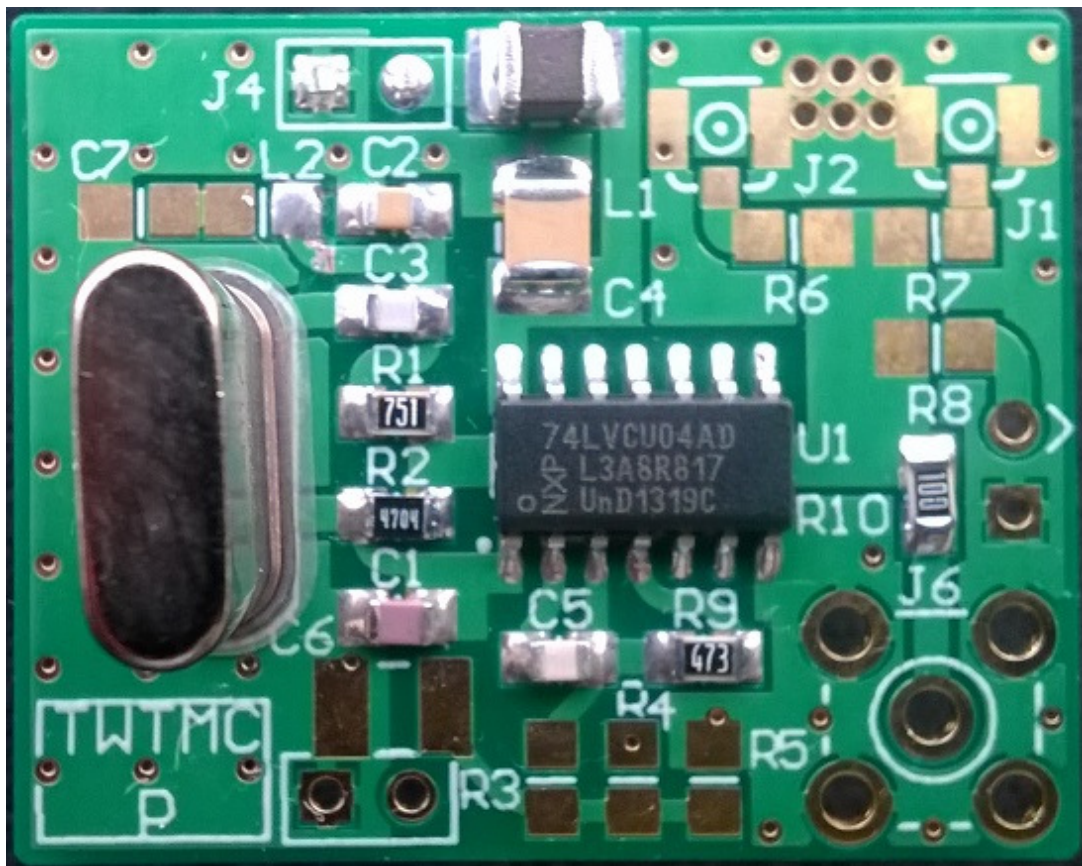
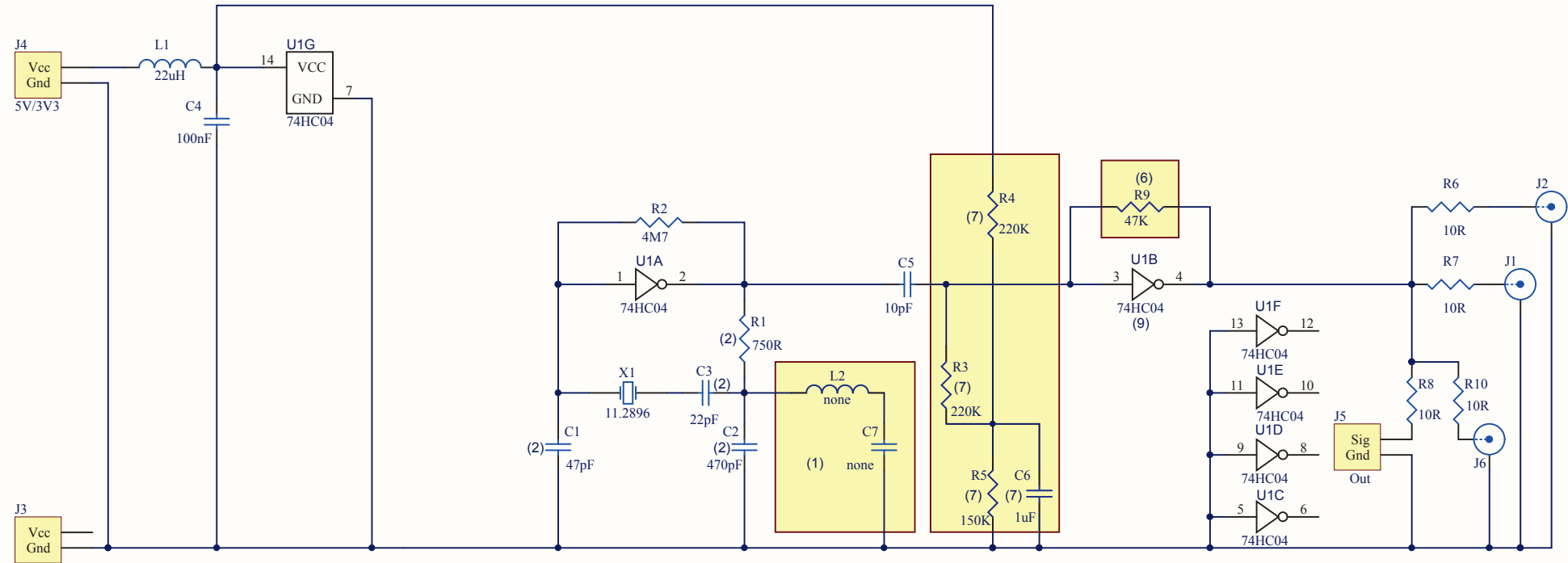


