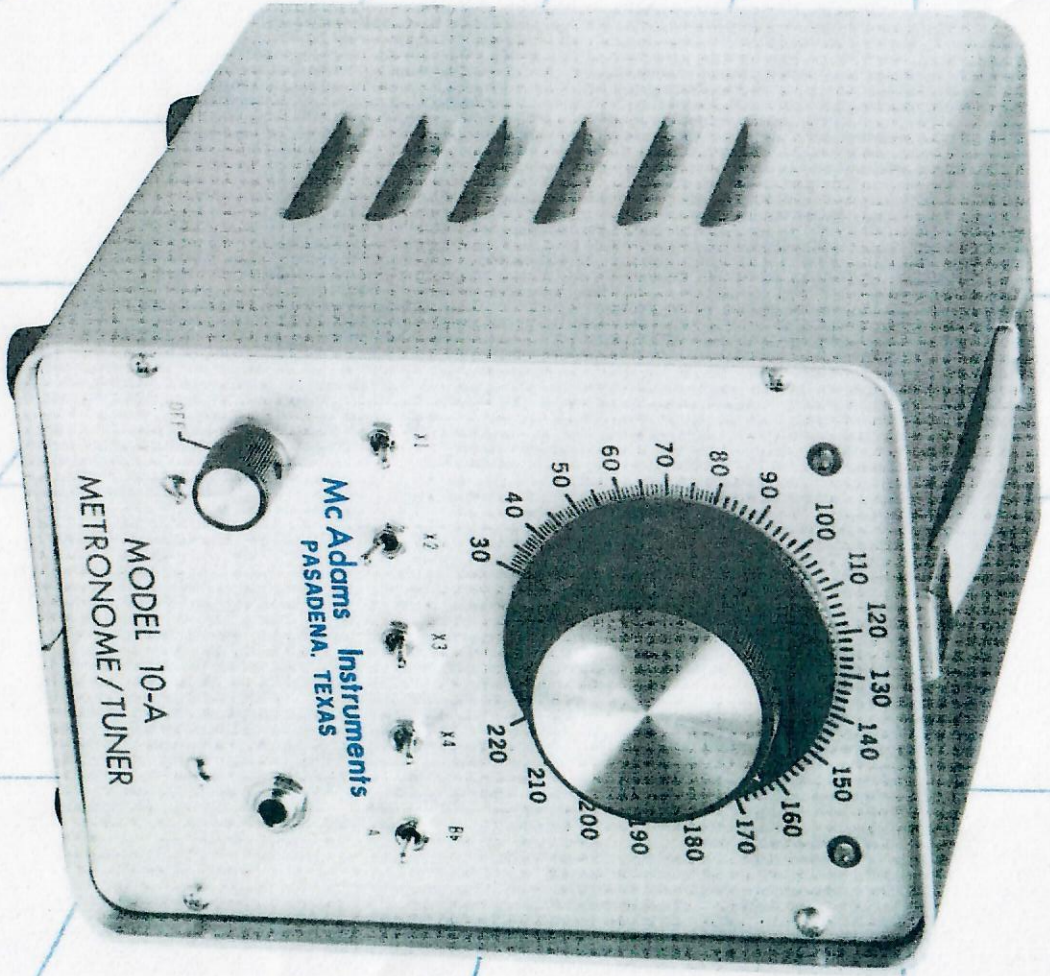
MODEL 10-A METRONOME/TUNER

McAdams Instruments



MODEL 10-A METRONOME/TUNER

The first Model 10-A was built at the suggestion of a high school orchestra teacher. The design was arrived at through talks with professional music educators with considerations given to portability and serviceability as well as to function. The result is an instrument that lasts and is very useful in the classroom. In the more than 15 years since that time, thousands have gone into use in schools all over the country.

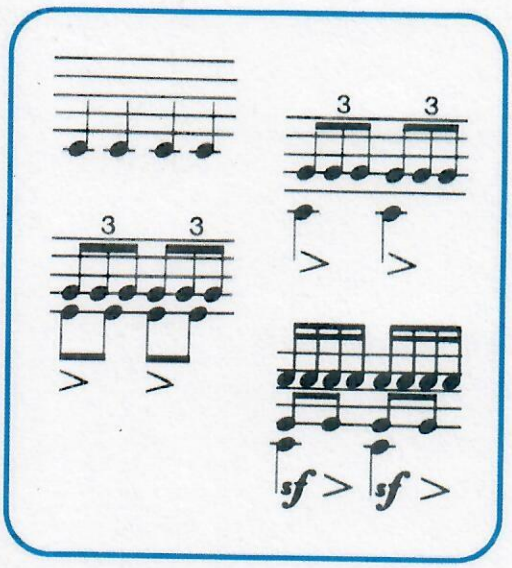
The MODEL 10-A is built to be used by professionals on the road or by students in the classroom. Its small size and aluminum case make it conveniently portable and it has no moving parts except for the controls and switches. It's built to take the abuse that any portable unit encounters.

The Model 10-A is easy to use. You can select the metronome or the tuner with the function switch.

Metronome

With the function switch in the middle position, the machine functions as a metronome. The metronome is continuously variable from 30 to 220 beats per minute by the use of a single knob. With the switches labeled x1, x2, x3, and x4 you can control the output of the metronome and produce one, two, three or four notes per beat. When a switch is down, the note controlled by that switch is not produced. Any combination of these switches can be up at one time to produce various rhythms. The illustrations show four of the fifteen combinations.

Sound produced by the metronome is pleasing to the ear–not like the beep of a computer game, but more like wood blocks or gourds.



Tuner

Tuning notes are produced when the function switch is moved up or down, for A (440) or B♭ (466.16). These tuning notes are accurate to within 0.17 cent and can, therefore, be used to check the calibration of other tuning devices you may have. The timbre of the tuning notes includes a controlled amount of overtones. This gives them tonal "color" which allows the notes to blend with most instruments for easy tuning.

