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DOME CONTROL SYSTEM SOFTWARE

User Manual

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Overview

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1   Overview of the Dome Control System

1.1   General Configuration

The Dome System is composed of several mechanical and electrical devices attached to the telescope protecting enclosure. This structure is divided in two: the fixed part, which remains static respect to the telescope; and the rotating portion, which turns according to the telescope azimuth positioning requirements.

The moving dome is driven by four AC motors controlled by high power electronic controllers, located at the telescope equipment room. A barcode reader senses the dome position, reading a tape installed along the entire dome periphery. There are 20 louvers on the rotating part of the dome, numbered in pairs from 0 to 9, their function is to allow the air circulate freely across the enclosure, keeping a thermal equilibrium between the telescope structure and the ambient. Also, to let the light in, the dome has huge shutter sliding doors and to avoid wind disturbances or moon interference, the wind screen and moon screen could be extended. Finally, attached to the dome is the crane used for instrument changes or any heavy items lifting. To control all these devices located at the rotating dome, a PLC is used along with a couple of power line modems that pass the communication signal down to the control computer through the dome slip rings.

In the fixed part, the Dome System groups 8 louvers, numbered individually from 0 to 7, the floor lift which is an elevator to carry things to/from the telescope level, and the hatch which is a cover on the telescope floor that gives access to a lower level. A PLC monitors and controls here too, but the serial communications reach directly the Dome computer.

Controlling all of this hardware is the function of the software explained in this manual. Some of the tasks the software is required to perform, are:

- Accept high level commands (both locally at the keyboard and remotely from higher level computer systems) to rotate the dome according with telescope azimuth position, and convert them to low level commands for the various motor drives.

- Report the dome position together with the motor drives ratings (both on the local display and to higher level computer systems).

- Monitor and command louvers opening.

- Extend or retract the wind/moon screen and report their status.

- Report floor lift, crane, hatch status.

- Operate dome high lights.

1.2   Devices

There are a number of devices attached to the Dome Control Computer, which executes the DMCTL.EXP program:

- Upper Dome Programmable Logic Controller (UPLC): The UPLC is installed in the upper part of the dome, and its main function is to control the opening of 10 pairs of rotating louvers, sensing each motion status and position. It also controls the shutter doors, the wind/moon screen, the high lights and senses the status of the crane. The UPLC serial communication link is routed using an upper Power Line Modem (PLM) through the dome sliding contacts to a lower PLM which is directly attached to COM1 (3F8H) at the Dome computer.

- Lower Dome Programmable Logic Controller (LPLC): The LPLC is located in the fixed part of the dome and controls the opening of 8 louvers, sensing their motion status and position. It also senses the floor hatch and lift status. The LPLC serial communication link is directly attached to COM2 (2F8H) at the Dome computer.

- Baldor Motor Drives: These are four electronic controllers, each for an AC dome motor, and collectively, they take care of the dome motion. These motor controllers talk serially through four different RS-485 lines attached to a single serial card inside the Dome computer.

- Host Computer: The Dome computer takes commands on where to position the dome, and reports on the dome's current location. The dome computer is attached via a RS-232 connection on COM3 (3E8) to the higher level host computer (TCS, the Telescope Control System). The Dome computer prompt character, address character, and response character on this communications line is set internally in the code.

- Bar-Code reader. The dome position encoder is an optical bar-coded reader. It is wired directly to the COM4 (2E8) in the Dome computer.

1.3   Positions

The dome structure showing louver positions is shown in Fig. 1.

The rotating louvers are drawn in the inner circle; note that they are controlled in pairs, that's why they are numbered in the same way. The fixed louvers are part of the building and are drawn in the outer part of Fig. 1. The box at the bottom represents the control room. All louvers have four opening states: fully closed, ¼ open, ½ open, ¾ open and fully open.

Figure 1

Interface

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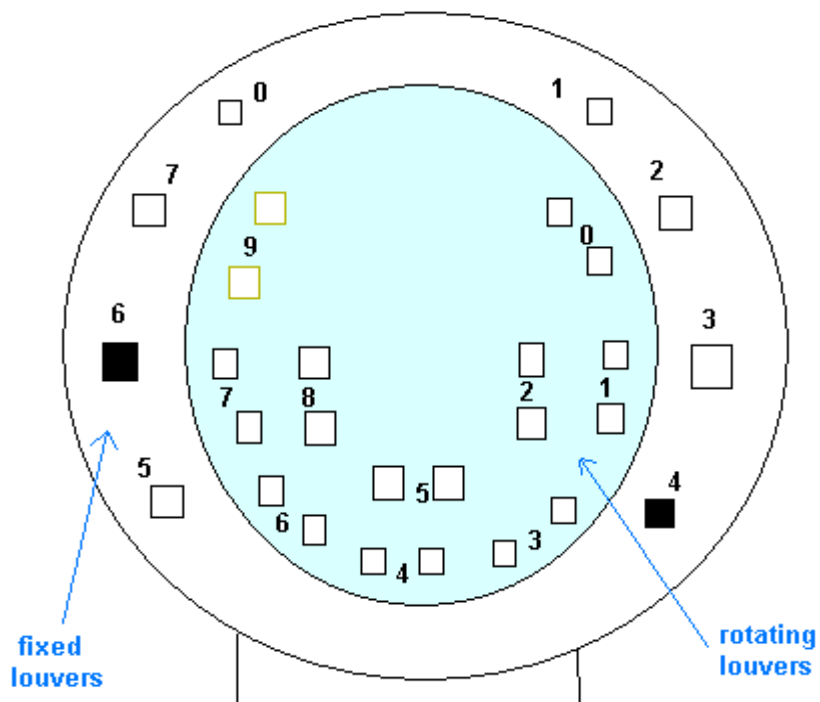## 2 Dome Control System Interface

To start the DOME program, push the reset button (the black rocker switch just below the red power switch) on the computer. The program will load automatically from the flash disk. Resetting the computer assures that the system will start each time in the proper state. When the program is loaded, you should see the usual video display of the dome control program. The different portions of the control screen are described below.

