

POWER MANAGEMENT

Features

- Operating Voltage — +4.5V to +16.5V
- Fast rise and fall times (20ns typical with 1000pf load)
- Dual MOSFET driver
- Peak drive current — 2A
- propagation delay — 40ns
- 8-pin SOIC / MSOP lead free packages. This product is fully WEEE and RoHS compliant
- Enable/disable control
- TTL-compatible input
- Under voltage lockout with hysteresis
- Low shutdown supply current
- Over temperature protection
- ESD protection
- Dual inverting/non-inverting and inverting/non-inverting configurations

Applications

- Switch-mode power supplies
- Battery powered applications
- Solenoid and motor drives

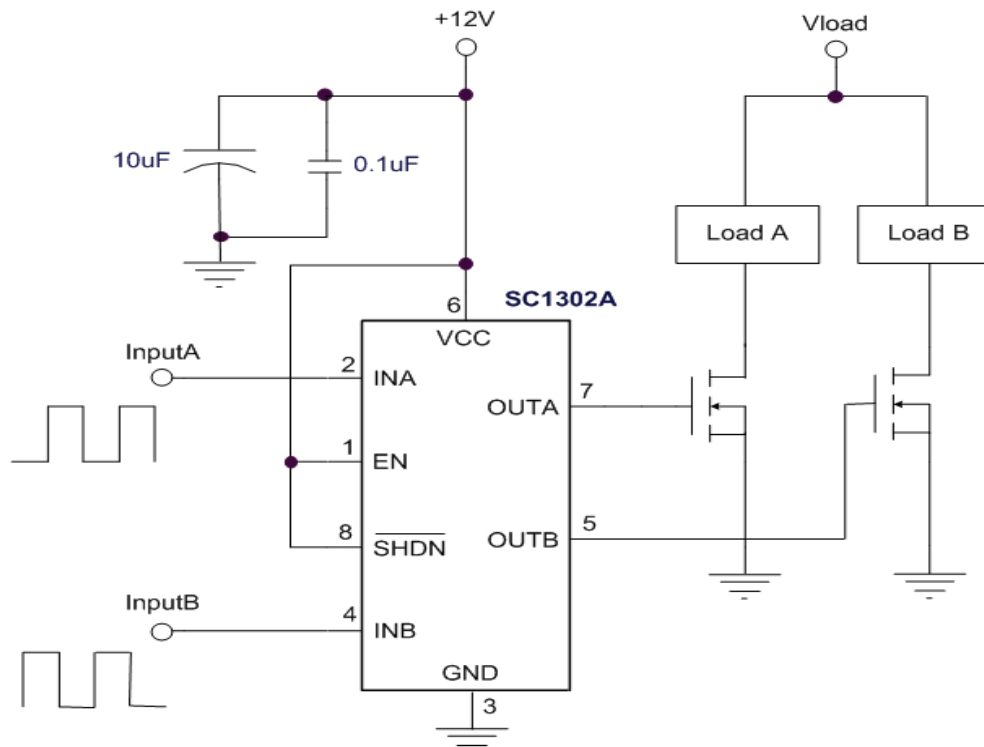
Description

The SC1302A/B/C/D/E/F family are low cost dual low-side MOSFET drivers. These drivers accept TTL-compatible inputs and are capable of supplying high current outputs (> 2A peak) to external MOSFETs. Fast switching allows operation up to 1 MHz. The SC1302A/B/C is available in six configurations: SC1302A is a dual non-inverting, SC1302B is a dual inverting and SC1302C alone has an inverting plus one non-inverting output.

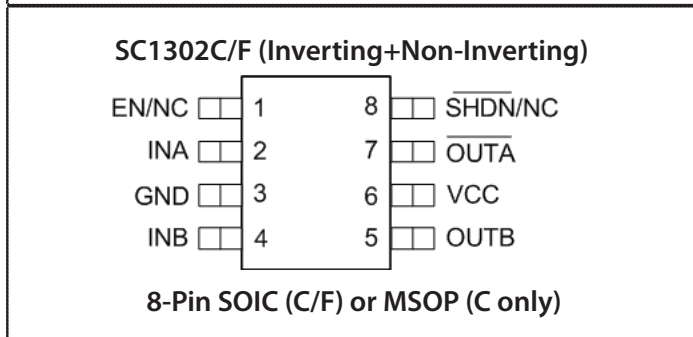
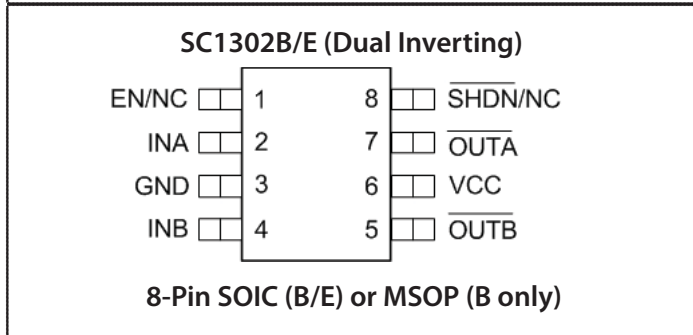
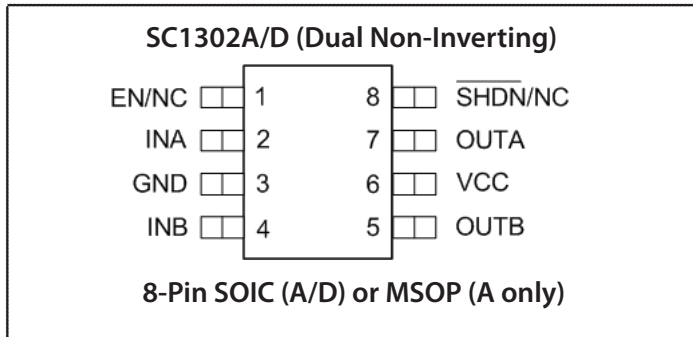
The SC1302D/E/F is the derivative part from SC1302A/B/C with pin 1 (EN) and pin 8 ($\overline{\text{SHDN}}$) internally tied to VCC.