The Well Tempered Master Clock

TWTMC-P



Pierce crystal oscillator



(1) overtone crystal only

(2) see BOM

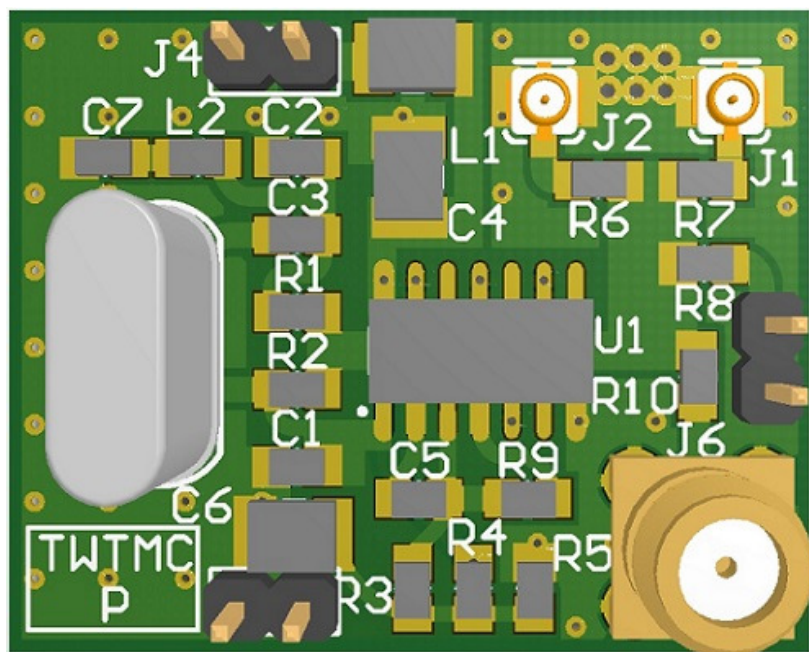
(6) squarer 1st option 50% duty cycle

(7) squarer 2nd option

(9) 74HC04 for 5V operation, 74LVC04 or Potato PO74GU04 for 3V3

Title TWTMC-P		
Size A4	Number 1	Revision 1
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File:	C:\Users\...\TWTMC-P.SchDoc	Drawn By: Andrea Mori

