# Detailed functional tests for DAS/CCD3 software
# CCD3 program functionality (CCD detectors only)

Date:      30/9 - 2009
Author:     Jacob Wang Clasen, NOT.
Version:    30/9 - 2009, Initial version.
               13/11 – Comments by AiC.
               20/4 – 2010 – Update based on real functionality at this point.

| Test number | **5** |
|---|---|
| Test name | **CCD3 functionality (CCD detectors only)** |
| Test document | **05-test-CCD3, with appendix 1 (Current NOT CCD control program and sequencer (external) commands)** |
| Depends on test | 1, Controller hardware tests (beyond the scope of this test document) |
| Require-ments | 1) The CCD3 programme shall be able to control the following types of exposures by sending the low-level commands described in ref. 8 of the ODF-TEST document to the camera controller electronics:<br>- dark (i.e. shutter remains closed during exposure)<br>- multiple dark exposures (executed as one command)<br>- normal (i.e. shutter operated during exposure)<br>- multiple normal exposures (executed as one command)<br>- focus exposure (I.e. multiple shutter openings/closings (sub-exposures) without readout between them, except after the last sub-exposure) and telescope/focus offset between the sub-exposures.<br><br>2) The CCD3 programme shall through commands control all geometry related functions of the controller, these being X-size, Y-size, X-begin, Y-begin, X-binning, Y-binning, on-chip overscan and prescan and artificial overscan and prescan.<br><br>3) The control of the in 1) and 2) mentioned shall be made using commands that has the same name and functionality as those currently used at the NOT (see ref. 2 of the ODF-TEST document) (Addendum 20/4-2010: It is only required that the NOT sequencer commands has the same name and functionality as those currently used at the NOT).<br><br>4) The CCD3 programme / detector controller shall be able to hold an on-going exposure and resume it, implementing the commands "hold" and "resume" (Addendum 20/4-2010: "as NOT sequencer commands. Underlying commands can/may be different"). When an exposure is on hold, the shutter shall be closed. |

5) The CCD3 programme / detector controller shall be able to add or subtract exposure time from an on-going exposure, providing the command "ADDTIME" (Addendum 20/4-2010: "as NOT sequencer commands. Underlying commands can/may be different"). If a negative number greater than the exposure time left is given, the exposure shall be ended, the shutter closed and the detector read out, like if the exposure had ended normally.

6) The CCD3 programme shall be able to forcefully read out the detector, implementing the command "readout" (Addendum 20/4-2010: "as NOT sequencer commands. Underlying commands can/may be different"). When the command is given the shutter (if open) shall be closed and the detector read out.

7) The CCD3 programme shall descramble (i.e. recompose the stream of pixels read from the camera controller into a geometric structure identical to the one the pixels have on the CCD detector) the pixel data from up to two amplifiers per CCD detector (normally referred to as amplifier A and amplifier B)

8) The CCD3 programme or camera controller shall implement the concept of "SHUTTER_DELAY" allow to correct the effective exposure time to send to the controller in such a way that the CCD is exposed for the desired time. This to account for the latency the hardware shutter has in opening and closing.

9) The CCD3 programme shall store the image in a way that is tested according to test number 1.

10) The CCD3 programme shall be able to control parameters connected with the image storage, such as (but not limited to) automatic storage of images after readout (autosave on/off), the filename, path and computer on which the image is stored. The commands for controlling these functions shall be as defined in ref. 2 of the ODF-TEST document.

11) The CCD3 programme shall provide a command or a macro so the user can set the value of the FITS header keywords "OBSERVER", "OBJECT" and "COMMENT" prior to the storage of the image on disk (Falls outside normal operation with external FITS information module, but is still a highly usefull and therefore relevant function to test).

12) The CCD3 programme shall provide a command or a macro so the user can set the value of the FITS header keywords "IMAGETYP", "OBS_MODE" and "IMAGECAT" prior to the storage of the image on disk (Falls outside normal operation with external FITS information module, but is still a highly usefull and therefore relevant function to test) .

