

## Dual High-Side Switch 40 mΩ

The 33289 is a Dual High Side Switch (DHSS) dedicated for use in automotive applications. It is designed to drive typical inductive loads such as solenoid valves.

This device consists of two independent 40 mΩ  $R_{DS(ON)}$  MOSFET channels plus corresponding control circuitry in a surface mount package. The 33289 can be interfaced directly to a microcontroller for input control and monitoring of diagnostic output.

Each switch offers independent protection and diagnosis during overcurrent, overvoltage, and undervoltage conditions, as well as an overtemperature shutdown feature.

A logic low on the Open Load Detect Enable pin (OLDE) minimizes bias current drain by disabling the open load circuitry current source. The device also has a very low quiescent current in standby mode.

### FEATURES

- Designed to drive Automotive Inductive loads
- Operating Voltage Range from 6.0 V to 27 V
- Maximum Breakdown Voltage greater than 40 V
- 40 mΩ  $R_{DS(ON)}$  at 25°C
- Overtemperature Protection with Hysteresis
- Overcurrent protection
- Under Voltage Shutdown
- Over Voltage Shutdown
- Open Load Detection in Off-State
- Independent Diagnostic Output
- ESD Protection 2.0 kV
- Standby Current less than 5.0 μA at  $V_{BAT}$  below 14 V

**33289**

**DUAL HIGH-SIDE SWITCH**



**DW SUFFIX)  
98ASB42343B  
20-PIN SOICW**

### ORDERING INFORMATION

Device	Temperature Range ( $T_A$ )	Package
MC33289DW/R2	-40°C to 125°C	20 SOICW

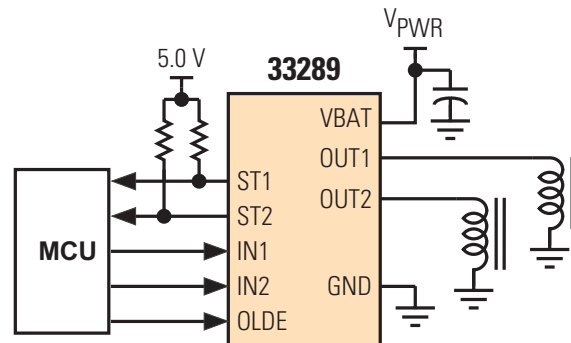
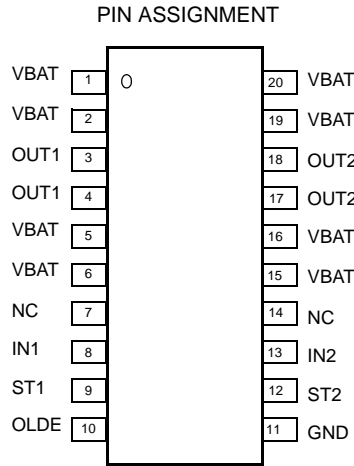


Figure 1. 33289 Simplified Application Diagram

\* This document contains certain information on a new product. Specifications and information herein are subject to change without notice.

## PIN CONNECTIONS



**Figure 2. 33289 Pin Connections**

**Table 1. Pin Function Description**

Pin Number	Pin Name	Pin Function	Definition
1, 2, 5, 6, 15, 16, 19, 20	VBAT	Supply Voltage	These are the power supply pins of the device. These pins are directly connected with the lead frame of the package and are tied to the drain of the switching MOSFET. These pins can be directly connected to the battery voltage. In addition to their supply function, these pins participate to the thermal behavior of the device in conducting the heat from the switching MOSFET to the printed circuit board.
3, 4, 18, 17	OUT1 OUT2	OUTPUT Channel 1 OUTPUT Channel 2	Pins 3 and 4 are the output 1 pins. Pins 17 and 18 are the output 2 pins. They are directly connected to the source of the power MOSFET. These pins are used by the control circuitry to sense the device output voltage. The $R_{DS(on)}$ is 40 mΩ max per output at 25°C and will increase to a maximum of 75 mΩ at 150°C junction temperature.
8, 13	IN1 IN2	INPUT Channel 1 INPUT Channel 2	These are the device input pins which directly control their associated outputs. The levels are CMOS compatible. When the input is a logic low, the associated output MOSFET is in the off state. When input is high, the MOSFET is turned on and the load is activated.  When both inputs are low, the device is in standby mode and its supply current is reduced. Each input pin has an internal active pull down, so that it will not float if disconnected.
9, 12	ST1 ST2	Status for Channel 1 Status for Channel 2	These pins are the channel 1 and channel 2 fault detection flags. Their internal structure is an open drain architecture with an internal clamp at 6.0 V. An external pull up resistor connected to $V_{DD}$ (5.0 V) is needed. This is an active low output. If the device is in its normal condition the status lines will be high. If open load or other fault occurs, the associated channel status flag will be pulled low. See Functional Truth Table.
10	OLDE	Open Load Detection Enable	This pin is a digital input which enables the open load current diagnostic circuitry. When OLDE is a logic low, the open load circuitry is not powered and the device's bias current draw is at a minimum. If OLDE is a logic high, the open load circuitry is functional at the price of a higher bias current draw. OLDE pin has a pull down resistor.
11	GND	GROUND	This is the GND pin of the device.

