General Purpose Timers

on the Tiva C Series TM4C123x Cortex-M Microcontroller

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Overview and Key Features

- The General Purpose Timer Module (GPTM) has 12 total timers
  - Six 16/32-bit timers
  - Six 32/64-bit ‘wide’ timers
- Each timer has 2 associated Capture and Compare Pins (CCP) for PWM
- Can count up or down
- Timer clock inputs have prescalers
  - 8 bit prescaler for 16/32 bit GPTM
  - 16 bit prescaler for 32/64 bit GPTM
- Timer synchronization - start counting on the same clock cycle

Pin Assignments

- Pin mux in action - multiple pins able to be assigned to the same internal timer endpoint
- Two Capture Compare Pins for each timer
- Several timer pins broken out on our LaunchPad

Pin Name	Pin Number	Pin Mux / Pin Assignment	Pin Type	Buffer Type[a]	Description
T1CCP0	30 58	PF2 (7) PB4 (7)	I/O	TTL	16/32-Bit Timer 1 Capture/Compare/PWM 0.
T1CCP1	31 57	PF3 (7) PB5 (7)	I/O	TTL	16/32-Bit Timer 1 Capture/Compare/PWM 1.
T2CCP0	5 45	PF4 (7) PB0 (7)	I/O	TTL	16/32-Bit Timer 2 Capture/Compare/PWM 0.
T2CCP1	46	PB1 (7)	I/O	TTL	16/32-Bit Timer 2 Capture/Compare/PWM 1.
T3CCP0	47	PB2 (7)	I/O	TTL	16/32-Bit Timer 3 Capture/Compare/PWM 0.
T3CCP1	48	PB3 (7)	I/O	TTL	16/32-Bit Timer 3 Capture/Compare/PWM 1.
T4CCP0	52	PC0 (7)	I/O	TTL	16/32-Bit Timer 4 Capture/Compare/PWM 0.
T4CCP1	51	PC1 (7)	I/O	TTL	16/32-Bit Timer 4 Capture/Compare/PWM 1.
T5CCP0	50	PC2 (7)	I/O	TTL	16/32-Bit Timer 5 Capture/Compare/PWM 0.
T5CCP1	49	PC3 (7)	I/O	TTL	16/32-Bit Timer 5 Capture/Compare/PWM 1.
WT0CCP0	16	PC4 (7)	I/O	TTL	32/64-Bit Wide Timer 0 Capture/Compare/PWM 0.
WT0CCP1	15	PC5 (7)	I/O	TTL	32/64-Bit Wide Timer 0 Capture/Compare/PWM 1.
WT1CCP0	14	PC6 (7)	I/O	TTL	32/64-Bit Wide Timer 1 Capture/Compare/PWM 0.
WT1CCP1	13	PC7 (7)	I/O	TTL	32/64-Bit Wide Timer 1 Capture/Compare/PWM 1.
WT2CCP0	61	PD0 (7)	I/O	TTL	32/64-Bit Wide Timer 2 Capture/Compare/PWM 0.
WT2CCP1	62	PD1 (7)	I/O	TTL	32/64-Bit Wide Timer 2 Capture/Compare/PWM 1.
WT3CCP0	63	PD2 (7)	I/O	TTL	32/64-Bit Wide Timer 3 Capture/Compare/PWM 0.
WT3CCP1	64	PD3 (7)	I/O	TTL	32/64-Bit Wide Timer 3 Capture/Compare/PWM 1.
WT4CCP0	43	PD4 (7)	I/O	TTL	32/64-Bit Wide Timer 4 Capture/Compare/PWM 0.
WT4CCP1	44	PD5 (7)	I/O	TTL	32/64-Bit Wide Timer 4 Capture/Compare/PWM 1.
WT5CCP0	53	PD6 (7)	I/O	TTL	32/64-Bit Wide Timer 5 Capture/Compare/PWM 0.
WT5CCP1	10	PD7 (7)	I/O	TTL	32/64-Bit Wide Timer 5 Capture/Compare/PWM 1.

Overflow Periods of Prescaler Settings

- Time values assume 80MHz System Clock
- TivaWare Calls
  - `ROM_TimerPrescaleSet()`
  - `ROM_TimerPrescaleGet()`

16/32 Bit Timers

Prescale (8-bit value)	# of Timer Clocks (Tc)[a]	Max Time	Units
00000000	1	0.8192	ms
00000001	2	1.6384	ms
00000010	3	2.4576	ms
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11111101	254	208.0768	ms
11111110	255	208.896	ms
11111111	256	209.7152	ms

32/64 Bit Timers

Prescale (16-bit value)	# of Timer Clocks (Tc)[a]	Max Time	Units
0x0000	1	53.687	s
0x0001	2	107.374	s
0x0002	3	214.748	s
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0xFFFD	65534	0.879	10^6 s
0xFFFE	65535	1.759	10^6 s
0xFFFF	65536	3.518	10^6 s

