LSI/CSI

LS7211-7212

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A3800

# PROGRAMMABLE DIGITAL DELAY TIMER

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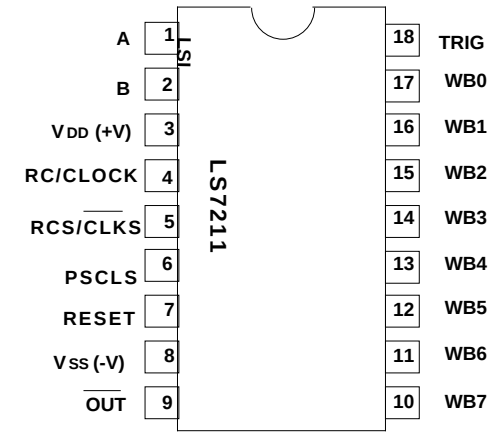
**FEATURES:**

- 8-bit programmable delay from nanoseconds to days
- On chip oscillator (RC or Crystal) or external clock time base
- Selectable prescaler for real time delay generation based on 50Hz/60Hz time base or 32.768KHz watch crystal
- Four operating modes
- Reset input for delay abort
- Low quiescent and operating current
- Direct relay drive
- +4V to +18V operation ($V_{DD}$-$V_{SS}$)
- LS7211/LS7212 (DIP), LS7211-S/LS7212-S (SOIC)-See Figure 1

**DESCRIPTION:**

The LS7211/LS7212 are monolithic CMOS integrated circuits for generating digitally programmable delays. The delay is controlled by 8 binary weighted inputs, WB0-WB7, in conjunction with an applied clock or oscillator frequency. The programmed time delay manifests itself in the Delay Output ($\overline{OUT}$) as a function of the Operating Mode selected by the Mode Select inputs A and B: One-Shot, Delayed Operate, Delayed Release or Dual Delay. The time delay is initiated by a transition of the Trigger Input (TRIG).

**PIN ASSIGNMENT - TOP VIEW**



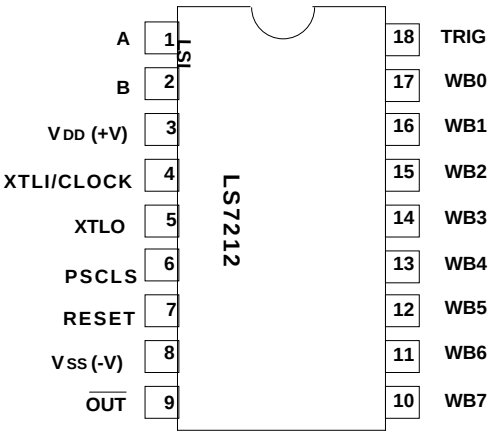




**FIGURE 1**

**I/O DESCRIPTION:**

**MODE SELECT Inputs (A &B, Pins 1 & 2)**

The 4 operating modes are selected by Inputs A and B according to Table 1

**TABLE 1. MODE SELECTION**

| A | B | MODE |
|---|---|---|
| 0 | 0 | One-Shot (OS) |
| 0 | 1 | Delayed Operate (DO) |
| 1 | 0 | Delayed Release (DR) |
| 1 | 1 | Dual Delay (DD) |

Each input has an internal pull-up resistor of about 500KΩ.

**One-Shot Mode (OS)**

A positive transition at the TRIG input causes $\overline{OUT}$ to switch low without delay and starts the delay timer. At the end of the programmed delay timeout, $\overline{OUT}$ switches high. If a delay timeout is in progress when a positive transition occurs at the TRIG input, the delay timer will be restarted. A negative transition at the TRIG input has no effect.

**Delayed Operate Mode (DO)**

A positive transition at the TRIG input starts the delay timer. At the end of the delay timeout, $\overline{OUT}$ switches low. A negative transition at the TRIG input causes $\overline{OUT}$ to switch high without delay. $\overline{OUT}$ is high when TRIG is low.

**Delayed Release Mode (DR)**

A negative transition at the TRIG input starts the delay timer. At the end of the delay timeout, $\overline{OUT}$ switches high. A postive transition at the TRIG input causes $\overline{OUT}$ to switch low without delay. $\overline{OUT}$ is low when TRIG is high.

**Dual Delay Mode (DD)**

A positive or negative transition at the TRIG input starts the delay timer. At the end of the delay timeout, $\overline{OUT}$ switches to the logic state which is the inverse of the TRIG input. If a delay timeout is in progress when a transition occurs at the TRIG input, the delay timer is restarted.

**TRIGGER Input (TRIG, Pin 18)**
A transition at the TRIG input causes $\overline{OUT}$ to switch with or without delay, depending on the selected mode. The TRIG input to $\overline{OUT}$ transition relation is always opposite in polarity, with the exception of One-Shot mode. (See Mode definitions above.) TRIG input has an internal pull-down resistor of about 500KΩ and is buffered by a Schmitt trigger to provide input hysterisis.