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| | 13) The CCD3 programme shall display the image in a DS9 image display after the readout has been completed. It is desirable if the image is displayed during readout<br><br>14) The CCD3 programme shall give error (and/or any other applicable) messages when the user gives a (series of) command(s) that will result in a technically impossible or conflicting action. |
| Circum-stances | – The CCD3 system shall be running, connected to a detector controller, controlling a CCD or reading out a dummy test pattern.<br>– All commands referred to here are NOT sequencer commands executed in a terminal window.<br>– The setup option to select each amplifier in it's own separate image extension shall be selected.<br>– The directory "/data/test_21" shall exist on the disk of the computer on which the CCD3 system is running. This directory shall have permissions such that the user of which the CCD3 program is running is allowed to store files there.<br>– The directory "/data/test_22" shall exist on the disk of the computer on which the CCD3 system is running. This directory shall have permissions such that the user of which the CCD3 program is running is **not** allowed to store files there.<br>– Except where stated otherwise in the test descriptions, the option to automatically store images after readout shall be active/set/chosen. |
| Test descrip-tions | Subtest 5.1 (dark):<br>The commands "ampl A" followed by "exp 60" shall be given in the CCD3 command window. Before the exposure time has elapsed, the command "READOUT" shall be given. The command "ampl" shall also be given with arguments that are outside their allowed ranges.<br><br>Subtest 5.2 (dark):<br>The commands "ampl B" followed by "dark 60" shall be given in the CCD3 command window. Before the exposure time has elapsed, the command "ADDTIME 60" shall be given. The command "dark" shall also be given with a negative exposure time, a letter as argument instead of a number and an exposure time greater than the maximum allowed.<br><br>Subtest 5.3 (dark):<br>The commands "ampl AB" followed by "dark 60" shall be given in the CCD3 command window. After 10 seconds, the command "ADDTIME -30" shall be given.<br><br>Subtest 5.4 (bias):<br>The commands "ampl A" followed by "dark 0" (command name: "bias", TBD) shall be given.(20/4-2010: deleted: "in the CCD3 command window") |

Subtest 5.5 (exp):
The command "ampl A" followed by "expose 10" shall be given (20/4-2010: deleted: "in the CCD3 command window"). Before the exposure time has elapsed, the command "IMTYPE SCIENCE" shall be given. The command "expose" shall also be given with a negative exposure time, a letter as argument instead of a number and an exposure time greater than the maximum allowed.

Subtest 5.6 (exp):
The command "ampl A" followed by "bin 2" followed by "expose 10" shall be given (20/4-2010: deleted: "in the CCD3 command window"). Before the exposure time has elapsed, the command "OBJECT "test"" shall be given. The command "OBJECT" with an argument containing special characters, such as ",', ~ ,#, *, &, ^, $, !, {, }, [, ], @ shall also be given.

Subtest 5.7 (exp):
The command "ampl A" followed by "bin 3" followed by "expose 10" shall be given (20/4-2010: deleted: "in the CCD3 command window"). Before the exposure time has elapsed, the command "OBSERVER "test"" shall be given.

Subtest 5.8 (exp):
The command "ampl B" followed by "expose 10" shall be given (20/4-2010: deleted: "in the CCD3 command window"). When the exposure is on-going, the command "IMTYPE CALIB" shall be given.

Subtest 5.9 (exp):
The command "ampl AB" followed by "expose 30" shall be given (20/4-2010: deleted: "in the CCD3 command window"). No "IMTYPE" command shall be given. During the exposure the command "HOLD" shall be given, followed by the command "RESUME".

Subtest 5.10 (focusexp):
The command "ampl A" followed by "focusexpose 23600 20 10" shall be given (20/4-2010: deleted: "in the CCD3 command window").

Subtest 5.11 (focusexp):
The command "ampl B" followed by "focusexpose 23600 20 10" shall be given (20/4-2010: deleted: "in the CCD3 command window").

Subtest 5.12 (focusexp):
The command "ampl AB" followed by "focusexpose 23600 20 10" shall be given (20/4-2010: deleted: "in the CCD3 command window").

Subtest 5.13 (mdark):
The command "ampl A" followed by "mdark 10 15" shall be given (20/4-2010: deleted: "in the CCD3 command window") . Before the exposure time has elapsed, the command "COMMENT "test comment"" shall be given.

