

SENSYLINK Microelectronics

(CT7035)

Analog Output Temperature Sensor

CT7035 is an Analog Output Temperature Sensor with $\pm 0.35^{\circ}\text{C}$ Accuracy (CT7035K). The sensor supports multi slope gain of Temperature-to-Voltage.

It is ideally used in General Temperature Sensing and Monitoring Systems, such as Industry Thermal Control and HVAC System etc.

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Description

The CT7035 is an analog output temperature sensor with $\pm 0.35^{\circ}\text{C}$ accuracy (CT7035K). It is easily to use to replace NTC by connection to A-to-D port of MCU.

The CT7035 serial parts have multi slope gain, which can replace industry stand parts directly, like LM20, LM35.

Each chip is calibrated in factory before shipment to customers. There is no need for re-calibration anymore for $\pm 0.35^{\circ}\text{C}$ (CT7035K) accuracy.

It includes a band-gap circuit, thermal diode, class AB output, a calibration unit.

It integrates a class AB output structure, which can offer up to $\pm 500\mu\text{A}$ output capability to drive 1000pFload.

Available Package: SOT-23 and SC70-5

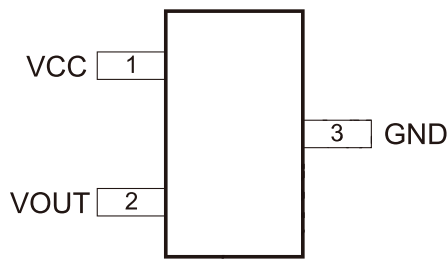
Features

- Operation Voltage: 1.8V to 5.5V
- Average Quiescent Current: 7 μA (Typ.)
- Temperature Accuracy:
 - $\pm 0.35^{\circ}\text{C}$ (Max.) from 10°C to 30°C (K version)
 - $\pm 1.0^{\circ}\text{C}$ (Max.) from -50°C to 150°C (K version)
 - $\pm 1.5^{\circ}\text{C}$ (Max.) from 10°C to 50°C (Non K version)
 - $\pm 3.5^{\circ}\text{C}$ (Max.) from -40°C to 125°C (Non K version)
- Multi Option for Slope Gain [$\text{mV}/^{\circ}\text{C}$]:
 - CT7035A, 19.5; CT7035B/J, 10.0
 - CT7035C, 6.25; CT7035D, -5.5
 - CT7035E, -8.2; CT7035F, -10.9
 - CT7035G, -11.77; CT7035H, -13.6
 - CT7035K, -5.8;
- Output Short Protection
- Temperature Range: -50°C to 150°C

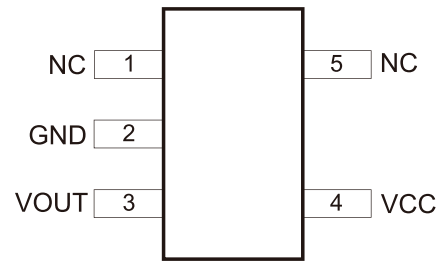
Applications

- Industry Thermal Control
- HVAC System

PIN Configurations (Top View)



SOT-23



SC70-5

Typical Application

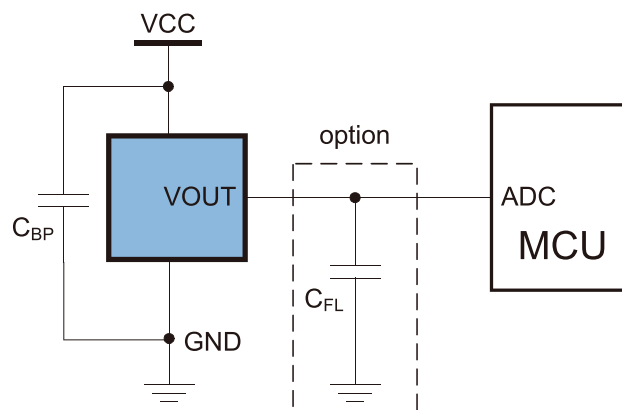


Figure 1. Typical Application of CT7035

Pin Description

PIN No.		PIN Name	Description
SOT-23	SC70-5		
1	4	VCC	Power supply input pin, it should connect a 100nF to 1.0uF ceramic cap to ground close to the sensor.
2	3	VOUT	Analog voltage output pin, proportional to temperature.
3	2	GND	Ground pin.
	1, 5	NC	No connection

