MICROCHIP

MIC5380/1

High Performance Dual 150 mA LDOs

Features

- 6-Lead 1 mm x 1 mm FTQFN Package
- 2.5V to 5.5V Input Voltage Range
- 150 mA Output Current per LDO
- High Output Accuracy ±1% Typical
- Low Quiescent Current of 32 µA per LDO
- Stable with 0402 1 µF Ceramic Output Capacitors
- Low Dropout Voltage 155 mV at 150 mA
- 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

General Description

The MIC5380 and MIC5381 are advanced dual LDOs that are ideal for powering space-constrained portable devices. The MIC5380/1 provide two independently controlled, high performance 150 mA LDOs in an ultra-small 1 mm x 1 mm FTQFN package.

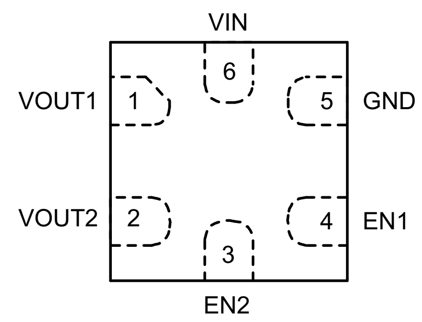
Ideal for battery powered applications, the MIC5380/1 offer ±1% typical accuracy, low dropout voltage (155 mV at 150 mA), and low ground current. The MIC5380/1 can also be put into a zero-off-mode current state, drawing virtually no current when disabled.

The MIC5380/1 offer 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 are available with fixed output voltages in a lead-free (RoHS compliant) 6-lead 1 mm x 1 mm FTQFN package.

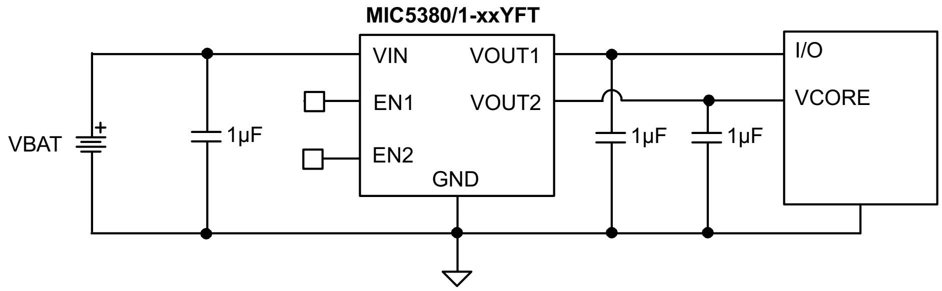
Package Type

MIC5380/MIC5381
6-Lead FTQFN (MT)
(Top View)



