MIC5380/1

High Performance Dual 150mA LDO
1mm x 1mm Thin MLF®

General Description

The MIC5380/1 is an advanced dual LDO ideal for powering space constrained portable devices. The MIC5380/1 provides two independently controlled, high performance 150mA LDOs in an ultra small 1mm x 1mm Thin MLF® package.

Ideal for battery powered applications, the MIC5380/1 offers ±1% typical accuracy, low dropout voltage (155mV at 150mA) and low ground current. The MIC5380/1 can also be put into a zero-off-mode current state, drawing virtually no current when disabled.

The MIC5380/1 offers fast transient response and high PSRR while consuming minimal operating current. When the MIC5381 is disabled an internal resistive load is automatically applied to the output to discharge the output capacitor.

The MIC5380/1 is available with fixed output voltages in a lead-free (RoHS compliant) 6-pin 1mm x 1mm Thin MLF® package.

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

Features

- 6-pin 1mm x 1mm Thin MLF® package
- 2.5V to 5.5V input voltage range
- 150mA output current per LDO
- High output accuracy ±1% typical
- Low quiescent current 32µA per LDO
- Stable with 0402 1µF ceramic output capacitors
- Low dropout voltage 155mV at 150mA
- Output discharge circuit on MIC5381
- Independent enable pins
- Thermal shutdown protection
- Current limit protection

Applications

- Bluetooth headsets
- Mobile phones
- GPS, PMP, PDAs , DSCs
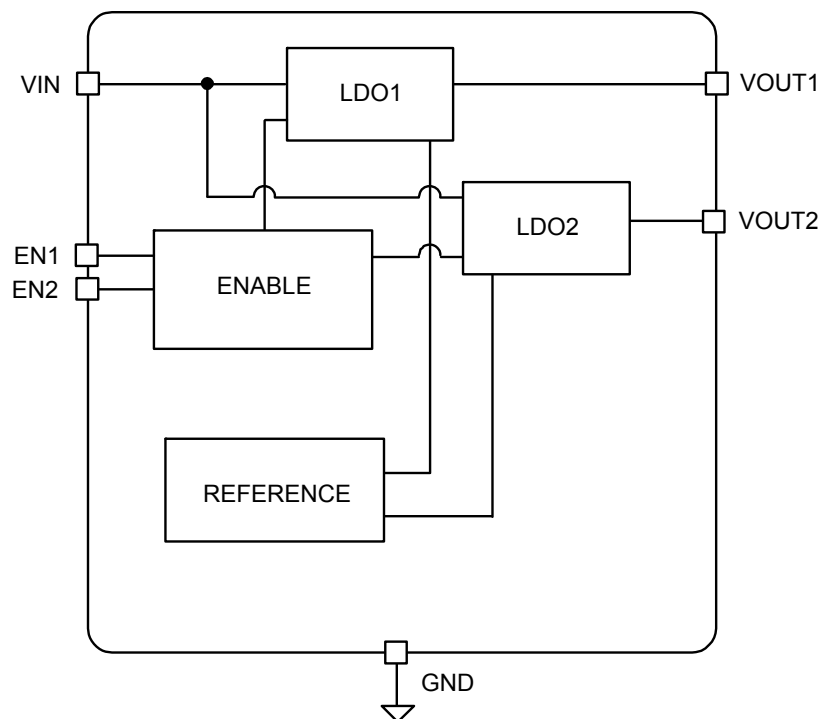- USB thumb drive
- Medical handheld
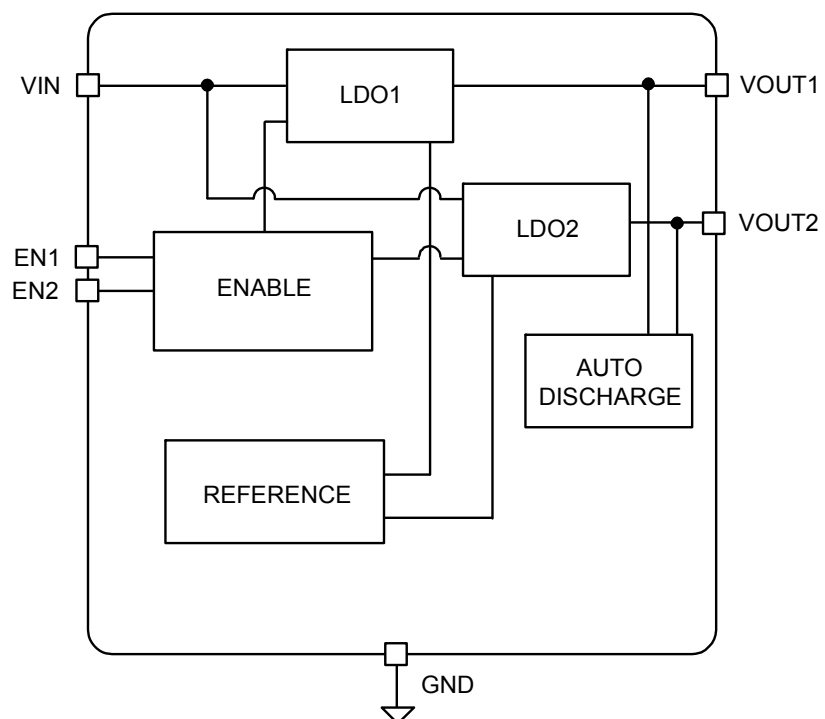- Portable handheld electronics

