MAQ5283

$120V_{IN}$, 150 mA, Ultra-Low I_Q, High PSRR, Automotive Linear Regulator

Features

- AEC-Q100 Qualified
- Wide Input Voltage Range: 6V to 120V DC
- Ultra-Low Quiescent Current: 8 µA
- 150 mA Guaranteed Output Current
- Adjustable Output from 1.23V to 5.5V
- Stable with Ceramic Capacitors
- Ultra-High PSRR (75 dB at 10 kHz)
- Ultra-High Line Rejection (Load Dump)
- High Output Accuracy:
  - ±3% Initial Accuracy
- Thermal Shutdown and Current Limit Protection
- Thermally Efficient, 8-Lead ePad SOIC Package

Applications

- Automotive
- Industrial
- Remote Keyless Entry
- Telecom
- Offline Power Supplies

General Description

The MAQ5283 high-performance linear regulator offers a very wide input operating voltage range, up to 120V DC, and supplies an output current of up to 150 mA.

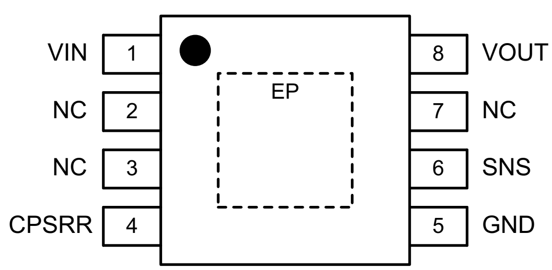
The MAQ5283 is ideal for high input voltage applications, such as automotive, industrial, and telecom, because it offers ±3% initial accuracy, extremely high power supply rejection ratio (75 dB at 10 kHz) and an ultra-low quiescent current of 8 µA. The MAQ5283 is optimized for high-voltage line transients, making it ideal for harsh environment applications.

The MAQ5283 is offered in both fixed output voltage (3.3V or 5.0V) and adjustable output voltage (1.23V to 5.5V) options.

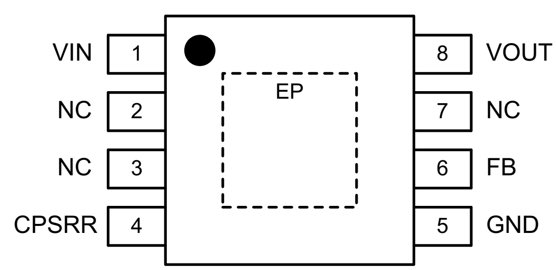
The MAQ5283 operates over a –40°C to +125°C temperature range and is available in a lead-free, RoHS-compliant, ePad SOIC-8 package.

Package Type

MAQ5283-x.xYME
8-Lead SOIC (ME)
Fixed Output Voltage
(Top View)

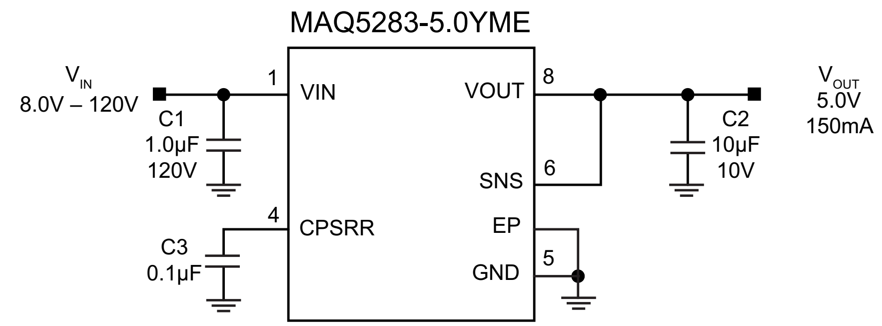


MAQ5283YME
8-Lead SOIC (ME)
Adjustable Output Voltage
(Top View)

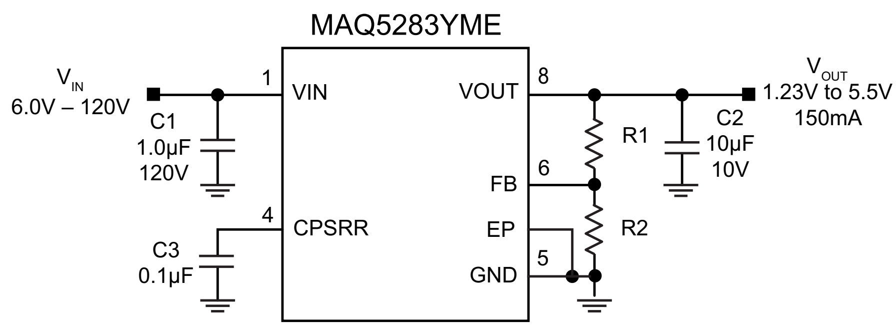


Typical Application Circuits

MAQ5283 Fixed Output Voltage

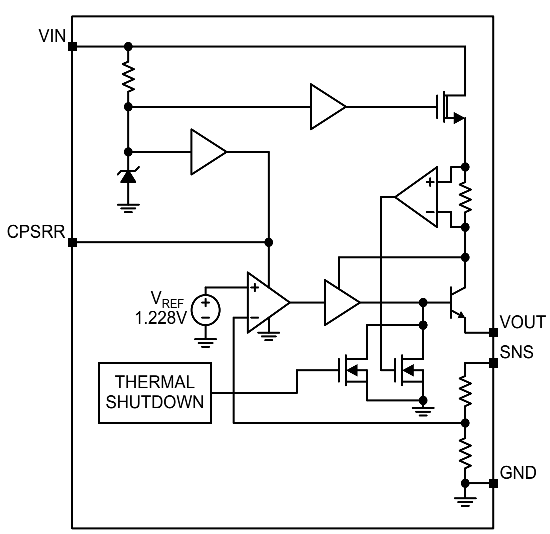


MAQ5283 Adjustable Output Voltage

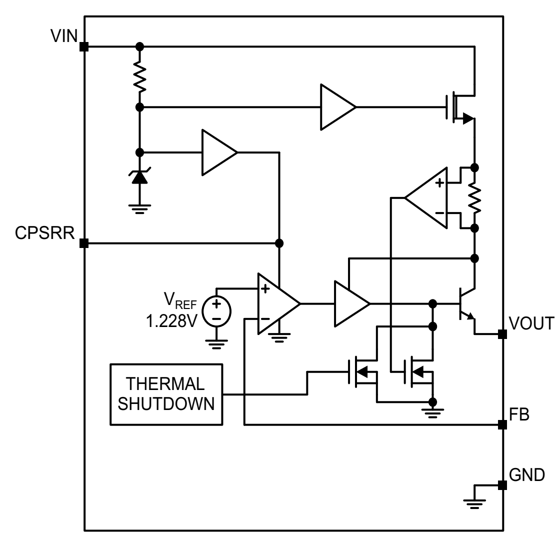


Functional Block Diagrams

Fixed Output Version



Adjustable Output Version



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V_{IN} to GND .... –0.3V to +125V
V_{CPSRR} to GND .... –0.3 to +14V
V_{FB}, V_{SNS}, V_{OUT} to GND .... –0.3V to +6V
ESD Ratings (Note 1)
HBM .... 2 kV
MM 200V

Operating Ratings ††

V_{IN} .... +6V to +120V
V_{OUT} Adjust Range .... +1.23V to +5.5V
Power Dissipation (P_D) .... Internally Limited (Note 2)

† Notice: Exceeding an absolute maximum rating may damage the device.

