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**DOUG HALL ELECTRONICS**

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815 East Hudson Street  
Columbus, Ohio 43211-1199  
(614) 261-8871

**4 R V**

**VOTER MANUAL**

***Specialized  
Communications  
Products***

**FOUR CHANNEL VOTER MANUAL**

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**THIS MANUAL CONTAINS:**

**EC. Level: 4.2.0**

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**For service send voter board to:**

**VOTER  
Doug Hall Electronics  
815 E. Hudson  
Columbus, Ohio 43211**

**There will be a flat rate of \$ 35.00 under most conditions.**

## 4RV SPECIFICATIONS

**Voting Method:** Signal-to-noise  
**Hysteresis:** Approx. 10% Factory set, Modifiable  
**Capacity:** Four channels expandable to 32, 4 channels per card  
**Voting Criteria:** approx. 2dB difference in signal-to-noise  
**Voting Time:** Continuous, fast voting - no delay or sampling  
Four independent circuits working simultaneously

**Calibration:** Built-in audio level calibrator

**Indicators:** 9 LED's Total  
4 Voted indicators  
4 COR indicators  
1 Audio level indicator

**Input Section:**

**Audio:** 100mv - 1v p-p into approx. 10K input impedance  
50mv - 3v p-p with modifications

**COR:** Ground is the active state (unscelched)  
12v CMOS input with 10K pull-up  
< 2.4v unscelched (low)  
> 4.0v scelched (high)  
Relay contact to ground or open collector NPN  
(Application notes included in 4RV manual)

**Mixer:** Audio mixer input available for external input

**Output Section:**

**Audio:** 5v p-p adjustable master level pot into approx. 1K load

**PTT:** Ground is the active state (unscelched)  
Open collector NPN output to ground - Will sink 500ma at not more than 50v or 100mw  
(Application notes included in 4RV manual)

**Disable Inputs:** CMOS low disabled (grounded)  
high enabled (open) - Same as COR inputs

**Voted Indicator**

**Outputs:** CMOS outputs (manual describes indicator drivers)

**Test Points:** (4) Audio level calibration points - 1 per receiver  
(1) Calibration buss on edge connector

**Power**

**Requirements:** +12v to +15v regulated at 500ma

**Dimensions:** 4.5"H x 6.8"L x 1/2"W (4.5" x 6.5")

**Connections:** 44 pin edge connector (22 per side) gold plated fingers - 0.156" spacing - similar to Vector R644 (not included)

**Circuit Board:** Fiberglass epoxy, double sided, tinned and gold plated contacts

**Manual:** 20 pages with application notes and symptom fix index

**Service:** Spare (loaner) voters available - \$35 flat rate under most circumstances

**Components:** 11 IC's, 17 Transistors, 33 Diodes, 9 LED's  
38 Capacitors, 104 Resistors, 9 Pots

PARTS LIST

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PART	QUANTITY	DESCRIPTION
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C1 A-D	4	.1 uf 50v disc or metal film 104
C2 A-D	4	1 uf 35v tantalum
C3 A-D	4	see options
C4 A-D	4	1 uf 35v tantalum
C5 A-D	4	.047 uf 50v disc or metal film
C6 A-D	4	2.2 uf 25v tantalum
C7 A-D	4	.01 uf 50v disc or metal film 103
C8 A-D	4	10 uf 25v tantalum
C9	1	1 uf 35v tantalum
C10	1	see options
C11	1	1 uf 35v tantalum
C14	1	1 uf 35v tantalum
C15	1	10 uf 25v tantalum
C16	1	33 uF 25v tantalum
D1 A-D	4	1N4148 diodes
D2 A-D	4	"
D3 A-D	4	"
D4 A-D	4	"
D5 A-D	4	"
D7 A-D	4	"
D8	1	"
D9 A-D	4	"
D10 A-D	4	"
LED1 A-D	4	red mini LED
LED2 A-D	4	green mini LED
LED4	1	green mini LED
LED5	1	red mini LED
P1 A-D	4	50k pot Bourns 3352w-1-503
P2 A-D	4	1k or 2k mini pot Bourns 3329h-1-102
P3	1	5k pot Bourns 3352w-1-502
Q1 A-D	4	2N4401 NPN silicon (MATCHED SET)
Q2 A-D	4	2N4403 PNP silicon
Q3 A-D	4	2N4403 PNP silicon
Q4	1	2N4401 NPN silicon
Q5 A-D	4	2N4403 PNP silicon

Components with a suffix of A,B,C, or D refer to which receiver the component functions with. Ie: P1A refers to the receiver input audio level pot for receiver A (channel 1). While there is four pots designated as P1, the part with suffix "A" is exclusive to receiver #1 and "B" is exclusive to #2, etc...

