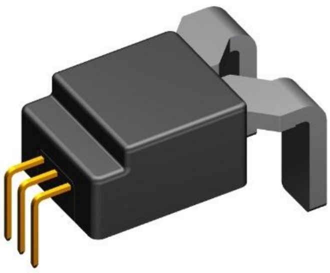
Current Sensor

Product Series: STK-600

Version: Ver 4.6



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CONTENT

1. Introduction

The STK-600 series current sensor is based on TMR (tunnel magnetoresistance) technology, and it has an open-loop design. It is suitable for DC, AC pulsed and any kind of irregular current measurement under the isolated conditions.

Typical applications

- AC Variable speed drives
- Motor driver
- Electric welder power supply
- BMS

General parameter

Parameter	Symbol	Unit	Value
Working temperature	T_A	℃	-40 ~ 125
Storage temperature	T_stg	℃	-40 ~ 125
Mass	m	g	4

Absolute maximum rating

Parameter	Symbol	Unit	Value
Supply voltage（not-destructive）	V_{CC}	V	6
ESD rating（HBM）	U_{ESD}	kV	4

Remark: the unrecoverable damage may occur when the product works on the conditions over the absolute maximum ratings. Long-time working on the absolute maximum ratings may cause the degradation on performance and reliability.

Isolation parameter

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC test 50Hz/1 min	Ud	kV	4	
Clearance distance (pri. -sec)	dCI	mm	8	Shortest distance through air
Creepage distance (pri. -sec)	dCp	mm	8	Shortest path along device body
Case material			V0 according to UL 94	

