

# CURRENT SENSOR

PRODUCT SERIES: STB-CAS

STB-15CAS

STB-25CAS

STB-50CAS

STB-15CAS/R

STB-25CAS/R

PRODUCT PART NUMBER: STB-50CAS/R

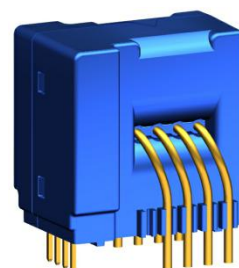
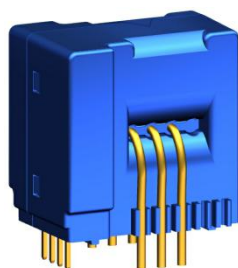
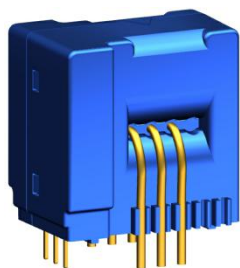
STB-15CAS/K

STB-25CAS/K

STB-50CAS/K

STB-75CAS/K

REVISION: Ver 4.8



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## 1. Description

STB-CAS series current sensors are based on close loop principle with TMR technology. The sensor can detect the current with DC, AC, pulse and irregular wave shape.

### Typical application

- Variable frequency converter
- Uninterruptible Power Supplies (UPS)
- Solar inverters.
- Direct-current dynamo
- Switched model power supplies (SMPS)

### General parameters

Parameter	Symbol	Unit	Value
Working temperature	T_A	°C	-40 ~ 105
Storage temperature	T_stg	°C	-40 ~ 105
Mass	m	g	13

### Absolute parameters

Parameters	Symbol	Unit	Value
Supply voltage	Vc	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 parameters

Parameter	Symbol	Unit	Value	Remark
RMS voltage for AC test 50Hz/1 min	Ud	kV	4	
Impulse withstand voltage 1.2/50µs	Ūw	kV	6	
Clearance distance (pri.-sec)	dCl	mm	9.5	Shortest distance through air
Creepage distance (pri.-sec)	dCp	mm	9.5	Shortest path along device body
Electrical clearance	dCe	mm	6.1 (CAS/R)	When mounted on PCB with recommended layout
			6.3 (CAS)	
			8.5 (CAS/K)	
Case material			V0 according to UL 94	
Comparative tracking index	CTI	V	600	

## 2. STB-15CAS parameters

Condition:  $V_{cc} = 5.0\text{ V}$ ,  $NP = 1$ ,  $RL = 10\text{ K}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		15		
Primary current measuring range	$I_{pm}$	A	-51		51	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	NP	Turn		1, 2, 3		
Offset voltage	$V_{off}$	V	2.48	2.5	2.52	Output @ 0 A
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{off} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{off} \pm 1.875$		
Theoretical sensitivity	$G_{th}$	mV/A		41.67		0.625V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-2.5 (-3)		2.5 (3)	-40°C ~ 105°C

### 3. STB-25CAS parameters

Condition:  $V_{cc} = 5.0\text{ V}$ ,  $NP = 1$ ,  $R_L = 10\text{ K}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		25		
Primary current measuring range	$I_{pm}$	A	-85		85	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	NP	Turn		1, 2, 3		
Offset voltage	$V_{off}$	V	2.48	2.5	2.52	Output @ 0 A
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{off} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{off} \pm 1.875$		
Theoretical sensitivity	$G_{th}$	mV/A		25		0.625V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-2.5 (-3)		2.5 (3)	-40°C ~ 105°C

#### 4. STB-50CAS parameters

Condition:  $V_{CC} = 5.0\text{ V}$ ,  $N_P = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		50		
Primary current measuring range	$I_{pm}$	A	-150		150	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	NP	Turn		1, 2, 3		
Offset voltage	$V_{off}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{off} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{off} \pm 1.875$		
Theoretical sensitivity	$G_{th}$	mV/A		12.5		0.625V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-2.5(-3)		2.5 (3)	-40°C ~ 105°C

## 5. STB-15CAS/R parameters

Condition:  $V_{CC} = 5.0\text{ V}$ ,  $N_P = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		15		
Primary current measuring range	$I_{pm}$	A	-51		51	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	$N_P$	Turn		1、2、3		
Reference voltage	$V_{ref}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{ref} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{ref} \pm 1.875$		
Electrical offset voltage	$V_{OE}$	mV		5		100 % tested $V_{out} - V_{ref}@ 0\text{ A}$
Theoretical sensitivity	$G_{th}$	mV/A		41.667		0.625 V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-1.15 (-1.5)		1.15 (1.5)	-40°C ~ 105°C

