

## General-purpose dual bipolar timers

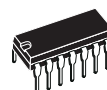
### Features

- Low turn-off time
- Maximum operating frequency greater than 500 kHz
- Timing from microseconds to hours
- Operates in both astable and monostable modes
- Output can source or sink up to 200 mA
- Adjustable duty cycle
- TTL compatible
- Temperature stability of 0.005% per °C

### Description

The NE556, SA556 and SE556 dual monolithic timing circuits are highly stable controllers capable of producing accurate time delays or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor.

The circuits may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200 mA.

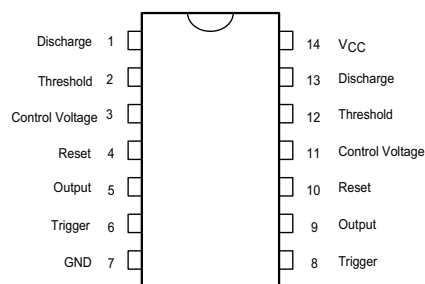


**N**  
**DIP14**  
(Plastic package)



**D**  
**SO14**  
(Plastic micropackage)

### Pin connections (top view)



# 1 Schematic diagrams

Figure 1. Block diagram

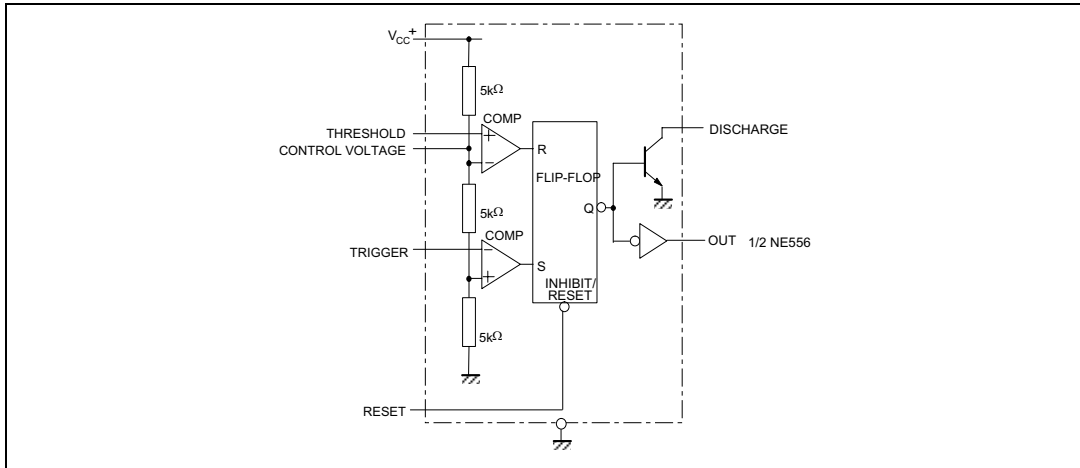
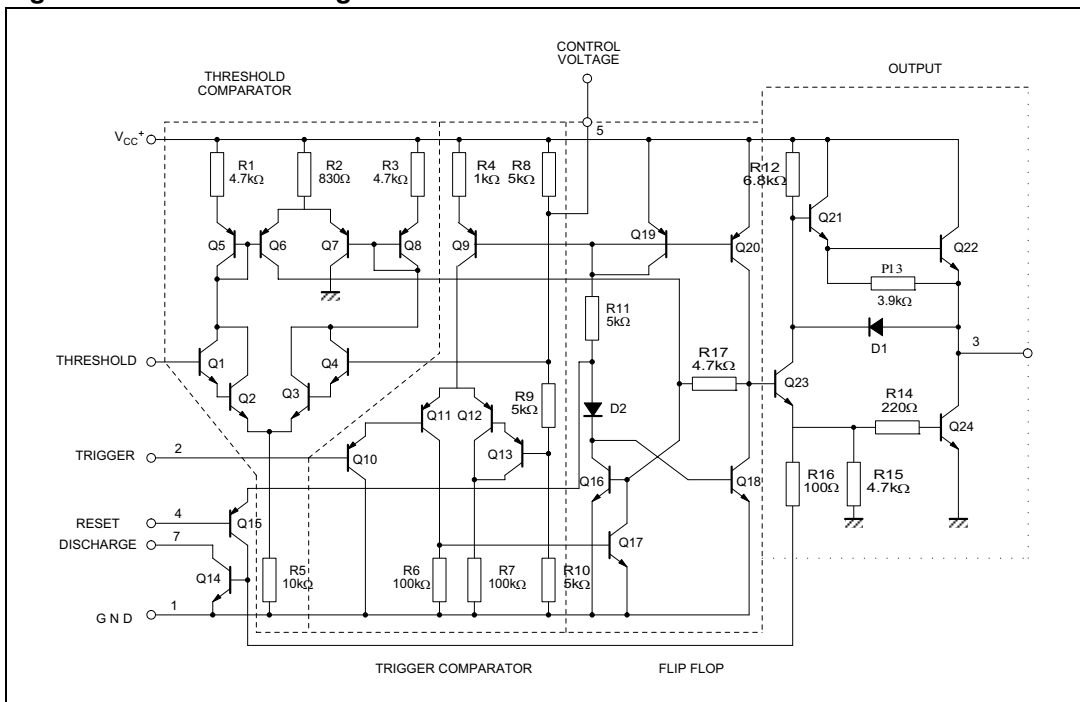


