SGM46000
3W Primary-Side Transformer H-Bridge Driver for Isolated Supplies

GENERAL DESCRIPTION

The SGM46000 is an integrated primary-side controller and H-bridge driver for isolated power-supply circuits. The device contains an on-board oscillator, protection circuitry and internal FET drivers to provide up to 3W of power to the primary winding of a transformer from +5V power supply. The SGM46000 can be operated using the internal programmable oscillator or can be driven by an external clock for improved EMI performance. Regardless of the clock source being used, an internal flip-flop stage guarantees a fixed 50% duty cycle to prevent DC current flow in the transformer.

The SGM46000 operates from a single-supply voltage of 2.5V to 5.5V, and includes under-voltage lockout for controlled startup. The device prevents cross-conduction of the H-bridge MOSFETs by implementing break-before-make switching. Thermal shutdown circuitry provides additional protection against damage due to over-temperature conditions.

The SGM46000 is available in Green SOIC-8 (Exposed Pad) package. It operates over an ambient temperature range of -40℃ to +125℃.

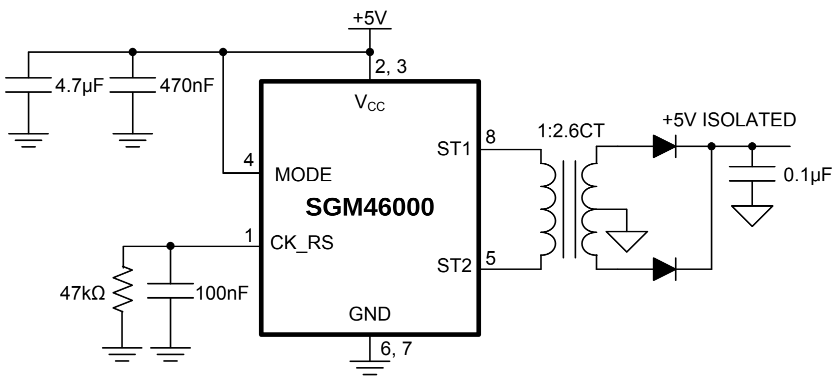
FEATURES

- **Provides Up to 3W to the Transformer in Isolated Power Supplies**
- **Single Supply 2.5V to 5.5V Wide Operation Range**
- **Internal Resistor-Programmable Oscillator Mode**
- **External Clock Mode with Watchdog**
- **Disable Mode**
- **Under-Voltage Lockout Function**
- **Thermal Shutdown**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in Green SOIC-8 (Exposed Pad) Package**

APPLICATIONS

Isolated Power Supplies
Industrial Process Control
Isolated Communications Links
Medical Equipment
Telecommunications

TYPICAL APPLICATION



+5V TO ISOLATED +5V TYPICAL APPLICATION

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDER NUMBER	PACKAGE MARKING	PACKING OPTION
SGM46000	SOIC-8 (Exposed Pad)	-40℃ to +125℃	SGM46000XPS8G/TR	SGM46000 XPS8 XXXXX	Tape and Reel, 2500

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

V_{CC} to GND .... -0.3V to 6V
CK_RS, ST1, ST2 [(1)] to GND .... -0.3V to V_{CC} + 0.3V
MODE .... -0.3V to 6V
ST1, ST2 Maximum Continuous Current
T_A < +125℃ ....±0.6A
T_A < +100℃ ....±0.9A
T_A < +85℃ ....±1.0A
Package Thermal Resistance
SOIC-8 (Exposed Pad), θ_{JA} .... 53℃/W
Power Dissipation, P_D @ T_A = +70℃
SOIC-8 (Exposed Pad) 1.5W
Junction Temperature .... +150℃
Storage Temperature Range ....-60℃ to +150℃
Lead Temperature (Soldering 10s) .... +260℃
ESD Susceptibility
HBM..5000V
MM..400V
CDM 1000V

NOTE:
1. ST1 and ST2 are not protected against short circuits. Damage to the device may result from a short-circuit fault.

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range ....-40℃ to +125℃
Supply Voltage Range ....2.5V to 5.5V

OVERSTRESS CAUTION

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

ESD SENSITIVITY CAUTION

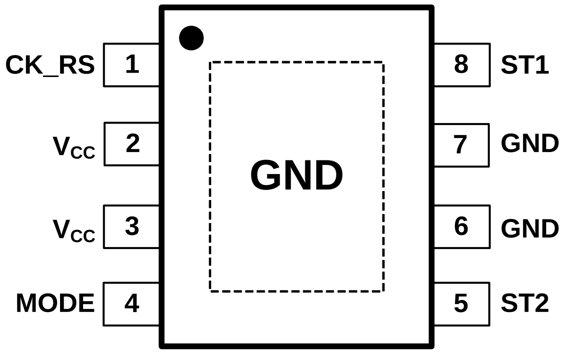
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time.

PIN CONFIGURATION

(TOP VIEW)



SOIC-8 (Exposed Pad)

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	CK_RS	Clock Input/Oscillator Frequency Adjust. When MODE is HIGH, set the internal oscillator frequency by connecting a 5kΩ or greater resistor and a 100nF ceramic capacitor from CK_RS to ground. When MODE is LOW, apply an external clock signal to CK_RS. The SGM46000 outputs switch at one half the external clock frequency.
2, 3	V_{CC}	V_{CC} Supply Voltage, 2.5V ≤ V_{CC} ≤ 5.5V. Bypass V_{CC} to ground with a 4.7μF capacitor and a 470nF ceramic capacitor. The capacitors are recommended to be placed very close to the supply pin.
4	MODE	Mode Control Input. Drive MODE high to enable internal oscillator. Drive MODE low and supply a valid clock signal on CK_RS for external clock mode.
5	ST2	Transformer Drive Output 2.
6, 7	GND	Ground.
8	ST1	Transformer Drive Output 1.
Exposed Pad	GND	Exposed Pad. Exposed pad is internally connected to GND. Connect it to a large ground plane to maximize thermal performance; not intended as an electrical connection point.