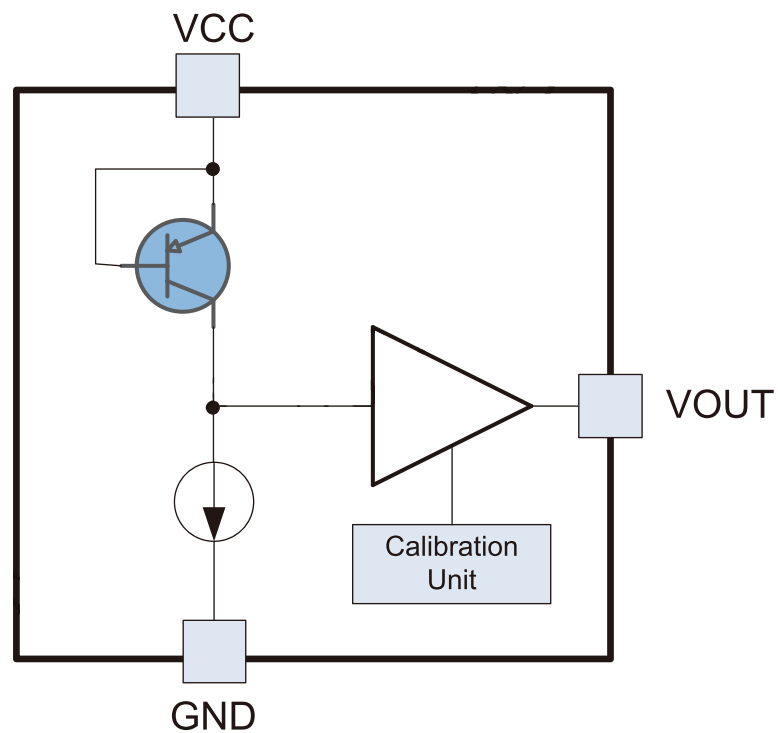
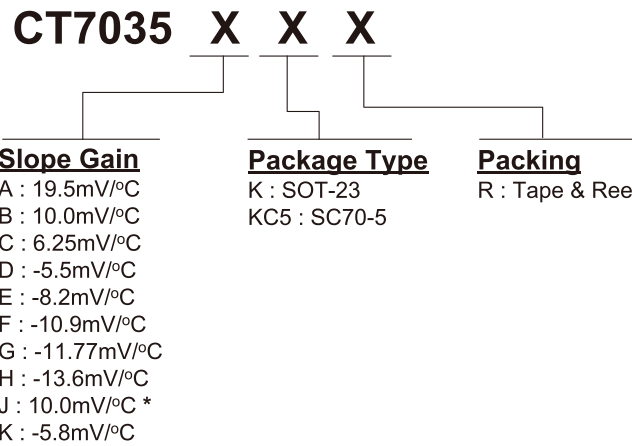
Function Block


Figure 2. CT7035 function block

Ordering Information (note 1)


Order PN	Slope Gain [mV/°C]	Green ¹	Package	Marking ID ²	Packing	MPQ	Operation Temperature
CT7035AKR	19.5	Halogen free	SOT-23	AUWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035BKR	10.0	Halogen free	SOT-23	BBWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035CKR	6.25	Halogen free	SOT-23	BCWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035DKR	-5.5	Halogen free	SOT-23	BDWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035EKR	-8.2	Halogen free	SOT-23	BEWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035FKR	-10.9	Halogen free	SOT-23	BFWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035GKR	-11.77	Halogen free	SOT-23	BGWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035HKR	-13.6	Halogen free	SOT-23	BHWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035JKR	10.0	Halogen free	SOT-23	BJWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035KKR	-5.8	Halogen free	SOT-23	BKWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035AKC5R	19.5	Halogen free	SC70-5	BYWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035BKC5R	10.0	Halogen free	SC70-5	BQWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035CKC5R	6.25	Halogen free	SC70-5	BRWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035DKC5R	-5.5	Halogen free	SC70-5	BSWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035EKC5R	-8.2	Halogen free	SC70-5	BTWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035FKC5R	-10.9	Halogen free	SC70-5	BUWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035GKC5R	-11.77	Halogen free	SC70-5	BPWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035HKC5R	-13.6	Halogen free	SC70-5	BZWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035JKC5R	10.0	Halogen free	SC70-5	CQWX	Tape & Reel	3,000	-50°C ~ +150°C
CT7035KKC5R	-5.8	Halogen free	SC70-5	CRWX	Tape & Reel	3,000	-50°C ~ +150°C

* for J version, output voltage is 750mV at Ta = 25°C, for B version, output voltage is 850mV at Ta = 25°C. for other slope gain version unlisted above, please contact Sensylink sales.

Note 1,

[Redacted content]

Absolute Maximum Ratings (Note 2)

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC} to GND	-0.3 to 5.5	V
Output pin Voltage	V_{OUT} to GND	-0.3 to 5.5	V
Operation junction temperature	T_J	-50 to 150	°C
Storage temperature Range	T_{STG}	-65 to 150	°C
Lead Temperature (Soldering, 10 Seconds)	T_{LEAD}	260	°C
ESD MM	ESD_{MM}	400	V
ESD HBM	ESD_{HBM}	4000	V
ESD CDM	ESD_{CDM}	1000	V

Note 2

1. *Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at the "Absolute Maximum Ratings" conditions or any other conditions beyond those indicated under "Recommended Operating Conditions" is not recommended. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.*
2. *Using 2oz dual layer (Top, Bottom) FR4 PCB with 4x4 mm² cooper as thermal PAD*

Recommended Operating Conditions

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	1.8 ~ 5.5	V
Ambient Operation Temperature Range	T_A	-50 ~ +150	°C

Electrical Characteristics (Note 3)

