MZ-30L

14 VDC Power Generator and Regulator System

Installation and Operation Manual

Version 3
Date: Nov 19, 2021

EXPERIMENTAL AIRCRAFT ONLY

INSTALLATION OF THE DESCRIBED EQUIPMENT ON CERTIFIED AIRCRAFT IS A VIOLATION OF THE LAW

1. Description

The MZ-30L consists of two main parts:

1. A rotating generator driven off the vacuum pump pad and
2. An externally mounted regulator.

Together they provide ~14.4 VDC up to a maximum load of 30 amps. This system is intended for use on Lycoming and Lycoming derivative engines where the vacuum pad rotation speed is 1.3 times the crankshaft rotation speed. Combined weight is ~2.5 lbs.

Warning: the outside of the generator moves during operation. For safety of flight ensure that everything is completely clear of the generator.

Additional Notices:

- **Please do not open the regulator box or remove the covers. There are no user servicing parts inside the regulator. Adhesive is used to dampen vibration within the regulator and opening the regulator risks tearing components off the circuit board causing permanent damage when the adhesive is pulled away from the components.**
- **Please use the terminals and sems terminal screws provided with the device as directed. Any other length of screw risks shorting live terminals to ground. Any other terminal risks damaging the circuit board.**
- **The installer should be familiar with best practices for aircraft wiring. All Crimped terminals should include a metal to metal electrical connection and a strain relief that captures the wire insulation.**

Installation Prerequisites:

- **Vacuum drive on the Lycoming engine**

Installation supplies:

- **10 AWG TEFZEL wire**
- **22-26 AWG wire**
- **Wire ties**
- **#6 mounting screws and nuts**
- **High Temp RTV (optional)**

1.1. Electrical Description

The MZ-30L generator provides a 3-phase AC voltage to the external regulator which rectifies the AC and provides a clean ~14.4 VDC output to the main bus. The maximum capable load current is a function of RPM. At approximately 900-1000 RPM tach speed the current is limited to 15 amps. At 1800 RPM the current limit rises to 30 amps.

1.1.1. Generator

The generator unit uses powerful permanent magnets to provide the 3-phase AC electrical output, no “field” current is required. The system is self-excited and will start and run without an external battery required.

1.1.2. Regulator

The external regulator receives the AC voltage and using state-of-the-art electronic technology provides a ~14.4 VDC output with current limiting and self-diagnostic features. The output is internally fused. These fuses are not replaceable on the aircraft, if they are blown they need to be replaced by a repair shop.

1.2. Mechanical Description

The system is composed of the generator and regulator.

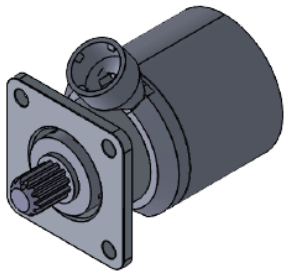
1.2.1. Generator

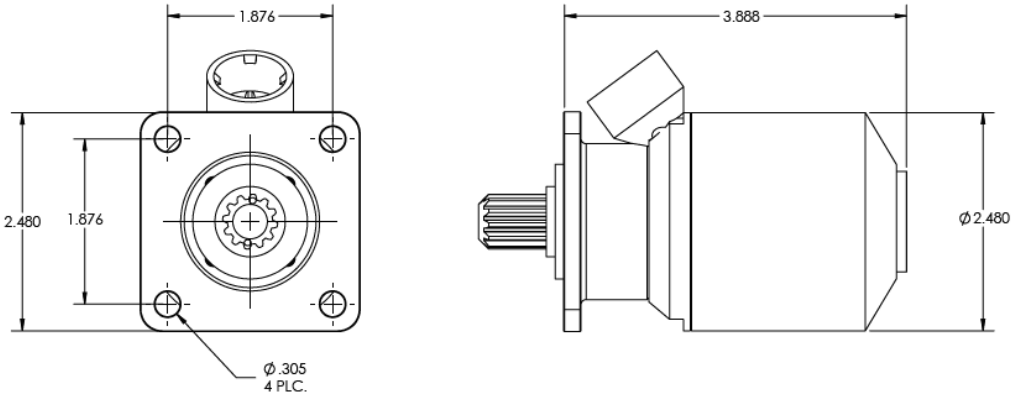
The generator bolts to the vacuum drive of the aircraft engine with a silicon/fiberglass gasket provided by Monkworkz and nuts and lock washers per engine manufacturer specifications. The generator uses cooling air through a 0.75 inch hole in the engine baffling. Air from the engine baffling is routed to the generator with corrugated nylon tubing.

