

FSD7304 系列板载式、高精度电流传感器

产品概述/Product overview

FSD7304 系列电流传感器，基于 TMR 隧道磁阻闭环原理。原 / 副边电路之间电气绝缘的，可以测量直流、交流和脉冲电流。

FSD7304 series current sensor, based on the TMR tunnel reluctance closed-loop principle. The electrical insulation between the primary and secondary side circuits can be used to measure DC, AC and pulse current.



FSD7304-B

FSD7304-C



FSD7304-D

FSD7304-E

产品特性/Product characteristics

- 高精度/High precision
- 优异的线性度/Excellent linearity
- 低温度漂移/Low temperature drift
- 快速响应时间/Fast response time
- 耐压隔离性能强/High voltage isolation performance
- 符合 RoHS & REACH/RoHS & REACH compliant

典型应用/Typical application

- 太阳能逆变器/Solar inverter
- 直流发电机/Dc generator
- 不间断电源(UPS)/Uninterruptible Power Supply (UPS)
- 开关电源(SMPS)/Switching Power Supply (SMPS)
- 变频转换器(VFD)/Variable Frequency Converter (VFD)

产品选型表/Product selection table

型号 Type	额定测量电流 Rated measuring current	测量电流范围 Measuring range	型号 Type	额定测量电流 Rated measuring current	测量电流范围 Measuring range
FSD7304-0060B	6 A	±20 A	FSD7304-0060C	6 A	±20 A
FSD7304-0150B	15 A	±51 A	FSD7304-0150C	15 A	±51 A
FSD7304-0250B	25 A	±85 A	FSD7304-0250C	25 A	±85 A
FSD7304-0500B	50 A	±150 A	FSD7304-0500C	50 A	±150 A
FSD7304-0060D	6 A	±20 A	FSD7304-0250D	25 A	±85 A
FSD7304-0150D	15 A	±51 A	FSD7304-0500D	50 A	±150 A
FSD7304-0750E	75 A	±180 A			

安规及环境参数/Safety and environmental parameters

参数 parameter	符号 Symbol	典型值 Typical value	单位 Unit
绝缘强度 Insulation strength	V_D	4.2	kV (50Hz, 1min)
绝缘电阻 Insulation resistance	R_{IS}	1000	MΩ
爬电距离 Creepage distance	d_{CP}	7.2	mm
电气间隙 Electrical clearance	d_{CL}	7.2	mm
使用温度 Operating temperature	T_A	-40 ~ +85	°C
储存温度 Storage temperature	T_{STG}	-50 ~ +105	°C
质量 Mass	m	12	g

1. FSD7304-B 性能参数/Performance parameter

除特殊说明外 $T_A = +25\text{ }^{\circ}\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$

$T_A = +25\text{ }^{\circ}\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$ unless otherwise specified

参数 Parameter	符号 Symbol	条件 Conditions	最小值 Minimum value	典型值 Typical value	最大值 Maximum value	单位 Unit
常规指标Conventional index						
额定输入电流 Rated input current	I_{PN}	FSD7304-0060B	-	6	-	A
		FSD7304-0150B	-	15	-	
		FSD7304-0250B	-	25	-	
		FSD7304-0500B	-	50	-	
测量电流范围 Measuring range	I_{PM}	FSD7304-0060B	-20	-	20	A
		FSD7304-0150B	-51	-	51	
		FSD7304-0250B	-85	-	85	
		FSD7304-0500B	-150	-	150	
灵敏度 sensitivity	S	$I_P = 0 \sim \pm I_{PN}$	FSD7304-0060B	104.2	-	mV/A
			FSD7304-0150B	41.67	-	
			FSD7304-0250B	25	-	
			FSD7304-0500B	12.5	-	
供电电压 Supply voltage	V_{CC}	$\pm 5\%$	-	5	-	V
零点输出电压 Zero output voltage	V_{OFF}	-	2.490	2.5	2.510	V
输出电压 Output voltage	V_{OUT}	$I_P = 0 \sim \pm I_{PM}$	-	$V_{OFF} + S \times I_P$	-	V
电流消耗 Current consumption	I_C	$I_P = 0$	-	12	-	mA
静态指标Static index						
基本误差 Basic error	X_G	$T_A = 25\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$		± 0.8	-	% I_{PN}
		$T_A = 85\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$	FSD7304-0060B	1.4	-	
			FSD7304-0150B	1.2	-	
			FSD7304-0250B	1.15	-	
线性度 linearity	ε_L	$I_P = 0 \sim \pm I_{PN}$	-	± 0.3	-	% I_{PN}
增益对称性 Gain symmetry	ε_{SYM}	$T_A = -40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$	99	100	101	%
动态指标Dynamic index						
响应时间 Response time	t_R	$di/dt > 50\text{ A}/\mu\text{s}$, 10% to 90% of I_{PN}	-	1	-	μs
频带宽度 Band width	BW	-3 dB	DC	300	-	kHz

2. FSD7304-C 性能参数/Performance parameter

除特殊说明外 $T_A = +25^\circ\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$

$T_A = +25^\circ\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$ unless otherwise specified