 Test Conditions: $V_{CC}=3.3V$, $T_A=25^{\circ}C$. Unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
Supply Voltage ¹	V_{CC}	(Note 3)	1.8		5.5	V	
Temperature Accuracy ²	T_{AC}	K version ²	$T_A = 10^{\circ}C$ to $30^{\circ}C$	-0.35	±0.15	0.35	$^{\circ}C$
			$T_A = -50^{\circ}C$ to $150^{\circ}C$	-1.0	±0.35	1.0	$^{\circ}C$
		Non K version	$T_A = 10^{\circ}C$ to $50^{\circ}C$	-1.5	±0.5	1.5	$^{\circ}C$
			$T_A = -40^{\circ}C$ to $125^{\circ}C$	-3.5	±1.0	3.5	$^{\circ}C$
			$T_A = -50^{\circ}C$ to $150^{\circ}C$		±2.0		$^{\circ}C$
Slope Gain	Gain	CT7035A		19.5		$mV/^{\circ}C$	
		CT7035B, CT7035J		10.0		$mV/^{\circ}C$	
		CT7035C		6.25		$mV/^{\circ}C$	
		CT7035D		-5.5		$mV/^{\circ}C$	
		CT7035E		-8.2		$mV/^{\circ}C$	
		CT7035F		-10.9		$mV/^{\circ}C$	
		CT7035G		-11.77		$mV/^{\circ}C$	
		CT7035H		-13.6		$mV/^{\circ}C$	
Output Voltage ³ @ $T = 25^{\circ}C$	V_{T25}	CT7035A		887.5		mV	
		CT7035B		850		mV	
		CT7035C		580		mV	
		CT7035D		895.5		mV	
		CT7035E		1365		mV	
		CT7035F		1834.5		mV	
		CT7035G		1574		mV	
		CT7035H		2293		mV	
		CT7035J		750		mV	
		CT7035K		1914.7		mV	
Supply Current	I_{CC}			7.0	12	μA	
Line Regulation		VCC change from Min. voltage to 5.0V		0.3		mV/V	
Output Resistance	R_O	$I_{LOAD} = -500\mu A$ to $500\mu A$		1		ohm	
Maximum Capacitive Load				1000		pF	

Note 3

1. The Min. supply voltage is always 250mV higher than that of output voltage at least, see below table for each part.
2. Temperature error is defined the temperature difference between temperature-to-voltage transfer function based on Table 1 and absolute temperature. K version means CT7035K, which is better temperature accuracy performance than other slope gain version.
3. For CT7035J, slope gain is $10.0mV/^{\circ}C$, V_{out} at $T_a = -25^{\circ}C$, is 250mV.

$\pm 0.35^{\circ}\text{C}$ Analog Output Temperature Sensor

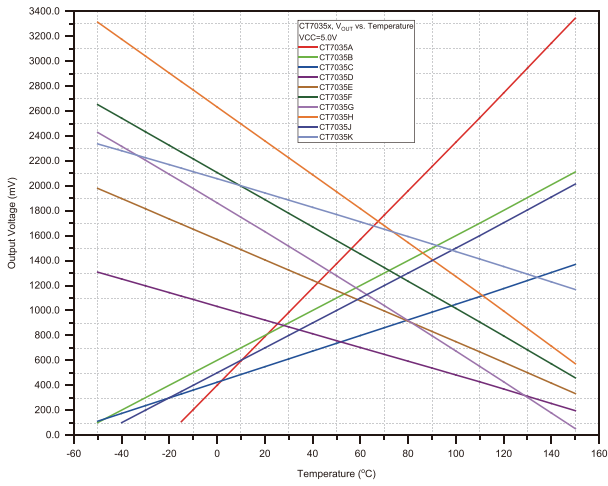


Figure 3. Output Voltage vs. Temperature

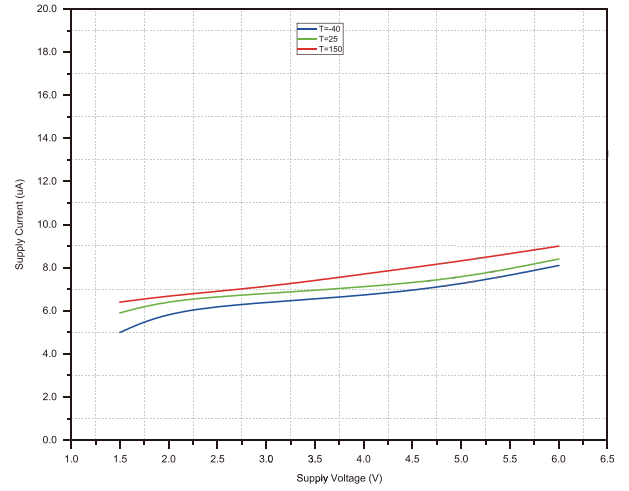


Figure 5. Supply Current vs. Supply Voltage

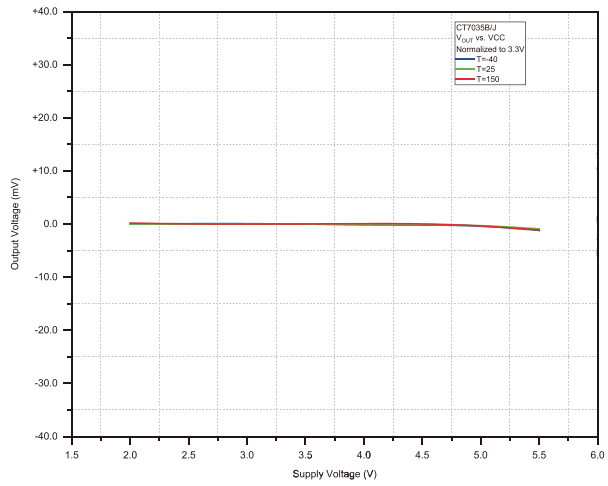


Figure 4. Output Voltage vs. Supply Voltage

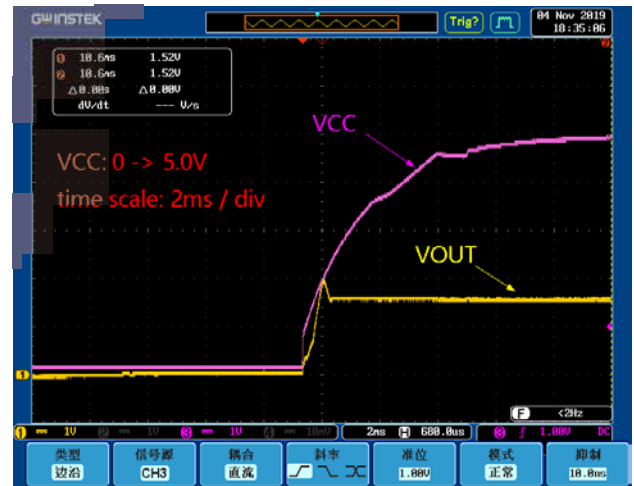


Figure 6. Output Voltage vs. Supply Voltage (power on)

1 Function Descriptions

The chip is an analog output temperature sensor with optimized thermal diode as temperature-sensing device. Also the chip has a class-AB output stage with buffer which can offer 500uA source/sink capability. Also CT7035 serial chips can offer several kinds of slope gain distinguished by suffix A to H, J and K.

