Fiber Optic Probe Details

Terry Fritz

8-17-1999

Rev. 4 VI Probe Theory

The VI Probe consists of three main parts. There is a transducer that turns either high voltages or high currents into smaller signals. A transmitter that takes the small signal from the transducer and converts it into an analog light signal. That signal is sent out over a fiber optic cable to a receiver where the light signals are converted back to electrical signals again. The fiber cable provides total isolation between the transmitters and the receiver.

Transducers

The current transducers are simply a single resistor or arrays of resistors that convert a current into a small voltage. The 500 amp transducer consists of 10 x 0.10 ohm resistors wired in parallel. This gives a total value of 0.010 ohms. When a 500 amp current is sent through this shunt, 5 volts appears across the resistor which is sent to the transmitter.

The voltage transducers consist of high value resistors that produce a small current from a high voltage input. The 50kV transducer consists of two resistor arrays of 2.5M ohm each for a total of 5M ohms. 50kV / 5Mohm = 10mA. The low current is then sent to the transmitter.

Various resistor values are used to measure various voltage and currents. The RMS heating of the resistors needs to be considered and the voltage breakdown of the high voltage resistors needs to be addressed. All the transducers use surface mount resistors for maximum bandwidth performance.

The 50kV voltage transducer is immersed oil. The others are just cast in epoxy mostly to hold them together. I use plastic pipe caps as a shell to put them in.

Transmitters

The system uses two transmitters. I usually use one for voltage and one for current but they can be used for any signals desired. The electronics of the transmitters can be put into top spheres with transducers to measure output arc currents and such. The electronics needs to be shielded.

The transmitters basically bias a fiber optic LED to the on state and the transducer currents are either added or subtracted from the bias level to vary the light output. If something goes "bad" the LED usually gets fried but the other simple electronic parts should be fine. The transmitters are simple and easily repaired but this is rarely needed. The transmitters accept either +-5 volt or +-10mA input.

Receiver

The receiver takes two light channels and inputs them into the receiver modules. There is a direct output from these modules that can be used for very high bandwidth (40+ MHz) measurements but you will have to calibrate the signal level with the oscilloscope. There is also a buffered and calibrated output but the bandwidth drops to 2MHz through the buffers. This is fine for most measurements and the calibration is very convenient for general use. I rarely use the 40MHz outputs.

Calibration

The receiver has two adjustments in it that allow the signal level to be adjusted to some convenient level. The gain should be kept reasonably near 1 so that the bandwidth is not affected greatly. Simply supply a 10mA or 5Volt signal to the transmitter and adjust the pots as needed. There are two variable capacitors on the bottom of the receiver PC board that allow for high frequency compensation. A high frequency square wave can be used and the adjustment is similar to adjusting scope probes were you turn the capacitors until the edges of the square wave look proper. The transducers don't need any calibration and should simply work as is. It is possible to damage them with excessive signals however.

I can be contacted at:

terrellf@uswest.net

I will answer your questions and help out as needed.

I can also get you parts if you wish. Digi-Key sells all these parts and the part numbers are given. I have most of the small surface mount parts that I can simply stick in an envelope and send you. Thus you don't have to order each little surface mount cap and resistor values which is a pain when you only need one.

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Ref Desg	Quantity	Part #	DK Number	Desc.	Cost Each	Total
	1			Receiver	126.93	126.93
	2			Transmitter	75.95	151.9
	1			Voltage Probe	35.81	35.81
	1			Current Probe	49.66	49.66
	1			Misc	41.89	41.89
					0	0
					0	0
					0	0
					0	0
					0	0
	6			TOTAL		406.19

Ref Desg	Quantity	Part #	DK Number	Desc.	Cost Each	Total
IC101,102	2		A20211-ND	Fiber-Optic Receiver	17.78	35.56
C101-C104	4		PCC104BCT-ND	100nF 50V SM Capacitor	0.61	2.44
C105-C106	2		PCC103BCT-ND	10nF 50V SM Capacitor	0.2	0.4
C107-C108	2		PCC101CCT-ND	100pF 50V SM Capacitor	0.19	0.38
C109-C110	2		PCS5106CT-ND	10uF 25V Tantalum Capacitor	0.7	1.4
C111	1		PCS2106CT-ND	10uF 10V Tantalum Capacitor	0.35	0.35
C112-C113	2		SG3028-ND	5-65pF Variable Capacitors	2.77	5.54
R101-R102	2		P10ECT-ND	10 Ohm 1/8W SM Resistor	0.026	0.052
R103-R104	2		P100ECT-ND	100 Ohm 1/8W SM Resistor	0.026	0.052
R105-R106	2		P51ECT-ND	51 Ohm 1/8W SM Resistor	0.026	0.052
R107-R108	2		P1MECT-ND	1M Ohm 1/8W SM Resistor	0.026	0.052
R109	1		P680ECT-ND	680 Ohm 1/8W SM Resistor	0.026	0.026
R110	1		P220ECT-ND	220 Ohm 1/8W SM Resistor	0.026	0.026
R111-R112	2		3296Y-103-ND	10K Ohm 3/4W Variable Resistor	2.5	5
R113-R114	2		P1.0KECT-ND	1K Ohm 1/8W SM Resistor	0.026	0.052
S101	1		CKN1034-ND	DPDT Switch	7.38	7.38
	4		RS-270-326	9V Battery Holders	0.5	2
J101-J104	4		ARF1064-ND	BNC Panel Connectors	2.1	8.4
J105-J108	4		BS121-ND	9V Batter Clips	0.31	1.24
J109	1		J587-ND	Ground Binding Post	1.92	1.92
IC103	1		LM837N-ND	LM837N Op Amp IC	2.28	2.28
IC104	1		LM337LZ-ND	LM337L Voltage Regulator	1.82	1.82
	4		724K-ND	Rubber Feet	0.349	1.396
	4		J181-ND	Aluminum Stand Offs	0.375	1.5
	16		H356-ND	3/8" #6 screws	0.0159	0.2544
	8		H220-ND	#6 Nuts	0.0128	0.1024
	8		H240-ND	#6 Lock Washers	0.0113	0.0904
	1		HM154-ND	Cast Aluminum Box	19.16	19.16
B201-B204	4			9V Alkaline Battery	2	8
PCB101	1		FinnPCB101	PB Board	20	20
				TOTAL		126.9252