**LS7211 TIME BASE Input (RC/CLOCK, Pin 4)**
For LS7211, the basic timing signal is applied at the RC/CLOCK input. The clock can be provided from either an external source or generated by an internal oscillator by connecting an R-C network to this input.
The frequency of oscillation is given by $f \approx 1/RC$. Chip-to-chip oscillation tolerance is ± 5% for a fixed value of RC.
The minimum resistance, $R_{MIN}$ = 4000Ω, $V_{DD}$ = + 4V
= 1200Ω, $V_{DD}$ = +10V
= 600Ω, $V_{DD}$ = +18V
The external clock mode is selected by applying a logic low to the RCS/$\overline{CLKS}$ input (Pin 5); the internal oscillator mode is selected by applying a high level to the RCS/$\overline{CLKS}$ input.

**LS7212 TIME BASE Input (XTLI/CLOCK, Pin 4)**
For LS7212, the basic timing clock is applied to the XLTI/CLOCK input from either an external clock source or generated by an internal crystal oscillator by connecting a crystal between XTLI/CLOCK input and the XTLO output (Pin 5).

**LS7211 TIME BASE SELECT Input (RCS/$\overline{CLKS}$, Pin 5)**
For LS7211, the external clock operation at Pin 4 is selected by applying a logic low to the RCS/$\overline{CLKS}$ input. The internal oscillator option with RC timer at Pin 4 is selected by applying a logic high at the RCS/$\overline{CLKS}$ input. RCS/$\overline{CLKS}$ input has an internal pull-down resistor of about 500KΩ.

**LS7212 TIME BASE Output (XTLO, Pin 5)**
For LS7212, when a crystal is used for generating the time base oscillation, the crystal is connected between XTLI/CLOCK and XTLO pins.

**PRESCALER SELECT Input (PSCLS, Pin 6)**
The PSCLS input is a 3-state input, which selects one of three prescale factors according to Table 2.

**TABLE 2. PRESCALE FACTOR SELECTION**

| PSCLS Input Logic Level | S (Prescale Factor ) LS7211 | LS7212 |
|---|---|---|
| Float | 1 | 1 |
| Low | 3000 | 32768 |
| High | 3600 | 32768x60 |

Using prescale factors of 3000 and 3600, delays in units of minutes can be produced from 50Hz and 60Hz line sources. Prescale factors of 32,768 and 32,768 x 60 can be used to generate accurate delays in units of seconds and minutes, respectively, from a 32KHz watch crystal.

**TIMER RESET Input (RESET, Pin 7)**
When RESET input switches high, any timeout in progress is aborted and $\overline{OUT}$ switches high without delay. With RESET high, $\overline{OUT}$ remains high. When RESET switches low with TRIG low in any mode, $\overline{OUT}$ remains high. When RESET switches low with TRIG high in Delayed Operate and Dual Delay modes, the delay timer is started and $\overline{OUT}$ switches low at the end of the delay timeout. When RESET switches low with TRIG high in Delayed Release mode, $\overline{OUT}$ switches low without delay. When RESET switches low with TRIG high in One-Shot mode, $\overline{OUT}$ remains high. RESET input has an internal pull-down resistor of about 500KΩ.

**$V_{SS}$ (-V, Pin 8)**
Supply voltage negative terminal or GND.

**DELAY Output ($\overline{OUT}$, Pin 9)**
Except in One-Shot mode, $\overline{OUT}$ switches with or without delay (depending on mode) in inverse relation to the logic level of the TRIG input. In One-Shot mode, a timed low level is produced at $\overline{OUT}$, in response to a positive transition of the TRIG input.

**WEIGHTING BIT Inputs (WB7 To WB0, Pins 10 - 17)**
Inputs WB0 through WB7 are binary weighted delay bits used to program the delay according to the following relations:

$$\text{One-Shot Mode: Pulse width} = \frac{SW}{f}$$

$$\text{All other Modes: Delay} = \frac{SW + .5}{f}$$

Where:
S = Prescale factor (See Table 2)
$f$ = Time base frequency at Pin 4
W = WB0 + WB1 + ..... WB7

The weighting factor W is calculated by substituting in the equation above for W, the weighted values for all the WB inputs that are at logic high. The weighted values for the WB inputs are shown in Table 3. Each WB input has an internal pull-down resistor of about 500KΩ.

**TABLE 3. BIT WEIGHTS**

| BITS | VALUE |
|---|---|
| WB0 | 1 |
| WB1 | 2 |
| WB2 | 4 |
| WB3 | 8 |
| WB4 | 16 |
| WB5 | 32 |
| WB6 | 64 |
| WB7 | 128 |

**$V_{DD}$ (+V, Pin 3)**
Supply voltage positive terminal.

**ABSOLUTE MAXIMUM RATINGS:** (All voltages referenced to $V_{SS}$)

| | SYMBOL | VALUE | UNIT |
|---|---|---|---|
| DC Supply Voltage | $V_{DD}$ | +19 | V |
| Voltage (Any Pin) | $V_{IN}$ | $V_{SS}$-.3 to $V_{DD}$+.3 | V |
| Operating Temperature | $T_A$ | -20 to +85 | °C |
| Storage Temperature | $T_{STG}$ | -65 to +150 | °C |

