OPERATION & SERVICE MANUAL

Model: 11-2820-0000
28.5 VDC Ground Power Unit

CE

05/2024 –– Rev. 06

For Spare Parts, Operations & Service Manuals or Service Needs
Scan the QR code or visit Tronair.com/aftermarket

The Tronair Group of Companies: Tronair | EBIS | Columbus Jack | Eagle | DAE | Malabar International

Tronair, Inc.
1 Air Cargo Pkwy East
Swanton, OH 43558

Phone: (419) 866-6301 | 800-426-6301
Web: www.tronair.com
Email: sales@tronair.com

REVISION	DATE	TEXT AFFECTED
01	02/2017	Original Release
02	10/2017	Modified Parts Lists
03	09/2018	Modified Parts List
04	11/2022	Modified Parts List
05	05/2023	Modified 9.7 Engine/Alternator/Engine Mounting
06	05/2024	Added 1.6 Cold Weather Features, Modified 10.2 Recommended Spare Parts Lists

TABLE OF CONTENTS

PAGE

This product can not be modified without the written approval of Tronair, Inc. Any modifications done without written approval voids all warranties and releases Tronair, Inc., it suppliers, distributors, employees, or financial institutions from any liability from consequences that may occur. Only Tronair OEM replacement parts shall be used.

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Diesel Powered GPU, 28.5 VDC Output, Tier 4 final

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit

1.3 MANUFACTURER

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

1.4 FUNCTION

The 11-2820-0000 Ground Power Unit (GPU), is a diesel powered unit designed to serve as a 28.5 volt DC power source for parked aircraft. It can provide 600 amps continuous for aircraft servicing, and up to 2000 amps peak for starting. The Current Limit (Soft Start) feature allows the user to select current limits for operations requiring current limit below the maximum output.

1.5 REQUIREMENTS

The GPU must run on ultra low sulfur Diesel Fuel only! The fuel filter is a disposable spin on type and must be changed every 500 hours of running time.

1.6 COLD WEATHER FEATURES

- 12 V control and starting circuitry for easy cold weather starting
- Automated glow plug control
- 12 V block heater
- Insulated engine enclosure for cold weather starting and sound dampening

2.0 SAFETY INFORMATION

WARNING! CALIFORNIA PROPOSITION 65 – DIESEL ENGINES. Diesel engine exhaust and some of its constituents are known by the State of California to cause cancer, birth defects, and other reproductive harm.

2.1 USAGE AND SAFETY INFORMATION

The GPU provides 28.5 Volts DC for performing aircraft service and maintenance.

To insure safe operations please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information. This manual contains safety precautions, which are explained below. Please read carefully.

WARNING! — Warning is used to indicate the presence of a hazard that ***can cause severe personal injury, death, or substantial property damage*** if the warning notice is ignored.

CAUTION! — Caution is used to indicate the presence of a hazard that ***will or can cause minor personal injury or property damage*** if the caution notice is ignored.

2.2 EXPLANATION OF WARNING & DANGER SIGNS

WARNING! Accidental Starts! Always turn off and lock out the battery switch before servicing this GPU. Only qualified service personnel may service this equipment. Read and understand the technical manual before servicing this equipment.

WARNING! Rotating Parts! Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the GPU with doors open or panels and guards removed.

WARNING! Electrical Shock! Caution: This GPU produces voltages and current sufficient to cause burns and death by electric shock! Always inspect cables and plugs for damage before use. Do not use if damaged. Always turn DC power to off before connecting or disconnecting cables. The human body has decreased resistance when wet; keep hands, feet and clothes dry when operating electrical equipment. Do not open doors or remove panels while the GPU is running. High current electrical components will be exposed. Always turn off and lock out the battery switch before servicing this GPU.

WARNING! Hot Surfaces! Engine components such as turbo chargers, exhaust pipes, and mufflers will remain hot after the engine has been shut down. Allow engine to cool before servicing.

WARNING! Batteries! Batteries give off flammable hydrogen gas and can explode if ignited. When servicing, do not allow arcing, sparks, or open flame near the battery. Acid and arcing from a ruptured battery can cause fires and additional damage.

WARNING! Fuel Hazard! Use only approved containers for transferring fuel. Shut down GPU before refueling. Fires and explosions can occur if the fuel tank is not grounded. Ground fuel tank before and during fuel transfer. Clean up all fuel spills immediately.

WARNING! Carbon Monoxide! Engine exhaust fumes can kill. If indoors, always pipe or vent exhaust fumes to a suitable exhaust duct. Never locate engine exhaust near air conditioner intake ducts.

WARNING! CALIFORNIA PROPOSITION 65 – DIESEL ENGINES Diesel engine exhaust and some of its constituents are known by the State of California to cause cancer, birth defects, and other reproductive harm.

No Access for Unauthorized Persons! Only qualified personnel may service this equipment.

Read Operation Manual! Read and understand the operation manual before using this equipment. Failure to follow operating instructions could result in death or serious injury.

Read Technical Manual! Read and understand technical manual before servicing.

Lockout! Shut down engine. Turn off and lockout battery switch before servicing. If working near the batteries or the battery switch, also disconnect the negative battery cable on all batteries (3 areas).

Loud Noise Hazard! Ear protection must be worn while operating this equipment.

2.3 COMPONENT SAFETY FEATURES

- Sheet metal panels
- Maintenance locks on doors
- Scrub brake system

2.4 FUNCTIONAL SAFETY FEATURES

- Emergency shut off switch
- Timed engine shut down
- Over current protection circuit
- Over voltage protection circuit
- Cable interlock protection circuit
- Battery shut off switch

2.5 PERSONAL PROTECTION EQUIPMENT

- Safety glasses and ear protection must be worn when operating the GPU
- Additional equipment required by employer (gloves, vest, etc)

2.6 SAFETY GUIDELINES

- Operator must be properly trained prior to operating the GPU
- Pre-operation check must be performed before each use. (Refer to operating instructions)
- DC contactor must be OFF when connecting and disconnecting the cable from the aircraft
- Use emergency stop for emergency only. Normal shut down is accomplished by pressing power off. This allows the engine to cool for one minute at idle speed before shutting off. Unit will power down completely one minute after the engine shuts off
- Always shut the unit off, allow to cool, and turn the battery switch to OFF before performing service or maintenance. If working near the batteries or the battery switch, also disconnect the negative battery cable on all batteries (3 areas)

2.7 GENERAL COMMENTS

The GPU is intended to be operated by personnel trained in the proper use in conjunction with the aircraft maintenance manual.

The GPU must be used in accordance with the Technical and Operator Manuals and the intended aircraft.

3.0 PREPARATION PRIOR TO FIRST USE

3.1 GENERAL

Prior to operating the GPU, the user must become familiar with this Operator Manual.

3.2 PRE-USE INSPECTION

CAUTION!

A pre-use inspection must be carried out prior to each use to ensure safe operation of the GPU. Failure to carry out these procedures listed below may result in severe damage to the GPU or prevent efficient operation.

1. Unit..... Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance
2. Radiator..... Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required
3. Engine Hoses..... Check integrity of hoses and clamps for tightness
4. Fuel Level..... Turn power on and check fuel level on fuel gauge. Top up as required with fuel
5. Engine..... Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block, oil pan, and valve covers for oil leakage
6. Oil Level ..... Remove dipstick to ensure oil level is at full mark. Replenish as required
7. Fan Belt..... Check belt for correct tension. Look for wear
8. Air Intake Filter ..... Ensure that filter inlet is not restricted
9. Tires ..... Check integrity of tires and tread wear and pressure
10. Brakes..... Check for proper operation

4.0 TRAINING

4.1 TRAINING REQUIREMENTS

The employer of the operator is responsible for providing a training program sufficient for the safe operation of the GPU.

4.2 TRAINING PROGRAM

The employer-provided operator training program should cover safety procedures concerning use of the GPU in and around the intended aircraft at the intended aircraft servicing location.

4.3 OPERATOR TRAINING

The operator training should provide the required training for safe operation of the GPU.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

5.0 OPERATION

5.1 OPERATING PARAMETERS

- The user shall use the GPU in accordance with the aircraft manufacturer's instructions.
- The user shall operate the GPU in accordance with the Operation and Service Manual.
- The employer of the operator shall provide all necessary training.

5.2 NUMERICAL VALUES

Model 11-2820-0000
Serial Number ..... (See Nameplate on GPU)

5.2.1 Physical

Weight (Dry) ..... 3000 lbs (1361 kg)
Width ..... 66.25 in (168 cm)
Height ..... 61 in (155 cm)
Length ..... 96.5 in (245 cm)
Output Cable ..... 30 ft (9.14 m) long

5.2.2 Engine

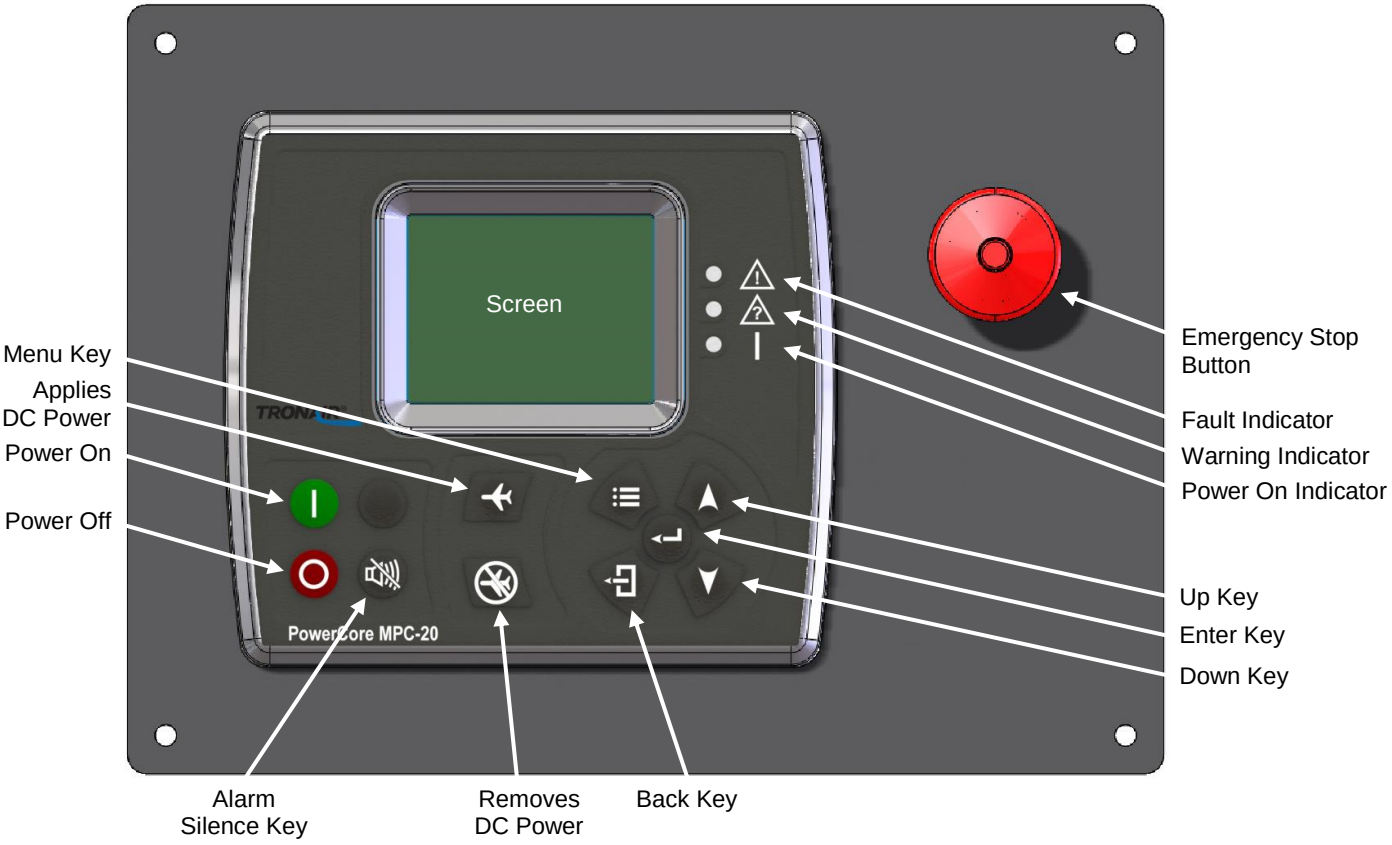
Doosan D24 ..... 2.4 Liter turbocharged after cooled, 4 cylinder, 4 stroke diesel engine
Horsepower ..... 68 hp (51 KW) at 1800 rpm
Electrical System ..... 12 volt, negative ground
Lubricating Oil ..... 2.4 gal (9.2 liters) w/filter
Coolant ..... 1 gal (3.7 liters)

5.2.3 Alternator

Marathon ..... Magna Plus 361PSL3161
Output Voltage ..... 21 volts AC, 6 phase
Output Power ..... 38 KW
Power Factor 0.8
Ambient Temp °C 40
Temperature Rise °C 80
Speed ..... 1800 RPM
Frequency 60HZ
Excitation ..... Externally regulated 66 volts DC, 4 amps
Insulation ..... Class F
Single Bearing ..... Sealed, pre-lubricated

5.3 LOCATION & LAYOUT OF CONTROLS

5.3.1 Control Panel (External)

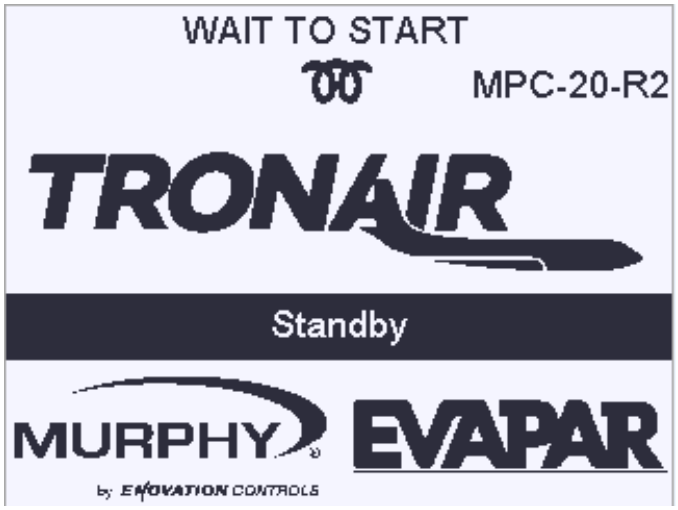


OPERATOR BUTTONS

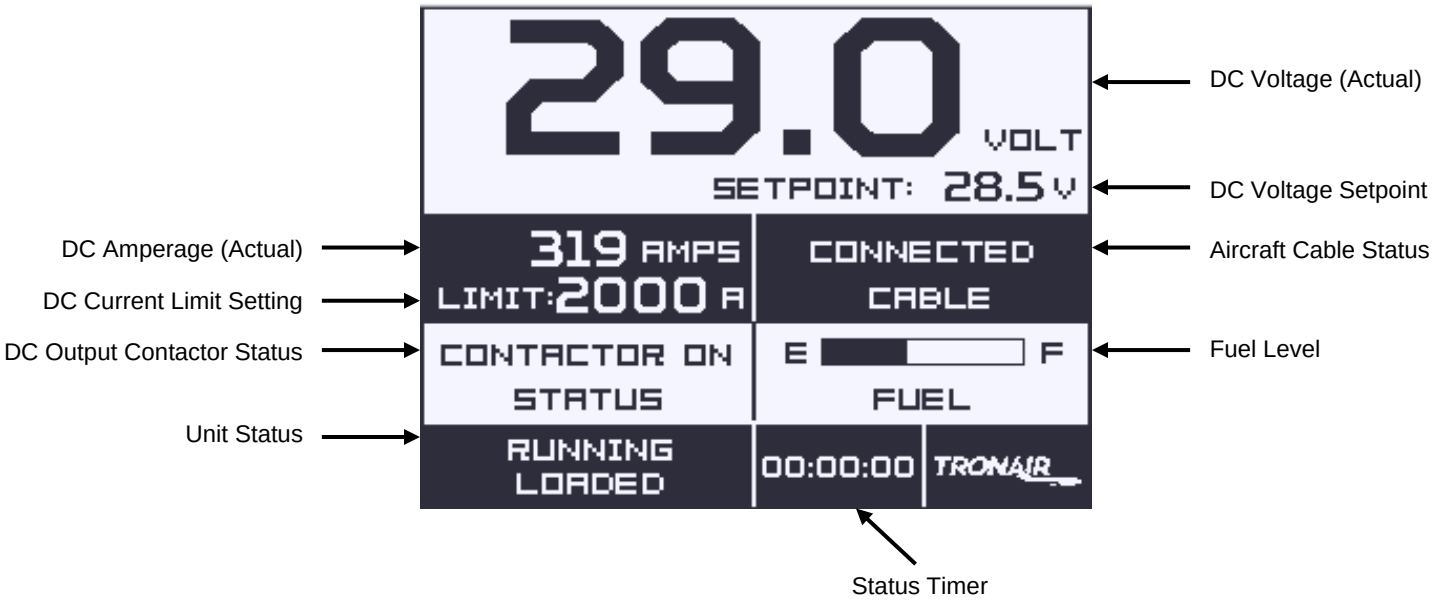
Description	Function
Power ON Position	Powers up unit, starts engine
Power OFF Position	Allows engine to idle for 1 minute before stopping, then 1 minute before unit powers down
Emergency STOP Button	Will immediately shut off power to the GPU and GPU will STOP **Use for emergency only**
Applies DC Power	Applies DC power to the aircraft cable
Removes DC Power	Removes DC power to the aircraft cable

5.3.2 Control Panel Screens

Power Up



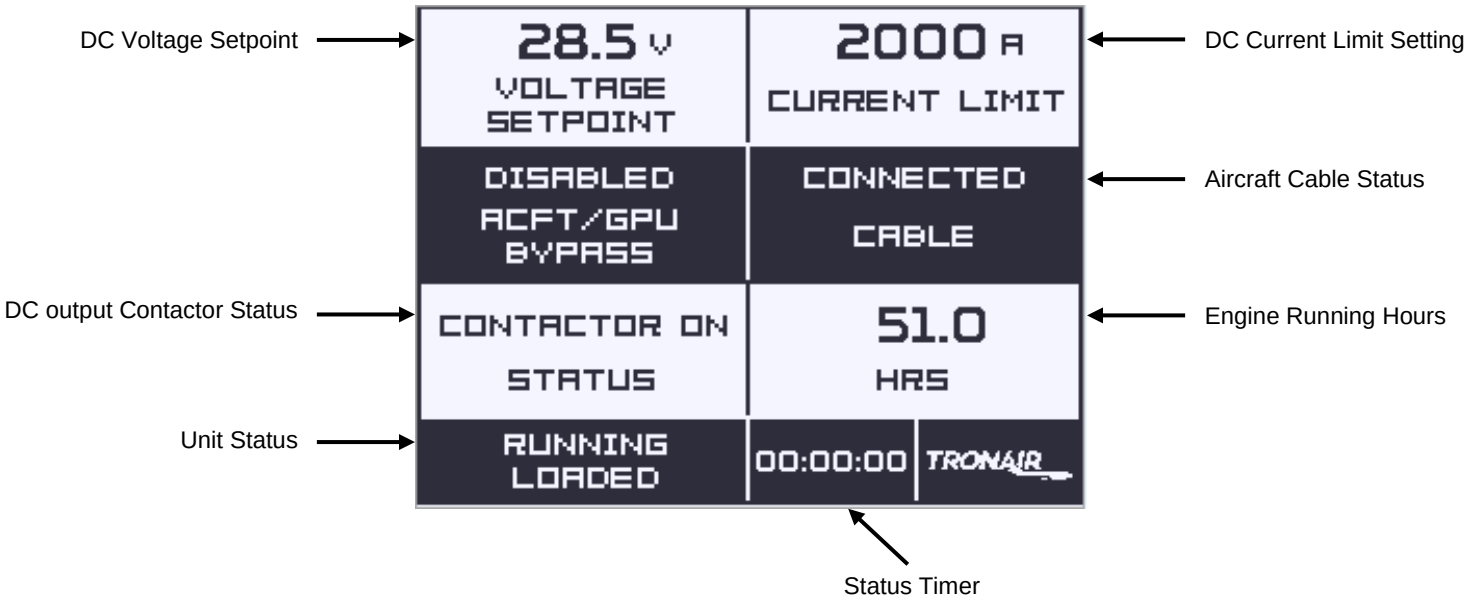
Main Operating



5.3.2 Control Panel Screens *(continued)*

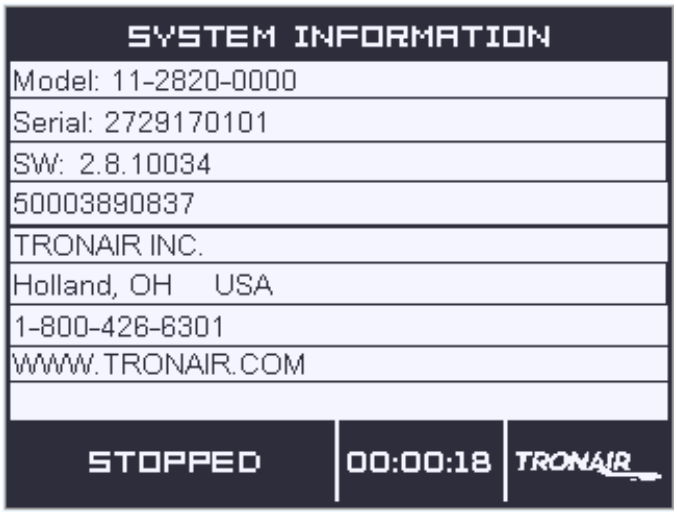
Engine Status

Alternator Status



5.3.2 Control Panel Screens *(continued)*

System Information

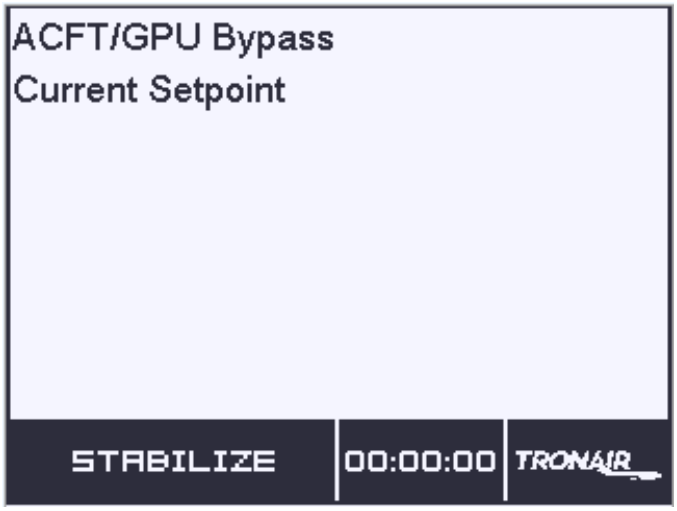


5.3.3 Control Panel Software Settings

1. To enter the software settings, press the Menu Key
2. Enter password **0000**, press Enter Key after each 0

5.3.3 Control Panel Software Settings *(continued)*

3. Select **ACFT/GPU Bypass**, press Enter Key



CAUTION!

The DC aircraft cable interlock is enabled when the third and smallest pin on the aircraft receptacle completes the circuit in the split pin connector. Under no circumstances should the split pin be bridged in order to switch on the DC.

CAUTION!

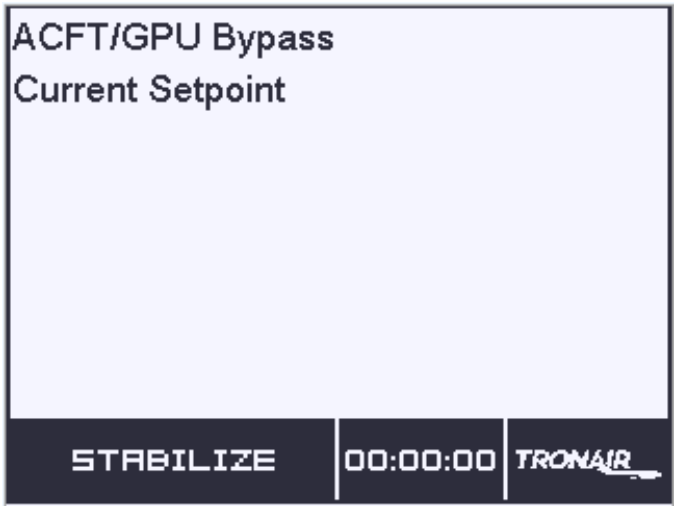
When the ACTF/GPU Bypass feature is in the enable mode the DC output cable will be live. Only trained, authorized personnel should use the equipment in this condition.

4. Select either **Disable** of **Enable**, press Enter Key

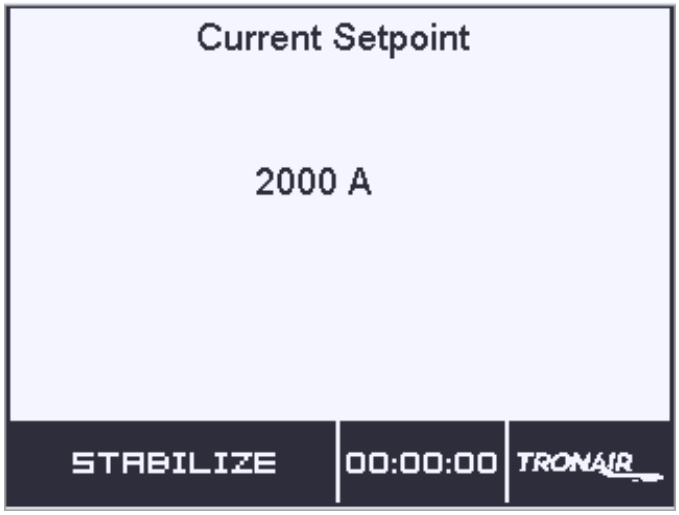
When Enabled, the ACTF/GPU Bypass feature allows the DC aircraft cable interlock feature to be overridden. The DC aircraft cable will be live when the DC Power key is pressed.

5.3.3 Control Panel Software Settings *(continued)*

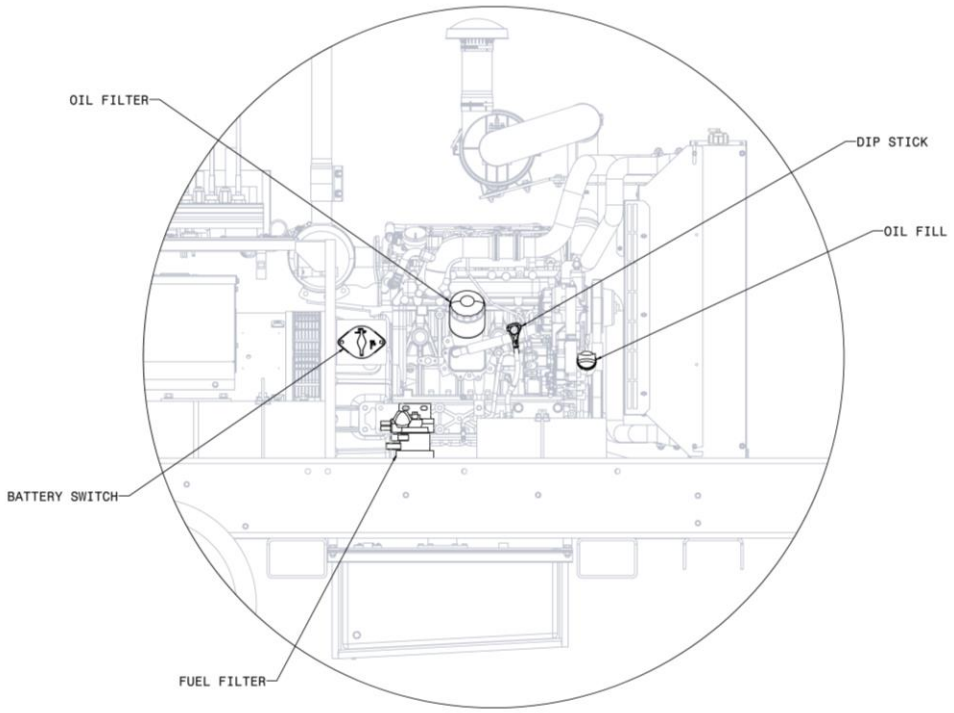
5. Select **Current Setpoint**, press Enter Key

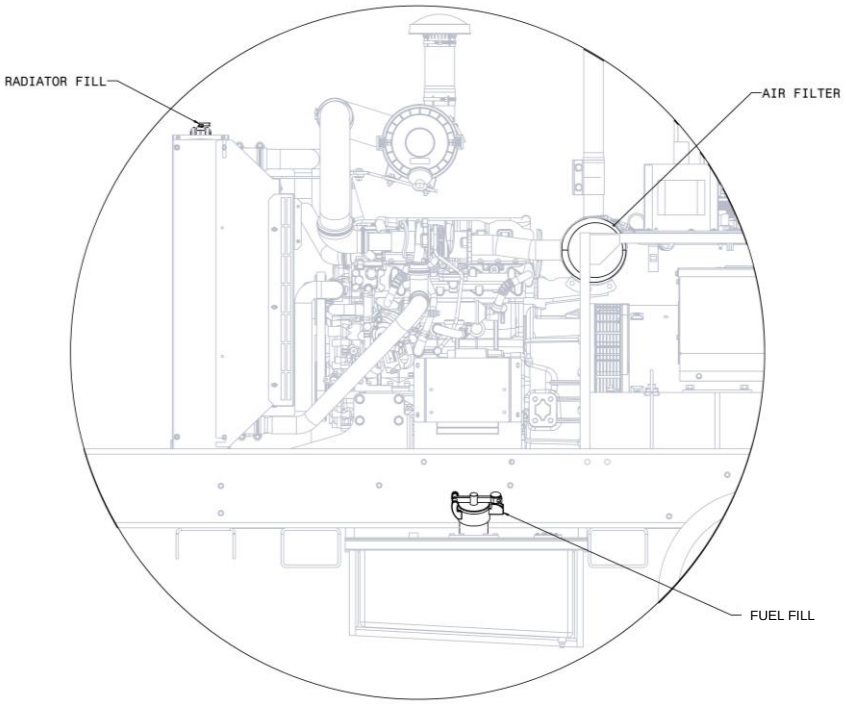


6. Adjust the Current Limit (2000A should be used if no current limit is required), press Enter Key



5.3.4 Controls, Engine Compartment





Item	Description	Function
1	Battery Switch	Connects and disconnects unit Pos. 12 Volt battery cables. Must be in the ON position for unit to run. GPU is shipped with switch in the OFF position

5.4 START UP PROCEDURES

5.4.1 Pre-Use Inspection

CAUTION!

A pre-use inspection must be carried out prior to each use to ensure safe operation of the GPU. Failure to carry out these procedures listed below may result in severe damage to the GPU or prevent efficient operation.

1. Unit..... Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance
2. Tires ..... Check treads for wear and tires for pressure
3. Radiator Coolant .... Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required
4. Engine Hoses..... Check integrity of hoses and clamps for tightness
5. Fuel Level..... Turn power on and check fuel level on fuel gauge. Top up as required with fuel
6. Engine ..... Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block oil pan and valve covers for oil leakage
7. Oil Level ..... Remove dipstick to ensure oil level is at full mark. Replenish as required
8. Fan Belt..... Check belt for correct tension. Look for wear
9. Brakes ..... Check for proper operation

5.4.2 Starting Sequence

The following sequence must be followed in the order shown:

1. The GPU battery disconnect switch must be selected to the ON position.
2. Press Power ON button. This will power up the unit.
3. Depending on air temperature the Wait To Start will display. Press Power ON button.
4. Engine will idle for 15 seconds, then go to operating speed.

CAUTION!

Battery must be fully charged to supply sufficient voltage for starting.

- If any warnings or faults display on screen respond accordingly.
- Unit should display 28.5 ± 0.1 volts, and the current limit setting (2000 A default).

5.4.3 Supplying DC Power to the Aircraft

1. Connect 28.5 VDC cable to aircraft. Make sure that power plug is fully and correctly inserted into the aircraft receptacle.

CAUTION!

Ensure that the current limit is in the correct setting for the aircraft to be started.
Consult aircraft technical manual for proper switch setting. Severe aircraft engine damage can occur if incorrect setting is used.

Current limit setting (done in software) is only to be adjusted by competent maintenance personnel. Helicopters and some small jets and turbo prop aircraft will require a "limit" on peak power. Do not use soft start on hard start engines. Insure aircraft bypass is set to disable.

2. Press the AIRCRAFT button. Display will say Contactor ON And Cable Connected..
3. The aircraft may now use DC power. During a start cycle, the DC voltage will fluctuate above and below 28.5 VDC. THIS IS NORMAL. The GPU will automatically compensate for the voltage drop in the cable to supply the starting voltage within specification at the aircraft receptacle. During the start, the Ammeter will show high amps initially and then quickly decay to show the continuing current draw.
4. Check all gauges for correct operation during the engine start cycle.
5. To shut down the GPU, press the power OFF button.
6. Unit will idle for 1 minute, then shut off.
7. Unit will automatically power down in 1 minute. Do not use emergency stop switch.
8. Stow DC plug and cable in cable tray.

5.4.4 Emergency Shut Down Procedure

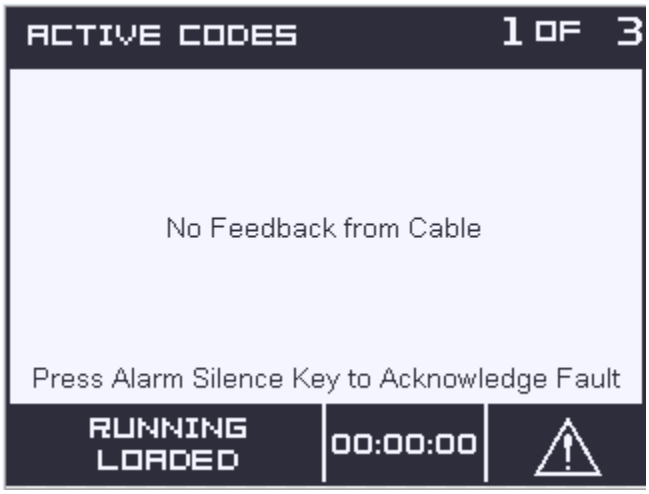
In the event an emergency shut down is necessary, press the emergency stop switch located on the operator panel. The Emergency Stop button is for emergencies only.

CAUTION!

Do not use for **normal** shut down. The Emergency Stop bypasses the timed cool down circuit and may cause engine damage.

