

400mA LOAD SWITCH FEATURING PNP TRANSISTOR AND N-MOSFET WITH GATE PULL-DOWN RESISTOR

NEW PRODUCT

General Description

- LMN400B01 is best suited for applications where the load needs to be turned on and off using control circuits like micro-controllers, comparators etc. particularly at a point of load. It features a discrete pass transistor with stable $V_{CE(SAT)}$ which does not depend on input voltage and can support continuous maximum current of 400 mA. It also contains a discrete N-MOSFET with gate pull-down resistor that can be used as control. The component devices can be used as a part of a circuit or as a stand alone discrete device.

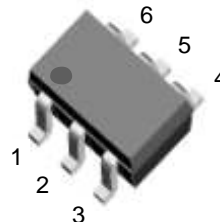


Fig. 1: SOT-26

Features

- Voltage Controlled Small Signal Switch
- N-MOSFET with Gate Pull-Down Resistor
- Surface Mount Package
- Ideally Suited for Automated Assembly Processes
- Lead Free By Design/ROHS Compliant (Note 1)**
- "Green" Device (Note 2)**

Mechanical Data

- Case: SOT-26
- 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 Copper leadframe. Solderable per MIL-STD-202, Method 208
- Marking & Type Code Information: See Last Page
- Ordering Information: See Last Page
- Weight: 0.016 grams (approx.)

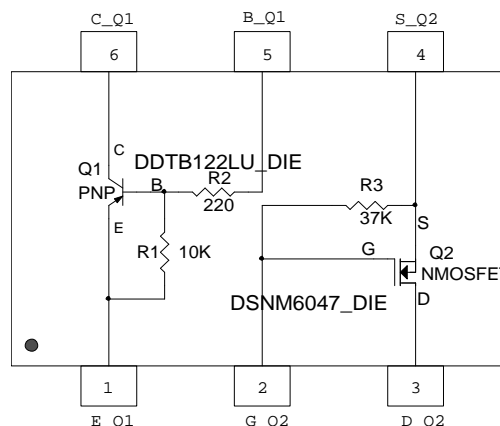


Fig. 2 Schematic and Pin Configuration

Sub-Components	Reference	Device Type	R1 (NOM)	R2 (NOM)	R3 (NOM)	Figure
DDTB122LU_DIE	Q1	PNP Transistor	10K	220		2
DSNM6047_DIE (with Gate Pull-Down Resistor)	Q2	N-MOSFET			37K	2

Maximum Ratings, Total Device @ $T_A = 25^\circ\text{C}$ unless otherwise specified

Characteristic	Symbol	Value	Unit
Power Dissipation (Note 3)	P_d	300	mW
Power Derating Factor above 100°C	P_{der}	2.4	mW/ $^\circ\text{C}$
Output Current	I_{out}	400	mA

Thermal Characteristics

Characteristic	Symbol	Value	Unit
Junction Operation and Storage Temperature Range	T_j, T_{stg}	-55 to +150	$^\circ\text{C}$
Thermal Resistance, Junction to Ambient Air (Note 3) (Equivalent to one heated junction of PNP transistor)	R_{JA}	417	$^\circ\text{C/W}$

- Notes:
- No purposefully added lead.
 - Diodes Inc.'s "Green" policy can be found on our website at http://www.diodes.com/products/lead_free/index.php.
 - 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>.

Maximum Ratings:
Sub-Component Device: Pre-Biased PNP Transistor (Q1) @ $T_A = 25^\circ\text{C}$ unless otherwise specified

Characteristic	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	-50	V
Collector-Emitter Voltage	V_{CEO}	-50	V
Supply Voltage	V_{CC}	-50	V
Input Voltage	V_{in}	+5 to -6	V
Output Current	I_C	-400	mA

Sub-Component Device:
N-MOSFET with Gate Pull-Down Resistor (Q2) @ $T_A = 25^\circ\text{C}$ unless otherwise specified

Characteristic	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	V
Drain Gate Voltage ($R_{GS} = 1\text{M}\Omega$)	V_{DGR}	60	V
Gate-Source Voltage	V_{GSS}	Continuous	+/-20
		Pulsed ($t_p < 50 \mu\text{s}$)	+/-40
Drain Current (Page 1: Note 3)	I_D	Continuous ($V_{GS} = 10\text{V}$)	115
		Pulsed ($t_p < 10 \mu\text{s}$, Duty Cycle <1%)	800
Continuous Source Current	I_S	115	mA

Electrical Characteristics:
Pre-Biased PNP Transistor (Q1) @ $T_A = 25^\circ\text{C}$ unless otherwise specified

