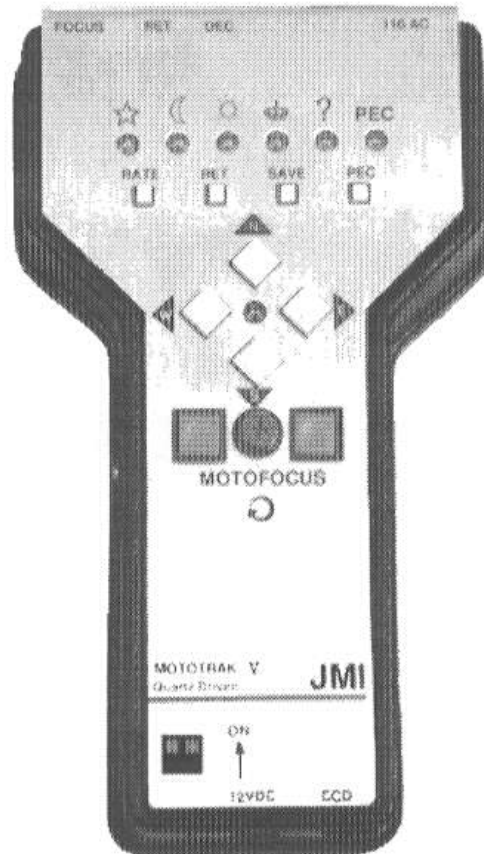


MOTOTRAK™ IV & V Operator's Guide



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Important Notice

When using a CCD camera for auto-guiding, a relay box is required on all CCD cameras except the ST4, ST5 and ST6. Failure to use a relay box may damage your MOTOTRAK V, prevent auto-guiding from occurring and void your warranty. Relay boxes are available from Santa Barbara Instrument Group (SBIG) dealers.

INTRODUCTION

Congratulations on your purchase of the **JMI MOTOTRAK IV** or **V Drive Corrector**. These drive correctors are the result of our commitment to produce innovative quality products that better serve the needs, and desires of our customers. For the first time, a drive corrector contains the hand unit, electronics and power supply all in one unit. These are more compact, more convenient, and more efficient than any other drive corrector previously available.

Your **MOTOTRAK** is a triple-control drive corrector featuring dual-axis, two speed correction and a variable speed focus control. It also features a blinking illuminated reticle output and CCD autoguiding compatibility. The **MOTOTRAK V** additionally has periodic error correction (PEC) and a user definable correction rate. Both models are designed to operate with telescopes utilizing a 110V-120V/60Hz AC synchronous motor for Right Ascension (R.A.) and a low-voltage DC motor on Declination (DEC). The PEC feature operates with telescopes using 144, 359 or 360 tooth drive gears.

SETUP

DIP SWITCH SETTINGS

Before operating your **MOTOTRAK** for the first time, you should prepare it for use with your specific telescope mount. This is accomplished by setting DIP switches found inside the unit according to the chart and illustrations below:

DIP SWITCH SETTINGS

SW 1 - Focus range selection:
OFF=Wide ON=Narrow

SW 2 - Reverse R.A. buttons

SW 3 - Reverse DEC buttons

SW 4, 5 - Teeth on R.A. gear.

#teeth*	SW 5	SW 4
360	OFF	OFF
359	OFF	ON
144	ON	OFF

Default: OFF/ON/OFF/ON/OFF

*A custom ROM is available for other sizes.

Number of teeth on R.A. gear for various telescope models (used for MOTOTRAK V only).

Bausch & Lomb 4000	359	Meade 628/645	359	Parks Petra Equatorial	144	Teeth	RPH	Period	base
Bausch & Lomb 8000	360	Meade 826/856/880	359	Parks Precision 6/8	96	48	2	30 min	Sol.
Celestron C-5(+)	359	Meade 1060/1266	359	Parks Superior 8/10/12.5	96	72	3	20 min	Sol.
Celestron C-8(+)	359	Meade 2040/2045	359	Parks PRT-46/PRT-813	359	96	4	15 min	Sol.
Celestron C-8 (Byers)	360	Meade 2080/2120 basic	359	Queslar 3.5	360	120	5	12 min	Sol.
Celestron Classic 8	359	Meade 2080/2120 MTS	359	Queslar 7	360	144	6	10 min	Sol.
Celestron Super C-8(+)	360	Meade 4500	100	Swift 856/859R	144	216	9	6.7 min	Sol.
Celestron C-11	216	Meade DS-10/DS-16	144	Tasco 13T/14F	144	240	10	6 min	Sol.
Celestron C-14	216	Meade SN6/SN8 MTS	359	Tasco 11TR/17TR	144	288	12	5 min	Sol.
Criterion Dynamax 8	360	Meade Starfinder 6-16	144	Unitron equatorial mounts	359	359	15	4 min	Sid.
Jason 313 telescope	144	Orion Sky Explorer 60/80	144	Vixen Polaris	144	360	15	4 min	Sol.
Jason 9226 mount	144	Orion Spaceprobe 4.5	144	Vixen Super Polaris/DX	144	480	20	3 min	Sol.
Meade 291/294/323	144	Orion Equatorial Mount	144	Vixen Great Polaris	144	718	30	2 min	Sid.
Meade 285/395	359	Parks Observatory series	96			720	30	2 min	Sol.

