LM4050QML Precision Micropower Shunt Voltage Reference

Check for Samples: LM4050QML

FEATURES

- **Low Dose Rate Qualified 100 krad(Si)**
- **SEFI Immune**
- **SET Immune with 60µF C_{LOAD}**
- **C_{LOAD} 0µF to 100µF**
- **Fixed Reverse Breakdown Voltage of 2.500V, 5.000V**

KEY SPECIFICATIONS

- **LM4050-2.5QML**
  - **Output Voltage Tolerance IR = 100µA ±0.1% @ 25°C**
  - **Low Temperature Coefficient 15 ppm/°C**
  - **Low Output Noise 50 µVrms(typ)**
  - **Wide Operating Current Range 60 µA to 15 mA**
- **LM4050-5.0QML**
  - **Output Voltage Tolerance IR = 100µA ±0.1% @ 25°C**
  - **Low Temperature Coefficient 23 ppm/°C**
  - **Low Output Noise 100 µVrms(typ)**
  - **Wide Operating Current Range 74 µA to 15 mA**

APPLICATIONS

- **Control Systems**
- **Data Acquisition Systems**
- **Instrumentation**
- **Process Control**
- **Energy Management**

DESCRIPTION

The LM4050QML precision voltage reference is available in a 10-Lead Ceramic CLGA package. The LM4050QML's design eliminates the need for an external stabilizing capacitor while ensuring stability with a capacitive load, thus making the LM4050QML easy to use. The LM4050-2.5QML has a 60 µA minimum and 15 mA maximum operating current. The LM4050-5.0QML has a 74 µA minimum and 15 mA maximum operating current.

The LM4050QML utilizes fuse and zener-zap reverse breakdown voltage trim during wafer sort to ensure that the prime parts have an accuracy of better than ±0.1% at 25°C. Bandgap reference temperature drift curvature correction and low dynamic impedance ensure stable reverse breakdown voltage accuracy over a wide range of operating temperatures and currents.

The LM4050QML operates over the temperature range of -55°C to +125°C.

Connection Diagram

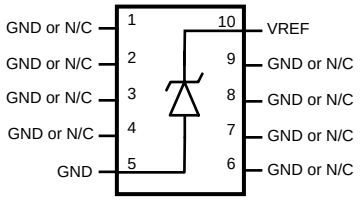

Figure 1. 10-Lead Ceramic CFP, Top View
See NAC0010A Package

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PIN DESCRIPTIONS

Pin Number	Pin Name	Function
1	GND/NC	Ground or No Connect
2	GND/NC	Ground or No Connect
3	GND/NC	Ground or No Connect
4	GND/NC	Ground or No Connect
5	GND	Ground
6	GND/NC	Ground or No Connect
7	GND/NC	Ground or No Connect
8	GND/NC	Ground or No Connect
9	GND/NC	Ground or No Connect
10	VREF	Reference Voltage

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings(1)

Reverse Current		20 mA
Forward Current		10 mA
Power Dissipation (T_A = 25°C)(2)	CLGA Package	467 mW
Lead Temperature (Soldering, 10 seconds)	CLGA Package	260°C
Storage Temperature		-65°C to +150°C
Package Weight (typical)	CLGA Package	241mg
ESD Tolerance (3)		Class 2 (2000V)

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

(2) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $PD_{max} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower. For the LM4050QML, T_{Jmax} = 125°C, and the typical thermal resistance (θ_{JA}), when board mounted, is 214°C/W for the 10-Lead Ceramic CLGA package.

(3) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin.

Operating Ratings (1)

Temperature Range		-55°C ≤ T_A ≤ +125°C
Reverse Current	LM4050-2.5QML	60 µA to 15 mA
	LM4050-5.0QML	74 µA to 15 mA

(1) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is $PD_{max} = (T_{Jmax} - T_A)/\theta_{JA}$ or the number given in the Absolute Maximum Ratings, whichever is lower. For the LM4050QML, T_{Jmax} = 125°C, and the typical thermal resistance (θ_{JA}), when board mounted, is 214°C/W for the 10-Lead Ceramic CLGA package.

Package Thermal Resistance

Package	θ_{JA} (Still Air)	θ_{JA} (500LF/Min Air flow)	θ_{JC}
CLGA Package on 2 layer, 1oz PCB	214°C/ W	147°C/ W	20.87°C/ W

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Quality Conformance Inspection

MIL-STD-883, Method 5005 - Group A

Subgroup	Description	Temp (C)
1	Static tests at	+25
2	Static tests at	+125
3	Static tests at	-55
4	Dynamic tests at	+25
5	Dynamic tests at	+125
6	Dynamic tests at	-55
7	Functional tests at	+25
8A	Functional tests at	+125
8B	Functional tests at	-55
9	Switching tests at	+25
10	Switching tests at	+125
11	Switching tests at	-55
12	Setting time at	+25
13	Setting time at	+125
14	Setting time at	-55

LM4050-2.5QML Electrical Characteristics SMD: 5962R0923561

The initial Reverse Breakdown Voltage tolerance is ±0.1% @ 100µA.

Symbol	Parameter	Conditions	Notes	Typical(1)	Min	Max	Units	Sub-groups
V_R	Reverse Breakdown Voltage	I_R = 100 µA		2.500			V	
	Reverse Breakdown Voltage Tolerance	I_R = 60µA				±2.5	mV	1
		I_R = 100µA				±2.5		
		I_R = 1mA				±3.75		
		I_R = 10mA				±10		
		I_R = 15mA				±13		
		I_R = 60µA				**±5**	mV	2
		I_R = 100µA				**±5**		
		I_R = 1mA				**±6.25**		
		I_R = 10mA				**±12.5**		
		I_R = 15mA				**±14**		
		I_R = 60µA				**±4.5**	mV	3
		I_R = 100µA				**±4.5**		
		I_R = 1mA				**±5.75**		
		I_R = 10mA				**±13**		
		I_R = 15mA				**±17.5**		
I_{RMIN}	Minimum Operating Current			40.5		60	µA	1
						65	µA	2, 3

(1) Typicals are at T_A = 25°C and represent most likely parametric norm.