Typical Application

MIC5380/1-xxYFT

Camera DSP Power Supply Circuit
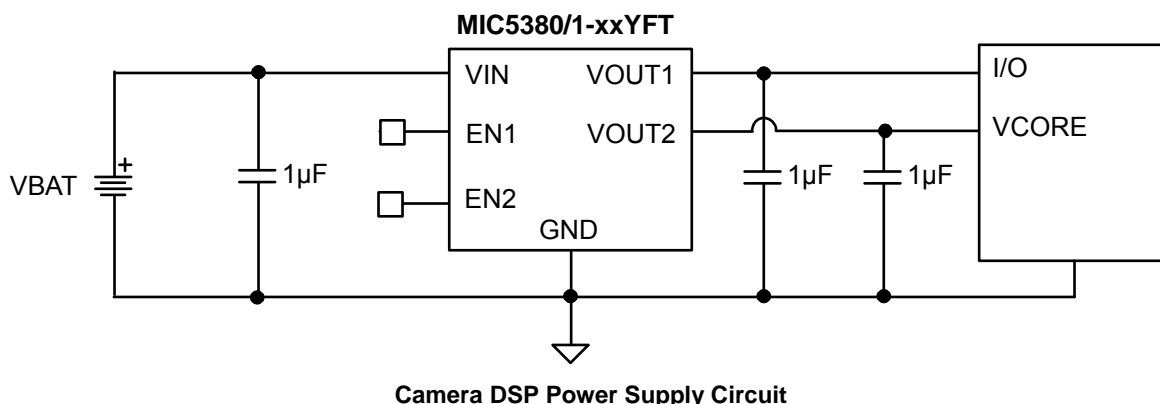
MLF and *Micro*LeadFrame are registered trademarks of Amkor Technology, Inc.

Block Diagrams

MIC5380 Block Diagram


MIC5381 Block Diagram

Ordering Information

Lead Free Part Number[1]	Manufacturing Part Number	Marking Code[2]	Voltage1	Voltage2	Junction Temp. Range	Package[3]
MIC5380-3.3/3.3YFT	MIC5380-SSYFT	S2	3.3V	3.3V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5380-3.0/3.0YFT	MIC5380-PPYFT	2P	3.0V	3.0V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5380-2.85/1.8YFT	MIC5380-NGYFT	NG	2.85V	1.8V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5380-2.8/1.8YFT	MIC5380-MGYFT	GM	2.8V	1.8V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5380-2.8/1.2YFT	MIC5380-M4YFT	4M	2.8V	1.2V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5380-2.7/2.7YFT	MIC5380-LLYFT	2L	2.7V	2.7V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5380-2.6/2.0YFT	MIC5380-KHYFT	KH	2.6V	2.0V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5380-1.8/1.2YFT	MIC5380-G4YFT	4G	1.8V	1.2V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5381-3.3/3.3YFT *	MIC5381-SSYFT	MK	3.3V	3.3V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5381-3.0/3.0YFT *	MIC5381-PPYFT	MF	3.0V	3.0V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5381-2.8/1.8YFT *	MIC5381-MGYFT	MG	2.8V	1.8V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5381-2.8/1.2YFT *	MIC5381-M4YFT	M4	2.8V	1.2V	–40° to +125°C	6-Pin 1x1 Thin MLF®
MIC5381-1.8/1.2YFT *	MIC5381-G4YFT	G4	1.8V	1.2V	–40° to +125°C	6-Pin 1x1 Thin MLF®

Note:

1. Other voltages available. Contact Micrel for details.

2. Thin MLF® Pin 1 Identifier = ▲.

3. Thin MLF® is a GREEN RoHS compliant package. Lead finish is NiPdAu. Mold compound is Halogen Free.

*   MIC5381 offers Auto-Discharge function.

