

# iOptron® Mount RS-232 Command Language

Version 3.10

January 4th, 2021

Abbreviations used:

YYMMDD	YY: last two digits of the year, year are assumed to be 21 <sup>st</sup> Century, MM: month, DD: day of the month
s	“+” or “-” sign, cannot be replaced by any other characters
MMM	minutes
TTTTTTTT(T)	0.01 arc-seconds
XXXXX(XXXXXXXXX)	milliseconds
n	digit(s)

All digits above including leading zeroes to match the format of each command.

Currently the document applies to the following products:

CEM120 series, CEM70 series, GEM45 series with firmware 210101 and later, CEM40 series with firmware 210101 and later, GEM28 series and CEM26 series.

CEM120 series stands for CEM120-EC2, CEM120-EC and CEM120.

CEM70 series stands for CEM70G-EC, CEM70-EC, CEM70G and CEM-70.

GEM45 series stands for GEM45(G)-EC and GEM45(G).

CEM40 series stands for CEM40(G)-EC and CEM40(G).

GEM28 series stands for GEM28-EC and GEM28.

CEM26 series stands for CEM26-EC and CEM26.

Unless specified, all commands applied to all products.

Underline is just to help you to separate adjacent data with different meanings.

## Get Information and Settings

Command: “:GLS#”

Response: “sTTTTTTTTTTTTTTTTnnnnn#”

This command gets longitude, latitude and all kinds of status. The response includes a sign and 22 digits.

The sign and first 8 digits indicate the current longitude. Valid data range is [-64,800,000, +64,800,000]. **Note: East is positive**, and the resolution is 0.01 arc-second.

The 9th to 16th digits equals the current latitude plus 90 degrees. Valid data range is [0, 64,800,000]. **Note: North is positive**, and the resolution is 0.01 arc-second.

The 17th digit indicates GPS status: 0 means GPS module malfunction or do not have a GPS module, 1 means GPS module works but have not received valid data, 2 means valid data has been received. The 18th digit indicates system status: 0 means stopped at non-zero position, 1 means tracking with periodic error correction disabled, 2 means slewing, 3 means auto-guiding, 4 means meridian flipping, 5 means tracking with periodic error correction enabled (only for non-encoder edition), 6 means parked, 7 means stopped at zero position (home position).

The 19th digit indicates tracking rates: 0 means sidereal rate, 1 means lunar rate, 2 means solar rate, 3 means King rate, 4 means custom rate.

The 20th digit indicates moving speed by arrow buttons: 1 means 1x sidereal tracking rate, 2 means 2x, 3 means 8x, 4 means 16x, 5 means 64x, 6 means 128x, 7 means 256x, 8 means 512x, 9 means maximum speed (please refer to the first page for different mount models).

The 21st digit indicate the time source of the mount: 1 means from RS-232 port or Ethernet port, 2 means from hand controller, 3 means from GPS module.

The 22nd digit indicate the current Hemisphere: 0 means Southern Hemisphere, 1 means Northern Hemisphere.

Command: “:GUT#”

Response: “sMMMnXXXXXXXXXXXXXXXXX#”

This command gets time related information. The response includes a sign and 17 digits.

The sign and first 3 digits indicate the minute offset from UTC (time zone). **Note: The Daylight-Saving Time will not be taking account into this value.**

The 4th digit indicates the Daylight-Saving Time, 0 means Daylight Saving Time has not been observed, 1 means Daylight Saving Time has been observed.

The 5th to 17th digits indicates the current UTC time and equals  $(JD(\text{current UTC time}) - J2000) * 8.64e+7$ . Note: the resolution is 1 millisecond. JD(current UTC time) means Julian Date of the current UTC time.

Command: “:GEP#”

Response: “sTTTTTTTTTTTTTTTTTTTTnn#”

This command gets right ascension and declination. The response includes a sign and 19 digits.

The sign and first 8 digits indicate the current declination. Valid data range is [-32,400,000, +32,400,000]. Note: The resolution is 0.01 arc-second.

The 9th to 17th digits indicates current right ascension. Valid data range is [0, 129,600,000]. Note: The resolution is 0.01 arc-second.

