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

- 12 timers with 2 CCP each provides 24 possible endpoints
- Pin multiplexing for some timers
- 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.

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

Configuring a Timer with TivaWare

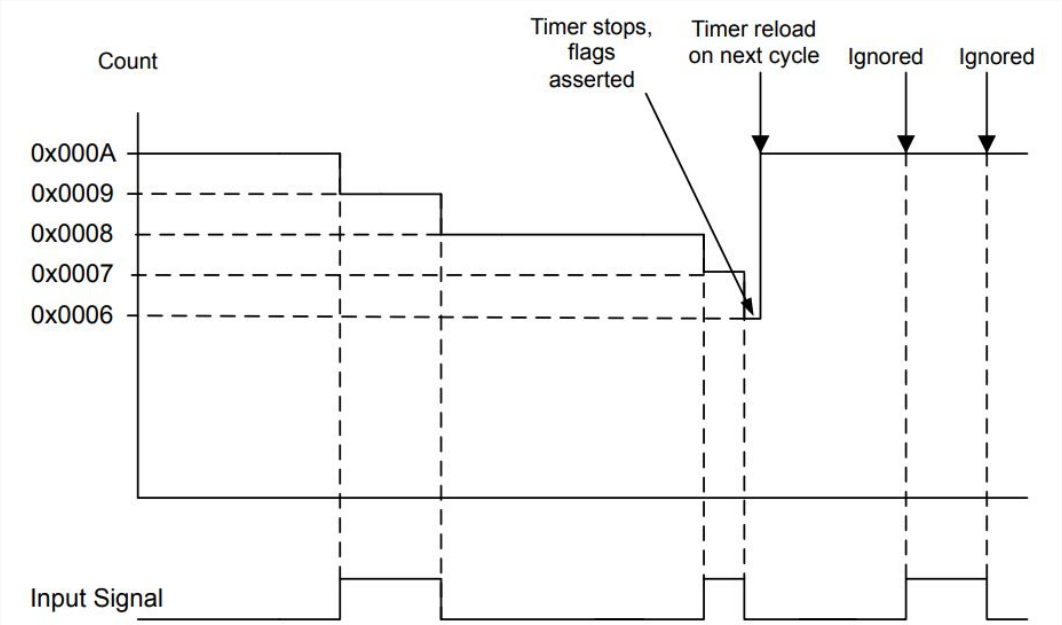
`TIMER_CFG_ONE_SHOT`	Down counting one shot timer, stops ticking after interrupt is thrown. Use `TIMER_CFG_ONE_SHOT_UP` to count up.
`TIMER_CFG_PERIODIC`	Down counting periodic timer, continues after interrupt is thrown. Use `TIMER_CFG_PERIODIC_UP` to count up.
`TIMER_CFG_RTC`	Full width Real Time Clock mode.

`TIMER_CFG_SPLIT_PAIR |`	`TIMER_CFG_A_ONE_SHOT`
	`TIMER_CFG_A_PERIODIC`
	`TIMER_CFG_A_CAP_COUNT`
	`TIMER_CFG_A_CAP_TIME`
	`TIMER_CFG_A_PWM`
	} Add `_UP` to increment instead of decrementing count
	`TIMER_CFG_B_*` also available

```
ROM_TimerConfigure( TIMER2, TIMER_CFG_SPLIT_PAIR | TIMER_CFG_A_PWM | TIMER_CFG_B_CAP_TIME_UP );
```