†† Notice: The device is not guaranteed to function outside its operating rating.

Note 1: Device is ESD sensitive; use proper handling precautions. Human body model, 1.5 kΩ in series with 100 pF.

2: The maximum allowable power dissipation at any T_A (ambient temperature) is $P_{D(MAX)} = (T_{J(MAX)} – T_A)/θ_{JA}$. Exceeding the maximum allowable power dissipation results in excessive die temperature and causes the regulator to enter thermal shutdown.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: V_{IN} = 12V, C_{IN} = 1.0 µF, C_{PSRR} = 0.1 µF, C_{OUT} = 10 µF, I_{OUT} = 100 µA, T_J = +25°C, **bold** values indicate –40°C ≤ T_J ≤ +125°C, unless noted. Note 1

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Power Supply Input						
Input Voltage Range	V_{IN}	**6**	—	**120**	V	—
Quiescent Supply Current	I_Q	—	8	**14**	µA	I_{OUT} = 0
Output Voltage						
Output Voltage Accuracy		**–5**	—	**5**	%	Variation from nominal V_{OUT}, 100 µA ≤ I_{OUT} ≤ 150 mA
Line Regulation		**–0.5**	0.04	**0.5**	%	V_{IN} = 10V to 120V
Feedback Input (Adjustable)						
FB Voltage	V_{FB}	**1.167**	1.228	**1.289**	V	100 µA ≤ I_{OUT} ≤ 150 mA
FB Current	I_{FB}	—	3.2	—	nA	—
Current Limit						
Current Limit	I_{LIM}	**180**	300	**500**	mA	V_{OUT} = 0V
Ripple Rejection						
Power Supply Rejection Ratio	PSRR	—	70	—	dB	I_{OUT} = 50 mA, 100 Hz ≤ f ≤ 1 kHz
		—	75	—		I_{OUT} = 50 mA, 1 kHz < f ≤ 30 kHz
		—	65	—		I_{OUT} = 50 mA, 30 kHz < f ≤ 100 kHz
Power Dropout Voltage						
Dropout Voltage	V_{DO}	—	1.8	**2.8**	V	I_{OUT} = 150 mA

Note 1: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: V_{IN} = 12V, C_{IN} = 1.0 µF, C_{PSRR} = 0.1 µF, C_{OUT} = 10 µF, I_{OUT} = 100 µA, T_J = +25°C, **bold** values indicate –40°C ≤ T_J ≤ +125°C, unless noted. Note 1

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Thermal Protection						
Thermal Shutdown Temperature	T_{SHDN}	—	155	—	°C	T_J rising
Thermal Shutdown Hysteresis		—	15	—	°C	—

Note 1: Specification for packaged product only.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Temperature Range	T_J	–40	—	+125	°C	—
Storage Temperature Range	T_S	–65	—	+150	°C	—
Lead Temperature	—	—	260	—	°C	Soldering, 10 sec.
Package Thermal Resistances						
Thermal Resistance, 8-Lead ePad SOIC	θ_{JA}	—	41	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

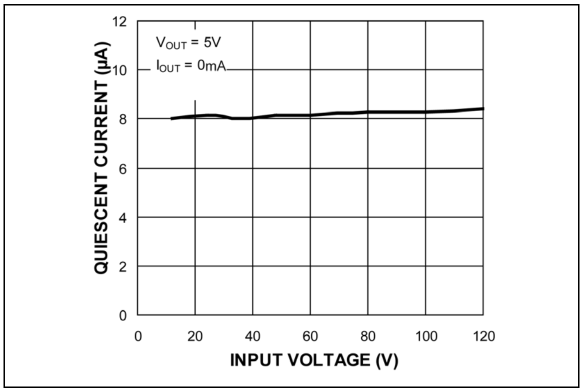


FIGURE 2-1: Quiescent Supply Current vs. Input Voltage.

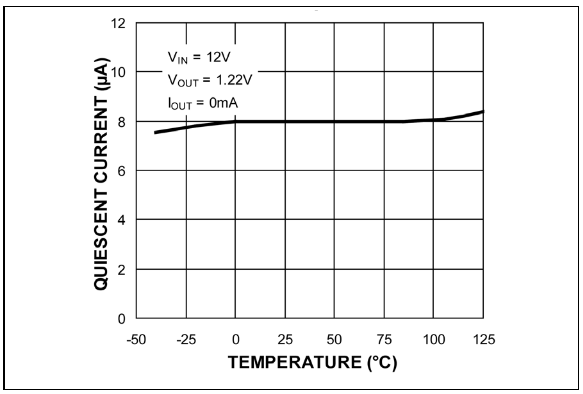


FIGURE 2-2: Quiescent Supply Current vs. Temperature.

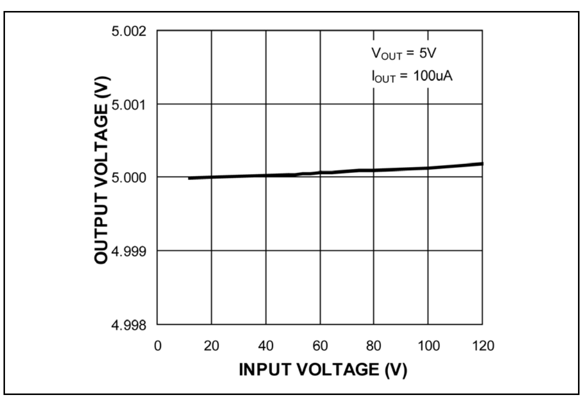


FIGURE 2-3: Output Voltage vs. Input Voltage.

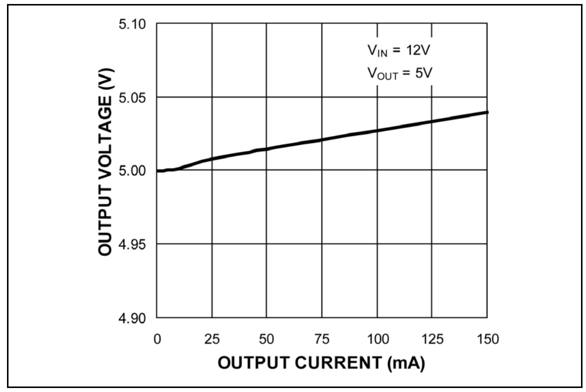


FIGURE 2-4: Output Voltage vs. Output Current.

