

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

Overview:

SC813 is a member of SENK SEMI 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 SENK SEMI 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.

SENK SEMI is committed to the research of core chip technology, aiming at bringing the best current detection solution to customers.

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°C~125°C
 - 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

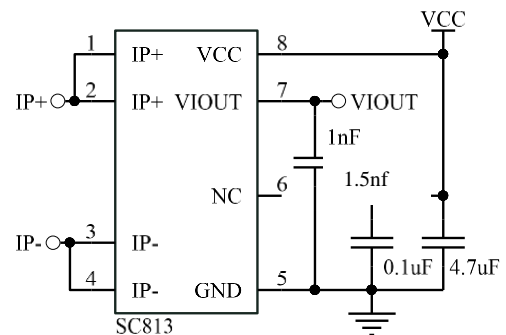


Packaging

- ◆ Schematic diagram of internal copper conductor in appearance view



Typical Application



Ordering information

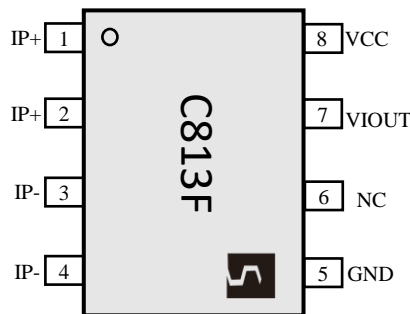
Part Number [1]	Characteristic Code	Temp. Range	Packing	IP Range (A)	0A Output (V)	Sensitivity (mV/A)
SC813FFT-05B3	F			±5	B3(0.5Vcc)	264
SC813FFT-10B3				±10	B3(0.5Vcc)	132
SC813FFT-20B3				±20	B3(0.5Vcc)	66
SC813FFT-25B3				±25	B3(0.5Vcc)	52.8
SC813FFT-30B3				±30	B3(0.5Vcc)	44
SC813FFT-50B3				±50	B3(0.5Vcc)	26.4
SC813FFT-10U3				+10	U3(0.1Vcc)	264
SC813FFT-20U3				+20	U3(0.1Vcc)	132
SC813FFT-40U3				+40	U3(0.1Vcc)	66
SC813DFT-05B3				D	F (-40~125°C)	T (3k pieces/Reel)
SC813DFT-10B3	±10	B3(0.5Vcc)	132			
SC813DFT-20B3	±20	B3(0.5Vcc)	66			
SC813DFT-25B3	±25	B3(0.5Vcc)	52.8			
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			
SC813DFT-50U3	+50	U3(0.1Vcc)	52.8			

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.

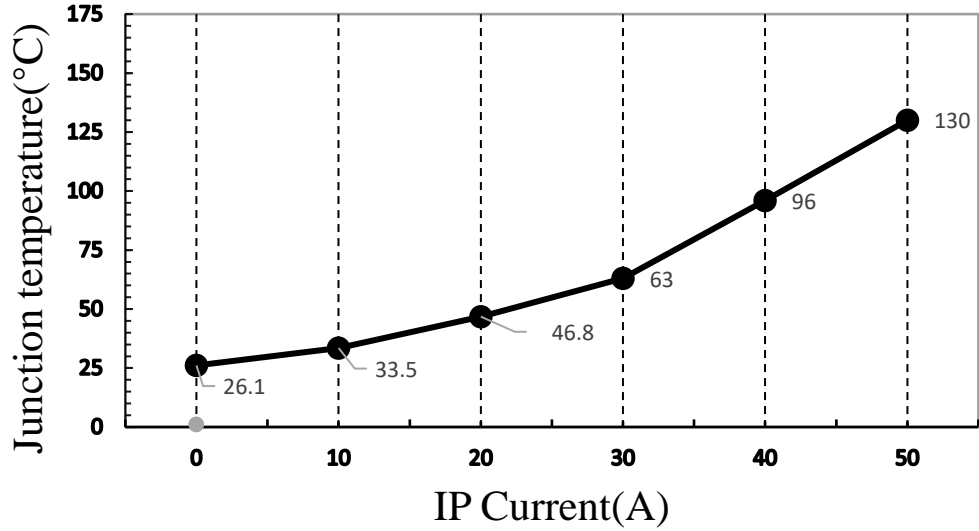
Pin Configuration



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+ VIOUT=IP* sensitivity +VIOUT@0A
8	VCC	supply voltage

