

# **DOG**

## Digital Observers Guide

NS 12 Series Astronomical Guiding Equipment

NS 10 Series Digital Display Panel

Manual

NS Kikaku

Please read this manual before using your NS series DOG.

Manual translation & Macintosh reference: G & M Bunn. v 1.0 May 96.

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## **Part 1      Outline**

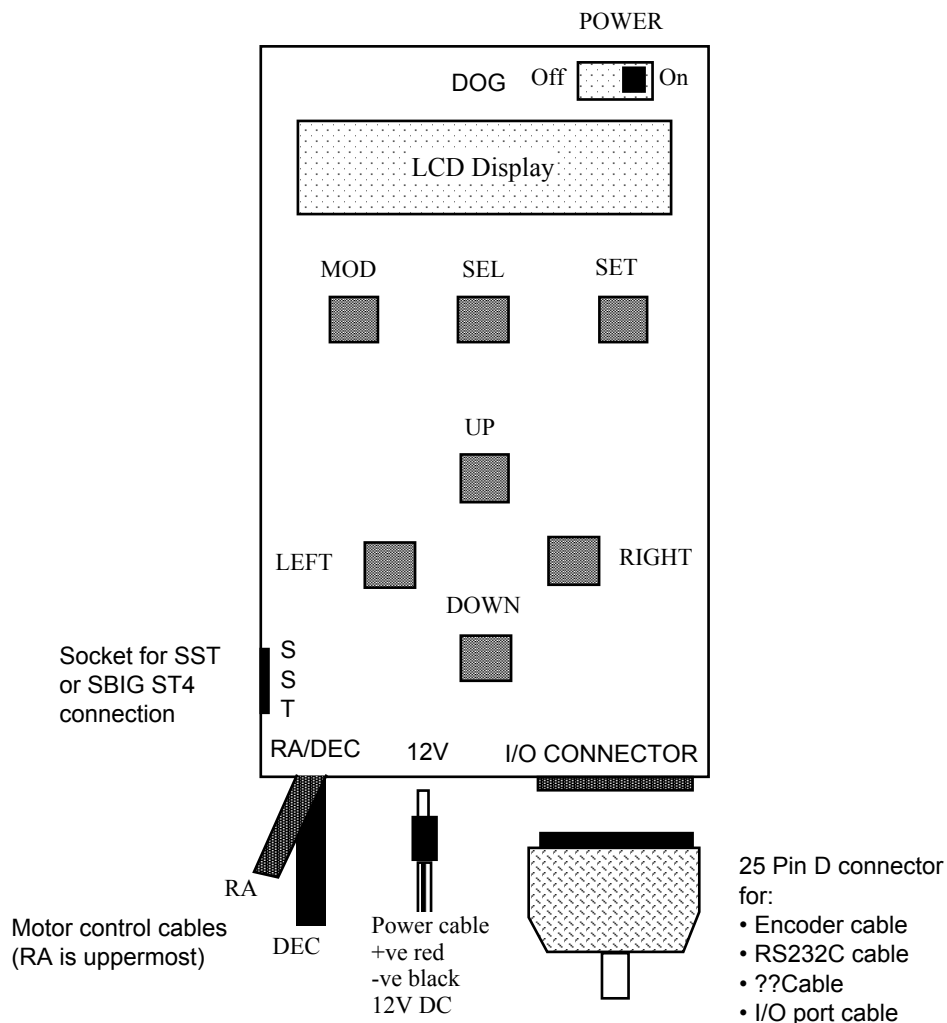
### **1.1 DOG NS Series**

DOG stands for Digital Observers Guider. I named it thinking that this guider would become a loyal dog for your astronomical hunting. The guider has the following features and functions.

- This guider is designed for the beginning amateur through experienced astro-photographers.
- Even beginners can find and guide on stars with this equipment.
  - You can initialize your telescope by pointing it at any Messier object, one of 231 bright stars in the “R” object database, or by manually setting celestial coordinates.
  - The DOG can be remotely commanded by invoking the CPU set-up function and
    - there are 3 methods of slewing; automatic, manual, and combined.
- Up to three encoders can be connected for DEC, RA and dome control purposes.
- Functions included for astro-photography are
  - Guide function
  - Metcalfe tracking
  - Key sense reversing
  - Timer
  - Sidereal time
  - autoguider connection as standard equipment (SST, ST-4).
- Can be connected to PC or Macintosh via RS232-C / RS242 port, and remote controlled. Compatible with The Sky from Software Bisque and Stellar Navigator for Windows. Also compatible with the Astro School Sky Sensor 3D with an optional adaptor unit.
- Input port, maximum 6 bit, Output maximum 16 bit.
- Controls RA and DEC motors.
  - Multi-speed controller, DEC backlash compensation, linear & one-shot guiding, high speed slewing, automatic RA rotation reversal in Southern Hemisphere.
- Designed to be used in the dark.
  - Operated with only seven keys. Backlit liquid crystal display. Buzzer.
- 341 object memory: 110 Messier objects (M), 231 bright stars (R)

- Lithium battery to back-up internal clock setting.
- Low current consumption by using automatic power-down in the DEC motor controller.
- DOG NS12 series and the NS10 digital display unit are compatible with previous versions, which can be upgraded.  
(NS10GP->DOG NS12EM200, and DOG NS12GP/D -> DOG NS12EM10)

## 1.2 Appearance & Names



## 1.3 Attention: Notes on using

1. Never put the plugs in the wrong sockets. There is a danger of damaging the guider.
2. Once you turn the switch off, wait at least 5 seconds before turning on again.  
Turning on and off is done by the main switch of the guider.
3. When you connect the SST autoguider or the I/O connector, be sure the power switch is off.
4. Don't keep the DOG in very hot or cold places, in humid or dusty conditions.
5. The DOG contains sensitive electronic parts. Avoid sudden shock or vibration.
6. Don't dismantle or open the cover. The guarantee will be void if you open the unit.
7. When you attach the DOG to your telescope, don't leave it unattended. If the DOG is accidentally touched or hits the mount when in auto tracking mode it might send the telescope crashing into the pier or tripod.

## 1.4 Prior to switching on

Procedure for switching on.

1. Check that the power switch is off.
2. Connect to 12 Volt battery / 12 Volt DC power supply: red +ve, black -ve.
3. Connect the DEC and RA plugs and the I/O connector, and your autoguider (SST or ST-4) if you are using one. For internal data set-up or testing it is not necessary to connect the unit to your mount, computer or autoguider, but if you do want to make an I/O connection, do it now, while the switch is off.
4. The DOG is now ready for use. For real observation, polar alignment of your mount should also be made before using your DOG.
5. Turn the unit on.
6. The buzzer will sound and a title will display in the LCD. Next, the date and time will be shown as below. If this doesn't happen, switch off and check the connections immediately.

95, 01/10	SAT
12h54m12s	

This shows the unit in CLOCK mode just after turning on. The date and time shown are 1st of October 1995 (Saturday), 12:54:12 (Japan mean time, which is UT+8). If the time is not correct, you can adjust it in the CLOCK mode which will be covered shortly.

Note: *With the present DOG firmware it is essential that the unit be set to Japan Mean Time (UT+8).*

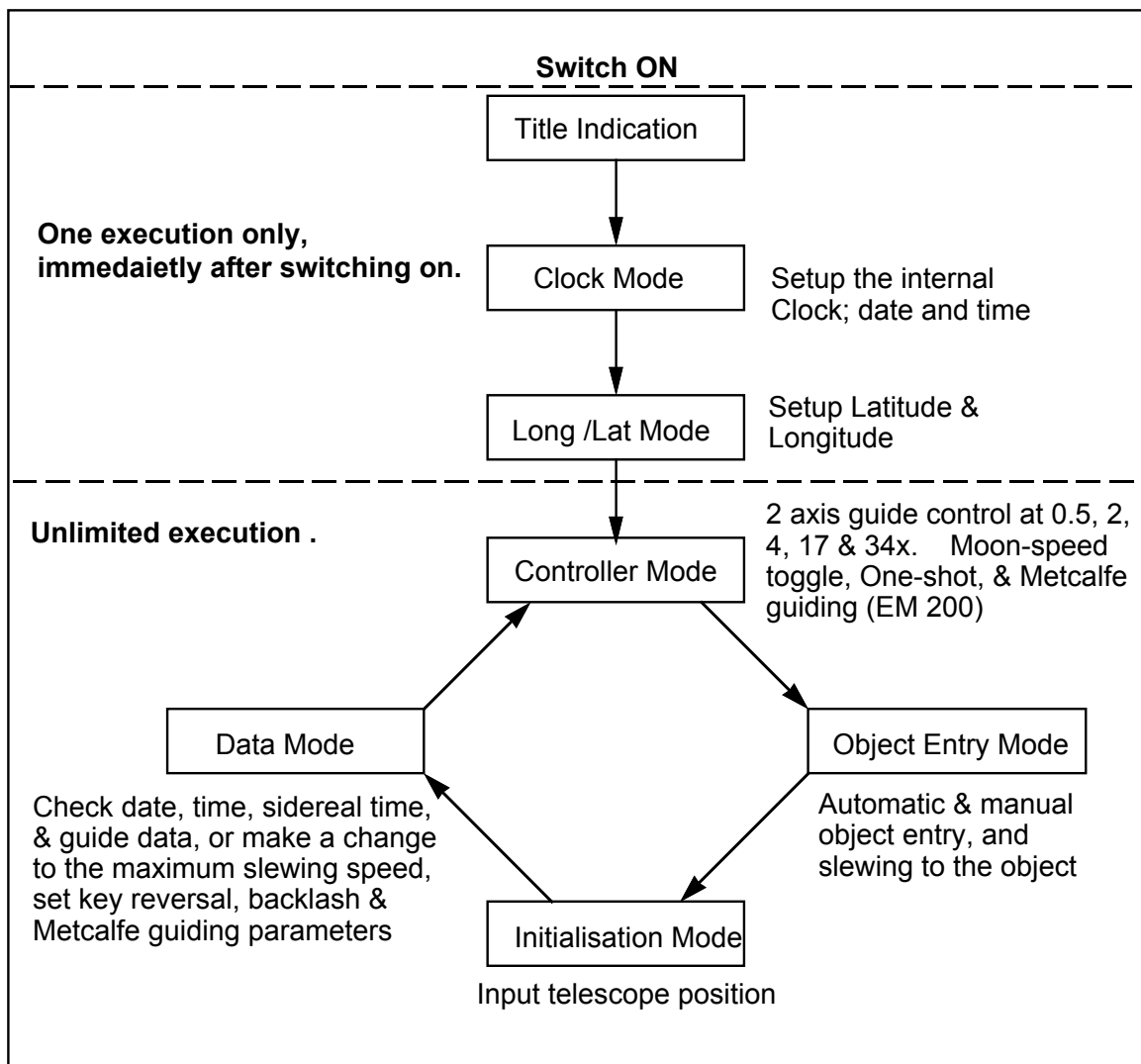


## Part 2 DOG Manual Operation

### 2.1 The Motion Modes & Key Operation

- The MOTION modes referred to here are a gathering of related functions.
  - for example, in CONTROLLER mode, the 16 x speed function, the 4x speed function, and the 0.5x speed guiding function are grouped together.
- There are two kinds of motion modes;
  - (i) After powering up the unit, there is only one opportunity for execution
  - (ii) Repeatedly available functions.

See below for an explanation of the two types of motion mode and their function.



- **Key operation.**  
The DOG panel has 7 keys. With only these seven keys you can easily operate all the functions available within the unit. Basic key operations in each motion mode are standardised for easy learning. For details of key operations, refer to the detailed descriptions below. Only the simplest key operations are described in this section.
- **MOD key.**  
If you press this key the current motion mode will change to the next motion mode; for example, clock mode changes to Long/Lat. mode.
- **SEL key**  
Each motion mode has several fixed functions. The SEL key is to switch between the functions in the current mode. When in clock mode for example, to move from year input to month input and to date, day, hour minute and second input.
- **SET key**  
SET has different functions according to the operating mode, but it basically works as an execution key, to execute the currently selected option.  
For example:- in clock mode; to set the time, and in slewing mode; to start slewing.
- **Up/Down keys**  
In controller mode, these control the DEC motor. In other modes, these keys input the object number, the time, or the DEC value.
- **Left/Right keys**  
In controller mode, these control the RA motor. In other modes, these keys are used to input the RA value.

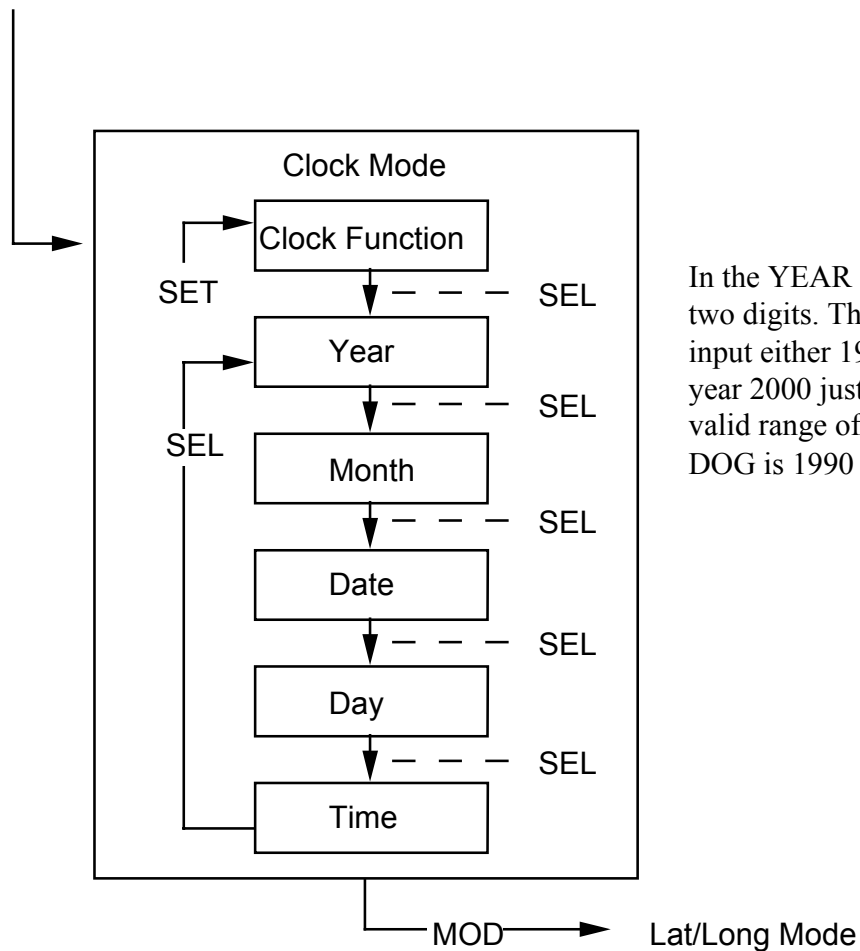
## 2.2 Clock Mode

There is a quartz clock in the DOG to keep track of the date and time. Clock mode is used to adjust these data.

The first time you use it please set the correct (JAPANESE) time. The clock is very accurate, but may nevertheless drift over time. It is recommended to check the time before each observing session. Local sidereal time is calculated from the actual date and time and the observers longitude and latitude. The time and date are backed up even when the switch is off, but the observer's latitude and longitude are *not* backed up.

The following are the key operations and functions of Clock Mode.

Power up,  
Title display, then;

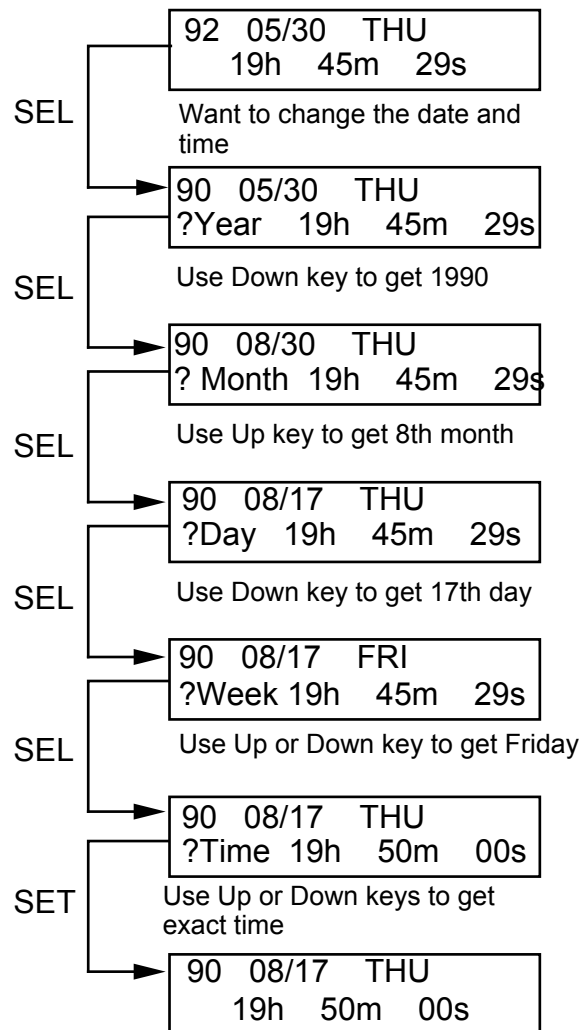


In the YEAR mode just input two digits. There is no need to input either 19 or 20. For the year 2000 just enter 00. The valid range of dates for the DOG is 1990 to 2050.