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
OFF CHARACTERISTICS						
Collector-Base Cut Off Current	I_{CBO}			-100	nA	$V_{CB} = -50V, I_E = 0$
Collector-Emitter Cut Off Current	I_{CEO}			-500	nA	$V_{CE} = -50V, I_B = 0$
Emitter-Base Cut Off Current	I_{EBO}			-1	mA	$V_{EB} = -5V, I_C = 0$
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$	-50			V	$I_C = -10 \mu A, I_E = 0$
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$	-50			V	$I_C = -2 \text{ mA}, I_B = 0$
Input Off Voltage	$V_{I(OFF)}$			-0.5	V	$V_{CE} = -5V, I_C = -100\mu A$
Output Voltage	V_{OH}	-4.9			V	$V_{CC} = -5V, V_B = -0.05V, R_L = 1K$
Output Current (leakage current same as I_{CEO})	$I_{O(OFF)}$			-500	nA	$V_{CC} = -50V, V_I = 0V$
ON CHARACTERISTICS						
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$		-0.055	-0.15	V	$I_C = -10\text{mA}, I_B = -0.3\text{mA}$
			-0.25	-0.3	V	$I_C = -100\text{mA}, I_B = -1\text{mA}$
			-0.12	-0.15	V	$I_C = -200\text{mA}, I_B = -20\text{mA}$
			-0.16	-0.2	V	$I_C = -300\text{mA}, I_B = -30\text{mA}$
			-0.2	-0.25	V	$I_C = -400\text{mA}, I_B = -40\text{mA}$
		-0.25	-0.3	V	$I_C = -500\text{mA}, I_B = -50\text{mA}$	
Equivalent on-resistance*	$R_{CE(SAT)}$			1.125		$I_C = 400\text{mA}, I_B = 20\text{mA}$
DC Current Gain	h_{FE}	70	220			$V_{CE} = -5V, I_C = -50 \text{ mA}$
		70	260			$V_{CE} = -5V, I_C = -100 \text{ mA}$
		70	265			$V_{CE} = -5V, I_C = -200 \text{ mA}$
		70	225			$V_{CE} = -5V, I_C = -400 \text{ mA}$
Input On Voltage	$V_{I(ON)}$	-2.45	-1.5		V	$V_O = -0.3V, I_C = -2 \text{ mA}$
Output Voltage (equivalent to $V_{CE(SAT)}$ or $V_{O(on)}$)	V_{OL}		-0.1	-0.3	V	$V_{CC} = -5V, V_B = -2.5V, I_O/I_I = -50\text{mA} / -2.5\text{mA}$
Input Current	I_i		-18	-28	mA	$V_I = -5V$
Base-Emitter Turn-on Voltage	$V_{BE(ON)}$		-1.2	-1.3	V	$V_{CE} = -5V, I_C = -400\text{mA}$
Base-Emitter Saturation Voltage	$V_{BE(SAT)}$		-1.9	-2.2	V	$I_C = -50\text{mA}, I_B = -5\text{mA}$
			-5.25	-5.5	V	$I_C = -400\text{mA}, I_B = -20\text{mA}$
Input Resistor (Base), +/- 30%	R2		0.22		K	
Pull-up Resistor (Base to V_{CC} supply), +/- 30%	R1		10		K	
Resistor Ratio (Input Resistor/Pullup resistor)	R1/R2		0.022			
SMALL SIGNAL CHARACTERISTICS						
Transition Frequency (gain bandwidth product)	f_T		200		MHz	$V_{CE} = -10V, I_E = -5\text{mA}, f = 100\text{MHz}$
Collector capacitance, (C_{cbo} -Output Capacitance)	C_C		20		pF	$V_{CB} = -10V, I_E = 0A, f = 1\text{MHz}$

* Pulse Test: Pulse width, $t_p < 300 \mu\text{s}$, Duty Cycle, $d = 0.02$

Electrical Characteristics:

N-MOSFET with Gate Pull-Down Resistor (Q2) @ T_A = 25°C unless otherwise specified

