



A MISSION CRITICAL ELECTRONICS BRAND

System Overview Guide

for

IMPAC™

BY MISSION CRITICAL ELECTRONICS

I Idle
M Mitigation
P Power
A Automation
C Control

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Change Log

Revision	Revision Date	Brief Description of Change
A	August 15, 2024	Pre-release Drafts
B	August 18, 2024	Initial Release

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The information covered in this document is subject to change without notice.

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This document applies to the below application type.	
Chassis Make	Isuzu
Chassis Model	NPR
Chassis Year	2024 - 2025
ZeroRPM Product	IMPAC
ZeroRPM Software	HMI v06.01.02
	PLC v6.00.00
	PDM v01.01.01

SECTION 1: INTRODUCTION TO THE IMPAC SYSTEM

The Idle Mitigation Power Automation Control (IMPAC) system is a vehicle energy management system that provides power to electrical tools and equipment in a mobile repair unit (MRU) or rapid assist vehicle (RAV) during vehicle repair operations. The IMPAC system includes 4kWh of energy storage capable of delivering high power for 12VDC loads as well as 120VAC power for an air compressor and electrical tools. When the state of charge (SOC) of the IMPAC batteries is low, the vehicle is in Park, and the equipment has been activated (indicated by a solid green light on the Equipment Activation button), the IMPAC system automatically turns on the engine to recharge the IMPAC batteries using the vehicle alternator. The IMPAC batteries can also be recharged via an integrated charger when the vehicle is connected to 120VAC shore power. The IMPAC system monitors the vehicle’s 12VDC lead-acid battery and keeps it charged during driving and repair operations.

Figure 1 shows a simplified diagram of the IMPAC system in an MRU/RAV.



NOTE: LithiumIron™ is the trade name for the LiFePO₄ (lithium iron phosphate) batteries used in the IMPAC system; they will be referred to as “IMPAC batteries” from this point onward. This type of battery is generally considered the safest type of lithium-ion battery available on the market. The IMPAC battery cells include a patented, built-in pressure relief valve that greatly reduces the risk when compared to other chemistries and mechanical cell designs.



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Figure 1 – IMPAC System

SECTION 2: IMPAC SYSTEM TYPICAL USAGE SCENARIO

This section describes a typical day using the IMPAC system from the perspective of the MRU/RAV service technician.

2.1. Start of the Day

There is no difference between starting a vehicle with the IMPAC system and starting a normal vehicle. At the beginning of the day, the technician simply gets in the truck, starts the engine with the key, shifts the transmission into Drive, and drives to the first worksite.

2.2. IMPAC System Operation During Driving

When the vehicle is in Drive, selected loads in the work truck body are automatically disabled by the IMPAC system to conserve energy, such as repair module lighting, the air compressor, the oil-change system, and other loads that are not needed when the service technician is driving the truck.

2.3. IMPAC System Operation at the Worksite

When the vehicle reaches the worksite, the service technician should place the truck in Park and engage the parking brake. To provide battery power to all equipment in the repair module, simply press the Equipment Activation pushbutton on the dashboard while the engine is running; this will cause the green light on the button to begin flashing. Remove the key from the ignition and the green light on the button will turn solid to indicate the repair tools and equipment in the repair module are now powered.

If the Equipment Activation button has been pressed but the green light on the button does not turn solid after the ignition key is removed, one or more of the following criteria have not been met:

- Shore Power Disconnected
- Cab in Travel Position and Locked
- Engine Running
- Gear = Park
- Parking Brake Engaged
- Key Removed from Ignition



NOTE: If the above conditions are not met within five seconds after the Equipment Activation button has been pressed, the green light will turn off and the operator must press the Equipment Activation button again to reinitiate the sequence.

The IMPAC system includes a battery pack which provides power to the equipment in the repair module. When the green light on the Equipment Activation button is solid, the IMPAC system will automatically start and stop the engine as needed to recharge the IMPAC batteries while the equipment in the repair module is being used by the service technician.