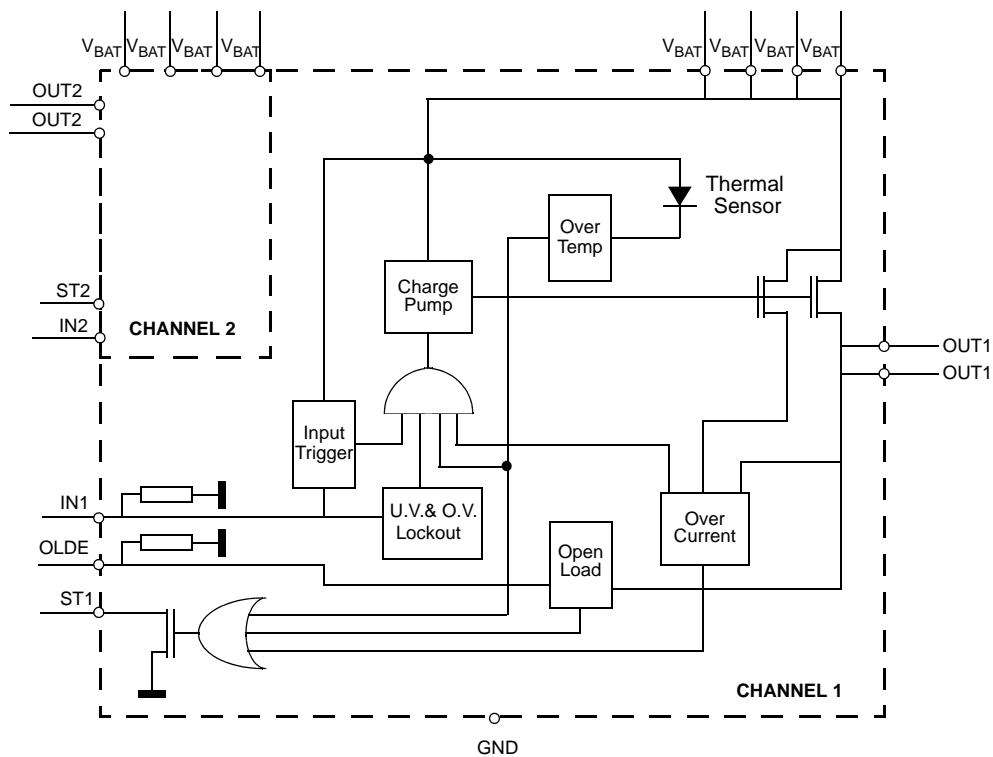


Figure 3. Simplified Internal Block Diagram

## ELECTRICAL CHARACTERISTICS

### MAXIMUM RATINGS

**Table 2. Maximum Ratings**

All voltages are with respect to ground unless otherwise noted. Exceeding these ratings may cause a malfunction or permanent damage to the device.

