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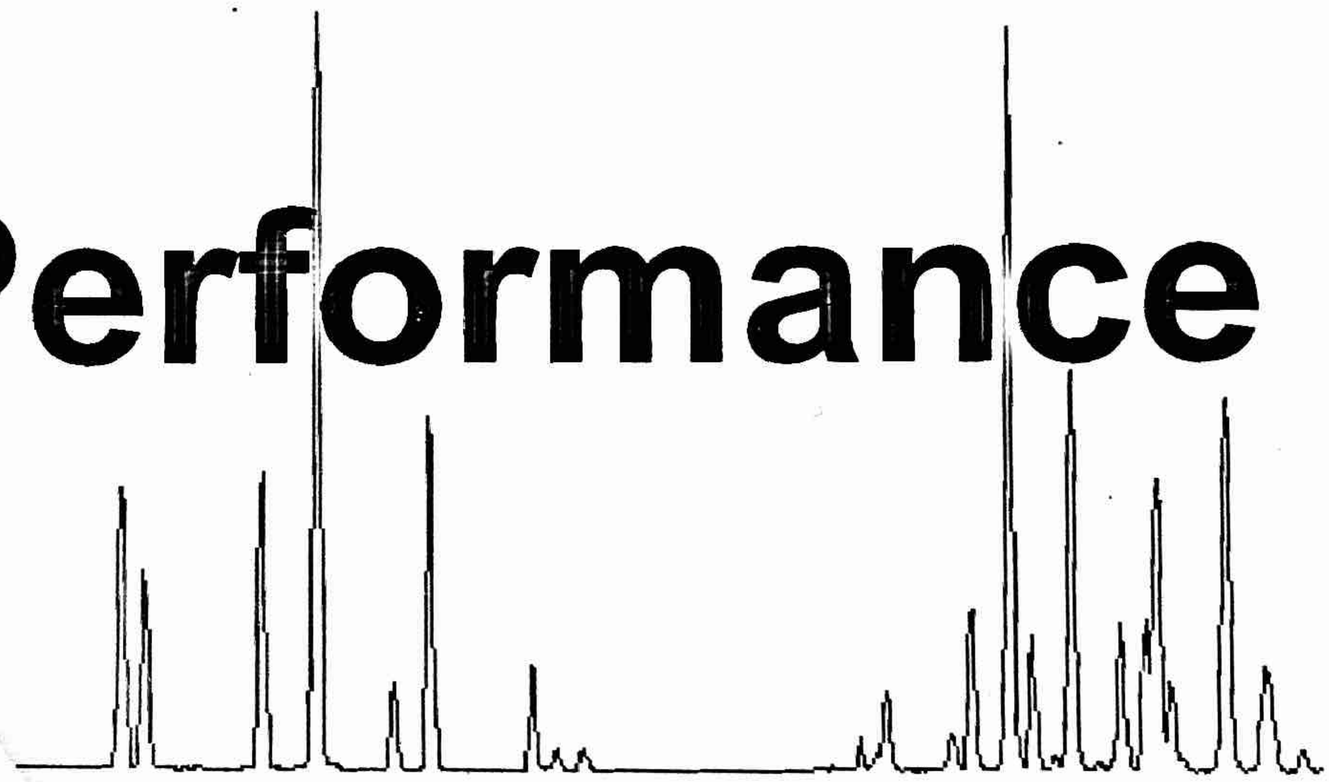
TECHNOLOGY

# SYSTEM Performance



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## Camera Overview

| Description | Model | | | | | | Serial Number |
|---|---|---|---|---|---|---|---|
| Head ▽ | DV8 | 87 | E | CS | - | FI | X-1288 |
| Controller Card | CCI-22 | | | | | | C-1288 |
| Other: | | | | | | | |
| Other: | | | | | | | |

▽ Sensor types are defined in Table 1 using the last letters in box Model Number.

| Special Feature | (✔) |
|---|---|
| Special AR coated Window | ✔ |
| $MgF_2$ Input | |
| Other (specify) | |

| A/D Feature | | |
|---|---|---|
| A/D resolution | Readout Time | Readout Speed |
| 14 bit | 100nS per pixel | 10MHz |
| 14 bit | 200nS per pixel | 5 MHz |
| 14 bit | 333nS per pixel | 3MHz |
| 14 bit ( D only ) | 1000nS per pixel | 1MHz |
| 16 bit ( E only ) | 1000nS per pixel | 1MHz |