## 6. STB-25CAS/R parameters

Condition:  $V_{CC} = 5.0\text{ V}$ ,  $N_P = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		25		
Primary current measuring range	$I_{pm}$	A	-85		85	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	$N_P$	Turn		1、 2、 3		
Reference voltage	$V_{ref}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{ref} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{ref} \pm 1.875$		
Electrical offset voltage	$V_{OE}$	mV		5		100 % tested $V_{out} - V_{ref}@ 0\text{ A}$
Theoretical sensitivity	$G_{th}$	mV/A		25		0.625 V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-1.15 (-1.3)		1.15 (1.3)	-40°C ~ 105°C



## 7. STB-50CAS/R parameters

Condition:  $V_{cc} = 5.0\text{ V}$ ,  $NP = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		50		
Primary current measuring range	$I_{pm}$	A	-150		150	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	NP	Turn		1、2、3		
Reference voltage	$V_{ref}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{ref} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{ref} \pm 1.875$		
Electrical offset voltage	$V_{OE}$	mV		5		100 % tested $V_{out} - V_{ref}@ 0\text{ A}$
Theoretical sensitivity	$G_{th}$	mV/A		12.5		0.625 V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-1.1 (-1.3)		1.1 (1.3)	-40°C ~ 105°C

## 8. STB-15CAS/K parameters

Condition:  $V_{CC} = 5.0\text{ V}$ ,  $N_P = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		15		
Primary current measuring range	$I_{pm}$	A	-51		51	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	$N_P$	Turn		1, 2, 4		
Reference voltage	$V_{ref}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{ref} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{ref} \pm 1.875$		
Electrical offset voltage	$V_{OE}$	mV		5		100 % tested $V_{out} - V_{ref}@ 0\text{ A}$
Theoretical sensitivity	$G_{th}$	mV/A		41.67		0.625 V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-1.15 (-1.3)		1.15 (1.3)	-40°C ~ 105°C

## 9. STB-25CAS/K parameters

Condition:  $V_{CC} = 5.0\text{ V}$ ,  $N_P = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		25		
Primary current measuring range	$I_{pm}$	A	-85		85	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	NP	Turn		1, 2, 4		
Reference voltage	$V_{ref}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{ref} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{ref} \pm 1.875$		
Electrical offset voltage	$V_{OE}$	mV		5		100 % tested $V_{out} - V_{ref}@ 0\text{ A}$
Theoretical sensitivity	$G_{th}$	mV/A		25		0.625 V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-1.15 (-1.3)		1.15 (1.3)	-40°C ~ 105°C

## 10. STB-50CAS/K parameters

Condition:  $V_{cc} = 5.0\text{ V}$ ,  $NP = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		50		
Primary current measuring range	$I_{pm}$	A	-150		150	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	NP	Turn		1, 2, 4		
Reference voltage	$V_{ref}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{ref} \pm 0.625$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{ref} \pm 1.875$		
Electrical offset voltage	$V_{OE}$	mV		5		100 % tested $V_{out} - V_{ref}@ 0\text{ A}$
Theoretical sensitivity	$G_{th}$	mV/A		12.5		0.625 V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-1.1 (-1.3)		1.1 (1.3)	-40°C ~ 105°C

## 11. STB-75CAS/K parameters

Condition:  $V_{CC} = 5.0\text{ V}$ ,  $NP = 1$ ,  $R_L = 10\text{ k}\Omega$ ,  $T_A = 25^\circ\text{C}$ , unless specified.

Parameters	Symbol	Unit	Min.	Typ.	Max.	Remark
Primary nominal rms current	$I_{pn}$	A		75		
Primary current measuring range	$I_{pm}$	A	-220		220	
Supply voltage	$V_c$	V	4.75	5	5.25	
Consumption current	$I_c$	mA		$15 + IP*NP/NS*1000$		NS =1200
Current turns	NP	Turn		1, 2, 4		
Reference voltage	$V_{ref}$	V	2.48	2.5	2.52	
Output voltage @ $I_{pn}$	$V_{FS}$	V		$V_{ref} \pm 0.4685$		
Output voltage @ $I_{pm}$	$V_{FSM}$	V		$V_{ref} \pm 1.125$		
Electrical offset voltage	$V_{OE}$	mV		5		100 % tested $V_{out} - V_{ref}@ 0\text{ A}$
Theoretical sensitivity	$G_{th}$	mV/A		6.25		0.4685 V @ $I_{pn}$
Linearity error 0 ~ $I_{pn}$	$\xi_L$	% of $I_{pn}$		0.3		Tested @25°C
Reaction time @ 10 % of $I_{PN}$	$t_{ra}$	$\mu\text{s}$		0.3		
Step response time @ 90 % of $I_{pn}$	$t_r$	$\mu\text{s}$		0.3		
-3 dB band width	BW	kHz		400		
Noise DC ~ 10 kHz DC ~ 100 kHz	$V_{noise}$	mVpp		5 6		
Accuracy @ RT	X	% of $I_{pn}$	-0.8		0.8	@ 25°C
Accuracy @ $T_A = 85^\circ\text{C}$ (105 °C)	$X_{TRange}$	% of $I_{pn}$	-1.1 (-1.3)		1.1 (1.3)	-40°C ~ 105°C

