MAQ5282

120V_{IN}, 50mA, Ultra-Low I_Q, High-PSRR Linear Regulator

Automotive

General Description

The MAQ5282 high-performance linear regulator offers a very-wide input operating voltage range, up to 120V DC, and supplies an output current of up to 50mA.

Ideal for high input voltage applications such as automotive, industrial and telecom, the MAQ5282 offers ±3% initial accuracy, extremely high-power supply rejection ratio (80dB at 10kHz) and ultra-low quiescent current of 6µA. The MAQ5282 is optimized for high-voltage line transients, making it ideal for harsh environment applications.

The MAQ5282 is offered in both fixed output voltage (3.3V/5.0V) and adjustable output voltage (1.27V to 5.5V) options.

The MAQ5282 operates over a –40°C to +125°C temperature range and is available in lead-free, RoHS-compliant, 8-pin ePad MSOP package. This part is also AEC-Q100 qualified for automotive applications.

Data sheet and support documentation are found on the Micrel website: www.micrel.com.

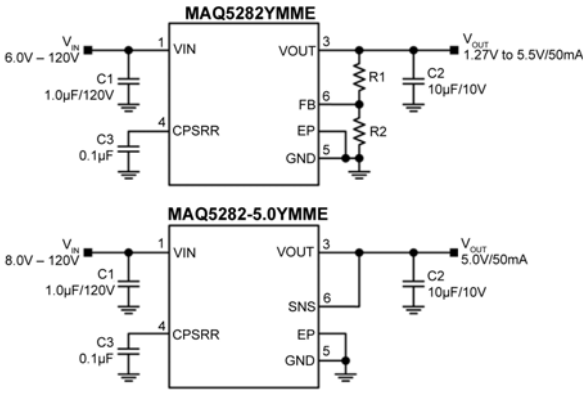
Features

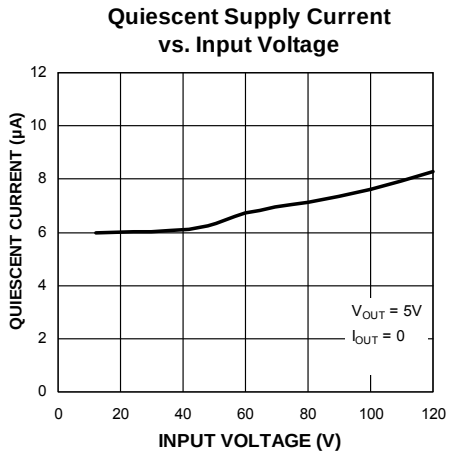
- AEC-Q100 qualified
- Wide input voltage range: 6V to 120V DC
- Ultra-low quiescent current: 6µA (typ)
- 50mA guaranteed output current
- Adjustable output from 1.27V to 5.5V
- Withstands up to +120V DC at the input
- Stable with ceramic capacitors
- Ultra-high PSRR (80dB at 10kHz)
- Ultra-high line transient rejection (load dump)
- High output accuracy:
  - ±3% initial accuracy
- Thermal-shutdown and current-limit protection
- Thermally-efficient, 8-pin ePad MSOP package

Applications

- Automotive
- Remote keyless entry power supply
- Telecom applications

Typical Applications

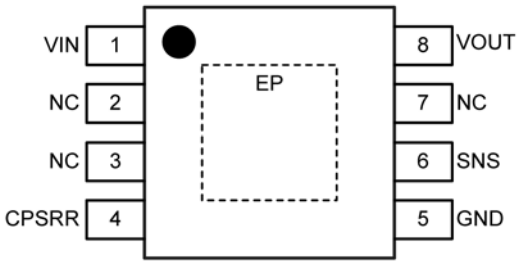




Ordering Information

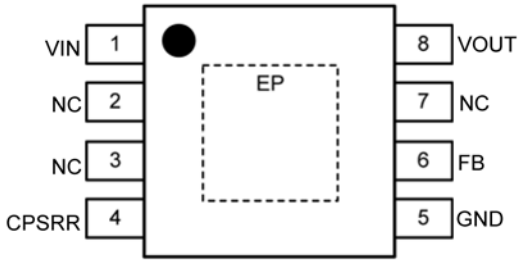
Part Number	Output Voltage	Top Mark	Temperature Range	Package	Lead Finish
MAQ5282YMME	Adjustable	A8Q2	–40°C to +125°C	8-Pin ePad MSOP	Pb-Free
MAQ5282-3.3YMME	3.3V	8Q2S	–40°C to +125°C	8-Pin ePad MSOP	Pb-Free
MAQ5282-5.0YMME	5.0V	58Q2	–40°C to +125°C	8-Pin ePad MSOP	Pb-Free

Pin Configuration



8-Pin ePad MSOP
MAQ5282-x.xYMME

(TOP VIEW)



8-Pin ePad MSOP
MAQ5282YMME

(TOP VIEW)

Pin Description

Pin		Name	Function
MAQ5282YMME	MAQ5282-x.xYMME		
1	1	VIN	Supply Voltage Input. Connect 1µF 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 0.1µF 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 10µF capacitor from VOUT to GND.
EP	EP	ePad	Exposed Pad (ePad) for Thermal Relief. Connect EP to GND.

Absolute Maximum Ratings[1]

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
Power Dissipation (P_D) ..... Internally Limited[3]
Lead Temperature (soldering, 10s) ..... +260°C
Junction Temperature ..... $-40°C \le T_J \le +125°C$
Storage Temperature ..... $-65°C \le T_A \le +150°C$
ESD Ratings[4]
HBM 2kV
MM 200V

Operating Ratings[2]

V_{IN} ..... +6V to +120V
V_{OUT} Adjust Range ..... +1.27V to +5.5V
Junction Temperature ..... $-40°C \le T_J \le +125°C$
Junction Thermal Resistance (θ_{JA})
8-pin ePad MSOP ..... 64°C/W

Electrical Characteristics[5]

V_{IN} = 12V, C_{IN} = 1.0µF, C_{PSRR} = 0.1µF, C_{OUT} = 10µF, I_{OUT} = 100µA, T_A = 25°C, **bold** values indicate $-40°C \le T_J \le +125°C$, unless noted.