参数 Parameter	符号 Symbol	条件 Conditions	最小值 Minimum value	典型值 Typical value	最大值 Maximum value	单位 Unit
常规指标Conventional index						
额定输入电流 Rated input current	I_{PN}	FSD7304-0060C	-	6	-	A
		FSD7304-0150C	-	15	-	
		FSD7304-0250C	-	25	-	
		FSD7304-0500C	-	50	-	
测量电流范围 Measuring range	I_{PM}	FSD7304-0060C	-20	-	20	A
		FSD7304-0150C	-51	-	51	
		FSD7304-0250C	-85	-	85	
		FSD7304-0500C	-150	-	150	
灵敏度 sensitivity	S	$I_P = 0 \sim \pm I_{PN}$	FSD7304-0060C	-	104.2	mV/A
			FSD7304-0150C	-	41.67	
			FSD7304-0250C	-	25	
			FSD7304-0500C	-	12.5	
供电电压 Supply voltage	V_{CC}	$\pm 5\%$	-	5	-	V
基准输出电压 Reference output voltage	V_{REF}	-	2.490	2.5	2.510	V
零点偏置电压 Zero bias voltage	V_{OFF}	-	-	2.5	-	V
输出电压 Output voltage	V_{OUT}	$I_P = 0 \sim \pm I_{PM}$	-	$V_{OFF} + S \times I_P$	-	V
电流消耗 Current consumption	I_C	$I_P = 0$	-	12	-	mA
静态指标Static index						
基本误差 Basic error	X_G	$T_A = 25^\circ\text{C}$, $I_P = 0 \sim \pm I_{PN}$		± 0.8	-	% I_{PN}
		$T_A = 85^\circ\text{C}$, $I_P = 0 \sim \pm I_{PN}$	FSD7304-0060C	-	1.4	
			FSD7304-0150C	-	1.2	
			FSD7304-0250C	-	1.15	
			FSD7304-0500C	-	1.1	
线性度 linearity	ε_L	$I_P = 0 \sim \pm I_{PN}$	-	± 0.3	-	% I_{PN}
增益对称性 Gain symmetry	ε_{SYM}	$T_A = -40^\circ\text{C} \sim +85^\circ\text{C}$, $I_P = 0 \sim \pm I_{PN}$	99	100	101	%
零点失调电压 Zero offset voltage	V_{OE}	$T_A = +25^\circ\text{C}$, $I_P = 0$	-5	-	5	mV
动态指标Dynamic index						
响应时间 Response time	t_R	$di/dt > 50\text{ A}/\mu\text{s}$, 10% to 90% of I_{PN}	-	1	-	μs
频带宽度 Band width	BW	-3 dB	DC	300	-	kHz

3. FSD7304-D 性能参数/Performance parameter

除特殊说明外 $T_A = +25\text{ }^{\circ}\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$

$T_A = +25\text{ }^{\circ}\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$ unless otherwise specified

参数 Parameter	符号 Symbol	条件 Conditions	最小值 Minimum value	典型值 Typical value	最大值 Maximum value	单位 Unit
常规指标Conventional index						
额定输入电流 Rated input current	I_{PN}	FSD7304-0060D	-	6	-	A
		FSD7304-0150D	-	15	-	
		FSD7304-0250D	-	25	-	
		FSD7304-0500D	-	50	-	
测量电流范围 Measuring range	I_{PM}	FSD7304-0060D	-20	-	20	A
		FSD7304-0150D	-51	-	51	
		FSD7304-0250D	-85	-	85	
		FSD7304-0500D	-150	-	150	
灵敏度 sensitivity	S	$I_P = 0 \sim \pm I_{PN}$	FSD7304-0060D	104.2	-	mV/A
			FSD7304-0150D	41.67	-	
			FSD7304-0250D	25	-	
			FSD7304-0500D	12.5	-	
供电电压 Supply voltage	V_{CC}	$\pm 5\%$	-	5	-	V
基准输出电压 Reference output voltage	V_{REF}	-	2.490	2.5	2.510	V
零点偏置电压 Zero bias voltage	V_{OFF}	-	-	2.5	-	V
输出电压 Output voltage	V_{OUT}	$I_P = 0 \sim \pm I_{PM}$	-	$V_{OFF} + S \times I_P$	-	V
电流消耗 Current consumption	I_C	$I_P = 0$	-	12	-	mA
静态指标Static index						
基本误差 Basic error	X_G	$T_A = 25\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$		± 0.8	-	% I_{PN}
		$T_A = 85\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$	FSD7304-0060D	1.4	-	
			FSD7304-0150D	1.2	-	
			FSD7304-0250D	1.15	-	
			FSD7304-0500D	1.1	-	
线性度 linearity	ε_L	$I_P = 0 \sim \pm I_{PN}$	-	± 0.3	-	% I_{PN}
增益对称性 Gain symmetry	ε_{SYM}	$T_A = -40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$	99	100	101	%
零点失调电压 Zero offset voltage	V_{OE}	$T_A = +25\text{ }^{\circ}\text{C}$, $I_P = 0$	-5	-	5	mV
动态指标Dynamic index						
响应时间 Response time	t_R	$di/dt > 50\text{ A}/\mu\text{s}$, 10% to 90% of I_{PN}	-	1	-	μs
频带宽度 Band width	BW	-3 dB	DC	300	-	kHz

4. FSD7304-E 性能参数/Performance parameter

除特殊说明外 $T_A = +25\text{ }^{\circ}\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$

$T_A = +25\text{ }^{\circ}\text{C}$, $V_{CC} = 5\text{ V}$, $R_L = 10\text{ k}\Omega$ unless otherwise specified

参数 Parameter	符号 Symbol	条件 Conditions	最小值 Minimum value	典型值 Typical value	最大值 Maximum value	单位 Unit
常规指标 Conventional index						
额定输入电流 Rated input current	I_{PN}	FSD7304-0750E	-	75	-	A
测量电流范围 Measuring range	I_{PM}	FSD7304-0750E	-180	-	180	A
灵敏度 Sensitivity	S	$I_P = 0 \sim \pm I_{PN}$	-	6.25	-	mV/A
供电电压 Supply voltage	V_{CC}	$\pm 5\%$	-	5	-	V
基准输出电压 Reference output voltage	V_{REF}	-	2.490	2.5	2.510	V
零点偏置电压 Zero bias voltage	V_{OFF}	-	-	2.5	-	V
输出电压 Output voltage	V_{OUT}	$I_P = 0 \sim \pm I_{PM}$	-	$V_{OFF} + S \times I_P$	-	V
电流消耗 Current consumption	I_C	$I_P = 0$	-	12	-	mA
静态指标Static index						
基本误差 Basic error	X_G	$T_A = 25\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$	-	± 0.8	-	% I_{PN}
		$T_A = 85\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$	-	1.1	-	
线性度 linearity	ε_L	$I_P = 0 \sim \pm I_{PN}$	-	± 0.3	-	% I_{PN}
增益对称性 Gain symmetry	ε_{SYM}	$T_A = -40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$, $I_P = 0 \sim \pm I_{PN}$	99	100	101	%
零点失调电压 Zero offset voltage	V_{OE}	$T_A = +25\text{ }^{\circ}\text{C}$, $I_P = 0$	-5	-	5	mV
动态指标Dynamic index						
响应时间 Response time	t_R	$di/dt > 50\text{ A}/\mu\text{s}$, 10% to 90% of I_{PN}	-	1	-	μs
频带宽度 Band width	BW	-3 dB	DC	300	-	kHz

