High Voltage Protection T/R Switch with Clamp Diodes

Features

- Up to ±100V input voltage protection
- Low on resistance - 15Ω typical
- Integrated clamp diodes
- Fast switching speed
- Four electrically isolated channels
- No external supplies needed

Applications

- Medical ultrasound imaging
- NDT applications
- Fast resettable fuses
- High side switches
- Data acquisition

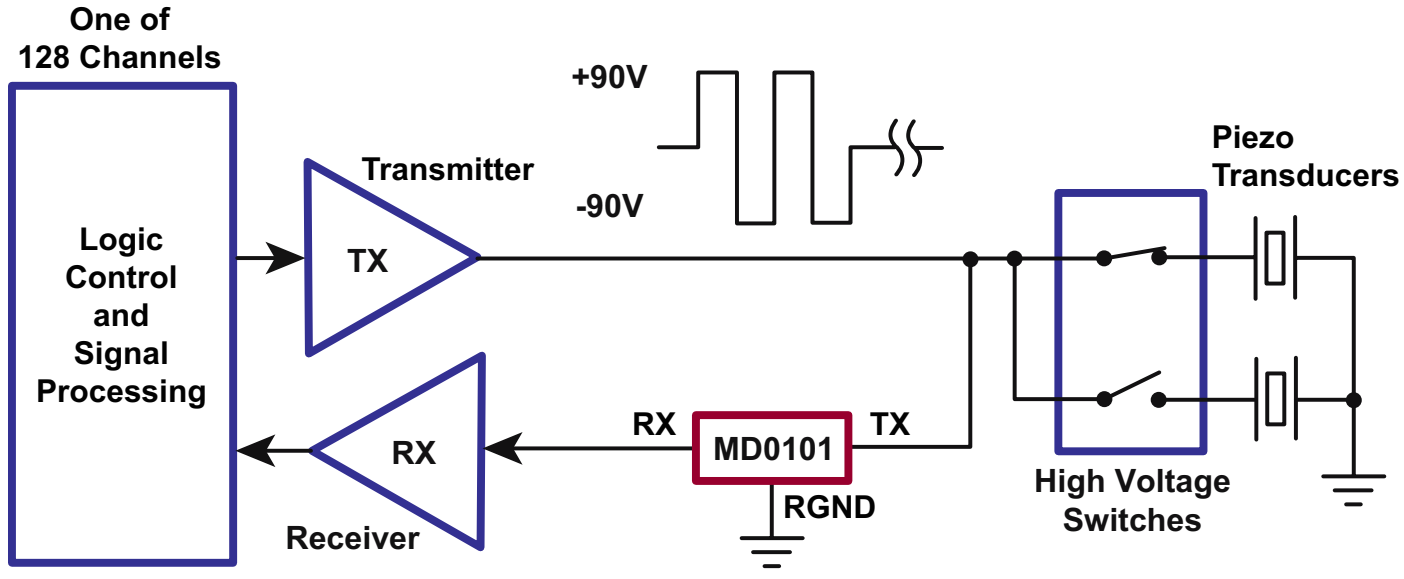
General Description

The Supertex MD0101 is a four channel, high voltage, current limiting protection device. It is designed to protect a low noise receiver from the high voltage transmit pulses in ultrasound applications and is commonly referred to as a T/R (transmit and receive) switch. Each channel has three terminals; Tx, Rx, and R_{GND}. The analog switch terminals are Tx and Rx. Rx has integrated clamping diodes to R_{GND} to protect the receiver against high voltages. Voltages greater than ±0.6V will start forward biasing the clamp diodes to R_{GND}.

The MD0101 can be considered as a normally closed switch with a typical switch resistance of 15Ω, allowing small signals to pass. Once the voltage drop across the switch exceeds a nominal value of ±1.0V, the device will start to turn off. In the off state, the MD0101 can withstand up to ±100V across its terminals. A small amount of current, 200µA, is allowed to flow through.

The MD0101 is not limited to just ultrasound applications. It can also be used for resettable fuses to protect power lines, output short circuit protection, and data acquisition. The MD0101 is available in an 18-Lead, 5x5mm DFN package as a four channel device for high density requirements.