To enable power to the air compressor, press and release the Air Compressor On/Off switch on the power distribution module (PDM) control panel. The red LED indicator on the Air Compressor On/Off switch will turn on solid when the air compressor has power available. To disable power to the air compressor, press and release the Air Compressor On/Off switch again. The air compressor will immediately be turned off and the red LED indicator on the Air Compressor On/Off switch will also be turned off.

If the air compressor is too cold to operate, the IMPAC system will automatically keep it warm when the vehicle is plugged into shore power, when the engine is running, or when the light on the Equipment Activation button is solid green. The IMPAC system will not enable power to the air compressor until the compressor reaches its minimum operating temperature.



NOTE: This action is necessary because cold temperatures increase the viscosity of oil in the air compressor, which can result in high startup currents and potentially damage the inverter/charger.

2.4. Leaving the Worksite

When leaving the worksite, the service technician will enter the cab and start the engine with the ignition key. The engine can also be started by turning the key to the Run position and stepping on the brake pedal. Once the engine has been started, the IMPAC system automatically disables the air compressor and the Jump-Start feature, the two most power-intensive loads in the MRU/RAV; the green light on the Equipment Activation button automatically turns off. When you shift into Drive, the “Circuits Disabled in Drive” bank of breakers will automatically be deactivated. The IMPAC system disables automatic starting and stopping of the engine when the green light on the Equipment Activation button is off.



NOTE: If the engine is already running to charge the IMPAC batteries, insert the key and roll it to the Run position to deactivate the equipment.

2.5. Charging the IMPAC Batteries

The IMPAC system will automatically recharge the IMPAC batteries whenever 120VAC shore power is connected to the vehicle’s Shore Power Auto-Eject charge inlet. The IMPAC system also automatically recharges the IMPAC batteries via the alternator while the vehicle is driving, while the vehicle is running in Park for other reasons, or during operation when the state of charge (SOC) of the IMPAC batteries reaches 25% during engine-off operation.

2.6. At the End of the Day

Once the equipment has been deactivated and the key has been removed from the ignition, a ZeroRPM feature called ZeroDRAW™ will continue to power most of the vehicle and worksite loads for 10 minutes. At the end of the 10-minute countdown, the IMPAC system will power down and automatically turn off all loads.




NOTE: This feature is called “ZeroDRAW” because it reduces the current draw on the chassis battery to zero when the ZeroDRAW contactor is closed and connected to the IMPAC batteries. When the ZeroDRAW contactor opens, the loads powered by the IMPAC system are shed and the remaining loads on the chassis battery are near zero (returned to factory parasitic levels) to ensure the chassis engine-start battery has sufficient state of charge to start the engine. The ZeroDRAW contactor will also open if the state-of-charge drops below 35% during the 10-minute timeout.

SECTION 3: IMPAC SYSTEM OPERATION

This section provides detailed technical information about the IMPAC system.

3.1. Basic IMPAC System Operation

The IMPAC system reduces worksite fuel consumption and eliminates fumes, noise, and wear and tear on vehicle auxiliary equipment, such as air compressors and generators, caused by idling gas and diesel engines. When the vehicle is in Park, the parking brake is engaged, and all system safety and operational criteria have been met, the service technician will activate the equipment (indicated by a solid green light on the Equipment Activation button) and remove the key from the ignition. Once this has occurred, the IMPAC system will automatically stop the engine following a 10-second countdown and provide power to the onboard electrical equipment from the IMPAC batteries while the engine is off. The IMPAC system will automatically start and stop the engine as necessary to recharge the IMPAC batteries. When the technician wishes to drive the vehicle, starting the engine with the ignition key (or pressing the brake pedal with the key in the Run position) will disable the IMPAC system's on/off control of the engine and disconnect power from the air compressor in the repair module. If the technician does not want to drive the vehicle but wishes to disable Equipment Active mode, simply turning the ignition key to the Run position will disable the IMPAC system's on/off control of the engine and disconnect power from the air compressor in the repair module.

