

GENERAL DESCRIPTION

The SGM2209 is a low power, low noise, fast transient response and low dropout voltage linear regulator. It provides -500mA output current capability. The operating input voltage range is from -2.7V to -24V. The adjustable output voltage range is from -1.2V to $(-V_{IN} + V_{DROP})$.

Other features include logic-controlled shutdown mode, short-circuit current limit and thermal shutdown protection. The SGM2209 has automatic discharge function to quickly discharge V_{OUT} in the disabled status.

The SGM2209 is available in Green TDFN-2×2-6AL, TDFN-3×3-8L and SOT-23-5 packages. It operates over an operating temperature range of -40°C to +125°C.

APPLICATIONS

Industrial and Medical Equipment
 Communications and Infrastructure
 Precision Amplifiers
 ADC and DAC Circuits

FEATURES

- **Input Voltage Range: -2.7V to -24V**
- **Output Voltage Accuracy: $\pm 1\%$ at +25°C**
- **Fixed Outputs of 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V and 5.0V**
- **Adjustable Output from -1.2V to $(-V_{IN} + V_{DROP})$**
- **-500mA Output Current**
- **Low Quiescent Current:**
 $I_{GND} = -1.2mA$ (TYP) with -500mA Load
- **Low Dropout Voltage:**
 $-345mV$ (TYP) at -500mA, at $V_{OUT} = -3.0V$
- **Low Noise:**
 - ◆ $10.5\mu V_{RMS}$ (TYP) at $V_{OUT} = -1.2V$
 - ◆ $12\mu V_{RMS}$ (TYP) at $V_{OUT} = -2.5V$
 - ◆ $16\mu V_{RMS}$ (TYP) at $V_{OUT} = -5.0V$
- **PSRR: -60dB at 10kHz at $V_{OUT} = -2.5V$**
- **Positive or Negative Enable Logic**
- **Stable with Small 2.2μF Ceramic Output Capacitor**
- **Low Shutdown Current: -1.1μA (TYP)**
- **Current Limiting and Thermal Protection**
- **-40°C to +125°C Operating Temperature Range**
- **Available in Green TDFN-2×2-6AL, TDFN-3×3-8L and SOT-23-5 Packages**

TYPICAL APPLICATION

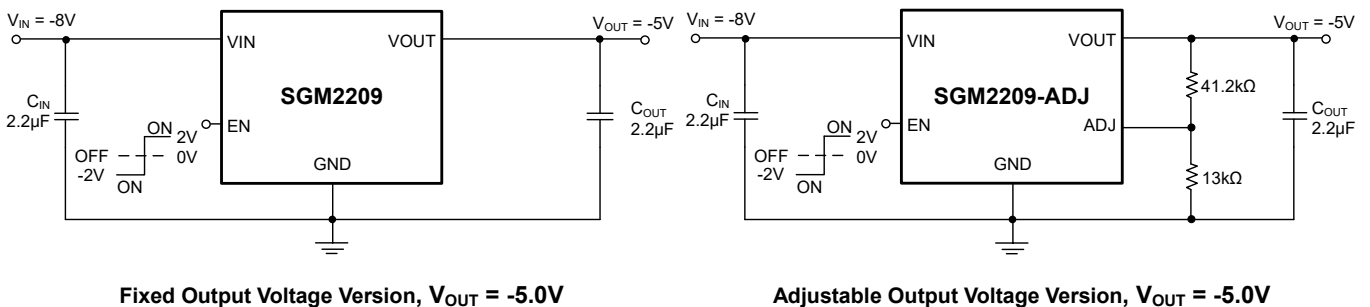


Figure 1. Typical Application Circuits

PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|-------------|---------------------|-----------------------------|----------------------|-----------------------|---------------------|
| SGM2209-1.2 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-1.2XTDI6G/TR | MY2 XXXX | Tape and Reel, 3000 |
| SGM2209-1.5 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-1.5XTDI6G/TR | MY3 XXXX | Tape and Reel, 3000 |
| SGM2209-1.8 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-1.8XTDI6G/TR | CA3 XXXX | Tape and Reel, 3000 |
| SGM2209-2.5 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-2.5XTDI6G/TR | MY4 XXXX | Tape and Reel, 3000 |
| SGM2209-2.8 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-2.8XTDI6G/TR | CA4 XXXX | Tape and Reel, 3000 |
| SGM2209-3.0 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-3.0XTDI6G/TR | CA5 XXXX | Tape and Reel, 3000 |
| SGM2209-3.3 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-3.3XTDI6G/TR | CA6 XXXX | Tape and Reel, 3000 |
| SGM2209-5.0 | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-5.0XTDI6G/TR | MY5 XXXX | Tape and Reel, 3000 |
| SGM2209-ADJ | TDFN-2×2-6AL | -40°C to +125°C | SGM2209-ADJXTDI6G/TR | MY6 XXXX | Tape and Reel, 3000 |
| SGM2209-1.2 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-1.2XTDB8G/TR | SGM C9CDB XXXXX | Tape and Reel, 4000 |
| SGM2209-1.5 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-1.5XTDB8G/TR | SGM C9DDB XXXXX | Tape and Reel, 4000 |
| SGM2209-1.8 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-1.8XTDB8G/TR | SGM C9EDB XXXXX | Tape and Reel, 4000 |
| SGM2209-2.5 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-2.5XTDB8G/TR | SGM C9FDB XXXXX | Tape and Reel, 4000 |
| SGM2209-2.8 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-2.8XTDB8G/TR | SGM CA0DB XXXXX | Tape and Reel, 4000 |
| SGM2209-3.0 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-3.0XTDB8G/TR | SGM CA1DB XXXXX | Tape and Reel, 4000 |
| SGM2209-3.3 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-3.3XTDB8G/TR | SGM CA2DB XXXXX | Tape and Reel, 4000 |
| SGM2209-5.0 | TDFN-3×3-8L | -40°C to +125°C | SGM2209-5.0XTDB8G/TR | SGM MY0DB XXXXX | Tape and Reel, 4000 |
| SGM2209-ADJ | TDFN-3×3-8L | -40°C to +125°C | SGM2209-ADJXTDB8G/TR | SGM MY1DB XXXXX | Tape and Reel, 4000 |

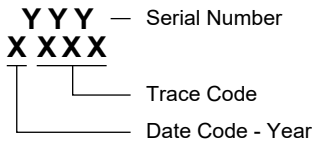
PACKAGE/ORDERING INFORMATION (continued)

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|-------------|---------------------|-----------------------------|--------------------|-----------------|---------------------|
| SGM2209-1.2 | SOT-23-5 | -40°C to +125°C | SGM2209-1.2XN5G/TR | C9AXX | Tape and Reel, 3000 |
| SGM2209-1.5 | SOT-23-5 | -40°C to +125°C | SGM2209-1.5XN5G/TR | C9BXX | Tape and Reel, 3000 |
| SGM2209-1.8 | SOT-23-5 | -40°C to +125°C | SGM2209-1.8XN5G/TR | MX9XX | Tape and Reel, 3000 |
| SGM2209-2.5 | SOT-23-5 | -40°C to +125°C | SGM2209-2.5XN5G/TR | MXAXX | Tape and Reel, 3000 |
| SGM2209-2.8 | SOT-23-5 | -40°C to +125°C | SGM2209-2.8XN5G/TR | MXBXX | Tape and Reel, 3000 |
| SGM2209-3.0 | SOT-23-5 | -40°C to +125°C | SGM2209-3.0XN5G/TR | MXCXX | Tape and Reel, 3000 |
| SGM2209-3.3 | SOT-23-5 | -40°C to +125°C | SGM2209-3.3XN5G/TR | MXDXX | Tape and Reel, 3000 |
| SGM2209-5.0 | SOT-23-5 | -40°C to +125°C | SGM2209-5.0XN5G/TR | MXEXX | Tape and Reel, 3000 |
| SGM2209-ADJ | SOT-23-5 | -40°C to +125°C | SGM2209-ADJXN5G/TR | MXFXX | Tape and Reel, 3000 |

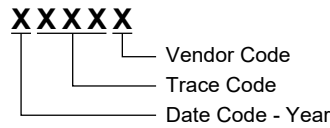
MARKING INFORMATION

NOTE: X = Date Code. XX = Date Code. XXXX = Date Code, Trace Code and Vendor Code.

