ASSEMBLING YOUR SCIENCE WORKSHOP SPECTRUM ANALYZER, MONITOR RECEIVER

This project has grown substantially over the past few years. It started out with 2 modules. We are now up to about 10, with no end in sight! Figure 1 is an attempt to pull everything together. However, it should only represent a starting point, since most of you will have better ideas on how you would like to combine the individual modules for your own application. There is no "best" way. For example, you might want to add a calibrated attenuator ahead of the tuners, another deck on the switches to operate LED's to indicate the selected functions, or to break up the 500MHz range on the center frequency control into 10 equal parts, by using a voltage divider made up of 10 equal value resistors in series, with the center frequency control switched across only one tenth of the voltage, acting as a fine tuning control.

Since any calibration would be performed after the project has been completely assembled, you can select components whose values may not be exactly the same as the ones I've specified. None of the resistor or capacitor values are critical. 20% substitutions are acceptable. This applies especially to the values of the controls. For example, the value of the RF Gain control for the UHF tuner can be any value that doesn't draw excessive current from the B + supply, since the control is only acting as a voltage divider. Any value over 5K should work well. The same thing applies to most of the other controls. Try what you have in your "junk box" before you go out to buy a part.

S1 switches between Analyzer and Receiver Modes and inserts a audio noise filter into the "tune" line. The 1 Meg resistor and the .1 Mfd capacitor should be added to the circuit. S2 switches between the 2 or more tuners.

CONSTRUCTION.

1.) The power supply is the logical starting place, since nothing can be checked out without it. Five levels of voltage are required, 30, 24, 18, 12 and 5 volts. The 5 and 18 volt levels must be regulated. The supply should be able to deliver 200 ma., or 300 ma. if the tracking generator is added.

Since the sensitivity of this instrument is in the order of microvolts (the same as a modern TV set), it is important that the input of the tuner be protected from strong signals. This means shielding and using attenuators on the input if the analyzer is to be used in a high RF environment. Transmitter output can be checked using an in-line impedance matching pad with a tap, which will feed a small sample of the transmitter's output to the analyzer.
NOTE: You MUST complete the basic analyzer (Main Board, Ramp Board & Tuner) and be sure it is working properly BEFORE you

