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MIC5281

120V_{IN}, 25mA, Ultra-Low IQ, High-PSRR Linear Regulator

General Description

The MIC5281 high-performance linear regulator offers a very-wide input operating voltage range, up to 120V DC, and supplies an output current of up to 25mA.

Ideal for high input voltage applications such as industrial and telecom, the MIC5281 offers ±3% initial accuracy, extremely high-power supply rejection ratio (>90db) and ultra-low quiescent current of 6µA. The MIC5281 is optimized for high-voltage line transients, making it ideal for harsh environment applications.

The MIC5281 is offered in both fixed output voltage (3.3V/5.0V) and adjustable output voltage (1.27V to 5.5V) options.

The MIC5281 operates over a –40ºC to +125ºC temperature range and is available in lead-free, RoHS-compliant, 8-pin ePad MSOP, and 8-pin MSOP packages

Datasheets and support documentation are available on Micrel's web site at: www.micrel.com.

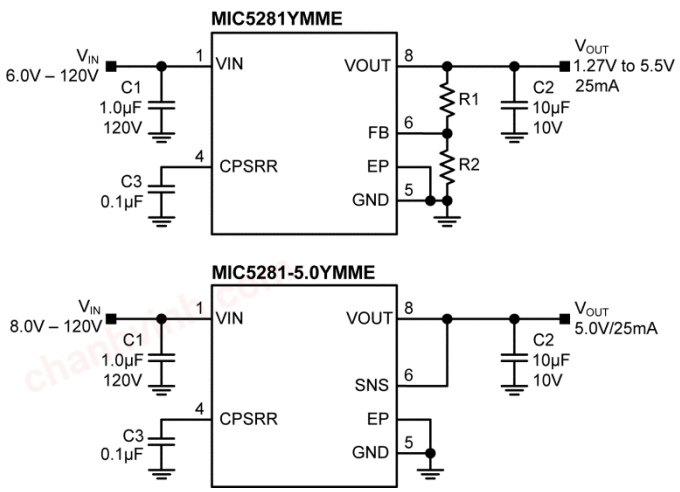
Features

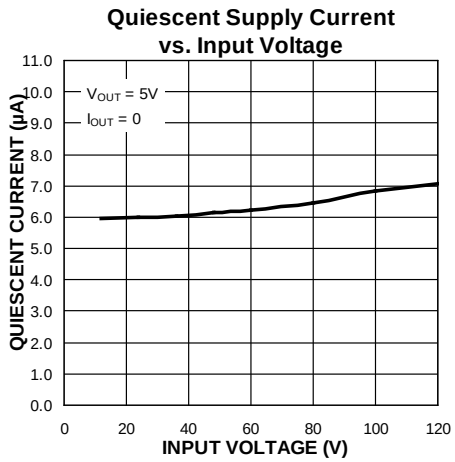
- Wide input voltage range: 6V to 120V DC
- Ultra-low quiescent current: 6µA
- 25mA guaranteed output current
- Adjustable output from 1.27V to 5.5V
- Withstands up to +120V DC at the input
- Stable with ceramic capacitors
- Ultra-high PSRR >90dB
- Ultra-high line rejection (load dump)
- High output accuracy:
  - ±3% initial accuracy
- Thermal-shutdown and current-limit protection:
  - Thermally-efficient, 8-pin MSOP, and 8-pin ePad MSOP packages

Applications

- Industrial applications
- Remote keyless entry power supply
- Telecom applications
- Off-line power supplies

Typical Application



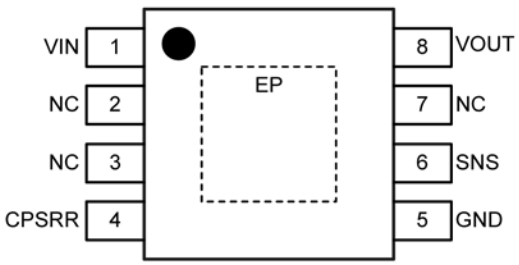


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Ordering Information

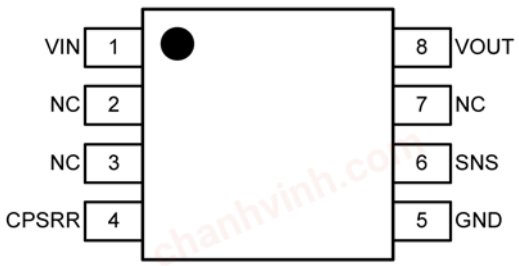
Part Number	Output Voltage	Top Mark	Temperature Range	Package	Lead Finish
MIC5281YMME	Adjustable	781A	–40°C to +125°C	8-Pin ePad MSOP	Pb-Free
MIC5281-3.3YMME	3.3V	781S	–40°C to +125°C	8-Pin ePad MSOP	Pb-Free
MIC5281-5.0YMME	5.0V	7815	–40°C to +125°C	8-Pin ePad MSOP	Pb-Free
MIC5281YMM	Adjustable	5281 YMM	–40°C to +125°C	8-Pin MSOP	Pb-Free
MIC5281-3.3YMM	3.3V	5281 3.3Y	–40°C to +125°C	8-Pin MSOP	Pb-Free
MIC5281-5.0YMM	5.0V	5281 5.0Y	–40°C to +125°C	8-Pin MSOP	Pb-Free

Pin Configuration



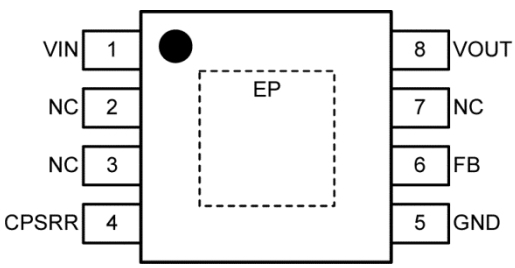
8-Pin ePAD MSOP
MIC5281-x.xYMME

(TOP VIEW)



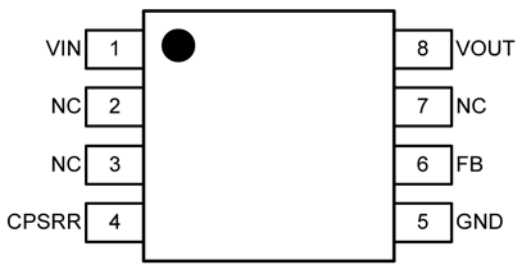
8-Pin MSOP
MIC5281-x.xYMM

(TOP VIEW)