PCB layout



BOM

Label	Item	Pkg.	Manufacturer	Manufacturer part	Supplier	Supplier part	Q.ty	Note
C1								(1) according to the crystal's frequency
C2								(2) according to the crystal's frequency
C3								(3) Fundamental
C4	100nF 100V X7R	1210	AVX	12101C104KAT2A	Mouser	581-12101C104KAT2A	1	
C5	10pF NP0	0805	Kemet	C0805C100J5GACTU	Mouser	80-C0805C100J5G	1	
C6								(4) squarer 2nd option
C7								(5) Overtone
R1								(6) according to the crystal's ESR
R2	4M7 1/10W	0805	Vishay	CRCW08054M70FKEA	Mouser	71-CRCW08054M70FKEA	1	
R3 R4								(4) squarer 2nd option
R5								(4) squarer 2nd option
R6 R7 R8 R10								(7) Q.ty dependent on used outputs
R9								(8) slicer 1st option 50% duty cycle
L1	22uH	1210	Taiyo Yuden	CBC3225T220MR	Mouser	963-CBC3225T220MR	1	
L2								(9) Overtone
X1								(10) according to the selected oscillator frequency
U1								(11) Select for desired output voltage
J1 J2								(12) Q.ty dependent on used outputs
J5								(13) Header output
J6	SMA connector	-	Molex	73391-0070	Mouser	538-73391-0070	1	SMA output
	Crystal insulator		Bivar	CI-192-028	Mouser	749-CI-192-028	1	

(1)								
AT 11.2896 MHz	47pF C0G/NP0	0805	Kemet	C0805C470J5GACTU	Mouser	80-C0805C470J5G	1	
AT 12.288 MHz	47pF C0G/NP0	0805	Kemet	C0805C470J5GACTU	Mouser	80-C0805C470J5G	1	
AT 22.5792 MHz	33pF C0G/NP0	0805	Kemet	C0805C330J5GACTU	Mouser	80-C0805C330J5G	1	
AT 24.576 MHz	33pF C0G/NP0	0805	Kemet	C0805C330J5GACTU	Mouser	80-C0805C330J5G	1	
AT 25.0000 MHz	33pF C0G/NP0	0805	Kemet	C0805C330J5GACTU	Mouser	80-C0805C330J5G	1	
AT 5.6448 MHz	68pF C0G/NP0	0805	Kemet	C0805C680J5GACTU	Mouser	80-C0805C680J5G	1	
AT 6.144 MHz	68pF C0G/NP0	0805	Kemet	C0805C680J5GACTU	Mouser	80-C0805C680J5G	1	
AT 16.9344 MHz	39pF C0G/NP0	0805	Kemet	C0805C390J5GACTU	Mouser	80-C0805C390J5G	1	
AT 33.8688 MHz	18pF C0G/NP0	0805	Kemet	C0805C180J5GACTU	Mouser	80-C0805C180J5G	1	
AT 45.1584 MHz	15pF C0G/NP0	0805	Kemet	C0805C150J5GACTU	Mouser	80-C0805C150J5G	1	
AT 49.152 MHz	15pF C0G/NP0	0805	Kemet	C0805C150J5GACTU	Mouser	80-C0805C150J5G	1	
AT 90.3168 MHz	15pF C0G/NP0	0805	Kemet	C0805C150J5GACTU	Mouser	80-C0805C150J5G	1	
AT 98.304 MHz	15pF C0G/NP0	0805	Kemet	C0805C150J5GACTU	Mouser	80-C0805C150J5G	1	