An under-voltage lockout circuit guarantees that the driver outputs are low when Vcc is less than 4.5V (typical). An internal temperature sensor shuts down the driver in the event of over temperature.

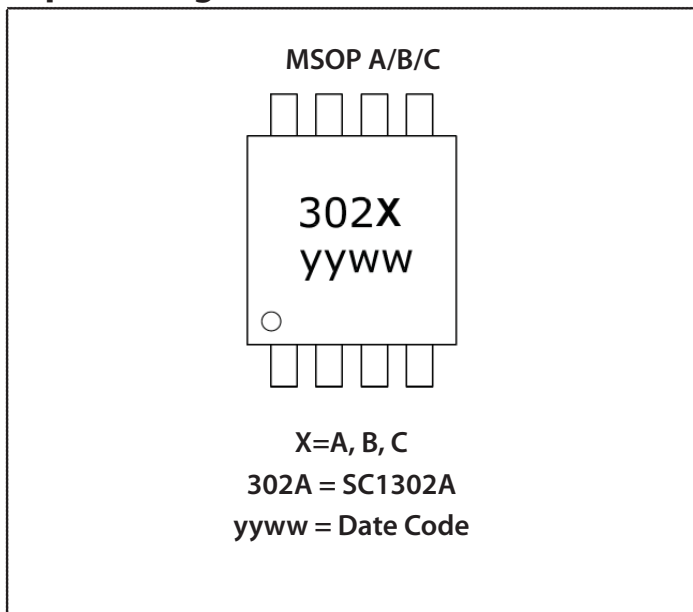
Typical Application Circuit



Pin Configuration



Top Marking Information



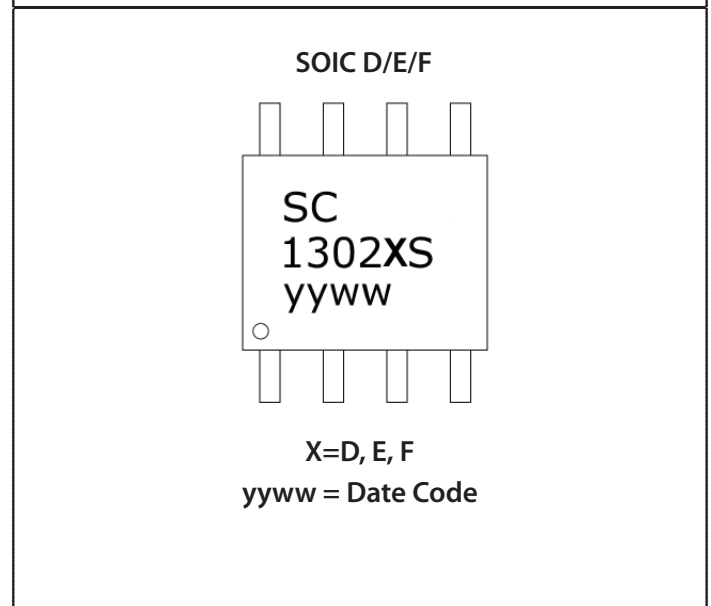
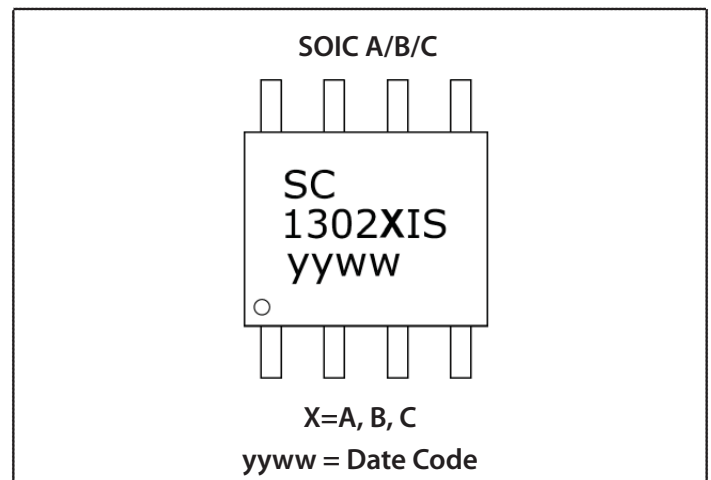
Ordering Information

| Device | Package | Temperature Range (T _j) |
|--------------|---------|-------------------------------------|
| SC1302AISTR | SOIC-8 | -40°C to +125°C |
| SC1302BISTR | | |
| SC1302CISTR | | |
| SC1302DSTR | | |
| SC1302ESTR | | |
| SC1302FSTR | | |
| SC1302AIMSTR | MSOP-8 | -40°C to +125°C |
| SC1302BIMSTR | | |
| SC1302CIMSTR | | |

Notes:

- (1) Available in tape and reel only. A reel contains 2,500 devices.
- (2) Lead-free package only. Device is WEEE and RoHS compliant.

