

Introduction:

Generates a square waveform with a frequency of 19Hz using Timer RB in programmable waveform generation mode.

Hardware:

To generate a square waveform, the internal peripheral of the R8C micon is used. R8C2X devices have a range of Timers, Timer RA, Timer RB, Timer RD and Timer RE. Each timer has different mode of operations. To generate a square waveform, Timer RB is used. Timer RB is used in Programmable waveform generation mode.

The Timer RB output pin P31 (TRB0) is connected to a point LED to view the flashing of the LED. The frequency of the square waveform is measured at the same pin.

Connections:

LED -> P31 (TRB0).

Functional Description:

The Timer operates in the down counter mode and it counts the internal clock. Internal clock is the peripheral clock separately obtained from the main clock. Using TCSS register, different clock frequencies are selected.

The timer clock is divided by the prescaler register (TRBPRES). The Timer counter is initially set with the TRBPR value. The timer always counts the underflow of the prescaler register. Now the timer counts down. During this period, the TRB0 pin is set to '1' level (based on the TOPL bit in TRBIOC register).

When the timer underflows, the TRB0 pin output changes to '0' level. At the same time, the timer is reloaded with the secondary register (TRBSC) contents. Now again the timer counts the underflow signal of the prescaler. When it underflows, the level at TRB0 pin changes and reloads with the TRBPR register contents. This process is repeated continuously and hence a squarewave is generated. The timer reload value is obtained from the primary register and the secondary register alternatively.

If equal count values are loaded in both the primary and secondary registers, a square waveform with 50% duty cycle will be generated.

The frequency of the waveform is calculated as

$$= \frac{(F_{osc} / 8)}{(n+1) ((m+1)+(p+1))}$$

n - Prescaler value
m - Primary register
p - Secondary register

$$\begin{aligned}
 & (20000000 / 8) \\
 & = \frac{\text{-----}}{(256)^* (256 + 256)} \\
 & = 19 \text{ Hz (approx.)}
 \end{aligned}$$

Registers used:

- TRBPRES - 8-bit Prescaler Register for Timer RB
- TRBPR - 8-bit Timer RB Primary Register
- TRBSC - 8-bit Timer RB Secondary Register
- TRBIOC - Timer RB IO Control Register
- TRBMR - Timer RB Mode Register
- TRBCR - Timer RB Control Register

Timer RB IO Control Register - TRBIOC

	Symbol TRBIOC	Address 010Ah	After Reset 00h	
	Bit Symbol	Bit Name	Function	RW
	TOPL	Timer RB Output Level Select Bit	0 : Outputs "H" for primary period Outputs "L" for secondary period Outputs "L" when the timer is stopped 1 : Outputs "L" for primary period Outputs "H" for secondary period Outputs "H" when the timer is stopped	RW
	TOCNT	Timer RB Output Switch Bit ⁽¹⁾	0 : Outputs timer RB waveform 1 : Outputs value in P3_1 port register	RW
	NOSTG	One-Shot Trigger Control Bit	Set to "0" in programmable waveform generation mode	RW
	NOSEG	One-Shot Trigger Polarity Select Bit	Set to "0" in programmable waveform generation mode	RW
	— (b7-b4)	Nothing is assigned. When write, set to "0". When read, its content is "0".		—

NOTES :

1. This bit is enabled only when operating in programmable waveform generation mode.

1. Set TOPL to 0 level to generate a 1 level output for primary period and 0 level output for secondary period
2. Set TOCNT to 0 level to output timer RB waveform in P30 pin.

Timer RB Mode Register - TRBMR

b7 b6 b5 b4 b3 b2 b1 b0		Symbol	Address	After Reset	
		TRBMR	010Bh	00h	
Bit Symbol	Bit Name	Function	RW		
TMOD0 ⁽¹⁾	Timer RB Operating Mode Select Bit	b1 b0 0 1 : Programmable waveform generation mode	RW		
TMOD1 ⁽¹⁾			RW		
— (b2)	Nothing is assigned. When write, set to "0". When read, its content is "0".		—		
TWRC ⁽³⁾	Timer RB Write Control Bit	Set to "1" in programmable waveform generation mode	RW		
TCK0 ⁽²⁾	Timer RB Count Source Select Bit	b5 b4 0 0 : f1 0 1 : f8 1 0 : Timer RA underflow 1 1 : f2	RW		
TCK1 ⁽²⁾			RW		
— (b6)	Nothing is assigned. When write, set to "0". When read, its content is "0".		—		
TCKCUT ⁽²⁾	Timer RB Count Source Cutoff Bit	0 : Provides count source 1 : Cuts off count source	RW		