5.5 INTERNAL FAULTS

- Contactor Off Feedback On
- No Feedback from Cable
- Contactor Off
- Over Voltage
- Over Current
- Under Voltage
- Rectifier High Temperature
- No Fuel
- Low Fuel Level
- Low Oil Pressure
- Under Speed
- High Engine Temp
- Over Crank
- Battery Not Charged
- Battery Weak
- Battery Low
- Battery High
- Emergency Stop Pressed



Internal Fault screen Example

6.0 PACKAGING AND STORAGE

6.1 PACKAGING REQUIREMENTS

1. Turn battery switch to OFF position
2. Drain fuel
3. Ensure fuel cap is secure
4. Securely fasten doors
5. Wrap for paint protection
6. Strap unit in truck or shipping container using 4 cargo straps. Hook one strap through each tie-down ring on the front

NOTE: Use at least four (4) straps with a minimum 3,000 lb (136 kg) capacity each.

6.2 HANDLING

The unit is designed to be lifted using a forklift.

6.3 PACKAGING PROTECTION

No special packaging material for cushioning or suspension is required for shipments within the continental United States.

6.4 LABELING OF PACKAGING

Packaging should be labeled as follows: **DO NOT DROP**
THIS SIDE UP
DO NOT STACK

6.5 STORAGE COMPATIBILITY

6.5.1 Short Term Storage (less than 3 months)

The following steps are recommended if the unit is to be placed out of services for three months or less. The unit should be prepared for storage as soon as possible after being removed from service.

1. Make sure that the mixed coolant is adequate for the lowest anticipated temperatures during time of storage.
2. Add oil to the FULL mark level on dip stick.
3. Drain a small portion of fuel from fuel tank by using the drain valve. This will remove any water that may have accumulated on the fuel tank.

NOTE: Do not drain the fuel system or crankcase.

4. Install new fuel filters.
5. Fill fuel tank to capacity. A full fuel tank prevents moisture laden air from entering the tank during the cool periods.
6. Close all access doors to minimize build-up of foreign particles in the unit.
7. Store unit in a building that is dry.
8. If the storage area has high humidity levels, place moisture absorbing chemicals inside the unit.

6.5.2 Long Term Storage

Special precautions are necessary to protect the GPU from rust and corrosion. It is recommended that the unit be stored in a building that is heated during winter months. Moisture absorbing chemicals should be placed inside the unit in climates where there is excessive dampness. Parts of the diesel requiring special attention are given below. The unit should be prepared for storage as soon as possible after being removed from service.

1. Drain the cooling system. Flush with clean water. Refill with 50/50 mix of water and antifreeze or mix according to ratio for temperature as recommended in the Doosan Operation and Maintenance Manual.
2. Circulate the coolant by operating the engine until the normal operating temperature is reached.
3. Stop the engine.
4. Drain the engine crankcase. Reinstall the drain plug. Install new lubricating oil filter element. Refill with high quality lubricating oil as recommended in the Doosan Operation and Maintenance Manual.
5. Drain the fuel tank of contaminants, fuel/water. Add additives, fill with fuel, and operate the engine for about ten minutes.

NOTE: Where biological contamination may be a problem, add a biocidal such as Biobor JF or equivalent to the fuel. Follow the biocidal manufacturer's concentration recommendations and observe all warnings and cautions.

6. Remove the spin-on fuel filters, discard, fill new filters with fuel and reinstall on the engine.
7. Remove and clean battery terminals and cables with baking soda-water solution, rinse with fresh water. Do not allow the soda water to enter the battery. Add distilled water to the electrolyte, if necessary fully charge the battery. Store the battery in a cool dry place (never below 32ºF, or 0 degrees C). Keep the battery fully charged and check the specific gravity of the electrolyte regularly.
8. Seal all engine openings, including the exhaust outlets with moisture resistant tape. Use cardboard, plywood, or metal covers where practical.
9. Tag engine Control Panel "DO NOT RUN, READY FOR STORAGE".

7.0 TRANSPORTATION

- Do not stack.
- Unit is designed to be lifted with a fork lift.
- Strap unit in truck or shipping container using 4 cargo straps. Hook one strap through each tie-down ring. Raise tow-bar into latch and block wheels.
- Weight**:** 3000 lbs (1361 kg)

8.0 TROUBLE SHOOTING

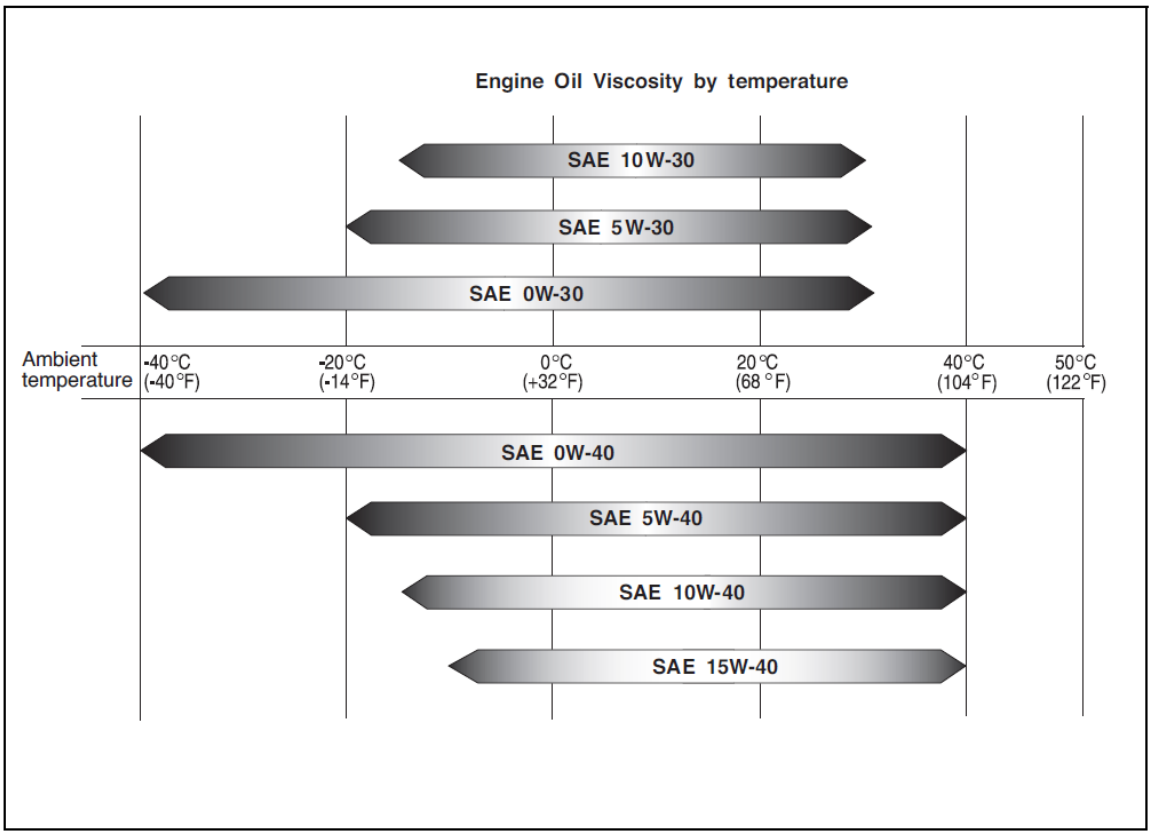
FAULT	POSSIBLE CAUSE	SOLUTION
No Power When "Power On" Switch is Pressed	Battery switch turned to off	Check, turn to on
	Loose battery terminals	Check, clean and tighten terminals
	Power ON switch inoperative	Check fuse one on ECU bracket
Contactor Off Feedback On	Contactor welded closed	Change DC output contactor
No Feedback from Cable	Damaged cable	Check continuity of Cable
	Not inserted fully into socket	Ensure cable is plugged all the way in
	Aircraft missing third pin	Change to GPU mode
Over Voltage	Large current drop	Consult Tronair
	AVR out of adjustment	Adjust volt adjustment on AVR
	Damaged AVR	Replace damaged AVR
Over Current	Exceeding current rating	Consult Tronair
	Current limit set to low	Raise current limit adjustment
Under Voltage	AVR out of adjustment	Adjust volt adjustment on AVR
Rectifier High Temperature	Rectifier overheat	Let GPU cool down by removing load
	Damaged temp switch	Check continuity and replace switch if faulty
No Fuel	Damaged fuel sending unit	Check sending unit resistance. If less than 4 ohms when unit is filled, replace
	No fuel	Fill with diesel until fault clears
Low Fuel Level	Low fuel	Fill with diesel until fault clears
	Damaged fuel sending unit	Check sending unit resistance. If less than 45 ohms when unit is filled, replace
Low Oil Pressure	Low oil/No oil	Check engine oil level and verify pressure using engine status screen. Add oil as necessary
High Engine Temp	Low coolant	Check coolant level when engine is cool. Add coolant as necessary
	Dirty radiator fins	Clean radiator of debris
	Broken fan belt	Replace
Over Crank	No fuel	Fill fuel tank
Battery Not Charged	Battery not charged	
Battery Weak	Loose battery connection	Check, clean and tighten terminals
	Low battery voltage	Check, using a multi meter, Charge or replace if necessary
Battery High	Bad alternator	Check alternator output voltage, replace if necessary
Emergency Stop Pressed	Emergency stop has been pushed	Pull emergency stop out

9.0 MAINTENANCE

As with all Ground Support Equipment it is very important to provide proper preventative maintenance and service. This will increase the service life of the diesel engine, which can be expected to operate for 30,000 hours without a major overhaul (this may vary according to local operating conditions.) The following specifies consumable service requirements:

Fuel: Ensure that the correct diesel fuel ASTM D 975 is used. Refer to the Doosan Operation and Maintenance Manual (provided as a supplement to this manual) for other allowable fuels.

Engine Oil: 15W-40 (API CH-4) is suitable for most operating temperatures. However, lower viscosity oils can be used to aid starting at temperatures below -20° C (-4° F). The engine requires the use of low ash oil. Refer to engine Operation and Maintenance Manual for oil and viscosity recommendations.



CAUTION!

Do not over fill the engine as damage may occur. Always use the engine oil level dipstick to ensure the correct level. Always use the same brand of engine oil. When topping up the oil level always prevent dirt from entering by cleaning around the oil filler prior to filling. The engine oil level should be checked every 10 hours of operation.

9.0 MAINTENANCE *(continued)*

Cooling System: Use 50/50 ethylene glycol and diethylene glycol mixture. Refer to section 4 of the Deutz Operation and Maintenance Manual (provided as a supplement to this manual) for anti-freeze and water quality recommendations. Must meet ASTM D3306-00A Standard.

Ambient Temperature (ºC)	Coolant (ºC)	Antifreeze (%)
Above -10	85	15
-10	80	20
-15	73	27
-20	67	33
-25	60	40
-30	56	44
-40	50	50

Filters: Fuel/water filter.....Change every 500 hours or 6 months
Engine oil filter.....Change every 500 hours or 6 months with oil change
Air cleaner filter.....Check daily. Change when clog indicator shows clogged
Fuel filter.....Change every 500 hours or 6 months

9.1 GENERAL (DAILY CHECKS)

1. Unit..... Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance.
2. Radiator..... Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required.
3. Engine Hoses..... Check integrity of hoses and clamps for tightness.
4. Fuel Level..... Turn power on and check fuel level on fuel gauge. Top up as required with fuel.
5. Engine..... Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block oil pan and valve covers for oil leakage.
6. Oil Level..... Remove dipstick to ensure oil level is at full mark. Replenish as required.
7. Fan Belt..... Look for wear and cracking.
8. Air Intake Filter..... Ensure that plugged filter indicator shows clean, if not, replace air filter. Check again once unit is running.
9. Doors..... Check that all doors are securely latched before driving or starting

9.2 SHORT TERM PREVENTIVE MAINTENANCE SCHEDULE

It is recommended to change the engine oil and filter after the first 50 hours of operation.

The following table is provided as a guide to for frequent service intervals. The Doosan Operation and Maintenance Manual (provided as a supplement to this manual) provides engine service interval information for daily, 250 hour, 500 hour, 1000 hour and 2000 hour intervals. See the Doosan Operation and Maintenance Manual.

Regular Inspection table

General Conditions

Regular inspection and replacement according to the recommended regular inspection table allows you to maintain the engine with optimum conditions and best performance for a long period and prevent unexpected accidents in advance.

(○ : Inspection and Adjustment, ● : Replacement)

Check Points	Daily	Inspection interval (x 1,000 hours)									
		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Coolant system											
State of connection between cooler and coolant hose	○										
Capacity and state of coolant[a]	○	Replace every 1,200 hours[b]									
Cooling fan belt tension	○										
Lubrication system											
Lubricating device and oil leakage	○										
Capacity and condition of engine oil[cd]	○	●	●	●	●	●	●	●	●	●	●
Engine oil filter	○	●	●	●	●	●	●	●	●	●	●
Fuel system											
Fuel line and connection unit	○										
Fuel volume	○										
Water draining from water separator	○										
Fuel injection time		Inspect and adjust if required									
Injector		Inspect and adjust if required									
Compression pressure		Inspect and adjust if required									
Intake/Exhaust system											
Air cleaner	○	Clean and replace if required									
Throttle body cleaning	○										
Intake line and connection unit	○										
Exhaust line and connection unit	○										
Emission state	○										
Cylinder head											
Intake/Exhaust valve gap state			○		○		○		○		○
Electric system											
Battery charging state	○										
Various electric units	○										

a. Replenish coolant if required.
b. Check coolant every 500 hours to maintain the concentration of antifreeze and additives.
c. Replace it every 500 hours after the first 50 hours (Tier-4).
d. Replace it every 250 hours after the first 50 hours (Tier-3).

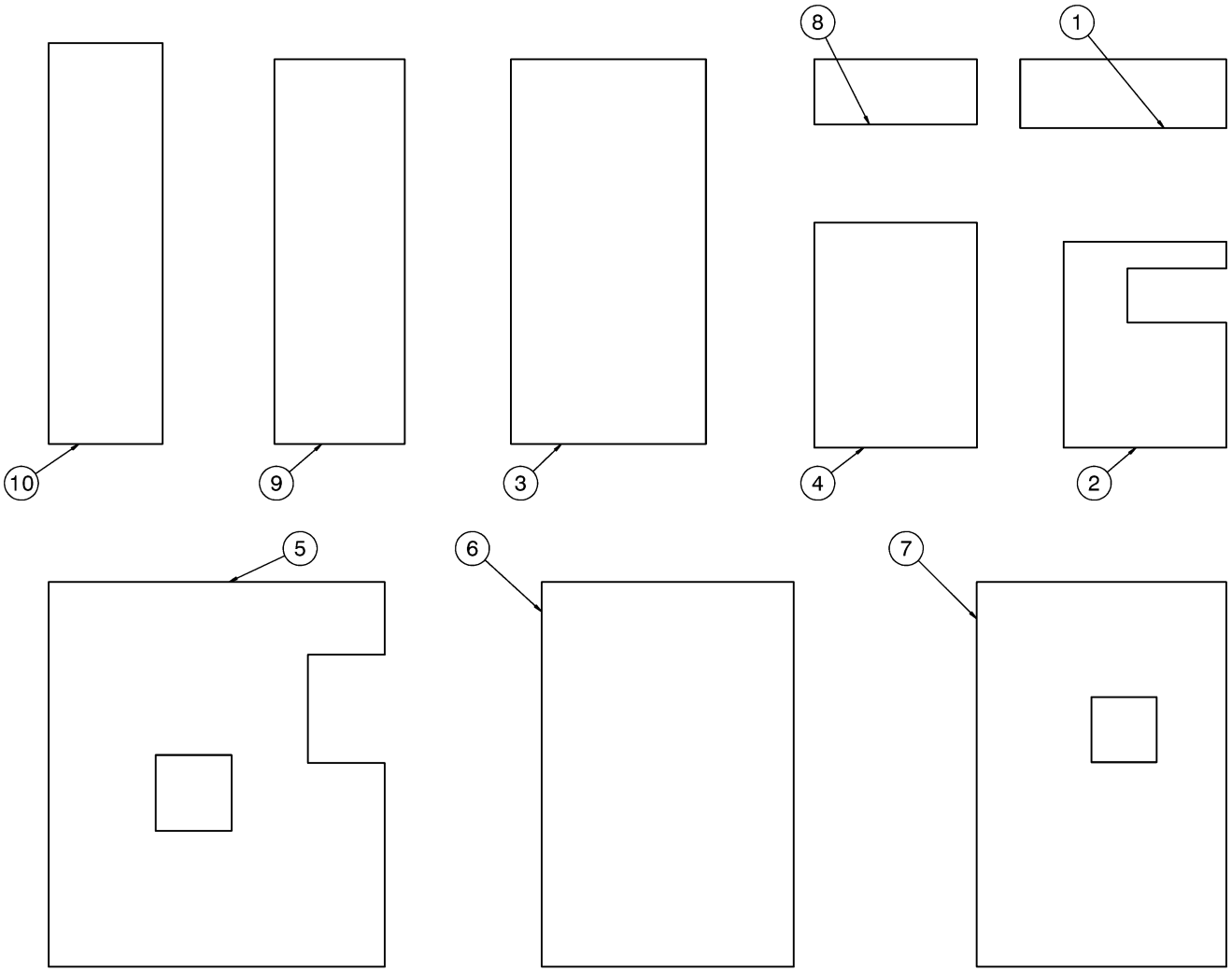
9.3 DAILY CHECKS

1. Unit..... Visually inspect outside of GPU for loose hardware, loose parts, frayed wires/cables and general appearance.
2. Radiator..... Open radiator access door and remove radiator cap (cold only). Ensure that coolant is up to the bottom of the fill neck. Service as required.
3. Engine Hoses..... Check integrity of hoses and clamps for tightness.
4. Fuel Level..... Turn power on and check fuel level on fuel gauge. Top up as required with fuel.
5. Engine..... Inspect all fuel lines and fittings for traces of fuel leakage. Visually inspect cylinder block oil pan and valve covers for oil leakage.
6. Oil Level..... Remove dipstick to ensure oil level is at full mark. Replenish as required.
7. Fan Belt..... Check belt for correct tension. Look for wear.
8. Air Intake Filter..... Ensure that air filter is not plugged.
9. Doors..... Check that all doors are securely latched before driving or starting

Reference Sections **9.2 – 9.14** for Parts Lists, Descriptions and Illustrations

9.4 SOUNDFOAM

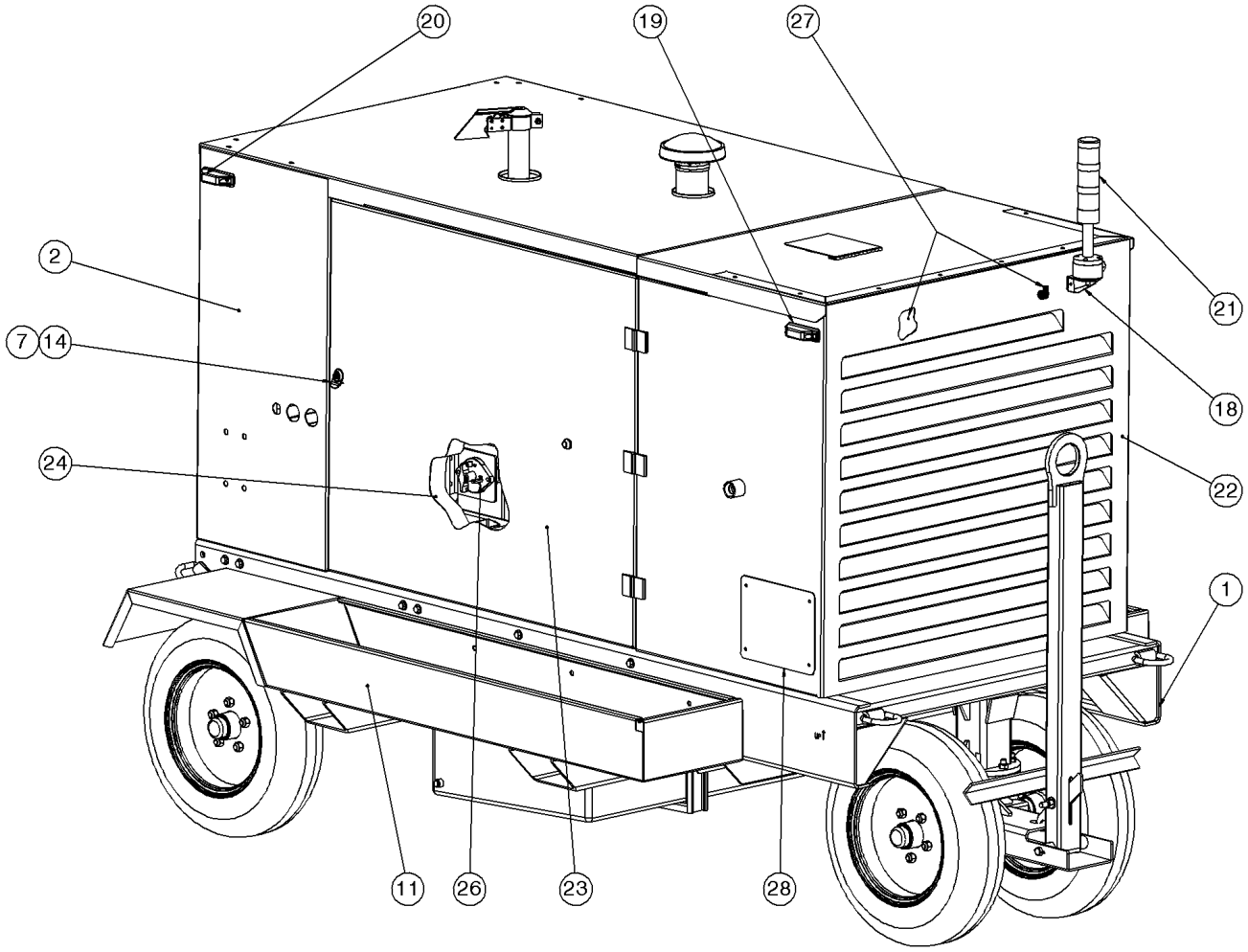
NOTES:
1. **All panels to be 2” thick**
2. **Panels are soundfoam M**
3. **Finish is black matte film and MDK adhesive**



4. **Panels drawn with adhesive side shown**

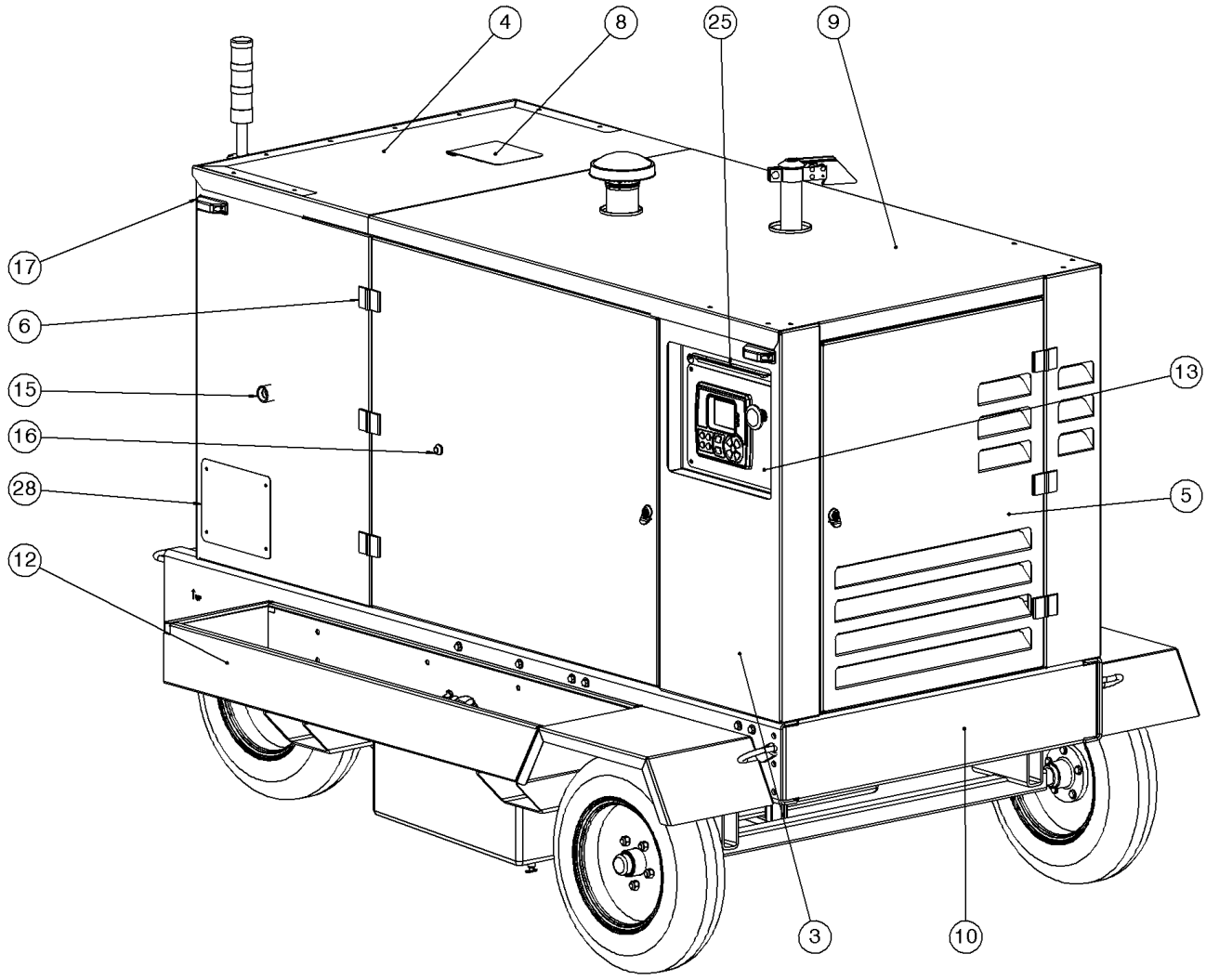
Item	Part Number	Description	Qty
1	K-5176-A	Soundproofing, Back Panel	1
2	K-5176-B	Soundproofing, Fire Extinguisher Bottom	1
3	K-5176-C	Soundproofing, Doors	4
4	K-5176-D	Soundproofing, Control Panel	1
5	K-5176-E	Soundproofing, Top Panel Middle	1
6	K-5176-F	Soundproofing, Top Panel Rear	1
7	K-5176-G	Soundproofing, Top Panel Front	1
8	K-5176-H	Soundproofing, Fire Extinguisher Top	1
9	K-5176-J	Soundproofing, Louver Pre-Fan Side	2
10	K-5176-K	Soundproofing, Louver Post-Fan Side	2

9.5 EXTERNAL COMPONENTS



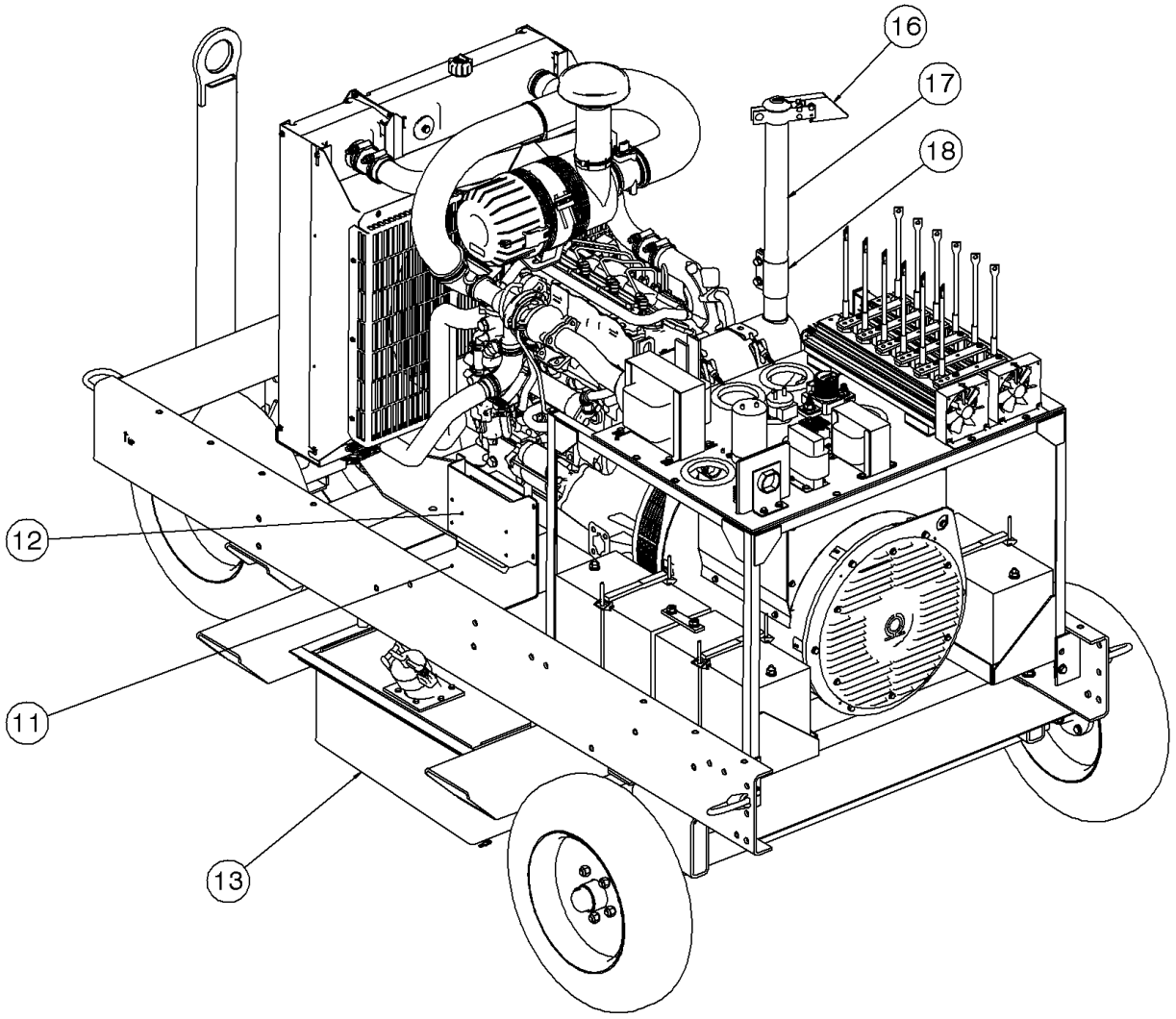
Item	Part Number	Description	Qty
1	Z-9167	GPU CHASSIS ASSEMBLY	1
2	S-3011-01	LOUVER, BACK LEFT	1
7	H-2884	DOOR, LATCH	3
11	S-2411	SIDE, TRAY RT	1
14	H-2915	PULL, TAB	3
18	EC-1794	BOX, VERTICAL MOUNTING JUNCT	1
19	EC-2709	BASE, BLACK FOR 169 LED LIGHT	4
20	EC-2708	LED, 12V RED	2
21	EC-2984	LIGHT, TOWER GRN, AMBR, RED, 12V	1
22	Z-9279	WELDMENT, 28V LOUVER	1
23	Z-9278	DOOR, ENGINE LONG	2
24	K-5176	KIT, SOUNDPROOFING	1
26	EC-2700	SWITCH, DISCONNECT	1
27	H-1721-01	CLAMP, ELECTRICAL	2
28	S-3274	PANEL, ACCESS	2

9.5 EXTERNAL COMPONENTS *(continued)*



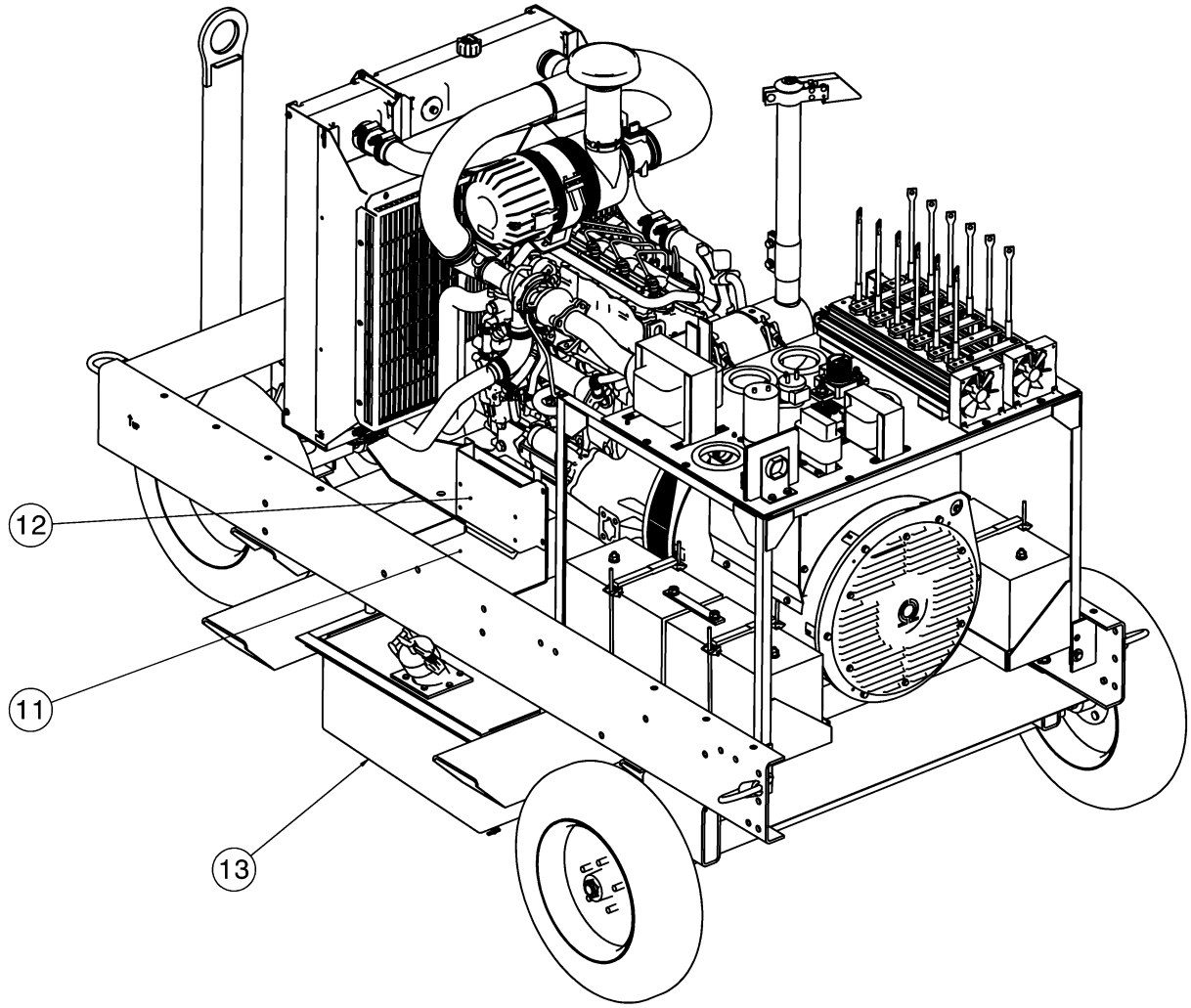
Item	Part Number	Description	Qty
3	Z-9229	WELDMENT, CONTROLS PANEL	1
4	S-3014	PANEL, TOP FRONT	1
5	Z-9230	WELDMENT, LOUVER DOOR	1
6	H-2827	HINGE, DOOR	9
8	Z-6168-00	LID, RADIATOR ACCESS (P)	1
9	Z-9231	WELDMENT, TOP REAR	1
10	J-6341	MEMBER, REAR CROSS	1
12	S-2410	SIDE TRAY, LEFT	1
13	EC-3441-285	PANEL, CONTROLS	1
15	H-3697	RUBBER DOOR HOLDER	2
16	H-3697 MALE	RUBBER DOOR HOLDER	2
17	EC-2707	LED, 12V AMBER	2
25	EC-3010	LIGHTS ASSY, PANEL LED	1

