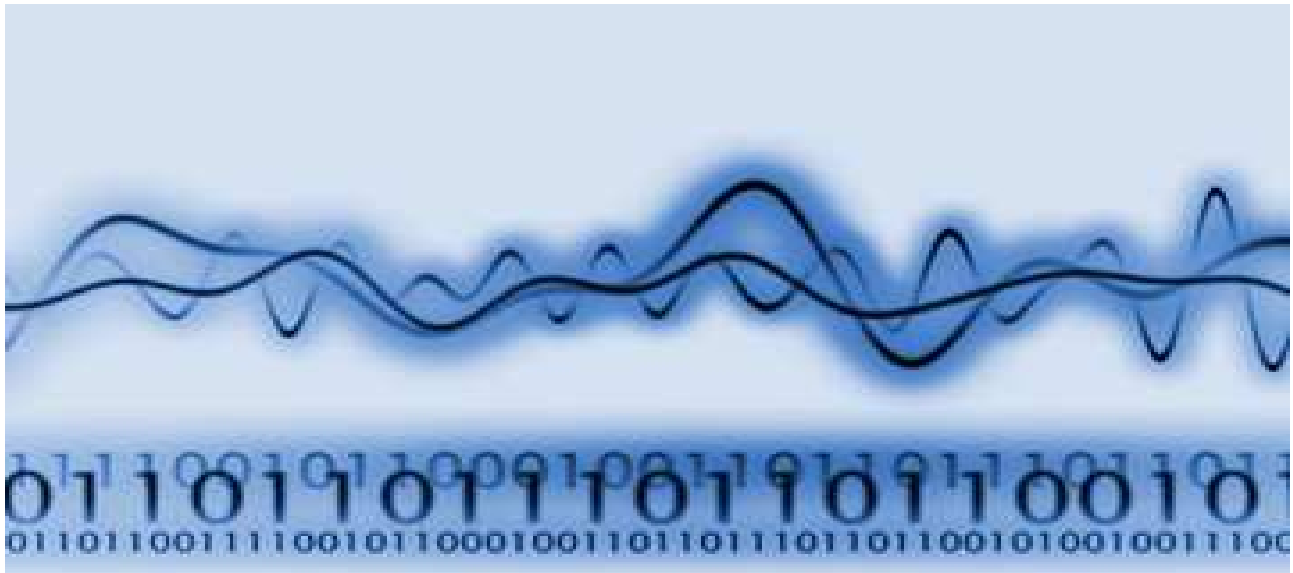**CSS**
Custom Silicon Solutions, Inc.

CSS555C Demonstration Kit

Operating Manual

Safety Precautions:
Always power-down the test socket before removing or inserting an IC.
Do not make or change connections while power is on.

Always ground yourself to discharge any static charge before touching the module. The devices on the module are sensitive to static electric charges and may be damaged. Use a grounding wrist strap at all times. Place all components in a static-dissipative material or shielded bag when they are not installed in the module.

CSS555C   Demonstration Kit

Table of Contents

Technical Support

This operating manual provides details for the installation and operation of the CSS555C Demo Kit. It includes troubleshooting tips. CSS555C specifications and an application note covering its serial interface are also included on the CD.

For technical questions and assistance, please contact Custom Silicon Solutions at:

Phone: (949) 797-9224
Email: TechSupport@CustomSiliconSolutions.com

CSS555C   Demonstration Kit

Introduction

The CSS555C Demonstration Kit provides an "easy to use" tool to evaluate and program Custom Silicon Solutions' 555 timer ICs (CSS555C & CSS555). Although the CSS555(C) can be configured as a standard 555 timer, it also has advanced features that can be enabled via its serial interface. This kit provides an intuitive graphics interface using a PC, a USB port and a custom PCB. This manual provides detailed instructions for installing software, using the tool and the design of the PCB.

Contents

1) Quick Start Guide (hard copy)
2) Eight CSS555 & CSS555C ICs (four DIP & four SOIC packages)
3) USB Cable
4) CSS555C-DMK PCB
5) CD containing:
       Application software (executable & drivers)
       CSS555C Demonstration Kit Manual
       CSS555 & CSS555C Specifications
       CSS555 Application Note – Serial Interface
       CSS555 Timer Delay, Frequency and Supply Current Calculators
6) Optional SOIC to DIP Adaptor (Version A kits only)

Installing Software and Hardware

System requirements:
       PC running Windows 98, 2000, XP or Vista
       One USB port
       Hard drive memory - < 10 Meg

Installation:
1) Insert the CD and copy the folder named "CSS555C" from the CD to the PC's hard drive.
       (This folder contains the executable file, support documents and tools.)

2) Connect the CSS555C-DMK demo board to any of the PC's USB ports using the supplied cable.

3) Wait for Windows to display the "Found New Hardware Wizard". (see Figure 1 below)
    The wizard will then prepare to install drivers for the Serial Interface module.
    Select the 3rd option "**No**", Click "Next >" (Note – some versions of Windows will skip this prompt.)

4) The wizard will identify the hardware it found (DLP-USB245M) (see Figure 2 below)
    Check the box for "**Install from a list or specific location (Advanced)**", Click "Next >"
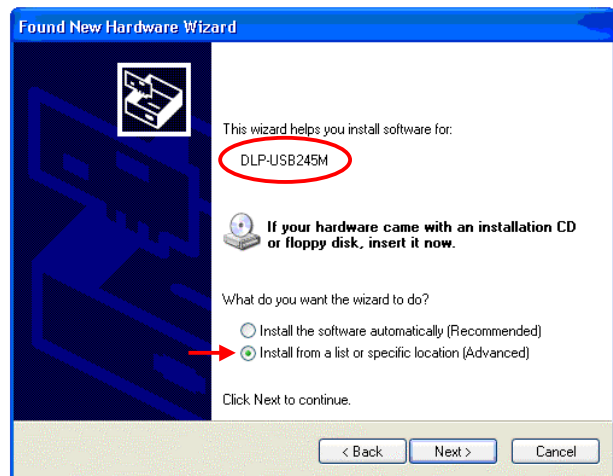

Figure 1 (Step 3)	Figure 2 (Step 4)

CSS555C   Demonstration Kit

Installing Software and Hardware (cont.)

5) Specify the location of the drivers: (see Figure 3 below)
     Select "**Search for the best driver in these locations.**"
     Check the "**Search removable media (floppy, CD-ROM…**" box. Click "**Next >**"

6) Install drivers: (see Figure 4 below)
     The Wizard will search the CD for the best driver and install it.
     The dialog box will momentarily display the files that are being copied to the PC.
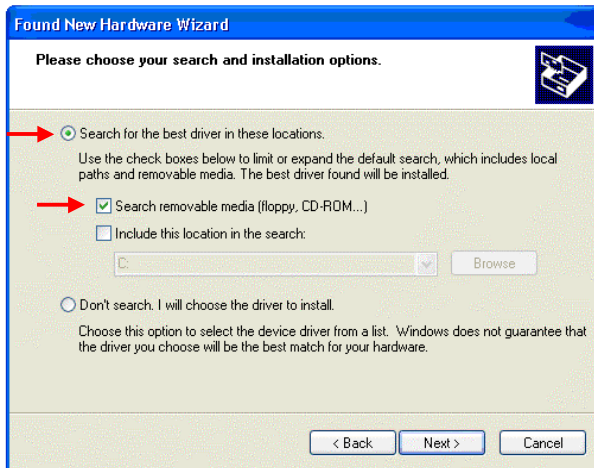   When installation of the USB Serial Converter drivers has been completed, click "**Finish**"

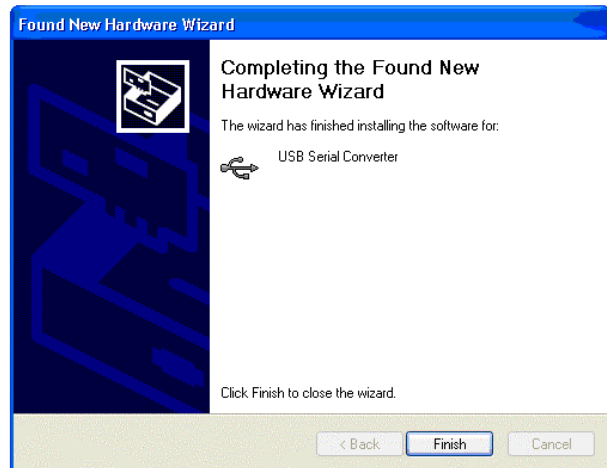|	
Figure 3 (Step 5)	**Figure 4 (Step 6)**

7) USB Serial <u>Port</u> driver
     After the USB Serial <u>Converter</u> driver is installed, a prompt to install a USB Serial <u>Port</u> driver will appear.
     <u>Do Not</u> Install this driver! Click "**Cancel**" (The display may be as shown in Figure 5, Step 7A or 7B)

     Note: The 2nd driver is for a "Virtual COM Port" (VCP), which is not needed and may interfere with the USB Serial Converter just installed. Installing this driver may cause the Read and Program operations to be erratic. To inhibit this prompt every time the hardware is connected to the USB port, uncheck the "Load VCP" box located in the Serial Converter's advanced properties tab. (See step 8)

If the VCP driver has been installed inadvertently, see "Removing Drivers" in the Troubleshooting section.

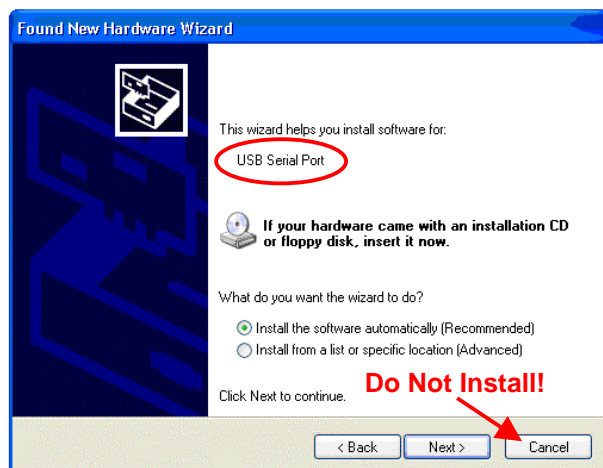|	
Figure 5, Step 7A	**Figure 5, Step 7B**

CSS555C   Demonstration Kit

Installing Software and Hardware (cont.)

