

25µA Micropower Voltage References

ISL21070

The ISL21070 voltage references are analog voltage references featuring low supply voltage operation at ultra-low 25µA max operating current.

Additionally, the ISL21070 family features guaranteed initial accuracy as low as ±0.2% and 30ppm/°C temperature coefficient.

These references are ideal for general purpose applications for performance at lower cost. The ISL21070 is provided in an industry standard 3 Ld SOT-23 pinout.

The ISL21070 offers output voltages that can be used as precision voltage sources for control loops, standby voltages for low power states for DSP, FPGA, Datapath Controllers, Microcontrollers and other core voltages: 1.024V, 2.048V, 2.5V, and 3.3V.

Applications* (see page 11)

- Battery Management/Monitoring
- Low Power Standby Voltages
- Portable Instrumentation
- Consumer/Medical Electronics
- Wearable Electronics
- Lower Cost Industrial and Instrumentation
- Power Regulation Circuits
- Control Loops and Compensation Networks
- LED/Diode Supply

Features

- Reference Output Voltage 1.024V, 2.048V, 2.500V, 3.300V
- Initial Accuracy: 1.024V ±0.5%
- Initial Accuracy: 2.048V ±0.25%
- initial Accuracy: 2.5V, 3.3V ±0.2%
- Input Voltage Range
 - ISL21070-10 (Coming Soon) 2.7V to 5.5V
 - ISL21070-20 (Coming Soon) 2.7V to 5.5V
 - ISL21070-25 2.7V to 5.5V
 - ISL21070-33 (Coming Soon) 3.5V to 5.5V
- Output Voltage Noise 30µV_{p-p} (0.1Hz to 10Hz)
- Supply Current 25µA (Max)
- Tempco 30ppm/°C
- Output Current Capability ±10mA
- Operating Temperature Range -40°C to +85°C
- Package 3 Ld SOT-23
- Pb-Free (RoHS compliant)

Related Literature* (see page 11)

- [AN1533](#), "X-Ray Effects on Intersil FGA References"
- [AN1494](#), "Reflow and PC Board Assembly Effects on Intersil FGA References"

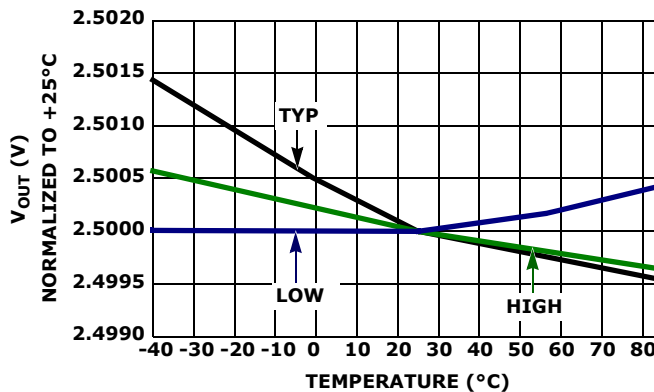
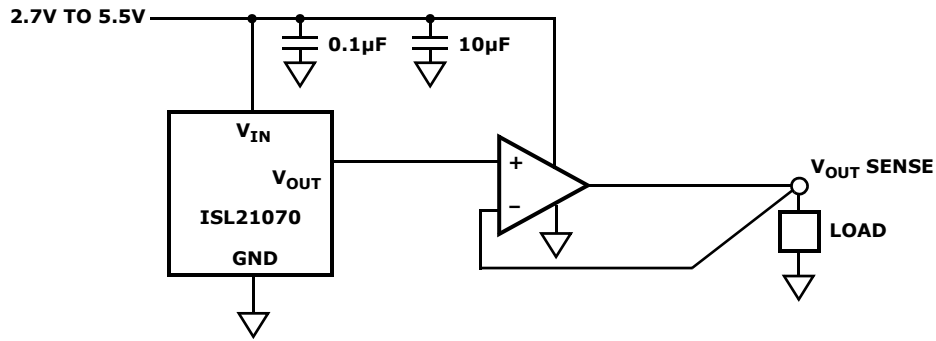
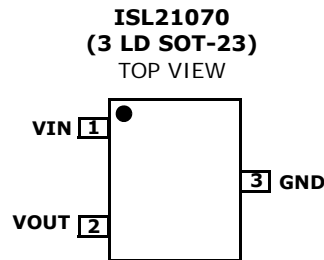


FIGURE 1. V_{OUT} vs TEMPERATURE NORMALIZED to +25°C

Typical Application Circuit



Pin Configuration



Pin Descriptions

PIN NUMBER	PIN NAME	DESCRIPTION
1	VIN	Input Voltage Connection. Range: 2.7 to 5.5V
2	VOUT	Voltage Reference Output.
3	GND	Ground Connection

Ordering Information

PART NUMBER (Notes 1, 2, 3)	PART MARKING	V _{OUT} OPTION (V)	GRADE	TEMP. RANGE (°C)	PACKAGE (Pb-Free)	PKG. DWG. #
ISL21070CIH310Z-TK	BCGA	1.024	±0.5%, 30ppm/°C	-40 to +85	3 Ld SOT-23	P3.064
ISL21070CIH320Z-TK	BCHA	2.048	±0.25%, 30ppm/°C	-40 to +85	3 Ld SOT-23	P3.064
ISL21070CIH325Z-TK	BCJA	2.5	±0.2%, 30ppm/°C	-40 to +85	3 Ld SOT-23	P3.064
ISL21070CIH333Z-TK	BCKA	3.3	±0.2%, 30ppm/°C	-40 to +85	3 Ld SOT-23	P3.064

NOTES:

1. Please refer to [TB347](#) for details on reel specifications.
2. These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
3. For Moisture Sensitivity Level (MSL), please see device information page for [ISL21070](#). For more information on MSL please see techbrief [TB363](#).