**ELECTRICAL CHARACTERISTICS (Voltages referenced to Vss)**

| Characteristic | SYMBOL | $V_{DD}$ | -20°C | | +25°C | | +85°C | | Unit | Condition |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max | Min | Max | | |
| Supply Voltage | $V_{DD}$ | - | 4.0 | 18.0 | 4.0 | 18.0 | 4.0 | 18.0 | V | - |
| Supply Current | $I_{DD}$ | 4.0 | 32 | - | 27 | - | 20 | - | µA | with the clock off |
| | | 10.0 | 190 | - | 160 | - | 110 | - | µA | |
| | | 18.0 | 560 | - | 437 | - | 330 | - | µA | |
| **Input Voltages:** | | | | | | | | | | |
| Trigger Low | $V_{TL}$ | 4.0 | - | 1.0 | - | 1.0 | - | 1.0 | V | - |
| | | 10.0 | - | 3.0 | - | 3.0 | - | 3.0 | V | |
| | | 18.0 | - | 5.8 | - | 5.8 | - | 5.8 | V | |
| Trigger High | $V_{TH}$ | 4.0 | 3.0 | - | 3.0 | - | 3.0 | - | V | - |
| | | 10.0 | 6.6 | - | 6.6 | - | 6.6 | - | V | |
| | | 18.0 | 11.0 | - | 11.0 | - | 11.0 | - | V | |
| Trigger Hysteresis | | 4.0 | 1.5 | - | 1.5 | - | 1.5 | - | V | - |
| | | 10.0 | 3.0 | - | 3.0 | - | 3.0 | - | V | |
| | | 18.0 | 4.8 | - | 4.8 | - | 4.8 | - | V | |
| All other inputs, Low | $V_{IL}$ | 4.0 | - | 1.2 | - | 1.2 | - | 1.2 | V | - |
| | | 10.0 | - | 4.1 | - | 4.1 | - | 4.1 | V | |
| | | 18.0 | - | 7.2 | - | 7.2 | - | 7.2 | V | |
| All other inputs, High | $V_{IH}$ | 4.0 | 2.1 | - | 2.1 | - | 2.1 | - | V | - |
| | | 10.0 | 5.3 | - | 5.3 | - | 5.3 | - | V | |
| | | 18.0 | 9.3 | - | 9.3 | - | 9.3 | - | V | |
| **Input Currents:** | | | | | | | | | | |
| PSCLS Low | $I_{PL}$ | 4.0 | - | 2.6 | - | 2.0 | - | 1.5 | µA | Input at $V_{SS}$ |
| | | 10.0 | - | 22.0 | - | 17.0 | - | 13.0 | µA | |
| | | 18.0 | - | 70.0 | - | 54.0 | - | 41.0 | µA | |
| PSCLS High | $I_{PH}$ | 4.0 | - | 5.8 | - | 4.4 | - | 3.4 | µA | Input at $V_{DD}$ |
| | | 10.0 | - | 26.0 | - | 20.0 | - | 15.2 | µA | |
| | | 18.0 | - | 82.0 | - | 63.0 | - | 48.0 | µA | |
| A, B Low | $I_{ML}$ | 4.0 | - | 2.0 | - | 1.6 | - | 1.3 | µA | Input at $V_{SS}$ |
| | | 10.0 | - | 37.0 | - | 28.0 | - | 22.0 | µA | |
| | | 18.0 | - | 132.0 | - | 101.0 | - | 77.0 | µA | |
| A, B High | $I_{MH}$ | - | - | 100 | - | 100 | - | 200 | nA | Input at $V_{DD}$ |
| All other inputs, Low | $I_{IL}$ | - | - | 100 | - | 100 | - | 200 | nA | Input at $V_{SS}$ |
| All other inputs, High | $I_{IH}$ | 4.0 | - | 4.6 | - | 3.5 | - | 2.7 | µA | Input at $V_{DD}$ |
| | | 10.0 | - | 33.0 | - | 25.0 | - | 19.0 | µA | |
| | | 18.0 | - | 121.0 | - | 93.0 | - | 71.0 | µA | |
| **Output Current:** | | | | | | | | | | |
| $\overline{OUT}$ Sink | $I_{OSNK}$ | 4.0 | 23.0 | - | 18.0 | - | 13.0 | - | mA | Vo = +0.5V |
| | | 10.0 | 43.0 | - | 33.0 | - | 25.0 | - | mA | |
| | | 18.0 | 56.0 | - | 43.0 | - | 32.0 | - | mA | |
| $\overline{OUT}$ Source | $I_{OSRC}$ | 4.0 | 2.6 | - | 2.0 | - | 1.5 | - | mA | Vo = $V_{DD}$-.5V |
| | | 10.0 | 7.8 | - | 6.0 | - | 4.5 | - | mA | |
| | | 18.0 | 11.5 | - | 8.8 | - | 6.5 | - | mA | |

