KAPower Starting Module (KSM)

INSTALLATION – OPERATION MANUAL
Gen 3. Rev E

Gen 3
12 & 24 Volt

KBI/Kold-Ban International, Ltd.
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ATA VMRS - T44 KLDBN

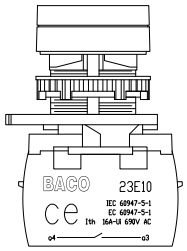
PARTS LIST:

1. KSM Enclosure.
2. Double Pole Single Throw (DPST) push button switch.
3. Wiring harness. (Not Shown)
4. Terminal grease. (Not Shown)
5. Protective boots. (Not Shown)

ITEMS NEEDED FOR INSTALLATION:

1. Battery cables, 4/0 cable is recommended.
2. Terminals for battery cable.
3. Torque wrench with ¾ inch socket.
4. Minimum 16 gauge wire for harnesses.

KSM Enclosure



DPST Switch

SAFETY AWARENESS

SAFETY AWARENESS SYMBOLS are inserted in this manual to alert you to possible SAFETY HAZARDS. Whenever you see these symbols:

WARNING or CAUTION heed their instructions!

SAFETY AWARENESS SYMBOLS AND MEANINGS:

WARNING

THIS WARNING SYMBOL IDENTIFIES SPECIAL INSTRUCTIONS OR PROCEDURES, WHICH, IF NOT CORRECTLY FOLLOWED, COULD RESULT IN PERSONAL INJURY.

CAUTION

THIS CAUTION SYMBOL IDENTIFIES SPECIAL INSTRUCTIONS OR PROCEDURES, WHICH, IF NOT STRICTLY OBSERVED, COULD RESULT IN DAMAGE TO OR DESTRUCTION OF EQUIPMENT.

WARNING

KAPower module is a product of high electric power.

Never short circuit KAPower module terminals! Burning or igniting of combustible materials adjacent to the point of short circuit may follow such a short circuit. In case of accidental short-circuit-ing of the KAPower module or individual capacitors immediately disconnect the KAPower module from the electric circuit. Use caution when doing so as short-circuited cables can become very hot, while spewing melting insulation and copper

CAUTION

Noncompliance with the requirements set forth in this Manual may result in KAPower module failure. Such requirements shall be reviewed prior to and observed in the course of KAPower module operation and installation.

The KAPower module is polarity sensitive. Polarity shall be strictly observed when connecting the KAPower module!

Note: KAPower ***is not*** a high-voltage device. It simply supplies the same voltage that it was charged up to. Treat it with the same respect you would give to a fully charged battery.

TABLE OF CONTENTS:

Notes:

INTRODUCTION:

The KSM enclosure houses a KAPower module, a contactor, a PLC Module, a circuit breaker, cables, conductors and connectors. The cover of the KSM enclosure can be removed by unscrewing and removing the ten (10) fasteners found on the top and sides of the enclosure. The cover should only be removed for servicing or troubleshooting at the direction of KBI.

KAPower is designed as an auxiliary power source to be installed in parallel with your cranking batteries. It derives its power from your batteries or engine charging system and discharges this power when needed. KAPower is intended for supplying electric power to various loads operated in high pulse power (engine cranking) modes. KAPower will enhance and provide for reliable cranking and starting of internal combustion engines. You may be able to remove half or all of the existing starting batteries. See Appendix A for detail.

KAPower:

•Stores Cranking Voltage Until Needed •Long Service Life – Upwards of a Million Cycles
•Performance Virtually Unaffected by Temperatures •Increases the Life of Batteries
•Requires NO Maintenance •Safe & Easy to Install

KAPower Basic Description:

The KAPower module is an energy storage device. KAPower is a High Power device with Low Energy density. The cranking or discharge periods will be short but powerful (typically less than 30 seconds) with the time to full recharge rated in tens of seconds. Recharging can be accomplished from virtually any 12 or 24 volt DC electrical power source. Cycling, charge and discharge events will not wear out the device. The Cycle Duty is rated in hundreds of thousands of cycles approaching one million cycles.

The KAPower Module:

The KAPower module, which is housed within the KSM enclosure, represents an internal bank of 6, 10 or 12 capacitor cells series-connected to each other.

An Electrochemical Capacitor (EDLC):

An Electrochemical Double layer Capacitor represents a device capable of storing and delivering electric power due mainly to the existing capacitance of the double electric layer, which is formed by the capacitor's electrodes being in contact with electrolyte. The capacitor consists of negative and positive electrodes with terminals, separator, electrolyte, and a shell.

INSTALLATION:

WARNING The KAPower KSM is a product of high electric power. Avoid shorting module terminals! A brief, short circuit will not cause product failure, however, it may result in burning or igniting of combustible materials adjacent to the point of short circuit.

IMPORTANT!

Remember, Electrical Resistance in the circuit created is the consumer of the electrical energy in your KAPower Module. Keep the resistance to an absolute minimum. Short, heavy cables and good, clean cable connections are essential!

CAUTION When selecting a location for installation, make sure that the KAPower KSM module will clear any lids and other movable parts. Install the KAPower KSM module as close to the engine's starting batteries or starter as possible. Avoid locations that are subject to extreme heat, humidity, dripping water (under deck ventilation systems aboard boats for instance), road dirt, ice and snow. Prevent the external case of the KAPower KSM module from physical impacts.

Visually inspect the external case prior to mounting the module. Make sure that no traces of physical impacts are present on the external case of the KAPower KSM module.

WARNING DO NOT remove the external plastic case cover of the KAPower module located within the KSM enclosure. DO NOT short circuit terminals.

Before installation, familiarize yourself with the specifications of your KAPower KSM module. Insure that you have the proper device for your application.

