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SIGNETICS CORPORATION

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DESCRIPTION
The NE/SE 555 monolithic timing circuit is a highly stable controller capable of producing 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 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 circuit may be triggered and reset on falling waveforms, and the output structure can source or sink up to 200mA or drive TTL circuits.

FEATURES
• TIMING THROUGH NINE DECADES
• OPERATES IN BOTH ASTABLE AND MONOSTABLE MODES
• ADJUSTABLE DUTY CYCLE
• HIGH CURRENT OUTPUT CAN SOURCE OR SINK 200mA
• OUTPUT CAN DRIVE TTL
• TEMPERATURE STABILITY OF 0.05% PER °C
• NORMALLY ON AND NORMALLY OFF OUTPUT

APPLICATIONS
PRECISION TIMING
PULSE GENERATION
SEQUENTIAL TIMING
TIME DELAY GENERATION
PULSE WIDTH MODULATION
PULSE POSITION MODULATION
MISSING PULSE DETECTOR

ABSOLUTE MAXIMUM RATINGS
Supply Voltage +18V
Power Dissipation 600 mW
Operating Temperature Range
NE555 0°C to +70°C
SE555 -55°C to +125°C
Storage Temperature Range
-65°C to +150°C
Lead Temperature (Soldering, 60 seconds) +300°C
ELECTRICAL CHARACTERISTICS \( T_A = 25^\circ C, V_{CC} = +5V \) to +15V unless otherwise specified

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>SE 555</th>
<th>NE 555</th>
<th>UNITS</th>
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<td>TYP</td>
<td>MAX</td>
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<td>6</td>
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<td>Drift with Temperature</td>
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<td>Drift with Supply Voltage</td>
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<td>0.2</td>
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<td></td>
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<tr>
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<td>2/3</td>
<td></td>
<td>2/3</td>
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<td>Supply Current</td>
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<tr>
<td>Supply Current</td>
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<td></td>
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<td>Supply Current</td>
<td>0.1</td>
<td>0.25</td>
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<td>0.1</td>
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<td>Supply Current</td>
<td>12.5</td>
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<td>Supply Current</td>
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<td>Supply Current</td>
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<tr>
<td>Supply Current</td>
<td>100</td>
<td>100</td>
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</tbody>
</table>

NOTES:
1. Supply Current when output high typically 1mA max.
2. Tested at \( V_{CC} = 5V \) and \( V_{CC} = 15V \)
3. This will determine the maximum value of \( R_A + R_B \). For 15V operation, the max total \( R = 30 \) megohm.

EQUIVALENT CIRCUIT (Shown for One Side Only)
DESCRIPTION
The NE/SE556 Dual Monolithic timing circuit is a highly stable controller capable of producing accurate time delays or oscillation. The 556 is a dual 555. Timing is provided by an external resistor and capacitor for each timing function. The two timers operate independently of each other sharing only Vcc and ground. The circuits may be triggered and reset on falling waveforms. The output structures may sink or source 150mA.

FEATURES
• TIMING THROUGH NINE DECADES
• REPLACES TWO 555 TIMERS
• OPERATES IN BOTH ASTABLE, MONOSTABLE, TIME DELAY MODES
• HIGH OUTPUT CURRENT
• ADJUSTABLE DUTY CYCLE
• TTL COMPATIBLE
• TEMPERATURE STABILITY OF 0.05% PER °C

APPLICATIONS
PRECISION TIMING
SEQUENTIAL TIMING
PULSE SHAPING
PULSE GENERATOR
MISSING PULSE DETECTOR
TONE BURST GENERATOR
PULSE WIDTH MODULATION
TIME DELAY GENERATOR
FREQUENCY DIVISION
INDUSTRIAL CONTROLS
PULSE POSITION MODULATION
APPLIANCE TIMING
TRAFFIC LIGHT CONTROL
TOUCH TONE ENCODER

ABSOLUTE MAXIMUM RATINGS
Supply Voltage +18V
Power Dissipation 600mW
Operating Temperature Range NE556 0°C to +70°C
SE556 -55°C to +125°C
SE556C -55°C to +125°C
Storage Temperature Range -65°C to +125°C
Lead Temperature (Soldering, 60 sec) +300°C