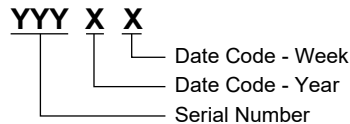
TDFN-2x2-6AL



TDFN-3x3-8L



SOT-23-5



Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

| | |
|--|---------------------|
| VIN to GND..... | +0.3V to -25V |
| VOUT to GND..... | +0.3V to VIN - 0.3V |
| EN to GND..... | +5V to VIN - 0.3V |
| EN to VIN..... | +25V to -0.3V |
| ADJ to GND..... | +0.3V to VOUT |
| Package Thermal Resistance | |
| TDFN-2x2-6AL, θ_{JA} | 101°C/W |
| TDFN-2x2-6AL, θ_{JB} | 39°C/W |
| TDFN-2x2-6AL, θ_{JC} | 83°C/W |
| TDFN-3x3-8L, θ_{JA} | 70°C/W |
| TDFN-3x3-8L, θ_{JB} | 25°C/W |
| TDFN-3x3-8L, θ_{JC} | 47°C/W |
| SOT-23-5, θ_{JA} | 186°C/W |
| SOT-23-5, θ_{JB} | 45°C/W |
| SOT-23-5, θ_{JC} | 74°C/W |
| Junction Temperature..... | +150°C |
| Storage Temperature Range..... | -65°C to +150°C |
| Lead Temperature (Soldering, 10s)..... | +260°C |
| ESD Susceptibility | |
| HBM..... | 8000V |
| CDM..... | 1000V |

RECOMMENDED OPERATING CONDITIONS

| | |
|---|-----------------|
| Input Voltage Range..... | -2.7V to -24V |
| Operating Junction Temperature Range..... | -40°C to +125°C |
| Input Capacitance, CIN..... | 1.5µF (MIN) |
| Output Capacitance, COUT..... | 1.5µF to 10µF |

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

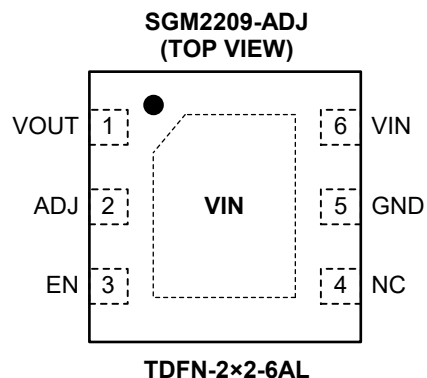
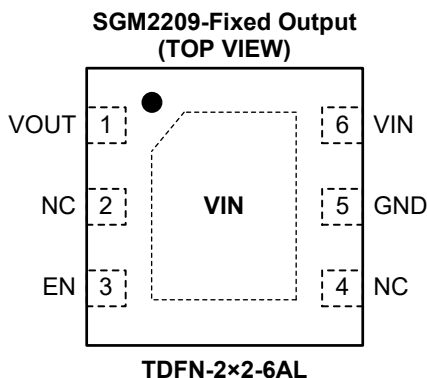
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

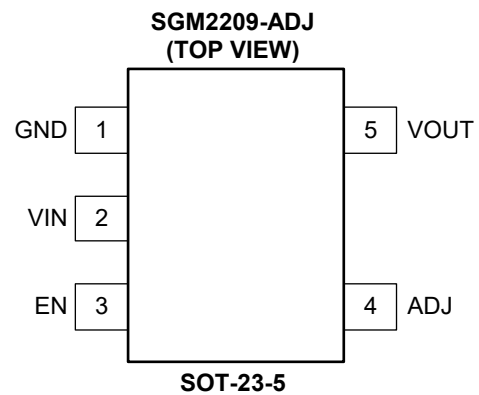
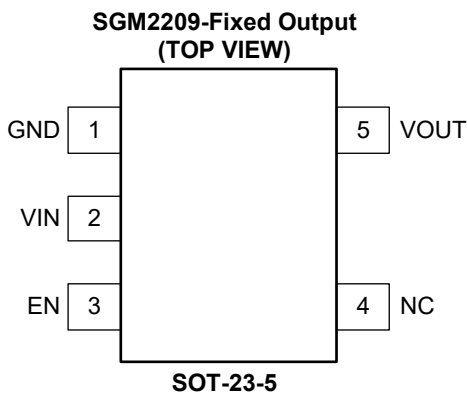
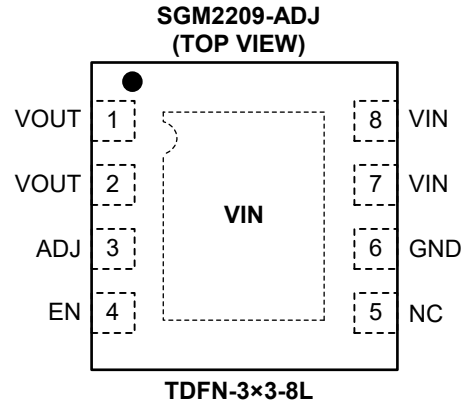
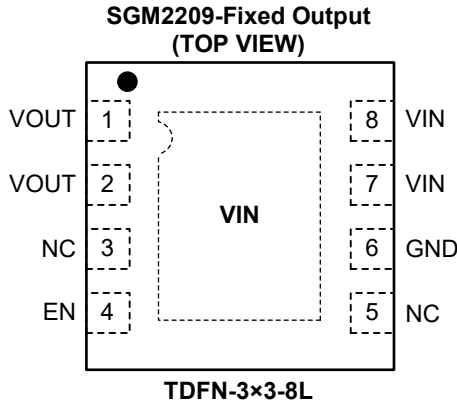
DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATIONS



PIN CONFIGURATIONS (continued)



PIN DESCRIPTION

| PIN | | | NAME | FUNCTION |
|--------------|-------------|----------|------|---|
| TDFN-2x2-6AL | TDFN-3x3-8L | SOT-23-5 | | |
| 1 | 1, 2 | 5 | VOUT | Regulator Output Pin. It is recommended to use a ceramic capacitor with effective capacitance in the range of 1.5µF to 10µF to get good power supply decoupling. This ceramic capacitor should be placed as close as possible to VOUT pin. |
| 2 | 3 | 4 | NC | Not Connected (fixed voltage version). |
| | | | ADJ | Adjustable Input (adjustable voltage version only). Connect this pin to the midpoint of an external resistor divider to adjust the output voltage. Place the resistors as close as possible to this pin. |
| 3 | 4 | 3 | EN | Enable Pin. Drive EN 2.0V above or below ground to turn on the regulator. Drive EN to ground to turn off the regulator. Connect the EN pin to the VIN pin when using automatic startup. |
| 4 | 5 | – | NC | Not Connected. |
| 5 | 6 | 1 | GND | Ground. |
| 6 | 7, 8 | 2 | VIN | Input Voltage Supply Pin. It is recommended to use a 2.2µF or larger ceramic capacitor from VIN pin to ground. This ceramic capacitor should be placed as close as possible to VIN pin. |
| Exposed Pad | Exposed Pad | – | VIN | Exposed Pad. Connect the exposed pad at the bottom of the package to the internal VIN for maximum thermal performance. In normal use, connect the exposed pad to the VIN on the board, which is the most negative potential in the negative voltage regulating circuit. |

