CHA611

AEC-Q100 Qualified, Programmable Linear Hall Sensor IC

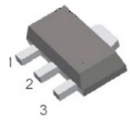
Features

- AEC-Q100 automotive qualified
- Linear Hall, customer programmable, high resolution offset and sensitivity trimming with EEPROM
- Programmable sensitivity: **0.6mV/G - 32mV/G**
- Factory programmed sensitivity and quiescent output voltage TC with extremely stable temperature performance
- Up to **180kHz** bandwidth, **2µs** response time (TO-94 package)
- Output voltage clamp provides short circuit diagnostic
- Wide temperature range: -40ºC to 150ºC
- Lead-Free Package: Flat TO-92, TO-94, SOT-89-3L
- High ESD Protection: 8kV HBM
- RoHS Compliant 2011/65/EU

Package

TO-92S

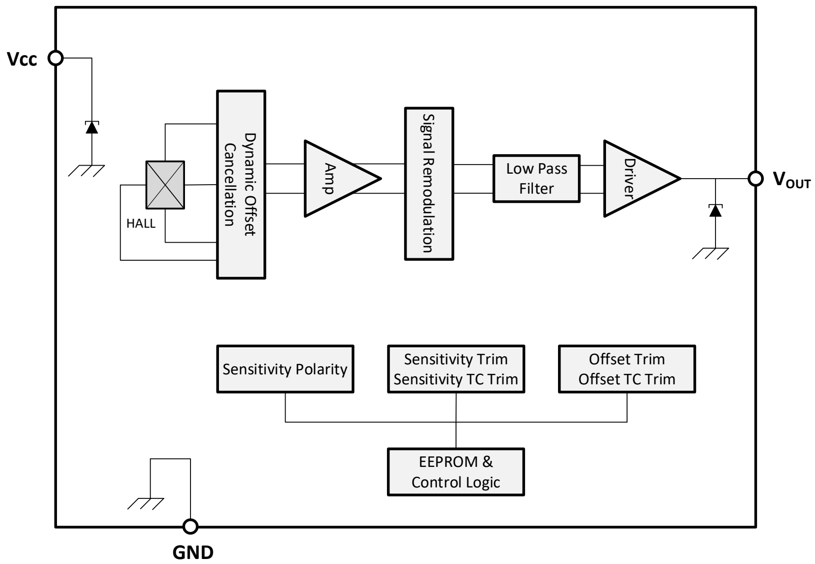
TO-94



SOT-89-3L

(preliminary)

Functional Block Diagram



Applications

- Inverter current sensing
- BMS current sensing
- Motor control
- Linear Position Detection
- Rotary Position Sensing

Description

The CHA611 is a customer-programmable, high-precision linear Hall effect sensor IC. It is packaged in subminiature package to allow for easy integration with a magnetic core to create a highly accurate current sensing module. The programmable nature of the CHA611 enables it to account for manufacturing tolerances in the final current sensing module assembly.

It provides a voltage output that is proportional to the applied magnetic field. The quiescent voltage output is user-adjustable around 50% of the supply voltage and the output sensitivity is programmable within a range of 0.6 mV/Gs to 32 mV/Gs. This device uses EERPOM to optimize device sensitivity and the quiescent output voltage (QVO) (output with no magnetic field) for a given application or circuit.

The temperature coefficient of CHA611 is also programmable at end of line test, allowing for optimized performance over temperature. This makes it ideal for use in EV BMS and inverter current sensing applications which require high accuracy over a wide temperature range of –40°C to+150°C.

Revision History

Date	Revision	Change
May 2020	1	Initial release
May 2021	1.1	Updated front page
Oct 2021	1.2	Updated part number naming convention (added polarity)
Feb 2022	1.3	Specified response time separately for different packages; updated bandwidth
April 2022	1.4	Updated package POD; updated programming sensitivity range, Figure 1 and absolute max output voltage.

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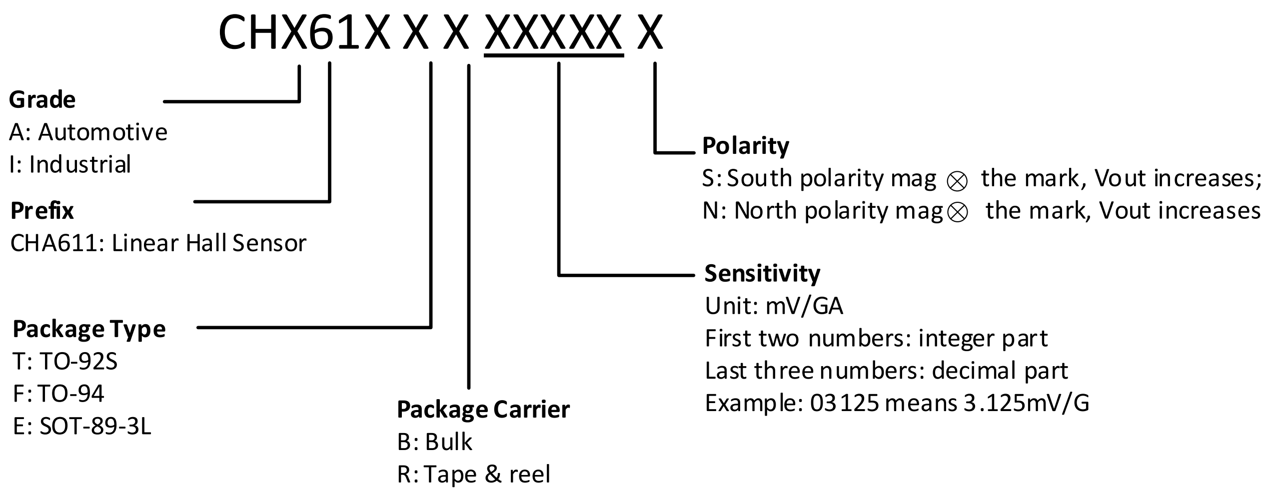
1. Product Family Members

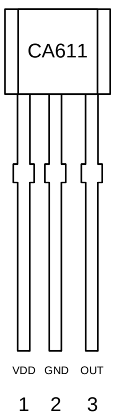
Part Number	Marking ID	Description
CHA611TB	CA611	Flat, TO-92S package, bulk packing (1000 units per bag)
CHA611FB	CA611	Flat, TO-94 package, bulk packing (1000 units per bag)
*CHA611ER	CA611	SOT-89-3L package, tape and reel packing (1000 units per reel)