The 18th digit indicates side of pier, 0 means pier east, 1 means pier west, 2 means pier indeterminate.

The 19th digit indicates pointing state, 0 means counterweight up, 1 means normal.

**Note: Please ignore the side of pier and pointing state if the mount is not an equatorial mount.**

Command: “:GAC#”

Response: “sTTTTTTTTTTTTTTTTTT#”

This command gets altitude and azimuth, the response includes a sign and 17 digits.

The sign and first 8 digits indicate current altitude. Valid data range is [-32,400,000, +32,400,000]. Note: The resolution is 0.01 arc-second.

The last 9 digits indicate current azimuth. Valid data range is [0, 129,600,000]. Note: The resolution is 0.01 arc-second.

Command: “:GTR#”

Response: “nnnnn#”

This command gets the saved custom tracking rate, the tracking rate is n.nnnn \* sidereal rate.

Note: This tracking rate will be applied only after a “Custom Tracking Rate” has been selected. Valid data range is [0.1000, 1.9000] \* sidereal rate.

Command: “:GPC#”

Response: “TTTTTTTTTTTTTTTTTT#”

This command gets parking position, the response includes 17 digits.

The first 8 digits indicate the altitude of parking position. Valid data range is [0, 32,400,000]. Note: The resolution is 0.01 arc-second.

The last 9 digits indicate the azimuth of parking position. Valid data range is [0, 129,600,000]. Note: The resolution is 0.01 arc-second.

Command: “:GSR#”

Response: “7#”, “8#” or “9#”

This command gets the maximum slewing speed. 7 stands for 256x sidereal rate, 8 stands for 512x sidereal rate, 9 stands for the maximum speed (please refer to the first page for different mount models).

Command: “:GAL#”

Response: “snn#”

This command gets the altitude limit value. The response includes a sign and 2 digits. The altitude limit not only applies to tracking, but also applies to slewing. Moving by arrow buttons does not affect by this limit. Tracking will be stopped if you move or slew the mount to a position lower than the altitude limit.

Note: Valid data range is [-89, +89]. The resolution is 1 degree.

Command: “:AG#”

Response: “nnnn#”

This command gets the right ascension guiding rate and the declination guiding rate.

The first 2 “nn” stands for the right ascension guiding rate  $0.nn * \text{sidereal rate}$ . The last 2 “nn” stands for the declination guiding rate  $0.nn * \text{sidereal rate}$ .

**Note: Valid range of guiding rate of right ascension is [0.01, 0.90] \* sidereal rate, and valid range of guiding rate of declination is [0.10, 0.99] \* sidereal rate. This command only available in equatorial mounts.**

Command: “:GMT#”

Response: “nn#”

This command will get the behavior about meridian treatment. The first digit 0 stands for stop at the position limit set below. The first digit 1 stands for flip at the position limit set below. The last 2 digits stands for the position limit of degrees past meridian.

**Note: This command only available in equatorial mounts.**

Command: “:GGF#”

Response: “0”, “1”

This command gets the status of auto-guiding filter of RA axis. “0” indicates auto-guiding signal of RA axis will get through, “1” indicates auto-guiding signal of RA axis will be filtered. When filter enabled, all auto-guiding signals of RA axis regardless from ST-4 port or RS-232/Ethernet port will be filtered, leave the RA axis only accept the correction signal from built-in encoder. the guiding command of Dec axis will not be affected.

**Note: This command only available in equatorial mounts with encoders.**

Command: “:GPE#”

Response: “0”, “1”

This command gets the integrity of the periodic error data. “1” means complete, “0” means incomplete.

**Note: This command only available in equatorial mounts without encoders.**

Command: “:GPR#”

Response: “0”, “1”

This command gets the status of periodic error recording. “0” stands for periodic error recording stopped, “1” stands for periodic error is being recording.

