# SGM4547
# High Speed Piezo-Sounder and Ultra-Sound Transducer Driver

## GENERAL DESCRIPTION

The SGM4547 is matched dual-channel high speed piezo-sounder and ultra-sound transducer driver which is integrated boost DC/DC to achieve high driven voltage. The unique circuit design provides excellent performance for delivering 2A peak current to highly capacitive loads.

To reduce problems with time and clock skew, SGM4547 is a good choice, with matching delays and maintaining integrity of input to output pulse-widths. Matching rise/fall delay times improve the drive capability and speed. Non-overlapping drive technology is used to minimize the dynamic switching loss.

In order to get higher volume sound from piezo-sounder and ultra-sound transducer, boost DC/DC is integrated to provide high driven voltage. The tiny package makes the device very suitable for space limited applications.

The SGM4547 is available in a Green TDFN-3×3-14L package. It operates over an ambient temperature range of -40℃ to +85℃.

## FEATURES

- **Integrated Boost DC/DC to Achieve 26V (MAX) Driven Voltage**
- **2A Peak Driven Current to Drive Capacitive Loads**
- **Wide Operating Voltage Range**
- **High Speed Driver**
- **Very Short Rise Time and Fall Time**
- **Improved Response Times**
- **Matched Rise Time and Fall Time**
- **Independent Enable Control for Each Channel**
- **Reduced Clock Skew between Dual Channels**
- **Output is at Low under UVLO Protection, Enable Pin Floating or Disable Status**
- **High Noise Immunity**
- **Improved Clocking Rate**
- **Low Supply Current and Output Impedance**
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in a Green TDFN-3×3-14L Package**

## APPLICATIONS

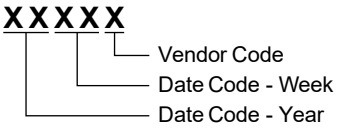
Ultra-Sound Transducer Driver
Piezo-Sounder Driver

# PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM4547 | TDFN-3×3-14L | -40℃ to +85℃ | SGM4547YTDK14G/TR | SGM<br>4547DK<br>XXXXX | Tape and Reel, 4000 |

## MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.




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 (Boost DC/DC) ..... -0.3V to 22V
Voltage on SW (Driver) ..... -0.3V to 40V
Voltage on FB and COMP ..... -0.3V to 3V
VCC to GND ..... -0.3V to 28V
ENA, ENB, CTRL to GND ..... -0.3V to 6V
INA, INB to GND ..... -0.3V to $V_{CC}$ + 0.3V
Combined Peak Output Current ..... 4A
Package Thermal Resistance
TDFN-3×3-14L, $\theta_{JA}$ ..... 200℃/W
Junction Temperature ..... 150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... 260℃
ESD Susceptibility
HBM ..... 4000V
MM ..... 250V
CDM ..... 1000V

## RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range ..... -40℃ to +85℃
Operating Junction Temperature Range ..... -40℃ to +125℃
Input Voltage Range ..... 2.5V to 20V

## 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

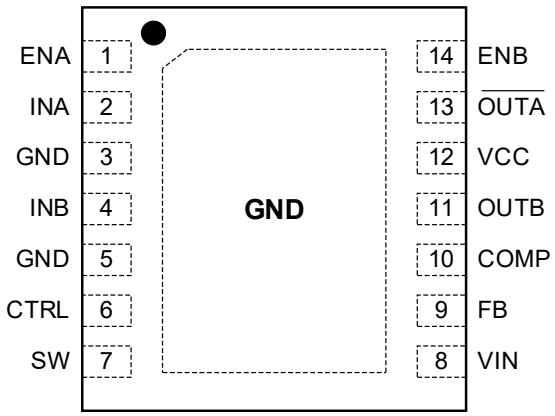
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

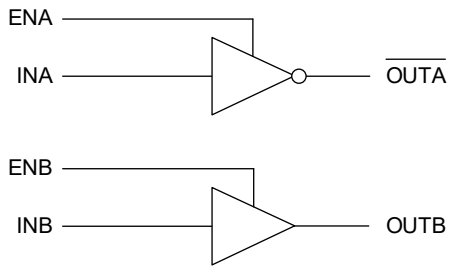
## PIN CONFIGURATION

(TOP VIEW)




TDFN-3×3-14L

## LOGIC SYMBOL




## FUNCTION TABLE

| ENA | ENB | INA | INB | $\overline{\text{OUTA}}$ | OUTB |
|---|---|---|---|---|---|
| H | H | L | L | H | L |
| H | H | L | H | H | H |
| H | H | H | L | L | L |
| H | H | H | H | L | H |
| H | H | Floating | Floating | L | L |
| L | L | — | — | L | L |
| Floating | Floating | — | — | L | L |

## PIN DESCRIPTION

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | ENA | Enable Input for Channel A. A high signal on this pin will enable the channel A output. Logic low or floating will disable channel A output, regardless of the INA logic is high or low. |
| 2 | INA | Input for Channel A. Inverting channel input. If INA is unbiased or floating, $\overline{OUTA}$ will remain low. |
| 3, 5 | GND | Ground. |
| 4 | INB | Input for Channel B. Non-inverting channel input. If INB is unbiased or floating, OUTB will remain low. |
| 6 | CTRL | Enable Control Pin of the Boost Regulator. Pulling this pin logic high enables the regulator and pulling it logic low disables the regulator. |
| 7 | SW | Switching Node of the Boost Regulator. Drain connection of low-side power MOSFET. |
| 8 | VIN | The Input Supply Pin for the Boost Regulator. |
| 9 | FB | Feedback Pin of Boost Regulator's Output Voltage. An external resistor divider programs the output voltage. |
| 10 | COMP | Control Loop Compensation Pin. |
| 11 | OUTB | Output of Channel B. |
| 12 | VCC | Supply Input of Driver. |
| 13 | $\overline{OUTA}$ | Output of Channel A. |
| 14 | ENB | Enable Input for Channel B. A high signal on this pin will enable the channel B output. Logic low or floating will disable channel B output, regardless of the INB logic is high or low. |
| Exposed Pad | GND | Ground. |

# ELECTRICAL CHARACTERISTICS

## Driver Only

($V_{CC}$ = 24V, $V_{ENA}$ = $V_{ENB}$ = 3.3V, $T_A$ = +25℃, unless otherwise noted.)

| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| **Input** | | | | | |
| Input Signal High Threshold ($V_{IH}$) | $T_A$ = -40℃ to +85℃ | 1.6 | | | V |
| Input Signal Low Threshold ($V_{IL}$) | $T_A$ = -40℃ to +85℃ | | | 0.7 | V |
| Input Signal Hysteresis ($V_{HYS}$) | $T_A$ = -40℃ to +85℃ | | 0.3 | | V |
| Input Signal High Current ($I_{IH}$) | Inverting Input Current, $V_{INA}$ = 24V | | 6 | 8 | μA |
| | Non-Inverting Input Current, $V_{INB}$ = 24V | | 108 | 145 | |
| Input Signal Low Current ($I_{IL}$) | Inverting Input Current, $V_{INA}$ = 0V | | 102 | 125 | μA |
| | Non-Inverting Input Current, $V_{INB}$ = 0V | | 0.1 | 1 | |
| **Output** | | | | | |
| Pull-Up Resistance ($R_{OH}$) | Source Current = 100mA | | 2.3 | 3.1 | Ω |
| Pull-Down Resistance ($R_{OL}$) | Sink Current = -100mA | | 1.6 | 2.2 | Ω |
| Peak Output Current ($I_{PK}$) | Source Current, f = 1kHz, $C_L$ = 0.1μF | | 2 | | A |
| | Sink Current, f = 1kHz, $C_L$ = 0.1μF | | -2 | | |
| Continuous Output Current ($I_{DC}$) | Source/Sink Current | | ±200 | | mA |
| **Power Supply** | | | | | |
| Power Supply Current ($I_{CC}$) | Inputs Floating, $V_{ENA}$ = $V_{ENB}$ = 3.3V | | 1.17 | 1.58 | mA |
| | Inputs Floating, $V_{ENA}$ = $V_{ENB}$ = 0V | | 0.18 | 0.24 | |
| Supply Voltage Range ($V_{CC}$) | | 4.5 | | 26.5 | V |
| Under-Voltage Lockout On Threshold | | | 3.6 | 4 | V |
| Under-Voltage Lockout Hysteresis | | | 0.5 | | V |
| **Enable Logic** | | | | | |
| EN Signal High Threshold ($V_{ENH}$) | $T_A$ = -40℃ to +85℃ | 2.1 | | | V |
| EN Signal Low Threshold ($V_{ENL}$) | $T_A$ = -40℃ to +85℃ | | | 0.6 | |
| EN Signal Hysteresis ($V_{EN-HYS}$) | $T_A$ = -40℃ to +85℃ | | 0.8 | | |
| EN Signal High Current ($I_{ENH}$) | $V_{ENA}$ = 5.5V or $V_{ENB}$ = 5.5V | | 22 | 28.5 | μA |
| EN Signal Low Current ($I_{ENL}$) | $V_{ENA}$ = 0V or $V_{ENB}$ = 0V | | 0.1 | 1 | |
| **Switching Characteristics** | | | | | |
| Rise Time ($t_R$) | $C_L$ = 1000pF | | 12 | | ns |
| Fall Time ($t_F$) | $C_L$ = 1000pF | | 13 | | ns |
| Turn-On Delay Time ($t_{D1}$) | See Figure 1 and Figure 2 | | 21 | | ns |
| Turn-Off Delay Time ($t_{D2}$) | See Figure 1 and Figure 2 | | 23 | | ns |
| EN to Output Propagation Delay ($t_{D3}$) | See Figure 3 and Figure 4 | | 10 | | μs |
| EN to Output Propagation Delay ($t_{D4}$) | See Figure 3 and Figure 4 | | 27 | | ns |
| **Over-Temperature Protection** | | | | | |
| Thermal Shutdown Threshold ($T_{SHDN}$) | | | 150 | | ℃ |
| Thermal Shutdown Threshold Hysteresis ($T_{HYS}$) | | | 15 | | ℃ |

# ELECTRICAL CHARACTERISTICS (continued)

## Boost Regulator Only

($V_{IN}$ = 3.6V, $V_{EN}$ = $V_{IN}$, Full = -40℃ to +85℃, typical values are at $T_A$ = +25℃, unless otherwise noted.)

| PARAMETER | CONDITIONS | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **Supply Current** | | | | | | |
| Input Voltage Range ($V_{IN}$) | | +25℃ | 2.5 | | 20 | V |
| Operating Quiescent Current into VIN ($I_Q$) | Device PWM Switching No Load | +25℃ | | 400 | 600 | μA |
| Shutdown Current ($I_{SHDN}$) | $V_{CTRL}$ = GND, $V_{IN}$ = 4.2V | +25℃ | | | 1 | μA |
| Under-Voltage Lockout Threshold (UVLO) | $V_{IN}$ Falling | +25℃ | | 2.2 | 2.5 | V |
| Under-Voltage Lockout Hysteresis ($V_{HYS}$) | | +25℃ | | 70 | | mV |
| **Enable And Reference Control** | | | | | | |
| CTRL Logic High Voltage ($V_{IH}$) | $V_{IN}$ = 2.5V to 20V | Full | 1.5 | | | V |
| CTRL Logic Low Voltage ($V_{IL}$) | $V_{IN}$ = 2.5V to 20V | Full | | | 0.35 | V |
| CTRL Pull-Down Resistor ($R_{CTRL}$) | | +25℃ | 300 | 500 | 700 | kΩ |
| **Voltage and Current Control** | | | | | | |
| Voltage Feedback Regulation Voltage ($V_{REF}$) | | Full | 1.185 | 1.211 | 1.237 | V |
| Voltage Feedback Input Bias Current ($I_{FB}$) | $V_{FB}$ = 1.3V | Full | | | 200 | nA |
| Oscillator Frequency ($f_{OSC}$) | | Full | 0.96 | 1.2 | 1.44 | MHz |
| Maximum Duty Cycle (D) | $V_{FB}$ = 1.1V | +25℃ | 90 | 94 | | % |
| Minimum ON Pulse Width ($t_{MIN\_ON}$) | | +25℃ | | 80 | | ns |
| COMP Pin Sink Current ($I_{SINK}$) | | +25℃ | | 55 | | μA |
| COMP Pin Source Current ($I_{SOURCE}$) | | +25℃ | | 55 | | μA |
| Error Amplifier Transconductance ($G_{EA}$) | | Full | 220 | 300 | 440 | μmho |
| **Power Switch** | | | | | | |
| N-Channel MOSFET On-Resistance ($R_{DS(ON)}$) | $V_{IN}$ = 3.6V | +25℃ | | 0.36 | 0.55 | Ω |
| | $V_{IN}$ = 3.0V | +25℃ | | | 0.6 | |
| N-Channel Leakage Current ($I_{LN\_NFET}$) | $V_{SW}$ = 35V, $V_{CTRL}$ = 0V | +25℃ | | | 1 | μA |
| **OC and SS** | | | | | | |
| N-Channel MOSFET Current Limit ($I_{LIM}$) | | +25℃ | 0.8 | 1.1 | 1.3 | A |
| $V_{REF}$ Ramp Up Time ($t_r$) | | +25℃ | | 2 | | ms |
| **Thermal Shutdown** | | | | | | |
| Thermal Shutdown Threshold ($T_{SHDN}$) | | | | 150 | | ℃ |
| Thermal Shutdown Threshold Hysteresis ($T_{HYS}$) | | | | 15 | | ℃ |

## RECOMMENDED COMPONENTS OF TEST CIRCUITS

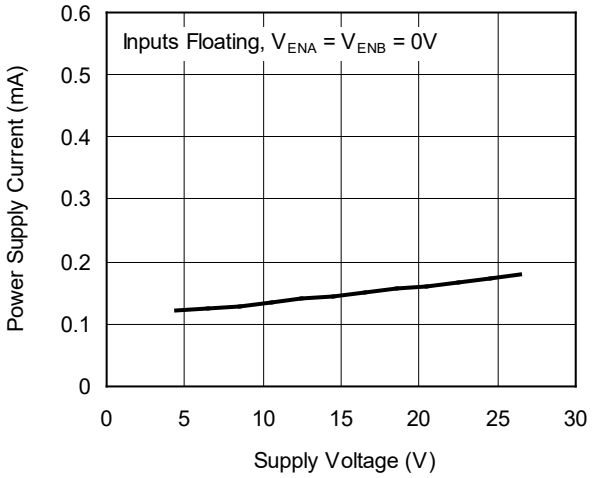
| | COMPONENT | | COMPONENT |
|---|---|---|---|
| INDUCTOR | 10μH/CD75NP-100KC | CAPACITOR | 10μF/08055C106KAT2A |
| CAPACITOR | 10nF/C2012X7R1H103KT | | 0.1μF/0805B104J500NT |
| | 4.7μF/C2012X7R1H475KT | | 1nF/0805B102K500NT |
| DIODE | On Semi MBR0540T1 | | |

## TYPICAL PERFORMANCE CHARACTERISTICS

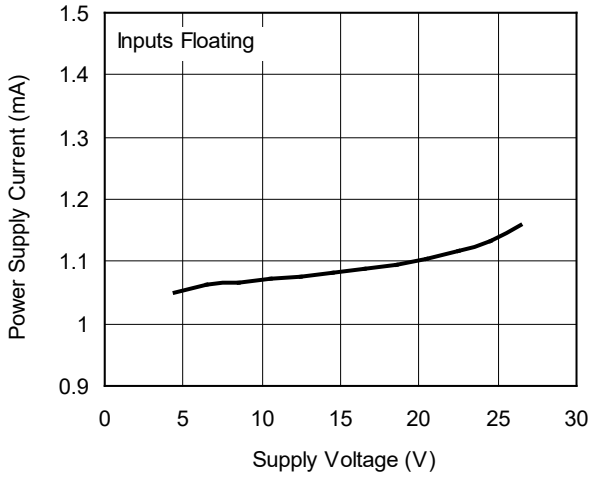
### Driver Only

$T_A$ = +25℃, $V_{CC}$ = 24V, $V_{ENA}$ = $V_{ENB}$ = 5V, $C_{VCC}$ = 4.7μF, $C_{\overline{OUTA}}$ = $C_{OUTB}$ = 1nF, unless otherwise noted.