*SOT-89-3L package preliminary

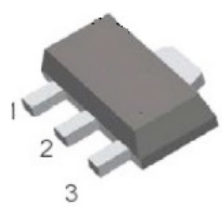


2. Pin Definitions and Descriptions

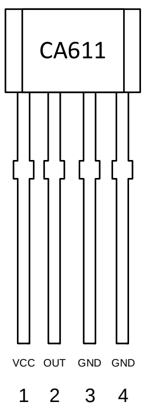
TO-92S	SOT-89	TO-94	Name	Type	Function
1	1	1	VDD	Supply	Supply Voltage pin
3	3	2	OUT	Output	Open Collector Output pin
2	2	3	GND	Ground	Ground pin (no connection pin for TO-94)
		4	GND	Ground	Ground pin



TO-92S



SOT-89-3L



TO-94

3. Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Supply Voltage	V_{CC}	-	6	V
Reverse Supply Voltage	V_{RCC}	-0.1	-	V
Output Voltage	V_{IOUT}	-	18	V
Reverse Output Voltage	V_{RIOUT}	-0.1	-	V
Output Source Current	Iout(source)		2	mA
Output Sink Current	Iout(sink)		10	mA
Maximum Number of EEPROM Write Cycles	EEPROM(max)		100	Cycles
Operating Ambient Temperature	T_A	-40	150	°C
Storage Temperature	T_S	-65	165	°C
Junction temperature	$T_{J(max)}$		165	°C
Magnetic Flux	B	No Limit		Gauss

Note: Exceeding the absolute maximum ratings may cause permanent damage. Exposure to absolute-maximum- rated conditions for extended periods may affect device reliability.

4. ESD Protections

Parameter	Value	Unit
All pins 1)	+/-8000	V
All pins 2)	+/-500	V
All pins 3)	+/-750	V

1) HBM (Human Body Mode) according to AEC-Q100-002
2) MM (Machine Mode) according to AEC-Q100-003
3) CDM (charged device mode) according to AEC-Q100-011

5. Transfer Characteristics

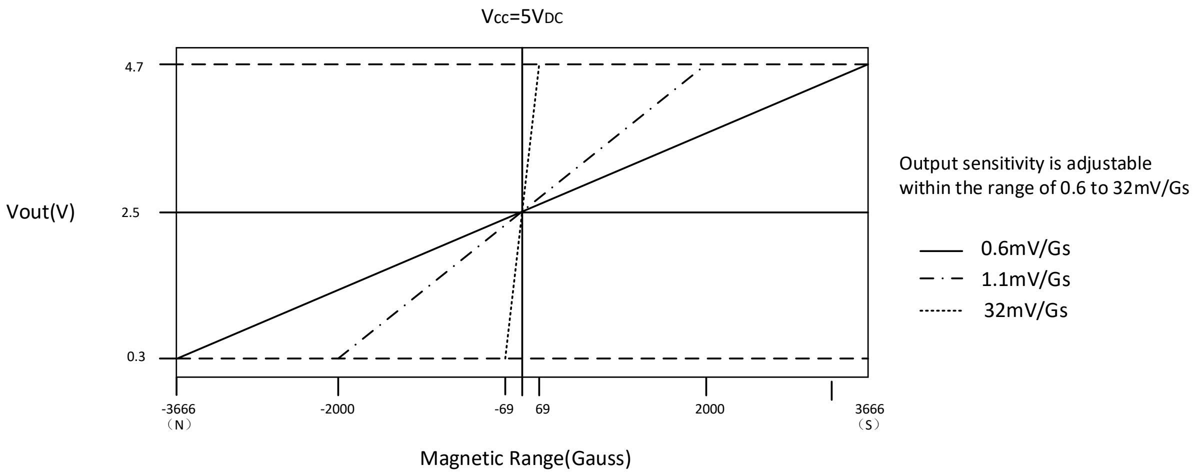


Figure 1 CHA611 Transfer Characteristics

6. Parameters Specification

Valid through the full range of TA, CBYPASS=100nF, VCC = 5 V, unless otherwise specified.

ELECTRICAL CHARACTERISTICS						
V_{CC}	Supply Voltage		4.5	5	5.5	V
I_{CC}	Supply Current	No load on V_{OUT}	–	7	10	mA
t_{PO}	Power-On Time[2]	T_A = 25°C, $C_{L(PROBE)}$ = 10pF	–	30	–	µs
V_{UVLOHI}	Under voltage Threshold	T_A = 25°C, V_{CC} rising	2.8	2.9	3	V
$V_{UVLOLOW}$		T_A = 25°C, V_{CC} falling	2.5	2.6	2.7	V
V_z	Supply Zener Clamp Voltage	T_A = 25°C, I_{CC} = 30mA	6	6.5	–	V
BW_i	Internal Bandwidth (TO-94)	Small signal –3 dB	–	180		kHz
f_C	Chopping Frequency[3]	T_A = 25°C (Programmable)	–	1000	2000	kHz
OUTPUT CHARACTERISTICS						
$V_{CLP(HIGH)}$	Output Voltage Clamp[4]	T_A = 25°C, $R_{L(PULLDWN)}$ = 10 kΩ to GND	4.55	–		V
$V_{CLP(LOW)}$		T_A = 25°C, $R_{L(PULLUP)}$ = 10 kΩ to VCC		–	0.45	V
	Clamp Disable Bit			1		Bit
$V_{SAT(HIGH)}$	Output Saturation Voltage[2]	T_A = 25°C, $R_{L(PULLDWN)}$ = 10 kΩ to GND	4.8	–	–	V
$V_{SAT(LOW)}$		T_A = 25°C, $R_{L(PULLDWN)}$ = 10 kΩ to VCC	–	–	0.2	V
V_N	Output Referred Noise[5]	T_A = 25°C, CL = 1 nF	–	1*$Sens_{init}$	–	mV_{p-p}
V_{NRMS}	Input Referred Noise Density	T_A = 25°C, No load, f<<BWi		1.5		mG/√(Hz)
R_{OUT}	DC Output Resistance		–	<1	–	Ω
$RL_{(PULLUP)}$	Output Load Resistance	VOUT to VCC	4.7	–	–	kΩ
$RL_{(PULLDWN)}$		VOUT to GND	4.7	–	–	kΩ
C_L	Output Load Capacitance[6]	VOUT to GND	–	1	10	nF
t_R	Rise time	T_A = 25°C, magnetic field step of 400G, CL=1nF, Sens=2mV/G		2.6		µs
$T_{RESPONSE}$	Response time (TO-92S, SOT89-3L)	T_A = 25°C, magnetic field step of 400G, CL=1nF, Sens=2mV/G		6		µs
	Response time (TO-94)			2		µs
t_{PD}	Propagation Delay time	T_A = 25°C, magnetic field step of 400G, CL=1nF, Sens=2mV/G		2.2		µs
t_{CLP}	Delay to Clamp	T_A = 25°C, magnetic field step of 400G, CL=1nF, Sens=2mV/G	–	10	–	µs
QUIESCENT VOLTAGE OUTPUT ($V_{OUT(Q)}$)[2]						
$V_{OUT(QBI)init}$	Initial Unprogrammed Quiescent Voltage Output[2,8]	T_A = 25°C		2.5		V

