QUAD PRECISION HIGH SPEED MICROPPOWER TIMER

GENERAL DESCRIPTION
The ALD4501 timer is a high performance QUAD monolithic timing circuit built with advanced silicon gate CMOS technology. It offers the benefits of high input impedance, thereby allowing smaller timing capacitors and longer timing cycle; high speed with typical cycle time of 500ns; low power dissipation for battery operated environment; and reduced supply current spikes allowing smaller and lower cost decoupling capacitors. Each of the four timers can be independently operated in either the monostable, astable, or 50% duty cycle mode.

Each timer is capable of producing accurate time delays and oscillations in both monostable and astable operation. It operates in the one-shot (monostable) mode or 50% duty cycle free running oscillation mode with a single resistor and one capacitor. The inputs and outputs are fully compatible with CMOS, NMOS or TTL logic.

There are three matched internal resistors (approximately 200KΩ each) that set the threshold and trigger levels at two-thirds and one-third respectively of V+. These levels can be adjusted by using the control terminal. When the trigger input is below the trigger level, the output is in the high state and sourcing 2mA. When the threshold input is above the threshold level at the same time the trigger input is above the trigger level, the internal flip-flop is reset, the output goes to the low state and sinks up to 10mA. The reset input overrides all other inputs and when it is active (reset voltage less than 1V), the output is in the low state. All four timers share the same control and reset pins so that timing functions are synchronized.

FEATURES
- High speed operation -- 2MHz typical oscillation at 5V
- Each discharge output sinking current: 40mA at 5V
- Guaranteed low operating supply voltage of 2 to 12V
- Each timer is functionally equivalent to NE555 with greatly expanded high and low frequency ranges
- High speed, low power, monolithic CMOS technology
- Low supply current: 150µA typical
- Extremely low trigger, threshold and reset currents: 10pA typical
- Operates in both monostable and astable modes
- Fixed 50% duty cycle or adjustable duty cycle
- CMOS, NMOS and TTL compatible input/output
- Low supply current spikes

APPLICATIONS.
- High speed one-shot (monostable) pulse generation
- Precision timing
- Sequential timing
- Long delay timer
- Pulse width and pulse position modulation
- Missing pulse detector
- Frequency divider
- Synchronized timer

PIN CONFIGURATION

<table>
<thead>
<tr>
<th>RST</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISC1</td>
<td>2</td>
</tr>
<tr>
<td>TRIG1</td>
<td>3</td>
</tr>
<tr>
<td>DISC2</td>
<td>4</td>
</tr>
<tr>
<td>TRIG2</td>
<td>5</td>
</tr>
<tr>
<td>DISC3</td>
<td>6</td>
</tr>
<tr>
<td>TRIG3</td>
<td>7</td>
</tr>
<tr>
<td>DISC4</td>
<td>8</td>
</tr>
<tr>
<td>TRIG4</td>
<td>9</td>
</tr>
<tr>
<td>V-</td>
<td>10</td>
</tr>
<tr>
<td>V+</td>
<td>11</td>
</tr>
<tr>
<td>OUT1</td>
<td>12</td>
</tr>
<tr>
<td>THRES1</td>
<td>13</td>
</tr>
<tr>
<td>OUT2</td>
<td>14</td>
</tr>
<tr>
<td>THRES2</td>
<td>15</td>
</tr>
<tr>
<td>OUT3</td>
<td>16</td>
</tr>
<tr>
<td>THRES3</td>
<td>17</td>
</tr>
<tr>
<td>OUT4</td>
<td>18</td>
</tr>
<tr>
<td>THRES4</td>
<td>19</td>
</tr>
<tr>
<td>CONT</td>
<td>20</td>
</tr>
</tbody>
</table>

ORDERING INFORMATION (*L* suffix denotes lead-free (RoHS))

<table>
<thead>
<tr>
<th>0°C to +70°C</th>
<th>0°C to +70°C</th>
<th>-55°C to +125°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-Pin Small Outline Package (SOIC)</td>
<td>20-Pin Plastic Package</td>
<td>20-Pin CERDIP Package</td>
</tr>
</tbody>
</table>

ALD4501SEL | ALD4501PEL | ALD4501DE

* Contact factory for leaded (non-RoHS) or high temperature versions.