ELECTRICAL CHARACTERISTICS

(V_{CC} = 2.5V to 5.5V, Full = -40℃ to +125℃. Typical values are at V_{CC} = 5V and T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Supply Voltage Range	V_{CC}		Full	2.5		5.5	V
Supply Current (1)	I_{CC}	MODE = V_{CC}, R_S = 390kΩ	Full		0.7	1.6	mA
Disable Supply Current	I_{SD}	MODE = GND, R_S = 390kΩ	Full		20	40	μA
External Resistance	R_S		Full	5		390	kΩ
Driver Total Resistance (2)	R_{OHL}	V_{CC} = 4.5V	Full		0.50	0.82	Ω
		V_{CC} = 3V	Full		0.58	0.95	
Under-Voltage Lockout Threshold	V_{UVLO}	V_{CC} Rising	Full	1.3	1.9	2.4	V
Under-Voltage Lockout Hysteresis	V_{UVLO_HST}		Full		160		mV
Logic-Low Level (MODE, CK_RS)	V_{IL}		Full			0.4	V
Logic-High Level (MODE, CK_RS)	V_{IH}		Full	1.7			V
Input Leakage Current (MODE)	I_{LK}		Full		0.01	1	μA
Internal Pull-Down Resistance on CK_RS	R_{S_INT}	MODE = GND	Full		160		kΩ
Thermal Shutdown Temperature	T_{SHDN}				155		℃
Thermal Shutdown Hysteresis	ΔT_{SHDN}				15		℃

TIMING CHARACTERISTICS

(V_{CC} = 2.5V to 5.5V, Full = -40℃ to +125℃. Typical values are at V_{CC} = 5V and T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Watchdog Timeout	t_{WDOG}	MODE = GND	Full	14		56	μs
CK_RS Input Frequency	f_{IN}	MODE = GND	Full	0.2		2	MHz
Switching Frequency	f_{SW}	MODE = V_{CC}, R_S = 5.1kΩ	+25℃	0.75	1	1.45	MHz
		MODE = V_{CC}, R_S = 390kΩ	+25℃	100	150	200	kHz
ST1 and ST2 Duty Cycle	Dtc	MODE = V_{CC}	+25℃		50		%
Crossover Dead Time	t_{DEAD}	R_L = 100Ω	+25℃		10		ns

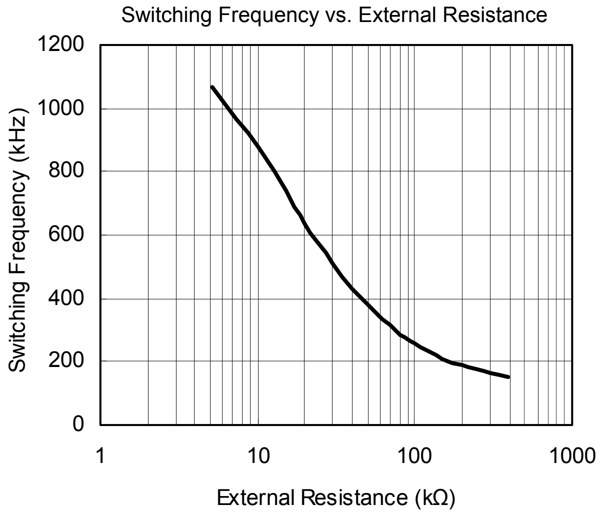
NOTES:

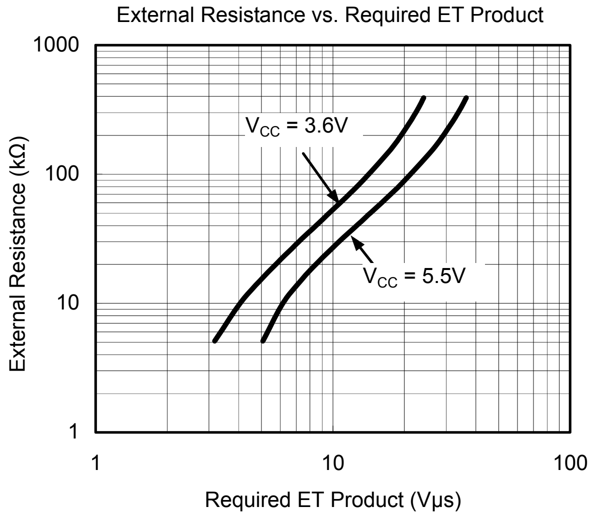
1. Minimum and maximum limits tested with ST1, ST2 unconnected.

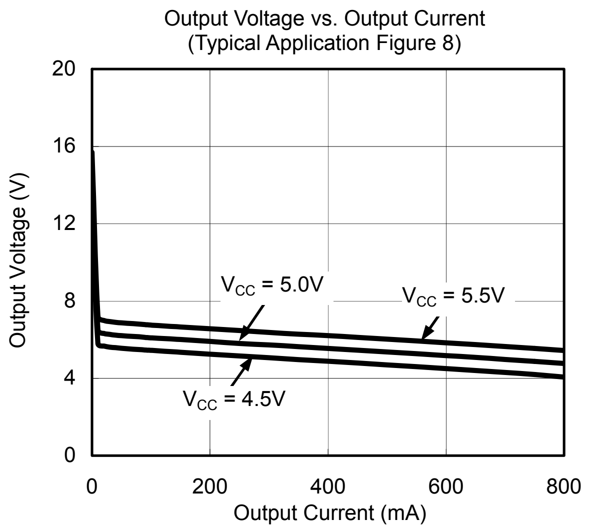
2. Total driver resistance includes the on-resistance of the top and the bottom internal FETs. If R_{OH} is the high-side resistance, and R_{OL} is the low-side resistance, R_{OHL} = R_{OH} + R_{OL}.

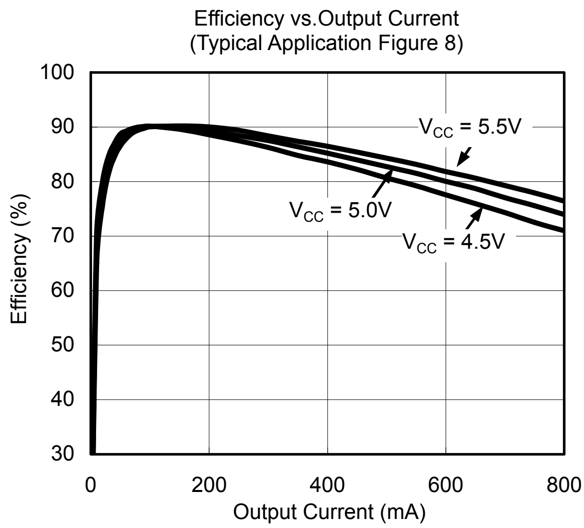
TYPICAL PERFORMANCE CHARACTERISTICS

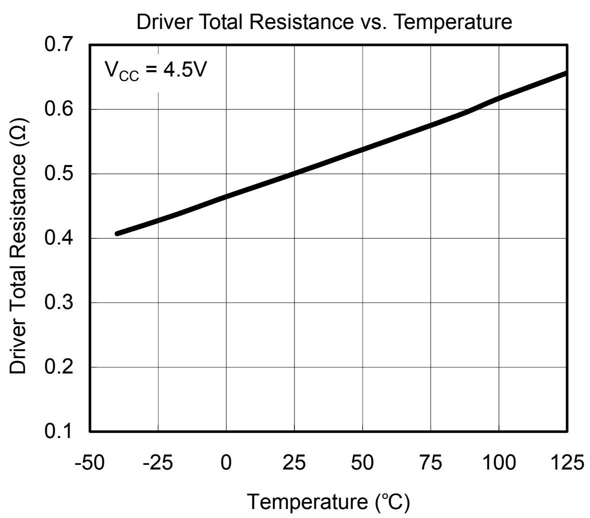
V_{CC} = 5V, T_A = +25℃, unless otherwise noted.