9.6 ENGINE/ALTERNATOR/ENGINE MOUNTING



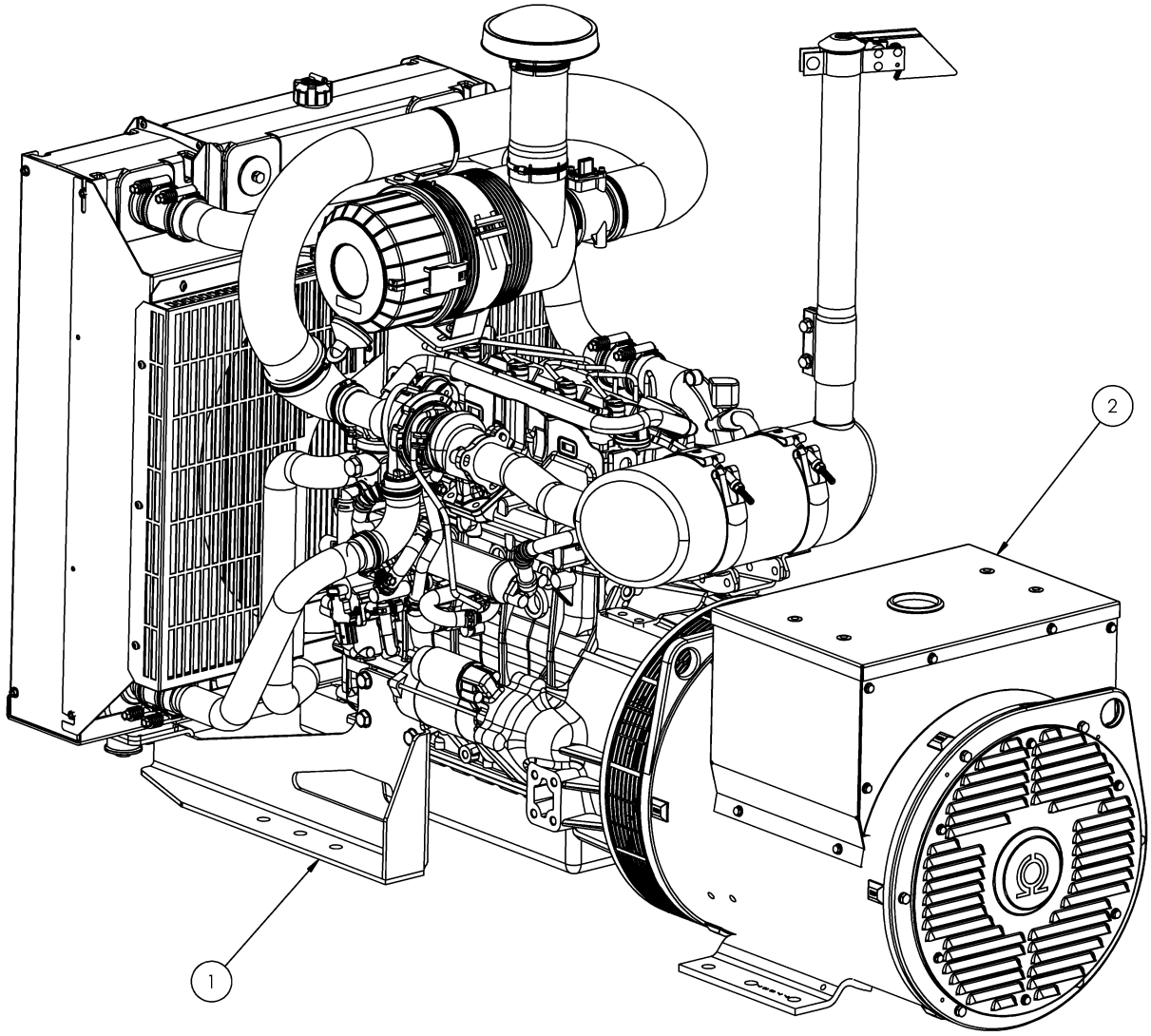
Item	Part Number	Description	Qty
1	Z-9232	GPU CHASSIS	1
2	TS-2665-01	TUBE, MOUNTING	1
3	TS-2664-01	TUBE, MOUNTING	1
5	Z-9233	ASSEMBLY, ENGINE/ALTERNATOR	1
6	Z-9208	ASSEMBLY, SHELF	1
7	Z-9217-01	WELDMENT, STARTER BATTERY TRAY	1
8	EC-3149	BATTERY, 12 VOLT	1
9	H-4005	TIE-DOWN, BATTERY	1
10	H-4025	FUEL FILTER	1
15	S-3018-01	BRACKET, FUEL FILTER SUPPORT	1
16	H-4192	CAP, RAIN 2”	1
17	TR-2505	TUBE, EXHAUST	1
18	394-098	CLAMP, MUFFLER	1

9.6 ENGINE/ALTERNATOR/ENGINE MOUNTING *(continued)*



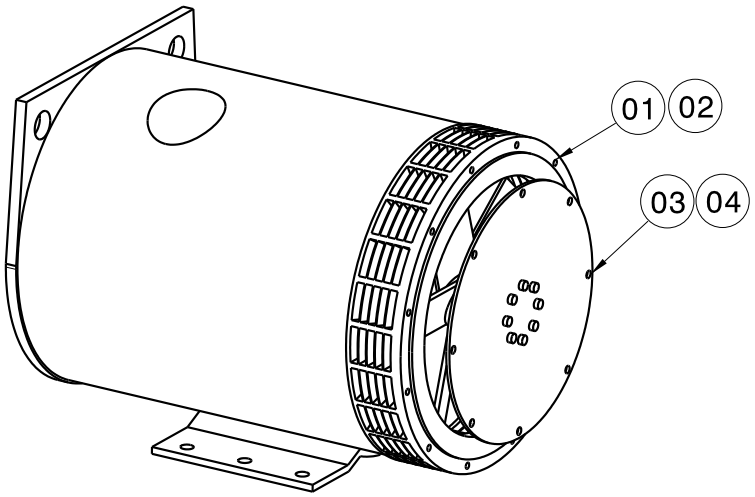
Item	Part Number	Description	Qty
4	H-4028	VMC ISOLATOR	4
11	S-3019-01	BRACKET, ECU SUPPORT	1
12	EC-2982	FUSE HOLDER, ECU	1
13	Z-9243	ASSEMBLY, FUEL TANK	1
14	J-6369-01	SPACER, ENGINE MOUNT	4
15	S-3018-01	BRACKET, FUEL FILTER SUPPORT	1

9.6 ENGINE/ALTERNATOR/ENGINE MOUNTING *(continued)*



Item	Part Number	Description	Qty
1	H-4024	ENGINE	1
2	EC-3093	ALTERNATOR	1

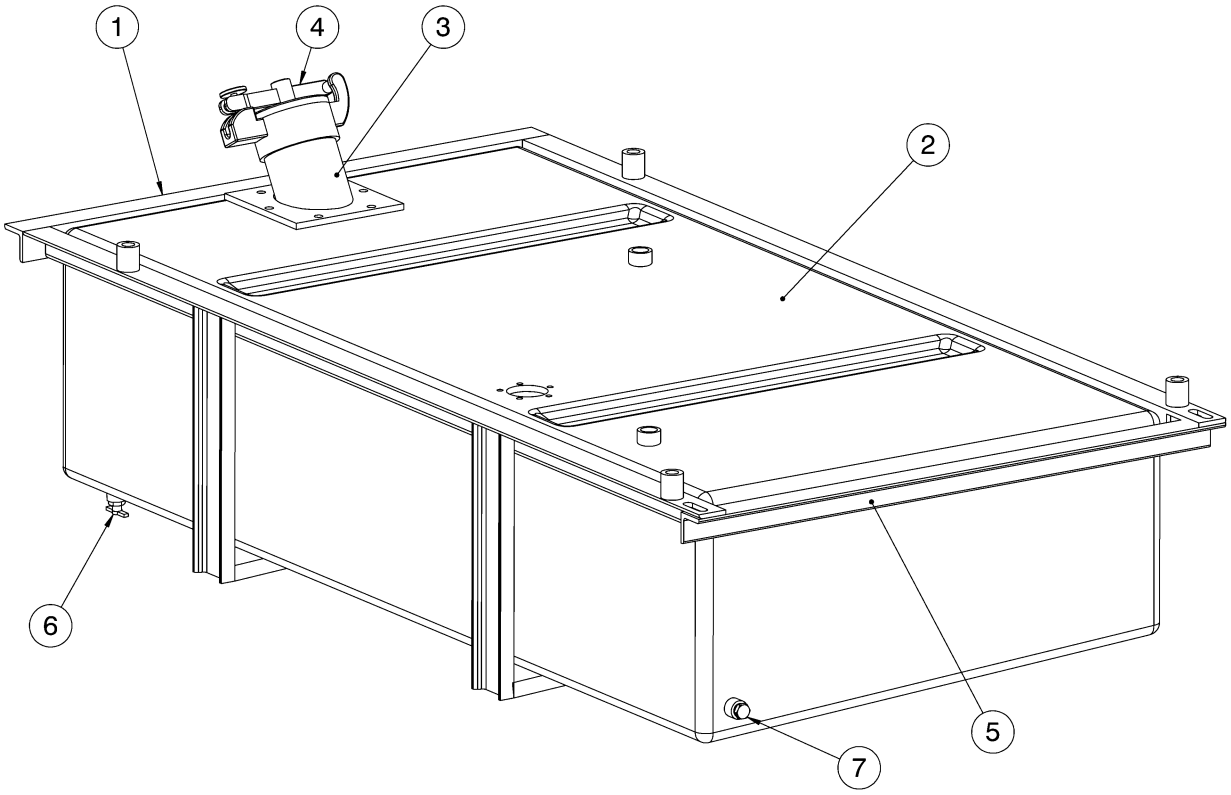
9.7 ALTERNATOR



EC-2046
38 KW ALTERNATOR

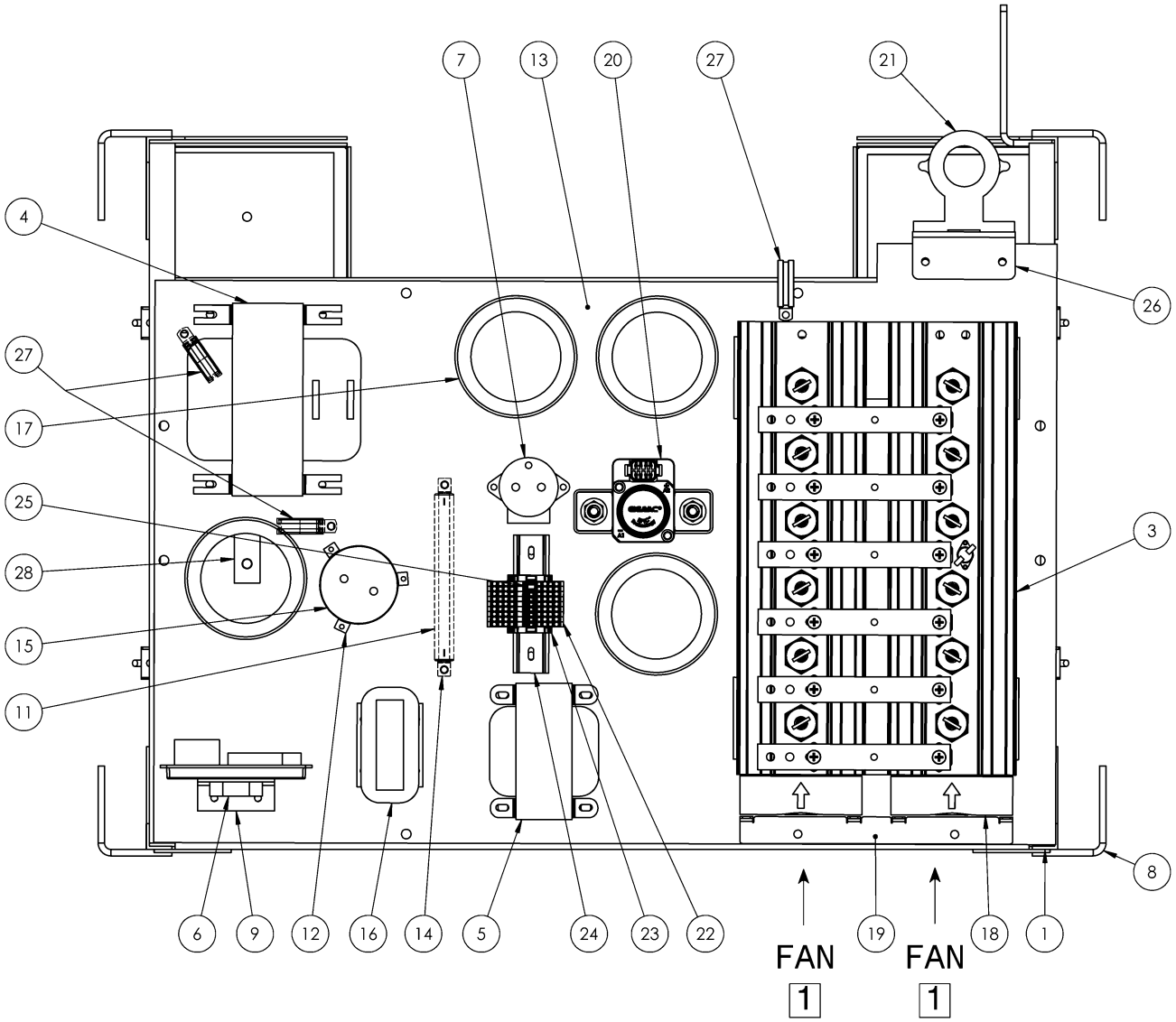
Item	Part Number	Description	Qty
1	G-1420-107010	Bolt, Hex Head Grade 8, ⅜ - 16 x 1 Long	8
2	G-1513-1070N	Flatwasher, ⅜ Hardened	8
3	G-1514-M100R	Lockwasher, M10	18
4	G-1533-100035	Bolt, Hex Head, M10 x 35 mm	10

9.8 FUEL TANK AND FRAME



Item	Part Number	Description	Qty
1	Z-7773-01	WELDMENT, FUEL TANK CAGE	1
2	H-4196	FUEL TANK	1
3	Z-7756	WELDMENT, FUEL NECK	1
4	15253	FILL CAP LESS SCREEN (GREEN)	1
5	A-1279-01	ANGLE, SUPPORT	1
6	N-2783-02	DRAIN, COCK	1
7	N-2206-03-SS	PLUG, HEX HEAD	1

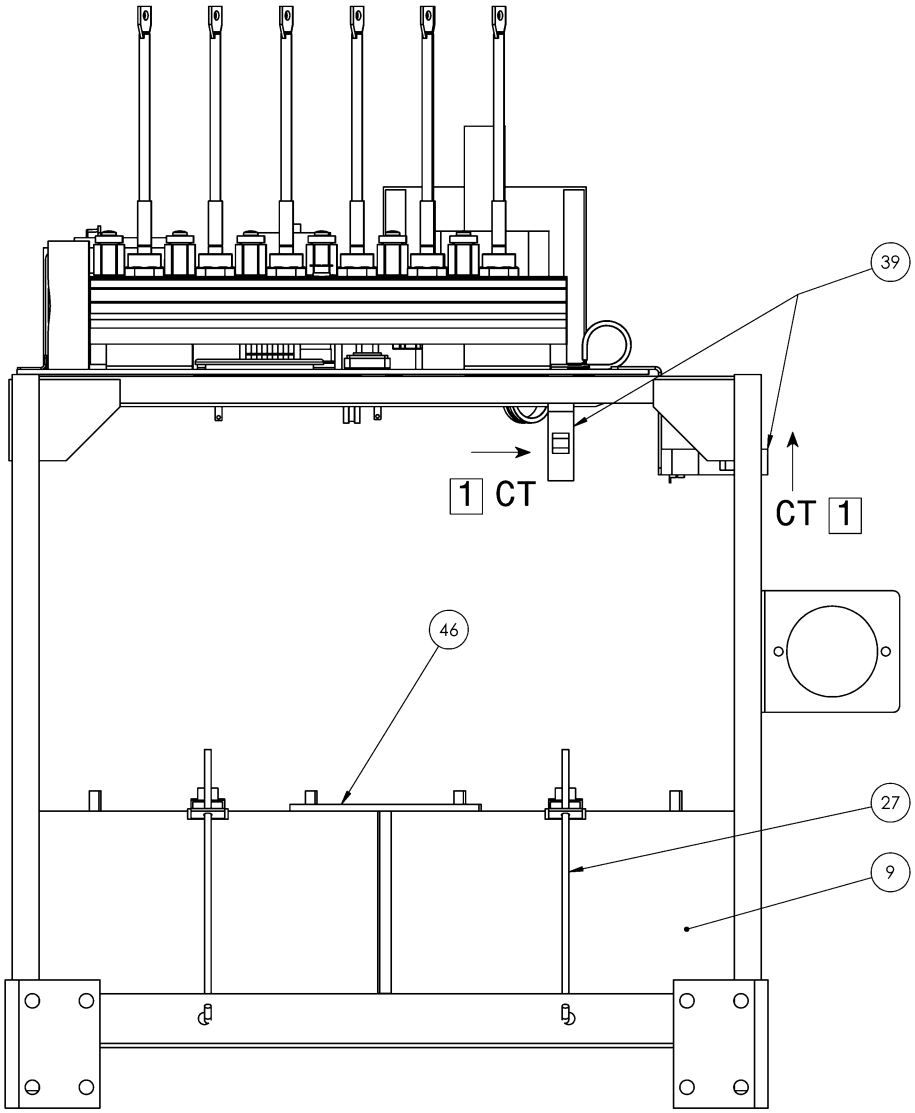
9.9 RECTIFIER/CONTACTOR/BATTERY SWITCH/OUTPUT CABLE



NOTE: 1 Align arrows on Item 18 (Fan) per drawing.

This page left blank intentionally.

9.9 RECTIFIER/CONTACTOR/BATTERY SWITCH/OUTPUT CABLE *(continued)*

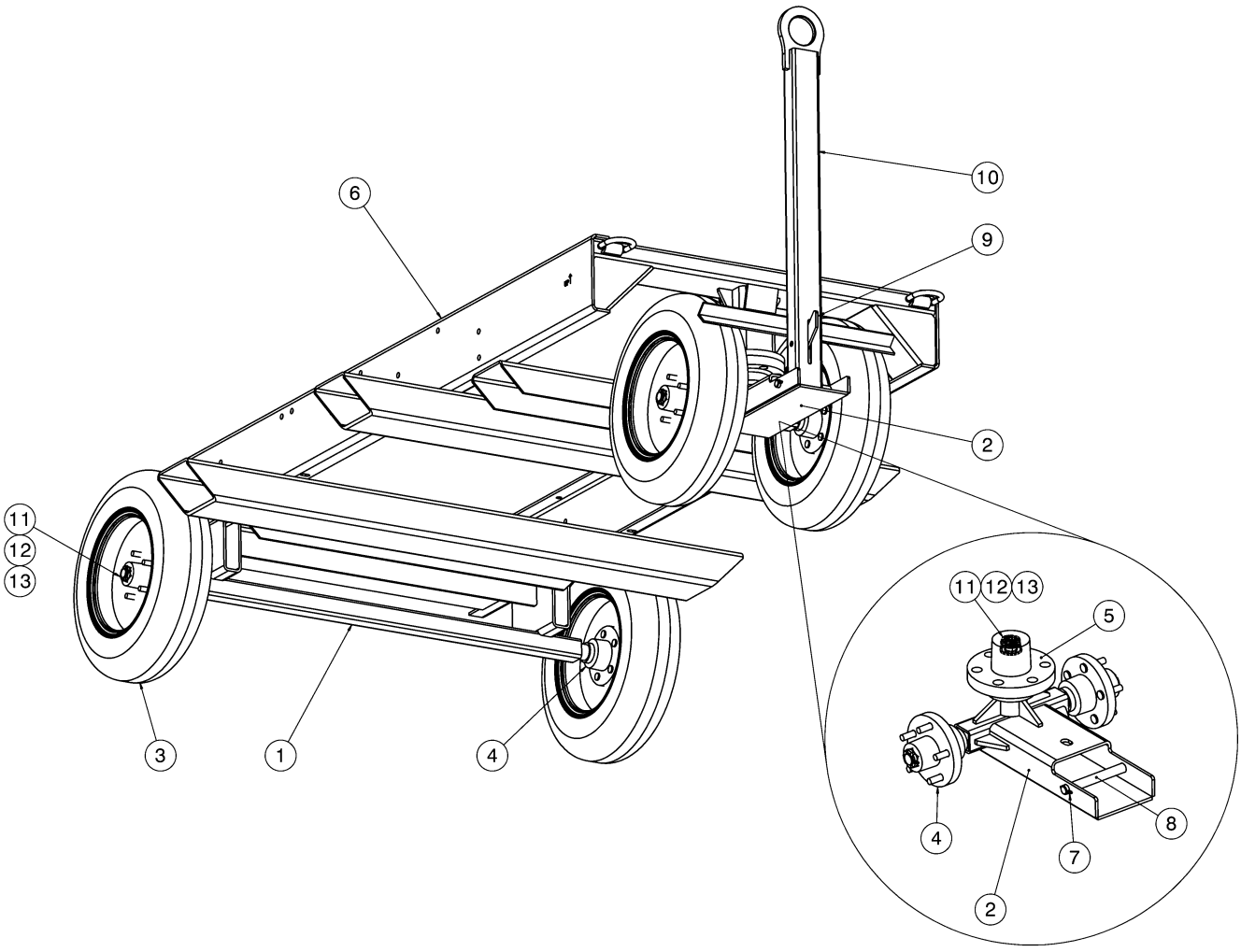


NOTE: 1 Align arrows on Item 21 (CT) per drawing.

9.9 RECTIFIER/CONTACTOR/BATTERY SWITCH/OUTPUT CABLE (continued)

Item	Part Number	Description	Qty
1	Z-9209-01	WELDMENT, SHELF	1
2	EC-1656	BATTERY, 12 VOLT	4
3	EC-2045	RECTIFIER, 28VDC 6-PHASE	1
4	EC-2395	CHOKE	1
5	EC-2968	TRANSFORMER, SINGLE PHASE	1
6	EC-2970	VOLTAGE REGULATOR	1
7	EC-2971	RELAY, 500A 12VDC	1
8	J-6312-01	BRACKET	4
9	S-3003-01	MOUNTING BRACKET, ARV	1
10	H-4005	TIE-DOWN, BATTERY	4
11	EC-2979	RESISTOR, 10 OHM, 100W, 5%	1
12	H-3480	CLAMP, MOUNTING CAPACITOR	1
13	S-3001	PLATE, SHELF	1
14	EC-2981	BRACKET, RESISTOR	2
15	EC-2397	CAPACITOR	1
16	EC-2967	TRANSFORMER, 3 PHASE	1
17	H-4027	GROMMET, RUBBER 4.75OD x 3.5ID	4
18	EC-3004	FAN, GPU RACK	2
19	S-3070-01	BRACKET, FANS	1
20	EC-3006	CONTACTOR 600 AMP 12 VDC	1
21	EC-3008	SPLIT CORE HALL EFFECT DC CURRENT SENSOR	2
22	EC-2083	TERMINAL BLOCK, 4 COND (LT GRAY)	9
23	13070	ANCHOR DINRAIL END	2
24	EC-1895-005.37	RAIL, DIN	1
25	EC-2072	JUMPER, 2 CONDUCTOR	1
26	S-3074-01	BRACKET, CURRENT SENSOR	1
27	H-1721-08	CLAMP, ELECTRICAL	3
28	J-6402	BUSBAR, BATTERY CONNECT	2
29	K-5181	ELECTRICAL HARNESS	1

9.10 SUB ASSEMBLY COMPONENTS



Item	Part Number	Description	Qty
1	Z-9178	WELDMENT, REAR AXLE	1
2	Z-9179	WELDMENT, FRONT AXLE	1
3	H-4000	TIRE, GPU CHASSIS	4
4	H-3424	HUB	4
5	H-3200	HUB	1
6	Z-9191	WELDMENT, FRAME	1
7	G-1301-02	1/8" Cotter Pin	2
8	R-2096	PIN, TOWBAR	1
9	J-3427	LEVER	1
10	Z-9193	WELDMENT, TOWBAR RAIL	1
11	G-1230-01	NUT, AXLE 1"	5
12	G-1283	WASHER, SPINDLE	5
13	G-1301-05	PIN, 5/32 X 1.5" LG. COTTER	5
1	Z-9178	WELDMENT, REAR AXLE	1

10.0 PROVISION OF SPARES

10.1 SOURCE OF SPARE PARTS

Spare parts may be obtained from the manufacturer:

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

For Spare Parts, Operations & Service Manuals or Service Needs:
Scan the QR code or visit Tronair.com/aftermarket

10.2 RECOMMENDED SPARE PARTS LISTS

Reference the following page(s) for Replacement Parts and Kits available.

Recommended Spares:
H-5260..... V-Belt
EC-3680 ..... Alternator
H-5262..... Oil Filter
H-5263..... Fuel Filter Element
H-5264..... Secondary Air Element
H-5265..... Primary Air Element
H-5266..... Injector Assembly
H-5267..... EGR Valve
H-5268..... Starter
H-5269..... Water Pump
H-5270..... Thermostat
H-5271..... Auto Tensioner

11.0 IN SERVICE SUPPORT

Contact Tronair, Inc. for technical services and information. See Section 1.3 – Manufacturer.

12.0 GUARANTEES/LIMITATION OF LIABILITY

Tronair products are warranted to be free of manufacturing or material defects for a period of one year after shipment to the original customer. This is solely limited to the repair or replacement of defective components. This warranty does not cover the following items:

a) Parts required for normal maintenance
b) Parts covered by a component manufacturers warranty
c) Replacement parts have a 90-day warranty from date of shipment

If you have a problem that may require service, contact Tronair immediately. Do not attempt to repair or disassemble a product without first contacting Tronair, any action may affect warranty coverage. When you contact Tronair be prepared to provide the following information:

a) Product Model Number
b) Product Serial Number
c) Description of the problem

If warranty coverage is approved, either replacement parts will be sent or the product will have to be returned to Tronair for repairs. If the product is to be returned, a Return Material Authorization (RMA) number will be issued for reference purposes on any shipping documents. Failure to obtain a RMA in advance of returning an item will result in a service fee. A decision on the extent of warranty coverage on returned products is reserved pending inspection at Tronair. Any shipments to Tronair must be shipped freight prepaid. Freight costs on shipments to customers will be paid by Tronair on any warranty claims only. Any unauthorized modification of the Tronair products or use of the Tronair products in violation of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately void any warranty, express or implied.

The obligations of Tronair expressly stated herein are in lieu of all other warranties or conditions expressed or implied. **Any unauthorized modification of the Tronair products or use of the Tronair products in violations of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately *void any warranty, express or implied* and Tronair *disclaims any and all liability for injury (WITHOUT LIMITATION and including DEATH), loss or damage arising from or relating to such misuse*.**

13.0 APPENDICES

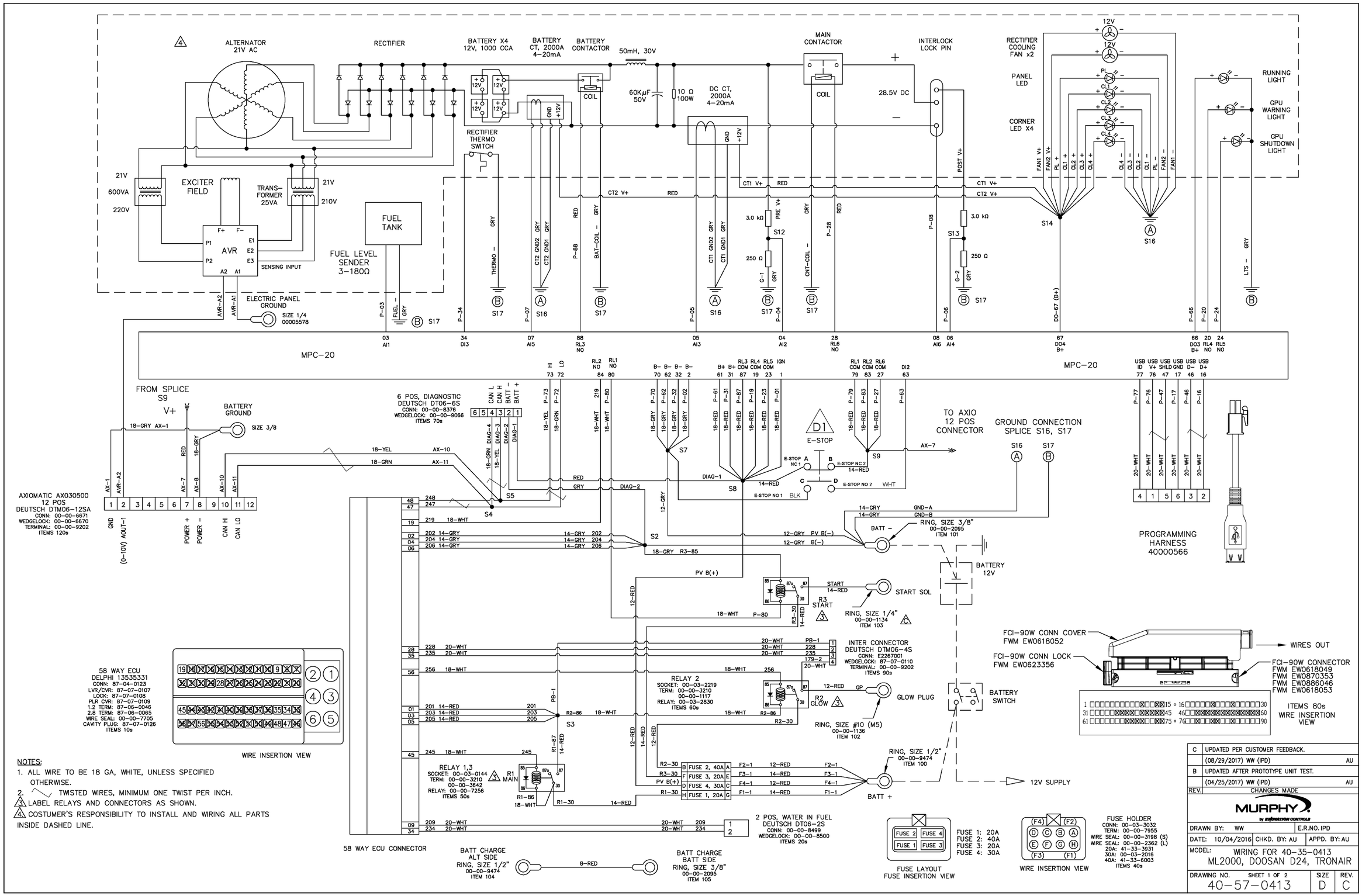
APPENDIX I Wiring Diagram – INS-2372
APPENDIX II Controller - Murphy MPC-20
APENDIX III Alternator Operation & Maintenance Manual – Magnaplus 361
APPENDIX IV Declaration of Conformity

Additional Documents
See Doosan for D34 Operation & Maintenance Manual

APPENDIX I

Wiring Schematic
(INS-2372)

REVISIONS					
REV	DESCRIPTION	EC#	DWN	CHK	DATE
D	1) UPDATED E-STOP TERMINALS AND WIRE LABELS 2) UPDATED WIRE HARNESS DRAWINGS (SHEETS 2 & 3) 3) PUT SCHEMATIC AND WIRE HARNESS DRAWINGS ONTO TRONAIR TITLE BLOCK	26101	NGL	KJY	9/6/2023



NOTES:
1. ALL WIRE TO BE 18 GA, WHITE, UNLESS SPECIFIED OTHERWISE.
2. ⁓ TWISTED WIRES, MINIMUM ONE TWIST PER INCH.
3. LABEL RELAYS AND CONNECTORS AS SHOWN.
4. COSTUMER'S RESPONSIBILITY TO INSTALL AND WIRING ALL PARTS INSIDE DASHED LINE.

