CHIP CHARACTERISTICS
FOR
TK 512 CB
(ESO #33)

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1 General Description

ESO S/N : # 33
Chip type : TEKTRONIX TK 512 CB, Grade 1, thinned, AR–coated
Chip format: 512x512, 50 pre–scan pixel in horizontal direction
Pixel size : 27x27 μm^2
Serial No. : 1529–CR–01–10

The chip described in this report is a thinned and anti-reflection coated (AR) Tektronix CCD.

This CCD is intended for use on OPTOPUS. It is delivered in a new assembled cryostat detector head of the old design (Model 1982).

The 50 pre–scan pixel thermally 'isolate' the amplifier from the image section; they contain no intensity information, but reflect the system offset value applied to all pixel. During test period it is recommended to read out this section. During observations the pre–scan area can easily be truncated by defining a readout window in the '*CCD Frame and Binning*' table of the CCD program. Numbering of the image in IHAP starts then with i.e 51 and ends with 562. It is however possible to suppress these pre–scan pixels already in the CCD system so the first active pixel would have number 1, but this could lead to confusion if sometimes the first active pixel is at X1 and sometimes at X51.

This CCD has been tested with the ESO VME CCD Camera system and the old Cryostat-head (that is delivered) and an adapter-box, that contains the pre-amplifier, but it is also operable with the Princeton GEN5 system.

2 Interconnection

Same cables required as for all RCA and GEC CCDs, if used with the PSI CCD Control Camera.

If used with the VME system, additional the adapter box and the usual VME system cryostat cables are necessary. In this case it is useful, to have very short cables between the cryostat and the adapter box.

The outer wiring of the CCD dewar head is compatible with all other CCD heads with the 'old' design. Before connecting the video-cable with the CCD-dewar be sure, that there is **no** remaining conductive foam in the video sleeve at the cryostat. This would produce a short-cut and could damage the chip.

3 System Setup

At present this chip can be used with the PSI GEN5 CCD– and with the ESO-VME CCD camera system.

The C-amplifier is used. Most parameters are set to their correct values by executing the FORTH file TEKC[1]. With the VME-system the clock-pattern Tk512c[2] is used.

The preamp current is controlled by a 20 kOhm resistor, that is the nominal VOC load.

All tests were performed at 142 K or 162 K, if not otherwise stated. The optimal operation temperature is 150 - 165 K.

The cryostat has a hold time of about 33 hours at this temperature on condition that the vacuum is good (1E-6 mbar) and the liquid nitrogen filling is done at this temperature of 162 K.

4 Voltage Setup

See table 1 on page 3 for all voltage values. Please note that especially the values VDR, VDD, RLO and RHI have a rather high influence on the gain. They should be adjusted as accurate as possible.

[1] See [6] for details
[2] see [1] for details

VLO1	-8.00	VHI1	+3.00	VLO2	-8.00	VHI2	+3.00
HLO1	-5.00	HHI1	+5.30	HLO2	-5.00	HHI2	+5.30
RLO1	0.00	RHI1	+12.00	RLO2	0.00	RHI2	10.50
VDD1	+23.00	VDR1	+13.60	VDD2	+15.00	VDR2	+1.10
VGS1	-3.00	VSS1	0.00	VGS2	0.00	VSS2	0.00

Table 1: Telemetry values

5 Noise and Gain

The conversion factor during our tests **is** 3.58 ± 0.07 **e^-/ADU.**

This and all other tests have been done with the ESO-VME CCD camera system.

The system gain was set to high (SUBPATT 3 GAIN 2).

The readout-noise is approx. 8.7 ± 0.5 **e^- RMS.**

The noise and gain was measured using HP-desktop procedure "MEASURE CONFACT" at different illumination levels.

It can be also measured using the IHAP batch 'CONTHO' at illumination levels around 8 000 counts (16 bit ADC).

To achieve these values a connection from the signal ground of the CCD camera to the cryostat case was necessary.

6 Quantum Efficiency

The RQE was measured using an automatic mode, using the test-bench computer. The values listed below might be no more accurate than ±3% (relative), because the measurement of CCD conversion gain in e^-/ADU is the biggest uncertainty. We have assumed the worst case for the quantum efficiency.

The peak value for RQE of CCD was around 80.3 % at 650 NM.

Figure 1 on page 5 shows a plot of the obtained values.