Typical Application Circuit



Ordering Information

Part Number	Package	Packing
MD0101K6-G	18-Lead DFN (5x5)	490/Tray
MD0101K6-G M932	18-Lead DFN (5x5)	2500/Reel

-G denotes a lead (Pb)-free / RoHS compliant package

ESD Sensitive Device

Absolute Maximum Ratings[1]

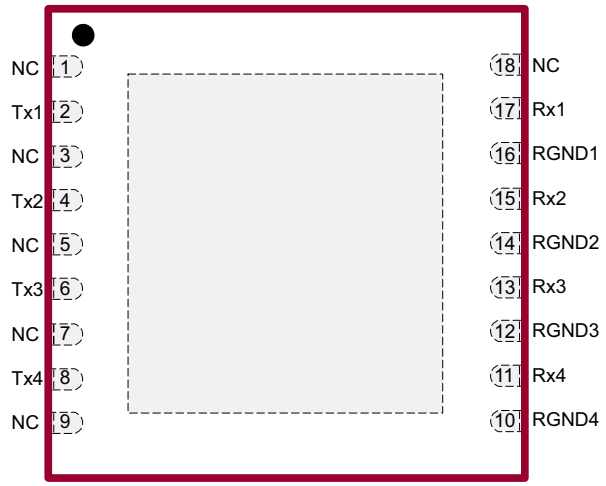
Parameter	Value
V_{TX} - V_{RX}, Differential voltage drop	0 to ±110V
Maximum junction temperature	+125°C
Storage temperature range	-65°C to 150°C
Power dissipation, 18-Lead DFN[2]	1.6W

1. *Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. Continuous operation of the device at the absolute rating level may affect device reliability. All voltages are referenced to device ground.*
2. *Mounted on FR4 board, 25mm x 25mm x 1.57mm*

Typical Thermal Resistance

Package	θ_{ja}
18-Lead DFN	30°C/W

Pin Configuration



18-Lead DFN
(top view)
(Pad is at bottom of device)

Product Marking

L = Lot Number
YY = Last Digit of Year Sealed
WW = Code for Week Sealed
A = Assembler ID
C = Country of Origin
= "Green" Packaging

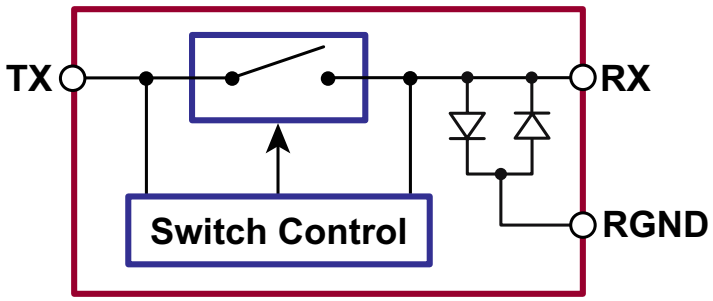
18-Lead DFN

Package may or may not include the following marks: Si or

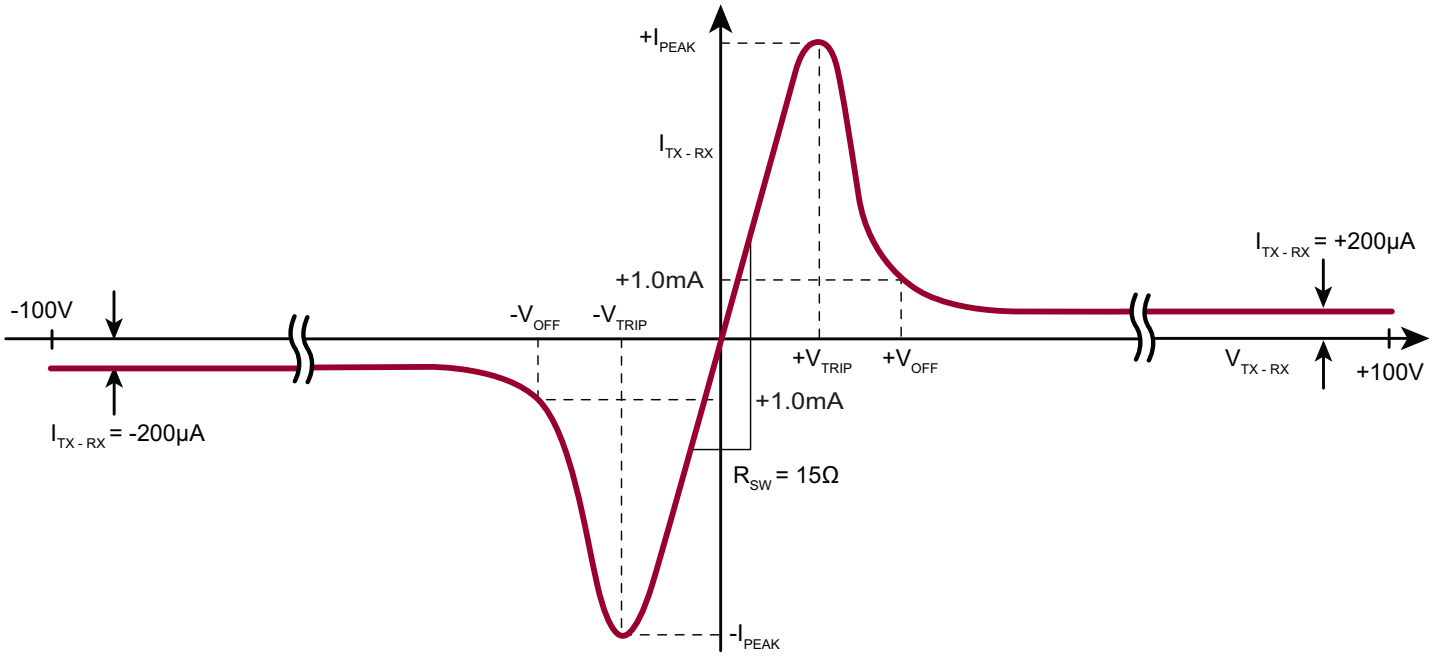
Electrical Characteristics *(T_a = 25ºC, unless otherwise specified)*