ISL21070

Absolute Voltage Ratings

Max Voltage	
V_{IN} to GND	-0.5V to +6.5V
V_{OUT} (pin) to GND (10s)	-0.5V to $V_{OUT} + 1V$
ESD Ratings	
Human Body Model (Tested per JESD22-A114)	6000V
Machine Model (Tested per JESD22-A115)	500V
Charged Device Model (Tested per JESD22-C101)	2kV
Latch Up (Tested Per JESD-78)	100mA

Environmental Operating Conditions

X-Ray Exposure (Note 4)	10mRem
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Thermal Information

Thermal Resistance (Typical)	θ_{JA} (°C/W)
3 Ld SOT-23 (Note 5)	371
Continuous Power Dissipation ($T_A = +85^\circ\text{C}$)	99mW
Storage Temperature Range	-65°C to $+150^\circ\text{C}$
Pb-Free Reflow Profile (Note 6)	see link below
	http://www.intersil.com/pbfree/Pb-FreeReflow.asp

Recommended Operating Conditions

Temperature Range (Industrial)	-40°C to $+85^\circ\text{C}$
Supply Voltage	2.7V to 5.5V

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

NOTES:

- Measured with no filtering, distance of 10" from source, intensity set to 55kV and 70mA current, 30s duration. Other exposure levels should be analyzed for Output Voltage drift effects. See "Applications Information" on page 8.
- θ_{JA} is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief TB379 for details.
- Post-reflow drift for the ISL21070 devices will range from 100 μV to 1.0mV based on experimental results with devices on FR4 double sided boards. The design engineer must take this into account when considering the reference voltage after assembly.

Electrical Specifications (ISL21070-xx, $V_{OUT} = 1.024\text{V}$ to 2.048V) $V_{IN} = 3.0\text{V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $I_{OUT} = 0$, unless otherwise specified. **Boldface limits apply over the operating temperature range, -40°C to $+85^\circ\text{C}$.**

SYMBOL	PARAMETER	CONDITIONS	MIN (Note 10)	TYP	MAX (Note 10)	UNITS
V_{OUT}	Output Voltage			1.024		V
				2.048		V
V_{OA}	V_{OUT} Accuracy @ $T_A = +25^\circ\text{C}$	ISL21070 C-grade: 1.024	-0.5		+0.5	%
		ISL21070 C-grade: 2.048	-0.25		+0.25	%
TC V_{OUT}	Output Voltage Temperature Coefficient (Note 7)	ISL21070 C-grade			30	ppm/ $^\circ\text{C}$
V_{IN}	Input Voltage Range		2.7		5.5	V
I_{IN}	Supply Current			16	25	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$2.7\text{V} \leq V_{IN} \leq 5.5\text{V}$		50	250	$\mu\text{V}/\text{V}$
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	Sourcing: $0\text{mA} \leq I_{OUT} \leq 10\text{mA}$		6	100	$\mu\text{V}/\text{mA}$
		Sinking: $-10\text{mA} \leq I_{OUT} \leq 0\text{mA}$		10	100	$\mu\text{V}/\text{mA}$
I_{SC}	Short Circuit Current	$T_A = +25^\circ\text{C}$, V_{OUT} tied to GND		50		mA
t_R	Turn-on Settling Time	$V_{OUT} = \pm 0.1\%$		150		μs
	Ripple Rejection	$f = 10\text{kHz}$		-20		dB
e_N	Output Voltage Noise	$0.1\text{Hz} \leq f \leq 10\text{Hz}$		30		μV_{P-P}
V_N	Broadband Voltage Noise	$10\text{Hz} \leq f \leq 10\text{kHz}$		10		μV_{RMS}
$\Delta V_{OUT}/\Delta T_A$	Thermal Hysteresis (Note 8)	$\Delta T_A = +125^\circ\text{C}$		100		ppm
$\Delta V_{OUT}/\Delta t$	Long Term Stability (Note 9)	$T_A = +25^\circ\text{C}$		50		ppm

ISL21070

Electrical Specifications (ISL21070-25, V_{OUT} = 2.5V) V_{IN} = 3.0V, T_A = -40°C to +85°C, I_{OUT} = 0, unless otherwise specified. **Boldface limits apply over the operating temperature range, -40°C to +85°C.**