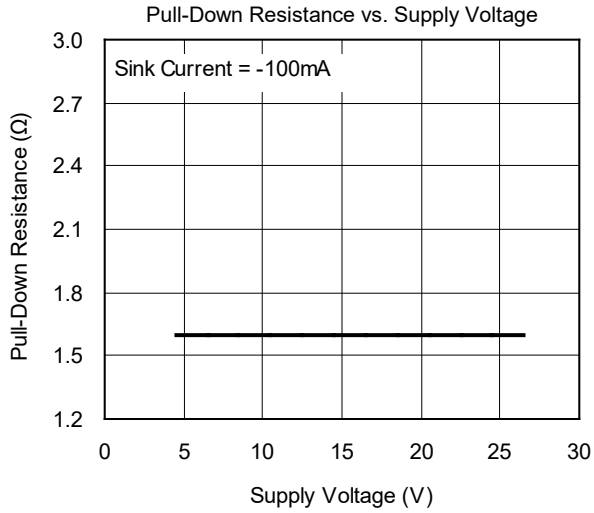
Power Supply Current vs. Supply Voltage



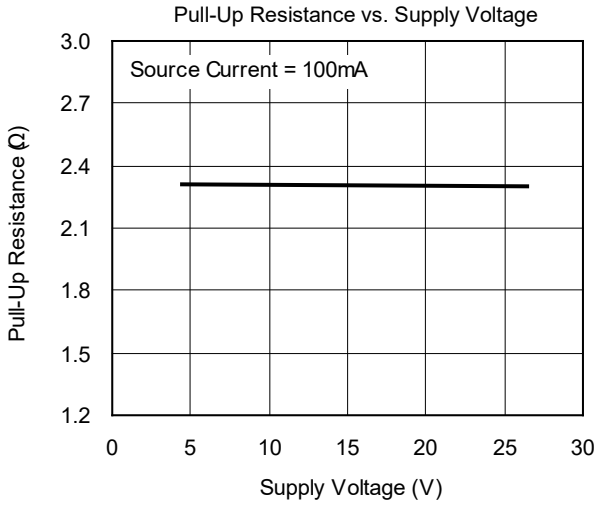

Power Supply Current vs. Supply Voltage




Pull-Down Resistance vs. Supply Voltage




Pull-Up Resistance vs. Supply Voltage

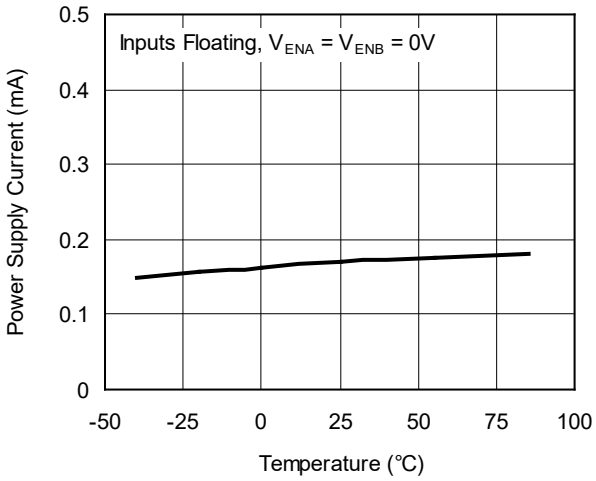


## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

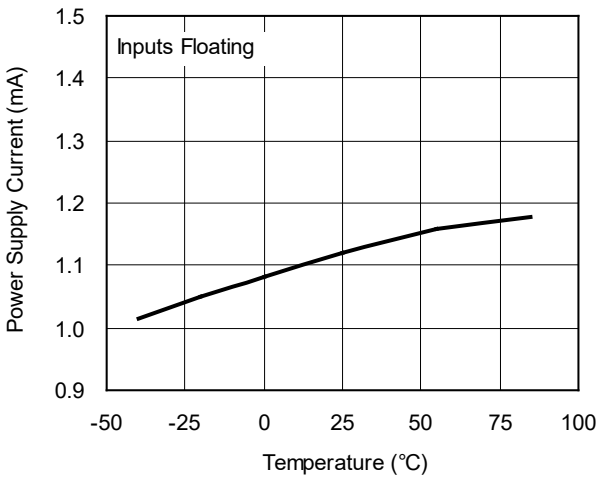
### Driver Only

$T_A$ = +25℃, $V_{CC}$ = 24V, $V_{ENA}$ = $V_{ENB}$ = 5V, $C_{VCC}$ = 4.7μF, $C_{\overline{OUTA}}$ = $C_{OUTB}$ = 1nF, unless otherwise noted.

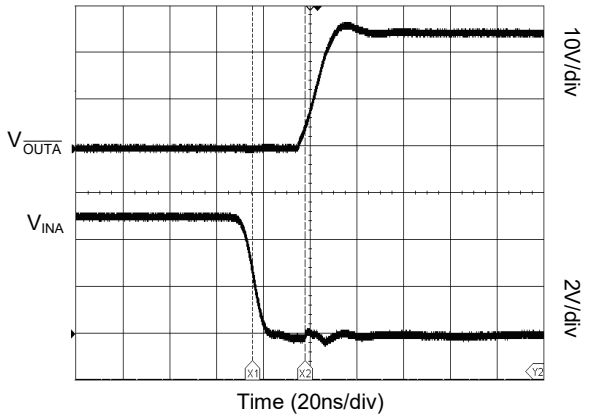
Power Supply Current vs. Temperature



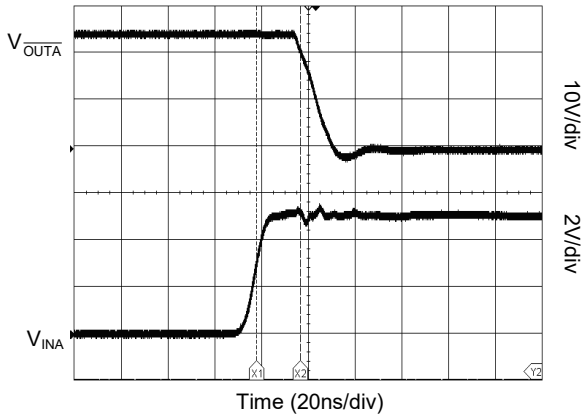

Power Supply Current vs. Temperature



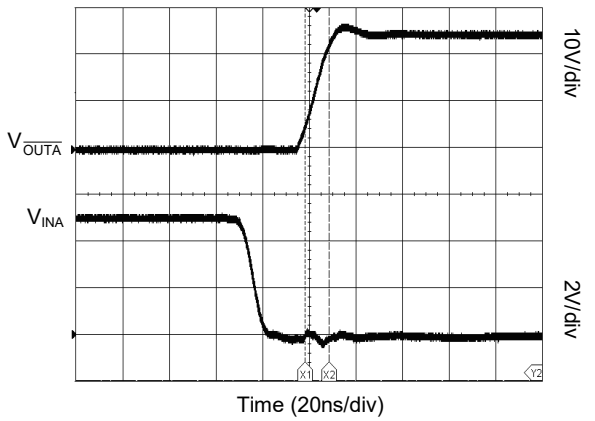

Turn-On Delay Time $t_{D1}$ (Inverting)



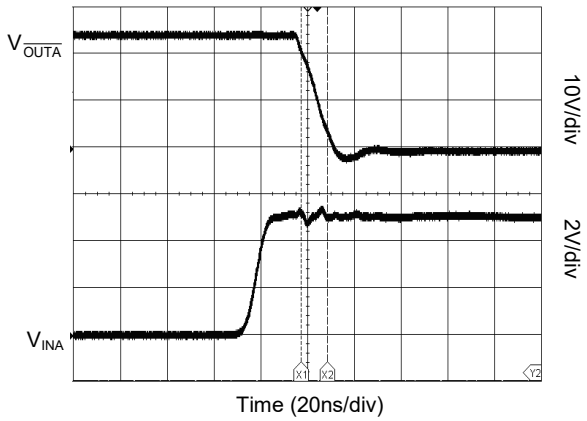

Turn-Off Delay Time $t_{D1}$ (Inverting)




