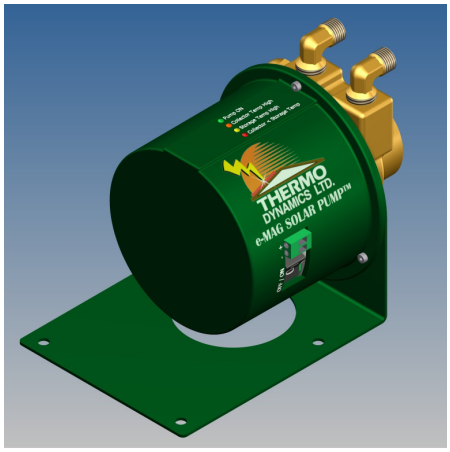
e-Mag Solar Pump™

12 VDC Pump/Motor with Solar Controller

Technical Specifications & Operation Manual

Models: P24070EM & P50140EM

Thermo Dynamics Ltd.
101 Frazee Avenue
Dartmouth, Nova Scotia
Canada, B3B-1Z4
Tel: (902) 468-1001 Fax: (902) 468-1002
Email: solarinfo@thermo-dynamics.com
www.thermo-dynamics.com



1.0 General Information

The Thermo Dynamics Electronic Mag-Drive Solar Pump™ (e-Mag Solar Pump™) is an advanced solar powered pump. The unit is equipped with a brushless DC (BLDC) motor, positive displacement vane pump, and integral motor controller with differential temperature controls. About the size of a large grapefruit, the e-Mag Solar Pump™ is the latest advancement in solar pump technology and is unparalleled in efficiency and reliability. Designed specifically for solar thermal applications, the e-Mag Solar Pump™ includes all the electronics and control functionality necessary for a typical solar water heater. The e-Mag Solar Pump™ is also suitable for a variety of other applications where low pumping power is required.

2.0 Background

Thermo Dynamics Ltd. (TDL) manufactures a line of pumps under the tradename Solar Pump™. The Solar Pump™ is designed for operation with photovoltaic (PV) modules, or another source of DC power (e.g., batteries, DC power supply). The e-Mag Solar Pump™ is the latest evolution of TDL's Solar Pump™ family, occupying less than one half the footprint of its predecessor while maintaining all of the functionality and efficiency. The compact size has been achieved by replacing the brushed motor and magnetic pump-to-motor coupler with a substantially smaller BLDC motor. The BLDC motor couples directly to the pump via a rotating electro-magnetic field that interacts with a magnet secured to the shaft of the pump rotor. As the electro-magnetic field rotates, so does the pump rotor, thus causing the pump to circulate. All motor control functions are handled by the integral motor control circuit with built-in solar controller.

TDL has conducted extensive research and development on solar powered pumps in order to design a 100% solar powered solar water heater and overcome the inefficiencies of AC powered circulator pumps.

In 1992 TDL introduced the very first Solar Pump™. Since then, TDL has continued to develop increasingly compact and efficient Solar Pump™ models. In 2002, after extensive development and testing in the laboratory and in the field, TDL introduced the Mag-Drive Solar Pump™. After several more years of research and development with brushless DC motors, TDL is proud to introduce the e-Mag Solar Pump™ as the successor to the Mag-Drive Solar Pump™.

The following e-Mag Solar Pump™ models replace the former Mag-Drive Solar Pump™:

- P24070EM replaces P24070M
- P50140EM replaces P50140M

Currently there is no Mag-Drive or e-Mag model of the P118330 Direct-Drive Solar Pump™.

3.0 Description of Electro-Mag-Drive

There is a powerful magnet on the shaft of the pump rotor. The rotor magnet, and the entire pump rotor, is sealed inside the pump housing. There is no rotating shaft to penetrate the pump housing, and therefore, no need for a mechanical seal.

When power is applied to the e-Mag control circuit (assuming the differential temperature parameters are satisfied) a powerful electro-magnetic field is generated at three poles of the 9-pole BLDC motor. The resulting electro-magnetic force will cause the pump rotor to turn 120°, a rotation that will successively be detected by sensors on the e-Mag control circuit. Power will then be diverted by the control circuit to the next three poles of the BLDC motor, causing the pump rotor to turn once more. As the pump rotor continues to turn, the e-Mag controller continues to track the rotor position, energizing the respective poles of the 9-pole BLDC motor, and thus enabling continuous rotation of the pump rotor.