ELECTRICAL CHARACTERISTICS

($V_{IN} = (V_{OUT(NOM)} - 0.5V)$ or $-2.7V$ (whichever is greater), $V_{EN} = V_{IN}$, $I_{OUT} = -10mA$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = -40^\circ C$ to $+125^\circ C$, typical values are at $T_J = +25^\circ C$, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | TEMP | MIN | TYP | MAX | UNITS | |
|---|---|---|---------------------------------|---------------------------------|-------|--------|---------------|----|
| Input Voltage Range | V_{IN} | $I_{OUT} = -250mA$ | $+25^\circ C$ | -2.7 | | -24 | V | |
| | | $I_{OUT} = -350mA$ | $+25^\circ C$ | -3.0 | | -24 | V | |
| | | $I_{OUT} = -500mA$ | $+25^\circ C$ | -3.3 | | -24 | V | |
| Under-Voltage Lockout Thresholds | V_{UVLO} | V_{IN} falling | $-40^\circ C$ to $+125^\circ C$ | | -2.42 | -2.50 | V | |
| | | V_{IN} rising | $-40^\circ C$ to $+125^\circ C$ | -2.24 | -2.33 | | V | |
| Operating Supply Current | I_{GND} | $I_{OUT} = 0\mu A$ | $-40^\circ C$ to $+125^\circ C$ | | -42 | -83 | μA | |
| | | $I_{OUT} = -500mA$ | $-40^\circ C$ to $+125^\circ C$ | | -1.2 | -2.1 | mA | |
| Shutdown Current | I_{SHDN} | $V_{EN} = GND$ | $-40^\circ C$ to $+125^\circ C$ | | -1.1 | -3.0 | μA | |
| | | $V_{EN} = GND, V_{IN} = -24V$ | $-40^\circ C$ to $+125^\circ C$ | | -1.2 | -10 | | |
| ADJ Pin Input Bias Current | I_{ADJ} | $V_{ADJ} = -1.3V, V_{IN} = -2.7V$ to $-24V$ | $-40^\circ C$ to $+125^\circ C$ | -3.5 | | 3.5 | nA | |
| Output Voltage Accuracy | V_{OUT} | $I_{OUT} = -10mA$ | $+25^\circ C$ | -1 | | 1 | % | |
| | | $V_{IN} = (V_{OUT(NOM)} - 0.5V)$ to $-24V$, $I_{OUT} = -1mA$ to $-500mA$ | $-40^\circ C$ to $+125^\circ C$ | -1.5 | | 1.5 | % | |
| Feedback Voltage | V_{ADJ} | $I_{OUT} = -10mA$ | $+25^\circ C$ | -1.188 | -1.2 | -1.212 | V | |
| | | $V_{IN} = (V_{OUT(NOM)} - 0.5V)$ to $-24V$, $I_{OUT} = -1mA$ to $-500mA$ | $-40^\circ C$ to $+125^\circ C$ | -1.182 | | -1.218 | V | |
| Line Regulation | $\frac{\Delta V_{OUT}}{\Delta V_{IN} \times V_{OUT}}$ | $V_{IN} = (V_{OUT(NOM)} - 0.5V)$ to $-24V$ | $-40^\circ C$ to $+125^\circ C$ | | 0.001 | 0.03 | %/V | |
| Load Regulation | $\frac{\Delta V_{OUT}}{V_{OUT}}$ | $I_{OUT} = -1mA$ to $-500mA$ | $-40^\circ C$ to $+125^\circ C$ | | 0.03 | 0.8 | % | |
| Dropout Voltage ⁽¹⁾ | V_{DROP} | $I_{OUT} = -250mA$ | $V_{OUT(NOM)} = -2.5V$ | $-40^\circ C$ to $+125^\circ C$ | | -230 | -350 | mV |
| | | | $V_{OUT(NOM)} = -3.0V$ | $-40^\circ C$ to $+125^\circ C$ | | -160 | -260 | |
| | | | $V_{OUT(NOM)} = -5.0V$ | $-40^\circ C$ to $+125^\circ C$ | | -125 | -220 | |
| | | $I_{OUT} = -350mA$ | $V_{OUT(NOM)} = -3.0V$ | $-40^\circ C$ to $+125^\circ C$ | | -230 | -370 | |
| | | | $V_{OUT(NOM)} = -5.0V$ | $-40^\circ C$ to $+125^\circ C$ | | -180 | -300 | |
| | | $I_{OUT} = -500mA$ | $V_{OUT(NOM)} = -3.0V$ | $-40^\circ C$ to $+125^\circ C$ | | -345 | -550 | |
| $V_{OUT(NOM)} = -5.0V$ | $-40^\circ C$ to $+125^\circ C$ | | | -260 | -420 | | | |
| Output Current Limit ⁽²⁾ | I_{LIM} | $V_{IN} = \text{MIN}(V_{OUT(NOM)} - 1V, -4V)$ | $+25^\circ C$ | -0.68 | -1.05 | | A | |
| Short-Circuit Current | I_{SHORT} | $V_{OUT} = 0V, V_{IN} = \text{MIN}(V_{OUT(NOM)} - 1V, -4V)$ | $+25^\circ C$ | | -360 | | mA | |
| Output Voltage Noise | e_n | 10Hz to 100kHz | $V_{OUT(NOM)} = -1.2V$ | $+25^\circ C$ | | 10.5 | μV_{RMS} | |
| | | | $V_{OUT(NOM)} = -2.5V$ | $+25^\circ C$ | | 12 | | |
| | | | $V_{OUT(NOM)} = -5.0V$ | $+25^\circ C$ | | 16 | | |
| | | 10Hz to 100kHz, $V_{OUT(NOM)} = -15V$, adjustable mode, $C_{NR} = \text{open}$, $R_{NR} = \text{open}, R_{FB1} = 150k\Omega, R_{FB2} = 13k\Omega$ | $+25^\circ C$ | | 130 | | | |
| 10Hz to 100kHz, $V_{OUT(NOM)} = -15V$, adjustable mode, $C_{NR} = 100nF$, $R_{NR} = 13k\Omega, R_{FB1} = 150k\Omega, R_{FB2} = 13k\Omega$ | $+25^\circ C$ | | 31 | | | | | |

ELECTRICAL CHARACTERISTICS (continued)

($V_{IN} = (V_{OUT(NOM)} - 0.5V)$ or $-2.7V$, whichever is greater, $V_{EN} = V_{IN}$, $I_{OUT} = -10mA$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = -40^\circ C$ to $+125^\circ C$, typical values are at $T_J = +25^\circ C$, unless otherwise noted.)

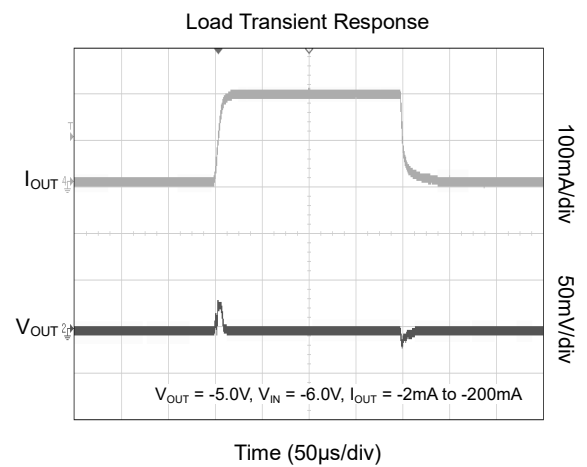
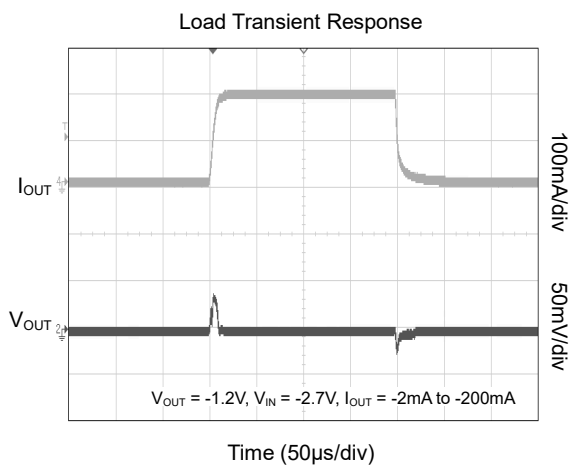
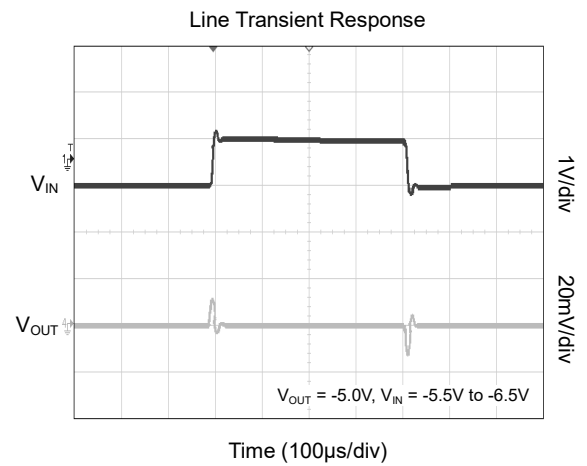
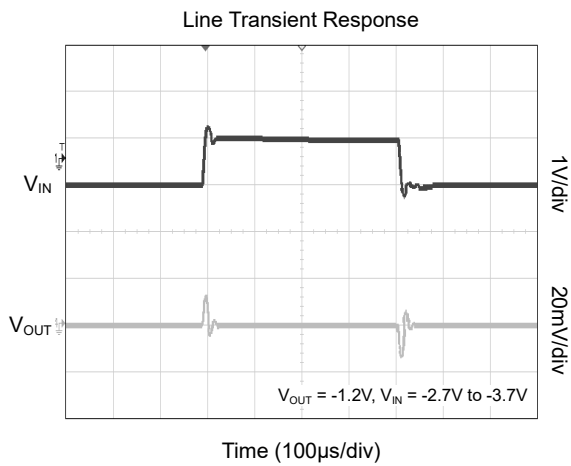
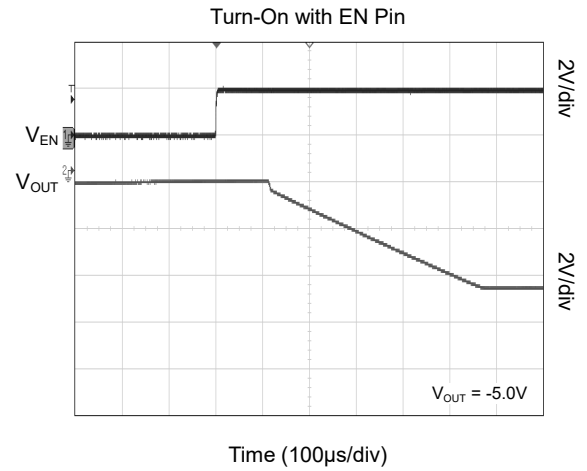
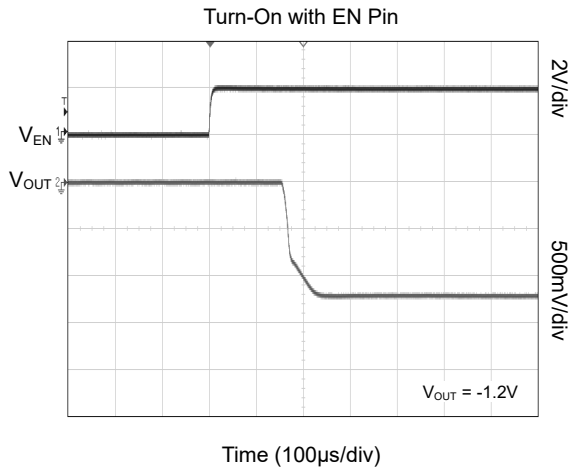
| PARAMETER | SYMBOL | CONDITIONS | TEMP | MIN | TYP | MAX | UNITS |
|------------------------------------|-------------------|--|-----------------|-------|------|------|---------|
| Power Supply Rejection Ratio | PSRR | $V_{IN} = V_{OUT(NOM)} - 1V$, $\Delta V_{RIPPLE} = 0.2V_{P-P}$, all fixed output voltage options | f = 1kHz | +25°C | | -75 | dB |
| | | | f = 10kHz | +25°C | | -60 | |
| | | | f = 100kHz | +25°C | | -42 | |
| | | $V_{IN} = -16V$, $V_{OUT(NOM)} = -15V$, $\Delta V_{RIPPLE} = 0.2V_{P-P}$, adjustable mode, $C_{NR} = 100nF$, $R_{NR} = 13k\Omega$, $R_{FB1} = 150k\Omega$, $R_{FB2} = 13k\Omega$ | f = 1kHz | +25°C | | -71 | dB |
| | | | f = 10kHz | +25°C | | -60 | |
| | | | f = 100kHz | +25°C | | -44 | |
| Start-Up Time ⁽³⁾ | t_{STR} | $V_{OUT(NOM)} = -1.2V$ | +25°C | | 210 | | μs |
| | | $V_{OUT(NOM)} = -5.0V$ | +25°C | | 540 | | |
| Positive Enable High-Level Voltage | $V_{EN(+HI)}$ | | -40°C to +125°C | 1.22 | | | V |
| Positive Enable Low-Level Voltage | $V_{EN(+LO)}$ | | -40°C to +125°C | | | 0.3 | |
| Negative Enable High-Level Voltage | $V_{EN(-HI)}$ | | -40°C to +125°C | | | -2.0 | V |
| Negative Enable Low-Level Voltage | $V_{EN(-LO)}$ | | -40°C to +125°C | -0.55 | | | |
| EN Positive Input Current | I_{EN_P} | $V_{EN} = 5V$, $V_{IN} = -19V$ | -40°C to +125°C | | 0.9 | 3 | μA |
| EN Negative Input Current | I_{EN_N} | $V_{EN} = -24V$, $V_{IN} = -24V$ | -40°C to +125°C | | -0.1 | -1 | μA |
| Thermal Shutdown Temperature | T_{SHDN} | | | | 160 | | °C |
| Thermal Shutdown Hysteresis | ΔT_{SHDN} | | | | 20 | | °C |

