

# Temma-2 Technical Report

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## Introduction

The Temma-2, which is the third generation of Takahashi's go-to mounts, is now available. The Temma-2 is the successor to the Temma-PC. The programming has been updated to allow it to perform more complicated tasks. The new and improved Temma-2, which along with the new more advanced programming, will permit the Temma-2 to drive in both axes at the same time thereby reducing the go-to time.

Different from an open loop system, the servo control system employed by the Temma-2 monitors the real-time position for the R.A. and Dec. This is accomplished by using a 16-bit CPU to make these complicated calculations.

## Temma Evolution

### Highly Integrated Built-in Printed Circuit

The LSI used to drive the stepping motors allows the components to be miniaturized making the entire assembly smaller.



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- \$B#T#e#m#m#a• (B-
- \$B#P#C• (B



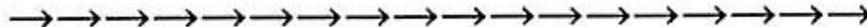
**Application of the LSI for the 2nd Generation Stepping Motors**  
 In successive generations of the motors have been improved for tracking

### LSI for the 1st Generation Driver



The first generation stepping motors could not produce an even pulse which resulted in a uneven \$B!!#v• (Bibration and buzzing).

### LSI for the 2nd Generation Driv• \$B#i#n#g!!#M#o#t#o#r• (B



The uniformity of the steps allows the motor to turn without wow and flutter and hence quietly

[Note] The thickness and length of the arrows indicate uneven ro• \$B#t• (Bation.

#### Micro-miniaturization of the steps for sidereal tracking of stars:

By doubling the micro steps with newly developed motors, motor vibration has been reduced and the accuracy of the tracking has been increased. By doubling the steps from 50 pps to 100 pps more accurate tracking is the result.

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The turning arc distance of the tube movement per pulse [arc sec][R.A.]

• \$B#M#o#d#e#l• (B	1• \$B#s#t• (BTEMMA	2• \$B#n#d• (BTEMMA-PC	3• \$B#r#d• (BTEMMA-2
EM-10JR• (I\$• (B200JR• (I\$• (B200	0.0398	0.0199	0.0099
NJP	0.0199	0.0199	0.0049
EM-500	0.0166	0.0166	0.0087

**The new motors allow for high speed driving at 12V.**

Another great feature has been added to the new Temma-2. The movement of the motor has been dramatically improved with micro-step LSI. As a result, the new motor can turn at a higher speed when operated at 12V when compared to the Temma-PC, which allowed for high-speed operation at 24V only! This is a great advantage to the astronomer who only has a 12V power source in the field.

- \$B#C#o#m#p#a#r#i#s#o#n!!#t#a#b#l#e!!#f#o#r!!#d#r#i#v#i#n#g!!#s#p#e#e#d!!#a#t!!#g#i#v#e#n!!  
#p#o#w#e#r!!#v#o#l#t#a#g#e!J#R• (B• \$B#A• (B• \$B!K• (B• \$B!!• (B

• \$B#T#y#p#e• (B	Temma-PC (12V/24V)	Temma-2 (12V/24V)
• \$B!!• (BEM10JR	• \$B!!• (B × 50 / 150	• \$B!!• (B × 120 / 250
• \$B!!• (BEM200JR	• \$B!!• (B × 50 / 150	• \$B!!• (B × 120 / 250
• \$B!!• (BEM200	• \$B!!• (B × 200 / 400	• \$B!!• (B × 350 / 700
• \$B!!• (BNJP	• \$B!!• (B × 200 / 400	• \$B!!• (B × 175 / 350
• \$B!!• (BEM500	• \$B!!• (B × 200 / 400	• \$B!!• (B × 260 / 520

**Temma-2• \$B!!#A#n#i#m#a#t#i#o#n• (B**

(EM-200Temma-2/24V/700• \$B!\_• (B)

email.mov



• \$B#C#l#i#c#k!!#t#h#e!!#p#i#c#t#u#r#e!!#a#n#d!!#t#h#e#n!!#i#t!!#c#a#n!!#b#e!!#r#e#p#r#o#d#u#c#e#d• (B

