



Power Anytime, Anywhere

Tesla™ TI5679 MPU-24

User Manual



Built Smart...Proven Tough

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New Castle, DE 19720
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**NOTE: All users must read this entire manual prior
to operating the TI5679 MPU-24.**

The TI5679 MPU-24 is a limited maintenance-free and sealed unit. No repairs are authorized. Warranty will be voided if unit is tampered with in any way, or if unauthorized repairs are made. For technical support please contact:

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CAUTION

Shock Hazard Potential

Improper use or failure to follow instructions in this user manual can result in unit damage and/or injury or death by electrical shock.

Any attempts to open or examine the inside of the TI5679 MPU-24 via a tool or device (borescope, probe, etc.) can result in unit failure and/or injury by electrical shock. This MPU is maintenance free and should not be opened or disassembled for any reason.

Always protect the unit from short circuit.

Shipping Hazards: The TI5679 MPU-24 contains sealed, dry cell rechargeable batteries that do not pose a shipping hazard.

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INFORMATION ONLY - PLEASE READ SECTION X

SECTION I - PRODUCT AND MANUFACTURER IDENTITY

Product Identity:

Tesla[®]™ Turbo Start[®]™ Ground Power Unit (GPU) and Micro Power Unit (MPU) Containing Dry Cell (Starved Electrolyte) Batteries Used on Aviation/Military Application

Manufacturer's Name and Address:

Tesla Industries Inc.
101 Centerpoint Blvd.
New Castle, Delaware 19720

Emergency Telephone Number:

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SECTION II - INGREDIENTS

| Hazardous Components | CAS # | OSHA PEL-TWA | % (By weight) |
|---------------------------|-----------|-----------------------|---------------|
| Lead | 7439-92-1 | 50 µg/m ³ | 45 - 60 % |
| Lead Dioxide | 1309-60-0 | 50 µg/m ³ | 15 - 25% |
| Sulfuric Acid Electrolyte | 7664-93-9 | 1.0 mg/m ³ | 15 - 20% |
| Non-Hazardous Materials | N/A | N/A | 5 - 10% |

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point - N/A

Specific Gravity (H₂O=1) - NA

Vapor Pressure (mm Hg.) - N/A

Melting Point - N/A

Solubility in Water - N/A

Appearance & Color - N/A

SECTION IV - FIRE & EXPLOSION HAZARD DATA

Flash Point (Method Used): N/A

Flammable Limits: N/A

LEL: N/A

UEL: N/A

Extinguishing Media: Multipurpose Dry chemical CO₂ or water spray.

Special Fire Fighting Procedures: Cool GPU/MPU exterior to prevent rupture. Acid mists and vapors in a fire are toxic and corrosive.

Unusual Fire and Explosion Hazards: Hydrogen gas may be produced and may explode if ignited. Remove all sources of ignition.

SECTION V - REACTIVITY DATA AND SHIPPING/HANDLING ELECTRICAL SAFETY

Stability: Stable

Conditions to Avoid: Avoid shorting, high levels of short circuit current can be developed across the battery terminals. Do not rest tools or cables on the battery. Avoid over-charging. Use only approved charging methods. Do not charge in gas tight containers.

SECTION VI - HEALTH HAZARD DATA

Routes of Entry: N/A

Health Hazards (Acute & Chronic): N/A

Emergency & First Aid Procedures:

Battery contains acid electrolyte, which is absorbed in the separator material. If battery case is punctured, completely flush any released material from skin or eyes with water.

Proposition 65:

Warning: Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the State of California to cause cancer and reproductive harm. Batteries also contain other chemical known to the State of California to cause cancer. Wash hands after handling

SECTION VII - PRECAUTIONS FOR SAFE HANDLING & USE

Steps to be taken in case material is released or spilled

Avoid contact with acid materials. Use soda ash or lime to neutralize. Flush with water.

Waste Disposal Method

Dispose of in accordance with Federal, State, & Local Regulations. Do not incinerate. Batteries should be shipped to a reclamation facility for recovery of the metal and plastic components as the proper method of waste management. Contact distributor for appropriate product return procedures.

SECTION VIII - CONTROL MEASURES - NOT APPLICABLE

SECTION IX - OTHER REGULATORY INFORMATION

Tesla™ Industries GPU/MPU batteries are sealed electrolyte batteries, which means the electrolyte is absorbed in the separator material. The batteries are also sealed.

NFPA Hazard Rating for Sulfuric Acid:

Health (Blue) = 3

Flammability (Red) = 0

Reactivity (Yellow) = 2

Sulfuric Acid is Water Reactive if concentrated.

U.S. DOT: Tesla™ Industries GPU/MPU batteries are classified as Nonspillable. They have been tested and meet the nonspillable criteria listed in 49 CFR § 173.159(f) and 173.159a(d)(1).

Nonspillable batteries are excepted from 49 CFR Subchapter C requirements, provided that the following criteria are met:

1. The batteries must be securely packed in strong outer packagings and meet the requirements of 49 CFR § 173.159a.
2. The batteries' terminals must be protected against short circuit.
3. Each battery and their out packaging must be plainly and durably marked "NONSPILLABLE" or "NONSPILLABLE BATTERY".

The exception from 49 CFR, Subchapter C means shipping papers need not show proper shipping name, hazard class, UN number and packing group. Hazardous labels are not required when transporting a nonspillable battery.

IATA: Tesla™ Industries GPU/MPU batteries have been tested and meet the nonspillable criteria listed in IATA Packing Instruction 872 and Special Provision A67. Nonspillable batteries must be packed according to IATA Packing Instructions 872. This means shipping papers need not show proper shipping name, hazard class, UN number and packing group. Hazardous labels are not required when transporting a nonspillable battery.

These batteries are excepted from all IATA regulations provided that the batteries are packed in a suitable out packaging and their terminals are protected against short circuits.

IMDG: Tesla™ Industries GPU/MPU batteries have been tested and meet the nonspillable criteria listed in Special Provision 238. Non-spillable batteries must be packed according to IMDG Packing Instruction P003. This means shipping papers need not show proper shipping name, hazard class, UN number and packing group. Hazardous labels are not required when transporting a nonspillable battery. These batteries are excepted from all IMDG codes provided that the batteries are packed in a suitable out packaging and their terminals are protected against short circuits per PP16.

RCRA: Spent lead-acid batteries are not regulated as hazardous waste by the EPA when recycled, however state and international regulations may vary.

CERCLA (Superfund) and EPCRA:

- (a) Reportable Quantity (RQ) for spilled 100% sulfuric acid under CERCLA (Superfund) and EPCRA (Emergency Planning Community Right to Know Act) is 1,000 lbs. State and local reportable quantities for spilled sulfuric acid may vary.
- (b) Sulfuric acid is a listed "Extremely Hazardous Substance" under EPCRA, with a Threshold Planning Quantity (TPQ) of 1,000 lbs.
- (c) EPCRA Section 302 notification is required if 1,000 lbs. or more of sulfuric acid is present at one site.
- (d) EPCRA Section 312 Tier 2 reporting is required for batteries if sulfuric acid is present in quantities of 500 lbs. or more and/or if lead is present in quantities of 10,000 lbs. or more.
- (e) Supplier Notification: this product contains toxic chemicals, which may be reportable under EPCRA Section 313 Toxic Chemical Release inventory (Form R) requirements.

If you are a manufacturing facility under SIC codes 20 through 39, the following information is provided to enable you to complete the required reports:

| <u>Toxic Chemicals</u> | <u>CAS Number</u> | <u>Approximate % by Wt.</u> |
|------------------------|-------------------|-----------------------------|
| Lead | 7439-92-1 | 45-60 |
| Sulfuric Acid | 7664-93-9 | 15-20 |

SECTION X - ADDITIONAL INFORMATION

The Tesla™ Industries GPU/MPU sealed lead acid battery is determined to be an "article" according to the OSHA Hazard Communication Standard and is thereby excluded from any requirements of the standard. The Material Safety Data Sheet is therefore supplied for informational purposes only.

The information and recommendations contained herein have been compiled from sources believed to be reliable and represent current opinion on the subject. No warranty, guarantee, or representation is made by Tesla™ Industries, as to the absolute correctness or sufficiency of any representation contained herein and Tesla™ Industries assumes no responsibility in connection therewith, nor can it be assumed that all acceptable safety measures are contained herein, or that additional measures may not be required under particular or exceptional conditions or circumstances.

*N/A or Not Applicable - Not applicable for finished product used in normal conditions.

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Abbreviations and Symbols

Abbreviations that may be used within the text, headings and titles of this manual.

LIST OF ABBREVIATIONS




Abbreviation **Definition**

| | |
|----------|---|
| ac | Alternating Current |
| AFT | Airflow Technology |
| AWG | American Wire Gauge |
| amp or A | Ampere |
| cont | Continuous |
| °C | Degree Celsius |
| °F | Degree Fahrenheit |
| dc | Direct Current |
| EFF | Efficiency |
| ft | Feet |
| FWD | Forward |
| GPU | Ground Power Unit |
| Hr | Hour |
| Hz | Hertz |
| kg | Kilograms |
| kHz | Kilohertz |
| kW | Kilowatts |
| LED | Light Emitting Diode |
| max | Maximum |
| MΩ | megaohm |
| min | Minimum |
| MPU | Micro Power Unit |
| NEMA | National Electrical Manufacturers Association |
| Ω | ohm |
| PF | power factor |
| PFC | power factor correction |
| rms | root-mean-square |
| THD | Total Harmonic Distortion |
| TMDE | Test, Measurement, & Diagnostic Equipment |
| UAV | Unmanned aerial vehicle |
| Vac | Volts, Alternating Current |
| Vdc | Volts, Direct Current |
| W | watts |

Section 1 – Safety Review

1.1 - Safety Notices

Safety notices appear throughout this manual to alert the user to important information regarding proper installation, operation, maintenance and storage of the unit. These notices, as illustrated below, contain a key word that indicates the level of hazard and a triangular icon that indicates the specific type of hazard.

| | |
|--|--|
|  WARNING | Indicates a condition, operating procedure or practice, which if not adhered to could result in serious injury or death. |
|  CAUTION | Indicates a condition or operating procedure, which if not strictly adhered to could result in damage or destruction of equipment. |
|  NOTE | Indicates a condition, operating procedure or practice, which is essential to highlight. |

1.2 - Symbols

The following symbols will appear within the warning triangles to alert the user to the specific type of danger or hazard.



Figure 1.2.1 – Different types of hazard and caution symbols

1.3 – Hazards

 **WARNING** Shock Hazard Potential

Severe injury or death from electrical shock may occur if either the user or the unit is wet while the operating unit is connected to a power source. Be sure to disconnect ac power from the ac source if the unit has come into contact with water. If AC Input Circuit Breaker has tripped due to water infiltration, DO NOT try to reset it with the ac line voltage attached.