1.2.2. Regulator

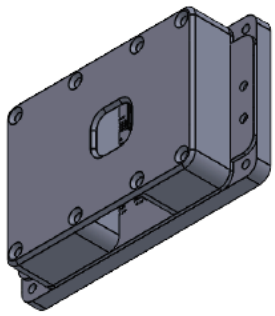
The regulator is designed to be mounted inside the engine cowling ideally within 15 inches of the generator to prevent the need for extending the provided electrical wiring from the generator. The regulator uses cooling air through a 0.75 inch hole in the engine baffling. Air from the engine baffling is routed to the regulator with corrugated polypropylene tubing.

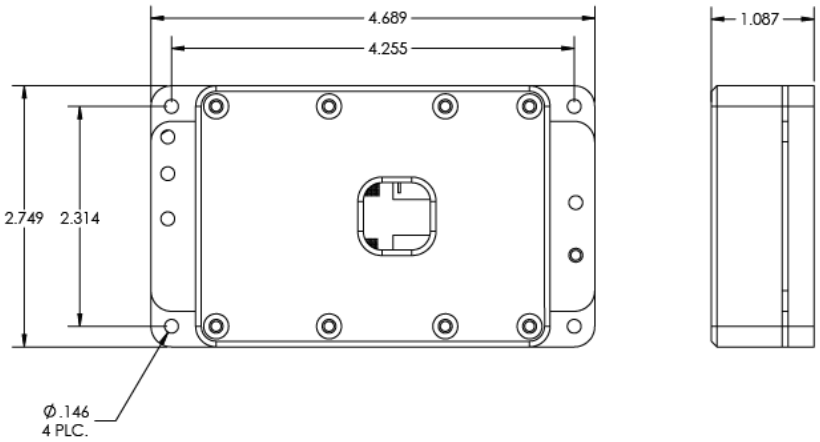
1.3. Drawing of Generator and Regulator





Generator drawing, units are inches





1.4. Installation Requirements

1.4.1. Cooling

Discussed above: two 0.75 inch holes in the engine baffling plumbed independently to the generator and regulator, force fit into both.

1.4.2. Electrical Installation

1.4.2.1. Generator and Regulator Connections (refer to 2.1, wiring schematic)

The power connections are as follows:

1. **3x 14 AWG wires from the generator to the regulator**, Dress, cut to length and terminate with provided ring terminals. Keep away from exhaust plumbing and route such that there is no strain on any of the leads. The regulator has onboard fuses so no external current limiting is required.
2. **2 x 10 AWG wires from the regulator are used for ~14.4 VDC output and ground.** An onboard fuse is provided so no additional current limiting is necessary. If there is no main generator breaker, the positive 14.4 volt lead can be wired directly to the main bus or the load side of the master relay. If there is an existing circuit breaker for the old generator, the output can be wired to that where the previous power source was

connected. The breaker maximum rating can exceed 30 amps as the MZ-30L regulator will current limit at 30 amps. This breaker will provide the following benefits:

a. protect the wiring between the breaker and regulator output
b. provide a means for isolating the MZ-30L for testing
c. provide a means of isolating the regulator output from the bus for any reason.

1.4.2.2. Required Signal Connections

1. **Enable terminal on pin 1 of molex output connector.** This control signal on pin-1 needs to go to the center post of the provided toggle switch. Pin -6 of the same connector needs to go to the switch's N-O(normally open) connection. When the switch is activated the N-O contacts close and the regulator is enabled.
2. **Generator thermistors on pin 1 and pin 5 of the molex input connector and common thermistor ground on pin 6.**The thermistors are connected through the provided, prewired molex connector installed on the generator. Thermistor is used to monitor the generator temperature and disable the system if temperature limits are not maintained.
    a. Note: If the thermistor cable is not plugged into the regulator the system will not provide an output voltage.

1.4.2.3. Optional Signal Connections

1. **Active on output Molex pin 2.** This pin will go to 5 VDC when the generator/regulator system is active. In installations where the system is providing backup power this can be used for an EFIS to monitor when the system is providing power so that the pilot can be notified that the primary power has failed. This pin can also drive 30 mA or less into an LED with an appropriately sized current limit resistor.
2. **Current shunt + and - on output Molex pin 3 (+) and pin 4 (-).** Traditional current shut driven ammeters can use this output for real time current measurement.
3. **Proportional Current output on output Molex Pin 5.** This pin will output from 0 to 4.5V proportionally reflecting the real time current output of the device on a scale from 0 to 30 amps, where zero amps output from the device is reported to pin 5 as zero volts and 30 amps output from the device is reported to pin 5 as 4.5 volts. This connection can be connected to devices that translate 5 V sensor devices into human readable outputs.

