POWER-GATE™ Solid-State Devices
Dual Rectifier, 400A, 500A, 600A
Specification Sheet

Generation 4.0

Made in U.S.A

ABSOLUTE MAXIMUM RATINGS(1)

All devices ("x" = don't care) , all amperages DC, all voltages DC and referenced to device ground, unless otherwise specified.

Symbol	Parameter	Min.	Max.	Units
V_A	Anode Voltage, Model DRxxxA	-0.3(2)	21(3)	V
	Anode Voltage, Model DRxxxB	-0.3(2)	39(4)	
V_K	Cathode Voltage (anode voltage at min), Model DRxxxA	-0.6(2)	21(3)	V
	Cathode Voltage (anode voltage at min), Model DRxxxB	-0.6(2)	39(4)	
$V_{R,gndfloat}$(5)	Reverse Voltage (ground floating), Model DRxxxA	-	21	V
	Reverse Voltage (ground floating), Model DRxxxB	-	39	
$I_{F,gndfloat}$(5)	Forward Current (per rectifier, ground floating), DR400x	-	40	A
	Forward Current (per rectifier, ground floating), DR500x	-	50	
	Forward Current (per rectifier, ground floating), DR600x	-	60	
T_A	Ambient Temperature	-45	+110	°C
V_{IGN}	Ignition Alternator Excitation Trigger Voltage	-39(6)	39(4)	V
$V_{STARTER}$	Starter Alternator Excitation Trigger Voltage	-39(6)	39(4)	
$I_{LED,MAX}$	External LED Maximum Current	-	30	mA
$V_{LED(OFF),MAX}$	External LED Maximum Voltage (LED Off)	-50	50	V

RECOMMENDED OPERATING CONDITIONS

All devices ("x" = don't care), all voltages DC and referenced to device ground, unless otherwise specificied.

Symbol	Parameter	Min.	Max.	Units
V_A	Anode Voltage, Model DRxxxA	5.6	18	V
	Anode Voltage, Model DRxxxB	5.6	36	
V_K	Cathode Voltage (anode voltage at min), Model DRxxxA	5.5	18	V
	Cathode Voltage (anode voltage at min), Model DRxxxB	5.5	36	
T_A	Ambient Temperature	-40	+105	°C
V_{IGN}	Ignition Alternator Excitation Trigger Voltage	0	36	V
$V_{STARTER}$	Starter Alternator Excitation Trigger Voltage	0	36	

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ELECTRICAL SPECIFICATIONS

All devices ("x" = don't care), all amperages DC, all voltages DC and referenced to ground, T_A = +25 ± 3 °C, 5.6 V ≤ V_A (DRxxxA) ≤ 18 V, 5.6 V ≤ V_A (DRxxxB) ≤ 36 V, all LEDs enabled, unless otherwise specified.