 **WARNING** Shock Hazard Potential

Severe injury or death from electrical shock can occur when damp electrical plugs are connected to the unit. Make sure the unit is turned off before making any connections. Failure to use proper grounding can cause potential shock hazard! In different countries, the power cord may require the use of a plug adapter to achieve plug style compatibility for operation. Use only adapters with proper grounding mechanism.

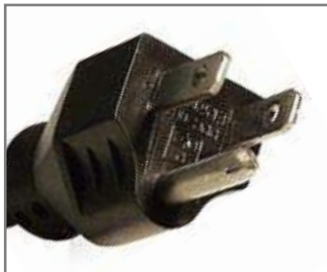


Figure 1.3.1 – Proper Ground Grounded Plug with Grounding Pin




Figure 1.3.2 – Proper Ground Adapter with Grounding Mechanism (Secured to Outlet)



Figure 1.3.3 – Improper Ground Plug with No Grounding Pin

1.4 – Important Safety Precautions

 **WARNING** Fire/Explosion Hazard Potential

Severe injury or death from fire or explosion can occur if electrical sparks are produced near fuel vapors. DO NOT CONNECT ac power supply WHILE FUELING. AC power functions of unit shall not be operated during any fuel handling operation. Power output is restricted to dc power only.

1.5 – Extreme Environments

 **CAUTION** Unit Damage Potential

The unit is equipped with a charger temperature switch that automatically disables the unit when the internal temperature exceeds 150°F (65°C). This protects the unit from overheating and damage. If the unit shuts down, move the unit into a cooler environment such as shade or air conditioning when possible. Perform a full function test after the unit has been allowed to cool prior to use.

Section 2 – Product Overview

1.1 – Introduction

This manual contains the complete operating instructions and procedures for the TI5679 Micro Power Unit (MPU). The TI5679 MPU-24 is intended to provide dc electrical ground power for aircraft flight line and maintenance ground support operations. The unit is designed to provide 24 volt dc electrical power output for aircraft engine starting and 24 or 28.5 volts dc electrical support for ground maintenance, avionics/ electrical trouble shooting and testing. The observance of procedures, limitations and performance criteria is essential to ensure peak operating efficiency and to maximize operational capabilities and life of the TI5679 MPU-24.



Figure 2.1.1 – TI5679 MPU-24

2.2 – Indication of Terms Shall, Should and May

Within this technical manual the word “shall” is used to indicate a mandatory requirement for proper operation and warranty purposes. The word “should” is used to indicate a non-mandatory but preferred method of accomplishment. The word “may” is used to indicate an acceptable method of accomplishment.

2.3 – General Specifications

Electrical

DC Output:

- 3000 peak starting amps
- 10 amps continuous @ 28.5 Vdc (when plugged into ac power)
- 56 amp hours (1309 watt hours) with ac power
- 46 amp hours (1024 watt hours) of rechargeable battery power without ac

Recharge Rate From Full Discharge:

- 281 minutes @ 25 °C

AC Input:

- Operates and charges from single phase 100-260 Vac 50/60 Hz
- 5.5 amps @ single phase 120 Vac 60 Hz
- 2.75 amps @ single phase 240 Vac 60 Hz

Physical Properties:

- 15.57" long x 10.345" wide x 9.5" high
- 395.5 mm x 262.6 mm x 241.3 mm
- Weight: 97 lbs (44 kg)

Operating Temperature:

- -40 °C to +60 °C (-40 °F to 140 °F) without ac power
- -40 °C to +55 °C (-40 °F to 131 °F) with ac power

Storage Temperature:

- -65 °C to +105 °C (-85 °F to 221 °F)

Cell Capacity:

- +40 °C 110% ± 05%
- +25 °C 100% ± 05%
- +00 °C 80% ± 05%
- -20 °C 65% ± 10%
- -40 °C 50% ± 10%

2.4 – Physical Dimensions

* All dimensions are in inches [millimeters]

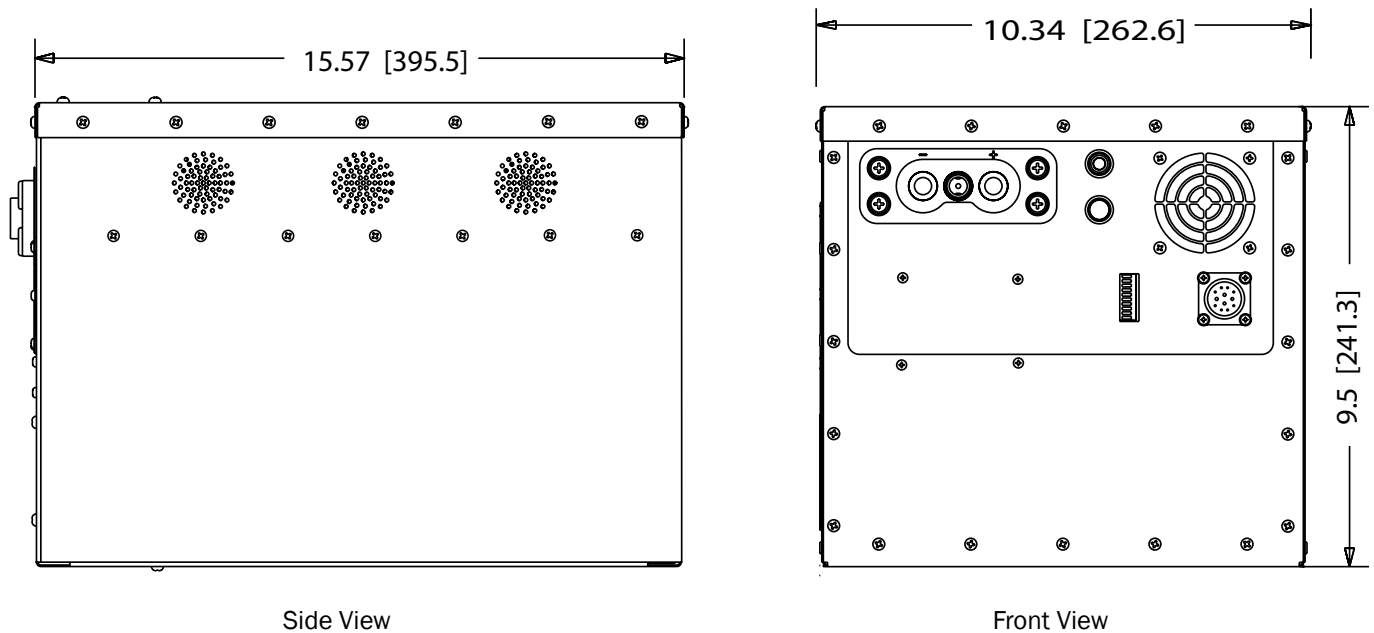


Figure 2.4.1 – TI5679 MPU-24 physical dimensions

2.5 – Airflow Ports



CAUTION

Damage may occur if the TI5679 MPU-24's air intake or outlet ports are obstructed. Ensure that ports are clear at all times.

The internal cooling system of the TI5679 MPU-24 has been designed to efficiently regulate unit temperature regardless of load. At room temperature (+77 °F) the exhaust air will not exceed the ambient temperature by more than 5 °F. In more extreme temperatures (greater than 90 °F) the exhaust air will not exceed the ambient temperature by more than 10 °F.

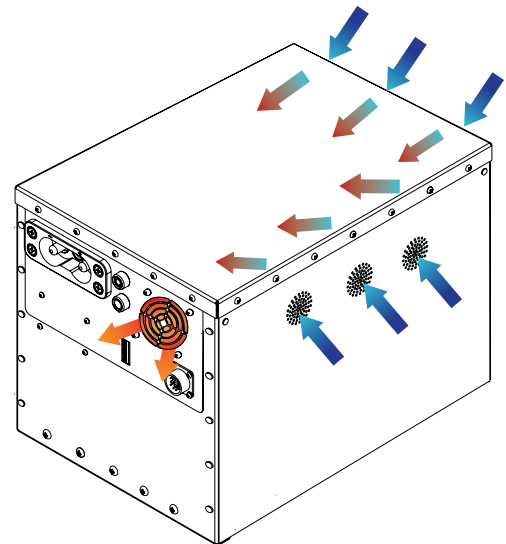
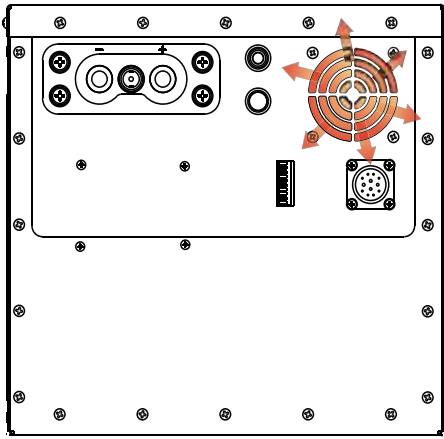


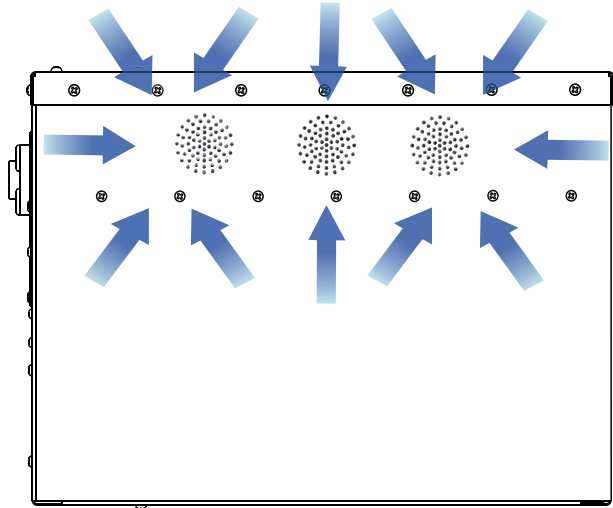
Figure 2.5.1 – Air intake and exhaust ports and internal air circulation

2.6 – Operating Position

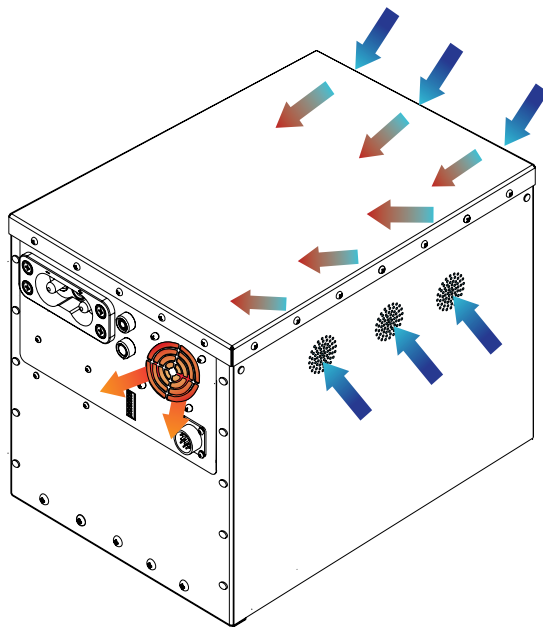
The TI5679 MPU-24 should be operated in the horizontal position as shown. Make sure that the airflow is not obstructed from air intake and outlet.