1.5. Operational Description:

The system requires that the enable switch is closed for the regulator to operate and provide output voltage. This switch should be accessible to the pilot. If this is a retrofit install, this switch has the same effect that the old “field” switch had. This switch, when closed (on position), provides a shorting path to pin-6 to enable the operation, when open (off position) the regulator turns off the output.

As a failsafe, the system has an overvoltage protection circuit that monitors the output voltage and shuts the regulator output down in less than a second. In this event the bus will then be powered by the a/c battery. Upon start up, the OVP circuit goes through a self check and if a failure is detected the system will not provide an output voltage.

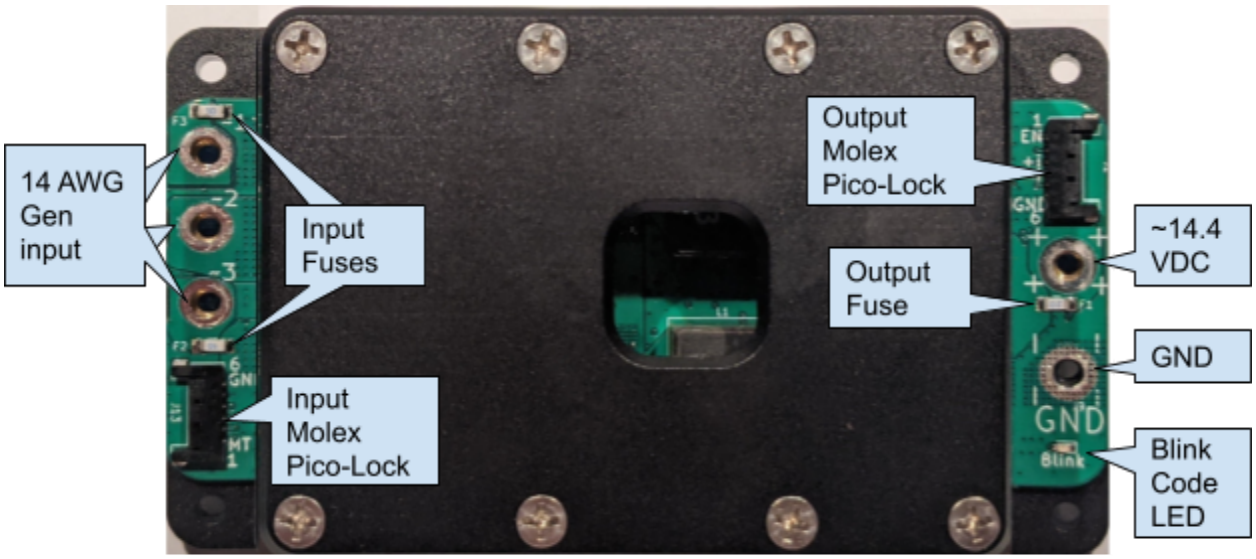
Note: During operation, if the OVP circuit is activated (3) three times during the same flight, the system will shut down for the remaining duration of that flight, if this happens on three flights the device will require service from Monkworkz.

Both the generator and regulator have been constructed with materials and components that can withstand normal temperatures under the cowling of a typical general aviation aircraft. In spite of this the device also has thermal protection for both the generator and regulator. If limit temperatures are reached the device will first enter into a protected mode where half the current limit is applied. If the out of limit temperature continues to rise above a second higher threshold then the device will shut down completely until temperatures have recovered below a recovery threshold.