Figure 2. Schematic diagram



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol     | Parameter   | Value      | Unit                        |
|------------|---|------------|-----------------------------|
| $V_{CC}$   | Supply voltage  | 18         | V                           |
| $I_{OUT}$  | Output current (sink and source)                      | $\pm 225$  | mA                          |
| $R_{thja}$ | Thermal resistance junction to ambient <sup>(1)</sup> |            | $^{\circ}\text{C}/\text{W}$ |
|            | DIP14<br>SO-14  | 80<br>105  |                             |
| $R_{thjc}$ | Thermal resistance junction to case <sup>(1)</sup>    |            | $^{\circ}\text{C}/\text{W}$ |
|            | DIP14<br>SO-14  | 33<br>31   |                             |
| ESD        | Human body model (HBM) <sup>(2)</sup>                 | 1000       | V                           |
|            | Machine model (MM) <sup>(3)</sup>                     | 150        |                             |
|            | Charged device model (CDM) <sup>(4)</sup>             | 1500       |                             |
|            | Latch-up immunity                                     | 200        | mA                          |
| $T_{LEAD}$ | Lead temperature (soldering 10 seconds)               | 260        | $^{\circ}\text{C}$          |
| $T_j$      | Junction temperature                                  | 150        | $^{\circ}\text{C}$          |
| $T_{stg}$  | Storage temperature range                             | -65 to 150 | $^{\circ}\text{C}$          |

- Short-circuits can cause excessive heating. These values are typical and valid only for a single layer PCB.
- Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5k $\Omega$  resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5  $\Omega$ ). This is done for all couples of connected pin combinations while the other pins are floating.
- Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

**Table 2. Operating conditions**

| Symbol  | Parameter                            | Value                    | Unit               |
|---|--------------------------------------|--------------------------|--------------------|
| $V_{CC}$  | Supply voltage                       |                          | V                  |
|   | NE556                                | 4.5 to 16                |                    |
|   | SA556<br>SE556                       | 4.5 to 16<br>4.5 to 18   |                    |
| $V_{th}$ , $V_{trig}$ ,<br>$V_{cl}$ , $V_{reset}$ | Maximum input voltage                | $V_{CC}$                 | V                  |
| $I_{OUT}$   | Output current (sink and source)     | $\pm 200$                | mA                 |
| $T_{oper}$  | Operating free air temperature range |                          | $^{\circ}\text{C}$ |
|   | NE556                                | 0 to 70                  |                    |
|   | SA556<br>SE556                       | -40 to 105<br>-55 to 125 |                    |

### 3 Electrical characteristics

Table 3.  $T_{amb} = +25^{\circ}C$ ,  $V_{CC} = +5V$  to  $+15V$  (unless otherwise specified)

| Symbol         | Parameter  | SE556 |      |      | NE556 - SA556 |      |       | Unit                         |
|----------------|--|-------|------|------|---------------|------|-------|------------------------------|
|                |  | Min.  | Typ. | Max. | Min.          | Typ. | Max.  |                              |
| $I_{CC}$       | Supply current ( $R_L \rightarrow \infty$ ) (2 timers)   |       |      |      |               |      |       | mA                           |
|                | Low state $V_{CC} = +5V$   |       | 6    | 10   |               | 6    | 12    |                              |
|                | $V_{CC} = +15V$  |       | 20   | 24   |               | 20   | 30    |                              |
|                | High State $V_{CC} = +5V$  |       | 4    |      |               | 4    |       |                              |
|                | Timing error (monostable)<br>( $R_A = 2k\Omega$ to $100k\Omega$ , $C = 0.1\mu F$ )                     |       |      |      |               |      |       | %<br>ppm/ $^{\circ}C$<br>%/V |
|                | Initial accuracy <sup>(1)</sup>  |       | 0.5  | 2    |               | 1    | 3     |                              |
|                | Drift with temperature   |       | 30   | 100  |               | 50   |       |                              |
|                | Drift with supply voltage  |       | 0.05 | 0.2  |               | 0.1  | 0.5   |                              |
|                | Timing error (astable)<br>( $R_A, R_B = 1k\Omega$ to $100k\Omega$ , $C = 0.1\mu F$ , $V_{CC} = +15V$ ) |       |      |      |               |      |       | %<br>ppm/ $^{\circ}C$<br>%/V |
|                | Initial accuracy <sup>(1)</sup>  |       | 1.5  |      |               | 2.25 |       |                              |
|                | Drift with temperature   |       | 90   |      |               | 150  |       |                              |
|                | Drift with supply voltage  |       | 0.15 |      |               | 0.3  |       |                              |
| $V_{CL}$       | Control voltage level  |       |      |      |               |      |       | V                            |
|                | $V_{CC} = +15V$  | 9.6   | 10   | 10.4 | 9             | 10   | 11    |                              |
|                | $V_{CC} = +5V$   | 2.9   | 3.33 | 3.8  | 2.6           | 3.33 | 4     |                              |
| $V_{th}$       | Threshold voltage  |       |      |      |               |      |       | V                            |
|                | $V_{CC} = +15V$  | 9.4   | 10   | 10.6 | 8.8           | 10   | 11.2  |                              |
|                | $V_{CC} = +5V$   | 2.7   | 3.33 | 4    | 2.4           | 3.33 | 4.2   |                              |
| $I_{th}$       | Threshold current <sup>(2)</sup>   |       | 0.1  | 0.25 |               | 0.1  | 0.25  | $\mu A$                      |
| $V_{trig}$     | Trigger voltage  |       |      |      |               |      |       | V                            |
|                | $V_{CC} = +15V$  | 4.8   | 5    | 5.2  | 4.5           | 5    | 5.6   |                              |
|                | $V_{CC} = +5V$   | 1.45  | 1.67 | 1.9  | 1.1           | 1.67 | 2.2   |                              |
| $I_{trig}$     | Trigger current ( $V_{trig} = 0V$ )  |       | 0.5  | 0.9  |               | 0.5  | 2.0   | $\mu A$                      |
| $V_{reset}$    | Reset voltage <sup>(3)</sup>   | 0.4   | 0.7  | 1    | 0.4           | 0.7  | 1     | V                            |
| $I_{reset}$    | Reset current  |       |      |      |               |      |       | mA                           |
|                | $V_{reset} = +0.4V$  |       | 0.1  | 0.4  |               | 0.1  | 0.4   |                              |
|                | $V_{reset} = 0V$   |       | 0.4  | 1    |               | 0.4  | 1.5   |                              |
| $V_{OL}$       | Low level output voltage   |       |      |      |               |      |       | V                            |
|                | $V_{CC} = +15V$  |       | 0.1  | 0.15 |               | 0.1  | 0.25  |                              |
|                | $I_{O(sink)} = 10mA$   |       | 0.4  | 0.5  |               | 0.4  | 0.75  |                              |
|                | $I_{O(sink)} = 50mA$   |       | 2    | 2.2  |               | 2    | 2.5   |                              |
|                | $I_{O(sink)} = 100mA$  |       | 2.5  |      |               | 2.5  |       |                              |
|                | $I_{O(sink)} = 200mA$  |       | 0.1  | 0.25 |               | 0.3  | 0.4   |                              |
| $V_{CC} = +5V$ |  | 0.05  | 0.2  |      | 0.25          | 0.35 |       |                              |
| $V_{OH}$       | High level output voltage  |       |      |      |               |      |       | V                            |
|                | $V_{CC} = +15V$  | 13    | 12.5 |      |               | 12.5 |       |                              |
|                | $I_{O(sink)} = 200mA$  |       | 13.3 |      |               | 13.3 |       |                              |
|                | $I_{O(sink)} = 100mA$  |       | 3    | 3.3  |               | 3.3  |       |                              |
|                | $V_{CC} = +5V$   |       |      |      | 12.75         |      | 12.75 |                              |
|                | $I_{O(sink)} = 100mA$  |       |      |      | 2.75          |      | 3.3   |                              |