To set the date after adjustment, press the SET key. If not, the new date & time will not be registered.

Pressing the MOD key will move the DOG to Lat./Long mode.

Clock mode operation example.



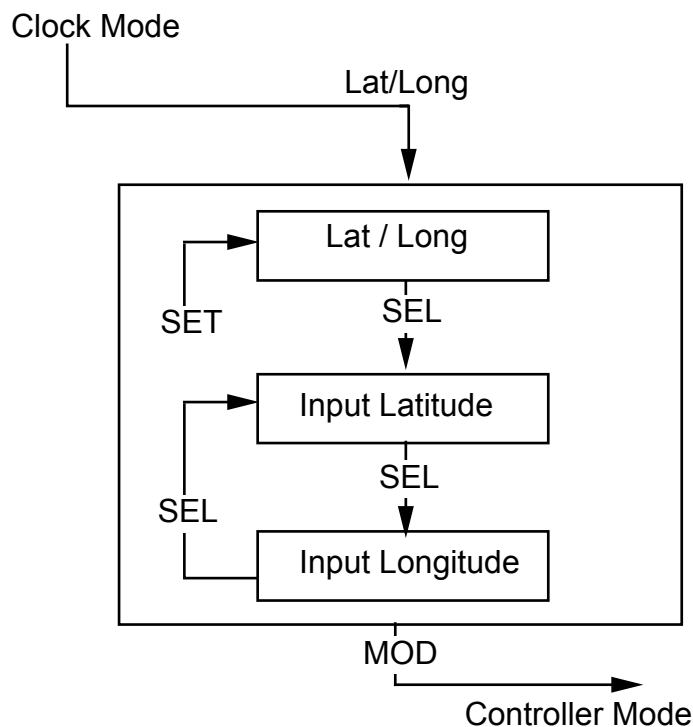
Clock mode key operation summary

- MOD go to lat./long mode
- SEL to choose the function
- SET to set the clock date and time
- U/D to change the values of date and time
- L/R not used in this mode.

### 2.3 Latitude & Longitude Mode

When inputting the Longitude please do so in EAST Longitude. In the case of a WEST Longitude, calculate the East Longitude value as  $(360^\circ - \text{West Longitude})$ . For Latitude, North is +ve and South is -ve. The minimum increment is 15".

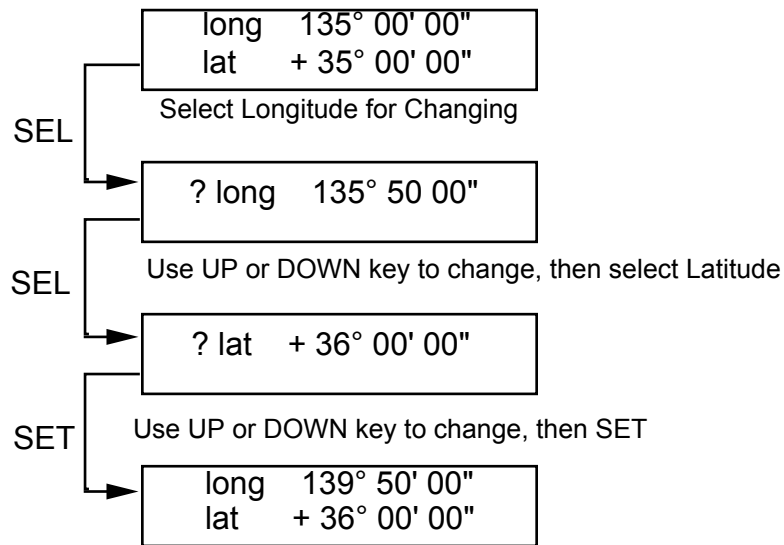
- Immediately after switching on, the East Longitude and the Latitude are whatever they have been programmed to be at the time of manufacture. The actual Latitude and Longitude are NOT backed-up between power-down and power-up. (Note that when you ordered your DOG from NS Kikaku you should have been asked to specify your preferred coordinate values so that they could be programmed into the DOG's EPROM)
- East Longitude is used to calculate the local sidereal time. Please make sure that the East Longitude is input as accurately as possible.
- Latitude is not as critical, but the more accurate the better.



Note. After inputting your site's Latitude & Longitude, be sure to press the SET key, otherwise the Latitude and Longitude are not actually set.

After inputting Latitude and Longitude data and saving them for the session with the SET key, the MODE key is used to move the DOG to the controller mode.

### Lat./Long mode operation example



### Key operation summary for Lat./Long mode.

- MOD to go to controller mode
- SEL to switch between latitude and longitude
- SET to set the chosen values of latitude and longitude
- U/D to adjust the values of latitude and longitude
- L/R not used in this mode.

## 2.4 Initial Set-up Mode

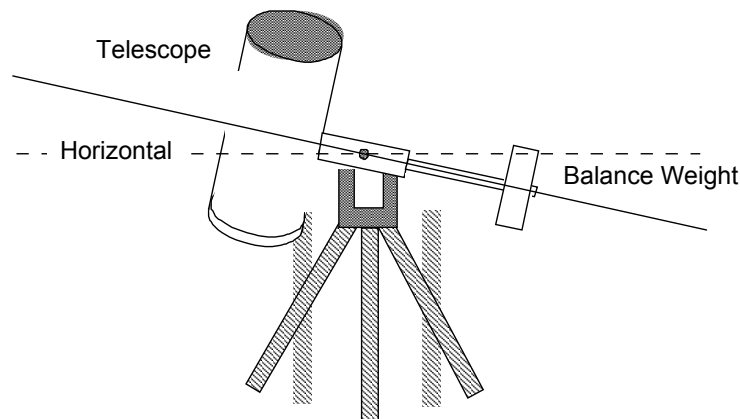
If you don't know where the telescope is pointing the DOG cannot help you!. Before using the DOG in controller mode, slewing mode etcetera, the DOG must be told where the telescope is pointing via the initial set-up mode. Once initial set-up is done, wherever the telescope points, you can start slewing to target objects.

- Procedure for initial set-up.

1. First, check the brightest star near the object you want to slew to, which should ideally be in the R object database. Release the clamps, and slew to the chosen bright star, centering it in the eyepiece. Close the clamps.

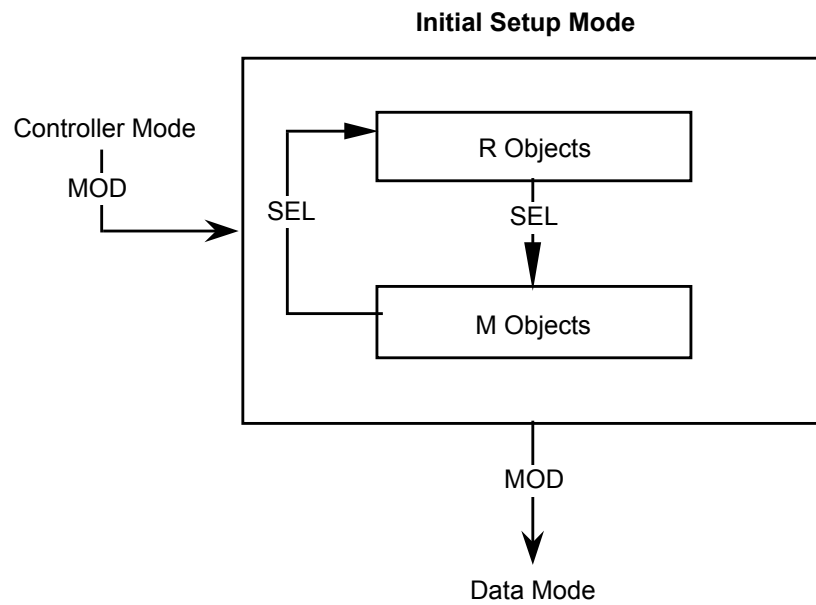
Notes.

- (i) At this time the centre of the telescope should be above the balance weights (see picture). For this purpose it is best to avoid stars near the meridian line. If you really need to use a star near the meridian line, make a judgment by comparing the sidereal time and the RA of the object, and choose an initial object on the same side of the meridian as your target. Sidereal time can be checked in the time function of data mode.
- (ii) If the star to be used for initial set-up and the object to be slewed to are divided by the meridian, it might take time to automatically slew to the object. It is better to choose a star on the same side of the meridian as the desired object.



2. Change to controller mode, and by operating the UD/LR keys, bring the star to the centre of the telescope's field.
3. Press the MOD key to get to initial set-up mode. Use the SEL key to choose the type of object (M or R) which has just been centred in the field.
4. Use the U/D key to choose the specific object that you have centred in the eyepiece.
5. Press the SET key to execute the initial set-up.

Note that Initial set-up cannot be made with manually entered object coordinates.



Key operation summary for the initial set-up mode.

MOD change to data mode.

SEL switch between M and R databases.

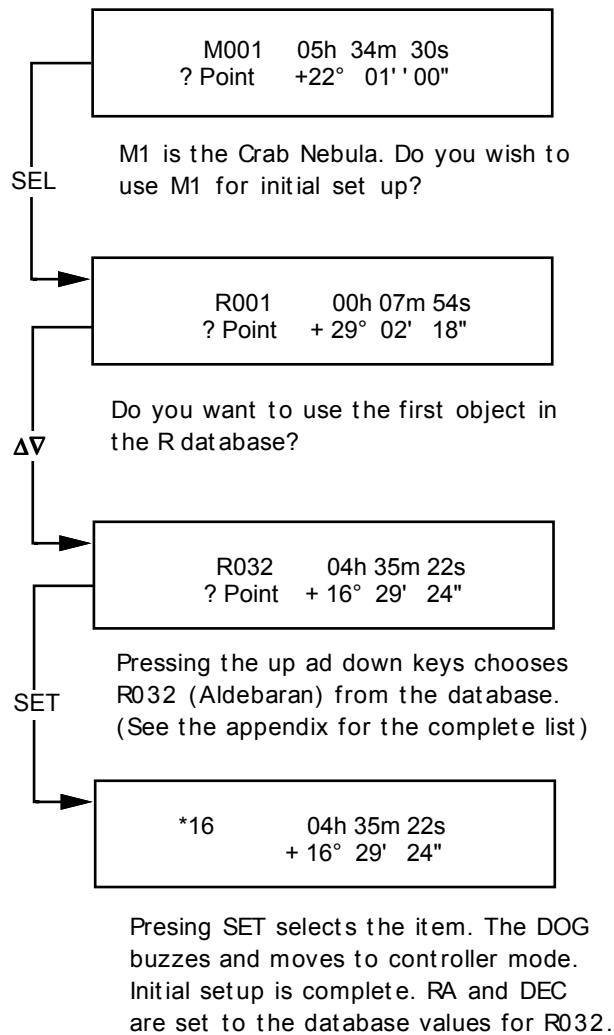
SET execute initial set-up and change to controller mode.

U/D Input the # of the object

L/R not used in this mode



Operation example of initial set-up.



Notes:

- 1) The display of DEC is rounded to the nearest 15".
- 2) "? Point" in the display indicates that the DOG is in initial set-up mode. When in controller mode, the word "? Point" does not appear.

## 2.5 Controller Mode

In this mode, the DOG operates as a 2-axis motor drive controller with built in guiding function. Several motor speeds are available which are fractions or multiples of the sidereal rate. For the EM200, the controller mode speeds are 0.5, 2, 4, 17, 30 and 34 x the sidereal rate.

### The DOG has 2 systems of motor speed control

- (i) If a speed more than 2x faster than the standard speed has been selected, the motor revolves *when the key is pressed*. When the key is released the motor continues at the selected speed. Pressing the key again makes the motor go back to the normal motor speeds. (i.e. at the sidereal rate for RA and stopped in DEC).
- (ii) If less than 2 times, the motor revolves at the selected speed *only when the key is pressed down*. Releasing the key lets the motor go back to normal speed.
- The direction of rotation is set in the DATA mode menu, under the rotation direction function.
- The maximum speed is set with the High Speed function in DATA mode.
- Backlash which is generated when reversing the direction of the DEC motor is automatically compensated for by using the backlash function in DATA mode.

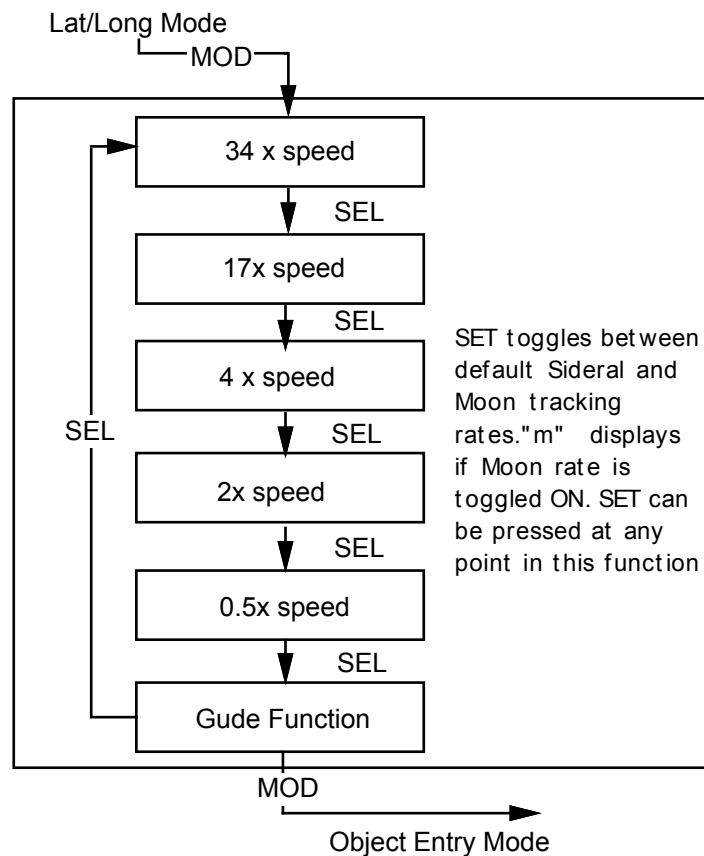
### Guiding

During guiding you can choose freely between the MODE and SEL keys.

