Using External Oscillators for the DP857x Real Time Clocks with the Battery Backed Mode Selected

This application note describes how external oscillators may be used with the DP857x family of real time clocks, by using the "test mode" to configure the DP857x in the battery backed mode prior to starting the clock.

THE PROBLEM

In the battery backed mode, the external oscillator peak-to-peak voltage must not exceed the voltage at the V_{BB} pin. When the chip is first time powered up, it is in the single supply mode. The single supply mode references the oscillator inverter to V_{CC}. This means that in normal operation the OSC in pin needs to swing positively to about 3.5V minimum. If an external oscillator is set to the V_{BB} value, then its high going signal may not be high enough to trip the internal inverter. If the internal inverter doesn't pass the external signal, you cannot program the chip into the battery backed mode, because the internal OSC fail signal will always be set (catch-22).

THE SOLUTION

General Description

Select the test mode and disable the oscillator fail circuitry (refer to AN 589 in the Real Time Clock Handbook). Now, the battery backed mode may be selected independent of any oscillator signal. This action references the internal inverter to V_{BB}. As a result, the inverter will pass the external oscillator signal which is set to the battery voltage plus one diode drop. Once the chip is operating in the battery backed mode, clear the "test mode" register and leave the test mode. The circuits of *Figures 1* and *2* were used to check out this solution. Both the LP2951 and LM611 are available as mini-dip packages. The LP2951 is more expensive, but is designed to do this type of application and is fully compensated for temperature and voltage changes. As shown, the circuits provide for battery backed operation of the external oscillator and DP857x. The disadvantage is extra current drain from the battery. The advantage is that the user has complete control over the oscillator design and can temperature compensate as well as tune the oscillator for maximum accuracy. The external oscillator was implemented using a 74HC04 (see *Figures 3* and *4*). The 74HC device was chosen because it is specified to operate down to 2.0V. A commercial oscillator could be used as long as it can operate at the V_{BB} voltage chosen by the user. *Figure 5* is a set of curves of C_{OUT} versus C_{IN} for a 32.768 kHz Pierce parallel resonant oscillator. These curves are helpful for choosing starting values for the oscillator to ensure reliable start up and nominal operation.
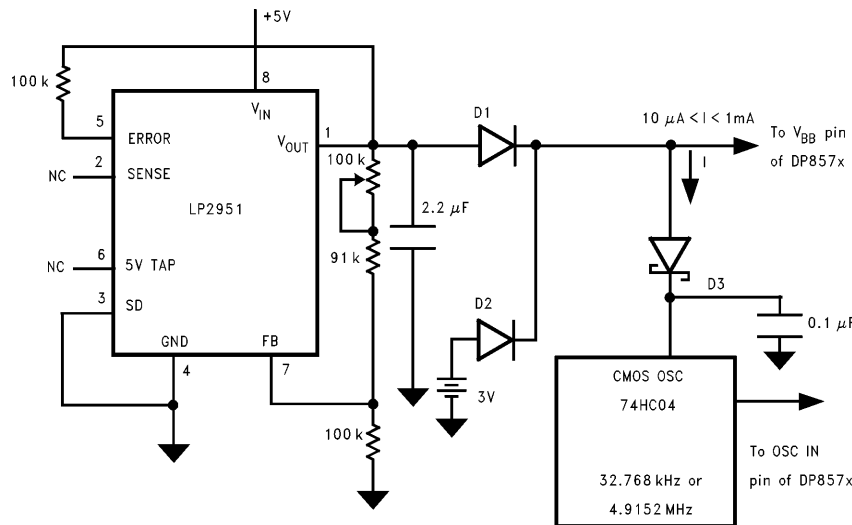

TL/F/11846–1

FIGURE 1. Voltage Regulator as a V_{CC} Supply for an External Oscillator

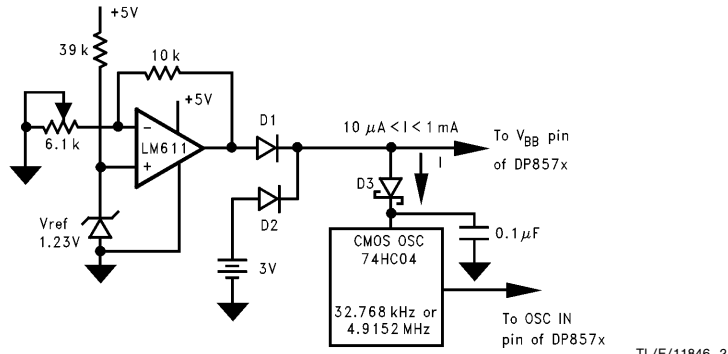**FIGURE 2. LM611 as a V_{CC} Supply for an External Oscillator**