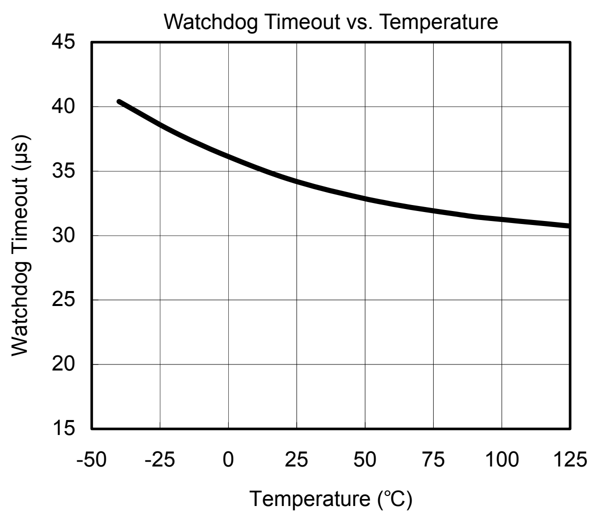








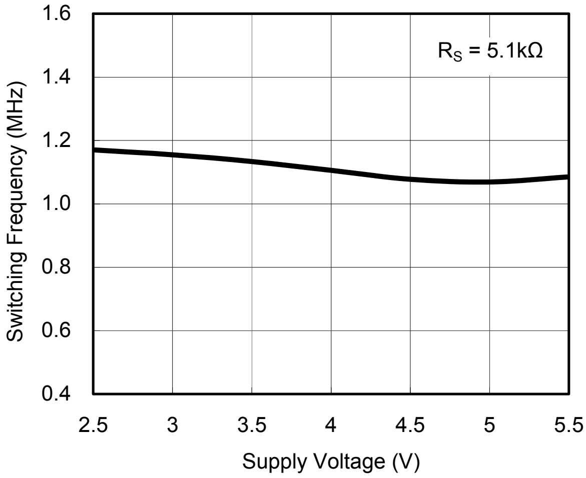




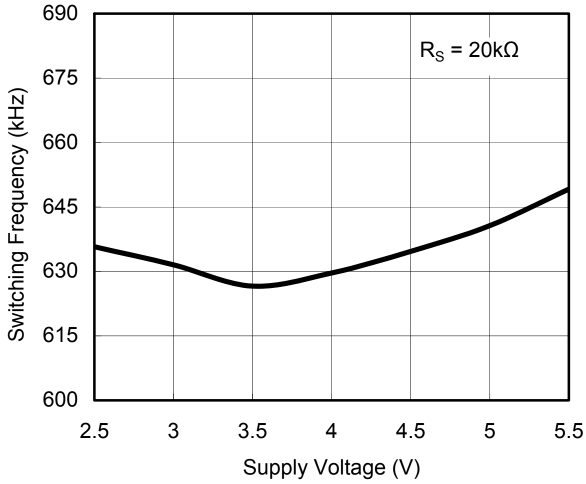
TYPICAL PERFORMANCE CHARACTERISTICS

V_{CC} = 5V, T_A = +25℃, unless otherwise noted.