1.6. Installation Kit Contents:

1. MZ-30L Generator

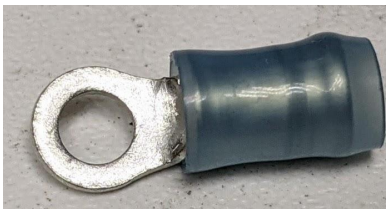
2. MZ regulator



3. Fuses are shop replaceable but failure likely indicates that the regulator has failed

4. Accessory Bag Contents:
   a. (3) 10/12 AWG #6 screw PIDG terminals (2 required)

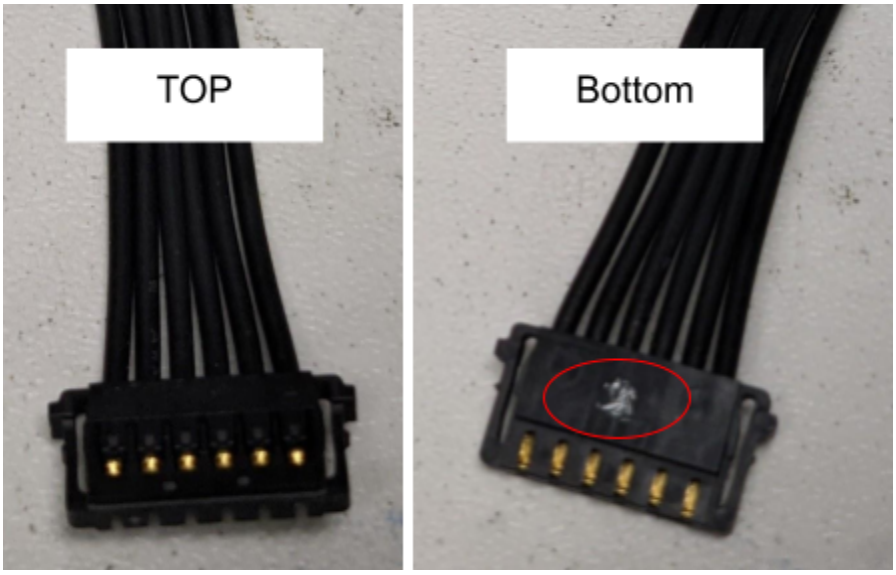
   b. (4) 14/16 AWG #6 screw PIDG terminals (3 required)



c. (3) 10/12 AWG 5/16 screw PIDG terminals (Optional, 1-2 required)

d. (3) butt splices for enable connection from regulator to pilot operated switch, 2 recommended.

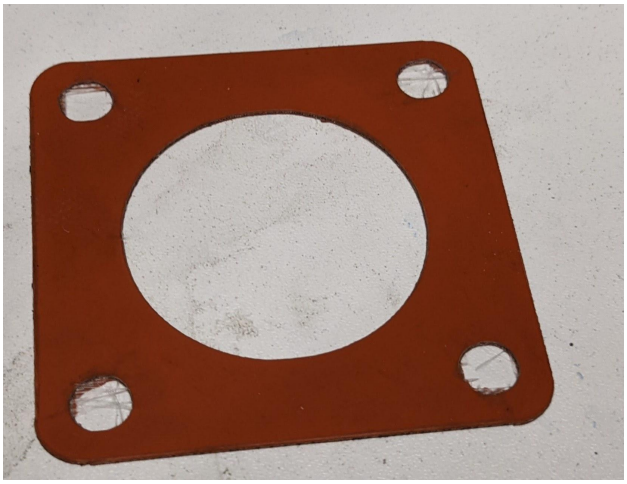
e. (2) Molex PicoLock connectors (1 prewired to generator for thermistors, 1 for connection to pilot accessible enable switch. 2 required) pin 6 is denoted with a small triangle on the top side of the connector.



f. (6) #6 SEMS screws with captive lock washers (5 required)

g. (1) Pilot operated switch

h. Orange silicon gasket



5. Cooling Duct Material - snaps into regulator, generator and ¾” holes in sheet metal baffling

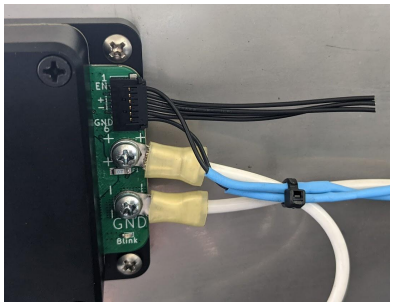
2. Installation

Warning: the outside of the generator moves during operation. For safety of flight make sure everything is completely clear of the generator.

Installation must be performed by qualified personnel with knowledge of best electrical wiring practices in aircraft. The installation should also be designed to meet the requirements of the targeted aircraft. Meeting the requirements of specific aircraft is beyond the scope of this manual but the content provided herein provides the necessary information for a qualified person to make that determination. Please seek professional assistance if you are unqualified to determine how to connect or install the MZ-30L.