4.0 Advantages of the Solar Pump™

- 100% solar powered
- built-in differential temperature controller with fail-safe functionality and high-temperature limits
- built-in linear current booster
- high head & pressure (up to 35 m / 115 ft)
- self-priming
- no air separator required
- no charging pump required
- smaller diameter tube may be used
- reduced installation time
- life expectancy of over twenty years
- ten-year limited warranty
- no high-voltage electrical connections
- no certified electrician to install pump
- no electrical permit required
- no high-voltage electromagnetic fields

5.0 BLDC Motor Driver

Developed by TDL, the e-Mag Solar Pump™ on-board motor control circuit utilizes electronic commutation and hall effect sensors for driving the BLDC motor. The motor control circuit also integrates the full functionality of the TDL Delta-T Booster™ solar controller, featuring a linear current booster (LCB), and differential temperature controller, making it ideal for solar thermal applications.

Since 2000, TDL has developed an evolving line of linear current boosters (LCB). The LCB is a motor driver recommended for PV powered applications and functions by matching the DC motor load to the PV power supply, thus optimizing performance. The e-Mag Solar Pump™ motor driver includes TDL's most recent LCB technology complete with differential temperature control, fail-safe protection, high-temperature limits, and an electronic jolting function to overcome static friction and/or minor pump blockages.

6.0 Power Requirements

Voltage (nominal)	12 VDC
Minimum voltage, V_{MIN}	15 VDC
Maximum voltage, V_{MAX}	30 VDC
Minimum current, I_{MIN}	0.08 A
Maximum current, I_{MAX}	2.00 A
PV Module size	10 to 50 W_p

7.0 Flow Rates

Solar Pump™ P24070EM
12 VDC (nominal):
0.3 - 2.4 L/min (0.1 - 0.6 USGPM)

Solar Pump™ P50140EM
12 VDC (nominal):
0.8 - 5.0 L/min (0.2 - 1.4 USGPM)

8.0 Pressure Ratings

These ratings indicate the maximum pressure increases produced by the e-Mag Solar Pump™. Operating line pressures can be as high as 150 psi (10 bar)

Solar Pump™ P24070EM
12 VDC (nominal): 50 psi (3.4 bar)

Solar Pump™ P50140EM
12 VDC (nominal): 50 psi (3.4 bar)

9.0 Temperature Sensors

The e-Mag Solar Pump™ uses 10K NTC thermistor temperature sensors for differential temperature control (sold separately).

10. Port Size

Inlet & Outlet port: 3/8" FPT
The e-Mag Solar Pump™ can be supplied with a variety of fittings and hoses for an additional charge. Please specify your requirements at the time of order.

Thermo Dynamics Ltd.
101 Frazee Avenue
Dartmouth, Nova Scotia
Canada, B3B-1Z4
Tel: (902) 468-1001 Fax: (902) 468-1002
Email: solarinfo@thermo-dynamics.com
www.thermo-dynamics.com

11.0 Operation

The e-Mag Solar Pump™ includes a built-in differential temperature controller with linear current boosting functionality. It has been designed specifically for solar thermal pumping applications that utilize a photovoltaic (PV) solar module as the power source. The controller provides all the control functionality necessary for a typical solar thermal system powered 100% by the sun.

The controller functions by maintaining the voltage of the photovoltaic (PV) module at approximately 13 VDC. If the motor voltage rises above 13 VDC the controller allows the PV voltage to rise with the motor voltage. During low sunlight conditions when the PV module can not produce sufficient power to drive the Solar Pump™ continuously, the controller stores the electrical energy from the PV module and releases it in bursts of power to cause rotation of the pump. This feature also serves to start the pump earlier in the day when it might remain at rest due to static friction after resting overnight.

The e-Mag Solar Pump™ has two terminal blocks for connection to: (1) a PV module, and (2) two temperature sensors. The two-pole terminal block is for the PV module. The four-pole terminal block is for two temperature sensors. The controller compares the values of the two temperature sensors and energizes the motor only when the collector sensor is hotter than the storage sensor. The controller also includes high and low temperature limits, and fail safe protection in the event of an open or short circuited temperature sensor.

Connections:

PV+	Positive terminal of PV module
PV-	Negative terminal of PV module
Coll.	Collector temperature sensor
Coll.	Collector temperature sensor
Stor.	Storage temperature sensor
Stor.	Storage temperature sensor

Service Plug:

The "Service Plug" is used to override the e-Mag Solar Pump's differential temperature controller to force the unit into a "Pump ON" state (if power is available from the PV module). This Service Plug is useful for commissioning and/or servicing.

"Pump ON":

The e-Mag Solar Pump™ will begin pumping ("Pump ON") when the collector sensor measures 3°C (5ºF) higher than the storage sensor.

