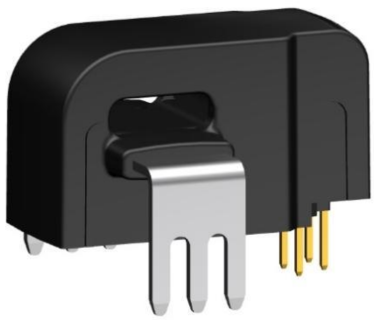
# Current Sensor

Product Series： STK-PL

Part number： STK-50PL/P3

Version: Ver 1.2



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# CONTENT

# 1. Summary

The STK-PL series is based on TMR (Tunneling-Magnetoresistance) technology and open-loop design. It is suitable for DC, AC, pulsed and any kind of irregular current measurement under the isolated conditions. The nominal current range of the STK-PL/P3 current sensor consists of 50 A.

## Typical applications

- PV combiner box
- PV inverter (MPPT & AC)
- motor driver controller
- SMPS & UPS
- Battery management system

## Standards

- EN50178:1997
- IEC 61010-1:2010
- IEC 61326-1:2012

## General parameter

| Parameter | Symbol | Unit | Value |
|---|---|---|---|
| Working temperature | T_A | ℃ | -40 ~ 105 |
| Storage temperature | T_stg | ℃ | -40 ~ 105 |
| Mass | m | g | 10 |

## Absolute maximum rating

| Parameter | Symbol | Unit | Value |
|---|---|---|---|
| Supply voltage（non-destructive） | $V_C$ | V | 6.0 |
| ESD rating（HBM） | $U_{ESD}$ | kV | 4 |
| ESD rating（CDM） | $U_{CDM}$ | kV | 1.5 |

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.

## Ratings

| Parameter | Symbol | Unit | Value |
|---|---|---|---|
| Primary involved potential | | V AC/DC | 600 |
| Ambient operating temperature | T_A | ℃ | 105 |
| Primary current | I_p | A | According to series primary current |
| Secondary supply voltage | U_c | V DC | 5 |
| Output voltage | V_out | V | 0.1 ~ 4.9 |

## Isolation parameter

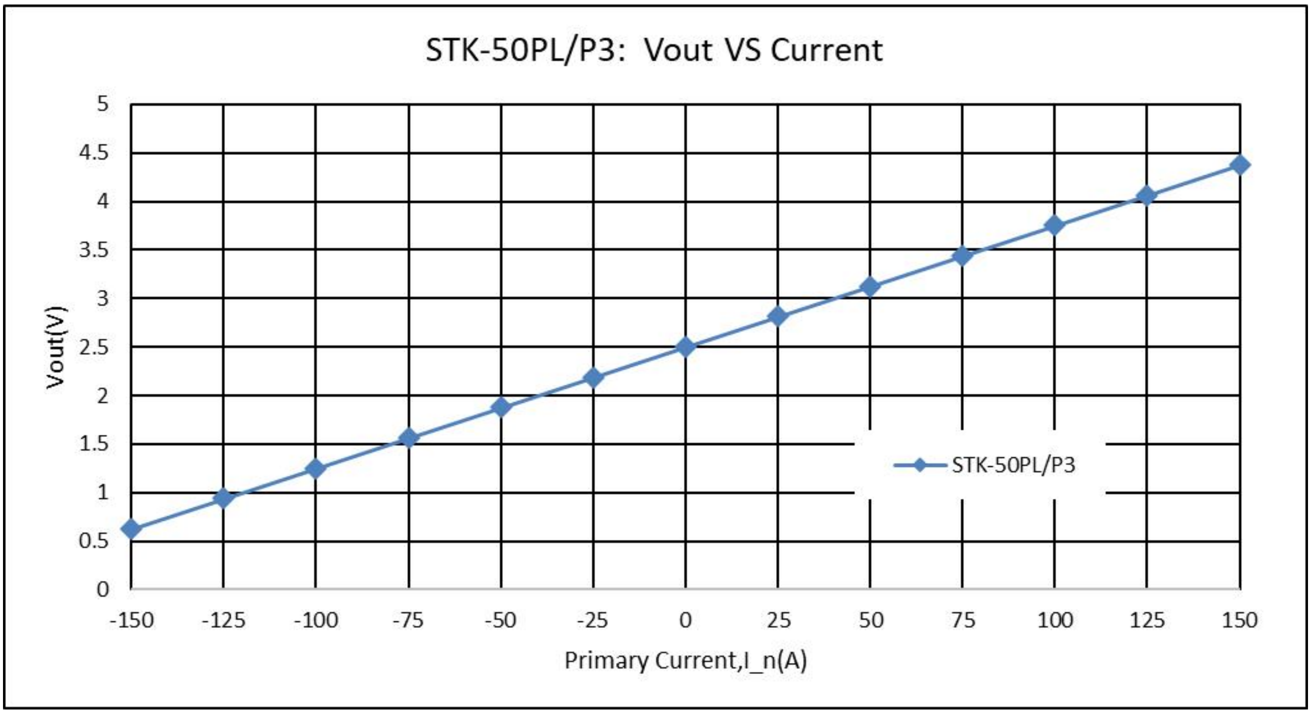
| Parameter | Symbol | Unit | Value | Comment |
|---|---|---|---|---|
| RMS voltage for AC test 50Hz/1 min | Ud | kV | 5 | |
| Impulse withstand voltage 1.2/50μs | Ûw | kV | 8 | |
| Clearance distance (pri. -sec) | dCI | mm | 8 | Shortest distance through air |
| Creepage distance (pri. -sec) | dCp | mm | 8 | Shortest path along device body |
| Case material | | | V0 according to UL 94 | |
| Application example | | V | 600 | Reinforced insulation, CAT III, PD 2, non uniform field according EN 50178, IEC 61010 |
| Application example | | V | 1000 | Basic insulation, CAT III, PD 2, non uniform field according EN 50178, IEC 61010 |
| Application example | | V | 1500 | Basic insulation, CAT III, PD 2, according to IEC 62109-1 Altitude ≤ 3000 m |
| Application example | | V | 600 | CAT III, PD 2, according to UL 508 |

