MOTOROLA
Semiconductor Technical Data

Order Number: MC33286/D
Rev. 5.4, 06/2001

MC33286

AUTOMOTIVE DUAL HIGH SIDE DRIVER

SEMICONDUCTOR TECHNICAL DATA



DW SUFFIX
SO20WB Package
CASE 751D-05

Advance Information

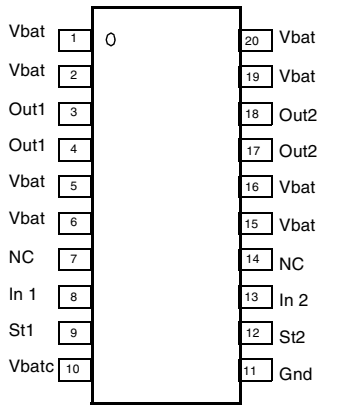
Automotive Dual High Side Driver

This device is a dual high side power switch dedicated for automoive applications. In comparison with mechanical relays, this device offers higher reliability as well as protection and diagnostic features.

The device consists of two independent 35mΩ Rdson switches in a surface mount package. It can be directly interfaced with a microcontroller for control and diagnostic functions. The device is fully protected against overcurrents, short-circuits and incorporates an overtemperature shutdown. It can be directly and continuously supplied by the battery and offers a very low quiescent current in standby mode.

- Designed for Automotive Applications
- Junction Temperature Range from -40°C to 150°C
- Operating Voltage Range from 8V to 40V
- Maximum Breakdown Voltage greater than 40V
- Surface Mount Package
- 35mΩ Rdson at 25°C
- Overtemperature Protection with Hysteresis
- Under Voltage Shutdown
- Reverse Battery protected
- Open Load Detection in On-State
- Diagnostic Output
- ESD Protection 2kV
- Current Limitation at 30A
- Loss of ground protected
- Standby Current less than 10μA at Vbat = 14V