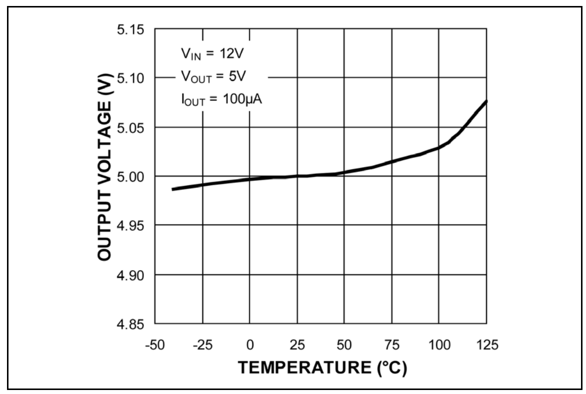


FIGURE 2-5: Output Voltage vs. Temperature.

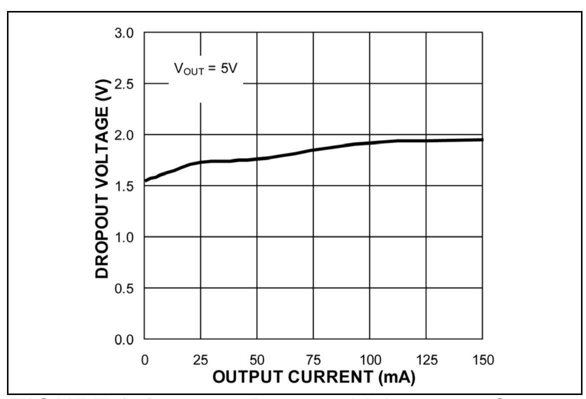


FIGURE 2-6: Dropout Voltage vs. Output Current.