 **NOTE:** When deactivated, the green light on the Equipment Activation switch will automatically turn off to indicate that Equipment Active mode is disabled.

3.2. IMPAC System Display

Figure 2 provides an overview of the IMPAC system display and icons that may appear on it during operation.

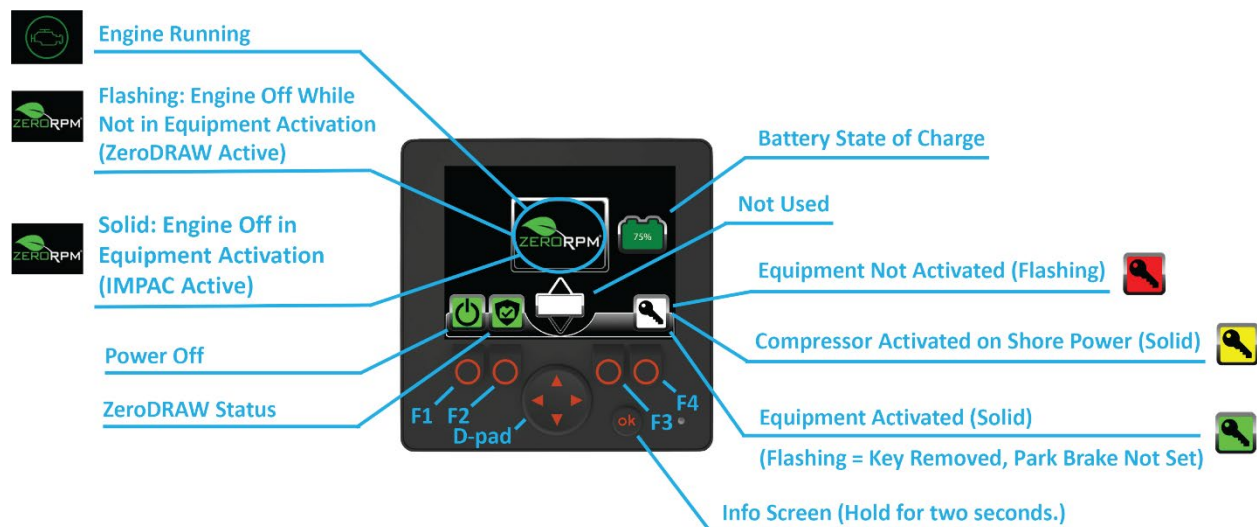


Figure 2 – IMPAC System Display

3.3. IMPAC Battery Management

The IMPAC system includes batteries which provide power to all onboard electrical equipment when the IMPAC system is in Equipment Active mode (i.e., when the green light on the Equipment Activation button is solid). When the equipment has been activated and the battery SOC is 25% or below, the IMPAC system automatically starts the engine to recharge the IMPAC batteries. When the IMPAC batteries reach 60% SOC, the IMPAC system automatically stops the engine and resumes delivery of power to all onboard electrical equipment from the IMPAC batteries. The IMPAC batteries can be charged to 100% SOC via the 12VDC alternator output during driving, or the inverter/battery charger when the vehicle is connected to shore power. The IMPAC system manages the IMPAC batteries at the cell level via voltage and temperature monitoring to ensure maximum safety and battery life.



NOTE: The IMPAC system allows the air compressor to operate when the equipment has been activated (indicated by a solid green light on the Equipment Activation button) and the IMPAC batteries are connected, or when the vehicle is connected to shore power and the compressor is activated on shore power (accomplished by pressing the F4 softkey; confirmed by the key icon above the F4 softkey turning yellow). These interlocks are necessary to prevent brownouts that may result from the chassis battery powering this heavy load.

3.4. IMPAC System User Controls

This section describes features of the IMPAC system that are manually controlled by the user.