BLOCK DIAGRAM
### SIGNETICS DUAL TIMER • 556

**ELECTRICAL CHARACTERISTICS**

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>SE 556</th>
<th>NE 556</th>
<th>UNITS</th>
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</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
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<td>MIN</td>
<td>TYP</td>
<td>MAX</td>
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<td>Supply Current</td>
<td>$V_{CC} = 5V$</td>
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<td>4.5</td>
<td>16</td>
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<td></td>
<td>$R_I = \infty$</td>
<td>4.5</td>
<td>4.5</td>
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<td>Initial Accuracy</td>
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<td>1.5</td>
<td>0.75</td>
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<td>Drift with Temperature</td>
<td>$V_{CC} = 15V$</td>
<td>30</td>
<td>100</td>
<td>50</td>
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<tr>
<td>Drift with Supply Voltage</td>
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<td>0.05</td>
<td>0.2</td>
<td>0.1</td>
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<td>Timing Error (Astable)</td>
<td>$R_A = 2K\Omega$ to 100K$</td>
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<td>2.25</td>
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<td>Initial Accuracy</td>
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<td>Threshold Voltage</td>
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<tr>
<td>Trigger Voltage</td>
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<td>$V_{CC} = 5V$</td>
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<td>Trigger Current</td>
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<td>Reset Voltage</td>
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<td>1</td>
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<tr>
<td>Reset Current</td>
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<td>0.1</td>
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<tr>
<td>Control Voltage Level</td>
<td>$V_{CC} = 15V$</td>
<td>9.6</td>
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<tr>
<td></td>
<td>$V_{CC} = 5V$</td>
<td>2.9</td>
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<td>Output Voltage Drop (low)</td>
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<td>0.15</td>
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<tr>
<td></td>
<td>$\text{SINK} = 10mA$</td>
<td>0.4</td>
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<tr>
<td></td>
<td>$\text{SINK} = 50mA$</td>
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<td>$\text{SINK} = 100mA$</td>
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<td>$\text{SINK} = 200mA$</td>
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<td>$\text{SINK} = 8mA$</td>
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<td></td>
<td>$\text{SINK} = 5mA$</td>
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<td>Output Voltage Drop (high)</td>
<td>$\text{SOURCE} = 200mA$</td>
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<td>12.5</td>
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<tr>
<td></td>
<td>$V_{CC} = 15V$</td>
<td>13.0</td>
<td>13.3</td>
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<tr>
<td></td>
<td>$\text{SOURCE} = 100mA$</td>
<td>3.0</td>
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<td>2.75</td>
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<td>Rise Time of Output</td>
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<td>Fall Time of Output</td>
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<td>Discharge Leakage Current</td>
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<td>Matching Characteristics</td>
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<td>(Note 4)</td>
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<tr>
<td>Timing Drift with Temperature</td>
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<tr>
<td>Drift with Supply Voltage</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**NOTES**

1. Supply current when output is high is typically 1.0mA low.
2. Tested at $V_{CC} = 5V$ and $V_{CC} = 15V$.
3. This will determine the maximum value of $R_A = R_B$ for 15V operation. The maximum total $R = 20$ megohms.
4. Matching characteristics refer to the difference between performance characteristic of each timer section.

---

**EQUIVALENT CIRCUIT** (Shown for One Side Only)

**TYPICAL CHARACTERISTICS**

**MINIMUM PULSE WIDTH REQUIRED FOR TRIGGERING**

**SUPPLY CURRENT vs SUPPLY VOLTAGE**

**LOW OUTPUT VOLTAGE vs OUTPUT SINK CURRENT**

**HIGH OUTPUT VOLTAGE vs SOURCE CURRENT**
APPLICATIONS INFORMATION
MONOSTABLE OPERATION

In this mode of operation, the timer functions as a one-shot. Referring to Figure 1a, the external capacitor is initially held discharged by a transistor inside the timer. Upon application of a negative trigger pulse to pin 2, the flip-flop is set which releases the short circuit across the external capacitor and drives the output high. The voltage across the capacitor, now, increases exponentially with the time constant \( R \text{C} \). When the voltage across the capacitor equals 2/3 \( V_{CC} \), the comparator resets the flip-flop which in turn discharges the capacitor rapidly and drives the output to its low state. Figure 1b shows the actual waveforms generated in this mode of operation.

The circuit triggers on a negative going input signal when the level reaches 1/3 \( V_{CC} \). Once triggered, the circuit will remain in this state until the set time is elapsed, even if it is triggered again during this interval. The time that the output is in the high state is given by \( t = \frac{1}{3} R \text{C} \) and can easily be determined by Figure 1c. Notice that since the charge rate, and the threshold level of the comparator are both directly proportional to supply voltage, the timing interval is independent of supply. Applying a negative pulse simultaneously to the reset terminal (pin 4) and the trigger terminal (pin 2) during the timing cycle discharges the external capacitor and causes the cycle to start over again. The timing cycle will now commence on the positive edge of the reset pulse. During the time the reset pulse is applied, the output is driven to its low state.