2.1 Input Interface / Log Display

Once the program has been started, you can type commands, which appear at the "*" prompt in the input panel. At the top of the input panel, the average and maximum cycle times for the program status loop are displayed in milliseconds.

Status messages are displayed in the system message box. The UT at which the message occurred is followed by a three-digit message identification code. A red LED indicates that the message describes an error. A green LED indicates that the message describes a normal condition. Most of the errors are caused by serial communications errors, or by some piece of remote equipment being turned off. A certain number of errors may occur when the program is loaded, before the serial communications are properly initialized. A few errors will occur during normal operation.

The messages are numbered from 0 to 999. When the message buffer is full, new messages are written over the old ones starting from the beginning (so message 1000 is written to location 0 and so on). The most recent message is displayed in white. You can scroll back and forth through the message buffer using the appropriate keys. To return to the page with the most recent message, be sure to type <End>, or else new messages will not be displayed on the screen (although new messages will *always* be written to the message buffer).

The elapsed time, in days, that the program has been running is shown in the "et" entry, and the current UT is shown as well. The UT is set by the CMOS clock in the CPU when the program starts, but is updated by the TCS computer as soon as communication is established, and afterwards once per hour.

2.2   Dome Rotation Display

The top panel on the screen is the dome rotation display. The dome encoder is a bar-code reader. The bar-code reader is turned off when the keyswitch on the dome drive and stow pin control box (in the dome) is set to the "off" position. Because the lifetime of the bar-code reader is only about 10,000 hours, please be sure to turn the keyswitch "off" when the telescope is not in use. Turn the keyswitch to "remote" in order to enable computer control of the dome rotation.

If the bar-code reader is not working, or is turned off, a red LED will be displayed next to the azimuth reading. If the bar-code reader is working properly, and a code is being detected, the LED will be green. If the bar-code reader is between two codes (this happens about 25% of the time) the LED will be black. The dome azimuth is 0° when the dome is pointed north, and 90° when the dome is pointed east.

The left-hand graph shows the dome rotation velocity. The dome accelerates to full speed in 10 seconds, and decelerates from full speed in 10 seconds (full speed is currently set to 1.78° /s). For short moves the dome will never reach full speed and the velocity profile will be a triangle. For a long move the dome will move at full speed for some of the time, and the velocity profile will be a trapezoid. Numerical values for the velocity and for the scale of the display are shown to the left of the graph, in white.

There are 4 dome-drive motors. The right-hand graph shows the current in each of the motors. If the motors are turned off, the values will be zero. When the motors are turned on, the baseline current will be 3 amps, and will increase above 3 amps when torque is required to turn the dome. The current in each of the motors should be similar.

If each motor is working, 4 green LED's will be displayed to the left of the graph. A fault condition in one of the motors will cause the corresponding LED to turn red. If one of the motors is not working and has been disconnected from its drive wheel, then status checking for that motor can be disabled by typing the command "BALD n 0" (for motor n; the motors are made by Baldor). When status checking for a motor has been disabled, the corresponding LED will turn black.

In order to move the dome to a particular azimuth, type the command "DOME n" where n is the desired azimuth angle. If the program has just been started, but the bar-code reader is between codes, the dome will make a small jog in order to scan a nearby bar-code and find out where it is. Then the dome will take off for the desired azimuth. The dome is commanded to move for a certain length of time, and the bar-code reader is only checked when the dome has come to a stop. There is some variation in how far the dome will actually go during a given move, and if the dome is not close enough, one or two additional moves will occur to correct the final azimuth.

The dome rotation motion can be stopped in the middle of a move by typing <Esc>. If a serious problem occurs with the dome rotation control logic, it is possible for the dome to stop responding to commands, or even to be stuck in an indefinitely long move. If this happens, DO NOT switch the keyswitch to off, because the dome will come to a screeching halt. Instead, cycle the power to the lower PLC. This will cause the dome to come to a controlled stop, and will also reset the dome control logic.

2.3 Louver Control Display

The largest panel on the screen is the louver control display. The louvers are actually controlled by two PLC's (programmable logic controllers). The upper PLC (UPLC) controls all functions on the rotating part of the dome. The lower PLC (LPLC) controls the louvers on the fixed part of the dome, as well as the dome rotation drives.

If the PLC's are functioning properly, then the corresponding LED on the display will be green. If there is a problem with a PLC, then the corresponding LED will be red. Data is alternately read from and written to each PLC. When a read or write cycle has been completed successfully, the corresponding "R" or "W" flag turns green.

There are 20 louvers on the rotating part of the dome, numbered in pairs from 0 to 9. There are 8 louvers on the fixed part of the dome, numbered individually from 0 to 7. The TCS display includes a graphical representation of the louver system which can be used to identify the actual location of each louver. Each pair of louvers on the rotating part of the dome, or individual louver on the fixed part of the dome, can be commanded to open from 0/4 to 4/4 of the full-open position. When the program is first started, there are no command values, and "-/4" is displayed instead. In this case, the louvers will be left in their current positions.

The position of each louver is sensed by a potentiometer. The output of the potentiometer, scaled to fit in the range from 0 to 999, is displayed for each louver in the "Val" column. The requested potentiometer reading for each louver is displayed in the "Req" column. The gain and zero point for each potentiometer have been adjusted so that openings 0/4, 1/4, 2/4, 3/4, and 4/4 correspond to values of 100, 200, 300, 400, and 500, respectively.