## 2. STK-50PL/P3 Electrical performance

Condition：T_A = 25℃ Vcc = 5 V (Except special instructions)

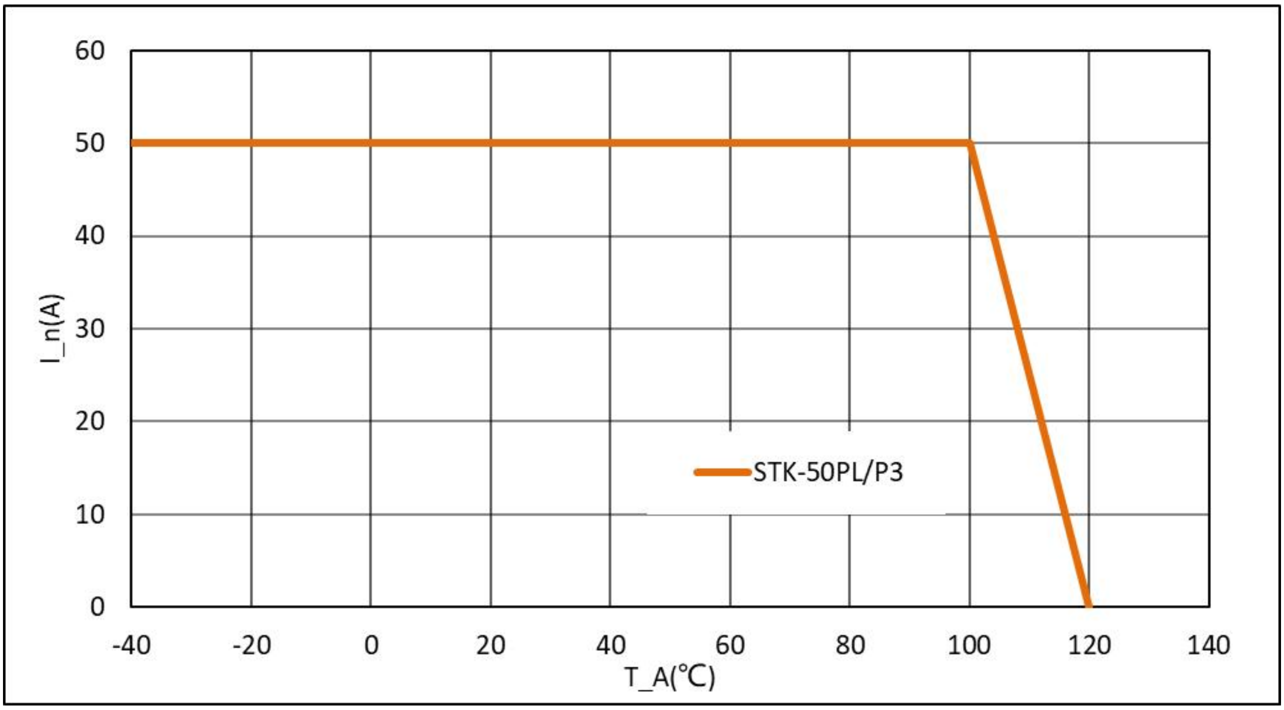
| Parameter | Symbol | Unit | Min | Typ | Max | Comment |
|---|---|---|---|---|---|---|
| Primary nominal current rms | I_pn | A | | 50 | | |
| Primary current measuring range | I_pm | A | -150 | | 150 | |
| Supply voltage | Vcc | V | 4.75 | 5 | 5.25 | |
| Current consumption | Icc | mA | | 5 | 10 | |
| Reference voltage | Vref | V | 2.48 | 2.5 | 2.52 | Output function |
| Rated output voltage` | V_FS | V | | 0.625 | | Vout - Vref @ I_pn |
| Internal output resistance | R_out | Ω | | 1 | | Vout @ 0 A |
| Internal output resistance | R_ref | Ω | | 1 | | Vout @ 0 A |
| Quiescent voltage | Voff | V | 2.48 | 2.5 | 2.52 | Vout @ 0 A |
| Electrical offset voltage | Voe | mV | -10 | | 10 | (Vout – Vref) @ 0 A |
| Temperature drift of Voe | Voe_TRange | %V_FS | -1.5 | | 1.5 | -40℃ ~ 105℃ |
| Magnetic offset current | I_om | A | -0.25 | | 0.25 | @ ±10 x I_pn |
| Theoretical gain | G_th | mV/A | | 12.5 | | 625 mV @ I_pn |
| Error of gain | Err_G | %G_th | -0.5 | | 0.5 | Trimmed in the factory @ 25℃ |
| Temperature drift of gain | Err_G_TRange | %V_FS | -1.0 | | 1.0 | -40℃ ~ 105℃ |
| Rated linearity error | Non-L | %I_pn | -0.5 | | 0.5 | ±I_pn |
| Linearity error @ I_pm | Non-L | %I_pm | -3 | | 3 | ±I_pm |
| Reaction time | t_ra | μs | | 0.5 | | @10% of I_pn |
| Step response time | t_res | μs | | 2.5 | | @90% of I_pn |
| Delay time | t_delay | μs | | 1.5 | | 200 kHz sine wave |
| Frequency bandwidth (-3dB) | BW | kHz | | 200 | | No RC circuit |
| Output voltage noise<br>DC ~ 10 kHz<br>DC ~ 100 kHz | Vnoise | mVpp | | <br>10<br>15 | | |
| Accuracy @ 25℃ | X | % of I_pn | -1 | | 1 | @ 25℃ |
| Accuracy @ -40℃ ~ 105℃ | X_TRange | % of I_pn | -2 | | 2 | -40℃ ~ 105℃ |