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
OFF CHARACTERISTICS (Note 4)						
Drain-Source Breakdown Voltage, BVDSS	V _{(BR)DSS}	60			V	V _{GS} = 0V, I _D = 10uA
Zero Gate Voltage Drain Current (Drain Leakage Current)	I _{DSS}			1	μA	V _{GS} = 0V, V _{DS} = 60V
Gate-Body Leakage Current, Forward	I _{GSSF}			0.95	mA	V _{GS} = 20V, V _{DS} = 0V
Gate-Body Leakage Current, Reverse	I _{GSSR}			-0.95	mA	V _{GS} = -20V, V _{DS} = 0V
ON CHARACTERISTICS (Note 4)						
Gate Source Threshold Voltage (Control Supply Voltage)	V _{GS(th)}	1	1.86	2.2	V	V _{DS} = V _{GS} , I _D = 0.25mA
Static Drain-Source On-State Voltage	V _{DS(on)}		0.08	1.5	V	V _{GS} = 5V, I _D = 50mA
			0.15	3.75		V _{GS} = 10V, I _D = 115mA
On-State Drain Current	I _{D(on)}	500			mA	V _{GS} = 10V, V _{DS} = 2 x V _{DS(on)}
Static Drain-Source On Resistance	R _{DS(on)}		1.55	3		V _{GS} = 5V, I _D = 50mA
			1.4	2		V _{GS} = 10V, I _D = 500mA
Forward Transconductance	g _{FS}	80	240		mS	V _{DS} = 2 x V _{DS(on)} , I _D = 115 mA
		80	350			V _{DS} = 2 x V _{DS(on)} , I _D = 200 mA
Gate Pull-Down Resistor, +/- 30%	R3		37		K	
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	V _{DD} = 30V, V _{GS} = 10V, I _D = 200mA, R _G = 25 Ω, R _L = 150 Ω
Turn-Off Delay Time	t _{d(off)}			40	ns	
SOURCE-DRAIN (BODY) DIODE CHARACTERISTICS AND MAXIMUM RATINGS						
Drain-Source Diode Forward On-Voltage	V _{SD}		0.88	1.5	V	V _{GS} = 0V, I _S = 115 mA*
Maximum Continuous Drain-Source Diode Forward Current (Reverse Drain Current)	I _S			115	mA	
Maximum Pulsed Drain-Source Diode Forward Current	I _{SM}			800	mA	

* Pulse Test: Pulse width, t_p < 300 μs, Duty Cycle, d = 0.02

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

Typical Characteristics

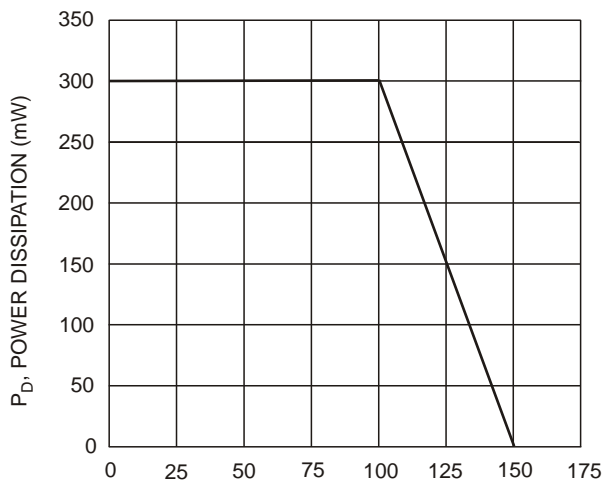


Fig. 3, Max Power Dissipation vs Ambient Temperature

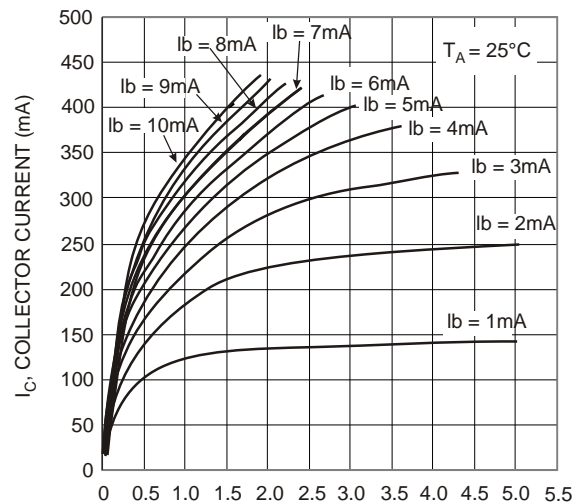


Fig. 4, Output Current vs. Voltage Drop (Pass Element PNP)

