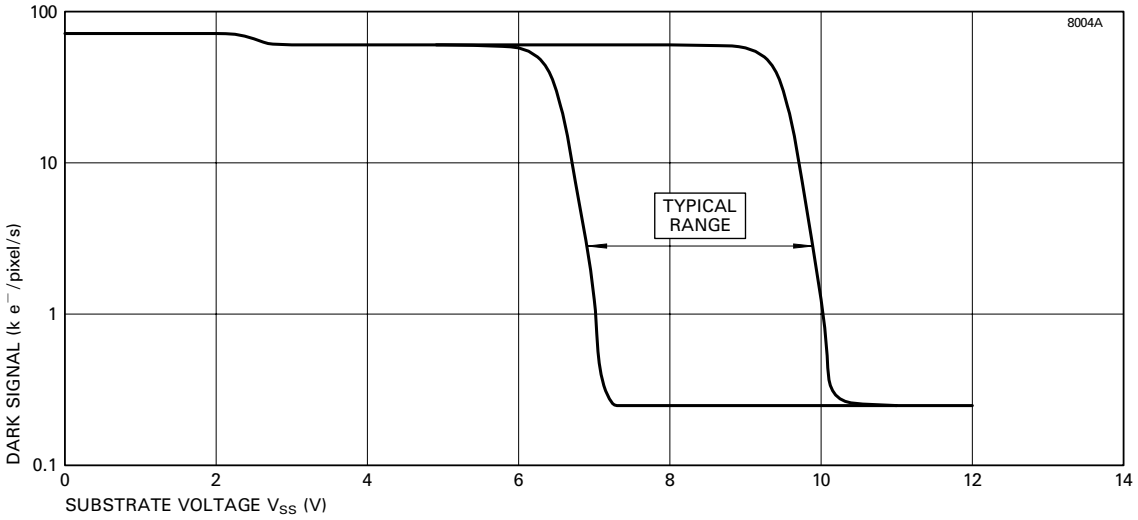
TYPICAL SPECTRAL RESPONSE (At −20 °C, no window)



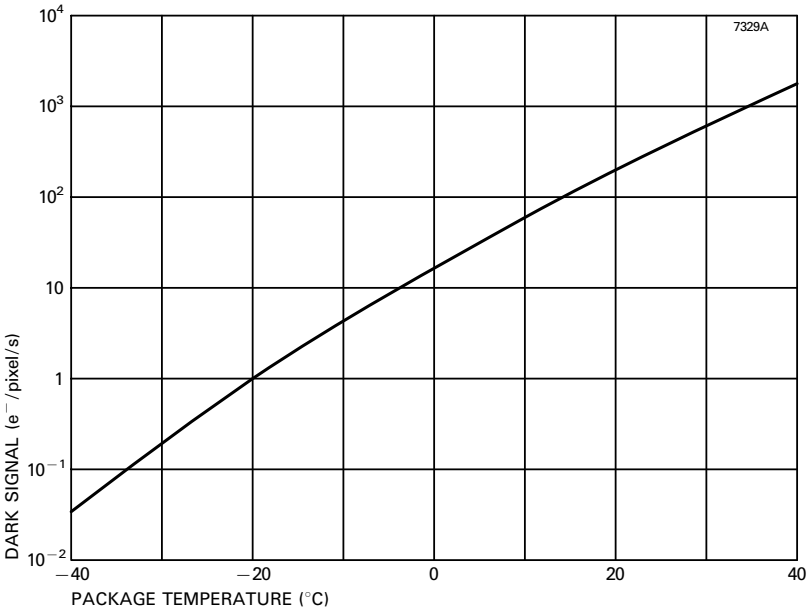
TYPICAL OUTPUT CIRCUIT NOISE (Measured using clamp and sample)



TYPICAL VARIATION OF DARK CURRENT WITH SUBSTRATE VOLTAGE AT 20 °C



TYPICAL VARIATION OF DARK SIGNAL WITH TEMPERATURE



DEVICE SCHEMATIC