8-Pin ePAD MSOP
MIC5281YMME

(TOP VIEW)



8-Pin MSOP
MIC5281YMM

(TOP VIEW)

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Pin Description

Pin				Name	Function
MIC5281YMME	MIC5281-x.xYMME	MIC5281YMM	MIC5281-x.xYMM		
1	1	1	1	VIN	Supply Voltage Input. Connect 1µF capacitor from VIN to GND.
2, 3, 7	2, 3, 7	2, 3, 7	2, 3, 7	NC	Not internally connected. Connect NC to GND or leave unconnected.
4	4	4	4	CPSRR	Bypass Capacitor Connection. Connect 0.1µF capacitor from CPSRR to GND.
5	5	5	5	GND	Ground.
6	–	6	–	FB	Feedback Connection. For external resistor divider to set V_{OUT}.
–	6	–	6	SNS	Sense input. Connect SNS to VOUT.
8	8	8	8	VOUT	Regulator Output. Connect 10µF capacitor from VOUT to GND.
EP	EP	–	–	EP	Exposed Pad (ePad) for Thermal Relief. Connect EP to GND.

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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
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 ..... $-40°C \le T_J \le +125°C$
Power Dissipation (P_D) ..... Internally Limited[3]
Junction Thermal Resistance (θ_{JA})
8-pin ePad MSOP ..... 64°C/W
8-pin MSOP ..... 160°C/W

Electrical Characteristics[5]

V_{IN} = 12V, C_{IN} = 1.0µF, C_{PSRR} = 0.1µF, C_{OUT} = 10µF, V_{OUT} = 5.0V or 3.3V, 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	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 25mA	**–1.0**	0.2	**+1.0**	%
Line Regulation[7]	V_{IN} = 10V to 120V	**–0.5**	0.04	**+0.5**	%
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	**30**	65	**130**	mA
Ripple Rejection					
Power Supply Rejection Ratio	f = 20kHz to 2MHz		90		dB

Notes:

1. Exceeding an 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 $V_{IN} \ge (V_{OUT} + 3V)$ and $V_{IN} \ge 6V$.
7. Line regulation is a percentage of V_{OUT}.

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Electrical Characteristics[5] (Continued)

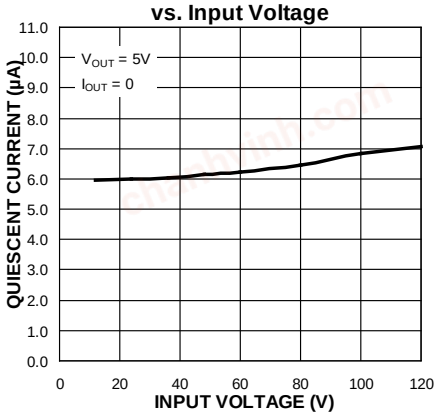
V_{IN} = 12V, C_{IN} = 1.0µF, C_{PSRR} = 0.1µF, C_{OUT} = 10µF, V_{OUT} = 5.0V or 3.3V, I_{OUT} = 100µA, T_A = 25°C, **bold** values indicate –40°C ≤ T_J ≤ +125°C, unless noted.

Parameter	Condition	Min.	Typ.	Max.	Units
Power Dropout Voltage					
Dropout Voltage	I_{OUT} = 25mA		2	**3**	V
Thermal Protection					
Thermal-Shutdown Temperature	T_J rising		157		°C
Thermal-Shutdown Hysteresis			15		°C

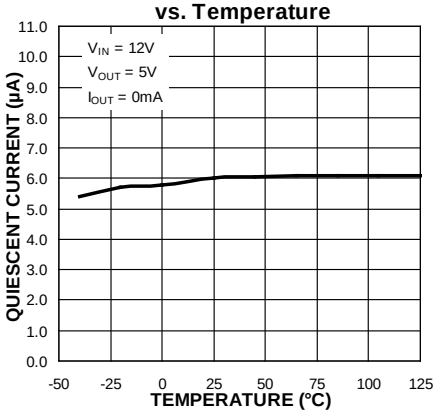
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Typical Characteristics

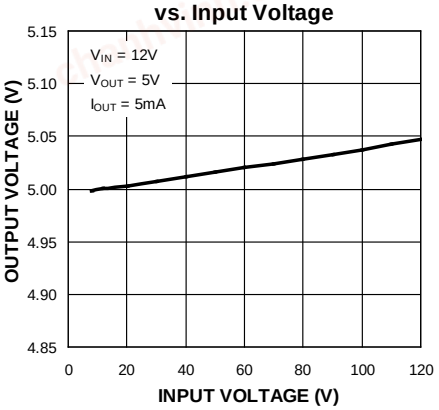
Quiescent Supply Current vs. Input Voltage



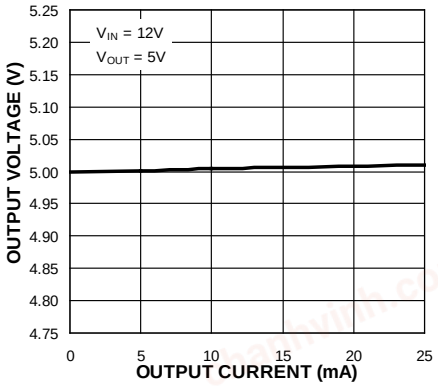
Quiescent Supply Current vs. Temperature