Pin Configuration
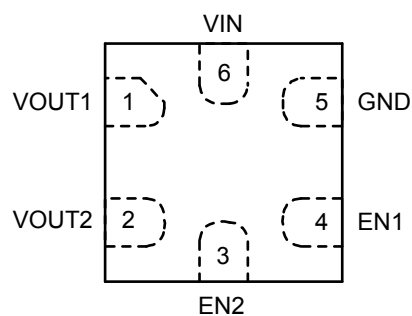
6-Pin 1mm x 1mm Thin MLF® (FT)
(Top View)

Pin Description

Pin Number	Pin Name	Pin Function
1	VOUT1	Regulator Output – LDO1.
2	VOUT2	Regulator Output – LDO2.
3	EN2	Enable Input (regulator 2). Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
4	EN1	Enable Input (regulator 1). Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
5	GND	Ground.
6	VIN	Supply Input.

Absolute Maximum Ratings[1]

Supply Voltage (V_{IN})....................................... –0.3V to +6V
Enable Voltage (V_{EN1}, V_{EN2}).............................–0.3V to V_{IN}
Power Dissipation (P_D)........................... Internally Limited[3]
Lead Temperature (soldering, 10sec.)....................... 260°C
Junction Temperature (T_J) .... –40°C to +125°C
Storage Temperature (T_s) .... –65°C to +150°C
ESD Rating[4]... 2kV

Operating Ratings[2]

Supply Voltage (V_{IN})....................................... +2.5V to 5.5V
Enable Voltage (V_{EN1}, V_{EN2})..............................–0.3V to V_{IN}
Junction Temperature (T_J) .... –40°C to +125°C
Junction Thermal Resistance
    1mm x 1mm Thin MLF-6 (θ_{JA}) ....150°C/W

Electrical Characteristics[5]

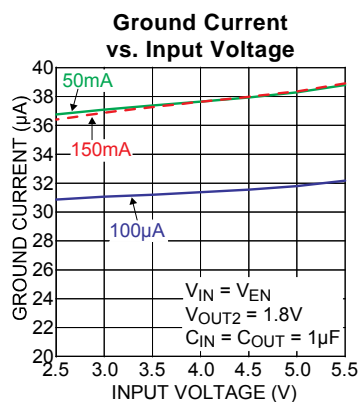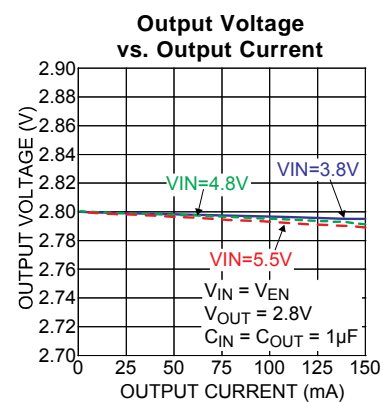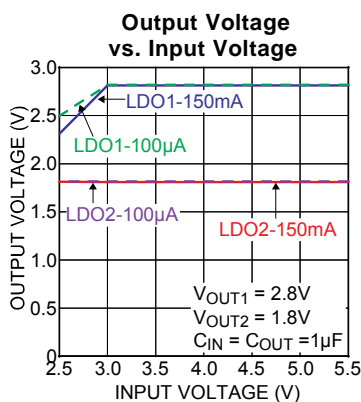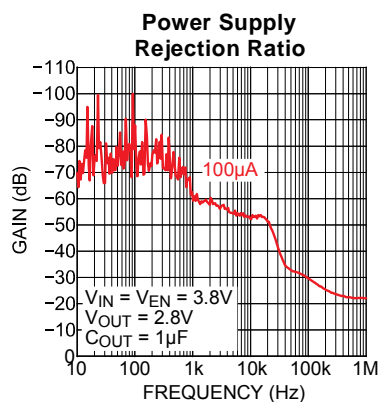V_{IN} = V_{EN1} = V_{EN2} = V_{OUT} + 1V; higher of the two regulator outputs; $I_{OUTLDO1}$ = $I_{OUTLDO2}$ = 100µA; C_{OUT1} = C_{OUT2} = 1µF;
T_J = 25°C, **bold** values indicate –40°C to +125°C, unless noted.