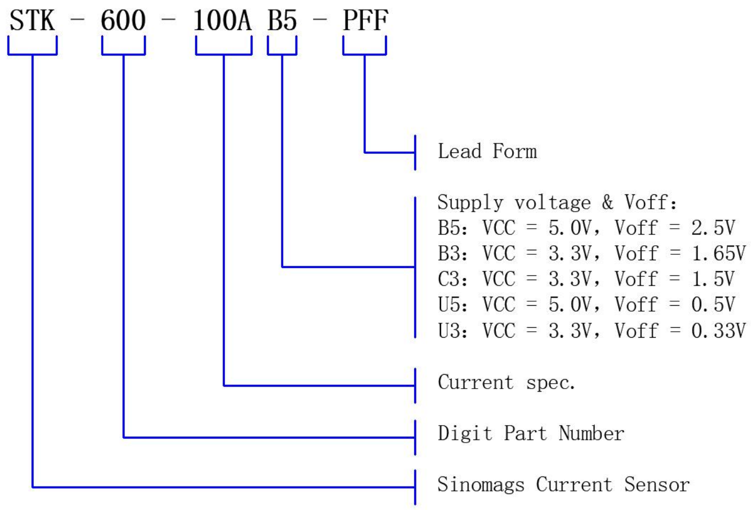
2. Package: 5-pin package

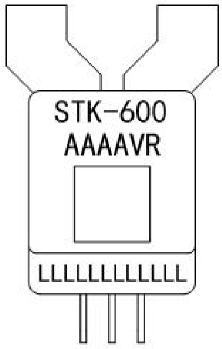
PFF Leadform

3. Features and Benefits

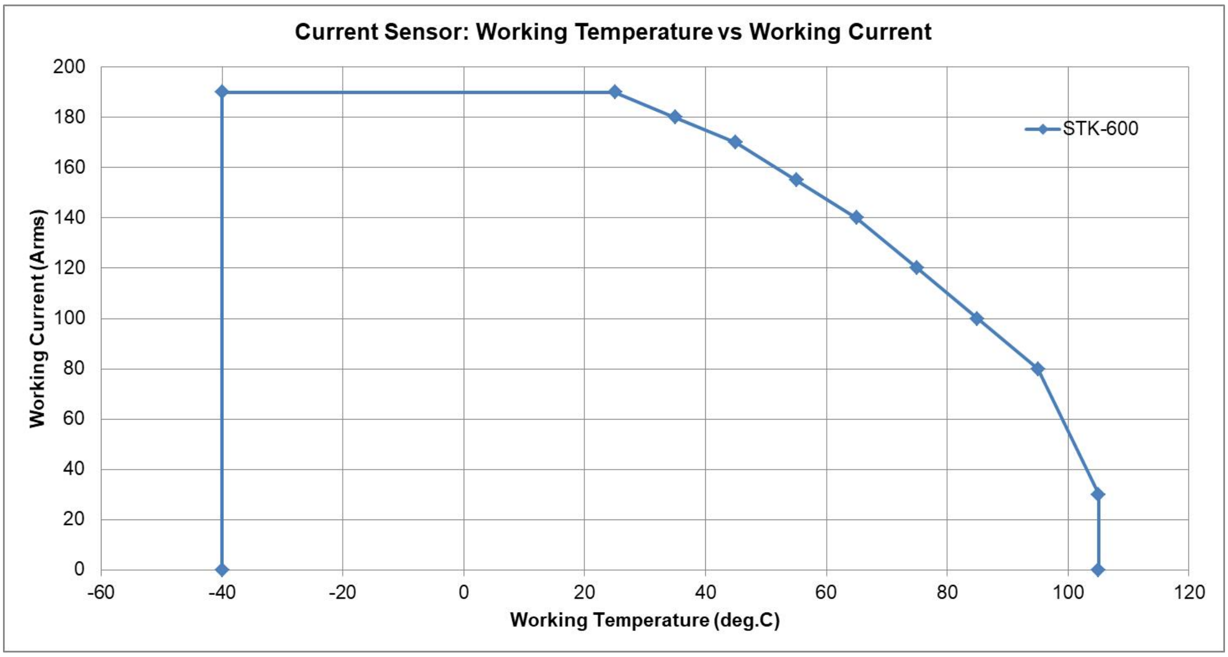
UL certified, File No. E507664.

4. Product Information





Production information is printed on the package surface by laser marking.



The relationship between working temperature & working current. It is suggested that the temperature of sensor not exceed 105 deg.C for better accuracy.

5. Electrical Data

Condition: T_A = 25℃，STK-600-XXXAB5

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current	I_{PN}	A		50		STK-600-050AB5
				100		others
Current range (refer remark)	I_{PM}	A	-50		50	STK-600-050AB5
			-100		100	STK-600-100AB5
			-166		166	STK-600-166AB5
			-200		200	STK-600-200AB5
			-300		300	STK-600-300AB5
			-400		400	STK-600-400AB5
Sensitivity	Sens	mV/A		40		STK-600-050AB5
				20		STK-600-100AB5
				12		STK-600-166AB5
				10		STK-600-200AB5
				6.66		STK-600-300AB5
				5		STK-600-400AB5
Supply voltage	Vcc	V		5 ± 5%		All
Power up Delay	T_delay	ms		80	120	All
Current consumption	Icc	mA		6		All
Quiescent voltage Vout @ 0 A	Voff	V	2.48	2.5	2.52	STK-600-XXXAB5
Peak output voltage (Vout @ ±I_pm) –Voff	V_FS	V		± 2		STK-600-XXXAB5
Internal output resistance	R_out	Ω		2		All
Rated linearity error	E_{LIN}	% I_{PN}		± 1		± I_{PN}
Step response time @90% of I_{PM}	t_res	μs		2.0		STK-600-XXXAB5
Frequency bandwidth (-3dB)	BW	kHz		180		STK-600-XXXAB5
Output voltage noise DC ~ 10 kHz DC ~ 100 kHz	Vnoise	mVpp		 20 30		All
Accuracy @ 25℃	E_{TOT}	% of I_{PM}	-2.4	±1	2.4	All
Accuracy @ -40℃ ~ 105℃	E_{TOT}	% of I_{PM}	-3.5		3.5	STK-600-050AB5 ~ STK-600-166AB5
Accuracy @ -40℃ ~ 85℃	E_{TOT}	% of I_{PM}	-3.5		3.5	STK-600-200AB5 ~ STK-600-400AB5