Rev 2.0 ©2010 Advanced Linear Devices, Inc. 415 Tasman Drive, Sunnyvale, CA 94089-1706 Tel: (408) 747-1155 Fax: (408) 747-1286 www.aldinc.com
### Absolute Maximum Ratings

- **Supply voltage, \( V^+ \):** 13.2V
- **Input voltage range:** -0.3V to \( V^+ \) +0.3V
- **Power dissipation:** 600 mW
- **Operating temperature range:**
  - SEL, PEL packages: 0°C to +70°C
  - DE package: -55°C to +125°C
- **Storage temperature range:** -65°C to +150°C
- **Lead temperature, 10 seconds:** +260°C

### Operating Electrical Characteristics

**\( T_A = 25^\circ C \) \( V^+ = +5V \) unless otherwise specified**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>( V^+ )</td>
<td>2</td>
<td>12</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Supply Current</td>
<td>( I_S )</td>
<td>150</td>
<td>270</td>
<td></td>
<td>( \mu A )</td>
<td>Outputs Unloaded</td>
</tr>
<tr>
<td>Timing error / Astable mode Initial Accuracy</td>
<td>( t_{err} )</td>
<td>1.0</td>
<td>2.6</td>
<td></td>
<td>%</td>
<td>( C = 0.1\mu F )</td>
</tr>
<tr>
<td>Drift with Temperature (^1)</td>
<td>( \frac{\Delta t}{\Delta T} )</td>
<td>10.0</td>
<td>0.1</td>
<td></td>
<td>ppm/°C</td>
<td>( R_A = 1K\Omega )( R_B = 1K\Omega )</td>
</tr>
<tr>
<td>Drift with Supply Voltage (^1)</td>
<td>( \Delta V )</td>
<td>1.0</td>
<td>0.1</td>
<td></td>
<td>%/V</td>
<td></td>
</tr>
<tr>
<td>Threshold Voltage</td>
<td>( V_{TH} )</td>
<td>3.233</td>
<td>3.333</td>
<td>3.433</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Trigger Voltage</td>
<td>( V_{TRIG} )</td>
<td>1.567</td>
<td>1.667</td>
<td>1.767</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Trigger Current (^2)</td>
<td>( I_{TRIG} )</td>
<td>.01</td>
<td></td>
<td>0.4</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Reset Voltage</td>
<td>( V_{RST} )</td>
<td>0.4</td>
<td>0.7</td>
<td></td>
<td>1.0</td>
<td>V</td>
</tr>
<tr>
<td>Reset Current (^2)</td>
<td>( I_{RST} )</td>
<td>.01</td>
<td></td>
<td>0.4</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Threshold Current (^2)</td>
<td>( I_{TH} )</td>
<td>.01</td>
<td></td>
<td>0.4</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Control Voltage Level</td>
<td>( V_{CONT} )</td>
<td>3.233</td>
<td>3.333</td>
<td>3.433</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output Voltage Drop (Low)</td>
<td>( V_{OL} )</td>
<td>0.2</td>
<td></td>
<td>0.4</td>
<td>V</td>
<td>( I_{SINK} = 10mA )</td>
</tr>
<tr>
<td>Output Voltage Drop (High)</td>
<td>( V_{OH} )</td>
<td>4.2</td>
<td>4.6</td>
<td></td>
<td>V</td>
<td>( I_{SOURCE} = -2mA )</td>
</tr>
<tr>
<td>Rise Time of Output (^1)</td>
<td>( t_r )</td>
<td>10</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>( R_L = 10M\Omega )</td>
</tr>
<tr>
<td>Fall Time of Output (^1)</td>
<td>( t_f )</td>
<td>10</td>
<td></td>
<td>20</td>
<td>ns</td>
<td>( C_L = 10pF )</td>
</tr>
<tr>
<td>Discharge Transistor Leakage Current</td>
<td>( I_{DL} )</td>
<td>.01</td>
<td></td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Discharge Voltage Drop</td>
<td>( V_{DISC} )</td>
<td>0.5</td>
<td>0.2</td>
<td>1.0</td>
<td>V</td>
<td>( I_{DISCHARGE} = 40mA )( I_{DISCHARGE} = 15mA )</td>
</tr>
<tr>
<td>Maximum Frequency Astable Mode</td>
<td>( f_{MAX} )</td>
<td>2</td>
<td></td>
<td></td>
<td>MHz</td>
<td>( R_A = 470\Omega )( R_B = 200\Omega )( C_T = 100pF )</td>
</tr>
<tr>
<td>Minimum Trigger Pulse Width (^2)</td>
<td>( t_{TRIG} )</td>
<td>50</td>
<td></td>
<td>100</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- \(^1\) Sample tested parameters.
- \(^2\) Consists of junction leakage currents with strong temperature dependence.
TYPICAL PERFORMANCE CHARACTERISTICS

**Time Delay in the Monostable Mode**

![Graph showing time delay as a function of RA and C]

- **TA = 25°C**
- **V* = 2V**
- **V* = 5V**
- **V* = 12V**

**Frequency Change in the Astable Mode**

![Graph showing frequency change as a function of supply voltage]

