



# SD3102F2

## LED Digital Display Meter IC DC instantaneous value and AC true rms value

### Features

- Maximum display: -19999~29999
- Conversion rate: 0.8~8Hz
- Range: fixed range (support user setting)
- Operating voltage: 2.5~3.6V
- AC rectification: built-in true RMS processor
- Display: common cathode LED digital display
- Temperature drift performance: 40ppm/°C (supports external reference input)
- Measurement type: AC/DC voltage, AC/DC current
- Other types: support transformer, current shunt
- Other functions: filter settings, upper and lower limits, etc.
- Zero adjustment: support zero clearing
- Supports common ground for signal and power
- Supports key menu programming
- Calibration mode: support digital calibration (default 100mV calibration), potentiometer trimming, and menu trimming

### Description

SD3102F2 has a built-in high precision low-noise analog-to-digital converter ( $\Sigma\Delta$ -ADC) that can measure up to 99,999 counts stable readings.

With the built-in digital signal processor (DSP),

SD3102F2 can achieve 400Hz bandwidth true RMS measurement without any external rectification components. The overall accuracy is better than class 0.5.

Built-in function menu allows for advanced features such as modifying measurement range, changing AC/DC measurement modes, setting display range, modifying filter coefficients, and calibration.

Built-in amplifier supports up to 16x gain setting, thus reducing the current sampling resistor power dissipation in high-current detection application. It supports zero trimming, which can effectively filter out signal interference.

Built-in self-test and calibration algorithm simplifies the calibration process. Calibration value is stored inside the chip with 100mV as the default value. User can adjust this value through menu or potentiometer.

Production tool is provided to automate menu parameters configuration, thus saving operation time at production.

