

**atrin** **electronic**

Expertise, variety and quality



[www.atrinelec.com](http://www.atrinelec.com)

**آترین الکترونیک**

تخصص، تنوع و کیفیت

02166766957 - 02166766927



[info@atrinelec.com](mailto:info@atrinelec.com)



تهران پاساژ امجد طبقه 1 واحد 16



@atrinelec



## LM555 Timer

 Check for Samples: [LM555](#)

### FEATURES

- Direct Replacement for SE555/NE555
- Timing from Microseconds through Hours
- Operates in Both Astable and Monostable Modes
- Adjustable Duty Cycle
- Output Can Source or Sink 200 mA
- Output and Supply TTL Compatible
- Temperature Stability Better than 0.005% per °C
- Normally On and Normally Off Output
- Available in 8-pin VSSOP Package

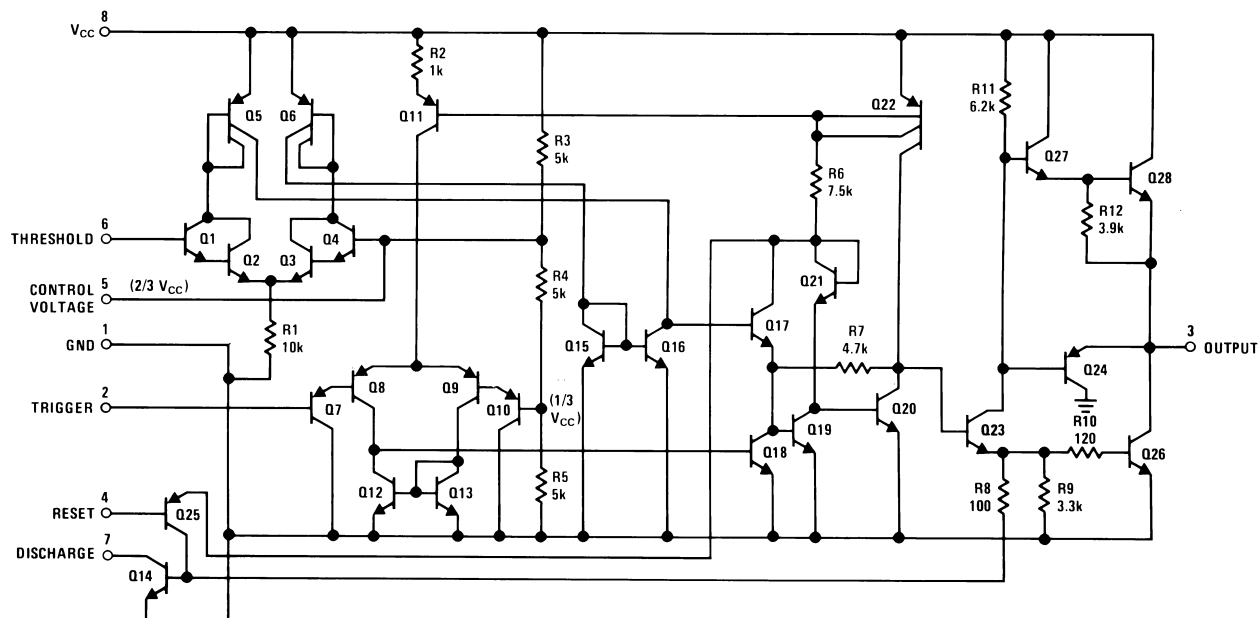
### DESCRIPTION

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200mA or drive TTL circuits.

### APPLICATIONS

- Precision Timing
- Pulse Generation
- Sequential Timing
- Time Delay Generation
- Pulse Width Modulation
- Pulse Position Modulation
- Linear Ramp Generator

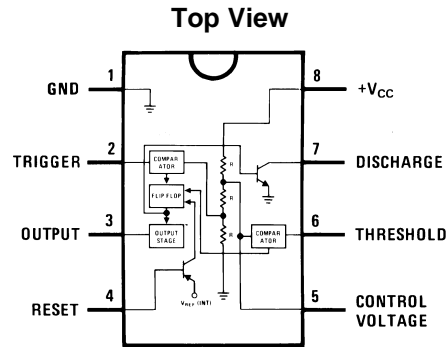
### Schematic Diagram



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

## Connection Diagram



**Figure 1. PDIP, SOIC,  
and VSSOP Packages**



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings<sup>(1)(2)</sup>

Supply Voltage	+18V
Power Dissipation <sup>(3)</sup>	
LM555CM, LM555CN <sup>(4)</sup>	1180 mW
LM555CMM	613 mW
Operating Temperature Ranges	
LM555C	0°C to +70°C
Storage Temperature Range	-65°C to +150°C
Soldering Information	
PDIP Package	
Soldering (10 Seconds)	260°C
Small Outline Packages (SOIC and VSSOP)	
Vapor Phase (60 Seconds)	215°C
Infrared (15 Seconds)	220°C

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which ensures specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not ensured for parameters where no limit is given, however, the typical value is a good indication of device performance.
- (2) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
- (3) For operating at elevated temperatures the device must be derated above 25°C based on a +150°C maximum junction temperature and a thermal resistance of 106°C/W (PDIP), 170°C/W (SOIC-8), and 204°C/W (VSSOP) junction to ambient.
- (4) Refer to RETS555X drawing of military LM555H and LM555J versions for specifications.