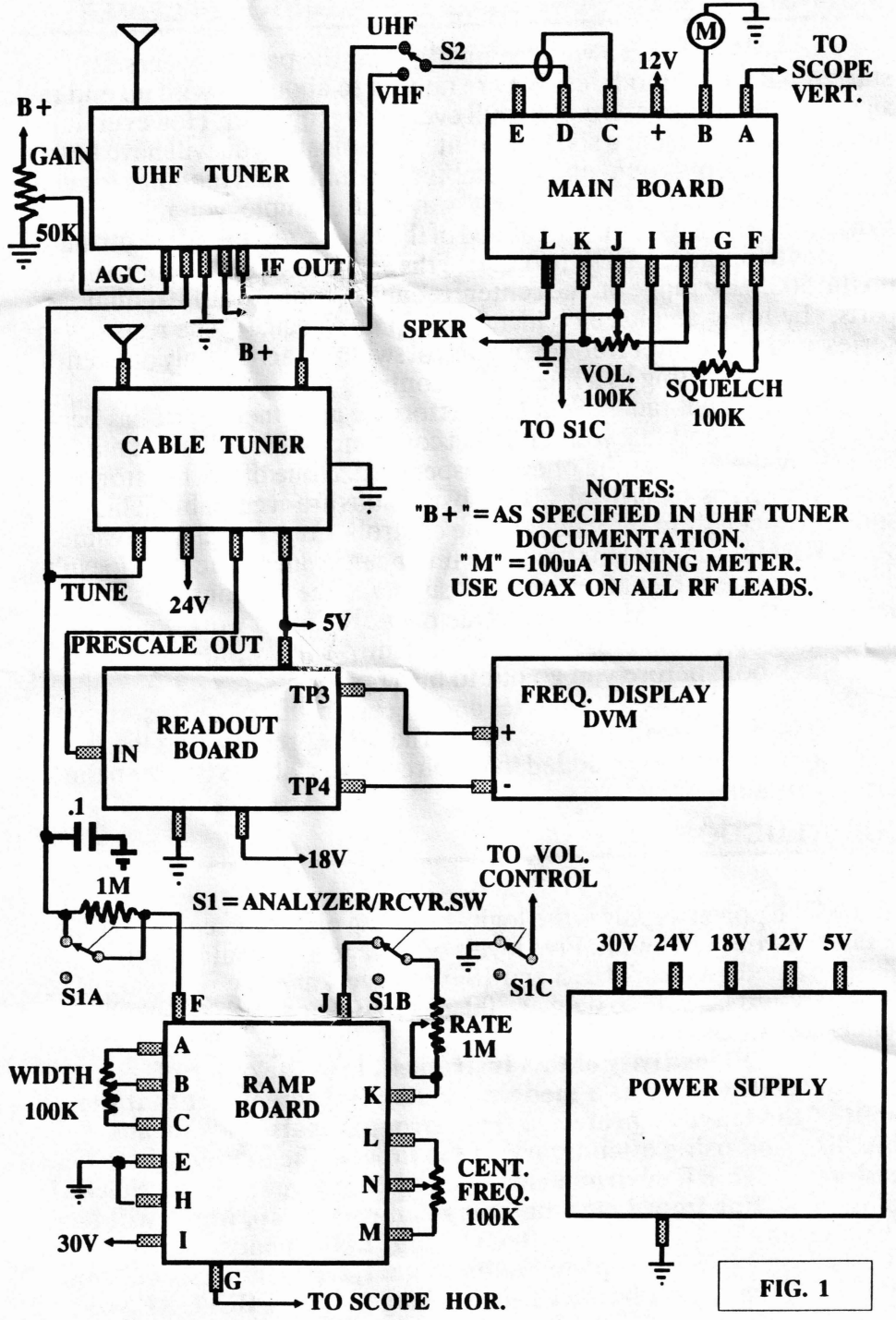

UHF
S2
VHF
12V
M
TO SCOPE VERT.
B+
GAIN
50K
UHF TUNER
AGC
IF OUT
E D C + B A
MAIN BOARD
L K J I H G F
SPKR
VOL. 100K
SQUELCH 100K
TO S1C
B+
CABLE TUNER
NOTES:
"B+" = AS SPECIFIED IN UHF TUNER DOCUMENTATION.
"M" = 100uA TUNING METER.
USE COAX ON ALL RF LEADS.
TUNE
24V
5V
PRESCALE OUT
TP3
READOUT BOARD
IN
TP4
FREQ. DISPLAY DVM
+
-
.1
1M
18V
TO VOL. CONTROL
S1 = ANALYZER/RCVR.SW
S1A
S1B
S1C
F
J
RATE 1M
WIDTH 100K
A
B
C
E
H
I
RAMP BOARD
K
L
N
M
CENT. FREQ. 100K
30V
G
TO SCOPE HOR.
30V 24V 18V 12V 5V
POWER SUPPLY

FIG. 1

add any other assemblies!! Checking out each assembly individually, and then interconnected, assures success in the final assembly, plus an understanding of the principles involved.

2.) **Testing the tuner and ramp board circuits using a TV set.** Wire the Ramp Board circuit and interconnect the power supply, Ramp Board and tuner. Open switch S-1 on the ramp board circuit. This puts the system in the "receive" mode by disabling the ramp generator. Connect the "IF" output of the tuner to the TV's VHF antenna input. Set the TV's tuner to channel 3. The "center frequency" control should now permit operation of the TV with the analyzer's tuner serving as a substitute TV tuner. This test assures us that the tuner, ramp board and power supply are working.

3.) Follow assembly and testing instructions packed with the Main Board, UHF Tuners, Digital Readout Board and Tracking Generator, etc.

MAIN BOARD SW-6006 (Rev.1) ASSEMBLY INSTRUCTIONS

(Refer to board drawing and parts list on page 4.)

1.) Install 13 resistors in locations indicated.

2.) Install 15 capacitors as indicated. (Observe polarity of C6 and C7).

3.) Install FL1, FL2 and FL3. These 3-lead devices are symmetrical and can be installed either way.

4.) Install 3 inductors (L1 thru L3) as indicated. Leads may have to be bent slightly to line up with the hole patterns. L2 is a two hole balun. Install with twisted lead towards IC1.

5.) If you haven't had much experience working with IC's, install sockets for the 3 chips. They have all been tested before being shipped. Handle them carefully! Install them in the locations indicated.

7.) Check your work carefully for excess solder, splashes, shorts or "cold" solder joints. This completes the assembly of the Main Board.