3.4.1. Equipment Activation Button

The Equipment Activation button is a momentary pushbutton switch with a built-in green light mounted on the dashboard in the front cab (see Figure 3). It is used by the operator to activate the equipment (indicated by the light turning solid green). In this state, the IMPAC batteries are connected to provide 12VDC and 120VAC power to the electrical equipment in the repair module and to support the Jump-Start Customer Vehicle feature.

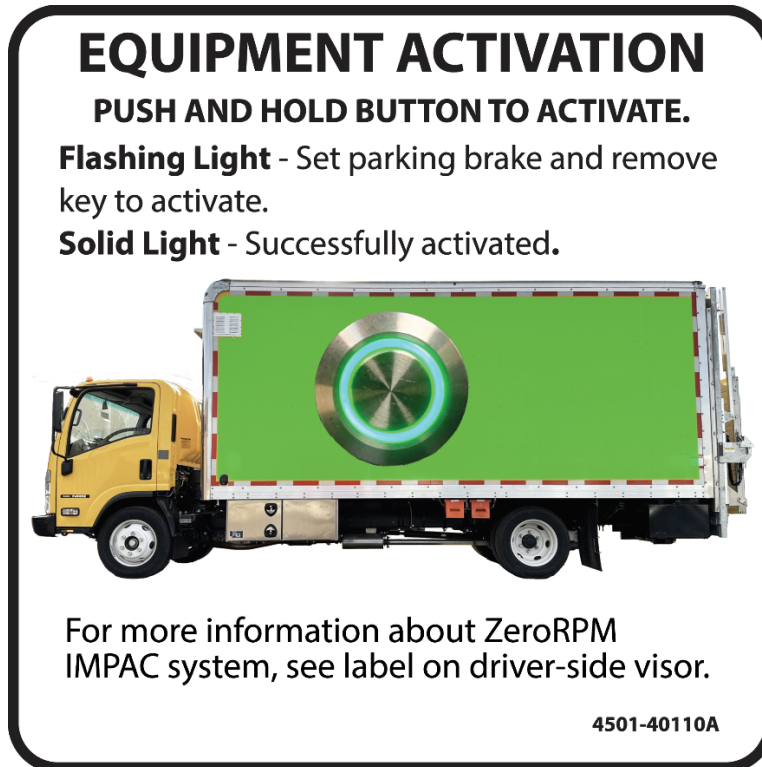




Figure 3 – Equipment Activation Button

 **NOTE:** The air compressor and jump-start will not work if the equipment has not been activated. If you forget to activate the equipment from the cab, the IMPAC display will show a flashing red key icon and state, “Equipment Not Activated” (see Figure 2). If you removed the key but forgot to set the parking brake, the IMPAC display will flash a green key and state, “Parking Brake Not Set” (see Figure 2).

3.4.2. PDM Feature Control Switches

There are five switches on the PDM that can be used to control specific IMPAC system features (see Figure 4):

1. Air Compressor Request – Toggles power to the air compressor on and off.
2. Engine Start/Stop Override – Prevents the engine from shutting down.
3. Boost-Start MRU/RAV – Boosts the chassis engine-start battery from the IMPAC batteries.
4. IMPAC Download/Diagnostic – Provides constant power for over-the-air software updates.
5. Jump-Start Customer Vehicle – Safely jump-starts a down customer battery from the IMPAC batteries.

 **NOTE:** Engine Start/Stop Override and IMPAC Download/Diagnostic are single-pole single-throw (SPST) switches that can be set by the user to either the On or Off position. The remaining controls are momentary rocker switches that are recognized by the IMPAC system when the user presses the switch for at least one second and then releases it.

