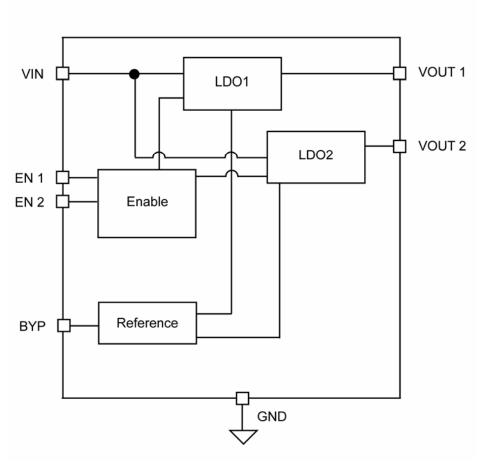
RF Power Supply Circuit

Block Diagram



MIC5310 Fixed Block Diagram

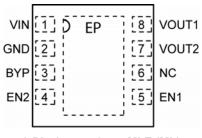
Ordering Information

Functional Part number	Ordering Part Number	Marking ¹	V _{OUT1} /V _{OUT2} ²	Junction Temperature Range	Package ³
MIC5310-1.8/1.5YML	MIC5310-GFYML	GFZ	1.8V/1.5V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-1.8/1.8YML	MIC5310-GGYML	GGZ	1.8V/1.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-1.8/1.6YML	MIC5310-GWYML	Ğ₩Z	1.8V/1.6V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.5/1.8YML	MIC5310-JGYML	JGZ	2.5V/1.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.5/2.5YML	MIC5310-JJYML	JJZ	2.5V/2.5V	-40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.6/1.85YML	MIC5310-KDYML	KDZ	2.6V/1.85	-40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.6/1.8YML	MIC5310-KGYML	KGZ	2.6V/1.8V	-40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.7/2.7YML	MIC5310-LLYML	LLZ	2.7V/2.7V	-40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.8/1.5YML	MIC5310-MFYML	MFZ	2.8V/1.5V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.8/1.8YML	MIC5310-MGYML	MGZ	2.8V/1.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.8/2.6YML	MIC5310-MKYML	MKZ	2.8V/2.6V	-40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.8/2.8YML	MIC5310-MMYML	MMZ	2.8V/2.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.85/1.85YML	MIC5310-NDYML	NDZ	2.85V/1.85V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.85/2.6YML	MIC5310-NKYML	NKZ	2.85V/2.6V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.85/2.85YML	MIC5310-NNYML	NNZ	2.85V/2.85V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.9/1.5YML	MIC5310-OFYML	OF Z	2.9V/1.5V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.9/1.8YML	MIC5310-OGYML	ŌĠZ	2.9V/1.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-2.9/2.9YML	MIC5310-OOYML	00 z	2.9V/2.9V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.0/1.8YML	MIC5310-PGYML	PGZ	3.0V/1.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.0/2.5YML	MIC5310-PJYML	PJZ	3.0V/2.5V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.0/2.6YML	MIC5310-PKYML	PKZ	3.0V/2.6V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.0/2.8YML	MIC5310-PMYML	PMZ	3.0V/2.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.0/2.85YML	MIC5310-PNYML	PNZ	3.0V/2.85V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.0/3.0YML	MIC5310-PPYML	PPZ	3.0V/3.0V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/1.5YML	MIC5310-SFYML	SFZ	3.3V/1.5V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/1.8YML	MIC5310-SGYML	<u>s</u> Gz	3.3V/1.8V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/2.5YML	MIC5310-SJYML	SJZ	3.3V/2.5V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/2.6YML	MIC5310-SKYML	SKZ	3.3V/2.6V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/2.8YML	MIC5310-SMYML	SMZ	3.3V/2.8V	–40°C to +125°C	8-Pin 2x2 MLF®
MIC5310-3.3/2.85YML	MIC5310-SNYML	SNZ	3.3V/2.85V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/2.9YML	MIC5310-SOYML	SOZ	3.3V/2.9V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/3.0YML	MIC5310-SPYML	SPZ	3.3V/3.0V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/3.2YML	MIC5310-SRYML	SRZ	3.3V/3.2V	–40°C to +125°C	8-Pin 2x2 MLF [®]
MIC5310-3.3/3.3YML	MIC5310-SSYML	SSZ	3.3V/3.3V	–40°C to +125°C	8-Pin 2x2 MLF [®]