MAIN BOARD TEST AND ALIGNMENT PROCEDURE

(Note: The Tuner and Ramp Board should have been interconnected and tested before the following steps are performed.)

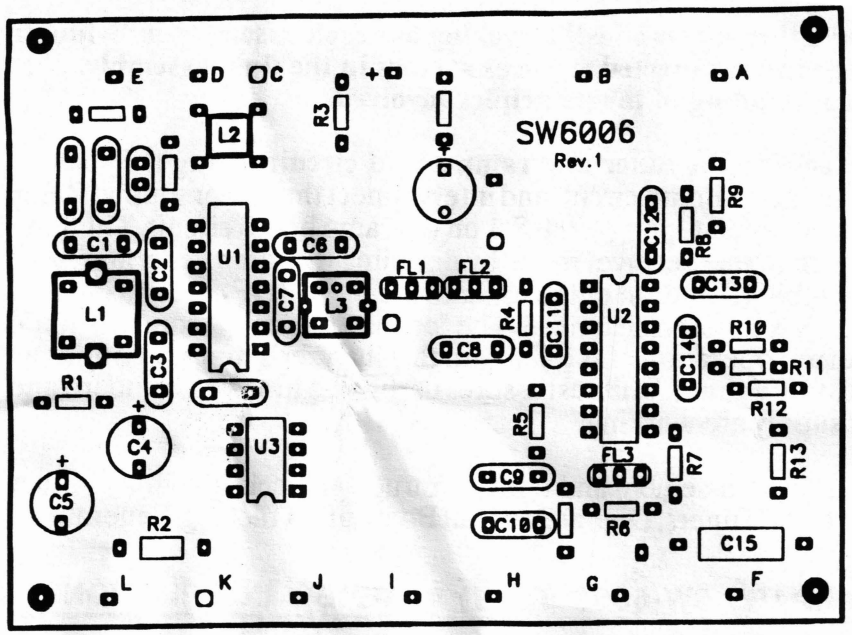
1.) Install jumper (or 100 uA meter) from "B" to ground.

2.) Connect scope vertical input between "A" and ground.

3.) Connect "C" and "D" to IF output of Tuner.

4.) Connect a ground lead between the Tuner, the Ramp Board (E) and the Main Board (K).

5.) Connect a 12 volt supply between " +" and ground. (Board should draw approximately 35 mA.)



CAPACITORS	RESISTORS	INDUCTORS
C1 16pf	R1 120 brn, red, brn	L1 black*
C2 33pf	R2 10 brn, blk, blk	L2 Balun
C3 16pf	R3 120 brn, red, brn	L3 pink*
C4 220mfd	R4 330 org, org, brn	
C5 220mfd	R5 3.3k org, org, red	*core color
C6 .01mfd	R6 10k brn, blk, org	L1 can be installed either of
C7 20pf	R7 2.2k red, red, red	two ways, both correct.
C8 .01mfd	R8 10k brn, blk, org	
C9 .01mfd	R9 33k org, org, org	
C10 .1mfd	R10 3.3k org, org, red	
C11 .01mfd	R11 470 yel, viol, brn	**FILTERS**
C12 .01mfd	R12 120 brn, red, brn	FL1, FL2, FL3 10.7MHz
C13 .001mfd	R13 20k red, blk, org	
C14 .01mfd		**IC's**
C15 .22mfd	Values can vary +-20%	U1 SO42P
		U2 LM3089
		U3 LM386