5. 典型输出特性曲线/Typical output characteristic curve

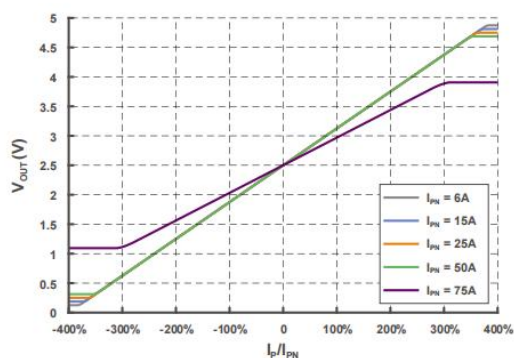


图 1 输出特性曲线

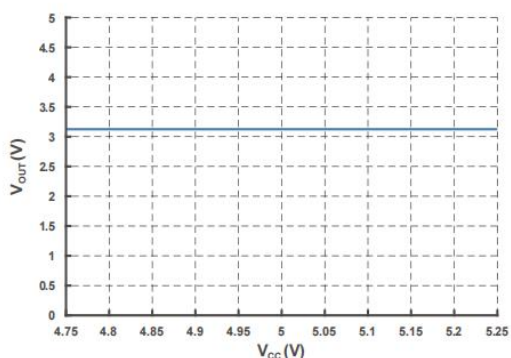


图 2 输出特性与供电电压曲线 (@ $I_P = I_{PN}$)

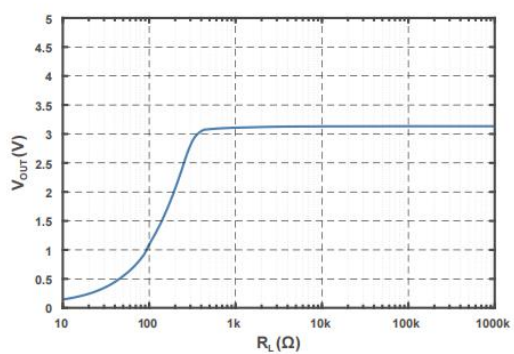


图 3 负载电阻特性曲线 (@ $I_P = I_{PN}$)

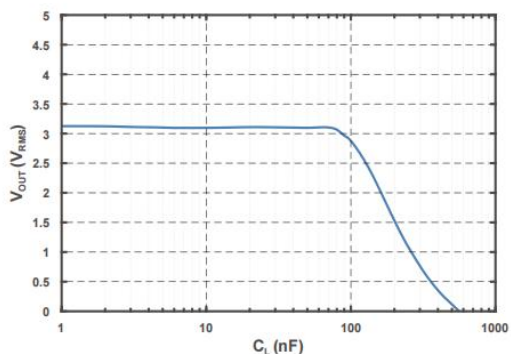


图 4 负载电容特性曲线 (@ $I_P = I_{PN}$)

