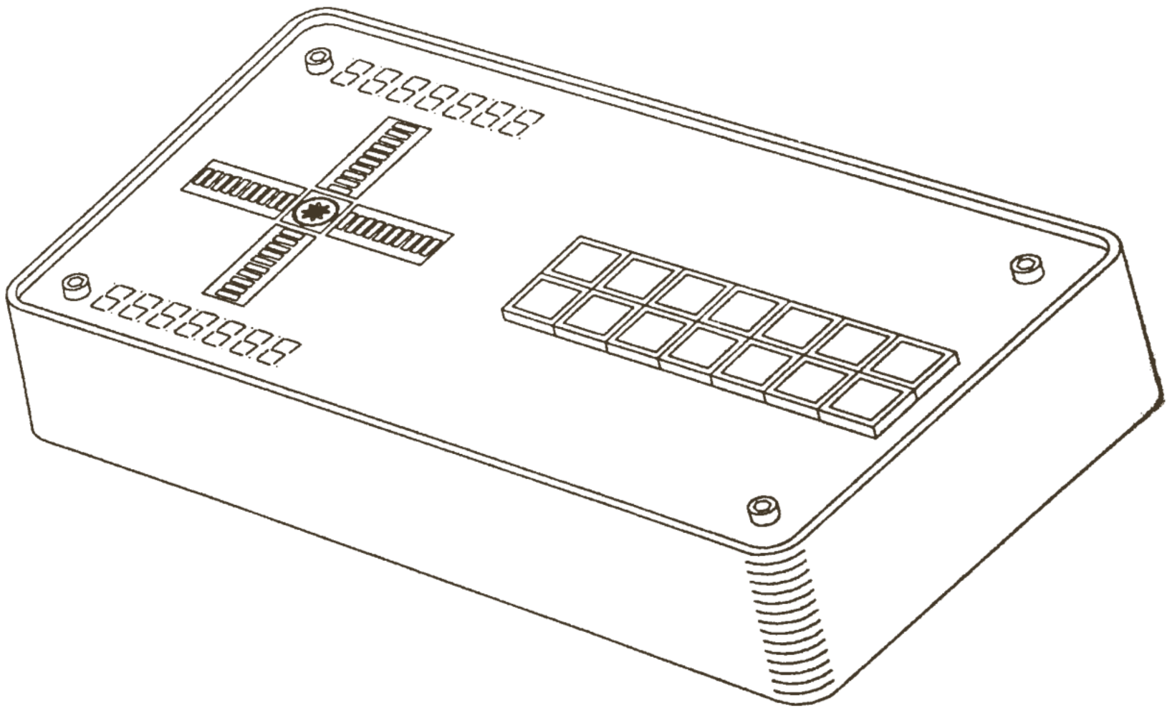
OPERATING INSTRUCTIONS
MEADE "CAT" T.M.
COMPUTER AIDED TELESCOPE

#9008: For Meade 8" Model 2080/LX6 Schmidt-Cassegrain Telescopes
#9010: For Meade 10" Model 2120/LX6 Schmidt-Cassegrain Telescopes
#9008-RS: For Meade 8" Model 2080/LX6 Schmidt-Cassegrain Telescopes
#9010-RS: For Meade 10" Model 2120/LX6 Schmidt-Cassegrain Telescopes



Assembled in 2020 by Rick T. Many thanks to Lars L. and his friend who provided the images. If you have a better-quality scan of this manual, please contact rick@deepskies.com!

Meade Instruments Corporation
1675 Toronto Way, Costa Mesa, California 92626 U.S.A. (714) 556-2291

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0° 24' 24 50

COMPLETE FOR FUTURE REFERENCE

OBSERVING SITE	LONG	LAT	COMMENTS
AVENELLS	000° 08' W	52° 04' N	[illegible] 52 [illegible]
WENDY + PETER'S HAMPSTEAD [illegible]	002° 16' W	51° 51'	51° 51'
	[illegible]° 25' W	° '	
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GMT is your local time plus the value under your time zone (see table below). Use the top row during Standard Time and the bottom row during Daylight Savings Time. If the result is 24 hrs or more, subtract 24 hrs and the GMT date is 1 day later than your local date.

ZONE ⟶	HAWAII	PACIFIC	MOUNTAIN	CENTRAL	EASTERN
STANDARD	+ 10 hrs	+ 8 hrs	+ 7 hrs	+ 6 hrs	+ 5 hrs
DAYLIGHT	+ 9 hrs	+ 7 hrs	+ 6 hrs	+ 5 hrs	+ 4 hrs

Example: You live in the Pacific Time Zone and it is currently 9:15pm local time on June 30th, 1988 and you are on Daylight Savings Time. The GMT is your local time (21:15) plus 7 hours = 28:15. That's more than 24 hours, so subtract 24 hours to get the GMT time (04:15) and add 1 to your local date to get the GMT date (July 1, 1988).

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CHAPTER 1 - INTRODUCTION

A. What is the CAT?

The CAT is a Computer Aided Telescope accessory that can be adapted to virtually any telescope with an equatorial mounting. Special mounting hardware has been developed for Meade 8" 2080/LX6 and 10" 2120/LX6 Schmidt-Cassegrain telescopes. The mounting hardware supplied is easy to install with hand tools and no modifications to the existing telescope are required. The CAT is powered directly from the LX6 Power Panel (see the LX6 Supplementary Instructions for details and power requirements).

B. What does the CAT do?

The CAT can do many useful things. The most basic are:

1. Keep track of the sky coordinates (RA & DEC) that your scope is pointed at. In this respect the CAT is a higher resolution equivalent of setting circles plus digital readout.

2. Keep track of the coordinates and characteristics of thousands of astronomical objects. So the CAT serves the same function as star charts plus reference books, but in a much more convenient form.

3. Keep track of miscellaneous information that is necessary or useful during observing, like time, date, site location, exposure time, etc.

4. Identify the object closest to the center of the field and tell how many other **CNGCs** are in the field (the **FIELD** command).

5. Automatically select objects to view based upon characteristics that you specify (type, brightness, size, visual quality, minimum altitude, etc.) in a convenient sequence that minimizes the distance between objects. The display describes them and the **RED CROSS** leads you to them, one after the other. This is the **FIND** command.

6. Compute information that is not directly available (altitude, azimuth, hour angle).

As you read this manual, you will find that the CAT has many capabilities not mentioned above.

C. Features

- The CAT has the following object libraries in the internal system memory:

  The first object library is the **CNGC** library, which is a catalog of deep-sky objects. The entries in this library are referred to as **CNGC 1** through **CNGC 7840**.

  The second object library consists of a **STAR** catalog, which is a database of 351 stars. Reference to the **STAR** database is made from **STAR 1** through **STAR 351**.

  The third library is the Messier library. This object library consists of the Messier catalog of deep-sky objects, and is referred to as **M 1** through **M 110**.

  Finally, the fourth object library consists of the planets Mercury through Pluto, and is referred to as **STAR 901** through **STAR 909**.*

- Detailed information is displayed for each object, making star charts and atlases a thing of the past.
- 14, 9-segment LED's are used to display telescope position and numerical information.
- 14 command keys with audible, visual, and tactile feedback, for entering information and commands into the CAT.
- 112 bar LED's are used to display command key meanings and object information.
- 4, 10-element LED's are used to form a **RED CROSS** to indicate telescope position relative to the object of interest.
- The **RED CROSS** is a graphic display of the direction and distance to an object. Just move your scope to make the red lights converge - the object is centered! You can find **hundreds** of objects per hour this way!
- The CAT is lightweight, compact, and consumes **less than 10 Watts of power.**
- *High precision optical shaft encoders are incorporated to keep track of telescope position,* ***even if the telescope is moved manually.***
- *Precision optical encoders monitor RA and DEC motion to a resolution many times higher than conventional setting circles.* The CAT resolves .5m in RA and 3' in DEC; that's 1/8° in RA and 1/20° in DEC.
- *Installation of the CAT takes less than half an hour on most telescopes, with only simple hand tools.*
- *The CAT has a built-in exposure timer, with a "time-out" alarm.*
- *The complete listing of the* **CNGC**, *containing 7840 deep-sky entries, is available in a durable notebook.*
- *The CAT can be interfaced with printers and computers with an optional RS-232 interface.*

* *Planetary data is supplied through the year 1996. After this time, new ROM's will be available. See your* **Meade dealer** *for new updates.*

D. Important Preliminaries

- Be sure to read this manual before attempting to assemble or use your CAT

- Assembly and testing should be carried out indoors (or in an observatory) with your scope set up next to a cleared table.

- Try out ALL the commands indoors (after testing). Do not operate your CAT for the first time under the night sky or at a remote site.

- Handle the encoder mechanics with care. The encoders contain glass discs which may break if dropped. The CAT warranty does not include broken encoders due to mishandling. Replacement encoders are expensive, so take extra precautions when handling.

- Use only Meade cables to power your CAT.

- Be sure the power cable is only connected to power sources for which they are intended.

- When you are familiar with the CAT's basic operation, try out the commands indoors a few times before taking it out for an observing session. It's fun, and you won't be sorry!

- Be sure you carry out the steps in Chapter 5 - First Night Out - before you try to use your CAT. Alignment and adjustment steps are described that must be carried out for the CAT to work properly!

- If you live "down under" or plan to take your scope to the southern hemisphere, a few items (in the assembly procedure particularly) are different from the normal instructions, but not in a different order. This manual tries to note them all.

- The term **Pole Star** refers to **Polaris** (STAR 19) in the northern hemisphere and to **Sigma Octans** (STAR 351) in the southern hemisphere.

- Fill in the observing site table in the inside front cover of this manual with the longitude & latitude of all sites you observe from. Otherwise, you'll need to refer to maps that show the longitude and latitude of your observing sites.

- If your CAT seems to be functioning improperly, check this manual carefully and repeat the command or process that causes the symptom. In most cases the CAT is operating properly and you have misunderstood the documentation. If, however, you still think you have found a "bug", contact Meade.

CHAPTER 2 - UNPACKING

standard LX6-CAT is packed in one box, and includes:

- Console / Tripod Tray.
- RA Encoder.
- DEC Encoder.
- Encoder Cables.
- 1.5 Amp Wall Adapter (use in place of the wall adapter supplied with the telescope).
- Junction Box.
- Belts, pulleys, and hardware.
- User's Manual.

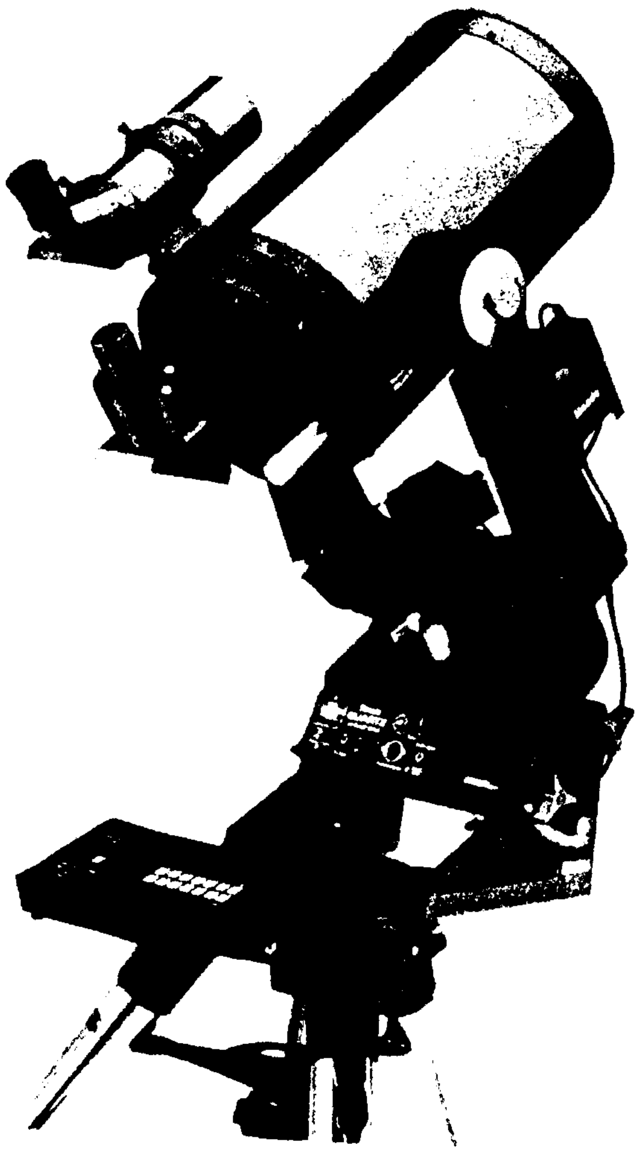


Fig 1: The CAT and a Meade Model 2080

Carefully unpack the carton and compare the contents to the packing list supplied. Identify each part (especially the parts in the "Small Parts Bag") to be sure you can find the correct part during the installation procedures.

A. CAT Console / Tripod Tray

The CAT console is an 8" x 4" x 1" enclosure that houses a special purpose computer that you control with 14 keys. More than 100 L.E.D. displays are used to keep you informed and guide you through the commands. These displays are not visible until the unit is turned on. (The CAT can be turned ON when it is not connected to the encoders, but always keep your hands away from the encoder connectors. **Static discharges can destroy electronics in the console and encoders.**

The console is attached to a combination tripod tray / stand, ready to mount directly to the tripod of the LX6 telescopes for maximum convenience. It can also be adapted to other tripods and piers. Alternatively, the tripod tray acts as a stand that can be set on any flat surface.

The CAT runs on 9-13 Volts DC at less than 1 Amp, and gets its power from the LX6 Power Panel. The console has no separate ON/OFF switch, but the LX6 ON/OFF switch controls both the telescope and the CAT.

WARNING!

The LX6-CAT is supplied with a 1.5 Amp Wall Adapter. When using the LX6 telescope with the CAT, this 1.5 Amp wall adapter must be used in place of the standard 1.0 Amp wall adapter (supplied with the telescope). **Failure to use the 1.5 Amp wall adapter can result in damage to the telescope, the CAT or both.**

B. RA Encoder Mechanics

The RA Encoder system consists of the following parts:

1. The RA Encoder with small timing pulley.

2. A large timing pulley and short shoulder bolt.

3. A timing belt to couple the small pulley to the large pulley.

C. DEC Encoder Mechanics

The DEC Encoder system and consists of the following parts:

1. The DEC Encoder with small timing pulley.

2. A large timing pulley.

3. A timing belt to couple the small pulley to the large pulley.

CHAPTER 3 - INSTALLATION

While the following instructions may seem a bit intimidating at first glance, installation of the CAT is actually very straight forward, and, after reading these instructions, will only require about 15 to 30 minutes.

Installation of the CAT involves four basic steps: Attaching the two optical encoders and pulley systems; connecting a plug inside the telescope's drive base; attaching the Junction Box into the fork arm; and mechanically aligning the mount. No special tools are needed.

Disconnect the telescope from all power sources before proceeding.

These instructions apply to both the 8" Model 2080/LX6 and 10" Model 2120/LX6.

A. Installing the Declination Encoder

Refer to Fig. 2 for the following instructions.

1. Remove the right hand fork arm Dec. setting circle and cover by removing the knurled knob located at the center of the setting circle. These parts will not be used, and may be discarded. (The right hand fork arm is the one without the Dec. slow motion knob and locking lever.) Save any spacers that are behind the setting circle.

2. Remove the plastic setting circle pointer located on the flat surface of the fork arm. Underneath this pointer is a tapped hole. Also remove the plastic hole plug covering the Dec. encoder mounting hole (#7, Fig. 2).

3. Thread a large hex nut onto the encoder with the short cable and place the encoder through the slot in the fork arm. (Note, the 10" LX6 does not require a large hex nut.) Thread a small hex nut onto the encoder. Adjust the inside hex nut so that the outside hex nut is just flush with the top of the threads on the encoder. Hand tighten the hex nut. Carefully rotate the telescope in Declination to check that the telescope clears the encoder. Readjust the two hex nuts if necessary.

4. Slide the small 24-tooth pulley onto the encoder shaft. Make sure the hub of the pulley is toward the encoder. Position the pulley so that the hub does not quite touch the shaft support housing or hex nut (about 1/64"). This will insure that the pulley rotates freely and does not "drag" on the encoder housing. Tighten the set screw to a firm feel only. Do not overtighten, as this may strip the threads of the pulley.

5. Thread the Dec shaft extension (#2, Fig. 2) into the tube adapter, where the Dec. setting circle knob was located and tighten firmly. Replace any spacers removed in Step 1, above. Make sure the telescope rotates freely in Declination.

6. Slide the large 120-tooth pulley with the three set screws onto the Dec shaft extension. Position this pulley so that it is directly in line with the 24-tooth pulley. Tighten the three set screws to a firm feel only. Again, do not overtighten.

7. Place the 165-tooth timing belt onto the two pulleys.

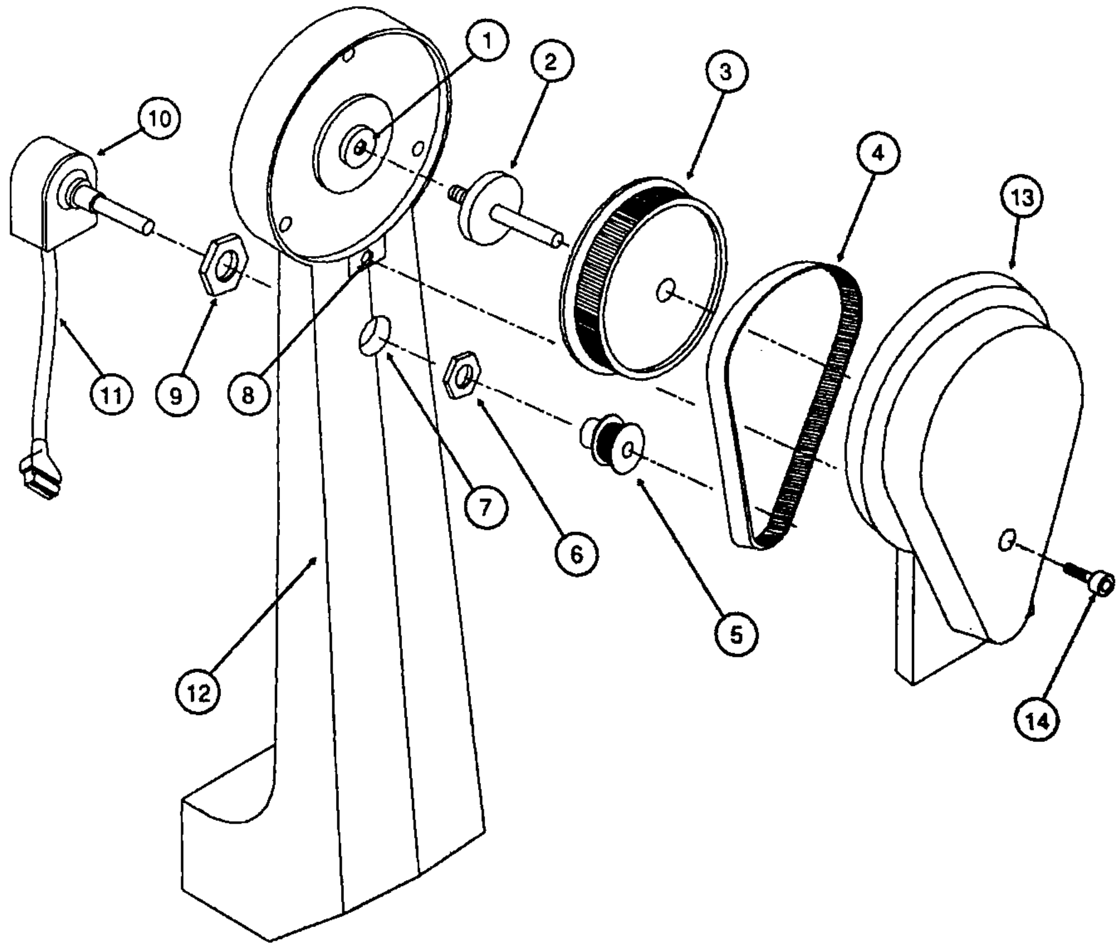
8. Move the encoder assembly in the fork arm slot until the timing belt is just snug. Using the special wrench supplied, carefully tighten the outside hex nut so that the encoder will not rotate as the telescope is moved in Declination.

After tightening the hex nut, check the tightness of the belt. It should have about 1/8" of movement in the belt. The belt should be just tight enough so that any motion in Declination immediately moves the encoder pulley. If it is too loose, there will be "play" between the two pulleys and the timing belt, resulting in the position readouts not being as responsive as they should be. Worse, however, is having the timing belt too tight. This will create excessive wear on the encoder, resulting in shortened encoder life.

If the timing belt tension is not correct, loosen the hex nut and reposition the encoder.

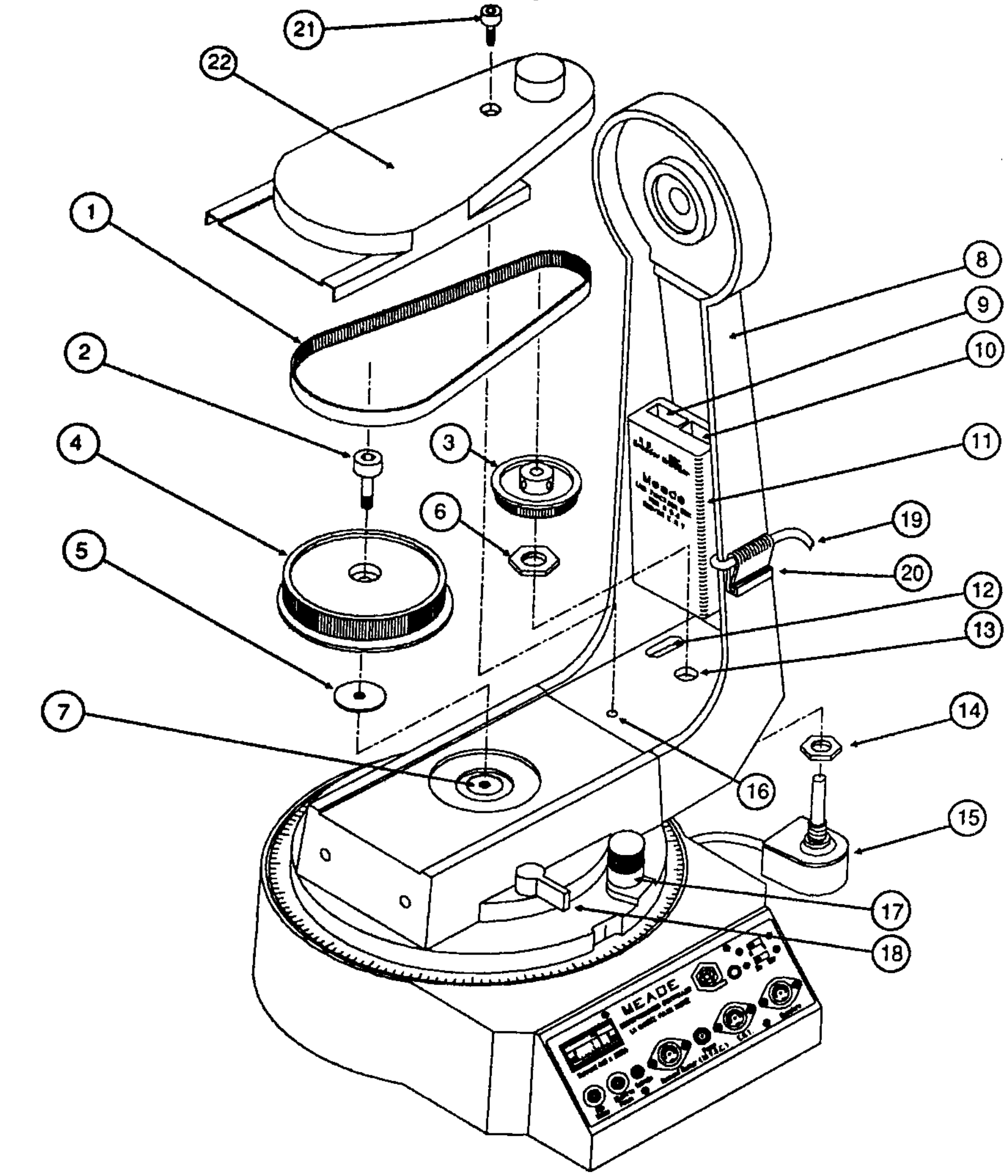
9. Position the Dec encoder cover onto the fork arm and thread the mounting bolt into the encoder mounting hole. Lightly tighten this bolt.

Installation of the Declination encoder is now complete.