Sym	Parameter	Min	Typ	Max	Units	Conditions
V_{TX-RX}	Max. differential input voltage from TX to RX	±100	-	-	V	I_{TX-RX} = ±500µA
R_{SW}	Switch ON resistance from TX to RX	-	15	-	Ω	I_{TX-RX} = ±5.0mA
V_{TRIP}	$V_{TX - RX}$ trip point to turn off	-	±1.0	±2.0	V	---
V_{OFF}	Switch turn off voltage	-	±2.0	-	V	I_{TX-RX} = ±1.0mA
$I_{A-B(OFF)}$	Switch off current	-	±200	±300	µA	V_{TX-RX} = ±100V
I_{PEAK}	Peak switching current	-	±60	-	mA	---
T_{OFF}	Turn off time	-	-	20	ns	---
T_{ON}	Turn on time	-	-	20	ns	---
$C_{TX(ON)}$	Switch ON capacitance from TX to RX	-	15	-	pF	SW = ON
$C_{TX(OFF)}$	Switch OFF capacitance from TX to RX	-	9.0	-	pF	V_{TX-RX} = 25V
BW	Small signal bandwidth	-	100	-	MHz	R_{LOAD} = 50Ω
T_J	Operating junction temperature	-40	-	+125	°C	---
V_{RX}	Diode forward voltage drop	-	±1.6	-	V	I_{RX} = ±200mA, RGND = 0V, TX = Open
C_D	RX capacitance to RGND	-	20	-	pF	RGND = 0V, TX = Open

Block Diagram



Typical I-V Characteristics



Functional Description

The Supertex MD0101 can be considered a normally closed switch, controlled by a switch control (please refer to the block diagram). The switch control monitors the voltage drop across terminals TX and RX. If the voltage difference is greater than ±1.0V, the T/R switch will start to open. Once in the open state, there is a small amount of current flowing through the T/R switch, 200µA, to detect if the high voltage is still present or not. The T/R switch will not close until the voltage across terminals TX and RX drops below ±2.0V. Connecting the RGND to ground will allow the initial peak current, about 60mA, to flow through the switch then to the clamp diodes to RGND. The clamp diode I-V Curve is shown in Figure 8. If external diodes are desired, the RGND pin can be connected to the corresponding RX pin or left floating. The external diodes can then be connected to RX to ground.

The MD0101 does not require a power supply. There are only three pins per channel; one connects to the transmitter side, one connects to the receiver side, and the other one is the ground connection for diodes.

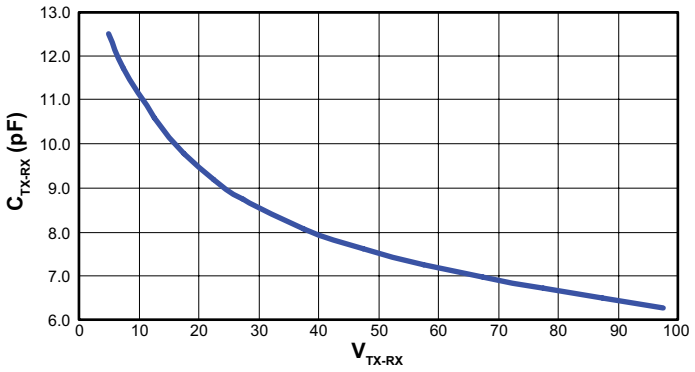
On Resistance

When the voltage across terminals TX and RX is below ±1.0V, the switch is in the receive mode, and the R_{ON} is typically 15Ω. Once the voltage across the terminals TX and RX is greater than ±2.0V, the switch is in the transmit mode and blocks the high voltage pulses from passing through to the receiver and damaging it.

