

Voltage Detector

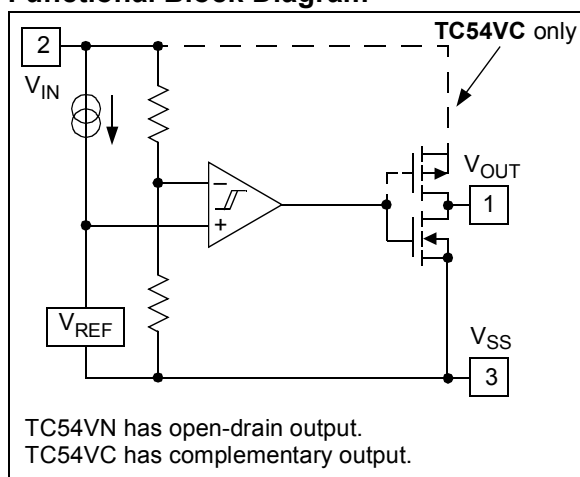
Features

- Precise Detection Thresholds: Standard $\pm 2.0\%$, Custom $\pm 1.0\%$
- Small Packages: 3-Pin SOT-23A, 3-Pin SOT-89, TO-92 and 5-Pin SOT-23A (7.7V only)
- Low Current Drain: Typ. $1 \mu\text{A}$
- Wide Detection Range: 1.1V to 6.0V and 7.7V
- Wide Operating Voltage Range: 0.7V to 10V

Applications

- Battery Voltage Monitoring
- Microprocessor Reset
- System Brown-Out Protection
- Switching Circuit in Battery Backup
- Level Discriminator

Functional Block Diagram



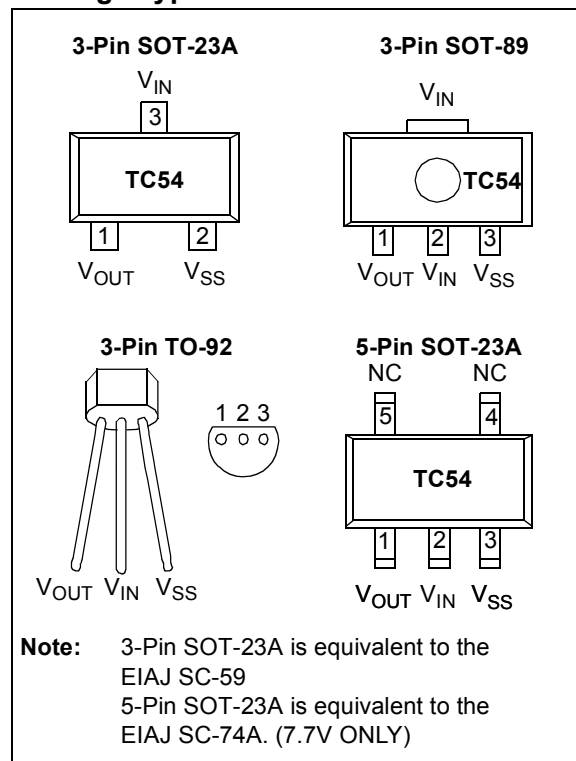
General Description

The TC54 Series are CMOS voltage detectors that are especially well suited for battery-powered applications because of their extremely low $1 \mu\text{A}$ operating current and small surface-mount packaging. Each part is laser-trimmed to the desired threshold voltage, which can be specified from 1.4V to 7.7V for a 2% tolerance, and 1.5V to 6.0V for a 1% tolerance.

The device includes a comparator, low-current high-precision reference, laser-trimmed divider, hysteresis circuit and output driver. The TC54 is available with either an open-drain or complementary output stage.

In operation, the TC54's output (V_{OUT}) remains in the logic-high state as long as V_{IN} is greater than the specified threshold voltage (V_{DET}). When V_{IN} falls below V_{DET} , the output is driven to a logic-low. V_{OUT} remains low until V_{IN} rises above V_{DET} by an amount V_{HYST} , whereupon it resets to a logic-high.

Package Types



TC54

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage	+12V
Output Current	50 mA
Output Voltage: CMOS.....	(V _{SS} - 0.3V) to (V _{IN} + 0.3V)
Open-Drain.....	(V _{SS} - 0.3V) to 12V
Power Dissipation (T _A ≤ 70°C):	
3-Pin SOT-23A	240 mW
3-Pin SOT-89.....	500 mW
5-Pin SOT-23A	240 mW
3-Pin TO-92	300 mW
Operating Temperature Range.....	-40°C to +85°C
Storage Temperature Range.....	-65°C to +150°C

† Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

PIN FUNCTION TABLE

Symbol	Description
V _{OUT}	Digital Output
V _{IN}	Analog Input
V _{SS}	Ground Terminal
NC	No Connect
NC	No Connect

