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GUIDER CAMERA CONTROL SYSTEM SOFTWARE

User Manual

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Interface

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1 Guider Camera Control System Interface

1.1 Starting the Camera

To start the camera interface, press the reset button on the computer. The program will start automatically from the flash disk. If the camera stops operating for any reason, the command “DSPI” will reset the processor inside the camera and re-load the program. The camera should start running again.

1.2 Running the Camera

The camera runs in two modes. The full-frame mode is used for field acquisition and to take Shack-Hartmann images. The field in full-frame mode is 1000 x 1000 native pixels. Each native pixel is 13.5 microns square, corresponding to 0.092 arcsec when the offset guider is configured for field acquisition. The full field of view is 92 arcsec square. The full frame is displayed in the center of the screen. When the camera is in full-frame mode, a magnified image of the region-of-interest (selected by adjusting the position of cursor number 5) is displayed above and to the left of the full-frame image. The region-of-interest is 71 (native) pixels square. The subraster mode is used for guiding. In subraster mode the full-frame display does not update. Only the magnified region-of-interest display is used.

In either mode the camera read-out is actually binned either 2x2 or 4x4. In full-frame mode the resulting image is actually either 500x500 or 250x250. In guider (subraster) mode the resulting image is actually either 36x36 or 19x19. However, in all cases the cursor coordinates and image displays are referenced to the original 1000x1000 native pixel format.

The exposure time in full-frame mode can be changed by entering the “TF” command. The shortest possible exposure in full-frame, binned-2 mode is 0.71 sec. The shortest exposure in full-frame, binned-4 mode is 0.25 sec. Entering a smaller value for TF (including zero) will result in the shortest possible exposure, which will be displayed in the ACQ (for acquisition time) entry on the screen.

The exposure time in guide mode can be changed by entering the “TG” command. The shortest possible exposures in guide mode vary from about 0.02 to 0.04 sec, depending on the location of the guide box on the CCD.

Note that the temperature readout of the CCD requires a minimum time between successive readouts of 0.05 seconds. If less than 0.05 sec is available, the temperature readout will not update. Entering a value for TF of 0.75 sec in binned-2 mode, or 0.3 sec in binned-4 mode will guarantee that there is enough time between readouts to update the temperature reading. In guide mode, a value for TG of 0.1 sec will guarantee that enough time is available to update the temperature.

1.3 Scaling the Display

The program will automatically adjust the zero-point of the display by estimating the intensity value in the CCD readout which corresponds to a certain percentile in the overall distribution of intensities for all of the pixels in each frame. The program will then scale the output so that the percentile CCD intensity corresponds to a given brightness on the TV screen. To adjust the percentile of the estimate, use the command “PCT”. This might be necessary, for example, if there is a strong gradient in the intensity of the CCD image. To adjust the corresponding brightness of the display, use the command “BKG”.

To turn off the automatic adjustment of the zero-point, enter the value “PCT 0”. Then choose a fixed zero-point (corresponding to black on the display) by using the “ZERO” command. The “SPAN” command is used to adjust the range of intensities on the CCD which is displayed between the black and white values on the TV screen.

1.4 Guiding

In order to guide, the camera needs to know the orientation of the image. This is accomplished using the “PA” command. The sign of PA is used to indicate the parity of the image, so a value of 0.0 is not allowed. Use + or – 360. instead. The value of PA is the same as the value of PA which is displayed in the TCS program when set for this camera via the CN command. If APA is enabled (which it is by default), the PA symbol on the screen will be green instead of black, and the PA angle will be read automatically from the TCS. The guider should be able to work properly as long as the value of PA is accurate to within about 20 degrees.

The guider also needs to know the pixel size (this is the native pixel size, which is independent of binning). The value for the camera in the X-Y guider is 0.092 arcsec. Note that the on-screen display of the pixel size is shown without a decimal point (integer thousandths of an arcsec).

In full-frame mode, choose a star to guide on which is adequately bright. Move the square cursor to the desired position, then press <F3> and the camera will start guiding. Note that the centroiding algorithm currently only works with a binning value (BG) of 2.

The centroiding algorithm will use a square region of the subraster which is determined by the “BX” (box) command. Larger boxes with more data take longer to calculate, and are more susceptible to problems caused by cosmic rays. The calculation time can be estimated from the “mx” value shown in the input box (mx is the maximum cycle time for the program status loop, in milliseconds). Use a box which is somewhat larger than the image, but not too much.