1.1 Temperature-to-Voltage Transfer Function

It is recommended to use below transfer function to express the relationship between temperature and output voltage. For CT7035A/B/C/D/E/F/H/J, to use 1st order equation; for CT7035G, CT7035K, prefer to use 2nd order equation.

Part No.	Temperature Range	Output Voltage (unit: mV) ^{NOTE4}	Temperature (unit: °C) ^{NOTE4}
CT7035A	-40°C~150°C	$V_O = 19.5 * T + 400$	$T = (V_O - 400) / 19.5$
CT7035B	-40°C~150°C	$V_O = 10.0 * T + 600$	$T = (V_O - 600) / 10.0$
CT7035C	-40°C~150°C	$V_O = 6.25 * T + 424$	$T = (V_O - 424) / 6.25$
CT7035D	-40°C~110°C	$V_O = -5.5 * T + 1033$	$T = (V_O - 1033) / (-5.5)$
	110°C~150°C	$V_O = -5.8 * (T - 110) + 428$	$T = (V_O - 428) / (-5.8) + 110$
CT7035E	-40°C~110°C	$V_O = -8.2 * T + 1570$	$T = (V_O - 1570) / (-8.2)$
	110°C~150°C	$V_O = -8.35 * (T - 110) + 668$	$T = (V_O - 668) / (-8.35) + 110$
CT7035F	-40°C~110°C	$V_O = -10.9 * T + 2107$	$T = (V_O - 2107) / (-10.9)$
	110°C~150°C	$V_O = -11.2 * (T - 110) + 908$	$T = (V_O - 908) / (-11.2) + 110$
CT7035G	-40°C~150°C	$V_O = -0.00388 * T^2 - 11.5 * T + 1863.9$	$T = -1481.96 + \sqrt{[2.1962 * 10^6 + (1863.9 - V_O) / (3.88 * 10^{-3})]}$
CT7035H	-40°C~110°C	$V_O = -13.6 * T + 2633$	$T = (V_O - 2633) / (-13.6)$
	110°C~150°C	$V_O = -14.1 * (T - 110) + 1137$	$T = (V_O - 1137) / (-14.1) + 110$
CT7035J	-40°C~110°C	$V_O = 10.0 * T + 500$	$T = (V_O - 500) / 10.0$
	110°C~150°C	$V_O = 10.35 * (T - 110) + 1600$	$T = (V_O - 1600) / 10.35 + 110$
CT7035K	-40°C~150°C	$V_O = -0.00174 * T^2 - 5.666 * T + 2057.4$	$T = -1628.16 + \sqrt{[2.65098 * 10^6 + (2057.4 - V_O) / (1.74 * 10^{-3})]}$

Table 1. Transfer Function between Temperature and Output Voltage

*Note 4: Here T is temperature with Celsius degree, Vo unit is mV.

Temperature (°C)	CT7035A	CT7035B	CT7035C	CT7035D	CT7035E	CT7035F	CT7035G	CT7035H	CT7035J	CT7035K
150	3325	2100	1361.5	196	334	460	51.6	573	2014	1168.4
140	3130	2000	1299	254	417.5	572	177.8	714	1910.5	1230.1
130	2935	1900	1236.5	312	501	684	303.3	855	1807	1291.4
120	2740	1800	1174	370	584.5	796	428	996	1703.5	1352.4
110	2545	1700	1111.5	428	668	908	552	1137	1600	1413.1
100	2350	1600	1049	483	750	1017	675.1	1273	1500	1473.4
90	2155	1500	986.5	538	832	1126	797.5	1409	1400	1533.4
80	1960	1400	924	593	914	1235	919.1	1545	1300	1593
70	1765	1300	861.5	648	996	1344	1039.9	1681	1200	1652.3
60	1570	1200	799	703	1078	1453	1159.9	1817	1100	1711.2

±0.35°C Analog Output Temperature Sensor

50	1375	1100	736.5	758	1160	1562	1279.2	1953	1000	1769.8
40	1180	1000	674	813	1242	1671	1397.7	2089	900	1828
30	985	900	611.5	868	1324	1780	1515.4	2225	800	1885.9
20	790	800	549	923	1406	1889	1632.3	2361	700	1943.4
10	595	700	486.5	978	1488	1998	1748.5	2497	600	2000.6
0	400	600	424	1033	1570	2107	1863.9	2633	500	2057.4
-10	205	500	361.5	1088	1652	2216	1978.5	2769	400	2113.9
-15	107.5	450	330.3	1115.5	1693	2270.5	2035.5	2837	350	2142
-20	--	400	299	1143	1734	2325	2092.3	2905	300	2170
-30	--	300	236.5	1198	1816	2434	2205.4	3041	200	2225.8
-40	--	200	174	1253	1898	2543	2317.7	3177	100	2281.3
-50	--	100	111.5	1306	1973	2644	2429.2	3308	--	2336.4

Table 2. Temperature Data Look-up Table

Due to different gain slope, there is different working temperature range.