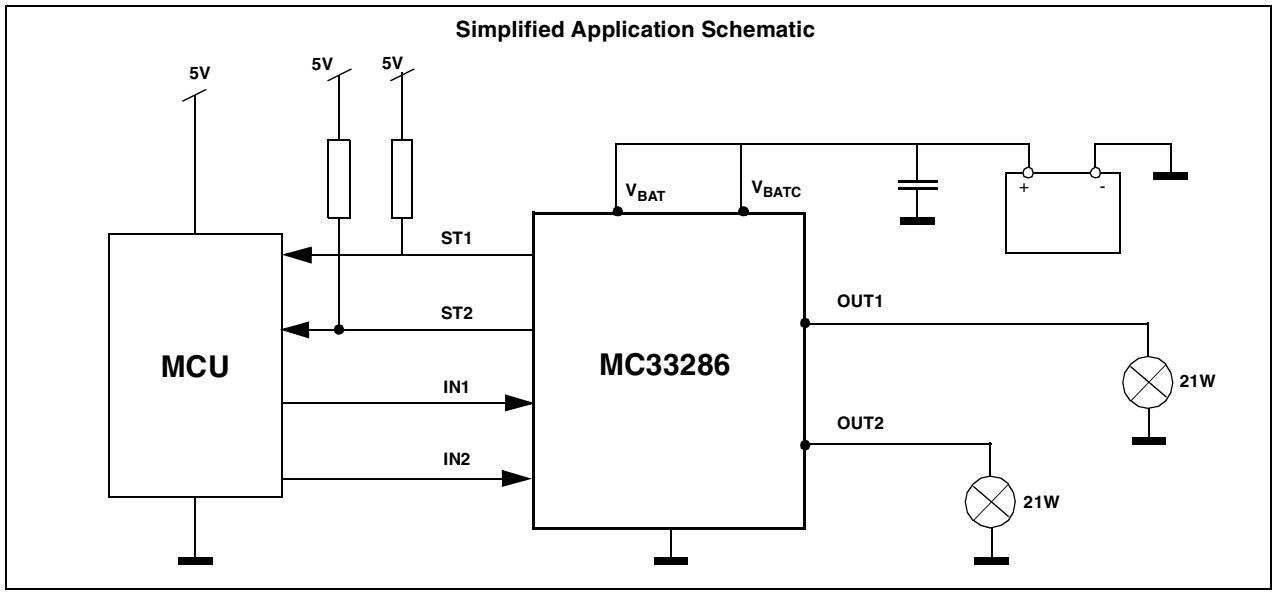
PIN ASSIGNMENT



ORDERING INFORMATION

Device	Operating Temperature Range	Package
PC33286DW	TA=-40° to +125°C	SO20

Simplified Application Schematic



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MOTOROLA digital dna™

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MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
V_{bat} and V_{batc} Voltage : Continuous/Pulse	V_{bat}	-0.3 to 40	V
OUT1, OUT2 Voltage with Respect to Gnd : Continuous/ Pulse	V_{out}	-0.3 to 40	V
OUT1, OUT2 to V_{btap} Voltage : Continuous	V_{out}	40	V
St1, St2 Voltage : Continuous/Pulse	V_{st}	-0.3 to 5.5	V
IN1, IN2 Voltage : Continuous/Pulse	V_{in}	-0.3 to 10	V
In1, In2, St1, St2 Current	I_{in}	+/-4	mA
ESD all Pins	V_{esd}	+/-2000	V
OUT1, OUT2 DC Output Current	I_{out}	6	A
OUT1, OUT2 Pulse Current (Note 1)	I_{outp}	30	A

THERMAL RATINGS

Junction Temperature	T_j	-40 to 150	°C
Storage Temperature	T_{st}	-65 to 150	°C
Thermal Resistance Junction to Ambient (note 2)	R_{thja}	70	°C/W

NOTES : 1. During lamps inrush current. Value internally limited.
2. Device mounted with minimum pcb dimensions.

ELECTRICAL CHARACTERISTICS T_j from - 40°C to +125°C, V_{bat} from 8V to 16V, unless otherwise noted.Typical values reflect approximate mean at 25°C, V_{bat} =12V, at time of device characterization.

Description	Symbol	Characteristics			Unit	Conditions
		Min	Typ	Max		
Operating Voltage	V_{bat}	8		40	V	
Under Voltage Threshold	V_{uv}		7	8	V	
Drain-Source on Resistance	R_{dson}		25	35	mΩ	V_{bat} > 9V ; T_j = 25°C
Drain-Source on Resistance	R_{dson}		35	50	mΩ	V_{bat} > 9V ; T_j = 150°C
High Current Limitation	I_{limh}		30		A	V_{OUT} > 1V
Short-Circuit Current Limitation	I_{liml}		10		A	V_{OUT} < 1V, T_j = 25°C
Body Diode Forward Voltage	Vf		0.7		V	I_{out} = -2A, Tj = 25°C
Body Diode Forward Voltage	Vf		0.6		V	I_{out} = -2A, Tj = 125°C
Hot Open Load Current	I_{ol}		400	700	mA	Device in On State
Standby Current	I_{stdby}			10	µA	V_{bat} < 14V ; V_{in} < 0.8V
Supply Current : One Channel On	I_{on1}			10	mA	In1 or In 2 in High State
Supply Current : Both Channels On	I_{on2}			20	mA	In1 and In 2 in High State
Low Input Voltage	V_{il}			1.5	V	
High Input Voltage	V_{ih}	3.5			V	
Input Hysteresis	V_{hyst}	0.4	0.7	0.9	V	
Input Current	I_{ih}		20	100	µA	V_{in} = 3.5V
Status Voltage	V_{status}			0.5	V	I_{st} = 1mA ; Output in Fault
Thermal Shutdown	T_{shut}	150			°C	
Thermal Shutdown Hysteresis	T_{hyst}		20		°C	
Output Maximum Positive Slew Rate	S_{rpout}	0.05	0.2	0.5	V/µs	Load = 6Ω, V_{bat} =12V
Output Maximum Negative Slew Rate	S_{rnout}	0.15	0.8	1.5	V/µs	Load = 6Ω, V_{bat} =12V
PWM frequency	f_{PWM}			150	Hz	
Turn-on Delay Time	t_{don}		100	150	µs	In=2.5V to 10% V_{out}, V_{bat}=12V

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ELECTRICAL CHARACTERISTICS T_j from - 40°C to +125°C, V_{bat} from 8V to 16V, unless otherwise noted.Typical values reflect approximate mean at 25°C, V_{bat} =12V, at time of device characterization.