Once the camera is guiding, a number of quantities will be displayed. TC is the total count (in data numbers) in the image. MX is the maximum value in DN. Avoid using a star with a value of MX greater than 10,000 – it may be saturated. BK is the background value. FW is the full-width at half-maximum in arcseconds. IT is the number of iterations required to obtain convergence. DX and DY are the positions of the image centroid in pixels.

The guider works best when the error signal is used to move the telescope promptly. Delays introduce phase lags which degrade the value of the error signal and can cause the position feedback to become unstable. The problem is that the TCS only updates the position of the telescope (using a command to the main drives) every 0.4 second. So it is not a good idea to use exposure times (TG) which are much smaller than this value. 0.3 is OK. Also, it is not a good idea to use exposure times which are a multiple of 0.4 sec, because the latency might get stuck at a high value for a long time. Odd values of the guider exposure time (0.3 or 0.5 sec) are better for this reason.

The sensitivity of the guider is controlled using the SN command. A value for SN of 0.5 is conservative and should be very stable. Increasing the value of SN may improve the rms position residuals as shown in the graphical display, but too large a value will start to make the feedback unstable, and the position residuals will get worse. A value of 0.6 or 0.8 will probably OK, and for long exposures (1.0 sec or greater) a value of 1.0 might be good.

Note that the sensitivity of the guider is independent of the averaging parameter (AVG). Using an averaging parameter of 2 (or in some cases even 3 or 4) is recommended, because the centroiding algorithm will converge more rapidly, and the smoother graphical displays of the position error will provide a more realistic estimate of the guider performance.

The graphical display of TC is scaled to the value for the first frame after pressing <F2> or <F3>. Sometimes the first frame will be atypical (for example if the star is not quite in the data box), and the scale for TC will be wrong. To re-scale the TC display, just press <F2> or <F3> again.

The graphical display for FW is scaled from 0 to 2.0 arcsec. The graphical displays for the AZ and EL error values are scaled to +/- 1.0 arcsec.

1.5 Recording Data

A single frame can be sent over the ethernet connection to the active optics computer, by typing the “SEND” command. Successive frames can be sent every n seconds by entering the command “SEND n”. To stop sending successive frames, enter “SEND 0”.

Commands

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2 Commands Summary

2.1 Camera Commands

Command	Description
TF n	Set the exposure time (in seconds) for full-frame mode
TG n	Set the exposure time (in seconds) for guide mode
BF n	Set the pixel binning for full-frame mode (n = 2 or 4)
BG n	Set the pixel binning for guide mode (n = 2 or 4)
AVF n	Set the leaky-memory averaging parameter for full-frame mode (n = 0 to 99)
AVG n	Set the leaky-memory averaging parameter for guide mode (n = 0 to 99)
SKY	Save a sky frame for later subtraction
SUB	Enable/disable sky subtraction of stored frame

2.2 Guider Commands

Command	Description
SN n	Set the guider sensitivity (n = 0.1… 2.0)
BX n	Set the centroid data box to n pixels (odd n, 7… 69)
PX n	Set the pixel size in arcseconds
APA	Toggle automatic setting of camera position angle from the TCS
PA n	Set the camera position angle in degrees manually
GM n	Set the guider mode (n = 1,2,3). (Currently does nothing.)
FM n	Set the function key mode (n = 1,2,3).
<F1> or FONE	Switch to full-frame mode (guider off) But if FM is 2, do not do that, but rather save the current values of AVF, TF, and SEND, and then set them all to 0.
<F2> or FTWO	Switch to subraster (guide) mode, calculate only.
<F3> or FTHR	Switch to subraster (guide) mode, calculate and move telescope But if FM is 2, do not do the above, but rather restore the values of AVF, TF, and SEND, that were last saved by F1.
<F4> or FFOU	Like F2, but center the box on the star first
<F5> or FFIV	Like F3, but center the box on the star first
<F9> or FNIN	Send a FLDn command to the Guider Probe Control program
<F10> or FTEN	Send a SHAn command to the Guider Probe Control

	program
TC	

2.3 Other Camera Commands

Command	Description
DSPI	Initialize (or re-initialize) the DSP
TEC n	Set the thermoelectric cooler current to n amps (n = 0… 2.5).
SEND	Send one frame over the ethernet link
SEND n	Send a frame over the ethernet link every n seconds (0 = never).
SH n	Indicate that the next frame sent is of the Shack-Hartmann mask and that the Shack-Hartmann correction loop should be triggered. (n=1 -> YES, n=0 -> NO).
SPAN n	Set the black-to-white scaling of the image display to n DN
PCT n	Set the percentile value of the intensity histogram for auto-zero.
ZERO n	Set the black level of the image display in DN (if PCT is 0).
BKG n	Set the grayscale level corresponding to the percentile value (n = 1… 63).
AMP n	Select right (n = 1) or left (n = 2) on-chip amplifier
GATE n	Set the CCD output gate voltage to n volts (n = -5.0…

	-9.0).
ES	Toggle the output of extended guiding commands to the TCS. Used to record tracking errors.