## CCD Details

| Manufacturer / Model No. | Pixels | Serial Number |
|---|---|---|
| E2V TECH CCD65 | 576x288, 20x30$\mu m^2$ | |
| E2V TECH CCD87 | 512x512, 16$\mu m^2$ | 02342-04-13 |
| E2V TECH CCD97 | 512x512, 16$\mu m^2$ | |
| E2V TECH CCD60 | 128x128, 24$\mu m^2$ | |

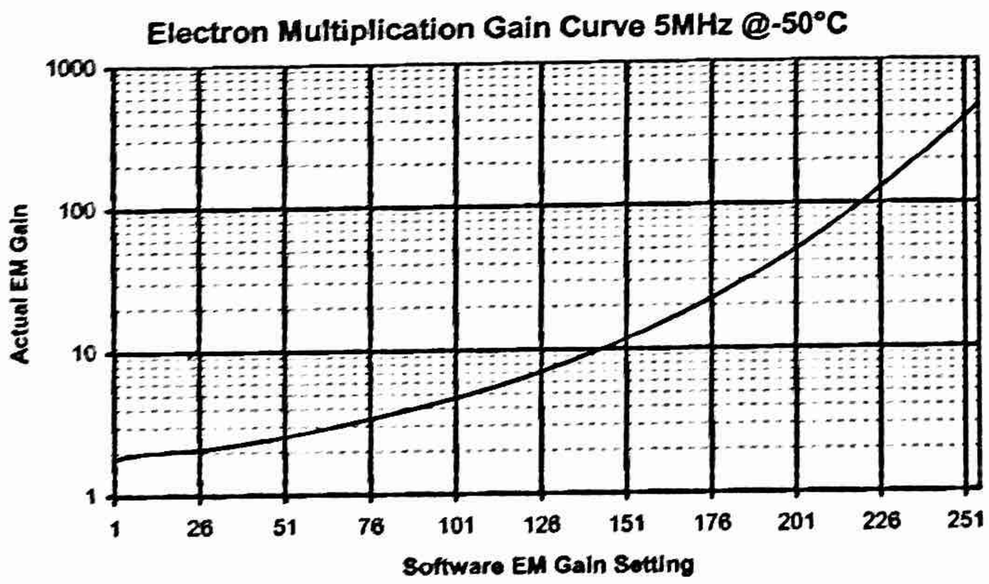
▽ *Table 1; Key code to define the meanings of the last letters in the Model Number*

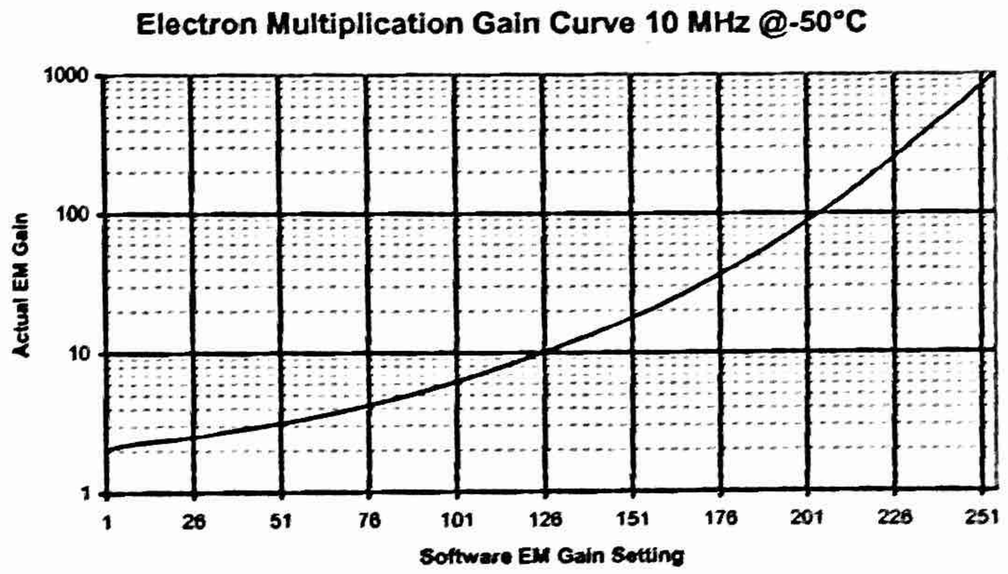
| Options | | | |
|---|---|---|---|
| **Letters** | **Sensor** | | **Window** |
| → FI | Front illuminated sensor | | Standard AR coated fused silica window |
| BV | Back illuminated sensor with 550nm AR coating | | Standard AR coated fused silica window |
| UV | Front illuminated sensor with UV phosphor | | Uncoated fused silica window |
| UVB | Back illuminated sensor with UV phosphor | | Uncoated fused silica window |