Ratings	Symbol	Value	Unit
<b>ELECTRICAL RATINGS</b>			
V <sub>BAT</sub> and V <sub>BATC</sub> Voltage: Continuous/Pulse	V <sub>BAT</sub>	-0.3 to 41	V
OUT1, OUT2 Voltage with Respect to GND: Continuous/Pulse	V <sub>OUT</sub>	-4.0 to 41	V
OUT1, OUT2 to V <sub>BTAP</sub> Voltage: Continuous	V <sub>OUT</sub>	41	V
ST1, ST2 Voltage: Continuous/Pulse	V <sub>ST</sub>	-0.3 to 7.0	V
IN1, IN2 Voltage: Continuous	V <sub>IN</sub>	-0.3 to 7.0	V
IN1, IN2, ST1, ST2, OLDE Current	I <sub>IN</sub>	+/-4.0	mA
ESD all Pins			
Human Body Model <sup>(1)</sup>	V <sub>ESD1</sub>	+/-2000	V
Machine Model <sup>(1)</sup>	V <sub>ESD2</sub>	+/-200	V
<b>THERMAL RATINGS</b>			
Operating Junction Temperature	T <sub>J</sub>	-40 to 150	°C
Storage Temperature	T <sub>ST</sub>	-55 to 150	°C
Thermal Resistance Junction to Ambient <sup>(2)</sup>	R <sub>THJA</sub>	70	°C/W
Thermal Resistance Junction to lead: Both Channel on	R <sub>THJL1</sub>	15	°C/W
Thermal Resistance Junction to lead: One Channel on	R <sub>THJL2</sub>	15	°C/W
Thermal Resistance Junction to lead: Logic Die	R <sub>THJL3</sub>	30	°C/W

Notes

- EDS1 testing is performed in accordance with the Human Body Model (Czap = 100 pF, Rzap = 1500 Ω) EDS2 testing is performed in accordance with the Machine Model (Czap = 100 pF, Rzap = 0 Ω)
- With minimum PCB dimensions.

**STATIC ELECTRICAL CHARACTERISTICS**

**Table 3. Static Electrical Characteristics**

Characteristics noted under conditions  $7.0\text{ V} \leq V_{\text{SUP}} \leq 18\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ ,  $\text{GND} = 0\text{ V}$  unless otherwise noted. Typical values noted reflect the approximate parameter means at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
<b>POWER INPUT</b>					
Operating Voltage	$V_{\text{BAT}}$	6.0		$V_{\text{OV}}$	V
Supply Current: Both Channels On $V_{\text{BAT}} = 13.5\text{ V}$ ; OLDE High	$I_{\text{BAT1}}$		6.0	16	mA
Supply Current: One Channel On $V_{\text{BAT}} = 13.5\text{ V}$ ; OLDE High	$I_{\text{BAT2}}$		5.0	10	mA
Supply Current: Both Channels Off $V_{\text{BAT}} = 12.6\text{ V}$ ; OLDE Low, $T_J < 125^\circ\text{C}$	$I_{\text{BAT3}}$			5.0	$\mu\text{A}$
Supply Current: Any State $V_{\text{BAT}} = 13.5\text{ V}$	$I_{\text{BAT\_MAX}}$			30	mA
Output Off state leakage current per channel $V_{\text{BAT}} = 13.5\text{ V}$ ; IN1, 2, OLDE low, Both output grounded, $T_J < 125^\circ\text{C}$	$I_{\text{DSS}}$		0.1	5.0	$\mu\text{A}$
Drain-Source On Resistance $V_{\text{BAT}} > 10\text{ V}$ , $T_{\text{AMB}} = 25^\circ\text{C}$	$R_{\text{DSON1}}$			40	m $\Omega$
Drain-Source On Resistance $V_{\text{BAT}} > 10\text{ V}$ , $T_{\text{AMB}} = 150^\circ\text{C}$	$R_{\text{DSON2}}$			75	m $\Omega$
Negative Inductive Clamp Voltage $I_{\text{OUT}} = 1\text{ A}$	$V_{\text{CLAMP}}$	-4.0		-1.0	V

**INPUT CHARACTERISTICS**

High Input Voltage (IN1, IN2)	$V_{\text{IH}}$	3.25			V
High Input Voltage (OLDE)	$V_{\text{OLDEH}}$	3.5			V
Low Input Voltage (IN1, IN2, OLDE)	$V_{\text{IL}}$			1.5	V
Logic Input Hysteresis IN1, IN2	$V_{\text{HYST}}$	0.4	0.6	0.8	V
Logic Input Current $V_{\text{IN}} = 1.5\text{ V}$	$I_{\text{IN}}$	3.0			$\mu\text{A}$
Logic Input Current $V_{\text{IN}} = 3.25\text{ V}$	$I_{\text{IN}}$			32.5	$\mu\text{A}$
Logic Input Clamp Voltage At $I_{\text{IN}} = 1\text{ mA}$	$V_{\text{CLMP}}$	5.5		7.0	V
Input Capacitance IN1, IN2 $R_{\text{IN}} = 47\text{ k}\Omega$ @ $100\text{ kHz}$	$C_{\text{IN}}$			80	pF

