User's Manual

# ISL73100SEHEV1Z

## User's Manual: Evaluation Board

High Reliability



Renesas Electronics Corporation
www.renesas.com

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# ISL73100SEHEV1Z

Evaluation Board

The ISL73100SEHEV1Z evaluation board is designed to evaluate the performance of the ISL70100SEH and ISL73100SEH. The ISL70100SEH and ISL73100SEH are radiation hardened 40V current-sense amplifiers built using the Renesas proprietary PR40 SOI process.

## Key Features

- Large current-sense resistor footprint (2512)
- Easy gain configuration using a single resistor
- Kelvin sensing for improved measurement accuracy

## Specifications

- Power supply voltage range: 2.7V to 40V
- Current-sense input common-mode range: -0.3V to 40V (regardless of power supply voltage)
- Board dimension: 4.25cmx5.25cm
- Board layers: Two
- Board revision: A

## Ordering Information

| Part Number | Description |
|---|---|
| ISL73100SEHEV1Z | ISL73100SEHEV1Z evaluation board |

## Related Literature

For a full list of related documents, visit our website:

- ISL73100SEH, ISL70100SEH device pages

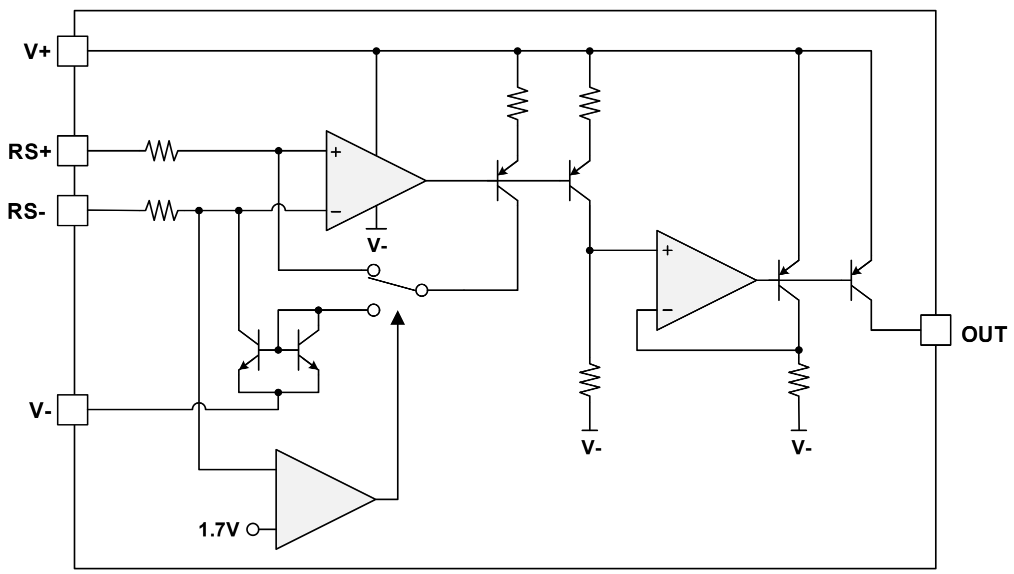


**Figure 1. ISL73100SEHEV1Z Block Diagram**

# 1. Functional Description

The evaluation board includes a 2512 sized SMD pad for populating a current-sense resistor and an output termination resistor to set the current-sense to output voltage scaling.

## 1.1 Operating Range

The ISL70100SEH and ISL73100SEH have a wide power supply range from 2.7V up to 40V. The input common-mode range extends from -0.3V to 40V, making them ideal to use in both high-side and low-side current-sense applications. The current-sense amplifiers are voltage-to-current converters that monitor current using an external sense resistor and output a scaled current of the sensed input voltage.

