MIC5316

Low Voltage Dual 300mA LDO with Power on Reset and Voltage Select

General Description

The MIC5316 is a high performance, dual low input voltage, low dropout regulator with Power On Reset (POR) and voltage select. Major features include two 300mA LDOs, input voltage down to 1.7V, ultra low drop out of 85mV at full load, Power on Reset, and voltage select. Each LDO has its own low voltage input for system flexibility. The low input voltages and low drop out operation provides high efficiency by reducing the input to output voltage step which minimizes the regulator power loss. Voltage select is incorporated into the second output, which reduces the output voltage to further save power while in stand-by mode. An adjustable delay time POR output is provided for the second regulator for design flexibility.

Ideal for battery operated applications; the MIC5316 offers 1% accuracy and low ground current to increase light load efficiency. The MIC5316 can also be put into a zero-off-mode current state, drawing virtually no current when disabled.

The MIC5316 is available in fixed output voltages in the 12-pin 2.5mm x 2.5mm Thin MLF® leadless package.

Data sheets and support documentation can be found on Micrel's web site at: www.micrel.com.

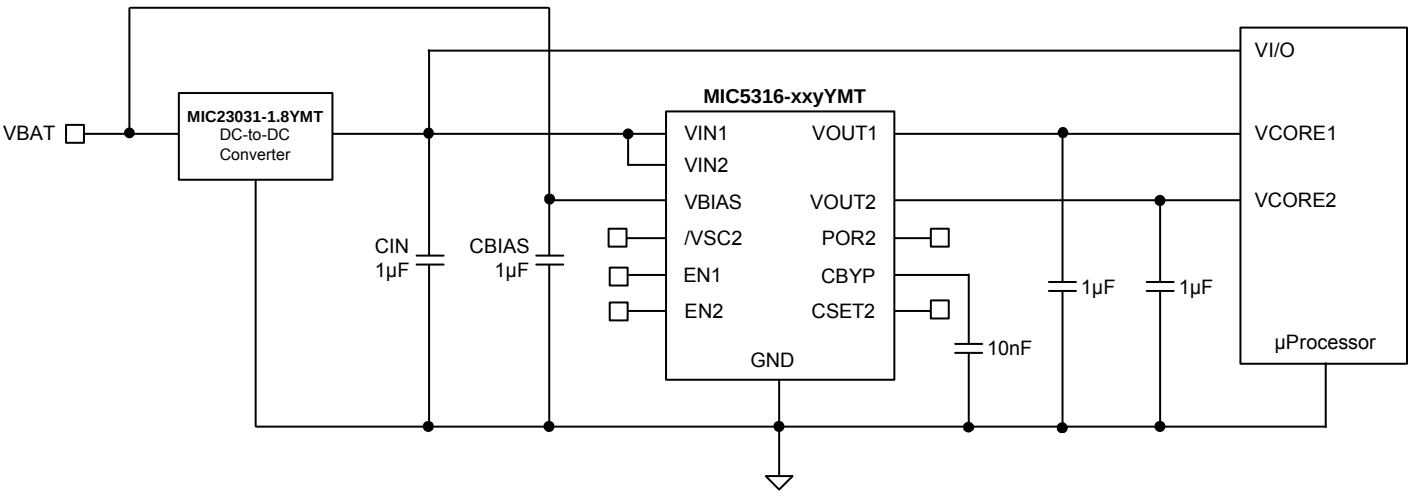
Features

- 300mA output current for each LDO
- Dual low voltage regulator inputs: 1.7V to 5.5V
- Low output voltage range: 0.8V to 2.0V
- Ultra-low dropout voltage of 85mV @ 300mA
- Voltage select function
- Power On Reset output with adjustable delay
- Stable with 1µF ceramic output capacitors
- Very fast transient response
- Thermal shutdown and current limit protection
- Tiny 12-pin 2.5mm x 2.5mm Thin MLF® package

Applications

- Mobile Phones
- GPS and Navigation Devices
- Portable Media Players
- Digital still and video cameras
- PDAs
- Portable electronics

Typical Application



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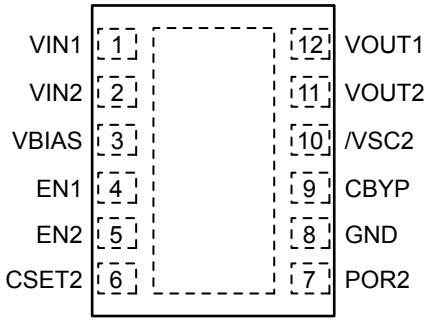
Ordering Information

Part Number	Manufacturing Part Number	Marking[1]	VOUT1[2]	VOUT2[2]	Junction Temp. Range	Package[3]
MIC5316-1.5/1.2/1.0YMT	MIC5316-F4CYMT	QSF4C	1.5V	1.2V/1.0V	–40°C to +125°C	12-Pin 2.5mm x 2.5mm Thin MLF®
MIC5316-1.5/1.3/1.0YMT	MIC5316-F5CYMT	QSF5C	1.5V	1.3V/1.0V	–40°C to +125°C	12-Pin 2.5mm x 2.5mm Thin MLF®
MIC5316-1.8/1.6/1.1YMT	MIC5316-GW3YMT	QSGW3	1.8V	1.6V/1.1V	–40°C to +125°C	12-Pin 2.5mm x 2.5mm Thin MLF®
MIC5316-1.8/1.8/1.0YMT	MIC5316-GGCYMT	QSGGC	1.8V	1.8V/1.0V	–40°C to +125°C	12-Pin 2.5mm x 2.5mm Thin MLF®

Notes:

1. Pin 1 identifier = ▲.
2. For other voltage option, contact Micrel Marketing for details
3. MLF® is a GREEN RoHS compliant package. Lead finish is NiPdAu. Mold compound is Halogen Free.