Top Marking Information



Absolute Maximum Ratings

| | |
|--|--------------------|
| Supply Voltage V_{CC} (V) | -0.3 to +20 |
| Input Voltages (V) | -0.3 to V_{CC} |
| Peak Output Currents (A) | 3 |
| Enable Voltage SC1302A/B/C (V) | -0.3 to V_{CC} |
| Shutdown Voltage SC1302A/B/C (V) | -0.3 to V_{CC} |
| Continuous Power Dissipation (W) | Internally limited |
| ESD Protection Level (kV) | 2 |

Recommended Operating Conditions

| | |
|--|--------------------------|
| Operating Temperature Range (°C) | $-40 \leq T_J \leq +125$ |
| Operating Supply Voltage (V) | -0.3 to 16.5 |

Thermal Information

| | |
|--|-------------|
| Thermal Resistance, Junction to Ambient MSOP (°C/W) .. | .206 |
| Thermal Resistance, Junction to Ambient SIOC (°C/W) .. | 165 |
| Maximum Junction Temperature (°C) | +150 |
| Storage Temperature Range (°C) | -65 to +150 |
| Lead Temperature (Soldering) 10s (°C) | +260 |

Exceeding the above specifications may result in permanent damage to the device or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not recommended.

DC Electrical Characteristics

Unless otherwise specified, $-40^\circ\text{C} < T_A = T_J < 125^\circ\text{C}$, $V_{CC} = 12\text{V}$, $V_{IN} = 5\text{V}$, $V_{EN} = 5\text{V}$ (SC1302A/B/C), $V_{SHDN} = 5\text{V}$ (SC1302A/B/C)

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|--------------------------------|--------------|--|-----|-----|-----|---------------|
| Supply Current | | | | | | |
| Quiescent Current | I_Q | $V_{CC} < V_{START}$ | | 1 | 1.8 | mA |
| Quiescent Current | I_Q | $V_{EN} = V_{SHDN} = 3\text{V}$ for SC1302A/B/C, $V_{INA} = V_{INB} = 3\text{V}$ | | 5.7 | 8.1 | mA |
| Quiescent Current | I_Q | $V_{SHDN} = 0\text{V}$ for SC1302A/B/C | | 3 | 8 | μA |
| Under-Voltage Lockout | | | | | | |
| Threshold Voltage | V_{START} | $V_{SHDN} = V_{EN} = 3\text{V}$ for SC1302A/B/C, $V_{INA} = V_{INB} = 3\text{V}$ | 4.2 | 4.5 | 4.7 | V |
| Hysteresis | | $V_{SHDN} = V_{EN} = 3\text{V}$ for SC1302A/B/C, $V_{INA} = V_{INB} = 3\text{V}$ | 250 | 320 | 475 | mV |
| Enable for SC1302A/B/C | | | | | | |
| Enable Voltage | V_{EN} | $0 < V_{EN} < V_{CC}$ | 2.0 | | | V |
| Disable Voltage | V_{EN} | $0 < V_{EN} < V_{CC}$ | | | 0.8 | V |
| Delay to Output ⁽¹⁾ | t_{D_EN} | EN from low to high | | 70 | | ns |
| Delay to Output ⁽¹⁾ | t_{D_DIS} | EN from high to low | | 55 | | ns |
| Enable Input Current | I_{EN} | $0 < V_{IN} < V_{CC}$ | 10 | 14 | 19 | μA |

Electrical Characteristics (continued)

Unless otherwise specified, $-40^{\circ}\text{C} < T_A = T_J < 125^{\circ}\text{C}$, $V_{CC} = 12\text{V}$, $V_{IN} = 5\text{V}$, $V_{EN} = 5\text{V}$ (SC1302A/B/C), $V_{\overline{\text{SHDN}}} = 5\text{V}$ (SC1302A/B/C)

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---|------------------------------|---|-----|------|------|--------------------|
| Input | | | | | | |
| High Level Input Voltage | V_{IH} | $0 < V_{IN} < V_{CC}$ | 2.0 | | | V |
| Low Level Input Voltage | V_{IL} | $0 < V_{IN} < V_{CC}$ | | | 0.8 | V |
| Input Current | I_{IN} | $0 < V_{IN} < V_{CC}$, Non-inverting Input(s) of SC1302A/C/D/F | | 13 | 18.5 | μA |
| | | $0 < V_{IN} < V_{CC}$, Inverting Input(s) of SC1302B/C/E/F | | | -8 | μA |
| Output | | | | | | |
| Output Peak Current | I_{PK_SOURCE} | $V_{OUT} = 0.5\text{V}$, $t_{PW} < 10 \mu\text{s}$ | | 1600 | | mA |
| | I_{PK_SINK} | $V_{OUT} = V_{CC} - 0.5\text{V}$, $t_{PW} < 10 \mu\text{s}$ | | 1600 | | mA |
| Shutdown for SC1302A/B/C | | | | | | |
| $\overline{\text{SHDN}}$ Input Voltage High | $V_{\overline{\text{SHDN}}}$ | | 2 | | | V |
| $\overline{\text{SHDN}}$ Input Voltage Low | $V_{\overline{\text{SHDN}}}$ | | | | 0.3 | V |
| $\overline{\text{SHDN}}$ Pin current | $I_{\overline{\text{SHDN}}}$ | $V_{\overline{\text{SHDN}}} = 5\text{V}$ | | 32 | 40 | μA |
| Thermal Shutdown | | | | | | |
| Over Temperature Trip Point ⁽¹⁾ | T_{J_OT} | | | 150 | | $^{\circ}\text{C}$ |
| Hysteresis ⁽¹⁾ | | | | 10 | | $^{\circ}\text{C}$ |