(1) Dec. Pulley Mounting Hole
(2) Dec. Shaft Extension
(3) 120-Tooth Pulley
(4) 165-Tooth Timing Belt
(5) 24-Tooth Encoder Pulley
(6) Small Outer Hex Nut
(7) Dec. Encoder Mounting Hole
(8) Dec. Encoder Cover Mounting Hole
(9) Large Inner Hex Nut
(10) Declination Encoder
(11) Encoder Cable
(12) Right-Hand Fork Arm
(13) Dec. Encoder Cover
(14) Dec. Encoder Cover Mounting Bolt

Fig. 2: Dec. Encoder Installation



(1) R.A. Timing Belt
(2) Shoulder Bolt
(3) 60-Tooth Pulley
(4) 120-Tooth Pulley
(5) Flat Washer
(6) Large Upper Hex Nut
(7) R.A. Pulley Mounting Hole
(8) Right Fork Arm
(9) R.A. Encoder Plug
(10) Dec. Encoder Plug
(11) Junction Box
(12) Encoder Cable Slot
(13) R.A. Encoder Mounting Hole
(14) Small Lower Hex Nut
(15) R.A. Encoder
(16) R.A. Encoder Cover Mounting Hole
(17) R.A. Slow Motion Knob
(18) R.A. Lock Lever
(19) Junction Box Encoder Cord
(20) Cable Tie
(21) RA Encoder Mounting Bolt
(22) RA Encoder Cover

Fig. 3: R.A. Encoder Installation

B. Installing the Right Ascension Encoder

Refer to Fig. 3 for the following installation instructions:

1. Remove the plastic Polar Cover from the center of the RA drive base, and the plastic hole plug covering the R.A. encoder mounting hole (#13, Fig. 3).

2. Remove the standard flat washer located in the center of the drive base by removing the hex-head bolt. Replace this washer with the new one supplied (#5, Fig. 3).

3. Place the large pulley with the counterbore over the center of the RA drive base with the hub down (against the washer on top of the R.A. axis). Put the shoulder (#2, Fig. 3) bolt through the pulley and washer and thread it into the end of the RA axis until it holds the pulley in place.

4. The R.A. encoder is the one with the long cable. Thread the cable through the Encoder Cable slot (#12, Fig. 3) from the bottom side.

5. Thread the small hex nut (#14, Fig. 3) onto the R.A. encoder and place the encoder through the slot in the fork arm. Rotate the encoder so that the cable points toward the inside corner of the fork arm. Thread the large hex nut onto the encoder. Adjust the lower hex nut so that the upper hex nut is just flush with the top of the threads on the encoder. Hand tighten the upper hex nut.

6. Slide the small 60-tooth pulley onto the encoder shaft. Make sure the hub of the pulley is away from the encoder. Position the pulley so that it does not quite touch the floor of the fork arm or hex nut (about 1/64"). This will insure that the pulley rotates freely and does not "drag" on the encoder housing. Tighten the three set screws to a firm feel only. Do not overtighten, as this may strip the threads of the pulley.

7. Place the R.A. timing belt (215-tooth for the 8" and 255-tooth for the 10") onto the two pulleys.

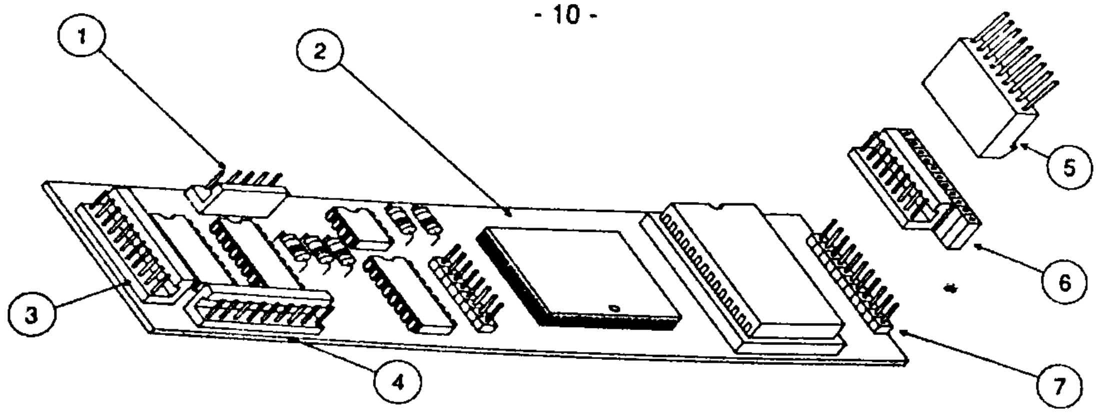
8. Move the encoder assembly in the fork arm slot until the timing belt is just snug. Using the special wrench supplied, carefully tighten the small hex nut so that the encoder will not rotate as the telescope is moved in RA.

After tightening the hex nut, check the tightness of the belt. It should have about 1/8" of movement in the belt. The belt should be just tight enough so that any motion in Right Ascension immediately moves the encoder pulley. If it is too loose, there will be "play" between the two pulleys and the timing belt, resulting in the position readouts not being as responsive as they should be. Worse, however, is having the timing belt too tight. This will create excessive wear on the encoder, resulting in shortened encoder life.

If the timing belt tension is not correct, loosen the hex nut and reposition the encoder.

9. Position the R.A. encoder cover onto the fork arm and thread the RA encoder cover mounting bolt into the encoder cover mounting hole. Lightly tighten this bolt.

Installation of the R.A. encoder is now complete.



(1) 5-Pin Motor Connerctor
(2) Base Controller PCB
(3) 11-Pin Power Panel Connector
(4) 9-Pin Power Panel Connector
(5) Power Panel Connector
(6) Connector Adapter
(7) Connector Pins

Fig. 4: LX6 Drive Electronics

C. Connecting the Encoder Plug

The next step in the addition of the LX6-CAT, is connecting a cable inside the telescope drive base. Refer to Fig. 4 for the following instructions:

1. Remove the four phillips-head screws that hold the Power Panel in place. Carefully move the Power Panel aside, revealing the Base Controller PCB. You will notice a loose cable coming from the back side of the Power Panel. This cable will plug into the Base Controller PCB (#2, Fig. 4).

2. Using the special connector adapter (# 6, Fig. 4), plug the loose 9-pin cable (#5, Fig. 4) onto the Base Controller PCB Connector Pins. Be careful to get the connector adapter in the correct orientation.

3. Replace the Power Panel.

D. Installation of the Junction Box

The Junction Box for the LX6-CAT combines the two encoder signals into one cable. In addition, the Local Time battery backup is located in this box.

1. Remove the Junction Box cover plate and insert two size AA batteries. High quality Alkaline batteries should be used. Replace the cover plate.

2. Position the Junction Box into the inside of the fork arm, just above the R.A. Encoder Cover. The junction box has rubber spacers on the sides and back, and are designed to press into the fork arm. Position the R.A. Encoder cable (still hanging loose) in behind the Junction Box, so that it is held in place by the Junction Box. Press the Junction Box into the fork arm until it is flush with the edge of the fork arm.

3. The coil cable from the Junction Box should be bent around the edge of the fork arm and attached to the side of the fork arm using a self-adhesive cable tie (see #19 and #20, Fig. 3). The other end of the cable is plugged into the Power Panel in the Encoders Socket.

4. Plug the Dec. Encoder Cable into the Junction Box Dec. Encoder slot. The locking ridge on the cable connector should face toward the fork arm. Plug the R.A. Encoder cable into the Junction Box R.A. Encoder slot.

Installation of the CAT is now complete.

CHAPTER 4 - TESTING

1. Read this section once before carrying out the steps.

2. Attach the console to the tripod or set it on a table next to your telescope.

3. Plug the cable from the LX6-CAT into the the "CAT" socket located on the telescope's Power Panel, and unplug the encoders from the "Encoder" socket.

4. Using either the 12 VDC power cable (supplied with the LX6 telescope) or the 1.5 Amp wall adapter (supplied with the LX6-CAT), turn the telescope (and CAT) on.

5. Observe the CAT console. It should flash all of the displays and legends for a few seconds and emit a tone. If it does, go to the next step. If it does not, disconnect the power cable from the console and power source, and carefully repeat the testing sequence, starting at step 3. If it still does not operate properly, consult Appendix D for problem solving tips.

6. Turn off the telescope and unplug the power cable from the telescope.

7. Plug the encoder cables from the Junction Box into the "Encoder" socket of the Power Panel.

8. Plug the power cable back into the telescope, and turn it on.

9. The CAT console should flash all the displays and legends for a few seconds and emit a tone. If it does, go to the next step. If not, unplug the power cable from the telescope, disconnect the encoder cable, and carefully repeat the testing sequence. If it still does not operate properly, consult Appendix D for problem solving tips.

10. Listen for a tone from the CAT console as you rotate the tube assembly in DEC through several complete revolutions. (Be sure there is clearance before rotating the tube through the fork arms. The viewfinder may hit the fork arms, and need to be removed before continuing.) If you hear a tone, the CAT is detecting DEC encoder transition errors. These are almost always a result of too much force on the DEC encoder shaft, which can pull the encoder out of internal alignment. In this case, repeat the DEC belt tensioning steps in the installation guide.

11. Listen for a tone from the CAT console as you rotate the telescope back and forth in RA several times. Since the encoder cable will get wrapped up if you rotate the scope more than once in RA, you must move in this back and forth manner in RA. If you hear a tone, the CAT is detecting RA encoder transition errors. These are almost always a result of too much force on the RA encoder shaft, which can pull the encoder out of internal alignment. In this case, repeat the RA belt tensioning steps in the installation guide.

CHAPTER 5 - FIRST NIGHT OUT

Now that you have installed the encoder and completed the indoor tests, you may want to skip over this chapter and familiarize yourself with the displays and commands. You will have to attend to a few one-time details before the CAT is fully operational, and some understanding of the commands will be helpful on the first night out.

On your first night out, remember to take:

- Telescope
- Eyepieces, including one with crosshairs
- CAT console and Instruction Manual
- Telescope tools and tools to loosen the fork arm
- Usual Observing Accessories

A. First-Time Details

The CAT has several times the resolution of setting circles, which is one reason the CAT is much more useful. To take advantage of this higher accuracy:

1. The index marks on the encoders must be set properly.

2. The axes of your telescope must be set properly.

3. Polar alignment of your telescope must be done correctly.

This chapter will describe how to accomplish these steps.

B. The Index Marks

If you followed the installation instructions carefully, the pulleys, timing belts, and encoders should be properly aligned. But you still need to set the encoder index marks. These index marks are special positions on the encoders where, once per revolution of the encoder shaft, a signal is sent to the CAT. These marks must be positioned at HA = 00 hours in RA (telescope pointing at the meridian) and +90° in Dec. Once this is done the CAT can detect these special positions of your telescope at the beginning of each viewing session (in the **START** command). This makes polar alignment much quicker, easier, and more accurate.

The procedure for setting the index marks is described later in this chapter, under "Getting Everything Aligned".

C. Telescope Axes

The three axes of a telescope are shown in Figure 5 and listed below:

THE AXIS	HOW IT IS DEFINED
OPTICAL	In the direction the optics are pointed
RA	East/West motion is rotation around the RA (polar) axis
DEC	North/South motion is rotation around the DEC axis

D. Polar Alignment

Finally, even if the encoders and telescope are installed perfectly, the RA axis must accurately point at the Celestial Pole for pointing accuracy to be good. Remember, **Pole Star** refers to Polaris (**Star 19**) in the northern hemisphere, and Sigma Octantis (**Star 351**) in the southern hemisphere. Also replace +90° with -90° if you are "down under".

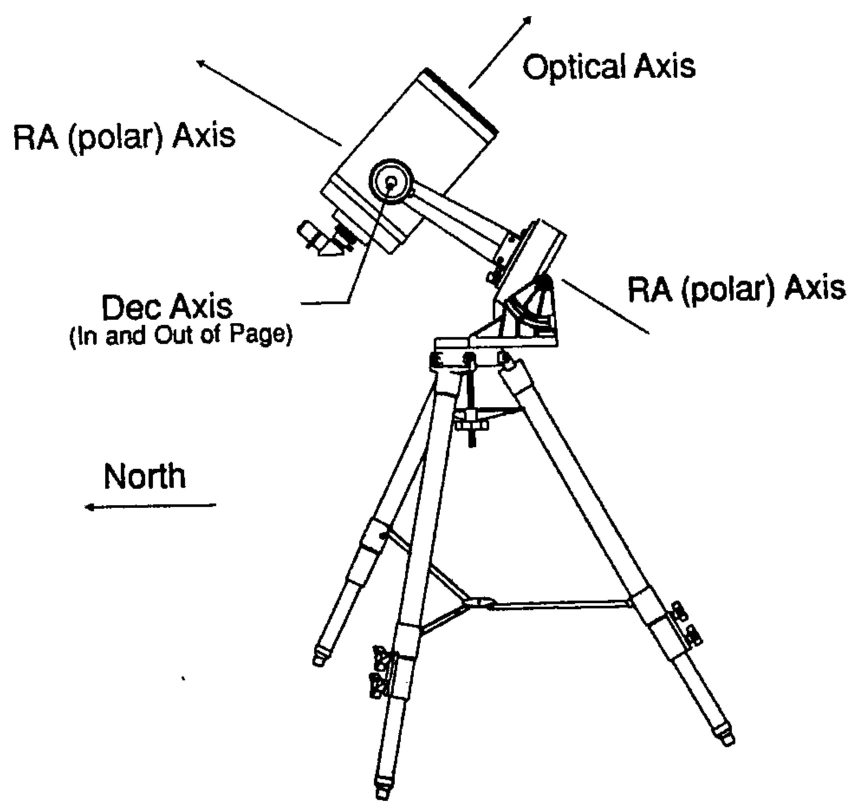


Fig. 5: Telescope Axes

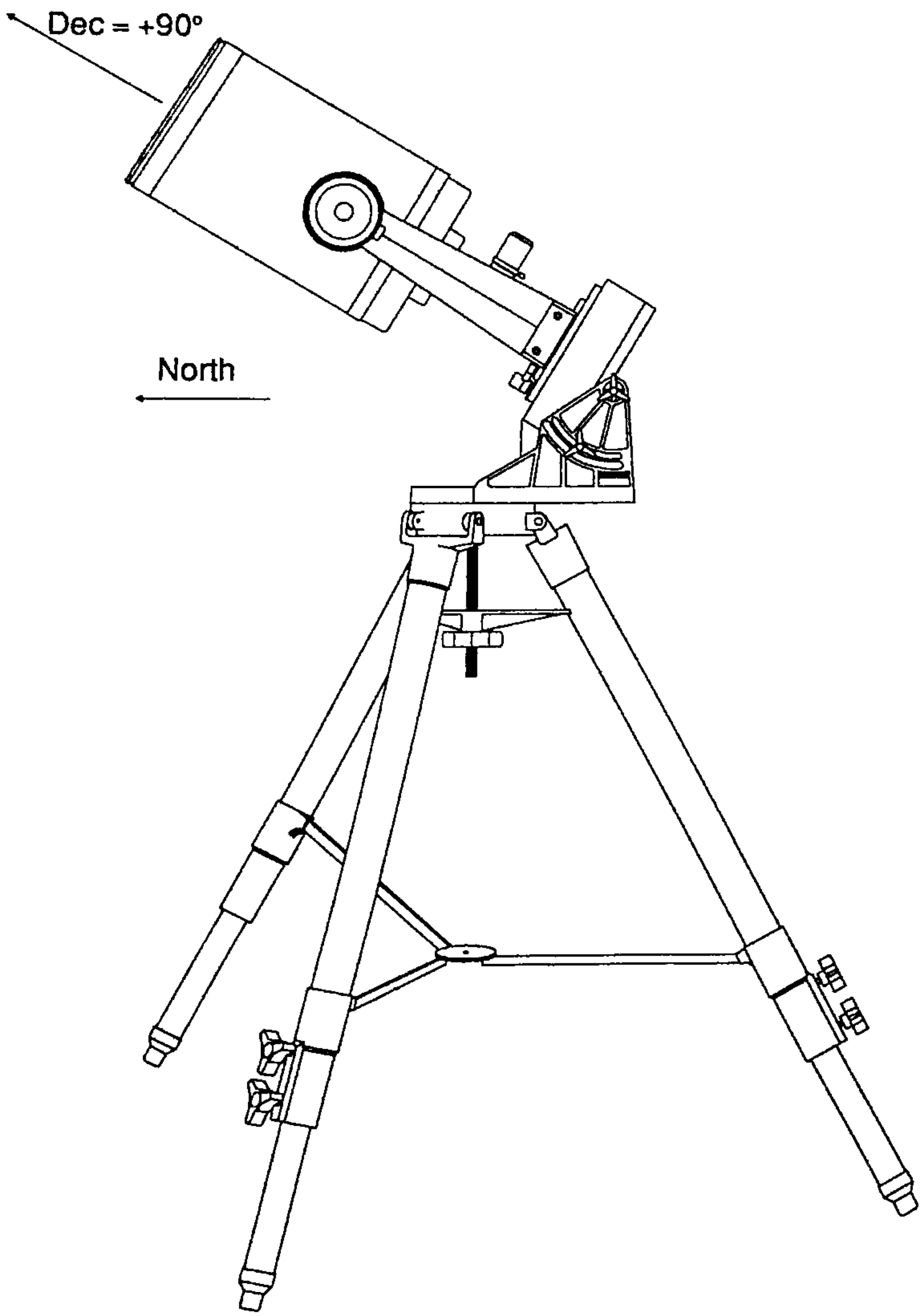


Fig. 6: Telescope Pointing at HA = 00 and DEC = +90 Degrees

E. Pointing Accuracy and Pointing Errors

The pointing error introduced by misalignment varies between zero and twice the misalignment. In other words, an alignment error of 5' will result in pointing errors up to 10'. The pointing error will vary with telescope position, from zero in one area of the sky up to twice the error in others.

Aligning the RA and Dec. axes need to be done only once - on your "first night out". Follow the instructions carefully, for pointing accuracy on all subsequent observing sessions depends upon how well you carry out these important steps. If you do well, pointing errors will be small and the CAT position displays will be accurate.

Flexure of the telescope also affects pointing accuracy. Flexure is primarily a function of the design and fabrication of the telescope, but may be aggravated by adding weight to the mounting or tube assembly.

The following instructions accomplish the alignment of the RA and Dec. axes in one set of steps. If you carry out these instructions properly, the pointing accuracy should be consistently good, so be careful and take plenty of time.

F. Getting Everything Aligned

The goal of most of the steps below is to make your telescope's optical axis and RA axis parallel. You've achieved this when you can look into the eyepiece of your telescope, rotate it ± 90° in RA, and see stars rotating around the **center** of the field. If you can't get it exactly centered, do as well as you can and see "How Close Can You Get" at the end of this section. You will also set the encoder index marks to HA = 00 hours (see box below) and Dec. = 90° as required for successful use of the **START** procedure.

Set up the tripod so the RA axis is pointing as close as possible to the Pole Star and find a patient assistant. A low-power eyepiece with a cross hair reticle in a right-angle diagonal are best for this procedure. Orient the diagonal and cross hairs so the North/South and East/West motions make stars move parallel to the cross hairs. The cross hair that is parallel to Dec. motion will be called the N/S (North/South or vertical) cross hair and the cross hair that is parallel to RA motion will be called the E/W (East/West or horizontal) cross hair. The point around which the stars rotate will be called the "point-of-rotation" which is shown in the figures as "o". The previous position of "o" is shown as " ● " see Figure 7c and 7d.

1. Steps 1a through 1e (below) set Dec. to +90°. Note which direction stars move in the field when you move the scope in Dec. (with the Dec. slow-motion knob on the left-hand fork arm). This is the direction in which the following steps will move the "point-of-rotation" in the field. See Figure 7a through 7d for an illustration of this process before continuing.

00h Hour Angle (HA-00h) occurs when the telescope passes the Meridian. This happens when the fork arms are at the same height as they rotate in R.A. (see Fig. 7), and represents when an object reaches it highest position in the sky. This position is also the point where sidereal time is determined. The Right Ascension of a star passing the Meridian is defined to be the Sidereal Time. So, for example, when the star Vega (R.A. = 18:36.5) passes the Meridian, the Sidereal time is 18 hours, 36.5 minutes.

a. Point the telescope as close to +90° in Dec. as possible and lock the Dec. clamp. (Stand back from your scope a few feet and make sure the tube looks parallel with the fork arms; adjust if necessary). Also position the telescope at about HA = 00h as shown in Figure 6.

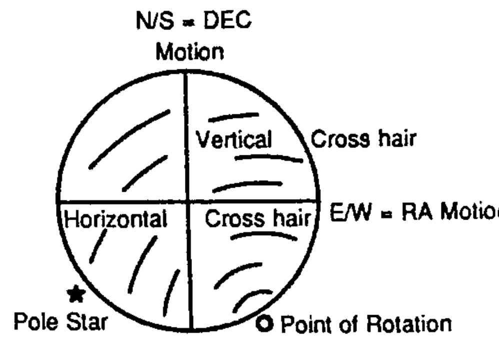
b. Use the altitude and azimuth controls on the wedge to bring the Pole Star into the field of view. The Pole Star is used here because it is bright and won't move much during this procedure.

c. Unlock the RA clamp, and rotate your scope in RA a considerable distance (± 45° or more) while looking through the eyepiece. If the point-of-rotation is somewhere along the E/W (horizontal) crosshair (Figure 7d), then Dec. is set at +90° - go to step 2. Otherwise, make a mental note of the location of the point-of-rotation in the field.

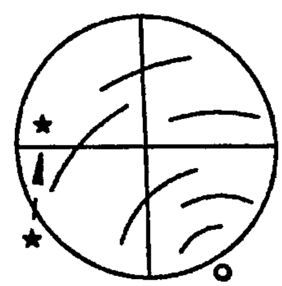
d. Use the Dec. slow-motion control knob to move the point-of-rotation from its current position to the E/W (horizontal) cross hair (Figure 7c). If this moves the Pole Star out of the field, use the polar elevation angle and azimuth adjustments on the wedge to get it back.

e. Again rotate the scope in RA and note the point-of-rotation. It should be closer to the E/W (horizontal) cross hair than last time (if it isn't, you moved the wrong way in Dec.). Repeat steps 1c through 1e until the point-of- rotation is on the E/W (horizontal) cross hair (Figure 7d).

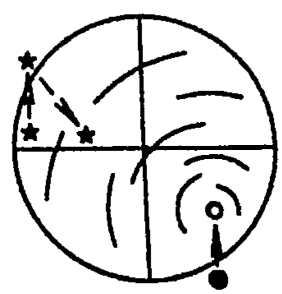
7a: After step 1a, the Pole Star and/or the "point-of-rotation" may be out of the field of view.



7b: Using the polar elevation angle and azimuth controls on the wedge, bring the Pole Star into the field of view. This will not change the position of the "point-of-rotation" in the field. Step 1b.



7c: Using the DEC slow-motion control, bring the "point-of-rotation" approximately to the E/W (horizontal) cross hair. Turning the DEC knob also moves the Pole Star, so if the Pole Star moves out of the field, bring it back in with the polar elevation angle and azimuth controls on the wedge.



7d: Repeat step 1c through 1e until the "point-of-rotation" is on the E/W (horizontal) cross hair.

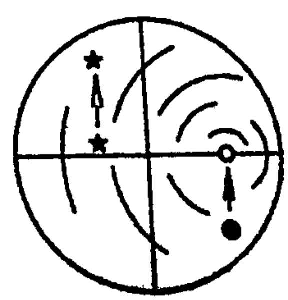


Fig. 7: Pointing the Telescope at +90 Degrees

2. Steps 2a through 2f (below) make the RA and OPTICAL axes parallel, which will make the RA and DEC axes perpendicular (ie, the DEC axis perpendicular to the OPTICAL axis). This procedure is similar to 1a through 1e, but the point-of-rotation will be moved along the E/W (horizontal) cross hair to the center of the field. See Figure 8a through 8c for an illustration of this process before continuing.

   a. If the point-of-rotation is in the center of the field (Figure 8c), the RA and OPTICAL axes are parallel and step 2 is complete, so go to step 3.

   b. Look through the eyepiece while your assistant **slightly** loosens the two bolts that hold the left-hand fork arm to the drive base.

   c. When the bolts are loose, have your assistant move the fork arm along the RA axis, towards or away from the Pole Star, whichever brings the point-of-rotation closer to the center of the field. You may find a flat-blade screwdriver useful to move the fork arm along the RA axis. Place the flat blade at the bottom of the fork arm and lever against the drive base. When the point-of-rotation is approximately centered, have your assistant retighten the fork arm bolts.

   d. Rotate your scope $\pm 45^{o}$ or more in RA and see if the point-of-rotation is in the center of the field (tightening the bolts may have moved it slightly, along either or both cross hairs - Figure 8b). If the point-of-rotation is in the center of the field, then go to step 3.

   e. If the point-of-rotation is East or West (left or right) of the N/S (vertical) cross hair, then go back to step 2b and try again.

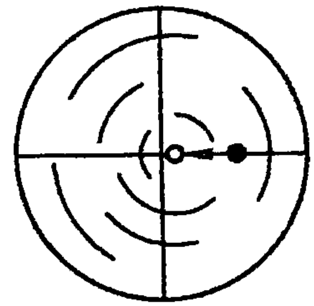
   f. If the point-of-rotation is ON the N/S (vertical) crosshair, but is North or South (above or below) the E/W (horizontal) cross hair, then go back to step 1a and proceed as directed.

3. Make sure the bolts that hold the fork arm to the drive base are tightened. As you manually move the scope +/-90^{o} in RA, the Pole Star and other stars in the field should rotate around a point close to the center of the field. If they don't, go back to step 1. If they do, turn off your clock drive and move your scope in RA **only** until the fork arms are at equal heights, that is HA = 00h = pointing at the meridian (see Figure 6). Use a bubble level if you have one. The RA and DEC axes are now perpendicular.