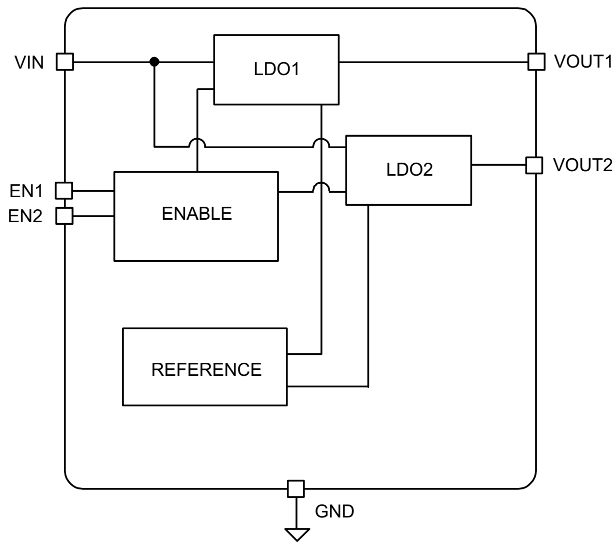
Typical Application Circuit

Camera DSP Power Supply Circuit

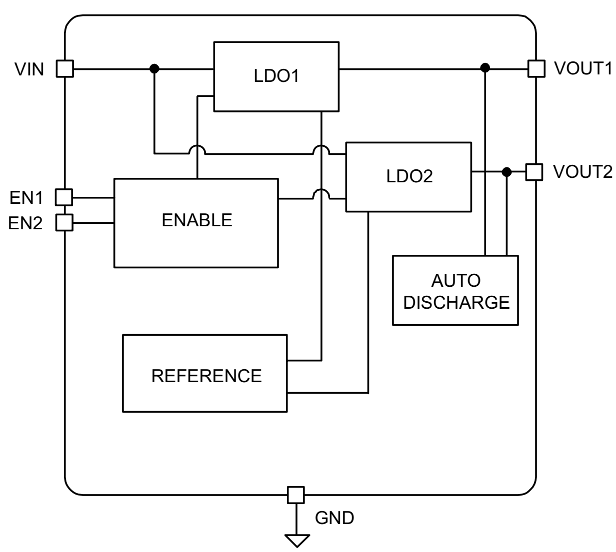


Functional Block Diagrams

MIC5380 Block Diagram



MIC5381 Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{IN}) ..... –0.3V to +6V
Enable Voltage (V_{EN1}, V_{EN2}) ..... –0.3V to V_{IN}
Power Dissipation (P_D) (Note 1) ..... Internally Limited
ESD Rating (Note 2) ..... 2 kV

Operating Ratings ††

Supply Voltage (V_{IN}) ..... +2.5V to +5.5V
Enable Voltage (V_{EN1}, V_{EN2}) ..... –0.3V to V_{IN}

† Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

†† Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: 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.

2: Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

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

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	—	—	±1	—	%	Variation from nominal V_{OUT}
		–3.0	—	**3.0**	%	Variation from nominal V_{OUT}; –40°C to +85°C
Line Regulation	$ΔV_{OUT}/(V_{OUT} \times ΔV_{IN})$	—	0.02	**0.3**	%/V	$V_{IN} = V_{OUT}$ + 1V to 5.5V, I_{OUT} = 100 µA
Load Regulation	$ΔV_{OUT}/V_{OUT}$	—	0.3	1	%	I_{OUT} = 100 µA to 150 mA
Dropout Voltage	V_{DROP}	—	55	**110**	mV	I_{OUT} = 50 mA
		—	155	**310**	mV	I_{OUT} = 150 mA
Ground Pin Current	I_{GND}	—	32	**45**	µA	V_{EN1} = High; V_{EN2} = Low; I_{OUT} = 0 mA
		—	32	**45**	µA	V_{EN1} = Low; V_{EN2} = High; I_{OUT} = 0 mA
		—	59	**85**	µA	$V_{EN1} = V_{EN2}$ = High; $I_{OUT1} = I_{OUT2}$ = 0 mA
Ground Pin Current in Shutdown	I_{SHDN}	—	0.05	1	µA	$V_{EN1} = V_{EN2}$ = 0V
Ripple Rejection	PSRR	—	60	—	dB	f = 1 kHz; C_{OUT} = 1 µF
Current Limit	I_{LIMIT}	200	325	550	mA	V_{OUT} = 0V
Output Voltage Noise	e_N	—	200	—	$µV_{RMS}$	C_{OUT} = 1 µF, 10 Hz to 100 kHz

Note 1: Specification for packaged product only.

ELECTRICAL CHARACTERISTICS (CONTINUED)

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

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Auto-Discharge NFET Resistance	R_{DS}	—	30	—	Ω	MIC5381 Only; $V_{EN1} = V_{EN2}$ = 0V; V_{IN} = 3.6V
Enable Inputs (EN1/EN2)						
Enable Input Voltage	V_{EN}	—	—	**0.2**	V	Logic Low
		1.2	—	—	V	Logic High
Enable Input Current	I_{EN}	—	0.01	**1**	µA	V_{IL} ≤ 0.2V
		—	0.01	**1**	µA	V_{IH} ≥ 1.2V
Turn-On Time	t_{ON}	—	50	**125**	µs	C_{OUT} = 1 µF

Note 1: Specification for packaged product only.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Temperature Range	T_J	–40	—	+125	°C	—
Storage Temperature Range	T_S	–65	—	+150	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 10 sec.
Package Thermal Resistances						
Thermal Resistance, FTQFN 6-Ld	θ_{JA}	—	150	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

