

### POWER MANAGEMENT

#### Description

The SC1156 is a low-cost, full featured synchronous, voltage-mode controller designed for use in single ended power supply applications where efficiency is of primary concern. Synchronous operation allows for the elimination of heat sinks in many applications. The SC1156 is ideal for implementing DC/DC converters needed to power advanced microprocessors such as Pentium® II (Klamath), in both single and multiple processor configurations. Internal level-shift, high-side drive circuitry, and preset shoot-thru control, allows for use of inexpensive n-channel power switches.

SC1156 features include an integrated 5-bit VID DAC, temperature compensated voltage reference, triangle wave oscillator, current limit comparator, frequency shift over-current protection, and an accessible, internally compensated error amplifier. Power good signaling, logic compatible shutdown, and over voltage protection are also provided.

The SC1156 operates at a fixed 200KHz, providing an optimum compromise between efficiency, external component size, and cost.

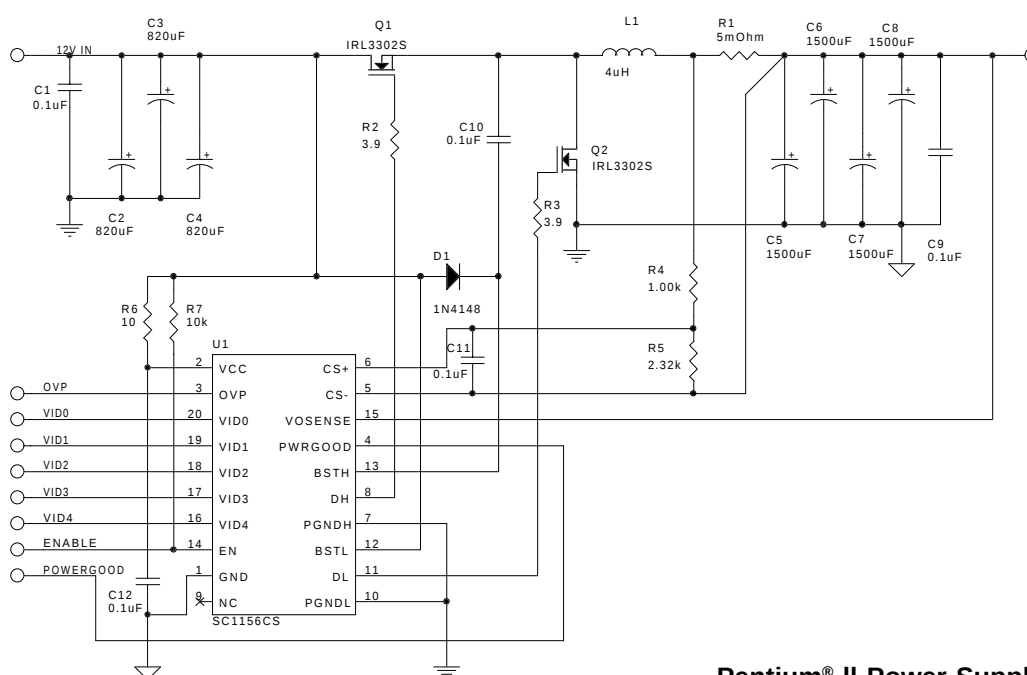
#### Features

- ◆ Low cost / full featured
- ◆ Synchronous operation
- ◆ 5 Bit VID DAC programmable output
- ◆ On-chip power good and OVP functions
- ◆ Designed to meet Intel VRM8.1 (Klamath)

#### Applications

- ◆ Pentium® II (Klamath) Core Supply
- ◆ Multiple MicroProcessor Supplies
- ◆ Voltage Regulation Modules (VRM)
- ◆ Programmable Power Supplies
- ◆ High Efficiency DC/DC Conversion

