

Voltage Detector

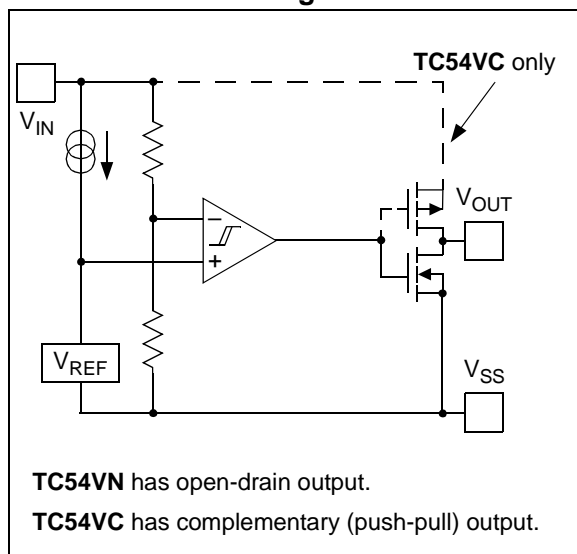
Features:

- $\pm 2.0\%$ Detection Thresholds
- Small Packages: 3-Pin SOT-23A, SOT-89, and TO-92
- Low Current Drain: 1 μA , typical
- Wide Detection Range: 1.1V to 6.0V
- 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

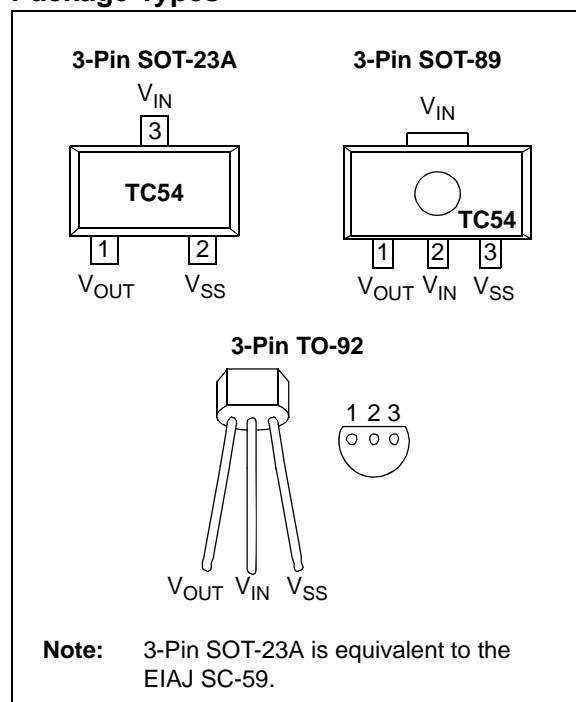


General Description:

The TC54 series are CMOS voltage detectors especially well-suited for battery-powered applications because of their extremely low 1 μA 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 6.0V with a 2% tolerance.

The TC54 is available with either an open-drain or complementary output stage. During operation, the 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} , when it resets to a logic-high state.

Package Types



Device Features

Device	Output		Reset Delay	Std. Trip Points ⁽¹⁾ (typical)
	Type	State		
TC54VN	Open-Drain	Active Low	No	1.4V, 2.1V, 2.7V, 2.9V
TC54VC	Push-Pull	Active Low	No	3.0V, 4.2V, 4.3V

Note 1: Custom Trip Points available. Minimum order requirement. Information available upon request.

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
3-Pin TO-92	300 mW
Operating Temperature Range.....	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C

† **Notice:** 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.

DC CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T _A = +25°C.						
Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions
Operating Voltage	V _{IN}	0.7	—	10.0	V	(V _{DET-}) ≥ 1.6V
		0.7	—	6.0	V	(V _{DET-}) < 1.6V
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
		N.M.-2%	N.M.	N.M.+2%		TC54VXNM (Note 2)
Hysteresis Voltage	V _{HYST}	28	70	112	mV	V _{DET} = 1.4V (typical)
		42	105	168		V _{DET} = 2.1V (typical)
		54	135	216		V _{DET} = 2.7V (typical)
		58	145	232		V _{DET} = 2.9V (typical)
		60	150	240		V _{DET} = 3.0V (typical)
		84	210	336		V _{DET} = 4.2V (typical)
		86	215	344		V _{DET} = 4.3V (typical)
		Q-60%	Q	Q+60%		V _{DET} = (20*Q)V (typical) (Note 2)
Output Current	I _{OUT}	3.0	7.7	—	mA	V _{OL} = 0.5V, V _{IN} = 2.0V
		5.0	10.1	—		V _{OL} = 0.5V, V _{IN} = 3.0V
		6.0	11.5	—		V _{OL} = 0.5V, V _{IN} = 4.0V
		7.0	13.0	—		V _{OL} = 0.5V, V _{IN} = 5.0V
		—	-10.0	-2.0		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.

2: Represents all other custom Threshold Voltage options.