REV.	CHANGES MADE	
C	UPDATED PER CUSTOMER FEEDBACK.	
	(08/29/2017) WW (IPD)	AU
B	UPDATED AFTER PROTOTYPE UNIT TEST.	
	(04/25/2017) WW (IPD)	AU

MURPHY by ENPRESS CONTROLS

DRAWN BY: WW		E.R.NO. IPD	
DATE: 10/04/2016	CHKD. BY: AU	APPD. BY: AU	
MODEL:	WIRING FOR 40–35–0413 ML2000, DOOSAN D24, TRONAIR		
DRAWING NO. 40–57–0413	SHEET 1 OF 2	SIZE D	REV. C

MADE FROM N/A	BREAK ALL SHARP EDGES AND CORNERS INTERPRET PER ASME Y14.5-2009	TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT
MATERIAL N/A	DIMENSIONS IN INCHES AND TOLERANCES PER BELOW UNLESS OTHERWISE SPECIFIED: **DIMENSION INCH [mm]:** .X [X] ± .1 [3] .XX [.X] ± .03 [0.8] .XXX [.XX] ± .010 [0.25] .XXXX [.XXX] ± .0030 [0.076] **FRACTION INCH [mm]:** 1/XX [1/X] ± 1/16 [1.6] **ANGULAR DEGREE [RADIANS]:** X [XXX] ± .5 [.001]	DWN BY NGL · CKD BY · DATE no/tc/heck
FINISH N/A		SCHEMATIC, ELECTRICAL
THIRD ANGLE PROJECTION · SCALE: 1:1 · SIZE C		INS-2372 · REV D
DO NOT SCALE DRAWING		WEIGHT: LB · SHEET 1 OF 3

D2

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
1	1	18	RED	SPLICE A	BATT(+)
9	2	18	BLK	SPLICE B	BATT(-)
37	3	18	WHT	FUEL SENDER	FUEL LEVEL
39	4	18	WHT	SPLICE F	PRE-VOLTAGE (+)
47	5	18	WHT	MAIN CT SIGNAL	MAIN CT SIGNAL
43	6	18	WHT	SPLICE H	POST-VOLTAGE (+)
48	7	18	WHT	BATTERY CT SIGNAL	BATTERY CT SIGNAL
49	8	18	WHT	POST V (-)	POST-VOLTAGE (-)
2	19	18	RED	SPLICE A	BATT(+)
50	20	18	WHT	WARNING LIGHT	WARNING LIGHT
3	23	18	RED	SPLICE A	BATT(+)
51	24	18	WHT	SHUTDOWN LIGHT	SHUTDOWN LIGHT
52	27	18	RED	SPLICE K	BATT (+)
57	28	18	WHT	MAIN CONTACTOR [2]	DO-BATT(+)
4	31	18	RED	SPLICE A	BATT(+)
10	32	18	BLK	SPLICE B	BATT(-)
58	34	18	WHT	THERMO SWITCH	THERMO SWITCH
5	61	18	RED	SPLICE A	BATT(+)
11	62	18	BLK	SPLICE B	BATT(-)
59	63	18	WHT	E-STOP NO-2	E-STOP SIGNAL
60	66	18	WHT	RUNNING LIGHT	RUNNING LIGHT
61	67	18	RED	SPLICE M	DO-BATT (+)
38	70	18	BLK	SPLICE E	BATT(-)
74	72	18	GRN	SPLICE R	CAN_L
75	73	18	YEL	SPLICE S	CAN_H
53	79	18	RED	SPLICE K	BATT (+)
71	80	14	WHT	ENGINE [D]	CRANK
54	83	18	RED	SPLICE K	BATT (+)
72	84	14	WHT	ENGINE [G]	IGNITION
6	87	18	RED	SPLICE A	BATT(+)
73	88	18	WHT	BATT RLY COIL (+)	BATTERY RELAY COIL (+)

NO.	POS	AWG	COLOR	DESTINATION
81	16	USB CABLE	GN	
82	17		BLK	
83	46		WHT	
84	47		BLU	
85	76		RED	

MPC-20
(ITEM 1)

12.0" [75]
(LOOM)

USB

128.0
(LOOM)

3.0"

17.0
(LOOM)
- 51 WHT "SHUTDOWN LIGHT"
- 50 WHT "WARNING LIGHT"
- 60 WHT "RUNNING LIGHT"
- 27 BLK LIGHTS GROUND

27.0
(LOOM)
- 65 RED "CORNER LIGHT 4"
- 28 BLK CORNER LIGHT 4 GROUND

8.0
(LOOM)
- 64 RED "CORNER LIGHT 3"
- 29 BLK CORNER LIGHT 3 GROUND

60.0
(LOOM)
- 37 WHT "FUEL SENDER"
- 30 BLK FUEL SENDER GROUND

10.0
(LOOM)
- 31 BLK "AVR-A1"
- 80 WHT "AVR-A2"

14.0
(LOOM)
- 7 14-RED "E-STOP NC 1"
- 55 14-RED "E-STOP NC 2"
- 32 BLK "E-STOP NO 1"
- 59 WHT "E-STOP NO 2"

20.0
(LOOM)
- 66 RED "PANEL LIGHT"
- 33 BLK PANEL LIGHT GROUND
- 62 RED "CORNER LIGHT 1"
- 34 BLK CORNER LIGHT 1 GROUND

48.0
(LOOM)

24.0
(LOOM)

ENGINE
(ITEM 2)

36.0
(LOOM)

AXIOMATIC
(ITEM 4)

SPLICE D

SPLICE B

SPLICE C

12.0
(LOOM)

3.0
(LOOM)
- 46 WHT "POST V (+)"
- 49 WHT "POST V (-)"
- 73 WHT "BATT RLY COIL (+)"
- 16 BLK "BATT RLY COIL (-)"

9.0
(LOOM)

MAIN
CONTACTOR
(ITEM 3)

6.0
(LOOM)

3.0
(LOOM)

"PRE V (+)" WHT 41

18.0
(LOOM)

6.0
(LOOM)
- 69 RED "MAIN CT (+)"
- 47 WHT "MAIN CT SIGNAL"
- 17 BLK MAIN CT GROUND 1
- 18 BLK MAIN CT GROUND 2

12.0
(LOOM)
- 70 RED "BATTERY CT (+)"
- 48 WHT "BATERY CT SIGNAL"
- 19 BLK BATTERY CT GROUND 1
- 20 BLK BATTERY CT GROUND 2

18.0
(LOOM)

"THERMO SWITCH" WHT 58

THERMO SWITCH GROUND BLK 24

3.0
(LOOM)

6.0
(LOOM)
- 63 RED "CORNER LIGHT 2"
- 21 BLK CORNER LIGHT 2 GROUND

18.0
(LOOM)

3.0
(LOOM)
- 67 RED "FAN1 (+)"
- 22 BLK FAN1 GROUND

8.0
(LOOM)
- 68 RED "FAN2 (+)"
- 23 BLK FAN2 GROUND

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
25	1	18	BLK	SPLICE C	BATT(-)
57	2	18	WHT	MPC-20 [28]	BATT(+)
				CAVITY PLUG	
				CAVITY PLUG	
				CAVITY PLUG	
				CAVITY PLUG	
				CAVITY PLUG	
				CAVITY PLUG	

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
	A			CAVITY PLUG	
8	B	12	RED	SPLICE A	BATTERY (+)
	C			CAVITY PLUG	
71	D	14	WHT	MPC-20 [80]	CRANK
14	E	12	BLK	SPLICE B	BATTERY (-)
	F			CAVITY PLUG	
73	G	14	WHT	MPC-20 [88]	IGNITION
	H			CAVITY PLUG	
	J			CAVITY PLUG	ALT ENABLE
	K			CAVITY PLUG	
	L			CAVITY PLUG	
	M			CAVITY PLUG	
	N			CAVITY PLUG	
	P			CAVITY PLUG	
	R			CAVITY PLUG	
	S			CAVITY PLUG	
	T			CAVITY PLUG	
76	U	18	GRN		CAN_L
77	V	18	YEL		CAN_H
	W			CAVITY PLUG	
	X			CAVITY PLUG	

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
35	1	18	BLK		GROUND
80	2	18	WHT		
	3			CAVITY PLUG	
	4			CAVITY PLUG	
	5			CAVITY PLUG	
	6			CAVITY PLUG	
56	7	18	RED		BATT(+)
36	8	18	BLK		GROUND
	9			CAVITY PLUG	
79	10	18	YEL		CAN_H
78	11	18	GRN		CAN_L
	12			CAVITY PLUG	

NOTES:
1. ALL WIRE TO BE 18 AWG UNLESS OTHERWISE NOTED.
2. DIMENSIONS IN [ ] ARE MILLIMETERS.
3. ALL WIRES THAT ARE NOT IN CONNECTORS TO EXTEND 3.0" PAST LOOM.

REV	DESCRIPTION OF CHANGE	DWN	APVD

DESCRIPTION
TRONAIR 28.5V
HARNESS, EVAPAR

ci8group

SCALE	DATE	DRAWN BY	APPRVD BY
NTS	03/29/2022	MR	MR

SIZE	DRAWING	SHEET	REV
B	00EVAP07	1 OF 2	A

D3

MADE FROM	N/A
MATERIAL	N/A
FINISH	N/A
THIRD ANGLE PROJECTION	SCALE: 1:1
SIZE	C
	DO NOT SCALE DRAWING

BREAK ALL SHARP EDGES AND CORNERS
INTERPRET PER ASME Y14.5-2009

DIMENSIONS IN INCHES AND TOLERANCES
PER BELOW UNLESS OTHERWISE SPECIFIED:
DIMENSION INCH [mm]:
.X [X] ± .1 [3]
.XX [.X] ± .03 [0.8]
.XXX [.XX] ± .010 [0.25]
.XXXX [.XXX] ± .0030 [0.076]
FRACTION INCH [mm]:
1/XX [1/X] ± 1/16 [1.6]
ANGULAR DEGREE [RADIANS]:
X [XXX] ± .5 [.001]

TRONAIR
AIRCRAFT GROUND SUPPORT EQUIPMENT

DWN BY	CKD BY	DATE
NGL		no/tc/heck

SCHEMATIC, ELECTRICAL

		REV
	INS-2372	D

WEIGHT:	SHEET
LB	SHEET 2 OF 3

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
1	1	14	RED	SPLICE A	BATT(+)
2	3	14	RED	SPLICE A	BATT(+)
3	5	14	RED	SPLICE A	BATT(+)
7	2	14	BLK	SPLICE C	BATT(-)
8	4	14	BLK	SPLICE C	BATT(-)
9	6	14	BLK	SPLICE C	BATT(-)
12	28	18	WHT	FFTS [2]	
13	30	18	YEL	SPLICE F	CAN1_H
14	31	18	GRN	SPLICE N	CAN1_L
19	32	18	BRN	FFTS [1]	
20	35	18	WHT	PANEL [H]	PARKING BRAKE
21	40	18	WHT	E-FEED RELAY [85]	E-FEED RELAY (-)
22	44	18	YEL/BRN	WIF [1]	
23	48	18	BRN	WIF [2]	
24	69	18	GRN	INTER1_OLV [4]	
25	70	18	BLK	INTER1_OLV [3]	
26	75	18	WHT	FUSE CONNECTOR [G]	ECU ENABLE
27	76	18	WHT/RED	INTER3_MAF [4]	
28	79	18	WHT	INTER3_MAF [2]	
30	80	18	GRN	SPLICE G	CAN2_L
29	81	18	YEL	SPLICE P	CAN2_H
35	86	18	GRN	INTER3_MAF [1]	
36	87	18	YEL/BRN	INTER3_MAF [3]	
37	88	18	WHT	MAIN RELAY [85]	MAIN RELAY (-)

MAF
(ITEM 9)

NO.	POS	AWG	COLOR	DESTINATION
35	1	18	GRN	ECU [86]
28	2	18	WHT	ECU [79]
36	3	18	YEL/BRN	ECU [87]
27	4	18	WHT/RED	ECU [76]

NOTES:
1. ALL WIRE TO BE 18 AWG UNLESS OTHERWISE NOTED.
2. DIMENSIONS IN [ ] ARE MILLIMETERS.
3. YELLOW AND GREEN CAN WIRES TO BE TWISTED.

ECU CONNECTOR
(ITEM 1)

3.0" [75] (LOOM) · 7.0" [175] (LOOM) · 4.0" [100] (LOOM) · 1.0" [25] (LOOM) · 5.0" [125] (LOOM) · 48.0" [1200] (LOOM) · 8.0" [200] (LOOM) · 8.0" [200] (LOOM) · 39.0" [990] (LOOM) · 12.0" [300] (LOOM)

GLOW FUSE
(ITEM 14)

42 10-RED
75 10-RED
76 10-RED
BATT (+)
(ITEM 15)

10.0" [250] (LOOM)

11 10-BLK
48 10-BLK
67 10-BLK
BATT (-)
(ITEM 15)

10.0" [250] (LOOM)

INTER1_OLV
(ITEM 2)

NO.	POS	AWG	COLOR	DESTINATION
41	1	18	RED	SPLICE H
64	2	18	WHT	GLOW RELAY [85]
25	3	18	BLK	ECU [70]
24	4	18	GRN	ECU [69]

14.0" [350] (LOOM) · 60.0" [1525] (LOOM) · 12.0" [300] (LOOM) · 3.0" [75] (LOOM)

OBD2
(ITEM 4)

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
5	1	16	RED	SPLICE A	BATT (+)
10	2	16	BLK	SPLICE C	BATT (-)
15	3	18	YEL	SPLICE F	CAN1_H
16	4	18	GRN	SPLICE N	CAN1_L
31	5	18	YEL	SPLICE P	CAN2_H
32	6	18	GRN	SPLICE G	CAN2_L

PANEL
(ITEM 3)

12.0" [300] (LOOM) · 16.0" [400] (LOOM) · 16.0" [400] (LOOM) · 16.0" [400] (LOOM)

81 10-RED — GLOW PLUG #8 RING (ITEM 16)
82 12-RED — STARTER SOLENOID #8 RING (ITEM 17)

ALTERNATOR
(ITEM 5)

NO.	POS	AWG	COLOR	DESTINATION
	1			CAVITY PLUG
53	2	18	WHT	PANEL [J]
	3			CAVITY PLUG

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
50	1	16	PUR	SPLICE J	BATT (+)
	2			CAVITY PLUG	
55	3	16	WHT	PANEL [W]	FUEL LEVEL
54	4	16	ORG	PANEL [R]	ALARM
56	5	16	YEL	PANEL [X]	AUX INPUT
47	6	14	BLK	SPLICE [L]	GROUND

INTER6
(ITEM 10)

20.0" [500] (LOOM) · 12.0" [300] (LOOM) · 43.0" [1090] (LOOM) · 12.0" [300] (LOOM) · 2.0" [50] (LOOM) · 10.0" [254] (LOOM)

74 · 70,71

FHHS
FUSE
(ITEM 14)

NO.	POS	AWG	COLOR	DESTINATION
65	1	16	RED	E-FEED RELAY [87]
66	2	16	BLK	SPLICE K

E-FEED PUMP
(ITEM 11)

D3

NO.	POS	AWG	COLOR	DESTINATION
22	1	18	YEL/BRN	ECU [44]
23	2	18	BRN	ECU [48]

16.0" [400] (LOOM)

WIF
(ITEM 11)

NO.	POS	AWG	COLOR	DESTINATION
19	1	18	BRN	ECU [32]
12	2	18	WHT	ECU [28]

4.0" [100] (LOOM) · 16.0" [400] (LOOM)

FFTS
(ITEM 13)

NO.	POS	AWG	COLOR	DESTINATION
69	A	12	BLK	SPLICE K
71	B	12	RED	FHHS FUSE

FFHS2
(ITEM 12)

8.0" [200] (LOOM) · 8.0" [200] (LOOM)

FFHS1
(ITEM 12)

NO.	POS	AWG	COLOR	DESTINATION
68	A	12	BLK	SPLICE K
70	B	12	RED	FHHS FUSE

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
	A			CAVITY PLUG	
38	B	12	RED	SPLICE H	BATTERY (+)
	C			CAVITY PLUG	
43	D	14	BLU	START RELAY [86]	CRANK
44	E	12	BLK	SPLICE L	BATTERY (-)
	F			CAVITY PLUG	
49	G	14	PUR	SPLICE J	IGNITION
20	H	18	WHT	ECU [35]	PARKING BRAKE
53	J	18	WHT	ALTERNATOR [J]	ALT ENABLE
34	K	18	GRN	SPLICE G	CAN2_L
33	L	18	YEL	SPLICE P	CAN2_H
	M			CAVITY PLUG	
	N			CAVITY PLUG	
	P			CAVITY PLUG	
54	R	16	ORG	INTER6 [4]	ALARM O/P
	S			CAVITY PLUG	
	T			CAVITY PLUG	
18	U	18	GRN	SPLICE N	CAN1_L
17	V	18	YEL	SPLICE F	CAN1_H
55	W	16	WHT	INTER6 [3]	FUEL LEVEL
56	X	16	YEL	INTER6 [5]	AUX INPUT

FUSE
CONNECTOR
(ITEM 6)

NO.	POS	AWG	COLOR	DESTINATION	FUNCTION
57	A	14	RED	SPLICE B	25A FUSE
39	B	14	RED	SPLICE H	25A FUSE
60	C	16	RED	SPLICE E	5A FUSE
6	D	16	RED	SPLICE A	5A FUSE
63	E	12	RED	START RELAY [30]	30A FUSE
40	F	12	RED	SPLICE H	30A FUSE
26	G	18	WHT	ECU [75]	15A FUSE
52	H	16	PUR	SPLICE J	15A FUSE

1.0" [25] (LOOM) · 12.0" [300] (LOOM)

	75	46	51	74
	10-RED	16-BLK	16-PUR	10-RED
30	85	86	87	

FFHS RELAY (ITEM 7)

	61	21	62	85
	16-RED	WHT	16-RED	16-RED
30	85	86	87	

E-FEED RELAY (ITEM 8)

	63	45	43	82
	12-RED	14-BLK	14-BLU	12-RED
30	85	86	87	

START RELAY (ITEM 8)

	58	37	59	4
	14-RED	WHT	16-RED	14-RED
30	85	86	87	

MAIN RELAY (ITEM 8)

	79	54	80	81
	10-RED	WHT	16-RED	10-RED
30	85	86	87	

GLOW PLUG RELAY (ITEM 7)

REV	DESCRIPTION OF CHANGE	DWN	APVD
B	MOVED GLOW PLUG AND FHHS FUSES; REMOVED	MR	MR
	SPLICE M; UPDATED RELAY / FUSE LAYOUT; INCREASED		
	LENGTH AND CHANGED P/N FOR MAF. [12/29/20]		

DESCRIPTION
DOOSAN DM01 / 02
HARNESS, EVAPAR

ci8group

SCALE	DATE	DRAWN BY	APPRVD BY
NTS	12/09/2020	MR	MR

SIZE	DRAWING	SHEET	REV
B	00EVAP01	1 OF 2	B

MADE FROM
N/A

MATERIAL
N/A

FINISH
N/A

THIRD ANGLE PROJECTION · SCALE: 1:1 · SIZE C

DO NOT SCALE DRAWING

BREAK ALL SHARP EDGES AND CORNERS
INTERPRET PER ASME Y14.5-2009

DIMENSIONS IN INCHES AND TOLERANCES PER BELOW UNLESS OTHERWISE SPECIFIED:
DIMENSION INCH [mm]:
.X [X] ± .1 [3]
.XX [.X] ± .03 [0.8]
.XXX [.XX] ± .010 [0.25]
.XXXX [.XXX] ± .0030 [0.076]
FRACTION INCH [mm]:
1/XX [1/X] ± 1/16 [1.6]
ANGULAR DEGREE [RADIANS]:
X [XXX] ± .5 [.001]

TRONAIR — AIRCRAFT GROUND SUPPORT EQUIPMENT

DWN BY	CKD BY	DATE
NGL		no/tc/heck

SCHEMATIC, ELECTRICAL

INS-2372 — REV D

WEIGHT: LB — SHEET 3 OF 3

TRONAIR®

APPENDIX II

Controller
(Murphy MPC-20)

Software Release: 2.8.10043

MURPHY®
by ENOVATION CONTROLS

MPC-20

Engine Controller

Operations Manual

Software Release 2.8.10043

*Approved by CSA for non-hazardous locations (Group Safety Publication EIC 61010-1)
Products covered in this document comply with European Council electromagnetic compatibility directive 2004/108/EC and electrical safety directive 2006/95/EC.

00-02-0898
2015-10-29
Section 40

Software Release: 2.8.10043

In order to consistently bring you the highest quality, full-featured products, we reserve the right to change our specifications and designs at any time.

Warranty - A limited warranty on materials and workmanship is given with this Murphy product.
A copy of the warranty may be viewed or printed by going to www.fwmurphy.com/warranty.

ENOVATION CONTROLS has made efforts to ensure the reliability of the MPC-20 and to recommend safe use practices in system applications. Please note that in any application, operation and controller failures can occur. These failures might result in full control outputs or other outputs that might cause damage to or unsafe conditions in the equipment or process connected to the MPC-20.

Good engineering practices, electrical codes and insurance regulations require that you use independent external protective devices to prevent potentially dangerous or unsafe conditions. Assume that the MPC-20 can fail with outputs full ON, outputs full OFF or that other unexpected conditions can occur.

Please read the following information before installing.

BEFORE BEGINNING INSTALLATION OF THIS MURPHY PRODUCT:

- A visual inspection of this product before installation for any damage during shipping is recommended.
- Disconnect all electrical power to the machine. Failure to disconnect all electrical power connections before welding can result in damage to the panel and/or its components.
- It is your responsibility to have a qualified technician install the unit and make sure installation confirms with local codes.
- Observe all Warnings and Cautions in each section of these instructions.
- The MPC-20 is designed for use in industrial environments. There might be potential difficulties in ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbances.
- Please contact ENOVATION CONTROLS immediately if you have any questions.

IMPORTANT! False or improper use and operation of electronic products could be dangerous. It is required that point-of-operation guarding devices be installed and maintained. All such devices must meet OSHA and ANSI Machine safety standards. The manufacturer shall not accept any responsibility for installation, application or safety of systems.

Table of Contents

Introduction

This document is designed to support a user in getting familiar with the MPC-20 and how to navigate the interface, modify the settings when installing and operating the controller. The Quick Set Up guide assists with establishing the different functions in the MPC-20 System Controller. Before attempting to set up the controller, be sure to read and understand this manual in its entirety.

Murphy PowerCore 20 (MPC-20)

The Murphy PowerCore 20 Controller (MPC-20) is a general all-purpose manual/auto start and manual/auto throttling engine controller. The controller is purposed primarily for pump and irrigation applications. However, it is versatile and flexible enough to be used on many applications outside pump and irrigation. This is a powerful controller that supports J1939 CAN protocols for electronically governed engines as well as mechanical engines for fault and safety shutdowns.

The MPC-20 is flexible in many aspects. The flexibility consists of the ability to:

- use in most applications where auto start or auto throttling is required or desired.
- use the same controller on electronically governed J1939 and mechanical engines.
- use the same controller on 12VDC or 24VDC systems.
- use as auto start or manual start controller.
- use as manual throttle or auto throttle controller.
- change the input type for the analog inputs.
- use additional analog inputs as digital ground inputs.
- assign functions and actions to digital inputs.
- use digital inputs as battery or ground inputs.
- be mounted in all-weather environment.
- be customer-mounted in panel of choice.

Engine Application States

The MPC-20 Controller, while reprogrammable, follows a standard operating sequence. This operating sequence is a set of machine states that happen in a predetermined order. Machine states can be set to zero if not needed or adjusted to fit the application. The following states will be executed during the auto sequence, provided that the corresponding timer has not been set to 00:00:00 or the controller has not been placed in a manual mode of operation:

- Stabilize: This is a timed state to allow the controller to enable the ECU or any senders without warnings or errors. This timer can be disabled if set up for mechanical engine use.
- Stopped: This is a timed state where the engine is ready to be started manually or automatically.

- Standby: This is a timed state that will shut off the LCD backlight, heater and CAN transceiver to conserve power while the unit waits for a key press or an automatic start condition.
- Auto Start Delay: (**available in Auto mode only)** The auto start condition is ignored and must remain active throughout this delay, or the delay is reset to zero.
- Check Safe To Start: This is a non-timed state that will check to ensure the engine can start safely.
- Auto Stop Delay: (available in Auto Mode only) The auto stop condition is ignored and must remain active throughout this delay, or the delay is reset to zero.
- Minimum Run Time: This timer is only active using autostart and with all autostart types except local key and clock. Local stop key will also initiate the stop sequence before the timer expires, if pressed.
- ECU Stabilize Timer: This delay begins timing when the controller is powered up, Spindown or Standby delays have expired. During this delay, the ECU enable output is turned on. The ECU output turns off when the Standby, ETS or Spindown delays begin timing.
- Prestart Delay 1: (available in Auto Mode only) After an auto start condition has been accepted by the controller, this delay begins timing, and the prestart output turns on. When this delay expires, the output is turned off, and the auto sequence continues.
- *Prestart Delay 2 (precrank): (available in Auto Mode only) After an auto start condition has been accepted by the controller, this delay begins timing, and the prestart output turns on. When this delay expires, the output is turned off, and the auto sequence continues. During this delay, the controller checks for faults, J1939 com, etc.
- *Prestart Delay 2 (crank through): (available in Auto Mode only) After an auto start condition has been accepted by the controller, this delay begins timing, and the prestart output turns on. When this delay expires, the output remains on, and the auto sequence continues. The output turns off when the engine actually starts. During this delay, the controller checks for faults, J1939 com, etc.
- Crank: This is a timed state to try and start the engine.
- Crank Rest: This is a timed state to rest the starter between cranks in case the engine did not start during the crank state.
- False Start Check: This is a non-timed state that will ensure the engine stays above the crank cut RPM after cranking.
- Warm-up: (**available in Auto mode only)** This is a timed state that will allow the engine to change from idle to desired warm-up RPM after starting. Warm-up will only set as low as the minimum RPM set point.
- Line Fill 1: (**available in Auto mode only)** This is a timed state that will exit if the timer times out or the pressure set point for this state is reached.
- Line Fill 2: (**available in Auto mode only)** This is a timed state that will exit if the timer times out or the pressure set point for this state is reached.
- Running Loaded: This is a non-timed state that the controller will stay in until a stop condition occurs.

- Cooldown: (**available in Auto mode only)** This is a timed state that will allow the engine to run at a desired speed to cool down before allowing to go into a stopped state.
- Energize to Stop: This is a timed state that will control an output in order to stop the engine.
- Spindown: The time allotted for the engine to stop all revolutions and be in a stopped state with no frequency.
- Post Crank Lockout Delay (setup): This delay begins timing when the engine actually starts. During this delay, the selected function is ignored. When this delay expires, the selected function is armed. During the duration of this delay, the selected function can cycle from active to not active and not reset the delay.
- Post Warmup Lockout Delay (setup):This delay begins timing when the warmup delay expires. During this delay, the selected function is ignored. When this delay expires, the selected function is armed. During the duration of this delay, the selected function can cycle from active to not active and not reset the delay.
- Bubble Lockout Delay (setup): This delay begins timing when the selected function is active. If the selected function is removed during this delay, the delay resets to zero. If the selected function remains active throughout this delay, the selected action will occur.

User Interface

The keypad on the MPC-20 is comprised of 11 tactile buttons. This section describes the functions of each button.

The buttons have the following functions:

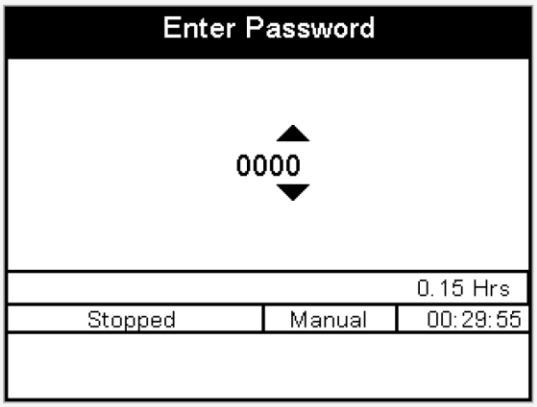
- **Start Key** – Allows the operator to start sequence in Manual Mode or initiate an auto start sequence when in Auto Mode.
- **Stop Key** – Allows the operator to initiate the stop sequence in either mode of operation. A single button press in auto will initiate an auto stop. As a safety feature, when the stop button is pressed twice or held (in auto mode), the controller will skip the cool-down state and (upon shutting down) will place itself in manual mode to eliminate an auto crank condition. This happens if the autostart condition is still present.
- **Auto Key** – Allows the operator to change from Auto to Manual or Manual to Auto Mode by press-hold for 3 seconds.

- **Alarm Silence Key** – Allows the operator to silence the internal siren when an alarm or shutdown is present on the controller.
- **Manual Throttle Increase Key** – Allows the operator to manually increase the engine throttle in Manual Mode.
- **Manual Throttle Decrease Key** – Allows the operator to manually decrease the engine throttle in Manual Mode.
- **Menu Key** – Allows the operator to get into and out of the menus.
- **Back Key** – Allows the operator to move back one step while in the menu.
- **Enter Key** – Allows the operator to enter a value in the menu when selected and is used to acknowledge internal and external alarm/shutdowns.
- **Up Key** – Allows the operator to navigate up through the menu and page forward on the main pages.
- **Down Key** – Allows the operator to navigate down through the menu and page reverse on the main pages.

Accessing the Menu

To access the MPC-20 menu, press the menu button: 

The following screen will display to enter the password (3482):



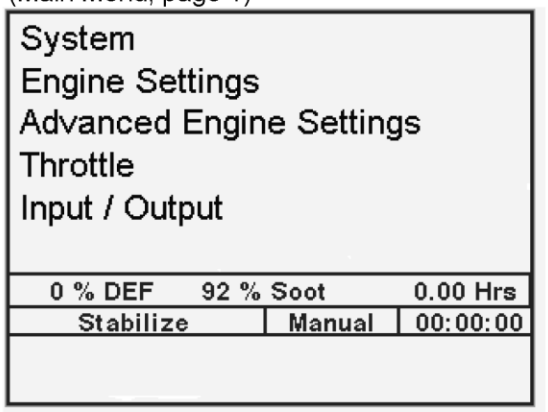
The password will be entered right to left. Utilize the up and down arrows, and press the Enter button after each correct number:  . Entering this password will allow full

access to the menu. If you enter the wrong password, it will reset the display to 0000, allowing you to restart the entering process.

Main Menu

The MPC-20 controller is incredibly versatile within the menu structure. The operator is able to change many parameters and settings from the face without the need of a PC tool, if desired. The controller has to be in its stopped state in order to change a setting in the menu. (The Tier 4 menu is the exception). Described below are the main sections of the controller's menu. **Cycling power to the controller is recommended after making changes to set points.**

(Main Menu, page 1)



System

The controller System menu provides the operator with the ability to set the Date/Time, Units, Language, Brightness, Contrast, Service Reminders and several other system settings. Review System under the Menu Glossary section of this manual for a full list and definition of each setting.

Engine Settings

The Engine Settings menu allows the operator to establish common user-configurable parameters that would be changed from factory default settings when pairing the controller to an engine. This menu allows the operator to choose whether the engine is J1939 or mechanical; the engine's speed source; the minimum and maximum RPM the operator requires/allows the engine to run; the RPM step size; warm-up/cool-down settings; and other common engine settings. Review Engine Settings under the Menu Glossary section of this manual for a full list and definition of each setting.

Advanced Engine Settings

The Advanced Engine Settings menu allows the operator to set up the less common user-configurable parameters that are not in the Engine Settings menu and which would be changed from factory default settings when pairing the controller to an engine. This menu allows the operator to set items such as the J1939 address claim for the controller, ECU Source Address, ECU hour select, crank attempts, crank disconnect speed, clutch engage/disengage speed, run to destruct mode and other user-specific engine settings. Review Advanced Engine Settings under the Menu Glossary section of this manual for a full list and definition of each setting.

Throttle

The Throttle menu allows the operator to set up the items for throttling the engine such as throttle type, rate of RPM increase/decrease, throttle Inc/Dec pulse time, throttle RPM deadband and other parameters pertaining to throttling of the engine. Review Throttle under the Menu Glossary section of this manual for a full list and definition of each setting.

Input / Output

The Input/Output Menu allows the user to establish the I/O needed for the application. This includes Digital Inputs, Analog Inputs, Relay Outputs and Digital Outputs. This menu is tied to other aspects of the controller menu such as Auto Start Functions, Auto Throttling Methods, Analog inputs for Mechanical Engine setup, Warning / Shutdown functions and all outputs needed for starting/controlling the engine and alerting the user.

The Digital Inputs of this menu can be configured from the face of the controller to accept three types of inputs.

- High, B(+)
- Low, B(-)
- Open.

The Analog Inputs of this menu can be configured from the face of the controller to accept one of four types of senders without having to order a new controller or arrange jumpers on the hardware.

- Resistive
- 4-20mA
- 0-5VDC
- B(-) for additional Digital Inputs

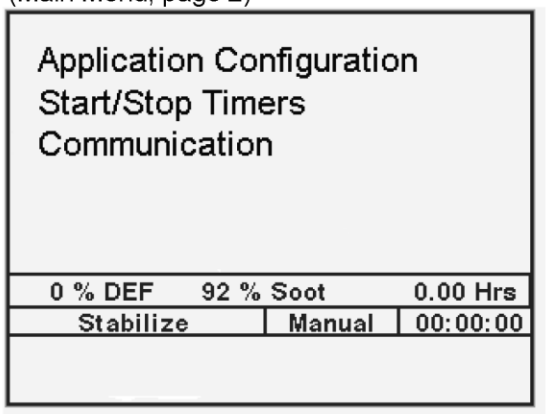
The Outputs are configurable for the operator to choose which output function to use with the desired output type as shown below.

- Relay [10A, Form C]
- Digital Out [200mA, 5VDC]

- Digital Out [2A, B(+)]
- Digital Out [1A, B(-)]

> **NOTE:** Although the functionality exists to set all analog and digital inputs to the same function, Enovation Controls strongly advises against this.

(Main Menu, page 2)



Application Configuration

The Application Configuration menu is where an operator will set up the controller's Auto Start Functions and Auto Throttle Methods, if the intended use is as an auto start and/or auto throttling controller. Depending on which application is chosen in the menu, there are certain auto start functions and auto throttling methods hidden that are not pertinent to the application chosen. This automatic hiding feature allows for a simpler, more intuitive controller menu in the MPC-20. Review Application Configuration under the Menu Glossary section of this manual for the full list and definition of each setting.

Pump All Purpose

The Pump All Purpose application houses most all auto start functions and auto throttling methods of the controller. This application is the most versatile application thus requiring so many combinations of settings for the operator to choose.

The auto start functions and auto throttle methods to choose from are listed below.

Auto Start/Stop Functions

- Level Transducer (will require an Analog Input Setting)
- Flow Transducer (will require an Analog Input Setting)
- Single Contact
- Local Key Start
- Two Contact Maintained
- Two Contact Momentary
- Pressure Transducer (Will require an analog input setting)

Auto Throttle Methods
- Maximum RPM
- Pressure Transducer
- Level Transducer
- Flow Transducer
- Local Throttle Input (This feature throttles the engine proportionally between the minimum and maximum rpm set points.