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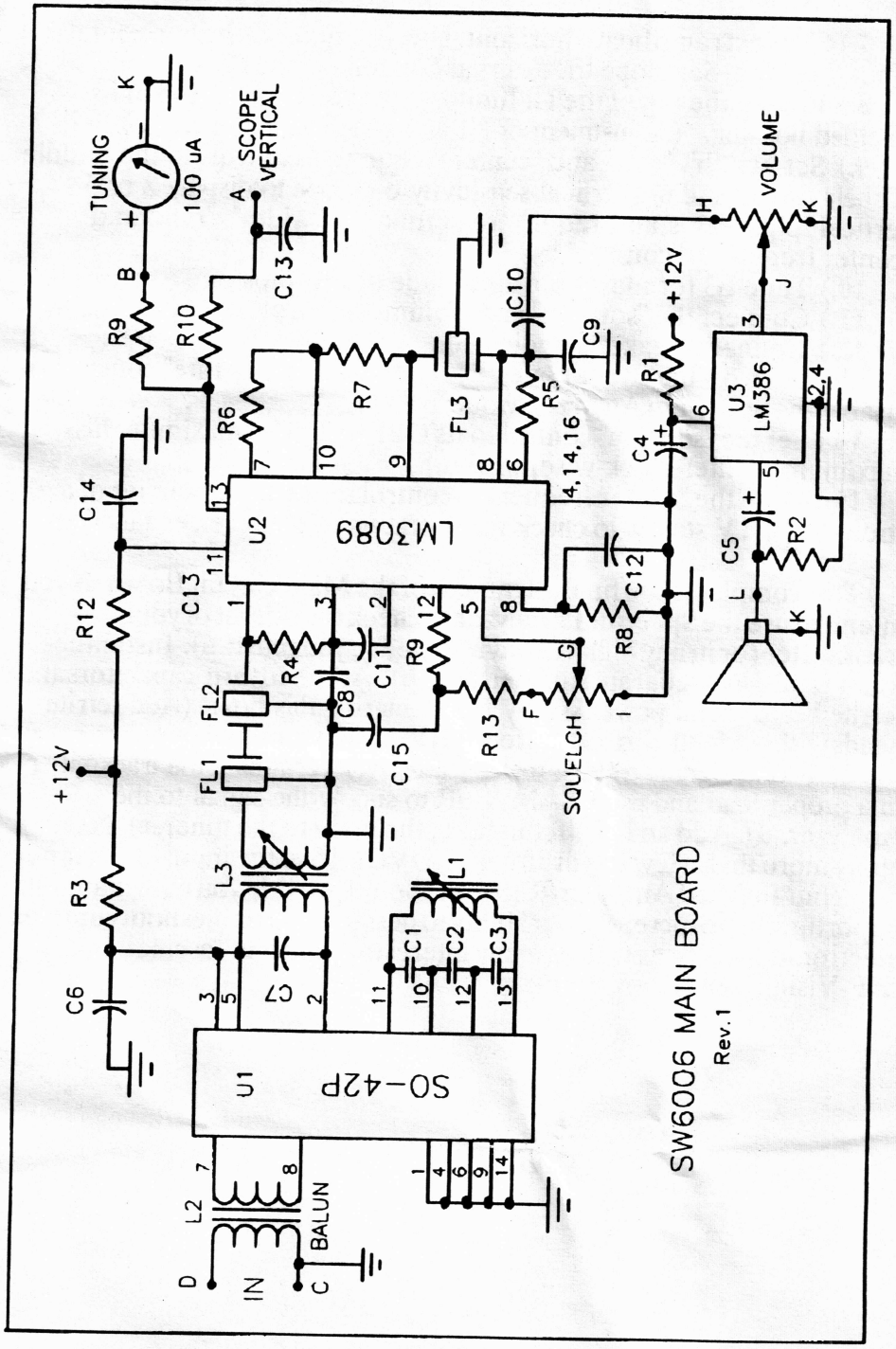

SW6006 MAIN BOARD
Rev.1
TUNING
100 uA
SCOPE
VERTICAL
VOLUME
+12V
SQUELCH
BALUN
IN
LM3089
SO-42P
LM386

7.) Connect ramp board horizontal sweep output to the horizontal input on scope. Set scope to "external horizontal input".

8.) Pre-set the top of the L1 tuning core even with the top of its shielded housing. (Adjustment of L1 shifts the frequency range).

9.) Set "width", "rate" and "center frequency" controls to the middle of their range. Adjust vertical sensitivity on scope to display 2 or 3 vertical "pips". This may require re-setting the "width", "rate" and "center frequency" controls.

10.) Tune L3 for maximum amplitude of the "pips".

11.) Connect the "squelch" and "volume" controls as indicated.

12.) Connect speaker as indicated.

13.) Turn off the sweep (open S1 in series with the "rate" control) to disable the Spectrum Analyzer Mode.

14.) Set the "squelch" control to its OFF position (maximum hiss, maximum counter-clock-wise position).

15.) Tune the "center frequency" control to the sound carrier of a strong local TV station to check the operation of the receiver function.