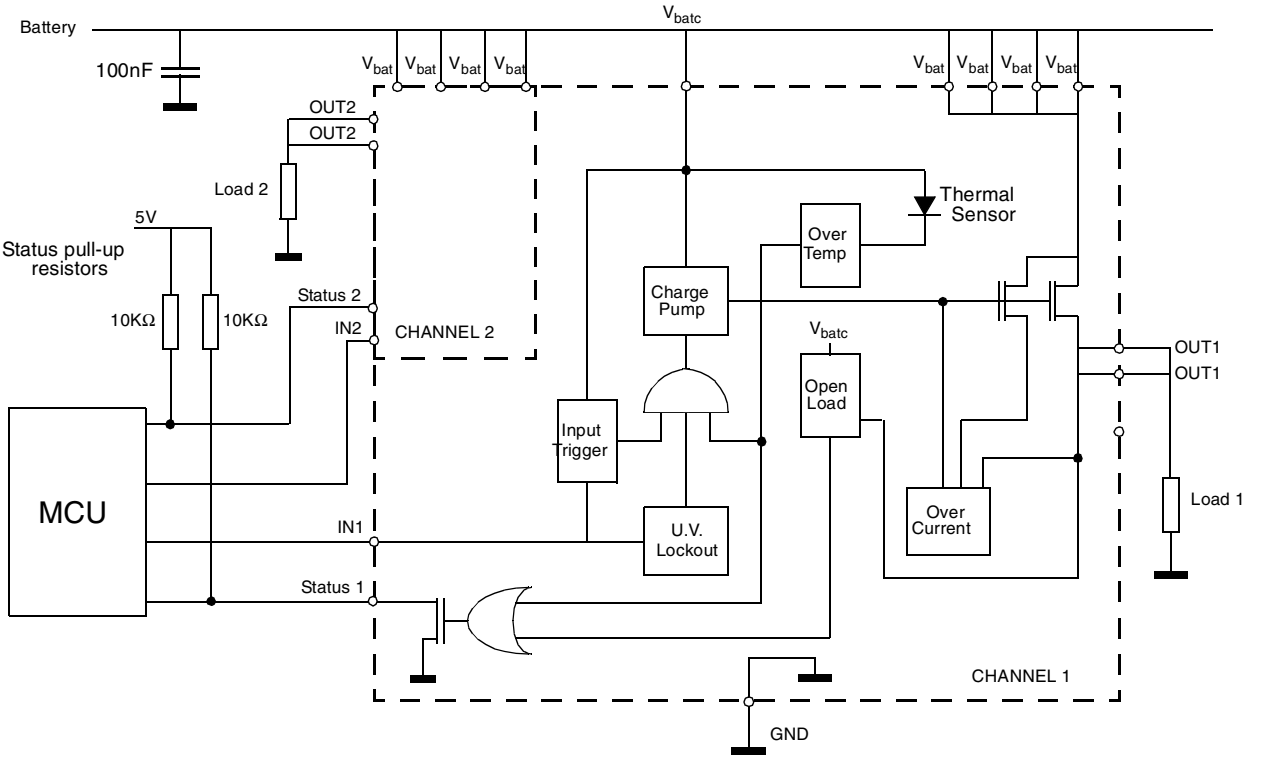
Description	Symbol	Characteristics			Unit	Conditions
		Min	Typ	Max		
Turn-off Delay Time	t_{doff}		100	150	µs	IN = 2.5V to 90% V_{out}, V_{bat}=12V
Open Load to Status Low Delay Time	T_{OL}		10		µs	

FUNCTIONAL TRUTH TABLE

Conditions	IN1	IN2	OUT1	OUT2	St1	St2
Normal Operation	L H L H	L L H H	L H L H	L L H H	H H H H	H H H H
Undervoltage	X	X	L	L	H	H
Overtemperature Channel 1 Overtemperature Channel 2 Overtemperature Channel 1/Channel 2	H X H	X H H	L X L	X L L	L H L	H L L
Open Load Channel 1 Open Load Channel 2	H X	X H	H X	X H	L H	H L
Overcurrent Channel 1 Overcurrent Channel 2	H X	X H	X X	X X	H H	H H

