19-0481; Rev 2; 11/92

# MAXIM
# General Purpose Timers



## General Description

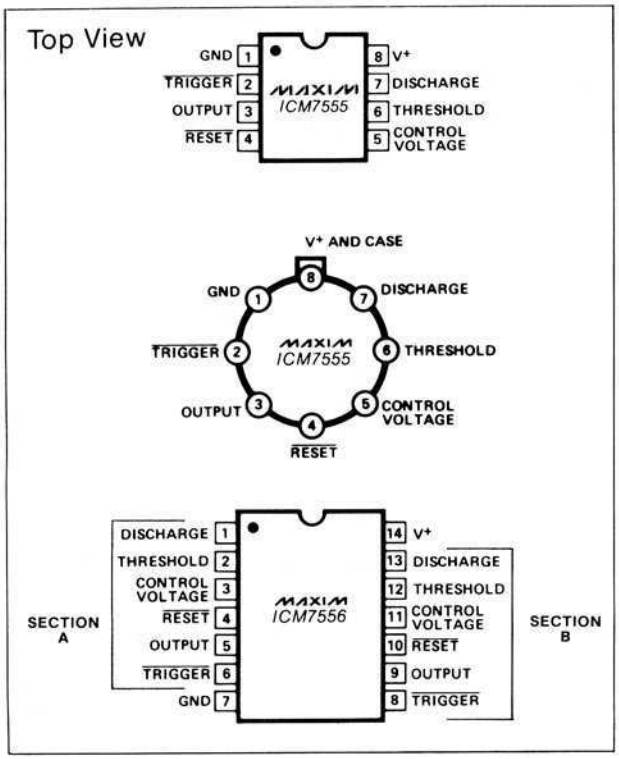
The Maxim ICM7555 and ICM7556 are respectively single and dual general purpose RC timers capable of generating accurate time delays or frequencies. The primary feature is an extremely low supply current, making this device ideal for battery-powered systems. Additional features include low THRESHOLD, TRIGGER, and RESET currents, a wide operating supply voltage range, and improved performance at high frequencies.

These CMOS low-power devices offer significant performance advantages over the standard 555 and 556 bipolar timers. Low-power consumption, combined with the virtually non-existent current spike during output transitions, make these timers the optimal solution in many applications.

## Applications

| | |
|---|---|
| Pulse Generator | Pulse Position Modulation |
| Precision Timing | Sequential Timing |
| Time Delay Generation | Missing Pulse Detector |
| Pulse Width Modulation | |

## Pin Configuration



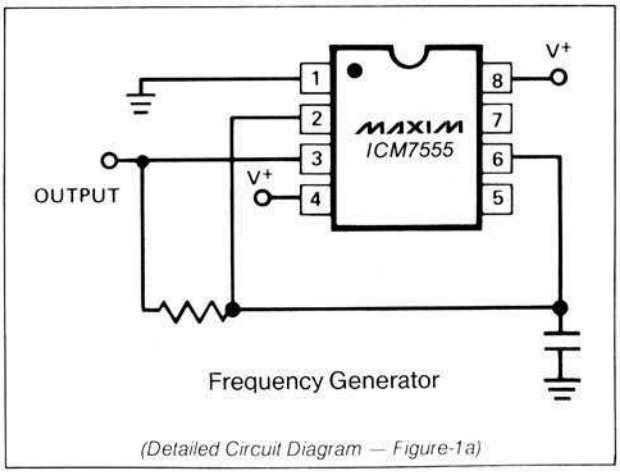

## Features

- **Improved 2nd Source! (See 3rd page for "Maxim Advantage™").**
- **Wide Supply Voltage Range: 2-18V**
- **No Crowbarring of Supply During Output Transition**
- **Adjustable Duty Cycle**
- **Low THRESHOLD, TRIGGER and RESET Curents**
- **TTL Compatible**
- **Monolithic, Low Power CMOS Design**

## Ordering Information

| PART | TEMP. RANGE | PACKAGE |
|---|---|---|
| ICM7555IPA | -20°C to +85°C | 8 Lead Plastic DIP |
| ICM7555IJA | -20°C to +85°C | 8 Lead CERDIP |
| ICM7555ITV | -20°C to +85°C | TO-99 Can |
| ICM7555MJA | -55°C to +125°C | 8 Lead CERDIP |
| ICM7555MTV | -55°C to +125°C | TO-99 Can |
| ICM7555ISA | -20°C to +85°C | 8 Lead Small Outline |
| ICM7555/D | 0°C to +70°C | Dice |
| ICM7556IPD | -20°C to +85°C | 14 Lead Plastic DIP |
| ICM7556MJD | -55°C to +125°C | 14 Lead CERDIP |
| ICM7556ISD | -20°C to +85°C | 14 Lead Small Outline |
| ICM7556/D | 0°C to +70°C | Dice |

## Typical Operating Circuit




(Detailed Circuit Diagram — Figure-1a)

# General Purpose Timers

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage ..... +18 Volts
Input Voltage TRIGGER
Control Voltage THRESHOLD <$V^+ + 0.3V$ to $\geq -0.3V$
RESET