2.4 Cursor Commands

Command	Description
XY n	Select the active cursor (n = 1… 5). XY 5 controls the square cursor. The XY 1 cursor is controlled by the TCS trackball
XYS n x y	Set cursor n to position x, y (0-999.9)
XYR n x y	Move cursor n delta x,y (-999.9 to 999.9) relative to its present position
MM n	Set the mouse mode to n (1-3). When the left mouse button is clicked while holding down the right mouse button, mode 1 moves the box to the mouse position, mode 2 moves the guide probe so that the star at the mouse position moves into the box, mode 3 (default) moves the telescope so that the star at the mouse position moves into the box. (Without holding down the right mouse button, the move is one tenth the amount.)
MC n	Simulate a mouse button click. n = 1 for the left button, n = 2 for the right button, n = 3 for both.
<Del>	Increase the cursor motion step size (.1, 1, 4, 40).
<Ins>	Decrease the cursor motion step size (40, 4, 1, .1).
<Up>	Move the selected cursor up one step
<Dn>	Move the selected cursor down one step

<Lf>	Move the selected cursor left one step.
<Rt>	Move the selected cursor right one step
<Home>	Move the selected cursor up and to the left one step
<Pg Up>	Move the selected cursor up and to the right one step
<End>	Move the selected cursor down and to the left one step
<Pg Dn>	Move the selected cursor down and to the right one step

2.5 Message Commands

Command	Description
Ctrl-<Up>	Scroll system message display back one line
Ctrl-<Pg Up>	Scroll system message display back one page
Ctrl-<Dn>	Scroll system message display forward one line
Ctrl-<Pg Dn>	Scroll system message display forward one page
Ctrl-<Home>	Set system message display to show the first message
Ctrl-<End>	Reset system message display to show the current message

2.6 Other Commands

Command	Description

EXIT	Exit the program.

Configuration

3

3 Guider Camera Configuration

3.1 GCAM.INI file, Magellan I

Camera1

200

28

147

28

5700

Camera2

200

28

147

28

5701

Camera3

200

28

147

28

5702

3.2 GCAM.INI, Magellan II

Camera1

200

28

147

59

5700

Camera2

200

28

147

59

5701

Camera3

200

28

147

59

5702

3.3 GCAM.INI Description

Serial Communication

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4 Control System Serial Communication Standards

There is always a host (upstream) computer, and a guest (downstream) computer. The host computer is frequently the TCS, with the guest being Guider Camera computer. The host system sends a command, and the guest responds immediately to that command. Guest computers never broadcast without being queried, which allows multiple guests to be chained on the same serial line.

Full command format:

:Nnddddddddddccr

The "**:**" is the prompt character to initiate communication. **N** is the guest computer's unit address, in this case the guider camera 1. **n** is a command number, **d**'s are data specific to the command (variable length), **cc** is a checksum, and **r** is a carriage return (ASCII 13).

The unit address for guider camera 2 is "O". Guider camera 3 guest computer uses unit address "P".

Full response format:

~Nnddddddddccr

The "**~**" is the response character for guest computer responses. **N** is the guest computer's unit address. **n** is the command number this is in response to, **d**'s are data specific to the response (variable length), **cc** is a checksum, and **r** is a carriage return (ASCII 13).

For very short commands and responses the checksum may be omitted (this is noted in the command description).

For all commands and responses that include a checksum, the checksum is composed of two hexadecimal digits (from 0-F). The checksum is calculated by starting with zero and XORing it with all characters in the message from the unit letter to the last data character before the checksum (the underlined part of the command and response above).

Commands that are received but misunderstood (checksum wrong, unknown command, etc) are replied to like this:

~N?r

Most guest computers maintain a running system log that contains important messages and all system status information. Each also maintains a pointer into that log that keeps track of the oldest message that hasn't been sent to the host computer. The "2" and "3" commands let the host computer command the guest computer to transmit one of its log entries or re-transmit the last entry. This is referred to as the "Engineering Data Stream", or EDS.