## 12. Frequency band width

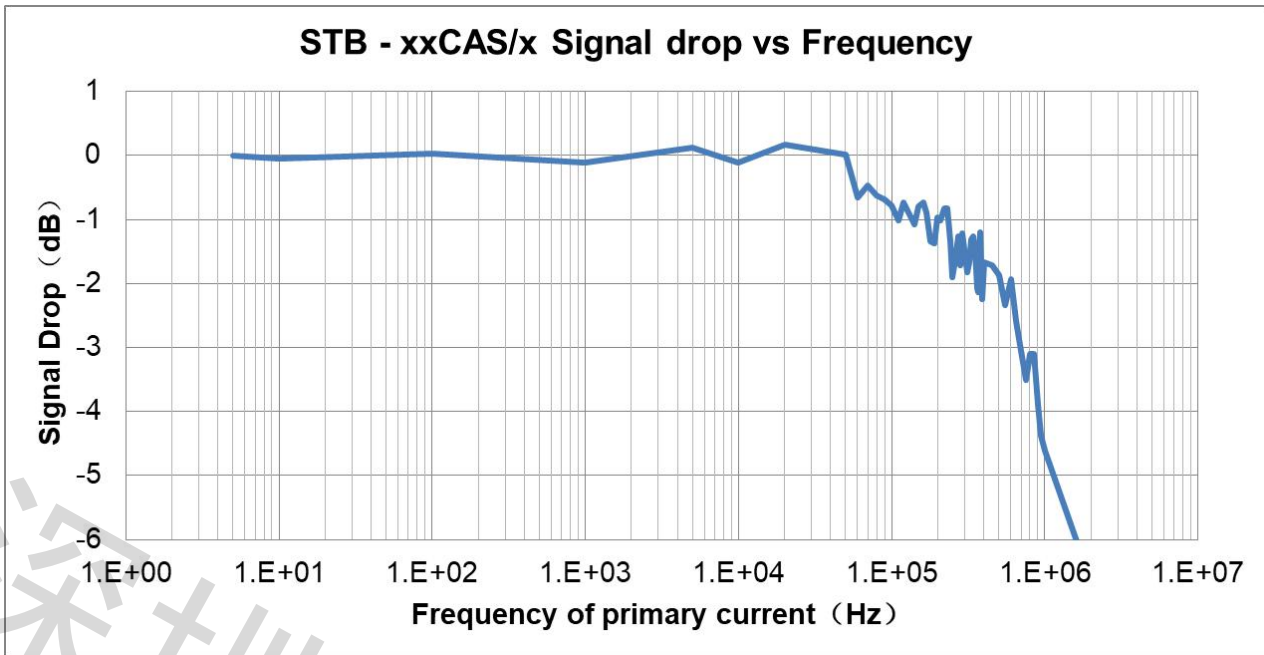


Fig.1 the band width of STB-xxCAS/x series current sensors. The bandwidth was tested after differential amplification with 1x magnification.

## 13. Step response time

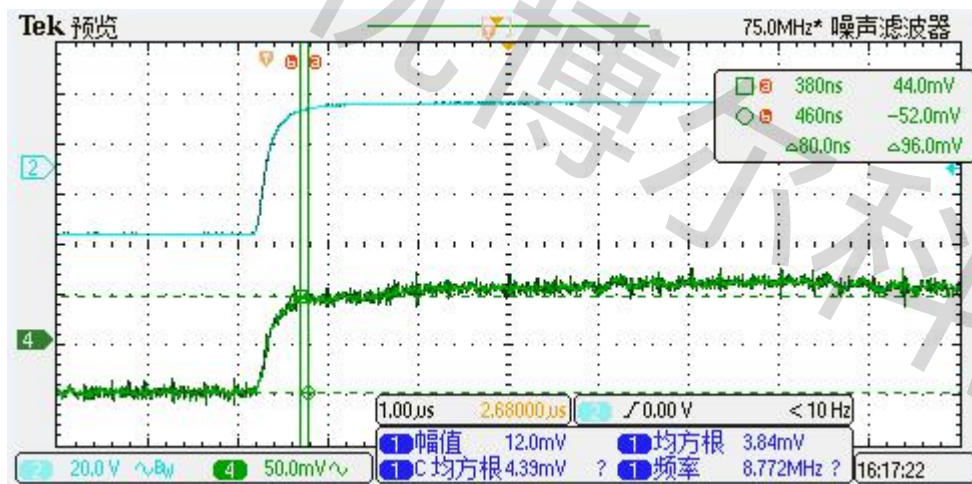


Fig.2 the step response time of STB-xxCAS current sensors. The blue is primary current, while the green is output signal of current sensor. The step response time is less than 0.3  $\mu$ s.