## 1.2 Quick Start Guide

1. R2 is a 15mΩ 2512 sized to provide 150mV for 10A. The analog differential input voltage for RS+ to RS- is 0V to 150mV. If R2 needs to be changed, the product of the current-sense resistance and maximum load current must fall within 150mV.
2. With the load unbiased: Connect the current-sense terminals to the circuit load either in a high-side sense (RS+ goes to load positive supply rail, RS- goes to load positive terminal) or low-side sense (RS+ goes to load negative terminal, RS- goes to load negative supply rail) configuration.
3. Provide a power supply voltage to V+ (BA1) and GND (BA2) terminals of the ISL73100SEHEV1Z board. The power supply voltage range is 2.7V to 40V.
4. Power-up load.
5. The voltage on OUT (BNC1) with the 25kΩ output resistor is 50mV for every 1mV input sense voltage. The full-scale 150mV input produces 7.5V output.
   **Note:** To use the full-scale output voltage at 150mV full-scale input sense voltage with the 25kΩ output resistor, the minimum supply range must be increased to 9.5V to account for the 2.0V output head-room to the V+ supply voltage.

## 1.3 Current-Sense Resistor

To pick the current-sense resistor value, a decision has to be made between power dissipation and measurement accuracy. As a general rule for all applications, the sense resistor should be as small as possible while still providing adequate input dynamic range across the operating range. The minimum accurately sensed input voltage is primarily limited by the offset voltage of the ISL70100SEH and ISL73100SEH.

The sense resistor value can be calculated when the maximum load current is determined. The maximum recommended sense voltage for the amplifier is 150mV, so dividing that by the maximum load current provides the sense resistor value.

The current-sense error is the amplifier offset voltage divided by the current-sense resistor.

On the ISL73100SEHEV1Z, the current-sense signal is connected to the R2 current-sense resistor in a Kelvin configuration for sense accuracy.

## 1.4 Current-Sense Amplifier Output Voltage (Gain Setting)

The ISL73100SEHEV1Z is populated with a 25kΩ resistor at the current-sense amplifier output to GND (BNC terminal OUT).

The overall gain ($A_{CSA}$) on the ISL70100SEH can be adjusted using a single resistor on the output. The ISL70100SEH outputs 2µA for every 1mV of differential across the inputs. Equation 1 can be used to calculate the output load resistance to get a specific gain:

(EQ. 1) $$ROUT = \frac{A_{CSA}}{gm}$$

For the 25kΩ resistor, the current-sense amplifier gain ACSA is (25mV/µA) * (2µA/mV) = 50V/V. Therefore, at full-scale of the 150mV input, 300µA output current, the 25kΩ output resistor produces a full-scale output voltage of 7.5V. Therefore, the output produces 50mV for every 1mV input sense voltage.

## 1.5 Power Supply Bias Range

The ISL73100SEHEV1Z can be biased anywhere from 2.7V to 40V. The current-sense input common-mode voltage range is from -0.3V to 40V, regardless of the V+ to V- power supply bias. The current-sense amplifier output voltage range is V- to 2.0V below V+.

The ISL73100SEHEV1Z is populated with a 25kΩ output resistor that produces 7.5V output voltage at 150mV full-scale input voltage. To achieve full-scale output voltage, the minimum power supply bias voltage is 9.5V.

If the minimum power supply of 2.7V is used with the 25kΩ output resistor, the maximum accurately sensed current would be 0.93A.

# 2. Layout Recommendations

To ensure the best accuracy, Renesas recommends connecting the sense inputs to the sense resistor using a Kelvin connection. This 4-terminal approach to measurements helps eliminate the losses due to parasitic resistances in the high current path. To ensure that the bandwidth of the amplifier is not inadvertently compromised, care must be taken to minimize stray capacitance on the output.