**Electrical Characteristics** (1) (2)

 ( $T_A = 25^\circ\text{C}$ ,  $V_{CC} = +5\text{V}$  to  $+15\text{V}$ , unless otherwise specified)

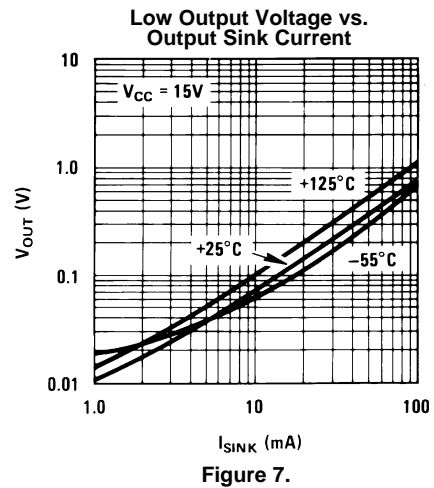
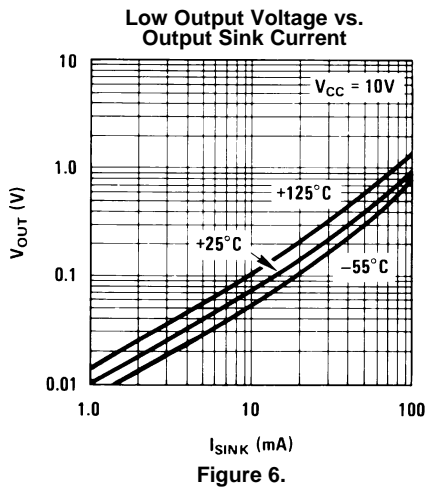
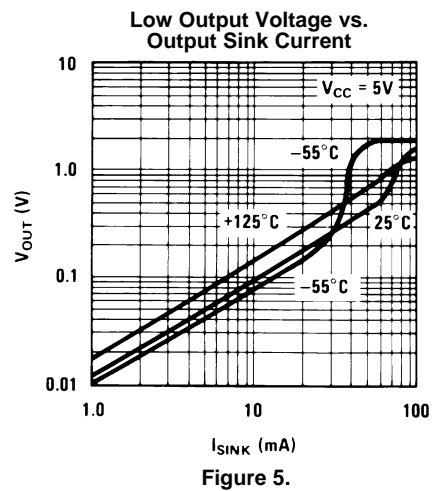
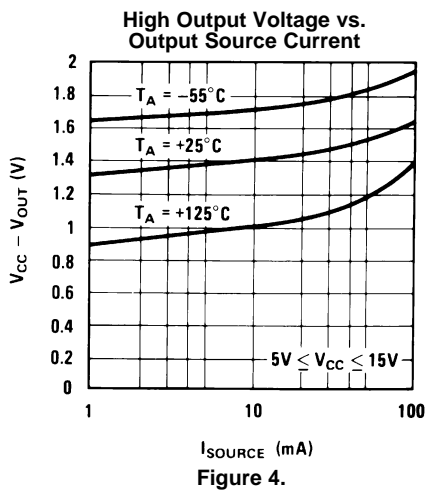
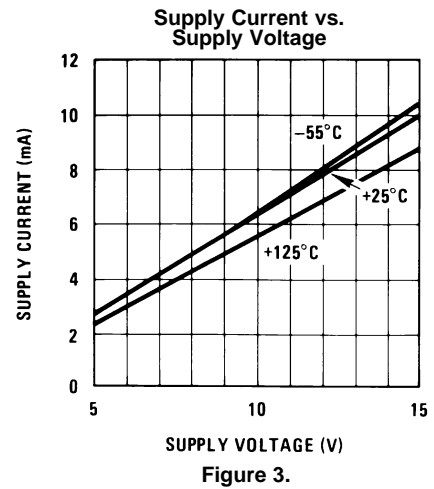
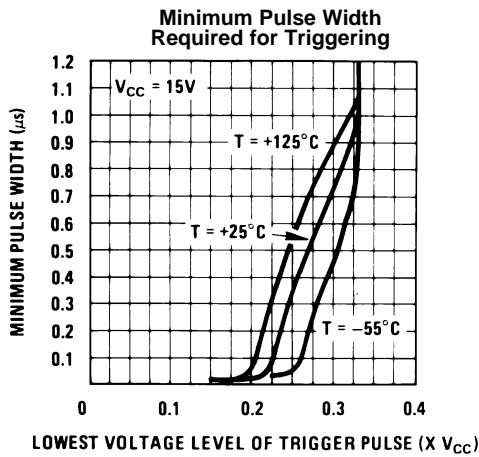
Parameter	Test Conditions	Limits			Units
		LM555C			
		Min	Typ	Max	
Supply Voltage		4.5		16	V
Supply Current	$V_{CC} = 5\text{V}$ , $R_L = \infty$ $V_{CC} = 15\text{V}$ , $R_L = \infty$ (Low State) (3)		3 10	6 15	mA
Timing Error, Monostable	$R_A = 1\text{k}$ to $100\text{k}\Omega$ , $C = 0.1\mu\text{F}$ , (4)				
Initial Accuracy			1		%
Drift with Temperature			50		ppm/ $^\circ\text{C}$
Accuracy over Temperature			1.5		%
Drift with Supply		0.1		%/V	
Timing Error, Astable	$R_A, R_B = 1\text{k}$ to $100\text{k}\Omega$ , $C = 0.1\mu\text{F}$ , (4)				
Initial Accuracy			2.25		%