**STATUS CHARACTERISTICS**

Status Voltage $I_{\text{ST}} = 1\text{ mA}$ ; Output in fault	$V_{\text{ST}}$			0.5	V
Status Leakage Current $V_{\text{ST}} = 5\text{ V}$	$I_{\text{STLK}}$			10	$\mu\text{A}$

**Table 3. Static Electrical Characteristics**

Characteristics noted under conditions  $7.0\text{ V} \leq V_{\text{SUP}} \leq 18\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ ,  $\text{GND} = 0\text{ V}$  unless otherwise noted. Typical values noted reflect the approximate parameter means at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
Status Pin Capacitance $V_{\text{ST}} = 5\text{ V}$	$C_{\text{ST}}$			80	pF

**OVERLOAD PROTECTION CHARACTERISTICS**

Overcurrent latchoff threshold $V_{\text{BAT}} = 13.5\text{ V}$	$I_{\text{OCT}}$	4.0		9.0	A
Thermal Shutdown	$T_{\text{SHUT}}$	150	165	175	$^\circ\text{C}$
Thermal Shutdown Hysteresis	$T_{\text{HYST}}$			10	$^\circ\text{C}$
Overvoltage Shutdown Threshold Both IN1, IN2 logic high	$V_{\text{OV}}$	27		38	V
Overvoltage Shutdown Hysteresis Both IN1, IN2 logic high	$V_{\text{OVHYST}}$	0.1		2.0	V
Undervoltage Shutdown Threshold Both IN1, IN2 logic high	$V_{\text{UV}}$	4.75		6.0	V
Undervoltage Shutdown Hysteresis Both IN1, IN2 logic high	$V_{\text{UVHYST}}$	0.3	0.6	1.0	V

**OPEN CIRCUIT DETECTION CHARACTERISTICS**

Open Load Detect Current $V_{\text{OUT}} = 3.5\text{ V}$ , $\text{OLDE} = 4.0\text{ V}$	$I_{\text{OL}}$	200	290	400	$\mu\text{A}$
Open Load Threshold Voltage	$V_{\text{OL}}$	1.5	2.4	3.5	V
Openload threshold voltage	$V_{\text{INOL}}$	1.5	2.5	3.5	V

**DYNAMIC ELECTRICAL CHARACTERISTICS**

**Table 4. Dynamic Electrical Characteristics**

Characteristics noted under conditions  $7.0\text{ V} \leq V_{\text{SUP}} \leq 18\text{ V}$ ,  $-40^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ ,  $\text{GND} = 0\text{ V}$  unless otherwise noted. Typical values noted reflect the approximate parameter means at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Description	Symbol	Min	Typ	Max	Unit
<b>OVERLOAD PROTECTION CHARACTERISTICS</b>					
Overcurrent latchoff delay From OverCurrent Treshold achieved to Output Voltage = 10% $V_{\text{BAT}}$	$T_{\text{OCTDLY}}$			30	$\mu\text{s}$
Overcurrent latchoff status delay From Output Voltage = 10% $V_{\text{BAT}}$ to Status Flag <1 V	$T_{\text{OCTSTDLY}}$			50	$\mu\text{s}$
<b>OPEN CIRCUIT DETECTION CHARACTERISTICS</b>					
Open Load to Status Low Delay Time From $I_N = 1.5$ to Status Flag <1.5 V	$T_{\text{OLSTDY}}$			100	$\mu\text{s}$
Open Load Detect BlankingTime From $I_N = 1.5$ to Openload circuitry enable	$T_{\text{OLDBT}}$	3.0	10	50	$\mu\text{s}$
<b>SWITCHING CHARACTERISTICS <sup>(3)</sup></b>					
Turn-on Slew Rate From 10% to $V_{\text{BAT}} - 3.0\text{ V}$	$S_{\text{RPOUT1}}$	1.0		20	$\text{V}/\mu\text{s}$
Turn-on Slew Rate From $V_{\text{BAT}} - 3.0\text{ V}$ to 90%	$S_{\text{RPOUT2}}$	0.1		3.0	$\text{V}/\mu\text{s}$
Turn-off Slew Rate From 90% to 10%	$S_{\text{RNOUT}}$	1.0		20	$\text{V}/\mu\text{s}$
Turn-on Delay Time From $V_{\text{IN}}/2$ to 10% $V_{\text{BAT}}$	$t_{\text{DON}}$	1.0	2.5	15	$\mu\text{s}$
Turn-off Delay Time From $V_{\text{IN}}/2$ to 90% $V_{\text{BAT}}$	$t_{\text{DOFF}}$	1.0	5.0	15	$\mu\text{s}$
Notes					
3. $8\text{ V} < V_{\text{BAT}} < 18\text{ V}$ , $R_{\text{LOAD}} = 7\ \Omega$					