Center Pivot / Linear Irrigation

The Center Pivot / Linear Irrigation application houses the auto start functions and auto throttle methods meant to be used on center pivot and linear movement irrigation applications.

The auto start functions and auto throttle methods to choose from are listed below.

Auto Start/Stop Functions
- Single Contact (will require a digital input for start and stop)
- Local Start Key
- Two Contact Maintained (will require a digital input for start and stop)
- Two Contact Momentary (will require a digital input for start and stop)

Auto Throttle Methods
- Maximum RPM
- Pressure Transducer (will require an analog input)
- Flow Transducer (will require an analog input)
- Local Throttle Input

Air Compressor

The Air Compressor application houses the auto start functions and auto throttle methods meant to be used on all engine-driven air compressor applications. The MPC-20 allows for the compressor to start/stop and maintain a desired pressure during operation.

The auto start functions and auto throttle methods to choose from are listed below.

Auto Start/Stop Functions
- Single Contact (will require a digital input for start and stop)
- Two Contact Maintained (will require a digital input for start and stop)
- Two Contact Momentary (will require a digital input for start and stop)
- Pressure Transducer (will require an analog input)

Auto Throttle Methods
- Maximum RPM
- Pressure Transducer (will require an analog input)
- Local Throttle Input

Hose Reel Irrigation

The Hose Reel Irrigation application houses the auto start functions and auto throttle methods meant to be used on hose reel irrigation systems. The MPC-20 allows for the hose reel pump to auto start with several methods, including the Local Key Start which may be the most used in this application. The key feature of this application is the auto throttling method. This feature allows the controller to manage the pump's throttle in order to maintain a pressure in the hose during irrigation.

The auto start functions and auto throttle methods to choose from are listed below.

Auto Start/Stop Functions

- Single Contact (will require a digital input for start and stop)
- Local Start Key
- Two Contact Maintained (will require digital inputs for start and stop)
- Two Contact Momentary (will require digital inputs for start and stop)

Auto Throttle Methods

- Maximum RPM
- Pressure Transducer (will require an analog input)
- Local Throttle Input

Frost Protection

The Frost Protection application houses the auto start functions and auto throttle methods meant to be used on frost protection systems. This application allows for wind machine, sprinkler or other forms of frost protection using single contact or a temperature transducer.

The auto start functions and auto throttle methods to choose from are listed below.

Auto Start/Stop Functions

- Single Contact (will require a digital input for start and stop)
- Temperature Transducer (will require an analog input for start and stop)

Auto Throttle Methods

- Maximum RPM

Start / Stop Timers

The Start/Stop Timers menu provides the operator the ability to add a countdown timer and start/stop times. The countdown timer allows for the operator to set a desired countdown time and walk away from the engine for a controlled shutdown when the timer expires. There are eight Start/Stop Timers the operator can choose from within this menu that allows for the specific day and hour the controller will start and stop utilizing the internal clock. Review Start/Stop Timers under Menu Glossary section of this manual for full list and definition of each setting.

Start / Stop timers work in conjunction with other Start / Stop types. If the engine is already running from another Start / Stop type when a Start / Stop timer occurs, the Start / Stop timer is

ignored. Once the engine is started by the Start / Stop timer, the timer has to expire for a controlled shutdown to occur.

Communication

The Communications menu allows the operator to choose the type of RS485 communications such as PVA Gauge, Modbus or Local Display. The menu also allows for the operator to choose the RS485 slave address, RS485 Serial setup and whether or not the controller uses the internal CAN terminating resistor. Review Communication under the Menu Glossary section of this manual for a full list and definition of each setting.

Start/Stop Settings

There are eight automatic start/stop types in the MPC-20. Each is detailed below:

Single Contact Start/Stop:

The Single Contact Start/Stop is when a remote contact closes and remains closed for auto start and re-opens for auto stop.

Two Contact Maintained Start/Stop (commonly known as Floats)

The Two Contact Maintained Start/Stop is when both contacts close for auto start and both contacts open for auto stop (not momentarily). This may also be reversed by altering menu settings.

Two Contact Momentary Start/Stop:

The Two Contact Momentary Start/Stop is when one contact closes momentarily for start and another contact closes momentarily for stop.

(Level, Pressure, Temperature or Flow) Transducer Start/Stop:

A transducer is used for auto throttling and start/stop. There are set points, allowing the operator to enter the appropriate values.

Local Start Key Start/Stop:

The Local Start Key Start/Stop is used to remove any other auto start/stop types within the controller if they are not needed, regardless if in auto or manual modes.

If an auto stop condition occurs during the warmup delay, the controller will enter an auto stop sequence.

Quick-Start Setup Guide

The following sections serve to provide a walk-through of the steps necessary for some of the various configurations and settings available on the MPC-20 Controller. **Cycling power to the controller is recommended after making changes to setpoints.**

Stepping through the Menu will be depicted as follows:

Menu/System/Contrast directs the operator to go into the Menu first, then look for a parameter titled System and press **[Enter]** to go into the System menu. Then look for a parameter titled Contrast and press **[Enter]** to go into the Contrast menu, etc.

Adjusting the Contrast if the screen is too dark/light

1. Access **Menu/System/Contrast.**
2. Utilize the Up and Down arrows to adjust the Contrast (values of 0 to 255), and press **[Enter]** when the desired number appears.
3. Press the **[Menu]** key to leave the Menu Setup screens.

> **NOTE:** The following parameters all utilize the Application Configuration of **Pump All Purpose**. The MPC-20 will hide or display certain parameters that are specific to the Application Configuration chosen.

Setting the MPC-20 to Mechanical Engine

1. Access **Menu/Engine Settings/Engine Type/Mechanical/Speed Source**, and select either Alternator or Magnetic Pickup.
2. Press **[Back]** and down arrow to **Speed Calibration,** press **[Enter]**.
3. Utilize the Up and Down arrows to establish the appropriate number of flywheel teeth or engine alternator pulses, and press **[Enter]**.
4. Press the **[Back]** key twice, and down arrow to **Input/Output**, and press **[Enter]**.
5. Access **Analog Inputs** and assign one Analog input for Oil Pressure and one for Coolant Temperature. Press **[Enter]** to save the settings.
6. Press **[Back]** and access Relay and Digital Outputs.
7. Down arrow to DO1-6, and assign outputs to Crank, Excite Eng. Alternator and Fuel.
8. Press the **[Menu]** key to leave the Menu Setup screens.

Setting MPC-20 to J1939 Engine

1. Access **Menu/Engine Settings/Engine Type/J1939.**
2. Select J1939, and press **[Enter]**.
3. Ensure the engine is using TSC1 throttle or Inc/Dec inputs into the ECU.
4. Set the outputs for Crank, Excite Eng. Alternator, ECU Enable and Inc/Dec Throttling (if selected).
5. Ensure the analog inputs aren't set to oil pressure or coolant temp (disable or change to something else).
6. Press the **[Menu]** key to leave the Setup screens.

Setting MPC-20 to Auto Start on a Single Contact Input

1. Access **Menu/Application Configuration/Auto Start_Stop Function/Single Contact.**
2. Press **[Back]** once and select **Input / Output/Digital Inputs**.
3. Assign the Function of Single Contact Start/Stop to one of the Digital Inputs.
4. Press the **[Menu]** key to leave the Menu Setup screens.

Setting MPC-20 to Auto Start on Local Key

1. Access **Menu/Application Configuration/Auto Start_Stop Function/Local Start Key** and press **[Enter].**
2. Press the **[Menu]** key to leave the Menu Setup screens.

Setting MPC-20 to Auto Start on Float Inputs

1. Access **Menu/Application Configuration/Auto Start_Stop Function**.
2. Highlight Single Contact, Two Contact Maintained or Two Contact Momentary and press **[Enter].**
3. Press **[Back]** once and access **Input / Output/Digital Inputs**, and select a Digital Input to modify.
4. Assign the appropriate input for the selected AI.

> **NOTE:** If Single Contact is chosen, only one digital input needs to be configured. If Two Contact (Maintained and Momentary) is chosen, two digital inputs need to be configured, one for start and one for stop.

5. Ensure the appropriate number of Digital Inputs is configured (as per the Note above) and press the **[Menu]** key to leave the Menu Setup screens.

Setting MPC-20 to Auto Start on Pressure

1. Access **Menu/Application Configuration/Auto Start_Stop Function/Pressure Transducer**, and press **[Enter].**
2. Complete the parameters that apply (i.e., Maintain Pressure, High/Low Pressure, Start/Stop Pressure, etc.)
3. Press **[Back]** twice and access **Input_Output/Analog Inputs.**
4. Select an Analog Input to modify.
5. Assign the appropriate pressure input for the selected AI.
6. Press the **[Menu]** key to leave the Menu Setup screens.

Setting MPC-20 to Auto Start on Level

1. Access **Menu/Application Configuration/Auto Start_Stop Function/Level Transducer**. Press **[Enter]**.
2. Press **[Back]** once and access **Input_Output/Analog Inputs**, and select an Analog Input to modify.
3. Assign the appropriate level input for the selected AI.
4. Press the **[Menu]** key to leave the Menu Setup screens.

Setting MPC-20 to Auto Start on Flow

1. Access **Menu/Application Configuration/Auto Start_Stop Function/Flow Transducer**. Press **[Enter].**
2. Press **[Back]** once and access **Input_Output/Analog Inputs**, and select an Analog Input to modify.
3. Assign the appropriate flow input for the selected AI.
4. Press the **[Menu]** key to leave the Menu Setup screens.

Setting MPC-20 to Auto Start on Clock

> **NOTE:** Ensure the correct date and time are established in the System menu prior to establishing the Auto Start on Clock settings.

1. Access **Menu/Start_Stop Timers**, and select the first Start/Stop Timer.
2. Select Start Day 1 and then select the appropriate day or Daily.
3. Select Start Time 1 and establish the hour, minute and second to start.
4. Establish the Stop Day and Time as in steps 3-4.

> **NOTE:** The MPC-20 Controller has the ability to establish eight different Start/Stop dates and times. If desired, repeat steps 3-5 for subsequent Timers.

Setting MPC-20 to Auto Start on Temperature

1. Access **Menu/Application Configuration/Frost Protection/Auto Start_Stop Function/Temperature Transducer.** Press **[Enter]**.
2. Press **[Back]** once and access **Temperature Transducer**.
3. Establish a Start and Stop Temperature, and press **[Back]** twice.
4. Access **Input_Output/Analog Inputs**, and select an Analog Input.
5. Assign the appropriate temperature input for the selected AI.
6. Press the **[Menu]** key to leave the Menu Setup screens.

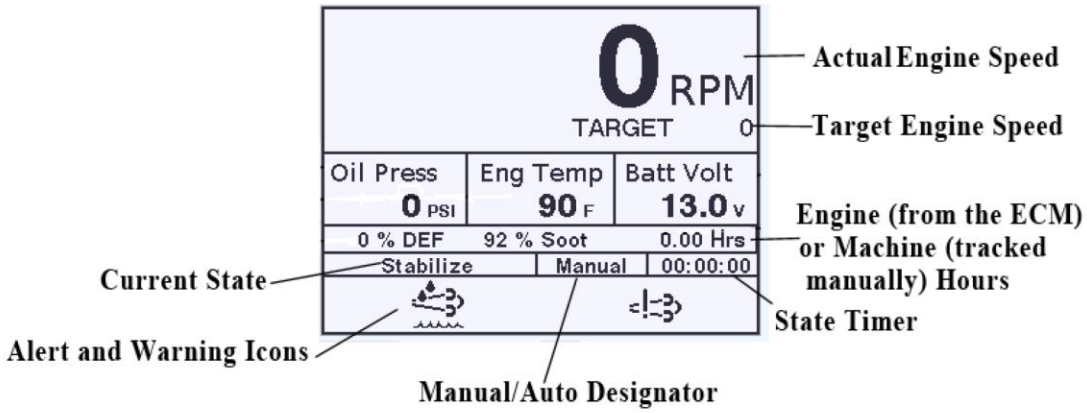
> **NOTE:** If an auto stop condition occurs during the warmup delay, the controller will enter an auto stop sequence.

Setting MPC-20 to Stop the Engine from Utilizing the Countdown Timer

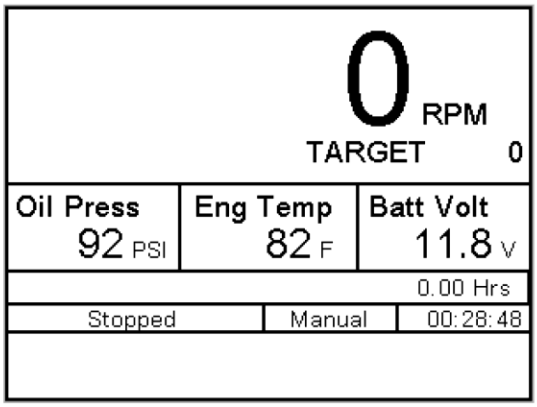
The MPC-20 will control the running of the engine until the chosen stop condition is met or until the Countdown timer runs out of time. Once set, the operator will be required to disable or change the timer in order to eliminate the countdown timer being active on every startup.

1. Access **Menu/Start_Stop Timers/Countdown Timer**.
3. Set the hours, minutes and seconds desired for the running of the engine, and press **[Enter]**.
4. Press the **[Menu]** key to leave the Menu Setup screens.

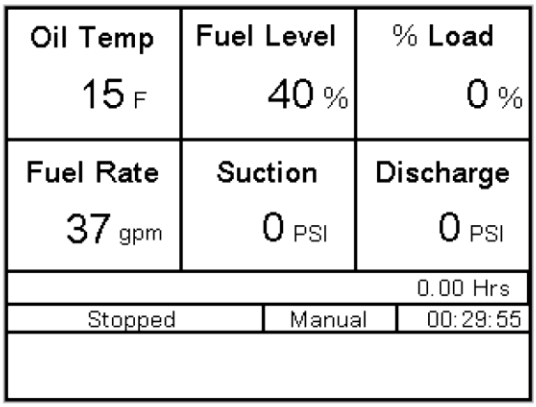
Screen Examples



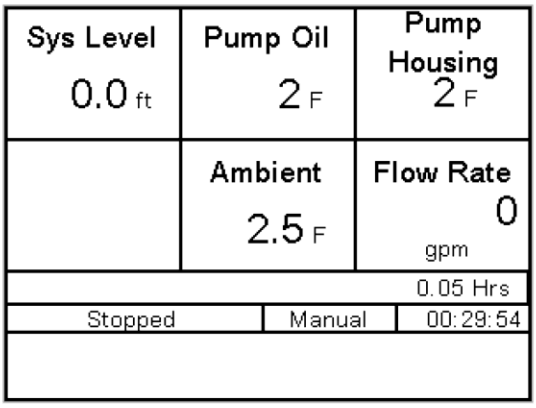
MPC-20 Screens in order



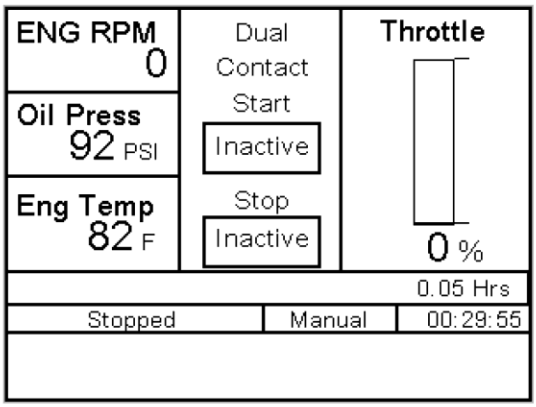
This is the main screen, and it displays actual and target RPM, Oil Pressure, Engine Temperature, Battery Voltage, Engine Hours, Engine State and Mode of Operation.



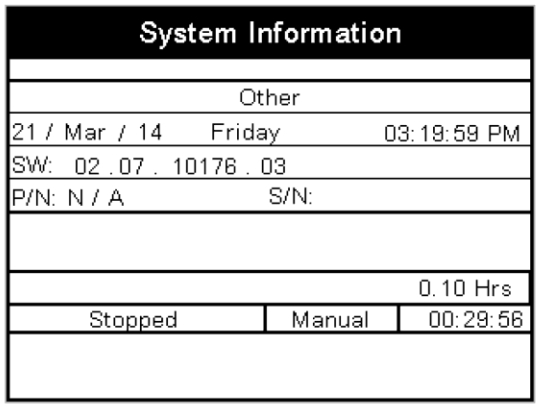
This screen is the first six-up screen, and it displays Oil Temperature, Fuel Level, % Load, Fuel Rate, Suction and Discharge to the operator. If alternate parameters are desired, these may be changed within the free MPC-20 Software Configuration tool.



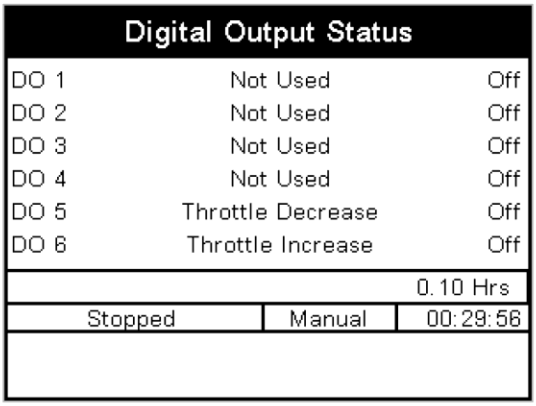
This screen is the second six-up screen, and it displays to the operator System Level, Pump Oil, Pump Housing (temperature), Ambient (temperature) and Flow Rate (gpm). If alternate parameters are desired, these may be changed within the free MPC-20 Software Configuration tool.



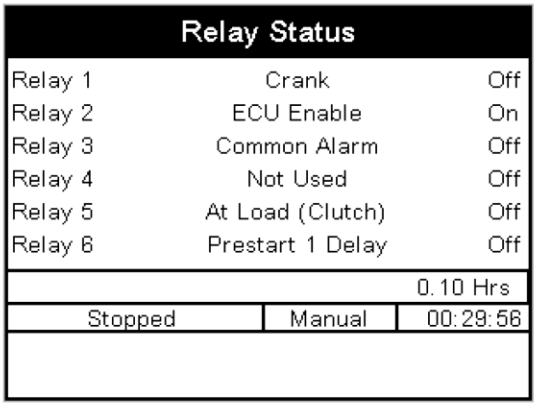
This screen displays the auto start/stop type and will also illustrate the throttling method for the auto start/stop. This screen is set to display dual contact start (floats) and throttling to max RPM.



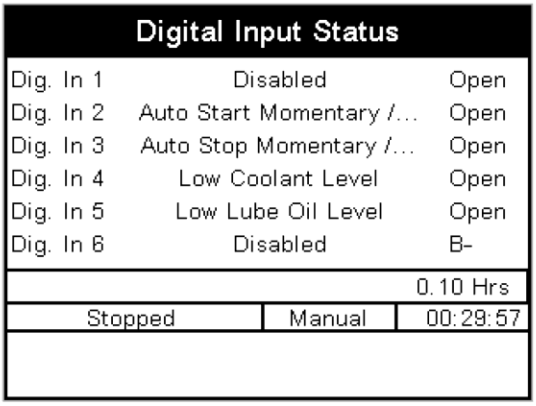
This screen displays the date, day, time, software version number, engine manufacturer, part number (if available) and serial number (if available). This page will assist Technical Services Support should their services be needed.



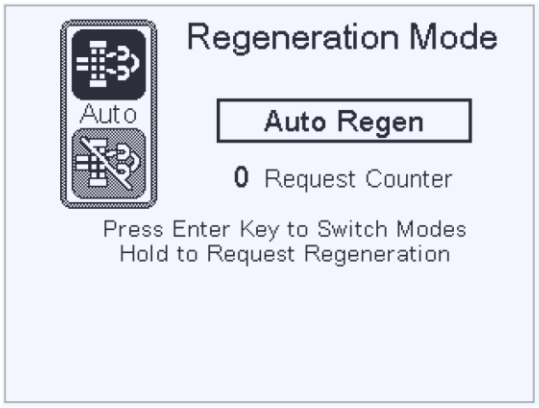
This screen will allow the operator to see what the digital output functions are set to without accessing the menu, and the active setting which informs the user of the output status.



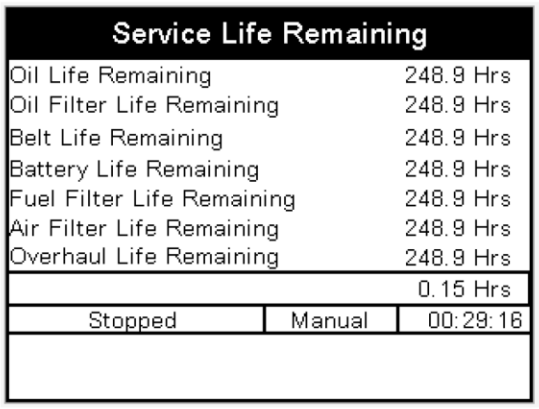
This screen will allow the operator to see what the relay status functions are set to without accessing the menu and the active setting which informs the user of the relay status.



This screen will allow the operator to see what the digital input functions are set to without accessing the menu and the active setting which informs the user of the input status.



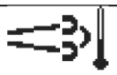
This screen displays the Regeneration Control for Tier 4 engines. Use the Enter button to change from Auto to Inhibit. With Auto Regen selected, hold the Enter button for Regeneration request.



This screen provides a list of service reminders and the hours left until the internal alarm will display the services needed. When 0 hours is reached, the hours will continue to count down in negative numbers.

Warning and Shut-down Icons

The following icons can be displayed at the bottom of the MPC-20 screen to designate that a warning or shut-down situation has occurred:

Icon	Description
	Displays when High Exhaust System Temperature (HEST) is active and exhaust temperature is above normal operating condition.
	Low diesel exhaust fluid. Displays when the DEF is low.
	Displays when engine aftertreatment is in need of a regeneration. This is due to the aftertreatment filter reaching the engine manufacturer's set soot level for a regeneration to occur.
	Displays when the Engine ECU has inhibited a regeneration from occurring. This should also be shown when inhibiting regeneration selection is made in the menu.
	Displays when an emissions aftertreatment malfunction has occurred. Contact your local engine manufacturer's service department for direction.
	Displays when an active and unacknowledged DTC warning exists. The icon will only disappear if the fault has been acknowledged and is no longer active.
	Displays when an active (unacknowledged) DTC shutdown exists.

Icon Troubleshooting

The warnings and shutdowns internally generated by the controller will show an Internal Fault on the top of the screen when a fault is displayed. Check all fluid levels and pressures. Ensure the cooling system and engine are functioning properly.

The warnings and shutdowns the ECU generates will also be accompanied by a cause for the error. Consult with the engine manufacturer regarding fault codes shown on the screen.

If everything checks out normal, consider checking the set points or the bypass timer(s) to ensure the ranges are within normal operating settings.

Menu Glossary

System

Date/Time: allows the setting of the controller's date and time.

Pressure Units: allows the selection of psi, kPa or BAR for pressure designation. **Factory set to PSI.**

Temperature Units: allows the selection of Fahrenheit or Celsius for temperature designation. **Factory set to Fahrenheit.**

Level Units: allows the selection of Feet or Meters for Level designation. **Factory set to Feet.**

Flow Units: allows the selection of gal/min (US), gal/min (UK) and lpm (Liters Per Minute)for flow designation. **Factory set to gal/min (US).**

Brightness: allows the backlight of the screen to be adjusted. **Factory set to 90.**

Contrast: allows the contrast of the screen to be adjusted. **Factory set to 150.**

Backlight Control: turns off (disables) or on (enables) the screen's backlight. **Factory set to Enable.**

Beeper: turns off (disables) or on (enables) the alarm beeper for the controller. **Factory set to Enable**

Standby Timer: setting this timer (HH:MM:SS) allows the screen the designated amount of time before the controller goes into Standby mode. **Factory set to 00:30:00.**

Service Reminders: when the service reminder is set to 0, the alarms will be disabled. However, the countdown will continue and will show the numbers as (-) numbers as it counts down past 0 for the following parameters: **All service reminders factory set to 250 Hrs.**

- Oil Life
- Oil Filter Life
- Belt Life
- Battery Life
- Fuel Filter Life
- Air Filter Life
- Overhaul Life
- Reset All

Stored Fault Codes: allows the operator to query the Engine ECU for review of its stored fault codes.

Auto / Manual: allows the controller to power up in either Manual or Auto Mode of operation depending on the selection chosen. **Factory set to Manual.**

Restore Factory Defaults: allows the operator to reset all menu settings set as defaults from the last configuration loaded in the controller.

View Alarm History: allows the viewing of stored alarms.

Clear Event History: allows the clearing of stored events (alarms).

Engine Settings

Engine Type: allows the selection between J1939 and Mechanical. If Mechanical is chosen, some parameters associated with J1939 will no longer appear in the menu. **Factory set to J1939.**

Engine Manufacturer: allows the selection of the specific Engine Manufacturer (i.e., Caterpillar, Cummins, John Deere, Deutz, Kubota, Yanmar, JCB, Volvo, FPT, Isuzu, Other). **Factory set to Other.**

Engine Emission: allows the selection of the emissions controls (i.e., Tier 3 or less, Interim Tier 4, or Tier 4 / EU Stage IIIA, IIIB). **Factory set to Tier 3 or Less.**

Tier 4 Regeneration: (only appears if Interim Tier 4 or Tier 4 / EU Stage IIIA, IIIB is chosen) allows the automatic running or inhibition of regeneration and/or the requesting of a regeneration. Note: Inhibiting the Regen may cause the engine to de-rate or shut down if the soot level is too high. Recommend leaving this setting in Auto Regen. The ECU may not allow the Regen request if certain parameters do not meet the engine manufacturer's requested levels. **Factory set to Auto Regen.**

Speed Source: allows the selection of the appropriate speed source of the engine (i.e., J1939, Alternator or Magnetic Pickup). **Factory set to J1939.**

Speed Calibration: allows the setting of the correct number of flywheel teeth or engine alternator pulses for mechanical engines. When Speed Source is set to J1939, the Speed Calibration menu is hidden. **Factory set to 150.0.**

Minimum Engine Speed: allows the setting of the lowest engine speed for continual operation. The controller will not allow the engine to throttle under the minimum engine speed. **Factory set to 700 RPM.**

Maximum Engine Speed: allows the setting of the highest engine speed for continual operation. The controller will not allow the engine to throttle above the maximum engine speed. **Factory set to 2000 RPM.**

RPM Step Size: allows the setting of the increments by which the RPM will increase or decrease. **Factory set to 25 RPM**

Warm-Up Speed: allows the setting of the speed of the engine during the warm-up phase. This speed setting must be at or above the minimum engine speed setting. **Factory set to 900 RPM.**

Warm-up Delay: allows the operator to set the desired warm-up time/delay for the engine. This is the length of time the engine will run at a lower speed for its warm-up cycle. **Factory set to 00.03.00.**

Cooldown Speed: allows the setting of the speed of the engine while it is cooling down. This speed setting must be at or above the minimum engine speed setting. **Factory set to 900 RPM.**

Cooldown Delay: allows the operator to set the desired cool down time/delay for the engine. This is the length of time the engine will run at a lower speed for its cool down cycle. **Factory set to 00.03.00.**

Warnings and Shutdowns: allows the settings of the parameters between which the following components will operate:

Low Fuel Level Shutdown: allows the operator to select the desired shutdown in the controller for Low Fuel to shut down the engine before running out of fuel. **Factory set to 5%**

Low Fuel Level Warning: allows the operator to select the desired warning in the controller for Low Fuel to alert the operator when fuel is low. **Factory set to 10%.**

High Battery Warning: allows the operator to select the desired warning in the controller for High Battery to alert the operator when the voltage of the battery is too high. **Factory set to 16.0 V.**

Low Battery Warning: allows the operator to select the desired warning in the controller for Low Battery to alert the operator when the voltage of the battery is too low. **Factory set to 10.0 V.**

Weak Battery Warning: allows the operator to select the desired warning in the controller for Weak Battery to alert the operator when the battery is becoming too weak to function. **Factory set to 11.0 V.**

Underspeed Shutdown: allows the operator to select the desired shutdown in the controller for Underspeed Shutdown to alert the operator when the engine is being shut down due to operating below the established minimum speed when in the running loaded state for this shutdown. **Factory set to 0 RPM.**

Overspeed Shutdown: allows the operator to select the desired shutdown in the controller for Overspeed Shutdown to alert the operator when the engine is being shut down due to operating above the established maximum speed when in the running loaded state for this shutdown. **Factory set to 2400 RPM.**

Advanced Engine Settings

J1939 Address Claim: allows the setting of the address for the controller used in the J1939 engine setting. **Factory set to 3.**

ECU Source Address: source address of the ECU being connected to. Normally set to 0, 1 or 2. **Factory set to 0.**

ECU Hour Select: choose from ECU Hours (engine hours reported by the ECU) or Internal (hours calculated internally by the MPC-20 (provided the RPM>50). **Factory set to ECU Hours.**

Crank Attempts: format of 0.00 to 20.00. The number of times the engine will attempt to start before providing an overcrank shutdown. **Factory set to 3.**

Crank Disconnect Speed: the speed at which the crank will disconnect barring other input parameters. **Factory set to 500 RPM.**

Clutch Engage Speed: the speed at which the clutch will engage. **Factory set to 1200 RPM.**

Clutch Disengage Speed: the speed at which the clutch will disengage. **Factory set to 1000 RPM.**

Run to Destruct: choose from Enable or Disable. This setting will prevent the controller from shutting down the engine for any fault shutdown to allow a run to destruct condition. This setting is primarily used for marine or fire pump applications. **CAUTION: If enabled, the operator must manually select Disable to allow shutdowns and protect the engine. Factory set to Disable**

Timers: establish parameters for the:

Auto Start Delay: the auto start condition must remain active throughout this delay for an auto start to occur. If the auto start condition is removed during this delay, the delay is reset to zero. **Factory set to 00.00.03**

Auto Stop Delay: this auto stop condition must remain active throughout this delay for an auto stop to occur. If the auto stop condition is removed during this delay, the delay is reset to zero. **Factory set to 00.00.03**

Minimum Run Time: auto stop conditions are ignored during this delay. **Factory set to 00.00.00**

ECU Stabilize Timer: on startups, this delay allows the ECU to stabilize and broadcast on the CAN bus prior to actual cranking. **Factory set to 00.00.05**

Crank Time: this is the length of time the crank output is turned on during cycle cranking. **Factory set to 00.00.10**

Crank Rest: this is the length of time the crank output is turned off during cycle cranking. **Factory set to 00.00.10**

Prestart Delay 1: after an auto start condition has been accepted by the controller, this delay begins timing, and the prestart #1 output turns on. When this delay expires, the output is turned off, and the auto sequence continues. **Factory set to 00.00.00**

Prestart Delay 2: after an auto start condition has been accepted by the controller, this delay begins timing, and the prestart #2 output turns on. **Factory set to 00.00.00**

Prestart Delay 2 Mode: this setting determines if the prestart #2 output is active through the crank state or only through the prestart #2 state. Prestart functions are available in Manual mode. **Factory set to PreCrank.**

Energize to Stop Time: this delay begins timing and an output is turned on after an auto stop condition has been accepted by the controller. The output is turned off when this delay expires. **Factory set to 00.00.00**

Spindown Timer: this delay begins timing when there is no call to run and the engine speed is zero. No auto start functions will occur until this delay expires. **Factory set to 00.00.30**

Post Crank Lockout Setup: this is a setup for a delay that begins timing when the engine actually starts. During this delay, the selected functions (Warnings and Shutdowns) are ignored. When this delay expires, the selected functions are armed. During the duration of this delay, the selected functions can cycle from active to not active and not reset the delay.

Post Crank Lockout Time. **Factory set to 00.00.30**
Post Crank Lockout 1. **Factory set to Low Oil Pressure**
Post Crank Lockout 2. **Factory set to Low Discharge Pressure**.
Post Crank Lockout 3. **Factory set to Disabled.**
Post Crank Lockout 4. **Factory set to Disabled**.
Post Crank Lockout 5. **Factory set to Disabled.**

Post Warm-up Lockout Setup: this is a setup for a delay that begins timing when the warm-up delay expires. During this delay, the selected functions (Warnings and Shutdowns) are ignored. When this delay expires, the selected functions are armed. During the duration of this delay, the selected functions can cycle from active to not active and not reset the delay.

Post Warm-up Lockout Time. **Factory set to 00.00.00**
Post Warm-up Lockout 1. **Factory set to Disabled.**
Post Warm-up Lockout 2. **Factory set to Disabled.**
Post Warm-up Lockout 3. **Factory set to Disabled**.
Post Warm-up Lockout 4. **Factory set to Disabled**.
Post Warm-up Lockout 5. **Factory set to Disabled.**

Bubble Lockout Setup: this is a setup for a delay that begins timing when the selected functions are active. If the selected functions are removed during this delay, the delay resets to zero. If the selected functions remain active throughout this delay, the selected action for the parameter will occur.