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions	Test Setup Figure
$I_{F,MAX}$	Maximum Forward Continuous Current (per rectifier)	-	-	400	A	Model DR400x, -40 °C ≤ T_A ≤ +105 °C	-
		-	-	500		Model DR500x, -40 °C ≤ T_A ≤ +105 °C	
		-	-	600		Model DR600x, -40 °C ≤ T_A ≤ +105 °C	
$I_{SURGE,MAX}$	Maximum Forward Surge Current (per rectifier)	-	-	5 x $I_{F,MAX}$		Pulse width = 2 s, -40 °C ≤ T_A ≤ +105 °C	-
$I_{R,TURN-OFF,MAX}$	Maximum Reverse Turn-Off Current (per rectifier)	-	-	3 x $I_{F,MAX}$		-40 °C ≤ T_A ≤ +105 °C	-
$L_{LOOP,MAX}$	Maximum Loop Inductance[7]	-	-	1.5	µH	Model DR400A, Reverse Turn-Off Current = $I_{R,TURN-OFF,MAX}$, T_A = +105 °C	-
		-	-	2.5		Model DR500A, Reverse Turn-Off Current = $I_{R,TURN-OFF,MAX}$, T_A = +105 °C	
		-	-	2.2		Model DR600A, Reverse Turn-Off Current = $I_{R,TURN-OFF,MAX}$, T_A = +105 °C	
		-	-	2.6		Model DR400B, Reverse Turn-Off Current = $I_{R,TURN-OFF,MAX}$, T_A = +105 °C	
		-	-	2.1		Model DR500B, Reverse Turn-Off Current = $I_{R,TURN-OFF,MAX}$, T_A = +105 °C	
		-	-	1.5		Model DR600B, Reverse Turn-Off Current = $I_{R,TURN-OFF,MAX}$, T_A = +105 °C	
V_F	Forward Voltage Drop[8]	-	39	-	mV	DR400A, Forward Current = $I_{F,MAX}$	-
		-	51	56		DR400A, Forward Current = $I_{F,MAX}$, T_A = +105 °C	
		-	44	-		DR500A, Forward Current = $I_{F,MAX}$	
		-	57	63		DR500A, Forward Current = $I_{F,MAX}$, T_A = +105 °C	
		-	51	-		DR600A, Forward Current = $I_{F,MAX}$	
		-	66	73		DR600A, Forward Current = $I_{F,MAX}$, T_A = +105 °C	
		-	44	-		DR400B, Forward Current = $I_{F,MAX}$	
		-	62	68		DR400B, Forward Current = $I_{F,MAX}$, T_A = +105 °C	
		-	52	-		DR500B, Forward Current = $I_{F,MAX}$	
		-	74	81		DR500B, Forward Current = $I_{F,MAX}$, T_A = +105 °C	
		-	59	-		DR600B, Forward Current = $I_{F,MAX}$	
		-	83	91		DR600B, Forward Current = $I_{F,MAX}$, T_A = +105 °C	
I_S	Operating Current[9]	-	1.7	-	mA	$V_{K,main}$ = $V_{K,aux}$ = 5.5 V, Anode floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	7
		-	2.0	-		$V_{K,main}$ = $V_{K,aux}$ = 12.0 V, Anode floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	2.4	-		$V_{K,main}$ = $V_{K,aux}$ = 18.0 V, Anode floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	2.6	-		Model DRxxxB, $V_{K,main}$ = $V_{K,aux}$ = 24.0 V, Anode floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	3.2	-		Model DRxxxB, $V_{K,main}$ = $V_{K,aux}$ = 36.0 V, Anode floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	48.4	-		V_A = 5.5 V, Cathodes floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	8
		-	49.0	-		V_A = 12.0 V, Cathodes floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	50.8	-		V_A = 18.0 V, Cathodes floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	52.6	-		Model DRxxxB, V_A = 24.0 V, Cathodes floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	56.1	-		Model DRxxxB, V_A = 36.0 V, Cathodes floating, V_{IGN} = $V_{STARTER}$ = 0 V, Combine not active	
		-	75.5	-		$V_{K,x}$ = 12.0 V, Anode and other cathode floating, Combine active (COMBINE+ and COMBINE- shorted)	9
		-	78.9	-		Model DRxxxB, $V_{K,x}$ = 24.0 V, Anode and other cathode floating, Combine active (COMBINE+ and COMBINE- shorted)	
I_R	Reverse Leakage Current (per rectifier)	-	9	-	µA	DR400A, $V_{K,x}$ = 5.5 V, V_A = 0 V	10
		-	21	-		DR400A, $V_{K,x}$ = 12.0 V, V_A = 0 V	
		-	63	-		DR400A, $V_{K,x}$ = 18.0 V, V_A = 0 V	
		-	7	-		DR500A, $V_{K,x}$ = 5.5 V, V_A = 0 V	
		-	7	-		DR500A, $V_{K,x}$ = 12.0 V, V_A = 0 V	
		-	9	-		DR500A, $V_{K,x}$ = 18.0 V, V_A = 0 V	
		-	15	-		DR600A, $V_{K,x}$ = 5.5 V, V_A = 0 V	
		-	108	-		DR600A, $V_{K,x}$ = 12.0 V, V_A = 0 V	
		-	567	-		DR600A, $V_{K,x}$ = 18.0 V, V_A = 0 V	
		-	7	-		DR400B, DR500B, DR600B, $V_{K,x}$ = 5.5 V, V_A = 0 V	
		-	7	-		DR400B, DR500B, DR600B, $V_{K,x}$ = 12.0 V, V_A = 0 V	
		-	7	-		DR400B, DR500B, DR600B, $V_{K,x}$ = 18.0 V, V_A = 0 V	
		-	7	-		DR400B, DR500B, $V_{K,x}$ = 24.0 V, V_A = 0 V	
		-	7	-		DR400B, DR500B, $V_{K,x}$ = 36.0 V, V_A = 0 V	
		-	8	-		DR600B, $V_{K,x}$ = 24.0 V, V_A = 0 V	
		-	17	-		DR600B, $V_{K,x}$ = 36.0 V, V_A = 0 V	
$V_{IGN,ON}$	Ignition Alternator Excitation Trigger On Voltage[10]	-	2.01	-	V		11
$V_{IGN,OFF}$	Ignition Alternator Excitation Trigger Off Voltage[11]	-	1.98	-			
$V_{IGN,HYS}$	Ignition Alternator Excitation Trigger Hysteresis Voltage[12]	-	30	-	mV		
$V_{STARTER,TRIP}$	Starter Alternator Excitation Trigger Trip Voltage[13]	-	2.02	-	V		12
$V_{STARTER,GO}$	Starter Alternator Excitation Trigger Go Voltage[13]	-	1.99	-			
I_{IGN}	Ignition Alternator Excitation Trigger Current	-	26	-	µA	V_{IGN} = 5.0 V	13
		-	60	-		V_{IGN} = 12.0 V	
		-	111	-		V_{IGN} = 18.0 V	
		-	171	-		V_{IGN} = 24.0 V	
		-	290	-		V_{IGN} = 36.0 V	
$I_{STARTER}$	Starter Alternator Excitation Trigger Current	-	51	-		$V_{STARTER}$ = 5.0 V	14
		-	120	-		$V_{STARTER}$ = 12.0 V	
		-	222	-		$V_{STARTER}$ = 18.0 V	
		-	341	-		$V_{STARTER}$ = 24.0 V	
		-	579	-		$V_{STARTER}$ = 36.0 V	
$t_{ALTEXC,DELAY}$	Alternator Excitation Delay Time[14]	-	4	-	s		-
$t_{ALTEXC,PULSEON}$	Alternator Excitation Pulse On Time[14]	-	0.5	-	s		-
$t_{ALTEXC,PULSEOFF}$	Alternator Excitation Pulse Off Time[14]	-	3	-	s		-
$I_{COMBINE}$	Combine Trigger Current	-	33	-	µA	COMBINE+ and COMBINE- shorted together	15
$V_{COMBINE+}$	COMBINE+ Floating Voltage	-	3.3	-	V		-
t_{RR}	Rectifier Reverse Recovery Time[15]	-	-	340	µs	Model DRxxxA, I_F = $I_{SURGE,MAX}$	-
		-	-	590		Model DRxxxB, I_F = $I_{SURGE,MAX}$	
$t_{MOSFET,START}$	MOSFET Start-up Time[16]	-	140	-	ms	V_A = 0 to 12 V, Cathodes floating	-
		-	1.5	-		$V_{K,x}$ = 14 V to floating, V_A = 12 V	-