Output Current ..... 100mA
Power Dissipation[2] ICM7556 ..... 300mW
ICM7555 ..... 200mW
Operating Temperature Range
ICM7555IJA (Maxim) ..... −20°C to +85°C
ICM7555ISA (Maxim) ..... −20°C to +85°C
ICM7555IPA ..... −20°C to +85°C
ICM7555ITV ..... −20°C to +85°C
ICM7556IPD ..... −20°C to +85°C
ICM7555MTV ..... −55°C to +125°C
ICM7556MJD ..... −55°C to +125°C
Storage Temperature ..... −65°C to +150°C
Lead Temperature (Soldering 60 Seconds) ..... +300°C

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

## ELECTRICAL CHARACTERISTICS

($V^+ = +2$ to $+15$ volts; $T_A = 25°C$, Unless Noted)

| PARAMETER | SYMBOL | TEST CONDITIONS | | | VALUE MIN | VALUE TYP | VALUE MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| Supply Voltage | $V^+$ | $-20°C \leq T_A \leq +70°C$<br>$-55°C \leq T_A \leq +125°C$ | | | 2<br>3 | | 18<br>16 | V<br>V |
| Supply Current [3] | $I^+$ | ICM7555 | $V^+ = 2V$<br>$V^+ = 18V$ | | | 60<br>120 | 200<br>300 | µA<br>µA |
| | | ICM7556 | $V^+ = 2V$<br>$V^+ = 18V$ | | | 120<br>240 | 400<br>600 | µA<br>µA |
| Timing Error | | $R_A, R_B$ = 1k to 100k, C = 0.1µF | $5V \leq V^+ \leq 15V$ | | | | | |
| Initial Accuracy | | Note 4 | | | | 2.0 | 5.0 | % |
| Drift with Temperature | | Note 4 | $V^+ = 5V$<br>$V^+ = 10V$<br>$V^+ = 15V$ | | | 50<br>75<br>100 | | ppm/°C |
| Drift with Supply Voltage | | $V^+ = 5V$ | | | | 1.0 | 3.0 | %/V |
| Threshold Voltage | $V_{TH}$ | | $V^+ = 5V$ | | 0.63 | 0.66 | 0.67 | V |
| Trigger Voltage | $V_{TRIG}$ | | $V^+ = 5V$ | | 0.29 | 0.33 | 0.34 | V |
| Trigger Current | $I_{TRIG}$ | $V^+ = 18V$<br>$V^+ = 5V$<br>$V^+ = 2V$ | | | | 50<br>10<br>1 | | pA<br>pA<br>pA |
| Threshold Current | $I_{TH}$ | $V^+ = 18V$<br>$V^+ = 5V$<br>$V^+ = 2V$ | | | | 50<br>10<br>1 | | pA<br>pA<br>pA |
| Reset Current | $I_{RST}$ | $V_{RESET}$ = Ground | $V^+ = 18V$<br>$V^+ = 5V$<br>$V^+ = 2V$ | | | 100<br>20<br>2 | | pA<br>pA<br>pA |
| Reset Voltage | $V_{RST}$ | $V^+ = 18V$<br>$V^+ = 2V$ | | | 0.4<br>0.4 | 0.7<br>0.7 | 1.0<br>1.0 | V<br>V |
| Control Voltage Lead | $V_{CV}$ | | $V^+ = 5V$ | | 0.62 | 0.66 | 0.67 | V |
| Output Voltage Drop | $V_O$ | Output Lo | $V^+ = 18V$<br>$V^+ = 5V$ | $I_{SINK} = 3.2mA$<br>$I_{SINK} = 3.2mA$ | | 0.1<br>0.15 | 0.4<br>0.4 | V<br>V |
| | | Output Hi | $V^+ = 18V$<br>$V^+ = 5V$ | $I_{SOURCE} = 1.0mA$<br>$I_{SOURCE} = 1.0mA$ | 17.25<br>4.0 | 17.8<br>4.5 | | V<br>V |
| Rise Time of Output | $t_r$ | $R_L = 10M\Omega$ | $C_L = 10pF$ | $V^+ = 5V$ | 35 | 40 | 75 | ns |
| Fall Time of Output | $t_f$ | $R_L = 10M\Omega$ | $C_L = 10pF$ | $V^+ = 5V$ | 35 | 40 | 75 | ns |
| Guaranteed Max Osc Freq | $f_{max}$ | Astable Operation | | | 500 | | | kHz |

**Note 1:** Due to the SCR structure inherent in the CMOS process used to fabricate these devices, connecting any terminal to a voltage greater than $V^+ + 0.3V$ or less than $V^- - 0.3V$ may cause destructive latchup. For this reason it is recommended that no inputs from external sources not operating from the same power supply be applied to the device before its power supply is established. In multiple systems, the supply of the ICM7555/6 must be turned on first.

**Note 2:** Junction temperatures should not exceed 135°C and the power dissipation must be limited to 20mW at 125°C. Below 125°C power dissipation may be increased to 300mW at 25°C. Derating factor is approximately 3mW/°C (7556) or 2mW/°C (7555).