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| | Subtest 5.14 (mdark):<br>The command "ampl B" followed by "mdark 10 15" shall be given  (20/4-2010: deleted: "in the CCD3 command window"). Before the exposure time has elapsed, the command "COMMENT 1 "test comment"" (or equivalent) shall be given.<br><br>Subtest 5.15 (mdark):<br>The command "ampl AB" followed by "mdark 10 15" shall be given (20/4-2010: deleted: "in the CCD3 command window").<br><br>Subtest 5.16 (mexp):<br>The command "ampl A" followed by "mexpose 10 15" shall be given (20/4-2010: deleted: "in the CCD3 command window").<br><br>Subtest 5.17 (mexp):<br>The command "ampl B" followed by "mexpose 10 15" shall be given (20/4-2010: deleted: "in the CCD3 command window").<br><br>Subtest 5.18 (mexp):<br>The command "ampl AB" followed by "mexpose 10 15" shall be given (20/4-2010: deleted: "in the CCD3 command window").<br><br>Subtest 5.19 (windowing):<br>The commands "xbegin 1", "ybegin 1", "xsize 400", "ysize 500" and "expose 10" shall be given (20/4-2010: deleted: "in the CCD3 command window") .<br><br>Subtest 5.20 (windowing):<br>The commands "xbegin 201", "ybegin 301", "xsize 400", "ysize 500" and "expose 10" shall be given  (20/4-2010: deleted: "in the CCD3 command window"). The commands "xbegin", "ybegin", "xsize" and "ysize" shall also be given with arguments that are outside their allowed ranges.<br><br>Subtest 5.21 (image storage control):<br>The command "impath /data/test_21" shall be given.<br><br>Subtest 5.22 (image storage control):<br>The command "impath /data/test_22" shall be given.<br><br><br>Subtest 5.23 (image storage control):<br>The command "impath /data/test_23" shall be given.<br><br>Subtest 5.24 (image storage control):<br>The command "autosave_off" followed by "expose 10" shall be given. |
| Criterias | The result is acceptable and thus the test is PASSED when<br><br>Common:<br>–   The CCD3 programme does not freeze (i.e. does not stop responding or doing the actions it would normally do) under any of the specific tests |

described in this document.

– The image produced by the CCD3 programme is binned by the value specified  using the command "BIN", "XBIN"  or "YBIN" up to a binning of 1,2 or 3. (20/4-2010: delete: "or a maximum of half the size of the readout window used").

– The image is displayed in a DS9 image display window as it is read out (not a NOT requirement) and when the whole image is read out.

– The commands mentioned in "requirements, 3." in this document are as listed in ref.2 of the ODF-TEST document (20/4-2010: There is not need for the internal CCD3COMM commands to live up to this criteria, only the NOT sequencer commands).

– The commands mentioned in "requirements, 3." in this document implements syntax check to assure that their arguments are within allowed range and type (TBD). (20/4-2010: There is not need for the internal CCD3COMM commands to live up to this criteria, only the NOT sequencer commands).

– The filenames of the images produced follows the same naming rules as the current BIAS program used (see ref. 3 of the ODF-TEST document).

– The filenames are prepended with an instrument specific prefix that can be set in the configuration file (see ref. 3 of the ODF-TEST document).

– The instrument specific prefix is "AL" for ALFOSC, "ST" for StanCam, "FI" for FIES and "NC" for NOTCam.


For subtest 5.1:
The command "exp 60" results in the following:
– The CCD is cleared.
– The CCD is read out via amplifier "A" after the command "readout" has been given.
– The exposure time is written in the value of the corresponding FITS keyword.
– The difference between the absolute time recorded in the CCD3 programme as the start of the exposure and the absolute time the detector start to be exposed shall be less than 0.001 second.
– The image is stored on disk in the directory specified using the proper setup file keyword ("IMPATH" or "IMAGEPATH" or similar).
– The coordinates of the individual pixels in the resulting image is identical to the coordinates of the same pixels on the CCD detector.
– The command "ampl" called with arguments outside their allowed ranges results in an error message and the illegal value is not applied.

For subtest 5.2:
The command "dark 60" results in the same as for subtext 5.1 with the

difference that
- The command "addtime 60" results in the total integration time being 120 seconds.
- The shutter remains closed throughout the exposure.
- The CCD is read out after 120 seconds via amplifier "B".
- The command "dark" called with a negative exposure time, a letter as argument or an exposure time greater than the maximum allowed results in an error message and the illegal value is not applied.

For subtest 5.3:
The command "dark 60" results in the same as for subtest 5.1 with the difference that
- The command "addtime -30" results in the total integration time being 30 seconds.
- The CCD is read out after 30 seconds via amplifier "A" and "B" simultaneously.

For subtest 5.4:
The command "dark 0" results in the same as for subtest 5.1 with the difference that
- The CCD is read out immediately via amplifier "A".
- The FITS keyword "IMAGETYP" has the value "BIAS". (20/4-2010: Note that this is still a valid criteria allthough the keyword is managed differently).