**Note: This command only available in equatorial mounts without encoders.**

## Change Settings

Command: “:RT0#”, “:RT1#”, “:RT2#”, “:RT3#” or “:RT4#”

Response: “1”

These commands select the tracking rate. It selects sidereal (“:RT0#”), lunar (“:RT1#”), solar (“:RT2#”), King (“:RT3#”), or custom (“:RT4#”). This command has no effect on the slewing or moving by arrow buttons. **Note: The sidereal rate is assumed as a default by the next power up.**

Command: “:SRn#”

Response: “1”

This command sets the moving rate used for the N-S-E-W buttons. For n, specify an integer from 1 to 9. 1 stands for 1x sidereal tracking rate, 2 stands for 2x, 3 stands for 8x, 4 stands for 16x, 5 stands for 64x, 6 stands for 128x, 7 stands for 256x, 8 stands for 512x, 9 stands for maximum speed available. **Note: 64x is assumed as a default by the next power up.**

Command: “:SGF0#”, “:SGF1#”

Response: “1”

This command sets the status of auto-guiding filter of RA axis. “:SGF0#” set auto-guiding signal of RA axis will get through, “:SGF1#” set auto-guiding filter of RA axis enabled. For the detail meanings, please refer to the “:GGF#” command. **Note: This command only available in equatorial mounts with encoders. Auto-guiding filter of RA axis disabled is assumed as a default by the next power up.**

**Data entered with the following commands in “Change Settings” section will be saved in all times, and will be automatically reapplied during power cycles:**

Command: “:SGsMMM#”

Response: “1”

This command sets the minute offset from UTC (The Daylight-Saving Time will not be taking account into this value). Valid data range is [-720, +780]. The resolution is 1 minute.

Command: “:SDS0#” or “:SDS1#”

Response: “1”

These commands set the status of Daylight-Saving Time. “:SDS1#” means Daylight Saving Time has been observed, “:SDS0#” means Daylight Saving Time has not been observed.

Command: “:SUTXXXXXXXXXXXXX#”

Response: “1”

This command sets the current UTC Time. The number equals (JD(current UTC Time) – J2000) \* 8.64e+7. Note: JD(current UTC time) means Julian Date of current UTC time. The resolution is 1 millisecond.

Command: “:SLOsTTTTTTTT#”

Response: “1”

This command sets the current longitude. Valid data range is [-64,800,000, +64,800,000]. **Note: East is positive**, and the resolution is 0.01 arc-second.

Command: “:SLAsTTTTTTTT#”

Response: “1”

This command sets the current latitude. Valid data range is [-32,400,000, +32,400,000]. **Note: North is positive**, and the resolution is 0.01 arc-second.

Command: “:SHE0#” or “:SHE1#”

Response: “1”

These commands set the hemisphere. 0 means Southern Hemisphere, 1 means Northern Hemisphere.

Command: “:MSRn#”

Response: “1”

This command sets the maximum slewing speed. Note: n could only be 7, 8 or 9. 7 stands for 256x, 8 stands for 512x, 9 stands for maximum speed available.

Command: “:SALsnn#”

Response: “1”

This command sets the altitude limit. The altitude limit not only applies to tracking, but also applies to slewing. Movement caused by arrow buttons does not affect by this limit. Tracking will be stopped if you move the mount to a position exceeds any limit.

**Note: Valid data range is [-89, +89]. The resolution is 1 degree.**

Command: “:RGnnnn#”

Response: “1”

This command sets the right ascension guiding rate and the declination guiding rate.

The first 2 “nn” stands for the right ascension guiding rate 0.nn \* sidereal rate. The last 2 “nn” stands for the declination guiding rate 0.nn \* sidereal rate.

**Note: Valid range of guiding rate of right ascension is [0.01, 0.90] \* sidereal rate, and valid range of guiding rate of declination is [0.10, 0.99] \* sidereal rate. This command only available in equatorial mounts.**

Command: “:SMTnnn#”

Response: “1”

This command will set the behavior about meridian treatment. The first digit 0 stands for stop at the position limit set below. The first digit 1 stands for flip at the position limit set below. The last 2 digits stands for the position limit of degrees past meridian.

**Note: This command only available in equatorial mounts.**

Command: “:RAS#”

Response: “1”

This command will reset all settings to the default. Note: Time zone, Daylight-Saving Time observed, Date and Time will be persevered.

## Mount Motion

Command: “:MS1#”, “:MS2#”

Response: “1” if command accepted,  
“0” The desired object is below the altitude limit or exceed the mechanical limits.

