

Oakley Sound Systems

TM3030

PCB Issue 3

Builder's Guide

V3.3

Tony Allgood
Oakley Sound Systems
CARLISLE
United Kingdom

Introduction

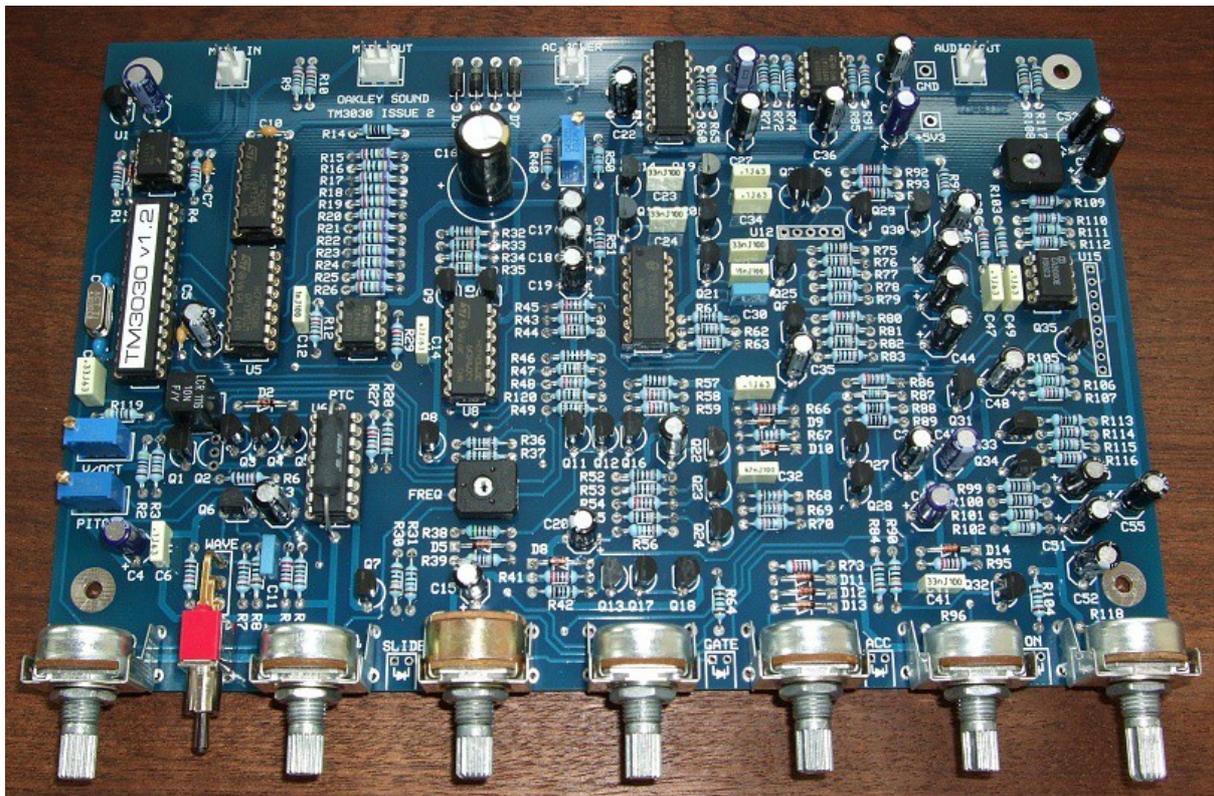
This is the Builder's Guide for the issue 3 TM3030 sound module from Oakley Sound. This document contains a basic introduction to the board, a full parts list for the components needed to populate the board or boards, and a list of the various interconnections,

For the User Manual which contains an overview of the operation of the unit and the calibration procedure please visit the main project webpage at:

<http://www.oakleysound.com/tm3030.htm>

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or <http://www.oakleysound.com/parts.pdf>.

For general information on how to build our modules, including circuit board population, mounting front panel components and making up board interconnects please see our generic Construction Guide at the project webpage or <http://www.oakleysound.com/construct.pdf>.



An issue 2 board awaiting its case and LEDs. This one has been built with a matched BC550B pair in the VCF and a CA3080 and discrete buffer for the VCA. Issue 3 is almost identical.

Parts Information

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide which is linked from the TM3030 project webpage or direct at:

<http://www.oakleysound.com/parts.pdf>.

Some special considerations for this project

I recommend to use a close tolerance polystyrene for the VCO timing cap, C9. This will give better pitch stability. Use a cheaper part if you can accept a small drift in VCO pitch with time. The PCB is laid out to accept the superbly specified 10nF LCR type EXFS/HR series.

Standard axial polystyrene types will fit into the board if mounted on one end. The working voltage can be quite low, 63V is common.

Other alternatives to polystyrene are polypropylene. But make sure you get low voltage types like 63V or so. Polypropylene capacitors are also used in suppression and can get very very big.

The three ceramic capacitors should be 'low-K', NP0, or C0G ceramic plates or dipped ceramics. The lead spacing is 2.5mm.

I have also used some axial multilayer ceramics for the power supply decoupling on the digital sections. These parts can be substituted with ordinary low voltage radial polyesters if you wish. Watch out for the pitch spacing as the board is laid out to accept 0.3", 7.5mm, for these devices.

The horizontal preset or trimmer resistors are just ordinary carbon types. No need to buy the expensive cermet types for these positions. Carbon sealed units have more resistance to dust than the open frame types. Piher make a suitable type to use here. Pin spacing is 0.2" at the base, with the wiper 0.4" away from the base line.

The multiturn trimmers are the ones that have the adjustment on the top of the box. Spectrol and Bourns make these. Some types are 22 turns, while others are 25 turns. Either will do. They should have three pins that are in a line at 0.1" pitch. Don't chose the 10-turn ones with the adjustment on the end, they won't fit on the PCB.

With the exception of the differential amplifier in the filter (Q36 & Q37) all the transistors shown as BC549 on the schematic can be pretty much any NPN transistor that corresponds to the same pin out. For example: BC550, BC548, BC547 etc. However, I recommend using BC549 or BC550 as these are low noise devices. A BC550 is actually just a BC549 that can operate at a slightly higher voltage. Quite often you see an A, B or C suffix used, eg. BC549C. This letter depicts the gain or grade of the transistor (actually hfe of the device). The TM3030 is designed to work with any grade NPN devices although I have used BC550B in my issue 2 prototype.

The PNP transistors shown as BC559 on the schematic should be high gain BC559C or BC560C types.

The SCR in the VCO uses different transistors. Here I have used BC212L and BC182L. Although these are actually pretty ordinary transistors, they have a different pin out to the other NPN and PNP transistors used in the TM3030. They also have the same pin out as the Japanese parts used in the original device. You could substitute these three transistors with the Japanese parts if you can get them. The BC212L is equivalent to the 2SA733P, and the BC182L is equivalent to the 2SC536F. It is in my opinion that there are no sonic differences between the European and Japanese parts in this part of the circuit. Note that the BC212 and BC182 cannot be used as they are as they have a different pin out to the BC212L and BC182L.

The FET buffer of the VCO can be one of two parts. The PCB is laid out for both, but you must ensure the one you use goes into the correct place on the board. Q1 should be a 2SK30A-O. Q2 should be a J201. Do not fit both. The original design and my own TB3030 used the 2SK30A-0 but these are quite tricky to find. In the TB3031 I used the J201, and I still think this is a very good substitute for the Japanese part. In fact, it's possibly more accurate since the variation between any two J201 devices may well be less than that of any two 2SK30A-0.

I will leave the choice of device to you. However, I have tested both parts in the TM3030 and recorded and compared the resultant audio output. I cannot tell the difference in the outputs from the two types.

Q18 is also a 2SK30A-Y device. You should seek out this part if you want the envelopes to behave in the same way as the original. Y types are easier to get hold of than O types and various places sell them on line although the easiest place to buy is probably Ebay.

As we have seen the original design used two variants of the 2SK30A, the O and the Y types. These two different types differ only by their value of I_{dss} . This is the current that runs through the device when the gate and source are grounded and the drain is taken to 10V. The O types are defined as having a I_{dss} of 0.6mA to 1.4mA. The Y types are defined as having I_{dss} of 1.2mA to 3.0mA. Look at the range of I_{dss} for the 2SK30A-O. It is interesting to note this, because the sound of the square wave is dependant on the I_{dss} of the O type device. So no wonder that people have commented some TB303s sound slightly different to one another.

The original Japanese NPN pair is the 2SC1583. It is a superb component and although not made any more it is still available from some places. Matched NPN pairs are required in three places in the TM3030, the exponential convertor, the filter ladder and the differential amp in the VCF. Only in the differential amplifier have I made space on the board to take the 2SC1583. In the other two positions I have used modern substitutes.

For the exponential converter I have decided to use the more easily available THAT300P in place of the 2SC1583. There will be no sonic difference here and the THAT array is more easily affixed to the temp co resistor used in our design.

For the filter ladder the original design uses two matched pairs, one at the bottom of the ladder, a 2SC1583, and one at the top, a 2SC2291. Although the 2SC1583 is available,

getting hold of the 2SC2291 is usually very hard. I didn't want to rely on builders getting this part so I again have chosen the THAT300P which has been used successfully in the earlier TM3030 issues and Oakley Diode Superladder modules. The THAT300 is four very well matched NPN devices in one package. In my tests I found that this part sounds identical to the Japanese parts and is therefore an excellent substitute.

THAT300P can be obtained from Profusion and Farnell in the UK, Small Bear in the US, and also at Mouser (part #887-300P14-U). It is a good part but is somewhat expensive.

The differential amplifier of the filter uses a single 2SC1583F in the original design. The TM3030 allows for this if you can get hold of the 2SC1583. If not, then do not worry, as the board can also be fitted with a hand matched pair of BC549B, BC550B, BC549C or BC550C transistors in positions Q36 and Q37. Again, like the FET in the VCO buffer either the two transistors or the 2SC1583 need to be fitted. Do not fit both U12, and Q36 and Q37.

As stated, if you are fitting them, Q36 and Q37 should be a matched BC549B, BC550B, BC549C or BC550C pair. This means that both Q36 and Q37 should have identical characteristics. It is unlikely that two randomly picked NPN transistors will be exactly the same since the manufacturing process is not that precise. However, it is of my opinion that if both transistors are of the same type, eg. both BC550C, and are bought new from the same vendor and at the same time there is a very good chance that they will be matched well enough for this application. Modern fabrication methods are much better than they used to be.

The VCA circuit also allows the builder some choice in the construction. The board is laid out to accept either the original R-Ohm BA662 OTA chip, the excellent BA662 clone part from 'Open Music Labs', or a my own VCA design based around the CA3080 OTA and a discrete buffer circuit. I have tested this part of the circuit very thoroughly, and I am convinced there is little or no perceivable audible difference in the two designs.

It should be said that both OTA chips are now obsolete, but the CA3080 is still available from many sources. The original BA662 is nigh on impossible to find without paying very high prices so Open Music Lab's clone is the best bet if you want to go the BA662 route.

In either case, do ensure that you build your board to suit your choice. The 3080 design uses an additional FET (Q35) and resistor (R118) and neither of these should be fitted if you are using a BA662 or the new BA662 clone.

For the dual op-amps in the TM3030 I have specified the same parts as used in the original unit. These are AN6562 devices. They have a very large input voltage range, that includes zero volts, so they cannot be substituted with more common op-amps like the TL072. Alternatively you can use the LM358 instead. This is a good part and although it does behave slightly differently to the AN6562 in some conditions it does not appear to affect the TM3030's sound in any way.

The AN6562 devices are available from various online places for a modest amount. You need two of them, one for the VCO circuit, the other for the power supply. The LM358 is more readily available.

The PIC is a special programmed device that is supplied when you buy the PCB. Spare pre-programmed PICs, should you break yours, are also available for a small charge. Neither Sequentix nor Oakley Sound will provide the firmware separately.

The other semiconductors used in the TM3030 are standard parts that you should be able to get from your local parts supplier.

The PTC is a 1K +3500ppm/K positive temperature coefficient resistor. This means its resistance goes up with temperature. It's there to keep the VCO's frequency relatively stable as the ambient temperature changes. The PTC I now use for this job is made by KRL in the US. They can be most easily obtained from Oakley Sound with your PCB or via Thonk.

Other PTCs do exist and good use can be had from the cheaper Meggitt series. Farnell's part number is 1174306 and Mouser's 279-LT300014T261K0J. It's a 1K +3000ppm/K 900mW device. The old TB3030 used this part and I thought it was great until I tried the KRL parts. I can simply say that once fitted the KRL parts give much better tuning stability over a wider range of temperatures.

Input and output sockets are not board mounted. You can choose whichever type of sockets you wish. However, to reduce the possibility of earth loops you may be wise to use plastic sockets for the audio output socket.

The LEDs can be any type, although I recommend the use of standard round 3mm types. You will need to bend their legs if you want them to stick through the panel. More detail about mounting the LEDs is given on this later on this document. Many manufacturers do ready made preformed LEDs in little plastic boxes. These may be perfect for the job, but be careful that your LEDs have the cathode on the right hand side as you look at the front of the device.

The suggested colours for the LEDs are just that, suggestions. You can chose any colour you want for any of the LEDs. However, bear in mind blue LEDs and other high efficiency LEDs may appear to be too bright unless you reduce the current with a bigger current limiting resistor. The current limiting resistors are R64 for the gate, R84 for accent, R31 for slide and R104 for the power on LEDs. If your chosen LEDs are too bright simply double the value of the current limiting resistor, say to 2K2, and see what that looks like.

The front panel switch can be any style if you are not fitting it directly to the PCB. However, the PCB is designed to use the miniature toggle range from C&K. Ones made by Multicomp also fit very nicely. The switch should be an ordinary ON-ON switch, sometimes called SPDT.

The C&K types are 'type 2 horizontal' non-sealed units. C&K's part number is 7101MD9AV2BE. Farnell part number: 9575502. Multicomp switches are similar but cheaper and can also be obtained from Farnell. The Multicomp part number is 1MS1T2B4M7RE. Farnell sell it as part number: 9473297.

The power on switch will probably be fitted to the rear of the unit if you are using a half rack case or fitting two TM3030 units in one 1U rack. You can chose any type of switch you fancy, but I normally go for ones that need a circular mounting hole since these are easier to fit.

The power inlet socket should be one to match your choice of wallwart supply. However, it is important that you chose an insulated design, ie. one made from a plastic housing. It is imperative that you do not let either of the input power leads connect to the chassis.

Sometimes people like to substitute parts in place of my own recommendations. Feel free to do this, but remember that there is normally a good reason why I have selected that particular part. If you do find that, say changing an transistor with another one, makes an improvement, please do let me know via the our forum at Muffwiggler.com.

Parts List

I strongly advise you to read the 'Parts Information' section above before you place any order for parts.

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or <http://www.oakleysound.com/parts.pdf>.

A quick note on European part descriptions. To prevent loss of the small '.' as the decimal point, a convention of inserting the unit in its place is used. eg. 4R7 is a 4.7 ohm, 4K7 is a 4700 ohm resistor, 6n8 is a 6.8 nF capacitor.

Resistors

All resistors 1/4W 5% unless stated.

10R	R60
22R	R65, R70
100R	R88, R89, R113, R14, R61, R42
220R	R1,R9,R10
1K	R4, R117, R104, R84, R31, R64
1K5	R106
1K8 1% metal film	R85
2K2	R12, R29, R109, R112, R107, R110, R63, R44, R43, R94, R59, R58, R80
2K2 1% metal film	R91
3K3 1% metal film	R40
3K9 1% metal film	R50
4K7	R119
5K1 1% metal film	R38, R72
6K8	R74
10K	R6, R13, R7, R116, R114, R100, R51, R97, R78, R77, R79, R57, R46, R83, R62, R67, R53 ,R52 ,R69, R68, R5
10K	R118 - <i>only if not fitting BA662 in U15.</i>
10K 1% metal film	R71
22K	R95, R11, R92, R93, R54, R41, R73, R66
47K 1% metal film	R2, R96, R102, R39
51K 1% metal film	R105
68K	R56
100K 1% metal film	R28, R8, R33, R108, R32, R35, R101, R103, R99, R115, R36, R37, R90, R30, R55, R75, R76, R82, R49, R47, R81, R120
100K 0.1% metal film	R16, R18, R20, R22, R24
180K	R3
200K 0.1% metal film	R15, R21, R25, R26, R23, R19, R17
220K 1% metal film	R27
220K	R45, R98, R48, R86
1M	R111, R34
1M5	R87

1K +3500ppm/K

PTC - *see text for mounting information.*

Capacitors

10nF 1% polystyrene	C9
33pF ceramic plate	C1, C2
330p ceramic plate	C21
3n3, 100V polyester	C30
1nF, 100V polyester	C12
10nF, 100V polyester	C11
15nF, 100V polyester	C29
33nF 100V polyester	C41, C23, C28, C24
47nF 100V polyester	C32
100nF, 63V polyester	C31, C6, C49, C47, C33, C34
220nF, 63V polyester	C14
330nF, 63V polyester	C56
100nF, 63V axial ceramic	C5, C7, C10
1u0, 63V elect	C37, C13, C55, C52, C19, C53, C51, C42, C46, C44, C35, C43, C15, C20
2u2, 63V elect	C22, C8
10uF, 35V elect	C54, C48, C27, C38, C36, C50, C17, C18, C25
22uF, 35V elect	C4, C3
47uF, 35V elect	C45, C26, C39, C40
470uF, 35V elect	C16

Discrete Semiconductors

1N4004 power diode	D7, D6, D4, D3
1N4148 signal diode	D2, D14, D1, D5, D8, D13, D12, D10, D9, D11
BC182L NPN transistor	Q5, Q4
BC212L PNP transistor	Q3
BC550 NPN transistor	Q34, Q9, Q10, Q27, Q8, Q26, Q7, Q20, Q19, Q21, Q15, Q14, Q29, Q30, Q24, Q25, Q12, Q17, Q23, Q13
BC550C NPN transistor	Q36, Q37 - <i>matched pair, see text.</i>
BC560C PNP transistor	Q31, Q6, Q33, Q32, Q11, Q16, Q22, Q28
J201 FET	Q35 - <i>only if not fitting BA662 in U15</i>
J201 FET	Q2 - <i>only if not fitting 2SK30A-0 in Q1</i>
2SK30A-O FET	Q1 - <i>only if not fitting J201 in Q2</i>
2SK30-Y FET	Q18
2SC1583 NPN pair	U12 - <i>only if not fitting Q36 & Q37</i>
THAT300P NPN array	U6, U9

Integrated Circuits

4050 hex non-inverting buffer	U5, U4
4066 quad analogue switch	U8
6562 or LM358 dual op-amp	U7, U13
6N137 opto coupler	U2
LM723 voltage regulator	U10
78L05 +5V regulator	U1
BA662 Roland OTA	U15 - <i>fit only if not fitting CA3080 in U14</i>
CA3080 OTA	U14 - <i>fit only if not fitting BA662 in U15</i>
PIC18F242 TM midi-chip	U3 - <i>supplied with PCB</i>

Trimmers

2K multiturn cermet	PSU
10K multiturn cermet	V/OCT
50K multiturn cermet	PITCH
470K horizontal carbon	FREQ, OFFSET

Pots

All Alpha 16mm types with seven matching brackets. Note Alpha and ALPS use A and B suffixes on their pot values. A = log and B = linear.

1M log	DECAY
50K lin	TUNE, ENV_MOD, FREQUENCY, ACCENT
50K lin x 2 (dual gang)	RESONANCE
50K log	VOLUME

Miscellaneous

4.000MHz crystal	X1 - <i>see text for mounting information.</i>
5-pin DIN socket	MIDI_IN, MIDI_OUT
1/4" jack socket	AUDIO_OUT
2.5mm power inlet	AC_POWER
Power switch	
LED 3mm red	SLIDE, ON
LED 3mm green	GATE
LED 3mm yellow	ACC
SPDT toggle switch	WAVE
Knobs	Seven off to suit pot shafts

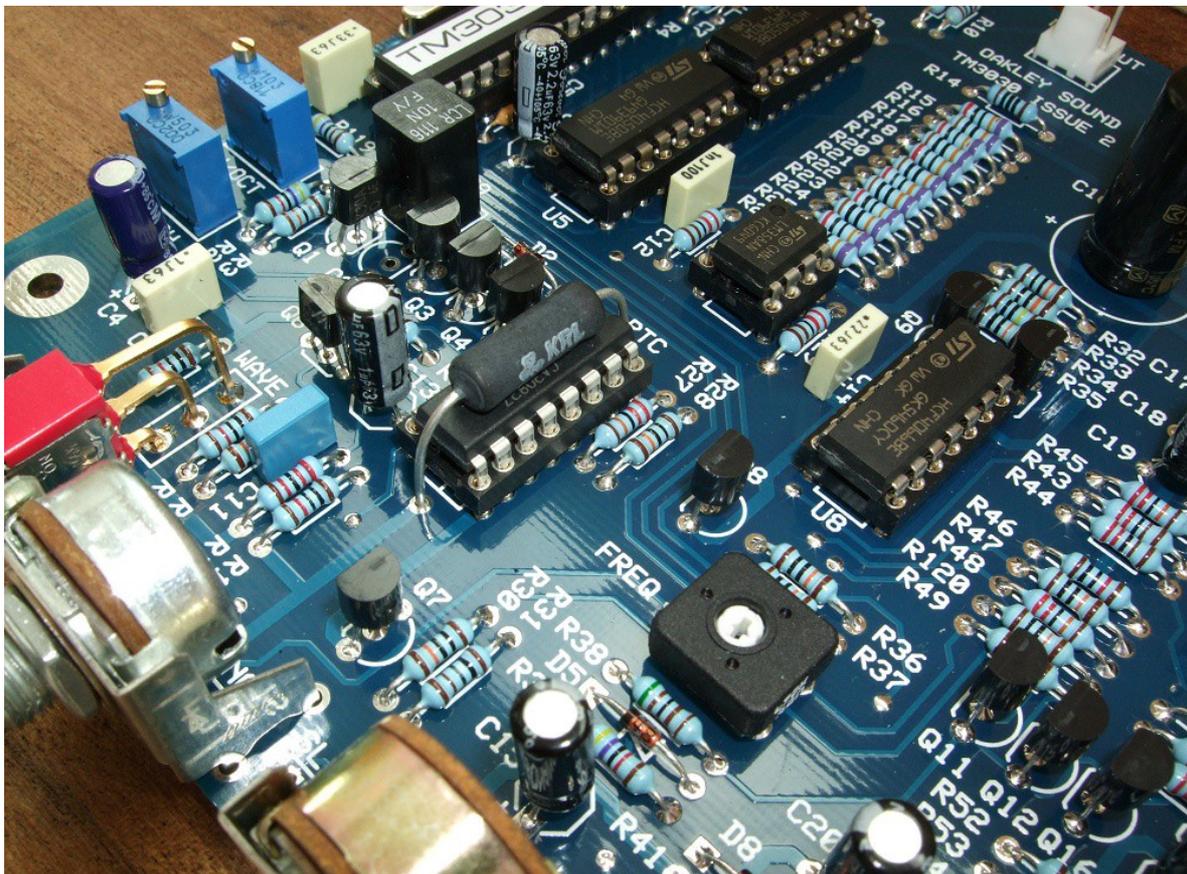
Also you will need solder, connecting wire of some sort and a case to put it all in. You may want to use IC sockets for all the ICs. I do recommend that you use an 28-pin 0.3" wide IC socket for the PIC.

Populating the TM3030 PCB

For general information on how to build Oakley projects, including circuit board population, mounting front panel components and making up board interconnects please see our generic Construction Guide at the project webpage or <http://www.oakleysound.com/construct.pdf>.

There are a few things I ought to draw your attention to that are not covered in the Construction Guide.

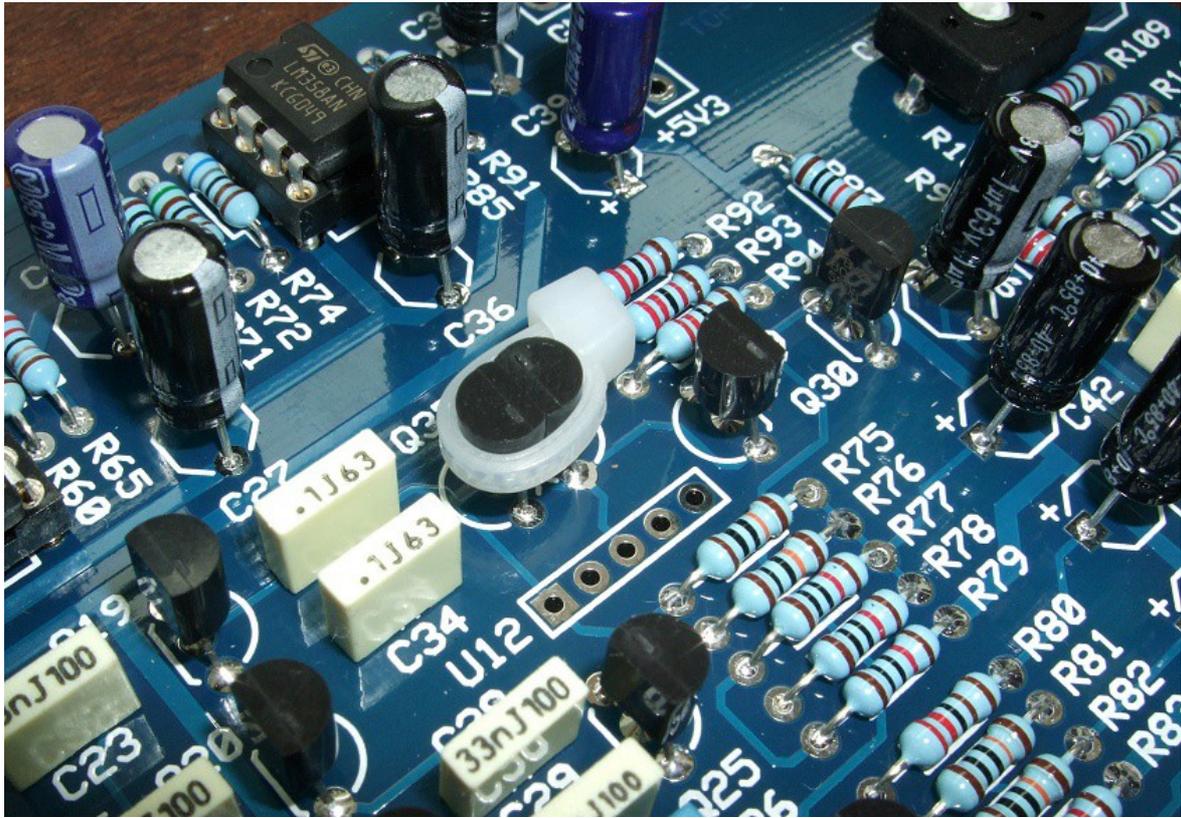
1. The 4MHz crystal should be soldered into the board so that its bottom surface sits above but not against the top surface of the printed circuit board. A small gap of around 1mm is recommended.
2. The positive temperature coefficient (PTC) resistor is mounted so that it lies across the top of U6. This is to ensure that both it and U6 are at the same temperature so that the resistor can compensate for the temperature dependency of the VCO control circuitry.



A close up of the VCO circuitry of the TM3030. Note the positioning of the positive temperature coefficient (PTC) resistor. Although not used here, a small amount of thermal paste can be used to keep both U6 and the PTC at the same temperature.

3. If you are not fitting a 2SC1583 to the filter circuit then you need to use a matched pair of BC550B or BC549B transistors. In theory these should be perfectly matched and thermally

bonded together. One way of thermally connecting them is to tie them together with a cable tie as seen in the photograph below.



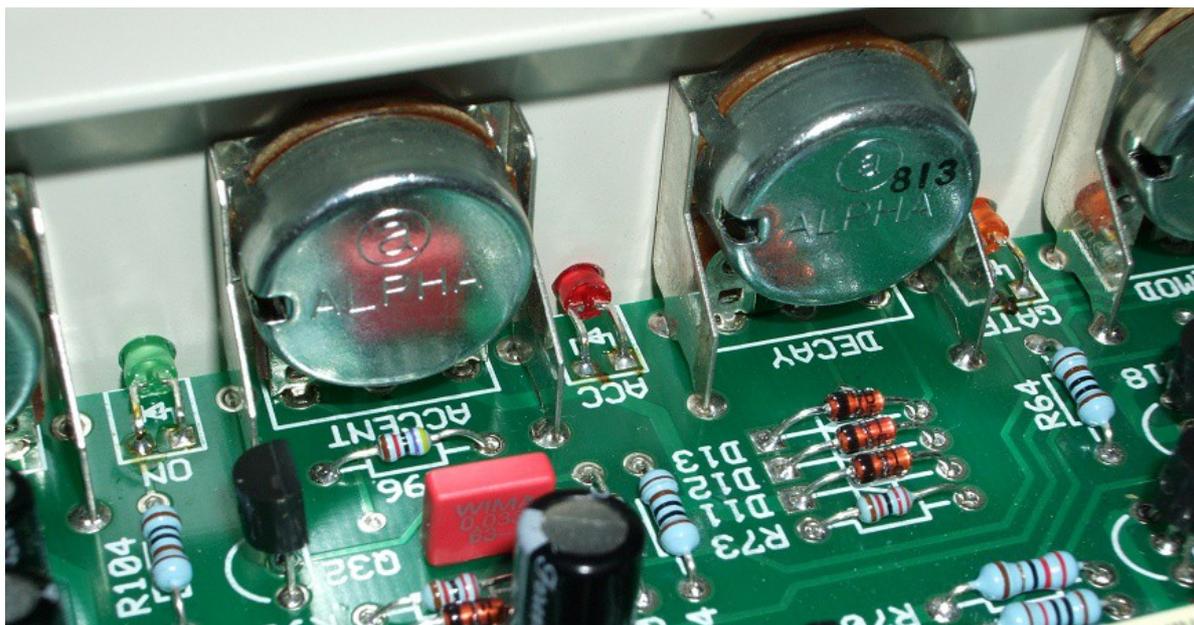
Two BC550B transistors face to face and fixed together with a simple cable tie. Again, a small amount of heat conducting paste can be used if desired.

Mounting the Pots, LEDs and Switches

If you are using the recommended Alpha pots, then they can support the PCB with specially manufactured pot brackets. You will not normally need any further support for the board. When constructing the board, fit the pot brackets to the pots by the nuts and washers supplied with the pots. Now fit them into the appropriate holes in the PCB. But only solder the three, or six, pins that connect to the pot. **Do not** solder the pot bracket at this stage. When you have soldered all the pots you can fit the board to your front panel. Position the PCB at right angles to the panel, the pot's own pins will hold it fairly rigid for now. Then you can solder each of the brackets. This will give you a very strong support and not stress the pot connections.

The Alpha pots are labelled with an A or B suffix. For example: 50KB or 1MA. Alpha and ALPS do the opposite to our European convention and use A = log and B = linear. So a 1MA is a 1 megohm log pot.

The four front panel mounted LEDs must be fitted carefully if you are using the directly mounted technique. Although this sounds fiddly, it's actually quite easy and it reduces wiring, interference and possible errors.



A close up of the LEDs in a 19" rack mounted issue 1 TM3030. You can see that the LEDs simply poke through the front panel.

Remove the front panel so that you just have the board again. Get the four LEDs and find the cathode for each one. Make sure the cathode of the LEDs will go into the round pad, pin 2, on the board. Carefully bend the LED's legs at a point 6mm away from the plastic body of the LED. The legs should be bent by 90 degrees so that the legs are pointing straight down. Check to see if they fit into the board. The bottom of the LED's body should fit just flush to the board edge. Fit all four LEDs to the board but do not solder them in at this stage. Let their legs poke through, there's no need to cut them down yet. Now fit the front panel again to the board and tighten the pot nuts. You should find that the board now fits snugly into position

and each LED should be just poking out of its hole neatly, albeit loosely. Align the LEDs if they aren't quite straight and solder each one in turn, trimming its leads nice and short afterwards.

With panel removed once again, you can now fit the switches. The C&K PCB mountable switch should fit tightly into its respective holes on the board. You may need to use a pair of fine nosed pliers to help the flexible gold pins into the board holes.

Make sure the switch body is flat against the board. Now refit the front panel and make sure the round switch barrel fits into its hole in the front panel. Now solder all the pins on the switch including the securing pins to the front.

That completes the soldering of the front panel components.

Housing your TM3030 module

The PCB has been designed to fit into a standard 1u high 19" rack or half rack unit. Your local parts distributor should have these. However, good rack units can be quite expensive and will contribute heavily to the final cost of your completed TM3030. Expect to pay around 40GBP or so.

Your choice of case will also be affected by what else you want in your enclosure. It is possible, in theory at least, to fit two TM3030 units side by side in a 1U rack case. This does depend on the rack case you have chosen, but most should have the front panel space to allow this. If you are choosing to use an internal mains supply, make sure you give yourself enough room for the transformer and associated wiring.

In the UK Bryant Broadcast, Holt Broadcast Services, Electrospeed and RS Electronics Ltd do have a range of rack units that may be suitable.

The Bryant and Holt Broadcast ones are both superbly made, but they do not allow you to use a standard 3mm thick Schaeffer front panel in place of the blank one supplied with the case. Their cases utilise the front panel as part of the enclosure. Simply swapping the Bryant/Holt panel with one obtained from Schaeffer or Front Panel Express will not work. Both Bryant and Holt do custom metal work, so it may be possible to try their services. This is one area I would like to try in the near future. Another option is to send the plain Bryant or Holt front panel to Schaeffer for engraving. Contact Schaeffer or Front Panel Express for details of this service but don't expect it to be cheap.

A Schaeffer FPD file can be found on the TM3030's project webpage which can be downloaded and edited. If printed out at 100% size and in 'wire mode' with reference points, you can then use it as a template for drilling your own front panel holes.

My current favourite method of labelling a front panel on one of these empty rack cases is to use a thin (1.5mm) engraved black anodised aluminium 'overlay' panel from Schaeffer. This is held onto the main case's front panel by two 3mm screws at either end of the overlay and the components simply stick out from holes. The pot nuts are secured to the front panel of the rack case so the pot holes in the overlay need to be sufficiently large enough not to snag on the pot nuts and washers. I use 14mm diameter holes in the overlay which are nicely covered up by the control knobs. The LED holes need to be 3.2mm and the switch hole 7mm.

The other choice is to fit the TM3030 into a half rack. My first issue 1 TM3030 prototype was built into a half rack width two tone metal case from RS Components Ltd. They no longer sell this particular case but others are available in a similar size and style.

It is possible to mount the TM3030 behind a 5U high modular panel when mounted vertically. However, the TM3030 is just too wide to fit between standard MOTM and Dotcom mounting rails. When fitting into a wooden case the rails can be cut back to let the board fit.

A desktop version can be made, and many people over the years have done this to their TM3030. However, try to keep your wiring tidy and don't make the wires too long as they can be prone to pick up stray electrical signals.



My first issue 2 TM3030 fitted into the now obsolete case from RS Components (pt no: 222-020).

I should point out that the best performance will always come from using metal cases. Metal cases are not only more rugged but they also provide screening. A good grounded case will protect the TM3030 from extraneous radiation from CRTs, amplifiers and computers. The TM3030's VCO is particularly susceptible to mains hum fields. Although the PCB layout is carefully designed to minimise this, if you fit your unit into a plastic or wooden case, you may find that you will get a little 50Hz (60Hz) or 100Hz (120Hz) wobble in the unit's pitch. You can use some aluminium foil to shield the circuitry, this can be stuck down on the lower part of the case, underneath the PCB, and connected to the GND pad of the TM3030. Do not connect your screening to any lug of the power pack inlet socket though.

When using any metal case it is essential that the case is grounded so that the screening is most effective. Grounded means electrically connecting the metal case to the 0V or ground of the circuitry. The GND pad provides a handy point from which to wire your panel's metalwork to. However, you will probably not need to use the GND pad at all if you have used metal midi sockets or a jack socket with a metal bush. See the chapter on midi, power and audio connections for more details on this.

For those of you fitting an internal toroidal transformer you must make sure there is no way the bolt that secures the transformer can touch both the bottom and top of the metal case. If the metal support of transformer together with the case makes a complete loop around the

core, then you have a shorted one turn secondary. ('Well, there was a large hum, more of a buzzy rattle really, then a smell of burning rubber and then a lot of smoke... '). You may also like to consider the use of a nylon bolt to hold the transformer in place.

When an internal transformer, toroid or otherwise, is being used then the metal case **must be connected securely to earth**. This is best done with a M4 bolt, nut, toothed washer and solder tag directly wired (with thick wire) to the IEC inlet socket's earth tag. The TM3030's circuitry should be then tied to earth via another wire from the GND pad on the board back to the bonding point.

There is little more information about using internal mains transformers later in this document. I should stress that building a component level mains transformer into any DIY project should not be taken lightly as the consequences for getting it wrong can be severe.

The PCB will be supported well enough by the pots and pot brackets. However, this may give some people nightmares so it for them it will be a good idea to provide additional support. Small holes, to fit M3 bolts, have been provided on the outer corners of the PCB to do this. Feel free to enlarge these holes if you wish. My prototype has been very happy just supported by the pots. However, my unit doesn't get moved around much. If you intend to take it out on the road, extra support may be a good idea.

Midi, Power and Audio Connections

The original issue 1 prototype had its input and output sockets mounted on to the PCB itself. This initially seemed quite practical, but in reality would only be useful if everyone was going to be using the same casing as me. In the production runs of the PCB I have used 0.1" headers for all the I/O connections. This should give you more flexibility in making your unit suit your own needs. The TM3030 board will be held in place in the case either by the pot brackets or the four mounting posts, or even a mixture of the two. The sockets should then be mounted onto the rear panel and then hand wired to the PCB.

0.1" headers are commonplace on commercial units to speed up manufacture. You can use either Molex [strip and crimp] or MTA [insulation displacement] type connectors. For those who haven't a clue about either of these forms, it is probably best for you to just solder the connecting wires in place. 0.1" headers are useful and easy to use, but both types require special and relatively expensive tools to make up the wiring. So, for many of you it will be easier to simply solder the wires into the correct holes on the TM3030 PCB.

The type of wire is often asked about on the forum. I use multistrand hook up wire and this often comes in hobbyist packs of varying colours. The size that I use is typically described as 7/0.2mm which is seven strands of 0.2mm diameter wire. Don't use single strand wire since this tends to break easily. Remember to keep all wires as short as you can, but allow for a little extra so that no wire will ever become taut. I usually tin the bare wire ends with a bit of solder before I place the wire into the board or terminal hole. This stops the wire end from fraying and makes a better solder joint.

NOTE: Pin 1 of the headers are denoted by a square solder pad on the PCB. All the others are round.

You have just four sockets to wire up and it doesn't take long at all. Lets deal with the power inlet first. You'll probably want to include a power switch, but this isn't shown on any of the schematics. If you have chosen a nice SPST switch, it will only have two terminals. Simply wire this in series with one of the connecting wires from the power inlet to the PCB.

If you are using a metal case then the power inlet socket should not have a metal mounting bush. That means that it should not have any metal part on main body of the socket touching the TM3030's metal case. We do not want any direct connection from the power supply's wiring to connect to the case.

The power inlet socket has two or three terminals. The ones you need are the terminals that connect to the the inserted power plug. The third terminal is the 'normally closed' lug, sometimes called the NC or normalising lug. This should be ignored in our application. The header labelled AC_POWER will connect to the power inlet and the power switch.

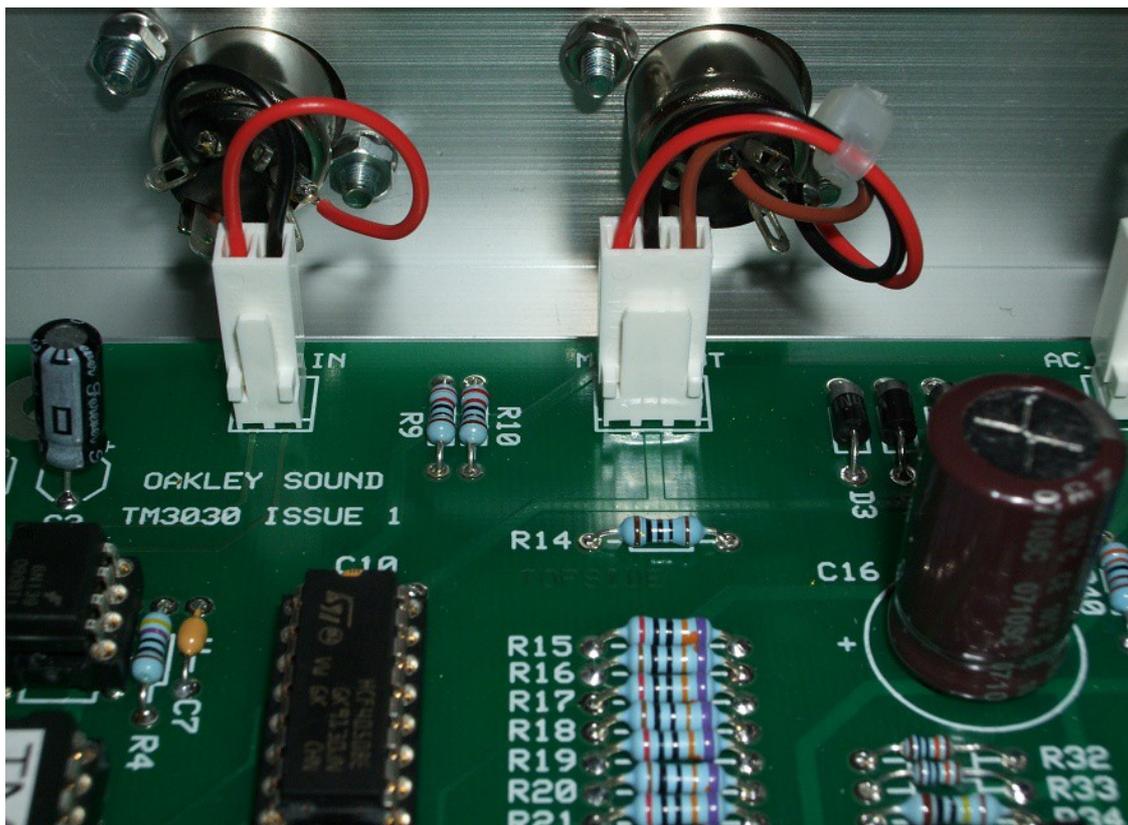
Pin 1 of AC_POWER should go to any terminal on the switch. Pin 2 should go to any of the two terminals on the power socket that are not the NC lug. You should connect the other terminal on the switch to the remaining terminal on the power inlet that isn't the NC lug.

Remember the TM3030 uses a bridge rectifier on its power input, so it doesn't matter about the polarity of the input voltage.

The next socket we shall wire up is the audio output. This should be a 1/4" jack socket and you can use either plastic framed sockets (with a plastic securing nut) or ones with a metal bush (and metal securing nut). Both types will probably have three lugs, but may have six or just two. You will be connecting only to the terminals that will connect to the tip and sleeve of the connected jack plug.

Connect pin 1 of AUDIO_OUT to the terminal that will connect to the tip of the jack plug. This wire will carry the audio signal. Connect pin 2 of AUDIO_OUT to the terminal that connects to the sleeve of the jack plug. This is the 'earth', or ground, of the signal.

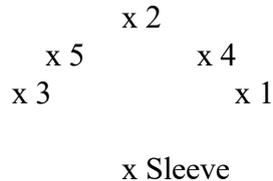
Now if you have used a socket with a metal bush and securing nut and have a metal case then the jack socket will have grounded your case. By grounding your metal case you will help screen the internal circuitry from outside electrical interference. To help make a good connection with the case it is best to use a toothed or sprung washer between the socket and the inside of the case. If you have a plastic output socket do not worry you'll be grounding your case with the midi sockets.



A close up of an older issue 1 TM3030 showing the midi connections done with Molex KK 0.1" headers and housings. Issue 3 boards can be wired in a similar way.

Wiring the midi sockets often causes the most confusion since it's sometimes difficult to know which pin goes to where. Midi sockets are numbered in a most confusing way. If you get this wrong the TM3030 won't be damaged, but it will not operate correctly.

When you look at the **back** of a midi socket, you will see six terminals. If you are lucky then they will be labelled, but quite often they are not. We will firstly consider the five of them that form a half circle. If you position the socket so that the middle terminal is at the top, then the pin numbers go 3, 5, 2, 4, 1. Pin 2 is therefore at the top. The sixth terminal is normally opposite to pin 2 and connects to the metal surrounding of the socket. We shall call this pin the 'sleeve' pin.



The midi sockets are wired up as follows:

MIDI_IN

Pin 1 on PCB goes to Pin 4 on socket
 Pin 2 on PCB goes to Pin 5 on socket

MIDI_OUT

Pin 1 on PCB goes to Pin 4 on socket
 Pin 2 on PCB goes to Pin 2 on socket
 Pin 3 on PCB goes to Pin 5 on socket

If you have used a plastic audio output socket then you should also connect pin 2 on the midi output socket to the sleeve solder tag. This can normally be done with a small length of solid core wire on the socket itself. By making this connection you will have connected the metal case to 0V (ground) and screened your case.

If you have used plastic midi sockets, or have metal ones with no sleeve connection, as well as a plastic output socket you should still ground your case. Drill a 3mm hole into your metal case at the rear. Fit an M3 screw through this hole and with a nut, toothed washer and solder tag create a grounding point on the inside of your case. Then connect a wire from this grounding point to the GND pad on the TM3030 PCB.

That completes the wiring of the TM3030.

Fitting an Internal Mains Transformer

I do not endorse, nor recommend, any method that uses the direct powering of any Oakley equipment with the mains supply. It is up to you to use your PCB wisely and to make sure you make your project in a safe manner. Furthermore you should ensure that the finished project is safe to any persons who are using it. Oakley Sound Systems cannot take any responsibility for what you do with your TM3030 PCB.

The following advice is only for those who know how to wire mains rated equipment safely. If you do not know how to do this then make no attempt to do so. The following information, provided in italics, is the only information I am prepared to give regarding direct mains supply for the TM3030.

Transformer rating; Secondary or secondaries: 15-0 or 7.5-0-7.5 @ 3VA minimum

Do not connect the common of any dual secondary windings to ground. Winding end wires go to pin 1 and pin 2 of the connector marked AC power. Neither pin 1 or pin 2 should be connected to ground.

*CI6 should be adequately rated for the input voltage you are using. ie. At least equal to 1.4xVac. Where Vac is the **maximum** output RMS voltage of the transformer.*

Line fuse; T250mA

All mains carrying conductors must be suitably insulated and mounted away from the low voltage parts of the unit.

All parts of the metal case MUST be connected to mains safety earth. A suitable and secure bonding point must be made to the case. Note that the case's paint or other coating should be removed from around the bonding point to ensure that the metalwork is making a good contact to the bonding point hardware. The bonding point should then be connected via a suitably thick piece of wire back to the earth terminal of the IEC socket or earth inlet connection.

If you have used a laminated EI transformer, ie. not a toroid, then you should earth the exposed metal frame of the transformer.

The 0V on the TM3030 circuit board should also be tied to earth. This should be done using a piece of insulated wire connecting the earth bonding point to the GND pad on the board. In this instance only it may be preferable to use a plastic audio jack socket and leave floating the sleeve pin on the midi output socket.

Final Comments

If you have any problems with the module, an excellent source of support is the Oakley Sound Forum at Muffwiggler.com. Paul Darlow and I are on this group, as well as many other users and builders of Oakley modules.

If you can't get your project to work, then Oakley Sound Systems are able to offer a 'get you working' service. If you wish to take up this service please e-mail me, Tony Allgood, at my contact e-mail address found on the website. I can service either fully populated PCBs or whole modules. You will be charged for all postage costs, any parts used and my time at 25GBP per hour. Most faults can be found and fixed within one hour, and I normally return modules within a week. The minimum charge is 25GBP plus return postage costs.

If you have a comment about this user guide, or have found a mistake in it, then please do let me know. But please do not contact me directly with questions about sourcing components or general fault finding. Honestly, I would love to help but I do not have the time to help everyone individually by e-mail. Questions are always best directed to the Oakley Sound Forum.

Tony Allgood at Oakley Sound

Cumbria, UK

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