## 2.1 ISL73100SEHEV1Z Evaluation Board

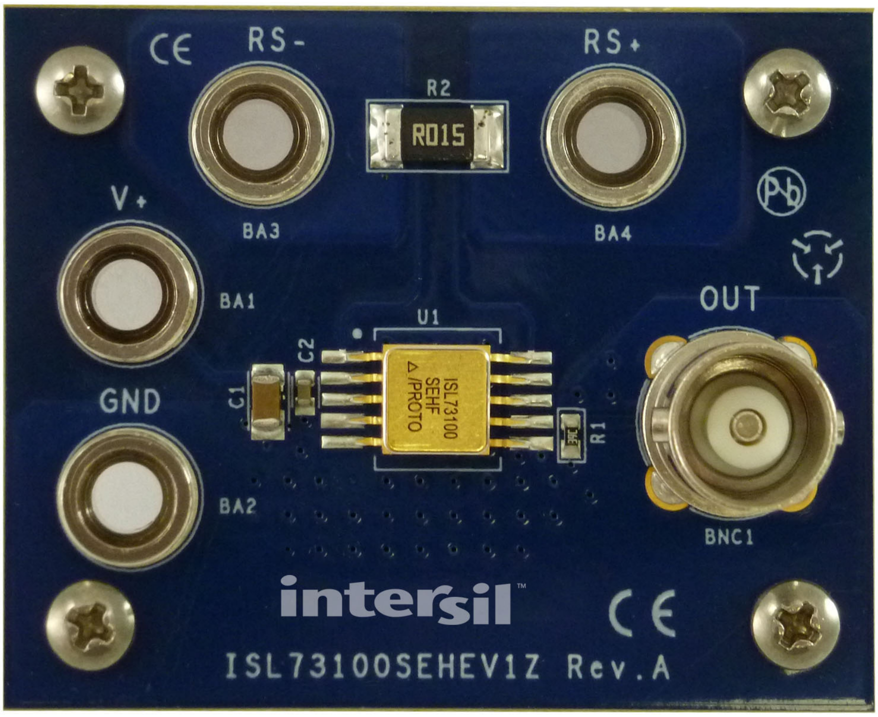


**Figure 2. ISL73100SEHEV1Z (Top)**

## 2.2 ISL73100SEHEV1Z Circuit Schematic

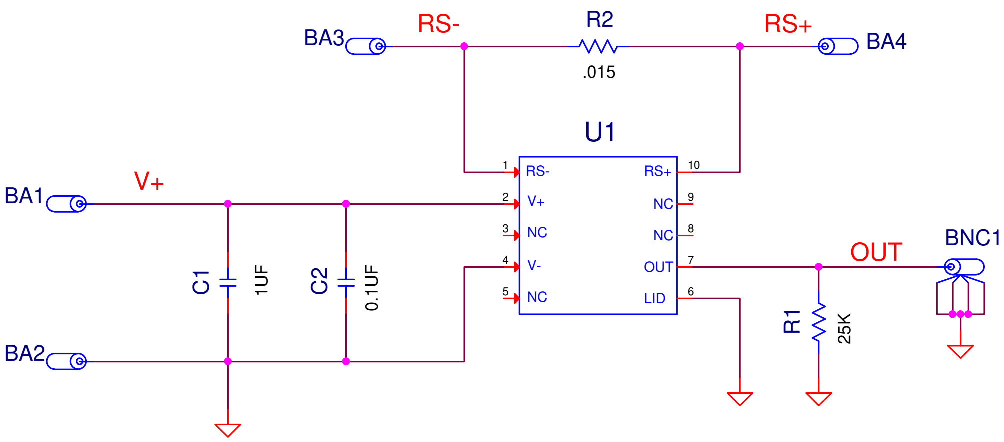


**Figure 3. Schematic**

# 3. Bill of Materials

| Qty | Reference Designator | Description | Manufacturer | Manufacturer Part Number |
|---|---|---|---|---|
| 1 | | PWB-PCB, ISL73100SEHEV1Z, REVA, ROHS | Imagineering Inc | ISL73100SEHEV1ZREVAPCB |
| 1 | C2 | CAP, SMD, 0603, 0.1µF, 100V, 10%, X7R, ROHS | Murata | GRM188R72A104KA35J |
| 1 | C1 | CAP, SMD, 1206, 1µF, 100V, 10%, X7R, ROHS | Venkel | C1206X7R101-105KNE |
| 1 | BNC1 | CONN-BNC, RECEPTACLE, TH, 4 POST, 50Ω, SILVERCONTACT, ROHS | Amphenol | 31-5329-51RFX |
| 4 | BA1-BA4 | CONN-JACK, MINI BANANA, 0.175 PLUG, NICKEL/BRASS, ROHS | Keystone | 575-4 |
| 1 | U1 | IC-PROTO, RAD HARD, CURRENT SENSE AMP, SMD, 10P, CDFP | Renesas | ISL73100SEHF/PROTO |
| 1 | R2 | RES-AEC-Q200, SMD, 2512, 0.015Ω, 3W, 1%, MF, ROHS | Bourns | CRA2512-FZ-R015ELF |
| 1 | R1 | RES, SMD, 0603, 24.9k, 1/10W, 1%, TF, ROHS | Panasonic | ERJ-3EKF2492V |
| 4 | Four corners | SCREW, 4-40x1/4in, PHILLIPS, PANHEAD, STAINLESS, ROHS | Building Fasteners | PMSSS 440 0025 PH |
| 4 | Four corners | STANDOFF, 4-40x3/4in, F/F, HEX, ALUMINUM, 0.25 OD, ROHS | Keystone | 2204 |