Parameter	Condition	Min.	Typ.	Max.	Units
Power Supply Input					
Input Voltage Range[6]		6		120	V
Quiescent Supply Current[7]	I_{OUT} = 0		6	**11**	µA
Output Voltage					
Output Voltage	Adjustable	1.27		5.5	V
	Fixed 3.3V	3.2	3.3	3.4	
		3.13	3.3	**3.47**	
	Fixed 5.0V	4.85	5.0	5.15	
		4.75	5.0	**5.25**	
Output Voltage Accuracy	Variation from nominal V_{OUT}	-3		+3	%
		-5		**+5**	%
Load Regulation	I_{OUT} = 100µA to 50mA	**-1.0**	0.5	**+1.0**	%
Line Regulation[8]	V_{IN} = 10V to 120V	**-0.5**	0.04	**+0.5**	%/V
Feedback Input (Adjustable)					
FB Voltage		1.232	1.270	1.308	V
		1.206	1.270	**1.333**	
FB Current	V_{FB} = 1.27V		3.2		nA
Current Limit					
Current Limit	V_{OUT} = 0V	**60**	125	**260**	mA
Ripple Rejection					
Power Supply Rejection Ratio	f = 20kHz to 1MHz		80		dB

Electrical Characteristics[5] (Continued)

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

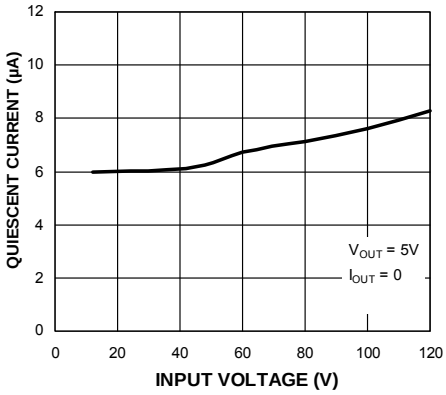
Parameter	Condition	Min.	Typ.	Max.	Units
Power Dropout Voltage					
Dropout Voltage	I_{OUT} = 50mA		2	**3**	V
Thermal Protection					
Thermal-Shutdown Temperature	T_J rising		157		°C
Thermal-Shutdown Hysteresis			15		°C

Notes:

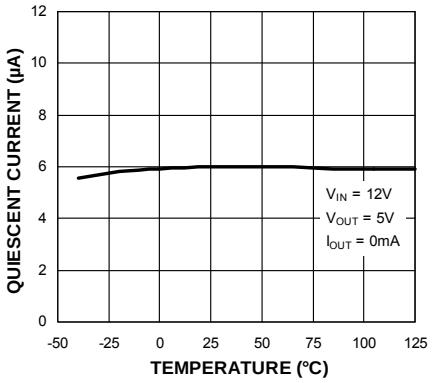
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. The maximum allowable power dissipation at any T_A (ambient temperature) is $P_{D(max)} = (T_{J(max)} - T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation results in excessive die temperature, and causes the regulator to enter thermal shutdown.
4. Devices are ESD sensitive; use proper handling precautions. Human body model, 1.5kΩ in series with 100pF.
5. Specifications are for packaged products only.
6. Assure that $V_{IN} \geq (V_{OUT} + 3V)$ and $V_{IN} \geq 6V$.
7. Quiescent current is specified for the adjustable option. The fixed options will add approximately 1µA due to the internal feedback resistors.
8. Line regulation is a percentage of V_{OUT}.

Typical Characteristics

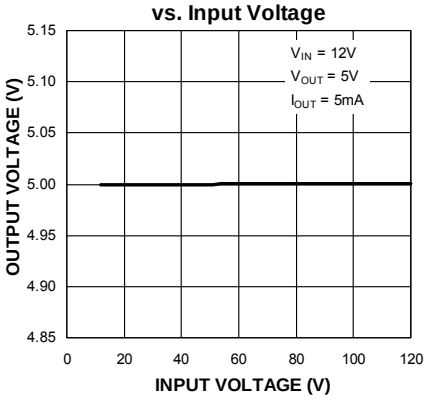
Quiescent Supply Current vs. Input Voltage



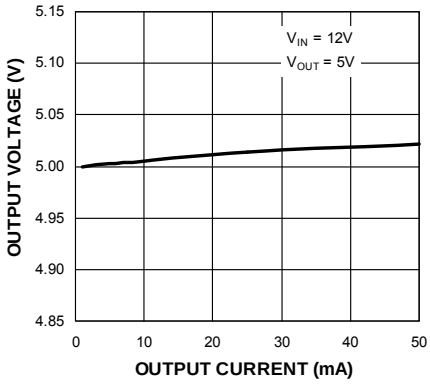
Quiescent Supply Current vs. Temperature



