

CHIP CHARACTERISTICS  
FOR  
Tektronix tk1024A 1769BR02-01 CCD # 42

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## 1 General Description

Chip type : Tektronix tk1024A  
Chip characteristics: Grade 1,  
: back illuminated, AR coated, Indium die attach, MPP  
Chip format : 1024x1024, 50 pre-scan pixels in horizontal direction  
Pixel size :  $24 \times 24 \mu m^2$   
Serial No. : 1769BR02-01

This CCD was installed in November 1996 at the SUSI instrument at the NTT telescope as CCD # 42.

## 2 Flatness of the chip

TBD

## 3 System Setup

This chip has been tested with the ESO-VME CCD camera system.

The clock-pattern tk1024cbmpp and tk1024admpp have been used for the tests.

Parameters are set to SUBPATT 3 and GAIN 2, if not otherwise mentioned.

All tests were performed between 160 K and 180 K, if not otherwise mentioned.

## 4 Voltage Setup

See table 1 on page 2 for all voltage values.

VL01 : -7.99 VHI1 : 3.00 VL02 : -8.01 VHI2 : 3.03  
 HL01 : -1.98 HHI1 : 9.97 HL02 : -2.01 HHI2 : 10.05  
 RL01 : 0.00 RHI1 : 12.04 RL02 : 0.00 RHI2 : 12.05  
 VDD1 : 22.99 VDR1 : 13.01 VDD2 : 23.00 VDR2 : 13.00  
 VGS1 : 0.51 VSS1 : -0.01 VGS2 : 0.49 VSS2 : 0.00

Table 1: Telemetry values

## 5 Noise and Gain

Amplifier 1:

**The conversion factor** is (at GAIN = 2)

**6.227±0.173 e<sup>-</sup>/ADU.** at subpatt 1

**3.025±0.177 e<sup>-</sup>/ADU.** at subpatt 2

**1.585±0.041 e<sup>-</sup>/ADU.** at subpatt 3

**1.708±0.088 e<sup>-</sup>/ADU.** at subpatt 3 and 2x2 binning

**The readout-noise** is

**9.8±0.4 e<sup>-</sup> RMS** at subpatt 1

**7.9±0.6 e<sup>-</sup> RMS** at subpatt 2

**6.4±0.3 e<sup>-</sup> RMS** at subpatt 3

**7.3±0.3 e<sup>-</sup> RMS** at subpatt 3 and 2x2 binning

Amplifier 2:

**The conversion factor** is (at GAIN = 2)

**1.553±0.033 e<sup>-</sup>/ADU.** at subpatt 3

**The readout-noise** is

**6.4±0.2 e<sup>-</sup> RMS** at subpatt 3

The noise and gain was measured using the HP-desktop procedure “MEASURE CONFACT” at different illumination levels. This procedure takes two equal dark- and two equal flat-field exposures calculating noise and gain independent from the light level with the variance of the difference of the two flat-fields.

## 6 Pick-up Noise

At slow-mode pick-up noise of **7 e<sup>-</sup> peak to peak** could be seen at short dark exposures.

## 7 Quantum Efficiency

CCD SENSITIVITY CALIBRATION:

15 Oct 1994 13:08:05

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Detector ID       : TK10176      Detector       : Tektronix
Calibrated against : _SDC1_NP_1   Type          : TK1024A
Detector area (cm2) : 5.76E-06     ESO CCD No.   : 1203
e-/[ADU]         : 1.48         Used Output(s) : 1
System gain      : 2           Subpattern     : 3
Misc.Comments    : tk1024admpp_1769BR02-01

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CCD System values :           Scanned CCD area
-----          :           -----
Hor. act. Pixels  : 1124      First pixel    : 55
Tot. vert. Lines : 1050      Last pixel     : 1070
Hor. Binning     : 1         First line     : 5
Vert. Binning    : 1         Last line      : 1020