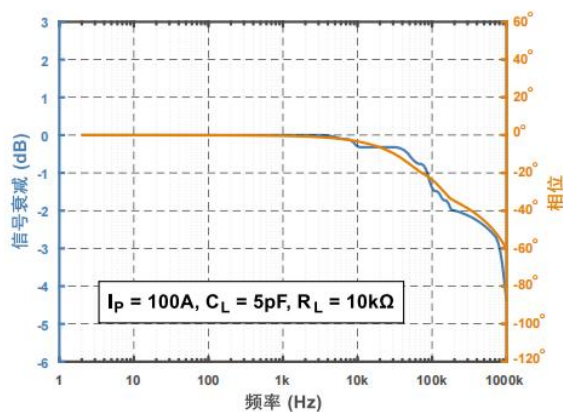


图 5 频响特性曲线

6. 温度特性曲线 / Temperature characteristic curve

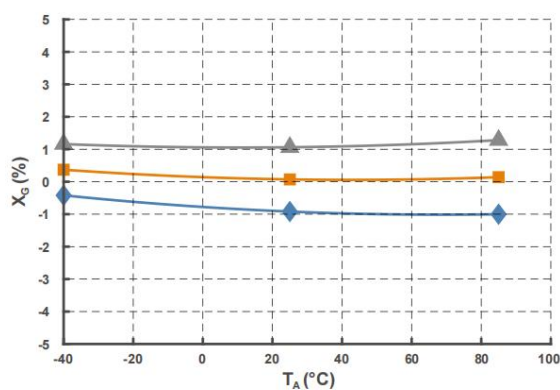


图 6 基本误差曲线

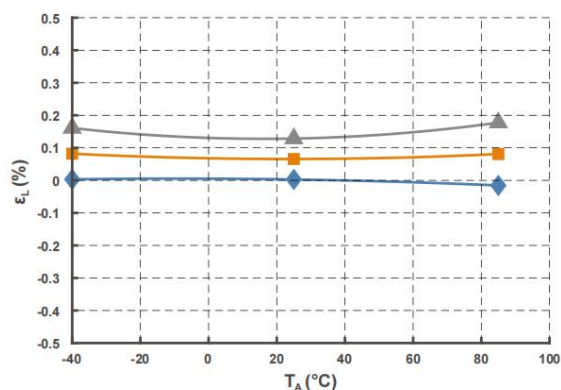


图 7 线性度曲线

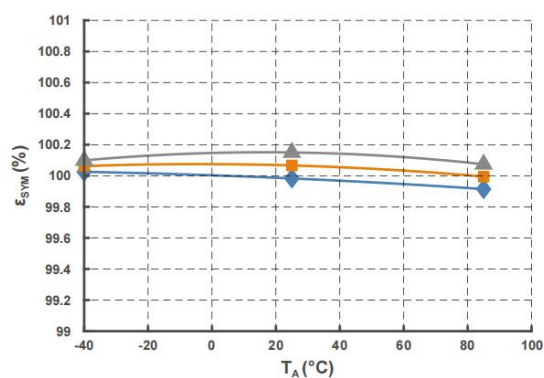


图 8 增益对称性曲线

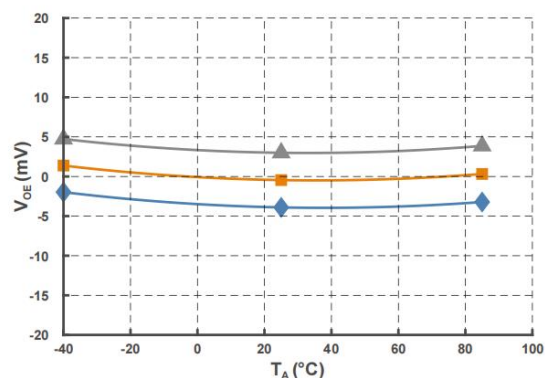


图 9 零点失调电压曲线

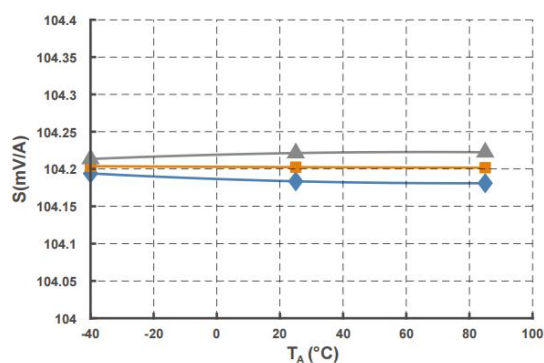


图 10 灵敏度曲线 (@ $I_{PN} = 6$ A)

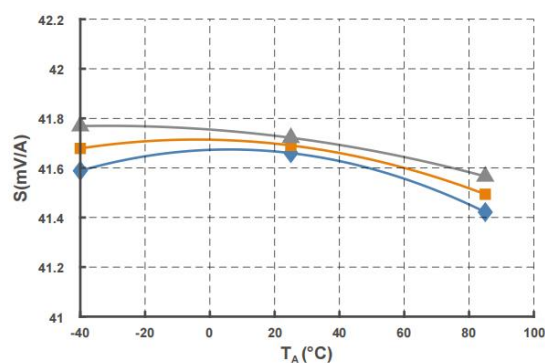


图 11 灵敏度曲线 (@ $I_{PN} = 15$ A)

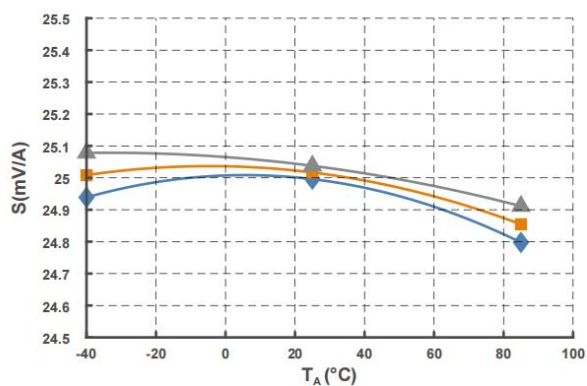


图 12 灵敏度曲线 (@ $I_{PN} = 25\text{ A}$)

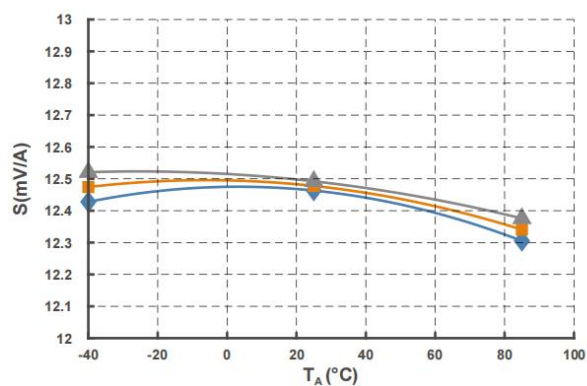


图 13 灵敏度曲线 (@ $I_{PN} = 50\text{ A}$)

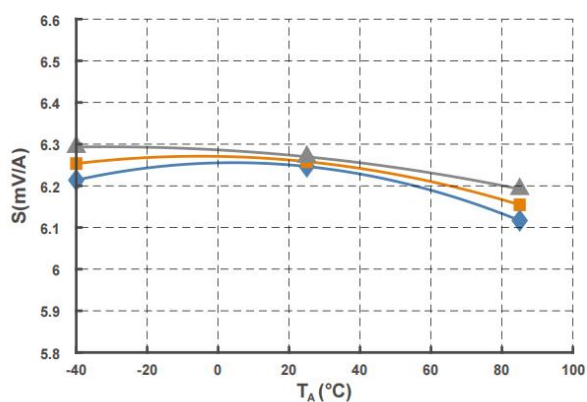


图 14 灵敏度曲线 (@ $I_{PN} = 75\text{ A}$)