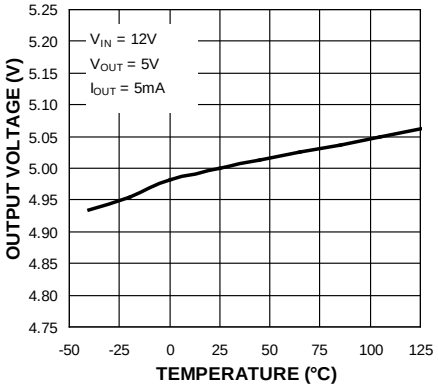
Output Voltage vs. Input Voltage



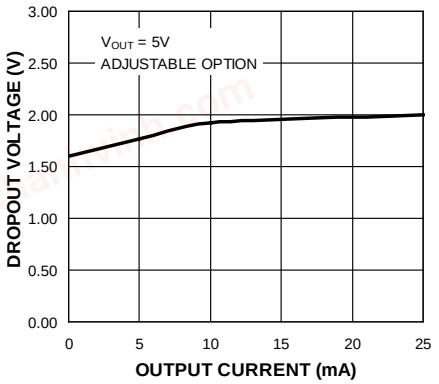
Output Voltage vs. Output Current



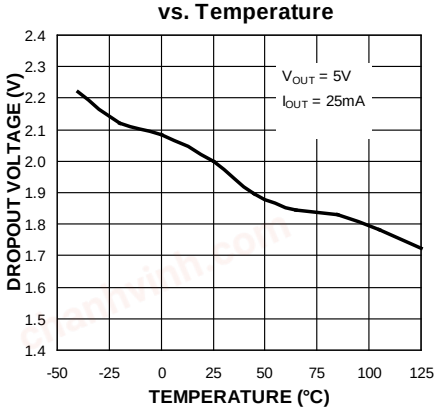
Output Voltage vs. Temperature



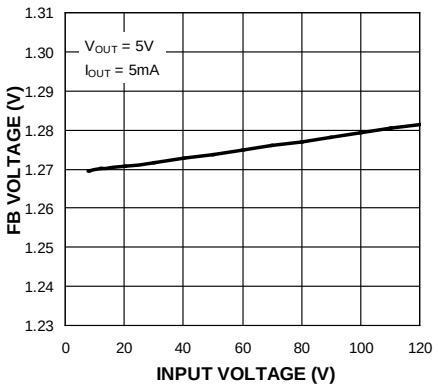
Dropout Voltage vs. Output Current



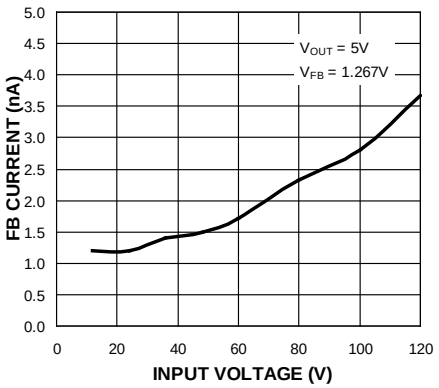
Dropout Voltage vs. Temperature



FB Voltage vs. Input Voltage



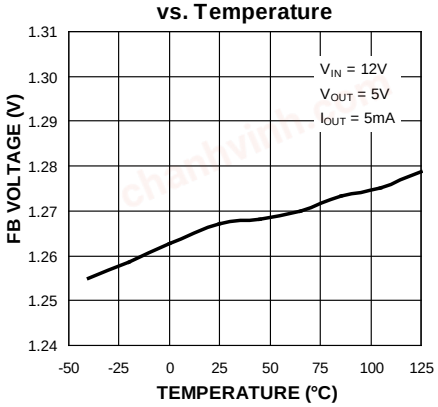
FB Current vs. Input Voltage



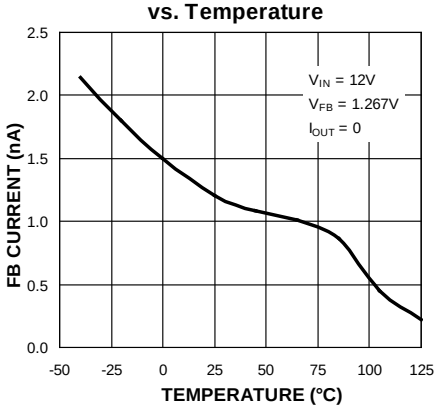
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Typical Characteristics (Continued)