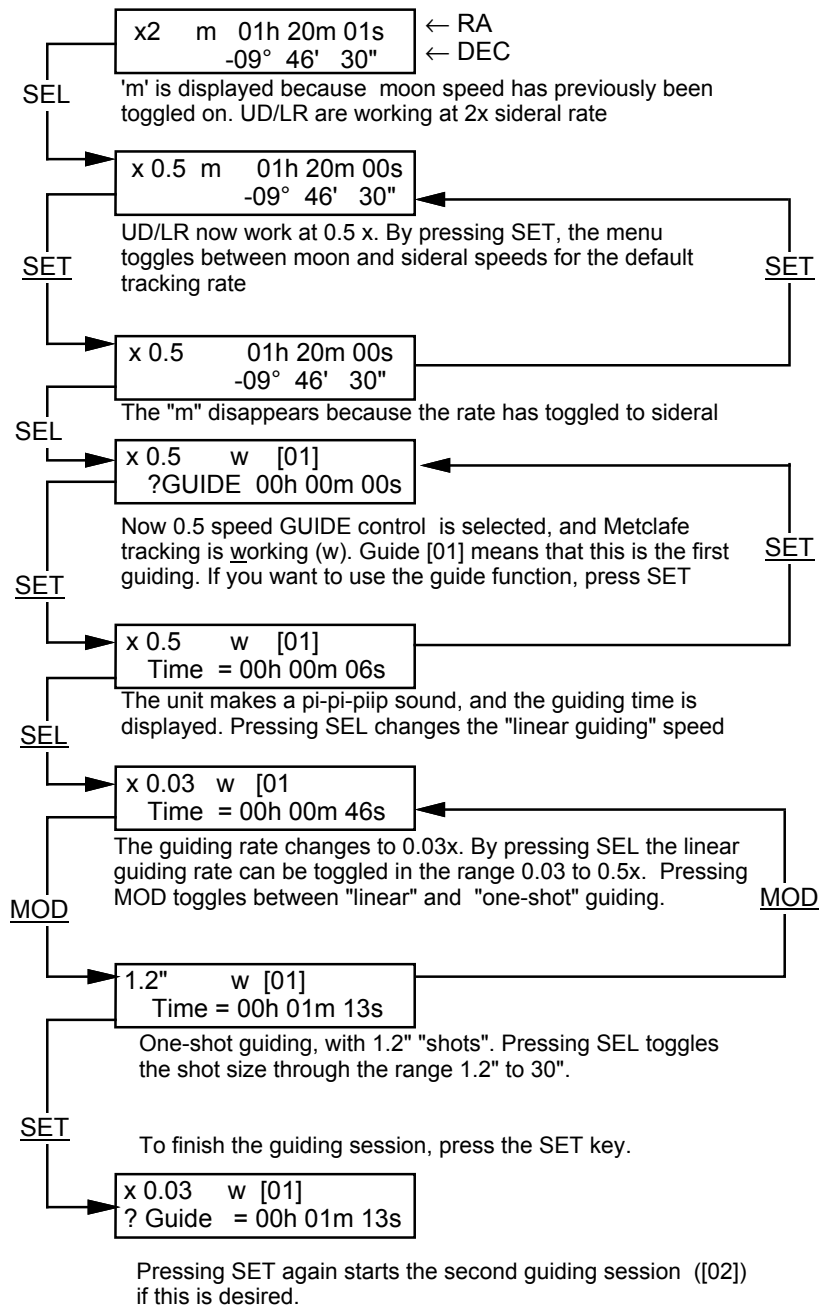
- When guiding, there are two special types of motor control besides varying the speed between 0.5 to 34x (for the EM200).
  - (i) For “Linear” guiding, there are 5 speed steps to choose from between 0.03x and 0.5x normal. This is the same as the standard higher speed function.
  - (ii) For “One Shot” guiding, when you press the U/D/L/R keys, the mount will move one shot as directed each time. In the case of DEC it will stop after moving. In the case of RA, it goes back to sidereal or moon speed as expected; whichever has been chosen as the automatic tracking rate. The amount of one shot is between 1.2 and 30” for the EM200. There are 5 steps.
- Using the guide function, you can track using the Metcalfe method, which is set up in the DATA mode tracking function menu. If there is backlash in DEC, the backlash function will compensate for it automatically.

- In the multiple speed menus, pressing SET causes an “m” to be displayed, and the RA rotation rate toggles to “moon speed”. Pressing SET again removes the m, and the RA rotation speed toggles back to the normal, sidereal rate.
- If the motor/encoder function of DATA mode has been set-up is for guiding with encoders, the correct DEC and RA will always be displayed even if you release the clamps and move the telescope.

Controller mode diagram for EM200



Controller mode example:



1. If you stop guiding in the guiding mode, the "w" which indicates that Metcalfe tracking is working is eliminated. Refer to the DATA mode page for Metcalfe tracking details.
2. To terminate guiding at any point, press the SET key.
3. When in the guiding mode, the MOD key toggles between Linear and One-Shot guiding, and the SEL key selects either the size of a "shot" or the fractional guiding speed.

## 2.6 Telescope Slewing

- To set-up the target object to which you wish to slew the telescope, choose from the M or the R database or manually input the desired coordinates. M stands for Messier objects. R objects are bright fixed stars. You can use the appropriate database object number for the desired object if this is what you want. See the Appendix for database contents.

- If manually inputting coordinates, set the desired DEC and RA to the correct values for the object which the telescope is to slew to.

- If using remote control mode via a PC connected to the DOG's I/O connection port, *you will have to use manual object coordinate* input, but otherwise, everything is the same. (The database objects are not directly accessible via remote control).

- How to do it; the DOG has two types and three 'styles' of set-up.

1. When you don't use encoders: i.e. Motor style. [ "open loop control": no feedback].

- i. Automatic slewing. Always keep the clamps tightly closed.

2. When using Encoders. [ "closed loop control"; with feedback]

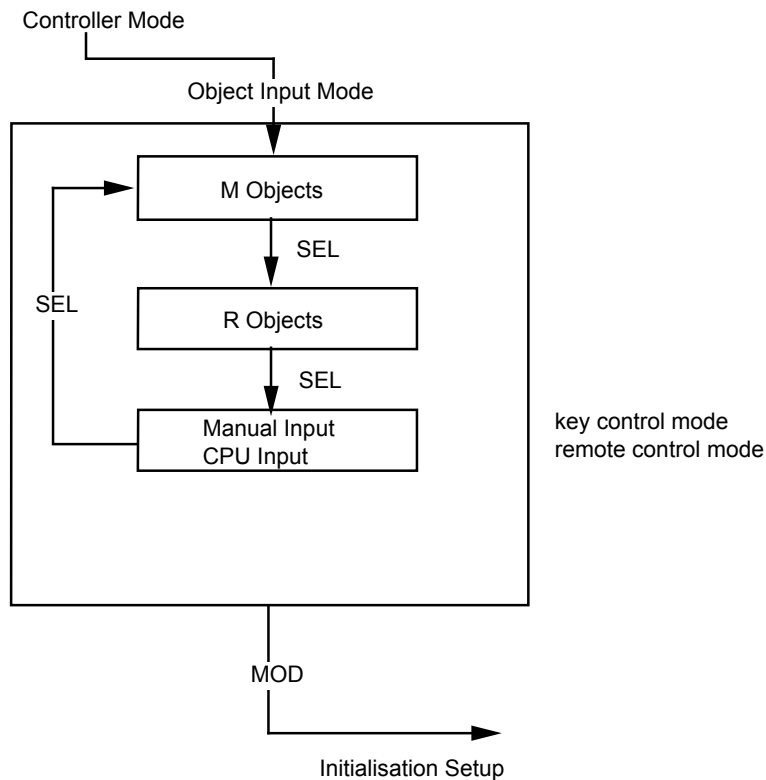
- i. Automatic. Do not release the clamps. Same as 1.(i)

- ii. Manual. Release the clamp and manually point the telescope to the desired object.

- iii. Combined style. After manual operation, slew to the aimed star as in auto slewing.

<p>The automatic slewing speed is set in the high speed function of DATA mode. You would normally set this to the highest possible value for your particular mount. e.g. 34x the sidereal rate for an EM200. The only reason to set it lower would be that your battery voltage has dropped, in which case the highest speeds simply won't work any more.</p>
---

Selection of target objects:



Key operation summary for target selection and slewing:

**SET** starts slewing to the desired object. When automatic slewing is finished the DOG reverts to controller mode. If you press the SET key during the slew, slewing is cancelled and the unit reverts back to controller mode.

**U/D** are for changing the number of the M or R object for selection as an object to slew to. In manual input, the U/D keys are for inputting the DEC of the desired object. The minimum input unit is 1 arcsecond.

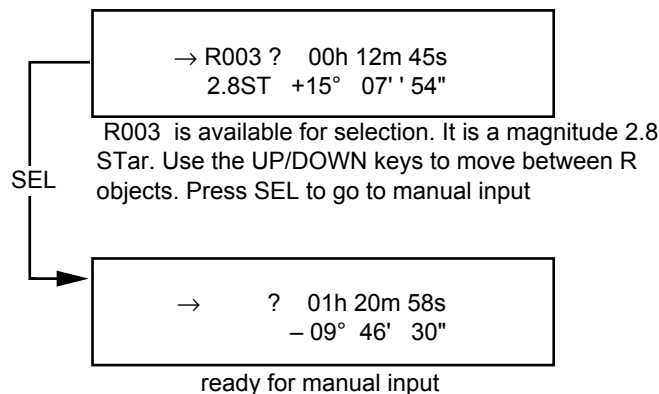
**L/R** are for manual input of the the RA of the desired objecn. The minimum unit is 10 seconds.

1. Refer to chapter 3 regarding key- and remote control mode.
2. Encoder vs. motor method; combined manual/auto; see 2.7 and 2.11 for a description.



## Slewing examples;

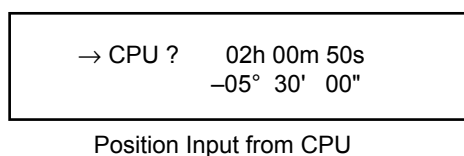
### 1. Automatic slewing using motors (key control mode; not remote control)



The first display shows what the telescope is pointing at. To set up the position to which you wish to slew you have to use the up/down and left/right keys for inputting the desired position.

- When the desired position is displayed, press the SET key. A buzzer sounds and auto-slewing starts. The buzzer will continue to beep briefly at short intervals to let you know it is still slewing.
- The DEC/RA values are displayed in real time.
- If you want to stop auto-slewing before it is finished, press the SET key again.
- If you finish or interrupt slewing, the unit gives a long beep and automatically reverts to controller mode and displays the DEC and RA at the current position. You can continue auto-slewing by returning to slewing mode again.

### 2. Slewing using encoders (using remote control mode from a PC for this example).



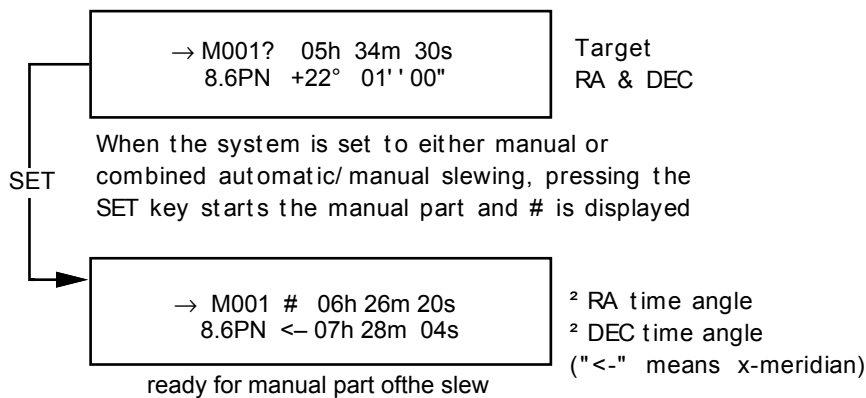
- The display shows the DEC and RA of the "CPU object". Use the L/R and UP/DOWN keys to change DEC and RA. Be sure to keep the clamps locked.
- Press the SET key to start automatic slewing using the encoders. (or issue the "PUSH (SET key)" command from the PC when in remote control mode).



### 3. Manual slewing and combined manual/auto slewing, using encoders.

When using manual or combined automatic/manual slewing with encoders, pressing the SET key to choose a target object (M1 in this example) causes the DEC and RA display to change to the required *changes* of DEC and RA, and a hash mark (#) is added to the top of the display to indicate that the manual part of the slewing process can now be performed.

The DOG displays the distance between the current telescope position and the target in angular/hour angle units thus:



Slewing then proceeds as follows:

- Manual slewing with encoders;  
 Release the clamps then try to make the DEC and RA increments as close as possible to zero by changing the position of the telescope. When the operation is finished and you can see the desired object in the telescope, close the clamps and press the SET key, then the DOG will go back to controller mode.
- Combined manual / auto slewing;  
 Do the same as for manual slewing, getting as close to zero as possible. Then close the clamps and press the MODE key, so that automatic guiding with encoders will start. When slewing is finished the buzzer sounds and the DOG returns to controller mode.

Depending on the position of the target object, a left pointing arrow is sometimes displayed in the DEC display. This means that the current position and the desired point are divided by the N-S meridian line. If the telescope is pointing West, it has to be changed to the East and vice versa. The arrow mark then disappears and is replaced by the hash mark.

Note; When changing position, be sure the telescope is above the balance weights. Refer to Initial set-up mode in section 2.1.

Refer to the description of motor/encoder selection in DATA mode for the set-up of the combined motor / encoder method.

## 2.7 Data Mode

This mode displays the Time (which is always Japan Mean Time with the present firmware release) and the Local Sidereal Time, and allows setting up of the high speed slewing rate, key reversal, backlash compensation, Metcalfe tracking, encoder/motor operations and so on.

### • High Speed function.

To choose the maximum speed in controller mode and the automatic slewing speed. If the motors don't work at the maximum speed because the battery voltage is getting low, reduce the maximum speed with this function. The motors may work at lower speeds even with a weak battery. (Or they may not! Keep your battery well charged).

NJP	x54	46	40	36	32	29	25	20
EM200/EX	x34	30	26	23	21	19		
EM10	x30	26	23	21	19			
GP/D (SP/DX)/SE	x33	29	25	23	21	19		

Note. The maximum possible speed depends on the type of mount. It may be lower than the above figures depending on the individual mount.

### • Key reversal function.

In controller mode, the sense of the U/D (DEC) & L/R (RA) keys can be reversed. This is convenient for photo-guiding. You can make the movement of the guide star correspond to the key direction.

### • Backlash compensation function.

Backlash generated when you reverse the direction of the DEC motor might cause problems or even total failure when guiding for astro-photography etc. This will not be noticed at more than 2x guiding speed. When the guide speed is less than 0.5x, however, the guide star might not be visibly moved when reversing the motor. To solve the problem, the backlash function causes the motor to reverse at a higher speed for a set number of pulses to compensate for the backlash. The amount and speed of compensation are specified here.

Backlash compensation is *always* used in controller mode. There are two speeds that can be chosen, and the amount of compensation can be adjusted from 2 to 999 pulses. Note that the amount of compensation is set to standard figures (100 pulses for the EM200) at unit power-up; custom values are not saved between power down and power up.

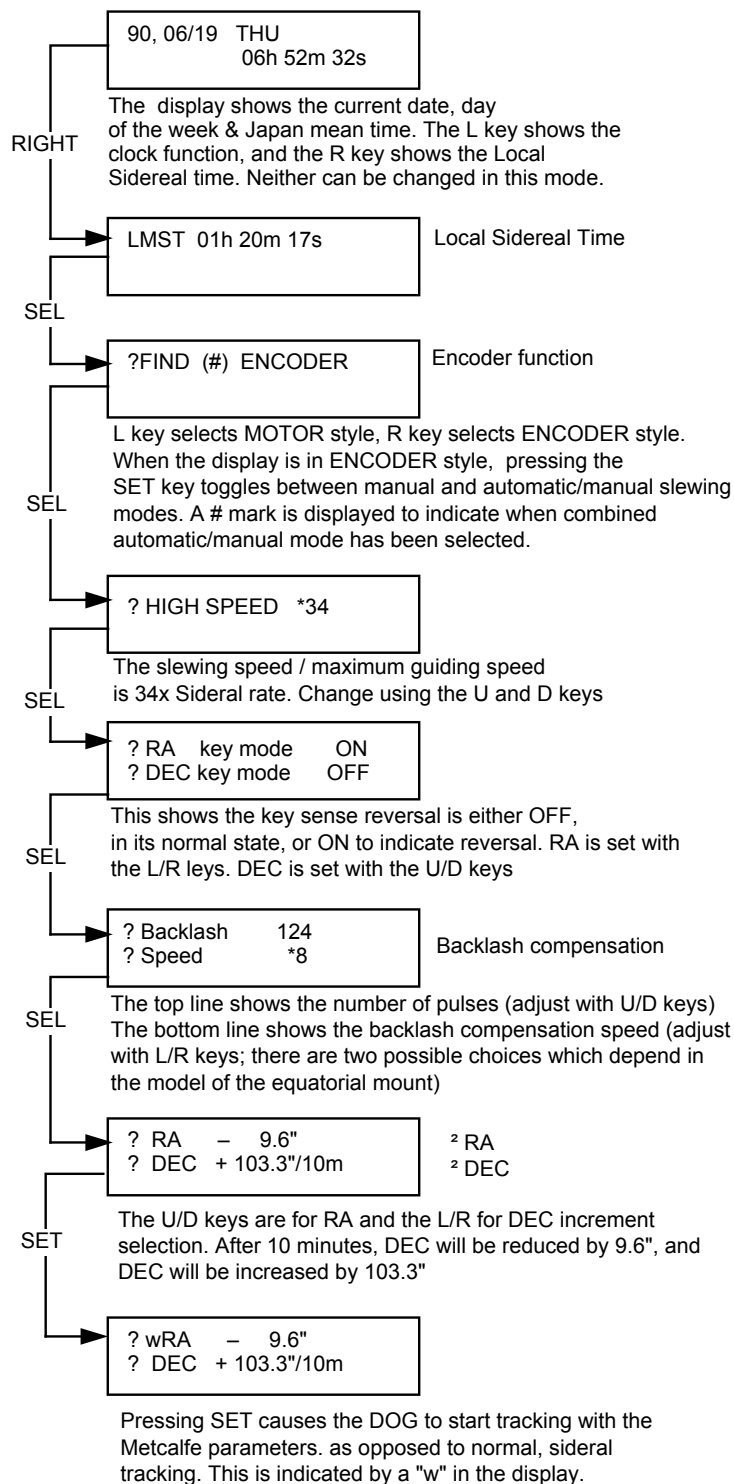
### • Metcalfe tracking function.