2.1. Installation tips

- The Molex Pico-Lock connectors are delicate. Please treat them with care. A moderate amount of tension can unseat the conector. To prevent this it is recommended that maintenance loops(~0.5 inches of extra slack in the connector wires) be added and secured to the nearby 14 or 10 AWG wires:



- Install the regulator under the cowling. It is robust enough to endure the expected temperatures under the cowling.
- Avoid long wire lengths on the regulator positive and negative terminal outputs. The available voltage will only decrease with distance from the regulator.
- Keep the cooling duct runs short but with enough duct length to keep them either in compression or with sufficient slack to prevent them from pulling out of either end. The cooling duct for the generator can usually be run a few inches to the baffling directly ahead of the generator.
- Ground the enabled wire at the regulator. Electrically it is possible to run the enable wire to the aircraft panel and provide the switch a ground from a source nearby the enable

switch but in many installations this will cause “ground loops” and may cause erratic behavior. In aircraft that have a history of electrical noise in the audio or radio systems it is recommended that shielded wire be used with the shield only grounded at the regulator end of the run.

2.2. Minimum Installation / Required Connections

Installation will vary according to the goals of the user and the equipment being interfaced with but one possible means to complete a simple installation would require the following:

1. **Positive output connected to the switched side of the master relay / battery contactor with 10 AWG tefzel wire.** 30 amp current limiting is recommended on the bus end of the wire to protect the wire from a short between the regulator and bus, if the installation is a retrofit then the previous breaker can be used.

2. **Negative output attached to ground** (airframe structure, firewall, etc.) with 10 AWG tefzel. The ground should be bolted to a clean metal surface, no paint or corrosion should be between the connection and ground surface. Secure the cable with adel clamps or wire ties to prevent movement and ensure that the cable does not chafe against anything. There should be no tension on the cable at either the regulator terminal or ground point. If the battery’s negative terminal is nearby the ground wire can be connected to the negative terminal instead of the airframe.

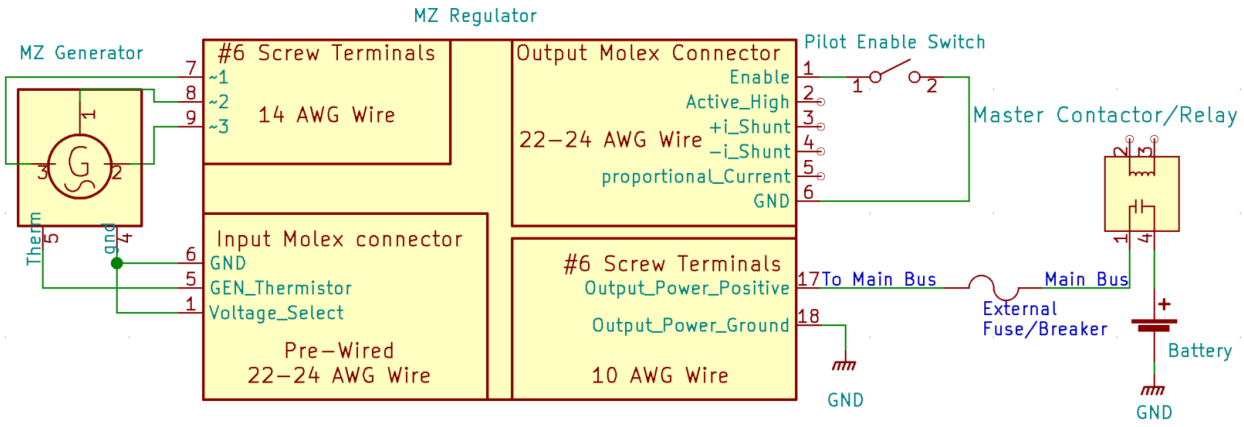
3. **Pilot Enable Switch** to the regulator output/prewired Molex. Splicing a 22-20 awg leads to the existing pigtails on pin 1 and pin 6 is a good approach. Those leads can then go to the toggle switch on the inst panel. Wire it such that when the toggle bat is in the up(on) position the wires are shorted by the switch contact.

4. **3x 14 AWG outputs from generator** mounted on the vacuum pad attached to the three inputs labeled ~1,~2,~3 (phases 1, 2 and 3) on the regulator. Care should be taken to ensure that the wires are routed such that the movement of the engine relative to the airframe does not place any tension on wires. If desired an adel clamp attached to one of the vacuum pad studs can be used to capture all three wires (and the thermistor wire) to reduce the fatigue on the wires as they enter the generator.