$V_{OUT(QBI)PR}$	Quiescent Voltage Output Programming Range[2,4,9]	T_A = 25°C	2.35	–	2.65	V
QVO	Quiescent Voltage Output Programming Bits[10]		–	8	–	bit
$Step_{VOUT(Q)}$	Average Quiescent Voltage Output Programming Step Size[2,11,12]	T_A = 25°C	1.9	2.3	2.8	mV
$Err_{PGVOUT(Q)}$	Quiescent Voltage Output Programming Resolution[2,13]	T_A = 25°C	–	±0.5 × $Step_{VOUT(Q)}$	–	mV
SENSITIVITY (Sens)[2]						
$Sens_{init}$	Default Sensitivity[8]	SENS_COARSE = 000, T_A = 25°C	–	0.85	–	mV/G
		SENS_COARSE = 001, T_A = 25°C	–	1.4	–	mV/G
		SENS_COARSE = 010, T_A = 25°C	–	2.3	–	mV/G
		SENS_COARSE = 011, T_A = 25°C	–	3.8	–	mV/G
		SENS_COARSE = 100, T_A = 25°C	–	6.2	–	mV/G
		SENS_COARSE = 101, T_A = 25°C	–	10.3	–	mV/G
		SENS_COARSE = 110, T_A = 25°C	–	17.2	–	mV/G
		SENS_COARSE = 111, T_A = 25°C	–	28	–	mV/G
$Sens_{PR}$	Sensitivity Programming Range[4,9]	SENS_COARSE = 000, T_A = 25°C	0.6	–	1	mV/G
		SENS_COARSE = 001, T_A = 25°C	1	–	1.6	mV/G
		SENS_COARSE = 010, T_A = 25°C	1.6	–	2.7	mV/G
		SENS_COARSE = 011, T_A = 25°C	2.7	–	4.5	mV/G
		SENS_COARSE = 100, T_A = 25°C	4.5	–	7.3	mV/G
		SENS_COARSE = 101, T_A = 25°C	7.3	–	12.1	mV/G
		SENS_COARSE = 110, T_A = 25°C	12.1	–	20.2	mV/G
		SENS_COARSE = 111, T_A = 25°C	20.2		32.9	mV/G
SENS_COARSE	Coarse Sensitivity Programming Bits[14]		–	3	–	bit
SENS_FINE	Fine Sensitivity Programming Bits[10]		–	8	–	bit
$Step_{SENS}$	Average Fine Sensitivity and Temperature Compensation Programming Step Size[2,14]	SENS_COARSE = 000, T_A = 25°C	2.4	3.3	3.9	µV/G
		SENS_COARSE = 001, T_A = 25°C	3.9	5.5	6.3	µV/G
		SENS_COARSE = 010, T_A = 25°C	6.3	8.9	10.6	µV/G
		SENS_COARSE = 011, T_A = 25°C	10.5	14.8	17.6	µV/G
		SENS_COARSE = 100, T_A = 25°C	17.6	24.2	28.5	µV/G
		SENS_COARSE = 101, T_A = 25°C	28.5	40.2	47.3	µV/G

		SENS_COARSE = 110, T_A = 25°C	47.3	67.2	78.9	µV/G
		SENS_COARSE = 111, T_A = 25°C	78.9	109.4	128.5	µV/G
Err_{PGSENS}	Sensitivity Programming Resolution[2,13]	T_A = 25°C	–	±0.5 × $Step_{SENS}$	–	µV/G
FACTORY-PROGRAMMED SENSITIVITY TEMPERATURE COEFFICIENT						
TC_{SENS}	Sensitivity Temperature Coefficient[2]	T_A = 150°C, T_A= –40°C, calculated relative to 25°C	–	0.02	–	%/°C
$\Delta Sens_{TC}$	Sensitivity Drift Through Temperature Range[2,9]	T_A = 25°C to 150°C	–	±1.5	–	%
		T_A = –40°C to 25°C	–	±1.8	–	%
FACTORY-PROGRAMMED QUIESCENT VOLTAGE OUTPUT TEMPERATURE COEFFICIENT						
TC_{QVO}	Quiescent Voltage Output Temperature Coefficient[2]	T_A = 150°C, calculated relative to 25°C	–	0.1	–	mV/°C
$\Delta VOU_{T(Q)TC}$	Quiescent Voltage Output Drift Through Temperature Range[2,9]	T_A = 25°C to 150°C;	–15		15	mV
		T_A = –40°C to 25°C	-30		+30	mV
ERROR COMPONENTS						
Lin_{ERR}	Linearity Sensitivity Error[2,15]			<±1		%
		Sens=24mV/G		<±1.5		%
Sym_{ERR}	Symmetry Sensitivity Error[2]			<±1.3		%
		Sens=24mV/G		<±1.5		%
$Rat_{ERRVOUT(Q)}$	Ratiometry Quiescent Voltage Output Error[2,16]	Through supply voltage range (relative to V_{CC} = 5 V ±5%); SENS_COARSE = 00	-1		+1	%
$Rat_{ERRSens}$	Ratiometry Sensitivity Error[2,16]	Through supply voltage range (relative to V_{CC} = 5 V ±5%)		±1		%
Rat_{ERRCLP}	Ratiometry Clamp Error[2,17]	Through supply voltage range (relative to V_{CC} = 5 V ±5%), T_A = 25°C		<±1		%
$\Delta Sens_{PKG}$	Sensitivity Drift Due to Package Hysteresis[2]	T_A = 25°C, after temperature cycling, 25°C to 150°C and back to 25°C	–	±1.5	–	%
$\Delta Sens_{LIFE}$	Sensitivity Drift Over Lifetime[18]	TA = 25°C, shift after AEC Q100 grade 0 qualification testing		±1		%