Specifications

	12 V 6 Cell Unit	12 V 10 Cell Unit	24 V 10 Cell Unit	24 V 12 Cell Unit
Electrical Characteristics				
Operating Voltage Window	7 – 14.5 V	7 – 14.5 V	8 – 29 V	8 – 29 V
Maximum Voltage	18 V	18 V	30 V	33 V
Minimum Voltage	0 V	0 V	0 V	0 V
Internal Resistance	0.0011 ohms	0.0008 ohms	0.0019 ohms	0.0022 ohms
Capacitance	525 F	1260 F	315 F	263 F
Energy Stored within Operating Voltage Window	42.3 kJ	101.6 kJ	122.4 kJ	102 kJ
Energy Stored at Max Voltage	85.1 kJ	141.8 kJ	141.8 kJ	142.9 kJ
Maximum Power	47 kW	112 kW	112 kW	94 kW
Leakage Current at Max Voltage	4.5 mA	4.5 mA	4.5 mA	4.5 mA
Operating Conditions				
Operating Temperature Range	-40° – 185°F (-40° – 85°C)	-40° – 185°F (-40° – 85°C)	-40° – 185°F (-40° – 85°C)	-40° – 185°F (-40° – 85°C)
Cycle Life	>1,000,000	>1,000,000	>1,000,000	>1,000,000
Dimensions and Weight				
Length x Width x Height	14.79" x 7.75" x 8"	19.44" x 7.75" x 8"	19.44" x 7.75" x 8"	19.44" x 7.75" x 8"
Weight	22 lb	32.5 lb	32.5 lb	34.5 lb

ELECTRICAL CABLE SELECTION:

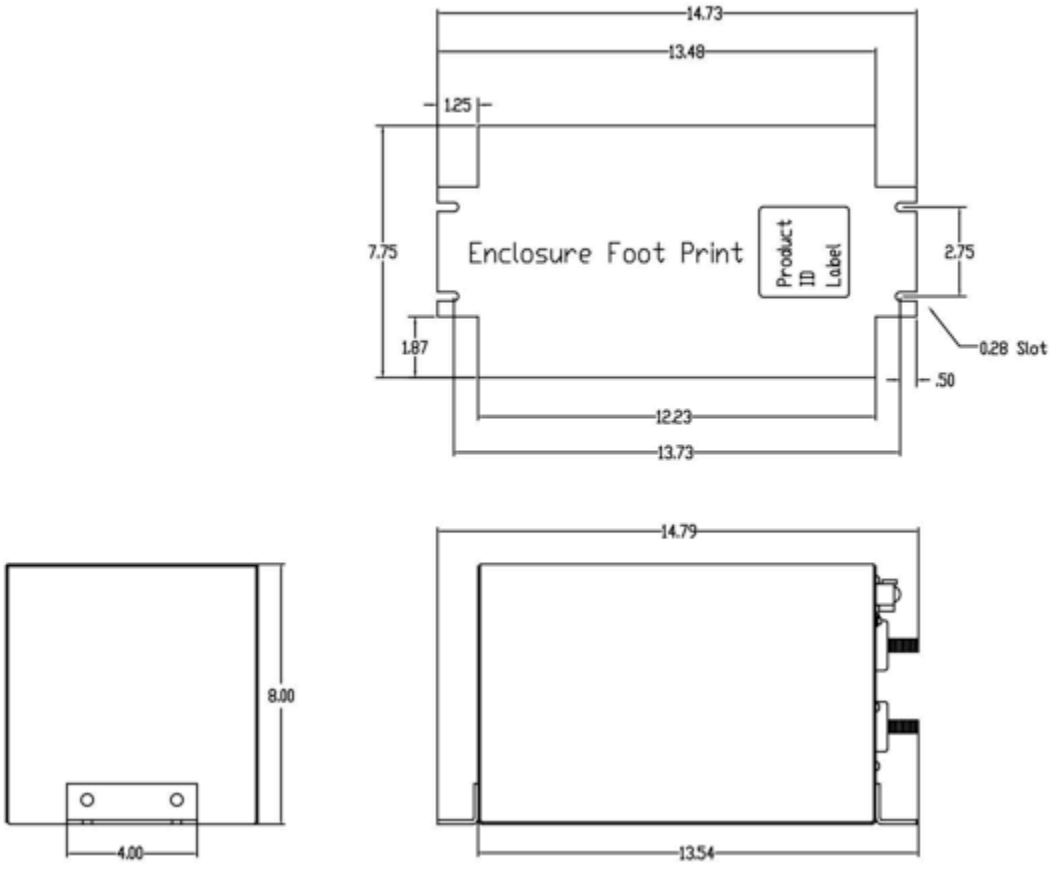
1. Electrical resistance in the circuit you create is a significant consumer of the power available in the KAPower device. Create and keep the integrity of the circuit you create to the highest possible standards.
2. Use the heaviest gauge cable available. It is recommended that 4/0 cable be used.
3. Keep cable length to an absolute minimum. The circuit resistance increases with cable length.
4. Ensure that the cable termination connections (terminals) are properly crimped, and ensure that the holes in ring terminals match the size of the studs over which they are placed. Do not use welding cable; use high quality, fine strand type II or III battery cable. For marine applications tinned cable and use of a conductant paste or dielectric grease on connections is recommended.
5. The quality of the cable connections from the KSM to the vehicle or equipment is critical. Make sure to provide good, clean, robust cable interface connections. The cables between the KSM module and the battery do not benefit from over-current protection, i.e. they have no fuse or circuit breaker. If a short circuit occurs the cable will overheat and it may catch fire, or ignite nearby combustible materials. Therefore, make certain the cable is well-secured, at least every 18", and protected from damage and chafe. For marine installations, follow American Boat and Yacht Council Guidelines found in chapter E-11.
6. The 4 Pin Deutsch connector has been supplied with a mating connector. Be sure to follow proper wire schemes as identified in the diagrams.
7. The supplied DPST switch will be installed in addition to or paralleling the existing key-start switch. Locate and install the DPST switch in a convenient location relative to the key switch.

