# 3.3V power supply, cost-effective, small size and high precision current sensor chip

## Overview:

SC813 is a member of Hall current sensor product series. Its differential output mode is convenient for later application, and its ultra-wide dynamic detection ability supports customers to detect the measured current range as low as 1A and as high as 50A. It meets the requirements of users to realize the detection of load current under the condition of insulation and isolation, and is suitable to replace other passive or discrete sensor detection schemes such as power resistor, linear optocoupler and transformer.

SC813 series of is an isolated current detection chip which works on the principle of open-loop Hall sensor detection. By introducing the current wire on the high voltage side into the package, based on the magnetic effect of current, the equal specific magnetic field generated around the tested wire is induced by the magnetic sensor of the built-in chip, and then converted into a treatable equal specific voltage signal. This voltage signal is read and amplified by the built-in high-precision ADC, and with the help of digital calibration technology, environmental variables such as temperature, noise, hysteresis, nonlinearity and so on are removed, and finally a voltage value with a nearly ideal ratio with the measured current value is output, thus realizing isolated current measurement.

SC813 adopts automatic production and processing, which can bring customers incomparable consistency, high quality, high reliability and low cost. The standard package design is very suitable for customers to carry out batch automatic patch production, and it is the best solution for power device current detection, household appliances, power supply, load detection and other applications.

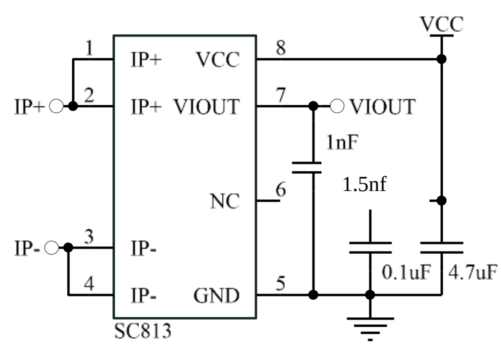
## Features

- Isolated measurement, isolated withstand voltage Up to 3.0kv @50HZ,1min
- Can measure DC and AC current.
- Minimum current conductor impedance: 1mΩ
- Ultra-wide current detection range, suitable for detecting amperage current.
- Optional reference mode: 0.5Vcc 0.1Vcc
- Zero voltage hysteresis close to zero.
- Response time as low as 4uS
- Wide working temperature range: -40℃~125℃
- High precision: the precision error at room temperature is less than 1%
  Operating temperature range: < 3% accuracy error.
- Strong driving ability, supporting the output port to connect the load as low as 2kΩ.
- Extremely simple peripheral circuit
- Support wave soldering full-automatic patch, tape packaging
- Free from interference of wire magnetic field, external magnetic field and geomagnetic field.
- 3.3V power supply
- Independent research and development, no technical dependence


## Packaging

- ◆ Schematic diagram of internal copper conductor in appearance view


## Typical Application



## Ordering information

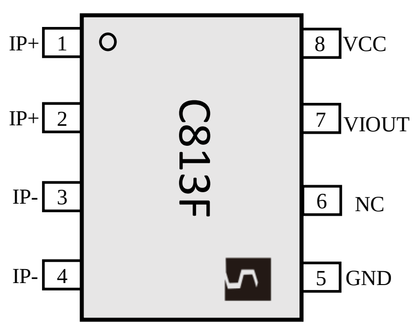
| Part Number [1] | Characteristic Code | Temp. Range | Packing | IP Range (A) | 0A Output (V) | Sensitivity (mV/A) |
|---|---|---|---|---|---|---|
| SC813FFT-05B3 | F | F (-40~125℃) | T (3k pieces/Reel) | ±5 | B3(0.5Vcc) | 264 |
| SC813FFT-10B3 | | | | ±10 | B3(0.5Vcc) | 132 |
| SC813FFT-20B3 | | | | ±20 | B3(0.5Vcc) | 66 |
| SC813FFT-30B3 | | | | ±30 | B3(0.5Vcc) | 44 |
| SC813FFT-50B3 | | | | ±50 | B3(0.5Vcc) | 26.4 |
| SC813FFT-10U3 | | | | +10 | U3(0.1Vcc) | 264 |
| SC813FFT-20U3 | | | | +20 | U3(0.1Vcc) | 132 |
| SC813DFT-05B3 | D | | | ±5 | B3(0.5Vcc) | 264 |
| SC813DFT-10B3 | | | | ±10 | B3(0.5Vcc) | 132 |
| SC813DFT-20B3 | | | | ±20 | B3(0.5Vcc) | 66 |
| SC813DFT-30B3 | | | | ±30 | B3(0.5Vcc) | 44 |
| SC813DFT-40B3 | | | | ±40 | B3(0.5Vcc) | 33 |
| SC813DFT-50B3 | | | | ±50 | B3(0.5Vcc) | 26.4 |
| SC813DFT-63B3 | | | | ±63 | B3(0.5Vcc) | 20.83 |
| SC813DFT-10U3 | | | | +10 | U3(0.1Vcc) | 264 |
| SC813DFT-20U3 | | | | +20 | U3(0.1Vcc) | 132 |
| SC813DFT-30U3 | | | | +30 | U3(0.1Vcc) | 88 |
| SC813DFT-40U3 | | | | +40 | U3(0.1Vcc) | 66 |

Note 1: For the reference output types of B and U with IP=0A, the B(0.5Vcc output voltage) is recommended.

| | |
|---|---|
| B | When there is no current in IP, VIOUT@0A=0.5VCC, which is suitable for bidirectional current detection, and the zero point and sensitivity change with VCC ratio. |
| U*[2] | When there is no current in IP, VIOUT@0A=0.1VCC, which is suitable for unidirectional current detection, and the zero point and sensitivity change with VCC ratio. |

Note 2: For U type, the dynamic range is x2, so the sensitivity is x2; If customers have different sensitivity requirements, please ask our FAE/ agent for them.