Rise Time $t_R$ (Inverting)




Fall Time $t_F$ (Inverting)

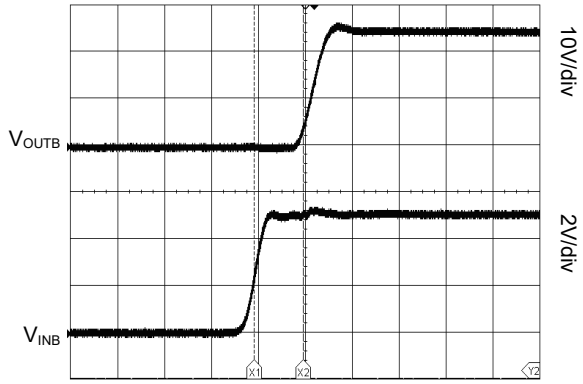


## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

### Driver Only

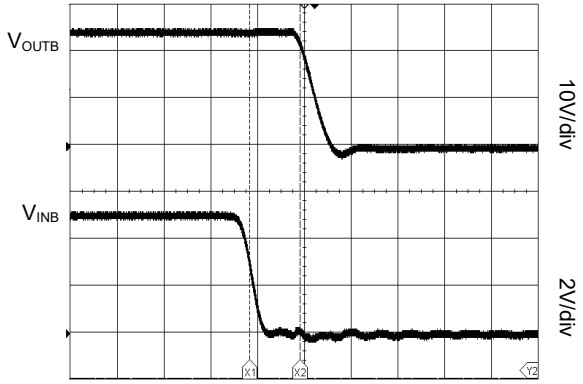
$T_A$ = +25℃, $V_{CC}$ = 24V, $V_{ENA}$ = $V_{ENB}$ = 5V, $C_{VCC}$ = 4.7μF, $C_{\overline{OUTA}}$ = $C_{OUTB}$ = 1nF, unless otherwise noted.

Turn-On Delay Time $t_{D1}$ (Non-Inverting)



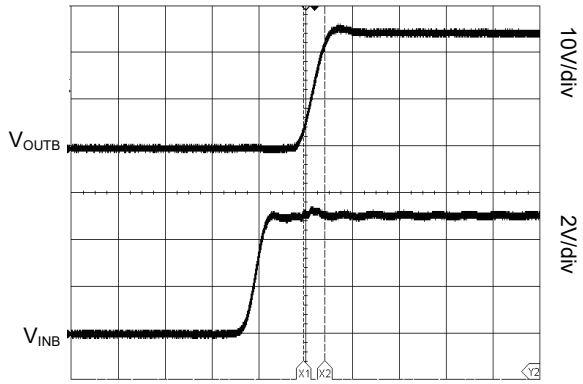

Time (20ns/div)

Turn-Off Delay Time $t_{D2}$ (Non-Inverting)



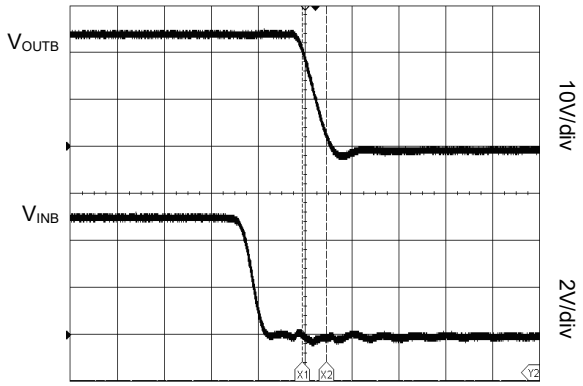

Time (20ns/div)

Rise Time $t_R$ (Non-Inverting)




Time (20ns/div)

Fall Time $t_F$ (Non-Inverting)



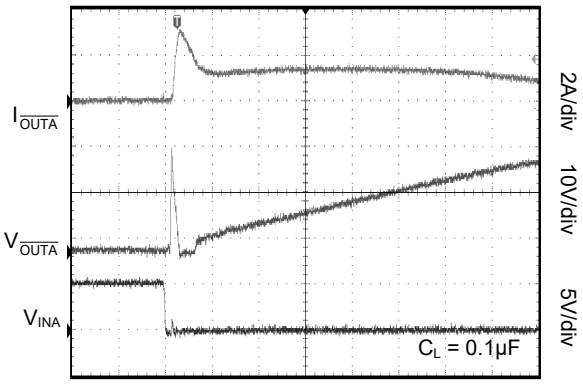

Time (20ns/div)

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

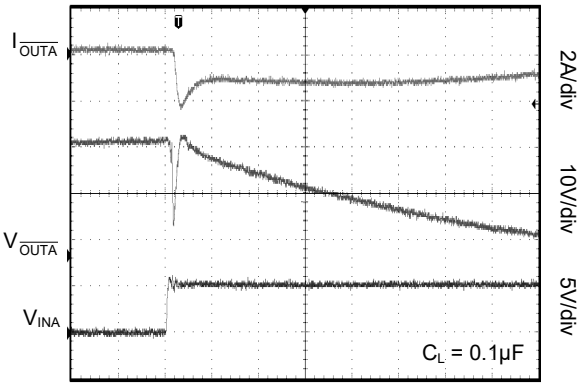
### Driver Only

$T_A$ = +25℃, $V_{CC}$ = 24V, $V_{ENA}$ = $V_{ENB}$ = 5V, $C_{VCC}$ = 4.7μF, $C_{\overline{OUTA}}$ = $C_{OUTB}$ = 1nF, unless otherwise noted.

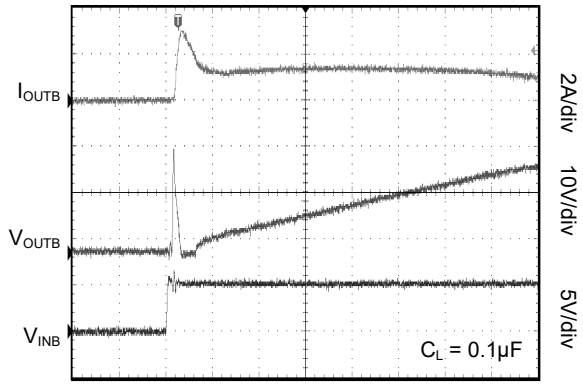
Quasi-Static Source Current (Inverting)



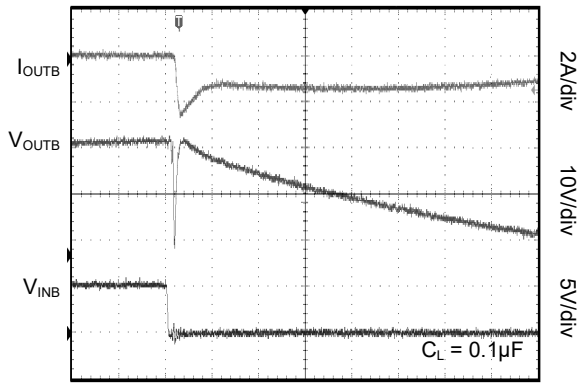

Quasi-Static Sink Current (Inverting)




Quasi-Static Source Current (Non-Inverting)




Quasi-Static Sink Current (Non-Inverting)