5. **Pre-wired Molex connector from the generator** to the regulator. Routed along with the three phase wires above. This cable is the thermistor sensor output and must be connected for the system to function.

6. **Two 3/4 inch cooling ducts from engine baffling.** One routed to the generator and the other routed to the regulator. The cooling duct material is a force fit into both the generator and regulator. Do not oversize the holes in the baffling! RTV can be used to provide a more complete seal and keep them in place.

2.3. Minimum installation schematic



2.4. Using the MZ-30L as a backup power source:

The MZ-30L can be connected in parallel with existing power sources and used as a backup or secondary power source. The recommended configuration for this is to:

1. disconnect pin 1 on the input molex connector to set MZ regulator output voltage to ~14.2V. (see voltage configuration below)
2. Set the primary power source at 14.4VDC.

This configuration will put the MZ regulator in a standby state, preventing the MZ regulator from interfering with the primary power source. When the bus voltage drops below 13.7 VDC the MZ regulator will exit the standby state and begin providing power to the bus and will maintain 14.2 VDC up to the maximum current limit based on the RPM.

2.4.1. Voltage selection

The standard output voltage of the regulator is 14.6 VDC. The voltage is selected because most battery systems used on experimental aircraft operate well in the range of 14.4-14.8 VDC. In a

configuration with 10 AWG(1 mOhm/ft) wire running 4 feet for power and ground for an 8 foot round trip to the battery and back you can calculate that at max current of 30 amps the battery voltage will be 14.4V. At a more minimal current the battery will be provided with ~14.56V. Both of these voltages will ensure maximum longevity of AGM batteries based on manufacturer information. 14.6 VDC also allows a user to have a diode isolated critical bus and still maintain enough voltage for maximum battery life after the drop in voltage through the isolating diode.

2.4.2. Voltage Configuration
Two output voltages can be selected: 14.6 VDC for primary power installations and 14.2 VDC for backup installations. In backup applications selection of the lower voltage should mitigate the chances of the primary power source being interfered with by the MZ-30L provided the primary power source is set at greater than 14.2 VDC. In this case when the primary power source is running the MZ-30L will enter a standby state. In the event that the primary power source fails the MZ-30L will see the bus voltage drop to battery level and then begin providing power to the bus at 14.2 V. This should be enough to support the attached equipment but may not be optimal voltage for long term maintenance of any attached batteries.

The MZ-30L comes configured for 14.6 VDC, if the lower voltage setting is desired, disconnect pin 1, labeled MT, on the input side Molex Pico-Lock connector. This can be done by cutting the wire or by releasing the pin from the connector. To release the pin use the tip of an exacto knife to gently and slightly lift the retaining clip on the pin and then secure the pin out of the way.
The operating voltage is set at start up and will remain set for the duration of time that power(mechanical or electrical) is applied to the MZ-30L: connecting and disconnecting the pin after start-up will not change the voltage.

2.5. Cooling Ducts

Cooling is required for both the motor and power conditioner. Duct material is provided that will tightly fit into the generator, regulator and ¾ inch holes in typical engine baffling material. The duct material may need to be partially collapsed and pressed back into shape with finger pressure or a small blunt tool pressed against kinked corrugations. RTV can be applied for a better seal with the engine baffling.

2.6. Optional Connections

The MZ-30L has additional functionality that a user can leverage for further reduction of the electrical system weight, installation complexity and cost specifically by eliminating the need for a current shunt or oversized ANL type fuse at the output of the regulator.

2.6.1. Current shunt

The MZ-30L output fuse has a small stable resistance across a wide range of temperatures. This makes it ideal for use as a current shunt. To facilitate this each terminal of the fuse is routed through 2.1k resistors to the output side Molex Pico-Lock connector. Pin 3 is labeled “i+” and Pin 4 is labeled “i-” that should be attached to the positive and negative terminals of a customer provided ammeter. The fuse has a nominal resistance of 1.9 mOhms which will measure 75 mV at approximately 40 amps. For best performance calibration of the ammeter for the actual resistance is recommended.

2.6.2. Analog Current Output

Some avionics packages offer a means to take analog voltages from 0-5 V and map to measured values such as current. The MZ-30L also has an analog voltage output that ranges from zero to 4.4 V reflecting a linear increase from 0 to 30 amps output from the device. The analog current output is available on pin 5 of the output side Pico-Lock connector of the power conditioner.