**Note 3:** The supply current value is essentially independent of the TRIGGER, THRESHOLD and RESET voltages.

**Note 4:** Parameter is not 100% tested. Majority of all units meet this specification.

*The electrical characteristics above are a reproduction of a portion of Intersil's copyrighted (1983/1984) data book. This information does not constitute any representation by Maxim that Intersil's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with the descriptive excerpts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.*

- Lower Supply Current
- Increased Output Source Current
- Guaranteed THRESHOLD, TRIGGER and RESET Input Currents
- Guaranteed Discharge Output Voltage
- Supply Current Guaranteed Over Temperature
- Significantly Improved ESD Protection (Note 6)
- Maxim Quality and Reliability

## ABSOLUTE MAXIMUM RATINGS

This device conforms to the Absolute Maximum Ratings on adjacent page.

## ELECTRICAL CHARACTERISTICS

Specifications below satisfy or exceed all "tested" parameters on adjacent page.
($V^+$ = +2 to +15 volts; $T_A$ = 25°C, unless noted.)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Supply Voltage | $V^+$ | $-20°C \le T_A \le +85°C$<br>$-55°C \le T_A \le +125°C$ | 2<br>3 | | 16.5<br>16 | V<br>V |
| **Supply Current** (Note 3) | $I^+$ | **ICM 7555** $V^+$ = 2-16.5V; $T_A$ = +25°C<br>$V^+$ = 5V; $T_A$ = +25°C<br>$V^+$ = 5V; $-20°C \le T_A \le +85°C$<br>$V^+$ = 5V; $-55°C \le T_A \le +125°C$ | | 30 | 250<br>120<br>250<br>300 | µA<br>µA<br>µA<br>µA |
| | | **ICM 7556** $V^+$ = 2-16.5V; $T_A$ = +25°C<br>$V^+$ = 5V; $T_A$ = +25°C<br>$V^+$ = 5V; $-20°C \le T_A \le +85°C$<br>$V^+$ = 5V; $-55°C \le T_A \le +125°C$ | | 60 | 500<br>240<br>500<br>600 | µA<br>µA<br>µA<br>µA |
| Timing Error (Note 4)<br>Initial Accuracy (Note 5)<br>Drift with Temperature<br><br><br>Drift with Supply Voltage | | Circuit of figure 1(b);<br>$R_A = R_B$ = 100kΩ, C = 0.1µF, $V^+$ = 5V<br><br>$V^+$ = 5V<br>$V^+$ = 10V<br>$V^+$ = 15V<br>$V^+$ = 5V | | <br>2.0<br><br>50<br>75<br>100<br>1.0 | <br>5.0<br><br><br><br><br>3.0 | <br>%<br><br>ppm/°C<br>ppm/°C<br>ppm/°C<br>%/V |
| Threshold Voltage | $V_{TH}$ | $V^+$ = 5V | 0.63 | 0.66 | 0.67 | $V^+$ |
| Trigger Voltage | $V_{TRIG}$ | $V^+$ = 5V | 0.29 | 0.33 | 0.34 | $V^+$ |
| **Trigger Current** | $I_{TRIG}$ | $V^+$ = 16.5V<br>$V^+$ = 5V<br>$V^+$ = 2V | | 50<br>10<br>1 | | pA<br>pA<br>pA |
| **Threshold Current** | $I_{TH}$ | $V^+$ = 16.5V<br>$V^+$ = 5V<br>$V^+$ = 2V | | 50<br>10<br>1 | | pA<br>pA<br>pA |
| **Reset Current** | $I_{RST}$ | $V_{RESET}$ = Ground $V^+$ = 16.5V<br>$V^+$ = 5V<br>$V^+$ = 2V | | 100<br>20<br>2 | | pA<br>pA<br>pA |
| Reset Voltage | $V_{RST}$ | $V^+$ = 16.5V<br>$V^+$ = 2V | 0.4<br>0.4 | 0.7<br>0.7 | 1.2<br>1.2 | V<br>V |
| Control Voltage | $V_{CV}$ | $V^+$ = 5V | 0.62 | 0.66 | 0.67 | $V^+$ |
| **Output Voltage Drop** | $V_O$ | Output Lo $V^+$ = 16.5V $I_{SINK}$ = 3.2mA<br>$V^+$ = 5V $I_{SINK}$ = 3.2mA<br>**Output Hi** $V^+$ = 16.5V $I_{SOURCE}$ = 2.0mA<br>$V^+$ = 5V $I_{SOURCE}$ = 2.0mA | <br><br>15.75<br>4.0 | 0.1<br>0.15<br>16.25<br>4.5 | 0.4<br>0.4 | V<br>V<br>V<br>V |
| **Discharge Output Voltage** | $V_{DIS}$ | $V^+$ = 5V, $I_{DIS}$ = 3.2mA | | 0.1 | 0.4 | V |
| Rise Time of Output (Note 4) | $t_r$ | $R_L$ = 10MΩ $C_L$ = 10pF $V^+$ = 5V | 35 | 40 | 75 | ns |
| Fall Time of Output (Note 4) | $t_f$ | $R_L$ = 10MΩ $C_L$ = 10pF $V^+$ = 5V | 35 | 40 | 75 | ns |
| Guaranteed Max Osc. Freq. (Note 4) | $f_{max}$ | Astable Operation | 500 | | | kHz |

**Note 1:** Due to the SCR structure inherent in the CMOS process used to fabricate these devices, connecting any terminal to a voltage greater than $V^+$ +0.3V or less than $V^-$ −0.3V may cause destructive latchup. For this reason it is recommended that no inputs from external sources not operating from the same power supply be applied to the device before its power supply is established. In multiple systems, the supply of the ICM7555/6 must be turned on first.