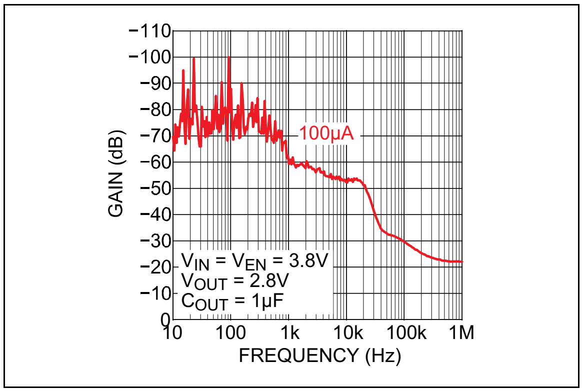


FIGURE 2-1: *Power Supply Rejection Ratio.*

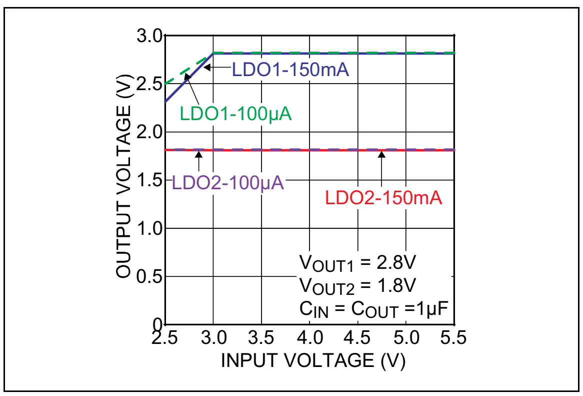


FIGURE 2-2: *Output Voltage vs. Input Voltage.*

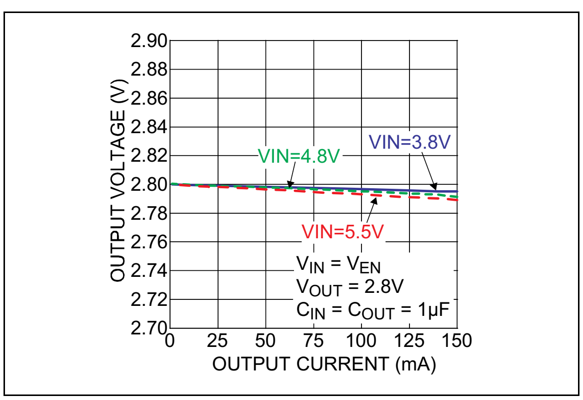


FIGURE 2-3: *Output Voltage vs. Output Current.*

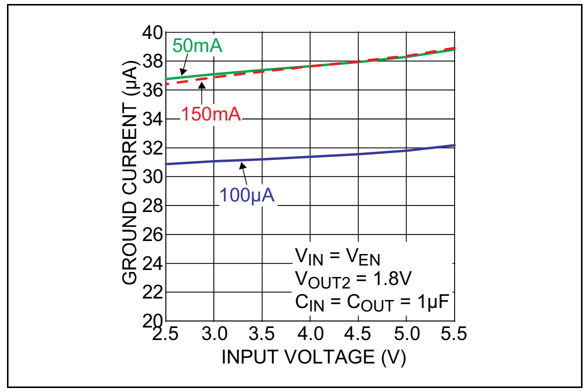


FIGURE 2-4: *Ground Current vs. Input Voltage.*

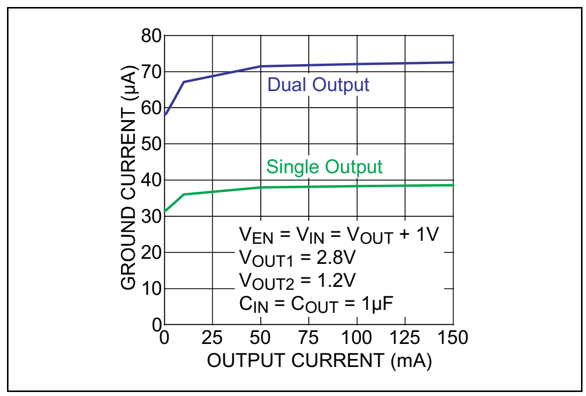


FIGURE 2-5: *Ground Current vs. Output Current.*

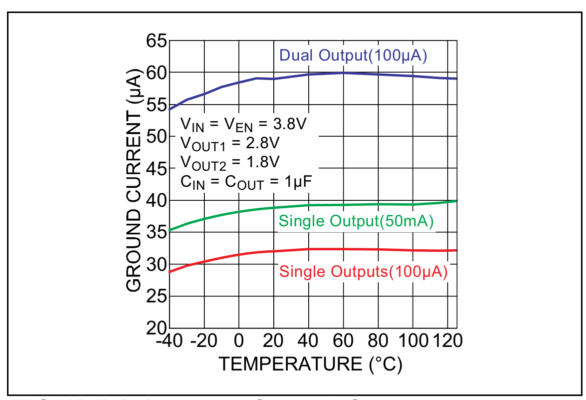