Table 3.  $T_{amb} = +25^{\circ}C$ ,  $V_{CC} = +5V$  to  $+15V$  (unless otherwise specified) (continued)

| Symbol         | Parameter  | SE556 |      |      | NE556 - SA556 |      |      | Unit    |
|----------------|--|-------|------|------|---------------|------|------|---------|
|                |  | Min.  | Typ. | Max. | Min.          | Typ. | Max. |         |
| $I_{dis(off)}$ | Discharge pin leakage current (output high)<br>( $V_{dis} = 10V$ )   |       | 20   | 100  |               | 20   | 100  | nA      |
| $V_{dis(sat)}$ | Discharge pin saturation voltage (output low) <sup>(4)</sup><br>$V_{CC} = +15V, I_{dis} = 15mA$<br>$V_{CC} = +5V, I_{dis} = 4.5mA$ |       | 180  | 480  |               | 180  | 480  | mV      |
|                |  |       | 80   | 200  |               | 80   | 200  |         |
| $t_r$<br>$t_f$ | Output rise time   |       | 100  | 200  |               | 100  | 300  | ns      |
|                | Output fall time   |       | 100  | 200  |               | 100  | 300  |         |
| $t_{off}$      | Turn-off time <sup>(5)</sup> ( $V_{reset} = V_{CC}$ )  |       | 0.5  |      |               | 0.5  |      | $\mu s$ |

1. Tested at  $V_{CC} = +5V$  and  $V_{CC} = +15V$
2. This will determine the maximum value of  $R_A + R_B$  for +15V operation the max total is  $R = 20 M\Omega$  and for +5 V operation the max total  $R = 3.5 M\Omega$
3. Specified with trigger input high
4. No protection against excessive pin 7 current is necessary, providing the package dissipation rating will not be exceeded
5. Time measured from a positive going input pulse from 0 to  $0.8 \times V_{CC}$  into the threshold to the drop from high to low of the output trigger is tied to threshold.