MOUNTING THE KSM UNIT:

Using the dimensions shown below, use four (4) ¼" bolts, nuts & lock washers (not supplied) to mount the KSM unit to vehicle, vessle or equipment chassis**.**

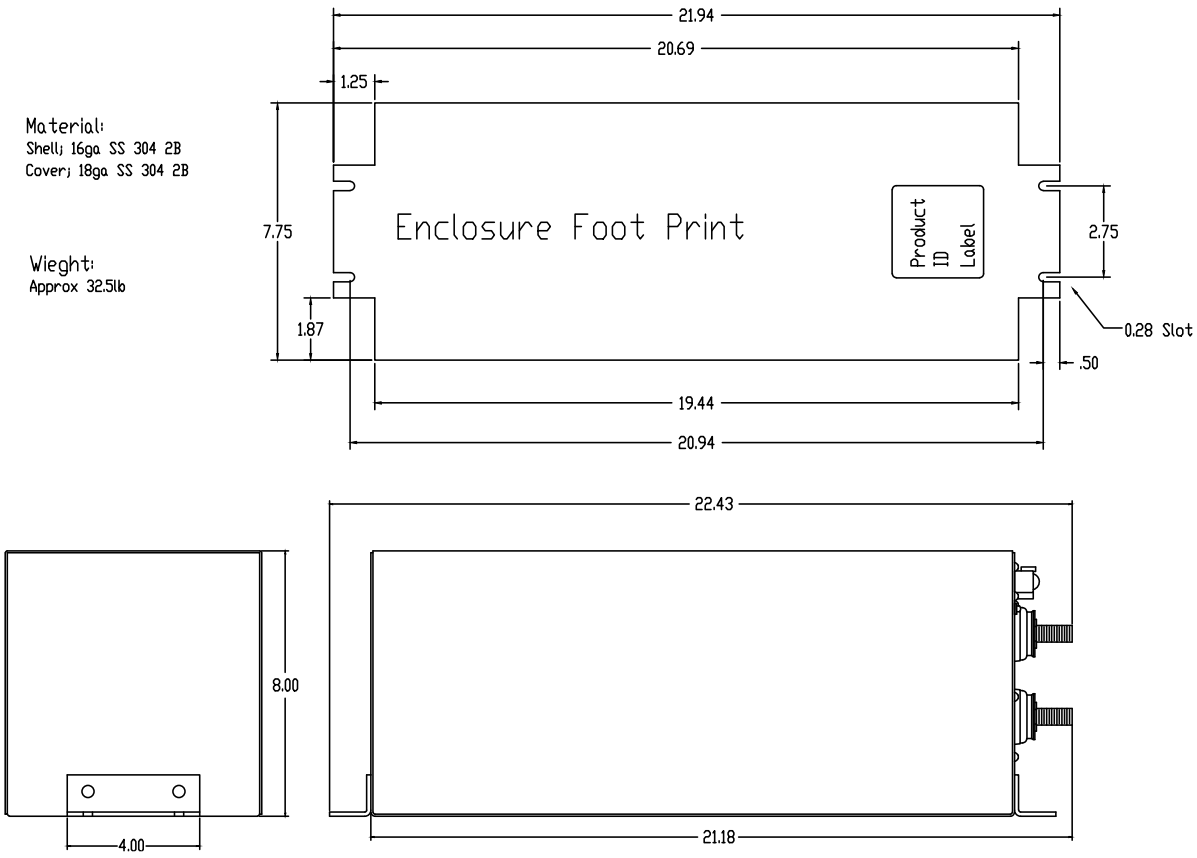
CAUTION

When selecting a location for installation, make sure that the KSM module and cables will clear any hoods, hatches, lids, covers and other movable vehicle, vessel or equipment parts. Avoid locations that are subject to extreme heat, dripping water, humidity, road dirt, ice and snow. While the KSM unit may be mounted in any position or orientation, do not mount it directly over batteries, or under ventilation systems through which water might drip. The internal components of the KSM are IP67 rated but the KSM itself is not IP rated. Take care to prevent the external case of the KSM module from receiving any physical impacts.



6 cell KSM

*The J1939 connector is used for KBI Factory programing only. Contact KBI for details***.**

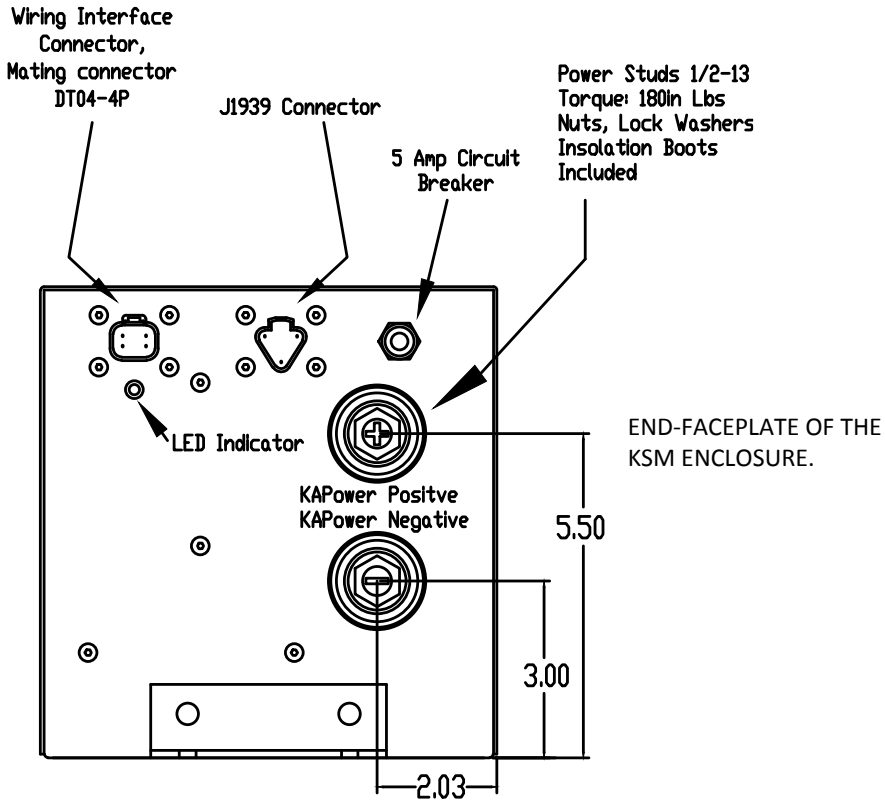


10 & 12 cell KSM

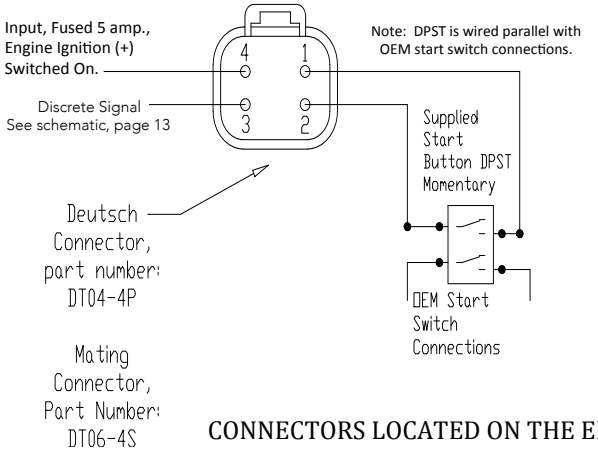
The J1939 connector is used for KBI Factory programing only. Contact KBI for details.

