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MD0100

Single/Dual-Channel High-Voltage Protection T/R Switch

Features

- Up to ±100V Input Voltage Protection
- Low On-Resistance, 15Ω Typical
- Fast-Switching Speed
- Effective Simple Two-Terminal Device
- No External Supplies Needed

Applications

- Medical Ultrasound Imaging
- Non-Destructive Testing Applications
- Fast Resettable Fuses
- High-Side Switches
- Data Acquisition

General Description

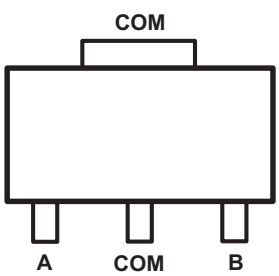
The MD0100 is a high-voltage, two-terminal, bi-directional, current-limiting protection device. The two terminals are interchangeable. It is designed to protect a low-noise receiver from high-voltage transmit pulses in ultrasound applications and is commonly referred to as a transmit-and-receive (T/R) switch.

The MD0100 can be considered as a normally closed switch with a typical switch resistance of 15Ω that allows small signals to pass. When the voltage drop across the two terminals exceeds a nominal value of ±2V, the device turns off. In the OFF state, the MD0100 can withstand up to ±100V across its terminals. A small amount of current (typically 200 µA) is allowed to flow through.

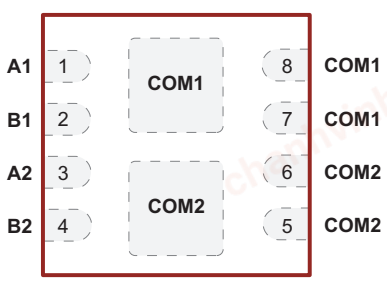
The applications for the MD0100 are not limited to just ultrasound. It can also be used as resettable fuses to protect power lines, output short-circuit protection and data acquisition. The MD0100 is available in an SOT-89 package as a single-channel device, as well as in a 4 mm x 4 mm 8-lead DFN package as a dual-channel device.

Package Types

3-lead SOT-89
(Top view)



8-lead DFN
(Top view)



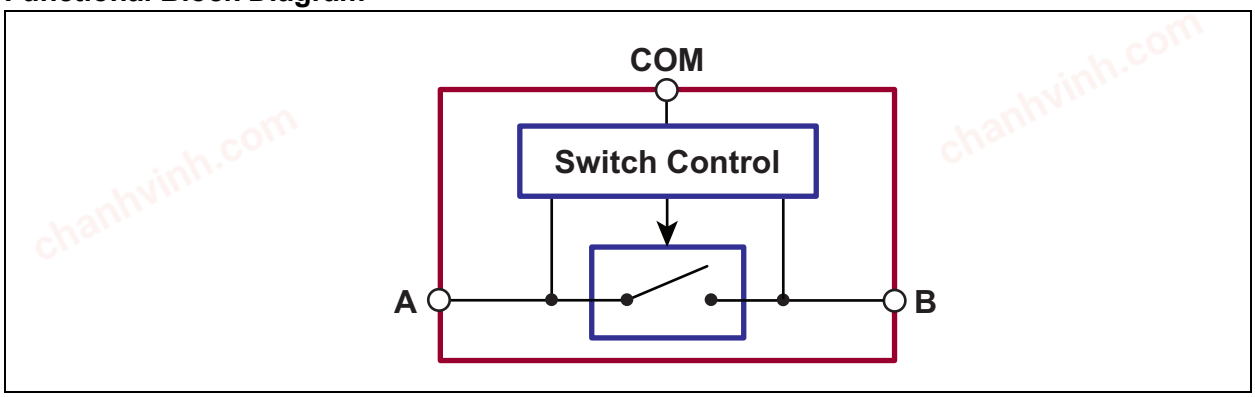
See Table 2-1 and Table 2-2 for pin information.