### Applications

Digital display meter

High precision AC/DC digital display meter

High precision signal detection

### Ordering Information

SSOP28 package

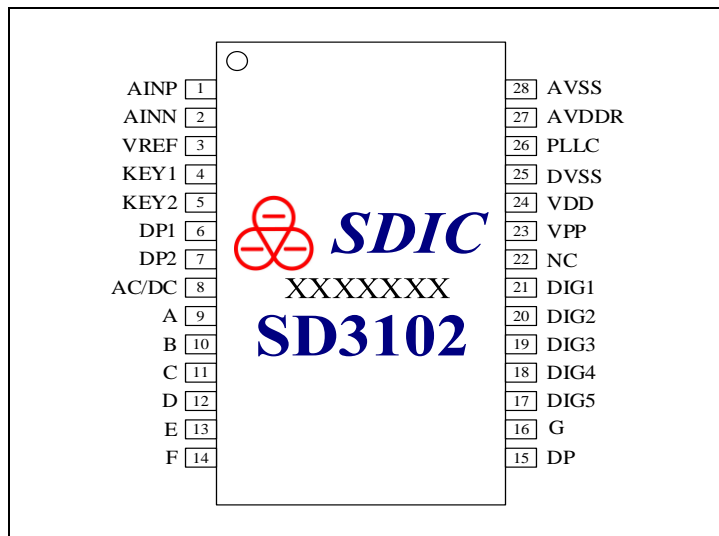
**Pin Diagram**


Figure 1. Pin out diagram

## Pin Descriptions

Table 1. Pin Descriptions

| Pin No. | Pin Name | Descriptions   |
|---------|----------|--|
| 1       | AINP     | Analog signal input positive terminal  |
| 2       | AINN     | Analog signal input negative terminal  |
| 3       | VREF     | Reference voltage. Connects to 0.1 $\mu$ F and 10 $\mu$ F to AVSS. Supports external voltage reference input |
| 4       | KEY1     | Key Input 1 or calibration enable control  |
| 5       | KEY2     | Key Input 2 or calibration enable control  |
| 6       | DP1      | Range select 1   |
| 7       | DP2      | Range select 2   |
| 8       | AC/DC    | AC / DC switch   |
| 9       | A        | LED segment A  |
| 10      | B        | LED segment B  |
| 11      | C        | LED segment C  |
| 12      | D        | LED segment D  |
| 13      | E        | LED segment E  |
| 14      | F        | LED segment F  |
| 15      | DP       | LED segment DP   |
| 16      | G        | LED segment G  |
| 17      | DIG5     | LED drive common terminal 5 or display digits selection  |
| 18      | DIG4     | LED drive common terminal 4  |
| 19      | DIG3     | LED drive common terminal 3  |
| 20      | DIG2     | LED drive common terminal 2  |
| 21      | DIG1     | LED drive common terminal 1  |
| 22      | NC       | No connect, do not connect to any external circuit   |
| 23      | VPP      | Connect 1 $\mu$ F to DVSS  |
| 24      | VDD      | Power supply, connect 0.1 $\mu$ F to DVSS  |
| 25      | DVSS     | Digital ground   |
| 26      | PLLC     | PLL capacitor, connect 1nF to DVSS   |
| 27      | AVDDR    | Internal LDO output for IC's analog modules, connect 1 $\mu$ F to AVSS                                       |
| 28      | AVSS     | Analog ground  |

## Measurement signal

DC voltage: 300.00mV / 3.0000V / 30.000V / 300.00V / 1000.0V

AC voltage: 300.00mV / 3.0000V / 30.000V / 300.00V / 1000.0V

DC current: 30.000μA/300.00μA/3.0000mA / 30.000mA / 300.00mA / 3.0000A / 10.000A

AC current: 30.000μA/300.00μA/3.0000mA / 30.000mA / 300.00mA / 3.0000A / 10.000A

## Function definition

### Measurement Range setting

Decimal point position is set through the DP menu or DP2/1 pins.

DP menu settings: 0 means 0 digit behind decimal point, 1 means 1 digit behind decimal point. One can set a maximum of 4 digits (in 5-digit display mode). 5 means that the decimal point position is set by the DP2/1 pins as shown in Table 2. DP default value is 5.

Table 2. Measurement range setting

| Five-digit display | Four-digit display | DP2 | DP1 |
|--------------------|--------------------|-----|-----|
| X.XXXX             | X.XXX              | 0   | 0   |
| XX.XXX             | XX.XX              | 0   | 1   |
| XXX.XX             | XXX.X              | 1   | 0   |
| XXXX.X             | XXXX               | 1   | 1   |

Remark: DP2/1 pins are pulled up internally, 0 for grounding, 1 for floating.

### AC / DC measurement selection

Switch between AC or DC measurement mode through the AC/DC pin level or the Type menu.

Type menu settings:

0: DC measurement mode;

1: AC measurement mode;

2 (default): measurement mode through the AC/DC pin level, grounding for AC mode, and floating for DC mode.

### Number of display digits selection

Switch between 4 or 5 display digits through the DIG5 pin level or the LED menu.

LED command settings:

0: 4 display digits;

1: 5 display digits;

2 (default): display digits through the LED pin level, grounding for 4 digits, floating or connected to the LED display common terminal for 5-digits.

### Switch

KEY1 / KEY2 pins accommodate 4 switches: UP, DOWN, LEFT and SET. Refer to the switch circuit section in Figure 2 for detail.

The switches are used for menu selection, programming and calibration operations.

UP

- Enter the menu and short press to cycle up the menu items;

- Enter the menu parameter setting and short press to increase the cursor setting value;
- Long press the up power until CALL is displayed. The instrument enters calibration mode. Normal measurement mode is restored after re-powering;

**DOWN**

- Enter the menu and short press to cycle down the menu items;
- Enter the menu item parameter setting and short press to decrease the cursor setting value;

**LEFT**

- Enter the menu item parameter setting and short press to cycle left;

**SET**

- Long press to enter the menu, long press again to exit;
- In menu mode, short press to enter the current menu item parameter setting. After parameter modification, short press to confirm and display the next menu item;
- During measurement, short press to hold the current value. (HOLD)

**UP+LEFT**

- Under normal measurement mode, long press UP+LEFT about 5s to enter the Offset/Gain repair mode.

