Description

The DZDH0401DW is intended to drive a p-channel enhancement MOSFET configured as an ideal diode. The device operates as a differential amplifier and PMOS controller to minimize forward current losses when $V_{IN} > V_{OUT}$ and provide high isolation when $V_{IN} < V_{OUT}$. The circuit compares the voltage between IN and OUT. If the differential is greater than ~34mV (typ.) V_{BIAS} will fall and the PMOS will turn on, If the differential is less than ~70mV V_{BIAS} will rise and the PMOS will turn off, isolating IN from OUT.

Features

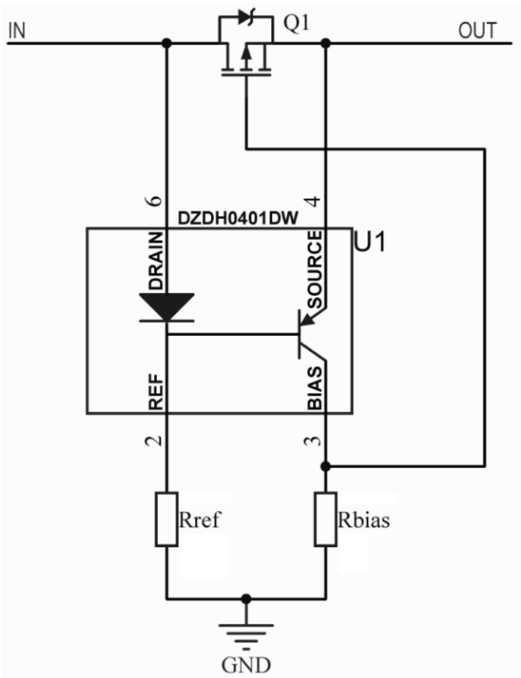
- Max Input Voltage: 40V
- Peak Bias Current: -300mA
- Max Reverse Voltage Protection: 50V
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen- and Antimony-Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.**
  https://www.diodes.com/quality/product-definitions/

Applications

- High Side Gate Driving PMOS
- High Side Disconnect Switch
- Battery Discharge Protection
- Emergency Lighting
- Active OR'ing Redundant Power Supplies

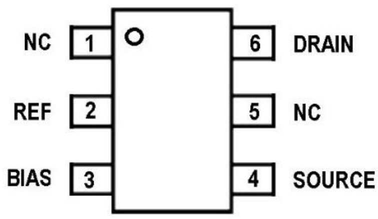
Mechanical Data

- Case: SOT363
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish — Matte Tin Finish. Solderable per MIL-STD-202, Method 208 (e3)
- Weight: 0.006 grams (Approximate)



Typical Configuration

SOT363 Top View



Pinout

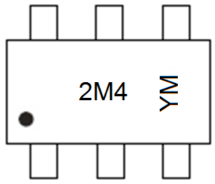
Ordering Information (Note 4)

Part Number	Marking	Reel Size (inches)	Tape Width (mm)	Quantity per Reel
DZDH0401DW-7	2M4	7	8	3,000

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information

SOT363



2M4 = Product Type Marking Code
YM = Date Code Marking
Y = Year (ex: H = 2020)
M = Month (ex: 3 = March)

Date Code Key

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Code	H	I	J	K	L	M	N	O	P	R	S	T

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Code	1	2	3	4	5	6	7	8	9	O	N	D

Absolute Maximum Ratings (@ T_A = +25°C unless otherwise specified.)

Characteristic	Symbol	Value	Unit
DRAIN BIAS Voltage	$V_{DRAIN-BIAS}$	40	V
SOURCE DRAIN Voltage	$V_{SOURCE-DRAIN}$	50	V
BIAS Current	I_{BIAS}	-300	mA
DRAIN Current	I_{DRAIN}	300	mA

Thermal Characteristics – Total Device (@ T_A = +25°C unless otherwise specified.)

Characteristic	Symbol	Value	Unit
Power Dissipation (Note 5)	P_D	300	mW
Thermal Resistance, Junction to Ambient (Note 5)	$R_{\theta JA}$	424	°C/W
Thermal Resistance, Junction to Case (Note 5)	$R_{\theta JC}$	111	°C/W
Operating and Storage Temperature Range	T_J, T_{STG}	-65 to +150	°C

Note: 5. For a device mounted on minimum recommended pad layout with 1oz copper that is on a single-sided 1.6mm FR4 PCB; the device is measured under still air conditions whilst operating in a steady-state.