FIGURE 2-6: *Ground Current vs. Temperature.*

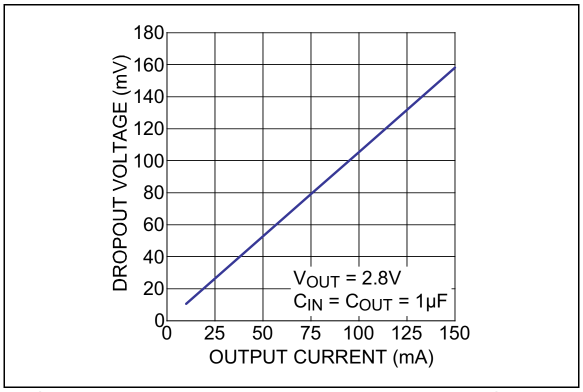


FIGURE 2-7: *Dropout Voltage vs. Output Current.*

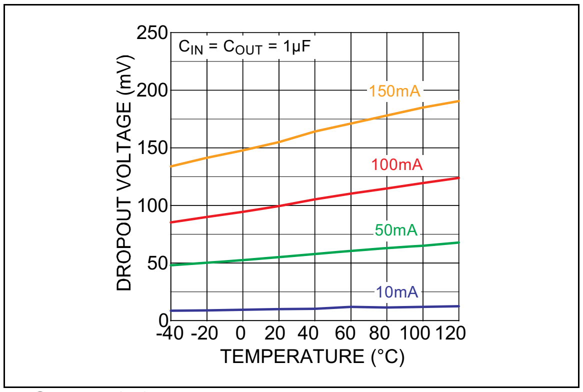


FIGURE 2-8: *Dropout Voltage vs. Temperature.*

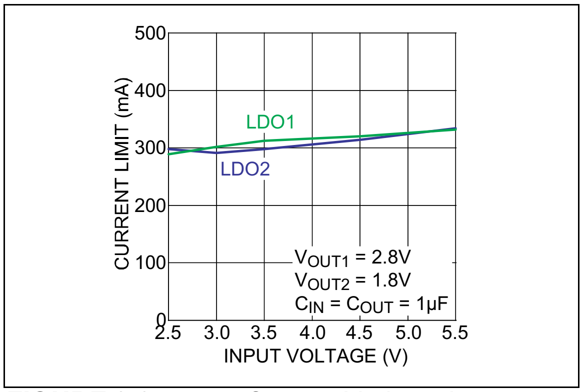


FIGURE 2-9: *Current Limit vs. Input Voltage.*

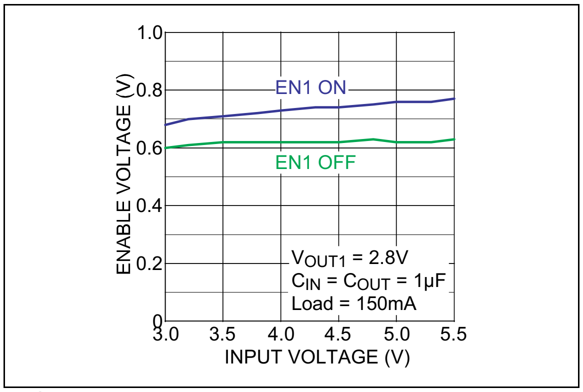


FIGURE 2-10: *Enable Voltage vs. Input Voltage.*

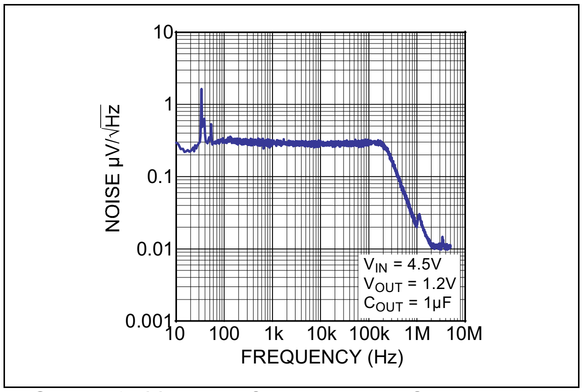


FIGURE 2-11: *Output Noise Spectral Density.*