Switch Capacitance

The typical switch ON capacitance, $C_{SW(ON)}$, is 21pF. This is measured from TX to RX when the switch is ON. The switch OFF capacitance is a function of the voltage across the T/R switch. The $C_{TX(OFF)}$ is about 11 - 6.5pF for 10 - 90V of the transmit voltage. Please see Figure 1 for the C-V curve of the $C_{TX(OFF)}$.

Figure 1: C_{TX-RX} vs V_{TX-RX}



T_{ON} and T_{OFF} Time

The T_{ON} and T_{OFF} of the MD0101 are less than 20ns, which provide a fast switch between the transmit mode and the receive mode. The T_{ON} and T_{OFF} are input rise/fall time dependent. The T/R switch turns ON and OFF faster when the rise and fall times of the transmit pulse are faster. On the other hand, the switch turns ON and OFF slower if the rise and fall times of the transmit pulse are slower. The T_{OFF} and T_{ON} set ups are shown in Figure 2 and Figure 5 respectively.

Figure 2: Test set up for T_{OFF}

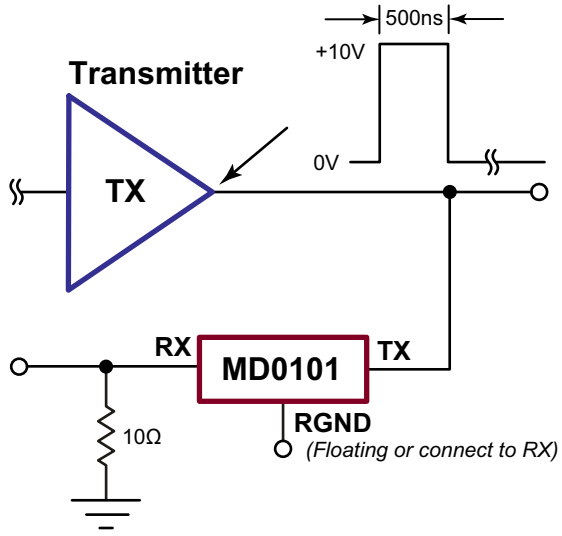


Figure 3: T_{OFF} Timing Diagram

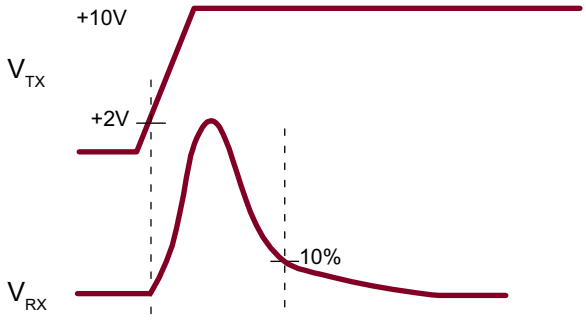


Figure 4: T_{OFF} at V_{TX} = 10V

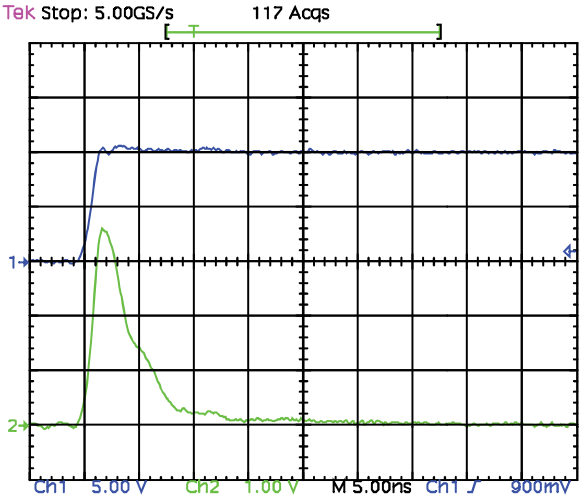


Figure 4 shows the actual waveform and measurement of the T_{OFF}. The T_{OFF} is measured from 2.0V of the V_{TX} to 10% of the V_{RX}.