TEMPERATURE SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, all limits are specified for: $V_{DD} = +1.8V$ to $+5.5V$, $V_{SS} = GND$.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Temperature Range	T_A	-40	—	+85	°C	
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 3L-SOT-23A	θ_{JA}	—	308	—	°C/W	
Thermal Resistance, 3L-SOT-89	θ_{JA}	—	131.7	—	°C/W	
Thermal Resistance, 3L-TO-92	θ_{JA}	—	146	—	°C/W	

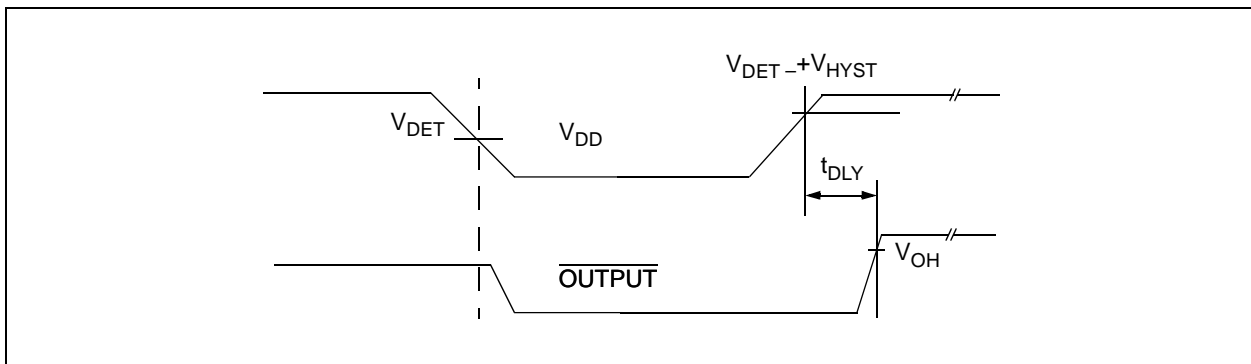


FIGURE 1-1: Timing Diagram.

TC54

2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 2-1](#).

TABLE 2-1: PIN FUNCTION TABLE

TC54			Symbol	Description
SOT-23A	SOT-89	TO-92		
1	1	1	V_{OUT}	Digital Output
3	2	2	V_{IN}	Analog Input
2	3	3	V_{SS}	Ground Terminal
—	Tab	—	V_{IN}	Analog Input

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](#)).

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.

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 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} . When 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 the input rises above V_{DET+} , the output will assume its Inactive state (high for TC54VC, open-drain for TC54VN).

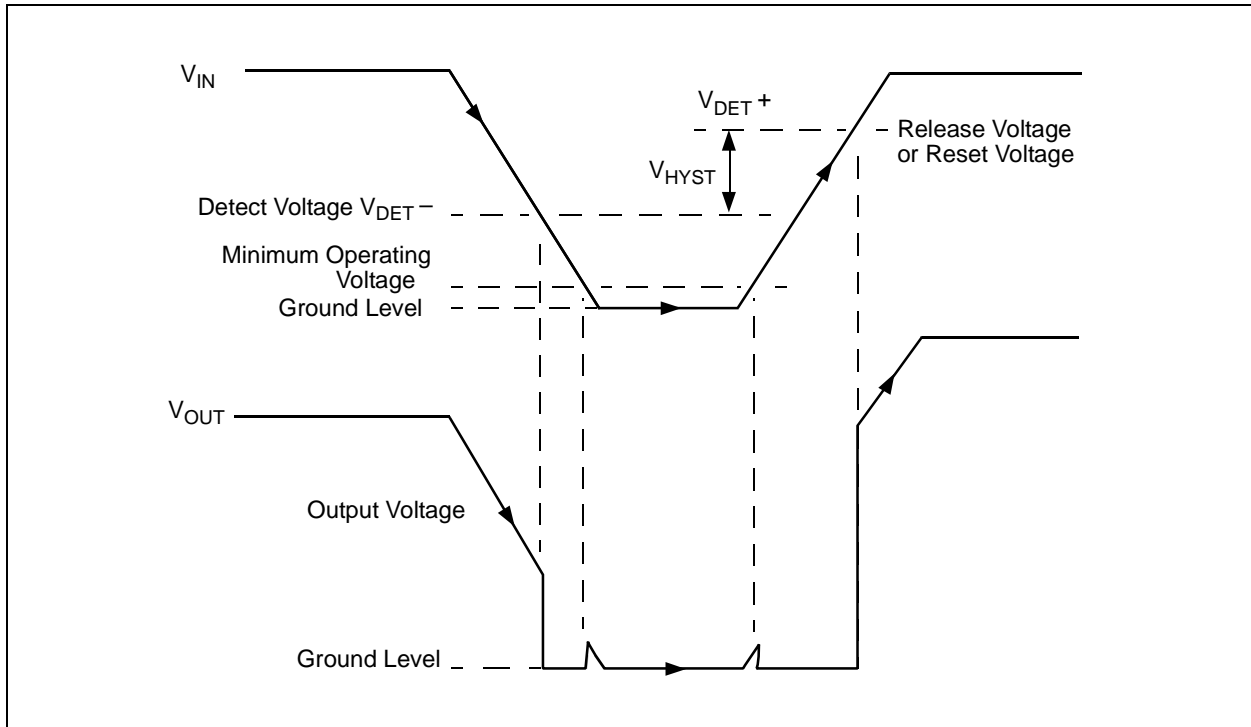


FIGURE 3-1: Timing Diagram.

TC54

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.