(2)								
AT 11.2896 MHz	470pF C0G/NP0	0805	Kemet	C0805C471J5GACTU	Mouser	80-C0805C471J5G	1	
AT 12.288 MHz	470pF C0G/NP0	0805	Kemet	C0805C471J5GACTU	Mouser	80-C0805C471J5G	1	
AT 22.5792 MHz	330pF C0G/NP0	0805	Kemet	C0805C331J5GACTU	Mouser	80-C0805C331J5G	1	
AT 24.576 MHz	330pF C0G/NP0	0805	Kemet	C0805C331J5GACTU	Mouser	80-C0805C331J5G	1	
AT 25.0000 MHz	330pF C0G/NP0	0805	Kemet	C0805C331J5GACTU	Mouser	80-C0805C331J5G	1	
AT 5.6448 MHz	1nF C0G/NP0	0805	Kemet	C0805C102J5GACTU	Mouser	80-C0805C102J5G	1	
AT 6.144 MHz	1nF C0G/NP0	0805	Kemet	C0805C102J5GACTU	Mouser	80-C0805C102J5G	1	
AT 16.9344 MHz	390pF C0G/NP0	0805	Kemet	C0805C391J5GACTU	Mouser	80-C0805C391J5G	1	
AT 33.8688 MHz	68pF C0G/NP0	0805	Kemet	C0805C680J5GACTU	Mouser	80-C0805C680J5G	1	
AT 45.1584 MHz	68pF C0G/NP0	0805	Kemet	C0805C680J5GACTU	Mouser	80-C0805C680J5G	1	
AT 49.152 MHz	68pF C0G/NP0	0805	Kemet	C0805C680J5GACTU	Mouser	80-C0805C680J5G	1	
AT 90.3168 MHz	68pF C0G/NP0	0805	Kemet	C0805C680J5GACTU	Mouser	80-C0805C680J5G	1	
AT 98.304 MHz	68pF C0G/NP0	0805	Kemet	C0805C680J5GACTU	Mouser	80-C0805C680J5G	1	

(3)								
AT 11.2896 MHz	22pF C0G/NP0	0805	Kemet	C0805C220J5GACTU	Mouser	80-C0805C220J5G	1	
AT 12.288 MHz	22pF C0G/NP0	0805	Kemet	C0805C220J5GACTU	Mouser	80-C0805C220J5G	1	
AT 22.5792 MHz	27pF C0G/NP0	0805	Kemet	C0805C270J5GACTU	Mouser	80-C0805C270J5G	1	
AT 24.576 MHz	27pF C0G/NP0	0805	Kemet	C0805C270J5GACTU	Mouser	80-C0805C270J5G	1	
AT 25.0000 MHz	27pF C0G/NP0	0805	Kemet	C0805C270J5GACTU	Mouser	80-C0805C270J5G	1	
AT 5.6448 MHz	18pF C0G/NP0	0805	Kemet	C0805C180J5GACTU	Mouser	80-C0805C180J5G	1	
AT 6.144 MHz	18pF C0G/NP0	0805	Kemet	C0805C180J5GACTU	Mouser	80-C0805C180J5G	1	
AT 16.9344 MHz	22pF C0G/NP0	0805	Kemet	C0805C220J5GACTU	Mouser	80-C0805C220J5G	1	
AT 33.8688 MHz	0R0 jumper	0805	Yageo	AF0805JR-070RL	Mouser	603-AF0805JR-070RL	1	
AT 45.1584 MHz	0R0 jumper	0805	Yageo	AF0805JR-070RL	Mouser	603-AF0805JR-070RL	1	
AT 49.152 MHz	0R0 jumper	0805	Yageo	AF0805JR-070RL	Mouser	603-AF0805JR-070RL	1	
AT 90.3168 MHz	0R0 jumper	0805	Yageo	AF0805JR-070RL	Mouser	603-AF0805JR-070RL	1	
AT 98.304 MHz	0R0 jumper	0805	Yageo	AF0805JR-070RL	Mouser	603-AF0805JR-070RL	1	

(4)								
C6	1uF 100V X7R	1210	AVX	12101C105KAT2A	Mouser	581-12101C105KAT2A	1	
R3 R4	220K 1/10W	0805	Susumu	RR1220P-224-D	Mouser	754-RR1220P-224D	2	
R5 - 5V	180K 1/10W	0805	Susumu	RR1220P-184-D	Mouser	754-RR1220P-184D	1	
R5 - 3V3	150K 1/10W	0805	Susumu	RR1220P-154-D	Mouser	754-RR1220P-154D	1	