Front Outlet



Side Inlets




Vertical Position

2.7 – “Press for Capacity” Button and LED Status Indicator


The “Push to Test” button is used to indicate the capacity of the power cells without applying ac input power. It allows the end user to check the status of the power cells. This lets the operator know if there is enough power to perform another engine start, or if the unit has to be connected to ac power to allow it to recharge.

1. Make sure that you wait at least 2 minutes after ac power is applied, or dc power is extracted from the unit, before you press the “Push to Test” button. This will ensure a correct reading.
2. Without ac power input or dc power output, simply press the “Push to Test” button on the faceplate and hold for approximately 2 to 3 seconds.
3. At this time the LED bar graph should light up indicating the status of the power cells.
4. The fan should also operate at this time. If you do not hear the fan running, stop pressing the button and check for any obstructions to the fan.



CAUTION

Never press the “Push to Test” button while the unit is plugged into ac power for recharge, or plugged into aircraft for dc power output.

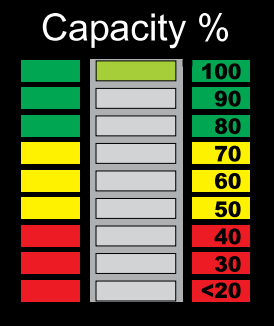
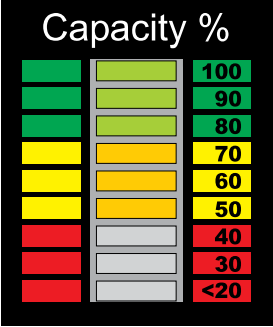
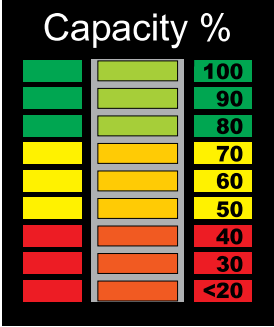


CAUTION

Never press the “Push to Test” button for more than 5 seconds. This may cause a temperature sensor to temporarily disrupt “Push to Test” function. (If this sensor is tripped, allow ten minutes for unit to cool before operating “Push to Test” button.)

Figure 2.7.1 “Press for Capacity” button location (outlined in blue)

Figure 2.7.2 Pressing Button

| Capacity % | Capacity % | Capacity % |
|---|---|--|
|  |  |  |
| Full Charge | Half Charge | No Charge |

TI5679 MPU-24

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2.8 – Maintenance Check

Check the unit for dents, punctures, case distortion or misalignment, and cracked or loose connectors. Check cables for cuts, chafing or evidence of crushing. Check connectors for cracks, cuts, distortion, excessive wear, broken or loose fasteners, and cables or strain relieves. If no external damage is evident, proceed to next step. Otherwise contact Tesla™ for further instructions.

2.9 – Pre-Installation Procedures

Removing Original Battery

Follow the aircraft's operator manual procedures to remove and dispose of the original aircraft battery properly and safely. Once the original battery has been removed from the battery compartment, proceed to the next step.

Check Unit Charge State

Before installing the unit into the aircraft, make sure the unit is fully charged. Remove the ac line cord from the ac input connector and wait two minutes. Then, push the "Press for Capacity" button to verify that the power cells are fully charged. Under a full charge the Capacity Meter will show a single green LED.



NOTE

If the unit is not fully charged after 281 minutes, the power cells may need to be replaced. Return the unit to Tesla™ Industries for evaluation and maintenance.

Section 3 – Operating Procedures

3.1 – Operating Procedures

This section deals with normal procedures, and includes all steps necessary to ensure safe and efficient operation of the TI5679 MPU-24.



NOTE

When the TI5679 MPU-24 is not in use, it should always remain plugged into a suitable ac power source to insure operational readiness at all times.



NOTE

If current demand exceeds 10 amps, converter output voltage will drop below 28.5 Vdc and two or more LED status indicator bars will illuminate. If all LED status indicator bars illuminate, both the converter and power cells are supplying 24 Vdc power output.

3.2 – General

Correct operation of the TI5679 MPU-24 includes both pre-use and operational checks of the unit. Knowledge of the operating limits, restrictions, performance, unit capabilities and functions is fundamental to correct and safe operation. The operator shall ensure compliance with the instructions in this manual that affect operational safety and the warranty of the unit.

3.3 – Operating Limits and Restrictions

The minimum, maximum and normal operating ranges result from careful engineering and evaluation of test data. These limitations must be adhered to during all phases of operation.

3.4 – Performance


Refer to Section 7, PERFORMANCE DATA to determine the capability of the TI5679 MPU-24. Consideration must be given to changes in performance resulting from variations in ambient temperature, mode of operation, state of charge (with or without 120 or 240 Vac power), and aircraft dc bus system inefficiency (voltage drops).




Figure 5.7.1 Starting S-61 Sikorsky aircraft with TI5679 MPU-24

3.5 – Engine Starting Power

Operators should always ensure the unit is charged above 80% prior to ground support engine starting. However, circumstances may exist during use where unit recharge is not readily available and immediate external engine starting power is required. The following provides minimum states of charge necessary to provide ample power for an efficient engine start under specific current load demands.

| | |
|---|--|
|  NOTE | <p>The ambient temperature may cause the unit’s protective “over-temperature” sensors to shut down the 120-240 ac functions (converter and charger) until the unit cools to normal operating temperatures. If the unit shuts itself down, get the unit into a cooler environment such as shade or air conditioning (if possible). Perform a full function check prior to continued use once the unit is allowed to cool. For continued use in extremely hot environments, it is advised to send the unit back to Tesla™ for recalibration for use in these environments.</p> |
|---|--|

| | |
|---|---|
|  NOTE | <p>In the event that the temperature sensors do not shut the system down, extended use above specified limits may damage the unit. If the unit is operated when cold or heat soaked temperatures are exceeded, a full functional check should be accomplished prior to continued use.</p> |
|---|---|

| <u>ENGINE START PEAK CURRENT Requirements</u> | | <u>MINIMUM CHARGE</u> |
|---|--------------------|-----------------------|
| 600 | peak starting amps | 40% charged |
| 750 | peak starting amps | 50% charged |
| 900 | peak starting amps | 60% charged |
| 1050 | peak starting amps | 70% charged |
| 1200 | peak starting amps | 80% charged |
| 1350 | peak starting amps | 90% charged |
| 1500 | peak starting amps | 100% charged |

3.6 – Temperature Specifications

Cold/Hot Soaked Temperature

The ambient temperature that a unit is exposed to for one (1) hour or more establishes the unit’s cold/hot soaked stabilization temperature. If the unit’s cold/hot soaked temperature is outside the normal operating temperature range, the unit must be stabilized prior to operation. For COLD SOAKED temperature stabilization, the unit must be placed in an environment with a temperature above +10°C (+41°F) for 3 hours or a temperature above +20°C (+68°F) for 2 hours. For HOT SOAKED temperature stabilization, the unit must be placed in an environment with a temperature below +38°C (+100°F) for 1 hour.

Cell Storage Capacity

The graph below illustrates the TI5679’s available cell capacity as a function of temperature.

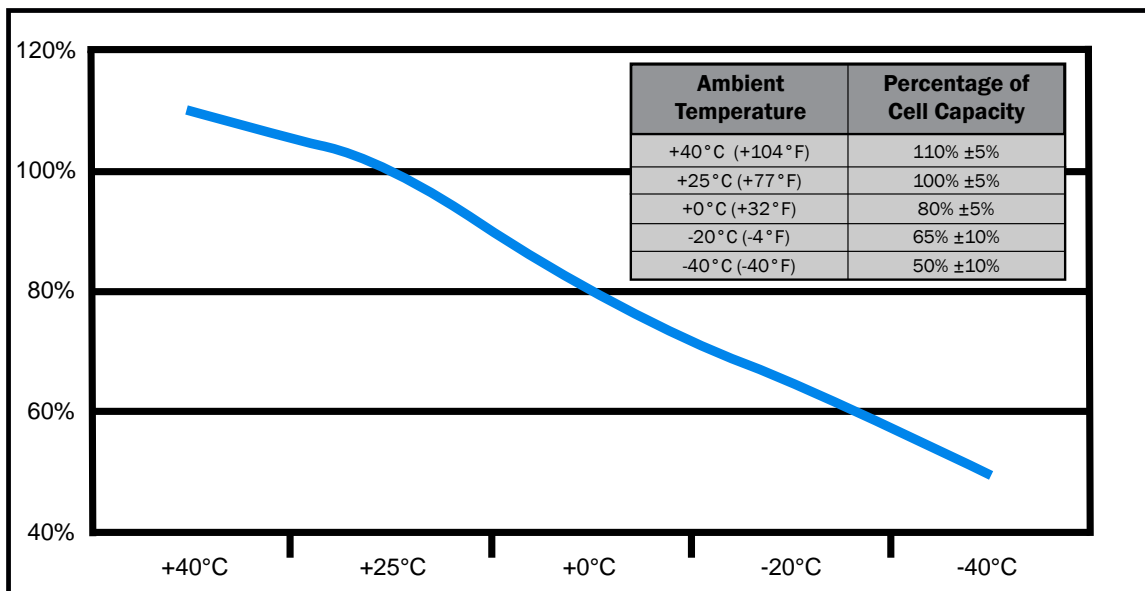



Figure 3.6.1 – Output power capability versus ambient temperature

Hot Soaked or Cold Soaked Definition

Simple terms: When a material is exposed to a change in temperature, its temperature will also change. Some material changes temperature quickly, others slowly. If the ambient temperature changes and is then held constant, the materials temperature will also change until its temperature stabilizes. Once the material temperature has stabilized, it is considered “soaked”.

Example: The unit is moved from the cool shade into the hot sun. The unit’s temperature will increase until it stabilizes. Once stabilized, the unit would be considered “hot soaked”.



NOTE

The unit is equipped with a temperature switch that automatically disables AC power functions when the internal temperature is above 150°F (65°C). This protects the unit from overheating and damage. If the unit shuts down, move the unit into a cooler climate such as shade or air conditioning when possible. Perform a full function test prior to use after the unit has been allowed to cool.