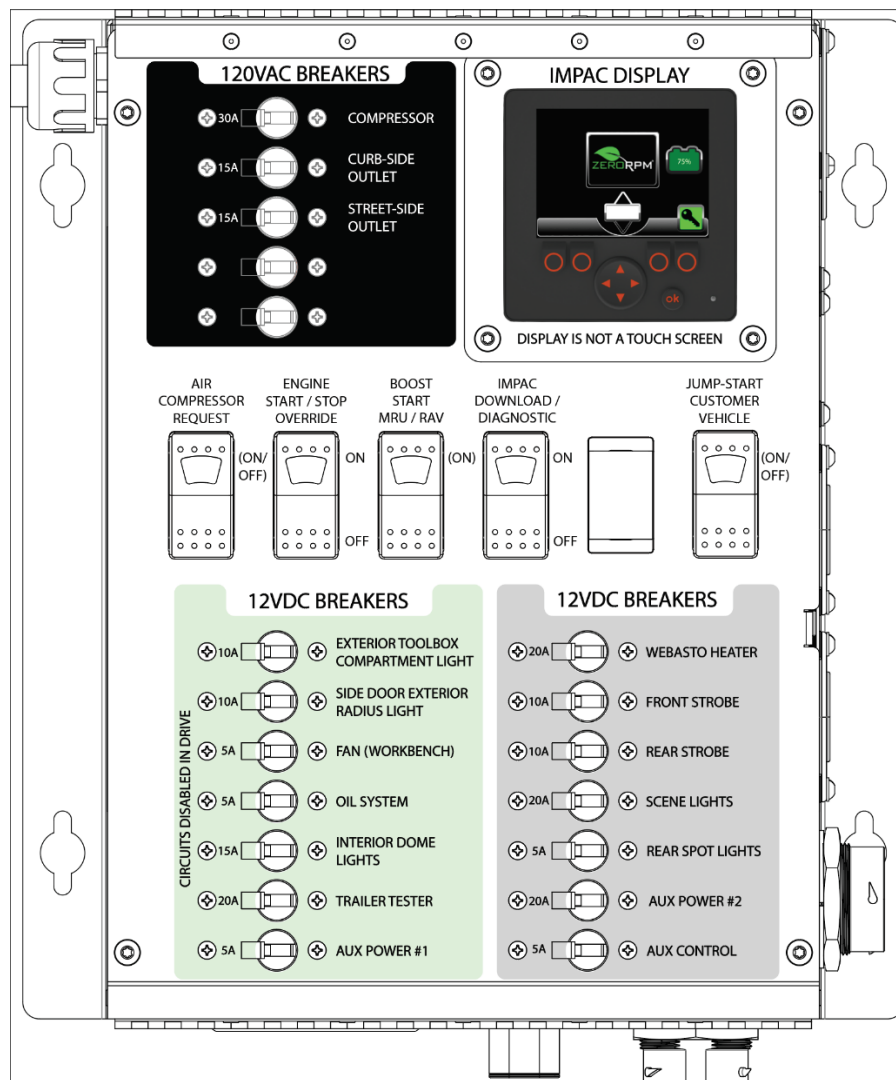

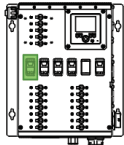
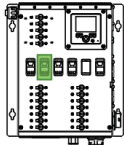
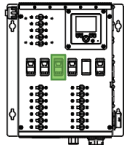
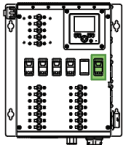


Figure 4 – PDM User Interface

3.5. IMPAC Operator Quick-start Guide

A quick-start guide for the IMPAC system (see Figure 5) is located on the front of the IMPAC system and on the visor label in the cab. This label provides a reference for how to activate various functions of the IMPAC.