To get an optimal UV–quantum efficiency **and** a fairly low dark current the operating temperature has to be set to less or equal 162 K.

7 Charge Transfer Efficiency

The Charge Transfer Efficiency (CTE) is measured using a flat-field exposure and the IHAP batch "CTE". With the first two overscan pixels of all rows can be calculated the Serial and with the first two pixels of all columns can be calculated the Parallel CTE.

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CCD SENSITIVITY CALIBRATION:                                    4 Dec 1992   11:30:41
===========================

Detector ID          : T5_01_10cr
Calibrated against   : MEAN [ADU]
Detector area (cm2)  : 7.29E-06
e-/[ADU]             : 3.87
System gain          :     2    Subpattern          :     3
Misc.Comments        : thinned,AR-coated,C-Amp.

CCD System values    :          Scanned CCD area
-----------------    :          ----------------
Hor. act. Pixels     :   570    First pixel         :   270
Tot. vert. Lines     :   520    Last pixel          :   310
Hor.  Binning        :     1    First line          :   250
Vert. Binning        :     1    Last line           :   290


Lambda Time  Dens  Temp Counts  RQE  Sensitivity Photon flux  Irradiance
  [nm] [sec] {log}  [K]  [ADU]  [%]  [A/(W/cm2)]  [Phot/cm2}   [W/cm2]
*******************************************************************
   320   300  0.0  141.6   582 28.69  +5.429E-07  +3.588E+06  +2.213E-12
   340   300  0.0  141.6  3643 41.10  +8.236E-07  +1.568E+07  +9.134E-12
   360   300  8.6  141.6  4202 47.84  +1.014E-06  +1.554E+07  +8.563E-12
   380    60  8.6  141.6  4153 57.78  +1.294E-06  +6.359E+07  +3.315E-11
   400    40  0.0  141.6  5525 69.01  +1.619E-06  +1.063E+08  +5.287E-11
   450    10  0.0  141.6  5124 70.38  +1.859E-06  +3.865E+08  +1.708E-10
   500    10   .3  141.6  5405 75.79  +2.227E-06  +3.786E+08  +1.504E-10
   550    10   .7  141.6  5061 78.84  +2.550E-06  +3.408E+08  +1.230E-10
   600    10   .9  141.6  4715 80.28  +2.827E-06  +3.118E+08  +1.034E-10
   650    10   .9  141.6  5220 78.87  +2.982E-06  +3.514E+08  +1.085E-10
   700    10   .9  141.6  6487 76.67  +3.152E-06  +4.492E+08  +1.275E-10
   750    10   .9  141.6  4302 67.83  +2.985E-06  +3.367E+08  +8.929E-11
   800    10   .6  141.6  8177 59.97  +2.817E-06  +7.238E+08  +1.799E-10
   850    10   .8  141.6  6322 45.55  +2.278E-06  +7.368E+08  +1.720E-10
   900    10   .4  141.6  6566 30.86  +1.631E-06  +1.129E+09  +2.494E-10
   950    10  0.0  141.6  8092 18.68  +1.041E-06  +2.299E+09  +4.815E-10
  1000    20  0.0  141.6  9339  7.74  +4.536E-07  +3.204E+09  +6.378E-10