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LM4050-2.5QML Electrical Characteristics SMD: 5962R0923561 (continued)

The initial Reverse Breakdown Voltage tolerance is ±0.1% @ 100µA.

Symbol	Parameter	Conditions	Notes	Typical[1]	Min	Max	Units	Sub-groups
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient @ 25°C ≤ T_A ≤ 125°C	I_R = 60µA	See[2]	±3		**±15**	ppm/°C	2
		I_R = 100µA		±3		**±16**		
		I_R = 1mA		±3		**±18**		
		I_R = 10mA		±4		**±20**		
		I_R = 15mA		±6		**±22**		
	Average Reverse Breakdown Voltage Temperature Coefficient @ −55°C ≤ T_A ≤ 25°C	I_R = 60µA	See[2]	±3		**±18**		3
		I_R = 100µA		±3		**±19**		
		I_R = 1mA		±3.5		**±22**		
		I_R = 10mA		±10		**±32**		
		I_R = 15mA		±15		**±45**		
Z_R	Reverse Dynamic Impedance	I_R = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_R		0.3			Ω	
V_N	Output Noise Voltage	0.1 Hz ≤ f ≤ 10 Hz		9			µVpp	
		10 Hz ≤ f ≤ 10KHz		50			µVrms	
C_{LOAD}	Load Capacitor	Stable Over Temperature	See[3]	60	0	100	µF	
V_{HYST}	Thermal Hysteresis	ΔT = −55°C to 125°C	See[4]	1			ppm	

(2) Not tested post irradiation. Typical post irradiation values listed in the post radiation Tempco table.

(3) Capacitive load not required but improves SET stability. This parameter is ensured by design and/or characterization and is not tested in production.

(4) Thermal hysteresis is defined as the change in voltage measured at +25°C after cycling to temperature -55°C and the 25°C measurement after cycling to temperature +125°C.

$$V_{HYST} = \frac{|V_{R1} - V_{R2}|}{V_R} \times 10^6 \text{ ppm}$$

Where: V_{HYST} = Thermal hysteresis expressed in ppm
V_R = Nominal preset output voltage
V_{R1} = V_R before temperature fluctuation
V_{R2} = V_R after temperature fluctuation.

Post Radiation @ 25°C[1]

The initial Reverse Breakdown Voltage tolerance is ±0.1% @ 100µA. Qualification is performed with a 1.5X overtest. See for TOTAL IONIZING DOSE details.

Symbol	Parameter	Conditions		30 krad	50 krad	100 krad	Sub-groups
V_R	Reverse Breakdown Voltage Tolerance	I_R = 60µA	Max	+0.42%	+0.67%	+1.75%	1
		I_R= 100µA					
		I_R = 1mA					
		I_R = 10mA					
		I_R = 15mA					

(1) Pre and post irradiation limits are identical to those listed under electrical characteristics except as listed in the post radiation table.

Post Radiation Tempco[1]

Symbol	Parameter	Conditions	TYPICALS			
			30 krad	50 krad	100 krad	Units
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient Drift @ 25°C ≤ T_A ≤ 125°C	60µA ≤ I_R ≤ 15mA	+41	+83	+144	ppm/°C
	Average Reverse Breakdown Voltage Temperature Coefficient Drift @ −55°C ≤ T_A ≤ 25°C	60µA ≤ I_R ≤ 15mA	+46	+87	+166	ppm/°C

(1) Not tested post irradiation. Typical post irradiation values listed in the post radiation Tempco table.

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Operational Life Test Delta Parameters

This table represents the drift seen from initial measurements post 1000hr Operational Life Burn-In. All units will remain within the electrical characteristics limits post 1000hr Operational Life Burn-In. Deltas required for QMLV product at Group B, Sub-Group 5.

Symbol	Parameter	Conditions	Note	Min	Max	Units	Temp
V_R	Reverse Breakdonwn Voltage Tolerance	I_R = 60µA		-0.873	0.873	mV	1
		I_R = 100µA		-0.873	0.873		
		I_R = 1mA		-0.998	0.998		
		I_R = 10mA		-3.93	3.93		
		I_R = 15mA		-5	5		
I_{RMIN}	Minimum Operating Current			-0.623	0.623	µA	1

LM4050-5.0QML Electrical Characteristics SMD: 5962R0923562

The initial Reverse Breakdown Voltage tolerance is ±0.1% @ 100µA.

Symbol	Parameter	Conditions	Notes	Typical[1]	Min	Max	Units	Sub-groups
V_R	Reverse Breakdown Voltage	I_R = 100 µA		5.000			V	
	Reverse Breakdown Voltage Tolerance	I_R = 74µA				±5.0	mV	1
		I_R = 100µA				±5.0		
		I_R = 1mA				±8		
		I_R = 10mA				±18		
		I_R = 15mA				±20		
		I_R = 74µA				**±10**	mV	2
		I_R = 100µA				**±10**		
		I_R = 1mA				**±12**		
		I_R = 10mA				**±22.5**		
		I_R = 15mA				**±28**		
		I_R = 74µA				**±9**	mV	3
		I_R = 100µA				**±9**		
		I_R = 1mA				**±11.5**		
		I_R = 10mA				**±29**		
		I_R = 15mA				**±37**		
I_{RMIN}	Minimum Operating Current			53		70	µA	1
						74	µA	2, 3
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient @ 25°C ≤ T_A ≤ 125°C	I_R = 74µA	See[2]	±9		**±23**	ppm/°C	2
		I_R = 100µA		±9		**±25**		
		I_R = 1mA		±10		**±28**		
		I_R = 10mA		±11		**±35**		
		I_R = 15mA		±11		**±40**		
	Average Reverse Breakdown Voltage Temperature Coefficient @ −55°C ≤ T_A ≤ 25°C	I_R = 74µA	See[2]	±10		**±25**		3
		I_R = 100µA		±10		**±29**		
		I_R = 1mA		±10		**±34**		
		I_R = 10mA		±15		**±45**		
		I_R = 15mA		±20		**±60**		
Z_R	Reverse Dynamic Impedance	I_R = 1 mA, f = 120 Hz, I_{AC} = 0.1 I_R		0.5			Ω	
V_N	Output Noise Voltage	10 Hz ≤ f ≤ 10KHz		100			µVrms	

(1) Typicals are at T_A = 25°C and represent most likely parametric norm.
(2) Not tested post irradiation. Typical post irradiation values listed in the post radiation Tempco table.