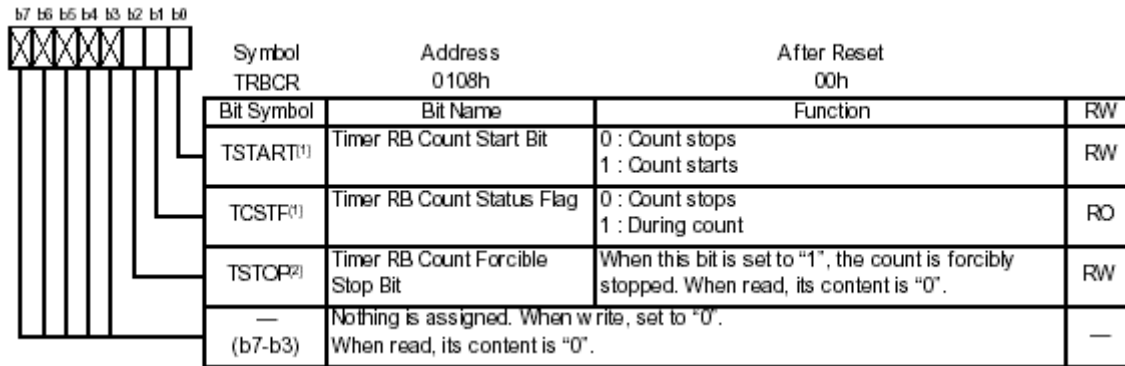
NOTES :

1. Select operation mode while the count stops.
2. Do not switch or cut off a count source during a count operation. Stop the timer count before switching or cutting off a count source.
3. When the TCSTF bit in the TRBCR register is set to "1" (counting), the count value is written to the reload register only. When the TCSTF bit is set to "0" (Stops counting), the count value is written to both the reload register and counter.

To select programmable waveform generation mode.

1. Set TMOD0 to 1 level and TZMOD1 to 0 level
2. Set TMOD1 to 0 level
3. Set TCK0 bit to 1 and TCK1 bit to 0 to select the timer clock as f8

Timer RB Control Register - TRBCR



The TSTART bit is used to start or stop the timer RA.

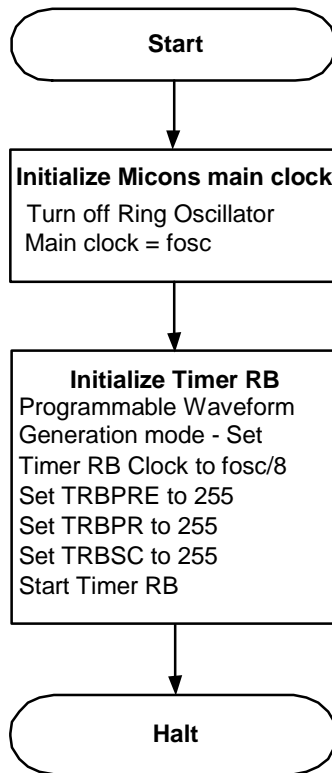
Software Description:

- Initialize the micon to select the frequency of operation as fosc with no division in frequency.
- Initialize timer RB to operate in programmable waveform generation mode. Load prescaler register with a value of 255. Set the primary and secondary registers with a value of 255. Now start the timer.
- Timer RB will generate a square waveform continuously at the timer RB output pin P31(TRB0). LED connected at the timer output pin P31 will be flashing with a frequency of 19Hz. Once initialized, the timer will generate the waveform continuously at the timer RB output pin P31.

The functions in the file “**Demo18.C**” and short descriptions are listed below:

<i>Functions</i>	<i>Description</i>
main	Main routine which initializes the micon and the Timer RB and stays in an unconditional loop.
MCUInitialize	Initializes Micon
Initialize Timer RB	Initialize Timer RB to operate in Programmable waveform generator mode

Program Flow.