Bubble Lockout Time. **Factory set to 00.00.00**
Bubble Lockout 1. **Factory set to Disabled.**
Bubble Lockout 2. **Factory set to Disabled**.
Bubble Lockout 3. **Factory set to Disabled.**
Bubble Lockout 4. **Factory set to Disabled**.
Bubble Lockout 5. **Factory set to Disabled.**

Warnings and Shutdowns: establish parameters for the:

Low Fuel Level Warning: sounds a warning when the fuel level reaches the set lower limit parameter. **Factory set to 10%**

Low Fuel Level Shutdown: shuts down the engine when the fuel level reaches the set lower limit parameter. **Factory set to 5%**

High Battery Warning: sounds a warning when the charge on the battery reaches the set higher limit parameter. **Factory set to 16.00 V.**

Low Battery Warning: sounds a warning when the charge on the battery reaches the set lower limit parameter. **Factory set to 10.00 V.**

Weak Battery Warning: sounds a warning when the charge on the battery reaches the set parameter for weakness. **Factory set to 11.00 v.**

LOP High Speed: the speed setting in which the Low Oil Pressure (LOP) will be active at high speed. **Factory set to 2000 RPM.**

LOP Warning/High Speed: the Low Oil Pressure (LOP) setting in which the controller will provide a warning if dropping below at high speed. **Factory set to 35.00 psi.**

LOP Shutdown/High Speed: the Low Oil Pressure (LOP) setting in which the controller will provide a shutdown if dropping below at high speed. **Factory set to 30.00 psi.**

Low Oil Pressure Warning: sounds a warning when the oil pressure reaches the set lower limit parameter for oil pressure. **Factory set to 15.00 psi.**

Low Oil Pressure Shutdown: shuts down the engine when the oil pressure reaches the set lower limit parameter for oil pressure. **Factory set to 10.00 psi.**

High Oil Temp Warning: sounds a warning when the oil temperature reaches the set higher limit parameter for oil temperature. **Factory set to 210 F.**

High Oil Temp Shutdown: shuts down the engine when the oil temperature reaches the set higher limit parameter for oil temperature. **Factory set to 225 F.**

High Oil Pressure Warning: sounds a warning when the oil pressure reaches the set higher limit parameter for oil pressure. **Factory set to 200.0 psi.**

High Oil Pressure Shutdown: shuts down the engine when the oil pressure reaches the set higher limit parameter for oil pressure. **Factory set to 200.00 psi.**

High Engine Temp Warning: sounds a warning when the temperature of the engine reaches the set higher limit parameter for temperature. **Factory set to 210 F.**

High Engine Temp Shutdown: shuts down the engine when the temperature of the engine reaches the set higher limit parameter for temperature. **Factory set to 225 F.**

Low Engine Temp Warning: sounds a warning when the temperature of the engine reaches the set lower limit parameter for temperature. **Factory set to 32 F.**

Underspeed Shutdown: shuts down the engine when the speed reaches the set lower limit parameter for speed. **Factory set to 0 RPM.**

Overspeed Shutdown: shuts down the engine when the speed reaches the set higher limit parameter for speed. **Factory set to 2400 RPM.**

Throttle Menu

Throttle Type: allows the selection of J1939 TSC1, Pulse Inc/Dec or Analog 0-5VDC as the throttle type for the engine. **Factory set to J1939 TSC1.**

J1939 TSC1: this setting will be used when an electronic engine is used for J1939 Throttling. (Verify with Engine Dealer this type of throttling is accepted on the specific engine).

Pulse Inc/Dec: this setting will be used when throttling a mechanical engine, using a throttle actuator and also an electronic engine using digital pulses into the ECU for throttling.

Analog 0-5 VDC: this setting will be used for throttling an electronic engine utilizing 0-5V output.

Auto Throttle Type: Factory set to NON PID Auto Throttle.

NON PID Auto Throttle: this type does not use the P I D adjustments found in the Transducer setups in the Application menu.

PID Auto Throttle: this type does use the P I D adjustments found in the Transducer setups in the Application menu.

Target RPM Step Size: this is the step size of the target RPM when increasing and decreasing. The actual rate of change is much higher when throttling in auto vs. manually with the push buttons. **Factory set to 25 RPM.**

Throttle Deadband RPM: (only appears when Pulse Inc/Dec or Analog, 0-5 VDC is chosen for the Throttle Type) format of **#** RPM. Plus/minus value added to the target to provide a range of RPM during which the throttle is not active. No throttling will occur when the engine RPM is within the RPM deadband.

Throttle Inc/Dec Pulse: (only appears when Pulse Inc/Dec is chosen) format of **#** mS. The amount of time to pulse the throttle. Increase this value for faster engine response, decrease this value for slower engine response.

Throttle Inc/Dec Pulse Delay: (only appears when Pulse Inc/Dec is chosen) format of **#** mS. The amount of delay time before pulsing the throttle. Increase this value for slower engine response, decrease this value for faster engine response.

Throttle Inc Rate: the rate the engine is signaled to increase in RPM. **Factory set to 10 RPM/s.**

Throttle Dec Rate: the rate the engine is signaled to decrease in RPM. **Factory set to 10 RPM/s.**

Analog Minimum Value: (only appears when analog throttle type is chosen) The analog throttle output will not go lower than this setpoint. **Factory set to .50 V.**

Analog Maximum Value: (only appears when analog throttle type is chosen) The analog throttle output will not go higher than this setpoint. **Factory set to 4.5 V.**

Input / Output Menu

Digital Inputs (1-6): for each of the digital inputs, the ability to select the following parameters exists:

Digital input 1. **Factory set to Disabled**
Digital Input 2. **Factory set to Auto Start Momentary/Maintained**
Digital Input 3. **Factory set to Auto Stop Momentary/Maintained**
Digital Input 4. **Factory set to Low Coolant Level**
Digital Input 5. **Factory set to Low Lube Oil Level**
Digital Input 6. **Factory set to Disabled**

Function:
- Disabled
- Single Contact Start/Stop
- Auto Start Momentary / Maintained
- Auto Stop Momentary / Maintained
- Remote Alarm Acknowledge
- Low Fuel Level
- Fuel Leak
- Fuel Filter Restriction
- Low Lube Oil Level
- Low Coolant Level
- Remote Stop
- Idle Engine
- Water in Fuel
- No Flow
- Engine Over Speed
- Crank Termination
- Air Damper Closed
- Air Filter Restriction
- Battery Charger Fail
- Oil Filter Restriction
- Run To Destruct Override
- User 1 through User 6
- Speed 1 through Speed 5
- Parking Brake (Kubota)
- Neutral Switch (Kubota)

Active
- B- (ground input to a function chosen above) **Factory Default**
- B+ (battery positive to a function chosen above).
- Open (sender/switch is open)

Action
- Not Used
- Warning
- Shutdown **Factory Default**
- Shutdown, Controlled (The input will initiate an auto stop. The input has to be inactive for the controller to accept a new auto start signal.)
- Relay Control: used to control one of the relay outputs.

DI Speed Set points: used in place of Throttle Inc/Dec. Provides five throttle set points to which the engine will throttle. These speed inputs will override any other throttling type. When inputs are not active, any other throttling type in use will resume. Digital input 1 will override 2 through 4. Digital 2 will override 3 through 5, and so on.

Analog Inputs (1-8): for each of the analog inputs, the ability to select the following parameters exists:

Analog input 1. **Factory set to Disabled**
Analog Input 2. **Factory set to Disabled**
Analog Input 3. **Factory set to Disabled**
Analog Input 4. **Factory set to Disabled**
Analog Input 5. **Factory set to Disabled**
Analog Input 6. **Factory set to Disabled**
Analog Input 7. **Factory set to Disabled**
Analog Input 8. **Factory set to Disabled**

Function:

- Disabled
- 4-20 mA Oil Pressure
- 0-5V Oil Pressure
- 4-20mA Coolant Temp
- 0-5V Coolant Temp
- 4-20mA Fuel Level
- 0-5V Fuel Level
- 4-20mA Oil Temp
- 0-5V Oil Temp
- 4-20mA Suction Pressure
- 0-5V Suction Pressure
- 4-20mA Discharge Pressure
- 0-5V Discharge Pressure
- 4-20mA System Level
- 4-20mA Flow Rate
- 4-20mA Pump Oil Temperature
- 0-5V Pump Oil Temp
- 4-20mA Pump Housing Temp
- 0-5V Pump Housing Temp
- 4-20mA Ambient Temp
- 0-5V Ambient Temp
- 4-20mA Gear Box Pressure
- 0-5V Gear Box Pressure
- 0-5V Throttle Input
- Datcon Oil Pressure
- Murphy Oil Pressure
- VDO5 Bar Oil Pressure
- VDO7 Bar Oil Pressure
- Murphy Coolant Temp
- Datcon Coolant Temp
- VDO Coolant Temp
- Murphy Fuel Level
- VDO Fuel Level
- Datcon Fuel Level
- Murphy Oil Temp
- Datcon Oil Temp
- VDO Oil Temp
- Murphy Discharge Pressure
- Murphy Suction Pressure
- Datcon Pump Housing Temp
- Murphy Pump Housing Temp
- VDO Pump Housing Temp
- Murphy Pump Oil Temperature
- Datcon Pump Oil Temperature
- VDO Pump Oil Temperature

Murphy PMK-400 Pressure
Analog.Digital1

Sensor Setup (only appears when the analog inputs are configured. This sets the range of sensors for 4-20mA or 0-5V senders).
Oil Pressure (0-5V) or (4-20mA)
Ambient Temp (0-5V) or (4-20mA)
Coolant Temp (0-5V) or (4-20mA)
Discharge Pressure (0-5V) or (4-20mA)
Fluid Pressure (0-5V) or (4-20mA)
Fuel Level (0-5V) or (4-20mA)
Oil Temp (0-5V) or (4-20mA)
Pump Housing Temp (0-5V) or (4-20mA)
Pump Oil Temp (0-5V) or (4-20mA)
Suction Pressure (0-5V) or (4-20mA) By raising the minimum value (5mA or 1V) in the sensor setup, a negative Suction Pressure can be read by the Controller.
Flow Rate (4-20mA)
Speed (4-20mA)
System Level (4-20mA)
Set mA per Ft

Relay (1-6) and Digital (1-6) Outputs: these same parameters are used for both the Relay and Digital Outputs.

Relay 1. **Factory set to Crank.**
Relay 2. **Factory set to ECU Enable.** The controller will not transmit on the CAN bus when this output is off.
Relay 3. **Factory set to Common Alarm.**
Relay 4. **Factory set to Not Used.**
Relay 5. **Factory set to At Load (Clutch).**
Relay 6. **Factory set to Prestart 1 Delay.**
DO1 (5V, 200mA). **Factory set to Not Used.**
DO2 (5V, 200mA). **Factory set to Not Used.**
DO3 (B+, 2A) **Factory set to Not Used.**
DO4 (B+, 2A). **Factory set to Not Used.**
DO5 (B-, 1A). **Factory set to Throttle Decrease.**
DO6 (B-, 1A). **Factory set to Throttle Increase.**

Not Used
Prestart 1 Delay Please see Timers on page 26.
Prestart 2 Delay Please see Timers on page 26.
Crank Please see Timers on page 26.
Fuel Please see Timers on page 26.
ECU Enable Used for enabling the ECU on electronic engines. This output is on anytime the controller is powered up or in the crank/run state. It's turned off if the controller is in the standby state.
Excite Engine Alternator Used for alternators requiring excite from battery. This output is turned on in the crank/run state.
At Load (Clutch) This output is turned on when the warm-up delay has expired and the engine reaches the clutch engage RPM set point. It is turned off during the cool down delay and the engine reaches the clutch disengage RPM set point.
Gov. Control This output turns on after the warmup delay expires and turns off when the cooldown delay begins timing.
Shutdown This output turns on when a fault shutdown occurs.
Common Alarm This output turns on when either a shut-down or a non shut-down warning occurs.
Remote Alarm This output turns on when a either a shut-down or a non shut-down warning occurs.
Air Damper N/De-energized This output turns off during the energize to stop delay.
Not in Auto This output turns on when the controller is in the manual mode.

Air Damper N/Energized This output turns on during the energize to stop delay.
Energize to Stop Please see Timers on page 26.
Engine Running This output turns on after the engine actually starts and off when the engine stops.
Throttle Increase
Throttle Decrease The increase and decrease outputs are used for the pulse inc/dec throttling type.
Digital Input (1-6) A digital input can be assigned to turn on a digital output.
Analog (1-8) Digital An analog input configured to be a digital input can be assigned to turn on a digital output.

Application Configuration

Application

Pump All Purpose: The Pump All Purpose application houses most all auto start functions and auto throttling methods of the controller. This application is the most versatile application thus requiring so many combinations of settings for the operator to choose. **Factory Default**

Center Pivot / Linear Irrigation: The Center Pivot / Linear Irrigation application houses the auto start functions and auto throttle methods meant to be used on center pivot and linear movement irrigation applications.

Air Compressor: The Air Compressor application houses the auto start functions and auto throttle methods meant to be used on all engine-driven air compressor applications. The MPC-20 allows for the compressor to start/stop and maintain a desired pressure during operation.

Hose Reel Irrigation: The Hose Reel Irrigation application houses the auto start functions and auto throttle methods meant to be used on hose reel irrigation systems. The MPC-20 allows for the hose reel pump to auto start with several methods, including the Local Key Start which may be the most used in this application. The key feature of this application is the auto throttling method. This feature allows the controller to manage the pump's throttle in order to maintain a pressure in the hose during irrigation.

Frost Protection: The Frost Protection application houses the auto start functions and auto throttle methods meant to be used on frost protection systems. This application allows for wind machine, sprinkler or other forms of frost protection using single contact or a temperature transducer.

Auto Start / Stop Function

Single Contact (Center Pivot/Linear Irrigation, Air Compressor, Hose Reel Irrigation, Frost Protection)
Local Start Key (Center Pivot/Linear Irrigation, Hose Reel Irrigation)
Two Contact Maintained (Center Pivot/Linear Irrigation, Air Compressor, Hose Reel Irrigation) **Factory Default**
Two Contact Momentary (Center Pivot/Linear Irrigation, Air Compressor, Hose Reel Irrigation)
Pressure Transducer (Air Compressor, Hose Reel Irrigation)
Level Transducer (Pump All Purpose)
Flow Transducer (Pump All Purpose)
Temperature Transducer (Frost Protection)

Auto Throttle Method

Maximum RPM (Pump All Purpose, Center Pivot/Linear Irrigation, Air Compressor, Hose Reel Irrigation, Frost Protection) **Factory Default**
Pressure Transducer (Pump All Purpose, Center Pivot/Linear Irrigation, Air Compressor, Hose Reel Irrigation)
Level Transducer (Pump All Purpose)
Flow Transducer (Pump All Purpose, Center Pivot/Linear Irrigation)
Local Throttle Input - this is for use when an analog input is selected for 0-5V throttle input. (Pump All Purpose, Center Pivot/Linear Irrigation, Air Compressor, Hose Reel Irrigation)

Pressure Transducer

Maintain Pressure. The engine will be throttled between the min. and max. RPM set points to maintain this pressure. **Factory set to 0 psi.**

Deadband Pressure. This extends above and below the maintain set point, no throttling occurs while the pressure is in the deadband. **Factory set to 0 psi.**
Pressure Maintain. Suction / Discharge. Suction starts on high, stops on low. Suction throttles by decreasing the RPM below the deadband and increasing the RPM above the deadband. This is opposite of Discharge pressure. **Factory set to Discharge.**
Steady / Proportional. Steady throttles the engine to the max. RPM set point when starting and stopping on pressure. Proportional throttles the engine proportionally between the min. and max. RPM set points when starting and stopping on pressure. 0 psi must be selected in the maintain pressure for the steady/proportional features to work. **Factory set to Steady.**
Line Fill 1 Speed. The engine is throttled to this speed after warm-up to purge the line. **Factory set to 900 RPM.**
Line Fill 1 Delay. This is the time the engine is held at the Line Fill 1 speed. **Factory set to 00.00.00.**
Line Fill 1 Pressure. The engine is held at the Line Fill 1 Speed until either this pressure set point is reached or the Line Fill 1 Delay expires. **Factory set to 0 psi.**
Line Fill 2 Speed. The engine is throttled to this speed after warm-up to purge the line. **Factory set to 900 RPM.**
Line Fill 2 Delay. This is the time the engine is held at the Line Fill 1 speed. **Factory set to 00.00.00.**
Line Fill 2 Pressure. The engine is held at the Line Fill 1 Speed until either this pressure set point is reached or the Line Fill 1 Delay expires. **Factory set to 0 psi.**
Line Fill 2 features only available when Hose Reel is selected in the Applications menu.
Start Pressure. When the pressure reaches this set point, an auto start will occur. **Factory set to 0 psi.**
Stop Pressure. When the pressure reaches this set point, an auto stop will occur. **Factory set to 0 psi.**
Pressure P. Allows adjustment If using PID throttling. **Factory set to 0.020**
Pressure I. Allows adjustment if using PID throttling. **Factory set to 0.020**
Pressure D. Allows adjustment if using PID throttling. **Factory set to 0.001.**

Level Transducer

Maintain Level. The engine will be throttled between the min. and max. RPM set points to maintain this level. **Factory set to 0.0 ft.**
Deadband Level. This extends above and below the maintain set point, no throttling occurs while the level is in the deadband. **Factory set to 0.0 ft.**
Steady / Proportional. Steady throttles the engine to the max. RPM set point when starting and stopping on level. Proportional throttles the engine proportionally between the min. and max. RPM set points when starting and stopping on level. 0.0 ft must be selected in the maintain level for the steady/proportional features to work. **Factory set to Steady.**
Level Type. Empty / Fill. Empty starts on high, stops on low. Empty throttles by decreasing the RPM below the dead band, and increasing the RPM above the dead band. This is opposite of Fill. **Factory set to Empty.**
Start Level. When the level reaches this set point, an auto start will occur. **Factory set to 0.0 ft.**
Stop Level. When the level reaches this set point, an auto stop will occur. **Factory set to 0.0 ft.**
Level P. Allows adjustment If using PID throttling **Factory set to 0.020**
Level I. Allows adjustment if using PID throttling. **Factory set to 0.020**
Level D. Allows adjustment if using PID throttling. **Factory set to 0.001.**

Flow Transducer

Start Flow Rate. When the flow reaches this set point, an auto start will occur. **Factory set to 0 gpm.**
Stop Flow Rate. When the flow reaches this set point, an auto stop will occur. **Factory set to 0 gpm.**
Maintain Flow.The engine will be throttled between the min. and max. RPM set points to maintain this flow. **Factory set to 0 gpm.**
Steady / Proportional. Steady throttles the engine to the max. RPM set point when starting and stopping on flow. Proportional throttles the engine proportionally between the min. and max. RPM set points when starting and stopping on flow. 0 gpm must be selected in the maintain flow for the steady/proportional features to work. **Factory set to Steady.**
Deadband Flow. This extends above and below the maintain set point, no throttling occurs while the flow in the deadband. **Factory set to 0 gpm.**

Flow Maintain Type. In / Out. Empty / Fill. In starts on low, stops on high. In throttles by increasing the RPM below the deadband and decreasing the RPM above the deadband. This is opposite of Out. **Factory set to Out.**
Flow P. Allows adjustment if using PID throttling **Factory set to 0.020**
Flow I. Allows adjustment if using PID throttling. **Factory set to 0.020**
Flow D. Allows adjustment if using PID throttling. **Factory set to 0.001.**

Temperature Transducer

Start Temperature. When the temperature drops to this set point, an auto start will occur. **Factory set to 32 F**
Stop Temperature. When the temperature rises to this set point, an auto stop will occur. **Factory set to 32 F**.

Warnings and Shutdowns

High Level Warning. **Factory set to 0.0 ft**.
High Level Shutdown. **Factory set to 0.0 ft.**
Low Level Warning**. Factory set to 0.0 ft.**
High Flow Warning**. Factory set to 0 gpm.**
High Flow Shutdown. **Factory set to 0 gpm.**
Low Flow Warning. **Factory set to 0 gpm**.
Low Flow Shutdown. **Factory set to 0 gpm**.
High Discharge Pressure Warning. **Factory set to 0.00 psi.**
High Discharge Pressure Shutdown. **Factory set to 0.00 psi**.
Low Discharge Pressure Warning. **Factory set to 0.00 psi.**
Low Discharge Pressure Shutdown. **Factory set to 0.00 psi.**
High Suction Pressure Warning. **Factory set to 0.00 psi.**
High Suction Pressure Shutdown**. Factory set to 0.00 psi.**
Low Suction Pressure Warning. **Factory set to 0.00 psi.**
Low Suction Pressure Shutdown. **Factory set to 0.00 psi.**
High Pump Housing Temp. Warning. **Factory wet to 32 F**.
High Pump Housing Temp. Shutdown. **Factory set to 32 F.**
High Pump Oil Temp. Warning. **Factory set to 32 F**.
High Pump Oil Temp. Shutdown. **Factory set to 32 F**.

Start / Stop Timers

This section allows the setting of the timers to start and stop the engine. There are eight timers, each with a Start Day and a Stop Day, a Start Time and a Stop Time.

Countdown Timer: The countdown timer will be active upon every auto startup until the time is changed or disabled. It is used when it is desirable for a machine to run for a specific amount of time unmonitored and then shut itself off when that time has expired or when an alternate Stop condition has been met. Format of HH:MM:SS

Start / Stop Timer (1-8): each of the eight timers contains the ability to select from the following parameters:

Days of the week are factory set to Off.
Start and stop Times are factory set to 12.00.00 AM.

Start Day
- Sunday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Daily
- Off

Start Time: format of HH:MM:SS

Stop Day:
- Sunday
- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Daily
- Off

Stop Time: format of HH:MM:SS

Communication

Communication Type:

PVA Gauge: this function will be used if utilizing PVA Gauges on the RS485 Modbus.

Modbus: this function will be used if using a SCADA or telemetry device for polling the Modbus register list. See Modbus Register Map. **Factory Default.**

Local Display: this function will be used to connect the display to a remote viewing application. This can be a program running on a PC or another MPC-20 set up as a remote viewer.

Slave Address. This is the Modbus slave node number. **Factory set to 1**.

Serial Setup.

Baudrate. **Factory set to 19200**.

Stopbits. **Factory set to 1**.

Parity. **Factory set to None**.

PV CAN Backlight Enable. **Factory set to Off**.

Can Termination. **Factory set to Enable.**

Modbus Registers

NOTE: The registers labeled Read/Write will allow the operator to change values through the Modbus as a temporary modification. If power is cycled to the MPC-20, the values changed via Modbus will revert back to the last value entered locally at the MPC-20.

REGISTER #	TYPE	DESCRIPTION	
40001	Read Only	Current Engine Hours	
40002	Read Only	Running Hours LSB.	
40003	Read Only	Current RPM.	
40004	Read Only	Modbus Voltage	
40005	Read Only	Current Oil Pressure	
40006	Read Only	Current Engine Temperature	
40007	Read Only	Current Engine State:	
		#0	ECU Stabilize Delay timing: (1) yes (0) no
		#1	Engine Stopped: (1) yes (0) no
		#2	Controller in Standby Mode: (1) yes (0) no
		#3	Prestart Delay 1 Timing: (1) yes (0) no
		#4	Check Safe to Start: (1) yes (0) no
		#5	Prestart 2 Delay Timing: (1) yes (0) no
		#6	Crank on: (1) yes (0) no

REGISTER #	TYPE	DESCRIPTION	
		#7	Crank Rest: (1) yes (0) no
		#8	False Start Check: (1) yes (0) no
		#9	Warmup Delay Timing: (1) yes (0) no
		#10	Line Fill 1 Delay Timing: (1) yes (0) no
		#11	Line Fill 2 Delay Timing: (1) yes (0) no
		#12	Running Loaded: (1) yes (0) no
		#13	Cooldown Delay Timing: (1) yes (0) no
		#14	Energize to Stop Delay Timing: (1) yes (0) no
		#15	Spindown Delay Timing: (1) yes (0) no
40008	Read Only	Shutdown Status: The following is a description of the bits:	
		Bit 0	Overspeed SD Status: (1) yes (0) no
		Bit 1	Underspeed SD Status: (1) yes (0) no
		Bit 2	Overcrank SD Status: (1) yes (0) no
		Bit 3	Low Oil Pressure SD Status: (1) yes (0) no
		Bit 4	High engine Temperature SD Status: (1) yes (0) no
		Bit 5	Low Fuel SD Status: (1) yes (0) no
		Bit 6	Low Discharge Pressure SD Status: (1) yes (0) no
		Bit 7	High Discharge Pressure SD Status: (1) yes (0) no
		Bit 8	Speed Signal Lost SD Status: (1) yes (0) no
		Bit 9	Low Lube Level SD Status: (1) yes (0) no
		Bit 10	Fuel Leak SD Status: (1) yes (0) no
		Bit 11	Fuel Filter Restriction SD Status: (1) yes (0) no
		Bit 12	Air Damper Closed SD Status: (1) yes (0) no
		Bit 13	Air Filter Restriction SD Status: (1) yes (0) no
		Bit 14	Oil Filter Restriction SD Status: (1) yes (0) no
		Bit 15	Remote Stop SD Status: (1) yes (0) no
40009	Read Only	Shutdown Status: The following is a description of the bits:	
		Bit 0	Coolant Level SD Status: (1) yes (0) no
		Bit 1	High Level SD Status: (1) yes (0) no
		Bit 2	Low Level SD Status: (1) yes (0) no
		Bit 3	High Flow SD Status: (1) yes (0) no
		Bit 4	Low Flow SD Status: (1) yes (0) no
		Bit 5	High Pump Oil Temperature SD Status: (1) yes (0) no
		Bit 6	High Pump Housing Temperature SD Status: (1) yes (0) no
		Bit 7	Water in Fuel SD Status: (1) yes (0) no
		Bit 8	Low Suction SD Status: (1) yes (0) no
		Bit 9	High Suction SD Status: (1) yes (0) no
		Bit 10	High Engine Oil Pressure SD Status: (1) yes (0) no
		Bit 11	High Engine Oil Temperature SD Status: (1) yes (0) no
		Bit 12	Low Gear Box Pressure SD Status: (1) yes (0) no

REGISTER #	TYPE	DESCRIPTION
		Bit 13 High Gear Box Pressure SD Status: (1) yes (0) no
		Bit 14 Battery Charger Fail SD Status: (1) yes (0) no
		Bit 15 Red Lamp Status: (1) yes (0) no
40010	Read Only	Current Discharge Pressure. kPa
40011	Read Only	Current System Level. Feet
40012	Read / Write	Modbus Start Stop: (1) yes (0) no
40013	Read / Write	RPM Run Speed
40014	Read Only	Current Ambient Temperature. Celsius
40015	Read Only	Auto / Manual Mode: (1) Auto (0) Manual
40016 through 40037	Read Only	Reserved
40038	Read / Write	Pressure Start Engine. kPa
40039	Read / Write	Pressure Stop Engine. kPa
40040	Read / Write	Pressure Maintain Value. kPa
40041	Read / Write	Level Maintain Start. Feet
40042	Read / Write	Level Maintain Stop. Feet
40043	Read / Write	Level Maintain Value. Feet
40044	Read / Write	FlowRate.Start. Gpm
40045	Read / Write	FlowRate.Stop. Gpm
40046 through 40200	Read Only	Reserved
40201	Read Only	Version.App.1
40202	Read Only	Version.App.2
40203	Read Only	Version.App.3
40204	Read Only	Version.App.4
40205	Read Only	Version.Config.1
40206	Read Only	Version.Config.2
40207	Read Only	Version.Config.3
40208	Read Only	Serial Number
40210	Read Only	J1939.Engine.Catalyst Tank Level
40211	Read Only	J1939.Engine.Diesel Particulate Filter 1 Soot Load Percent.
40212	Read Only	J1939.Transmit.Diesel Particulate Filter Regeneration Inhibit Switch
40213	Read Only	J1939.Engine.Diesel Particulate Filter Active Regen Inhibited Due to Inhibit Switch
		#0 (LSB) Inhibited Due to Inhibit Switch: (1) yes (0) no
		#1 Reserved
		#2 Reserved
		#3 Reserved
		#4 Reserved
		#5 Reserved

REGISTER #	TYPE	DESCRIPTION
		#6 Reserved
		#7 Reserved
		#8 Reserved
		#9 Reserved
		#10 Reserved
		#11 Reserved
		#12 Reserved
		#13 Reserved
		#14 Reserved
		#15 (MSB) Reserved
40214	Read Only	State Timer.
40215	Read Only	Engine RPM Setpoint.
40216	Read Only	AllPurposeAutoStartFunction
		#0 Single Contact
		#1 Local Start Key
		#2 Two Contact Maintained
		#3 Two Contact Momentary
		#4 Pressure Transducer
		#5 Level Transducer
		#6 Flow Transducer
40217	Read/Write	Pressure Deadband. kpa
40218	Read/Write	Level Deadband. Feet
40219	Read/Write	Flow Deadband. US Gal/min
40220	Read/Write	Start Temperature. Celcius
40221	Read/Write	Stop Temperature. Celcius
40222	Read Only	Current Ambient Temperature. Celcius
40223	Read/Write	Maintain Flow. US Gal/min
40224	Read/Write	RPM Low Idle
40225	Read Only	Service Reminder: Air Filter Life.
40226	Read Only	Service Reminder: Air Filter Life Remaining.
40227	Read Only	Service Reminder: Battery Life.
40228	Read Only	Service Reminder: Battery Life Remaining.
40229	Read Only	Service Reminder: Belt Life.
40230	Read Only	Service Reminder: Belt Life Remaining.
40231	Read Only	Service Reminder: Fuel Filter Life.
40232	Read Only	Service Reminder: Fuel Filter Life Remaining.
40233	Read Only	Service Reminder: Oil Filter Life.
40234	Read Only	Service Reminder: Oil Filter Life Remaining.
40235	Read Only	Service Reminder: Oil Life.
40236	Read Only	Service Reminder: Oil Life Remaining.

REGISTER #	TYPE	DESCRIPTION
40237	Read Only	Service Reminder: Overhaul Life.
40238	Read Only	Service Reminder: Overhaul Life Remaining.
40239	Read Only	Current Fuel Level
40240	Read/Write	Save Changes to Modbus: (1) yes (0) no
40241	Read Only	Modbus EEPROM Saved: (1) yes (0) no
40242	Read Only	Warning Status: The following is a description of bits:
		#0 Low Fuel Warn Status: (1) yes (0) no
		#1 Fuel Leak Warn Status: (1) yes (0) no
		#2 Fuel Filter Restriction Warn Status: (1) yes (0) no
		#3 Low Lube Level Warn Status: (1) yes (0) no
		#4 Coolant Level Warn Status: (1) yes (0) no
		#5 Water in Fuel Warn Status: (1) yes (0) no
		#6 No Flow Warn Status: (1) yes (0) no
		#7 High Engine Oil Temperature Warn Status: (1) yes (0) no
		#8 Low Oil Pressure Warn Status: (1) yes (0) no
		#9 High Engine Temperature Warn Status: (1) yes (0) no
		#10 High Discharge Pressure Warn Status: (1) yes (0) no
		#11 Low Discharge Pressure Warn Status: (1) yes (0) no
		#12 High Suction Warn Status: (1) yes (0) no
		#13 Low Suction Warn Status: (1) yes (0) no
		#14 High Level Warn Status: (1) yes (0) no
		#15 Low Level Warn Status: (1) yes (0) no
40243	Read Only	Warning Status: The following is a description of bits:
		#0 High Flow Warn Status: (1) yes (0) no
		#1 Low Flow Warn Status: (1) yes (0) no
		#2 High Pump Oil Temperature Warn Status: (1) yes (0) no
		#3 High Pump Housing Temperature Warn Status: (1) yes (0) no
		#4 Low Gear Box Pressure Warn Status: (1) yes (0) no
		#5 High Gear Box Pressure Warn Status: (1) yes (0) no
		#6 Air Damper Closed Warn Status: (1) yes (0) no
		#7 Air Filter Restriction Warn Status: (1) yes (0) no
		#8 Oil Filter Restriction Warn Status: (1) yes (0) no
		#9 Low Engine Temperature Warn Status: (1) yes (0) no
		#10 High Engine Oil Pressure Warn Status: (1) yes (0) no
		#11 Battery Charger Fail Warn Status: (1) yes (0) no
		#12 Run To Destruct Warn Status: (1) yes (0) no
		#13 Battery High Warn Status: (1) yes (0) no
		#14 Battery Low Warn Status: (1) yes (0) no
		#15 Amber Lamp Status: (1) yes (0) no

Slave Address: the Modbus Slave device address.

Serial Setup:

- Baud Rate
  - 9600
  - 19200
  - 38400
  - 57600
  - 115200
- Stop Bits
  - 0
  - 1
  - 2
- Parity
  - None
  - Odd
  - Even

PV CAN Backlight Enable

- Off
- On

CAN Termination

- Enable
- Disable

PC Configuration Software

The MPC-20 controller is the first engine controller released utilizing Murphy's PowerVision Configuration Studio®. With PowerVision, engineering will be able to deliver quicker software updates with the flexibility of a software developer's environment. The new addition of PowerVision to this controller gives Enovation Controls the ability to provide a free-of-charge basic PC configuration program to change default parameters in the controller to all customers.

The simplified version of PowerVision that will be utilized to create the configuration for the MPC-20 Controller will be available via download from our website (Forum).
http://forum.fwmurphy.com/viewforum.php?f=49

Customers who require a developer's environment to change or add additional functionality in the controller may do so in their own time without waiting or paying non-recurring engineering fees (also referred to as NRE) to make the changes (requires purchase of full version of PowerVision Configuration Studio®).