• \$B!J• (B.mov• \$B!!#f#i#l#e• (B/• \$B#s#i#z#e• (B707KB• \$B!K• (B

When• \$B!!• (Bthe• \$B!!#g#e#n#e#r#a#l!!#p#h#o#n#e!!#n#e#t#w#o#r#k#s!!#a#r#e!!#u#s#e#d!\$• (B

• \$B#d#o#w#n#l#o#a#d#i#n#g!!#t#a#k#c#s!!#a!!#f#e#w!!#m#i#n#u#t#e#s!%• (B

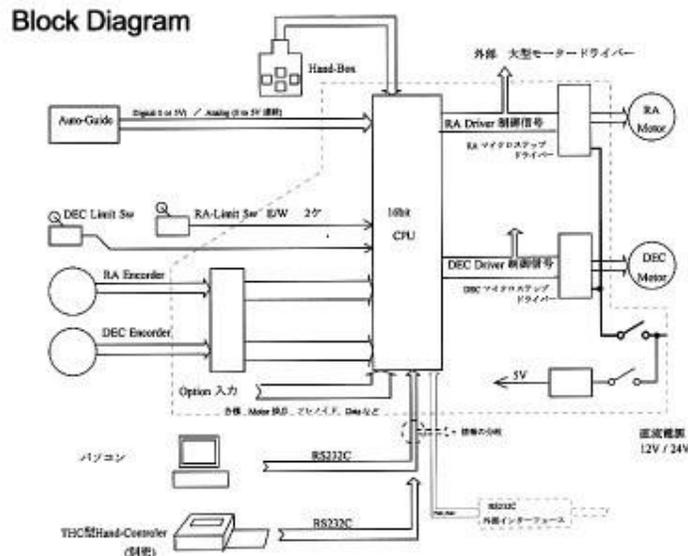
- \$B"(#I#f!!#t#h#e!!#p#i#c#t#u#r#e!!#c#a#n#n#o#t!!#r#e#p#r#o#d#u#c#e#d!\$#d#o#w#n#l#o#a#d!!• (B
- Quick• \$B#t#i#m#e!!#P#l#a#y#e#r!!#a#t!!#t#h#e!!#s#i#t#e!!#b#e#l#o#w!%• (B

<http://www.apple.co.jp/quicktime/download/>

**Control**

**Brock Diagram**

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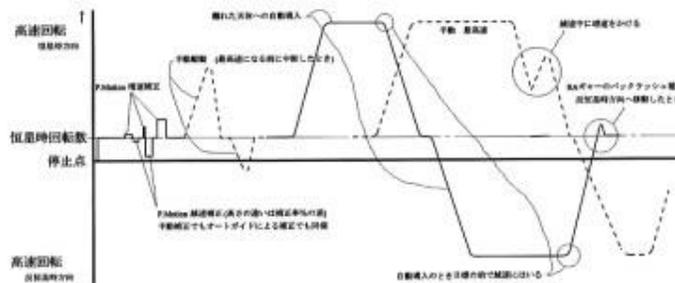


• \$B#C#l#i#c#k!#t#o!#e#n#l#a#r#g#e!#t#h#e!#d#i#a#g#r#a#m• (B• \$B!%• (B

### Speed-up and Slow-down at low/high speed drive settings

The inertia developed by a mount moving in a given direction is larger. If the mount is ordered to change a direction abruptly, this could cause excessive gear wear or damage. In order to prevent this from happening, the speed-up and slow-down ramping are optimally set. See the diagram below.