This is a partial listing of mounts and telescopes which may be used with the **MOTOTRAK**. While every effort has been made to ensure the accuracy of this information, the user is ultimately responsible for determining the correct information for his mount.

DIP switches 2 and 3 reverse the function of the R.A. and DEC buttons, respectively. Due to differences in optical designs and operator preferences, you may wish to reverse one or both of these. As some of the references to these buttons in this manual assume that these have not been reversed, we suggest leaving them unchanged for now.

OPERATION



POWER SWITCH

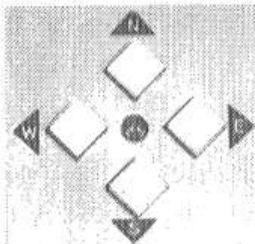
By throwing the power switch to the ON position (toward top of unit), the **MOTOTRAK** circuit is powered from the optional internal battery or external DC supply. Once the motor drive has been started, it will continue to operate until switched off, or the battery becomes low.

MOTOTRAK V NOTES: When switched off, the unit does not power down immediately. The controller will wait about one second to allow the operator to turn the unit back on in

the event the switch is accidentally bumped. After the one second delay, the motor will begin to slow down, in order to bring it to a controlled stop so as to retain the PEC synchronization. This will generally take 3 to 5 seconds. Once the motor has stopped, the PEC data will be updated, and the unit powered down. If at any time the Power LED flashes, it indicates that the power source voltage is low.

In order to maintain the PEC integrity, the R.A. motor will not start immediately. If the **PEC** key is pressed, the motor drive will start with Periodic Error Correction *enabled*. If a previous PEC sequence has been saved, that sequence will start up from the point at which the unit was last turned off. If the **WEST** button is pressed instead, the R.A. motor will start with PEC *disabled*. With the PEC programmed for telescope (A), you could operate the drive corrector with telescope (B), then return it to telescope (A) without losing the PEC synchronization. This scenario assumes that the R.A. motor in telescope (A) will not be operated except with the **MOTOTRAK V** and its PEC program, and that PEC will not be used on telescope (B).

NOTICE: If the power source is abruptly disconnected, without allowing the unit to go through its shutdown sequence, the PEC synchronization will be lost, and the PEC will no function properly. If this occurs, it will be necessary to reprogram the PEC data.



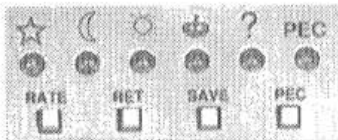
R.A./DEC CORRECTION BUTTONS

While the unit is operating, the four directional buttons will operate the R.A. and DEC motors as commanded. The R.A. motor drive frequency will increase or decrease when the **EAST** or **WEST** button is pressed, returning to the selected tracking frequency when neither is pressed. The DEC motor is driven only when the **NORTH** or **SOUTH** button is pressed.

TWO SPEED CORRECTION is possible by pressing both the **EAST** and **WEST** buttons simultaneously, thus toggling between the low and high settings. The **MOTOTRAK** is normally in the high correction rate — when switched to low, the correction rate is halved.

NOTE: The motors are intended for small adjustments only, such as needed for photographic guiding or object centering within an eyepiece. They are not fast enough for slewing the telescope from object-to-object.

FUNCTION KEYS (MOTOTRAK V only)



RATE

The **RATE** function key is used to select the desired tracking rate for the R.A. motor. With each press, this key will increment through the **SIDEREAL**, **LUNAR**, **SOLAR**, **KING** and **USER** rates. A description of each of these rates is provided here:

SIDEREAL This rate is used for tracking objects other than the Moon and Sun (e.g. stars and deep-sky objects).