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MD0100

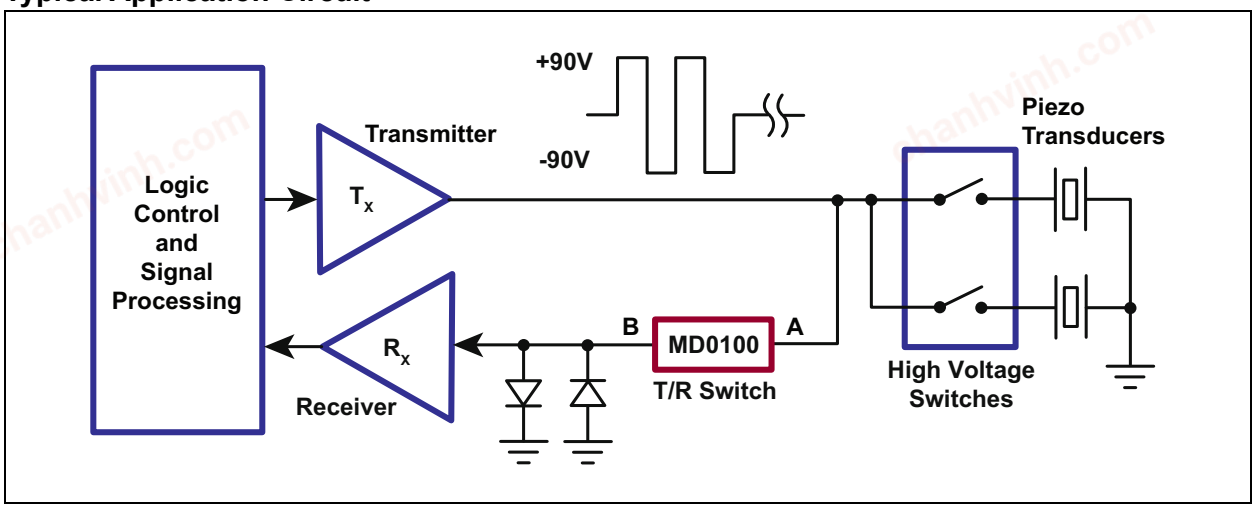
Functional Block Diagram



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Typical Application Circuit



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1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Differential Voltage, V_{A-B} ..... 0V to +110V
Maximum Junction Temperature, T_J ..... +125°C
Storage Temperature, T_S ..... –65°C to +150°C
Power Dissipation:
3-lead SOT-89 (**Note 1**, **Note 2**) 1.6W
8-lead DFN (**Note 1**, **Note 2**) 1.67W

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

Note 1: Mounted on an FR4 board, 25 mm x 25 mm x 1.57 mm

2: The maximum power dissipation is per die. A package has two dies.

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: T_J = 25°C unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Maximum Differential Input Voltage from A to B	V_{A-B}	±100	—	—	V	$I_{A–B}$ = ±500 µA
Switch-On Resistance from A to B	R_{SW}	—	15	—	Ω	$I_{A–B}$ = ±5 mA
V_{A-B} Trip Point to Turn Off	V_{TRIP}	—	±1	±2	V	
Switch Turn-Off Voltage	V_{OFF}	—	±2	—	V	$I_{A–B}$ = ±1 mA
Switch-Off Current	$I_{A-B(OFF)}$	—	±200	±300	µA	$V_{A–B}$ = ±100V

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: T_J = 25°C unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Peak Switching Current	I_{PEAK}	—	±60	—	mA	See Figure 3-8.
Turn-Off Time	T_{OFF}	—	—	20	ns	See Figure 3-2, Figure 3-3 and Figure 3-4.
Turn-On Time	T_{ON}	—	—	20	ns	See Figure 3-5, Figure 3-6 and Figure 3-7.
Switch-On Capacitance from A to B	$C_{SW(ON)}$	—	21	—	pF	SW = ON
Switch-Off Capacitance from A to B	$C_{SW(OFF)}$	—	15	—	pF	V_{SW} = 25V
Small Signal Bandwidth	BW	—	100	—	MHz	R_{LOAD} = 50Ω