This completes the final alignment of the Main Circuit Board. If you intend to use the Spectrum Analyzer to check the output of your transmitter (or in any high RF environment), you must: **a).** Install the Main Board in a separate shielded box. **b).** Add feed thru-capacitors and ferrite beads on all power supply leads entering this box. (Add ferrite beads without feed-thru capacitors on the volume control, speaker, squelch, and signal strength meter leads). **c.)** Terminate the transmitter in a proper load and use a SAMPLER to supply the signal to the Analyzer. **d).** Add an RF attenuator at the input to the tuner. **e).** Never apply more than a few hundred MICROVOLTS to the input of the tuner.

Your finished Analyzer/Receiver should provide you with many opportunities to increase your ability to design and troubleshoot complex electronic circuits, as well as many interesting hours of fascinating "RF-Vision" operation. Enjoy!

TYPICAL MAIN BOARD IC VOLTAGES

SO-42P				CA-3089				LM-386			
1	0V.	8	2V.	1	2V.	9	5.4V.	1	1.3V.	5	5.8V.
2	11.7V.	9	0V.	2	2V.	10	5.4V.	2	0V.	6	11.4V.
3	11.7V.	10	1V.	3	2V.	11	9.2V.	3	0V.	7	5.7V.
4	0V	11	11.4V.	4	0V.	12	4.4V.	4	0V.	8	1.3V.
5	11.7V.	12	1V.	5	0/5V.*	13	0.1V.				
6	0V.	13	1.4V	6	4.8V.	14	0V.				
7	2.9V.	14	0V.	7	4.6V	15	4.5V.				
				8	5.4V.	16	0V.				
				*Varies with squelch control settings							

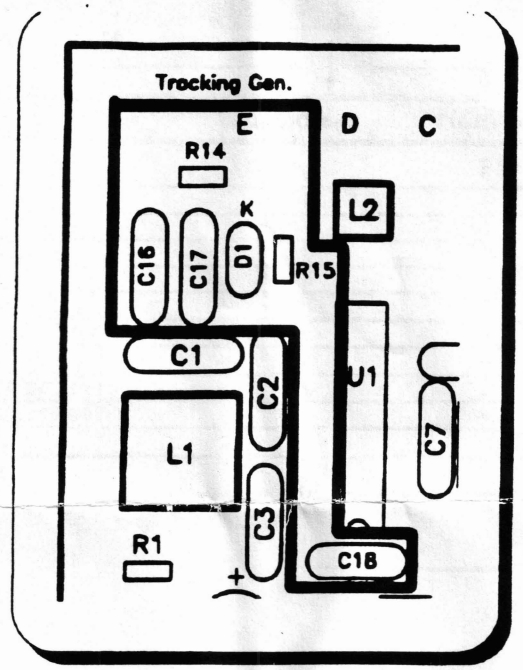
Rev.4-101793 (Rev.1 Board)

NOTES

TRACKING GENERATOR UPGRADE INFORMATION.

If you decide to add the Tracking Generator option, add these notes to the Tracking Generator installation instructions.

This Main Board has space for some of the additional components required for upgrades. It does not use a 3.3pf disc capacitor. Modify the instructions supplied with the upgrade kit as follows:



The 2 extra disc capacitors that were not installed on the Main Board are used in this upgrade.

The 12pf capacitor is installed at C16, shown above, replacing the function of the 3.3pf capacitor when the tracking generator option is installed.

The .01MFD disc capacitor is installed at C18.

R14 is 3.3K, R15 is 100K.

C17 is 0.1MFD.

Install the varactor diode at D1 with the black end at "K".

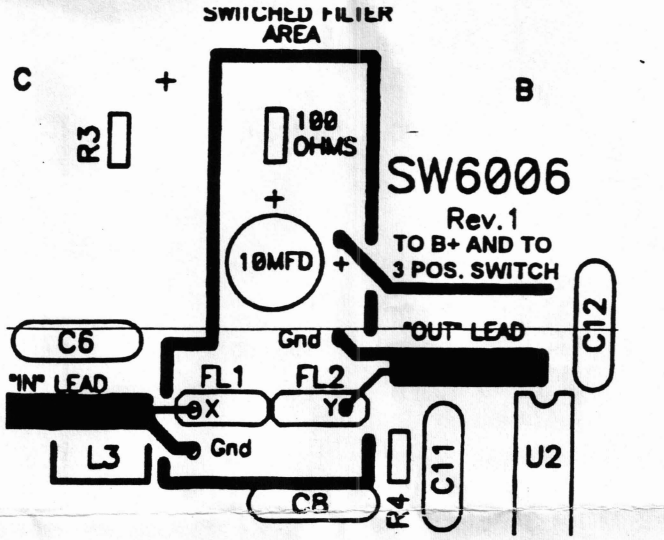
Disregard the instructions on page 4 about adding a jumper to the solder side of the board at L1.

