

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

Features

- Up to $\pm 100\text{V}$ 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

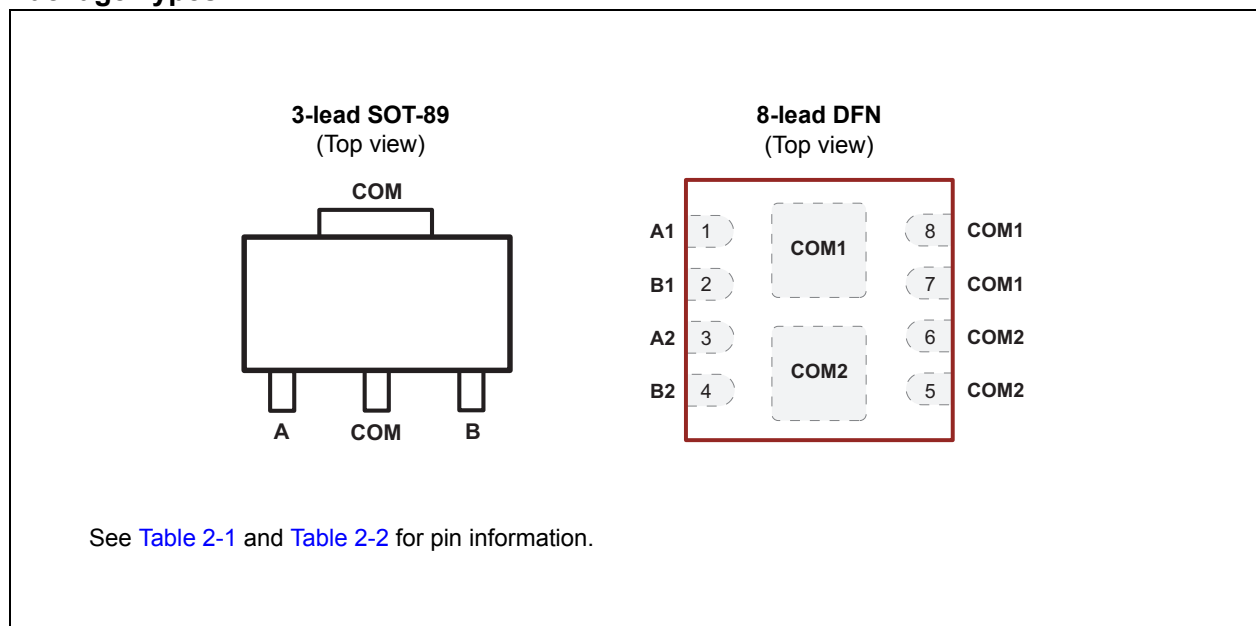
General Description

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 $\pm 2\text{V}$, the device turns off. In the OFF state, the MD0100 can withstand up to $\pm 100\text{V}$ across its terminals. A small amount of current (typically $200\ \mu\text{A}$) is allowed to flow through.

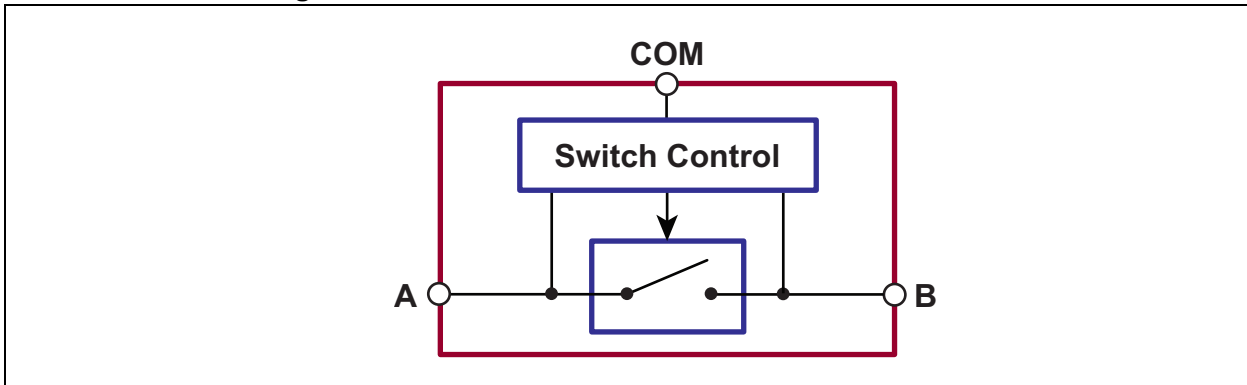
The applications for the MD0100 are not limited to just ultrasound. It can also be used as resettable fuses to protect power lines, output short-circuit protection and data acquisition. The MD0100 is available in an SOT-89 package as a single-channel device, as well as in a $4\ \text{mm} \times 4\ \text{mm}$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

