LX200 Hand Controller Communications

Exploring the Communications between the Hand Controller and a LX200 Classic

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Dissecting the LX-200 Hand Controller and Command Codes

After stripping my LX-200 hand controller PCB of all parts, I created a new schematic, as well as the PCB layout, of the board (see Appendix A). I fear curiosity got the better of me and I decided to decode the communications between the hand controller and the main telescope. I was not prepared for the massive amount of communication or the elegance of design provided by Meade engineers of the late 1980's – early 1990's.

DISCLAIMER: While I have made every effort to make all information accurate and correct, I assume no responsibility for any damage to your equipment should there be an error in this document. PLEASE NOTE that MEADE no longer supports the LX-200 Classic and they have left you own your own for repairs. It would be ashamed to ruin a perfectly good telescope by experimenting in an area of limited expertise. As of January 2008 there is a report that a single individual at MEADE is now repairing LX200 Classics.

Basic Overview

There are 4 wires between the hand controller and the main telescope – abbreviated as HC and MT throughout this document. Two of the wires provide power (ground and +12v to +18vdc depending on your power supply). The other two wires are data from the MT to receive of the HC and data from the HC to receive of the MT. Communications takes place at 9600 baud, 8 bits, no parity, and 1 stop bit with inverted output (a standard serial communication). The voltage levels on the data lines is 0v and +5v. PLEASE NOTE: This is not a standard RS-232 circuit and connecting RS-232 voltages to this circuit could cause permanent damage to your LX-200! With this said, you can connect either data line to the RECEIVE line of a standard RS-232 serial port and monitor the data. In my setup, I used two computers running a free terminal program (Terminal v1.96 b – 12082002 – by Bray++), which I found on the Internet. This program allows you to see the value of printable and non-printable characters. One computer monitored the MT transmit line and the other computer monitored the HC transmit line. My primary computer has a single serial port built in, and an additional 8 serial ports on a PCI card. However the data was not accurate using the 8 port serial card – thus the second computer. I tried going to every screen on the HC and using every function while noting the data from the HC, the data from the MT and what was being displayed on the LCD HC display. I may have missed a couple of screens – but not many. The collected information took 47 pages in a notebook! In order to verify the operation of each command individually, I built a circuit (see Appendix B), which allowed me to replace the HC with a computer so I could issue commands and see the results of each command. This circuit does provide the correct voltages for the LX-200 Keypad interface port.

Basic Results

There are over 200 commands from the HC to the MT! The Meade manual for my LX-200 ver. 2.50, listed 103 commands. A large number of the commands from the HC are the same as the RS-232 Commands listed in the LX-200 Manual. There are some

differences. The data from the MT to the HC is different in most cases. Most all of the data from the MT is information to be displayed, or codes to note the acceptance of data from the HC, or to sound the beeper on the HC. One point I found interesting was how many of the menu displays come from the LX-200, but not all of them. I wonder why? Another surprise is the countdown timer – that is done totally in the HC – the MT knows nothing about it. My attempt in the remainder of this document is to take you through the communications screen by screen, function by function to see what transpires. My secondary purpose in doing this is to enable me to create a replacement HC with some additional features (such as a built in joystick, a 4 line display where RA & DEC are always visible, and a few other ideas).

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Hand Controller Commands
I. GENERAL TELESCOPE INFORMATION

Command 06h   (ASCII 06h)
Returns A, L, P, or G   (ASCII 41h, 4Ch, 50h, or 47h)
Gets alignment status, A for alt-az, L, L for land, P for polar, G for
German mount polar.

Command H   (ASCII 48h)
Returns Nothing
First character sent upon power up. Telescope will not respond to any
other command until this has been sent.
Note: H06h (ASCII 48h 06h) is sent as a pair on power up.

Command :GV#   (ASCII 3Ah 47h 56h 23h)
Returns 2.51L#   (ASCII 32h 2Eh 31h 4Ch 23h)
Returns version of database EPROM's – example is for 8,000 object
database.
NO Equivalence

Command :GR#   (ASCII 3Ah 47h 52h 23h)
Returns HH:MM.T#
Returns the current Right Ascension
Equivalent to :GR#

Command :GD#   (ASCII 3Ah 47h 44h 23h)
Returns sDDβMM# (where s is sign (+ or -) and β is ASCII DFh and
shows as the ° symbol on the LCD display.
Gets the current Declination
Equivalent to :GD#

Command :GA#   (ASCII 3Ah 47h 41h 23h)
Returns sDDβMM# (where s is sign (+ or -) and β is ASCII DFh and
shows as the ° symbol on the LCD display.
Gets the current altitude.
Equivalent to :GA#

Command :GZ#   (ASCII 3Ah 47h 5Ah 23h)
Returns DDDβMM# (where β is ASCII DFh and shows as the ° symbol
on the LCD display.
Gets the current azimuth.
Equivalent to :GZ#

Command :GS#   (ASCII 3Ah 47h 53h 23h)
    Returns HH:MM:SS#
    Gets the current sidereal time
    Equivalent to :GS#

Command :GL#   (ASCII 3Ah 47h 77h 23h)
    Returns HH:MM:SS#
    Gets the local time in 24 hour mode, regardless of current mode.
    Equivalent to :GL#

Command :SL HH:MM:SS#   (ASCII 3Ah 53h 4Ch 20h xxh xxh 3Ah xxh
                                 xxh 3Ah xxh xxh23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the local time in 24 hour mode. Range 00:00:00 to 23:59:59
    Equivalent to :SL HH:MM:SS#

Command :GC#   (ASCII 3Ah 47h 43h 23h)
    Returns MM/DD/YY#
    Gets the calendar date.
    Equivalent to :GG#

Command :SC MM/DD/YY#   (ASCII 3Ah 53h 43h 20h xxh xxh 2Fh xxh
                                 xxh 2F xxh xxh 23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the calendar date. See additional note on returned data.
    Equivalent to :SC MM/DD/YY#
    NOTE: After valid date, a message is sent to the display:
    Updating   planetary data. #   (ASCII 55h 70h 64h 61h 74h 69h
                                          6Eh 67h 20h 20h 20h 20h 20h 20h
                                          20h 20h 70h 6Ch 61h 6Eh 65h 74h
                                          61h 72h 79h 20h 64h 61h 74h 61h
                                          2Eh 20h 23h)

    After the planetary data has been updated, the following message is sent to
    the HC: # (ASCII 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 20h 20h 20h 20h 20h 23h)

Command :Ga#   (ASCII 3Ah 47h 61h 23h)
    Returns HH:MM:SS#
    Gets the local time in either 24 or 12 hour mode according to mode.
    Equivalent to :Ga#

Command :Gt#   (ASCII 3Ah 47h 74h 23h)
    Returns sDDβMM# (where s is sign (+ or -) and β is ASCII DFh and
    shows as the ° symbol on the LCD display.
    Gets latitude for currently selected site
    Equivalent to :Gt#

Command :St sDDβMM#   (ASCII 3Ah xxh 53h 74h 20h xxh xxh DFh
                                 xxh xxh 23h) where s can be + (ASCII
                                 2Bh) or – (ASCII 2Dh)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets latitude for currently selected site
    Equivalent to :St sDD*MM #

Command :Gg#   (ASCII 3Ah 47h 67h 23h)
    Returns DDDβMM# (where β is ASCII DFh and shows as the ° symbol
    on the LCD display.
    Gets longitude for currently selected site
    Equivalent to :Gg#

Command :Sg DDDβMM #   (ASCII 3Ah 53h 67h 20h xxh xxh xxh DFh
                                 xxh xxh 23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets longitude for currently selected site
    Equivalent to :Sg DDD*MM#

Command :SG sHH #   (ASCII 3Ah 53h 47h 20h xxh xxh xxh 23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the offset from GMT. Range is ±24.
    Equivalent to :SG sHH #

Command :GG#   (ASCII 3Ah 47h 47h 23h)
    Returns sHH#   (ASCII xxh xxh 23h)
    Gets the offset from GMT. Range is ±24.
    Equivalent to :GG#

Command :W1#   (ASCII 3Ah 57h 31h 23h)
    Returns Nothing
    Sets the current site number to 1
    Equivalent to :W1#
    NOTE: Performing a :GM# now will return XYZ   √ # (ASCII xxh
                                                         xxh xxh 20h 20h
                                                         20h 20h 20h 20h
                                                         20h 20h 02h 20h
                                                         23h)

Command :W2#   (ASCII 3Ah 57h 32h 23h)
    Returns Nothing
    Sets the current site number to 2
    Equivalent to :W2#
    NOTE: Performing a :GN# now will return XYZ   √ # (ASCII xxh
    xxh xxh 20h 20h 20h 20h 20h 20h 20h 20h 02h 20h 23h)

Command :W3#   (ASCII 3Ah 57h 33h 23h)
    Returns Nothing
    Sets the current site number to 3
    Equivalent to :W3#
    NOTE: Performing a :GO# now will return XYZ   √ # (ASCII xxh
    xxh xxh 20h 20h 20h 20h 20h 20h 20h 20h 02h 20h 23h)

Command :W4#   (ASCII 3Ah 57h 34h 23h)
    Returns Nothing
    Sets the current site number to 4
    Equivalent to :W4#
    NOTE: Performing a :GP# now will return XYZ   √ # (ASCII xxh xxh
    xxh 20h 20h 20h 20h 20h 20h 20h 20h 02h 20h 23h)

II. TELESCOPE MOTION

Command :Mn#   (ASCII 3Ah 4Dh 6Eh 23h)
    Returns Nothing
    Issued on pressing N - starts the telescope in motion to the N at the current rate.
    Upon release   :Qn#   (ASCII 3Ah 51h 6Eh 23h)
    Equivalent to :Mn# and :Qn#

Command :Ms#   (ASCII 3Ah 4Dh 73h 23h)
    Returns Nothing
    Issued on pressing S - starts the telescope in motion to the S at the current rate.
    Upon release   :Qs#   (ASCII 3Ah 51h 73h 23h)
    Equivalent to :Ms# and :Qs#

Command :Me#   (ASCII 3Ah 4Dh 65h 23h)
    Returns Nothing
    Issued on pressing E - starts the telescope in motion to the E at the current rate.
    Upon release   :Qe#   (ASCII 3Ah 51h 65h 23h)
    Equivalent to :Me# and :Qe#

Command :Mw#   (ASCII 3Ah 4Dh 77h 23h)
    Returns Nothing
    Issued on pressing W - starts the telescope in motion to the W at the current rate.
    Upon release   :Qw#   (ASCII 3Ah 51h 77h 23h)
    Equivalent to :Mw# and :Qw#

Command :Qn#   (ASCII 3Ah 51h 6Eh 23h)
    Returns Nothing
    Issued on releasing N.
    Equivalent to :Qn#

Command :Qs#   (ASCII 3Ah 51h 73h 23h)
    Returns Nothing
    Issued on releasing S.
    Equivalent to:Qs#

Command :Qe#   (ASCII 3Ah 51h 65h 23h)
    Returns Nothing
    Issued on releasing E.
    Equivalent to :Qe#

Command :Qw#   (ASCII 3Ah 51h 77h 23h)
    Returns Nothing
    Issued on releasing W.
    Equivalent to :Qw#

Command :MS#   (ASCII 3Ah 4Dh 53h 23h)
    Returns 0\   (ASCII 30h 5Ch) 0 if the telescope can
complete the slew and \ (ASCII 5Ch) when the slew is complete.
    Returns 1Object below   horizon.   #   (ASCII 31h 4Fh 62h 6Ah 65h
                                         63h 74h 20h 62h 65h 6Ch 6Fh
                                         77h 20h 20h 20h 20h 68h 6Fh
                                         72h 69h 7Ah 6Fh 6Eh 2Eh 20h
                                         20h 20h 20h 20h 20h 20h 20h
                                         23h) - if the object is below
                                         the horizon – no slew.
    Returns 2Object below   altitude limit. #   (ASCII 32h 4Fh 62h 6Ah 65h
                                           63h 74h 20h 62h 65h 6Ch 6Fh
                                         77h 20h 20h 20h 20h 61h 6Ch
                                         74h 69h 74h 75h 64h 65h 20h
                                         6Ch 69h 6Dh 69h 74h 2Eh 20h
                                         23h) - if the object is below
                                         the 'higher' limit – no slew.
   Slew the telescope to coordinates currently in the scope. These may be
   from the object library or from manually entered coordinates.
   If this command is issued while a slew is in progress the slew will stop
   and a \ will be returned.
   Equivalent to :MS#
   Equivalent to :Q# for stopping a slew

Command :RS#   (ASCII 3Ah 52h 53h 23h)
    Returns Nothing
    Sets the motion rate to SLEW.
    Equivalent to :RS#

Command :RM#   (ASCII 3Ah 52h 4Dh 23h)
    Returns Nothing
    Sets the motion rate to FIND.
    Equivalent to :RM#

Command :RC#   (ASCII 3Ah 52h 43h 23h)
    Returns Nothing
    Sets the motion rate to CENTER.
    Equivalent to :RC#

Command :RG#   (ASCII 3Ah 52h 47h 23h)
    Returns Nothing
    Sets the motion rate to GUIDE.
    Equivalent to :RG#

III.   LIBRARY OBJECTS

Command :Gr#   (ASCII 3Ah 47h 72h 23h)
    Returns HH:MM.T#   (ASCII xxh xxh 3Ah xxh xxh 2E xxh 23h)
    Gets the object Right Ascension
    Equivalent :Gr#

Command :Sr DD:MM.T#   (ASCII 3Ah 53h 72h 20h xxh xxh 3Eh
                                           xxh xxh 2Eh xxh 23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Range is from 0-24 hours, 0-59 minutes and 0-9 tenths.
    Sets a position in Right Ascension for the telescope to slew to using the
    :MS# command.
    Equivalent to :Sr DD:MM.T#

Command :Gd#   (ASCII 3Ah 47h 64h 23h)
    Returns sDDβMM#   (ASCII xxh xxh xxh DFh xxh xxh 23h)
    Gets the object Declination
    Equivalent :Gd#

Command :Sd sDDβMM#   (ASCII 3Ah 53h 64h 20h xxh xxh xxh DFh
                                           xxh xxh 23h) (where s is sign (+ or -) and β
                                           is ASCII DFh and shows as the ° symbol on
                                           the LCD display.)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Range is from ±0-90 degrees, 0-59 minutes; not to exceed ±90:00
    Sets a position in Declination for the telescope to slew to using the :MS#
    command.
    Equivalent to :Sd sDD*MM.T#

Command :CM#   (ASCII 3Ah 43h 4Dh 23h)
    Returns Coordinates   matched:XXXXXX# (ASCII 43h 6Fh 6Fh 72h
                                                   64h 69h 6Eh 61h 74h 65h
                                                 73h 20h 20h 20h 20h 20h
                                                 6Dh 61h 74h 63h 68h 65h
                                               64h 3Ah xxh xxh xxh xxh
                                               xxh xxh xxh xxh 23h)
    Matches coordinates with current RA & DEC being shown. Used to sync
    telescope to a known object. The XXXXXXX is a string of characters
    (up to 8 characters, padded with spaces if not all used) identifying the
    object synced to.
    NO Equivalent

Command :Gy#   (ASCII 3Ah 47h 79h 23h)
    Returns GPDCO#   (ASCII 47h 50h 44h 43h 4Fh 23h) or any
    letter as lower case.
    Returns gpdco#   (ASCII 67h 70h 64h 61h 6Fh 23h)
    Gets the 'type' string for the FIND operation. A capital letter means that
    the corresponding type is selected, while a lower case letter indicates it is
    not.
    Equivalent :Gy#

Command :Sy GPDCO#   (ASCII 47h 50h 44h 43h 4Fh 23h) or any
                                    letter as lower case. (ASCII 67h 70h 64h
                                    61h 6Fh 23h).
    Returns 1   If the command was accepted
    Returns Nothing if command was NOT accepted.
    Sets the 'type' string for the FIND operation.
    Equivalent :Sy GPDCO#

Command :Gq#   (ASCII 3Ah 47h 71h 23h)
    Returns SU#, EX#, VG#, GD#, FR#, PR#, or VP#(ASCII 53h 55h 23h, or
                                      45h 58h 23h, or 56h
                                      47h 23h, or 47h 44h
                                      23h, or 46h 52h 23h, or
                                      50h 52h 23h, or 56h
                                      50h 23h)
    Gets the current minimum quality for the FIND operation.
    Equivalent :Gq#

Command :Sq#   (ASCII 3Ah 53h 71h 23h)
    Returns Nothing
    Steps to the next minimum quality for the FIND operation.
    Equivalent :Gq#

Command :Gh#   (ASCII 3Ah 47h 68h 23h)
    Returns DDβ#   (ASCII xxh xxh DFh 23h)
    Gets the current 'higher' limit. Works in POLAR or ALTAZ Modes.
    Equivalent :Gh#

Command :Sh DD#   (ASCII 3Ah 53h 68h xxh xxh 23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the current 'higher' limit for FIND Operation. Range is 0 to 90.
    Works in POLAR or ALTAZ Modes.
    Equivalent :Gh#

Command :Gb#   (ASCII 3Ah 47h 62h 23h)
    Returns sMM.M#   (ASCII xxh xxh xxh 2Eh xxh 23h)
    Gets the 'brighter' magnitude limit for FIND Operation.
    Equivalent :Gb#

Command :Sb sMM.M#   (ASCII 3Ah 53h 62h 20h xxh xxh 2Eh xxh
                                    23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the 'brighter' magnitude limit for FIND Operation. Range is -05.5 to
    +20.0.
    Equivalent : Sb sMM.M#

Command :Gf#   (ASCII 3Ah 47h 66h 23h)
    Returns sMM.M#   (ASCII xxh xxh xxh 2Eh xxh 23h)
    Gets the 'fainter' magnitude limit for FIND Operation.
    Equivalent :Gf#

Command :Gl#   (ASCII 3Ah 47h 6Ch 23h)
    Returns NNN'#   (ASCII xxh xxh xxh 27h 23h)
    Gets the 'larger' size limit for FIND Operation.
    Equivalent :Gh#

Command :GF#   (ASCII 3Ah 47h 46h 23h)
    Returns NNN'#   (ASCII xxh xxh xxh 27h 23h)
    Gets the 'field' radius for FIND Operation.
    Equivalent :GF#

Command :SF NNN#   (ASCII 3Ah 53h 62h 20h xxh xxh 2Eh xxh
                                    23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the 'brighter' magnitude limit for FIND Operation. Range is 0 to
    200.
    Equivalent : SF NNN#

Command :LF#   (ASCII 3Ah 4Ch 46h 23h)
    Returns Nothing
    Starts a FIND operation.
    Equivalent :LF#

Command :LN#   (ASCII 3Ah 4Ch 4Eh 23h)
    Returns Nothing
    Finds the next object in a FIND sequence
    Equivalent :LN#

Command :LB#   (ASCII 3Ah 4Ch 42h 23h)
    Returns Nothing
    Finds the previous object in a FIND sequence
    Equivalent :LB#

Command :Lf#   (ASCII 3Ah 4Ch 66h 23h)
    Returns Objects: CC   #   (ASCII 4fh 62h 6Ah 63h 74h 3Ah
    20h 20h xxh xxh xxh xxh xxh xxh xxh xxh xxh 20h 20h20h 20h
    20h20h 20h 20h20h 20h 20h20h 20h 20h 23h) where xxh xxh is the
    number of items in the field and the object that is closest to the center of
    the field.
    Performs a FIELD operation returning the number objects in the field and
    the object that is closest to the center of the field.
    Equivalent :LB#

Command :LC NNNN#   (ASCII 3Ah 45h 20h xxh xxh xxh xxh 23h)
    Returns Nothing
    Sets the object to the CNGC specified by the number. If the object
    number is out of range, a :LI# command returns a "No matching object
    found" message. A follow up :LI# command returns information on the
    last good object.
    Equivalent to :LC NNNN#

Command :LM NNNN#   (ASCII 3Ah 4Dh 20h xxh xxh xxh xxh 23h)
    Returns Nothing
    Sets the object to the MESSIER Object specified by the number. If the
    object number is out of range, a :LI# command returns a "No matching
    object found" message. A follow up :LI# command returns information
    on the last good object.
    Equivalent to :LM NNNN#

Command :LS NNNN#   (ASCII 3Ah 53h 20h xxh xxh xxh xxh 23h)
    Returns Nothing
    Sets the object to the STAR (Planet) specified by the number. If the
    object number is out of range, a :LI# command returns a "No matching
    object found" message. A follow up :LI# command returns information
    on the last good object.
    Equivalent to :LS NNNN#

Command :LI#   (ASCII 3Ah 4Ch 49h 23h)
    Returns XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX#
    (ASCII xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
    xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
    23h) – a 32 byte ASCII string of the data regarding any object matching
    the current point position, OR
    Returns No matching   object…   # (ASCII(4Eh 6Fh 20h 6Dh 61h 74h
    63h 68h 69h 6Eh 67h 20h 20h 20h 20h 20h 6Fh 62h 6Ah 65h 63h 74h 2Eh
    2Eh 2Eh 20h 20h 20h 20h 20h 20h 20h 23h) if the last object entered by
    :LC NNNN#, :LM NNNN# or :LS NNN # was not a valid object.
    Gets the current object information
    Equivalent :LI#

IV. MISC

Command :B+#   (ASCII 3Ah 42h 2Bh 23h)
    Returns Nothing
    Increases the brightness of the RETICLE PORT. Output starts a 0vdc; the
    first :B+# command starts a PWM pattern of 1ms on out of 10ms. Each
    subsequent :B+# command adds another 1ms on time to the 10ms until
    full on. Voltage out is +5vdc.
    Equivalent :B+#

Command :B-#   (ASCII 3Ah 42h 2Dh 23h)
    Returns Nothing
    Decreases the brightness of the RETICLE PORT. Output starts a 5vdc;
    the first :B-# command starts a PWM pattern of 1ms off out of 10ms.
    Each subsequent :B-# command adds another 1ms off time to the 10ms
    until full off Voltage out is +5vdc.
    Equivalent :B-#

Command :B0#   (ASCII 3Ah 42h 30h 23h)
    Returns Nothing
    Produces a long term PWM pattern of in 1ms steps. The ON pattern is
    modified by the :B+# and :B-# command. As described in those sections,
    these commands produce a PWM wave 10ms in length with intervals of
    1ms. This command will allow the wave to go from full OFF to full ON
    in 10 steps.
    Equivalent :B0#

Command :B1#   (ASCII 3Ah 42h 31h 23h)
    Returns Nothing
    Produces a long term PWM pattern of .5second (.25sec on/.25sec off).
    The ON pattern is modified by the :B+# and :B-# command. As described
    in those sections, these commands produce a PWM wave 10ms in length
    with intervals of 1ms.
    Equivalent :B1#

Command :B2#   (ASCII 3Ah 42h 32h 23h)
    Returns Nothing
    Produces a long term PWM pattern of .5second (.115sec on/.385sec off).
    The on pattern is modified by the :B+# and :B-# command. As described
    in those sections, these commands produce a PWM wave 10ms in length
    with intervals of 1ms.
    Equivalent :B2#

Command :B3#   (ASCII 3Ah 42h 33h 23h)
    Returns Nothing
    Produces a long term PWM pattern of 1 second (.121sec on/.879sec off).
    The ON pattern is modified by the :B+# and :B-# command. As described
    in those sections, these commands produce a PWM wave 10ms in length
    with intervals of 1ms.
    Equivalent :B3#

Command :F+#   (ASCII 3Ah 46h 2Bh 23h)
    Returns Nothing
    Created when the FOCUS key is depressed and then the PREV is also
    depressed. Provided +8 vdc or +16 vdc depending on the setting of :FS#
    or :FF# respectively to the FOCUSER Port.
    Equivalent :F+#

Command :F-#   (ASCII 3Ah 46h 2Dh 23h)
    Returns Nothing
    Created when the FOCUS key is depressed and then the NEXT is also
    depressed. About -.5vdc present regardless of the setting of :FS# or :FF#
    respectively to the FOCUSER Port. (This may be an anomaly with my
    LX-200).
    Equivalent :F-#

Command :FQ#   (ASCII 3Ah 46h 51h 23h)
    Returns Nothing
    Command created when the FOCUS key is pressed and also again when
    released.
    Used in conjunction with NEXT and PREV key.
    Equivalent :FQ#

Command :FF#   (ASCII 3Ah 46h 46h 23h)
    Returns Nothing
    Provides a higher voltage to the FOCUSER Port when activated.
    Equivalent :FF#

Command :FS#   (ASCII 3Ah 46h 53h 23h)
    Returns Nothing
    Provides a lower voltage to the FOCUSER Port when activated.
    Equivalent :FS#

Command :GM#   (ASCII 3Ah 47h 4Dh 23h)
    Returns XYZ   #   (ASCII xxh xxh xxh 20h 20h 20h 20h 20h
                                20h 20h 20h 20h 20h 23h)

    Gets site name #1
    Equivalent to :GM#

Command :GN#   (ASCII 3Ah 47h 4Eh 23h)
    Returns XYZ   #   (ASCII xxh xxh xxh 20h 20h 20h 20h 20h
                                20h 20h 20h 20h 20h 23h)

    Gets site name #2
    Equivalent to :GN#

Command :GO#   (ASCII 3Ah 47h 4Fh 23h)
    Returns XYZ   #   (ASCII xxh xxh xxh 20h 20h 20h 20h 20h
                                20h 20h 20h 20h 20h 23h)

    Gets site name #3
    Equivalent to :GO#

Command :GP#   (ASCII 3Ah 47h 50h 23h)
    Returns XYZ   #   (ASCII xxh xxh xxh 20h 20h 20h 20h 20h
                                20h 20h 20h 20h 20h 23h)

    Gets site name #4
    Equivalent to :GP#

Command :SM XYZ#   (ASCII 3Ah 53h 4Dh 20h xxh xxh xxh 23h)
    Returns 1 (ASCII 31h)
    Sets site name #1 toXYZ
    Equivalent to :SM XYZ#

Command :SN XYZ#   (ASCII 3Ah 53h 4Eh 20h xxh xxh xxh 23h)
    Returns 1 (ASCII 31h)
    Sets site name #2 toXYZ
    Equivalent to :SN XYZ#

Command :SO XYZ#   (ASCII 3Ah 53h 4Fh 20h xxh xxh xxh 23h)
    Returns 1 (ASCII 31h)
    Sets site name #3 toXYZ
    Equivalent to :SO XYZ#

Command :SP XYZ#   (ASCII 3Ah 53h 50h 20h xxh xxh xxh 23h)
    Returns 1 (ASCII 31h)
    Sets site name #4 toXYZ
    Equivalent to :SP XYZ#

Command :GT#   (ASCII 3Ah 54h 51h 23h)
    Returns TT.T#   (ASCII xxh xxh 2Eh xxh 23h)
    Returns current track 'frequency' from 56.4 to 60.1
    Equivalent to :GT#

Command :ST TT.T#   (ASCII 3Ah 53h 54h 20h xxh xxh 2Eh xxh
                                     23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Range is from 56.4 to 60.1
    Sets the current track 'frequency'. Must be in manual mode (:TM#)
    Equivalent to :ST TT.T#

Command :TQ#   (ASCII 3Ah 54h 51h 23h)
    Returns Nothing
    Switches to Sidereal rate; quartz setting
    Equivalent to :TQ#

Command :TM#   (ASCII 3Ah 54h 4Dh 23h)
    Returns Nothing
    Switches to manual rate. See :ST TT.T# to set rate
    Equivalent to :TM#

Command :T+#   (ASCII 3Ah 54h 2Bh 23h
    Returns Nothing
    Increments manual frequency by .1 Hz
    Equivalent to :T+#

Command :T-#   (ASCII 3Ah 54h 2Dh 23h)
    Returns Nothing
    Decrements manual frequency by .1 Hz
    Equivalent to :T-#

Command :Gc#   (ASCII 3Ah 47h 67h 23h)
    Returns (24)#   (ASCII 28h 32h 34h 29h 23h) OR
    Returns (12)#   (ASCII 28h 32h 34h 29h 23h)
    (24) indicates local time will be displayed in 24 hour format.
    (12) indicates local time will be displayed in 12 hour format.
    Equivalent to:Gc#

Command :^13#   (ASCII 3Ah 5Eh 31h 33h 23h)
    Returns Nothing
    Toggles between 12 hour and 24 hour mode
    Equivalent to :H#

V. KEYPAD SPECIFIC

Command :D#   (ASCII 3Ah 23h)
　　Returns BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB#
　　　　　 (ASCII xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
　　　　　 xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
　　　　　 xxh xxh 23h) where xxh is either FFh or 20h. FFh represents a block
　　　　　 displayed on the Hand Controller LCD. Each block represents 10°
　　　　　 of movement. The first 16 blocks are Right Ascension and the
　　　　　 second 16 blocks are for Declination. Unused positions are sent as
　　　　　 spaces.
　　Gets the distance to object in 10° blocks.
　　Equivalent :D#   Listed under Keypad Hand Controller Specific