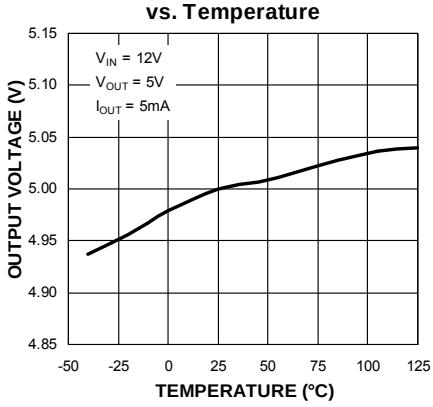
Output Voltage vs. Input Voltage



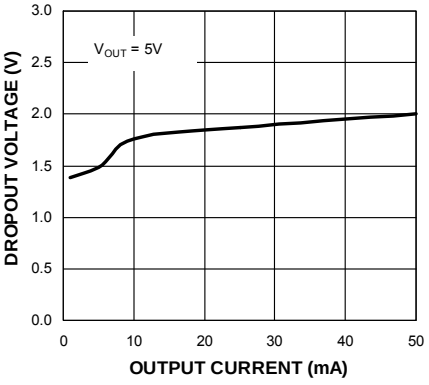
Output Voltage vs. Output Current



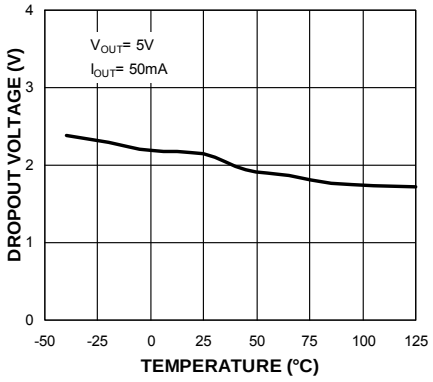
Output Voltage vs. Temperature



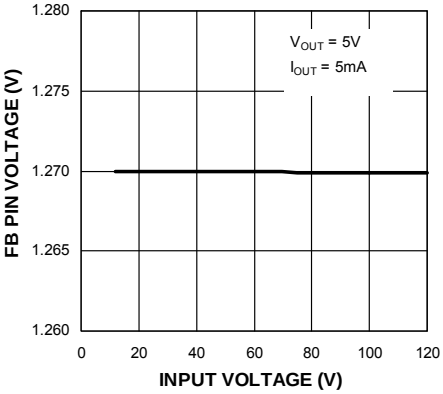
Dropout Voltage vs. Output Current



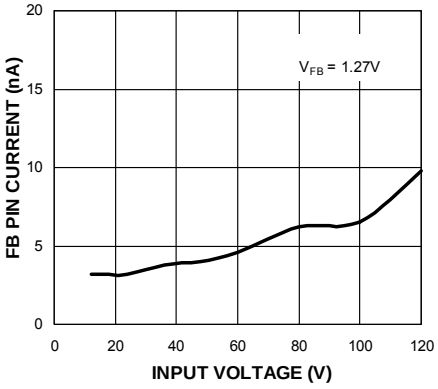
Dropout Voltage vs. Temperature



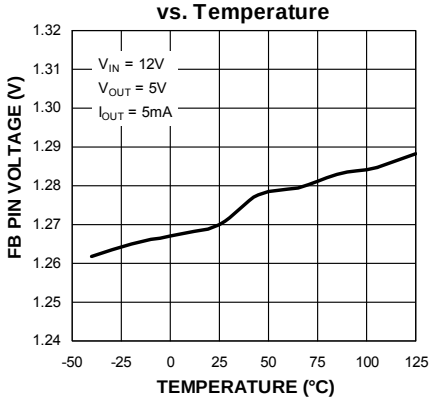
Feedback Pin Voltage vs. Input Voltage

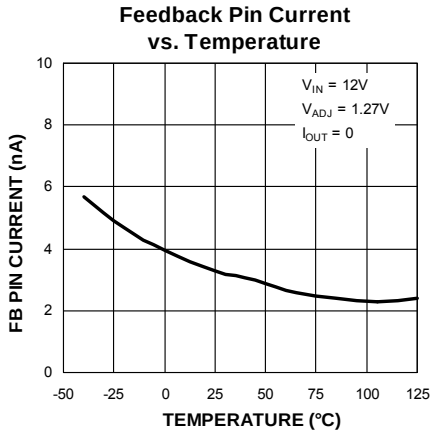


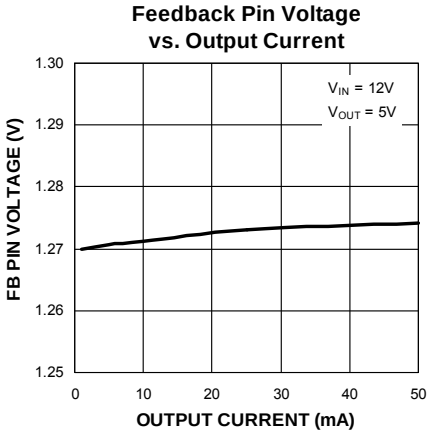
Feedback Pin Current vs. Input Voltage

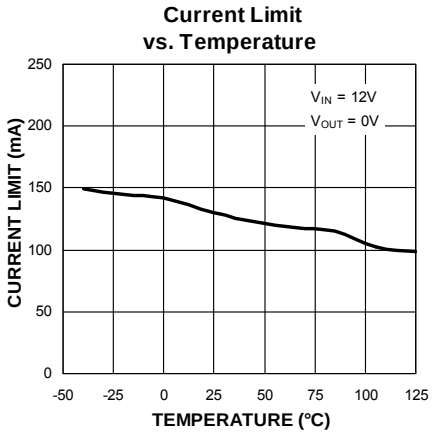


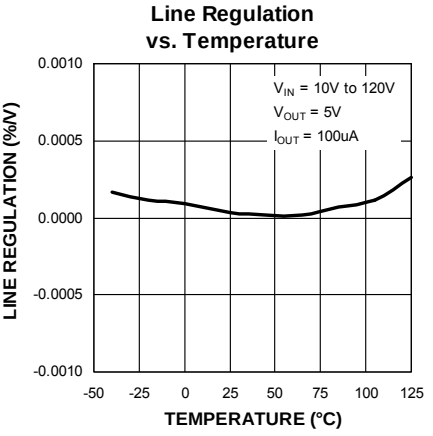
Typical Characteristics (Continued)

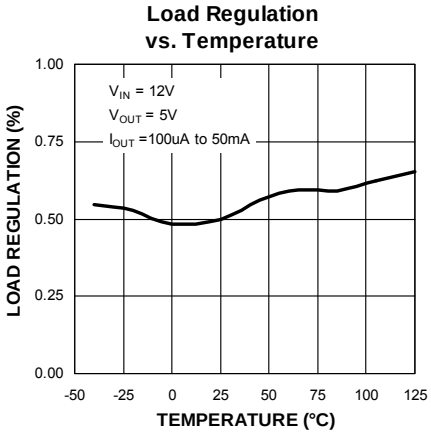


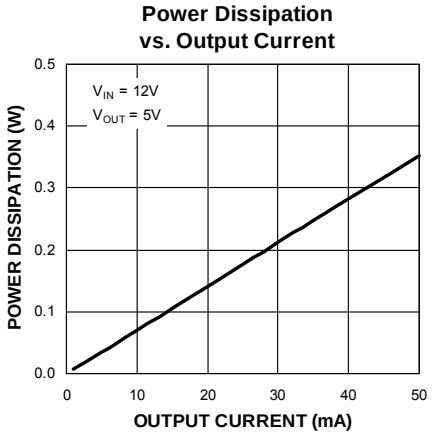


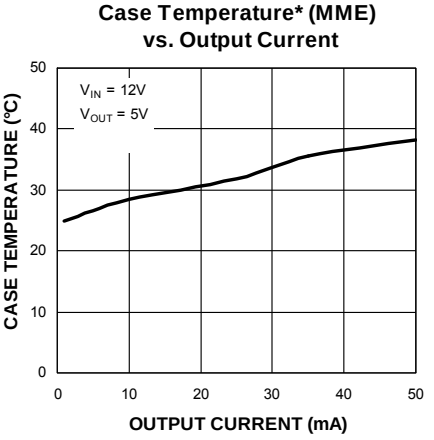


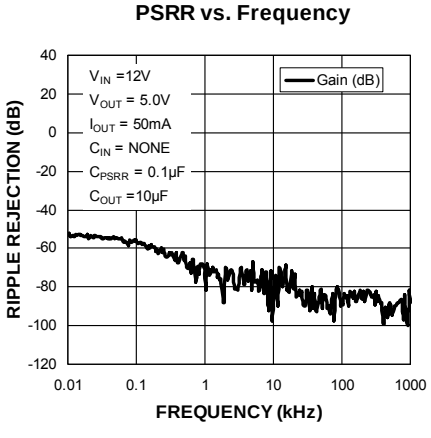








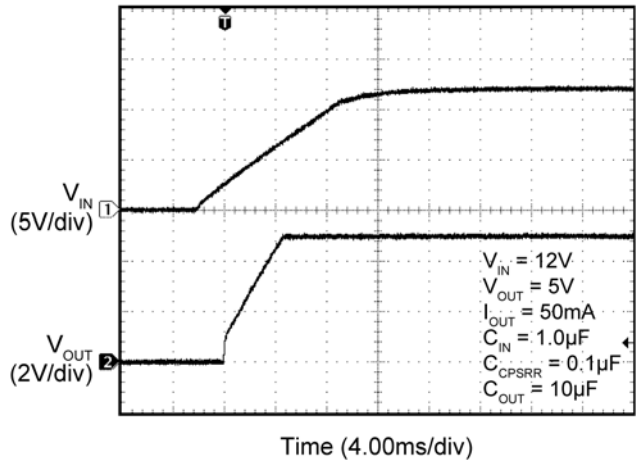




Case Temperature*: The temperature measurement was taken at the hottest point on the MAQ5282 case mounted on a 2.25 square inch PCB at an ambient temperature of 25°C; see “Thermal Measurement” section. Actual results will depend upon the size of the PCB, ambient temperature and proximity to other heat emitting components.