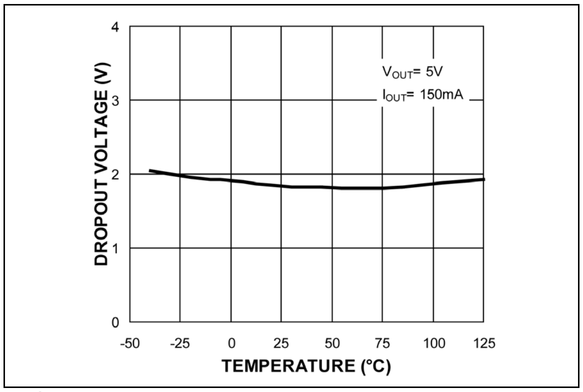


FIGURE 2-7: *Dropout Voltage vs. Temperature.*

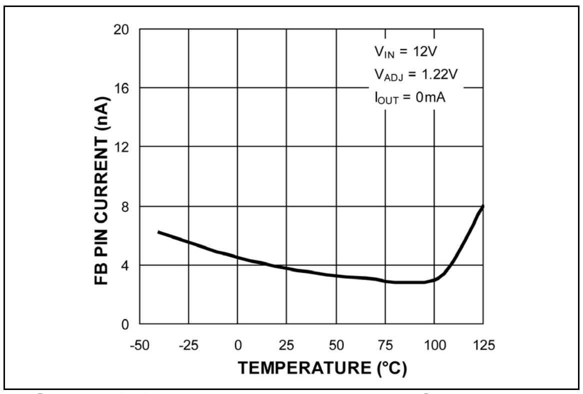


FIGURE 2-8: *Feedback Pin Current vs. Temperature.*

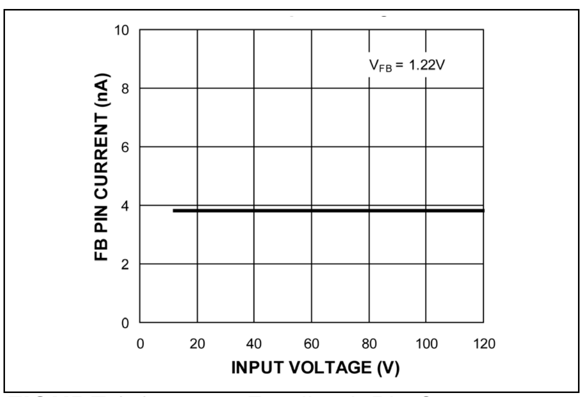


FIGURE 2-9: *Feedback Pin Current vs. Input Voltage.*

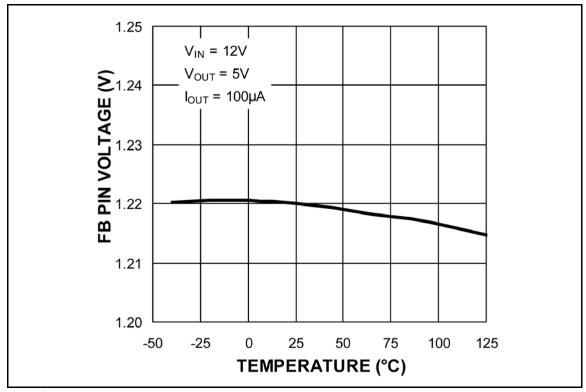


FIGURE 2-10: *Feedback Pin Voltage vs. Temperature.*

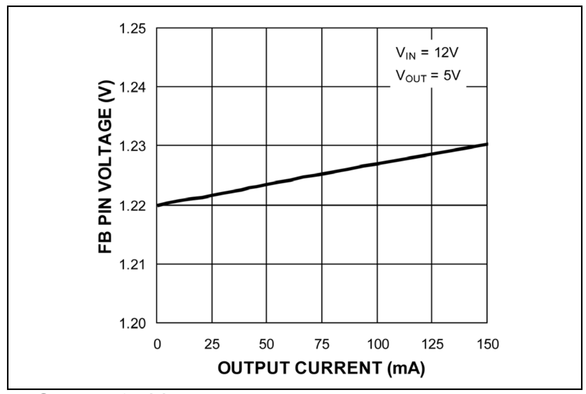


FIGURE 2-11: *Feedback Pin Voltage vs. Output Current.*

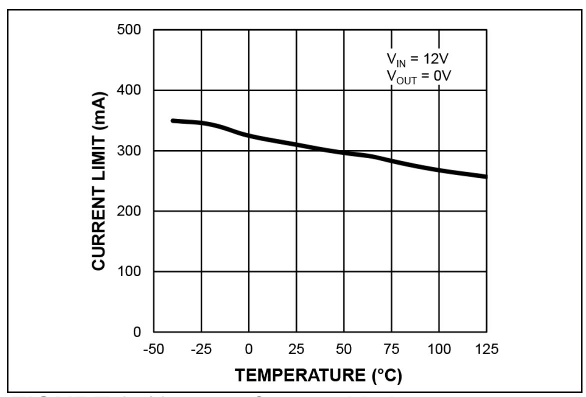


FIGURE 2-12: *Current Limit vs. Temperature.*

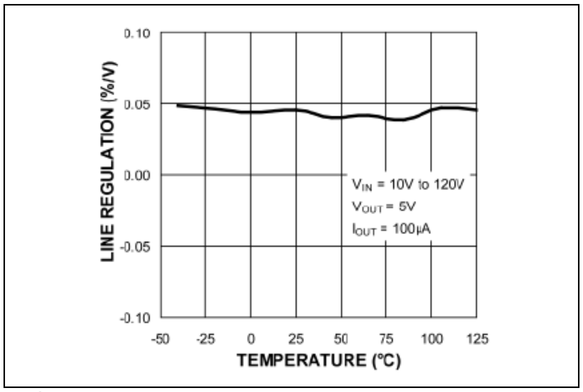


FIGURE 2-13: *Line Regulation vs. Temperature.*

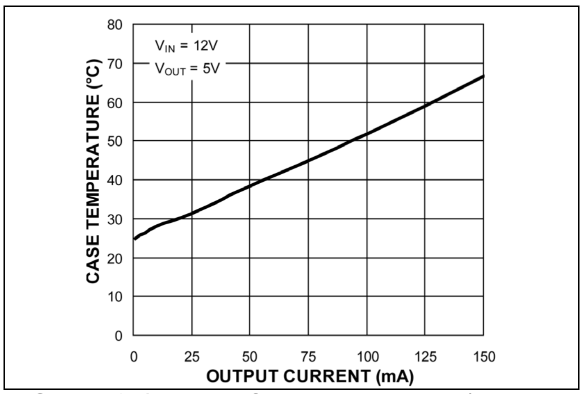


FIGURE 2-14: *Case Temperature* vs. Output Current.*

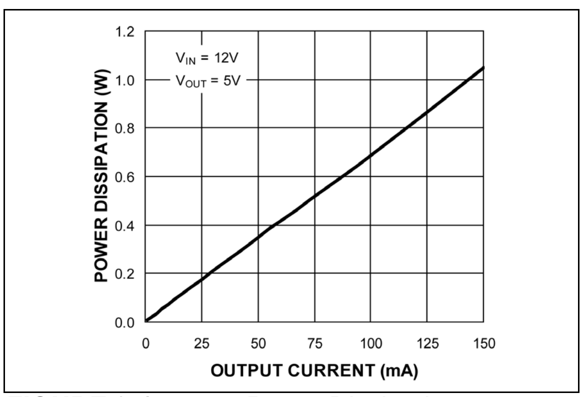


FIGURE 2-15: *Power Dissipation vs. Output Current.*

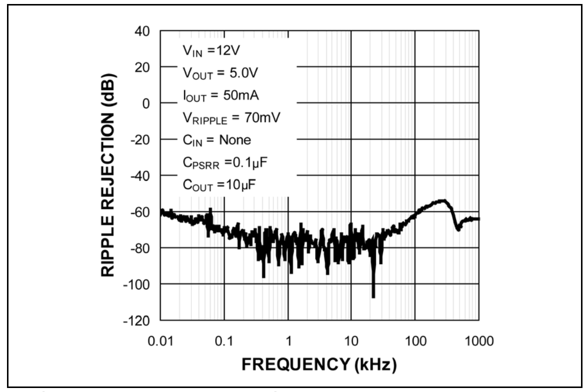


FIGURE 2-16: *PSRR vs. Frequency.*

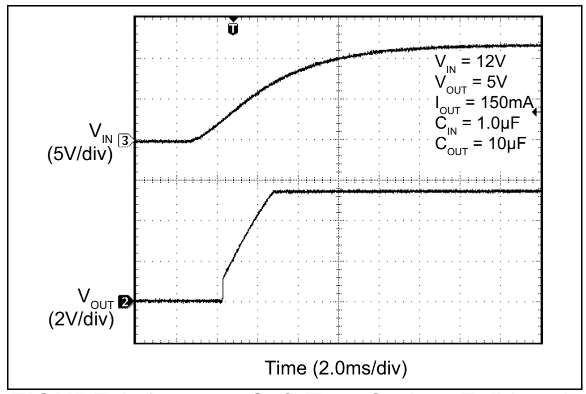


FIGURE 2-17: *Soft Turn-On into Full Load.*

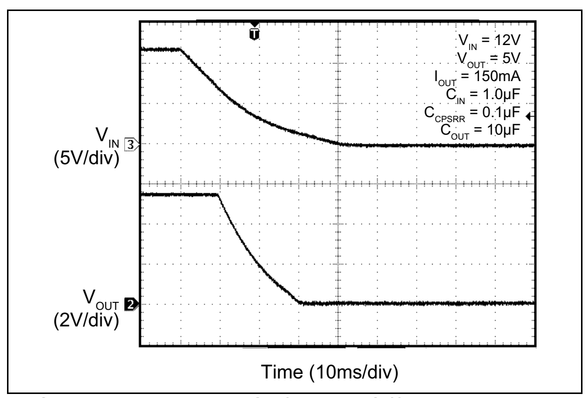


FIGURE 2-18: *Soft Turn-Off.*

Note: *The temperature measurement was taken at the hottest point on the MAQ5283 case mounted on a 2.25-square-inch PCB at an ambient temperature of 25°C; see the Thermal Measurements section. Actual results depend on the size of the PCB, ambient temperature, and proximity to other heat emitting components.