(5)								
AT 33.8688 MHz	1nF C0G/NP0	0805	Kemet	C0805C102J5GACTU	Mouser	80-C0805C102J5G	1	
AT 45.1584 MHz	1nF C0G/NP0	0805	Kemet	C0805C102J5GACTU	Mouser	80-C0805C102J5G	1	
AT 49.152 MHz	1nF C0G/NP0	0805	Kemet	C0805C102J5GACTU	Mouser	80-C0805C102J5G	1	
AT 90.3168 MHz	1nF C0G/NP0	0805	Kemet	C0805C102J5GACTU	Mouser	80-C0805C102J5G	1	
AT 98.304 MHz	1nF C0G/NP0	0805	Kemet	C0805C102J5GACTU	Mouser	80-C0805C102J5G	1	

(6)								
AT 11.2896 MHz	750R 1/10W	0805	Susumu	RR1220P-751-D	Mouser	754-RR1220P-751D	1	
AT 12.288 MHz	750R 1/10W	0805	Susumu	RR1220P-751-D	Mouser	754-RR1220P-751D	1	
AT 22.5792 MHz	470R 1/10W	0805	Susumu	RR1220P-471-D	Mouser	754-RR1220P-471D	1	
AT 24.576 MHz	470R 1/10W	0805	Susumu	RR1220P-471-D	Mouser	754-RR1220P-471D	1	
AT 25.0000 MHz	470R 1/10W	0805	Susumu	RR1220P-471-D	Mouser	754-RR1220P-471D	1	
AT 5.6448 MHz	1K5 1/10W	0805	Susumu	RR1220P-152-D	Mouser	754-RR1220P-152D	1	
AT 6.144 MHz	1K5 1/10W	0805	Susumu	RR1220P-152-D	Mouser	754-RR1220P-152D	1	
AT 16.9344 MHz	750R 1/10W	0805	Susumu	RR1220P-751-D	Mouser	754-RR1220P-751D	1	
AT 33.8688 MHz	10pF C0G/NP0	0805	Kemet	C0805C100J5GACTU	Mouser	80-C0805C100J5G	1	
AT 45.1584 MHz	5.6pF C0G/NP0	0805	Kemet	C0805C569D5GACTU	Mouser	80-C0805C569D5G	1	
AT 49.152 MHz	5.6pF C0G/NP0	0805	Kemet	C0805C569D5GACTU	Mouser	80-C0805C569D5G	1	
AT 90.3168 MHz	22pF C0G/NP0	0805	Kemet	C0805C220J5GACTU	Mouser	80-C0805C220J5G	1	
AT 98.304 MHz	22pF C0G/NP0	0805	Kemet	C0805C220J5GACTU	Mouser	80-C0805C220J5G	1	

(7)								
1 output	10R 1/10W	0805	Susumu	RR1220Q-100-D	Mouser	754-RR1220Q-100D	1	
2 outputs	10R 1/10W	0805	Susumu	RR1220Q-100-D	Mouser	754-RR1220Q-100D	2	
3 outputs	10R 1/10W	0805	Susumu	RR1220Q-100-D	Mouser	754-RR1220Q-100D	3	
4 outputs	10R 1/10W	0805	Susumu	RR1220Q-100-D	Mouser	754-RR1220Q-100D	4	

(8)								
R9	47K 1/10W	0805	Susumu	RR1220P-473-D	Mouser	754-RR1220P-473D	1	

(9)								
AT 33.8688 MHz	470nH	0805	TDK	MLF2012DR47JT000	Mouser	810-MLF2012DR47JT000	1	
AT 45.1584 MHz	270nH	0805	TDK	MLF2012DR27J	Mouser	810-MLF2012DR27J	1	
AT 49.152 MHz	270nH	0805	TDK	MLF2012DR27J	Mouser	810-MLF2012DR27J	1	
AT 90.3168 MHz	82nH	0805	Bourns	CE201210-82NJ	Mouser	652-CE201210-82NJ	1	
AT 98.304 MHz	82nH	0805	Bourns	CE201210-82NJ	Mouser	652-CE201210-82NJ	1	