- Frequency (Hz)
  - 1.0
  - 1K
  - 10K
  - 100K
  - 1M
  - 10M
  - 100M

- Supply Voltage (V)
  - 0
  - 1
  - 2
  - 3
  - 4

**Minimum Pulse Width Required for Triggering**

![Graph showing minimum pulse width as a function of supply voltage]

- **TA = 25°C**
- **V* = 2V**
- **V* = 5V**
- **V* = 12V**

**Discharge Sink Current as a Function of Discharge Low Voltage**

![Graph showing discharge sink current]

- **TA = 25°C**
- **V* = 12V**
- **V* = 5V**
- **V* = 2V**

**Supply Current as a Function of Supply Voltage**

![Graph showing supply current]

- **TA = -40°C**
- **TA = 25°C**
- **TA = 85°C**

**Free Running Frequency as a Function of RA, RB and C**

![Graph showing free running frequency]

- Capacitance
  - 10 mF
  - 1 mF
  - 100 µF
  - 10 µF
  - 1 µF
  - 100 nF
  - 10 nF
  - 1 nF
  - 100 pF

- Frequency (Hz)
  - 0.1
  - 1
  - 10
  - 100
  - 1k
  - 10k
  - 100k
  - 1M
  - 10M
  - 100M

**Supply Current as a Function of Supply Voltage**

- Supply Voltage (V)
  - 0
  - 2
  - 4
  - 6
  - 8
  - 10
  - 12

- Supply Current (µA)
  - 0
  - 30
  - 60
  - 90
  - 120
  - 150
  - 180
  - 210
  - 240
  - 270
  - 300

**Discharge Output Sink Current as a Function of Discharge Low Voltage**

![Graph showing discharge sink current]

- **TA = 25°C**
- **V* = 12V**
- **V* = 5V**
- **V* = 2V**

**Lowest Voltage Level of Trigger Pulse (%)**

- **V+= 5V**
- **V+ = 12V**
- **V+ = 2V**

**Minimum Pulse Width Required for Triggering**

![Graph showing minimum pulse width]

- **TA = 25°C**
- **V* = 2V**
- **V* = 5V**
- **V* = 12V**

**Free Running Frequency as a Function of RA, RB and C**

- Frequency (Hz)
  - 1.0
  - 1K
  - 10K
  - 100K
  - 1M
  - 10M
  - 100M

- Capacitance
  - 10 mF
  - 1 mF
  - 100 µF
  - 10 µF
  - 1 µF
  - 100 nF
  - 10 nF
  - 1 nF
  - 100 pF

- Frequencies (% V+)
  - 0
  - 1
  - 2
  - 3
  - 4

**Time Delay in the Monostable Mode**

- **TA = 25°C**
- **R**
- **C**

- Time Delay (ns)
  - 0
  - 100
  - 200
  - 300
  - 400
  - 500
  - 600
  - 700

- Capacitance
  - 10 mF
  - 1 mF
  - 100 µF
  - 10 µF
  - 1 µF
  - 100 nF
  - 10 nF
  - 1 nF
  - 100 pF

- Time Delay (s)
  - 100ns
  - 1µs
  - 10µs
  - 100µs
  - 1ms
  - 10ms
  - 100ms
  - 1s
  - 10s
  - 100s
TYPICAL PERFORMANCE CHARACTERISTICS (cont'd)

**OUTPUT SINK CURRENT AS A FUNCTION OF OUTPUT VOLTAGE**

![Graph showing output sink current as a function of output voltage.]

**OUTPUT SOURCE CURRENT AS A FUNCTION OF OUTPUT VOLTAGE**

![Graph showing output source current as a function of output voltage.]

**TYPICAL APPLICATIONS**

**QUAD ASTABLE MODE OPERATION (FREE RUNNING OSCILLATOR)**

- Frequency \(f = \frac{1.46}{(RA + 2RB)}C\)
- Duty Cycle \(DC = \frac{RB}{(RA + 2RB)}\)

**QUAD MONOSTABLE MODE OPERATION (ONE SHOT PULSE)**

- Pulse Delay \(td = 1.1RC\)

**SYNCHRONIZED TIMING GENERATORS**

- Timer 4 oscillates in free running mode (50% Duty Cycle) and drives the trigger inputs of timers 1, 2, 3, each with independently set time delays.