8) Inhibiting the prompt to install the USB Serial Port driver
Open the Control Panel and select System Properties
Select the "**Hardware**" tab, Click "**Device Manager**" (see Figure 6, Step 8A)
Scroll down to the "**Universal Serial Bus controllers**" and expand that group (see Figure 6, Step 8B)
Right click on "**USB Serial Converter**", Click on "**Properties**"
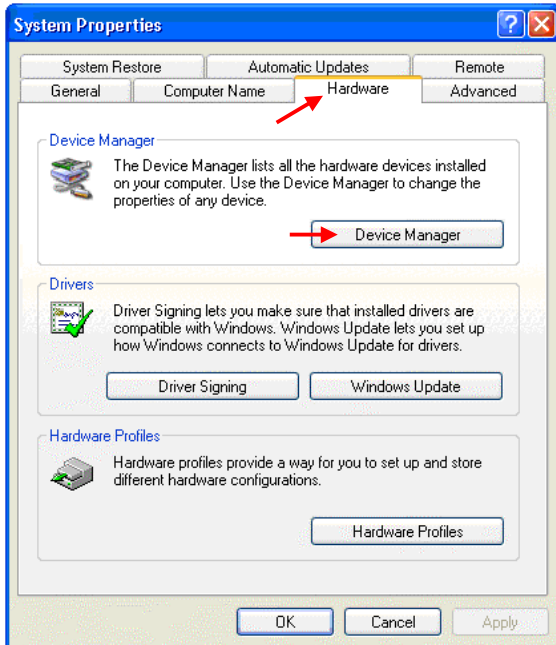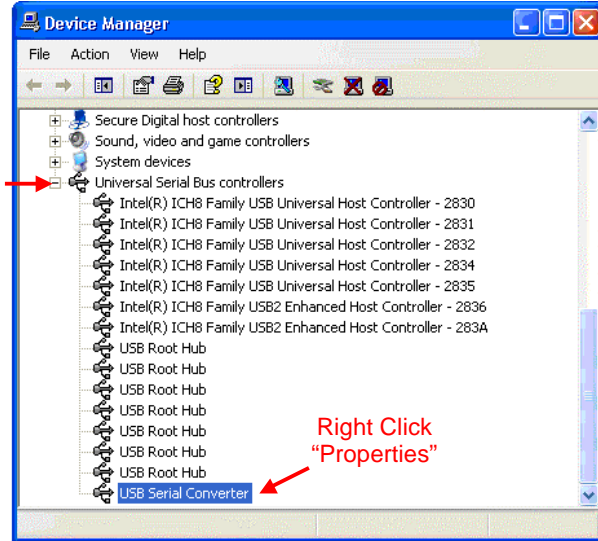

Figure 6, Step 8A

Figure 6, Step 8B

Select the "**Advanced**" tab (Figure 6, Step 8C)
The "Load VCP" box is checked. **Uncheck it**. (Figure 6, Step 8D)
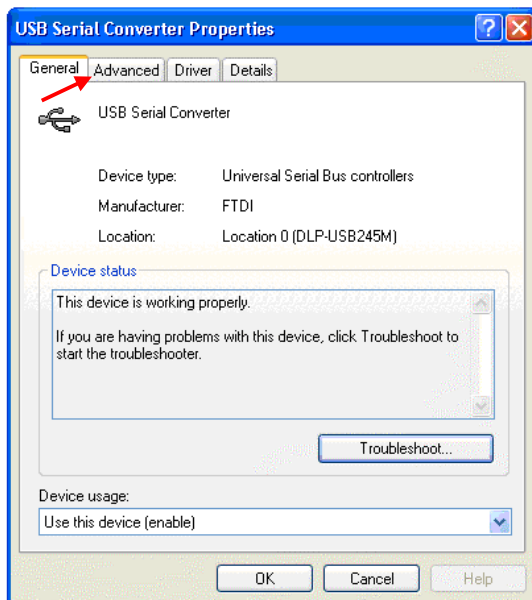Click "**OK**" and exit the Device Manager. Click "**OK**" and exit "System Properties".
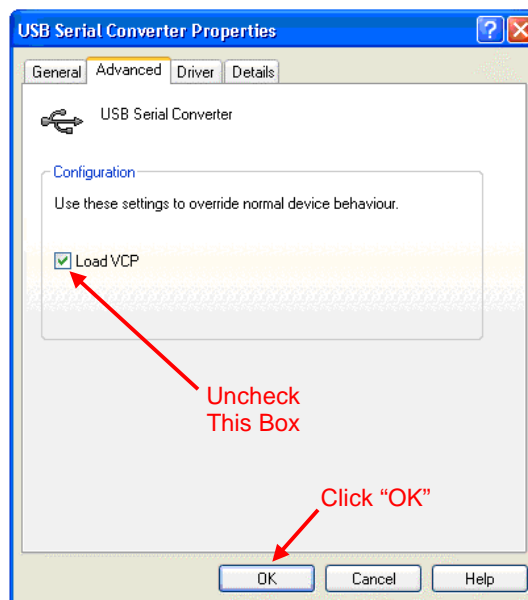

Figure 6, Step 8C

Figure 6, Step 8D

CSS555C   Demonstration Kit

Installing Software and Hardware (cont.)

After the drivers have been installed, run the CSS555C Demo program and test the USB interface.
    With the Demo Board connected to the PC,
      Run Program: Go to the CSS555C folder, double click "CSS555C_DemoKit.exe"
         You may want to create a shortcut – just "Right Click" on the .exe file and select "Create Shortcut"
      The dialog box shown below will be displayed.
      Click the "Device Power" ON/OFF buttons and toggle the red LED.
      With Power = ON, Click "Read Device". The current settings will be displayed.
         (If a CSS555C is installed, the "Trim Capacitor" section will be enabled.)
      Detailed instructions for the dialog box are provided in the "Graphic User Interface" section. (Page 6)

SOIC Socket Adapter
    The Demo Kit comes with an SOIC to DIP socket adapter. To program an SOIC device, the diagram on
    page 13 shows the proper orientation of the adapter and pin 1.

Notes:
    The Demo Board <u>must</u> be connected to the USB port before running the program. The program starts by
    running an initialization routine. If the Demo Board does not respond, two errors will be displayed: "Could
    not open a device" and "Error writing data to target". Click "OK", connect the Demo Board to the USB port
    and try again.

    When the Demo Board is first connected to the USB port, the red and green LEDs will be ON. This is
    normal. After the CSS555C_Demo program is run, the red LED will be OFF, indicating that the
    initialization routine completed normally and the V_{DD} supply to the IC has been turned off. Before
    attempting to read or program the device, turn V_{DD} on using the "Device Power" control.

    If the dialog box is not displayed after running "CSS555C_DemoKit.exe" or the red LED does not toggle
    when clicking the "Device Power" buttons, please refer to the Troubleshooting Guide for help. If you still
    can't resolve the problem, contact CSS's Technical Support. (For Tech Support, see Page i.)
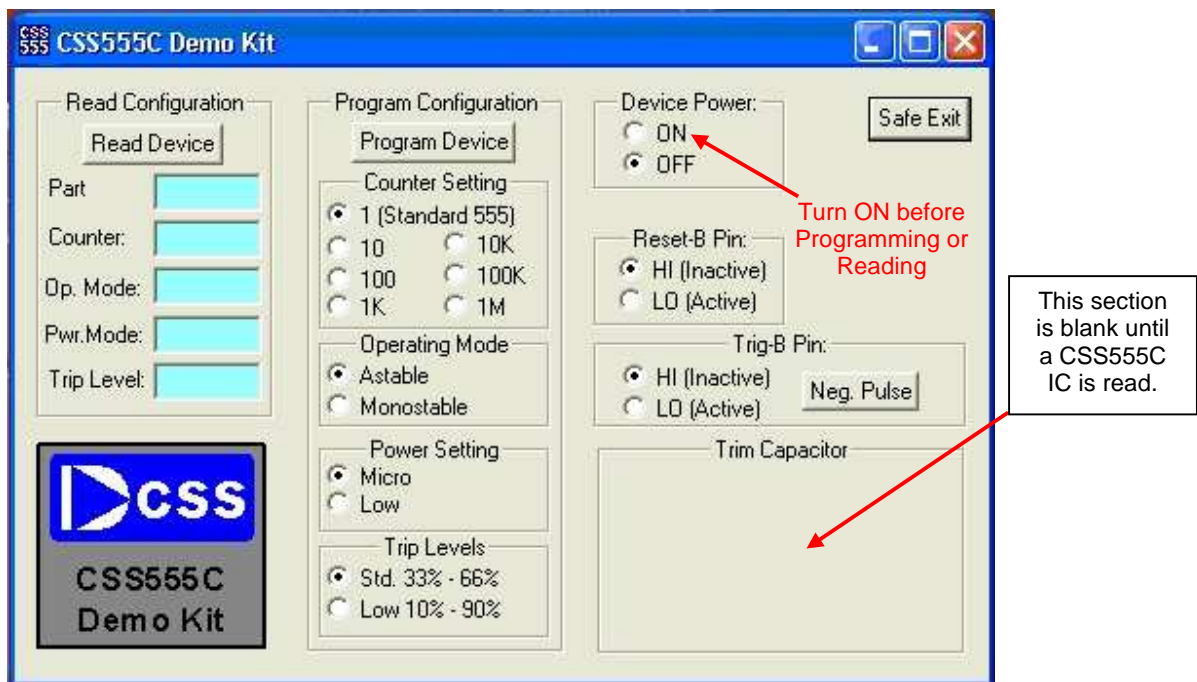
Graphic User Interface (GUI) at Start-up

CSS555C   Demonstration Kit

Jumpers, LEDs and Test Points

The following tables summarize the functions of the board's jumpers, LEDs and test points. (Please refer to the "PCB Component Locations" on page 13 to locate their postions.)

The CSS555 Demo Kit is shipped with jumpers JP1 and JP3 installed. This is the normal configuration for programming and reading the IC. Changing the jumpers allow users to manually configure the module for their own, unique application. Jumper JP1 allows a current meter to be added in the IC's power supply line so that I_{DD} can be monitored. Jumper JP3 allows the PC to control the TRIGGER input and is required for programming and reading the configuration data. It also allows the PC to trigger a monostable timing cycle and enable astable operation when the internal counter is enabled. For 1X astable operation, the TRIGGER pin needs to be connected to the THRESHOLD pin. Removing JP3 and installing JP2 disconnects TRIGGER from the PC and connects it to THRESHOLD. (Make sure to switch the jumper back in order to program or read the device.)