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.

ASTABLE OPERATION

If the circuit is connected as shown in Figure 2a (pins 2 and 6 connected) it will trigger itself and free run as a multivibrator. The external capacitor charges through \( R_A \) and discharges through \( R_B \) only. Thus the duty cycle may be precisely set by the ratio of these two resistors.
The charge time (output high) is given by:
\[ t_1 = 0.693 \left( \frac{R_A + R_B}{C} \right) \]
and the discharge time (output low) by:
\[ t_2 = 0.693 \left( \frac{R_B}{C} \right) \]
Thus the total period is given by:
\[ T = t_1 + t_2 = 0.693 \left( \frac{R_A + 2R_B}{C} \right) \]
The frequency of oscillation is then:
\[ f = \frac{1}{T} = \frac{1.44}{R_A + 2R_B} \]
and may be easily found by Figure 2c.
The duty cycle is given by:
\[ D = \frac{R_B}{R_A + 2R_B} \]

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 2b shows actual waveforms generated in this mode of operation:

The device triggers on the negative going edge of a low going pulse. The trigger pulse must be of shorter duration than the "RC" time interval. If the trigger is held low, the output will stay high until trigger is driven high again.

The 556 timer is capable of oscillating at up to 1000 kHz; however, for temperature stability the limit should be around 200 kHz.
RESET VOLTAGE

The reset acts as an inhibit. When the reset (Pin 4) is above 1 volt the device is free to function. If the reset is taken below 4 volts, the output is forced low. When the reset is released, the output will still remain low until a trigger pulse is applied.

INITIAL ACCURACY

The initial accuracy is the timing repeatability from device to device and also the same device today, tomorrow and 3 years from now, with the same “RC” network and supply voltage. Typically, the NE555 has a 1% initial accuracy.

THE INITIALLY GUARANTEED RESET VOLTAGE IS NOT TO BE SEEN AS A SHUNT HAVING A VOLTAGE OF 1 Volt ≤ Vcc 4 Vols.

RESET

THE OUTPUT IS FORCED LOW.

WHEN THE RESET IS RELEASED, THE OUTPUT WILL STILL REMAIN LOW UNTIL A TRIGGER PULSE IS APPLIED.

INITIAL ACCURACY

THE INITIAL ACCURACY IS THE TIMING REPEATABILITY FROM DEVICE TO DEVICE AND ALSO THE SAME DEVICE TODAY, TOMORROW AND 3 YEARS FROM NOW, WITH THE SAME "RC" NETWORK AND SUPPLY VOLTAGE. TYPICALLY, THE NE555 HAS A 1% INITIAL ACCURACY.
THE TIMING OF THE DEVICE WILL VARY SLIGHTLY WITH CHANGE IN SUPPLY VOLTAGE. THE TYPICAL TIMING DRIFT IS 0.1% PER VOLT.

THE TIMER IN THE MONOSTABLE MODE HAS A TIMING DRIFT OF 50 ppm/°C TYPICAL. IN THE ASTABLE MODE, SINCE BOTH COMPARATORS OF THE DEVICE ARE USED, THE DRIFT IS SOMEWHAT GREATER, TYPICALLY 150 ppm/°C DRIFT.

THE DUTY CYCLE IS "ON TIME" EXPRESS IN TERMS OF TOTAL CYCLE TIME. THE DUTY CYCLE IS LIMITED, UNDER NORMAL CIRCUMSTANCES, TO 50%. HOWEVER, BY ADDING A DIODE A DUTY CYCLE OF LESS THAN 50% CAN BE ACHIEVED.

A NEGATIVE VOLTAGE AT PIN 3 CAN CAUSE A LATCH UP. THE SOLUTION IS TO ADD TWO DIODES AS SHOWN. THIS CIRCUIT PROHIBITS A NEGATIVE VOLTAGE FROM REACHING PIN 3.
PIN 5, THE CONTROL VOLTAGE PIN, IS PRIMARILY USED FOR FILTERING WHEN DEVICE IS USED IN NOISY ENVIRONMENTS. HOWEVER, BY IMPOSING A VOLTAGE AT THIS POINT, IT IS POSSIBLE TO VARY THE TIMING OF THE DEVICE INDEPENDENTLY OF THE "RC" NETWORK. THE CONTROL VOLTAGE MAY BE VARIED FROM 45° TO 90° OF VQC IN THE MONOSTABLE MODE, AND FROM 1.7 VOLTS TO VCC IN THE ASTABLE MODE.