Ie: P1 (A-D) 50K Potentiometer  
           P1A = Receiver 1  
           P1B = Receiver 2  
           P1C = Receiver 3  
           P1D = Receiver 4

PARTS LIST CONTINUED

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PART	QUANTITY	DESCRIPTION
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All resistors 5% 1/4 watt except as noted.

R1 A-D	4	10k
R2 A-D	4	100k
R3 A-D	4	10k
R4 A-D	4	100k
R5 A-D	4	47k
R6 A-D	4	220k
R7 A-D	4	220k
R8 A-D	4	10k
R9 A-D	4	100k
R10 A-D	4	100 ohm
R11 A-D	4	150k
R12 A-D	4	10k
R13 A-D	4	470k
R14 A-D	4	10k
R15 A-D	4	4.7k
R16 A-D	4	1k
R17 A-D	4	10k
R18 A-D	4	4.7k
R19 A-D	4	4.7k
R20 A-D	4	4.7k
R21 A-D	4	10k
R22 A-D	4	4.7k
R23	1	47k
R24	1	4.7k
R25	1	2.2k
R26	1	10k
R27	1	4.7k
R28	1	4.7k
R29	1	2.2k
R30	1	4.7k
R31 A-D	4	10k
R32 A-D	4	10k 1/8W Located on bottom of board
S1-S4	1	4 position dip switch
U1-U5	5	LM324N quad op amp
U6	1	4069 hex cmos inverter
U7-U8	2	4081B quad cmos and
U9	1	4066B quad analog switch
U10	1	LM1458 dual op amp
U11	1	7805 Positive 5V regulator
	9	14 pin I.C. sockets for U1-U9
	1	8 pin I.C. socket for U10

## OPTIONS

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Depending on your system configuration, you may not even need to read this page at all. The standard configuration consists of matched receivers with de-emphasis at the receivers and normal balanced audios. If that is not the case then read on.

C3: Capacitor C3 is an optional capacitor for the purpose of permitting audio tailoring on the voter card. If for example you were deriving your receiver audio directly from the discriminator, you don't have any de-emphasis, it must be compensated for. Most receivers these days have the de-emphasis built into the FM detector so you must know if your audio has, or has no de-emphasis. If you need some high frequency roll-off, or de-emphasis, install a 0.001uf capacitor in the C3 position of the receiver that needs it. If more roll-off is desired use a 0.005uf or .01uf. If every receiver is the same but all need roll-off use C10.

C10: Capacitor C10 serves the same purpose as C3 except it has the same effect on all the receivers at the same time.

To reduce the voting rate, you can increase the hysteresis of the comparator, this will make the voter require a little better signal once voted to re-select another. This is accomplished by reducing the value of R13's as mentioned in the service aids.

Disable inputs: Each receiver has a corresponding pin on the edge connector that can be used to disable that receiver. Simply Ground that pin and that receiver will not get voted. This can be tied into a touch tone decoder for remote control, or used as an input from C.T.C.S. decoder.

VOTER CARD PINOUT

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SHOWN FROM THE CONNECTOR END  
 CONNECTOR SIMILAR TO VECTOR R644 44 PIN .156" SPACING.  
 COMPONENT SIDE FOIL SIDE

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N/C	A	1	N/C
AUDIO OUT	B	2	CALIBRATE BUS
RCVR #2 AUDIO IN	C	3	RCVR #1 AUDIO IN
RCVR #4 AUDIO IN	D	4	RCVR #3 AUDIO IN
+5V IN	E	5	+5V IN
RCVR #2 T.P.	F	6	RCVR #1 T.P.
GROUND	H	7	SELECT RCVR #2
COMPARATOR BUS	J	8	SELECT RCVR #1
+12V	K	9	+12V
+12V	L	10	+12V
GROUND	M	11	GROUND
REG +5V	N	12	REG +5V
RCVR #4 T.P.	P	13	SELECT RCVR #3
RCVR #3 T.P.	R	14	SELECT RCVR #4
RCVR #3 DISABLE	S	15	RCVR #4 COR
RCVR #4 DISABLE	T	16	RCVR #3 COR
RCVR #2 COR	U	17	RCVR #2 VOTED
RCVR #1 COR	V	18	RCVR #1 VOTED
RCVR #2 DISABLE	W	19	RCVR #4 VOTED
RCVR #1 DISABLE	X	20	RCVR #3 VOTED
COR OUT	Y	21	AUDIO MIXER IN
GROUND	Z	22	GROUND

JUMPER THE FOLLOWING PINS TOGETHER:  
 5 to 12, 9 to 10, H to M and Z.

