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***Specialized Communications Products***

# 4RV/2

4RV/2 Version 4.1.1

# VOTER MANUAL

Manual Revision 1.3
07/25/94

# CONTENTS

# INTRODUCTION

Doug Hall Electronics
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June 06, 1994

Doug Hall Electronics is proud to announce the new version of the popular 4RV Voter card. The old 4RV card is being replaced with our new 4RV/2 (4RV version 4.1) voter. Since 1984 we have sold thousands of 4RV cards and have continuously improved on the original design. With the input from our customers we have taken a big step to our new 4RV/2. Although the base comparator has remained similar, the support circuitry and construction have been completely re-engineered. We will cover the enhancements and differences between the old and the new in the following pages.

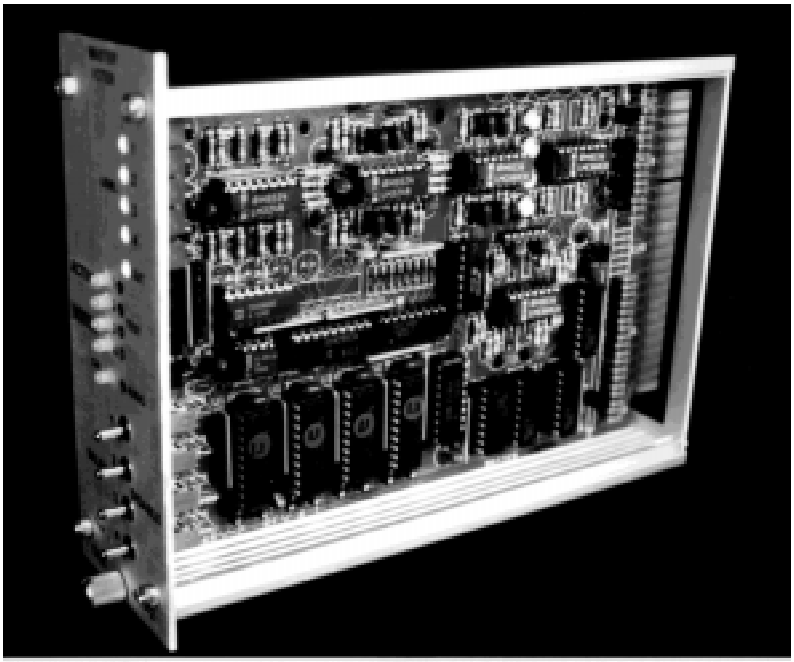
The Doug Hall Electronics Voter has been in production since 1984. With our simple philosophy and a high performance product we have enhanced the coverage of many radio systems around the world. With the high performance to price ratio we have set a new standard and made quality Voting available to a very broad and diversified market. With our close support we have adapted the original 4RV to many applications. The 4RV/2 was designed with versatility in mind.

The 4RV/2 Voter card accepts 4 audio and COR inputs (of the same audio source) and automatically selects the input channel that has the estimated best signal-to-noise signal and returns a single audio and COR as output.