Amplifier

The MODEL 10-A has an internal amplifier and speaker capable of 25 watts peak power, making it useful with relatively large groups. For more volume, a jack is provided on the front panel which allows you to connect the MODEL 10-A to another amplifier.

Weight: 6 lbs. (2.7 kg)
Size: 6"W x 8"H x 10"L

McAdams Instruments • P.O.Box 3465 • Pasadena, Texas 77501 • TEL (713) 941-6394 • FAX • (713) 664-6861

GENERAL DESCRIPTION

The Model 10-A is a dual purpose instrument. Its primary use is that of a metronome. However, it will do much more than a standard metronome.

The "old standby" in metronomes is typically a small mechanical timer utilizing a variable-length pendulum to produce a tapping sound at rates which span the normal tempos used in music. The Model 10-A differs from this in several ways.

The Model 10-A is all electronic and does not depend upon mechanical devices to produce the sound or regulate its tempo. It is more accurate in its calibration than most other types of metronomes.

However, the biggest difference between the Model 10-A and other metronomes is that the Model 10-A can play certain simple rhythmic patterns. In addition to producing klopping sounds at the basic tempo selected by the tempo control, the Model 10-A can also produce klopping sounds at twice, three times, and four times that tempo. These are all synchronized so that a "klop" from the basic beat always coincides exactly with "klops" from the other tempos.

In addition to its function as a metronome, the Model 10-A can also produce the most common tuning notes used by orchestras and bands. These are A (440.00) and B♭ (466.16). The pitches of these notes are controlled by quartz crystal oscillators resulting in a much more accurate pitch than the more common devices such as tuning forks or pitch pipes.

The quality of the sound produced by the Model 10-A is another

area in which it differs from other devices. The wave shape of the klopping sounds produced by the metronome was specifically chosen to be musically pleasing. The sound for each rate has a definite tonal center and is easily distinguishable from the others. The sound produced by the tuner is processed in such a manner that it contains both even and odd harmonics in proportions similar to most musical instruments. Due to its harmonic content, the sound produced by the Model 10-A blends well with most musical instruments and is easy to tune to. Very often, tuners, particularly electronic tuners, produce waves which have very low harmonic content. These tuners are difficult to tune to.

Finally, the Model 10-A has a much more powerful output than is usual for an instrument of this type. For this reason it is useful with small bands or orchestras. It is not restricted to use by one or two individuals the way a standard metronome or tuning fork is.

FUNCTIONAL DESCRIPTION: METRONOME MODE

The more complicated of the two modes of operation is the metronome mode. In the upper left hand corner of the block diagram is a block labeled "mode selector". When the function switch is set in the metronome position, the only output line from the mode selector that is active is line X, the metronome line. The A and B♭ lines, and the tuner line, labeled Y, are all inactive. This causes gate 1 to be closed and gate 2 to be open. In this mode, the variable frequency oscillator feeds a signal through gate 2 into frequency divider number 2. The output of frequency divider number 2 is at

afrequency of twelve times the rate selected by the main tempo control. This is indicated by the designation 12f on the block diagram. This frequency will be processed by the following circuits to produce four rates: the rate shown on the tempo control dial, twice that rate, three times that rate, and four times that rate.

Frequency divider number 3 divides the 12f signal by four to produce 3f. Frequency divider number 4 divides the 12f signal by 3 to produce 4f. Frequency dividers 5 and 6 then divide the 4f signal twice (each time by 2) to produce 2f and f. These four different waves are then fed into five pulse generators. These are circuits which produce a short output pulse for every cycle of the input wave. You will notice that divider number 6 has two pulse generators connected to it. One is similar to the first three, while the other is connected to a different type circuit. When in the metronome mode, the bottom pulse generator is used to send a synchronization pulse back to frequency divider number 3. This synchronization pulse insures that a times 3 pulse will always occur at the same instant as a times 1 pulse. The times 4 and the times 2 stay synchronized with the times 1 pulse naturally by virtue of the way the frequency dividers operate.

The outputs of the top four pulse generators feed through front panel switches into the four section gate. These front panel switches are for the purpose of selecting which pulse rate should be allowed to produce sounds from the metronome. For instance, if all switches are open except the times 1 switch, the metronome will simply klop at the rate selected by the tempo dial. In the metronome mode, the four section gate allows any of the four inputs to pass to its respective output. Each of these outputs has a sound generator connected to it which produces a wave which sounds simi-

lar to a hollow wooden block being struck with a stick. The only difference between the four sound generators is that each is tuned to a different frequency simulating blocks of different sizes. The outputs of all four sound generators are then mixed together and fed into the power amplifier where the volume control is located. It will drive a speaker or an external amplifier. There is no signal being fed into the power amplifier from the filter (while in the metronome mode) due to the fact that gate 3 is closed by the inactive state on the Y control line.

FUNCTIONAL DESCRIPTION: TUNER MODE

When the mode selector is in either the A or B♭ tuner mode, the states of the tuner and metronome control lines are reversed. Specifically, the tuner line, line Y, is active while the metronome line, line X, is inactive. Also, either the A or B♭ crystal oscillator is enabled and feeds a signal to frequency divider number 1. This frequency is divided by a factor of 256 and fed through gate number 1. Gate number 2 is closed, thereby shutting out any signals from the variable frequency oscillator. The signal from gate number 1 is then fed into frequency divider number 2, and from there into frequency dividers number 4, 5, and 6. This results in a total division factor of 12,288. In this mode the frequency present on the line labeled f will either be 440 Hz for A, or 466.16 Hz for B♭. The bottom pulse generator puts out short pulses at the same frequency as the input wave form which are then fed through gate 3 to the filter. The wave form at the input of the filter contains a very high harmonic content (these harmonics

are essential for ease in tuning musical instruments. However, they are very harsh to the ear in the proportions that are present at the input to the filter). The filter is a low pass filter which attenuates but does not eliminate the higher harmonics. The frequency response of this filter is adjusted to losely imitate the harmonic structure of most musical instruments. The filter output then feeds into the power amplifier in the same manner as the metronome did. No sounds are fed into the power amplifier from the sound generators due to the fact that control line X causes the four section gate to be closed.