Pin Configuration



12-Pin 2.5mm × 2.5mm Thin MLF® (MT)

Pin Description

Pin Number	Pin Name	Pin Function
1	VIN1	Voltage Input for LDO1.
2	VIN2	Voltage Input for LDO2.
3	VBIAS	Bias Input Voltage.
4	EN1	Enable Input for LDO1. Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
5	EN2	Enable Input for LDO2. Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
6	CSET2	Delay Set Input for POR2. Connect an external capacitor to GND to set the delay for POR2. When left open, there is no delay. Do not ground this pin.
7	POR2	Power-on Reset for LDO2.
8	GND	Ground.
9	CBYP	Bypass: Connect a capacitor to ground to improve output noise and PSRR.
10	/VSC2	Voltage Select Input for LDO2. Active Low Input. Logic High = Full Output Voltage; Logic Low = Low Output Voltage. Do not leave floating.
11	VOUT2	Output of regulator 2.
12	VOUT1	Output of regulator 1.

Absolute Maximum Ratings[1]

Main Input Voltage ($V_{IN1,}$ V_{IN2}) ..... 0V to V_{BIAS}
Bias Supply Voltage (V_{BIAS}) ..... 0V to +6V
Enable Input Voltage (V_{EN1}, V_{EN2}) ..... 0V to V_{BIAS}
Voltage Select Input Voltage ($V_{/VSC2}$) ..... 0V to V_{BIAS}
POR Voltage (V_{POR2}) ..... 0V to V_{BIAS}
Power Dissipation ..... Internally Limited[3]
Lead Temperature (soldering, 3sec.) ..... 260°C
Storage Temperature (T_s) ..... –65°C to +150°C
ESD Rating[4] 2kV

Operating Ratings[2]

Supply voltage (V_{IN1}, V_{IN2}) ..... +1.7V to V_{BIAS}
Bias Supply Voltage (V_{BIAS}) ..... 2.5V to +5.5V
Enable Input Voltage (V_{EN1}, V_{EN2}) ..... 0V to V_{BIAS}
Voltage Select Input Voltage ($V_{/VSC2}$) ..... 0V to V_{BIAS}
POR Voltage (V_{POR2}) ..... 0V to V_{BIAS}
Junction Temperature (T_J) ..... –40°C to +125°C
Junction Thermal Resistance
2.5mm x 2.5mm Thin MLF-12 (θ_{JA}) ..... 70°C/W

Electrical Characteristics[4]

V_{BIAS} = 3.6V; V_{IN1}= V_{IN2} = V_{OUT} (Highest of two regulators) + 1V; C_{BIAS}=C_{OUT}= 1.0µF, C_{BYP}=0.01µF, I_{OUT} = 100µA; T_J = 25°C, **bold** values indicate –40°C to + 125°C; unless noted.

Parameter	Condition	Min	Typ	Max	Units
Output Voltage Accuracy	Variation from nominal V_{OUT1} & V_{OUT2}	–1.0		+1.0	%
	Variation from nominal V_{OUT1} & V_{OUT2}	**–2.0**		**+2.0**	%
Select Mode Output Voltage Accuracy	V_{OUT2}; $V_{/VSC2}$ = Logic Low	–3.0		+3.0	%
	V_{OUT2}; $V_{/VSC2}$ = Logic Low	**-4.0**		**+4.0**	%
V_{IN} Line Regulation	V_{IN} = V_{OUT} +1V to 5.5V, V_{BIAS} = 5.5V		0.02	**0.3**	%/V
V_{BIAS} Line Regulation	V_{BIAS} = 3.6V to 5.5V, V_{IN} = V_{OUT} +1V		0.02	**0.3**	%/V
Load Regulation	I_{OUT} = 100µA to 300mA		0.4	**1.0**	%
Dropout Voltage	I_{OUT} = 150mA		40	**100**	mV
	I_{OUT} = 300mA		85	**200**	mV
Ground Pin Current V_{IN1},V_{IN2}	V_{EN1} = High; V_{EN2} = Low; I_{OUT1} = 100µA to 300mA		7	**12**	µA
	V_{EN1} = Low; V_{EN2} = High; I_{OUT2} = 100µA to 300mA		7	**12**	µA
Ground Pin Current V_{BIAS}	I_{OUT1} = I_{OUT2} = 100µA to 300mA		30	**46**	µA
Ground Pin Current in Shutdown	V_{EN} ≤ 0.2V		0.01	1.0	µA
V_{IN} Ripple Rejection	f = 1kHz; C_{OUT} = 1.0µF; C_{BYP} = 0.01µF		65		dB
	f = 20kHz; C_{OUT} = 1.0µF; C_{BYP} = 0.01µF		40		dB
Current Limit	V_{OUT} = 0V	350	550		mA
Output Voltage Noise	C_{OUT} = 1µF, C_{BYP} = 0.01µF, 10Hz to 100kHz		30		μV_{RMS}
Enable					
Enable Input Voltage	Logic Low			**0.2**	V
	Logic High	**1.2**			V
Enable Input Current	V_{IL} ≤ 0.2V		0.02	**1**	µA
	V_{IH} ≥ 1.2V		0.2	**1**	µA
Turn-on Time	C_{OUT} = 1µF; C_{BYP} = 0.01µF		150	**300**	µs