Condition: T_A = 25℃，STK-600-XXXAB3

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current	I_{PN}	A		100		All
Current range (refer remark)	I_{PM}	A	-100		100	STK-600-100AB3
			-150		150	STK-600-150AB3
Sensitivity	Sens	mV/A		13.2		STK-600-100AB3
				8.8		STK-600-150AB3
Supply voltage	Vcc	V		3.3 ± 5%		All
Current consumption	Icc	mA		6		All
Power up Delay	T_delay	ms		80	120	All
Quiescent voltage Vout @ 0 A	Voff	V	1.63	1.65	1.67	STK-600-XXXAB3
Peak output voltage (Vout @ ±I_pm) –Voff	V_FS	V		± 1.32		STK-600-XXXAB3
Internal output resistance	R_out	Ω		2		All
Rated linearity error	E_{LIN}	% I_{PN}		± 1		± I_{PN}
Step response time @90% of I_{PM}	t_res	μs		2.0		STK-600-XXXAB3
Frequency bandwidth (-3dB)	BW	kHz		180		STK-600-XXXAB3
Output voltage noise DC ~ 10 kHz DC ~ 100 kHz	Vnoise	mVpp		20 30		All
Accuracy @ 25℃	E_{TOT}	% of I_{PM}	-2.4	±1	2.4	All
Accuracy @ -40℃ ~ 105℃	E_{TOT}	% of I_{PM}	-3.5		3.5	STK-600-100AB3~ STK-600-150AB3

Condition: T_A = 25℃，STK-600-XXXAC3

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current	I_{PN}	A		100		All
Current range (refer remark)	I_{PM}	A	-200		200	STK-600-200AC3
			-250		250	STK-600-250AC3
Sensitivity	Sens	mV/A		6		STK-600-200AC3
				4.8		STK-600-250AC3
Supply voltage	Vcc	V		3.3 ± 5%		All
Power up Delay	T_delay	ms		80	120	All
Current consumption	Icc	mA		6		All
Quiescent voltage Vout @ 0 A	Voff	V	1.48	1.5	1.52	STK-600-XXXAC3
Peak output voltage (Vout @ ±I_pm) –Voff	V_FS	V		± 1.2		STK-600-XXXAC3
Internal output resistance	R_out	Ω		2		All
Rated linearity error	E_{LIN}	% I_{PN}		± 1		± I_{PN}
Step response time @90% of I_{PM}	t_res	μs		2.0		STK-600-XXXAC3
Frequency bandwidth (-3dB)	BW	kHz		180		STK-600-XXXAC3
Output voltage noise DC ~ 10 kHz DC ~ 100 kHz	Vnoise	mVpp		20 30		All
Accuracy @ 25℃	E_{TOT}	% of I_{PM}	-2.4	±1	2.4	All
Accuracy @ -40℃ ~ 85℃	E_{TOT}	% of I_{PM}	-3.5		3.5	STK-600-200AC3~ STK-600-250AC3