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

Figure 1. Application Schematic



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Pin No.	Name/Function	Description
1, 2, 5, 6, 15, 16, 19, 20	V_{bat} 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 functions, these pins participate to the thermal behaviour of the device in conducting the heat from the switching MOSFET to the printed circuit board.
3, 4, 18, 17	OUT1 OUTPUT Channel 1 OUT 2 OUTPUT Channel 2	Pins 3 and 4 are the output 1 terminals. Pins 17 and 18 are the output 2 terminals. They are directly connected to the source of the power MOSFET. The Rdson is 35mΩ max per output at 25°C. Its value increases up to 50mΩ at 150°C junction temperature.
8, 13	IN 1 INPUT Channel 1 IN 2 INPUT Channel 2	These are the device input pins, which directly control their associated output. The thresholds are CMOS compatible. When the input is in low state, the associated output MOSFET is off. 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 less than 1mA for V_{bat} up to 12V.
9, 12	St1 Status for Channel 1 St2 Status for Channel 2	These pins are the channel 1 and 2 status. Their internal structure is an open drain with an internal clamp at 6V. An external pull up connected to the 5V is needed. When the device is in normal condition the status is high. If open load or overtemperature occurs on one channel, the associated output status will be pulled low. See Functional Truth Table.
10	V_{batc} VBAT Control	This pin is the supply voltage pin for the control portion of the device. It has to be connected to the V_{bat} line and to the other V_{bat} pins listed above. An internal 45V zener diode is connected between pin 10 and Gnd.
11	GND GROUND	This is the Gnd pin of the device.

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General Information

This device is a dual high side power switch dedicated for automotive applications. In comparison with mechanical relays, this device offers higher reliability as well as protection and diagnostic features. It has been designed to be directly connected to the battery voltage.

In the future, the number of electronic switches directly connected to the battery will increase, so the MC33286 includes a special input trigger and architecture which allows to have a very low standby current when the V_{bat} is lower than 12V.

The MC33286 concept uses a dual chip approach packaged in a single SO20 package. This low power package can be used because the ON resistance of the switch (35mΩ max at 25°C) guarantees a low power dissipation (less than 300mW) when driving two 21Watts lamps. The two chips are internally connected by die to die wire bonding to allow the transfer of analog and control information between the two dice.

The two chips are the Control and Power dice.

The Control chip uses the SMARTMOS3.5NVM technology. The two channels of this control chip are totally symmetrical and independant. It drives the gate of the output power MOSFET and manages the analog information from the power MOSFET die to ensure power device protection.

The Power chip uses the HDTMOS3 technology. It has one independent sources plus current sensing cells for open load detection and current limitation. In addition, a thermal sensor (diode) is located in the middle of each source to protect the MC33286 against overtemperature. The drain of the Power die is connected to the battery voltage by the lead frame of the package. This lead frame has been especially developed and has eight pins connected together to the V_{bat}. These pins are used as the V_{bat} connection as well as thermal path.

Supply Voltage

The MC33286 can be directly connected to the V_{bat} line. Figure 4 shows the supply voltage characteristics. The V_{batc} (V_{bat} of Control die, pin 10) and V_{bat} (V_{bat} of power die, pins 1, 2, 5, 6, 15, 16, 19, 20) are not internally connected, so the V_{bat} and V_{batc} have to be connected externally by the printed circuit board.

Under Voltage

Figure 4 also shows the supply voltage characteristic when one or two sides of the MC33286 are turned on. From 0V to undervoltage level (7V typical), all blocks of the MC33286 are not totally supplied. The undervoltage threshold value versus temperature is shown in Figure 2.The under voltage function allows the turn-off of the output transistor, because the V_{bat} voltage will be not enough to guarantee the full on state of the output transistor due to an incomplete drive of the gate. When the V_{bat} is greater than the undervoltage threshold, the supply current increases due to the charge pump start up and MOSFET driver activation.

Reverse Battery Protection

When a negative battery voltage arises, the current flows in a reverse direction from the source region to drain region of both of the MosFets through the body diode. The limitation is then the temperature reached by the junction, which is linked to the thermal impedance from the junction to the ambiant.

Input Trigger

The MC33286 has a special input trigger circuitry allowing the device to have less than 0.5µA typical standby current. When the input level is below 1.5V, the circuit is in sleep mode (see Figure 4).

Status Output

The output status is an open drain structure, active at low level, so an external pull-up resistor is required to read the status information.