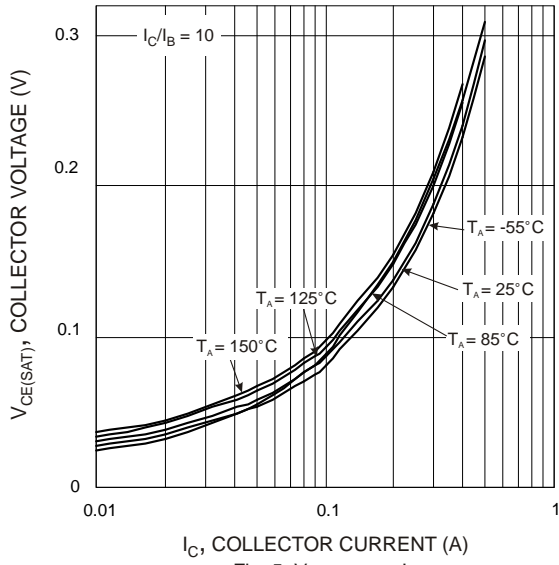


Fig. 5 $V_{CE(SAT)}$ vs. I_C

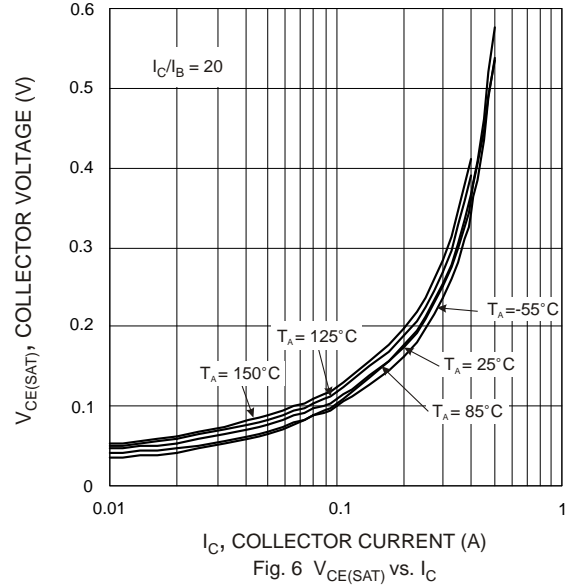


Fig. 6 $V_{CE(SAT)}$ vs. I_C

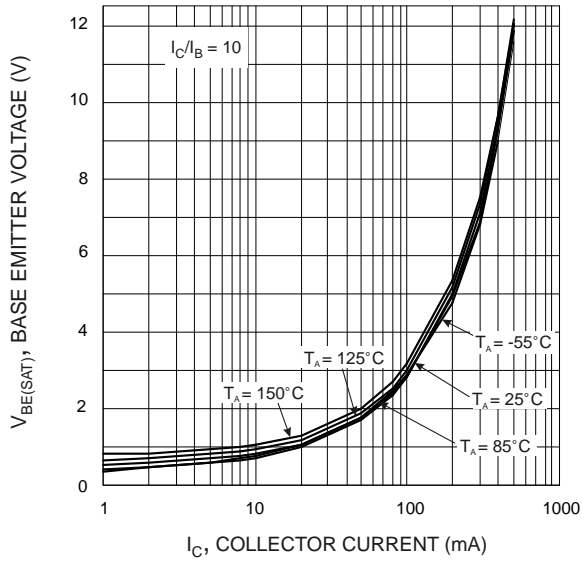