#### Typical Application Circuit



**Pentium® II Power Supply**

**POWER MANAGEMENT**
**Absolute Maximum Ratings**

| Parameter                              | Symbol        | Maximum     | Units |
|----------------------------------------|---------------|-------------|-------|
| VCC to GND                             | $V_{IN}$      | -0.3 to +15 | V     |
| PGND to GND                            |               | +1          | V     |
| BST to GND                             |               | -0.3 to +26 | V     |
| Operating Temperature Range            | $T_A$         | 0 to +70    | °C    |
| Junction Temperature Range             | $T_J$         | 0 to +125   | °C    |
| Storage Temperature Range              | $T_{STG}$     | -65 to +50  | °C    |
| Thermal Resistance Junction to Case    | $\theta_{JC}$ | 30          | °C/W  |
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | 95          | °C/W  |
| Lead Temperature (Soldering) 10 Sec.   | $T_{LEAD}$    | 300         | °C    |

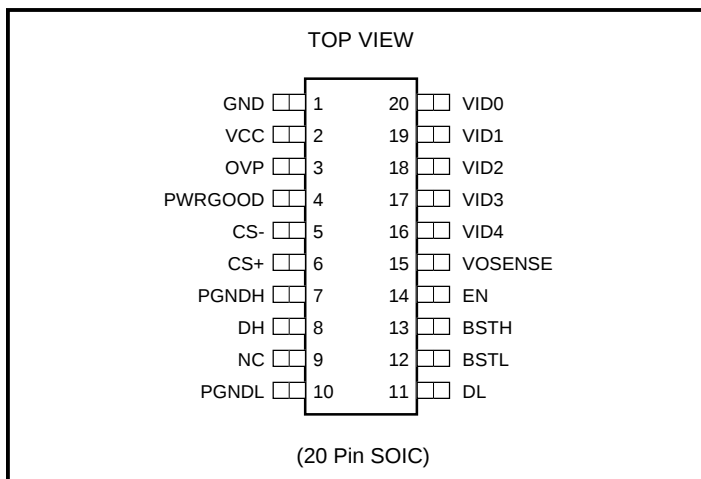
**Electrical Characteristics**

(Unless otherwise noted:  $V_{CC} = 11.4V$  to  $12.6V$ ;  $GND = PGND = 0V$ ;  $FB = V_O$ ;  $0mV < (CS+ - CS-) < 60mV$ ;  $T_J = 25^\circ C$  )

| Parameter                    | Conditions                        | Min                      | Typ | Max | Units |
|------------------------------|-----------------------------------|--------------------------|-----|-----|-------|
| Output Voltage               | $I_O = 2A^{(1)}$                  | See Output Voltage Table |     |     |       |
| Supply Voltage               | $V_{CC}$                          | 4.2                      |     | 15  | V     |
| Supply Current               | $V_{CC} = 12.0V$                  |                          | 5   |     | mA    |
| Load Regulation              | $I_O = 0.3A$ to $15A^{(1)}$       |                          | 1   |     | %     |
| Line Regulation              | All VID codes <sup>(1)</sup>      |                          | 0.5 |     | %     |
| Gain (AOL)                   | VOSENSE to $V_O$                  |                          | 35  |     | dB    |
| Current Limit Voltage        |                                   | 60                       | 70  | 80  | mV    |
| Oscillator Frequency         |                                   | 180                      | 200 | 220 | kHz   |
| Oscillator Max Duty Cycle    |                                   |                          | 95  |     | %     |
| DH Sink/Source Current       | BSTH - DH = 4.5V, DH - PGNDH = 2V | 1                        |     |     | A     |
| DL Sink/Source Current       | BSTL - DL = 4.5V, DL - PGNDL = 2V | 1                        |     |     | A     |
| OVP threshold Voltage        |                                   |                          | 120 |     | %     |
| OVP source current           | $V_{OVP} = 3V$                    | 10                       |     |     | mA    |
| Power good threshold voltage |                                   | 90                       |     | 110 | %     |
| Dead time                    |                                   | 50                       | 100 |     | ns    |

**NOTE:**

(1) Specification refers to Typical Application Circuit

**POWER MANAGEMENT**
**Pin Configuration**

**Ordering Information**

| Device <sup>(1)</sup> | Package | Temp Range (T <sub>j</sub> ) |
|-----------------------|---------|------------------------------|
| SC1156SW.TR           | SO-20   | 0° to 125°C                  |

Note:

(1) Only available in tape and reel packaging. A reel contains 1000 devices.