Drift with Temperature			150		ppm/ $^\circ\text{C}$
Accuracy over Temperature			3.0		%
Drift with Supply		0.30		%/V	
Threshold Voltage			0.667		$\times V_{CC}$
Trigger Voltage	$V_{CC} = 15\text{V}$ $V_{CC} = 5\text{V}$		5 1.67		V V
Trigger Current			0.5	0.9	$\mu\text{A}$
Reset Voltage		0.4	0.5	1	V
Reset Current			0.1	0.4	mA
Threshold Current	(5)		0.1	0.25	$\mu\text{A}$
Control Voltage Level	$V_{CC} = 15\text{V}$ $V_{CC} = 5\text{V}$	9 2.6	10 3.33	11 4	V V
Pin 7 Leakage Output High			1	100	nA
Pin 7 Sat (6)					
Output Low	$V_{CC} = 15\text{V}$ , $I_7 = 15\text{mA}$		180		mV
Output Low	$V_{CC} = 4.5\text{V}$ , $I_7 = 4.5\text{mA}$		80	200	mV
Output Voltage Drop (Low)	$V_{CC} = 15\text{V}$ $I_{\text{SINK}} = 10\text{mA}$ $I_{\text{SINK}} = 50\text{mA}$ $I_{\text{SINK}} = 100\text{mA}$ $I_{\text{SINK}} = 200\text{mA}$ $V_{CC} = 5\text{V}$ $I_{\text{SINK}} = 8\text{mA}$ $I_{\text{SINK}} = 5\text{mA}$		0.1 0.4 2 2.5	0.25 0.75 2.5	V V V V
			0.25	0.35	V