TEMPERATURE SPECIFICATIONS

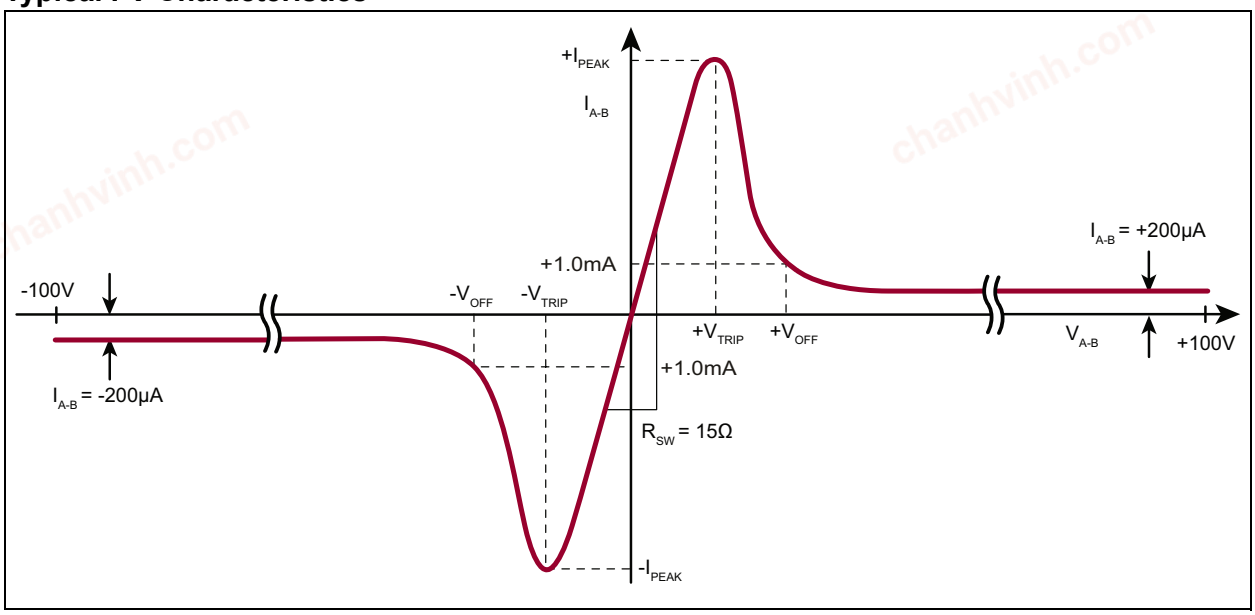
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Junction Temperature	T_J	–40	—	+125	°C	
Storage Temperature	T_S	–65	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
3-lead SOT-89	θ_{JA}	—	133	—	°C/W	**Note 1**
8-lead DFN	θ_{JA}	—	44	—	°C/W	

Note 1: 4-inch-x-4.5-inch JEDEC 2s2p PCB

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Typical I-V Characteristics



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2.0 PIN DESCRIPTION

The functional descriptions for the pins of MD0100 are listed in Table 2-1 and Table 2-2. See **Package Types** for the location of pins.

TABLE 2-1: 3-LEAD SOT-89 PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	A	Switch Terminal A
2	COM	Do not connect.
3	B	Switch Terminal B

TABLE 2-2: 8-LEAD DFN PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	A1	Switch Terminal A1
2	B1	Switch Terminal B1
3	A2	Switch Terminal A2
4	B2	Switch Terminal B2
5, 6, and Heat Slug 2	COM2	Do not connect.
7, 8, and Heat Slug 1	COM1	Do not connect.

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3.0 DETAILED DESCRIPTION

The MD0100 can be considered as a normally closed switch controlled by a built-in control circuit. (See **Functional Block Diagram**.) The switch control circuit monitors the voltage drop between Terminal A and Terminal B. If the voltage difference is greater than ±2V, the T/R switch will be opened. Once in the Open state, there is a small amount of current flowing through the T/R switch (200 uA) to detect if high voltage is still present. The T/R switch will not close until the voltage between Terminal A and Terminal B drops within ±2V. A pair of back-to-back diodes, from Terminal B (if it is connected to the receiver side) to ground is needed to complete the circuit and allow the peak current (about 60 mA) to flow through the switch. If the diodes are not present, there is no current path and the voltage drop across Terminal A and B will be less than ±2V. As a result, the switch will remain in the ON position.