## 3. Output voltage VS primary current



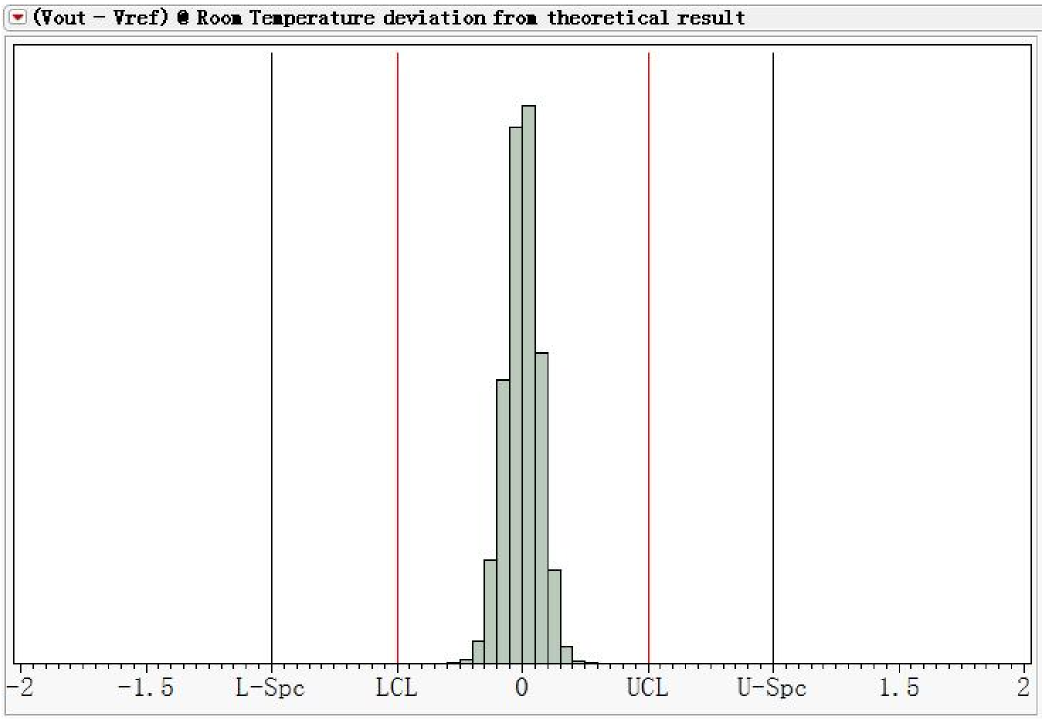

The dependence of Vout of STK-50PL/P3 on the primary current.

## 4. Maximum continues DC current



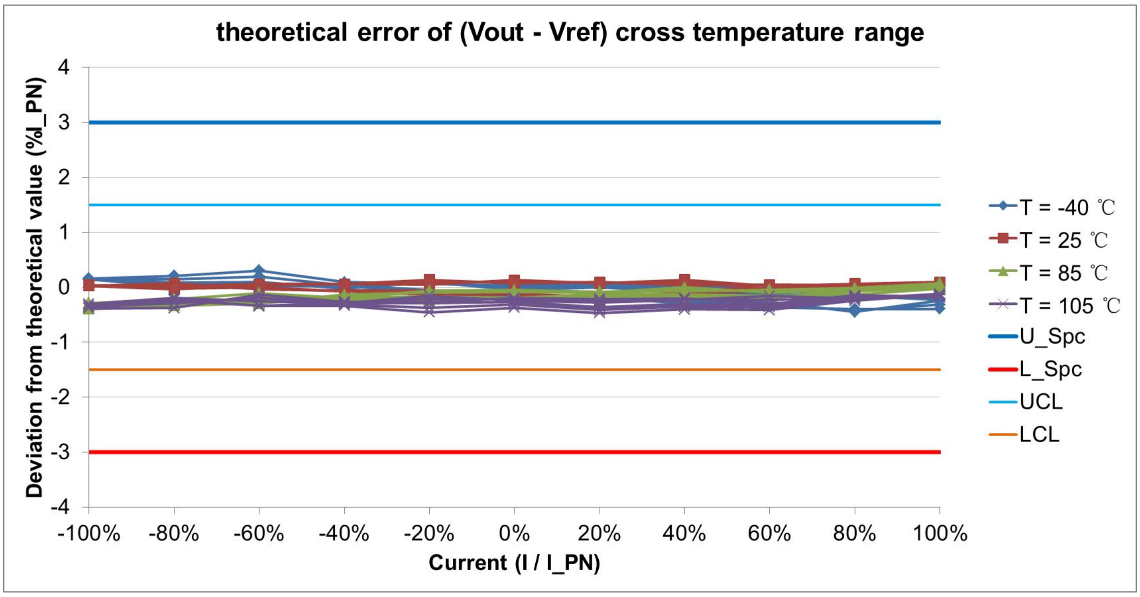

The dependence of maximum continues current of STK-50PL/P3 current on the working temperature.