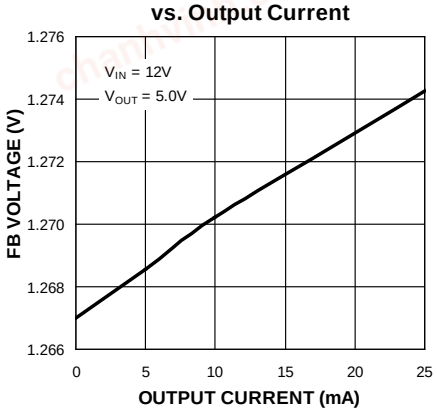
FB Voltage vs. Temperature



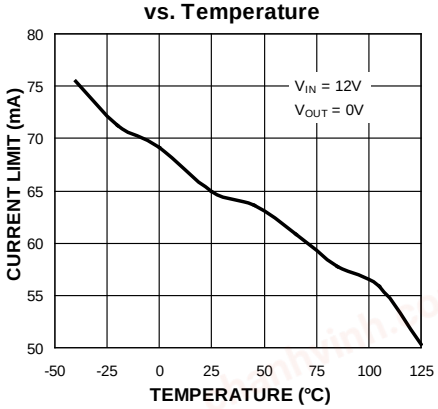
FB Current vs. Temperature



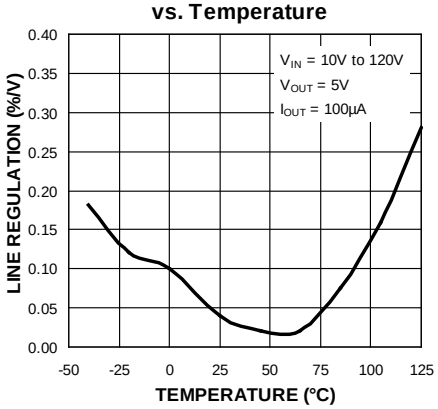
FB Voltage vs. Output Current



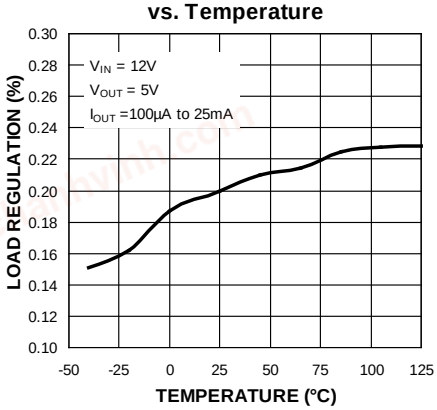
Current Limit vs. Temperature



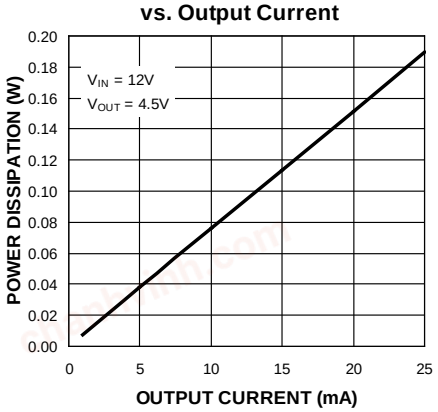
Line Regulation vs. Temperature



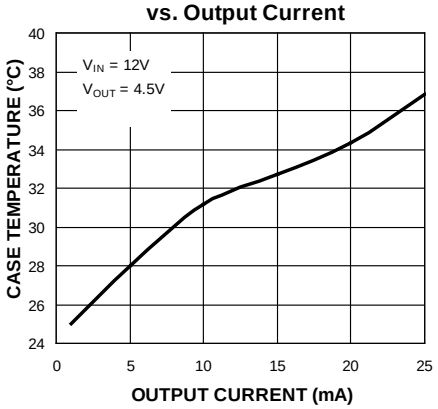
Load Regulation vs. Temperature



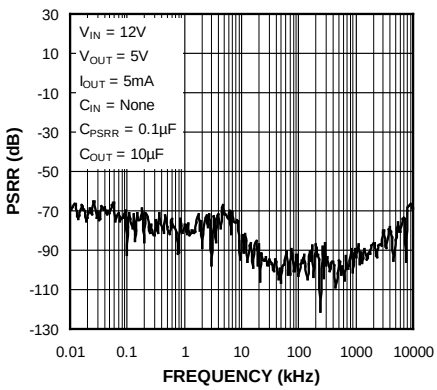
Power Dissipation vs. Output Current



Case Temperature (MME) vs. Output Current



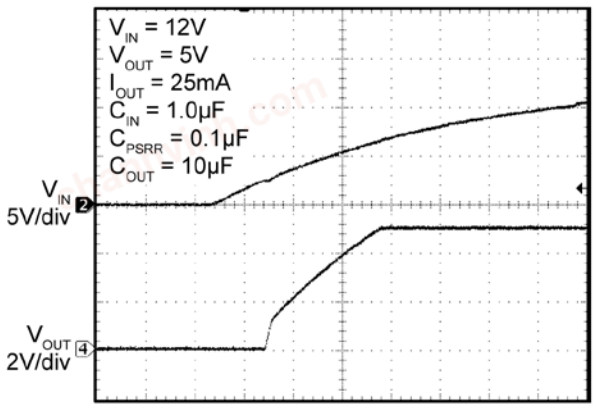
PSRR vs. Frequency



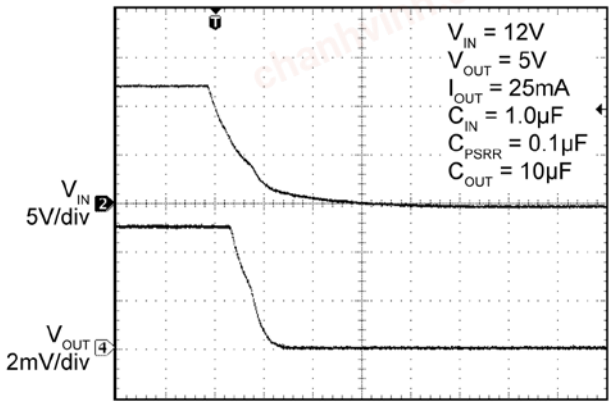
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Functional Characteristics