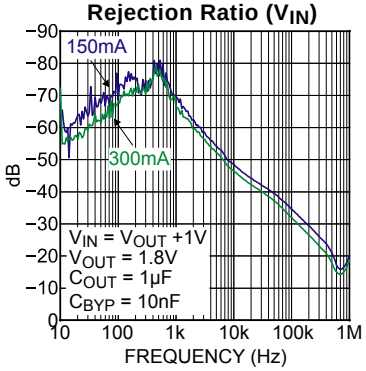
Parameter	Condition	Min	Typ	Max	Units
POR2 Output					
V_{TH}	Low Threshold, % of V_{OUT2} (Flag ON)	88			%
	High Threshold, % of V_{OUT2} (Flag OFF)			98	%
V_{OL}	POR2 Output Logic Low Voltage; I_L = 250µA		0.02	0.1	V
I_{POR2}	Flag Leakage Current, Flag OFF	–1	0.01	+1	µA
CSET2 INPUT					
CSET2 Pin Current Source	V_{CSET2} = 0V	**0.8**	1.4	**2**	µA
CSET2 Pin Threshold Voltage	POR2 = High	1.212	1.25	1.288	V

Notes:

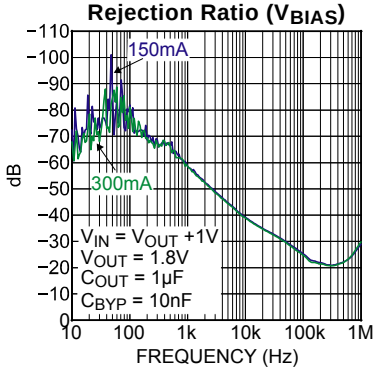
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. The maximum allowable power dissipation of any T_A (ambient temperature) is $P_{D(max)} = T_{J(max)} – T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
4. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5kΩ in series with 100pF.
5. Specification for packaged product only.

Typical Characteristics

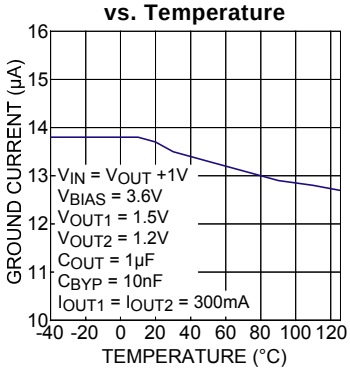
Power Supply Rejection Ratio (V_{IN})



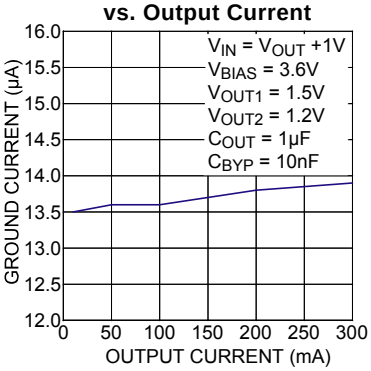
Power Supply Rejection Ratio (V_{BIAS})



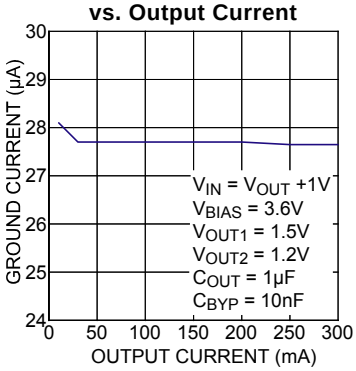
Ground Current (V_{IN}) vs. Temperature



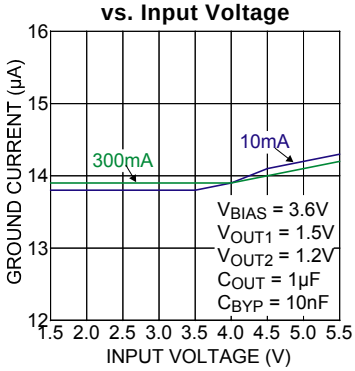
Ground Current (V_{IN}) vs. Output Current



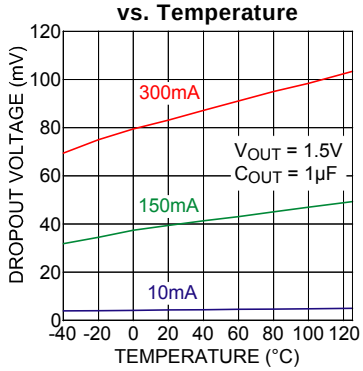
Ground Current (V_{BIAS}) vs. Output Current



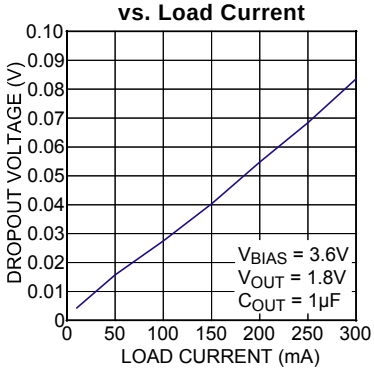
Ground Current (V_{IN}) vs. Input Voltage