## Application notes

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Included with your Voter is all the documentation that you should need, but in the event you have a question or problem you are encouraged to write to our engineers.

Some tips on a good voter system...

1. The voter circuit requires unsquelched audio from the receiver. Speaker audio is unacceptable.
2. The C.O.R. inputting the voter unsquelched must be "ground going", or grounded. The C.O.R. must be an open circuit when squelched and never exceed the supply voltage of +12v.
3. The PTT output will sink 500ma.
4. Your repeater receivers should have "quality" matched audio to take full advantage of any voter system.
5. Voted outputs are CMOS outputs, see figures on application notes.
6. The disable inputs can be used for Continuous Tone Coded Squelch (C.T.C.S.) detect, open is C.T.C.S. active and ground is C.T.C.S. inactive. When using C.T.C.S. decode, C.O.R. must also be used.

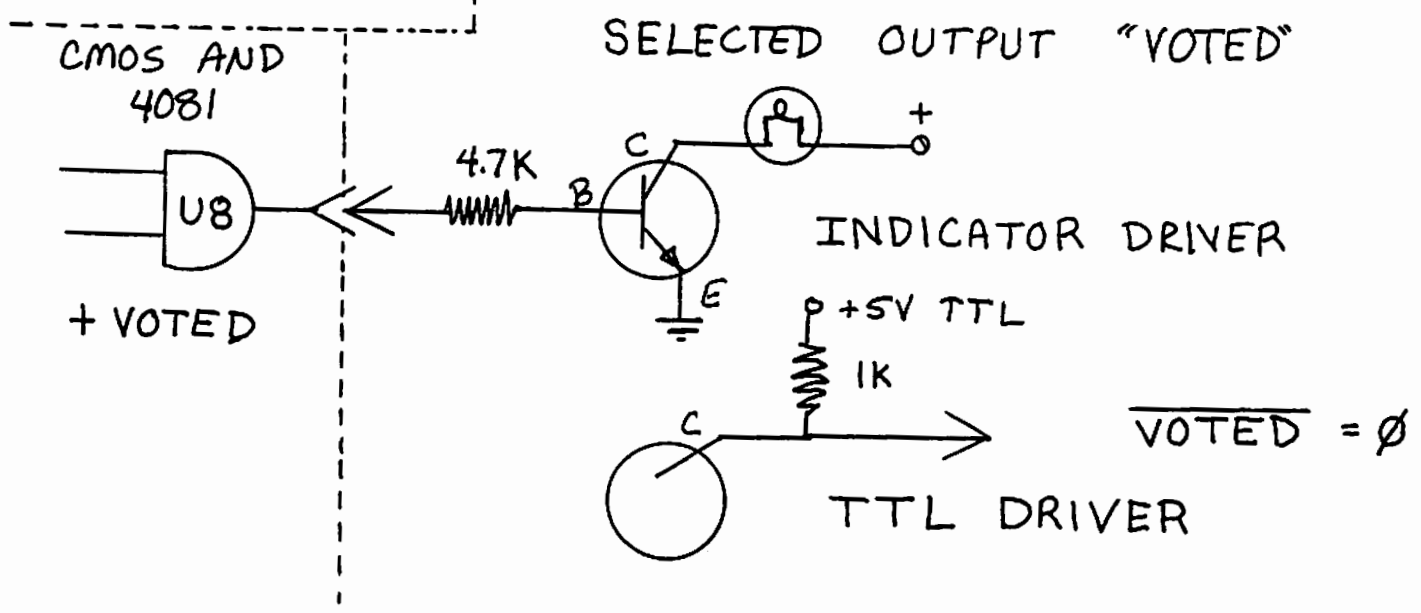
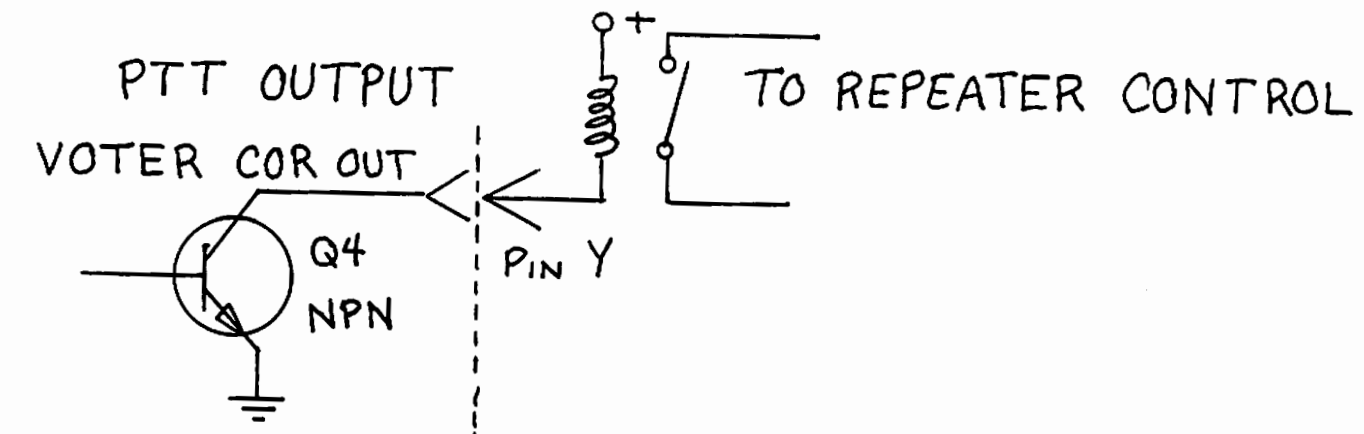
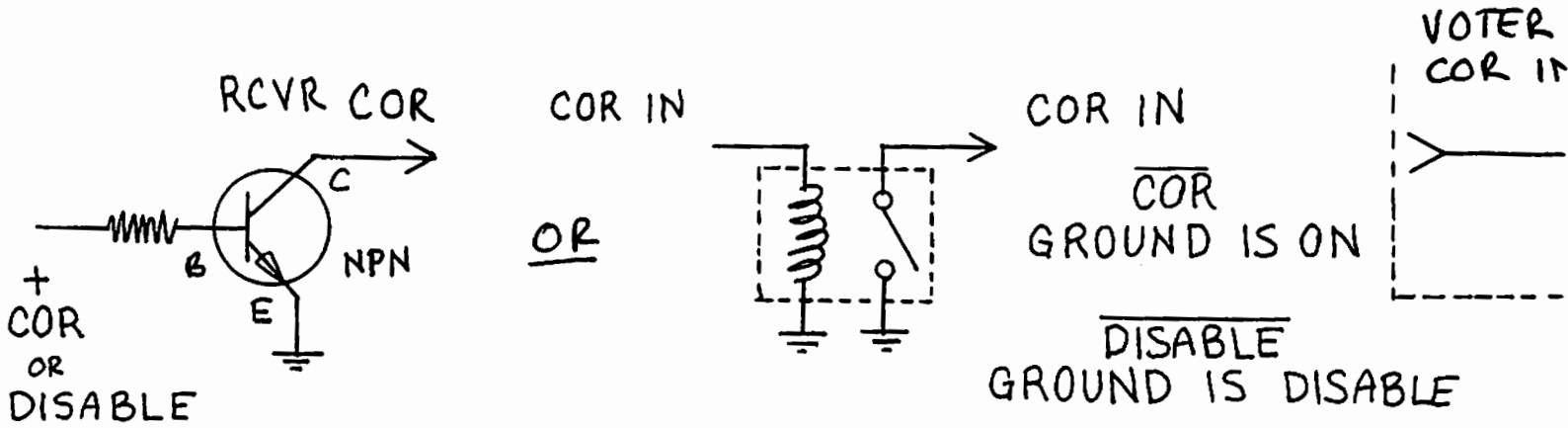
**RECEIVER LINEARITY:** Non-linear audio will cause unexpected results. If there is any limiting or compression at any receiver local or remote, the voter will misjudge the best receiver. Because you calibrate on the peak level, and if that level is not the true peak, but a limited value, the actual noise that the voter uses to evaluate the signal will be compressed and look like a higher level of noise than a linear receiver would exhibit with the same signal quality, the result is the wrong receiver being voted. To prevent this set your remote link transmitter deviation to approx. 6kc. Then set your link transmitter audio gain so that a 5kc signal will repeat with 3 TO 4kc unlimited linear deviation. That way a normal 5kc signal will stay out of the link transmitter deviation limiting and stay within the link receivers bandwidth. If there is too much high frequency roll-off on any of your receivers, the voter will not know how much noise is really there, since most noise is in the high frequency range.

**NOTE:** At the voter audio input, there should be approx. 300mv A.C. P-P. 120mv minimum. If this cannot be achieved then the values of R1 A-D can be reduced to increase the gain of U1. A 4.7k will increase the gain by a factor of 2. This will allow a minimum 60mv P-P input to be possible. If this input level is not achieved, the calibrator will appear not to work or the input level controls (P1) will be at the end of their range.