**MENU**

Instrument supports function parameter setting. The adjusted parameters are stored inside the IC. By default, each parameter can be modified 100 times.

**HrnG**

The display value corresponding to the calibration high.

Parameter range: 00000 ~ 99999 (five digit), 0000 ~ 9999 (four digit)

Default parameter: 20000 (five digit), 2000 (four digit)

Remarks: In order to ensure better accuracy, it is recommended to use the full scale point as a high point calibration point. For example, when using a 20V range, use a 20V signal for calibration, and set HrnG to 20.000.

**LrnG**

The display value corresponding to the calibration low.

Parameter range: -19999 ~ 99999 (five digit), -999 ~ 9999 (four digit)

Default parameter: 00000 (five digit), 0000 (four digit)

Remarks: In order to ensure better accuracy, it is recommended to use the low point as a low point calibration point. For example, when using a 20V range, use a 0V signal for calibration, and set LrnG to 00.000.

**Span**

Display range settings, indicate the quantity limit.

Parameter range: 00000 ~ 99999 (five digit), 0000 ~ 9999 (four digit)

Default parameter: 99999 (five digit), 9999 (four digit)

Remarks: "OL" will be displayed when the measurement result's absolute value exceeds the SPAN setting. "-1" will be displayed when the measurement result is lower than -19999. This indicates that the display range is exceeded.

**CTK**

Transformer multiplier setting.

Range: 0~50 (Step value: 5)

Default parameters: 0 (Off)

#### CLK

Shunt Multiplier Setting. Default value is 75mV.

Range: 0~100 (Step value: 10)

Default parameters: 0 (Off)

#### OPEN

Adjust the zero threshold, zero menu, zero treatment in floating state;

Parameter range: 0-99,

Default value 2

Remarks: such as -200.0 ~ 200.0mv range, default -0.2 ~ 0.2mv display 0.

#### FILT

Filter coefficient. Change the refreshing rate of the displayed results;

Range: 0~9

Default parameters: 2 for AC and 1 for DC (First time power on)

Remark: Increase the filter coefficient value to obtain stable reading when the signal noise is large and the measurement result is unstable. Data output rate calculation:  $8 / (\text{filter coefficient} + 1)$  Hz.

#### Fran

The scope of the filter threshold to improve the response speed of the rapid change voltage current signal;

Parameter range: 1 ~ 100

Default parameter: 10

Remarks: The larger the value, the less sensitive it is to signal changes. Filtering process is performed on 10% of the full scale range signal by default.

#### PGA

The internal amplifier gain setting.

Range: 1, 2, 8, 16

Default parameters: 1

Remarks: When measuring high currents, the internal amplifier's gain can be used to reduce the sampling resistor's power, thus reducing its temperature drift influence.

#### VREF

The VREF switching menu, the default settings IN (internal VREF);

Parameter setting range: IN (internal VREF), OUT (external VREF)

Remarks: Set VREF to OUT when using the external potentiometer adjustment function.

#### Dp

Set the menu positioning menu, use external IO control decimal digits by default;

Parameter setting range: 0-5, 0-4 indicates that the decimal digits are set using software, 5 indicates that the hardware IO controls the decimal digits, the default value 5;

#### Type

AC/DC measurement mode selection menu;

Parameter setting range: 0-2, 0 represents DC, 1 represents AC, 2 represents using external IO to control AC or DC. Default value is 2.

LED

Display digit number selection menu;

Parameter setting range: 0-2, 0 represents 4-digit display, 1 represents 5-digit display, 2 represents using external IO to control the number of display digit. Default value is 2.

CODE

Password setting.

Range: 00000~59999 (5-digit) / 0000~9999 (4-digit)

Default parameters: 00001 (5-digit) / 0001 (4-digit)

Ofst

Measurement result offset adjustment. The current signal measurement result is displayed once entering this menu. Use key to adjust the displayed result until it is consistent with the external standard meter. Press the SET key shortly and the system will automatically calculate the appropriate offset value.