1.2 Minimum Supply Voltage

Since the chip output is analog voltage, and changed versus temperature with different slope. The minimum supply voltage is different at different temperature shown as below table for each version.

Temperature (°C)	Minimum Supply Voltage (V)									
	CT7035A	CT7035B	CT7035C	CT7035D	CT7035E	CT7035F	CT7035G	CT7035H	CT7035J	CT7035K
+150	Vout+0.15	Vout+0.18	1.8	1.8	1.8	1.8	1.8	1.8	Vout+0.18	1.8
+125	Vout+0.19	Vout+0.25	1.8	1.8	1.8	1.8	1.8	1.8	Vout+0.25	1.8
+100	Vout+0.21	1.8	1.8	1.8	1.8	1.8	1.8	Vout+0.77	1.8	1.8
+75	Vout+0.24	1.8	1.8	1.8	1.8	1.8	1.8	Vout+0.66	1.8	1.8
+50	1.8	1.8	1.8	1.8	1.8	Vout+0.5	Vout+0.63	Vout+0.58	1.8	Vout+0.20
+25	1.8	1.8	1.8	1.8	1.8	Vout+0.4	Vout+0.54	Vout+0.51	1.8	Vout+0.25
0	1.8	1.8	1.8	1.8	1.8	Vout+0.3	Vout+0.44	Vout+0.44	1.8	Vout+0.30
-25.0	1.8	1.9*	1.8	1.8	Vout+0.23	Vout+0.3	Vout+0.35	Vout+0.36	1.9*	Vout+0.30
-50.0	1.8	2.0*	1.9*	1.9*	Vout+0.23	Vout+0.26	Vout+0.26	Vout+0.29	2.0*	Vout+0.30

* -- For CT7035B/J version, it is better to apply 2.0V at T = -50°C, 1.9V at T = -25°C to keep enough margin; For CT7035C/D version, it is better to apply 2.0V at T = -50°C, 1.9V at T = -25°C to keep enough margin;

Table 3. Minimum Supply Voltage Table

1.3 Output Driver and Capacitive Load

If the chip is used in noisy environment, or connected to a switched sampling input of post ADC, it is necessary to add a filter capacitor shown as below, to minimize noise coupling. The output can drive maximum capacitive load is 1000pF. If capacitive loads greater than 1000pF, a series resistor is required on the output, to maintain stable conditions.

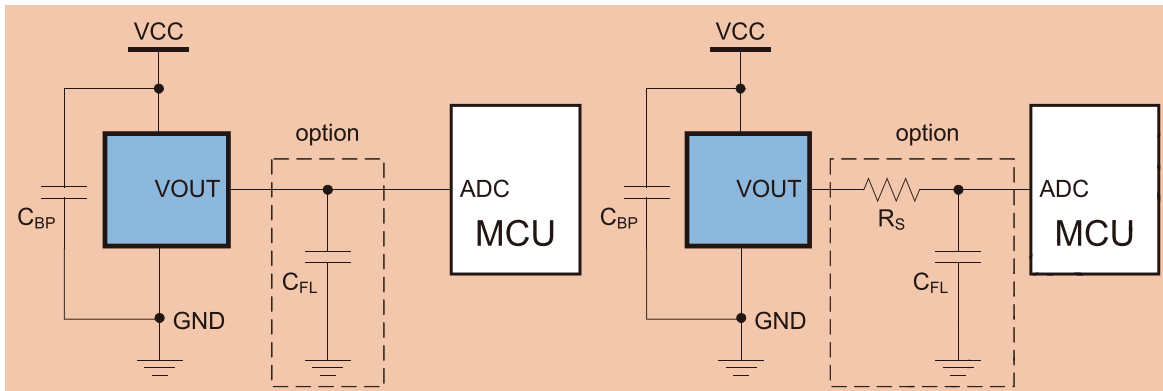


Figure 7. Capacitive Load with/without R_s

1.4 Bypass Capacitor

Bypass Capacitor is necessary to filter noise and placed as close as the chip in most application. And the capacitance value could be 100pF to 1.0nF depending on noise frequency.

1.5 PCB Layout

It is recommended PCB layout shown as below.