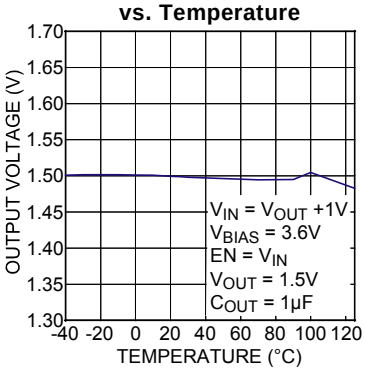
Dropout Voltage vs. Temperature



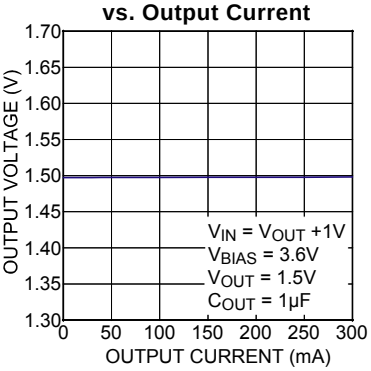
Dropout Voltage vs. Load Current



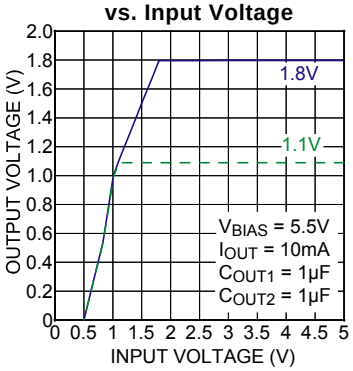
Output Voltage vs. Temperature



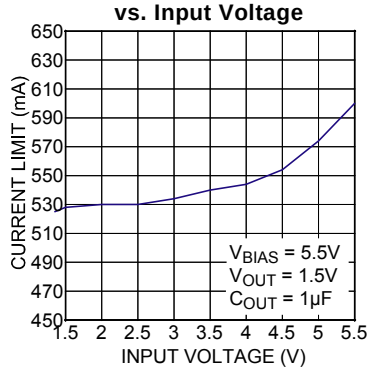
Output Voltage vs. Output Current



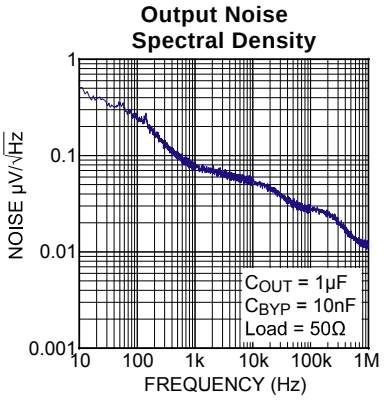
Output Voltage vs. Input Voltage



Current Limit vs. Input Voltage

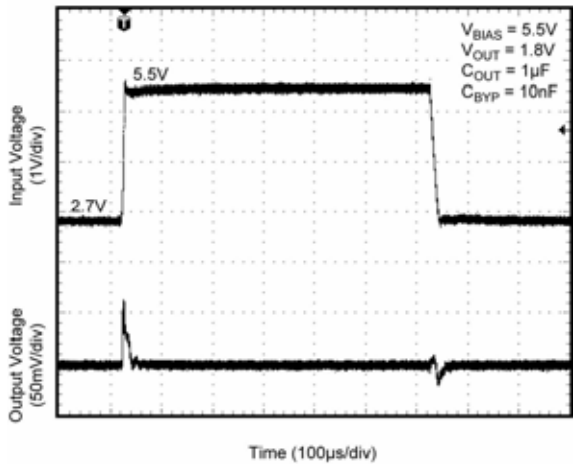


Typical Characteristics (continued)

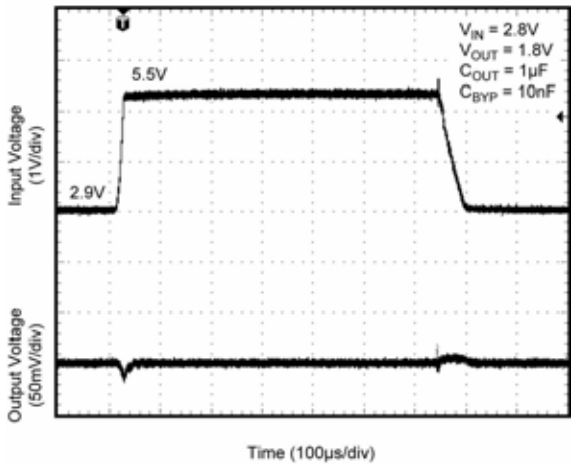


Functional Characteristics

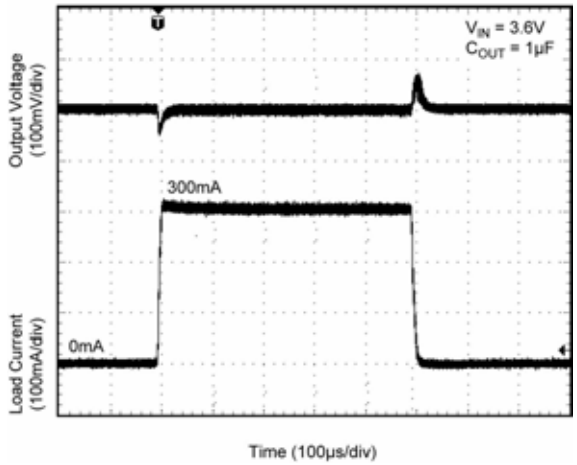
Line Transient (V_{IN})



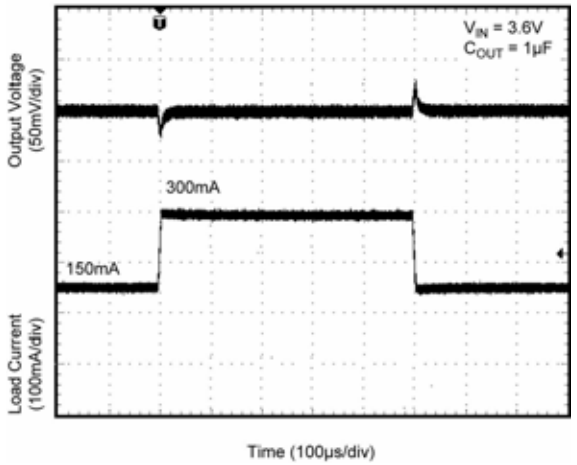
Line Transient (V_{BIAS})