- **Output Sinks Current (mA)**
  - \(V^+ = 2V\)
  - \(V^+ = 5V\)
  - \(V^+ = 12V\)

- **Output Sources Current (mA)**
  - \(V^+ = 2V\)
  - \(V^+ = 12V\)
  - \(V^+ = 5V\)
SOIC-20 PACKAGE DRAWING

20 Pin Plastic SOIC Package

<table>
<thead>
<tr>
<th>Dim</th>
<th>Millimeters</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.15 - 2.90</td>
<td>0.085  - 0.114</td>
</tr>
<tr>
<td>A₁</td>
<td>0.10 - 0.30</td>
<td>0.004  - 0.012</td>
</tr>
<tr>
<td>b</td>
<td>0.35 - 0.45</td>
<td>0.014  - 0.018</td>
</tr>
<tr>
<td>c</td>
<td>0.23 - 0.28</td>
<td>0.009  - 0.011</td>
</tr>
<tr>
<td>D-20</td>
<td>12.50 - 13.30</td>
<td>0.492  - 0.524</td>
</tr>
<tr>
<td>E</td>
<td>7.25 - 8.00</td>
<td>0.285  - 0.315</td>
</tr>
<tr>
<td>e</td>
<td>1.27 BSC</td>
<td>0.050 BSC</td>
</tr>
<tr>
<td>H</td>
<td>9.80 - 10.60</td>
<td>0.386  - 0.417</td>
</tr>
<tr>
<td>L</td>
<td>0.60 - 2.937</td>
<td>0.024  - 0.037</td>
</tr>
<tr>
<td>Ø</td>
<td>0°, 8°</td>
<td>0°, 8°</td>
</tr>
<tr>
<td>S</td>
<td>0.25 - 0.75</td>
<td>0.010  - 0.030</td>
</tr>
</tbody>
</table>
PDIP-20 PACKAGE DRAWING

20 Pin Plastic DIP Package

<table>
<thead>
<tr>
<th>Dim</th>
<th>Millimeters</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Min: 3.81</td>
<td>Max: 5.08</td>
</tr>
<tr>
<td>A1</td>
<td>Min: 0.38</td>
<td>Max: 1.27</td>
</tr>
<tr>
<td>A2</td>
<td>Min: 1.27</td>
<td>Max: 2.03</td>
</tr>
<tr>
<td>b</td>
<td>Min: 0.89</td>
<td>Max: 1.65</td>
</tr>
<tr>
<td>b1</td>
<td>Min: 0.38</td>
<td>Max: 0.51</td>
</tr>
<tr>
<td>c</td>
<td>Min: 0.20</td>
<td>Max: 0.30</td>
</tr>
<tr>
<td>D-20</td>
<td>Min: 24.89</td>
<td>Max: 26.92</td>
</tr>
<tr>
<td>E</td>
<td>Min: 5.59</td>
<td>Max: 7.11</td>
</tr>
<tr>
<td>E1</td>
<td>Min: 7.62</td>
<td>Max: 8.26</td>
</tr>
<tr>
<td>e</td>
<td>Min: 2.29</td>
<td>Max: 2.79</td>
</tr>
<tr>
<td>e1</td>
<td>Min: 7.37</td>
<td>Max: 7.87</td>
</tr>
<tr>
<td>L</td>
<td>Min: 2.79</td>
<td>Max: 3.81</td>
</tr>
<tr>
<td>S-20</td>
<td>Min: 1.02</td>
<td>Max: 2.03</td>
</tr>
<tr>
<td>θ</td>
<td>Min: 0°</td>
<td>Max: 15°</td>
</tr>
</tbody>
</table>
20 Pin CERDIP Package

<table>
<thead>
<tr>
<th>Dim</th>
<th>Millimeters</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.55</td>
<td>0.140</td>
</tr>
<tr>
<td>A1</td>
<td>1.27</td>
<td>0.050</td>
</tr>
<tr>
<td>b</td>
<td>0.97</td>
<td>0.038</td>
</tr>
<tr>
<td>b1</td>
<td>0.36</td>
<td>0.014</td>
</tr>
<tr>
<td>C</td>
<td>0.20</td>
<td>0.008</td>
</tr>
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<td>D-20</td>
<td>--</td>
<td>26.92</td>
</tr>
<tr>
<td>E</td>
<td>5.59</td>
<td>0.220</td>
</tr>
<tr>
<td>E1</td>
<td>7.73</td>
<td>0.290</td>
</tr>
<tr>
<td>e</td>
<td>2.54 BSC</td>
<td>0.100 BSC</td>
</tr>
<tr>
<td>e1</td>
<td>7.62 BSC</td>
<td>0.300 BSC</td>
</tr>
<tr>
<td>L</td>
<td>3.81</td>
<td>0.150</td>
</tr>
<tr>
<td>L1</td>
<td>3.18</td>
<td>0.125</td>
</tr>
<tr>
<td>L2</td>
<td>0.38</td>
<td>0.015</td>
</tr>
<tr>
<td>S</td>
<td>--</td>
<td>0.098</td>
</tr>
<tr>
<td>Ø</td>
<td>0°</td>
<td>15°</td>
</tr>
</tbody>
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**Notes:**
- BSC: Basic Sizing Characteristic
- Dimensions are rounded to the nearest 0.001 mm for millimeters and 0.0001 inch for inches.