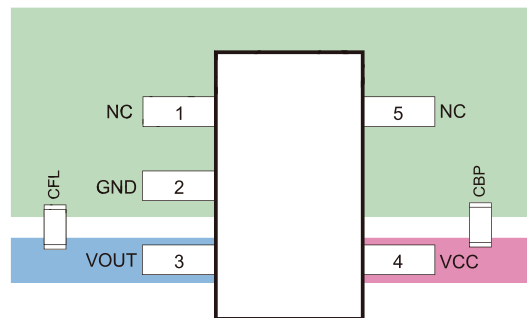
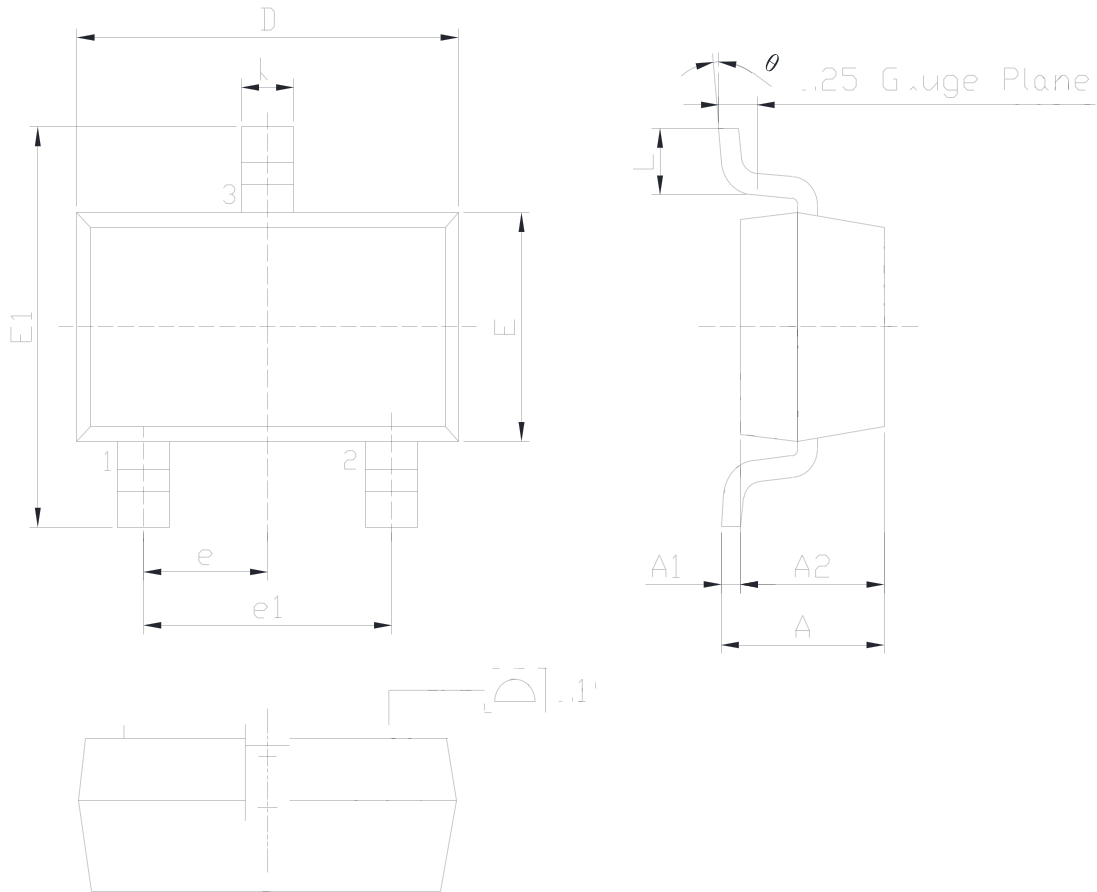
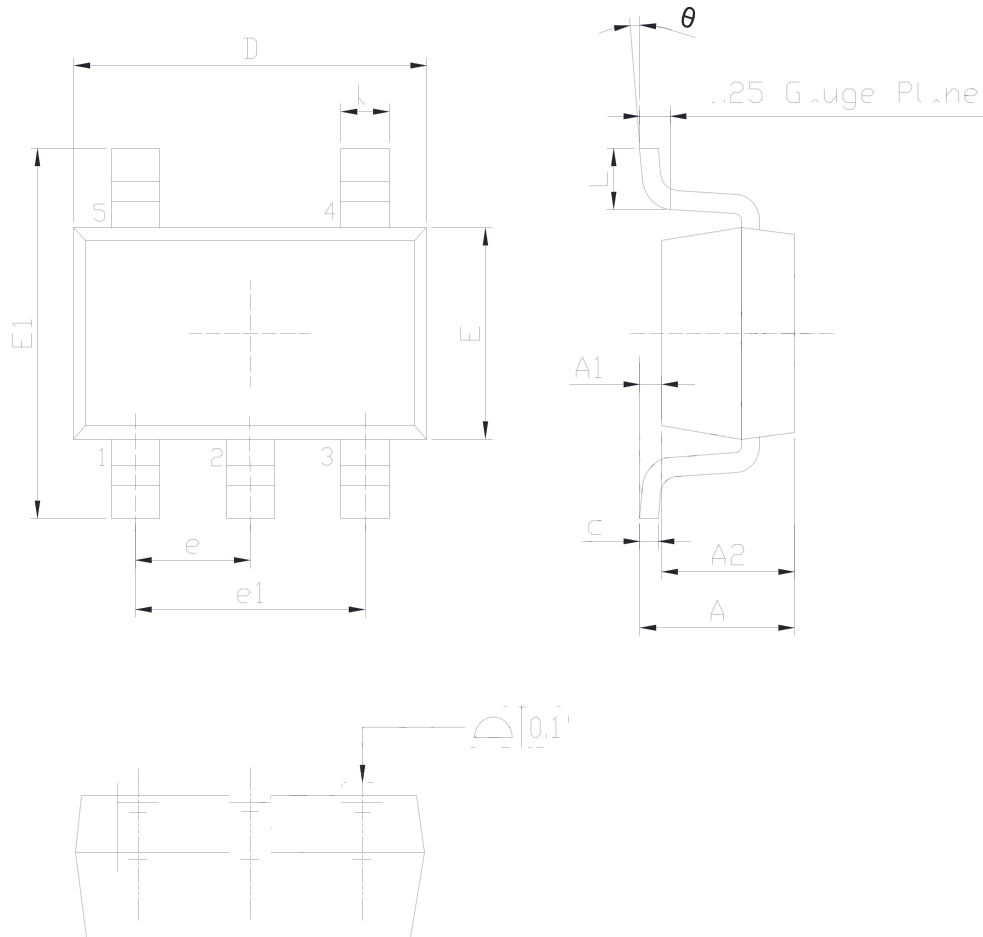