Thermal Characteristics – Total Device

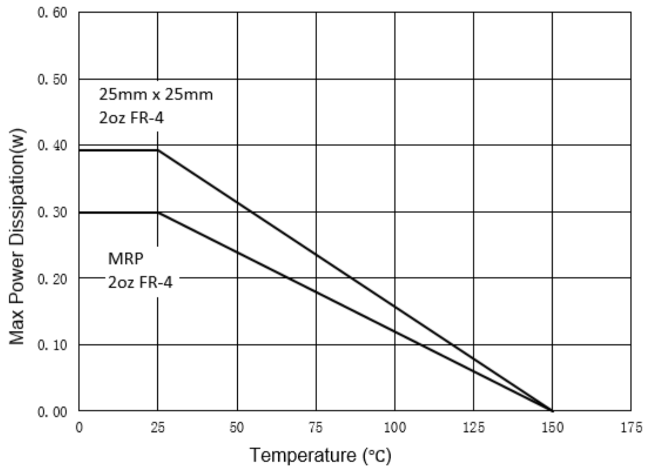


Fig.1 Derating Curve

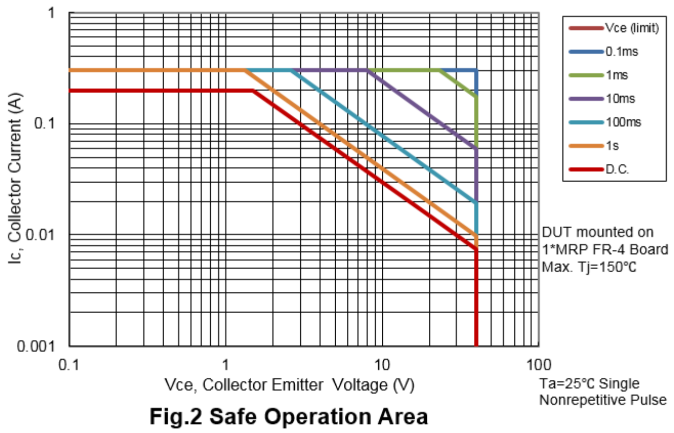


Fig.2 Safe Operation Area

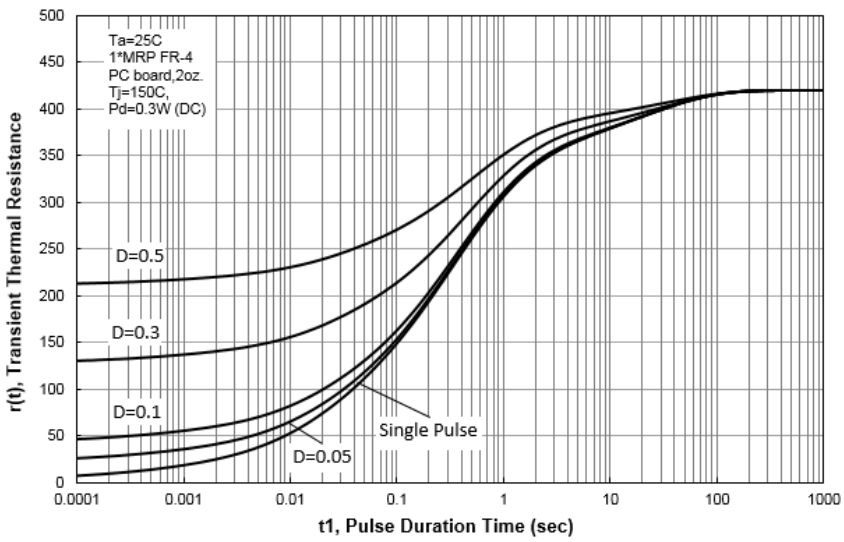


Fig.3 Transient Thermal Resistance

Electrical Characteristics (@ T_A = +25°C unless otherwise specified)