Figure 3. Minimum pulse width required for triggering

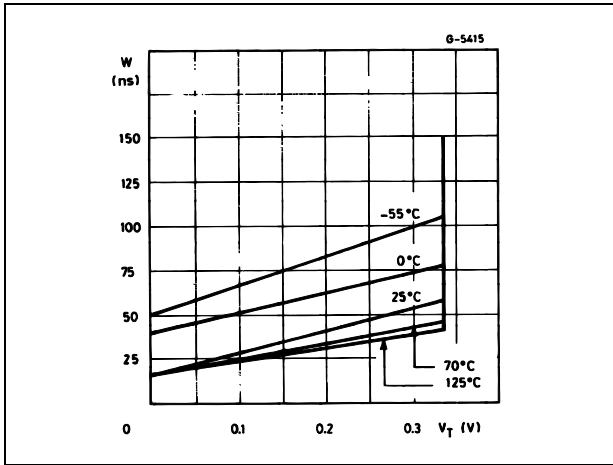


Figure 4. Supply current versus supply voltage

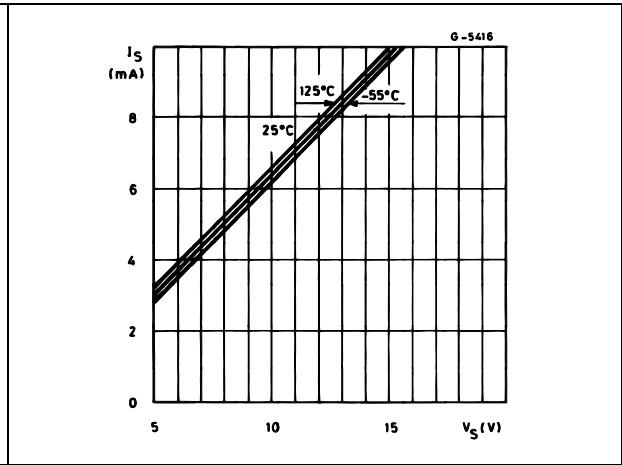


Figure 5. Delay time versus temperature

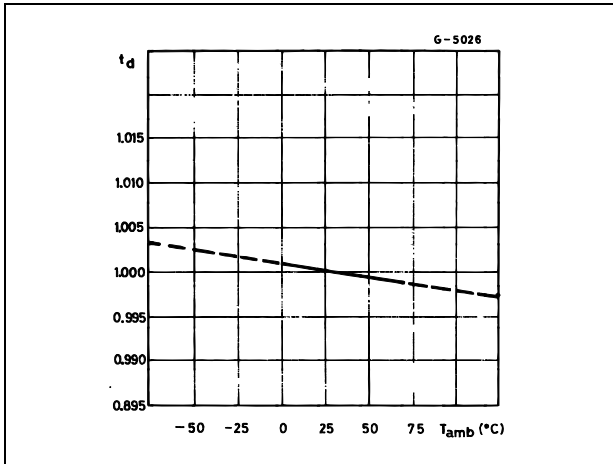


Figure 6. Low output voltage versus output sink current

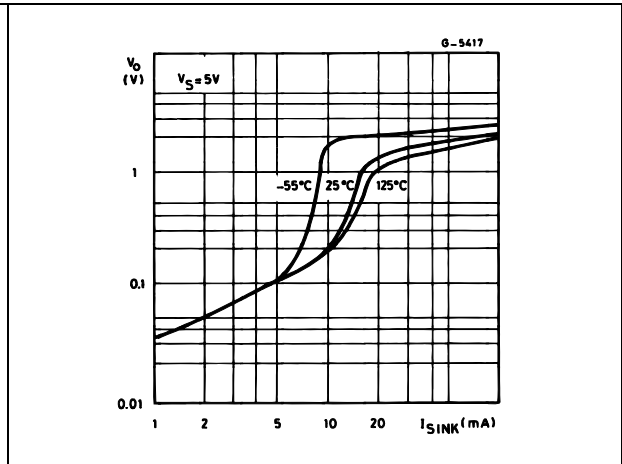


Figure 7. Low output voltage versus output sink current

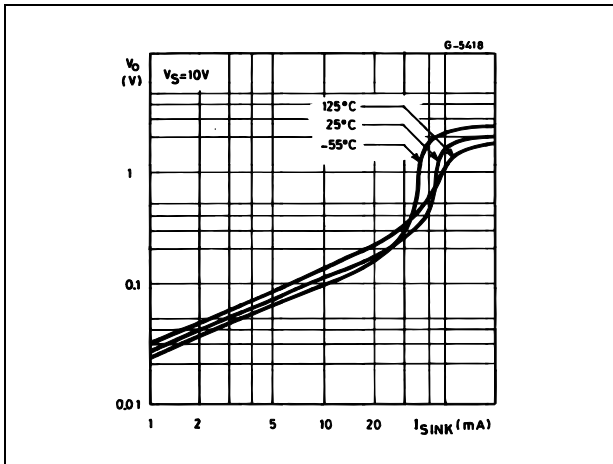