https://www.zerorpm.com/resources/start-impac NOTICE					
ZeroRPM IMPAC Operator Quick-Start Guide					
FUNCTION	EQUIPMENT ACTIVATION	AIR COMPRESSOR REQUEST	ENGINE START / STOP OVERRIDE	BOOST-START MRU/RAV	JUMP-START CUSTOMER VEHICLE
VISUAL					
OPERATION	<ol style="list-style-type: none"> Ensure vehicle is in park. Start vehicle if engine is not running. Engage emergency brake. Push "EQUIPMENT ACTIVATION" button; hold until green light flashes. Remove key from Ignition. Light will be solid when activated. Chassis doors may now be locked. 	<ol style="list-style-type: none"> Press "AIR COMPRESSOR REQUEST" button for one second to enable air compressor. While air compressor is active, press "AIR COMPRESSOR REQUEST" button for one second to disable. <p>NOTE: Air compressor is automatically deactivated if inverter is overloaded, key is inserted and turned to Run position (deactivating equipment), or jump-start is engaged.</p>	<ol style="list-style-type: none"> Press top ("ON") position of "ENGINE START/STOP OVERRIDE" button to override automatic engine start/stop function. While active, engine will be started and continue to run. Press bottom ("OFF") position of button to allow automatic engine start/stop function to start and stop engine as needed to charge batteries. <p>NOTE: LED will be solid any time engine is unable to automatically start or stop.</p>	<ol style="list-style-type: none"> When MRU/RAV battery fails to start engine, press "BOOST-START MRU/RAV" button for one second. If MRU/RAV battery is above 4VDC, lithium batteries will be connected to engine-start battery for three minutes. Start MRU/RAV engine during three-minute boost cycle. Boost will automatically disengage after three minutes. <p>NOTE: MRU/RAV engine will run to charge start battery for approximately three minutes any time it has been key-started. Equipment will not be active during this charge cycle, which normally occurs while driving.</p>	<ol style="list-style-type: none"> Connect red jumper cable to positive post and black jumper cable to negative post on customer vehicle. Press "JUMP-START CUSTOMER VEHICLE" button for one second, then release. Wait while customer vehicle battery is charging. Start customer vehicle when LED on jump-start switch turns solid. Disconnect jumper cables. <p>NOTE: See "Jump-Start Procedure" label for details.</p>
DIAGNOSTICS	<ul style="list-style-type: none"> Solid = Equipment active. Flashing = Parking brake is not set or key has not been removed. If button has been pressed and key has not been removed within seven seconds, equipment activation sequence will time out. 	<ul style="list-style-type: none"> Solid = Air Compressor: Active 2 Flashes = Air Compressor: Inverter Load Too High 3 Flashes = Air Compressor: Stall Protection Active 4 Flashes = Air Compressor: System Interlocks Not Met 5 Flashes = Air Compressor: Case Too Cold 	<ul style="list-style-type: none"> Solid = Engine start/stop will not change states automatically due to system being either overridden or not activated. 	<ul style="list-style-type: none"> Solid = Lithium batteries and engine-start batteries are in parallel, allowing MRU/RAV to be started. LED will remain solid for three minutes. 	<ul style="list-style-type: none"> Solid = Jump-Start: Start Customer Vehicle Rapid, Continuous Flashes = Jump-Start: Wait While Charging 2 Flashes = Jump-Start: System Interlocks Not Met 3 Flashes = Jump-Start: Battery Not Connected 4 Flashes = Jump-Start: Alternator Ramp Incomplete 5 Flashes = Jump-Start: Customer Battery Not Charging 6 Flashes = Jump-Start: Battery Voltage Too Low 7 Flashes = Jump-Start: Battery Voltage Too High

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Figure 5 – IMPAC Operator Quick-Start Guide

3.6. IMPAC System Modes of Operation

The below table is a quick reference to understand which loads are powered under certain operating modes.







Icons Displayed While Mode is Active							
Mode Number		Mode 0	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5
Mode Name		Engine Running, Equipment Not Active	Equipment Active	Shore Power	ZeroDRAW	Sleep	Off
Lift Gate	Lift Gate	X	X	X	X	X	X
Always-on 12VDC Loads	Webasto Heater	X	X	X	X		
	Front Strobe	X	X	X	X		
	Rear Strobe	X	X	X	X		
	Scene Lights	X	X	X	X		
	Rear Spotlights	X	X	X	X		
	Aux Power #2	X	X	X	X		
	Aux Control	X	X	X	X		
Disabled-in-Drive 12VDC Loads	Exterior Toolbox Compartment Light	X	X	X	X		
	Side Door Exterior Radius Light	X	X	X	X		
	Fan (Work Bench)	X	X	X	X		
	Oil System	X	X	X	X		
	Interior Dome Lights	X	X	X	X		
	Trailer Tester	X	X	X	X		
	Aux Power #1	X	X	X	X		
Controls	IMPAC Controls	X	X	X	X		
120VAC Loads	Curb-side Outlet	X	X	X	X		
	Street-side Outlet	X	X	X	X		
	Air Compressor		X – N1	X – N3			
Export	Jump Start		X – N2				