SYMBOL	PARAMETER	CONDITIONS	MIN (Note 10)	TYP	MAX (Note 10)	UNIT
V _{OUT}	Output Voltage			2.5		V
V _{OA}	V _{OUT} Accuracy @ T _A = +25°C	ISL21070 C-grade	-0.2		+0.2	%
TC V _{OUT}	Output Voltage Temperature Coefficient (Note 7)	ISL21070 C-grade			30	ppm/°C
V _{IN}	Input Voltage Range		2.7		5.5	V
I _{IN}	Supply Current	V _{EN} = V _{IN}		11	25	μA
ΔV _{OUT} /ΔV _{IN}	Line Regulation	2.7V ≤ V _{IN} ≤ 5.5V		15	250	μV/V
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	Sourcing: 0mA ≤ I _{OUT} ≤ 7mA		6	100	μV/mA
		Sourcing: 0mA ≤ I _{OUT} ≤ 10mA (T _A = +70°C)		133		μV/mA
		Sinking: -10mA ≤ I _{OUT} ≤ 0mA		10	100	μV/mA
I _{SC}	Short Circuit Current	T _A = +25°C, V _{OUT} tied to GND		30		mA
t _R	Turn-on Settling Time	V _{OUT} = ±0.1%		150		μs
	Ripple Rejection	f = 10kHz		-20		dB
e _N	Output Voltage Noise	0.1Hz ≤ f ≤ 10Hz		30		μV _{P-P}
V _N	Broadband Voltage Noise	10Hz ≤ f ≤ 10kHz		10		μV _{RMS}
ΔV _{OUT} /ΔT _A	Thermal Hysteresis (Note 8)	ΔT _A = +125°C		20		ppm
ΔV _{OUT} /Δt	Long Term Stability (Note 9)	T _A = +25°C		50		ppm

ISL21070

Electrical Specifications (ISL21070-33, $V_{OUT} = 3.3V$) $V_{IN} = 5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, $I_{OUT} = 0$, unless otherwise specified. **Boldface limits apply over the operating temperature range, $-40^{\circ}C$ to $+85^{\circ}C$.**

SYMBOL	PARAMETER	CONDITIONS	MIN (Note 10)	TYP	MAX (Note 10)	UNIT
V_{OUT}	Output Voltage			3.3		V
V_{OA}	V_{OUT} Accuracy @ $T_A = +25^{\circ}C$	ISL21070 C-grade	-0.2		+0.2	%
TC V_{OUT}	Output Voltage Temperature Coefficient (Note 7)	ISL21070 C-grade			50	ppm/ $^{\circ}C$
V_{IN}	Input Voltage Range		3.5		5.5	V
I_{IN}	Supply Current	$V_{EN} = V_{IN}$			25	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$3.5V \leq V_{IN} \leq 5.5V$		50	100	
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	Sourcing: $0mA \leq I_{OUT} \leq 10mA$		20	70	$\mu V/mA$
		Sinking: $-10mA \leq I_{OUT} \leq 0mA$		20	70	$\mu V/mA$
I_{SC}	Short Circuit Current	$T_A = +25^{\circ}C$, V_{OUT} tied to GND		30		mA
t_R	Turn-on Settling Time	$V_{OUT} = \pm 0.1\%$		150		μs
	Ripple Rejection	$f = 10kHz$		-20		dB
e_N	Output Voltage Noise	$0.1Hz \leq f \leq 10Hz$		30		μV_{P-P}
V_N	Broadband Voltage Noise	$10Hz \leq f \leq 10kHz$		10		μV_{RMS}
$\Delta V_{OUT}/\Delta T_A$	Thermal Hysteresis (Note 8)	$\Delta T_A = +125^{\circ}C$		100		ppm
$\Delta V_{OUT}/\Delta t$	Long Term Stability (Note 9)	$T_A = +25^{\circ}C$		50		ppm

NOTES:

- Over the specified temperature range. Temperature coefficient is measured by the box method whereby the change in V_{OUT} is divided by the temperature range; in this case, $-40^{\circ}C$ to $+85^{\circ}C = +125^{\circ}C$.
- Thermal Hysteresis is the change of V_{OUT} measured @ $T_A = +25^{\circ}C$ after temperature cycling over a specified range, ΔT_A . V_{OUT} is read initially at $T_A = +25^{\circ}C$ for the device under test. The device is temperature cycled and a second V_{OUT} measurement is taken at $+25^{\circ}C$. The difference between the initial V_{OUT} reading and the second V_{OUT} reading is then expressed in ppm. For $\Delta T_A = +125^{\circ}C$, the device under test is cycled from $+25^{\circ}C$ to $+85^{\circ}C$ to $-40^{\circ}C$ to $+25^{\circ}C$.
- Long term drift is logarithmic in nature and diminishes over time. Drift after the first 1000 hours will be approximately $10ppm/\sqrt{1khrs}$
- Parameters with MIN and/or MAX limits are 100% tested at $+25^{\circ}C$, unless otherwise specified. Temperature limits established by characterization and are not production tested.

Typical Performance Characteristics Curves $V_{OUT} = 2.5V, V_{IN} = 3V, I_{OUT} = 0mA, T_A = +25^\circ C$
 unless otherwise specified.