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LM4050-5.0QML Electrical Characteristics SMD: 5962R0923562 (continued)

The initial Reverse Breakdown Voltage tolerance is ±0.1% @ 100µA.

Symbol	Parameter	Conditions	Notes	Typical(1)	Min	Max	Units	Sub-groups
C_{LOAD}	Load Capacitor	Stable Over Temperature	See(3)	60	0	100	µF	
V_{HYST}	Thermal Hysteresis	ΔT = -55°C to 125°C	See(4)	20			ppm	

(3) Capacitive load not required but improves SET stability. This parameter is ensured by design and/or characterization and is not tested in production.

(4) Thermal hysteresis is defined as the change in voltage measured at +25°C after cycling to temperature -55°C and the 25°C measurement after cycling to temperature +125°C.

$$V_{HYST} = \frac{|V_{R1} - V_{R2}|}{V_R} \times 10^6 \text{ ppm}$$

Where: V_{HYST} = Thermal hysteresis expressed in ppm
V_R = Nominal preset output voltage
V_{R1} = V_R before temperature fluctuation
V_{R2} = V_R after temperature fluctuation.

Post Radiation @ 25°C(1)

The initial Reverse Breakdown Voltage tolerance is ±0.1% @ 100µA. Qualification is performed with a 1.5X overtest. See for TOTAL IONIZING DOSE details.

Symbol	Parameter	Conditions		30 krad	50 krad	100 krad	Sub-groups
V_R	Reverse Breakdown Voltage Tolerance	I_R = 74µA	Max	+0.42%	+0.67%	+1.75%	1
		I_R= 100µA					
		I_R = 1mA					
		I_R = 10mA					
		I_R = 15mA					

(1) Pre and post irradiation limits are identical to those listed under electrical characteristics except as listed in the post radiation table.

Post Radiation Tempco(1)

Symbol	Parameter	Conditions	TYPICALS			
			30 krad	50 krad	100 krad	Units
$\Delta V_R/\Delta T$	Average Reverse Breakdown Voltage Temperature Coefficient Drift @ 25°C ≤ T_A ≤ 125°C	74µA ≤ I_R ≤ 15mA	+87	+166	+387	ppm/°C
	Average Reverse Breakdown Voltage Temperature Coefficient Drift @ −55°C ≤ T_A ≤ 25°C	74µA ≤ I_R ≤ 15mA	+96	+162	+343	ppm/°C

(1) Not tested post irradiation. Typical post irradiation values listed in the post radiation Tempco table.

Operational Life Test Delta Parameters

This table represents the drift seen from initial measurements post 1000hr Operational Life Burn-In. All units will remain within the electrical characteristics limits post 1000hr Operational Life Burn-In. Deltas required for QMLV product at Group B, Sub-Group 5.

Symbol	Parameter	Conditions	Note	Min	Max	Units	Temp
V_R	Reverse Breakdonwn Voltage Tolerance	I_R = 74µA		−0.8	0.8	mV	1
		I_R = 100µA		−0.8	0.8		
		I_R = 1mA		−0.84	0.84		
		I_R = 10mA		−1.6	1.6		
		I_R = 15mA		−2.6	2.6		
I_{RMIN}	Minimum Operating Current			−0.623	0.623	µA	1

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Typical Performance Characteristics

Output Impedance vs Frequency

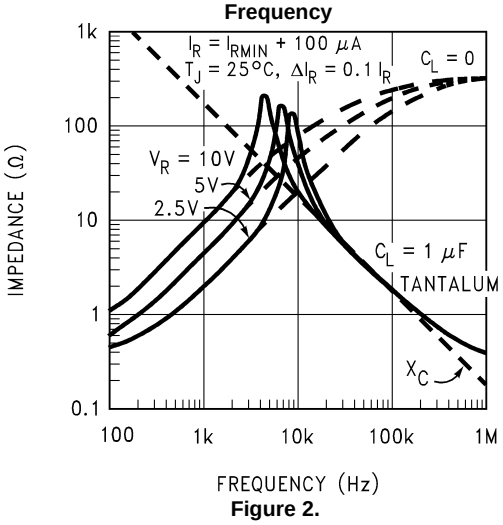

Figure 2.

Output Impedance vs Frequency

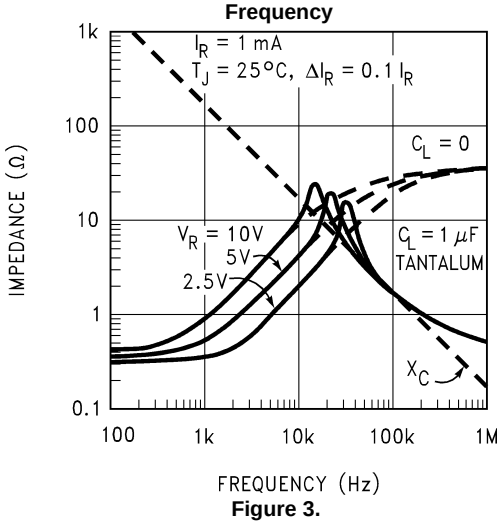

Figure 3.

Reverse Characteristics and Minimum Operating Current

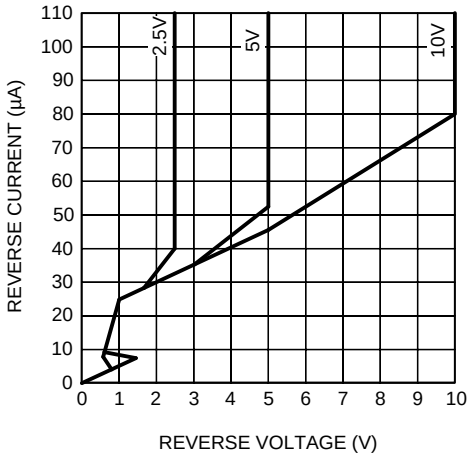

Figure 4.