AC Electrical Characteristics

Unless otherwise specified, $T_A = T_J = 25^{\circ}\text{C}$, $V_{CC} = 12\text{V}$, $V_{EN} = 5\text{V}$, $C_L = 1000\text{pF}$

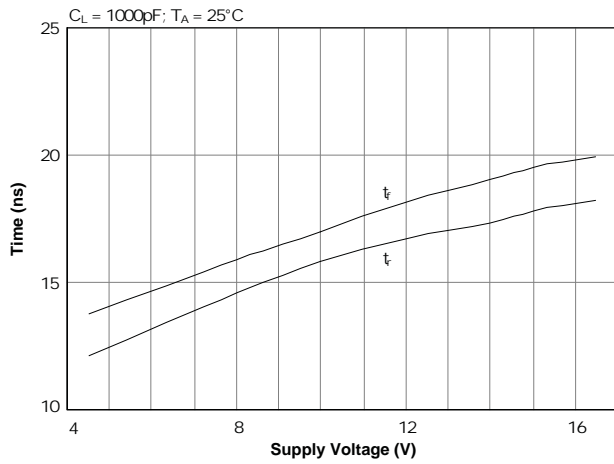
| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|---------------------------------------|----------|--|-----|-----|-----|-------|
| Rise Time ⁽¹⁾ | t_R | See Timing Diagram | | 20 | | ns |
| Fall Time ⁽¹⁾ | t_F | See Timing Diagram | | 20 | | ns |
| Propagation Delay Time ⁽¹⁾ | t_{D1} | $T_A = -40^{\circ}\text{C} \sim 125^{\circ}\text{C}$ | | 53 | 70 | ns |
| Propagation Delay Time ⁽¹⁾ | t_{D2} | $T_A = -40^{\circ}\text{C} \sim 125^{\circ}\text{C}$ | | 41 | 60 | ns |

Notes:

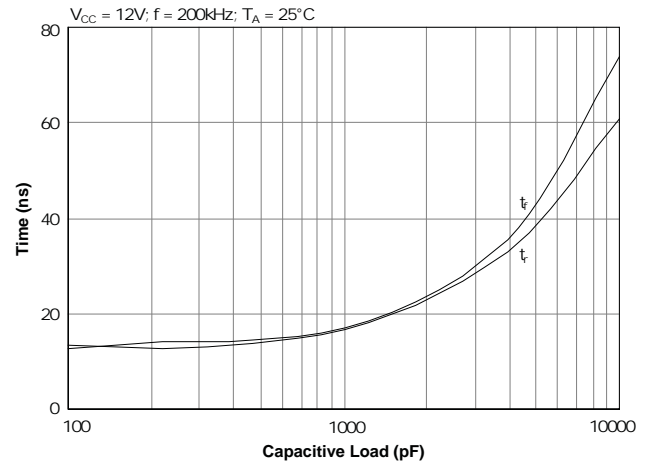
- (1) Guaranteed by design
- (2) Negative sign indicates that the input current flows out of the device.