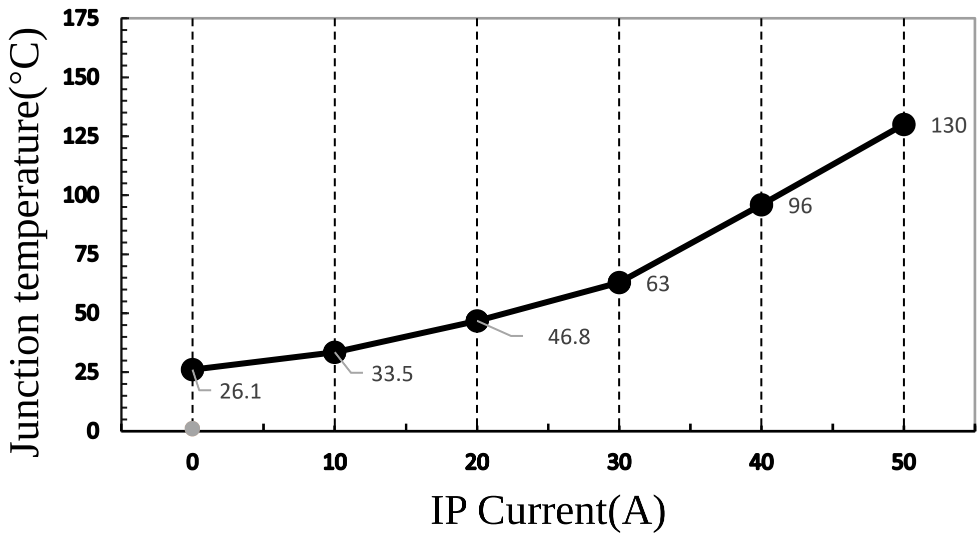
## Pin Configuration




| Pin No. | Pin name | Description |
|---|---|---|
| 1/2 | IP+ | Primary current input positive terminal |
| 3/4 | IP- | Primary current output negative terminal |
| 5 | GND | Weak current GND insulated from primary current line |
| 6 | NC (SC813F series) | NC, supporting GND connection, with an open drain pull-down tube inside |
| | NC (SC813D series) | NC, supporting GND connection, suspended inside |
| 7 | VIOUT | Output voltage equal to primary current, in the same direction as IP+<br>VIOUT=IP* sensitivity +VIOUT@0A |
| 8 | VCC | supply voltage |

## Package Temperature with Measured Current Diagram

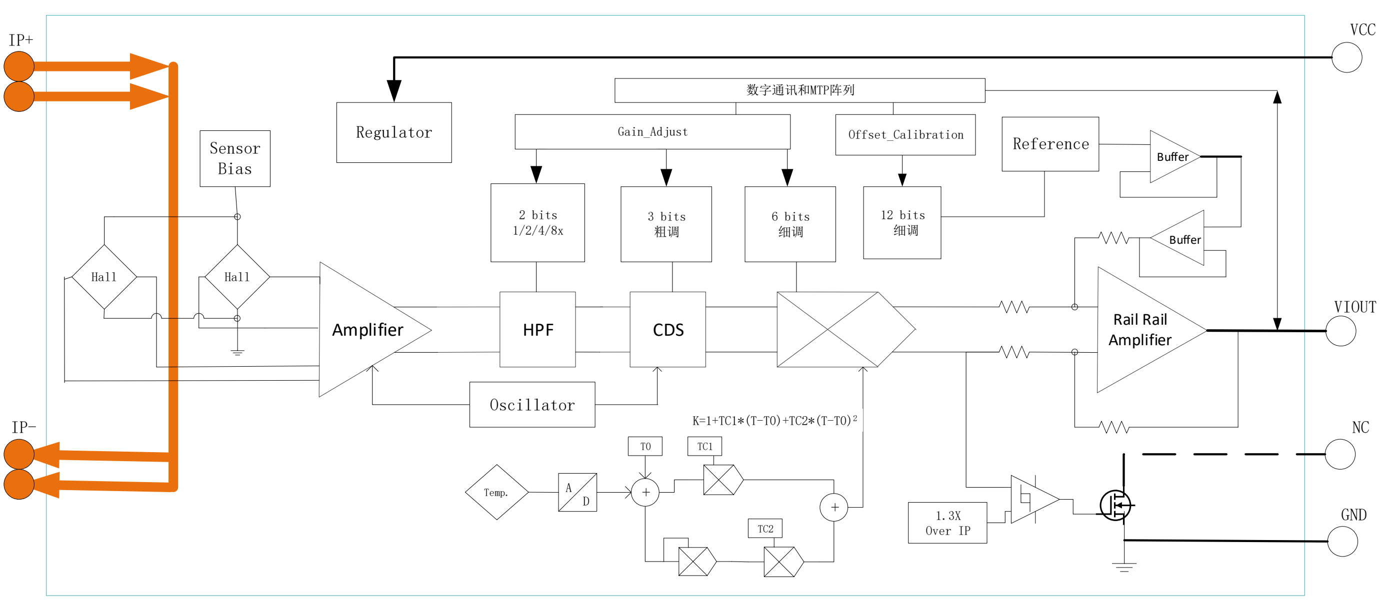
Remarks: at the ambient temperature of 26℃, the relationship diagram between package temperature and primary current is obtained from the full series of SC813 tests based on our DEMO board.