# 4. Board Layout

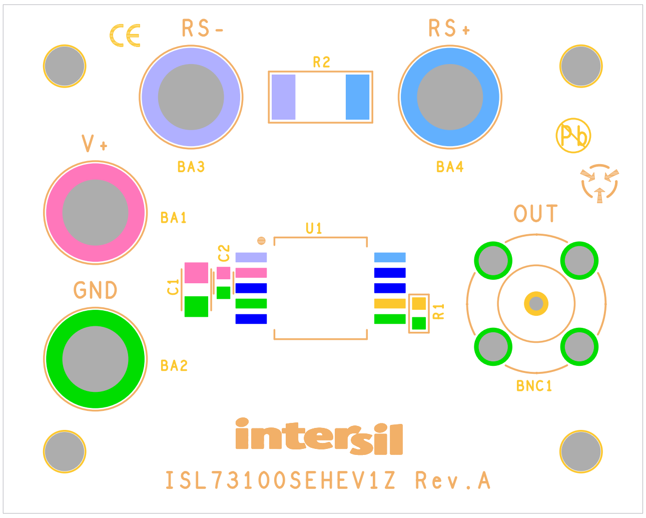


**Figure 4. Silk Screen Top**

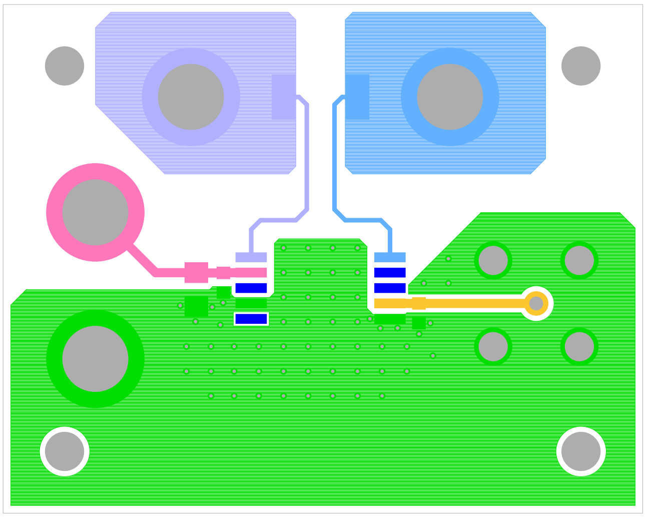

**Figure 5. Top Layer Component Side**

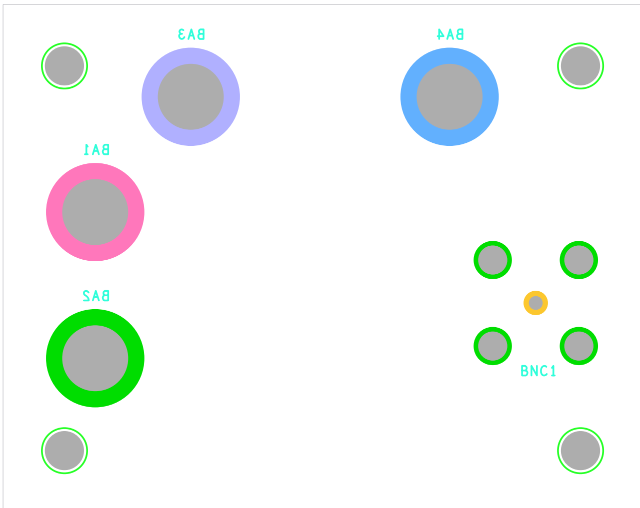

**Figure 6. Silk Screen Bottom**

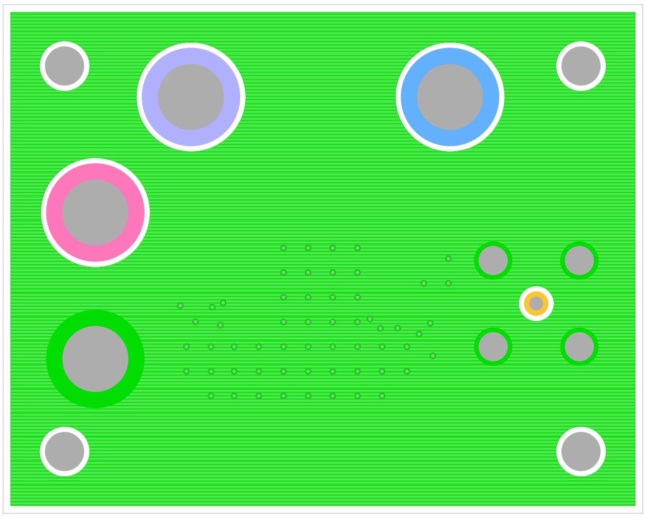

**Figure 7. Bottom Layer Solder Side**

# 5. Typical Performance Curves

Recommended operating conditions, V+ = $V_{RS+}$ = 12V, V- = 0V, $V_{SEN}$ = ($V_{RS+}$ - $V_{RS-}$), $R_{OUT}$ = 5kΩ and $T_A$ = +25°C unless otherwise specified.