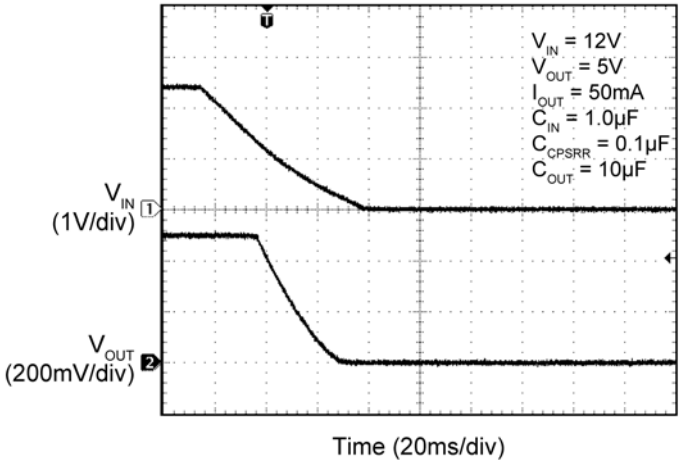
Functional Characteristics

Soft Turn-On into Full Load



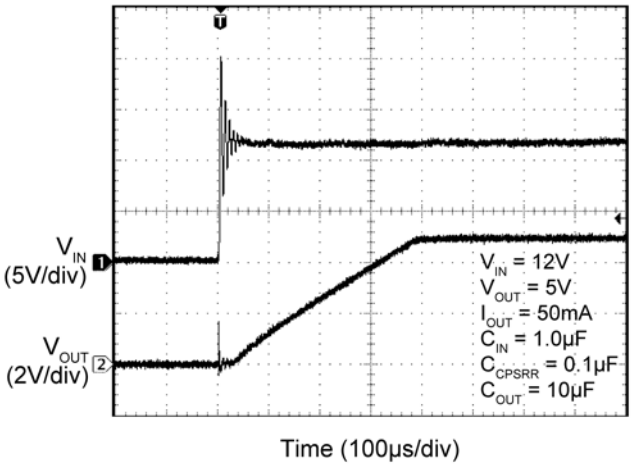
Time (4.00ms/div)

Soft Turn-Off



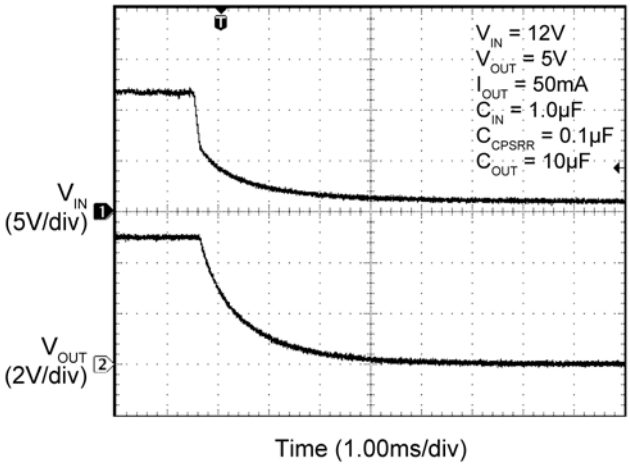
Time (20ms/div)

Hot Plug



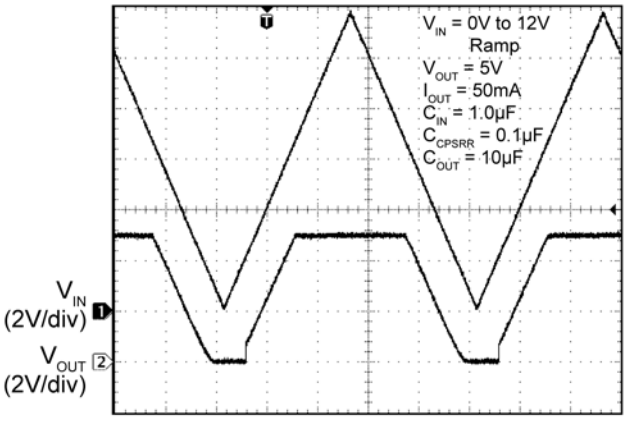
Time (100µs/div)

Hot Un-Plug



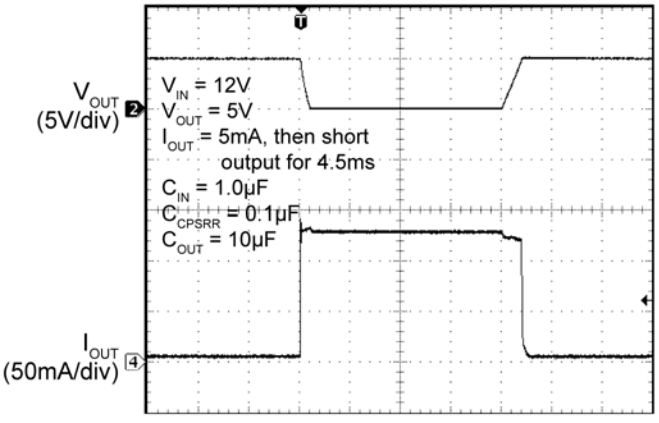
Time (1.00ms/div)

V_{IN} UVLO Threshold



Time (200ms/div)

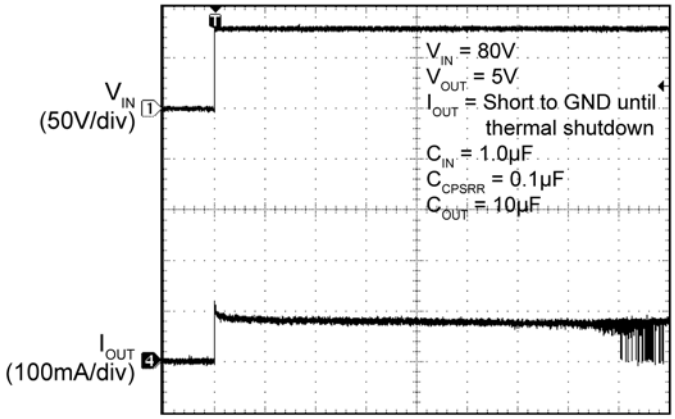
Current Limit



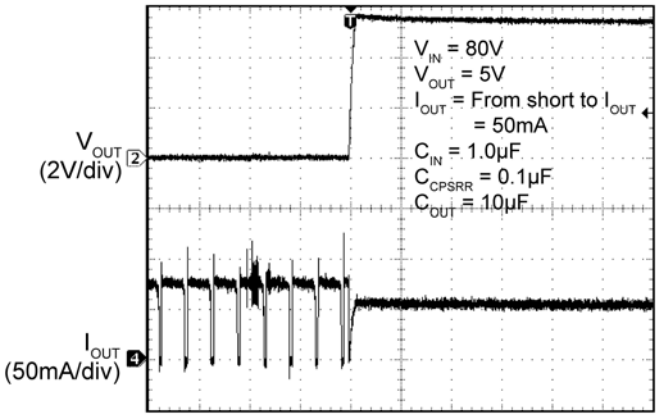
Time (1.00ms/div)

