2.4 Time Trimming Circuit

Using the time trimming circuit gain or lose of clock may be adjusted with high precision by changing clock pulses for one second every 20 seconds. When adjustment with this circuit is not necessary, set (F_6, F_5, F_4, F_3, F_2, F_1, F_0) to (∗, 0, 0, 0, 0, 0,∗) to disable adjustment. (∗ mark indicates 0 or 1.)
Adjustment amount may be calculated using the following formula.

2.4-1 When oscillation frequency*1 >target frequency*2 (clock gains)

$$\text{Adjustment amount}^{*3} = \frac{(\text{Oscillation frequency} - \text{Target frequency} + 0.1)}{\text{Oscillation frequency} \times 3.051 \times 10^{-6}}$$

$$\fallingdotseq (\text{Oscillation frequency} - \text{Target frequency}) \times 10 + 1$$

When 32.000kHz crystal oscillator is used, the same formula,

$$\text{Adjustment amount} = \frac{(\text{Oscillation frequency} - \text{Target frequency} + 0.1)}{\text{Oscillation frequency} \times 3.125 \times 10^{-6}}$$

$$\fallingdotseq (\text{Oscillation frequency} - \text{Target frequency}) \times 10 + 1$$

is used.

∗1) Oscillation frequency : Clock frequency output from the $\overline{\text{INTRB}}$ (32KOUT for the RS5C372B) pin as in ?2.2 Oscillation Frequency Measurement? at a room temperature.

∗2) Target frequency : A frequency to be adjusted to.
Since temperature characteristics of a 32.768kHz crystal oscillator are such that it will generally generates the highest frequency at a room temperature, we recommend to set the target frequency to approx. 32768.00Hz to 32768.10Hz (+3.05ppm to 32768Hz).
We also recommend setting of approx. 32000.00Hz to 32000.10Hz
(3.125ppm to 32000Hz) also for the 32.000kHz crystal.
Note that this value may differ based on the environment or place where the device will be used.

∗3) Adjustment amount : A value to be set finally to F6 to F0 bits. This value is expressed in 7bit binary digits with sign bit (two's compliment).

2.4-2 When oscillation frequency=target frequency (no clock gain or loss)

Set the adjustment value to 0 or +1, or –64 or –63 to disable adjustment.

2.4-3 When oscillation frequency<target frequency (clock loses)

$$\text{Adjustment amount} = \frac{(\text{Oscillation frequency} - \text{Target frequency})}{\text{Oscillation frequency} \times 3.051 \times 10^{-6}}$$

$$\fallingdotseq (\text{Oscillation frequency} \,.\, \text{Target frequency}) \times 10$$

Also a 32.000kHz crystal is used, the same formula,

$$\text{Adjustment amount} = \frac{(\text{Oscillation frequency} - \text{Target frequency})}{\text{Oscillation frequency} \times 3.051 \times 10^{-6}}$$

$$\fallingdotseq (\text{Oscillation frequency} - \text{Target frequency}) \times 10$$

is used.

Example of Calculations

(1) When oscillation frequency=32768.85kHz ; target frequency=32768.05kHz
Adjustment value= (32768.85-32768.05+0.1) / (32768.85×3.051×10^{-6})≒(32768.85+32768.05)×10+1=9.001=9
Set (F_6, F_5, F_4, F_3, F_2, F_1, F_0) to (0, 0, 0, 1, 0, 0, 1).
As this example shows, adjustments to be used when the clock gains shall be distance from 01h.

(2) When actual oscillation frequency=32763.95kHz ; target frequency=32768.05kHz
Adjustment value = (32763.95-32768.05) / (32763.95×3.051×10^{-6})≒(32763.95-32768.05)×10=–41.015≒–41
To express –41 in 7bit binary digits with sign bit (two's compliment),
Subtract 41(29h) from 128(80h) in the above case, 80h-29h=57h.
Thus, set (F_6, F_5, F_4, F_3, F_2, F_1, F_0) to (1, 0, 1, 0, 1, 1, 1).
As this example shows, adjustments to be used when the clock loses shall be distance from 80h.

After adjustment, adjustment error against the target frequency will be approx. ±1.5ppm at a room temperature.

Notes

1) Clock frequency output from the $\overline{\text{INTRB}}$ (32KOUT for the RS5C372B) pin will not change after adjustment by the clock adjustment circuit.
2) Adjustable range: The range of adjustment values for a case oscillation frequency is higher than target frequency (clock gains) is (F_6, F_5, F_4, F_3, F_2, F_1, F_0)=(0, 0, 0, 0, 0, 1, 0) to (0, 1, 1, 1, 1, 1, 1) and actual adjustable amount shall be –3.05ppm to –189.2ppm (–3.125ppm to –193.7ppm for 32.000kHz crystal), thus clock error may be adjusted until clock gain reaches +189.2ppm (+193.7ppm for 32.000kHz crystal). On the other hand, the range of adjustment values for a case when oscillation frequency is lower than target frequency (clock loses) is (F_6, F_5, F_4, F_3, F_2, F_1, F_0)=(1, 1, 1, 1, 1, 1, 1) to (1, 0, 0, 0, 0, 1, 0) and actual adjustable amount shall be +3.05ppm to +189.2ppm (+3.125ppm to +193.8ppm for 32.000kHz crystal), thus clock error may be adjsted until clock loss reaches –189.2ppm (–193.8ppm for 32.000kHz crystal).
3) If following 3 conditions are completed, actual clock adjustment value could be different from target adjustment value that set by Time Trimming function.
   1. Using Time Trimming function
   2. Access to RS5C372A/B at random, or synchronized with external clock that has no relation to R2051, or synchronized with periodic interrupt in pulse mode.
   3. Access to RS5C372A/B more than 2 times per each second on average.

   For more details, please contact to Ricoh.