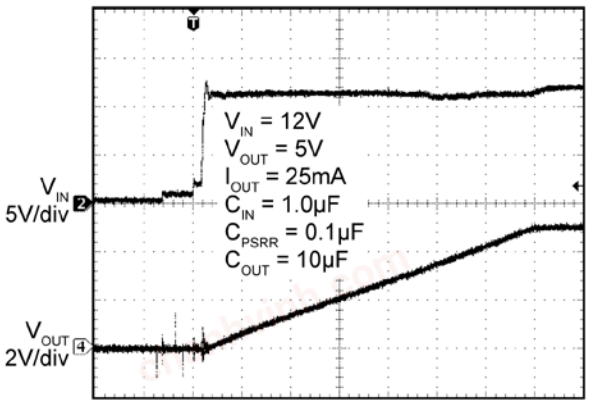
Soft Turn-On into Full Load



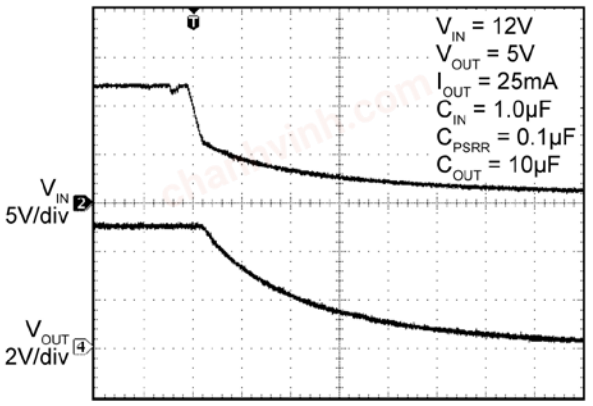
Soft Turn-Off



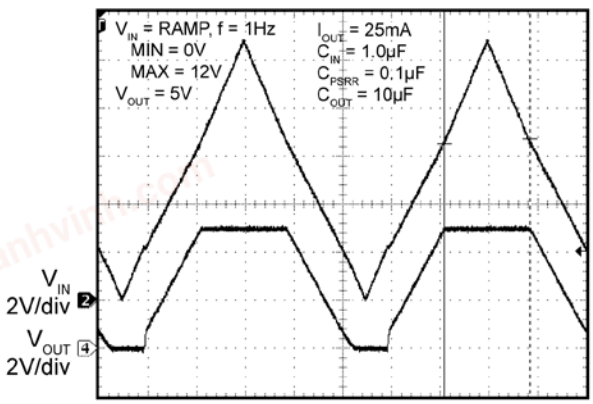
Hot Plug



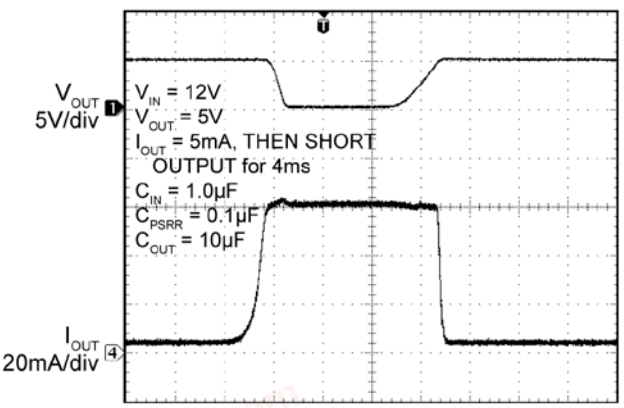
Hot Un-Plug



Turn-On and Turn-Off



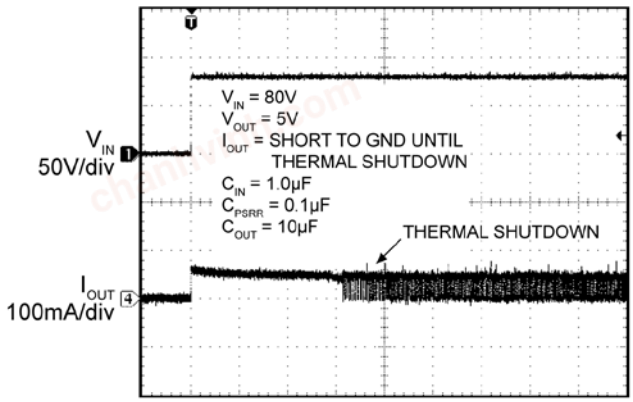
Current Limit



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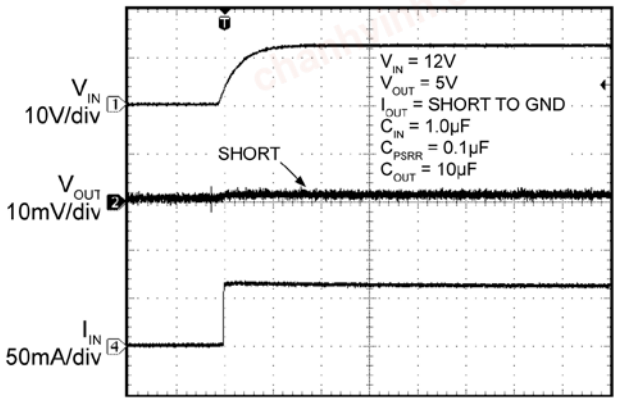
Functional Characteristics (Continued)

Thermal Shutdown, Short Circuit



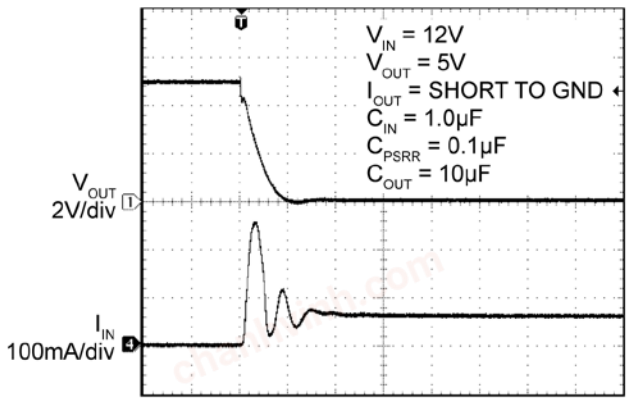
Time (100ms/div)

Turn-On into Short Circuit



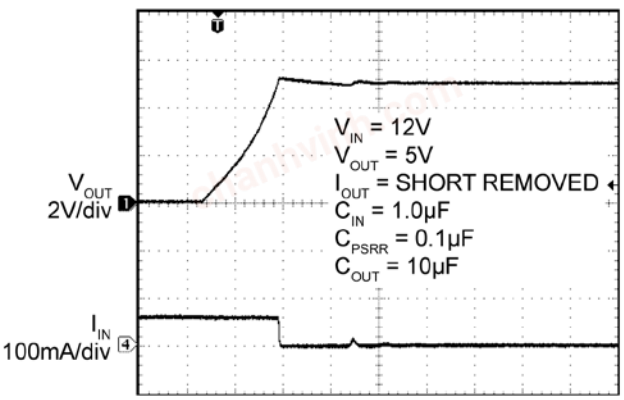
Time (40ms/div)

Short-Circuit Response



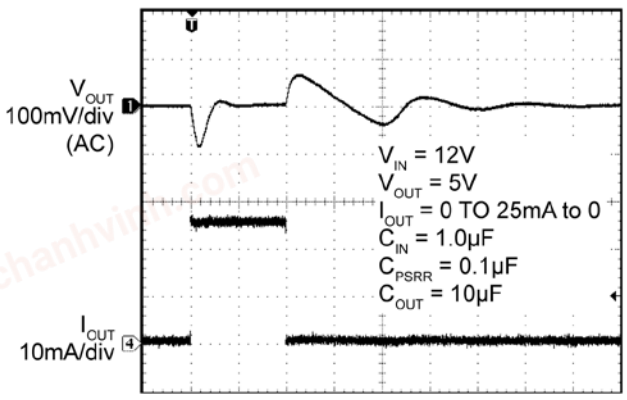
Time (4.0µs/div)

Short-Circuit Output Voltage Recovery



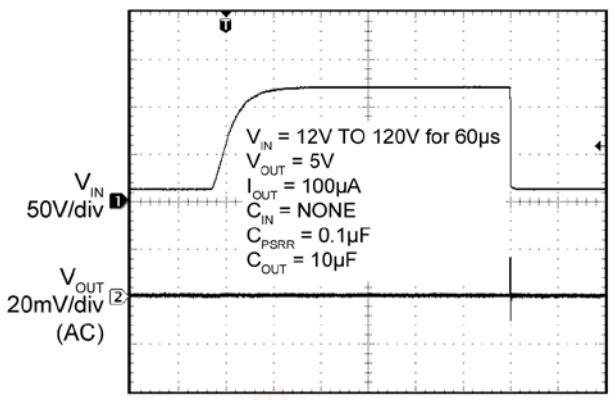
Time (400µs/div)

Load Transient Response



Time (100µs/div)