**Pin Descriptions**

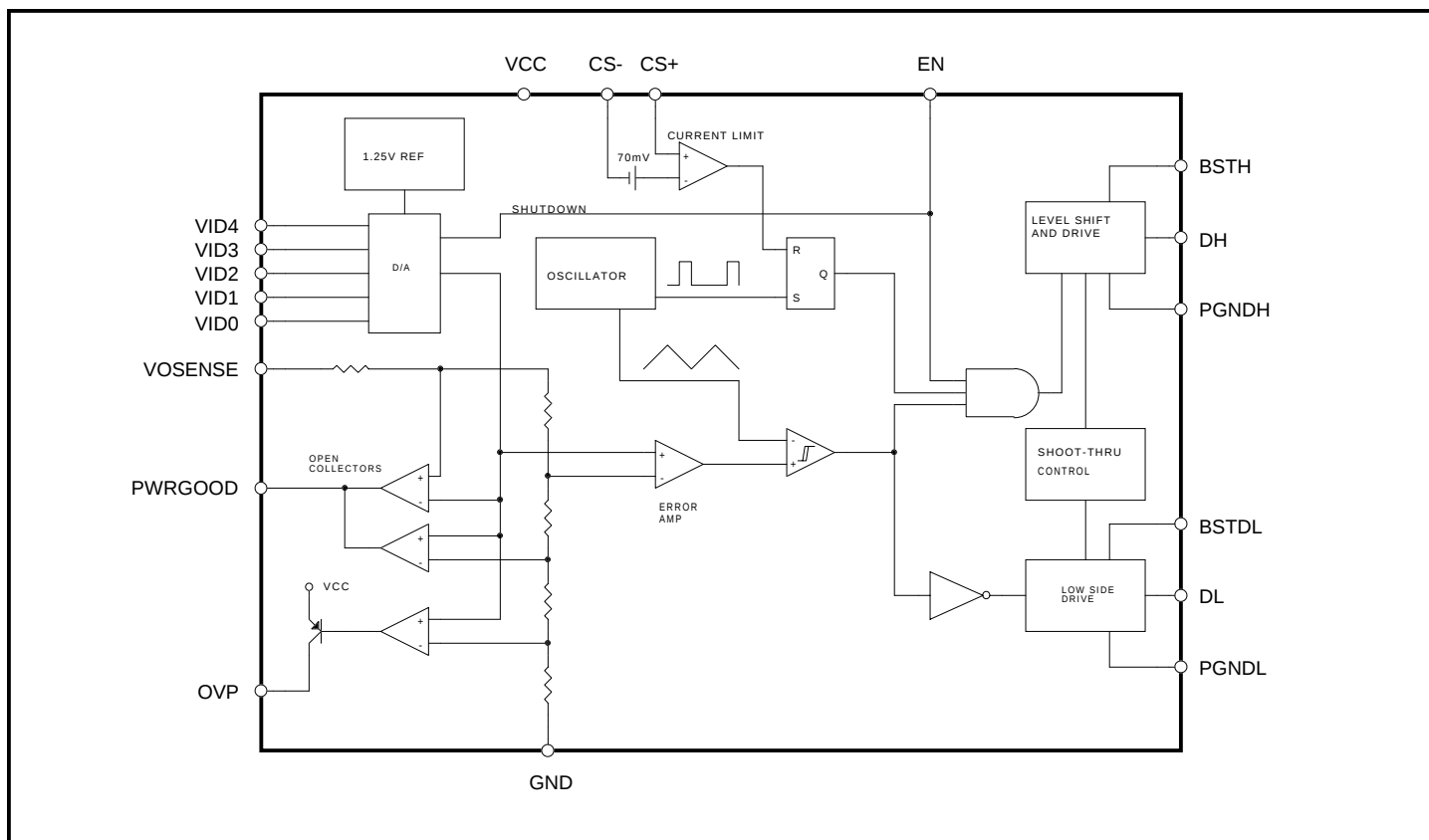
| Pin # | Pin Name               | Pin Function                                                               |
|-------|------------------------|----------------------------------------------------------------------------|
| 1     | GND                    | Small Signal Analog and Digital Ground                                     |
| 2     | VCC                    | Chip Supply Voltage                                                        |
| 3     | OVP                    | High Signal out if V <sub>o</sub> > setpoint + 20%                         |
| 4     | PWRGOOD <sup>(1)</sup> | Open collector logic output, high if V <sub>o</sub> within 10% of setpoint |
| 5     | CS-                    | Current Sense Input (negative)                                             |
| 6     | CS+                    | Current Sense Input (positive)                                             |
| 7     | PGNDH                  | Power Ground for High Side Switch                                          |
| 8     | DH                     | High Side Driver Output                                                    |
| 9     | NC                     | Not Connected                                                              |
| 10    | PGNDL                  | Power Ground for Low Side Switch                                           |
| 11    | DL                     | Low Side Driver Output                                                     |
| 12    | BSTL                   | Vcc for Low Side Driver (Boost)                                            |
| 13    | BSTH                   | Vcc for High Side Driver (Boost)                                           |
| 14    | EN <sup>(1)</sup>      | Logic low shuts down the converter                                         |
| 15    | VOSENSE                | Feedback                                                                   |
| 16    | VID4 <sup>(1)</sup>    | Programming Input (MSB)                                                    |
| 17    | VID3 <sup>(1)</sup>    | Programming Input                                                          |
| 18    | VID2 <sup>(1)</sup>    | Programming Input                                                          |
| 19    | VID1 <sup>(1)</sup>    | Programming Input                                                          |
| 20    | VID0 <sup>(1)</sup>    | Programming Input (LSB)                                                    |