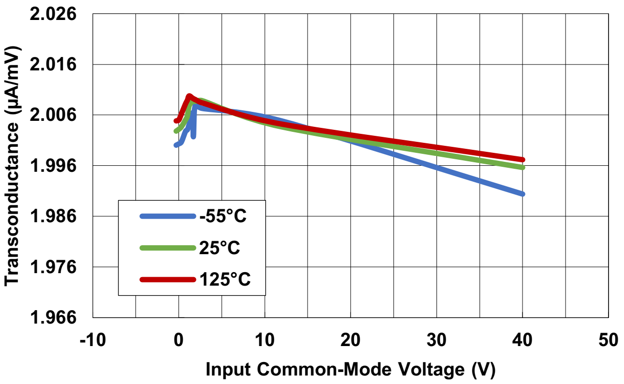


Figure 8. Transconductance, V+ = 12V

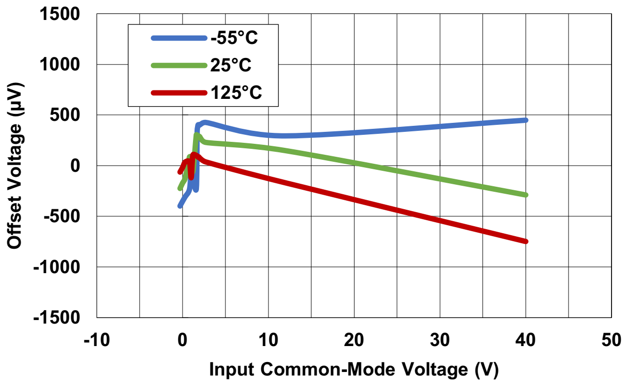


Figure 9. Common-Mode Voltage vs $V_{OS}$, V+ = 12V

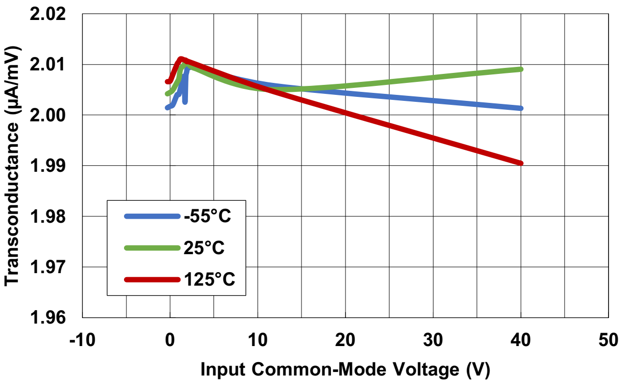


Figure 10. Transconductance, V+ = 40V

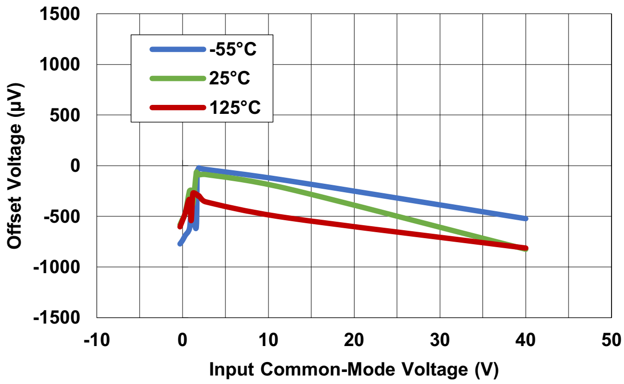


Figure 11. Common-Mode Voltage vs $V_{OS}$, V+ = 40V

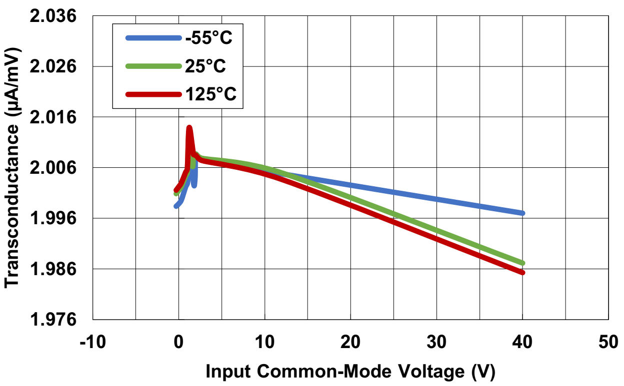


Figure 12. Transconductance, V+ = 2.7V

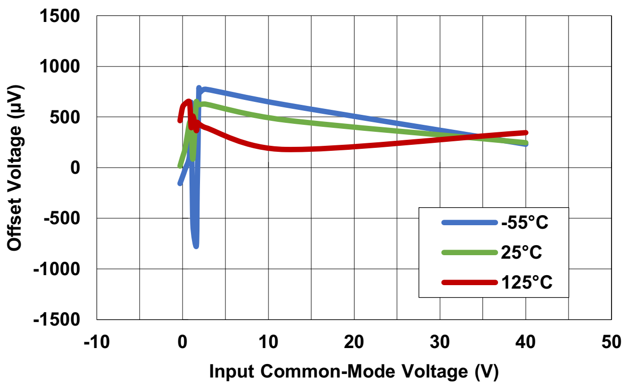


Figure 13. Common-Mode Voltage vs $V_{OS}$, V+ = 2.7V

Recommended operating conditions, V+ = $V_{RS+}$ = 12V, V- = 0V, $V_{SEN}$ = ($V_{RS+}$ - $V_{RS-}$), $R_{OUT}$ = 5kΩ and $T_A$ = +25°C unless otherwise specified.