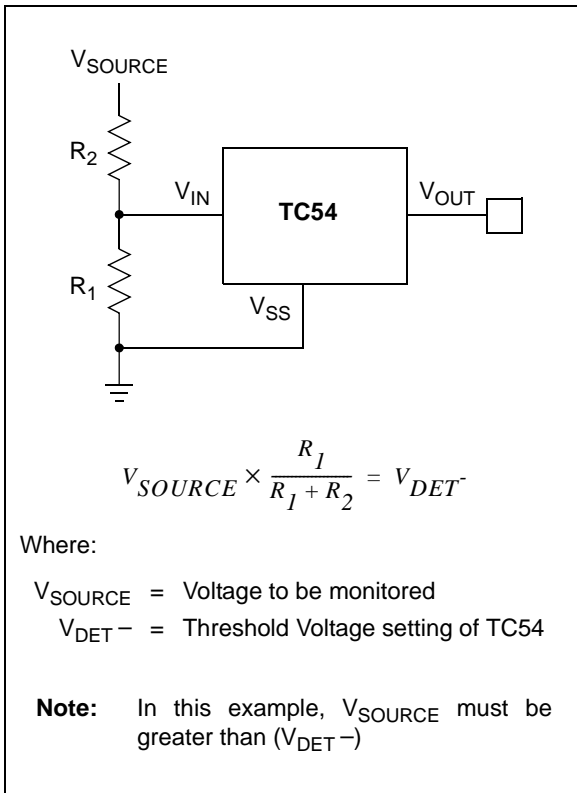


FIGURE 4-1: Modify Trip-point of the TC54 using External Resistor Divider.

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 the 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.

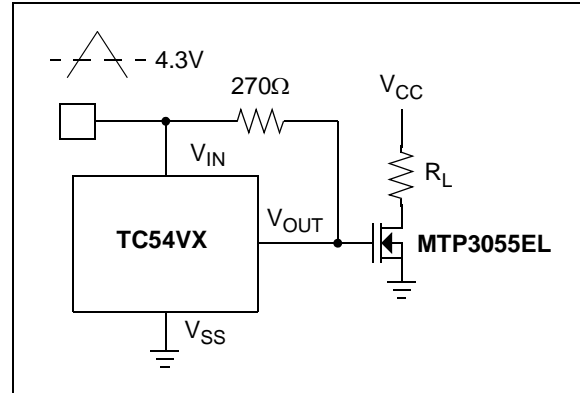


FIGURE 4-2: MOSFET Low Drive Protection.

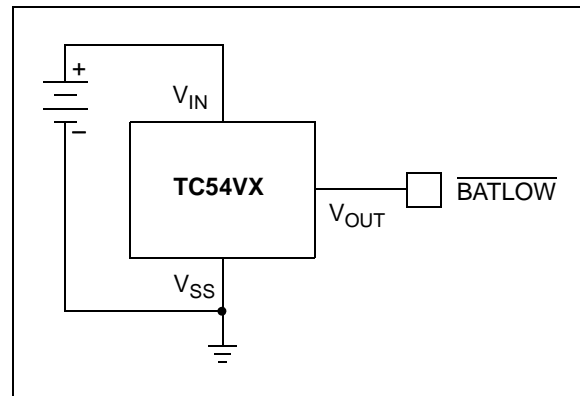


FIGURE 4-3: Battery Voltage Monitor.

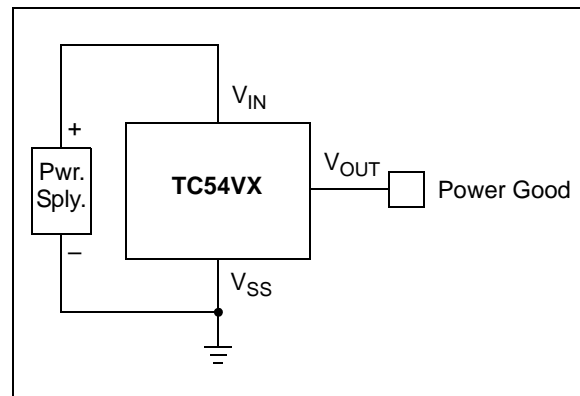
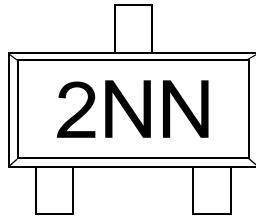


FIGURE 4-4: Power Good Monitor.

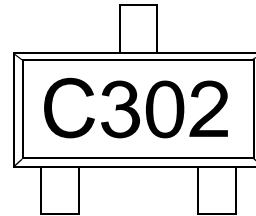
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

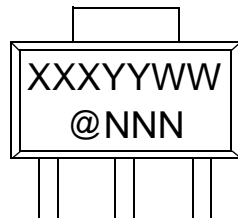
3-Lead SOT-23A



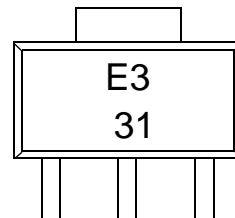
Example



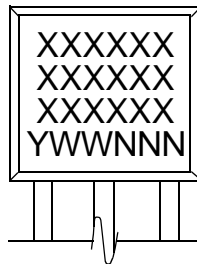
3-Lead SOT-89



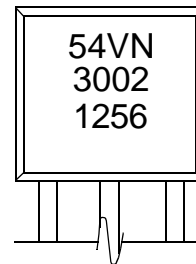
Example



3-Lead TO-92

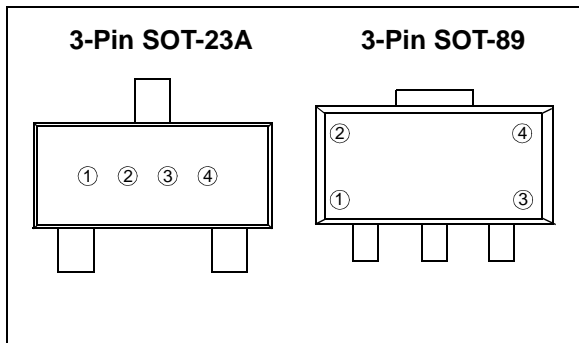


Example



Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.
Note:	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.	