GENERAL WIRING INSTALLATION PROCEDURE:

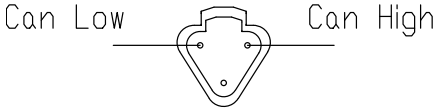
CAUTION KSM Power Stud Nuts should be torqued to 180 Inch Pounds.



Wire Interface Connector Pin-Out



J1939 Connector Pin-Out



Deutsch Connector
DT04-3P

The J1939 connector is used for KBI Factory programing only. Contact KBI for details.

CONNECTORS LOCATED ON THE END-FACEPLATE OF THE KSM ENCLOSURE.

GENERAL WIRING INSTALLATION PROCEDURE: (CONTINUED)

Theory of Operation, explaining how the KSM module works:

Once installed and wired properly, the LED on the End-Faceplate of the KSM will be illuminated green whenever the KSM contactor relay is closed. When the LED is illuminated, the contactor is closed; the KAPower Module is running parallel with the vehicle, vessel or equipment batteries and electrical system.

When the DPST switch is depressed you are closing the contactor inside the KSM enclosure, using power from the KAPower module, regardless of the state of charge of the vehicle or equipment's batteries. When depressing the DPST switch you are also engaging the cranking motor circuit, just as you would if you turned the key switch to the crank/start position, or pressed the vehicle's or vessel's start button if so equipped. The DPST switch is wired in parallel with the existing starting system. This is done by wiring and using the recommended electrical circuit, displayed on the schematic (page 13). By doing so, you have paralleled with the OEM (Original Equipment Manufacture) electrical circuit allowing both the KSM and the OEM cranking motor circuit to be engaged, simultaneously. Once the engine starts, the Programmable Logic Controller (PLC) inside the KSM monitors the condition of the KAPower Module and will close or open the Contactor Relay inside the KSM, based on the preprogrammed parameters inside the PLC. When the engine is stopped, the equipment is turned off, the contactor opens and the KAPower module remains isolated, waiting for the next engine-starting event, when the DPST switch is pressed.

The PLC preprogrammed functions:

The PLC has been preprogrammed to monitor and control the state-of-charge of the KAPower capacitor module based on temperature, voltage & time. Once a voltage signal is received at pin four (4) of the Wiring Interface Connector the PLC "wakes-up" and will determine when and how long to keep the contactor closed. Remember, anytime the LED Status Indicator is illuminated the contactor is closed. In a typical engine-starting event you will see the LED illuminate during engine cranking and then go out for several seconds after the engine has started. The LED will then illuminate again and could remain illuminated for several seconds based on the condition of the KAPower module. The LED may even begin to "cycle" depending on the vehicle or system voltage during the recharging events.

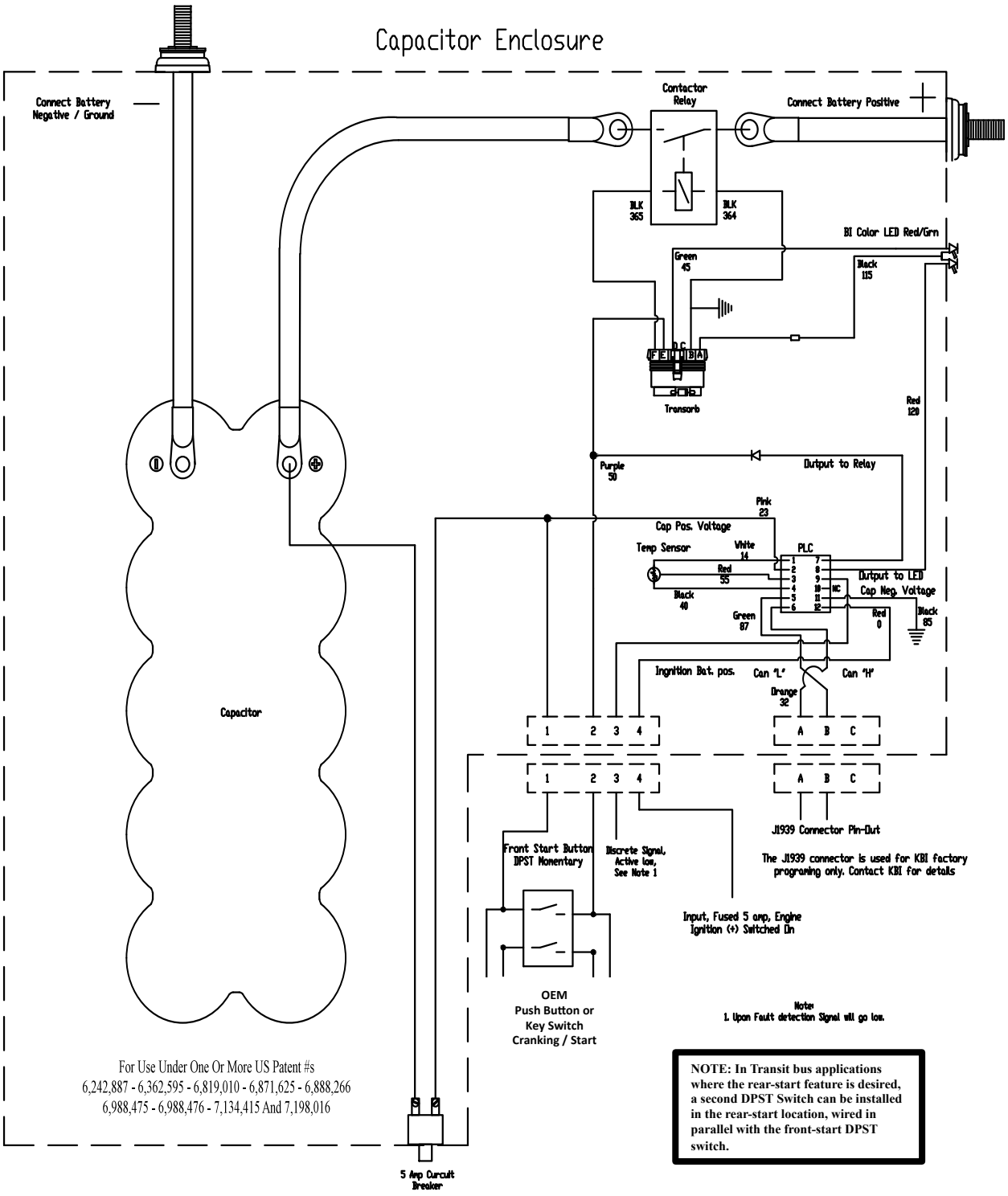
The J1939 connector is used for KBI Factory programing only. Contact KBI for details.