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• \$B!!• (B• \$B#C#l#i#c#k!#t#o!#e#n#l#a#r#g#e!#t#h#e!#d#i#a#g#r#a#m!%• (B

• \$B!!• (B

### Tracking Comets, Planets, Asteroids and the Moon

The Temma-2 is equipped with a differential tracking ability, which will allow the R.A. and Dec. to track continuously at differential rate to track a comet, an asteroid, a planet, or the Moon. This is accomplished by entering the a-day moving vector of the object. Tracking, photographing or imaging these objects for long periods is now available.

[Note] Since the Moon drifts in Dec. at a specific rate in either direction once the rate is determined, it can be set in for the Dec. to drive in that direction at the same speed allowing long • \$B#!• (Bunar exposure.

### Manual Control and Go-To Control

The Temma-2 makes accurate positioning easier with a precise ramp up and down and precise slow motion centering of the desired object.

### Periodic Error Correction and Auto Guiding

The Temma-2 has a finely developed auto guiding control that due to the inherent small periodic mechanical errors of Takahashi mounts, the compensation circuitry reads the signal from the auto guider and allows for small correction steps to compensate for any periodic error for extremely accurate auto guiding.

**Stand-By Function**

This function allows the user to place the mount on Stand-By so long as power is supplied to the mount and it will keep tracking of the position until it is turned on once again. The internal CPU keeps monitoring the current R.A. and Dec. and this function remains until the power is cut out.

**R.A. Backlash Compensation**

Since the R.A. gear is turning continuously, it could be possible that there may be a small amount of backlash to be taken up when the direction of movement is reversed. In order to compensate for this, the Temma-2 by pass the object and back up to the correct position to compensate for the backlash.

**Worldwide Usability**

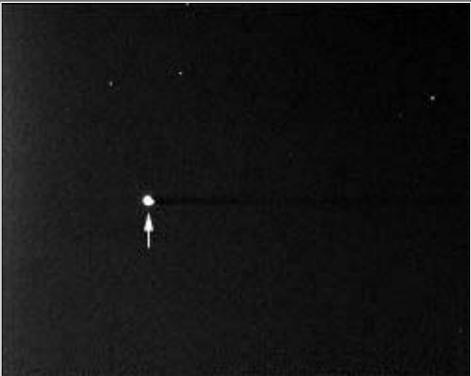
The Temma-2 can be used in either the Northern or Southern Hemisphere with a PC or THC [Temma Hand Control] optionally available. The direction of rotation can be changed with the hand control box, which is standard with each mount.

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**Go-To Accuracy**

The following photos demonstrate examples of the accuracy of the Temma-2 go-to operation.

• \$BE#x#a#m#p#l#e#s!!#o#f!!#c#o#n#t#i#n#u#o#u#s!!#g#o• (B-  
 • \$B#t#o!!#b#e#t#w#e#e#n!!#s#t#a#r#s!!#w#i#t#h!!#a!!#l#o#n#g!!#d#i#s#t#a#n#c#e!%• (B