Command :??#   (ASCII 3Ah 3Fh 23h)
　　Returns Section 1-Keys   # (ASCII 53h 65h 53h 74h 69h 6Fh
　　　　　　　　　　　　　　　　　 6Eh 20h 31h 2Dh 4Bh 65h 79h 73h
　　　　　　　　　　　　　　　　　 20h 20h 20h 20h 20h 20h 20h 20h
　　　　　　　　　　　　　　　　　 20h 20h 20h 20h 20h 20h 20h 20h
　　　　　　　　　　　　　　　　　 20h 20h 23h)

　　First line of HELP menu.
　　Equivalent :?#   Listed under Keypad Hand Controller Specific

Command :?+#   (ASCII 3Ah 3Fh 2Bh 23h)
　　Returns Nothing - moves to next page of help text.
　　Next line of HELP menu.
　　Equivalent :?+#   Listed under Keypad Hand Controller Specific

Command :?-#   (ASCII 3Ah 3Fh 2Dh 23h)
　　Returns Nothing – moves to previous page of help text.
　　Previous line of HELP menu.
　　Equivalent :?-#   Listed under Keypad Hand Controller Specific

Command :?#   (ASCII 3Ah 3Fh 23h)
　　Returns – displays current page of help text.
　　Current line of HELP menu.
　　Equivalent :?#   Listed under Keypad Hand Controller Specific

Command :G0#   (ASCII 3Ah 47h 30h 23h)
    Returns ALTAZ   #   (ASCII 41h 4Ch 54h 41h 5Ah 20h 20h 20h
                                20h 20h 20h 20h 20h 20h 20h 20h 23h) IF
                                not in alt-az mode, OR
    Returns ALTAZ   √   #   (ASCII 41h 4Ch 54h 41h 5Ah 20h 20h 20h
                                20h 20h 02h 20h 20h 20h 20h 20h 23h) IF in
                                alt-az mode
    First menu line in ALIGN MENU
    NO Equivalent

Command :G1#   (ASCII 3Ah 47h 31h 23h)
    Returns POLAR   #   (ASCII 50h 4Fh 4Ch 41h 52h 20h 20h 20h
                                20h 20h 20h 20h 20h 20h 20h 20h 23h) IF
                                not in polar mode, OR
    Returns POLAR   √   #   (ASCII 50h 4Fh 4Ch 41h 52h 20h 20h 20h
                                20h 20h 02h 20h 20h 20h 20h 20h 23h) IF in
                                polar mode
    Second menu line in ALIGN MENU
    NO Equivalent

Command :G2#   (ASCII 3Ah 47h 32h 23h)
    Returns LAND   #   (ASCII 4Ch 41h 4Eh 44h 20h 20h 20h 20h
                                20h 20h 20h 20h 20h 20h 20h 23h) IF
                                not in land mode, OR
    Returns LAND   √   #   (ASCII 50h 4Fh 4Ch 41h 52h 20h 20h 20h
                                20h 20h 02h 20h 20h 20h 20h 23h) IF in
                                land mode
    Third menu line in ALIGN MENU
    NO Equivalent

Command :AA#   (ASCII 3Ah 41h 41h 23h)
    Returns Nothing
    Sets telescope in ALT-AZ mode
    NO Equivalent

Command :AP#   (ASCII 3Ah 41h 50h 23h)
    Returns Nothing
    Sets telescope in POLAR mode
    NO Equivalent

Command :AL#   (ASCII 3Ah 41h 4Ch 23h)
    Returns Nothing
    Sets telescope in LAND mode
    NO Equivalent

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Command :@10#   (ASCII 3Ah 40h 31h 30h 23h)
  Returns 1)SITE # (ASCII 31h 29h 53h 49h 54h 45h 20h 20h
              20h 20h 20h 20h 20h 20h 20h 23h)
  First menu line in TELESCOPE Mode 1
  NO Equivalent

Command :@11#   (ASCII 3Ah 40h 31h 31h 23h)
  Returns 2)ALIGN # (ASCII 32h 29h 41h 4Ch 49h 47h 4Eh 20h
              20h 20h 20h 20h 20h 20h 20h 23h)
  Second menu line in TELESCOPE Mode 1
  NO Equivalent

Command :@12#   (ASCII 3Ah 40h 31h 32h 23h)
  Returns 3)SMART # (ASCII 33h 29h 53h 4Dh 41h 52h 54h 20h
              20h 20h 20h 20h 20h 20h 20h 23h)
  Third menu line in TELESCOPE Mode 1
  NO Equivalent

Command :@13#   (ASCII 3Ah 40h 31h 33h 23h)
  Returns 4)12/24 HR (24)# (ASCII 34h 29h 31h 32h 2Fh 32h 34h 20h
              48h 52h 20h 28h 32h 34h 29h 23h)
  Fourth menu line in TELESCOPE Mode 1
  NO Equivalent

Command :@14#   (ASCII 3Ah 40h 31h 34h 23h)
  Returns 5)HELP # (ASCII 35h 29h 48h 45h 4Ch 50h 20h 20h
              20h 20h 20h 20h 20h 20h 20h 23h)
  Fifth menu line in TELESCOPE Mode 1
  NO Equivalent

Command :@15#   (ASCII 3Ah 40h 31h 35h 23h)
  Returns 6)REVERSE N/S # (ASCII 36h 29h 52h 45h 56h 45h 52h 53h
              45h 20h 4Eh 2Fh 53h 20h 20h 23h)
  Sixth menu line in TELESCOPE Mode 1
  NO Equivalent

Command :@16#   (ASCII 3Ah 40h 31h 36h 23h)
  Returns 7)REVERSE E/W # (ASCII 37h 29h 52h 45h 56h 45h 52h 53h
              45h 20h 45h 2Fh 57h 20h 20h 23h)
  Seventh menu line in TELESCOPE Mode 1
  NO Equivalent

Command :A0#   (ASCII 3Ah 41h 30h 23h)
    Returns Level base, thenpress ENTER   # (ASCII 4Ch 65h 76h 65h
                                                                6Ch 20h 62h 61h 73h 65h
                                                               2Ch 20h 74h 68h 65h 6Eh
                                                               70h 72h 65h 73h 73h 20h 45h
                                                               4Eh 54h 45h 52h 20h 20h
                                                               20h 20h 20h 23h) IF in ALT-
                                                               AZ mode, OR
    Returns Move to Dec 90, HA 0.Press ENTER#   (ASCII 4Dh 6Fh 76h
                                                               65h 20h 74h 6Fh 20h
                                                               44h 65h 63h 20h 39h
                                                               30h 2Ch 20h 48h 41h
                                                               20h 30h 2eh 50h 72h
                                                               65h 73h 73h 20h 45h
                                                               4Eh 54h 45h 52h 23h)
                                                               IF in POLAR mode.
    First menu line in ALTAZ and POLAR ALIGN process
    NO Equivalent

Command :A1#   (ASCII 3Ah 41h 31h 23h)
    Returns \   (ASCII 5Ch) causes the hand controller to beep
    Moves the telescope to Polaris while in the Polar Mode.
    NO Equivalent

Command :A2#   (ASCII 3Ah 41h 30h 23h)
    Returns Press ENTER,then pick align star # (ASCII 50h 72h 65h 73h 73h
                                                                    20h 45h 4Eh 54h 45h 52h
                                                               2Ch 74h 68h 65h 6Eh 70h
                                                               69h 63h 6Bh 20h 61h 6Ch
                                                               69h 67h 6Eh 20h 73h 74h
                                                               61h 72h 20h 23h) IF in ALT-
                                                               AZ mode, OR
    Returns Center POLARIS then press ENTER #   (ASCII 43h 65h 6Eh
                                                               74h 65h 72h 20h 50h
                                                               4Fh 4Ch 41h 52h 49h
                                                               53h 20h 20h 74h 68h
                                                               65h 6Eh 20h 70h 72h
                                                               65h 73h 73h 20h 45h
                                                               4Eh 54h 45h 52h 23h)
                                                               IF in POLAR mode.
    Second menu line in ALTAZ and POLAR ALIGN process.
    NO Equivalent

Command :A3#   (ASCII 3Ah 41h 33h 23h)
    Returns Press ENTER,then pick align star #   (ASCII 50h 72h 65h 73h
                                                73h 20h 45h 4Eh 54h 45h
                                                52h 2Ch 74h 68h 65h 6Eh
                                                70h 69h 63h 6Bh 20h 61h
                                                6Ch 69h 67h 6Eh 20h 73h
                                                74h 61h 72h 20h 23h) IF in
                                                ALT-AZ mode, OR
Returns \   (ASCII 5Ch) which causes the hand
                                controller to beep IF in POLAR mode.
    Move the telescope to an alignment star.
    Third menu line in ALTAZ ALIGN process.
    NO Equivalent

Command :A4#   (ASCII 3Ah 41h 34h 23h)
    Returns Center XXXXXXXXXthen press ENTER#   (ASCII 43h 65h
                                                6Eh 74h 65h 72h
                                                20h xxh xxh xxh
                                                xxh xxh xxh xxh
                                                xxh xxh 74h 68h
                                                65h 6Eh 20h 70h
                                                72h 65h 73h 73h
                                                20h 45h 4Eh 54h
                                                45h 52h 23h) IF in
                                                POLAR or ALTAZ
                                                Mode.
    The alignment star name may take up to 9 places. If the star name is less
    than 9 characters, the remaining characters are filled in as spaces (ASCII
    20h).
    Forth Menu line in ALTAZ ALIGN process, OR
    Third menu line in POLAR ALIGN process.
    NO Equivalent

Command :A5#   (ASCII 3Ah 41h 35h 23h)
    Returns Nothing
    Acknowledgment command that the telescope is centered on a POLAR
    alignment star in POLAR ALIGN, or on an ALTAZ alignment star in
    ALTAZ MODE.
    NO Equivalent

Command :A+#   (ASCII 3Ah 41h 2Bh 23h)
    Returns \   (ASCII 5Ch)
    Command in POLAR ALIGNEMENT causes the scope to slew to the
    position of POLARIS. \ (ASCII 5Ch) is used to sound beeper when slew
    is finished.
    NO Equivalent

Command :@50#   (ASCII 3Ah 40h 35h 30h 23h)
    Returns 1)LEARN   #   (ASCII 31h 29h 4Ch 45h 41h 52h 4Eh 20h
                                20h 20h 20h 20h 20h 20h 20h 23h) OR
    Returns 1)LEARN   NNN#   (ASCII 31h 29h 4Ch 45h 41h 52h 4Eh 20h
                                20h 20h 20h 20h xxh xxh xxh 23h) when
                                Smart drive LEARN active, where NNN is
                                the number of seconds x2 before the worm
                                home is reached.
    First menu line in SMART DRIVE mode
    NO Equivalent

Command :@51#   (ASCII 3Ah 40h 35h 31h 23h)
    Returns 2)UPDATE   #   (ASCII 32h 29h 55h 50h 44h 41h 54h 45h
                                20h 20h 20h 20h 20h 20h 20h 23h) OR
    Returns 2)UPDATE   NNN#   (ASCII 32h 29h 55h 50h 44h 41h 54h 45h
                                20h 20h 20h 20h xxh xxh xxh 23h) when
                                Smart drive LEARN active, where NNN is
                                the number of seconds x2 before the worm
                                home is reached.
    Second menu line in SMART DRIVE mode
    NO Equivalent

Command :@52#   (ASCII 3Ah 40h 35h 32h 23h)
    Returns 3)ERASE   #   (ASCII 33h 29h 45h 52h 41h 53h 45h 20h
                                20h 20h 20h 20h 20h 20h 20h 23h)
    Third menu line in SMART DRIVE mode
    NO Equivalent

Command :@53#   (ASCII 3Ah 40h 35h 33h 23h)
    Returns 4)DEC LEARN   # (ASCII 34h 29h 44h 45h 43h 20h 4Ch 45h
                                41h 52h 4Eh 20h 20h 20h 20h 23h)
    Forth menu line in SMART DRIVE mode
    NO Equivalent

Command :@54#   (ASCII 3Ah 40h 35h 34h 23h)
    Returns 5)DEC CORRECT #   (ASCII 35h 29h 44h 45h 44h 20h
                                 43h 4Fh 52h 52h 45h 43h 54h 20h
                                 20h 23h)
    Fifth menu line in SMART DRIVE mode
    NO Equivalent

Command :^50#   (ASCII 3Ah 5Eh 35h 30h 23h)
    Returns Nothing
    Starts Smart Drive LEARN Process. User must wait for worm to return to
    home position. This is determined by issuing :@50# command. When the
    Smart Drive LEARN is active, the return data will include a number that is
    counting down to 0. As the counter reaches 5 seconds, a beep is issued as
    a warning. During the 8 minutes of training, a beep will be sounded
    ~every 10 seconds. When finished a pair of beeps will be sounded.
    NO Equivalent

Command :^51#   (ASCII 3Ah 5Eh 35h 31h 23h)
    Returns Nothing
    Starts Smart Drive UPDATE Process. User must wait for worm to return
    to home position. This is determined by issuing :@51# command. When
    the Smart Drive UPDATE is active, the return data will include a number
    that is counting down to 0. As the counter reaches 5 seconds, a beep is
    issued as a warning. During the 8 minutes of training, a beep will be
    sounded ~every 10 seconds. When finished a pair of beeps will be
    sounded.
    NO Equivalent

Command :^52#   (ASCII 3Ah 5Eh 35h 32h 23h)
    Returns Nothing
    Erases Smart Drive training.
    NO Equivalent

Command :^53#   (ASCII 3Ah 5Eh 35h 33h 23h)
    Returns Nothing
    Starts DEC Drive LEARN Process. User can determine mode by issuing
    :@53# command. When the DEC Drive LEARN is active, the return data
    will be 4)DEC LEARN   √# (ASCII 34h 29h 44h 45h 43h 20h 4Ch 45h
    41h 52h 4Eh 20h 20h 20h 02h 23h). DEC training will continue until
    :^53# is issued again. All DEC LEARN is lost when the LX-200 is
    powered down. It can also be erased by issuing two :^53# commands in
    sequence.
    NO Equivalent

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Command :^54#   (ASCII 3Ah 5Eh 35h 34h 23h)
    Returns Nothing
    Starts playback of DEC LEARN. Issuing the same command a second
    time will stop the DEC LEARN playback.
    NO Equivalent

Command :^13#   (ASCII 3Ah 5Eh 31h 33h 23h)
    Returns Nothing
    Toggles clock between 12 and 24 hour display for local time.
    Equivalent :H#

Command :^15#   (ASCII 3Ah 5Eh 31h 35h 23h)
    Returns Nothing
    Toggles the N/S motion buttons direction of motion.
    NO Equivalent

Command :^16#   (ASCII 3Ah 5Eh 31h 36h 23h)
    Returns Nothing
    Toggles the E/W motion buttons direction of motion.
    NO Equivalent

Command :Sl NNN#   (ASCII 3Ah 53h 6Ch 20h xxh xxh xxh 23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the 'larger' limit for FIND Operation. Range is 0 to 200.
    Equivalent : Sl NNN#

Command :Gs#   (ASCII 3Ah 47h 73h 23h)
    Returns NNN'#   (ASCII xxh xxh xxh 27h 23h)
    Gets the 'smaller' size limit for FIND Operation.
    Equivalent :Gs#

Command :Ss NNN#   (ASCII 3Ah 53h 73h 20h xxh xxh xxh 23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the 'smaller' limit for FIND Operation. Range is 0 to 200.
    Equivalent : Ss NNN#

Command :Sf sMM.M#   (ASCII 3Ah 53h 66h 20h xxh xxh 2Eh xxh
                                     23h)
    Returns 1 (ASCII 31h) if in range, 0 (ASCII 30h) if out of range.
    Sets the 'fainter' magnitude limit for FIND Operation. Range is -05.5 to
    +20.0.
    Equivalent : Sf sMM.M#

VI.   KEYPAD ALTAZ ALIGNMENT

Command :AN 01 0#   (ASCII 3Ah 41h 4Eh 20h 30h 31h 20h 30h
                                     23h)
    Returns ~ACHERNAR   ACRUX A   #
    (ASCII 7Eh 41h 43h 48h 45h 52h 4Eh 41h 52h 20h 20h 20h 20h 20h
    20h 20h 20h 41h 43h 52h 55h 58h 20h 41h 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
    Shows first and second ALTAZ alignment stars with ACHERNAR
    selected.
    NO Equivalent

Command :AN 01 1#   (ASCII 3Ah 41h 4Eh 20h 30h 31h 20h 31h
                                     23h)
    Returns ACHERNAR   ~ACRUX A   #
    (ASCII 20h 41h 43h 48h 45h 52h 4Eh 41h 52h 20h 20h 20h 20h 20h
    20h 20h 7Eh 41h 43h 52h 55h 58h 20h 41h 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
    Shows first and second ALTAZ alignment stars with ACRUX A selected.
    NO Equivalent

Command :AN 02 0#   (ASCII 3Ah 41h 4Eh 20h 30h 32h 20h 30h
                                     23h)
    Returns ~ACRUX A   ALIBERO   #
    (ASCII 7Eh 41h 43h 52h 55h 58h 20h 41h 20h 20h 20h 20h 20h 20h
    20h 20h 20h 41h 4Ch 42h 49h 52h 45h 4Fh 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
    Shows second and third ALTAZ alignment stars with ACRUX A selected.
    NO Equivalent

Command :AN 02 1#   (ASCII 3Ah 41h 4Eh 20h 30h 32h 20h 31h
                                     23h)
    Returns ACRUX A   ~ALIBERO   #
    (ASCII 20h 41h 43h 52h 55h 58h 20h 41h 20h 20h 20h 20h 20h 20h
    20h 20h 7Eh 41h 4Ch 42h 49h 52h 45h 4Fh 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
    Shows second and third ALTAZ alignment stars with ALIBERO selected.
    NO Equivalent

Command :AN 03 0#   (ASCII 3Ah 41h 4Eh 20h 30h 33h 20h 30h 23h)

    Returns ~ALIBERO   ALCAID   #

        (ASCII 7Eh 41h 4Ch 42h 49h 52h 45h 4Fh 20h 20h 20h 20h 20h 20h 20h 20h 20h 41h 4Ch 43h 41h 49h 44h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows third and fourth ALTAZ alignment stars with ALIBERO selected.
    NO Equivalent

Command :AN 03 1#   (ASCII 3Ah 41h 4Eh 20h 30h 33h 20h 31h 23h)

    Returns   ALIBERO   ~ALCAID   #

        (ASCII 20h 41h 4Ch 42h 49h 52h 45h 4Fh 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 41h 4Ch 43h 41h 49h 44h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows third and fourth ALTAZ alignment stars with ALCAID selected.
    NO Equivalent

Command :AN 04 0#   (ASCII 3Ah 41h 4Eh 20h 30h 34h 20h 30h 23h)

    Returns ~ALCAID   ALDEBARAN#

        (ASCII 7Eh 41h 4Ch 43h 41h 49h 44h 20h 20h 20h 20h 20h 20h 20h 20h 20h 41h 4Ch 44h 45h 42h 41h 52h 41h 4Eh 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows fourth and fifth ALTAZ alignment stars with ALCAID selected.
    NO Equivalent

Command :AN 04 1#   (ASCII 3Ah 41h 4Eh 20h 30h 34h 20h 31h 23h)

    Returns   ALCAID   ~ALDEBARAN#

        (ASCII 20h 41h 4Ch 43h 41h 49h 44h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 41h 4Ch 44h 45h 42h 41h 52h 41h 4Eh 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows fourth and fifth ALTAZ alignment stars with ALDEBARAN selected.
    NO Equivalent

Command :AN 05 0#   (ASCII 3Ah 41h 4Eh 20h 30h 35h 20h 30h 23h)

    Returns ~ALDEBARAN   ALNILAM   #

    (ASCII 7Eh 41h 4Ch 44h 45h 42h 41h 52h 41h 4Eh 20h 20h 20h 20h 20h 20h 20h 41h 4Ch 4Eh 49h 4Ch 41h 4Dh 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows fifth and sixth ALTAZ alignment stars with ALDEBARAN selected.

    NO Equivalent

Command :AN 05 1#   (ASCII 3Ah 41h 4Eh 20h 30h 35h 20h 31h 23h)

    Returns   ALDEBARAN   ~ALNILAM   #

    (ASCII 20h 41h 4Ch 44h 45h 42h 41h 52h 41h 4Eh 20h 20h 20h 20h 20h 20h 7Eh 41h 4Ch 4Eh 49h 4Ch 41h 4Dh 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows fifth and sixth ALTAZ alignment stars with ALNILAM selected.

    NO Equivalent

Command :AN 06 0#   (ASCII 3Ah 41h 4Eh 20h 30h 36h 20h 30h 23h)

    Returns ~ALNILAM   ALPHARD   #

    (ASCII 7Eh 41h 4Ch 4Eh 49h 4Ch 41h 4Dh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 41h 4Ch 50h 48h 41h 52h 44h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows sixth and seventh ALTAZ alignment stars with ALNILAM selected.

    NO Equivalent

Command :AN 06 1#   (ASCII 3Ah 41h 4Eh 20h 30h 36h 20h 31h 23h)

    Returns   ALNILAM   ~ALPHARD   #

    (ASCII 20h 41h 4Ch 4Eh 49h 4Ch 41h 4Dh 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 41h 4Ch 50h 48h 41h 52h 44h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows sixth and seventh ALTAZ alignment stars with ALPHARD selected.

    NO Equivalent

Command :AN 07 0#   (ASCII 3Ah 41h 4Eh 20h 30h 37h 20h 30h
                                     23h)
     Returns   ~ALPHARD   ALPHEKKA   #
          (ASCII 7Eh 41h 4Ch 50h 48h 41h 52h 44h 20h 20h 20h 20h 20h 20h
          20h 20h 20h 41h 4Ch 50h 48h 45h 4Bh 4Bh 41h 20h 20h 20h 20h 20h
          20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
          Display.
     Shows seventh and eighth ALTAZ alignment stars with ALPHARD
     selected.
     NO Equivalent

Command :AN 07 1#   (ASCII 3Ah 41h 4Eh 20h 30h 37h 20h 31h
                                     23h)
     Returns   ALPHARD   ~ALPHEKKA   #
          (ASCII 20h 41h 4Ch 50h 48h 41h 52h 44h 20h 20h 20h 20h 20h 20h
          20h 20h 7Eh 41h 4Ch 50h 48h 45h 4Bh 4Bh 41h 20h 20h 20h 20h 20h
          20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
          Display.
     Shows seventh and eighth ALTAZ alignment stars with ALPHEKKA
     selected.
     NO Equivalent

Command :AN 08 0#   (ASCII 3Ah 41h 4Eh 20h 30h 38h 20h 30h
                                     23h)
     Returns   ~ALPHEKKA   ALTAIR   #
          (ASCII 7Eh 41h 4Ch 50h 48h 45h 4Bh 4Bh 41h 20h 20h 20h 20h 20h
          20h 20h 20h 41h 4Ch 54h 41h 40h 52h 20h 20h 20h 20h 20h 20h 20h
          20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
          Display.
     Shows eighth and ninth ALTAZ alignment stars with ALPHEKKA
     selected.
     NO Equivalent

Command :AN 08 1#   (ASCII 3Ah 41h 4Eh 20h 30h 38h 20h 31h
                                     23h)
     Returns   ALPHEKKA   ~ALTAIR   #
          (ASCII 20h 41h 4Ch 50h 48h 45h 4Bh 4Bh 41h 20h 20h 20h 20h 20h
          20h 20h 7Eh 41h 4Ch 54h 41h 40h 52h 20h 20h 20h 20h 20h 20h 20h
          20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
          Display.
     Shows eighth and ninth ALTAZ alignment stars with ALTAIR selected.
     NO Equivalent

Command :AN 09 0#   (ASCII 3Ah 41h 4Eh 20h 30h 39h 20h 30h 23h)

Returns ~ALTAIR   ANTARES   #
(ASCII 7Eh 41h 4Ch 54h 41h 40h 52h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 41h 4Eh 54h 41h 52h 45h 53h 41h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

Shows ninth and tenth ALTAZ alignment stars with ALTAIR selected.
NO Equivalent

Command :AN 09 1#   (ASCII 3Ah 41h 4Eh 20h 30h 39h 20h 31h 23h)

Returns   ALTAIR   ~ANTARES   #
(ASCII 20h 41h 4Ch 54h 41h 40h 52h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 41h 4Eh 54h 41h 52h 45h 53h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

Shows ninth and tenth ALTAZ alignment stars with ANTARES selected.
NO Equivalent

Command :AN 10 0#   (ASCII 3Ah 41h 4Eh 20h 31h 30h 20h 30h 23h)

Returns ~ANTARES   ARCTURUS   #
(ASCII 7Eh 41h 4Eh 54h 41h 52h 45h 53h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 41h 52h 43h 54h 55h 52h 55h 53h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

Shows tenth and eleventh ALTAZ alignment stars with ANTARES selected.
NO Equivalent

Command :AN 10 1#   (ASCII 3Ah 41h 4Eh 20h 31h 30h 20h 31h 23h)

Returns   ANTARES   ~ARCTURUS   #
(ASCII 20h 41h 4Eh 54h 41h 52h 45h 53h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7eh 41h 52h 43h 54h 55h 52h 55h 53h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

Shows tenth and eleventh ALTAZ alignment stars with ARCTURUS selected.
NO Equivalent

Command :AN 11 0#   (ASCII 3Ah 41h 4Eh 20h 31h 31h 20h 30h
                                     23h)
        Returns   ~ARCTURUS   BETELGEUSE   #
        (ASCII 7eh 41h 52h 43h 54h 55h 52h 55h 53h 20h 20h 20h 20h 20h
        20h 20h 20h 42h 45h 54h 45h 4Ch 47h 45h 55h 53h 45h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
        Shows eleventh and twelfth ALTAZ alignment stars with ARCTURUS
        selected.
        NO Equivalent

Command :AN 11 1#   (ASCII 3Ah 41h 4Eh 20h 31h 31h 20h 31h
                                     23h)
        Returns   ARCTURUS   ~BETELGEUSE   #
        (ASCII 20h 41h 52h 43h 54h 55h 52h 55h 53h 20h 20h 20h 20h 20h
        20h 20h 7Eh 42h 45h 54h 45h 4Ch 47h 45h 55h 53h 45h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
        Shows eleventh and twelfth ALTAZ alignment stars with BETELGEUSE
        selected.
        NO Equivalent

Command :AN 12 0#   (ASCII 3Ah 41h 4Eh 20h 31h 32h 20h 30h
                                     23h)
        Returns   ~BETELGEUSE   BOGARDUS   #
        (ASCII 7Eh 42h 45h 54h 45h 4Ch 47h 45h 55h 53h 45h 20h 20h 20h
        20h 20h 20h 42h 4Fh 47h 41h 52h 44h 55h 53h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
        Shows twelfth and thirteenth ALTAZ alignment stars with BETELGEUSE
        selected.
        NO Equivalent

Command :AN 12 1#   (ASCII 3Ah 41h 4Eh 20h 31h 32h 20h 31h
                                     23h)
        Returns   BETELGEUSE   ~BOGARDUS   #
        (ASCII 20h 42h 45h 54h 45h 4Ch 47h 45h 55h 53h 45h 20h 20h 20h
        20h 20h 7Eh 42h 4Fh 47h 41h 52h 44h 55h 53h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
        Shows twelfth and thirteenth ALTAZ alignment stars with BOGARDUS
        selected.
        NO Equivalent

Command :AN 13 0#   (ASCII 3Ah 41h 4Eh 20h 31h 33h 20h 30h 23h)

    Returns ~BOGARDUS   CANOPUS   #
    (ASCII 7Eh 42h 4Fh 47h 41h 52h 44h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 43h 41h 4Eh 4Fh 50h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows thirteenth and fourteenth ALTAZ alignment stars with BOGARDUS selected.
    NO Equivalent

Command :AN 13 1#   (ASCII 3Ah 41h 4Eh 20h 31h 33h 20h 31h 23h)

    Returns BOGARDUS   ~CANOPUS   #
    (ASCII 20h 42h 4Fh 47h 41h 52h 44h 55h 53h 20h 20h 20h 20h 20h 20h 20h 7Eh 43h 41h 4Eh 4Fh 50h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows thirteenth and fourteenth ALTAZ alignment stars with CANOPUS selected.
    NO Equivalent

Command :AN 14 0#   (ASCII 3Ah 41h 4Eh 20h 31h 34h 20h 30h 23h)

    Returns ~CANOPUS   CAPELLA   #
    (ASCII 7Eh 43h 41h 4Eh 4Fh 50h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 43h 41h 50h 45h 4Ch 4Ch 41h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows fourteenth and fifteenth ALTAZ alignment stars with CANOPUS selected.
    NO Equivalent

Command :AN 14 1#   (ASCII 3Ah 41h 4Eh 20h 31h 34h 20h 31h 23h)

    Returns CANOPUS   ~CAPELLA   #
    (ASCII 20h 43h 41h 4Eh 4Fh 50h 55h 53h 20h 20h 20h 20h 20h 20h 20h 7Eh 43h 41h 50h 45h 4Ch 4Ch 41h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows fourteenth and fifteenth ALTAZ alignment stars with CAPELLA selected.
    NO Equivalent