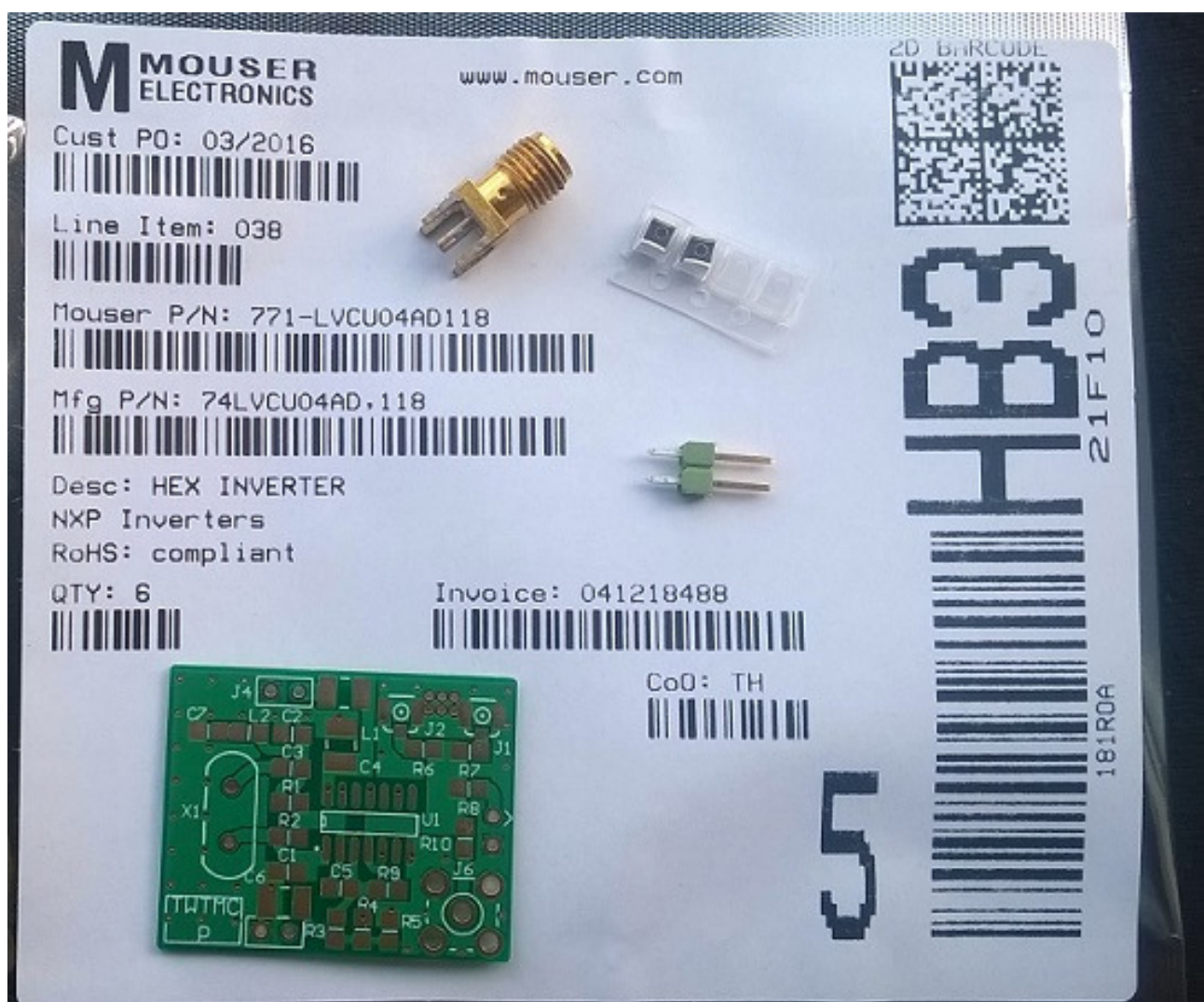
(10)								
AT 11.2896 MHz	AT-cut 11.2896 MHz	HC-43/U	Laptech	XT4117	Custom	Custom	1	
AT 12.288 MHz	AT-cut 12.288 MHz	HC-43/U	Laptech	XT4332	Custom	Custom	1	
AT 22.5792 MHz	AT-cut 22.5792 MHz	HC-43/U	Laptech	XT4273	Custom	Custom	1	
AT 24.576 MHz	AT-cut 24.576 MHz	HC-43/U	Laptech	XT4274	Custom	Custom	1	
AT 25.0000 MHz	AT-cut 25.0000 MHz	HC-43/U	Laptech	XT4334	Custom	Custom	1	
AT 5.6448 MHz	AT-cut 5.6448 MHz	HC-43/U	Laptech	XT4272	Custom	Custom	1	
AT 6.144 MHz	AT-cut 6.144 MHz	HC-43/U	Laptech	XT4304	Custom	Custom	1	
AT 16.9344 MHz	AT-cut 16.9344 MHz	HC-43/U	Laptech	XT4333	Custom	Custom	1	
AT 33.8688 MHz	AT-cut 33.8688 MHz	HC-43/U	Laptech	XT4118	Custom	Custom	1	3rd overtone
AT 45.1584 MHz	AT-cut 45.1584 MHz	HC-43/U	Laptech	XT4275	Custom	Custom	1	3rd overtone
AT 49.152 MHz	AT-cut 49.152 MHz	HC-43/U	Laptech	XT4276	Custom	Custom	1	3rd overtone
AT 90.3168 MHz	AT-cut 90.3168 MHz	HC-43/U	Laptech	XT4277	Custom	Custom	1	5th overtone
AT 98.304 MHz	AT-cut 98.304 MHz	HC-43/U	Laptech	XT4278	Custom	Custom	1	5th overtone