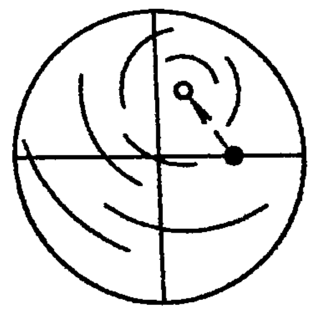
4. Execute the **START** command (not the short form) through Step 3d (the point where you would normally move the telescope past Dec. = +90^{o} and HA = 00h 00.0m, **but do not move your telescope**. Instead, slightly loosen the bolt that holds the large pulley to the RA axis and slowly rotate the pulley **(not the telescope)** until you hear the tone from the CAT console. Carefully tighten the pulley to the RA axis, and make sure you still hear the tone when it is secured. Then move your telescope slightly in RA to stop the tone. Repeat this process with the large pulley on the Dec. axis. Press **ABORT** - you have now set the encoder index marks. Then execute the complete **START** command and begin observing.

Note: In addition to the tone, the "BEEP" legend (in the RA Display Group) will illuminate anytime the tone is generated. It may be easier to look for this legend than try to hear the tone while setting the pulleys. Any **function that generates a tone,** also illuminated the "BEEP" legend.

9a: Try to center the "point-of-rotation" by moving the fork arm along the RA axis. Retighten the bolts and check the "point-of-rotation". If it is East or West of the N/S (vertical) cross hair, but still on the E/W (horizontal) cross hair, repeat steps 2b through 2f.



9b: Tightening the bolts may have moved the "point-of-rotation" off the E/W (horizontal) crosshair. If so, repeat steps 1a through 2f.



9c: If the "point-of-rotation" is on the center of the field, go to step 3.

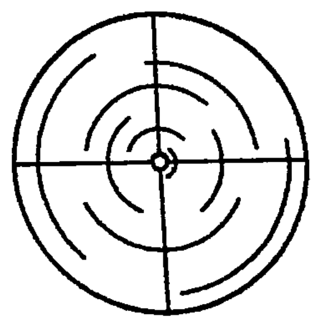


Fig. 8: Making the Optical Axis Parallel to the RA Axis

G. How Close Can You Get?

It is important to have an eyepiece that gives the lowest power practical. This will make the alignment procedure easier to follow.

Because the telescope's polar axis is tilted at an angle (to compensate for your latitude), chances are you will not be able to exactly center the point-of-rotation. Mechanical flexure, "mirror shift", and other factors will usually result in changes in the apparent position of the point-of-rotation as the telescope is rotated in R.A. Take plenty of time, and do the best job you can.

The pointing error introduced by telescope flexure is roughly equal to the amount of flexure. But telescope flexure during the polar alignment process can cause some polar alignment error, which adds to the total pointing error. It is not easy to reduce the flexure of your scope, but you can improve polar alignment by "fine tuning". The easiest way to fine tune the polar alignment is to execute the short form of the START command two to five times. You can also use the classical "star drift" method, but it takes much more time.

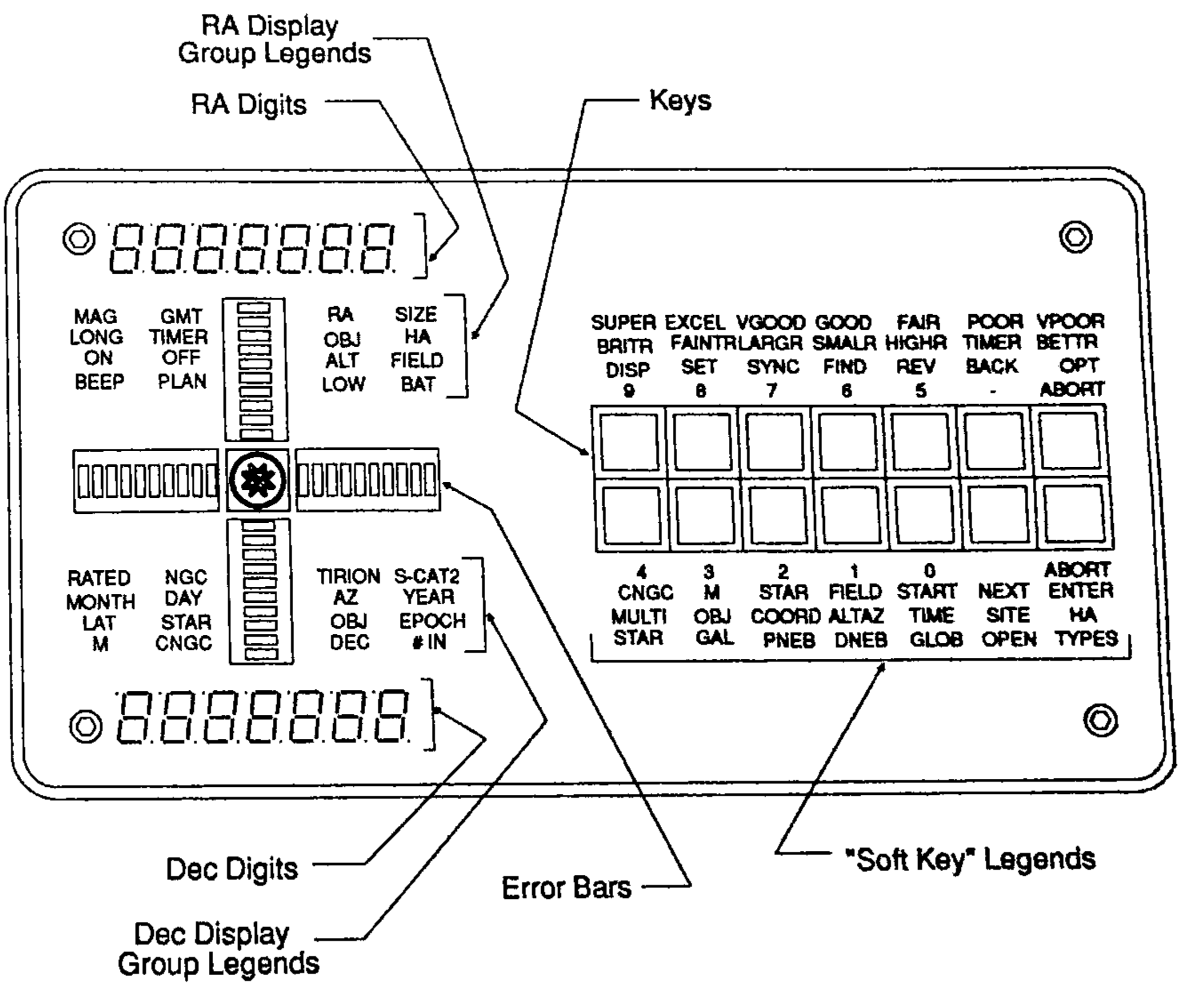


Fig. 9: CAT Console with all Displays & Legends Illuminated

CHAPTER 6 - CONSOLE FUNCTIONS

This chapter, and the following one, describe how to use the CAT and what it can do. You'll find these chapters most useful if you have your telescope and CAT set up next to the table you're sitting at. You'll be able to see exactly what the text describes and try out the commands first hand. Don't do this outdoors - it's not time yet!

In the following chapters, a "+" is used to separate keystrokes and/or actions, a "#" to specify a number that you should input, [square brackets] to enclose optional steps, a "o" to represent the decimal point , and (parentheses) to encolse comments or actions that you or the CAT take.

The CAT uses three types of LED's to display information.

NAME	TYPE	FUNCTION
DIGITS	9 Segment LED's	Numeric digits
LEGENDS	Bar LED's	Illuminates various words
ERROR BARS	10 Element LED's	Used to help find objects

Look at Figure 9. It shows the location of all the digits, legends, and error bars. You can illuminate all of these by pressing OPT+ o.

A. Soft Keypad

Commands are entered by pressing one or more of the 14 "soft-keys". Each soft-key is comprised of the key plus the 4 backlit legends above or below it. The functions of the keys change as you enter commands - they're called "soft-keys" because their function is continually updated by software in the CAT.

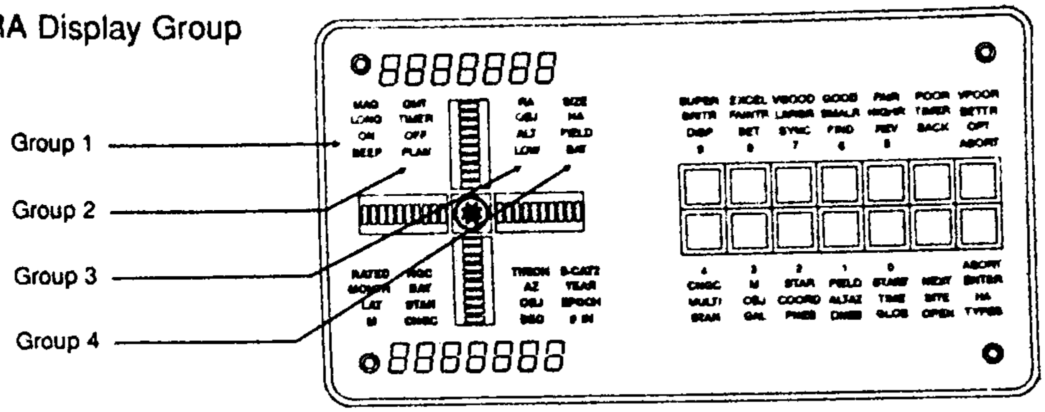
For example, the upper left soft-key can be **9** or **DISP** or **BRITR** or **SUPERB** or nothing at all, depending upon which legend is illuminated, if any. Power up your unit and press the upper left key (**DISP**) to get an idea of how the soft-keypad works.

Note how the soft-keypad makes it easier to use the CAT than a conventional keyboard. There are no keywords to remember, no reference cards to consult, no ambiguity. At all times the soft-keypad tells you exactly what you can do next by illuminating the appropriate legends. If a soft-key has no function, then none of its legends are illuminated. If you press a soft-key with no function, nothing happens, except the beep you always hear when you press a key.

Execute a **DISP** + **TIMER** command for example. Then press **TIMER** several times to toggle the timer ON/OFF/ON/OFF.... Watch the timer value start and stop on the upper row of digits. With the timer running, press **REV** + **TIMER**. Note how the timer starts counting in reverse (ie down).

The displays are arranged in DISPLAY GROUPS as described on the following pages.

B. RA Display Group



GROUP 1	DEFINITION	RANGE
MAG	Objects(**CNGC**, **STAR** ,**M** or **Planet**)	
LONG	Your observing sites Longitude	(DDD°MM') DDD = 0 to 180 (+,-) degrees and MM = 0 to 59 minutes
ON	Specified option bit is ON	
BEEP	Visible feedback for audible tone	

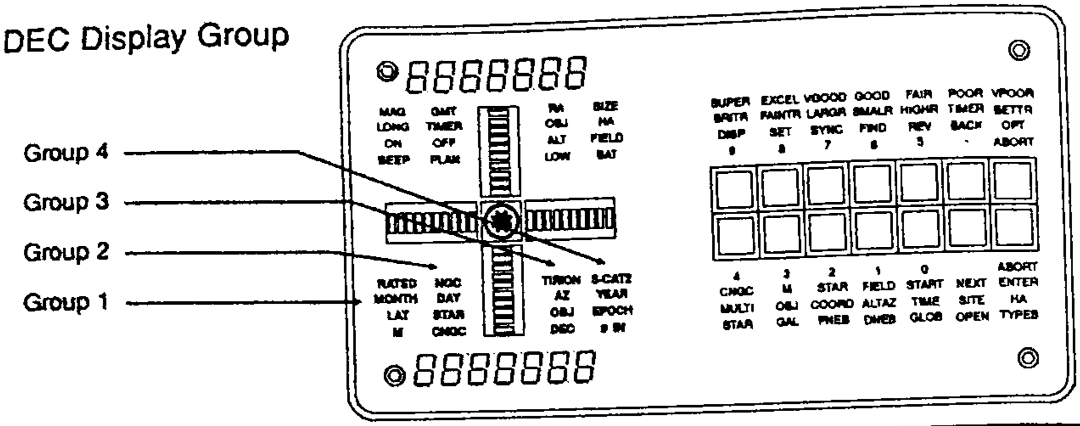
GROUP 2	DEFINITION	RANGE
GMT	Greenwich Mean Time	(HH:MM:SS S) HH = 0 to 23 hours, MM = 0 to 59 minutes, and SS.S = 0 to 59 9 seconds
TIMER	Timer value	(HH MM:SS S) HH = 0 to 23 hours, MM = 0 to 59 minutes, and SS.S = 0 to 59 9 seconds
OFF	Specified option bit is OFF	
PLAN	Object is a planet	

GROUP 3	DEFINITION	RANGE
RA	The telescope's Right Ascension	(HH MM M) HH = 0 to 23 hours, MM.M = 0 to 59.9 minutes.
OBJ + ALT	The object's altitude above the horizon	(DD) DD = 0 to 90 (+,-) degrees.
ALT	The telescope's altitude above the horizon	(DD) DD = 0 to 90 (+,-) degrees.
LOW	The object is below the horizon	

GROUP 4	DEFINITION	RANGE
SIZE	The object's (**CNGC**, **STAR**, **M**, or **Planet**) size	
HA	The telescope's hour angle	(HH MM.M) HH = 0 to 23 hours, MM.M = 0 to 59.9 minutes.
FIELD*	The radius of the Field	(MMM) MMM = 0 to 199 arc-minutes. Default = 15' radius.
BAT	Not used	

* FIELD is the field **radius** = (FLe x AFe) / (2 x FLs). **FLe** is the Focal Length of the Eyepiece. **AFe** is the Apparent Field diameter of the Eyepiece. **FLs** is the Focal Length of the Scope in the same units as **FLe**. x means multiply and / means divide. The default field radius (upon power-up) is 15'. See Appendix E for useful telescope equations.

C. DEC Display Group



GROUP 1	DEFINITION	RANGE
RATED	Object rated by visual observation	
MONTH	GMT month	(MM:DD:YY) MM = 01 to 12 (month), DD = 01 to 31 (day), and YY = 00 to 99 (year).
LAT	Your observing site's latitude	(DD°MM') DD° = 0 to 90 (+,-) degrees, and MM = 0 to 59 arc-minutes.
M*	Messier number	

GROUP 2	DEFINITION	RANGE
NGC	Object is in the RNGC with the same #	
DAY	GMT day	(MM:DD:YY) MM = 01 to 12 (month), DD = 01 to 31 (day), and YY = 00 to 99 (year).
STAR	Star number	
CNGC*	CNGC number	

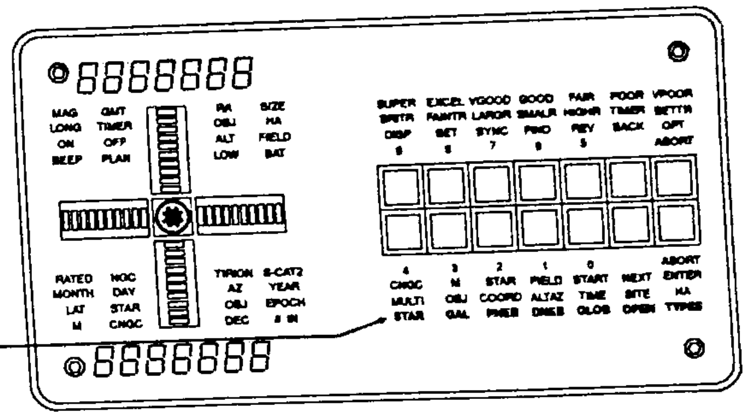
GROUP 3	DEFINITION	RANGE
TIRION	Object is in the <u>TIRION SKY ATLAS 2000</u>	
AZ	The telescope's azimuth	(DDD° MM') DDD = 0 to 360 degrees, MM = 0 to 59 arc-minutes.
OBJ + AZ	The object's azimuth	(DDD° MM') DDD = 0 to 360 degrees, MM = 0 to 59 arc-minutes.
DEC	The telescope's declination	(DD°MM') DD° = 0 to 90 (+,-) degrees, and MM = 0 to 59 arc-minutes.

GROUP 4	DEFINITION	RANGE
S-CAT2	Object is in the <u>Sky Catalogue 2000.0</u>	
YEAR	GMT year	(MM:DD:YY) MM = 01 to 12 (month), DD = 01 to 31 (day), and YY = 00 to 99 (year).
EPOCH	Not used	
# IN	Number of CNGC objects in the field	

*** If both the CNGC and M are illuminated, the CNGC object displayed is also in the M catalog. The CNGC and M numbers will be alternately displayed while CNGC or M flashes.**

D. Object Type Display Group

These OBJECT TYPE legends are shared with the soft-keypad, except they FLASH to indicate they are not intended as soft-key functions, but refer to the type of the **CNGC**, **STAR**, **M** or **PLAN**et object.



Group 1

GROUP 1	DEFINITION
STAR	Star
GAL	Galaxy
PNEB	Planetary Nebula (Or filamentary or SN remnants)
DNEB	Diffuse Nebula (Emmission/Reflection)
GLOB	Globular Star Cluster
OPEN	Open Star Cluster

In addition to the above legends, special combinations are used to describe the following object types:

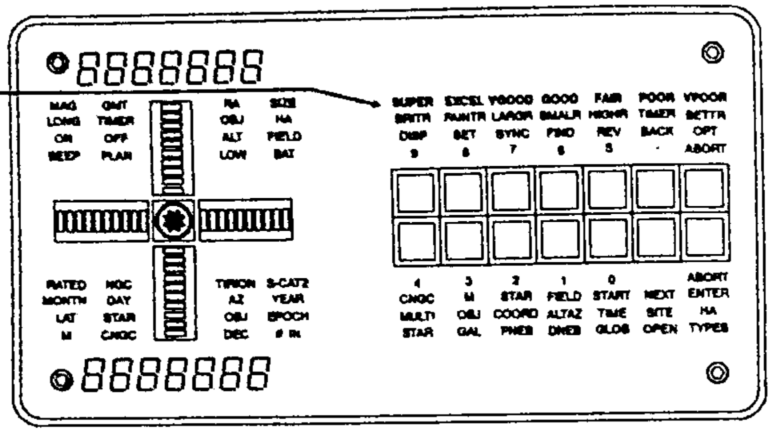
LEGENDS	DEFINITION
DNEB GAL	Diffuse Nebula in an external galaxy
DNEB OPEN	Diffuse Nebula & Open Cluster
GLOB GAL	Globular Cluster in an external galaxy
MULTI GAL	Multiple galaxy
MULTI STAR	Double or Triple star
OPEN GAL	Open Star Cluster in an external galaxy

External galaxies are large, nearby galaxies that contain deep-sky objects large enough to qualify for the **CNGC**. This includes the Large and Small Magellanic Clouds and a few of the nearest galaxies.

E. Object Quality Display Group

These OBJECT QUALITY legends are shared with the soft-keypad, except they FLASH to indicate they are not soft-key assignments, but refer to the quality of the **CNGC** or **M** object. Their meanings are as follows:

Group 1



The soft-key pad employs a plurality of OBJECT QUALITY legends that flash in order to indicate that they are not soft-key assignments and refer to the quality of the **CNGC** or **M** object. Specifically, the CAT uses 7 mnemonics for quality: **SUPER, EXCEL, V GOOD, GOOD, FAIR, POOR AND V POOR** which respectively refer to the qualities, superb, excellent, very good, good, fair, poor, and very poor. A dump category called "can't compute" is also employed in the CAT. Finally, each one of these quality categories is referred to by a respective **CNGC** system listing letter, wherein a capital or a lower case letter; a refers to **superb**, b for **excellent**, c for **very good**, d for **good**, e for **fair**, f for **poor**, g for **very poor** and 0 for **can't compute**.

• A listing of the **CNGC** is available for the CAT. It contains all the information in the CAT plus alternate names and more complete data. See your Meade dealer for more information.

The following guide was used in the visual rating process:

SUPER	Very bright, large, with interesting detail or structure if applicable
EXCEL	Bright, fairly large, some interesting detail or structure if applicable
V GOOD	Very easy to see, some detail or structure if applicable
GOOD	Fairly bright without averted vision, a little detail or structure
FAIR	Easily visible without averted vision, no detail or structure
POOR	Not hard to see with averted vision and visible without averted vision
V POOR	A struggle to see, even with careful use of averted vision

Objects falling near the border of two ratings were given the better rating when interesting features were noted (large size, interesting shape or structure, visually interesting field). The poorer rating was given if interesting features were lacking. See Appendix C for a more detailed description of the rating system.

After you have become familiar with the rating system, let Meade know if you find quality ratings, magnitudes, sizes, or coordinates that you think are incorrect. We will reobserve the objects and make changes if appropriate. Be sure to remember that the rating guide is based on observations with a 14" telescope in excellent observing conditions.

If you have a smaller telescope, these visual quality ratings are just as useful. In 8" to 10" scopes, for example, objects will usually appear 1 or 2 ratings lower, but the ratings will still be fairly consistent. You will soon learn what to expect from each rating with your telescope and sky conditions.

F. The RED CROSS

The **RED CROSS** is a pointing guide composed of four **ERROR BARS**, each with ten red elements. It is a graphic display of the direction and distance to a sky object selected by you or your CAT. In effect, it is a display of the current pointing error of your telescope.

The **direction** to an object is specified by which legs of the **RED CROSS** are illuminated. The legs of the **RED CROSS** specify the **astronomical** or **rotational** pointing error. If the right leg is illuminated, your scope is pointing too far to the west... move it eastward in RA to center the object. If the top leg is illuminated, your scope is pointing too far to the north... move it southward in DEC to center the object.

Using the **RED CROSS** is as simple as this: To center an object, just move your scope toward the center of the **RED CROSS**. That's eastward and southward in the example above.

The **distance** to the object on each axis is specified by the number of elements illuminated. As you move your scope towards the object, the number of illuminated elements decreases from 10 to 9 to 8... to 2 to 1 to 0. When you extinguish all elements on **both** axes, the "Bulls-Eye" in the center illuminates and you have centered the object.

The number of elements illuminated is not a linear function of the size of the pointing error. Far from it! The **RED CROSS** gets more sensitive the closer you are to the object. Each element represents twice the pointing error of the element nearer the center. The 1st element illuminates when the pointing error is one display unit, which is .5m in RA and 3' in DEC. The 2nd element illuminates at 1.0m or 6', the 3rd at 2.0m or 12', etc.

If you are trying to center an object, but the **RED CROSS** changes instantly from one leg completely illuminated to the opposite leg completely illuminated, you are 180° away from the object. At this point the direction of the shortest route to the object changes, hence the instant reversal of the **RED CROSS**.

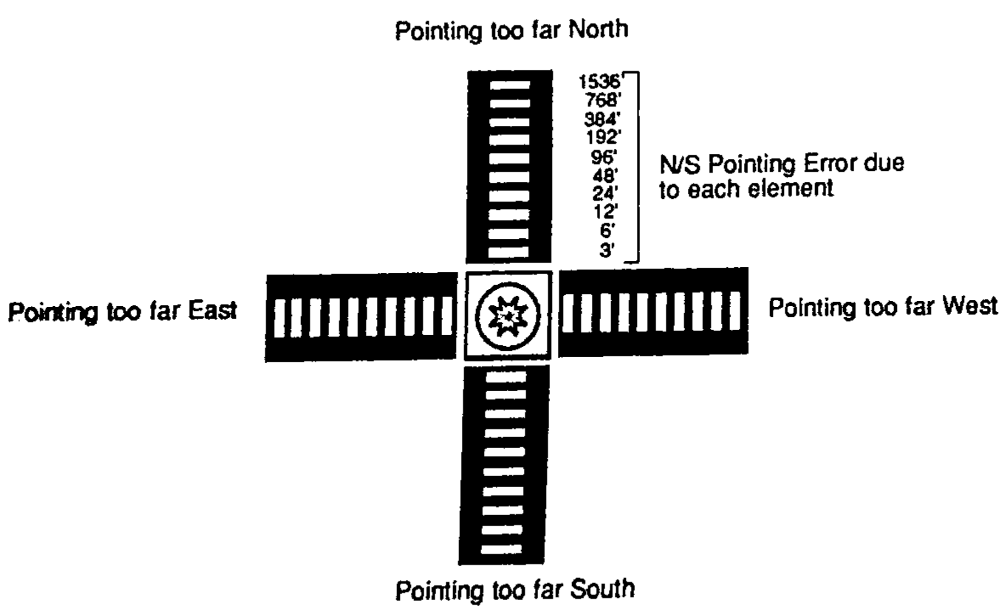


Fig. 10: Red Cross

When you first try the **RED CROSS**, you will notice that the CAT has much higher resolution than conventional setting circles. As you get close to an object, the **RED CROSS** gets really sensitive! It is so sensitive, in fact, that you may find it difficult to extinguish all the elements! Don't let that worry you ...

First, there's no need to exactly center objects. If you are using a low power, wide-field eyepiece as recommended (32mm to 40mm fl), then your field will be at least 30' in diameter. A 4' to 7' pointing error (3 **RED CROSS** elements) will not throw objects out of the field.

Second, pointing errors will be introduced by imperfect polar alignment and non-perpendicularity of the telescope axes (RA / DEC / OPTICAL), etc. Due to these pointing errors, you should always use low power eyepieces to locate objects. Since the fields of higher power eyepieces are correspondingly smaller, these pointing errors will cause objects to fall outside the field of view at some power, even when the **RED CROSS** says the object is perfectly centered.