Specifications

Electrical

Display: 3.8" Monochrome, Transflective, White Backlight LCD with Heater
Operating Voltage: 8-32 VDC, protected against reverse battery polarity and load-dump
Power Consumption: 18W max without 2 2A High-sides active, 146W max with 2 2A High-sides active
Communications
- **2-CAN:** J1939 (only one supported in initial release)
- **USB:** 2.0B (Only supported for programming)
- **Ethernet:** (Not supported in initial release)
- **RS485:** Modbus RTU

Connection: Delphi SICMA 90 way connector
Keyboard: 11 Tactile Feedback Buttons
Inputs
- **6-Digital Inputs:** configurable (high/low)
- **8-Analog Inputs:** configurable (4-20mA, 0-5V, resistive)
- **1-Frequency Input:**
  - supporting Magnetic Pickup:
    - (2 Hz – 10 kHz, 3.6 VAC – 120 VAC)
  - Supporting Engine Alternator:
    - (2 Hz – 10 kHz, 4.5 VRMS – 90 VRMS)

Outputs
- **6-Relays:** 10A, SPDT, Form C (30 VDC @ 10A max.), 40A maximum aggregate @ 85C
- **2-Low-side Outputs:** 1A
- **2-High-side Outputs:** 2A
- **2-5V Outputs:** 200mA (to drive external relays)
- **1-Analog Output:** 0-5V

Real-time clock: with battery backup

Environmental

Operating Temperature: -40°F to 185°F (-40°C to +85°C)
Storage Temperature: -40°F to 185°F (-40°C to +85°C)
Protection: IP 67 front and back, Panel seal is IP66 when used with Accessory Gasket
Emissions: SAE J1113
Immunity: SAE J1113
Vibration: Random vibration, 7.86 Grms (5-2000 Hz), 3 axis
Shock: ± 50G in axis

Mechanical

Case Material: Polycarbonate/ABS
Keypad/Gasket Material: Silicone

-THIS PAGE INTENTIONALLY LEFT BLANK-

Software Release: 2.8.10043

ENOVATION CONTROLS CORPORATE HEADQUARTERS
5311 S 122ND EAST AVENUE
TULSA, OK 74146

ENOVATION CONTROLS – SAN ANTONIO OFFICE
5757 FARINON DRIVE
SAN ANTONIO, TX 78249

ENOVATION CONTROLS – HOUSTON OFFICE
105 RANDON DYER RD
ROSENBERG, TX 77471

ENOVATION CONTROLS LTD. – UNITED KINGDOM
CHURCH ROAD LAVERSTOCK
SALISBURY SP1 1QZ UK

MURPHY ECONTROLS TECHNOLOGIES (HANGZHOU) CO, LTD.
77 23RD STREET
HANGZHOU ECONOMIC & TECHNOLOGICAL DEVELOPMENT AREA
HANGZHOU, ZHEJIANG 310018 CHINA

DOMESTIC SALES & SUPPORT

ECONTROLS PRODUCTS
PHONE: 210 495 9772
FAX: 210 495 9791
EMAIL: INFO@ECONTROLS.COM
WWW.ECONTROLS.COM

MURPHY PRODUCTS
PHONE: 918 317 4100
FAX: 918 317 4266
EMAIL: SALES@FWMURPHY.COM
WWW.FWMURPHY.COM

MURPHY CONTROL SYSTEMS & SERVICES
PHONE: 281 633 4500
FAX: 281 633 4588
EMAIL: CSS-SOLUTIONS@FWMURPHY.COM

MURPHY INDUSTRIAL PANEL DIVISION
PHONE: 918 317 4100
FAX: 918 317 4124
EMAIL: IPDSALES@FWMURPHY.COM

INTERNATIONAL SALES & SUPPORT

UNITED KINGDOM
PHONE: +44 1722 410055
FAX: +44 1722 410088
EMAIL: SALES@ENOVATIONCONTROLS.EU
WWW.FWMURPHY.EU

CHINA
PHONE: +86 21 6237 5885
FAX: +86 21 6237 5887
EMAIL: APSALES@FWMURPHY.COM

LATIN AMERICA & CARIBBEAN
PHONE: 918 317 2500
EMAIL: LASALES@FWMURPHY.COM

SOUTH KOREA
PHONE: +82 70 7951 4100
EMAIL: SKOREASALES@FWMURPHY.COM

INDIA
PHONE: +91 91581 37633
EMAIL: INDIASALES@FWMURPHY.COM

FM 28221 (Tulsa, OK - USA)
FM 28221 (Rosenberg, TX - USA)
FM 29422 (UK)

FM 523851 TS 16949 (China)

Printed in the USA

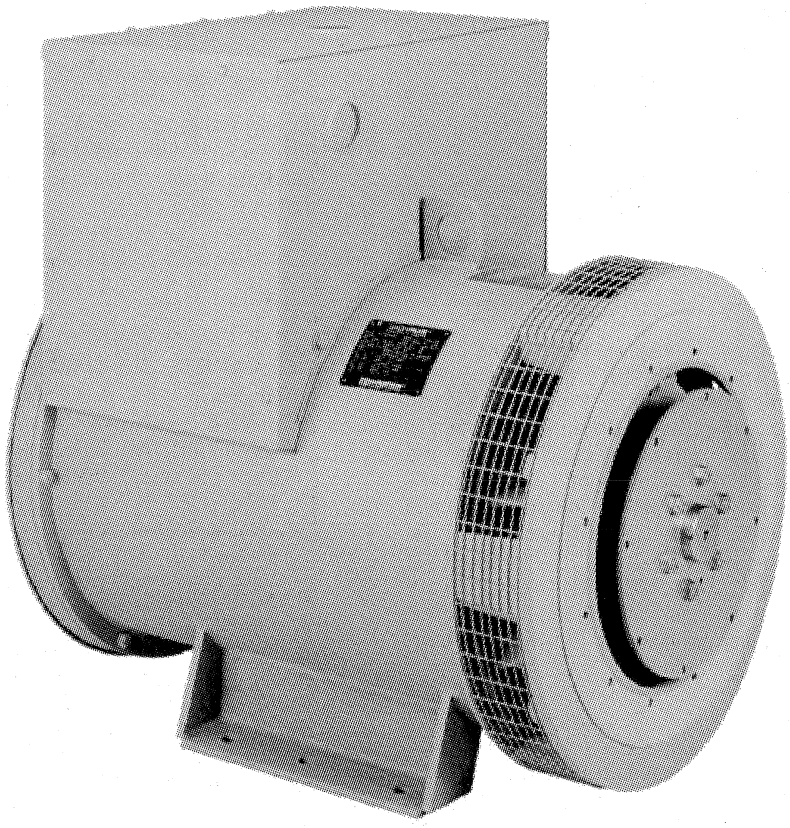
TRONAIR®

APPENDIX III

Alternator Operation and Maintenance Manual (Magnaplus 361)

MAGNAPLUS® GENERATOR

280–430 Frame
Installation, Operation, and Maintenance Manual



MARATHON® ELECTRIC

A Subsidiary of Regal-Beloit Corporation

Marathon Electric Mfg. Corp.
A Subsidiary of Regal-Beloit Corp.
P.O. Box 8003
Wausau, WI 54402-8003
Phone: (715) 675 3359
Fax: (715) 675 8026
www.marathonelectric.com

CONTENTS

SAFETY

PLEASE REMEMBER SAFETY FIRST. If you are not sure of the instructions or procedures contained herein, seek qualified help before continuing.

This service manual emphasizes the safety precautions necessary during the installation, operation, and maintenance of your MagnaPLUS generator. Each section of this manual has caution and warning messages. These messages are for your safety, and the safety of the equipment involved. If any of these cautions or warnings are not readily understood, seek clarification from qualified personnel before proceeding.

Before any service work is done, disconnect all power sources and lock out all controls to prevent an unexpected start-up of the generator set driver. Proper grounding (earthing) of the generator frame and distribution system in compliance with local and national electrical codes and specific site requirements must be provided. These safety precautions are necessary to prevent potential serious personal injury, or even death.

The hazards associated with lifting or moving your MagnaPLUS generator are pointed out in the installation and maintenance sections. Incorrect lifting or moving can result in personal injury or damage to the unit.

Prior to start-up of the unit ensure that all generator leads are properly connected to the generator link board located inside the connection box. Always assume that there will be voltage present at the generator terminals whenever the generator's shaft is rotating, and proceed accordingly. Residual voltage is present at the generator terminals and at the automatic voltage regulator panel connections even with the regulator fuse removed. Caution must be exercised, or serious injury or death can result.

This manual is not intended to be a substitute for properly trained personnel. Installation and repairs should only be attempted by qualified, trained people. The cautions and warnings point out known conditions and situations that are potentially hazardous. Each installation may well create its own set of hazards

When in doubt, ask. Questions are much easier to handle than mistakes caused by a misunderstanding of the information presented in this manual.

RECEIVING AND STORAGE

RECEIVING AND STORAGE

Upon receipt of the generator, it is recommended that it be carefully examined for possible shipping damage. The generator was given to the freight carrier in good condition; thus, the carrier is responsible for the product from the factory dock to the destination. Any damage should be noted on the freight bill before accepting the shipment. Any claims for damage must be promptly filed with the delivering carrier.

UNPACKING AND HANDLING

Carefully read all instruction tags shipped with the unit. When lifting, attach an overhead crane to the lifting lug(s) on the generator frame. Apply lifting forces in a vertical direction. When transporting single bearing generators, the generator's rotor must be adequately supported to prevent damage.

WARNING

THE LIFTING LUG(S) ON THE GENERATOR ARE DESIGNED TO SUPPORT THE GENERATOR ONLY. DO NOT LIFT A COMPLETE GENERATOR AND DRIVER ASSEMBLY BY MEANS OF LIFTING LUG(S) ON THE GENERATOR. PERSONAL INJURY OR EQUIPMENT DAMAGE MAY RESULT.

STORAGE

In the event that the generator is not immediately installed on its prime mover, it is recommended that the unit be stored indoors in a clean, dry area which is not subject to rapid changes in temperature and humidity. If the generator is stored for a long period of time, the generator should be tested, cleaned and dried as required before being put into service. See the maintenance section of this manual for further information. If the unit has been stored in an area where it has been subject to vibration, it is recommended that the bearing(s) be inspected and replaced as necessary.

PRINCIPLES OF OPERATION

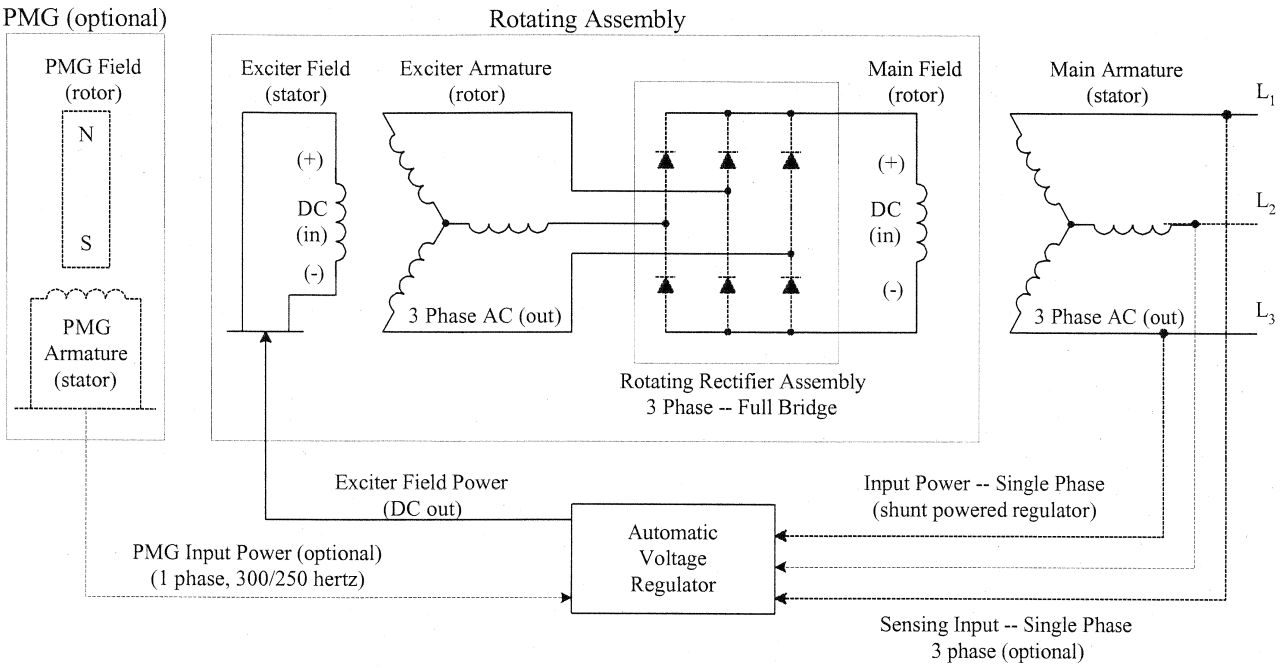


FIGURE 1 -- MagnaPLUS Circuit Diagram

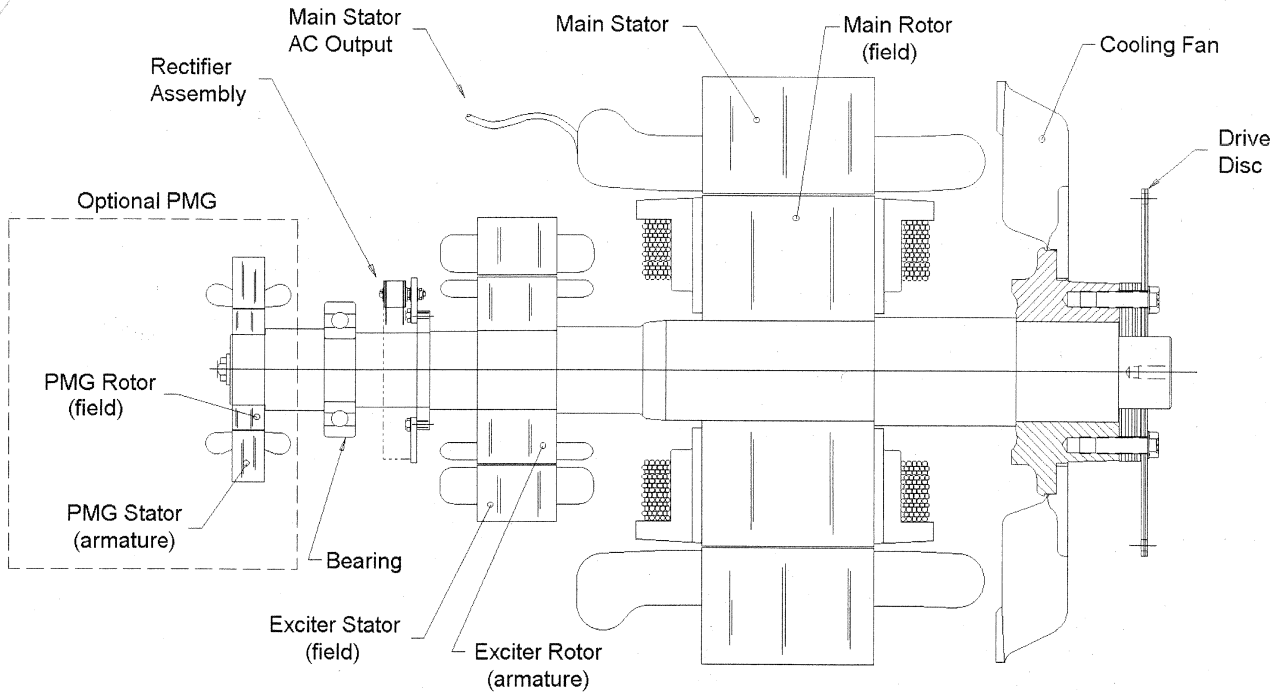


FIGURE 2 -- Typical MagnaPLUS Layout Diagram

PRINCIPLE OF OPERATION

MagnaPLUS generators are a brushless, self excited, externally voltage regulated, synchronous AC generator. The generator is made up of six major components: main stator (armature), main rotor (field), exciter stator (field), exciter rotor (armature), rectifier assembly, and voltage regulator. In understanding the above terminology, note the following: stators are stationary, rotors rotate, a field is an electrical input, and an armature is an electrical output. These system components are electrically interconnected as shown in figure 1 and physically located as shown in figure 2.

The generator's exciter consists of a stationary field and a rotating armature. The stationary field (exciter stator) is designed to be the primary source of the generator's residual magnetism. This residual magnetism allows the exciter rotor (armature) to produce AC voltage even when the exciter stator (field) is not powered. This AC voltage is rectified to DC by the rotating rectifier assembly and fed directly to the main rotor (field). As the generator shaft continues to rotate, the main rotor (field) induces a voltage into the generator's main stator (armature). At rated speed, the main stator's voltage produced by the residual magnetism of the exciter allows the automatic voltage regulator to function. The regulator provides voltage to the exciter resulting in a build-up of generator terminal voltage. This system of using residual magnetism eliminates the need for a special field flashing circuit in the regulator. After the generator has established the initial residual voltage, the regulator provides a controlled DC field voltage to the exciter stator resulting in a controlled generator terminal voltage.

Voltage Regulation

In the standard configuration (shunt excited), the automatic voltage regulator receives both its input power and voltage sensing from the generator's output terminals (See Figure 1). With the optional PMG configuration, the regulator receives input power from the PMG. The regulator automatically monitors the generator's output voltage against an internal reference set point and provides the necessary DC output voltage to the exciter field required to maintain constant generator terminal voltage. The generator's terminal voltage is changed by adjusting the regulator's reference set point. Consult the regulator manual for specific adjustment and operating instructions.

MOTOR STARTING

When a motor is started, a large surge of current is drawn by the motor. This starting current is equivalent to the motors locked rotor or stall current and is 5 to 10 times normal full load current. When the generator supplies this in-rush of starting current, the generator voltage dips temporarily. If the motor is too large for the generator, the generator's voltage dips greater than 30 percent. This may result in the motor starter de-energizing or the motor stalling. MagnaPlus generators generally supply .3 to .4 horsepower per generator KW in motor starting capability. For specific data contact Marathon Electric.

PARALLEL OPERATION

All MagnaPlus generators are built with 2/3 pitch main stator windings and full amortisseur (damper) windings. These features make the MagnaPlus generators suitable for parallel operation when equipped with the proper voltage regulators and voltage regulator accessories. Consult with the factory for further information relative to parallel operations.

NONLINEAR LOADING

Solid state electronic control devices (variable frequency drives, precision motor controls, battery chargers, etc.) utilize electronic switching circuits (thyristors, SCRs, Diodes, etc.). These switching circuits introduce high frequency harmonics which distort the normal wave form of the generator. This creates additional heat in the generator windings and may cause the generator to over-heat. Problems which can occur are not limited to the generator. Poor wave shape may adversely effect various loads connected to the generator. Consult Marathon Electric for further information relative to nonlinear loads.

INSTALLATION

PREPARATION FOR USE

Although the generator has been carefully inspected and tested in operation prior to shipment from the factory, it is recommended that the generator be thoroughly inspected. Check all bolts for tightness and examine the insulation on lead wires for chafing prior to proceeding with installation. Remove all shipping tapes, bags, skids and rotor support blocking. For two bearing units, rotate the shaft by hand to ensure that it rotates smoothly without binding.

WARNING

DISABLE AND LOCKOUT ANY ENGINE CRANKING DEVICES BEFORE ATTEMPTING TO INSTALL OR SERVICE THE GENERATOR. FOR ELECTRIC START SETS, DISCONNECT THE CRANKING BATTERY. FOR AIR START, DISCONNECT THE AIR SUPPLY. FOR MOTOR GENERATOR SETS, OPEN THE POWER SUPPLY TO THE DRIVE MOTOR. FAILURE TO COMPLY WITH THESE SAFETY PROCEDURES COULD RESULT IN SEVERE PERSONAL INJURY OR EQUIPMENT DAMAGE.

NEVER "BAR OVER" THE ENGINE GENERATOR SET USING THE GENERATOR'S FAN. THE FAN IS NOT DESIGNED FOR THIS PURPOSE. BARRING OVER THE SET WITH THE FAN COULD DAMAGE THE FAN AND RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE.

GENERATOR MOUNTING

Single Bearing Units.

Single bearing units are provided with an SAE flywheel housing adapter flange and flexible drive discs. Coupling the generator's shaft to the engine flywheel is accomplished with special steel drive discs bolted to the shaft. In addition to the drive discs, there may be a hub spacer, spacer discs, or a combination of hub spacer and spacer discs inserted between the drive discs and the shaft to achieve the proper shaft extension ("G" dimension per SAE J620c). Holes are provided in the periphery of the coupling discs which correspond to tapped holes in the prime mover's flywheel. The outside diameter of the drive discs fit in a rabbet in the flywheel so that concentricity is assured.

Grade 8 place bolts and hardened washers are recommended to mount the drive discs to the flywheel. DO NOT USE SPLIT TYPE LOCK WASHERS. Split lock washers when biting into the drive disc cause stress risers which may result in the disc fracturing.

The SAE flywheel housing adapter ring and the engine flywheel housing are designed to match each other with no further alignment necessary. Use grade 5 or greater mounting bolts. MagnaPLUS generator frames are constructed with two or three bolt holes per foot. The feet should be shimmed where necessary to obtain solid contact with the sub-base. With the frame securely bolted to the engine flywheel housing, there is no side thrust or pull on the generator frame, thus no real need to secure the feet with more than one bolt per foot.

GENERATOR MOUNTING

Two Bearing Generators -- Direct Drive

Two bearing generators are provided with a keyed shaft extension. For direct drive generators, the assembler furnishes a flexible coupling which is installed between the driver and the generator's shaft. Aligning the generator and its driver as accurately as possible will reduce vibration, increase bearing life, and ensure minimum coupling wear. It may be necessary to shim the generator feet for proper support and alignment. Secure the feet of the generator with grade 5 or greater bolts through the holes provided in the mounting feet. Consult the coupling manufacturer's instructions for alignment specifications and procedures.

GENERATOR MOUNTING

Two Bearing Units -- Belt Driven

Two bearing MagnaPLUS generators can be belt driven provided belts are sized and applied correctly. Please refer to your supplier of belts and sheaves for correct sizing and tensioning specifications. A bearing life calculation should be performed. Marathon Electric recommends a minimum B-10 life of 40,000 hours. If cog type belts are used, a vibration may be introduced which could lead to premature failure of the bearings.

END PLAY TESTING

Refer to the engine manual for recommended end play specifications and measurement procedures. If end play is not to specification, it is an indication that the generator shaft is not moving freely in the assembly, and normal life of the thrust bearing could be impaired. Probable causes of this problem are:

1. Improper seating of drive discs in the flywheel resulting in misalignment.
2. Improper mating of generator frame to engine flywheel housing resulting in misalignment.
3. Improper "G" dimension per SAE J620c on either the engine or generator.

TORSIONAL VIBRATION

Torsional vibrations are generated in all rotating shaft systems. In some cases, the amplitude of these vibrations at critical speeds may cause damage to either the generator, its driver, or both. It is therefore necessary to examine the torsional vibration effect on the entire rotating system. IT IS THE RESPONSIBILITY OF THE GENERATOR SET ASSEMBLER TO ASSURE THE TORSIONAL COMPATIBILITY OF THE GENERATOR AND ITS DRIVER. Drawings showing pertinent dimensions and weights of the rotating assembly will be supplied by Marathon Electric upon request.

ENVIRONMENTAL CONSIDERATIONS

The MagnaPLUS generator is designed for heavy duty industrial applications; however, dirt, moisture, heat and vibration are enemies of rotating electrical machinery. Excessive exposure to the elements may shorten generator life. The temperature of the cooling air entering the intake openings of the generator should not exceed the ambient temperature shown on the generator's nameplate. Generators intended for outdoor application should be protected with housings having adequate ventilation. Although the standard insulation systems are moisture and humidity resistant, space heaters are recommended for extreme conditions. If the generator is to be installed in an area where blowing sand and dust are present, the enclosure should be fitted with filters. Filters reduce erosion on the generator's insulation by blocking high velocity abrasive particles generated by the flow of cooling air through the generator. Consult the factory for appropriate filters and generator deratings required.

WIRING CONNECTIONS

Wiring of the generator and accessories should be done in accordance with good electrical practices. Follow government, industry and association standards.

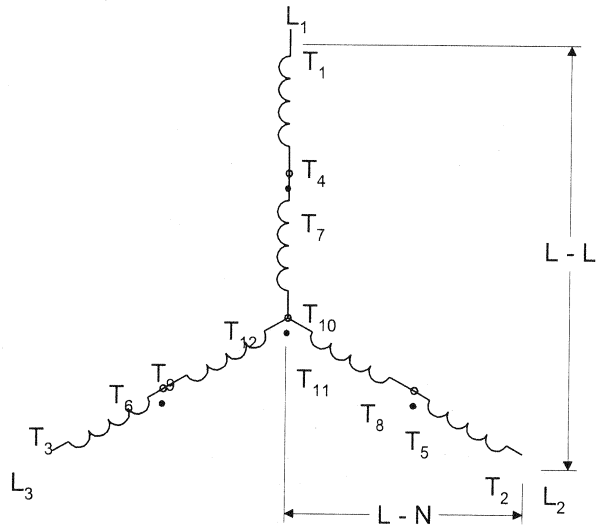
The generator conduit box construction allows cable entry from multiple sides. A hole saw or other appropriate tool may be used to provide for conduit entrance. Protect the interior of the generator from shavings when drilling or sawing. An approved connector must be used in conjunction with the conduit. To minimize the transmission of vibration, it is essential that flexible conduit be used for all electrical entrance to the generator conduit box.

All MagnaPLUS generators are equipped with link boards (terminal strips) for both internal and external connections. All connections made to the studs of the link board should be made with high quality ring terminals. Ring terminal sizes are: 6 mm (280 Series Frames) and 10 mm (360 and 430 Series Frames). Torque link board connections to the following specifications: 280 frame -- 5.4 NM (4 Ft Lb); 360 & 430 frame -- 27 NM (20 Ft Lb).

Refer to the connection diagram supplied with the generator and / or the proper diagrams shown in this manual. Install all inter-component and external wiring in accordance with national and local electrical codes. The neutral in the following connection diagrams shown below may be either grounded (earthed) or left above ground potential (floating). See national and local codes and / or the system distribution wiring schematic diagram for the proper connection of the neutral.

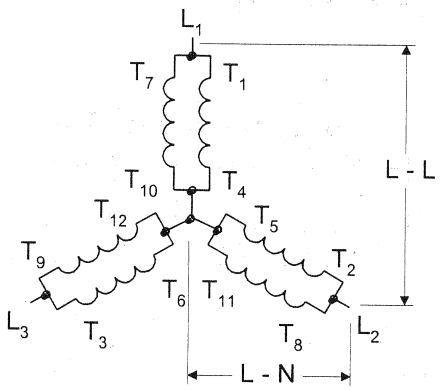
The following connection diagrams are shown for twelve lead generators. Ten lead generators have the same terminal designations except for leads T10, T11, and T12. These three leads are internally connected inside the generator and brought out as a single lead (T0). Ten lead generators can only be connected in a wye configuration

HIGH (SERIES) WYE CONNECTION



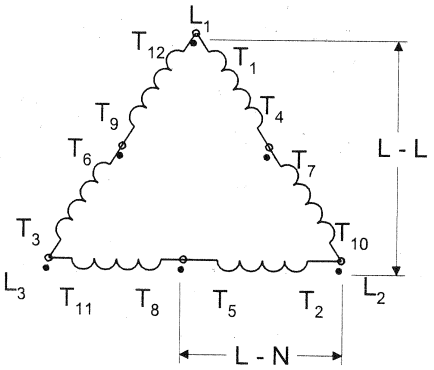
VOLTAGE (HIGH WYE)		
Hz	L-L	L-N
60	480	277
	460	266
	440	254
	416	240
	380	219
50	416	240
	400	231
	380	219

LOW (PARALLEL) WYE CONNECTION



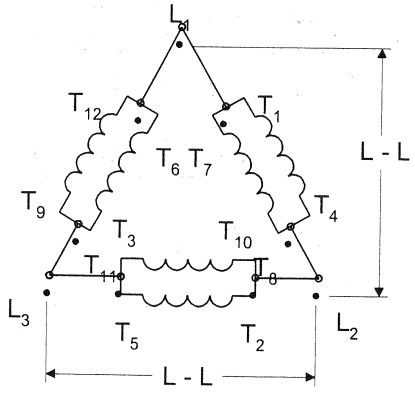
VOLTAGE (LOW WYE)		
Hz	L-L	L-N
60	240	139
	230	133
	220	127
	208	120
	190	110
50	208	120
	200	115
	190	110

HIGH (SERIES) DELTA CONNECTION



VOLTAGE (HIGH DELTA)		
Hz	L-L	L-N
60	277	139
	240	120
50	240	120
	220	110
	200	100

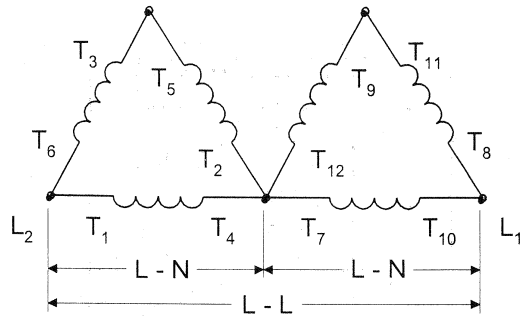
LOW (PARALLEL) DELTA CONNECTION



VOLTAGE (LOW DELTA)		
Hz	L-L	L-N
60	120	NA
	110	NA
50	110	NA
	100	NA

MARATHON ELECTRIC
A Subsidiary of Regal-Beloit Corporation

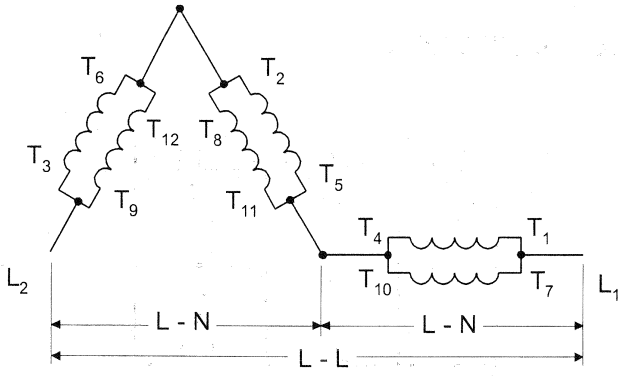
DOUBLE DELTA -- SINGLE PHASE CONNECTION



VOLTAGE (DOUBLE DELTA)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

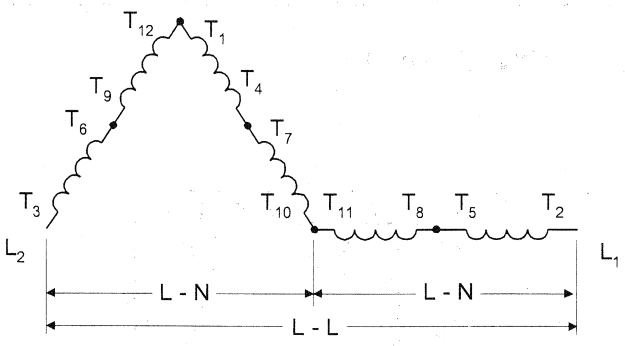
LOW ZIG ZAG -- SINGLE PHASE (PARALLEL) CONNECTION



VOLTAGE (LOW ZIGZAG)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110
	200	100

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

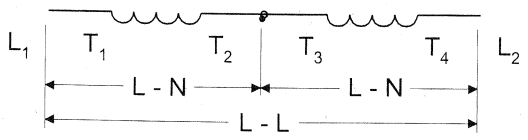
HIGH ZIG ZAG -- SINGLE PHASE (SERIES) CONNECTION



VOLTAGE (HIGH ZIGZAG)		
Hz	L-L	L-N
60	480	240
	460	220
50	415	208
	380	190

Note: Single phase KW/KVA ratings are approximately equal to 50% of the generator's three phase ratings.

DEDICATED SINGLE PHASE CONNECTION
HIGH VOLTAGE - SERIES CONNECTED



VOLTAGE (DEDICATED)		
Hz	L-L	L-N
60	240	120
	220	110
50	220	110
	200	100

OPERATION

PRE-START INSPECTION

Before starting the generator for the first time, the following inspection checks are recommended:

1. A visual inspection should be made for any loose parts, bad connections, or foreign materials.
2. Bar the set over by hand for at least 2 revolutions to be sure that there is no interference and that the set turns freely. If the set does not turn freely, check for clearance in the generator and exciter air gap.
3. Check all wiring against the proper connection diagrams, and ensure that all connections and terminations are tight and properly insulated.

WARNING

MAGNAPLUS GENERATORS MAY HAVE VOLTAGE PRESENT AT THE LEAD TERMINALS WHEN THE SHAFT IS ROTATING. DO NOT PERMIT OPERATION OF THE GENERATOR UNTIL ALL LEADS HAVE BEEN CONNECTED AND INSULATED. FAILURE TO DO THIS MAY RESULT IN PERSONAL INJURY OR EQUIPMENT DAMAGE

4. Verify that all equipment is properly grounded (earthed).
5. Clear the surrounding area of any materials that could be drawn into the generator.
6. Check all fasteners for tightness.
7. Check all access plates, covers, screens and guards. If they have been removed for assembly or inspection, reinstall and check for security.
8. Review all prime mover prestart-up instructions, and ensure that all recommended steps and procedures have been followed.
9. Remove any masking materials affixed during painting. Inspect the generator, prime mover, and any accessory equipment to ensure that nameplates, and all safety warning / caution signs and decals provided with the equipment are in place and clearly visible.

   Note: It is strongly recommended that the authority having jurisdiction over the installation site be consulted to determine if any additional warning or caution notices, or additional safety devices are required by local codes / standards. Any such required notices or devices should be installed prior to initial startup.

START-UP

The following procedure should be followed when starting the generator set for the first time.

1. The generator output must be disconnected from the load. Be sure that the main circuit breaker or fused disconnect is in the open position.
2. Open the input power to the automatic voltage regulator. Remove the fuse or disconnect and insulate one of the regulator input power leads. (See separate regulator manual)
3. Verify that all prime mover start-up procedures have been followed.
4. If the unit is provided with space heaters, ensure that they are de-energized. In some installations, a set of auxiliary contacts on the main circuit breaker or transfer switch will automatically open the space heater circuit when the generator is connected to the load.
5. Start the prime mover, and adjust it for proper speed. See generator nameplate.

6. The purpose of this initial test with the regulator out of the circuit is to detect any wiring mistakes without exposing the unit to undue risk. Check all line to line and line to neutral voltages for balanced voltage. If voltages are balanced, shut down the set and reconnect the regulator. If voltages are unbalanced, shut down the equipment and check for improper wiring. If the problem persists, consult the factory.

   With the regulator de-energized, the residual voltage should be 10 - 25% of rated value. It is recommended that this residual voltage and driver RPM be recorded for use as a future troubleshooting benchmark.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

7. Start the set and adjust the terminal voltage to the desired value by means of the regulator voltage adjustment. If the regulator is equipped with a stability adjustment, follow the instructions in the regulator manual to adjust the stability. Again, check all line to line and line to neutral voltages for balance. It is recommended practice to record the no load excitation (DC voltage to the exciter stator), generator terminal voltage, and driver speed as a benchmark for future troubleshooting.

8. Close the main circuit breaker to the load.

9. Monitor the generator output current to verify that it is at or below nameplate value.

10. Check generator speed (frequency) under load. Adjust as necessary. (Refer to prime mover or governor manuals)

SHUTDOWN PROCEDURE

There are no specific instructions for shutting down the generator; however, several good practices should be observed to prolong equipment life.

1. It is advisable to disconnect all loads (open main circuit breaker or disconnect) prior to shutdown. This is especially important if loads can be damaged by low voltage or low frequency conditions during generator "coast down".

2. Isolate all conditions that could apply voltage to the generator terminals while the generator is at rest. Failure to comply could result in personnel injury or equipment damage.

3. If the unit is equipped with space heaters, verify that the heater circuit is energized.

MAINTENANCE

The following maintenance procedures should be followed to ensure long equipment life and satisfactory performance. Maintenance intervals will depend upon operating conditions.

1. Routinely check intake and exhaust air screens to ensure that they are clean and free of debris. Clogged intake air screens will reduce cooling air flow and result in higher operating temperatures. This will reduce generator life and may result in generator damage.

2. All MagnaPLUS generators are equipped with double shielded ball bearings lubricated for the life of the bearing. Every 1,000 hours check the bearing(s) for smooth, quiet operation. For continuous duty generators, recommended practice is to replace the bearing during major overhauls of the engine.