Package Temperature with Measured Current Diagram

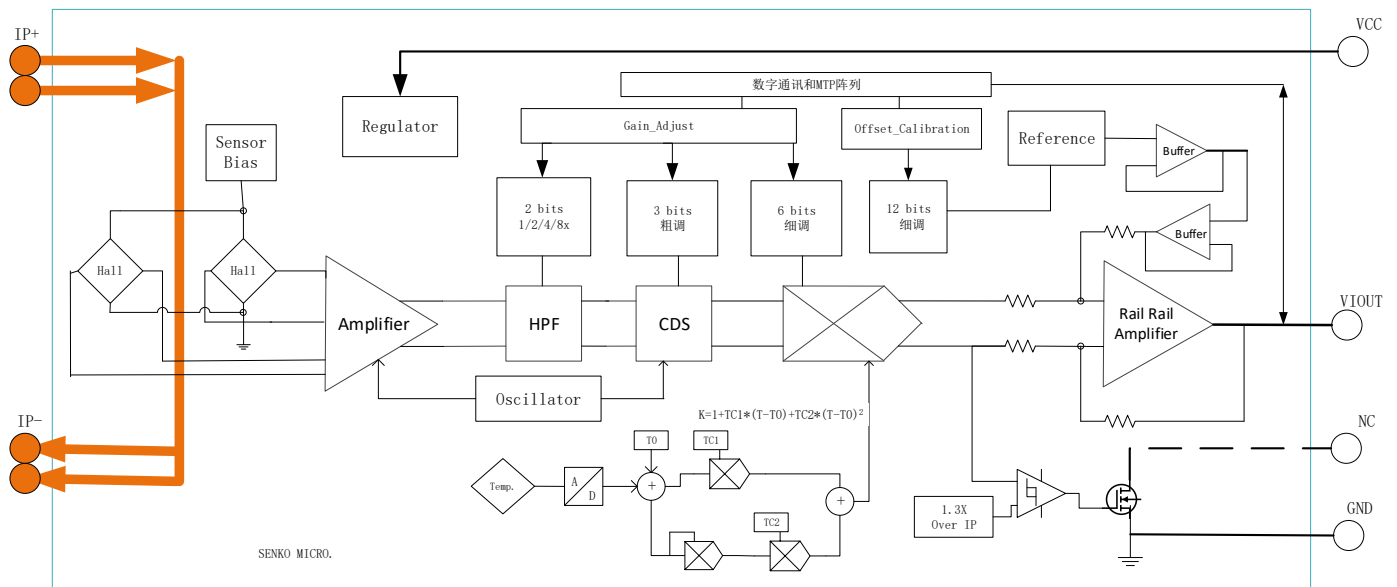
Remarks: at the ambient temperature of 26°C, the relationship diagram between package temperature and primary current is obtained from the full series of SC813 tests based on our DEMO board.