2.5V Thermal Hysteresis

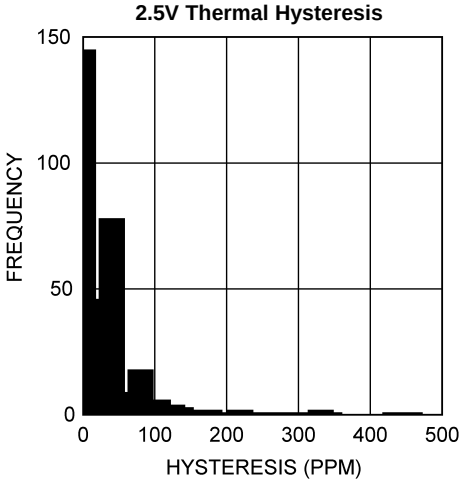

Figure 5.

5.0V Thermal Hysteresis

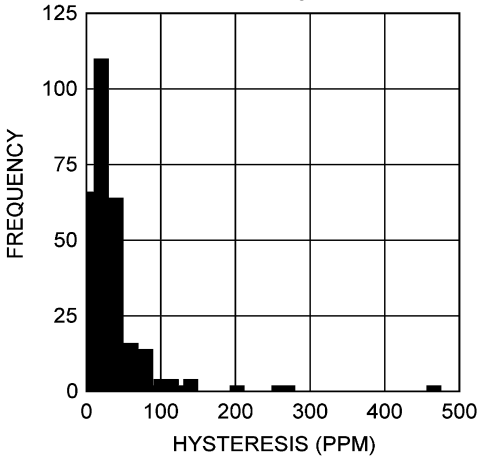

Figure 6.

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Typical Radiation Characteristics

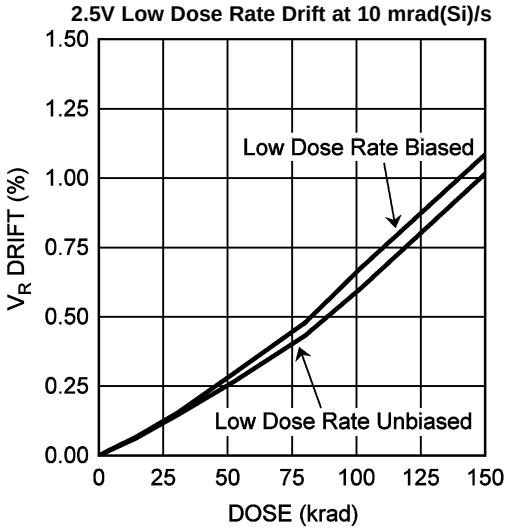

Figure 7.

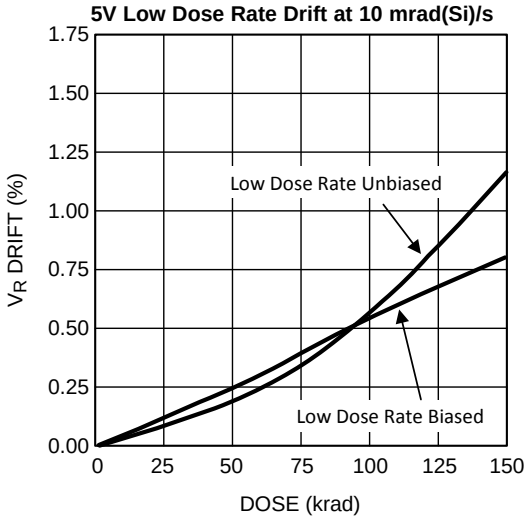

Figure 8.

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Start-Up Characteristics

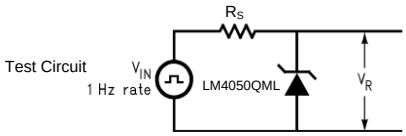


Figure 9.

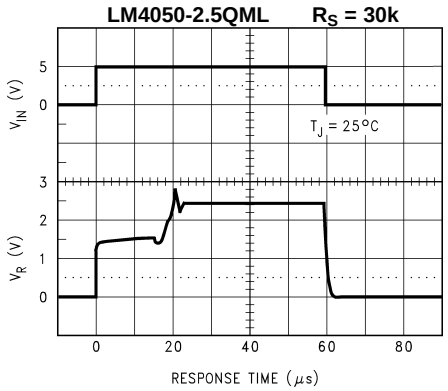


Figure 10.

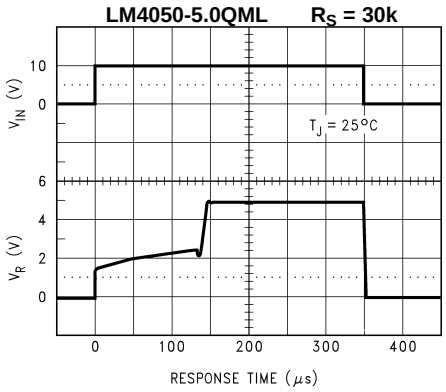
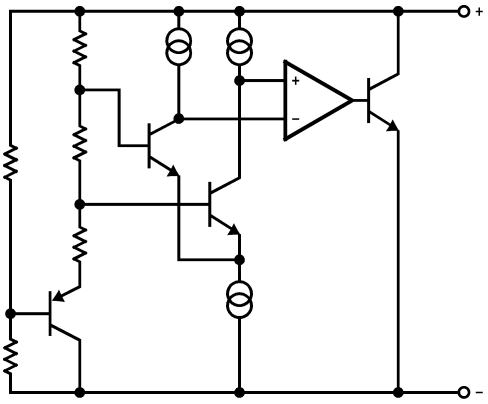


Figure 11.

Functional Block Diagram



APPLICATIONS INFORMATION

The LM4050QML is a precision micro-power curvature-corrected bandgap shunt voltage reference. The LM4050QML is available in the 10-Lead Ceramic CLGA package. The LM4050QML has been designed for stable operation without the need of an external capacitor connected between the "+" pin and the "−" pin. If, however, a bypass capacitor is used, the LM4050QML remains stable. The LM4050-2.5QML has a 60 µA minimum and 15 mA maximum operating current. The LM4050-5.0QML has a 74 µA minimum and 15 mA maximum operating current.