## Demo Board Information

| Board name | A10-V2 |
|---|---|
| PCB layer | 2 |
| Area of copper skin connected with primary pin (including all layers) | 1224 mm$^2$ |
| Copper coating thickness of single-layer PCB | 2oz / 70um |
| PCB thickness | 1mm |

## Functional block diagram



## Absolute Maximum Ratings

Absolute maximum rating is the limit of device operation, exceeding this value may cause device damage, and long-term use this value range, it may affect device reliability.

| Parameter | Description | Remarks | Rating | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Power supply voltage | | 6.0 | V |
| $V_{RCC}$ | Reverse supply voltage | | -0.1 | V |
| $V_{IOUT}$ | Output voltage | | 6.0 | V |
| $V_{RIOUT}$ | Reverse output voltage | | -0.1 | V |
| $T_A$ | Ambient temperature range | Range F | -40~125 | ℃ |
| $T_{J\,(max)}$ | Maximum junction temperature | | 165 | ℃ |
| $T_{stg}$ | Storage temperature | | –65~170 | ℃ |
| $I_{OUT(Source)}$ | Output pin pull current | Shorted Output-to-Ground Current | 3.43 | mA |
| $I_{OUT(Sink)}$ | Output foot irrigation current | Shorted Output-to-VCC Current | 40 | mA |
| $IP_{max}$ | Maximum IP value that can be continuously loaded at ambient temperature. | It is directly related to the heat dissipation capacity of PCB. This data depends on the demo test board | 40 | A |
| $I_{pover}$ | Transient overload IP line end capability under ambient temperature conditions | It is directly related to the heat dissipation capacity of PCB. This data depends on the demo test board<br>1pulse, 100ms, 1% duty ratio | 100 | A |
| ESD | HBM mode | | 4 | kV |

## Insulation Isolation Characteristic

| Parameter | Description | Remarks | Rating | Unit |
|---|---|---|---|---|
| $V_{ISO}$ | 1 minute isolation withstand voltage test (50Hz) | Agency type-tested for 60 seconds per UL60950-1 | 3000 | Vrms |
| $V_{WVRI}$ | Long-term maximum work is basically isolation voltage | Maximum working voltage according to UL60950-1 | 420 | $V_{Peak}$ |
| Dcl | electric clearance | Minimum distance through air from IP leads to signal leads | 3.8~4 | mm |
| Dcr | creepage distance | Minimum distance along package body from IP leads to signal leads | 3.8~4 | mm |
| CTI | Leakage tracing index | The electrical breakdown(tracking) properties of an insulating material | 600 | V |
| Surge Voltage | 1.2/50μs impulse voltage | | / | kV |
| Impact Current | 8/20μs impulse current | | / | kA |

## Parameter Values of Peripheral Application Components

| Parameter | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $C_{VCC}$ | Power filter capacitor connected between VCC/GND | 0.1 | 4.7 | | uF |
| $C_{VIOUT}$ | Output VIOUT filter capacitor, connected between VIOUT/GND. | | 1.5 | 3 | nF |

## Common Operating Characteristics

Note:
Unless otherwise noted, the temp. range of SC813F series is $T_A$ = 25°C, $C_{BYPASS}$ = 4.7uF+0.1uF, $C_{Load}$ = 1.5nF, VCC = 3.3V, sensitivity = 66mv/A.
Temp. range of SC813D series is $T_A$ = 25°C, $C_{BYPASS}$ = 0.47uF, $C_{Load}$ = 1.5nF, VCC = 3.3V, sensitivity = 66mv/A.

| Parameter | Symbol | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | Operating | 3.0 | 3.3 | 3.6 | V |
| Supply current | $I_{CC}$ | $V_{CC}$ = 3.1~3.6V, output open | 10 | 11 | 12 | mA |
| Output resistance load | $R_L$ | Between VIOUT and GND | 2.2 | | | kΩ |
| Hall coupling factor | CF | $T_A$ = 25°C | | 2.5 | | G/A |
| Suppression ratio against external magnetic interference | CMFR | The external interference magnetic field is perpendicular to the chip surface. | | -38 | | db |
| Primary current conductor impedance | $R_{PRIMARY}$ | $T_A$ = 25°C | | 1.0 | | mΩ |
| Impedance temperature coefficient of primary conductor | $TC_R$ | $T_A$=-40~125℃ | | 4000 | | ppm/℃ |
| Hysteresis | $V_{hys}$ | Viout (load +20A, return to 0A)-<br>Viout (load -20A, return to 0A) | | 3 | | mV |
| Risetime | $t_r$ | IP=20A (50A/us) | | 2.5 | | µS |
| Delay time | $t_{pd}$ | IP=20A (50A/us) | | 2 | | µS |
| Response time | $t_{response}$ | IP=20A (50A/us) | | 3 | | µS |
| Bandwidth | f | Small signal--3 DB | | 80 | | kHz |
| Noise spectral density | IND | $T_A$ = 25°C, $C_L$=1nf | | 407.27 | | µA(rms)/ √Hz |
| Noise effective value | $I_N$ | | | 460 | | mA(rms) |
| | $I_N$ | BW=10KHz | | 120 | | mA(rms) |
| | $I_N$ | BW=1KHz | | 50 | | mA(rms) |
| Nonlinearity | $E_{LIN}$ | -20A<IP<20A | | | 1 | % |
| Proportional coefficient of follow-up sensitivity (applicable to B5 suffix products) | Scoef | In the reference voltage mode with zero related to VCC,<br>VCC=3.13~3.6V,<br>Scoef=Sens(VCC)/Sens(3.3V) | | VCC/3.3 | | |
| VIOUT linear rail-to-rail output range | Vrail-rail | $R_L$=4.7KΩ | 10 | | 90 | %VCC |
| Power on time | $t_{PO}$ | Output reaches steady state level, $T_J$ = 25°C | | 100 | 200 | µS |