MISSING PULSE DETECTOR

Using the circuit of Figure 3a, the timing cycle is continuously reset by the input pulse train. A change in frequency, or a missing pulse, allows completion of the timing cycle which causes a change in the output level. For this application, the time delay should be set to be slightly longer than the normal time between pulses. Figure 3b shows the actual waveforms seen in this mode of operation.

FREQUENCY DIVIDER

If the input frequency is known, the timer can easily be used as a frequency divider by adjusting the length of the timing cycle. Figure 4 shows the waveforms of the timer in Figure 1a when used as a divide by three circuit. This application makes use of the fact that this circuit cannot be retriggered during the timing cycle.

PULSE WIDTH MODULATION (PWM)

In this application, the timer is connected in the monostable mode as shown in Figure 5a. The circuit is triggered with a continuous pulse train and the threshold voltage is
APPLICATIONS INFORMATION (Cont'd)

modulated by the signal applied to the control voltage terminal (pin 5). This has the effect of modulating the pulse width as the control voltage varies. Figure 5b shows the actual waveforms generated with this circuit.

![Waveforms](image)

**APPLICATIONS INFORMATION**

Each half of the 555 behaves like a separate 555 timer and as such all of the applications indicated in the Data Sheet for the 555 also are applicable to the 556.

**LONG TIME DELAYS**

In the 556 timer the timing is a function of the charging rate of the external capacitor. For long time delays expensive capacitors with extremely low leakage are required. The practicality of the components involved limits the time between pulses to something in the neighborhood of ten minutes.

To achieve longer time periods both halves may be connected in tandem with a "Divide-by-N" network to give an output with the period of N/f0. This can then be used to trigger the second half of the 556. The total time delay is now a function of N and f0.

**APPLICATIONS INFORMATION**

![Waveforms](image)

**TONE BURST GENERATOR**

The 556 Dual Timer makes an excellent Tone Burst Generator. The first half is connected as a one shot and the second half as an oscillator.

The pulse established by the one shot turns on the oscillator allowing a burst of pulses to be generated.

![Waveforms](image)

**SEQUENTIAL TIMING**

One feature of the Dual Timer is that by utilizing both halves it is possible to obtain sequential timing. By connecting the output of the first half to the input of the second half via a 0.01µfd coupling capacitor sequential timing may be obtained. Delay t1 is determined by the first half and t2 by the second half delay.

![Waveforms](image)
APPLICATIONS (Cont'd)

DUAL ASTABLE

This circuit maintains the temperature stability of the monostable mode for astable operation. It also allows a load to be driven in push-pull.

TOUCH CONTROL

The 27k resistor is suitable for industrial or public environments, with lower ambient noise. A higher value of resistor may be necessary.
**BURGLAR ALARM**

The small inductor in the load is to reduce voltage spikes at switch-on. It may be omitted if mains spikes can be tolerated. To reduce radiated noise further, the triac may be driven from a gated zero-crossing switch.

**PHOTOCURRENT TIMER**

The interruption of incident light to the phototransistor causes current to flow through the load.

**TTL MONOSTABLE**

This circuit has superior timing accuracy to conventional TTL monostables. The 4.7kΩ resistor may be replaced by a diode, having the cathode to the gate.

**LINEAR PULSE WIDTH MODULATOR**

The 15V supply must be well-regulated.
APPLICATIONS (Cont'd)

SPEED WARNING DEVICE

The input pulse train is derived from a transducer sensing the vehicle propeller shaft. The output of the second timer goes low when a preset speed is exceeded.

OPERATING WAVEFORMS

REMOTE CONTROLLED DC SWITCHING REGULATOR

AUTOMATIC TURN OFF FOR TV SET
WASHER TIMER

AUTO BURGLAR ALARM

SWITCHING STEP-DOWN REGULATOR

SCHEMATIC DIAGRAM OF DELAYED LIGHT TURN-OFF

FIGURE 1

FIGURE 2
INTERNATIONAL SALES

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Phone: 604-2307 TELEX: 26801

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Signetics GmbH, Gustavstr. 29, D-B Munchen 19
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Signetics GmbH, Ernst-Haschadlebenstrasse 17, D 7 Stuttgart
Phone: (0711) 73-60-61 TELEX: 7285998
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