**NOTE:**

(1) All logic inputs and outputs are open collector TTL compatible.

## POWER MANAGEMENT

### Block Diagram



### Theory of Operation

The D/A Converter generates an output voltage determined by an internal trimmed bandgap voltage reference and the status of the VID0 through VID4 inputs. This voltage is applied to the non-inverting input of the error amplifier, the inverting input of the error amplifier is fed from the VOSENSE pin via a precision resistor divider. The error amplifier itself is a transconductance amplifier with an internal load resistor. The open loop gain is internally set to approximately 40 dB.

The internal oscillator uses an on-chip capacitor and a trimmed precision current source to set the frequency of oscillation to 200 kHz. The triangular output of the oscillator is compared to the output of the error amplifier. The output of the PWM comparator is a pulse width modulated signal whose duty cycle increases as the voltage at the VOSENSE pin decreases.

The output of the current limit comparator goes high when

its input voltage exceeds approximately 70mV, this sets the current limit latch, immediately terminating the current ON time. The current limit latch is reset in the middle of the OFF time when the triangular wave oscillator reaches its highest point.

When the output of the PWM comparator is high, output DH is driven high, provided that the VID code is valid, the current limit latch has not been set and the Enable (EN) pin is not pulled low. When the PWM comparator output is low DL is always driven high.

The Shoot-through control circuitry modifies the DH and DL waveforms slightly, ensuring that there is a short delay between one turning OFF and the other turning ON. This ensures that the ON times of the external FETs driven by DH and DL do not overlap.