NOTES:

1. The dropout voltage is defined as the difference between V_{IN} and V_{OUT} when V_{OUT} falls to $95\% \times V_{OUT(NOM)}$.
2. Output current limit has the function of current foldback protection and refers to the current at which V_{OUT} falls to $90\% \times V_{OUT(NOM)}$.
3. The start-up time is defined as the time between the EN rising edge to V_{OUT} reaching $90\% \times V_{OUT(NOM)}$.

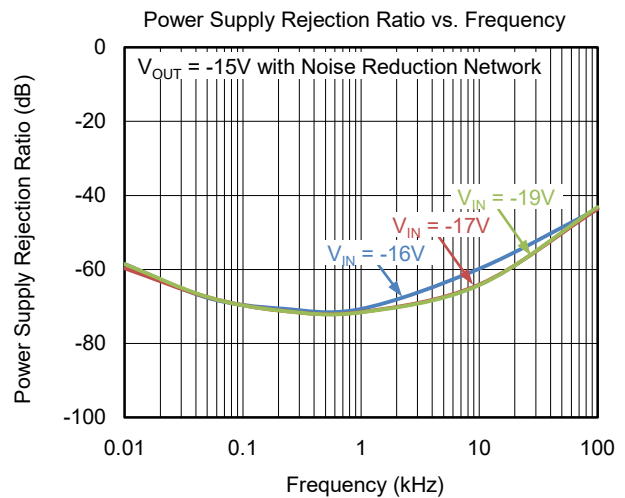
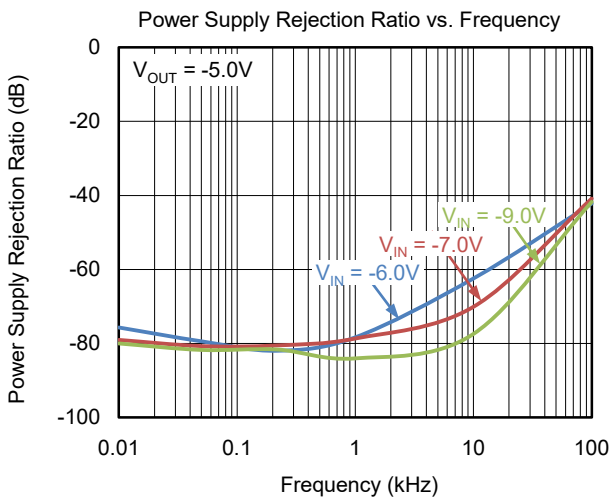
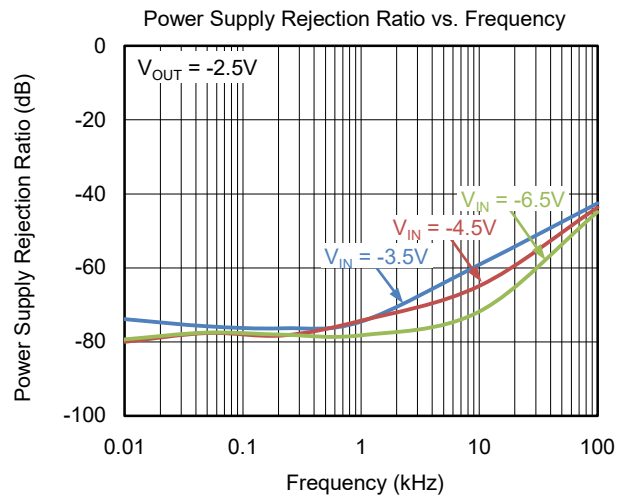
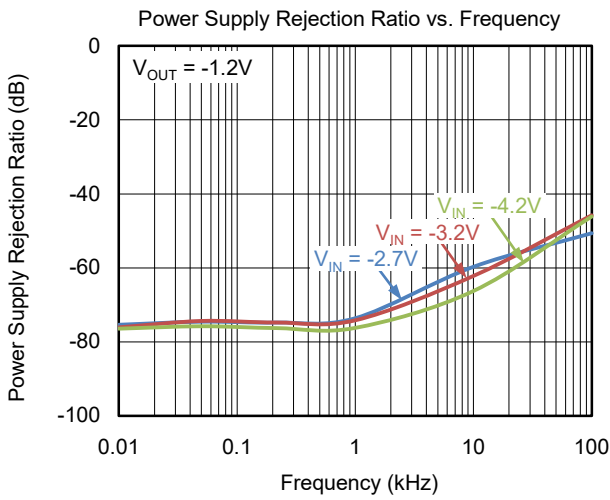
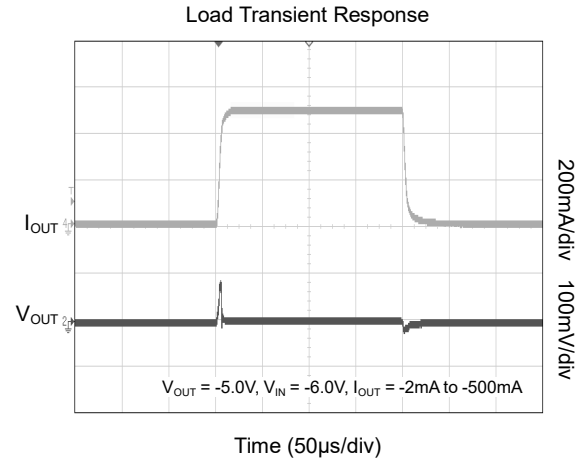
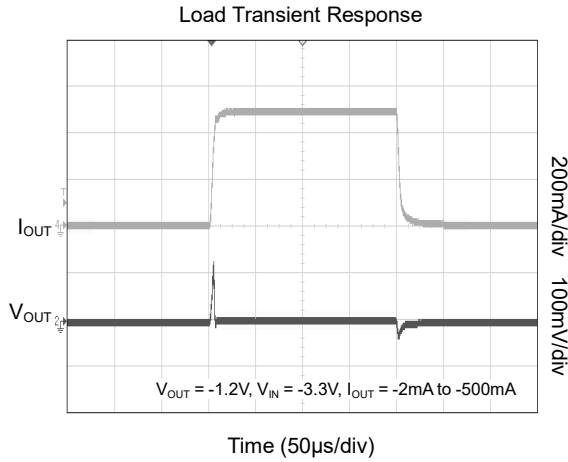
TYPICAL PERFORMANCE CHARACTERISTICS

$V_{IN} = (V_{OUT(NOM)} - 0.5V)$ or $-2.7V$, whichever is greater, $V_{EN} = V_{IN}$, $I_{OUT} = -10mA$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = +25^\circ C$, unless otherwise noted.