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Lambda [nm]	Time [sec]	Dens [log]	Temp [K]	Counts [ADU]	RQE [%]	+/- [%]	Sensitivity [A/(W/cm2)]	Photon flux [Phot/cm2]	Irradiance [W/cm2]
320	300	0.0	172.0	1121	21.90	1.13	+3.275E-07	+4.377E+06	+2.700E-12
340	300	0.0	172.0	6035	30.75	1.33	+4.869E-07	+1.679E+07	+9.780E-12
360	300	8.6	172.0	7867	39.63	1.66	+6.633E-07	+1.699E+07	+9.358E-12
380	60	8.6	172.0	8138	52.51	2.13	+9.289E-07	+6.631E+07	+3.457E-11
400	40	.4	172.0	5046	63.94	2.63	+1.185E-06	+5.064E+07	+2.520E-11
450	10	.4	172.0	5190	66.05	2.71	+1.378E-06	+2.017E+08	+8.913E-11
500	10	.7	172.0	4685	70.63	2.92	+1.640E-06	+1.703E+08	+6.763E-11
550	10	1.0	172.0	6070	74.57	3.05	+1.906E-06	+2.089E+08	+7.538E-11
600	10	1.0	172.0	7857	77.69	3.16	+2.161E-06	+2.596E+08	+8.605E-11
650	10	1.0	172.0	8745	78.22	3.15	+2.337E-06	+2.870E+08	+8.858E-11
700	10	1.0	172.0	11316	76.59	3.05	+2.488E-06	+3.793E+08	+1.077E-10
750	10	1.0	172.0	7135	70.34	2.85	+2.446E-06	+2.604E+08	+6.905E-11
800	10	1.0	172.0	8684	61.87	2.51	+2.296E-06	+3.603E+08	+8.952E-11
850	10	1.0	172.0	9116	48.09	2.00	+1.900E-06	+4.866E+08	+1.136E-10
900	10	.8	172.0	8044	34.16	1.48	+1.427E-06	+6.044E+08	+1.335E-10
950	10	.7	172.0	4913	21.85	.99	+9.623E-07	+5.771E+08	+1.208E-10
1000	20	.8	172.0	5887	10.01	.49	+4.637E-07	+7.549E+08	+1.503E-10

```

Calibration_error= 1.50% Conversion_factor_error= 3.44%
_TK10176_11 stored on /users/ms/cali:HFS at 15 Oct 1994 16:23:45

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Table: RQE measurement protocols for the CCD chip

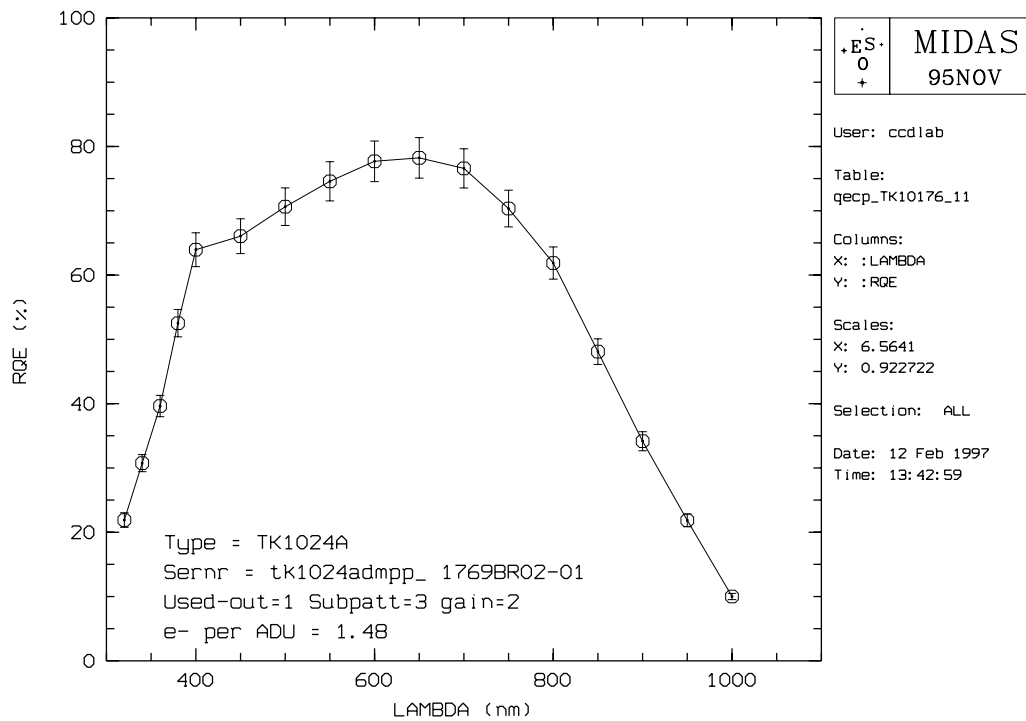


Figure 1: Plot of RQE values of the CCD (complete surface) at 170 K