## SC813xFT-30B3 Electrical Characteristics

Note:
Unless otherwise noted, the temp. range of SC813F series is $T_A$ = -40~125°C, $C_{BYPASS}$ = 4.7uF+0.1uF, $C_{Load}$ = 1.5nF, VCC = 3.3V,
Temp. range of SC813D series is $T_A$ = -40~125°C, $C_{BYPASS}$ = 0.47uF, $C_{Load}$ = 1.5nF, VCC = 3.3V

| Parameter | Symbol | Test condition | Min. | Typ. [1] | Max. | Unit |
|---|---|---|---|---|---|---|
| **Ratings** | | | | | | |
| Current measuring range | $I_{PR}$ | | -30 | | 30 | A |
| IP=0A, VIOUT output voltage | Voq | IP=0A | | 0.5Vcc | | V |
| Sensitivity | Sens | -30A<IP<30A | | 44*$S_{coef}$ | | mV/A |
| **Resolution Index** | | | | | | |
| Sensitivity error | $E_{SENS}$ | IP = ±30 A, $T_A$ = 25°C | | ±0.5 | | % |
| | | IP = ±30 A, $T_A$ = 25~125°C | | ±1.5 | | % |
| | | IP = ±30 A, $T_A$ = - 40~25°C | | ±1.5 | | % |
| Single-ended output zero error | $V_{OE}$ | IP=0A, $T_A$ = 25°C | | ±10 | | mV |
| | | IP=0A, $T_A$ = 25~125°C | | ±14 | | mV |
| | | IP=0A, $T_A$ = - 40~25°C | | ±26 | | mV |
| Nonlinearity | $E_{LIN}$ | Measured using full-scale and half-scale IP | | | 1 | % |
| **Total error composition: $E_{TOT}$ = $E_{SENS}$+$V_{OE}$ /(Sens × IP)** | | | | | | |
| Total error [2] | $E_{TOT}$ | IP = 30 A, $T_A$=25°C±30 A, T | | ±1.0 | | % |
| | | IP = ±30 A, $T_A$=25°C~125°C | | ±3.0 | | % |
| | | IP = ±30 A, $T_A$= - 40°C ~ 25°C | | ±2.8 | | % |

[1] The typical value is +/-1 Sigma, and 68.27% of the products are within this range; The maximum/minimum value is +/-3 Sigma, and 99.73% of the products are within this range.
[2] Percentage value based on peak current IP.

## SC813DFT-20U3 Electrical Characteristics

Note: unless otherwise noted, the temp. range of SC813D series is $T_A$ =-40 ~ 125 C, $C_{BYPASS}$ = 0.47 uF, $C_{Load}$ = 1.5 nF, and VCC = 3.3 V.

| Parameter | Symbol | Test condition | Min | Typ. [1] | Max | Unit |
|---|---|---|---|---|---|---|
| **Ratings** | | | | | | |
| Current measuring range | $I_{PR}$ | | 0 | | 20 | A |
| IP=0A, VIOUT output voltage | Voq | IP=0A | | 0.1Vcc | | V |
| Sensitivity | Sens | 0A<IP<20A | | 132*$S_{coef}$ | | mV/A |
| **Resolution Index** | | | | | | |
| Sensitivity error | $E_{SENS}$ | IP = 20 A, $T_A$ = 25°C | | ±1.0 | | % |
| | | IP = 20 A, $T_A$ = 25~125°C | | ±1.7 | | % |
| | | IP = 20 A, $T_A$ = - 40~25°C | | ±2.7 | | % |
| Single-ended output zero error | $V_{OE}$ | IP=0A, $T_A$ = 25°C | | ±14 | | mV |
| | | IP=0A, $T_A$ = 25~125°C | | ±28 | | mV |
| | | IP=0A, $T_A$ = - 40~25°C | | ±17 | | mV |
| Nonlinearity | $E_{LIN}$ | Measured using full-scale and half-scale IP | | | 1 | % |
| **Total error composition: $E_{TOT}$ = $E_{SENS}$+$V_{OE}$ /(Sens × IP)** | | | | | | |
| Total error [2] | $E_{TOT}$ | IP = 20 A, $T_A$=25°C | | ±1.5 | | % |
| | | IP = 20 A, $T_A$=25°C~125°C | | ±2.8 | | % |
| | | IP = 20 A, $T_A$= - 40°C ~ 25°C | | ±3.1 | | % |

[1] The typical value is +/-1 Sigma, and 68.27% of the products are within this range; The maximum/minimum value is +/-3 Sigma, and 99.73% of the products are within this range.
[2] Percentage value based on peak current IP.

## SC813DFT-40U3 Electrical Characteristics

Note: unless otherwise noted, the temp. range of SC813D series is $T_A$ =-40 ~ 125 C, $C_{BYPASS}$ = 0.47 UF, $C_{Load}$ = 1.5 nF, and VCC = 3.3 V.

| Parameter | Symbol | Test Condition | Min. | Typ. [1] | Max | Unit |
|---|---|---|---|---|---|---|
| **Ratings** | | | | | | |
| Current measuring range | $I_{PR}$ | | 0 | | 40 | A |
| IP=0A, VIOUT output voltage | Voq | IP=0A | | 0.1Vcc | | V |
| Sensitivity | Sens | 0A<IP<40A | | 66*$S_{coef}$ | | mV/A |
| **Resolution Index** | | | | | | |
| Sensitivity error | $E_{SENS}$ | IP = 40 A, $T_A$ = 25°C | | ±1.0 | | % |
| | | IP = 40 A, $T_A$ = 25~125°C | | ±3.0 | | % |
| | | IP = 40 A, $T_A$ = - 40~25°C | | ±2.7 | | % |
| Single-ended output zero error | $V_{OE}$ | IP=0A, $T_A$ = 25°C | | ±13 | | mV |
| | | IP=0A, $T_A$ = 25~125°C | | ±14 | | mV |
| | | IP=0A, $T_A$ = - 40~25°C | | ±15 | | mV |
| Nonlinearity | $E_{LIN}$ | Measured using full-scale and half-scale IP | | | 1 | % |
| **Total error composition: $E_{TOT}$ = $E_{SENS}$+$V_{OE}$ /(Sens × IP)** | | | | | | |
| Total error [2] | $E_{TOT}$ | IP = 40 A, $T_A$=25°C | | ±2.6 | | % |
| | | IP = 40 A, $T_A$=25°C~125°C | | ±3.6 | | % |
| | | IP = 40 A, $T_A$= - 40°C ~ 25°C | | ±3.0 | | % |

[1] The typical value is +/-1 Sigma, and 68.27% of the products are within this range; The maximum/minimum value is +/-3 Sigma, and 99.73% of the products are within this range.
[2] Percentage value based on peak current IP.