Command Summary:

2: Query Next EDS Message

3: Repeat Last EDS Message

4: Set UT

9: Free-form Command

4.1 Command Description

4.1.1 2: Query Next EDS Message

Commands the guest computer to send its oldest un-sent EDS log entry, and advance its internal pointer to the next EDS log entry.

Command Format: :N2r (note that this command has no checksum)

Response Format: ~N2qqnnttttttttfffddddddccr

N: Guest guider camera 1 computer address (usually an upper-case letter)

qq: Two-digit number of EDS messages left in the guest queue

nn: Two-digit number of characters in the message (in the underlined section). 00 if no message available.

tttttttt: Eight-digit message time stamp (no punctuation), with two-digit hour, two-digit minute, two-digit second, and two-digit hundredths of a second.

fff: Three-digit message number. Message numbers from 0-799 denote errors, 800-899 are numberical data formats, and 900-999 are successes.

ddddddd: Variable length message data section. For error and success messages, typically a simple text message. For numeric data formats, a combination of ASCII, decimal, and hexadecimal characters/digits, with the format being determined by the particular message number.

cc: Checksum, described above.

r: ASCII charater 13, a carriage return.

4.1.2 3: Repeat Last EDS Message

Commands the guest computer to re-send the last message it sent (implying that the host computer had a serial communication error during the last reponse). The guest's internal pointer should remain unchanged.

Command Format: :N3r (note that this command has no checksum)

Response Format: ~N3qqnn<u>tttttttttfffddddddd</u>ccr

N: Guest computer address (usually an upper-case letter)

qq: Two-digit number of EDS messages left in the guest queue

nn: Two-digit number of characters in the message (in the underlined section). 00 if no message available (there is no time stamp, message number, or data in this case).

tttttttt: Eight-digit message time stamp (no punctuation), with two-digit hour, two-digit minute, two-digit second, and two-digit hundredths of a second.

fff: Three-digit message number. Message numbers from 0-799 denote errors, 800-899 are numberical data formats, and 900-999 are successes.

ddddddd: Variable length message data section. For error and success messages, typically a simple text message. For numeric data formats, a combination of ASCII, decimal, and hexadecimal characters/digits, with the format being determined by the particular message number.

cc: Checksum, described above.

r: ASCII charater 13, a carriage return.

4.1.3 4: Set UT

Commands the guest computer to set its clock to the Universal Time given in this command. The control computers keep their clocks synchronized to GPS-provided universal time in this way.

Command Format: :N4tttttttccr

Response Format: ~N4er (note that this response has no checksum)

N: Guest computer address (usually an upper-case letter)

tttttttt: Eight-digit universal time (no punctuation), with two-digit hour, two-digit minute, two-digit second, and two-digit hundredths of a second.

cc: Checksum, described above.

r: ASCII charater 13, a carriage return.

e: Error flag: 0 if an error occurred, 1 if OK.

4.1.4 9: Free-form Command

Sends the guest Guider Camera 1 computer a free-form command, typically similar to the commands entered via the guest computer's keyboard. This is used to command moves, homes, etc.

Command Format: :N9nnddddddccr

Response Format: ~N9ennmmmmccr

N: Guest computer address (usually an upper-case letter)

nn: Two-digit number of characters in the message (in the underlined section). 00 if no message available.

ddddddd: Variable length free-form command section. This section will contain a command parseable by the guest computer, such as "MOVE 1000"

cc: Checksum, described above.

r: ASCII charater 13, a carriage return.

e: Error flag: 0 if OK, 1 or higher if an error occurred.

mmmm: Variable length diagnostic message (such as "Move ignored, brake on"). This should be printed out by the host computer in the command input box if the command was given by the user, or in the system log if the command was given by an automated routine in the host program. nn=00 in the response if there is no diagnostic message.