# 5. Accuracy characteristics in room temperature

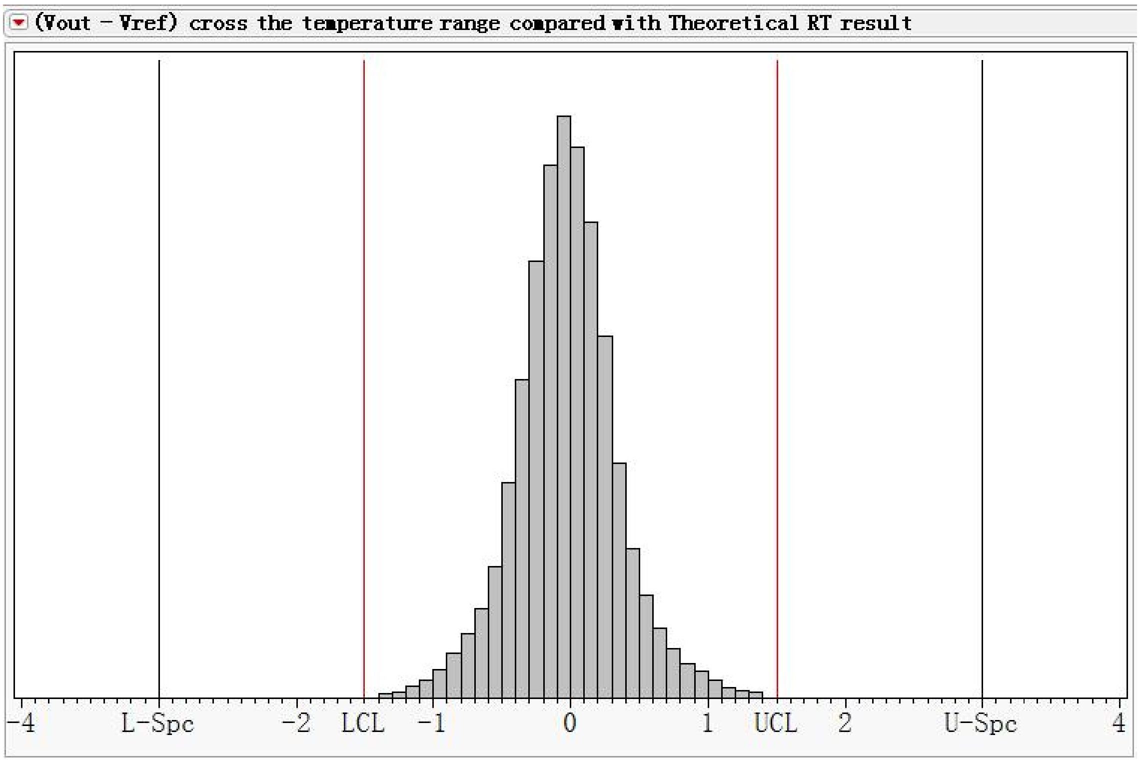



The error of current sensor at 25℃ compared with the standard output，((Vout – Vref)_measure @ I_n @ 25℃–Voe@25℃ – G_th * In) / V_FS。Vout represents voltage of Vout, Vref the voltage of Vref, I_n the primary current, Voe the (Vout – Vref)@0A, G_th the theoretical gain, V_FS the rated output voltage.

