NMSD200B01

200 mA SYNCHRONOUS RECTIFIER FEATURING N-MOSFET AND SCHOTTKY DIODE

NEW PRODUCT

General Description

- NMSD200B01 is best suited for switching voltage regulator and power management applications. It improves efficiency and reliability of DC-DC converters used in Voltage Regulator Modules (VRM) and can support continuous maximum current of 200mA. It features an ESD protected discrete N-MOSFET with low on-resistance and a discrete Schottky diode with low forward drop. It reduces component count, consumes less space and minimizes parastic losses. The component devices can be used as a part of a circuit or as a stand alone discrete device.

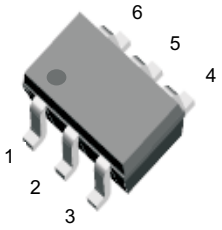


Fig. 1: SOT-363

Features

- N-MOSFET with ESD Gate Protection
- N-MOSFET with Low On-Resistance ($R_{DS(ON)}$)
- Low V_f Schottky Diode
- Low Static, Switching and Conduction Losses
- Good dynamic performance
- Surface Mount Package Suited for Automated Assembly
- Lead Free By Design/ROHS Compliant (Note 1)
- "Green" Device (Note 2)

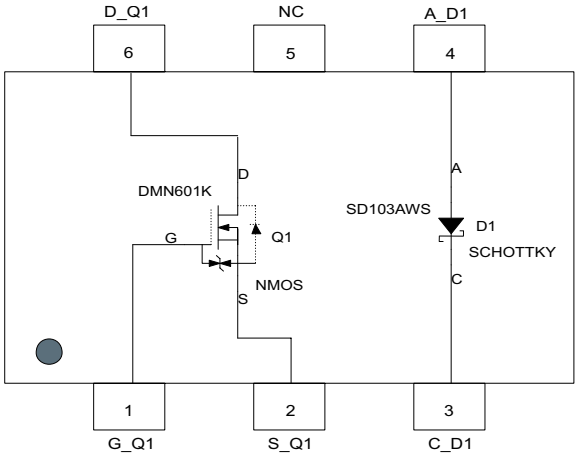


Fig 2 : Schematic and Pin Configuration

Mechanical Data

- Case: SOT-363
- Case Material: Molded Plastic. "Green Molding" Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020C
- Terminal Connections: See Diagram
- Terminals: Finish - Matte Tin annealed over Alloy 42 leadframe. Solderable per MIL- STD -202, Method 208
- Marking & Type Code Information: See Page 7
- Ordering Information: See Last Page
- Weight: 0.016 grams (approximate)

Sub-Components	Reference	Device Type	Figure
DMN601K_DIE (ESD Protected)	Q1	N-MOSFET	2
SD103AWS_DIE	D1	Schottky Diode	2

Maximum Ratings, Total Device @ T_A = 25°C unless otherwise specified

Characteristic	Symbol	Value	Unit
Power Dissipation (Note 3)	P_d	200	mW
Power Derating Factor above 25 °C	P_{der}	1.6	mW/°C
Output Current	I_{out}	200	mA

Thermal Characteristics

Characteristic	Symbol	Value	Unit
Junction Operation and Storage Temperature Range	T_j, T_{stg}	-55 to +150	°C
Thermal Resistance, Junction to Ambient Air (Note 3) (Equivalent to one heated junction of N-MOSFET)	$R_{\theta JA}$	625	°C/W

Notes: 1. No purposefully added lead.
2 . Diodes Inc.'s "Green" policy can be found on our website at http:/www.diodes.com/products/lead_free/index.php.
3. Device mounted on FR-4 PCB, 1 inch x 0.85 inch x 0.062 inch; pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at http://www.diodes.com/datasheets/ap02001.pdf.