## TYPICAL APPLICATIONS

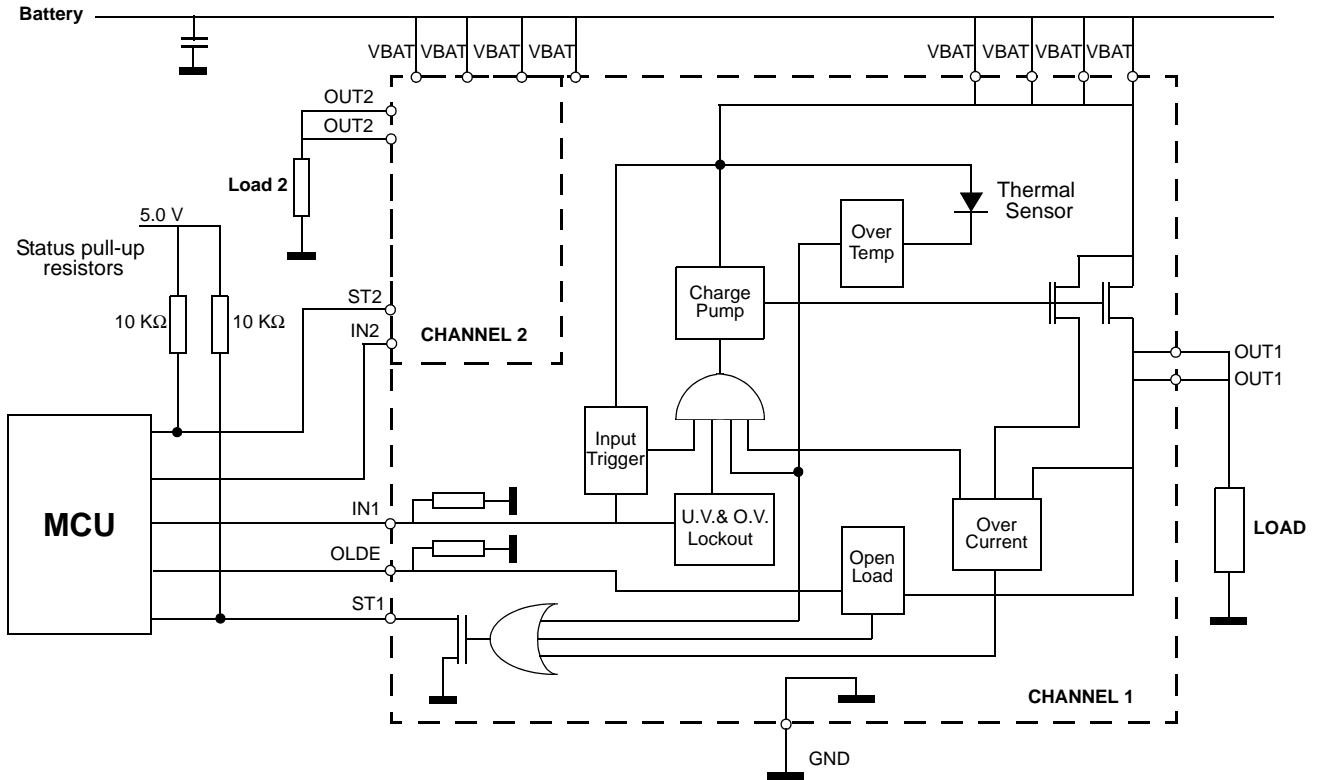


Figure 4. MC33289 Typical Application

Table 5. Functional Truth Table

Conditions	IN1	IN2	OUT1	OUT2	ST1	ST2
Normal Operating Conditions	L	L	L	L	H	H
	H	L	H	L	H	H
	L	H	L	H	H	H
	H	H	H	H	H	H
Overtemperature Channel 1	H	X	L	X	L	H
Overtemperature Channel 2	X	H	X	L	H	L
Overtemperature Channel 1/Channel 2	H	H	L	L	L	L
Open Load Channel 1	L	X	H	X	L	H
Open Load Channel 2	X	L	X	H	H	L
Overcurrent Channel 1	H	X	L	X	L	H
Overcurrent Channel 2	X	H	X	L	H	L
Undervoltage Condition	X	X	L	L	H	H
Overvoltage Condition	X	X	L	L	H	H