If a louver has been switched to remote mode and is operating properly, a green LED will appear in the "E" column. If an error occurs, the LED will turn red. If the louver is not in remote mode, the LED will be black. Once an error occurs, the louver will not operate until it is reset, by turning the keyswitch on the appropriate louver control box in the dome from "remote" to "off", and then back to "remote."

When the motor for a particular louver is energized, the corresponding symbol in the "M" column will change to an up or down arrow, displayed in green. When the open or closed limit switch for a particular louver has been encountered, the corresponding symbol in the "L" column will change to an up or down arrow, displayed in green. If there is an error reading the limit switches, the symbol will turn red. Note that if power to even one of the louver control boxes has been turned off, the PLC will be unable to read the status of any of the louvers, and all of the limit symbols will turn red.

The closed limit switch for each louver has been adjusted so that it is encountered at about the value 105, and the open limit switch for each louver has been adjusted so that it is encountered near the value 495. Normally, when a louver is commanded to go to an opening of 0/4 or 4/4, the louver should stop near the value 105 or 495, and the corresponding limit switch symbol should turn green. If the louver travels all the way to 100 or 500, and the display indicates that no limit switch has been encountered, then the corresponding limit switch is probably broken.

2.4 Miscellaneous Functions Display

Next to the louver control display is the miscellaneous functions display. If the shutter door control box has been switched to remote mode, the "L" and "R" LED's will turn green. There are two open and two closed limit switches for each shutter door. If both limit switches in a pair are engaged, the corresponding "OPN" or "CLS" indicator will turn green. If only one switch is engaged, the indicator will turn red. In this case one of the limit switches in the pair is broken and should be repaired immediately.

The shutter doors normally take about 100 seconds to open or close. The program allows 120 seconds to elapse before a limit switch is encountered. If more than 120 seconds is required, the shutter doors will stop and an error message will be displayed. The shutter doors can be stopped at an intermediate position by typing <Esc>.

Commands to the moonscreen or windscreen are entered as a percent of full extension, from 0 (completely retracted) to 99 (completely extended). When the program is first started, there are no command values, and "--" is displayed instead. In this case, the moonscreen or windscreen will be left in its current position.

The moonscreen and windscreen encoder values, scaled to fit in the range from 0 to 999, are displayed in the "Val" column. If there is an encoder error, this value will be displayed in red. The requested value for each encoder is displayed in the "Req" column. If the moonscreen and windscreen control box has been switched to remote mode, the LED's in the "E" column will turn green. If a control error occurs, the corresponding LED will turn red. If the moonscreen motor or the windscreen motor is energized, the corresponding arrow in the "M" column will be displayed in green. If the either the moonscreen or the windscreen has reached an open or closed limit, the corresponding arrow in the "L" column will be displayed in green.

The moonscreen and windscreen closed limits should normally be encountered at about the value 1/99, and the open limits at about the value 98/99. If a command of 0 or 99 is entered, motion should stop just short of the requested encoder reading, and the corresponding limit switch indicator should turn green. If the motion continues all the way to the requested value, and there is no indication that a limit switch has been encountered, then the corresponding limit switch is broken and should be repaired immediately.

Commands

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3   Commands Summary

3.1   Dome Command Syntax

All DOME commands begin with a command code of up to four letters, followed by up to two numeric arguments. The numeric arguments (if there are more than one) are separated by spaces; spaces are permitted but not required between the command and the first numeric argument. Letters may be upper or lower case. The numeric arguments may include a decimal point. For example, the commands

<div align="center">

dome47.2

DOME 47.20

</div>

will both rotate the dome to position angle 47.2 degrees. The backspace key moves the cursor back one character at time. All commands are terminated by a <cr>.

During normal operation, the host computer communicates with the Dome computer via COM 3: (the serial port). The host computer will typically use the EDS (Engineering Data Stream) log entries to check for errors and get the system's current status. It will then use the move commands to update the dome position. The **ESC** key can be used to attempt to stop the most important moving parts in case any problem arises, so normal operation could be resumed then.

The Dome computer adheres to the serial communication protocol defined in D.M. Carr's "Proposed RS-485 Control System Communications Protocol", DOC#96CY0007. The Dome computer uses a prompt character of ':', an address of 'K', and a response character of '~'. These are defined within the code Refer to the Chapter 6 "Control System Serial Communication Standards" for a description of Engineering Data Stream (EDS) communications.

3.2   Dome Commands

Command	Description
DOME n	Rotate the dome to azimuth angle n (n = 0.0,…,359.9).
OPN	Open the shutter doors.
CLS	Close the shutter doors.
MOON n	Move the moonscreen to position n (n = 0,…,99).
WIND n	Move the windscreen to position n (n = 0,…,99).
<Esc>	Stop dome rotation or shutter door motion
HL	Turn dome highlights on / off (toggle).
MR	Put moonscreen and windscreen motion in remote mode. Further movements are automatic according to telescope elevation.
ML	Put moonscreen and windscreen motion in local mode. Further movements for both are manual. Default mode.

3.3   Louver Commands

Command	Description
FL n m	Set fixed louver n (n = 0,…,7) to opening m (m = 0,…,4).
RL n m	Set rotating louver pair n (n = 0,…,9) to opening m (m = 0,…,4).
AFL n	Set all fixed louvers to opening n (n = 0,…,4).
ARL n	Set all rotating louvers to opening n (n = 0,…,4).
HFL n	Disable (hold) / enable commands for fixed louver n (toggle) (n = 0,…,7)
HRL n	Disable (hold) / enable commands for rotating louver pair n (toggle) (n = 0,…,9).

3.4   Message Commands

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

3.5   Display Commands

Command	Description
DSC n	Set scale for the delta-position display to n deg (n = 1.0,…,10.0).
VSC n	Set scale for the rotation velocity display to n°/s (n = 0.1,…,3.0).
ASC n	Set scale for the motor current display to n amps (n = 1.0,…,30.0).