Third, once you have roughly centered an object (less than 3 **RED CROSS** elements), you can use the slow motion controls on your scope to accurately center it - that's what they're for! On the LX6, the RA clamp lever should only be partially locked so the RA slow motion knob works smoothly.

It is **much** easier to zero the **RED CROSS** one axis at a time. Unclamp the RA lever, move the scope towards the center of the **RED CROSS** until only a few elements are illuminated, lightly clamp RA, and zero the **RED CROSS** with the slow motion knob (+/- 1 or 2 elements). Then unclamp DEC, move the scope towards the center of the **RED CROSS** until only a few elements are illuminated, clamp DEC, and zero the **RED CROSS** with the DEC slow motion knob.

CHAPTER 7 - "CAT" COMMANDS

A. Command Notation

The following notations are used to define variables and data :

(Parentheses)	- Used to enclose comments or actions that the CAT can take.
o	- Used to represent a decimal point.
+	- Used to separate keyboard strokes and/or actions.
#	- Used to specify a number that you should enter into the CAT.
[Square brackets]	- Used to enclose optional steps.

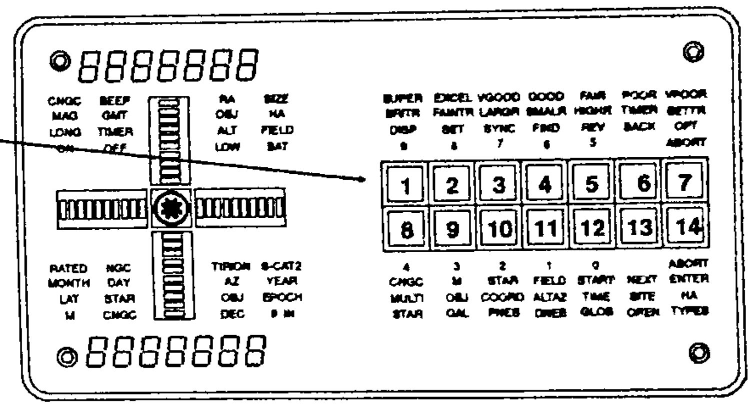
The command summary for **START** contains most of these notations, so it is shown below as an example.

ENTER + # (GMT DATE as MM:DD 'YY) +
ENTER + # (LONG as DDD°MM') +
ENTER + # (LAT as DD°MM') +
ENTER + (Move scope past HA & DEC index marks) +
ENTER + (Move scope to extinguish the **RED CROSS**)
(Center Pole Star using ALT & AZ adjustments [on wedge]) +
ENTER + (Find STAR with **RED CROSS**, then center in field) +
ENTER

B. Command Summary

The following chart explains the 14 basic key commands that the CAT uses. A detailed explanation of each command is given later in this chapter.

Command Buttons

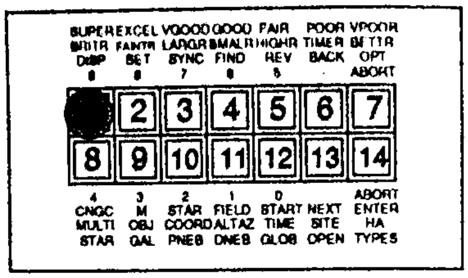


Command Button #	Command Button Function
#1	**DISP**: Display information in CAT internal memory.
#2	**SET**: Input data or limits for the **SITE**, **TIMER**, **BRITR**, **HIGHR**, etc. commands.
#3	**SYNC**: Sync on the position of the telescope with the coordinates displayed by the CAT.
#4	**FIND**: Find objects in the **CNGC** that satisfy criteria that you have specified. Object data is displayed and the **RED CROSS** will help you locate them. Pressing the **NEXT** key tells the CAT to find the next one.
#5	**REV**: Reverse the direction of the timer or current N/S search direction of the **FIND** command.
#6	**TIMER**: Turn timer ON or OFF.
#7	**OPT** : The **OPTION** command is used to select optional operating modes and to permit extensions to the capabilities of the CAT.
#8	**CNGC**: Display data about a **CNGC** object and lead the way to it with the **RED CROSS**.
#9	**M**: Display data about an **M** object and lead the way to it with the **RED CROSS**.
#10	**STAR**: Display data about a **STAR** or Planet and lead the way to it with the **RED CROSS**.
#11	**FIELD**: Display information on deep-sky objects within the field of view (determined by the **SET** command), if any. Default field radius = 15'.
#12	**START**: START the observing session by entering data needed to initialize the CAT and polar aligning the telescope.
#13	**NEXT**: Find the **NEXT** object (pick up where the last **FIND** left off).
#14	**ABORT**: Stop current CAT function, if any. The telescope position coordinates are displayed

C. ABORT COMMAND

When you press **ABORT**, the CAT exits out of any of the following commands and displays the coordinates of the telescope. If you want to display the last displayed object after you **ABORT**, press **DISP + OBJ + OBJ**.

D. DISP COMMAND



The purpose of the **DISP** command is to display the information available in the CAT.

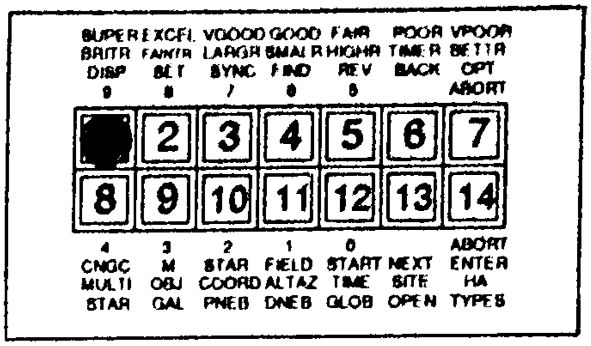
The following commands will display the current value for each function:

Button Sequence	Button Labels	Button Action
#1 + #6	DISP + TIMER	Display the current value of the TIMER
#1 + #12	DISP + TIME	Display the current GMT TIME and DATE
#1 + #13	DISP + SITE	Display the LONG & LAT of your observing site

When you display the coordinates (**COORDs**) or hour angle (**HA**) of your telescope or an object, the display is continously updated. Altitude and azimuth, on the other hand, are computed each time they are requested, so they are valid for only a minute or two after you display them. The accuracy of **ALT** & **AZ** depends upon the part of the sky the telescope is pointed at (or the object occupies). **ALT** & **AZ** are almost always accurate to better than 15', and often to 1' to 3'.

Note that HA is displayed in the same format as RA (00h to 24h). In many sources, HA is given in a different format, namely -12 hours to +12 hours. 00 hours through +12 hours are identical in both systems. To convert HAs > 12h from CAT format to the alternate format, subtract 24h from the HA value given by the CAT. For example, HA = 22h in CAT format is the same as -02h in the alternate format (22h - 24h). To convert negative HAs from the alternate format to CAT format, add 24h to the alternate HA. For example, HA = -04h in the alternate format is the same as 20h in CAT format.

Button Sequence	Button Labels	Button Action
#1 + #10	DISP + COORD	Display RA and DEC of the telescope
#1 + #11	DISP + ALTAZ	Display ALT and AZ of the telescope
#1 + #14	DISP + HA	Display HA and DEC of the telescope
#1 + #9 + #9	DISP + OBJ + OBJ	Display characteristics of the object
#1 + #9 + #10	DISP + OBJ + COORD	Display RA and DEC of the object
#1 + #9 + #11	DISP + OBJ + ALTAZ	Display ALT and AZ of the object
#1 + #9 + #14	DISP + OBJ + HA	Display HA and DEC of the object



The following commands display the specified limit used in the **FIND** command. See the **FIND** command for a detailed description of these limits.

Button Sequence	Button Labels	Button Action
#1 + #1	DISP + BRITR	Display the BRITER THAN limit for **FIND**
#1 + #2	DISP + FAINTR	Display the FAINTER THAN limit for **FIND**
#1 + #3	DISP + LARGR	Display the LARGER THAN limit for **FIND**
#1 + #4	DISP + SMALR	Display the SMALLER THAN limit for **FIND**
#1 + #5	DISP + HIGHR	Display the HIGHER THAN limit for **FIND**
#1 + #7	DISP + BETTR	Display the BETTER THAN limit for **FIND**

E. FIELD COMMAND

The purpose of the **FIELD** command is to identify objects in the field of view of the telescope.

When you power-up your CAT, the radius of the field is set to 15' automatically. When the **FIELD** key is first pushed, the CAT will display the information on the object nearest the center of the field. If more than one object is in the field of view, the CAT will show the number of objects in the field; if no object is in the field, no data is displayed (the display is blanked). As the telescope is moved and other objects come nearer to the center of the field, the CAT will display the information for the new object.

To change the size of the field, use **SET + FIELD**.

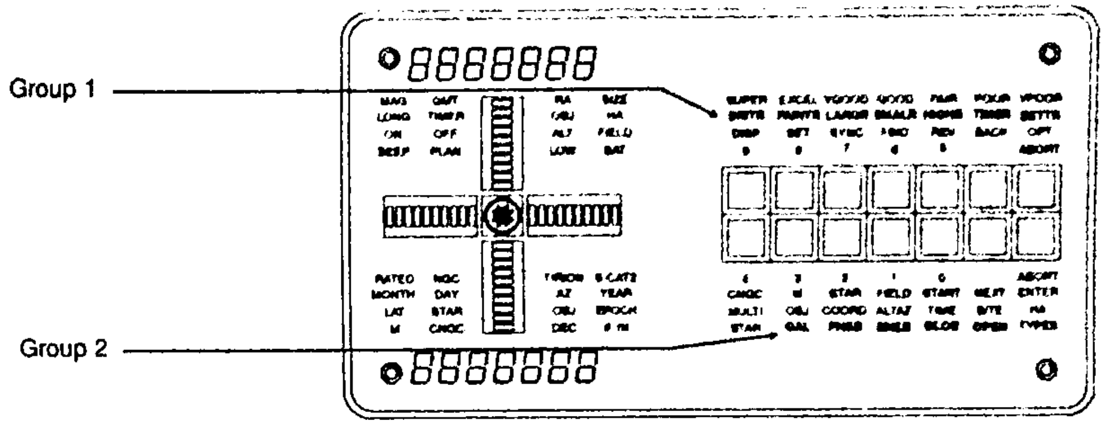
If you want to find the object specified on the displays, push **FIND**. This nullifies the **FIELD** command, and the **RED CROSS** will help you find the object without "fielding" other objects along the way. When you are ready to resume the **FIELD** command, just press **FIELD** again.

FIELD is also useful for casual scanning for interesting objects. Set the field radius to a large value - say 120' to 180', the radius of a typical finderscope field. Then, as you slowly move your scope, **FIELD** will "capture" many objects. By watching the display of object type, brightness, size, and visual quality, you can "preview" a vast number of objects in a short time, centering and observing any that look interesting.

F. FIND COMMAND

The purpose of the **FIND** command is to selectively locate **CNGC** objects from the CAT's internal memory, based on the limits you determine by the **SET** command

The following limits are used by the **FIND** command search pattern



GROUP 1	DEFINITION
BRITR	The **FIND** command search includes objects that are brighter than the limit selected with the **SET BRITR** command. **BRITR** can range from 19.9 to 0.0, or ALL objects.
FAINTR	The **FIND** command search includes objects that are fainter than the limit selected with the **SET FAINTR** command. **FAINTR** can range from 19.9 to 0.0, or ALL objects.
LARGR	The **FIND** command search includes objects that are larger than the limit selected with the **SET LARGR** command. **LARGR** can range from 1' to 199', or ALL objects.
SMALR	The **FIND** command search includes objects that are smaller than the limit selected with the **SET SMALR** command. **SMALR** can range from 1' to 199', or ALL objects.
HIGHR	The **FIND** command search includes objects that are higher than the limit selected with the **SET HIGHR** command. **HIGHR** can range from 0° to 89°, or ALL objects.
BETTR	The **FIND** command search includes objects that are better than the limit selected with the **SET BETTR** command. **BETTR** can range from **VPOOR** to **SUPER**, or **ALL**

GROUP 2	DEFINITION
GAL	Galaxy
PNEB	Planetary Nebula (Or filamentary or SN remnants)
DNEB	Diffuse Nebula (Emmission/Reflection)
GLOB	Globular Star Cluster
OPEN	Open Star Cluster

When you power-up your CAT, these limits are automatically set to:

LIMIT	START	STARTING QUALIFICATION
OBJECT TYPES	ALL	All objects qualify
BRITER THAN	ALL	All objects qualify
FAINTER THAN	ALL	All objects qualify
LARGER THAN	ALL	All objects qualify
SMALLER THAN	ALL	All objects qualify
HIGHER THAN	0°	All objects above the horizon qualify
BETTER THAN	ALL	All objects qualify

These limits remain unchanged until you change them with **SET. If you are having trouble making FIND work as you want, make sure all of these criteria are set properly.** Remember that a **lower** magnitude is **brighter.**

Often there is no need to set the **BRITR, FAINTR, LARGR** or **SMALR** limits. The **BETTR** limit takes the brightness and size of the object into account, so unless you have a particular reason to restrict object selection with one of the other limits, it will often be unnecessary.

The command sequences that start with **FIND** are:

FIND + START	**FIND** objects starting at the northern most **CNGC** in scope coords strip
FIND + NEXT	**FIND** the next object (in **FIND** sequence - to be described)
FIND + ENTER	**FIND** objects starting near current scope coords
FIND + OBJ	**FIND** objects starting at most recent CNGC object
FIND + BACK	**FIND** backwards one object (previous object)
FIND + REV	Reverse N/S direction of the **FIND** command

You can **ABORT** a **FIND** command, execute other commands, then pick up **FIND** where it left off. You may want to change some of the **FIND** limits, for example. To escape and reenter **FIND:**

1. Press **ABORT** to get out of the **FIND** command.
2. Use **SET** to change the desired **FIND** limits or types, and/or execute as many other commands as you wish.
3. Press **NEXT** to continue the **FIND** command where it left off.

Using FIND - Examples

If you want to get someone interested in astronomy, or you'd like to see the best the sky has to offer (just one more time), there's no better way than to use the **FIND** command. Assume you haven't **SET** any of the **FIND** limits, so they're all in their default (power-up) states.

Tell the CAT you want to see only objects that are **VGOOD** or better - by pressing **SET + BETTR + VGOOD**. Then **FIND + START**. What could be easier? The CAT will display the identity and characteristics of each object and lead you to it with the **RED CROSS**. Just press **NEXT** when you're ready for the next object. In half-an-hour you can see them all!

To summarize in an easier to read form:

The CAT will take you on a guided tour of the objects you've asked to see, in a sequence computed to minimize the distance between consecutive objects. It might start like this...

SET + OBJ + (Object Types until only **PNEB** is selected (flashing))
SET + BETTR + FAIR
SET + HIGHR + # (30°) **+ ENTER**
FIND + START

The CAT displays the identity of the object (**CNGC 651**), its type (**PNEB**), its magnitude (**12.2**), its size (**4.8'**), its visual quality (**VGOOD**), and more. The **RED CROSS** guides you to it in a few seconds. When you're ready for the next planetary nebula, just press **NEXT**. What could be easier? No charts, no long waits, no preparation, no flashlights, no frustrating hunting, no wondering whether you have the right object. Just rapid fire fun.

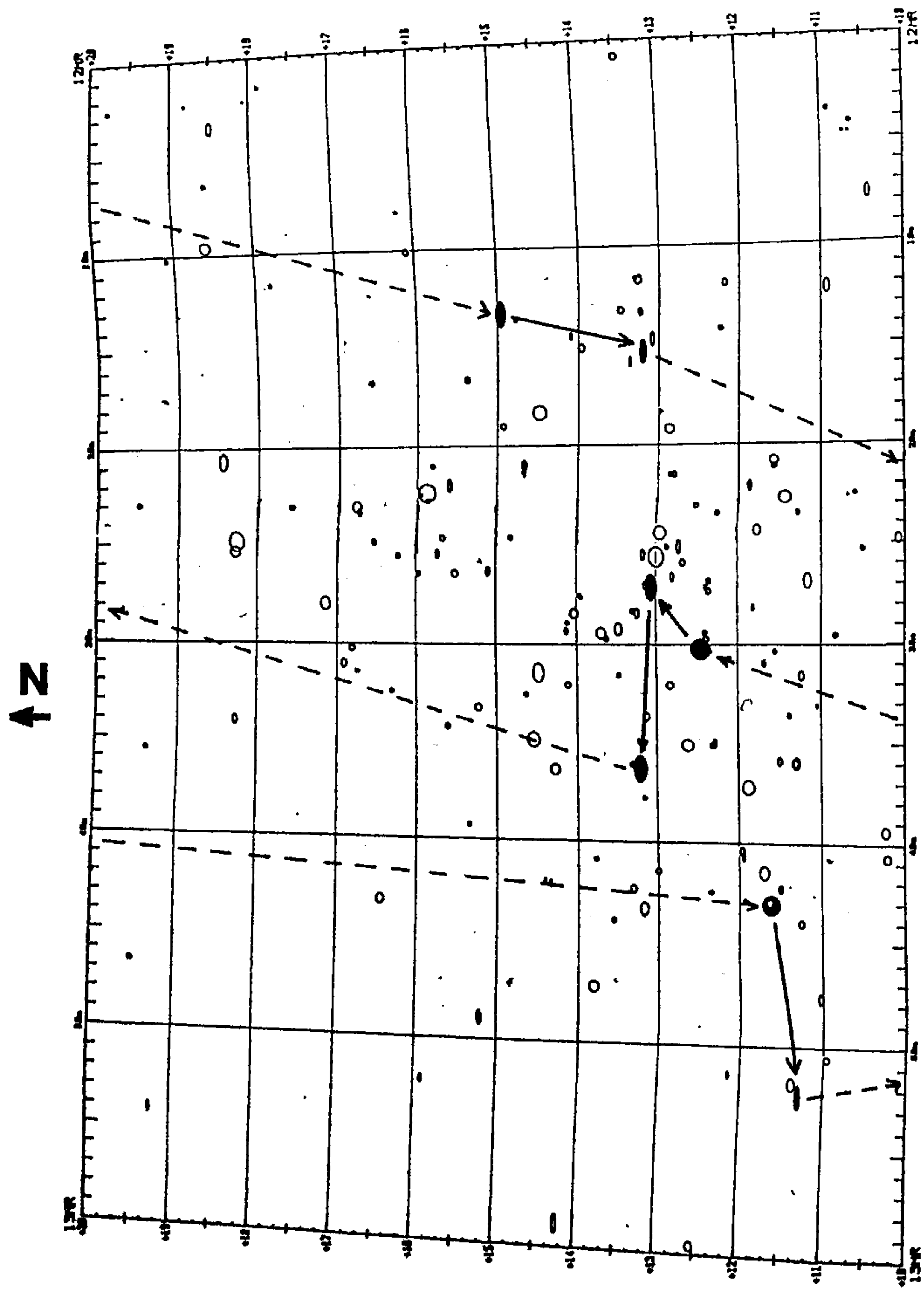


Fig. 11: Progression of FIND to Objects Better Than VGOOD

The **FIND** command uses an organized search pattern to find objects in the **CNGC** that satisfy the **FIND** limits and type restrictions.

The CAT organizes the **CNGC** into 31 strips of 256 objects (except the final strip) as shown below:

STRIP 1	CNGC 0000 - CNGC 0255	STRIP 17	CNGC 4096 - CNGC 4351
STRIP 2	CNGC 0256 - CNGC 0511	STRIP 18	CNGC 4352 - CNGC 4607
STRIP 3	CNGC 0512 - CNGC 0767	STRIP 19	CNGC 4608 - CNGC 4863
STRIP 4	CNGC 0768 - CNGC 1023	STRIP 20	CNGC 4864 - CNGC 5119
STRIP 5	CNGC 1024 - CNGC 1279	STRIP 21	CNGC 5120 - CNGC 5375
STRIP 6	CNGC 1280 - CNGC 1535	STRIP 22	CNGC 5376 - CNGC 5631
STRIP 7	CNGC 1536 - CNGC 1791	STRIP 23	CNGC 5632 - CNGC 5887
STRIP 8	CNGC 1792 - CNGC 2047	STRIP 24	CNGC 5888 - CNGC 6143
STRIP 9	CNGC 2048 - CNGC 2303	STRIP 25	CNGC 6144 - CNGC 6399
STRIP 10	CNGC 2304 - CNGC 2559	STRIP 26	CNGC 6400 - CNGC 6655
STRIP 11	CNGC 2560 - CNGC 2815	STRIP 27	CNGC 6656 - CNGC 6911
STRIP 12	CNGC 2816 - CNGC 3071	STRIP 28	CNGC 6912 - CNGC 7167
STRIP 13	CNGC 3072 - CNGC 3327	STRIP 29	CNGC 7168 - CNGC 7423
STRIP 14	CNGC 3328 - CNGC 3583	STRIP 30	CNGC 7424 - CNGC 7679
STRIP 15	CNGC 3584 - CNGC 3839	STRIP 32	CNGC 7680 - CNGC 7840
STRIP 16	CNGC 3840 - CNGC 4095		

Each strip is about 12° wide in RA, extending from the north celestial pole to the south celestial pole; see Figure 12.

When you execute **FIND** + **START**, the CAT computes the section of sky that the telescope is currently pointing at. It then picks the northern-most **CNGC** object that satisfies the search parameters, and the object's characteristics are displayed and the **RED CROSS** guides you to it. When you press **NEXT**, **FIND** selects the next northern-most **CNGC** object in the search pattern, and directs you to it using the **RED CROSS**. So, the telescope is always moving a little south of the previous object, and typically a few degrees away in RA.

When the southern-most object within the current strip of sky has been observed, **FIND** repeats the same process in the next strip (to the east) except in a south-to-north direction.

Figure 11 illustrates how the **FIND** command progresses through a small area of the sky. In this example, the Visual Quality is set to **VGOOD** or better - objects better than **VGOOD** are shown solid. Figure 12 on the next page shows all the **CNGC** objects in the sky. The small rectangle outlines the area shown in Figure 11. RA = 00 hours is along the right edge, RA = 12 hours is at the center, RA = 24 hours = 00 hours is along the left edge.

G. NEXT COMMAND

The **NEXT** command selects the next object which satisfies the parameters determined by the **SET** command, and displays that object.

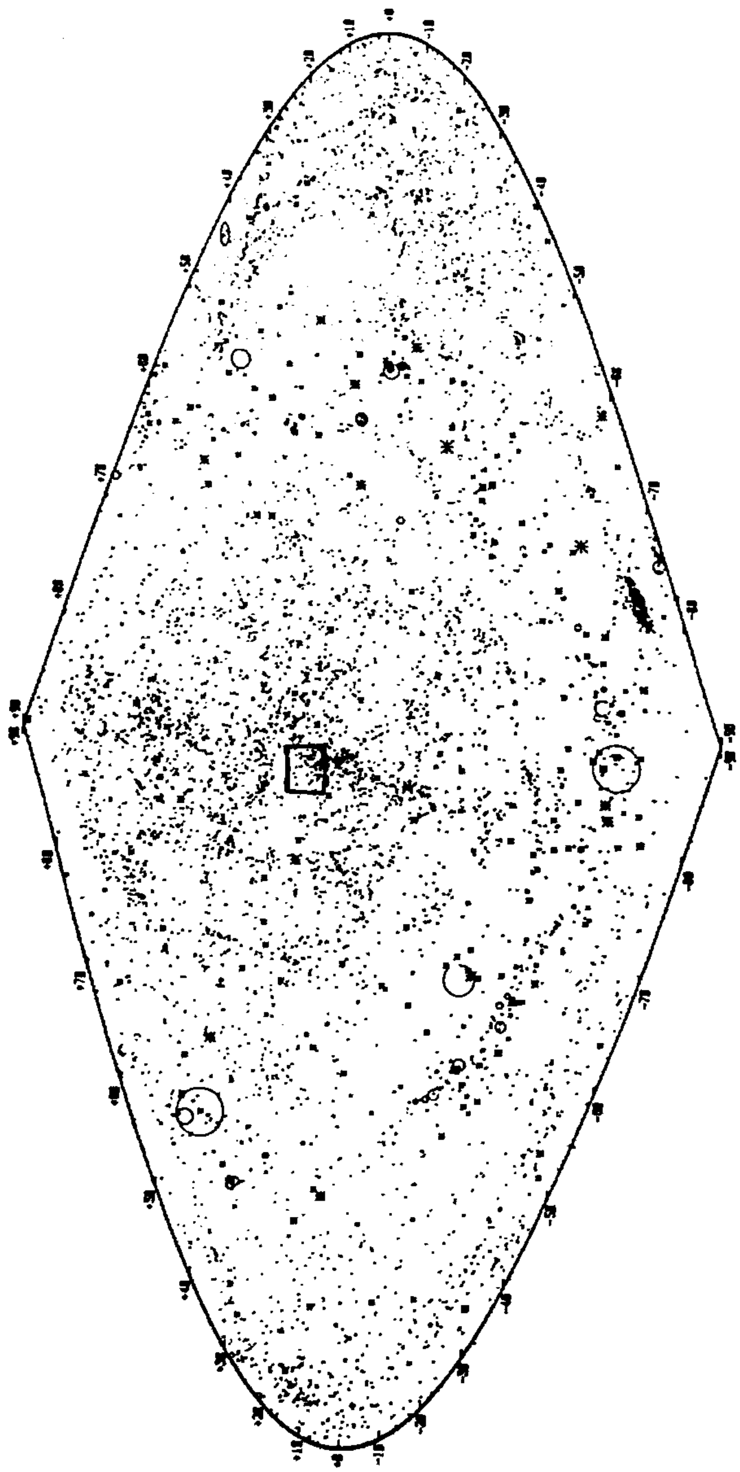


Fig. 12: The Whole Sky Catalog (CNGC)

H. OBECT CATALOGS

1. CNGC COMMAND

CNGC + # (1 thru 7840) + **ENTER**	Describe/Locate **CNGC** # xxxx
CNGC + **NEXT**	Describe/Locate **CNGC** # + 1
CNGC + **BACK**	Describe/Locate **CNGC** # - 1
CNGC + **ENTER**	Describe/Locate **CNGC** # last described

2. STAR COMMAND

STAR + # (1 thru 351) + **ENTER**	Describe/Locate **STAR** # xxx
STAR + **NEXT**	Describe/Locate **STAR** # + 1
STAR + **BACK**	Describe/Locate **STAR** # - 1
STAR + **ENTER**	Describe/Locate **STAR** # last described

3. M COMMAND

M + # (1 thru 110) + **ENTER**	Describe/Locate **M** # xxx
M + **NEXT**	Describe/Locate **M** # + 1
M + **BACK**	Describe/Locate **M** # - 1
M + **ENTER**	Describe/Locate **M** # last described

> The **NEXT** and **BACK** versions of these commands help you look through the catalogs in numeric order (**M1, M2, M3**... etc). The **ENTER** version let you look again at the last described **CNGC**, **STAR**, or **M** object.