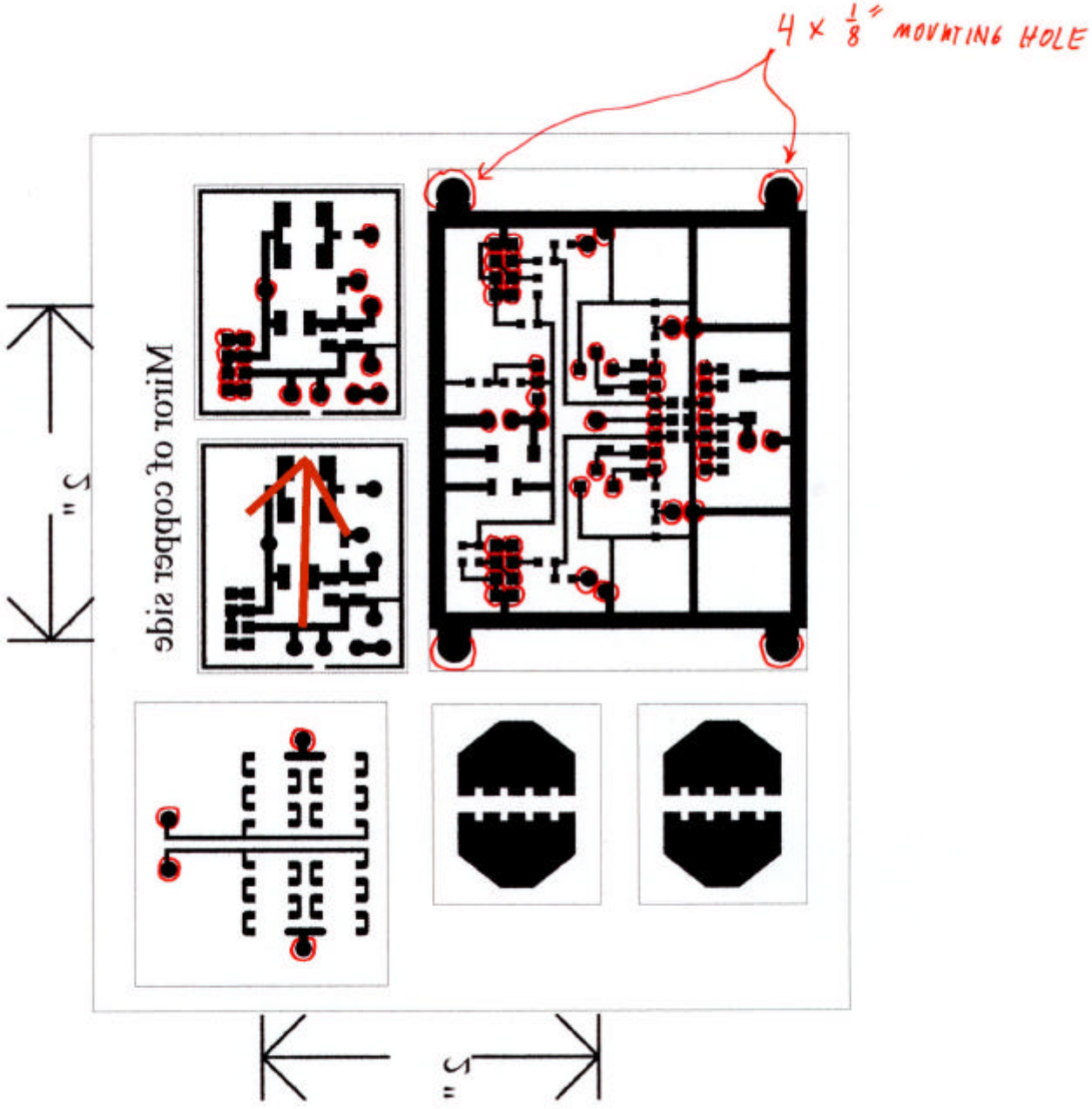
Ref Desg	Quantity	Part #	DK Number	Desc.	Cost Each	Total
	1		A11BBC-0210D-ND	10 Meter Fiber-Optic Cable	37.42	37.42
	1		PC300-69-ND	0.029" Drill Bit	2.51	2.51
	1		PC300-60-ND	0.040" Drill Bit	1.96	1.96
				TOTAL		41.89