GENERAL WIRING INSTALLATION PROCEDURE: (CONTINUED)

1. Before attaching the large battery cables to the KSM posts, remember to slide included protective boots onto the cables. The first cable shall be connected to the positive **+** terminal of the KSM and then connected to the positive **+** terminal of the battery.
2. Slide included protective boot onto the negative **-** cable. This second cable shall be connected to the negative **-** clamp or terminal of the battery and then connected to the negative **-** terminal of the KSM module.
3. As based on page 10 & 13 create and wire the harnesses to the Deutsch connector. The KSM Deutsch connector has been provided with mating connector that has pigtail wire leads tagged and identified in order to facilitate installation.
4. For the PLC input, pin four (4) of the wire interface connector, you must find a 5-amp power source from the vehicle or vessel, "key-on" ignition source that is live positive **+ only** when the ignition switch is on, and is capable of delivering up to 5 amps. This can often be sourced at the engine. Install a 5-amp fuse in this circuit within seven [7] inches of the power source. Use care not to disturb or compromise the engine's own wiring harness or connections.
5. Wire the DPST switch and find and wire the appropriate PLC input (pin 4) as based and depicted on the diagram & schematic pages 10 & 13. You will not be connecting any wiring to the J1939 Connector. *The J1939 CAN-Bus is used for KBI Factory programming only. Contact KBI for details.*
6. Apply provided protective grease on KSM positive **+** and negative **-** terminals.
7. Attach provided protective boots to terminals on KSM module.
8. If you wish to monitor the KSM state of charge, you can order and install the KBI Voltmeter wire-harness and connector accessory kit, KBI part number 302809. See Appendix B. The meter you use may be digital or analogue; however, it **must** be activated only with a momentary on switch or button. Permanently wiring a voltmeter to the KSM will accelerate the depletion of its charge
9. Wiring is complete and the unit is now ready to operate.

CAUTION

After the installation and wiring are complete, whenever the DPST switch is depressed the KSM positive **+** and negative **-** terminals will be live. Do not short-circuit the terminals.


Capacitor Enclosure
Connect Battery Negative / Ground
Contactor Relay
Connect Battery Positive
BLK 365
BLK 364
BI Color LED Red/Grn
Green 45
Black 115
Transorb
Red 128
Purple 50
Output to Relay
Pink 23
Cap Pos. Voltage
Temp Sensor
White 14
Red 55
Black 40
PLC
Output to LED
Cap Neg. Voltage
Green 67
Red 0
Black 85
Ignition Bat. pos.
Can "L"
Can "H"
Orange 32
Capacitor
1 2 3 4
A B C
Front Start Button DPST Momentary
Discrete Signal, Active low, See Note 1
J1939 Connector Pin-Out
The J1939 connector is used for KBI factory programing only. Contact KBI for details
Input, Fused 5 amp, Engine Ignition (+) Switched In
OEM Push Button or Key Switch Cranking / Start
Note: 1. Upon Fault detection Signal will go low.
For Use Under One Or More US Patent #s
6,242,887 - 6,362,595 - 6,819,010 - 6,871,625 - 6,888,266
6,988,475 - 6,988,476 - 7,134,415 And 7,198,016
5 Amp Circuit Breaker
NOTE: In Transit bus applications where the rear-start feature is desired, a second DPST Switch can be installed in the rear-start location, wired in parallel with the front-start DPST switch.

OPERATION

CAUTION

Do not attempt to bypass the PLC functionality. Charge voltage and temperature shall not exceed the Maximum Voltage and Temperature as specified in the Tables on page 6. It is important to MONITOR the voltage when charging the KAPower module to its Maximum Voltage. If the voltage exceeds these ranges contact KBI for further troubleshooting instructions. This is the main purpose and function of the PLC. Failure to adhere to these specifications will result in premature module failure.

Using the system:

- Confirm, using the wiring diagram on page 10, that you have properly installed the KSM module before activation.
- Simply turn the vehicle or vessel key switch to the on position, then push and hold down the DPST switch to engage the KAPower KSM system until the engine starts.
- By using power from the KAPower capacitor, the KSM contactor will close and stay closed whenever the DPST switch is depressed. The DPST switch is designed to engage the vehicle, vessel or equipment's OEM cranking motor circuit.
- Whenever the KSM KAPower contactor is closed, the LED on the End-Faceplate should be illuminated green.
- The engine should begin to crank-over with power being supplied from both the KSM capacitor module and the standard batteries.
- Once the engine starts and the DPST switch is released, the KSM internal PLC module will be active, keeping the contactor closed when required, allowing the KAPower module to recharge.
- **NOTE: If the vehicle, vessel or equipment's batteries are completely discharged, if the battery is dead, it may be necessary to keep the DPST switch depressed until the vehicle's electrical (charging/alternator) system has become active. The dead batteries, on their own, may not support all of the engine's electrical power requirements to keep it running. In this case, keep the DPST switch depressed until you are sure the vehicle's or vessel's charging system is active, you can note this by watching the engine's volt or amp meter. The KAPower module *will* have enough power to keep the engine running until the engine's charging system becomes active. *Warning: This can only be done if the engine is equipped with automatic starter disengagement; if the starter remains engaged while the start button is depressed, after the engine has started, the starter may be damaged, in which case this procedure cannot be used.***
- When the engine stops and the vehicle or equipment is turned off the KSM contactor will open, keeping the fully charged KAPower module in reserve for the next engine-starting event.