3.7 – Environmental



WARNING

Operating any electrical equipment in the presence of moisture creates possible safety hazards and/or potential for equipment damage. Every effort has been made, within the scope of existing technology to prevent foreseeable safety hazards and make the unit moisture resistant to prevent damage or failure.

If the unit is exposed to significant moisture, preventive measures and precautions shall be taken to:

- A. Prevent accumulation of moisture on ac and dc connectors/receptacles
- B. Minimize moisture entering forward inlet and outlet cooling fan vent ports

When not in use, unit inlet and outlet vent ports shall be covered from exposure. Unit shall be kept horizontal.

3.8 – Transporting Unit

The TI5679 has a rugged nylon carrying strap permanently attached to the top of the unit to provide easy transport and placement into the aircraft. Be sure to check for frays prior to moving unit.



Figure 3.8.1 Nylon Carrying Strap

3.9 – Normal Function Test Procedures

This section deals with “normal function” test procedures, and includes all steps necessary to ensure that the TI5679 MPU-24 is operating within specified parameters prior to use. A digital multimeter (an example is shown in Figure 3.9.1) capable of measuring dc and ac voltage and resistance will be required to perform some of the tests. These functional test procedures should become routine.



Figure 3.9.1 – Digital Multimeter

Check Unit for Evidence of Damage

Check for dents, punctures, case distortion or misalignment, and cracked or loose connectors. If no damage is evident, proceed to the next step. If damage is evident, contact Tesla™ Industries, Inc.

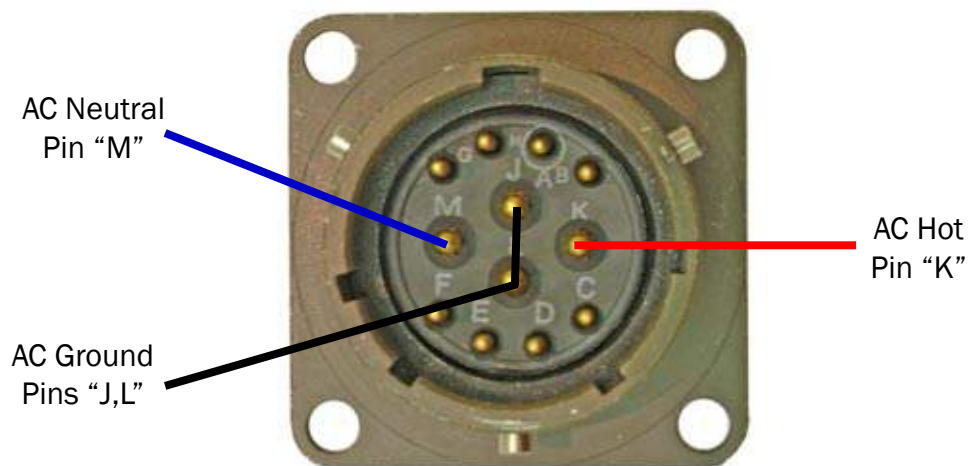


Figure 3.9.2 – AC Input Connector wiring diagram

Check Unit Internal Resistance (Test for Shorts)

This section deals with “normal function” test procedures, and includes all steps necessary to ensure that the TI5679 MPU-24 is operating within specified parameters prior to use. A digital multimeter (an example is shown in Figure 3.9.1) capable of measuring dc and ac voltage and resistance will be required to perform some of the tests. It is essential to test for shorts to detect any problems with the unit. First, set the multimeter to the “resistance”. Next, test to see if both terminals are isolated from the chassis ground and the line ground using the steps below. In steps 2, 3, 5 and 6, a reading of greater than 10 MΩ will assure no shorts exist. In steps 1 and 4, the multimeter should read less then 1Ω.



1. Place the negative probe on the ac ground probe (J or L) and the positive probe on an exposed part of the metal case.



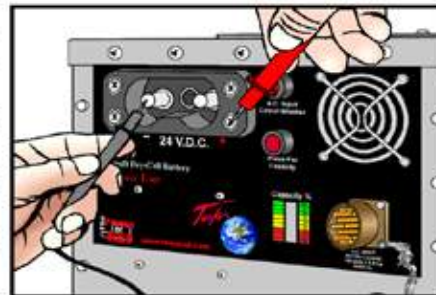
2. Move the positive probe to the dc positive post on the dc output connector.



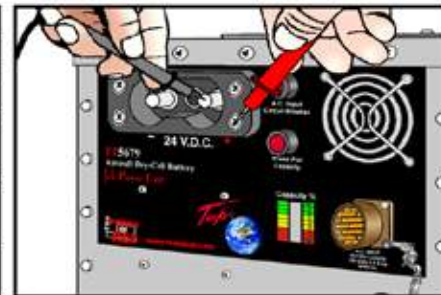
3. Move the positive probe to the dc negative post on the dc output connector.



4. Move the positive probe to one of the four screws securing the dc output connector to the unit casing.



5. Move the negative probe to the dc negative post on the dc output connector.



6. Move the negative probe to the dc positive post on the dc output connector.

Check DC Voltage Reading at DC Receptacle Terminals

To verify that the power cells are fully charged, set the digital multimeter to measure dc voltage. Place the positive probe (red) on the positive post of the dc output connector, as shown in Figure 3.9.3. Next, place the negative probe on the negative post. The multimeter display should read approximately 28.5 Vdc (± 0.5 Vdc) when power cells are fully charged and the unit is plugged into an ac power source. When the unit is not plugged into an ac power source, the multimeter display should read 25.5 Vdc.



Figure 3.9.3 – Testing DC Receptacle

3.10 – Regulated 28.5 VDC Ground Power

Connecting DC Power Cable To Unit

Ensure dc power cable plug is fully seated into the MPU's DC Battery Receptacle. Attaching a dc plug is quick and easy. Line up the plug with the receptacle. Push forward while rotating the T-handle one full turn clockwise. The unit is now ready to safely transfer power.



Figure 3.10.1 Attaching dc power cable to TI5679 MPU-24

3.11 – Regulated AC Power

Plugging in with AC Power

When the unit is plugged into ac power, the output is 28.5 volts. This voltage allows the system to recondition and recharge the aircraft's battery(ies). It is also an optimum voltage for powering avionics and lighting on most aircraft. The MPU's ac to dc converter produces continuous amps of dc power depending on the size of the system.

Ensure 120 or 240 Vac power cord is properly connected to an approved ac power supply. After approximately 5-8 seconds, unit's LED status indicator will illuminate indicating power cell state of charge. Cooling fan will operate. Ensure LED status indicator and cooling fan is operational prior to continuing.



Figure 3.11.1 Connecting TI5679 to AC Power Supply

Connect DC Power To Aircraft (Low Power Demand)

Low power demand is defined by a requirement of 10 amps or less. Connect dc power to aircraft ground power receptacle. DC bus power should come on and aircraft voltmeter should indicate 28.5 Vdc to 27 Vdc (26.5 Vdc minimum). If aircraft power demand is less than 10 amps converter output will remain at 28.5 Vdc (only one GREEN LED status indicator bar will illuminate). If aircraft power demand exceeds 10 amps converter voltage output will decrease and two or more LED status indicator bars will illuminate.

Connect DC Power To Aircraft (High Power Demand)

High power demand is defined by a requirement of greater than 10 amps. Connect to aircraft ground power receptacle. DC bus power should come on and aircraft voltmeter should indicate 28.5 Vdc to 23.5 Vdc (23 Vdc minimum). If current demand is greater than 10 amps, converter output voltage will drop below 28.0 Vdc and LED status indicator lights will illuminate indicating current is being drawn from the power cells. The greater the current draw, the quicker the LED status indicator will approach red. Note the LED status indicator shows the status of the power cells.



NOTE

When all LED status indicator bars illuminate, both the converter and power cells are supplying 24 Vdc power output for current demands above 10 amps.

Engine Starting

UNPLUG AC POWER CORD BEFORE STARTING ENGINE WITH TI5679 MPU-24

Prior to engine start, ensure power cell charge is sufficient to provide an efficient engine start. Users should follow ground power engine starting procedures as specified in the aircraft's operator manual.

3.12 – Charging Unit

Attaching AC Input Power

Before plugging the line cord into an ac outlet, attach and lock the mating plug to the ac input connector. Once accomplished, the unit can be plugged into an electrical outlet to begin charging. The Capacity Meter will immediately show the current charge state of the power cells. Make sure there is at least 2 to 3 inches of clearance in the front of the Air Exhaust Fan to provide for sufficient ventilation. If the unit is completely discharged, a minimum of 281 minutes will be required to fully recharge the unit.



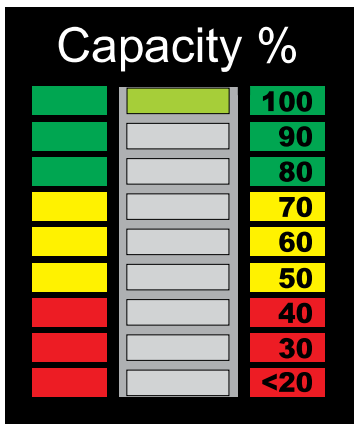
Figure 3.12.1 AC Input Connector (outlined in blue)



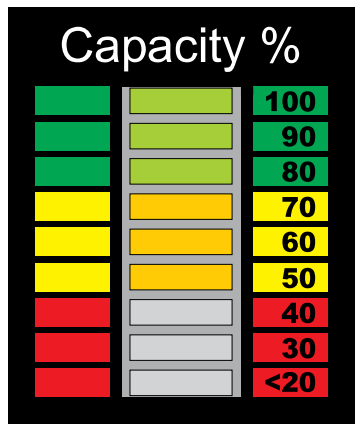
Figure 3.12.2 Attaching AC Line Cord

LED and Fan Activity

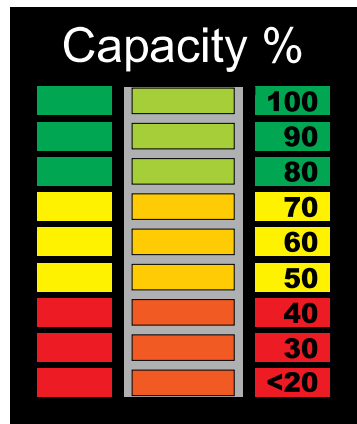
Initially, several LEDs will be illuminated on the Capacity Meter. As the unit charges, the LEDs will go out one by one. Under full charge, the Meter will show either a single solid or pulsating green LED. In addition, the fan will be running at reduced RPM. This indicates that the unit is in standby mode and ready for use.