The above adjustment should make the adjusted signal as close to zero as possible.

Gain

Measurement result gain adjustment. The current signal measurement result is displayed once entering this menu. Use key to adjust the displayed result until it is consistent with the external standard meter. Press the SET key shortly and the system will automatically calculate the appropriate gain value.

The above adjustment should make the adjusted signal as close to the full scale point as possible.

Yes

Parameter save selection. Parameter is lost after power off if it is set to 0. Parameter is stored and not lost after power off if it is set to 1.

The set parameter takes effect immediately after exiting the menu. Make sure the settings are correct during the instrument debugging. Save it to avoid wasting parameter modification times after confirming that there is no problem.

## Calibration

Offset and gain Adjustment

Default empirical value saved is 100mV. User can use the Ofst and Gain adjustment menu items to modify the measurement value, thus omitting manual calibration. The specific operations are as follows:

- Determine the measuring range;
- Select the appropriate resistance according to table 3. The full scale range signal after calibration should be close to 200mv;
- Long press the UP+LEFT key during normal measurement. The meter enters the offset/gain adjustment mode and Ofst is displayed;
- Short press the UP key to circulate between Ofst (offset adjust), Gain (gain adjust), and Yes (saving menu);
- Short press the SET key to enter the corresponding menu item. Adjust the displayed result with UP/DOWN keys until it is same as the external standard meter;
- First, adjust the zero position through Ofst. Connect a signal close to zero to the meter.
- Then, adjust the full scale position through Gain. Connect a signal close to full scale range to the meter.

- Change the signal connected to the meter. Ensure that its display is still the same as the external standard meter. Set Yes to 1 to save the adjustment value.
- Exit the menu mode. Offset and gain adjustment is completed.

#### Standard Signal Calibration

The meter supports digital calibration. The calibration value is stored inside the IC. By default, the calibration can be repeated up to 100 times.

- To activate the calibration mode, turn on power with KEY1 pin at low level. CLL is displayed. Release KEY1;
- Short press the UP key (KEY1 at low level) to circulate between CLL (DC zero calibration, displaying LmG), DCLH (DC full scale calibration, displaying HmG), and ACLH (AC full scale calibration, displaying HmG);
- Connect a standard calibration signal to the meter. Short press the LEFT key (KEY2 at low level) to start calibration. Measurement result is displayed after the calibration is completed. Short press the UP key once to re-enter the current calibration event, or short press the UP key twice to enter into the next calibration event. Short press the LEFT button to start calibration. After all desired calibrations are completed, long press the LEFT key to save the calibration value. The prompt "Yes" indicates that the save is successful. At this time, short pressing the UP key will no longer enter calibration mode.
- Calibration is completed and normal operation begins.

#### Potentiometer Trim

Support using external potentiometer to adjust VREF. When potentiometer calibration is not required, the potentiometer circuit can be omitted.

If the potentiometer is used, set VREF parameter to Out.

#### Tool support

Automated parameter configuration tool and its associated PC software are Provided. Based on the key port implementation, User is recommended to use them for setting and saving the internal menu parameters initially during production. Doing so saves production time.

If the meter requires standard signal calibration, it is recommended to use the key operation. The tool can also be used. When high voltage measurement signal is involved, the tool and the computer need to be isolated to avoid damage.

#### Others

##### Reset password

Password is required to enter the menu. Default is 0001. It can be changed through the CODE menu. Password can be reset to 0001.

Password reset procedure:

- Press and hold LEFT when power is turning on. Release the switch when version number is displayed;
- Short press UP three times. CODE 0001 is displayed and password is reset to 0001;
- The meter enters into measurement mode after reset. Users can enter the menu with password 0001.

##### CLK

- Set HrnG and Dp to the appropriate value such as 100.0. Use 100.0mV signals for calibration.
- At this point, the instrument should display 100.0
- Enter the menu, select the CLK to option 075, save and exit;
- The input signal is adjusted to 75mV, and the instrument will display 100.0.