[1] 1 G (gauss) = 0.1 mT (millitesla).
[2] See Characteristic Definitions section.
[3] f_C varies up to approximately ±20% over the full operating ambient temperature range, T_A, and process.
[4] Sens, VOUT(Q) , VCLP(LOW) , and VCLP(HIGH) scale with VCC due to ratiometry.
[5] Noise, measured in mV_{PP} and in mV_{RMS} , is dependent on the sensitivity of the device.
[6] Output stability is maintained for capacitive loads as large as 10 nF.
[7] High-to-low transition of output voltage is a function of external load components and device sensitivity.
[8] Raw device characteristic values before any programming.

[9] Exceeding the specified ranges will cause sensitivity and Quiescent Voltage Output drift through the temperature range to deteriorate beyond the specified values.
[10] Refer to Functional Description section.
[11] Step size is larger than required, in order to provide for manufacturing spread.
[12] Non-ideal behavior in the programming DAC can cause the step size at each significant bit rollover code to be greater than twice the maximum specified value of StepVOUT(Q) or StepSENS.
[13] Overall programming value accuracy. See Characteristic Definitions section.
[14] Each CHA611 part number is factory programmed and temperature compensated at a different coarse sensitivity setting. Changing coarse bits setting could cause sensitivity drift through temperature range, $\Delta Sens_{TC}$, to exceed specified limits.
[15] Linearity applies to output voltage ranges of ±2 V from the quiescent output for bidirectional devices.
[16] Percent change from actual value at V_{CC} = 5 V, for a given temperature, through the supply operating range.
[17] Percent change from actual value at V_{CC} = 5 V, T_A = 25°C, through the supply voltage operating range.
[18] Based on characterization data obtained during standardized stress test for Qualification of Integrated Circuits. Cannot be guaranteed. Drift is a function of customer application conditions. Please contact Cosemitech for further information.

7. Application Information

7.1 Typical Application Circuit

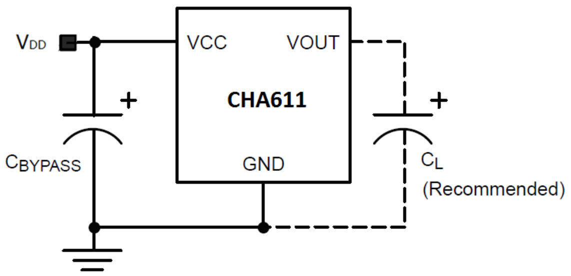


Figure 2 CHA611 Typical Application Circuit

7.2 Power-On Time (t_{PO})

When the supply is ramped to its operating voltage, the device requires a finite time to power its internal components before responding to an input magnetic field.
Power-On Time (t_{PO}) is defined as: the time it takes for the output voltage to settle within ±10% of its steady-state value under an applied magnetic field, after the power supply has reached its minimum specified operating voltage (VCC(min)) as shown in Figure 3.

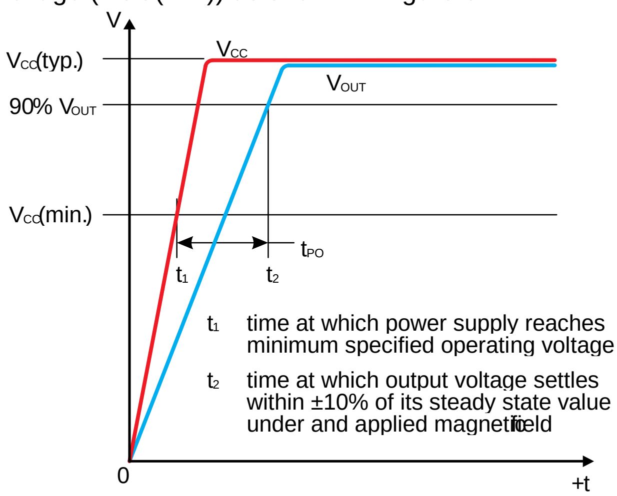


Figure 3 Power-on Time Definition

7.3 Temperature Compensation Power-On Time (t_{TC})

After power-on time (t_{PO}) elapses, t_{TC} is also required before a valid temperature compensated output.

7.4 Propagation Delay (tpd)

The time interval between a) when the applied magnetic field reaches 20% of its final value, and b) when the output reaches 20% of its final value (see Figure 4).

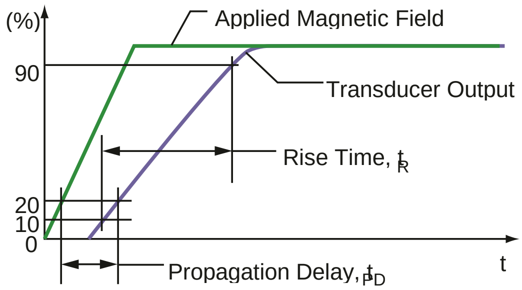


Figure 4: Propagation Delay and Rise Time Definitions

7.5 Rise Time (tr)

The time interval between a) when the sensor IC reaches 10% of its final value, and b) when it reaches 90% of its final value (see Figure 4).

7.6 Response Time ($t_{RESPONSE}$)

The time interval between a) when the applied magnetic field reaches 80% of its final value, and b) when the sensor reaches 80% of its output corresponding to the applied magnetic field (see Figure 5). The 90%-90% is also shown in the Electrical Characteristics table.

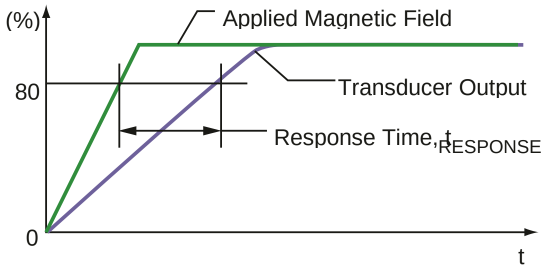


Figure 5: Response Time Definition

7.7 Delay to Clamp (t_{CLP})

A large magnetic input step may cause the clamp to overshoot its steady-state value. The Delay to Clamp (t_{CLP}) is defined as: the time it takes for the output voltage to settle within ±1% of its steady-state value, after initially passing through its steady-state voltage, as shown in Figure 6.