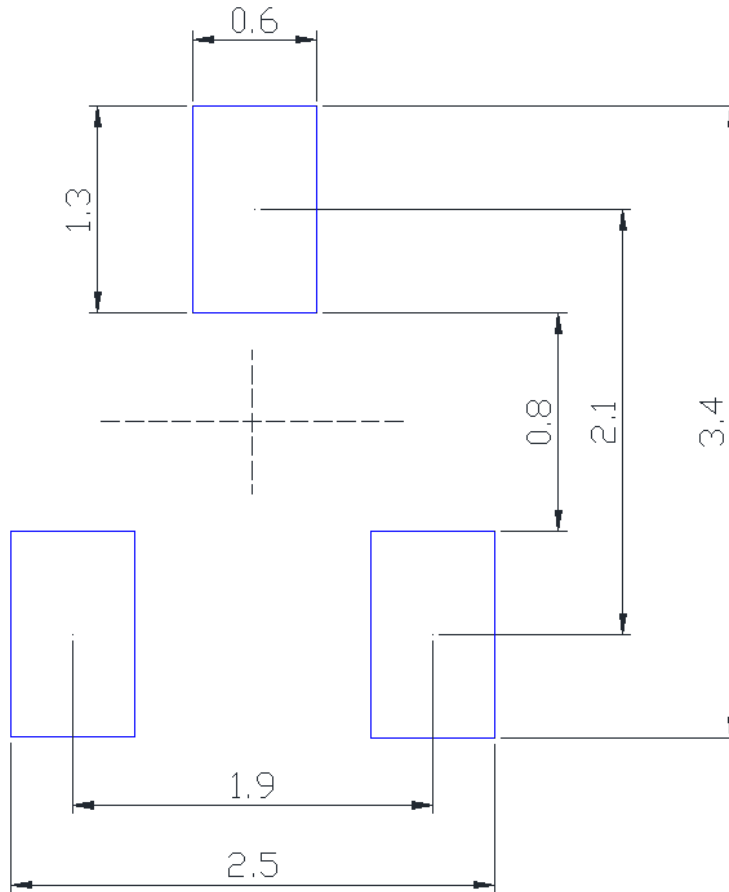
Figure 8. Recommended PCB Layout

Package Outline Dimensions (SOT-23)
SOT-23 Unit (mm)


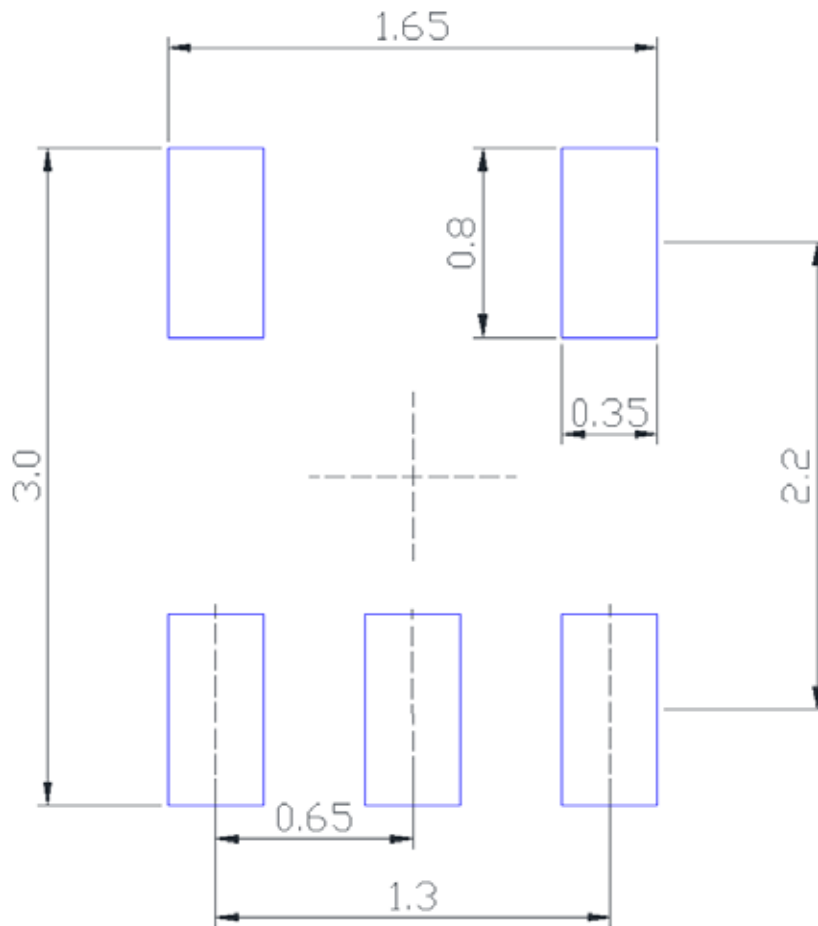
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	0.900	1.150	0.035	0.045
A1	0.000	0.100	0.000	0.004
A2	0.900	1.050	0.035	0.041
b	0.300	0.500	0.012	0.020
c	0.080	0.200	0.003	0.008
D	2.800	3.000	0.110	0.118
E	1.200	1.400	0.047	0.055
E1	2.200	2.600	0.087	0.102
e	0.950 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Package Outline Dimensions (SC70-5)
SC70-5 Unit (mm)