##### Other function



After powering up, all displays are on for 1s and then firmware version is displayed. The meter then enters into measurement mode and the measured value is displayed;

Err1: The parameter save reaches its upper limit. Power on to enter measurement mode. The last saved parameter value will be used;

Err2: Failed to save the parameters. Power on to enter measurement mode.

## Resistance selection table

The resistor selection will ensure that the full scale signal is between 200 ~ 300mV. It guarantees the highest performance in accuracy and resolution for the meter.

Table 3. Resistance selection table

| Signal          | Range | RS1      | RS2         | RS3      | Remarks       |
|-----------------|-------|----------|-------------|----------|---------------|
| AC / DC voltage | 300mV | --       | Short       | --       |               |
|                 | 3V    | --       | 10K/1W/0.5% | 1K/0.5%  |               |
|                 | 30V   | --       | 10K/1W/0.5% | 100/0.5% |               |
|                 | 300V  | --       | 1M/2W/0.5%  | 1K/0.5%  |               |
|                 | 1000V | --       | 1M/2W/0.5%  | 100/0.5% |               |
| AC / DC current | 3mA   | 100R/1W  | Short       | --       |               |
|                 | 30mA  | 10R/1W   | Short       | --       |               |
|                 | 300mA | 1R/1W    | Short       | --       |               |
|                 | 3A    | 10mR/2W  | Short       | --       | PGA set as 8  |
|                 | 10A   | 1.5mR/2W | Short       | --       | PGA set as 16 |

Note:

1. For voltmeter, the signal after voltage division should be close to 300mV. This will ensure the highest accuracy;
2. For ammeter with large current range such as 10A, user can select a higher PGA gain and thus using a smaller sampling resistor. This can reduce the measurement temperature drift.