Full Charge



Half Charge



No Charge

3.13 – AC Input Circuit Breaker

The AC input circuit breaker is located above the “Press for Capacity” button. When the circuit breaker has been tripped, the red buttons will pop out. In the event that the breaker trips:

1. Disconnect the ac and dc connectors. (Unplug ac line cord on military unit.)
2. Wait for a minimum of 60 seconds.
3. Reset breaker by pressing red button.
4. Reconnect ac and dc connections to the unit. (Plug in ac line cord on military unit.)

The unit should power up automatically. If the breaker continues to trip, return the unit to Tesla™ Industries for repair.

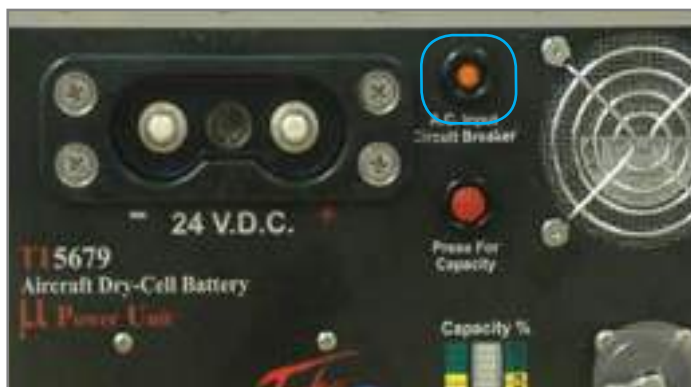


Figure 3.13.1 AC Input Circuit Breaker location (outlined in blue)



Figure 3.13.2 Pushing AC Input Circuit Breaker

3.14 – Universal AC Input Line Cord

Units equipped with universal ac inputs are outfitted with a cylindrical connector and a circuit breaker. Custom ac line cords are used to plug the unit into standard 110 Vac or 240 Vac wall outlets.



Figure 3.14.1 AC Input (outlined in blue)



Figure 3.14.2 AC Input Line Cord Attached

Section 4 – Post Operation

4.1 – General


Although the TI5679 MPU-24 has been ruggedized and made weather resistant within the scope of unit's intended use, it is essential that good general care be taken to maintain unit in good operating condition and to maximize unit's operational life.

4.2 – After Use

Unit should be protected from environmental elements and man made hazards. Ideally unit should be secured in a building or shed. Most importantly, unit shall be fully covered if stored while exposed to environmental elements.

4.3 – Power Cell Recharge

When installed in an operating aircraft, the TI5679 MPU-24 will back-charge from the aircraft's dc power. Otherwise, the TI5679 MPU-24 has an intelligent recharging system that will enable it to rapidly recharge when connected to an ac power source. If the unit's power cells become fully discharged, the unit should be recharged within 24 hours to ensure maximum life and performance. Under normal circumstances a minimum of 281 minutes will be required to fully recharge the unit.

| | |
|---|---|
|  NOTE | Plug the TI5679 MPU-24 into ac power to keep the cells charged whenever it is not in use, even if it is at Full Charge. The unit will not overcharge or overheat. |
|---|---|

Connect AC Power Cord to Unit

Ensure 120 or 240 Vac power cord is properly connected to an approved ac power supply. After approximately 5-8 seconds, ensure unit's LED status indicator illuminates indicating power cell state of charge and cooling fan is operating.

| | |
|--|--|
|  CAUTION | Guard From Incorrect Power Source |
|--|--|

The TI5679 MPU-24's power cells may be damaged if recharged by NiCad or Lead Acid-type battery chargers. Power cells should only be charged by either the TI5679 MPU-24's internal charger and the ac power cord furnished with the equipment, or when connected to aircraft's external dc power receptacle.



Figure 4.3.3 Proper and Improper Charging Methods

Section 5 – Unit Care and Maintenance



DANGER

Severe injury or death from electrical shock will occur if either the user or the unit is wet while operating the unit with an ac power source attached.



CAUTION

Damage may occur if an unapproved or modified ac line cable or input plug is attached to the MPU. Do not use any type of ac voltage converter.

5.1 - Unit Care

Avoid Prolonged Exposure to Extremely Damp Environments

Be sure to disconnect ac power from the ac source if the TI5679 MPU-24 has come into contact with water. If the AC Input Circuit Breaker has tripped due to water infiltration, allow the unit to dry out before attempting to reset circuit breaker. Cover the unit to prevent water seepage. If the unit is operated in extremely damp conditions, it should be stored in an environmentally controlled building when not in use. Wipe unit clean periodically with a soft cloth to remove dust, dirt, etc.



Protect Cables from Damage

Do not cut, crush, or drag the input or output power cables when handling the TI5679 MPU-24. Always inspect cables prior to use. If no damage is evident, proceed to the next step. If damage is evident, contact Tesla™ Customer Service. Do not attempt to use any other type of power cables other than the Tesla™ cables included with the TI5679 MPU-24.



Figure 5.1.1 – Damaged cable

5.2 – Unit Servicing

The TI5679 MPU-24 is a maintenance-free, sealed unit. No repairs outside of Tesla™ are authorized. Warranty will be voided if unit is tampered with in any way including any damage to the WARRANTY VOID stickers located on the case (see Figure 5.2.1 below). If the unit requires maintenance, please contact Tesla™ Customer Service at (302) 324-8910. A Repair Request Form can be found in the back of this manual.



Figure 7.3.1 – Warranty Void stickers on the TI5679 MPU-24

5.3 – Packaging and Shipping

When returning the MPU, please ensure that it is properly packaged. The only method for transport is in a sturdy shipping crate or Tesla™ Shipping Case (be sure to enclose the Repair Request Form). Seal the crate on all sides and return it to Tesla™ at the address listed below. Please contact Tesla™ Customer Service at (302) 324-8910 with any questions or concerns.

TESLA™ INDUSTRIES, INCORPORATED
101 CENTERPOINT BLVD.
CENTERPOINT INDUSTRIAL PARK
NEW CASTLE, DELAWARE 19720
PHONE: (302) 324-8910 FAX: (302) 324-8912
Website: www.teslaind.com Email: Tesla1@teslaind.com

Section 6 – Frequently Asked Questions

1. Why should I buy a Tesla™ Turbo Start™ System?

Tesla™ Turbo Starts are multi-functional systems that are ideal for support of 24 Vdc vehicles and aircraft and their electronics/avionics on the bench. Tesla™ manufactures various systems, of different sizes and capacities, that are man-portable, maintenance free and provide pure, flat-line dc power in a completely safe package. Designed for Military applications, these systems are equally valuable in maintenance support at the main facility or in remote locations. They are easily transported and air-portable. They will also provide 28.5 Vdc when the system is connected to the appropriate ac source.

2. How does a Turbo Start™ work?

The Turbo Start™ combines state of the art power conversion electronics with our proprietary “dry cell” batteries. The system’s electronics incorporate an intelligent charging system for the cells as well as an ac to dc converter. The cells are ideal for this application as they are non-spillable, absorbed electrolyte dry cells that are sealed, maintenance free and safe for air transport.

3. How are Turbo Starts used in Aviation Support?

There are many ways a Turbo Start™ will benefit your operation. By using it for pre-flight testing, you will avoid depleting the aircraft’s battery. You can start the aircraft’s engine with the Turbo Start™ as well. In the hangar, when connected to ac power, the Turbo Start™ will provide 28.5 Vdc for avionics testing and will also recondition and recharge the aircraft’s battery. *Another benefit is the ability to fly with the Turbo Start™ aboard your aircraft. You may take the Turbo Start™ anywhere you travel, ensuring that you will always have power.

4. How much power will my Turbo Start™ provide?

Depending on the system, the TI5679 MPU-24 will provide anywhere from 10 continuous to 3000 peak starting amps. Please visit our website (www.teslaind.com) to determine the proper MPU for your needs.

5. Will a Tesla™ Turbo Start™ spool up a turbine engine?

Nothing will start a turbine engine faster or safer than the right Tesla™ Turbo Start™. Not only will it eliminate hot starts, but it will extend the life of your starter, your engine and your battery while reducing maintenance. The Turbo Start™ senses the impedance from the starter/generator. It then provides the exact power required throughout the start-up curve.

6. How many engine starts will my TI5679 provide until it is depleted?

If your aircraft does not have a voltage lockout feature at the auxiliary power receptacle, the TI5679 MPU-24 will back-charge from the aircraft’s Vdc. The TI5679 MPU-24 back-charges, almost instantly, once the aircraft is started and the generator is on line. This “power flywheel” feature enables the TI5679 MPU-24 to recharge right from the vehicle it started in less than 30 seconds. If your aircraft does have a voltage lockout feature at the auxiliary power receptacle, the TI5679 MPU-24 will be prohibited from charging. Under these circumstances, the TI5679 MPU-24 is good for three to four starts.

7. How do you prolong the life of the Turbo Start’s cells?

All you need to do is plug the unit in to the appropriate ac power outlet the system requires. AC power will recharge the system and keep the cells healthy. Users who regularly plug the system in can expect to get 5-7 years from their cells before they need to be replaced. Tesla™ cells do not have a memory like cell phone batteries. There is no need to fully discharge them. The recharging system will not overcharge the unit or produce excess heat.

8. Are Tesla™ MPUs used in shop maintenance and testing?

Tesla™ systems are gaining popularity throughout maintenance facilities, instructional facilities, laboratories, manufacturing plants, aircraft hangars and many other locations. The reason is due to the precise flat line dc power, the small, portable and quiet nature of our systems and the maintenance free aspect of our GPU's. We can custom tailor micro power systems to fit your individual requirements.

9. Is it waterproof?

The TI5679 MPU-24 is water-resistant, but not water proof. Cover unit to prevent migration of moisture. If unit is operated in extremely damp environments, unit should be stored in environmentally controlled building.

10. Is the Turbo Start™ in the government purchasing system?

Yes. Tesla Industries is an approved vendor/supplier – our cage code is OVWE2. Most Tesla products are class IX, have a NSN (National Stock Number) designation and can be acquired through the DLA (Defense Logistics Agency).

11. How long does this unit stay charged?

Unit should never be allowed to discharge fully. In-field use, it receives a dc back charge directly from a running engine. When not in use, unit should be plugged into ac power (outlet) all the time. Tesla™ systems will retain 80% of their capacity after one year of storage.

12. How do I get my Turbo Start™ serviced?

Contact Tesla™ at (302) 324-8910. Ask for customer service. You can also email us at tesla1@teslainsd.com. Once we receive the unit at our facility, we will examine it. Systems that are protected under warranty will be repaired at no charge. If the warranty has expired, you will receive a quote for necessary repairs prior to work being done. Our turnaround time is 48 hours once repairs are authorized.

13. Can I make my own repairs to unit?

During the warranty period, the unit can only be repaired by Tesla™ Industries for the warranty to remain in effect. Regardless, we strongly recommend allowing Tesla™ to repair any unit as we will analyze the complete system and re-calibrate it.