Figure 8. Low output voltage versus output sink current

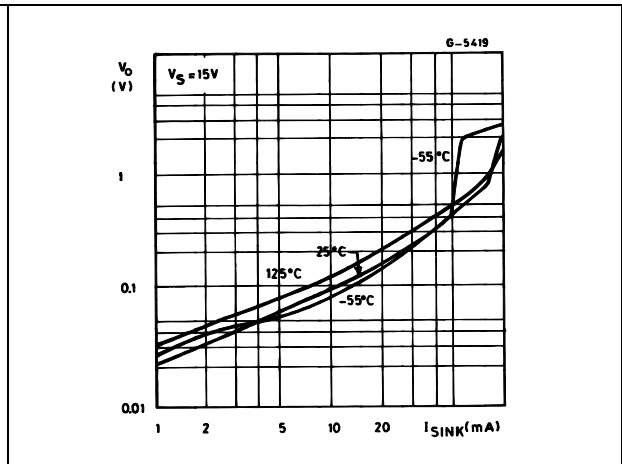


Figure 9. High output voltage drop versus output

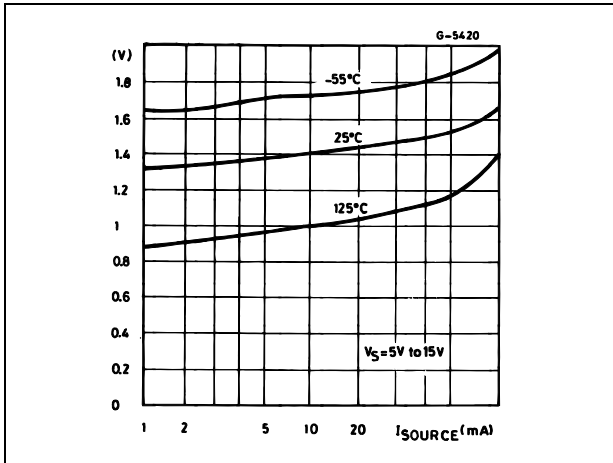


Figure 10. Delay time versus supply voltage

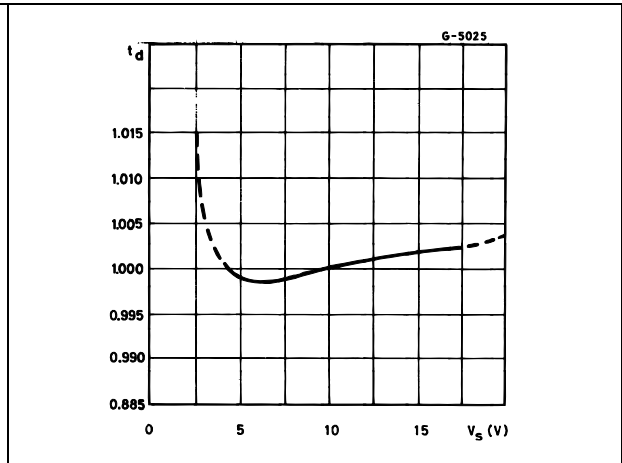
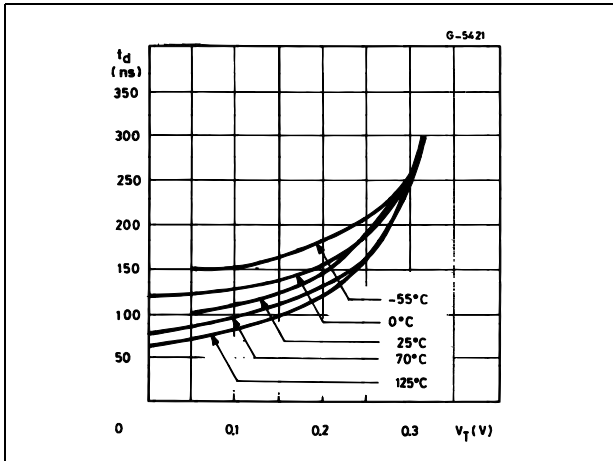


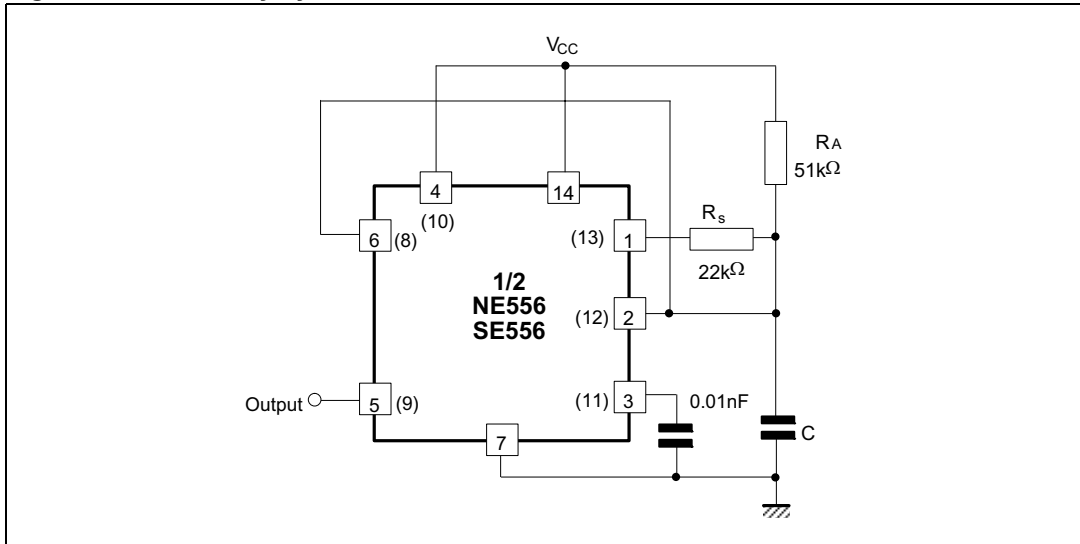
Figure 11. Propagation delay versus voltage level of trigger value