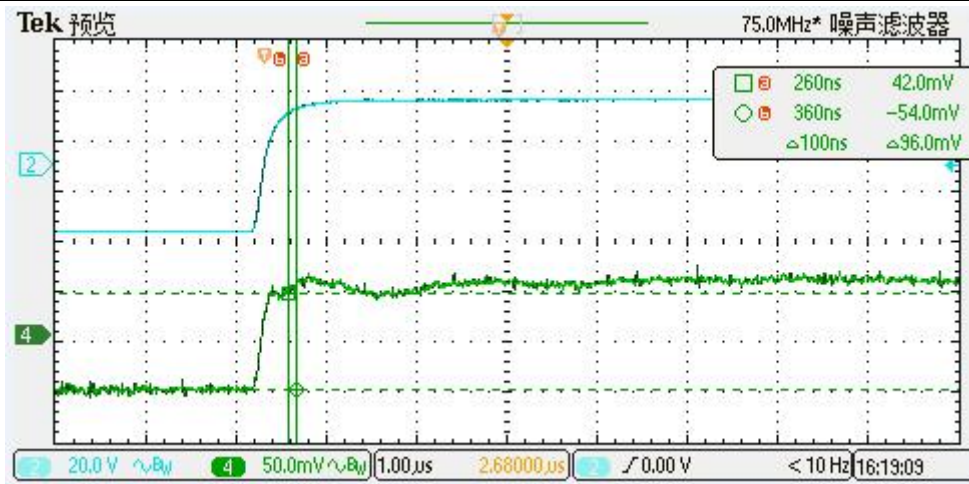


Fig.4 the step response time of STB-xxCAS/R & STB-xxCAS/K current sensors. The blue line is primary current, while the green line is output signal of current sensor. The step response time is less than 0.3  $\mu$ s.