- (1) All voltages are measured with respect to the ground pin, unless otherwise specified.
- (2) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which ensures specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not ensured for parameters where no limit is given, however, the typical value is a good indication of device performance.
- (3) Supply current when output high typically 1 mA less at  $V_{CC} = 5\text{V}$ .
- (4) Tested at  $V_{CC} = 5\text{V}$  and  $V_{CC} = 15\text{V}$ .
- (5) This will determine the maximum value of  $R_A + R_B$  for 15V operation. The maximum total ( $R_A + R_B$ ) is  $20\text{M}\Omega$ .
- (6) No protection against excessive pin 7 current is necessary providing the package dissipation rating will not be exceeded.

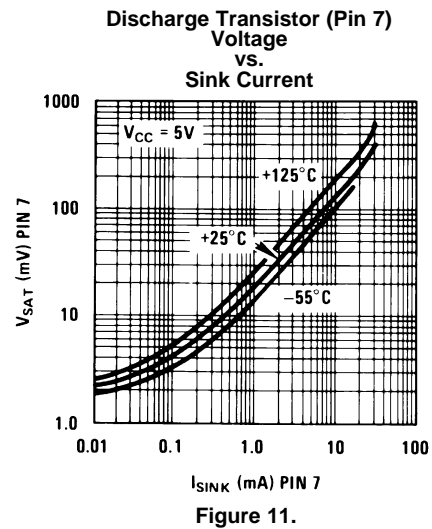
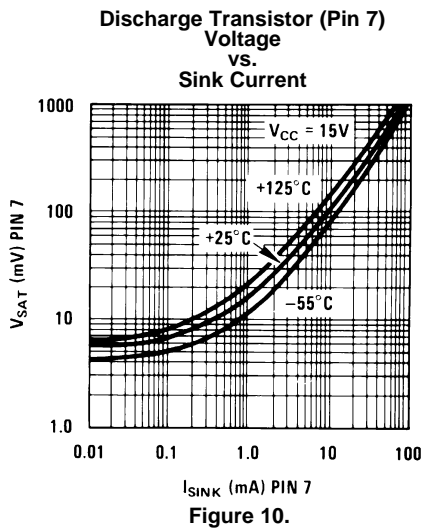
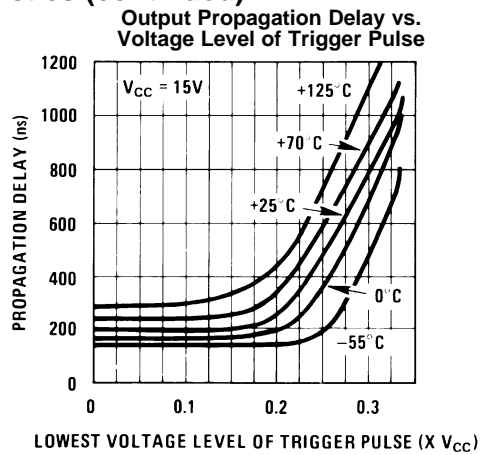
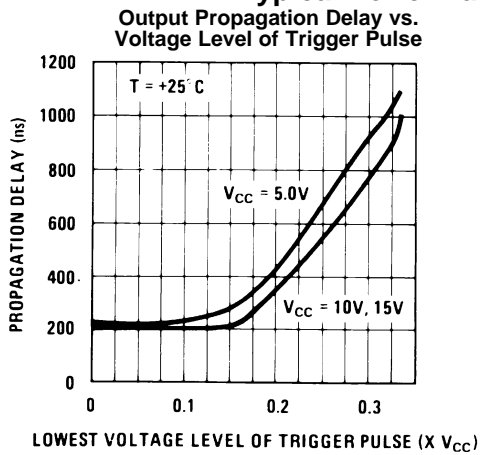
**Electrical Characteristics <sup>(1)</sup> <sup>(2)</sup> (continued)**
 $(T_A = 25^\circ\text{C}, V_{CC} = +5\text{V to } +15\text{V}, \text{ unless otherwise specified})$ 

Parameter	Test Conditions	Limits			Units
		LM555C			
		Min	Typ	Max	
Output Voltage Drop (High)	$I_{SOURCE} = 200\text{mA}, V_{CC} = 15\text{V}$		12.5		V
	$I_{SOURCE} = 100\text{mA}, V_{CC} = 15\text{V}$	12.75	13.3		V
	$V_{CC} = 5\text{V}$	2.75	3.3		V
Rise Time of Output			100		ns
Fall Time of Output			100		ns

Typical Performance Characteristics



Typical Performance Characteristics (continued)



## APPLICATIONS INFORMATION

### MONOSTABLE OPERATION

In this mode of operation, the timer functions as a one-shot (Figure 12). The external capacitor is initially held discharged by a transistor inside the timer. Upon application of a negative trigger pulse of less than  $\frac{1}{3} V_{CC}$  to pin 2, the flip-flop is set which both releases the short circuit across the capacitor and drives the output high.

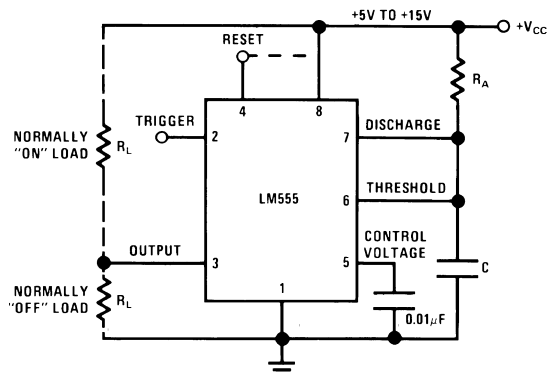
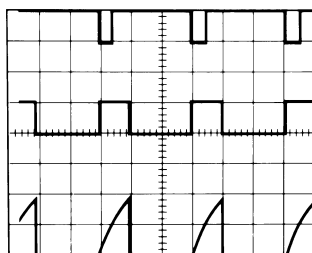


Figure 12. Monostable

The voltage across the capacitor then increases exponentially for a period of  $t = 1.1 R_A C$ , at the end of which time the voltage equals  $\frac{2}{3} V_{CC}$ . The comparator then resets the flip-flop which in turn discharges the capacitor and drives the output to its low state. Figure 13 shows the waveforms generated in this mode of operation. Since the charge and the threshold level of the comparator are both directly proportional to supply voltage, the timing interval is independent of supply.