DC CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T _A = +25°C.						
Parameter	Sym	Min	Typ	Max	Units	Test Conditions
Operating Voltage	V _{IN}	0.7	—	10.0	V	(V _{DET -}) = 0.8 to 6.0V
Quiescent Current	I _{SS}	—	0.8	2.7	µA	V _{IN} = 2.0V
		—	0.9	3.0		V _{IN} = 3.0V
		—	1.0	3.2		V _{IN} = 4.0V
		—	1.1	3.6		V _{IN} = 5.0V
Threshold Voltage Note 1	V _{DET -}	1.37	1.4	1.43	V	TC54VX14
		2.06	2.1	2.14		TC54VX21
		2.65	2.7	2.75		TC54VX27
		2.84	2.9	2.96		TC54VX29
		2.94	3.0	3.06		TC54VX30
		4.12	4.2	4.28		TC54VX42
		4.21	4.3	4.39		TC54VX43
		7.54	7.7	7.86		TC54VX77 (5-pin SOT-23A only)
Hysteresis Voltage	V _{HYST}	28	70	112	mV	V _{DET} = 1.4V (typ)
		42	105	168		V _{DET} = 2.1V (typ)
		54	135	216		V _{DET} = 2.7V (typ)
		58	145	232		V _{DET} = 2.9V (typ)
		60	150	240		V _{DET} = 3.0V (typ)
		84	210	336		V _{DET} = 4.2V (typ)
		86	215	344		V _{DET} = 4.3V (typ)
		154	385	616		V _{DET} = 7.7V (typ)
Output Current	I _{OUT}	—	7.7	—	mA	V _{OL} = 0.5V, V _{IN} = 2.1V
		—	10.1	—		V _{IN} = 3.0V
		—	11.5	—		V _{IN} = 4.0V
		—	13.0	—		V _{IN} = 5.0V
		—	-10.0	—		TC54VC Only: V _{OH} = V _{IN} - 2.1V, V _{IN} = 8.0V
Tempco of (V _{DET -})	T _C (V _{DET -})	—	±100	—	ppm/°C	-40°C ≤ T _A ≤ 85°C
Delay Time	t _{DLY}	—	—	0.2	ms	V _{DET -} → V _{OUT} inversion

Note 1: For other voltage options, please contact your regional Microchip sales office.

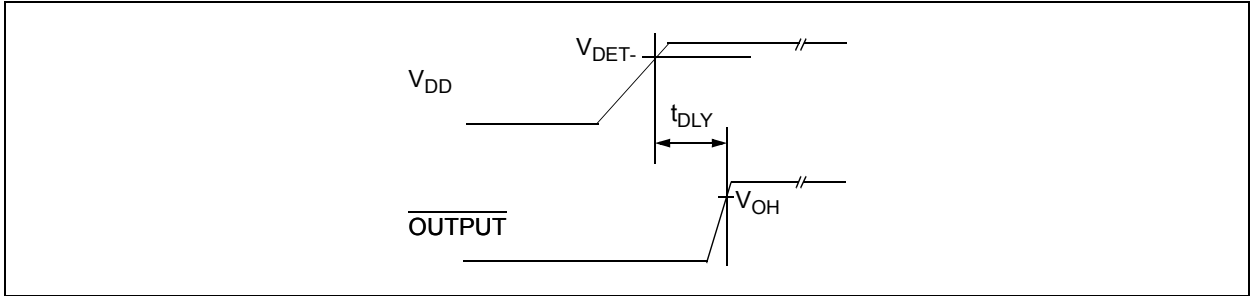


FIGURE 1-1: Timing Diagram.

TC54

2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin No. (3-Pin SOT-23A)	Pin No. (3-Pin SOT-89) (3-Pin TO-92)	Pin No. (5-Pin SOT-23A)	Symbol	Description
1	1	1	V_{OUT}	Digital Output
3	2	2	V_{IN}	Analog Input
2	3	3	V_{SS}	Ground Terminal
—	—	4	NC	No Connect
—	—	5	NC	No Connect

2.1 Digital Output (V_{OUT})

V_{OUT} goes low when V_{IN} drops below V_{DET-} and returns high when V_{IN} rises above $V_{DET-} + V_{HYST}$. (See Figure 3-1, "Timing Diagram".)

2.2 Analog Input (V_{IN})

V_{IN} can be used for power supply monitoring or a voltage level that requires monitoring.

2.3 Ground Terminal (V_{SS})

V_{SS} provides the negative reference for the analog input voltage. Typically, the circuit ground is used.

2.4 No Connect (NC)

No internal connection.

3.0 DETAILED DESCRIPTION

In normal steady-state operation when $V_{IN} > V_{DET-}$, the output will be at a logic-high (see Figure 3-1). In the case of the TC54VN, this is an open-drain condition. If and when the input falls below V_{DET-} , the output will pull down (Logic 0) to V_{SS} . Generally, V_{OUT} can pull down to within 0.5V of V_{SS} at rated output current and input voltage. (See Section 1.0, "Electrical Characteristics").

The output (V_{OUT}) will stay valid until the input voltage falls below the minimum operating voltage (V_{INMIN}) of 0.7V. Below this minimum operating voltage, the output is undefined. During power-up (or anytime V_{IN} has fallen below V_{INMIN}), V_{OUT} will remain undefined until V_{IN} rises above V_{INMIN} . Once this occurs, the output will become valid. V_{OUT} will be in its active-low state, while $V_{INMIN} < V_{IN} < V_{DET+}$ (therefore, $V_{DET+} = V_{DET-} + V_{HYST}$). If and when the input rises above V_{DET+} , the output will assume its inactive state (high for TC54VC, open-drain for TC54VN).