Notes:

- 1. Over bar symbol () may not be to scale. Over bar at Pin 1.
- 2. Other voltage options available. Contact Micrel for more details.
- 3. MLF® is a GREEN RoHS compliant package. Lead finish is NiPdAu. Mold compound is Halogen Free.

Pin Configuration



8-Pin 2mm x 2mm MLF (ML) Top View

Pin Description

Pin Number	Pin Name	Pin Function
1	VIN	Supply Input.
2	GND	Ground
3	BYP	Reference Bypass: Connect external 0.1µF to GND to reduce output noise. May be left open when bypass capacitor is not required.
4	EN2	Enable Input (regulator 2). Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
5	EN1	Enable Input (regulator 1). Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
6	NC	Not internally connected
7	VOUT2	Regulator Output – LDO2
8	VOUT1	Regulator Output – LDO1
_	EP	Exposed Pad. Connect EP to GND.

Absolute Maximum Ratings(1)

Supply Voltage (V _{IN})	0V to +6V
Enable Input Voltage (V _{EN})	0V to +6V
Power Dissipation	Internally Limited ⁽³⁾
Lead Temperature (soldering, 3se	c260°C
Storage Temperature (T _S)	65°C to +150°C
ESD Rating ⁽⁴⁾	2kV

Operating Ratings⁽²⁾

Supply voltage (V _{IN})	+2.3V to +5.5V
Enable Input Voltage (V _{EN})	0V to V _{IN}
Junction Temperature	40°C to +125°C
Junction Thermal Resistance	
MLF-8 (θ _{JA})	90°C/W

Electrical Characteristics⁽⁵⁾

 V_{IN} = EN1 = EN2 = V_{OUT} + 1.0V; higher of the two regulator outputs, $I_{OUTLDO1}$ = $I_{OUTLDO2}$ = 100 μ A; C_{OUT1} = C_{OUT2} = 1 μ F; C_{BYP} = 0.1 μ F; T_J = 25°C, **bold** values indicate -40°C $\leq T_J \leq +125$ °C, unless noted.