Typical Characteristics

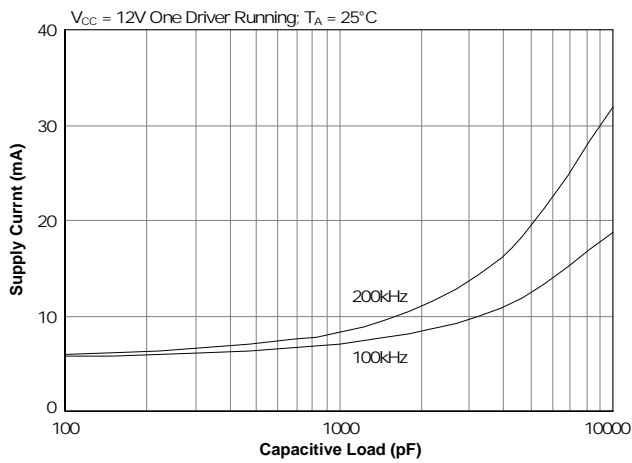
Rise and Fall Time vs. Supply Voltage



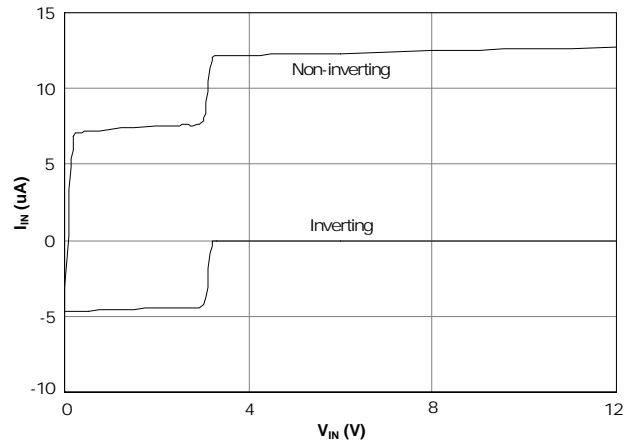
Rise and Fall Time vs. Capacitive Load



Supply Current vs. Capacitive Load



Input Pin Current

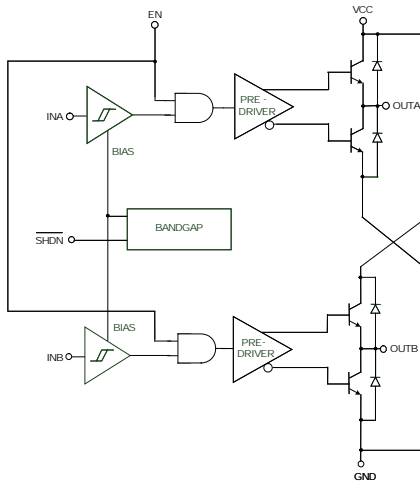


Pin Descriptions

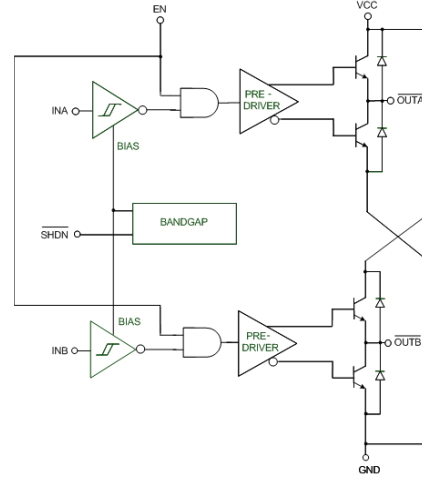
| Pin # | SC1302A/D | SC1302B/E | SC1302C/F | Pin Function |
|-------|-----------------------------|-----------------------------|-----------------------------|--|
| 1 | EN/NC | EN/NC | EN/NC | Enable/Disable Control — When the EN is driven low, both outputs are low. When left open, both outputs are low. Enable both drivers by tying EN pin to a voltage greater than 2V. No connection on versions D, E, and F. |
| 2 | INA | INA | INA | TTL compatible input to driver A — When left open, Pin 7 is low. |
| 3 | GND | GND | GND | Ground connection |
| 4 | INB | INB | INB | TTL compatible input to driver B — When left open, Pin 5 is low. |
| 5 | OUTB | $\overline{\text{OUTB}}$ | OUTB | Output gate drive B for external MOSFET |
| 6 | VCC | VCC | VCC | Supply: +4.5V to +16.5V supply. During UVLO the outputs are held low. |
| 7 | OUTA | $\overline{\text{OUTA}}$ | $\overline{\text{OUTA}}$ | Output gate drive A for external MOSFET |
| 8 | $\overline{\text{SHDN/NC}}$ | $\overline{\text{SHDN/NC}}$ | $\overline{\text{SHDN/NC}}$ | Shutdown pin — Apply a voltage from 2V to VCC to enable device. Pull below 0.3V for low-power shut down. No connection on versions D, E, and F. |

Block Diagram

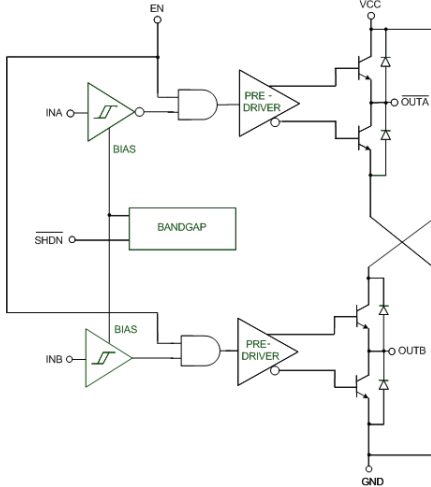
SC1302A



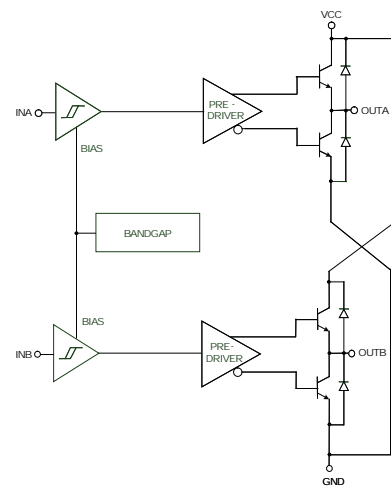
SC1302B



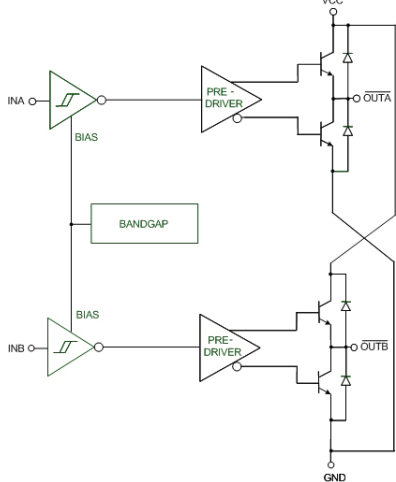
SC1302C



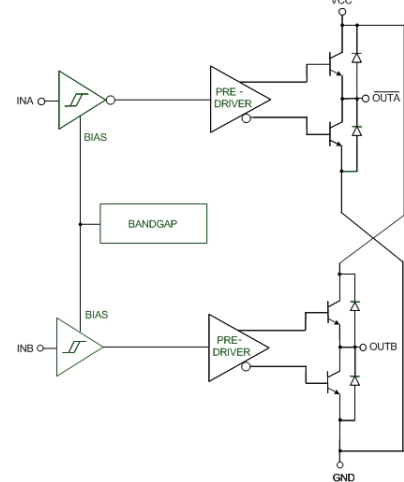
SC1302D



SC1302E



SC1302F



Applications Information

General Description

The SC1302A/B/C/D/E/F is a high speed, high peak current dual MOSFET driver. It is designed to drive power MOSFETs with ultra-low rise/fall time and propagation delays. As the switching frequency of PWM controllers is increased to reduce power converters volume and cost, fast rise and fall times are necessary to minimize switching losses. While a discrete solution can achieve reasonable drive capability, implementing delay and other housekeeping functions necessary for safe operation can become cumbersome and costly. The SC1302A/B/C/D/E/F presents a total solution for the high-speed, high-power density applications. Wide input supply range of 4.5V to 16.5V allows use in battery powered applications as well as distributed power systems.