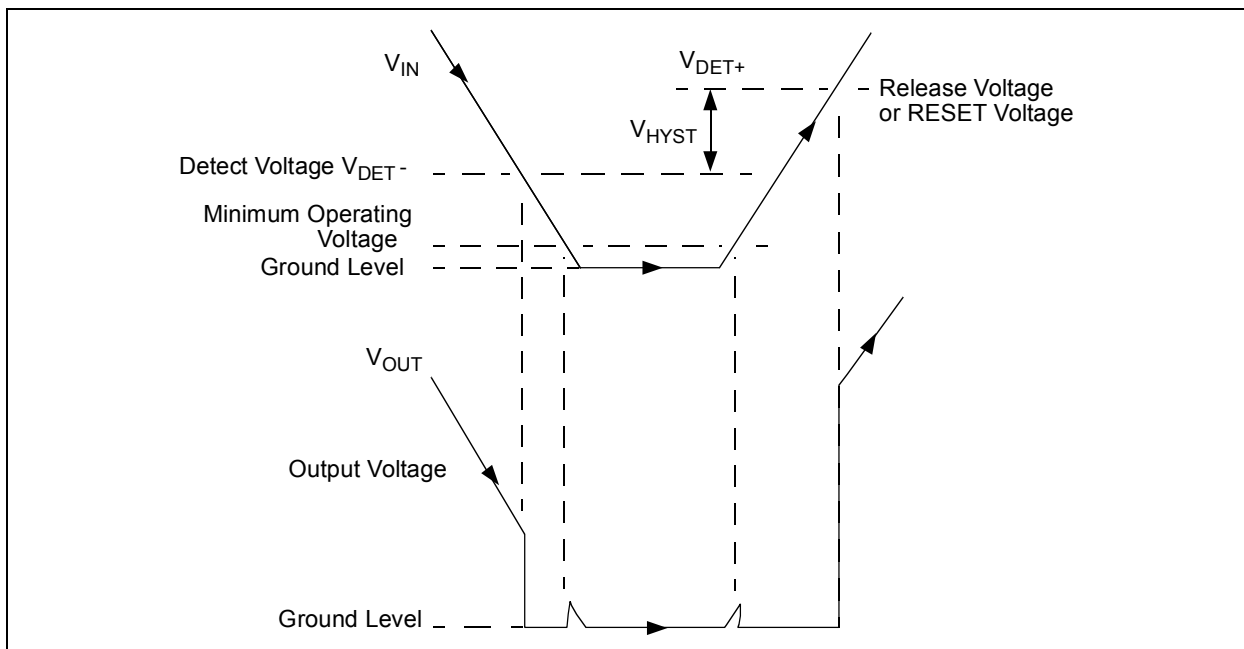


FIGURE 3-1: Timing Diagram.

4.0 APPLICATIONS INFORMATION

4.1 Modifying The Trip Point, V_{DET-}

Although the TC54 has a pre-programmed V_{DET-} , it is sometimes necessary to make adjustments during prototyping. This can be accomplished by connecting an external resistor divider to a TC54, which has a V_{DET-} lower than that of V_{SOURCE} (Figure 4-1).

To maintain detector accuracy, the bleeder current through the divider should be significantly higher than the 1 μ A operating current required by the TC54. A reasonable value for this bleeder current is 100 μ A (100 times the 1 μ A required by the TC54). For example, if $V_{DET-} = 2V$ and the desired trip point is 2.5V, the value of $R_1 + R_2$ is 25 k Ω (2.5V/100 μ A). The value of $R_1 + R_2$ can be rounded to the nearest standard value and plugged into the equation of Figure 4-1 to calculate values for R_1 and R_2 . 1% tolerance resistors are recommended.

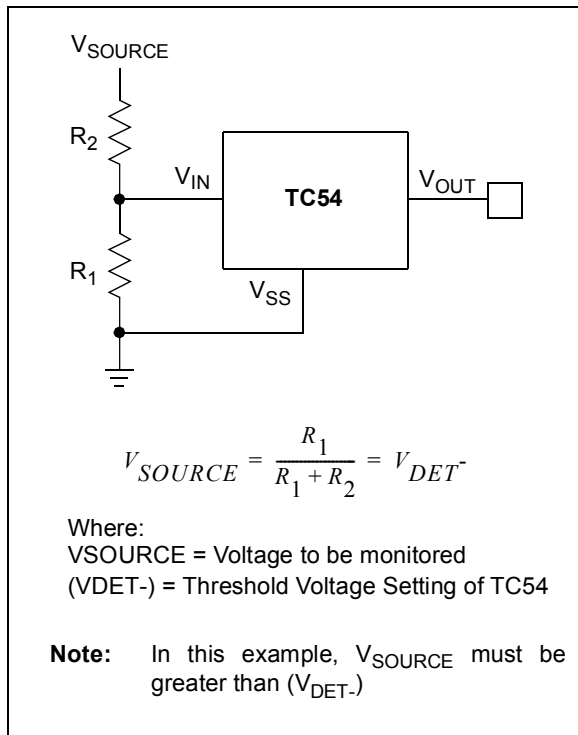


FIGURE 4-1: Modify trip-point of the TC54 using external resistor divider.