3.6   Engineering Commands

Command	Description
BALD n m	Set status checking of Baldor amplifier n (n = 1,…,4) to level m (m = 0, 1).
DR n	Rotate dome right n deg (n = 0.1,…,180.0).
DL n	Rotate dome left n deg (n = 0.1,…,180.0).
DXR n	Rotate (index) dome right to azimuth angle n deg (n = 0.0,…,359.9).
DXL n	Rotate (index) dome left to azimuth angle n deg (n = 0.0,…,359.9).

3.7   Other Commands

Command	Description
EXIT	Exit from the program.

Configuration

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4   Dome Configuration

DMCTL.INI is the configuration file for the Dome program. It includes all of the parameters that might need to be modified. It can be edited in a simple text editor outside of the program

DMCTL.INI follows a simple format: Any line beginning with a semicolon is ignored (it's a comment). All other lines are significant.   On each of these lines there is a number, a semicolon and a comment. The number is the data relevant to the program. Everything after the semicolon is ignored. There are two types of data: integers and floating point numbers. Following there is a detailed description of the file. Note that it should be mostly self-documented.

4.1   DMCTL.INI File at Magellan I (Baade)

```
       1  ;(1) Telescope Baade                 i*4
     531  ;(2) CPU clock rate (ppm), +=fast    i*4
     245  ;(3) Windscreen retract limit        i*4
     500  ;(4) Windscreen extend limit         i*4
     100  ;(5) Moonscreen retract limit        i*4
     789  ;(6) Moonscreen extend limit         i*4
 0.12389  ;(7) Barcode reader scale            r*4
  -500.0  ;(8) Barcode reader zero point       r*4
     0.0  ;(9) Barcode reader offset (deg)     r*4
;
;This is the Magellan dome control INI file.  The lines
;are numbered from (1) to (9).  All lines MUST be
;present.  The ini value is the first entry on each
;line, followed by the line number and the description.
;Use a text editor to change ONLY the ini values.  Be
;sure to maintain the appropriate data type for each
;entry.
;
```

4.2   DMCTL.INI File at Magellan II (Clay)

```
        2  ;(1) Telescope Clay                    i*4
      531  ;(2) CPU clock rate (ppm), +=fast      i*4
      291  ;(3) Windscreen retract limit          i*4
      960  ;(4) Windscreen extend limit           i*4
      100  ;(5) Moonscreen retract limit          i*4
      789  ;(6) Moonscreen extend limit           i*4
  0.08808  ;(7) Barcode reader scale              r*4
      0.0  ;(8) Barcode reader zero point         r*4
    -20.0  ;(9) Barcode reader offset (deg)       r*4
;
;This is the Magellan dome control INI file.  The lines
;are numbered from (1) to (9).  All lines MUST be
;present.  The ini value is the first entry on each
;line, followed by the line number and the description.
;Use a text editor to change ONLY the ini values.  Be
;sure to maintain the appropriate data type for each
;entry.
;
```

4.3   DMCTL.INI Description

(1) Telescope: Telescope number this file belongs to: Magellan 1 (Baade telescope) or Magellan 2 (Clay telescope)

(2) CPU clock rate (ppm): speeds up or slows down the system clock by the given number of parts per million per second.

(3) Windscreen retract limit: Windscreen software lower limit.

(4) Windscreen extend limit: Windscreen software upper limit.

(5) Moonscreen retract limit: software lower limit.

(6) Moonscreen extend limit: software upper limit.

(7) Barcode reader scale

(8) Barcode reader zero point

(9) Barcode reader offset (deg)

These last three values (7, 8, 9), are used to obtain final azimuth dome position. With the barcode value as an input, the formula to convert in degrees is:

Azimuth value = Barcode scale * (barcode value + zero point) + offset

Serial Standard

5

5   Control System Serial Communication Standards

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

Full command format:

:Kndddddddddddccr

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

Full response format:

~Knddddddddccr

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

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

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

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

```
~K?r
```

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

Command Summary:

> 2: Query Next EDS Message
>
> 3: Repeat Last EDS Message
>
> 4: Set UT
>
> 9: Free-form Command

5.1   Command Description

5.1.1   2: Query Next EDS Message

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

Command Format: `:K2r` (note that this command has no checksum)

Response Format: `~K2qqnntttttttttfffddddddddccr`

K   Guest Dome computer address (usually an upper-case letter)

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

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

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

fff   Three-digit message number. Message numbers from 0-799 denote errors,

800-899 are numberical data formats, and 900-999 are successes.

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

cc   Checksum, described above.

r   ASCII charater 13, a carriage return.

5.1.2   3: Repeat Last EDS Message

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

Command Format: `:K3r` (note that this command has no checksum)

Response Format: `~K3qqnnttttttttfffddddddddccr`

K   Dome computer address (usually an upper-case letter)

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

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

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

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

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

cc   Checksum, described above.

r   ASCII charater 13, a carriage return.

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

Command Format: `:K4tttttttttccr`

Response Format: `~K4er` (note that this response has no checksum)

K   Guest computer address (usually an upper-case letter)

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

cc   Checksum, described above.

r   ASCII charater 13, a carriage return.

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

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

Command Format: `:K9nnddddddddccr`

Response Format: `~K9ennmmmmmccr`

K   Dome computer address (usually an upper-case letter)

nn   Two-digit number of characters in the message (in the underlined section).

               00 if no message available.

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

cc   Checksum, described above.

r   ASCII character 13, a carriage return.

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

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

5.2   TCS and Dome control software Communication Links

5.2.1   8: Telescope Elevation Information

TCS control software sends telescope elevation information every 30 seconds. This information is used to move windscreen and moonscreen.