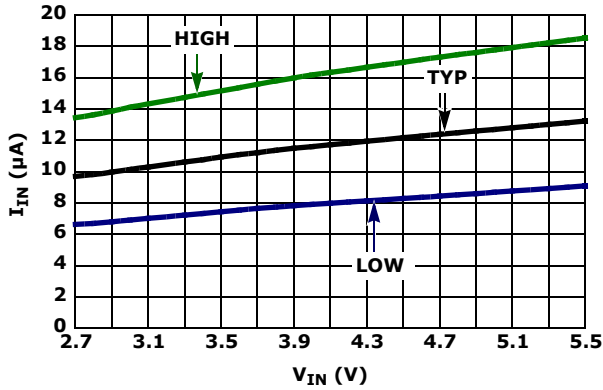


FIGURE 2. I_{IN} vs V_{IN} , 3 UNITS

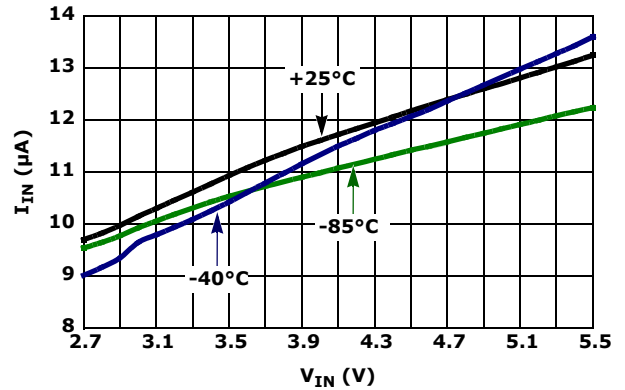


FIGURE 3. I_{IN} vs V_{IN} OVER-TEMPERATURE

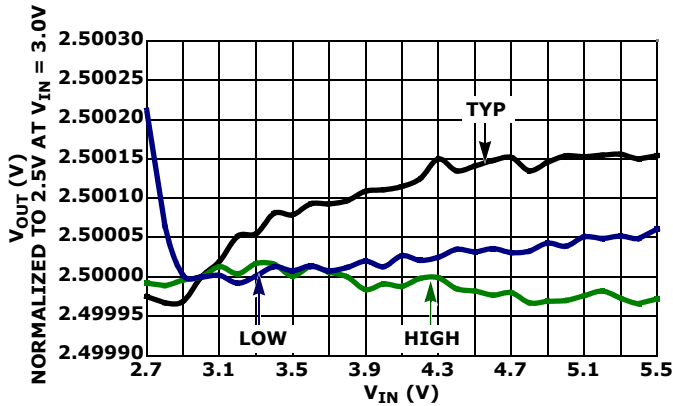


FIGURE 4. LINE REGULATION, 3 UNITS

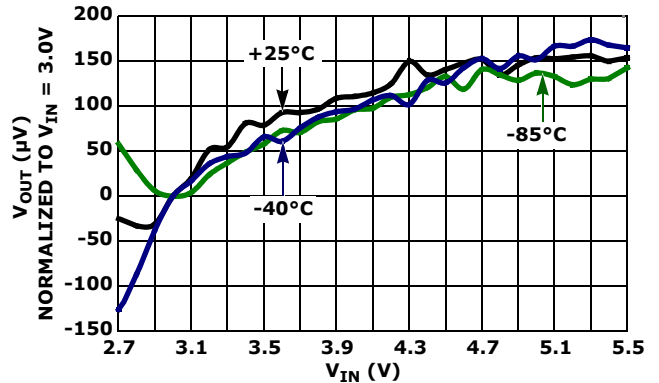


FIGURE 5. LINE REGULATION OVER-TEMPERATURE

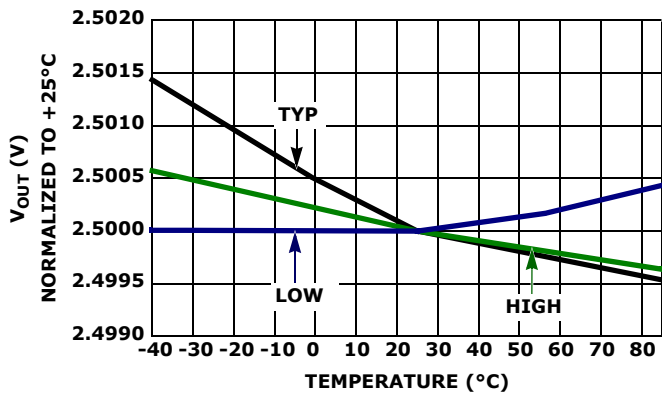


FIGURE 6. V_{OUT} vs TEMPERATURE NORMALIZED to $+25^\circ C$

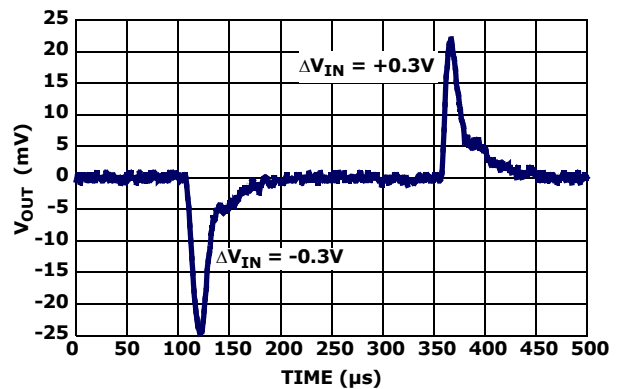


FIGURE 7. LINE TRANSIENT RESPONSE, WITH 1nF CAPACITIVE LOAD

Typical Performance Characteristics Curves $V_{OUT} = 2.5V$, $V_{IN} = 3V$, $I_{OUT} = 0mA$, $T_A = +25^\circ C$ unless otherwise specified. **(Continued)**