## 4 Application information

### 4.1 Typical application

Figure 12. 50% duty cycle oscillator



$$t_1 = 0.693 R_A \cdot C$$

$$t_2 = [(RARB)/(RA+RB)]CLn \left[ \frac{RB - 2RA}{2RB - RA} \right]$$

$$f = \frac{t_1}{t_1 + t_2} \quad RB < \frac{1}{2} RA \quad ti$$

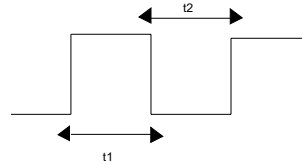


Figure 13. Pulse width modulator

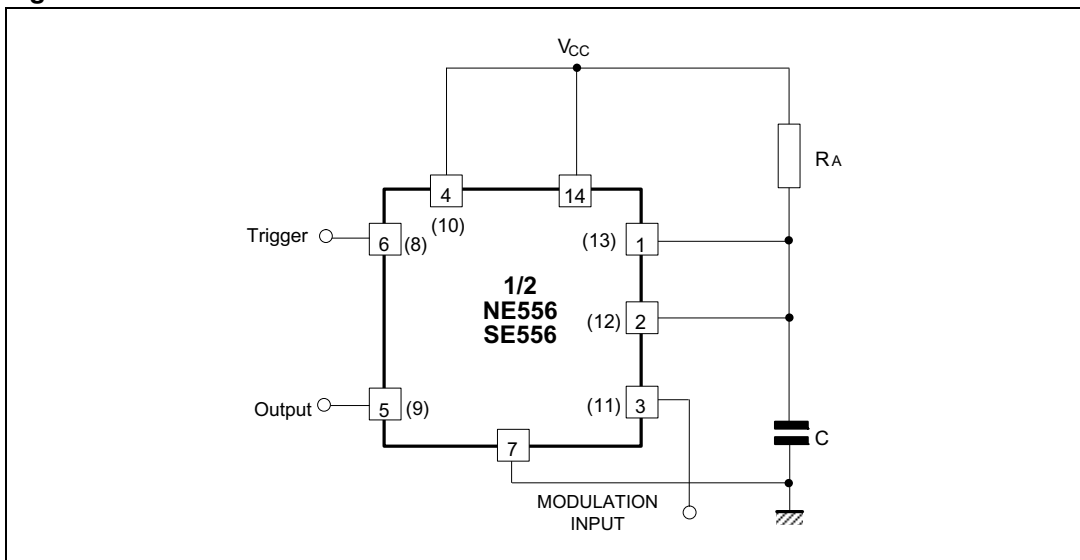
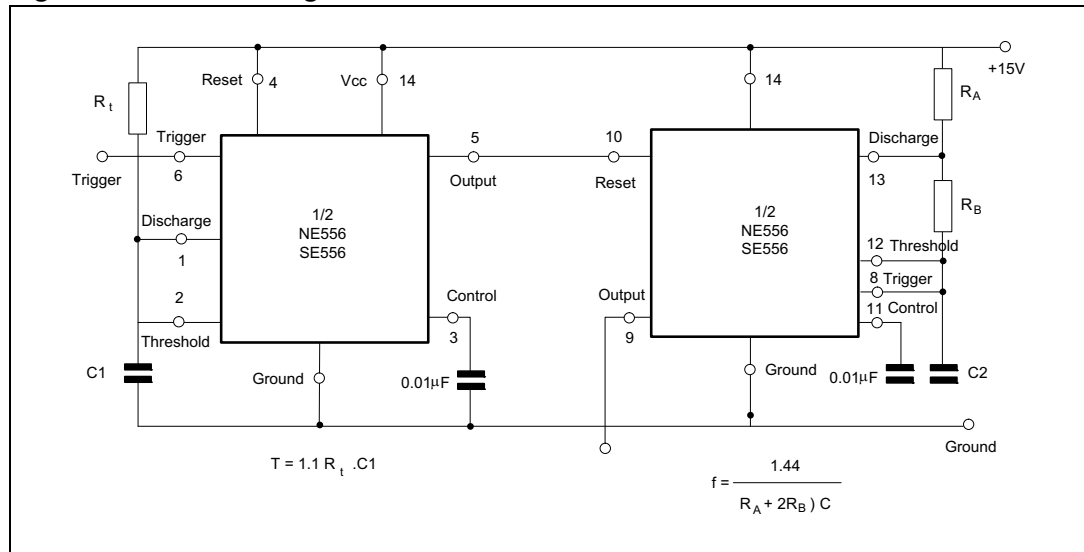




Figure 14. Tone burst generator



For a tone burst generator the first timer is used as a monostable and determines the tone duration when triggered by a positive pulse at pin 6. The second timer is enabled by the high output or the monostable. It is connected as an astable and determines the frequency of the tone.

Figure 15. Monostable operation

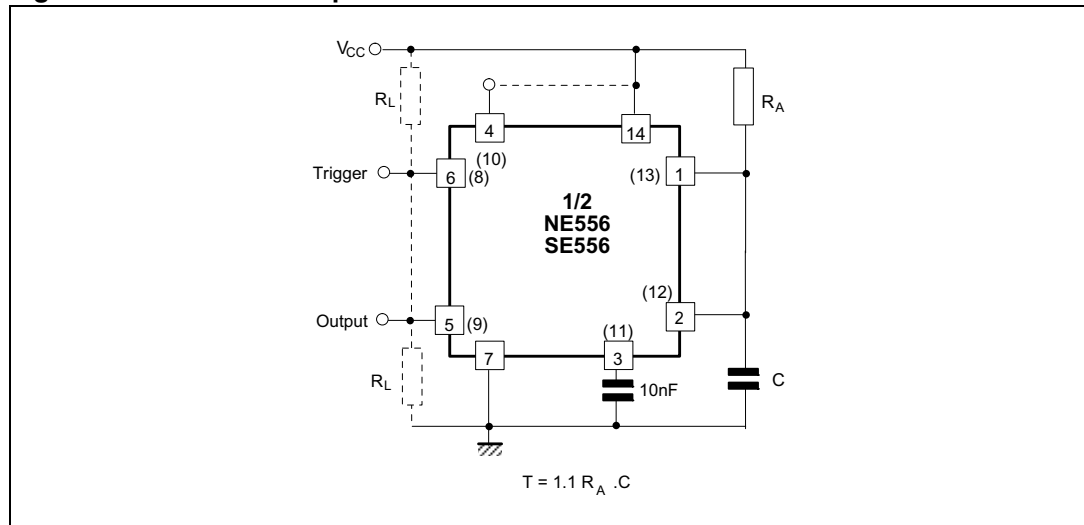
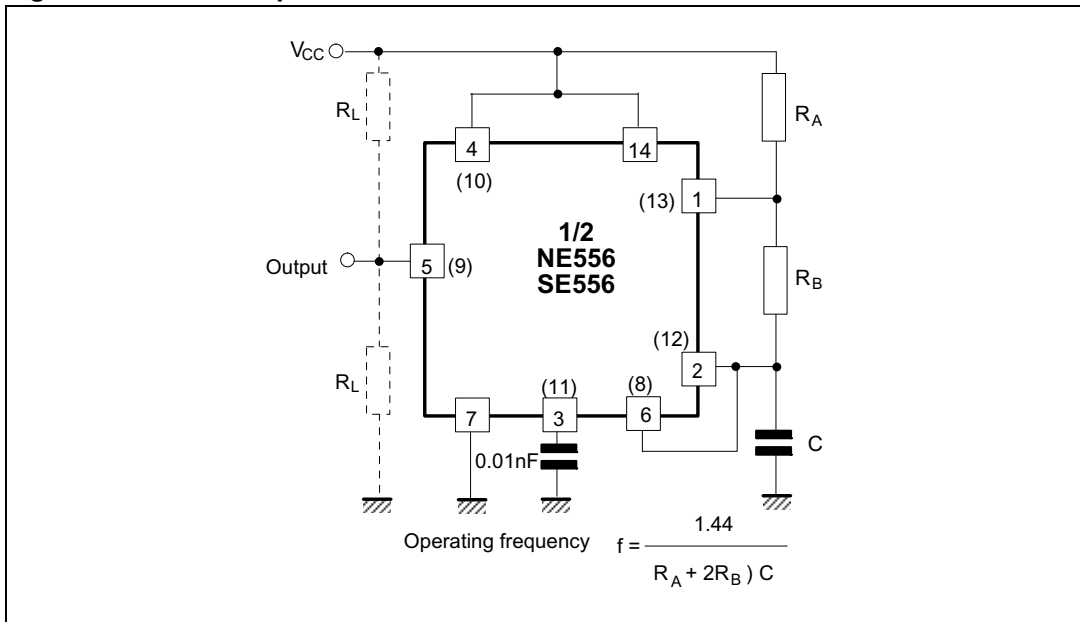
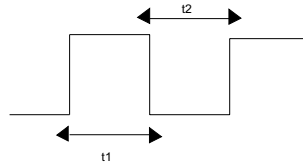