TROUBLESHOOTING AND MAINTENANCE:

Maintenance of the KAPower module within the KSM enclosure shall not be required provided that the operating conditions are proper and that the requirements specified in this Manual are observed.

For testing purposes, you may wish to periodically start the engine using only the vehicle's or vessel's own key switch or start button. Doing so will prevent the KSM from coming on line, thereby allowing you to test the condition of the starting battery.

- The LED located on the End-Faceplate of the KSM indicates the active condition of the KSM module. See page 10 for location of this light. If the LED is not illuminated when the expected, (see Theory of Operation, page 11) then ensure that all wiring and connections are in accordance with the instructions within this manual. Check the integrity of the DPST switch and the power supply to the PLC (sourced from the engine ignition switched when on) wiring harness you created.
- This bi-color (red/green) LED is also an indicator for how the KSM is functioning. The green side of the LED is connected parallel with the contactor. The red side is connected to an output on the PLC as shown in the schematic depicted on page 13. The PLC monitors the capacitor voltage during and after the recharge cycle. If the capacitor voltage drops to below an acceptable level in the first 5 minutes after the recharge, the red LED will flash, indicating a fault. If at any time while the PLC is powered up and the KSM Circuit Breaker trips or the capacitor voltage level drops below 4 volts the red LED will flash in a sequence that indicates the fault, see below.

Priority	Name	Flash Rate
1	Capacitor Over Temperature	2
5	Temperature Sensor Error	3
4	Contactor Over Current Error	4
2	Low Capacitor Voltage Error	6
3	Rapid Voltage Decay after Recharge	7

TO CHECK KSM INTERNAL CIRCUIT:

- If the wiring and harnesses are in good order continue troubleshooting by unplugging the Deutsch connector on the end-faceplate of the KSM, giving you access to the pin terminals on the KSM connector. Refer to pages 10 & 13.
- With the circuit breaker reset, using a voltmeter check voltage at Pin #1 of the Deutsch four-pin connector and the KSM negative **-** ground power stud terminal. If voltage is present the circuit is good. The voltage reading is the actual KAPower module voltage and should be at least 10 volts for the 24-volt models and 4 volts for the 12-volt models, in order to activate the contactor.
- Jump pins 1 and 2 on the four-pin connector, the contactor should activate, you will hear a clunk. If not, you may need to remove the KSM cover and check for faulty contactor or internal wiring. Before removing the KSM cover it is recommended you contact KBI for assistance.
- If the circuit breaker continues to trip check the integrity of the vehicle or vessel side of the wiring harness for issues such as shorts, corrosion, chafing or bad connections and components.
- Check the circuit breaker and contactor relay connections within the KSM module. In order to service or replace any of these components you will have to remove the cover of the KSM enclosure. Reference page 5, **INTRODUCTION:** Again, contact KBI for assistance.
- The PLC Module is a sealed unit. It cannot be serviced. If additional troubleshooting is required contact KBI.

STORAGE:

CAUTION

The KAPower module should be discharged prior to storage and for prolonged periods (>1 year) should be stored in a completely discharged state. The KSM can be discharged by hooking up the power studs to any resistive load (a light bulb or motor of the appropriate voltage) and activating the unit (jump pins 1 and 2 on the four-pin connector, the contactor should activate) until the desired voltage is reached (6 volts for 12 volt systems and 20 volts for 24 volt systems). Voltage can be monitored at the power studs.

The KAPower modules shall be stored within enclosed heated or unheated premises outfitted with a natural ventilation system in regions having moderate or cold weather conditions. Climate control systems are not required. The required storage temperature range is -76º to 185ºF (-60º to 85ºC).

TRANSPORTATION:

The KAPower KSM modules can be shipped in approved corrugated cardboard, wooden, or plastic containers. For more information on transportation contact KBI.

LIMITED WARRANTY

The KAPower module itself, inside the KSM, is guaranteed against defects in material and workmanship for three (3) years from date of purchase. All other KSM components are guaranteed against defects in material and workmanship for one (1) year from the date of purchase. The KAPower module is a sealed unit - do not tamper with. If the KSM does not operate properly within the warranty period, it must be returned to the factory, prepaid, in order to determine warranty disposition. If factory inspection determines the product to be defective under the terms of this warranty, it will be replaced without charge.

Failure due to accident, abuse, neglect, use other than in the intended application specified in this manual, improper installation or maintenance, mishandling, and repairs or attempted repairs which have been made by others, are not covered under the terms of this warranty.

Kold-Ban International, Ltd. shall not be liable for loss of use of the KAPower KSM or other incidental or consequential costs, expenses or damages incurred by the purchaser or user.

This warranty does not include labor for repair or replacement.

Kold-Ban International, Ltd.