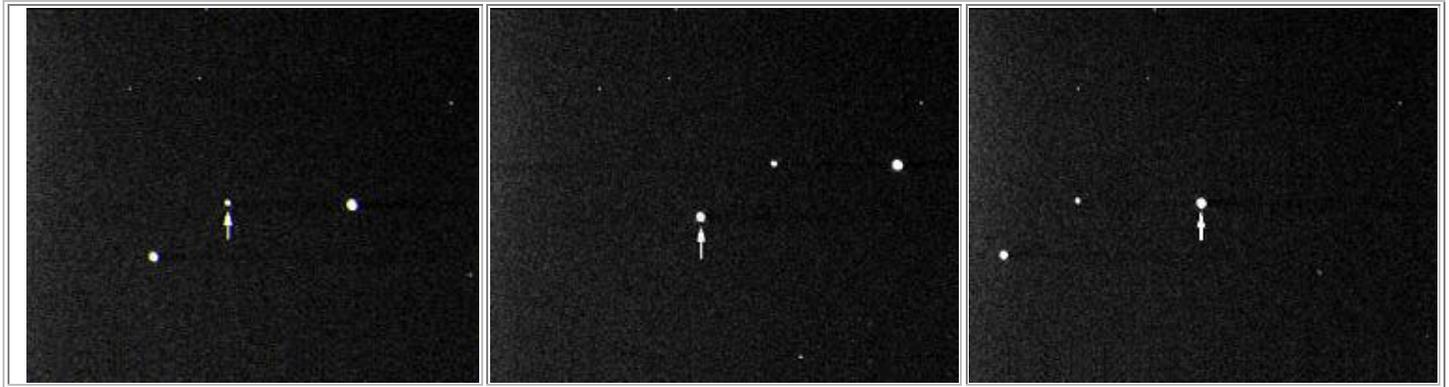
<p>!#u#s!J• (BS• \$B#t#a#r#t!K• (B          • (BDEC+11• \$B!k• (B58• \$B!!• (B</p>	<p>• \$B#C#o#r!!#C#a#r#o#l#i!J#D#i#s#t#i#n#a#t#i#o#n!K• (B          RA12h56.0m• \$B!?!• (BDEC+39• \$B!k• (B19• \$B!!• (B</p>	<p>• \$B#R#e#g#l#u#s!J#R#e#t#u#r#n!K          RA10h8.4m• \$B!?!• (BDEC+11• \$B!k• (B</p>
		

• \$B!!• (B

• \$B"(#B#y!!• (BEM-200• \$B!\• (BFC-76• \$B!J#f#l!a• (B600• \$B-  
 P!K!\• (B1/2• \$B!#v#i#d#e#o!!#c#a#m#e#r#a!%#N#o!!#t#r#i#m#m#i#n#g!%!!• (B

• \$BE#x#a#m#p#l#e#s!!#o#f!!#c#o#n#t#i#n#u#o#u#s!!#g#o• (B-  
 • \$B#t#o!!#b#e#t#w#e#e#n!!#s#t#a#r#s!!#w#i#t#h!!#a!!#s#h#o#r#t!!#d#i#s#t#a#n#c#e!%• (B

<p>SAO132331• \$B#S#t#a#r#t!• (B)          RA05h35.56m• \$B!?!• (BDEC-          04• \$B!k• (B50.3• \$B!!• (B</p>	<p>SAO132336(1• \$B#s#t• (B)          RA05h35.66m• \$B!?!• (BDEC-          04• \$B!k• (B51.4• \$B!!• (B</p>	<p>SAO132320(2• \$B#n#d• (B)          RA05h35.39m• \$B!?!• (BDEC-          04• \$B!k• (B50.4• \$B!!• (B</p>
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• \$B"(\$B#y!! (BEM-200• \$B!\&L• (B-180• \$B!J#f#l!a• (B2160• \$B-  
 P!K!\ (B1/2• \$B!I#v#i#d#e#o!!#c#a#m#e#r#a!%#N#o!!#t#r#i#m#m#i#n#g!%• (B

w#i#l!!#d#e#p#e#n#d!!#o#n!!#s#c#t#t#i#n#g!!#t#h#e!!#e#q#a#t#o#r#i#a#l!!#m#o#u#n#t!%#T#h#e#s#e!!#a#r#e!!#r#e#f#e#r#r#e#d!!#j#u#s#t!

## Capabilities

• \$B#P#o#w#e#r!!#v#o#l#t#a#g#e!! (B12• \$B#v!%#V#a#l#u#e#s!!#i#n!!#p#a#r#e#n#t#h#e#s#e#s!!  
 #a#r#e!!#t#h#e!!#c#u#r#r#e#n#t!!#a#t!!#r#a#m#p!%• (B