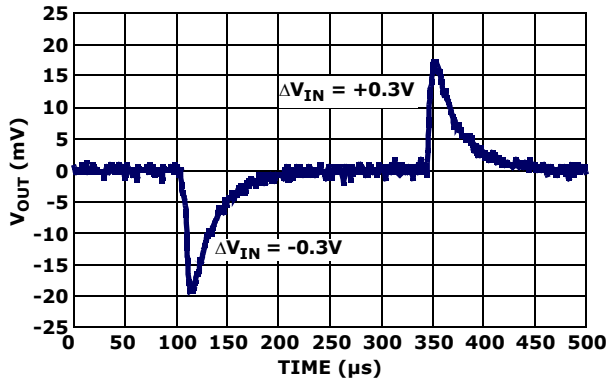


FIGURE 8. LINE TRANSIENT RESPONSE, WITH NO CAPACITIVE LOAD

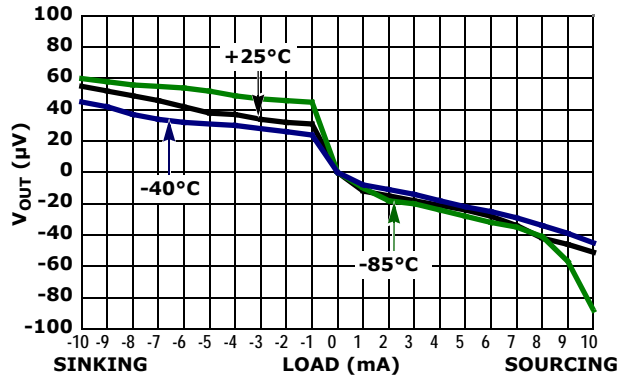


FIGURE 9. LOAD REGULATION OVER-TEMPERATURE

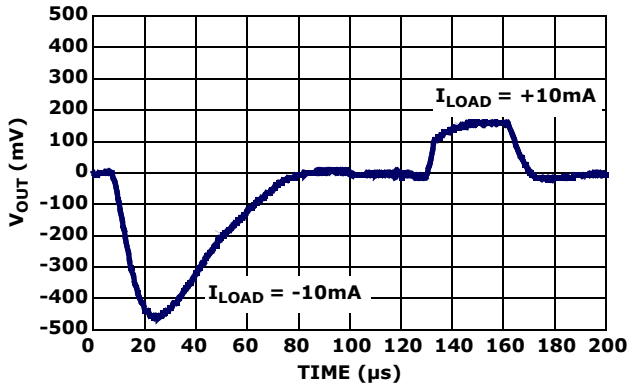


FIGURE 10. LOAD TRANSIENT RESPONSE

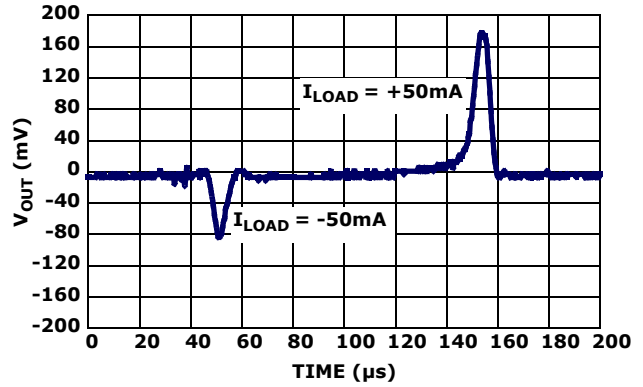


FIGURE 11. LOAD TRANSIENT RESPONSE

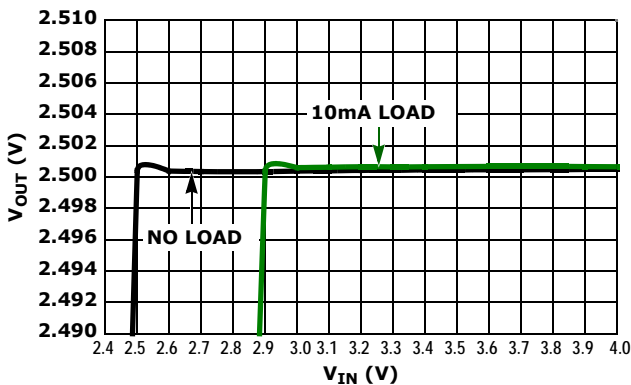


FIGURE 12. DROPOUT

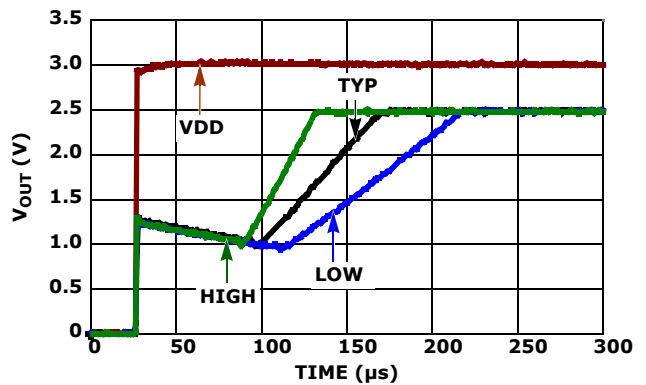


FIGURE 13. TURN-ON TIME

Typical Performance Characteristics Curves $V_{OUT} = 2.5V$, $V_{IN} = 3V$, $I_{OUT} = 0mA$, $T_A = +25^\circ C$ unless otherwise specified. (Continued)

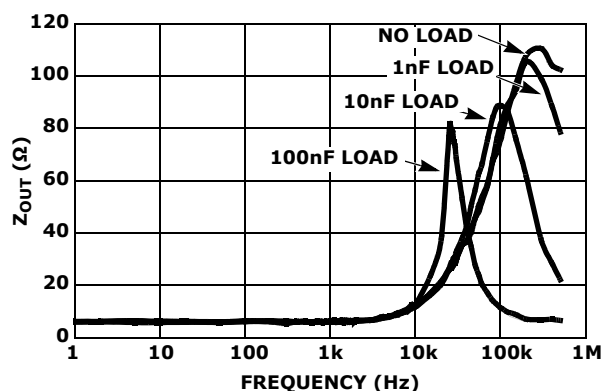
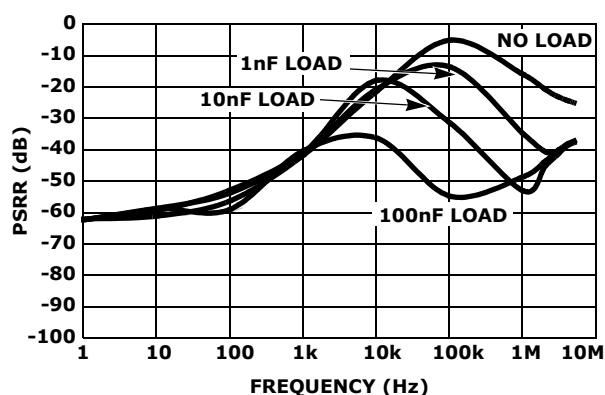
FIGURE 14. Z_{OUT} vs f vs C_L 

FIGURE 15. PSRR vs FREQUENCY

Applications Information

FGA Technology

The ISL21070 series of voltage references use the floating gate technology to create references with very low drift and supply current. Essentially, the charge stored on a floating gate cell is set precisely in manufacturing. The reference voltage output itself is a buffered version of the floating gate voltage. The resulting reference device has excellent characteristics which are unique in the industry: very low temperature drift, high initial accuracy, and almost zero supply current. Also, the reference voltage itself is not limited by voltage bandgaps or zener settings, so a wide range of reference voltages can be programmed (standard voltage settings are provided, but customer-specific voltages are available).

The process used for these reference devices is a floating gate CMOS process, and the amplifier circuitry uses CMOS transistors for amplifier and output transistor circuitry. While providing excellent accuracy, there are limitations in output noise level and load regulation due to the MOS device characteristics. These limitations are addressed with circuit techniques discussed in other sections.

Handling and Board Mounting

FGA references provide excellent initial accuracy and low temperature drift at the expense of very little power drain. There are some precautions to take to insure this accuracy is not compromised. Excessive heat during solder reflow can cause excessive initial accuracy drift, so the recommended $+260^\circ C$ max temperature profile should not be exceeded. Expect up to 1mV drift from the solder reflow process.

FGA references are susceptible to excessive X-radiation like that used in PC board manufacturing. Initial accuracy can change 10mV or more under extreme radiation. If an assembled board needs to be

X-rayed, care should be taken to shield the FGA reference device.

Board Mounting Considerations

For applications requiring the highest accuracy, board mounting location should be reviewed. Placing the device in areas subject to slight twisting can cause degradation of the accuracy of the reference voltage due to die stresses. It is normally best to place the device near the edge of a board, or the shortest side, as the axis of bending is most limited at that location. Obviously, mounting the device on flexprint or extremely thin PC material will likewise cause loss of reference accuracy.

Board Assembly Considerations

FGA references provide high accuracy and low temperature drift but some PC board assembly precautions are necessary. Normal Output voltage shifts of $100\mu V$ to 1mV can be expected with Pb-free reflow profiles or wave solder on multi-layer FR4 PC boards. Precautions should be taken to avoid excessive heat or extended exposure to high reflow or wave solder temperatures, this may reduce device initial accuracy.

Post-assembly x-ray inspection may also lead to permanent changes in device output voltage and should be minimized or avoided. If x-ray inspection is required, it is advisable to monitor the reference output voltage to verify excessive shift has not occurred. If large amounts of shift are observed, it is best to add an X-ray shield consisting of thin zinc ($300\mu m$) sheeting to allow clear imaging, yet block x-ray energy that affects the FGA reference.

Special Applications Considerations

In addition to post-assembly examination, there are also other X-ray sources that may affect the FGA reference long term accuracy. Airport screening machines contain X-rays and will have a cumulative effect on the voltage reference output accuracy. Carry-on luggage screening uses low level X-rays and is not a major source of output voltage shift, however, if a product is expected to pass

through that type of screening over 100 times, it may need to consider shielding with copper or aluminum. Checked luggage X-rays are higher intensity and can cause output voltage shift in much fewer passes, thus devices expected to go through those machines should definitely consider shielding. Note that just two layers of 1/2 ounce copper planes will reduce the received dose by over 90%. The leadframe for the device which is on the bottom also provides similar shielding.

If a device is expected to pass through luggage X-ray machines numerous times, it is advised to mount a 2-layer (minimum) PC board on the top, and along with a ground plane underneath will effectively shield it from 50 to 100 passes through the machine. Since these machines vary in X-ray dose delivered, it is difficult to produce an accurate maximum pass recommendation.

Noise Performance and Reduction

The output noise voltage in a 0.1Hz to 10Hz bandwidth is typically 30µV_{p-p}. The noise measurement is made with a bandpass filter made of a 1 pole high-pass filter with a corner frequency at 0.1Hz and a 2-pole low-pass filter with a corner frequency at 12.6Hz to create a filter with a 9.9Hz bandwidth. Wideband noise is reduced by adding capacitor to the output, but the value should be limited to 1nF or less to insure stability.

Temperature Drift

The limits stated for output accuracy over-temperature are governed by the method of measurement. For the -40°C to 85°C temperature range, measurements are made at +25°C and the two extremes. This measurement method combined with the fact that FGA references have a fairly linear temperature drift characteristic insures that the limits stated will not be exceeded over the temperature range.

Typical Application Circuits

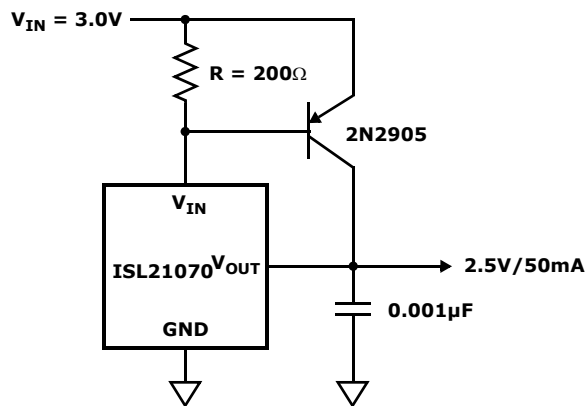


FIGURE 17. PRECISION 2.5V 50mA REFERENCE

ISL21070 Used as a Low Cost Precision Current Source

Using an N-JET and the ISL21070, a precision, low cost, high impedance current source can be created. The precision of the current source is largely dependent on the tempco and accuracy of the reference. The current setting resistor contributes less than 20% of the error.

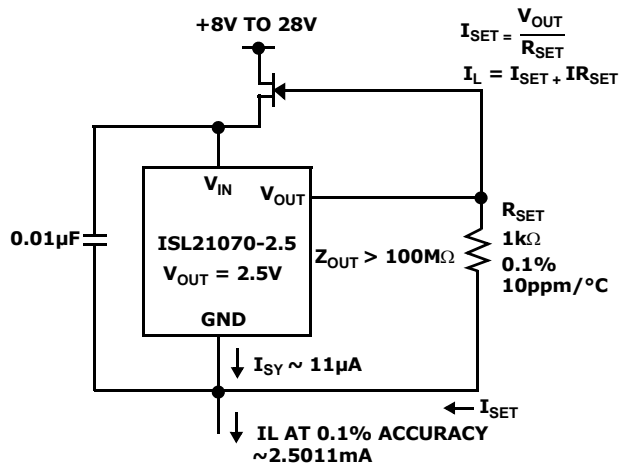


FIGURE 16. ISL21070 USED AS A LOW COST PRECISION CURRENT SOURCE

Typical Application Circuits (Continued)

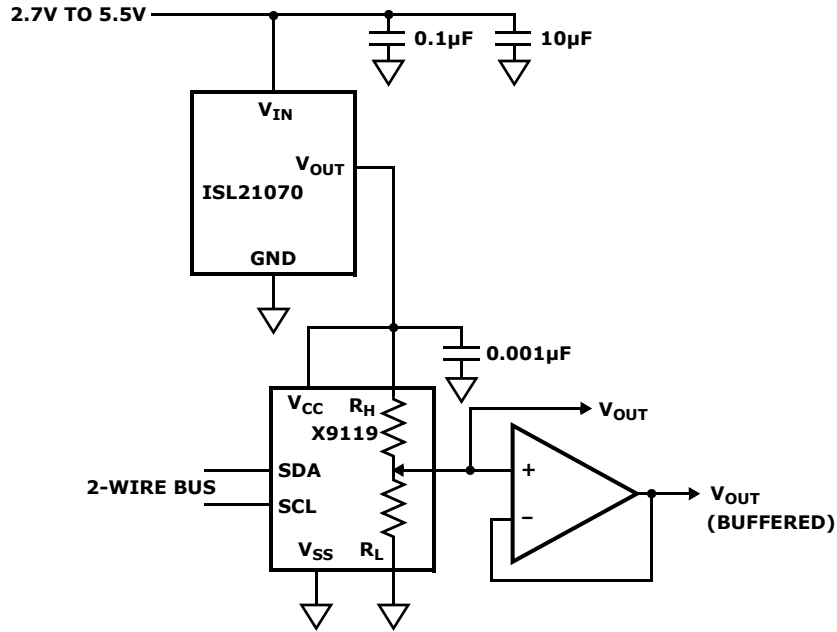


FIGURE 18. 2.5V FULL SCALE LOW-DRIFT 10-BIT ADJUSTABLE VOLTAGE SOURCE

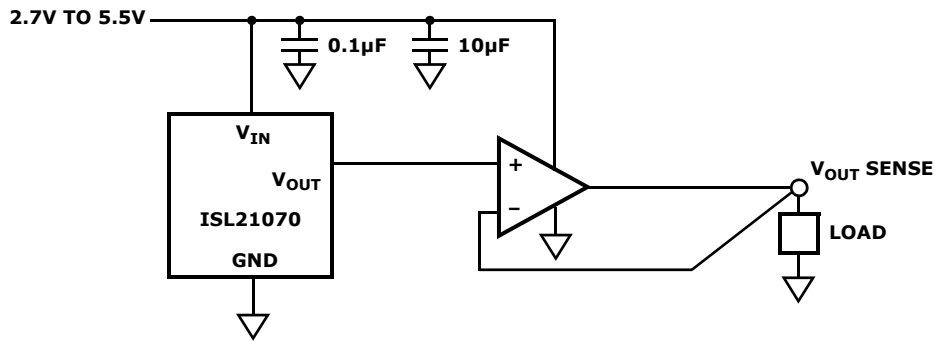


FIGURE 19. KELVIN SENSED LOAD

Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest Rev.