**POWER MANAGEMENT**
**Output Voltage Table**

Unless otherwise noted:  $V_{CC} = 4.75V$  to  $5.25V$ ;  $GND = PGND = 0V$ ;  $FB = V_O$ ;  $0mV < (CS+ - CS-) < 60mV$ ;  $T_J = 25^\circ C$

| Parameter                     | Conditions                                   | VID<br>43210 | Min   | Typ   | Max   | Units |
|-------------------------------|----------------------------------------------|--------------|-------|-------|-------|-------|
| Output Voltage <sup>(1)</sup> | $I_O = 2A$ in Application circuit (Figure 1) | 00101        | 1.782 | 1.800 | 1.818 | V     |
|                               |                                              | 00100        | 1.832 | 1.850 | 1.868 |       |
|                               |                                              | 00011        | 1.881 | 1.900 | 1.919 |       |
|                               |                                              | 00010        | 1.931 | 1.950 | 1.969 |       |
|                               |                                              | 00001        | 1.980 | 2.000 | 2.020 |       |
|                               |                                              | 00000        | 2.030 | 2.050 | 2.070 |       |
|                               |                                              | 11111        | 1.980 | 2.000 | 2.020 |       |
|                               |                                              | 11110        | 2.079 | 2.100 | 2.121 |       |
|                               |                                              | 11101        | 2.178 | 2.200 | 2.222 |       |
|                               |                                              | 11100        | 2.277 | 2.300 | 2.323 |       |
|                               |                                              | 11011        | 2.376 | 2.400 | 2.424 |       |
|                               |                                              | 11010        | 2.475 | 2.500 | 2.525 |       |
|                               |                                              | 11001        | 2.574 | 2.600 | 2.626 |       |
|                               |                                              | 11000        | 2.673 | 2.700 | 2.727 |       |
|                               |                                              | 10111        | 2.772 | 2.800 | 2.828 |       |
|                               |                                              | 10110        | 2.871 | 2.900 | 2.929 |       |
|                               |                                              | 10101        | 2.970 | 3.000 | 3.030 |       |
|                               |                                              | 10100        | 3.069 | 3.100 | 3.131 |       |
|                               |                                              | 10011        | 3.168 | 3.200 | 3.232 |       |
|                               |                                              | 10010        | 3.267 | 3.300 | 3.333 |       |
|                               |                                              | 10001        | 3.366 | 3.400 | 3.434 |       |
|                               |                                              | 10000        | 3.465 | 3.500 | 3.535 |       |

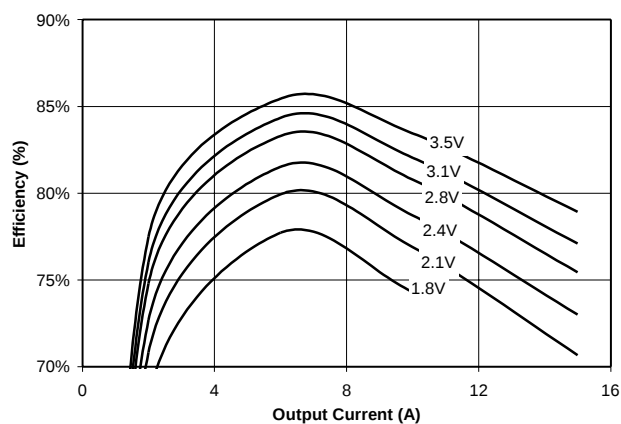
**NOTE:**

(1) All VID codes not specifically listed are invalid and cause shutdown exactly as if the shutdown pin had been asserted.