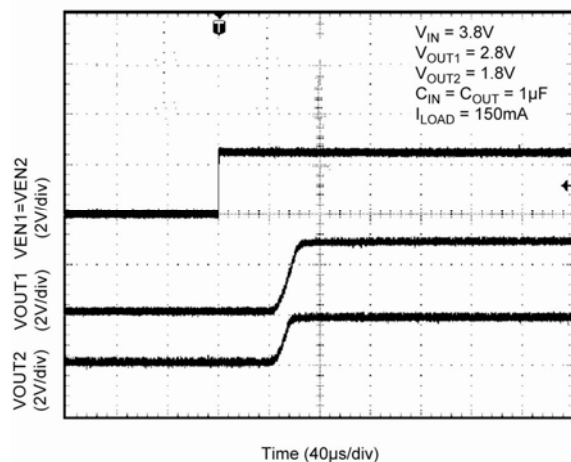| Parameter	Condition	Min	Typ	Max	Units
Output Voltage Accuracy	Variation from nominal V_{OUT}		±1		%
	Variation from nominal V_{OUT}; –40°C to +85°C	**–3.0**		**+3.0**	%
Line Regulation	V_{IN} = V_{OUT} +1V to 5.5V, I_{OUT} = 100µA		0.02	**0.3**	%/V
Load Regulation	I_{OUT} = 100µA to 150mA		0.3	1	%
Dropout Voltage	I_{OUT} = 50mA		55	**110**	mV
	I_{OUT} = 150mA		155	**310**	mV
Ground Pin Current	V_{EN1} = High; V_{EN2} = Low; I_{OUT} = 0mA		32	**45**	µA
	V_{EN1} = Low; V_{EN2} = High; I_{OUT} = 0mA		32	**45**	µA
	V_{EN1} = V_{EN2} = High; I_{OUT1} = I_{OUT2} = 0mA		59	**85**	µA
Ground Pin Current in Shutdown	V_{EN1} = V_{EN2} = 0V		0.05	1	µA
Ripple Rejection	f = 1kHz; C_{OUT} = 1µF		60		dB
Current Limit	V_{OUT} = 0V	200	325	550	mA
Output Voltage Noise	C_{OUT} = 1µF, 10Hz to 100kHz		200		µV$_{RMS}$
Auto-Discharge NFET Resistance	MIC5381 Only; V_{EN1} = V_{EN2} = 0V; V_{IN} = 3.6V		30		Ω
Enable Inputs (EN1/EN2)					
Enable Input Voltage	Logic Low			**0.2**	V
	Logic High	**1.2**			V
Enable Input Current	V_{IL} ≤ 0.2V		0.01	**1**	µA
	V_{IH} ≥ 1.2V		0.01	**1**	µA
Turn-on Time	C_{OUT} = 1µF		50	**125**	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, 1.5kΩ in series with 100pF.