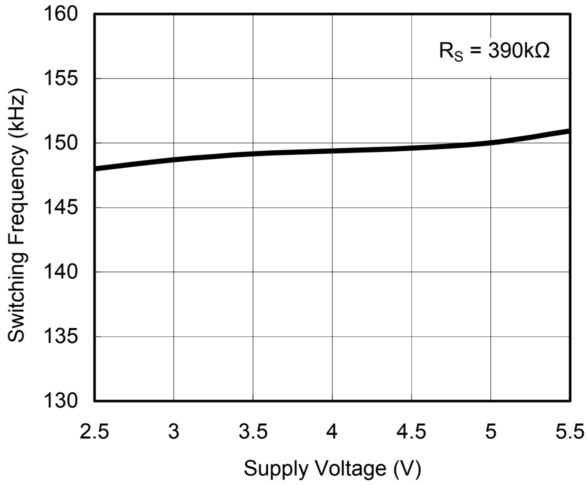
Switching Frequency vs. Supply Voltage



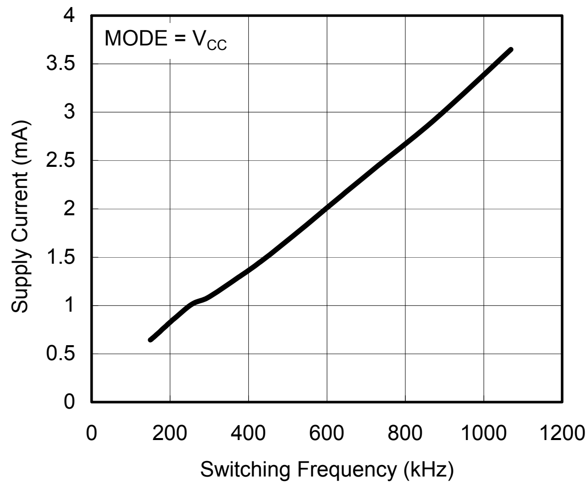
Switching Frequency vs. Supply Voltage



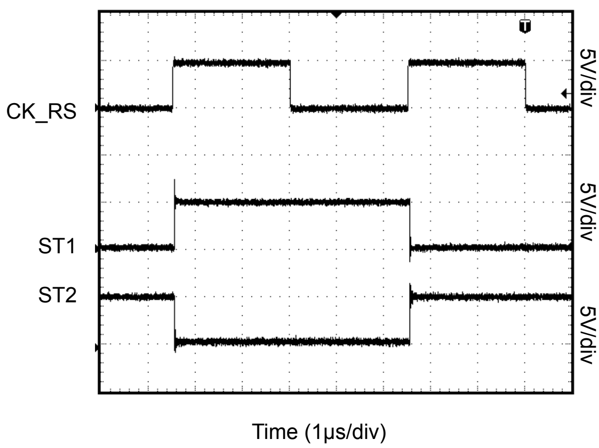
Switching Frequency vs. Supply Voltage



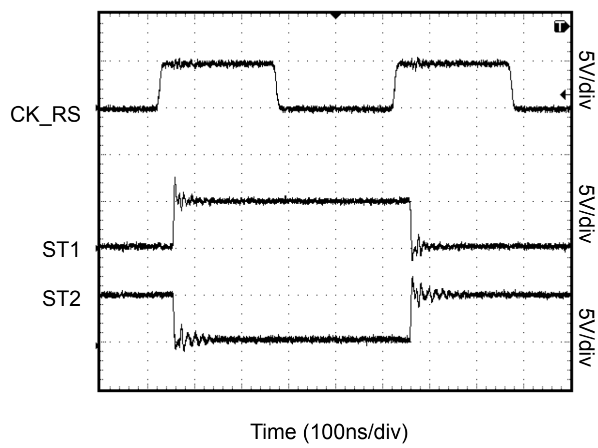
Supply Current vs. Switching Frequency



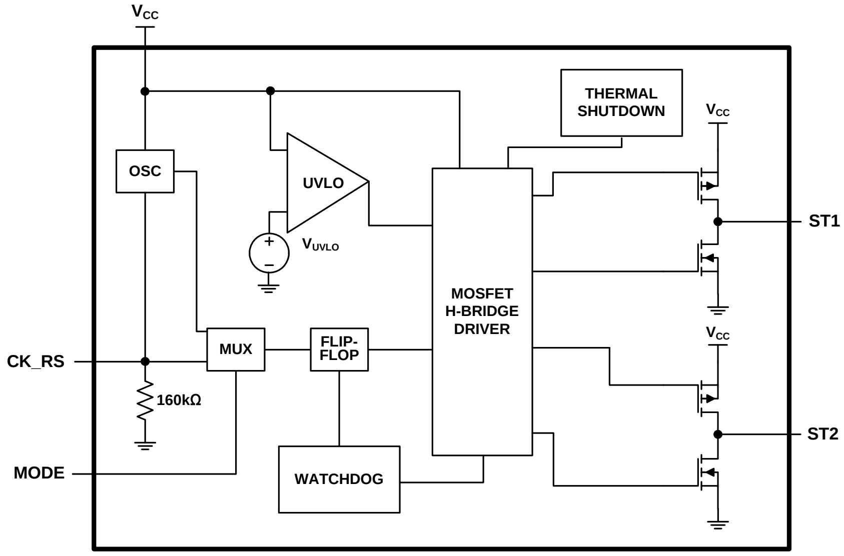
Operation at 100kHz



Operation at 1MHz



FUNCTIONAL BLOCK DIAGRAM



DETAILED DESCRIPTION

The SGM46000 is an integrated primary-side controller and H-bridge driver for isolated power-supply circuits. The device contains an on-board oscillator, protection circuitry, and internal FET drivers to provide up to 3W of power to the primary winding of a transformer. The SGM46000 can be operated using the internal programmable oscillator, or can be driven by an external clock for improved EMI performance. Regardless of the clock source being used, an internal flip-flop stage guarantees a fixed 50% duty cycle to prevent DC current flow in the transformer.

The SGM46000 operates from a single-supply voltage of 2.5V to 5.5V, and includes under-voltage lockout for controlled startup. The device prevents cross-conduction of the H-bridge MOSFETs by implementing break-before-make switching. Thermal shutdown circuitry provides additional protection against damage due to over-temperature conditions.

Oscillator Modes

The SGM46000 is driven by the internal programmable oscillator or an external clock. The logic state of MODE determines the clock source (see Table 1). Drive MODE high to select the internal resistor programmable oscillator. Drive MODE low to operate the SGM46000 with an external clock signal on CK_RS.

Internal Oscillator Mode

The SGM46000 includes a 150kHz to 1MHz programmable oscillator. Set the oscillator frequency by connecting CK_RS to ground with a 5kΩ or larger resistor. Connect a 390kΩ from CK_RS to ground to set the oscillator to the minimum frequency of 150kHz. CK_RS is internally pulled to ground with a 160kΩ resistor.

Table 1. Oscillator Modes

OSCILLATOR MODE	CK_RS	MODE	OPERATION
Internal Programmable Frequency	Pulled to ground by R_S. R_S must be greater than 5kΩ.	V_{CC}	150kHz to 1MHz (TYP). Connect a 390kΩ from CK_RS to ground for minimum switching frequency.
External Clock	Digital input. Drive CK_RS with an external clock signal.	Ground	CK_RS is pulled to ground by an internal 160kΩ resistor. The device switches at one half the external clock frequency.
Disable	Connected to V_{CC} or GND (external clock mode).	Ground	The device is disabled after a maximum of 56μs following the last rising edge on CK_RS.
	Unconnected or pulled to ground with R_S (internal clock mode).		

DETAILED DESCRIPTION

External Clock Mode

The SGM46000 provides an external clock mode. When operating in external clock mode, an internal flip-flop divides the external clock by two in order to generate a switching signal with a guaranteed 50% duty cycle. As a result, the SGM46000 outputs switch at one half the external clock frequency. The device switches on the rising edge of the external clock signal.

Watchdog

When the SGM46000 is operating in external clock mode, a stalled clock could cause excessive DC current to flow through the primary winding of the transformer. The SGM46000 features an internal watchdog circuit to prevent damage from this condition. The SGM46000 is disabled when the external clock signal on CK_RS remains at the same logic level for longer than 56μs (MAX). The device resumes normal operation upon the next rising edge on CK_RS.

Disable Mode

When using the internal oscillator, drive MODE low to disable the SGM46000. The device is disabled within 56μs after MODE goes low. When operating in external clock mode, suspend the clock signal for longer than 56μs to disable the SGM46000. The device resumes normal operation when MODE is driven high or when the external clock signal resumes.

Power-Up and Under-Voltage Lockout

The SGM46000 provides an under-voltage lockout feature to ensure a controlled power-up state and prevent operation before the oscillator has stabilized. On power-up and during normal operation (if the supply voltage drops below 1.75V), the under-voltage lockout disables the device.

Thermal Shutdown

The SGM46000 is protected from over-temperature damage by a thermal shutdown circuit. When the junction temperature (T_J) exceeds +155℃, the device is disabled. The device resumes normal operation when T_J falls below +140℃.

APPLICATION INFORMATION

Available Output Power

The output power is specified at ST1 and ST2 since losses in the transformer and rectification network are dependent upon component selection and topology. The power dissipation of the SGM46000 is approximated by:

$$P_D = R_{OHL} \times I_{PRI}^2$$

where R_{OHL} is the total high-side and low-side on-resistance of the internal FET drivers, and I_{PRI} is the load current flowing through the transformer primary between ST1 and ST2. For low output load currents, include the contribution to P_D from the quiescent supply current: $I_{CC} \times V_{CC}$.

