MOD 11 Synchronous Binary Counter using IC 74163

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Abstract—A counter is a device which stores (and sometimes displays) the number of times a particular event or process has occurred, often in relationship to a clock signal. We needed to design a decade counter which counts from 0 – 10 in binary i.e. 0000 – 1010 which is shown with the help of 4 light emitting diodes (LEDs). We have implemented the counter with the help of IC 74163, a 4-bit Synchronous Binary Counter. This decade counter can further be used to drive many devices and thus is widely used.

I. INTRODUCTION

The 74163 are high-speed synchronous modulo-16 binary counters. They are synchronously presettable for application in programmable dividers and have two types of Count Enable inputs plus a Terminal Count output for versatility in forming synchronous multistage counters. The 74163 has a Synchronous Reset input that overrides counting and parallel loading and allows the outputs to be simultaneously reset on the rising edge of the clock.

II. INTERNAL DESCRIPTION

A. A brief overview of IC74163

These synchronous, presettable counters feature an internal carry look-ahead for application in high-speed counting designs. The '160/162/LS160A/LS162A, and '162 are decade counters and the '161/163/LS161A/LS163A, and '162 are 4-bit binary counters. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enable inputs and internal gating. This mode of operation eliminates the output counting spikes that are normally associated with asynchronous (ripple clock) counters, however counting spikes may occur on the (RCO) ripple carry output. A buffered clock input triggers the four flip-flops on the rising edge of the clock input waveform.

These counters are fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable inputs. Low-to-high transitions at the load input of the IC should be avoided when the clock is low if the enable inputs are high at or before the transition. The clear function is synchronous and a low level at the clear input sets all four of the flip flop outputs low after the next clock pulse, regardless of the levels of the enable inputs. This synchronous clear allows the count length to be modified easily as decoding the maximum count desired can be accomplished with one external NAND gate. The gate output is connected to the clear input to asynchronously clear the counter to 0000 (LLLL).

B. Inside the IC 74163

There are two separate enable inputs, ENT and ENP, setting either of these inputs to logic 0 stops counting asynchronously. Ripple Carry Output (RCO) is normally at logic 0 and goes to logic 1 when counter reaches its highest count i.e., ‘1111’. It is used in cascading multiple 74163 ICs.

Load is an active, low input which allows the count on ‘ABCD’ to reflect on ‘QAQBQCQD’ at active clock edges. CLR is also an active low input which clears counter asynchronously to ‘0000’.

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<th>TABLE I</th>
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<tr>
<td>PIN ASSIGNMENT OF IC 74163</td>
</tr>
<tr>
<td>LD</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>X</td>
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C. Specifications: Absolute Maximum Ratings

- Supply Voltage (Vcc): -0.5V to +7.0V
- DC Input Diode Current: (Iik)
  - V1 = -0.5V -20 mA
  - V1 = Vcc + 0.5V +20 mA
- DC Input Voltage (Vil): -0.5V to Vcc + 0.5V
- DC Output Diode Current (Iok)
  - V0 = -0.5V : -20 mA
  - V0 = Vcc + 0.5V : +20 mA
- DC Output Voltage (VOL): -0.5V to Vcc + 0.5V
- DC Output Source or Sink Current (IO): ±50 mA
- DC $V_{CC}$ or Ground Current per Output Pin ($I_{CC}$ or $I_{GND}$): ±50 mA
- Storage Temperature ($T_{STG}$): -65°C to +150°C
- Junction Temperature ($T_J$) PDIP: 140°C

### D. IC Specifications: Recommended Operating Conditions

- Supply Voltage ($V_{CC}$):
  - AC: 2.0V to 6.0V
  - ACT: 4.5V to 5.5V
- Input Voltage ($V_I$): 0V to $V_{CC}$
- Output Voltage ($V_O$): 0V to $V_{CC}$
- Operating Temperature ($T_A$): -40°C to +85°C
- Minimum Input Edge Rate ($\Delta V/\Delta t$):
  - AC Devices
    - $V_{IN}$ from 30% to 70% of $V_{CC}$
    - $V_{CC}$ @ 3.3V, 4.5V, 5.5V: 125 mV/ns
  - ACT Devices
    - $V_{IN}$ from 0.8V to 2.0V
    - $V_{CC}$ @ 4.5V, 5.5V: 125 mV/ns

### E. IC Specifications: Features

- $I_{CC}$ reduced by 50%
- High-speed synchronous expansion
- Typical count rate of 125 MHz
- Outputs source/sink 24 mA
- ACT163 has TTL-compatible inputs
- Internal Look-Ahead for Fast Counting
- Carry Output for n-Bit Cascading
- Synchronous Counting and loading
- Synchronously Programmable
- Load Control Line
- Diode-Clamped Inputs

### F. Schematic Description

Although 74163 is a modulus 16 counter, it can be made to count in a module less than 16 by using CLR and LD inputs. Let us see the design of MOD 11 Counter using 74163. A MOD11 counter counts state from 0, 1, 2,..... 10. That means it should count from '0000' to '1010' and as soon as it enters in '1011' state the counter should reset to '0000' asynchronously waiting for the clock pulse. This is possible by connecting QB and QD outputs to a NAND gate and feeding its output to CLR input i.e. whenever QB and QD become '11' output of NAND gate becomes '0' and CLR input of 74163 is activated to get the count '0000' immediately as CLR is an asynchronous input.

### III. SCHEMATIC AND INTERNAL STRUCTURE OF IC 74163

Fig. 3. Schematic of the MOD 11 Synchronous Binary Counter using IC 74163. In the above schematic, R1=R2=R3=R4=100Ω, G1=5V, R5=1KΩ
IV. WAVEFORMS OF MOD11 COUNTER

Fig. 5. Figure showing waveforms of the MOD11 Counter

V. CONCLUSION

The MOD11 Counter using IC 74163 has been successfully implemented.

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REFERENCES