14. What type of maintenance does the Turbo Start™ require?

Although the systems are maintenance free, please keep units plugged in while not in use. This will greatly extend the life of the cells. Also, keep the vent areas clean and free of debris. Keep units in a well ventilated area while charging. Keep the unit in a protected environment when not in use (maintenance facility, shed).

15. What is included with my Turbo Start™?

Aviation customers will receive an eight (8') foot dc cable with an aviation plug. Ground vehicle customers will receive a fifteen (15') foot dc cable with terminal ends. This cable requires a NATO plug, alligator clips or another connector prior to its use. Tesla can provide these connectors at an additional charge. Both customers receive an ac line cord for their home country and a full two year warranty.

16. Are there any HAZMAT issues or disposability problems?

There are none. Tesla™ will reclaim all battery cells for disposability purposes. Contact Tesla™ if you have questions.

6.2 - Basic Usage/Operation Questions

1. What's the best position to place the unit for use?

The only position for the MPU is the upright position for stability and airflow considerations.

2. Does the unit have to be plugged in all the time?

No, but for maximum performance and cell longevity, keep the unit plugged in while not in use.

3. What happens if I don't keep it plugged in?

Unit will eventually lose its charge and cell life is shortened.

4. How do I check the status of the charge?

Press the "Push to Test" LED bar indicator on the unit's faceplate. A fully charged unit will have one green LED light showing.

5. Why is the cooling fan always running when I am plugged into AC power?

Constant cooling fan operation ensures proper and consistent ventilation of the unit.

6. Why does the cooling fan slow down?

Cooling fan rpm varies for better temperature regulation.

7. Why does my LED flicker when the unit is plugged in?

Older Turbo Starts™ indicated a full charge with a flickering LED readout. Newer models feature the illumination of one green bar on the LED readout when the unit is fully charged.

8. What do I do if a circuit breaker trips?

The AC input circuit breaker is located above the AC Input Connector. When the circuit breaker has been tripped, either of the red buttons will pop out. In the event that the breaker trips:

1. Disconnect the ac and dc connectors. (Unplug ac line cord on unit.)
2. Wait for a minimum of 60 seconds.
3. Reset breaker by pressing red button.
4. Reconnect ac and dc connections to the unit. (Plug in ac line cord on unit.)

The unit should power up automatically. If the breaker continues to trip, return the unit to Tesla™ Industries for repair.

Section 7 – Performance Data

7.1 – Purpose

This section provides performance data for the TI5679 MPU-24. Continual reference to this information will enable the user to obtain maximum performance, utilization and service life from the MPU. Although maximum performance is not always required, regular referral to this section is recommended for the following reasons:

- A.** To generate knowledge of unit's performance margins to enable the operator to make sound judgment when unexpected conditions or alternate operational requirements are encountered.
- B.** To enable the user to readily recognize situations requiring maximum performance.
- C.** To gain experience in accurately estimating the effects of variables for which data is not presented.
- D.** To help the operator determine if an aircraft system malfunction exists by comparing actual performance with expected performance.



NOTE

The information provided in this section is primarily intended for operational planning and is most useful when planning operations under unfamiliar conditions or environmental extremes. The data may also be used to establish local operating procedures and to ensure unit's operational life is maximized.

7.2 – General

The data presented covers the maximum range of conditions and performance that can reasonably be expected. In each area of performance, the effects of temperature and dc electrical load demand relating to the ground power support requirements are presented. Wherever practical, data is presented conservatively. However, **NO GENERAL CONSERVATISM HAS BEEN APPLIED**. All performance data presented is within the applicable limits of the MPU.

7.3 – Data Basis

The type of data used is indicated at the bottom of each performance chart under DATA BASIS. The applicable report and date of the data are also given. The data provided generally are based on one of three categories:

- A.** Derived From Actual Controlled Testing: Controlled test data obtained on a similar unit type.
- B.** Calculated Data: Data based on tests, but not on a similar unit type placed under a controlled test.
- C.** Estimated Data: Data based on estimates using rules of physics, mathematics, and electrical engineering principles and concepts, but not verified by tests.

7.4 – Specific Conditions

The data presented are accurate only for specific conditions listed under the title of each chart or graph. Variables for which data are not presented, but which may affect that phase of performance, are discussed in associated text. Where data is available or reasonable estimates can be made the amount that each variable affect performance will be given.

7.5 – General Conditions

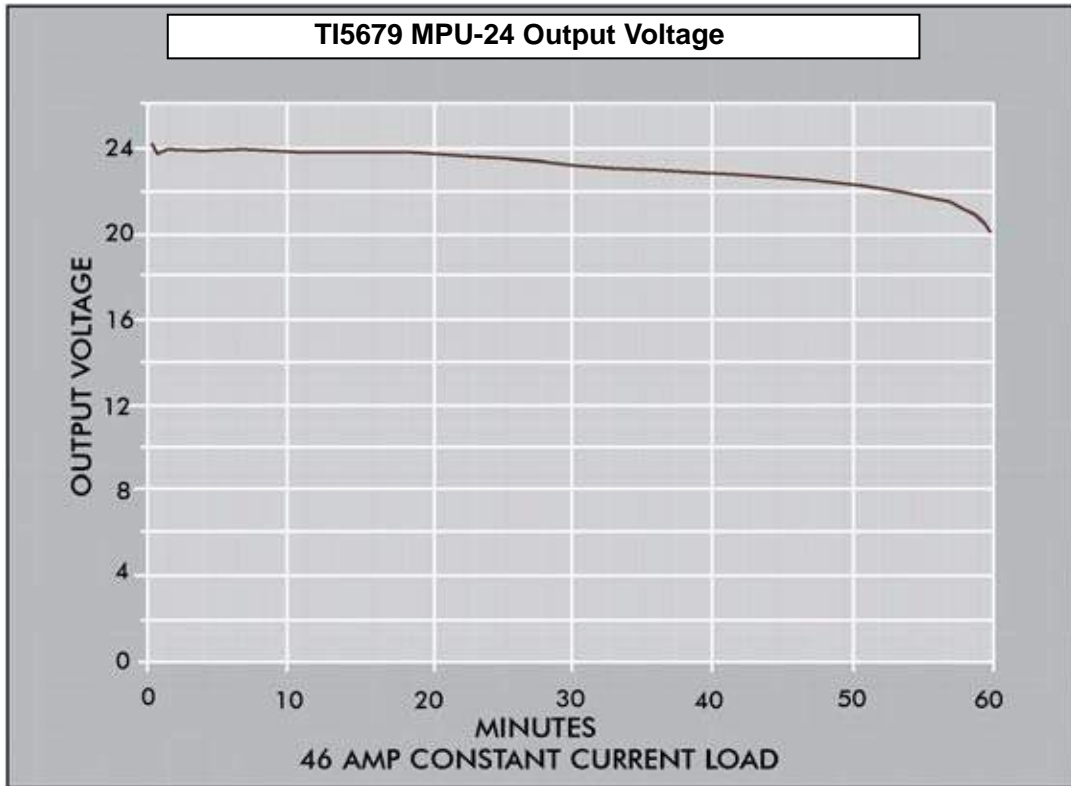
In addition to the specific conditions, the following general conditions are applicable to the performance data.

- A.** Variation in Aircraft: Power demand differences between individual aircraft of the same make and model are known to exist due to variations in dc electrical system efficiency. These differences, however, are considered insignificant and are not individually accounted for.
- B.** Ground Support and Aircraft Instrument Variations: The data shown in the performance charts do not account for instrument tolerance differences or inaccuracies.