The typical thermal hysteresis specification is defined as the change in +25°C voltage measured after thermal cycling. The device is thermal cycled to temperature -55°C and then measured at 25°C. Next the device is thermal cycled to temperature +125°C and again measured at 25°C. The resulting V_{OUT} delta shift between the 25°C measurements is thermal hysteresis. Thermal hysteresis is common in precision references and is induced by thermal-mechanical package stress. Changes in environmental storage temperature, operating temperature and board mounting temperature are all factors that can contribute to thermal hysteresis.

In a conventional shunt regulator application (Figure 12) , an external series resistor (R_S) is connected between the supply voltage and the LM4050QML. R_S determines the current that flows through the load (I_L) and the LM4050QML (I_Q). Since load current and supply voltage may vary, R_S should be small enough to supply at least the maximum ensured I_{RMIN} (spec. table) to the LM4050QML even when the supply voltage is at its minimum and the load current is at its maximum value. When the supply voltage is at its maximum and I_L is at its minimum, R_S should be large enough so that the current flowing through the LM4050QML is less than 15 mA.

R_S is determined by the supply voltage, (V_S), the load and operating current, (I_L and I_Q), and the LM4050QML's reverse breakdown voltage, V_R.

$$R_S = \frac{V_S - V_R}{I_L + I_Q} \quad (1)$$

Radiation Environments

Careful consideration should be given to environmental conditions when using a product in a radiation environment.

TOTAL IONIZING DOSE

Radiation hardness assured (RHA) products are those part numbers with a total ionizing dose (TID) level specified in the Ordering Information table on the front page. Testing and qualification of these products is done on a wafer level according to MIL-STD-883, Test Method 1019. Wafer level TID data is available with lot shipments.

Testing and qualification is performed at the 30, 50 and 100 krad TID levels at a dose rate of 10 mrad/s, using a 1.5X overtest at each TID level. For the 30 krad level units are tested to 50 krad, for 50 krad units are tested to 80 krad and for 100 krad units are tested to 150 krad, with all parameters remaining inside the post irradiation test limits.

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SINGLE EVENT EFFECTS (SEE)

One time single event effects characterization was performed according to EIA/JEDEC Standard, EIA/JEDEC57.

A test report is available upon request.

SINGLE EVENT TRANSIENTS (SET)

With a 60 µF capacitor on the output, no single event transients were seen at the highest linear energy transfer (LET) tested: 59 MeV-cm^2/mg.

SET characterization with other capacitor values is in the SEE report, available upon request.

SINGLE EVENT FUNCTIONAL INTERRUPT (SEFI)

No single event functional interrupts were detected to the highest linear energy transfer (LET) tested: 100 MeV-cm^2/mg.

Typical Applications

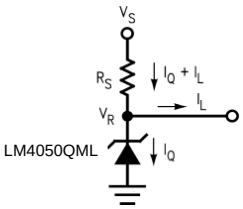

Figure 12. Shunt Regulator

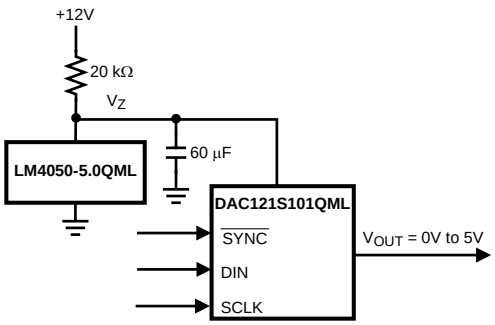

Figure 13. The LM4050QML as a power supply and reference

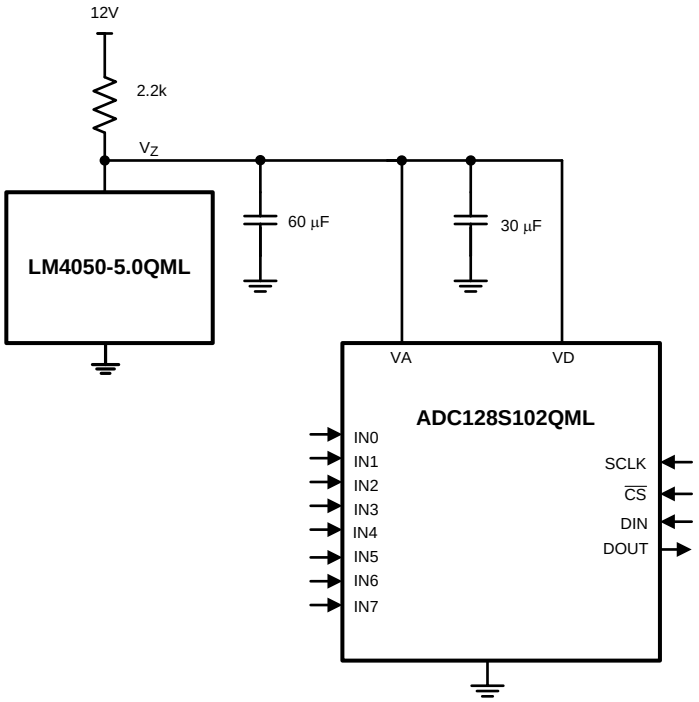

Figure 14. The LM4050QML as a power supply and reference

The LM4050QML is a good choice as a power regulator for the DAC121S101QML or ADC128S102QML. The minimum resistor value in the circuit of Figure 13 or Figure 14 should be chosen such that the maximum current through the LM4050QML does not exceed its 15 mA rating. The conditions for maximum current include the input voltage at its maximum, the LM4050QML voltage at its minimum, the resistor value at its minimum due to tolerance, and the DAC121S101QML or ADC128S102QML draws zero current. The maximum resistor value must allow the LM4050QML to draw more than its minimum current for regulation plus the maximum DAC121S101QML or ADC128S102QML current in full operation. The conditions for minimum current include the input voltage at its minimum, the LM4050QML voltage at its maximum, the resistor value at its maximum due to tolerance, and the DAC121S101QML or ADC128S102QML draws its maximum current. These conditions can be summarized as

$$R(min) = (V_{IN}(max) - V_Z(min) / (I_A(min) + I_Z(max) \quad (2)$$

and

$$R(max) = (V_{IN}(min) - V_Z(max) / (I_A(max) + I_Z(min) \quad (3)$$

where $V_Z(min)$ and $V_Z(max)$ are the nominal LM4050QML output voltages ± the LM4050QML output tolerance over temperature, $I_Z(max)$ is the maximum allowable current through the LM4050QML, $I_Z(min)$ is the minimum current required by the LM4050QML for proper regulation, $I_A(max)$ is the maximum DAC121S101QML or ADC128S102QML supply current, and $I_A(min)$ is the minimum DAC121S101QML or ADC128S102QML supply current.