Figure 16. Astable operation



$t_1 = 0.693 (R_A + R_B) C$  output high

$t_2 = 0.693 R_B C$  output low



## 5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 5.1 DIP14 package information

Figure 17. DIP14 package mechanical drawing

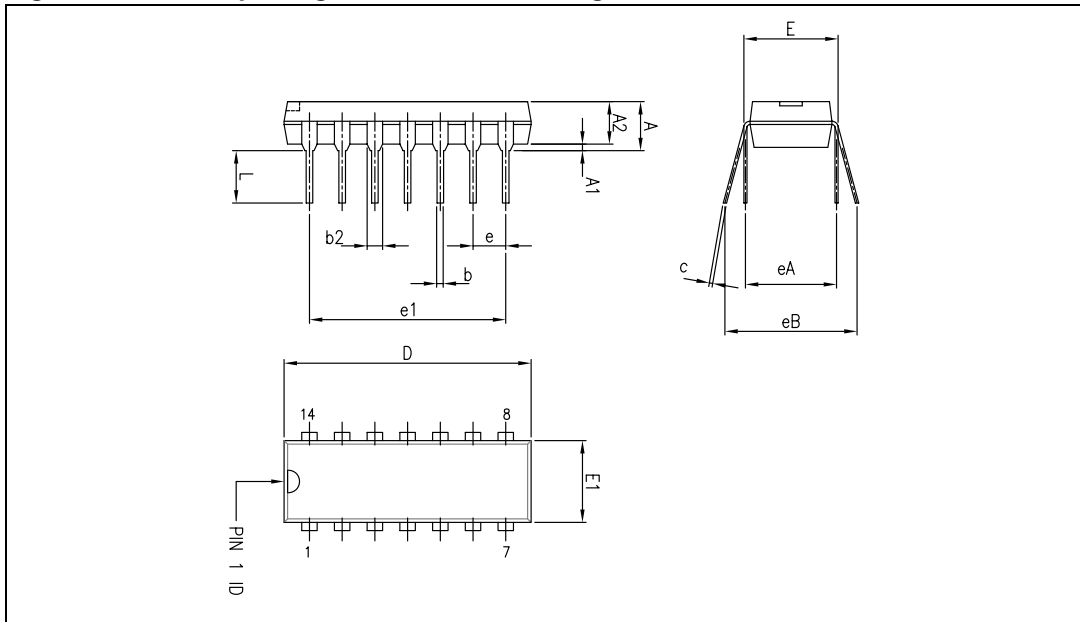


Table 4. DIP14 package mechanical data

| Dimensions |             |       |       |        |       |       |
|------------|-------------|-------|-------|--------|-------|-------|
| Ref.       | Millimeters |       |       | Inches |       |       |
|            | Min.        | Typ.  | Max.  | Min.   | Typ.  | Max.  |
| A          |             |       | 5.33  |        |       | 0.21  |
| A1         | 0.38        |       |       | 0.015  |       |       |
| A2         | 2.92        | 3.30  | 4.95  | 0.11   | 0.13  | 0.19  |
| b          | 0.36        | 0.46  | 0.56  | 0.014  | 0.018 | 0.022 |
| b2         | 1.14        | 1.52  | 1.78  | 0.04   | 0.06  | 0.07  |
| c          | 0.20        | 0.25  | 0.36  | 0.007  | 0.009 | 0.01  |
| D          | 18.67       | 19.05 | 19.69 | 0.73   | 0.75  | 0.77  |
| E          | 7.62        | 7.87  | 8.26  | 0.30   | 0.31  | 0.32  |
| E1         | 6.10        | 6.35  | 7.11  | 0.24   | 0.25  | 0.28  |
| e          |             | 2.54  |       |        | 0.10  |       |
| e1         |             | 15.24 |       |        | 0.60  |       |
| eA         |             | 7.62  |       |        | 0.30  |       |
| eB         |             |       | 10.92 |        |       | 0.43  |
| L          | 2.92        | 3.30  | 3.81  | 0.11   | 0.13  | 0.15  |

Note: D and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25 mm.