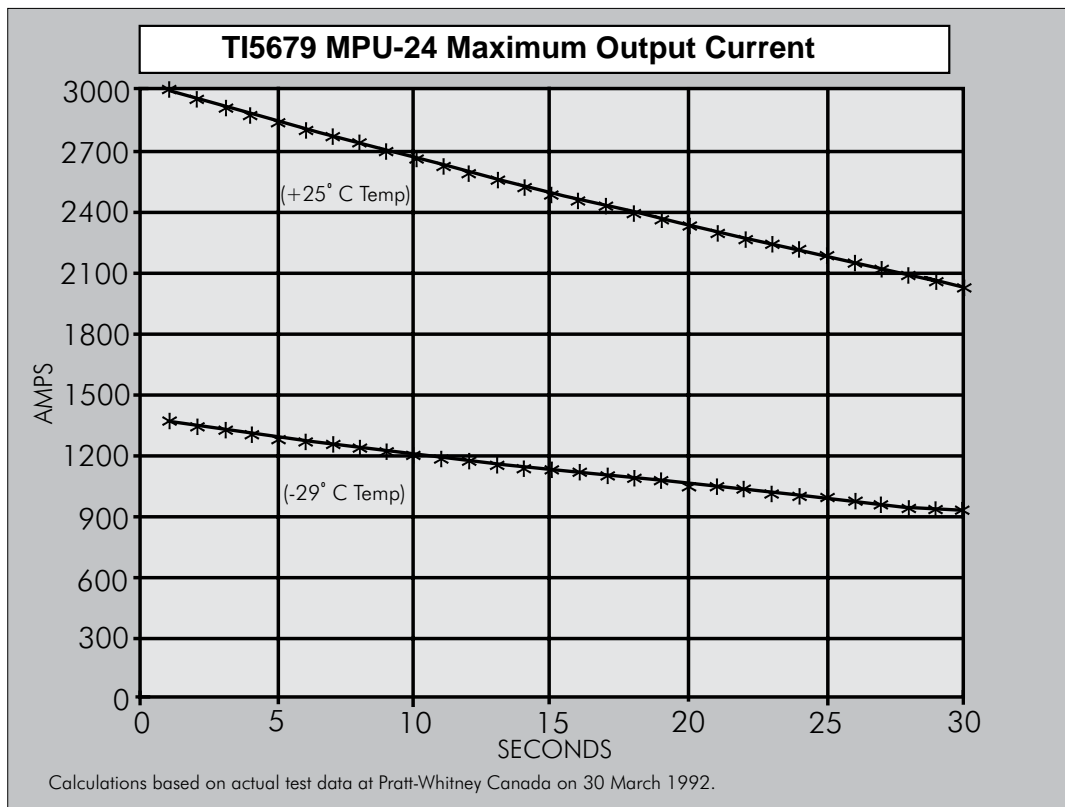
7.6 – Temperature Conversion Chart

| °C | °F | °C | °F | °C | °F | °C | °F |
|-------|-------|-------|-------|------|-------|------|-------|
| -60.0 | -76.0 | -27.0 | -16.6 | 6.0 | 42.8 | 39.0 | 102.2 |
| -59.0 | -74.2 | -26.0 | -14.8 | 7.0 | 44.6 | 40.0 | 104.0 |
| -58.0 | -72.4 | -25.0 | -13.0 | 8.0 | 46.4 | 41.0 | 105.8 |
| -57.0 | -70.6 | -24.0 | -11.2 | 9.0 | 48.2 | 42.0 | 107.6 |
| -56.0 | -68.8 | -23.0 | -9.4 | 10.0 | 50.0 | 43.0 | 109.4 |
| -55.0 | -67.0 | -22.0 | -7.6 | 11.0 | 51.8 | 44.0 | 111.2 |
| -54.0 | -65.2 | -21.0 | -5.8 | 12.0 | 53.6 | 45.0 | 113.0 |
| -53.0 | -63.4 | -20.0 | -4.0 | 13.0 | 55.4 | 46.0 | 114.8 |
| -52.0 | -61.6 | -19.0 | -2.2 | 14.0 | 57.2 | 47.0 | 116.6 |
| -51.0 | -59.8 | -18.0 | -0.4 | 15.0 | 59.0 | 48.0 | 118.4 |
| -50.0 | -58.0 | -17.0 | 1.4 | 16.0 | 60.8 | 49.0 | 120.2 |
| -49.0 | -56.2 | -16.0 | 3.2 | 17.0 | 62.6 | 50.0 | 122.0 |
| -48.0 | -54.4 | -15.0 | 5.0 | 18.0 | 64.4 | 51.0 | 123.8 |
| -47.0 | -52.6 | -14.0 | 6.8 | 19.0 | 66.2 | 52.0 | 125.6 |
| -46.0 | -50.8 | -13.0 | 8.6 | 20.0 | 68.0 | 53.0 | 127.4 |
| -45.0 | -49.0 | -12.0 | 10.4 | 21.0 | 69.8 | 54.0 | 129.2 |
| -44.0 | -47.2 | -11.0 | 12.2 | 22.0 | 71.6 | 55.0 | 131.0 |
| -43.0 | -45.4 | -10.0 | 14.0 | 23.0 | 73.4 | 56.0 | 132.8 |
| -42.0 | -43.6 | -9.0 | 15.8 | 24.0 | 75.2 | 57.0 | 134.6 |
| -41.0 | -41.8 | -8.0 | 17.6 | 25.0 | 77.0 | 58.0 | 136.4 |
| -40.0 | -40.0 | -7.0 | 19.4 | 26.0 | 78.8 | 59.0 | 138.2 |
| -39.0 | -38.2 | -6.0 | 21.2 | 27.0 | 80.6 | 60.0 | 140.0 |
| -38.0 | -36.4 | -5.0 | 23.0 | 28.0 | 82.4 | 61.0 | 141.8 |
| -37.0 | -34.6 | -4.0 | 24.8 | 29.0 | 84.2 | 62.0 | 143.6 |
| -36.0 | -32.8 | -3.0 | 26.6 | 30.0 | 86.0 | 63.0 | 145.4 |
| -35.0 | -31.0 | -2.0 | 28.4 | 31.0 | 87.8 | 64.0 | 147.2 |
| -34.0 | -29.2 | -1.0 | 30.2 | 32.0 | 89.6 | 65.0 | 149.0 |
| -33.0 | -27.4 | 0.0 | 32.0 | 33.0 | 91.4 | 66.0 | 150.8 |
| -32.0 | -25.6 | 1.0 | 33.8 | 34.0 | 93.2 | 67.0 | 152.6 |
| -31.0 | -23.8 | 2.0 | 35.6 | 35.0 | 95.0 | 68.0 | 154.4 |
| -30.0 | -22.0 | 3.0 | 37.4 | 36.0 | 96.8 | 69.0 | 156.2 |
| -29.0 | -20.2 | 4.0 | 39.2 | 37.0 | 98.6 | 70.0 | 158.0 |
| -28.0 | -18.4 | 5.0 | 41.0 | 38.0 | 100.4 | 71.0 | 159.8 |

7.7 – Output Voltage



7.8 – Maximum Output Current



Section 8 – Optional Accessories

8.1 – Tesla™ AC Line Cords

AC line cords come in several lengths or can be custom-ordered to fit your needs. Tesla™ specializes in outfitting cables with a variety of connectors and junction boxes. Contact Tesla™ customer service to find out more about our selection of cords.

Universal Line Cords

| | |
|-------------|---|
| TI25000-111 | North American Line Cord 105-125 Vac 60 Hz 6.50 amps max NSN: 5935-01-576-4422 (CL IX) |
| TI25000-112 | Italian Line Cord 10A/250V |
| TI25000-113 | European Line Cord 10A/250V-210-250 Vac 50/60 Hz 3.25 amps max |
| TI25000-114 | Old British Line Cord 210-250 Vac 50/60 Hz 3.25 amps max |
| TI25000-115 | England Line Cord 10A/250- 210/250 Vac 50/60 Hz 3.25 amps max |
| TI25000-120 | Israel Line Cord 6/10A/250V |



APPENDIX A

OPTIONAL LINE CORDS FOR WORLDWIDE OPERATIONS

| <u>COUNTRY</u> | <u>VOLTS</u> | <u>HZ</u> | <u>TESLA™ PART #</u> |
|------------------------------|--------------|-----------|--|
| Afghanistan | 220 | 50 | TI25000-004 Old British Line Cord |
| Algeria | 220 | 50 | TI25000-004 Old British Line Cord |
| American Samoa | 240 | 60 | TI25000-011 Australian Line Cord |
| Angola | 220 | 50 | TI25000-003 Continental European Line Cord |
| Anguilla (U.K.) | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Antigua | 230 | 60 | TI25000-005 United Kingdom Line Cord |
| Argentina | 220 | 50 | TI25000-011 Australian Line Cord |
| Aruba | 115 | 60 | TI25000-001 North American Line Cord |
| Australia | 240 | 50 | TI25000-011 Australian Line Cord |
| Austria | 220 | 50 | TI25000-003 Continental European Line Cord |
| Azores (Portugal) | 220 | 50 | TI25000-004 Old British Line Cord |
| Bahamas | 120 | 60 | TI25000-001 North American Line Cord |
| Bahrain | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Bangladesh | 220 | 50 | TI25000-004 Old British Line Cord |
| Barbados | 115 | 50 | TI25000-001 North American Line Cord |
| Belgium | 220 | 50 | TI25000-003 Continental European Line Cord |
| Belize (Br. Hond.) | 110 | 60 | TI25000-001 North American Line Cord |
| Benin | 220 | 50 | TI25000-004 Old British Line Cord |
| Bermuda | 120 | 60 | TI25000-005 United Kingdom Line Cord |
| Bolivia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Botswana | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Brazil | 110 | 60 | TI25000-001 North American Line Cord |
| Bulgaria | 220 | 50 | TI25000-003 Continental European Line Cord |
| Burkina Faso | 220 | 50 | TI25000-003 Continental European Line Cord |
| Burma (Now Myanmar) | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Burundi | 220 | 50 | TI25000-003 Continental European Line Cord |
| Cambodia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Cameroon | 230 | 50 | TI25000-003 Continental European Line Cord |
| Canada | 120 | 60 | TI25000-001 North American Line Cord |
| Canary Islands (Spain) | 220 | 50 | TI25000-003 Continental European Line Cord |
| Cape Verde, Rep. of | 220 | 50 | TI25000-003 Continental European Line Cord |
| Cayman Islands | 120 | 60 | TI25000-001 North American Line Cord |
| Central African Republic | 220 | 50 | TI25000-003 Continental European Line Cord |
| Chad | 220 | 50 | TI25000-003 Continental European Line Cord |
| Channel Islands | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Chile | 220 | 50 | TI25000-002 Italian Line Cord |
| China, Peoples Republic of | 220 | 50 | TI25000-011 Australian Line Cord |
| Christmas Island (Australia) | 240 | 50 | TI25000-011 Australian Line Cord |
| Cocos Islands (Australia) | 240 | 50 | TI25000-011 Australian Line Cord |
| Columbia | 220 | 60 | TI25000-003 Continental European Line Cord |
| Congo, Republic of | 220 | 50 | TI25000-003 Continental European Line Cord |
| Cook Island (New Zealand) | 240 | 50 | TI25000-011 Australian Line Cord |
| Costa Rica | 120 | 60 | TI25000-001 North American Line Cord |
| Curacao Islands | 110 | 60 | TI25000-001 North American Line Cord |
| Cyprus | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Czech, Republic of | 220 | 50 | TI25000-003 Continental European Line Cord |
| Denmark | 220 | 50 | TI25000-300 Denmark Line Cord |
| Djibouti, Republic of | 220 | 50 | TI25000-003 Continental European Line Cord |
| Dominica | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Dominican Republic | 110 | 60 | TI25000-001 North American Line Cord |

APPENDIX A (Cont.)

OPTIONAL LINE CORDS FOR WORLDWIDE OPERATIONS

| <u>COUNTRY</u> | <u>VOLTS</u> | <u>HZ</u> | <u>TESLA™ PART #</u> |
|----------------------|--------------|-----------|--|
| Ecuador | 120 | 60 | TI25000-001 North American Line Cord |
| Egypt | 220 | 50 | TI25000-003 Continental European Line Cord |
| El Salvador | 115 | 60 | TI25000-001 North American Line Cord |
| England | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Equatorial Guinea | 220 | 50 | TI25000-003 Continental European Line Cord |
| Estonia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Ethiopia | 220 | 50 | TI25000-003 003 Continental European Line Cord |
| Fiji | 240 | 50 | TI25000-011 Australian Line Cord |
| Finland | 220 | 50 | TI25000-003 Continental European Line Cord |
| France | 220 | 50 | TI25000-003 Continental European Line Cord |
| French Guiana | 220 | 50 | TI25000-003 Continental European Line Cord |
| Gabon | 220 | 50 | TI25000-003 Continental European Line Cord |
| Gambia | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Georgia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Germany | 220 | 50 | TI25000-003 Continental European Line Cord |
| Ghana | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Gibraltar | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Greece | 220 | 50 | TI25000-003 Continental European Line Cord |
| Greenland (Denmark) | 220 | 50 | TI25000-300 Denmark Line Cord |
| Grenada | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Guadeloupe | 220 | 50 | TI25000-003 Continental European Line Cord |
| Guam | 110-120 | 60 | TI25000-001 North American Line Cord |
| Guatemala | 120 | 60 | TI25000-001 North American Line Cord |
| Guinea | 220 | 50 | TI25000-003 Continental European Line Cord |
| Guinea-Bissau | 220 | 50 | TI25000-003 Continental European Line Cord |
| Guyana | 110 | 50/60 | TI25000-001 North American Line Cord |
| Haiti | 110-120 | 50-60 | TI25000-001 North American Line Cord |
| Honduras | 110 | 60 | TI25000-001 North American Line Cord |
| Hong Kong | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Hungary | 220 | 50 | TI25000-003 Continental European Line Cord |
| Iceland | 220 | 50 | TI25000-003 Continental European Line Cord |
| India | 220-250 | 50 | TI25000-004 Old British Line Cord |
| Indonesia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Iran | 220 | 50 | TI25000-003 Continental European Line Cord |
| Iraq | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Ireland, Republic of | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Isle of Man | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Israel | 230 | 50 | TI25000-200 Israel Line Cord |
| Italy | 220 | 50 | TI25000-002 Italian Line Cord |
| Ivory Coast | 220 | 50 | TI25000-003 Continental European Line Cord |
| Jamaica | 110 | 50 | TI25000-001 North American Line Cord |
| Japan | 110 | 50/60 | TI25000-001 North American Line Cord |
| Jordan | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Kenya | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Korea, South | 220 | 60 | TI25000-003 Continental European Line Cord |
| Kuwait | 240 | 50 | TI25000-005 United Kingdom Line Cord |

APPENDIX A (Cont.)