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	°C
T _{J(max)}	Maximum junction temperature		165	°C
T _{stg}	Storage temperature		-65~170	°C
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
I _{Pmax}	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 of SENK SEMI.	40	A
I _{povert}	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 of SENK SEMI. 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	V _{rms}
V _{WVRI}	Long-term maximum work is basically isolation voltage	Maximum working voltage according to UL60950-1	420	V _{Peak}
D _{cl}	electric clearance	Minimum distance through air from IP leads to signal leads	3.8~4	mm
D _{cr}	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		μF
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 $T_A = 25^\circ\text{C}$, $C_{\text{BYPASS}} = 4.7\mu\text{F} + 0.1\mu\text{F}$, $C_{\text{Load}} = 1.5\text{nF}$, $V_{\text{CC}} = 3.3\text{V}$, sensitivity = 66mV/A.
 Temp. range of SC813D series is $T_A = 25^\circ\text{C}$, $C_{\text{BYPASS}} = 0.47\mu\text{F}$, $C_{\text{Load}} = 1.5\text{nF}$, $V_{\text{CC}} = 3.3\text{V}$, 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}	$V_{\text{CC}} = 3.1\sim 3.6\text{V}$, output open	10	11	12	mA
Output resistance load	R_{L}	Between VIOUT and GND	2.2			k Ω
Hall coupling factor	CF	$T_A = 25^\circ\text{C}$		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}	$T_A = 25^\circ\text{C}$		1.0		m Ω
Impedance temperature coefficient of primary conductor	T_{CR}	$T_A = -40\sim 125^\circ\text{C}$		4000		ppm/ $^\circ\text{C}$
Hysteresis	V_{hys}	Viout (load +20A, return to 0A)- 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	$T_A = 25^\circ\text{C}$, $C_{\text{L}} = 1\text{nf}$		407.27		$\mu\text{A}(\text{rms})/\sqrt{\text{Hz}}$
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, $V_{\text{CC}} = 3.13\sim 3.6\text{V}$, Scoef=Sens(VCC)/Sens(3.3V)		VCC/3.3		
VIOUT linear rail-to-rail output range	Vrail-rail	$R_{\text{L}} = 4.7\text{k}\Omega$	10		90	% VCC
Power on time	t_{PO}	Output reaches steady state level, $T_{\text{J}} = 25^\circ\text{C}$		100	200	μs

SC813xFT-30B3 Electrical Characteristics

Note:

Unless otherwise noted, the temp. range of SC813F series is $T_A = -40 \sim 125^\circ\text{C}$, $C_{\text{BYPASS}} = 4.7\mu\text{F} + 0.1\mu\text{F}$, $C_{\text{Load}} = 1.5\text{nF}$, $V_{\text{CC}} = 3.3\text{V}$,
 Temp. range of SC813D series is $T_A = -40 \sim 125^\circ\text{C}$, $C_{\text{BYPASS}} = 0.47\mu\text{F}$, $C_{\text{Load}} = 1.5\text{nF}$, $V_{\text{CC}} = 3.3\text{V}$

Parameter	Symbol	Test condition	Min.	Typ. ^[1]	Max.	Unit
Ratings						
Current measuring range	I_{PR}		-30		30	A
IP=0A, VIOUT output voltage	V_{OQ}	IP=0A		0.5V _{CC}		V
Sensitivity	Sens	-30A<IP<30A		44*S _{coef}		mV/A
Resolution Index						
Sensitivity error	E_{SENS}	IP = ± 30 A, $T_A = 25^\circ\text{C}$		± 0.5		%
		IP = ± 30 A, $T_A = 25 \sim 125^\circ\text{C}$		± 1.5		%
		IP = ± 30 A, $T_A = -40 \sim 25^\circ\text{C}$		± 1.5		%
Single-ended output zero error	V_{OE}	IP=0A, $T_A = 25^\circ\text{C}$		± 10		mV
		IP=0A, $T_A = 25 \sim 125^\circ\text{C}$		± 14		mV
		IP=0A, $T_A = -40 \sim 25^\circ\text{C}$		± 26		mV
Nonlinearity	E_{LIN}	Measured using full-scale and half-scale IP			1	%
Total error composition: $E_{\text{TOT}} = E_{\text{SENS}} + V_{\text{OE}} / (\text{Sens} \times \text{IP})$						
Total error ^[2]	E_{TOT}	IP = 30 A, $T_A = 25^\circ\text{C} \pm 30$ A, T		± 1.0		%
		IP = ± 30 A, $T_A = 25^\circ\text{C} \sim 125^\circ\text{C}$		± 3.0		%
		IP = ± 30 A, $T_A = -40^\circ\text{C} \sim 25^\circ\text{C}$		± 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 $T_A = -40 \sim 125^\circ\text{C}$, $C_{\text{BYPASS}} = 0.47\mu\text{F}$, $C_{\text{Load}} = 1.5\text{nF}$, and $V_{\text{CC}} = 3.3\text{V}$.