LUNAR This rate is used for tracking the Moon only.

SOLAR This rate is used for tracking the Sun only. (**NOTICE:** You should never direct your telescope at the Sun without first installing a proper Solar filter. Do not use eyepiece filters for this purpose, as they may crack from the intense heat and result in possible permanent eye damage.)

KING This is a specialized rate developed by Harvard astronomer E.S. King, circa 1900. As an object rises from the horizon toward the meridian, the amount of atmosphere its light passes through decreases. As it sets, the opposite is true. Because the thicker atmosphere at the horizon refracts (bends) the light more than the thinner atmosphere at the meridian, the rate of the object's apparent motion is constantly changing. The amount of change varies with many factors, including temperature, barometric pressure, and observer's elevation.

In order to best approximate actual conditions, the **KING** rate is based on an average of all these factors. As the resultant rate is only 0.033% slower than the **SIDEREAL** rate, you will probably not detect the difference.

USER This rate is user-definable to any frequency between 40 and 80 Hz to a precision of 2 micro-hertz. See the **PROGRAMMING USER RATE** section later in this manual.

RET (Reticle)

The **RET** function key is used to change the intensity of an optional illuminated reticle. The output is pulsed to cause the reticle (usually a red crosshair or bullseye pattern) to blink on and off within the eyepiece. With each press, this key will increase the brightness of the reticle until the tenth setting is reached. Upon reaching the brightest setting, you must press the key twice to return to the dimmest setting — this is so that you will know when you have reached the brightest setting without keeping track of key presses.

Many photographers feel that a blinking reticle is easier to guide with because it allows the eye a chance to rest between pulses. It can also make it easier to see a star which might otherwise be hidden by the reticle's glare.

SAVE

The **SAVE** function key will cause several session parameters to be stored in the **MOTOTRAK V**'s non-volatile memory for later recall. The parameters which are stored are: tracking rate selected, user-defined rate, and reticle intensity. When the unit is turned on, it will use the settings stored when **SAVE** was last pressed. This will save you the time of choosing your preferred settings with each session.

PEC

The **PEC** function key has two functions. First, upon turning the **MOTOTRAK V** on, this key must be pressed to start the R.A. motor with Periodic Error Correction *enabled*. Secondly, this key is also used to initiate the PEC training session as described below.

All telescope mounts exhibit tracking errors to some degree. These errors can be caused by manufacturing limitations in the mount itself, and by inaccuracies in polar alignment by the operator. Electronic solutions can be applied to reduce the affect of these errors.

The **MOTOTRAK V**'s Periodic Error Correction (PEC) is one such solution. By recording the guiding corrections you make for one rotation of the drive shaft and then playing those same corrections back in a continuous loop (synchronized with the drive shaft), it is possible to reduce tracking errors by a factor of ten or more. This can greatly reduce the number of corrections required for guided astrophotography, especially with an accurate polar alignment.

To train the PEC for your mount, you will need to keep a star centered in a high-powered eyepiece (an illuminated reticle eyepiece is recommended) for between four and fourteen minutes, depending upon the size of your R.A. gear. The **MOTOTRAK V** automatically knows how long to record your corrections based upon the gear size defined with the DIP switches (see **SETUP**, DIP Switch Settings earlier in this manual). You can determine this by dividing 1436 minutes by the number of gear teeth (this is based upon the Sidereal tracking rate, which is best for training, though any but the User rate can be used).

With the star centered, start the PEC recording by pressing the **PEC** key. The PEC LED (Light Emitting Diode) will blink for ten seconds before starting, providing you the opportunity to abort without altering the previously saved PEC program. If you do not wish to start the recording, simply press the **PEC** key once again and the LED will turn off.

If the **EAST** or **WEST** button is pressed while the PEC LED is blinking, the ten second delay will be restarted. This permits centering the star between the time of pressing the **PEC** key and the start of the PEC recording.

After the ten second delay, the PEC LED will stay lit throughout the training session and any guiding corrections you make to the R.A. motor will be recorded. Then after one rotation of the drive shaft, the PEC LED will turn off, and the recorded corrections will be played back. As the PEC program is automatically stored, it is not necessary to press the **SAVE** key.

Up to 125 corrections will be recorded, for a maximum of 160 seconds per correction. PEC is not active in the User tracking rate, although PEC synchronization will be maintained.