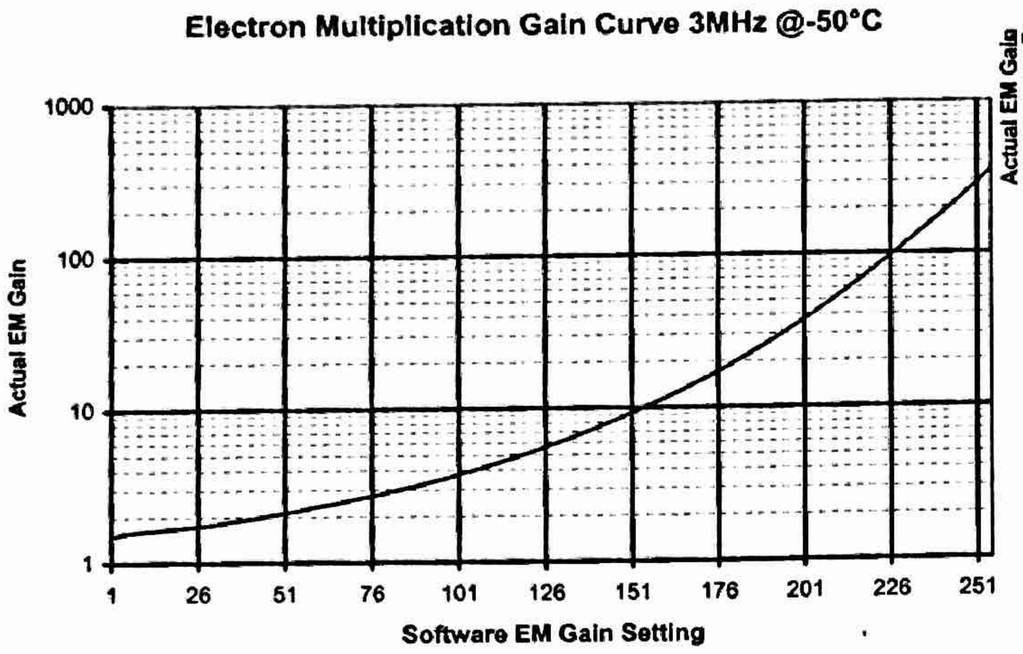
## Summary of System Test Data
### Readout Noise ♦1 *and* Base Mean Level

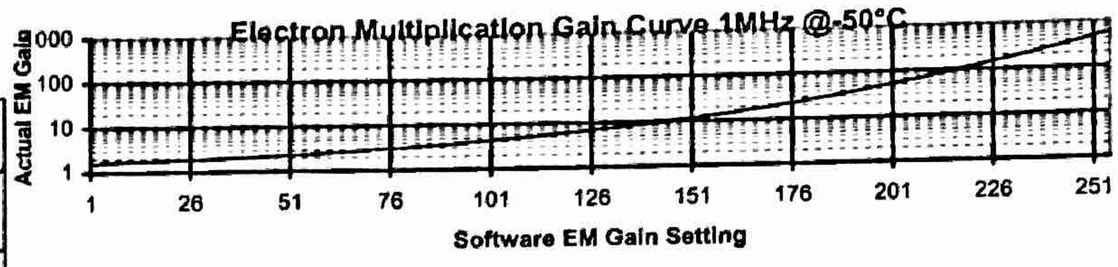
| A/D Rate | EM = electron multiplication Con = conventional | Options (✔) | CCD Sensitivity ♦3 eles per A/D count | Single Pixel Noise electrons | Base Level ♦2 (Counts) |
|---|---|---|---|---|---|
| 10 MHz 14 bit EM amplifier | | ✔ | 18 | 69.74 | 977 |
| 5 MHz 14 bit EM amplifier | | ✔ | 18 | 44.5 | 1005 |
| 3 MHz 14 bit EM amplifier | | ✔ | 18 | 30.97 | 1005 |
| 1 MHz 14 bit EM amplifier ( D only ) | | | | | |
| 1 MHz 16 bit EM amplifier ( E only ) | | ✔ | 9 | 20.92 | 1005 |
| 3 MHz 14 bit Con amplifier | | ✔ | 3 | 10.1 | 981 |
| 1 MHz 14 bit Con amplifier ( D only ) | | | | | |
| 1 MHz 16 bit Con amplifier ( E only ) | | ✔ | 2 | 9.74 | 980 |
| **Saturation Signal per pixel** (5MHz 14 bit EM amplifier) | | | 288000 | Electrons/pixel | |

## EMCCD Gain Characteristics
♦4






**Note:** Maximum Electron Multiplication Gain will reduce by approximately a factor of two for every 10°C rise in temperature. Software EM gain setting of zero equates to an actual gain of unity.