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

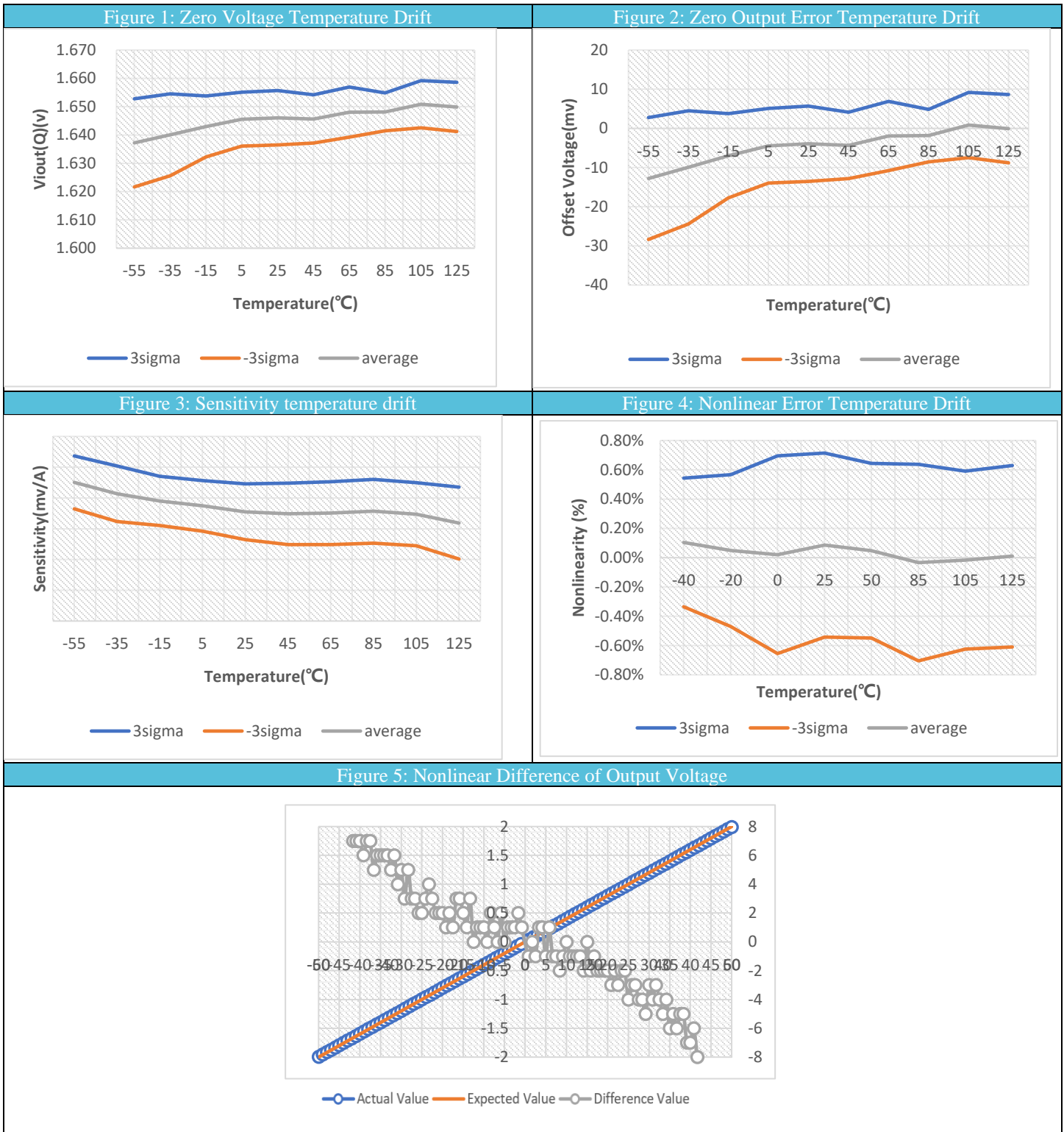
Note: unless otherwise noted, the temp. range of SC813D series is $T_A = -40 \sim 125$ C, $C_{BYPASS} = 0.47$ uF, $C_{Load} = 1.5$ nF, and $VCC = 3.3$ V.