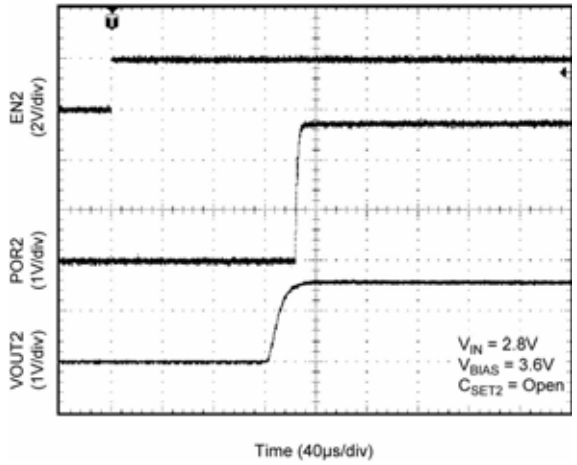
Load Transient



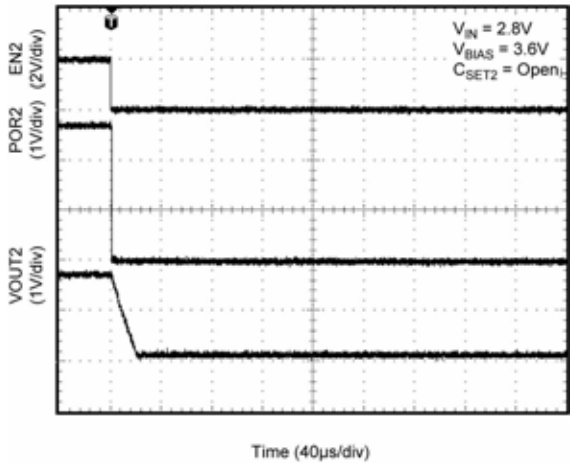
Load Transient



Power-On Reset (Turn-On)

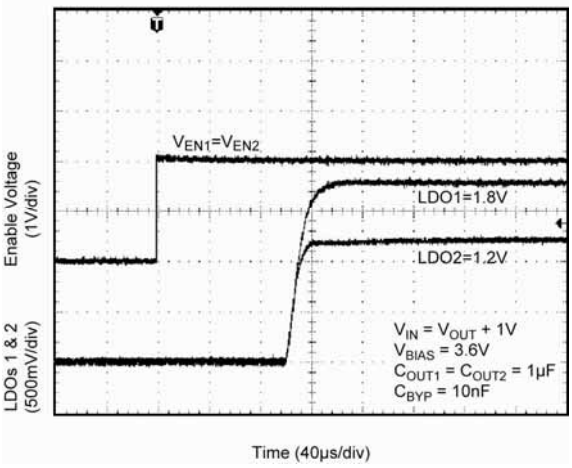


Power-On Reset (Turn-Off)

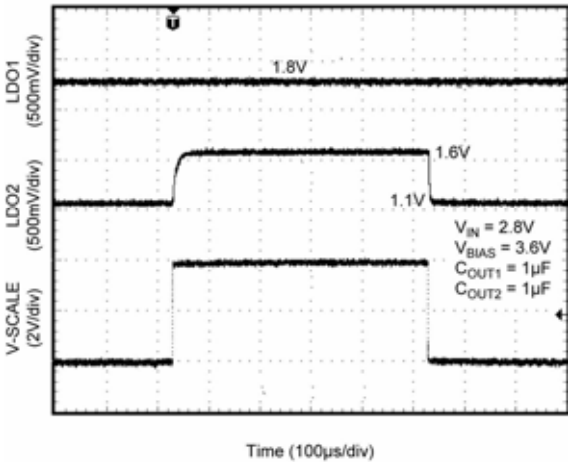


Functional Characteristics (continued)