## Accuracy Characteristic Curve (based on SC813xFT-30B3)

Figure 1: Zero Voltage Temperature Drift

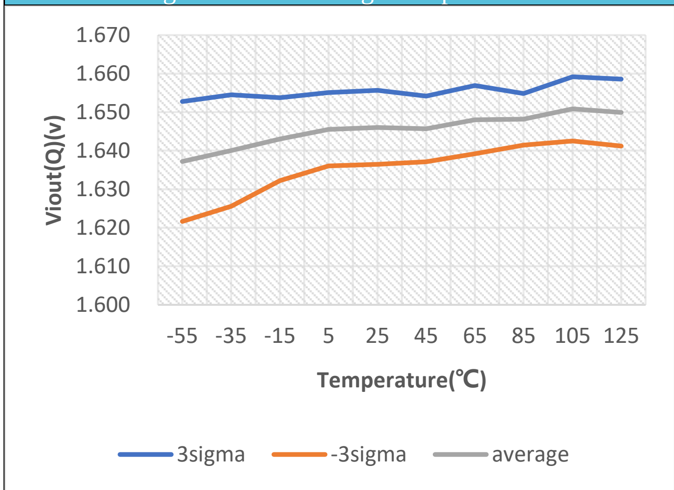



Figure 2: Zero Output Error Temperature Drift

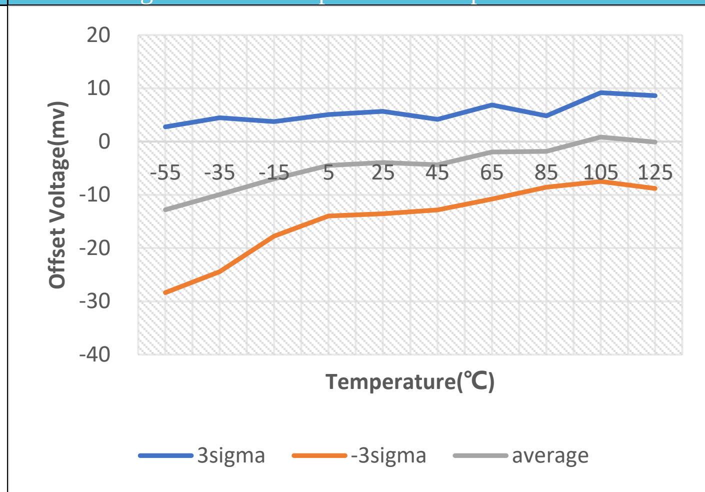



Figure 3: Sensitivity temperature drift

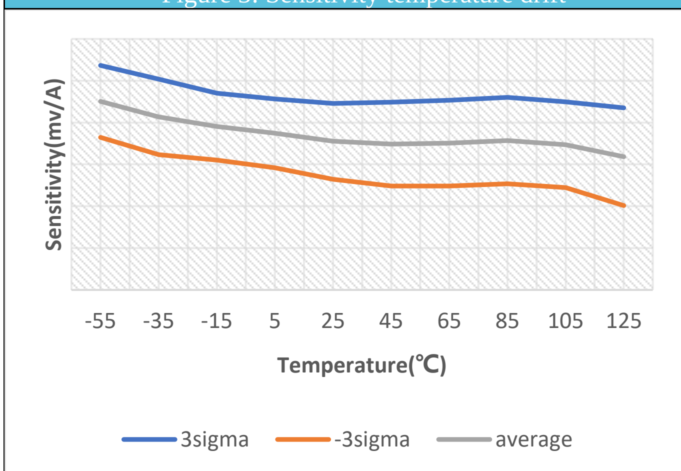



Figure 4: Nonlinear Error Temperature Drift

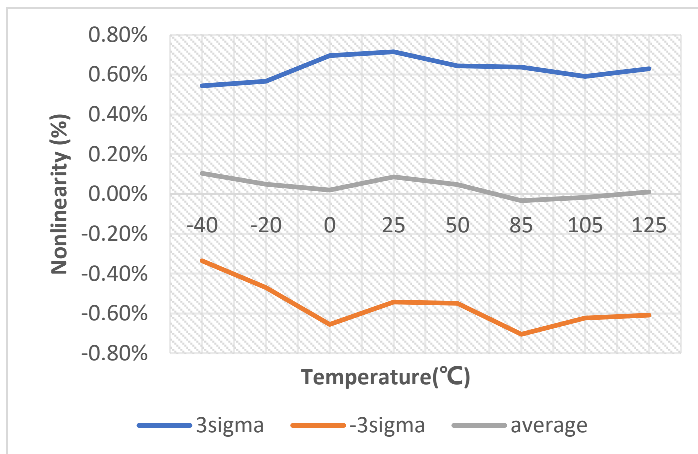
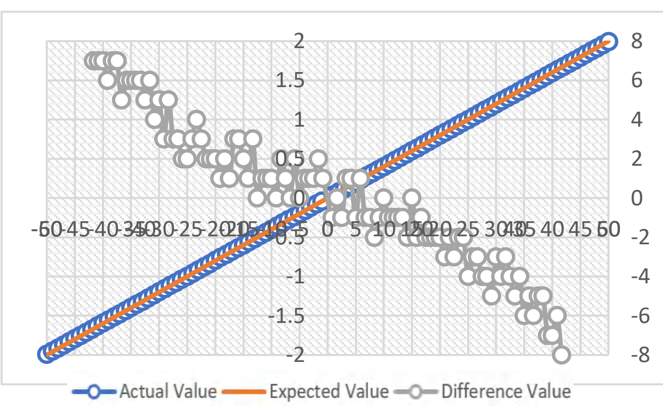