The **CNGC**, **STAR**, and **M** commands are used to display the data for any **CNGC**, **STAR**, or **M** object. The **STAR** command is also used to display planetary information. The **RED CROSS** pointing guide will guide you to the object. If the object is below the **HIGHR** limit (altitude above the horizon), the **LOW** legend will flash. If the object is below the horizon (0° altitude), the **ALT** and **LOW** legends will both flash.

If you execute a **CNGC** command that displays data for a **CNGC** object that is also in the **M** catalog, both **CNGC** and **M** will be illuminated. The object's **CNGC** and **M** numbers will be alternately displayed while the corresponding **CNGC** or **M** legend is flashed.

Some examples of these commands will illustrate their use. Assume the last few commands you executed were

CNGC	4656	ENTER	Data & RED CROSS for CNGC 4656
STAR	78	ENTER	Data & RED CROSS for STAR 78
M	82	ENTER	Data & RED CROSS for M 82
DISP	OBJ	ALTAZ	Altitude & Azimuth of M 82

Here's what you'll get if you execute the following sequence of commands:

STAR	BACK		Data & RED CROSS for STAR 77
CNGC	NEXT		Data & RED CROSS for CNGC 4657
M	BACK		Data & RED CROSS for M 81
CNGC	ENTER		Data & RED CROSS for CNGC 4657
M	NEXT		Data & RED CROSS for M 82
M	NEXT		Data & RED CROSS for M 83
M	NEXT		Data & RED CROSS for M 84
CNGC	BACK		Data & RED CROSS for CNGC 4656
CNGC	BACK		Data & RED CROSS for CNGC 4655

4. Planets

To locate a planet, add 900 to the planet's orbital postion and enter that number as a **STAR**. For example, to locate each planet:

PLANET	STAR #		KEYS
MERCURY	901		STAR + 901+ ENTER
VENUS	902		STAR + 902+ ENTER
MARS	904		STAR + 904+ ENTER
JUPITER	905		STAR + 905+ ENTER
SATURN	906		STAR + 906+ ENTER
URANUS	907		STAR + 907+ ENTER
NEPTUNE	908		STAR + 908+ ENTER
PLUTO	909		STAR + 909+ ENTER

If after entering the planets number, you get a long tone and no **RED CROSS** is displayed, it is because the planet is too close to the Sun. **Planetary positions will not be displayed if they are within 15° of the Sun.**

When you execute **CNGC**, **STAR**, or **M**, the following is displayed

CNGC, M, STAR	Object Catalog
1 to 7840	Object Number
GAL, DNEB, OPEN, etc...	Object Type
-5.4 to 19.9	Object Magnitude
1" to 5.9°	Object Size
SUPER, EXCEL, etc...	Object Quality
S-CAT2	Object is in <u>Sky Catalog 2000.0</u>
TIRION	Object is in <u>Sky Atlas 2000</u> by Tirion
NGC	Object is also in the RNGC (with same #)
RATED	Object rated by visual observation
RED CROSS	Direction & distance to the object

When a **CNGC** object that is also an **M** object is displayed, **CNGC** and **M** are both illuminated. Every two seconds, the CAT alternates between displaying the **CNGC** and **M** numbers. While the CAT displays the **CNGC** number, the **CNGC** legend flashes. While the **M** number is displayed, the **M** legend flashes.

If **LOW** illuminates or flashes, the object is lower than the **HIGHR** limit. If both **ALT** and **LOW** illuminate or flash, then the object is also below the horizon. In either case, the **RED CROSS** will still guide you to the object if you want - to see how long before it rises, for example.

The **HIGHR** limit is a value that you can set (with the **SET** command) to any value between 0° and 89° to specify your "programmable horizon". For example, if you have trees or haze that extend from the horizon to 25° above the horizon, you should set **HIGHR** to 25°. Then the **LOW** legend will flash when object information is displayed for any object that is not HIGHER THAN 25° above the horizon. A more complete description of the **HIGHR** limit appears in the **FIND** command section.

I. OPTION COMMAND

The purpose of the **OPT** command is to select special features or functions in the CAT.

Option Bits

There are 8 option bytes, numbered 0 to 7. Each option byte contains 8 bits, also numbered 0 to 7. Each option bit is represented by a two digit number - the most significant digit is the option byte and the least significant digit is the option bit. The range of option bits is thus represented as 00 to 07, 10 to 17, ... 70 to 77. All option bits are set to 0 when power is applied to the CAT.

To turn any of the option bits **ON** or **OFF**, execute **OPT** as follows:

OPT + #(Option Byte #) + #(Option Bit#) + "=" + # (0 or 1)

For example, if you want to set bit 3 in option byte 4, you press these keys:

OPT + 43 + ("=" displayed by CAT) + 1.

At the time this version of the CAT User's Manual went to print, the following **OPTION** commands had been implemented (YES) or not yet implemented (NO):

OPT BIT	DESCRIPTION	BIT= 0	BIT=1	DONE
OPT 00	RA counting direction	**Normal**	**Reverse**	**YES**
OPT 01	DEC counting direction	**Normal**	**Reverse**	**YES**
OPT 02	RA **RED CROSS** direction	**Normal**	**Reverse**	**YES**
OPT 03	DEC **RED CROSS** direction	**Normal**	**Reverse**	**YES**
OPT 05	**RED CROSS** style	**Normal**	**Binary**	**YES**
OPT 06	Pole Star in **START**	**Normal**	**Skip it**	**YES**
OPT 10	Observing Log*	**OFF**	**ON**	**YES**

* The **CAT-COM** RS-232 option must have been installed in your CAT for you to be able to take advantage of this capability.

"Secret" Options"

There are a couple commands that are used for testing, but may occasionally be useful to observers. These are **OPT** + o and **OPT** + -.

Pressing **OPT** + o tells the CAT to illuminate all displays and legends. This is used in product testing, but is also useful for playing with your CAT as you read this manual, since you can see ALL the legends at once. Also, with all the displays lit, the CAT puts out enough light to make a page of a book readable if held nearby. Any keystroke will cancel this condition and return the CAT to the normal "ready-for-command" state.

Pressing **OPT** + - does exactly the opposite. It turns off all the displays and indicators (except the lower **ABORT** legend). If the eyepiece is close to the display of the CAT, and you are observing a very faint object, you may find that extinguishing the displays helps just enough to make a difference. Any keystroke will cancel this condition and return the CAT to the normal "ready-for-command" state.

Last, pressing **OPT** + **ENTER** + o will display the CAT serial number.

J. REV COMMAND

The purpose of the **REV** Command is to (a)- reverse the timer counting direction and (b)- reverse the search pattern direction and (c)- undo the **SYNC** command.

REV + SYNC	Reverse the previous **SYNC**
REV + TIMER	Reverse the counting direction of the **TIMER**
REV + FIND	Reverse the N/S search direction of the **FIND**

Whenever **SYNC** is pressed, the coordinates of the telescope are saved before being set to the coordinates of the object. A **REV + SYNC** resets the telescope coordinates to the saved value. In effect, it reverses the effect of the **SYNC**. This is useful only if the telescope has not been moved since the **SYNC**.

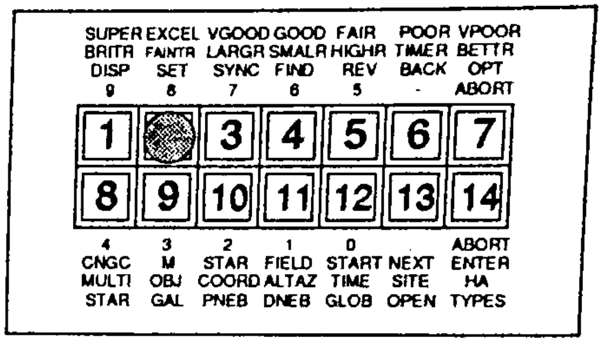
The counting direction of the timer is toggled back and forth between UP and DOWN by **REV + TIMER**. The timer does not have to be displayed or running for **REV + TIMER** or **TIMER** to work. When the CAT is powered up, the timer is set to zero, is not counting, and is set to count UP.

The N/S direction in which the **FIND** command is currently progressing is reversed by **REV + FIND**. If it was progressing from north to south, it will begin progressing from south to north... and vice versa.

K. SET COMMAND

The purpose of the **SET** command is to set or initialize different functions of the CAT.

The following execution sequences show how to set these internal functions:



Button Sequence	Button Labels	Button Action
2+6+#+14	SET+TIMER+#+ENTER	Set TIMER
2+12+#+14+#+14	SET+TIME+#+ENTER+#+ENTER	Set GMT
2+13+#+14+#+15	SET+SITE+#+ENTER+#+ENTER	Set LONG & LAT
#2+11+ #+14	SET+FIELD+#+ENTER	Set FIELD radius

The **TIMER** is in HH:MM:SS.S format - as shown on the CAT displays when you execute the **SET + TIMER** command. See the **TIMER** command for a description of how to use the internal timer.

The **TIME** portion of **GMT** is in HH:MM:SS.S format. The **DATE** is in MM:DD'YY format - as shown on the CAT displays when you execute **SET + TIME.**

The **LONG** (longitude) portion of **SITE** is in DDD°MM' format.

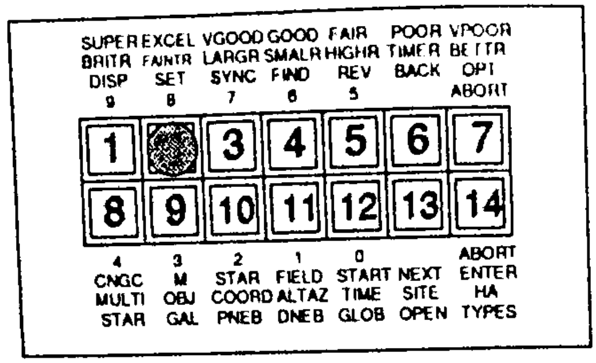
The **LAT** (latitude) portion of **SITE** is in -DD°MM' format.

The **FIELD** radius is in MMM' format (arc-minutes). Remember that you are setting the **radius** of the field, not the diameter! See the boxed equations below to find the field of view with any eyepiece / telescope combination. The default field radius (upon power-up) is 15'. See the **FIELD** command for more information about the **FIELD** variable.

Computing Magnification and Eyepiece Field

MAG = FLs / FLe
TFe = AFe / MAG
FRe = TFe / 2

MAG = Magnification
FLs = Focal Length of Scope
FLe = Focal Length of Eyepiece in same units as FLs
TFe = True Field diameter of Eyepiece - Telescope Combination
AFe = Apparent Field diameter of Eyepiece (from mfg)
FRe = Field Radius for FIELD command (default = 15')



The following command sequences show how to set position functions:

Button Sequence	Button Labels
2+10+#+14+#+14	SET + COORD + # (RA) + ENTER + # (DEC) + ENTER
2+10+13	SET + COORD + o
2+9+10+#+14+#+14	SET + OBJ + COORDS + # (RA) + ENTER + # (DEC) + ENTER

RA is given in HH MM.M format

DEC is given in -DD°MM' format

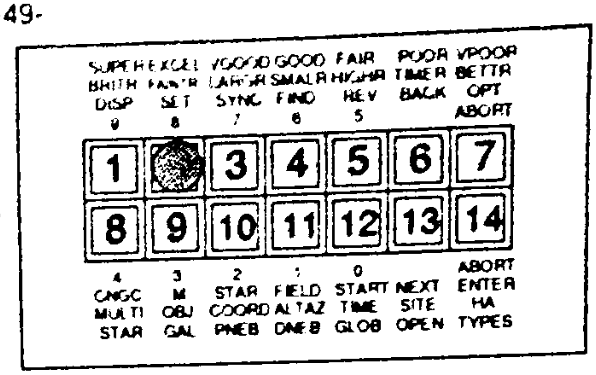
The first command shown above is used to set the CAT coordinates to the telescope's field of view. This is used if the object in the center of the field is not in the CAT's internal memory. If the object is in any of the internal object catalogs, it is easier to execute **CNGC + # + SYNC**, or **STAR + # + SYNC**, or **M + # + SYNC** than to execute this **SET + COORD** command.

SET + COORD + o sets the telescope coordinates to HA = 00h and DEC = +90°.

The third command sequence shown above is used to find objects that are not in the internal **CNGC**, **STAR**, or **M** Catalogs. This is most useful for finding moving objects such as asteroids and comets. When you have completed the command sequence, the **RED CROSS** pointing guide will lead you to the object in the same way as objects from the internal catalogs.

Occasionally you may want to observe objects that are not in any of the CAT's internal catalogs. Asteroids and comets move in the sky and therefore could not be assigned fixed coordinates in an internal CAT catalog. When you want to find an object that is not in one of the CAT's internal catalogs, you can **DISP + COORDS** and move your scope until the **RA** and **DEC** displays match the current object position. Or, you can have the **RED CROSS** guide you the object by setting the objects coordinates with the **SET + OBJ + COORDS** command sequence shown above.

The following commands show how to set the object type limits for the **FIND** command



Button Sequence	Button Labels	Button Action
2+9+14	SET + OBJ + TYPES	Set OBJECT TYPES for **FIND**
2+1+#	SET + BRITR + # (Mag)	Set BRITER THAN limit for **FIND**
2+2+#	SET + FAINTR + # (Mag)	Set FAINTER THAN limit for **FIND**
2+3+#	SET + LARGR + # (Size)	Set LARGR THAN limit for **FIND**
2+4+#	SET + SMALR + # (Size)	Set SMALLER THAN limit for **FIND**
2+5+#	SET + HIGHR + # (Alt)	Set HIGHER THAN limit for **FIND**
2+7+#	SET + BETTR + (Quality)	Set BETTER THAN limit for **FIND**
2+4+#	SET + CNGC + #	Set starting "CNGC #" for **FIND**

Object types are **GAL**, **DNEB**, **PNEB**, **GLOB**, **OPEN**. To select object types for the FIND command, press the appropriate soft-keys to flash (select) or unflash (deselect) the desired types. Each time you press a particular object type soft-key, it toggles between the selected (flashing) and deselected (unflashing) state. You can select any combination of these objects, including none and all. If you select none (none flashing), then only "Non-Existent" objects will be qualified by the **FIND command**. To select **ALL** of the above types **plus** "Non-Existent" objects, press **SET + OBJ + TYPES + -**. **A** flashing "-" indicates this state.

Object qualities are **SUPER**, **EXCEL**, **V GOOD**, **GOOD**, **FAIR**, **POOR**, **V POOR**. **When you press** the soft-keys assigned to one of these qualities, that quality and all better qualities are **selected**. **SET + BETTR +** 0 selects objects of **ALL** qualities, including those with no assigned **qualities**.

Magnitudes range from 0.0 (very bright) to 19.9 (very faint). Sizes must be **specified in 3-digit** arc-minutes format (MMM'). Altitude must be specified in 2-digit degrees format (DD°).

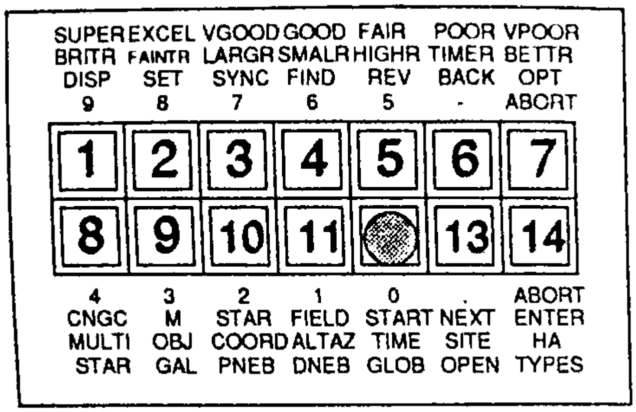
In any **SET** command that sets magnitude, size, or altitude limits, you can tell the **CAT to qualify ALL** objects as far as this limit is concerned, by pressing the 0 key instead of **entering a value**. **For** example, if you don't want a **SMALR** limit on object selection, press **SET + SMALR + 0**.

The CAT assigns **ALL** to these limits when you power up the system, so there is **no need to change** them unless you want to for purposes of the **FIND** command. See the **FIND command for a thorough description of these limits.**

L. START COMMAND

NOTE: You must have set the encoder index marks properly on your First Night Out (Chapter 5) before you can use START successfully.

The purpose of the **START** command is to give the CAT the basic information needed to operate.



Time, date, and observing location are entered using the keypad at the beginning of each observing session. The telescope is then moved through the encoder index marks, which tells the CAT where the tube assembly is pointing, relative to the mount. Last, the CAT helps you align the telescope polar axis to the **Pole Star. Pole Star** means Polaris **STAR 19** in the northern hemisphere and Sigma Octans **STAR 351** in the southern hemisphere.

The command sequence summary for the **START** command is shown below:

START + # (GMT TIME as HH:MM:SS.S) +
ENTER + # (GMT DATE as MM:DD' YY) +
ENTER + # (LONG as DDD°MM') +
ENTER + # (LAT as DD°MM') +
ENTER + (You move scope past HA = 00h & DEC = 90° index marks) +
ENTER + (Move scope to extinguish the **RED CROSS**)
(Center Pole Star using ALT & AZ adjustments [on wedge]) +
ENTER + (Find STAR with **RED CROSS**, then center in field) +
ENTER

If your telescope is permanently aligned with the pole, you can tell the CAT to skip 5a and 5b by setting OPT 06 = 1 when you power the system up. This will save you a few seconds on the **START** command.

The following flow-chart describes the **START** command. First, time, date, and location are entered:

CAT Display	**Observer Entry**
	Press button #12 (**START**) to initiate the command.
The **GMT** (Greenwich Mean Time) legend blinks.	Compute the **GMT** from your time zone and local time using the guide at the front of this manual. **GMT** is also called CUT (Coordinated Universal Time) on radio station WWV (time signals, at 2.5 MHz, 5.0 MHz, 10 MHz, 15 MHz, short wave). Enter the **GMT** and press **ENTER** to complete the entry.
The **MONTH** legend blinks.	Enter the **GMT MONTH**.
The **DAY** legend blinks.	Enter the current **GMT DAY**. (Note that the **GMT DAY** is often one day later than the local day. This is the case (in the Western Hemisphere) when it is before midnight local time and after midnight **GMT** time.
The **YEAR** legend blinks.	Enter the **GMT YEAR.** Press **ENTER.**
The **LONG** legend blinks.	If your observing site is at West Longitude, enter the <u>WEST</u> longitude of your observing site followed by **ENTER**. If you are at an EAST longitude, your WEST longitude = 360° - EAST longitude. Use the table in the inside front cover of this manual to record the longitude and latitude of your observing
The **LAT** legend blinks.	Enter the latitude of your observing site followed by **ENTER.** (Northern observing sites are entered as **a positive number**, southern sites as a negative number.)

Next, move the telescope through the encoder index marks as follows:

The CAT waits for you to slowly move your scope until the encoder index marks are passed (HA = 00h 00.0m & DEC = +/-90). The Index Marks must have been set on your "First Night Out" (Chapter 5) for the following polar alignment and coordinate referencing steps to work. The CAT indicates that the telescope is at an index mark by "beeping" (but only at this specific point in the **START** command sequence). Slowly move your scope past +90° DEC (beep), then **slowly** back through +90° again (beep), but not far (less than 45° - See the diagram below). Your scope should now be pointing above the pole (closer to the zenith).

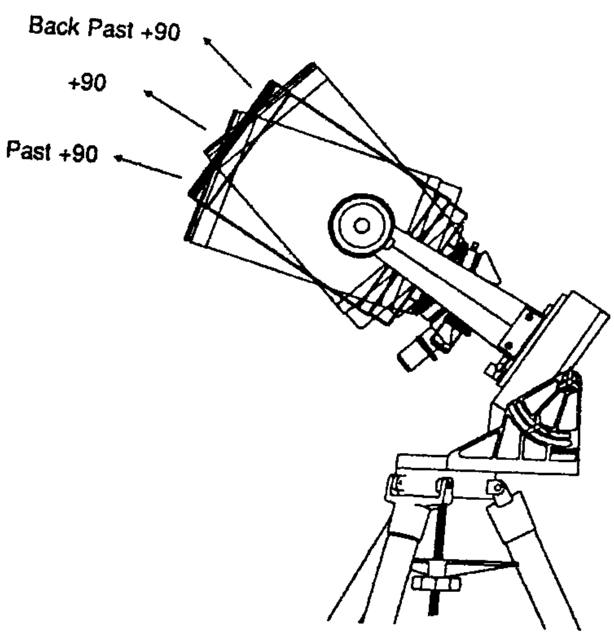
Move your scope slowly in RA through the meridian (fork arms level) - the CAT will beep again. Be sure to do RA after DEC.

Press **ENTER** to tell the CAT that the index marks have been passed in **both** axes.

Last, align the telescope's polar axis to the Pole Star as follows:

The CAT displays the **RED CROSS** and data for the Pole Star and waits for you to point the telescope to extinguish the **RED CROSS**. Your scope is then pointing where the Pole Star would be located if the altitude & azimuth controls (on the wedge) were set properly (RA axis aligned with the earth's axis).

The CAT blinks **ALTAZ**. You align the polar axis of your telescope with the celestial pole by adjusting the altitude and azimuth controls [on the wedge] until the Pole Star is centered in the field of view. Then press **ENTER**.



The CAT displays the **RED CROSS** and data for a bright star near the meridian.

You move your telescope in RA and/or DEC until the **star** is positioned in the center of the field. Note: this may not extinguish the **RED CROSS**, but it should be close. Also, if the RED CROSS directs you to point the telescope toward the ground, you have moved the telescope in Dec incorrectly during the Index Marks sequence. Restart the **START** command and follow the step at the top of this page exactly.

Press **ENTER**. The CAT will beep twice as it initializes its coordinates to the coordinates of the object.

Fig. 18: Moving Past Index Marks

M. START COMMAND - Short Form

It is usually beneficial to go through the **START** procedure more than once to "fine tune" polar alignment. If you bump the tripod you may need to polar align again. Or, if objects aren't centered as precisely as usual, a repeat of the **START** sequence may solve the problem. The short form of **START** lets you skip the GMT (time and date) and SITE (longitude and latitude) entry steps, which will already be correct if you entered them correctly when you executed **START** at the beginning of the observing session. The short form of **START** cannot be used to set the index marks in the FIRST NIGHT OUT procedure.

In the short form, instead of entering the first digit of the GMT, just press **ENTER**. The CAT will go right to where you move your scope to extinguish the **RED CROSS** and then center the Pole Star with the ALT & AZ adjustments on your scope. Here's how the short form of **START** works:

CAT Display	Observer Entry
	Press button #12 (**START**) to initiate the command.
The **GMT** (Greenwich Mean Time) legend blinks.	You press **ENTER** to skip past the GMT and SITE entry steps.

Polar align the telescope as follows:

The CAT displays the **RED CROSS** and data for the Pole Star and waits for you to point the telescope to extinguish the **RED CROSS**. Your scope is now pointing where the Pole Star would be located if the altitude & azimuth controls (on the wedge) were set properly (RA axis aligned with the earth's axis).

The **ALTAZ** legend blinks. Using the wedge latitude and azimuth controls, position the Pole Star in the center of the field of view. Then press **ENTER**.

The CAT displays the **RED CROSS** and data for a bright star near the meridian.

You move your scope in RA and/or DEC to center the star in the field.

Press **ENTER**. The CAT will beep twice as it initializes its coordinates to the coordinates of the object.

START +
ENTER + (Move scope to extinguish the **RED CROSS**)
(Center Pole Star using ALT & AZ adjustments [on **wedge**]) +
ENTER + (Find STAR with **RED CROSS**, then center **in field**) +
ENTER

N. SYNC COMMAND

The purpose of the **SYNC** command is to synchronize the telescope's position as displayed by the CAT with the center of the telescope's field of view.