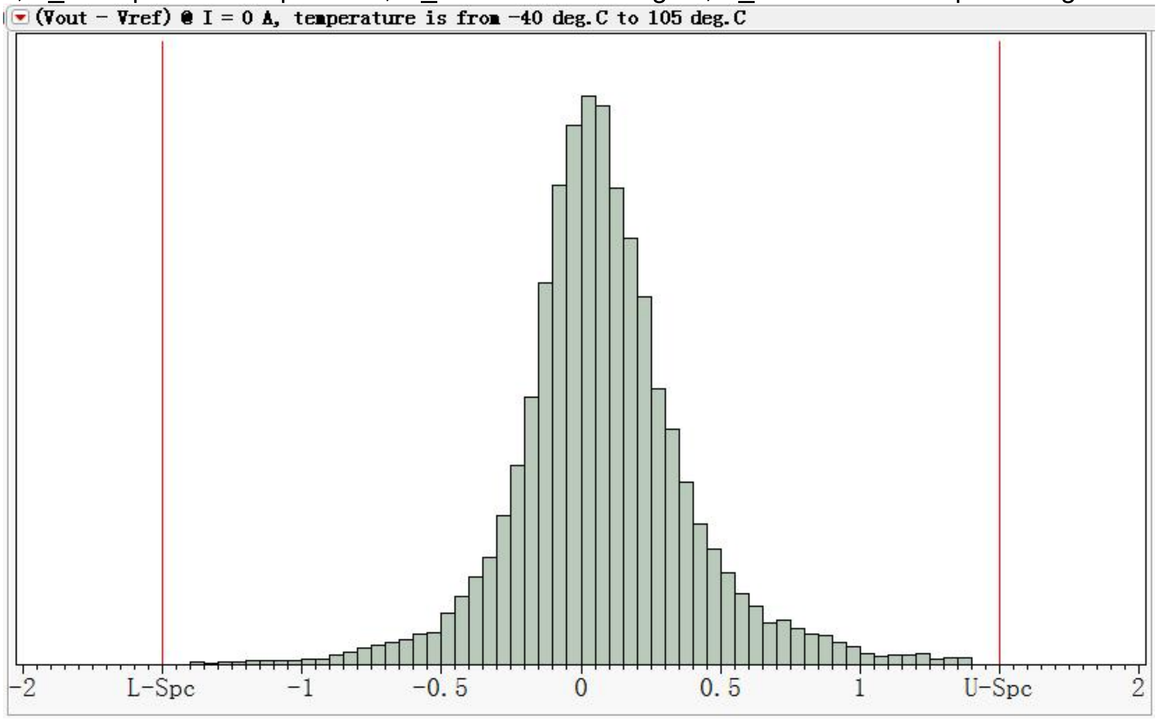
# 6. Accuracy cross temperature



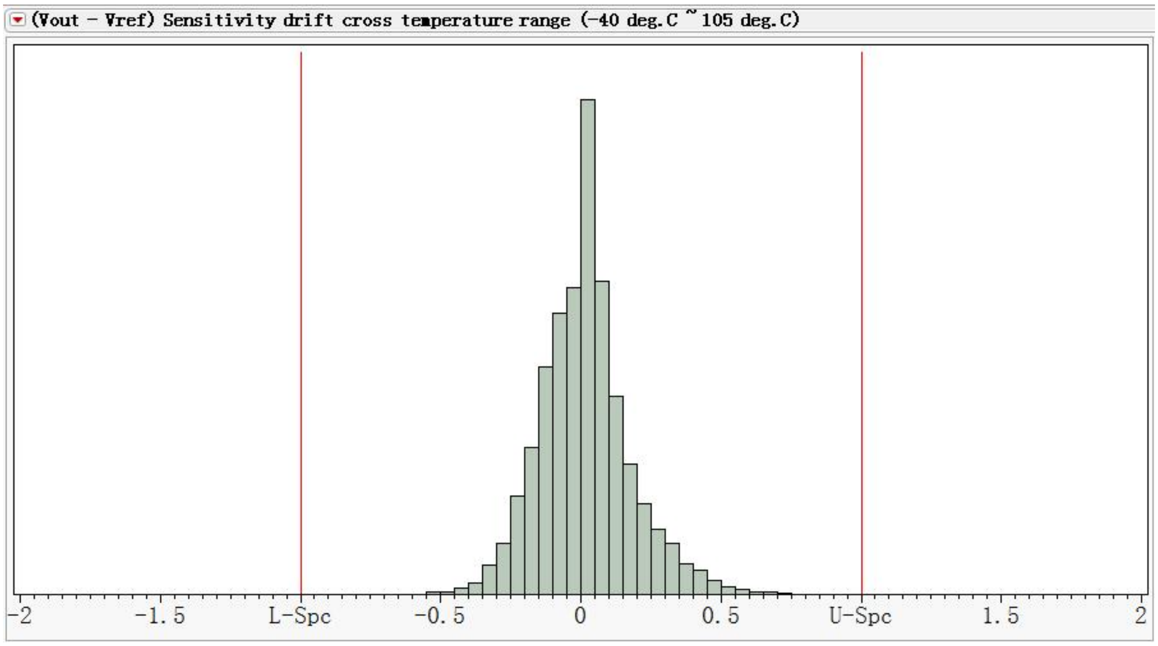

The error of current sensor at -40℃ ~105℃ compared with the standard output at room temperature, ((Vout – Vref)_measure @ I_n @ T_x –Voe@ T_x– G_th * In) / V_FS. Where, Vout represents voltage of Vout, Vref the voltage of Vref, I_n the primary current, T_x the present temperature, Voe the (Vout – Vref)@0A, G_th the theoretical gain, V_FS the rated output voltage.




The error of output (Vout – Vref) current sensor at -40℃ ~ 105℃ compared with the standard output (V = G_th * I_n), ((Vout – Vref) @ I_n @ T_x- G_th * I_n) / V_FS, Where, I_n represents present primary current, T_x the present temperature, G_th the theoretical gain, V_FS the rated output voltage.