NEW PRODUCT

Maximum Ratings: @ T_A = 25°C unless otherwise specified
Sub-Component Device: ESD Protected N-Channel MOSFET (Q1)

Characteristic		Symbol	Value	Unit
Drain Source Voltage		V_{DSS}	60	V
Drain Gate Voltage (RGS <+ 1MOhm		V_{DGR}	60	V
Gate Source Voltage	Continuous	V_{GSS}	+/-20	V
	Pulsed (tp<50 uS)		+/-40	
Drain Current (Page 1: Note 3) Continuous (Vgs=10V)		I_D	200	mA
Pulsed (tp<10uS, Duty Cycle<1%)			800	
Continuous Source Current		I_S	200	mA

Sub-Component Device: Schottky Diode (D1) @ T_A = 25°C unless otherwise specified

Characteristic	Symbol	Value	Unit
Peak Repetitive Reverse Voltage Working Peak Reverse Voltage DC Blocking Voltage	V_{RRM} V_{RWM} V_R	40	V
RMS Reverse Voltage	$V_{R(RMS)}$	28	V
Foward Continuous Current (Page 1: Note 3)	I_{FM}	350	mA
Non-Repetitive Peak Foward Surge Current @ t<1.0 s	I_{FSM}	1.5	A

Electrical Characteristics:
ESD Protected N-Channel MOSFET (Q1) @ T_A = 25°C unless otherwise specified

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
OFF CHARACTERISTICS (Note 4)						
Drain-Source Breakdown Voltage, BV_{DSS}	$V_{BR(DSS)}$	60	—	—	V	V_{GS} = 0V, I_D = 10μA
Zero Gate Voltage Drain Current (Drain Leakage Current)	I_{DSS}	—	—	1	μA	V_{GS} = 0V, V_{DS} = 60V
Gate Body Leakage Current, Foward	I_{GSSF}	—	—	10	μA	V_{GS} = 20V, V_{DS} = 0V
Gate Body Leakage Current, Reverse	I_{GSSR}	—	—	-10	μA	V_{GS} = -20 V, V_{DS} = 0V
ON CHARACTERISTICS (Note 4)						
Gate Source Threshold Voltage (Control Supply Voltage)	$V_{GS(th)}$	1	1.6	2.5	V	V_{DS} = V_{GS}=10V, I_D = 0.25mA
		1.65	1.8	3	V	V_{DS} = V_{GS} = 10V, I_D = 1mA
Static Drain-Source On-State Voltage	$V_{DS(on)}$	—	0.09	1.5	V	V_{GS} = 5V, I_D = 50mA
		—	0.62	1.25	V	V_{GS} = 10V, I_D = 500mA
On-State Drain Current	$I_{D(on)}$	500	—	—	mA	V_{GS} = 10V, V_{DS} >=2*$V_{DS(ON)}$
Static Drain-Source On Resistance	$R_{DS\ (on)}$	—	1.6	3	Ω	V_{GS} = 5V, I_D= 50mA
		—	1.25	2		V_{GS} = 10V, I_D = 500mA
Foward Transconductance	g_{FS}	80	260	—	mS	V_{DS} >=2*$V_{DS(ON)}$, I_D=200mA
Dynamic Characteristics						
Input Capacitance	C_{iss}	—	—	50	pF	V_{DS} = 25V, V_{GS} = 0V, f = 1MHz
Output Capacitance	C_{OSS}	—	—	25	pF	
Reverse Transfer Capacitance	C_{rss}	—	—	5	pF	
Switching Characteristics*						
Turn-On Delay Time	$t_{d(on)}$			20	ns	
Turn-Off Delay Time	$t_{d(off)}$			40	ns	
Drain-Source (Body) Diode Characteristics and Maximum Ratings						
Drain-Source Diode Foward On-Voltage	V_{SD}		0.88	1.5	V	V_{GS} = 0V, I_S = 300 mA*
Maximum Continuous Drain-Source Diode Foward Current (Reverse Drain Current)	I_S			300	mA	
Maximum Pulsed Drain-Source Diode Foward Current	I_{SM}			800	mA	