**Note 2:** Junction temperatures should not exceed 135°C and the power dissipation must be limited to 20mW at 125°C. Below 125°C power dissipation may be increased to 300mW at 25°C. Derating factor is approximately 3mW/°C (7556) or 2mW/°C (7555).

**Note 3:** The supply current value is essentially independent of the TRIGGER, THRESHOLD AND RESET voltages.

**Note 4:** Parameter is not 100% tested. Majority of all units meet this specification.

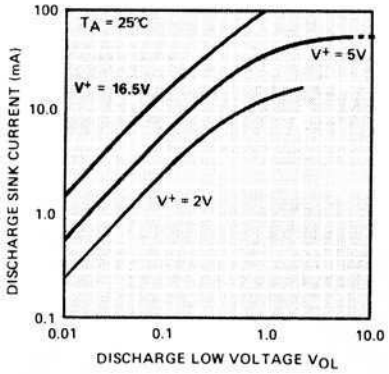
**Note 5:** Deviation from $f = 1.46/(R_A + 2R_B)C$, $V^+$ = 5V.

**Note 6:** All pins are designed to withstand electrostatic discharge (ESD) levels in excess of 2000V. (Mil Std 883B, Method 3015.1 Test Circuit.)

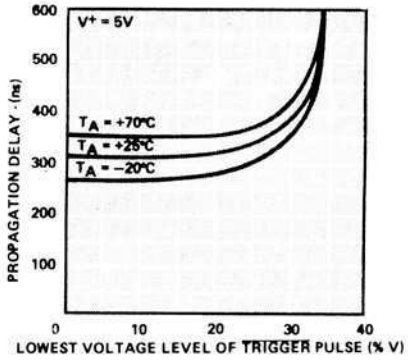
# General Purpose Timers

## Typical Operating Characteristics

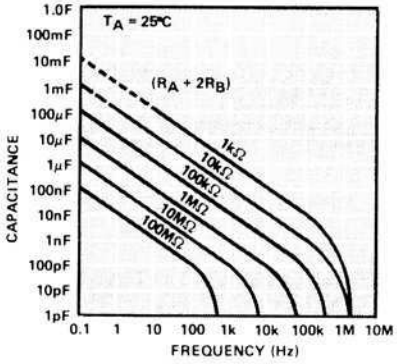
### DISCHARGE OUTPUT CURRENT AS A FUNCTION OF DISCHARGE OUTPUT VOLTAGE



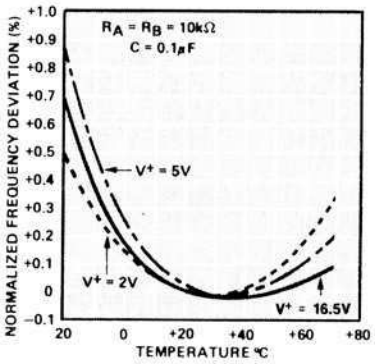

### PROPAGATION DELAY AS A FUNCTION OF VOLTAGE LEVEL OF TRIGGER PULSE



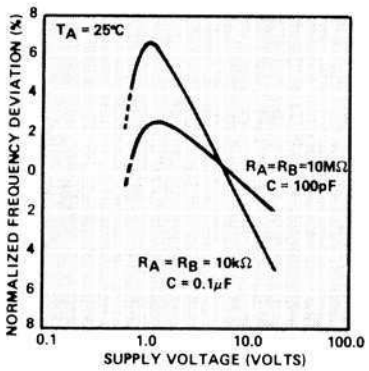

### FREE RUNNING FREQUENCY AS A FUNCTION OF $R_A$, $R_B$ AND C



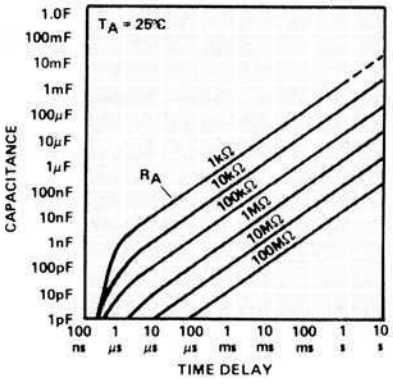

### NORMALIZED FREQUENCY STABILITY IN THE ASTABLE MODE AS A FUNCTION OF TEMPERATURE




### NORMALIZED FREQUENCY STABILITY IN THE ASTABLE MODE AS A FUNCTION OF SUPPLY VOLTAGE




### TIME DELAY IN THE MONOSTABLE MODE AS A FUNCTION OF $R_A$ AND C

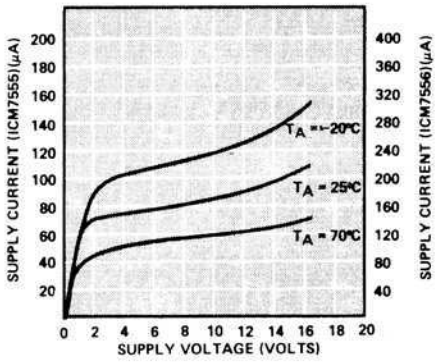




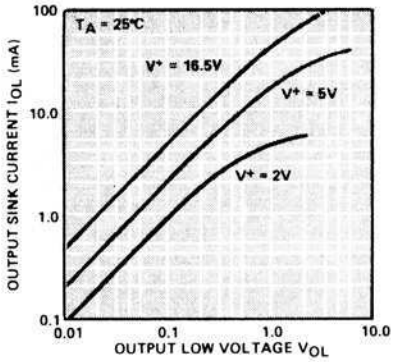

MAXIM