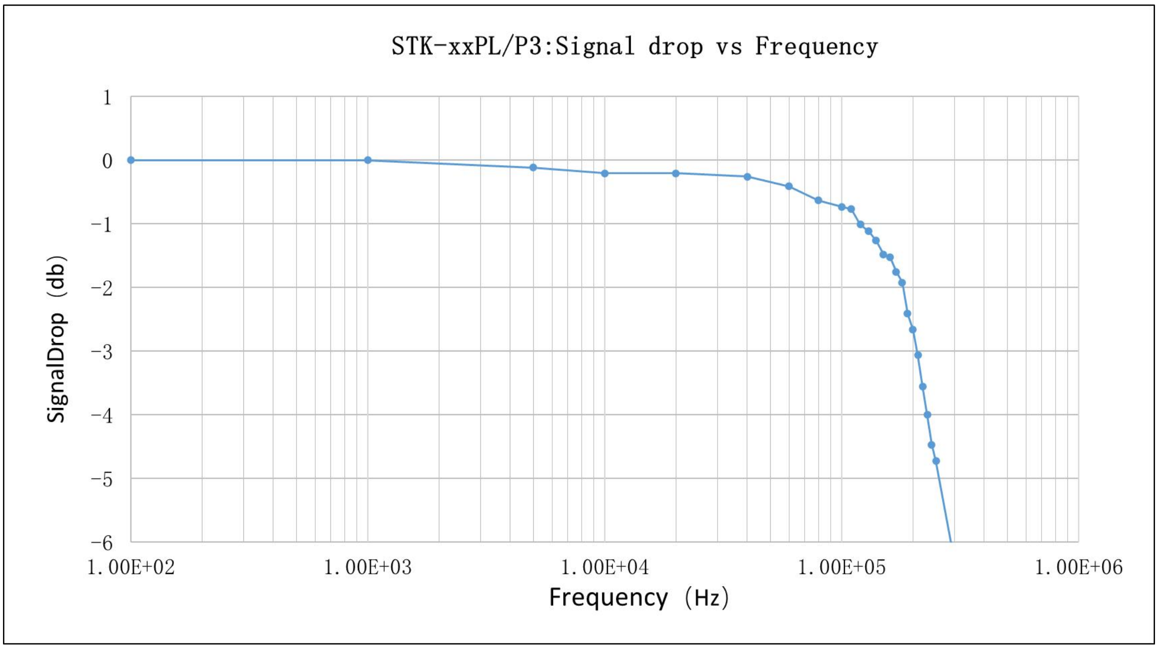



Temperature drift of Voe, Voe_TRange = (Voe @ T_x – Voe @ 25℃) / V_FS. T_x represents present temperature, V_FS the rated output voltage.



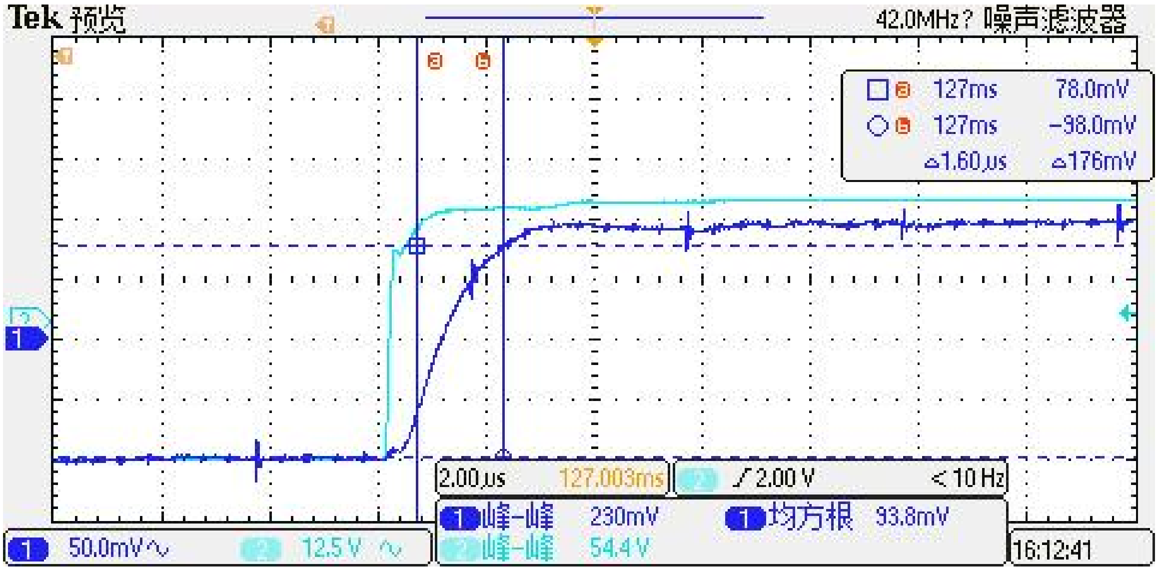

Error of gain, Err_G = ((((Vout – Vref) @ I_pn – (Vout – Vref) @( -I_pn)) / 2) – V_FS) / V_FS. Where I_pn represents the rated current, -I_pn the reversed rated current.

## 7. Frequency response and bandwidth



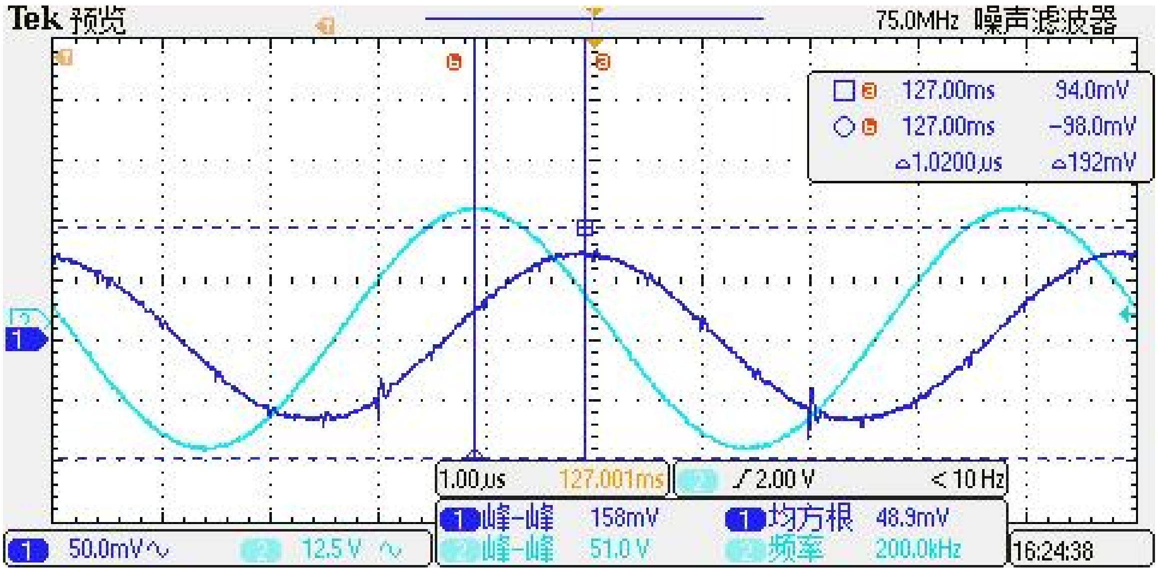

The frequency bandwidth of STK-50PL/P3 series current sensor. The bandwidth of current sensor is DC ~ 200 kHz (-3dB).