Jumper Summary

Jumper	Function
JP1	V_{DD} isolation (for I_{DD} measurement)
JP2	Connect TRIG to THRESHOLD (1X astable mode only)
JP3	Connect TRIG to serial interface (PC controls TRIG)

The LEDs provide a quick monitoring capability for power supply status and the state of the timer output. The function of each LED is listed in the table below.

LED Summary

LED	Function
D1 - Green	+5V USB power supply (ON when +5V is present)
D2 - Red	V_{DD} power to timer IC (ON when present)
D3 - Blue	Timer Output (ON when TIMER OUT = 1)

Each of the CSS555C's pins is brought to a test point to provide easy access for scope probes and test equipment. The second column lists the normal 555 function for each pin. The third column shows the function of each pin during a Read or Program cycle. (The Read and Program modes are enabled by forcing pin 5 (CONTROL V) to GND.)

Test Points

Test Point	Normal 555 Mode	Read/Program Modes
TP1	GND	GND
TP2	TRIGGER	SERIAL CLOCK
TP3	TIMER OUT	DATA OUT
TP4	RESET	DATA IN
TP5	CONTROL V	READ/PROG ENABLEB
TP6	THRESHOLD	THRESHOLD
TP7	DISCHARGE	DISCHARGE
TP8	V_{DD}	V_{DD}

# CSS555C   Demonstration Kit

Graphic User Interface

The Graphic User Interface (GUI) allows the user to enable and disable the CSS555's power supply (V_{DD}) and set the logic level of the RESET and TRIGGER signals. It also provides read/write access to the internal EEPROM. The EEPROM stores configuration data for the various operating modes. For the CSS555C device, it also stores the trim setting for the internal 100pF timing capacitor.

V_{DD}, Reset & Trigger Controls

Device power, RESET and TRIGGER are controlled using the GUI dialog box (shown below). Clicking the "Device Power ON" button enables the V_{DD} supply. The state of the V_{DD} supply is indicated by the red LED. ("ON" = Enabled).

The RESET and TRIGGER signals may be set high or low by clicking on their "HI/LO" buttons. Both signals are active low. To trigger a single delay pulse, click on the "Neg. Pulse" button. A single, 1 millisecond pulse will be applied to the TRIGGER pin. Please refer to the Application Information section (pages 17 & 18) for descriptions of the Monostable and Astable operating modes.

The "Safe Exit" button disables the V_{DD} supply and ends the program.
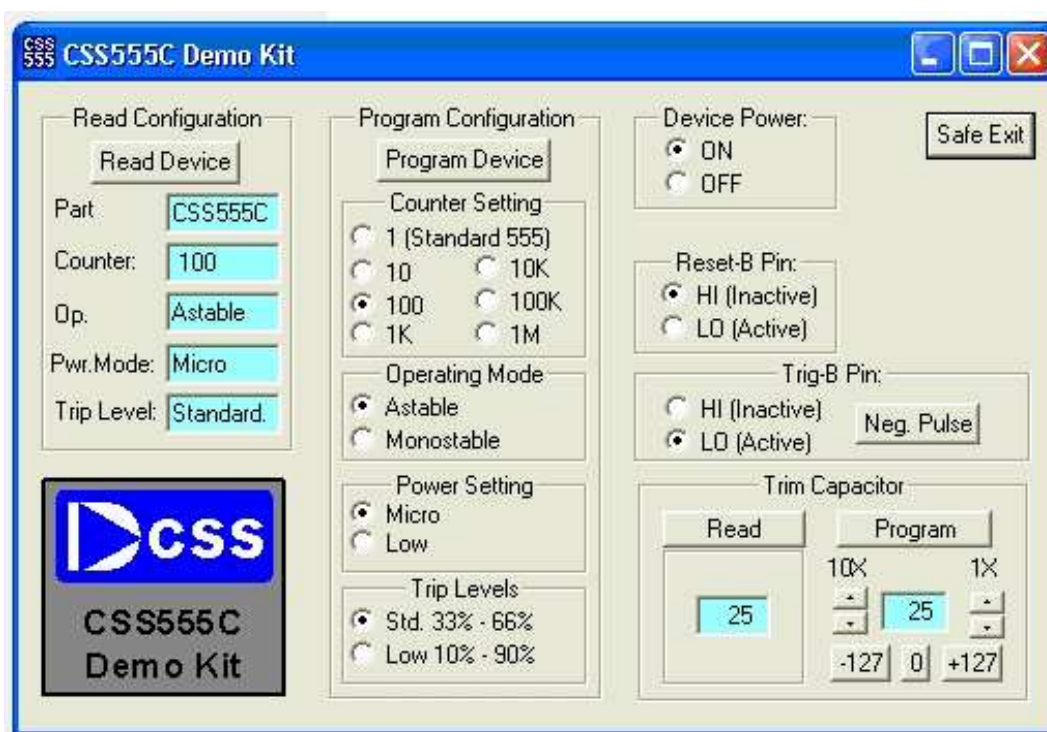
Graphic User Interface (GUI)

Reading Configuration Data

To read the current configuration settings, press the "Read Device" button. (Make sure that power has been enabled. The red LED should be ON.) Configuration data is then read and displayed in the dialog box shown above.

Programming Configuration Data

To change the configuration data, use the "Program Configuration" dialog box shown above. Select the desired Counter, Operating Mode, Power and Trip Level settings. Make sure power has been enabled (Red LED = ON). Press "Program Device". To check the new settings, use the "Read Device" command. (A summary of the configuration options is provided in the next section.)

CSS555C   Demonstration Kit

Graphic User Interface (cont.)

Adjusting the Timing Capacitor (CSS555C only)
The internal timing capacitor (C_T) is trimmed at the factory to 100pF ±1%. In most applications, it does not need any further adjustment. However, it may be trimmed by the user to compensate for errors in the values of R_A and R_B. The "Trim Capacitor" section of the dialog box provides access to C_T's trim setting. The trim setting has a range of ±127, with 0 being approximately 100pF. Changing the trim setting by one count corresponds to approximately a 1/8 pF change in C_T.

Note: The internal 100pF timing capacitor is only available in the CSS555C device. The internal timing capacitor is not available in the CSS555 IC. (The MSB of the configuration data indicates the part type.) The "Trim Capacitor" section of the dialog box will be blank if a CSS555 part is detected. This indicates that trimming the internal timing capacitor is not available for the CSS555 part type.

Configuration Options

Decade Counter (C_T Multiplier)
A six-decade programmable counter is available for generating long time delays or low frequency clocks. It effectively multiplies the value of the timing capacitor (C_T) by the multiplier setting. Three EEPROM bits select one of seven possible multiplier values. (1, 10, 100, 1K, 10K, 100K and 1M) With this range of counter values, the internal 100pF timing capacitor can generate time delays that are equivalent to delays provided by capacitors from 100pF to 100uF. Delay times lasting minutes, hours or days are easily realized. (If the multiplier value is set to 1, the decade counter is disabled and the CSS555 functions like a standard 555 timer. For more details, see the specification.)

Operating Mode (Astable or Monostable)
If the counter setting equals one, the decade counter is bypassed and the CSS555 functions as a standard 555 timer. The operating mode, Astable or Monostable, is determined by the external connections. (The configuration setting has no affect.)

If the counter setting is greater than one, the operating mode is set internally. If the monostable mode is selected, pulsing the TRIGGER input low initiates a single output pulse. The duration of the pulse is equal to N oscillator cycles, where N equals the counter (multiplier) setting. If the astable mode is selected and TRIGGER is held low, the timer output will be a continuous clock. The output frequency is divided by the multiplier setting. Pulsing the TRIGGER pin low in the astable mode produces a single output clock. Since the output clock starts with the low half of the clock cycle, this mode can be used to generate a delayed pulse (A delayed output pulse typically takes two 555's to implement.)

Power Setting (Micro-power or Low-power)
The power level can be optimized for low power or high speed. When the "Micro-power" setting is selected, the operating current is approximately 2uA at 1.5V, 4.5uA at 5.0V. For applications where high speed is required, the "Low power" setting should be used. At this setting, the operating current is about 12uA at 1.5V and 25uA at 5.0V. (These current levels are for the IC only – current associated with the timing resistors or the load at the timer output must be added to get the total circuit power.)

Trip Levels (Standard or Low Voltage)
The standard trip levels for almost all 555 timers are ⅓ and ⅔ of V_{DD}. To extend the operating range at low supply voltages, the trip levels can be changed to 10% and 90% of V_{DD}. The "Low Voltage" trip levels should be used whenever V_{DD} is less than 1.8V. When these levels are selected, the delay time is about 2X longer if Multiplier = 1 and about 3X longer if Multiplier > 1. (See the spec or the Timer Calculator for exact values.)

Configuration Options (cont.)

Summary of Configuration Options

Option Name	Configuration Settings	Description
Counter Setting	Mult = 1	Configure as a standard 555 (internal decade counter is disabled)
	Mult = 10, 100… 1M	Enable internal decade counter & select Multiplier setting
Operating Mode	If Mult = 1	This setting is a "Don't Care"
	Astable (Mult > 1)	Free-running oscillator, enabled when TRIGGER = 0
	Monostable (Mult > 1)	Single output pulse, initiated by falling edge of TRIGGER
Power Setting	Micro-power	Lowest power setting (I_{DD} = 2uA to 5uA)
	Low-power	Higher power setting for higher speed (I_{DD} = 10uA to 25uA)
Trip Levels	Standard	Trip levels = ⅓ x V_{DD} & ⅔ x V_{DD} (standard 555 levels)
	Low Voltage	Trip levels = 10% & 90% of V_{DD} (use if V_{DD} < 1.8V)

Selecting the Timing Components (R_A, R_B and C_T)

Optimizing for Low Power, Accuracy and Low Cost

The following tables show the wide range of Delay Times and Oscillator Frequencies that are possible. By using the internal decade counter, the effective value of the timing capacitor can be multiplied by up to 1 million, making a 100pF capacitor "look like" a 100uF capacitor. Delay times from several microseconds to hundreds of hours are easily realized.

To minimize power, the value of R_A should be as high as practical. Its maximum value is usually limited by leakage current at the PCB level. A maximum value of several megohms is typical. (Reducing V_{DD}, if that is an option, also minimizes power.) The value of the timing capacitor (C_T) is selected to generate the desired delay time or frequency. By using the internal decade counter, C_T can be orders of magnitude smaller than what would be required with a standard 555 timer. Reducing the value of C_T saves board space and money.