This function is for tracking objects such as comets or asteroids across the RA *and* DEC axes. The range of motion for Metcalfe tracking is approximately  $\pm 100''$  / 10 minutes of time for both RA and DEC. This can be input directly by watching the display. This is done in the Metcalfe Tracking and Guide functions of Controller Mode. The next section describes Metcalfe tracking in more detail.

### • Motor/Encoder style function.

The method of getting DEC and RA position information from your telescope's mount is determined with this function. The diagram on the next page explains the selection process and section 2.10 explains the differences in detail.

## Operation example of DATA mode.



### Notes:

- 1) When Metcalfe Tracking be sure to press the SET key to display the "w". To cancel, press the SET key again.
- 2). Refer to Motor/Encoder style descriptions for details of these.

## 2.8 Tracking Comets etc'. (Metcalf)

The following is an explanation of the use of the Metcalfe tracking function, with examples assuming that you are using the NS-12-EM200.

- let's suppose the telescope is pointing at  
RA  $\alpha=11:57:00$  & DEC,  $\delta = +02^{\circ} 33'' 00'$
- execute Metcalfe set-up as below

Example of the DOG display in Metcalfe tracking mode showing the amount of additional RA & DEC movement which will be executed over a ten minute period of time (the RA compensation is +31.2 seconds, and DEC compensation is -60.0 arcseconds per ten minutes):

? wRA	+	31.2"
? DEC	-	60.0" /10m

- Ten minutes after starting Metcalfe tracking, the telescope will have moved to the following position:

$$\text{RA } \alpha = 11:57:02, \text{ DEC, } \delta = +02^{\circ} 32' 00''$$

Note that the  $\alpha$  and  $\delta$  values displayed by the DOG are rounded off in the display. They may not be the same as the actual values being pointed at and retained by the DOG for internal use.

- $\alpha$  and  $\delta$  after ten minutes can be calculated as follows:

$$\begin{aligned} \alpha &\rightarrow \alpha + \Delta\alpha \\ \delta &\rightarrow \delta + \Delta\delta \end{aligned}$$

in the example above, RA is  $\alpha + 31.2''$ , and DEC is  $\delta - 60.0''$

- Let's see an example of tracking comet Suchiya-Kiuchi 1990i, which moves as below:

Date	RA (h:m)	DEC (deg, min)
05/11/1990	10:20.68	-12° 49.4'
15/11/1990	09:15.00	-20° 57.6'

1. Calculate the average movement for e.g. ten days as follows. (pay careful attention to the symbols).

$$\begin{aligned} \Delta\alpha &= 9\text{h}51\text{m}00\text{s} - 10\text{h}20\text{m}41\text{s} = -29\text{m}41\text{s} / 10 \text{ days} \\ \Delta\delta &= -20^{\circ}57'36'' + 12^{\circ}49'24'' = -8^{\circ}8'12'' / 10 \text{ days} \end{aligned}$$

Convert into arcseconds:

$$\begin{aligned} \Delta\alpha &= -29\text{m}41\text{s} \rightarrow -(0 \times 60 \times 60 + 29 \times 60 + 41) \times (360/24) = -26715 \text{ ''} / 10 \text{ days} \\ \Delta\delta &= -8^{\circ} 8' 12'' \rightarrow -(8 \times 60 \times 60 + 8 \times 60 + 12) = -29292 \text{ ''} / 10 \text{ days} \end{aligned}$$

2. Calculate the average motion per ten minutes from the above values:

$$\Delta\alpha = -26715 / (10 \times 24 \times 6) = -18.5'' / 10 \text{ minutes}$$

$$\Delta\delta = -29292 / (10 \times 24 \times 6) = -20.3'' / 10 \text{ minutes}$$

3. Using the closest to these values that can be input to the DOG for Metcalfe tracking, we can track comet Suchiya-Kiuchi 1990i.

This calculation is based on the average motion over a ten day period. It cannot therefore correspond perfectly to the actual cometary motion. However, it should be enough for photographic purposes. If you have access to comet ephemeris close to the time when you wish to track, you can calculate the mean motion over a shorter period which includes your observing time.

## 2.9 Backlash and Pointing Accuracy

### • Backlash in DEC

1. DEC backlash compensation can be set up in terms of the number of pulses of additional motor rotation in the backlash function of DATA mode.

The actual amount of DEC backlash compensation is more or less equal to the # of pulses selected x  $\partial$  arcseconds. The coefficient  $\partial$  depends on the mount as follows:

mount	EM200, EM10, EX	NJP	GP/D, SP/DX, SE
$\partial$	0.6	0.75	0.78

2. The approximate number of pulse to get the correct backlash compensation is typically between 80-150 for the EM200 and the EM10. For the NJP the typical value is between 20-100. For the Polaris mounts the backlash may be greater.

3. For actual set-up, set an estimated compensation value, then check it at one of the higher speeds in controller mode. Repeat this several times to find the best value.

4. Backlash consists of a variable and a fixed component. The size of the variable part, according to tests, is 10-30'' for smaller mounts. This depends on the mechanical characteristics of the gears and mechanical parts of the individual mount.

If you attempt to compensate for the variable part, the backlash compensation function sometimes results in star movement. In other words it is possible to overcompensate. Therefore it is better to restrict backlash compensation to smaller values than may at first seem necessary.

### • Pointing Accuracy

- using Motors only (no encoders), the automatic slewing error is typically:

EM200 , NJP	< ±15'
-------------	--------

GP/D, EM10, SE, EX	< ±20'
--------------------	--------

- Using encoders, the mount can be slewed to within approximately 40-50' of the target.
- Slewing error depends on the following factors. If you have a problem, check these:

In both motor and encoder methods:

- (i) polar alignment error (most likely)
- (ii) RA/DEC alignment error (i.e. if they are not at exactly 90° to each other in a badly assembled mount)
- (iii) telescope imbalance/clutch slipping.
- (iv) error of initial position set-up (an easy mistake to make)
- (v) epoch error (i.e. comparing positions at two different epochs)
- (vi) atmospheric refraction error.

Only when using encoders:

- (vii) improper encoder set-up
- (viii) badly made encoder wheel/s: hard luck.

## **2.10 The Motor / Encoder control methods (“styles”)**

The most important system parameter for auto slewing equipment is the current aiming point of the telescope. Without knowing where the telescope is currently pointing, it is impossible to execute the digital display function, automatic or manual slewing and so on. The DOG gets RA and DEC information either one of two ways:

### **1. Motor method. (Motors only: no encoders)**

The mount has two pulse motors to control motion in the RA and DEC axes. A digital signal is sent to drive the pulse motors. Pulse motors have the very important feature of turning only a very accurate discrete amount per pulse. In the Motor style, the RA and DEC are obtained by knowing the number of pulse sent to each motor. While the DOG is connected to the two axes, it will always obtain the correct RA and DEC. The relationship is valid only while the clutch clamps are closed. This is generally called OPEN LOOP CONTROL, because there is no feedback from e.g. encoders.

- In motor style, the clamps cannot be released after the initial set-up without invalidating the set-up.
- Motor style is only appropriate to automatic slewing: it does not support the digital display function, manual slewing, or the combined automatic/slewing method.
- the angle turned during one pulse of the motor/s is extremely small. Compared to encoder style, therefore, it is superior in slewing accuracy.



- pulse motor turning angle per pulse is  $0.3'' - 0.78''$  depending on the mount.
- encoder angle turned per encoder pulse is  $30.0'' - 43.2''$ .

## 2. Encoder method.

When the mount has encoders attached to both axes, the DOG can obtain the RA and DEC even when the clamps are released.

Instead of pulse-motor pulses, the DOG uses pulses output by the two axis encoders. If the rotation of the two axes is always entirely reflected by the output pulses of the encoders, the DOG always obtains accurate RA and DEC values. Therefore, rotation of the two axes can be either manual or by the pulse motors. This is generally called CLOSED LOOP CONTROL.

- When using encoders the clamps can be released even after the initial set-up in order to slew the scope. However, when operating the telescope in this manner, take care to do it slowly.

If the scope is moved too fast, the DOG will beep to warn that there has been an error in the RA/DEC information acquired from the encoders.

- Encoder style can be used for any kind of slewing.

Note. Depending on the set-up of the RA/DEC encoders, the displayed changes of DEC and/or RA may be in the wrong sense. In this case, refer to 5.5, DIPSW set-up, then reverse the sense. Example: when the RA encoder sense is reversed: if DIPSW #2 is OFF, change it to ON to return the encoder to the correct sense.

## 2.11 M & R objects

- Display of M& R objects

Messier (M) object display	M001 05h 34m 30s 8.6PN +22° 01' 00"
-------------------------------	--

The object displayed is M1, a planetary nebula (The Crab), PN, magnitude +8.6

R (other) object display	R060 06h 23m 45s -0.7ST -52° 41' 24"
-----------------------------	---

The object displayed is R060 in the database. It is Canopus, a magnitude -0.7 star, ST

The kinds of objects shown are as follows:

- |   |    |                  |
|---|----|------------------|
| 1 | ST | Star             |
| 2 | VA | variable star    |
| 3 | DB | Double star      |
| 4 | DA | Dark nebula      |
| 5 | DN | Diffused Nebula  |
| 6 | PN | Planetary nebula |
| 7 | OP | Open Cluster     |
| 8 | GL | Globular cluster |
| 9 | GA | Galaxy           |

Depending on the model, the above kinds of objects may or may not be included in the database.

- For the DOG NS-12, there are 231 R objects as detailed in appendix A, plus the entire Messier object catalogue.
- Object positions are based on Epochs 2000 and 1990.5. This should be sufficiently accurate for this system. To obtain more accurate values for the current epoch, refer to other sources.

range	number of objects	types
R001-231	231	ST (star)

## Part 3 DOG Remote Control / Communications function

### 3.1 Outline

The DOG can be operated in one of two ways:

- (i) as a stand-alone unit by “key control” or
- (ii) controlled remotely from a PC or Macintosh.

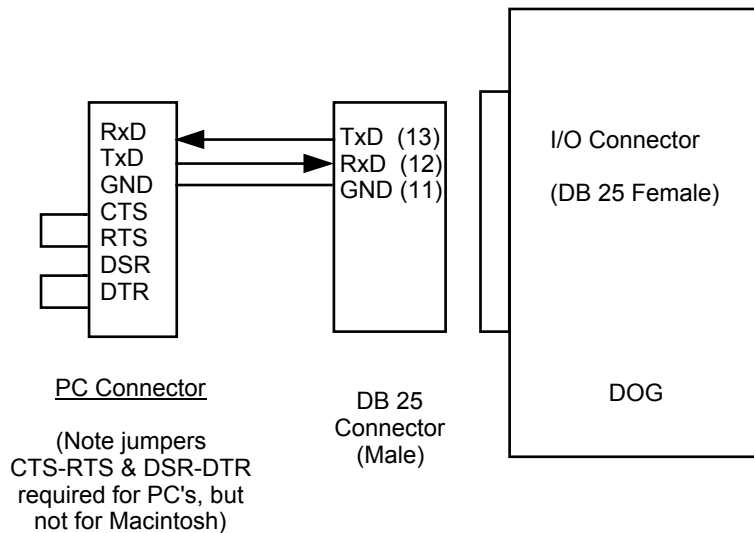
The previous sections have covered the first, stand-alone mode of operation. The following sections deal with the manner in which the DOG can be operated remotely from a PC. You do not need to read this section unless you wish to understand how to communicate with the DOG from a personal computer.

#### 3.1.1 Remote Control Mode

The DOG and PC/Mac can be connected by an RS232-C serial interface (via the RS242 serial ports in the case of Mac). Key control functions can be executed by both normal key operations, and remotely from the PC. As well as duplicating the key functions, remote control also offers several other functions. Communication is achieved by sending and receiving ASCII commands between the DOG and PC according to a fixed procedure.

#### 3.1.2 RS232C cable

The RS232-C serial connection is made according to the following diagram:



### 3.1.3 General Communication Concepts

1) The DOG is set up in the following manner:

Data: 8 Bits, No parity, 1 Stop bit, 9600 BAUD transmit and receive

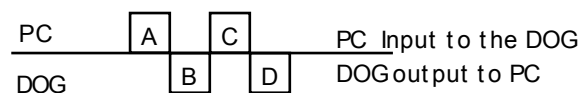
The PC must be set up in exactly the same way if communications are to be achieved.

2) The character CR is 0DH. LF is 0AH.

3) The DOG will neglect the Null, (00H) and LF, (0AH) characters when receiving a command.

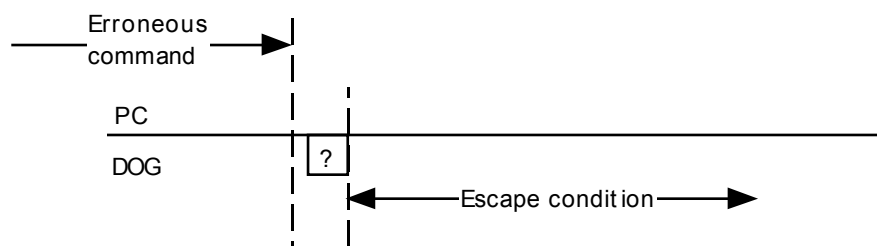
### 3.1.4 The sequence table

The following sections explain transmission in remote control mode by showing examples using the sequence table, which goes from left to right:

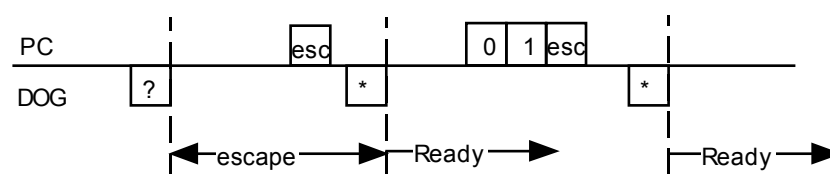


### 3.1.5 Errors

When there is a communication error while receiving a command or there is a command syntax error, the DOG will output a question mark (3FH) and go into “escape” condition.

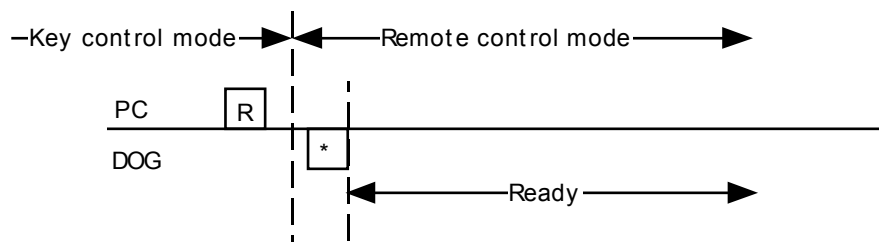


While in “escape” condition the DOG waits for an escape command (1BH). It will neglect all other characters. When the DOG receives the escape character, whatever condition it was in, it will output an asterisk, \*, and go back to the ready condition.



### 3.2 Change to remote control mode

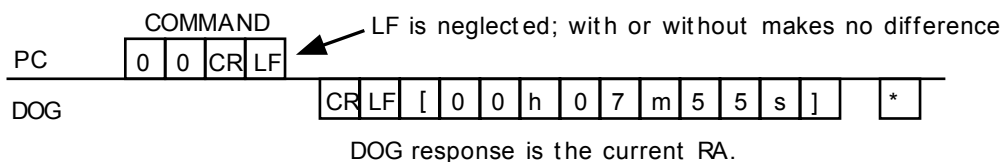
- 1) When the DOG is in normal key control mode it is waiting to receive the R character.
- 2) The control character R (52H, i.e. 52 Hexadecimal) is sent to the DOG to put it into remote control mode. Any character other than R is neglected.
- 3) Once the DOG receives R, it moves to remote control mode and outputs an \* (2AH). It is now in the "ready" condition.