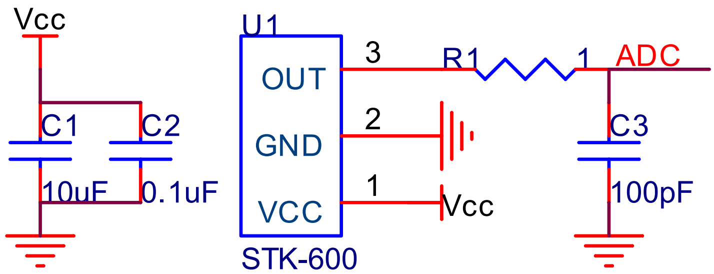
Condition: T_A = 25℃，STK-600-XXXAU5

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current	I_{PN}	A		100		All
Current range (refer remark)	I_{PM}	A	0		400	STK-600-400AU5
Sensitivity	Sens	mV/A		10		STK-600-400AU5
Supply voltage	Vcc	V		5 ± 5%		All
Power up Delay	T_delay	ms		80	120	All
Current consumption	Icc	mA		6		All
Quiescent voltage Vout @ 0 A	Voff	V	0.48	0.5	0.52	STK-600-XXXAU5
Peak output voltage (Vout @ ±I_pm) –Voff	V_FS	V		4		STK-600-XXXAU5
Internal output resistance	R_out	Ω		2		All
Rated linearity error	E_{LIN}	% I_{PN}		± 1		± I_{PN}
Step response time @90% of I_{PM}	t_res	μs		2.0		STK-600-XXXAU5
Frequency bandwidth (-3dB)	BW	kHz		180		STK-600-XXXAU5
Output voltage noise DC ~ 10 kHz DC ~ 100 kHz	Vnoise	mVpp		20 30		All
Accuracy @ 25℃	E_{TOT}	% of I_{PM}	-2.4	±1	2.4	All
Accuracy @ -40℃ ~ 85℃	E_{TOT}	% of I_{PM}	-3.5		3.5	STK-600-400AU5

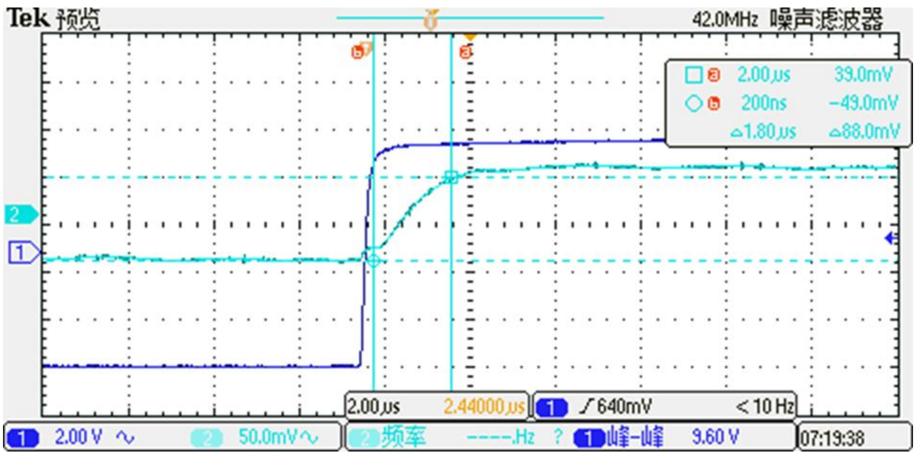
Condition: T_A = 25℃, STK-600-XXXAU3

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current	I_{PN}	A		100		STK-600-100AU3
Current range (refer remark)	I_{PM}	A	0		100	STK-600-100AU3
Sensitivity	Sens	mV/A		26.4		STK-600-100AU3
Supply voltage	Vcc	V		3.3 ± 5%		All
Power up Delay	T_delay	ms		80	120	All
Current consumption	Icc	mA		6		All
Quiescent voltage Vout @ 0 A	Voff	V	0.31	0.33	0.35	STK-600-XXXAU3
Peak output voltage (Vout @ ±I_pm) –Voff	V_FS	V		2.64		STK-600-XXXAU3
Internal output resistance	R_out	Ω		2		All
Rated linearity error	E_{LIN}	% I_{PN}		± 1		± I_{PN}
Step response time @90% of I_{PM}	t_res	μs		2.0		STK-600-XXXAU3
Frequency bandwidth (-3dB)	BW	kHz		180		STK-600-XXXAU3
Output voltage noise DC ~ 10 kHz DC ~ 100 kHz	Vnoise	mVpp		 20 30		All
Accuracy @ 25℃	E_{TOT}	% of I_{PM}	-2.4	±1	2.4	All
Accuracy @ -40℃ ~ 105℃	E_{TOT}	% of I_{PM}	-3.5		3.5	STK-600-100AU3