File _T5_01_1_1 stored on :,800,0,4 at  4 Dec 1992 12:19:13
```

Table 2: RQE measurement protocol for the CCD chip at a temperature of 141.6 K

Parallel CTE = 0.9999988 and Serial CTE = 0.9999966

8 Dark Current

The dark current was measured with three one hour dark exposures at temperatures of 143.5 K and 162 K.

The mean dark current rate is 0.5 ± 0.2 $e^-/pixel/hour$ **at 143.5 K The mean dark current rate is** 6.5 ± 1 $e^-/pixel/hour$ **at 162 K**

9 Linearity

Linearity was measured taking 10 sec exposures at different light levels at 700 NM from about 4 electrons/pixel up to 6.9 $\cdot 10^5$ electrons/pixel. There is a maximum deviation from the mean value of $\pm 0.7\%$ over these 4.2 decades and of $\pm 2.0\%$ over these 5.2 decades. This measurement is limited in the low light region from shot-noise and in the high light region from the precision of the current measurement device (measuring the

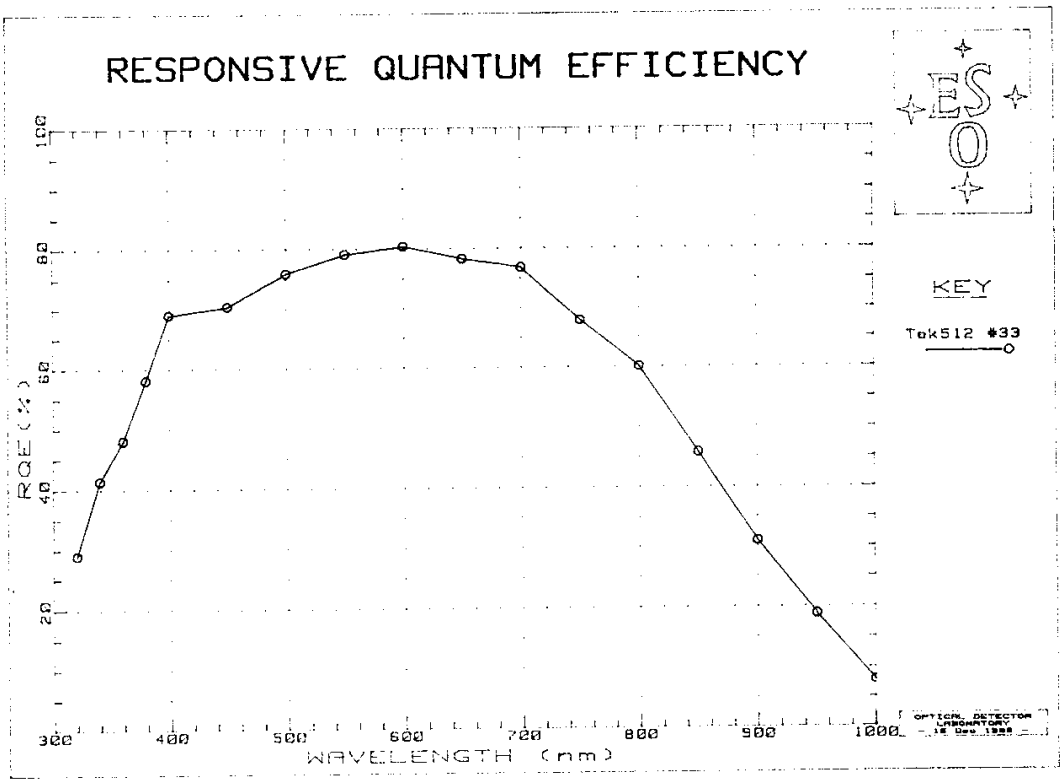

Figure 1: Plot of RQE values of the CCD chip

photo-current of the reference diode).

10 Full well capacity

The saturation value (capacity of one pixel) or so called

full well capacity is $6.9 \pm 0.3 \cdot 10^5$ **e$^-$ per pixel.**

The linearity limit (deviation $> 0.7\%$) is $5.8 \pm 0.3 \cdot 10^5$ **e$^-$ per pixel.**

11 Cosmic Ray Events

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

The cosmic ray event rate is 2.9 ± 0.2 $events/min/cm^2$**.**

This value is usual for thinned Tektronix CCDs.

12 Blemishes

There are no blemishes at all (e.g.: warm or hot spots, warm, hot or dark lines and traps) on high and low light level and dark exposures.

13 Uniformity

The flat-field exposures show no blemishes. Values of deviations from homogeneity are given in table 3.

Flat-field exposure at a wavelength in [NM]	Maximal RMS Deviation from mean value in [%]
340	1.55
400	1.35
550	1.25
700	1.20
850	1.25
1000	1.25

Table 3: Uniformity of the CCD

14 Remanence and Blooming

No significant higher Remanence and Blooming was noted as compared with other thinned Tektronix CCDs.

References

[1] Roland Reiß: The VME-CCD Camera: Universal Introduction

[2] IBM. PC–DOS 3.10 Reference Manual.

[3] IBM. IBM XT Hardware Reference Manual.

[4] Princeton Scientific Instruments. GEN5 Hardware Manual.

[5] Princeton Scientific Instruments. GEN5 Software Manual.

[6] Roland Reiß. Operating Manual for GEN5 System.

[7] Miller. FORTH Compiler Manual.

[8] Tektronix Inc. CCD IMAGERS Data Sheet.