- 4) All command sequences start and finish in the "ready" condition.

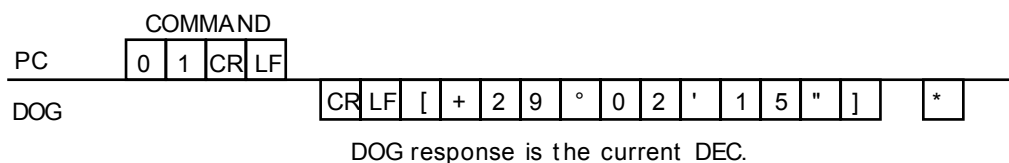
### 3.3 RA command

- 1) To retrieve the current RA value



### 3.4 DEC command

- 1) To retrieve the current DEC value.



### 3.5 The Monitor commands: Read & Write

- 1) The DOG's memory is read/write-able.
- 2) Valid memory addresses are in the range FE00H to FFFFH
- 3) The write command will change the contents of memory, so don't execute it unless the address is in the range specified above, or the system might crash.
- 4) To simplify the explanation, memory addresses are represented by symbols which are the names used for the contents of the memory location. For the actual memory addresses, refer to the symbol list in section 3.19.

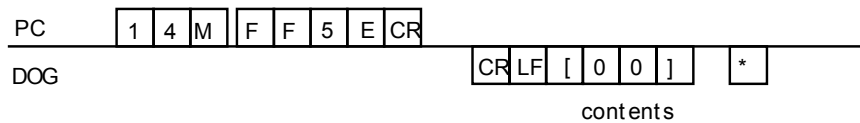
The symbols are named according to 16 bit memory addresses.

Example: SWSEL is a memory address  
 (SWSEL) is the content of the memory at address SWSEL.

#### 3.5.1 Read command

To retrieve the contents of a specified memory address

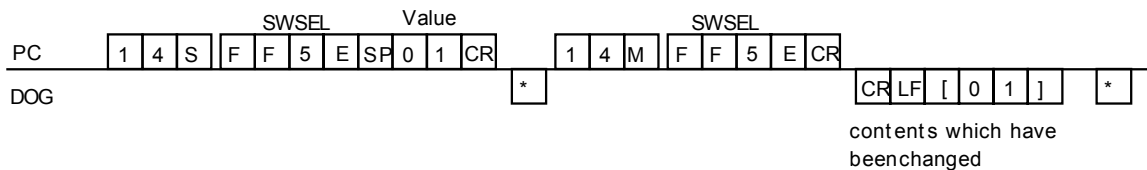
example: retrieve (SWSEL) from FF5EH



#### 3.5.2 Write command

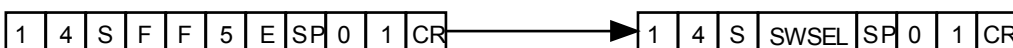
To change the contents of a specified memory address to a specified value.

Example: to change the contents of SWSEL to 01H



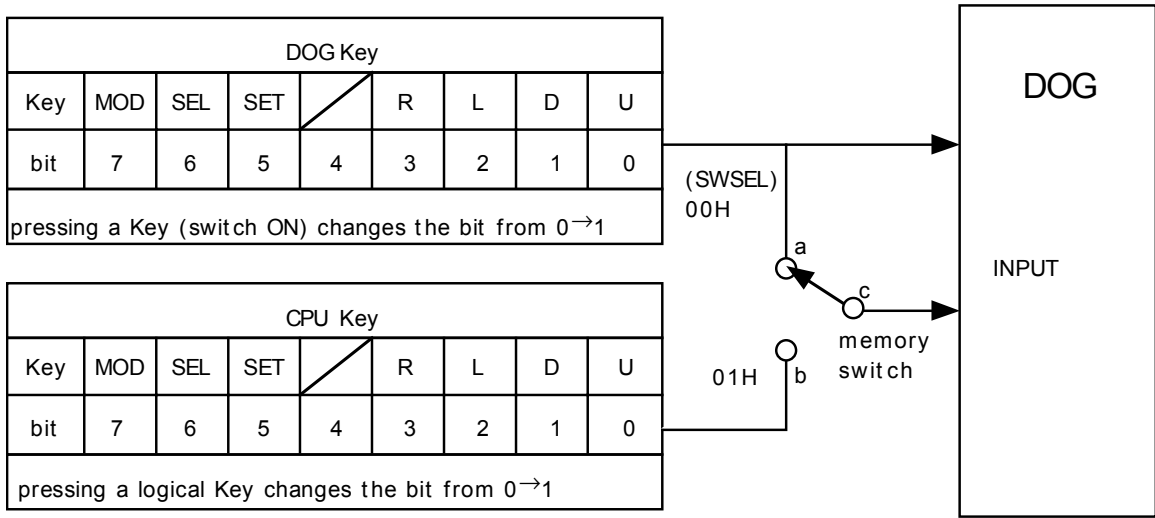
SP means space, which is 20H.

Symbols shown in a sequence table look like this:



### 3.6 Remote Control key commands: Push, On & Off

- 1) These commands operate the DOG's keys in remote control.
- 2) The remote control mode has two types of key for input. The first is the DOG's own keys, and the other is the CPU's keys. The DOG's keys are MOD, SEL, SET, Left, Right, Up and Down. The keys are pushed manually. The "CPU keys" are "logical" keys having the same effect as the DOG's keys, operated by remote control.
- 3) The Key structure diagram is as follows:



- Depending on the content of symbol SWSEL the connection of the memory switch will change. If (SWSEL) = 00H the connection point *a* connects to *c* and the DOG keys are used for input. If (SWSEL) = 01H the connection point *b* connects to *c*, and the CPU keys are used for input. To perform remote control using CPU keys, make (SWSEL) = 01H with the write command before attempting to operate the keys from the PC.

- It is possible to reconfirm the DOG key condition using the input port command.

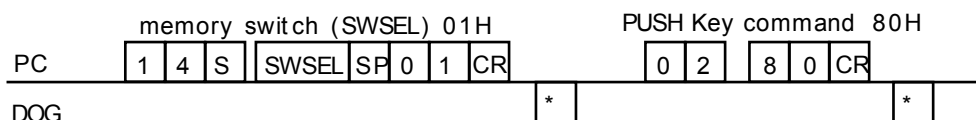
- To press the logical CPU key, you set a bit from 0 to 1 with an appropriate key command:

#### 3.6.1 PUSH key command

PUSH the CPU key only once, and the key bit will change from 0 to 1, then back to 0.

Example: PUSH the MOD key.

The MOD key is bit #7, therefore 10000000B → 80H



This command is very convenient for the operation of the MOD, SEL & SET keys. However, when it is shifted to CPU key mode, the DOG cannot be operated by the DOG's own keys.

Summary:

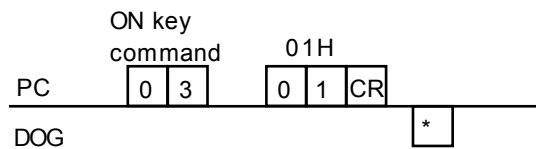
To PUSH the MOD key: 0280 CR  
 To PUSH the SEL key: 0240 CR  
 To PUSH the SET key: 0220 CR

### 3.6.2 ON key command

Make the CPU key ON; i.e. press it and hold it down. (Bit changes from 0 to 1).

Example: To turn the UP key on.

The UP key is bit 0, therefore 00000001B becomes 01H.



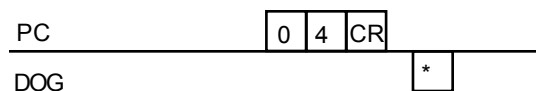
This command is convenient for UP, DOWN, LEFT and RIGHT key operations.

summary:

To press and hold the UP key: 0201 CR  
 To press and hold the DOWN key: 0202 CR  
 To press and hold the LEFT key: 0204 CR  
 To press and hold the RIGHT key: 0208 CR

### 3.6.3 OFF key command

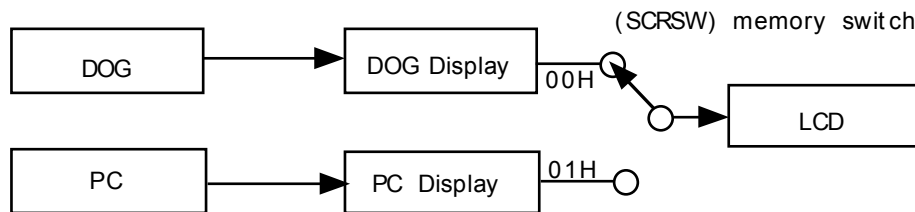
Make all the bits of the CPU key OFF. (All bits change to 0).





### 3.7 The Display commands

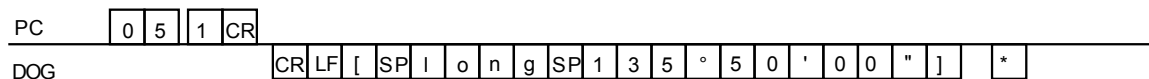
- 1). In remote control mode the display command shows the same information in both the DOG's display and the PC's display.
- 2). The message which the DOG outputs is first shown on the DOG's LCD.
- 3). The DOG screen displays the DOG's message. The CPU screen displays the message by CPU display command.
- 4). Structure of the DISPLAY command



#### 3.7.1 DOG Display command 1

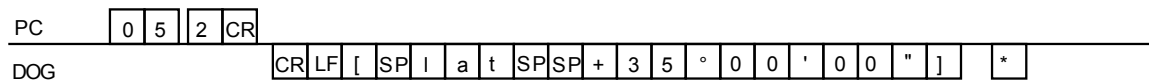
Retrieve the contents of the first line of the DOG display.  
 Example, suppose that the LCD is as follows:

long	135°	50'	00"
lat	+	35°	00' 00"



#### 3.7.2 DOG Display command 2

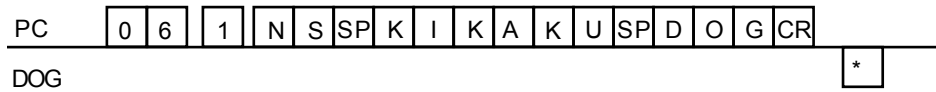
Retrieve the contents of the second line of the DOG display.  
 Example, suppose that the LCD is still as above:



Note. The DOG display commands 1 & 2 can be executed regardless of the content of the memory switch (SCRSW).

#### 3.7.3 CPU Display command 1

Display the contents of the command in the first line of the DOG display.  
 The message is up to a maximum of 16 characters.

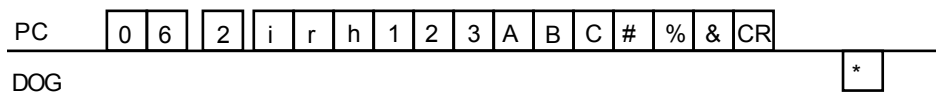


The characters of the message are in the range 00 to 1FH. The \$ character (24H) and characters in the range 80-9FH are prohibited.

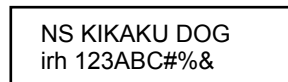
### 3.7.4 CPU Display command 2

Display the contents of the command in the second line of the DOG display.

Example:



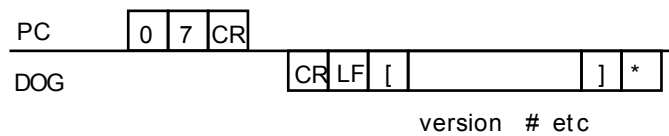
Executing examples 1 & 2 gives the following display on the DOG :



Note. The CPU display commands 1 & 2 can be executed regardless of the contents of memory switch (SCRSW). To see the CPU display, make (SCRSW) = 01H.

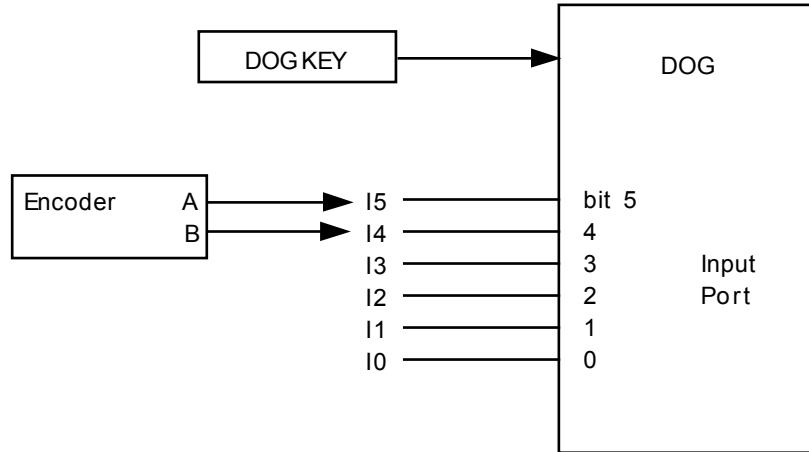
### 3.8 Version command

This retrieves the DOG system version.



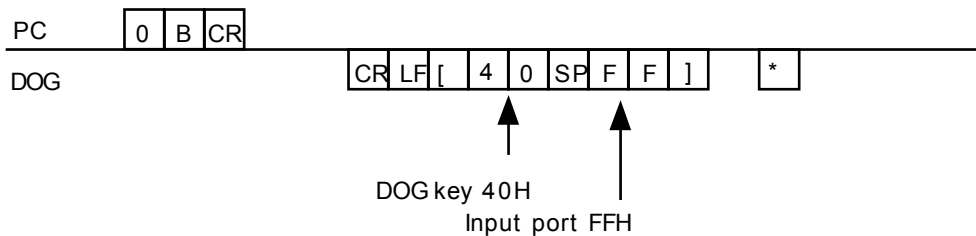
### 3.9 Input port command

1. To retrieve the condition of the DOG keys and the condition of the input port.
2. The structure of the INPUT PORT command:



- Input Port pins I5 and I4 are combined with the port for external encoders.
- Input of I5 to I0 are pulled up by resistance, therefore when they are open, each bit becomes 1. Bits 7 and 6 are infinite.
- I3 to I0 signal lines are not pulled up to the I/O connector.

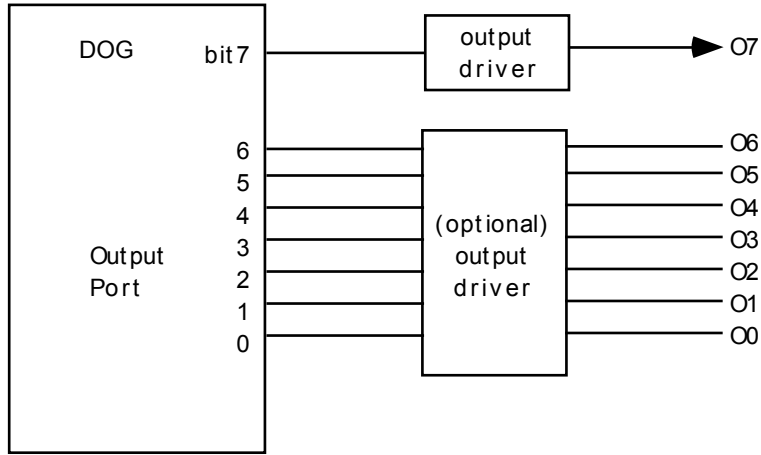
Example. Input port pins I5 to I0 are open while pressing the SEL key (bit 6). Executing the command gives.



Reference. The following things can be connected to the Input port. For example; switches, encoders (both a and b phase, such as GP encoders), PC, Mouse etc.

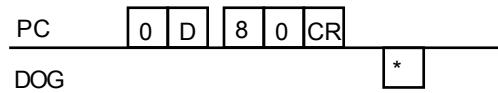
### 3.10 Output port command

1. To write data in the output port.
2. The structure of the output port



- All output drivers are open collector output of transistors.
- Output drivers from O6 to O0 are optional
- When a bit becomes 1 the transistor switches on.
- Soon after switching on, each bit becomes 0.

Example: to set output port bit 7 to 1 (Data bit 7)



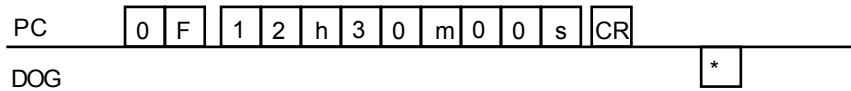
- The condition of the output port can be retrieved by the command 0C CR.