After the above parts are installed, continue to follow the instructions to complete the installation.

SWITCHED FILTER UPGRADE INFORMATION.

If you decide to add the Switched Filter option, add these notes to the Switched Filter installation instructions.

This Main Board has space for some of the additional components required for upgrades. Modify the instructions supplied with the upgrade kit as follows:



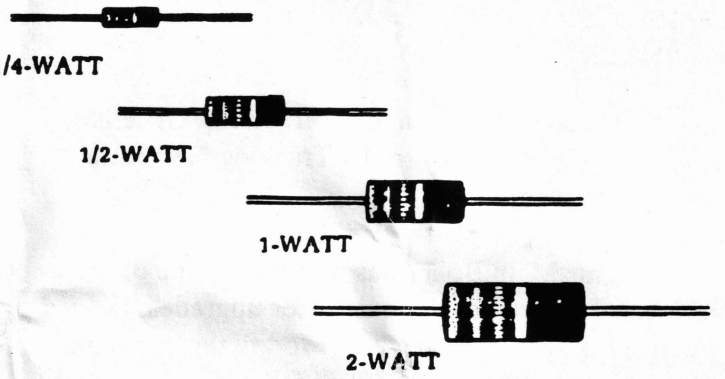
The 100 ohm resistor and the 10MFD capacitor can be installed on the main board, eliminating the need for mounting them on a separate terminal strip.

Steps 15, 16 and 17 describe the steps involved in connecting the add on board to the Main Board. Refer to the above illustration for these connections, rather than to Fig.2. It will not be necessary to add any jumpers or enlarge any holes.

Step 20 refers to the 100 ohm resistor and 10MFD capacitor. Mount these 2 parts on the main board (rather than on a terminal strip) as illustrated above. Observe polarity of the capacitor. The junction of these 2 parts now become the B+ source for both the add-on board and the 3 position slide switch.

PARTS

Resistors will be called out by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). Certain types of resistors will have the value printed on the body, while others will be identified by a color code.



EXAMPLES:

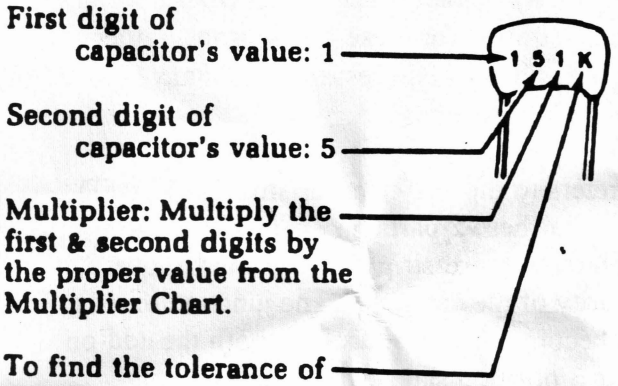
15 × 1,000 = 15,000 Ω (15,000 OHMS), or "15 kΩ"

30 × 100,000 = 3,000,000 Ω (or 3 MΩ)
3 MΩ = 3 MEGOHMS

RESISTOR COLOR CODE

COLOR	1st DIGIT	2nd DIGIT	MULTIPLY BY
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD			.1
SILVER			.01

Capacitors will be called out by their capacitance value in μF (microfarads) or pF (picofarads) and type: ceramic, Mylar*, electrolytic, etc. Some capacitors may have their value printed in the following manner:



EXAMPLES:

151K = 15 × 10 = 150 pF
759 = 75 × 0.1 = 7.5 pF

NOTE: The letter "R" may be used at times to signify a decimal point; as in: 2R2 = 2.2 (pF or μF).

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10pF OR LESS	LETTER	OVER 10pF
0	1	±0.1pF	B	
1	10	±0.25pF	C	
2	100	±0.5pF	D	
3	1000	±1.0pF	F	±1%
4	10,000	±2.0pF	G	±2%
5	100,000		H	±3%
			J	±5%
8	0.01		K	±10%
9	0.1		M	±20%

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