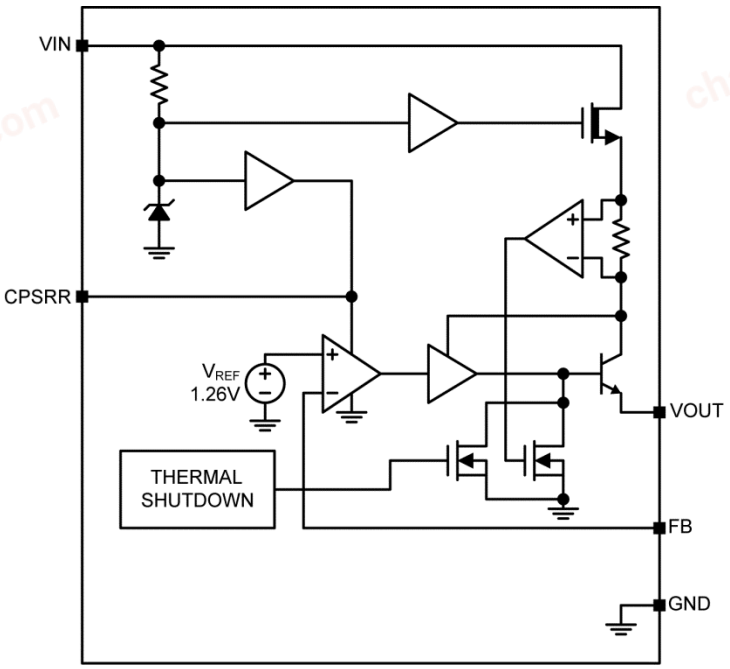
Line Transient Response



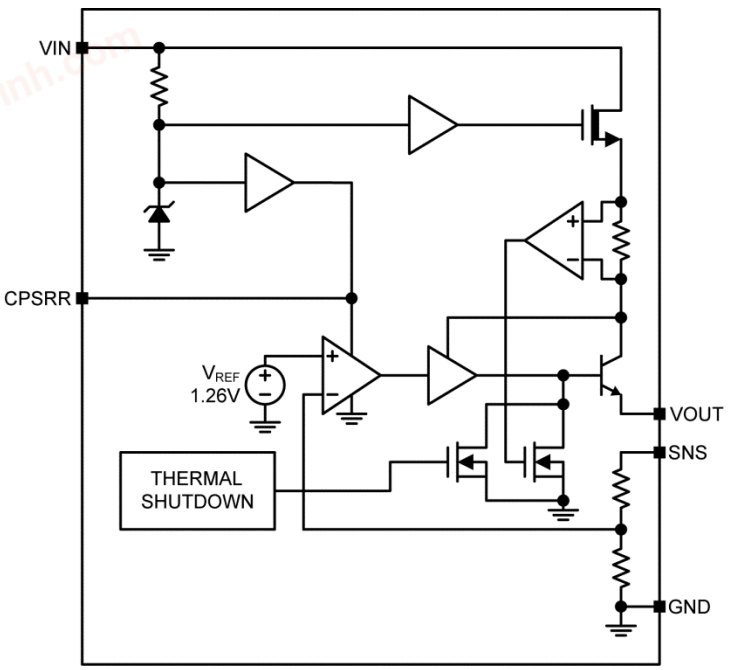
Time (10µs/div)

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Functional Diagram



MIC5281 Adjustable Version



MIC5281 Fixed Version

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Functional Description

The MIC5281 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 25mA of output current. The MIC5281YMM and MIC5281YMME offer an adjustable output voltage from 1.27V to 5.5V. The MIC5281-3.3YMME and MIC5281-3.3YMM offer fixed 3.3V outputs and the MIC5281-5.0YMME and MIC5281-5.0YMM 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

MIC5281 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 will result in a cycled output during continuous thermal-overload conditions.

Current Limit

MIC5281 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 1.0µF capacitor from VIN to GND. Micrel recommends the C5750X7R2E105M, 1.0µF, 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 MIC5281.

Output Voltage Setting

For the MIC5281YMME and MIC5281YMM, V_{OUT} is programmed from 1.27V to 5.5V using Equation 1:

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

where V_{REF} = 1.267V, and R1 and R2 are shown in the Typical Applications circuit.

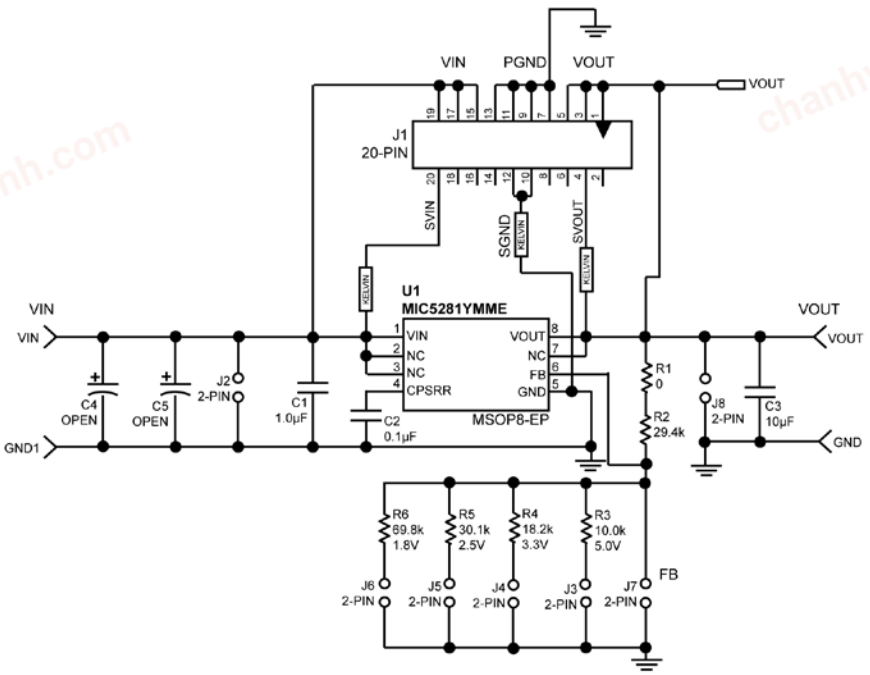
Thermal Measurements

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 thermal couple 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.