See Notes on next page...

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ELECTRICAL SPECIFICATIONS (continued)

All devices ("x" = don't care), all amperages DC, all voltages DC and referenced to ground,
T_A = +25 ± 3 °C, 5.6 V ≤ V_A (DRxxxA) ≤ 18 V, 5.6 V ≤ V_A (DRxxxB) ≤ 36 V, all LEDs enabled, unless otherwise specified.

Notes:

1. Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. Exposure to any absolute maximum rating condition for extended periods may affect device reliability and lifetime.

2. Larger negative voltages will blow internal fuse. If fuse blows, as long as V_A is not more negative than -21/-39 V for model DRxxxA/DRxxxB, respectively, and is less than V_K, no damage to device will occur. Only use manufacturer-specified fuse for replacement.

3. Transient-protected to 40 V. Additional external protection may be required in some applications.

4. Transient-protected to 60 V. Additional external protection may be required in some applications.

5. Using the rectifier with the device ground disconnected is not recommended. Exceeding any of these ratings will cause excessive heat buildup, leading to MOSFET failure.

6. Transient-protected to -60 V. Additional external protection may be required in some applications.

7. Loop inductances are defined as the external system inductances seen between the common anode and each of the cathodes, as well as between the common anode and rectifier ground. See Figures 1-6 and application sheet for further information.

8. Voltage drop tested under pulsed conditions with pulse length ≤ 2 s.

9. I_S sourced from cathode (anode), when $V_A < V_K$ ($V_A > V_K$).

10. Ignition alternator excitation trigger on voltage defined as the ignition line voltage at which the alternator excitation process begins. Voltage must stay above this value during entire excitation process.

11. Ignition alternator excitation trigger off voltage defined as the ignition line voltage at which the alternator excitation process is terminated and reset; voltage must rise above the ignition alternator trigger on voltage to restart the alternator excitation process.

12. Ignition alternator excitation trigger hysteresis is defined as $V_{IGN,ON} - V_{IGN,OFF}$.

13. Starter alternator excitation trigger trip voltage is defined as the rising starter line voltage at which the device detects a start event. Starter alternator excitation trigger go voltage is defined as the falling starter line voltage at which the alternator excitation process begins (after the voltage has first risen above $V_{STARTER,TRIP}$). If at any time during the alternator excitation process the starter line voltage rises above $V_{STARTER,TRIP}$, the alternator excitation process will be terminated and the device will wait for the voltage to fall below $V_{STARTER,GO}$ before initiating a new alternator excitation process.

14. See application sheet for more information on the alternator excitation process.

15. Reverse recovery time measured from the time the anode-to-cathode voltage goes negative until the MOSFET array turns completely off. Reverse current may continue to flow through the MOSFET transient voltage supression diodes or the inductive load diode depending on the inductance in the system.

16. MOSFET start-up time is defined as the time from when $V_A - V_K$ becomes positive to when the MOSFETs enter their low-resistance state.

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TYPICAL PERFORMANCE

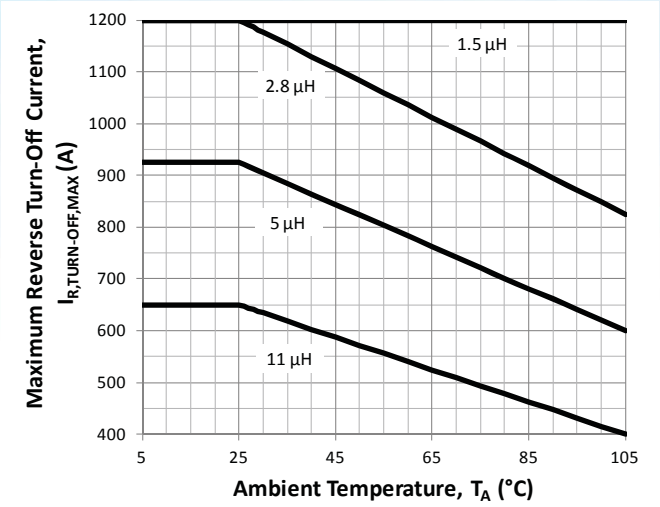

Figure 1: Maximum Reverse Turn-Off Current vs. Temperature and Loop Inductance (DR400A)