The other purpose of the diodes is to clamp voltage spikes to ±0.7V during transmitting and receiving periods. Low-voltage diodes with low reverse recovery time and low junction capacitances (like BAV99T) should be used.

3.1 On Resistance

When the voltage between Terminal A and Terminal B is within ±2V, the switch is ON and the R_{ON} is typically 15Ω. Once the voltage between Terminal A and Terminal B is greater than ±2V, the switch will be OFF and prevent high-voltage pulses from passing through to the receiver and damaging it.

The MD0100 does not require any power supply. There are only two active pins: the first connects to the transmitter side and the second connects to the receiver side.

3.2 Switch Capacitance

The typical switch-on capacitance $CSW_{(ON)}$ is 21 pF. This is measured from A to B or B to A when the switch is turned on.

The switch-off capacitance is a function of the voltage across the T/R switch. The $C_{SW(OFF)}$ is about 12 pF to 19 pF for 10V to 100V of transmit voltage. Refer to Figure 3-1 for the C–V curve of $C_{SW(OFF)}$.

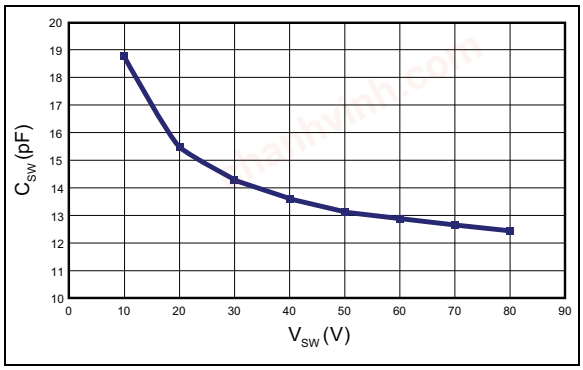


FIGURE 3-1: *$C_{SW(OFF)}$ vs. V_{SW}.*

3.3 T_{ON} and T_{OFF} Time

The T_{ON} and T_{OFF} of the MD0100 are less than 20 ns, which provides a quick transition between the Transmit and Receive modes. T_{ON} and T_{OFF} times are proportional to the rise and fall times of the transmit pulses. The T_{OFF} and T_{ON} setups are shown in Figure 3-2 and Figure 3-5, respectively.

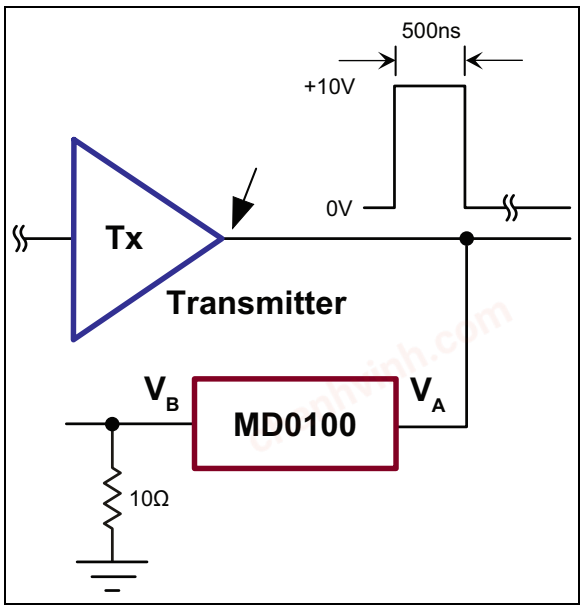


FIGURE 3-2: *Test Setup for T_{OFF}.*

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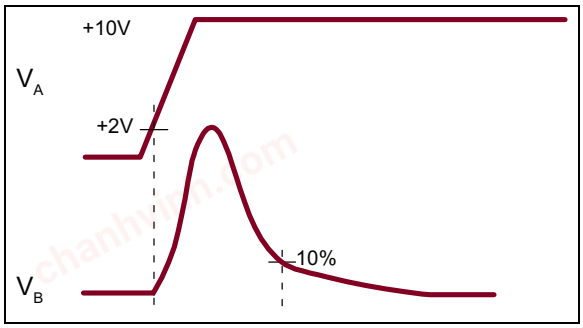