Fig. 7 $V_{BE(SAT)}$ vs. I_C

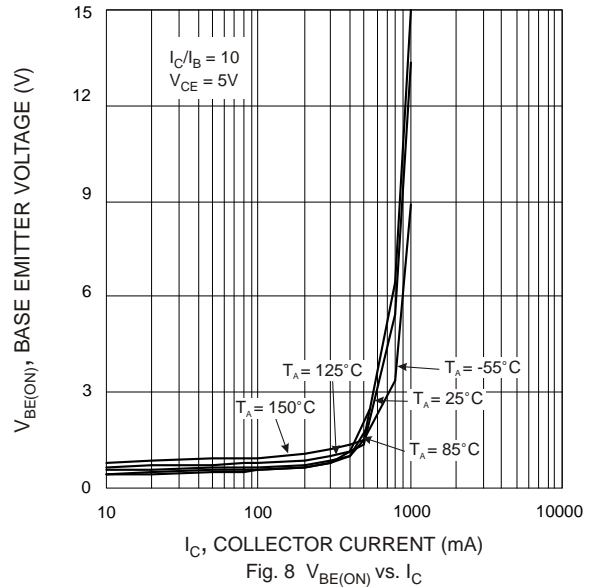


Fig. 8 $V_{BE(ON)}$ vs. I_C

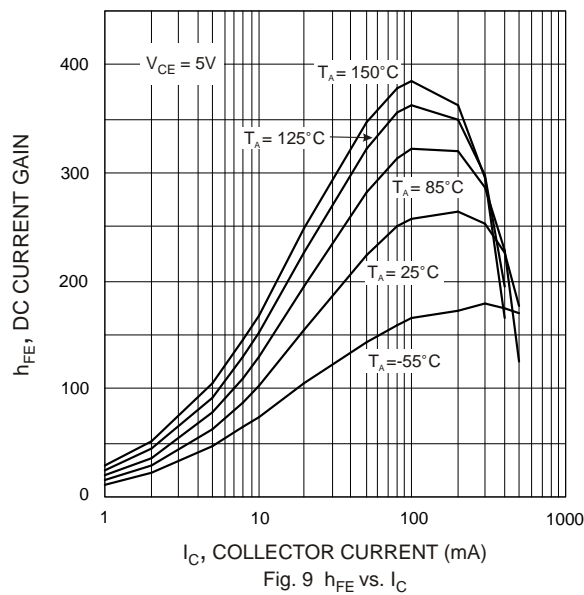
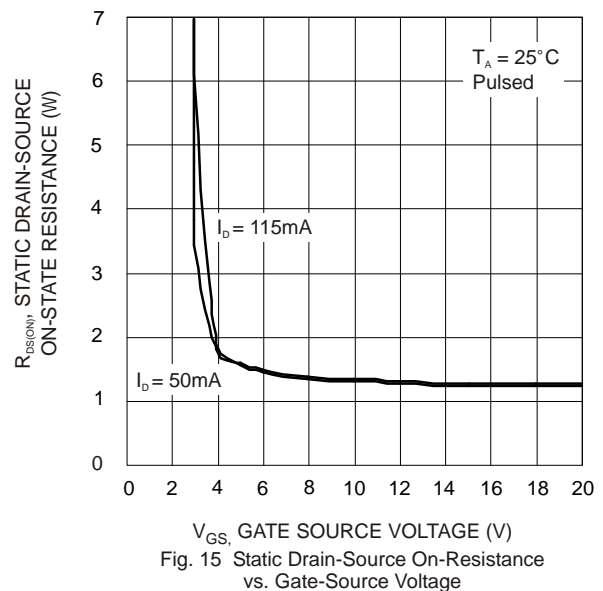