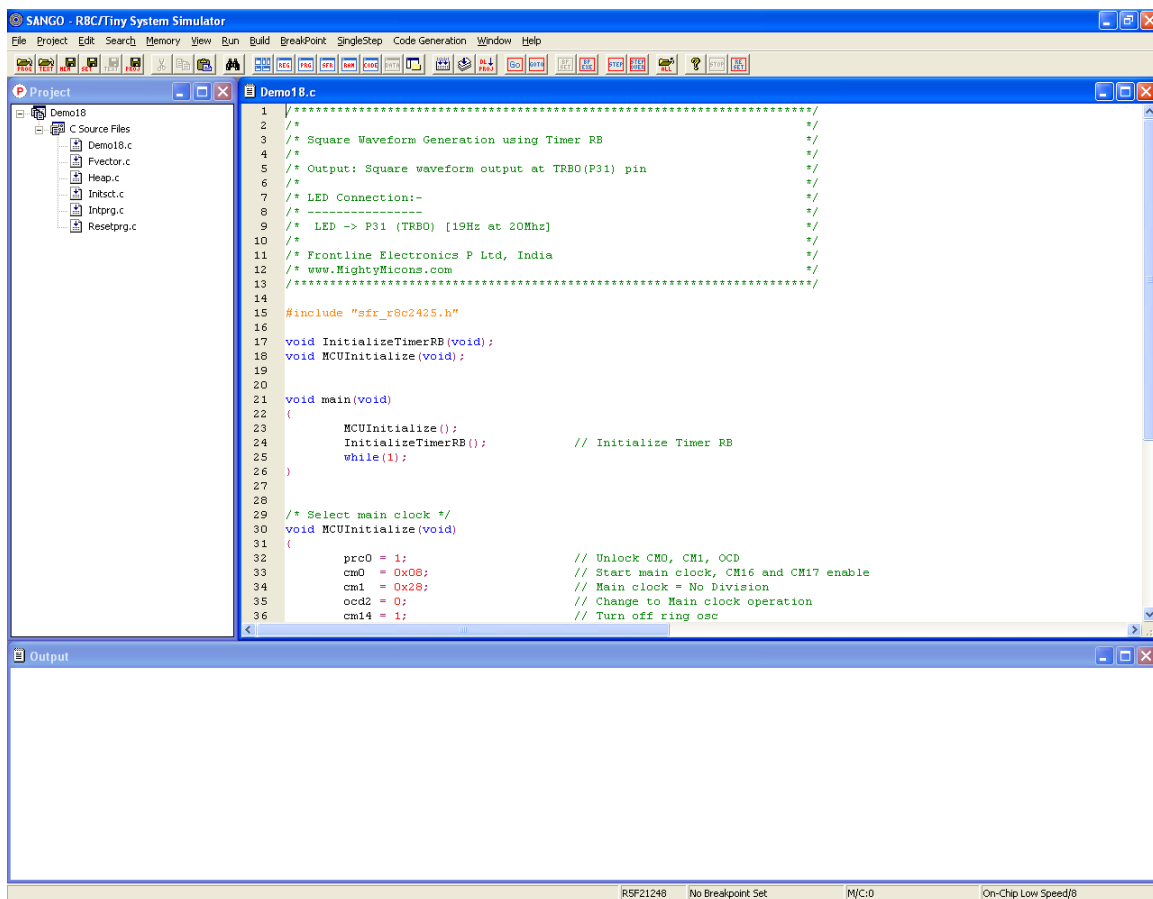
Execute Study:

The LED connected to TRB0 line flashes at a frequency of 19Hz which is visible to the eyes.

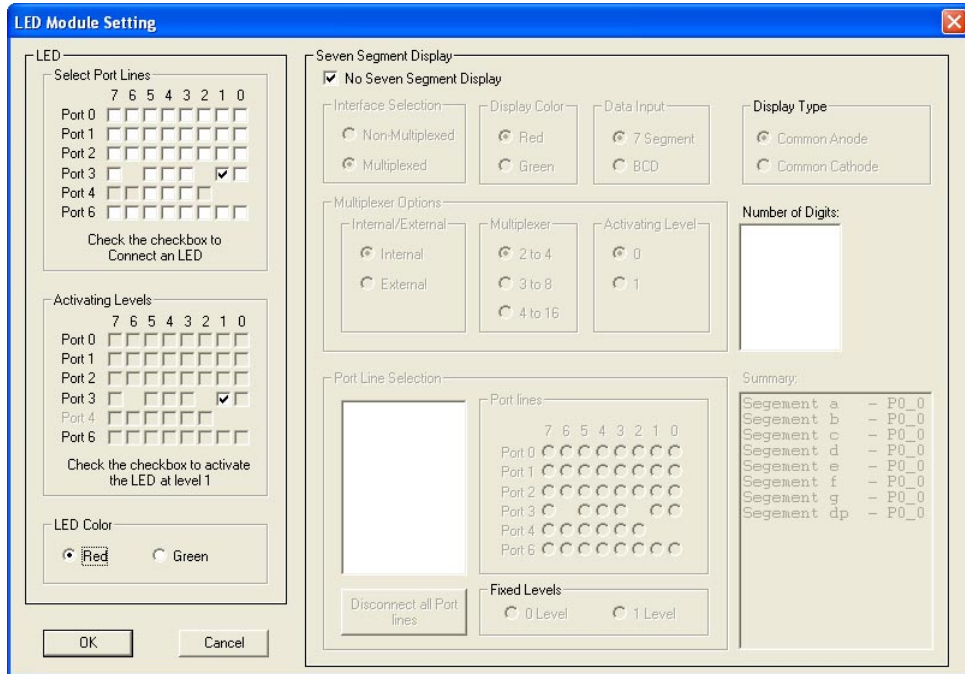
Use Topview Simulator to Verify the Design.