5. Specification for packaged product only.
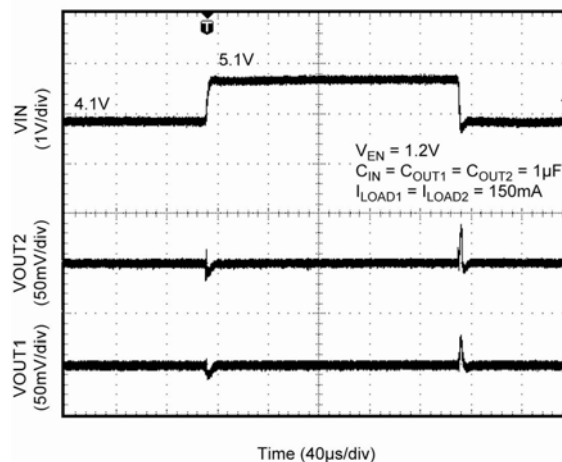
Typical Characteristics

Power Supply Rejection Ratio

Output Voltage vs. Input Voltage

Output Voltage vs. Output Current

Ground Current vs. Input Voltage

Ground Current vs. Output Current

Ground Current vs. Temperature

Dropout Voltage vs. Output Current

Dropout Voltage vs. Temperature

Current Limit vs. Input Voltage

Enable Voltage vs. Input Voltage

Output Noise Spectral Density
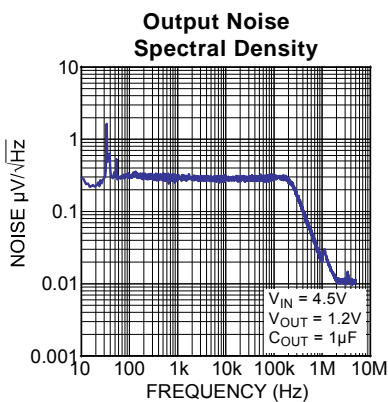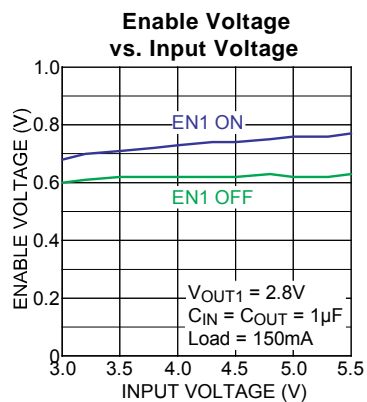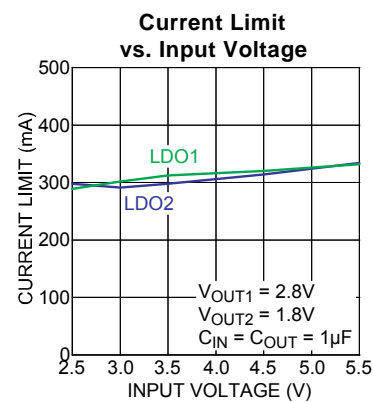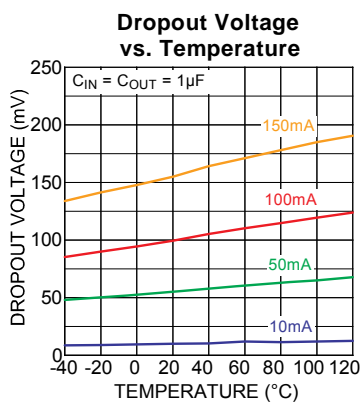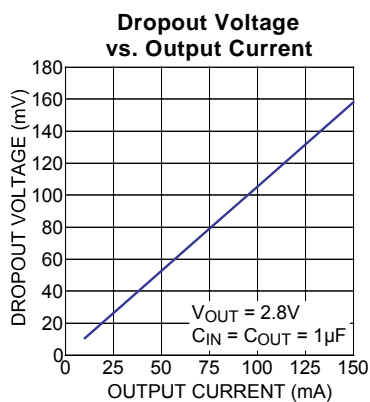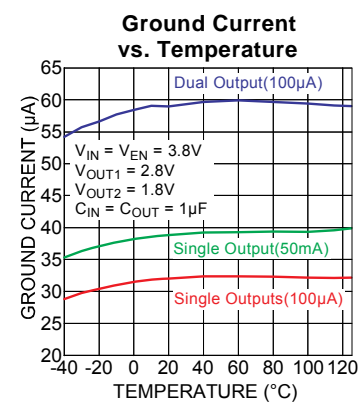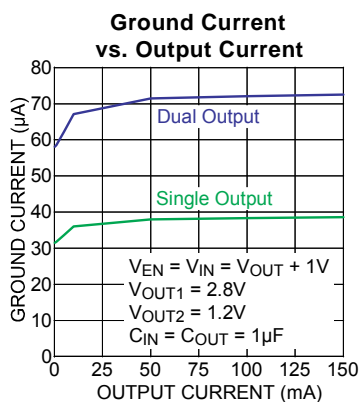
Functional Characteristics

Turn-On Time

$V_{IN} = 3.8V$
$V_{OUT1} = 2.8V$
$V_{OUT2} = 1.8V$
$C_{IN} = C_{OUT} = 1\mu F$
$I_{LOAD} = 150mA$

Time (40µs/div)

Line Transient

5.1V

4.1V

$V_{EN} = 1.2V$
$C_{IN} = C_{OUT1} = C_{OUT2} = 1\mu F$
$I_{LOAD1} = I_{LOAD2} = 150mA$

Time (40µs/div)

Load Transient

$V_{OUT1} = 2.8V$
$V_{OUT2} = Off$
$C_{IN} = C_{OUT1} = C_{OUT2} = 1\mu F$

Time (40µs/div)