(11)								
5V	74VHC04	SOIC-14	On Semi	MC74VHCU04DR2G	Mouser	863-MC74VHCU04DR2G	1	
3V3	74LVC04	SOIC-14	NXP Semi	74LVCU04AD,118	Mouser	771-LVCU04AD118	1	
3V3	74GU04	SOIC-14	Potato Semi	PO74GU04A	Potato	PO74GU04A	1	

(12)								
1 u.fl. Output	u.fl. Connector		Hirose	U.FL-R-SMT(10)	Mouser	798-U.FL-R-SMT10	1	
2 u.fl. Output	u.fl. Connector		Hirose	U.FL-R-SMT(10)	Mouser	798-U.FL-R-SMT10	2	

(13)								
Vertical	2 pin header r.a.		AMP	826631-2	Mouser	571-826631-2	1	
Horizontal	2 pin header		AMP	826646-2	Mouser	571-826646-2	1	

Assembly guide



The TWTMC-P is a Pierce crystal oscillator suitable for digital audio.

The board works with fundamental and overtone AT-Cut crystals and can be used for frequencies from 5 MHz up to 100 MHz. **Although it works up to 100 MHz, for frequencies above 25 MHz it's not recommended. At these frequencies the TWTMC-D Driscoll oscillator is strongly recommended.**

It needs 1 external power supply: +3V3/+5V, depending on the output voltage desired.

There are two options to convert sine wave to TTL, starting from a C-MOS inverter.

The board provides 4 outputs with different connectors: 1 x SMA, 2 x u.fl, 1 x pin strip.

Some component values depend on the crystal operating mode and on the chosen frequency. The following table shows the values of the components for each frequency.

Frequency	Cut	Mode	C1	C2	C3	C7	R1	L2
5.6448 MHz	AT	fund	68pF	1nF	18pF	none	1K5	none
6.144 MHz	AT	fund	68pF	1nF	18pF	none	1K5	none
11.2896 MHz	AT	fund	47pF	470pF	22pF	none	750R	none
12.288 MHz	AT	fund	47pF	470pF	22pF	none	750R	none
16.9344 MHz	AT	fund	39pF	390pF	22pF	none	750R	none
22.5792 MHz	AT	fund	33pF	330pF	27pF	none	470R	none
24.576 MHz	AT	fund	33pF	330pF	27pF	none	470R	none
25.0000 MHz	AT	fund	33pF	330pF	27pF	none	470R	none
33.8688 MHz	AT	3rd	18pF	68pF	0R0	1nF	10pF	470nH
45.1584 MHz	AT	3rd	15pF	68pF	0R0	1nF	5.6pF	270nH
49.152 MHz	AT	3rd	15pF	68pF	0R0	1nF	5.6pF	270nH
90.3168 MHz	AT	5th	15pF	68pF	0R0	1nF	22pF	82nH
98.304 MHz	AT	5th	15pF	68pF	0R0	1nF	22pF	82nH

Firstly place the following components: C1, C2, C4, C5, R1, R2, L1, and X1. **Remember to insert the appropriate insulator between the crystal and the board** (see BOM).