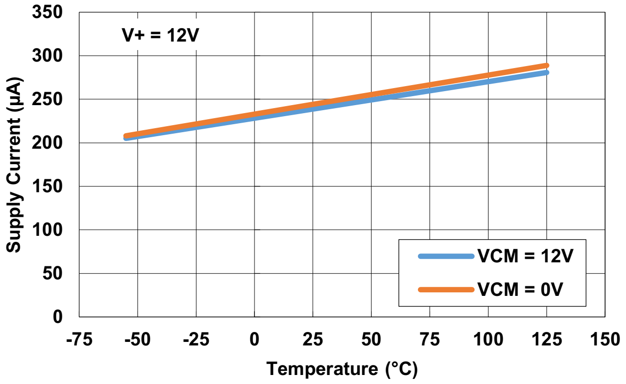


Figure 14. Supply Current, V+ = 12V

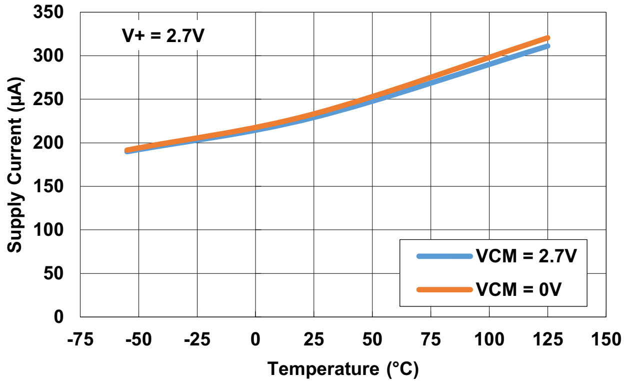


Figure 15. Supply Current, V+ = 2.7V

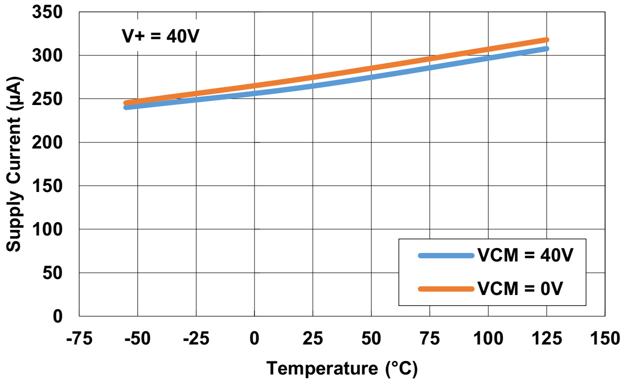


Figure 16. Supply Current, V+ = 40V

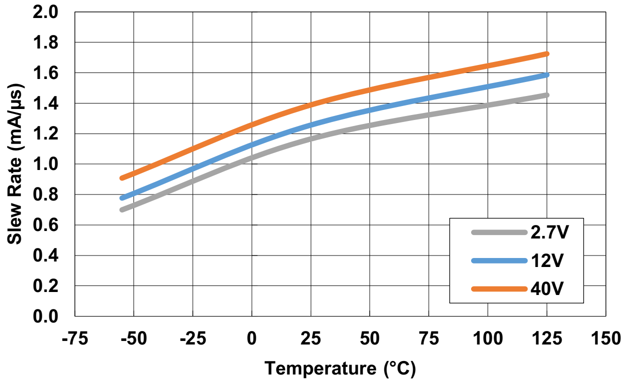


Figure 17. Slew Rate

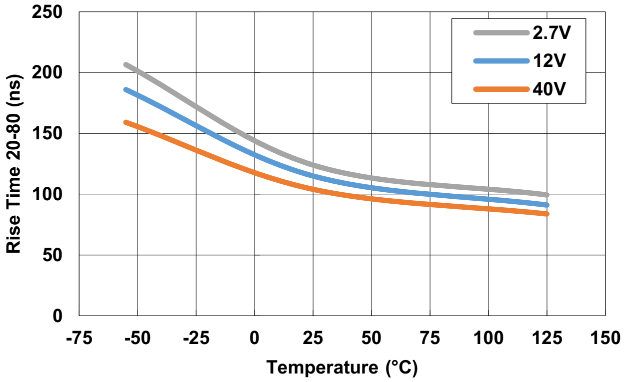


Figure 18. Rise Time

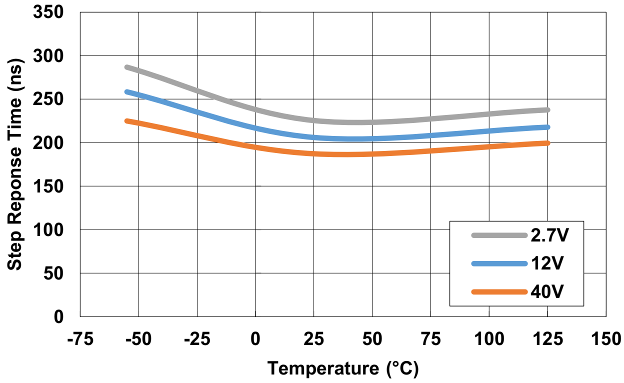


Figure 19. Step Response Time

Recommended operating conditions, V+ = $V_{RS+}$ = 12V, V- = 0V, $V_{SEN}$ = ($V_{RS+}$ - $V_{RS-}$), $R_{OUT}$ = 5kΩ and $T_A$ = +25°C unless otherwise specified.