Load Transient

$V_{OUT1} = Off$
$V_{OUT2} = 1.8V$
$C_{IN} = C_{OUT1} = C_{OUT2} = 1\mu F$

Time (40µs/div)
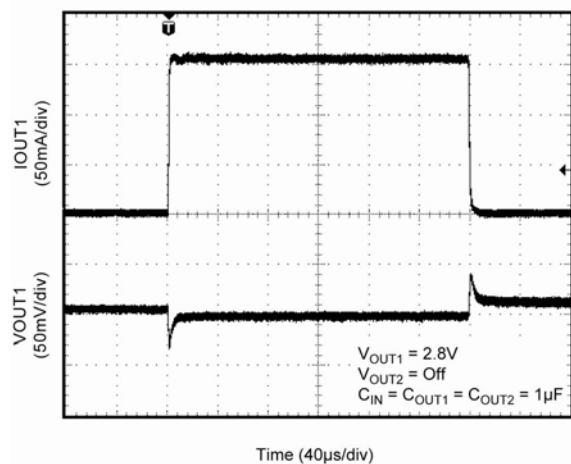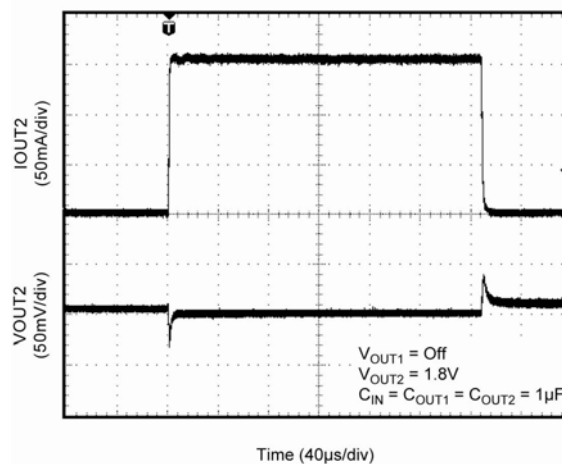
Turn-Off Time MIC5381 (Auto-Discharge)

$V_{IN} = 3.8V$
$V_{OUT1} = 2.8V$
$V_{OUT2} = 1.8V$
$C_{IN} = C_{OUT1} = C_{OUT2} = 1\mu F$
No Load

Time (40µs/div)
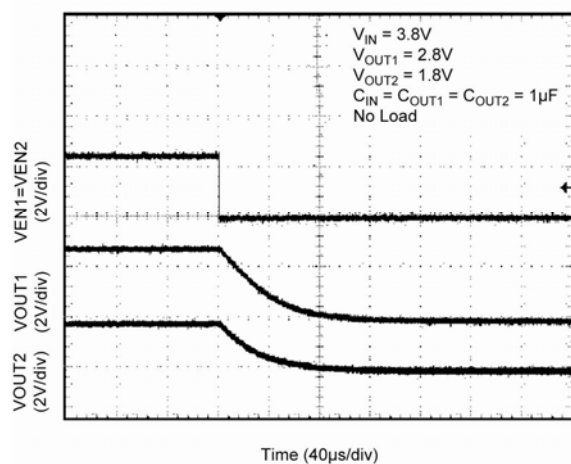
Application Information

MIC5380/1 is a dual 150mA LDO in a small 1mm x 1mm Thin MLF® package. The MIC5381 includes an auto-discharge circuit for each of the LDO outputs that is activated when the output is disabled. The MIC5380/1 regulator is fully protected from damage due to fault conditions through linear current limiting and thermal shutdown.

Input Capacitor

The MIC5380/1 is a high-performance, high bandwidth device. An input capacitor of 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 MIC5380/1 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.

No-Load Stability

Unlike many other voltage regulators, the MIC5380/1 will remain stable and in regulation with no load. This is especially important in CMOS RAM keep-alive applications.

Enable/Shutdown

The MIC5380/1 comes with two 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. When disabled the MIC5381 switches a 30Ω (typical) load on the regulator output to discharge the external capacitor.

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.

Thermal Considerations

The MIC5380/1 is designed to provide 150mA 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. For example, if the input voltage is 3.6V, and the output voltage 3.0V for V_{OUT1}, 3.0V for V_{OUT2} and output current = 150mA, then the actual power dissipation of the regulator circuit can be calculated using the equation:

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

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.

$$P_D = (3.6V - 3.0V) \times 150mA + (3.6V - 3.0V) \times 150mA$$
$$P_D = 0.18W$$

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, and the maximum junction temperature of the die, θ_{JA}, thermal resistance = 150°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 junction-to-ambient thermal resistance for the minimum footprint is 150°C/W.