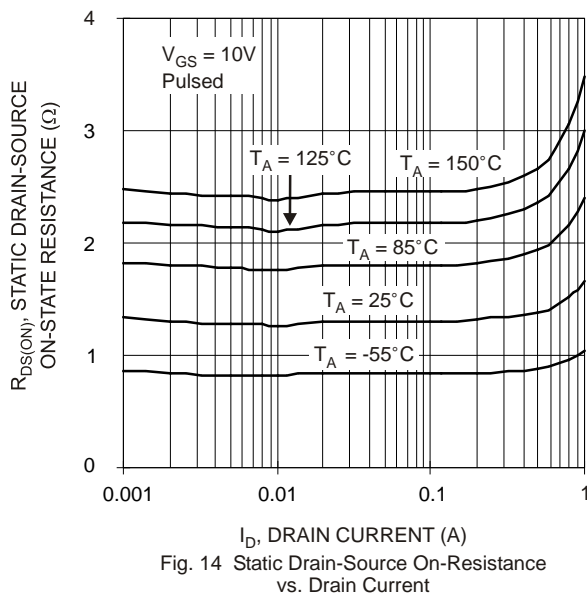
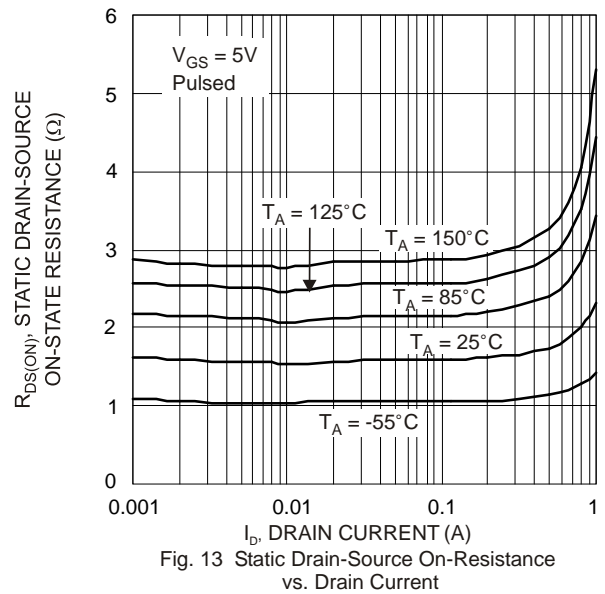
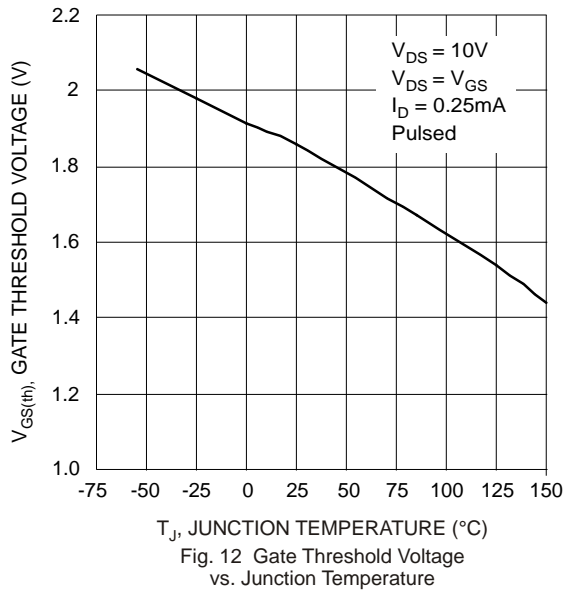
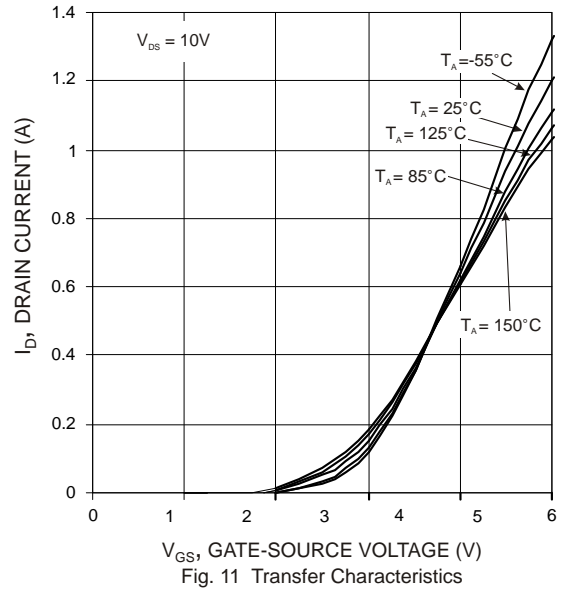
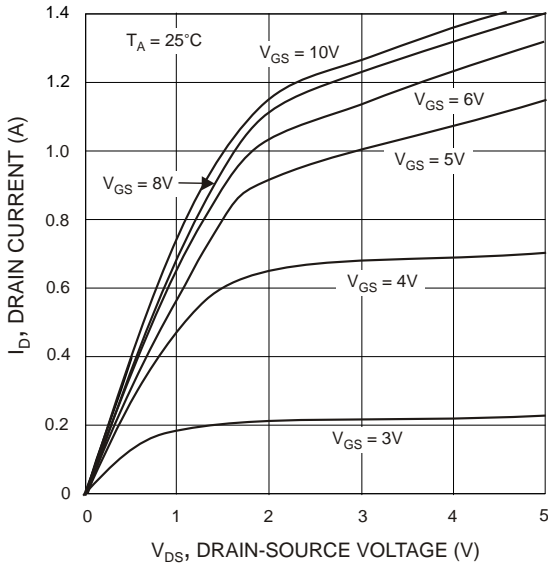