Functional Characteristics (Continued)

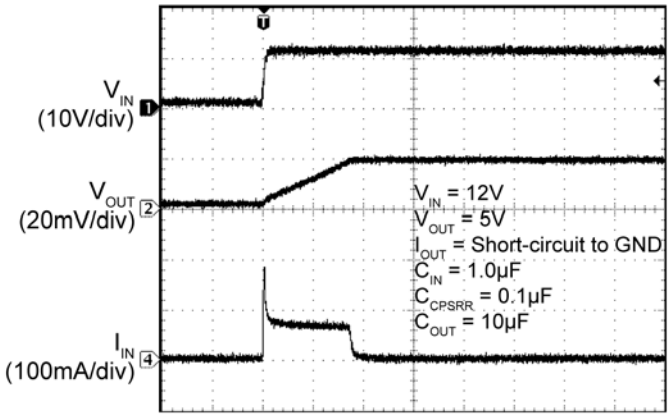
Thermal-Shutdown Response



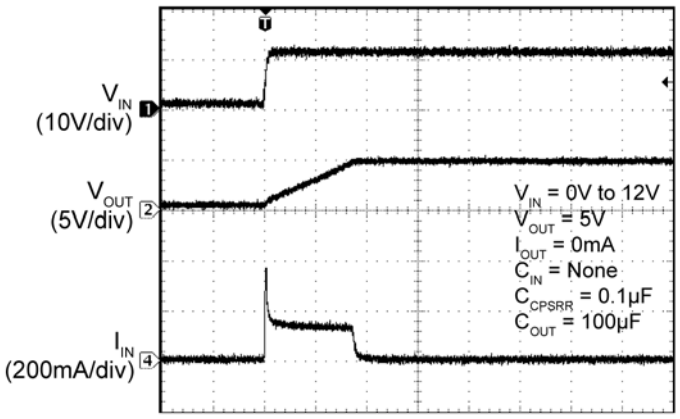
V_{OUT} Recovery from Thermal Shutdown



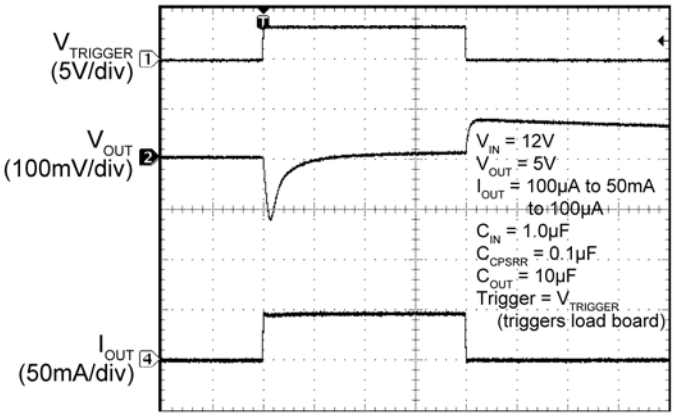
Turn-On into Short Circuit



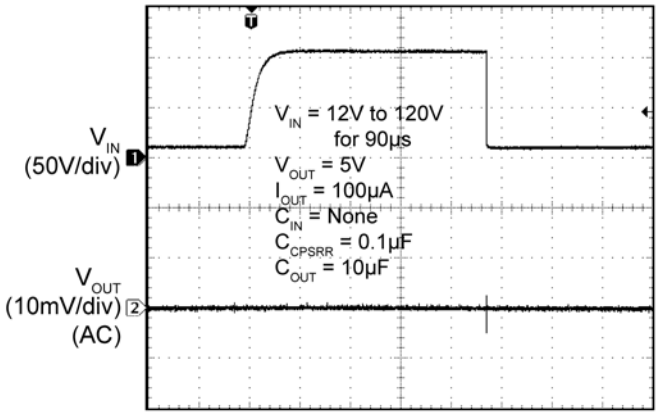
Inrush Current Response



Load Transient Response



Line Transient Response



Detailed Description

The MAQ5282 voltage regulator accepts a 6V to 120V input and has an ultra-low 6µA typical quiescent current while offering an excellent line transient response and PSRR. These features make it ideal for harsh, noisy environments. All options of the device offer 50mA of output current. The MAQ5282YMME offer an adjustable output voltage from 1.27V to 5.5V. The MAQ5282-3.3YMME offer fixed 3.3V outputs and the MAQ5282-5.0YMME offer fixed 5.0V outputs. The YMME packaged devices feature a heat slug to more effectively remove heat from the die.

Applications Information

Thermal Protection

The MAQ5282 has an internal thermal shutdown circuit 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 will result in a cycled output during continuous thermal-overload conditions.

Current Limit

The MAQ5282 features output current-limit protection. The output sustains a continuous short circuit to GND without damage to the device, but thermal shutdown often results.

Input Capacitor

Connect a 1µF capacitor from VIN to GND. Micrel recommends the C5750X7R2E105M, 1µF, 250V capacitor made by TDK. When using a different capacitor, assure that the voltage rating of the capacitor exceeds any potential transient.

CPSRR Capacitor

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

Output Capacitor

Connect a 10µF capacitor from VOUT to GND. Assure that the voltage rating of the capacitor exceeds the designed output voltage of the MAQ5282.

Output Voltage Setting

For the MAQ5282YMME, V_{OUT} is programmed from 1.27V to 5.5V using:

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

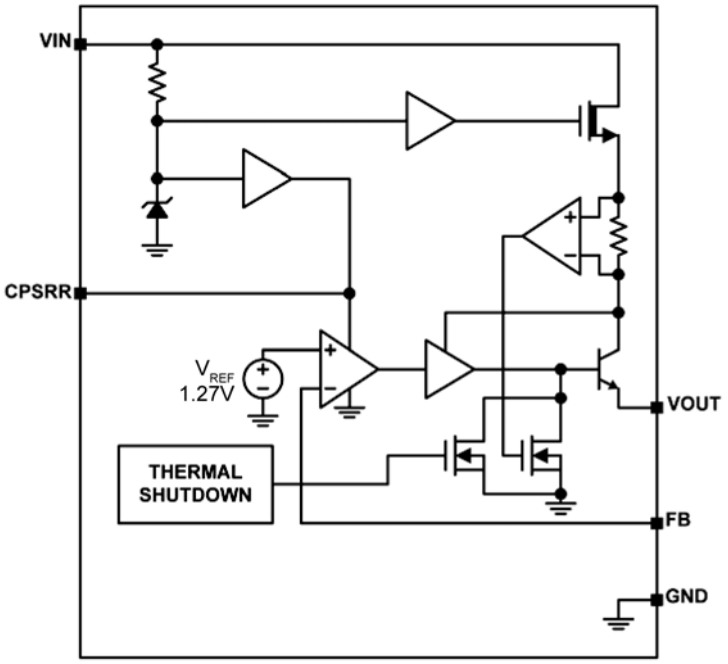
where V_{REF} = 1.27V, and R1 and R2 are shown in the Typical Applications circuit.