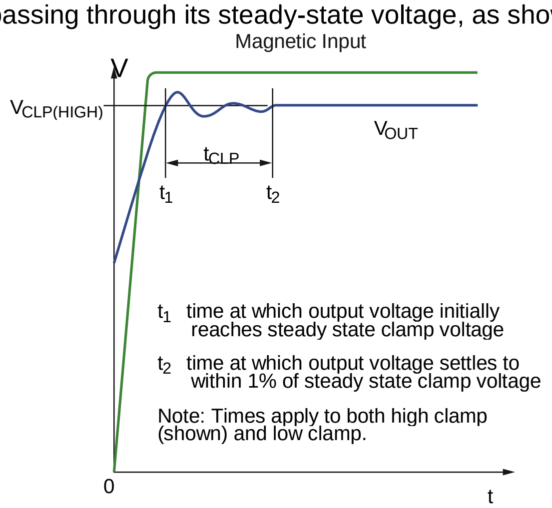


Figure 6: Delay to Clamp Definition

7.8 Quiescent Voltage Output (VOUT(Q))

In the quiescent state (no significant magnetic field: B = 0 G), the output (VOUT(Q)) has a constant ratio to the supply voltage (VCC) throughout the entire operating ranges of VCC and ambient temperature (TA) .

7.9 Initial Unprogrammed Quiescent Voltage Output (VOUT(Q)init)

Before any programming, the Quiescent Voltage Output (VOUT(Q)) has a nominal value of VCC / 2, as shown in Figure 7.

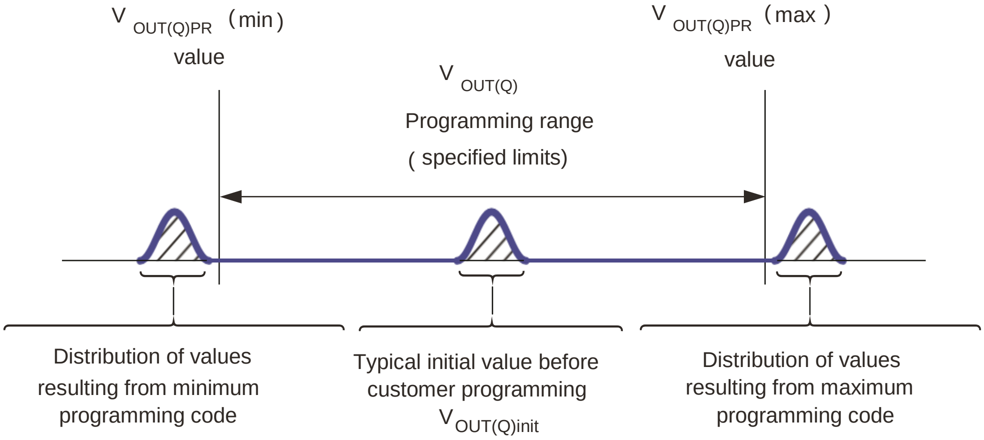


Figure 7: Quiescent Voltage Output Range Definition

7.10 Average Quiescent Voltage Output Programming Step Size (StepVOUT(Q))

The Average Quiescent Voltage Output Progamming Step Size (StepVOUT(Q)) is determined using the following calculation:

$$\mathrm{StepVOUT(Q)} = \frac{VOUT(Q)maxcode - VOUT(Q)mincode}{2^n - 1} \quad (1)$$

Where n is the number of available programming bits in the trim range, 9 bits, VOUT(Q)maxcode is at decimal code 255, and VOUT(Q)mincode is at decimal code 256.

7.11 Quiescent Voltage Output Programming Resolution (ErrPGVOUT(Q))

The programming resolution for any device is half of its programming step size. Therefore, the typical programming resolution will be:

$$Err_{PGVOUT(Q)}(typ) = 0.5 \times Step_{VOUT(Q)}(typ) \quad (2)$$

7.12 Quiescent Voltage Output Temperature Coefficient (TCQVO)

Device $V_{OUT(Q)}$ changes as temperature changes, with respect to its programmed Quiescent Voltage Output Temperature Coefficient, TC_{QVO} . TC_{QVO} is programmed at 150°C and calculated relative to the nominal $V_{OUT(Q)}$ programming temperature of 25°C. TC_{QVO} (mV/°C) is defined as:

$$TC_{QVO} = [V_{OUT(Q)T2} – V_{OUT(Q)T1}][1/(T2 – T1)] \quad (3)$$

where T1 is the nominal $V_{OUT(Q)}$ programming temperature of 25°C, and T2 is the TC_{QVO} programming temperature of 150°C. The expected $V_{OUT(Q)}$ through the full ambient temperature range ($V_{OUT(Q)EXPECTED(TA)}$) is defined as:

$$V_{OUT(Q)EXPECTED}(T_A) = V_{OUT(Q)T1} + TC_{QVO}(T_A – T1) \quad (4)$$

$V_{OUT(Q)EXPECTED(TA)}$ should be calculated using the actual measured values of $V_{OUT(Q)T1}$ and TC_{QVO} rather than programming target values.

7.13 Quiescent Voltage Output Drift Through Temperature Range (ΔVOUT(Q)TC)

Due to internal component tolerances and thermal considerations, the Quiescent Voltage Output ($V_{OUT(Q)}$) may drift from its nominal value through the operating ambient temperature (T_A). The Quiescent Voltage Output Drift Through Temperature Range ($\Delta_{VOUT(Q)TC}$) is defined as:

$$D_{VOUT(Q)TC} = V_{OUT(Q)(TA)} - V_{OUT(Q)EXPECTED(TA)} \quad (5)$$

$\Delta V_{OUT(Q)TC}$ should be calculated using the actual measured values of $\Delta V_{OUT(Q)(TA)}$ and $\Delta V_{OUT(Q)EXPECTED(TA)}$ rather than programming target values.

7.14 Sensitivity (Sens)

The presence of a south polarity magnetic field, perpendicular to the branded surface of the package face, increases the output voltage from its quiescent value toward the supply voltage rail. The amount of the output voltage increase is proportional to the magnitude of the magnetic field applied. Conversely, the application of a north polarity field decreases the output voltage from its quiescent value. This proportionality is specified as the magnetic sensitivity, Sens (mv/G), of the device, and it is defined as:

$$\text{Sens} = \frac{VOUT(BPOS) - VOUT(BNEG)}{BPOS - BNEG} \quad (6)$$

where BPOS and BNEG are two magnetic fields with opposite polarities.