Parameter	Symbol	Test Condition	Min.	Typ. ^[1]	Max	Unit
Ratings						
Current measuring range	IPR		0		40	A
IP=0A, VIOU 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: $E_{TOT} = E_{SENS} + V_{OE} / (Sens \times IP)$						
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		%

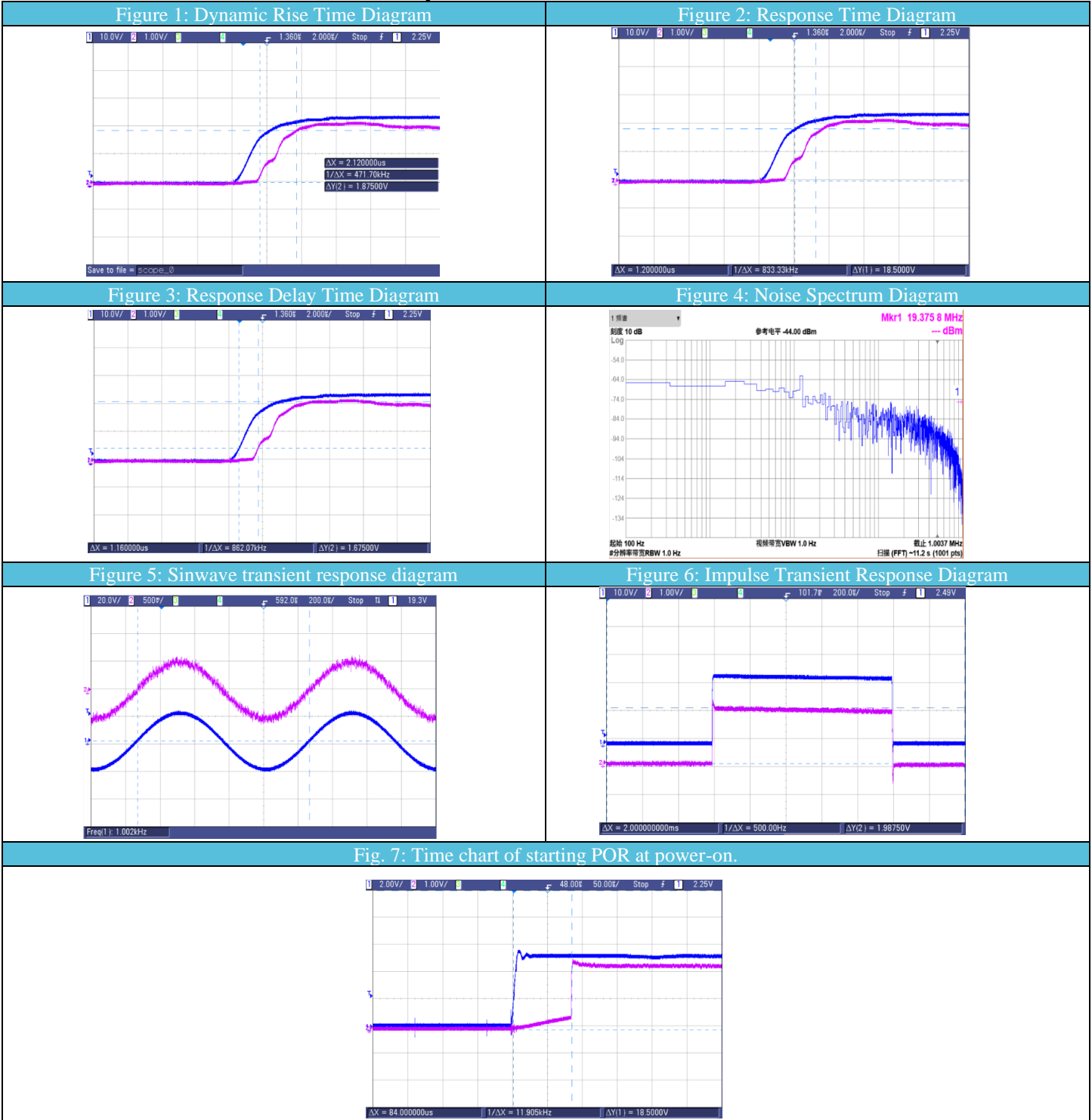
[1] The typical value is +/-1 Sigma, and 68.27% of the products are within this range; The maximum/minimum value is +/-3 Sigma, and 99.73% of the products are within this range.