## Typical Operating Characteristics

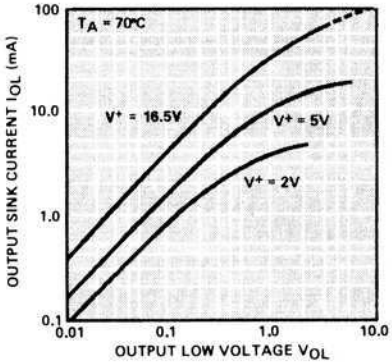
SUPPLY CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



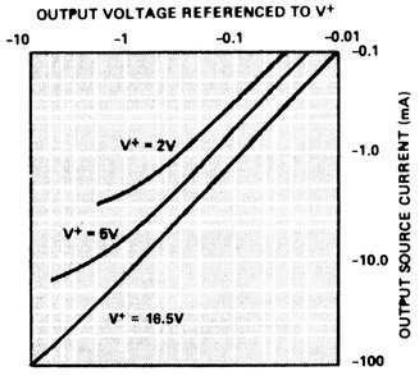

OUTPUT SINK CURRENT AS A FUNCTION OF OUTPUT VOLTAGE



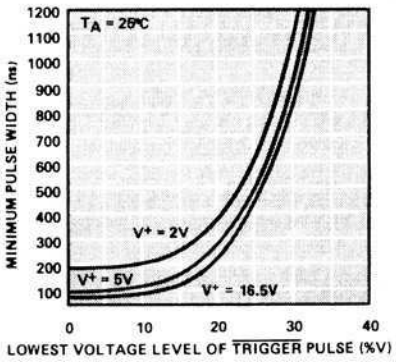

OUTPUT SINK CURRENT AS A FUNCTION OF OUTPUT VOLTAGE



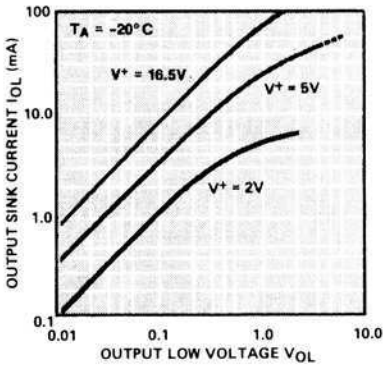

OUTPUT SOURCE CURRENT AS A FUNCTION OF OUTPUT VOLTAGE




MINIMUM PULSE WIDTH REQUIRED FOR TRIGGERING




OUTPUT SINK CURRENT AS A FUNCTION OF OUTPUT VOLTAGE



# General Purpose Timers

## Detailed Description

Both the ICM7555 timer and the ICM7556 dual timer can be configured for either astable or monostable operation. In the astable mode the free running frequency and the duty cycle are controlled by two external resistors and one capacitor. Similarly, the pulse width in the monostable mode is precisely controlled by one external resistor and capacitor.

The external component count is decreased when replacing a bipolar timer with the ICM7555 or ICM7556. The bipolar devices produce large crowbar currents in the output driver. To compensate for this spike, a capacitor is used to decouple the power supply lines. The CMOS timers produce supply spikes of only 2-3mA vs. 300-400mA (Bipolar), therefore supply decoupling is typically not needed. This current spike comparison is illustrated in Figure 3. Another component is eliminated at the control voltage pin. These CMOS timers, due to the high impedance inputs of the comparators, do not require decoupling capacitors on the control voltage pin.