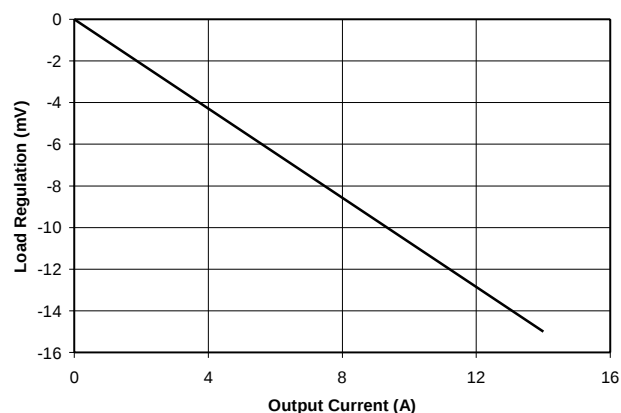
## POWER MANAGEMENT

### Characteristic Curves

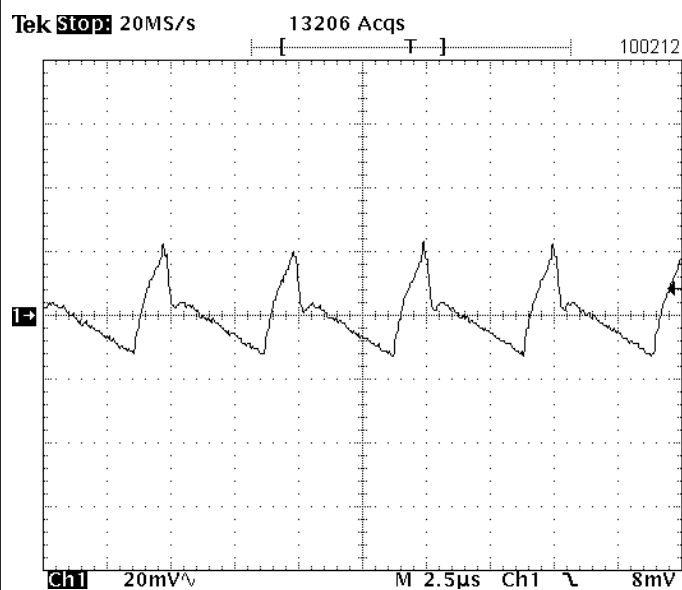
SC1156 Efficiency in Application Circuit



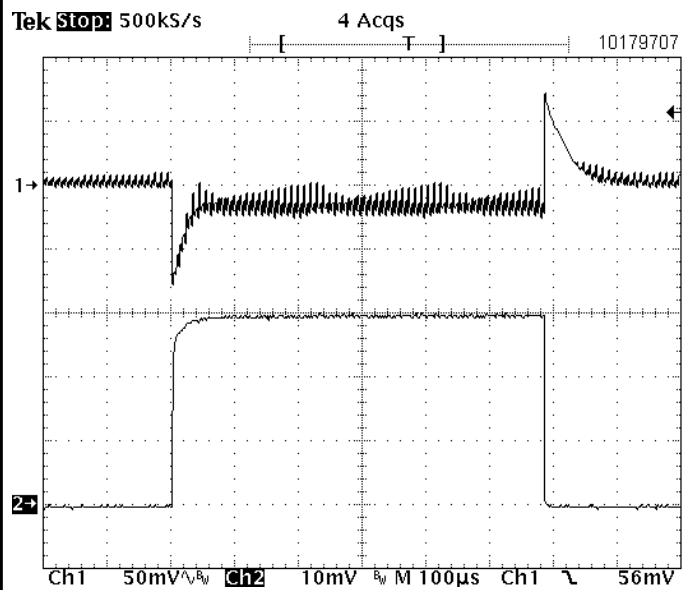
SC1156 Regulation in Application Circuit