Monostable Delay Time Examples

Trip Levels	Multiplier Setting						
	1	10	100	1K	10K	100K	1M
C_{TI} = 100pF, No C_{TX}, R_A, R_B = 1MΩ (Demo Kit default values)							
1/3, 2/3	0.22 msec	2.1 msec	21 msec	210 msec	2.1 sec	21 sec	3.5 min
10%, 90%	0.46 msec	6.4 msec	66 msec	660 msec	6.6 sec	66 sec	11.0 min
C_{TI} = 100pF, No C_{TX}, R_A, R_B = 10KΩ (Low impedance R_A, R_B for short delays)							
1/3, 2/3	2.2 usec	21 usec	210 usec	2.1 msec	21 msec	210 msec	2.1 sec
10%, 90%	4.6 usec	64 usec	660 usec	6.6 msec	66 msec	660 msec	6.6 sec
C_{TI} = 100pF, C_{TX} = 0.1uF, R_A, R_B = 2.5MΩ (High impedance R_A, R_B & external C_T for long delays)							
1/3, 2/3	0.55 sec	5.2 sec	52 sec	8.7 min	87 min	14.4 hours	144 hours
10%, 90%	1.15 sec	16.0 sec	164 sec	27.5 min	275 min	45.8 hours	458 hours

Astable Frequency Examples

Trip Levels	Multiplier Setting						
	1	10	100	1K	10K	100K	1M
C_{TI} = 100pF, No C_{TX}, R_A, R_B = 1MΩ (Demo Kit default values)							
1/3, 2/3	4.81 KHz	481 Hz	48.1 Hz	4.81 Hz	0.481 Hz	0.0481 Hz	0.0048 Hz
10%, 90%	1.52 KHz	152 Hz	15.2 Hz	1.52 Hz	0.152 Hz	0.015 Hz	0.0015 Hz
C_{TI} = 100pF, No C_{TX}, R_A, R_B = 10KΩ (Low impedance R_A, R_B for high frequency)							
1/3, 2/3	481 KHz	48.1 KHz	4.81 KHz	481 Hz	48.1 Hz	4.81 Hz	0.48 Hz
10%, 90%	152 KHz	15.2 KHz	1.52 KHz	152 Hz	15.2 Hz	1.52 Hz	0.15 Hz

CSS555C   Demonstration Kit

Selecting the Timing Components (Cont.)

Using the Timer Calculator

The "CSS555 Timer Calculator" is located in the "Tools" folder. This file is an Excel spread sheet that is a design aid for selecting R_A, R_B and if required, an external timing capacitor (C_T). It calculates the timing parameters and supply current. It allows the circuit design to be optimized quickly and easily.

The timing components and configuration settings are entered in the green boxes. Resistor values may be entered in K ohms or Meg ohms, values for the timing capacitor (C_T) can be entered in pF, nF or uF. If the operating mode is "Astable", the output Period, Frequency and Duty Cycle are calculated and listed in the blue boxes. If "Monostable" operation is selected, the output delay and recovery times are shown. For either mode of operation, the Idle and Active supply currents are also provided. (The current associated with the timing components is included. A small, capacitive load is assumed for the Timer Output pin and is therefore negligible.)
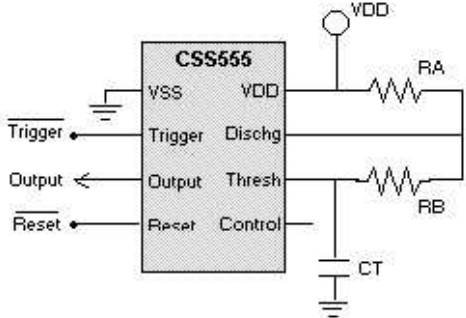
CSS555 Timer Calculator

Notes:

If a supply voltage less than 1.8V is entered, the "Low Voltage" trip levels (10% & 90%) are selected and the timer output calculations are adjusted accordingly.

The supply current calculation assumes that the Power Level is set for "Micro-power". If the Low-power setting is selected, add 15uA to both values (Idle and Active).

CSS555C   Demonstration Kit
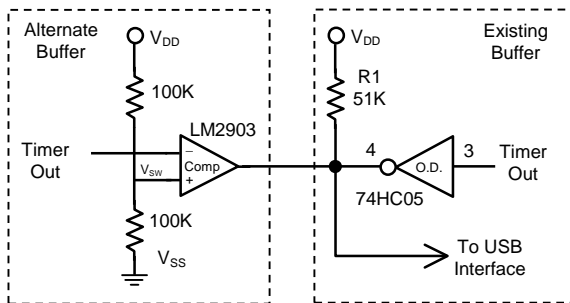
Test Options

Using an External V_{DD}

The default V_{DD} supply is +5.0V. To operate the 555 timer at lower voltages, disable the internal supply (using the GUI) and connect an external DC supply (or battery) to the V_{DD} line. An extra through-hole is available in the proto area for this purpose.

Caution: To avoid damaging the PCB, the external supply should never be connected to V_{DD} when the internal supply is enabled. Always disconnect the external supply before starting/stopping the GUI program. (A series diode can be used to isolate the supplies.)
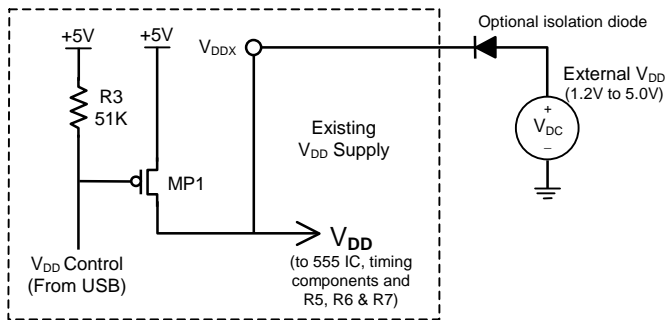
Reading the Configuration Data at Low Voltage

The 74HC05 hex inverter is powered by the +5V supply. Its input switch level is about +V/2, or 2.5V. If the supply voltage to the CSS555C IC is less than 3.0V, an alternate buffer circuit is required.

CSS555C   Demonstration Kit

Test Options (cont.)

Measuring I_{DD}

The supply current of the CSS555C can be monitored be removing jumper JP1 and replacing it with a current meter.
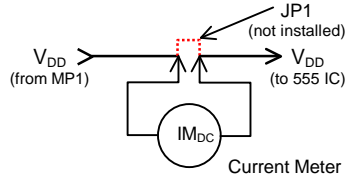

Monostable Operation, Delay < 1msec

The USB protocol limits the minimum trigger pulse to 1 msec. For shorter delay times, the circuit shown below should be used. Typical values for R_{PU} are 1K to 10K. (JP3 must be reinstalled to program.)
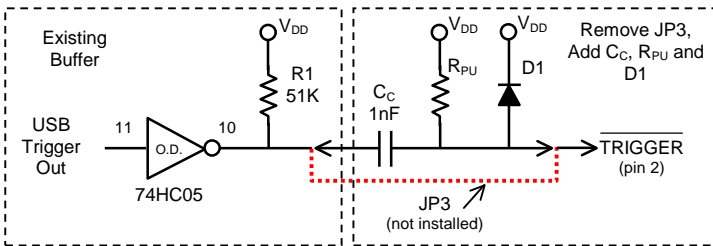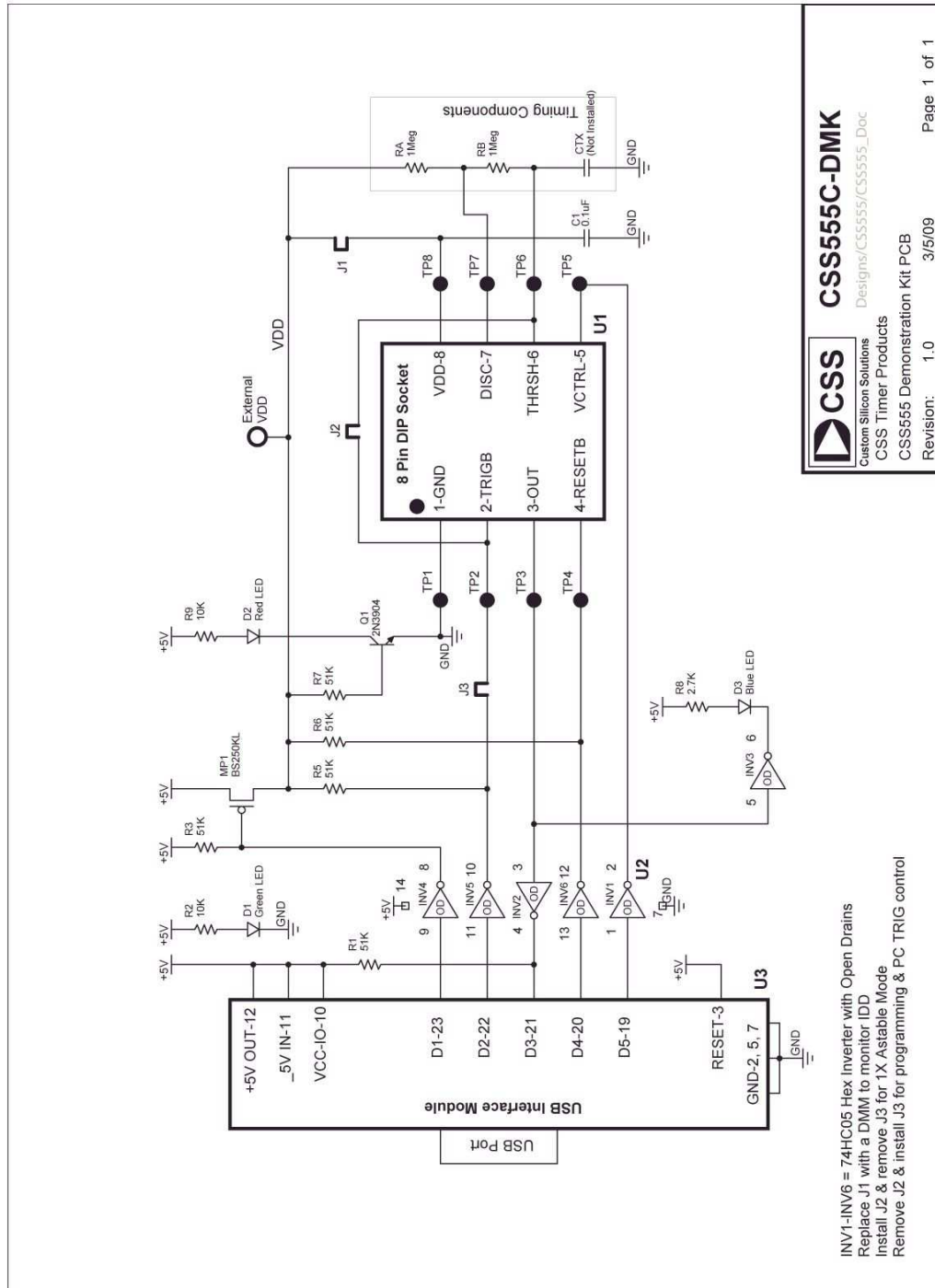