* Pulse Test: Pulse width, tp <300 us, Duty Cycle, d ≤2%

Electrical Characteristics: Schottky Barrier Diode (D1) @ T_A = 25°C unless otherwise specified

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
Reverse Breakdown Voltage (Note 4)	$V_{(BR)R}$	40	—	—	V	I_R = 10μA
Foward Voltage Drop (Note 4)	V_{FM}	—	—	0.37	V	I_F =20mA
		—	—	0.6		I_F =200mA
Peak Reverse Current (Note 4)	I_{RM}	—	—	5	μA	V_R = 30V
Total Capacitance	C_T	—	28	—	pF	V_R = 0V, f = 1.0 MHz
Reverse Recovery Time	t_{rr}	—	10	—	ns	I_F=I_R= 200 mA, I_{rr}= 0.1xI_R, R_L= 100 Ω

Notes: 4. Short duration test pulse used to minimize self-heating effect.

Typical Characteristics

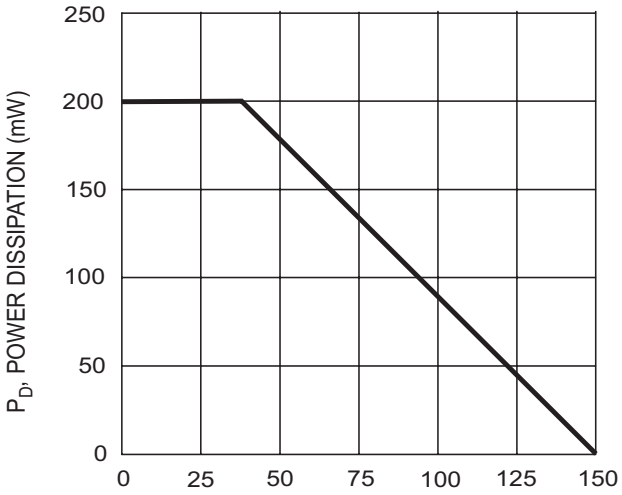


Fig. 3, Max Power Dissipation vs. Ambient Temperature

Typical N-Channel MOSFET-Q1 (ESD Protected) Characteristics

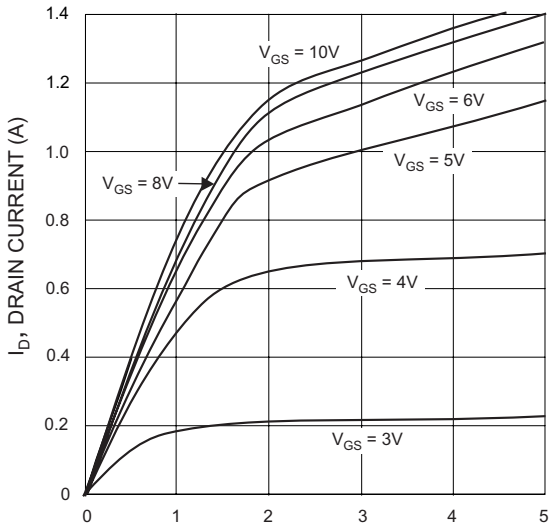


Fig. 4 Output Characteristics

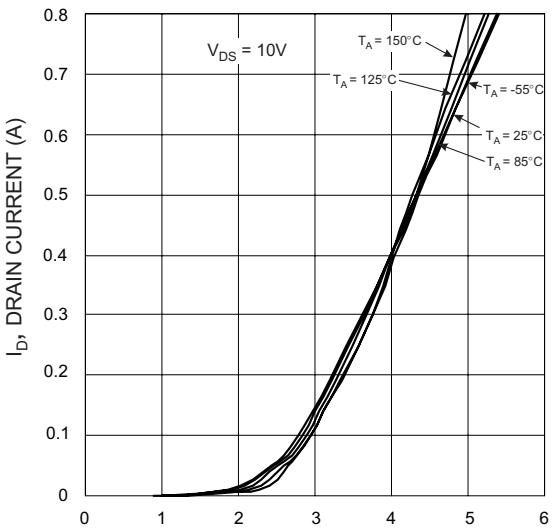


Fig. 5 Transfer Characteristics

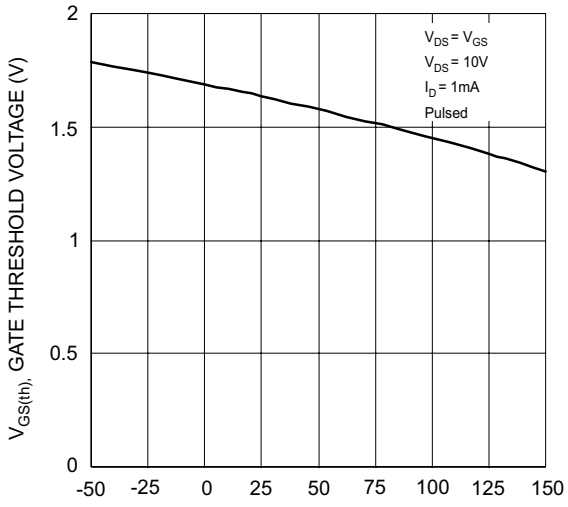


Fig. 6 Gate Threshold Voltage vs. Junction Temperature

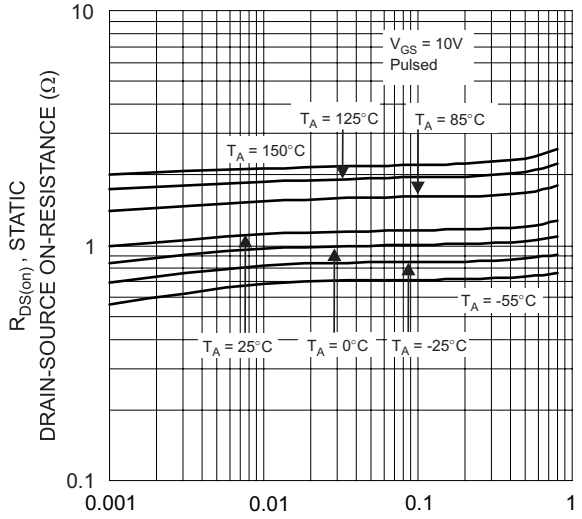


Fig. 7 Static Drain-Source On-Resistance vs. Drain Current

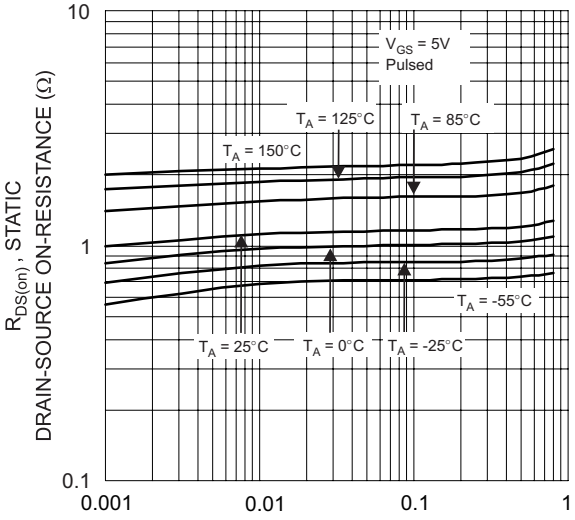