4.2 Other Applications

Low operating power and small physical size make the TC54 Series ideal for many voltage detector applications, such as those shown in Figures 4-2, 4-3 and 4-4. Figure 4-2 shows a low-voltage gate drive protection circuit that prevents overheating of the logic-level MOSFET due to insufficient gate voltage. When the input signal is below the threshold of the TC54VN, its output grounds the gate of the MOSFET. Figure 4-3 and Figure 4-4 show the TC54 in conventional voltage monitoring applications.

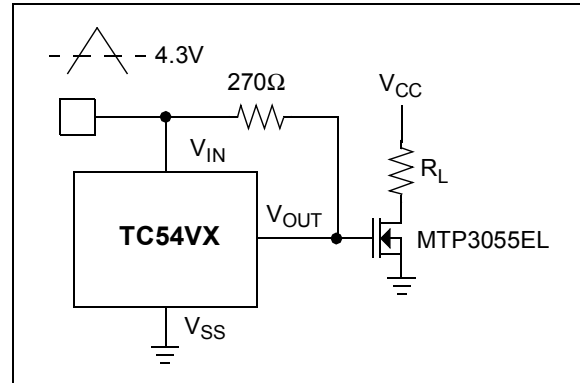


FIGURE 4-2: MOSFET Low Drive Protection.

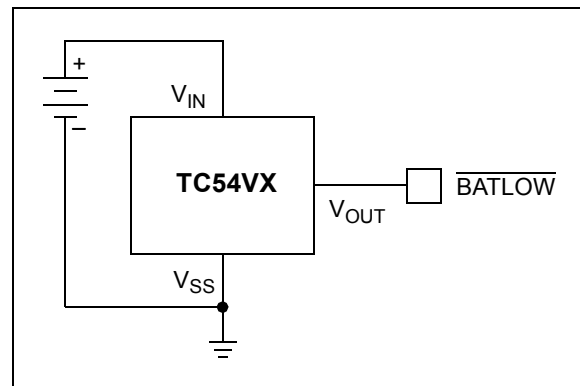


FIGURE 4-3: Battery Voltage Monitor.

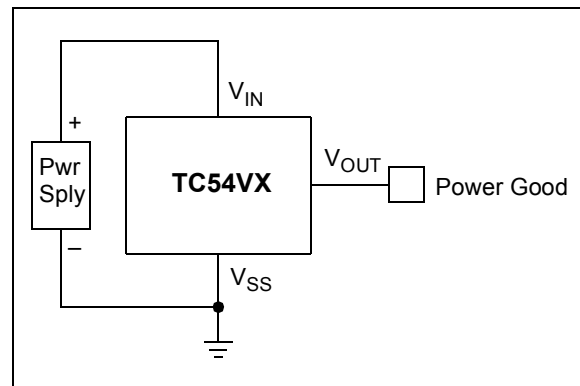
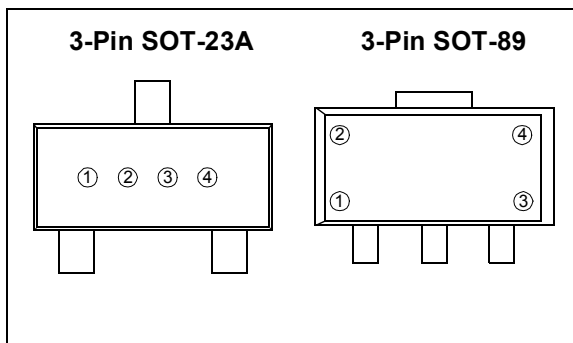


FIGURE 4-4: Power Good Monitor.

5.0 PACKAGING INFORMATION

5.1 Package Marking Information



① represents output configuration (CMOS or Nch) and first integer of voltage

Ex: CMOS 3.x = ① ○ ○ ○

Symbol	Output	Voltage
B	CMOS	1.
C	CMOS	2.
D	CMOS	3.
E	CMOS	4.
F	CMOS	5.
H	CMOS	6.
I	CMOS	7.

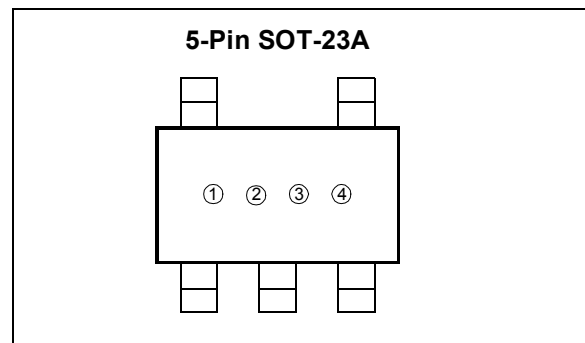
Symbol	Output	Voltage
L	Nch	1.
M	Nch	2.
N	Nch	3.
P	Nch	4.
R	Nch	5.
S	Nch	6.
T	Nch	7.

② represents first decimal of output voltage (0-9)

Ex: CMOS 3.x = ① ④ ○ ○

Symbol	Voltage	Symbol	Voltage
0	.0	6	.6
1	.1	7	.7
2	.2	8	.8
3	.3	9	.9
4	.4		
5	.5		

③ & ④ represents assembly lot code



① represents output configuration and first integer of voltage

Symbol	Output	Voltage
T	Nch	7.