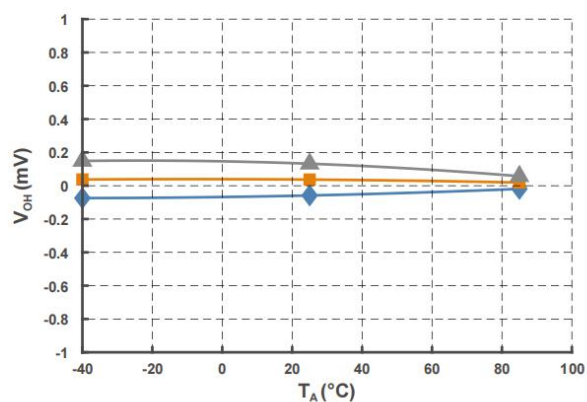


图 15 磁滞特性曲线

7. 参数定义及计算公式/Parameter definition and calculation formula

1) 输出电压/Output voltage

$$V_{OUT} = V_{OFF} + S \times I_p$$

式中， V_{OFF} 为传感器零点偏置电压， S 为传感器灵敏度， I_p 为传感器原边输入待测电流， V_{OUT} 为原边输入电流 I_p 时传感器输出。

Where, V_{OFF} is the zero-bias voltage of the sensor, S is the sensitivity of the sensor, I_p is the input current to be measured on the primary side of the sensor, and V_{OUT} is the output of the sensor when the input current I_p on the primary side is used.

2) 基本误差/Basic error

$$X_G = \max_{I_p \in [-I_{PN}, I_{PN}]} \left(\frac{(V_{OUT} - V_{REF}) - (S \times I_p)}{S \times I_{PN}} \times 100\% \right)$$

式中， I_{PN} 为额定输入电流。

Where I_{PN} is the rated input current.

3) 灵敏度/sensitivity

$$S = \frac{V_{OUT(@I_{PN})} - V_{OUT(@-I_{PN})}}{2 \times I_{PN}}$$

式中， $V_{OUT(@I_{PN})}$ 、 $V_{OUT(@-I_{PN})}$ 分别为原边输入电流为 I_{PN} 、 $-I_{PN}$ 时传感器的输出。

Where, $V_{OUT(@I_{PN})}$ and $V_{OUT(@-I_{PN})}$ are respectively the output of the sensor when the input current on the primary side is I_{PN} and $-I_{PN}$.

4) 线性度/linearity

$$\epsilon_L = \max_{I_p \in [-I_{PN}, I_{PN}]} \left(\frac{(V_{OUT} - V_{REF}) - (\bar{V}_{OE} + \bar{S} \times I_p)}{S \times I_{PN}} \times 100\% \right)$$

式中， $\bar{S}$ 、 $\bar{V}_{OE}$ 分别为传感器实际多次测量的平均灵敏度和零点失调电压。

In the formula, $\bar{S}$ and $\bar{V}_{OE}$ are respectively the average sensitivity and zero offset voltage of the actual multiple measurements of the sensor.

5) 增益对称度/Gain symmetry

$$\epsilon_{SYM} = \left| \frac{V_{OUT(@I_{PN})} - \bar{V}_{OFF}}{V_{OUT(@-I_{PN})} - \bar{V}_{OFF}} \right| \times 100\%$$

6) 磁滞/hysteresis

$$V_{OH} = \max \Delta H$$

式中， ΔH 为同一输入电流 I_p 时传感器在上、下行程实际输出的差值。

Where ΔH is the difference between the actual output of the sensor in the upper and lower stroke when the same input current I_p is used.

7) 零点失调电压/Zero offset voltage

$$V_{OE} = V_{OUT(@I_p = 0)} - V_{REF}$$

8. 应用指南/Application guide

电气连接图/Electrical connection diagram

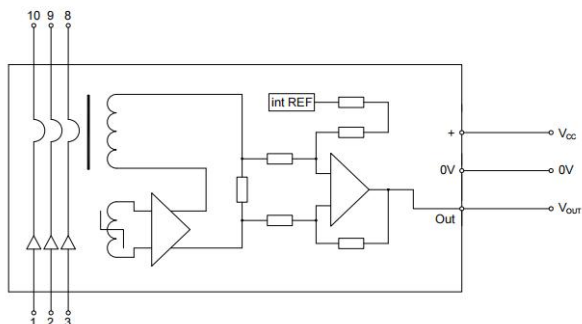


图16 FSD7304-B 电气连接图

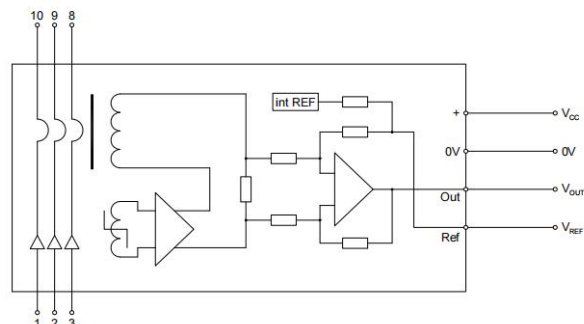


图17 FSD7304-C 电气连接图

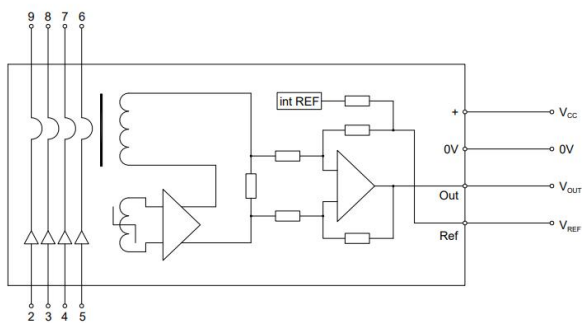


图18 FSD7304-D 电气连接图

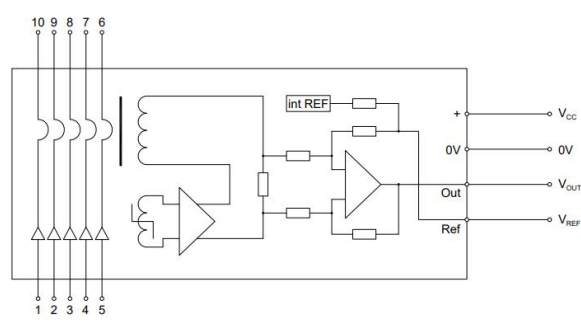


图19 FSD7304-E 电气连接图

FSD7304 使用说明/Instructions

1) 当原边电流 (I_p) 方向沿产品打标处箭头方向流动时, V_{OUT} 为正向, 反之则为负向;

When the primary current (I_p) direction flows along the arrow direction of the product marking, V_{OUT} is positive; otherwise, it is negative.