6. Typical Application Circuit

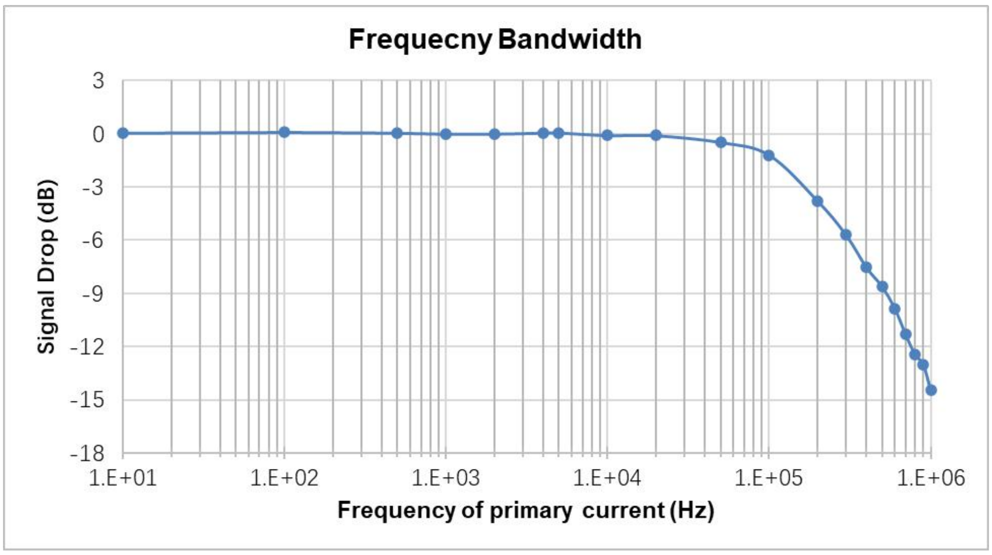


7. Response Time



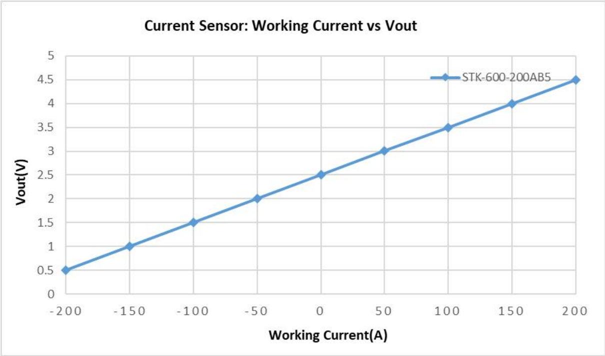
STK-600 response time

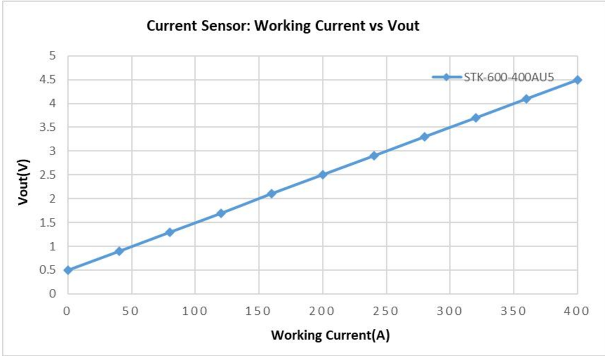
8. Frequency Bandwidth

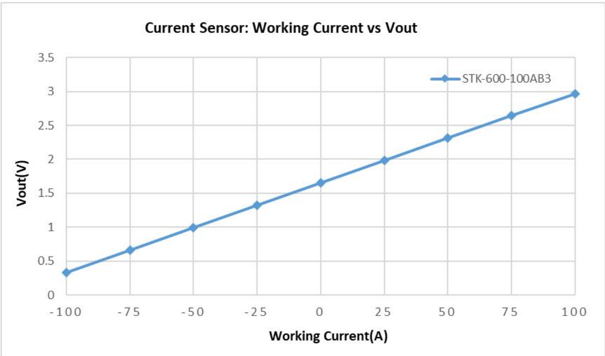


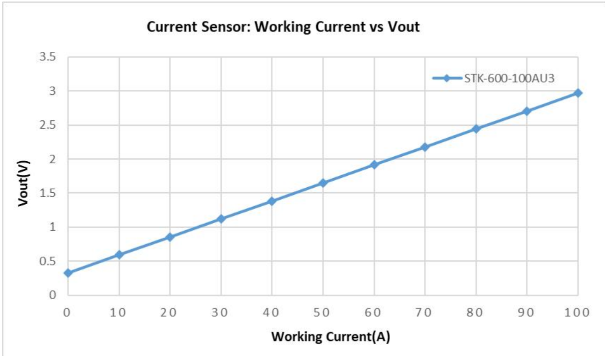
STK-600 bandwidth

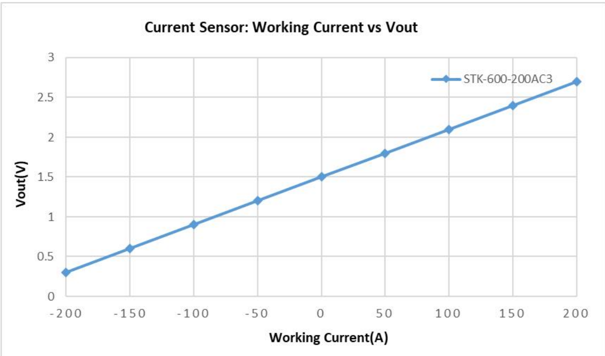
9. Working Current vs Vout