$V_{CC} = 5V$   
 TIME = 0.1 ms/DIV.  
 $R_A = 9.1k\Omega$   
 $C = 0.01\mu F$

Top Trace: Input 5V/Div.  
 Middle Trace: Output 5V/Div.  
 Bottom Trace: Capacitor Voltage 2V/Div.

Figure 13. Monostable Waveforms

During the timing cycle when the output is high, the further application of a trigger pulse will not effect the circuit so long as the trigger input is returned high at least  $10\mu s$  before the end of the timing interval. However the circuit can be reset during this time by the application of a negative pulse to the reset terminal (pin 4). The output will then remain in the low state until a trigger pulse is again applied.

When the reset function is not in use, it is recommended that it be connected to  $V_{CC}$  to avoid any possibility of false triggering.

Figure 14 is a nomograph for easy determination of R, C values for various time delays.

#### NOTE

In monostable operation, the trigger should be driven high before the end of timing cycle.



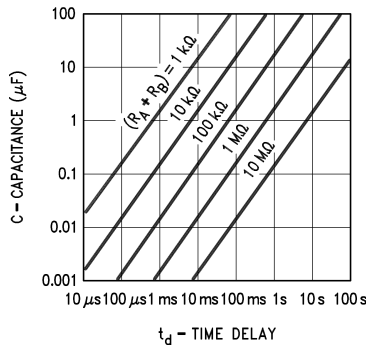


Figure 14. Time Delay

**ASTABLE OPERATION**

If the circuit is connected as shown in Figure 15 (pins 2 and 6 connected) it will trigger itself and free run as a multivibrator. The external capacitor charges through  $R_A + R_B$  and discharges through  $R_B$ . Thus the duty cycle may be precisely set by the ratio of these two resistors.

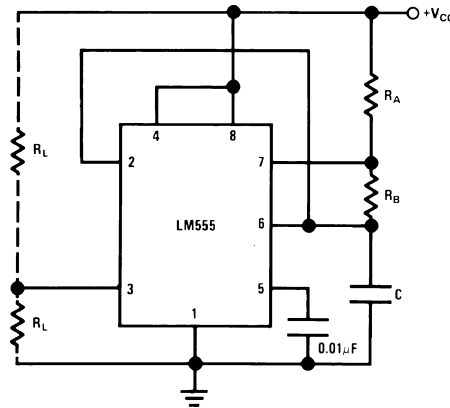
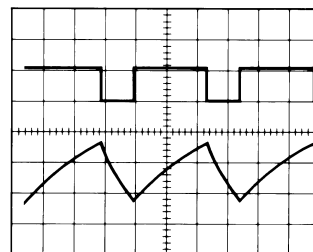


Figure 15. Astable

In this mode of operation, the capacitor charges and discharges between  $1/3 V_{CC}$  and  $2/3 V_{CC}$ . As in the triggered mode, the charge and discharge times, and therefore the frequency are independent of the supply voltage.

Figure 16 shows the waveforms generated in this mode of operation.



$V_{CC} = 5V$   
 TIME = 20µs/DIV.      Top Trace: Output 5V/Div.  
 $R_A = 3.9k\Omega$       Bottom Trace: Capacitor Voltage 1V/Div.  
 $R_B = 3k\Omega$   
 $C = 0.01\mu F$

Figure 16. Astable Waveforms

The charge time (output high) is given by:

$$t_1 = 0.693 (R_A + R_B) C \quad (1)$$

And the discharge time (output low) by:

$$t_2 = 0.693 (R_B) C \quad (2)$$

Thus the total period is:

$$T = t_1 + t_2 = 0.693 (R_A + 2R_B) C \quad (3)$$

The frequency of oscillation is:

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2R_B) C} \quad (4)$$

Figure 17 may be used for quick determination of these RC values.

The duty cycle is:

$$D = \frac{R_B}{R_A + 2R_B} \quad (5)$$

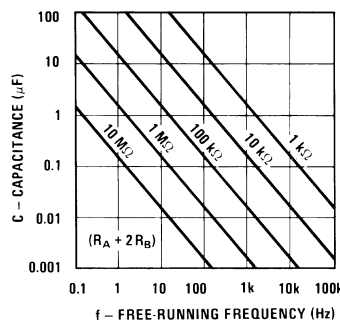
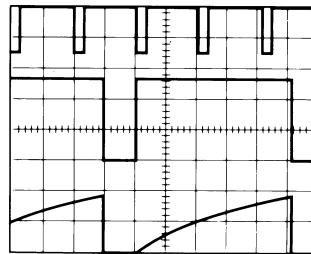


Figure 17. Free Running Frequency

## FREQUENCY DIVIDER

The monostable circuit of Figure 12 can be used as a frequency divider by adjusting the length of the timing cycle. Figure 18 shows the waveforms generated in a divide by three circuit.