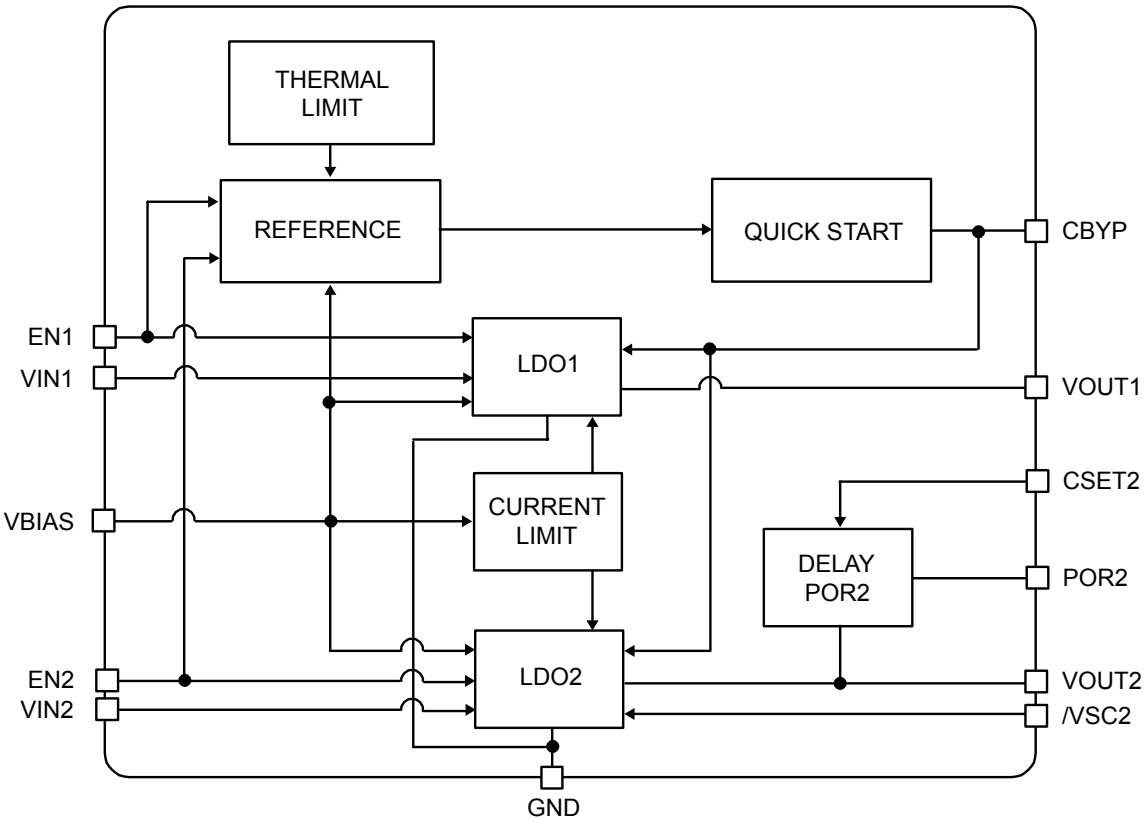
Enable Turn-On



Voltage Scale Function



Functional Diagram



MIC5316 Block Diagram

Application Information

The MIC5316 is a high performance, dual low input voltage, ultra-low dropout regulator designed for applications requiring very fast transient response. The MIC5316 utilizes two input supplies (V_{IN} and V_{BIAS}), significantly reducing the dropout voltage.

The MIC5316 regulator is fully protected from damage due to fault conditions, offering linear current limiting and thermal shutdown.

Bias Supply Voltage

V_{BIAS}, requiring relatively light current, provides power to the control portion of the MIC5316. Bypassing on the bias pin is recommended to improve performance of the regulator during line and load transients. A 1µF ceramic capacitor from V_{BIAS}-to-ground is recommended to help reduce the high frequency noise from being injected into the control circuitry.

Input Supply Voltage

V_{IN1} and V_{IN2}, provide the supply to power the LDOs independently. The minimum input voltage is 1.7V allowing conversion from low voltage supplies. The low input voltage provides high efficiency by reducing the input to output voltage step which minimizes the regulator power loss.

Input Capacitor

The MIC5316 is a high-performance, high bandwidth device. Therefore, it requires a well-bypassed input supply for optimal performance. A 1µF capacitor is required from the input-to-ground to provide stability. Low-ESR ceramic capacitors provide optimal performance at a minimum of space. Additional high-frequency capacitors, such as small-valued NPO dielectric-type capacitors, help filter out high-frequency noise and are good practice in any RF-based circuit. X5R or X7R dielectrics are recommended for the input capacitor. Y5V dielectrics lose most of their capacitance over temperature and are therefore, not recommended.

Output Capacitor

The MIC5316 requires an output capacitor of 1µF or greater to maintain stability. The design is optimized for use with low-ESR ceramic chip capacitors. High ESR capacitors may cause high frequency oscillation. The output capacitor can be increased, but performance has been optimized for a 1µF ceramic output capacitor and does not improve significantly with larger capacitance.

X7R/X5R dielectric-type ceramic capacitors are recommended because of their temperature performance. X7R-type capacitors change capacitance by 15% over their operating temperature range and are the most stable type of ceramic capacitors. Z5U and Y5V dielectric capacitors change value by as much as 50% and 60%, respectively, over their operating temperature ranges. To use a ceramic chip capacitor with Y5V dielectric, the value must be much higher than an X7R ceramic capacitor to ensure the same minimum capacitance over the equivalent operating temperature range.

Bypass Capacitor

A capacitor can be placed from the bypass pin-to-ground to reduce the output voltage noise. The capacitor bypasses the internal reference. A 0.01µF capacitor is recommended for applications that require low-noise outputs. The bypass capacitor can be increased, further reducing noise and improving PSRR. Turn-on time increases slightly with respect to the bypass capacitance. A unique, quick-start circuit allows the MIC5316 to drive a large capacitor on the bypass pin without significantly slowing turn-on time.

No-Load Stability

Unlike many other voltage regulators, the MIC5316 will remain stable and in regulation with no load. This is especially important in CMOS RAM keep-alive applications.

Enable/Shutdown

The MIC5316 is provided with dual active-high enable pins that allow each regulator to be disabled independently. Forcing the enable pin low disables the regulator and sends it into a “zero” off-mode-current state. In this state, current consumed by the regulator goes nearly to zero. Forcing the enable pin high enables the output voltage. The active-high enable pin uses CMOS technology and the enable pin cannot be left floating; a floating enable pin may cause an indeterminate state on the output.

Power On Reset

The second regulator (LDO2) provides a Power On Reset (POR2) status pin. This pin is an open drain output. When LDO2 is enabled an active low POR2 indicates an under voltage condition on V_{OUT2}.

The POR2 status signal can be programmed for a delay (1sec/µF) by adding a capacitor from the C_{SET2} pin to ground. Zero delay is added by leaving the C_{SET2} pin open circuit.

Voltage Select

The MIC5316 incorporates voltage select technology to set LDO2’s voltage output to a preset lower level. The /VSC2 pin is an active low input. A logic high signal sets V_{OUT2} to the full output voltage; while a logic low signal sets V_{OUT2} to the lower output voltage.