Log Message System

5

5 Log Message System

5.1 Error Messages

'000: DOS date error, code = xxx'

'001: PCI BIOS not present'

'002: PCI interface not found'

'003: Error opening S-record file'

'004: EOF encountered in S-record file'

'005: at record xxxx'

'006: Unrecognized S-record format'

'007: at record xxxx'

'008: Checksum error at record xxxx'

'009: expected xxxx, received xxxx'

'011: record =xxxx, FIFO count = xxxx'

'012: Checksum timeout at record xxxx'

'013: Error, final FIFO count'

'014: DSP test FIFO count error'

'015: DSP test timeout error'

'020: DSP initialization failure'

'021: Tmp. query error code xxxx'

'022: DSP FIFO error, code = xxxx'

'023: Initial FIFO count = xxxx'

'024: Final FIFO count = xxxx'

'025: DSP time-out, xxxxxx words to go'

'026: DSP read-back error, code = xxxx'

'027: DSP error count exceeded'

'028: DSP FIFO Counter sync error'

'029: DSP read-back error, item = xxxxx'

'030: TCS error messages suspended'

'041: TCS guide cmd transmit error'

'041: TCS angle command checksum error'

'041: TCS cursor com checksum error'

'041: TCS EDS command response error'

'041: TCS camera com checksum error'

'041: TCS com checksum error'

'041: TCS UT com checksum error'

'043: TCS guide command data error'

'043: TCS angle command data error'

'043: TCS cursor command data error'

'043: TCS EDS command data error'

'043: TCS camera command data error'

'043: TCS command data error'

'043: TCS UT command data error'

'044: TCS guide command com error X'

'044: TCS angle command com error X'

'044: TCS cursor command com error X'

'044: TCS EDS command com error X'

'044: TCS camera command com error X'

'044: TCS command com error X'

'044: TCS UT command com error X'

'101: TCP Open Socket failure'

'102: TCP connection timeout'

'103: TCP write timeout error XXX YYY'

'104: TCP connection broken'

'105: TCP write socket overflow'

'105: TCP communications suspended'

5.2 Success Messages

'975: DSP function test OK'

'976: Running DSP function test'

'977: xxxx S-records read, no errors'

'978: Loading DSP program'

'979: TCP communications resumed'

'979: Final FIFO count

'980: DSP initialization success'

'980: TCP socket opened'

'980: Initial FIFO count

'981: Resetting DSP'

'982: PT1, PT2 map xxxxxxxx, xxxxxxxx'

'983: PT1, PT2 adr xxxxxxxx, xxxxxxxx'

'984: I/O base adr xxxxxxxx'

'985: Reading config registers'

'986: PCI device number is xxxx'

'987: Checking for PCI interface'

'988: PCI BIOS vx.x detected'

'989: Checking for PCI BIOS'

'990: TCP connection established'

'991: TCP buffer size

'992: TCP buffer address

'994: UT set by TCS to HH MM SS.FF'

'997: TCS error messages resumed'

'998: UT clock initialized by CPU'

5.3 EDS Log Messages

The EDS log is the same for GCAM1, GCAM2 and GCAM3.

801: Information about centroid display for guider cameras.

Format: 801;fffffgxxxxxyyyyyccccc

fffff : fwhm (arcseconds)

g : guide flag

1: off or no guide corrections calculated

2: guide corrections in progress (no TCS motion commands)

3: motion command sent to TCS, motion in progress

xxxxx : x correction in pixels

yyyyy : y correction in pixels

ccccc : Total Counts

82i: Cursor positions

Format: 82i;xxxxyyyy

i : cursor number (1-5) where n=1 is mouse cursor, and n=5 is box

xxxx : x position * 10 (000.0-999.9) unbinned pixels

yyyy : y position * 10 (000.0-999.9)

810: Operator entered command

Format: 810aaaaaaaaaaaaaaaaaaaaaa

aaaaaaaaaaaaaaaaaaaaaa = Command entered

811: tcs entered command

Format: 810aaaaaaaaaaaaaaaaaaaaaa

aaaaaaaaaaaaaaaaaaaaaa = Command entered

808: Command error response

809: Command error response

System Details

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6 Guider Camera Control System differences between Magellan I and II

Troubleshooting

7

7 Troubleshooting

Appendix

A

Appendix A

GCAM.TXT

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Notes for programming guider cameras.