FOCUS CONTROL



MOTOFOCUS

The **MOTOFOCUS** section of the **MOTOTRAK** can be used to provide precision focus control. The two red buttons direct the motor in or out, and the turn pot between them is used to vary the speed (clockwise is faster).

Most DC focus motors are compatible with the **FOCUS** jack output. Some older motors may require an adaptor to the industry-standard 3.5mm (1/8") mono plug. If your motor stalls at the slower speeds, try setting DIP switch 1 ON.

SECONDARY HAND UNIT

An optional, secondary hand unit may be used with the **MOTOTRAK**. This smaller, light-weight hand unit provides separate control of the Right Ascension and Declination motors. This is useful for long-exposure astrophotography (comfortably guide from the eyepiece) or during cold weather (the hand unit fits inside a coat pocket).

The secondary hand unit's cable plugs into the CCD jack on the **MOTOTRAK**. The two-speed toggling is supported.

PROGRAMMING USER RATE

(MOTOTRAK V only)

For custom mounts, or under unusual circumstances, it may be desirable to use a tracking rate other than SIDEREAL, LUNAR, SOLAR, or KING. The User tracking rate permits the definition and use of any frequency between 40 and 80 Hz to a precision of 2 micro-hertz.

To select the User tracking rate, press the **RATE** key repeatedly until the User Rate LED ("?) is lit. At this point the R.A. motor will be driven at the rate previously saved. Pressing the **RATE** key again will enter the rate definition mode in which you may program a new frequency. If you wish to exit this mode, simply press the **RATE** key once more.

Follow these steps to program your custom frequency:

1. Find the custom Sidereal tracking frequency with this formula:
$$F = \frac{T \times 2.507}{R}$$

Where **F** is the frequency, **T** is the number of teeth on the R.A. gear, and **R** is the speed of the R.A. motor in rph (at 60Hz). (Substitute 2.500 for Solar, 2.414 for Lunar, and 2.506 for King.)

2. With the frequency known, find the period with this formula:
$$P = \frac{1,000,000}{F}$$

Where **P** is the custom period (in microseconds) and **F** the custom frequency (in Hz).

3. Now determine the change in period from the 60Hz base frequency:
$$D = P - 16,666$$

Where **D** is the change (delta) in period and **P** the custom period.

4. Find the number of coarse adjustments to make with this formula:
$$C = \frac{D}{800}$$

Where **C** is the number of coarse adjustments to be made (drop any fractional value, e.g. 4.1675 = 4).

5. Find the number of medium adjustments to make with this formula:
$$M = \frac{D - (C \times 800)}{40}$$

Where **M** is the number of medium adjustments to be made (drop any fractional value, e.g. 3.35 = 3).

6. Find the number of small adjustments to make with this formula:
$$S = \frac{D - (C \times 800) - (M \times 40)}{2}$$

Where **S** is the number of small adjustments to be made (round any fraction).

Now that the exact adjustments necessary to obtain the custom frequency are known, they can be programmed into the **MOTOTRAK V** as follows:

1. With the unit on, press the **RATE** function key until the **USER** rate LED begins blinking. It will be blinking about every half second, indicating the coarse adjustment setting.
2. Press the **RET** function key to reset the user frequency to 60 Hz.
3. When making changes, the **WEST** button is used to increase the period, and the **EAST** button to decrease. If **C** is greater than zero then press the **WEST** button **C** times. If **C** is less than zero then press the **EAST** button **C** times (e.g., if **C**=4, then press the button four times).
4. With the coarse adjustment made, press the **SOUTH** button to change to the medium setting (the LED will blink about once per second).
5. Press the **EAST** or **WEST** button (per the directions in step 3) **M** times.
6. Press the **SOUTH** button once more to change to the small adjustment setting (the LED will blink about once every one-and-a-half seconds).
7. Press the **EAST** or **WEST** button **S** times.
8. If you wish this user frequency to be stored for future use, press the **SAVE** function key. If you do not save the new frequency, it will only be used for the current session and the previously stored user frequency retained.

CCD JACK

The CCD auto-guider jack provides external access to the directional switching. Cables are available from JMI for use with several popular CCD cameras which offer auto-guiding capabilities (e.g. the ST-4, ST-6, and Lynxx). This jack is also used for the optional secondary hand unit.

The following pinout may be used to assemble an auto-guider cable for use with a Santa Barbara Instrument Group CCD camera (such as the ST-4). For this purpose, the CCD jack's wires are numbered from left-to-right.