The last remaining section on the block diagram is the regulated power supply. This takes 110v AC power from the wall socket and converts it to the various voltages utilized by the electronics. These voltages are electronically stabilized so that minor variations in input voltage will have no effect on the operation of the circuit.

ADJUSTMENT

There are two types of adjustments that have to be made in the 10-A. The cloppers have to have a frequency adjustment and the metronome must be set to the proper rate as indicated on the main dial.

Clopper Adjustment

Two types of field adjustments are possible. The quickest requires someone to have a "good ear". To tune by ear, note that the four cloppers are tuned to the notes of a major chord. The interval between x1 and x2 is a third; x1 and x3 is a fifth; and x1 and x4 is an octave. Listening to two cloppers at a time, adjust R28, R36, and R40 for the proper intervals.

An oscilloscope can also be used if adjustments must be made without a trained ear.

Set the scope up to be triggered by the rising edge of the pulse at the collector of Q6 or the falling edge of the waveform at pin 12 of IC6. This will trigger the scope once each quarter note. (Set the rate dial at 120 BPM or more for easier measurments.) Accurately line the trace up with the horizontal line in the center of the screen. This line should have markings at least every 0.2 cm.

With the trace accurately centered vertically, display the waveform at pin 7 of IC9. Ignore the first cycle. Set the sweep speed so that the second cycle can be accurately measured (4 cm is a convenient value for its period). All other cloppers are set by making their period a certain fraction of the period of the x1 clop.

To set x2, examine the waveform at pin 7 of IC8. Again ignoring the first cycle, adjust R36 until the period is exactly 0.8 times the period which was measured at pin 7 of IC9 (the x1 clop).

To set x3, examine the waveform at pin 1 of IC9. Again ignoring the first cycle, adjust R28 until the period is exactly 0.67 times the period which was measured at pin 7 of IC9 (the x1 clop).

To set x4, examine the waveform at pin 1 of IC8. Again ignoring the first cycle, adjust R40 until the period is exactly 0.5 times the period which was measured at pin 7 of IC9 (the x1 clop).

This completes the adjustments of the cloppers. Go back and confirm that the measurements are correct and that the scope did not drift. When the adjustments are correct place a small dab of fingernail polish on the potentiometers to secure them in place. This is a difficult adjustment to make on a scope and should only be done when it is necessary, not routinely.

Metronome Rate Adjustment

The metronome rate can be done with a stop watch or a frequency counter. The best and fastest way is to use a counter which can measure the period of the waveform, otherwise a 10 second count is necessary.

To calibrate using a stop watch do the following:

1) Set the dial at 60 BPM and listen to the x1 and x4 cloppers. (x4 helps to synchronize the stop watch.) Start the watch running exactly on a x1 beat giving that beat a count of zero. Count the x1 beats and stop the watch exactly on the count of 30. Adjust R9 until this procedure yields a watch time of 30 + or - .4 seconds. (Using longer counts such as 60 yields more accurate results if you have the time.)

2) Set the dial to 180 BPM and listen only to the x1 clopper. Start the watch exactly on a beat giving that beat a count of zero. Count in the following fashion: "0 2 3, 1 2 3, 2 2 3, 3 2 3, 4 2 3, 5 2 3, 6 2 3, etc." You count as if you were counting the measures in a waltz. Stop the watch exactly on the count of 30. Adjust R11 until this procedure yields a time of 30 + or - .4 seconds. (As before, longer counts yield more accurate results.)

3) These adjustments interact with each other so it is necessary to repeat steps 1 and 2 until both measurements are accurate without making any changes in R9 or R11.

To calibrate using a frequency counter do the following:

1) Set the counter up to measure period in microseconds or to give a 10 second count of frequency. The counter can be connected to the collector of Q1 or to pin 11 of IC2, whichever gives the most stable results on your counter.

2) Set the dial to 60 BPM and adjust R9 to give 20,833 + or - 20 microseconds (or 48.0 + or - 0.2 Hz).

3) Set the dial to 220 BPM and adjust R11 to give 5682 + or - 10 microseconds (or 176.0 + or - 0.2 Hz).

4) These controls interact with each other so it is necessary to repeat steps 2 and 3 until the proper measurements are obtained without making any changes to R9 or R11.

