



**MOTM-890 μ Mixer
Assembly Instructions & Owner's Manual**

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MOTM-890 PARTS LIST

Please carefully check that all parts are in your kit. If you have a suspected shortage, please call or email. If you get free extra stuff, keep it for next time.

Capacitor bag, containing the following 8 parts:

2ea 10mfd, 50V Electrolytic	C2, C3
3ea 22pf (marked 220 or 22P) ceramic axial	C6, C7, C8
1ea 100pf (marked 101) ceramic axial	C1
2ea 0.1mfd (marked 104) ceramic axial	C4, C5

Resistor bag, containing the following 17 parts:

8ea 100K 1% (brown, black, black, orange)	R1 – R8
3ea 10K 1% (brown, black, black, red)	R9, R10, R11
3ea 33K (orange, orange, orange)	R15, R16, R17
1ea 2K2 (red, red, red)	R12
1ea 7K5 (violet, green, red)	R13
1ea 1K 1% (brown, black, black, brown)	R14 << BE CAREFUL!! SEE TEXT.

IC bag, containing the following 2 parts:

2ea OP275GP precision dual opamp	U1, U2
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Misc #1 bag, containing the following 3 parts:

2ea Axial ferrite beads (plain, gray things)	L1, L2
1ea MTA-156 power connector	JP1

Knobs, 3ea, ALCO PKES90B1/4

Jacks, containing

6ea Switchcraft 112A

- Pots**, 3ea containing the following:
3ea 100K log conductive plastic (Spectrol 148) VR1, VR2, VR3
- Front panel**
- Mounting bracket**
- Wire bag**, containing the following 7 wires:
6ea RG-174 coax, 4 ½ inches
1ea Power Cable, 20"
- Hardware bag**, containing:
4ea #8-32 x 3/8 black screws (for mounting module to rack)
4ea #6-32 x 1/2 zinc screws (for attaching pc board to bracket)
4ea 1/4 inch aluminum spacers
4ea #6 KEPS nuts
7ea small tie-wraps
- Organic Solder**
- No-clean Solder**
- PC Board**, MOTM-890

GENERAL INFORMATION

Thank you for purchasing the MOTM-890 μ Mixer. If you have any issues concerning the building or use of the kit, please contact us at (817) 498-3782 or by email: synth1@airmail.net.

This kit should take the average builder between 1 and 2 hours. The kit contains many different resistors and special parts. However, please remember this is NOT a speed contest; it is an accuracy contest. There is no rule that you have to complete the entire kit in one day (as long as you wash the flux off!).

Successful kit building relies on having the proper tools. Here is a list of what you will need to build your MOTM-890:

- Soldering iron, 50W max power
- Needle-nose or chain-nose pliers
- Diagonal cutters
- Allen key set for securing the knobs (1/16" or 1.6mm)
- Magnifying glass: to read the capacitor codes and to inspect solder joints
- Lead bending tool (optional, but makes the job go much faster)
- DVM (Digital Volt Meter) or oscilloscope (to check the output)
- #1 Philips screwdriver
- Fingernail brush for washing off the organic flux
- Old towel for blotting dry pc board

For more information of tools used and suggestions, see the MOTM FAQ and Catalog pages at <http://www.synthtech.com>.

HOW TO FOLLOW THE DIRECTIONS

Please read the entire instruction before proceeding. There may be valuable information at the end of the instruction. Each instruction has a check box next to it. After you complete the instruction, check the box. This way you can keep track of where you are in the process.

VERIFY THE PARTS LIST

- Verify that all of the parts are in the kit as shown on the parts list.

A WORD ON SOLDERING

There are 2 very different types of solder used in the kit. Most of the soldering uses 'Organic Flux' solder. ***This is strictly for use on the pc board, and is NOT to be used on the front panel wiring!***

In order for solder to 'stick' to the copper, a chemical called 'flux' is embedded in the solder. The flux leaves a residue on the pc board that should be cleaned with warm water. DO NOT USE SOAP OR OTHER CLEANSERS. Most of the parts in the kits are 'waterproof' and can be washed in the sink. The flux is OSHA approved for flushing down the drain, so don't worry

about that! A soft brush is used to gently scrub the board. We recommend a ‘fingernail brush’, which is about 1” x 2” and can be found for about \$1.

The other type of solder is called ‘No Clean Flux’; because as the name implies it does not require washing. This solder is used for wiring the pots, switches, jacks, etc. This solder is harder to use on the pc board; because even when melted, it is not very fluid (about the consistency of toothpaste). We will use it VERY SPARINGLY on the pc board.

OK, let’s get started on the board!

PART #1: SOLDERING THE RESISTORS

Since there are more resistors than anything else, we will start here. If you do not know the resistor color code, refer to the parts list. Resistors are not polarity sensitive, but the board will be easier to debug (and look nicer) if you point the first color band in the same direction for all the parts. The color code is also in the README FIRST document that every customer receives with his or her first order.

You will start by soldering in ALL of the resistors.

- Find the **RESISTOR** bag.
- Find the MOTM-890 blank pc board. There is a copy (larger than actual size) of the silkscreen which shows where the parts go at the end of this document. It will be useful if you locate the part on the print first, put the part in the board, then ‘check off’ the silkscreen. All parts are inserted from the side of the board with the white silkscreen (the “top” side).
- We will stuff the resistors by value to make things easier. The resistors are inserted on a 0.4 inch spacing. The important thing is to be sure that the part is sitting all the way down on the board. Push the leads in the holes, push the part on the board, and then bend the leads on the bottom outwards to a 45 degree angle (roughly!). This is called ‘cinching the leads’: and keeps the part from falling out! From the bottom of the board, solder (using the organic flux), applying heat to the pad for about a half second first, then applying just enough solder to make a small puddle that looks like a tiny pyramid. Enough solder should flow in the hole such that on the top (component) side, a small amount is on the top pad as well

The rule of soldering: don’t use too much, you can always add more! Cut the leads flush with the top of the solder joint with your diagonal cutters.

NOTE: later in the assembly, you will need 5 scraps of resistor lead. Be sure to save some!

ANOTHER NOTE! DO NOT confuse the 1K 1% resistor with the 100K 1% resistors. It may be difficult to determine if the last color band is Orange (100K) or Brown (1K). DO NOT GUESS! Use a DVM to measure it.

Locate the 100K 1% resistors (8pcs). Solder the resistors into R1 – R3 (right of U1), R4 – R6 (left of U1) and R7 and R8 (right of U2).

- Locate the 10K 1% resistors (3) and solder into R9 – R11 (below U1).
- Locate the 33K resistors (3) and solder into R15 (by R4), R16 (by VR1) and R17 (sideways, by C7).
- Locate the 2K2 resistor and solder into R12 (left of U2).
- Locate the 7K5 resistor and solder into R13 (below R12).
- Locate the 1K 1% resistor (***make SURE it's not a 100K 1% resistor!***) and solder into R14.

PART #2: BOARD WASH #1

- Verify all the resistors are in the correct position.
- Verify all the resistors are flat on the board. Correct if needed. Check solder joints.
- Wash the board in warm water, gently scrubbing *both* sides. **DO NOT USE ANY SOAP!** Just water! Blot dry with old towel and let it sit for at least 15 minutes.
- Take a little break! You are about 1/3rd of the way finished.

PART #3: CAPACITORS

- Locate the **CAPACITOR** bag. Note that the ceramic axial caps are bent on 0.300 centers. If you are using the Mouser red plastic bending guide, you will see there is no 'slot' for the 0.300 spacing. However, we can use a clever trick! You use the round hole at the small end. Lay the body of the cap across the hole, and bend the leads over the sides as before. A perfect 0.300 bend!
- Locate the 22pf ceramic axial caps (3) and solder into C6 (by R6), C7 (by R3) and C8 (by VR2). **DO NOT GET THESE MIXED UP WITH THE OTHER 100pf CERAMIC CAP OR THE MIXER WILL NOT OPERATE PROPERLY!!!**
- Locate the 0.1mfd axial ceramic caps (2) and solder into C4 and C5 (by U1 and U2).
- Locate the 100pf ceramic axial cap and solder into C1 (by R13).

- Locate the 10 μ fd electrolytics (2). Note that there is a stripe on the NEGATIVE terminal. The pc board has a + on the POSITIVE terminal. Carefully stick the capacitors into C2 and C3 with the stripe **away** from the + pad on the board.

PART #4: MISC and IC STUFF

Almost done with the parts on the pc board! This will finish up the soldering with the organic flux.

- Locate the **MISC #1** bag and the **IC** bag.
- Locate the ferrite beads (2). They are axial parts, gray colored with no markings. These are non-polar, and are soldered into L1 and L2 (by JP1).
- Locate the MTA-156 power connector. Solder into JP1. Note that the connector has a 'locking tab' on one side. This side is the "inside" facing relative to the pc board. Note the silkscreen symbol for JP1 has a line on one side, indicating this is the side where the locking tab goes.
- Locate the OP275GP op amps (2). Solder into U1 and U2. Note that all ICs are pointing "down" towards the bottom edge of the pc board. The IC will have a 'notch' or indentation in the top by Pin #1.
- Apply a small bit of solder to the via holes. These are the small pads that allow traces to "change sides" of the pc board. **DO NOT SOLDER PADS FOR THE REMAINING COMPONENTS!!** As an example, if you look above VR3, you will see traces, surrounded by copper, with 2 via holes around it.

PART #5: FINAL BOARD WASH & INSPECTION

- Verify all the parts are in the correct locations. Make sure all of the ICs are pointing the same direction.
- Inspect the solder joints. Any solder shorts? Too much solder? Missing joints?
- Wash the board under warm water. Scrub gently. Dry.

THIS IS A GOOD STOPPING PLACE TO REST OR PUT THE KIT AWAY UNTIL LATER.

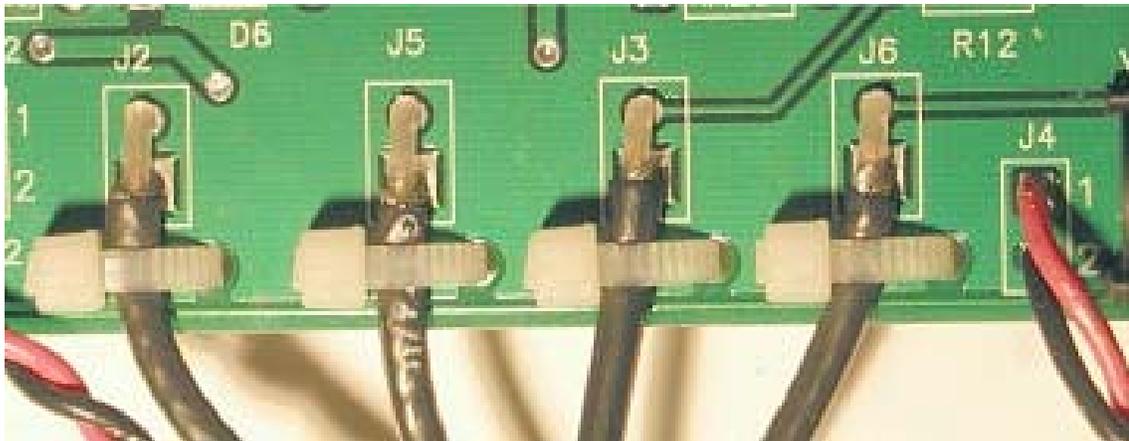
You are now finished with the Organic flux solder. All soldering past this point is using the No-Clean solder. You do not have to wash the board anymore.

PART #6: FINISHING THE PCB

You will now solder in the remaining parts on the pcb in preparation for wiring to the front panel. USE THE NO-CLEAN SOLDER. BE CAREFUL!

- ❑ Locate the Spectrol 148 pots. They mount into VR1-VR3. Be sure they are flat and sticking out perpendicular to the pc board.
- ❑ Locate the 6 pieces of RG-174 black coax cable. Again, note that one end has longer wires stripped than the other. The short ends will go in the pc board in locations J1 – J6. Look at the pc board. Notice that in the coax positions, there is a large hole pad (lower pad) and a smaller pad (top hole). The braided wire is soldered into the larger hole. The smaller, inner conductor goes in the top hole. **BE SURE THE SHORTER BRAIDED END GOES INTO THE PC BOARD.**

Solder each coax cable into the holes. Attach a tie-wrap to secure the coax cable flush to the board. The tie-wrap goes down, into the left hole and up through the right hole. Secure and trim off any excess. See the photograph below for proper mounting (this is generic photo, not *specifically* using the MOTM-890 pc board).



YOU ARE NOW FINISHED WITH THE PC BOARD WORK! BREAK TIME.

PART #7: FRONT PANEL PREPARATION

You will now attach components to the front panel. It is **HIGHLY** recommended that you use a set of hollow shaft nut drivers, **NOT PLIERS**, to tighten the nuts. This prevents scratching. **NOTE:** all references to part orientation is from the **REAR** of the panel.

- ❑ Locate the 6 Switchcraft jacks. Notice that from the rear, there is a beveled corner. This corner is **ALWAYS CONNECTED TO GROUND, WITH A BRAIDED CONDUCTOR**. Each jack has a flat washer, a lockwasher, and a ½” hex nut. Remove the nuts and washers from each jack. Place aside. Keep the lockwasher on the jacks.

- ❑ Insert the 6 jacks/lockwashers, with the beveled corner in the **upper right** corner, into the 6 holes. Place the flat washer on the jack, then the hex nut. Hold the jack with one hand on the backside, keeping it 'square'. Tighten the hex nut with a nut driver. NOTE: when tight, not much of the exposed threads of the jack are exposed.

Remember those resistor lead scraps you have been saving? They solder on the IN jacks. Solder the scrap in between the TOP and the BEVELED lugs. Be sure to leave enough space on the beveled lug to attach the coax braid.

You are now ready to attach the pc board to the bracket and then wire up to the panel.

PART #8: ATTACH PC BOARD TO BRACKET/PANEL

- ❑ In the **HARDWARE** bag, locate 4 #6-32 x 3/8 screws, 4 #6 KEPS nuts, and 4 spacers.
- ❑ Locate the mounting bracket. The pc board attaches to the bracket, with the 4 screws threading from the top of the board, through the spacers, through the bracket, and then out the bottom of the bracket. If the bracket has a protective plastic covering, remove it first. The #6 KEPS nuts attach on the **bottom** of the bracket. Note the bracket has 3 large holes on the "flange", where the 3 pots "stick out". The first step is to attach a hex nut (without the washer and outer hex nut) to each pot. Tighten each nut by hand, all the way until it touches the face of the pot. **Then, loosen the nut one-fourth of a turn.**

Attach the pc board to the bracket. You will have to angle the pc board slightly as you insert the 3 pots through the 3 large holes on the flange. Place the 4 spacers over the 4 holes, and thread the screws in from the TOP side. **Loosely** tighten the 4 KEPS nuts on the bottom.

- ❑ **THIS IS A VERY IMPORTANT STEP, SO PAY ATTENTION AND READ ALL OF IT BEFORE PROCEEDING!**
- ❑ Slide the pcb **ALL THE WAY TO THE RIGHT AS FAR AS IT WILL GO**, so that the 3 pot nuts are all *pressing against the flange*. Now, tighten the 4 KEPS nuts on the bracket. The pcb and bracket should be secure, with the pc board snugly against the flange.

Insert the pcb/bracket assembly through the 3 pots holes on the rear of the front panel. As you press the assembly in place, place a washer and hex nut over each pot from the front. Using a hollow-shaft nut driver, tighten each outer hex nut as far as it will go, up against the washer.

PART #9: FINISH WIRING TO THE PANEL

Please read the following instructions carefully. In order to neatly attach the many wires to the front panel components, the wires are soldered in a specific order.

- Now you will solder to the 6 jacks. Each jack has 3 lugs from the rear we will refer to them as LEFT, TOP, and BEVELED. The TOP lug is for the switched contact: this is a NC (normally closed) contact that is opened when a plug is inserted. The resistor lead scraps placed between the TOP and the BEVELED lugs purposely shorts unused inputs to ground. This lowers the noise and the DC offset voltage.
- Solder the coax in J6 to the OUT jack. The braid goes to the **BEVELED** lug. The inner conductor goes to the **LEFT** lug. This is true of ALL coax wires.
- Solder the coax in J4 to IN4.
- Solder the coax in J2 to IN2.
- Solder the coax in J5 to IN5.
- Solder the coax in J3 to IN3.
- Solder the coax in J1 to IN1. Use the remaining tie-wrap to bundle the coax together.
- Rotate all of the front panel pots fully counter-clockwise. Locate the **KNOBS**. Notice each knob has a white line on it. Place the knob on the pot shaft, align the white line to the '0' tick mark, and tighten the hex screw. The silver part of the knob has a protective clear plastic overlay that can be removed if desired. Gently rub with your fingernail across it and it will peel off.

CONGRATULATIONS! YOU HAVE FINISHED BUILDING THE MOTM-890!

All that's left to do is test it! But before we do, please read the following Theory of Operation.

THEORY OF OPERATION

Compared to most other MOTM modules, the MOTM-890 is very simple. There are 2 inverting, summing amps with unity gain (U1A and U1B) and a separate unity gain inverter U2A. The 22pf caps C6 - C8 are used to keep high-frequency overshoots out of the outputs. The OP275 is a special type of op amp: not only is it fast and has low THD for audio, it also has very good DC drift and offset specifications. This is important for summing control voltages.

The gain of each 'channel' is unity. There are 2 pairs of inputs (IN1/IN2 and IN3/IN4) that are added together *before* the panel level control. The fifth input, cleverly named IN5, has it's own level control.

The panel pots used are called 'log' or 'audio taper' pots. These pots have a non-linear resistance versus rotation, because the human ear is non-linear in terms of perceived loudness versus signal amplitude. In other words, making a signal twice as big (say 1V pk-pk to 2V pk-

pk) **does not** make the signal twice as loud. The log pots try to attenuate the signal in such a manner that as you turn the knob, the loudness ('volume') changes smoothly from soft to loud.

The 3 summed and leveled signals are summed by inverting amp U2B. The gain of this stage is $(R13/Rin)$, where for each channel Rin is 10K. Therefore, for each channel, the gain is 0.75 when the panel level control is set to '10' This is just an arbitrary value, chosen so that if you are mixing 3 full-scale outputs (from say 3 VCOs), that the output would be about 10V pk-pk when all 3 pots were at '5' on the panel. Fell free to adjust this value to suit. You may also want IN5 to offer a gain path if needed. A good value is to make R8 a 205K 1% resistor.

In order to reduce DC offset drift, each '+' input on the op amps has a resistor tied to ground. In many other uses, this pin is just tied to ground. However, if the desired result is low DC drift, the impedance the op amp 'sees' needs to be equal on the '-' and the '+' pins.

Note that there are no capacitors in the 'path' of the mixer. You can mix audio as well as DC voltages, even at the same time.

TROUBLESHOOTING

If your MOTM-890 does not work, please verify ALL of the following before contacting us. The following reference directions assume that you are looking at the pc board with the panel to the right and the power connector to the left.

- All of the ICs are pointing the same way and all notches are 'down'.
- The braided wire on the coax goes to the beveled side of the jacks. Check all of the pots and switch wiring.
- The parts are in the right places, you didn't swap the 1K 1% with a 100K 1%.
- No solder shorts or missing joints.

USING THE MOTM-890

The main use of the '890 is to add audio signals, control voltages or both to form a single output. The most common use is to add the outputs from multiple VCOs together before feeding a filter or other processor.

The MOTM-890 is **NOT INTENDED** to replace a standard audio mixer in your studio. Rather, it is a simple module without 'coloration' or EQ.

The only thing to remember is that IN1/IN2 and IN3/IN4 add the signals on the jacks together **before** the level control.

The MOTM-890 is set up to **attenuate only**. You cannot get gain out of this module. See the previous section on changing resistor values if you want gain.

SPECIFICATIONS

MOTM-890 μ Mixer

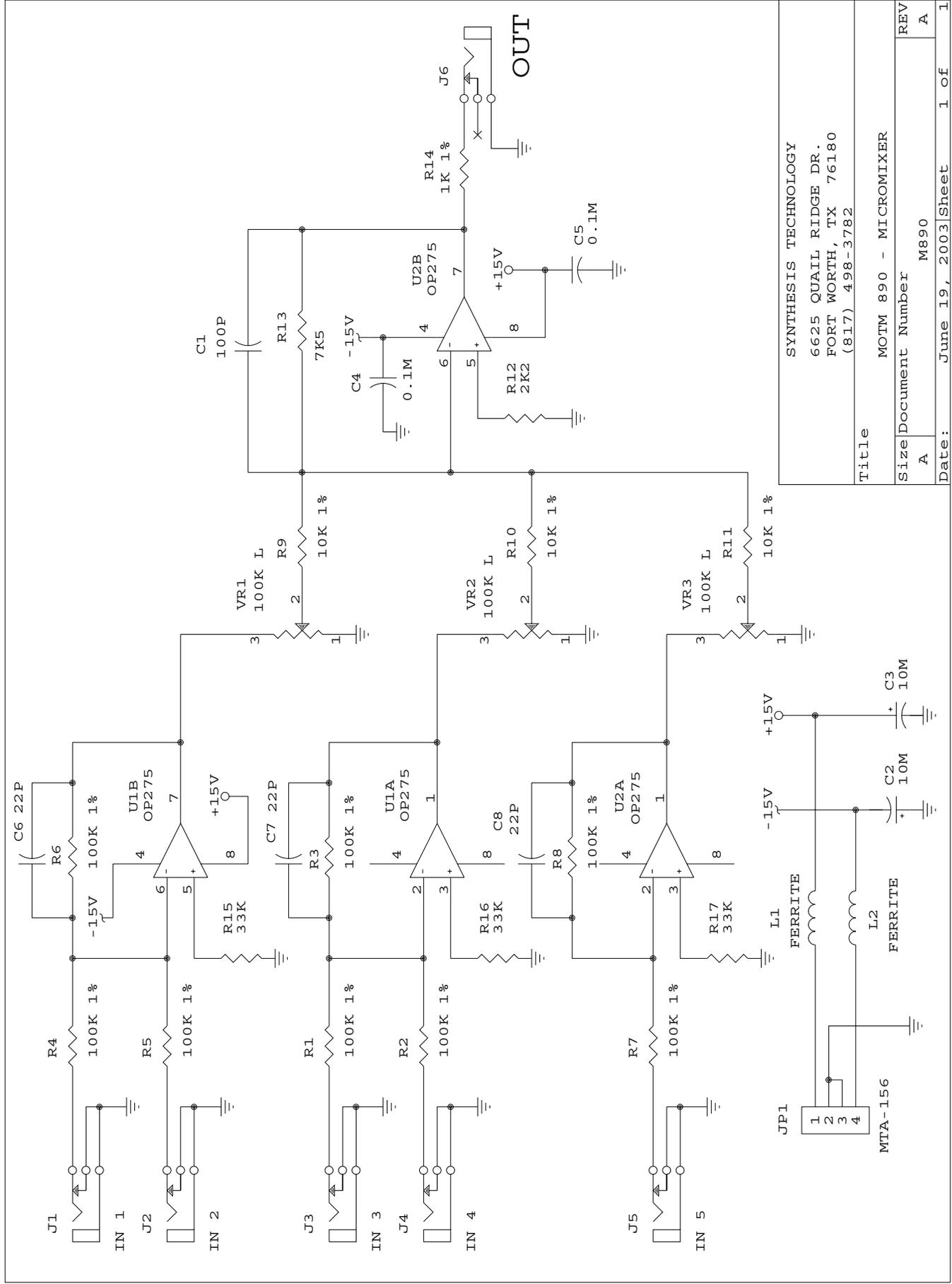
Input signal level (any input)	-7V to +7V
Output level	20V peak-peak before clipping
Output distortion	<0.01% at 1Khz
Output SNR	86dB min.

CONTROLS

IN1-IN2	Attenuator for the sum of IN1 + IN2
IN3-IN4	Attenuator for the sum of IN3 + IN4
IN5	Attenuator for IN5

GENERAL

Power Supply	-15VDC @ 12 ma nominal +15VDC @ 12 ma nominal
Size	1U x 5U 1.72" x 8.72" 44.1mm x 221.5mm
Depth behind panel	4.375 inches (111mm)



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