2.6.3. Output Active

Pin 2 of the output Pico-Lock connector will present zero or 5 V when the regulator is active and maintaining a voltage of 14 V or greater. If the electrical demand exceeds the current limit the regulator reduces the output voltage automatically to maintain the current limit. If the output voltage is below 14 V and the regulator is in current limit, i.e. trying to maintain output voltage but failing because the current demand exceeds the current limit then the active output will flash once per second alerting the user that the bus voltage is not being maintained. In backup installations this pin can be captured by an EFIS to alarm when the device is active.

Alternatively this pin can supply 30 mA to an LED with an appropriate series resistor for a simple panel mounted alert when the MZ-30L is active(solid on) and when it is active but not able to maintain the bus voltage above 14 V(flashing).

3. Operation

The pilot can set the enable switch to the on position prior to starting the engine as part of the pre-start checklist. As an option this activation can be done at idle. After start-up and when the engine rpm exceeds 1000 rpm the MZ-30L will perform an internal self-test. This will require from 2-4 seconds. After which time, if all checks are good, the unit will provide output voltage to the main bus.

3.1. Servicing

3.1.1. Input and Output Fuses

Input and output fuses are installed and are accessible for test or replacement. If either the input or output fuse fails it is very likely that the regulator has failed and requires service. The fuses can be tested using the ohmmeter function on any voltmeter, when tested the fuses should show zero resistance or nearly the same resistance as when the multimeter test leads are connected together. Contact Monkworkz for replacement information.

3.1.2. Shear Coupling

A shear coupling is located between the input spline and motor shaft. This coupling will break if for any reason the torque specification of the vacuum drive is exceeded. If this happens contact Monkworkz for a replacement.

3.1.3. Troubleshooting

3.1.3.1. Symptoms

- No output:
    - Does produce power
    - System not charging
    - Voltage remains at battery level and does not increase

3.1.3.2. Possible reasons:

1. Enable not connected to pin 6 on output side Pico-Lock connector: Verify the Enable(pin 1 on the output side connector) shows continuity to pin 6 by using an ohmmeter when the enable switch is “on" and no continuity when the enable switch is off. With the output side Pico-Lock connector inserted into the output side Pico-Lock receptacle use one lead on the Enable input, pin 1 and the other lead touching the output ground screw. This test should show continuity with the switch in the “on” position and no continuity in the “off” position, otherwise there is a wiring failure. See blink codes below as well to verify enable and disable.

2. Shear coupling has split: Gently try to rotate the outside of the generator, if it rotates freely contact Monkworkz for a replacement shear coupling.

3. Thermistor is not connected from the generator to the regulator, and would be indicated by the regulator blink LED which will quick blink i.e. flash, once per second when the

regulator is connected to bus power. Verify that the thermistor is connected to the regulator.

4. If power is intermittent check the cooling ducts, potentially the device is entering thermal shutdown.

5. An Overvoltage condition has transpired (3) three times during a single operation cycle(flight) in three separate cycles(flights). The regulator LED will blink 2 quick flashes under this condition which requires the regulator to be replaced.

3.1.3.3. Blink codes

The output side of the regulator has an LED that lights up when there is an issue with the system. The integrated trouble codes are as follows:

1. Thermistor disconnected - shown as one flash on the device per second. Check that the thermistor is connected. Check to see that the resistance of the thermistor is on the order of 100kOhm.

2. Over Voltage lock out - shown as two flashes per second. If this code is shown then the device has experienced three over voltage events on three separate sessions for a total of 9 over voltage events and the device needs to be returned to Monkworkz for service/replacement.

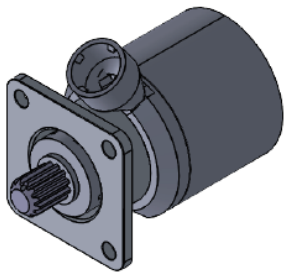
3. Disabled - shown as three flashes per second when device is otherwise functioning but enabled pin 1 on the output side is not attached to ground pin 6 on the output side. Gives the installer an easy way to test the pilot accessible enable switch. Available on units shipped after 19 November 2021.