-----------------------------------------------------

Linux device driver startup report:

insmod amcc
amcc_init >>> START <<<
amcc_dev.major = 125
amcc: pcidev_base_address[0] = 0x0000e001
amcc: IO_MAP BADR[0] = 0x0000e000
amcc: Getting configuration for PT regions
amcc: PT[1] base_address [e9000000]
amcc: PT[2] base_address [e9020000]
amcc: PT[3] base_address [e9040000]
amcc: PT[4] base_address [e9061000]
amcc: pt[1] mask fffe0000 val e9000000
amcc: PT[1] size 131072  Phys e9000000 Virt c2875000
amcc: pt[2] mask fffe0000 val e9020000
amcc: PT[2] size 131072  Phys e9020000 Virt c2896000
amcc: pt[3] mask fffe0000 val e9040000
amcc: PT[3] size 131072  Phys e9040000 Virt c28b7000
amcc: pt[4] mask fffffe00 val e9061000
amcc: PT[4] size 512     Phys e9061000 Virt c28d8000
amcc_init: ICSR: 0x00000c0c
amcc_init:  RCR: 0x00000000
amcc_init: MBEF: 0x80000000
amcc_init: PTCR: 0x00000000
amcc_init: function terminated successfully
amcc: AMCC S5920 Rev 0.5
```

To reboot from Linux, ctrl-alt-del is OK.

Pass-thru 1 sends and receives data.
Pass-thru 2 has counter for number of words in FIFO.
Pass-thru 3 and 4 not used.

Pass-thru 1 and 2 have NO address decoding. They act like single 32-bit
registers, but only the LEAST significant 16-bits get sent or received.

When you write, must wait about 2 usec to allow data to be transmitted
serially. When the frame sync bit is high, the transmit register is busy.

When you read, a 16-bit word gets popped out of the FIFO.

The mail box register has a bit which indicates the transmit register is
busy, and a bit which indicates that the FIFO has data:

MB_TX_BUSY 0x01000000
MB_RX_RDY 0x02000000

There is a PROM on the DSP which contains the program which starts on reset
or power-up. It is looking for a program to load, appearing in the input
register.

The load sequence consists of a byte count, an address, and the data. The
DSP returns a checksum. There are load sequences of different type
depending on the memory area to be loaded. A special type (8) starts the
program from the specified address.

The memory is 24 bits, so two 16-bit words are used for each memory location.
One byte is discarded.

Once running, the top level routine is looking for a command word which
specifies what the camera is supposed to do next.

The DSP program is in S-file format. DON'T use the S-record checksum. The
DSP checksum is the 16-bit sum of the characters in the record. Note that
the first two characters of each S-record (i.e. "S0" or "S2" are not
transmitted and not counted in the checksum).

Appendix

B

Appendix B

GCCOM.SRT

```
ampcom   --------------  DSP control settings
ampcom   dspset   gcds1
ampcom   gcset    gcset
ampcom   main     gcam
avpcom   --------------  leaky memory params
avpcom   dspchk   gcck3
avpcom   main     gcam
bincom   --------------  pixel binning params
bincom   dspload  gcds1
bincom   dspset   gcds1
bincom   gcset    gcset
bincom   main     gcam
clkcom   --------------  UT / Julian time
clkcom   clock2   gcck2
clkcom   gcset    gcset
clkcom   puteds   gceds
clkcom   putmsg   gcmsg
clkcom   utclk    gcutc
clkctl   --------------  clock rate and mode
clkctl   gcset    gcset
clkctl   utclk    gcutc
clklog   --------------  clock interrupt error log
clklog   clkerr   gcck2
clklog   dspmsg   gcmsg
clkvar   --------------  clock control
clkvar   clock2   gcck2
clkvar   utclk    gcutc
colors   --------------  video palette info
colors   gcset    gcset
cr1com   --------------  cursor positions
cr1com   curval   gcim1
cr1com   curvid   gcim2
cr1com   curwrt   gcim2
cr1com   dspset   gcds1
```

```
cr1com   gcset    gcset
cr1com   magnif2  gcim1
cr1com   magnif4  gcim1
cr1com   main     gcam
cr1com   screen   gcim1
cr2com   --------------  cursor saved data
cr2com   currst   gcim2
cr2com   curvid   gcim2
cr2com   curwrt   gcim2
drfake   --------------  dophot calculation flag
drfake   plsphot  gcpho
drfake   pseud2d  gcpho
dspcom   --------------  DSP status values
dspcom   dspchk   gcck3
dspcom   dspload  gcds1
dspcom   dsprun   gcds2
dspcom   dspset   gcds1
dspcom   gcset    gcset
dspcom   main     gcam
edscom   --------------  engineering message queue
edscom   puteds   gceds
expcom   --------------  Exposure time values
expcom   dspchk   gcck3
expcom   dsprun   gcds2
expcom   dspset   gcds1
expcom   main     gcam
fifcom   --------------  FIFO buffer status
fifcom   dsprun   gcds2
fontcom  --------------  screen fonts
fontcom  gcset    gcset
fontptr  --------------  pointers to fonts
fontptr  gcset    gcset
frmcom   --------------  grays for screen panels
frmcom   gcset    gcset
imgcom   --------------  CCD image buffer
imgcom   curval   gcim1
imgcom   dspchk   gcck3
imgcom   dsprun   gcds2
imgcom   magnif2  gcim1
imgcom   magnif4  gcim1
imgcom   screen   gcim1
magcom   --------------  magnified image buffer
magcom   magnif2  gcim1
magcom   magnif4  gcim1
magcom   screen   gcim1
msgcom   --------------  system message log
msgcom   dspmsg   gcmsg
msgcom   putmsg   gcmsg
msgctl   --------------  message display params
msgctl   dspmsg   gcmsg
msgctl   main     gcam
```