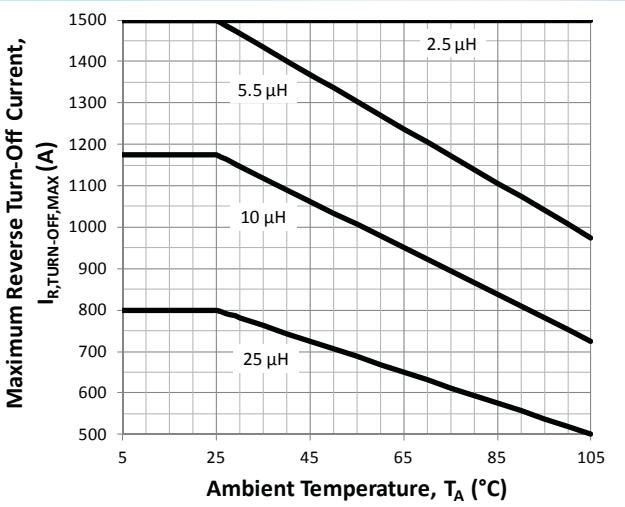

Figure 2: Maximum Reverse Turn-Off Current vs. Temperature and Loop Inductance (DR500A)

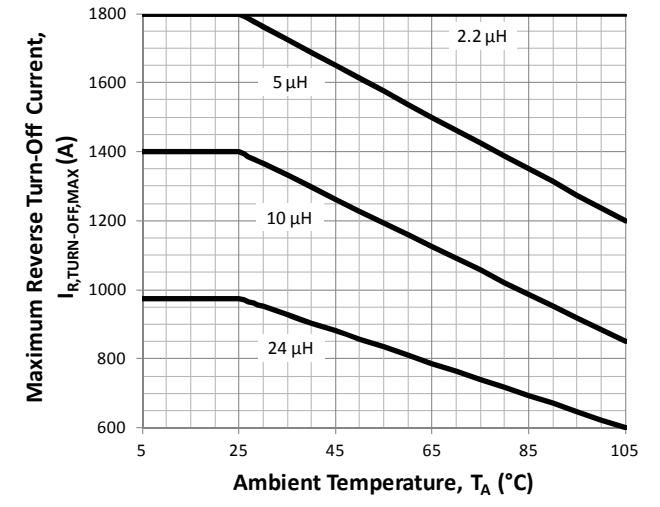

Figure 3: Maximum Reverse Turn-Off Current vs. Temperature and Loop Inductance (DR600A)

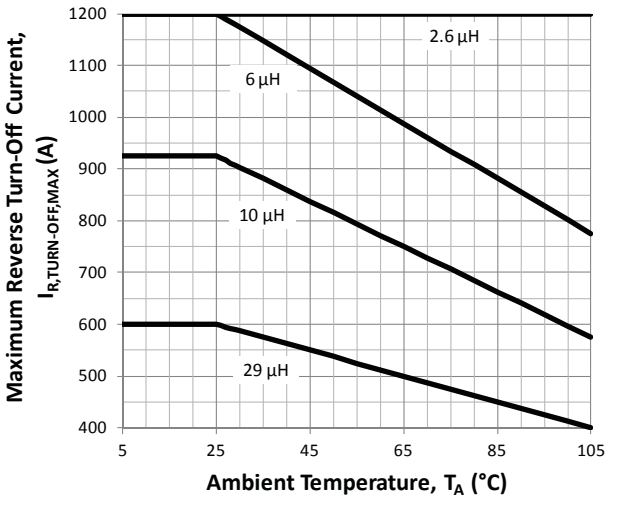

Figure 4: Maximum Reverse Turn-Off Current vs. Temperature and Loop Inductance (DR400B)

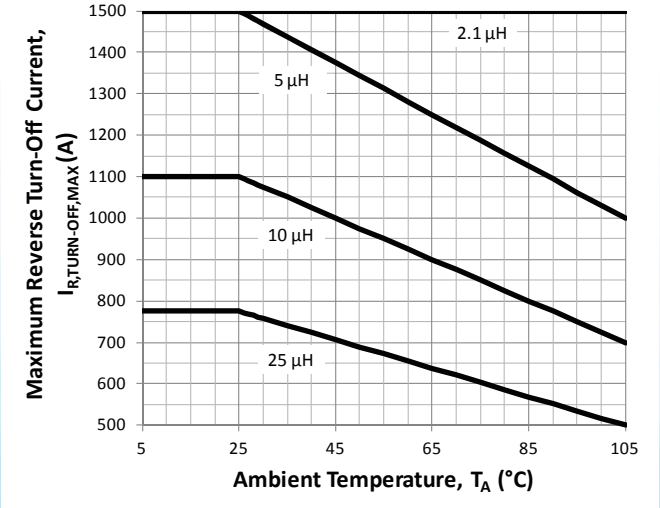

Figure 5: Maximum Reverse Turn-Off Current vs. Temperature and Loop Inductance (DR500B)