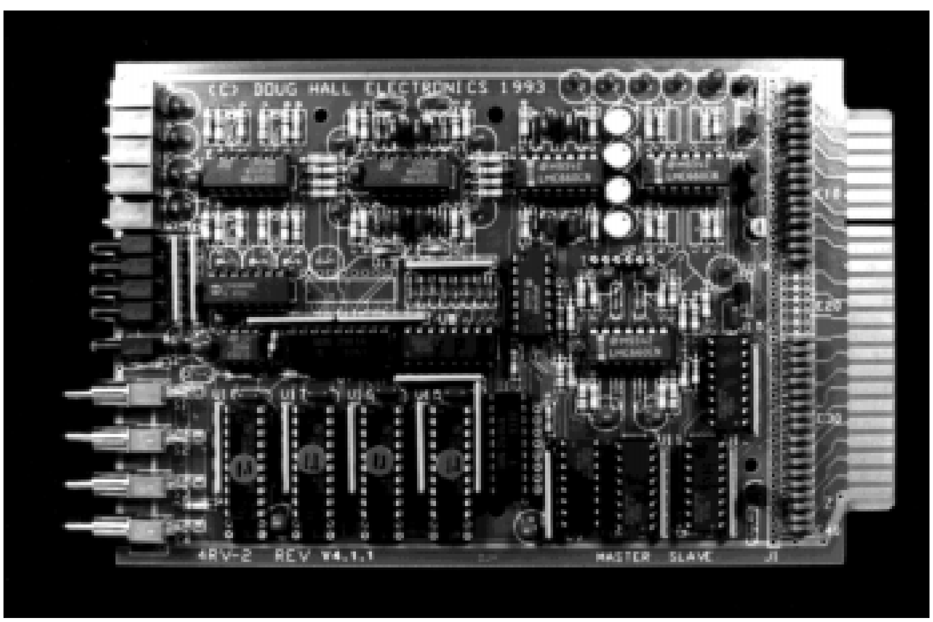
This manual covers only the 4RV/2 voter comparator section. For the VLC (voter line card) , RLC (receiver line card), or interconnection use the corresponding manual or combination manual.

# 4RV/2 PICTURES

4RV/2 module.



4RV/2 card.