2) 错误接线可能导致传感器损坏;

Incorrect wiring may cause sensor damage.

3) 当原边频率过高时, 过大的容性负载可能导致传感器波形失真, 具体请参考输出容性负载曲线;

When the primary side frequency is too high, excessive capacitive load may cause distortion of the sensor waveform. For details, refer to the output capacitive load curve.

4) 波峰焊接最高温度260 °C, 持续时间 10 s;

The maximum temperature of wave crest welding is 260 °C, the duration is 10 s;

5) 可根据客户需求定制传感器。

Sensors can be customized according to customer needs.

9. 外形尺寸/Overall dimension

FSD7304-B 外形尺寸图/FSD7304-B dimensions

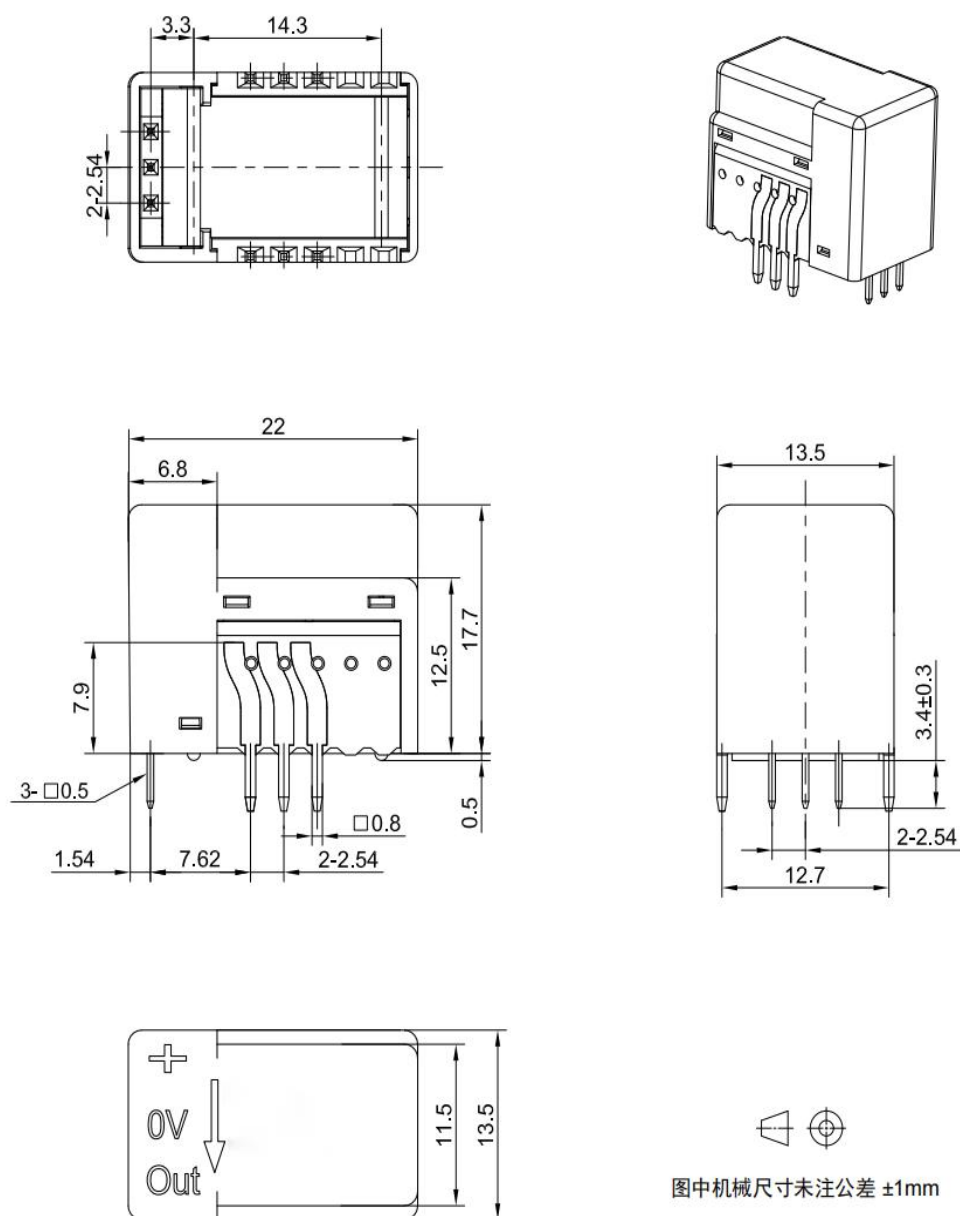


图20 FSD7304-B 外形尺寸图（尺寸单位：mm）

FSD7304-C 外形尺寸图/FSD7304-C dimensions

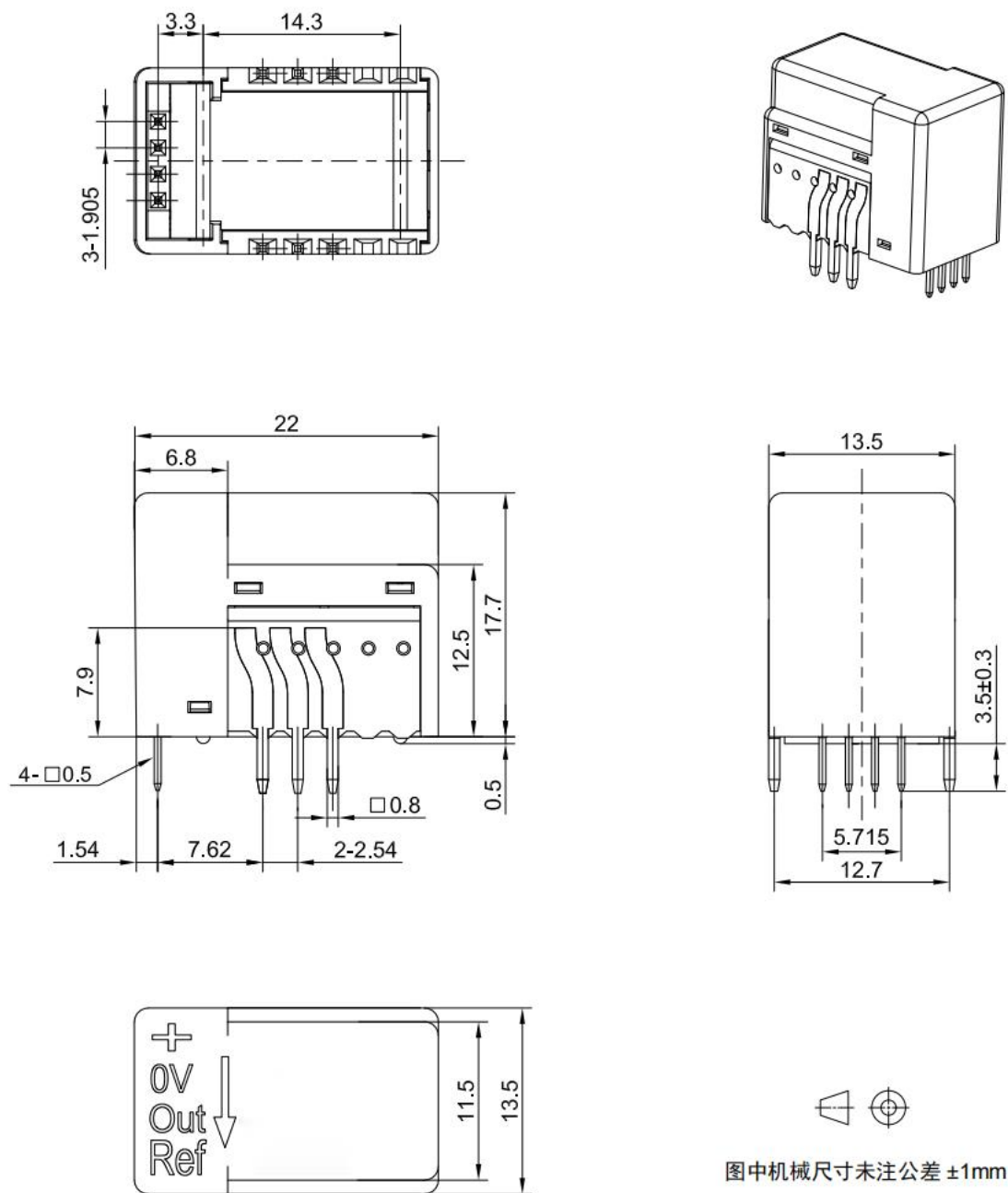


图21 FSD7304-C 外形尺寸图 (尺寸单位: mm)