For subtest 5.5:
The command "expose 10" results in the following:
- The CCD is cleared.
- The shutter is opened for the whole exposure time. The actual integration time sent to the hardware takes into account the latency the shutter has in opening and closing in such a way that the integration time sent to the hardware results in an exposure time of 10.00 seconds.
- The CCD is read out via amplifier "A" after the exposure time.
- The exposure time is written in the value of the corresponding FITS keyword.
- The difference between the absolute time recorded in the CCD3 programme as the start of the exposure and the absolute time the detector start to be exposed shall be less than 0.001 second.
- The image is stored on disk in the directory specified using the proper setup file keyword ("IMPATH" or "IMAGEPATH" or similar).
- The coordinates of the individual pixels in the resulting image is identical to the coordinates of the same pixels on the CCD detector.
- The FITS keyword "IMAGETYP" has the value "SCIENCE". (20/4-2010: Note that this is still a valid criteria allthough the keyword is managed differently)
- The command "expose" called with a negative exposure time, a letter as argument or an exposure time greater than the maximum allowed results in an error message and the illegal value is not applied.

For subtest 5.6:

The command "bin 2" results in the CCD being binned by 2 in the x and y direction.

The command "expose 10" results in the same as for subtest 5.5 with the difference that

- The value of the FITS keyword "IMAGETYP" is " " (i.e. an empty string).
- The FITS keyword "OBJECT" has the value "test" when the argument to the "OBJECT" command is "test".
- The FITS keyword "OBJECT" has the value of the argument to the command "OBJECT", also when this contains the special characters tested.


For subtest 5.7:

The command "bin 3" results in the CCD being binned by 4 in the x and y direction.

The command "expose 10" results in the same as for subtest 5.5 with the difference that

- The value of the FITS keyword "OBJECT" is " " (i.e. an empty string)
- The FITS keyword "OBSERVER" has the value "test".


For subtest 5.8:

The command "expose 10 " results in the same as for subtest 5.5 with the difference that

- The CCD is read out via amplifier "B".
- The value of the FITS keyword "OBSERVER" is preserved from the previous exposure (in subtest 5.6) and until it is changed.
- The FITS keyword "IMAGETYP" has the value "CALIB".


For subtest 5.9:

The command "expose 30" results in the same as for subtest 5.5 with the difference that

- The command "hold" is given, the shutter closes.
- The command "resume" is given, the shutter opens.
- The CCD is read out via the amplifiers "A" and "B" simultaneously.
- The exposure time is written in the value of the corresponding FITS keyword.
- The difference between the absolute time recorded in the CCD3 programme as the start of the exposure and the absolute time the detector start to be exposed shall be less than 0.001 second.
- The exposure time written in the value of the above FITS keyword is the sum of the periods where the shutter is open.


For subtest 5.10:

The command "focusexpose 23600 20 10" results in the same as for subtest 5.5 with the difference that

- Before the exposure is started, the telescope focus is moved to position 23600 via the execution of the sequencer command "focus-position 23600".
  1) After 10 seconds exposure time the shutter closes, but the CCD is not read out.

2) After the shutter closes, the telescope is offset 20 arcsec in the CCD y direction via the execution of the sequencer command "teloffset 0 20".
3) After the telescope has been offset, the shutter opens for 10 seconds

- Step 1 to 3 is repeated until the number of focus sub-exposures (as defined in the setup file) has been reached.
- Before the last sub-exposure, the telescope is offset 20 arcsec in the CCD x direction.
- The CCD is read out via amplifier "A" after the exposure time.
- The exposure time FITS keyword has the value of "10.00".
- The external FITS information is collected at the start of the first sub-exposure.
- The FITS keyword "TM_START" and "DATE-OBS" has the value that corresponds to the start of the exposure of the CCD (i.e. start of first sub-exposure).
- The FITS keyword "TM_END" has the value that corresponds to the end of the exposure of the CCD (i.e. end of last sub-exposure).
- The FITS keyword "DATE-AVG" has the value that corresponds to the midpoint in time between the opening of the shutter of the first sub-exposure and the closing of the shutter of the last sub-exposure.

For subtest 5.11:
The command "focusexpose 23600 20 10" results in the same as for subtest 5.10 with the difference that
- The CCD is read out via amplifier "B".

For subtest 5.12:
The command "focusexpose 23600 20 10" results in the same as for subtest 5.10 with the difference that
- The CCD is read out via amplifiers "A" and "B" simultaneous.

For subtest 5.13:
The command "mdark 10 15" results in the same as for subtest 5.1 with the difference that
- 15 consecutive dark exposures are made.
- The FITS keyword "COMMENT" has the value "test comment" in the FITS header of the first image.
- The FITS keyword "IMAGETYP" has the value "DARK" in the FITS header of all 15 images.