Characteristic	Symbol	Min	TYP	Max	Unit	Test Condition
DRAIN - BIAS Voltage	$V_{DRAIN-BIAS}$	40	78	—	V	I_{DRAIN}=100µA
SOURCE – DRAIN Voltage	$V_{SOURCE-DRAIN}$	50	84	—	V	I_{SOURCE}=100µA
DRAIN – REF Voltage	$V_{DRAIN-REF}$	—	588	—	mV	I_{DRAIN}=100uA
SOURCE Current	I_{SOURCE}	—	11.6	—	µA	$V_{SOURCE-REF}$=0.56V
REF-SOURCE Voltage	$V_{REF-SOURCE}$	—	-554	—	mV	I_{REF}=-10µA
Turn-Off Differential Voltage	V_T	5	34	80	mV	I_{DRAIN}=100µA; I_{SOURCE}=10µA
REF-SOURCE Voltage ($V_{BIAS\ low}$)	$V_{REF-SOURCE}$	-250	-472	—	mV	$V_{BIAS-SOURCE}$=-5V; I_{BIAS}=-1µA
		-300	-541	—	mV	$V_{BIAS-SOURCE}$=-5V; I_{BIAS}=-10µA
REF-SOURCE Voltage ($V_{BIAS\ high}$)	$V_{REF-SOURCE}$	—	-601	-800	mV	$V_{BIAS-SOURCE}$=-0.5V; I_{BIAS}=-100µA
		—	-663	-850	mV	$V_{BIAS-SOURCE}$=-0.5V; I_{BIAS}=-1mA

Typical Electrical Characteristics (@ T_A = +25°C unless otherwise specified.)