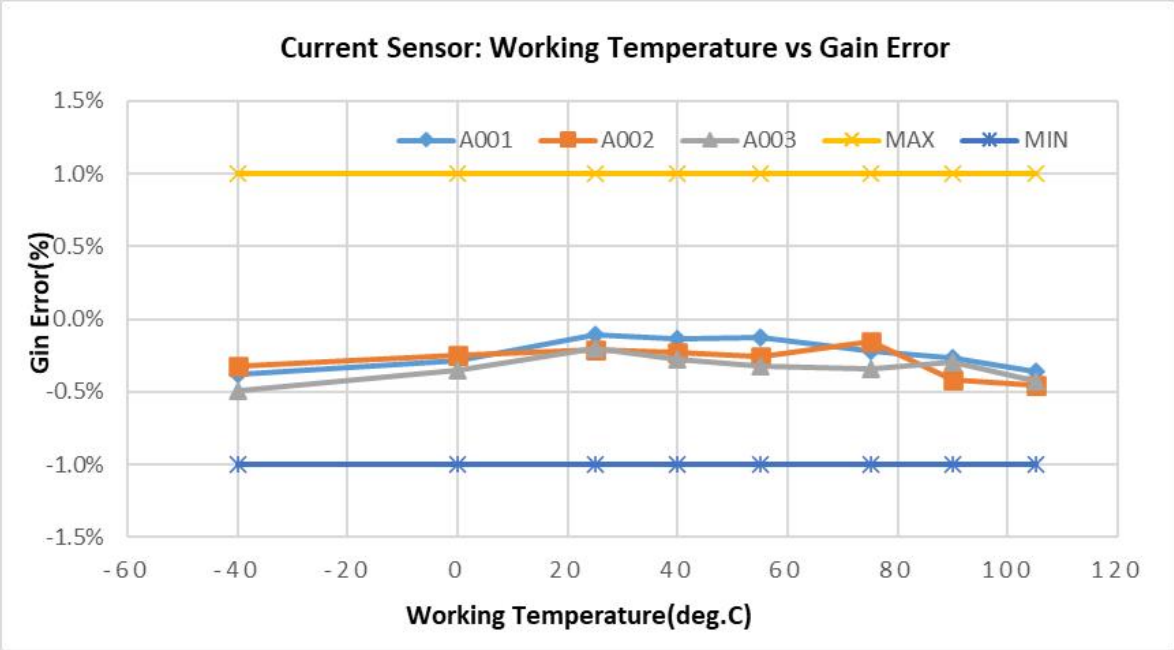








10. Working Temperature vs Gain Error



11. Characteristic Definitions

SENSITIVITY (Sens)

The change in sensor output in response to a 1 A change through the primary conductor. The sensitivity is the sensor gain (mV/A) for the full-scale current of the device. The sensitivity is fixed and does not change with the supply voltage.