Command :AN 15 0#   (ASCII 3Ah 41h 4Eh 20h 31h 35h 20h 30h 23h)
    Returns   ~CAPELLA   CASTOR A   #
    (ASCII 7Eh 43h 41h 50h 45h 4Ch 4Ch 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 43h 41h 53h 54h 4Fh 52h 20h 41h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows fifteenth and sixteenth ALTAZ alignment stars with CAPELLA selected.
    NO Equivalent

Command :AN 15 1#   (ASCII 3Ah 41h 4Eh 20h 31h 35h 20h 31h 23h)
    Returns   CAPELLA   ~CASTOR A   #
    (ASCII 20h 43h 41h 50h 45h 4Ch 4Ch 41h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 43h 41h 53h 54h 4Fh 52h 20h 41h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows fifteenth and sixteenth ALTAZ alignment stars with CASTOR A selected.
    NO Equivalent

Command :AN 16 0#   (ASCII 3Ah 41h 4Eh 20h 31h 36h 20h 30h 23h)
    Returns   ~CASTOR A   DENEB   #
    (ASCII 7Eh 43h 41h 53h 54h 4Fh 52h 20h 41h 20h 20h 20h 20h 20h 20h 20h 20h 44h 45h 4Eh 45h 42h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows sixteenth and seventeenth ALTAZ alignment stars with CASTOR A selected.
    NO Equivalent

Command :AN 16 1#   (ASCII 3Ah 41h 4Eh 20h 31h 36h 20h 31h 23h)
    Returns   CASTOR A   ~DENEB   #
    (ASCII 20h 43h 41h 53h 54h 4Fh 52h 20h 41h 20h 20h 20h 20h 20h 20h 20h 7Eh 44h 45h 4Eh 45h 42h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.
    Shows sixteenth and seventeenth ALTAZ alignment stars with DENEB selected.
    NO Equivalent

Command :AN 17 0#   (ASCII 3Ah 41h 4Eh 20h 31h 37h 20h 30h
                              23h)
    Returns   ~DENEB   DENEBOLA#
        (ASCII 7Eh 44h 45h 4Eh 45h 42h 20h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 20h 44h 45h 4Eh 45h 42h 4Fh 4Ch 41h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows seventeenth and eighteenth ALTAZ alignment stars with DENEB
    selected.
    NO Equivalent

Command :AN 17 1#   (ASCII 3Ah 41h 4Eh 20h 31h 37h 20h 31h
                              23h)
    Returns   DENEB   ~DENEBOLA#
        (ASCII 20h 44h 45h 4Eh 45h 42h 20h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 7Eh 44h 45h 4Eh 45h 42h 4Fh 4Ch 41h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows seventeenth and eighteenth ALTAZ alignment stars with
    DENEBOLA selected.
    NO Equivalent

Command :AN 18 0#   (ASCII 3Ah 41h 4Eh 20h 31h 38h 20h 30h
                              23h)
    Returns   ~DENEBOLA   DIPHDA#
        (ASCII 7Eh 44h 45h 4Eh 45h 42h 4Fh 4Ch 41h 20h 20h 20h 20h 20h
        20h 20h 20h 44h 49h 50h 48h 44h 41h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows eighteenth and nineteenth ALTAZ alignment stars with
    DENEBOLA selected.
    NO Equivalent

Command :AN 18 1#   (ASCII 3Ah 41h 4Eh 20h 31h 38h 20h 31h
                              23h)
    Returns   DENEBOLA   ~DIPHDA#
        (ASCII 20h 44h 45h 4Eh 45h 42h 4Fh 4Ch 41h 20h 20h 20h 20h 20h
        20h 20h 7Eh 44h 49h 50h 48h 44h 41h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows eighteenth and nineteenth ALTAZ alignment stars with DIPHDA
    selected.
    NO Equivalent

Command :AN 19 0#   (ASCII 3Ah 41h 4Eh 20h 31h 39h 20h 30h
                              23h)
    Returns   ~DIPHDA   ENIF   #
       (ASCII 7Eh 44h 49h 50h 48h 44h 41h 20h 20h 20h 20h 20h 20h 20h
       20h 20h 20h 45h 4Eh 49h 46h 20h 20h 20h 20h 20h 20h 20h 20h 20h
       20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
       Display.
    Shows nineteenth and twentieth ALTAZ alignment stars with DIPHDA
    selected.
    NO Equivalent

Command :AN 19 1#   (ASCII 3Ah 41h 4Eh 20h 31h 39h 20h 31h
                              23h)
    Returns   DIPHDA   ~ENIF   #
       (ASCII 20h 44h 49h 50h 48h 44h 41h 20h 20h 20h 20h 20h 20h 20h
       20h 20h 7Eh 45h 4Eh 49h 46h 20h 20h 20h 20h 20h 20h 20h 20h 20h
       20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
       Display.
    Shows nineteenth and twentieth ALTAZ alignment stars with ENIF
    selected.
    NO Equivalent

Command :AN 20 0#   (ASCII 3Ah 41h 4Eh 20h 32h 30h 20h 30h
                              23h)
    Returns   ~ENIF   FOMALHAUT   #
       (ASCII 7Eh 45h 4Eh 49h 46h 20h 20h 20h 20h 20h 20h 20h 20h 20h
       20h 20h 20h 46h 4Fh 4Dh 41h 4Ch 48h 41h 55h 54h 20h 20h 20h 20h
       20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
       Display.
    Shows twentieth and twenty-first ALTAZ alignment stars with ENIF
    selected.
    NO Equivalent

Command :AN 20 1#   (ASCII 3Ah 41h 4Eh 20h 32h 30h 20h 31h
                              23h)
    Returns   ENIF   ~FOMALHAUT   #
       (ASCII 20h 45h 4Eh 49h 46h 20h 20h 20h 20h 20h 20h 20h 20h 20h
       20h 20h 7Eh 46h 4Fh 4Dh 41h 4Ch 48h 41h 55h 54h 20h 20h 20h 20h
       20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
       Display.
    Shows twentieth and twenty-first ALTAZ alignment stars with
    FORALHAUT selected.
    NO Equivalent

Command :AN 21 0#   (ASCII 3Ah 41h 4Eh 20h 32h 31h 20h 30h
             23h)
  Returns ~FOMALHAUT HADAR #
    (ASCII 7Eh 46h 4Fh 4Dh 41h 4Ch 48h 41h 55h 54h 20h 20h 20h 20h
    20h 20h 20h 48h 41h 44h 41h 52h 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
  Shows twenty-first and twenty-second ALTAZ alignment stars with
  FORALHAUT selected.
  NO Equivalent

Command :AN 21 1#   (ASCII 3Ah 41h 4Eh 20h 32h 31h 20h 31h
             23h)
  Returns FOMALHAUT ~HADAR #
    (ASCII 20h 46h 4Fh 4Dh 41h 4Ch 48h 41h 55h 54h 20h 20h 20h 20h
    20h 20h 7Eh 48h 41h 44h 41h 52h 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
  Shows twenty-first and twenty-second ALTAZ alignment stars with
  HADAR selected.
  NO Equivalent

Command :AN 22 0#   (ASCII 3Ah 41h 4Eh 20h 32h 32h 20h 30h
             23h)
  Returns ~HADAR HAMAL #
    (ASCII 7Eh 48h 41h 44h 41h 52h 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 20h 48h 41h 4Dh 41h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
  Shows twenty-second and twenty-third ALTAZ alignment stars with
  HADAR selected.
  NO Equivalent

Command :AN 22 1#   (ASCII 3Ah 41h 4Eh 20h 32h 32h 20h 31h
             23h)
  Returns HADAR ~HAMAL #
    (ASCII 20h 48h 41h 44h 41h 52h 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 7Eh 48h 41h 4Dh 41h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h
    20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
    Display.
  Shows twenty-second and twenty-third ALTAZ alignment stars with
  HAMAL selected.
  NO Equivalent

Command :AN 23 0#   (ASCII 3Ah 41h 4Eh 20h 32h 33h 20h 30h 23h)

    Returns   ~HAMAL   MARKAB   #

    (ASCII 7Eh 48h 41h 4Dh 41h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 4Dh 41h 52h 4Bh 41h 42h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 48h 41h 4Dh 41h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows twenty-third and twenty-fourth ALTAZ alignment stars with HAMAL selected.

    NO Equivalent

Command :AN 23 1#   (ASCII 3Ah 41h 4Eh 20h 32h 33h 20h 31h 23h)

    Returns   HAMAL   ~MARKAB   #

    (ASCII 20h 48h 41h 4Dh 41h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 4Dh 41h 52h 4Bh 41h 42h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows twenty-third and twenty-fourth ALTAZ alignment stars with MARKAB selected.

    NO Equivalent

Command :AN 24 0#   (ASCII 3Ah 41h 4Eh 20h 32h 34h 20h 30h 23h)

    Returns   ~MARKAB   MIRA   #

    (ASCII 7Eh 48h 41h 4Dh 41h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 4Dh 49h 52h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows twenty-fourth and twenty-fifth ALTAZ alignment stars with MARKAB selected.

    NO Equivalent

Command :AN 24 1#   (ASCII 3Ah 41h 4Eh 20h 32h 34h 20h 31h 23h)

    Returns   MARKAB   ~MIRA   #

    (ASCII 20h 48h 41h 4Dh 41h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 4Dh 49h 52h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows twenty-fourth and twenty-fifth ALTAZ alignment stars with MIRA selected.

    NO Equivalent

Command :AN 25 0#   (ASCII 3Ah 41h 4Eh 20h 32h 35h 20h 30h
                           23h)
    Returns ~MIRA   POLARIS   #
        (ASCII 7Eh 4Dh 49h 52h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 20h 50h 4Fh 4Ch 41h 52h 49h 53h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows twenty-fifth and twenty-sixth ALTAZ alignment stars with MIRA
    selected.
    NO Equivalent

Command :AN 25 1#   (ASCII 3Ah 41h 4Eh 20h 32h 35h 20h 31h
                           23h)
    Returns   MIRA   ~POLARIS   #
        (ASCII 20h 4Dh 49h 52h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 7Eh 50h 4Fh 4Ch 41h 52h 49h 53h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows twenty-fifth and twenty-sixth ALTAZ alignment stars with
    POLARIS selected.
    NO Equivalent

Command :AN 26 0#   (ASCII 3Ah 41h 4Eh 20h 32h 36h 20h 30h
                           23h)
    Returns   ~POLARIS   POLLUX   #
        (ASCII 7Eh 50h 4Fh 4Ch 41h 52h 49h 53h 20h 20h 20h 20h 20h 20h
        20h 20h 20h 50h 4Fh 4Ch 4Ch 55h 58h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows twenty-sixth and twenty-seventh ALTAZ alignment stars with
    POLARIS selected.
    NO Equivalent

Command :AN 26 1#   (ASCII 3Ah 41h 4Eh 20h 32h 36h 20h 31h
                           23h)
    Returns   POLARIS   ~POLLUX   #
        (ASCII 20h 50h 4Fh 4Ch 41h 52h 49h 53h 20h 20h 20h 20h 20h 20h
        20h 20h 7Eh 50h 4Fh 4Ch 4Ch 55h 58h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
    Shows twenty-sixth and twenty-seventh ALTAZ alignment stars with
    POLLUX selected.
    NO Equivalent

Command :AN 27 0#   (ASCII 3Ah 41h 4Eh 20h 32h 37h 20h 30h
                                     23h)
     Returns ~POLLUX   PROCYON   #
        (ASCII 7Eh 50h 4Fh 4Ch 4Ch 55h 58h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 20h 50h 52h 4Fh 43h 59h 4Fh 4Eh 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
     Shows twenty-seventh and twenty-eighth ALTAZ alignment stars with
     POLLUX selected.
     NO Equivalent

Command :AN 27 1#   (ASCII 3Ah 41h 4Eh 20h 32h 37h 20h 31h
                                     23h)
     Returns   POLLUX   ~PROCYON   #
        (ASCII 20h 50h 4Fh 4Ch 4Ch 55h 58h 20h 20h 20h 20h 20h 20h 20h
        20h 20h 7Eh 50h 52h 4Fh 43h 59h 4Fh 4Eh 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
     Shows twenty-seventh and twenty-eighth ALTAZ alignment stars with
     PROCYON selected.
     NO Equivalent

Command :AN 28 0#   (ASCII 3Ah 41h 4Eh 20h 32h 38h 20h 30h
                                     23h)
     Returns ~PROCYON   REGULUS   #
        (ASCII 7Eh 50h 52h 4Fh 43h 59h 4Fh 4Eh 20h 20h 20h 20h 20h 20h
        20h 20h 20h 52h 45h 47h 55h 4Ch 55h 53h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
     Shows twenty-eighth and twenty-ninth ALTAZ alignment stars with
     PROCYON selected.
     NO Equivalent

Command :AN 28 1#   (ASCII 3Ah 41h 4Eh 20h 32h 38h 20h 31h
                                     23h)
     Returns PROCYON   ~REGULUS   #
        (ASCII 20h 50h 52h 4Fh 43h 59h 4Fh 4Eh 20h 20h 20h 20h 20h 20h
        20h 20h 7Eh 52h 45h 47h 55h 4Ch 55h 53h 20h 20h 20h 20h 20h 20h
        20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD
        Display.
     Shows twenty-eighth and twenty-ninth ALTAZ alignment stars with
     REGULUS selected.
     NO Equivalent

Command :AN 29 0#   (ASCII 3Ah 41h 4Eh 20h 32h 39h 20h 30h 23h)

    Returns ~REGULUS   RIGEL   #

    (ASCII 7Eh 52h 45h 47h 55h 4Ch 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 20h 52h 49h 47h 45h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows twenty-ninth and thirtieth ALTAZ alignment stars with REGULUS selected.

    NO Equivalent

Command :AN 29 1#   (ASCII 3Ah 41h 4Eh 20h 32h 39h 20h 31h 23h)

    Returns REGULUS   ~RIGEL   #

    (ASCII 20h 52h 45h 47h 55h 4Ch 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 52h 49h 47h 45h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows twenty-ninth and thirtieth ALTAZ alignment stars with RIGEL selected.

    NO Equivalent

Command :AN 30 0#   (ASCII 3Ah 41h 4Eh 20h 33h 30h 20h 30h 23h)

    Returns ~RIGEL   SIRUS   #

    (ASCII 7Eh 52h 49h 47h 45h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 53h 49h 52h 49h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirtieth and thirty-first ALTAZ alignment stars with RIGEL selected.

    NO Equivalent

Command :AN 30 1#   (ASCII 3Ah 41h 4Eh 20h 33h 30h 20h 31h 23h)

    Returns RIGEL   ~SIRUS   #

    (ASCII 20h 52h 49h 47h 45h 4Ch 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 53h 49h 52h 49h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirtieth and thirty-first ALTAZ alignment stars with SIRUS selected.

    NO Equivalent

Command :AN 31 0#   (ASCII 3Ah 41h 4Eh 20h 33h 31h 20h 30h 23h)

    Returns ~SIRUS   SPICA   #

    (ASCII 7Eh 53h 49h 52h 49h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 53h 50h 49h 43h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirty-first and thirty-second ALTAZ alignment stars with SIRUS selected.

    NO Equivalent

Command :AN 31 1#   (ASCII 3Ah 41h 4Eh 20h 33h 31h 20h 31h 23h)

    Returns SIRUS   ~SPICA   #

    (ASCII 20h 53h 49h 52h 49h 55h 53h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 53h 50h 49h 43h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirty-first and thirty-second ALTAZ alignment stars with SPICA selected.

    NO Equivalent

Command :AN 32 0#   (ASCII 3Ah 41h 4Eh 20h 33h 32h 20h 30h 23h)

    Returns ~SPICA   VEGA   #

    (ASCII 7Eh 53h 50h 49h 43h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 56h 45h 47h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirty-second and thirty-third ALTAZ alignment stars with SPICA selected.

    NO Equivalent

Command :AN 32 1#   (ASCII 3Ah 41h 4Eh 20h 33h 32h 20h 31h 23h)

    Returns SPICA   ~VEGA   #

    (ASCII 20h 53h 50h 49h 43h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 56h 45h 47h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirty-second and thirty-third ALTAZ alignment stars with VEGA selected.

    NO Equivalent

Command :AN 33 0#   (ASCII 3Ah 41h 4Eh 20h 33h 33h 20h 30h 23h)

    Returns ~VEGA   ACHERNAR   #

    (ASCII 7Eh 56h 45h 47h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 41h 43h 48h 45h 52h 4Eh 41h 52h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirty-third and first ALTAZ alignment stars with VEGA selected.
    NO Equivalent

Command :AN 33 1#   (ASCII 3Ah 41h 4Eh 20h 33h 33h 20h 31h 23h)

    Returns VEGA   ~ACHERNAR   #

    (ASCII 20h 56h 45h 47h 41h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 7Eh 41h 43h 48h 45h 52h 4Eh 41h 52h 20h 20h 20h 20h 20h 20h 20h 23h) where 7Eh appears as → on the Hand Controller LCD Display.

    Shows thirty-third and first ALTAZ alignment stars with ACHERNAR selected.
    NO Equivalent

VII. KEYPAD ALTAZ ALIGNMENT COMMANDS

Command :A3 01#   (ASCII 3Ah 41h 33h 20h 30h 31h 23h)
    Returns Nothing
    Sets ACHERNAR as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 02#   (ASCII 3Ah 41h 33h 20h 30h 32h 23h)
    Returns Nothing
    Sets ACRUX A as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 03#   (ASCII 3Ah 41h 33h 20h 30h 33h 23h)
    Returns Nothing
    Sets ALBIERO as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 04#   (ASCII 3Ah 41h 33h 20h 30h 34h 23h)
    Returns Nothing
    Sets ALCAID as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 05#   (ASCII 3Ah 41h 33h 20h 30h 35h 23h)
    Returns Nothing
    Sets ALDEBARAN as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 06#   (ASCII 3Ah 41h 33h 20h 30h 36h 23h)
    Returns Nothing
    Sets ALNILAM as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 07#   (ASCII 3Ah 41h 33h 20h 30h 37h 23h)
    Returns Nothing
    Sets ALPHARD as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 08#   (ASCII 3Ah 41h 33h 20h 30h 38h 23h)
    Returns Nothing
    Sets ALPHEKKA as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 09#   (ASCII 3Ah 41h 33h 20h 30h 39h 23h)
    Returns Nothing
    Sets ALTAIR as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 10#   (ASCII 3Ah 41h 33h 20h 31h 30h 23h)
    Returns Nothing
    Sets ANTARES as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 11#   (ASCII 3Ah 41h 33h 20h 31h 31h 23h)
    Returns Nothing
    Sets ARCTURUS as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 12#   (ASCII 3Ah 41h 33h 20h 31h 32h 23h)
    Returns Nothing
    Sets BETELGEUSE as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 13#   (ASCII 3Ah 41h 33h 20h 31h 33h 23h)
    Returns Nothing
    Sets BOGARDUS as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 14#   (ASCII 3Ah 41h 33h 20h 31h 34h 23h)
    Returns Nothing
    Sets CANOPUS as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 15#   (ASCII 3Ah 41h 33h 20h 31h 35h 23h)
    Returns Nothing
    Sets CAPELLA as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 16#   (ASCII 3Ah 41h 33h 20h 31h 36h 23h)
    Returns Nothing
    Sets CASTOR A as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 17#   (ASCII 3Ah 41h 33h 20h 31h 37h 23h)
    Returns Nothing
    Sets DENEB as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 18#   (ASCII 3Ah 41h 33h 20h 31h 38h 23h)
       Returns Nothing
       Sets DENEBOLA as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 19#   (ASCII 3Ah 41h 33h 20h 31h 39h 23h)
       Returns Nothing
       Sets DIPHDA as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 20#   (ASCII 3Ah 41h 33h 20h 32h 30h 23h)
       Returns Nothing
       Sets ENIF as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 21#   (ASCII 3Ah 41h 33h 20h 32h 31h 23h)
       Returns Nothing
       Sets FOMALHAUT as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 22#   (ASCII 3Ah 41h 33h 20h 32h 32h 23h)
       Returns Nothing
       Sets HADAR as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 23#   (ASCII 3Ah 41h 33h 20h 32h 33h 23h)
       Returns Nothing
       Sets HAMAL as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 24#   (ASCII 3Ah 41h 33h 20h 32h 34h 23h)
       Returns Nothing
       Sets MARKAB as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 25#   (ASCII 3Ah 41h 33h 20h 32h 35h 23h)
       Returns Nothing
       Sets MIRA as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 26#   (ASCII 3Ah 41h 33h 20h 32h 36h 23h)
       Returns Nothing
       Sets POLARIS as the ALTAZ Alignment Star.
       NO Equivalent

Command :A3 27#   (ASCII 3Ah 41h 33h 20h 32h 37h 23h)
    Returns Nothing
    Sets POLLUX as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 28#   (ASCII 3Ah 41h 33h 20h 32h 38h 23h)
    Returns Nothing
    Sets PROCYON as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 29#   (ASCII 3Ah 41h 33h 20h 32h 39h 23h)
    Returns Nothing
    Sets REGULUS as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 30#   (ASCII 3Ah 41h 33h 20h 33h 30h 23h)
    Returns Nothing
    Sets RIGEL as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 31#   (ASCII 3Ah 41h 33h 20h 33h 31h 23h)
    Returns Nothing
    Sets SIRUS as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 32#   (ASCII 3Ah 41h 33h 20h 33h 32h 23h)
    Returns Nothing
    Sets SPICA as the ALTAZ Alignment Star.
    NO Equivalent

Command :A3 33#   (ASCII 3Ah 41h 33h 20h 33h 33h 23h)
    Returns Nothing
    Sets VEGA as the ALTAZ Alignment Star.
    NO Equivalent

VIII. KEYPAD HELP TEXT

Opening Help Page Section 1-Keys   #   (ASCII 53h 65h 53h 74h 69h 6Fh 6Eh 20h 31h 2Dh 4Bh 65h 79h 73h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Second Help Page ENT:Press to   select an item,↓#   (ASCII 45h 4Eh 54h 3Ah 50h 72h 65h 73h 73h 20h 74h 6Fh 20h 20h 20h 20h 73h 65h 6Ch 63h 74h 20h 61h 6Eh 20h 69h 74h 65h 6Dh 2Ch 03h 20h 23h)

Third Help Page press and hold to change a   ↓#   (ASCII 70h 72h 65h 73h 73h 20h 61h 6Eh 64h 20h 68h 6Fh 6Ch 64h 20h 20h 74h 6Fh 20h 63h 68h 61h 6Eh 67h 65h 20h 61h 20h 20h 20h 03h 23h)

Forth Help Page value.   #   (ASCII 76h 61h 6Ch 75h 65h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Fifth Help Page MODE:Cycles   through modes ↓#   (ASCII 4Dh 4Fh 44h 45h 3Ah 43h 79h 63h 6Ch 65h 73h 20h 20h 20h 20h 20h 74h 68h 72h 6Fh 75h 67h 68h 20h 6Dh 6Fh 64h 65h 73h 20h 20h 03h 23h)

Sixth Help Page and exits   menus.   #   (ASCII 61h 6Eh 64h 20h 65h 78h 69h 74h 73h 20h 20h 20h 20h 20h 20h 20h 6Dh 65h 6Eh 75h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Seventh Help Page NSEW:Direction   keys.   E and W ↓#   (ASCII 4Eh 53h 45h 57h 3Ah 44h 69h 72h 65h 63h 74h 69h 6Fh 6Eh 20h 20h 6Bh 65h 79h 73h 2Eh 20h 20h 45h 20h 61h 6Eh 64h 20h 57h 20h 03h 23h)

Eighth Help Page move cursor   while editing ↓#   (ASCII 6Dh 6Fh 76h 65h 20h 63h 75h 72h 73h 6Fh 72h 20h 20h 20h 20h 20h 77h 68h 69h 6Ch 65h 20h 65h 64h 69h 74h 69h 6Eh 67h 20h 20h 03h 23h)

Ninth Help Page values.   #   (ASCII 76h 61h 6Ch 75h 65h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Tenth Help Page SLEW,FIND:Fast   movement and   ↓#   (ASCII 76h 61h 6Ch 75h 65h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Eleventh Help Page focus rates.   # (ASCII 66h 6Fh 63h 75h 73h
   20h 72h 61h 74h 65h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h
   20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Twelfth Help Page CNTR,GUIDE Slow movement and ↓#   (ASCII 43h
   4Eh 54h 52h 2Ch 47h 55h 49h 44h 45h 3Ah 53h 6Ch 6Fh 77h 20h 6Dh
   6Fh 76h 65h 6Dh 65h 6Eh 74h 20h 61h 6Eh 64h 20h 20h 20h 03h 23h)

Thirteenth Help Page focus rates.   # (ASCII 66h 6Fh 63h 75h 73h
   20h 72h 61h 74h 65h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h
   20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Fourteenth Help Page RET:Sets reticlebrightness   # (ASCII 52h 45h 54h
   3Ah 53h 65h 74h 73h 20h 72h 65h 74h 69h 63h 6Ch 65h 62h 72h 69h 67h
   68h 74h 6Eh 65h 73h 73h 2Eh 20h 20h 20h 20h 20h 23h)

Fifteenth Help Page FOCUS:Change   focus   #   (ASCII 46h
   4Fh 43h 55h 53h 3Ah 43h 68h 61h 6Eh 67h 65h 73h 20h 20h 20h 66h 6Fh
   63h 75h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Sixteenth Help Page MAP:Toggles map light.   # (ASCII 4Dh 41h 50h
   3Ah 54h 6Fh 67h 67h 6Ch 65h 73h 20h 6Dh 61h 70h 20h 6Ch 69h 67h
   68h 74h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Seventeenth Help Page M:Messier   objects.   # (ASCII 4Dh 3Ah 4Dh
   65h 73h 73h 69h 65h 72h 20h 20h 20h 20h 20h 20h 20h 6Fh 62h 6Ah 65h
   63h 74h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 23h)

Eighteenth Help Page STAR:Stars   #   (ASCII 53h 54h 41h
   52h 3Ah 53h 74h 61h 72h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 20h
   20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Nineteenth Help Page CNGC:CNGC   objects.   # (ASCII 43h 4Eh 47h
   43h 3Ah 43h 4Eh 47h 43h 20h 20h 20h 20h 20h 20h 20h 6Fh 62h 6Ah
   65h 63h 74h 73h 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Twentieth Help Page PREV,NEXT:Moves item selector ↓#   (ASCII 50h
   52h 45h 56h 2Ch 4Eh 45h 58h 54h 3Ah 4Dh 6Fh 76h 65h 73h 20h 69h
   74h 65h 6Dh 20h 73h 65h 6Ch 65h 63h 74h 6Fh 72h 20h 20h 03h 23h)

Twenty-first Help Page (arrow) on   display. Moves↓#   (ASCII 28h
   61h 72h 72h 6Fh 77h 29h 20h 6Fh 6Eh 20h 20h 20h 20h 20h 64h 69h
   73h 70h 6Ch 61h 79h 2Eh 20h 20h 4Dh 6Fh 76h 65h 73h 03h 23h)

Twenty-second Help Page to the next   object in a   ↓#   (ASCII 74h
    6Fh 20h 74h 68h 65h 20h 6Eh 65h 78h 74h 20h 20h 20h 20h 20h 6Fh 62h
    6Ah 65h 63h 74h 20h 69h 6Eh 20h 61h 20h 20h 20h 20h 03h 23h)

Twenty-fourth Help Page reticle   brightness.   #   (ASCII 72h 65h 74h
    69h 63h 6Ch 65h 20h 20h 20h 20h 20h 20h 20h 20h 20h 62h 72h 69h 67h
    68h 74h 6Eh 65h 73h 73h 2Eh 20h 20h 20h 20h 20h 23h)

Twenty-fifth Help Page PREV,NEXT(edit):Changes sign ↓#   (ASCII 50h
    52h 45h 56h 2Ch 4Eh 45h 58h 54h 28h 65h 64h 69h 74h 29h 3Ah 43h 68h
    61h 6Eh 67h 65h 73h 20h 73h 69h 67h 6Eh 2Eh 20h 20h 03h 23h)

Twenty-sixth Help Page Changes letter (site name) ↓#   (ASCII 43h
    68h 61h 6Eh 67h 65h 73h 20h 6Ch 65h 74h 74h 65h 72h 20h 20h 28h 73h
    69h 74h 65h 20h 6Eh 61h 6Dh 65h 29h 2Eh 20h 20h 20h 03h 23h)

Twenty-seventh Help Page Selects type   (FIND TYPE).   #   (ASCII 53h
    65h 6Ch 65h 63h 74h 73h 20h 74h 79h 70h 65h 20h 20h 20h 20h 28h 46h
    49h 4Eh 44h 20h 54h 59h 50h 45h 29h 2Eh 20h 20h 20h 20h 23h)

Twenty-eighth Help Page Section 2-GMT   Offsets   #   (ASCII 53h
    65h 63h 74h 69h 6Fh 6Eh 20h 32h 2Dh 47h 4Dh 54h 20h 20h 20h 4Fh
    66h 66h 73h 65h 74h 73h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Twenty-ninth Help Page PST +8   PDT +7   # (ASCII 50h 53h 54h
    20h 2Bh 38h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 50h 44h 54h 20h
    2Bh 37h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Thirtieth Help Page MST +7   MDT +6   #   (ASCII 4Dh 53h 54h
    20h 2Bh 37h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 4Dh 44h 54h 20h
    2Bh 36h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Thirty-first Help Page CST +6   CDT +5   #   (ASCII 43h 53h 54h
    20h 2Bh 36h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 43h 44h 54h 20h
    2Bh 35h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Thirty-second Help Page EST +5   EDT +4   # (ASCII 45h 53h 54h
    20h 2Bh 35h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 45h 44h 54h 20h
    2Bh 34h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

IX. STARTING UP

When you first power up the LX-200, the HC displays:

```
Meade LX-200
```

On the 1st line of the LCD display. This comes from the HC microprocessor – you get this message if the HC is not plugged into the MT and you supply external power. The first command from the HC is:

   HC HACK   (ASCII 48h 06h)
   MT P   (ASCII 50h)

The command is sent almost immediately upon power up – the MT will not respond to any other commands until it has received the H. The ACK (ASCII 06h) is simply a request by the HC for the current alignment mode (Polar, Altaz, or Land) of the telescope. It takes the MC about 10 seconds to respond with the current alignment mode (P, A, or A).