The RQE was measured in an automatic mode using the test-bench computer. The quantum-efficiency values and their errors are listed below. The given error is the geometrical sum of the error of test-bench calibration (approximate 1.5%), the error of the CCD conversion factor measurement (approximate 3.4%) and of the variation of the quantum-efficiency over the whole chip surface (dependent from the light wavelength). The variation of quantum efficiency over the chip can be seen in detail in the homogeneity measurement in section 14 on page 9.

The peak value for RQE of CCD was approx. 78 % at 650 nm.

Figure 1 on page 5 shows the plot of QE for the CCD.

## 8 Charge Transfer Efficiency

The CTE was measured using Flat Field exposures and its over-scan regions and gives:

Amplifier 1:

Serial CTE = 0.9999992 and Parallel CTE = 0.999998

## 9 Dark Current

The dark current was measured with a 20 minutes dark exposures after more than 5 hours in the dark wiping the CCD every minute.

The mean dark current rate is approx.  $6.6 \pm 1.5 e^-/pixel/hour$  at 170 K.

## 10 Linearity

Linearity was measured taking exposures of the same exposure-time at different light levels and at a wavelength of 700 nm.

### Amplifier 1:

There is a maximum deviation of less than  $\pm 0.74\%$  from the average value within 3.44 decades from 82 to 223300  $e^-$  per pixel.

### Amplifier 2:

There is a maximum deviation of less than  $\pm 0.82\%$  from the average value within 2.8 decades from 370 to 230000  $e^-$  per pixel.

See figure 2 on page 6 for details.

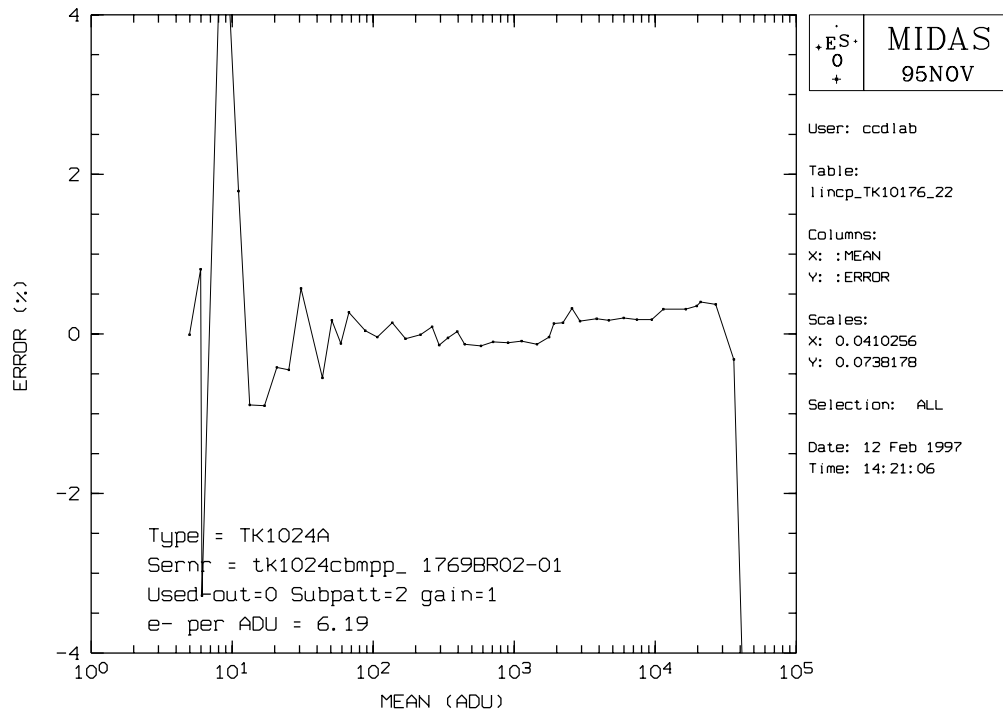


Figure 2: Linearity Measurement with amplifier 1