CCD Jack pin	ST-4 Relay pin	Function
1 (BLU)	10	+X (R.A. East)
2 (YEL)	13	+Y (Dec. North)
3 (GRN)	7	-Y (Dec. South)
4 (RED)	4	-X (R.A. West)
5 (BLK)	11	GND (Jumped to 5, 8, and 14)
6 (WHT)	n/c	Not used

The cable connector to the SBIG CCD camera is a female 15-socket D-subminiature.

TROUBLESHOOTING GUIDE

Symptom

The unit does not come on.

The R.A. motor does not run.

The focus motor does not run.

The Declination motor does not run.

The Power LED is blinking.

All rate and PEC LED's are blinking.

What to check

- Low battery or power supply not connected
- On the **MOTOTRAK V** model, **WEST** or **PEC** must be pressed to start the R.A. motor.
- Is the motor's cable plugged into the **MOTOTRAK**?
- The R.A. motor may require more than 3A current
- Is the motor plugged into the **MOTOTRAK**?
- Turn variable speed pot clockwise to full
- Is the motor cable plugged into the **MOTOTRAK**?
- Power supply voltage is low
- An error occurred in writing data to the EEPROM (Reset unit. If problem persists, contact JMI.)

WARNINGS

Your **MOTOTRAK** outputs high voltage similar to that of a wall outlet, and should be treated with the same respect:

- All motor connections should be made before turning the drive corrector on.
- Never use a power cord which is frayed or damaged.
- Do not attempt to operate high-current devices (such as a dew remover) from the **MOTOTRAK**.
- Do not operate the drive corrector in contact with a wet surface. Keep liquids away from unit at all times.
- Open unit only to insert/remove battery or to set DIP switches. Do not remove inner circuit covers.
- Do not attempt self-repairs or modifications. Obtain a return authorization from JMI for servicing.

LIMITED WARRANTY

Jim's Mobile Incorporated (JMI) warrants its **MOTOTRAK IV** and **MOTOTRAK V** drive correctors to be free of defects in workmanship and materials for a period of one year from date of original purchase. If required, please contact JMI at 303-233-5353 (FAX: 303-233-5359) for a Return Authorization. The unit will be repaired or replaced at JMI's discretion.

This warranty supercedes all other warranties, express or implied, for merchantability, product fitness, or otherwise.

Battery Pack Instructions for MOTOTRAK IV & V

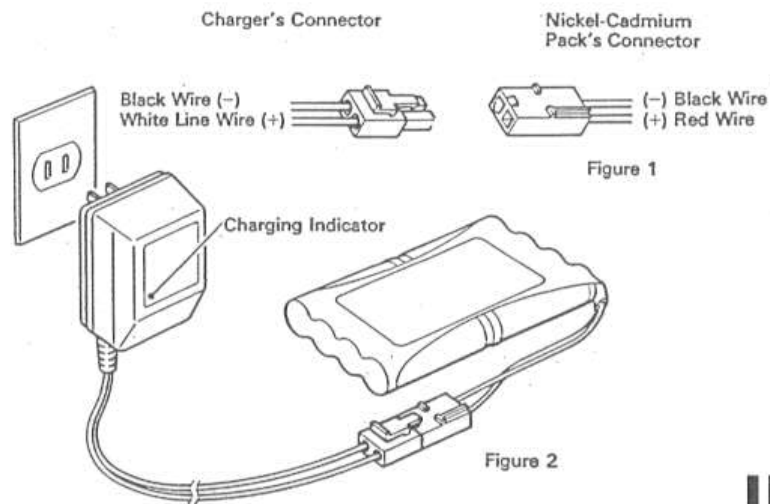
Installation Instructions:

The battery that you have ordered with your MOTOTRAK will run most telescopes for three to five hours, depending on motor wattage and temperature. To install the battery in your MOTOTRAK, simply turn the knob on the back of your MOTOTRAK one quarter turn. Pull off the back of the MOTOTRAK. Connect the wires in the MOTOTRAK to the wires from the battery and place the battery in between the foam at the top of the MOTOTRAK. Replace the cover and twist the knob one quarter turn.

Recharging instructions:

1. Connect the terminal of the charger to the battery. Be sure of correct polarity. (Figure 1)
2. Plug the charger into a standard AC outlet. The charging indicator on the module will light. (Figure 2)
3. Charge the battery pack for 14 to 16 hours.
4. When charging is complete remove the charger from the outlet and disconnect the battery.

NOTE: Do not overcharge battery, and do not begin charging until battery is completely discharged.



JMI