Astable Operation, Multiplier = 1X

For ASTABLE operation with a multiplier setting of 1X (counter bypassed, standard 555 operating mode) remove JP3 and install JP2. This will disconnect TRIGGER from the USB interface and connect it to THRESHOLD (pin 6). (JP3 must be reinstalled to program.)
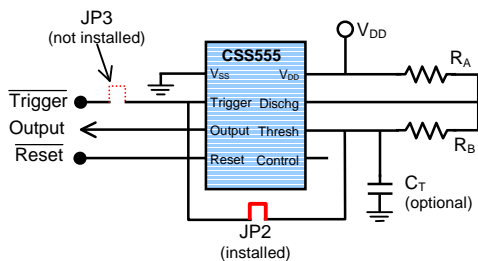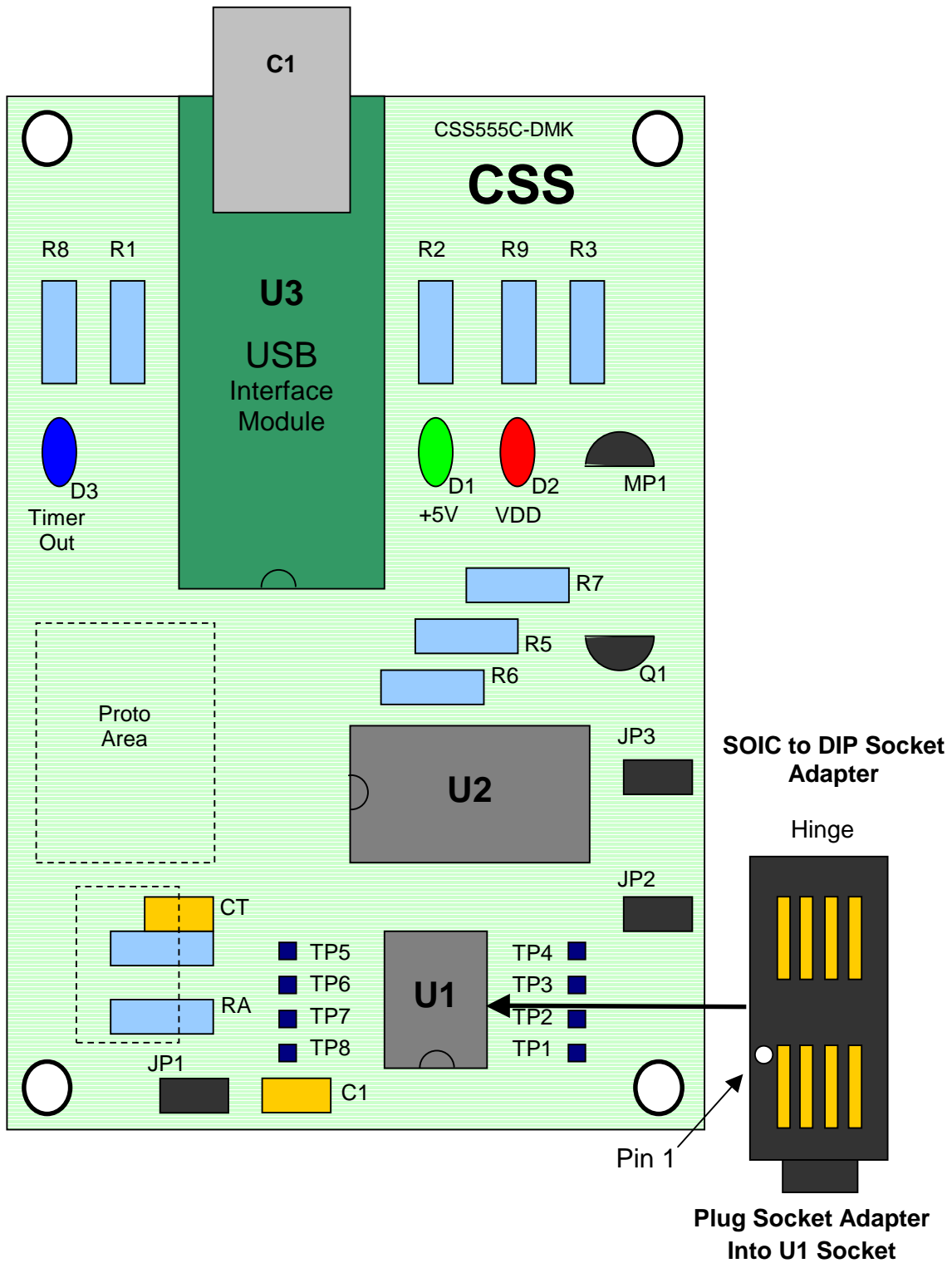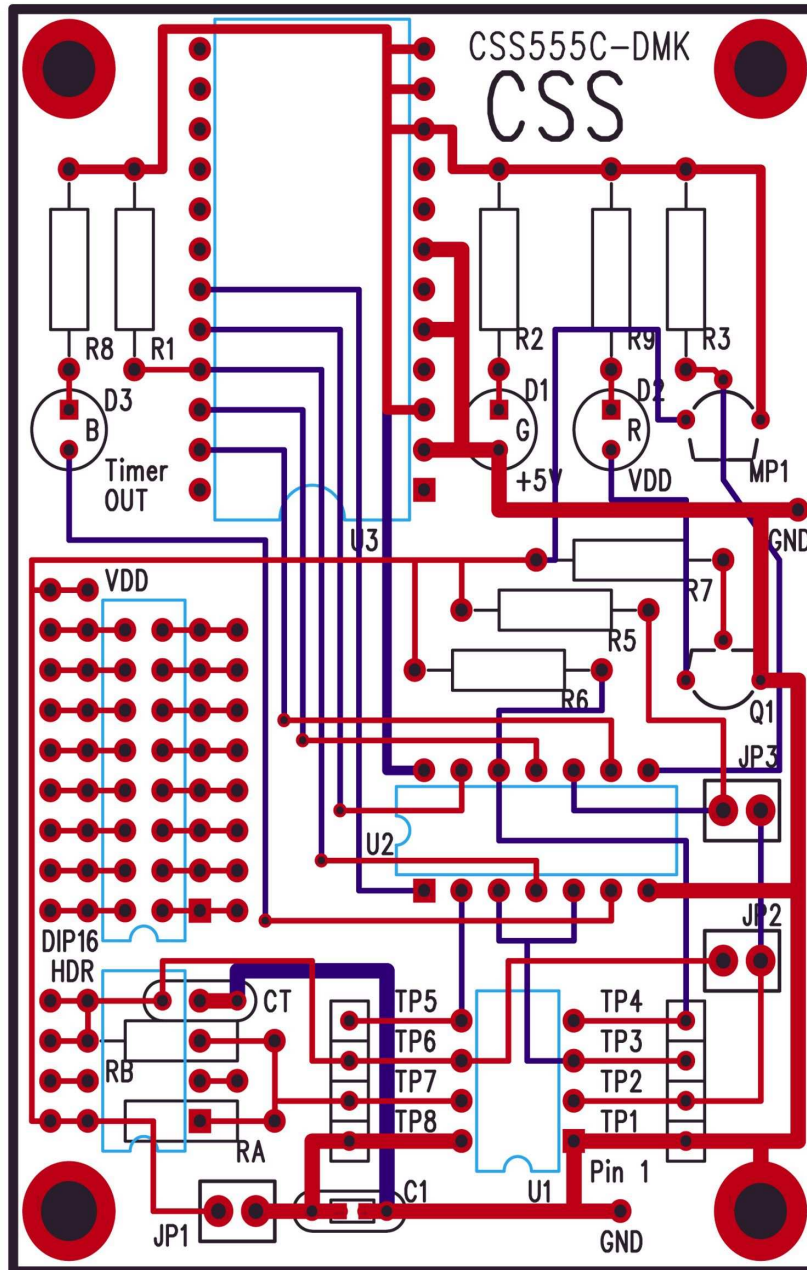
PCB Schematic

Note: There is a provision for an external timing capacitor (C_{TX}), but the PCB is shipped without it installed. This is to allow the internal 100pF timing capacitor to be evaluated without a parallel off-chip capacitor.

Demonstration Kit

PCB Component Locations

C1

CSS555C-DMK

CSS

R8 R1

U3

USB
Interface
Module

R2 R9 R3

D3
Timer
Out

D1
+5V

D2
VDD

MP1

R7

R5

R6

Q1

Proto
Area

U2

JP3

**SOIC to DIP Socket
Adapter**

Hinge

JP2

CT

RA

TP5

TP6

TP7

TP8

U1

TP4

TP3

TP2

TP1

JP1

C1

Pin 1

**Plug Socket Adapter
Into U1 Socket**

PCB Wiring Diagram

Notes: Red = Top-side metal

Blue = Bottom-side metal

Bottom-right mounting hole is tied to GND

CSS555C Demonstration Kit
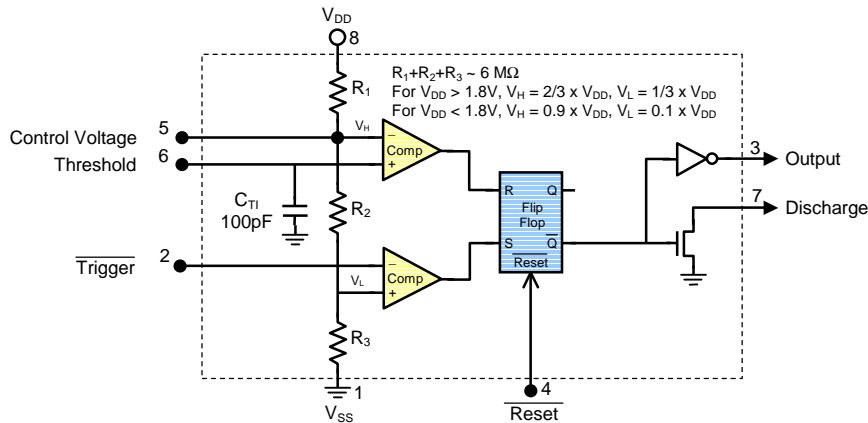
Bill of Materials