**ELECTRICAL CHARACTERISTICS (Voltages referenced to Vss) (Con't)**

| Characteristic | SYMBOL | VDD | Min | Max | Min | Max | Min | Max | Unit | Condition |
|---|---|---|---|---|---|---|---|---|---|---|
| **Switching Characteristics** (See Fig. 3) | | | | | | | | | | |
| | | 4.0 | - | 1.3 | - | 1.0 | - | 0.76 | MHz | |
| RC Oscillator Frequency | fosc | 10.0 | - | 4.0 | - | 3.0 | - | 2.3 | MHz | - |
| | | 18.0 | - | 6.0 | - | 4.5 | - | 3.4 | MHz | |
| | | 4.0 | - | 2.3 | - | 1.8 | - | 1.3 | MHz | For prescale |
| External Clock or | fext | 10.0 | - | 7.0 | - | 5.5 | - | 4.0 | MHz | factor S = 1 or 3000 |
| Crystal Oscillator | | 18.0 | - | 11.0 | - | 8.5 | - | 6.5 | MHz | or 3600 |
| Frequency | | 4.0 | - | 1.2 | - | 0.93 | - | 0.7 | MHz | S = 32768 |
| | fext | 10.0 | - | 4.0 | - | 3.0 | - | 2.3 | MHz | or |
| | | 18.0 | - | 7.0 | - | 5.5 | - | 4.2 | MHz | 32768 X 60 |
| TRIG Set-Up Time | t1 | - | 23 | - | 30 | - | 40 | - | ns | - |
| A, B Set-Up Time | t2 | - | 0 | - | 0 | - | 0 | - | ns | - |
| WB0 - WB7 Set-Up Time | t3 | - | 0 | - | 0 | - | 0 | - | ns | - |
| | | 4.0 | 215 | - | 280 | - | 370 | - | ns | |
| Clock to $\overline{\text{Out}}$ Delay | t4 | 10.0 | 80 | - | 105 | - | 140 | - | ns | CL = 50pF |
| | | 18.0 | 50 | - | 65 | - | 85 | - | ns | |