In view of the other problems with this CCD, the linearity was not optimized with the

voltage setup.

## 11 Full well capacity

The full well capacity was measured with flat-field exposures of high intensities in MPP-mode. The limit of linearity is reached, if at higher intensities the deviation from linearity starts to get larger than the given maximum deviation in the section 10 on page 6.

**Amplifier 1: Upper limit of linearity: 243 000 e<sup>-</sup>/pixel**  
**Saturation-value: 293 000 e<sup>-</sup>/pixel**

**Amplifier 2:**

**Upper limit of linearity: 246 000 e<sup>-</sup>/pixel**  
**Saturation-value: 273 000 e<sup>-</sup>/pixel**

Horizontal voltage has to be adjusted to prevent charge smearing at high illumination values.

## 12 Cosmic Ray Events

The Cosmic Ray Event rate was measured using our standard method (MIDAS Batch: COSMIC) to count *events* independently of their actual size.

**The cosmic ray event rate is  $3.05 + 0.25 - 0.25$  events/min/cm<sup>2</sup>.**

## 13 Blemishes

This was measured using three weak light images.

This test is very sensitive: A column defect is any defect which is longer than 10 pixels and a defect is any pixel which is lower than 50 % or higher than 200 % of the mean level of a weak light flat field exposure.

Number of hot defects:

Hot spots: 0; Hot cluster: 0; Hot columns: 0

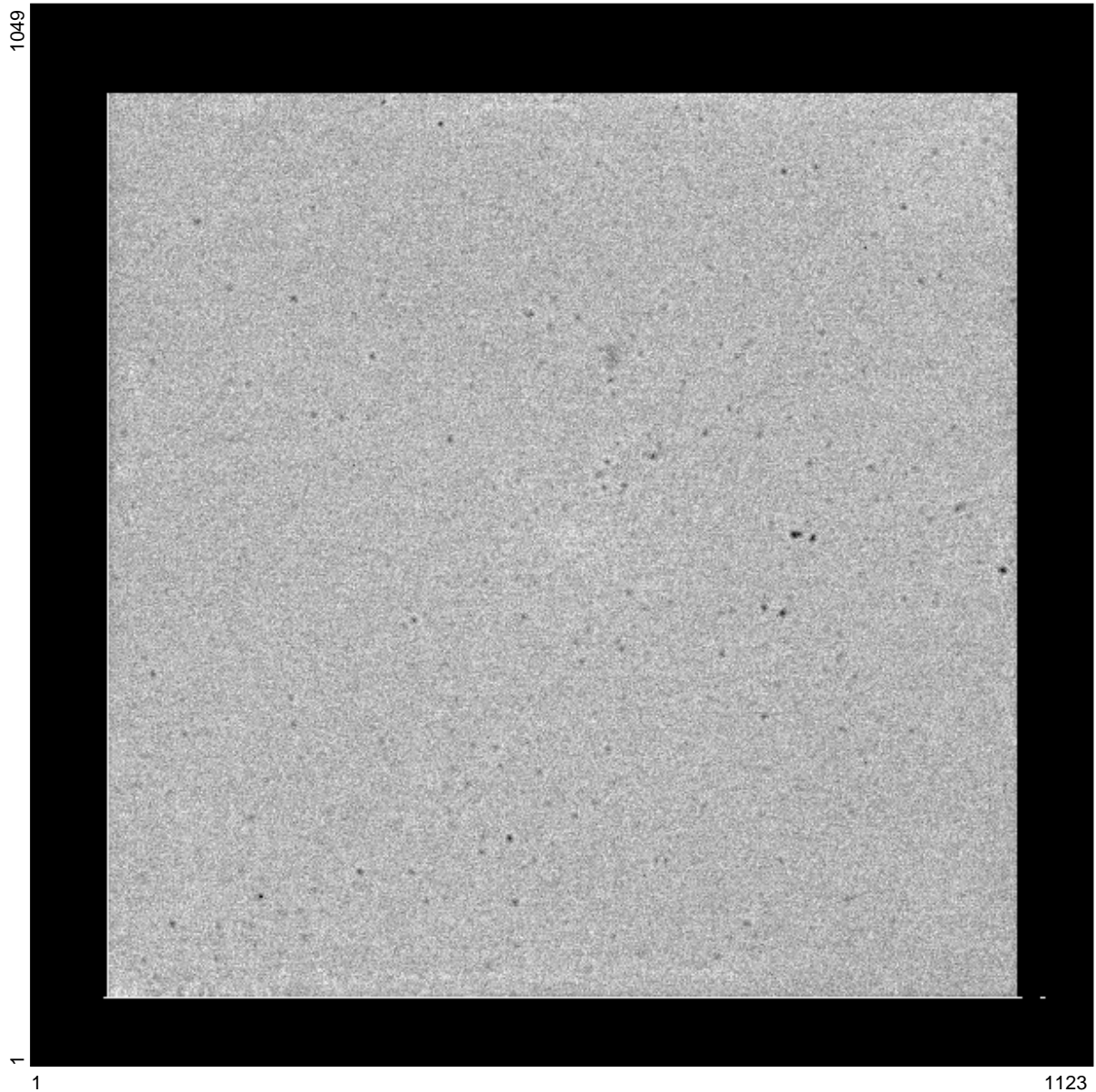
Number of dark defects:

Dark pixel: 0; Dark cluster: 1; Dark columns: 0; Traps: 1

Number of all defects: 2

We, 12 Feb 1997 15:06:23

MIDAS version: 95NOV



Frame : weakmean  
Identifier : average frame  
ITT-table : ramp.itt  
Coordinates : 1, 1 : 1123, 1049  
Pixels : 1, 1 : 600, 600  