FIGURE 3-3: *T_{OFF} Timing Diagram.*

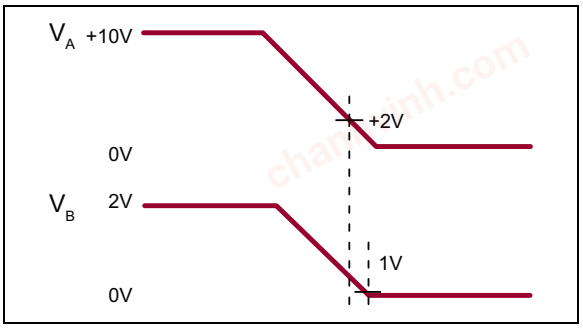


FIGURE 3-6: *T_{ON} Timing Diagram.*

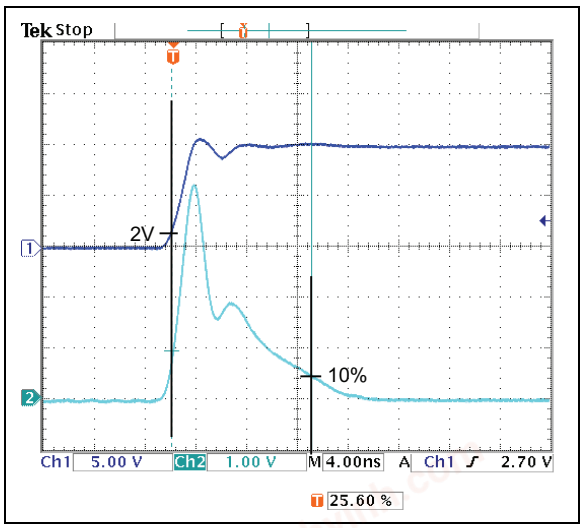


FIGURE 3-4: *T_{OFF} at V_A = 10V.*

Figure 3-4 shows the actual waveform and measurement of T_{OFF}. T_{OFF} is measured from 2V of V_A to 10% of V_B. From the above waveform, T_{OFF} is 11 ns.

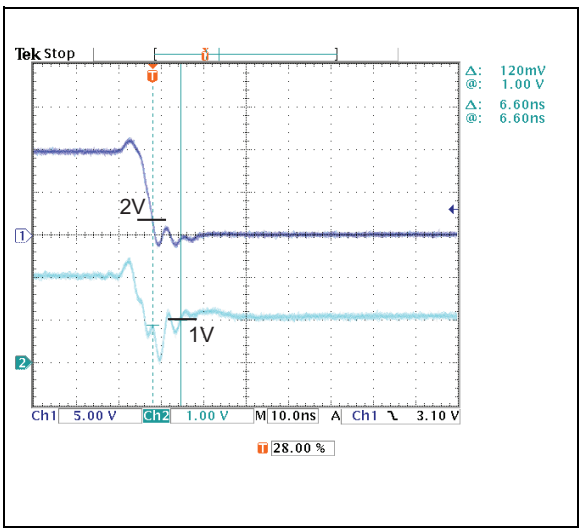


FIGURE 3-7: *T_{ON} at V_A = 10V.*

Figure 3-7 illustrates the actual waveform and measurement of T_{ON}. T_{ON} is measured from 2V of V_A to 1V of V_B. From the above waveform, T_{ON} is 6.6 ns.