SENSITIVITY ERROR (E_{Sens})

The sensitivity error is the percent difference between the ideal sensitivity and the measured sensitivity.

$$E_{Sens} = \frac{Sens_{Meas} - Sens_{Ideal}}{Sens_{Ideal}}$$

NONLINEARITY (E_{LIN})

The STK-600 is designed to provide a linear output in response to a ramping current. Consider two current levels: I1 and I2. Nonlinearity is present when there is a difference between the sensitivities measured at I1 and I2. Nonlinearity is calculated separately for the positive (E_{LINpos}) and negative (E_{LINneg})

$$E_{LINpos} = 100(\%) * \{1 - \frac{Sens_{IPOS2}}{Sens_{IPOS1}}\}$$

$$E_{LINneg} = 100(\%) * \{1 - \frac{Sens_{INEG2}}{Sens_{INEG1}}\}$$

applied currents as follows:

and I_{POSx} and I_{NEGx} are positive and negative currents and I_{POSx} =2* I_{POS1} and I_{NEG2} = 2*I_{NEG1}.

ZERO CURRENT OUTPUT VOLTAGE (Voff))

$$Sens_{Ix} = \frac{V_{IOUT(Ix)} - V_{IOUT(Q)}}{I_x}$$

$$E_{LIN} = max(E_{LINpos}, E_{LINneg})$$

The output of the sensor when the primary current is zero. When the power supply is 5V, it nominally remains at 2.5V for a bidirectional device and 0.5V for a unidirectional device. When the power supply is 3.3V, it nominally remains at 1.65V for a bidirectional device and 0.5V for a unidirectional device.

TOTAL OUTPUT ERROR (E_{TOT})

The difference between the current measurement from the sensor and the actual current (IP), relative to the actual current. The Total Output Error incorporates all sources of error and is a function of IP.

$$E_{TOT}(I_P) = \frac{V_{IOUT(I_P)} - V_{IOUT(ideal)(I_P)}}{Sens_{ideal} * I_P}$$

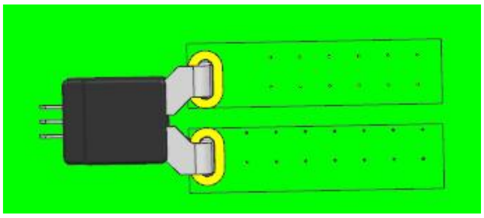
$$V_{IOUT(ideal)(I_P)} = V_{IOUT(Q)} + Sens_{ideal} * I_P$$

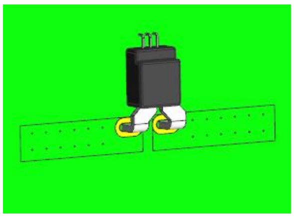
12. Applications Information

LAYOUT GUIDELINES

There are a few considerations during PCB layout that will help to maintain high accuracy when using STK-600. STK-600 detects current by measuring the magnetic field generated by the current. STK-600 includes a U-shaped conductor inside and senses a differential field generated by the primary current which can provide immunity to external magnetic fields. Therefore, the sensor will reject any common mode magnetic field originating from outside of its package. However, it is still prudent to avoid exposure to external magnetic fields. Therefore, it’s important to consider the effect of externally generated magnetic fields, whether from a magnet component and another current flowing in the system. STK-600 is most sensitive to the magnetic field in the X-Y plane (the plane of the PCB surface). When laying out the PCB, care should be taken to avoid a current passing directly underneath the device itself, because the magnetic field generated by that current will be parallel to the PCB surface.