Once the MC has responded with the current mode, the HC issues a series of commands:

      HC :GV#:RS#:TQ#   (ASCII 3Ah 47h 56h 23h 3Ah 52h 53h 23h
                             3Ah 54h 51h 23h)
      MT   2.51L#   (ASCII 32h 2Eh 35h 31h 4Ch 23h)

The display shows:

```
Meade LX-200
Ver 2.50-2.51L
```

The :GV# (ASCII 3Ah 47h 56h 23h) command gets the version of the MT and Object Library.

The :RS# (ASCII 3Ah 52h 53h 23h) command sets the motion rate to SLEW.

The :TQ# (ASCII 3Ah 54h 51h 23h) command sets tracking to the Sidereal Rate using the quartz clock.

This message remains for about 1 second before being replaced with the Mode 1 Main Menu.

The display shows:

```
→TELESCOPE
  OBJECT LIBRARY
```

At this time the HC starts issuing the ACK (ASCII 06h) command every 14ms to determine the current mode (P, A, or L). The MT responds with either P, A, or L (ASCII 50h, 41h or 4Ch). There is no change to the display. The MODE 1 Display comes not from the MT but the HC. There is no command to show this display.

Pressing the MODE key moves the display to MODE 2, which shows the current R.A and DEC.

```
RA    =03:59.9
 DEC  =-00°01
```

This is accomplished by the HC issuing the following pair of commands:

    HC :GR#:GD#   (ASCII 3Ah 47h 52h 23h 3Ah 47h 44h 23h)
    MT 03:54.8#-00β01# (ASCII 30h 33h 3Ah 35h 34h 2Eh 38h 23h 2Dh
                       30h 30h DFh 30h 31h 23h) (where β is ASCII
                       DFh and shows as the ° symbol on the LCD
                       display.)

This command sequence is repeated at about the same rate as the ACK (ASCII 06h) command.

Pressing the MODE key moves the display to MODE 3, which shows the Clock/Calendar.

The display shows:

```
→LOCAL=21:56:44
  SIDE =04:14:58
```

This is accomplished by the HC issuing the following pair of commands:

    HC :Ga#:GS#   (ASCII 3Ah 47h 61h 23h 3Ah 47h 53h 23h)

MT 21:54:35#04:14:58# (ASCII 32h 31h 3Ah 35h 34h 3Ah 33h 35h 23h
                            30h 34h 3Ah 31h 34h 3Ah 35h 38h 23h)

This command sequence is repeated at about the same rate as the ACK (ASCII 06h) command.

Pressing the MODE key moves the display to MODE 4, which shows the Timer/Freq.

The display shows:

```
→TIMER=00:00:00
FREQ =60.1   Q
```

This is accomplished by the HC issuing the following command:

    HC :GT#   (ASCII 3Ah 47h 54h 23h)
    MT 60.1#   (ASCII 36h 30h 2Eh 31h 23h)

The TIMER function is totally generated within the HC.

The Q on the FREQ line indicates that the quartz clock is being used.

This command sequence is repeated at about the same rate as the ACK (ASCII 06h) command.

Pressing the MODE key moves the display to MODE 5, which is the Keypad Off/Brightness Adjust

The display shows:

```

```

The HC issues no command during this time period.
    HC no output
    MT no output

To set the HC brightness, press ENTER and then use the PREV/NEXT keys to adjust the LEDs. There are 10 steps available.

Press the MODE key to return to MODE 1.

X. MANUAL TELESCOPE MOTION

To move the telescope, the N, S, E W keys are used. The speed at which the telescope slews is dependent on the speed previously chosen from SLEW, FIND, CNTR and GUIDE.

For SLEW speed:

    HC :RS#   (ASCII 3Ah 52h 53h 23h)
    MT no output

For FIND speed:

    HC :RM#   (ASCII 3Ah 52h 4Dh 23h)
    MT no output

For CNTR speed:

    HC :RC#   (ASCII 3Ah 52h 43h 23h)
    MT no output

For GUIDE speed:

    HC :RG#   (ASCII 3Ah 52h 47h 23h)
    MT no output

To move North, pressing the N key, the HC issues a single command, and when the N key is released the HC issues another command.

    HC :Mn#   (ASCII 3Ah 4Dh 6Eh 23h)
    MT no output

Upon release of N Key:

    HC :Qn#   (ASCII 3Ah 51h 6Eh 23h)
    MT no output

To move South, pressing the S key, the HC issues a single command, and when the S key is released the HC issues another command.

    HC :Ms#   (ASCII 3Ah 4Dh 73h 23h)
    MT no output

Upon release of S Key:

    HC :Qs#   (ASCII 3Ah 51h 73h 23h)
    MT no output

To move East, pressing the E key, the HC issues a single command, and when the E key is released the HC issues another command.

    HC :Me#   (ASCII 3Ah 4Dh 65h 23h)
    MT no output

Upon release of E Key:

    HC :Qe#   (ASCII 3Ah 51h 65h 23h)
    MT no output

To move West, pressing the W key, the HC issues a single command, and when the W key is released the HC issues another command.

    HC :Mw#   (ASCII 3Ah 4Dh 77h 23h)
    MT no output

Upon release of W Key:

    HC :Qw#   (ASCII 3Ah 51h 77Eh 23h)
    MT no output

XI. MODE 1 Commands

A. TELESCOPE Menu File

Pressing the MODE key at any menu will back up one level, unless you are at a MODE menu – then it cycles to the next MODE menu.

With the display at MODE 1 it displays:

```
→TELESCOPE
  OBJECT LIBRARY
```

Pressing ENTER will move the menu to the first two items in the TELESCOPE Menu:

```
→1)SITE
  2)ALIGN
```

This is accomplished by the HC issuing the following pair of commands:

HC :@10#:@11#   (ASCII 3Ah 40h 31h 30h 23h 3Ah 40h
                             31h 31h 23h)
MT 1)SITE   #2)SITE   # (ASCII 31h 29h 53h 49h 54h 45h 20h
                             20h 20h 20h 20h 20h 20h 20h 20h 23h
                             32h 29h 53h 49h 54h 45h 20h 20h 20h
                             20h 20h 20h 20h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to 2)ALIGN, but no extra data is transmitted from the HC or MT.

Pressing the NEXT key moves the display to second and third TELESCOPE Menu items the display shows:

```
→2)ALIGN
  3)SMART
```

This is accomplished by the HC issuing the following pair of commands:

HC :@11#:@12#   (ASCII 3Ah 40h 31h 31h 23h 3Ah
                              40h 31h 32h 23h)
MT 2)ALIGN   #3)SMART   # (ASCII 32h 29h 41h 4Ch 49h 47h
                              4Eh 20h 20h 20h 20h 20h 20h 20h
                              20h 23h 33h 29h 53h 4Dh 41h 52h
                              54h 20h 20h 20h 20h 20h 20h 20h
                              20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to 3)SMART, but no extra data is transmitted from the HC or MT.

Pressing the NEXT key moves the display to third and fourth TELESCOPE Menu items

```
→3)SMART
  4)12/24 HR (24)
```

This is accomplished by the HC issuing the following pair of commands:

HC :@12#:@13#   (ASCII 3Ah 40h 31h 32h 23h
                              3Ah 40h 31h 33h 23h)
MT 3)SMART   #4)12/24 HR (24)# (ASCII 33h 29h 53h 4Dh 41h 52h
                              54h 20h 20h 20h 20h 20h 20h
                              20h 20h 23h 34h 29h 31h 32h
                              2Fh 32h 34h 20h 48h 52h 20h
                              28h 32h 34h 29h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to 4)12/24 HR (24), but no extra data is transmitted from the HC or MT.

Pressing the NEXT key moves the display to fourth and fifth TELESCOPE Menu items

```
→4)12/24 HR (24)
  5)HELP
```

This is accomplished by the HC issuing the following pair of commands:

HC :@13#:@14#   (ASCII 3Ah 40h 31h 33h 23h
                                       3Ah 40h 31h 34h 23h)
MT 4)12/24 HR (24)#5)HELP   #   (ASCII 34h 29h 31h 32h 2Fh
                                       32h 34h 20h 48h 52h 20h 28h
                                       32h 34h 29h 23h 35h 29h 48h
                                       45h 4Ch 50h 20h 20h 20h 20h
                                       20h 20h 20h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to 5)HELP but no extra data is transmitted from the HC or MT.

Pressing the NEXT key moves the display to fifth and sixth TELESCOPE Menu items

```
→5)HELP
  6)REVERSE N/S
```

This is accomplished by the HC issuing the following pair of commands:

HC :@14#:@15#   (ASCII 3Ah 40h 31h 34h 23h
                                       3Ah 40h 31h 35h 23h)
MT 5)HELP   #6)REVERSE N/S # (ASCII 35h 29h 48h 45h 4Ch
                                       50h 20h 20h 20h 20h 20h 20h
                                       20h 20h 20h 23h 36h 29h 52h
                                       45h 56h 45h 52h 53h 45h 20h
                                       4Eh 2Fh 53h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to 6)REVERSE N/S but no extra data is transmitted from the HC or MT.

Pressing the NEXT key moves the display to sixth and seventh TELESCOPE Menu items:

```
→6)REVERSE N/S
  7)REVERSE E/W
```

This is accomplished by the HC issuing the following pair of commands:

HC :@15#:@16#   (ASCII 3Ah 40h 31h 35h
                                       23h 3Ah 40h 31h 36h 23h)
MT 6)REVERSE N/S #7)REVERSE E/W # (ASCII 36h 29h 52h 45h
                                       56h 45h 52h 53h 45h 20h
                                       4Eh 2Fh 53h 20h 20h 23h
                                       37h 29h 52h 45h 56h 45h
                                       52h 53h 45h 20h 45h 2Fh
                                       57h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to 7)REVERSE E/W but no extra data is transmitted from the HC or MT.

Pressing the NEXT key moves the display to seventh and first TELESCOPE Menu items

```
→7)REVERSE E/W
  1)SITE
```

This is accomplished by the HC issuing the following pair of commands:

HC :@16#:@10#   (ASCII 3Ah 40h 31h 36h 23h
                                       3Ah 40h 31h 30h 23h)
MT 7)REVERSE E/W #1)SITE   #   (ASCII 37h 29h 52h 45h 56h
                                       45h 52h 53h 45h 20h 45h 2Fh
                                       57h 20h 20h 23h 31h 29h 53h
                                       49h 54h 45h 20h 20h 20h 20h
                                       20h 20h 20h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to 1)SITE but no extra data is transmitted from the HC or MT.

1. SITE Menu

Press ENTER with SITE selected:

```
→1)SITE
  2)ALIGN
```

The HC responds with a pair of commands:

HC : GM#:GN#   (ASCII 3Ah 47h 4Dh 23h 3Ah 47h 4Eh 23h)

MT XYZ   √ # XYZ   # (ASCII xxh xxh xxh 20h 20h 20h 20h 20h 20h 20h 20h 02h 20h 23h xxh xxh xxh 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

Where xxh xxh xxh is the 3 character identification for the site.

The Display now has the names of the first two sites displayed:

```
→1)WIL          √
  2)LAK
```

The √ symbol is represented by 02h in the data string and is the next to the last character (15th) on the line for the site currently selected.

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to second site but no extra data is transmitted from the HC or MT.

Press NEXT again will move the display to the second and third sites.

The HC responds with a pair of commands:

HC :GN#:GO#   (ASCII 3Ah 47h 4Eh 23h 3Ah 47h 4Fh 23h)

MT XYZ   # XYZ   # (ASCII xxh xxh xxh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h xxh xxh xxh 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

The Display will now look similar to:

```
  →2)LAK
    3)LOT
```

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.
Pressing NEXT moves the arrow down to third site but no extra data is transmitted from the HC or MT.

Press NEXT again will move the display to the third and fourth sites.

The HC responds with a pair of commands:

    HC :GO#:GP#   (ASCII 3Ah 47h 4Fh 23h 3Ah 47h 50h 23h)
    MT XYZ   # XYZ   # (ASCII xxh xxh xxh 20h 20h 20h 20h 20h 20h
                              20h 20h 20h 20h 23h xxh xxh xxh 20h 20h
                              20h 20h 20h 20h 20h 20h 20h 20h 23h)

The Display will now look similar to:

```
  →3)LOT
    4)AAA
```

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to fourth site but no extra data is transmitted from the HC or MT.

Pressing NEXT again will move the display to the fourth and first sites.

The HC responds with a pair of commands:

    HC :GP#:GM#   (ASCII 3Ah 47h 50h 23h 3Ah 47h 4Dh 23h)
    MT XYZ   # XYZ   # (ASCII xxh xxh xxh 20h 20h 20h 20h 20h
                              20h 20h 20h 20h 20h 23h xxh xxh xxh 20h
                              20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

The Display will now look similar to:

```
  →4)AAA
    1)WIL
```

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing NEXT moves the arrow down to first site but no extra data is transmitted from the HC or MT.

a. SELECTING A SITE

From the display of the first two sites, pressing NEXT to move the arrow to site 2, the display changes from :

```
→1)WIL          √
  2)LAK
```

to:

```
  1)WIL
→ 2)LAK          √
```

Pressing ENTER at this point will select Site 2 as the current site.

The HC responds with a command for the change:

HC :W2#   (ASCII 3Ah 57h 32h 23h)
MT Returns Nothing

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

To see the results of the ENTER, the HC issues the following commands:

HC :GM#:GN#   (ASCII 3Ah 47h 4Dh 23h 3Ah 47h 4Eh 23h)
MT XYZ   # XYZ   √ #   (ASCII xxh xxh xxh 20h 20h 20h 20h 20h
                          20h 20h 20h 20h 20h 23h xxh xxh xxh 20h
                          20h 20h 20h 20h 20h 20h 02h 20h 23h)

The Display now has the names of the first two sites displayed:

```
  1)WIL
→2)LAK          √
```

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Selection of the other 3 sites follows suite using the :W1# for Site, :W2# for Site 2, :W3# for Site 3, and :W4# for Site 4.
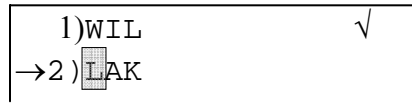
b. NAMING A SITE

To change the name of a site, with the → on the site, press and release ENTER to make it the active site. Then press and hold ENTER. After about 1 second, the first letter in the site name will start flashing. If we were modifying Site 1, the HC would issue the following commands:

HC :GM#:GN#:GM#   (ASCII 3Ah 47h 4Dh 23h 3Ah 47h 4Eh 23h 3Ah 47h 4Dh 23h)

MT Returns Nothing

The Display will now look similar to:

```
 1)WIL              √
→2)LAK
```

Use the NEXT key to go forward and the PREV key to go backwards through the alphabet. The E/W keys move the cursor left and right. Press ENTER when done.

If the WIL were renamed to HOM, the HC would issue the following when ENTER was pressed:

HC :SM HOM#   (ASCII 3Ah 53h 4Dh 20h 48h 4Fh 4Dh 23h)

There are two possible responses from the MT, accepted or not accepted.

MT 1   (ASCII 31h) means it was accepted
MT no response means it was not accepted

If the new name was not accepted, the site will remain in the edit mode.

If the new name was accepted then the following HC commands are issued:

HC :@Gg#:@Gt#   (ASCII 3Ah 40h 47h 67h 23h 3Ah 40h 47h 74h 23h)
MT DDDβMM# sDDβMM# (ASCII xxh xxh xxh DFh xxh xxh 23h xxh xxh xxh DFh xxh xxh 23h) (where s is sign (+ or -) and β is ASCII DFh and shows as the ° symbol on the LCD display.)

David V. Fansler   DFansler@DV-Fansler.com   www.dv-fansler.com

The Display will now look similar to:

```
LAT  =+35°45
LONG =077°58
```

With the cursor flashing over the LAT 10's unit for editing. Use the numeric keys to enter the LAT and the E/W keys to position within LAT. Press ENTER when done.

 The HC then sends the following commands (35°45' for my location):

    HC :St 35β45#   (ASCII 3Ah 53h 74h 20h 33h 35h DFh 34h 35h 23h)
    MT 1   (ASCII 31h) IF within range OR
    MT 0   (ASCII 30h) IF out of range

If the value was out of range the display remains in the edit mode. Range is ±0-90° and 0-60' with a maximum value of 90°00'.

If the LAT was within range and accepted then the HC issues the following command:

    HC :Gg#   (ASCII 3Ah 47h 67h 23h)
    MT DDDβMM#   (ASCII xxh xxh xxh DFh xxh xxh 23h)

This returns the LONG and positions the flashing cursor over the 100's unit of the LONG for editing. Use the numeric keys to enter the LONG and the E/W keys to position within LONG. Press ENTER when done.

 The HC then sends the following commands (077°58' for my location):

    HC :Sg 077β58#   (ASCII 3Ah 53h 67h 20h 30h 37h 37h DFh 35h 38h
                         23h)
    MT 1   (ASCII 31h) IF within range OR
    MT 0   (ASCII 30h) IF out of range

    If the value was out of range the display remains in the edit mode. Range is 0-360° and 0-60' with a maximum value of 360°00' (which is returned as 000°00).

    If the LONG was within range and accepted then the HC issues the following command:

    HC :GM#:GN#ACK   (ASCII 3Ah 47h 4Dh 23h 3Ah 47h 4Eh 23h
                                  06h)

MT XYZ   # XYZ   #P   (ASCII xxh xxh xxh 20h 20h 20h 20h 20h
20h 20h 20h 20h 20h 23h xxh xxh xxh 20h
20h 20h 20h 20h 20h 20h 20h 20h 23h
50h)

The above commands are repeated every 14ms. The final P is an indicator the
telescope is in Polar mode.

2. ALIGN Menu
a. ALTAZ ALIGNMENT

Press ENTER with ALIGN selected:

```
   1)SITE
 →2)ALIGN
```

The HC responds with a pair of commands:

HC :G0#:G1#   (ASCII 3Ah 47h 30h 23h 3Ah 47h 31h
23h)
MT ALTAZ   #POLAR   √   # (ASCII 41h 4Ch 54h 41h 5Ah 20h 20h
20h 20h 20h 20h 20h 20h 20h 20h 20h 20h
23h50h 4Fh 4Ch 41h 52h 20h 20h 20h
20h 20h 02h 20h 20h 20h 20h 20h
23h)

The display now shows:

```
 →ALTAZ
   POLAR              √
```

The display indicates that the telescope is in POLAR Mode. The above
commands are repeated every 14ms, along with an ACK (ASCII 06h) command.

Press and holding the ENTER key will change the mode from POLAR to
ALTAZ, with the HC issuing the following commands:

HC : AA#   (ASCII 3Ah 41h 41h 23h)
MT returns nothing

The HC goes back to the following commands every 14ms:

HC :G0#:G1#ACK (ASCII 3Ah 47h 30h 23h 3Ah 47h
31h 23h 06h)
MT ALTAZ √ #POLAR #A (ASCII 41h 4Ch 54h 41h 5Ah 20h
20h 20h 20h 20h 02h 20h 20h 20h
20h 20h 23h 50h 4Fh 4Ch 41h 52h
20h 20h 20h 20h 20h 20h 20h 20h
20h 20h 20h 23h 41h)

The display now shows:

```
→ALTAZ              √
  POLAR
```

Pressing the ENTER key will start the ALTAZ alignment process. The HC/MT
data is:

HC :A0# (ASCII 3Ah 41h 30h 23h)
MT Level base, thenpress ENTER # (ASCII 4Ch 65h 76h 65h 6Ch 20h
62h 61h 73h 65h 2Ch 20h 74h 68h
65h 6Eh 70h 72h 65h 73h 73h 20h
45h 4Eh 54h 45h 52h 20h 20h 20h
20h 20h 23h)

The display shows:

```
Level base, then
Press ENTER
```

No data is being transmitted to or from the HC at this time. Pressing ENTER at
this point, the HC/MT data is

HC :A2# (ASCII 3Ah 41h 32h 23h)
MT Press ENTER,thenpick align star # (ASCII 50h 72h 65h 73h 73h 20h
45h 4Eh 54h 45h 52h 2Ch 74h 68h
65h 6Eh 70h 69h 63h 6Bh 20h 61h
6Ch 69h 67h 6Eh 20h 73h 74h 61h
72h 20h 23h)

The display shows:

```
Press ENTER, then
pick align star
```

No data is being transmitted to or from the HC at this time. Pressing ENTER at this point, the HC/MT data is

HC :AN 01 0#   (ASCII 3Ah 41h 4Eh 20h 30h 31h
                                                          20h 30h 23h)
MT ~ACHERNAR   ACRUX A   # (ASCII 7Eh 41h 43h 48h 45h 52h
                                                          4Eh 41h 52h 20h 20h 20h 20h 20h
                                                          20h 20h 20h 41h 43h 52h 55h 58h
                                                          20h 41h 20h 20h 20h 20h 20h 20h
                                                          20h 20h 23h) where 7Eh appears
                                                          as → on the Hand Controller LCD
                                                          Display.

The display shows:

```
┌──────────────────────────┐
│ →ACHERNAR                │
│   ACRUX  A               │
└──────────────────────────┘
```

If you do not want Achernar, use the NEXT key to move to ACRUX A. Doing so results in the following HC/MT data:

HC :AN 01 1#   (ASCII 3Ah 41h 4Eh 20h 30h 31h
                                                          20h 31h 23h)
MT ACHERNAR   ~ACRUX A   # (ASCII 20h 41h 43h 48h 45h 52h
                                                          4Eh 41h 52h 20h 20h 20h 20h 20h
                                                          20h 20h 7Eh 41h 43h 52h 55h 58h
                                                          20h 41h 20h 20h 20h 20h 20h 20h
                                                          20h 20h 23h) where 7Eh appears
                                                          as → on the Hand Controller LCD
                                                          Display

The display shows:

```
┌──────────────────────────┐
│   ACHERNAR               │
│ →ACRUX  A                │
└──────────────────────────┘
```

Using the NEXT/PREV keys you can scroll through a list of 33 alignment stars. The data layout for each pair is similar to above and can be found in the command section of this document.

When a suitable alignment star is found, pressing ENTER results in the following HC/MT data exchange (the example is for ACRUX A being selected):

HC :A3 02#   (ASCII 3Ah 41h 33h 20h 30h 32h 23h)
MT Returns Nothing

Followed by:

HC :A4#   (ASCII 3Ah 41h 34h 23h)
MT Center XXXXXXXXXthen press ENTER# (ASCII 43h 65h 6Eh 74h 65h
                                      72h 20h xxh xxh xxh xxh xxh
                                      xxh xxh xxh xxh 74h 68h 65h
                                      6Eh 20h 70h 72h 65h 73h
                                      73h 20h 45h 4Eh 54h 45h
                                      52h 23h)

The display shows:

```
 Center ACRUX A
 then press ENTER
```

There are 33 different :Ax# commands, where x is from 1 to 33 for the different alignment stars. The data layout for each star found in the command section of this document.

When the alignment star is centered, pressing ENTER results in the following HC/MT data exchange:

HC :A5#   (ASCII 3Ah 41h 35h 23h)
MT Returns Nothing

The display returns to MODE 1 Menu:

```
 TELESCOPE
→OBJECT LIBRARY
```

Often with the Object Library selected.

b. POLAR ALIGNMENT – NEW

From the previous example of ALTAZ ALIGNMNET, the display now shows:

```
┌─────────────────────────────┐
│ →ALTAZ            √          │
│    POLAR                     │
└─────────────────────────────┘
```

Pressing the NEXT key will move the arrow to POLAR. Pressing the ENTER key will select POLAR ALIGNMENT. The HC/MT data is:

   HC :AP#   (ASCII 3Ah 41h 50h 23h)
   MT Returns Nothing

Then:

   HC :G0#:G1#   (ASCII 3Ah 47h 30h 23h 3Ah 47h
                                   31h 23h)
   MT ALTAZ   # POLAR   √   # (ASCII 41h 4Ch 54h 41h 5Ah 20h
                                   20h 20h 20h 20h 20h 20h 20h 20h
                                   20h 20h 23h 50h 4Fh 4Ch 41h 52h
                                   20h 20h 20h 20h 20h 02h 20h 20h
                                   20h 20h 20h 23h)

The display now shows:

```
┌─────────────────────────────┐
│    ALTAZ                     │
│ →POLAR            √          │
└─────────────────────────────┘
```

Pressing the ENTER key will select POLAR ALIGNMENT. The HC/MT data is:

   HC :A0#   (ASCII 3Ah 41h 30h 23h)
   MT Move to Dec 90, HA 0.Press ENTER# (ASCII 4Dh 6Fh 76h 65h 20h
                                   74h 6Fh 20h 44h 65h 63h 20h
                                   39h 30h 2Ch 20h 48h 41h 20h
                                   30h 2eh 50h 72h 65h 73h 73h
                                   20h 45h 4Eh 54h 45h 52h 23h

The display now shows:

```
┌─────────────────────────────┐
│    Move to Dec 90,           │
│    HA 0.Press ENTER          │
└─────────────────────────────┘
```

No data is being transmitted to or from the HC at this time. Pressing ENTER at this point, the HC/MT data is

   HC :A1#   (ASCII 3Ah 41h 31h 23h)
   MT Returns \ (ASCII 5Ch) when the telescope has finished its slew. \ (ASCII
            5Ch) is used to sound the beeper.

The :A1# (ASCII 3Ah 41h 31h 23h) command slews the telescope to Polaris. There is no change of the display until after the slew is complete – denoted by the \ (ASCII 5Ch) from the MT.

Upon receipt of \ (ASCII 5Ch) the HC/MT data is:

HC :A2#   (ASCII 3Ah 41h 32h 23h)

MT Returns Center POLARIS then press ENTER #   (ASCII 43h 65h 6Eh 74h 65h 72h 20h 50h 4Fh 4Ch 41h 52h 49h 53h 20h 20h 74h 68h 65h 6Eh 20h 70h 72h 65h 73h 73h 20h 45h 4Eh 54h 45h 52h 23h)

The display shows:

```
Center POLARIS
then press ENTER
```

No data is being transmitted to or from the HC at this time. Pressing ENTER at this point, the HC/MT data is

HC :A3 02#   (ASCII 3Ah 41h 33h 20h 30h 32h 23h)

MT Returns \ (ASCII 5Ch) when the telescope has finished its slew. \ (ASCII 5Ch) is used to sound the beeper.

The :A3 02# (ASCII 3Ah 41h 33h 20h 30h 32h 23h) command slews the telescope to Polaris. There is no change of the display until after the slew is complete – denoted by the \ (ASCII 5Ch) from the MT.

Upon receipt of \ (ASCII 5Ch) the HC/MT data is:

HC :A4#   (ASCII 3Ah 41h 34h 23h)

MT Center XXXXXXXXthen press ENTER#   (ASCII 43h 65h 6Eh 74h 65h 72h 20h xxh xxh xxh xxh xxh xxh xxh xxh xxh 74h 68h 65h 6Eh 20h 70h 72h 65h 73h 73h 20h 45h 4Eh 54h 45h 52h 23h)

Where XXXXXXXXX is the name of the POLAR ALIGNMENT star the telescope is pointing to. The name is truncated if over 9 characters long. Star names shorter than 9 characters are post-padded with spaces to make 9 characters.

The display shows:

```
Center FORMALHAUT
then press ENTER
```

No data is being transmitted to or from the HC at this time. Pressing ENTER at this point, the HC/MT data is:

   HC :A5#   (ASCII 3Ah 41h 35h 23h)
   MT Returns Nothing

The HC returns to MODE 1 MENU, generally pointing to Object Library, and issuing ACK (ASCII 06h) every 14ms.

The display is:

```
 TELESCOPE
→OBJECT LIBRARY
```

c. POLAR ALIGNMENT – REFINEMENT

When the telescope is already POLAR ALIGNED, you can skip the positioning the telescope to 90° Dec and R.A. of 0hr.