PC Board Layout Guidelines

As with all power-supply circuits, careful PC board layout is important to achieve low switching losses and stable operation. For thermal performance, connect the exposed paddle to a solid copper ground plane. The traces from ST1 and ST2 to the transformer must be low-resistance and inductance paths. Place the transformer as close as possible to the SGM46000 using short, wide traces.

When the device is operating with the internal oscillator, it is possible for high-frequency switching components on ST1 and ST2 to couple into the CK_RS circuitry through PC board parasitic capacitance. This capacitive coupling can induce duty-cycle errors in the oscillator, resulting in a DC current through the transformer. To ensure proper operation, shield the CK_RS circuitry from ST1 and ST2 by placing a grounded trace between these circuits. Place RS as close as possible to the CK_RS pin.

Output Voltage Regulation

For many applications, the unregulated output of the SGM46000 meets the supply voltage tolerances. This configuration represents the highest efficiency possible with the SGM46000.

For applications requiring a regulated output voltage, SGMICRO provides several solutions. In the following examples, assume a tolerance of ±10% variation for the input voltage. When a full-bridge power supply is operated under maximum input voltage and low output load current, the voltage at the output of the rectifier network can exceed the absolute maximum input voltage of the low dropout regulator (LDO). If the minimum output load current is less than approximately 5mA, connect a zener diode from the output voltage to ground (as shown in Figure 2) to limit the output to a safe value.

+3.3V to Isolated, Regulated +5V

In the circuit of Figure 2, the LDO regulates the output of the SGM46000 to +5V. The Halo TGMH281NF provides a center-tapped 1:2.6 turns ratio, and the secondary circuit implements a 4-diode bridge rectifier (Figure 1A).

For a minimum input voltage of +3V, the output voltage of the bridge rectifier is approximately +5.5V at a current of 200mA. A 15V zener diode protects the LDO from high input voltages, but adds a few microamps to the no-load input current of the SGM46000.

+5V to Isolated, Regulated +3.3V

In Figure 3, the LDO is used with the TGMH281NF transformer and a 2-diode push-pull rectifier (Figure 1B). This topology produces approximately +4.5V at a current of 350mA. The LDO produces a regulated +3.3V output voltage.

+5V to Isolated, Regulated +12V

In Figure 4, the 12V output LDO is used with the TGMH281NF transformer and the voltage doubler network (Figure 1C). This circuit produces approximately +12.5V at a load current of 150mA. The LDO produces a regulated +12V output.

APPLICATION INFORMATION

+5V to Isolated, Regulated ±15V

In Figure 5, the SGM46000 is used with two TGMH281NF transformers and voltage doubler networks (Figure 1C) to supply 20V to a pair of 15V regulators. The circuit produces a regulated ±15V at 50mA.

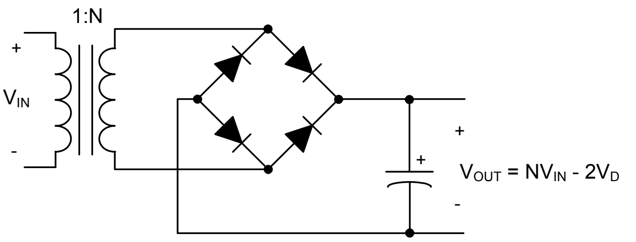


Figure 1A. Full-Wave Rectifier

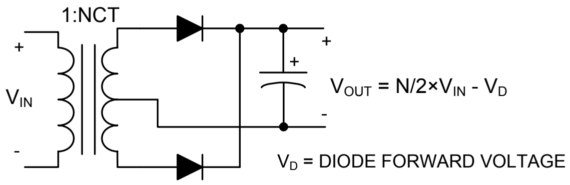


Figure 1B. Push-Pull Rectification

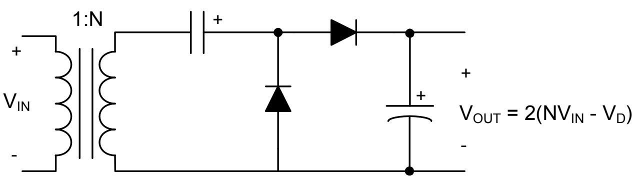


Figure 1C. Voltage Doubler

Figure 1. Secondary-Side Rectification Topologies

Isolated DAC/ADC Interface for Industrial Process Control

The SGM46000 provides isolated power for data converters in industrial process control applications (Figure 6). The 3W isolated power output capability allows for data converters operating across multiple isolation barriers. The power output capability also supports circuitry for signal conditioning and multiplexing.

Isolated RS-485/RS-232 Data Interfaces

The SGM46000 provides power for multiple transceivers in isolated RS-485/RS-232 data interface applications. The 3W isolated power output capability of the SGM46000 allows more than ten RS-485 transceivers simultaneously.

Isolated Power Supply

The SGM46000 allows a versatile range of secondary-side rectification circuits (see Figure 1). The secondary transformer winding can be wound to provide a wide range of isolated voltages. Figure 8 shows a +5V to isolated +5V application that delivers up to 500mA.

The SGM46000 provides the advantages of the full-bridge converter topology, including multiple isolated outputs, step-up/step-down or inverted output, relaxed filtering requirements, and low output ripple.

Power-Supply Decoupling

Bypass V_{CC} to ground with a 0.47μF ceramic capacitor as close to the device as possible. Additionally, place a 4.7μF capacitor from V_{CC} to ground.

Exposed Paddle

Ensure that the exposed paddle is soldered to the bottom layer ground for best thermal performance. Failure to provide a low thermal impedance path to the ground plane will result in excessive junction temperatures when delivering maximum output power.