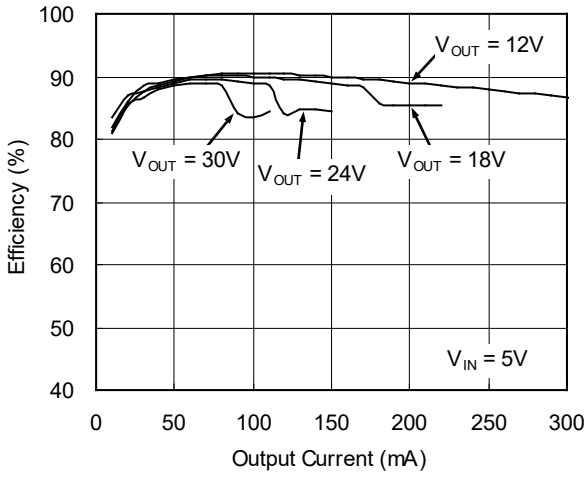


# TYPICAL PERFORMANCE CHARACTERISTICS (continued)

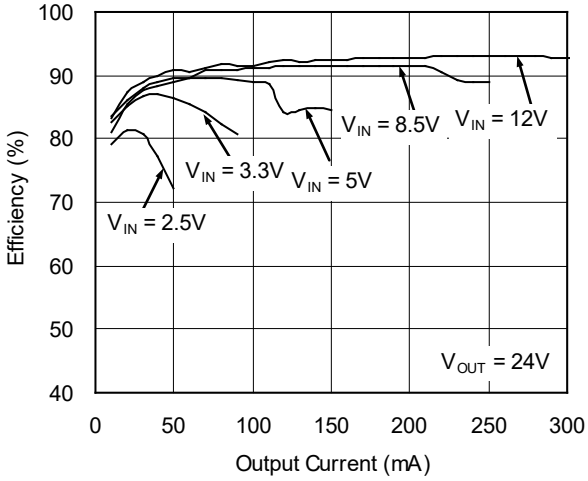
## Boost Regulator Only

$T_A$ = +25℃, L = 10μH, unless otherwise noted.

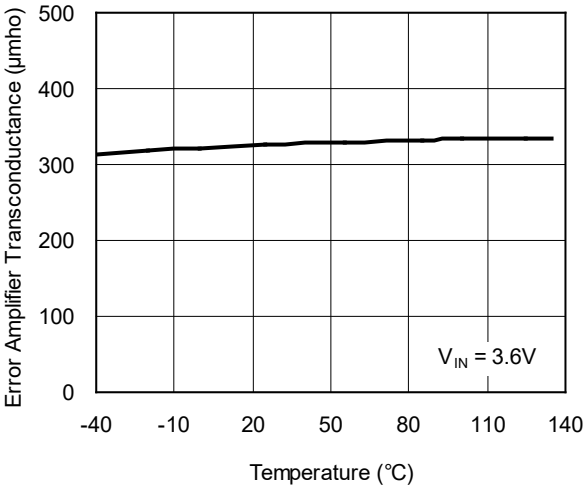
Efficiency vs. Output Current



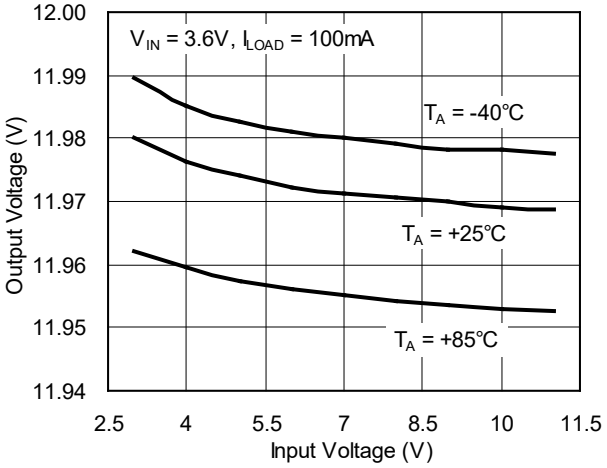

Efficiency vs. Output Current



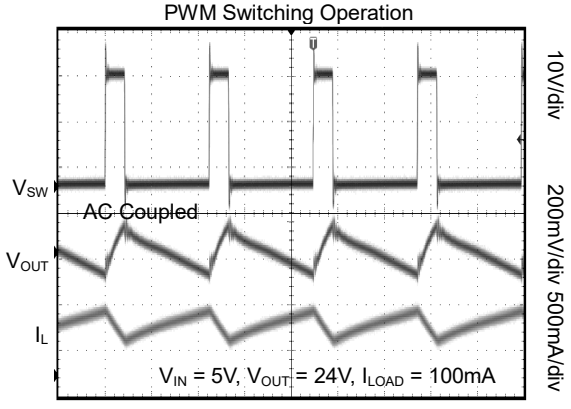

Error Amplifier Transconductance vs. Temperature




Output Voltage vs. Input Voltage

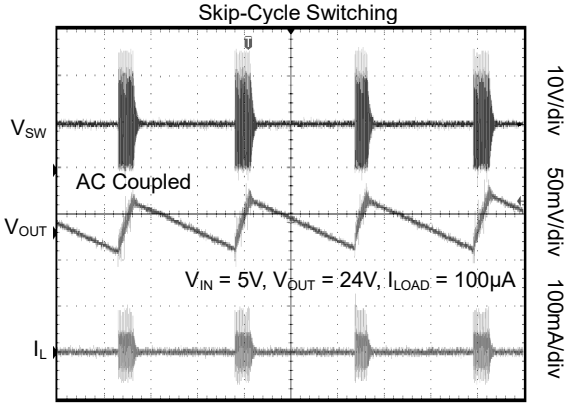



PWM Switching Operation




Time (400ns/div)

Skip-Cycle Switching



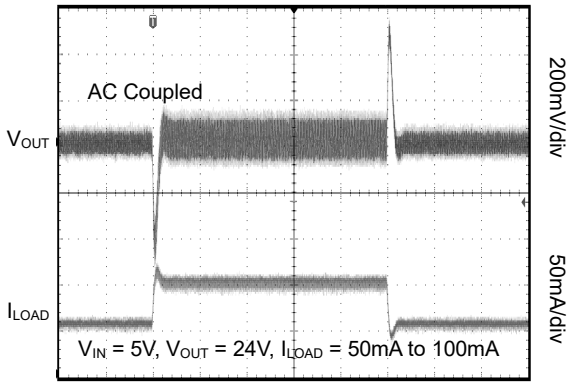

Time (40μs/div)

# TYPICAL PERFORMANCE CHARACTERISTICS (continued)

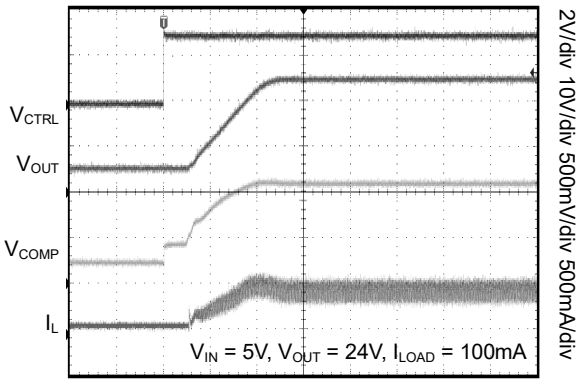
## Boost Regulator Only

$T_A$ = +25℃, L = 10μH, unless otherwise noted.

