

## Ats a NE11000TH GX1 RESONATOR

Thank you for purchasing the NE11000TH GX1 bandpass filter/resonator circuit board. This document includes the parts list, schematic, a reference layout image, construction notes and operation notes.

### Construction Notes:

The attached bill of materials (BoM) lists all parts needed for the board. The board has provision for a 2x5 or 2x8 power header. A keyed, shrouded header is recommended.

All parts mount to the component side (see fig. 2). Pay attention to the trimming of leads including jack lugs so the modules fit comfortably into a 4HP rack space. The 4HP panel supplied with the board (if that option was ordered) is 5 mils short of 4HP to provide a “slop gap” in case other modules make things a tight fit.

The board uses CUI MJ-3536 type right-angle jacks: <http://www.cui.com/product/resource/mj-3536.pdf> These are available from Erthenvar, Thonk, etc. An equivalent part number is PJ302M. The three linear pots (two 100K, one 10K) are 9mm Alpha right-angle types, also available from Erthenvar, Thonk, Small Bear, etc. The 10K pot must be in fact 10K (no substitutions!)

The BoM uses mostly Digikey product numbers for reference, but parts can of course be ordered from any supplier such as Mouser or your favorite octopart.com search result. Some folks like to use all 1% metal film resistors, but it is not necessary. The only critical tolerances are tuning capacitors C6 through C10, these need to be polyester film types. The NPN/PNP general purpose transistors can be BC550C/560C and the FET can be any N-channel general purpose device like a J112 or BF545 as opposed to the values described in the BoM, just be sure to pay attention to the lead order. (see note 5)

The board is made with a lead-free hot air solder layer, but soldering with leaded solder is fine. Similarly, you can use “no-clean” or organic solder, just be sure to rinse the board in the case of organic soldering. It is recommended to avoid soldering mechanical parts like jacks, switches or pots with organic solder, use “no-clean” or good old tin-lead rosin core.

Part reference designator note: Some markers are omitted, an example being C1 through C10, then it skips to C15 through C22. There are no placements for C11, C12, C13 or C14. Those are on a different board which expects a +/-15VDC power supply. Other unused markers are R18 and R19.

Transistor array IC2 is an SMT part that comes pre-soldered. The through-hole version is getting hard to find, but many vendors stock the SMT part and they are in plentiful supply.

Some vendor links:

<http://www.digikey.com/>

<http://www.thonk.co.uk/>

<http://shop.erthenvar.com/>

<http://smallbear-electronics.mybigcommerce.com/>

## Operation Notes:

The NE11000 circuit is a “discrete equivalent” implementation of the Yamaha NE11000 custom epoxy-potted filter module made by Yamaha in the early-1970s for their GX1 stage synthesizer as well as the “SY” solo synthesizer models and “CSY” combo organ/synth instruments. These modules were not made past 1976 and none were available until Crow tore some apart and recreated new ones, see [http://www.cs80.com/ne\\_proj.html](http://www.cs80.com/ne_proj.html) for details on the NE projects.

Old Crow's Synth Shop designed the original NE11000 plug-in board in 2004 as a drop-in to an NE11000 on-board module space. The NE11000 5U and euro module boards such as the NE11000TH have been made to bring the distinct sound of the GX1 bandpass resonator to the modular synthesizer user base. The only key difference between the original NE11000 and cs80.com's NE11000TH is that the original module is a linear response device (volts/decade) whereas the NE11000TH is an exponential response circuit (volts/octave) as this is the standard for modular control voltage paths.



*Fig. 1: A re-created "original" NE filter module by the Old Crow*

The NE11000TH is a Sallen-Key bandpass filter that uses a matched transistor array (IC2) as a set of matched diodes to form a resonant cell along with tuning capacitors C6-C10. Current mirror Q1 takes the control voltage provided by IC1 and the Q4-T1-T2 dual current sink circuit and provides the mirror current at the “top” of the resonant cell that is equal to and opposing the current (from T2) at the bottom of the cell. Refer to the schematic to understand why “top” and “bottom” are used. An audio signal is introduced into the resonant cell via tuning capacitors C9 and C10, with the feedback amplifier built around transistors T6-T7 providing the negative feedback needed to make the cell actually resonate. Signal buffer FET1 is used to prevent overloading of the cell's output.

The original NE11000 did not have externally adjustable resonance. The Q factor for the original was fixed at 5 and was used to select harmonics from the sawtooth waveform. The NE11000TH provides for a variable resonance by variable damping of the FET buffer's output using C1, R29 and VR2 (panel pot). The module can be set to the GX1 default Q of 5 by adjusting the resonance knob to the position of the small dot at the 10 o'clock position on the dial scale.

## Calibration Notes:

Zero calibration should be done leaving the CV input unconnected and the FREQ control fully CCW. Apply an audio signal (3Vpp minimum) to the input and adjust board trimmer R27 until as small an amplitude as possible is observed at the filter output.

And that is it. Once calibrated it should not need adjustment again.

## NE11000TH specifications:

DC power requirements: [+/-12VDC@20mA](#) nominal

Frequency range: 0.1Hz to 20KHz

Output level: 3Vp-p

Response: 1V/octave

CV IN: -10V to +10V nominal.

Old Crow's Synth Shop at [www.cs80.com](http://www.cs80.com)

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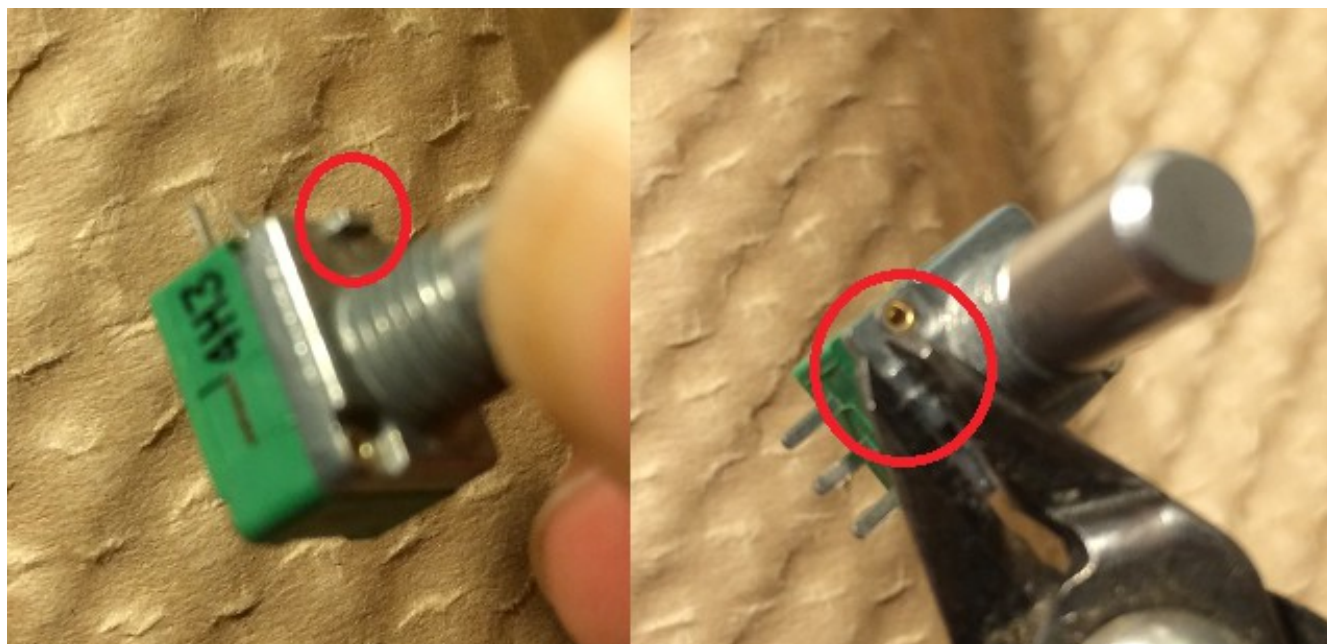
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## Partlist for VCO153TH

Digikey part numbers given as a reference unless otherwise noted.  
Tolerance is 1% for resistors but 5% is fine.

Qty	Value	Package	Refdes	Description	Digikey # (unless otherwise noted)
1	2x8 header	0.1" dual row	JP1	0.1" shrouded male header 2x8	ED10523-ND
1	Audio in	MJ-3536/PJ-302M	J1	3.5mm right-angle jack	Erthenvar /Thonk
1	Audio out	MJ-3536/PJ-302M	J2	"	"
1	FM IN	MJ-3536/PJ-302M	J3	"	"
1	CV IN	MJ-3536/PJ-302M	J4	"	"
1	68 Ohm	R-US_0207/7	R33	68.1 Ohm 1/4W 1% metal film	68.1XBK-ND
1	470 Ohm	R-US_0207/7	R42	475 Ohm 1/4W 1% metal film	475XBK-ND
4	1K	R-US_0207/7	R16, R20, R25, R40	1K 1/4W 1% metal film	1.0KXBK-ND
3	2K2	R-US_0207/7	R21, R22, R23	2.21K 1/4W 1% metal film	2.21KXBK-ND
1	3K3	R-US_0207/7	R41	3.3K 1/4W 1% metal film	3.32KXBK-ND
3	4K7	R-US_0207/7	R7, R15, R34	4.75K 1/4W 1% metal film	4.75KXBK-ND
2	10K	R-US_0207/7	R29, R36	10K 1/4W 1% metal film	10.0KXBK-ND
1	12K	R-US_0207/7	R30	12.1K 1/4W 1% metal film	12.1KXBK-ND
2	15K	R-US_0207/7	R10, R35	15K 1/4W 1% metal film	15.0KXBK-ND
3	22K	R-US_0207/7	R5, R6, R12	22.1K 1/4W 1% metal film	22.1KXBK-ND
2	33K	R-US_0207/7	R11, R17	33.2K 1/4W 1% metal film	33.2KXBK-ND
1	39K	R-US_0207/7	R32	39.2K 1/4W 1% metal film	39.2KXBK-ND
4	47K	R-US_0207/7	R8, R9, R14, R31	47.5K 1/4W 1% metal film	47.5KXBK-ND
1	54K9	R-US_0207/7	R24	54.9K 1/4W 1% metal film	54.9KXBK-ND
8	100K	R-US_0207/7	R2,R3,R4, R26, R28, R37, R38, R39	100K 1/4W 1% metal film	100KXBK-ND
1	150K	R-US_0207/7	R1	150K 1/4W 1% metal film	150KXBK-ND
1	220K	R-US_0207/7	R13	221K 1/4W 1% metal film	221KXBK-ND
2	100K	9mm right angle	VR1, VR3	Alpha 9mm B100K potentiometer	Erthenvar / Small Bear/Thonk
1	10K	9mm right angle	VR2	Alpha 9mm B10K potentiometer	"
1	20K	3362 1-turn trimmer	R27	Bourns 33xx series 20K trimmer	3362P-203LF-ND
4	10nF poly	5mm radial	C7, C8, C9, C10	0.01 uF polyester film cap	493-3422-ND
1	22nF poly	5mm radial	C6	0.022 uF polyester film cap	493-3393-ND
1	1uF	2mm radial	C1	1uF 50v aluminum	493-1099-ND
1	10uF	2mm radial	C4	10uF 35v aluminum cap	P5161-ND
3	22uF	2mm radial	C2, C3, C5	22uF 35v aluminum cap	P5162-ND
4	0.1uF	2.5mm radial	C15, C16, C20, C21	0.1uF 100v ceramic cap	478-4855-ND
4	100uF	2.5mm radial	C17, C18, C19, C22	100uF 25V aluminum cap	P5152-ND
1	J112	TO-92 GDS	FET1	N-channel FET TO-92	J112FS-ND
7	2N3904	TO-92 EBC	T1,T2,T3,T4,T5, T6,T7	NPN transistor TO-92	2N3904FS-ND
5	2N3906	TO-92 EBC	Q1A, Q1B, Q2, Q3, Q4	PNP transistor TO-92	2N3906FS-ND
1	TL072C(1P)	DIP8	IC1	Dual JFET OPAMP	296-14997-5-ND
NOTE: LM3046M is pre-installed, no need to order one. Included here for reference.					
1	LM3046M	SOIC14	IC2	NPN array	LM3046MX/NOPBCT-ND
1	LM337LZ	TO-92	IC3	100mA negative adj. regulator	LM337LZ/NOPB-ND
1	LM78L10Z	TO-92	IC4	100mA positive fixed 10V regulator	KA78L10AZTAFSCT-ND

NOTE 1: Use 9mm right-angle pots and jacks unless you are using a different panel or mounting scheme. The 9mm pots will need the panel anchor nub clipped off:



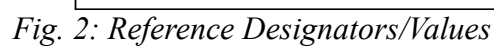
NOTE 2: The board is designed to allow fitting two PNPs like BC550C or 2N3906 as shown by the board graphic for Q1A and Q1B.

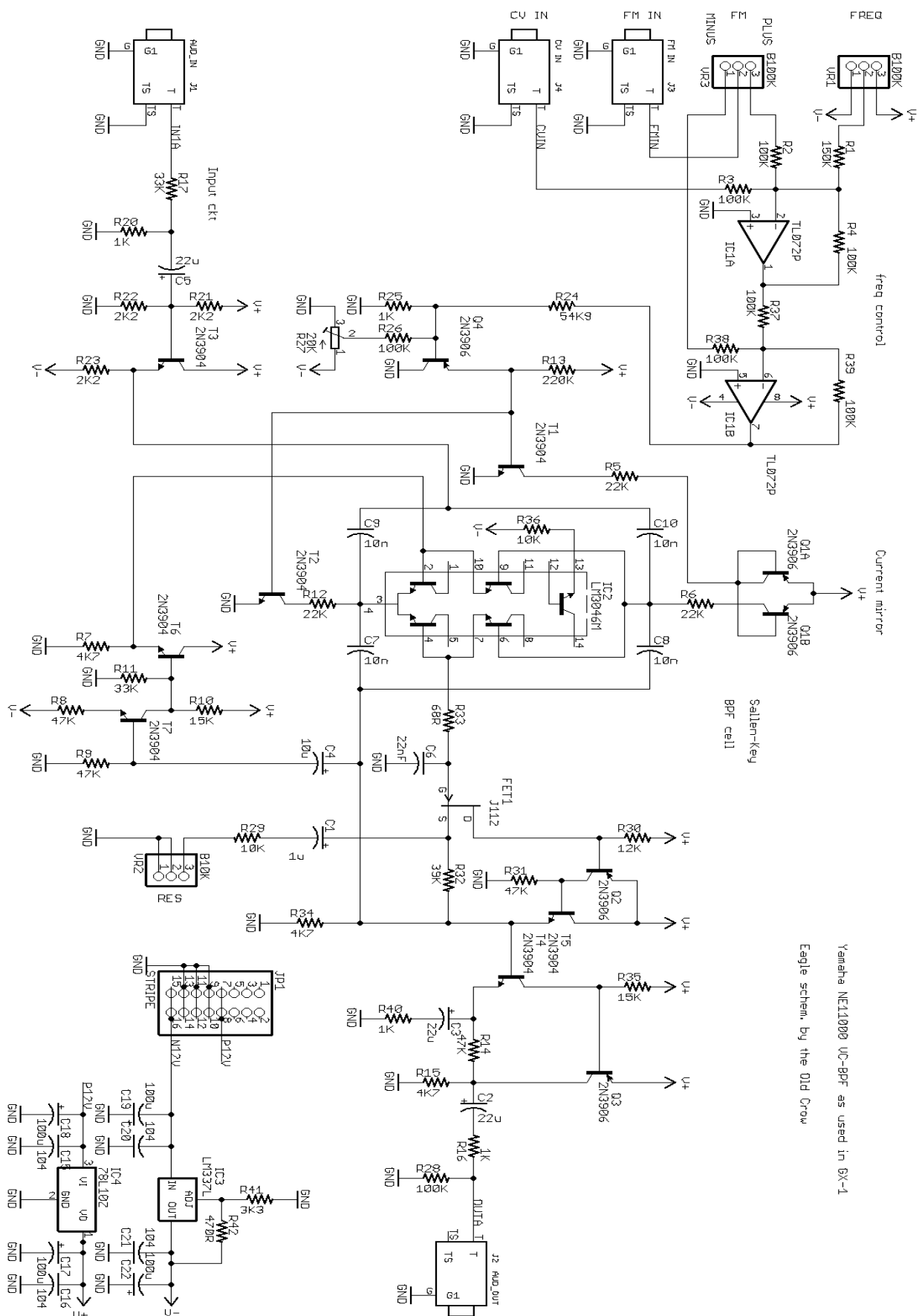
NOTE 3: Trimmer R27 can be a single turn or multi-turn type anywhere from 10K to 50K.

NOTE 4: Got a bunch of BC550Cs and/or BC560Cs? Go ahead and use those in place of the 2N3904s and 2N3906s. Just observe the pin order (E-C-B vs E-B-C depending on the part).

NOTE 5: FET1 is a J112 which mounts with a rotation. The flat side of the FET should face the 10 o'clock position. The “DGS” letters indicate which lead is soldered to which pad:







Yamaha NE11089 UC-8PF as used in BX-1

Eagle schem. by the DID Crow

Fig. 3: Schematic