

		So Far	
• Familiar v	/ith		
<ul> <li>threads</li> </ul>	, semaphores,	& interrupts	
Now move	on to		
• capturii	<b>Ig edge based</b>	inputs which ger	erate interrupts
<ul> <li>use of t</li> </ul>	he TCNT timer	to measure thing	gs like
» frequ	ency/period of a	a square wave	
» dela	/ between event	S	
» etc.			
	15/80 Lab /		
• 6870 st "weeki	Jdents move ir y" labs	nto project land r	ather than the
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Usage	e Example	5
• Find the frequency of a	periodic squa	re wave
<ul> <li>measure the period</li> </ul>		
» time between a pair o	of rising edges	
• frequency = 1/period		
Find the duty cycle of a	periodic squa	re wave
• duty cycle = % of period	d the input is a	1
• procedure	_	
» first find the period		
» then measure the tim	e the input is high	or "ON"
<ul> <li>time between risir</li> <li>period/high_time = d</li> </ul>	ig and falling edge uty cycle %	
<ul> <li>Measure jitter</li> </ul>		
<ul> <li>difference between ma falling) edge transition</li> </ul>	ax and min time ns	between rising (or
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Input Capture	
Hardware can be set up to capture the events	5
<ul> <li>registers you care about</li> </ul>	
» TSCR1[7] (a.k.a. TEN) – must be set to enable tim	er functions
» TSCR2[2:0] – timer prescale bits PR2, Pr1, PR0	
» TIOS – set corresponding bit to 0 for input capture • same with DDRT bit	Ð
» TIE – contains the mask/arm bits for the 8 possibl	e channels
» TFLG1 – contains the flag bits C7F C0F	
» TCTL3 – contains edge bits for IC[4:7]	
» TCTL4 – contains edge bits for IC [3:0]	
» 8 Input Capture registers: TCO – TC7 (one for eac	h IC channel)
On event capture	
• 2 or 3 things happen	
<ul> <li>always</li> <li>current TCNT value is copied into the input Capture</li> <li>input capture flag is set</li> </ul>	(IC) register
» IF mask is 1	
Interrupt is requested	
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TCTL3 and TCTL4         EDGnB       EDGnA       Active edge         0       0       None         0       1       Capture on rising         1       0       Capture on falling         1       1       Capture on both rising and falling         • TCTL3       » [EDG7B, EDG7A,, EDG4B, EDG4A]         • TCTL4       » [EDG3B, EDG3A,, EDG0B, EDG0A]	Edge Bits			
EDGnBEDGnAActive edge00None01Capture on rising10Capture on falling11Capture on both rising and falling• TCTL3• [EDG7B, EDG7A,, EDG4B, EDG4A]• TCTL4• [EDG3B, EDG3B, EDG3B, EDG0A]	тсті	.3 and TC1	114	
0 0 None 0 1 Capture on rising 1 0 Capture on falling 1 1 Capture on both rising and falling • TCTL3 » [EDG7B, EDG7A,, EDG4B, EDG4A] • TCTL4 » [EDG3B, EDG3A,, EDG0B, EDG0A]	EDG	nB EDGr	A Active ed	dge
0 1 Capture on rising 1 0 Capture on falling 1 1 Capture on both rising and falling • TCTL3 » [EDG7B, EDG7A,, EDG4B, EDG4A] • TCTL4 » [EDG3B, EDG3A,, EDG0B, EDG0A]	0	0	None	
1 0 Capture on falling 1 1 Capture on both rising and falling • TCTL3 » [EDG7B, EDG7A,, EDG4B, EDG4A] • TCTL4 » [EDG3B, EDG3A,, EDG0B, EDG0A]	0	1	Capture on	rising
<ul> <li>1 1 Capture on both rising and falling</li> <li>TCTL3 <ul> <li>[EDG7B, EDG7A,, EDG4B, EDG4A]</li> </ul> </li> <li>TCTL4 <ul> <li>[EDG3B, EDG3A,, EDG0B, EDG0A]</li> </ul> </li> </ul>	1	0	Capture on	falling
<ul> <li>TCTL3</li> <li>» [EDG7B, EDG7A,, EDG4B, EDG4A]</li> <li>TCTL4</li> <li>» [EDG3B, EDG3A,, EDG0B, EDG0A]</li> </ul>	1	1	Capture on both ris	ing and falling
	• то • то	CTL3 » [EDG7B, EI CTL4 » [EDG3B, EI	0G7A, , EDG4B, EDG4A] 0G3A, , EDG0B, EDG0A]	
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Period Measurement		
Resolution		
is the smallest chang	je that can be det	ected
» for TCNT varies from	<b>m 250 ns to 32</b> µ <b>s (4</b>	MHz E Clock)
<ul> <li>also the basic units of</li> </ul>	of measurement	
» e.g. TCNT ticks		
<ul> <li>Precision</li> </ul>		
<ul> <li>the number of separa</li> </ul>	te & distinguisha	ble measurements
» for TCNT = 2 <sup>16</sup> = 65,	,536 (a.k.a. 64K)	
• Range		
• min and max values t	that can be measu	<b>ired</b>
» min = 0		
» max = 65,535		
<ul> <li>Good measurement sy</li> </ul>	ystems should d	etect
<ul> <li>underflow and overflow</li> </ul>	<b>w</b>	
» for TCNT: TOF = TFI• we'll ignore this for	LG2[7] indicates tim or now	er overflow
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Component			6812
Process the interrupt (cycles, $\mu$ s)			9=2.25µs
Execute the entire handler (cycles, $\mu$ s)		31=7.75µs	
Minimum p	eriod (cycles, $\mu$ s)		40=10µs
		<b>-</b>	
Period ( $\mu$ s)	Cycles/interrupt	l ime ir	n handler (%
10	40		100
20	40		50
100	40		10
Р	40	1	.000/P



## **Period Measurement Initialization**

unsigned short Period; unsigned short First;	// 500 ns units // TCNT first edge
unsigned char Done;	// Set each rising
<pre>void Init(void){</pre>	
asm sei	// make atomic
TIOS &=~0x02;	// PT1 input capture
DDRT &=~0x02;	// PT1 is input
TSCR1 = 0x80;	// enable TCNT
TSCR2 = 0x01;	// 500ns clock
TCTL4 = (TCTL4 & 0xF3)   0x04;	// rising
First = TCNT;	<pre>// first will be wrong</pre>
Done = 0;	<pre>// set on subsequent</pre>
TFLG1 = 0x02;	// Clear C1F
TIE $ = 0x02;$	// Arm IC1
asm cli }	
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void interrupt 9 TIC1ha	andler(void){
if(Mode==0){	// first edge
First = TC1; Count=	=0;
Mode=1;	
if(((TC1&0x8000)==0	))&&(TFLG2&0x80)) Count;
} else {	// second edge
if(((TC1&0x8000)==0	))&&(TFLG2&0x80)) Count++;
Mode = $2;$	// measurement done
MsPeriod = Count;	
LsPeriod = TC1-Firs	st;
if(TC1 <first){< td=""><td></td></first){<>	
MsPeriod;	// borrow
}	
TIE=0x00; TSCR2=0x0	00;
}	
TFLG1 = $0x02;$ }	// ack, clear C1F