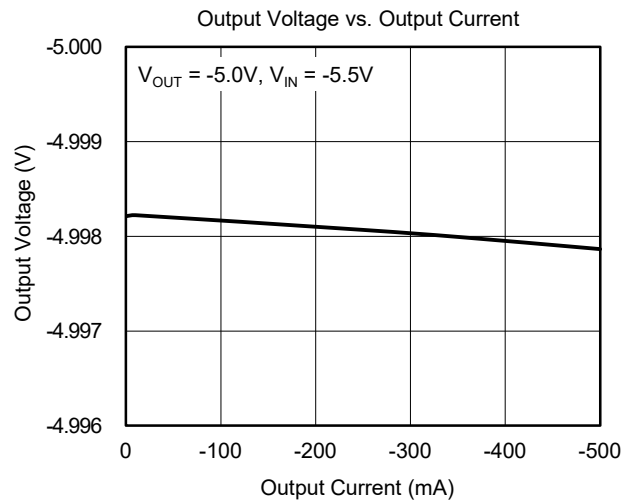
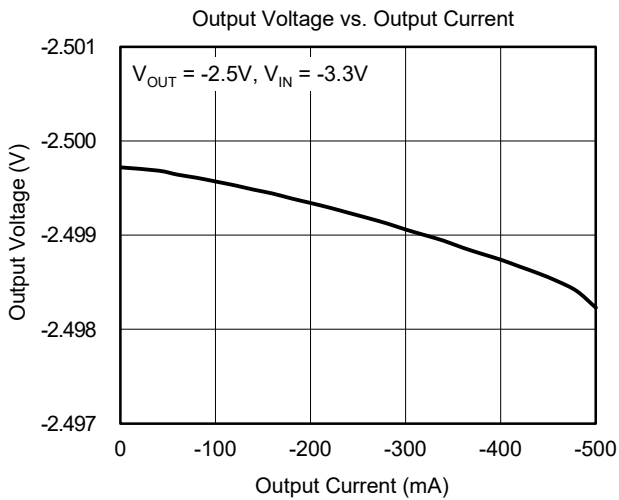
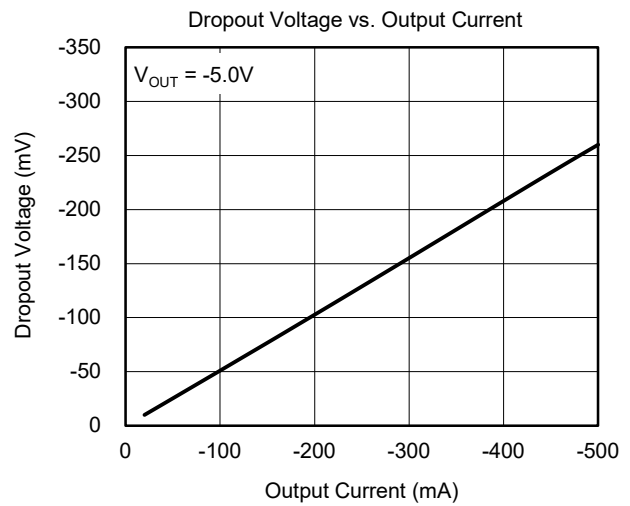
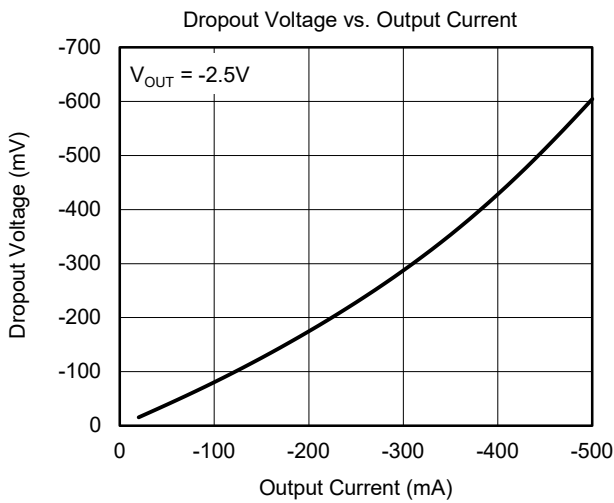
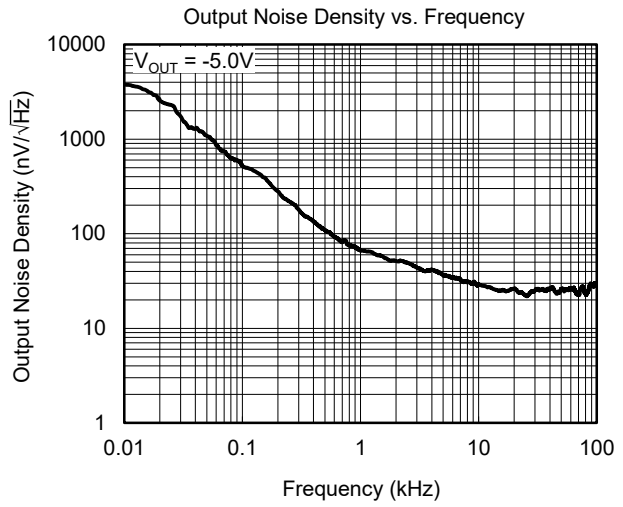
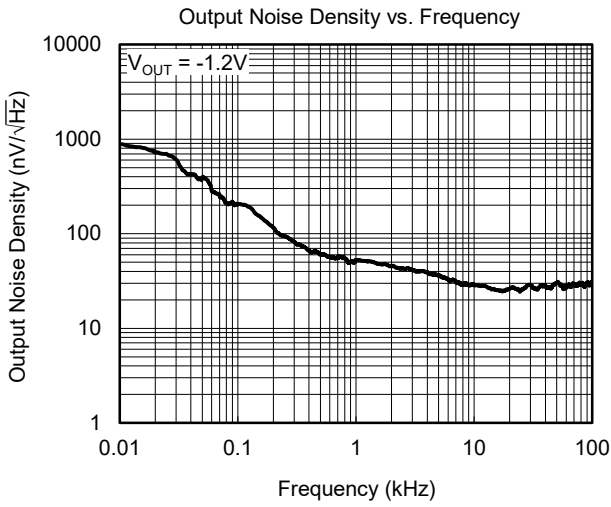
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$V_{IN} = (V_{OUT(NOM)} - 0.5V)$ or $-2.7V$, whichever is greater, $V_{EN} = V_{IN}$, $I_{OUT} = -10mA$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = +25^\circ C$, unless otherwise noted.