## Reference circuit

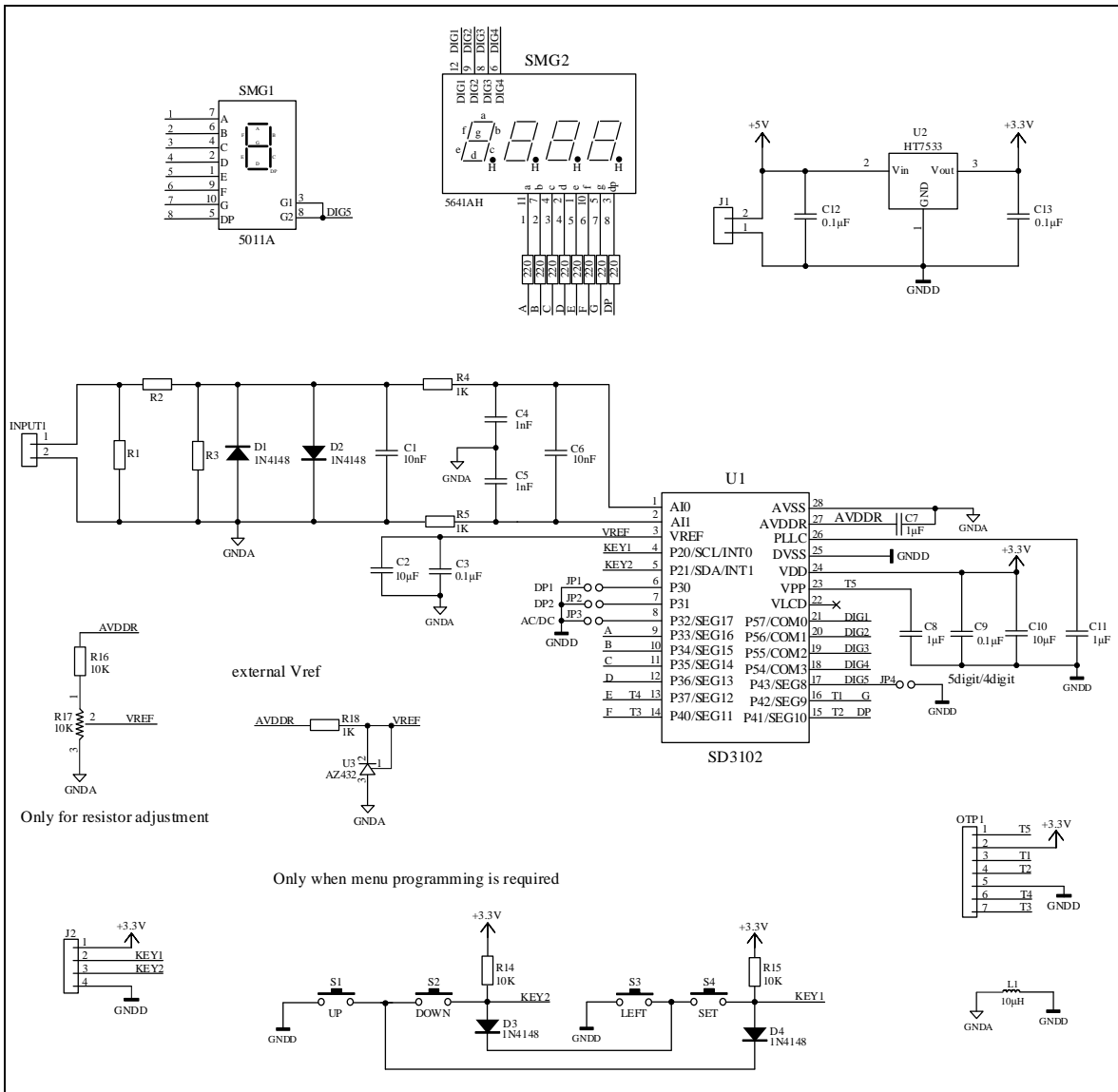


Figure 2. Reference circuit

Note:

1. Use common cathode digital display;
2. Include the potentiometer circuit only when VREF needs to be adjusted;
3. Include the switch circuit only when menu programming is required;
4. If on-board programming is used during production, the meter must be powered off before programming.
5. When lower temperature drift or the resolution higher than 40,000 is required, an external low temperature drift voltage reference circuit is needed;
6. J2 is an automation interface. The internal menu parameters can quickly be configured through automated production tools and PC software.

## Electrical Specifications

Table 4. Absolute Maximum Ratings

| Symbol                             | Parameter                    | Minimum                 | Maximum              | Unit |
|------------------------------------|------------------------------|-------------------------|----------------------|------|
| T <sub>A</sub>                     | Operating temperature        | -40                     | +85                  | °C   |
| T <sub>S</sub>                     | Storage temperature          | -55                     | +150                 | °C   |
| V <sub>DD</sub>                    | Supply voltage               | -0.2                    | +4.0                 | V    |
| V <sub>pp</sub>                    | Programming voltage          | -0.2                    | +7.5                 | V    |
| V <sub>IN</sub> , V <sub>OUT</sub> | Digital input/output voltage | -0.2                    | V <sub>DD</sub> +0.3 | V    |
| T <sub>L</sub>                     | Reflow temperature profile   | Per IPC/JEDECJ-STD-020C |                      | °C   |