The status indicates the open load and the over temperature information. The output short-circuit, current limitation and V_{bat} undervoltage are not reported on the status pin. But an output short-circuit to Gnd will be detected by an overtemperature because the total power dissipation of the device will make it reach the thermal detection.

Open Load Function

The open load detection is active during the ON phase (Hot open load detection). An amplifier measures the differential voltage between V_{bat} and V_{out} (this value is typically 400mA) at 25°C.

An open load condition will create a voltage lower than 12mV and the open load circuitry will detect it and will pull down the status output. If the open load condition is present before the device turn-on, the status will be pulled down after a delay due to the rise time of the output.

Overcurrent Function (High Current Limitation)

The device incorporates a current limitation at 30 Amps typical when outputs are loaded (Vout > 1V) . A 21 Watts lamp has a nominal current of about 2 amp and at turn on, the MC33286 has to drive a peak current of about 12A, as the lamp inrush current is about six times the nominal DC current. A standard current limitation set up at 30A will not being activated during the inrush current of one lamp but will protect the circuit against overcurrent. Figure 3 shows the overcurrent threshold versus temperature.

Short Circuit Protection (Low Current Limitation)

During a hard short-circuit to Gnd, the power dissipation would be 30A x 14V = 420 Watts if only the overcurrent limitation exists. The thermal protection will be activated and switch the device off. Nevertheless the peak power dissipation and energy is quite high.

Therefore, a short circuit protection has been implemented and is activated when the output voltage is lower than about 1V . As shown in the Figure 5, the low current limitation decreases with temperature. In the case of a short circuit, the power dissipated in the device decreases with time due to the decay of the current limitation with temperature.

Overtemperature Function

The overtemperature function uses a thermal sensor located in the middle of each output power HDTMOS transistor. The sensor is a diode connected to V_{bat} in the power die. The diode forward voltage varies of -2mV/°C. So, by measuring the diode voltage the power output MOSFET temperature is monitored. This diode voltage information is transferred to the control die and compared to a reference voltage generated from the band gap reference generator. When the temperature reaches the overtemp threshold, the circuit is turned off. As the input voltage is still high, the circuit is not in wake mode but the current consumption decreases due to the turn-off of the charge pump. The overtemperature

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comparator has an hysteresis which maintains the device off. As soon as the die power temperature decreases by around 20°C the device automatically switches on again.

If the cause of the overtemperature has not been removed, it is likely that the device will reach the overtemperature shutdown again and will cycle off and on until the overtemperature cause is removed. As soon as the device switches off, due to overtemperature, the status pin is pulled low to inform the microcontroller that an abnormal condition has occured.

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Figure 2. Undervoltage Threshold Versus Temperature