Ref Desg	Quantity	Part #	DK Number	Desc.	Cost Each	Total
10 Ohm Shunt	1					
R401	1		P10XCT-ND	10 Ohm 1 Watt SM Resistor	0.4718	0.4718
	2			18 Guage Test Lead - 5 inches	0.2	0.4
	2			22 Guage Wire - 4 inches	0.1	0.2
	1			1 Inch Pipe Cap	1	1
	1			Epoxy Cast	1	1
	2		A0885-ND	1/4 Inch - 18-22 Lug	0.2233	0.4466
						3.5184
1 Ohm Shunt	1					
R501	1		P1.0UCT-ND	1 Ohm 1 Watt SM Resistor	0.8822	0.8822
	2			18 Guage Test Lead - 5 inches	0.2	0.4
	2			22 Guage Wire - 4 inches	0.1	0.2
	1			1 Inch Pipe Cap	1	1
	1			Epoxy Cast	1	1
	2		A0885-ND	1/4 Inch - 18-22 Lug	0.2233	0.4466
						3.9288
0.1 Ohm Shunt	1					
R601	1		P.10UCT-ND	0.1 Ohm 1 Watt SM Resistor	1.633	1.633
	2			18 Guage Test Lead - 5 inches	0.2	0.4
	2			22 Guage Wire - 4 inches	0.1	0.2
	1			1 Inch Pipe Cap	1	1
	1			Epoxy Cast	1	1
	2		A0885-ND	1/4 Inch - 18-22 Lug	0.2233	0.4466
						4.6796
0.01 Ohm Shunt	1					
R701-R710	10		P.10UCT-ND	0.1 Ohm 1 Watt SM Resistor	1.633	16.33
	2			22 Guage Wire - 4 inches	0.1	0.2
	1			1.5 Inch Pipe Cap	1.5	1.5
	2			Copper Strap	1	2
	2			Current Shunt PCB	3	6
	1			Epoxy Cast	1.5	1.5
PCB701	2		FinnPCB701	PC Board	5	10
						37.53
				TOTAL		49.6568

Ref Desg	Quantity	Part #	DK Number	Desc.	Cost Each	Total
R301-R320	20		P1.0MXCT-ND	1M ohm 1 watt SM Resistors	0.4718	9.436
R321	1		P1.0KECT-ND	1K Ohm 1/8W SM Resistor	0.026	0.026
	2			22 Guage - 5 inch Wire	0.1	0.2
	2			Test Lead Wire - 10 inch	0.25	0.5
	1			2 inch PVC Pipe Cap	5	5
	1			Mineral Oil	0.25	0.25
	2		A0885-ND	1/4 Inch - 18-22 Lug	0.2233	0.4466
PCB301	1		FinnPCB301	PC Board	10	10
				TOTAL		25.8586

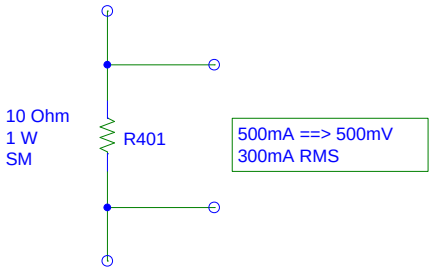
Ref Desg	Quantity	Part #	DK Number	Desc.	Cost Each	Total
R351-R358	8		P100KXCT-ND	100K Ohm 1 watt SM Resistors	0.4718	3.7744
R359	1		P1.0KECT-ND	1K Ohm 1/8W SM Resistor	0.026	0.026
	2			22 Guage - 5 inch Wire	0.1	0.2
	2			Test Lead Wire - 10 inch	0.25	0.5
	1			2 inch PVC Pipe Cap	5	5
	2		A0885-ND	1/4 Inch - 18-22 Lug	0.2233	0.4466
				TOTAL		9.947
				TOTAL		35.8056

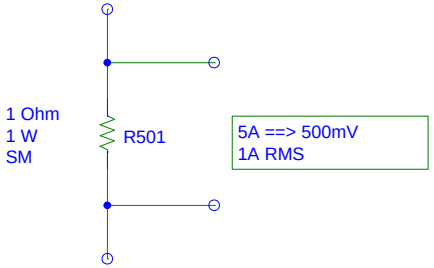
Ref Desg	Quantity	Part #	DK Number	Desc.	Cost Each	Total
C201-C202	2		PCS2476CT-ND	47uF 10V Tan Capacitor	1.208	2.416
C203	1		PCS2106CT-ND	10uF 10V Tan Capacitor	0.476	0.476
C204	1		PCC103BCT-ND	10nF 50V SM Capacitor	0.2	0.2
C205	1		PCC100CCT-ND	10pF 50V SM Capacitor	0.16	0.16
R201	1		P499FCT-ND	499 ohm 1% SM Resistor	0.039	0.039
R202	1		P470VCT-ND	470 ohm 1/2 watt SM Resistor	0.087	0.087
R203	1		P2.2KECT-ND	2.2k ohm 1/8 watt SM Resitor	0.026	0.026
D201	1		67-1165-ND	Amber Panel Mount LED	1.26	1.26
S201	1		CKN1021-ND	SPST Switch	3.75	3.75
IC201	1		A20210-ND	Fiber-Optic Transmitter	17.33	17.33
J201-J202	2		J164-ND	Red Binding Posts	1.54	3.08
J203	1		J165-ND	Black Binding Post	1.54	1.54
J204	1		J587-ND	Ground Binding Post	1.92	1.92
	1			PC Board	10	10
	1		HM158-ND	4.33x3.23.1.58 Cast Al Box	10.56	10.56
	1			#6 nut, screw, and washer	0.1	0.1
J205	1		BS121-ND	Battery Connector	0.31	0.31
	1		RS-270-326	Battery Holder	0.5	0.5
B201	1			9V Alkaline Battery	2	2
	1			3/8 inch Thin Nut	0.2	0.2
	1			12 inch 1/4 inch Copper RF Tape	0	0
	1			Cast Aluminium Box	10	10
PCB201	1		FinnPCB201	PC Board	10	10
				TOTAL		75.954

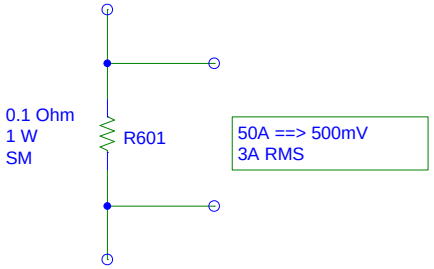


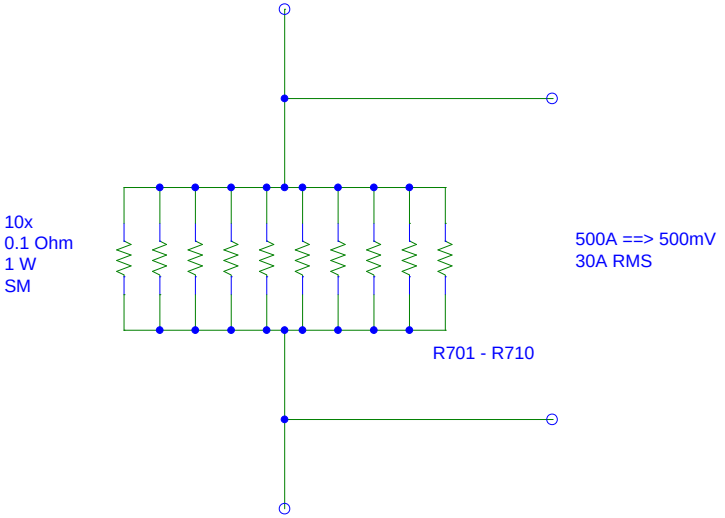
SQUARE HOLES = 0.029" dia

ROUND HOLES = 0.040" DIA









Fiber Optic Transducers
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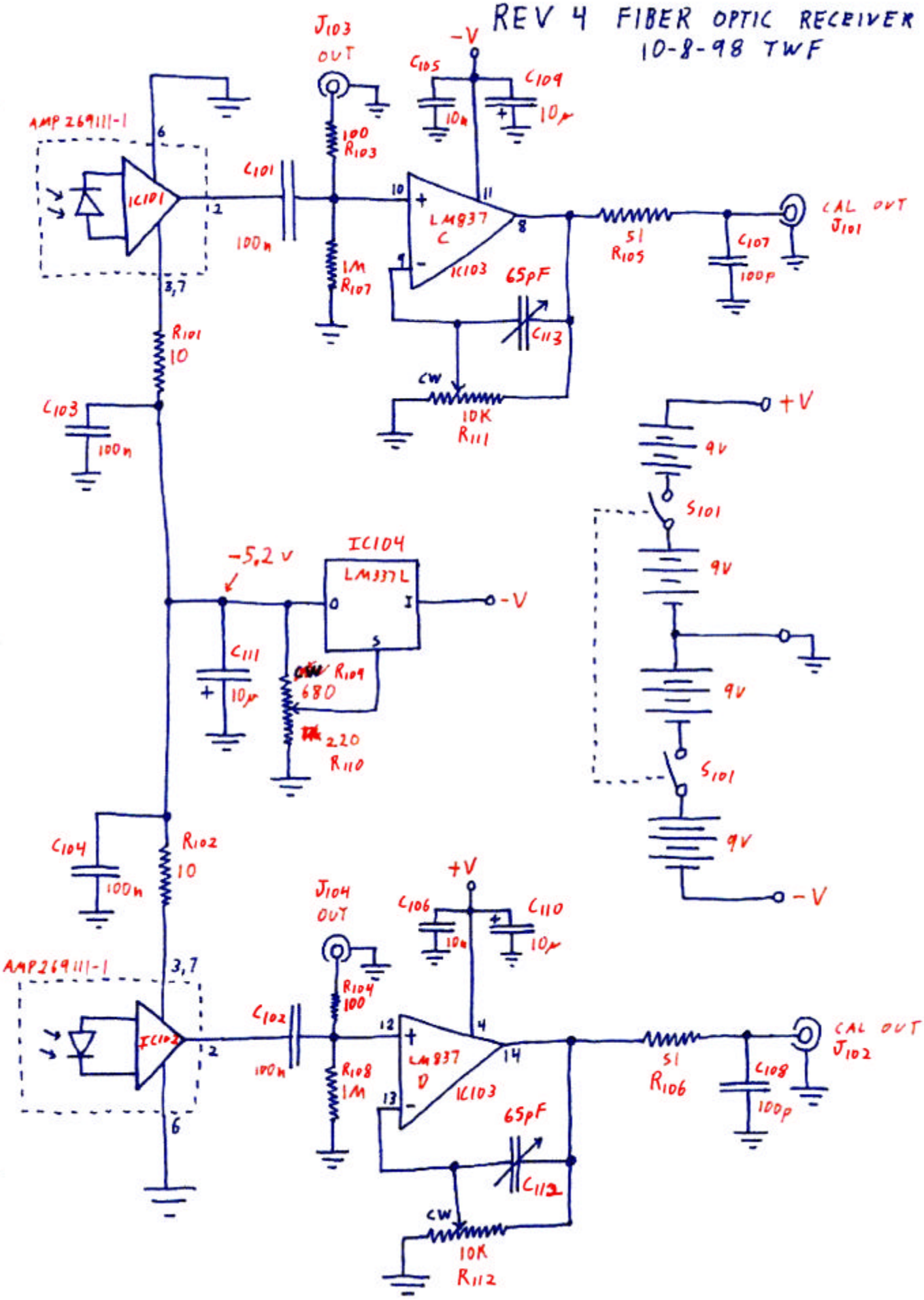
REV 4 FIBER OPTIC RECEIVER
10-8-98 TWF
J103
OUT
-V
C105
10n
C109
10µ
AMP 269111-1
6
IC101
2
3,7
C101
100n
100
R103
1M
R107
10
LM837
C
IC103
65pF
C113