TC54



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.

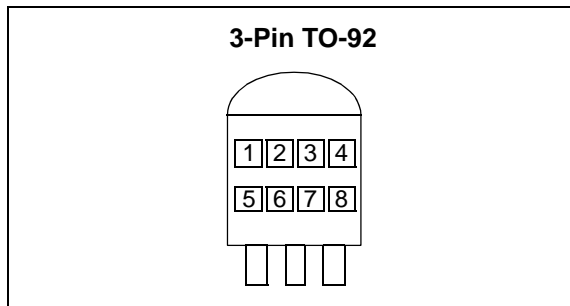
Symbol	Output	Voltage
L	N-Channel	1.
M	N-Channel	2.
N	N-Channel	3.
P	N-Channel	4.
R	N-Channel	5.
S	N-Channel	6.
T	N-Channel	7.

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

Ex: CMOS 3.x = ① ② ○ ○ ○

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 and ④ represent assembly lot code



①, ② and ③ = 54X (fixed)

④ represents output configuration (CMOS or N-Ch)

Ex: CMOS 3.x = ④ ○ ○ ○ ○

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

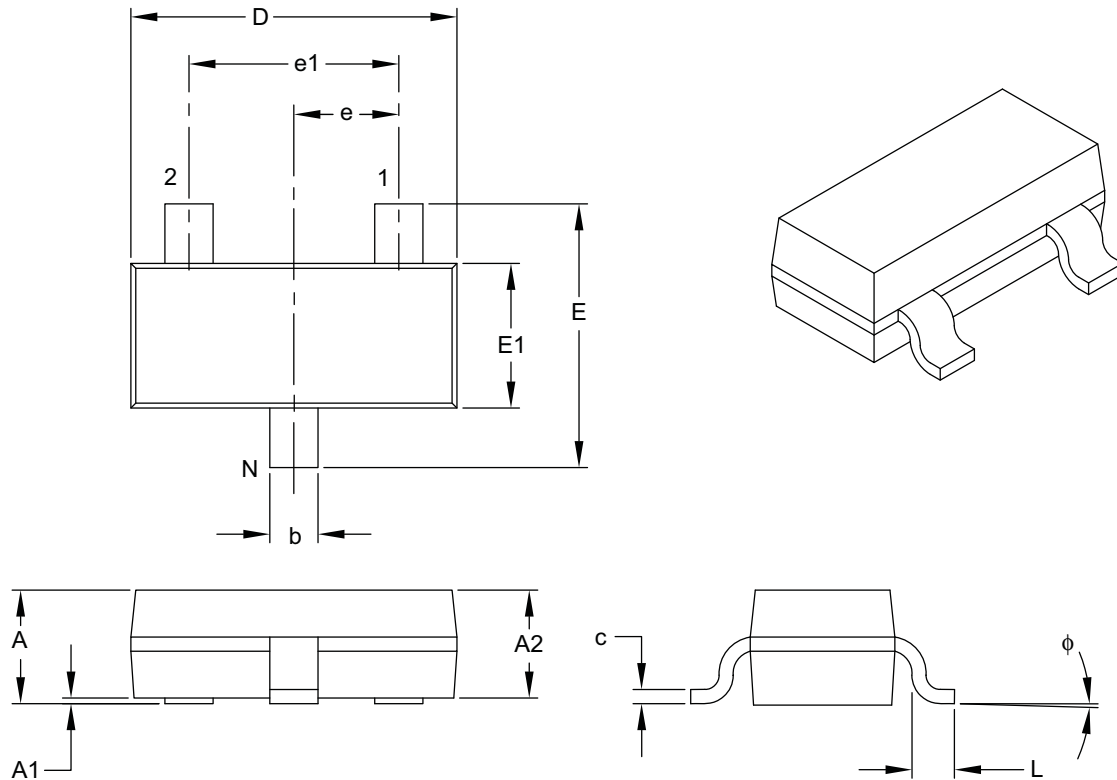
Symbol	Delay Time
0	No Delay

⑧ represents the device accuracy

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

3-Lead Plastic Small Outline Transistor (CB) [SOT-23A]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Pins	N	3		
Lead Pitch	e	0.95 BSC		
Outside Lead Pitch	e1	1.90 BSC		
Overall Height	A	0.89	-	1.45
Molded Package Thickness	A2	0.90	-	1.30
Standoff	A1	0.00	-	0.15
Overall Width	E	2.10	-	3.00
Molded Package Width	E1	1.20	-	1.80
Overall Length	D	2.70	-	3.10
Foot Length	L	0.15	-	0.60
Foot Angle	ϕ	0°	-	30°
Lead Thickness	c	0.09	-	0.26
Lead Width	b	0.30	-	0.51