Reference. By connecting the output port to a relay, the following application is possible: automatic photographing (to control an electronic shutter release or a motor drive), a motorized dome, or other external equipment such as heaters etc etc.

### 3.11 CPU RA command

To set the desired value of RA from the PC (i.e. the target object RA).

Example: to set up RA to 12h 13' 00".



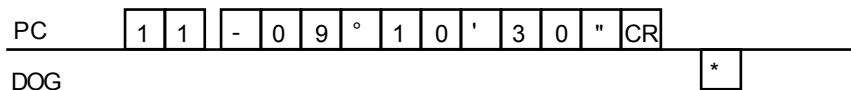
Note...

- that RA can be *retrieved* with the command 0E CR.
- h, m & s can be replaced by sp(ace).

### 3.12 CPU DEC command

To set the desired value of DEC from the PC (i.e. the target object DEC).

Example: to set DEC to -09° 10' 30".



Note ...

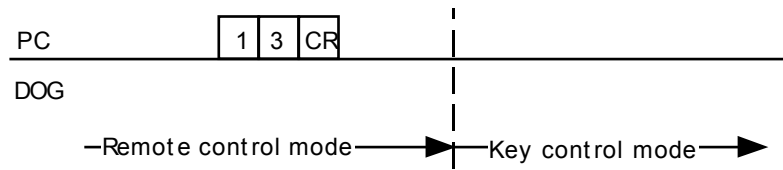
- that DEC can be retrieved with the command 10 CR.
- °, ' & " can be replaced by sp(ace).
- On Macintosh computers the ° (degree) symbol returned from the DOG displays as a “\_” (underbar) in the communications terminal window. Presumably this is due to a different ASCII definition for this character between PC's and Macintoshes.

Once the desired target coordinates have been set-up, a remote command sequence can be used to slew the telescope to the desired target. We must make sure that the DOG is in Object Entry mode, and that it is in the Manual/CPU object entry function of that mode. This can be checked out with the READ (MODE) command, 14MFE00, and the READ (Function) command, 14MFEE5.

If the returned result for the MODE is not [01], then the PUSH (MODE) Key command, 0280, must be sent the correct number of times after setting SWLEL to 01H with the command 14SFF5Esp01. Then the PUSH (SEL) Key command needs to be executed to get to manual object entry. Finally PUSH(SET) will start slewing.

### 3.13 Reset command

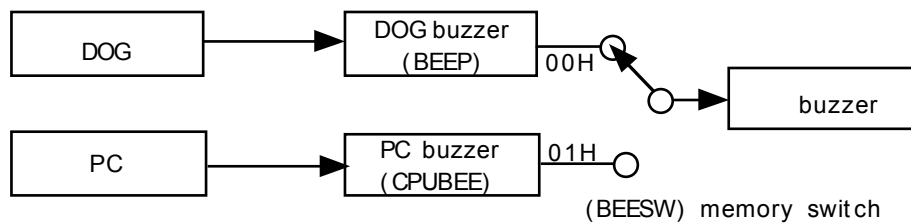
To shift from remote control mode to key control mode.



Upon executing the reset command, the DOG is left in the following state: Key operation is with the DOG's own keys, the DOG's display is in use, and the DOG's buzzer is in use.

### 3.14 Buzzer command

1. To operate the buzzer.
2. In remote control mode the DOG and PC buzzer are logically the same.
3. The DOG normally operates its own buzzer, which can also be operated with a write command from the remote CPU.
4. The structure of the buzzer command.

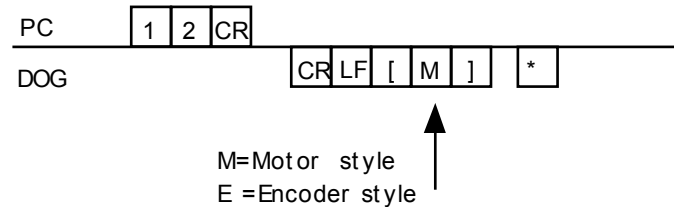


- (BEEP) & (CPUBEE) are normally 00H.
- To operate the buzzer, set (CPUBEE) = 10H with the write command. The Buzzer will then operate for approximately 10H (=16) x 10 milliseconds = 160 ms. When the buzzer terminates, the state of (CPUBEEP) will be reset to 00H.
- The DOG buzzer is generally operate by the DOG itself, but it can also be operated by setting up the contents of (BEEP) with a write command.
- When you shift to CPU controlled buzzer by stting BEESW = 01H, the DOG buzzer does not operate under DOG key operation.

### 3.15 Motor / Encoder style command

1. The DOG will read whether it is set to Motor or Encoder style.

Example:



2. The mode is selected by the content of memory switch (MTENSW).

(MTENSW) = 00H means Motor mode.  
01H means Encoder mode.

The contents of MTENSW are changed with the write command.

3. Slewing mode is selected by the content of AUMASW.

(AUMASW)= 00H means automatic slewing,  
FFH means combined automatic/manual slewing.

The contents of AUMASW are changed with the write command.

Attention.

- When setting combined automatic/manual slewing, be sure to do it in ENCODER mode, not in MOTOR mode.
- It is prohibited on digital display equipment to change the contents of MTENSW and AUMASW with the write command.

### 3.16 Motor stop command

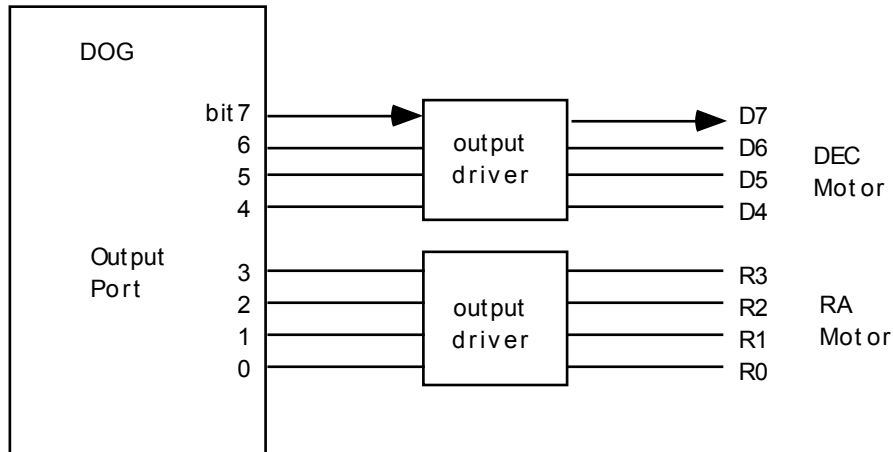
1. To stop the rotation of the RA/DEC motors(s)
2. Use for emergency stop.
3. This command is executed by changing the content of (SYSOFF). The normal state of (SYSOFF) = 00H. When (SYSOFF) = 01H, the motors are stopped.

Attention.

- It is not possible to change the contents of SYSOFF with the write command on digital display equipment.

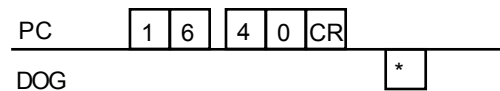
### 3.17 Motor port command

1. To write data in the motor port.
2. The motor port can be used as an output port besides being used to drive the pulse motors.
3. Structure of the motor port:



- All output drivers are open collector outputs of transistors.
- When a bit becomes 1, it's transistor switches on.
- The motor port is generally used by the DOG to drive the pulse motors. If it is used as an output port, it is necessary to stop the motor drive with the motor stop command.

Example: To set the motor port bit 6 to 1.



- The condition of the motor port can be read with the command 15 CR.
- On Digital display equipment the output driver is optional.



### 3.18 Encoder commands

1. To read the (16 bit) counter of the encoder.
2. When the command is executed, the counter will be reset to 0000H.
3. The counter counts the pulses clockwise and anti-clockwise from the encoder.

- With no pulses the counter is 0000H.
- Clockwise pulses count from 0001H to 7FFFH (+32767D)
- Anti-clockwise pulses count from FFFFH to 80000H (-32768D)

Anti-clockwise		Clockwise
8000H	0000H	7FFFH
-32768	0	+32767

Examples:

If the counter is FFF0H, the encoder has detected 16 pulses worth of anti-clockwise rotation.

If the counter is 0128H, the encoder has detected 296 pulses worth of clockwise rotation.

4. The DOG can connect to three encoders; RA, DEC and an external encoder for, e.g., a rotatable dome.

#### 3.18.1 RA encoder command

1. To read the RA encoder counter.
2. Valid only when the DOG is in MOTOR mode.



The returned counter value in this example is 128.

#### 3.18.2 DEC encoder command

1. To read the DEC encoder counter.
2. Valid only when the DOG is in MOTOR mode.
3. The command is 09 CR

#### 3.18.3 External encoder command

1. To read the External encoder counter.
2. Depending on the content of EXTSW, the command is either valid or not.

If (EXTSW) = 00H, the external encoder is invalid.

If (EXTSW) = 01H, the external encoder is valid.

3. The command is 0A CR

### 3.19 Symbol definition list

<u>SYMBOL</u>	<u>ADDRESS</u>	<u>CONTROLS</u>	<u>STATUS</u>
SWSEL	FF5E	Keys	00H = DOG 01H = CPU
SCRSW	FF7F	LCD	00H = DOG 01H = CPU
BEESW	FEB6		
BEEP	FEB8		
CPUBEE	FEB7		
MTENSW	FF4A	Mode	00H = Motor 01H = Encoder
AUMASW	FFD3	Slewing	00H = Auto' 01H = Manual/Auto'
SYSOFF	FFC2	Motors	00H = ON 01H = STOPPED
EXTSW	FF4B	Ext Encoder	00H = None 01H = Enabled
METF displayed)	FF2C	Vrbl tracking	00H = OFF 01H = ON (w is
RMTCDT	FF30+FF2F	Metcalfe RA Cycle time (16 bit)	
DMTCDT	FF34+FF33	Metcalfe DEC Cycle time (16 bit)	
		Cycle time =99.984ms x the value	

The following symbols are only used with the read command. It is prohibited to write to these addresses.

MODE	FE00	Mode number	
		[00]	initial data
		[01]	controller mode
		[02]	object entry mode
		[03]	initial set up mode
		[04]	data mode
PCFLG	FE01	Process control flag	
PCSW	FE02	Process control switch	
MBSW	FEDF	Function number in controller mode	
		[00]	*30 speed
		[01]	*17 speed
		[02]	*4 speed
		[03]	*2 speed
		[04]	*0.5 speed
		[05]	*0.5 guiding
ASW	FEE5	Function number in object entry mode	
		[00]	M(essier) object entry
		[01]	R object entry
		[02]	CPU/manual object entry
PSW	FEE6	Function number of initial set-up mode	
		[00]	R object selection
		[01]	M object selection
MFSW	FF10	Function number of data mode	
		[00]	Show date & time
		[01]	Motor / Encoder selection
		[02]	High speed slewing speed selection

- [03] RA/DEC key reversal
- [04] Backlash compensation setup
- [05] Metcalfe tracking setup

### 3.20 Remote Control Command Summary

The following is a summary table of the ASCII commands that can be sent to the DOG from your PC:

R		initiate remote control mode
00CR		retrieve the current RA
01CR		retrieve the current DEC
14M(addr) CR		READ the value at memory location (addr)
14S(addr) sp(value) CR		WRITE (value) into memory location (addr)
02(hexbit) CR		PUSH the key corresponding to (hexbit)
	0280	PUSH MOD
	0240	PUSH SEL
	0220	PUSH SET
03(hexbit) CR		set the key corresponding to (hexbit) ON
	0208	UP note: can also be PUSHed
	0204	DOWN note: can also be PUSHed
	0202	LEFT note: can also be PUSHed
	0201	RIGHT note: can also be PUSHed
04CR		set all keys OFF
051CR		retrieve contents of the 1st line of the DOG display
052CR		retrieve contents of the 2nd line of the DOG display
061(message) CR		display (message) on the 1st line of the DOG display
062(message) CR		display (message) on the 2nd line of the DOG display
07CR		retrieve the DOG version number
0BCR		retrieve the condition of the keys and the input port
0D(hexbit) CR		set output port bit (hexbit) to 1
0CCR		retrieve the condition of the output port
0F(value) CR		set the (desired) RA value to (value)
0ECR		retrieve the (desired) RA value
11(value) CR		set the (desired) DEC value to (value)
10CR		retrieve the (desired) DEC value
13CR		reset: i.e. go back to key control mode.
12CR		read the Motor/Encoder flag, MTENSW
16(hexbit) CR		set bit (hexbit) of the motor port to 1
15CR		retrieve the condition of the motor port
08CR		read the RA encoder counter
09CR		read the DEC encoder counter
0ACR		read the External encoder counter (if it is enabled)

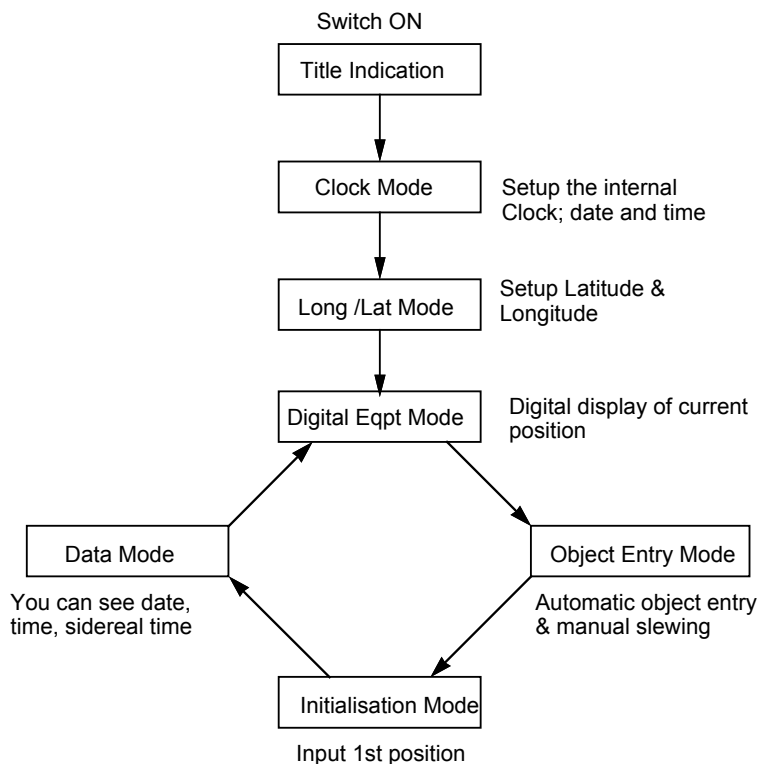
## Part 4 NS10 Digital Display Tool

### 4.1 Key operation

The operation of the digital display tool is not much different from the operation of the DOG, except that motors are neither controlled, nor used as pseudo-encoders. The Digital display tool only works with RA and DEC axis encoders. The Digital Display Tool operates in the same manner as if it were an DOG in all other respects.

### 4.2 Operation mode on digital display equipment

The following is an explanation of the kinds of functions in motion mode.



### 4.3 Explanation of the motion modes

1. Refer to 2.2. for a description of Clock mode.
2. Refer to 2.3 for a description of longitude/latitude mode.
3. Digital display mode only supports digital display functions. The selection and set keys are invalid. The equipment will display the correct RA and DEC even if you release the clamps and operate the telescope manually. Refer to sections 2.4, controller mode, and 2.10 motor/encoder mode, for a description.
4. Slewing mode only supports manual slewing with encoders. Refer to section 2.5, slewing mode.
5. Refer to 2.6, initial set-up mode.
6. Data mode only supports the clock and sidereal time functions. Refer to section 2.7, data mode.
7. Refer to Chapter 3 for details of the remote control mode of operation.