Thermal Measurements

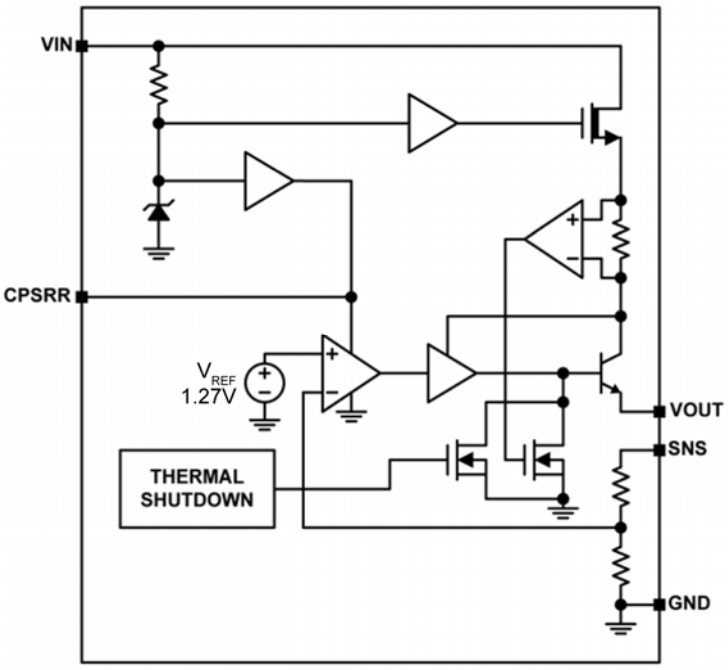
It is always wise to measure an IC's case temperature to make sure that it is within operating limits, but it is easy to get erroneous results. The standard thermocouple that comes with many voltage meters uses a large wire gauge that behaves like a heat-sink, resulting in artificially low case temperature 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 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 1mm spot size, 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.