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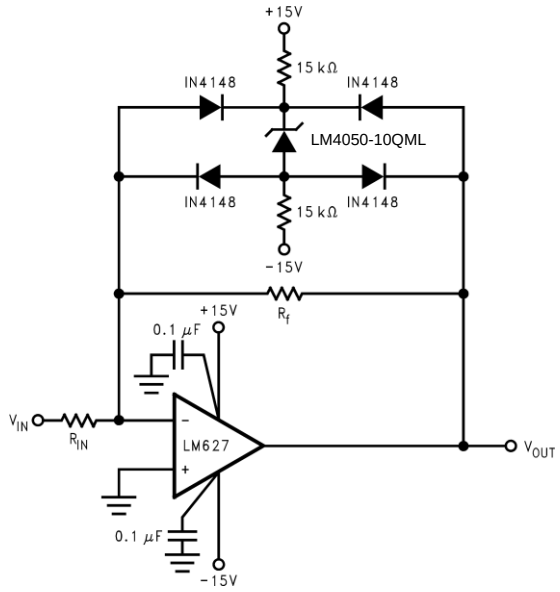
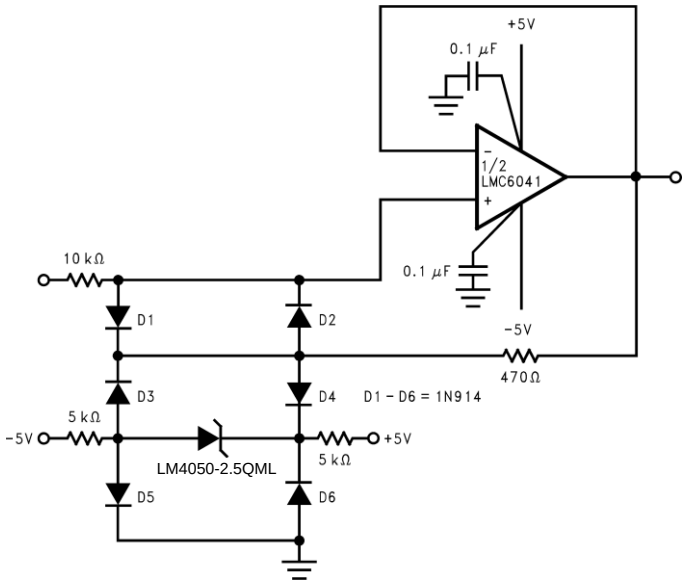


Nominal clamping voltage is ±11.5V (LM4050QML's reverse breakdown voltage +2 diode V_F).
Bounded amplifier reduces saturation-induced delays and can prevent succeeding stage damage.

Figure 15. Bounded amplifier



The bounding voltage is ±4V with the LM4050-2.5QML
(LM4050QML's reverse breakdown voltage + 3 diode V_F).

Figure 16. Protecting Op Amp input

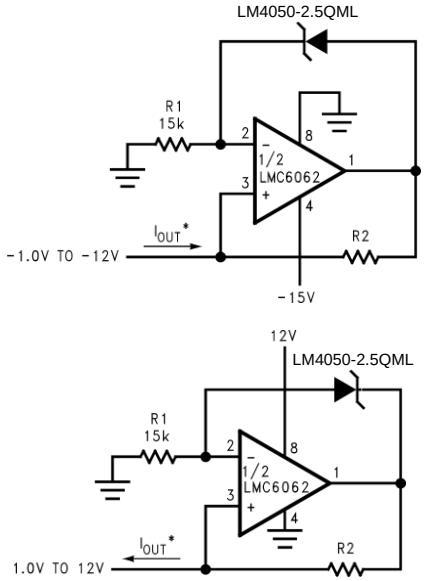


Figure 17. Precision 1 µA to 1 mA Current Sources

$$*I_{OUT} = \frac{2.5V}{R2} \quad (4)$$

Engineering Samples (Parts with MPR suffix)

Engineering samples are available for order and are identified by the "MPR" in the orderable device name (see Package Options Addendum at the end of the datasheet). Engineering (MPR) samples meet the performance specifications of the datasheet at room temperature only and have not received the full space production flow or testing. Engineering samples may be QCI rejects that failed tests that would not impact the performance at room temperature, such as radiation or reliability testing.

Revision History

Date Released	Revision	Section	Changes
08/20/2010	A	Initial Release	New Product Low Dose Qualified LM4050WG2.5RLQV Initial Release
01/20/2012	B	General Description, Features, Key Specifications, Ordering Table, Operating Ratings, Package Thermal Table, Electrical Section	General Description, Features, Key Specifications, Ordering Table, Operating Ratings, Package Thermal Table, Electrical Section — Added the 5.0 V option information for all sections. Added new NSIDS LM4050WG5.0RLQV and LM4050WG5.0–MPR Voltage option to data sheet. Revision A will be Archived.
05/23/2012	C	Electrical Section	Electrical Section — Updated Delta Vr/Delta T for typical limits for both the 2.5 and 5.0 versions. Revision B will be Archived.
04/01/2013	F	All	Changed layout of National Data Sheet to TI format.
07/12/2013	G	Post Radiation @ 25°C; Added Engineering Samples	Changed 5V and 2.5V Post Radiation limits so they are the same for both voltages. Added information about orderable engineering samples.