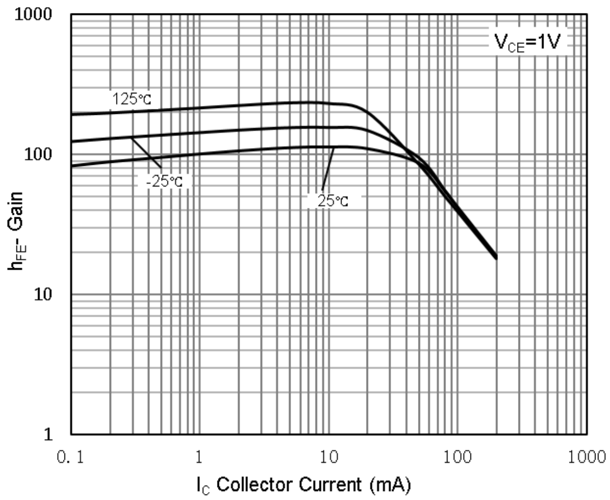


Fig.4 h_{FE} vs I_C

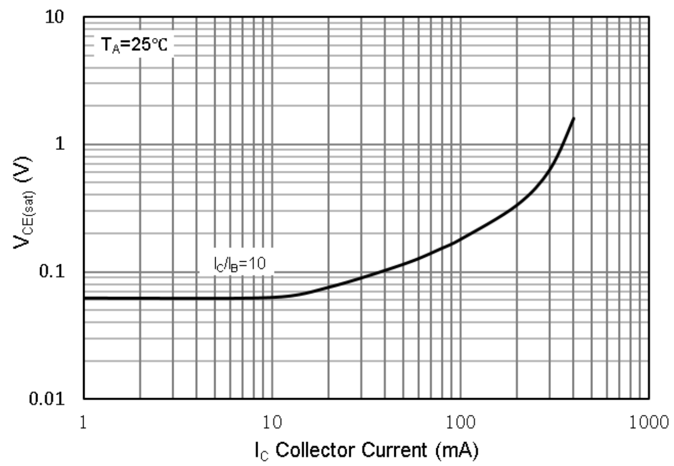


Fig.5 $V_{CE(sat)}$ vs I_C

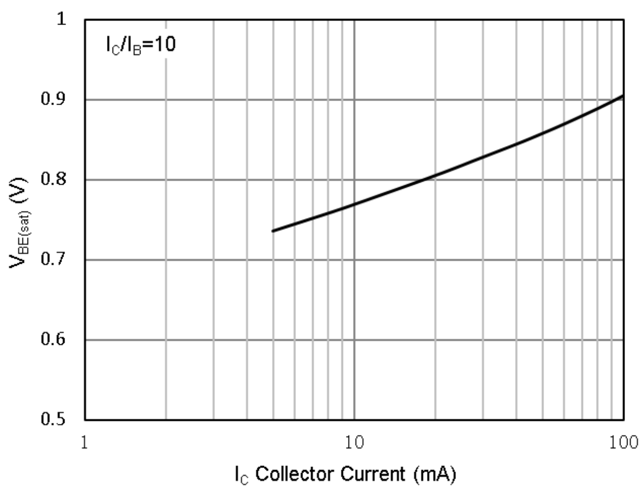


Fig.6 $V_{BE(sat)}$ vs I_C

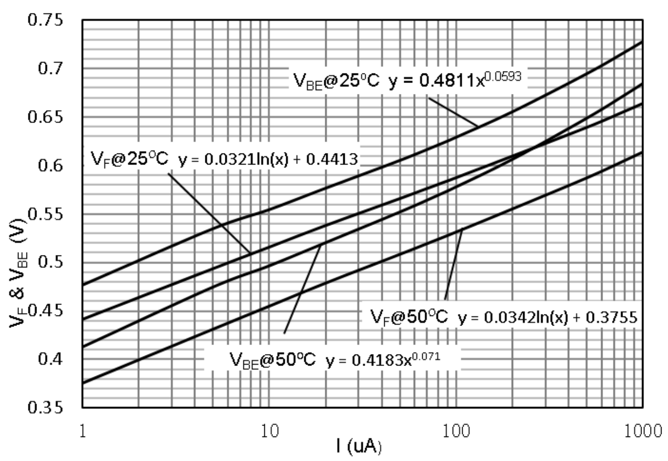
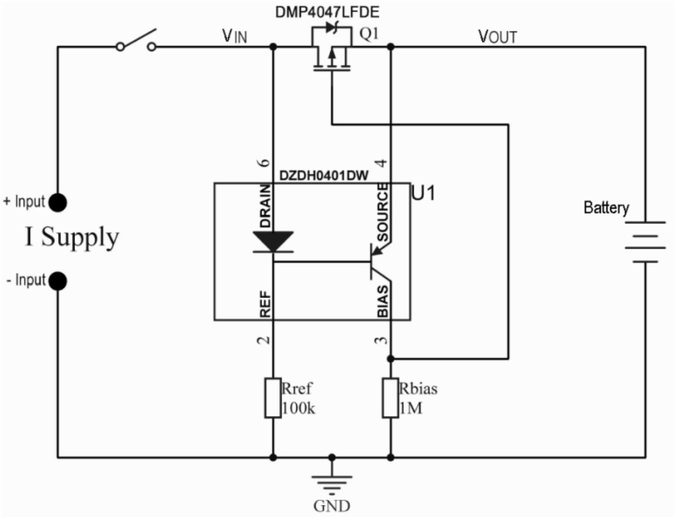


Fig.7 I vs V_F & V_{BE}

Typical Application Circuit/ Pin Out Details/ Functional Description



Typical Application Circuit

Pin	Name	Function
1	NC	No internal connection
2	REF	Reference current to set V_F
3	BIAS	Reference current to set V_{BE} and control Gate
4	SOURCE	V_{OUT} sense voltage
5	NC	No internal connection
6	DRAIN	V_{IN} sense voltage
n/a	Rref	This resistor sets the turn off speed of the FET. The lower the resistance, the more base drive to the transistor, the faster the transistor shorts out the gate to turn off the FET.
n/a	Rbias	This resistor sets the turn on speed of the FET. When the ideal diode circuit is turning on the PNP is held off by the diode and FET voltage drops. It is Rbias that pulls the gate low and turns on the FET.
n/a	Rbias : Rref	Ideal diode Turn-Off threshold voltage $V_T \alpha$ Rbias / Rref
n/a	Vref	Voltage across Rref

Functional Description *(Refer to typical application circuit above)*

Supply Connect:
As a +Input is applied, the body drain diode of Q1 becomes forward biased. U1 diode holds U1 transistor base at $V_{IN} – V_F$, and so V_{BE} is too low to turn on U1 transistor. As Q1 gate capacitance charges through Rbias, Q1 turns on and R_{DS} decreases causing V_{DS} to decrease and V_{BE} to increase until U1 transistor starts to conduct. This process continues until Q1 R_{DS} reaches its minimum value and U1 transistor V_{BE} cannot increase and I_C reaches its maximum. V_{GS} should be high enough at this point to ensure linear operation.

Rref and Rbias set the currents through U1 diode and U1 collector respectively so that $V_{F(DIODE)}$ is greater than $V_{BE(on)}$.

Supply Disconnect:
As the +Input is removed, $V_{DS} < V_T$, Q1 is on and $V_{IN} = V_{OUT}$, causing V_{REF} to fall and U1 $V_{BE} > V_{BE(on)}$ so U1 transistor discharges Q1 gate capacitance and Q1 turns off causing V_{IN} to fall to 0V.