Package Types

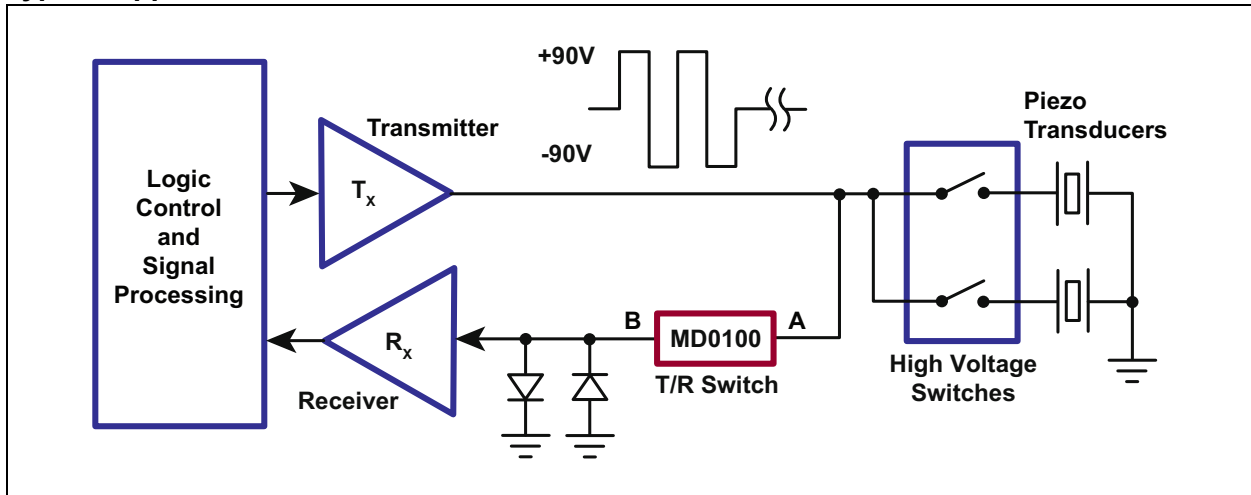


MD0100

Functional Block Diagram



Typical Application Circuit



MD0100

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: $T_J = 25^\circ\text{C}$ unless otherwise specified.						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Maximum Differential Input Voltage from A to B	V_{A-B}	± 100	—	—	V	$I_{A-B} = \pm 500 \mu\text{A}$
Switch-On Resistance from A to B	R_{SW}	—	15	—	Ω	$I_{A-B} = \pm 5 \text{ mA}$
V_{A-B} Trip Point to Turn Off	V_{TRIP}	—	± 1	± 2	V	
Switch Turn-Off Voltage	V_{OFF}	—	± 2	—	V	$I_{A-B} = \pm 1 \text{ mA}$
Switch-Off Current	$I_{A-B(OFF)}$	—	± 200	± 300	μA	$V_{A-B} = \pm 100\text{V}$