Command Format: `:K8nnnnnnccr`

Response Format: `~K8fr`

K   Dome computer address (usually an upper-case letter)

8   This number indicates to dome control software that information sent is about telescope elevation information.

nnnnnn   This is the elevation value.

f   Is the reply flag sent to TCS control software. If f =1 then the elevation value was read by dome software without problems. If f = 0 the elevation information was not received in perfect condition (checksum is bad, command sent by Tcs is corrupted, etc).

cc   Checksum, described above.

r   ASCII charater 13, a carriage return.

5.2.2   5: Dome Position

TCS control software sends new dome position.

Command Format: `:K5ppppeeeftccr`

Response Format: `~K5mr`

K   Dome computer address (usually an upper-case letter)

5   This number indicates to dome control software that information sent is about new position that dome control software should execute.

pppp   This is the elevation value.

eee   Position error.

f   Flag: 1, 2, 3, or 5, 6, 7.

t   number of position iterations

m   Is the reply flag sent to TCS control software. If f =1 then the dome position command was accepted. If f = 0 the information was not received in perfect condition (checksum is bad, command sent by TCS is corrupted, etc). If f = 2, command is ignored (another motion was executed).

cc   Checksum, described above.

r   ASCII charater 13, a carriage return.

5.2.3   1: Louver commands
_____

TCS control software sends a complete command sequence for 18 louvers, positions from 1 to 10 for rotating louvers, and positions from 11 to 18 for fixed louvers. If there is no new louver motion, the TCS control software doesn't send any louver command sequence.

Command Format: `:K1aaaaaaaaaaaaaaaaaaccr`

Response Format: `~K1mr`

K   Dome computer address (usually an upper-case letter)

1   This number indicates to dome control software that information sent is about telescope louvers.

aaaaaaaaaaaaaaaaaa   All louvers commands

f   Reply flag sent to TCS control software. If f =1 then the louver command was read by dome software without problems. If f = 0, information was not received in perfect condition (checksum is bad, command sent by TCS is corrupted, etc).

DOME CONTROL SYSTEM SOFTWARE   USER MANUAL

cc   Checksum, described above.

r   ASCII charater 13, a carriage return.

5.3   Communication Protocol between PLC and Dome Control Software

The communication protocol used between the PLC and Dome control software is called DirectNet. The Dome control Software is considered the master and the PLC is the slave. The Master station sends read or write request to the slave device(in this case to the Upper PLC or Lower PLC).

All DirectNet read and write protocol uses the following protocol components:

- Enquiry (ENQ): initiates a request (from the master) with the slave stations

- Header (HDR): defines operation as a read or write, the slave station address, and the type and amount of data to be transferred.

- Data (DATA): the actual data that is being transferred.

- Acknowledge (ACK): verifies communication is working correctly.

- End of Transmission (EOT): Indicates the communication is finished.

The Read request protocol is the following;

```
READ
REQUEST              Master              Slave

              ENQ                    |
              Initiate Request       |
                                     |
                                     |— ACK
                                     |
              HDR                    |
              Define Request         |
                                     |
                                     |— ACK + DATA
                                     |
              ACK                    |
              Acknowledge            |
              Receipt of data        |
                                     |
                                     |— EOT
                                     |   Finished all data sent
                                     |
              EOT                    |
              Finished               |
```
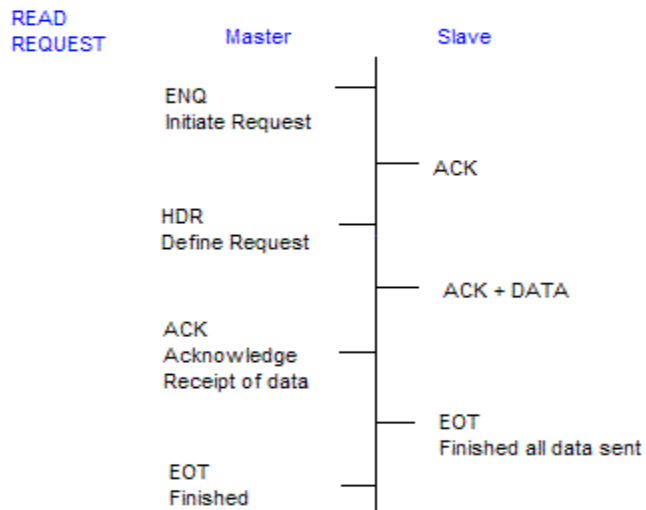
The write request protocol is the following:

```
WRITE
REQUEST              Master              Slave

              ENQ                    |
              Initiate Request       |
                                     |
                                     |— ACK
                                     |
              HDR                    |
              Define Request         |
                                     |
                                     |— ACK
                                     |
              DATA                   |
              Transmit  Data         |
                                     |
                                     |— ACK
                                     |
              EOT                    |
              Finished               |
```
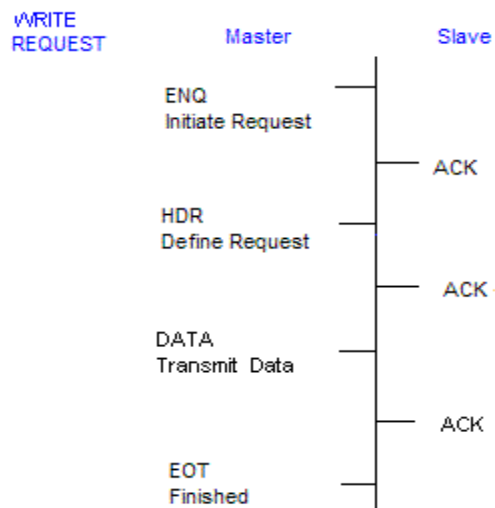
All information about DirectNET protocol can be found on DL405 user manual, 3rd Edition.