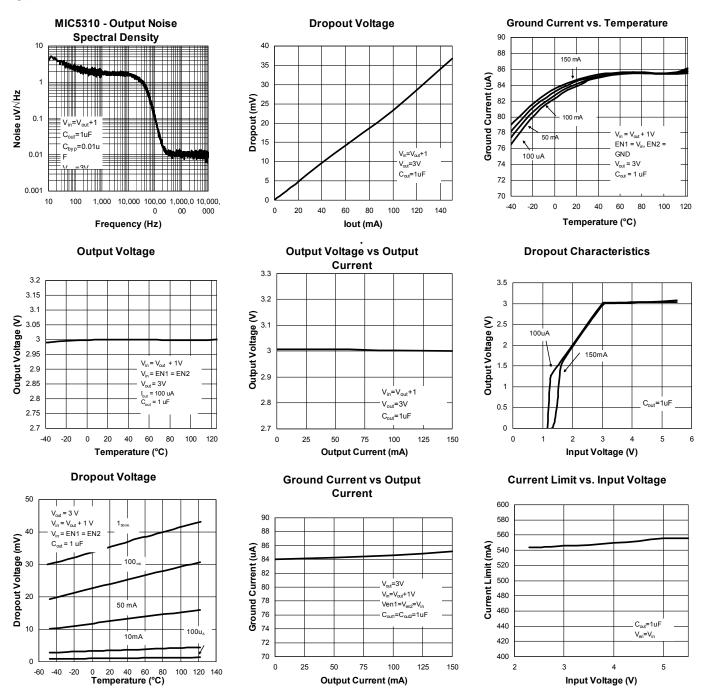
Parameter	Conditions	Min	Тур	Max	Units
Output Voltage Accuracy	Variation from nominal V _{OUT}	-2.0		+2.0	%
	Variation from nominal V _{OUT} ; –40°C to +125°C	-3.0		+3.0	%
Line Regulation	$V_{IN} = V_{OUT} + 1V \text{ to } 5.5V; I_{OUT} = 100 \mu\text{A}$		0.02	0.3 0.6	%/V %/V
Load Regulation	I _{OUT} = 100μA to 150mA		0.5	2.0	%
Dropout Voltage (Note 6)	I _{OUT} = 100μA		0.1		mV
	I _{OUT} = 50mA		12	50	mV
	I _{OUT} = 100mA		25	75	mV
	I _{OUT} = 150mA		35	100	mV
Ground Current	EN1 = High; EN2 = Low; I _{OUT} = 100μA to 150mA		85	120	μΑ
	EN1 = Low; EN2 = High; I _{OUT} = 100μA to 150mA		85	120	μΑ
	EN1 = EN2 = High; I _{OUT1} = 150mA, I _{OUT2} = 150mA		150	190	μΑ
Ground Current in Shutdown	EN1 = EN2 = 0V		0.01	2	μA
Ripple Rejection	$f = 1kHz; C_{OUT} = 1.0\mu F; C_{BYP} = 0.1\mu F$		70		dB
	$f = 20kHz; C_{OUT} = 1.0\mu F; C_{BYP} = 0.1\mu F$		65		dB
Current Limit	V _{OUT} = 0V	300	550	950	mA
Output Voltage Noise	C_{OUT} = 1.0 μ F; C_{BYP} = 0.1 μ F; 10Hz to 100kHz		30		μV_{RMS}
Enable Inputs (EN1 / EN2)					
Enable Input Voltage	Logic Low			0.2	V
	Logic High	1.1			V
Enable Input Current	V _{IL} ≤ 0.2V		0.01		μA
	V _{IH} ≥ 1.0V		0.01		μA
Turn-on Time (See Timing Diagram)					
Turn-on Time (LDO1 and 2)	$C_{OUT} = 1.0 \mu F; C_{BYP} = 0.01 \mu F$		30	100	μs

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) / θ_{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, 1.5k in series with 100pF.
- 5. Specification for packaged product only.
- Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal V_{OUT}. For outputs below 2.3V, the dropout voltage is the input-to-output differential with the minimum input voltage 2.3V.

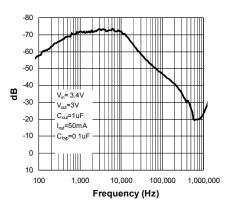
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Typical Characteristics

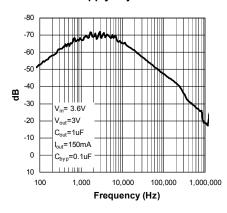


Typical Characteristics (Continued)

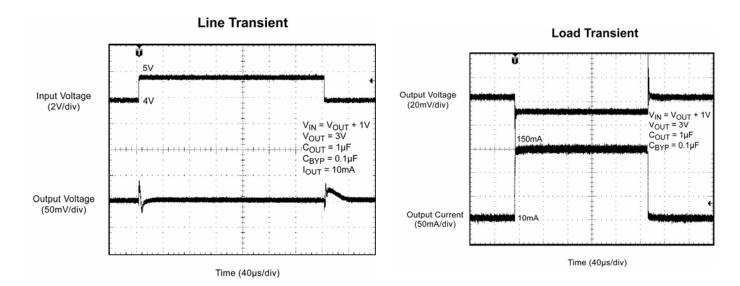
Power Supply Rejection Ratio

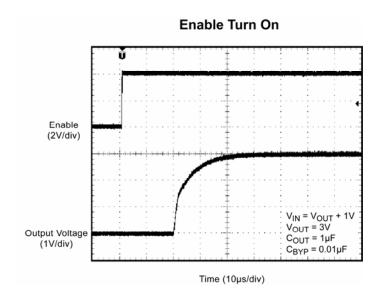


Power Supply Rejection Ratio



Functional Characteristics





Applications Information

Enable/Shutdown

The MIC5310 comes with dual active-high enable pins that allow each regulator to be enabled 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.