Qty	Instance	Description	Manufacturer	Part Number
1	U1	CSS555C timer IC	CSS	CSS555C
1	U2	Hex inverter (open drain outputs)	Texas Instruments	74AHC05
1	U3	USB Interface module	DLP Design	DLP-USB245M-G
5	R1, R3, R5-R7	Resistor, 51KΩ, 1/4W, 1%	Yageo	MFR-25FBF-2K80
2	R2, R9	Resistor, 10KΩ, 1/4W, 1%	Yageo	MFR-25FBF-10K
1	R8	Resistor, 2.8KΩ, 1/4W, 1%	Yageo	MFR-25FBF-51K1
2	RA, RB	Resistor, 1MΩ, 1/4W, 1%	Yageo	MFR-25FBF-1M00
1	C1	Capacitor, 0.1uF, 50V, 20%	Kemet	C322C104M5U5TA
1	CT	Timing capacitor, Not installed		
1	D1	LED, Green (5mm, oval)	Optek	OVLHGKD8
1	D2	LED, Red (5mm, oval)	Optek	OVLHRKD8
1	D3	LED, Blue (5mm, oval)	Optek	OVLHBKD8
1	MP1	Pch FET	Vishay	BS250KL-TR1-E3
1	Q1	Bipolar transistor, NPN	Fairchild Semi.	2N3904BU
1	S1	DIP socket, 8 pin	Mill-Max	110-93-308-41-001000
3	JP1-JP3	Jumpers	On Shore Tech	PH2-224/100
2	TP1-TP8	Connector, Header, 4-pos, 100 mil, VERT	Phoenix Enterprises	HWS15856

Block Diagram – Standard 555 Timer Configuration
(Programmable counter bypassed, Divider setting = 1)

$R_1 + R_2 + R_3 \sim 6\ M\Omega$
For $V_{DD} > 1.8V$, $V_H = 2/3 \times V_{DD}$, $V_L = 1/3 \times V_{DD}$
For $V_{DD} < 1.8V$, $V_H = 0.9 \times V_{DD}$, $V_L = 0.1 \times V_{DD}$

Block Diagram - Extended Period Configuration
(Programmable counter enabled, Divider setting ≥ 10)
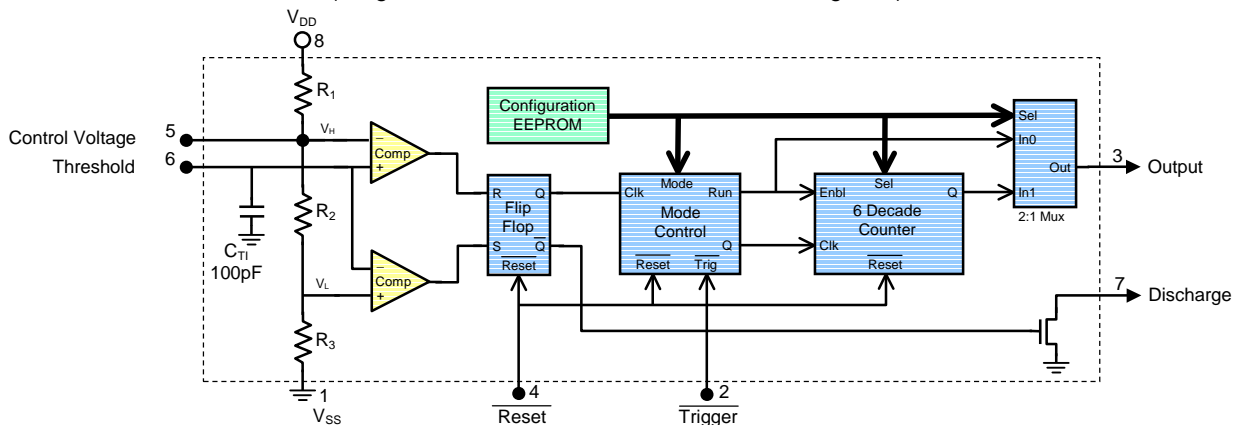
EEPROM Bit Assignments

Counter Configuration	Divider Setting (Mult)
xxxxx000	1 (Std. 555)
xxxxx001	10
xxxxx010	100
xxxxx011	1K
xxxxx100	10K
xxxxx101	100K
xxxxx110	1M
xxxxx111	1 (Std. 555)

| Mode Control Bits	Function
xxxx0xxx	Astable Mode ("Don't Care" if Std. 555)
xxxx1xxx	Monostable Mode ("Don't Care" if Std. 555)
xxx0xxxx	Micro Power
xxx1xxxx	Low Power
xx0xxxxx	Standard Voltage (Trip levels = ⅓ & ⅔ V_{DD})
xx1xxxxx	Low Voltage (Trip levels = 10% & 90% V_{DD})
Bit 6	Unused
Bit 7	0 if CSS555, 1 if CSS555C (Read Only)

Note: For detailed programming information, see Application Note AN555-1 (CSS555_App_Note1_Serial_Interface)
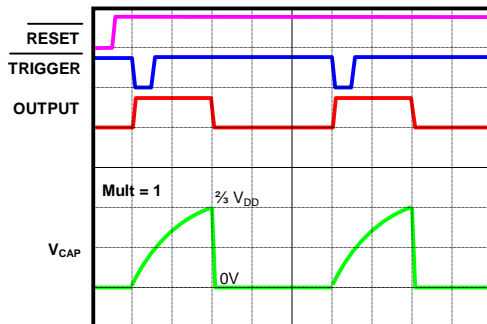
Reference Material (cont.)
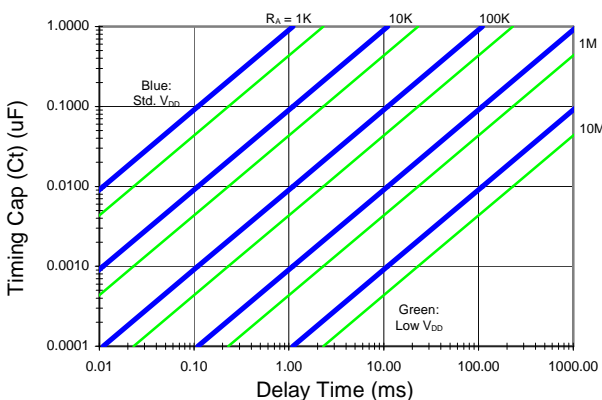
Monostable Operation
(Standard 555 Mode)

The circuit shown below is a monostable or "one shot" configuration. A single, positive output pulse is generated on the falling edge of the TRIGGER input. When TRIGGER goes low, a flip-flop is set, the OUTPUT pin is set high and DISCHARGE allows the timing capacitor to charge towards V_{DD} via R_A. When V_{TH} reaches the upper comparator trip level, the flip-flop is reset, OUTPUT is forced low and DISCHARGE pulls V_{TH} to GND. After V_{TH} has discharged, the circuit is ready for the next trigger pulse. Typical signal waveforms are shown below.
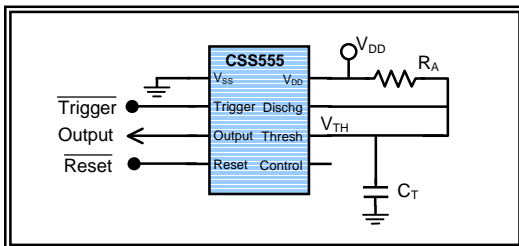
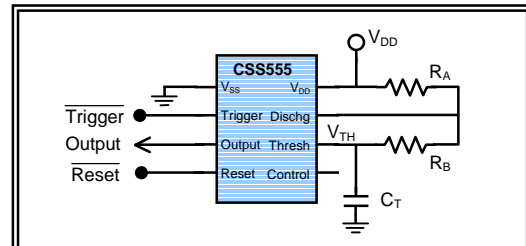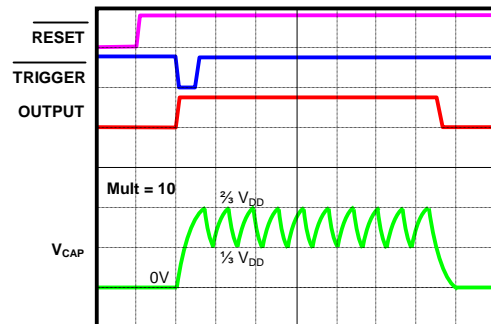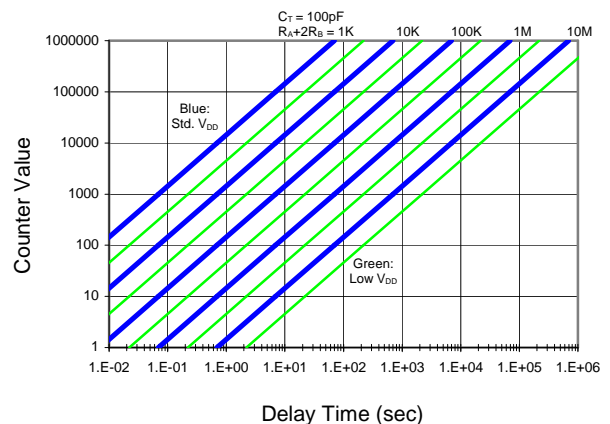### Monostable Operation
(Extended Period or "EP" Mode)

For longer time delays, the circuit shown below uses the internal decade counter to effectively multiply the value of the timing capacitor. Three bits in the EEPROM select a multiplier value from 10 to 10^6. The 555 analog block is configured as a free running oscillator, which is the input clock to the counter. On the falling edge of TRIGGER, the 555 oscillator is enabled, OUTPUT is set high, the decade counter is enabled and a new timing cycle begins. The timing cycle ends when the counter reaches the selected terminal count. Waveforms for an extended delay cycle are shown below.