Thermal Considerations

The MIC5316 is designed to provide 300mA of continuous current for both outputs in a very small package. Maximum ambient operating temperature can be calculated based upon the output current and the voltage drop across the part. Given that the input voltage is 1.8V, the output voltage is 1.5V for V_{OUT1}, 1.0V for V_{OUT2} and the output current = 300mA for each output. The actual power dissipation of the regulator circuit can be determined using the equation:

$$P_D = (V_{IN} – V_{OUT1})\ I_{OUT1} + (V_{IN} – V_{OUT2})\ I_{OUT2} + V_{BIAS}\ I_{GND}$$

Because this device is CMOS and the ground current is typically <100µA over the load range, the power dissipation contributed by the ground current is <1% and can be ignored for this calculation.

$$P_D = (1.8V – 1.5V) \times 300mA + (1.8V – 1.0V) \times 300mA$$

$$P_D = 0.33W$$

To determine the maximum ambient operating temperature of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

$$P_{D(MAX)} = \left(\frac{T_{J(MAX)} - T_A}{\theta_{JA}} \right)$$

$T_{J(max)}$ = 125°C, the maximum junction temperature of the die. The junction-to-ambient thermal resistance for the minimum footprint, is θ_{JA} = 70°C/W.

Substituting P_D for $P_{D(max)}$ and solving for the ambient operating temperature will give the maximum operating conditions for the regulator circuit.

The maximum power dissipation must not be exceeded for proper operation.

For example, when operating the MIC5316-F5CYMT at an input voltage of 1.8V and 300mA, loads at each output with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

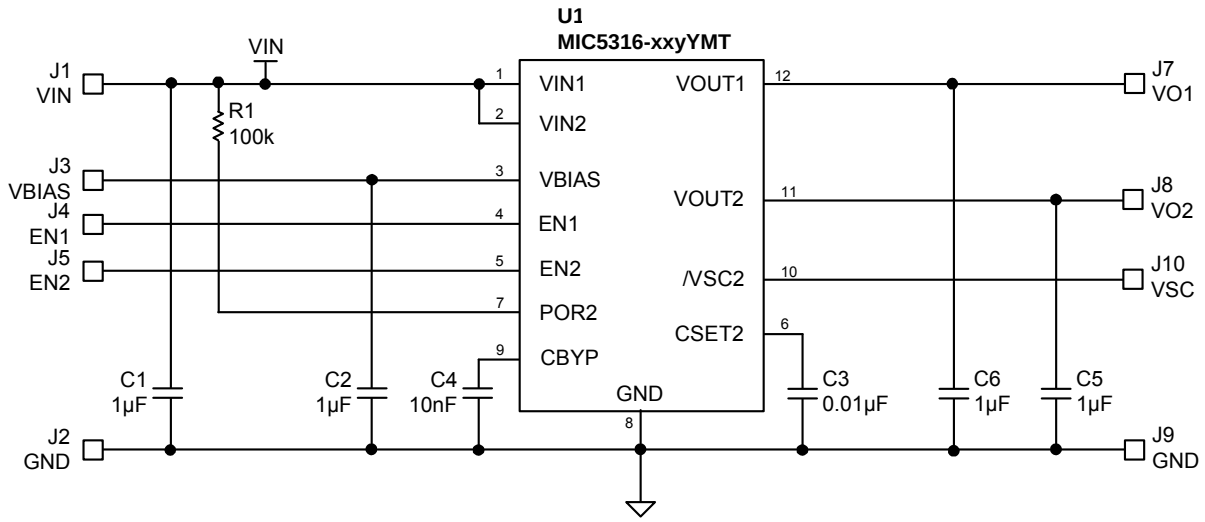
$$0.33W = (125°C – T_A)/(70°C/W)$$

$$T_A = 101.9°C$$

For a full discussion of heat sinking and thermal effects on voltage regulators, refer to the “Regulator Thermals” section of *Micrel’s Designing with Low-Dropout Voltage Regulators* handbook. This information can be found on Micrel's website at:

http://www.micrel.com/_PDF/other/LDOBk_ds.pdf

MIC5316 Typical Application Circuit



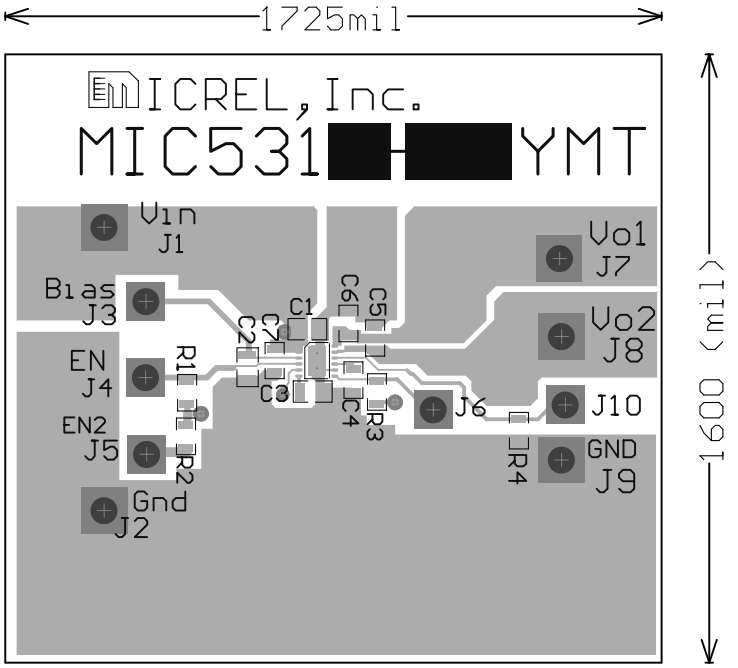
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty
C1, C2, C5, C6	C1608X5R1A105K	TDK[1]	Capacitor, 1µF Ceramic, 10V, X5R, Size 0603	4
C3	VJ0603Y104KXACW1BC	Vishay[2]	Capacitor, 0.1µF, 50V, X7R, Size 0603	1
C4	VJ0603Y103KXACW1BC	Vishay[2]	Capacitor, 0.01µF, 50V, X7R, Size 0603	1
R1	CRCW0603100KFKEA	Vishay[2]	Resistor, 100kΩ, 1%, 1/16W, Size 0603	1
U1	**MIC5316-xxyYMT**	**Micrel[3]**	**Low Voltage Dual 300mA LDO with POR and V Select**	**1**