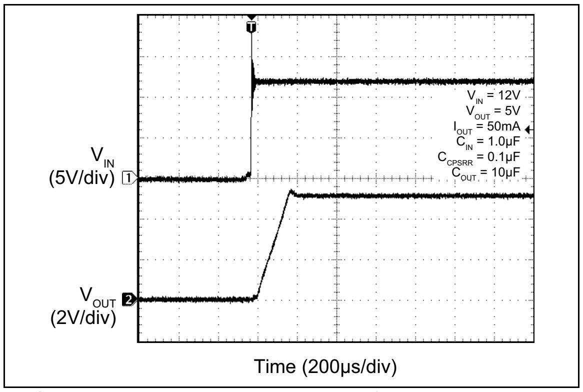


FIGURE 2-19: *Fast Turn-On.*

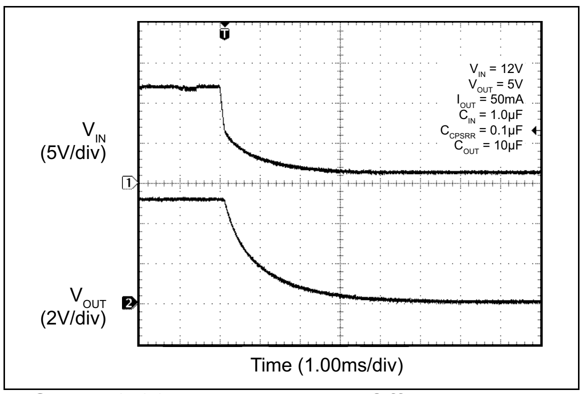


FIGURE 2-20: *Fast Turn-Off.*

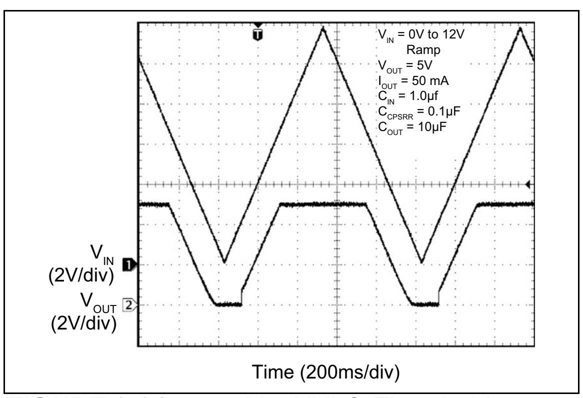


FIGURE 2-21: *V_{IN} UVLO Threshold.*

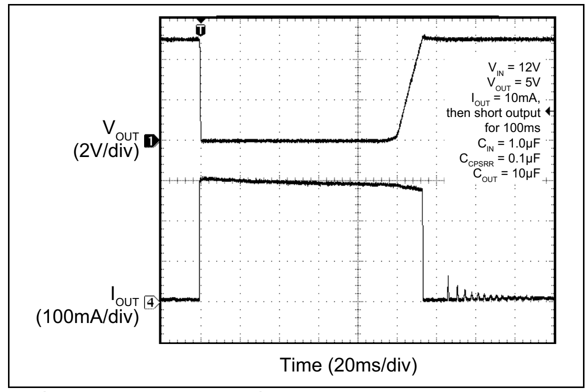


FIGURE 2-22: *Current Limit.*

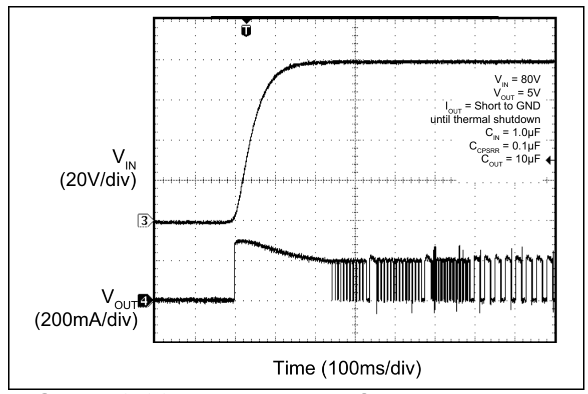


FIGURE 2-23: *Thermal Shutdown Response.*

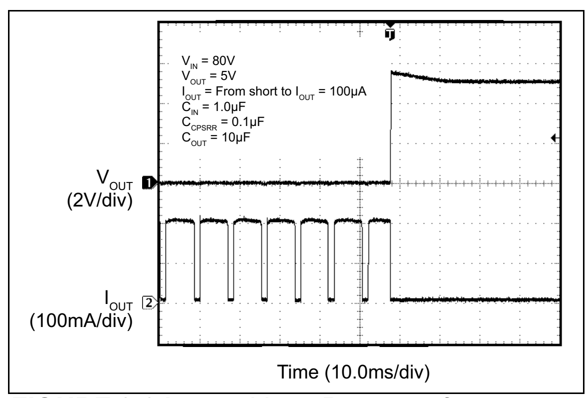


FIGURE 2-24: *V_{OUT} Recovery from Thermal Shutdown.*

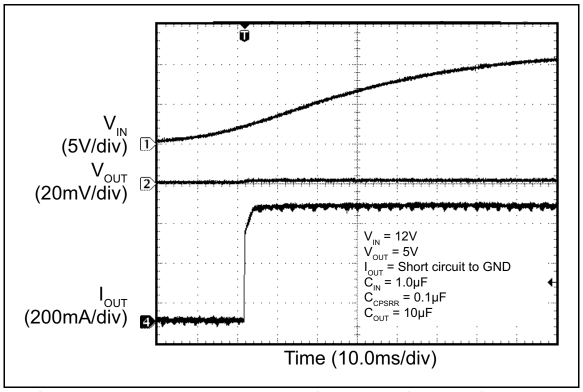


FIGURE 2-25: *Turn-On into Short Circuit.*

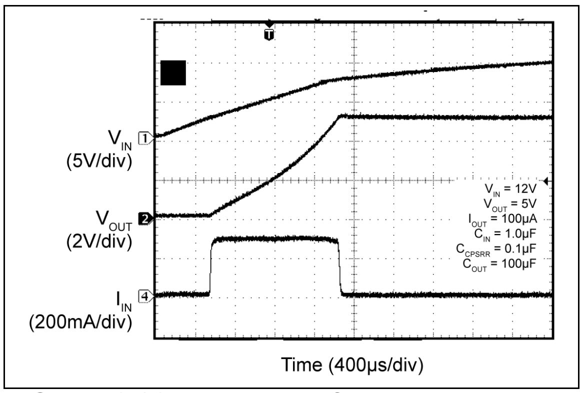


FIGURE 2-26: *Inrush Current Response.*

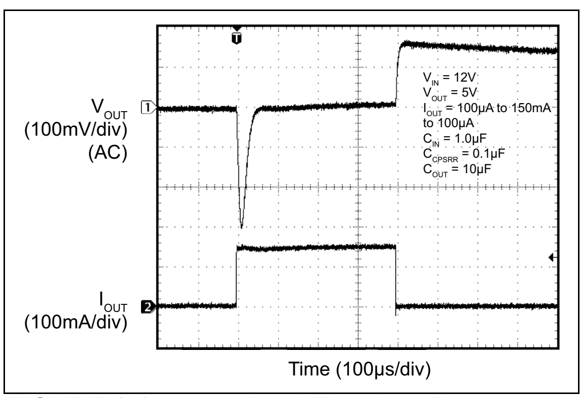


FIGURE 2-27: *Load Transient Response.*

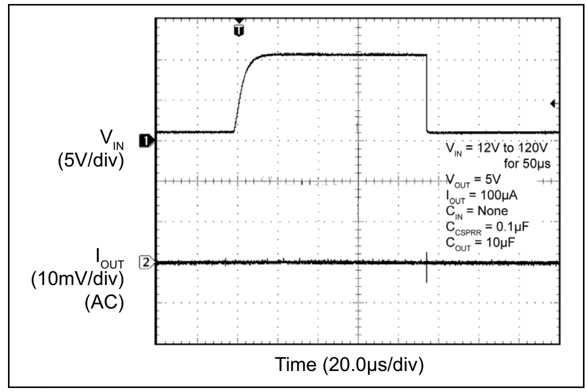


FIGURE 2-28: *Line Transient Response.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number (Fixed)	Pin Number (Adjustable)	Pin Name	Description
1	1	VIN	Supply Voltage Input. Connect 1 µF capacitor from VIN to GND.
2, 3, 7	2, 3, 7	NC	Not internally connected. Connect NC to GND or leave unconnected.
4	4	CPSRR	Bypass Capacitor Connection. Connect 0.1 µF capacitor from CPSRR to GND.
5	5	GND	Ground.
—	6	FB	Feedback Connection. For external resistor divider to set V_{OUT}.
6	—	SNS	Sense input. Connect SNS to VOUT.
8	8	VOUT	Regulator Output. Connect 10 µF capacitor from VOUT to GND.
EP	EP	ePad	Exposed Pad (ePad) for Thermal Dissipation. Connect to GND.