Monostable Circuit (Standard Mode)

Extended Period Delay Circuit

Monostable Waveforms (Standard Mode)

Extended Period Waveforms

Time Delay Chart
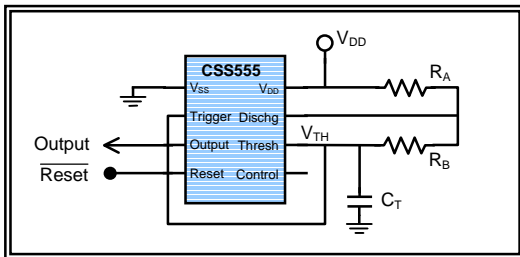
Extended Period Delay Chart

Reference Material (cont.)
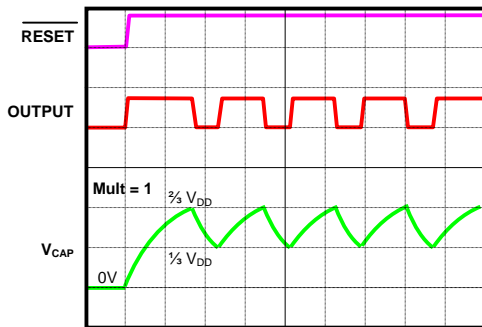
Astable Operation
(Standard 555 Mode)

The circuit shown below is an astable or "free running oscillator" configuration. If the counter setting equals one, the counter is bypassed and the device operates like a standard 555 timer. With the TRIGGER input tied to THRESHOLD, a new timing cycle is started each time V_{TH} drops below the lower comparator trip level.
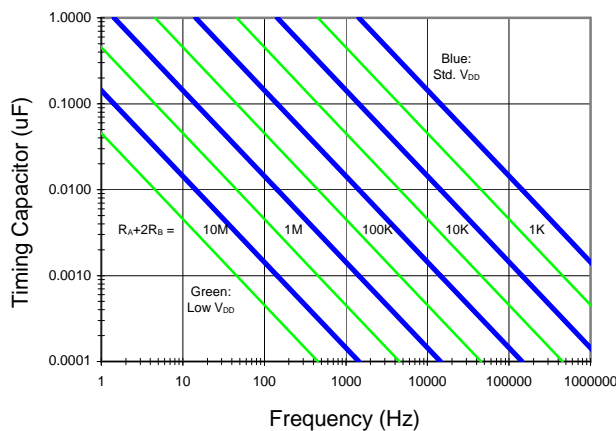
Note: A "Timer Calculator" is available for these circuits in the "Tools" folder on the CD. Open the file "CSS555_Timer_Delay_Calculator.xls".

Astable Circuit (Standard Mode)


Astable Waveforms (Standard Mode)

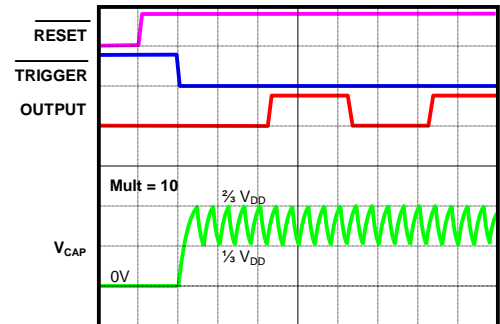**Astable Frequency Chart (Standard Mode)**

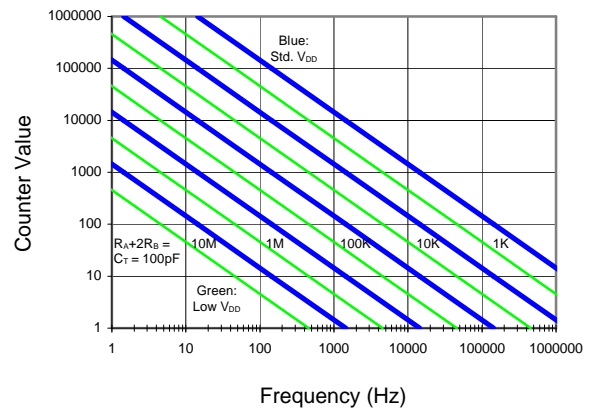### Astable Operation
(Extended Period or "EP" Mode)

The circuit shown below employs the internal decade counter to divide the 555 oscillator frequency by the multiplier setting. The multiplier value, 10 to 10^6, is selected by the EEPROM. The 555 analog block is configured as a free running oscillator, which supplies the input clock to the counter. The oscillator runs when RESET is high and TRIGGER is low. Each stage of the decade counter consists of a divide by 5 followed by a divide by 2. This configuration provides a 50% output duty cycle no matter which multiplier setting is selected. Waveforms for this mode are shown below.
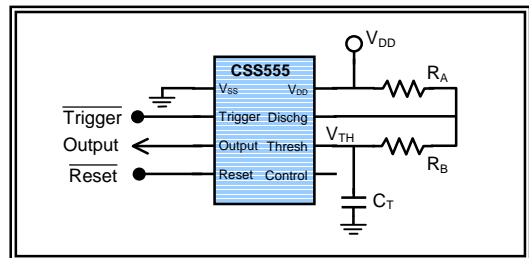
Astable Circuit (EP Mode)

Astable Waveforms (EP Mode)

Astable Frequency Chart (EP Mode)

Reference Material (cont.)

Astable Operation, Duty Cycle < 50%
(Extended Period or "EP" Mode)

In the astable mode with multiplier settings greater than one, the output duty cycle is normally 50%. (The output is low until the internal counter reaches its mid value.) Generating a lower duty cycle is easily accomplished by adding a feedback path from the Output pin to the Discharge pin as shown in the circuit below. When the output goes high the charging current increases, since resistor R_F is now in parallel with R_A. A higher frequency increases the clock rate of the counter and decreases the output high time. If we ignore the voltage drop across D1:

$$\text{Osc. Freq}_{LOW} = 1.44 / [(R_A + 2R_B) \times C_T]$$
$$\text{Osc. Freq}_{HIGH} = 1.44 / [(R_A||R_F + 2R_B) \times C_T]$$
$$\text{Output Time}_{LOW} = 0.5 \times \text{Mult}/\text{Freq}_{LOW}$$
$$\text{Output Time}_{HIGH} = 0.5 \times \text{Mult}/\text{Freq}_{HIGH}$$
$$\text{Duty Cycle} = \text{Time}_{HIGH} / (\text{Time}_{LOW} + \text{Time}_{HIGH})$$

If $R_B << R_A$ and R_F:
$$\text{Duty Cycle} \sim R_F / (R_A + 2R_F)$$

Note: A "Timer Calculator" is available for this circuit in the "Tools" folder. Open "CSS555_Adj_Duty_Calculator.xls".

Diode D1 allows a wider range of duty cycle values. Without D1, if $R_F \leq 2R_A$, V_T can't reach the upper trip level (⅔ V_{DD}). The lowest duty cycle without D1 is about 20%.
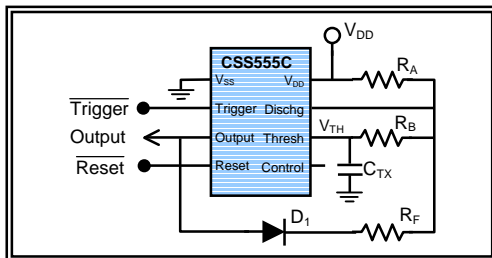
If the TRIGGER pin is held low, a continuous clock is generated at the Output pin, as shown below.
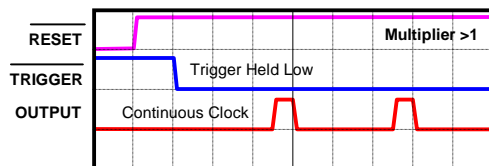
Adjustable Duty Cycle Clock (1% to 50%)

If TRIGGER is momentarily pulsed low, a single delayed pulse will be generated. (This function normally requires two monostable timers to implement.)
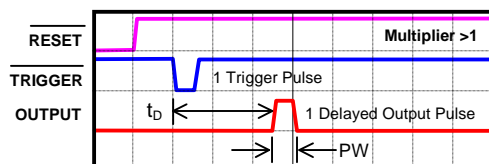
Delayed Pulse (t_D > Pulse Width)

Astable Operation, Duty Cycle > 50%
(Extended Period or "EP" Mode)

For values of duty cycle greater than 50%, the circuit shown below can be used. As in the previous circuit, the timer output is used to modulate the free running oscillator frequency. Resistor R_F is connected in parallel with R_A via MP1 (or PNP1) when the timer output pin is low. This reduces the output low time and increases the duty cycle. The timer equations are similar to the previous circuit. Since MP1 is "on" when the output is low, the equations are reversed.

If R_{ON} of MP1 is small with respect to R_F:

$$\text{Osc. Freq}_{LOW} = 1.44 / [(R_A||R_F + 2R_B) \times C_T]$$
$$\text{Osc. Freq}_{HIGH} = 1.44 / [(R_A + 2R_B) \times C_T]$$
$$\text{Output Time}_{LOW} = 0.5 \times \text{Mult}/\text{Freq}_{LOW}$$
$$\text{Output Time}_{HIGH} = 0.5 \times \text{Mult}/\text{Freq}_{HIGH}$$
$$\text{Duty Cycle} = \text{Time}_{HIGH} / (\text{Time}_{LOW} + \text{Time}_{HIGH})$$

If $R_B << R_A$ and R_F:
$$\text{Duty Cycle} \sim (R_A + R_F) / (R_A + 2R_F)$$

Note: A "Timer Calculator" is available for this circuit in the "Tools" folder. Open "CSS555_Adj_Duty_Calculator.xls".

Transistor MP1 can be any low power Pch FET. It may also be a PNP (2N3906) with an appropriate valued base resistor to limit the load on the output.
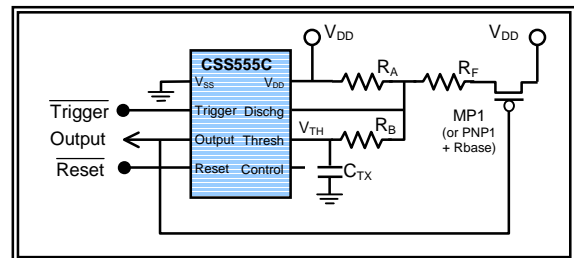

If the TRIGGER pin is held low, a continuous clock is generated at the Output pin, as shown below.
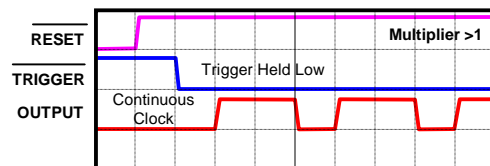
Adjustable Duty Cycle Clock (50% to 99%)

If TRIGGER is momentarily pulsed low, a single delayed pulse will be generated. (This function normally requires two monostable timers to implement.)

Delayed Pulse (t_D < Pulse Width)

Reference Material (cont.)