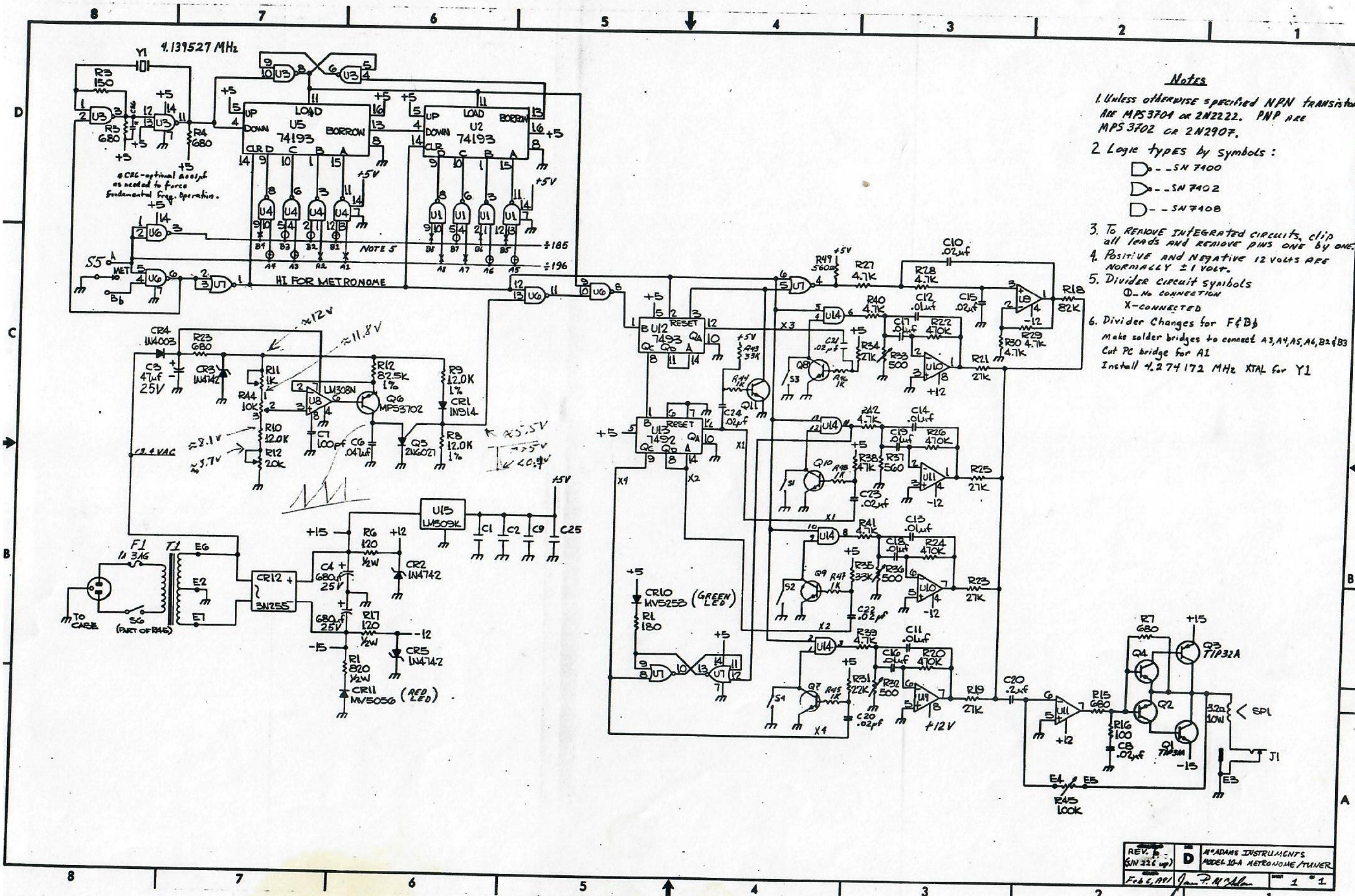
This completes the adjustment of the metronome. It should be done with the unit warmed up and in its operating position in still air for best results. However, this will only affect the accuracy by less than 1%.

20833
10416
6944

TROUBLE SHOOTING GUIDE

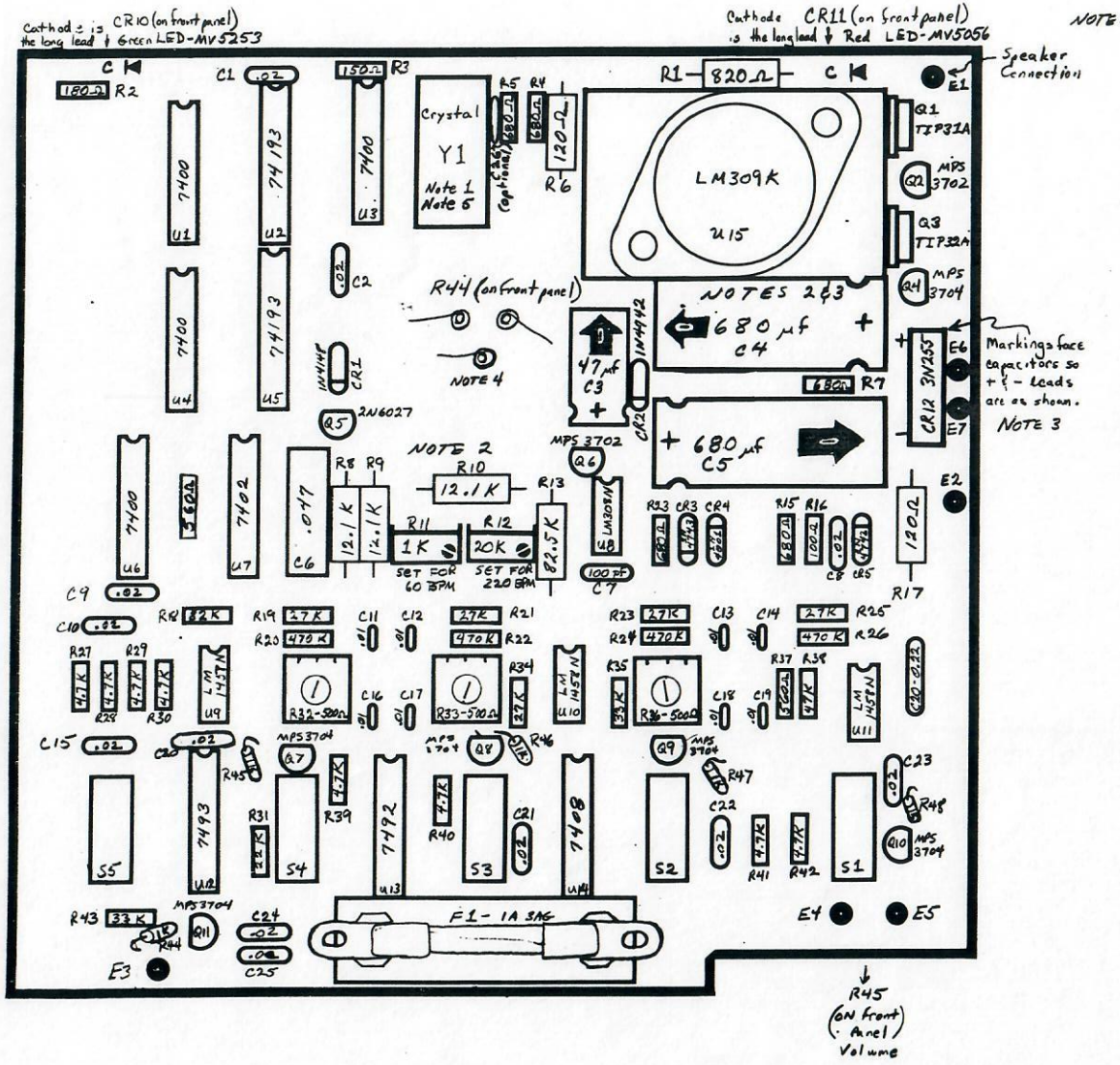
This describes some problems that have occurred before with enough frequency to justify special attention.