This command will let the mount slew to the most recently defined right ascension and declination coordinates. A pair of defined right ascension and declination must be issued before this command. “:MS1#” means slew to the “normal” position, “:MS2#” means slew to the “counterweight up” position. If the object is below the altitude limit, this will be stated, and no slewing will occur. After slewing, the tracking will be enabled automatically regardless the former status of tracking. **Note: “:MS2#” only available in equatorial mounts.**

Command: “:MSS#”

Response: “1” if command accepted,  
“0” The desired object is below the altitude limit or exceed the mechanical limits.

This command will let the mount slew to the most recently defined altitude and azimuth coordinates. A pair of defined altitude and azimuth must be issued before this command. If the object is below the altitude limit, this will be stated, and no slewing will occur. After slewing, the mount will be stopped regardless the former status of tracking.

Command: “:Q#”

Response: “1”

This command will stop all kinds of slewing operation regardless the source. status of tracking will not be affected.

Command: “:ST0#” or “:ST1#”

Response: “1”

These commands set tracking state. “:ST0#” indicates stop tracking, “:ST1#” indicates start tracking.

Command: “:ZSXXXXX#”, “:ZQXXXXX#”, “:ZEXXXXXX#” or “:ZCXXXXX#”

Response: (none)

These commands command motion for XXXXX milliseconds in the direction indicate below at the currently selected guiding rate. “:ZS” indicate for RA+ direction. “:ZQ” indicate for RA- direction. “:ZE” indicate for Dec+ direction. “:ZC” indicate for Dec- direction. The valid data range of XXXXX is [0, 99999]. **Note: These commands only available in equatorial mounts. They will supersede “:MnXXXXX#”, “:MeXXXXX#”, “:MsXXXXX#” and “:MwXXXXX#”.**

Command: “:MnXXXXX#”, “:MeXXXXX#”, “:MsXXXXX#” or “:MwXXXXX#”

Response: (none)

These commands command motion for XXXXX milliseconds in the direction specified at the currently selected guiding rate. The valid data range of XXXXX is [0, 99999]. **Note: These commands are deprecated and will be removed in a future version. These commands only available in equatorial mounts.**

Command: “:MP1#”

Response: “1” if command accepted,  
“0” if park failed.

This command parks to the most recently defined parking position. In parked mode, the mount cannot slew, track, guide or perform any movement unless an unpark command is issued. If you parked the mount and powered it off, the mount will unpark automatically at the beginning of the next power up.

Command: “:MP0#”

Response: “1”

This command unparks the mount. If the mount is already unparked, the command will have no effect.

Command: “:MH#”

Response: “1”

This command will slew to the zero position immediately.

Command: “:MSH#”

Response: “1”

This command will automatically search the mechanical zero position/home position immediately by detecting homing sensors. Current zero position/home position will be overwritten by this operation if the operation succeeds.

**This operation is designed to be a safe operation in any cases. This command only available in CEM120 series, CEM70 series, GEM45 series and CEM40 series.**

Command: “:SPR0#” or “:SPR1#”

Response: “1”

These commands set the status of periodic error recording. “0” stands for stop recording periodic error, “1” stands for start recording periodic error.

**Note: This command only available in equatorial mounts without encoders.**

Command: “:SPP0#” or “:SPP1#”

Response: “1”

These commands set the status of periodic error correction playback. “0” stands for periodic error correction playback disabled, “1” stands for periodic error correction playback enabled.

**Note: This command only available in equatorial mounts without encoders.**



Command: “:RRnnnnn#”

Response: “1”

This command sets the tracking rate of the RA axis to n.nnnn \*sidereal rate. This value could be set at any time, but “Custom Tracking Rate” (“:RT4#”) must be selected before this command to take effect. Currently the value is limited to the range of [0.1000, 1.9000] \* sidereal rate. Data entered with this command will be remembered through a power cycle and automatically re-applied on the next power up.

Command: “:mn#”, “:me#”, “:ms#” or “:mw#”

Response: (none)

These commands will move the mount to the specified direction at specified speed. “:mn#” indicates Dec- direction, “:me#” indicate RA- direction, “:ms#” means Dec+ direction, “:mw#” means RA+ direction. The mount will keep moving until a stop command like “:qR#”, “:qD#” or “:Q#” has been issued. The UP, RIGHT, DOWN or LEFT key on the hand controller will have the same behavior.