Fig. 9 h_{FE} vs. I_C



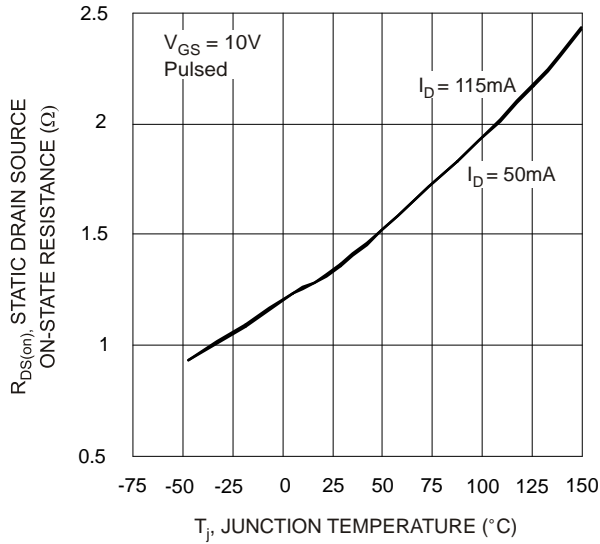


Fig. 16 Static Drain-Source On-State Resistance vs. Junction Temperature

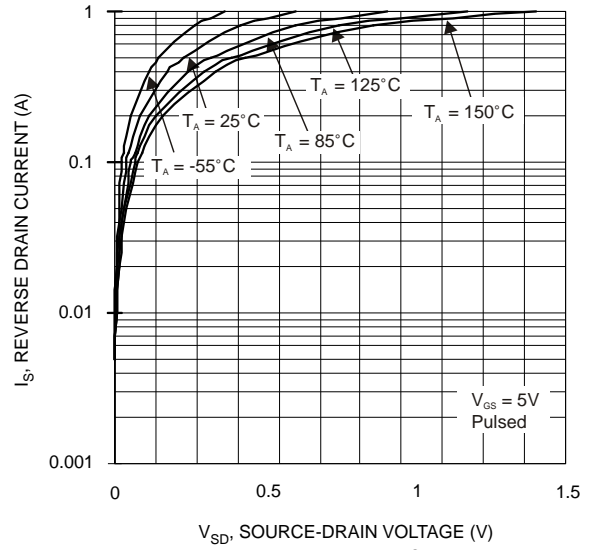


Fig. 17 Reverse Drain Current vs. Source-Drain Voltage

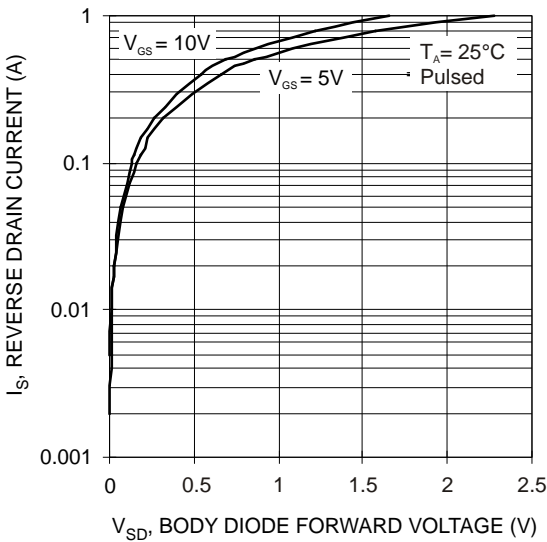


Fig. 18 Reverse Drain Current vs. Body Diode Forward Voltage

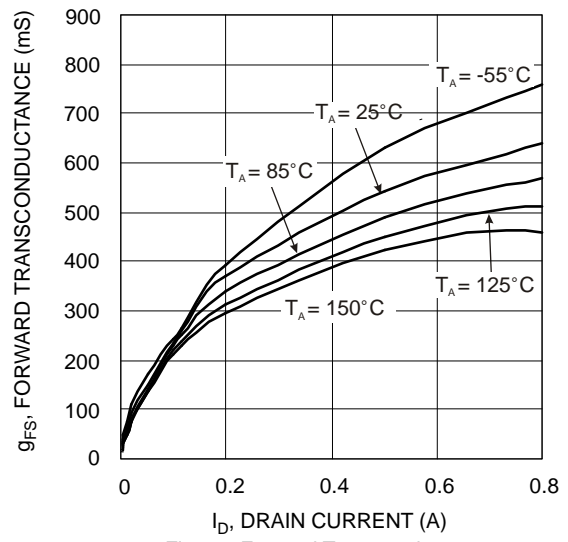


Fig. 19 Forward Transconductance vs. Drain Current ($V_{DS} > I_D \cdot R_{DS(ON)}$)

Application Details

- PNP Transistor (DDTB122LU) and N-MOSFET (DSNM6047) with gate pull-down resistor integrated as one in LMN400B01 can be used as a discrete entity for general application or as an integrated circuit to function as a Load Switch. When it is used as the latter as shown in Fig 20, various input voltage sources can be used as long as it does not exceed the maximum ratings of the device. These devices are designed to deliver continuous output load current up to a maximum of 400 mA. The MOSFET Switch draws no current, hence loading of control circuit is prevented. Care must be taken for higher level of dissipation while designing for higher load conditions. These devices provide high power and also consumes less space. The product mainly helps in optimizing power usage, thereby conserving battery life in a controlled load system like portable battery powered applications. (Please see Fig. 21 for one example of a typical application circuit used in conjunction with voltage regulator as a part of power management system)