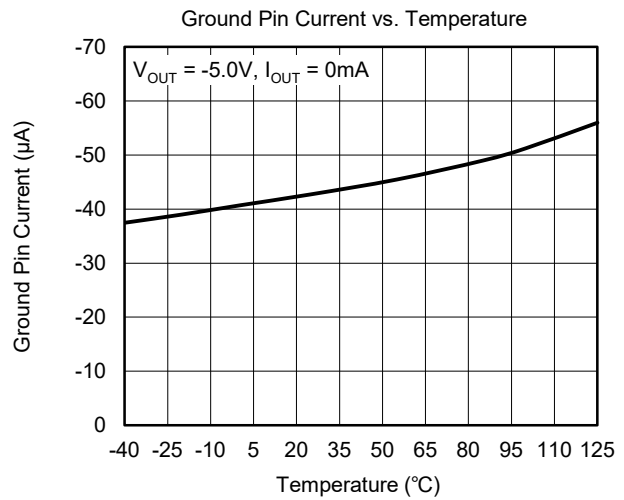
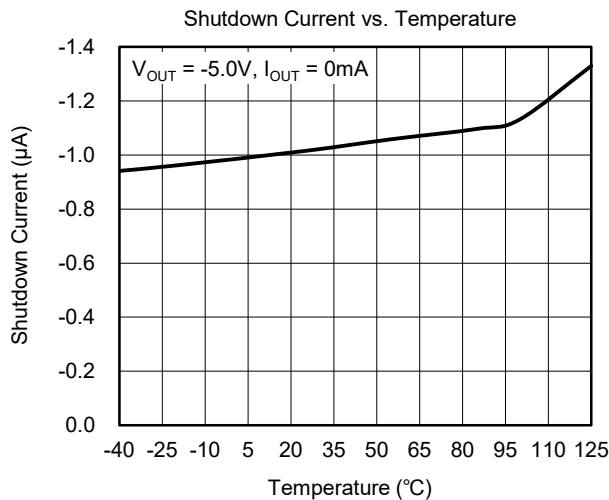
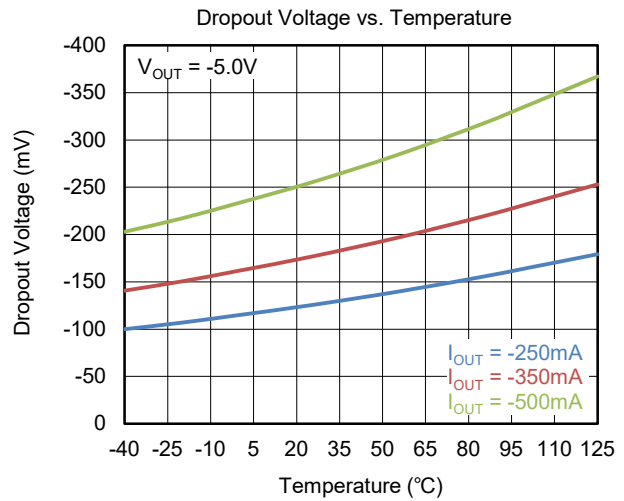
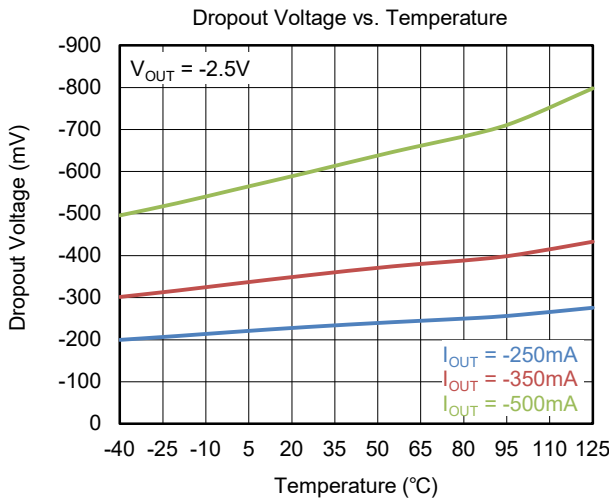
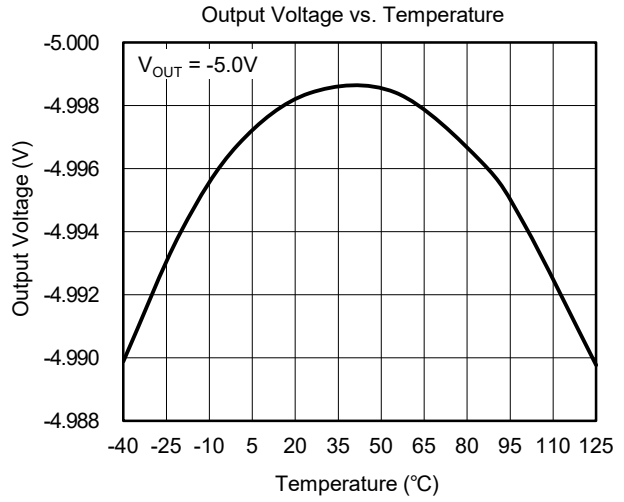
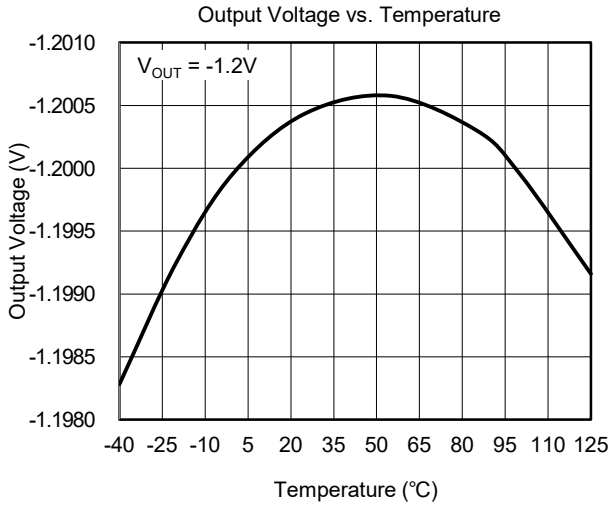
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$V_{IN} = (V_{OUT(NOM)} - 0.5V)$ or $-2.7V$, whichever is greater, $V_{EN} = V_{IN}$, $I_{OUT} = -10mA$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = +25^\circ C$, unless otherwise noted.



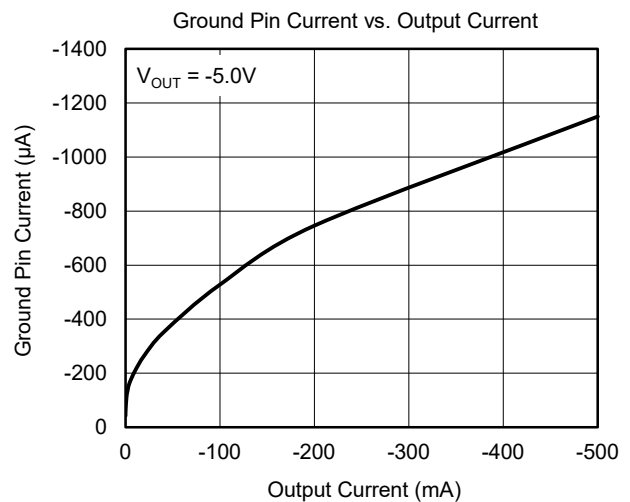
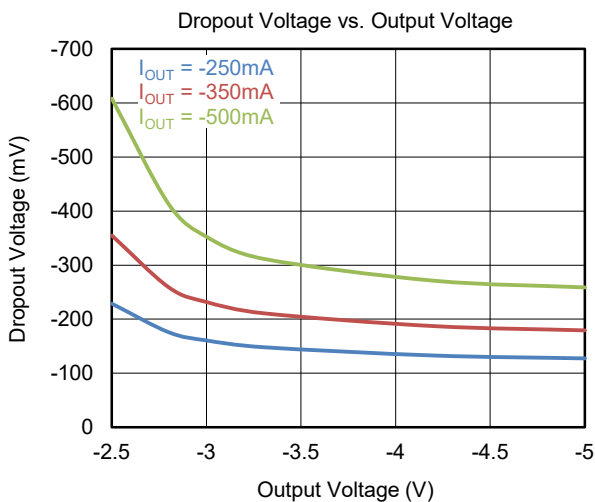
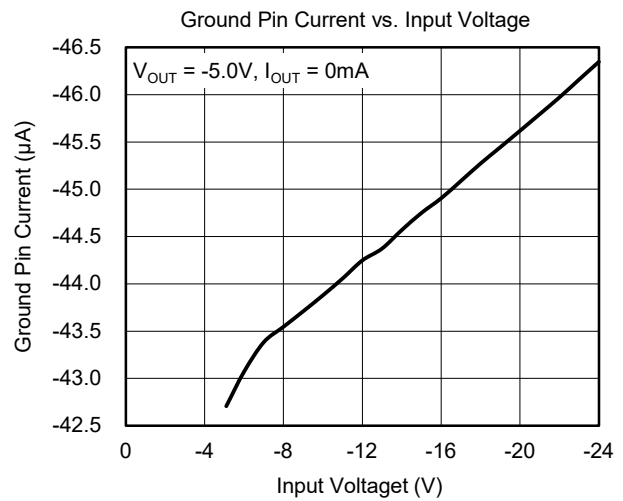
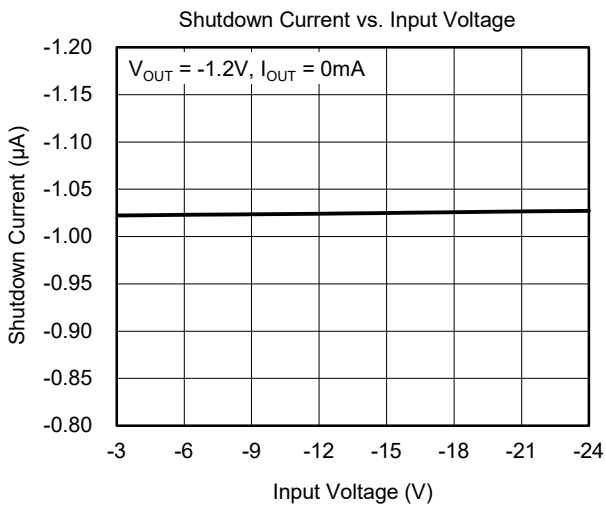
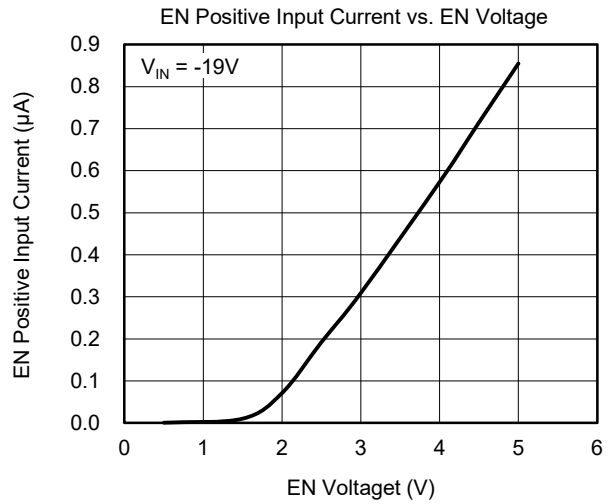
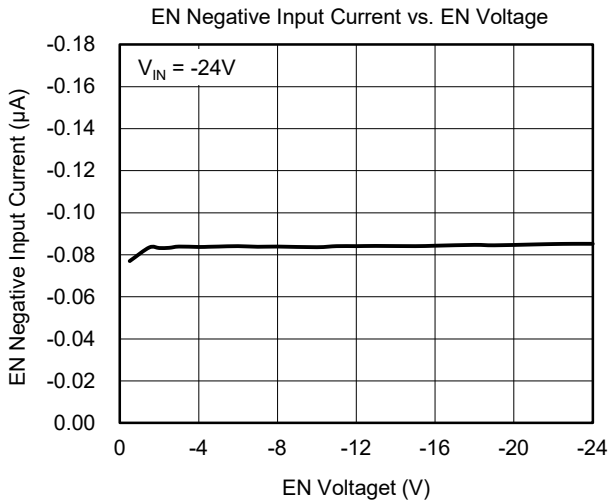
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$V_{IN} = (V_{OUT(NOM)} - 0.5V)$ or $-2.7V$, whichever is greater, $V_{EN} = V_{IN}$, $I_{OUT} = -10mA$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = +25^\circ C$, unless otherwise noted.