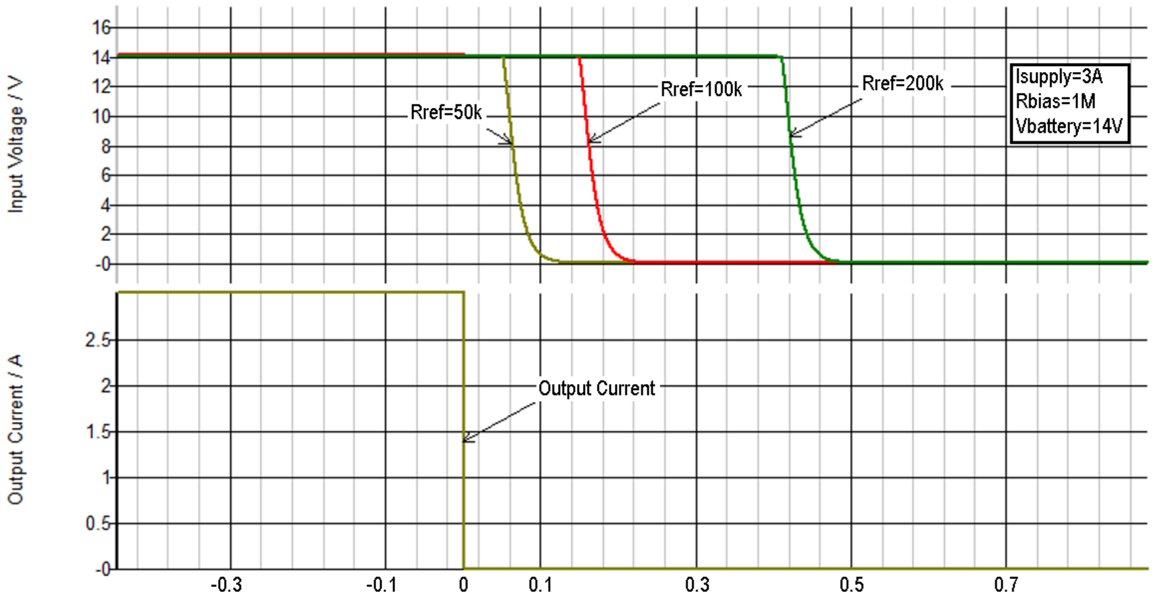
Quiescent Current and Isolation:
With a battery connected at Supply Out, there are two leakage paths back to the Supply In. One is straight through Q1 and the other is through $U1_{emitter-anode}$. The high reverse breakdown voltage of U1 diode provides a high isolation path. The Rref & Rbias currents bias U1 transistor on which keeps Q1 off. These resistors' values are chosen to minimize quiescent current operation of the circuit.

Typical Charging Conditions. (Ta=25°C Vbatt=14V switch closed, Isupply=3A)			
Parameter	Symbol	Typ	Unit
Input Voltage	V_{IN}	14.1	V
Input current	I_{IN}	3	A
Output Voltage	V_{OUT}	14	V
Output Current	I_{OUT}	3.0	A
Diode Forward Voltage	V_F	0.6	V
Diode forward Current	I_F	135	uA
Reference Voltage	V_{REF}	13.4	V
Reference Current	I_{REF}	136.6	uA
Base Current	I_B	1.6	uA
Emitter Current	I_E	12.1	uA
Bias Voltage	V_{BIAS}	10.5	V
Collector Current	I_C	10.5	uA
Operating Current	I_{CC}	147	uA