## 14. Frequency delay performance

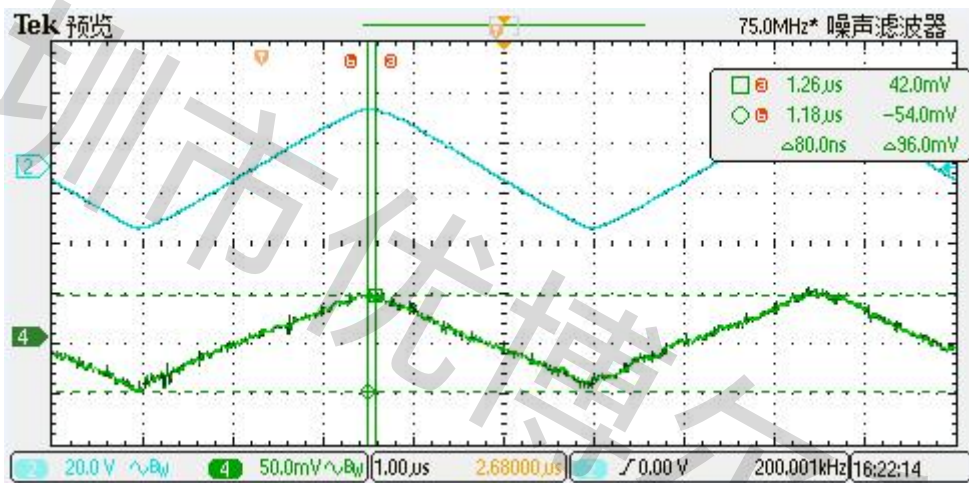
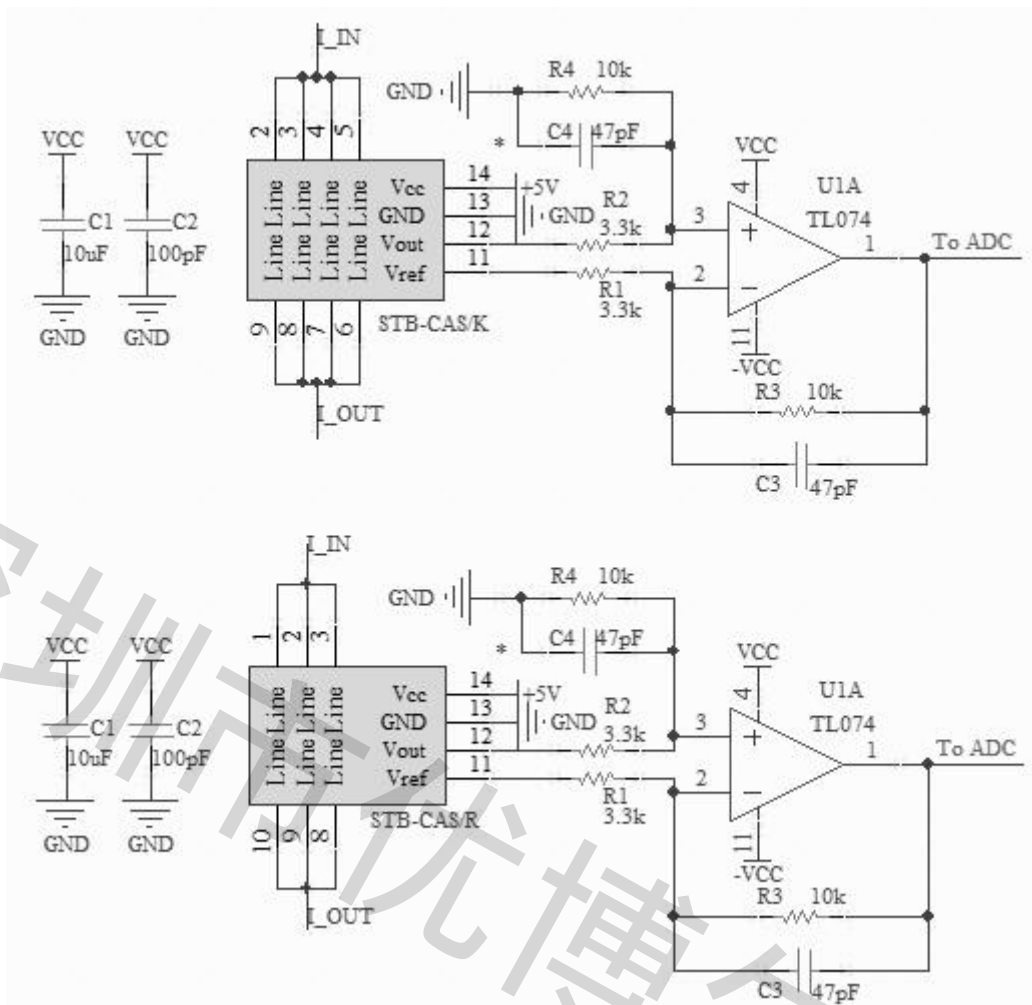
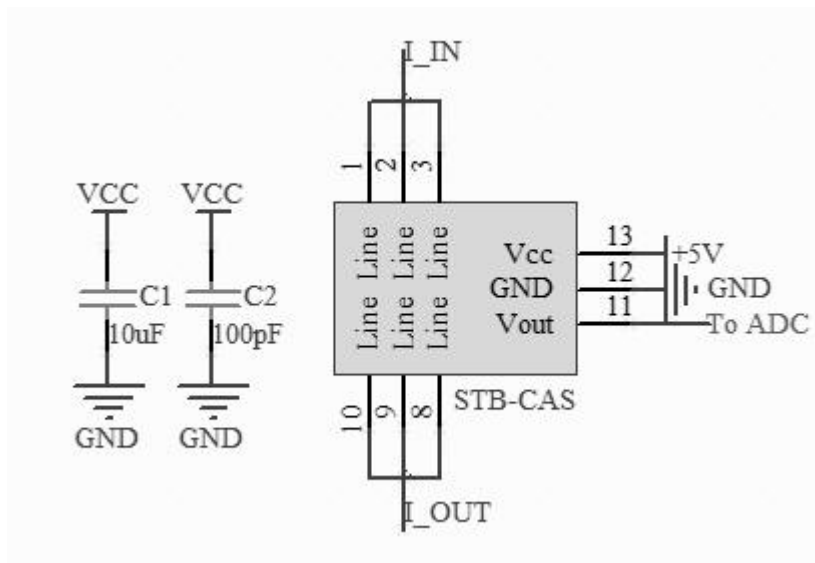


Fig.5 when detection the primary current with a frequency of 200 kHz. The delay time from primary current (blue) to the output of the sensor (green) is less than 0.3  $\mu$ s.