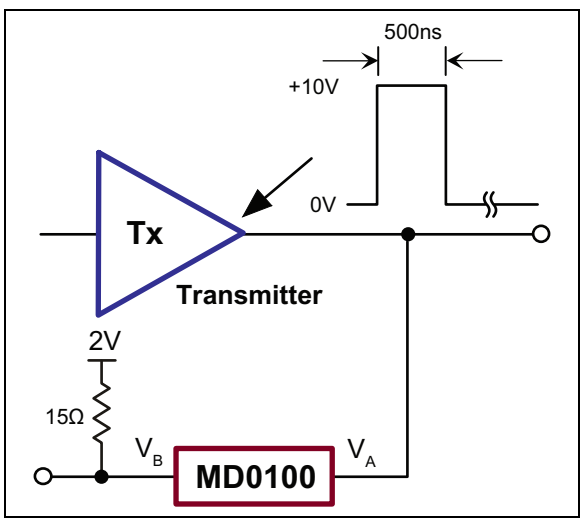


FIGURE 3-5: *Test Setup for T_{ON}.*

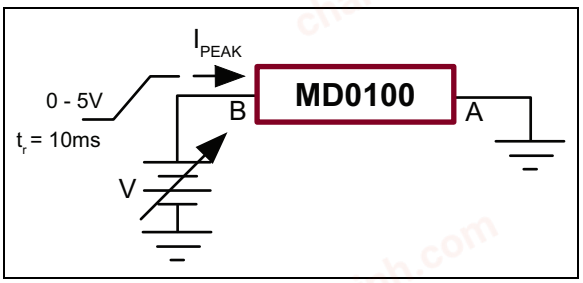


FIGURE 3-8: *Test Setup for I_{PEAK}.*

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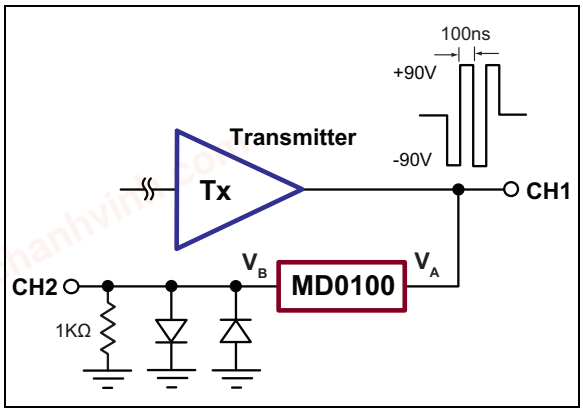


FIGURE 3-9: *Test Setup for Waveforms in Figure 3-10 and Figure 3-11.*

Figure 3-10 shows the waveforms of V_A and V_B for the test circuit in Figure 3-9. There is a small bump of about 0.5V at the tail of the V_B signal because the transmit signal falls into the ±2V range, and the MD0100 turns back on again. Figure 3-11 illustrates the same waveforms with both V_A and V_B shown with same voltage scale of 2V/div.