Figure 5: Nonlinear Difference of Output Voltage



## AC/Dynamic Characteristic Curve

Figure 1: Dynamic Rise Time Diagram

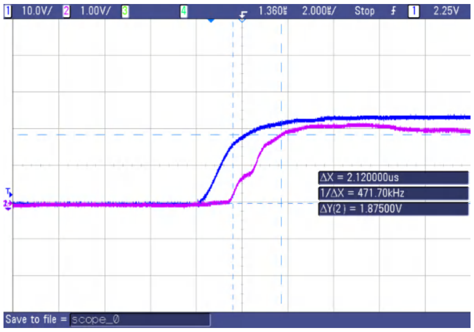



Figure 2: Response Time Diagram

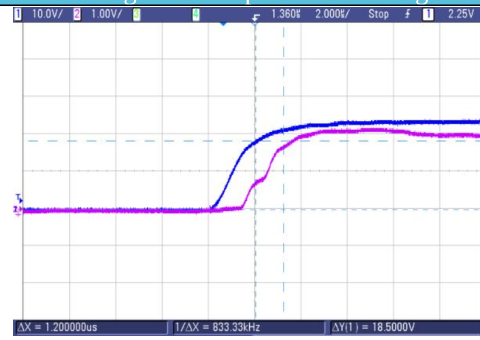



Figure 3: Response Delay Time Diagram

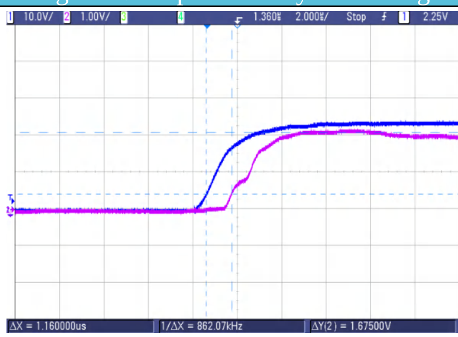



Figure 4: Noise Spectrum Diagram

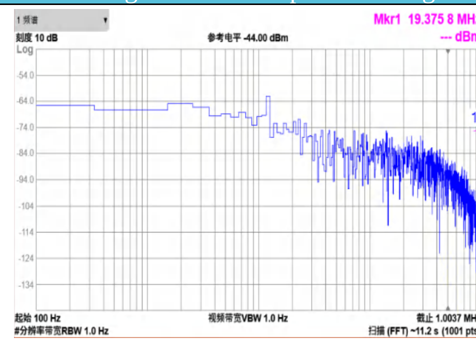



Figure 5: Sinwave transient response diagram

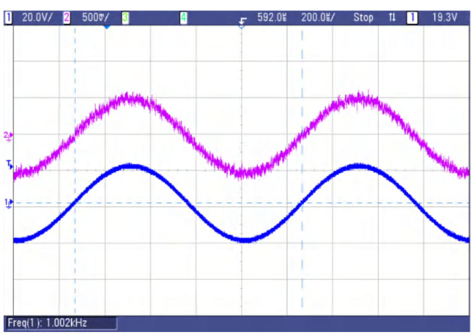



Figure 6: Impulse Transient Response Diagram

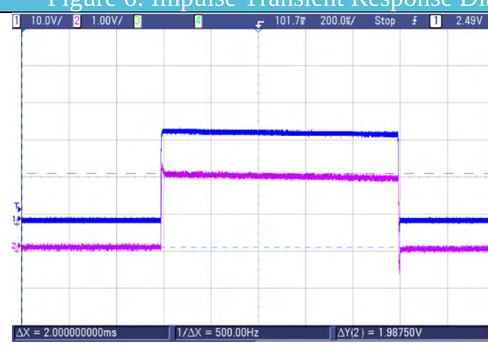



Fig. 7: Time chart of starting POR at power-on.

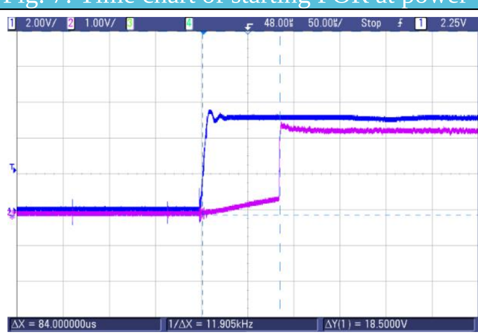



Figure 8: Normal Distribution of Batch Accuracy

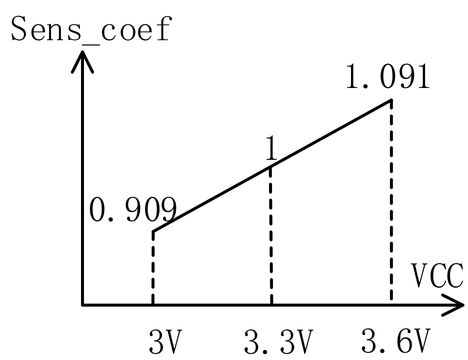
## Characteristic Definition and Description

### ◆ Proportional Coefficient of Follow-up Sensitivity (applicable to products with suffixes B and U)

Sensitivity ratio coefficient (Sens_coef) defines the coefficient whose sensitivity is proportional to VCC. The ideal coefficient is 1. If VCC increases by 10%, the sensitivity will increase by 10%. At this time, the coefficient is 1.1, which means that the sensitivity is increased by 10% compared with the ideal ratio. The relationship of the proportional coefficient is described by the following equation:

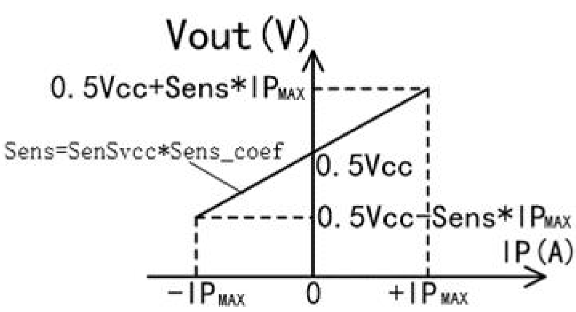
$$S_{coef}=Sens\_coef=SENS_{VCC}/SENS_{VCCN}$$

That is the ratio of the sensitivity $SENS_{VCC}$ at the power supply voltage VCC to the sensitivity $senseVCC_N$ at the rated power supply voltage vccn. Through this value, the sensitivity at any power supply voltage can be obtained.
Ideally:

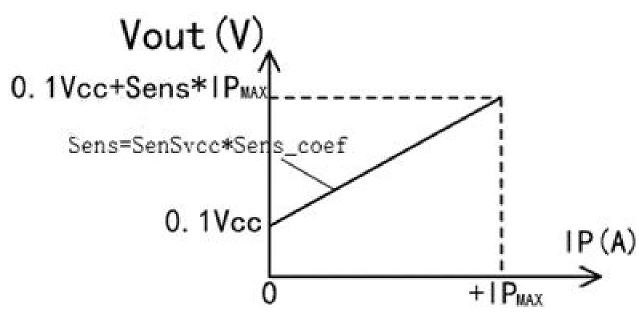



### ◆ Follow-up Proportional Relationship

When SC813**B3 is used, the zero voltage and sensitivity change with the VCC ratio, and the zero point is VCC/2, and the sensitivity is $SENS_{VCC}$ * Sens_coef.
When SC813**U3 is used, the zero voltage and sensitivity change with the VCC ratio, and the zero point is 0.1VCC, and the sensitivity is $SENS_{VCC}$ * Sens_coef.



B3 Suffix Product



U3 Suffix Product

### ◆ Anti-external Magnetic Interference

The anti-external magnetic interference ability of the sensor is expressed by the common-mode external field suppression ratio CMFR, and the greater the absolute value of CMFR, the stronger the anti-external magnetic interference ability is. CMFR is defined as
The absolute value of the ratio of the voltage change ACM (in mv/G) caused by external magnetic interference to the sensor itself is 20 times of the common logarithm, and the unit is decibel (Db).

$$CMFR = 20\lg\left|\frac{A_{CM}}{Sens/CF}\right|$$

Where CF is the magnetic coupling factor of the primary current in the sensor, Sens is the sensor sensitivity, and Sens/CF represents the transformation ratio of the sensor itself in mv/g..
For example, when CMFR= -40Db, a sensor Sens = 40mv/A and CF = 10G/A, the ACM is 0.04mv/G, that is, the output changes by 40uv for every 1Guass increase in the external magnetic field.

## ◆ Delay Time $t_{pd}$ and Response Time $t_{response}$

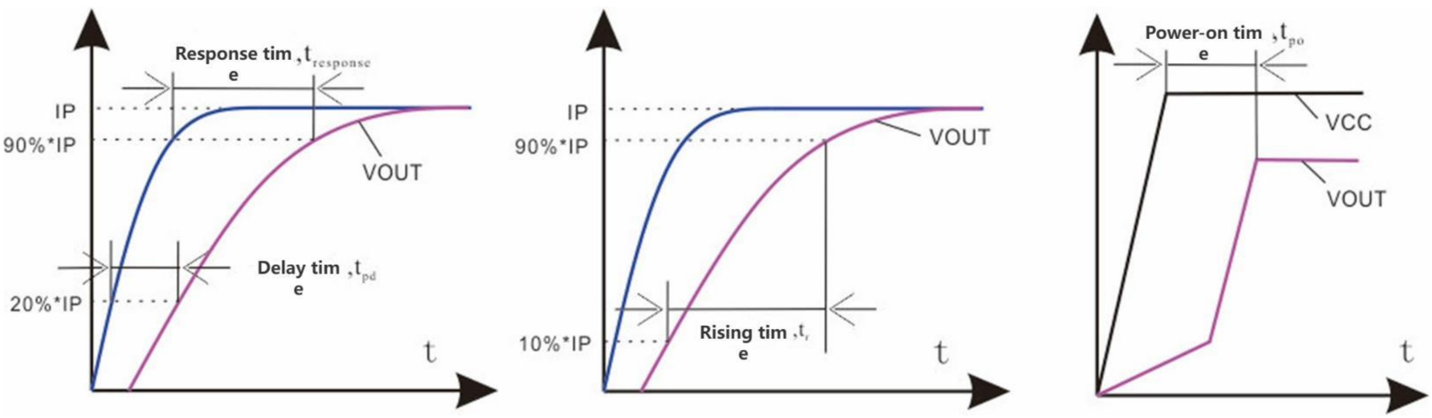
Both delay time and response time are used to characterize the time difference between the primary side and the secondary side.
The delay time is the time difference between when the secondary output reaches 20% of the steady-state output value and when the primary output reaches 20% of the steady-state current.
The response time is the time difference between when the secondary output reaches 90% of the steady-state output value and when the primary output reaches 90% of the steady-state current.

**Rising Time $t_r$**

The rise time is used to characterize the time difference of the secondary side itself, that is, the time difference when the secondary side output reaches 90% of the steady-state output value and reaches 10% of the steady-state output value.

**Power-on Time $t_{po}$**

The power-on time is used to characterize the time difference between the secondary side and the power supply VCC, that is, the time difference when the secondary side output reaches the steady-state output value and VCC reaches the steady-state output value.