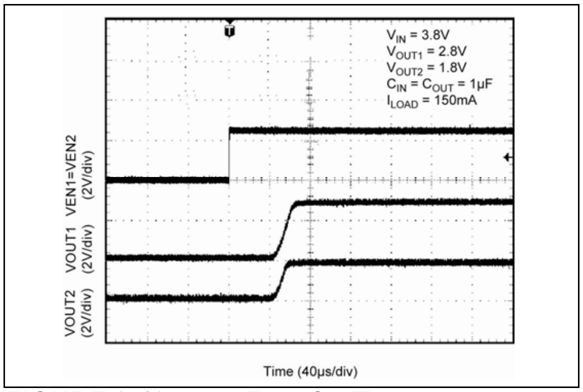


FIGURE 2-12: *Turn-On Time.*

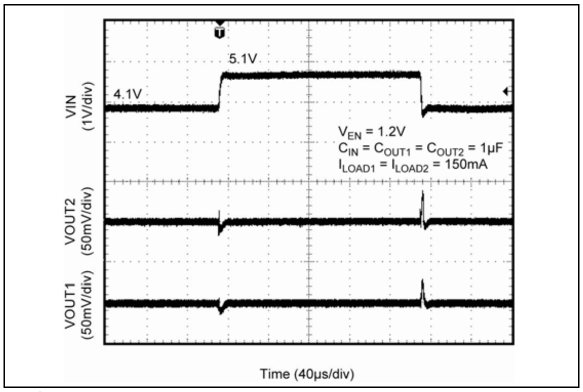


FIGURE 2-13: *Line Transient.*

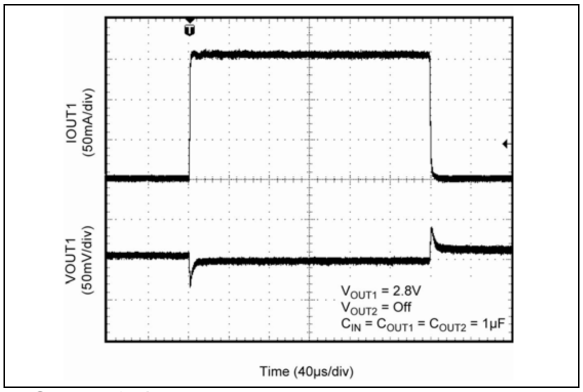


FIGURE 2-14: *Load Transient.*

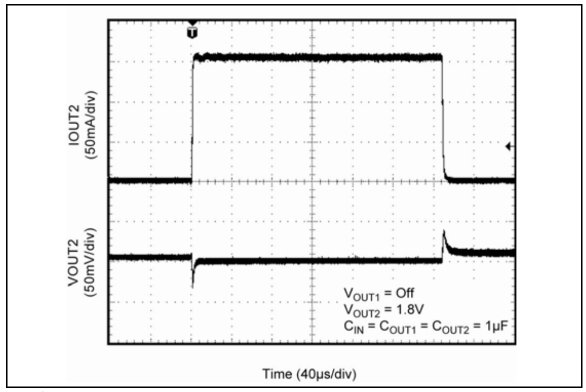


FIGURE 2-15: *Load Transient.*

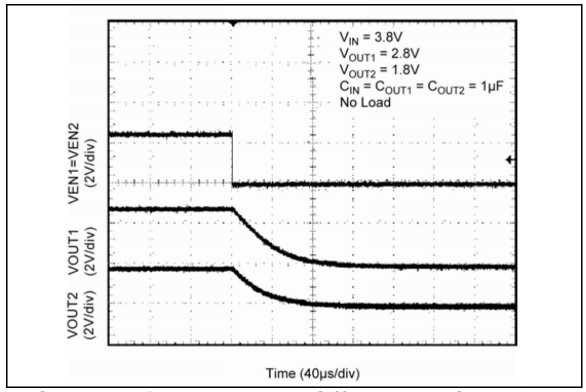


FIGURE 2-16: *Turn-Off Time MIC5381 (Auto-Discharge).*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
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.