Symptom	Possible Cause	Cure
1) Loud 120 Hz hum when the unit is on.	Shorted output transistor.	TURN IT OFF! This can destroy the speaker. Insert an open jack into J1 to disconnect the speaker then confirm the problem. (speaker connection will be + or - 15V and pin 1 of IC10 will be at 10V but the opposite polarity.) Replace Q2, Q12, Q10, and Q13. (Changing fewer transistors is risky.)
2) Distorted sound, low volume, squeal occurs with high volume settings.	Output transistor collector shorted to the heat sink.	Turn it off and insert the jack as above. Carefully confirm the problem. This will cause a blown output stage if allowed to persist.
3) Loud squeal at high volume settings.	Loose mounting screws on IC11.	These screws are part of the electrical circuit, confirm that they are tight using a screw driver and a 1/4" socket or nut driver.
4) Metronome rate is too fast and cannot be adjusted within limits.	Q11 might be leaky.	Replace Q11. (Its collector current in normal operation is only a few microamps.)
5) Clops are present for all four switches but not the proper number (IE, x3 may put out 2 clops per beat.)	IC6 is not doing its job.	Some 7492's (especially TI SN7492N's) won't work in this circuit. Replace IC6. Sometimes, the problem will exist with an entire batch of 7492's.



Notes

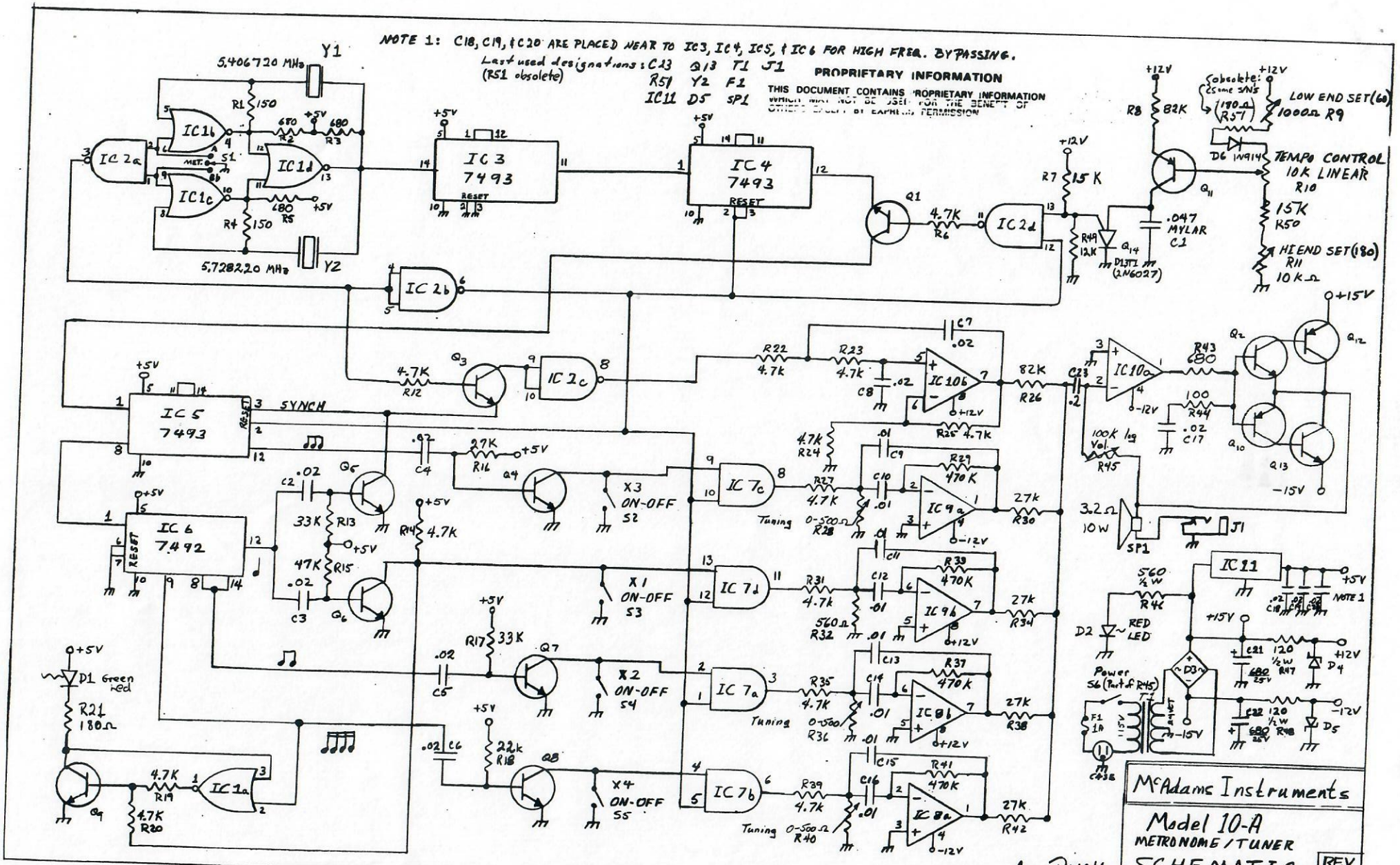
1. Unless otherwise specified NPN transistors are MPS3704 or 2N2222. PNP are MPS 3702 or 2N2907.
2. Logic types by symbols:
   - SN 7400
   - SN 7402
   - SN 7408
3. To remove integrated circuits, clip all leads and remove pins one by one.
4. Positive and negative 12 volts are normally ±1 volt.
5. Divider circuit symbols
   - ⊕ No connection
   - X Connected
6. Divider Changes for F & B♭
   - Make solder bridges to connect A3, A4, A5, A6, B2 & B3
   - Cut PC bridge for A1
   - Install 4.274172 MHz XTAL for Y1