## 8. Step response time




The typical frequency response of STK-xxPL/P3 current sensor. The response time from 90% of the primary current (light blue) to 90% of the secondary output (dark blue) is less than 2.5 μs

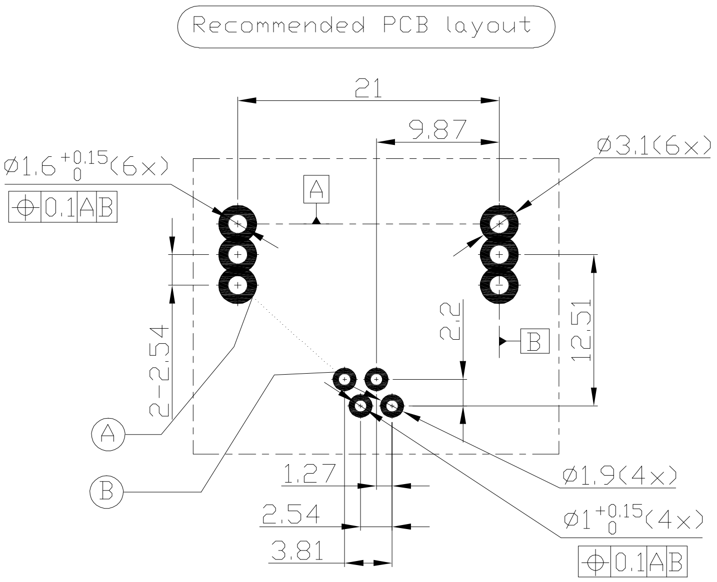
## 9. Frequency delay performance




When testing 200 kHz sine wave, the typical result of STK-xxPL/P3 current sensor's output. The response time from the primary current (light blue) to the secondary output (dark blue) is less than 1.5 μs.

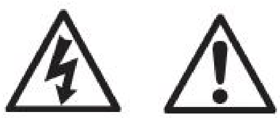
## 10. Recommended PCB layout

Installation of view: overlooking (unit: mm)




| | $d_{CI}$(mm) | $d_{Cp}$(mm) |
|---|---|---|
| A-B | 9.42 | 9.42 |

1. Installing angle：Overlook (observe from the side of installing transducer)
2. Recommended bore diameter of primary current line, (diameter of primary current × 1.2) mm
3. Recommended bore diameter of secondary current line, (diameter of secondary current × 1.2) mm
4. The maximum thickness of PCB is 2.5 mm
5. The curve of wave soldering: 260℃ × 10 s

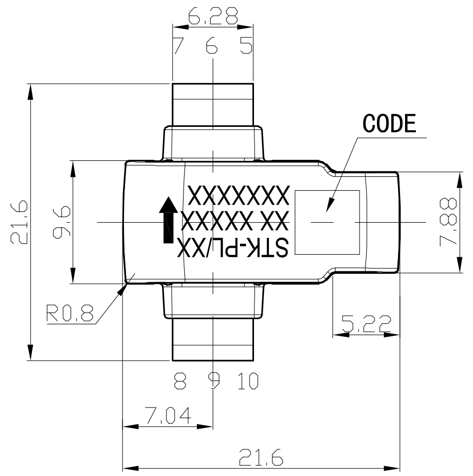


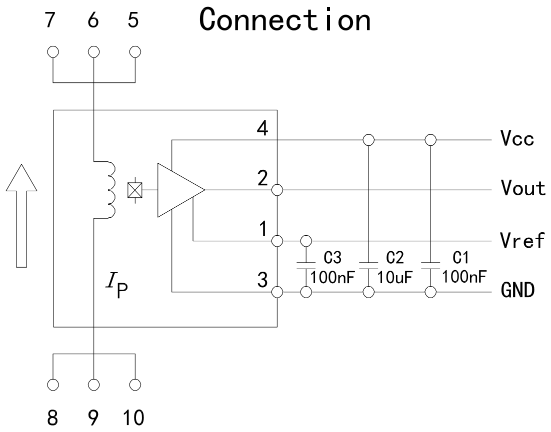
**Security：**

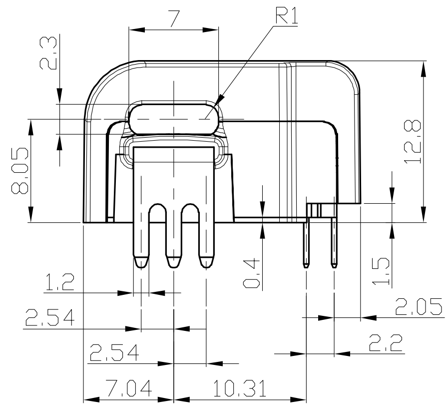
This current sensor must be used in limited-energy secondary circuit according to IEC 61010-1.