[2] Percentage value based on peak current IP.

Accuracy Characteristic Curve (based on SC813xFT-30B3)



AC/Dynamic Characteristic Curve



Characteristic Definition and Description

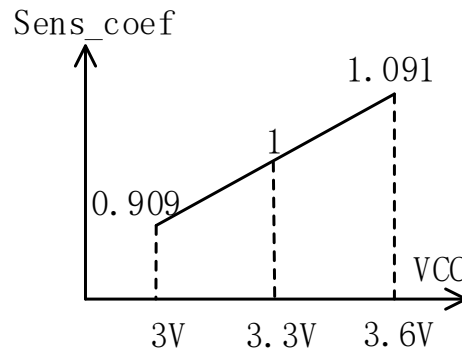
◆ **Proportional Coefficient of Follow-up Sensitivity (applicable to products with suffixes B and U)**

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 $sense_{VCCN}$ at the rated power supply voltage $vccn$. Through this value, the sensitivity at any power supply voltage can be obtained.

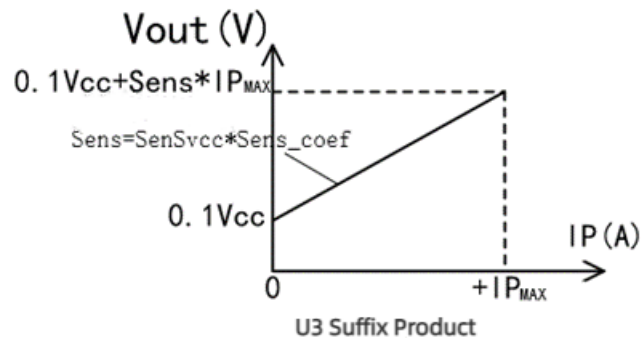
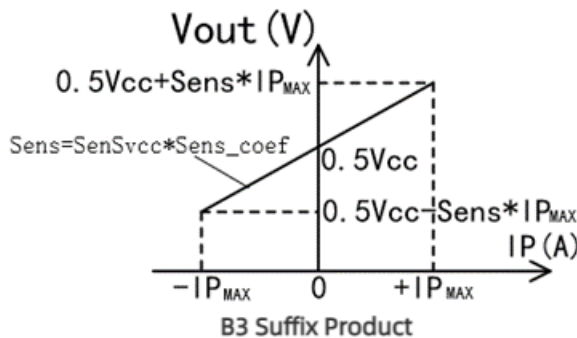
Ideally:



◆ **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 $SENS_{VCC} * Sens_coef$.



◆ **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 $40\mu v$ for every 1 Gauss 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.

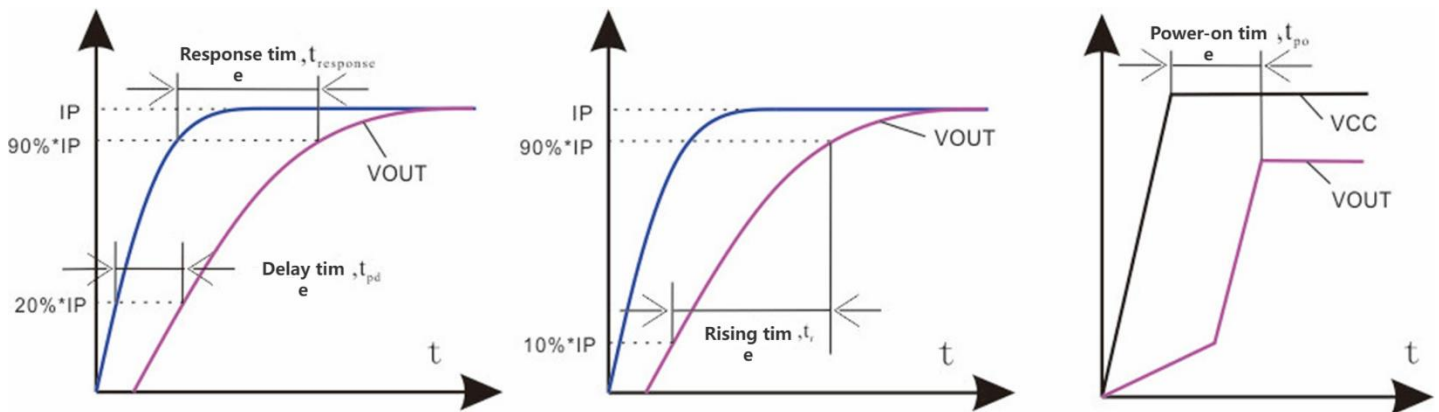
The response time is the time difference between when the secondary output reaches 90% of the steady-state output value and when the primary output reaches 90% of the steady-state current.