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
5962R0923561VZA	Active	Production	CFP (NAC) | 10	54 | JEDEC TRAY (5+1)	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM4050WG 2.5RLQV Q 5962R09235 61VZA ACO 61VZA >T
5962R0923562VZA	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM4050WG 5.0RLQV Q 5962R09235 62VZA ACO 62VZA >T
LM4050WG2.5-MPR	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	25 to 25	LM4050WG 2.5-MPR ES ACO ES >T
LM4050WG2.5RLQV	Active	Production	CFP (NAC) | 10	54 | JEDEC TRAY (5+1)	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM4050WG 2.5RLQV Q 5962R09235 61VZA ACO 61VZA >T
LM4050WG5.0-MPR	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	25 to 25	LM4050WG- 5.0-MPR ES ACO ES >T
LM4050WG5.0RLQV	Active	Production	CFP (NAC) | 10	54 | TUBE	No	SNPB	Level-1-NA-UNLIM	-55 to 125	LM4050WG 5.0RLQV Q 5962R09235 62VZA ACO 62VZA >T

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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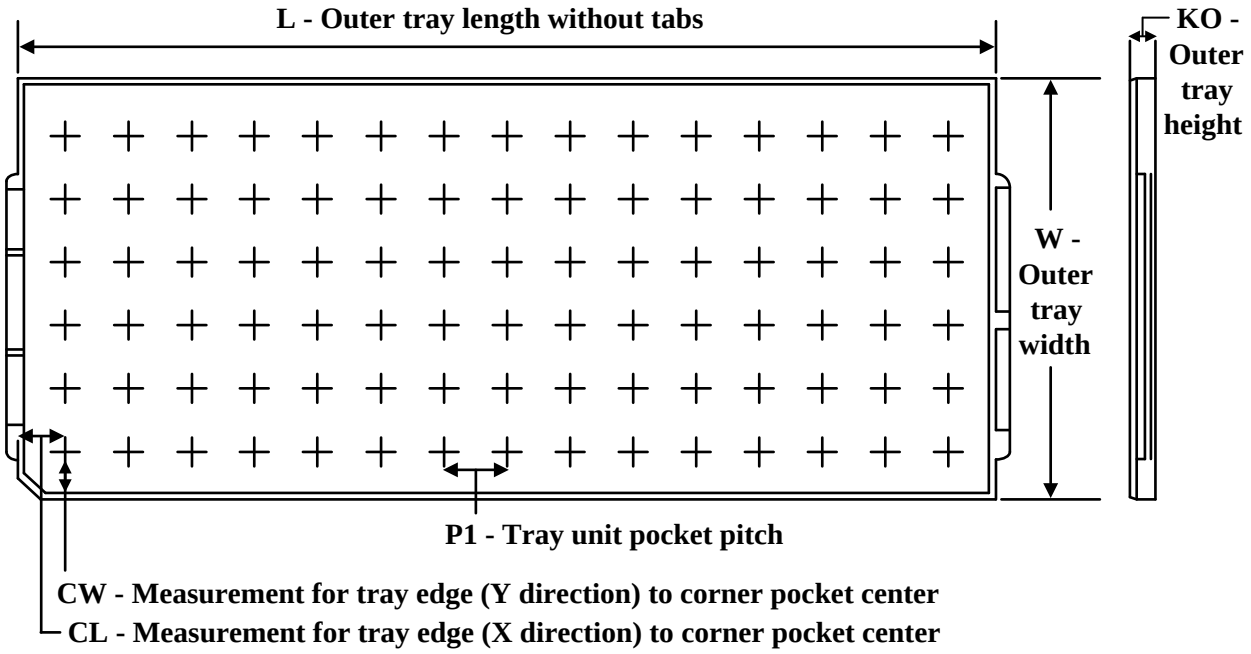
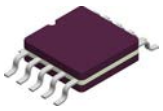
TRAY



Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
5962R0923561VZA	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
5962R0923562VZA	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
LM4050WG2.5-MPR	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
LM4050WG2.5RLQV	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
LM4050WG5.0-MPR	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08
LM4050WG5.0RLQV	NAC	CFP	10	54	6 X 9	100	101.6	101.6	8001	2.78	16.08	16.08