```
pcicom   --------------  PCI interface params
pcicom   dspchk   gcck3
pcicom   dspget   gcck3
pcicom   dspload  gcds1
pcicom   dsprun   gcds2
pcicom   dspsend  gcds1
pctcom   --------------  histogram search params
pctcom   dspchk   gcck3
pctcom   gcset    gcset
pctcom   main     gcam
pctcom   screen   gcim1
scbcom   --------------  screen buffer
scbcom   curvid   gcim2
scbcom   gcset    gcset
scbcom   screen   gcim1
sdtcom   --------------  autolink control
sdtcom   main     gcam
sdtcom   screen   gcim1
sndcom   --------------  TCP/IP link control
sndcom   main     gcam
sndcom   screen   gcim1
sndcom   tcp      gctcp
timcom   --------------  clock interrupt timers
timcom   clock2   gcck2
timcom   dspload  gcds1
timcom   dsprun   gcds2
timcom   main     gcam
timcom   screen   gcim1
timcom   tcp      gctcp
timcom   utclk    gcutc
tmpcom   --------------  temperature sensor values
tmpcom   dspchk   gcck3
tmpcom   dsprun   gcds2
tune14   --------------  dophot report level
tune14   chisq    gcpho
tune14   plsphot  gcpho
typcom   --------------  image type flag
typcom   magnif   gcim1
typcom   screen   gcim1
uplcom   --------------  uplink variables
uplcom   tcp      gctcp
xfscom   --------------  full-frame/subraster exp
xfscom   dspchk   gcck3
xfscom   dspset   gcds1
xfscom   gcset    gcset
xfscom   main     gcam
zptcom   --------------  zero and span values
zptcom   gcset    gcset
zptcom   magnif2  gcim1
zptcom   magnif4  gcim1
zptcom   main     gcam
```

```
zptcom   screen   gcim1
zrocom   --------------  screen intensities
zrocom   gcset    gcset
zrocom   magnif2  gcim1
zrocom   magnif4  gcim1
zrocom   main     gcam
zrocom   screen   gcim1
```

Appendix

C

Appendix C

GCCOM.TXT

```
ampcom   --------------  DSP control settings
avpcom   --------------  leaky memory params
bincom   --------------  pixel binning params
clkcom   --------------  UT / Julian time
clkctl   --------------  clock rate and mode
clklog   --------------  clock interrupt error log
clkvar   --------------  clock control
colors   --------------  video palette info
cr1com   --------------  cursor positions
cr2com   --------------  cursor saved data
drfake   --------------  dophot calculation flag
dspcom   --------------  DSP status values
edscom   --------------  engineering message queue
expcom   --------------  Exposure time values
fifcom   --------------  FIFO buffer status
fontcom  --------------  screen fonts
fontptr  --------------  pointers to fonts
frmcom   --------------  grays for screen panels
handcom  --------------  clock hand params
imgcom   --------------  CCD image buffer
magcom   --------------  magnified image buffer
msgcom   --------------  system message log
msgctl   --------------  message display params
pcicom   --------------  PCI interface params
pctcom   --------------  histogram search params
scbcom   --------------  screen buffer
sdtcom   --------------  autolink control
sndcom   --------------  TCP/IP link control
timcom   --------------  clock interrupt timers
tmpcom   --------------  temperature sensor values
tune14   --------------  dophot report level
typcom   --------------  image type flag
uplcom   --------------  uplink variables
xfscom   --------------  full-frame/subraster exp
```