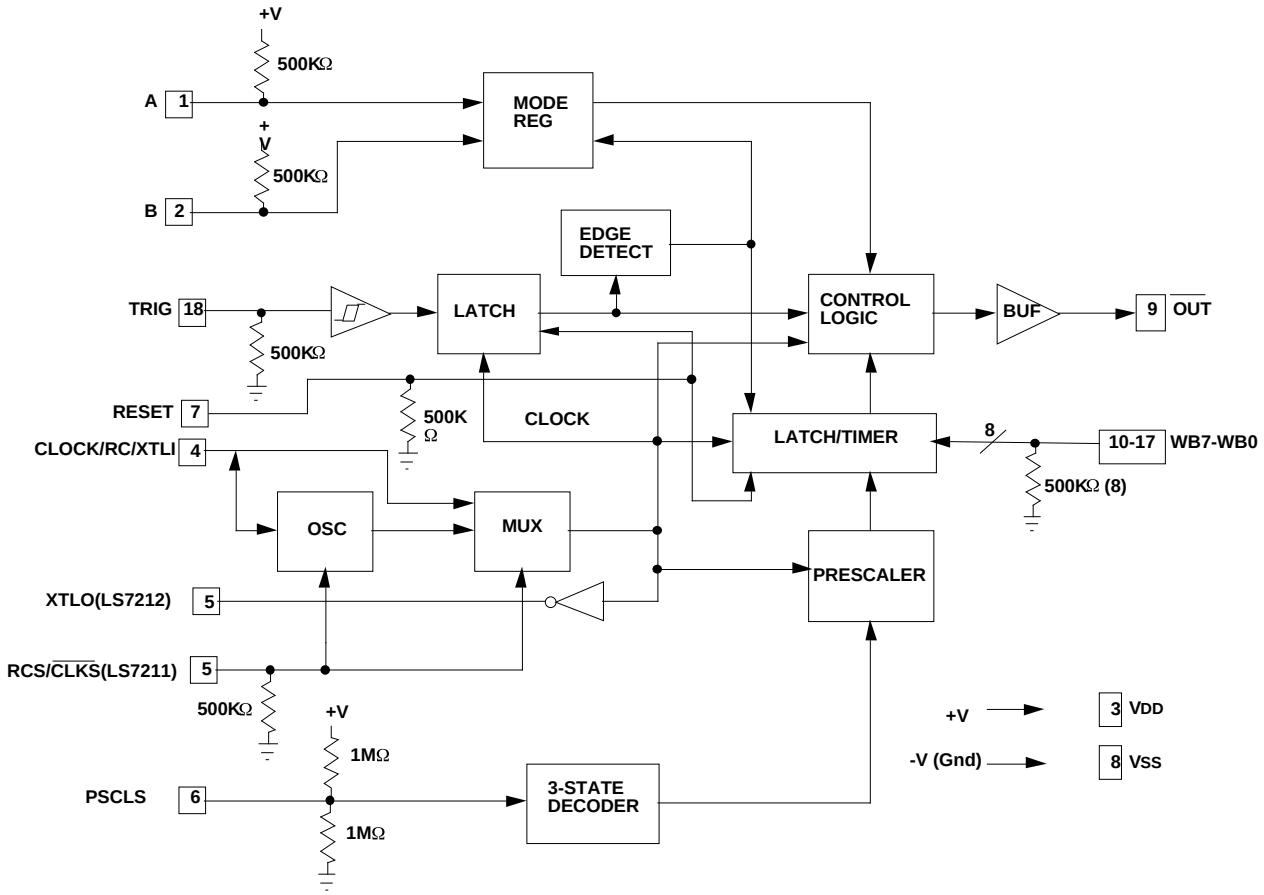
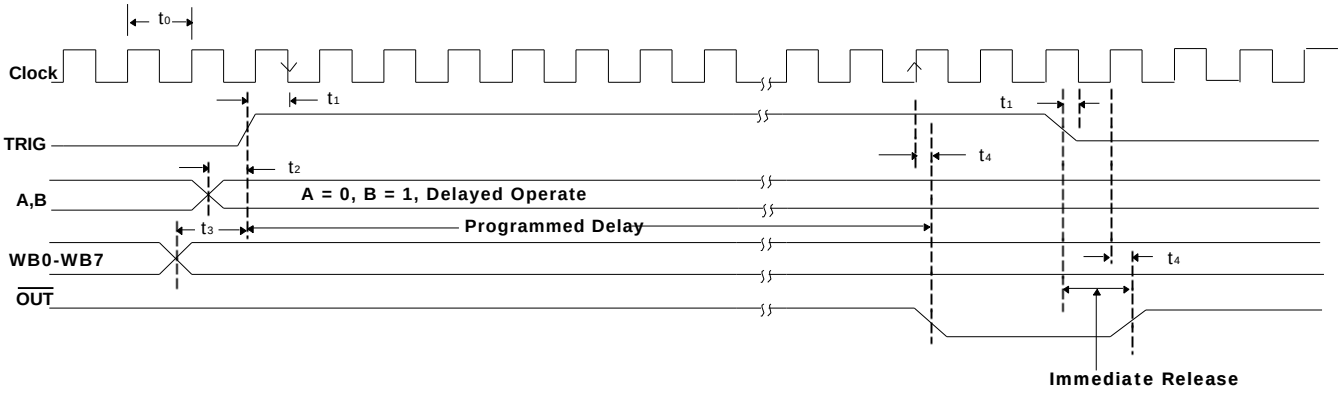
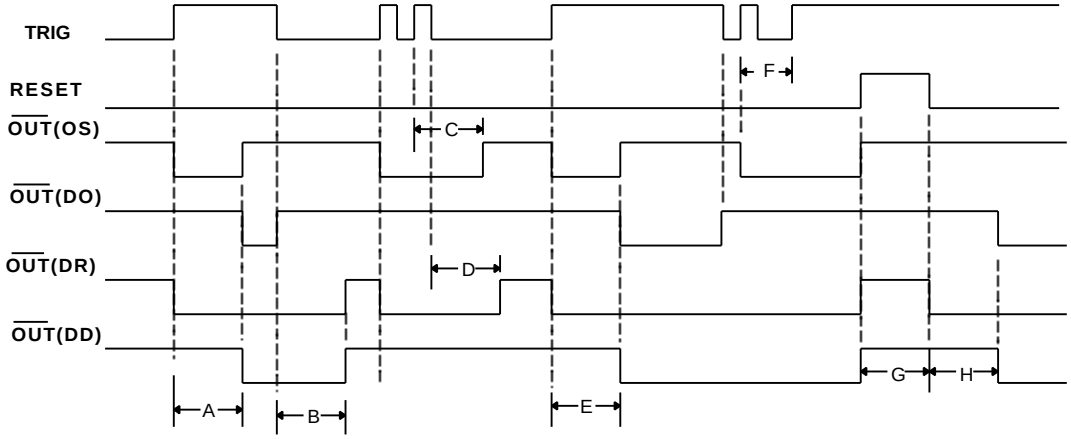



**FIGURE 2. LS7211/LS7212 BLOCK DIAGRAM**



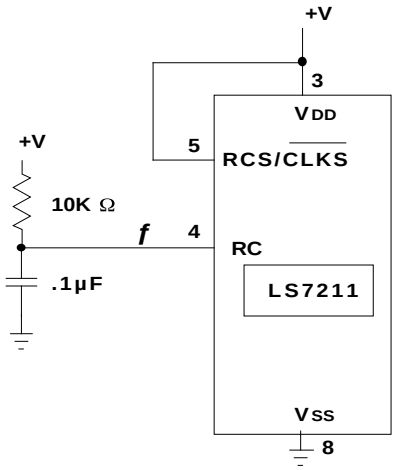

**Note 1.** TRIG input is clocked in by the negative edge of external clock.
**Note 2.** Inputs A, B and WB0 - WB7 are sampled only at a TRIG input transition and ignored at all other times.
**Note 3.** $\overline{OUT}$ is switched by the positive edge of the external clock.