8390 Pingree Road

Lake In The Hills, IL 60156-9637

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www.koldban.com

STARTING FLUID SYSTEMS
DIESELMATIC™ KOMPAC™ DIESEL START™
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ELECTROCHEMICAL DOUBLE LAYER CAPACITOR
KAPower™ KrankingKART™
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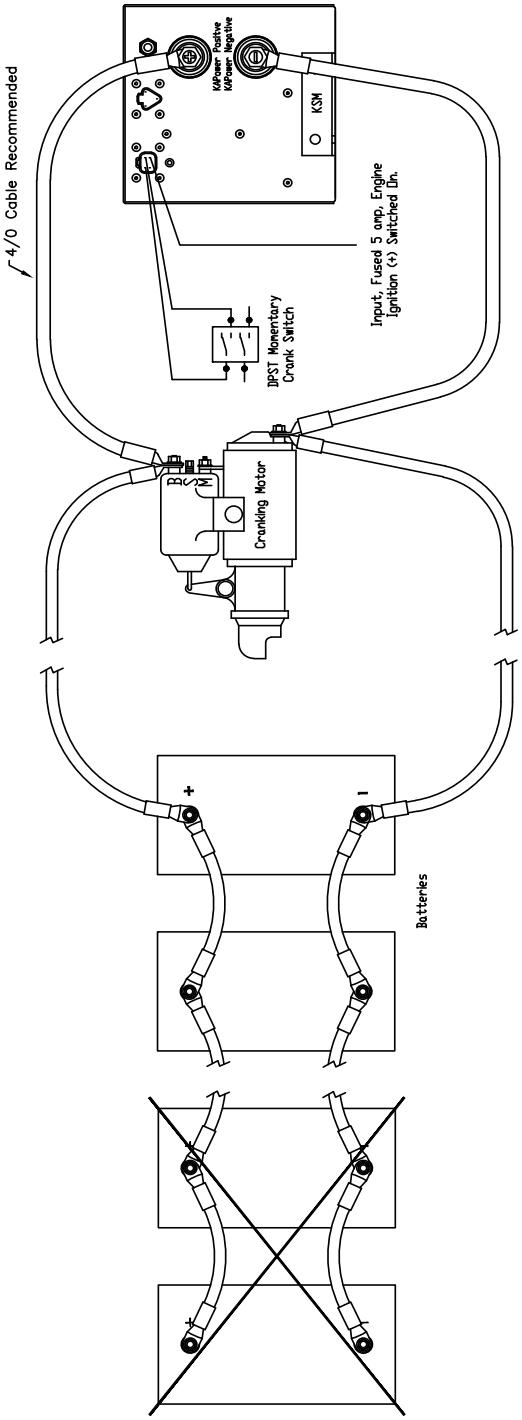
Ph (847) 658-8561, (800) 527-8278, Fax (847) 658-9280 www.koldban.com 4/06/05

PART NAME:	KSM INSTALL		PART NUMBER:	131425	
			CUSTOMER NUMBER:		
DRAWN BY:	MJB	SIZE: C	APPROVED BY:	JDB	CHECK BY:
DATE:	3/20/17		DATE:	3/20/17	DATE:
SCALE:	NONE	UNLESS OTHERWISE SPECIFIED DIMENSION TOLERANCES ARE: X ±0.015, XX ±0.010, XXX ±0.005, ANGLES ±0.5°, FINISH PER MIL STD-10. DO NOT SCALE DRAWING.			

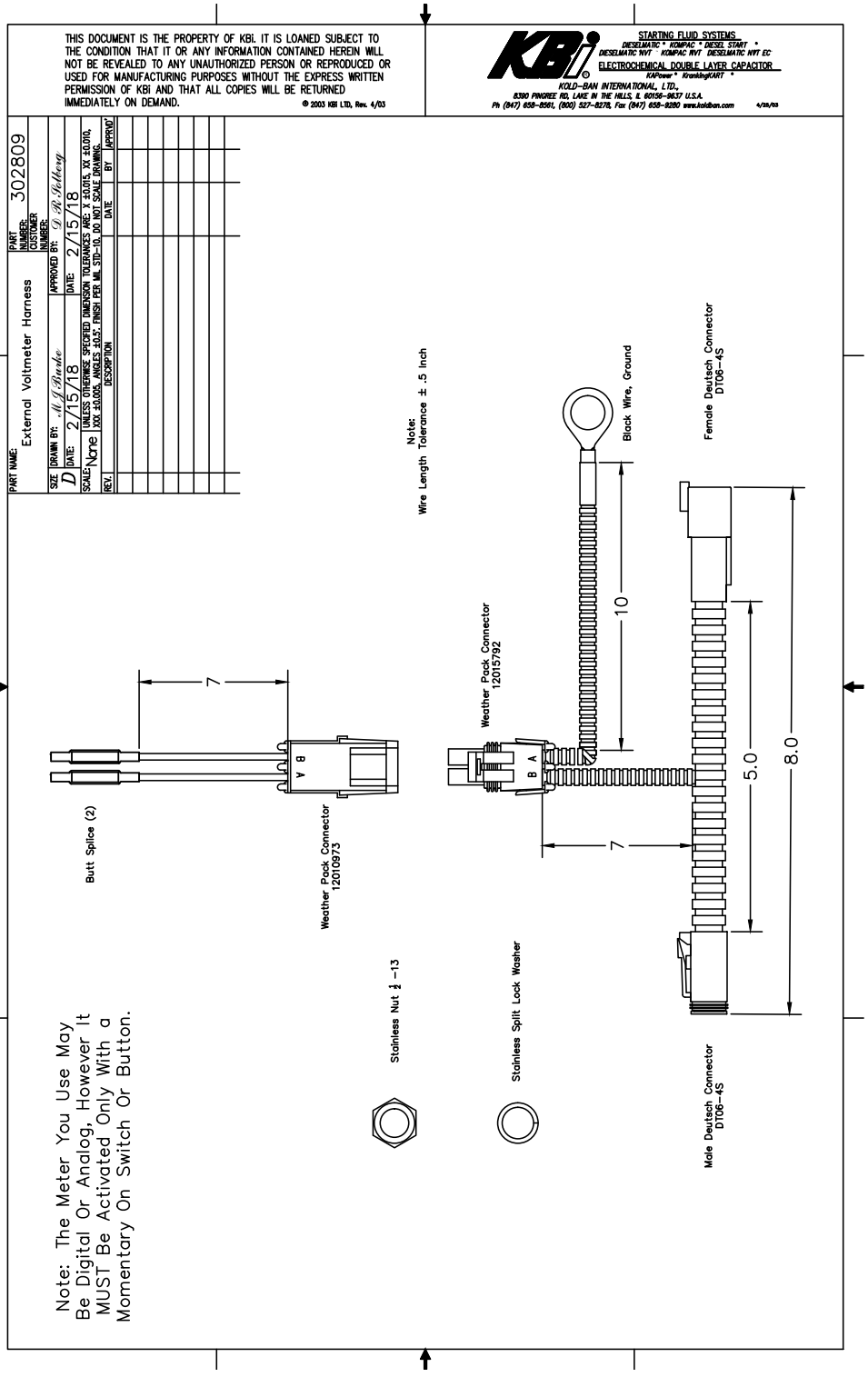
REV.	DESCRIPTION	DATE	BY	APPRVD



For Use Under One Or More US Patent #s 6,242,887 - 6,362,595 - 6,819,010 - 6,871,625 - 6,888,266 6,988,475 - 6,988,476 - 7,134,415 - 7,198,016 - 8,820,287B2 AND 20160053737A1

You may be able to remove half or all of the existing starting batteries when using a KAPower Module. Replacing any remaining lead acid batteries with deep cycle batteries will enhance your system.