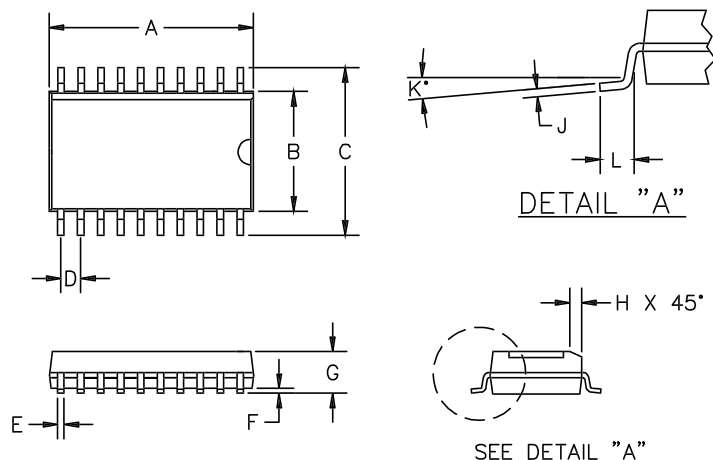


Ripple at  $V_o=2.00V$ ;  $I_o=15A$  in Application circuit



Transient at  $V_o=2.00V$ ;  $I_o=0$  to 15A in App. circuit

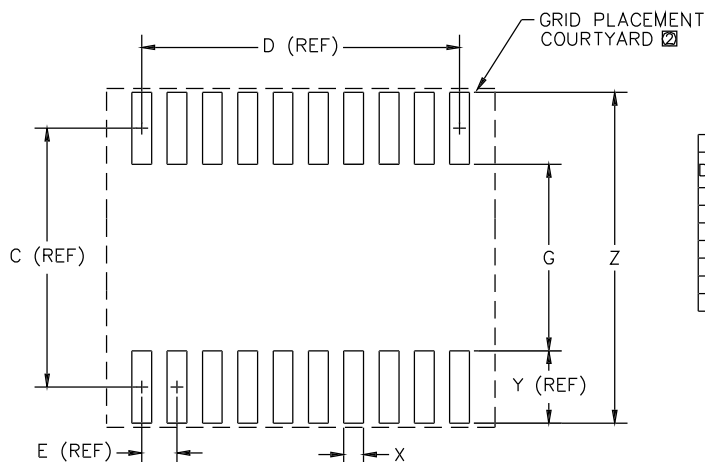


**POWER MANAGEMENT**
**Outline Drawing - SO-20**


| DIMENSIONS ①     |        |      |      |       |      |
|------------------|--------|------|------|-------|------|
| DIM <sup>N</sup> | INCHES |      | MM   |       | NOTE |
|                  | MIN    | MAX  | MIN  | MAX   |      |
| A                | .496   | .512 | 12.6 | 13.0  | ②    |
| B                | .291   | .299 | 7.40 | 7.60  | ②    |
| C                | .394   | .419 | 10.0 | 10.65 | —    |
| D                | .050   | BSC  | 1.27 | BSC   | —    |
| E                | .013   | .020 | 0.33 | 0.51  | —    |
| F                | .004   | .012 | .10  | .30   | —    |
| G                | .092   | .104 | 2.35 | 2.65  | —    |
| H                | .010   | .030 | .25  | .75   | —    |
| J                | .009   | .013 | .23  | .32   | —    |
| K                | 0°     | 8°   | 0°   | 8°    | —    |
| L                | .016   | .050 | .40  | 1.27  | —    |

- ② DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTUSIONS  
 ① CONTROLLING DIMENSION : MILLIMETERS.

Ref. MS-013AC

**Land Pattern - SO-20**


| DIMENSIONS ②     |        |      |       |       |      |
|------------------|--------|------|-------|-------|------|
| DIM <sup>N</sup> | INCHES |      | MM    |       | NOTE |
|                  | MIN    | MAX  | MIN   | MAX   |      |
| C                | —      | .362 | —     | 9.20  | —    |
| D                | —      | .45  | —     | 11.43 | —    |
| E                | —      | .05  | —     | 1.27  | —    |
| G                | .260   | .268 | 6.60  | 6.80  | —    |
| X                | .02    | .03  | .60   | .80   | —    |
| Y                | —      | .102 | —     | 2.60  | —    |
| Z                | .457   | .465 | 11.60 | 11.80 | —    |

- ② GRID PLACEMENT COURTYARD IS 28 X 24 ELEMENTS  
 (14mm X 12mm) IN ACCORDANCE WITH THE  
 INTERNATIONAL GRID DETAILED IN IEC PUBLICATION 97.  
 ① CONTROLLING DIMENSION: MILLIMETERS.

**Contact Information**

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