**FIGURE 3. INPUT/OUTPUT TIMING**




**A.** Turn-on delay in DO and DD modes; Pulse-width in OS mode.
**B.** Turn-off delay in DR and DD modes.
**C.** Pulse-width extended by re-trigger in OS mode. No effect in DO and DD modes because TRIG switches back low before turn-on delay has timed out.
**D.** Turn-off delay in DR mode.
**E.** Turn-on delay in DO and DD modes; pulse-width in OS mode.
**F.** No effect in DO, DR and DD modes because of TRIG's switching back to opposite levels.
**G.** Time-outs aborted and $\overline{OUT}$ force high by RESET.
**H.** After the removal of RESET, OUT switches to the inverse polarity of TRIG immediately (DR) or after the timeout (DO,DD). No effect in OS.

**FIGURE 4. MODE ILLUSTRATION WITH TRIG, $\overline{OUT}$ AND RESET**




$$f = \frac{1}{10 \times 10^{3} \times .1 \times 10^{-6}} = 1\text{KHz}$$

**FIGURE 5. RC- Oscillator Connection**

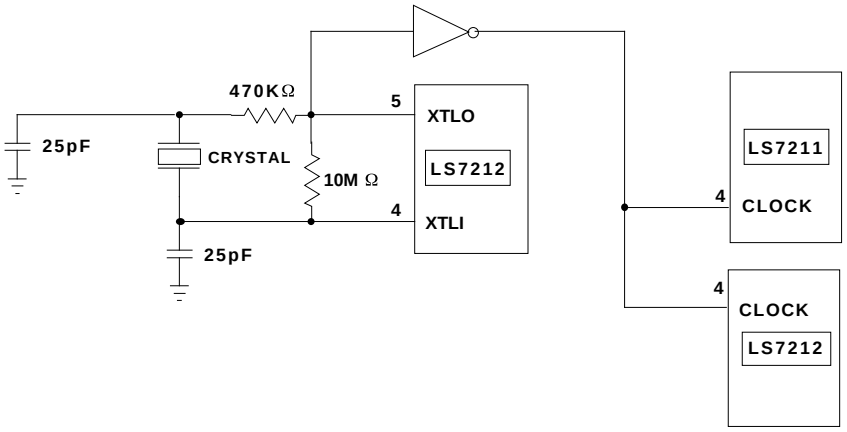



**FIGURE 6. MULTI-TIMER WITH SINGLE CRYSTAL TIME-BASE**

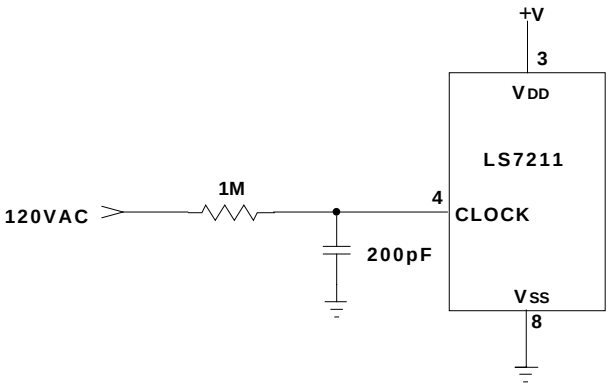
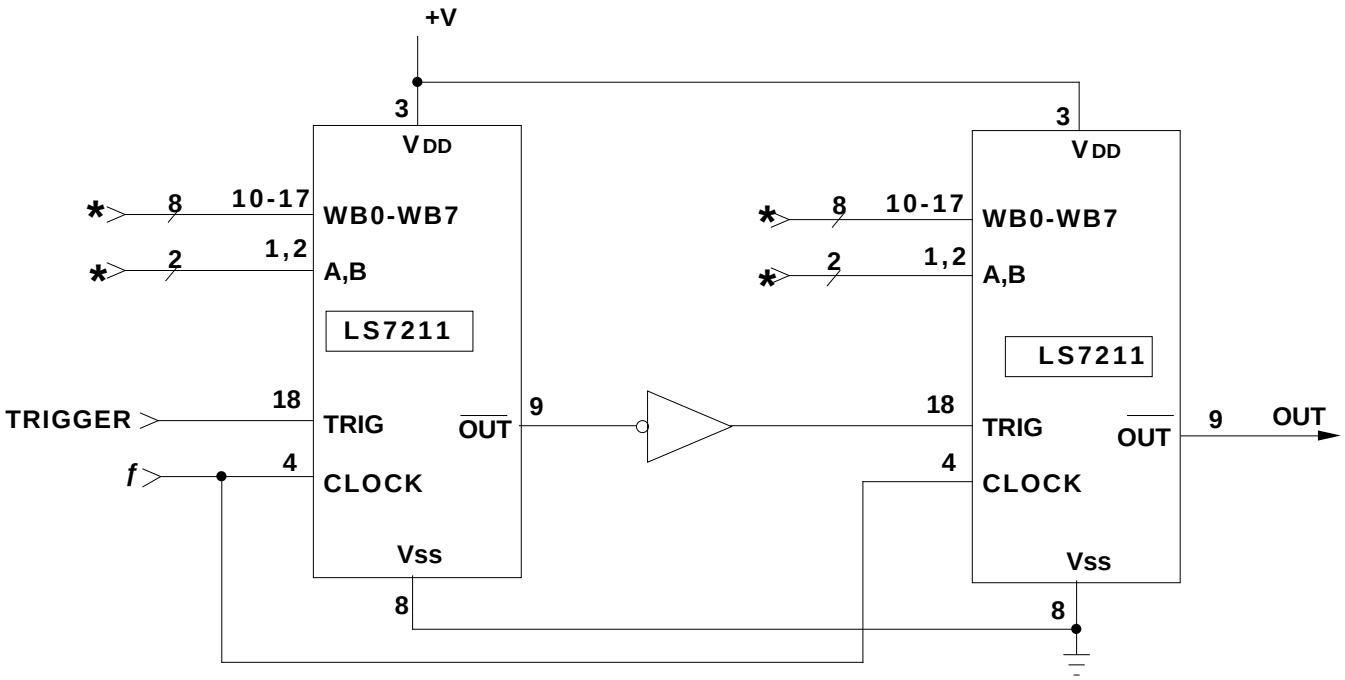
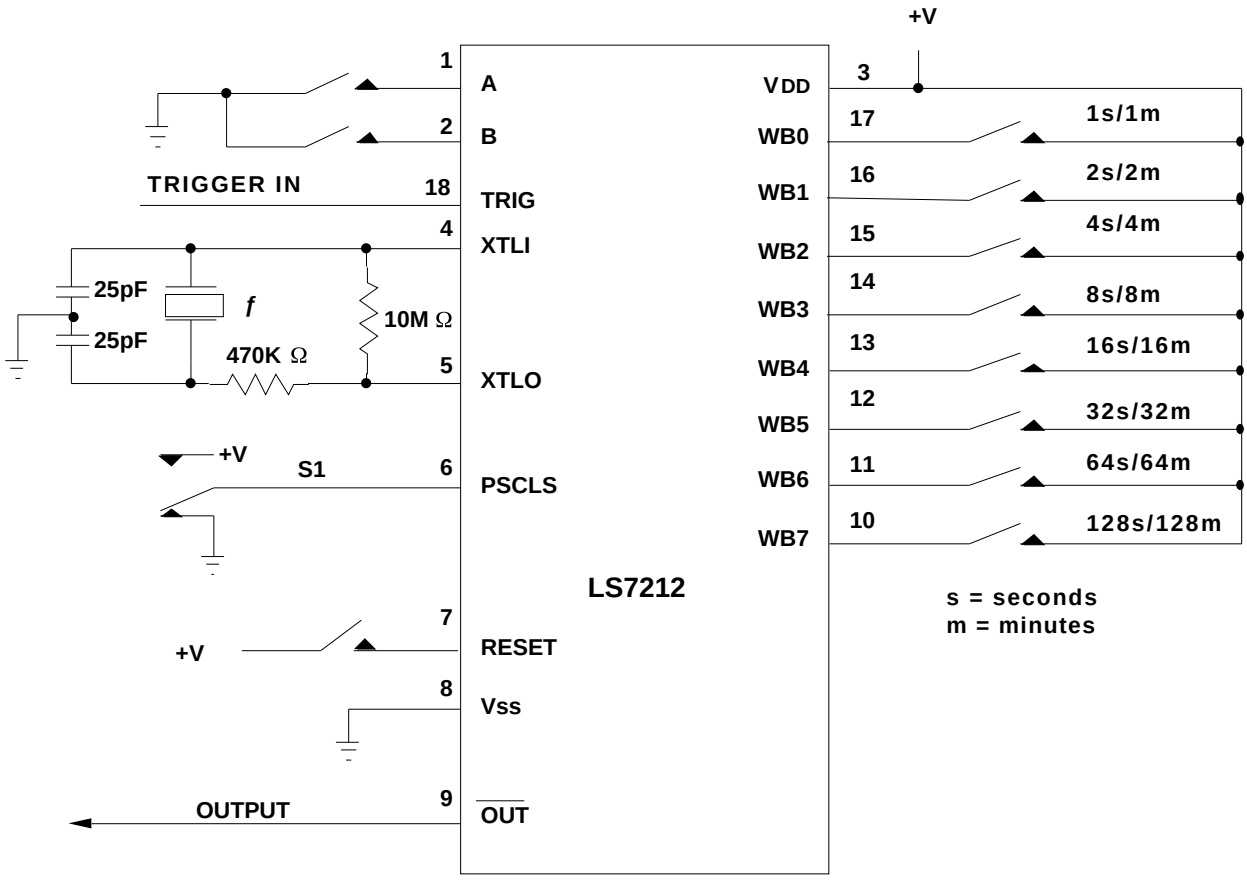