4.0 APPLICATION INFORMATION

The MAQ5283 voltage regulator accepts a 6V to 120V input voltage and has an ultra-low 8 µA typical quiescent current while offering an excellent line transient response and PSRR. These features make it ideal for harsh, noisy environments. All options offer 150 mA of output current. The MAQ5283YME offers an adjustable output voltage from 1.23V to 5.5V. The MAQ5283-3.3YME offers a fixed 3.3V output and the MAQ5283-5.0YME offers a fixed 5.0V output. The YME packaged devices feature a heat slug to remove heat from the die more effectively.

4.1 Thermal Protection

The MAQ5283 has internal thermal shutdown to protect it from excessive heating of the die. When the junction temperature exceeds approximately +155°C, the output is disabled and the device begins to cool down. The device turns back on when the junction temperature cools by 15°C. This results in a cycled output during continuous thermal-overload conditions.

4.2 Current Limit

The MAQ5283 features output current-limit protection. The output sustains a continuous short circuit to GND without damage to the device, but thermal shutdown often results. The typical value for the current limit of the MAQ5283 is 300 mA.

4.3 Input Capacitor

Connect a 1.0 µF capacitor from VIN to GND. Microchip recommends the C5750X7R2E105M, 1.0 µF, 250V capacitor made by TDK. When using a different capacitor, make sure that the voltage rating of the capacitor has enough headroom to withstand any potential transient.

4.4 CPSRR Capacitor

To maintain high power supply rejection, connect a 0.1 µF capacitor from CPSRR to GND. The voltage rating of the capacitor must be at least 14V.

4.5 Output Capacitor

Connect a 10 µF capacitor from VOUT to GND. Make sure that the voltage rating of the capacitor is greater than the designed output voltage of the MAQ5283.

4.6 Output Voltage Setting

For the MAQ5283YME, V_{OUT} is programmable from 1.23V to 5.5V using an external resistive divider. V_{OUT} is set using the following equation:

EQUATION 4-1:

$$V_{OUT} = V_{REF} \times \left(\frac{R1}{R2} + 1\right)$$

Where:

V_{REF} = 1.228V

R1 and R2 form the feedback voltage divider from V_{OUT} to GND.

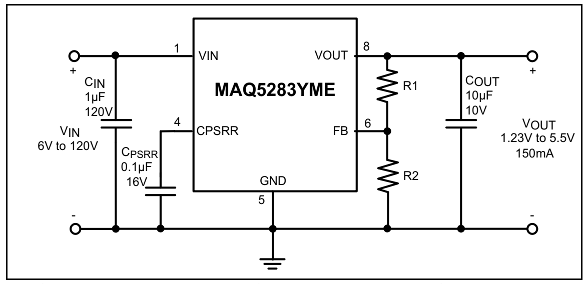


FIGURE 4-1: *Output Voltage Setting Diagram.*

4.7 Thermal Measurements

It is always a good idea to measure an IC's case temperature to make sure that it is within operating limits, but it is easy to get false results. The standard thermocouple that comes with many voltage meters uses a large wire gauge that behaves like a heat-sink. This causes artificially low case temperature measurements. Use a thermocouple of 36-gauge wire or smaller, such as the Omega (5SC-TT-K-36-36), to minimize the heat-sinking effect. Also, apply a thermal compound to maximize heat transfer between the IC and the thermocouple.

An infrared thermometer is a recommended alternative. The IR thermometer from Optris has a 1 mm spot size, which is ideal for monitoring small surface-mount packages. Also, the optional stand makes it easy to keep the beam on the IC for long periods of time.