Command: “:qR#”

Response: “1”

This command will stop moving by left and right arrow buttons or “:me#”, “:mw#” command. Other slewing movement and tracking movement will not be affected.

Command: “:qD#”

Response: “1”

This command will stop moving by up and down arrow buttons or “:mn#”, “:ms#” command. Other slewing movement and tracking movement will not be affected.

## Position

Command: “:CM#”

Response: “1”

This command calibrates mount (Synchronize). In equatorial mounts, the most recently defined right ascension and declination become the commanded right ascension and declination, respectively. In Alt-Azi mounts, the most recently defined altitude and azimuth become the commanded altitude and azimuth. This command assumes that the mount has been manually positioned on the proper pier side for the calibration object. This command is ignored if slewing is in progress. This command should be used for initial calibration. It should not be used after the mount has been tracking unless it is known that it has not tracked across the meridian.

Command: “:QAP#”

Response: “0#”, “1#”, “2#”

This command queries the number of available positions for most recently defined right ascension and declination coordinates which do not exceed the mechanical limits, altitude limits and meridian flip limits (including normal position and counterweight up position). The possible number is 0, 1 and 2. **Note: This command only available in equatorial mounts.**

Command: “:SRATTTTTTTTT#”

Response: “1”

This command defines the commanded right ascension, RA. Slew or calibrate commands operate on the most recently defined right ascension.

Command: “:SdsTTTTTTTT#”

Response: “1”

This command defines the commanded declination, Dec. Slew or calibrate commands operate on the most recently defined declination.

Command: “:SasTTTTTTTT#”

Response: “1”

This command defines the commanded altitude. Move or calibrate commands operate on the most recently defined altitude.

**Note: This command could work with all mounts when used after slewing commands. However, when used after synchronization command, this command only works with altitude-azimuth mounts.**

Command: “:SzTTTTTTTT#”

Response: “1”

This command defines the command azimuth. Move or calibrate commands operate on the most recently defined azimuth.

**Note: This command could work with all mounts when used after slewing commands. However, when used after synchronization command, this command only works with altitude-azimuth mounts.**

Command: “:SZP#”

Response: “1”

This command will set current position as zero position.

Command: “:SPATTTTTTTTT#”

Response: “1”

This command will set azimuth of the parking position.

Command: “:SPHTTTTTTTTT#”

Response: “1”

This command will set altitude of the parking position.

## Miscellaneous

Command: `“:FW1#”`

Response: `“YYMMDDYYMMDD#”`

This command gets the date of the mainboard’s and the hand controller’s firmware. The first “YYMMDD” indicates the date of the mainboard’s firmware, the second “YYMMDD” indicates the date of the hand controller’s firmware.

Command: `“:FW2#”`

Response: `“YYMMDDYYMMDD#”`

This command will get the date of the RA motor board’s and the Dec motor board’s firmware. The first “YYMMDD” indicates the date of the RA motor board’s firmware, the second “YYMMDD” indicates the date of the Dec motor board’s firmware.

Command: `“:MountInfo#”`

Response: `“0026”, “0027”, “0028”, “0029”, “0040”, “0041”, “0043”, “0044”, “0070”, “0071”, “0120”, “0121”, “0122”`

This command gets the mount model. “0026” means CEM26, “0027” means CEM26-EC, “0028” means GEM28, “0029” means GEM28-EC, “0040” means CEM40(G), “0041” means CEM40(G)-EC, “0043” means GEM45(G), “0044” means GEM45(G)-EC, “0070” means CEM70(G), “0071” means CEM70(G)-EC, “0120” means CEM120, “0121” means CEM120-EC, “0122” means CEM120-EC2.

## Additional information

The command set is written in ASCII character format with only letters, digits, colon, and hashtag, and can be used to write your own programs. All commands are case sensitive.

The maximum speed of CEM120 series is 960x sidereal rate.

The maximum speed of CEM70 series is 900x sidereal rate.

The maximum speed of CEM40 series and GEM45 series is 1066x sidereal rate.