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.



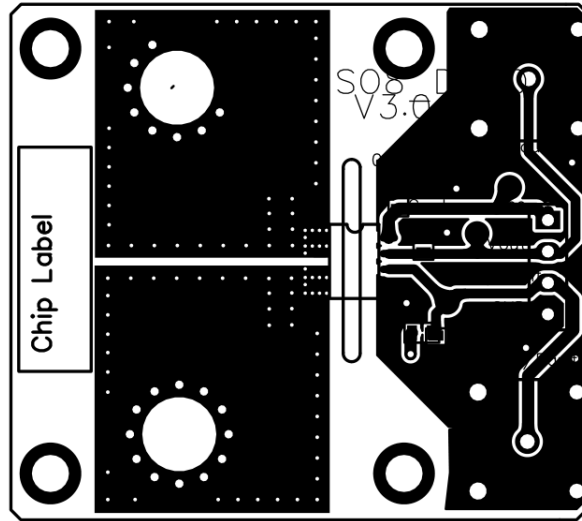
◆ **Thermal Resistance $R_{\theta ja}$**

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.

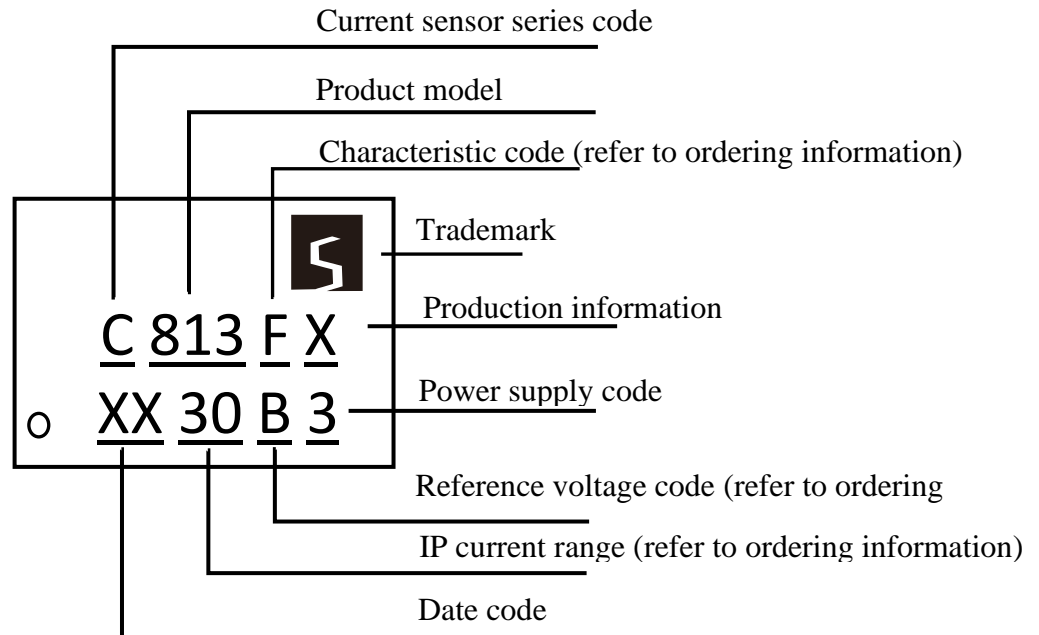
$$T_J = T_A + (R_{\theta JA} * POWER) = T_A + (R_{\theta JA} * IP^2 * R_{PRIMARY});$$

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

PCB Demo Layout



Marking Info.