DATE	REVISION	CHANGE
3/19/10	FN7599.0	Initial release.

Products

Intersil Corporation is a leader in the design and manufacture of high-performance analog semiconductors. The Company's products address some of the industry's fastest growing markets, such as, flat panel displays, cell phones, handheld products, and notebooks. Intersil's product families address power management and analog signal processing functions. Go to www.intersil.com/products for a complete list of Intersil product families.

*For a complete listing of Applications, Related Documentation and Related Parts, please see the respective device information page on intersil.com: [ISL21070](http://intersil.com/ISL21070)

To report errors or suggestions for this datasheet, please go to www.intersil.com/askourstaff

FITs are available from our website at <http://rel.intersil.com/reports/search.php>

For additional products, see www.intersil.com/product_tree

Intersil products are manufactured, assembled and tested utilizing ISO9000 quality systems as noted in the quality certifications found at www.intersil.com/design/quality

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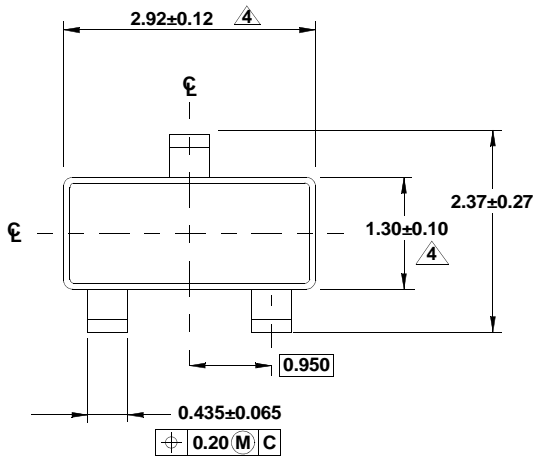
For information regarding Intersil Corporation and its products, see www.intersil.com

Package Outline Drawing

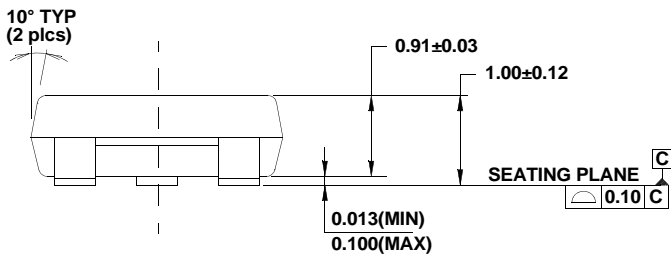
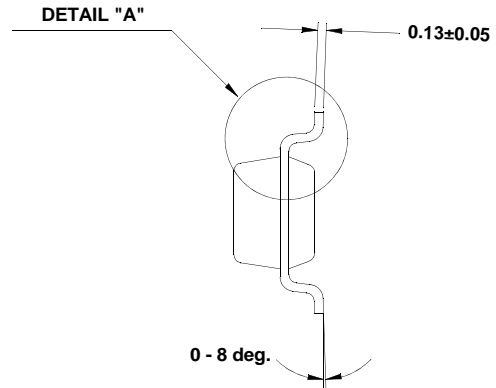
P3.064

3 LEAD SMALL OUTLINE TRANSISTOR PLASTIC PACKAGE (SOT23-3)

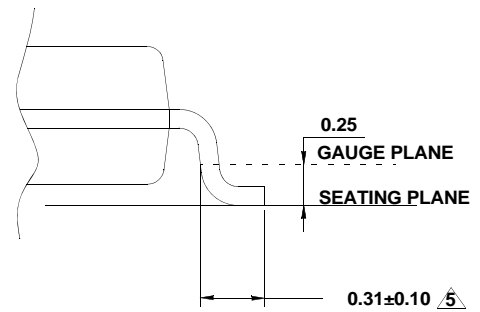
Rev 2, 9/09



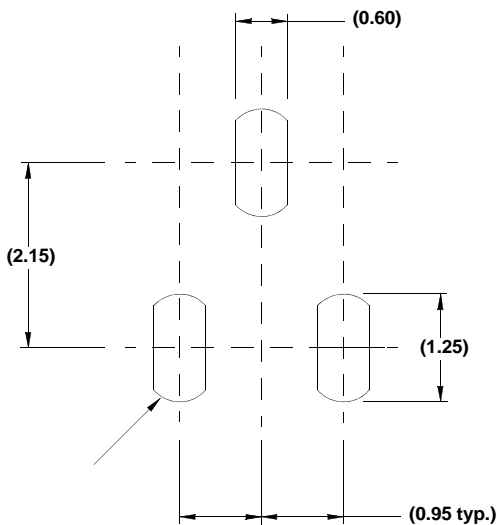
TOP VIEW



SIDE VIEW



DETAIL "A"



TYPICAL RECOMMENDED LAND PATTERN

NOTES:

1. Dimensions are in millimeters. Dimensions in () for Reference Only.
2. Dimensioning and tolerancing conform to AMSEY14.5m-1994.
3. Reference JEDEC TO-236.
4. Dimension does not include interlead flash or protrusions. Interlead flash or protrusions shall not exceed 0.25mm per side.
5. Footlength is measured at reference to gauge plane.