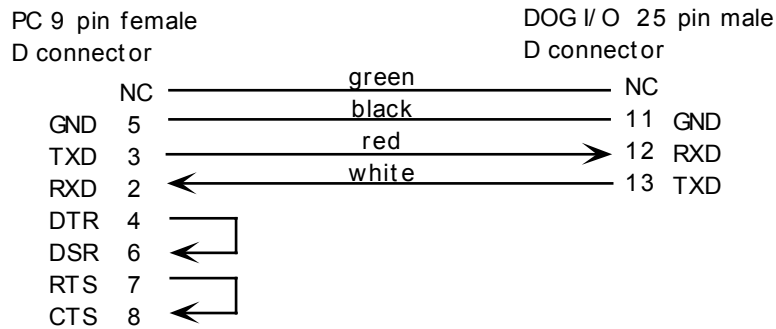
## Part 5 Hardware

### 5.1 I/O connector - PC

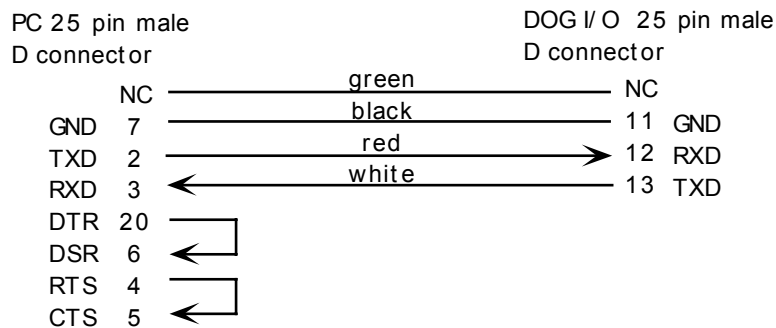
D25 female

Pin#	Name	Note
1	+ 5V	
2	RA -A	A. RA Encoder
3	RA -B	B.
4	GND	
5	GND	
6	B 12V	+12 Volt supply
7	B 12V	
8	+ 5V	
9	I 5	Input port A. EXT encoder
10	I 4	Input port B.
11	GND	
12	RxD	RS 232-C
13	TxD	
14	+ 5V	
15	DEC -A	A. DEC Encoder
16	DEC -B	B.
17	GND	
18	O7	
19	O6	
20	O5	
21	O4	Output
22	O3	Port
23	O2	
24	O1	
25	O0	

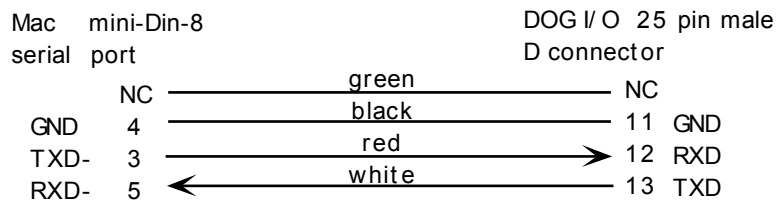
#### 5.1.1 I/O Port RS-232C to DOS/V PC



### 5.1.2 I/O Port RS-232C to PC-98



### 5.1.3 I/O Port RS-232C to Macintosh RS-242 serial port



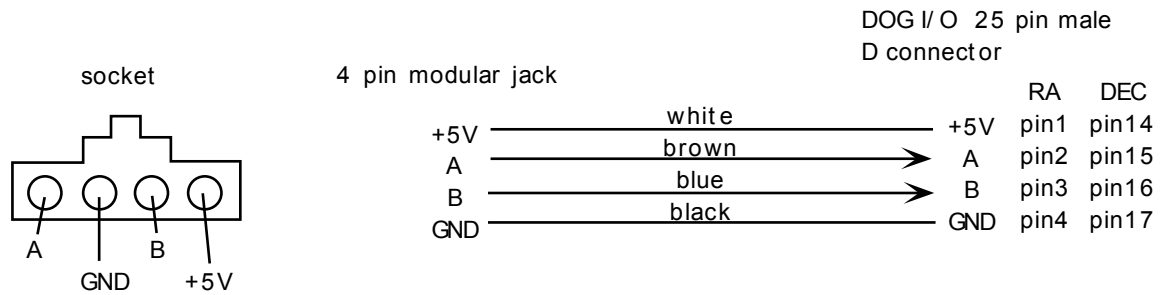
No jumpers are required for the Macintosh cable.

As you may require to build your own cable to connect your DOG to your Macintosh, note that the mini-Din 8 pin numbering is exactly the same as for the Takahashi encoder plug, as shown in the diagram on the following page.

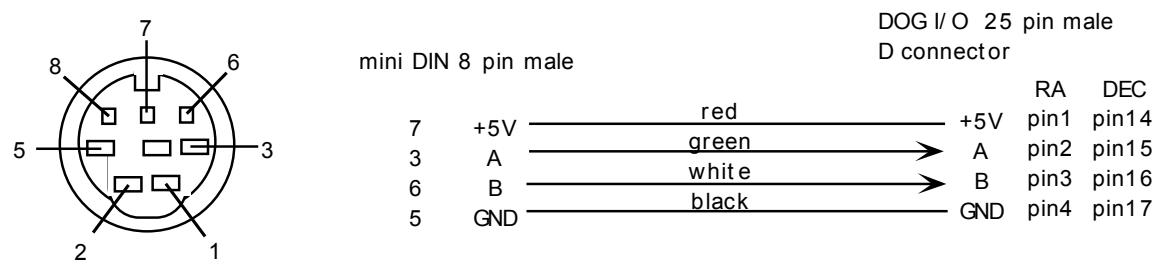
Note that the wire colours mentioned in the preceding diagrams have no significance if you are making your own cable. These colours are as used in cables made by NS Kikaku.

## 5.2 I/O connector -Encoder cables

### 5.2.1 GP Encoders



### 5.2.2 Takahashi (Pulsetech) Encoders

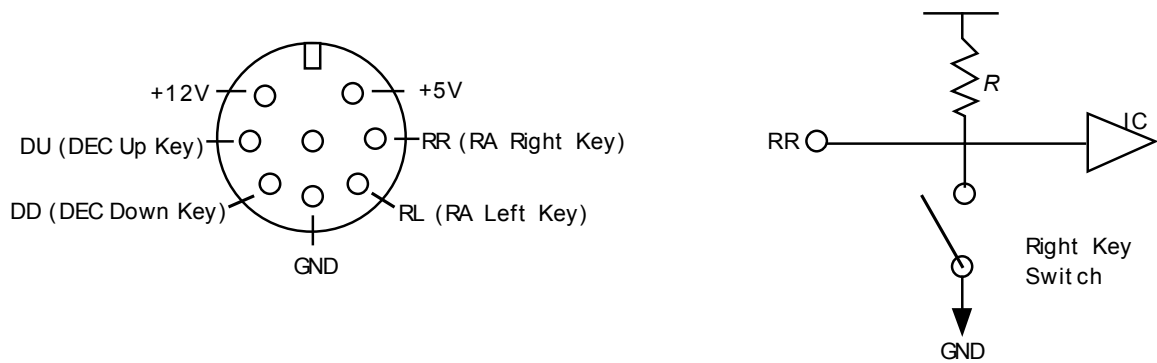


This shows the Mini-Din-8 plug from the back, or a female socket from the front.



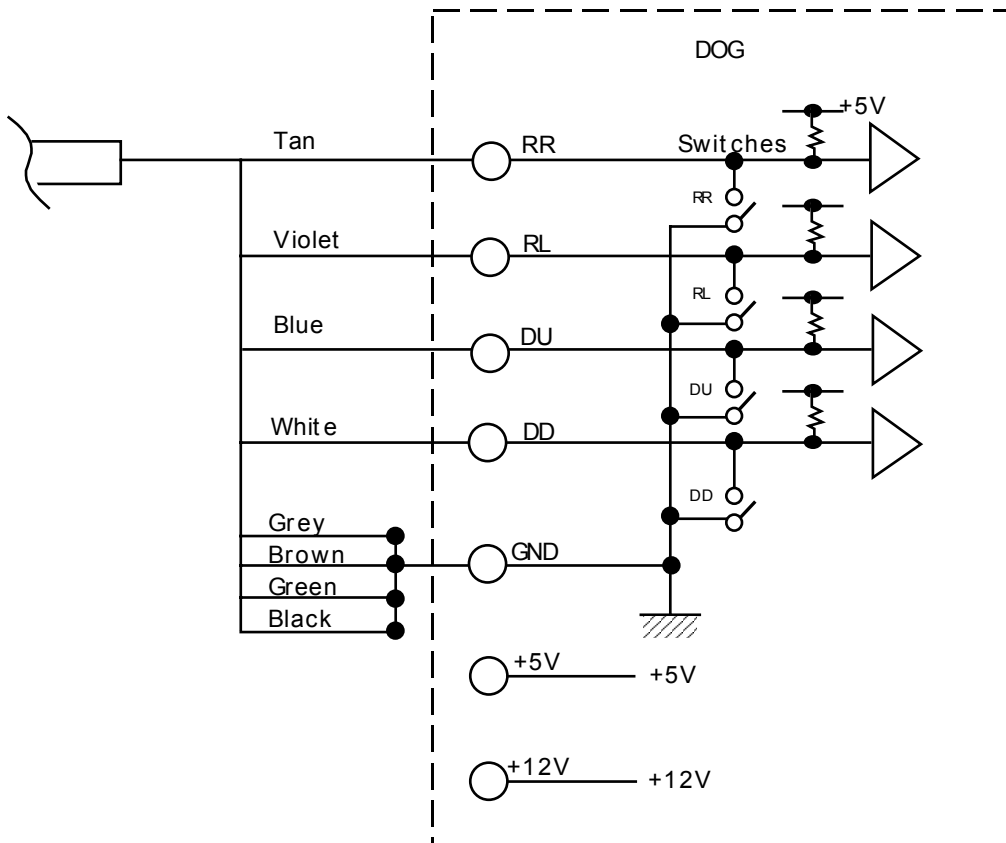
### 5.3 Auto Guider port (SST) connector

The SST port 8 Pin DIN female socket pin-out is as follows



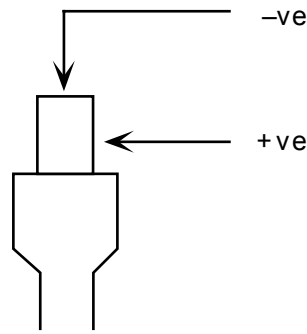
(i) To use the SST autoguider, simply plug it directly into the socket.

(ii) To use an SBIG ST-4, 4X, 5 or 6 in auto guider or track and accumulate modes, the original SBIG relay cable should be connected to the DOG as follows:



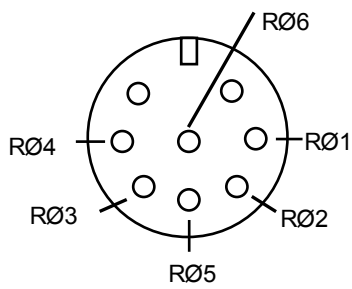
• Note: Do not connect any pins or wires which are not connected in the diagram above.

### 5.4 Ø2.1 Power Plug

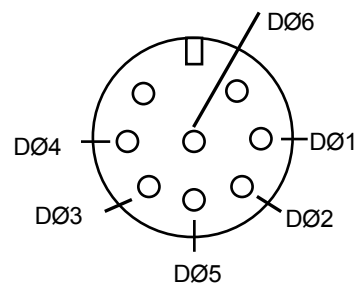


### 5.5 Motor plugs

8 Pin DIN male



RA Motor Plug

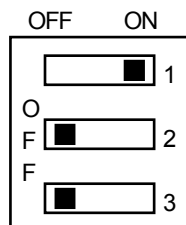


DEC Motor Plug

- For EM200, EM10 & EX mounts, RØ5 & RØ6 are GND.
- For other mounts, RØ5 and RØ6, and DØ5 and DØ6 are connected to +12V through a resistor. The resistance required depends on the unit.

### 5.6 DIP Switch set-up

The Dip switches inside the base panel of the DOG are used to set the default operating mode and encoder direction at start-up.



OFF	ON
On power-up use Encoder mode	On power-up use motor mode
DEC Encoder direction switch	
RA Encoder direction switch	

## Part 6 Specifications

Size	180 x 103 x 45 mm		
Weight	Body, w/o cable, ?? grams		
Power	12 Volts DC $\pm 10\%$		
Current draw		Max	Average
	NJP	0.6A	0.4A
	EM200,EM10,EX	0.5A	0.3A
	GP/D,SP/DX,SE	0.8A	0.4A
Data Base	231 Bright stars & 110 Messier objects		
CPU	CMOS Z80 (HD647180X-6)		
Display	2 line x 16 character EL Backlit		
Input	7 tactile switches		
	Autoguider (eg SST or SBIG-ST4)		
Back-up	Lithium battery with ~ 1 year capacity		
RS-232C	One channel		
Input port	2 bit (max 6 bit). 0~5 volts		
Output port	8 bit (max 16 bit)		
	Output 12 Volt		
	Collector (?) 40mA		
Encoders	Maximum of three supported		
Encoder types	(1) GP Encoders (3000 pulses).....	GP/D, SE	
	(2) Pulsetech encoders (4320 pulses).....	NJP, EM200, EM10, EX	

The DOG's guarantee period is for one year from the date of purchase. If a problem occurs during the guarantee period it will be repaired by NS Kikaku free of charge unless the problem is due to misuse by the customer, in which case the customer will be charged for repair work. Keep the guarantee card in a safe place.

We are not responsible for any damage caused by the customer or a third party.

The contents of this manual and the appearance of the DOG may be changed without notice for the purposes of improvement.

If you develop PC application software for the DOG, please inform NS Kikaku, and we will consider commercialising the software/hardware which you have developed. In case we agree to commercialize your software, we will negotiate a fixed royalty.

We are very pleased to hear your opinion of the DOG and this manual etc. We will consider all suggestions for future development and improvement.

This is the DOG Manual	Made by NS Kikaku Ltd.	
Version 1.0	1991 01/01	DOG NS-2 series
Version 2.0	1991 03/10	DOG NS-3, NS-4
Version 3.1	1994 22/06	DOG NS-12 & Digital Display NS-10

DOG design, development and manufacture by NS Kikaku Ltd. T243-04 kanagawa  
ken, Ebina shi, kami Imaizumi 2-6-24-105. Tel/Fax 0462-35-4084

## Appendix A: Object list

<u>By Constellation</u>			<u>By Index</u>		
<u>R #</u>	<u>Star/Constellation</u>	<u>name</u>	<u>R #</u>	<u>Star/Constellation</u>	<u>name</u>
1	$\alpha$ Andromeda	Alpheratz	1	$\alpha$ Andromeda	Alpheratz
10	$\beta$ Andromeda	Mirach	2	$\beta$ Cassiopea	Caph
6	$\delta$ Andromeda		3	$\gamma$ Pegasus	Enif
15	$\gamma$ Andromeda	Almach	4	$\beta$ Hydrus	
207	$\alpha$ Aquila	Altair	5	$\alpha$ Phoenix	Ankaa
206	$\gamma$ Aquila	Tarazed	6	$\delta$ Andromeda	
208	$\theta$ Aquila		7	$\alpha$ Cassiopea	Shedar
201	$\zeta$ Aquila	Deneb el Okab	8	$\beta$ Cetus	Diphda
222	$\alpha$ Aquilus	Sadalmelik	9	$\gamma$ Cassiopea	
218	$\beta$ Aquilus	Sadalsuud	10	$\beta$ Andromeda	Mirach
227	$\delta$ Aquilus	Skat	11	$\delta$ Cassiopea	Ruchbah
181	$\alpha$ Ara		12	$\alpha$ Eridanus	Achernar
178	$\beta$ Ara		13	$\beta$ Aries	Sheraton
172	$\zeta$ Ara		14	$\alpha$ Hydrus	
16	$\alpha$ Aries	Hamal	15	$\gamma$ Andromeda	Almach
13	$\beta$ Aries	Sheraton	16	$\alpha$ Aries	Hamal
40	$\alpha$ Auriga	Capella	17	$\beta$ Triangulum	
54	$\beta$ Auriga	Menkalinan	18	$\sigma$ Cetus	Mira
35	$\varepsilon$ Auriga	Almaaz	19	$\alpha$ Ursa Minor	Polaris
37	$\zeta$ Auriga	Hoedus	20	$\phi$ Eridanus	Acamar
34	$\iota$ Auriga		21	$\alpha$ Cetus	Menkar
55	$\theta$ Auriga		22	$\gamma$ Perseus	
135	$\alpha$ Boötes	Arcturus	23	$\beta$ Perseus	Algol
141	$\varepsilon$ Boötes	Izar	24	$\alpha$ Perseus	Mirfak
136	$\gamma$ Boötes	Haris or Seginus	25	$\delta$ Perseus	
130	$\eta$ Boötes	Mufrid	26	$\eta$ Taurus	Alcyone
152	$\alpha$ Borealis	Alphekka	27	$\gamma$ Hydrus	
64	$\alpha$ Canis Major	Sirius	28	$\zeta$ Perseus	Menkib
58	$\beta$ Canis Major	Mirzam	29	$\varepsilon$ Perseus	
69	$\delta$ Canis Major	Wezen	30	$\gamma$ Eridanus	Zaurak
67	$\varepsilon$ Canis Major	Adhara	31	$\alpha$ Dorado	Kraz
71	$\eta$ Canis Major	Aludra	32	$\alpha$ Taurus	Aldebaran
68	$\omicron$ Canis Major		33	$\pi$ Orion	
57	$\zeta$ Canis Major	Furud	34	$\iota$ Auriga	
75	$\alpha$ Canis Minor	Procyon	35	$\varepsilon$ Auriga	Almaaz
72	$\beta$ Canis Minor	Gomeisa	36	$\varepsilon$ Lepus	
121	$\alpha$ Cannes Venatici	Cor Coroli	37	$\eta$ Auriga	Hoedus
209	$\beta$ Capricornus	Dabih	38	$\beta$ Eridanus	Cursa
220	$\delta$ Capricornus	Deneb Algiedi	39	$\beta$ Orion	Rigel
60	$\alpha$ Carina	Canopus	40	$\alpha$ Auriga	Capella
85	$\beta$ Carina	Miaplacidus	41	$\gamma$ Orion	Bellatrix
80	$\varepsilon$ Carina	Avior	42	$\beta$ Taurus	El Nath
86	$\iota$ Carina	Turais	43	$\beta$ Lepus	