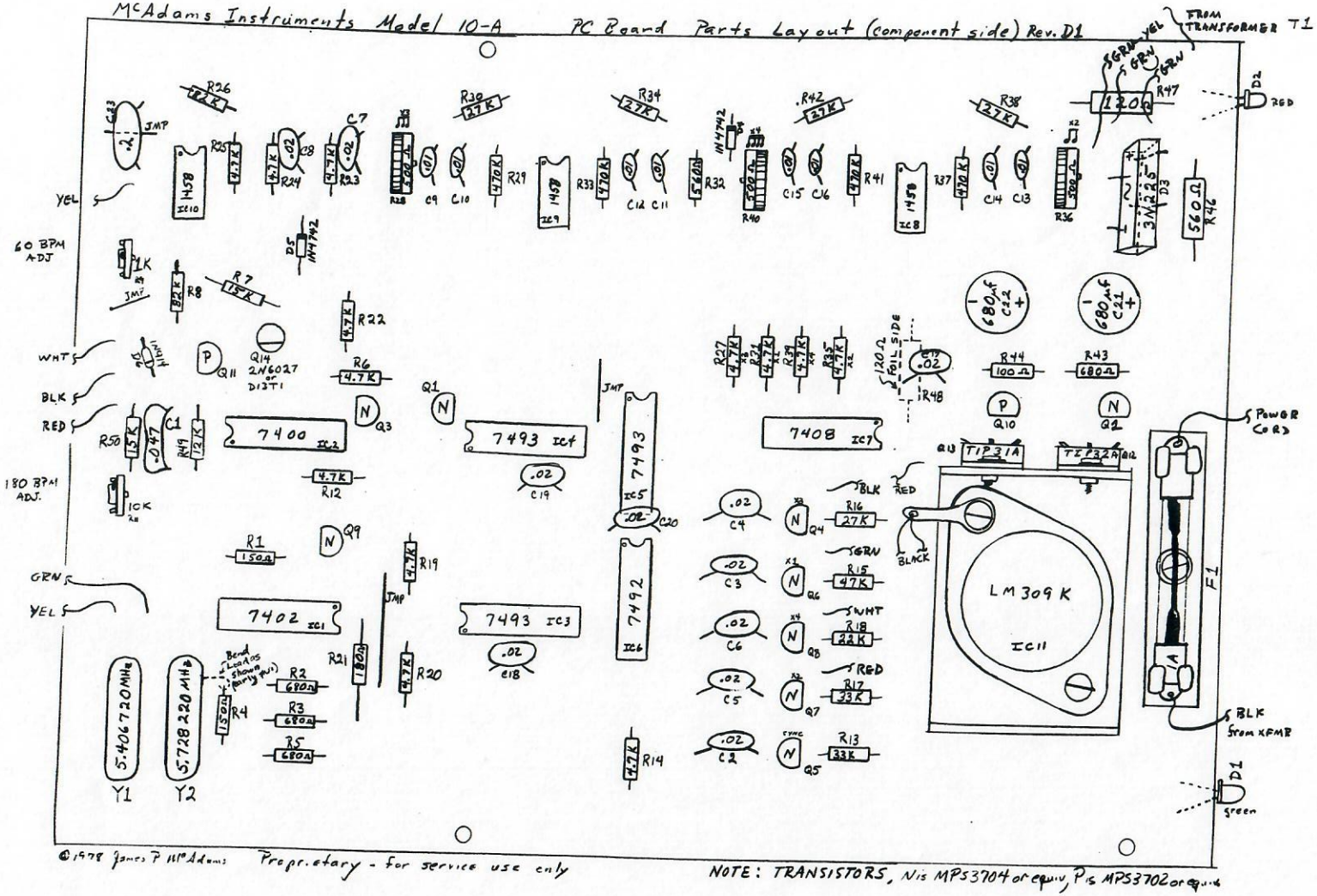
NOTES:

1) Take care that crystal leads tin properly. They are difficult.
2) Mount so that component values are visible.
3) Electrolytic capacitors will explode if installed backwards.
4) Take care that the jumpers to R44 (rate pot) do not get soldered to the inside of the plated through holes.
5) Leave a space of about 1/16 inch between the crystal and the PC board. DO NOT mount flush w/ PC board.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES .XX ± .XXX ±	CONTRACT NO.	McADAMS INSTRUMENTS
MATERIAL	APPROVALS / DRAWN / CHECKED	DATE / 4 Dec 86	COMPONENT OVERLAY AND ASSEMBLY DRAWING
FINISH	ISSUED	SIZE C / FSCM NO. / DWG. NO. AY-080880 / REV. 6
DO NOT SCALE DRAWING		SCALE 2:1 / SHEET 1 OF 1



Note: There are several versions of this same basic circuit. If you have a problem call 713-661-7178 (as of 2-84).