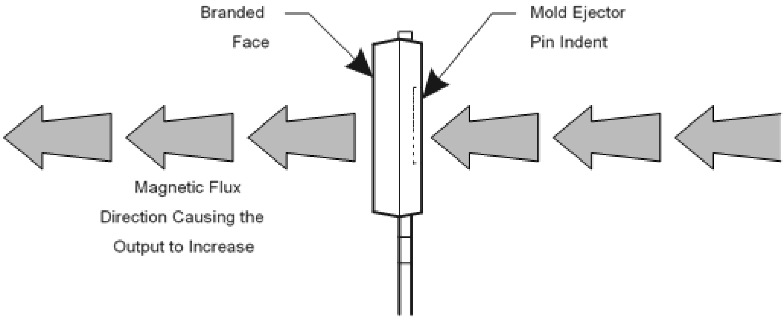


Figure 8: Magnetic Flux Direction

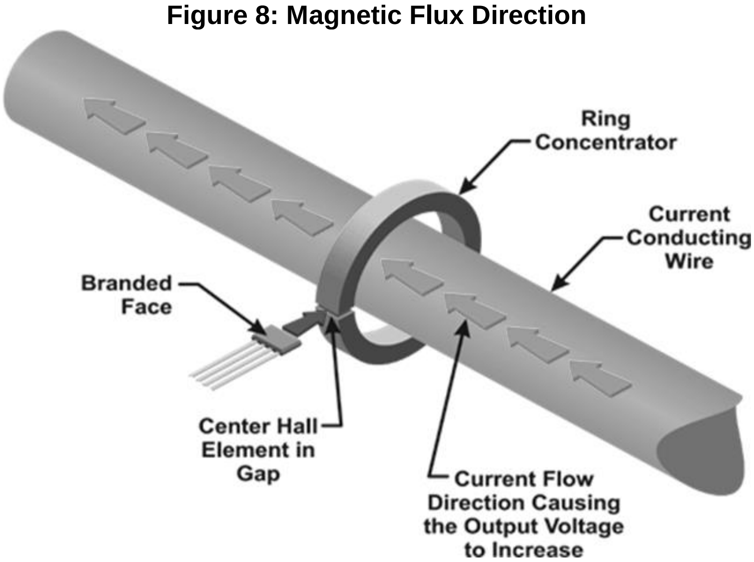


Figure 9: Sensor in Ring Concentrator

7.15 Initial Unprogrammed Sensitivity (Sensinit)

Before any programming, Sensitivity has a nominal value that depends on the SENS_COARSE bits setting. Each CH611 variant has a different SENS_COARSE setting.

7.16 Sensitivity Programming Range (SensPR)

The magnetic sensitivity (Sens) can be programmed around its initial value within the sensitivity range limits: $Sens_{PR}$(min) and $Sens_{PR}$(max). Exceeding the specified Sensitivity Range will cause Sensitivity Drift Through Temperature Range ($\Delta Sens_{TC}$) to deteriorate beyond the specified values. Refer to the

Quiescent Voltage Output Range section for a conceptual explanation of how value distributions and ranges are related.

7.17 Average Fine Sensitivity Programming Step Size (StepSENS)

Refer to the Average Quiescent Voltage Output Programming Step Size section for a conceptual explanation.

7.18 Sensitivity Programming Resolution (ErrPGSENS)

Refer to the Quiescent Voltage Output Programming Resolution section for a conceptual explanation.

7.19 Sensitivity Temperature Coefficient (TCSENS)

Device sensitivity changes as temperature changes, with respect to its programmed sensitivity temperature coefficient, TC_{SENS} . TC_{SENS} is programmed at 150°C and is calculated relative to the nominal sensitivity programming temperature of 25°C. TC_{SENS} (%/°C) is defined as:

$$TC_{SENS} = \left(\frac{Sens_{T2} - Sens_{T1}}{Sens_{T1}} \times 100\%\right)\left(\frac{1}{T2-T1}\right) \quad (7)$$

$$Sens_{EXPECTED(TA)} = Sens_{T1} \times \left(100\% + \frac{TC_{SENS}(TA-T1)}{100}\right) \quad (8)$$

$Sens_{EXPECTED(TA)}$ should be calculated using the actual measured values of $Sens_{T1}$ rather than programming target values.

7.20 Sensitivity Drift Through Temperature Range (ΔSensTC)

Second-order sensitivity temperature coefficient effects cause the magnetic sensitivity, Sens, to drift from its expected value over the operating ambient temperature range (T_A). The Sensitivity Drift Through Temperature Range ($\Delta Sens_{TC}$) is defined as:

$$\Delta \mathrm{SensTC} = \frac{Sens_{TA} - Sens_{EXPECTED(TA)}}{Sens_{EXPECTED(TA)}} \times 100\% \quad (9)$$

7.21 Sensitivity Drift Due to Package Hysteresis (ΔSensPKG)

Package stress and relaxation can cause the device sensitivity at T_A = 25°C to change during and after temperature cycling. The sensitivity drift due to package hysteresis ($\Delta Sens_{PKG}$) is defined as:

$$\Delta \mathrm{SensPKG} = \frac{Sens_{(25oC)2} - Sens_{(25oC)1}}{Sens_{(25oC)1}} \times 100\% \quad (10)$$

where $Sens_{(25°C)1}$ is the programmed value of sensitivity at T_A = 25°C, and $Sens_{(25°C)2}$ is the value of sensitivity at T_A = 25°C, after temperature cycling T_A up to 150°C and back to 25°C.

7.22 Linearity Sensitivity Error (LinERR)

The CH611 is designed to provide a linear output in response to a ramping applied magnetic field. Consider two magnetic fields, B1 and B2. Ideally, the sensitivity of a device is the same for both fields, for a given supply voltage and temperature. Linearity error is present when there is a difference between the sensitivities measured at B1 and B2.