Figure 5: Test set up for T_{ON}

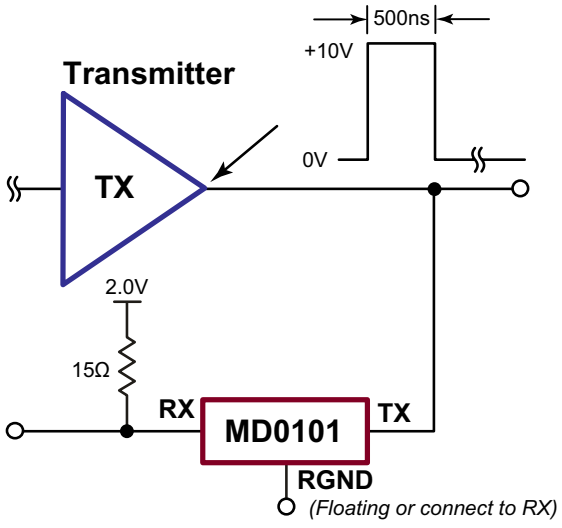


Figure 6: T_{ON} Timing Diagram

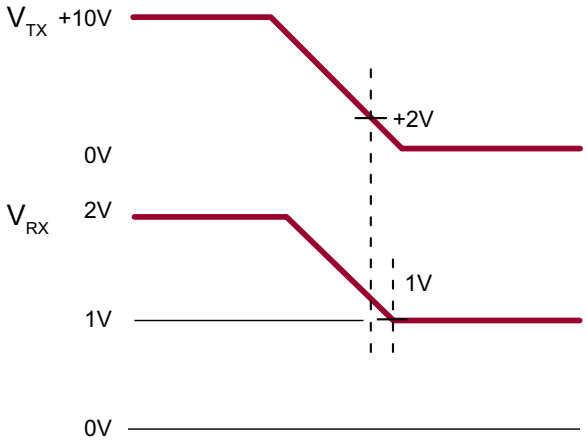


Figure 7: T_{ON} at V_{TX} = 10V

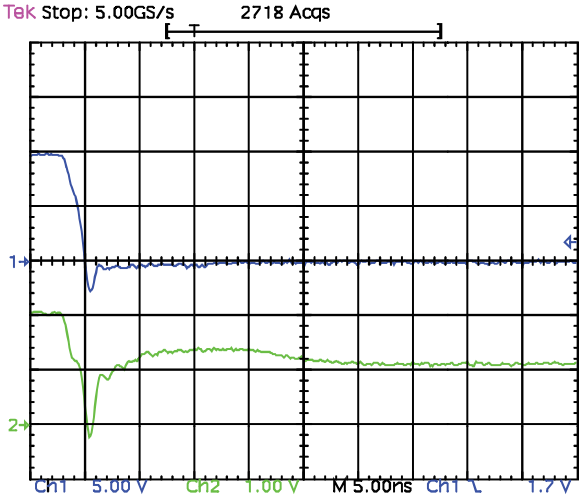
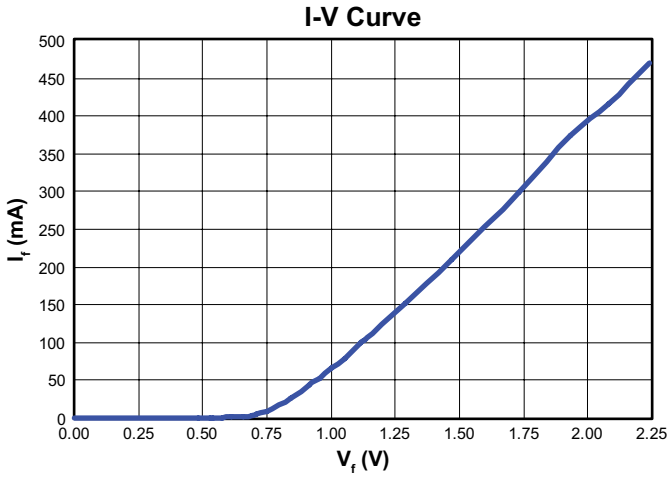


Figure 7 shows the actual waveform and measurement of the T_{ON}. The T_{ON} is measured from 2.0V of the V_{TX} to 1.0V of the V_{RX}.