FSD7304-D 外形尺寸图/FSD7304-D dimensions

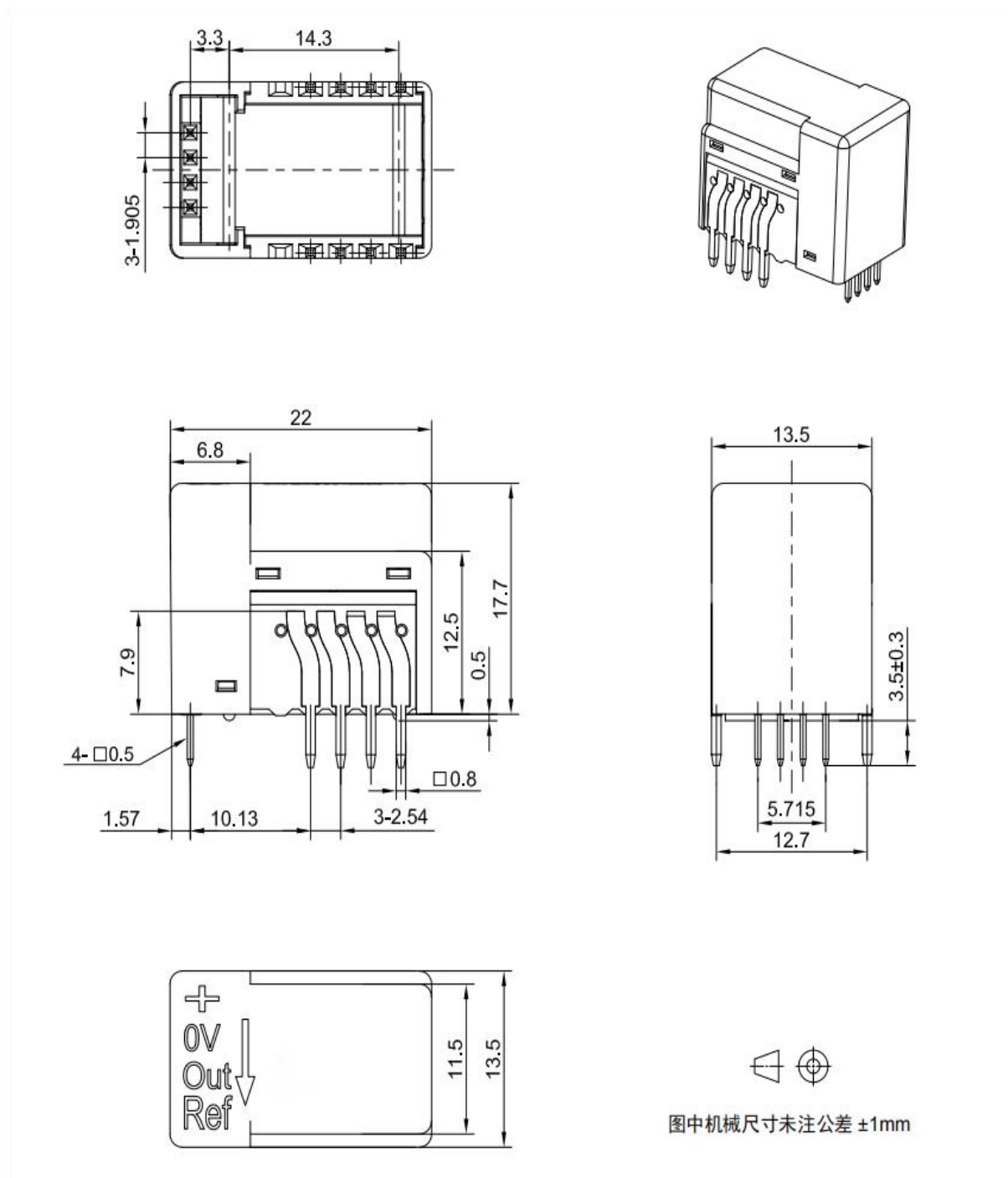


图22 FSD7304-D 外形尺寸图 (尺寸单位: mm)

FSD7304-E 外形尺寸图/FSD7304-E dimensions

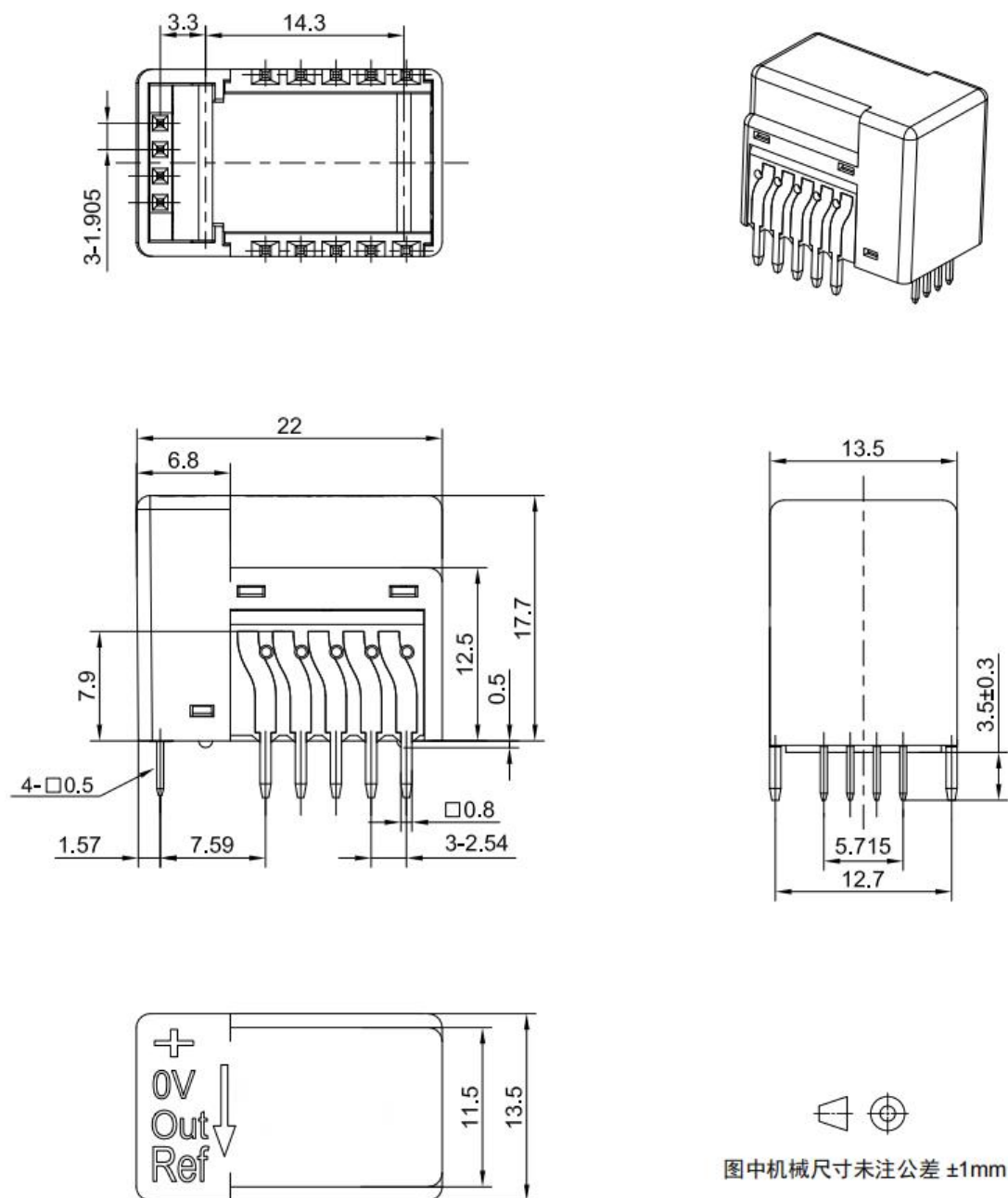


图23 FSD7304-E 外形尺寸图（尺寸单位：mm）