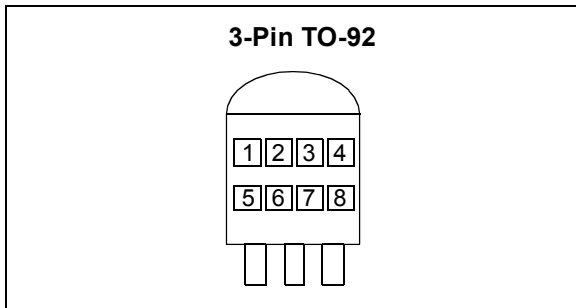
② represents first decimal of output voltage

Symbol	Voltage
0	.0
1	.1
2	.2
3	.3
4	.4
5	.5
6	.6
7	.7
8	.8
9	.9

③ & ④ represents assembly lot code

TC54

Package Marking Information (Continued)



①, ②, & ③ = 54X (fixed)

④ represents output configuration (CMOS or Nch)
Ex: CMOS 3.x = ○○○○

Symbol	Output
C	CMOS
N	N-Channel

⑤ represents first integer of detect voltage

Symbol	Voltage
2	2.
3	3.
4	4.
5	5.
6	6.

⑥ represents first decimal of detect voltage

Symbol	Voltage	Symbol	Voltage
0	.0	5	.5
1	.1	6	.6
2	.2	7	.7
3	.3	8	.8
4	.4	9	.9

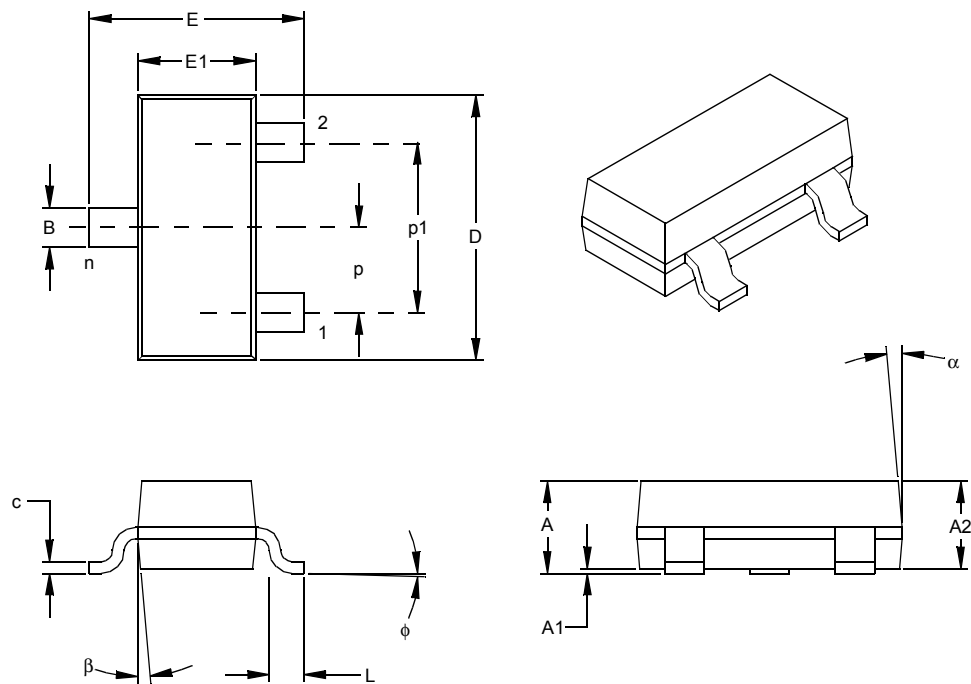
⑦ represents the output Delay Time

Symbol	Delay Time
0	No Delay

⑧ represents the device accuracy

Symbol	Accuracy
1	±1.0% (custom)
2	±2.0% (standard)

3-Lead Plastic Small Outline Transistor (CB) (SOT23)



Units		INCHES*			MILLIMETERS		
Dimension	Limits	MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		3			3	
Pitch	p		.038			0.96	
Outside lead pitch (basic)	p1		.076			1.92	
Overall Height	A	.035	.040	.044	0.89	1.01	1.12
Molded Package Thickness	A2	.035	.037	.040	0.88	0.95	1.02
Standoff §	A1	.000	.002	.004	0.01	0.06	0.10
Overall Width	E	.083	.093	.104	2.10	2.37	2.64
Molded Package Width	E1	.047	.051	.055	1.20	1.30	1.40
Overall Length	D	.110	.115	.120	2.80	2.92	3.04
Foot Length	L	.014	.018	.022	0.35	0.45	0.55
Foot Angle	φ	0	5	10	0	5	10
Lead Thickness	c	.004	.006	.007	0.09	0.14	0.18
Lead Width	B	.015	.017	.020	0.37	0.44	0.51
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* Controlling Parameter
 § Significant Characteristic

Notes:

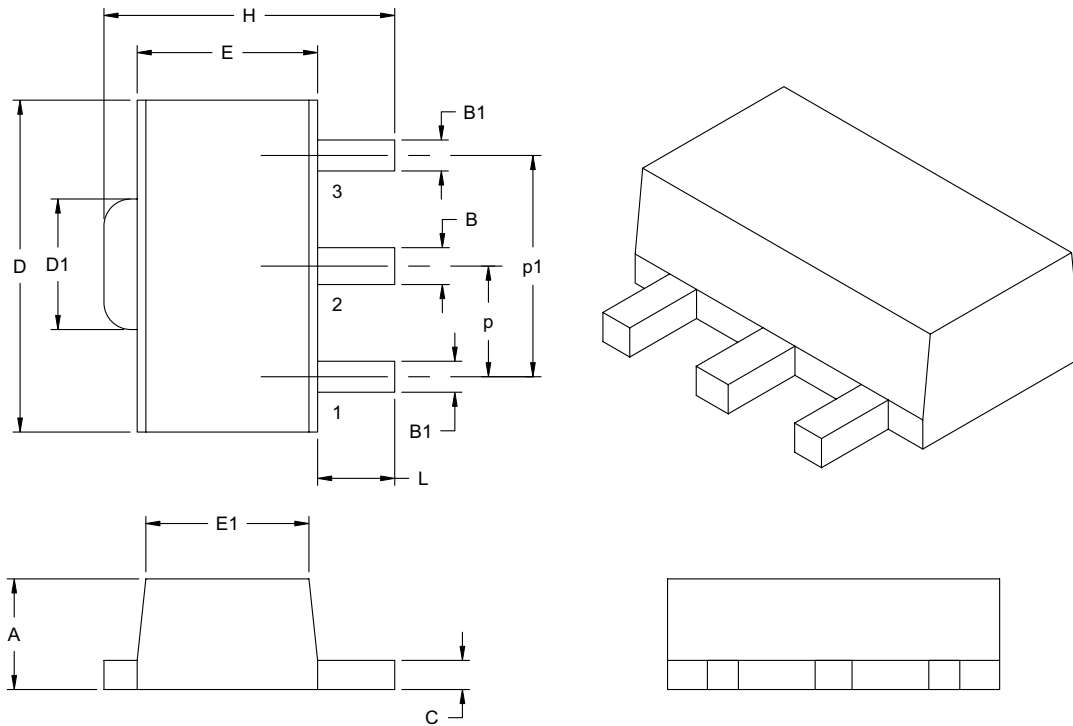
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: TO-236

Drawing No. C04-104

TC54

3-Lead Plastic Small Outline Transistor (MB) (SOT89)



Dimension Limits	Units	INCHES		MILLIMETERS*	
		MIN	MAX	MIN	MAX
Pitch	P	.059 BSC		1.50 BSC	
Outside lead pitch (basic)	p1	.118 BSC		3.00 BSC	
Overall Height	A	.055	.063	1.40	1.60
Overall Width	H	.155	.167	3.94	4.25
Molded Package Width at Base	E	.090	.102	2.29	2.60
Molded Package Width at Top	E1	.084	.090	2.13	2.29
Overall Length	D	.173	.181	4.40	4.60
Tab Length	D1	.064	.072	1.62	1.83
Foot Length	L	.035	.047	0.89	1.20
Lead Thickness	c	.014	.017	0.35	0.44
Lead 2 Width	B	.017	.022	0.44	0.56
Leads 1 & 3 Width	B1	.014	.019	0.36	0.48

*Controlling Parameter

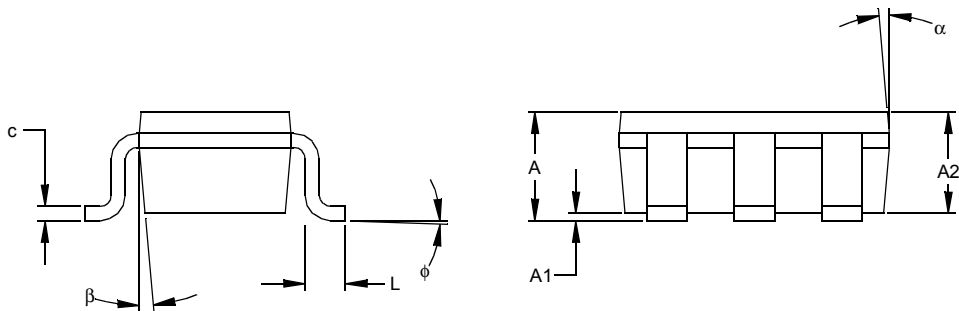
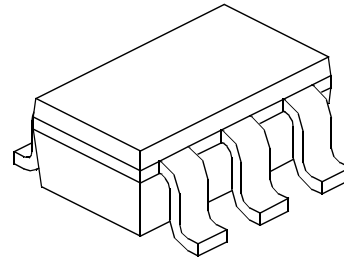
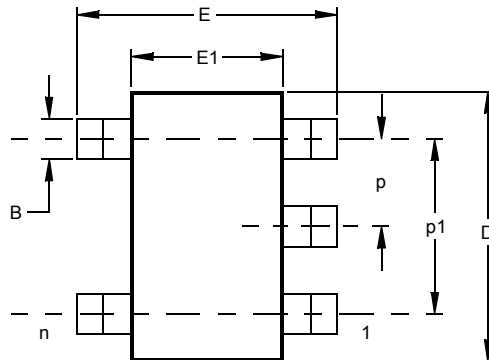
Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" (0.127mm) per side.