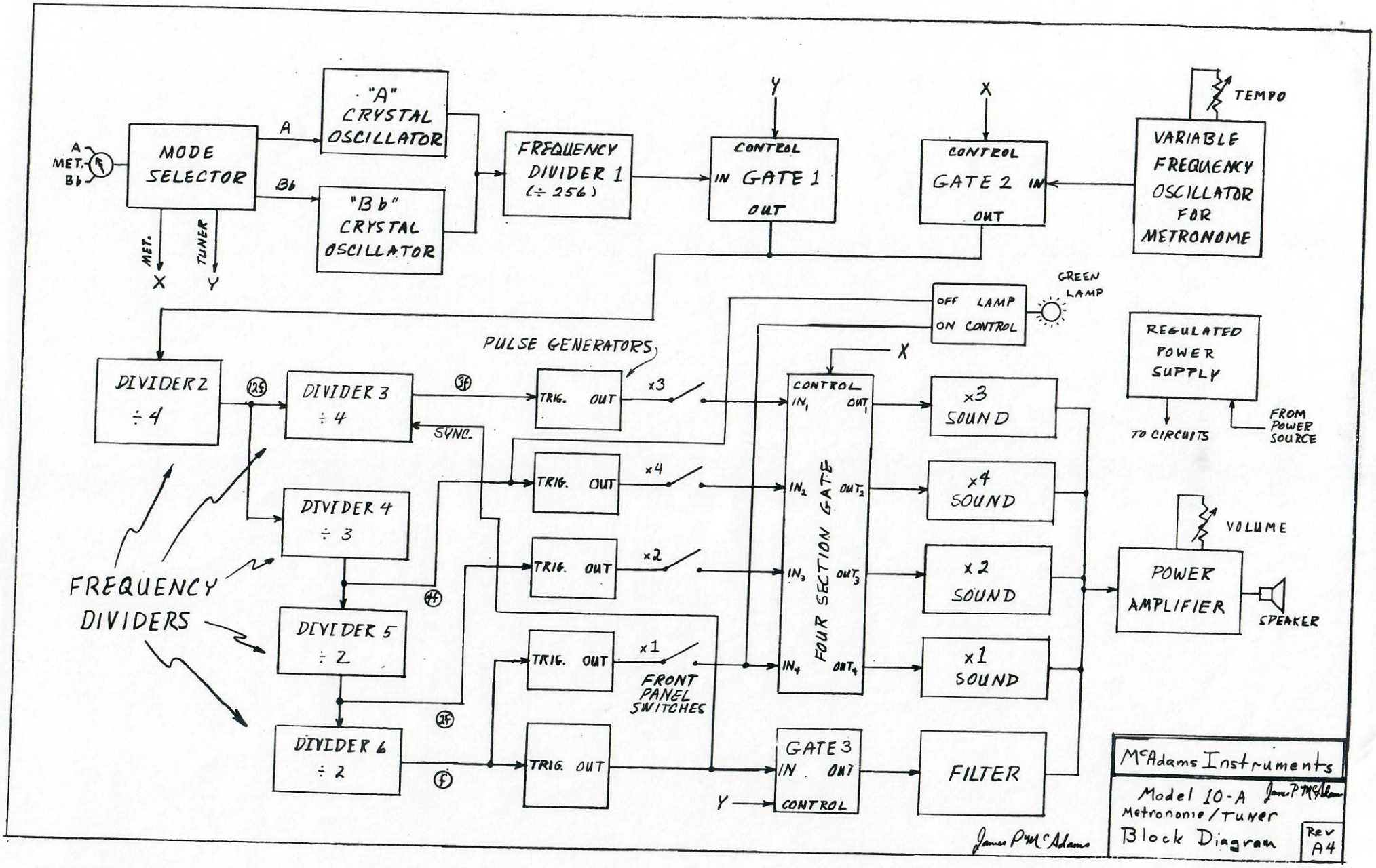


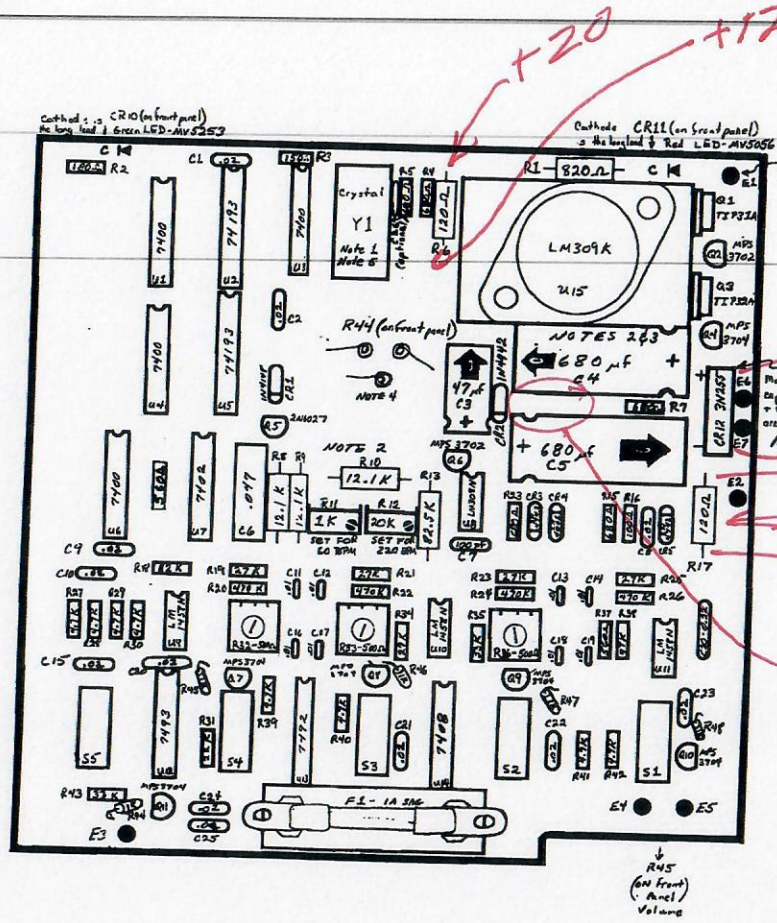
NOTE: TRANSISTORS, N is MPS3704 or equiv, P is MPS3702 or equiv