Appendix B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STARTING FLUID SYSTEMS
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KAPower * KranikingKART *
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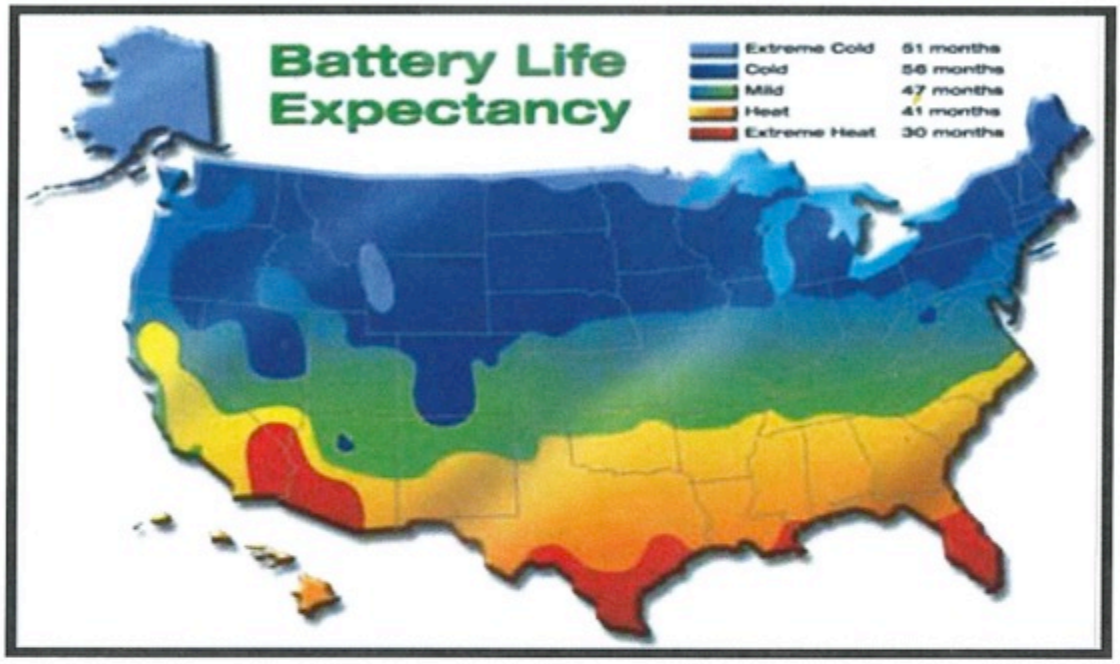
Ph (847) 658-8581, (800) 527-8278, Fax (847) 658-9280 www.koldsan.com
4/28/03
PART NAME: External Voltmeter Harness
PART NUMBER: 302809
CUSTOMER NUMBER:
SIZE D
DRAWN BY: M. J. Burke
DATE: 2/15/18
APPROVED BY: D. R. Stalberg
DATE: 2/15/18
SCALE: None
UNLESS OTHERWISE SPECIFIED DIMENSION TOLERANCES ARE: X ±0.015, XX ±0.010, XXX ±0.005, ANGLES ±0.5°, FINISH PER MIL STD-10, DO NOT SCALE DRAWING.
REV.
DESCRIPTION
DATE
BY
APPRVD
Note: Wire Length Tolerance ± .5 Inch
Black Wire, Ground
Female Deutsch Connector DT06-4S
Weather Pack Connector 12015792
Butt Splice (2)
Weather Pack Connector 12010973
Stainless Nut ½-13
Stainless Split Lock Washer
Male Deutsch Connector DT06-4S
7
10
5.0
8.0
B A
B A
Note: The Meter You Use May Be Digital Or Analog, However It MUST Be Activated Only With a Momentary On Switch Or Button.

12. WHAT ARE THE COMMON CAUSES OF PREMATURE BATTERY FAILURES?

Normally, premature battery failures are caused by one or more of the failures listed below. Prior to 1980, plate or grid shorts were the most common failure. Since then the manufacturers have significantly improved the life expectancy by using improved separators, plate alloys to reduce corrosion, and heat shields. By relocating sealed AGM and Gel Cell batteries to the passenger compartment (or trunk), also has considerably **decreased** premature battery failures. Batteries that have been in use for longer periods of time will typically fail from multiple causes. **All batteries will fail at some point in time.**



[Source: Interstate Batteries]

12.1. **Water Loss! (Car) and Sulfation! (Deep Cycle)**

12.2. **Water Loss! (Car) and Sulfation! (Deep Cycle)**

12.3. **Water Loss! (Car) and Sulfation! (Deep Cycle)**

12.4. For Car batteries, high under hood **heat** or overcharging causes a loss of water (which account for over **50%** of the failures); accelerated positive grid corrosion and growth; increased self discharge; or plate-to-strap shorts.

12.5. Sulfation from water loss, undercharging, excessive temperatures or prolonged periods of non-use account for approximately 85% of the Deep Cycle battery failures. (Please see Section 16.) Data Power Monitoring Corp. reports that 90% of the Deep Cycle VRLA battery failures are due to the battery itself.

12.6. Deep discharges, such as leaving your lights on.

12.7. Misapplication, for example, using a starting battery in a deep cycle application, a motive Deep Cycle battery instead of a stationary for a UPS, an under sized battery (or battery bank) that causes discharges greater than the battery was designed for or a mismatch to the charging system.

12.8. Excessive vibration due to a loose hold down clamp.

12.9. Calcium or magnesium sulfation from using **tap** or reverse osmosis water.

12.10. Freezing a discharged battery.

12.11. Undercharging which reduces capacity due to incomplete conversion of sulfate back to lead which causes plate, cracked grids and cell shorts.

12.12. Old age (positive plate shedding).

12.13. Fast recharging at rates greater than C/4 (amp hour capacity/four hours).

12.14. Temperatures above 80° F (26.7° C), especially above 100° F (37.8° C) causing VRLA battery "thermal runaway".