Notes:

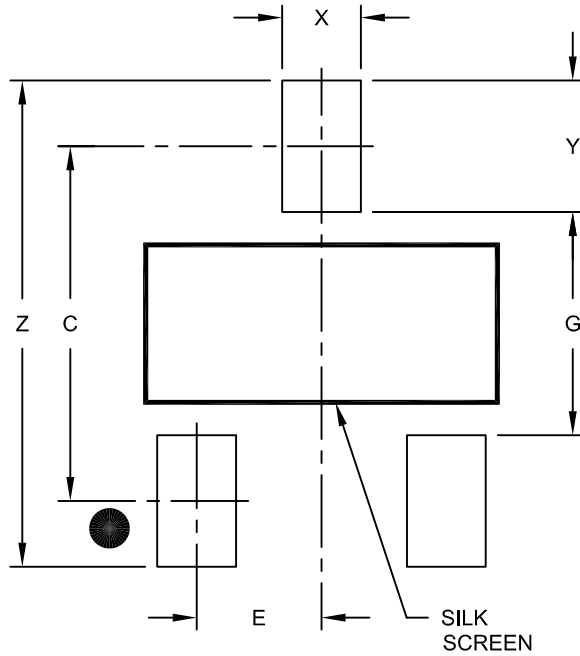
- Dimensions D and $E1$ do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.127 mm per side.
- Dimensioning and tolerancing per ASME Y14.5M.
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-130B

TC54

3-Lead Plastic Small Outline Transistor (CB) [SOT-23A]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.95 BSC		
Contact Pad Spacing	C		2.70	
Contact Pad Width (X3)	X			0.60
Contact Pad Length (X3)	Y			1.00
Distance Between Pads	G	1.70		
Overall Width	Z			3.70

Notes:

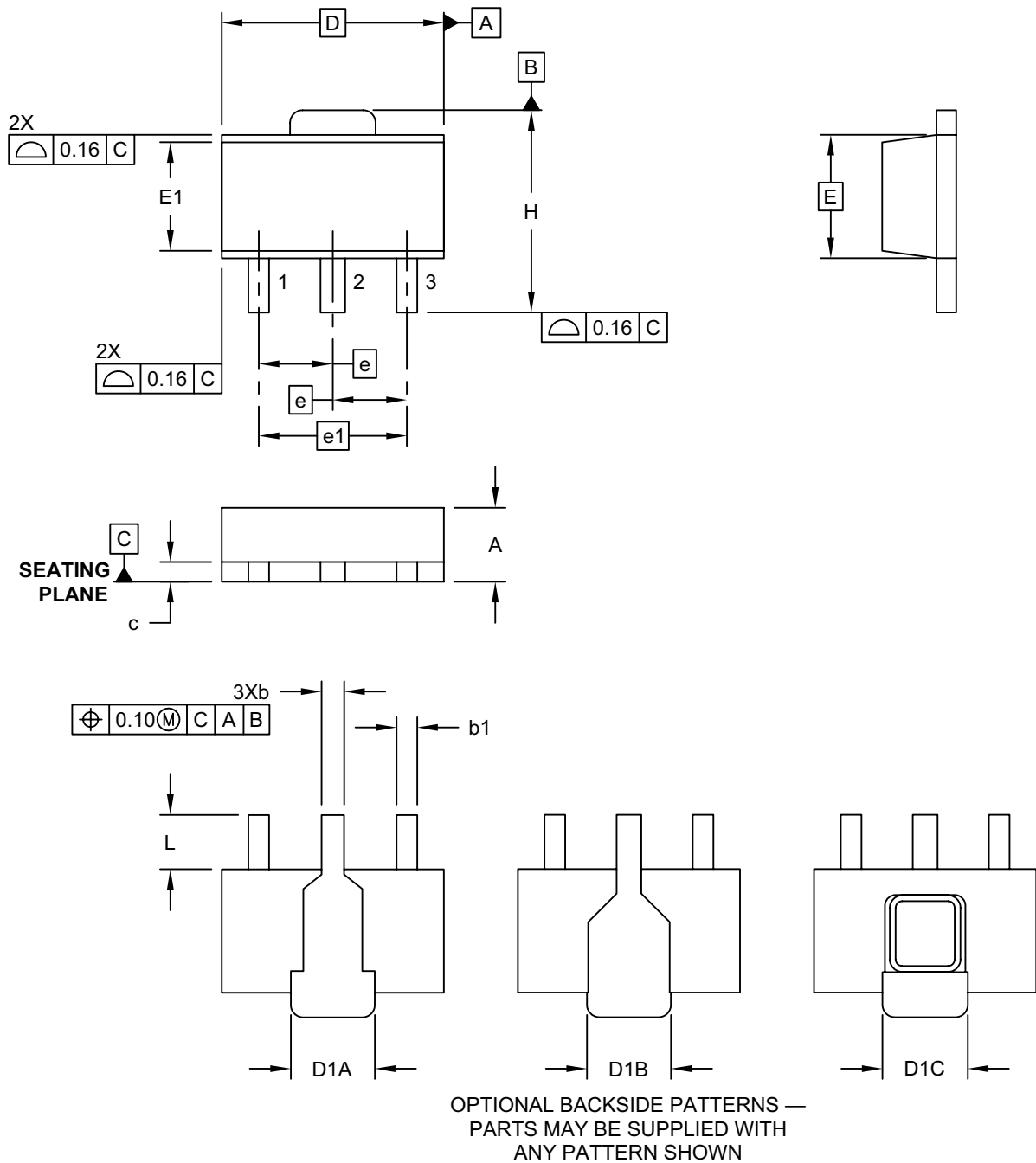
1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2130A