## 15. Typical application circuits

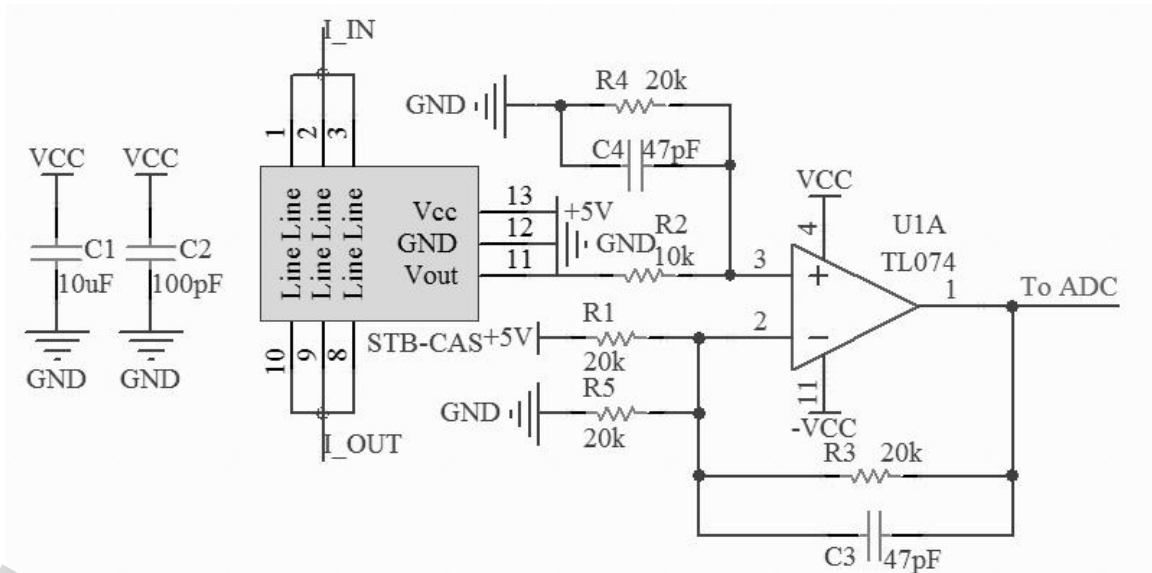


Typical application circuits for STB-CAS/K & STB-CAS/R current sensor. The magnification can be estimated as  $M = R4 / R2$  with the condition of  $R1 = R2$ , and  $R3 = R4$ . The magnification in the circuit above is around 3.



Typical application circuits for STB-CAS current sensor. The output and reference voltage can directly input to the ADC.



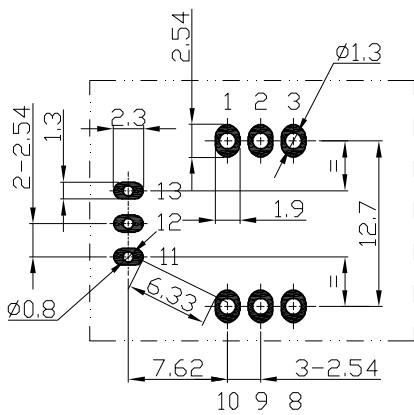
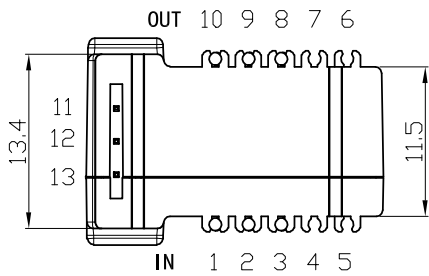
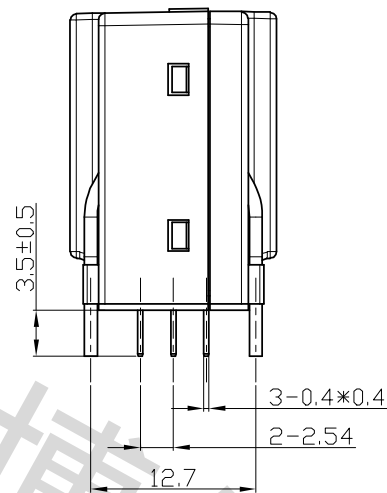
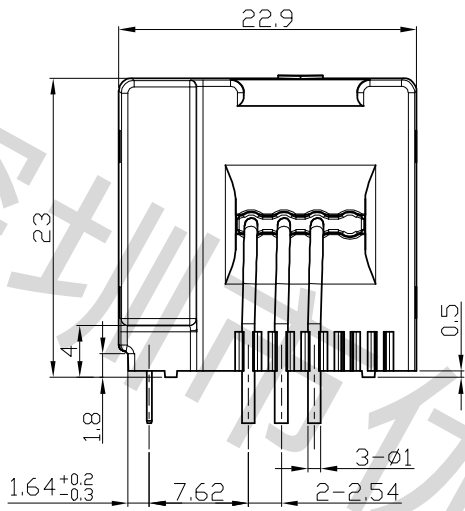
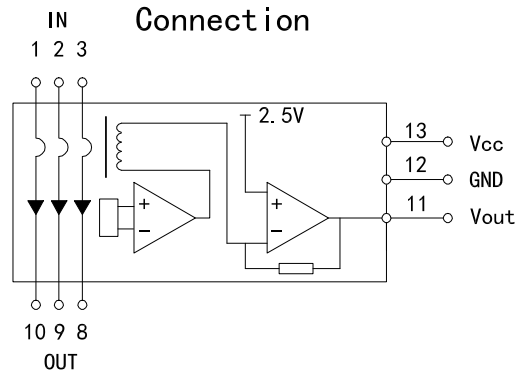
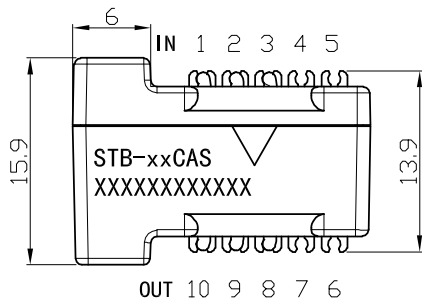