AC ELECTRICAL CHARACTERISTICS

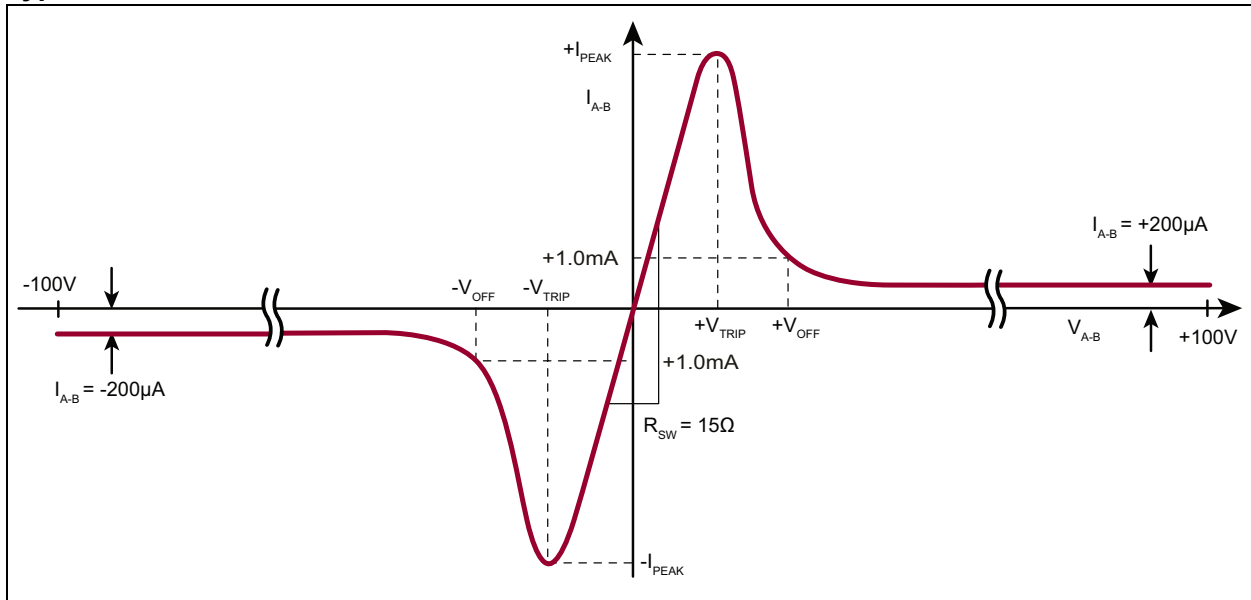
Electrical Specifications: $T_J = 25^\circ\text{C}$ unless otherwise specified.						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Peak Switching Current	I_{PEAK}	—	± 60	—	mA	See Figure 3-8.
Turn-Off Time	T_{OFF}	—	—	20	ns	See Figure 3-2, Figure 3-3 and Figure 3-4.
Turn-On Time	T_{ON}	—	—	20	ns	See 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	$V_{SW} = 25\text{V}$
Small Signal Bandwidth	BW	—	100	—	MHz	$R_{LOAD} = 50\Omega$

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

Typical I-V Characteristics



MD0100

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.

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 $\pm 2V$, 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 μA) 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 $\pm 2V$. 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 $\pm 2V$. As a result, the switch will remain in the ON position.

The other purpose of the diodes is to clamp voltage spikes to $\pm 0.7V$ 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 $\pm 2V$, the switch is ON and the R_{ON} is typically 15Ω . Once the voltage between Terminal A and Terminal B is greater than $\pm 2V$, 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 $C_{SW(ON)}$ 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 $C_{SW(OFF)}$.

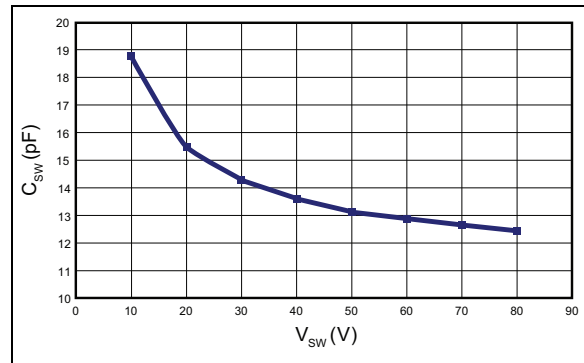


FIGURE 3-1: $C_{SW(OFF)}$ vs. V_{SW} .