Log Message
System

6

6   Log Message System

6.1   EDS Log Messages

803: Left rotating louvers Status, PLC scaled from 000 in the closed direction to 999 in the open direction. There are 10 rotating louvers, numbered from 0 to 9.

> **Format**: 803aaabcccdeeefggghiiijlllmooopqqqnsssstrrry
>
> aaa: Left rotating louver value
>
> b: left rotating louver status (louver 0)
>
> ccc: Left rotating louver value
>
> d: left rotating louver status (louver 1)
>
> eee: Left rotating louver value
>
> f: left rotating louver status (louver 2)
>
> ggg: Left rotating louver value
>
> h: left rotating louver status (louver 3)
>
> iii: Left rotating louver value
>
> j: left rotating louver status (louver 4)
>
> lll: Left rotating louver value
>
> m: left rotating louver status (louver 5)
>
> ooo: Left rotating louver value
>
> p: left rotating louver status (louver 6)
>
> qqq: Left rotating louver value
>
> n: left rotating louver status (louver 7)
>
> sss: Left rotating louver value
>
> t: left rotating louver status (louver 8)
>
> rrr: Left rotating louver value

y: left rotating louver status (louver 9)

804: Right rotating louvers Status, PLC scaled from 000 in the closed direction to 999 in the open direction. There are 10 right rotating louvers.

Format: 804aaabcccdeeefggghiiijlllmooopqqqnssstrrry

aaa: Right rotating louver value

b: Right rotating louver status (louver 0)

ccc: Right rotating louver value

d: Right rotating louver status (louver 1)

eee: Right rotating louver value

f: Right rotating louver status (louver 2)

ggg: Right rotating louver value

h: Right rotating louver status (louver 3)

iii: Right rotating louver value

j: Right rotating louver status (louver 4)

lll: Right rotating louver value

m: Right rotating louver status (louver 5)

ooo: Right rotating louver value

p: Right rotating louver status (louver 6)

qqq: Right rotating louver value

n: Right rotating louver status (louver 7)

sss: Right rotating louver value

t : Right rotating louver status (louver 8)

rrr: Right rotating louver value

y: Right rotating louver status (louver 9)

805: Other PLC data

Format: 805aaabbdddeellrrssny

aaa: Moonscreen encoder value

bb: Moonscreen status

ddd: Windscreen encoder value

ee: Windscreen status (encoder error and limit status)

ll: Left shutter door status

rr: Right shutter door status

ss: Status for shutter doors latch

n: Status for the crane

y: emergency stop status

806: Fixed louvers Status, PLC scaled from 000 in the closed direction to 799 in the open direction. They are numbered from 0 to 7.

Format: 806aaabcccdeeefggghiiijlllmooopqqqn

aaa: Fixed louver value,

b: Fixed louver status (louver 0)

ccc: Fixed louver value

d: Fixed louver status (louver 1)

eee: Fixed louver value

f: Fixed louver status (louver 2)

ggg: Fixed louver value

h: Fixed louver status (louver 3)

iii: Fixed louver value

j: Fixed louver status (louver 4)

lll: Fixed louver value

m: Fixed louver status (louver 5)

ooo: Fixed louver value

p: Fixed louver status (louver 6)

qqq: Fixed louver value

n: Fixed louver status (louver 7)

807: Other Lower PLC data.

Format: 807xy

x : Lift status

y: Hatch status

808: Baldors and Barcode Reader information

> **Format**: 808aaaab±xxxyyszyyszyyszyysz
>
> aaaa: Barcode reader value (azval)
>
> b: Barcode reader error count (azbits)
>
> ± : Vel. Direction
>
> xxx: vel value

There are four Baldor motor controllers that control dome motion. The following data is for each Baldor Motor Drive.

> yy: amplifier data (amps)
>
> s: fault code response (fcode)
>
> z: RPM Reading (bbits)