7.23 Linearity Error

Linearity error is calculated separately for the positive (Lin_{ERRPOS}) and negative (Lin_{ERRNEG}) applied magnetic fields. Linearity Error (%) is measured and defined as:

$$Lin_{ERRPOS} = \left(1 - \frac{SensBPOS2}{SensBPOS1}\right) \quad (11)$$

$$Lin_{ERRNEG} = \left(1 - \frac{SensBNEG2}{SensBNEG1}\right) \quad (12)$$

Where: $Sens_{BX} = |Vout_{(BX)} - Vout_{(Q)}|/Bx$ and BPOS*x* and BNEG*x* are positive and negative magnetic fields, with respect to the quiescent voltage output such that |BPOS2| = 2 × |BPOS1| and |BNEG2| = 2 × |BNEG1|.
Then:

$$LinERR = \max(LinERRPOS , LinERRNEG) . \quad (13)$$

7.24 Symmetry Sensitivity Error (SymERR)

The magnetic sensitivity of an CH611 device is constant for any two applied magnetic fields of equal magnitude and opposite polarities. Symmetry Error, Sym_{ERR} (%), is measured and defined as:

$$\mathrm{Sym}_{ERR} = \left(1 - \frac{SensBPOS}{SensBNEG}\right) \times 100\% \quad (14)$$

where $Sens_{Bx}$ is as defined in equation 12, and BPOSx and BNEGx are positive and negative magnetic fields such that |BPOSx| = |BNEGx|.

7.25 Ratiometry Error (RatERR)

The CH611 device features ratiometric output. This means that the Quiescent Voltage Output ($V_{OUT(Q)}$) magnetic sensitivity, Sens, and Output Voltage Clamp ($V_{CLP(HIGH)}$ and $V_{CLP(LOW)}$) are proportional to the Supply Voltage (V_{CC}). In other words, when the supply voltage increases or decreases by a certain percentage, each characteristic also increases or decreases by the same percentage. Error is the difference between the measured change in the supply voltage relative to 5 V, and the measured change in each characteristic.
The ratiometric error in Quiescent Voltage Output, $Rat_{ERRVOUT(Q)}$ (%), for a given supply voltage (V_{CC}) is defined as:

$$Rat_{ERRVOUT(QU)} = \left| 1 - \frac{\left(\frac{V_{OUT(QU)(VCC)}}{V_{OUT(QU)(5V)}}\right)}{\frac{VCC}{5V}} \right| \times 100\% \quad (15)$$

$Rat_{ERRVOUT(QU)}$ is defined in the same way as $Rat_{ERRVOUT(QB1)}$ with a factor of 1/5 multiplied.

$$Rat_{ERRVOUT(QU)} = \left| 1 - \frac{\left(\frac{V_{OUT(QU)(VCC)}}{V_{OUT(QU)(5V)}}\right)}{\frac{VCC}{5V}} \right| \times \frac{1}{5} \times 100\% \quad (16)$$

The ratiometric error in magnetic sensitivity, $Rat_{ERRSens}$ (%), for a given Supply Voltage (V_{CC}) is defined as:

$$Rat_{ERRSens} = \left| 1 - \frac{\left(\frac{S_{ens(VCC)}}{S_{ens(5V)}}\right)}{\frac{VCC}{5V}} \right| \times 100\% \quad (17)$$

The ratiometric error in the clamp voltages, Rat_{ERRCLP} (%), for a given supply voltage (V_{CC}) is defined as:

$$Rat_{ERRCLP} = \left| 1 - \frac{\left(\frac{S_{CLP(VCC)}}{S_{CLP(5V)}}\right)}{\frac{VCC}{5V}} \right| \times 100\% \quad (18)$$

where V_{CLP} is either $V_{CLP(HIGH)}$ or $V_{CLP(LOW)}$.

7.26 Power-On Reset Voltage (V_{POR})

On power-up, to initialize to a known state and avoid current spikes, the CH611 is held in Reset state. The Reset signal is disabled when V_{CC} reaches V_{PORH} and time t_{PORR} has elapsed, allowing the output voltage to go from a high-impedance state into normal operation. During power-down, the Reset signal is enabled when V_{CC} reaches V_{PORL}, causing the output voltage to go into a high-impedance state. (Note that a detailed description of POR can be found in the Functional Description section).

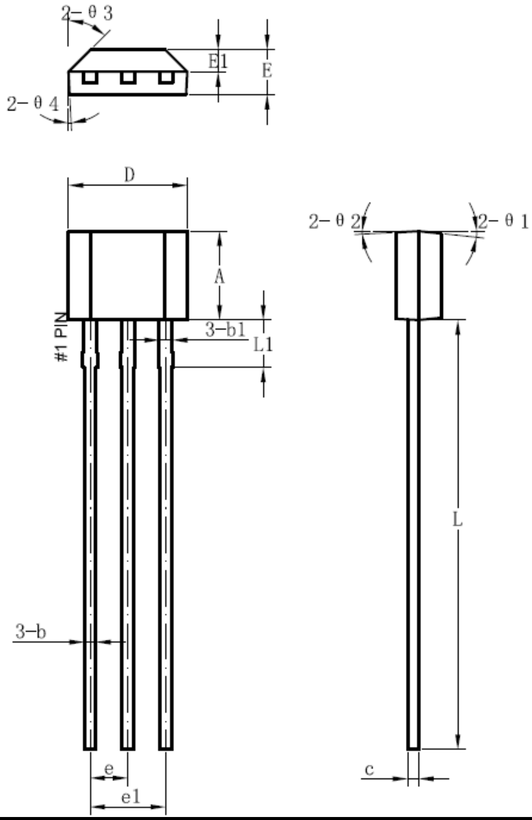
7.27 Power-On Reset Release Time (t_{PORR})

When V_{CC} rises to V_{PORH}, the Power-On Reset Counter starts. The CH611 output voltage will transition from a high-impedance state to normal operation only when the Power-On Reset Counter has reached t_{PORR} and V_{CC} has been maintained above V_{PORH}.