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$V_{IN} = (V_{OUT(NOM)} - 0.5V)$ or $-2.7V$, whichever is greater, $V_{EN} = V_{IN}$, $I_{OUT} = -10mA$, $C_{IN} = C_{OUT} = 2.2\mu F$, $T_J = +25^\circ C$, unless otherwise noted.



FUNCTIONAL BLOCK DIAGRAMS

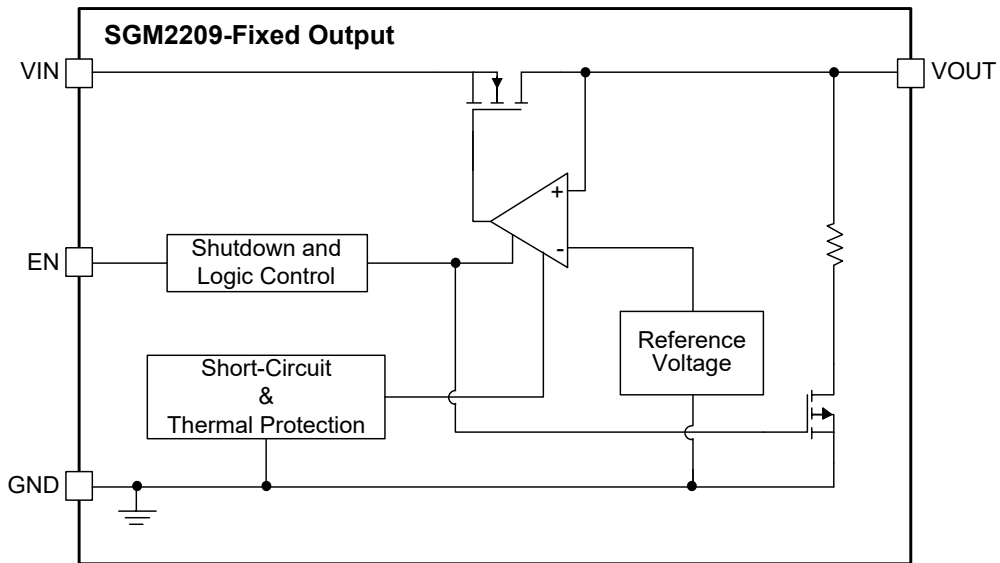


Figure 2. Fixed Output Voltage Internal Block Diagram

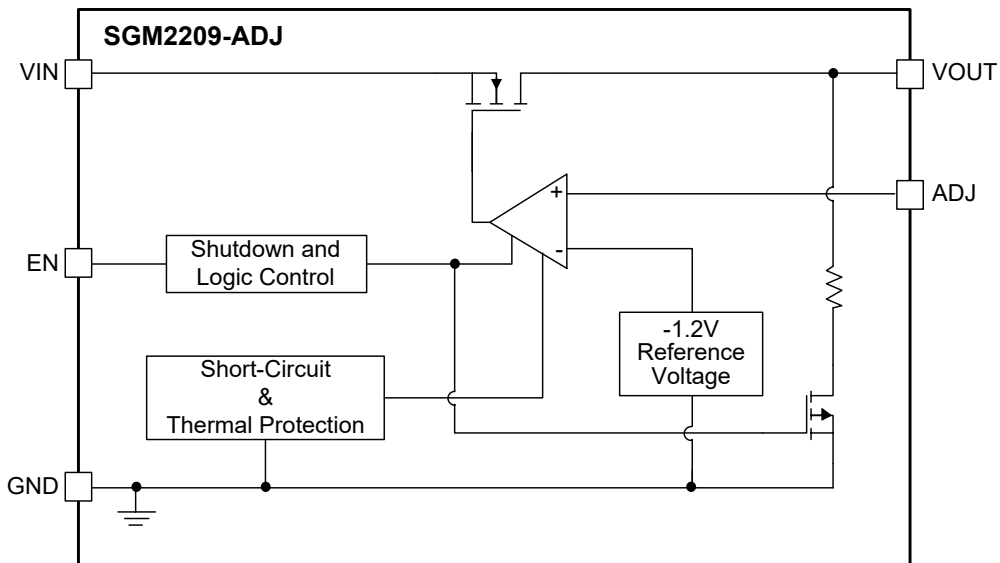


Figure 3. Adjustable Output Voltage Internal Block Diagram

APPLICATION INFORMATION

The SGM2209 is a low quiescent current, low noise and low dropout LDO and provides -500mA output current. These features make the device a reliable solution to solve many challenging problems in the generation of clean and accurate power supply. The high performance also makes the SGM2209 useful in a variety of applications. The SGM2209 provides the protection function for output overload, output short-circuit condition and overheating.

The SGM2209 provides an EN pin as an external chip enable control to enable/disable the device. When the regulator is in shutdown state, the shutdown current consumes as low as -1.1µA (TYP).

Input Capacitor Selection (C_{IN})

The input decoupling capacitor is necessary to be connected as close as possible to the VIN pin for ensuring the device stability. A 2.2µF or greater X7R or X5R ceramic capacitor is selected to get good dynamic performance.

When V_{IN} is required to provide large current instantaneously, a large effective input capacitor is required. Multiple input capacitors can reduce the impact from input trace inductance. Adding more input capacitors is available to restrict the ringing and to keep it below the device absolute maximum ratings.

Output Capacitor Selection (C_{OUT})

The output decoupling capacitor should be located as close as possible to the VOUT pin. A 2.2µF or greater X7R or X5R ceramic capacitor is selected to get good dynamic performance. The minimum effective capacitance of C_{OUT} that SGM2209 can remain stable is 1.5µF. For ceramic capacitor, temperature, DC bias and package size will change the effective capacitance, so enough margin of C_{OUT} must be considered in design. Larger capacitance and lower ESR C_{OUT} will help improve the load transient response and increase the high frequency PSRR.

Enable Pin Operation

The EN pin is used to enable and disable the VOUT pin under normal operating conditions. Connect the EN pin to the VIN pin when using automatic startup.

When EN is at ±2.0V with respect to GND, the device is in active state. When EN is at 0V, the device is in shutdown state. In this state, a discharge resistor

around 200kΩ connects to the VOUT pin and pulls the VOUT pin up to GND.

The EN pin of the SGM2209 is bipolar, even though the enable voltage can be positive or negative.

The typical hysteresis of the EN pin is shown in Figure 4. This feature is used to prevent on/off oscillations due to noise on the EN pin when it passes the threshold point.

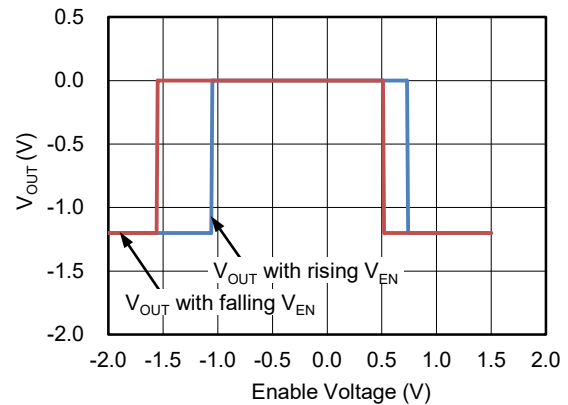


Figure 4. Typical EN Pin Operation

Adjustable Regulator

For the SGM2209-ADJ, set the output voltage by using a resistor divider as shown in Figure 5. Choose R_{FB2} less than 120kΩ to maintain a 10µA minimum load. Calculate the value for the output voltage using the following equation:

$$V_{OUT} = -1.2V \times (1 + R_{FB1}/R_{FB2})$$

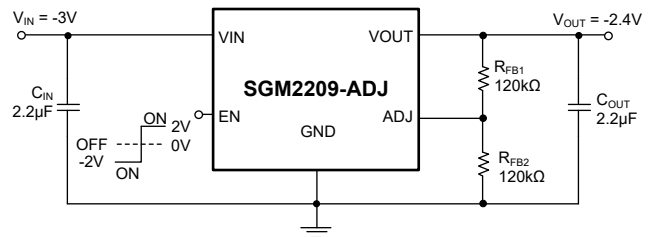


Figure 5. Adjustable Output Voltage Application

Soft-Start

When the device is enabled, the SGM2209 uses an internal soft-start to limit the inrush current. The start-up time for the -5.0V option is 540µs (TYP) from the time the EN active threshold is crossed to when V_{OUT} reaches 90% × V_{OUT(NOM)}.