Fig. 8 Static Drain-Source On-Resistance vs. Drain Current

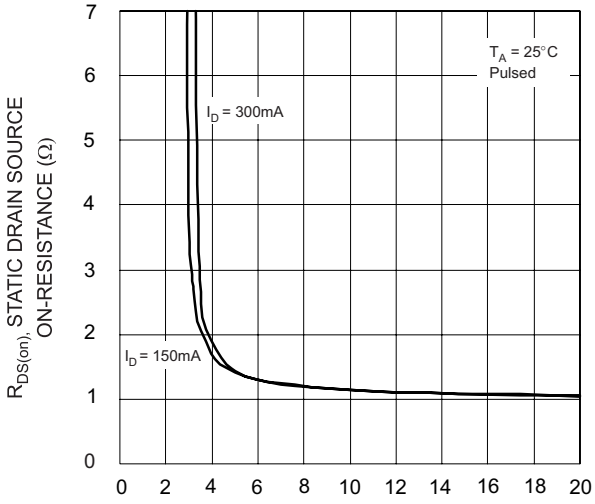


Fig. 9 Static Drain-Source On-Resistance vs. Gate-Source Voltage

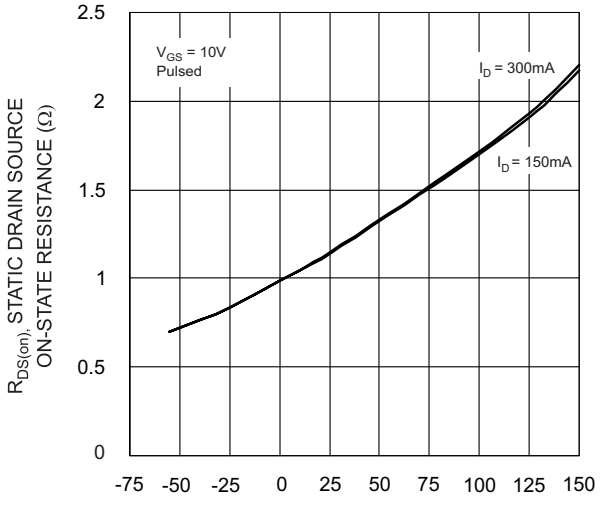


Fig. 10 Static Drain-Source On-State Resistance vs. Junction Temperature

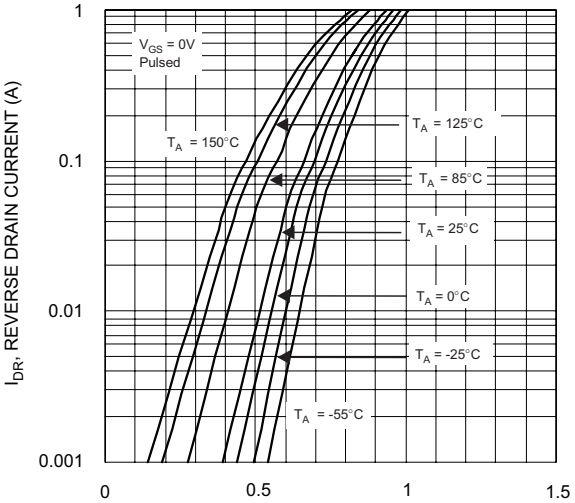


Fig. 11 Reverse Drain Current vs. Source-Drain Voltage

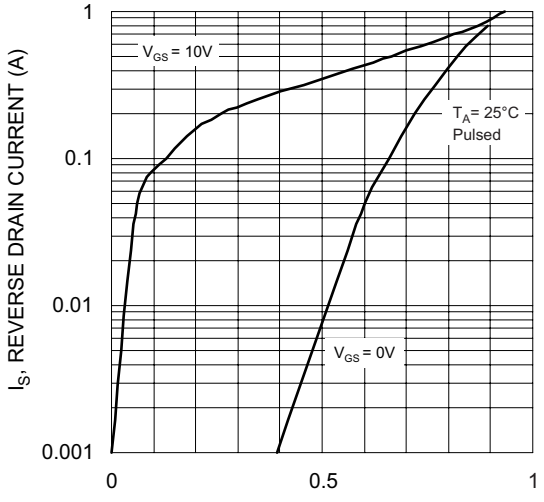


Fig. 12 Reverse Drain Current vs. Body Diode Forward Voltage

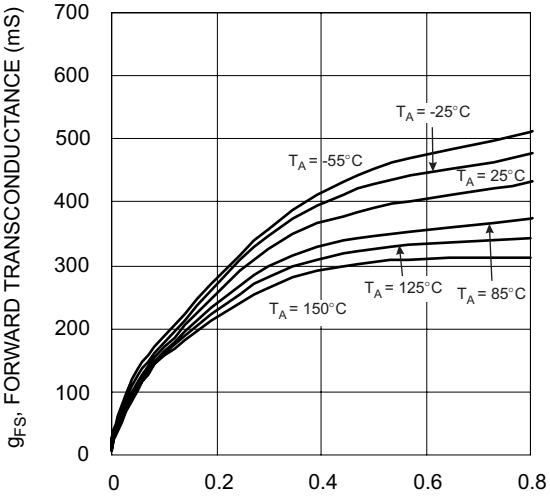


Fig. 13 Forward Transconductance vs. Drain Current ($V_{DS} > I_D * R_{DS(ON)}$)