3-Lead Plastic Small Outline Transistor (MB) - [SOT-89]

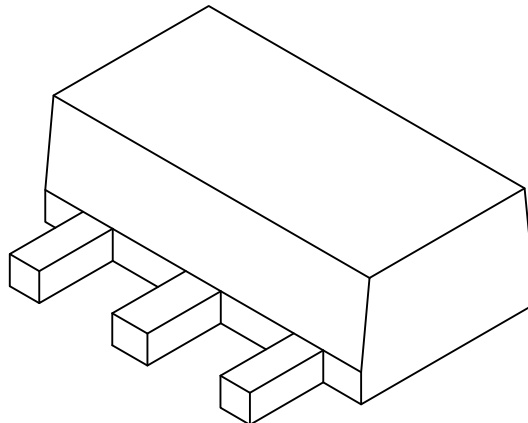
Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-029C Sheet 1 of 2

3-Lead Plastic Small Outline Transistor (MB) - [SOT-89]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Leads	N	3		
Pitch	e	1.50 BSC		
Outside Lead Pitch	e1	3.00 BSC		
Overall Height	A	1.40	1.50	1.60
Overall Width	H	3.94	4.10	4.25
Molded Package Width at Base	E	2.50 BSC		
Molded Package Width at Top	E1	2.13	2.20	2.29
Overall Length	D	4.50 BSC		
Tab Length (Option A)	D1A	1.63	1.73	1.83
Tab Length (Option B)	D1B	1.40	1.60	1.75
Tab Length (Option C)	D1C	1.62	1.73	1.83
Foot Length	L	0.79	1.10	1.20
Lead Thickness	c	0.35	0.40	0.44
Lead 2 Width	b	0.41	0.50	0.56
Leads 1 & 3 Width	b1	0.36	0.42	0.48

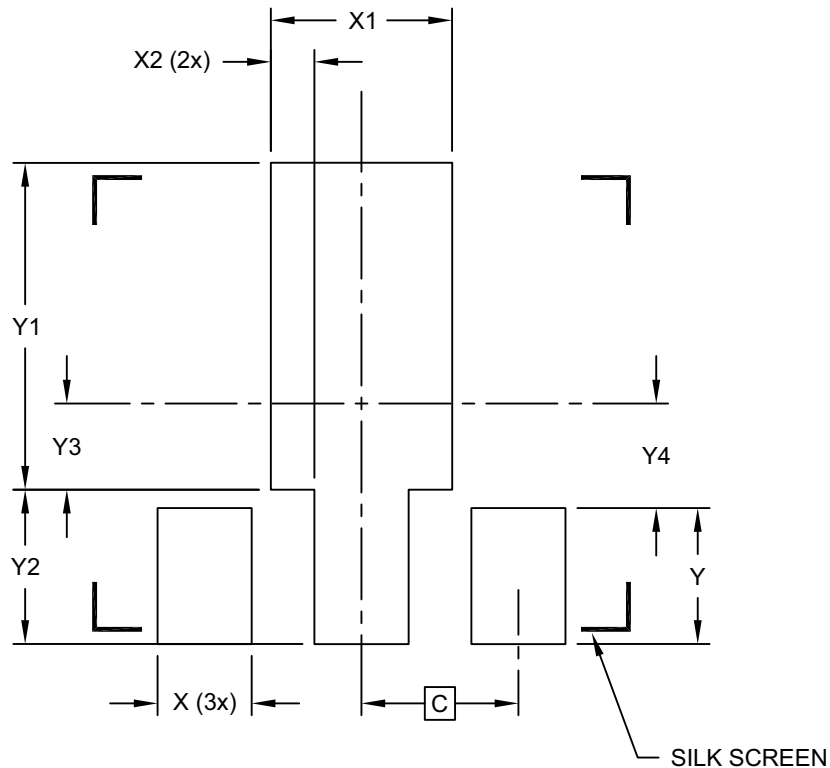
Notes:

- Dimensions D and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.127mm per side.
- Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-029C Sheet 2 of 2

3-Lead Plastic Small Outline Transistor (MB) - [SOT-89]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



RECOMMENDED LAND PATTERN

Units	MILLIMETERS		
	MIN	NOM	MAX
Dimension Limits			
C		1.50 (BSC)	
X		0.900	
X1		1.733	
X2		0.416	
Y		1.300	
Y1		4.600	
Y2		1.475	
Y3		0.950	
Y4		1.125	