Typical application circuits for CTB-CAS current sensor. The magnification can be estimated as  $M = R4 / R2$  with the condition of  $R1 // R5 = R2$ ,  $R1 = R5$ , and  $R3 = R4$ . The magnification in the circuit above is around 2.

$R3 \text{ (ohm)} = R4 \text{ (ohm)}$	$C3 \text{ (pF)} = C4 \text{ (pF)}$	Theoretical -3dB $f = 1/(2\pi RC)$ (kHz)	Tested -3dB (kHz)
20000	20	398	~ 400
20000	81	98	~ 100
20000	810	10	~ 10

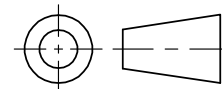
The frequency characteristics of STB-CAS/X series current sensor are not affected by the R-C setting (according to recommended R-C setting), therefore the active filter circuit or R-C circuit can be applied to modulate the sensor's frequency characteristics.

### 16. Dimensions: STB-CAS

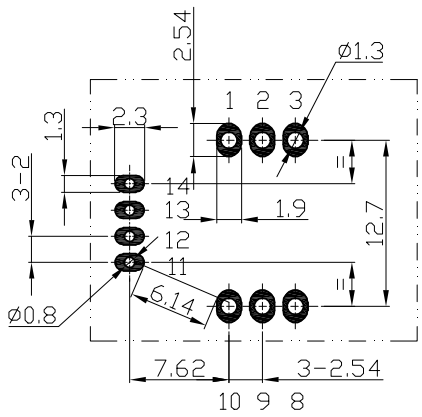
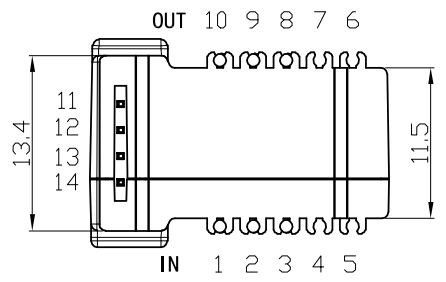
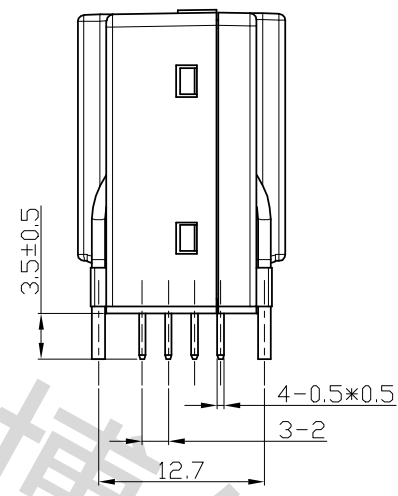
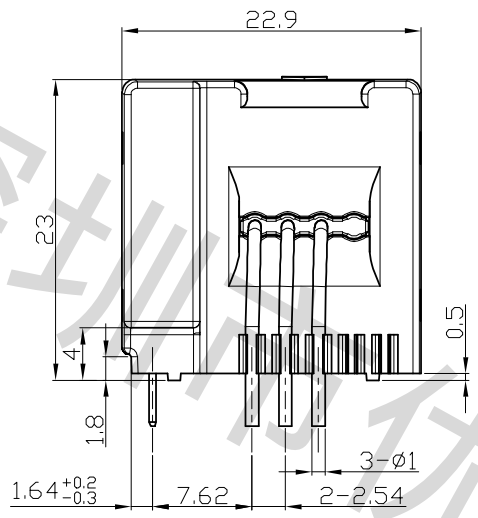
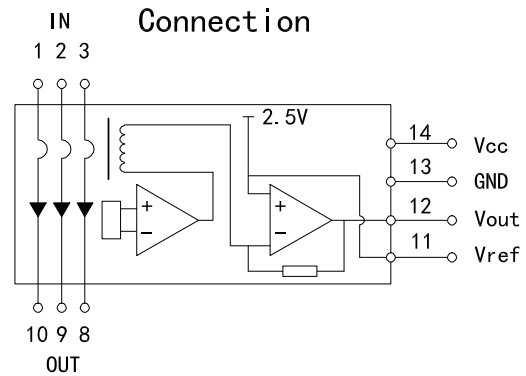
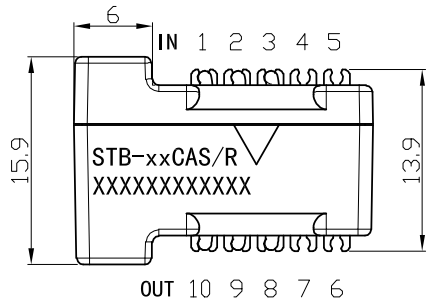