APPLICATION NOTES

EXAMPLES OF COR AND DISABLE INPUTS



## SYSTEM NOTES

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### SYMPTOM FIX

- 1: Audio distorted. See application notes.
- 2: Calibrator not working. See application notes
- 3: RX COR always on. Remove COR at Voter to isolate, if ok now, COR is loading COR input. Pull-up R18 or U6 is bad.
- 4: While receiving a strong signal at the receiver and fading in and out into another, the fading receiver will vote noisy at the first part then go back to the good receiver.  
  
FIX: Use unsquelched discriminator audio - do not use speaker audio. (Nonlinearity of audio or limiting can also cause this). Audio slow coming up at the remote site, or coming up off freq at first. Calibrated wrong. See audio linearity on application notes. Remote receivers also should have unsquelched audio to prevent the audio from coming up after the COR (Link TX). Any delay between the COR and audio is a full quieting signal to the voter which causes the voter to select that receiver for a short period of time until the audio gate opens.
- 5: Poor distinction between noisy and noisier signals.  
  
FIX: Audio frequency response not matched between receivers will also cause a nonlinearity that the voter will react to.

SERVICE AIDS

SYMPTOM FIX

THE FOLLOWING IS A COMPILED LIST OF COMMON PROBLEMS AND FIXES FOR THE FOUR CHANNEL VOTER CARD:

SYMPTOM	FIX
1: ALL CHANNELS VOTED	CHECK COMPARATOR VOLTAGE, SHOULD BE APPROX 11v WITH NO CORs. CHECK D5's AND R28. S1's SETTINGS D5's, U5, R13's.
2: DISABLE NOT WORKING	SWAP U8 WITH U7 TO ISOLATE.
3: ONE RECEIVER ACTING FUNNY	SWAP THE INPUTS TO ISOLATE TO VOTER OR RECEIVER.
4: P3 TOUCHY OR ALL THE WAY DOWN.	TOO MUCH GAIN, REDUCE 23 TO 10k.
5: VOTES TOO MUCH	INCREASE THE HYSTERESIS, REDUCE R13's.
6: NOT VOTING	CHECK S1, ONLY ONE CAN BE ON AT A TIME.
7: ONE RX ALWAYS VOTES WHEN ACTIVE	CHECK C8, C6, Q1's
8: PTT ON SOLID	Q4 SHORTED.

## POWER SUPPLIES

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Single +12v supply: +12v at 500 ma

The power supply must be well regulated to prevent noise from getting on the audio signal.

With the newest revision (4.2.0) a 7805 Voltage regulator was added on board to simplify the power requirements. Now the only voltage needed is +12V DC.

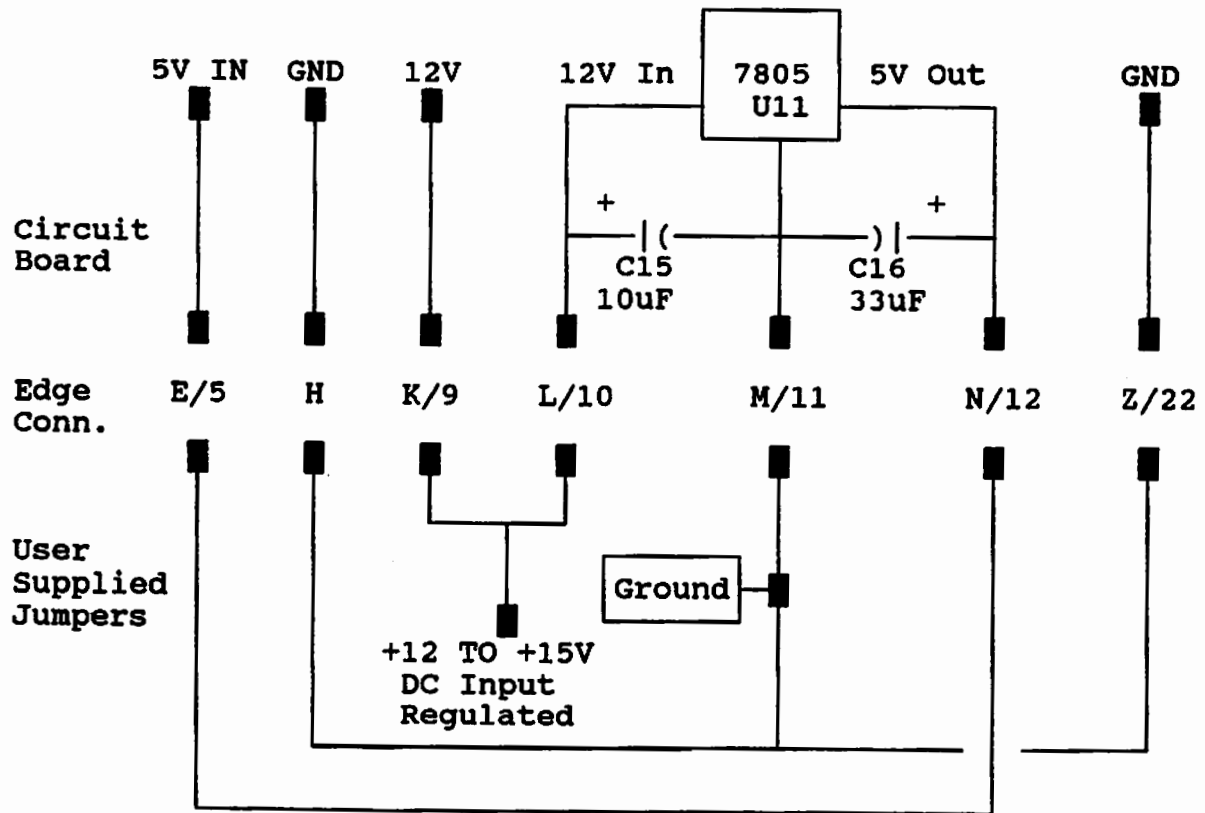
On the edge connector the following pins need to be jumpered together:

5 to 12  
9 to 10  
H to M and to Z

The following pins are connected together on the board and are electrically the same:

E and 5  
K and 9  
L and 10  
M and 11  
N and 12  
Z and 22

Supply +12V Regulated to pin 10 and connect ground to 11.



EXPANDING PAST FOUR CHANNELS

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To expand your four channel voter requires another card for every increment of four channels. To expand to 5 channels you must go to 8 anyway. The first card will be referred to as the master. The master card is the same as a standard four channel voter single card. All of the expansion cards will be referred to as slave cards. As many as five slave cards can be installed on one system giving you 24 channels.

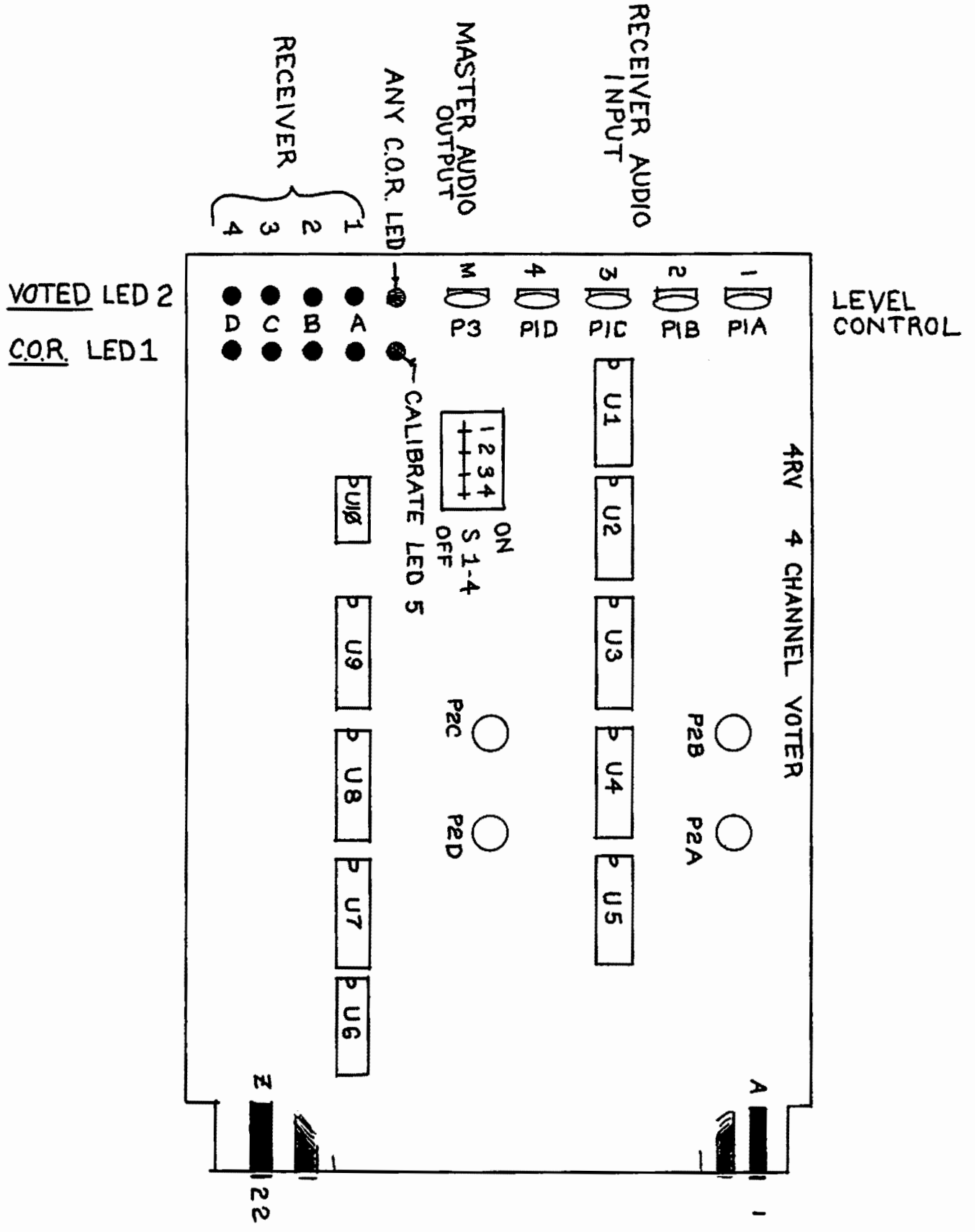
The slave cards get wired to the receivers the same as the standard card except you don't use pin B (audio out). Connect the following edge connector pins of all master and slave cards together:

pins:            2, 5, H, J, K, 9, Z, 22, 21, Y

On the slave voter cards the following components can be omitted:

U10, U11, C9, C10, C11, C14, P3, R23, R24, R29, R30, and LED5

LOCATIONS



## CALIBRATION AND ADJUSTMENT

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This calibration is required any time you change any audio on any receiver. To assist in the adjustment there is a built in calibrator circuit that provides an indication when the levels are adjusted right. This adjustment must be made accurate or else the voter will favor any receiver that's audio is on the low side.

- Step 1: Turn all DIP switches off.
- Step 2: Switch receiver 1 DIP switch on. Caution! Never turn more than one switch on at a time. Doing so will blow the corresponding Q2 transistor.
- Step 3: To calibrate the receiver levels, a strong base must transmit so that the signals are all full quieting into all receiver sites. The base should transmit a solid tone such as a touch tone digit. This will give a steady audio level to calibrate to. The tone should be right at  $\pm 5$ kc deviation.
- Step 4: Adjust P1A so that the red LED5 just starts to go out.
- Step 5: Turn switch one off and turn the next receiver to be calibrated on.
- Step 6: Adjust the next receiver being calibrated until LED5 just goes out.
- Step 7: Repeat steps 5 and 6 for all receivers installed.
- Step 8: Adjust P3 (master level) for required repeater audio.

As a final check, use a loud voice and give a test count to get another source of peak audio. Observe the calibrate LED on the voter. The light should be hard to "talk off", and should not go out easily on audio peaks. If it does, the base station calibrated to (with the tone) was of insufficient level to get a good calibration. Re-calibrate with a higher level.

VOTER COMPENSATION FOR SYSTEM NONLINEARITIES  
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Sometimes different receivers have some non-linearities either in response or limiting that can cause mis-voting.

Provisions have been made to minimize the effects, but this doesn't cover all situations.

If a noisy receiver out votes a better receiver there is a way to compensate by adjusting ( increasing ) the noisier receivers gain on the calibration pots P2A-P2D. On receivers A,B,D adjust P2 ccw and on receiver C adjust P2 cw until the better receiver overtakes the noisier one.

These adjustments don't effect the audio levels but adjusts the gain of the noise circuits to imbalance the voter to inversely match the receivers.

There is no scientific method of doing this, but it can cover up many sins.

These potentiometers are adjusted to match all the channels together. They are calibrated at the factory and marked.



**TEST POINTS**  
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<u>RCVR</u> ----	<u>T.P.</u> ----	
1	6	With a full quieting signal into All of the installed receivers and 5kc deviation, the levels should all be equal and approx 5 volts dual supply and 10.0v dc with a single supply.
2	F	
3	P	
4	R	

The following voltages are measured with no audio in and no COR's active. (idle)

U1	pin 1,7,8,14	+5v dc
U2	pin 1,7,8,14	+5v dc
U4	pin 1,7,8,14	+7v dc
U1,2,3,4	pin 3,5,10,12	+5v dc
U5	pin 2,6,9,13	Approx. +12v

All the following measurements are measured with > approx 0.1vp-p input (normal unsquelched audio with COR active, squelch running open).