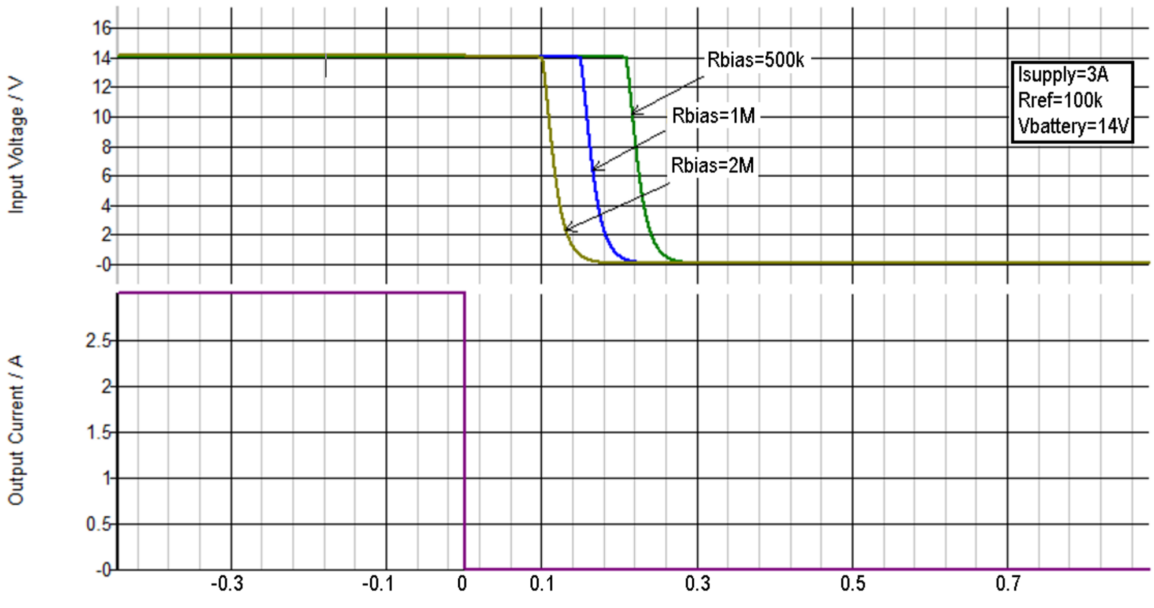
Typical Non-Charging Conditions. (Ta=25°C Vbatt=14V switch open, Isupply=3A)			
Parameter	Symbol	Typ	Unit
Input Voltage	V_{IN}	-	uV
Input current	I_{IN}	--	A
Output Voltage	V_{OUT}	14	V
Output Current	I_{OUT}	--	A
Diode Forward Voltage	V_F	--	V
Diode forward current	I_F	0	uA
Reference Voltage	V_{REF}	13.3	V
Reference Current	I_{REF}	133	uA
Base Current	I_B	133	uA
Emitter Current	I_E	145	uA
Bias Voltage	V_{BIAS}	13.94	V
Bias Current	I_{BIAS}	13.94	uA
Operating Current	I_{CC}	147	uA

Timing

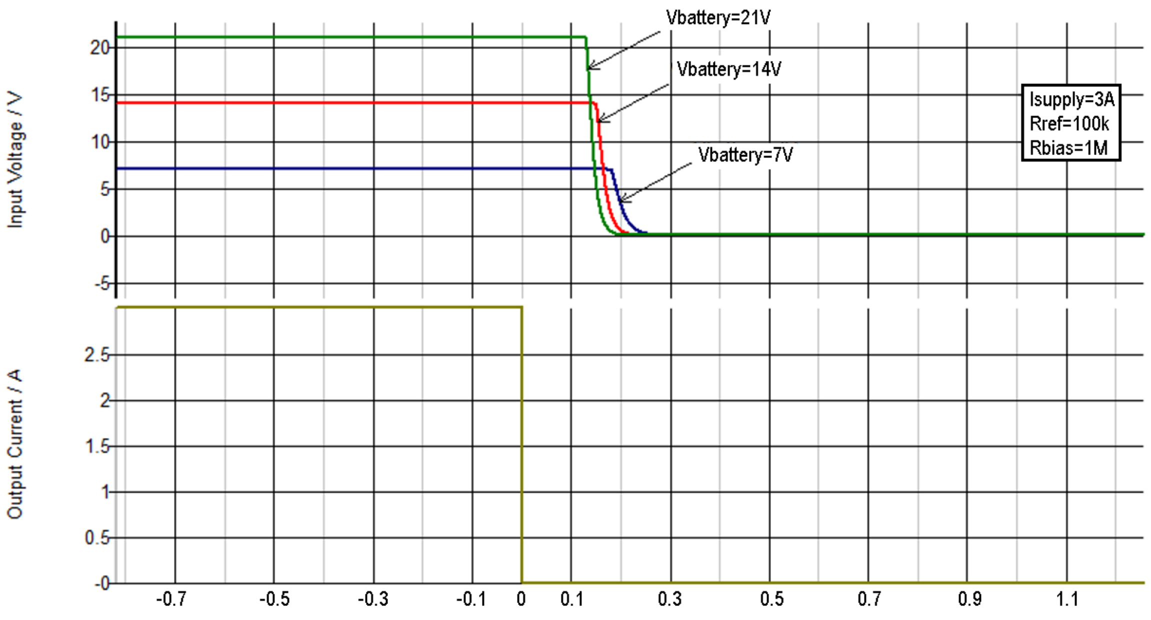
Switching speed is affected by PMOS characteristics, Rbias, Rref and operating voltage. Using the typical application circuit, we can see how modifying values can affect the timing in the simulations below