Number of primary turns $N_p$	Recommended connections
1	
2	
3	

Material : Fit UL94V-0 & RoHS requirements ;  
General tolerance :  $\pm 0.25$   
Unit :mm

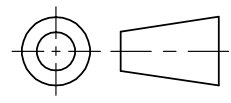


### 17. Dimensions: STB-CAS/R

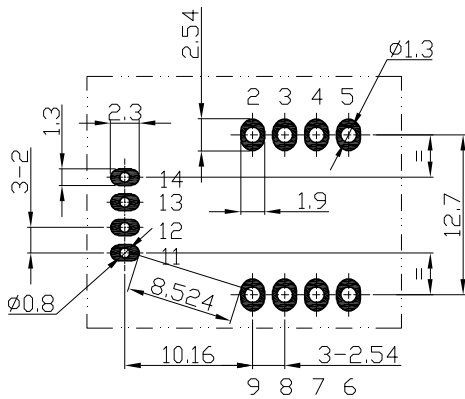
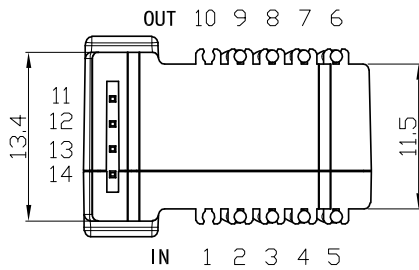
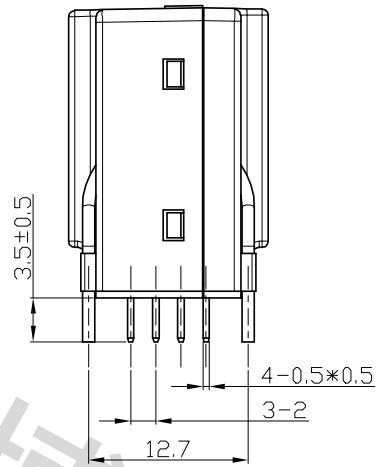
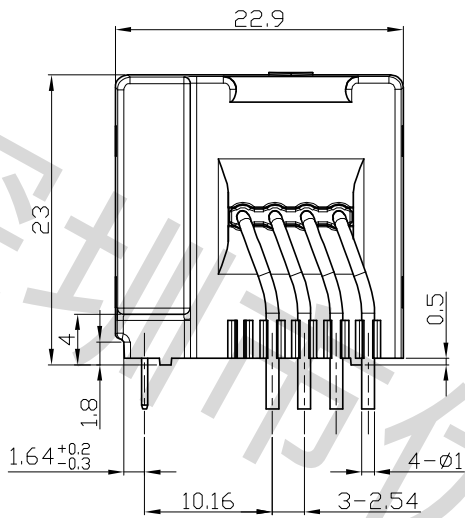
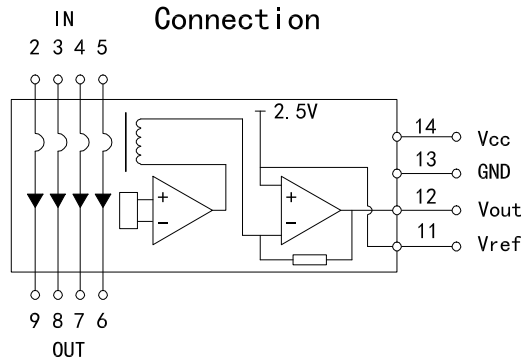
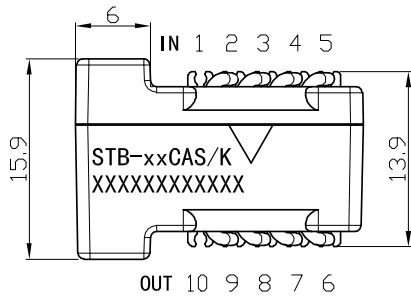


Number of primary turns $N_p$	Recommended connections
1	
2	
3	

Material : Fit UL94V-0 & RoHS requirements ;  
 General tolerance :  $\pm 0.25$   
 Unit :mm



### 18. Dimensions: STB-CAS/K



Number of primary turns $N_p$	Recommended connections
1	
2	
4	

Material : Fit UL94V-0 & RoHS requirements ;  
 General tolerance :  $\pm 0.25$   
 Unit : mm