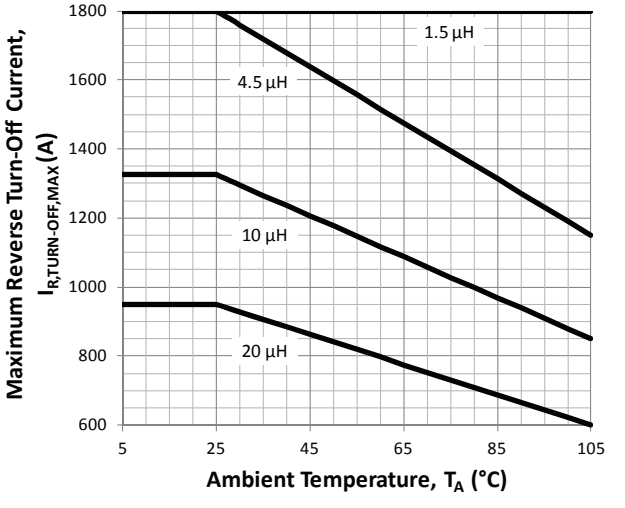

Figure 6: Maximum Reverse Turn-Off Current vs. Temperature and Loop Inductance (DR600B)

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TEST SETUPS

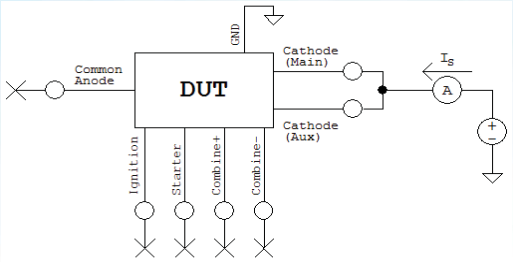

Figure 7: Operating Current ($V_K > V_A$)

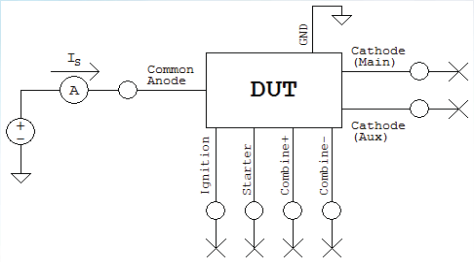

Figure 8: Operating Current ($V_A > V_K$)

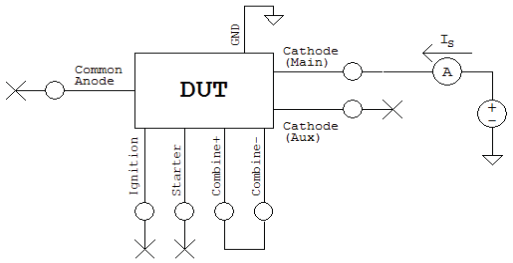

Figure 9: Operating Current (Combine Mode Active)