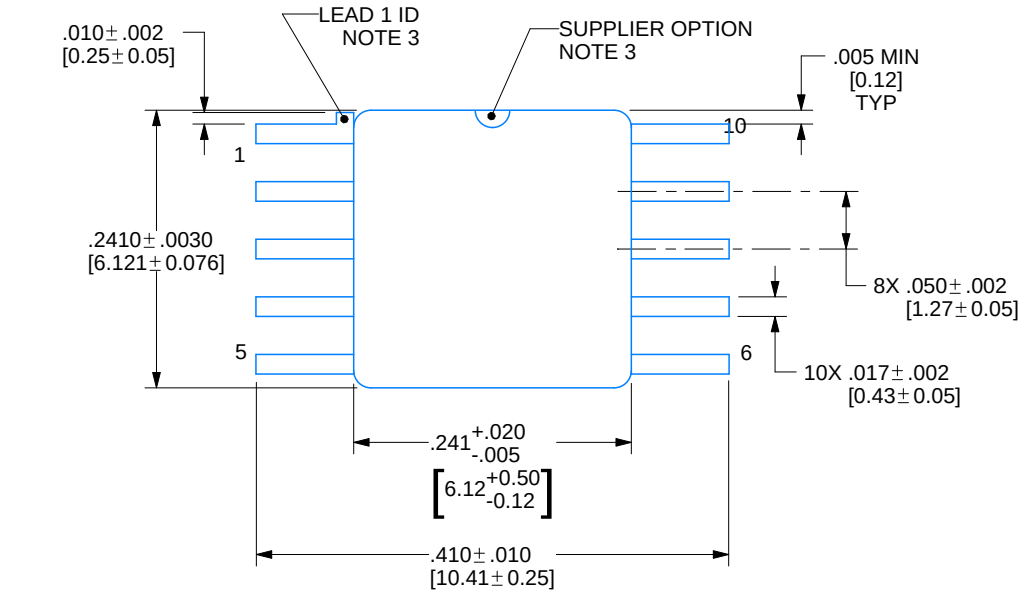


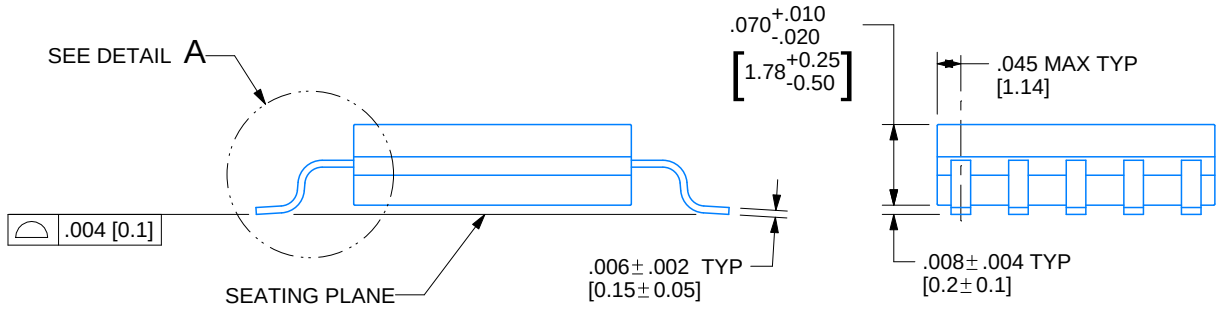
PACKAGE OUTLINE

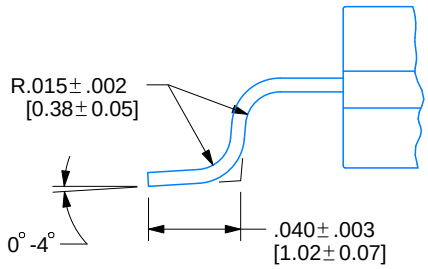
NAC0010A

CFP - 2.33mm max height

CERAMIC FLATPACK







DETAIL A
TYPICAL

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NOTES:

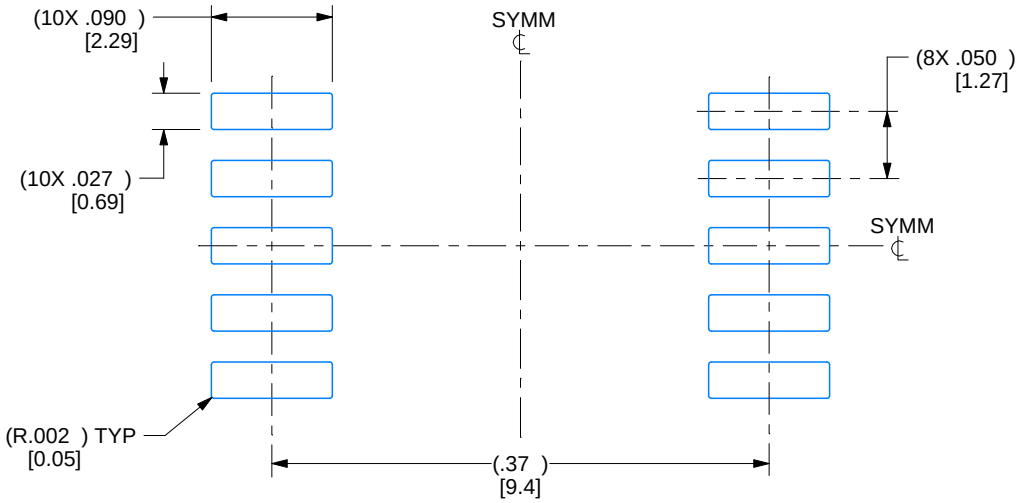
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. For solder thickness and composition, see the "Lead Finish Composition/Thickness" link in the packaging section of the Texas Instruments website
3. Lead 1 identification shall be:
   a) A notch or other mark within this area
   b) A tab on lead 1, either side
4. No JEDEC registration as of December 2021

EXAMPLE BOARD LAYOUT

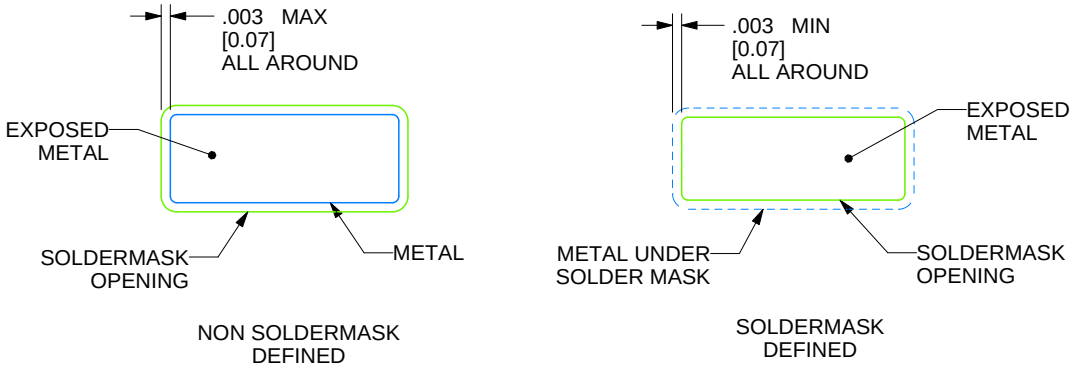
NAC0010A

CFP - 2.33mm max height

CERAMIC FLATPACK



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 7X



4215196/D 08/2022

REVISIONS

REV	DESCRIPTION	E.C.N.	DATE	BY/APP'D
A	RELEASE TO DOCUMENT CONTROL	2197877	12/30/2021	DAVID CHIN / ANIS FAUZI
B	NO CHANGE TO DRAWING; REVISION FOR YODA RELEASE;	2198820	02/14/2022	K. SINCERBOX
C	CHANGE PIN 1 ID LOCATION ON PIN	2198845	02/18/2022	D. CHIN / K. SINCERBOX
D	.2410± .0030 WAS .2700 +.0012/-.0002;	2200915	08/08/2022	D. CHIN / K. SINCERBOX

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