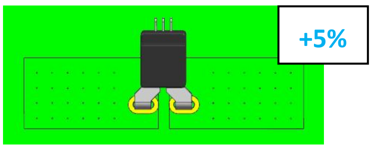
REFERENCE LAYOUT

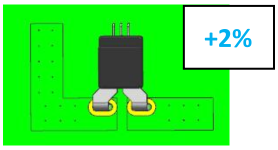




In general, no gain calibration is required in these reference layouts.

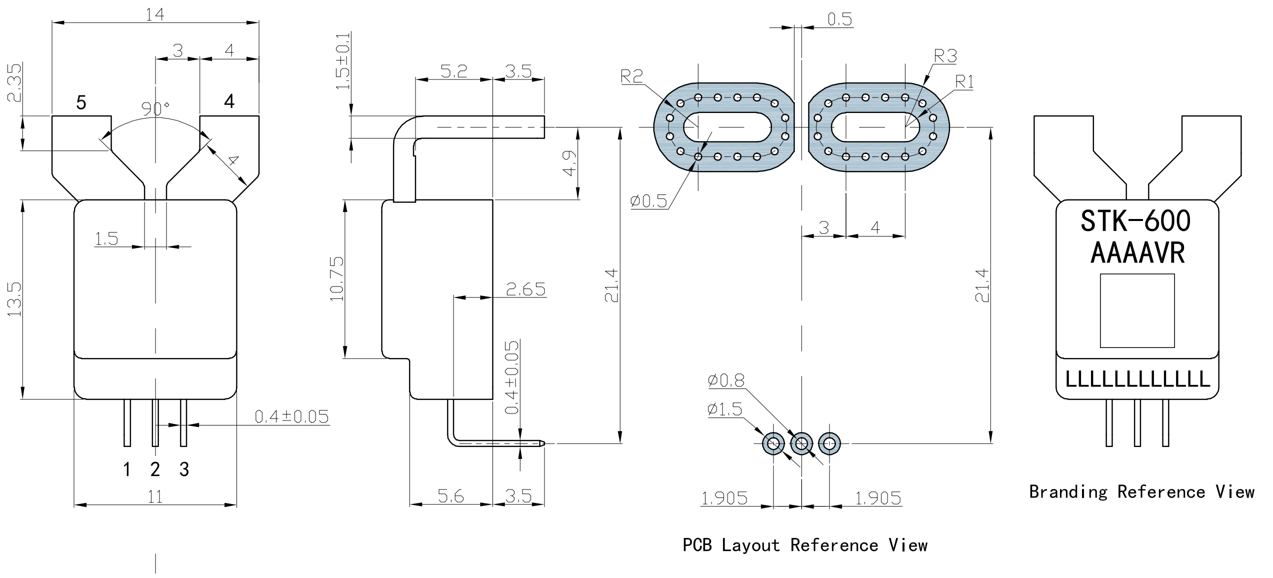
GAIN CALIBRATION REQUIRED LAYOUT

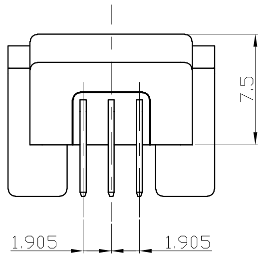




The gain error depends on the size of the current wire and its position relative to the package of the current sensor. The gain error can be calculated according to the electromagnetic theory or measured. If there is a complex PCB wiring under the sensor, please contact FAE to assist with the design. In these above typical layouts, the linearity is good, but the gain needs to be calibrated. The specific gain error value can be obtained by Maxwell equations or specific measurement.

13. Dimension & Pin Definitions





Terminals

(1)	VCC
(2)	GND
(3)	VOUT
(4)	IP+
(5)	IP-

Material : Fit UL94V-0 & RoHS requirements ;
General tolerance : ±0.5
Unit :mm