$V_{CC} = 5V$       Top Trace: Input 4V/Div.  
 TIME = 20µs/DIV.      Middle Trace: Output 2V/Div.  
 $R_A = 9.1k\Omega$       Bottom Trace: Capacitor 2V/Div.  
 $C = 0.01\mu F$

Figure 18. Frequency Divider

## PULSE WIDTH MODULATOR

When the timer is connected in the monostable mode and triggered with a continuous pulse train, the output pulse width can be modulated by a signal applied to pin 5. Figure 19 shows the circuit, and in Figure 20 are some waveform examples.

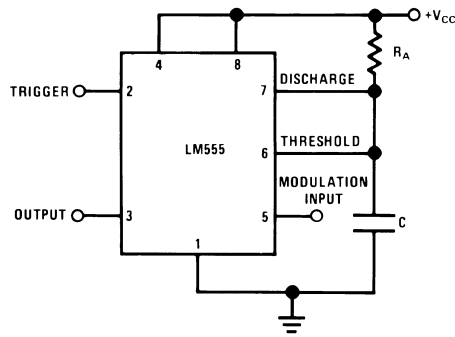
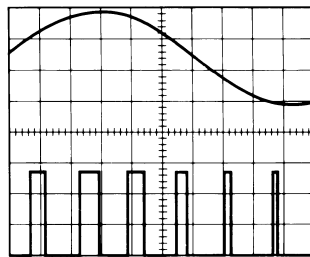


Figure 19. Pulse Width Modulator



$V_{CC} = 5V$       Top Trace: Modulation 1V/Div.  
 TIME = 0.2 ms/DIV.    Bottom Trace: Output Voltage 2V/Div.  
 $R_A = 9.1k\Omega$   
 $C = 0.01\mu F$

Figure 20. Pulse Width Modulator

### PULSE POSITION MODULATOR

This application uses the timer connected for astable operation, as in [Figure 21](#), with a modulating signal again applied to the control voltage terminal. The pulse position varies with the modulating signal, since the threshold voltage and hence the time delay is varied. [Figure 22](#) shows the waveforms generated for a triangle wave modulation signal.

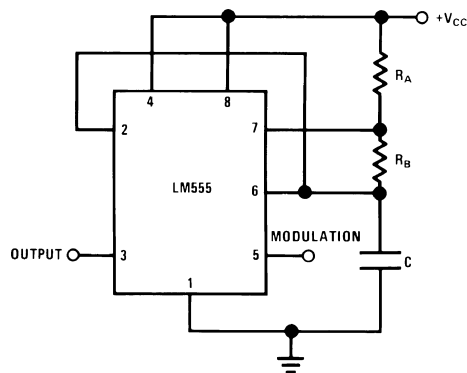
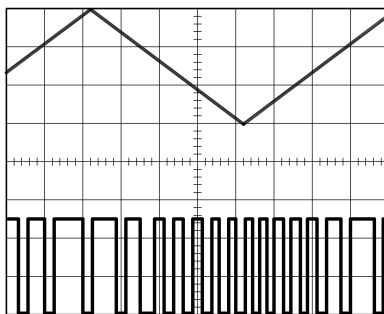


Figure 21. Pulse Position Modulator



$V_{CC} = 5V$   
 TIME = 0.1 ms/DIV.      Top Trace: Modulation Input 1V/Div.  
 Bottom Trace: Output 2V/Div.  
 $R_A = 3.9k\Omega$   
 $R_B = 3k\Omega$   
 $C = 0.01\mu F$

Figure 22. Pulse Position Modulator

### LINEAR RAMP

When the pullup resistor,  $R_A$ , in the monostable circuit is replaced by a constant current source, a linear ramp is generated. Figure 23 shows a circuit configuration that will perform this function.

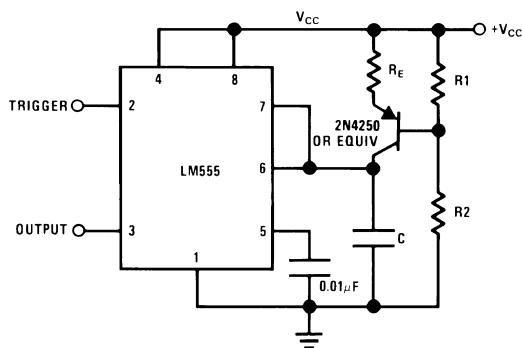


Figure 23.

Figure 24 shows waveforms generated by the linear ramp.