4.0 APPLICATION INFORMATION

MIC5380/1 is a dual 150 mA LDO in a small 1 mm x 1 mm FTQFN 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.

4.1 Input Capacitor

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

4.2 Output Capacitor

The MIC5380/1 requires an output capacitor of 1 µF 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 µF 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.

4.3 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.

4.4 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.

4.5 Thermal Considerations

The MIC5380/1 is designed to provide 150 mA 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 equals 150 mA, then the actual power dissipation of the regulator circuit can be calculated using the equation:

EQUATION 4-1:

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

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

EQUATION 4-2:

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

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:

EQUATION 4-3:

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

Where:

$T_{J(MAX)}$ = 125°C

θ_{JA} = Thermal resistance of 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 150 mA loads at each output with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

EQUATION 4-4:

$$0.18W = (125°C - T_A)/(150°C/W)$$

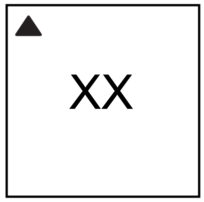
$$T_A = 98°C$$

Therefore, a 3.0V/3.0V application, with 150 mA at each output current, can accept an ambient operating temperature of 98°C in a 1 mm x 1 mm FTQFN package. For a full discussion of heat sinking and thermal effects on voltage regulators, refer to the “Regulator Thermals” section of Microchip’s Designing with Low-Dropout Voltage Regulators handbook.

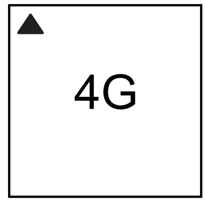
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

6-Lead FTQFN*



Example



Legend:

XX...X	Product code or customer-specific information
Y	Year code (last digit of calendar year)
YY	Year code (last 2 digits of calendar year)
WW	Week code (week of January 1 is week ‘01’)
NNN	Alphanumeric traceability code
(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

●, ▲, ▼ Pin one index is identified by a dot, delta up, or delta down (triangle mark).