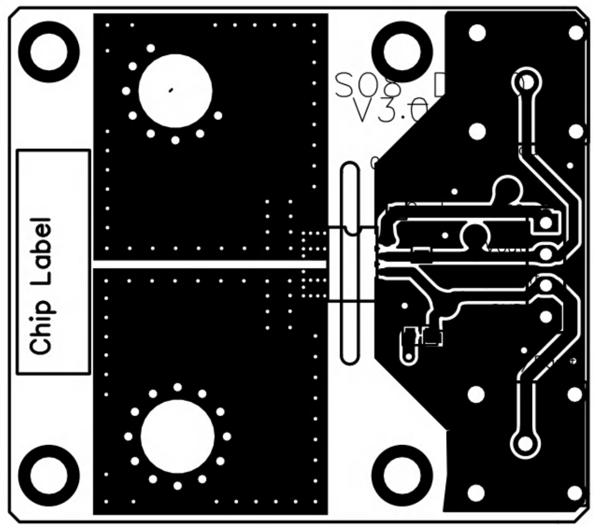

## ◆ Thermal Resistance $R_{\theta ja}$

Thermal resistance is the result of fitting calculation by measuring the temperature and power value at the top of the chip based on a demo board. According to the thermal resistance, it can be used as a reference for calculating junction temperature. For the actual measured surface temperature, see Diagram of the Package Temperature with Measured Current.

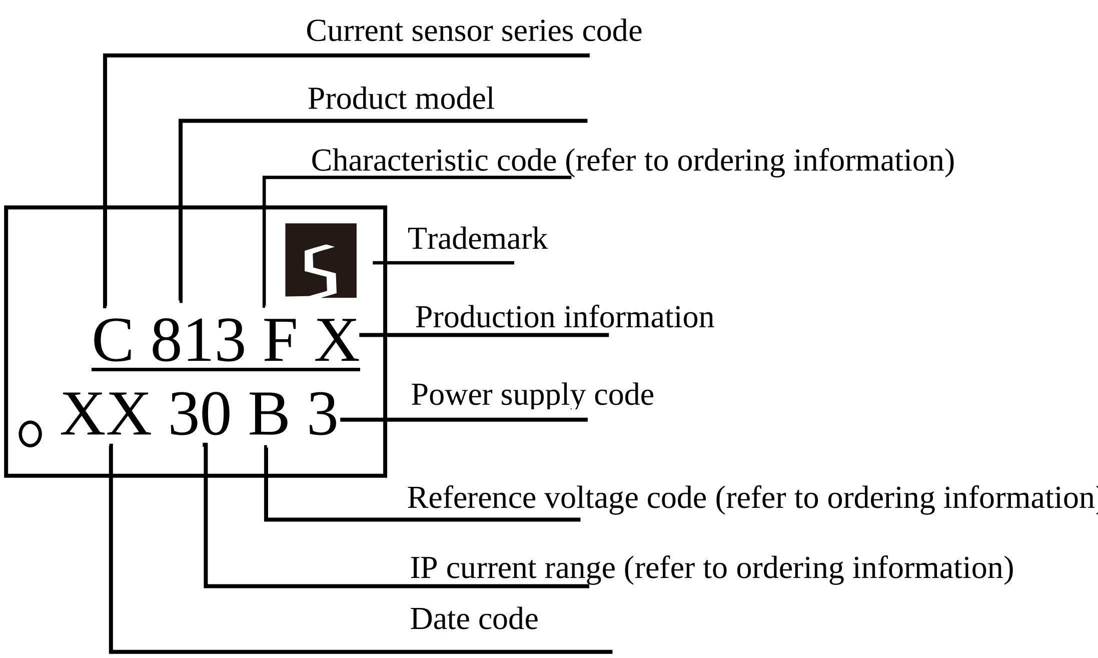
$$T_J = T_A + (R_{\theta JA} * POWER) = T_A + (R_{\theta JA} * IP^2 * R_{PRIMARY});$$

Where $T_J$ is the junction temperature and $T_A$ is the ambient temperature.

**PCB Demo Layout**




**Marking Info.**

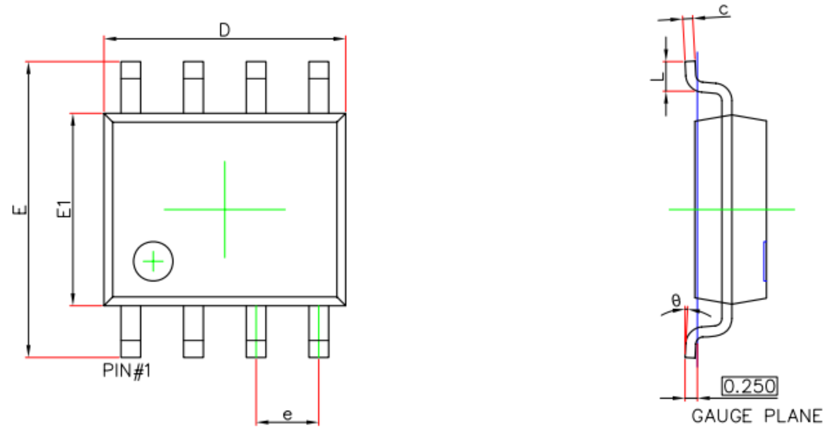


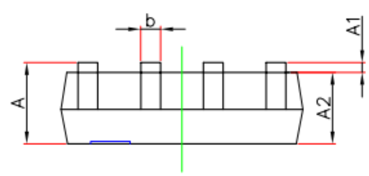

Note: X is a non-fixed character

## Package Information

Note: The package is SOP8 and all dimensions are in millimeters.

SOP8PACKAGE OUTLINE DIMENSIONS




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 1.450 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| 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 |
| e | 1.270（BSC） | | 0.050（BSC） | |
| E | 5.800 | 6.200 | 0.228 | 0.244 |
| E1 | 3.800 | 4.000 | 0.150 | 0.157 |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |