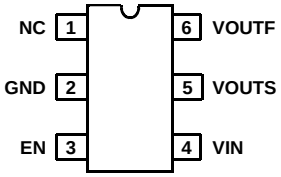
Precision, Low Noise FGA™ Voltage References

The ISL21060 FGA™ voltage references are low power, high precision voltage references fabricated on Intersil's proprietary Floating Gate Analog technology. A new disable feature allows the device to shut down the output and reduce supply current drain from 15µA operating to <500nA.

The ISL21060 family features guaranteed initial accuracy as low as ±1.0mV with drift down to 10ppm/°C. Noise is typically $10\mu V_{P-P}$ (10Hz BW). This combination of high initial accuracy, low power and low output noise performance of the ISL21060 enables versatile high performance control and data acquisition applications with low power consumption.

Pinout

ISL21060
(6 LD SOT-23)
TOP VIEW



Features

- Reference Output Voltage 2.500V, 3.000V, 4.096V
- Initial Accuracy . . . . . ±1.0mV, ±2.5mV
- Input Voltage Range
  - ISL21060-25 . . . . . 2.7V to 5.5V
  - ISL21060-30 . . . . . 3.2V to 5.5V
  - ISL21060-41 . . . . . 4.3V to 5.5V
- Output Voltage Noise . . . . . $10\mu V_{P-P}$ (0.1Hz to 10Hz)
- Supply Current . . . . . .40µA (Max)
- Tempco . . . . . 10ppm/°C, 25ppm/°C
- Output Current Capability . . . . . +10.0mA/-5mA
- Operating Temperature Range . . . . . -40°C to +125°C
- Package . . . . . 6 Ld SOT-23
- Pb-Free (RoHS compliant)

Applications

- High Resolution A/Ds and D/As
- Digital Meters
- Bar Code Scanners
- Basestations
- Battery Management/Monitoring
- Industrial/Instrumentation Equipment

Pin Descriptions

PIN NUMBER	PIN NAME	DESCRIPTION
1	NC	No Connect; Do Not Connect
2	GND	Ground Connection
3	EN	Enable Input. Active High. Do not Float.
4	VIN	Input Voltage Connection
5	VOUTS	Voltage Reference Output Connection (Sense)
6	VOUTF	Voltage Reference Output Connection (Force)

Ordering Information

PART NUMBER (Note)	PART MARKING	V_{OUT} OPTION (V)	GRADE (mV)	TEMP. RANGE (ppm/°C)	PACKAGE (Pb-Free)	PKG. DWG. #
ISL21060BFH625Z-TK*	GAEA	2.500	1.0	10	6 Ld SOT-23	MDP0038
ISL21060CFH625Z-TK*	GAGA	2.500	2.5	25	6 Ld SOT-23	MDP0038
ISL21060BFH630Z-TK*	GAHA	3.000	1.0	10	6 Ld SOT-23	MDP0038
ISL21060CFH630Z-TK*	GAJA	3.000	2.5	25	6 Ld SOT-23	MDP0038
ISL21060BFH641Z-TK*	GACC	4.096	1.0	10	6 Ld SOT-23	MDP0038
ISL21060CFH641Z-TK*	GACE	4.096	2.5	25	6 Ld SOT-23	MDP0038

*Please refer to TB347 for details on reel specifications.

NOTE: 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.

Absolute Voltage Ratings

Max Voltage
- V_{IN} to GND . . . . . -0.5V to +6.5V
- V_{OUT} to GND (10s) . . . . . -0.5V to V_{OUT} + 1V

Voltage on “DNC” pins . . . . . No connections permitted to these pins

ESD Rating
- Human Body Model 5500V
- Machine Model 550V
- Charged Device Model 2kV

Thermal Information

Thermal Resistance (Typical, Note 1) θ_{JA} (°C/W)
- 6 Ld SOT-23 230

Continuous Power Dissipation (T_A = +70°C, Note 3)

Storage Temperature Range . . . . . -65°C to +150°C

6 Ld SOT-23, derate
- 5.88mW/°C above +70°C 471mW

Pb-free Reflow Profile (Note 2) . . . . . see link below
- http://www.intersil.com/pbfree/Pb-FreeReflow.asp

Recommended Operating Conditions

Temperature Range (Industrial) . . . . . -40°C to +125°C

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.

IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typ values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: $T_J = T_C = T_A$

NOTE:

1. 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.
2. Post-reflow drift for the ISL21060 devices will range from 100µV 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 (ISL21060-25, V_{OUT} = 2.50V) V_{IN} = 3.0V, T_A = -40°C to +125°C, I_{OUT} = 0, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Output Voltage			2.500		V
V_{OA}	V_{OUT} Accuracy @ T_A = +25°C	ISL21060B25	-1.0		+1.0	mV
		ISL21060C25	-2.5		+2.5	mV
TC V_{OUT}	Output Voltage Temperature Coefficient (Note 3)	ISL21060B			10	ppm/°C
		ISL21060C			25	ppm/°C
V_{IN}	Input Voltage Range		2.7		5.5	V
I_{IN}	Supply Current	$V_{EN} = V_{IN}$		16	40	µA
$\Delta V_{OUT} / \Delta V_{IN}$	Line Regulation	2.7V ≤ V_{IN} ≤ 5.5V		50	150	µV/V
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	Sourcing: 0mA ≤ I_{OUT} ≤ 10mA		3	50	µV/mA
		Sinking: -5mA ≤ I_{OUT} ≤ 0mA		50	400	µV/mA
I_{SC}	Short Circuit Current	T_A = +25°C, V_{OUT} tied to GND		50		mA
t_R	Turn-on Settling Time	V_{OUT} = ±0.1%		300		µs
	Ripple Rejection	f = 10kHz		75		dB
e_N	Output Voltage Noise	0.1Hz ≤ f ≤ 10Hz		10		μV_{P-P}
V_N	Broadband Voltage Noise	10Hz ≤ f ≤ 1kHz		2.5		μV_{RMS}
	Noise Density	f = 1kHz		60		$nV/\sqrt{Hz}$
$\Delta V_{OUT}/\Delta T_A$	Thermal Hysteresis (Note 4)	ΔT_A = +165°C		100		ppm
$\Delta V_{OUT}/\Delta t$	Long Term Stability (Note 5)	T_A = +25°C		100		ppm
OUTPUT DISABLE						
V_{ENH}	Enable Logic High (ON)		1.6			V
V_{ENL}	Enable Logic Low (OFF)				0.8	V
I_{INSD}	Shutdown Supply Current	VEN ≤ 0.35V		0.4	1.5	µA

Electrical Specifications (ISL21060-30, V_{OUT} = 3.00V) V_{IN} = 5.0V, T_A = -40°C to +125°C, I_{OUT} = 0, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Output Voltage			3.000		V
V_{OA}	V_{OUT} Accuracy @ T_A = +25°C	ISL21060B30	-1.0		+1.0	mV
		ISL21060C30	-2.5		+2.5	mV
TC V_{OUT}	Output Voltage Temperature Coefficient (Note 3)	ISL21060B			10	ppm/°C
		ISL21060C			25	ppm/°C
V_{IN}	Input Voltage Range		3.2		5.5	V
I_{IN}	Supply Current	EN = V_{IN}		16	40	µA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	3.2V ≤ V_{IN} ≤ 5.5V		50	150	µV/V
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	Sourcing: 0mA ≤ I_{OUT} ≤ 10mA		3	50	µV/mA
		Sinking: -5mA ≤ I_{OUT} ≤ 0mA		130	400	µV/mA
I_{SC}	Short Circuit Current	T_A = +25°C, V_{OUT} tied to GND		50		mA
t_R	Turn-on Settling Time	V_{OUT} = ±0.1%		300		µs
	Ripple Rejection	f = 10kHz		75		dB
e_N	Output Voltage Noise	0.1Hz ≤ f ≤ 10Hz		10		μV_{P-P}
V_N	Broadband Voltage Noise	10Hz ≤ f ≤ 1kHz		2.5		μV_{RMS}
	Noise Density	f = 1kHz		60		nV/$\sqrt{Hz}$
$\Delta V_{OUT}/\Delta T_A$	Thermal Hysteresis (Note 4)	ΔT_A = +165°C		100		ppm
$\Delta V_{OUT}/\Delta t$	Long Term Stability (Note 5)	T_A = +25°C		100		ppm
OUTPUT DISABLE						
V_{ENH}	Enable Logic High (ON)		1.6			V
V_{ENL}	Enable Logic Low (OFF)				0.8	V
I_{INSD}	Shutdown Supply Current	V_{EN} ≤ 0.35V		0.4	1.5	µA
V_N	Broadband Voltage Noise	10Hz ≤ f ≤ 1kHz		2.5		μV_{RMS}
	Noise Density	f = 1kHz		60		nV/$\sqrt{Hz}$
$\Delta V_{OUT}/\Delta T_A$	Thermal Hysteresis (Note 4)	ΔT_A = +165°C		100		ppm
$\Delta V_{OUT}/\Delta t$	Long Term Stability (Note 5)	T_A = +25°C		100		ppm
OUTPUT DISABLE						
V_{ENH}	Enable Logic High (ON)		1.6			V
V_{ENL}	Enable Logic Low (OFF)				0.8	V
I_{INSD}	Shutdown Supply Current	V_{EN} ≤ 0.35V		0.4	1.5	µA

Electrical Specifications (ISL21060-41, V_{OUT} = 4.096V) V_{IN} = 5.0V, T_A = -40°C to +125°C, I_{OUT} = 0, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Output Voltage			4.096		V
V_{OA}	V_{OUT} Accuracy @ T_A = +25°C	ISL21060B41	-1.0		+1.0	mV
		ISL21060C41	-2.5		+2.5	mV
TC V_{OUT}	Output Voltage Temperature Coefficient (Note 3)	ISL21060B			10	ppm/°C
		ISL21060C			25	ppm/°C

Electrical Specifications (ISL21060-41, V_{OUT} = 4.096V) V_{IN} = 5.0V, T_A = -40°C to +125°C, I_{OUT} = 0, unless otherwise specified. **(Continued)**

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN}	Input Voltage Range		4.3		5.5	V
I_{IN}	Supply Current	EN = V_{IN}		20	40	µA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	4.3V ≤ V_{IN} ≤ 5.5V		50	150	µV/V
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	Sourcing: 0mA ≤ I_{OUT} ≤ 10mA		10	50	µV/mA
		Sinking: -5mA ≤ I_{OUT} ≤ 0mA		130	400	µV/mA
I_{SC}	Short Circuit Current	T_A = +25°C, V_{OUT} tied to GND		50		mA
t_R	Turn on Settling Time	V_{OUT} = ±0.1%		300		µs
	Ripple Rejection	f = 10kHz		75		dB
e_N	Output Voltage Noise	0.1Hz ≤ f ≤ 10Hz		10		μV_{P-P}
V_N	Broadband Voltage Noise	10Hz ≤ f ≤ 1kHz		2.5		μV_{RMS}
	Noise Density	f = 1kHz		60		nV/$\sqrt{Hz}$
$\Delta V_{OUT}/\Delta T_A$	Thermal Hysteresis (Note 4)	ΔT_A = +165°C		100		ppm
$\Delta V_{OUT}/\Delta t$	Long Term Stability (Note 5)	T_A = +25°C		100		ppm
OUTPUT DISABLE						
V_{ENH}	Enable Logic High (ON)		1.6			V
V_{ENL}	Enable Logic Low (OFF)				0.8	V
I_{INSD}	Shutdown Supply Current	V_{EN} ≤ 0.35V		0.4	1.5	µA

NOTES:

3. 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°C to +125°C = +165°C.
4. Thermal Hysteresis is the change of V_{OUT} measured @ T_A = +25°C after temperature cycling over a specified range, ΔT_A. V_{OUT} is read initially at T_A = +25°C for the device under test. The device is temperature cycled and a second V_{OUT} measurement is taken at +25°C. The difference between the initial V_{OUT} reading and the second V_{OUT} reading is then expressed in ppm. For ΔT_A = +165°C, the device under test is cycled from +25°C to +125°C to -40°C to +25°C.
5. Long term drift is logarithmic in nature and diminishes over time. Drift after the first 1000 hours will be approximately 10ppm/√1khrs.

Applications Information

FGA Technology

The ISL21060 voltage reference floating gate references passes very low drift and supply current. 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 and include 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 drive. This circuitry provides excellent accuracy with a trade-off in output noise level and load regulation due to the MOS device characteristics. These limitations are addressed with circuit techniques discussed in other sections.

Micropower Supply Current and Output Enable

The ISL21060 consumes extremely low supply current due to the proprietary FGA technology. Low noise performance is achieved using optimized biasing techniques. Supply current is typically 16µA and noise is $10\mu V_{P-P}$, benefitting precision, low noise portable applications, such as handheld meters and instruments.

The ISL21060 devices have the EN pin, which is used to Enable/Disable the output of the device. When disabled, the reference circuitry itself remains biased at a highly accurate and reliable state. When enabled, the output is driven to the reference voltage in a relatively short time (about 300µs). This feature allows multiple references to be connected and one of them selected. Another application is to disable any loads that draw significant current, saving power in standby or shutdown modes.

Board Mounting Considerations

For applications requiring the highest accuracy, board mounting location should be reviewed. The device uses a plastic SOIC package, which will subject the die to mild stresses when the PC board is heated and cooled and slightly changes shape. Placing the device in areas subject to slight twisting can cause degradation of the accuracy of the reference voltage due to these 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. Mounting the device in a cutout also minimizes flex. Obviously, mounting the device on flexprint or extremely thin PC material will likewise cause loss of reference accuracy.

Noise Performance and Reduction

The output noise voltage in a 0.1Hz to 10Hz bandwidth is typically $10\mu V_{P-P}$. 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. Noise in the 10kHz to 1MHz bandwidth is approximately $100\mu V_{P-P}$ with no capacitance on the output. This noise measurement is made with a 2 decade bandpass filter made of a 1-pole high-pass filter with a corner frequency at 1/10 of the center frequency and 1-pole low-pass filter with a corner frequency at 10x the center frequency. Load capacitance up to 1µF can be added to improve transient response.

Turn-On Time

The ISL21060 devices have low supply current and thus the time to bias up internal circuitry to final values will be longer than with higher power references. Normal turn-on time is typically 300µs. Circuit design must take this into account when looking at power-up delays or sequencing.

Temperature Coefficient

The limits stated for temperature coefficient (tempco) are governed by the method of measurement. The overwhelming standard for specifying the temperature drift of a reference is to measure the reference voltage at two temperatures take the total variation, ($V_{HIGH} - V_{LOW}$), and divide by the temperature extremes of measurement ($T_{HIGH} - T_{LOW}$). The result is divided by the nominal reference voltage (at T = +25°C) and multiplied by 10^6 to yield ppm/°C. This is the “Box” method for specifying temperature coefficient.

VOUT Kelvin Sensing

The voltage output for the ISL21060 has both a force and a sense output. This enables remote kevin sensing for highly accurate voltage setting with long traces and higher current loads. The VOUTF (force) can be routed to the load with the shortest, widest trace possible. The VOUTS (sense) is routed with a narrower trace to the point of the actual load where it is connected to the VOUTF trace.

The VOUTF and VOUTS traces must always be connected. If there is only a short trace to the load or even a very light load, then they can be connected at or near the ISL21060 device.