## 5.2 SO-14 package information

Figure 18. SO-14 package mechanical drawing

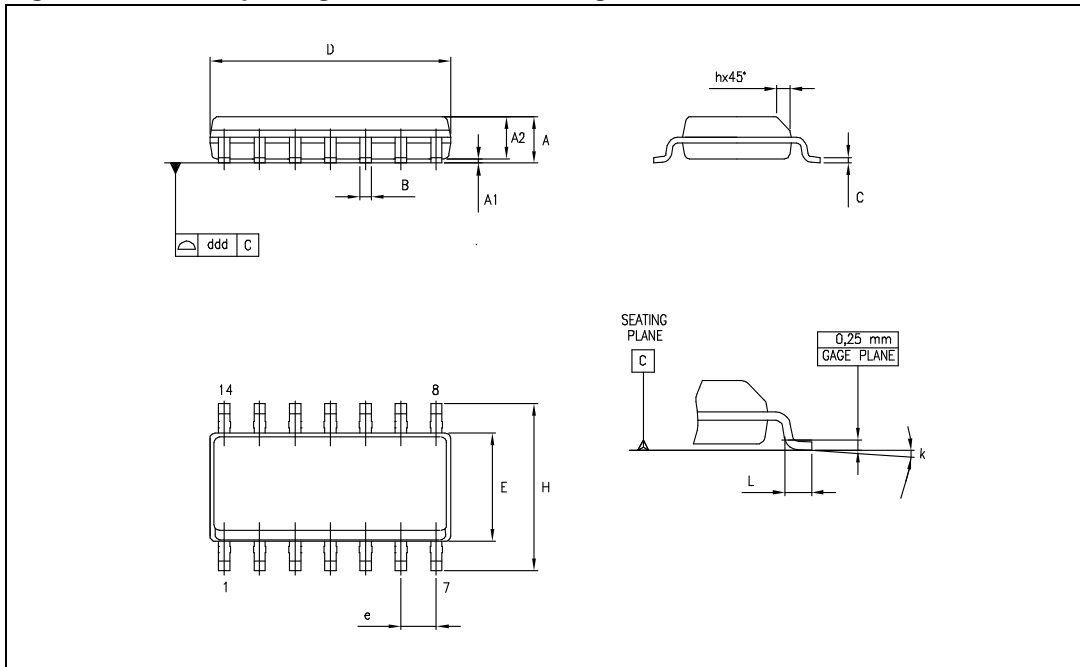


Table 5. SO-14 package mechanical data

| Dimensions |             |      |      |        |      |       |
|------------|-------------|------|------|--------|------|-------|
| Ref.       | Millimeters |      |      | Inches |      |       |
|            | Min.        | Typ. | Max. | Min.   | Typ. | Max.  |
| A          | 1.35        |      | 1.75 | 0.05   |      | 0.068 |
| A1         | 0.10        |      | 0.25 | 0.004  |      | 0.009 |
| A2         | 1.10        |      | 1.65 | 0.04   |      | 0.06  |
| B          | 0.33        |      | 0.51 | 0.01   |      | 0.02  |
| C          | 0.19        |      | 0.25 | 0.007  |      | 0.009 |
| D          | 8.55        |      | 8.75 | 0.33   |      | 0.34  |
| E          | 3.80        |      | 4.0  | 0.15   |      | 0.15  |
| e          |             | 1.27 |      |        | 0.05 |       |
| H          | 5.80        |      | 6.20 | 0.22   |      | 0.24  |
| h          | 0.25        |      | 0.50 | 0.009  |      | 0.02  |
| L          | 0.40        |      | 1.27 | 0.015  |      | 0.05  |
| k          | 8° (max.)   |      |      |        |      |       |
| ddd        |             |      | 0.10 |        |      | 0.004 |

Note: D and F dimensions do not include mold flash or protrusions. Mold flash or protrusions must not exceed 0.15 mm.

## 6 Ordering information

**Table 6. Order codes**

| Part number | Temperature range | Package | Packing             | Marking |
|-------------|-------------------|---------|---------------------|---------|
| NE556N      | 0°C, +70°C        | DIP14   | Tube                | NE556N  |
| NE556D/DT   |                   | SO-14   | Tube or tape & reel | NE556   |
| SA556N      | -40°C, +105°C     | DIP14   | Tube                | SA556N  |
| SA556D/DT   |                   | SO-14   | Tube or tape & reel | SA556   |
| SE556N      | -55°C, + 125°C    | DIP14   | Tube                | SE556N  |
| SE556D/DT   |                   | SO-14   | Tube or tape & reel | SE556   |

## 7 Revision history

Table 7. Document revision history

| Date        | Revision | Changes   |
|-------------|----------|---|
| 01-Jun-2003 | 1        | Initial release.  |
| 27-Jan-2009 | 2        | Document reformatted.<br>Added $I_{OUT}$ value in <a href="#">Table 1: Absolute maximum ratings</a> and <a href="#">Table 2: Operating conditions</a> .<br>Added ESD tolerance, latch-up tolerance, $R_{thja}$ and $R_{thjc}$ in <a href="#">Table 1: Absolute maximum ratings</a> .<br>Updated <a href="#">Section 5.1: DIP14 package information</a> and <a href="#">Section 5.2: SO-14 package information</a> . |

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