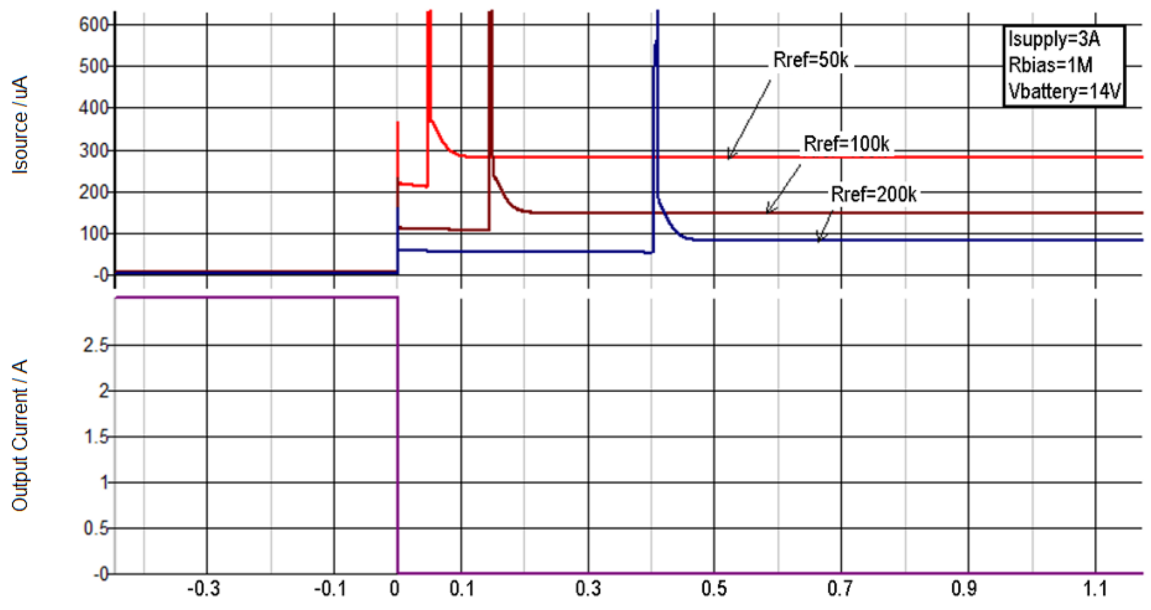
Disconnect Time vs Rref



Disconnect Time vs Rbias



Disconnect Time vs Battery Voltage



Quiescent Current vs Rref

Ideal Diode Power Saving.

The typical voltage drop across a standard diode rectifier means higher power dissipation and more heat to manage. This both wastes power and significantly drops the potential on low voltage rails.

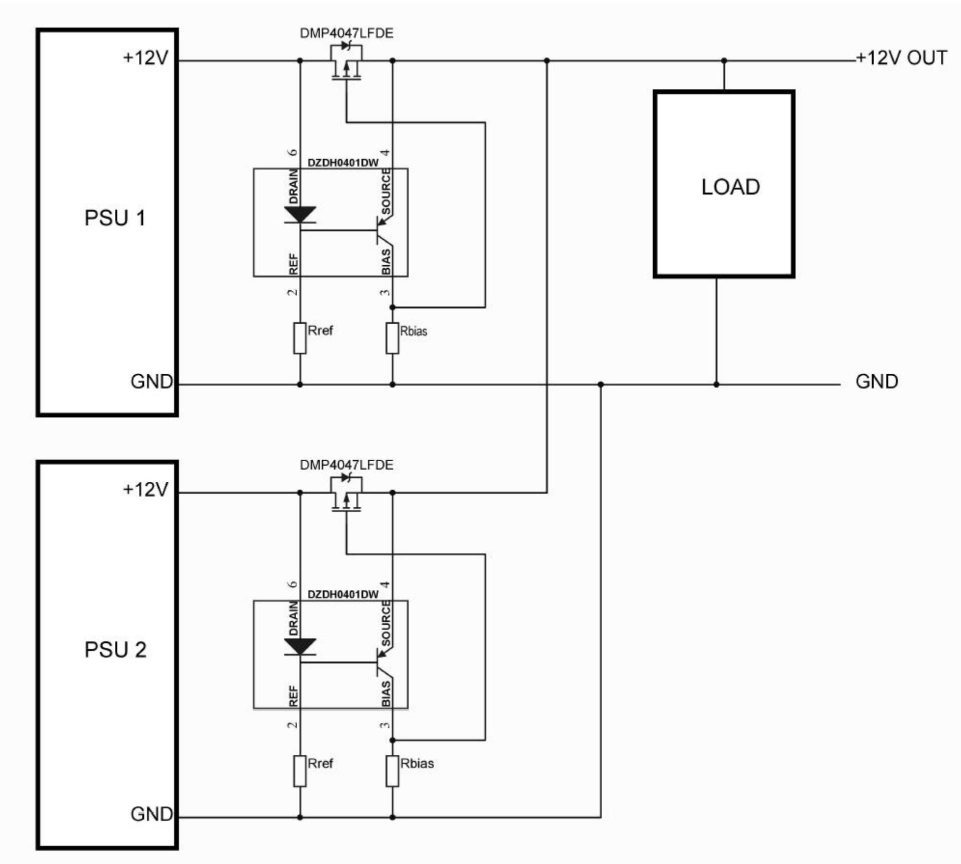
Example:
A diode rectifier with a typical forward voltage V_F =0.55V carrying 3A current would dissipate 1.65W (I x V_F).
Whereas with P-MOSFET such as the DMP4047LFDE that has an Rdson of 33mΩ, the power dissipation reduces to only 0.29W (I^2 x R).