If you are building an overtone oscillator (33.8688 MHz to 98.304 MHz), solder C7 and L2 following the above table.

If you are building a fundamental oscillator (5.6448 MHz to 25.000 MHz), solder C3 following the above table, else solder a jumper (0R0) in place of C3.

Place and solder the components U1.

Select the squarer option you desire, following this table:

Option	Type	Components	Duty cycle
1	Self-bias	R9	50%
2	Voltage divider	R3-R4-R5-C6	Configurable

Components listed in the BOM for the second option give around 50% duty cycle, but you can vary their values to get different duty cycle.

Warning. If you are planning to use this oscillator with TWTMC-D&D daughter board, using its feature "power off oscillator" (when the oscillator is not in use), you should select the second slicer option, avoiding to leave U1 input floating. If you desire anyway to use the first slicer option, you should solder also R3 and R5 (they will work as pull-down resistor).

Finally one or more output (up to 4) connectors have to be chosen within the possible options. See the following table:

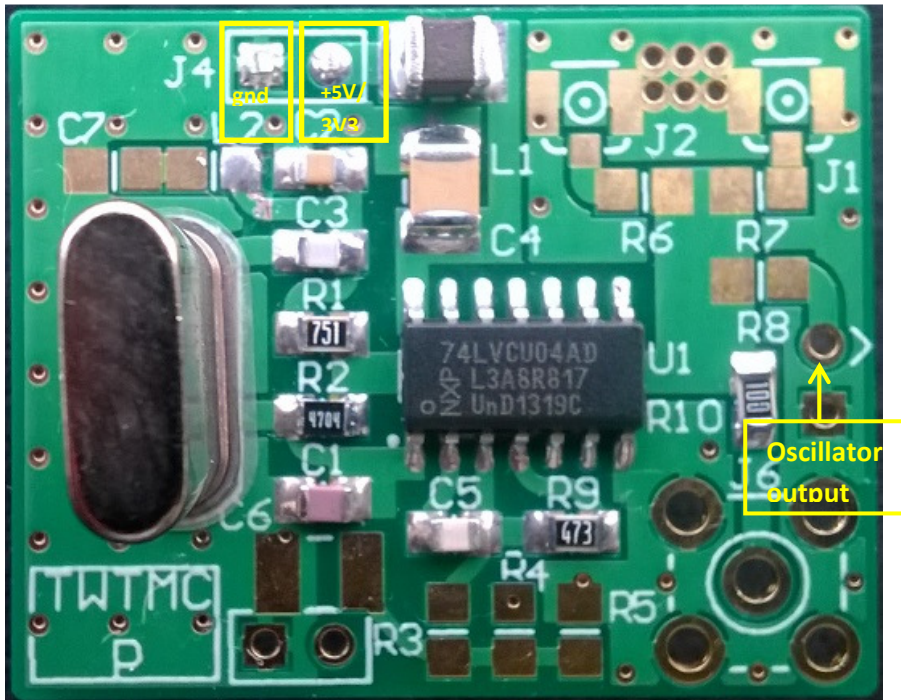
Label	Connector type	Resistor
J1	u.fl	R7
J2	u.fl	R6
J5 (> on board)	pin strip	R8
J6	SMA	R10

Solder connectors and their output resistors.

Solder J4 pin strip connector for power supply. Connector J3 is used for mechanical stability only, since the oscillator needs a single power supply (J4).

If you are planning to use the TWTMC-D&D daughter board to supply the oscillator you have to build the second regulator only (5V or 3V3).

If you own an oscilloscope you can check the output waveform. Apply 5V/3V3 and display the waveform. Keep in mind that to display correctly a square wave you need an oscilloscope with high bandwidth and a good probe. As a rule of thumb you can assume a bandwidth at least 9 times larger than the square wave frequency to be displayed. Otherwise you will get a distorted representation.



The crystal oscillator reach its best performance after several weeks of intensive use.

Finished 11.2896 MHz oscillator board.