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

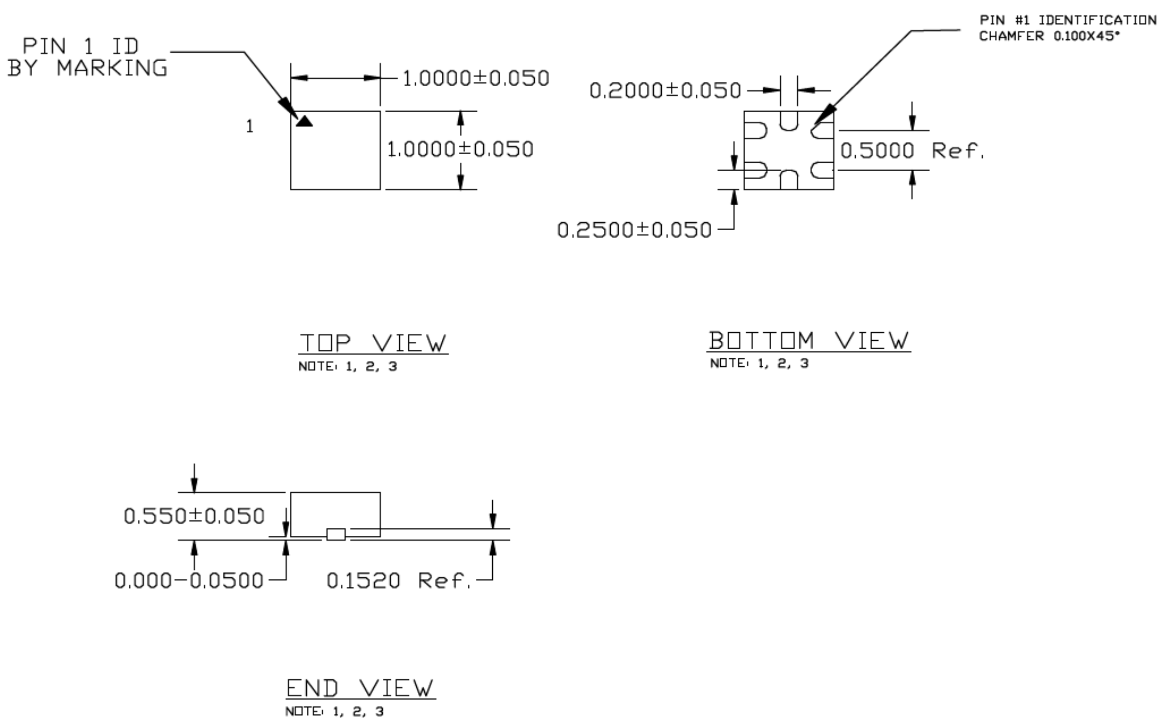
TABLE 5-1: MARKING CODES

Part Number	Marking Code	Voltage 1	Voltage 2	Auto-Discharge
MIC5380-SSYFT	S2	3.3V	3.3V	No
MIC5380-PPYFT	2P	3.0V	3.0V	No
MIC5380-NGYFT	NG	2.85V	1.8V	No
MIC5380-MGYFT	GM	2.8V	1.8V	No
MIC5380-M4YFT	4M	2.8V	1.2V	No
MIC5380-LLYFT	2L	2.7V	2.7V	No
MIC5380-KHYFT	KH	2.6V	2.0V	No
MIC5380-G4YFT	4G	1.8V	1.2V	No
MIC5381-SSYFT	MK	3.3V	3.3V	Yes
MIC5381-PPYFT	MF	3.0V	3.0V	Yes
MIC5381-MGYFT	MG	2.8V	1.8V	Yes
MIC5381-M4YFT	M4	2.8V	1.2V	Yes
MIC5381-G4YFT	G4	1.8V	1.2V	Yes

6-Lead 1 mm x 1 mm FTQFN Package Outline & Recommended Land Pattern

TITLE
6 LEAD FTQFN 1.0 x1.0 mm PACKAGE (Flip Chip) OUTLINE & RECOMMENDED LAND PATTERN

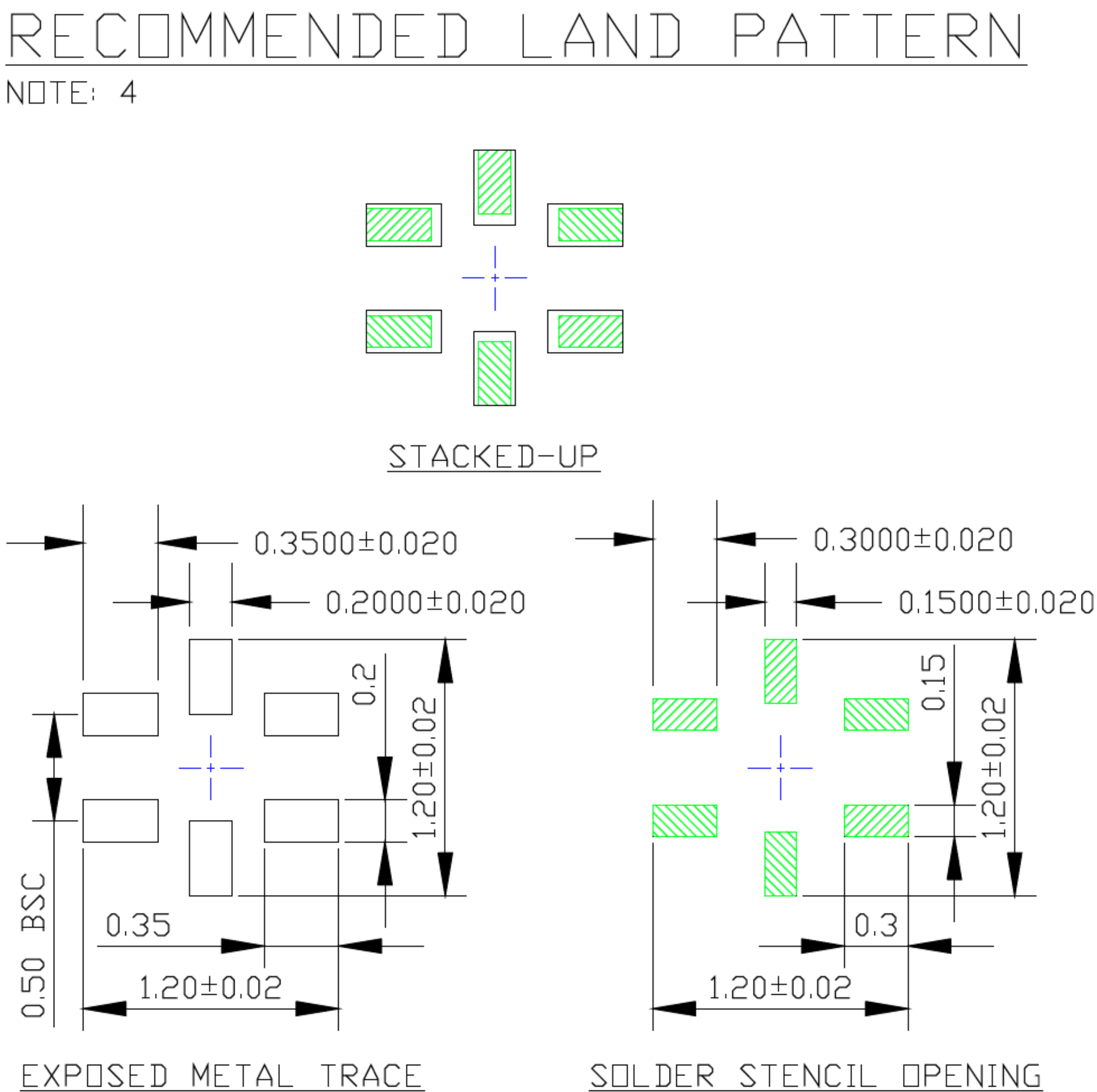
DRAWING #	FTQFN1010-6LD-PL-1	**UNIT**	MM
LEAD FRAME	NiPdAu	**LEAD FINISH**	NiPdAu