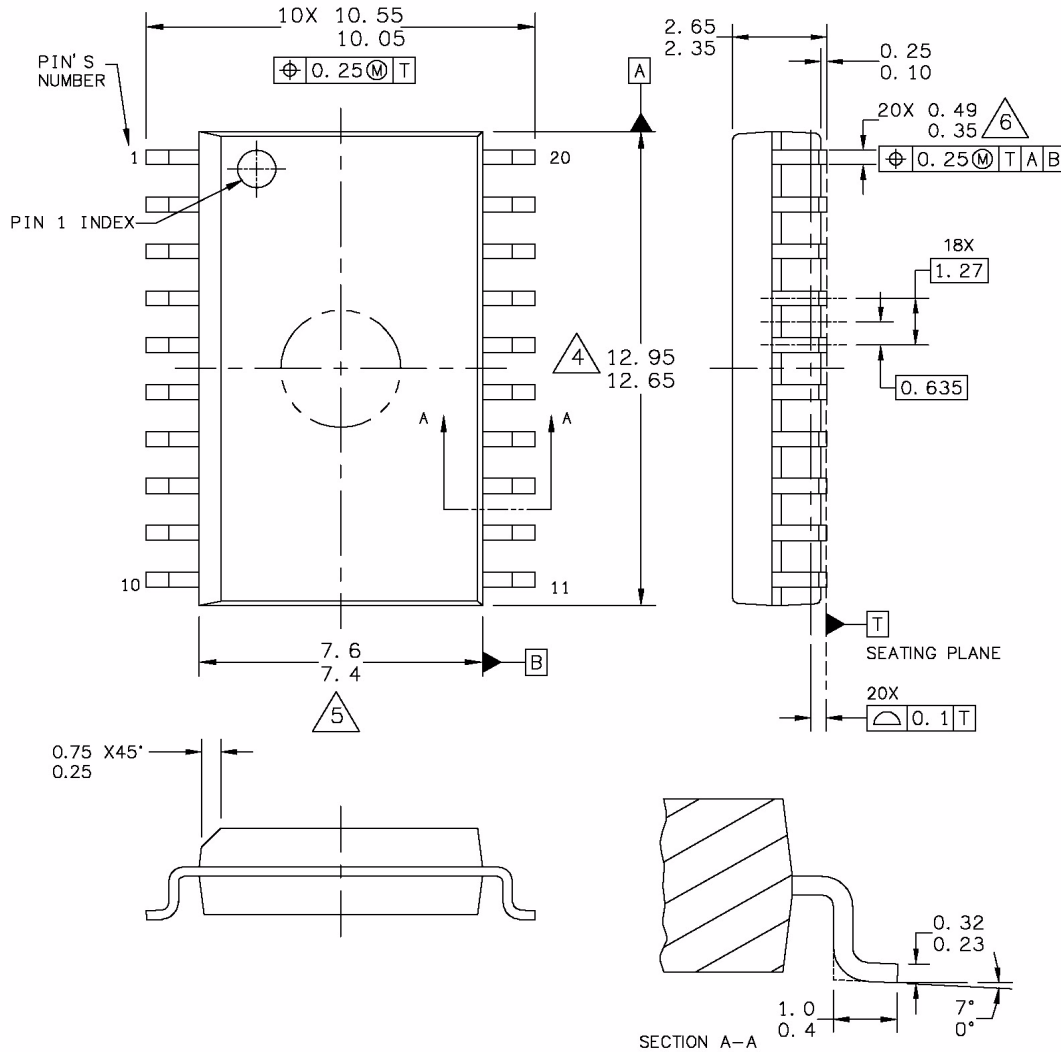
L = 'Low level'; H = 'High level'; X = 'don't care'



# PACKAGING

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**DW SUFFIX**  
20-PIN  
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98ASB42343B  
ISSUE J

## REVISION HISTORY

REVISION	DATE	DESCRIPTION OF CHANGES
4.0	6/2006	<ul style="list-style-type: none"><li>• Implemented Revision History page</li><li>• Converted to Freescale format</li><li>• Updated to the prevailing form and style</li></ul>

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