Schottky Barrier Diode-D1 Characteristics

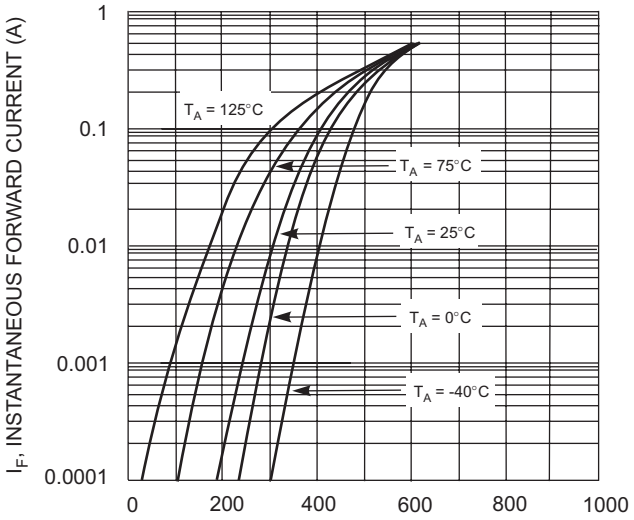


Fig. 14 Forward Characteristics

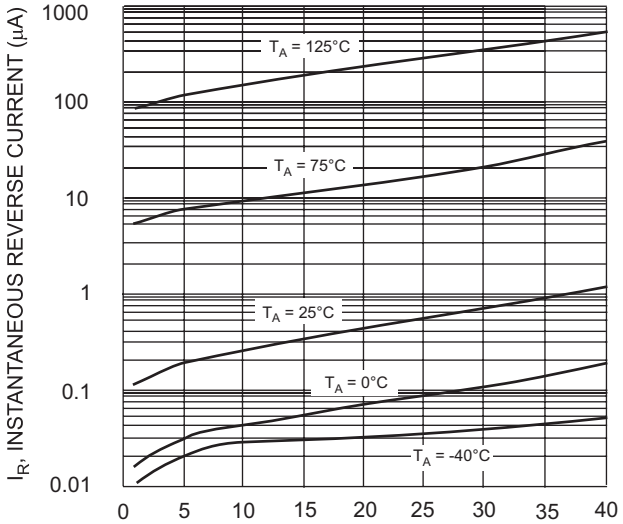


Fig. 15 Reverse Characteristics

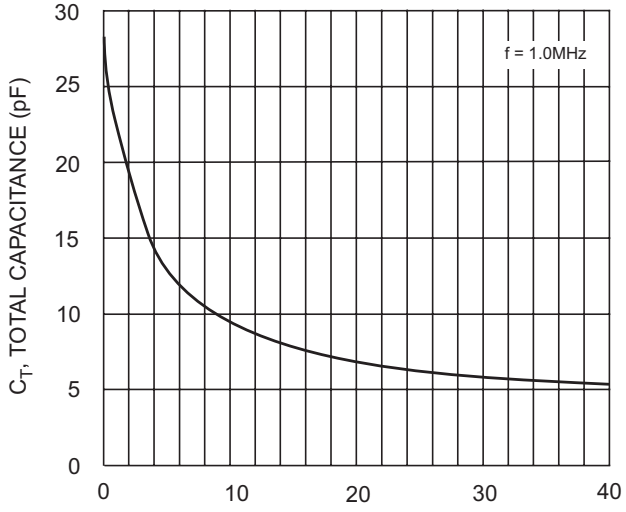


Fig. 16 Total Capacitance vs. Reverse Voltage

Application Details

ESD Protected N-MOSFET (DMN601K) and Schottky Barrier Diode (SD103AWS) integrated as one in NMSD200B01 can be used as a discrete entity for general applications or part of circuits to function as a low side switch in a Synchronous Rectifier. The N-MOSFET is selected based on the input voltage range as the maximum duty cycles can be greater than 45%. Schottky diode is selected based on instantaneous Vf (less than 0.75 V) at maximum operation current. The Schottky diode dissipates very little power because it is on for only a small portion of the switching cycle. Normally it shows much lower leakage current and smaller on-resistance (RDS(ON)) even compared to its monolithic counterpart. This device is designed to improve efficiency and reliability of synchronous buck converters used in voltage regulator modules (VRM). The lower Vf of the Schottky diode leads to lower static loss. Every time the high side MOSFET is turned on in the buck converter, the low side Schottky diode is forced to recover the stored charge and there will be lower loss due to the lower Reverse Recovery charge of the Schottky diode.

It is designed to replace a discrete N-MOSFET and a Schottky diode in two separate packages into one small package as shown in Fig. 17. The Schottky diode parallel to the MOSFET body diode is faster and has lower voltage drop compared to the integrated body diode. Overall this device consumes less board space and also helps to minimize conduction or switching losses due to parasitic inductances (e.g. PCB traces) in power supply applications. (Please see Fig. 18 for one example of typical application circuit used in conjunction with DC-DC converter as a part of power management system and Fig. 19 for low side DC load control.)