5.0 MAQ5283 EVALUATION BOARD SCHEMATIC

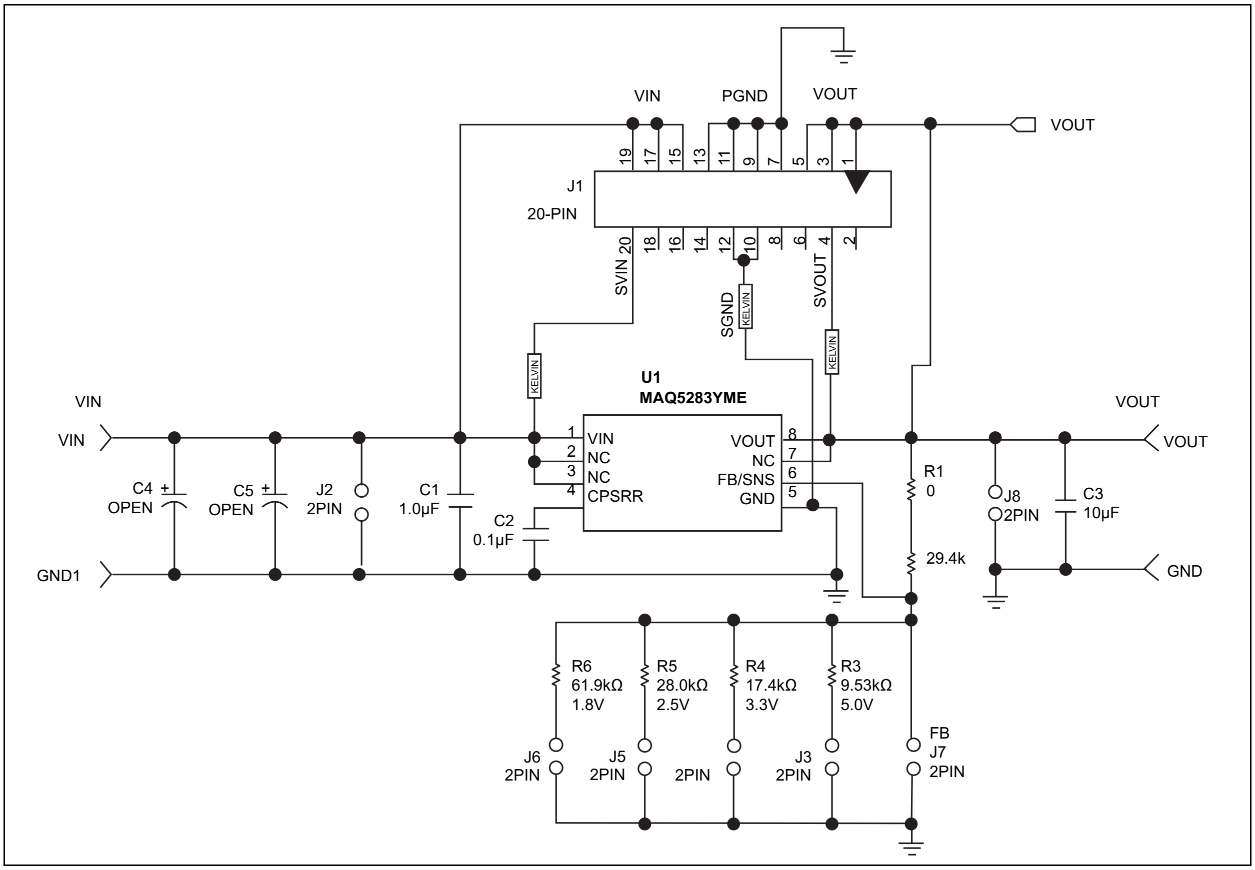


FIGURE 5-1: MAQ5283 Evaluation Board Schematic.

TABLE 5-1: BILL OF MATERIALS

Item	Part Number	Manufacturer	Description	Qty.
C1	C5750X7R2E105M	TDK	1.0 µF, 250V, 20%, X7R capacitor (2220)	1
C2	08053C104KAT2A	AVX	0.1 µF 25V 20%, X7R capacitor (0805)	1
C3	0805ZD106KAT2A	AVX	10 µF, 10V, 20%, X5R, capacitor (0805)	1
R1	CRCW06030000F	Vishay/Dale	0Ω, 1% resistor, 0603	1
R2	CRCW06032942F	Vishay/Dale	29.4 kΩ, 1% resistor, 0603	1
R3	CRCW06039531F	Vishay	9.53 kΩ Film Resistor, Size 0603, 1%	1
R4	CRCW06031742F	Vishay	17.4 kΩ Film Resistor, Size 0603, 1%	1
R5	CRCW06032802F	Vishay	28.0 kΩ Film Resistor, Size 0603, 1%	1
R6	CRCW06036192F	Vishay	61.9 kΩ Film Resistor, Size 0603, 1%	1
U1	MAQ5283YME	Microchip	$120V_{IN}$, 150 mA, Ultra-Low I_Q, High-PSRR Linear Regulator	1

6.0 PCB EVALUATION BOARD LAYOUT

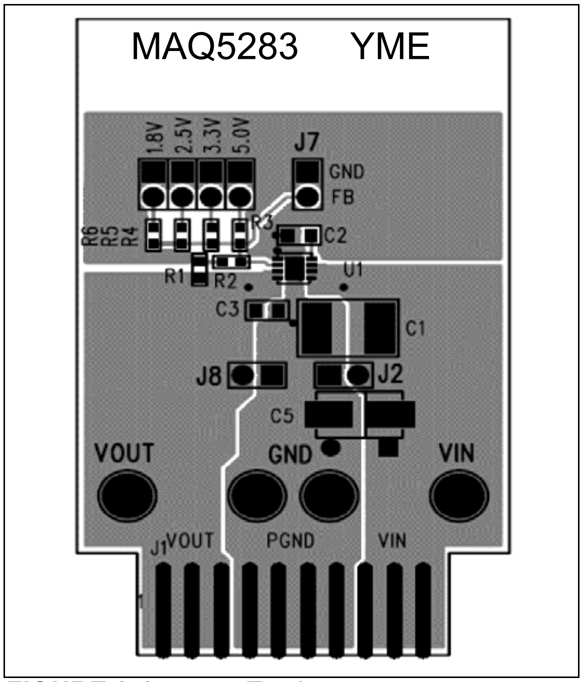


FIGURE 6-1: Top Layer.

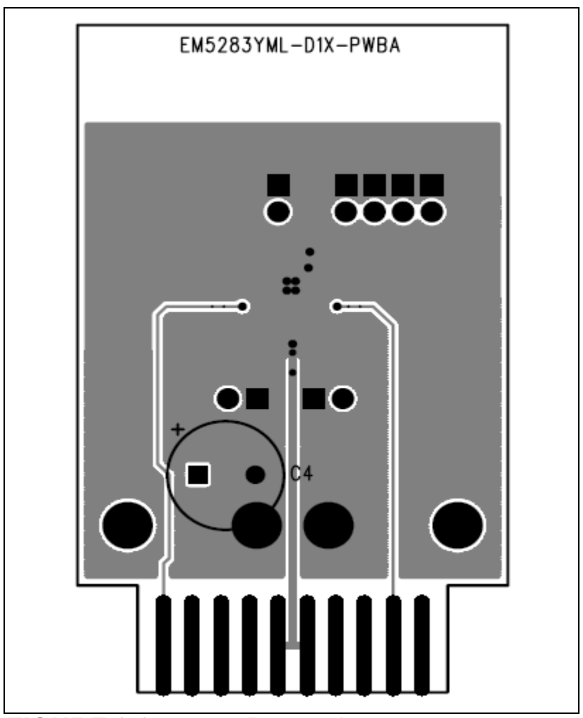


FIGURE 6-2: Bottom Layer.

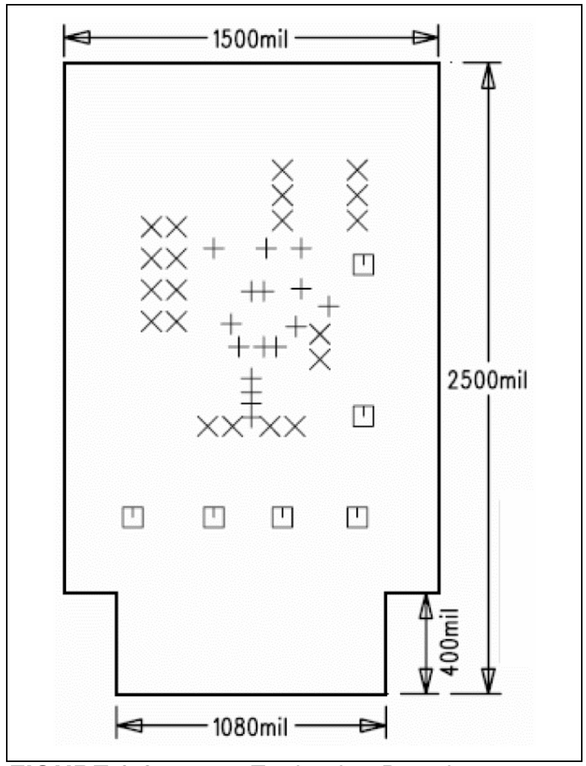
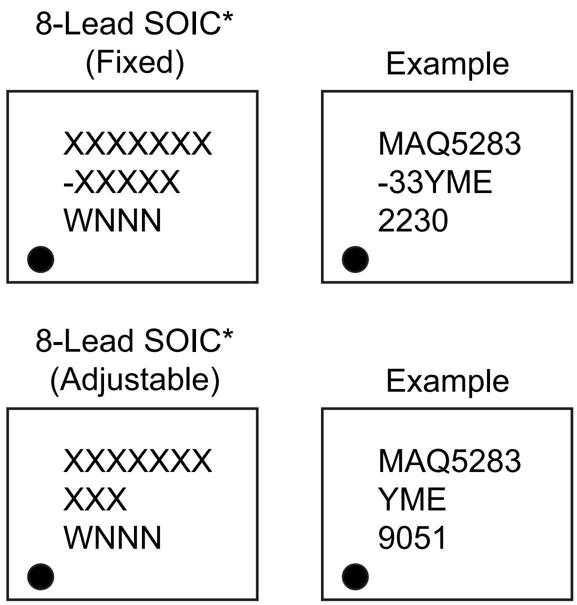