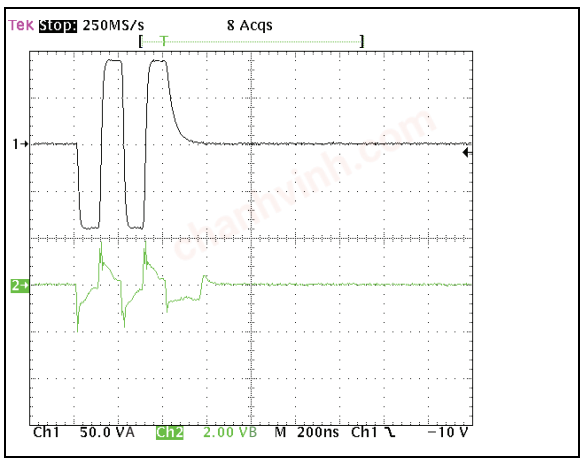


FIGURE 3-10: *Typical Waveform A.*

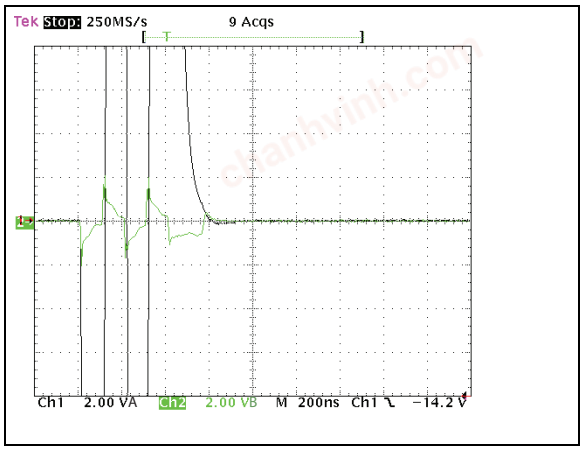


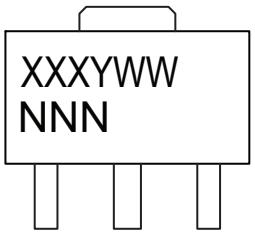
FIGURE 3-11: *Typical Waveform B.*

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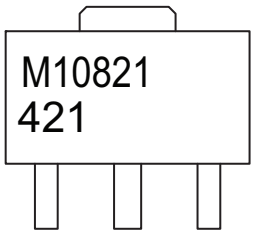
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

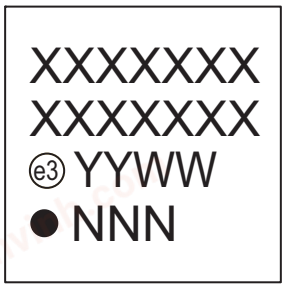
3-lead SOT-89



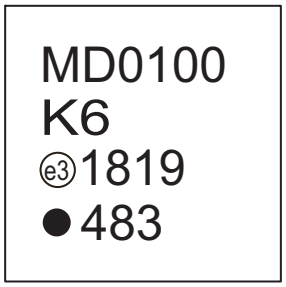
Example



8-lead DFN



Example



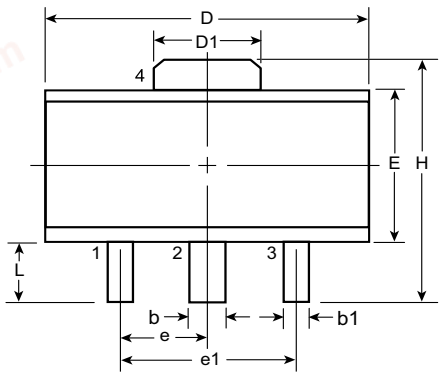
Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

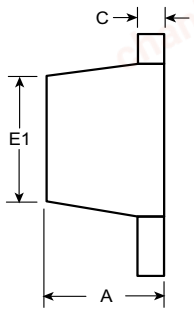
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3-Lead TO-243AA (SOT-89) Package Outline (N8)



Top View



Side View

Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Symbol		A	b	b1	C	D	D1	E	E1	e	e1	H	L
Dimensions (mm)	MIN	1.40	0.44	0.36	0.35	4.40	1.62	2.29	2.00†	1.50 BSC	3.00 BSC	3.94	0.73†
	NOM	-	-	-	-	-	-	-	-			-	-
	MAX	1.60	0.56	0.48	0.44	4.60	1.83	2.60	2.29			4.25	1.20