With the display showing:

```
 ALTAZ
→POLAR           √
```

Pressing the ENTER key will select POLAR ALIGNMENT. The HC/MT data is:

   HC :A0#   (ASCII 3Ah 41h 30h 23h)
   MT Move to Dec 90, HA 0.Press ENTER# (ASCII 4Dh 6Fh 76h 65h 20h
                                    74h 6Fh 20h 44h 65h 63h 20h
                                    39h 30h 2Ch 20h 48h 41h 20h
                                    30h 2eh 50h 72h 65h 73h 73h
                                    20h 45h 4Eh 54h 45h 52h 23h

The display now shows:

```
Move to Dec 90,
HA 0.Press ENTER
```

No data is being transmitted to or from the HC at this time. Instead of pressing ENTER at this point, press the MODE key; the HC/MT data is

HC :A+#   (ASCII 3Ah 41h 2Bh 23h)
MT Returns \ (ASCII 5Ch) when the telescope has finished its slew. \ (ASCII 5Ch) is used to sound the beeper.

The :A+# (ASCII 3Ah 41h 2Bh 23h) command slews the telescope to Polaris from its current position. That is, the telescope does not have to be manually moved to 90° Dec and R.A. of 0hr. There is no change of the display until after the slew is complete – denoted by the \ (ASCII 5Ch) from the MT.

Upon receipt of \ (ASCII 5Ch) the HC/MT data is

HC :A2#   (ASCII 3Ah 41h 32h 23h)
MT Center POLARIS then press ENTER # (ASCII 43h 65h 6Eh 74h 65h
                                        72h 20h 50h 4Fh 4Ch 41h 52h
                                        49h 53h 20h 20h 74h 68h 65h
                                        6Eh 20h 70h 72h 65h 73h 73h
                                        20h 45h 4Eh 54h 45h 52h 23h)

The display shows:

```
Center POLARIS
then press ENTER
```

No data is being transmitted to or from the HC at this time. Pressing ENTER at this point, the HC/MT data is

HC :A3 02#   (ASCII 3Ah 41h 31h 20h 30h 32h 23h)
MT Returns \   (ASCII 5Ch) when the telescope has finished its slew. \
                    (ASCII 5Ch) is used to sound the beeper.

The :A3 02# (ASCII 3Ah 41h 31h 20h 30h 32h 23h) command slews the telescope to Polaris. There is no change of the display until after the slew is complete – denoted by the \ (ASCII 5Ch) from the MT.

Upon receipt of \ (ASCII 5Ch) the HC/MT data is

HC :A4#   (ASCII 3Ah 41h 34h 23h)
MT Center XXXXXXXXXthen press ENTER#   (ASCII 43h 65h 6Eh 74h
                                        65h 72h 20h xxh xxh xxh
                                        xxh xxh xxh xxh xxh xxh
                                        74h 68h 65h 6Eh 20h 70h
                                        72h 65h 73h 73h 20h 45h
                                        4Eh 54h 45h 52h 23h)

Where XXXXXXXXX is the name of the POLAR ALIGNMENT star the
telescope is point to. The name is truncated if over 9 characters long. Star names
shorter than 9 characters are post-padded with spaces to make 9 characters.

The display shows:

```
Center FORMALHAUT
then press ENTER
```

No data is being transmitted to or from the HC at this time. Pressing ENTER at
this point, the HC/MT data is:

HC :A5#   (ASCII 3Ah 41h 35h 23h)
MT Returns Nothing

The HC returns to MODE 1 MENU, generally pointing to Object Library, and
issuing ACK (ASCII 06h)every 14ms.

The display is:

```
 TELESCOPE
→OBJECT LIBRARY
```

d. LAND MODE

The LAND MODE has no tracking motion. It will move the telescope using the
N, S, E, W buttons at the slew speed selected.

To move the telescope to LAND MODE with the display showing:

```
 ALTAZ
→POLAR          √
```

Pressing the NEXT key, the display now shows:

```
┌─────────────────────────────┐
│   POLAR          √          │
│  →LAND                      │
└─────────────────────────────┘
```

and the HC/MT data is:

HC :G1#:G2#   (ASCII 3Ah 47h 31h 23h 3Ah 47h 32h
                                   23h)
MT POLAR   √   #LAND   #   (ASCII 50h 4Fh 4Ch 41h 52h 20h 20h
                                   20h 20h 20h 02h 20h 20h 20h 20h 20h
                                   23 4Ch 41h 4Eh 44h 20h 20h 20h 20h
                                   20h 20h 20h 20h 20h 20h 20h 20h
                                   23h)

Pressing the ENTER key will select LAND MODE. The HC/MT data is:

HC :AL#   (ASCII 3Ah 41h 30h 23h)
MT Returns Nothing

The HC starts issuing and receiving the following data:

HC :G1#:G2#   (ASCII 3Ah 47h 31h 23h 3Ah 47h
                                   32h 23h)
MT POLAR   #LAND   √ # (ASCII 50h 4Fh 4Ch 41h 52h 20h
                                   20h 20h 20h 20h 20h 20h 20h 20h
                                   20h 20h 23 4Ch 41h 4Eh 44h 20h
                                   20h 20h 20h 20h 02h 20h 20h 20h
                                   20h 20h 20h 23h)

The display now shows:

```
┌─────────────────────────────┐
│   POLAR                     │
│  →LAND           √          │
└─────────────────────────────┘
```

There are no other actions associated with this mode. Press the MODE key to
move upward in the menu structure.

3. SMART Menu

The SMART Menu is used to train the RA and Dec drives for periodic errors. If
the telescope is not in POLAR Mode, SMART appears in lower case letters and
will only beep if selected.

From the display of:

```
  2)ALIGN
→3)SMART
```

This is accomplished by the HC issuing the following pair of commands:

HC :@11#:@12#   (ASCII 3Ah 40h 31h 31h 23h 3Ah 40h
                                 31h 32h 23h)
MT 2)ALIGN   #3)SMART   # (ASCII 32h 29h 41h 4Ch 49h 47h 4Eh
                                 20h 20h 20h 20h 20h 20h 20h 20h 23h
                                 33h 29h 53h 4Dh 41h 52h 54h 20h 20h
                                 20h 20h 20h 20h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing the ENTER key moves the display beginning of the SMART Menu items

```
→1)LEARN
  2)UPDATE
```

This is accomplished by the HC issuing the following pair of commands:

HC :@50#:@51#   (ASCII 3Ah 40h 35h 30h 23h 3Ah
                                 40h 35h 31h 23h)
MT 1)LEARN   # 2)UPDATE   # (ASCII 31h 29h 4Ch 45h 41h 52h
                                 4Eh 20h 20h 20h 20h 20h 20h 20h
                                 20h 23h 32h 29h 55h 50h 44h 41h
                                 54h 45h 20h 20h 20h 20h 20h 20h
                                 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

a. R.A. LEARN

Pressing the ENTER key with LEARN selected updates the display to:

```
→1)LEARN     NNN
  2)UPDATE
```

This is accomplished by the HC issuing the following command:

HC :^50#   (ASCII 3Ah 5Eh 35h 30h 23h)
MT Returns Nothing

Following the starting of the LEARN, the HC issuing the following trio of commands:

HC :@50#:@51#ACK   (ASCII 3Ah 40h 35h 30h 23h
                                     3Ah 40h 35h 31h 23h 06h)
MT 1)LEARN   NNN#2)UPDATE   #P (ASCII 31h 29h 4Ch 45h 41h 52h
                                     4Eh 20h 20h 20h 20h 20h xxh
                                     xxh xxh 23h32h 29h 55h 50h 44h
                                     41h 54h 45h 20h 20h 20h 20h
                                   20h 20h 20h 23h 50h)

When the Smart Drive LEARN is active, NNN is the number of seconds x2 before the R.A. worm home is reached.

The HC then issues this command sequence at the 14ms rate, with the MT responding.

As the count reaches 5 seconds to 0, a beep occurs to warn the user of the event. As always, a \ (ASCII 5Ch) is issued by the MT to sound the beeper.

While my manual indicates that the highest number that can be displayed is 240, the highest my LX-200 has ever shown is 200. Once the counter has reached 0, it resets to 200 and again starts counting down. Every 6 seconds a beep is sounded. Once 0 has been reached in the training time, the counter disappears and training is over. The HC continues to issue the same :@50#:@51#ACK (ASCII 3Ah 40h 35h 30h 23h 3Ah 40h 35h 31h 23h 06h) command sequence every 14ms.

To cancel the SMART drive countdown (pre-training or training) press ENTER again. The HC issues the following command:

HC :^50#   (ASCII 3Ah 5Eh 35h 30h 23h)
MT Returns Nothing

And we return to the following:

```
→1)LEARN
 2)UPDATE
```

This is accomplished by the HC issuing the following pair of commands:

HC :@50#:@51#   (ASCII 3Ah 40h 35h 30h 23h 3Ah
                                               40h 35h 31h 23h)
MT 1)LEARN   # 2)UPDATE   # (ASCII 31h 29h 4Ch 45h 41h 52h
                                               4Eh 20h 20h 20h 20h 20h 20h 20h
                                               20h 23h 32h 29h 55h 50h 44h 41h
                                               54h 45h 20h 20h 20h 20h 20h 20h
                                               20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the
MT responding.

b. R.A. UPDATE

Using the NEXT key to move to UPDATE, the display appears as:

```
  1)LEARN
→2)UPDATE
```

This is accomplished by the HC issuing the following pair of commands:

HC :@50#:@51#   (ASCII 3Ah 40h 35h 30h 23h 3Ah
                                               40h 35h 31h 23h)
MT 1)LEARN   # 2)UPDATE   # (ASCII 31h 29h 4Ch 45h 41h 52h
                                               4Eh 20h 20h 20h 20h 20h 20h 20h
                                               20h 23h 32h 29h 55h 50h 44h 41h
                                               54h 45h 20h 20h 20h 20h 20h 20h
                                               20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the
MT responding.

The sequence for UPDATE is identical to LEARN, except that pressing the
ENTER key, the HC issues a :^51# (ASCII 3Ah 5Eh 35h 30h 23h) command and
the countdown is on the UPDATE line. Pressing ENTER again during the pre-
training or during training will abort the training. The HC again issues the same
:^51# (ASCII 3Ah 5Eh 35h 30h 23h) command. The display returns to

```
   1)LEARN
→2)UPDATE
```

This is accomplished by the HC issuing the following pair of commands:

HC :@50#:@51#   (ASCII 3Ah 40h 35h 30h 23h 3Ah
                                       40h 35h 31h 23h)
MT 1)LEARN   # 2)UPDATE   # (ASCII 31h 29h 4Ch 45h 41h 52h
                                       4Eh 20h 20h 20h 20h 20h 20h 20h
                                       20h 23h 32h 29h 55h 50h 44h 41h
                                       54h 45h 20h 20h 20h 20h 20h 20h
                                       20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

c. R.A. ERASE

From this location in the SMART Drive Menu:

```
   1)LEARN
→2)UPDATE
```

Pressing the NEXT key will change the menu to:

```
   2)UPDATE
→3)ERASE
```

This is accomplished by the HC issuing the following pair of commands:

HC :@51#:@52#   (ASCII 3Ah 40h 35h 31h 23h 3Ah
                                       40h 35h 32h 23h)
MT 2)UPDATE   #3)ERASE   # (ASCII 32h 29h 55h 50h 44h 41h
                                       54h 45h 20h 20h 20h 20h 20h 20h
                                       20h 23h 33h 29h 45h 52h 41h 53h
                                       45h 20h 20h 20h 20h 20h 20h 20h
                                       20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER with ERASE selected will delete all training for the R.A. Drive. There is no warning of what you are about to do.

This is accomplished by the HC issuing the following command:

HC :^52#   (ASCII 3Ah 5Eh 35h 32h 23h)
MT Returns Nothing

The display continues to show:

```
  2)UPDATE
→3)ERASE
```

This is accomplished by the HC issuing the following pair of commands:

HC :@51#:@52#   (ASCII 3Ah 40h 35h 31h 23h 3Ah
                                 40h 35h 32h 23h)
MT 2)UPDATE   #3)ERASE   # (ASCII 32h 29h 55h 50h 44h 41h
                                 54h 45h 20h 20h 20h 20h 20h 20h
                                 20h 23h 33h 29h 45h 52h 41h 53h
                                 45h 20h 20h 20h 20h 20h 20h 20h
                                 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

d. DEC LEARN

From this location in the SMART Drive Menu:

```
  2)UPDATE
→3)ERASE
```

Pressing the NEXT key will change the menu to:

```
  3)ERASE
→4)DEC LEARN
```

This is accomplished by the HC issuing the following pair of commands:

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HC :@52#:@53#   (ASCII 3Ah 40h 35h 32h 23h 3Ah
                                           40h 35h 33h 23h)
MT 3)ERASE   #4)DEC LEARN   #   (ASCII 33h 29h 45h 52h 41h 53h
                                           45h 20h 20h 20h 20h 20h 20h 20h
                                           20h 23h 34h 29h 44h 45h 43h 20h
                                           4Ch 45h 41h 52h 4Eh 20h 20h 20h
                                           20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the
MT responding.

Pressing ENTER with DEC LEARN selected will start DEC training. It is not
time limited as R.A LEARN. You know you are in DEC LEARN by the √ on the
DEC LEARN line.

This is accomplished by the HC issuing the following command:

HC :^53#   (ASCII 3Ah 5Eh 35h 33h 23h)
MT Returns Nothing

Following the :^53# (ASCII 3Ah 5Eh 35h 33h 23h) command, the display will
now show:

```
   3)ERASE
 →4)DEC LEARN   √
```

This is accomplished by the HC issuing the following pair of commands:

HC :@52#:@53#   (ASCII 3Ah 40h 35h 32h 23h
                                           3Ah 40h 35h 33h 23h)
MT 3)ERASE   #4)DEC LEARN   √#   (ASCII 33h 29h 45h 52h 41h 53h
                                           45h 20h 20h 20h 20h 20h 20h
                                           20h 20h 23h 34h 29h 44h 45h
                                           43h 20h 4Ch 45h 41h 52h 4Eh
                                           20h 20h 20h 02h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the
MT responding.

Pressing ENTER while in DEC training will end the training. You know you are
no longer in DEC LEARN by the √ on the DEC LEARN line being removed.

This is accomplished by the HC issuing the following command:

HC :^53#   (ASCII 3Ah 5Eh 35h 33h 23h)
MT Returns Nothing

Following the :^53# (ASCII 3Ah 5Eh 35h 33h 23h) command, the HC starts issuing the following pair of commands:

HC :@52#:@53#   (ASCII 3Ah 40h 35h 32h 23h 3Ah
                                         40h 35h 33h 23h)
MT 3)ERASE   #4)DEC LEARN   #   (ASCII 33h 29h 45h 52h 41h 53h
                                         45h 20h 20h 20h 20h 20h 20h 20h
                                         20h 23h 34h 29h 44h 45h 43h 20h
                                         4Ch 45h 41h 52h 4Eh 20h 20h 20h
                                         20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

e. DEC CORRECT

From this location in the SMART Drive Menu:

```
  2)UPDATE
→3)ERASE
```

Pressing the NEXT key will change the menu to:

```
  3)ERASE
→4)DEC LEARN
```

This is accomplished by the HC issuing the following pair of commands:

HC :@52#:@53#   (ASCII 3Ah 40h 35h 32h 23h 3Ah
                                         40h 35h 33h 23h)
MT 3)ERASE   #4)DEC LEARN   #   (ASCII 33h 29h 45h 52h 41h 53h
                                         45h 20h 20h 20h 20h 20h 20h 20h
                                         20h 23h 34h 29h 44h 45h 43h 20h
                                         4Ch 45h 41h 52h 4Eh 20h 20h 20h
                                         20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER with DEC LEARN selected will start DEC training. It is not time limited as R.A LEARN. You know you are in DEC LEARN by the √ on the DEC LEARN line.

This is accomplished by the HC issuing the following command:

    HC :^53#   (ASCII 3Ah 5Eh 35h 33h 23h)
    MT Returns Nothing

Following the :^53# (ASCII 3Ah 5Eh 35h 33h 23h) command, the display will now show:

```
  3)ERASE
→4)DEC LEARN   √
```

This is accomplished by the HC issuing the following pair of commands:

HC :@52#:@53#	(ASCII 3Ah 40h 35h 32h 23h 3Ah 40h 35h 33h 23h)
MT 3)ERASE #4)DEC LEARN √#	(ASCII 33h 29h 45h 52h 41h 53h 45h 20h 20h 20h 20h 20h 20h 20h 20h 23h 34h 29h 44h 45h 43h 20h 4Ch 45h 41h 52h 4Eh 20h 20h 20h 02h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER while in DEC training will end the training. You know you are no longer in DEC LEARN by the √ on the DEC LEARN line being removed.

This is accomplished by the HC issuing the following command:

    HC :^53#   (ASCII 3Ah 5Eh 35h 33h 23h)
    MT Returns Nothing

Following the :^53# (ASCII 3Ah 5Eh 35h 33h 23h) command, the HC starts issuing the following pair of commands:

HC :@52#:@53#	(ASCII 3Ah 40h 35h 32h 23h 3Ah 40h 35h 33h 23h)
MT 3)ERASE #4)DEC LEARN #	(ASCII 33h 29h 45h 52h 41h 53h 45h 20h 20h 20h 20h 20h 20h 20h 20h 23h 34h 29h 44h 45h 43h 20h

4Ch 45h 41h 52h 4Eh 20h 20h 20h
                                        20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the
MT responding.

4. 12/24 Hour Menu

The 12/24 Hour Menu simply selects whether the local time is shown in 12 or 24
hour format. Sidereal time is always in the 24 hour format.

From the display of:

```
 2)ALIGN
→3)SMART
```

Pressing NEXT will show:

```
 3)SMART
→4)12/24 HR (24)
```

This is accomplished by the HC issuing the following pair of commands:

HC :@12#:@13#   (ASCII 3Ah 40h 31h 32h 23h 3Ah 40h
                                        31h 33h 23h)
MT 3)SMART   # 4)12/24 HR (24)#   (ASCII 33h 29h 53h 4Dh 41h 52h
                                        54h 20h 20h 20h 20h 20h 20h 20h 20h
                                        23h 34h 29h 31h 32h 2Fh 32h 34h 20h
                                        48h 52h 20h 28h 32h 34h 29h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate with the MT
responding.

Pressing the ENTER key will change the format to 12 hours, as seen here:

```
 3)SMART
→4)12/24 HR (12)
```

This is accomplished by the HC issuing the following command:

HC :^13#　　　　　(ASCII 3Ah 5Eh 31h 33h 23h)
MT Returns Nothing

Following the :^13# (ASCII 3Ah 5Eh 31h 33h 23h), the HC resumes issuing the following pair of commands:

HC :@12#:@13#　　　　　　　　(ASCII 3ah 40h 31h 32h 23h 3Ah
　　　　　　　　　　　　　　　　40h 31h 33h 23h)
MT 3)SMART　　　#4)12/24 HR (12)#　(ASCII 33h 29h 53h 4Dh 41h 52h
　　　　　　　　　　　　　　　　54h 20h 20h 20h 20h 20h 20h
　　　　　　　　　　　　　　　　20h 23h 34h 29h 31h 32h 2Fh 32h
　　　　　　　　　　　　　　　　34h 20h 48h 52h 20h 28h 31h 32h
　　　　　　　　　　　　　　　　29h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing the ENTER key will change the format back to 24 hours using the same :^13# (ASCII 3Ah 5Eh 31h 33h 23h) command.

5. HELP Menu

The HELP Menu gives a basic overview of the Hand Controller.

From the display of:

```
  3)SMART
→4)12/24 HR (24)
```

Pressing NEXT will show:

```
  4)12/24 HR (24)
→5)HELP
```

This is accomplished by the HC issuing the following pair of commands:

HC :@13#:@14#　　　　　　　(ASCII 3Ah 40h 31h 33h 23h 3Ah 40h
　　　　　　　　　　　　　　　31h 34h 23h)
MT 12/24 HR (24)#5)HELP　　#　(ASCII 31h 32h 2Fh 32h 34h 20h 48h
　　　　　　　　　　　　　　　52h 20h 28h 32h 34h 29h 23h 35h 29h

48h 45h 4Ch 50h 20h 20h 20h 20h 20h
20h 20h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing the ENTER key takes you to the first page of the HELP Menu. The display appears as:

```
Section 1-Keys


```

This is accomplished by the HC issuing the following command:

HC :??#   (ASCII 3Ah 3Fh 3Fh 23h)
MT 12/24 HR (24)#5)HELP   # (ASCII 31h 32h 2Fh 32h 34h 20h 48h
                                 52h 20h 28h 32h 34h 29h 23h 35h 29h
                                 48h 45h 4Ch 50h 20h 20h 20h 20h 20h
                                 20h 20h 20h 20h 23h)

Pressing NEXT will move forward through the HELP text, pressing PREV will move backwards through the HELP text. You must press MODE to escape the HELP text.

Pressing NEXT, the following command is issued:

HC :?+#   (ASCII 3Ah 3Fh 2Bh 23h)
MT Will return the next page to HELP text consisting of 32 characters.

Pressing PREV, the following command is issued:

HC :?-#   (ASCII 3Ah 3Fh 2Dh 23h)
MT Will return the previous page to HELP text consisting of 32 characters.

For details of each HELP page, see section VIII KEYPAD HELP TEXT in HAND CONTROLLER COMMANDS.

6. REVERSE N/S Menu

From the display of:

```
  4)12/24 HR (24
→5)HELP
```

Pressing NEXT will show:

```
  5)HELP
→6)REVERSE N/S
```

This is accomplished by the HC issuing the following pair of commands:

HC :@14#:@15#   (ASCII 3Ah 40h 31h 34h 23h 3Ah
                                           40h 31h 35h 23h)
MT 5)HELP   #6)REVERSE N/S # (ASCII 35h 29h 48h 45h 4Ch 50h
                                           20h 20h 20h 20h 20h 20h 20h 20h
                                           20h 23h 36h 29h 52h 45h 56h 45h
                                           52h 53h 45h 20h 4Eh 2Fh 53h 20h
                                           20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing the ENTER key will reverse the N/S buttons. The display appears as:

```
  5)HELP
→6)REVERSE N/S  √
```

This is accomplished by the HC issuing the following command:

HC :^15#   (ASCII 3Ah 5Eh 31h 35h 23h)
MT Returns Nothing

The HC resumes issuing the following command sequence:

HC :@14#:@15#   (ASCII 3Ah 40h 31h 34h 23h
                                           3Ah 40h 31h 35h 23h)

MT 5)HELP   #6)REVERSE N/S√ #   (ASCII 35h 29h 48h 45h 4Ch 50h
                                       20h 20h 20h 20h 20h 20h 20h
                                       20h 20h 23h 36h 29h 52h 45h
                                       56h 45h 52h 53h 45h 20h 4Eh
                                       2Fh 53h 20h 02h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER again with REVERSE N/S selected will have the N/S buttons resume a normal operation.

The display returns to:

```
  5)HELP
→6)REVERSE N/S
```

This is accomplished by the HC issuing the following command:

HC :^15#   (ASCII 3Ah 5Eh 31h 35h 23h)
MT Returns Nothing

The HC resumes issuing the following command sequence:

HC :@14#:@15#   (ASCII 3Ah 40h 31h 34h 23h 3Ah
                                       40h 31h 35h 23h)
MT 5)HELP   #6)REVERSE N/S #   (ASCII 35h 29h 48h 45h 4Ch 50h
                                       20h 20h 20h 20h 20h 20h 20h 20h
                                       20h 23h 36h 29h 52h 45h 56h 45h
                                       52h 53h 45h 20h 4Eh 2Fh 53h 20h
                                       20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

7. REVERSE E/W Menu

From the display of:

```
  5)HELP
→6)REVERSE N/S
```

Pressing NEXT will show:

```
  6)REVERSE N/S
→7)REVERSE E/W
```

This is accomplished by the HC issuing the following pair of commands:

    HC :@15#:@16#   (ASCII 3Ah 40h 31h 35h 23h
                                          3Ah 40h 31h 36h 23h)
    MT 6)REVERSE N/S #7)REVERSE E/W #   (ASCII 36h 29h 52h 45h 56h
                                          45h 52h 53h 45h 20h 4Eh 2Fh
                                          53h 20h 20h 23h 37h 29h 52h
                                          45h 56h 45h 52h 53h 45h 20h
                                          45h 2Fh 57h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing the ENTER key will reverse the E/W buttons. The display appears as:

```
  6)REVERSE N/S
→7)REVERSE E/W  √
```

This is accomplished by the HC issuing the following command:

    HC :^16#   (ASCII 3Ah 5Eh 31h 36h 23h)
    MT Returns Nothing

The HC resumes issuing the following command sequence:

    HC :@15#:@16#   (ASCII 3Ah 40h 31h 34h 23h
                                            3Ah 40h 31h 35h 23h)
    MT 5)HELP   #6)REVERSE E/W√ #   (ASCII 35h 29h 48h 45h 4Ch 50h
                                            20h 20h 20h 20h 20h 20h 20h
                                            20h 20h 23h 36h 29h 52h 45h
                                            56h 45h 52h 53h 45h 20h 45h
                                            2Fh 57h 20h 02h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER again with REVERSE E/W selected will have the E/W buttons resume a normal operation.

The display returns to:

```
  6)REVERSE N/S
→7)REVERSE E/W
```

This is accomplished by the HC issuing the following command:

HC :^16#   (ASCII 3Ah 5Eh 31h 36h 23h)
MT Returns Nothing

The HC resumes issuing the following command sequence:

HC :@15#:@16#   (ASCII 3Ah 40h 31h 35h 23h
                                    3Ah 40h 31h 36h 23h)
MT 6)REVERSE N/S#7)REVERSE E/W#   ASCII 36h 29h 52h 45h 56h 45h
                                    52h 53h 45h 20h 4Eh 2Fh 53h
                                    20h 20h 23h 37h 29h 52h 45h
                                    56h 45h 52h 53h 45h 20h 45h
                                    2Fh 57h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

From the display of:

```
  6)REVERSE N/S
→7)REVERSE E/W
```

Pressing NEXT will show:

```
  7)REVERSE E/W
→1)SITE
```

The HC resumes issuing the following command sequence:

HC :@16#:@10#   (ASCII 3Ah 40h 31h 36h 23h 3Ah
                                    40h 31h 30h 23h)
MT 7)REVERSE E/W #1)SITE   #   (ASCII 37h 29h 52h 45h 56h 45h
                                    52h 53h 45h 20h 45h 2Fh 57h 20h
                                    20h 23h 31h 29h 53h 49h 54h 45h

20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

The HC then issues the ACK (ASCII 06h) command at the 14ms rate, with the MT responding. Operation from here should be self evident.

B. OBJECT LIBRARY Menu File

From the display showing:

```
→TELESCOPE
  OBJECT LIBRARY
```

Pressing the NEXT key will move the arrow down. There is no change in data from the HC or MT.

```
 TELESCOPE
→OBJECT LIBRARY
```

At this time the HC is still issuing the ACK (ASCII 06h) command every 14ms to determine the current mode (P, A, or L). The MT responds with either P, A, or L (ASCII 50h, 41h or 4Ch). There is no change to the display. The MODE 1 Display comes not from the MT but the HC. There is no command to show this display.

Pressing ENTER changes the display to:

```
→1)OBJECT INFO
  2)START FIND
```

As with the MODE 1 Main Menu, there is no command to show this menu. The HC knows when this display should be shown and provides it.

1. OBJECT INFO Menu

Pressing ENTER at this display:

```
→1)OBJECT INFO
  2)START FIND
```

Changes the display to:

```
CNGCO
   -
```

This is accomplished by the HC issuing the following command:

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
MT CNGCO   -   #   (ASCII 43h 4Eh 47h 43h 30h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 2Dh 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 20h 23h)

CNGC0 is a non-exsistant object in the database, with a RA of 00:00.0 Hr and 00°00' Dec.

There is no data being transmitted by the HC or MT at this time.

Pressing NEXT moves the display to the next CNGC object

HC :LN#   (ASCII 3Ah 4Ch 4Eh 23h)
MT Returns Nothing

The HC then sends the following command:

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
MT CNGC7189 PR GAL MAG14.4 SZ 50"# (ASCII 43h 4Eh 47h 43h 37h
                                                              31h 38h 39h 20h 50h 52h 20h
                                                              47h 41h 4Ch 20h 4Dh 41h
                                                              47h 31h 34h 2Eh 34h 20h
                                                              53h 5Ah 20h 20h 20h 35h
                                                              30h 22h 23h)

Which displays as:

```
CNGC7189 PR GAL
MAG14.4 SZ    50"
```

It chose this object as the one closest to the current pointing position of the telescope, within the limits of parameters set by the user or as in this case the default parameters.

Where the NEXT key issues the :LN# (ASCII 3Ah 4Ch 4Eh 23h) command which will move forward through the CNGC Catalog, the PREV key issues a :LB# (ASCII 3Ah 4Ch 42h 23h).

Following every :LN# (ASCII 3Ah 4Ch 4Eh 23h) or :LB# (ASCII 3Ah 4Ch 42h 23h) command, a :LI# (ASCII 3Ah 4Ch 49h 23h) is issued to display the information on the HC LCD display.