APPLICATION INFORMATION

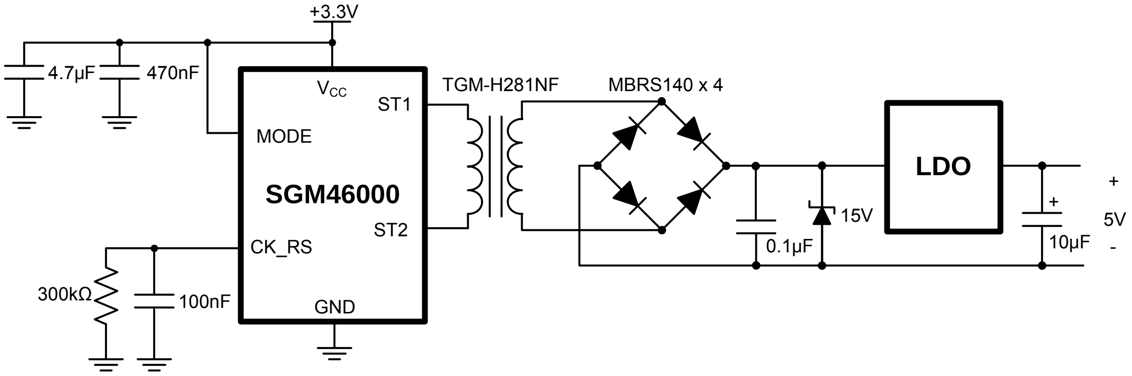


Figure 2. +3.3V to Isolated, Regulated +5V

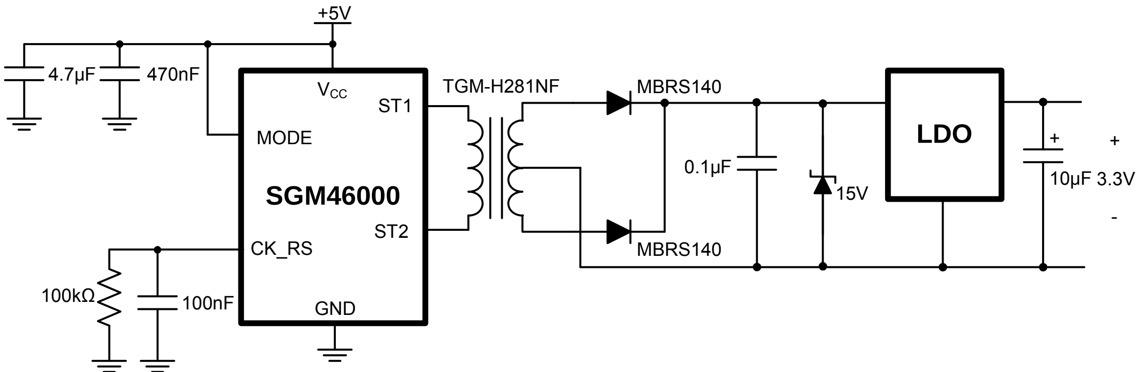


Figure 3. +5V to Isolated, Regulated +3.3V

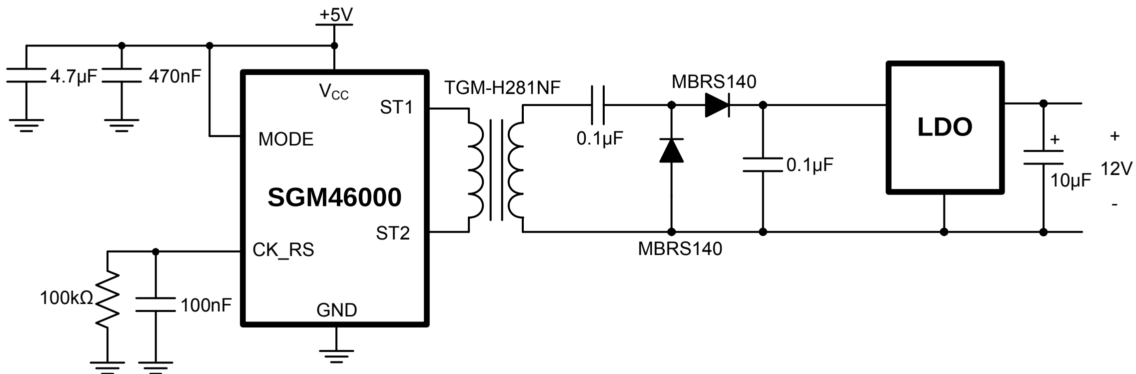


Figure 4. +5V to Isolated, Regulated +12V

APPLICATION INFORMATION

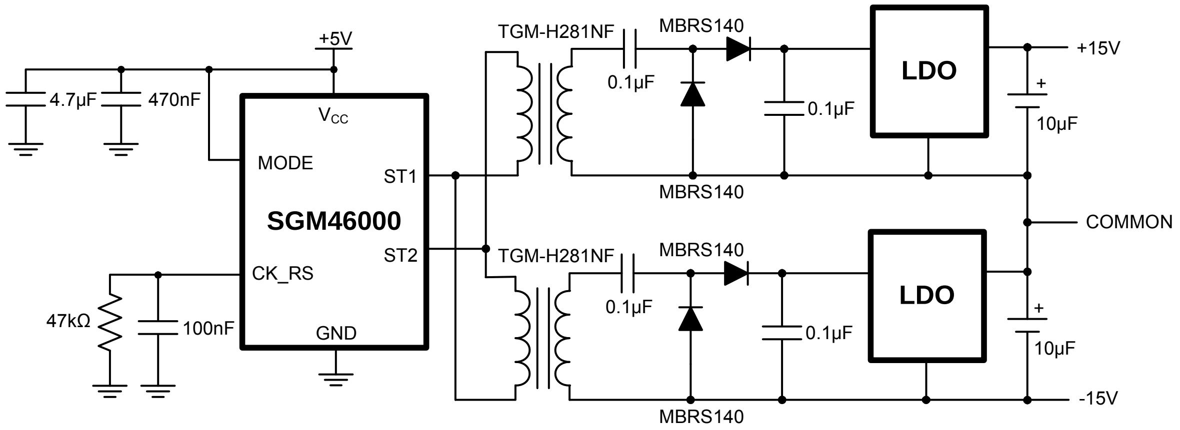


Figure 5. +5V to Isolated Regulated ±15V

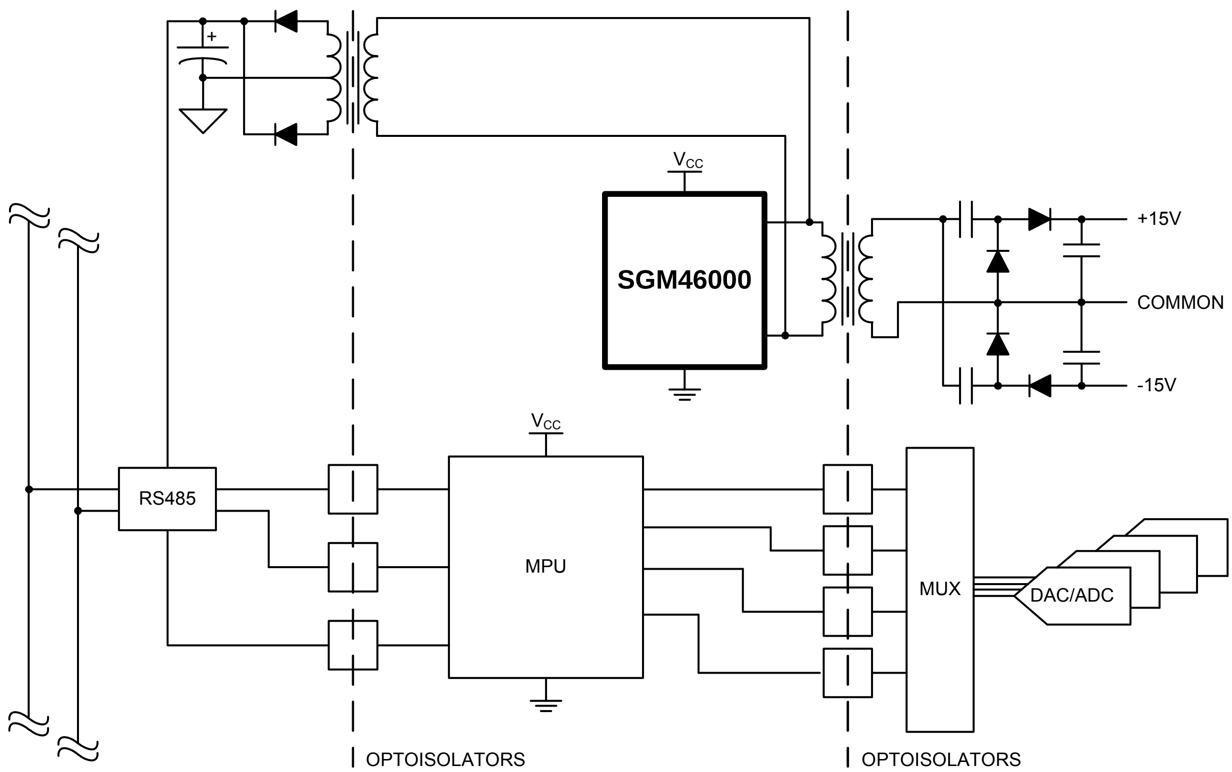


Figure 6. Isolated Power Supply for Process Control Applications

COMPONENT SELECTION

Transformer Selection

Transformer selection for the SGM46000 can be simplified by the use of a design metric, the ET product. The ET product relates the maximum allowable magnetic flux density in a transformer core to the voltage across a winding and switching period. Inductor current in the primary linearly increases with time in the operating region of the SGM46000. Transformer manufacturers specify a minimum ET product for each transformer. For the SGM46000, the requirement on ET product is calculated as:

$$ET = V_{CC} \times \frac{1}{2 \times f_{SW}}$$

By choosing a transformer with sufficient ET product in the primary winding, it is ensured that the transformer will not saturate during operation. Saturation of the magnetic core results in significantly reduced inductance of the primary, and therefore a large increase in current flow. Excessive transformer current results in a temperature rise and possible damage to the transformer and/or the SGM46000.

When connecting a 390kΩ from CK_RS to ground, the internal oscillator is programmed for the minimum frequency. See the External Resistance vs. Required ET Product plot to determine the required ET product for a given value of R_S.

In addition to the constraint on ET product, choose a transformer with a low DC-winding resistance. Power dissipation of the transformer due to the copper loss is approximated as:

$$P_{D\_TX} = I_{LOAD}{}^{2} \times (N^{2}R_{PRI} + R_{SEC})$$

where R_{PRI} is the DC-winding resistance of the primary, and R_{SEC} is the DC-winding resistance of the secondary. In most cases, an optimum is reached when:

$$R_{SEC} = N^{2}R_{PRI}$$

For this condition, the power dissipation is equal for the primary and secondary windings.

As with all power-supply designs, it is important to optimize efficiency. In designs incorporating small transformers, the possibility of thermal runaway makes low transformer efficiencies problematic. Transformer losses produce a temperature rise that reduces the efficiency of the transformer. The lower efficiency, in turn, produces an even larger temperature rise.