OPTIONAL LINE CORDS FOR WORLDWIDE OPERATIONS

| <u>COUNTRY</u> | <u>VOLTS</u> | <u>HZ</u> | <u>TESLA™ PART #</u> |
|------------------------------|--------------|-----------|--|
| Laos | 220 | 50 | TI25000-001 North American Line Cord |
| Latvia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Lebanon | 220 | 50 | TI25000-003 Continental European Line Cord |
| Lesotho | 240 | 50 | TI25000-004 Old British Line Cord |
| Liberia | 120 | 60 | TI25000-005 United Kingdom Line Cord |
| Liechtenstein | 220 | 50 | TI25000-006 Switzerland Line Cord |
| Lithuania | 220 | 50 | TI25000-003 Continental European Line Cord |
| Luxembourg | 220 | 50 | TI25000-003 Continental European Line Cord |
| Libya | 230 | 50 | TI25000-002 Italian Line Cord |
| Macao | 220 | 50 | TI25000-004 Old British Line Cord |
| Madagascar | 220 | 50 | TI25000-003 Continental European Line Cord |
| Maderia (Portugal) | 220 | 50 | TI25000-004 Old British Line Cord |
| Majorca | 220 | 50 | TI25000-003 Continental European Line Cord |
| Malawi | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Malaysia | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Maldives | 230 | 50 | TI25000-004 Old British Line Cord |
| Mali, Republic of | 220 | 50 | TI25000-003 Continental European Line Cord |
| Malta | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Martinique | 220 | 50 | TI25000-003 Continental European Line Cord |
| Mauritania | 220 | 50 | TI25000-003 Continental European Line Cord |
| Mauritius | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Mexico | 127 | 60 | TI25000-001 North American Line Cord |
| Monaco | 220 | 50 | TI25000-003 Continental European Line Cord |
| Mongolia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Montseurrat | 230 | 60 | TI25000-005 United Kingdom Line Cord |
| Morocco | 220 | 50 | TI25000-003 Continental European Line Cord |
| Mozambique | 220 | 50 | TI25000-003 Continental European Line Cord |
| Namibia (W.S. Africa) | 220-250 | 50 | TI25000-004 Old British Line Cord |
| Nepal | 220 | 50 | TI25000-004 Old British Line Cord |
| Neth. Antilles | 220 | 50/60 | TI25000-003 Continental European Line Cord |
| Netherlands | 220 | 50 | TI25000-003 Continental European Line Cord |
| New Caledonia | 220 | 50 | TI25000-003 Continental European Line Cord |
| New Zealand | 230 | 50 | TI25000-011 Australian Line Cord |
| Nicaragua | 120 | 60 | TI25000-001 North American Line Cord |
| Niger | 220 | 50 | TI25000-003 Continental European Line Cord |
| Nigeria | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Norfolk Islands (Australia) | 240 | 50 | TI25000-011 Australian Line Cord |
| North Ireland | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| North Mariana Islands (U.S.) | 115 | 60 | TI25000-001 North American Line Cord |
| Norway | 220 | 50 | TI25000-003 Continental European Line Cord |
| Okinawa | 100-120 | 60 | TI25000-001 North American Line Cord |
| Oman | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Pakistan | 230 | 50 | TI25000-004 Old British Line Cord |
| Panama | 110 | 60 | TI25000-001 North American Line Cord |
| Papua New Guinea | 240 | 50 | TI25000-011 Australian Line Cord |
| Paraguay | 220 | 50 | TI25000-003 Continental European Line Cord |
| Peru | 110 | 50/60 | TI25000-001 North American Line Cord |
| Philippines | 115 | 60 | TI25000-001 North American Line Cord |
| Piccairn Islands (U.K.) | 240 | 50 | TI25000-004 Old British Line Cord |
| Poland | 220 | 50 | TI25000-003 Continental European Line Cord |
| Portugal | 220 | 50 | TI25000-003 Continental European Line Cord |
| Puerto Rico | 120 | 60 | TI25000-001 North American Line Cord |

APPENDIX A (Cont.)

OPTIONAL LINE CORDS FOR WORLDWIDE OPERATIONS

| <u>COUNTRY</u> | <u>VOLTS</u> | <u>HZ</u> | <u>TESLA™ PART #</u> |
|--------------------------------|--------------|-----------|--|
| Romania | 220 | 50 | TI25000-003 Continental European Line Cord |
| Russia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Rwanda | 220 | 50 | TI25000-003 Continental European Line Cord |
| Saudi Arabia | 220 | 50/60 | TI25000-003 Continental European Line Cord |
| Scotland | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Senegal | 220 | 50 | TI25000-003 Continental European Line Cord |
| Seychelles | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Sierra Leone | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Singapore | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Slovakia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Somalia | 220 | 50 | TI25000-003 Continental European Line Cord |
| South Africa | 220-250 | 50 | TI25000-004 Old British Line Cord |
| Spain | 220 | 50 | TI25000-003 Continental European Line Cord |
| Sri Lanka | 230 | 50 | TI25000-004 Old British Line Cord |
| St. Pierre & Miquelon (France) | 115 | 60 | TI25000-001 North American Line Cord |
| St. Kitts & Nevis | 230 | 60 | TI25000-005 United Kingdom Line Cord |
| St. Lucia | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| St. Vincent | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Sudan | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| Surinam | 115 | 60 | TI25000-003 Continental European Line Cord |
| Svalbard (Norway) | 220 | 50 | TI25000-003 Continental European Line Cord |
| Swaziland | 230 | 50 | TI25000-004 Old British Line Cord |
| Sweden | 220 | 50 | TI25000-003 Continental European Line Cord |
| Switzerland | 220 | 50 | TI25000-006 Switzerland Line Cord |
| Syria | 220 | 50 | TI25000-003 Continental European Line Cord |
| Tahiti | 220 | 50 | TI25000-003 Continental European Line Cord |
| Taiwan | 110 | 60 | TI25000-001 North American Line Cord |
| Tanzania | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Thailand | 220 | 50 | TI25000-003 Continental European Line Cord |
| Togo | 220 | 50 | TI25000-003 Continental European Line Cord |
| Tonga | 115 | 60 | TI25000-004 Old British Line Cord |
| Trinidad & Tobago | 230 | 60 | TI25000-005 United Kingdom Line Cord |
| Tunisia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Turkey | 220 | 50 | TI25000-003 Continental European Line Cord |
| Uganda | 220 | 50 | TI25000-004 Old British Line Cord |
| United Arab Emir. | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| United Kingdom & Ireland | 240 | 50 | TI25000-005 United Kingdom Line Cord |
| United States | 120 | 60 | TI25000-001 North American Line Cord |
| Uruguay | 220 | 50 | TI25000-011 Australian Line Cord |
| Venezuela | 120 | 60 | TI25000-001 North American Line Cord |
| Vietnam | 220 | 50 | TI25000-003 Continental European Line Cord |
| Virgin Islands | 120 | 60 | TI25000-001 North American Line Cord |
| Wales | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Western Samoa | 230 | 50 | TI25000-005 United Kingdom Line Cord |
| Yemen | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Yugoslavia | 220 | 50 | TI25000-003 Continental European Line Cord |
| Zaire, Republic of | 220 | 50 | TI25000-003 Continental European Line Cord |
| Zambia | 220 | 50 | TI25000-005 United Kingdom Line Cord |
| Zimbabwe | 220 | 50 | TI25000-005 United Kingdom Line Cord |

APPENDIX A (Cont.)

UNIVERSAL LINE CORD KIT FOR WORLDWIDE OPERATIONS

NOTE: TESLA™ UNIVERSAL AC LINE CORD KIT, P/N: **TI25000-U00**, IS FOR UNITS ORIGINALLY BUILT WITH THE UNIVERSAL AC LINE CORD OPTION ONLY.
THE AC ADAPTER OPTION IS TESLA™ P/N **TI16000-19** AND MUST BE ORDERED WITH THE ORIGINAL PROCUREMENT OF UNIT(S). UNIT(S) MAY BE RETURNED TO TESLA™ INDUSTRIES, FOR A NOMINAL COST, AND MODIFIED TO ALLOW OPERATION WITH THE UNIVERSAL AC LINE CORD KIT.

TESLA™ UNIVERSAL AC LINE CORD KIT, P/N: **TI25000-U00**, IS COMPRISED OF THE FOLLOWING FIVE PART NUMBERS:

| | |
|-------------|--------------------------|
| TI25000-111 | NORTH AMERICAN LINE CORD |
| TI25000-113 | EUROPEAN 10A/250V |
| TI25000-114 | OLD BRITISH LINE CORD |
| TI25000-115 | ENGLAND 10A/250V |
| TI7000-131 | LINE CORD POUCH |

Repair Request Form

Please complete the information below to ensure prompt and accurate service. Include this form with the unit you are returning. Thank you.

Date of return: _____

Company name & _____

Billing address: _____

Contact person: _____

Phone #: _____ Fax #: _____

Email: _____

Purchase Order #: _____

Model #: _____ Serial #: _____

Model #: _____ Serial #: _____

Shipping method to Tesla™: _____

Description of shipping package: _____

Description of problem: _____

Return to Tesla™ Industries, Inc.

101 Centerpoint Boulevard, New Castle, DE 19720 Attention: Repair Department



WE GET THE MILITARY STARTED!

Tesla™ Industries, Inc.

101 Centerpoint Blvd.
New Castle, DE 19720 USA
Tel: 302-324-8910
Fax: 302-324-8912

9475 Double R Blvd., Suite 2
Reno, NV 89521
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