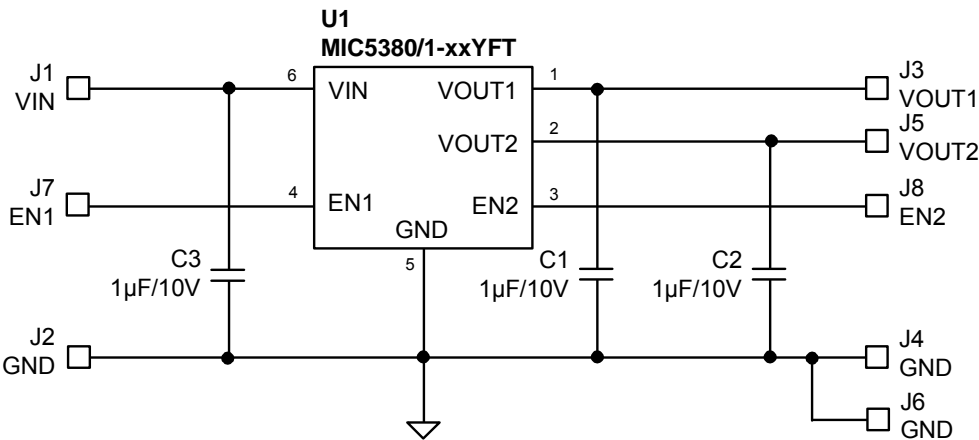The maximum power dissipation must not be exceeded for proper operation.

For example, when operating the MIC5380-PPYFT at an input voltage of 3.6V and 150mA loads at each output with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

$$0.18W = (125°C – T_A)/(150°C/W)$$

$$T_A = 98°C$$

Therefore, a 3.0V/3.0V application, with 150mA at each output current, can accept an ambient operating temperature of 98°C in a 1mm x 1mm 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:

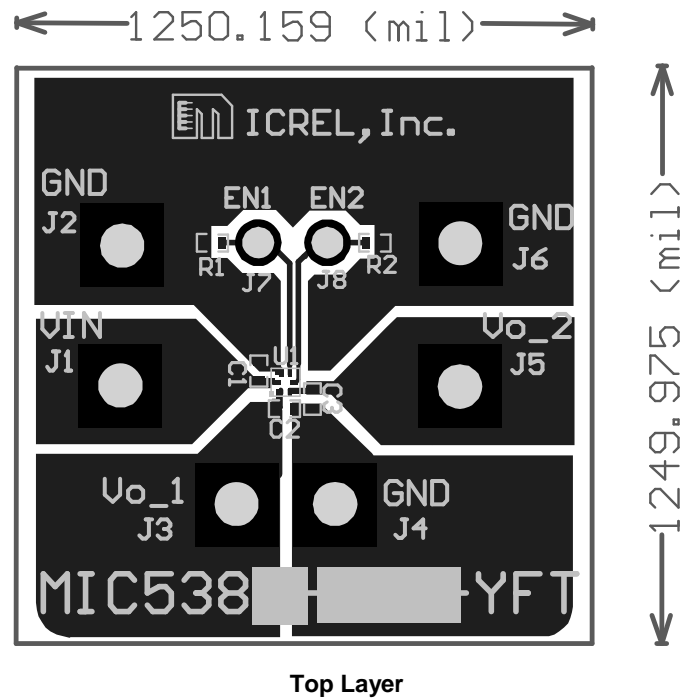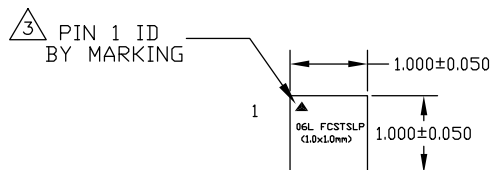http://www.micrel.com/_PDF/other/LDOBk_ds.pdf

U1
MIC5380/1-xxYFT

J1
VIN
6 | VIN   VOUT1 | 1
                           VOUT2 | 2
J7
EN1
4 | EN1   EN2 | 3
                    GND
                     5
C3
1µF/10V

J2
GND

J3
VOUT1
J5
VOUT2
J8
EN2

C1
1µF/10V
C2
1µF/10V

J4
GND
J6
GND

Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2, C3	GRM155R61A105KE19D	Murata[1]	Capacitor, 1µF Ceramic, 10V, X5R, Size 0402	3
	C1005X5R1A105K	TDK[2]	Capacitor, 1µF Ceramic, 10V, X5R, Size 0402	
	0402ZD105KAT2A	AVX[3]	Capacitor, 1µF Ceramic, 10V, X5R, Size 0402	
U1	**MIC5380/1-xxYFT**	**Micrel[4]**	**Dual, 150mA LDO, Size 1mm x 1mm Thin MLF®**	**1**