Typical Application Circuits

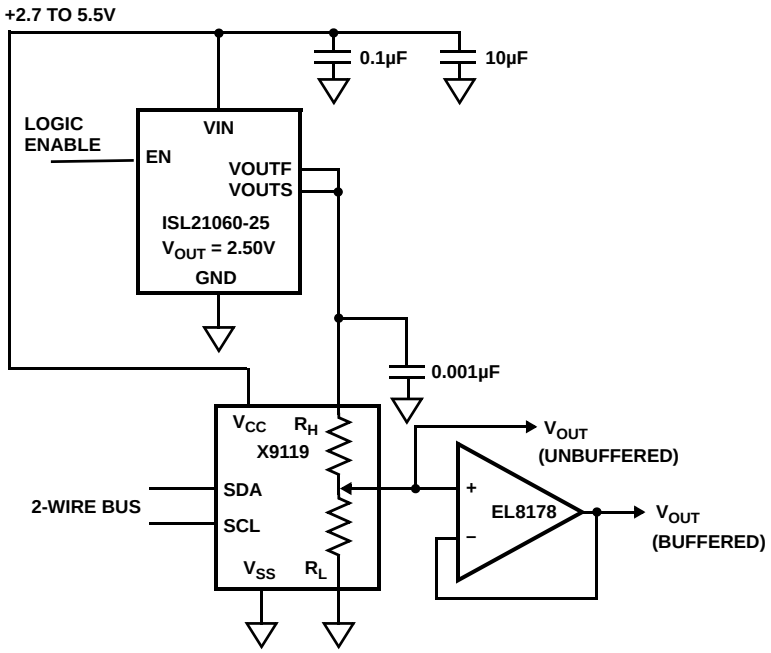


FIGURE 1. 2.5V FULL SCALE LOW-DRIFT, 10-BIT ADJUSTABLE VOLTAGE SOURCE WITH LOW POWER DISABLE

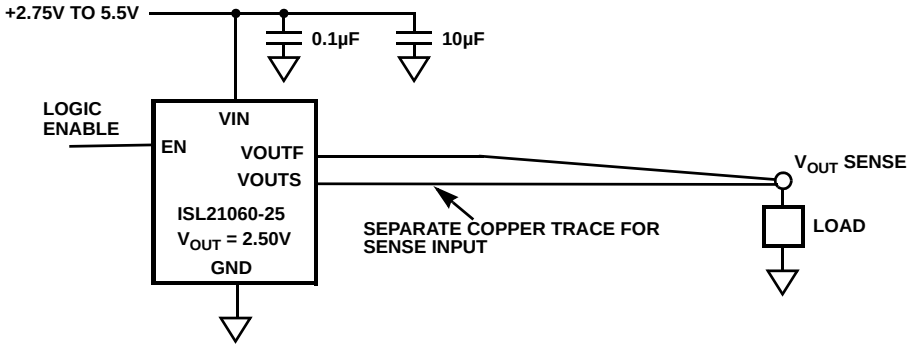
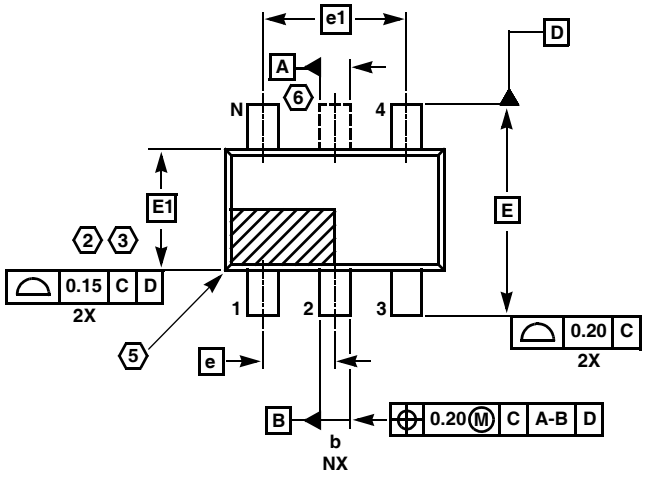
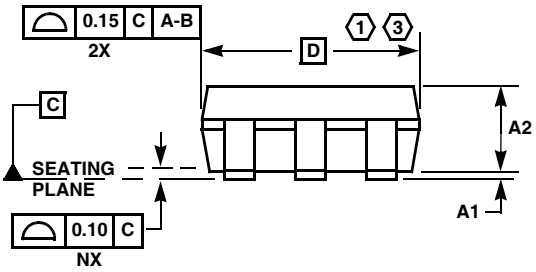
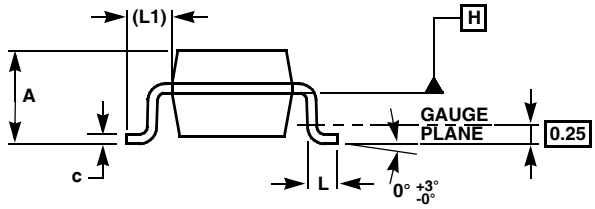


FIGURE 2. KELVIN SENSED LOAD

SOT-23 Package Family







MDP0038

SOT-23 PACKAGE FAMILY

SYMBOL	MILLIMETERS		TOLERANCE
	SOT23-5	SOT23-6	
A	1.45	1.45	MAX
A1	0.10	0.10	±0.05
A2	1.14	1.14	±0.15
b	0.40	0.40	±0.05
c	0.14	0.14	±0.06
D	2.90	2.90	Basic
E	2.80	2.80	Basic
E1	1.60	1.60	Basic
e	0.95	0.95	Basic
e1	1.90	1.90	Basic
L	0.45	0.45	±0.10
L1	0.60	0.60	Reference
N	5	6	Reference

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NOTES:

1. Plastic or metal protrusions of 0.25mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25mm maximum per side are not included.
3. This dimension is measured at Datum Plane “H”.
4. Dimensioning and tolerancing per ASME Y14.5M-1994.
5. Index area - Pin #1 I.D. will be located within the indicated zone (SOT23-6 only).
6. SOT23-5 version has no center lead (shown as a dashed line).