JEDEC Equivalent: TO-243

Drawing No. C04-29

5-Lead Plastic Small Outline Transistor (CT) (SOT23)



Units		INCHES*			MILLIMETERS		
Dimension	Limits	MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		5			5	
Pitch	p		.038			0.95	
Outside lead pitch (basic)	p1		.075			1.90	
Overall Height	A	.035	.046	.057	0.90	1.18	1.45
Molded Package Thickness	A2	.035	.043	.051	0.90	1.10	1.30
Standoff §	A1	.000	.003	.006	0.00	0.08	0.15
Overall Width	E	.102	.110	.118	2.60	2.80	3.00
Molded Package Width	E1	.059	.064	.069	1.50	1.63	1.75
Overall Length	D	.110	.116	.122	2.80	2.95	3.10
Foot Length	L	.014	.018	.022	0.35	0.45	0.55
Foot Angle	φ	0	5	10	0	5	10
Lead Thickness	c	.004	.006	.008	0.09	0.15	0.20
Lead Width	B	.014	.017	.020	0.35	0.43	0.50
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* Controlling Parameter
 § Significant Characteristic

Notes:

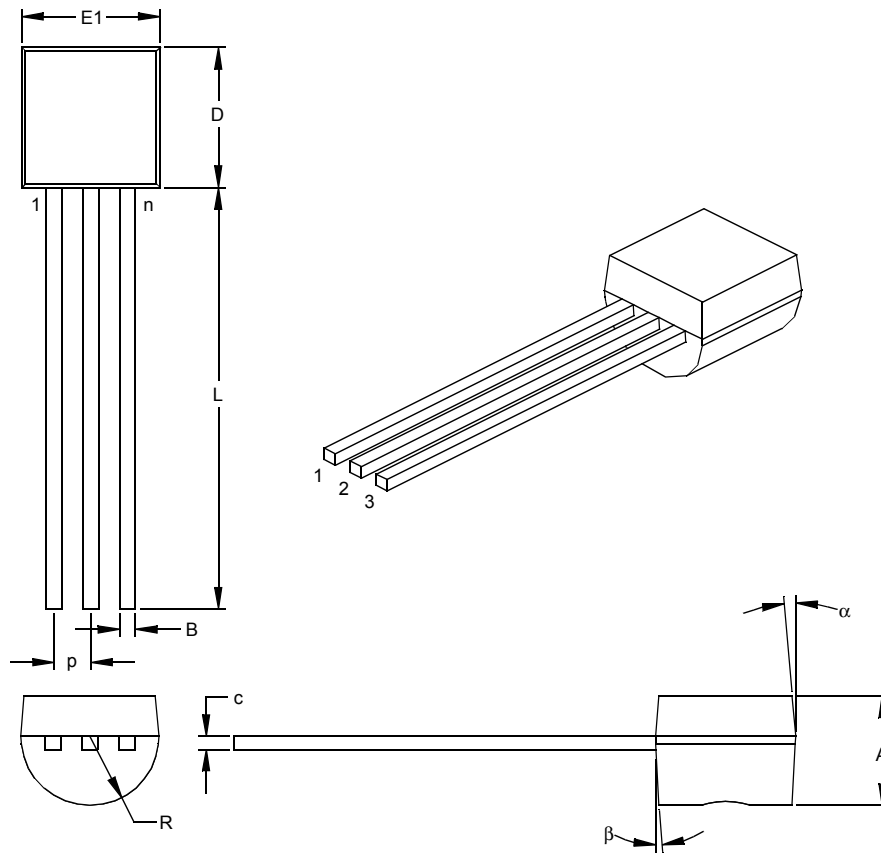
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MO-178

Drawing No. C04-091

TC54

3-Lead Plastic Transistor Outline (ZB) (TO-92)



Dimension Limits	Units	INCHES*			MILLIMETERS		
		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		3			3	
Pitch	p		.050			1.27	
Bottom to Package Flat	A	.130	.143	.155	3.30	3.62	3.94
Overall Width	E1	.175	.186	.195	4.45	4.71	4.95
Overall Length	D	.170	.183	.195	4.32	4.64	4.95
Molded Package Radius	R	.085	.090	.095	2.16	2.29	2.41
Tip to Seating Plane	L	.500	.555	.610	12.70	14.10	15.49
Lead Thickness	c	.014	.017	.020	0.36	0.43	0.51
Lead Width	B	.016	.019	.022	0.41	0.48	0.56
Mold Draft Angle Top	α	4	5	6	4	5	6
Mold Draft Angle Bottom	β	2	3	4	2	3	4