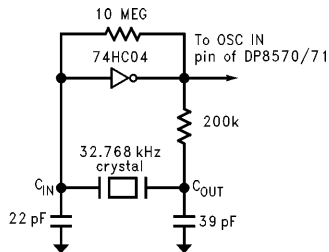**FIGURE 3. 32.768 kHz Oscillator using 'HC Inverter**

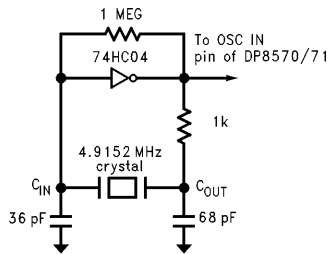**FIGURE 4. 4.9152 MHz Oscillator using 'HC Inverter**

DETAILED DESCRIPTION

Initialization procedure for first time power on:

1. Adjust output of voltage regulator to be 0.25V higher than V_{BB}. This will make sure that D2 is reversed biased and the battery will not power the external oscillator when V_{CC} is powered. For this case D1 and D2 are the same diodes (1N914). An alternate method is to use a Schottky diode for D1 and a 1N914 for D2. Then adjust the output of the voltage regulator equal to the battery. D3 is a Schottky diode (1N6263) that ensures the high level output of the oscillator is slightly lower than V_{BB}.

2. Connect external oscillator to OSC IN pin, and leave OSC OUT unconnected.

3. Select the clock frequency by writing to bits D6,D7 of the Real Time Mode Register (RTMR).

4. Write a ''1'' to D7 of the Periodic Flag Register (PFR). This selects the test mode.

5. Write a ''1'' to D7 of the RAM/Test Mode Register located at address 0x1F of page 0. Other bits = 0. The oscillator fail flag is now disabled.

6. Write ''0'' to D6 and ''1'' to D7 of the PFR. This action selects battery backed mode and test mode.

7. Start the clock by writing ''1'' to D3 of the RTMR. To check that the clock is actually running, read D3 of the RTMR and test that it is a ''1''.

8. Clear the RAM/TEST Mode Register.

9. Write ''0'' to D7,D6 of the PFR. You have now left the test mode and are in battery backed mode.

10. Read D3 of the RTMR and test for a ''1''. This is a double check that the clock is running.

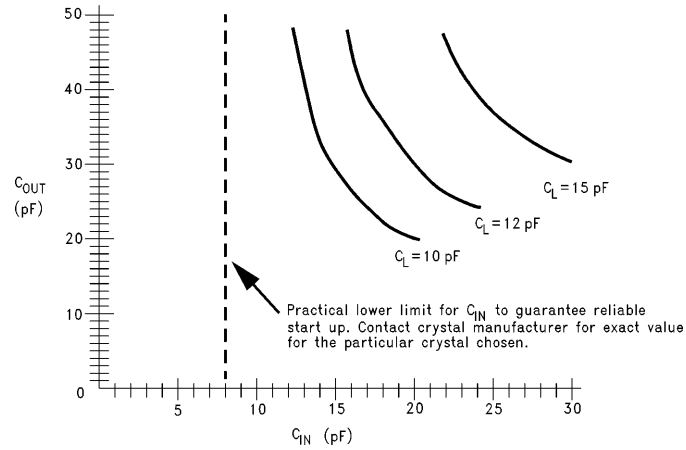11. Continue your regular initialization of the chip.

The above concept could be applied to any chip that uses an oscillator and has separate V_{BB}/V_{CC} pins that require mode selection for battery/single supply operation.

2

32.768 kHz Oscillator Hints for a Pierce Parallel Resonant Circuit

The below curves are a plot of C_{OUT} versus C_{IN} for constant Load Capacitance (C_L). The load capacitances selected show the typical range specified by various manufacturers.

The expression for calculating C_L is $\dfrac{1}{C_L} = \dfrac{1}{C_{IN}} + \dfrac{1}{C_{OUT}}$

Where C_{OUT} is usually greater than C_{IN}

Practical lower limit for C_{IN} to guarantee reliable start up. Contact crystal manufacturer for exact value for the particular crystal chosen.

$C_L = 15$ pF
$C_L = 12$ pF
$C_L = 10$ pF

TL/F/11846–3

Refer to AN-588 for additional information.

FIGURE 5

3

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.