90	η Carina		44	δ Orion	Mintaka
93	ν Carina		45	α Lepus	
97	θ Carina		46	ι Orion	
7	α Cassiopea	Shedar	47	ε Orion	Alnilam
2	β Cassiopea	Caph	48	ζ Taurus	
11	δ Cassiopea	Ruchbah	49	α Columba	Phaet
9	γ Cassiopea		50	ζ Orion	Alnitak
138	α Centaurus	Toliman	51	κ Orion	Saiph
132	β Centaurus	Hadar (Agena)	52	β Columba	Wezn
107	δ Centaurus		53	α Orion	Betelgeus
127	ε Centaurus		54	β Auriga	Menkalinan
116	γ Centaurus		55	θ Auriga	
137	η Centaurus		56	η Gemini	Tejat prior
124	ι Centaurus		57	ζ Canis Major	Furud
145	κ Centaurus		58	β Canis Major	Mirzam
104	λ Centaurus		59	μ Gemini	Tejat Posterior
129	μ Centaurus		60	α Carina	Canopus
134	θ Centaurus	Menkent	61	γ Gemini	Alhena
131	ζ Centaurus		62	ν Puppis	
216	α Cepheus	Alderamin	63	ε Gemini	Mebstuta
217	β Cepheus	Alfirk	64	α Canis Major	Sirius
231	γ Cepheus	Er Rai	65	α Pictor	
21	α Cetus	Menkar	66	τ Puppis	
8	β Cetus	Diphda	67	ε Canis Major	Adhara
18	σ Cetus	Mira	68	ο Canis Major	
140	α Circinus		69	δ Canis Major	Wezen
49	α Columba	Phaet	70	π Puppis	
52	β Columba	Wezn	71	η Canis Major	Aludra
114	β Corvus		72	β Canis Minor	Gomeisa
112	δ Corvus		73	σ Puppis	
108	ε Corvus		74	α Gemini	Casor
110	γ Corvus		75	α Canis Minor	Procyon
111	α Crux	Acrux	76	β Gemini	Pollux
119	β Crux	becrux	77	ζ Puppis	Naos
109	δ Crux		78	ρ Puppis	
113	γ Crux	Gacrux	79	γ Vela	Suhail al Mulif
213	α Cygnus	Deneb	80	ε Carina	Avior
204	β Cygnus	Albireo	81	δ Vela	
205	δ Cygnus		82	ζ Hydra	
214	ε Cygnus	Gienah	83	ι Ursa Major	
210	γ Cygnus	Sadr	84	λ Vela	Suhail
215	ζ Cygnus		85	β Carina	Miaplacidus
31	α Dorado	Kraz	86	ι Carina	Turais
180	β Draco	Restuba	87	α Lynx	
203	δ Draco	Nodus	88	κ Vela	
		Secundus			
189	γ Draco	Eltanin	89	α Hydra	Alphard
162	η Draco		90	η Carina	
151	ι Draco		91	θ Ursa Major	
173	ζ Draco	Nodus I	92	ε Leo	
12	α Eridanus	Achernar	93	ν Carina	

38	$\beta$ Eridanus	Cursa	94	$\alpha$ Leo	Regulus
20	$\phi$ Eridanus	Acamar	95	$\gamma$ Leo	Algieba
30	$\gamma$ Eridanus	Zaurak	96	$\mu$ Ursa Major	
74	$\alpha$ Gemini	Casor	97	$\theta$ Carina	
76	$\beta$ Gemini	Pollux	98	$\mu$ Vela	
63	$\varepsilon$ Gemini	Mebsuta	99	$\nu$ Hydra	
61	$\gamma$ Gemini	Alhena	100	$\beta$ Ursa Major	Merak
56	$\eta$ Gemini	Tejat prior	101	$\alpha$ Ursa Major	Dubhe
59	$\mu$ Gemini	Tejat Posterior	102	$\varphi$ Ursa Major	
223	$\alpha$ Grus	Altair	103	$\delta$ Leo	Zosma
225	$\beta$ Grus		104	$\lambda$ Centaurus	
221	$\gamma$ Grus	Al Dhanab	105	$\beta$ Leo	Denebola
164	$\beta$ Hercules	Kornephorus	106	$\gamma$ Ursa Major	Phad
175	$\delta$ Hercules	Sarin	107	$\delta$ Centaurus	
176	$\pi$ Hercules		108	$\varepsilon$ Corvus	
167	$\zeta$ Hercules		109	$\delta$ Crux	
89	$\alpha$ Hydra	Alphard	110	$\gamma$ Corvus	
123	$\gamma$ Hydra		111	$\alpha$ Crux	Acrux
99	$\nu$ Hydra		112	$\delta$ Corvus	
133	$\pi$ Hydra		113	$\gamma$ Crux	Gacrux
82	$\zeta$ Hydra		114	$\beta$ Corvus	
14	$\alpha$ Hydrus		115	$\alpha$ Musca	
4	$\beta$ Hydrus		116	$\gamma$ Centaurus	
27	$\gamma$ Hydrus		117	$\gamma$ Virgo	Porrima
212	$\alpha$ Indus		118	$\beta$ Musca	
94	$\alpha$ Leo	Regulus	119	$\beta$ Crux	becrux
105	$\beta$ Leo	Denebola	120	$\varepsilon$ Ursa Major	Alioth
103	$\delta$ Leo	Zosma	121	$\alpha$ Cannes Venatici	Cor Coroli
92	$\varepsilon$ Leo		122	$\varepsilon$ Virgo	Vindemiatrix
95	$\gamma$ Leo	Algieba	123	$\gamma$ Hydra	
45	$\alpha$ Lepus		124	$\iota$ Centaurus	
43	$\beta$ Lepus		125	$\zeta$ Ursa Major	Mizar
36	$\varepsilon$ Lepus		126	$\alpha$ Virgo	Spica
142	$\alpha$ Libra	Zubenelgelubi	127	$\varepsilon$ Centaurus	
147	$\beta$ Libra	Zubeneschema	128	$\eta$ Ursa Major	
		li			
146	$\sigma$ Libra	Brachium	129	$\mu$ Centaurus	
139	$\alpha$ Lupus		130	$\eta$ Boötes	Mufrid
144	$\beta$ Lupus		131	$\zeta$ Centaurus	
150	$\delta$ Lupus		132	$\beta$ Centaurus	Hadar (Agena)
153	$\gamma$ Lupus		133	$\pi$ Hydra	
87	$\alpha$ Lynx		134	$\theta$ Centaurus	Menkent
196	$\alpha$ Lyra	Vega	135	$\alpha$ Boötes	Arcturus
199	$\gamma$ Lyra	Sulaphat	136	$\gamma$ Boötes	Haris or Seginus
115	$\alpha$ Musca		137	$\eta$ Centaurus	
118	$\beta$ Musca		138	$\alpha$ Centaurus	Toliman
183	$\alpha$ Ophiuchus	Ras Alhague	139	$\alpha$ Lupus	
186	$\beta$ Ophiuchus	Cebalrai	140	$\alpha$ Circinus	
159	$\delta$ Ophiuchus	Yed Prior	141	$\varepsilon$ Boötes	Izar
160	$\varepsilon$ Ophiuchus	Yed Posterior	142	$\alpha$ Libra	Zubenelgelubi
174	$\eta$ Ophiuchus	Sabik	143	$\beta$ Ursa Minor	Kachab

171	$\kappa$ Ophiuchus		144	$\beta$ Lupus	
177	$\theta$ Ophiuchus		145	$\kappa$ Centaurus	
166	$\zeta$ Ophiuchus		146	$\sigma$ Libra	Brachium
53	$\alpha$ Orion	Betelgeus	147	$\beta$ Libra	Zubeneschemali
39	$\beta$ Orion	Rigel	148	$\gamma$ Triangulum Australe	
44	$\delta$ Orion	Mintaka	149	$\gamma$ Ursa Minor	Pherkad
47	$\epsilon$ Orion	Alnilam	150	$\delta$ Lupus	
41	$\gamma$ Orion	Bellatrix	151	$\iota$ Draco	
46	$\iota$ Orion		152	$\alpha$ Borealis	Alphekka
51	$\kappa$ Orion	Saiph	153	$\gamma$ Lupus	
33	$\pi$ Orion		154	$\alpha$ Serpens	Unukalhai
50	$\zeta$ Orion	Alnitak	155	$\beta$ Triangulum Australe	
211	$\alpha$ Pavo	Peacock	156	$\pi$ Scorpio	
230	$\alpha$ Pegasus	Markab	157	$\delta$ Scorpio	Dschubba
229	$\beta$ Pegasus	Scheat	158	$\beta$ Scorpio	Graffius
219	$\epsilon$ Pegasus	Matar	159	$\delta$ Ophiuchus	Yed Prior
3	$\gamma$ Pegasus	Enif	160	$\epsilon$ Ophiuchus	Yed Posterior
226	$\eta$ Pegasus		161	$\sigma$ Scorpio	
24	$\alpha$ Perseus	Mirfak	162	$\eta$ Draco	
23	$\beta$ Perseus	Algol	163	$\alpha$ Scorpio	Antares
25	$\delta$ Perseus		164	$\beta$ Hercules	Kornephorus
29	$\epsilon$ Perseus		165	$\tau$ Scorpio	
22	$\gamma$ Perseus		166	$\zeta$ Ophiuchus	
28	$\zeta$ Perseus	Menkib	167	$\zeta$ Hercules	
5	$\alpha$ Phoenix	Ankaa	168	$\alpha$ Triangulum Australe	Atria
65	$\alpha$ Pictor		169	$\epsilon$ Scorpio	
228	$\alpha$ Piscis Austrinis	Fomalhaut	170	$\mu$ Scorpio	
62	$\nu$ Puppis		171	$\kappa$ Ophiuchus	
70	$\pi$ Puppis		172	$\zeta$ Ara	
78	$\rho$ Puppis		173	$\zeta$ Draco	Nodus I
73	$\sigma$ Puppis		174	$\eta$ Ophiuchus	Sabik
66	$\tau$ Puppis		175	$\delta$ Hercules	Sarin
77	$\zeta$ Puppis	Naos	176	$\pi$ Hercules	
192	$\delta$ Sagittarius	Kaus Meridionalis	177	$\theta$ Ophiuchus	
194	$\epsilon$ Sagittarius	Kaus Australis	178	$\beta$ Ara	
197	$\phi$ Sagittarius		179	$\nu$ Scorpio	
190	$\gamma$ Sagittarius	Al Nasl	180	$\beta$ Draco	Restuba
191	$\eta$ Sagittarius		181	$\alpha$ Ara	
195	$\lambda$ Sagittarius		182	$\kappa$ Scorpio	
202	$\pi$ Sagittarius		183	$\alpha$ Ophiuchus	Ras Alhague
198	$\sigma$ Sagittarius	Nunki	184	$\theta$ Scorpio	
200	$\zeta$ Sagittarius	Ascella	185	$\lambda$ Scorpio	Shaula
188	G Scorpio	HR6630	186	$\beta$ Ophiuchus	Cebalrai
163	$\alpha$ Scorpio	Antares	187	$\iota$ Scorpio	
158	$\beta$ Scorpio	Graffius	188	G Scorpio	HR6630
157	$\delta$ Scorpio	Dschubba	189	$\gamma$ Draco	Eltanin
169	$\epsilon$ Scorpio		190	$\gamma$ Sagittarius	Al Nasl
187	$\iota$ Scorpio		191	$\eta$ Sagittarius	



182	$\kappa$ Scorpio		192	$\delta$ Sagittarius	Kaus Meridionalis
185	$\lambda$ Scorpio	Shaula	193	$\eta$ Serpens	
170	$\mu$ Scorpio		194	$\epsilon$ Sagittarius	Kaus Australis
179	$\nu$ Scorpio		195	$\lambda$ Sagittarius	
156	$\pi$ Scorpio		196	$\alpha$ Lyra	Vega
184	$\theta$ Scorpio		197	$\phi$ Sagittarius	
161	$\sigma$ Scorpio		198	$\varsigma$ Sagittarius	Nunki
165	$\tau$ Scorpio		199	$\gamma$ Lyra	Sulaphat
154	$\alpha$ Serpens	Unukalhai	200	$\zeta$ Sagittarius	Ascella
193	$\eta$ Serpens		201	$\zeta$ Aquila	Deneb el Okab
32	$\alpha$ Taurus	Aldebaran	202	$\pi$ Sagittarius	
42	$\beta$ Taurus	El Nath	203	$\delta$ Draco	Nodus secundus
26	$\eta$ Taurus	Alcyone	204	$\beta$ Cygnus	Albireo
48	$\zeta$ Taurus		205	$\delta$ Cygnus	
17	$\beta$ Triangulum		206	$\gamma$ Aquila	Tarazed
168	$\alpha$ Triangulum	Atria	207	$\alpha$ Aquila	Altair
	Australe				
155	$\beta$ Triangulum		208	$\theta$ Aquila	
	Australe				
148	$\gamma$ Triangulum		209	$\beta$ Capricornus	Dabih
	Australe				
224	$\alpha$ Tucana		210	$\gamma$ Cygnus	Sadr
101	$\alpha$ Ursa Major	Dubhe	211	$\alpha$ Pavo	Peacock
100	$\beta$ Ursa Major	Merak	212	$\alpha$ Indus	
120	$\epsilon$ Ursa Major	Alioth	213	$\alpha$ Cygnus	Deneb
106	$\gamma$ Ursa Major	Phad	214	$\epsilon$ Cygnus	Gienah
128	$\eta$ Ursa Major		215	$\zeta$ Cygnus	
83	$\iota$ Ursa Major		216	$\alpha$ Cepheus	Alderamin
102	$\phi$ Ursa Major		217	$\beta$ Cepheus	Alfirk
96	$\mu$ Ursa Major		218	$\beta$ Aquilus	Sadalsuud
91	$\theta$ Ursa Major		219	$\epsilon$ Pegasus	Matar
125	$\zeta$ Ursa Major	Mizar	220	$\delta$ Capricornus	Deneb Algiedi
19	$\alpha$ Ursa Minor	Polaris	221	$\gamma$ Grus	Al Dhanab
143	$\beta$ Ursa Minor	Kachab	222	$\alpha$ Aquilus	Sadalmelik
149	$\gamma$ Ursa Minor	Pherkad	223	$\alpha$ Grus	Altair
81	$\delta$ Vela		224	$\alpha$ Tucana	
79	$\gamma$ Vela	Suhail al Mulif	225	$\beta$ Grus	
88	$\kappa$ Vela		226	$\eta$ Pegasus	
84	$\lambda$ Vela	Suhail	227	$\delta$ Aquilus	Skat
98	$\mu$ Vela		228	$\alpha$ Piscis Austrinis	Fomalhaut
126	$\alpha$ Virgo	Spica	229	$\beta$ Pegasus	Scheat
122	$\epsilon$ Virgo	Vindemiatrix	230	$\alpha$ Pegasus	Markab
117	$\gamma$ Virgo	Porrina	231	$\gamma$ Cepheus	Er Rai