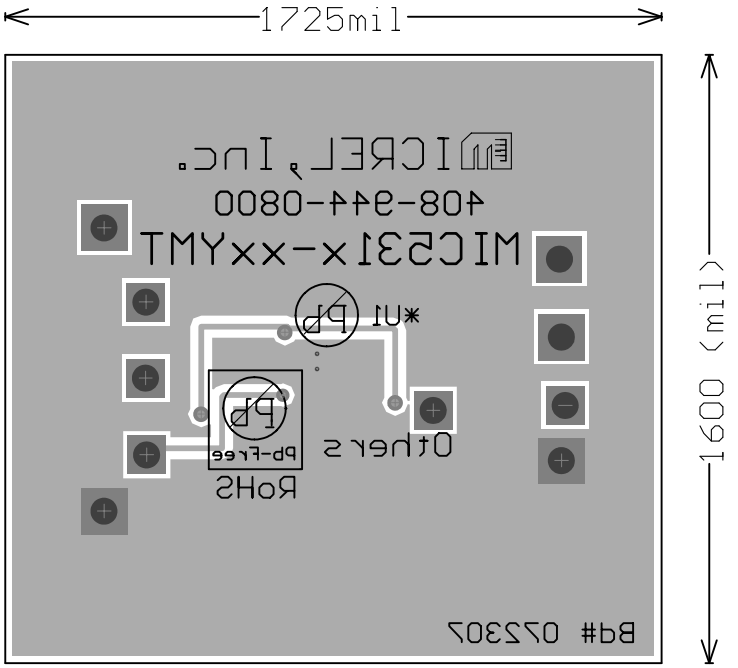
Notes:

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

PCB Layout Recommendations

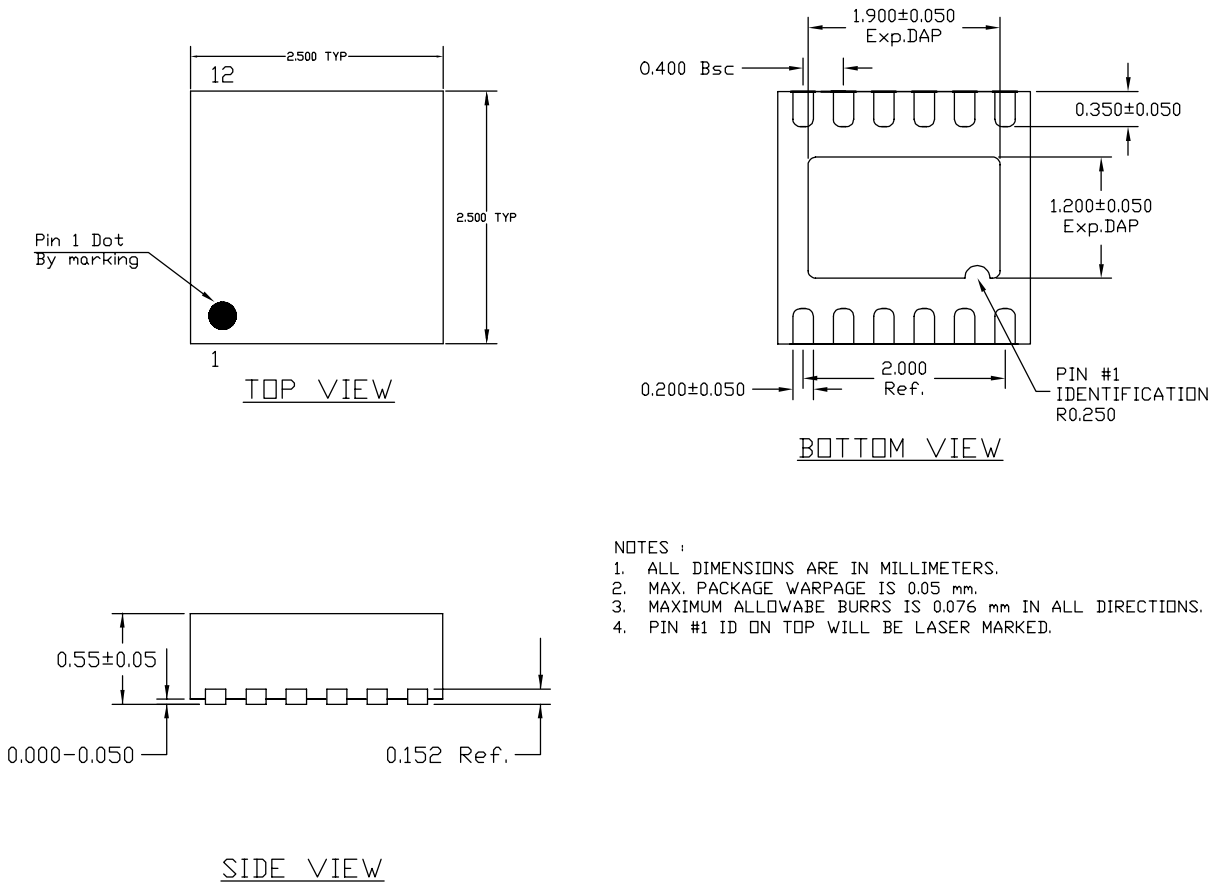


Top Layer



Bottom Layer

Package Information



12-Pin 2.5mm × 2.5mm Thin MLF® (MT)

MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA
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