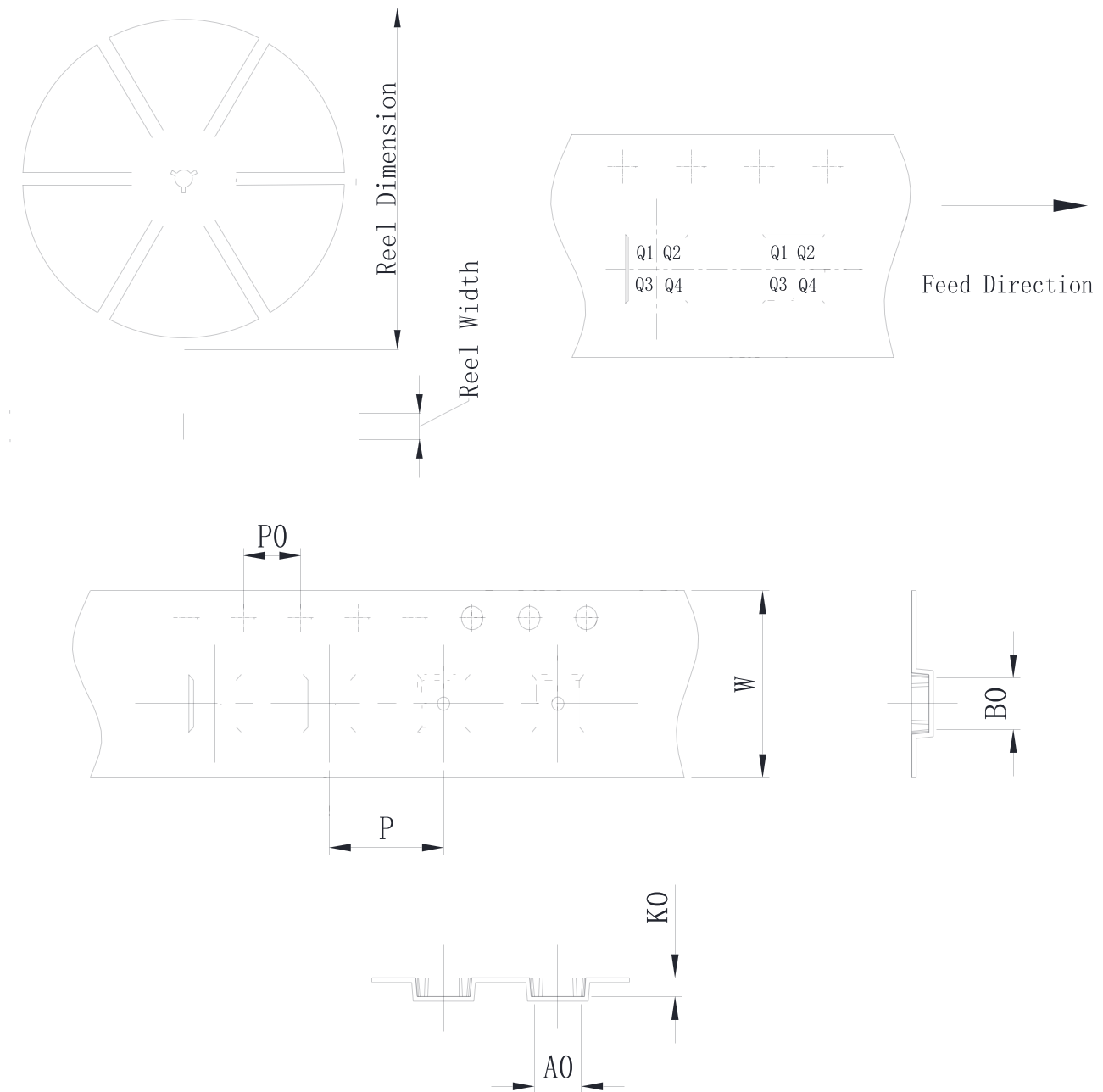
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650 (BSC)		0.026 (BSC)	
e1	1.200	1.400	0.047	0.055
L	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

Recommend Land Pattern Layout (SOT-23)
SOT-23 Unit (mm)

Note:

- 1 All dimensions are in millimeter
- 2 Recommend tolerance is within $\pm 0.1\text{mm}$
- 3 Change without notice

Recommend Land Pattern Layout (SC70-5)
SC70-5 Unit (mm)

Note:

- 1 All dimensions are in millimeter
- 2 Recommend tolerance is within $\pm 0.1\text{mm}$
- 3 Change without notice

Packing information


Package type	Reel size	Reel dimension ($\pm 3.0\text{mm}$)	Reel width ($\pm 1.0\text{mm}$)	A0 ($\pm 0.1\text{mm}$)	B0 ($\pm 0.1\text{mm}$)	K0 ($\pm 0.1\text{mm}$)	P ($\pm 0.1\text{mm}$)	P0 ($\pm 0.1\text{mm}$)	W ($\pm 0.3\text{mm}$)	Pin1
SOT-23	7'	180	8.4	3.15	2.77	1.22	4.0	4.0	8.0	Q3
SC70-5	7'	180	8.4	2.3	2.5	1.2	4.0	4.0	8.0	Q3

Revision History

Version	Date	Change Content
Ver1.0	2018.09	Initial version
Ver1.1	2019.06	Add J version (CT7035J)
Ver1.2	2019-08	Update Current
Ver1.3	2020-03	Update Function Descriptions
Ver1.4	2020-04	Update Marking Information, add K version (CT7035K)
Ver1.5	2020-06	Update Temperature Range
Ver1.6	2020-09	1. Optimize Marking 2. Add packing Information



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