Functional Diagram

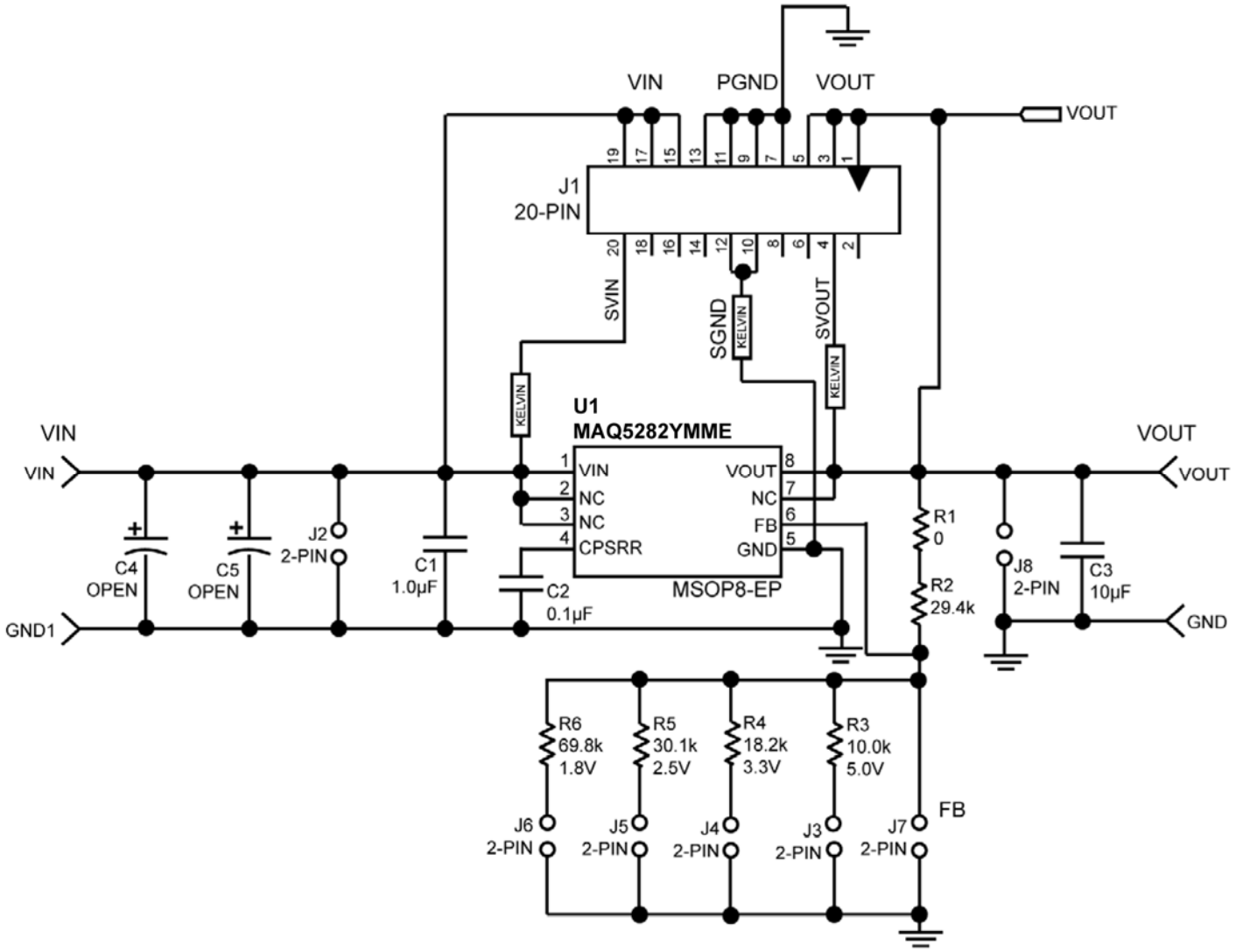


MAQ5282 Adjustable Version



MAQ5282 Fixed Version

MAQ5282 Evaluation Board Schematic



MAQ5282 Evaluation Board Schematic

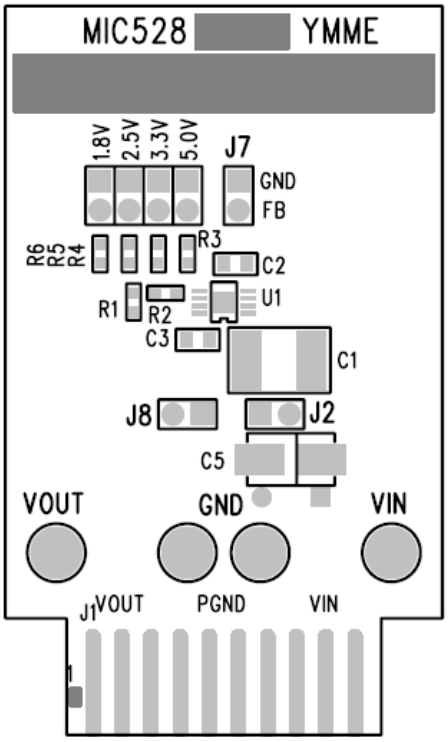
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1	C5750X7R2E105 M	TDK[1]	1.0µF, 250V, 20%, X7R capacitor (2220)	1
C2	08053C104KAT2A	AVX[2]	0.1µF 25V 20%, X7R capacitor (0805)	1
C3	0805ZD106KAT2A	AVX	10µF, 10V, 20%, X5R, capacitor (0805)	1
C4, C5	OPEN			0
R1	CRCW06030000F	Vishay/Dale[3]	0Ω, 1% resistor, 0603	1
R2	CRCW06032942F	Vishay/Dale	29.4kΩ, 1% resistor, 0603	1
R3	CRCW06031002F	Vishay/Dale	10.0kΩ, 1% resistor, 0603	1
R4	CRCW06031822F	Vishay/Dale	18.2kΩ, 1%, resistor, 0603	1
R5	CRCW06033012F	Vishay/Dale	30.1kΩ, 1% resistor chip, 0603	1
R6	CRCW06036982F	Vishay/Dale	69.8kΩ, 1%, resistor, 0603	1
U1	**MAQ5282YMME**	**Micrel[4]**	**120V_{IN}, 50mA, Ultra-Low I_Q, High-PSRR Linear Regulator**	**1**

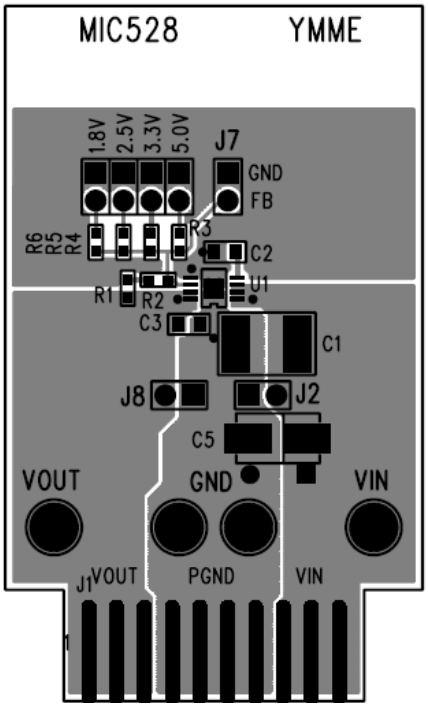
Notes:

1. TDK: www.tdk.com.
2. AVX.: www.avx.com.
3. Vishay Tel: www.vishay.com.
4. **Micrel, Inc.: www.micrel.com.**

PCB Evaluation Board Layout

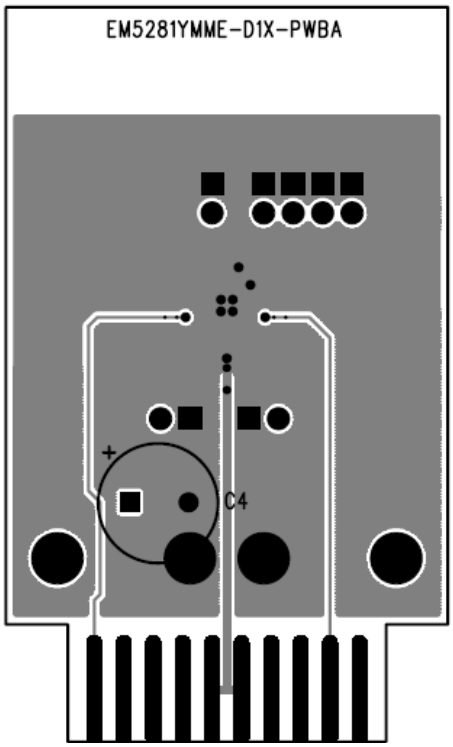


Top Layer Silk Screen

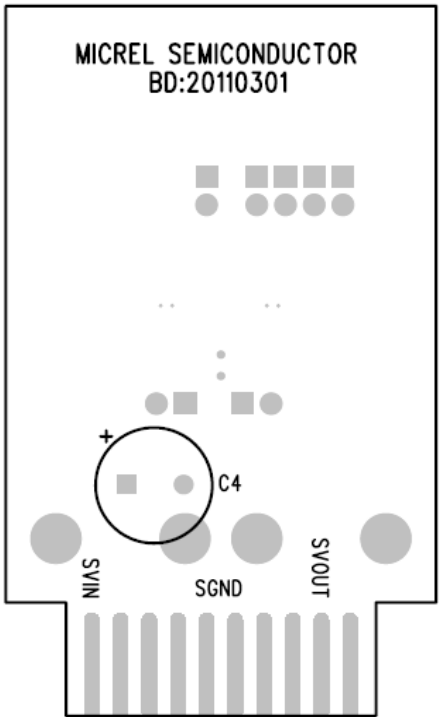


Top Layer Traces

PCB Evaluation Board Layout (Continued)