Figure 8: RX Clamp Diodes to RGND

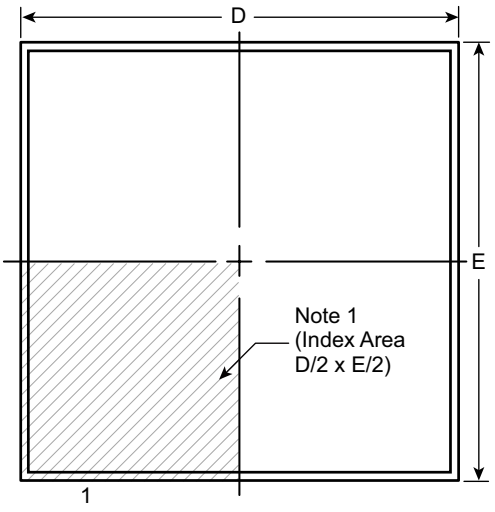


Pin Description

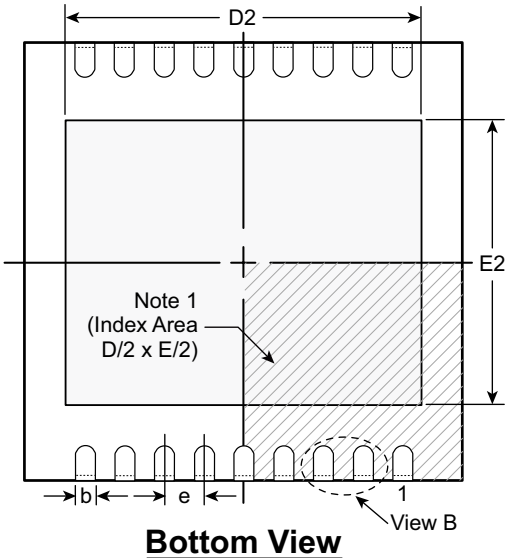
Pad	Name	Description
1	NC	No internal connection
2	TX1	Transmitter side of transmit/receive switch 1
3	NC	No internal connection
4	TX2	Transmitter side of transmit/receive switch 2
5	NC	No internal connection
6	TX3	Transmitter side of transmit/receive switch 3
7	NC	No internal connection
8	TX4	Transmitter side of transmit/receive switch 4
9	NC	No internal connection
10	RGND4	Clamp diode ground for transmit/receive switch 4
11	RX4	Receiver side for transmit/receive switch 4
12	RGND3	Clamp diode ground for transmit/receive switch 3
13	RX3	Receiver side for transmit/receive switch 3
14	RGND2	Clamp diode ground for transmit/receive switch 2
15	RX2	Receiver side for transmit/receive switch 2
16	RGND1	Clamp diode ground for transmit/receive switch 1
17	RX1	Receiver side for transmit/receive switch 1
18	NC	No internal connection
Center Tab	---	Connect to ground

18-Lead DFN Package Outline (K6)

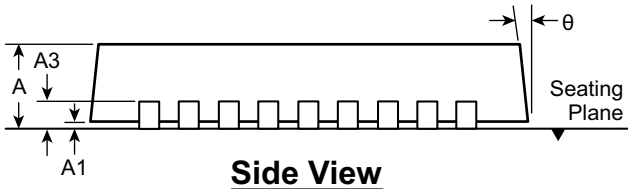
5.00x5.00mm body, 1.00mm height (max), 0.50mm pitch



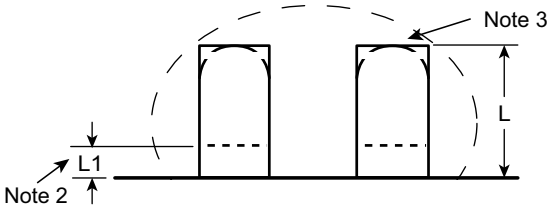
Top View



Bottom View



Side View



View B

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	L	L1	θ
Dimension (mm)	MIN	0.80	0.00	0.20 REF	0.18	4.85*	4.20†	4.85*	3.50†	0.50 BSC	0.30†	0.00*	0°
	NOM	0.90	0.02		0.25	5.00	4.35†	5.00	3.65†		0.40†	-	-
	MAX	1.00	0.05		0.30	5.15*	4.45†	5.15*	3.75†		0.50†	0.15	14°

JEDEC Registration MO-229, Variation VJJD-2, Issue C, Aug 2003.
** This dimension is not specified in the JEDEC drawing.*
† This dimension differs from the JEDEC drawing.
Drawings not to scale.
***Supertex Doc. #:** DSPD-18DFNK65X5P050, Version A013111.*

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to http://www.supertex.com/packaging.html.)

Supertex inc.
1235 Bordeaux Drive, Sunnyvale, CA 94089
Tel: 408-222-8888
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