If, when using the **RED CROSS** to locate an object, you find that the object is not exactly in the center of the field of view, center the object and press the **SYNC** key. This will **SYNC** the new telescope position to the CAT display, and minimize pointing errors for objects in the same part of the sky.

The **SYNC** command must be used only when the centered object is the one whose data is displayed. To review any errors caused by **SYNCing** on the wrong object if you have not moved the telescope since pressing the **SYNC** button, you can "**UNSYNC**" by pressing **REV + SYNC**.

If you **SYNC** on the wrong object and have moved the scope, then you'll have to do the following:

1. Point your scope to an object you are sure of.

2. Display the object information with the **CNGC**, **STAR** or **M** command.

3. Press **SYNC**.

If you're not sure of the location of any objects, execute the short version of **START** (press **START + ENTER**). This will cause **START** to skip the GMT (time & date) and SITE (longitude & latitude) input steps. Since you set them when you started the observing session, they should still be valid.

Note: The data for the planetary positions is interpolated from a table, and not exact. Therefore, it is recommended that you do not **SYNC** on planets.

O. TIMER COMMAND

TIMER	Toggle the **TIMER** on/off/on...

Using the TIMER

The timer in the CAT will count up or down. When you turn on your CAT, it is set to count up from zero and is not running. To make the timer run, just press **TIMER**. To make the timer count down, press **REV + TIMER.**

A common function of the timer is for timing exposures or for budgeting your observing time. For example, if you want to make a 45 minute exposure, you could:

DISP + TIMER	Make sure the timer isn't currently running
TIMER	Turn OFF the timer if it is running
SET + TIMER + #	Set timer to 00h 45m 00.0s
	Begin exposure
TIMER	Start the timer running
	Guide or wait for 2 second tone from the CAT
	End exposure when you hear the 2 second tone
TIMER	Stop the timer

If you are away from the telescope and do not hear the time-out tone, you can still find out how long it has been since you started the timer. When the timer is counting down and reaches zero, it begins counting up - to record the length of time past the time-out tone. So, for example, if you come back to your scope and notice that the timer is counting up, the elapsed time is just the starting value of the timer plus the current contents of the timer. This is also useful for extending exposures that are going particularly well. The total exposure is the value the timer started counting down from, plus the value of the timer when you stop the exposure.

If you want to time exposures or other events of unknown duration, stop the timer, set the timer to zero, and start the timer to begin timing. You can then display the timer at any time to find its current status or press **TIMER** to stop the timer and later **DISP + TIMER** to see how much time elapsed between starting and stopping the timer.

The **TIMER** key turns the timer ON and OFF. The **TIMER** operates in the following manner: The **TIMER** will first turn OFF when the **TIMER** is ON. If the **TIMER** unit is OFF, the **TIMER** will then turn back ON.

When the **TIMER** is counting down or reaches zero, a tone is emitted for a second or two to alert you that "your time is up." The **TIMER** does not have to be displayed for the **TIMER** or **REV+TIMER** commands to work.

APPENDIX A
THEORY OF OPERATION

12 VDC power is supplied to the CAT through the power cable that plugs into the LX6 Power Panel. The normal source of power is a car battery or 9-13 VDC portable power pack (usually a small rechargable battery). An AC to DC converter (wall adapter) that supplies 12 VDC at 1.5 Amp is also provided. Inside the console, this power is converted into the voltages needed by the various circuitry, primarily +5 VDC.

Motion of the RA and DEC axes is detected by two precision 360 cycle per revolution optical encoders. These encoders have three TTL compatible outputs - two 50% duty cycle outputs in quadrature ("A" and "B" channels), plus an index marks channel ("I" channel). Each time an encoder shaft is rotated one turn, the "A" and "B" channels output 360 square wave signals, but transitions of these channels are offset from each other by 1/4 cycle (hence the name quadrature). The "I" channel outputs only one narrow signal per revolution of the shaft, at one particular shaft position.

By "watching" the "A" and "B" signals, a specially programmed microcomputer in the CAT console detects 4 x 360 = 1440 transitions per revolution of each encoder shaft, and by keeping count of the transitions it can keep track of the position of the encoder shafts.

The RA Encoder is "geared-up" by 2:1 by the 60-tooth pulley on the RA Encoder shaft, the 120-tooth pulley attached to the RA axis, and the timing belt that couples them. This makes the shaft of the RA Encoder rotate twice for every revolution of the telescope in RA. The microcomputer knows that each of the 2880 increments from the encoder represents .5m of RA, so it adds +.5m or -.5m to RA for each increment is detects.

The DEC Encoder is "geared-up" by 5:1 by the 24-tooth pulley on the DEC Encoder shaft, the 120-tooth pulley attached to the DEC axis, and the timing belt that couples them. This makes the shaft of the DEC Encoder rotate five times for every revolution of the telescope in DEC. The microcomputer knows that each of the 7200 increments from the encoder represents 3' of DEC, so it adds +3' or -3' to DEC for each increment it detects.

A proprietary algorithm in the CAT software can keep track of position even when speeds become very high, up to at least 25,000 increments per second simultaneously for both axes. In the normal configuration, that's well over 1 revolution of the scope per second! There is, however, a limit to the acceleration that can be accomodated - equivalent to accelerating the telescope to full speed (25000 ips) in less than 1/100 of a second! This may seem like an outrageously high value, completely beyond any need for concern - after all, who would want to accelerate their telescopes to one revolution per second in less than 1/100 second? In normal use of a telescope, this limit is irrelevant.

However, if you "twang" the timing belt with your fingers, you are only accelerating the mass of the belt and small pulley for a short distance. In this way, you can generate too large an instantaneous rotational acceleration of the small pulley and "break" the encoder algorithm. In this case the coordinates will "go berserk" (if the RED CROSS is displayed, opposite legs will alternately flash. If this happens, turn the CAT off, and start over.

Generally, since the pulleys and belts are covered on the LX6 telescope, this is not a problem. However, the encoder algorithm can also be "broken" when a belt is too tight and/or if the belts are trying to "ride up" the side flanges. The raised lettering on the inside surface of the flange can grab the belt, lift it a little as the scope rotates, and "twang" when the belt slips off the lettering. If this happens, the pulley positions may need to be changed to allow unrestricted belt motion.

APPENDIX B
SPECIFICATIONS

Console Size	8" x 4" x 1" (approx)
Power Supply	9 - 13 VDC (Usually a car battery)
RA Encoder	360 cpr
Dec Encoder	360 cpr
RA Resolution	2880 ipr
Dec Resolution	7200 ipr
Max RA Slew Speed	25000 ips minimum
Max Dec Slew Speed	25000 ips minimum

APPENDIX C
CAT OBJECT CATALOGS

The CNGC

CNGC stands for "**Computerized New General Catalog of Non-Stellar Astronomical Objects**".

The **CNGC** contains 7840 objects most of which appear in the RNGC (Revised New General Catalog) with the same number. When the CAT displays information about a **CNGC** object that is also in the RNGC, it also illuminates the **NGC** legend. More than 400 objects were added to the RNGC to create the **CNGC**. Most of these "should have been" in the RNGC in the sense that they are bright and large enough to have been included.

The **CNGC** is enhanced from the RNGC in many ways. Angular sizes are given in arc-seconds on the **CNGC** listing, and in a convenient scaled format on the CAT displays. Magnitudes are given to .1 magnitude where possible. If the object is shown in TIRION SKY ATLAS 2000, the CAT illuminates **TIRION** and a "T" appears under "TAGS" section of the **CNGC** listing. If the object is listed in the SKY CATALOGUE 2000, the CAT illuminates **S-CAT2** and an "S" appears under "TAGS" section of the **CNGC** listing.

The coordinates in the **CNGC** listing and in the CAT are periodically. Currently the coordinates are given for 1988. It is advised that every few years you get a new **CNGC** listing and EPROM for the CAT. This will keep your coordinates accurate, and will also include the latest enhancements to the **CNGC** and the CAT.

Telescope	14" f/10 production Schmidt-Cassegrain
Low Power	FL = 40mm "Wide-Field" (1/2° field)
High Power	FL = 18mm "Wide-Field" (1/5° field)
Sky Cond.	Clear, dark sky. Relative humidity 50%.
Other	Object altitude 30° when possible
Far South	Far southern objects rated from southern hemisphere.

Objects have been assigned a "Visual Quality Rating", henceforth called **VQ**. A large number of VQs have been obtained by observing the objects. Eventually, all objects will be rated by observation, and later versions of the **CNGC** will include the new ratings. To make the VQs as useful as possible, all observations have been made with the same telescope and eyepiece under substantially identical observing conditions. Only for very small objects was a higher power eyepiece used. The standard system and observing conditions are as follows:

If the object has been rated by observation, an upper-case character (ABCDEFG) is used for the VQ on the **CNGC** listing, and the CAT illuminates the **RATED** legend. If the object has not yet been observed, the VQ has been estimated by a computer program from the object type, size, and brightness and the VQ is specified in lower-case characters (abcdefg). The VQs for visually-rated objects are a considerably more consistent guide to observability and appearance than either the computed VQs or an examination of the type, magnitude, and size data.

The following guide to VQs was used in the visual observing process.

SUPER	Very bright object with very interesting shape or structure.
EXCEL	Bright object with very interesting shape or structure. OR Very bright object with moderately interesting shape or structure.
V GOOD	Bright object with moderately interesting shape or structure. OR Very bright object with little or no interesting shape or structure.
GOOD	Easy to see without averted vision with some interesting shape or structure. OR Bright object, but little or no interesting shape or structure.
FAIR	Easy to see without averted vision, but little or no interesting shape or structure.
POOR	Easy to see with averted vision. Often borderline visible without averted vision.
V POOR	A struggle to see with careful use of averted vision.
(none)	Not yet rated AND missing information for computer estimate. OR Could not see despite careful use of averted vision.

All, or very nearly all, of the objects in the **CNGC** are visible with the standard instrumentation and observing conditions used to obtain the visual quality ratings. It is a good indication of what can be expected with similar equipment by experienced deep-sky observers in excellent sky conditions. Naturally smaller telescopes and/or less optimal observing conditions will lower the apparent quality of all objects.

The following is a description of the format of the optional **CNGC** listing for each object:

COLUMN	NAME	DESCRIPTION
1	CNGC #	**CNGC 0001** through **CNGC 7840**
2	RA	Right Ascension
3	DEC	Declination
4	SIZE	Size of object (arc-seconds)
5	MAG	Magnitude (-5.5 thru 19.9)
6	TYPE	Type of object
7	*	* means object is not in the RNGC
8	ALT CAT	Alternate catalog name and number
9	VQ	Visual Quality Rating (abcdefg) or (ABCDEFG)
10	TAGS	Object Type # (0-F) : S = Sky-Cat : T = Tirion
11	COMMENTS	Name, comments, other information

The following types are distinguished in the **CNGC**

TYPE	LEGEND	DESCRIPTION
0	None	Unverified Southern Object
1	OPEN	Open Cluster
2	GLOB	Globular Cluster
3	DNEB	Diffuse Nebula
4	PNEB	Planetary Nebula (or SN Remnant)
5	GAL	Galaxy
6	OPEN + DNEB	Open Cluster + Diffuse Nebula
7	None	Non-Existent Object
8	STAR	Star
9	MULTI+STAR	Multiple Star
A	MULTI+GAL	Multiple Galaxy (Usually Interacting)
B	DNEB	Dark Nebula in front of Diffuse Nebula
C	GAL+OPEN	Open Cluster in External Galaxy
D	GAL+GLOB	Globular Cluster in External Galaxy
E	GAL+DNEB	Diffuse Nebula in External Galaxy
F	GAL+OPEN+DNEB	Open Cluster + Diffuse Nebula in Galaxy

The STAR Catalog

The **STAR** Catalog contains the 250 brightest stars (**STAR 1** thru **STAR 250**), 100 interesting double stars (**STAR 251** thru **STAR 350**), plus Sigma Octantis, the southern pole star (**STAR 351**).

The **STAR** Catalog is listed in a separate notebook with the **CNGC** or **M**, in a format much like the **CNGC**.

The M Catalog

The **M** Catalog has been the benchmark deep-sky catalog for years. Recently expanded to 110 objects, the **M** (Messier) catalog contains most of the best deep-sky objects.

The **M** Catalog is listed in a separate notebook with the **CNGC** and **STAR** catalogs, in the same format as the **CNGC**.

The Planets

The CAT contains planetary data through the year 1996. When this time period runs out, the CAT will display random information if a planet is requested. Periodically, new data is generated (for the next eight year period), and is available in the EPROM upgrade (see page 58, above).

APPENDIX D
PROBLEM SOLVING

The CAT has been thoroughly tested before leaving the factory, and should give years of trouble-free service. If you feel that your CAT has a problem, reread this manual, to be sure that you are using the CAT correctly, especially Chapter 4 - Testing.

The following list covers most problems and solutions.

SYMPTOM: NO RESPONSE OR INDICATION OF POWER

PROBLEM: THE CAT IS NOT RECEIVING POWER

1. Be sure the cable is securely plugged into the LX6 Power Panel and the ON/OFF switch on the Power Panel are turned ON.

2. The telescope power extension cable may be connected to an improper power source. Connect it to a proper power source.

3. A power surge may have scrambled the CAT memory. Unplug the power supply, wait a few moments, and reconnect the power. The most common cause for a power spike is a faulty power cable. Check for faulty connectors.

SYMPTOM: DISPLAY WORKS -- RA or DEC COORDINATES DO NOT CHANGE PROPERLY

PROBLEM: RA or DEC ENCODER IS NOT PROPERLY COUPLED TO THE CONSOLE

1. The connectors between the Junction Box and the encoders may be improperly connected. Remove and reconnect the encoder cables.

2. An encoder pulley may be improperly secured and is slipping. Be sure that the nuts that hold the pulleys in place are tightened.

3. An encoder may not be functioning properly. The most likely cause is damage from misconnection of power to the CAT, especially if both encoders are non-functional.

4. There could also be a bad connector or broken wire in one of the encoder cables.

SYMPTOM: DISPLAY FLASHES RANDOM NUMBERS AND RED CROSS IS FLASHING OPPOSITE LEGS

PROBLEM: ENCODER ALGORITHM HAS BEEN "BROKEN"

1. An encoder belt has been "twanged" by physically hitting the belt or encoder. Unplug the CAT and start over. (See Appendix A.)

2. An encoder timing belt has "rode up" the pulley. The belt then catches on the raised lettering on the inside surface of the flange. Readjust the belts and start over. (See Installation - Chapter 3.)

3. Timing belt is too tight. Readjust the belts and start over. (See Installation - Chapter 3.)

APPENDIX E
EQUATIONS and TABLES

TERMINOLOGY

FLs	Focal Length of Scope
FLe	Focal Length of Eyepiece
AFe	Apparent Field diameter of Eyepiece
TFe	True Field diameter of Eyepiece / Scope Combination
TRe	True Field radius of Eyepiece / Scope Combination
EPe	Exit Pupil diameter of Eyepiece / Scope Combination
APs	Aperture of Scope
f/s	Focal Ratio of Scope
MAG	Magnification of Eyepiece / Scope Combination

EQUATIONS

MAG = FLs / FLe	
TFe = AFe / MAG	
TRe = TFe / 2	TRe is the value used in SET + FIELD
f/s = FLs / APs	
EPe = FLe / f/s	

APPENDIX F: STAR LIST

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
• 1	00 07.8	+29 02		2.1v	STAR B8.5p IV:(Hg+Mn)	Alpha And	8 ST	Alpheratz
• 2	00 08.6	+59 06		2.3v	STAR F2 III-IV	Beta Cas	8 ST	Caph
• 3	00 12.7	+15 08		2.8v	STAR B2 IV	Gamma Peg	8 ST	Algenib
• 4	00 25.2	-77 19		2.8v	STAR G1 IV	Beta Hyi	8 ST	
• 5	00 25.7	-42 22		2.4v	STAR K0 IIIb	Alpha Phe	8 ST	Ankaa
• 6	00 38.8	+30 48		3.3v	STAR K3 III	Delta And A	8 ST	
• 7	00 39.9	+56 29		2.2v	STAR K0 IIIa	Alpha Cas	8 ST	Shedir
• 8	00 43.0	-18 03		2.0v	STAR G9.5 III	Beta Cet	8 ST	Diphda
• 9	00 56.1	+60 40	20	2.5v	STAR B0 IVnpe(shell) + ?	Gamma Cas	9 ST	Marj B=8.8 Cih
• 10	01 05.6	-46 46	10	3.3v	STAR G8 III	Beta Phe AB	9 ST	B=Similar mag & spectrum
• 11	01 09.2	+35 34		2.1v	STAR M0 IIIa	Beta And	8 ST	Mirach
• 12	01 25.1	+60 11		2.7v	STAR A5 IV	Delta Cas	8 ST	Ruchbah Ecl-Bin @759d
• 13	01 37.3	-57 17		0.5v	STAR B3 Vnp (shell)	Alpha Eri	8 ST	Achernar
• 14	01 54.1	+20 46		2.6v	STAR A5 V	Beta Ari	8 ST	Sharatan
• 15	01 58.4	-61 38		2.9v	STAR A9 III-IVn	Alpha Hyi	8 ST	
• 16	02 03.3	+42 17	100	2.3v	STAR K3 IIb + B9 V + A0 V	Gamma And A	9 ST	Almaak B=5.4 C=6.2
• 17	02 06.6	+23 25		2.0v	STAR K2 IIIab	Alpha Ari	8 ST	Hamal
• 18	02 08.9	+34 56		3.0v	STAR A5 IV	Beta Tri	8 ST	
• 19	02 07.8	+89 14	180	2.0v	STAR F5-8 Ib + F3 V	Alpha UMi A	9 ST	Polaris B=8.2
• 20	02 18.9	-03 01	10	2.1v	STAR M5.5-9 IIIe + Bpe	Omicron Cet A	9 ST	Mira B=9.5
• 21	02 57.9	-40 22		3.2v	STAR A5 IV	Theta Eri A	8 ST	Acamar
• 22	03 01.8	+04 02		2.5v	STAR M1.5 IIIa	Alpha Cet	8 ST	Menkar
• 23	03 04.0	+53 28		2.9v	STAR G8 III + A2 V	Gamma Per	8 ST	Algenib
• 24	03 07.5	+40 55		2.1v	STAR B8 V + F:	Beta Per	8 ST	Algol
• 25	03 23.6	+49 49		1.8v	STAR F5 Ib	Alpha Per	8 ST	Mirphak
• 26	03 42.2	+47 46		3.0v	STAR B5 IIIn	Delta Per	8 ST	
• 27	03 46.9	+27 04		2.9v	STAR B7 IIIn	Eta Tau	8 ST	Alcyone
• 28	03 47.3	-74 17		3.2v	STAR M2 III	Gamma Hyi	8 ST	
• 29	03 53.5	+31 52	130	2.9v	STAR B1 Ib + B8 V	Zeta Per A	9 ST	B=9.2
• 30	03 57.1	+39 59	90	2.9v	STAR B0.5 IV + B9.5 V	Epsilon Per A	9 ST	B=7.9
• 31	03 57.5	-13 32		3.0v	STAR M0.5 III-IIIb	Gamma Eri	8 ST	Zaurak
• 32	04 33.8	-55 03	2	3.3v	STAR A0p III:(Si) + B9 IV	Alpha Dor AB	9 ST	A=3.8 B=4.3
• 33	04 35.3	+16 30		0.9v	STAR K5 III	Alpha Tau A	8 ST	Aldebaran
• 34	04 49.3	+06 56		3.2v	STAR F6 V	Pi^3 Ori	8 ST	Hassaleh
• 35	04 56.3	+33 10		2.7v	STAR K3 II	Iota Aur	8 ST	Ayn
• 36	05 01.2	+43 48		3.0v	STAR A9 Iae + B	Epsilon Aur A	8 ST	Anz
• 37	05 05.0	-22 23		3.2v	STAR K5 III	Epsilon Lep	8 ST	
• 38	05 05.8	+41 13		3.2v	STAR B3 V	Eta Ori AB	8 ST	Hoedus II
• 39	05 07.4	-05 06		2.8v	STAR A3 IIIn	Theta Eri	8 ST	Kursa
• 40	05 12.4	-16 13		3.1v	STAR B9p IV: (Hg+Mn)	Mu Lep	8 ST	
• 41	05 14.0	-08 12	90	0.1v	STAR B8 Iae + B5 V	Beta Ori A	9 ST	Rigel B=7.6 C=7.6
• 42	05 16.8	+46 00		0.1v	STAR G6: III + G2: III	Alpha Aur AB	8 ST	Capella
• 43	05 23.9	-02 25		3.3v	STAR B1 IV + B	Eta Ori AB	8 ST	
• 44	05 24.6	+06 20		1.6v	STAR B2 III	Gamma Ori	8 ST	Bellatrix
• 45	05 25.6	+28 36		1.7v	STAR B7 III	Beta Tau	8 ST	Alnath
• 46	05 27.8	-20 46	26	2.8v	STAR G5 II + ?	Beta Lep A	9 ST	B=7.4 Nihal
• 47	05 31.5	-00 19		2.2v	STAR O9.5 II	Delta Ori A	8 ST	Mintaka
• 48	05 32.2	-17 49		2.6v	STAR F0 Ib	Alpha Lep	8 ST	Arneb
• 49	05 45.9	-05 55	110	2.8v	STAR O9 III + B7 IIIp	Iota Ori A	9 ST	Nair al Saif B=7.8

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
• 50	05 35.6	-01 12		1.7v	STAR B0 Ia	Epsilon Ori	8 ST	Alnilam
• 51	05 37.0	+21 08		3.0v	STAR B2 IIIpe (shell)	Zeta Tau	8 ST ?	
• 52	05 39.3	-34 05		2.6v	STAR B7 IV	Alpha Col A	8 ST	Phaet
• 53	05 40.3	-01 57	24	2.1v	STAR O9.5 Ib + B0 III	Zeta Ori A	9 ST	Alnitak B=4.2
• 54	05 47.2	-09 40		2.1v	STAR B0.5 Ia	Kappa Ori	8 ST	Saiph
• 55	05 50.6	-35 46		3.1v	STAR K1.5 III	Beta Col	8 ST	Wezn
• 56	05 54.6	+07 24		0.4v	STAR M2 Iab	Alpha Ori	8 ST	Betelgeuse
• 57	05 58.7	+44 57		1.9v	STAR A1 IV	Beta Aur	8 ST	Menkalinan
• 58	05 59.0	+37 13	40	2.6v	STAR A0p III: (si) + G2 V	Theta Aur AB	9 ST	Bogardus B=7.2 G2V
• 59	06 14.3	+22 31		3.3v	STAR M3 III	Eta Gem	8 ST	Propus ? [illegible]
• 60	06 19.9	-30 03		3.0v	STAR B2.5 V	Zeta CMa	8 ST	Phurud
• 61	06 22.3	+22 31		2.8v	STAR M3 IIIab	Mu Gem	8 ST	Tejat Posterior
• 62	06 22.2	-17 57		2.0v	STAR B1 II-III	Beta CMa	8 ST	Murzim
• 63	06 23.8	-52 41		-0.7v	STAR A9 II	Alpha Car	8 ST	Canopus
• 64	06 37.1	+16 25		1.9v	STAR A1 IVs	Gamma Gem	8 ST	Alhena
• 65	06 37.4	-43 11		3.2v	STAR B8 IIIn	Nu Pup	8 ST	
• 66	06 43.3	+25 08		3.0v	STAR G8 Ib	Epsilon Gem	8 ST	Mebsuta
• 67	06 44.7	-16 42	95	-1.5v	STAR A0mA1 Va	Alpha CMa A	9 ST	Sirius B=8.5 50y
• 68	06 48.1	-61 56		3.3v	STAR A6 Vn	Alpha Pic	8 ST	
• 69	06 49.7	-50 36		2.9v	STAR K1 III	Tau Pup	8 ST	
• 70	06 58.2	-28 57		1.5v	STAR B2 II	Epsilon CMa A	8 ST	Adara
• 71	07 02.6	-23 49		3.0v	STAR B3 Iab	Omicron^2 CMa	8 ST	
• 72	07 07.9	-26 22		1.8v	STAR F8 Ia	Delta CMa	8 ST	Wezen
• 73	07 13.2	-44 37		2.6v	STAR M5 IIIe	L2 Pup	8 ST	HR2748
• 74	07 16.8	-37 04		2.7v	STAR K3 Ib	Pi Pup	8 ST	
• 75	07 23.7	-26 18		2.5v	STAR B5 Ia	Eta CMa	8 ST	Aludra
• 76	07 26.6	+08 18		2.9v	STAR B8 V	Beta CMi	8 ST	Gomeisa
• 77	07 28.9	-43 16	220	3.3v	STAR K5 III + G5: V	Sigma Pup A	9 ST	
• 78	07 33.9	+31 55	25	1.9v	STAR A1 V + A2mA5	Alpha Gem A	9 ST	Castor A
• 79	07 33.9	+31 55	25	2.9v	STAR A2mA5 + A1 V	Alpha Gem B	9 ST	Castor B
• 80	07 38.8	+05 16	40	0.4v	STAR F5 IV-V + ?	Alpha CMi A	9 ST	Procyon B=10.3
• 81	07 44.7	+28 03		1.1v	STAR K0 IIIb	Beta Gem	8 ST	Pollux
• 82	07 48.8	-24 50		3.3v	STAR G6 Ib	Xi Pup	8 ST	
• 83	08 03.2	-29 59		2.3v	STAR O5 Iafn	Zeta Pup	8 ST	Naos ?
• 84	08 07.1	-24 17		2.7v	STAR F6 IIp (var)	Rho Pup	8 ST	
• 85	08 09.2	-47 19		1.7v	STAR WC8 + O9 I:	Gamma^2 Vel	8 ST	Al Suhail al Muhlif
• 86	08 22.5	-59 29		1.9v	STAR K3: III	Epsilon Car	8 ST	Avior
• 87	08 44.4	-54 41	20	2.0v	STAR A1 IV	Delta Vel AB	9 ST	B=5.0
• 88	08 54.9	+05 59		3.1v	STAR G9 II-III	Zeta Hya	8 ST	
• 89	08 58.5	+48 08	40	3.1v	STAR A7 IVn + M1 V	Iota UMa A	9 ST	Talitha BC=10.8
• 90	09 07.6	-43 23		2.2v	STAR K4 Ib-IIa	Lambda Vel	8 ST	Suhail
• 91	09 13.2	-69 41		1.7v	STAR A1 III	Beta Car	8 ST	Miaplacidus
• 92	09 16.8	-59 14		2.2v	STAR A8 II	Iota Car	8 ST	Turais
• 93	09 20.4	+34 26		3.1v	STAR K7 IIIab	Alpha Lyn	8 ST	
• 94	09 21.8	-54 58		2.5v	STAR B2 IV-V	Kappa Vel	8 ST	
• 95	09 27.0	-08 36		2.0v	STAR K3 II-III	Alpha Hya	8 ST	Alphard
• 96	09 30.9	-56 58		3.1v	STAR K5 III	N Vel	8 ST	HR3803
• 97	09 32.8	+51 44		3.2v	STAR F6 IV	Theta UMa	8 ST	
• 98	09 45.3	+23 46		3.0v	STAR G1 II	1 Leo	8 ST	Ras Elased Aus ?
• 99	09 46.9	-65 02	50	3.0v	STAR A5 Ib + B7 III	Nu Car AB	9 ST	B=6.3