6.2   Error Messages

000: DOS date error, code = X

001: UPLC Initiate data error

002: UPLC Initiate com error X

003: UPLC Read Block data error

004: UPLC Read Block com error X

005: UPLC Read Ack data error

006: UPLC Read Ack com error X

007: UPLC Write Header data error

008: UPLC Write Header com error X

009: UPLC Write Block data error

010: UPLC Write Block com error X

011: UPLC EOT com error X

012: UPLC communication suspended

015: Barcode reader data error 1

016: Barcode reader data error 2

017: Barcode reader length error

018: Barcode reader com error

019: Barcode error messages suspended

021: Baldor unit X address data error

022: Baldor unit X address com error

023: Baldor unit X current data error

024: Baldor unit X current com error

025: Baldor X err messages suspended

026: Baldor unit X current decode err

027: Baldor unit X RPM decode error

028: Baldor unit X RPM data error

029: Baldor unit X RPM com error Y

031: TCS com error X

032: Louver command data error

033: TCS error messages suspended

034: UT set data error

035: Unrecognized TCS command

036: Baldor X disabled by operator

037: Baldor X fault code data error

038: Baldor X fault code com error

039: Baldor unit X fault code YYY

041: LPLC Initiate data error

042: LPLC Initiate com error

043: LPLC Read Block data error

044: LPLC Read Block com error

045: LPLC Read Ack data error

046: LPLC Read Ack com error

047: LPLC Write Header data error

048: LPLC Write Header com error

049: LPLC Write Block data error

050: LPLC Write Block com error

051: LPLC EOT com error

052: LPLC communication suspended

055: Rotation motion detect timeout

056: Rotation motion assert timeout

057: Rotation motion assert error

060: Dome position data error

061: Moonscr/Windscr data error

064: Open left shutter door timeout

065: Close left shutter door timeout

066: Open right shutter door timeout

067: Close right shutter door timeout

6.3 Success

992; Baldor Y enabled by operator

993; Barcode error messages resumed

994; UT set by TCS to HH MM SS.FF

995; LPLC communication resumed

996; TCS error messages resumed

997; Baldor X error messages resumed

998; UT clock initialized by CPU

999; UPLC communication resumed

System Details

7

7   Dome Control System differences between Magellan I and II

Troubleshooting

8

8   Troubleshooting

Appendix

A

Appendix A

DMCOM.SRT

bcrcom   barcode dmbcr

bcrcom   indexr   dmixr

bcrcom   puteds   dmeds

bl2com   bldtalk dmbld

bl2com   lplc   dmlp1

bl3com   bldtalk dmbld

bl3com   puteds   dmeds

bldcom   bldtalk dmbld

bldcom   dmset   dmset

bldcom   main   dmctl

bldcom   puteds   dmeds

clkcom   clock2   dmck2

clkcom   dmset   dmset

clkcom   lplc   dmlp1

clkcom   puteds   dmeds

clkcom   putmsg   dmmsg

clkcom   serchk1   dmck3

clkcom   serchk2   dmck3

clkcom   serchk3   dmck3

clkcom   serchk4   dmck3

clkcom   serchk5   dmck3

clkcom   uplc   dmup1

clkcom   utclk   dmutc

clkctl   dmset   dmset

clkctl   tcs   dmtcs

clkctl   utclk   dmutc

clklog   clkerr   dmck2

clklog   dspmsg   dmmsg

clkvar   clock2   dmck2

clkvar   utclk   dmutc

colors   dmset   dmset

colors   rbox   dmbx1

dm1com   dmset   dmset

dm1com   indexr   dmixr

dm1com   lplc   dmlp1

dm1com   main   dmctl

dm1com   puteds   dmeds

dm1com   tcs   dmtcs

dm1com   uplc   dmup1

dm2com puteds dmeds

dm2com uplc   dmup1

dm3com puteds dmeds

dm3com uplc   dmup1

dm4com lplc   dmlp1

dm4com puteds dmeds

dm5com puteds dmeds

dm5com uplc   dmup1

edscom puteds dmeds

edscom tcs   dmtcs

esccom main   dmctl

esccom uplc   dmup1

fontcom dmset   dmset

fontcom lbox   dmbx2

fontcom mbox   dmbx3

fontcom obox   dmbx2

fontcom pbox   dmbx3

fontcom rbox   dmbx1

fontptr cptr   dmutl

fontptr dmset   dmset

fontptr lbox   dmbx2

fontptr mbox   dmbx3

fontptr obox   dmbx2

fontptr pbox   dmbx3

fontptr rbox   dmbx1

frmcom coolfr dmfrm

frmcom dmset   dmset

frmcom subfrm dmfrm

handcom hand   dmvec

handcom handchk dmvec

ixrcom   indexr dmixr

ixrcom   main   dmctl

ixrcom   tcs   dmtcs

lplcom   lplc   dmlp1

lplcom   lpltalk dmlp2

msgcom   dspmsg dmmsg

msgcom   putmsg dmmsg

msgctl dspmsg dmmsg

msgctl main   dmctl

sclcom dmset   dmset

sclcom main   dmctl

sclcom rbox   dmbx1

scpcom opqchr1 dmvid

scpcom opqchr2 dmvid

scpcom opqvev dmvec

scpcom opqwrt dmfrm

scpcom ovlvec dmvec

scpcom scpdat dmvid

sr1com   serchk1 dmck3

sr1com   upltalk dmup2

sr2com   bldtalk dmbld

sr2com   serchk2 dmck3

sr3com   serchk3 dmck3

sr3com   tcs   dmtcs

sr4com   lpltalk dmlp2

sr4com   serchk4 dmck3

sr5com   barcode dmbcr

sr5com   serchk5 dmck3

timcom   bldtalk dmbld

timcom   clock2   dmck2

timcom   main   dmctl

timcom   utclk   dmutc

uplcom   uplc   dmup1

uplcom   upltalk dmup2

Appendix

B

Appendix B

DMCOM.TXT

msgctl   main   dmctl

timcom   main   dmctl

sclcom   main   dmctl

dm1com   main   dmctl

bldcom   main   dmctl

ixrcom   main   dmctl

esccom   main   dmctl

clkcom   dmset   dmset

clkctl   dmset   dmset

sclcom   dmset   dmset

dm1com   dmset   dmset

bldcom   dmset   dmset

colors   dmset   dmset

fontptr   dmset   dmset

fontcom   dmset   dmset

frmcom dmset dmset

clkcom utclk dmutc

clkvar utclk dmutc

clkctl utclk dmutc

timcom utclk dmutc

clkcom clock2 dmck2

clkvar clock2 dmck2