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.

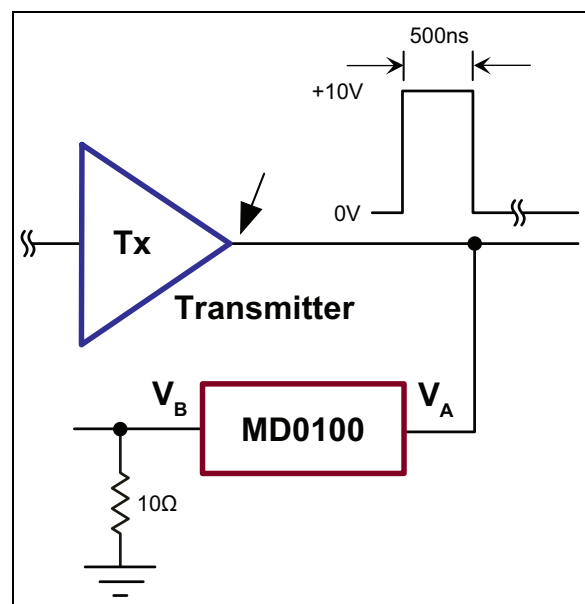


FIGURE 3-2: Test Setup for T_{OFF} .

MD0100

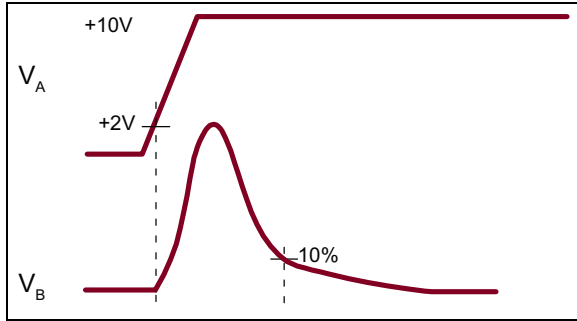


FIGURE 3-3: T_{OFF} Timing Diagram.

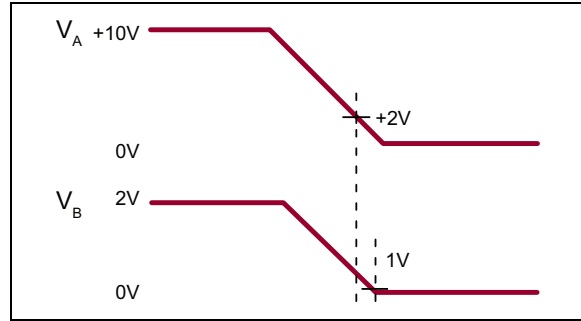


FIGURE 3-6: T_{ON} Timing Diagram.

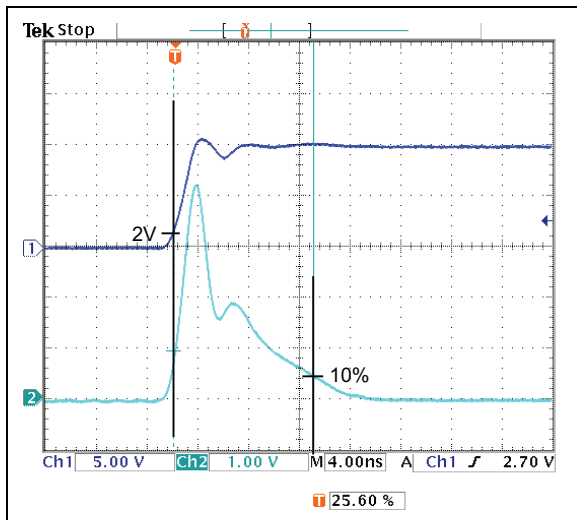


FIGURE 3-4: T_{OFF} at $V_A = 10V$.

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.