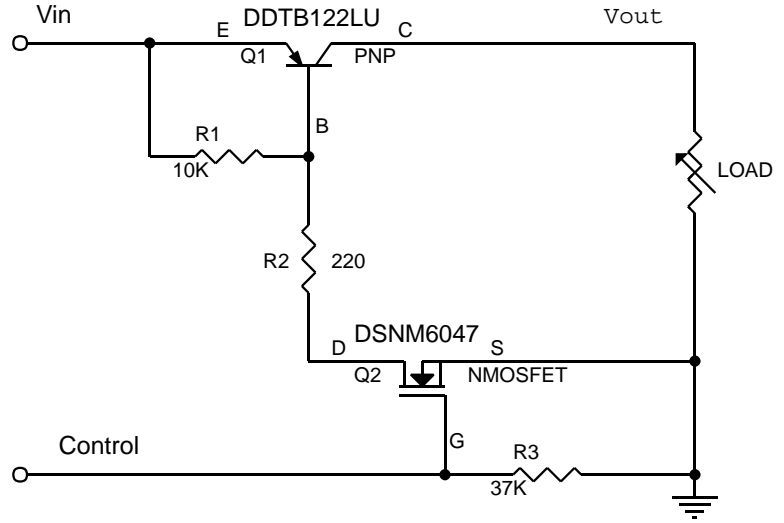


Fig 20 : Circuit Diagram

Typical Application Circuit

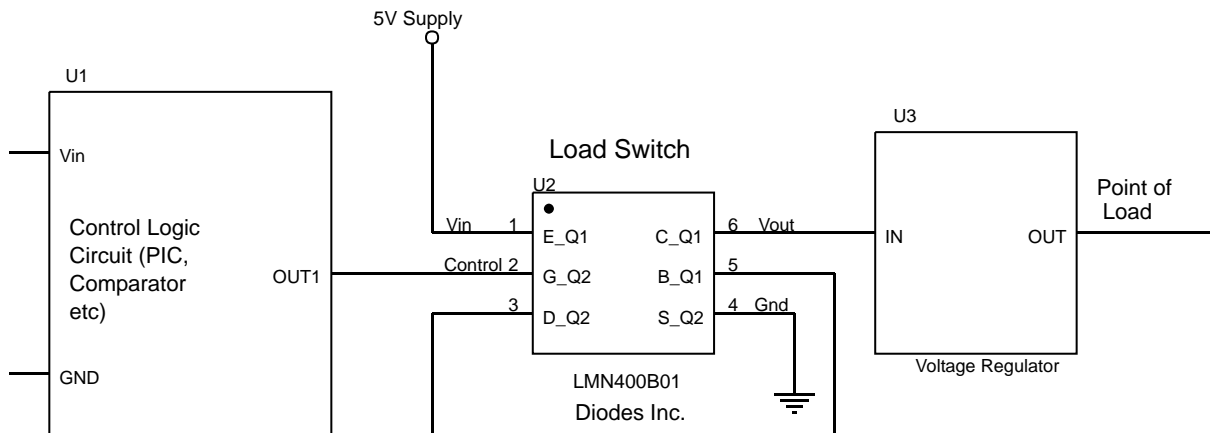


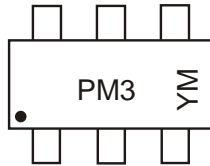
Fig 21

Ordering Information (Note 5)

Device	Marking Code	Packaging	Shipping
LMN400B01-7	PM3	SOT-26	3000/Tape & Reel

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

Marking Information



PM3 = Product Type Marking Code,
 YM = Date Code Marking
 Y = Year ex: T = 2006
 M = Month ex: 9 = September

Fig. 22

Date Code Key

Year	2006	2007	2008	2009
Code	T	U	V	W

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

Mechanical Details

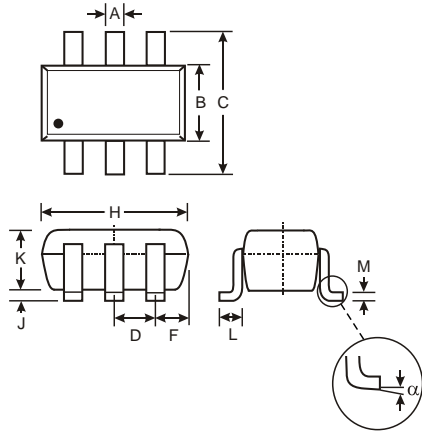


Fig. 23

SOT-26			
Dim	Min	Max	Typ
A	0.35	0.5	0.38
B	1.5	1.7	1.6
C	2.7	3	2.8
D	-	-	0.95
F	-	-	0.55
H	2.9	3.1	3
J	0.013	0.1	0.05
K	1	1.3	1.1
L	0.35	0.55	0.4
M	0.1	0.2	0.15
	0°	8°	-
All Dimensions in mm			

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

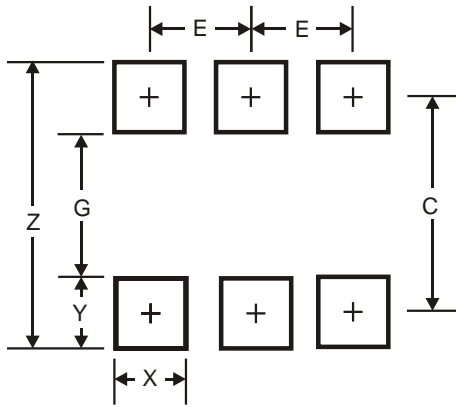


Fig. 24

Figure 24 Dimensions	SOT-26*
Z	3.2
G	1.6
X	0.55
Y	0.8
C	2.4
E	0.95

* Typical dimensions in mm

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