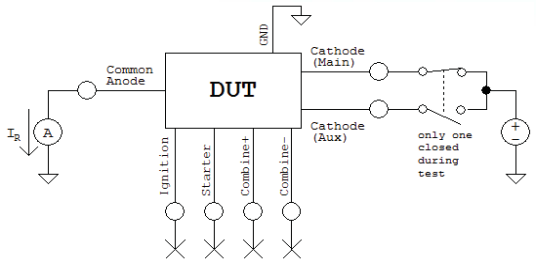

Figure 10: Reverse Leakage Current

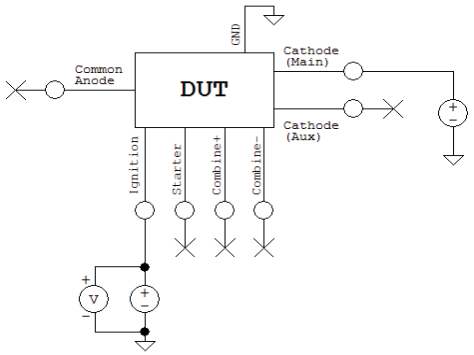

Figure 11: Ignition Alternator Excitation Voltage

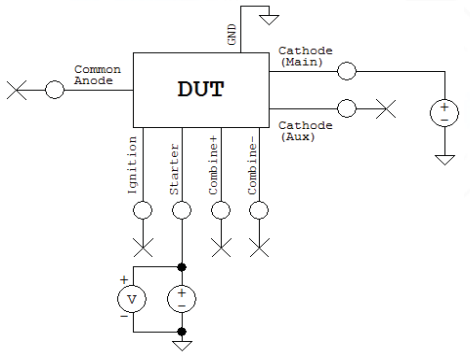

Figure 12: Starter Alternator Excitation Voltage

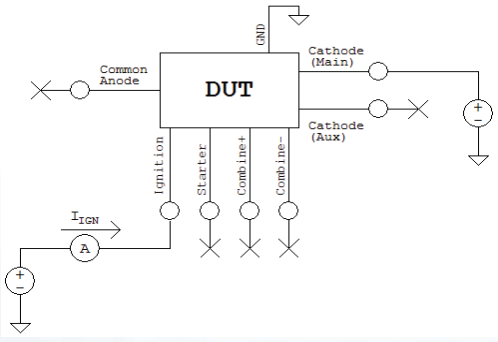

Figure 13: Ignition Alternator Excitation Current

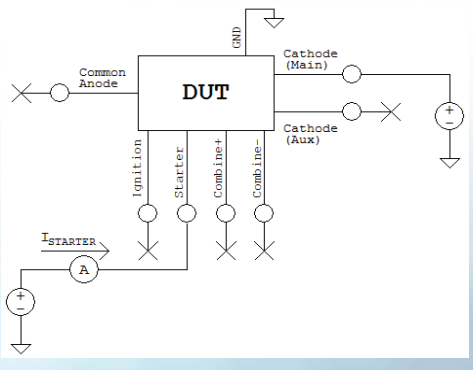

Figure 14: Starter Alternator Excitation Current

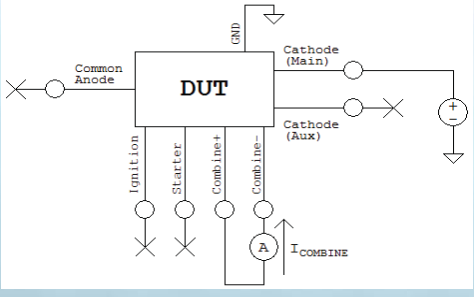

Figure 15: Combine trigger current

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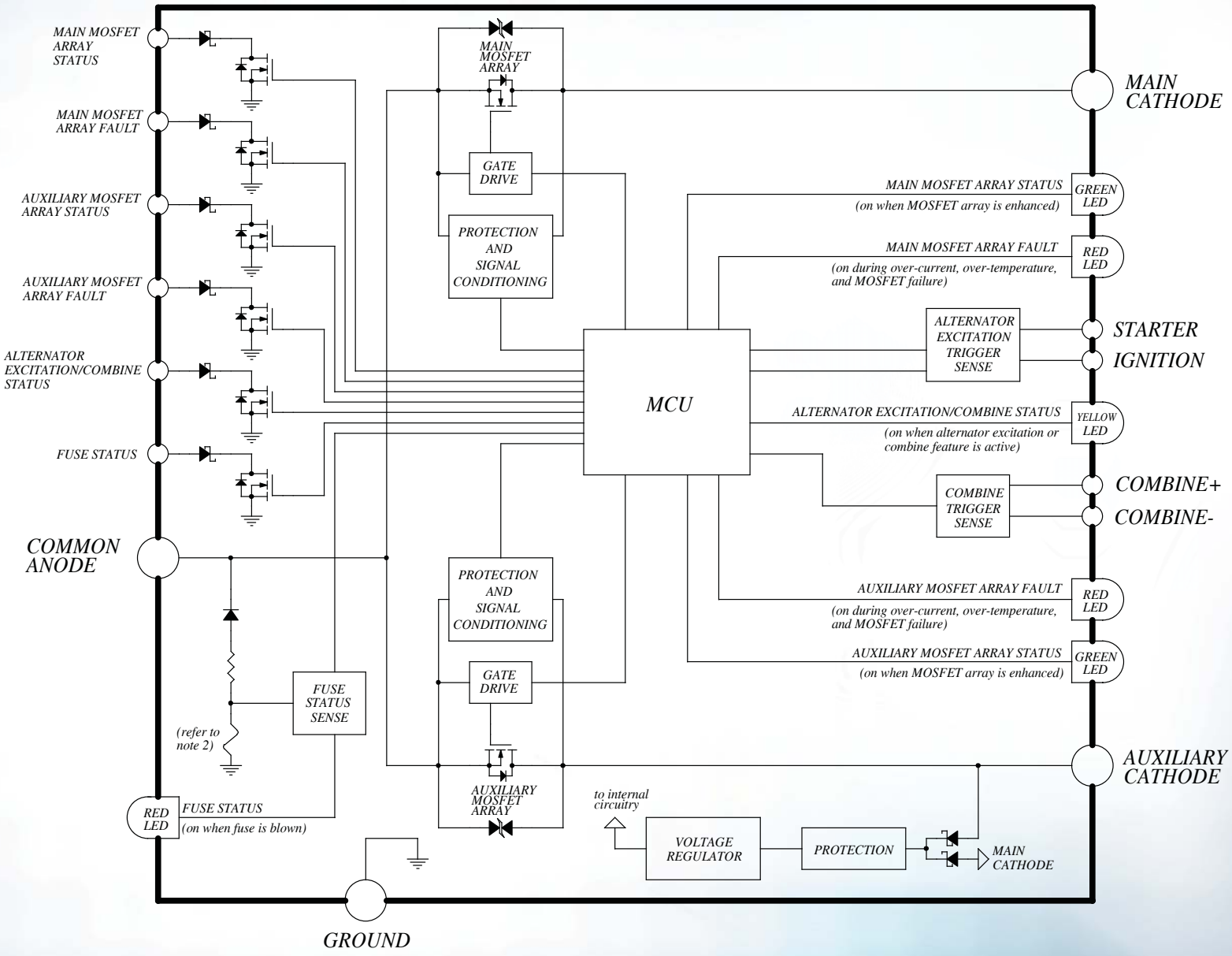
FUNCTIONAL BLOCK DIAGRAM