Input Capacitor

The MIC5310 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.

Output Capacitor

The MIC5310 requires an output capacitor of $1\mu F$ 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 $1\mu F$ ceramic output capacitor and does not improve significantly with larger capacitance.

X7R/X5R dielectric type ceramic capacitors are recommended because of their temperature X7R performance. 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 noise bypass pin to ground to reduce output voltage noise. The capacitor bypasses the internal reference. A 0.1µF 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 bypass capacitance. A unique, quick start circuit allows the MIC5310 to drive a large capacitor on the bypass pin without significantly slowing turn on time.

No-Load Stability

Unlike many other voltage regulators, the MIC5310 will remain stable and in regulation with no load. This is especially important in CMOS RAM keep alive applications.

Thermal Considerations

The MIC5310 is designed to provide 150mA of continuous current for both outputs in a very small package. Maximum ambient operating temperature can be calculated based on the output current and the voltage drop across the part. Given that the input voltage is 3.3V, the output voltage is 2.8V for V_{OUT1} , 1.5V for V_{OUT2} and the output current = 150mA. The actual power dissipation of the regulator circuit can be determined using the equation:

 $P_D = (V_{\text{IN}} - V_{\text{OUT1}}) \ I_{\text{OUT1}} + (V_{\text{IN}} - V_{\text{OUT2}}) \ I_{\text{OUT2}} + V_{\text{IN}} \ I_{\text{GND}}$ 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.

$$P_D = (3.3V - 2.8V) \times 150\text{mA} + (3.3V - 1.5) \times 150\text{mA}$$

 $P_D = 0.345W$

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 θ_{JA} thermal resistance = 90°C/W.

The table below shows junction-to-ambient thermal resistance for the MIC5310 in different packages.

Package	θ _{JA} Recommended Minimum Footprint	
8-Pin 2x2 MLF®	90°C/W	

Thermal Resistance

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 junction-to-ambient thermal resistance for the minimum footprint is 90°C/W .

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

For example, when operating the MIC5310-MFYML at an input voltage of 3.3V and 150mA loads at each output with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

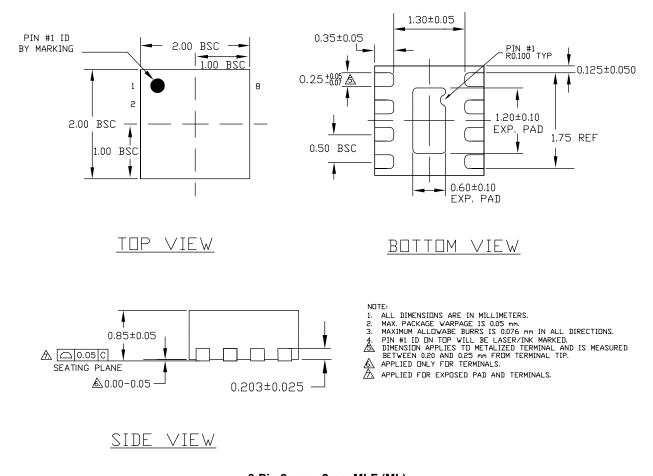
$$0.345W = (125^{\circ}C - T_A)/(90^{\circ}C/W)$$

 $T_A = 93.95^{\circ}C$

Therefore, a 2.8V/1.5V application with 150mA at each output current can accept an ambient operating temperature of 93.95°C in a 2mm x 2mm MLF® package. 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

Package Information



8-Pin 2mm x 2mm MLF (ML)

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