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MIC5281 Evaluation Board Schematic



Bill of Materials

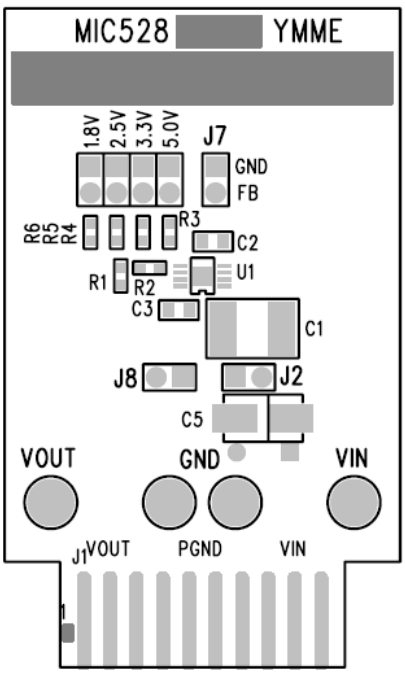
Item	Part Number	Manufacturer	Description	Qty.
C1	C5750X7R2E105M	TDK[8]	1.0µF, 250V, 20%, X7R capacitor (2220)	1
C2	08053C104KAT2A	AVX[9]	0.1µF 25V 20%, X5R capacitor (0805)	1
C3	0805ZD106KAT2A	AVX	10µF, 10V, 20%, X5R, capacitor (0805)	1
C4	OPEN	Panasonic[10]	100µF, 160V, 20% capacitor (ALU, 0.492"diameter can 0.197" lead spacing - Part # ECA-2CM101)	0
C5	OPEN	ANY	Capacitor	0
R1	CRCW06030000F	Vishay/Dale[11]	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	**MIC5281YMME**	**Micrel[12]**	**120V_{IN}, 25mA, Ultra-Low I_Q, High-PSRR Linear Regulator**	**1**

Notes:

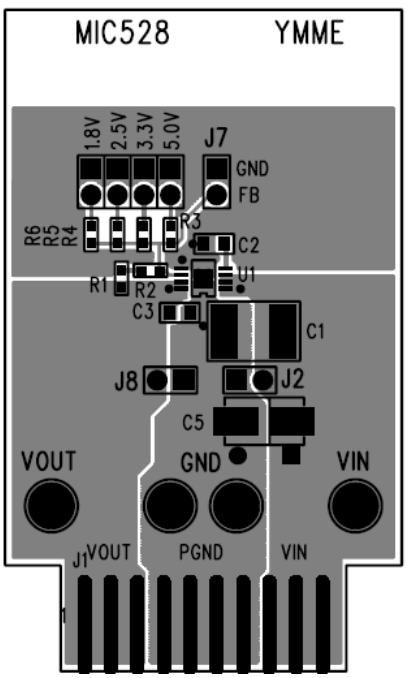
8. TDK: www.tdk.com.
9. AVX: www.avx.com.
10. Panasonic: www.panasonic.com.
11. Vishay: www.vishay.com.
12. **Micrel, Inc.:** www.micrel.com.

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PCB Layout Recommendations



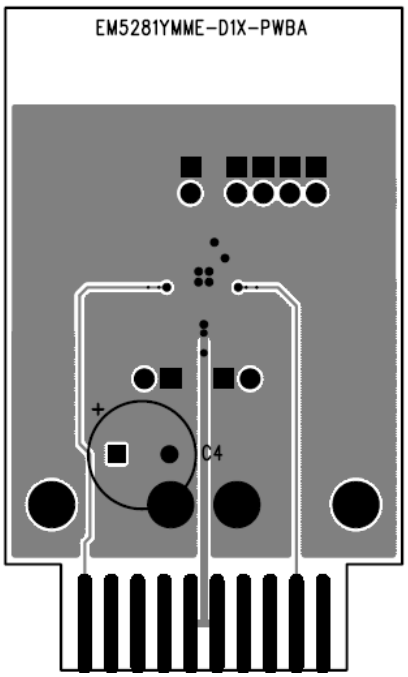
Top Layer Silk Screen



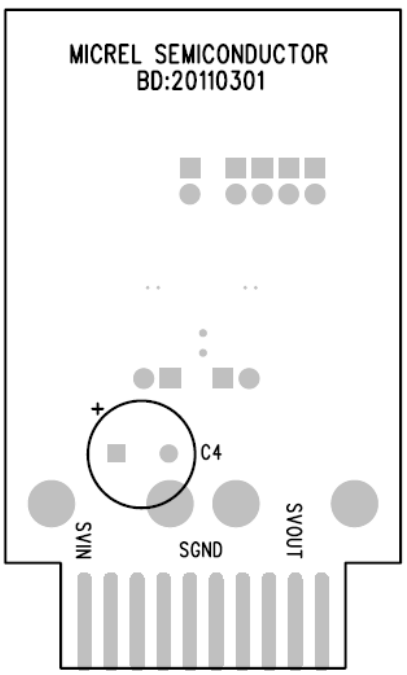
Top Layer Traces

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PCB Layout Recommendations (Continued)