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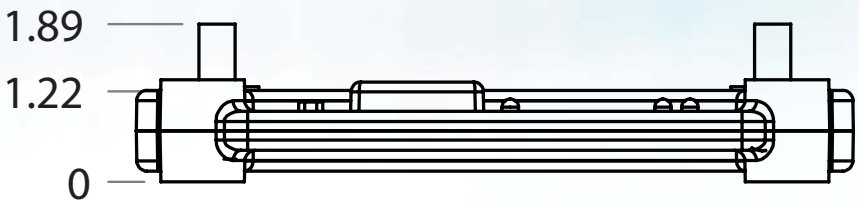
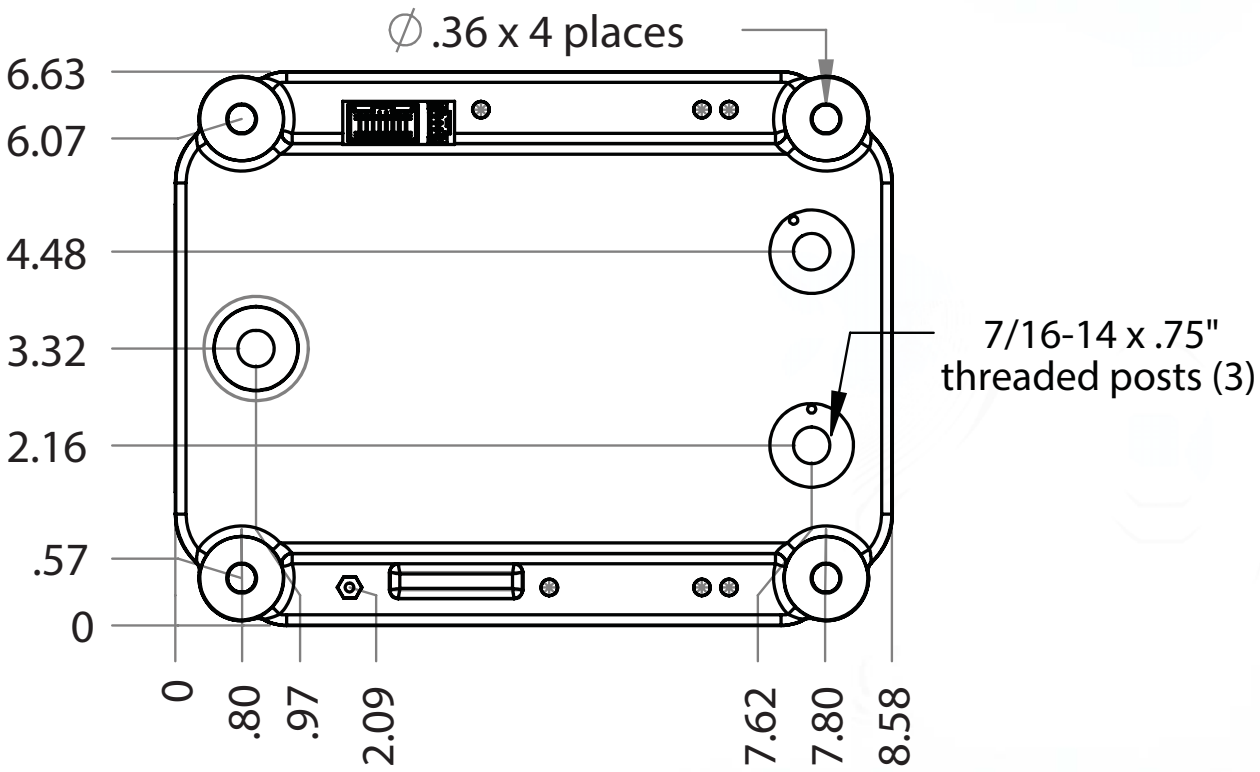
MECHANICAL SPECIFICATIONS



INCHES



Electronic assembly inserted into ABS enclosure and fully encapsulated with silicone elastomer specifically developed for potting electronic modules.

Four intgrated mounting points for user supplied 5/16" mounting hardware of suitable length.

Brass mounting posts, 7/16-14 x .75" with provided brass washers and nylon insert nuts. Mounting torque not to exceed 15 newton-meters.

Molex top-mounted control harness and expansion port for remote monitoring display.

Typical weight post encapsulation including provided hardware is 54 ounces (+ /- 10%)