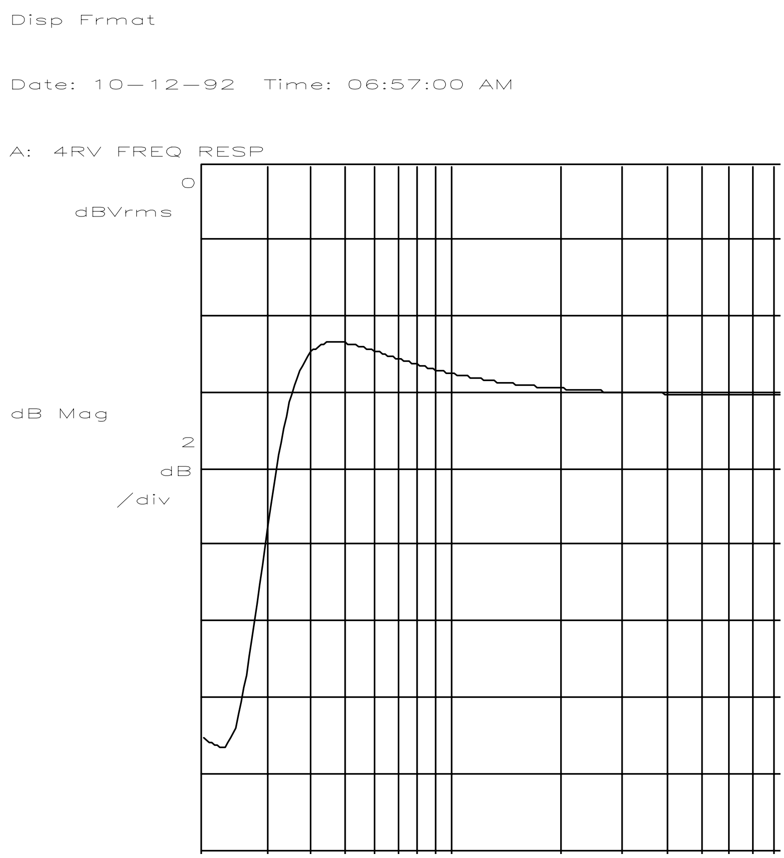
# SPECIFICATIONS

**<u>4RV Four Channel Voter</u>**

| | |
|---|---|
| Voting Method: | Signal-to-Noise. |
| Hysteresis: | Approximately 10% Factory set. See options section. |
| Capacity: | Four channels expandable to 32, 4 channels per card. |
| Voting Criteria: | Approximately 2db difference in signal-to-noise. (measured with low input noise levels) |
| Voting Time: | Continuous, fast voting - no delay or sampling, Four independent circuits working simultaneously. |
| Calibration: | Built-in audio level calibrator. Test points provided. |
| Indicators: | 5 LED’s ( 4 on slave cards. ) 4 Bicolor Voted (green) and Receiving / Active ( red ) |
| Audio in: | 100mv - 10v p-p into approximately 10K input impedance. |
| COR: | Ground is the active state (unsquelched) 12v sourced opto-isolated input with > ~2mA to ground active. |
| Mixer: | Audio mixer input available for external input. |
| Output Section: | |
| Audio: | 1v p-p adjustable with a master level pot into approximately a 5K load. |
| Distortion: | < 0.5% at rated output. |
| Frequency Response: | Ref. Figure in following pages. |
| PTT: | Ground is the active state (unsquelched). Open collector NPN output to ground and will sink at not more than 50v or 100mA. |
| Disable Inputs: | Low disabled (grounded) high enabled (open) - Same as COR inputs. |
| Voted Indicator Outputs: | +12V "VOTED" (sourced up to ~100 mA) outputs. |
| Vote-Lock time: | 1 secound + or - 0.3 secounds. |
| Vote-Lock Enable: | Ground active. |
| Test Points: | (4) Audio level calibration points - 1 per receiver on edge connector and front panel.<br>(1) Calibration bus on edge connector.<br>(1) Audio output test jack on front panel. |
| Power Requirements: | +11v to +15v regulated at < 500mA per 4 channels. |
| Dimensions: | 4.5"H x 6.8"L x 1/2"W (4.5" x 6.5") Card only. |
| 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. |
| Service: | Spare (loaner) cards available. |

# 4RV/2 FREQUENCY RESPONSE

The following graph represents the measured frequency response of the 4RV/2 voter card. The test was of just the new 4RV/2 card.



# ENHANCEMENTS

***"Vote -n- lock"***
On the new version of the voter additional circuitry was added to incorporate "vote locking" After a preset number of seconds into the transmission the voter will lock on the voted channel until its COR drops. The factory RC value sets the lock delay to one second. On data systems it can be set to the length of the carrier before data is present on a channel. Grounding pin 1 of the voter enables the " Vote Lock " mode.

***"Power Save"***
Grounding pin A of the 4RV/2 blanks the LED's for low power mode.

***Opto-Isolated I/O***
Opto-isolators were incorporated on the COR in, Disable in,  Select in, and Voted out lines. This Protects the voter circuitry from lightning damage, RF noise and static damage. The Voted out pin also provides a much higher drive current to drive external voted indicators without affecting the voters performance. The old voter was a CMOS sourced output. The new voted output is inverted and the active state is Ground and can sink 100 mA.

***EMI filtering***
All connections (except for ground) have series EMI filters to remove any RF that might be present around the voter.

***Increased dynamic range***
We have made subtle changes in the comparator circuitry to provide better voting in a wider variety of input conditions.

***Lower distortion***
Changes were made to the audio circuits to reduce the overall THD of the 4RV/2 voter card.

***Better frequency response***
Care was taken to improve the frequency response of the voter system. A plot of the frequency response is printed in the manual.

***Lower noise***
Cross channel noise and interaction were greatly improved.

***Front adjustable level pots***
Receiver input level and output level adjustments are now available on the front panel.

***Front mounted test points***
The test points for setting the levels are now available at the front panel. The calibrate procedure has been made much easier with the test jacks also connecting the calibrate LED to the channel being adjusted. (See the new calibrate procedure in the this manual.)

# ENHANCEMENTS CONTINUED

***Internal and External Select / Disable functions***
On the old model 4RV voter the select and disable functions were mechanically interlocked with the switch on the Line card. The new 4RV/2 has additional logic to allow control from both the provided switches and remoted switches.