3. Periodically inspect the unit for any buildup of contamination (dirt, oil, etc.) on the windings. If the wound components have become coated with heavy concentrations of oil and grime, the unit should be disassembled and thoroughly cleaned. This operation is not one that can be accomplished effectively on site, but rather one that should be conducted by an authorized service center equipped with the appropriate apparatus and solvents necessary to properly clean and dry the generator.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

4. Every 2,000 operating hours or in conjunction with scheduled engine maintenance, check the DC no load excitation voltage per item #7 in the startup procedure. Compare this voltage with the value recorded during initial startup. If this value of no load excitation voltage is markedly higher than the bench mark reading, it is an indication of problems in either the exciter, main field, or the rotating rectifier assembly. Ensure that RPM is the same as initial test.

5. Monitor and record insulation resistance with a 500 volt mega-ohm meter. The minimum acceptable reading is 2 mega-ohms. If the reading drops below the minimum, the generator should be cleaned and dried at an authorized service shop. Consult Marathon Electric for more information.

DRYING WINDINGS

Generators in service may inadvertently have their windings exposed to splashing or sprayed water. Units that have been in transit or storage for long periods of time may be subjected to extreme temperature and moisture changes causing excessive condensation. Regardless of the source of moisture, wet windings should be thoroughly dried out before operating the unit. If this precaution is not taken, serious damage to the generator can result. The following procedures may be utilized in drying the generator's windings. The method selected will be influenced by winding wetness and situation limitations.

Space Heaters
An electric heater may have been supplied with the generator. When energized from a power source other than the generator, the heater will gradually dry the generator. This process can be accelerated by enclosing the unit with a covering and inserting additional heating units. A hole should be left at the top of the covering to permit the escape of moisture. Care should be taken not to overheat various accessory equipment mounted with the generator.

Forced Air
Another method to dry the generator is to run the set with no excitation (see startup procedure item #2). The natural flow of ambient air through the generator will tend to dry the windings. This method can be accelerated by adding a source of heat at the air intake to the generator. Heat at point of entry should not exceed 80 C (180 F).

TESTING

Visual Inspection

Remove covers and look for any obvious problems: burnt windings, loose connections, broken wires, frayed insulation, cracked brackets, missing hardware, etc. Check for foreign objects which may have been drawn into the generator. Verify that the generator's air gaps (main rotor and exciter) are free from obstructions. If possible, rotate the generator manually to ensure free rotation. Never "bar over" the engine generator set using the generator fan.

WARNING

THE FOLLOWING TEST MUST BE CONDUCTED BY QUALIFIED ELECTRICAL PERSONNEL. LETHAL VOLTAGE MAY BE PRESENT AT BOTH THE GENERATOR AND VOLTAGE REGULATOR TERMINALS DURING THIS PROCEDURE. CAUTION MUST BE EXERCISED NOT TO COME INTO PERSONAL CONTACT WITH LIVE TERMINALS, LINKS, OR STUDS. SERIOUS INJURY OR DEATH COULD RESULT.

CONSTANT EXCITATION TEST (12V BATTERY TEST)

The generator "no load" voltage is dependent on exciter input voltage and generator speed. With the generator operating at rated speed and 12 volts dc applied to the exciter field, the generators terminal voltage will be near rated value.

1. Shutdown the generator set and connect a voltmeter on the generator terminals.

2. Disconnect the regulator's F+ (F1) and F- (F2) leads and connect them to a 12V battery. Caution should be taken to ensure that the battery is not exposed to any potential arcing.

3. With no load on the generator (main breaker open) run the generator at rated speed. Measure the generator's terminal voltage and compare this value with values recorded during installation.

If voltage readings are normal, the main generator and excitation are operating properly. Troubleshooting should continue with the regulator. If readings are not normal the problem is in the generator. Continue testing diodes, surge suppressor, and windings.

Continuity / Resistance Test

The generator has four components which can be checked using an ohm meter: exciter stator, exciter rotor, main stator and main rotor. Each of these components are comprised of various windings which form a complete electrical path of relatively low resistance. Using an ohm meter measure the loop resistance of each component. Compare these measured values with the values listed in the specification section of this manual. Note that very small resistance values require precision equipment to make accurate measurements; however, a standard ohm meter will provide a good indication of winding continuity.

Insulation Test

Insulation resistance is a measure of the integrity of the insulating materials that separate the electrical windings from the generator's steel core. This resistance can degrade over time or be degraded by contaminants: dust, dirt, oil, grease, and especially moisture. Most winding failures are due to a breakdown in the insulation system. In many cases, low insulation resistance is caused by moisture collected when the generator is shutdown

Insulation resistance is measured with a megger (mega-ohm meter). A megger measures insulation resistance by placing 500 volts between the winding and the frame of the generator. Caution must be taken to remove all electronic devices (regulators, diodes, surge protectors, capacitors, protective relays, etc.) from the winding circuit before checking the insulation. Winding insulation can be checked on the main stator, main rotor, exciter stator, and exciter rotor. Minimum resistance is 2 mega-ohms. If the winding resistance is low it must be dried (see maintenance section) or repaired.

DIODE TESTING

If the generator is close coupled to an engine, it may be necessary to "bar over" the engine in order to gain access to a given area of the rectifier assembly. **NEVER** use the generator's fan as a fulcrum to accomplish this. Use the engine manufacturer's recommended practice to manually turn over the engine. To prevent possible injury to personnel, and damage to the equipment, ensure that the engine cannot start during this procedure.

Remove the two main rotor leads and the three exciter rotor leads from the rectifier assembly (figure 4). The rectifier assembly is now electrically isolated from the generator. The diodes remain mounted and the diode leads remain connected to the terminal posts. Using an ohmmeter or a battery light continuity tester, place one test probe on the diode lead terminal post. In succession, touch the other test probe to the lead screw hole in each heat sink. Reverse the probes and repeat the procedure. You have now tested the three diodes connected to this terminal post in both the forward and reverse direction. Repeat the procedure using the other diode terminal post.

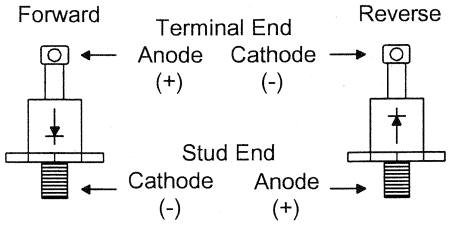


FIGURE 3: DIODE POLARITY

When the positive test probe is connected to the diode's anode and the negative test probe is connected to the diode's cathode (forward biased), the diode will switch on and conduct electricity (figure 3). This is observed by a low resistance reading when using an ohm meter or the lighting of the bulb when using a battery light continuity tester. Reversing the test leads (reverse biased) will result in the diode switching off and no electricity will be conducted. The results of these tests should indicate one of three conditions:

1. **Good diode:** Will have a much greater resistance in one direction than the other. Typical reverse biased resistance will be 30,000 ohms or greater, while forward biased resistance will be less than 10 ohms. The battery-light tester will have the light "on" in one direction and "off" in the other.

2. **Shorted condition:** Ohmmeter reading will be zero, or very low in both directions. The continuity tester will have the light "on" in both directions.

3. **Open condition:** Ohmmeter will have a maximum (infinity) reading in both directions. Continuity tester light will be off in both directions.

Diode failure after a 25 hour "run-in" period is generally traceable to external causes such as a lightning strike, reverse current, line voltage spikes, etc. All 6 diodes are essentially in the same circuit. When a diode is stressed to failure, there is no easy method to determine remaining life in the other diodes. To avoid possible continued failures, it is recommended that the entire rectifier assembly be replaced rather than replacing individual diodes.

SERVICE

GENERAL

The service procedures given in this section are those which can reasonably be conducted on-site with a minimum number of special tools and equipment. All service procedures should be conducted by qualified maintenance personnel. Replacement parts may be ordered through an authorized service center or directly from the factory.

FIELD FLASHING

Restoring Residual Magnetism
(not applicable on PMG equipped generators)

To restore residual magnetism to the generator, connect a 12 volt battery to the exciter field while the generator using the following procedure:

1. **Shutdown the generator set.** Remove the exciter field leads F+ and F- from the regulator.

CAUTION:
Failure to remove the exciter field leads from the automatic voltage regulator during flashing procedures may destroy the regulator.

2. Connect the F+ and F- leads to the battery's corresponding positive and negative terminals. This should be done using an appropriate length of lead wire to separate the battery from the point of connection (batteries may explode when exposed to an electric arc). After 3 to 5 seconds, remove the F- lead. An inductive arc should result. If no arc is drawn, repeat the procedure.

3. Reconnect the F+ and F- leads to the regulator. Restart the generator and verify that terminal voltage is developed. If terminal voltage does not develop, repeat the field flashing procedure and / or consult the trouble shooting section.

BEARING REMOVAL

Prior to performing this operation, it is suggested that the alternator's shaft be rotated until two of the main rotor poles are in a vertical position. Once the bearing bracket is backed out, the rotor will drop on the main stator core. Having the rotor in this position will limit the amount of rotor drop to that of the air gap. Visually inspect the bearing bore for damage or wear. If worn or damaged, replace prior to reassemble.

Opposite Drive End Bearing Bracket Removal.
Prior to proceeding with bracket removal, disconnect exciter field leads F+ and F- from the automatic voltage regulator and ensure that they are free to move when the bearing bracket is removed. Remove the bearing bracket retaining bolts. Using a pair of screw drivers, wedge the bracket off the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame and will drop until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore and o-ring (if equipped) for damage or wear. If worn or damaged, repair or replace prior to reassembly.

Drive End Bearing Bracket Removal, Two Bearing Units.
Remove any drive arrangement from the generator shaft extension. Remove the bearing lock ring retaining screws. There is no o-ring in the drive end bearing bracket. The shaft extension must be supported before proceeding further. A hoist and sling, jack, or some other means of support with a capacity of 2 tons should be used.

Remove the bearing bracket retaining cap screws. Using a flat bladed screw driver or chisel, pry the bracket back from the frame. After approximately 1/8 inch, the bracket will clear the locating register on the frame. Lower the shaft extension until the rotor is resting on the main stator core. Continue to pull the bracket free from the bearing. Visually inspect the bearing bore for damage or wear. If worn or damaged, sleeve or replace prior to reassembly.

Reassembly note: Before the bearing bracket is seated against the frame, a threaded rod may be used to help align the inner bearing cap with the bearing bracket.

BEARING REPLACEMENT

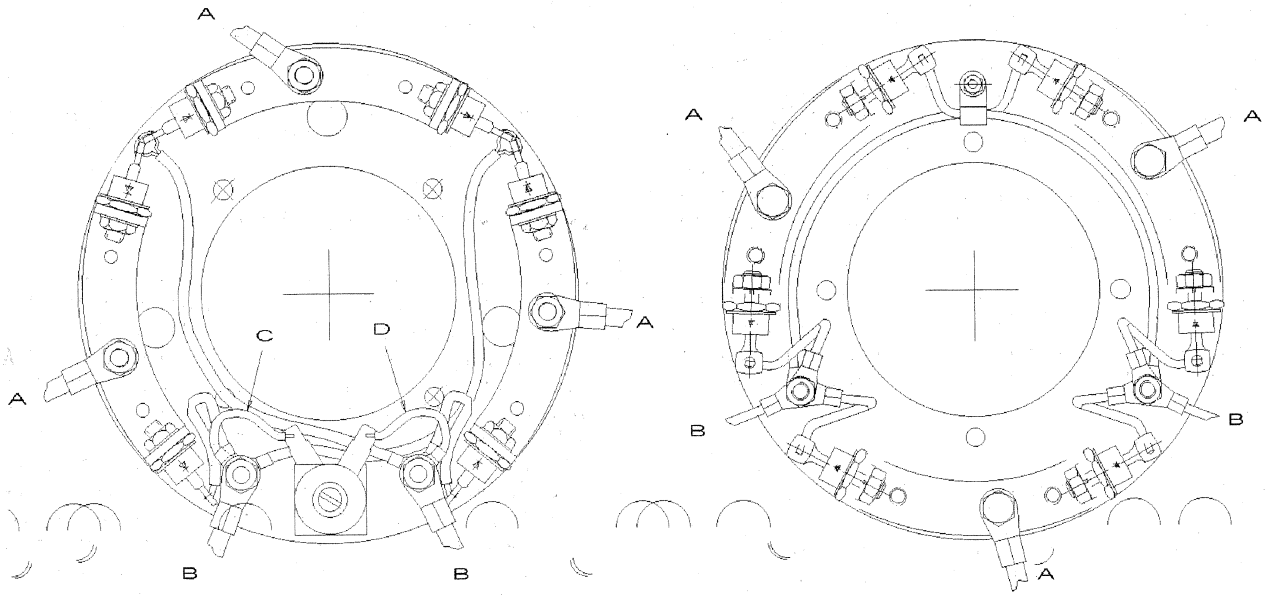
Using a bearing puller, remove the existing bearing. It is strongly recommended that the bearing be replaced any time the it is removed from the shaft. **ALWAYS** install the same type and size bearing that was supplied as original equipment. Order by part number from the parts list, and include the unit serial number and part number when ordering. Heat the bearing to a maximum of 100°C (212°F) in an oven. Apply a thin coat of clean lubricating oil to the press-fit area of the rotor shaft. Using suitable heat resistant gloves, install the bearing over the end of the shaft until it seats against the shaft shoulder. The bearing should slide on the shaft and be seated without excessive force. Should the bearing bind on the shaft prior to being seated against the shoulder, a piece of tubing slightly larger than the press fit area can be used to drive the bearing to its final position. Using light taps with a soft mallet, apply pressure to the inner race only.

RECTIFIER ASSEMBLY REMOVAL

The rectifier assembly cannot be removed until the opposite drive end bearing bracket and bearing have been removed (see bearing removal procedure). Remove the three exciter rotor leads from the heat sinks and the two main rotor leads from the main rotor posts (see Figures 4). Remove the screws securing the rectifier assembly and pull the assembly free from the shaft.

DIODE REPLACEMENT

Prior to installing a replacement diode on the heat sink, apply a thin film of conductive heat sink compound around the base of the diode (do not coat the threads). When installing a diode on the heat sink, care should be taken not to over torque the retaining nut which could cause damage to the device. Torque to 28 pound-inches. If not damaged, the existing diode lead wire may be unsoldered from the failed diode, and resoldered on the replacement.



430 FRAME **280 / 360 FRAME**

A - Exciter Rotor Lead, B - Main Rotor Lead, C - Red (+) Suppressor Lead, D - Black (-) Suppressor Lead

FIGURE 4: ROTATING RECTIFIER ASSEMBLY

RETURNED GOODS

Contact Marathon Electric Manufacturing Corporation for authorization before returning any product. We can not be responsible for any items returned without authorization.

CAUTION

Single bearing generators must have their rotor assembly properly secured to prevent damage during transit to the factory, or to an authorized service center.

TROUBLESHOOTING

This section is intended to suggest a systematic approach to locating and correcting generator malfunctions. The section is arranged according to the symptoms of the problem. The steps have been arranged in an attempt to do the easy checks first and prevent further damage when troubleshooting a disabled machine.

The first step of troubleshooting is to gather as much information as is possible from operating personnel and individuals present during the failure. Typical information includes: how long the unit had been operating; what loads were on line; weather conditions; protective equipment that did or did not function. In addition, information as to the operating condition of the generator's prime mover is vital. Has the prime mover been maintaining constant speed? If not, have there been extended periods of under speed operation? Has the prime mover experienced an over-speed condition? If yes, what was the maximum speed, and how long did the unit operate at that elevated speed?

The generator speed should be maintained at rated nameplate value during all operating tests. The frequency of the generator depends upon rotational speed. Most regulators used with MagnaPLUS generators have built in under frequency protection such that if the speed is reduced more than 5%, the voltage will drop off rather rapidly with further reductions in speed.

WARNING

HIGH VOLTAGES MAY BE PRESENT AT THE GENERATOR'S TERMINALS WHEN THE UNIT IS RUNNING. SOME ACCESSORY EQUIPMENT SUCH AS SPACE HEATERS MAY BE ENERGIZED FROM AN OUTSIDE POWER SOURCE WHEN THE UNIT IS AT REST. TOOLS, EQUIPMENT, CLOTHING AND YOUR BODY MUST BE KEPT CLEAR OF ROTATING PARTS AND ELECTRICAL CONNECTIONS. SPECIAL PRECAUTIONS MUST BE TAKEN DURING TROUBLESHOOTING SINCE PROTECTIVE COVERS AND SAFETY DEVICES MAY BE REMOVED OR DISABLED TO GAIN ACCESS AND PERFORM TESTS. BE CAREFUL. SERIOUS PERSONAL INJURY OR DEATH CAN RESULT FROM THESE HAZARDS. CONSULT QUALIFIED PERSONNEL WITH ANY QUESTIONS.

GENERATOR PRODUCES NO VOLTAGE

CAUSE	CHECK AND REMEDY
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for loose connections, open circuits, grounds, and short circuits.
Loss of residual	Flash the field. Refer to field flashing in the service section. If the generator is equipped with a PMG, field flashing is not necessary -- check regulator fuse and input power from the PMG.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator protection operating	Adjust regulator. Consult regulator manual.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE, NO LOAD

CAUSE	CHECK AND REMEDY
Underspeed operation	Check speed using a tachometer or frequency meter.
Voltmeter off or defective	Check voltage with a separate meter at the generator terminals.
Incorrect or defective connections	Verify generator connections. See drawings supplied with the generator or lead connection diagrams in this manual. Inspect all wiring for grounds, open circuits and short circuits.
Loss of regulator power	Check regulator fuse and input power. Input power is produced by the generator's residual voltage or from an optional PMG.
Regulator adjustment	Adjust regulator settings. Consult regulator manual.
Regulator incorrectly connected	Review the generator connection diagram or reference the regulator manual.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.
Regulator inoperative	Adjust or replace regulator. Consult regulator manual.

GENERATOR PRODUCES LOW VOLTAGE WHEN LOAD APPLIED

CAUSE	CHECK AND REMEDY
Excessive load	Reduce load. The load on each leg should be evenly balanced, and rated current should not be exceeded on any leg.
Large motor starting or low load power factor	Motor starting currents are too large for the generator. When starting multiple motors, sequence the motors and start the largest motors first. Reduce lagging power factor load.
Driver speed droop or belt slip	Check driver. If belt driven, check belt tension. Check under frequency setting on regulator. Under frequency voltage roll-off may be activated.
Reactive droop	If the generator is equipped for parallel operation, some droop is normal as reactive load increases. When operating as a single unit, the parallel CT can be shorted to eliminate this effect. Refer to Regulator manual.
Line drop	If voltage is proper at generator terminals but low at load terminals, increase external wire size.
Defective diodes, suppressor, or windings	Test the generator using the 12 volt battery test as specified in the testing section. If the results indicate generator problems, perform insulation, continuity, and diode tests as specified in the testing section.

GENERATOR PRODUCES FLUCTUATING VOLTAGE

CAUSE	CHECK AND REMEDY
Fluctuating engine speed	Check engine and governor systems for malfunctions. Check load for fluctuation.
Regulator stability	Adjust Regulator stability. Refer to Regulator manual.
Regulator external rheostat	Replace defective or worn rheostat. Use shielded cable to minimize electrical noise.
Defective rectifier assembly	Check assembly for loose connections. Test the diodes as specified in the test section.
Loose terminal or load connections	Improve connections both mechanically and electrically.
Defective regulator	Replace regulator.

GENERATOR PRODUCES HIGH VOLTAGE

CAUSE	CHECK AND REMEDY
Faulty metering	Check voltage with separate meter at generator terminals.
Incorrect connections	Verify generator connections. Refer to drawings supplied with the generator or connection diagrams in this manual.
Regulator adjustments	Adjust regulator. Consult regulator manual.
Leading power factor	Check the power factor of the load. If power factor is leading, change load configuration. Excessive leading power factor (capacitors) can cause voltage to climb out of control.
Incorrect regulator connection	Verify regulator voltage sensing is connected correctly. Consult regulator manual.
Defective regulator	Replace regulator.

GENERATOR BUILDS VOLTAGE FROM STARTUP, THEN GOES TO LOW (RESIDUAL) VOLTAGE

CAUSE	CHECK AND REMEDY
Regulator protective circuit operating	Check indicators on regulator. Correct problems and adjust regulator as is required. Refer to regulator manual.

GENERATOR IS OVERHEATING

CAUSE	CHECK AND REMEDY
Generator is overloaded	Reduce load. Check with ammeter and compare with nameplate rating.
Clogged ventilating screens	Clean air passages.
High room temperature or altitude	Improve ventilation or reduce load.
Insufficient circulation of cooling air	Generator location and enclosure design must provide adequate air flow and minimize recirculation of hot air.
Unbalanced load	The load on each leg should be as evenly balanced as possible and should not exceed rated current on any one leg.

GENERATOR PRODUCES MECHANICAL NOISE

CAUSE	CHECK AND REMEDY
Defective bearing	Replace bearing.
Loose or misaligned coupling	Tighten, realign, or replace coupling.
Belt slap or loose guards	Check belt tensioning. Check belt guard fasteners.

EQUIPMENT RUNS NORMALLY ON UTILITY POWER, BUT WILL NOT RUN ON GENERATOR SET

CAUSE	CHECK AND REMEDY
Distorted voltage waveform	Analyze load. Excessive SCR (thyristor) loading will cause distortion. Some equipment may be sensitive to distorted waveforms. Refer to Marathon Electric..
Improper generator voltage or frequency	Check name plates of devices comprising the load. Compare required voltage and frequency with that of the generator. Adjust driver speed and/or generator voltage as necessary to match generator output to load requirements.

CAUTION: Compare required voltage, frequency, and KVA with generator nameplate to ensure adequate generator capacity. If in doubt, consult Marathon Electric for information regarding generator capacity.

SPECIFICATIONS

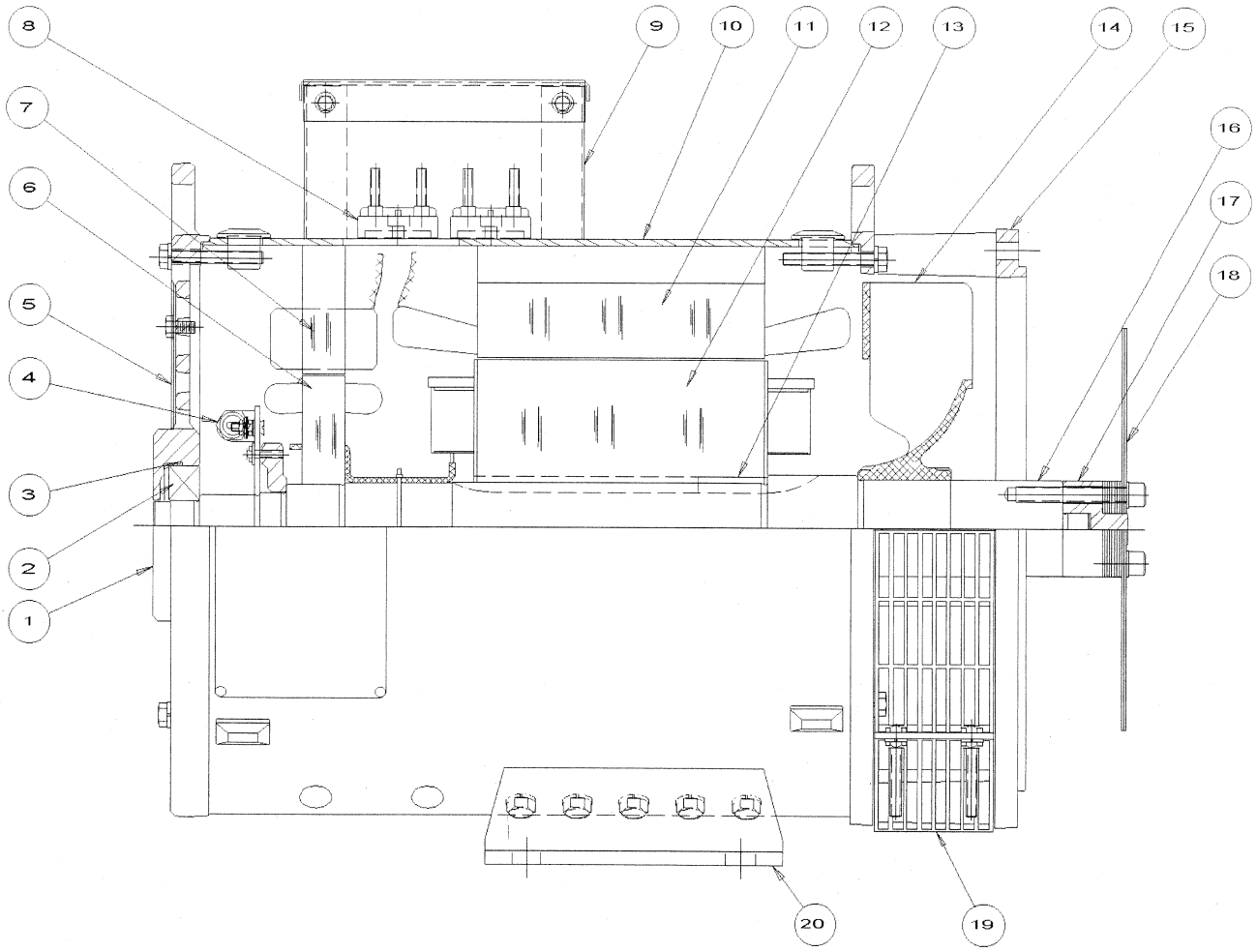
MODEL / FRAME SIZE	EXCITER RESISTANCE	
	STATOR	ROTOR
281, 282, 283, 284	23.0	.120
361, 362, 363 -- three phase	23.5	.120
361, 362, 363 -- dedicated single phase	23.0	.135
431, 432, 433 -- three phase	20.33	.076
431, 432 -- dedicated single phase	18.0	.105

MODEL	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS 480 V / 60 HZ	NO LOAD TERMINAL VOLTAGE WITH 12 VDC FIXED EXCITATION	
	STATOR*	ROTOR		HIGH WYE / 60 HZ	HIGH WYE / 50 HZ
281PSL1500	4.20	.400	11.0	485	400
281PSL1501	4.15	.400	11.0	490	404
281PSL1502	3.20	.439	9.0	528	435
282PSL1503	2.00	.470	10.4	500	415
282PSL1504	1.51	.512	11.3	490	400
282PSL1505	1.00	.575	10.1	515	415
283PSL1506	.681	.654	11.0	495	400
283PSL1507	.480	.758	12.0	480	390
284PSL1508	.346	.875	12.0	480	375
361PSL1600	.381	.750	11.8	485	400
361PSL1601	.264	.810	12.5	475	385
361PSL1602	.181	.990	14.1	460	370
362PSL1604	.138	1.05	12.2	480	380
362PSL1606	.0980	1.20	10.8	500	405
363PSL1607	.0692	1.37	12.2	475	380
431PSL6202	.0214	.8114	15.1	440	360
431PSL6204	.0477	.6373	13.6	455	385
431PSL6206	.0371	.6793	13.82	455	370
431PSL6208	.0133	.715	12.20	475	390
432PSL6210	.0214	.8114	15.1	440	360
432PSL6212	.0226	.8656	14.1	445	385
433PSL6216	.01215	1.0672	16.2	425	345
433PSL6220	.01214	.9743	15.6	430	350

* Stator resistance measured line to line in a high wye connection.

DEDICATED SINGLE PHASE	GENERATOR RESISTANCE		EXCITER FIELD NO LOAD VOLTS / 60 HZ
	STATOR	ROTOR	
281PSL1511	1.420	.381	8.3
281PSL1512	1.106	.395	8.1
281PSL1513	.632	.430	8.7
282PSL1514	.436	.450	9.2
282PSL1515	.240	.520	9.7
283PSL1516	.160	.620	13.3
284PSL1517	.0918	.760	12.2
284PSL1518	.0610	.857	16.6
361PSL1611	.0695	.750	17.5
361PSL1612	.0434	.857	16.1
361PSL1613	.0369	.926	13.6
362PSL1615	.0191	1.20	17.0
363PSL1617	.0119	1.35	23.0
431PSL1811	.0248	.516	9.9
431PSL1813	.0129	.615	13.8
432PSL1814	.00931	.643	15.1
432PSL1815	.00723	.852	11.2

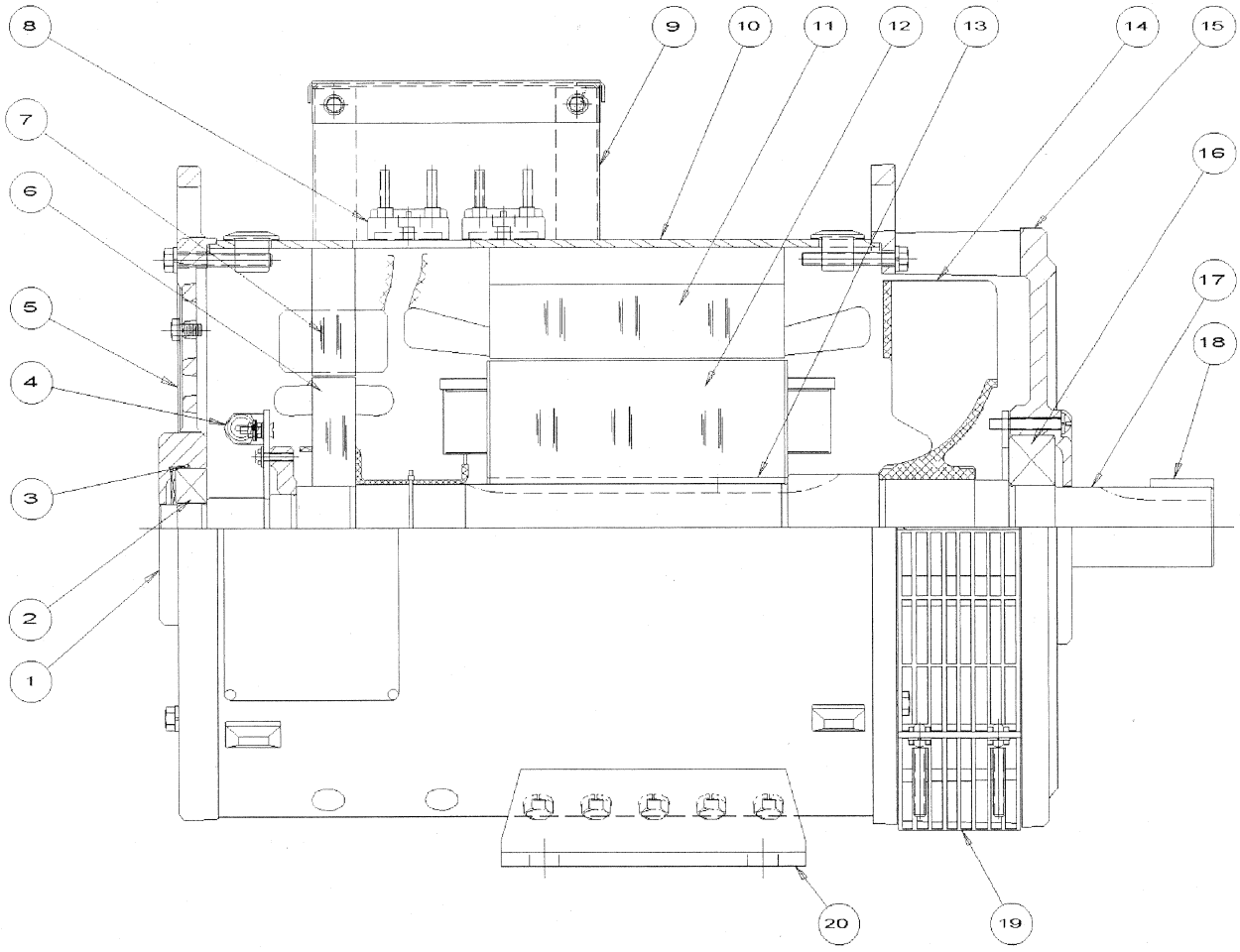
PARTS LIST – SINGLE BEARING
Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	Mounting Adapter (SAE)
6	Exciter Rotor	16	Shaft
7	Exciter Stator	17	Drive Hub
8	Link Board (terminal block)	18	Drive Disk (SAE)
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

PARTS LIST – DUAL BEARING
Typical Generator Cross Section



Reference Number	Part Name	Reference Number	Part Name
1	End Bracket (under end cover 360 & 430 frames)	11	Main Stator
2	Bearing (nondrive end)	12	Main Rotor
3	O-ring (280 frame only)	13	Rotor Integral Keyway
4	Rectifier Assembly	14	Fan
5	Air Intake Screen (280 frame only)	15	End Bracket (drive end)
6	Exciter Rotor	16	Bearing (drive end)
7	Exciter Stator	17	Shaft
8	Link Board (terminal block)	18	Key
9	Conduit Box	19	Exhaust Screen (drip cover not shown)
10	Generator Frame	20	Mounting Base

Note: Illustration above is a 280 frame MagnaPlus. Other Frame sizes are typical. Optional PMG not shown. The generator model and serial numbers are required when ordering parts.

APPENDIX IV

Declaration of Conformity

EU Declaration of Conformity

Model Number(s) 11-2820-0000

Product Type/Name: Diesel Ground Power Unit

Serial Number(s): Enter serial number(s)

Declaration: Tronair has assessed the equipment described above against the Essential Health and Safety Requirements of one or more Directives. Based on this assessment, the equipment described above is deemed to comply with the directive(s) listed below.

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Directives: European Machinery Directive 2006/42/EC

Standards:

prEN 1915-1:1995	General requirements – Part 1: Basic Safety
prEN 982:1996	Safety of machinery - Hydraulics
prEN 60204-1:1997	Safety of machinery - Part 1: Basic Safety
HFPA/JIC T2.24.1-1990	Hydraulic Fluid Power-- Systems Standard for Stationary Industrial Machinery
ISO 4021:1997	Hydraulic fluid power
ARP 1247B	Aircraft ground support equipment – General requirements
NFPA 70/NEC 1999	National electric code

Markings: CE

The technical documentation for the machinery is available from:

Mr. Joel Nunn
34 Epirus Road, SW6 7UH, London, UK
Email: jnunn@tronair.com

Location of Issue: Tronair, 1 Air Cargo Parkway East, Swanton, OH 43558

Certificate: EU_DoC_11-2820-0000

Identification of person empowered to sign on behalf of the Manufacturer:

Patrick Finch

Quality Assurance Representative

Enter a date

Date

Tronair, Inc.
1 Air Cargo Pkwy East
Swanton, OH 43558

Phone: (419) 866-6301 | 800-426-6301
Web: www.tronair.com
Email: sales@tronair.com