Notes:

1. Murata: www.murata.com

2. TDK: www.tdk.com
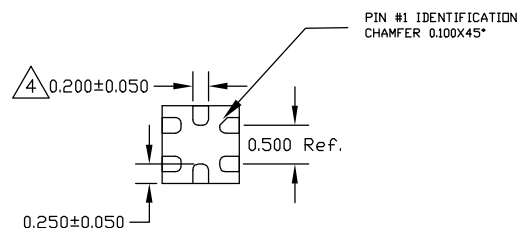
3. AVX: avx.com

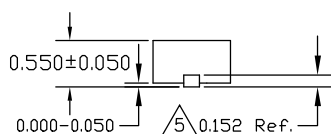4. **Micrel, Inc.: www.micrel.com**

PCB Layout Recommendations

Top Layer

Bottom Layer

Package Information

PIN 1 ID
BY MARKING

1

06L FCSTSLP
(1.0x1.0mm)

1.000±0.050

1.000±0.050

TOP VIEW

PIN #1 IDENTIFICATION
CHAMFER 0.100X45°

0.200±0.050

0.500 Ref.

0.250±0.050
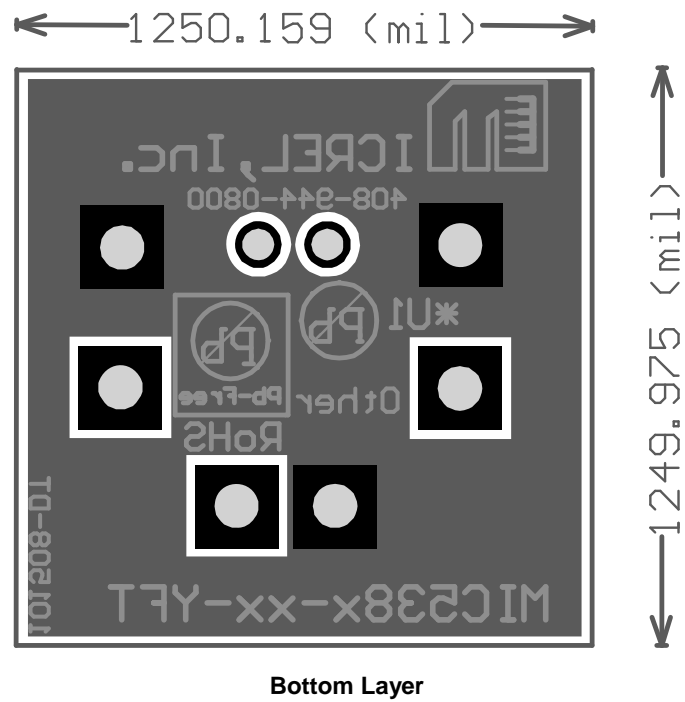
BOTTOM VIEW

NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.
   N IS THE TOTAL NUMBER OF TERMINALS.
2. MAX PACKAGE WARPAGE IS 0.05mm, MAX ALLOWABLE BURRS
   IS 0.076 mm IN ALL DIRECTIONS.
3. PIN #1 ID ON TOP WILL BE LASER/INK MARKED.
4. DIMENSION APPLIES TO PLATED TERMINAL AND IS MEASURED
   BETWEEN 0.20 AND 0.25mm FROM TERMINAL TIP.
5. APPLIED FOR EXPOSED PAD AND TERMINALS.

0.550±0.050

0.000-0.050

0.152 Ref.

SIDE VIEW

6-Pin 1mm x 1mm Thin MLF® (FT)

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Micrel](#):
  MIC5380-MGYFT TR   MIC5380-NGYFT TR   MIC5380-M4YFT TR   MIC5380-G4YFT TR   MIC5381-MGYFT TR
MIC5380-MGYFT-TR   MIC5380-SSYFT-TR   MIC5380-G4YFT-TR   MIC5380-LLYFT-TR   MIC5380-PPYFT-TR
MIC5380-NGYFT-TR   MIC5381-PPYFT-TR   MIC5381-MGYFT-TR   MIC5381-M4YFT-TR   MIC5380-M4YFT-TR
MIC5381-SSYFT-TR   MIC5381-G4YFT-TR   MIC5380-KHYFT-TR