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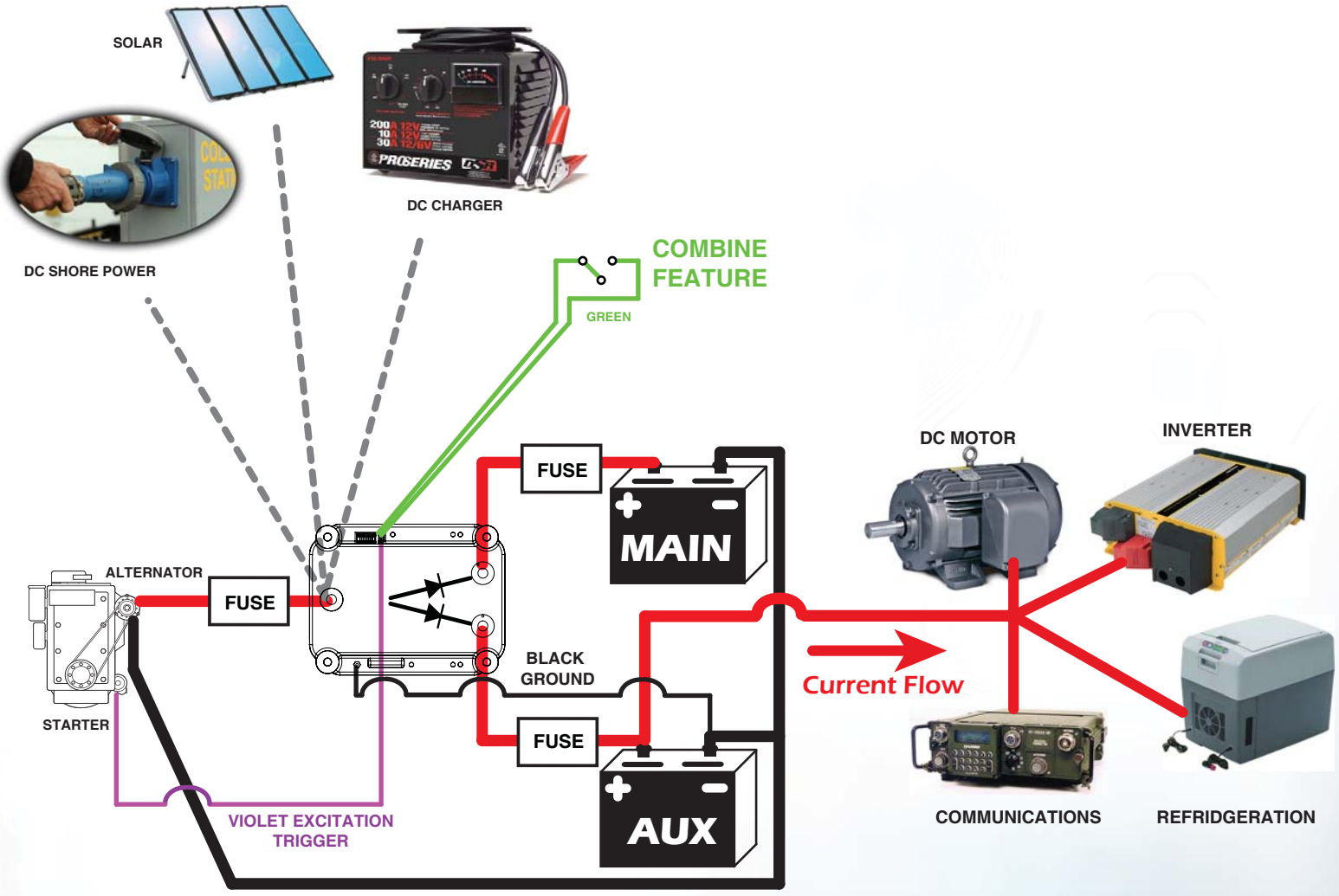
SAMPLE APPLICATIONS

Diagram 1

POWER-GATE Dual Rectifier allows all batteries in the network to be charged. In the diagram below, the alternator (or alternate charging source like DC shore power, solar array, or DC battery charger) is applying charging current to the anode (input) post of the rectifier. Current passes through two independent MOSFET arrays to Main Battery cathode and Auxiliary Battery cathode. Loads applied to the Auxiliary Battery are isolated from the Main Battery just as Main Battery loads are isolated from Auxiliary Battery.

The Violet alternator excitation circuit ensures that internally regulated alternators are energized by the down-stream battery during the engine cranking process, a necessity when placing an isolator between the alternator and the batteries.

The optional Battery Combine feature causes bi-directional current flow between the two batteries when the two "combine" wires are joined together. Should the Main Battery be discharged to a low, no-start condition, the Auxiliary Battery can be "jumped" to the Main Battery. The use of a momentary switch is recommended to ensure the battery combine feature is disabled by default.



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NOTES

REVISION HISTORY

REV	DATE	DESCRIPTION	PAGE NUMBER (S)
0	10/15/15	Original Release	

⚠ DANGER / PELIGRO / DANGER /GEFAHR / PERICOLO / PERIGO

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH.

- Disconnect all power before installing or working with this equipment.
- Verify all connections and replace all covers before turning on power.

Failure to follow these instructions will result in death or serious injury.

RIESGO DE DESCARGA ELECTRICA O EXPLOSION.

- Desconectar todos los suministros de energia a este equipo antes de trabajar con este equipo.
- Verificar todas las conexiones y colocar todas las tapas antes de energizer el equipo.

El incumplimiento de estas instrucciones puede provocar la muerte o lesiones serias.

RISQUE DE DESCHARGE ELECTRIQUE OU EXPLOSION

- Eteindre toutes les sources d'énergie de cet appareil avant de travailler dessus de cet appareil
- Vérifier tous connections, et remettre tous couverts en olace avant de mettre sous

De non-suivi de ces instructions provoquera la mort ou des lésions sérieuses sérieuses.

GEFAHR EINES ELEKTRISCHE N SCHLAGES ODER EINER EXPLOSION.

- Stellen Sie jeglichen Strom ab, der dieses Gerät versorgt, bevor Sie an dem Gerät Arbeiten durchführen
- Vor der Inbetriebnahme alle Anschlüsse überprüfen und alle Gehäuseteile montieren.

Unterlassung dieser Anweisungen können zum Tode oder zu schweren Verletzungen führen.

RISCHIO DI SCOSSA ELETTRICA O DELL'ESPLOSI ONE.

- Spenga tutta l'alimentazion e che fornisce questa apparecchiatu ra prima del lavorare a questa apparecchiatu ra
- Verificare tutti i collegamenti e sostituire tutte le coperture prima della rotazione sull'alimentazi one

L'omissione di seguire queste istruz ioni provocherà la morte o di lesioni serie

RISCO DE DESCARGA ELÉTTRICA OU EXPLOSÃO

- Desconectar o equipamento de toda á energia antes de instalar ou trabalhar com este equipamen to
- Verificar todas as conexões e recolocar todas as tampas antes de religar o equipamento

O não cumprimento destas instruções pode levar á morte ou lesões sérias.

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