timcom clock2 dmck2

clklog clkerr dmck2

clkcom serchk1 dmck3

sr1com serchk1 dmck3

clkcom serchk4 dmck3

sr4com serchk4 dmck3

clkcom serchk2 dmck3

sr2com serchk2 dmck3

clkcom serchk3 dmck3

sr3com serchk3 dmck3

clkcom serchk5 dmck3

sr5com serchk5 dmck3

msgcom dspmsg dmmsg

msgctl dspmsg dmmsg

clklog dspmsg dmmsg

msgcom putmsg dmmsg

clkcom putmsg dmmsg

fontptr cptr   dmutl

uplcom uplc   dmup1

dm1com uplc   dmup1

dm2com uplc   dmup1

dm3com uplc   dmup1

dm5com uplc   dmup1

clkcom uplc   dmup1

esccom uplc   dmup1

sr1com upltalk dmup2

uplcom upltalk dmup2

lplcom lplc   dmlp1

dm1com lplc   dmlp1

dm4com lplc   dmlp1

bl2com lplc   dmlp1

clkcom lplc   dmlp1

sr4com lpltalk dmlp2

lplcom lpltalk dmlp2

dm1com indexr dmixr

ixrcom indexr dmixr

bcrcom indexr dmixr

sr2com bldtalk dmbld

bldcom bldtalk dmbld

bl2com bldtalk dmbld

bl3com bldtalk dmbld

timcom bldtalk dmbld

sr5com barcode dmbcr

bcrcom barcode dmbcr

sr3com tcs   dmtcs

dm1com tcs   dmtcs

edscom tcs   dmtcs

clkctl tcs   dmtcs

ixrcom tcs   dmtcs

edscom puteds dmeds

clkcom puteds dmeds

dm1com puteds dmeds

dm2com puteds dmeds

dm3com puteds dmeds

dm4com puteds dmeds

dm5com puteds dmeds

bldcom puteds dmeds

bl3com puteds dmeds

bcrcom puteds dmeds

sclcom rbox   dmbx1

colors rbox   dmbx1

fontptr rbox   dmbx1

fontcom rbox   dmbx1

fontptr lbox   dmbx2

fontcom lbox   dmbx2

```
fontptr  obox    dmbx2

fontcom  obox    dmbx2

fontptr  pbox    dmbx3

fontcom  pbox    dmbx3

fontptr  mbox    dmbx3

fontcom  mbox    dmbx3

scpcom   scpdat  dmvid

scpcom   opqchr1 dmvid

scpcom   opqchr2 dmvid

handcom  handchk dmvec

handcom  hand    dmvec

scpcom   ovlvec  dmvec

scpcom   opqvev  dmvec

frmcom   coolfr  dmfrm

frmcom   subfrm  dmfrm

scpcom   opqwrt  dmfrm
```

Appendix

C

Appendix C

DMERR.TXT

This is a numerical index of all error messages from the Magellan dome control program.

----

         message   routine   module

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

000: DOS date error, code = X   dmset   dmset

001: UPLC Initiate data error   upltalk   dmup2

002: UPLC Initiate com error   upltalk   dmup2

003: UPLC Read Block data error   upltalk   dmup2

004: UPLC Read Block com error   upltalk   dmup2

005: UPLC Read Ack data error   upltalk   dmup2

006: UPLC Read Ack com error   upltalk   dmup2

007: UPLC Write Header data error   upltalk   dmup2

008: UPLC Write Header com error   upltalk   dmup2

009: UPLC Write Block data error   upltalk   dmup2

010: UPLC Write Block com error   upltalk   dmup2

011: UPLC EOT com error   upltalk   dmup2

012: UPLC communication suspended   upltalk   dmup2

015: Barcode reader data error 1   barcode   dmbcr

016: Barcode reader data error 2   barcode   dmbcr

017: Barcode reader length error   barcode   dmbcr

018: Barcode reader com error   barcode   dmbcr

019: Barcode error messages suspended   barcode   dmbcr

021: Baldor unit X address data error   bldtalk   dmbld

022: Baldor unit X address com error   bldtalk   dmbld

023: Baldor unit X current data error   bldtalk   dmbld

024: Baldor unit X current com error   bldtalk   dmbld

025: Baldor X err messages suspended   bldtalk   dmbld

026: Baldor unit X current decode err   bldtalk   dmbld

027: Baldor unit X RPM decode error   bldtalk   dmbld

028: Baldor unit X RPM data error   bldtalk   dmbld

029: Baldor unit X RPM com error   bldtalk   dmbld

031: TCS com error X   tcs   dmtcs

032: Louver command data error   tcs   dmtcs

033: TCS error messages suspended   tcs   dmtcs

034: UT set data error   tcs   dmtcs

035: Unrecognized TCS command   tcs   dmtcs

036: Baldor X disabled by operator   main   dmctl

037: Baldor X fault code data error   bldtalk   dmbld

038: Baldor X fault code com error   bldtalk   dmbld

039: Baldor unit X fault code YYY   bldtalk   dmbld

041: LPLC Initiate data error   lpltalk   dmlp2

042: LPLC Initiate com error   lpltalk   dmlp2

043: LPLC Read Block data error   lpltalk   dmlp2

044: LPLC Read Block com error   lpltalk   dmlp2

045: LPLC Read Ack data error   lpltalk   dmlp2

046: LPLC Read Ack com error   lpltalk   dmlp2

047: LPLC Write Header data error   lpltalk   dmlp2

048: LPLC Write Header com error   lpltalk   dmlp2

049: LPLC Write Block data error   lpltalk   dmlp2

050: LPLC Write Block com error   lpltalk   dmlp2

051: LPLC EOT com error   lpltalk   dmlp2

052: LPLC communication suspended   lpltalk   dmlp2

055: Rotation motion detect timeout   lplc   dmlp1

056: Rotation motion assert timeout   lplc   dmlp1

057: Rotation motion assert error   lplc   dmlp1

060: Dome position data error   tcs   dmtcs

061: Moonscr/Windscr data error   tcs   dmtcs

064: Open left shutter door timeout   uplc   dmup1

065: Close left shutter door timeout   uplc   dmup1

066: Open right shutter door timeout   uplc   dmup1

067: Close right shutter door timeout   uplc   dmup1

992; Baldor Y enabled by operator   main   dmctl

993; Barcode error messages resumed   barcode   dmbcr

994; UT set by TCS to HH MM SS.FF   tcs   dmtcs

995; LPLC communication resumed   lpltalk   dmlp2

996; TCS error messages resumed   tcs   dmtcs

997; Baldor X error messages resumed   bldtalk   dmbld

998; UT clock initialized by CPU   dmset   dmset

999; UPLC communication resumed   upltalk   dmup2