APPLICATION INFORMATION (continued)

Noise Reduction of the Adjustable SGM2209

One parallel capacitor (C_{NR}) and resistor (R_{NR}) with R_{FB1} can be used to improve the feedback loop stability and PSRR, increase the transient response and reduce the output noise. Use $R_{FB2} = 13k\Omega$ to maintain a minimum load.

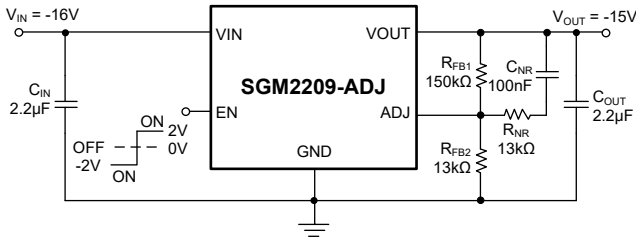


Figure 6. Noise Reduction Modification to Adjustable LDO

Output Current Limit and Short-Circuit Protection

When overload events happen, the output current is internally limited to -1.05A (TYP). When the VOUT pin is shorted to ground, the short-circuit protection will limit the output current to -360mA (TYP).

Thermal Shutdown

The SGM2209 can detect the temperature of die. When the die temperature exceeds the threshold value of thermal shutdown, the SGM2209 will be in shutdown state and it will remain in this state until the die temperature decreases to +140°C.

Layout Guidelines

To get good PSRR, low output noise and high transient response performance, the input and output bypass capacitors must be placed as close as possible to the VIN pin and VOUT pin separately.

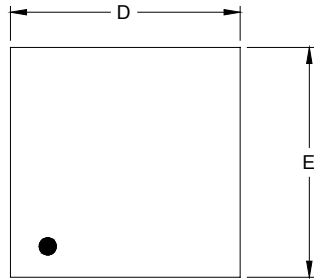
REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

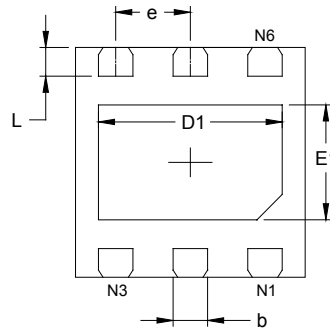
| Changes from Original (JANUARY 2020) to REV.A | Page |
|---|------|
| Changed from product preview to production data | All |

PACKAGE OUTLINE DIMENSIONS

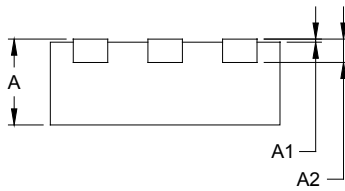
TDFN-2x2-6AL



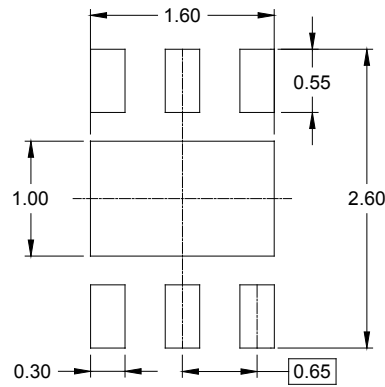
TOP VIEW



BOTTOM VIEW



SIDE VIEW

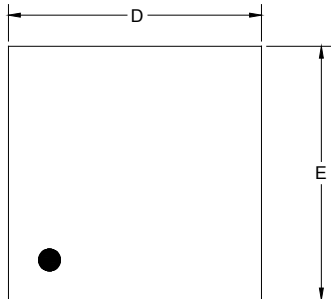


RECOMMENDED LAND PATTERN (Unit: mm)

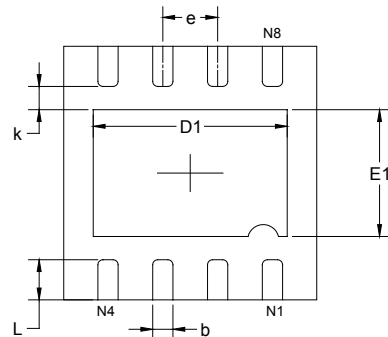
| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|------------------------------|-------|-------------------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203 REF | | 0.008 REF | |
| D | 1.900 | 2.100 | 0.075 | 0.083 |
| D1 | 1.500 | 1.700 | 0.059 | 0.067 |
| E | 1.900 | 2.100 | 0.075 | 0.083 |
| E1 | 0.900 | 1.100 | 0.035 | 0.043 |
| b | 0.250 | 0.350 | 0.010 | 0.014 |
| e | 0.650 BSC | | 0.026 BSC | |
| L | 0.174 | 0.326 | 0.007 | 0.013 |

PACKAGE OUTLINE DIMENSIONS

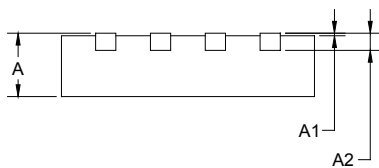
TDFN-3x3-8L



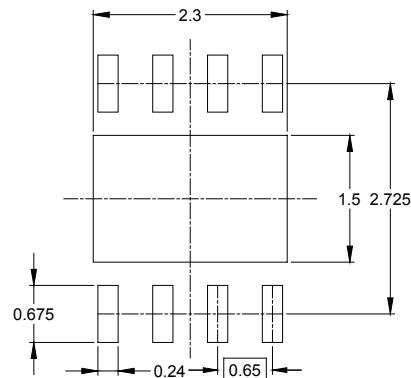
TOP VIEW



BOTTOM VIEW



SIDE VIEW



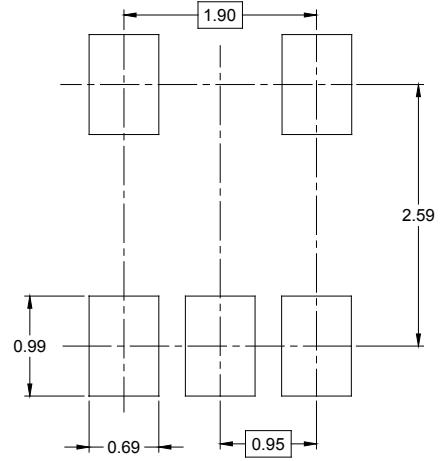
RECOMMENDED LAND PATTERN (Unit: mm)

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|------------------------------|-------|-------------------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203 REF | | 0.008 REF | |
| D | 2.900 | 3.100 | 0.114 | 0.122 |
| D1 | 2.200 | 2.400 | 0.087 | 0.094 |
| E | 2.900 | 3.100 | 0.114 | 0.122 |
| E1 | 1.400 | 1.600 | 0.055 | 0.063 |
| k | 0.200 MIN | | 0.008 MIN | |
| b | 0.180 | 0.300 | 0.007 | 0.012 |
| e | 0.650 TYP | | 0.026 TYP | |
| L | 0.375 | 0.575 | 0.015 | 0.023 |

PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

SOT-23-5



RECOMMENDED LAND PATTERN (Unit: mm)

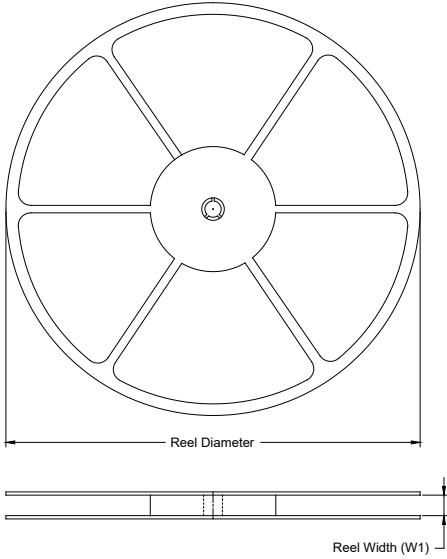


| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|----------|------------------------------|-------|-------------------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 1.500 | 1.700 | 0.059 | 0.067 |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 |
| e | 0.950 BSC | | 0.037 BSC | |
| e1 | 1.900 BSC | | 0.075 BSC | |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

PACKAGE INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|--------------|---------------|--------------------|---------|---------|---------|---------|---------|---------|--------|---------------|
| TDFN-2×2-6AL | 7" | 9.5 | 2.30 | 2.30 | 1.10 | 4.0 | 4.0 | 2.0 | 8.0 | Q1 |
| TDFN-3×3-8L | 13" | 12.4 | 3.35 | 3.35 | 1.13 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |
| SOT-23-5 | 7" | 9.5 | 3.20 | 3.20 | 1.40 | 4.0 | 4.0 | 2.0 | 8.0 | Q3 |

DD0001

PACKAGE INFORMATION

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

| Reel Type | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|-------------|-------------|------------|-------------|--------------|
| 7" (Option) | 368 | 227 | 224 | 8 |
| 7" | 442 | 410 | 224 | 18 |
| 13" | 386 | 280 | 370 | 5 |

DD0002