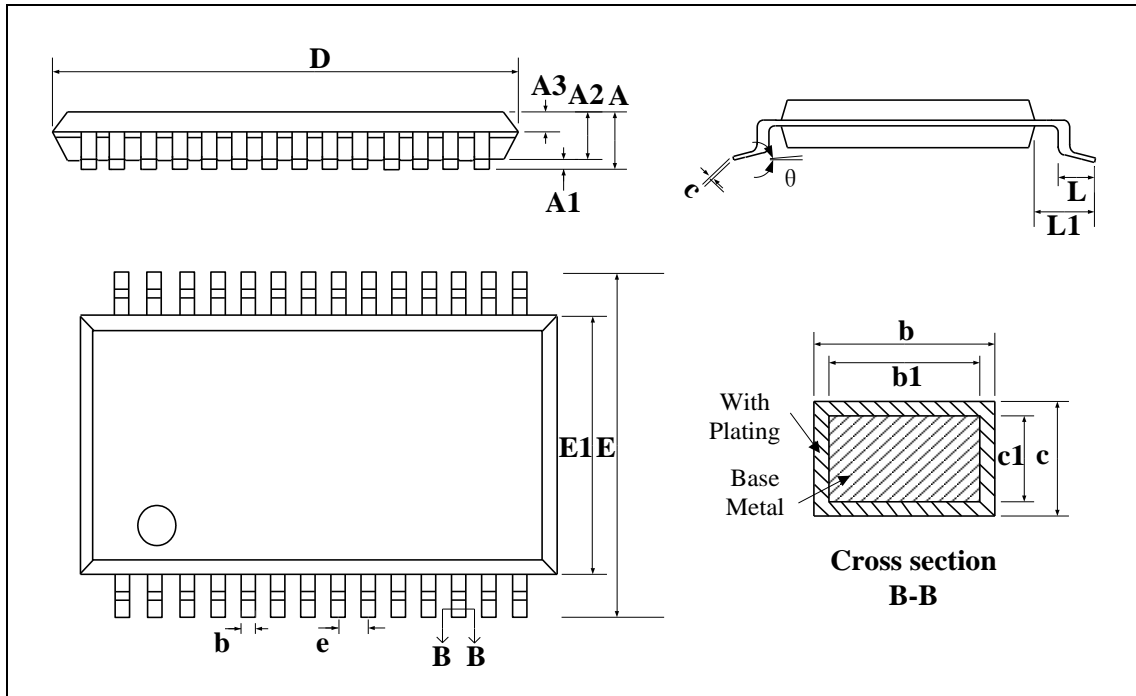
Remarks:

1. CMOS device can easily be damaged by electrostatics. It must be stored in conductive foam and must not exceed the operating voltage range.
2. Turn off power before inserting or removing the device.

 Table 5. Electrical Specifications (V<sub>DD</sub> = 3.3V, T<sub>A</sub> = 25°C)

| Symbol             | Parameter                            | Minimum | Typical | Maximum | Unit   | Conditions/Remarks                    |
|--------------------|--------------------------------------|---------|---------|---------|--------|---------------------------------------|
| V <sub>DD</sub>    | Power supply                         | 2.5     | 3.3     | 3.6     | V      | Digital circuits operate down to 2.0V |
| V <sub>INdif</sub> | ADC differential input voltage range | -0.3    | --      | +0.3    | V      | Gain = 1                              |
| V <sub>REF</sub>   | Voltage reference                    | --      | 1.16    | --      | V      |                                       |
| R <sub>vref</sub>  | V <sub>REF</sub> output resistance   | --      | 4       | --      | kΩ     |                                       |
| TC <sub>vref</sub> | V <sub>REF</sub> TC                  | --      | ±30     | --      | ppm/°C | -40~85°C                              |
| I <sub>avddr</sub> | AVDDr current capability             | --      | 10      | --      | mA     |                                       |

## Package Information



Dimensions: mm

| Symbol | Min.    | Nom.  | Max.  |
|--------|---------|-------|-------|
| A      | —       | —     | 2.00  |
| A1     | 0.05    | —     | 0.25  |
| A2     | 1.65    | 1.75  | 1.85  |
| A3     | 0.75    | 0.80  | 0.85  |
| D      | 10.00   | 10.20 | 10.40 |
| E      | 7.60    | 7.80  | 8.00  |
| E1     | 5.10    | 5.30  | 5.50  |
| L      | 0.55    | 0.75  | 0.95  |
| L1     | 1.25BSC |       |       |
| b      | 0.29    | —     | 0.37  |
| b1     | 0.28    | 0.30  | 0.33  |
| c      | 0.15    | —     | 0.20  |
| c1     | 0.14    | 0.15  | 0.16  |
| e      | 0.65BSC |       |       |
| θ      | 0°      | —     | 8°    |

Figure 3. SSOP28 mechanical specification