## CCD Dark Current

| | | | | |
|---|---|---|---|---|
| **Minimum Dark Current Achievable** ♦*5* | 0.0002 | electrons/pixel/sec | | |
| **@ Sensor Temperature of** ♦*6* | -90.2 | °C | 12 | °C water cooling |
| | | With PSU | | |

## Linearity and Uniformity

| | | |
|---|---|---|
| **Linearity better than** ♦*7* | 1 | % over 14 bits |
| **Response Uniformity better than** ♦*8* | 0.02 | % |

## Response Defects

| ***White/Black Spots*** ♦*9* | | (X, Y) |
|---|---|---|
| | ( X , X ) | |
| | ( X , X ) | |
| | ( , ) | |
| | ( , ) | |
| | ( , ) | |
| | ( , ) | |
| ***White/Black Columns*** ♦*10* | Column numbers indicated. | X X<br>X X |
| ***Traps*** ♦*11* | Column numbers indicated. | X X |

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## Dark Current Defects

| Hot Spots ♦12 | (X, Y) | | | |
|---|---|---|---|---|
| | (X, X) | | | |
| | (X, X) | | | |
| | ( , ) | ( , ) | ( , ) | ( , ) |
| | ( , ) | ( , ) | ( , ) | ( , ) |
| | ( , ) | ( , ) | ( , ) | ( , ) |
| **Hot Columns** ♦13 | Column numbers indicated. | X | X | |

## Test Conditions

| | | | | |
|---|---|---|---|---|
| **Readout Noise tested at** | -50 | °C with | 12 | °C water cooling |
| **Base Mean Level measured at** | -50 | °C with | 12 | °C water cooling |
| **Blemishes tested at** | -50 | °C with | 12 | °C water cooling |

## System Passed for Shipping

**Signed** D.EDGAR

**Date** 8-7-2004

## Version control information

| | POLO BOARD | CONNECTOR | DIGITAL | ANALOGUE | POWER BOARD | EEPROM VERSION |
|---|---|---|---|---|---|---|
| Hardware Version # | B | C | C | B | E | 5.12 |

| | MCD | COF | RBF |
|---|---|---|---|
| Shipping Software Version # | 1.1.41.1 | 150 | 38 |
| Testing Software Version # | 1.1.41.1 | 150 | 38 |

## Notes

**All tests are carried out with standard test card**
**Actual performance may differ slightly with supplied card, but will remain within specification**

♦1 Readout Noise is measured for single pixel readout with the CCD in darkness at temperature indicated and minimum exposure time.

♦2 Average electronic DC offset for CCD in darkness at temperature indicated and minimum exposure time under dark conditions and single pixel readout.

♦3 Sensitivity is measured in photoelectrons per A/D count from a plot of Total Noise against Signal. This quantity is not measured on individual systems.

♦4 The Electron multiplication gain characteristics on the sensor. Note that the gain achieved varies with operating temperature and may reduce slowly over time.

♦5 Dark current falls exponentially with temperature. However, for a given temperature the actual dark current can vary by more than an order of magnitude from device to device. The devices are specified in terms of minimum dark current achievable rather than minimum temperature.

♦6 Minimum temperature achieved for thermoelectric (TE) cooler set to maximum value with water cooling.

♦7 Linearity is measured from a plot of Counts vs. Signal over the 14 bit dynamic range. Linearity is expressed as a %age deviation from a straight line fit. This quantity is not measured on individual systems

♦8 RMS (root mean square) deviation from the average response of the CCD in full resolution image operation illuminated with uniform white light (defects not included).

♦9 A spot can be up to 3 pixels in size. White/black spots have signals >25% above/below the average (25% contrast) with uniform illumination across the sensor.

♦10 Columns which have ≥10 blackspots with uniform illumination across the sensor.

♦11 Pixels which absorb charge as it is clocked through the defective area. When the light source is switched off, the signal from the trap appears to drop off more slowly than the signal from the surrounding pixels.

♦12 A spot can be up to 3 pixels in size. For Grade A devices, hot spots are counted if they exhibit >50 times the maximum specified dark current at the test temperature indicated.

♦13 A column is considered defective if >10 pixels are affected, or if the column exhibits >2 times the maximum specified dark current at the test temperature indicated.