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

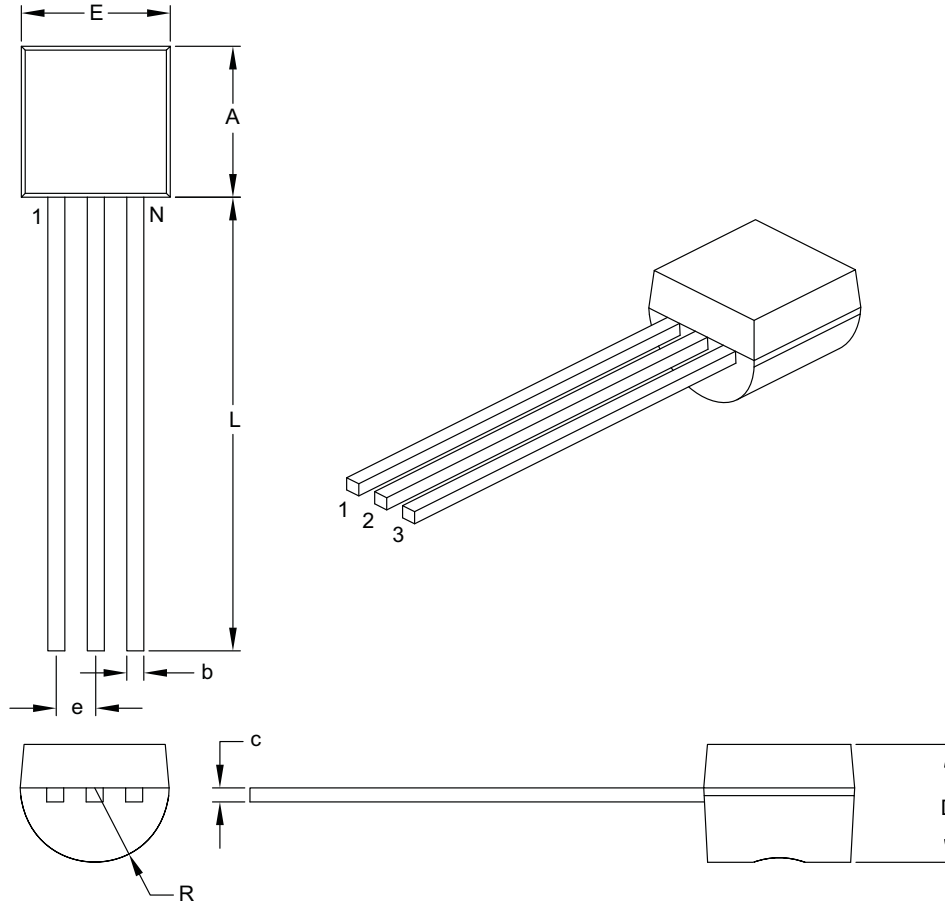
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2029B

TC54

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

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Dimension Limits	Units	INCHES	
		MIN	MAX
Number of Pins	N	3	
Pitch	e	.050 BSC	
Bottom to Package Flat	D	.125	.165
Overall Width	E	.175	.205
Overall Length	A	.170	.210
Molded Package Radius	R	.080	.105
Tip to Seating Plane	L	.500	-
Lead Thickness	c	.014	.021
Lead Width	b	.014	.022

Notes:

- Dimensions A and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" per side.
- Dimensioning and tolerancing per ASME Y14.5M.
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-101B

APPENDIX A: REVISION HISTORY

Revision K (July 2014)

The following is the list of modifications:

1. Updated the “[DC Characteristics](#)” table.

Revision J (June 2011)

The following is the list of modifications:

1. Updated temperature values in the “[Temperature Specifications](#)” table.
2. Corrected equation in [Figure 4-1](#).
3. Added new examples layout in [Section 5.1, Package Marking Information](#).

Revision H (December 2007)

The following is the list of modifications:

1. Updated Features section.
2. Removed 5-Pin SOT-23 related information.
3. Updated Output Current (I_{OUT}) Electrical Specification.
4. Removed 7.7V (typical) Voltage Trip Point Option. Max Trip Point Voltage is now 6.0V.
5. Updated Pin Function Table.
6. Updated Packaging Specification Information.
7. Added Revision History section.
8. Updated Product Identification System page.

Revision G (August 2004)

Undocumented changes.

Revision F (July 2004)

Undocumented changes.

Revision E (April 2003)

Undocumented changes.

Revision D (October 2002)

Undocumented changes.

Revision C (July 2002)

Undocumented changes.

Revision B (May 2002)

Undocumented changes.

Revision A (March 2001)

Original Release of this Document.