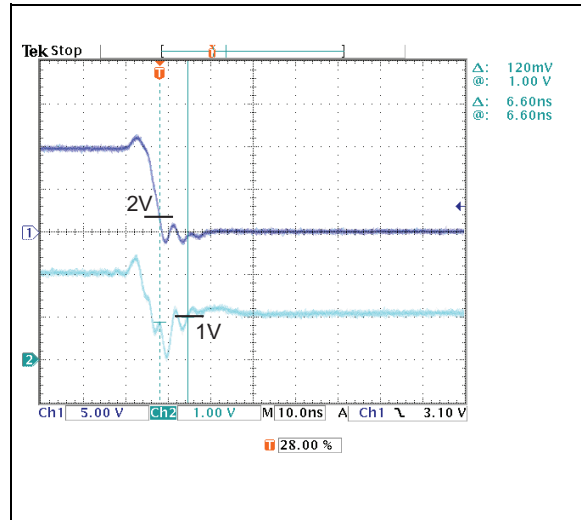


FIGURE 3-7: T_{ON} at $V_A = 10V$.

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.

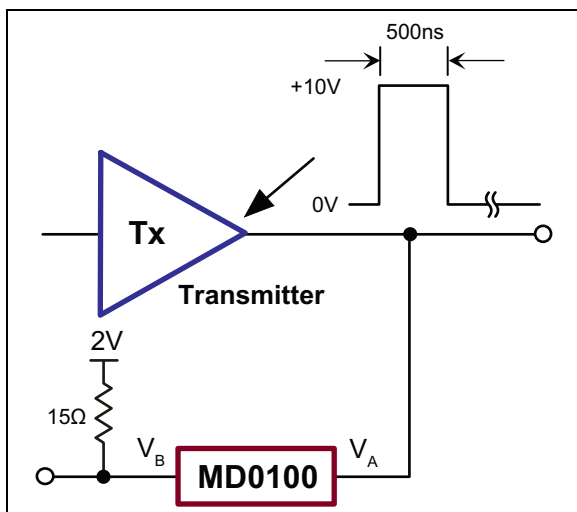


FIGURE 3-5: Test Setup for T_{ON} .

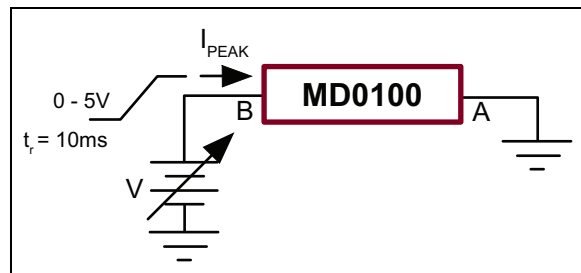


FIGURE 3-8: Test Setup for I_{PEAK} .

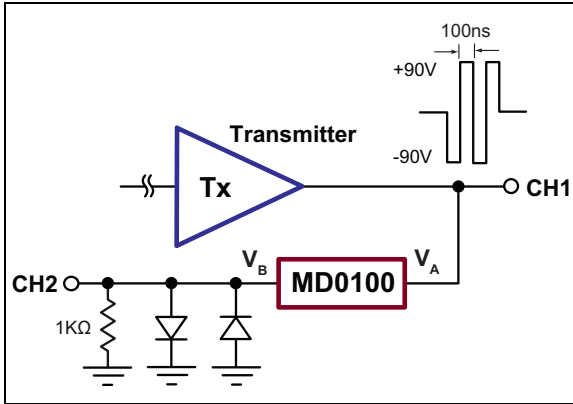


FIGURE 3-9: Test Setup for Waveforms in Figure 3-10 and Figure 3-11.

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.