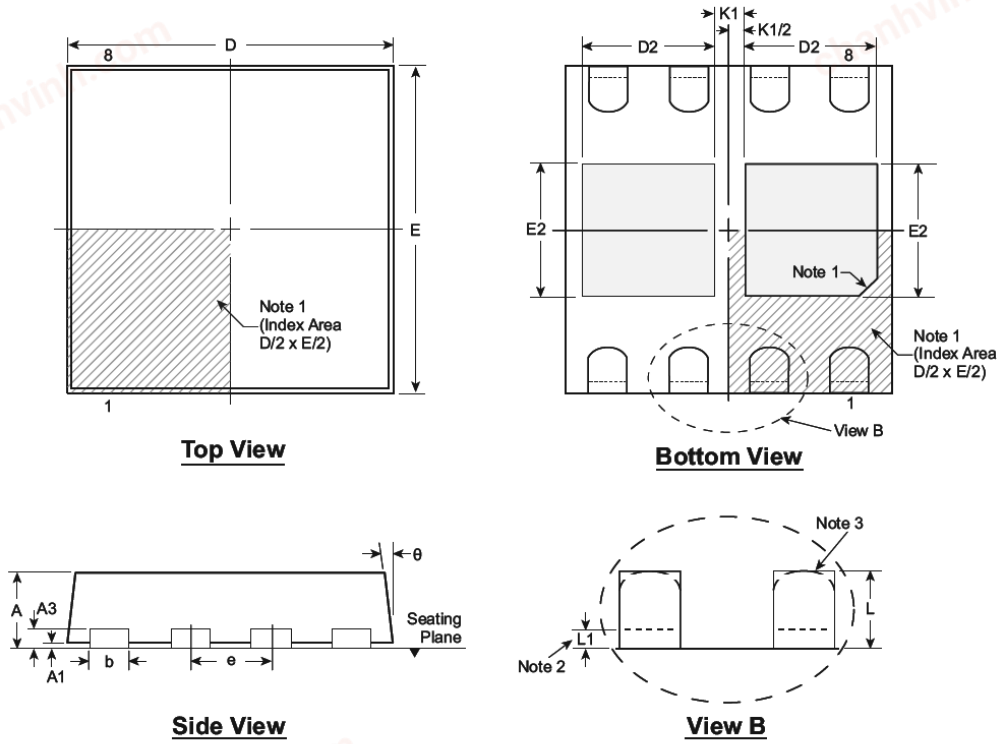
JEDEC Registration TO-243, Variation AA, Issue C, July 1986.
† This dimension differs from the JEDEC drawing
Drawings not to scale.

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8-Lead DFN Package Outline (K6)

4.00x4.00mm body, 1.00mm height (max), 1.00mm pitch (dual pad)



Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Notes:

1. *A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.*
2. *Depending on the method of manufacturing, a maximum of 0.15mm pullback (L1) may be present.*
3. *The inner tip of the lead may be either rounded or square.*

Symbol		A	A1	A3	b	D	D2	E	E2	e	K1	L	L1	θ
Dimension (mm)	MIN	0.80	0.00	0.20 REF	0.25	3.90	1.35	3.90	1.35	1.00 BSC	0.50 REF	0.40	0.00	0°
	NOM	0.90	-		0.30	4.00	1.45	4.00	1.45			0.50	-	-
	MAX	1.00	0.05		0.35	4.10	1.55	4.10	1.55			0.60	0.15	14°

Drawings not to scale

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APPENDIX A: REVISION HISTORY

Revision A (October 2018)

- Converted Supertex Doc# DSFP-MD0100 to Microchip DS20005738A
- Changed the power dissipation value of 8-lead DFN from “1.1W” to “1.67W”
- Changed Note 1 to “4-inch-x-4.5-inch JEDEC 2s2p PCB”
- Changed the package marking format
- Changed the quantity of the 8-lead DFN K6 package from 3000/Reel to 3300/Reel
- Changed the “3-lead TO-243AA (SOT-89)” package marking to “3-lead SOT-89”
- Made minor text changes throughout the document

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MD0100

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Devices:	MD0100	=	Single-Channel High-Voltage Protection T/R Switch, Single Channel
	MD0100D	=	Dual-Channel High-Voltage Protection T/R Switch
Packages:	N8	=	3-lead SOT89 (for single channel only)
	K6	=	8-lead (4x4) VDFN (for dual channel only)
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	2000/Reel for an N8 Package
	(blank)	=	3300/Reel for a K6 Package

Examples:

a) MD0100N8-G: Single-Channel High-Voltage Protection T/R Switch, 3-lead SOT89, 2000/Reel

b) MD0100DK6G: Dual-Channel High-Voltage Protection T/R Switch, 8-lead (4x4) VDFN, 3300/Reel

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Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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