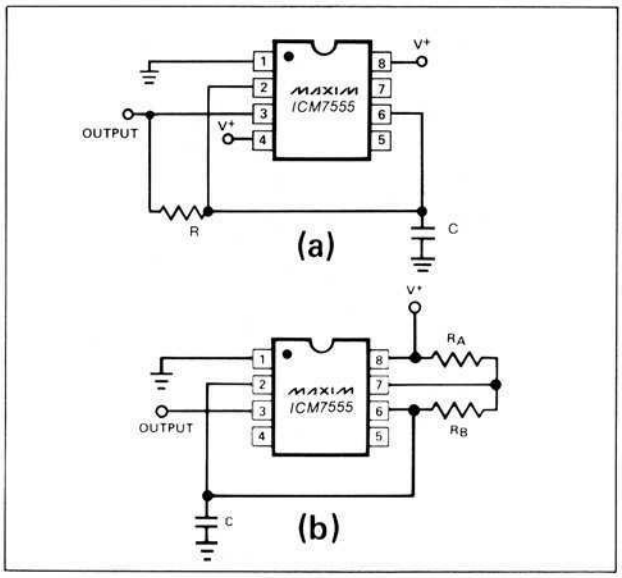



*Figure 1. Maxim ICM7555 used in two different astable configurations.*

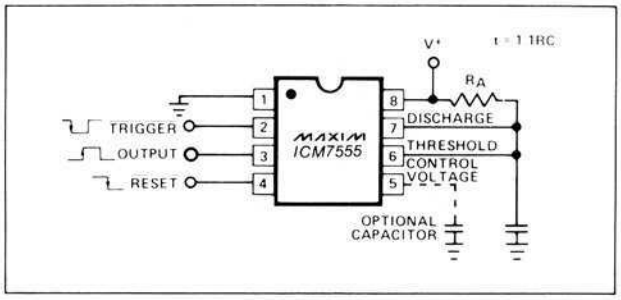



*Figure 2. Maxim ICM7555 in a monostable operation.*

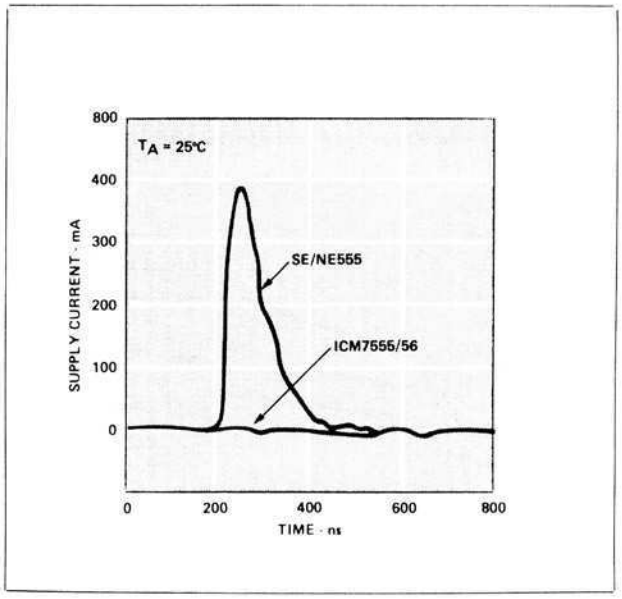



*Figure 3. Supply current transient compared with a standard bipolar 555 during an output transition.*

## Applications Information

### Astable Operation

We recommend either of the two astable circuit configurations illustrated in Figure 1. The circuit in (1a) provides a 50% duty cycle output using one timing resistor and capacitor. The oscillator waveform across the capacitor is symmetrical and triangular, swinging from ⅓ to ⅔ of the supply voltage. The frequency generated is defined by:

$$f = \frac{1}{1.4\ RC}$$

The circuit in (1b) provides a means of varying the duty cycle of the oscillator. The frequency is defined by:

$$f = \frac{1.46}{(R_A + 2R_B)C}$$

The duty cycle is:

$$D = \frac{R_B}{R_A + 2R_B}$$

### Monostable Operation

The circuit diagram in Figure 2 illustrates monostable operation. In this mode the timer acts as a one shot. Initially the external capacitor is held discharged by the discharge output. Upon application of a negative $\overline{\text{TRIGGER}}$ pulse to pin 2, the capacitor begins to charge exponentially through $R_A$. The device resets after the voltage across the capacitor reaches ⅔($V^+$).

$$t_{output} = -\ln(⅓)R_AC = 1.1\ R_AC$$

### Reset

The reset function is significantly improved over the standard bipolar 555 and 556 in that it controls only the internal flip-flop, which in turn simultaneously controls the state of the Output and Discharge pins. This avoids the multiple threshold problems sometimes encountered with slow-falling edges of the bipolar devices. This input is designed to have essentially the same trip voltage as the standard bipolar devices (0.6 to 0.7V). At all supply voltages this input maintains an extremely high impedance.