"Pump OFF":

The e-Mag Solar Pump™ will stop pumping when any of the following conditions occur:

• "**Low ΔT**" - the collector sensor drops in temperature so that it measures only 1ºC (2ºF) above the storage sensor, or less (eg. collector temp < storage temp)

• the "**Storage Temp High**" set-point is reached. This set-point is factory set to 70°C (158°F). NOTE: The "Storage Temp High" set-point can be adjusted from 32 - 90ºC (90 – 194ºF) via a potentiometer located next to the temperature sensor terminal block. Fully clockwise equals 90ºC (194ºF).

• the "**Collector Temp High**" set-point is reached when the collector sensor measures greater than 112°C (234°F).

• the "**Storage Temp Low**" set-point is reached when the storage sensor measures -3°C (27°F).

NOTE: There is 3°C (5°F) of hysteresis for all set-points, meaning that once a set-point has been reached the corresponding temperature must fall (or rise) by 3°C before the controller will turn ON (or OFF) again.

LEDS:

The following describes the conditions required to illuminate each LED (NOTE: ΔT refers to the differential between the collector sensor and the storage sensor)

• **RED**: Low ΔT (eg. collector temp < storage temp); collector sensor open circuit.

•**YELLOW**: Storage temperature HIGH; storage sensor short circuit.

•**AMBER**: Collector temperature HIGH; collector sensor short circuit.

•**GREEN**: "Pump ON" - the collector temperature is sufficiently greater than the storage temperature and the system should be running. NOTE: if there is minimal sunlight, the LED may be "ON" but the pump will not be turning. If so, wait for more sunlight.

• No LEDs will be illuminated when:
- The power switch is in the OFF position,
- There is no power from the PV panel (eg. no sunlight),
- The storage sensor is open circuited,
- The storage sensor measures -3°C or less.

Fuse:

The e-Mag Solar Pump™ has one internal fuse rated at 4 A, 250 VDC. Should the fuse require replacement, prior to replacing the fuse with an equivalent rated fuse, it is recommended to investigate the cause of failure. The fuse should not blow unless the power source provides excessive amperage.

Collector Temp High Limit - ENABLE / DISABLE:

A shunt, JP1, is installed on the circuit board to enable or disable the "Collector Temp High" limit of the e-Mag Solar Pump. The unit is shipped with the limit enabled (shunt on pins 2 & 3). To disable the limit, remove the shunt and place it on pins 1 & 2.

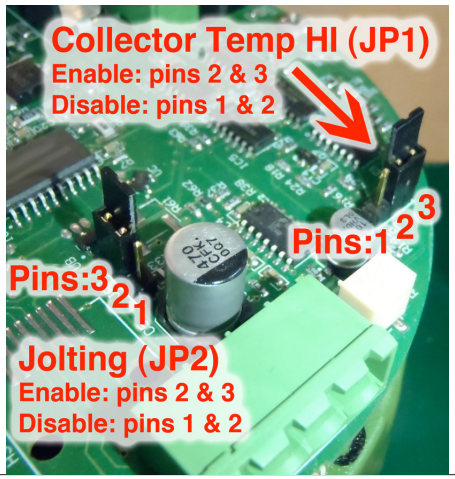
The "Collector High Limit" prevents the unit from turning ON when the collector temperature sensor is greater than 112°C (234°F). This is likely to occur when the unit stops circulating in sunny conditions because the "Storage Temp High" limit has been reached. It is unlikely that the "Collector Temp High" limit will be reached during normal operation of the pump.

The limit is provided to prevent sudden, unexpected noises from alarming home owners or occupants should the Storage temperature fall due to hot water usage, thus causing the pump to turn ON and circulate super-heated fluid from the solar collectors through the cooler pipes, potentially causing a disturbance.

Jolting Function - ENABLE / DISABLE:

A shunt, JP2, is installed on the circuit board to enable or disable the electronic jolting function of the e-Mag Solar Pump. The unit is shipped with jolting enabled (shunt on pins 2 & 3). To disable the jolting function, remove the shunt and place it on pins 1 & 2.

The jolting function helps to start the unit in low sunlight conditions by storing electrical energy if the pump is not turning, and releasing the energy in bursts. Jolting helps to overcome static friction and/or minor pump blockages.



Thermo Dynamics Ltd.
101 Frazee Avenue
Dartmouth, Nova Scotia
Canada, B3B-1Z4
Tel: (902) 468-1001 Fax: (902) 468-1002
Email: solarinfo@thermo-dynamics.com
www.thermo-dynamics.com

e-Mag Solar Pump™ - Dimensions

Models: P24070EM & P50140EM

Weight: 3.4 kg (7.6 lbs)