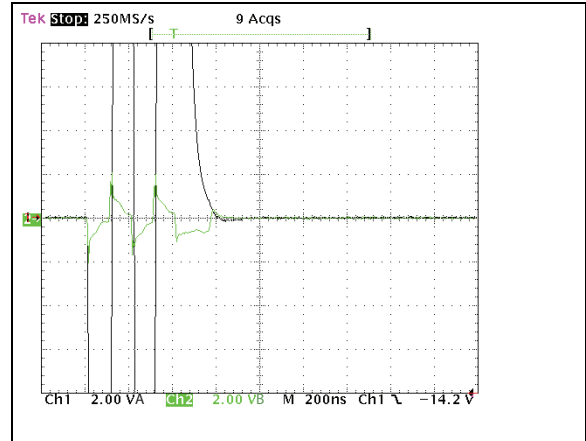


FIGURE 3-11: Typical Waveform B.

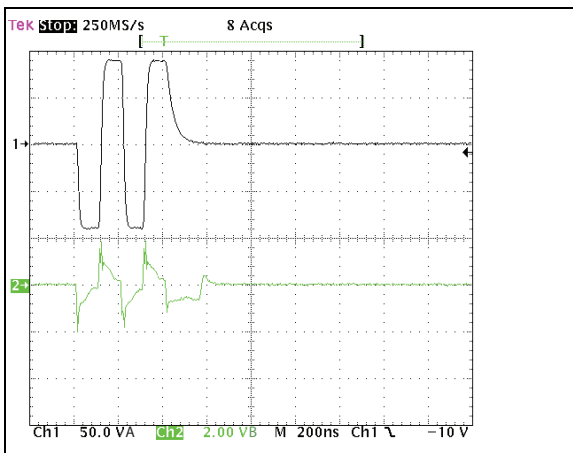


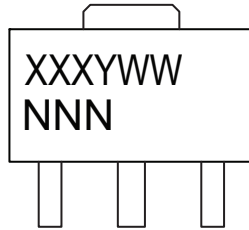
FIGURE 3-10: Typical Waveform A.

MD0100

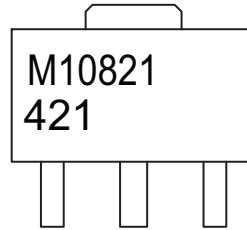
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

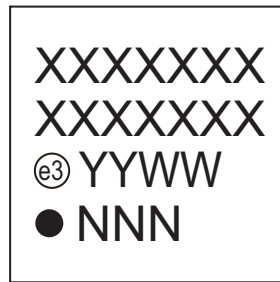
3-lead SOT-89



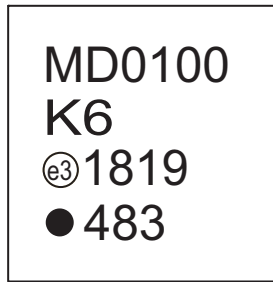
Example



8-lead DFN

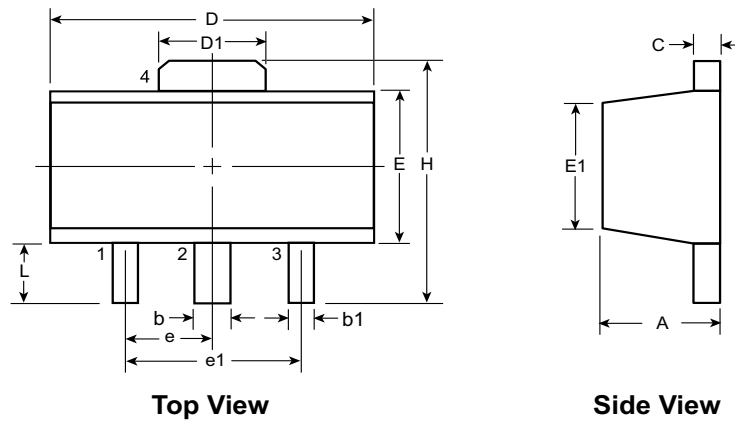


Example



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.	