FIGURE 6-3: Evaluation Board Dimensions.

7.0 PACKAGING INFORMATION

7.1 Package Marking Information



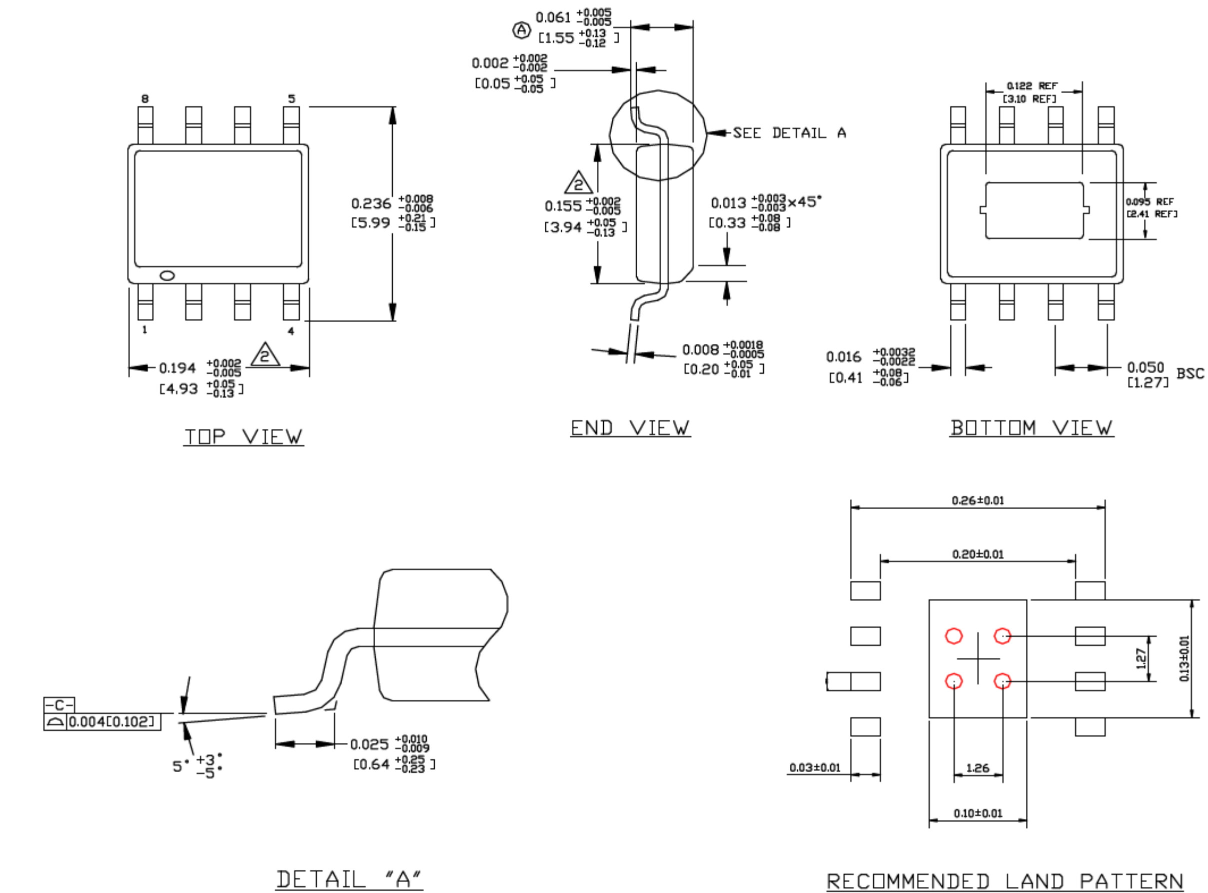
Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

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 customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

TITLE
8 LEAD SOICN EPAD PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOICNEP-8LD-PL-1	**UNIT**	INCH [MM]



NOTE:
1. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL EXCEED 0.006 INCHES PER SIDE
2. RED CIRCLES IN LAND PATTERN REPRESENT THERMAL VIAS. RECOMMENDED SIZE IS 0.30-0.30MM IN DIAMETER AND SHOULD BE CONNECTED TO GND FOR MAXIMUM THERMAL PERFORMANCE

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

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (January 2019)

- Converted Micrel document MAQ5283 to Microchip data sheet template DS20006151A.
- Minor grammatical text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

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

Device	-X.X	X	XX	-XX	XXX
Part No.	Output Voltage	Junction Temp. Range	Package	Media Type	Automotive Option

Device:	MAQ5283:	120V_{IN}, 150 mA, Ultra-Low I_Q, High-PSRR Linear Regulator
Output Voltage:	<blank>= Adjustable 3.3 = 3.3V 5.0 = 5.0V	
Junction Temperature Range:	Y =	–40°C to +125°C, RoHS-Compliant
Package:	ME =	8-Lead ePad SOIC
Media Type:	<blank>= 95/Tube TR = 2,500/Reel T5 = 500/Reel	
Automotive Option:	VAO = Automotive Option	

Examples:

a) MAQ5283YME-VAO: MAQ5283, Adjustable Output Voltage, –40°C to +125°C Temperature Range, 8-Lead ePad SOIC, 95/Tube, Automotive Option

b) MAQ5283-3.3YME-TRVAO: MAQ5283, 3.3V Output Voltage, –40°C to +125°C Temperature Range, 8-Lead ePad SOIC, 2,500/Reel, Automotive Option

c) MAQ5283-5.0YME-T5VAO: MAQ5283, 5.0V Output Voltage, –40°C to +125°C Temperature Range, 8-Lead ePad SOIC, 500/Reel, Automotive Option

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

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.

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.

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