Cut values : 358.68, 466.32  
User : ccclab

Figure 3: Weak Flat field (700nm,2.5): with amplifier 2.



## 14 Uniformity

The homogeneity was measured using a standard method of sampling the whole sensitive area and using the RMS value of it. Values of deviations from homogeneity are given in table 2 on page 9.

Flat-field exposure at a wavelength in [nm]	Maximal RMS Deviation from mean value in [%]
320	3.42
340	1.99
360	1.73
380	1.57
400	1.74
450	1.67
500	1.70
550	1.61
600	1.52
650	1.46
700	1.36
750	1.44
800	1.59
850	1.82
900	2.10
950	2.38

Table 2: Uniformity of the CCD

Fringing was not visible at different wavelengths.

## 15 Remanence

Exposure Type	Exposure Time in [sec]	Illumination in [photons/pixel]	CCD Saturation	Remanence in [e <sup>-</sup> per pixel]
FF white	1(Dens=1)	413000	0.92	—
DK	600	—	—	0
FF white	1	3635000	8.06	—
DK	600	—	—	2
DK	600	—	—	1
DK	600	—	—	1
FF white	10	36351000	80.64	—
DK	600	—	—	3
DK	600	—	—	1
DK	600	—	—	1

Table 3: Remanence of the CCD at 170 K

The Remanence test was made after 10 hours in the dark and periodical wiping at at temperature of 170 K. After a high level flat field with white light which give over-saturation on the CCD, several ten minutes dark exposures have been taken. The mean level in the centre of these dark exposures was compared with the mean level of a ten minute dark before these saturations and the remanence in  $e^-$  per pixel has been calculated. The results can be seen in table 3 on page 9.

## References

- [1] S. Deiries, M. Cullum: ESO Maintenance Manual No.5 July 89, CCD Cryostat for new VME-based Control Camera.
- [2] J. Janesick, JPL: Private communication