U1.	pin 1,7,8,14	1v p-p ac
U2.	Test Point 1-4	+10.5v dc
U3	pin 1,7,8,14	+4.5v dc
U4.	pin 1,7,8,14	+10.5v dc
U10	pin 1 pin 6	>6v p-p ac approx +5.2v calibrate reference.

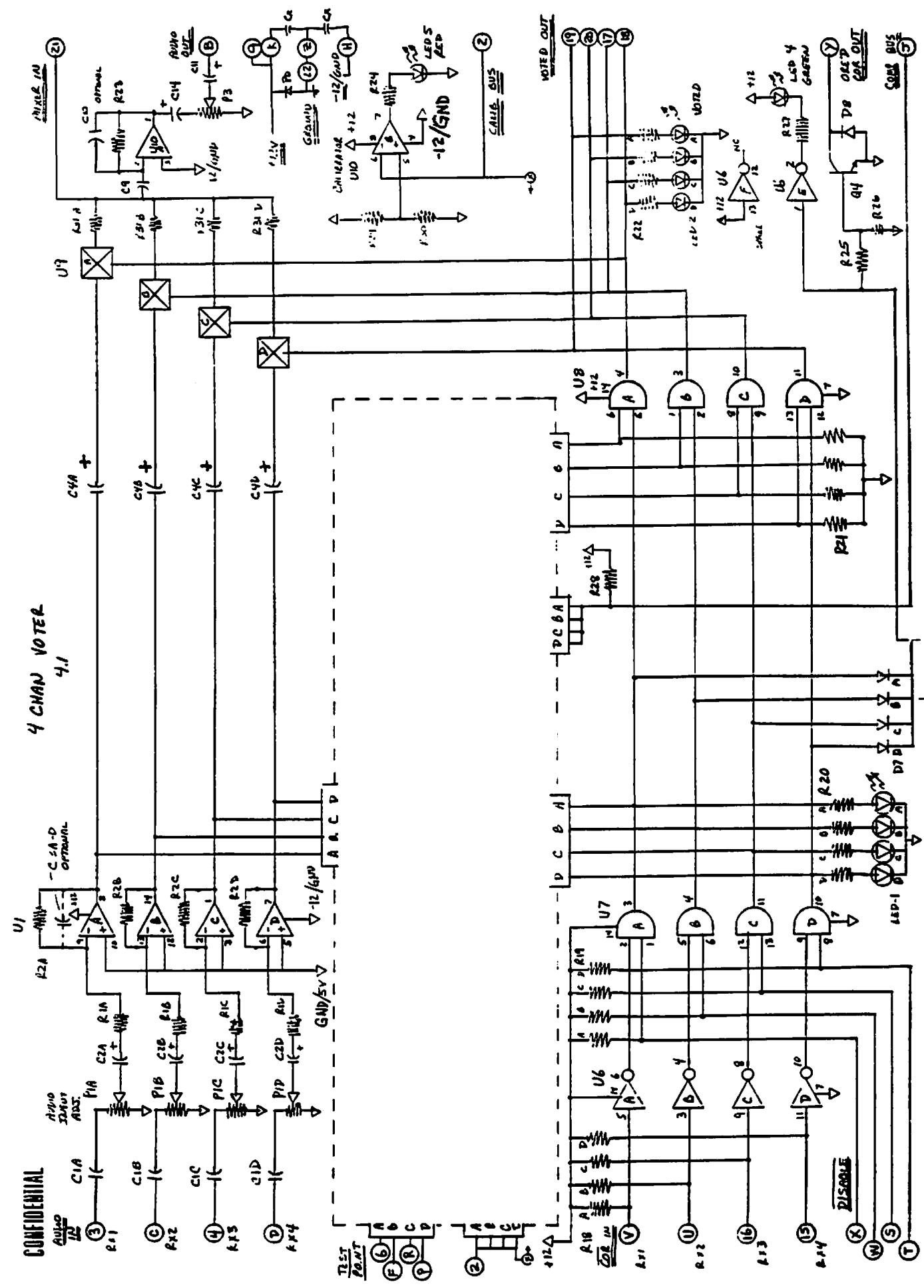
COR's all off or disabled. (disable voltages)

U8	pin 6,1,8,13	+12.5v dc
U5	pin 3,5,10,12	+12v dc
U2	Test points 1-4	+12v dc

Calibrator light will be out if switched to any receiver.

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COMPONENT SIDE

4 CHAN VOTER

4.1.3

VE

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