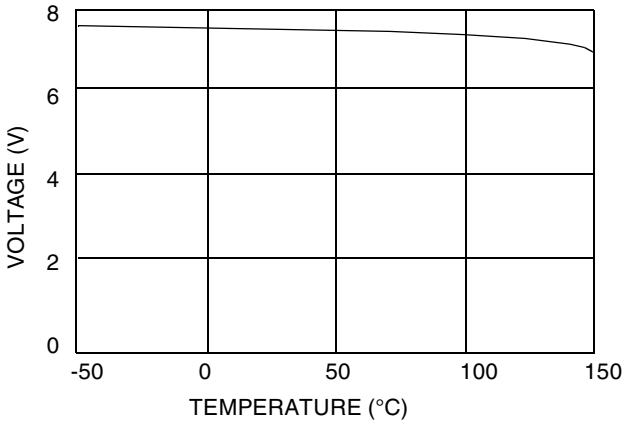


Figure 3. High Current Limitation Versus Temperature

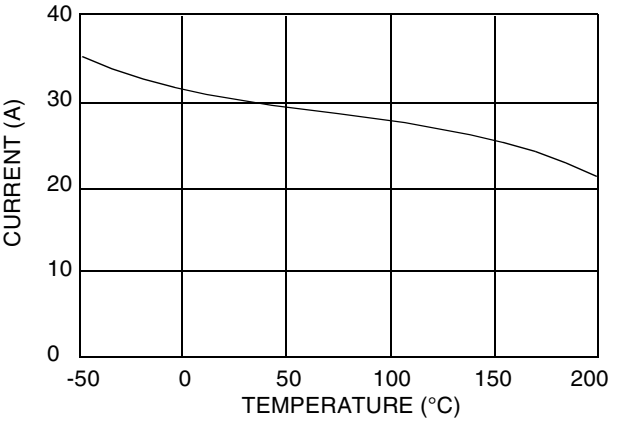


Figure 4. Battery Supply Current Versus Vbat

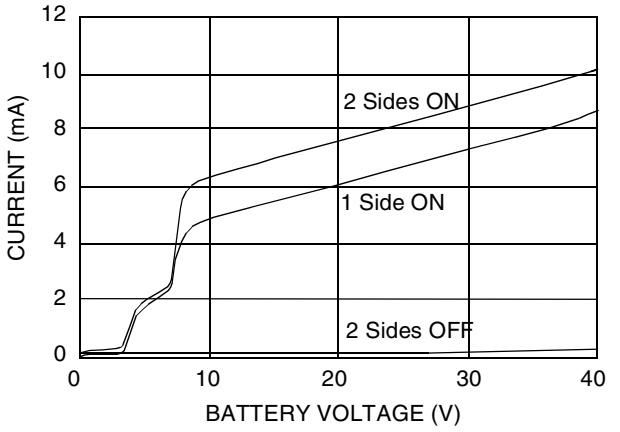


Figure 5. Short Circuit Current Limitation Versus Temperature

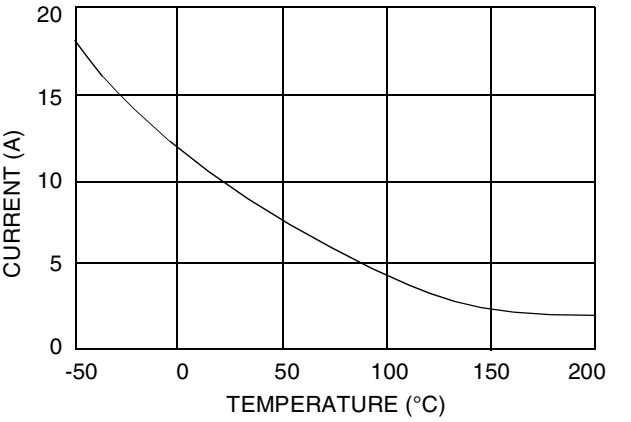


Figure 6. OpenLoad Current Threshold Versus Temperature

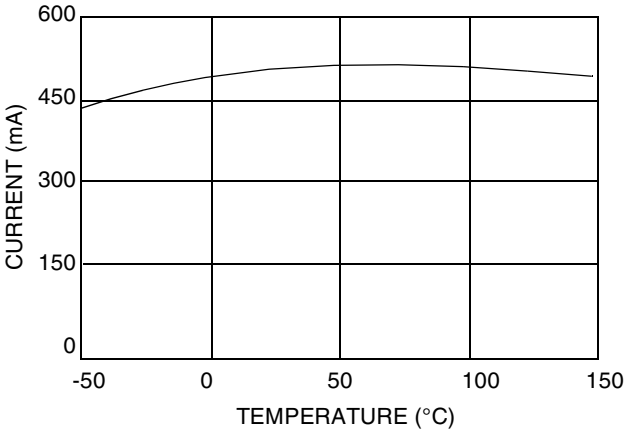
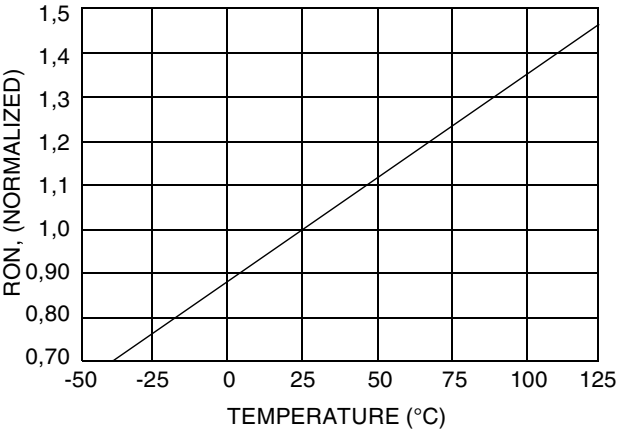


Figure 7. Ron Versus Temperature



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