Table 1 - Powered Loads vs. IMPAC System Modes

- N1: Upon request by pressing the “Air Compressor Request” button.
- N2: Upon request by pressing the “Jump-start Customer Vehicle” button.
- N3: Upon request by pressing F4 while connected to shore power.

3.7. Operator Screens

The images in Table 2 (below) show the IMPAC operator screen at varying states as described in Table 1. Above the image of each operator screen is the state the screen represents.



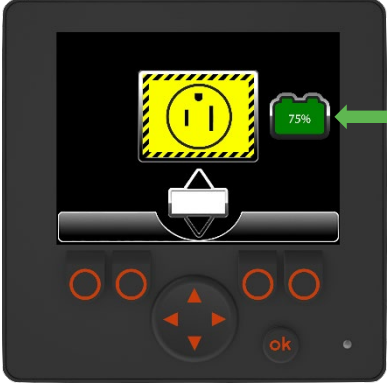


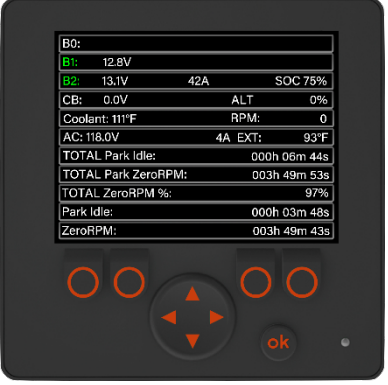
<p>Mode 0 (Engine Running, Equipment Not Active)</p> 	<p>Mode 1 (Equipment Active)</p> 																						
<p>Mode 2 (Shore Power)</p> 	<p>Mode 3 (ZeroDRAW)</p> 																						
<p>Mode 4 (Sleep) and Mode 5 (Off)</p> 	<p>Information Screen</p>  <table border="1"> <tr><td>B0:</td><td></td></tr> <tr><td>B1:</td><td>12.8V</td></tr> <tr><td>B2:</td><td>13.1V 42A SOC 75%</td></tr> <tr><td>CB:</td><td>0.0V ALT 0%</td></tr> <tr><td>Coolant:</td><td>111°F RPM: 0</td></tr> <tr><td>AC:</td><td>118.0V 4A EXT: 93°F</td></tr> <tr><td>TOTAL Park Idle:</td><td>000h 06m 44s</td></tr> <tr><td>TOTAL Park ZeroRPM:</td><td>003h 49m 53s</td></tr> <tr><td>TOTAL ZeroRPM %:</td><td>97%</td></tr> <tr><td>Park Idle:</td><td>000h 03m 48s</td></tr> <tr><td>ZeroRPM:</td><td>003h 49m 43s</td></tr> </table>	B0:		B1:	12.8V	B2:	13.1V 42A SOC 75%	CB:	0.0V ALT 0%	Coolant:	111°F RPM: 0	AC:	118.0V 4A EXT: 93°F	TOTAL Park Idle:	000h 06m 44s	TOTAL Park ZeroRPM:	003h 49m 53s	TOTAL ZeroRPM %:	97%	Park Idle:	000h 03m 48s	ZeroRPM:	003h 49m 43s
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TOTAL Park ZeroRPM:	003h 49m 53s																						
TOTAL ZeroRPM %:	97%																						
Park Idle:	000h 03m 48s																						
ZeroRPM:	003h 49m 43s																						

Table 2 – Operator Screens