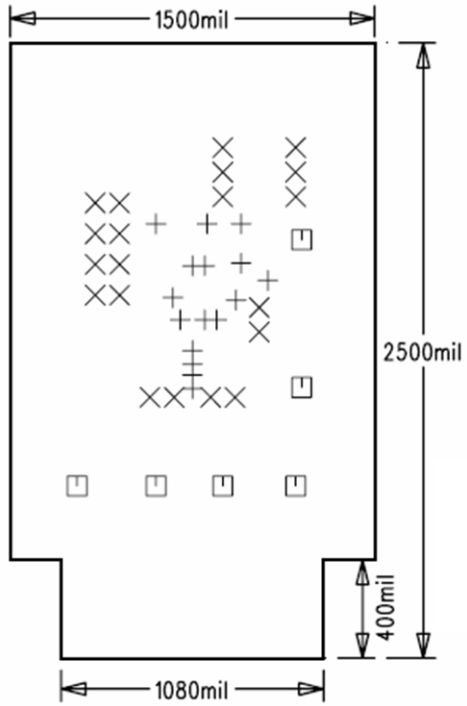
Bottom Layer Traces



Bottom Layer Silk Screen

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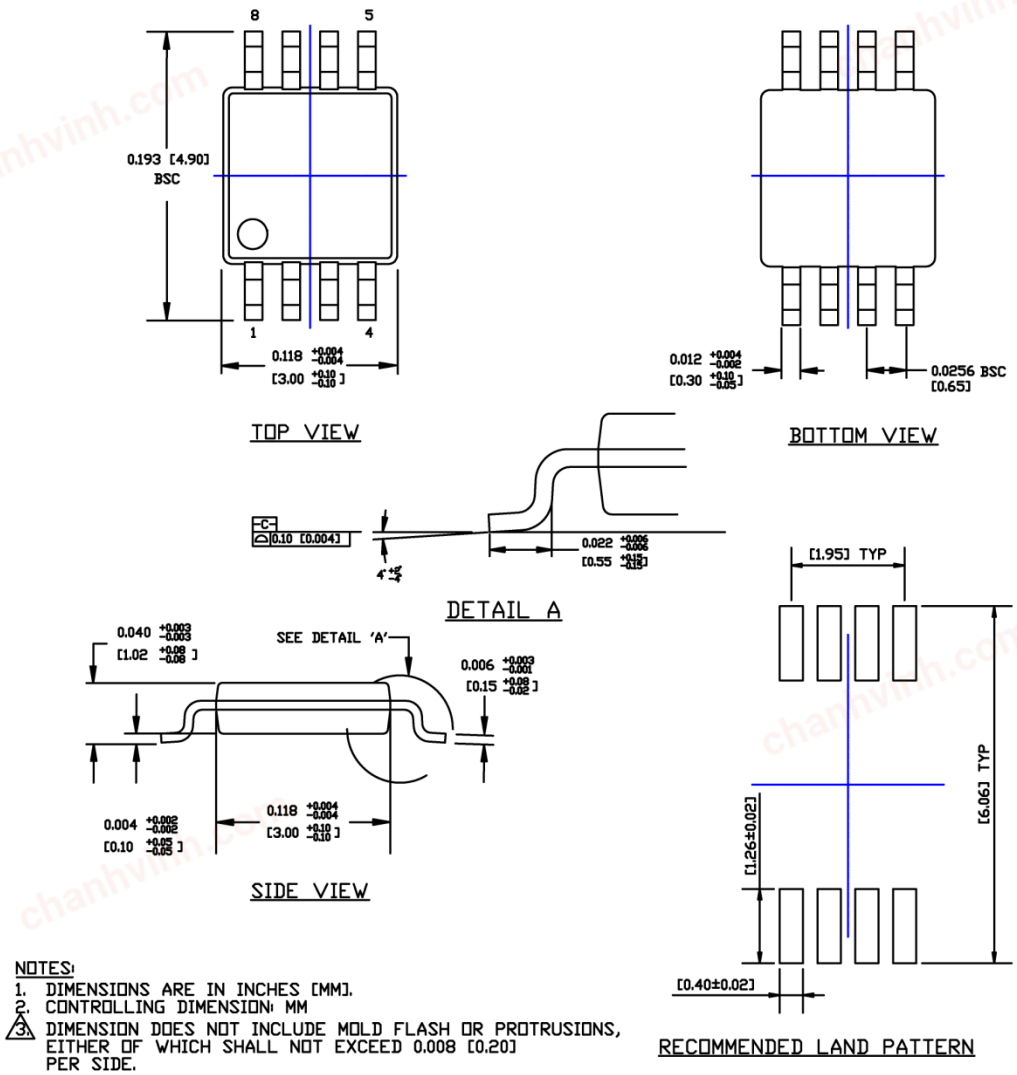
PCB Layout Recommendations (Continued)



Evaluation Board Dimensions

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Package Information and Recommended Landing Pattern[13]



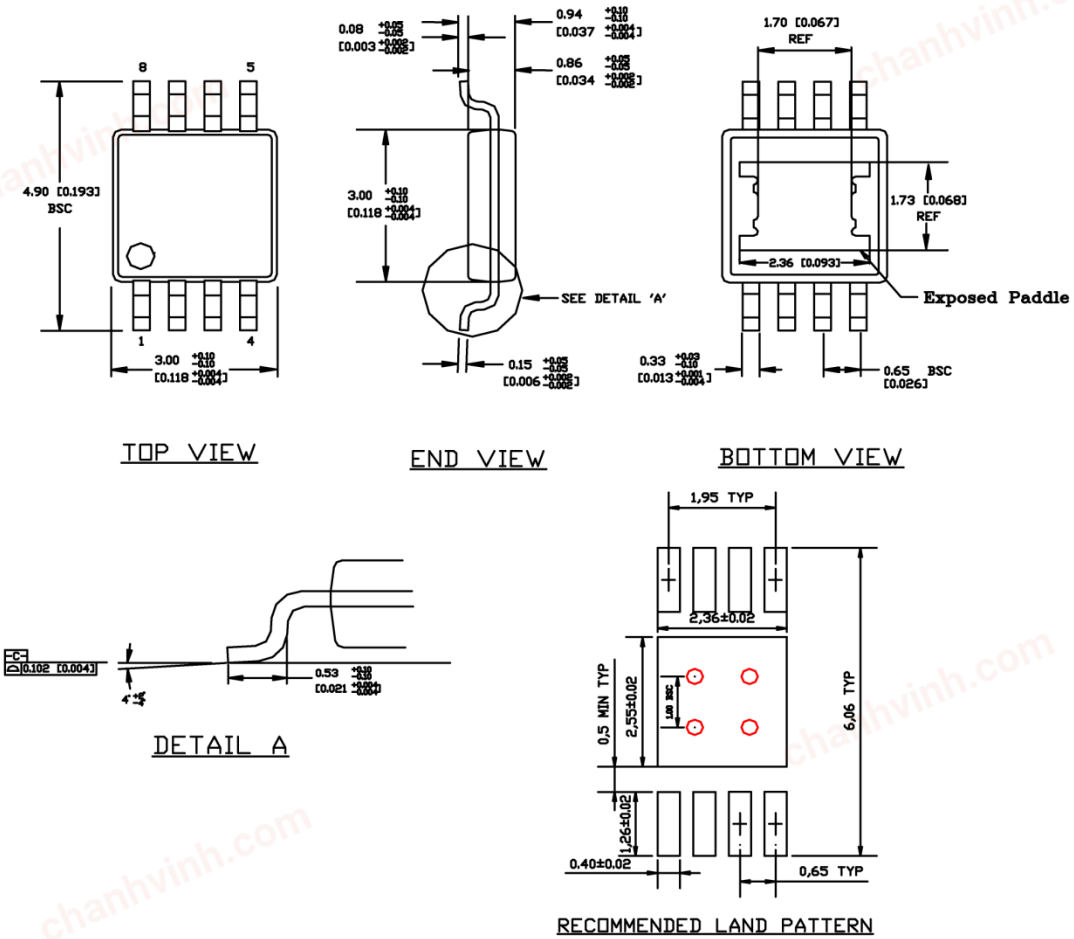
8-Pin MSOP

Note:

13. Package information is correct as of the publication date. For updates and most current information, go to www.micrel.com.

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Package Information and Recommended Landing Pattern[13] (Continued)



8-Pin Exposed Pad (ePad) MSOP

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