The time interval is given by:

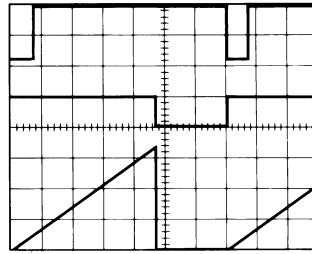
$$T = \frac{2/3 V_{CC} R_E (R_1 + R_2) C}{R_1 V_{CC} - V_{BE} (R_1 + R_2)}$$

$$V_{BE} \approx 0.6V$$

$$V_{BE} \approx 0.6V$$

(6)

(7)



$V_{CC} = 5V$   
 TIME = 20 $\mu$ s/DIV.  
 $R_1 = 47k\Omega$   
 $R_2 = 100k\Omega$   
 $R_E = 2.7 k\Omega$   
 $C = 0.01 \mu F$

Top Trace: Input 3V/Div.  
 Middle Trace: Output 5V/Div.  
 Bottom Trace: Capacitor Voltage 1V/Div.

**Figure 24. Linear Ramp**

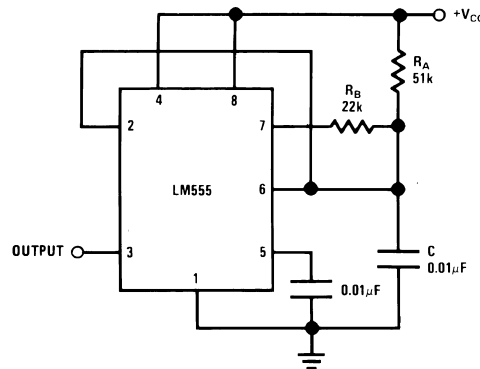
### 50% DUTY CYCLE OSCILLATOR

For a 50% duty cycle, the resistors  $R_A$  and  $R_B$  may be connected as in Figure 25. The time period for the output high is the same as previous,  $t_1 = 0.693 R_A C$ . For the output low it is  $t_2 =$

$$\left[ (R_A R_B) / (R_A + R_B) \right] C \ln \left[ \frac{R_B - 2R_A}{2R_B - R_A} \right] \quad (8)$$

Thus the frequency of oscillation is:

$$f = \frac{1}{t_1 + t_2} \quad (9)$$



**Figure 25. 50% Duty Cycle Oscillator**

Note that this circuit will not oscillate if  $R_B$  is greater than  $1/2 R_A$  because the junction of  $R_A$  and  $R_B$  cannot bring pin 2 down to  $1/3 V_{CC}$  and trigger the lower comparator.

### ADDITIONAL INFORMATION

Adequate power supply bypassing is necessary to protect associated circuitry. Minimum recommended is 0.1 $\mu$ F in parallel with 1 $\mu$ F electrolytic.

Lower comparator storage time can be as long as 10 $\mu$ s when pin 2 is driven fully to ground for triggering. This limits the monostable pulse width to 10 $\mu$ s minimum.

Delay time reset to output is 0.47 $\mu$ s typical. Minimum reset pulse width must be 0.3 $\mu$ s, typical.

Pin 7 current switches within 30ns of the output (pin 3) voltage.

---

**REVISION HISTORY**

<b>Changes from Revision B (March 2013) to Revision C</b>	<b>Page</b>
<hr/> <ul style="list-style-type: none"><li>• Changed layout of National Data Sheet to TI format .....</li></ul>	<hr/> <a href="#">12</a>

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM555CM	ACTIVE	SOIC	D	8	95	TBD	Call TI	Call TI	0 to 70	LM 555CM	<a href="#">Samples</a>
LM555CM/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM 555CM	<a href="#">Samples</a>
LM555CMM	ACTIVE	VSSOP	DGK	8	1000	TBD	Call TI	Call TI	0 to 70	Z55	<a href="#">Samples</a>
LM555CMM/NOPB	ACTIVE	VSSOP	DGK	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	Z55	<a href="#">Samples</a>
LM555CMMX/NOPB	ACTIVE	VSSOP	DGK	8	3500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	Z55	<a href="#">Samples</a>
LM555CMX	ACTIVE	SOIC	D	8	2500	TBD	Call TI	Call TI	0 to 70	LM 555CM	<a href="#">Samples</a>
LM555CMX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	0 to 70	LM 555CM	<a href="#">Samples</a>
LM555CN	ACTIVE	PDIP	P	8	40	TBD	Call TI	Call TI	0 to 70	LM 555CN	<a href="#">Samples</a>
LM555CN/NOPB	ACTIVE	PDIP	P	8	40	Green (RoHS & no Sb/Br)	SN	Level-1-NA-UNLIM	0 to 70	LM 555CN	<a href="#">Samples</a>
MC1455P1	ACTIVE	PDIP	P	8	40	TBD	Call TI	Call TI	0 to 70	LM 555CN	<a href="#">Samples</a>
NE555V	ACTIVE	PDIP	P	8	40	TBD	Call TI	Call TI	0 to 70	LM 555CN	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

---

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.