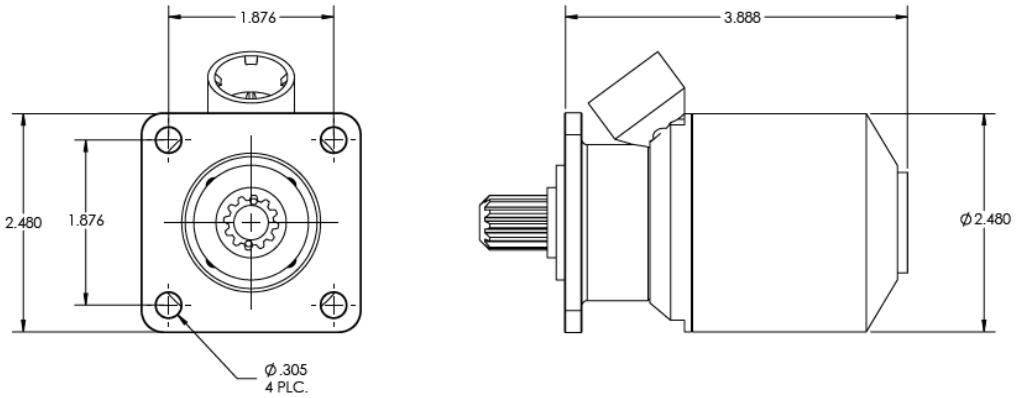
4. Enabled - shown as four flashes per second when device is otherwise functioning and enabled pin 1 on the output side is attached to ground pin 6 on the output side. Gives the installer an easy way to test the pilot accessible enable switch. Available on units shipped after 19 November 2021.

4. Specifications

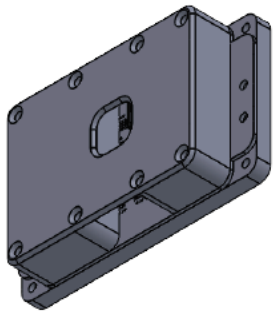
4.1. Mechanical

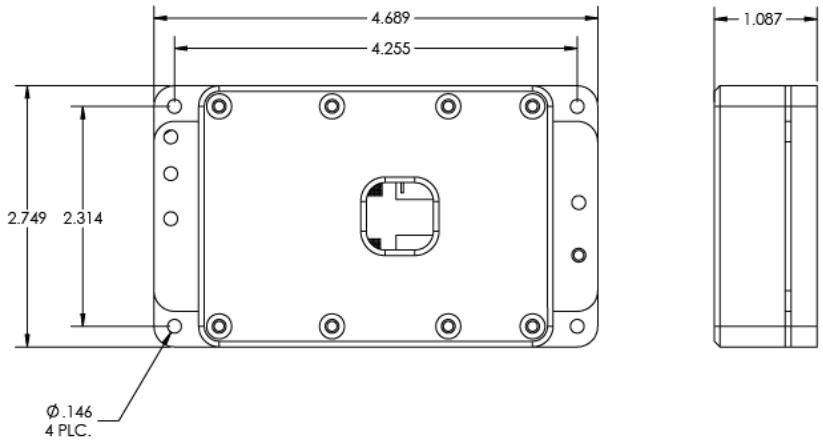
RPM Limit: 4000 Generator RPM / 3000 Crankshaft RPM
Generator Weight: 2 lbs, 1 oz.




1.876
2.480
1.876
Ø.305
4 PLC.
3.888
Ø2.480

Regulator Weight: 8 oz





4.2. Electrical

Connection name(s)	Connection location	Nominal Voltage	Absolute Maximum Rating relative to ground
Phase 1-3	Input side screw terminal	0-60 VAC	80 VAC
Ground	Input side Molex Connector	0 VDC	0 VDC
Generator thermistor, voltage select	Input side Molex Connector	0-5 VDC	5 VDC
Enable	Pin 1, Output Side Molex Connector	0-5 VDC	5 VDC
Proportional Current	Pin 2, Output Side Molex Connector	0-4.4 VDC	5 VDC
+i Shunt and -i Shunt	Pin 3 and 4, Output	0-14.6 VDC	20 VDC

	Side Molex Connector		
Output Active	Pin 5, Output Side Molex Connector	0-5 VDC	5 VDC
Ground	Pin 6, Output Side Molex Connector	0 VDC	0 VDC
Output power positive	Output Side	14.6 VDC +/- 1% 14.3 VDC +/- 1%	20 VDC
Output power negative	Output Side	0 VDC	0 VDC

Table 1: electrical ratings

4.3. Environmental

System tested function at up to 115 F ambient.
The outside of the rotor is magnetic: Keep ferrous metal away from the exterior of the generator and if drilling or filing ferrous metals nearby take precautions to keep metal shavings or filings away from the generator.