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
*100	10 07.9	+12 01		1.4v	STAR B7 Vn	Alpha Leo A	8 ST	Regulus
*101	10 13.5	-69 59		3.3v	STAR B8 IIIn	Omega Car	8 ST	
*102	10 19.4	+19 54	50	2.6v	STAR K1 IIIb Fe-0.5 + *	Gamma Leo A	9 ST	Algieba B=3 5 G7 III Fe-1
*103	10 21.7	+41 33		3.1v	STAR M0 IIIp	Mu Uma	8 ST	Tania Australis
*104	10 31.6	-61 38		3.3v	STAR B4 Vne	Rho Car	8 ST	HR4140
*105	10 42.6	-64 20		2.8v	STAR B0.5 Vp	Theta Car	8 ST	
*106	10 46.3	-49 22	20	2.7v	STAR G5 III + F8: V	Mu Vel AB	9 ST	B=6.4
*107	10 49.2	-16 07		3.1v	STAR K2 III	Ny Hya	8 ST	
*108	11 01.2	+56 26		2.4v	STAR A0mA1 IV-V	Beta UMa	8 ST	Merak
*109	11 03.1	+61 48	3	1.8v	STAR K0 IIIa + A8 V	Alpha UMa AB	9 ST	Dubhe B=4.8
*110	11 09.1	+44 33		3.0v	STAR K1 III	Psi UMa	8 ST	
*111	11 13.6	+20 35		2.6v	STAR A4 V	Delta Leo	8 ST	Zosma
*112	11 13.7	+15 29		3.3v	STAR A2 Vs	Theta Leo	8 ST	Chort
*113	11 35.3	-62 58		3.1v	STAR B9 III	Lambda Cen	8 ST	
*114	11 48.6	+14 38		2.1v	STAR A3 V	Beta Leo	8 ST	Denebola
*115	11 53.3	+53 45		2.4v	STAR A0 IV-Vn	Gamma UMa	8 ST	Phad Phekda
*116	12 07.8	-50 40		2.5v	STAR B2 IVne	Delta Cen	8 ST	
*117	12 09.6	-22 33		3.0v	STAR K3 IIIa	Epsilon Crv	8 ST	Minkar
*118	12 14.5	-58 41		2.8v	STAR B2 IV	Delta Cru	8 ST	
*119	12 15.0	+57 05		3.3v	STAR A2 IV-Vn	Delta UMa	8 ST	Megrez
*120	12 15.2	-17 29		2.6v	STAR B8p III: (Hg+Mn)	Gamma Crv	8 ST	Glenah Ghurab
*121	12 26.0	-63 02	50	1.3v	STAR B0.5 IV + B1 Vn	Alpha Cru A	9 ST	Acrux A B=1.7
*122	12 26.1	-63 03	50	1.7v	STAR B1 Vn + B0.5 IV	Alpha Cru B	9 ST	Acrux B A=1.3
*123	12 29.4	-16 27	240	3.0v	STAR B9.5 III + K2 V	Delta Crv A	9 ST	Algorab B=8.3
*124	12 30.6	-57 03		1.6v	STAR M3.5 III	Gamma Cru	8 ST	Gacrux
*125	12 33.8	-23 20		2.7v	STAR G5 II	Beta Crv	8 ST	Kraz
*126	12 36.6	-69 05		2.7v	STAR B2 IV-V	Alpha Mus	8 ST	
*127	12 41.0	-48 54	50	2.9v	STAR B9.5 III + A0 III	Gamma Cen A	9 ST	B=3.0
*128	12 40.9	-48 54	50	3.0v	STAR A0 III + B9.5 III	Gamma Cen B	9 ST	A=2.9
*129	12 41.2	-01 24	40	2.8v	STAR F1 V + F1 V	Gamma Vir AB	9 ST	Porrima B=3.5
*130	12 45.6	-68 03	10	3.1v	STAR B2 V + B2.5 V	Beta Mus AB	9 ST	B=4.1
*131	12 47.1	-59 38		1.2v	STAR B0.5 III	Beta Cru	8 ST	Becrux Mimosa
*132	12 53.5	+56 01		1.8v	STAR A0p IV: (Cr+Eu)	Epsilon UMa	8 ST	Alioth
*133	12 55.6	+38 22		2.9v	STAR A0p III: (Si+Eu+Sr)	Alpha^2 CVn A	8 ST	Cor Caroli B=5.6 F0 V
*134	13 01.7	+11 01		2.8v	STAR G9 IIIab	Epsilon Vir	8 ST	Vindemiatrix
*135	13 18.4	-23 07		3.0v	STAR G8 IIIa	Gamma Hya	8 ST	
*136	13 20.0	-36 39		2.8v	STAR A2 V	Iota Cen	8 ST	
*137	13 23.5	+54 59	140	2.3v	STAR A1p IV: (Si) + A1mA7	Zeta UMa A	9 ST	Mizar B=3.9
*138	13 24.7	-11 06		1.0v	STAR B1 V	Alpha Vir	8 ST	Spica
*139	13 39.2	-53 25		2.3v	STAR B1 III	Epsilon Cen	8 ST	
*140	13 47.1	+49 22		1.9v	STAR B3 V	Eta UMa	8 ST	Alcaid
*141	13 49.0	-42 25		3.0v	STAR B2 IV-Vpne	Mu Cen	8 ST	"
*142	13 54.1	+18 27		2.7v	STAR G0 IV	Eta Boo	8 ST	Mufrid
*143	13 54.9	-47 14		2.6v	STAR B2.5 IV	Zeta Cen	8 ST	
*144	14 03.1	-60 20		0.6v	STAR B1 III	Beta Cen AB	8 ST	Hadar
*145	14 05.8	-26 38		3.3v	STAR K2 IIIb	Pi Hya	8 ST	
*146	14 06.1	-36 19		2.1v	STAR K0 IIIb	Theta Cen	8 ST	Menkent
*147	14 15.1	+19 14		0.0v	STAR K1.5 III Fe-0.5	Alpha Boo	8 ST	Arcturus
*148	14 31.6	+38 22		3.0v	STAR A7 III-IV	Gamma Boo	8 ST	Seginus
*149	14 34.8	-42 07		2.4	STAR B1.5 IVpne	Eta Cen	8 ST	

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
*150	14 38.9	-60 48	210	0.0v	STAR G2 V + K4 V	Alpha Cen A	9 ST	Rigil Kentaurus B=1.3
*151	14 38.9	-60 48	210	1.3v	STAR K4 V + G2 V	Alpha Cen B	9 ST	A=0.0 Toliman
*152	14 41.2	-47 21		2.3v	STAR B1.5 III	Alpha Lup	8 ST	
*153	14 41.6	-64 56	160	3.2v	STAR A7p (Sr) + K5 V	Alpha Cir	9 ST	B=8.6
*154	14 46.1	+27 07	30	2.4v	STAR K0 II-III + A0 V	Epsilon Boo	9 ST	Izar B=5.1
*155	14 50.3	~~-51 00~~ -15 00		2.8v	STAR A3 IV	Alpha Lib A	8 ST	Zuben Elgenubi
*156	14 50.7	+74 12		2.1v	STAR K4 III	Beta UMi	8 ST	Kocab
*157	14 57.8	-43 05		2.7v	STAR B2 IV	Beta Lup	8 ST	
*158	14 58.5	-42 03		3.1v	STAR B2 V	Kappa Cen	8 ST	
*159	15 03.5	-25 15		3.3v	STAR M4 III	Sigma Lib	8 ST	Brachium
*160	15 16.5	-09 21		2.6v	STAR B8 Vn	Beta Lib	8 ST	Zuben Elschemali
*161	15 17.8	-68 39		2.9v	STAR A1 IIIn	Gamma TrA	8 ST	
*162	15 20.7	-40 37		3.2v	STAR B1.5 IVn	Delta Lup	8 ST	
*163	15 20.7	+71 53		3.1v	STAR A2.5 III	Gamma UMi	8 ST	Pherkad
*164	15 24.7	+59 01		3.3v	STAR K2 III	Iota Dra	8 ST	Ed Asich
*165	15 35.0	+26 45		2.2v	STAR A0 IV	Gamma CrB	8 ST	Alphekka
? *166	15 34.4	-41 08	5	2.8v	STAR B2 IVn + B2 IVn	Alpha Lup AB	9 ST	A=3.5 B=3.6 Gamma ?
*167	15 53.7	+06 27		2.7v	STAR K2 IIIb (CN1)	Alpha Ser	8 ST	Unukalhai
*168	15 54.2	-63 24		2.9v	STAR F0 IV	Beta Tra	8 ST	
*169	15 58.2	-26 06		2.9v	STAR B1 V + B2 V	Pi Sco A	8 ST	
*170	15 59.0	+25 56		2.0v	STAR gM3: + Bep	T CrB	8 ST	Galt
*171	15 59.7	-22 36		2.3v	STAR B0.3 IV	Delta Sco AB	8 ST	Dschubba
*172	16 04.9	-19 46	10	2.6v	STAR B0.5 IV	Beta Sco AB	9 ST	Graffias B=5.0 C=4.9 @ 14"
*173	16 13.8	-03 41		2.7v	STAR M0.5 III	Delta Oph	8 ST	Yed Prior Acrab
*174	16 17.6	-04 35		3.2v	STAR G9.5 IIIb Fe-0.5	Epsilon Oph	8 ST	Yed Posterior
*175	16 20.6	-25 35	200	2.9v	STAR B1 III + B9 V	Sigma Sco A	9 ST	Alniyat B=8.3
*176	16 23.8	+61 33	60	2.7v	STAR G8 IIIab	Eta Dra A	9 ST	Booboo B=8.7
*177	16 28.8	-26 24	30	0.9v	STAR M1.5 Iab + B2.5 V	Alpha Sco A	9 ST	Antares B=5.4
*178	16 29.7	+21 31		2.8v	STAR G7 IIIa	Beta Her	8 ST	Kornephoros
*179	16 35.2	-28 12		2.8v	STAR B0 V	Tau Sco	8 ST	
*180	16 36.6	-10 33		2.6v	STAR O9.5 Vn	Zeta Oph	8 ST	Fieht
*181	16 40.9	+31 37	11	2.8v	STAR G1 IV + G7 V	Zeta Her AB	9 ST	B=5.5
*182	16 47.5	-69 00		1.9v	STAR K2 IIb - IIIa	Alpha TrA	8 ST	Artia = Atria ?
*183	16 49.5	-34 16		2.3v	STAR K2 III	Epsilon Sco	8 ST	
*184	16 51.2	-38 02		3.0v	STAR B1.5 IVn	Mu^1 Sco	8 ST	
*185	16 57.1	+09 23		3.2v	STAR K2 III	Kappa Oph	8 ST	
*186	16 57.7	-55 59		3.1v	STAR K4 III	Zeta Ara	8 ST	
*187	17 08.7	+65 44		3.2v	STAR B6 III	Zeta Dra	8 ST	Aldhibah = Nodus I
*188	17 09.8	-15 43	10	2.4v	STAR A2 Vs + A3 V	Eta Oph AB	9 ST	Sabik A=3.0 B=3.5
*189	17 11.4	-43 13		3.3v	STAR F2p V: (Cr)	Eta Sco	8 ST	
*190	17 14.1	+14 23		3.1v	STAR M5 Ib-II	Alpha Her AB	8 ST	Ras Algethi
*191	17 14.6	+24 50	90	3.1v	STAR A1 IVn + ?	Delta Her	9 ST	Sarin B=8.8
*192	17 14.7	+36 48		3.2v	STAR K3 IIab	Pi Her	8 ST	
*193	17 21.4	-24 59		3.3v	STAR B2 IV	Alpha Oph	8 ST	
*194	17 24.5	-65 31		2.9v	STAR K3 Ib-IIa	Beta Ara	8 ST	
*195	17 24.5	-56 22		3.3v	STAR B1 Ib	Gamma Ara A	8 ST	
*196	17 30.0	-37 17		2.7v	STAR B2 IV	Upsilon Sco	8 ST	
*197	17 30.2	+52 18	40	2.8v	STAR G2 Ib-IIa + ?	Beta Dra A	9 ST	Restaban B=11.5
*198	17 31.0	-49 52		3.0v	STAR B2 Vne	Alpha Ara	8 ST	
*199	17 32.9	-37 07		1.6v	STAR B1.5 IV	Lambda Sco	8 ST	Shaula

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
*200	17 24.4	+12 34		2.1v	STAR A5 IIIn	Alpha Oph	8 ST	Rasalhague
*201	17 36.5	-43 00		1.9v	STAR F1 II	Theta Sco	8 ST	Sargas
*202	17 41.8	-39 01		2.4v	STAR B1.5 III	Kappa Sco	8 ST	
*203	17 42.9	+04 34		2.8v	STAR K2 III	Beta Oph	8 ST	Cebalrai
*204	17 46.8	-40 07		3.0	STAR F2 Ia	Iota^1 Sco	8 ST	
*205	17 49.1	-37 02		3.2v	STAR K2 III	G Sco	8 ST	HR6630
*206	17 56.4	+51 29		2.2v	STAR K5 III	Gamma Dra	8 ST	Etamin
*207	17 58.5	-09 46		3.3v	STAR K0 III	Nu Oph	8 ST	[illegible]
*208	18 05.1	-30 26		3.0v	STAR K0 III	Gamma^2 Sgr	8 ST	Nash [illegible]
*209	18 16.9	-36 46	40	3.1v	STAR M3.5 IIIab + G8: IV:	Eta Sgr A	9 ST	B=8.3
*210	18 20.3	-29 50		2.7v	STAR K2.5 IIIa	Delta Sgr	8 ST	Kaus Media
*211	18 20.8	-02 54		3.3v	STAR K0 III-IV	Eta Ser	8 ST	
*212	18 23.5	-34 24		1.9v	STAR A0 IIInp (shell)	Epsilon Sgr	8 ST	Kaus Australis
*213	18 27.3	-25 26		2.8v	STAR K1 IIIb	Lambda Sgr	8 ST	Kaus Borealis
*214	18 36.6	+38 46		0.0v	STAR A0 Va	Alpha Lyr	8 ST	Vega
*215	18 45.0	-27 00		3.2v	STAR B8.5 III	Phi Sgr	8 ST	
*216	18 54.6	-26 19		2.0v	STAR B2.5 V	Sigma Sgr	8 ST	Nunki
*217	18 58.5	+32 40		3.2v	STAR B9 III	Gamma Lyr	8 ST	Sulaphat
*218	19 02.0	-29 54	5	2.6v	STAR A2.5 V + A4: V:	Zeta Sgr AB	9 ST	Ascella A=3.2 B=3.5
*219	19 04.9	+13 52		3.0v	STAR A0 IVnn	Zeta Aql A	8 ST	Deneb el Okab
*220	19 06.3	-27 40		3.3v	STAR K1.5 IIIb	Tau Sgr	8 ST	
*221	19 09.2	-21 03	6	2.9v	STAR F2 II + ? + ?	Pi Sgr ABC	9 ST	Albaldah A=3.7 B=3.8
*222	19 12.6	+67 38		3.1v	STAR G9 III	Delta Dra	8 ST	Nodus Secundus
*223	19 30.3	+27 57	350	3.1v	STAR K3 II + B9.5 V	Beta Cyg A	9 ST	Albireo B=5.1
*224	19 44.7	+45 07	20	2.9v	STAR B9.5 III + F1 V	Delta Cyg AB	9 ST	B=6.4
*225	19 45.8	+10 36		2.7v	STAR K3 II	Gamma Aql	8 ST	Tarazed
*226	19 50.2	+08 50		0.8v	STAR A7 Vn	Alpha Aql	8 ST	Altair
*227	20 10.8	-00 52		3.2v	STAR B9.5 III	Theta Aql	8 ST	
*228	20 20.5	-14 49		3.1v	STAR K0 II + A5 V:n	Beta Cap A	8 ST	Dabih
*229	20 21.8	+40 14		2.2v	STAR F8 Ib	Gamma Cyg	8 ST	Sadr
*230	20 26.4	+15 03	?	1.9v	STAR B2.5 V	Alpha Pav	8 ST	Peacock
*231	20 36.8	-47 20		3.1v	STAR K0 III (Cn1)	Alpha Ind	8 ST	
*232	20 41.1	+45 14		1.3v	STAR A2 Ia	Alpha Cyg	8 ST	Deneb
*233	20 45.8	+33 56		2.5v	STAR K0 III	Epsilon Cyg	8 ST	Cat
*234	21 12.5	+30 11		3.2v	STAR G8 IIIa Ba 0.6	Zeta Cyg	8 ST	
*235	21 18.4	+62 33		2.4v	STAR A7 IV-V	Alpha Cep	8 ST	Alderamin
*236	21 28.5	+70 30		3.2v	STAR B1 III	Beta Cep	8 ST	Alphirk
*237	21 31.0	-05 38		2.9v	STAR G0 Ib	Beta Aqr	8 ST	Sadalsuud
*238	21 43.6	+09 50		2.4v	STAR K2 Ib	Epsilon Peg	8 ST	Enif '72 flare,
*239	21 46.5	-16 10		2.9v	STAR A3mF2 V:	Delta Cap	8 ST	Algiedi
*240	21 53.3	-37 25		3.0v	STAR B8 III	Gamma Gru	8 ST	
*241	22 05.3	-00 23		3.0v	STAR G2 Ib	Alpha Aqr	8 ST	Sadalmelik
*242	22 07.6	-47 01		1.7v	STAR B7 IV	Alpha Gru	8 ST	Al Nair
*243	22 17.8	-60 19		2.9v	STAR K3 III	Alpha Tuc	8 ST	
*244	22 42.1	-46 56		2.1v	STAR M5 III	Beta Gru	8 ST	
*245	22 42.5	+30 10		2.9v	STAR G8 II + F0 V	Eta Peg	8 ST	Matar
*246	22 53.1	-15 53		3.3v	STAR A3 IV	Delta Aqr	8 ST	Skat
*247	22 57.1	-29 41		1.2v	STAR A3 V	Alpha PsA	8 ST	Fomalhaut
*248	23 03.2	+28 02		2.4v	STAR M2 II-III	Beta Peg	8 ST	Scheat
*249	23 04.3	+15 09		2.5v	STAR B9.5 V	Alpha Peg	8 ST	Markab

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
*250	23 38 9	+77 34		3.2v	STAR K1 III-IV	Gamma Cep	8 ST	Alrai
*251	00 05.5	+58 22	15	6.4	STAR 6.4:7.2 @308	ADS 61	9 ST	1980=1 4 @287 107y
*252	00 39.4	+21 23	66	5.5	STAR 5.5:8.7 @194	ADS 558	9 ST	1964 Yellow Blue
*253	00 41.8	+04 07	15	7.8	STAR 7.8:9.4 @207	ADS 588	9 ST	1980=1.5 @ 200
*254	00 49.3	+27 39	44	6.3	STAR 6.3:6.3 @296	ADS 683	9 ST	1959 p(Yellow Blue)
*255	00 54.0	+19 08	5	6.2	STAR 6.2:6.9 @211	ADS 746	9 ST	1980=0 5 @ 224 400y
*256	00 54.4	+23 35	8	6.0	STAR 6.0:6.4 @292	ADS 755	9 ST	1980=0.6 @ 259
*257	01 05.1	+21 25	299	5.6	STAR 5.6:5.8 @159	ADS 899	9 ST	1964 Yellow pBlue
*258	01 08.9	+47 12	5	4.6	STAR 4.6:5.5 @133	ADS 940	9 ST	1980=0 5 @ 140
*259	01 13.1	+07 32	230	5.6	STAR 5.6:6.6 @063	ADS 996	9 ST	1972 Yellow:pBlue
*260	01 39.4	-56 15	113	5.8	STAR 5.8:5.8 @193	p Eri	9 ST	1980=11 1 @195
*261	02 25.2	+89 32	178	2.0	STAR 2.0:8.9 @216	ADS 1477	9 ST	Polaris North Star
*262	01 53.0	+19 15	78	4.6	STAR 4.6:4.7 @000	ADS 1507	9 ST	1969 1831=8 6
*263	01 55.3	+01 48	10	6.8	STAR 6.8:6.8 @057	ADS 1538	9 ST	1980=1.2 @053
*264	01 57.3	+23 33	385	4.7	STAR 4.7:7.7 @047	ADS 1563	9 ST	1973 Yellow Blue
*265	02 01.4	+02 42	16	4.2	STAR 4.2:5.2 @273	ADS 1615	9 ST	pBlue pGreen
*266	02 03.2	+42 16	98	2.2	STAR 2.2:5.1 @063	ADS 1630	9 ST	1967 Orange Emerald
*267	02 11.8	+30 15	39	5.3	STAR 5.3:6.9 @071	ADS 1697	9 ST	1959 Yellow Blue
*268	02 13.3	+47 26	11	6.6	STAR 6.6:7.1 @274	ADS 1709	9 ST	1980=1.1 @266
*269	02 28.1	+67 22	25	4.6	STAR 4.6:6.9 @232	ADS 1860	9 ST	1980=2.4 @234
*270	02 36.4	+24 38	383	6.6	STAR 6.6:7.4 @276	ADS 1982	9 ST	1973 Yellow pBlue
*271	02 42.7	+03 12	28	3.6	STAR 3.6:6.2 @297	ADS 2080	9 ST	1974 Yellow Ashen
*272	03 13.5	+00 09	11	8.8	STAR 8.8:8.8 @139	ADS 2416	9 ST	1980=1.0 @144
*273	03 17.0	+38 36	8	7.8	STAR 7.8:8.3 @259	ADS 2446	9 ST	1980=0.9 @265
*274	03 34.1	+60 00	14	6.8	STAR 6.8.7.6 @261	ADS 2612	9 ST	1980=1.3 @258
*275	03 33.8	+24 26	7	6.6	STAR 6.6:6.7 @002	ADS 2616	9 ST	1980=0.6 @006
*276	03 49.7	+25 33	4	5.8	STAR 5.8:6.2 @211	ADS 2799	9 ST	1980=0.6 @207
*277	03 53.8	-02 59	67	4.7	STAR 4.7:6.2 @347	ADS 2850	9 ST	Fixed
*278	04 08.0	+80 40	7	5.5	STAR 5.5:6.3 @120	ADS 2963	9 ST	1980=0.8 @109
*279	04 06.8	+38 03	16	7.4	STAR 7.4:8.9 @353	ADS 2995	9 ST	1980=1.4 @003
*280	04 15.3	+31 40	7	8.0	STAR 8.0:8.1 @275	ADS 3082	9 ST	1980=0.8 @270
*281	04 19.7	+27 20	496	5.1	STAR 5.1:8.5 @496	ADS 3137	9 ST	1973 Yel/Ora Blue
*282	04 22.1	+15 02	14	7.3	STAR 7.3:8.5 @352	ADS 3169	9 ST	Purple:Blue
*283	05 07.3	+08 29	7	5.8	STAR 5.8:6.5 @349	ADS 3711	9 ST	1980=0.7 @021
*284	05 14.0	-08 12	92	0.2	STAR 0.2:6.7 @206	ADS 3823	9 ST	Rigel
*285	05 34.6	+09 56	43	3.6	STAR 3.6:5.5 @044	ADS 4179	9 ST	1959 Yellow Purple
*286	05 34.7	-05 23	132	5.1	STAR 5.4:6.8:6.8	ADS 4186	9 ST	Trapezium in M42
*287	06 28.3	-07 02	99	4.6	STAR 4.6:5.1:5 4	ADS 5107	9 ST	Fixed White Stars
*288	06 45.3	+59 28	17	5.4	STAR 5.4:6.0 @074	ADS 5400	9 ST	1980=1.7 @079
*289	06 44.8	-16 41	45	-1.5	STAR -1.5:8.5 @005	ADS 4523	9 ST	1980=10.3 @049
*290	07 12.1	+27 15	13	7.2	STAR 7.2.7.2 @316	ADS 5871	9 ST	1980=1.3 @320 120y
*291	07 29.5	+50 00	8	8.8	STAR 8.8:8.8 @195	ADS 6117	9 ST	1980=0 8 @189
*292	07 33.9	+31 55	30	1.9	STAR 1.9:2.9 @073	ADS 6175	9 ST	1980=2 2 @095 420y
*293	08 11.6	+17 41	6	5.6	STAR 5.6:6.0 @182	ADS 6650	9 ST	Yellow:Yellow Blue
*294	09 20.4	+38 14	11	6.5	STAR 6.5:6.7 @271	ADS 7307	9 ST	1980=1.1 @254
*295	10 15.7	+17 47	14	7.2	STAR 7.2:7.5 @181	ADS 7704	9 ST	1980=1.4 @183
*296	10 19.4	+19 54	44	2.2	STAR 2.2:3.5 @124	ADS 7724	9 ST	1980=4.3 @123
*297	11 17.7	+31 36	13	4.3	STAR 4.3:4.8 @060	ADS 8119	9 ST	1980=2.9 @105
*298	11 31.7	+61 09	6	5.8	STAR 5.8:7.1 @295	ADS 8197	9 ST	1980=0.4 @211
*299	12 15.6	+40 43	115	5.9	STAR 5.9:9.0 @260	ADS 8489	9 ST	1925 Gold Blue