8. Package Information

Package Designator

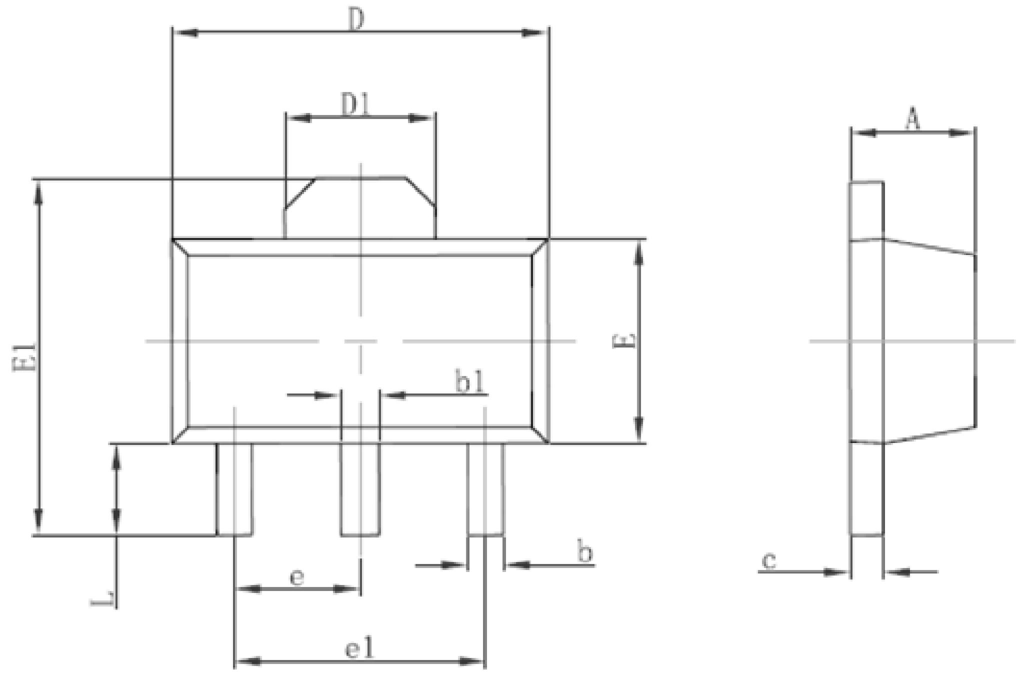
TO-92S



Symbol	Dimensions in Millimeters		
	Min.	Typ.	Max.
A	2.9	3	3.1
b	0.35	0.39	0.56
b1		0.44	
c	0.36	0.38	0.51
D	3.9	4	4.1
E	1.42	1.52	1.62
E1		0.75	
e		1.27	
e1		2.54	
L	13.5	14.5	15.5
L1		1.6	
θ1		6°	
θ2		3°	
θ3		45°	
θ4		3°	

Package Designator

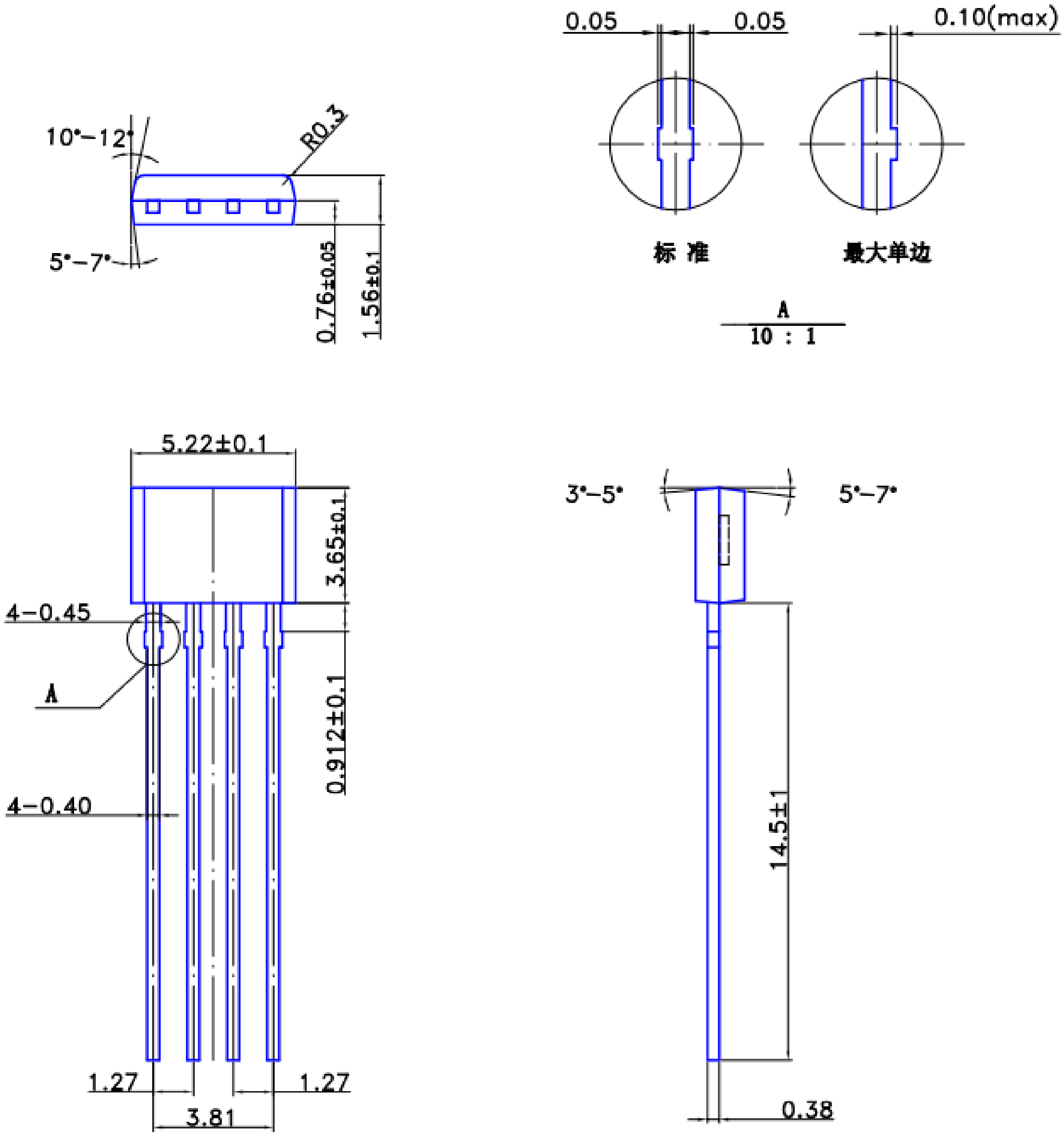
SOT-89-3L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF.		0.061 REF.	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP.		0.060 TYP.	
e1	3.000 TYP.		0.118 TYP.	
L	0.900	1.200	0.035	0.047

Package Designator

TO-94



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