**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM555CMM	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM555CMM/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM555CMMX/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM555CMX	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM555CMX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM555CMM	VSSOP	DGK	8	1000	210.0	185.0	35.0
LM555CMM/NOPB	VSSOP	DGK	8	1000	210.0	185.0	35.0
LM555CMMX/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LM555CMX	SOIC	D	8	2500	367.0	367.0	35.0
LM555CMX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0

P (R-PDIP-T8)

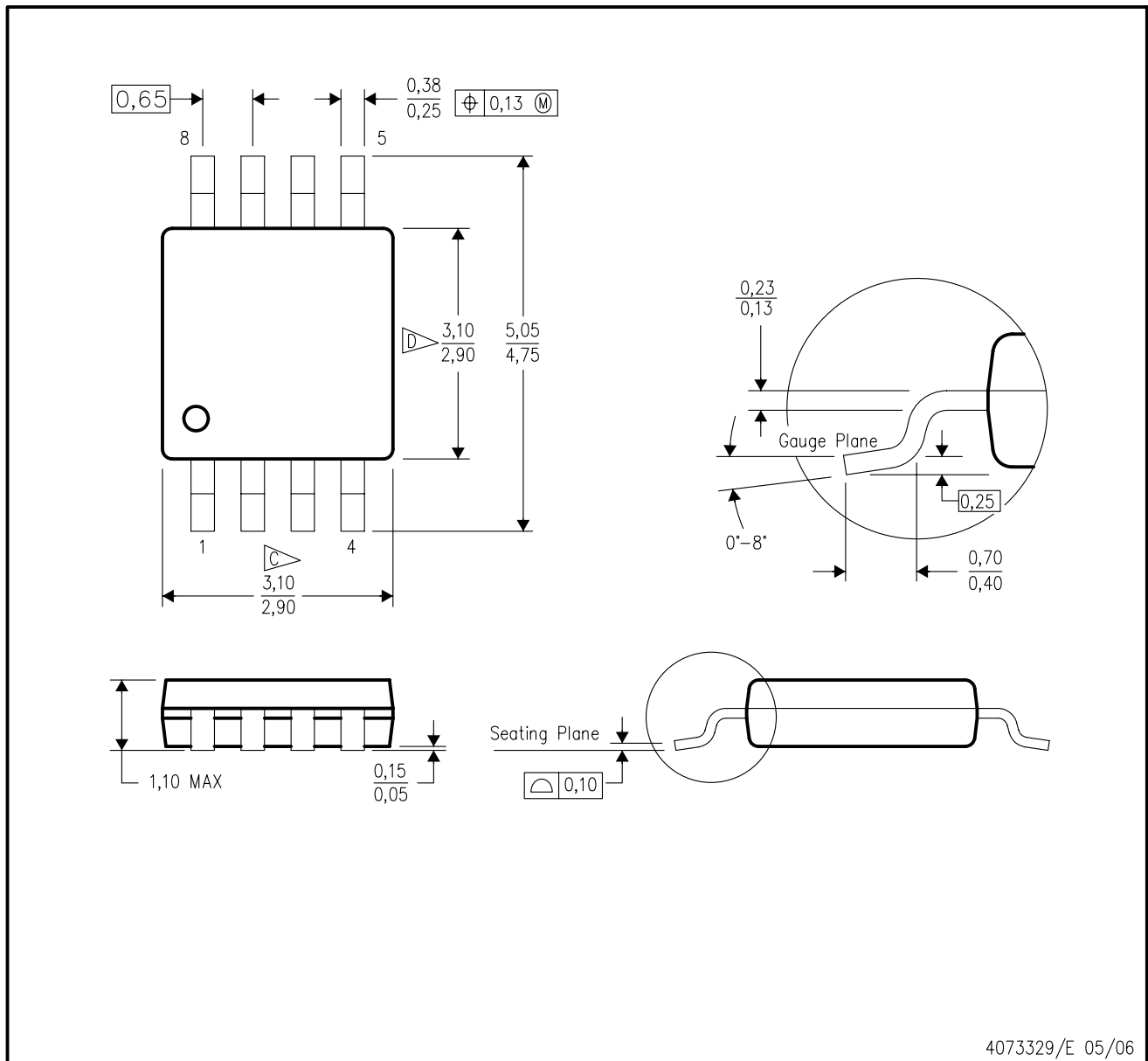
PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 per end.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
  - E. Falls within JEDEC MO-187 variation AA, except interlead flash.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)