Load Transient Response

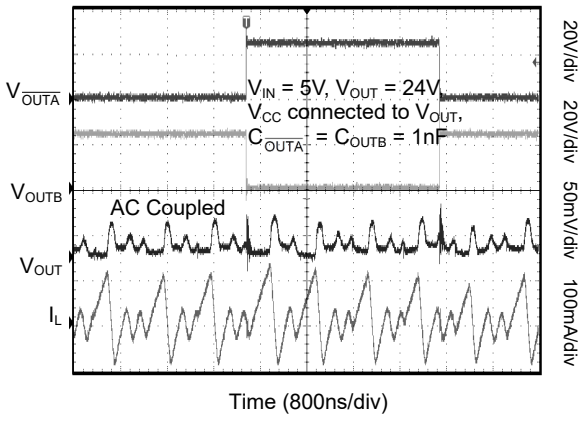



Start-Up

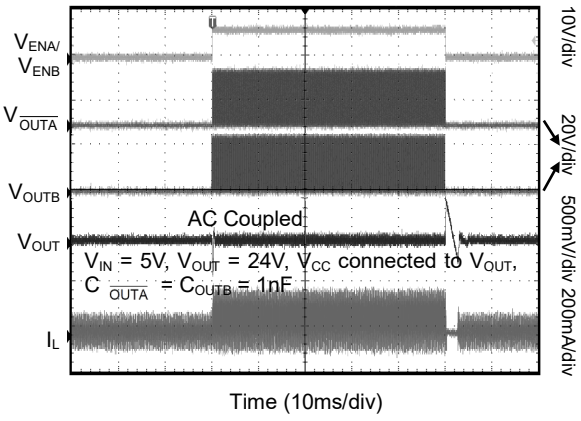



## Driver Driven By Boost Regulator

PWM Switching Operation




Load Transient Response



## TIMING TABLE OF DRIVER

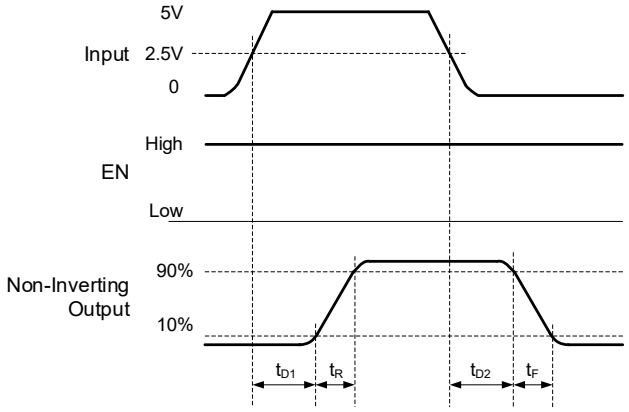



**Figure 1. Non-Inverting Input Driver Operation**

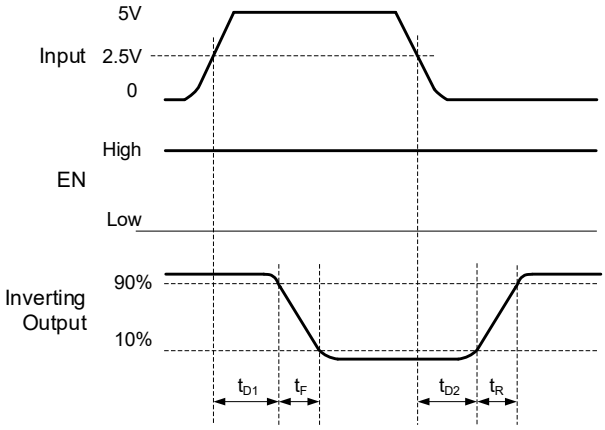



**Figure 2. Inverting Input Driver Operation**

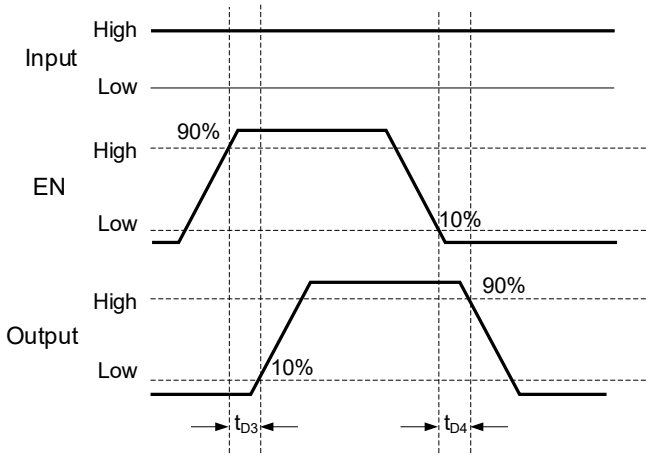



**Figure 3. Enable Function (For Non-Inverting Input)**

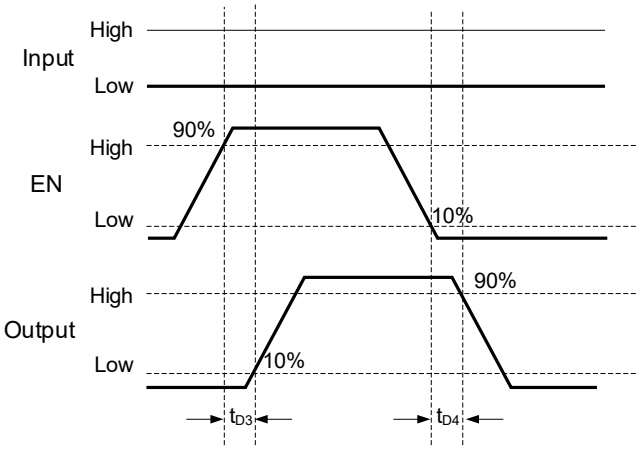



**Figure 4. Enable Function (For Inverting Input)**

## TEST CIRCUIT OF DRIVER

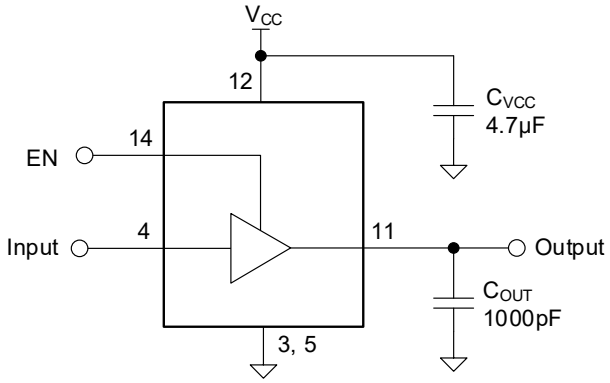



**Figure 5. Standard Test Configuration**

## FUNCTIONAL BLOCK DIAGRAM

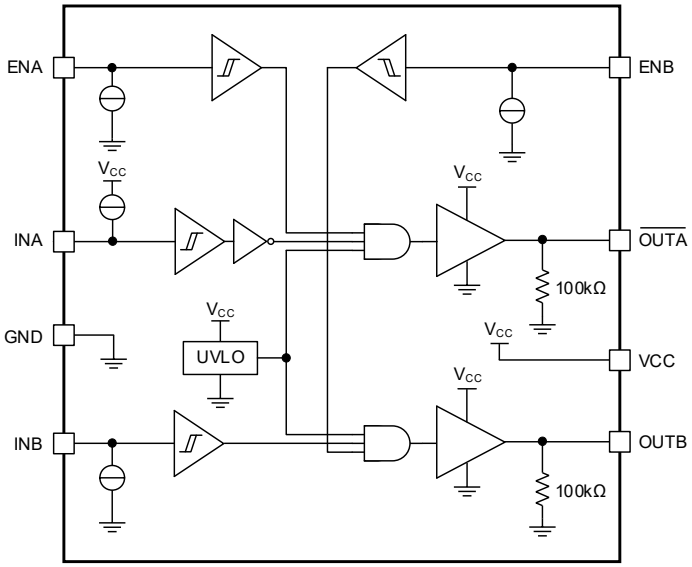



**Figure 6. Block Diagram of Driver**

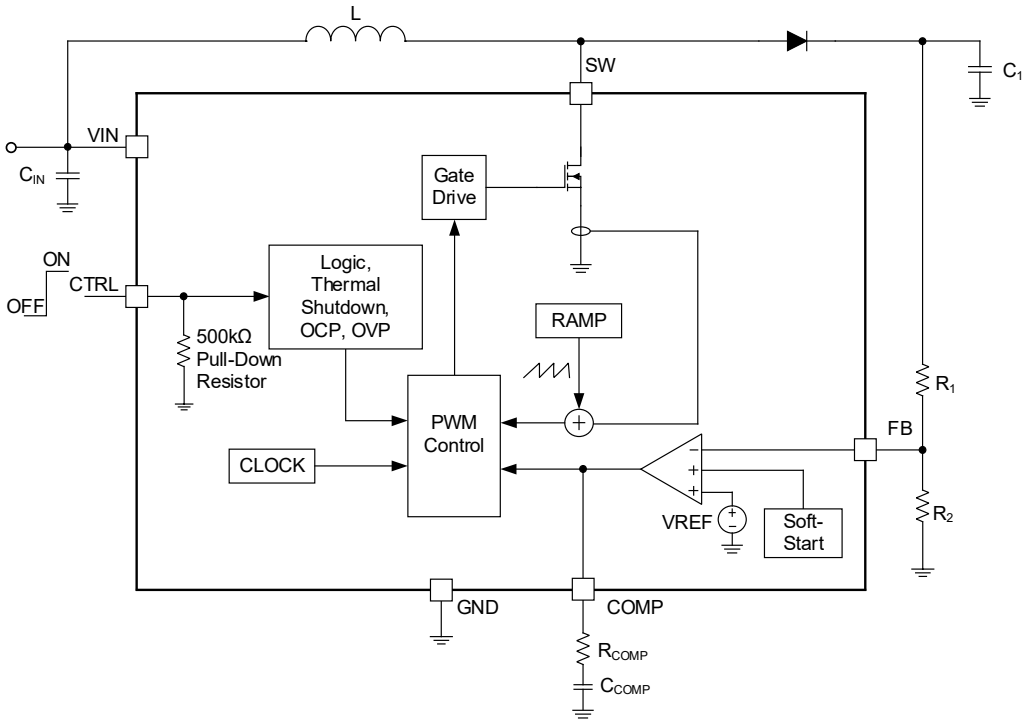



**Figure 7. Block Diagram of Boost Regulator**

# APPLICATION INFORMATION OF BOOST REGULATOR

## Program Output Voltage

The output voltage of SGM4547 is configured via a resistive divider connected to the FB pin. Use Equation 1 to program the output voltage. $R_1$ is the top feedback resistor and $R_2$ is the bottom feedback resistor.

$$V_{OUT} = 1.211V \times \left( \frac{R_1}{R_2} + 1 \right)$$

$$R_1 = R_2 \times \left( \frac{V_{OUT}}{1.211V} - 1 \right) \quad (1)$$

Due to the leakage current of the resistor divider, the resistance of $R_2$ should be no less than 10kΩ.

## Switch Duty Cycle

The Boost converter's duty cycle determines the Boost ratio available for the device. The SGM4547 implements maximum switch duty cycle (D) of 94% (TYP), the duty cycle and input/output voltage relationship is shown in Equation 2. Care should be taken to ensure that the maximum duty cycle limit is not reached.

$$D = \frac{V_{OUT} - V_{IN}}{V_{OUT}} \quad (2)$$

The SGM4547 also implements minimum on-time of 80ns (TYP), which is related to minimum duty cycle. In light load condition, the SGM4547 enters pulse-skipping mode, and the device operates with minimum duty cycle in this mode.

## Inductor Selection

Inductor is an essential element for current DC/DC switch mode power supplies regardless of topology. Inductor serves as the energy storage element for power conversion. Inductance and saturation current of inductor are two most important criterions for inductor selection. For general design guidance, the selected inductance should provide a peak to peak ripple current that is around 30% of the average inductor current at full load and nominal input voltage. The average inductor current for a Boost converter is the input current. Equation 3 shows the calculation of inductance selection, where $f_{SW}$ is the switching frequency and $\Delta I_L$ is the inductor ripple current.

$$L = \frac{V_{CC}}{\Delta I_L \times f_{SW}} \times \left( 1 - \frac{V_{IN}}{V_O} \right) \quad (3)$$

The selected inductor should have a saturation current rating higher than the 1.1A (TYP) current limit of SGM4547.

The inductor also affects the close loop response of the DC/DC converter. The recommended inductor ranges from 6.8μH to 22μH. Since the SGM4547 implements built-in slope compensation to prevent sub-harmonic oscillation, inductance lower than 6.8μH might results in insufficient slope compensation, which ultimately results in unstable operation.