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																																																																																																																																																										
<table border="1"> <tr> <td>Device:</td> <td colspan="2">TC54V: Voltage Detector</td> <td colspan="6"></td> </tr> <tr> <td>Output Configuration:</td> <td>N</td> <td>=</td> <td>N-Channel Open-Drain</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>C</td> <td>=</td> <td>CMOS Output</td> <td colspan="5"></td> </tr> <tr> <td>Detected Voltage:</td> <td>14</td> <td>=</td> <td>1.4V</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>21</td> <td>=</td> <td>2.1V</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>27</td> <td>=</td> <td>2.7V</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>29</td> <td>=</td> <td>2.9V</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>30</td> <td>=</td> <td>3.0V</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>42</td> <td>=</td> <td>4.2V</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>43</td> <td>=</td> <td>4.3V</td> <td colspan="5"></td> </tr> <tr> <td>Extra Feature Code:</td> <td>0</td> <td>=</td> <td>Fixed</td> <td colspan="5"></td> </tr> <tr> <td>Tolerance:</td> <td>2</td> <td>=</td> <td>2%</td> <td colspan="5"></td> </tr> <tr> <td>Temperature:</td> <td>E</td> <td>=</td> <td>-40°C to +85°C</td> <td colspan="5"></td> </tr> <tr> <td>Package:</td> <td>CB</td> <td>=</td> <td>Plastic Small Outline Transistor, SOT-23A, 3-lead</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>MB</td> <td>=</td> <td>Plastic Small Outline Transistor, SOT-89, 3-lead</td> <td colspan="5"></td> </tr> <tr> <td></td> <td>ZB</td> <td>=</td> <td>Plastic Transistor Outline, TO-92, 3-lead</td> <td colspan="5"></td> </tr> <tr> <td>Taping Direction:</td> <td>713</td> <td>=</td> <td>Standard Taping</td> <td colspan="5"></td> </tr> </table>									Device:	TC54V: Voltage Detector								Output Configuration:	N	=	N-Channel Open-Drain							C	=	CMOS Output						Detected Voltage:	14	=	1.4V							21	=	2.1V							27	=	2.7V							29	=	2.9V							30	=	3.0V							42	=	4.2V							43	=	4.3V						Extra Feature Code:	0	=	Fixed						Tolerance:	2	=	2%						Temperature:	E	=	-40°C to +85°C						Package:	CB	=	Plastic Small Outline Transistor, SOT-23A, 3-lead							MB	=	Plastic Small Outline Transistor, SOT-89, 3-lead							ZB	=	Plastic Transistor Outline, TO-92, 3-lead						Taping Direction:	713	=	Standard Taping					
Device:	TC54V: Voltage Detector																																																																																																																																																																
Output Configuration:	N	=	N-Channel Open-Drain																																																																																																																																																														
	C	=	CMOS Output																																																																																																																																																														
Detected Voltage:	14	=	1.4V																																																																																																																																																														
	21	=	2.1V																																																																																																																																																														
	27	=	2.7V																																																																																																																																																														
	29	=	2.9V																																																																																																																																																														
	30	=	3.0V																																																																																																																																																														
	42	=	4.2V																																																																																																																																																														
	43	=	4.3V																																																																																																																																																														
Extra Feature Code:	0	=	Fixed																																																																																																																																																														
Tolerance:	2	=	2%																																																																																																																																																														
Temperature:	E	=	-40°C to +85°C																																																																																																																																																														
Package:	CB	=	Plastic Small Outline Transistor, SOT-23A, 3-lead																																																																																																																																																														
	MB	=	Plastic Small Outline Transistor, SOT-89, 3-lead																																																																																																																																																														
	ZB	=	Plastic Transistor Outline, TO-92, 3-lead																																																																																																																																																														
Taping Direction:	713	=	Standard Taping																																																																																																																																																														
a)	TC54VC1402ECB713:	Tape and Reel, 1.4V Voltage Detector, 2% Tol., SOT-23A-3																																																																																																																																																															
b)	TC54VC1402EMB713:	Tape and Reel, 1.4V Voltage Detector, 2% Tol., SOT-89-3																																																																																																																																																															
c)	TC54VC1402EZB:	1.4V Voltage Detector, 2% Tol., TO-92																																																																																																																																																															
d)	TC54VC2102ECB713:	Tape and Reel, 2.1V Voltage Detector, 2% Tol., SOT-23A-3																																																																																																																																																															
e)	TC54VC2102EMB713:	Tape and Reel, 2.1V Voltage Detector, 2% Tol., SOT-89-3																																																																																																																																																															
f)	TC54VC2102EZB:	2.1V Voltage Detector, 2% Tol., TO-92																																																																																																																																																															
g)	TC54VC2702ECB713:	Tape and Reel, 2.7V Voltage Detector, 2% Tol., SOT-23A-3																																																																																																																																																															
h)	TC54VC3002ECB713:	Tape and Reel, 3.0V Voltage Detector, 2% Tol., SOT-23A-3																																																																																																																																																															
i)	TC54VN4202ECB713:	Tape and Reel, 4.2V Voltage Detector, 2% Tol., SOT-23A-3																																																																																																																																																															

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, FlashFlex, flexPWR, JukeBlox, KEELOQ, KEELOQ logo, Klear, LANCheck, MediaLB, MOST, MOST logo, MPLAB, OptoLyzer, PIC, PICSTART, PIC³² logo, RightTouch, SpyNIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

The Embedded Control Solutions Company and mTouch are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, ECAN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, KlearNet, KlearNet logo, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, RightTouch logo, REAL ICE, SQI, Serial Quad I/O, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademarks of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2001-2014, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-63276-422-5

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949 ==

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC[®] MCUs and dsPIC[®] DSCs, KEELOQ[®] code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.



MICROCHIP

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:
<http://www.microchip.com/support>
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880-3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Pforzheim
Tel: 49-7231-424750

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

03/25/14

Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

- ⊖ [View TC54VN2002ECB713 on WIN SOURCE](#)
- ⊖ [Microchip Technology](#) Information

Optimize Your Supply Chain with WIN SOURCE Solutions

- ✓ Global Sourcing Solution
- ✓ Obsolete Management
- ✓ Cost Control Management
- ✓ Shortage Management
- ✓ Alternative Solution
- ✓ Excess Inventory Management