NOTE:
1. MAX PACKAGE WARPAGE IS 0.05 MM
2. MAX ALLOWABLE BURR IS 0.076MM IN ALL DIRECTIONS
3. PIN #1 IS ON TOP WILL BE LASER MARKED
4. GREEN RECTANGLES (SHADED AREA) REPRESENT SOLDER STENCIL OPENING ON EXPOSED METAL TRACE

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

POD-Land Pattern drawing #FTQFN1010-6LD-PL-1



Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (April 2021)

- Converted Micrel document MIC5380/1 to Microchip data sheet template DS20006525A.
- Minor grammatical text changes throughout.
- All schematic and BOM references removed as they are found in the User's Guide for these parts.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

Device	-X	X	XX	-XX
Part No.	Output Voltages	Junction Temp. Range	Package	Media Type

Device:	MIC5380: MIC5381:	High Performance Dual 150mA LDO High Performance Dual 150mA LDO with Auto-Discharge
Output Voltages:	SS = PP = NG = MG = M4 = LL = KH = G4 =	3.3V/3.3V 3.0V/3.0V 2.85V/1.8V (MIC5380 Only) 2.8V/1.8V 2.8V/1.2V 2.7V/2.7V (MIC5380 Only) 2.6V/2.0V (MIC5380 Only) 1.8V/1.2V
Junction Temperature Range:	Y =	–40°C to +125°C
Package:	MT =	6-Lead 1 mm x 1 mm FTQFN
Media Type:	TR =	5,000/Reel

Examples:

a) MIC5380-SSYFT-TR: MIC5380, 3.3V/3.3V Output Voltages, –40°C to +125°C Temperature Range, 6-Lead FTQFN, 5,000/Reel

b) MIC5381-M4YFT-TR: MIC5381, 2.8V/1.2V Output Voltages, –40°C to +125°C Temperature Range, 6-Lead FTQFN, 5,000/Reel

c) MIC5380-LLYFT-TR: MIC5380, 2.7V/2.7V Output Voltages, –40°C to +125°C Temperature Range, 6-Lead FTQFN, 5,000/Reel

d) MIC5381-G4YFT-TR: MIC5381, 1.8V/1.2V Output Voltages, –40°C to +125°C Temperature Range, 6-Lead FTQFN, 5,000/Reel

e) MIC5381-MGYFT-TR: MIC5381, 2.8V/1.2V Output Voltages, –40°C to +125°C Temperature Range, 6-Lead FTQFN, 5,000/Reel

f) MIC5380-NGYFT-TR: MIC5380, 2.85V/1.8V Output Voltages, –40°C to +125°C Temperature Range, 6-Lead FTQFN, 5,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

ISBN: 978-1-5224-8007-5

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