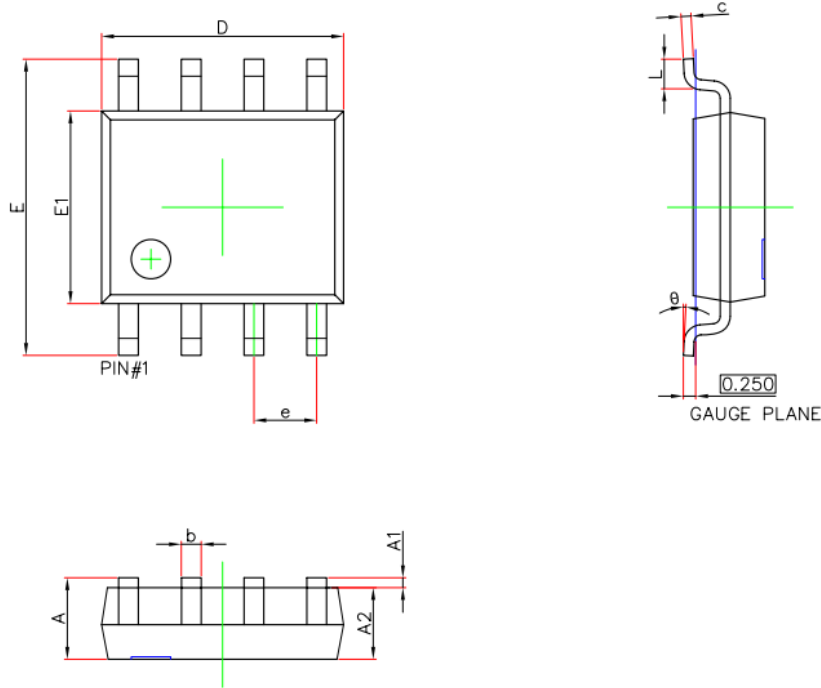


Note: X is a non-fixed character, which is defined by SENK SEMI naming rules.

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°

Important Notice

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SENK SEMI's products are not to be used in life support devices or systems, if a failure of a SENK product can reasonably be expected to cause the failure of that life support device or system, or to affect the safety or effectiveness of that device or system.

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Revision History

Revision	Change	Page	Author	Date
1.0	Initial draft		Jon	2016.03
2.0	Add order info.		Jon	2017.08
3.0	Revise Mark description	4	Tom	2018.06
4.0	Add SC813FFT25B3 Individual Performance Characteristics Add Thermal Rise vs. Primary Current Del fault function Revise PINOUT and MARK and Thermal rise Revise Thermal rise Add Chinese information 更新大批量主推型号按销售出货情况, 删除部分型号 Add SC813DFT-30U3& SC813DFT-40U3		Jon	2019.03
5.0	调整最低工作电压测试到 3v 增加 DFT 系列, 区别于外围电容和 pin6 定义 保留 20B3, 30B3, 50B3 型号, 修改了晶圆版本统一为 600A 新增 UL 与环保标志 新增 10B3 & 10U3 型号 新增 SC813DFT-10B3 型号		Emma	2020.07
6.0	修改 SC813DFT 6pin 定义为 NC, 内部悬空 新增 SC813DFT-05B3 型号 新增 SC813FFT-05B3 型号 新增 SC813DFT-40B3 型号 新增 SC813FFT-10U3 型号 新增 SC813DFT-30U3 型号 新增 SC813DFT-20U3& SC813DFT-40U3 型号 新增 SC813FFT-20U3 型号 新增 SC813DFT-63B3 型号	2	LCH	2022.2
7.0	新增 SC813FFT-40U3 & SC813DFT-50U3 型号 新增 SC813FFT-25B3 型号 新增 SC813DFT-25B3 型号	2	MWJ	2024.02.18