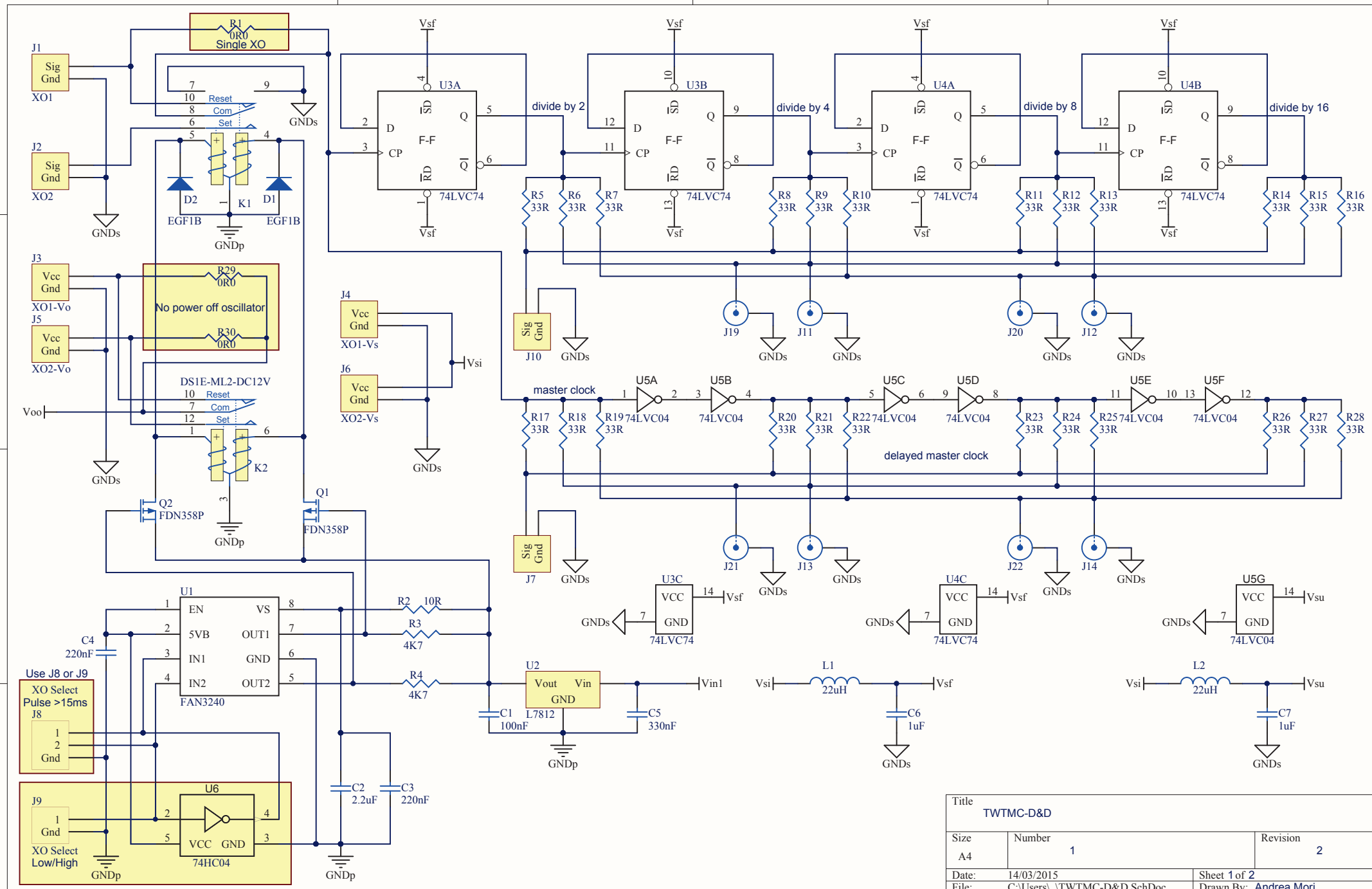


The Well Tempered Master Clock

TWTMC-D&D



Dual XO switching, power supply, dividers and delayed clock



Title TWTMC-D&D		
Size A4	Number 1	Revision 2
Date: 14/03/2015	Sheet 1 of 2	
File: C:\Users\...\TWTMC-D&D.SchDoc	Drawn By: Andrea Mori	



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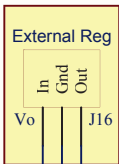
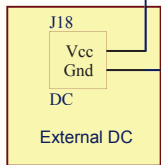
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(1) 390R for 3V3 - 1K2 for 5V



V_{oo}

V_{si}

Title		
TWTMC-D&D		
Size	Number	Revision
A4	1	2
Date:	14/03/2015	Sheet 2 of 2
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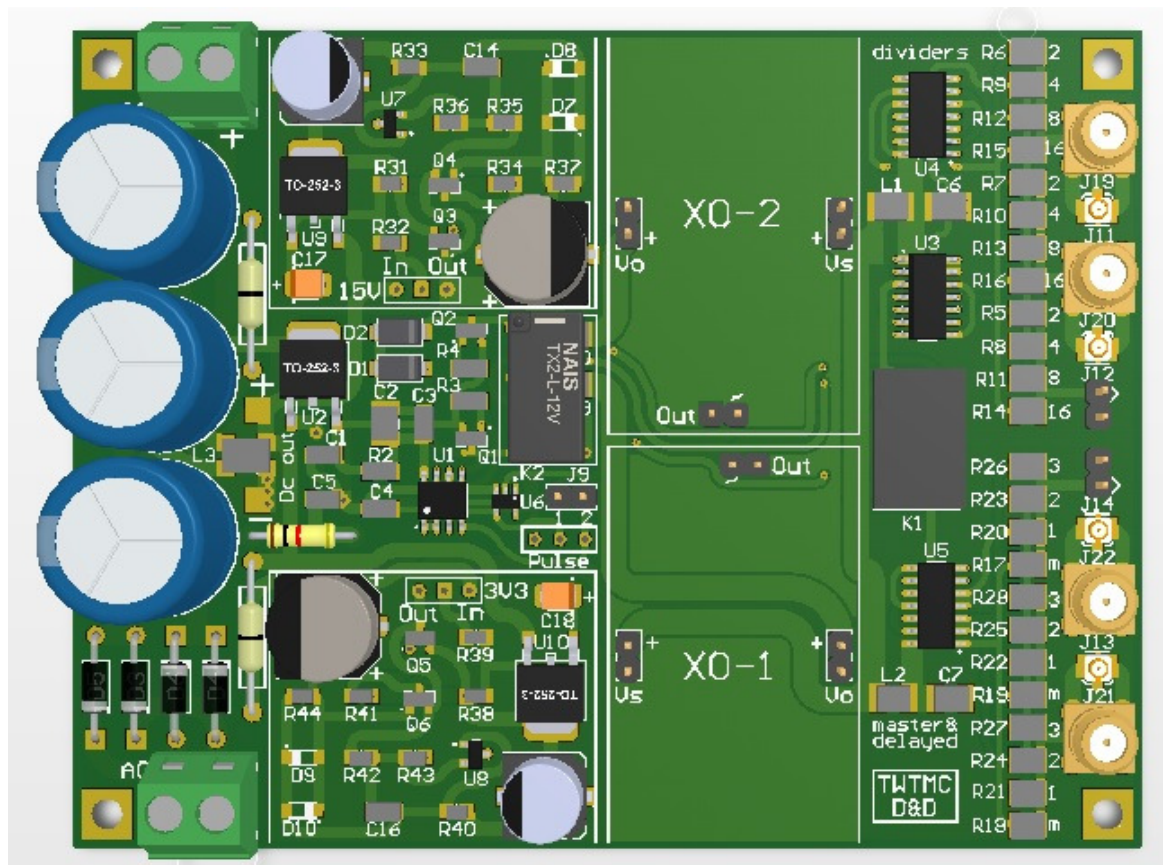
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PCB layout



BOM

Label	Item	Package	Manufacturer	Manufacturer part	Supplier	Supplier part	Q.ty	Note
C1	100nF 100V X7R	1206	AVX	12061C104KAZ2A	Mouser	581-12061C104KAZ2A	1	Dual XO
C2	2.2uF 100V X7R	1206	Taiyo Yuden	HMK325B7225KN-T	Mouser	963-HMK325B7225KN-T	1	Dual XO
C3 C4	220nF 100V X7R	1206	TDK	C3216X7R2A224K115AA	Mouser	810-C3216X7R2A224K	2	Dual XO
C5	330nF 100V X7R	1206	AVX	12061C334KAZ2A	Mouser	581-12061C334KAZ2A	1	Dual XO
C6 C7	1uF 100V X7R	1210	AVX	12101C105KAT2A	Mouser	581-12101C105KAT2A	2	Dividers & Delay
C8 C9 C10	3300 uF 25V	16d x 25h	Nichicon	UFW1E332MHD	Mouser	647-UFW1E332MHD	3	DC on board
C11 C12	220 uF 16V	8d x 10h	Nichicon	PCJ1C221MCL4GS	Mouser	647-PCJ1C221MCL4GS	2	Regulators on board
C13 C15	470 uF 16V	10d x 10h	Nichicon	PCG1C471MCL1GS	Mouser	647-PCG1C471MCL1GS	2	Regulators on board
C14 C16	100 nF 50V MLCC	1206	AVX	12065C104JAT2A	Mouser	581-12065C104J	2	Regulators on board
C17 C18	22 uF 25V Tant	1210	Panasonic	20TQC22MYFB	Mouser	667-20TQC22MYFB	2	Regulators on board
R1	0R0 jumper	2010	IRC	LRZ2010LF-R000-T	Mouser	66-LRZ2010LF-R000-T	1	Single XO
R29 R30	0R0 jumper	1210	Vishay/Dale	CRCW12100000Z0EA	Mouser	71-CRCW1210-0-E3	2	No power off oscillator
R2	10R 1/4W	1206	Vishay/Dale	CRCW120610R0FKEA	Mouser	71-CRCW1206-10-E3	1	Dual XO
R3 R4	4K7 1/4W	1206	Vishay/Dale	CRCW12064K70FKEA	Mouser	71-CRCW1206-4.7K-E3	2	Dual XO
R5 R6 R7 R8 R9 R10 R11 R12 R13 R14 R15 R16	33R 1/10W	1206	Yageo	RT1206FRE0733RL	Mouser	603-RT1206FRE0733RL	9	Depending on used dividers
R17 R18 R19 R20 R21 R22 R23 R24 R25 R26 R27 R28	33R 1/10W	1206	Yageo	RT1206FRE0733RL	Mouser	603-RT1206FRE0733RL	9	Depending on used master clock / delayed master clock
R31 R38	121R 1/10W	0805	Susumu	RR1220P-1210-D-M	Mouser	754-RR1220P-1210D-M	2	Regulators on board

R32	1K65 1//10W	0805	Susumu	RR1220P-1651-D-M	Mouser	754-RR1220P-1651D-M	1	Regulators TWTMC-C
	1K 1//10W	0805	Susumu	RR1220P-102-D	Mouser	754-RR1220P-102D	1	Regulators TWTMC-D
R33	560R 1/10W	0805	Susumu	RR1220P-561-D	Mouser	754-RR1220P-561D	1	Regulators TWTMC-C
	1K 1//10W	0805	Susumu	RR1220P-102-D	Mouser	754-RR1220P-102D	1	Regulators TWTMC-D
R34 R37 R41 R44	1K 1/10W	0805	Susumu	RR1220P-102-D	Mouser	754-RR1220P-102D	4	Regulators on board
R35	5K6 1/10W	0805	Susumu	RR1220P-562-D	Mouser	754-RR1220P-562D	1	Regulators TWTMC-C
	1K62 1/10W	0805	Susumu	RR1220P-1621-D-M	Mouser	754-RR1220P-1621D-M	1	Regulators TWTMC-D
R36	1K15 1/10W	0805	Susumu	RR1220P-1151-D	Mouser	754-RR1220P-1151-D	1	Regulators on board
R39	680R 1/10W	0805	Susumu	RR1220P-681-D	Mouser	754-RR1220P-681D	1	Regulators on board
R40	845R 1/10W	0805	Susumu	RR1220P-8450-D	Mouser	754-RR1220P-8450-D	1	Regulators on board
R42	390R 1/10W	0805	Susumu	RR1220P-391-D	Mouser	754-RR1220P-391D	1	Regulators on board - 3V3
	1K2 1/10W	0805	Susumu	RR1220P-122-D	Mouser	754-RR1220P-122D	1	Regulators on board - 5V
R43	1K2 1/10W	0805	Susumu	RR1220P-122-D	Mouser	754-RR1220P-122D	1	Regulators on board
R45	10R 1W	3d x 11h	Vishay/Dale	RS01A10R00FE12	Mouser	71-RS01A10R00FE12	1	DC on board
R46	10R 1/2W	2.5d x 6,5h	Yageo	MFR50SFTE52-10R	Mouser	603-MFR50SFTE52-10R	1	Dual XO
R47	180R 2W	3.9d x 12h	Vishay/BC	PR02000201800JR500	Mouser	594-5083NW180R0J	1	External Regs - Voltage drop
L1 L2	22uH	1210	Taiyo Yuden	CBC3225T220MR	Mouser	963-CBC3225T220MR	2	
L3	Common mode choke	1812	EPCOS	B82799S513N1	Mouser	871-B82799S513N1	1	
D1 D2	EGF1B	SMA	Fairchild	EGF1B	Mouser	512-EGF1B	2	Dual XO
D3 D4 D5 D6	MUR120	DO-41	On Semi	MUR120G	Mouser	863-MUR120G	4	DC on board
D7 D8 D9 D10	1N5817	SOD-123FL	MCC	SM5817PL-TP	Mouser	833-SM5817PL-TP	4	Regulators on board
Q1 Q2	FDN358P	SSOT-3	Fairchild	FDN358P	Mouser	512-FDN358P	2	Dual XO
Q3 Q5	2N4403	SOT-23	Fairchild	MMBT4403	Mouser	512-MMBT4403	2	Regulators on board
Q4 Q6	2N3904	SOT-23	Fairchild	MMBT3904	Mouser	512-MMBT3904	2	Regulators on board
U1	FAN3240	SOIC-8	Fairchild	FAN3240TMX	Mouser	512-FAN3240TMX	1	Dual XO
U2	L7812	D-PAK	On Semi	MC7812BDTRKG	Mouser	863-MC7812BDTRKG	1	Dual XO
U3 U4	74LVC74	SOIC-14	TI	SN74LVC74ADR	Mouser	595-SN74LVC74ADR	2	Dividers - 3V3
	74G74	SOIC-14	Potato Semi	PO74G74A	Potato	PO74G74A	2	Dividers (alternative) - 3V3
	74AHCT74	SOIC-14	TI	SN74AHCT74D	Mouser	595-SN74AHCT74D	2	Dividers - 5V

U5	74LVC04	SOIC-14	NXP	74LVCU04AD,118	Mouser	771-LVCU04AD118	1	Delay - 3V3
	74GU04	SOIC-14	Potato Semi	PO74GU04A	Potato	PO74GU04A	1	Delay (alternative) - 3V3
	74VHC04	SOIC-14	On Semi	MC74VHCU04DR2G	Mouser	863-MC74VHCU04DR2G	1	Delay - 5V
U6	74HCT04	SOT-23-5	TI	SN74AHCT1G04DBVR	Mouser	595-SN74AHCT1G04DBVR	1	Dual XO (Low/High Select)
U7 U8	TL431	SOT-23-3	TI	TL431BQDBZRQ1	Mouser	595-TL431BQDBZRQ1	2	Regulators on board
U9 U10	LD1085	D-PAK	STM	LD1085CDT-R	Mouser	511-LD1085CDT-TR	2	Regulators on board
K1	DPST RF 2 coil latch 12V	-	Panasonic	ARS1612	Mouser	769-ARS1612	1	Dual XO
K2	DPST 2 coil latch 12V	-	Panasonic	DS1E-ML2-DC12V	Mouser	769-DS1E-ML2-DC12V	1	Power off oscillator
J1 J2	XO pads	-	-	-	-	-	2	XO board
J3 J4 J5 J6	2 pin header	2.54 mm	AMP	826646-2	Mouser	571-826646-2	4	XO power supply
J7 J10	2 pin header	2.54 mm	AMP	826646-2	Mouser	571-826646-2	2	Depending on used output
J8	3 pin header	2.54 mm	AMP	826646-3	Mouser	571-826646-3	1	Dual XO (Pulse Select)
J9	2 pin header	2.54 mm	AMP	826646-2	Mouser	571-826646-2	1	Dual XO (Low/High Select)
J11 J12 J13 J14	u.fl. Connector	-	Hirose	U.FL-R-SMT(10)	Mouser	798-U.FL-R-SMT10	4	Depending on used output
J15	Header 2 screw	-	Molex	39880-0302	Mouser	538-39880-0302	1	DC on board
J18	Header 2 screw	-	Molex	39880-0302	Mouser	538-39880-0302	1	External DC
J16 J17	Regs pads	2.54 mm	-	-	-	-	2	External Regs
J19 J20 J21 J22	SMA connector	-	Molex	73391-0070	Mouser	538-73391-0070	4	Depending on used output (alternative to J11 J12 J13 J14)
TR	Transformer 17Vac 6VA	-	Hammond	229A34	Mouser	546-229A34	1	TWTMC-C
	Transformer 12.6Vac 6VA	-	Hammond	229A12	Mouser	546-229A12	1	TWTMC-D
	Transformer 12.6Vac 12VA	-	Hammond	229B12	Mouser	546-229B12	1	TWTMC-D + TWTMC-OVN

Assembly guide

The TWTMC-D&D daughter board was designed to accommodate two TWTMC crystal oscillators.

The board has the following features:

- it provides low noise power supply regulators for 2 TWTMC XO-OCXO (+15V/+6V, +3V3/+5V)
- it provides power supply for 2 TWTMC-OVN (OCXO oven, +16V unregulated)
- it provides the logic to switch between the two XOs/OCXOs, using an RF relay
- it provides one more relay to power off the oscillator when it's not in use
- it provides 4 clock dividers, from 2 up to 16 times (2/4/8/16)
- it provides 3 delayed master clock outputs, as well as the master clock direct output
- it provides multiple output connectors, such as u.fl, SMA and pin strip

The board consists of the following parts:

- rectification and filtering, using this section you need the power transformer only as external component
- power supply regulators, +15V/+6V for the oscillators and +3V3/+5V for slicers, dividers and delayed clock parts
- switching logic, you can use this section to switch between two XO, as well to power off the oscillator not selected to operate
- dividers, you can use this section to divide the master clock coming from each oscillator (2/4/8/16 times)
- delayed clock, you can use this section to pick up the master clock directly or to delay it several ns, depending on the speed of the used gates (1 to 3 cascaded gates)
- output connectors, this section provides multiple output options at the same time, with different connectors (u.fl, SMA, pin strip)

Power supply regulators. Populate this section if you would use the on-board power supply for oscillators (+15V/+6V) and dividers/delayed clock (+3V3/+5V). You can also install external regulators, using J16 (15V/6V) and J17 (3V3/5V) pin strip connectors. In this case you don't need to populate the section, you need only to solder 2 pin strip header, one for each voltage. Use Out and ground pads of each header (In pad not needed). If your lower voltage external regulator (3V3/5V) needs lower input voltage than the 15V/6V regulator, you can install the voltage drop resistor R47. The values of this component indicated in the BOM, has to be adjusted depending on the bias current of the external regulator. To calculate its value, you can assume a current absorption of around 40 mA using 2 XO/OCXO and the dividers/delayed clock sections installed. **Pay attention to the polarity when you connect the external regulators.**

There are a few components to be selected depending on the desired output voltage of the regulators (15V or 6V, 3V3 or 5V), as in the following table.

XO/OCXO Output voltage	R32	R33	R35	TR
+15V	1K65	560R	5K6	17Vac/6VA
+6V without oven	1K	1K	1K62	12.6Vac/6VA
+6V with oven	1K	1K	1K62	12.6Vac/12VA

Squarer/logic voltage	R42
+3V3	390R
+5V	1K2

For the TWTMC-C Colpitts-Clapp oscillator select the components of the row "+15V".

For the TWTMC-D Driscoll oscillator without the oven board TWTMC-OVN select the components of the row "+6V without oven".

For the TWTMC-D Driscoll oscillator with the oven board TWTMC-OVN select the components of the row "+6V with oven".

Firstly place all the resistors: R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R43 and R44.

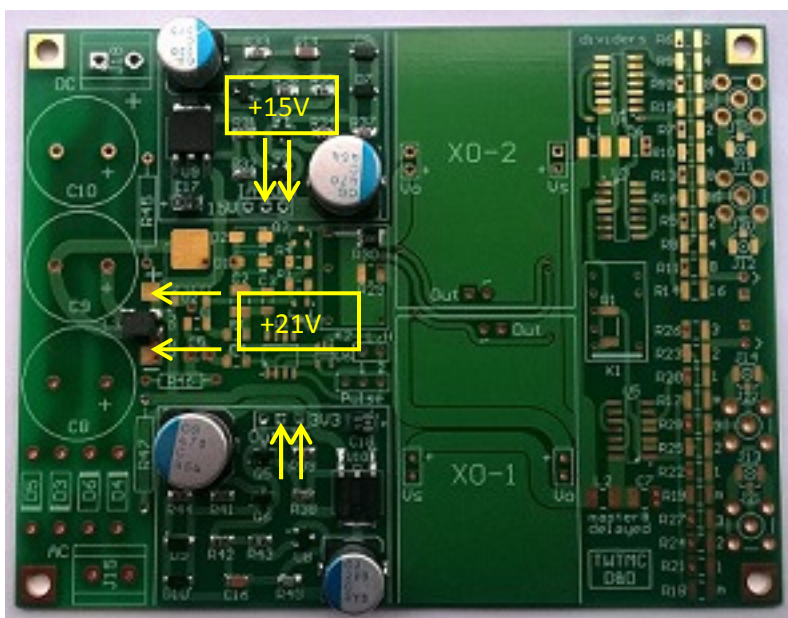
Solder the small capacitors: C14, C15, C17 and C18. **C17 and C18 are polarized components, pay attention to the polarity when placing them on the board.**

Solder transistors and shunt regulators: Q3, Q4, Q5, Q6, U7 and U8.

Solder the diodes D7, D8, D9 and D10. **Pay attention to its polarity.**

Place the LDOs U9 and U10.

Finally solder the big polarized capacitors C11, C12, C13 and C15. **Pay attention to its polarity.**



If you own a lab power supply, you can test the output voltage of the regulators with a DMM.

Apply around +21Vdc for a 15V regulator (or +16Vdc for a 6V regulator) as in the above picture. Now, with a DMM, you should measure around 14.6V (or 6V) at the output of the upper regulator, and around 3.3V (or 5V) at the output of the lower regulator.

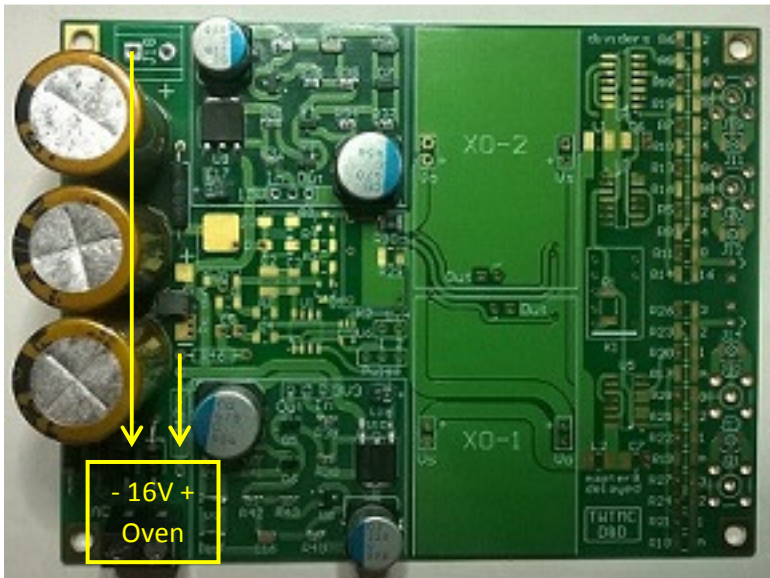
Rectification and filtering. Populate this section if you would use the on-board rectification and filtering section to provide the DC supply to the regulators, around 21V. You can also provide external DC to the regulators, using J18 (DC) connector. In this case you don't need to populate the section, you need only solder a 2 screws header connector and the common mode choke (L3). **Pay attention to the polarity when you connect the external DC.**

Firstly place the resistor R45 and the common mode choke L3.

Solder the diodes D3, D4, D5 and D6. **Pay attention to its polarity.**

Solder the connector J15 (AC).

Finally solder the polarized capacitors C8, C9 and C10. **Pay attention to its polarity.**



Now you can connect the power transformer to check again the output voltage of the regulators using a DMM.

If you are using one or two ovens for the oscillators you have to connect them as in the above picture. Take the minus rail from the ground pad of J18 (left pad). Take the plus rail from the left pad of R46.

Switching logic. Populate this section if you would use the ability of the board to switch between the two oscillators. If you are powering a single XO, but you are planning to use the dividers or the master/delayed clock section, you need to install R1 jumper (0R0) in place of the relay K1.

Dual XO switch	Components
yes	K1
no	R1

Optionally you can use the section to power off one of the two oscillator when it's not selected. Otherwise, you have to solder R29 and R30 jumpers (0R0) in place of the relay K2.

Power off oscillator	Components
yes	K2
no	R29-R30

To drive this logic you can use a pulse signal (> 15 ms), as well you can use a permanently logic level (low/high). In the first case you have to solder J8 connector (Pulse), while in the second case you have to solder J9 connector (L/H). **Pay attention to the polarity when you connect the driver cable to the connector chosen.**

Option	Type	Components	Operation
1	Pulse	J8	Pin 1 to select XO1 – Pin 2 to select XO2
2	Low/High	J9-U6	Low to select XO1 – High to select XO2

Warning. In any case don't install U6 if you want use pulse mode selection (J8).

Firstly solder the resistors: R2, R3, R4 and R46.

Place the capacitors C1, C2, C3, C4 and C5.

Install the diodes D1 and D2. **Pay attention to its polarity.**

Solder the mosfet Q1, Q2 and the IC U1,U2.

If you are planning to use two oscillators, install the relay K1, otherwise solder the jumper R1.

If you are planning to use the “power off oscillator” function, install the relay K2, else solder the jumpers R29 and R30.

According to the operation you have chosen to drive the switching logic, you have to solder J8 in case of pulse command, or J9 and U6 for low-high level command.

Dividers. Populate this section if you would extract divided clock from this board.

Division by	Components
2	U3
4	U3
8	U3-U4
16	U3-U4

Solder the flip-flop U3 and U4 according to the above table.

Solder the inductor L1 and the capacitor C6.

Master/delayed clock. Populate this section if you would extract master and/or delayed clock from this board.

Output	Components
Master clock	none
Delayed clock 1	U5-L2-C7
Delayed clock 2	U5-L2-C7
Delayed clock 3	U5-L2-C7

Solder the components according to the above table.

Outputs. Populate this section if you would extract divided clock, master and/or delayed clock from this board. See the following table for the divider outputs. You can take up to 3 different outputs from 3 different connectors.

Connector	Connector Type	Resistor	Output type
J10	Pin strip	R5	Divided by 2
J10	Pin strip	R8	Divided by 4
J10	Pin strip	R11	Divided by 8
J10	Pin strip	R14	Divided by 16
J11	u.fl	R6	Divided by 2
J11	u.fl	R9	Divided by 4
J11	u.fl	R12	Divided by 8
J11	u.fl	R15	Divided by 16
J19	SMA	R6	Divided by 2
J19	SMA	R9	Divided by 4
J19	SMA	R12	Divided by 8
J19	SMA	R15	Divided by 16
J12	u.fl	R7	Divided by 2
J12	u.fl	R10	Divided by 4
J12	u.fl	R13	Divided by 8
J12	u.fl	R16	Divided by 16
J20	SMA	R7	Divided by 2
J20	SMA	R10	Divided by 4
J20	SMA	R13	Divided by 8
J20	SMA	R16	Divided by 10

See the following table for the master/delayed clock outputs. You can take up to 3 different outputs from 3 different connectors.

Connector	Connector Type	Resistor	Output type
J7	Pin strip	R17	Master clock
J7	Pin strip	R20	Delayed clock 1
J7	Pin strip	R23	Delayed clock 2
J7	Pin strip	R26	Delayed clock 3
J13	u.fl	R18	Master clock
J13	u.fl	R21	Delayed clock 1
J13	u.fl	R24	Delayed clock 2
J13	u.fl	R27	Delayed clock 3
J21	SMA	R18	Master clock
J21	SMA	R21	Delayed clock 1
J21	SMA	R24	Delayed clock 2
J21	SMA	R27	Delayed clock 3
J14	u.fl	R19	Master clock
J14	u.fl	R22	Delayed clock 1
J14	u.fl	R25	Delayed clock 2
J14	u.fl	R28	Delayed clock 3
J22	SMA	R19	Master clock
J22	SMA	R22	Delayed clock 1
J22	SMA	R25	Delayed clock 2
J22	SMA	R28	Delayed clock 3

Solder the components according to the above tables.

Finished board.



Finished board with 2 XO.