## Compensation Capacitor Selection

The control loop's compensation is done externally on SGM4547, which provides design flexibility for various input and output voltage combinations. A series RC connected on the COMP pin forms a pole and zero, in addition to the inherent pole of current mode control, set the close loop frequency response of SGM4547.

Equations 4 to 8 indicate the calculation of corresponding poles and zeros of Boost frequency response. Equation 4 presents the dominant pole formed with $C_{COMP}$. Equation 5 presents the output load pole, where $R_{OUT}$ is the equivalent load resistance. Equation 6 presents the right half plane zero, the designed loop response cross over frequency should be less than $1/5^{th}$ of the right half plane zero frequency to ensure enough phase margin at cross over frequency. Equation 7 presents the phase Boost zero. Lastly, Equation 8 presents the DC gain of the system, where $G_{EA}$ can be found in the Electrical Characteristics table, $R_{SENSE}$ is 200mΩ.

$$f_{P1} = \frac{1}{2\pi \times 140M\Omega \times C_{COMP}} \quad (4)$$

$$f_{P2} = \frac{2}{2\pi \times R_{OUT} \times C_{OUT}} \quad (5)$$

$$f_{RHPZ} = \frac{R_{OUT}}{2\pi \times L} \times \left( \frac{V_{IN}}{V_{OUT}} \right)^2 \quad (6)$$

$$f_Z = \frac{1}{2\pi \times R_{COMP} \times C_{COMP}} \quad (7)$$

$$A = \frac{1.211V}{V_{OUT}} \times G_{EA} \times 140M\Omega \times \frac{V_{IN}}{V_{OUT} \times R_{SENSE}} \times R_{OUT} \times \frac{1}{2} \quad (8)$$

The recommended value for $R_{COMP}$ and $C_{COMP}$ is 4.99kΩ and 10nF to ensure stable operation and acceptable load transient response, $C_{COMP}$ can be tuned in the range of 1nF to 22nF.

## APPLICATION INFORMATION OF BOOST REGULATOR (continued)

### Schottky Diode Selection

The external rectification diode selection is critical to ensure device performance. A high speed and low forward voltage drop diode is recommended to improve efficiency. The average current rating of the diode should be higher than the peak load. The breakdown voltage of the selected diode should be higher than the programmed output voltage with margin, for example, a 12V output application requires a minimal of 20V breakdown voltage.

### Input and Output Capacitor Selection

The output capacitors of Boost converter dictate the output voltage ripple and load transient response. Equation 9 is used to estimate the necessary capacitance to achieve desired output voltage ripple, where ΔV is the maximum allowed ripple.

$$C_{MIN} = \frac{I_O \times (V_{OUT} - V_{CC})}{f \times \Delta V \times V_{OUT}} \quad (9)$$

The recommended output capacitor ranges from 1μF to 10μF. Due to the DC bias nature of ceramic capacitors, care should be taken by verifying manufacture's datasheet to ensure enough effective capacitance at desired output voltage.

Boost converter's input capacitor has continuous current throughout the entire switching cycle, a 4.7μF ceramic capacitor is recommended to place as close as possible between the VIN pin and GND pin of the device. For applications where the SGM4547 is located far away from the input source, a 47μF or higher capacitance capacitor is recommended to damp the wiring harness inductance.

## TYPICAL APPLICATION

In piezo-sounder or ultra-sound transducer application, the typical circuit is shown in Figure 9.