Pressing ENTER displays the R.A. and Declination of the object:

```
RA    =22:03.6 *
DEC   =+00°37
```

This is accomplished by the HC issuing the following command:

    HC :Gr#:Gd#   (ASCII 3Ah 47h 72h 23h 3Ah 47h 64h 23h)
    MT 22:03.6#+00β37# (ASCII 32h 32h 3Ah 30h 36h 2Eh 36h 23h 2Bh 30h
                       30h DFh 33h 37h 23h)

No further data is transmitted or received at the HC. The * (ASCII 2Ah) is an indicator that the telescope is not pointed at these coordinates. This calculation is generated by the HC.

Pressing ENTER displays the distance to the object using blocks. The upper block is R.A. and the lower blocks are DEC. Each block represents a distance of 10°. Since my telescope was pointing near the object, no blocks were returned.

```

```

This is accomplished by the HC issuing the following command:

    HC :D#   (ASCII 3Ah 44h
                                                        23h)
    MT BBBBBBBBBBBBBBBBBBBBBBBBBBBBBB# (ASCII xxh xxh
                                                        xxh xxh xxh xxh
                                                        xxh xxh xxh xxh
                                                        xxh xxh xxh xxh
                                                        xxh xxh xxh xxh
                                                        xxh xxh xxh xxh
                                                        xxh xxh xxh xxh
                                                        xxh xxh xxh xxh
                                                        xxh xxh 23h)

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As noted, each xxh is a block of 10°, or spaces to pad the extra characters on a line. In the example above MT sent thirty two spaces (ASCII 20h).

Pressing the ENTER key again will return the display to the first menu about the object:

```
CNGC7189 PR GAL
MAG14.4 SZ   50"
```

This done by the HC sending the following command:

    HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
    MT CNGC7189 PR GAL MAG14.4 SZ   50"# (ASCII 43h 4Eh 47h 43h 37h
                                          31h 38h 39h 20h 50h 52h 20h
                                          47h 41h 4Ch 20h 4Dh 41h
                                          47h 31h 34h 2Eh 34h 20h
                                          53h 5Ah 20h 20h 20h 35h
                                          30h 22h 23h)

Pressing the GOTO key will result in one of three actions - movement of the telescope to the object, a message that the object is below the horizon, or a message that the object is below the user set altitude limit.

If the telescope can reach the object, then slewing begins. The display changes to showing the 10° blocks as the telescope moves. For the example above the HC sends:

    HC :MS#   (ASCII 3Ah 4Dh 53h 23h)
    MT 0   (ASCII 30h)

The 0 (ASCII 30h) indicates that the object is within range. Had the object been below the horizon, the MT would have returned:

    MT 1Object below   horizon.   # (ASCII 31h 4Fh 62h 6Ah 65h 63h 74h
                                      20h 62h 65h 6Ch 6Fh 77h 20h 20h
                                      20h 20h 68h 6Fh 72h 69h 7Ah 6Fh
                                      6Eh 2Eh 20h 20h 20h 20h 20h 20h
                                      20h 20h 23h)

The display would show:

```
Object below
Horizon.
```

The 1 (ASCII 31h) indicates that the object is below the horizon. Had the object been below the user set altitude, the MT would have returned:

MT 2Object below altitude limit. #   (ASCII 32h 4Fh 62h 6Ah 65h 63h
                                        74h 20h 62h 65h 6Ch 6Fh 77h 20h
                                        20h 20h 20h 61h 6Ch 74h 69h 74h
                                        75h 64h 65h 20h 6Ch 69h 6Dh 69h
                                        74h 2Eh 20h 23h)

The display would show:

```
Object below
altitude limit.
```

The 2 (ASCII 32h) indicates that the object is below the user set altitude.

If the :MS# (ASCII 3Ah 4Dh 53h 23h) can slew the telescope to the object, then following the HC receiving the 0 (ASCII 30h), the HC starts issuing :D# (ASCII 3Ah 44h 23h) commands about 2 times a second, display the 10° blocks as the telescope moves. Once the telescope arrives at the object, the MT sends a \ (ASCII 5C) as an indicator. Upon receipt of the \ (ASCII 5C), the display shows the basic information about the object:

```
CNGC7189 PR GAL
MAG14.4 SZ   50"
```

This done by the HC sending the following command:

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
MT CNGC7189 PR GAL MAG14.4 SZ 50"# (ASCII 43h 4Eh 47h 43h 37h
                                        31h 38h 39h 20h 50h 52h 20h
                                        47h 41h 4Ch 20h 4Dh 41h
                                        47h 31h 34h 2Eh 34h 20h
                                        53h 5Ah 20h 20h 20h 35h
                                        30h 22h 23h)

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2. START FIND Menu

Pressing NEXT at this display:

```
→1)OBJECT INFO
  2)START FIND
```

Changes the display to:

```
  1)OBJECT INFO
→2)START FIND
```

There is no exchange of data between the HC and the MT for this change.

The HC continues to issue the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER with START FIND selected gives the following display:

```
Objects:  1
Center: CNGC7189#
```

This done by the HC sending the following command:

HC :Lf#   (ASCII 3Ah 4Ch 66h 23h)
MT Objects: 1   Center: CNGC7189# (ASCII 4Fh 62h 6Ah 65h 63h 74h
                                         73h 3Ah 20h 20h 31h 20h 20h 20h
                                         20h 20h 43h 65h 6Eh 74h 65h 72h
                                         3Ah 20h 43h 4Eh 47h 43h 37h 31h
                                         38h 39h 23h)

Basically the :Lf# (ASCII 3Ah 4Ch 66h 23h) command will return 32 characters of data that is displayed on the LCD Display. The NEXT/PREV keys have no effect at this time. Pressing ENTER will display the R.A. and DEC of the object by the HC issuing the following commands:

```
CNGC7189 PR GAL
 MAG14.4 SZ   50"
```

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)

MT CNGC7189 PR GAL MAG14.4 SZ   50"# (ASCII 43h 4Eh 47h 43h 37h
31h 38h 39h 20h 50h 52h 20h
47h 41h 4Ch 20h 4Dh 41h
47h 31h 34h 2Eh 34h 20h
53h 5Ah 20h 20h 20h 35h
30h 22h 23h)

Pressing ENTER displays the distance to the object using blocks. The upper block is R.A. and the lower blocks are DEC. Each block represents a distance of 10°. Since my telescope was pointing at the object, no blocks were returned.
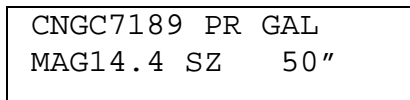
```
┌─────────────────────┐
│                     │
│                     │
│                     │
│                     │
└─────────────────────┘
```

This is accomplished by the HC issuing the following command:

HC :D#   (ASCII 3Ah 44h
23h)

MT BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB# (ASCII xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh 23h)

As noted, each xxh is a block of 10°, or spaces to pad the extra characters on a line. In the example above MT sent thirty two spaces (ASCII 20h).

Pressing the ENTER key again will return the display to the first menu about the object:

```
CNGC7189 PR GAL
MAG14.4 SZ   50"
```

From any of the 3 displays (Object Info, R.A.-DEC, Blocks). Pressing the mode key will return the display to the display:

```
Objects:   1
Center: CNGC7189#
```
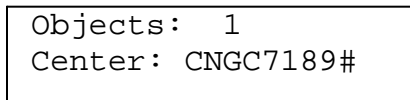
This done by the HC sending the following command:

HC :Lf#   (ASCII 3Ah 4Ch 66h 23h)
MT Objects: 1   Center: CNGC7189# (ASCII 4Fh 62h 6Ah 65h 63h 74h
                                                         73h 3Ah 20h 20h 31h 20h 20h 20h
                                                         20h 20h 43h 65h 6Eh 74h 65h 72h
                                                         3Ah 20h 43h 4Eh 47h 43h 37h 31h
                                                         38h 39h 23h)

3. FIELD Menu

Pressing NEXT at this display:

```
 1)OBJECT INFO
→2)START FIND
```

Changes the display to:

```
 2)START FIND
→3)FIELD
```

There is no exchange of data between the HC and the MT for this change.

The HC continues to issue the ACK (ASCII 06h) command about once a second, with the MT responding.

Pressing ENTER with FIELD selected gives the same 3 displays as seen in START FIND:

```
 Objects:   1
 Center: CNGC7189#
```

This done by the HC sending the following command:

HC :Lf#   (ASCII 3Ah 4Ch 66h 23h)
MT Objects: 1   Center: CNGC7189# (ASCII 4Fh 62h 6Ah 65h 63h 74h
                                                         73h 3Ah 20h 20h 31h 20h 20h 20h
                                                         20h 20h 43h 65h 6Eh 74h 65h 72h
                                                         3Ah 20h 43h 4Eh 47h 43h 37h 31h
                                                         38h 39h 23h)

Pressing the ENTER key moves the display to:

```
CNGC7189 PR GAL
MAG14.4 SZ   50"
```

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
MT CNGC7189 PR GAL MAG14.4 SZ   50"# (ASCII 43h 4Eh 47h 43h 37h
                                          31h 38h 39h 20h 50h 52h 20h
                                          47h 41h 4Ch 20h 4Dh 41h
                                          47h 31h 34h 2Eh 34h 20h
                                          53h 5Ah 20h 20h 20h 35h
                                          30h 22h 23h)

Pressing ENTER again moves the display to:

```
RA   =22:03.6 *
DEC  =+00°37
```

This is accomplished by the HC issuing the following command:

HC :Gr#:Gd#   (ASCII 3Ah 47h 72h 23h 3Ah 47h 64h 23h)
MT 22:03.6#+00β37#   (ASCII 32h 32h 3Ah 30h 36h 2Eh 36h 23h 2Bh 30h
                        30h DFh 33h 37h 23h)

Pressing ENTER again moves the display to the distance blocks, but since the telescope is pointing there, nothing but spaces are returned:

```



```

This is accomplished by the HC issuing the following command:

HC :D#   (ASCII 3Ah 44h
                                          23h)
MT BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB# (ASCII xxh xxh
                                          xxh xxh xxh xxh
                                          xxh xxh xxh xxh
                                          xxh xxh xxh xxh
                                          xxh xxh xxh xxh
                                          xxh xxh xxh xxh
                                          xxh xxh xxh xxh

Pressing the ENTER key again will return the display to the first menu about the object:

```
CNGC7189 PR GAL
MAG14.4 SZ   50"
```

From any of the 3 displays (Object Info, R.A.-DEC, Blocks). Pressing the mode key will return the display to the display:

```
Objects:  1
Center: CNGC7189#
```

This done by the HC sending the following command:

HC :Lf#   (ASCII 3Ah 4Ch 66h 23h)
MT Objects: 1   Center: CNGC7189# (ASCII 4Fh 62h 6Ah 65h 63h 74h
                                73h 3Ah 20h 20h 31h 20h 20h 20h
                                20h 20h 43h 65h 6Eh 74h 65h 72h
                                3Ah 20h 43h 4Eh 47h 43h 37h 31h
                                38h 39h 23h)

4. PARAMETERS Menu
a. TYPE

The purpose of the TYPE command is to limit the types of objects should be in a FIND.

Pressing NEXT at this display:

```
 2)START FIND
→3)FIELD
```

Changes the display to:

```
 3)FIELD
→4)PARAMETERS
```

There is no exchange of data between the HC and the MT for this change.

The HC continues to issue the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER with PARAMETERS selected results in the following display:

```
→ 1)TYPE     GPDCO
   2)BETTER     VP
```

This done by the HC sending the following commands:

    HC :Gy#:Gq#   (ASCII 3Ah 47h 79h 23h 3Ah 47h 71h 3Ah)
    MT GPDCO#VP#   (ASCII 47h 50h 44h 43h 4Fh 23h 56h 50h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Holding down the ENTER key for ~1.5 seconds stops data between the HC and MT and a flashing block cursor over the G in TYPE appears:

```
→ 1)TYPE     GPDCO
   2)BETTER     VP
```

Pressing the NEXT key changes the G to g – and indication that you do not want to include Galaxies in any searches. Pressing PREV will change a lower case g to G, once again including Galaxies in any searches. The P is for Planetary Nebula, D is for Diffuse Nebulae, C is for Globular Star Clusters and O is for Open Star Clusters. Use the E/W key to move between the different objects. This is all handled by the HC. Once the selections have been made, pressing the ENTER key will change the display to reflect the changes. If we were to not want Planetary Nebula, Diffuse Nebulae or Open Star Clusters included in a search, the display would appear as:

```
→ 1)TYPE     GpdCo
   2)BETTER     VP
```

This done by the HC sending the following commands:

    HC :Sy GpdCo#   (ASCII 3Ah 52h 79h 20h 47h 70h 64h 43h 6Fh 3Ah)
    MT 1   (ASCII 31h) means it was accepted

Actually I could not simulate a failed condition – so I do not know what else could be returned. The command is accepted if letters or numbers are entered and even if there are to few or too many! The :Gy# (ASCII 3Ah 47h 79h 23h) will return what ever was entered, but no more than 5 characters. While the MT will accept erroneous characters, the FIND function will not work with these characters. I appears that objects are only included in a FIND if the upper case letter for that object is present and in the correct position. Following a 1 (ASCII 31h) from the MT, the HC starts issuing the following commands:

    HC :Gy#:Gq# (ASCII 3Ah 47h 79h 23h 3Ah 47h 71h 3Ah)
    MT GPDCO#VP#   (ASCII 47h 70h 64h 43h 6Fh 23h 56h 50h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

b. BETTER

The purpose of the BETTER command is to set the lower limit of how easy/good an object should be in a FIND.

Pressing NEXT at this display:

```
→ 1)TYPE      GPDCO
   2)BETTER       VP
```

Changes the display to:

```
   1)TYPE      GPDCO
→ 2)BETTER       VP
```

This done by the HC sending the following commands:

    HC :Gy#:Gq#   (ASCII 3Ah 47h 79h 23h 3Ah 47h 71h 3Ah)
    MT GPDCO#VP#   (ASCII 47h 50h 44h 43h 4Fh 23h 56h 50h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing ENTER with BETTER selected results in the following display:

```
   1)TYPE      GPDCO
→2)BETTER       SU
```

This done by the HC sending the following commands:

    HC :Sq#   (ASCII 3Ah 53h 71h 23h)
    MT Returns Nothing

The HC returns to sending:

    HC :Gy#:Gq#   (ASCII 3Ah 47h 79h 23h 3Ah 47h 71h 3Ah)
    MT GPDCO#SU#   (ASCII 47h 50h 44h 43h 4Fh 23h 53h 55h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

With BETTER selected, each press of the ENTER key issues :Sq# (ASCII 3Ah 53h 71h 23h) command which will cycle the BETTER value (quality of object) through the sequence of VP for Very Poor, PR for Poor, FR for Fair, G for Good, VG for Very Good, EX for Excellent, and SU for Super. Once SU is reach, another press of the ENTER key will start over at VP.

c. HIGHER

The purpose of the HIGHER command is to set the lower limit of how low an object should be in a FIND.

Pressing NEXT at this display:

```
   1)TYPE      GPDCO
→2)BETTER       VP
```

Changes the display to:

```
   2)BETTER       VP
→3)HIGHER      00°
```

This done by the HC sending the following commands:

    HC :Gq#:Gh# (ASCII 3Ah 47h 71h 23h 3Ah 47h 68h 3Ah)

MT VP#00β# (ASCII 56h 50h 23h 30h 30h DFh 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing and holding ENTER for ~1.5 seconds with HIGHER selected results in a flashing cursor over the 10's digit:

```
 2)BETTER      VP
→3)HIGHER      0 0°
```

This done by the HC alone – all data between the HC and the MT stops.

Use the number keys to enter a value for HIGHER and the E/W key to move between the 10's and 1's digits. The acceptable range is 0° to 90°. Once the new value is displayed, pressing ENTER results in the following command:

    HC :Sh DD#   (ASCII 3Ah 63h 68h 20h xxh xxh 23h)
    MT 1 if entry is within range and accepted (ASCII 31h)
    MT 0\ if entry was out of range and rejected (ASCII 30h 5Ch)

xxh xxh are the ASCII values for the range 0 to 90.

If the value was out of range, the HC remains in the edit mode for HIGHER.

If the value was in range, the HC resumes sending:

    HC :Gq#:Gh#   (ASCII 3Ah 47h 71h 23h 3Ah 47h 68h 3Ah)
    MT VP#00β#   (ASCII 56h 50h 23h 30h 30h DFh 23h)

With the HIGHER value being what was entered by the user – in this case it remains at 00°

d. LARGER

The purpose of the LARGER command is to set the lower limit of how small an object should be in a FIND.

Pressing NEXT at this display:

```
 2)BETTER      VP
→3)HIGHER      00°
```

Changes the display to:

```
 3)HIGHER      00°
→4)LARGER     000'
```

This done by the HC sending the following commands:

    HC :Gh#:Gl# (ASCII 3Ah 47h 68h 23h 3Ah 47h 6Ch 3Ah)
    MT 00β#000'#   (ASCII 30h 30h DFh 23h 30h 30h 30h 27h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing and holding ENTER for ~1.5 seconds with LARGER selected results in a flashing cursor over the 100's digit:

```
 3)HIGHER      00°
→4)LARGER     0̲00'
```

This done by the HC alone – all data between the HC and the MT stops.

Use the number keys to enter a value for HIGHER and the E/W key to move between the 100's, 10's and 1's digits. The acceptable range is 0' to 200'. Once the new value is displayed, pressing ENTER results in the following command:

    HC :Sl DDD#   (ASCII 3Ah 53h 6Ch 20h xxh xxh xxh 23h)
    MT 1 if entry is within range and accepted (ASCII 31h)
    MT 0\ if entry was out of range and rejected (ASCII 30h 5Ch)

xxh xxh xxh are the ASCII values for the range 0 to 200.

If the value was out of range, the HC remains in the edit mode for LARGER.

If the value was in range, the HC resumes sending:

    HC :Gh#:Gl# (ASCII 3Ah 47h 68h 23h 3Ah 47h 6Ch 3Ah)
    MT 00β#000'#   (ASCII 30h 30h DFh 23h 30h 30h 30h 27h 23h)

With the LARGER value being what was entered by the user – in this case it remains at 000'.

e. SMALLER

The purpose of the SMALLER command is to set the upper limit of how large an object should be in a FIND.

Pressing NEXT at this display:

```
   3)HIGHER        00°
→4)LARGER         000'
```

Changes the display to:

```
   4)LARGER        000'
→5)SMALLER         000'
```

This done by the HC sending the following commands:

    HC :Gl#:Gs#   (ASCII 3Ah 47h 6Ch 23h 3Ah 47h 73h 3Ah)
    MT 000'#000'#   (ASCII 30h 30h 30h 27h 23h 30h 30h 30h 27h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing and holding ENTER for ~1.5 seconds with SMALLER selected results in a flashing cursor over the 100's digit:

```
   4)LARGER        000'
→5)SMALLER         ⬚00'
```

This done by the HC alone – all data between the HC and the MT stops.

Use the number keys to enter a value for SMALLER and the E/W key to move between the 100's, 10's and 1's digits. The acceptable range is 0' to 200'. Once the new value is displayed, pressing ENTER results in the following command:

    HC :Ss DDD#   (ASCII 3Ah 53h 73h 20h xxh xxh xxh 23h)
    MT 1 if entry is within range and accepted (ASCII 31h)
    MT 0\ if entry was out of range and rejected (ASCII 30h 5Ch)

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xxh xxh xxh are the ASCII values for the range 0 to 200.

If the value was out of range, the HC remains in the edit mode for SMALLER.

If the value was in range, the HC resumes sending:

   HC :Gl#:Gs#   (ASCII 3Ah 47h 6Ch 23h 3Ah 47h 73h 3Ah)
   MT 000'#000'#   (ASCII 30h 30h 30h 27h 23h 30h 30h 30h 27h 23h)

With the SMALLER value being what was entered by the user – in this case it remains at 000'.

f. BRIGHTER

The purpose of the BRIGHTER command is to set the lower limit of how bright an object should be in a FIND.

Pressing NEXT at this display:

```
  4)LARGER       000'
→5)SMALLER       000'
```

Changes the display to:

```
    5)SMALLER     000'
→6)BRIGHTER    +20.0
```

This done by the HC sending the following commands:
   HC :Gs#:Gb#   (ASCII 3Ah 47h 73h 23h 3Ah 47h 62h 3Ah)
   MT 000'#+20.0#   (ASCII 30h 30h 30h 27h 23h 2Bh 32h 30h 2Eh
                         30h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing and holding ENTER for ~1.5 seconds with BRIGHTER selected results in a flashing cursor over the 10's digit:

```
  5)SMALLER      000'
→6)BRIGHTER    +20.0
```

This done by the HC alone – all data between the HC and the MT stops.

Use the number keys to enter a value for BRIGHTER and the E/W key to move between the sign, 10's and 1's digits. The acceptable range is -05.5 to +20.0. The sign is changed using the NEXT/PREV keys. Once the new value is displayed, pressing ENTER results in the following command:

HC :Sb sDD.D#   (ASCII 3Ah 53h 62h 20h xxh xxh xxh 2Eh xxh 23h)
MT 1 if entry is within range and accepted (ASCII 31h)
MT 0\ if entry was out of range and rejected (ASCII 30h 5Ch)

Where the first xxh is for either + (ASCII 2Bh) or – (ASCII 2Dh) xxh xxh xxh are the ASCII values for the range 055 to 200.

If the value was out of range, the HC remains in the edit mode for BRIGHTER.

If the value was in range, the HC resumes sending:

HC :Gs#:Gb#   (ASCII 3Ah 47h 73h 23h 3Ah 47h 62h 3Ah)
MT 000'#+20.0# (ASCII 30h 30h 30h 27h 23h 2Bh 32h 30h 2Eh 30h 23h)

With the BRIGHTER value being what was entered by the user – in this case it remains at +20.0.

g. FAINTER

The purpose of the FAINTER command is to set the lower limit of how dim an object should be in a FIND.

Pressing NEXT at this display:

```
 5)SMALLER     000'
→6)BRIGHTER    +20.0
```

Changes the display to:

```
 6)BRIGHTER    +20.0
→7)FAINTER     -05.5
```

This done by the HC sending the following commands:

    HC :Gb#:Gf#   (ASCII 3Ah 47h 62h 23h 3Ah 47h 66h 3Ah)
    MT +20.0#-05.5#   (ASCII 2Bh 32h 30h 2Eh 30h 23h 2Dh 30h 35h 2Eh
                           35h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Pressing and holding ENTER for ~1.5 seconds with FAINTER selected results in a flashing cursor over the 10's digit:

```
  6)BRIGHTER    +20.0
→7)FAINTER      -05.5
```

This done by the HC alone – all data between the HC and the MT stops.

Use the number keys to enter a value for FAINTER and the E/W key to move between the sign, 10's, 1's and .1's digits. The acceptable range is -05.5 to +20.0. The sign is changed using the NEXT/PREV keys. Once the new value is displayed, pressing ENTER results in the following command:

    HC :Sf sDD.D#   (ASCII 3Ah 53h 66h 20h xxh xxh xxh 2Eh xxh 23h)
    MT 1 if entry is within range and accepted (ASCII 31h)
    MT 0\ if entry was out of range and rejected (ASCII 30h 5Ch)

Where the first xxh is for either + (ASCII 2Bh) or – (ASCII 2Dh) xxh xxh xxh are the ASCII values for the range 055 to 200.

If the value was out of range, the HC remains in the edit mode for FAINTER.

If the value was in range, the HC resumes sending:

    HC :Gb#:Gf#   (ASCII 3Ah 47h 62h 23h 3Ah 47h 66h 3Ah)
    MT +20.0#-05.5#   (ASCII 2Bh 32h 30h 2Eh 30h 23h 2Dh 30h 35h 2Eh 35h
                           23h)

With the FAINTER value being what was entered by the user – in this case it remains at -05.5.

h. RADIUS

The purpose of the RADIUS command is to set the boundaries of what and how many objects should be in a FIND for a given eyepiece. The lower the power of the eyepiece, the more objects that are likely to show in the field of view. The default values is 15' which relates to radius on a 26mm eyepiece of an 8" f/10 LX200.

To calculate the true filed of view in any eyepiece divide the focal length of the telescope by the focal length of the eyepiece. This gives the magnification. Then take the apparent field of view for the eyepiece and divide that by the magnification, divide that by 2 to get the radius of the true field of view.

For my 10" f/6.3 and the standard 26mm Super Plossl with a 52° field of view:

$$\frac{1600mm}{26mm} = 61.5 \, magnification \qquad \text{Telescope fl / Eyepiece fl}$$

$$\frac{61.5 \, magnification}{52°} = 1.18° \qquad \text{Field of view in degrees}$$

$$1.18° \cdot \frac{60 \, min}{1°} = 71.0' \qquad \text{Convert from degrees to minutes}$$

$$\frac{71.0'}{2} = 35.5' \, as \, the \, field \, of \, view \, radius$$

Pressing NEXT at this display:

```
 6)BRIGHTER    +20.0
→7)FAINTER     -05.5
```

Changes the display to:

```
 7)FAINTER     -05.5
→8)RADIUS      015'
```

This done by the HC sending the following commands:

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HC :Gf#:GF#   (ASCII 3Ah 47h 66h 23h 3Ah 47h 46h 3Ah)
MT -05.5#015'#   (ASCII 2Dh 30h 35h 2Eh 35h 23h 30h 31h 35h
                                        27h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h)
command at the 14ms rate, with the MT responding.

Pressing and holding ENTER for ~1.5 seconds with RADIUS selected results
in a flashing cursor over the 100's digit:

```
 7)FAINTER     -05.5
→8)RADIUS      ▯15'
```

This done by the HC alone – all data between the HC and the MT stops.

Use the number keys to enter a value for RADIUS and the E/W key to move
between the sign, 100's, 10's and 1's digits. The acceptable range is 000' to
200'. Once the new value is displayed, pressing ENTER results in the
following command:

HC :SF DDD#(ASCII 3Ah 53h 66h 20h xxh xxh xxh 23h)
MT 1 if entry is within range and accepted (ASCII 31h)
MT 0 if entry was out of range and rejected (ASCII 30h)

Where the first xxh are the ASCII values for the range 000 to 200.

If the value was out of range, the HC remains in the edit mode for RADIUS.

If the value was in range, the HC resumes sending:

HC :Gf#:GF#   (ASCII 3Ah 47h 66h 23h 3Ah 47h 46h 3Ah)
MT -05.5#015'#   (ASCII 2Dh 30h 35h 2Eh 35h 23h 30h 31h 35h
                                        27h 23h)

The HC continues to issue these commands with the ACK (ASCII 06h)
command at the 14ms rate, with the MT responding.

With the RADIUS value being what was entered by the user – in this case it
remains at 015'.

Pressing NEXT at this display:

```
 7)FAINTER    -05.5
→8)RADIUS      015'
```

Changes the display to:

```
 8)RADIUS      015'
→1)TYPE       GPDCO
```

This done by the HC sending the following commands:

HC :GF#:Gy#   (ASCII 3Ah 47h 46h 23h 3Ah 47h 79h 3Ah)
MT 015'#GPDCO#   (ASCII 30h 31h 35h 27h 23h 47h 50h 44h 43h
                   4Fh 23h)

The HC continues to issue these commands with the ACK (ASCII 06h) command at the 14ms rate, with the MT responding.

Operation from here should be self evident.

XII. MODE 2 Commands

Mode 2 commands deal with the setting the R.A. and DEC coordinates where you wish the telescope to point.

From the display :

```
→TELESCOPE
  OBJECT LIBRARY
```

Pressing the MODE key moves the display to MODE 2, which shows the current R.A and DEC.

```
RA    =03:59.9
DEC   =-00°01
```

This is accomplished by the HC issuing the following pair of commands:

HC :GR#:GD#   (ASCII 3Ah 47h 52h 23h 3Ah 47h 44h 23h)
MT 03:54.8#-00β01# (ASCII 30h 33h 3Ah 35h 34h 2Eh 38h 23h 2Dh 30h 30h DFh 30h 31h 23h) (where β is ASCII DFh and shows as the ° symbol on the LCD display.)

This command sequence is repeated at about the same rate as the ACK (ASCII 06h) command.

Pressing the ENTER key will switch the display from RA/DEC to ATL/AZ. The ALTAZ mode assumes that South is 0°, increasing clockwise (toward the West) to 359°59' before rolling over to 000°. Altitude defines the horizon as 0°0' and directly overhead (the zenith) as 90°00'.

```
ALT   =-45°50
AZ    =137°52
```

This is accomplished by the HC issuing the following pair of commands:
HC :GA#:GZ#   (ASCII 3Ah 47h 41h 23h 3Ah 47h 5Ah 23h)
MT -45β50 #137β52#   (ASCII 30h 33h 3Ah 35h 34h 2Eh 38h 23h 2Dh 30h 30h DFh 30h 31h 23h) (where β is ASCII DFh and shows as the ° symbol on the LCD display.)

This command sequence is repeated at about the same rate as the ACK (ASCII 06h) command.

Pressing the ENTER key will again will switch the display from ATL/AZ to RA/DEC.