To ensure that the transformer meets these requirements under all operating conditions, the design should focus on the worst-case conditions. The most stringent demands on ET product arise for minimum switching frequency, maximum input voltage, maximum temperature, and load current. Additionally, the worst-case values for transformer and rectifier losses should be considered.

The primary should be a single winding; however, the secondary can be center-tapped, depending on the desired rectifier topology. In most applications, the phasing between primary and secondary windings is not significant. Half-wave rectification architectures are possible with the SGM46000; however, these are discouraged. If a net DC current results due to an imbalanced load, the magnetic flux in the core is increased. This reduces the effective ET product and can lead to saturation of the transformer core.

Transformers for use with the SGM46000 are typically wound on a high-permeability magnetic core. To minimize radiated electromagnetic emissions, select a toroid, pot core, E/I/U core, or equivalent.

+3.3V Operation

The SGM46000 can be operated from a +3.3V supply by increasing the turns ratio of the transformer, or by designing a voltage-doubler or voltage-tripler circuit as shown in Figure 1C.

Optimum performance at +3.3V is obtained with fewer turns on the primary winding, since the ET product is lower than for a +5V supply. However, any of the transformers for use with a +5V supply will operate properly with a +3.3V supply. For a given power level, the transformer currents are higher with a +3.3V supply than with a +5V supply. Therefore, the DC resistance of the transformer windings has a larger impact on the circuit efficiency.

COMPONENT SELECTION

Diode Selection

The high switching speed of the SGM46000 necessitates high-speed rectifiers. Ordinary silicon signal diodes such as 1N914 or 1N4148 may be used for low-output current levels (less than 50mA). At higher output currents, select low forward-voltage Schottky diodes to improve efficiency. Ensure that the average forward current rating for the rectifier diodes exceeds the maximum load current of the circuit. For surface-mount applications, Schottky diodes such as the BAT54, MBRS140 and MBRS340 are recommended.

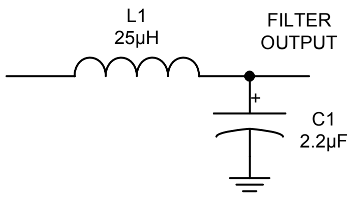


Figure 7. Output Ripple Filter

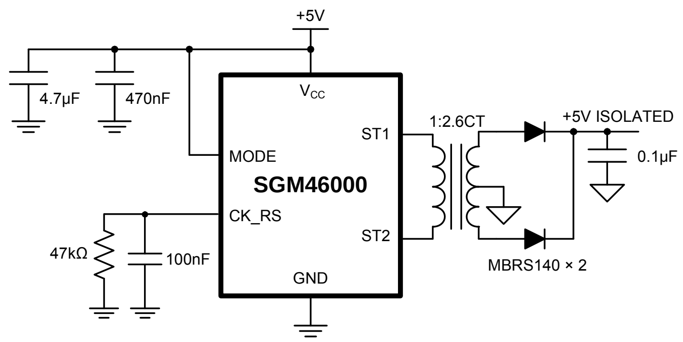


Figure 8. +5V to Isolated +5V

Capacitor Selection

Input Bypass Capacitor

Bypass the supply voltage to GND with a 0.47μF ceramic capacitor as close to the device as possible. Additionally, connect a 4.7μF or greater capacitor to provide input voltage filtering. The equivalent series resistance (ESR) of the input capacitors is not as critical as for the output capacitors. Typically, ceramic X7R capacitors are adequate.