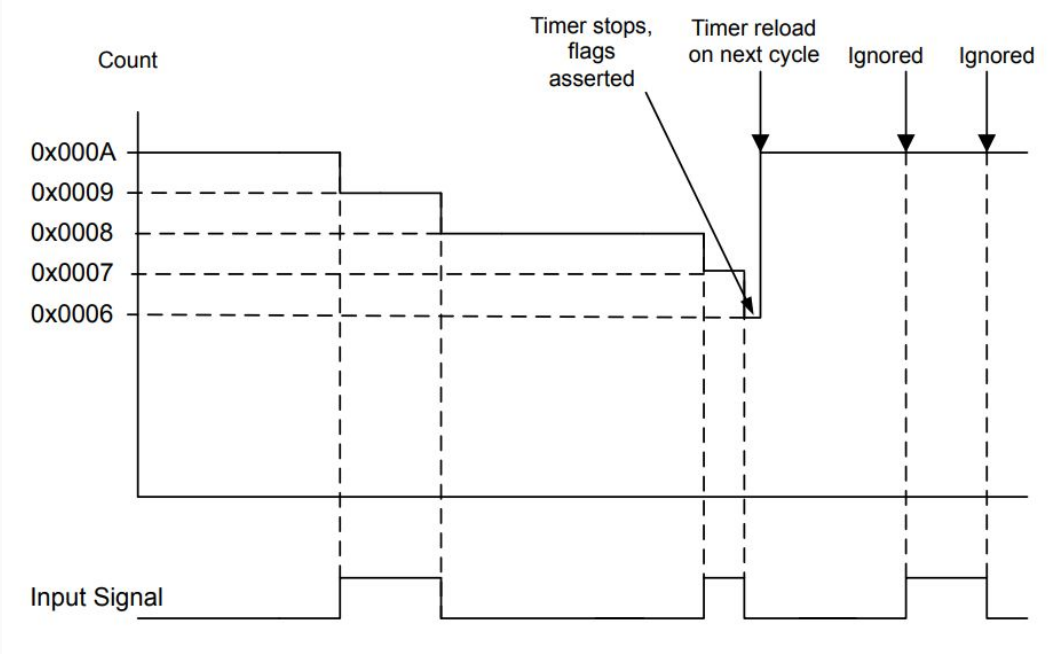
Available Timer Modes

- One Shot/Periodic
- **Edge Count**
- **Edge Time**
- **PWM**
- RTC

Mode	Timer Use	Count Direction	Counter Size		Prescaler Size[a]		Prescaler Behavior (Count Direction)
			16/32-bit GPTM	32/64-bit Wide GPTM	16/32-bit GPTM	32/64-bit Wide GPTM	
One-shot	Individual	Up or Down	16-bit	32-bit	8-bit	16-bit	Timer Extension (Up), Prescaler (Down)
	Concatenated	Up or Down	32-bit	64-bit	-	-	N/A
Periodic	Individual	Up or Down	16-bit	32-bit	8-bit	16-bit	Timer Extension (Up), Prescaler (Down)
	Concatenated	Up or Down	32-bit	64-bit	-	-	N/A
RTC	Concatenated	Up	32-bit	64-bit	-	-	N/A
Edge Count	Individual	Up or Down	16-bit	32-bit	8-bit	16-bit	Timer Extension (Both)
Edge Time	Individual	Up or Down	16-bit	32-bit	8-bit	16-bit	Timer Extension (Both)
PWM	Individual	Down	16-bit	32-bit	8-bit	16-bit	Timer Extension