Pressing the GOTO button will set the RA/DEC display to:

```
RA    =00:00.0*
DEC   =+00°00
```

This is accomplished by the HC issuing the following pair of commands:

HC :Gd#:Gr#   (ASCII 3Ah 47h 41h 23h 3Ah 47h 5Ah 23h)
MT 00:00.0#+00β00#   (ASCII 30h 30h 3Ah 30h 30h 2Eh 30h 23h 2Bh
                       30h 30h DFh 30h 30h 23h) (where β is ASCII
                       DFh and shows as the ° symbol on the LCD
                       display.)

The cursor is flashing on the 10's hour digit for RA, ready for editing. Once the new R.A. has been entered, using the number keys and the E/W keys as before, pressing ENTER will send the data to the MT.

```
RA    =10:00.0*
DEC   =+00°00
```

This is accomplished by the HC issuing the following command:

HC :Sr 10:00.0#   (ASCII 3Ah 47h 41h 23h 3Ah 47h 5Ah 23h)
MT 1 if entry is within range and accepted (ASCII 31h)
MT 0 if entry was out of range and rejected (ASCII 30h)

This example shows RA of 10:00.0.
Where range of values are 0-24 hours, 0-59.9', with a maximum of 00Hr 00.0' to 23Hr 59.9 minutes.

If the value was out of range, the HC remains in the edit mode for R.A. If the value was accepted then the flashing cursor moves to DEC.

The cursor is flashing on the 10's hour digit for DEC, ready for editing. Once the new DEC. has been entered, using the number keys and the E/W keys as before, pressing ENTER will send the data to the MT. Upon receipt of a valid

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DEC, the telescope will start slew to the location entered. The display shows current R.A. and DEC as the telescope slews to the new position.

```
RA    =10:00.0*
DEC   =+05°00
```

This is accomplished by the HC issuing the following command:

HC :Sd +05β00#   (ASCII 3Ah 53h 64h 20h 2Bh 30h 35h DFh 30h 30h 23h)

MT 1 if entry is within range and accepted (ASCII 31h)

MT 0 if entry was out of range and rejected (ASCII 30h)

This example shows RA of 05°00.

The range for DEC is 0 to 90 in degrees and 0 to 59 in minutes, with a min/max range of 00°00' to ±90°00'.

Once confirmation of a good DEC is returned, the HC issues the following commands:

HC :MS#   (ASCII 3Ah 4Dh 53h 23h)

MT 0\   (ASCII 30h 5Ch) 0 if the telescope can complete the slew and \ (ASCII 5Ch) when the slew is complete, OR

MT 1Object below   horizon.   #   (ASCII 31h 4Fh 62h 6Ah 65h 63h 74h 20h 62h 65h 6Ch 6Fh 77h 20h 20h 20h 20h 68h 6Fh 72h 69h 7Ah 6Fh 6Eh 2Eh 20h 20h 20h 20h 20h 20h 20h 20h 23h) - if the object is below the horizon – no slew, OR

MT 2Object below   altitude limit. #   (ASCII 32h 4Fh 62h 6Ah 65h 63h 74h 20h 62h 65h 6Ch 6Fh 77h 20h 20h 20h 20h 61h 6Ch 74h 69h 74h 75h 64h 65h 20h 6Ch 69h 6Dh 69h 74h 2Eh 20h 23h) - if the object is below the 'higher' limit – no slew.

Once the motion has started, pressing GOTO and entering a new set of coordinates seems to be the only method for stopping the slew.

You can not change the coordinates of the ALT/AZ display.

XIII. MODE 3 Commands

Mode 3 command deal with setting the local clock and the date
From the display :

```
→TELESCOPE
   OBJECT LIBRARY
```

Pressing the MODE key moves the display to MODE 2, which shows the current R.A and DEC.

```
RA    =03:59.9
DEC   =-00°01
```

Pressing the MODE key moves the display to MODE 3, which shows the current locat time and Sidereal Time.

```
→LOCAL=19:33:24
 SIDE =17:17:59
```

This is accomplished by the HC issuing the following pair of commands:

> HC :Ga#:GS#   (ASCII 3Ah 47h 61h 23h 3Ah 47h 53h 23h)
> MT 19:33:24#17:17:59# (ASCII 31h 39h 3Ah 33h 33h 3Ah 32h 34h 23h
>   31h 37h 3Ah 31h 30h 3Ah 35h 39h 23h)

This command sequence is repeated with the ACK (ASCII 06h) command at the 14ms rate.

Pressing the ENTER key will switch the display to the date:

```
DATE =01/19/08
```

This is accomplished by the HC issuing the commands:

> HC :GC#   (ASCII 3Ah 47h 43h

MT 01/19/08# (ASCII 30h 31h 2Fh 31h 39h 2Fh 30h 38h 23h)

This command sequence is repeated at about the same rate as the ACK (ASCII 06h) command.

Pressing the ENTER key will again will switch the display back to the Local/Sidereal Time display.

A. SETTING THE LOCAL TIME

Holding down the ENTER key with the Local Time selected place a flashing block cursor at the 10' of hours:

```
→LOCAL=19:33:24
 SIDE =17:17:59
```

This is accomplished by the HC issuing the following pair of commands:

    HC :GL#   (ASCII 3Ah 47h 4Ch 23h)
    MT 19:33:24#   (ASCII 31h 39h 3Ah 33h 33h 3Ah 32h 34h)

Notice that the time format used for editing the Local Time is the 24 hour format – regadless of the shown format.

The cursor is flashing on the 10's hour digit of Local Time, ready for editing. Once the new Local Time has been entered, using the number keys and the E/W keys as before, pressing ENTER will send the data to the MT.

This is accomplished by the HC issuing the following command:

    HC :SL 19:44:18#   (ASCII 3Ah 53h 4Ch 3Ah 34h 34h 3Ah 31h 38h 23h)
    MT 1 if entry is within range and accepted (ASCII 31h)
    MT 0 if entry was out of range and rejected (ASCII 30h)

This example shows a Local Time of 19:44:18.

The acceptable range is 0-23 hours, 0-59 minutes, 0-59 seconds with a min/max of 00:00:00 to 23:59:59.

B. SETTING GMT OFFSET

If the data was within range, then the display next shows:

```
Hours from GMT:
  ▓-05
```

This is accomplished by the HC issuing the following command:

    HC :GG#   (ASCII 3Ah 47h 47h 23h)
    MT :sDD#   (ASCII 3Ah xxh xxh xxh 23h)

Where s is either + (ASCII 2Bh) or – (ASCII 2Dh) and DD represents the current offset from GMT.

The display example is -05 hours offset from GMT (EDT)

Using the number keys and the E/W keys as before, the user sets the offset from GMT for their location. Pressing ENTER sends the data and restores the display to:

```
→LOCAL=19:33:24
 SIDE =17:17:59
```

Where range of values are 0-24 hours, 0-59.9', with a maximum of 00Hr 00.0' to 23Hr 59.9 minutes.

If the value was out of range, the HC remains in the edit mode for R.A. If the value was accepted then the flashing cursor moves to DEC.

This is accomplished by the HC issuing the following command:

    HC :SG -05#   (ASCII 3Ah 53h 47h 20h 2Dh 30h 35h 23h)
    MT 1 if entry is within range and accepted (ASCII 31h)
    MT 0 if entry was out of range and rejected (ASCII 30h)

This example shows OFFSET of -05 hours.

The range for OFFSET is 0 to ±24.

Once confirmation of a good OFFSET is returned, the HC issues the following commands:

    HC :Ga#:GS#   (ASCII 3Ah 47h 61h 23h 3Ah 47h 53h 23h)
    MT 19:33:24#17:17:59# (ASCII 31h 39h 3Ah 33h 33h 3Ah 32h 34h 23h
                            31h 37h 3Ah 31h 30h 3Ah 35h 39h 23h)

This command sequence is repeated with the ACK (ASCII 06h) command at the 14ms rate.

C. SETTING THE CALENDAR

From the display:

```
→LOCAL=19:33:24
 SIDE =17:17:59
```

Pressing the ENTER key gives the new display:

```
DATE =01/19/08
```

This is accomplished by the HC issuing the following command:

    HC :GC#   (ASCII 3Ah 47h 43h 23h)
    MT :MM/DD/YY#   (ASCII 3Ah xxh xxh 2Fh xxh xxh 2Fh xxh xxh
                          23h)

For the example above (January 19, 2008):

    MT 01/19/08#   (ASCII 30h 31h 2Fh 31h 39h 2Fh 30h 38h 23h)

Holding down the ENTER key, the HC places a flashing block cursor over the 10's of month:

```
DATE =01/19/08
```

Use the number keys and E/W keys to enter the date. When finished, pressing the ENTER key will send the data to the MT. If accepted the display will return to the Date display:

```
DATE =01/19/08
```

This is accomplished by the HC issuing the following command:

HC :SC 01/19/08#   (ASCII 3Ah 53h 43h 20h 30h 31h 2Fh 31h 39h 2Fh
                 30h 38h 23h))
MT 1 if entry is within range and accepted (ASCII 31h)
MT 0 if entry was out of range and rejected (ASCII 30h)

The range for the dates follows the standard calendar.

If the date was out of range, date display will continue to be in the edit mode.

If the date was accepted, then the MT issues the message:

Updating   planetary data. #   (ASCII 55h 70h 64h 61h 74h 69h
                                        6Eh 67h 20h 20h 20h 20h 20h 20h
                                        20h 20h 70h 6Ch 61h 6Eh 65h 74h
                                        61h 72h 79h 20h 64h 61h 74h 61h
                                        2Eh 20h 23h)

```
Updating
 planetary data.
```

After a short time and calculations are done, the MT issues a second message – 32 spaces terminated by a # (ASCII 23h)

MT   # (ASCII 20h 20h 20h 20h 20h 20h 20h 20h 20h
                                      20h 20h 20h 20h 20h 20h 20h 20h 20h 20h
                                      20h 20h 20h 20h 20h 20h 20h 20h 20h 20h
                                      20h 20h 20h 23h)

At this time the display returns to the date display

```
DATE =01/19/08
```

This is accomplished by the HC issuing the following command:

HC :GC#   (ASCII 3Ah 47h 43h 23h)
MT :MM/DD/YY# (ASCII 3Ah xxh xxh 2Fh xxh xxh 2Fh xxh xxh 23h)

For the example above (January 19, 2008):

MT 01/19/08#   (ASCII 30h 31h 2Fh 31h 39h 2Fh 30h 38h 23h)

Pressing the ENTER key will move the display back to:

```
→LOCAL=19:33:24
 SIDE =17:17:59
```

This is accomplished by the HC issuing the following pair of commands:

HC :Ga#:GS#   (ASCII 3Ah 47h 61h 23h 3Ah 47h 53h 23h)
MT 19:33:24#17:17:59# (ASCII 31h 39h 3Ah 33h 33h 3Ah 32h 34h 23h 31h 37h 3Ah 31h 30h 3Ah 35h 39h 23h)

This command sequence is repeated with the ACK (ASCII 06h) command at the 14ms rate.

D. SETTING THE SIDEREAL TIME

Not sure why you would want to do this since the telescope calculates it for you – but in trying to cover all possible commands, here it is!

From the display:

```
→LOCAL=19:33:24
 SIDE =17:17:59
```

Pressing the NEXT key will display:

```
 LOCAL=19:33:24
→SIDE =17:17:59
```

There is no change in data between the HC and MT during this display change.

Holding down the ENTER key, the display changes to a flashing block cursor over the 10's of hours digit, ready for editing. Once the new SIDEREIAL Time has been entered, using the number keys and the E/W keys as before, pressing ENTER will send the data to the MT.

This is accomplished by the HC issuing the following command:

HC :SS 17:17:59#   (ASCII 3Ah 53h 53h 20h 31h 37h 3Ah 31h 37h
                      3Ah 35h 39h 23h)
MT 1 if entry is within range and accepted (ASCII 31h)
MT 0 if entry was out of range and rejected (ASCII 30h)

This example shows a SIDEREAL Time of 17:17:59.

The acceptable range is 0-23 hours, 0-59 minutes, 0-59 seconds with a min/max of 00:00:00 to 23:59:59.

If the entry was out of range, the SIDEREAL Time display remains in the edit mode. Otherwise it returns to:

```
LOCAL=19:33:24
→SIDE =17:17:59
```

This is accomplished by the HC issuing the following pair of commands:

HC :Ga#:GS#   (ASCII 3Ah 47h 61h 23h 3Ah 47h 53h 23h)
MT 19:33:24#17:17:59# (ASCII 31h 39h 3Ah 33h 33h 3Ah 32h 34h 23h 31h 37h
                        3Ah 31h 30h 3Ah 35h 39h 23h)

This command sequence is repeated with the ACK (ASCII 06h) command at the 14ms rate.

XIV. MODE 4 Commands

Mode 4 command deal with setting the countdown timer and setting the frequency of the R.A. Drive

From the MODE 1 Menu:

```
→TELESCOPE
   OBJECT LIBRARY
```

Pressing the MODE key moves the display to MODE 2, which shows the current R.A and DEC.

```
 RA    =03:59.9
 DEC   =-00°01
```

Pressing the MODE key moves the display to MODE 3, which shows the current local time and Sidereal Time.

```
→LOCAL=19:33:24
 SIDE =17:17:59
```

Pressing the MODE key moves the display to MODE 4, which shows the countdown timer and R.A. frequency.

```
→TIMER=00:00:00
 FREQ =60.1   Q
```

This is accomplished by the HC issuing the following pair of commands:

    HC :GT#   (ASCII 3Ah 47h 54h 23h)
    MT 60.1#   (ASCII 36h 30h 2Eh 31h 23h)

This command sequence is repeated with the ACK (ASCII 06h) command at the 14ms rate.

A. SETTING THE TIMER

The Countdown TIMER is typically used to time photographs taken with the LX200. The counter is totally contained with in the HC – the MT has no knowledge of the TIMER.
From the display:

```
→TIMER=00:00:00
 FREQ =60.1    Q
```

Holding down the ENTER key will place the flashing block cursor over the 10's of hours digit. Use the numeric keypad and E/W keys to set the time to count down. The range is from 00:00:00 to 11:59:59. Maximum values of 59 for minutes and seconds apply. Once the time has been entered, press the ENTER button to set the time. A single press of the ENTER key will start and stop the Countdown TIMER. The timer will issue several beeps as 00:00:00 is reached. Pressing ENTER quickly at 00:00:00 will start the Countdown TIMER at 11:59:59.

B. SETTING THE FREQUENCY

For most situations the quartz controlled frequency of 60.1 Hz is the desired R.A. rate. If the quartz controlled frequency is being used, a Q appears in the display.

From the display:

```
→TIMER=00:00:00
 FREQ =60.1    Q
```

Pressing the NEXT key, the display changes to:

```
 TIMER=00:00:00
→FREQ =60.1   Q
```

Pressing the ENTER key and the display changes to:

```
 TIMER=00:00:00
→FREQ =60.1   M
```

This is accomplished by the HC issuing the following pair of commands:

HC : TM#   (ASCII 3Ah 54h 4Dh 23h)
MT Returns Nothing

Another press of the ENTER key and the display changes to:

```
 TIMER=00:00:00
→FREQ =60.1  M⇕
```

Another press of the ENTER key and the display changes back to:

```
 TIMER=00:00:00
→FREQ =60.1  Q
```

This is accomplished by the HC issuing the following pair of commands:

HC : TQ#   (ASCII 3Ah 54h 51h 23h)
MT Returns Nothing

The frequency cannot be changed while the quartz controller frequency is operating. So pressing ENTER the HC issues :TM# (ASCII 3Ah 54h 4Dh 23h) command to manual frequency and to move back to this display:

```
 TIMER=00:00:00
→FREQ =60.1  M
```

And holding down the ENTER key will place a flashing block cursor on the 10's digit:

```
 TIMER=00:00:00
→FREQ =6̲0.1  M
```

There is no data between the HC and MT at this time.

Using the numeric keys and the E/W keys, the user can adjust the frequency from an acceptable range of 56.4 to 60.1. Pressing ENTER once the new frequency has been entered, the display shows:

```
 TIMER=00:00:00
→FREQ =57.1  M
```

This is accomplished by the HC issuing the following pair of commands:

HC :ST 57.1##   (ASCII 3Ah 47h 54h 23h)

MT 1   (ASCII 31h) if value in range, OR
MT 0   (ASCII 30h) if out of range

If the value was out of range, the display remains in the edit mode for the frequency.

If the value was in range, the HC returns to issuing the following pair of commands:

HC :GT#   (ASCII 3Ah 47h 54h 23h)
MT 57.1#   (ASCII 35h 37h 2Eh 31h 23h)

This command sequence is repeated with the ACK (ASCII 06h) command at the 14ms rate.

C. SETTING FREQUENCY IN 10th's Hz

From the display:

```
 TIMER=00:00:00
→FREQ =60.1  M↕
```

Moving from the quartz controlled frequency, a :TM# (ASCII 3Ah 54h 4Dh 23h) command was issued. The :GT# (ASCII 3Ah 47h 54h 23h) command between the HC and the MT continues to run. Pressing the NEXT key will reduce the displayed frequency by 1/10th Hz, down to a minimum of 56.4. This is done by the HC issuing a :T-# (ASCII 3Ah 54h 2Dh 23h) command. Pressing the PREV will increase the displayed frequency by 1/10th Hz up to a maximum of 60.1. This is done by the HC issuing a :T+# (ASCII 3Ah 54h 2Bh 23h) command.

Pressing the ENTER key returns the user to the quartz controlled frequency display and the HC issuing a :TQ# (ASCII 3Ah 54h 51h 23h) command:

```
 TIMER=00:00:00
→FREQ =60.1  Q
```

This is accomplished by the HC issuing the following pair of commands:

HC : TQ#   (ASCII 3Ah 54h 51h 23h)
MT Returns Nothing

Once done the HC issues the following command:

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HC :GT#   (ASCII 3Ah 47h 54h 23h)
MT 60.1#   (ASCII 36h 30h 2Eh 31h 23h)

This command sequence is repeated with the ACK (ASCII 06h) command at the 14ms rate.

XV. MODE 5 Commands

In MODE 5 the display and all back light LED's are turned off. There is no data communication between the HC and the MT in MODE 5.

Pressing ENTER allows you to change the brightness of the backlights in the HC.

```
Set brightness
```

Using the PREV/NEXT keys, there are 10 levels of backlight brightness to choose from. Pressing ENTER blanks the display and backlights.

Pressing the MODE key will move the display back to MODE 1 menu.

XVI. CNGC, MESSIER & STAR GOTO

If you know the number of an object from the CNGC or MESSIER catalogs, you can point the telescope at those objects with just a few short key strokes. Stars and Planets are also readily available from the keypad.

A. CNGC OBJECTS

From most any menus, if you press the CNGC button on the keypad (shared with the #3), you will get this display:

```
CNGC Object:
▓
```

The gray block is a flashing block cursor awaiting the entry of a CNGC object number.

The HC issued this command when the CMGC button was pushed:

> HC :LC   (ASCII 3Ah 4Ch 43h)
> MT Nothing Returned

At this point the only keys active are the ENTER, the number keys and the E/W keys. There is no escaping from this display except by hitting the ENTER key.

When the ENTER key is pressed, the CNGC object number is sent to the MT from the HC:

> HC NNNN #   (ASCII xxh xxh xxh xxh 20h 3Ah)
> MT Nothing Returned

The HC then issues the following command:

> HC :LI#   (ASCII 3Ah 4Ch 49h 3Ah)

If the CNGC number is valid then the MT returns a 32 character message:
> HC XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX#
> (ASCII xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
> xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
> xxh xxh xxh xxh 23h) – a 32 byte ASCII string of the data
> regarding any object matching the current point position

If the CNGC number was not valid, then the MT returns:

HC No matching   object…   #   (ASCII 4Eh 6Fh 20h 6Dh 61h 74h 63h
68h 69h 6Eh 67h 20h 20h 20h 20h 20h
6Fh 62h 6Ah 65h 63h 74h 2Eh 2Eh
2Eh 20h 20h 20h 20h 20h 20h 20h
23h)

Pressing ENTER on a valid object will show the R.A. and DEC of the object:

```
RA   =22:03.6 *
DEC  =+00°37
```

This is accomplished by the HC issuing the following command:

HC :Gr#:Gd#   (ASCII 3Ah 47h 72h 23h 3Ah 47h 64h 23h)
MT 22:03.6#+00β37#   (ASCII 32h 32h 3Ah 30h 36h 2Eh 36h 23h 2Bh 30h
30h DFh 33h 37h 23h)

Pressing ENTER again moves the display to the distance blocks, but since the telescope is pointing there, nothing but spaces is returned:

```
██████
████
```

This is accomplished by the HC issuing the following command:

HC :D#   (ASCII 3Ah 44h
23h)

MT BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB# (ASCII xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh xxh xxh
xxh xxh 23h)

Pressing the ENTER key again will return the display to the first menu about the object:

```
CNGC7189 PR GAL
MAG14.4 SZ   50"
```

From any of the 3 displays (Object Info, R.A.-DEC, Blocks). Pressing the mode key will return the display to the MODE 1display:

```
→TELESCOPE
  OBJECT LIBRARY
```

Pressing the GOTO button will instruct the telescope to move to the object. If capable of moving (within horizon and altitude restraints) the HC will show the block screen to inform the user of the slew distance to the object. R.A. is on top, DEC on bottom: each block represents 10°.

The HC issues the following command to slew the telescope:

   HC :MS#   (ASCII 3Ah 4Dh 53h 23h)
   MT 0 (ASCII 30h)

The 0 (ASCII 30h) indicates that the object is within range. Had the object been below the horizon, the MT would have returned:

   MT 1Object below   horizon.   # (ASCII 31h 4Fh 62h 6Ah 65h 63h 74h
                               20h 62h 65h 6Ch 6Fh 77h 20h 20h 20h
                               20h 68h 6Fh 72h 69h 7Ah 6Fh 6Eh 2Eh
                               20h 20h 20h 20h 20h 20h 20h 20h 23h)

   The display would show:

```
Object below
Horizon.
```

The 1 (ASCII 31h) indicates that the object is below the horizon. Had the object been below the user set altitude, the MT would have returned:

   MT 2Object below   altitude limit. # (ASCII 32h 4Fh 62h 6Ah 65h 63h 74h
                                   20h 62h 65h 6Ch 6Fh 77h 20h 20h 20h
                                   20h 61h 6Ch 74h 69h 74h 75h 64h 65h
                                   20h 6Ch 69h 6Dh 69h 74h 2Eh 20h
                                   23h)

The display would show:

```
Object below
altitude limit.
```

The 2 (ASCII 32h) indicates that the object is below the user set altitude.

If the :MS# (ASCII 3Ah 4Dh 53h 23h) can slew the telescope to the object, then following the HC receiving the 0 (ASCII 30h), the HC starts issuing :D# (ASCII 3Ah 44h 23h) commands about 2 times a second, display the 10° blocks as the telescope moves. Once the telescope arrives at the object, the MT sends a \ (ASCII 5C) as an indicator. Upon recipt of the \ (ASCII 5C), the display shows the basic information about the object:

```
CNGC7189 PR GAL
MAG14.4 SZ   50"
```

This done by the HC sending the following command:

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
MT CNGC7189 PR GAL MAG14.4 SZ   50"# (ASCII 43h 4Eh 47h 43h 37h
                                                         31h 38h 39h 20h 50h 52h 20h
                                                         47h 41h 4Ch 20h 4Dh 41h
                                                         47h 31h 34h 2Eh 34h 20h
                                                         53h 5Ah 20h 20h 20h 35h
                                                         30h 22h 23h)

B. MESSIER OBJECTS

Using the MESSIER key (#9 on the keypad) works identical to the CNGC key, with one difference: when you press the M key the HC issues :LM (ASCII 3Ah 4Ch 4Dh) rather than :LC (ASCII 3Ah 4Ch 43h). All other operations and messages work the same.

HC :LM   (ASCII 3Ah 4Dh 43h)
MT Nothing Returned

At this point the only keys active are the ENTER, the number keys and the E/W keys. There is no escaping from this display except by hitting the ENTER key.

When the ENTER key is pressed, the MESSIER object number is sent to the MT from the HC:

HC NNNN #   (ASCII xxh xxh xxh xxh 20h 3Ah)
MT Nothing Returned

The HC then issues the following command:

HC :LI#   (ASCII 3Ah 4Ch 49h 3Ah)

If the MESSIER number is valid then the MT returns a 32 character message:
HC XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX#
    (ASCII xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
    xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
    xxh xxh 23h) – a 32 byte ASCII string of the data regarding any
    object matching the current point position

If the MESSIER number was not valid, then the MT returns:

HC No matching   object…   # (ASCII 4Eh 6Fh 20h 6Dh 61h 74h 63h
                                   68h 69h 6Eh 67h 20h 20h 20h 20h 20h
                                   6Fh 62h 6Ah 65h 63h 74h 2Eh 2Eh
                                   2Eh 20h 20h 20h 20h 20h 20h 20h
                                   23h)

Pressing ENTER on a valid object will show the R.A. and DEC of the object:

```
RA   =15:18.9 *
DEC  =+02°03
```

This is accomplished by the HC issuing the following command:

HC :Gr#:Gd#   (ASCII 3Ah 47h 72h 23h 3Ah 47h 64h 23h)
MT 22:03.6#+00β37# (ASCII 32h 32h 3Ah 30h 36h 2Eh 36h 23h 2Bh 30h
                           30h DFh 33h 37h 23h)

Pressing ENTER again moves the display to the distance blocks, but since the
telescope is pointing there, nothing but spaces is returned:

```
░░░░░░
░░░░
```

This is accomplished by the HC issuing the following command:

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HC :D#   (ASCII 3Ah 44h 23h)
MT BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB#
          (ASCII xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
          xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
          xxh 23h)

Pressing the ENTER key again will return the display to the first menu about the object:

```
 M5      EX GLOB
MAG 5.8 SZ 17.4'
```

From any of the 3 displays (Object Info, R.A.-DEC, Blocks). Pressing the mode key will return the display to the MODE 1display:

```
→TELESCOPE
  OBJECT LIBRARY
```

Pressing the GOTO button will instruct the telescope to move to the object. If capable of moving (within horizon and altitude restraints) the HC will show the block screen to inform the user of the slew distance to the object. R.A. is on top, DEC on bottom: each block represents 10°.

The HC issues the following command to slew the telescope:

HC :MS#   (ASCII 3Ah 4Dh 53h 23h)
MT 0   (ASCII 30h)

The 0 (ASCII 30h) indicates that the object is within range. Had the object been below the horizon, the MT would have returned:
MT 1Object below   horizon.   # (ASCII 31h 4Fh 62h 6Ah 65h 63h 74h 20h
                                     62h 65h 6Ch 6Fh 77h 20h 20h 20h 20h 68h
                                     6Fh 72h 69h 7Ah 6Fh 6Eh 2Eh 20h 20h 20h
                                     20h 20h 20h 20h 20h 23h)

The display would show:

```
Object below
Horizon.
```

The 1 (ASCII 31h) indicates that the object is below the horizon. Had the object been below the user set altitude, the MT would have returned:

MT 2Object below   altitude limit. #   (ASCII 32h 4Fh 62h 6Ah 65h 63h 74h
                                          20h 62h 65h 6Ch 6Fh 77h 20h 20h 20h
                                          20h 61h 6Ch 74h 69h 74h 75h 64h 65h
                                          20h 6Ch 69h 6Dh 69h 74h 2Eh 20h
                                          23h)

The display would show:

```
Object below
altitude limit.
```

The 2 (ASCII 32h) indicates that the object is below the user set altitude.

If the :MS# (ASCII 3Ah 4Dh 53h 23h) can slew the telescope to the object, then
following the HC receiving the 0 (ASCII 30h), the HC starts issuing :D# (ASCII
3Ah 44h 23h) commands about 2 times a second, display the 10° blocks as the
telescope moves. Once the telescope arrives at the object, the MT sends a \
(ASCII 5C) as an indicator. Upon receipt of the \ (ASCII 5C), the display shows
the basic information about the object:

```
 M5      EX GLOB
MAG 5.8 SZ 17.4'
```

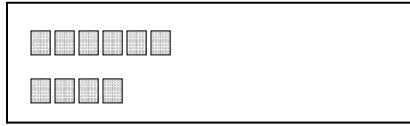This done by the HC sending the following command:

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
MT   M5   EX GLOBMAG 5.8 SZ 17.4'#   (ASCII 20h 20h 20h 4dh 35h 20h
                                      20h 20h 20h 45h 58h 20h 47h
                                      4Ch 4Fh 42h 4Dh 41h 47h 20h
                                      35h 2Eh 38h 20h 53h 5Ah 20h
                                      31h 37h 2Eh 34h 27h 23h)

D. STARS & PLANETS

Using the STAR key (#6 on the keypad) works identical to the CNGC key,
with one difference: when you press the STAR key the HC issues :LS (ASCII
3Ah 4Ch 53h) rather than :LC (ASCII 3Ah 4Ch 43h). All other operations
and messages work the same.

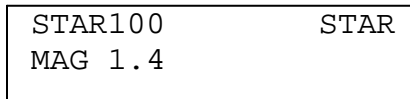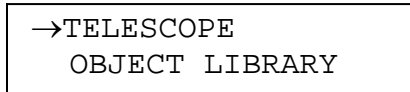HC :LS   (ASCII 3Ah 4Ch 53h)
MT Nothing Returned

At this point the only keys active are the ENTER, the number keys and the E/W keys. There is no escaping from this display except by hitting the ENTER key.