Output Filter Capacitor

In most applications, the actual capacitance rating of the output filter capacitor is less critical than the capacitor's ESR. In applications sensitive to output voltage ripple, the output filter capacitor must have low ESR. For optimal performance, the capacitance should meet or exceed the specified value over the entire operating temperature range. Capacitor ESR typically rises at low temperatures; however, OS-CON capacitors can be used at temperatures below 0℃ to help reduce output voltage ripple in sensitive applications. In applications where low output-voltage ripple is not critical, standard ceramic 0.1μF capacitors are sufficient.

Output-Ripple Filtering

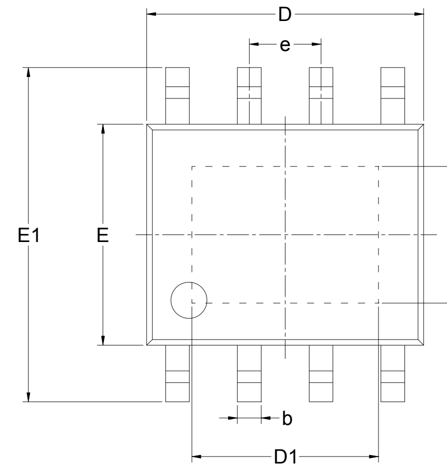
Output voltage ripple can be reduced with a low-pass LC pi-filter (Figure 7). The component values shown give a cutoff frequency of 21.5kHz by the equation:

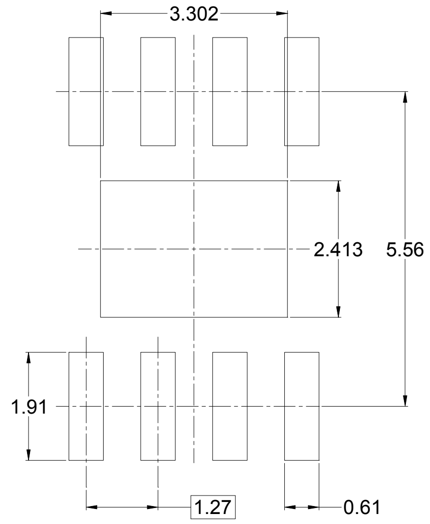
$$f_{3dB} = \frac{1}{2\pi\sqrt{LC}}$$

Use an inductor with low DC resistance and sufficient saturation current rating to minimize filter power dissipation.

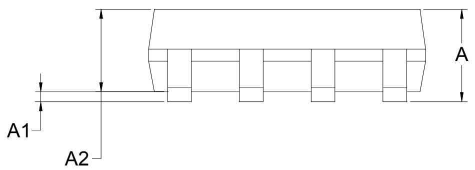
PACKAGE OUTLINE DIMENSIONS

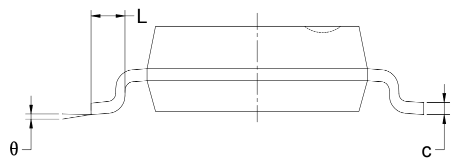
SOIC-8 (Exposed Pad)





RECOMMENDED LAND PATTERN (Unit: mm)

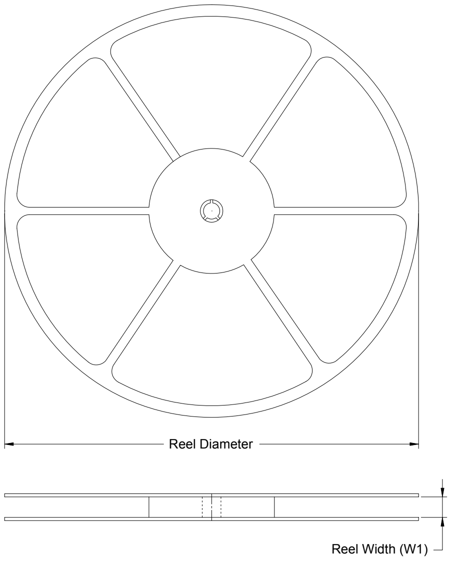




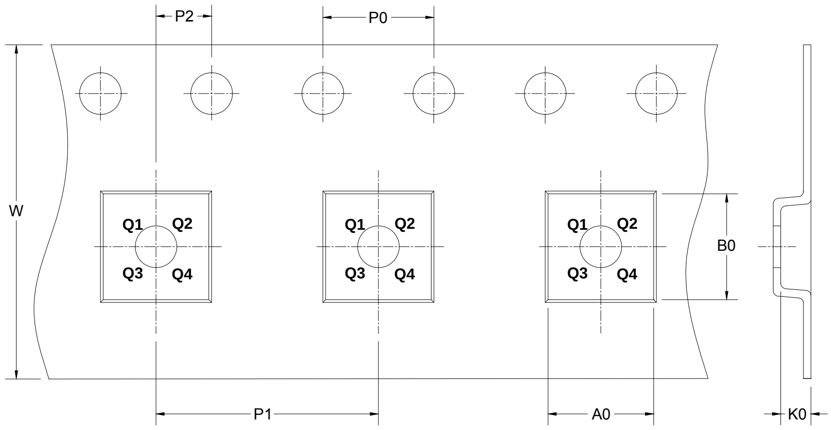
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.700		0.067
A1	0.000	0.150	0.000	0.006
A2	1.250	1.650	0.049	0.065
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
D1	3.100	3.500	0.122	0.137
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.200	2.600	0.086	0.102
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

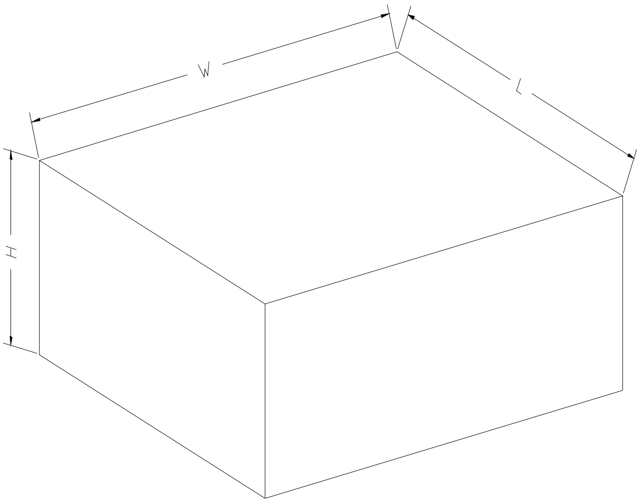
NOTE: The picture is only for reference. Please make the object as the standard.

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
SOIC-8 (Exposed Pad)	13″	12.4	6.4	5.4	2.1	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