The maximum speed of CEM26 series and GEM28 series is 1440x sidereal rate.

## Initialization sequence

To properly initialize the mount with your software, you must issue the following commands when you establish your link:

`:MountInfo#`

## RS-232 Port Settings

Baud Rate: 115200  
Parity: none  
Data bits: 8  
Flow Control: none (does not support Xon/Xoff or hardware flow control)  
Start Bits: 1  
Stop Bits: 1

## Version History

### 1.00 July 4<sup>th</sup>, 2014

Initial release.

### 2.00 August 8<sup>th</sup>, 2014

Commands now applies to CEM60 and later products.

Corrected the wrong response description of “:q#”, “:qR#” and “:qD#”.

“:GAS#” now can judge if the mount is at zero position.

Guiding rate has been expanded from [0.10, 0.80] to [0.10, 0.90].

Changed response of “:GEC#”, “:GAC#”, “:Gg#”, “:Gt#” and “:AG#”.

Changed the following set commands: time zone, local date, local time, longitude, latitude, custom tracking rate, target right ascension, target declination, target altitude, target azimuth.

“:AH#” has been removed.

Added set hemisphere commands “:SHE0#”, “:SHE1#”.

Added auto search zero position command “:MSH#”.

Added set zero position command “:SZP#”.

### 3.00 October 12<sup>th</sup>, 2017

Changed get guiding rate command “:AG#” to support separate guiding rate for both RA and Dec axes.

Changed set guiding rate command “:RG#” to support separate guiding rate for both RA and Dec axes.

Changed set custom tracking rate “:RR#” to a more efficient format, the range of custom tracking

rate has also been expanded.

“:V#” has been removed.

“:q#” has been removed.

Added get status command “:GLS#”, this command now supersedes “:GAS#”, “:Gg#” and “:Gt#”. “:GAS#”, “:Gg#” and “:Gt#” has been removed.

Added get time command “:GUT#”, this command now supersedes “:GLT#”. “:GLT#” has been removed.

Added get current position command “:GEP#”, this command now supersedes “:GEC#”. “:GEC#” has been removed.

Added get custom tracking rate command “:GTR#”.

Added get parking position command “:GPC#”.

Added get maximum speed command “:GSR#”.

Added get altitude limit command “:GAL#”.

Added get behavior about meridian treatment command “:GMT#”.

Added get auto guiding filter of RA axis command “:GGF#”.

Added get periodic error correction data integrity command “:GPE#”.

Added get the status of periodic error recording command “:GPR#”.

Added set auto guiding filter of RA axis command “:SGF0#”, “:SGF1#”.

Added set UTC time command “:SUT#”, this command now supersedes “:SC#” and “:SL#”. “:SC#” and “:SL#” has been removed.

Added set current longitude command “:SLO#”, this command now supersedes “:Sg#”. “:Sg#” has been removed.

Added set current latitude command “:SLA#”, this command now supersedes “:St#”. “:St#” has been removed.

Added set maximum speed command “:MSR#”.

Added set altitude limit command “:SAL#”.

Added set behavior about meridian treatment command “:SMT#”.

Added slew command for right ascension and declination coordinate “:MS1#” and “:MS2#”. These commands now supersede “:MS#”. “:MS#” has been removed.

Added slew command for altitude and azimuth coordinate “:MSS#”.

Added set the status of periodic error recording command “:SPR0#” and “:SPR1#”.

Added set the status of periodic error correction playback command “:SPP0#” and “:SPP1#”.

Added query available position command “:QAP#”.

Added set target right ascension command “:SRA#”, this command now supersedes “:Sr#”. “:Sr#” has been removed.

Added set parking position command “:SPA#” and “:SPH#”.

### 3.01 April 22<sup>nd</sup>, 2019

Changed description in RS-232 port settings.

Changed description in additional information.

Changed the response of “:QAP#”.

### 3.10 January 4<sup>th</sup>, 2021

Updated with latest product lines.

Added many missing comments for the document.

Added set maximum speed “:MSR#”.

Added query maximum speed “:GSR#”.

Added a new set of pulse guiding command “:ZSXXXXX#”, “:ZQXXXXX#”, “:ZEXXXXXX#” or “:ZCXXXXX#”.