Open the project Demo18 in the R8C/Tiny System Simulator using **Open Project** option from **Project** menu. The project window opens up along with the Demo18.c file. Use **Build** option from **Build** menu to compile the project. An output window captures the compiler output.

Use **Project -> Download Project** from main menu to download the .mot file into the simulator's memory for simulation.



Do the settings to the LED modules as shown. connect LED to port lines P31.



Then open the LED window as shown below. Run the program and the program will flash the LED connected to the port line P31.

Demo 18 - Timer - Waveform Generation Study

The screenshot shows the SANGO - RBC/Tiny System Simulator interface. The main window displays assembly code with columns for Address, BP, Opcodes, and Mnemonics. The code includes instructions like MOV, JNE, RTS, NOP, ESET, BCLR, PUSHM, POPM, REIT, BTST, and JNE. The status bar at the bottom indicates the current execution state: 'Executing from 041F6H...', 'RSP:21248', 'No Breakpoint Set', 'M/C:2278727', and 'External Clock'.

Address	BP	Opcodes	Mnemonics
04006	D9 10	MOV W	#1H, R0
04008	6E FD	JNE	04006H
0400A	F3	RTS	
0400B	04	NOP	
0400C	7E 9F 50 00	ESET	0.000AH
04010	C7 08 06 00	MOV.B	#08H, CM0
04014	C7 28 07 00	MOV.B	#28H, CM1
04018	7E 8F 62 00	BCLR	2.000CH
0401C	7E 9F 3C 00	ESET	4.0007H
04020	7E 8F 50 00	BCLR	0.000AH
04024	F3	RTS	
04025	04	NOP	
04026	C7 19 0B 01	MOV.B	#19H, TREMR
0402A	B7 0A 01	MOV.B	#0, TRBIOC
0402D	C4 FF	MOV.B	#FFH, R0L
0402F	03 0C 01	MOV.B	R0L, TRBPRE
04032	03 0E 01	MOV.B	R0L, TRBPR
04035	03 0D 01	MOV.B	R0L, TRBSC
04038	7E 9F 40 08	ESET	0.0108H
0403C	F3	RTS	
0403D	00	BRK	
0403E	EC FD	PUSHM	R0, R1, R2, R3, A0, A1, FB
04040	ED BF	POPM	R0, R1, R2, R3, A0, A1, FB
04042	FB	REIT	
04043	04	NOP	
04044	EC FD	PUSHM	R0, R1, R2, R3, A0, A1, FB
04046	ED BF	POPM	R0, R1, R2, R3, A0, A1, FB
04048	FB	REIT	
04049	04	NOP	
0404A	EC FD	PUSHM	R0, R1, R2, R3, A0, A1, FB
0404C	ED BF	POPM	R0, R1, R2, R3, A0, A1, FB
0404E	FB	REIT	
0404F	04	NOP	
04050	EC FD	PUSHM	R0, R1, R2, R3, A0, A1, FB
04052	7E BF BB 01	BTST	3.0037H
04056	6E 0D	JNE	04064H
04058	7E BF B2 01	BTST	2.0036H
0405C	6E 07	JNE	04064H
0405E	7E BF BA 01	BTST	2.0037H
04062	6E 01	JNE	04064H

Hardware display window: LED and 7 Segment Displays. P3_1

Status bar: Executing from 041F6H... RSP:21248 No Breakpoint Set M/C:2278727 External Clock