For subtest 5.14:
The command "mdark 10 15" results in the same as for subtest 5.1 with the difference that
- 15 consecutive dark exposures are made.
- The CCD is read out via amplifier "B".
- The FITS keyword "COMMENT" has the value "test comment" in the FITS header of all 10 images.
- The FITS keyword "IMAGETYP" has the value "DARK" in the FITS header of all 15 images.

For subtest 5.15:

The command "mdark 10 15" results in the same as for subtest 5.1 with the difference that
- 15 consecutive dark exposures are made.
- The CCD is read out via amplifiers "A" and "B" simultaneously.
- The FITS keyword "IMAGETYP" has the value "DARK" in the FITS header of all 15 images.

For subtest 5.16:
The command "mexpose 10 15" results in the same as for subtest 5.5 with the difference that
- 15 consecutive exposures are made.
- The FITS keyword "IMAGETYP" has the value "" (empty) in the FITS header of all 15 images.

For subtest 5.17:
The command "mexpose 10 15" results in the same as for subtest 5.5 with the difference that
- 15 consecutive exposures are made.
- The CCD is read out via amplifier "B".
- The FITS keyword "IMAGETYP" has the value "" (empty) in the FITS header of all 15 images.

For subtest 5.18:
The command "mexpose 10 15" results in the same as for subtest 5.5 with the difference that
- 15 consecutive exposures are made.
- The CCD is read out via amplifiers "A" and "B" simultaneously.
- The FITS keyword "IMAGETYP" has the value "" (empty) in the FITS header of all 15 images.

For subtest 5.19:
The command "expose 10" results in the same as for subtest 5.5 with the difference that
- A window of the CCD will be read out.
- This window begins at pixel number 1 (the first pixel) in the x and y direction.
- This window ends at pixel number 500 (the last pixel) in the x and y direction.
- The values of the corresponding FITS keywords in the image header corresponds to this geometry.

For subtest 5.20:
The command "expose 10" results in the same as for subtest 5.5 with the difference that
- A window of the CCD will be read out.
- This window begins at pixel number 201 (the first pixel) in the x direction
- This window begins at pixel number 301 (the first pixel) in the y direction.
- This window ends at pixel number 600 (the last pixel) in the x direction.
- This window ends at pixel number 800 (the last pixel) in the y direction.
- The values of the corresponding FITS keywords in the image header

corresponds to this geometry.
– The commands "xbegin", "ybegin", "xsize" and "ysize" called with arguments outside their allowed ranges results in an error message and the illegal value is not applied.

For subtest 5.21:
The command "impath /data/test_21" results in the path for image saving is set to "/data/test_21".

For subtest 5.22:
– The command "impath /data/test_22" results in an error message stating that the user does not have permissions to save the image in this directory.
– The illegal value is not applied.

For subtest 5.23:
– The command "impath /data/test_23" results in an error message stating that the directory does not exists.
– The illegal value is not applied.

For subtest 5.24:
The command "expose 10" results in that
– The CCD is cleared.
– The shutter is opened for the whole exposure time. The actual integration time sent to the hardware takes into account the latency the shutter has in opening and closing in such a way that the integration time sent to the hardware results in an exposure time of 10.00 seconds.
– The CCD is read out via amplifier "A" after the exposure time.
– The image is not stored on disk.
– The coordinates of the individual pixels in the resulting image is identical to the coordinates of the same pixels on the CCD detector.
– The command "expose" called with a negative exposure time or an exposure time greater than the maximum allowed results in an error message and the illegal value is not applied.

| Result | |
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| | ❑ Subtest 5.1 PASSED. Tested by _____ on ____ / ____ 20____ <br><br> Signed _____ <br><br><br> ❑ Subtest 5.2 PASSED. Tested by _____ on ____ / ____ 20____ <br><br> Signed _____ <br><br><br> ❑ Subtest 5.3 PASSED. Tested by _____ on ____ / ____ 20____ |

Signed _____

❏ Subtest 5.4 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.5 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.6 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.7 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.8 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.9 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.10 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.11 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.12 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.13 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.14 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.15 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.16 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.17 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.18 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.19 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.20 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❑ Subtest 5.21 PASSED. Tested by _____ on ____ / ____ 20____

Signed  _____

❏ Subtest 5.22 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.23 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

❏ Subtest 5.24 PASSED. Tested by _____ on ____ / ____ 20____

Signed _____

| Notes | |
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