TEMMA-2• \$B!!#S#e#r#i#e#s• (B	EM-10JR	EM-200JR	EM-200	• \$B#N#J#P• (B
#l• (B(• \$B#a#b#t• (B*• \$B!v• (BPPS)	100	100	100	200
s#p#e#e#d• (B(• \$B#t#o!!#s#i#d#e#r#e#l!!#r#a#t#e• (B)	• \$B!_• (B120	• \$B!_• (B120	• \$B!_• (B350	• \$B!_• (B175
#s#p#e#e#d• (B(• \$B#t#o!!#s#i#d#e#r#e#l!!#r#a#t#e• (B)	• \$B!_• (B120	• \$B!_• (B120	• \$B!_• (B350	• \$B!_• (B175
#o#n#s#u#m#p#t#i#o#n• (B(A)• \$B!!#a#t!!#s#i#d#e#r#e#a#l!!#r#a#t#e• (B	0.25	0.28	0.42	0.44
#o#n#s#u#m#p#t#i#o#n• (B(A)• \$B!!• (B !#a#x#e#s!!#h#i#g#h!!#s#p#e#e#d• (B	0.88(1.1)	1.42(1.58)	0.94(1.4)	0.71(2.1)
#o#n#s#u#m#p#t#i#o#n• (B(A)• \$B!!#a#t!!#s#t#a#n#d• (B-• \$B#b#y• (B	0.16	0.16	0.16	0.16

• \$B#P#o#w#e#r!!#v#o#l#t#a#g#e!! (B24• \$B#v!%#V#a#l#u#e#s!!#i#n!!#p#a#r#e#n#t#h#e#s#e#s!!  
 #a#r#e!!#t#h#e!!#c#u#r#r#e#n#t!!#a#t!!#r#a#m#p!%• (B• \$B!!• (B

te#r#i#e#s• (B	EM-10JR	EM-200JR	EM-200	• \$B#N#J#P• (B
#l• (B(• \$B#a#b#t• (B*• \$B!v• (BPPS)	100	100	100	200
s#p#e#e#d• (B(• \$B#t#o!!#s#i#d#e#r#e#l!!#r#a#t#e• (B)	• \$B!_• (B250	• \$B!_• (B250	• \$B!_• (B700	• \$B!_• (B350
#s#p#e#e#d• (B(• \$B#t#o!!#s#i#d#e#r#e#l!!#r#a#t#e• (B)	• \$B!_• (B250	• \$B!_• (B250	• \$B!_• (B700	• \$B!_• (B350
#o#n#s#u#m#p#t#i#o#n• (B(A)• \$B!!#a#t!!#s#i#d#e#r#e#a#l!!#r#a#t#e• (B	0.22	0.26	0.35	0.35
#o#n#s#u#m#p#t#i#o#n• (B(A)• \$B!!• (B !#a#x#e#s!!#h#i#g#h!!#s#p#e#e#d• (B	0.9(1.2)	1.94(1.96)	1.07(1.55)	0.84(1.70)
#o#n#s#u#m#p#t#i#o#n• (B(A)• \$B!!#a#t!!#s#t#a#n#d• (B-• \$B#b#y• (B	0.16	0.16	0.16	0.16

## Safety Devices

The Temma-2 will not operate within 5• \$B!k• (B of the horizon or within 5• \$B!k• (B of the Sun.

Nor will it accept a command to go to an object that has latitude of less than 5• \$B!k• (B.If the Temma-2 is set up properly, the CPU will prevent the telescope from running into the mount. If it reads

a command that will send the telescope to within 5° of the horizon, it will flip the telescope to the other side of the meridian to locate the object, thereby preventing damage to the instrument.

#### **Downward Pointing Prevention**

The Temma-2 safety protocol will prevent the tube assembly from pointing downward during meridian transit.

#### **Limit Switch [EM-2500/3500]**

Both mounts are equipped with limiting switches that prevent the instrument from running into the observatory building. This enables these mounts to be operated remotely.

#### **Emergency Stop Switch [EM-2500/3500]**

In the event there are large gatherings in the observatory building, each mount is equipped with an emergency stop switch to keep the instrument from running into a person.

- 5° (B

## **Compatible Software**

**Pegasus 21 and The Sky** [can be used with free English download]