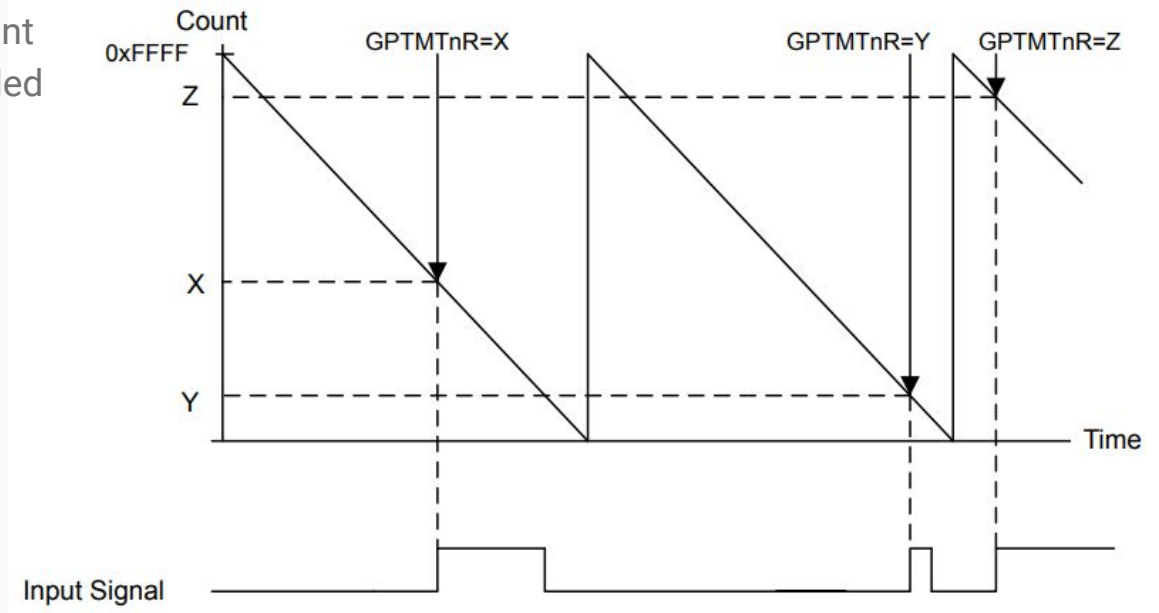
Edge Count Mode

- 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()*
- Ex: RPM calculation with optical encoder



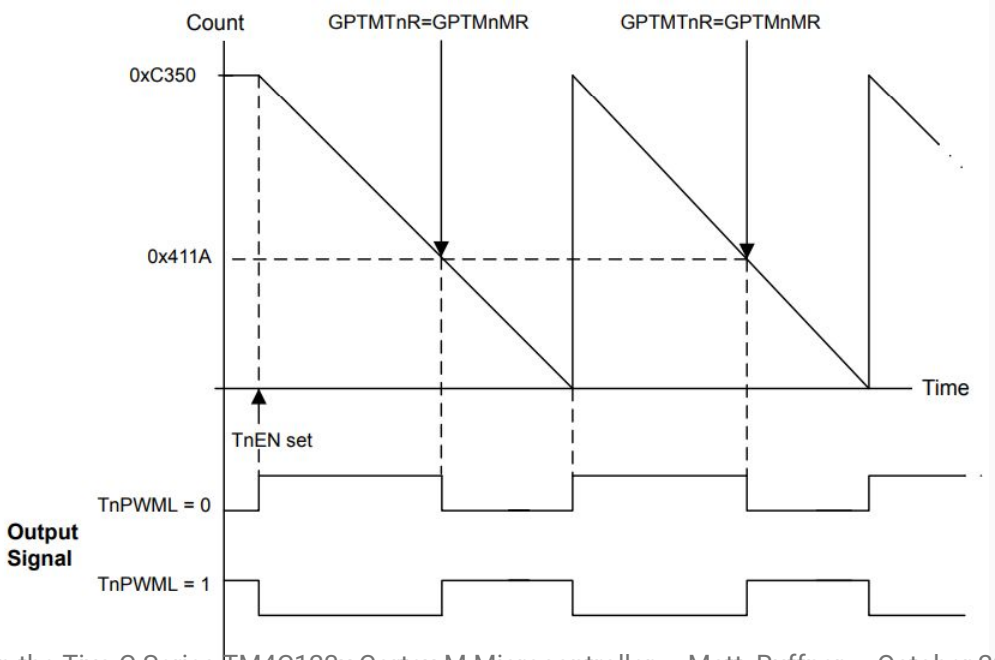
Edge Time Mode

- Each rising edge, the current count value of the running timer is loaded into the **GPTMT*n*R**
- TivaWare Calls
  - `ROM_TimerValueGet()`
  - `ROM_TimerValueGet64()`
- Usage: IR code reception



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 Edge Count 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);
```

Example PWM TivaWare API Calls

Calls necessary to setup PB5 as a PWM output with 75% duty cycle and 1ms period

```
ROM_SysCtlPeripheralEnable (SYSCTL_PERIPH_TIMER1);
ROM_SysCtlPeripheralEnable (SYSCTL_PERIPH_GPIOB);
ROM_GPIOPinConfigure       (GPIO_PB5_T1CCP1);
ROM_GPIOPinTypeTimer       (GPIO_PORTB_BASE, GPIO_PIN_5);
ROM_TimerConfigure         (TIMER1_BASE, TIMER_CFG_SPLIT_PAIR | TIMER_CFG_B_PWM);
ROM_TimerLoadSet           (TIMER1_BASE, TIMER_B, 50000);
ROM_TimerMatchSet          (TIMER1_BASE, TIMER_B, ROM_TimerLoadGet(TIMER1_BASE, TIMER_B) / 4);
ROM_TimerEnable            (TIMER1_BASE, TIMER_B);
```

References

Images from TM4C123GH6PM datasheet.

TivaWare calls from API timer interrupt example.