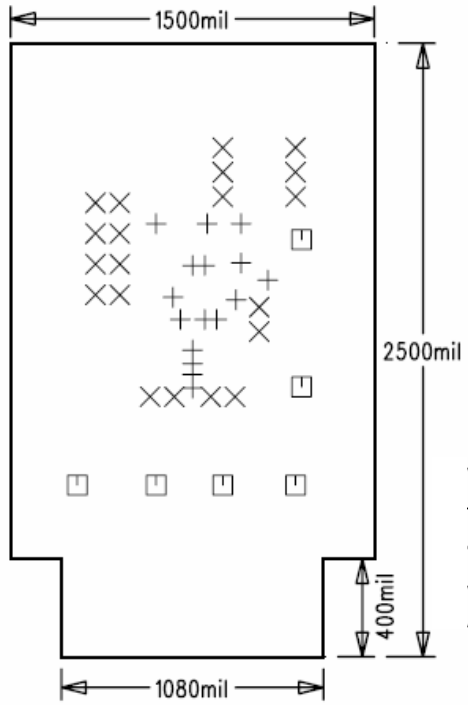


Bottom Layer Traces



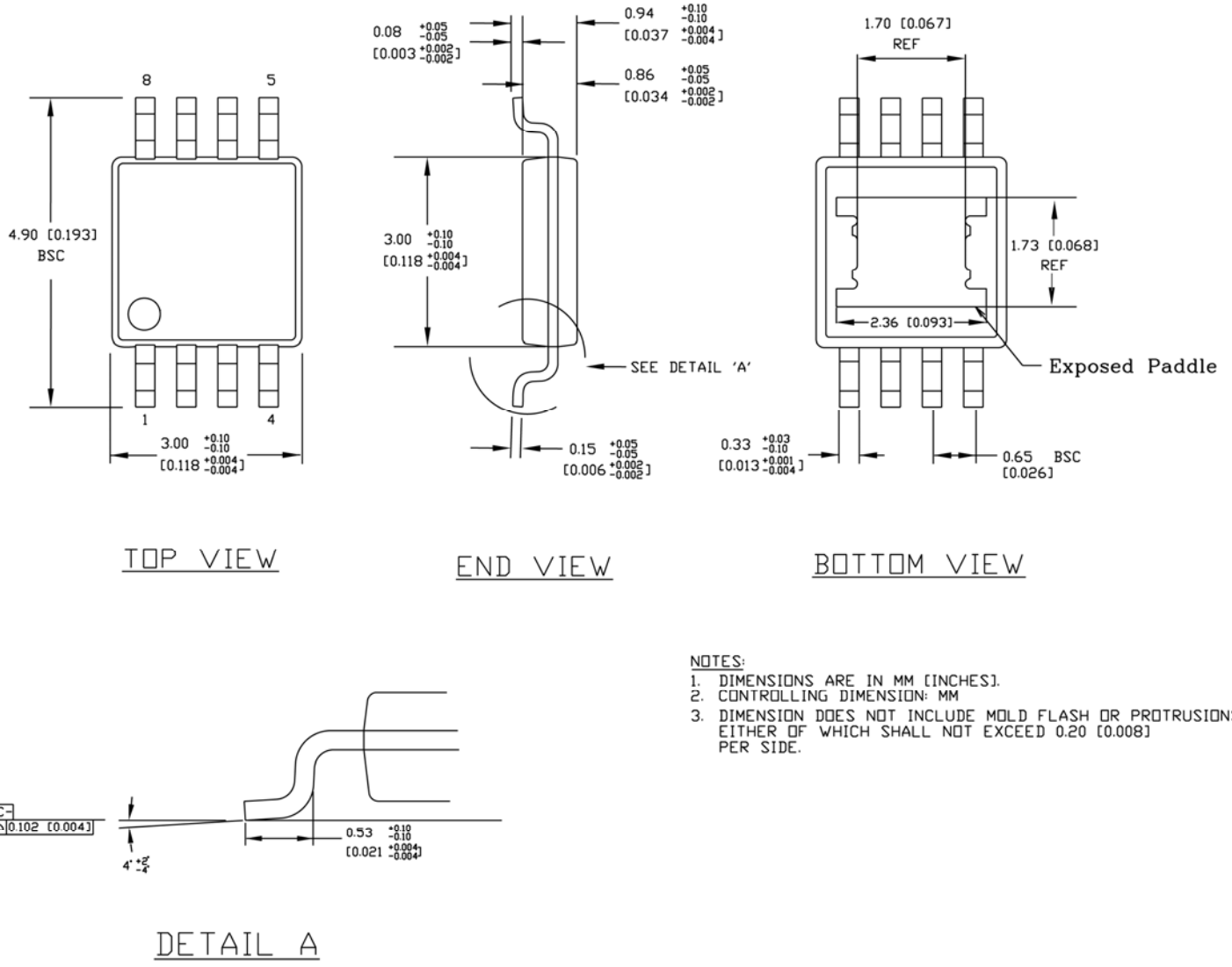
Bottom Layer Silk Screen

PCB Evaluation Board Layout (Continued)



EV Board Dimensions

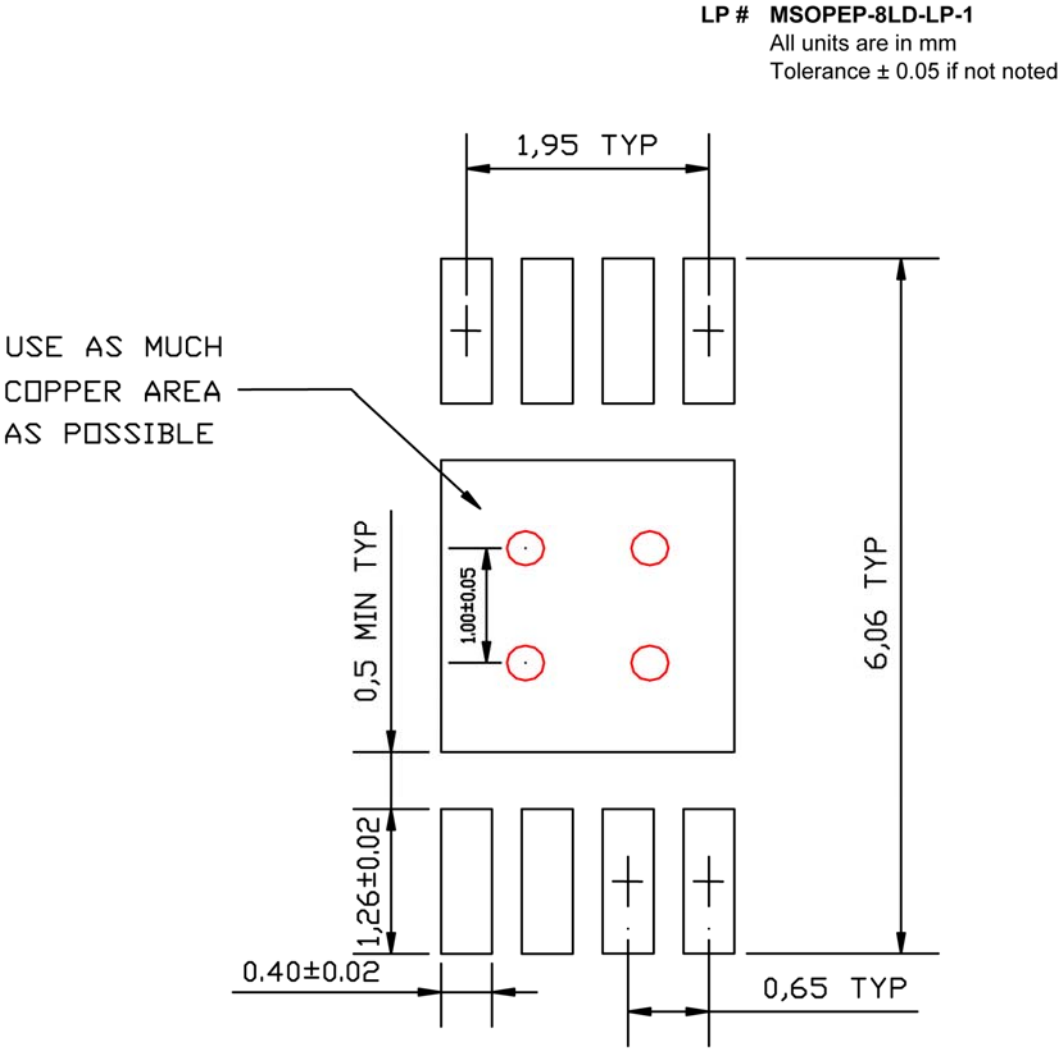
Package Information



NOTES:
1. DIMENSIONS ARE IN MM [INCHES].
2. CONTROLLING DIMENSION: MM
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.20 [0.008] PER SIDE.

8-Pin Exposed Pad (ePad) MSOP (MME)

Recommended Landing Pattern



8-Pin Exposed Pad (ePad) MSOP (MME)

Red circle indicates Thermal Via. Size should be .300mm – .350mm in diameter, 1.00mm pitch, and it should be connected to GND plane for maximum thermal performance.

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