Hence, very low $R_{DS(on)}$ Power MOSFETs can replace the standard rectifiers and the DZDH0401DW controls the MOSFET as an ideal diode.

N+1 redundancy OR'ing controller

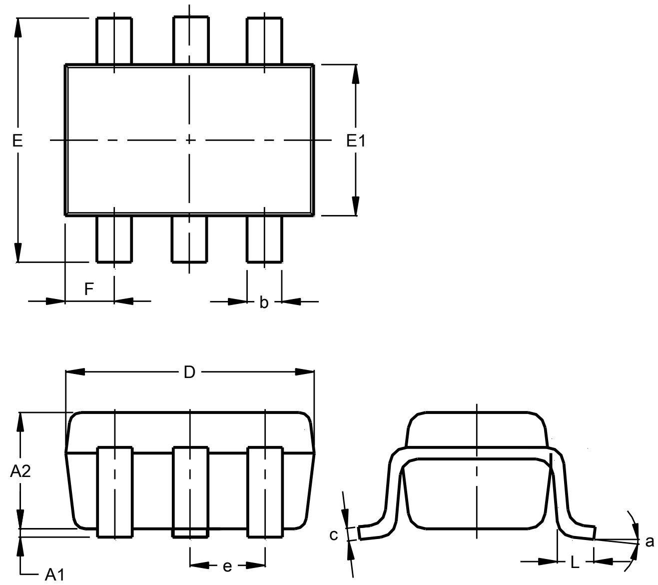
Critical systems require a fault-tolerant power supply that can be achieved by paralleling two or more PSUs into an (N+1) redundancy configuration.

During normal operation, usually all PSUs equally share the load for maximum reliability. If one of the PSUs is unplugged or fails, then the other PSUs fully support the load. To avoid the faulty PSU from affecting the common bus, an OR'ing rectifier blocks the reverse current flow into the faulty PSU. Likewise during hot-swapping, the OR'ing rectifiers isolate a PSU's discharged output capacitors from the common bus.



Package Outline Dimensions

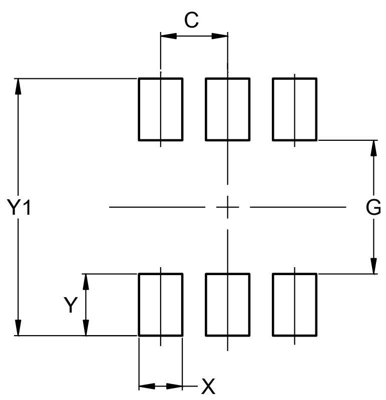
Please see http://www.diodes.com/package-outlines.html for the latest version.



SOT363			
Dim	Min	Max	Typ
A1	0.00	0.10	0.05
A2	0.90	1.00	1.00
b	0.10	0.30	0.25
c	0.10	0.22	0.11
D	1.80	2.20	2.15
E	2.00	2.20	2.10
E1	1.15	1.35	1.30
e	0.650 BSC		
F	0.40	0.45	0.425
L	0.25	0.40	0.30
a	0°	8°	--
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.



Dimensions	Value (in mm)
C	0.650
G	1.300
X	0.420
Y	0.600
Y1	2.500

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