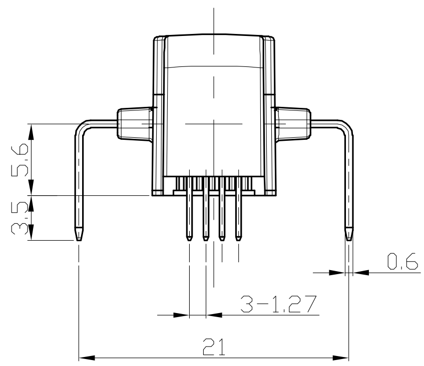
- This current sensor must be used in electric/electronic equipment with respect to appliance standards and safety requirement in accordance with the manufacture's operating instructions;
- When operating the current sensor, certain parts of the module can carry hazardous voltage;
- Failure to wiring as shown in the diagram will damage the current sensor;
- Ignoring this warning can lead to serious consequences.
- A protective housing or a additional shield could be used.
- Main supply must be able to disconnected.

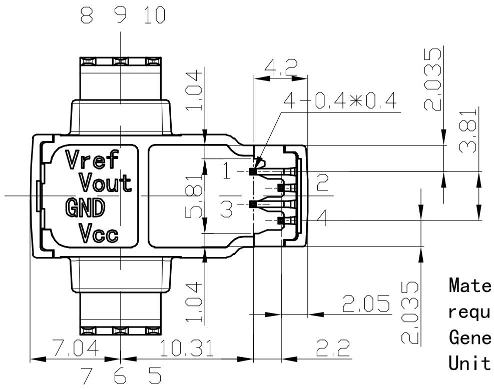
# 11. Dimension & Pin definitions



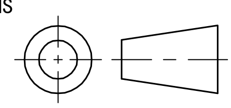



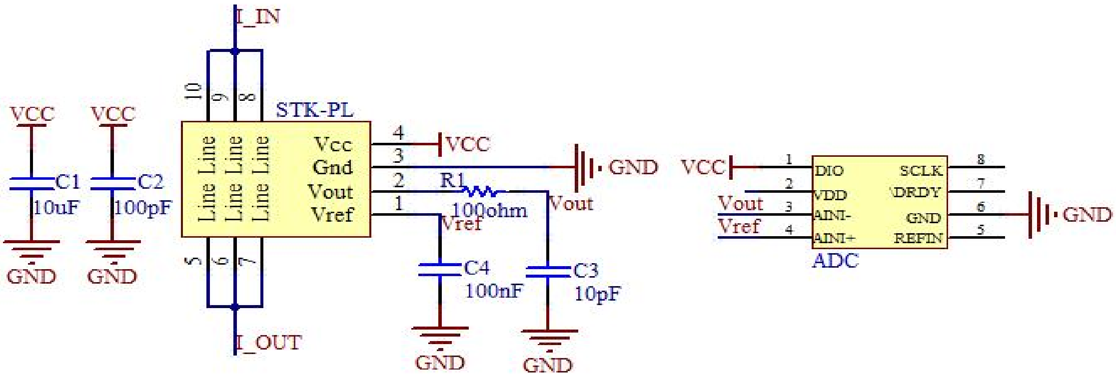



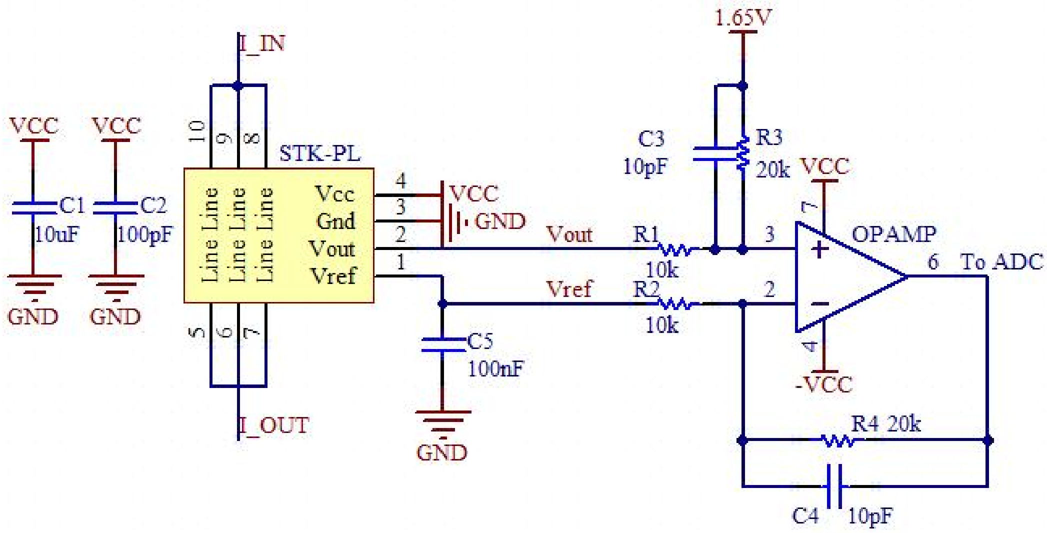

Terminal Pin Identification
1 : Vref
2 : Vout
3 : GND
4 : Vcc
5,6,7 : Primary input Current (-)
8,9,10 : Primary input Current (+)

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



# 12. Appendix: typical application circuit




| R3 (kohm) | C3 (pF) | Theoretical -3dB<br>f = 1/(2πRC)<br>(kHz) | Measured -3dB<br>(kHz) |
|---|---|---|---|
| 20 | 20 | 398 | ~ 400 |
| 20 | 81 | 98 | ~ 100 |
| 20 | 810 | 10 | ~ 10 |

The frequency characteristics of STK_PL series current sensor are not affected by the R-C setting (according to recommended R-C setting), therefore the active filter circuit or R-C circuit can be applied to modulate the sensor's frequency characteristics.

The signal input to ADC is 1.65+ R4/R2*(Vout-Vref) with the conditions: R1 = R2, R3 = R4, C3 = C4.