Supply Bypass and Layout

A 4.7μF to 10μF tantalum bypass capacitor with low ESR (equivalent series resistance) and an additional 0.1μF ceramic capacitor in parallel are recommended as a supply bypass to control switching and supply transients.

As with any high speed, high current circuit, proper layout is critical in achieving optimum performance of the SC1302A/B/C/D/E/F. Attention should be paid to the proper placement of the driver, the switching MOSFET, and the bypass capacitors.

The driver should be placed as close as possible to the external MOSFETs to eliminate the possibility of oscillation caused by trace inductance and the MOSFET gate capacitance. A resistor in the range of 10ohm could be used in series with the gate drive to damp the ringing if the drive output path is not short enough. The bypass capacitors should also be placed closely between V_{CC} and GND of the driver. A Schottky diode may be used to connect the ground and the output pin to avoid latch-ups in some applications.

Drive Capability and Power Dissipation

The SC1302A/B/C/D/E/F is able to deliver 1.6A peak current for driving capacitive loads, such as MOSFETs.

Fast switching of the MOSFETs significantly reduces switching losses for high frequency applications. Thermal stress is reduced and system reliability is improved.

For simplicity, it is assumed that the gate capacitance of a MOSFET is constant. The power delivered from the power supply can be estimated based on this simplification. The energy needed to charge the capacitor is given by the following equation

$$E_{ON} = \frac{1}{2} \times C \times V^2$$

where C is the load capacitance and V is the output voltage swing of the driver.

During turn off, the same amount of energy is dumped to the ground. Therefore, the energy dissipated in one switching cycle is:

$$E_{TOTAL} = C \times V^2$$

The power dissipation due to the gate driving actions is given by:

$$P_{GATE} = f \times C \times V^2$$

where, f is the switching frequency. With $V_{CC} = 12V$, $C = 1nF$ and $f = 200kHz$, the power dissipation per output is:

$$P_{GATE} = (200kHz) \times (1nF) \times (12)^2 = 29mW$$

The corresponding supply current is:

$$I = \frac{P_{GATE}}{V_{CC}} = \frac{29mW}{12V} = 2.4mA$$

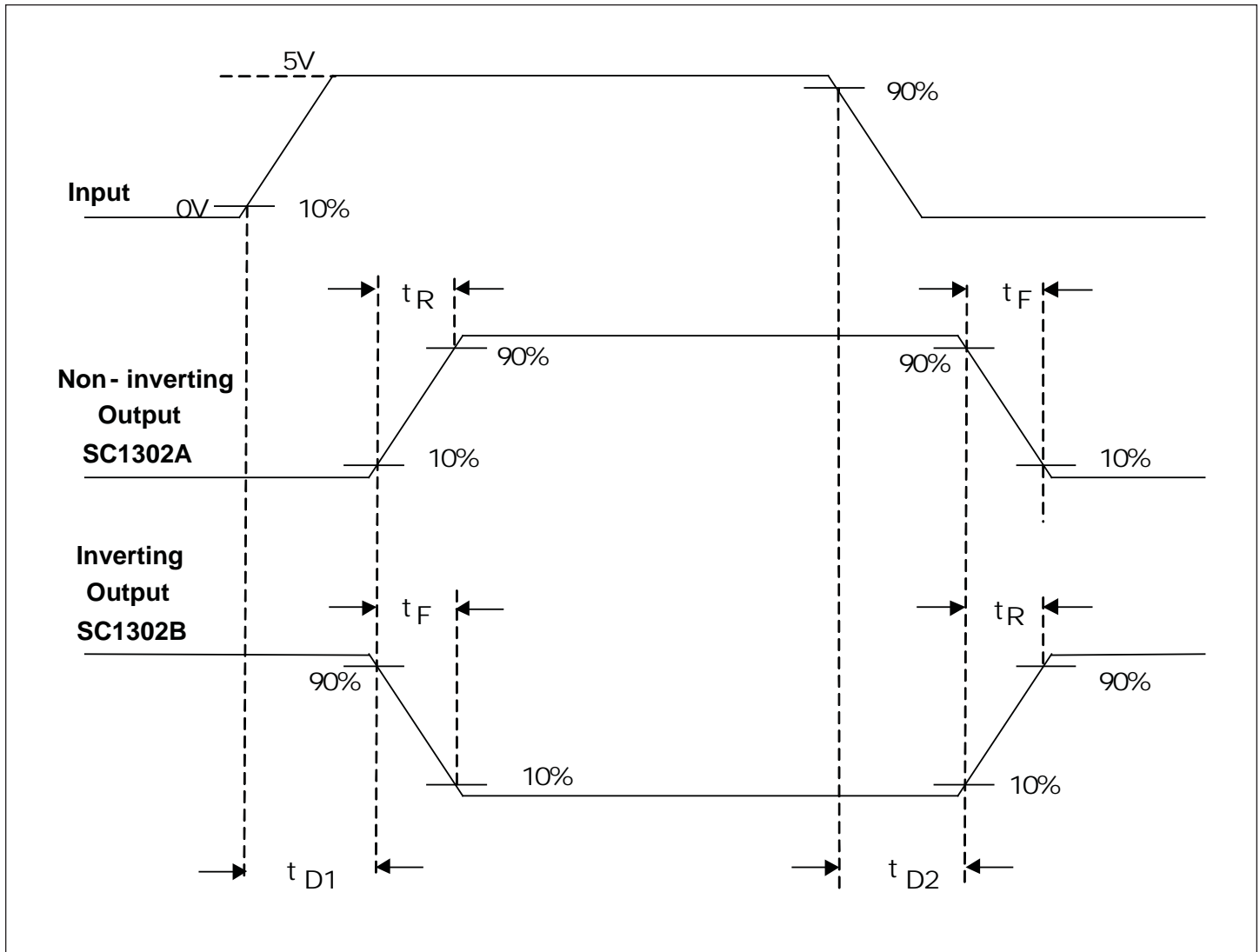
Thermal Information

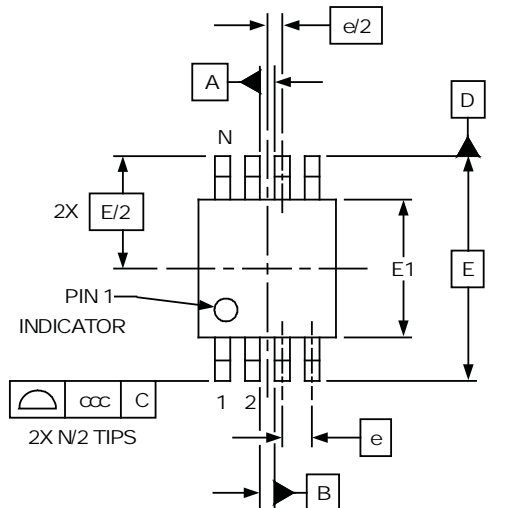
The driver's junction temperature must be kept within the rated limit at any time. The application system has to effectively remove the heat generated in the driver in order for proper functions and performance. If the junction temperature reaches 150°C, the internal protection circuit will be triggered to shut down the gate driver.

The power dissipation of the SC1302A/B/C/D/E/F should be derated according to the following formula:

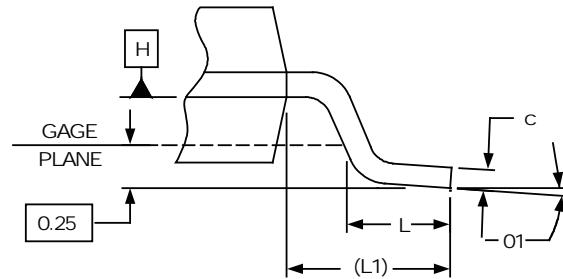
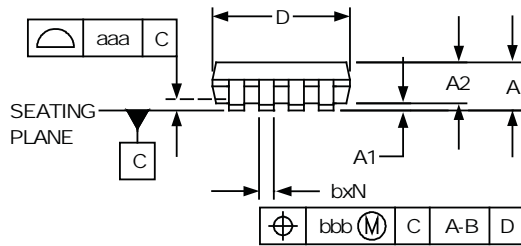
$$\text{PowerDissipation} < \frac{125^{\circ}\text{C} - T_A}{\theta_{jA}}$$

where T_A = ambient temperature.

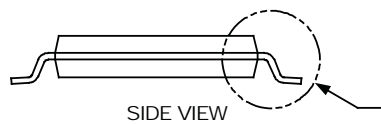
Timing Diagram


Outline Drawing — MSOP-8


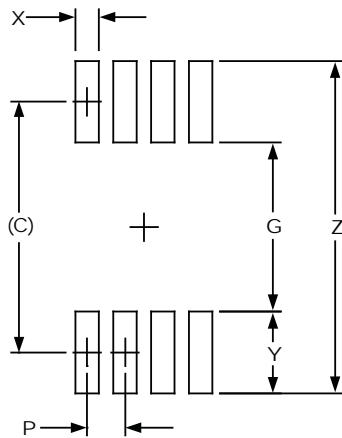
| DIM | DIMENSIONS | | | | | |
|-----|------------|------|------|-------------|------|------|
| | INCHES | | | MILLIMETERS | | |
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | - | - | .043 | - | - | 1.10 |
| A1 | .000 | - | .006 | 0.00 | - | 0.15 |
| A2 | .030 | - | .037 | 0.75 | - | 0.95 |
| b | .009 | - | .015 | 0.22 | - | 0.38 |
| c | .003 | - | .009 | 0.08 | - | 0.23 |
| D | .114 | .118 | .122 | 2.90 | 3.00 | 3.10 |
| E1 | .114 | .118 | .122 | 2.90 | 3.00 | 3.10 |
| E | .193 BSC | | | 4.90 BSC | | |
| e | .026 BSC | | | 0.65 BSC | | |
| L | .016 | .024 | .032 | 0.40 | 0.60 | 0.80 |
| L1 | (.037) | | | (.95) | | |
| N | 8 | | | 8 | | |
| -01 | 0° | - | 8° | 0° | - | 8° |
| aaa | .004 | | | 0.10 | | |
| bbb | .005 | | | 0.13 | | |
| ccc | .010 | | | 0.25 | | |



DETAIL A


NOTES:

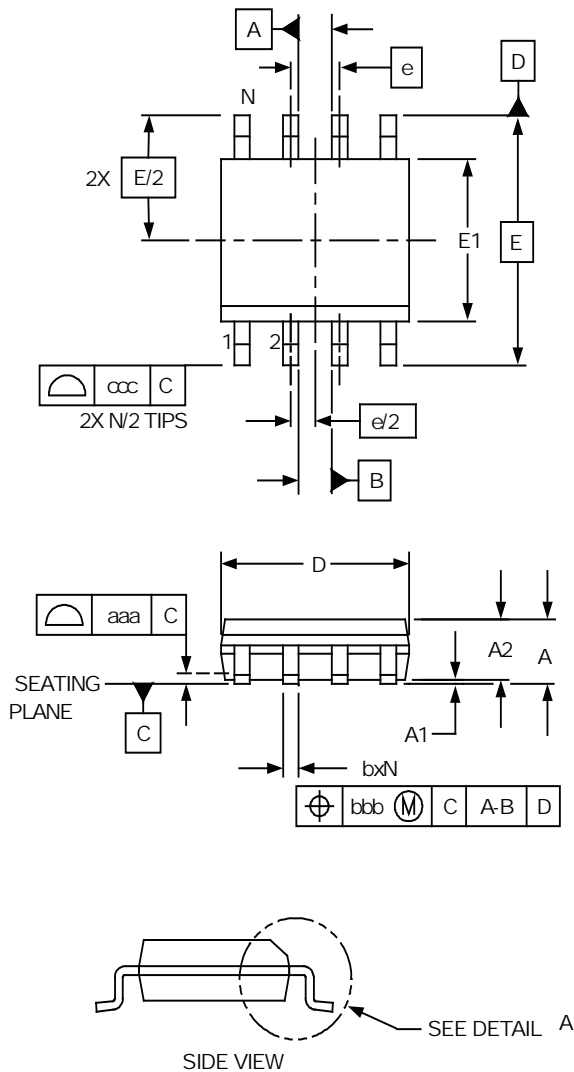
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. DATUMS **-A-** AND **-B-** TO BE DETERMINED AT DATUM PLANE **-H-**
3. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
4. REFERENCE JEDEC STD MO-187, VARIATION AA.

Land Pattern — MSOP-8


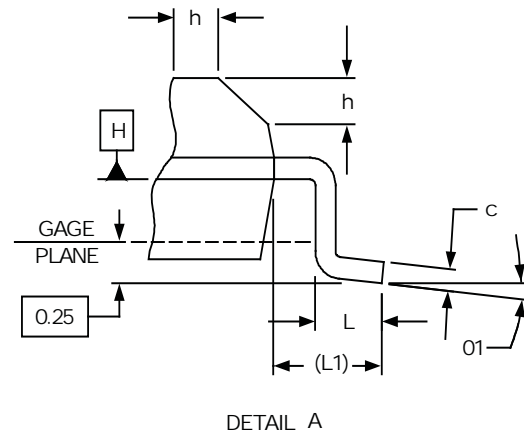
| DIMENSIONS | | |
|------------|--------|-------------|
| DIM | INCHES | MILLIMETERS |
| C | (.161) | (4.10) |
| G | .098 | 2.50 |
| P | .026 | 0.65 |
| X | .016 | 0.40 |
| Y | .063 | 1.60 |
| Z | .224 | 5.70 |

NOTES:

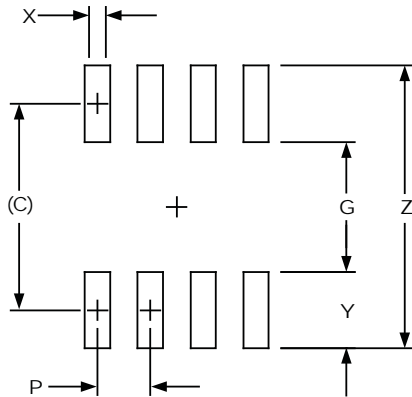
1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

Outline Drawing — SO-8


| DIM | DIMENSIONS | | | | | |
|-----|------------|------|------|-------------|------|------|
| | INCHES | | | MILLIMETERS | | |
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | .053 | - | .069 | 1.35 | - | 1.75 |
| A1 | .004 | - | .010 | 0.10 | - | 0.25 |
| A2 | .049 | - | .065 | 1.25 | - | 1.65 |
| b | .012 | - | .020 | 0.31 | - | 0.51 |
| c | .007 | - | .010 | 0.17 | - | 0.25 |
| D | .189 | .193 | .197 | 4.80 | 4.90 | 5.00 |
| E1 | .150 | .154 | .157 | 3.80 | 3.90 | 4.00 |
| E | .236 BSC | | | 6.00 BSC | | |
| e | .050 BSC | | | 1.27 BSC | | |
| h | .010 | - | .020 | 0.25 | - | 0.50 |
| L | .016 | .028 | .041 | 0.40 | 0.72 | 1.04 |
| L1 | (.041) | | | (1.04) | | |
| N | 8 | | | 8 | | |
| -01 | 0° | - | 8° | 0° | - | 8° |
| aaa | .004 | | | 0.10 | | |
| bbb | .010 | | | 0.25 | | |
| ccc | .008 | | | 0.20 | | |


NOTES:

- CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
- DATUMS **-A-** AND **-B-** TO BE DETERMINED AT DATUM PLANE **-H-**
- DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
- REFERENCE JEDEC STD MS-012, VARIATION AA.

Land Pattern — SO-8


| DIMENSIONS | | |
|------------|--------|-------------|
| DIM | INCHES | MILLIMETERS |
| C | (.205) | (5.20) |
| G | .118 | 3.00 |
| P | .050 | 1.27 |
| X | .024 | 0.60 |
| Y | .087 | 2.20 |
| Z | .291 | 7.40 |

NOTES:

1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.
2. REFERENCE IPC-SM-782A, RLP NO. 300A.

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