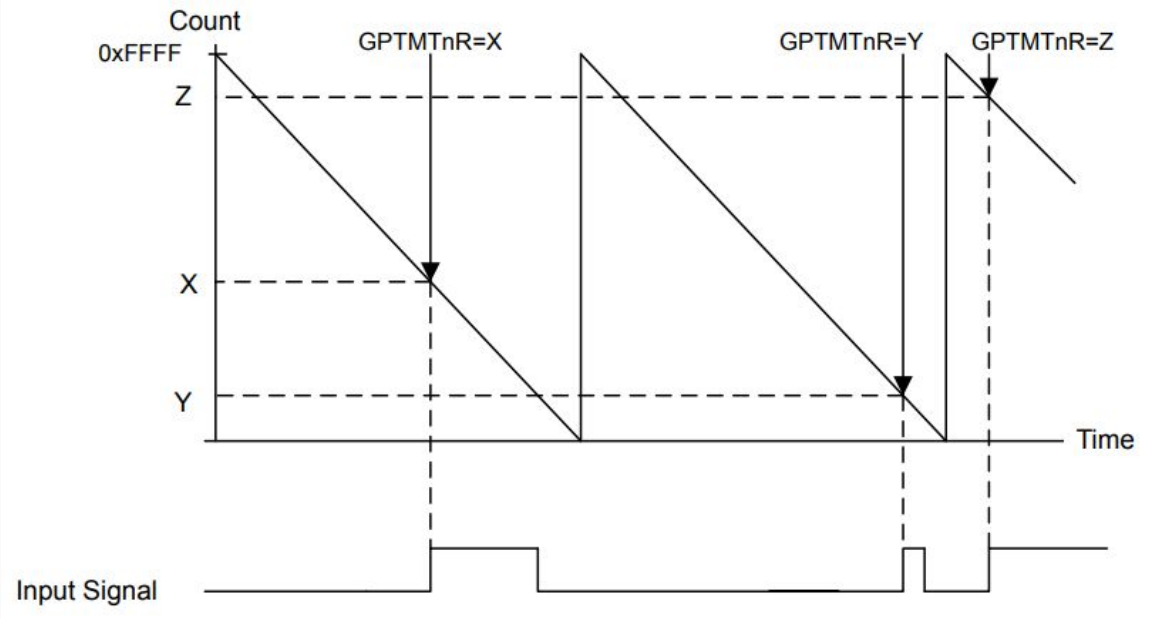
Edge Count Mode

- Starting value to count up/down from
  - **GPTMT*n*ILR** = 0x000A
  - Use *ROM_TimerLoadSet()*
- Match value to stop at
  - **GPTMT*n*MATCHR** = 0x0006
  - Use *ROM_TimerMatchSet()*



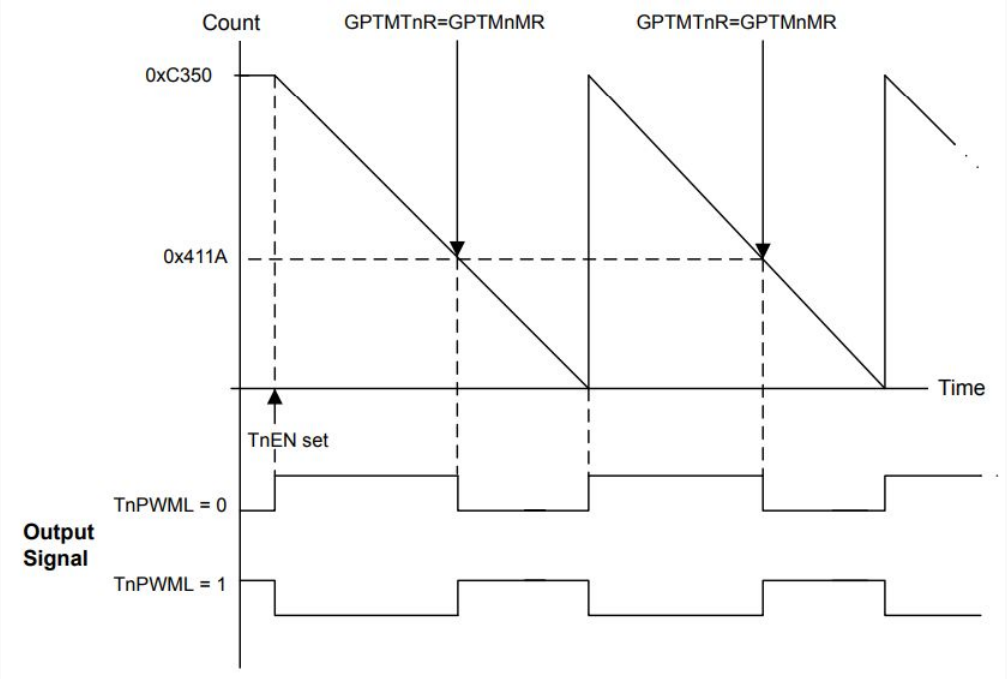
Edge Time Mode

- Each rising edge, the current count value is loaded into the **GPTMT*n*R**
- TivaWare Calls
  - `ROM_TimerValueGet()`
  - `ROM_TimerValueGet64()`



PWM Mode

- Output pin is toggled on compare match
- Varying compare value changes duty cycle (pulse width) of the output PWM signal.
- TivaWare Calls
  - `ROM_TimerControlLevel()`
  - `ROM_TimerControlTrigger()`



Example TivaWare API Calls

- Calls necessary to set up Timer 1A (pin PC6) in edge count mode
- Interrupt handler called on compare match after 9 rising rising edges

```
ROM_TimerConfigure    (TIMER1_BASE, (TIMER_CFG_SPLIT_PAIR | TIMER_CFG_A_CAP_COUNT));
ROM_TimerControlEvent (TIMER1_BASE, TIMER_A, TIMER_EVENT_POS_EDGE);
ROM_TimerLoadSet      (TIMER1_BASE, TIMER_A, 9);
ROM_TimerMatchSet     (TIMER1_BASE, TIMER_A, 0);
ROM_TimerIntEnable    (TIMER1_BASE, TIMER_CAPA_MATCH);
ROM_TimerEnable       (TIMER1_BASE, TIMER_A);
ROM_IntEnable         (INT_TIMER1A);
```

References

Images from TM4C123GH6PM datasheet.

TivaWare calls from timer interrupt example.