**FIGURE 7. DRIVING CLOCK INPUT FROM THE AC LINE**



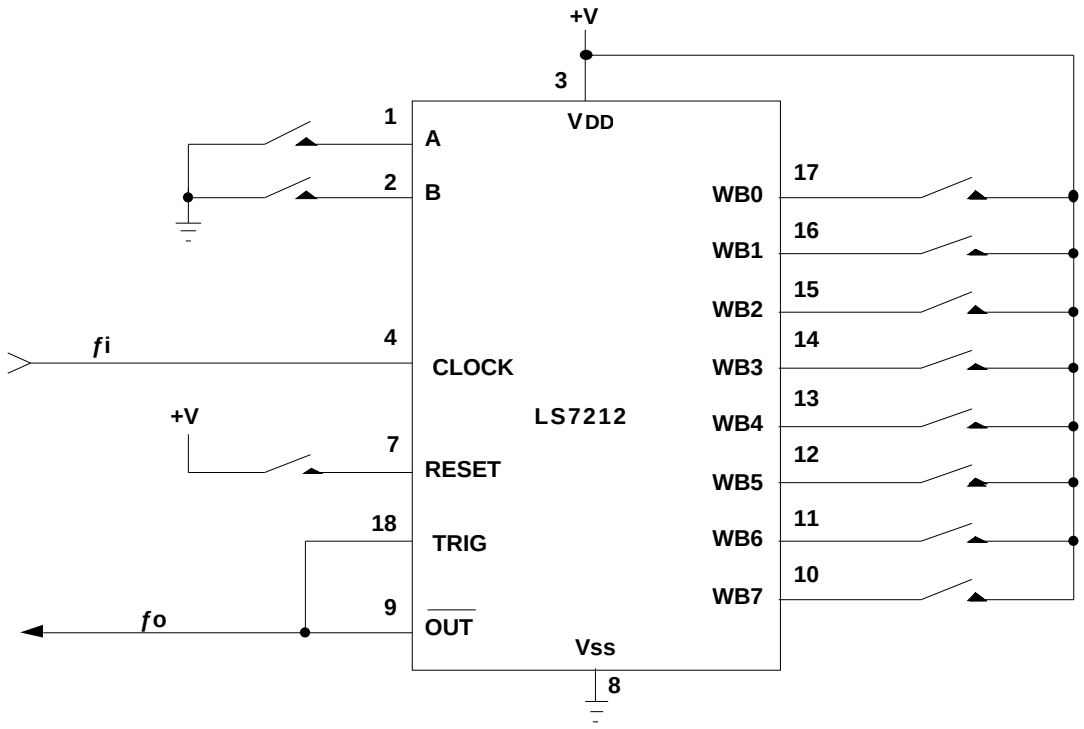

* Connect for desired delay and mode

**FIGURE 8. DELAY EXTENSION BY CASCADING**




**NOTE** : Crystal Frequency, $f$ = 32,768Hz
Switch: S1 low: Delay increment = 1s; Maximum Delay = 255s
S1 high: Delay increment = 1m; Maximum Delay = 255m

**FIGURE 9. PROGRAMMABLE ACCURATE REAL-TIME DELAY GENERATION**




**CASE 1. MODE = DO or DR; PRESCALE FACTOR, S = 1**

In this setup a frequency division of the input clock, $f$i by a factor of 2 to 257, in increments of 1 can be obtained according to the equation:

$$f\text{o} = \frac{f\text{i}}{W + 2}$$ where W (weighting factor) = 0 to 255

The $f$o pulse width is non-symmetrical (non-50% duty -cycle)

**CASE 2. MODE = DD; PRESCALE FACTOR, S = 1**

In this setup a frequency division of the input clock, $f$i by a factor of 2 to 512, in increments of 2 can be obtained according to the equation:

$$f\text{o} = \frac{f\text{i}}{2(W + 1)}$$ where W (weighting factor) = 0 to 255

The $f$o pulse widths are symmetrical with 50% duty -cycle

**EXAMPLES OF CASE 1 and CASE 2 FREQUENCY DIVISIONS WITH W = 2**

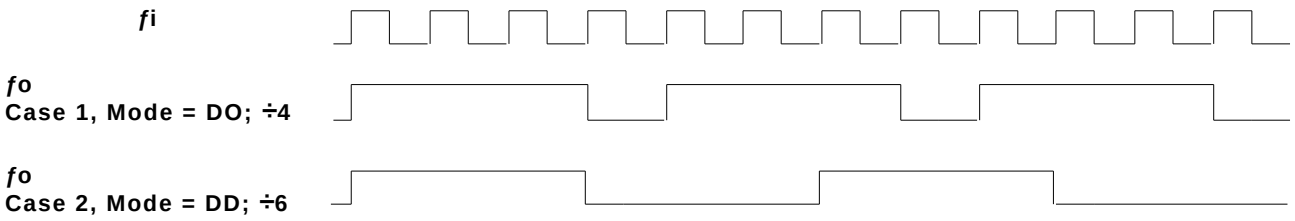



**FIGURE 10. PROGRAMMABLE FREQUENCY DIVIDER**