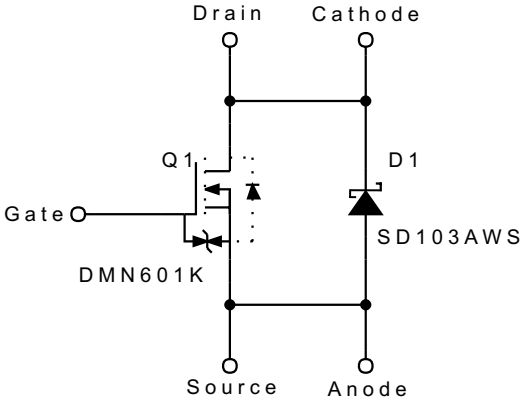


Fig 17 : Example Circuit Diagram

Typical Application Circuits

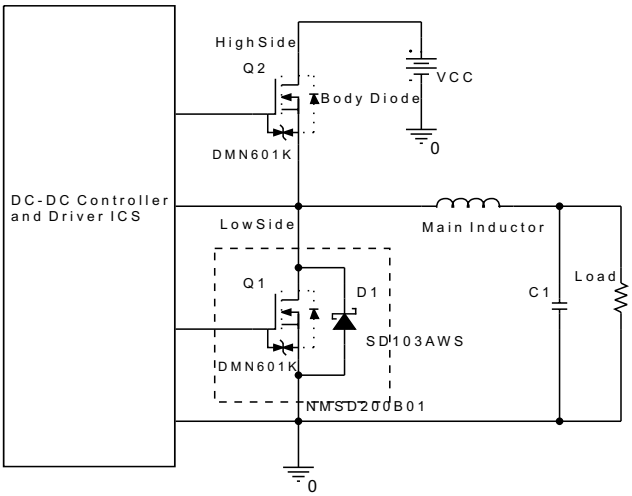
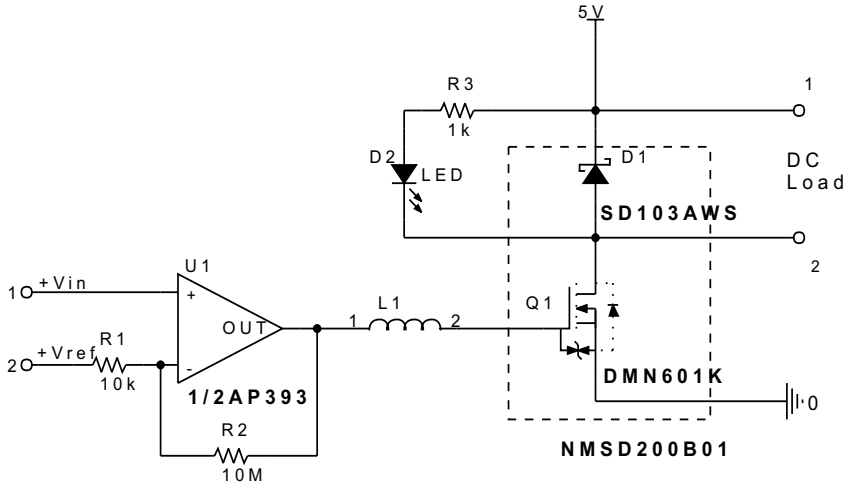


Fig. 18 Synchronous Buck Converter with Integrated Schottky Diode



(Comparator with Hysteresis)

Fig. 19 Low Side DC Load Control

Ordering Information (Note 5)

Device	Marking Code	Packaging	Shipping
NMSD200B01-7	SR1	SOT-363	3000/Tape & Reel

Notes: 5. For Packaging Details, go to our website at http://www.diodes.com/datasheets/ap02007.pdf.

Marking Information

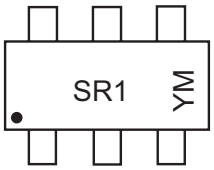


Fig. 20

SR1 = Product Type Marking Code,