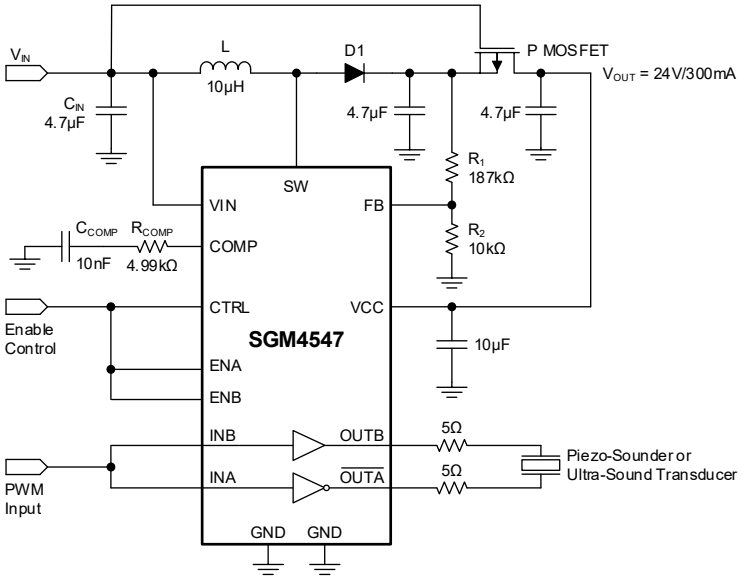



**Figure 8. Typical Circuit to Drive Piezo-Sounder or Ultra-Sound Transducer**

## REVISION HISTORY

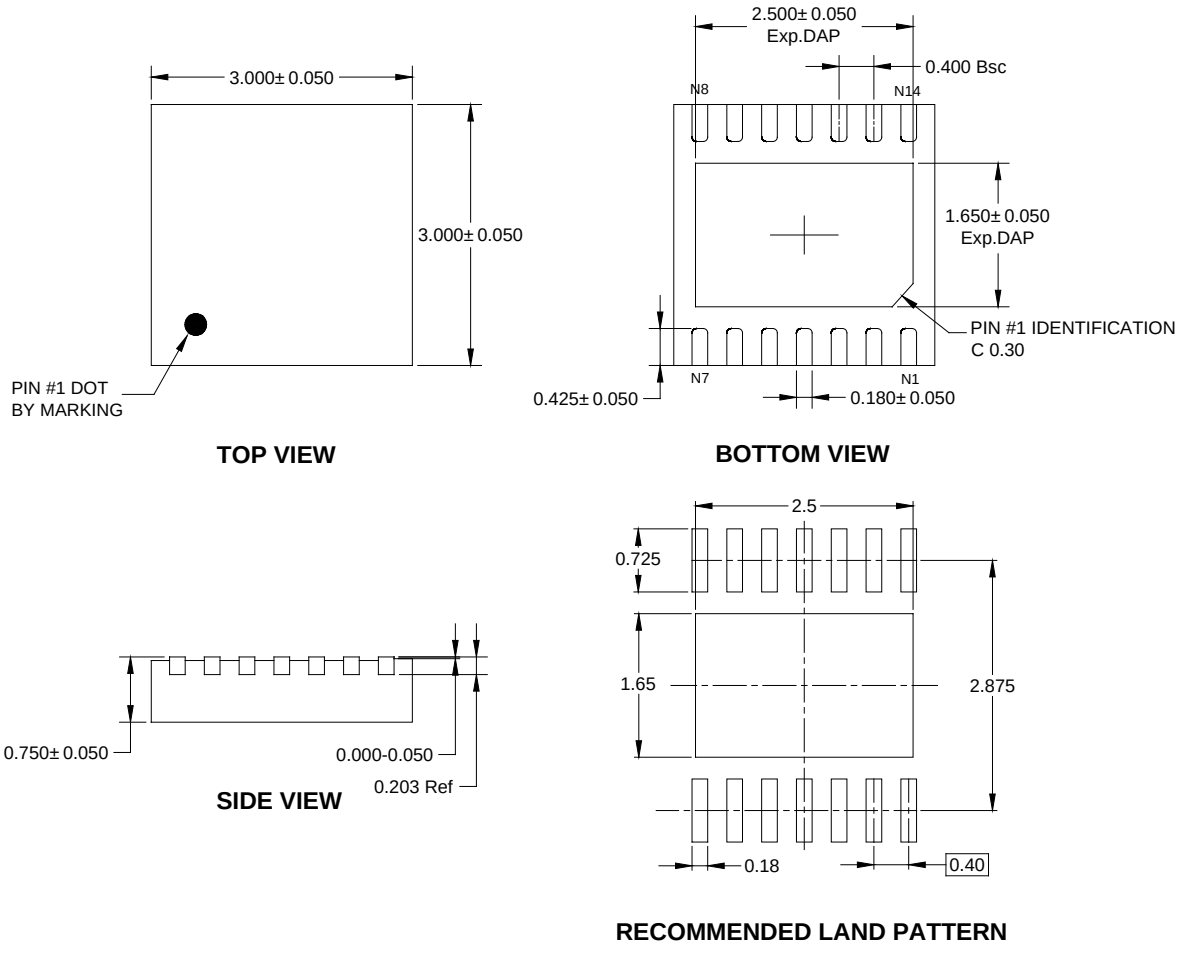
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| JANUARY 2023 – REV.A to REV.A.1 | Page |
|---|---|
| Updated Detailed Description and Application Information sections | 15, 16 |

| Changes from Original (SEPTEMBER 2015) to REV.A | Page |
|---|---|
| Changed from product preview to production data | All |

# PACKAGE OUTLINE DIMENSIONS

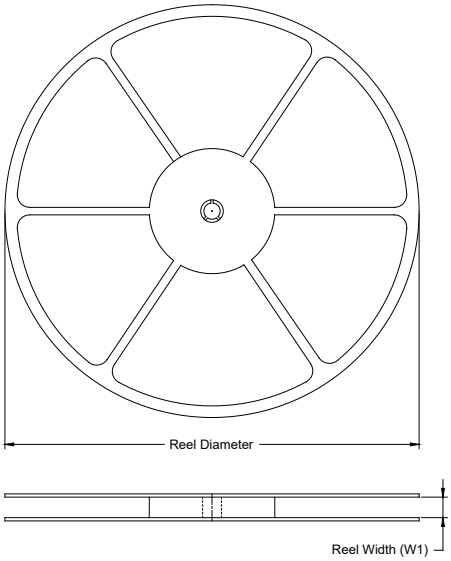
## TDFN-3×3-14L



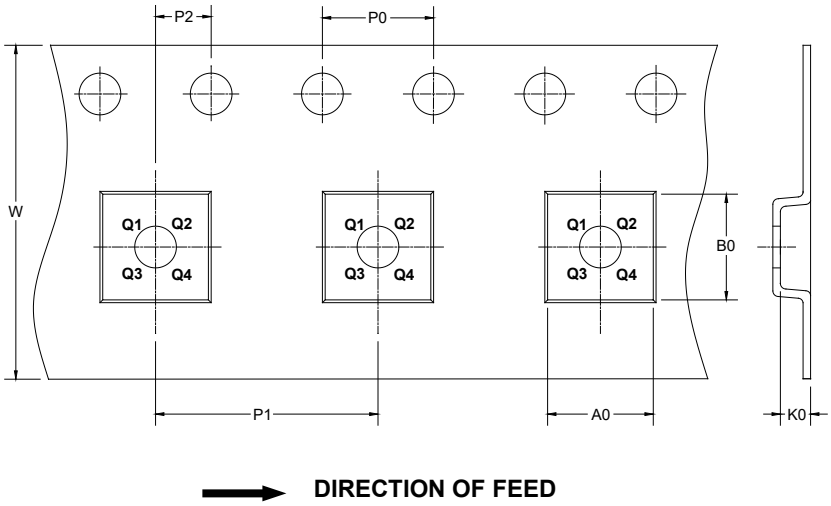

NOTES:
1. All linear dimensions are in millimeters.
2. This drawing is subject to change without notice.

# TAPE AND REEL INFORMATION

### REEL DIMENSIONS




### TAPE DIMENSIONS



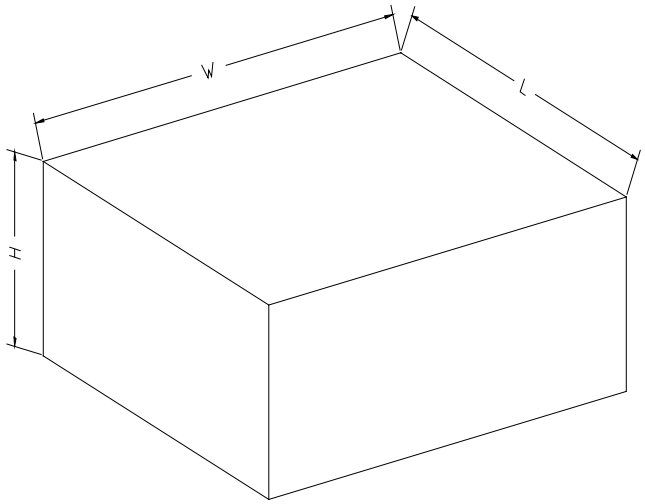

NOTE: The picture is only for reference. Please make the object as the standard.

## 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-3×3-14L | 13″ | 12.4 | 3.35 | 3.35 | 1.13 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |

DD0001

## 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 |
|---|---|---|---|---|
| 13″ | 386 | 280 | 370 | 5 |

DD0002