CW
10K
R111
51
R105
C107
100p
CAL OUT
J101
R101
10
C103
100n
+V
9V
S101
9V
9V
S101
9V
-V
IC104
LM337L
-5,2 V
C111
10µ
R109
680
220
R110
-V
C104
100n
R102
10
J104
OUT
+V
C106
10n
C110
10µ
AMP 269111-1
3,7
IC102
2
6
R104
100
C102
100n
R108
1M
LM837
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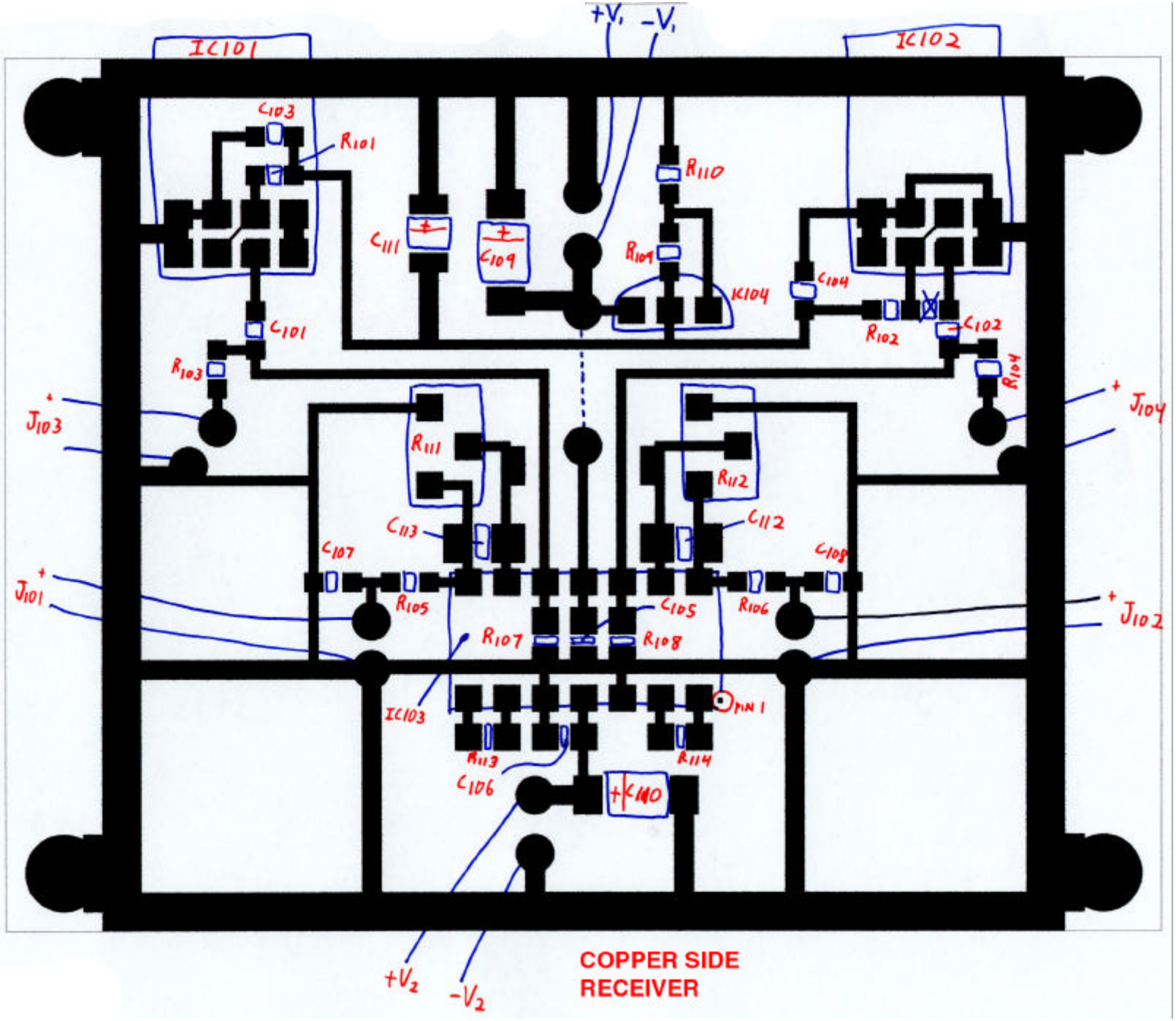
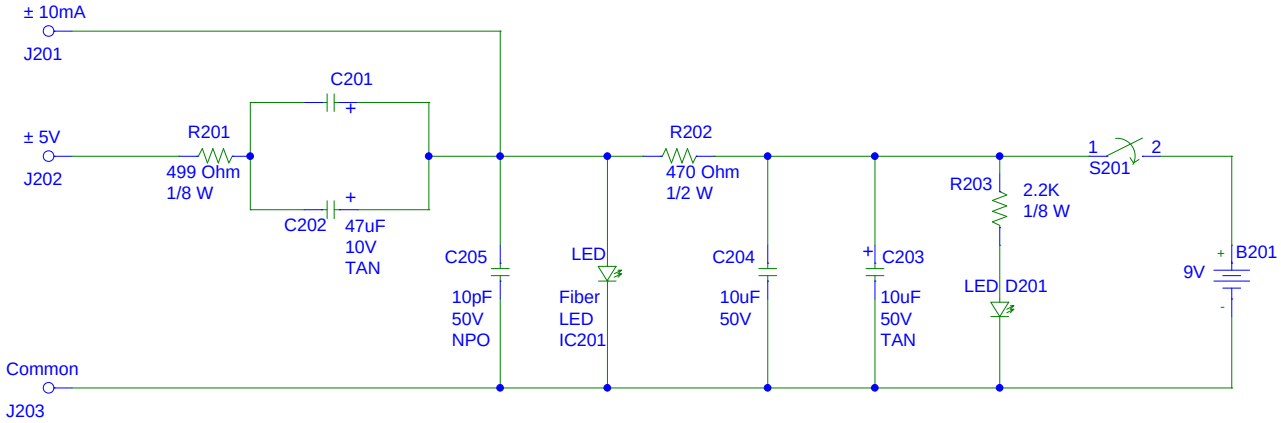
51
R106
C108
100p
CAL OUT
J102



COPPER SIDE
RECEIVER



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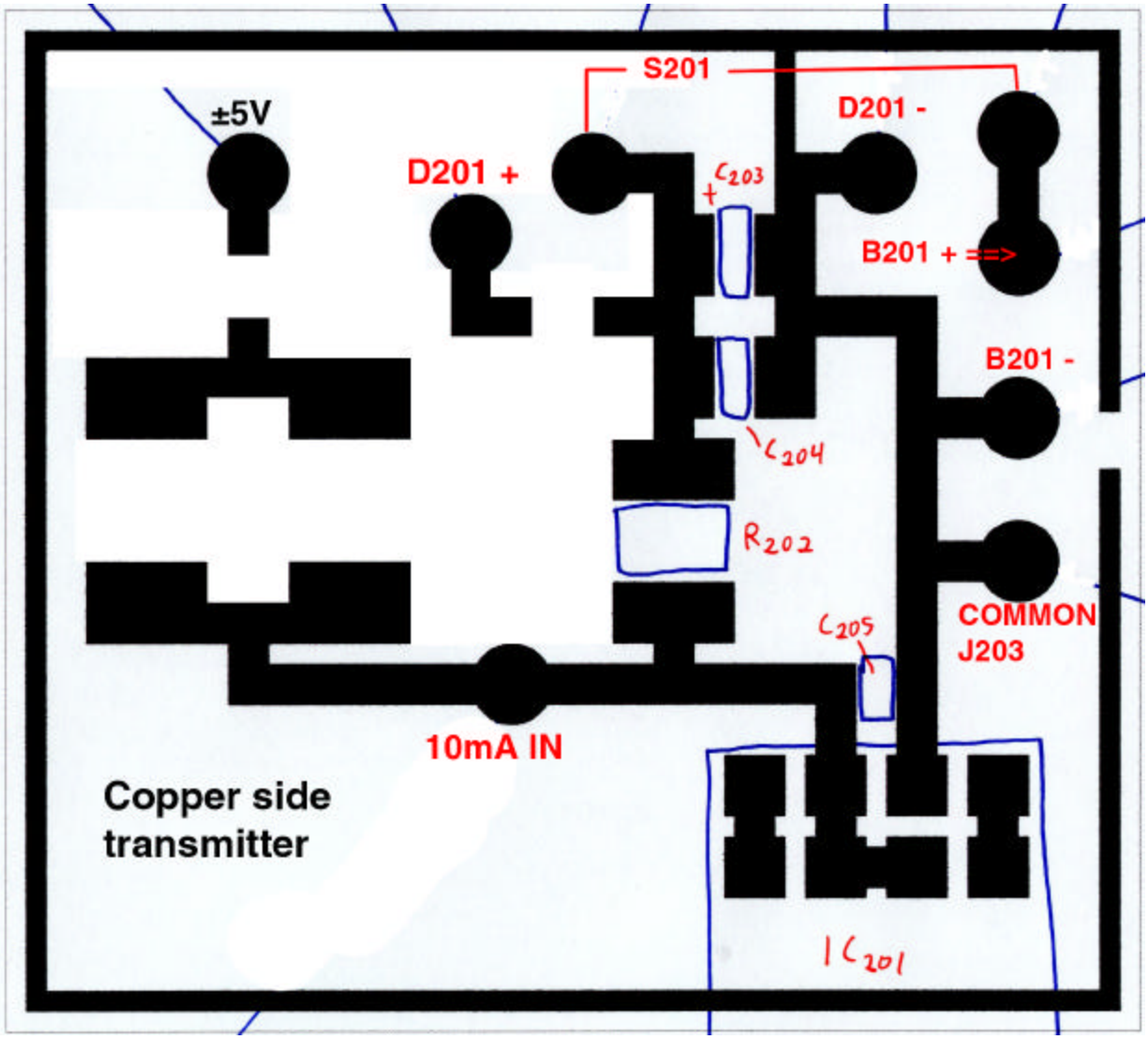
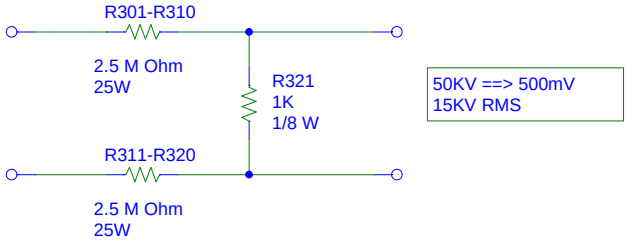
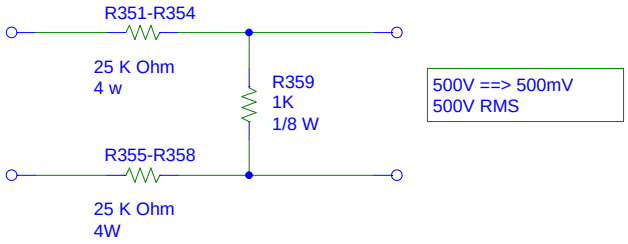

S201
±5V
D201 -
D201 +
C203
B201 + ==>
B201 -
C204
R202
COMMON
J203
C205
10mA IN
Copper side
transmitter
IC201



50KV ==> 500mV
15KV RMS

NOTE: 2.5M RESISTORS ARE 10 x 10M 1W RESISTORS IN OIL.



500V ==> 500mV
500V RMS

NOTE: 25K RESISTORS ARE 4 x 100K 1W IN EPOXY..

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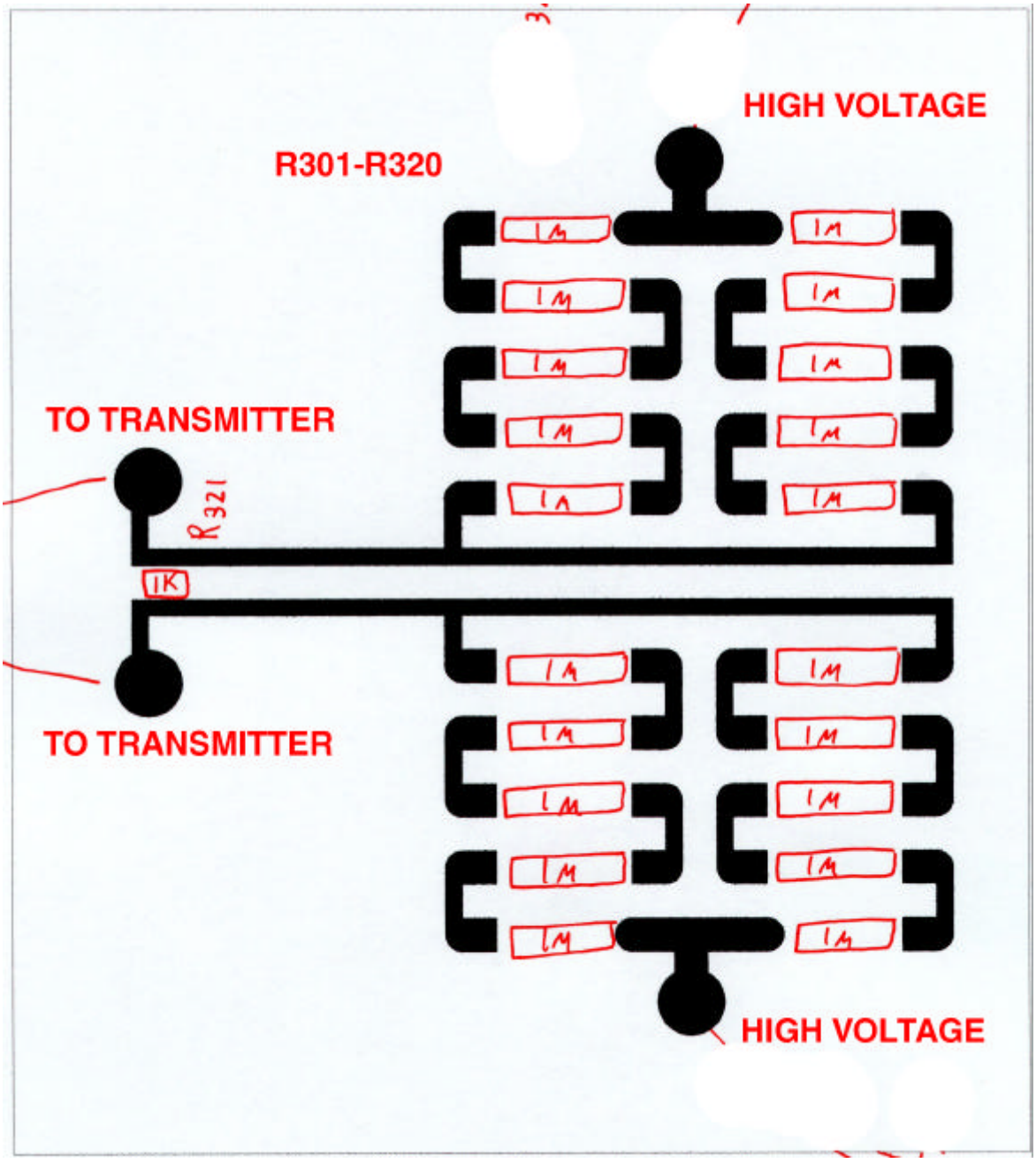
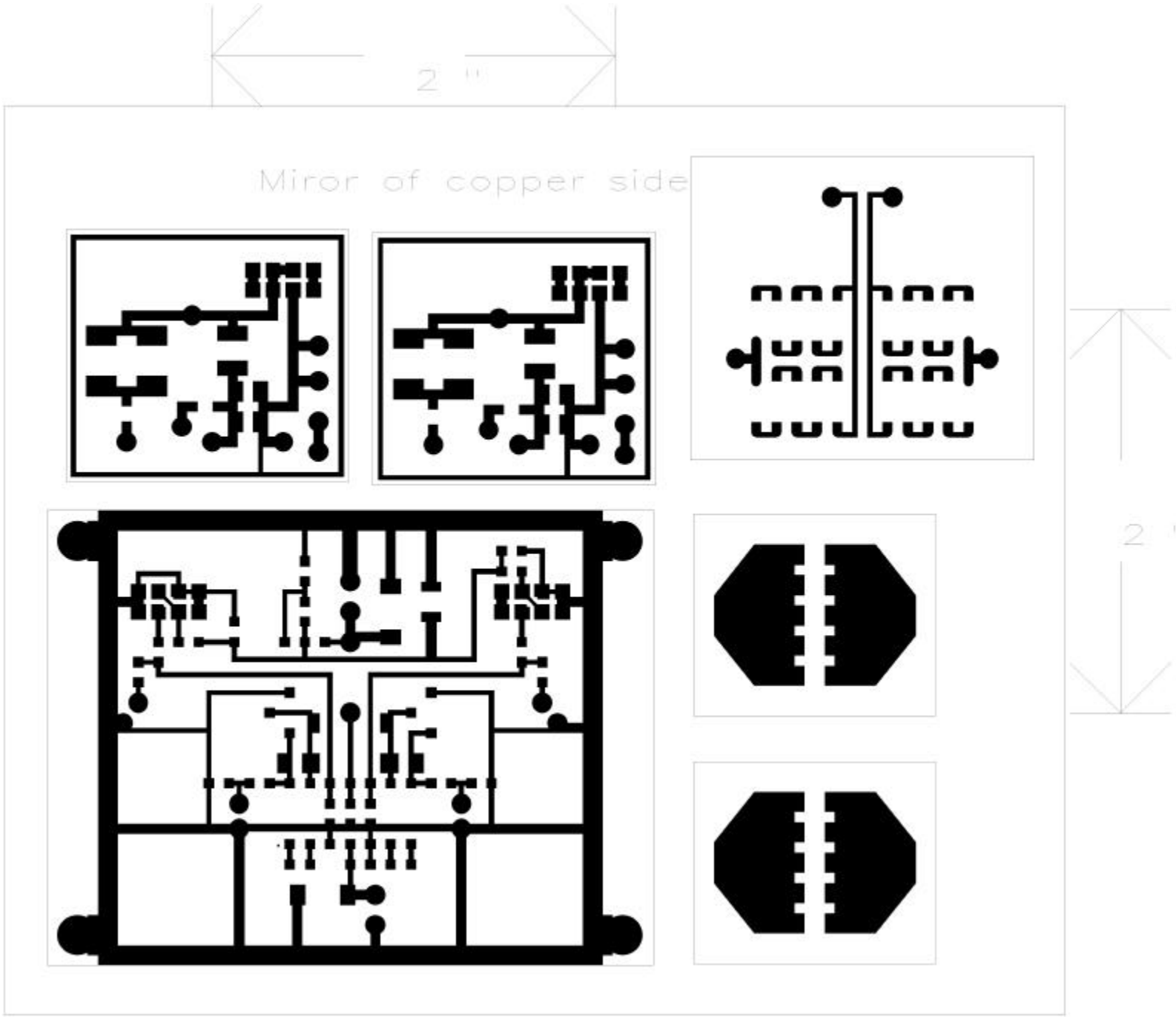

HIGH VOLTAGE
R301-R320
1M
TO TRANSMITTER
R321
1K
TO TRANSMITTER
HIGH VOLTAGE


2 "
Miror of copper side
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