Supply Current vs. Supply Voltage and Temperature
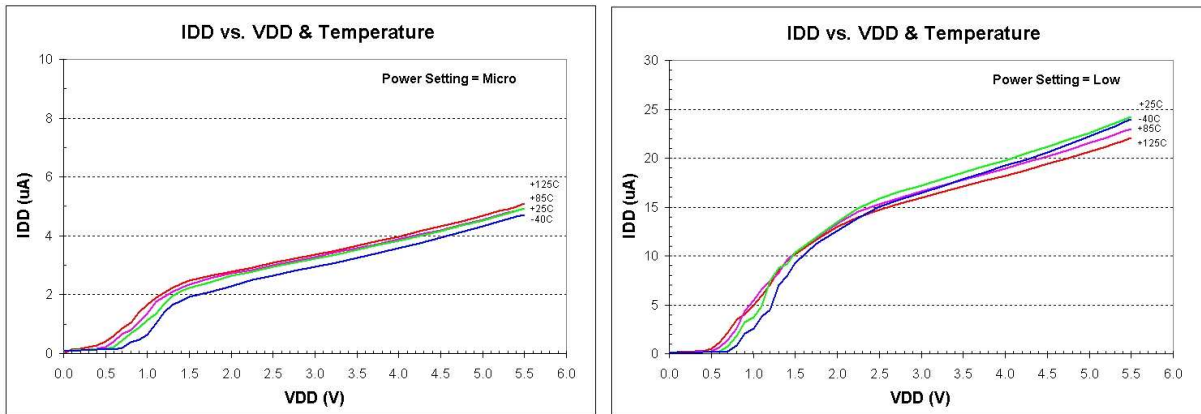
Frequency Drift vs. Supply Voltage and Temperature

Pinout Diagram

VSS —	1	8	— VDD
TRIGGER —	2	7	— DISCHARGE
OUTPUT —	3	6	— THRESHOLD
RESET —	4	5	— CONTROL V
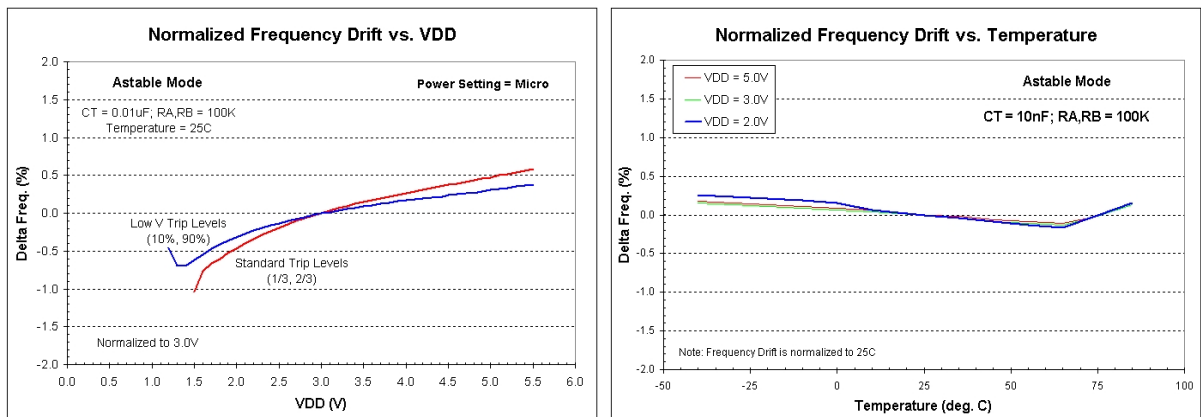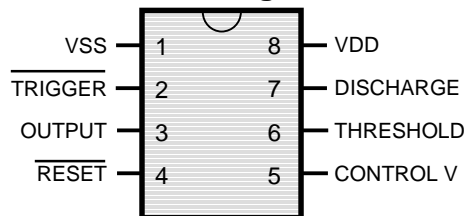
Pin Descriptions

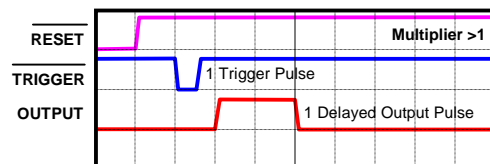| Pin Number	Pin Name	Primary Function (Normal Mode)	Secondary Function (EE Programming)
1	V_{SS}	Ground	
2	TRIGGER	Initiates timing cycles (Active low)	Serial Clock
3	OUTPUT	Timer Output (CMOS Levels)	Serial Data Out
4	RESET	Asynchronous timer reset (Active low)	Serial Data In
5	CONTROL V	Upper comparator switch level	R/W enable (Active if $V_{CTRL} < 0.5V$)
6	THRESHOLD	Upper comparator analog input	
7	DISCHARGE	Open drain FET, on when OUTPUT = 1	
8	V_{DD}	Positive voltage supply	

Note: Secondary function is activated when pin 5 (CONTROL V) is held below 0.5V.

CSS555C   Demonstration Kit

Troubleshooting Guide

Your Demo Kit should install and operate without problems. If you have trouble, please use the following guide to help isolate the problem.

Troubleshooting Table

Symptom	Possible Problem	Suggestions
Green LED is OFF	No +5V power to PCB	PC is off Bad USB port, try a different one. Make sure USB cable is properly installed. Bad USB cable, try another.
Error message: "Could not open a device."	USB link not working (Green LED is ON)	Bad USB port, try a different one. Make sure USB cable is properly installed & fully inserted. Bad USB cable, try another.

	Driver error	Drivers are not installed or not functioning properly
		Check driver status using the "Control Panel"
		   Connect the PCB to the PC's USB port
		   Go to System/Hardware/Device Manager
		   Expand "Universal Serial Bus Controllers"
		   Select "USB Serial Converter", Right click & select "Properties"
		   Check Device Status (under General tab)
		   If status is not "Working Properly", reinstall drivers
		   (see detailed instructions in the Operating Manual)

	USB Interface Module (located on PCB)	The USB interface module is in a socket. Make sure it is seated properly.

Can't find the USB Serial Converter driver	Driver not installed	Check for the "USB Serial Converter" driver
		   Connect the PCB to the PC's USB port
		   Go to System/Hardware/Device Manager
		   Expand "Universal Serial Bus Controllers"
		   If driver is not listed, rerun Driver Installation routine

	PCB not connected	The Demo Board must be connected to the PC for the Device Manager to display it.
Read function is not working	IC power is off	If red LED is off, Click "Device Power ON" button If using an external supply, check connections Make sure jumper JP1 is installed.
	No TRIGGER signal	Make sure jumper JP3 is installed, JP2 is not installed
	V_{DD} is too low	If using an external supply, V_{DD} must be > 3V to Read or… If V_{DD} < 3.0V, add comparator circuit (see test options)
	IC installed incorrectly	Make sure the IC is a CSS555 device Is pin 1 is correct? Check that all pins are in the socket
	Driver error	Drivers are not installed or not functioning properly (see previous "Driver Error" for suggestions)

Erratic read	Driver conflict with Virtual COM port driver	If the Virtual COM Port (VCP) driver is installed, it must be removed. (Uninstalling or disabling it will not work.)
		Check USB driver status using the "Control Panel"
		   Connect the PCB to the PC's USB port
		   Go to System/Hardware/Device Manager
		   If a COM5 port driver is installed, Uninstall it. (Step 1)
		   Refer to the "Removing the VCP Driver" section.

Program function is not working	IC power is off	If red LED is off, Click "Device Power ON" button If using an external supply, check connections Make sure jumper JP1 is installed.
	No TRIGGER signal	Make sure jumper JP3 is installed, JP2 is not installed
	V_{DD} is too low	If using an external supply, V_{DD} must be > 1.5V to Program
	IC installed incorrectly	Make sure the IC is a CSS555 device Is pin 1 is correct? Check that all pins are in the socket
	Driver error	Drivers are not installed or not functioning properly (see previous "Driver Error" for suggestions)

Troubleshooting Guide (cont.)

Removing the Virtual COM Port (VCP) driver (Windows XP)
The VCP driver is not required and may interfere with the USB Serial Converter driver. If it was installed inadvertently, it should be removed. **It is NOT sufficient to uninstall or disable it.**

To completely remove the USB Serial Port driver, complete the following steps:
1) Connect the Demo Board to the PC.
    (The driver is hidden unless the Demo Board is connected.)
2) Open the PC's "Control Panel"
    Select "System"
    Select the "Hardware" tab
    Open the "Device Manager"
    Expand the "Ports" section (click on the "+" sign)
    If there is a "USB Serial COM$_N$" port listed, right click on it and select "**Uninstall**" (left click)

    Expand the "Universal Serial Bus controllers" section (click on the "+" sign)
    Right click on "USB Serial Converter" and select "Properties"
    Select the "Advanced" tab and **uncheck** the "Load VCP" box
    Click "OK" and exit the Device Manager, Click "OK" and exit "System Properties"
    Close the Control Panel

3) Using Windows Explorer, delete the following files:
    In folder "C:WINDOWS\Inf", find the USB Serial Port "OEM$_{NN}$.inf" file. (where $_{NN}$ is a number)
    There are many OEM$_{NN}$.inf listed - one for each driver.
    Each OEM$_{NN}$.inf file is given a unique number (by Windows) when it is installed.
    If the USB Serial Port driver was installed recently, it will *probably* have the highest OEM number.
    Each "OEM$_{NN}$.inf" file has a corresponding "OEM$_{NN}$.PNF" file
    Look for an OEM$_{NN}$.INF file dated 2/17/09. (There should be two files with that date, try the 2nd.)
      (There will be a corresponding OEM$_{NN}$.PNF with a recent date, the date the drivers were installed.)
    The .INF file is a text file. Open it. The file to be deleted has "FTDIPORT.INF" on the first line.
    (If the first line is "FTDIBUS.INF", you selected the USB Serial <u>Converter</u> INF file… Do NOT delete)
    After confirming the OEM number of the FTDIPORT.INF file,
      Delete "OEM$_{NN}$.inf" and the "OEM$_{NN}$.PNF" with the same number.

    In folder "WINDOWS\System32"
      Delete "ftserui2.dll (size = 51K, Date Modified = 2/17/09 12:20PM)

    In folder "WINDOWS\System32\drivers"
      Delete "ftser2k.sys (size = 71K, Date Modified = 2/17/09 12:17PM)

    Close Windows Explorer

4) Confirm the removal of the USB Serial Port driver
    Unplug the Demo Board
    Reconnect the Demo Board
    There should be NO prompt to install a USB Serial Port Driver
    Run the program (CSS555C_DemoKit.exe)
    Verify that you can control V_{DD}, Program and Read the device.

A very detailed FTDI Drivers Installation guide can be found in Application Note AN_104. It can be found in the "Drivers" folder on the CD. It also includes a detailed description on uninstalling the drivers.