McAdams Instruments Model 10-A

PC Board Parts Layout

27 APRIL 78 | REV. D1 23 MARCH 80


A
MET.
Bb
MODE SELECTOR
A
Bb
"A" CRYSTAL OSCILLATOR
"Bb" CRYSTAL OSCILLATOR
MET.
TUNER
X
Y
FREQUENCY DIVIDER 1 (÷ 256)
Y
CONTROL IN GATE 1 OUT
X
CONTROL GATE 2 IN OUT
TEMPO
VARIABLE FREQUENCY OSCILLATOR FOR METRONOME
OFF LAMP ON CONTROL
GREEN LAMP
PULSE GENERATORS
REGULATED POWER SUPPLY
TO CIRCUITS
FROM POWER SOURCE
DIVIDER 2 ÷ 4
DIVIDER 3 ÷ 4
DIVIDER 4 ÷ 3
DIVIDER 5 ÷ 2
DIVIDER 6 ÷ 2
SYNC.
TRIG. OUT
x3
x4
x2
x1
FRONT PANEL SWITCHES
CONTROL IN1 OUT1 IN2 OUT2 IN3 OUT3 IN4 OUT4
FOUR SECTION GATE
x3 SOUND
x4 SOUND
x2 SOUND
x1 SOUND
VOLUME
POWER AMPLIFIER
SPEAKER
GATE 3 IN OUT CONTROL
FILTER
FREQUENCY DIVIDERS
McAdams Instruments
Model 10-A
Metronome/Tuner
Block Diagram
Rev A4
James P. McAdams



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+20

-20

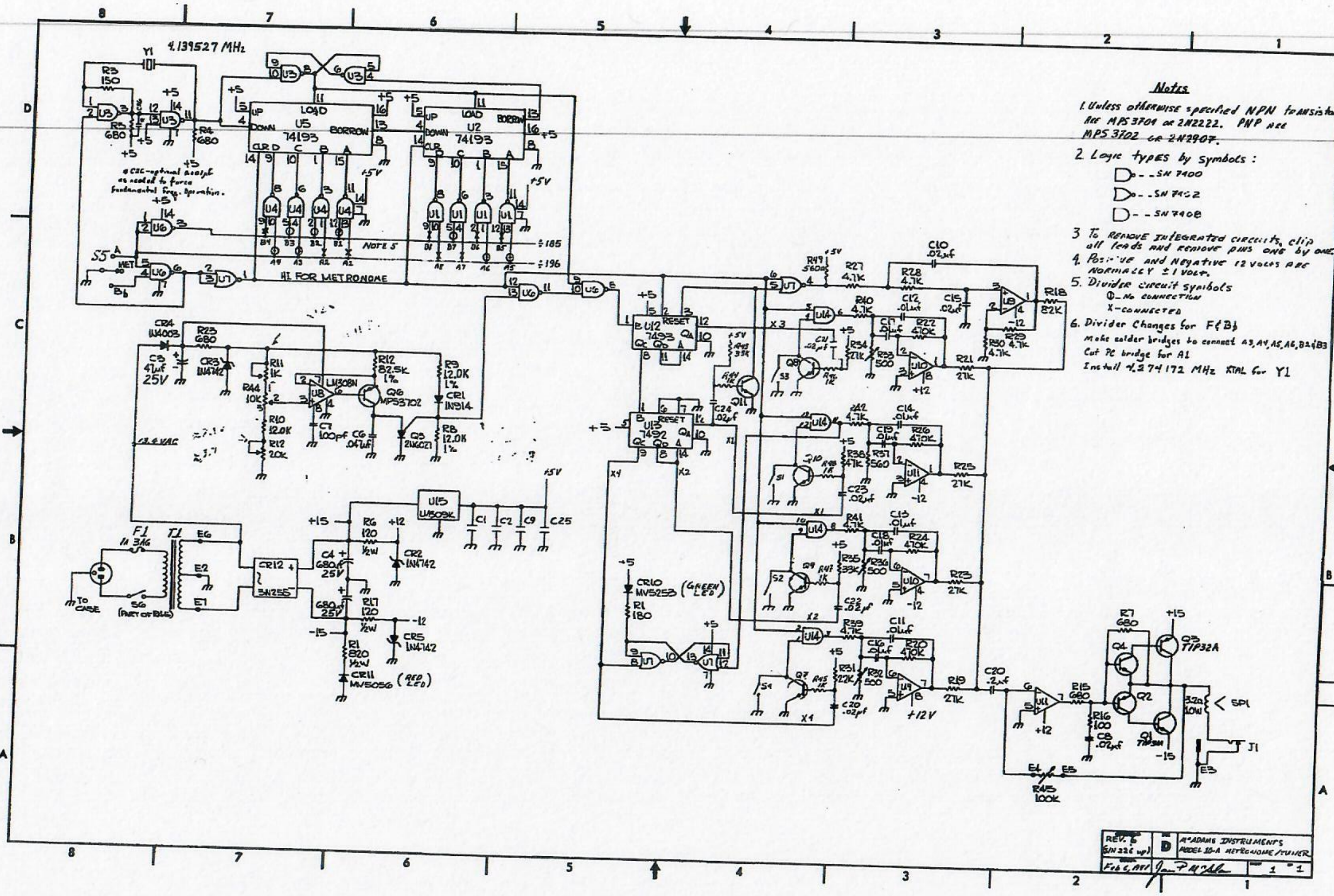
-20

This resistor sometimes opens & kills the -12

-12

on the ones with the small extra board R6 is in between the 2 capacitors.

DO NOT SCALE DRAWING		McAdams Instrument
		Component Overlay and Assembly Drawing
		SIZE C · FSCM NO. · DWG. NO. AY-010880 · REV 6
		SCALE 2:1 · SHEET 1 of 1



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Feb 6, 1981	Jim P McAdams	1 of 1