*Controlling Parameter

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: TO-92

Drawing No. C04-101

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<u>PART NO.</u>	X	XX	X	X	X	XX	XX	Examples:
Device	Output Config.	Detected Voltage	Extra Feature Code	Tolerance	Temp.	Pkg	Taping Direction	
Device:	TC54V:	Voltage Detector						a) TC54VC1402ECB713: 1.4V Voltage Detector, 2% Tol., SOT-23A-3-TR.
Output Configuration:	N	= Nch Open-Drain						b) TC54VC1402EMB713: 1.4V Voltage Detector, 2% Tol., SOT-89-3-TR.
	C	= CMOS Output						c) TC54VC1402EZB: 1.4V Voltage Detector, 2% Tol., TO-92.
Detected Voltage:	14	= 1.4V						d) TC54VC2102ECB713: 2.1V Voltage Detector, 2% Tolerance, SOT-23A-3-TR.
	21	= 2.1V						e) TC54VC2102EMB713: 2.1V Voltage Detector, 2% Tolerance, SOT-89-3-TR.
	27	= 2.7V						f) TC54VC2102EZB: 2.1V Voltage Detector, 2% Tolerance, TO-92.
	29	= 2.9V						g) TC54VC2702ECB713: 2.7V Voltage Detector, 2% Tolerance, SOT-23A-3-TR.
	30	= 3.0V						h) TC54VC3002ECB713: 3.0V Voltage Detector, 2% Tolerance, SOT-23A-3-TR.
	42	= 4.2V						i) TC54VN4202ECB713: 4.2V Voltage Detector, 2% Tolerance, SOT-23A-3-TR.
	43	= 4.3V						j) TC54VN7702ECT713: 7.7V Voltage Detector, 2% Tolerance, SOT-23A-3-TR.
Extra Feature Code:	0	= Fixed						
Tolerance:	1	= 1% (custom)						
	2	= 2% (standard)						
Temperature:	E	= -40°C to +85°C						
Package:	CB	= 3-Pin SOT-23A (equivalent to EIAJ SC-59)						
	MB	= 3-Pin SOT-89						
	CT	= 5-Pin SOT-23A (equivalent to EIAJ SC-74A) (7.7V ONLY)						
	ZB	= Transistor Outline (TO-92), 3-lead						
Taping Direction:	713	= Standard Taping						

Sales and Support

Data Sheets

Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

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TC54

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- Microchip is willing to work with the customer who is concerned about the integrity of their code.
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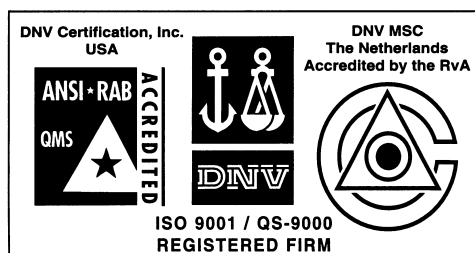
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WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office

2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: <http://www.microchip.com>

Atlanta

3780 Mansell Road, Suite 130
Alpharetta, GA 30022
Tel: 770-640-0034 Fax: 770-640-0307

Boston

2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago

333 Pierce Road, Suite 180
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Dallas

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Detroit

Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
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Tel: 248-538-2250 Fax: 248-538-2260

Kokomo

2767 S. Albright Road
Kokomo, IN 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles

18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

Phoenix

2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-4338

San Jose

Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto

6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC

Australia

Microchip Technology Australia Pty Ltd
Marketing Support Division
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing

Microchip Technology Consulting (Shanghai)
Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu

Microchip Technology Consulting (Shanghai)
Co., Ltd., Chengdu Liaison Office
Rm. 2401-2402, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-86766200 Fax: 86-28-86766599

China - Fuzhou

Microchip Technology Consulting (Shanghai)
Co., Ltd., Fuzhou Liaison Office
Unit 28F, World Trade Plaza
No. 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Hong Kong SAR

Microchip Technology Hongkong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

China - Shanghai

Microchip Technology Consulting (Shanghai)
Co., Ltd.
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

China - Shenzhen

Microchip Technology Consulting (Shanghai)
Co., Ltd., Shenzhen Liaison Office
Rm. 1812, 18/F, Building A, United Plaza
No. 5022 Binhe Road, Futian District
Shenzhen 518033, China
Tel: 86-755-82901380 Fax: 86-755-82966626

China - Qingdao

Rm. B505A, Fullhope Plaza,
No. 12 Hong Kong Central Rd.
Qingdao 266071, China
Tel: 86-532-5027355 Fax: 86-532-5027205

India

Microchip Technology Inc.
India Liaison Office
Marketing Support Division
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaughnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan

Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471-6166 Fax: 81-45-471-6122

Korea

Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore

Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-6334-8870 Fax: 65-6334-8850

Taiwan

Microchip Technology (Barbados) Inc.,
Taiwan Branch
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Austria

Microchip Technology Austria GmbH
Durisolstrasse 2
A-4600 Wels
Austria
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark

Microchip Technology Nordic ApS
Regus Business Centre
Lautrup høj 1-3
Ballerup DK-2750 Denmark
Tel: 45-4420-9895 Fax: 45-4420-9910

France

Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - ler Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany

Microchip Technology GmbH
Steinheilstrasse 10
D-85737 Ismaning, Germany
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy

Microchip Technology SRL
Via Quasimodo, 12
20025 Legnano (MI)
Milan, Italy
Tel: 39-0331-742611 Fax: 39-0331-466781

United Kingdom

Microchip Ltd.
505 Eskdale Road
Winkersley Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44-118-921-5869 Fax: 44-118-921-5820

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