YM = Date Code Marking
Y = Year, e.g., T = 2006
M = Month, e.g., 9 = September

Date Code Key

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

Year	2006	2007	2008	2009
Code	T	U	V	W

Mechanical Details

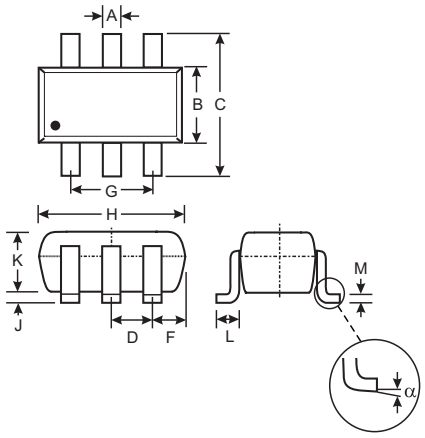


Fig. 21

SOT-363		
Dim	**Min**	**Max**
A	0.10	0.30
B	1.15	1.35
C	2.00	2.20
D	0.65 Nominal	
F	0.30	0.40
H	1.80	2.20
J	—	0.10
K	0.90	1.00
L	0.25	0.40
M	0.10	0.25
α	0°	8°
All Dimensions in mm		

Suggested Pad Layout: (Based on IPC-SM-782)

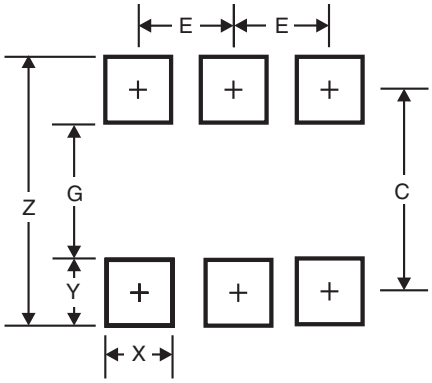


Fig. 22

Figure 14 Dimensions	SOT-363*
Z	2.5
G	1.3
X	0.42
Y	0.6
C	1.9
E	0.65

* Typical dimensions in mm