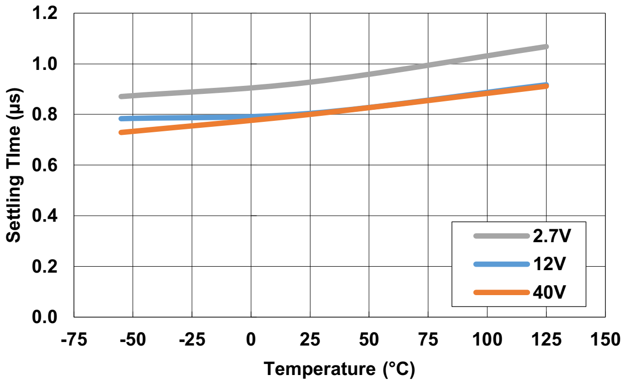


**Figure 20. Settling Time**

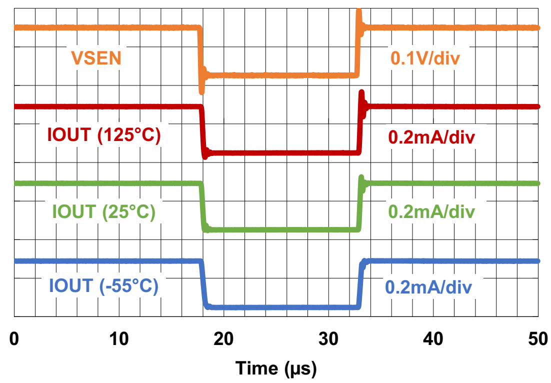


**Figure 21. Input Step Response**

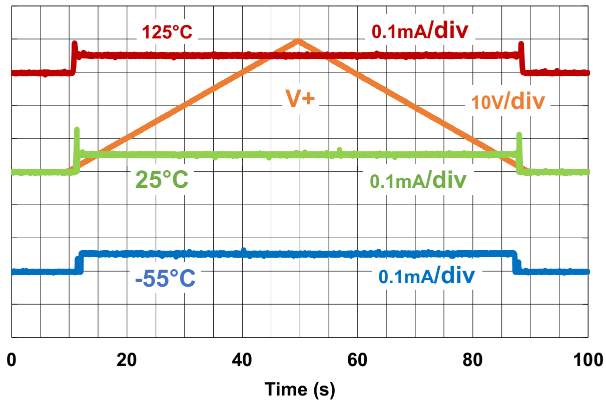


**Figure 22. Power Supply Ramp at 1V/s**

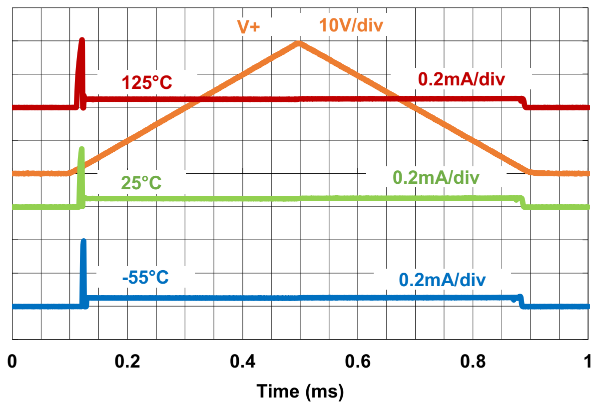


**Figure 23. Power Supply Ramp at 1V/10µs**

# 6. Revision History

| Rev. | Date | Description |
|---|---|---|
| 1.00 | May.28.20 | Initial release |

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