### Control Voltage

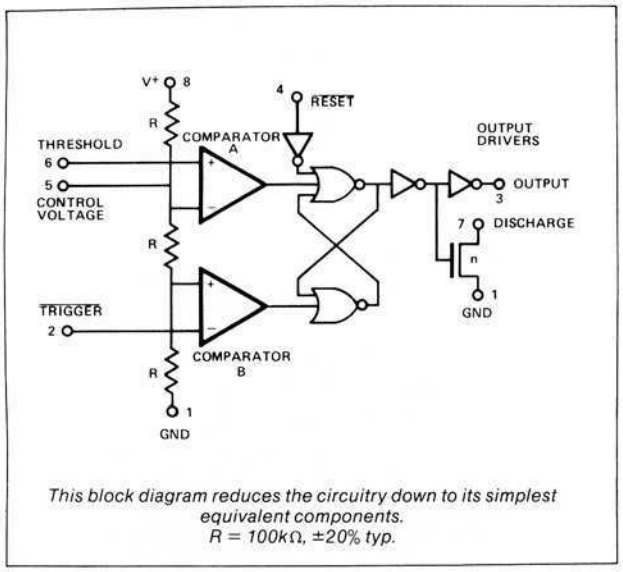
The control voltage regulates the two trip voltages for the THRESHOLD and $\overline{\text{TRIGGER}}$ internal comparators. This pin can be used for frequency modulation in the astable mode. By varying the applied voltage to the control voltage pin, delay times can be changed in the monostable mode.

### Power Supply Considerations

Since the $\overline{\text{TRIGGER}}$, THRESHOLD and Discharge leakage currents are very low, high impedance timing components may be used, keeping total system supply current at a minimum.

### Output Drive Capability

The CMOS output stage is capable of driving most logic families including CMOS and TTL. The ICM7555 and ICM7556 will drive at least two standard TTL loads at a supply voltage of 4.5V or greater. When driving CMOS, the output swing at all supply voltage levels will equal the supply voltage.




*This block diagram reduces the circuitry down to its simplest equivalent components.*
*R = 100kΩ, ±20% typ.*

*Figure 4. Block diagram of ICM7555.*

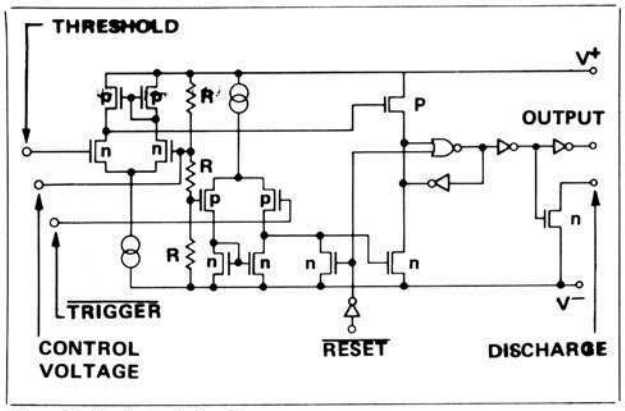



*Figure 5. Equivalent circuit.*

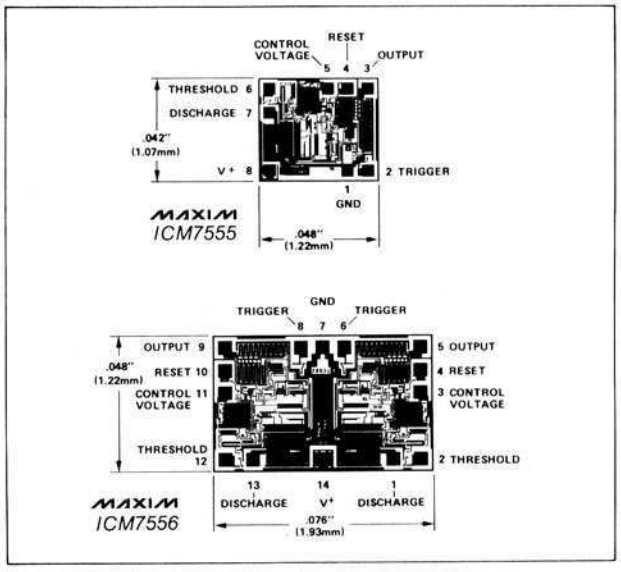
## Function Table

| RESET | TRIGGER VOLTAGE† | THRESHOLD VOLTAGE† | OUTPUT | DISCHARGE SWITCH |
|---|---|---|---|---|
| Low | Irrelevant | Irrelevant | Low | On |
| High | $< \frac{1}{3} V^+$ | Irrelevant | High | Off |
| High | $> \frac{1}{3} V^+$ | $> \frac{2}{3} V^+$ | Low | On |
| High | $> \frac{1}{3} V^+$ | $< \frac{2}{3} V^+$ | As previously established | |

†Voltages levels shown are nominal.

**NOTE:** $\overline{\text{RESET}}$ will dominate all other inputs. $\overline{\text{TRIGGER}}$ will dominate over THRESHOLD.