When the ENTER key is pressed, the STAR or PLANET object number is sent to the MT from the HC:

    HC NNNN #   (ASCII xxh xxh xxh xxh 20h 3Ah)
    MT Nothing Returned

The HC then issues the following command:

    HC :LI#   (ASCII 3Ah 4Ch 49h 3Ah)

If the MESSIER number is valid then the MT returns a 32 character message:

    HC XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX#
        (ASCII xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
        xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
        xxh xxh 23h) – a 32 byte ASCII string of the data regarding any
        object matching the current point position

If the STAR or PLANET number was not valid, then the MT returns:

    HC No matching   object…   # (ASCII 4Eh 6Fh 20h 6Dh 61h 74h 63h
                              68h 69h 6Eh 67h 20h 20h 20h 20h 20h
                              6Fh 62h 6Ah 65h 63h 74h 2Eh 2Eh
                              2Eh 20h 20h 20h 20h 20h 20h 20h
                              23h)

Pressing ENTER on a valid object will show the R.A. and DEC of the object:

```
RA   =22:03.6 *
DEC  =+00°37
```

This is accomplished by the HC issuing the following command:

    HC :Gr#:Gd#   (ASCII 3Ah 47h 72h 23h 3Ah 47h 64h 23h)
    MT 22:03.6#+00β37#   (ASCII 32h 32h 3Ah 30h 36h 2Eh 36h 23h 2Bh 30h
                              30h DFh 33h 37h 23h)

Pressing ENTER again moves the display to the distance blocks, but since the telescope is pointing there, nothing but spaces is returned:

```
┌─────────────────────────┐
│ ▯▯▯▯▯▯                   │
│ ▯▯▯▯                     │
└─────────────────────────┘
```

This is accomplished by the HC issuing the following command:

   HC :D#   (ASCII 3Ah 44h 23h)
   MT BBBBBBBBBBBBBBBBBBBBBBBBBBBBBB#
           (ASCII xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
           xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh xxh
           xxh xxh 23h)

Pressing the ENTER key again will return the display to the first menu about the object:

```
┌─────────────────────────┐
│ STAR100          STAR    │
│ MAG 1.4                  │
└─────────────────────────┘
```

From any of the 3 displays (Object Info, R.A.-DEC, Blocks). Pressing the mode key will return the display to the MODE 1display:

```
┌─────────────────────────┐
│ →TELESCOPE               │
│   OBJECT LIBRARY         │
└─────────────────────────┘
```

Pressing the GOTO button will instruct the telescope to move to the object. If capable of moving (within horizon and altitude restraints) the HC will show the block screen to inform the user of the slew distance to the object. R.A. is on top, DEC on bottom: each block represents 10°.

The HC issues the following command to slew the telescope:

   HC :MS#   (ASCII 3Ah 4Dh 53h 23h)
   MT 0   (ASCII 30h)

The 0 (ASCII 30h) indicates that the object is within range. Had the object been below the horizon, the MT would have returned:

   MT 1Object below   horizon.   # (ASCII 31h 4Fh 62h 6Ah 65h 63h 74h
                                        20h 62h 65h 6Ch 6Fh 77h 20h 20h 20h
                                        20h 68h 6Fh 72h 69h 7Ah 6Fh 6Eh 2Eh
                                        20h 20h 20h 20h 20h 20h 20h 20h 23h)

The display would show:

```
┌─────────────────────────────┐
│ Object below                │
│ Horizon.                    │
│                             │
└─────────────────────────────┘
```

The 1 (ASCII 31h) indicates that the object is below the horizon. Had the object been below the user set altitude, the MT would have returned:

MT 2Object below   altitude limit. # (ASCII 32h 4Fh 62h 6Ah 65h 63h 74h 20h 62h 65h 6Ch 6Fh 77h 20h 20h 20h 20h 61h 6Ch 74h 69h 74h 75h 64h 65h 20h 6Ch 69h 6Dh 69h 74h 2Eh 20h 23h)

The display would show:

```
┌─────────────────────────────┐
│ Object below                │
│ altitude limit.             │
│                             │
└─────────────────────────────┘
```

The 2 (ASCII 32h) indicates that the object is below the user set altitude.

If the :MS# (ASCII 3Ah 4Dh 53h 23h) can slew the telescope to the object, then following the HC receiving the 0 (ASCII 30h), the HC starts issuing :D# (ASCII 3Ah 44h 23h) commands about 2 times a second, display the 10° blocks as the telescope moves. Once the telescope arrives at the object, the MT sends a \ (ASCII 5C) as an indicator. Upon receipt of the \ (ASCII 5C), the display shows the basic information about the object:

```
┌─────────────────────────────┐
│ STAR100          STAR       │
│ MAG 1.4                     │
│                             │
└─────────────────────────────┘
```

This done by the HC sending the following command:

 HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
 MT STAR100   STARMAG 1.4   #   (ASCII 53h 54h 41h 52h 31h 30h
                                      30h 20h 20h 20h 20h 20h 53h 54h
                                      41h 52h 4Dh 41h 47h 20h 31h 2Eh
                                      34h 20h 20h 20h 20h 20h 20h
                                      20h 20h 23h)

At this time no other data is being transmitted or received by the HC or MT.

Planets also use the STAR key. Planets use numbers 90x where x is the planet's relative position from the sun.

Mercury is 901
Venus is 902
Earth nor the Moon are in the database
Mars is 904
Jupiter is 905
Saturn is 906
Neptune is 907
Uranus is 908
Pluto is 909

XVII. SYNC TO OBJECT

Sync to object allows quick alignment of a permanently mounted Polar Aligned LX200. The idea is to find a known star in the telescope field of view, using the STAR command from section VII, display the information about that star. Holding the ENTER key for ~1.5 seconds will then set the R.A. and DEC of the telescope to match those of the star. This feature works with any object in the telescope database.

Another use of this feature is to provide a "high resolution" in a particular area. Syncing on a know object close to another object of interest will increase the likelihood of the new object appearing in the field of view when using a GOTO.

Using the STAR 100 from the previous example

```
STAR100          STAR
MAG 1.4
```

This done by the HC sending the following command:

HC :LI#   (ASCII 3Ah 4Ch 49h 23h)
MT STAR100   STARMAG 1.4   #   (ASCII 53h 54h 41h 52h 31h
                                                          30h 30h 20h 20h 20h 20h 20h
                                                          53h 54h 41h 52h 4Dh 41h
                                                          47h 20h 31h 2Eh 34h 20h
                                                          20h 20h 20h 20h 20h 20h 20h
                                                          20h 23h)

At this time no other data is being transmitted or received by the HC or MT.

With STAR100 centered in the field of view, holding down the ENTER key gives the following response:

```
Coordinates
Matched:STAR100
```

The HC sent the following command:

HC :CM#   (ASCII 3Ah 43h 4Dh 23h)
MT Coordinates   matched:STAR100 # (ASCII 43h 6Fh 6Fh 72h 64h
                                                          69h 6Eh 61h 74h 65h 73h 20h
                                                          20h 20h 20h 20h 6Dh 61h 74h

63h 68h 65h 64h 3Ah xxh xxh
xxh xxh xxh xxh xxh xxh 23h)

Where xxh xxh xxh xxh xxh xxh xxh xxh is a field of 8 characters for the name of the object to which coordinates were matched. Unused characters are sent as spaces (ASCII 20h). The example shows STAR100 (ASCII 53h 54h 41h 52h 31h 30h 30h).

XVIII. MAP, FOCUS & RETICULE

A. MAP LIGHT

The MAP LIGHT is a built in source of illumination for such activities as reading charts or the setting circles on the telescope. It has two settings – On and Off. The control of the MAP LIGHT, like the Countdown TIMER is totally in the HC.

I always found the red LED to dim to do much with and recently replaced it with a white LED. It may be too bright, but time will tell.

The MAP LIGHT is turned on and off using the MAP key (#2) from most any menu. The exception is when the HC is looking for a numeric input – such as setting the time or when the user is entering the number of an object.

B. FOCUS

The FOCUS key is designed to be used with the PREV/NEXT keys to adjust the focus on an electric eyepiece holder. According to the manual it has two speeds (SLEW and FIND for fast speeds and CNTR and GUIDE for slow speeds).

On my particular LX200, there is no difference in the voltage measured coming out of the FOCUS port at any setting – with or without a motor connected. This may be a problem with my particular unit.

There are no changes in the LCD display and no data returned from the MT when issuing FOCUS commands.

The FOCUS control can only be used when the telescope is not expecting for a numeric input – such as setting the time or when the user is entering the number of an object.

The SLEW/FIND/CNTR/GUIDE commands have already been covered.

Holding the FOCUS button the HC issues:

    HC :FQ#   (ASCII 3Ah 46h 51h 23h)

Releasing the FOCUS button the HC issues:

    HC :FQ#   (ASCII 3Ah 46h 51h 23h)

Pressing the PREV key while holding the FOCUS the HC issues:

HC :F+#   (ASCII 3Ah 46h 2Bh 23h)

On my LX200, there is ~8vdc at the FOCUS Port at this time.

Releasing the PREV button the HC issues:

HC :FQ#   (ASCII 3Ah 46h 51h 23h)

On my LX200, there is 0vdc at the FOCUS Port at this time.

Pressing the NEXT key while holding the FOCUS the HC issues:

HC :F-#   (ASCII 3Ah 46h 2Dh 23h)

On my LX200, there is ~.5vdc at the FOCUS Port at this time.

Releasing the NEXT button the HC issues:

HC :FQ#   (ASCII 3Ah 46h 51h 23h)

On my LX200, there is 0vdc at the FOCUS Port at this time.

C. RETICULE

The RETICULE output is designed to operate and LED illuminated eyepiece. Someone took some time on this coding – the different modes available are amazing. Operation of the RETICULE is not exactly straight forward. I think part of the reason is instead of using the RETICULE key in conjunction with the SLEW/FIND/CNTR/GUIDE keys to choose the 4 modes; the GUIDE/CNTR/MAP/CNGC keys are used.

In addition to the GUIDE/CNTR/MAP/CNGC keys, the PREV/NEXT keys are also used.

There are no changes in the LCD display and no data returned from the MT when issuing RETICULE commands.

1.   :B0# (ASCII 3Ah 42h 30h 23h)

Holding the RETICULE key and the pressing the GUIDE key turns on the RETICULE Port (5vdc). The HC issues:

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HC :B0#   (ASCII 3Ah 42h 30h 23h)

If you then hold the RETICULE and press the NEXT key, the RETICULE output becomes a PWM (pulse width modulated) wave with a 10 ms period. Each press of the NEXT key will add 1ms of off time to the output. Ten presses of the NEXT key will turn the RETICULE port off.

HC :B-#   (ASCII 3Ah 42h 2Dh 23h)

Pressing the PREV key will add 1ms to the on time, up to full on.

HC :B+#   (ASCII 3Ah 42h 2Bh 23h)

The only way to turn the RETICULE off appears to be to use the NEXT key to turn the output off.

:B0# TIMING
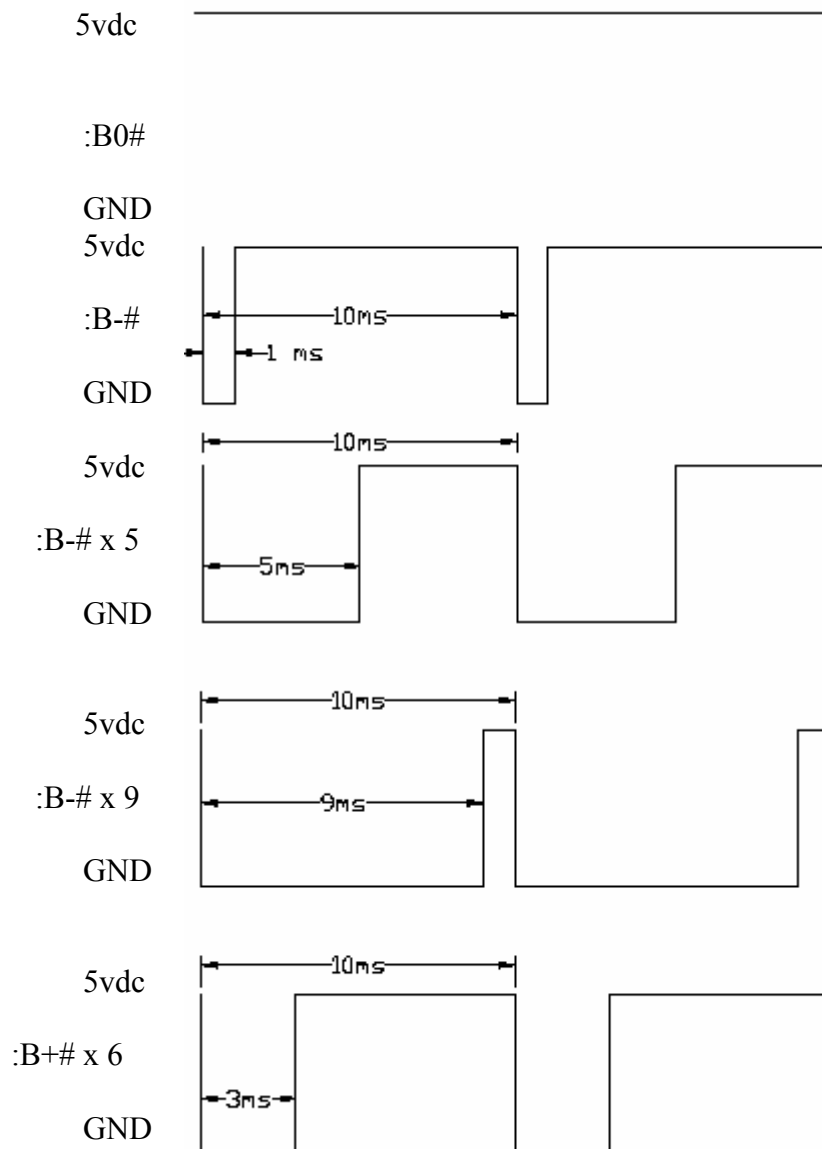
2. :B1# (ASCII 3Ah 42h 31h 23h)

This is the first of three RETICULE modes that provide a flashing RETICULE. That is there is a period of time when the RETICULE will be off, and a period of time that the RETICULE is on, and the brightness of the on can also be controlled. The off time for this mode is .25sec and the controlled on time is .25sec.

Holding the RETICULE key and the pressing the CNTR key turns on the RETICULE Port (5vdc). The HC issues:

    HC :B1#   (ASCII 3Ah 42h 31h 23h)

The RETICULE port output is a PWM wave of .5sec period at 50% on time. If you then hold the RETICULE and press the NEXT key, the high RETICULE output (.25 sec) becomes 25 PWM (pulse width modulated) waves with a 10 ms period. Each press of the NEXT key will add 1ms of off time to the output – but only on the high portion of the main PWM wave. Ten presses of the NEXT key will turn the RETICULE port off.

    HC :B-#   (ASCII 3Ah 42h 2Dh 23h)

 Pressing the PREV key will add 1ms to the on time, up to 50% on.

    HC :B+#   (ASCII 3Ah 42h 2Bh 23h)

The only way to turn the RETICULE off appears to be to use the NEXT key to turn the output off.

3.   :B2# (ASCII 3Ah 42h 32h 23h)

This is the second of three RETICULE modes that provide a flashing RETICULE. That is there is a period of time when the RETICULE will be off, and a period of time that the RETICULE is on, and the brightness of the on can also be controlled. The off time for this mode is .385 sec and the controlled on time is .115 sec.

Holding the RETICULE key and the pressing the CNTR key turns on the RETICULE Port (5vdc). The HC issues:

    HC :B2#   (ASCII 3Ah 42h 32h 23h)

The RETICULE port output is a PWM wave of .5sec period at 23% on time. If you then hold the RETICULE and press the NEXT key, the high RETICULE output (.115 sec) becomes 13 PWM (pulse width modulated) waves with a 10 ms period. Each press of the NEXT key will add 1ms of off time to the output – but only on the high portion of the main PWM wave. Ten presses of the NEXT key will turn the RETICULE port off.

    HC :B-#   (ASCII 3Ah 42h 2Dh 23h)

 Pressing the PREV key will add 1ms to the on time, up to 23% on.

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HC :B+#   (ASCII 3Ah 42h 2Bh 23h)

The only way to turn the RETICULE off appears to be to use the NEXT key to turn the output off.

4.   :B3# (ASCII 3Ah 42h 33h 23h)

This is the third of three RETICULE modes that provide a flashing RETICULE. That is there is a period of time when the RETICULE will be off, and a period of time that the RETICULE is on, and the brightness of the on can also be controlled. The off time for this mode is .879sec and the controlled on time is .121 sec.

Holding the RETICULE key and the pressing the CNTR key turns on the RETICULE Port (5vdc). The HC issues:

HC :B3#   (ASCII 3Ah 42h 33h 23h)

The RETICULE port output is a PWM wave of 1 second period at 12% on time. If you then hold the RETICULE and press the NEXT key, the high RETICULE output (.121 sec) becomes 12 PWM (pulse width modulated) waves with a 10 ms period. Each press of the NEXT key will add 1ms of off time to the output – but only on the high portion of the main PWM wave. Ten presses of the NEXT key will turn the RETICULE port off.

HC :B-#   (ASCII 3Ah 42h 2Dh 23h)

 Pressing the PREV key will add 1ms to the on time, up to 12% on.

HC :B+#   (ASCII 3Ah 42h 2Bh 23h)

The only way to turn the RETICULE off appears to be to use the NEXT key to turn the output off.
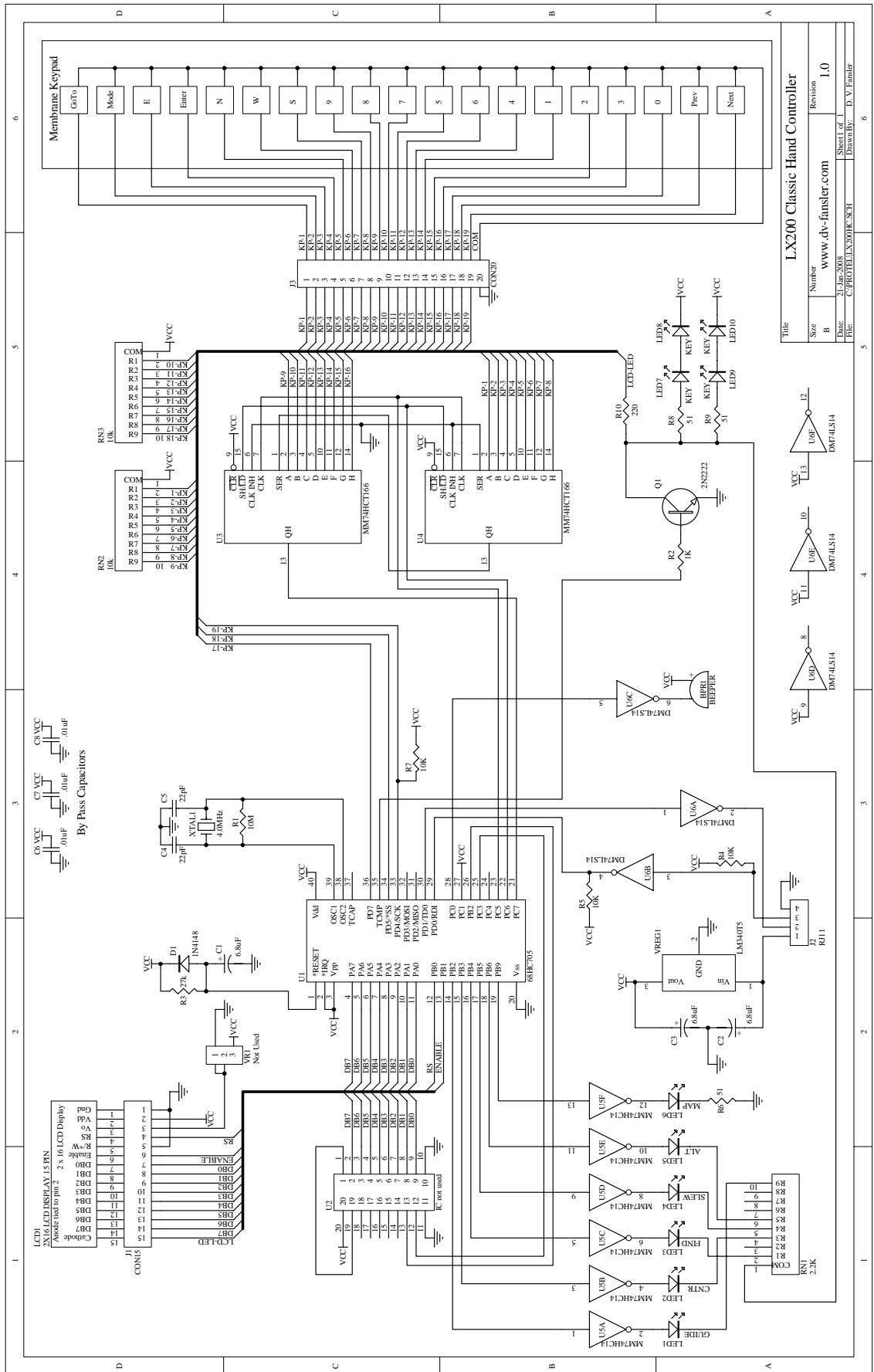
:B1# - :B3# TIMING
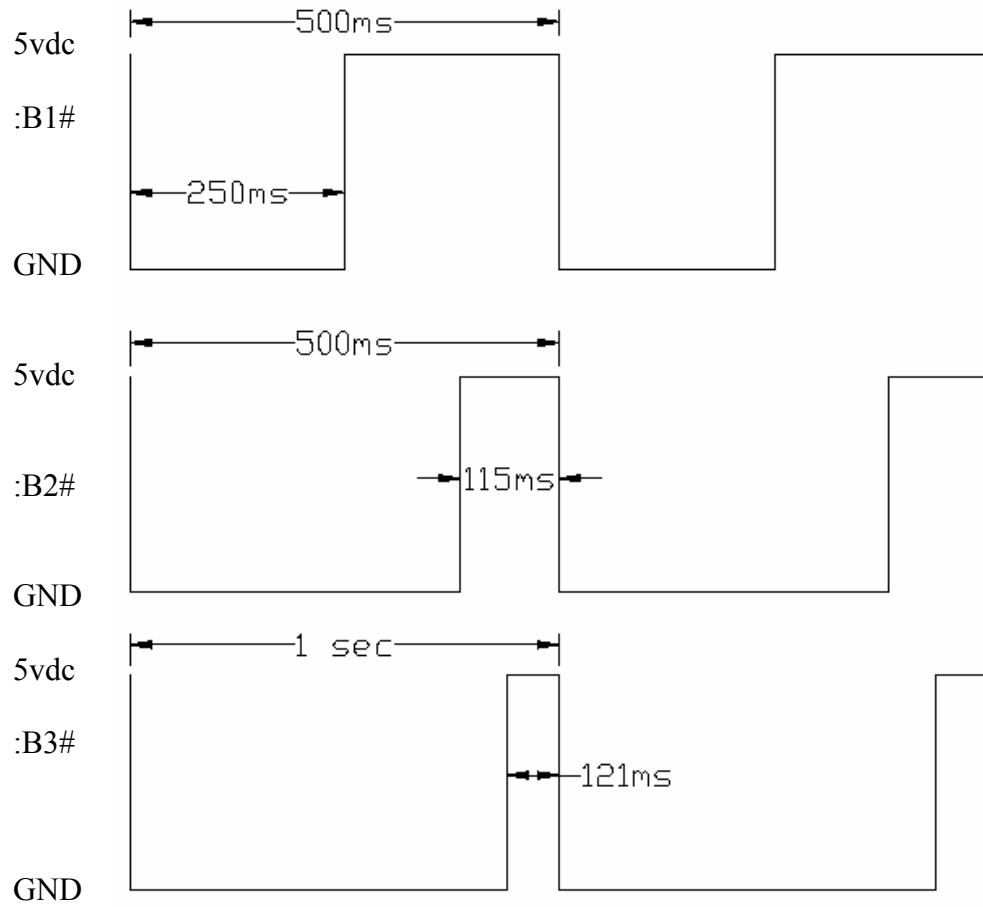
XIX. CONCLUSIONS AND OBSERVATIONS

In my humble opion, the electronics in the LX200 Classic are a work of art. I have been involved in embedded design since the mid-1970's, and working with the hand controller/telescope has given me a new appreciation for what my LX200 is and can do.

At some point in the future, I may try some of the newly discovered hand controller commands via the RS-232 port to see if they are accepted there. Another task for the future is to look at the command structure of my Meade ETX-60's AutoStar. I am will to bet the format has not changed much from the LX200 Classic.
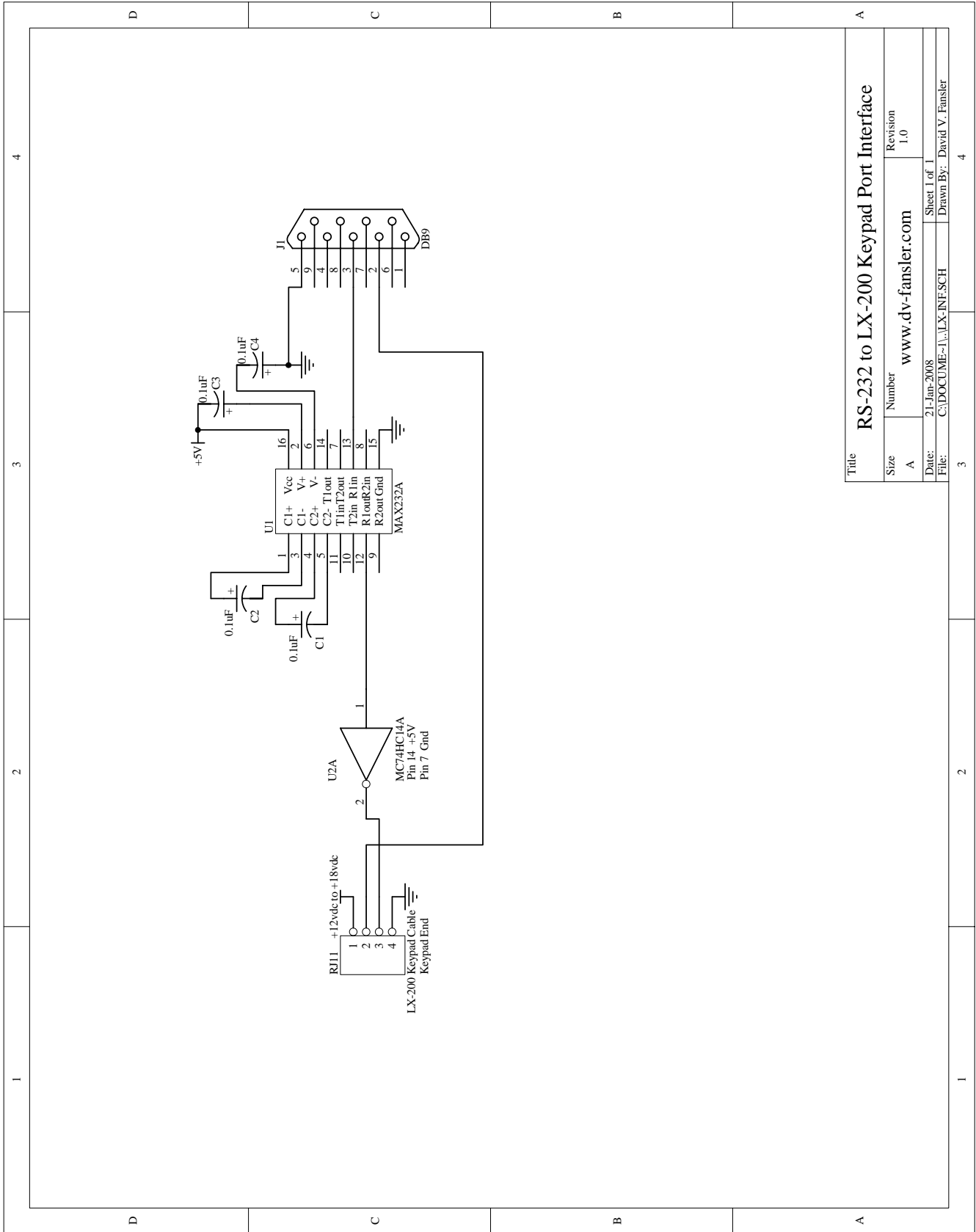
It has taken me about 3 weeks to complete this examination of the communication between the LX200 Hand Controller and the LX200 Telescope. While every effort has been made to not have any mistakes, I know there has to be a few. If you find any, please feel free to drop me an email and let me know.

Appendix A: KEYPAD SCHEMATIC

RS-232 to LX-200 Keypad Port Interface

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Title	RS-232 to LX-200 Keypad Port Interface	
Size	Number	Revision
A		1.0
Date:	21-Jan-2008	Sheet 1 of 1
File:	C:\DOCUME~1\..\LX-INF.SCH	Drawn By: David V. Fansler