STAR#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
*300	12 23.9	+25 39	16	6.8	STAR 6.8:7.8 @325	ADS 8539	9 ST	1980=1.5 @326
*301	12 26.0	-63 02	47	1.6	STAR 1.6:2.1 @114	Alpha Cru	9 ST	1943 White:White
*302	12 34.6	+18 26	202	5.2	STAR 5.2:6.8 @271	ADS 8600	9 ST	1963 Yellow:vBlue
*303	12 41.1	-01 24	30	3.5	STAR 3.5:3.5 @287	ADS 8630	9 ST	1980=3.9 @297 White
*304	12 52.7	+21 18	8	5.1	STAR 5.1:7.2 @194	ADS 8695	9 ST	1980=0.8 @175
*305	13 23.5	+54 59	144	2.3	STAR 2.3:4.0 @151	ADS 8891	9 ST	1967
*306	13 48.6	+27 02	34	7.6	STAR 7.6:8.0 @167	ADS 9031	9 ST	1980=3.4 @159
*307	14 14.8	+03 11	12	7.8	STAR 7.8:7.9 @239	ADS 9182	9 ST	1980=1.1 @252
*308	14 19.9	+48 33	13	8.1	STAR 8.1:8.3 @105	ADS 9229	9 ST	1980=1.2 @104 White
*309	14 39.2	-60 48	197	0.0	STAR 0.0:1.2 @214	Alpha Cen	9 ST	1980=21.8 @209
*310	14 40.7	+13 47	10	4.5	STAR 4.5:4.6 @160	ADS 9343	9 ST	1980=1.1 @305 White
*311	14 44.5	+27 07	28	2.5	STAR 2.5:5.0 @339	ADS 9372	9 ST	1971 Orange:Green
*312	14 50.9	+19 08	70	4.7	STAR 4.7:6.9 @326	ADS 9413	9 ST	Orange:Blue
*313	14 51.0	+44 58	11	8.4	STAR 8.4:8.6 @348	ADS 9418	9 ST	1980=1.1 @346
*314	15 17.9	+26 52	15	7.3	STAR 7.3:7.4 @255	ADS 9578	9 ST	1980=1.4 @250
*315	15 22.7	+30 20	10	5.6	STAR 5.6:5.9 @027	ADS 9617	9 ST	1980=0.4 @321
*316	15 24.1	+37 23	22	7.0	STAR 7.0:7.6 @012	ADS 9626	9 ST	1980=2.2 @016
*317	15 34.3	+10 34	39	4.1	STAR 4.1:5.2 @179	ADS 9701	9 ST	1960 Yel-Whi:Ashen
*318	15 39.0	+36 40	63	5.1	STAR 5.1:6.0 @305	ADS 9737	9 ST	1957
*319	16 03.8	-11 20	7	4.9	STAR 4.9:4.9 @044	ADS 9909	9 ST	1980=1.2 @021
*320	16 14.3	+33 53	69	5.6	STAR 5.6:6.6 @235	ADS 9979	9 ST	1980=6.7 @233
*321	16 28.7	-26 24	24	0.9v	STAR 0.9:5.5 @276	ADS 10074	9 ST	Antares Red:pGreen
*322	16 28.4	+13 26	17	7.7	STAR 7.7:7.8 @129	ADS 10075	9 ST	1980=1.4 @136
*323	16 30.4	+02 01	15	4.2	STAR 4.2:5.2 @022	ADS 10087	9 ST	1980=1.3 @ 013
*324	16 56.4	+65 03	14	7.1	STAR 7.1:7.3 @069	ADS 10279	9 ST	1980=1.3 @069
*325	17 05.1	+54 29	19	5.7	STAR 5.7:5.7 @025	ADS 10345	9 ST	1980=1.9 @042
*326	17 14.7	-26 35	48	5.1	STAR 5.1:5.1 @151	ADS 10417	9 ST	Orange:Orange
*327	17 14.2	+14 24	47	3.2	STAR 3.2:5.4 @107	ADS 10418	9 ST	1968 Yellow:Blue
*328	17 23.4	+37 09	40	4.6	STAR 4.6:5.5 @316	ADS 10526	9 ST	1964
*329	18 01.1	+21 36	65	5.1	STAR 5.1:5.2 @258	ADS 10993	9 ST	1953 Yellow:pRed
*330	18 02.5	-08 11	18	5.2	STAR 5.2:5.9 @280	ADS 11005	9 ST	1980=1.9 @277
*331	18 04.8	+02 32	15	4.2	STAR 4.2:6.0 @220	ADS 11046	9 ST	Yel-Ora:Ora
*332	18 24.6	+27 23	7	6.5	STAR 6.5:7.5 @126	ADS 11334	9 ST	1980=0.7 @129
*333	18 35.4	+16 58	15	6.8	STAR 6.8:7.0 @155	ADS 11483	9 ST	1980=1.6 @161
*334	18 44.0	+39 39	26	5.0	STAR 5.0:6.1 @353	ADS 11635	9 ST	1980=2.7 @355 White
*335	18 44.0	+39 35	24	5.2	STAR 5.2:5.5 @080	ADS 11635	9 ST	1980=2.3 @084 White
*336	18 56.7	+32 53	10	5.4	STAR 5.4:7.5 @021	ADS 11871	9 ST	1980=1.1 @051
*337	19 05.7	-37 04	13	4.8	STAR 4.8:5.1 @109	Gamma CrA	9 ST	1980=1.5 @157
*338	19 26.1	+27 18	20	8.1	STAR 8.1:8.4 @292	ADS 12447	9 ST	1980=1.8 @298
*339	19 30.3	+27 57	344	3.2	STAR 3.2:5.4 @054	ADS 12540	9 ST	1967 Gold:Blue
*340	19 45.1	+33 36	24	8.3	STAR 8.3:8.4 @349	ADS 12889	9 ST	1980=2.9 @[illegible]
*341	20 20.4	-14 49	2050	3.1	STAR 3.1:6.2 @267	Beta Cap	9 ST	Yellow:Blue
*342	20 46.1	+16 06	98	4.3	STAR 4.3:5.2 @268	ADS 14279	9 ST	1967 Gold:Blue-Grn
*343	20 47.0	+36 27	9	4.9	STAR 4.9:6.1 @011	ADS 14296	9 ST	White:pBlue
*344	20 58.6	+04 15	10	6.0	STAR 6.0:6.3 @285	ADS 14499	9 ST	1980=1.1 @[illegible]
*345	21 01.7	+07 08	28	7.3	STAR 7.3:7.5 @217	ADS 14556	9 ST	1961
*346	21 06.2	+38 39	297	5.2	STAR 5.2:6.0 @148	ADS 14636	9 ST	1980=[illegible] @146
*347	22 28.2	+00 12	19	4.3	STAR 4.3:4.5 @207	ADS 15971	9 ST	pYellow:pBlue
*348	22 27.8	+57 39	33	9.8	STAR 9.8:11.5 @132	ADS 15972	9 ST	1980=2.6 @176 Reds
*349	22 32.7	+69 51	4	6.5	STAR 6.5:7.0 @094	ADS 16057	9 ST	1980=0.5 @[illegible]
*350	23 38.4	+31 16	4	5.6	STAR 5.6:5.7 @290	ADS 16836	9 ST	1980=0.4 @257
*351	[illegible]	[illegible]		5.5	STAR VAR 5.3-5.7 P[illegible]	Sigma Oct	9 ST	S-Pole * Sigma Oct

APPENDIX G: MESSIER LIST

MESS#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
M 1	05 33.9	+22 01	360	8.4	PLAN NEB EMIS SN REM	CNGC 1952	B 4 ST	M1 Crab Nebula 4kly
M 2	21 32.9	-00 53	774	6.5v	GLOB CLUS sp=F4	CNGC 7089	C 2 ST	M2 40kly
M 3	13 41.8	+28 26	972	6.4v	GLOB CLUS sp=F7	CNGC 5272	B 2 ST	M3 35kly
M 4	16 23.0	-26 30	1578	5.9v	GLOB CLUS sp=G0	CNGC 6121	B 2 ST	M4 14kly
M 5	15 18.0	+02 07	1044	5.8v	GLOB CLUS sp=F6	CNGC 5904	B 2 ST	M5 26kly
M 6	17 39.3	-32 12	900	4.2v	OPEN CLUS sp=B4	CNGC 6405	C 1 ST	M6 1500ly
M 7	17 53.3	-34 49	4800	3.3v	OPEN CLUS sp=B5	CNGC 6475	C 1 ST	M7 800ly
M 8	18 02.5	-24 23	5400	5 2	OPEN CLUS + ENEB sp=O5	CNGC 6523	B 6 ST	M8 Lagoon Nebula 5100ly
M 9	17 18.5	-18 30	558	7.9v	GLOB CLUS	CNGC 6333	D 2 ST	M9
M 10	16 56.6	-04 06	906	6.6v	GLOB CLUS sp=G1	CNGC 6254	D 2 ST	M10 20kly
M 11	18 50.5	-06 17	840	5.8v	OPEN CLUS sp=B8	CNGC 6705	C 1 ST	M11 Very rich 5600ly
M 12	16 46.6	-01 56	870	6.6v	GLOB CLUS sp=F8	CNGC 6218	D 2 ST	M12 24kly
M 13	16 41.3	+36 29	996	5.9v	GLOB CLUS sp=F6	CNGC 6205	B 2 ST	M13 Hercules Globular
M 14	17 37.0	-03 16	702	7.6v	GLOB CLUS	CNGC 6402	D 2 ST	M14
M 15	21 29.5	+12 07	738	6.4v	GLOB CLUS sp=F2	CNGC 7078	C 2 ST	M15 X-Ray Source 34kly
M 16	18 18.2	-13 47	2100	6.0v	OPEN CLUS + ENEB sp=O7	CNGC 6611	D 6 ST	M16 Eagle Nebula 5500ly
M 17	18 20.1	-16 11	2760	6.0v	DIFF ENEB + OPEN CLUS HII	CNGC 6618	B 6 ST	M17 Omega/Swan/Horseshoe
M 18	18 19.3	-17 08	540	6.9v	OPEN CLUS	CNGC 6613	D 1 ST	M18
M 19	17 01.9	-26 14	810	7.2v	GLOB CLUS OBLATE	CNGC 6273	D 2 ST	M19 Oblate Shape Globular
M 20	18 01.7	-23 02	1740	6 3v	DIFF ENEB + OPEN CLUS HII	CNGC 6514	B 6 ST	M20 Trifid Nebula 3500ly
M 21	18 04.0	-22 30	780	5 9v	OPEN CLUS	CNGC 6531	D 1 ST	M21
M 22	18 35.7	-23 56	1440	5 1v	GLOB CLUS sp=F7	CNGC 6656	C 2 ST	M22 10kly
M 23	17 56.3	-19 01	1620	5.5v	OPEN CLUS sp=B8	CNGC 6494	D 1 ST	M23 1400ly
M 24	18 19.3	-18 26	4800	4.7	OPEN CLUS	CNGC 6630	c 1 T	M24 Best with large field
M 25	18 32.8	-19 14	2400	6.5	OPEN CLUS SPARSE	CNGC 6634	c 1	M25 IC 4725 Sparse Cluster
M 26	18 44.8	-09 25	900	8.0v	OPEN CLUS	CNGC 6694	D 1 ST	M26
M 27	19 59.1	+22 41	910	7.6p	PLAN NEB	CNGC 6853	B 4 ST	M27 Dumbbell Nebula 3500ly
M 28	18 23.9	-24 53	672	6 9v	GLOB CLUS	CNGC 6626	D 2 ST	M28
M 29	20 23.5	+38 30	420	6.6v	OPEN CLUS	CNGC 6913	D 1 ST	M29
M 30	21 39 7	-23 14	660	7.5v	GLOB CLUS	CNGC 7099	D 2 S	M30
M 31	00 42.2	+41 13	10680	3.5	GALAXY Sb I-II	UGC 454	B 5 ST	M31 Andromeda Gal 178x63
M 32	00 42.2	+40 49	456	8.2	GALAXY E2	UGC 452	C 5 ST	M32 Comp of M31 7.6x5 8
M 33	01 33.3	+30 36	3720	5.7	GALAXY Sc II-III	UGC 1117	C 5 ST	M33 Triangulum Gal 62x39
M 34	02 41.3	+42 44	2100	5.2v	OPEN CLUS	CNGC 1039	C 1 ST	M34
M 35	06 08.2	+24 21	1680	5.1v	OPEN CLUS sp=B5	CNGC 2168	C 1 ST	M35 2800ly
M 36	05 35.5	+34 08	720	6.0v	OPEN CLUS	CNGC 1960	C 1 ST	M36
M 37	05 51.6	+32 33	1440	5.6v	OPEN CLUS sp=B8	CNGC 2099	C 1 ST	M37 4200ly
M 38	05 28.0	+35 50	1260	6.4v	OPEN CLUS sp=B5	CNGC 1912	C 1 ST	M38 4600ly
M 39	21 31 8	+48 23	1920	4.6v	OPEN CLUS	CNGC 7092	D 1 ST	M39
M 40	12 35.8	+26 03	972	9.6	GALAXY Sb I: + 3-SYS FNT	UGC 7772	B A ST	M40 16.2x2.8 Edge-On Lane
M 41	06 46.6	-20 45	2280	4.5v	OPEN CLUS sp=B4	CNGC 2287	C 1 ST	M41 2200ly
M 42	05 34.8	-05 23	3960	3 9	DIFF RNEB + ENEB	CNGC 1976	A 3 ST	M42 Orion Nebula Blue+Red
M 43	05 35.0	-05 16	1200	5 8	DIFF RNEB + ENEB	CNGC 1982	C 3 ST	M43 Orion Nebula Extension
M 44	08 39.4	+20 02	5700	3 1v	OPEN CLUS sp=A0	CNGC 2632	C 1 ST	M44 Praesepe/Beehive 590ly
M 45	03 46.4	+24 05	7200	1 6	OPEN CLUS + RNEB sp=B6	CNGC 1457	c 6 ST	M45 Pleiades 410ly
M 46	07 41 4	-14 48	1620	6 1v	OPEN CLUS sp=B8	CNGC 2437	C 1 ST	M46 5400ly (+CNGC 2438 Pl
M 47	07 36 1	-14 27	1800	4.4v	OPEN CLUS sp=B3	CNGC 2422	D 1 ST	M47 1600ly
M 48	08 13.1	-05 45	3240	5.8v	OPEN CLUS	CNGC 2548	D 1 ST	M48
M 49	12 29 2	+08 04	534	8.4	GALAXY E4	UGC 7629	C 5 ST	M49 8.9x7.4

MESS#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
M 50	07 02.4	-08 19	960	5.9v	OPEN CLUS	CNGC 2323	D 1 ST	M50
M 51	13 29.5	+47 15	660	8.4	GALAXY Sc I 2-SYS FACE	UGC 8493	B A ST	M51 11.0x7.8 Whirlpool Gal
M 52	23 23.7	+61 32	780	6.9v	OPEN CLUS	CNGC 7654	D 1 ST	M52
M 53	13 12.4	+18 13	756	7.7v	GLOB CLUS	CNGC 5024	D 2 ST	M53
M 54	18 54.5	-30 29	546	7.7v	GLOB CLUS	CNGC 6715	D 2 ST	M54
M 55	19 39.4	-30 58	1140	7.0	GLOB CLUS sp=F5	CNGC 6809	D 2 ST	M55 20kly
M 56	19 16.2	+30 09	426	8.3v	GLOB CLUS	CNGC 6779	D 2 ST	M56
M 57	18 53.1	+33 01	150	9.7p	PLAN NEB RING-LIKE	CNGC 6720	B 4 ST	M57 Ring Nebula 5kly
M 58	12 37.2	+11 53	324	9.8	GALAXY Sb	UGC 7796	C 5 ST	M58 5.4x4.4 Near CNGC 462
M 59	12 41.5	+11 42	306	9.8	GALAXY E3	UGC 7858	D 5 ST	M59 5.1x3.4 Near CNGC 457
M 60	12 43.1	+11 37	432	8.8	GALAXY E1	UGC 7898	D 5 ST	M60 7.2x6.2 Near CNGC 462
M 61	12 21.4	+04 32	360	9.7	GALAXY Sc I 2-SYS	UGC 7420	D A ST	M61 6.0x5.5 Face-On
M 62	17 00.6	-30 07	846	6.6v	GLOB CLUS OBLATE	CNGC 6266	D 2 ST	M62 Non-symmetrical
M 63	13 15.3	+42 06	738	8.6	GALAXY Sb+ II	UGC 8334	C 5 ST	M63 12.3x7.6 Sunflower Gal
M 64	12 56.2	+21 44	558	8.5	GALAXY Sb-	UGC 8062	C 5 ST	M64 9.3x5.4 Black Eye Gal
M 65	11 18.4	+13 09	600	9.3	GALAXY Sb II:	UGC 6328	C 5 ST	M65 10.0x3.3 Near M66
M 66	11 19.7	+13 03	522	9.0	GALAXY Sb+ II:	UGC 6346	C 5 ST	M66 8.7x4.4 Near M65
M 67	08 50.5	+11 51	1800	6.9v	OPEN CLUS sp=F2	CNGC 2682	D 1 ST	M67 Very old 2700ly
M 68	12 38.9	-26 42	720	8.2v	GLOB CLUS	CNGC 4590	D 2 ST	M68
M 69	18 30.6	-32 21	426	7.7v	GLOB CLUS	CNGC 6637	D 2 ST	M69
M 70	18 42.5	-32 19	468	8.1v	GLOB CLUS	CNGC 6681	D 2 ST	M70
M 71	19 53.2	+18 45	432	8.3v	GLOB CLUS	CNGC 6838	D 2 ST	M71
M 72	20 52.9	-12 35	354	9.4v	GLOB CLUS	CNGC 6981	D 2 ST	M72
M 73	20 58.4	-12 40	168	8.9p	OPEN CLUS	CNGC 6994	D 1 ST	M73
M 74	01 36.1	+15 44	612	9.2	GALAXY Sc I	UGC 1149	D 5 ST	M74 10.2x9.5
M 75	20 05.6	-21 57	360	8.6v	GLOB CLUS	CNGC 6864	D 2 ST	M75
M 76	01 41.3	+51 31	290	12.2	PLAN NEB PART OF 0651	CNGC 0650	C 4 ST	M76 Little Dumbbell Nebula
M 77	02 42.1	-00 04	414	8.8	GALAXY Sbp SEYFERT	UGC 2188	D 5 ST	M77 6.9x5.9 Seyfert Galaxy
M 78	05 46.2	+00 03	480	11.3	DIFF RNEB	CNGC 2068	C 3 ST	M78 Blue 1500ly
M 79	05 23.8	-24 32	522	8.0v	GLOB CLUS	CNGC 1904	D 2 ST	M79
M 80	16 16.5	-22 58	534	7.2v	GLOB CLUS	CNGC 6093	D 2 ST	M80
M 81	09 54.8	+69 07	1542	6.9	GALAXY Sb I-II	CNGC 3031	C 5 ST	M81 25.7x14.1 Near M82
M 82	09 55.0	+69 44	672	8.4	GALAXY P EDGE-ON	UGC 5322	C 5 ST	M82 11.2x4.6 Exploding
M 83	13 36.5	-29 48	672	8.2	GALAXY Sc I-II FACE-ON	CNGC 5236	B 5 ST	M83 11.2x10.2
M 84	12 24.5	+12 57	300	9.3	GALAXY E1	UGC 7494	C 5 ST	M84 5.0x4.4 Near M86
M 85	12 24.9	+18 15	426	9.2	GALAXY Ep 2-SYS	UGC 7508	C A ST	M85 7.1x5.2
M 86	12 25.7	+13 00	444	9.2	GALAXY E3	UGC 7532	C 5 ST	M86 7.4x5.5
M 87	12 30.3	+12 27	432	8.6	GALAXY E1 + E0 2-SYS	UGC 7654	D A ST	M87 7.2x6.8 + CNGC 4471
M 88	12 31.5	+14 29	414	9.5	GALAXY Sb+ I MULTI-ARM	UGC 7675	D 5 ST	M88 6.9x3.9
M 89	12 35.1	+12 37	252	9.8	GALAXY E0	UGC 7760	D 5 ST	M89 4.2x4.2
M 90	12 36.3	+13 13	570	9.5	GALAXY Sb+	UGC 7786	C 5 ST	M90 9.5x4.7
M 91	12 34.9	+14 33	324	10.2	GALAXY SBb + Sc 2-SYS	UGC 7753	D A ST	M91 5.4x4.4 Near CNGC 457
M 92	17 16.8	+43 09	672	6.5v	GLOB CLUS sp=F1	CNGC 6341	D 2 ST	M92 X-Ray Source 26kly
M 93	07 44.1	-23 51	1320	6.2v	OPEN CLUS + DNEB	CNGC 2447	D 6 ST	M93 Includes dark nebula
M 94	12 50.4	+41 11	660	8.2	GALAXY Sb-p II:	UGC 7996	C 5 ST	M94 11.0x9.1
M 95	10 43.4	+11 46	444	9.7	GALAXY S(B)b II	UGC 5850	C 5 ST	M95 7.4x5.1 Near M96
M 96	10 46.2	+11 53	426	9.2	GALAXY Sbp	UGC 5882	C 5 ST	M96 7.1x5.1 Near M95
M 97	11 14.1	+55 06	194	12.0p	PLAN NEB	CNGC 3587	C 4 ST	M97 Owl Nebula 12kly
M 98	12 13.8	+14 58	570	10.1	GALAXY Sb I-II: 3-SYS	UGC 7231	D A ST	M98 9.5x[illegible]
M 99	12 18.8	+14 29	324	9.8	GALAXY Sc I NEAR FACE-ON	UGC 7345	B 5 ST	M99 5.4x[illegible]

MESS#	RA	DEC	SIZE	MAG	TYPE & DESCRIPTION	ALT NAME	Q TAGS	COMMON NAME/COMMENTS
M100	12 22.4	+15 53	414	9.4	GALAXY Sc I FACE-ON	UGC 7450	D 5 ST	M100 6.9x6.2 Brite Nucleus
M101	14 02.9	+54 25	1614	7.7	GALAXY Sc I FACE-ON	UGC 8981	C 5 S	M101 26.9x26.3 Pinwheel
M102	15 06.2	+55 48	312	10.0	GALAXY E6p 2-SYS	UGC 9723	D A ST	M102 5.2x2.3
M103	01 32.5	+60 39	360	7.4v	OPEN CLUS	CNGC 0581	D 1 ST	M103
M104	12 39.3	-11 34	534	8.3	GALAXY Sb-	CNGC 4594	C 5 ST	M104 8.9x4.1 "Sombrero"
M105	10 47.3	+12 39	270	9.3	GALAXY E1 2-SYS	UGC 5902	C A ST	M105 4.5x4.0
M106	12 18.4	+47 22	1092	8.3	GALAXY Sb+p	UGC 7353	C 5 ST	M106 18.2x7.9
M107	16 31.9	-13 01	600	8.1v	GLOB CLUS	CNGC 6171	D 2 ST	M107
M108	11 10.9	+55 44	498	10.1	GALAXY Sc NEAR EDGE-ON	UGC 6225	C 5 ST	M108 8.3x2.5 Near M97
M109	11 57.0	+53 26	456	9.8	GALAXY S(B)b+ I	UGC 6937	D 5 ST	M109 7.6x4.9
M110	00 39.8	+41 38	1044	8.0	GALAXY E6:	UGC 426	C 5 ST	M110 Comp of M31 17.4x9.8