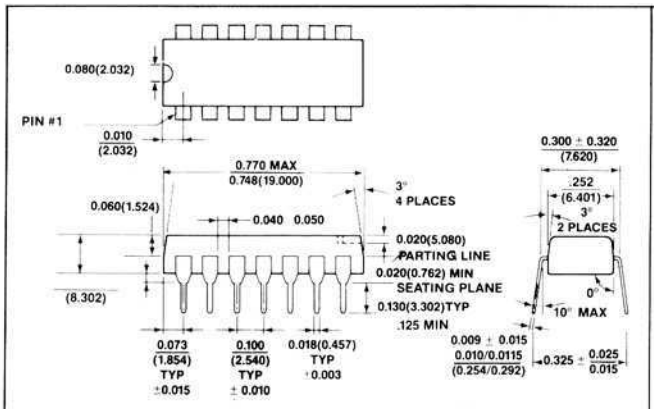
## Chip Topographies



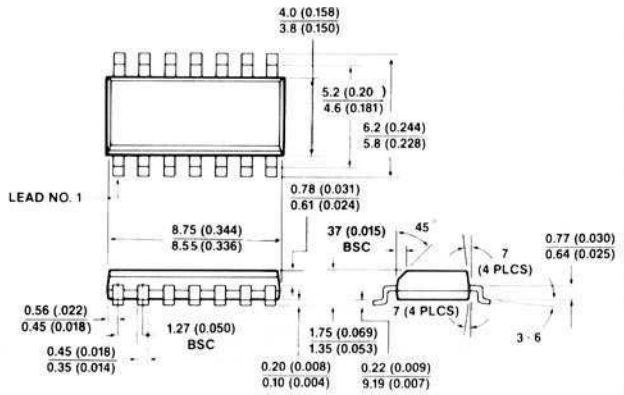
# General Purpose Timers

## Package Information

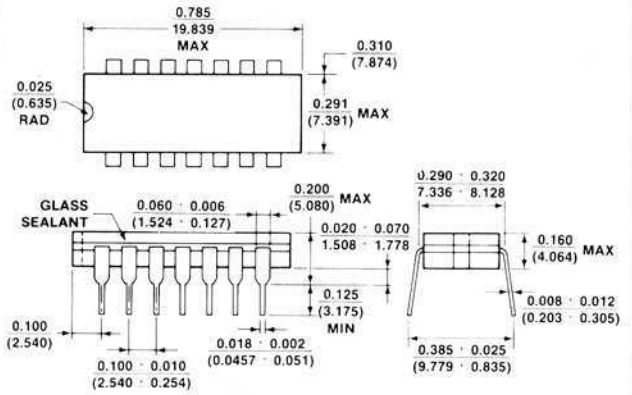
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)



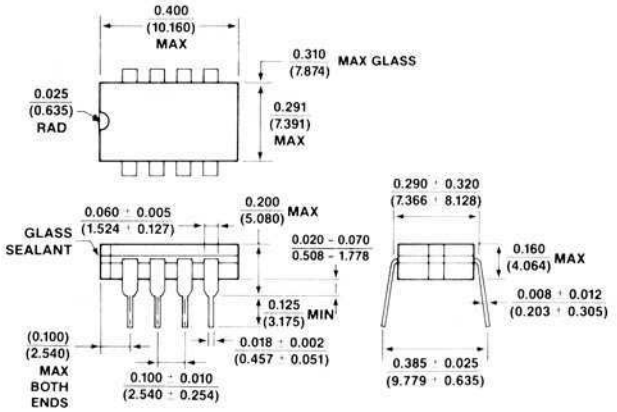

**14 Lead Plastic DIP (PD)**
$\theta_{JA}$ = 140° C/W
$\theta_{JC}$ = 70° C/W



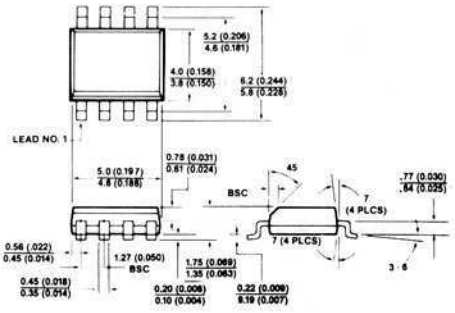

**14-Lead Small Outline (SO)**



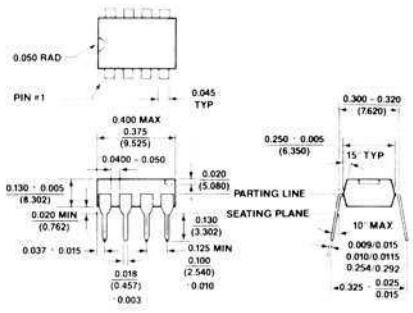

**14 Lead CERDIP (JD)**
$\theta_{JA}$ = 105° C/W
$\theta_{JC}$ = 50° C/W



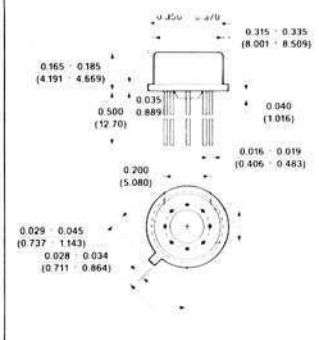

**8 Lead CERDIP (JA)**
$\theta_{JA}$ = 125° C/W
$\theta_{JC}$ = 55° C/W




**8-Lead Small Outline (SO)**




**8 Lead Plastic DIP (PA)**
$\theta_{JA}$ = 160° C/W
$\theta_{JC}$ = 75° C/W




**8 Lead TO-99 Can (TV)**
$\theta_{JA}$ = 150° C/W
$\theta_{JC}$ = 45° C/W