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



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	

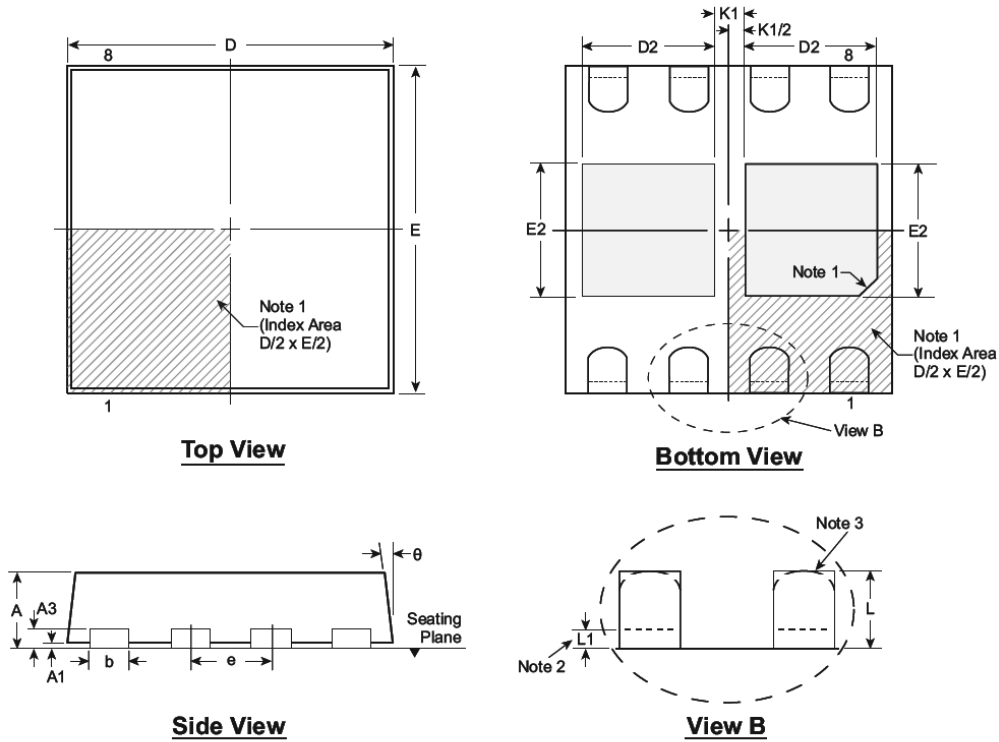
JEDEC Registration TO-243, Variation AA, Issue C, July 1986.

† This dimension differs from the JEDEC drawing

Drawings not to scale.

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

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

MD0100

PRODUCT IDENTIFICATION SYSTEM

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

<u>PART NO.</u>					
Device	XX Package Options	-	X Environmental	-	X 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

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.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

**QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
= ISO/TS 16949 =**

Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Helder, JukeBlox, KeeLoq, Klear, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntellIMOS, mTouch, Precision Edge, and Quiet-Wire are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, INICnet, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, memBrain, Mindi, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2018, Microchip Technology Incorporated, All Rights Reserved.
ISBN: 978-1-5224-3685-0



MICROCHIP

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
<http://www.microchip.com/support>
Web Address:
www.microchip.com

Atlanta

Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX

Tel: 512-257-3370

Boston

Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago

Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas

Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit

Novi, MI
Tel: 248-848-4000

Houston, TX

Tel: 281-894-5983

Indianapolis

Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles

Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC

Tel: 919-844-7510

New York, NY

Tel: 631-435-6000

San Jose, CA

Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto

Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733

China - Beijing
Tel: 86-10-8569-7000

China - Chengdu
Tel: 86-28-8665-5511

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

China - Nanjing
Tel: 86-25-8473-2460

China - Qingdao
Tel: 86-532-8502-7355

China - Shanghai
Tel: 86-21-3326-8000

China - Shenyang
Tel: 86-24-2334-2829

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

China - Wuhan
Tel: 86-27-5980-5300

China - Xian
Tel: 86-29-8833-7252

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444

India - New Delhi
Tel: 91-11-4160-8631

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880-3770

Korea - Daegu
Tel: 82-53-744-4301

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

Malaysia - Penang
Tel: 60-4-227-8870

Philippines - Manila
Tel: 63-2-634-9065

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

Thailand - Bangkok
Tel: 66-2-694-1351

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-67-3636

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820