```
zptcom   --------------  zero and span values
zrocom   --------------  screen intensities
msgctl   main     gcam
dspcom   main     gcam
timcom   main     gcam
expcom   main     gcam
xfscom   main     gcam
zptcom   main     gcam
zrocom   main     gcam
cr1com   main     gcam
avpcom   main     gcam
bincom   main     gcam
sndcom   main     gcam
sdtcom   main     gcam
pctcom   main     gcam
ampcom   main     gcam
clkcom   gcset    gcset
clkctl   gcset    gcset
cr1com   gcset    gcset
dspcom   gcset    gcset
xfscom   gcset    gcset
bincom   gcset    gcset
ampcom   gcset    gcset
scbcom   gcset    gcset
pctcom   gcset    gcset
zptcom   gcset    gcset
zrocom   gcset    gcset
colors   gcset    gcset
fontptr  gcset    gcset
fontcom  gcset    gcset
frmcom   gcset    gcset
clkcom   clock2   gcck2
clkvar   clock2   gcck2
timcom   clock2   gcck2
clklog   clkerr   gcck2
clkcom   utclk    gcutc
clkvar   utclk    gcutc
clkctl   utclk    gcutc
timcom   utclk    gcutc
dspcom   dspchk   gcck3
tmpcom   dspchk   gcck3
imgcom   dspchk   gcck3
pcicom   dspchk   gcck3
xfscom   dspchk   gcck3
expcom   dspchk   gcck3
avpcom   dspchk   gcck3
pctcom   dspchk   gcck3
pcicom   dspget   gcck3
pcicom   dspload  gcds1
dspcom   dspload  gcds1
timcom   dspload  gcds1
```

```
bincom   dspload  gcds1
pcicom   dspsend  gcds1
dspcom   dspset   gcds1
xfscom   dspset   gcds1
expcom   dspset   gcds1
bincom   dspset   gcds1
cr1com   dspset   gcds1
ampcom   dspset   gcds1
pcicom   dsprun   gcds2
dspcom   dsprun   gcds2
tmpcom   dsprun   gcds2
fifcom   dsprun   gcds2
timcom   dsprun   gcds2
imgcom   dsprun   gcds2
expcom   dsprun   gcds2
timcom   screen   gcim1
imgcom   screen   gcim1
cr1com   screen   gcim1
zptcom   screen   gcim1
zrocom   screen   gcim1
scbcom   screen   gcim1
typcom   screen   gcim1
magcom   screen   gcim1
pctcom   screen   gcim1
sndcom   screen   gcim1
sdtcom   screen   gcim1
typcom   magnif   gcim1
imgcom   magnif2  gcim1
cr1com   magnif2  gcim1
zptcom   magnif2  gcim1
zrocom   magnif2  gcim1
magcom   magnif2  gcim1
imgcom   magnif4  gcim1
cr1com   magnif4  gcim1
zptcom   magnif4  gcim1
zrocom   magnif4  gcim1
magcom   magnif4  gcim1
imgcom   curval   gcim1
cr1com   curval   gcim1
cr1com   curwrt   gcim2
cr2com   curwrt   gcim2
cr2com   currst   gcim2
cr1com   curvid   gcim2
cr2com   curvid   gcim2
scbcom   curvid   gcim2
tune14   plsphot  gcpho
drfake   plsphot  gcpho
tune14   chisq    gcpho
drfake   pseud2d  gcpho
timcom   tcp      gctcp
uplcom   tcp      gctcp
```

```
sndcom   tcp      gctcp
msgcom   dspmsg   gcmsg
msgctl   dspmsg   gcmsg
clklog   dspmsg   gcmsg
msgcom   putmsg   gcmsg
clkcom   putmsg   gcmsg
edscom   puteds   gceds
clkcom   puteds   gceds
fontptr  cbox     gcbx1
fontcom  cbox     gcbx1
fontptr  vbox     gcbx2
fontcom  vbox     gcbx2
fontptr  pbox     gcbx3
fontcom  pbox     gcbx3
fontptr  mbox     gcbx3
fontcom  mbox     gcbx3
fontptr  cptr     gcutl
frmcom   coolfr   gcfrm
frmcom   subfrm   gcfrm
scpcom   opqwrt   gcfrm
scpcom   scpdat   gcvid
scpcom   opqchr1  gcvid
scpcom   opqchr2  gcvid
handcom  handchk  gcvec
handcom  hand     gcvec
scpcom   ovlvec   gcvec
scpcom   opqvec   gcvec
```