***Programmable logic***
The logic circuitry on the new 4RV/2 is programmable to allow for custom functions and features.

***Serviceability***
More critical components are now incorporated into socketed IC's making repairs quicker and easier.

# OPTIONS

***C1. CX8 Frequency rolloff***
The 4RV/2 has provisions to add de-emphasis and frequency rolllоff to the receiver inputs. For individual input compensation adding optional CX8 (CA8,CB8,CC8,CD8) will roll off the frequency response. Values between 0.001 to 0.1 uF will provide most needed response curves. For overall output frequency rolloff adding C1 will have a global effect

***Switches***
The front mounted select / disable switches can be special ordered with an optional locking switch that would be used in console configured voters to prevent accidental changes. The standard 4RV/2 voter that will replace our old 4RV voter comes with select / disable switches. Future version of the VLC line card will not have these switches on them.

***Test points***
The front mounted test points can be omitted.

***Adjustment pots***
The front mounted pots can be ordered so that the pots are only adjustable from inside the voter module. Eliminating the hole in the front panel and removing the adjustment from the front.

***Piggy back card***
Provisions were made to allow a piggyback card to be mounted on the 4RV/2 card. J1 is a 42 pin connector allowing all edge connector pins to be available to the optional card. Mounting holes were also provided to mount the board. Optional mode switches could be mounted on this option board if necessary. I.E. "VOTE-LOCK".

***Opto Isolators***
Opto-isolators can be omitted to allow TTL level interfacing if required.

# ADJUSTMENTS

**Overview**

The voter input levels must be set to guarantee that the voter circuitry is in its operational range and the channels must be balanced for an equal comparison. An input level set too high will result in improper operation where high levels of sustained speech will limit the DC circuits of the channel that is set too high. To make the adjustment simple and provide a means of detecting when the levels are out of range a built in calibrator is provided.

The input AC levels are converted to a proportional DC level by U2. This DC level is present at each channels test jacks. The test jacks are special. When a test probe is inserted into the test jack, the proportional DC voltage is connected to the calibrate circuitry. The test jack acts as a switch. Provided with your system is a test point probe which can be inserted into the test jack to do the adjustments.

Several methods can be used to set the input levels. All methods require the signal into the receiver being adjusted to be modulated to it's maximum* expected level. This level is then used set the input stage gain to match the needs of the voter.

***Method 1 ( preferred ):***

Pick a channel to adjust first. In this example we will use channel 1 on the master voter.

With the test signal present, verify that the Active indicator is on for channel 1.
The COR must be active and the channel cannot be disabled or selected to make this adjustment. Insert the provided test probe into the jack marked TEST 1 on the master card.

The calibrate LED (red) marked CAL will light if the input level is exceeding the range of the voter. Adjust the level pot marked 1 on the master voter clockwise until the CAL led comes on.

Reduce the input level until it goes off. (Note: This calibrate procedure is deferent than previous models of the 4RV voter.) If a meter + probe tip is used it must be between 0.5 and 0.6 inches long. Connect the negative lead to the Master voter GND test point. A meter should indicate approximately 8.4 volts DC. (Note: The 4RV/2 voter does not internally connect ground to the chassis of the rack.)

Once channel 1 is set to the working range of the voter, just match the levels of the other channels to channel level. This is best done by using a scope or a dB meter the audio output at the Audio test jack.

# ADJUSTMENTS CONTINUED

Select channel 1, note the audio level on the scope or meter.  Provide the next channel with the input signal. Now select (with the select switch) the channel being adjusted and adjust the input level pot so the audio output level  matches the level noted on channel 1.

Repeat these steps for each channel used.

* The maximum input audio level should be the same source used on all channels at the "on channel" receiver input, not links. This adjustment and voter operation requires that no limiting of the original source through linking equipment be present.

***Method 2:***

Adjust all channels to the built in calibrator as channel 1 was in method 1.

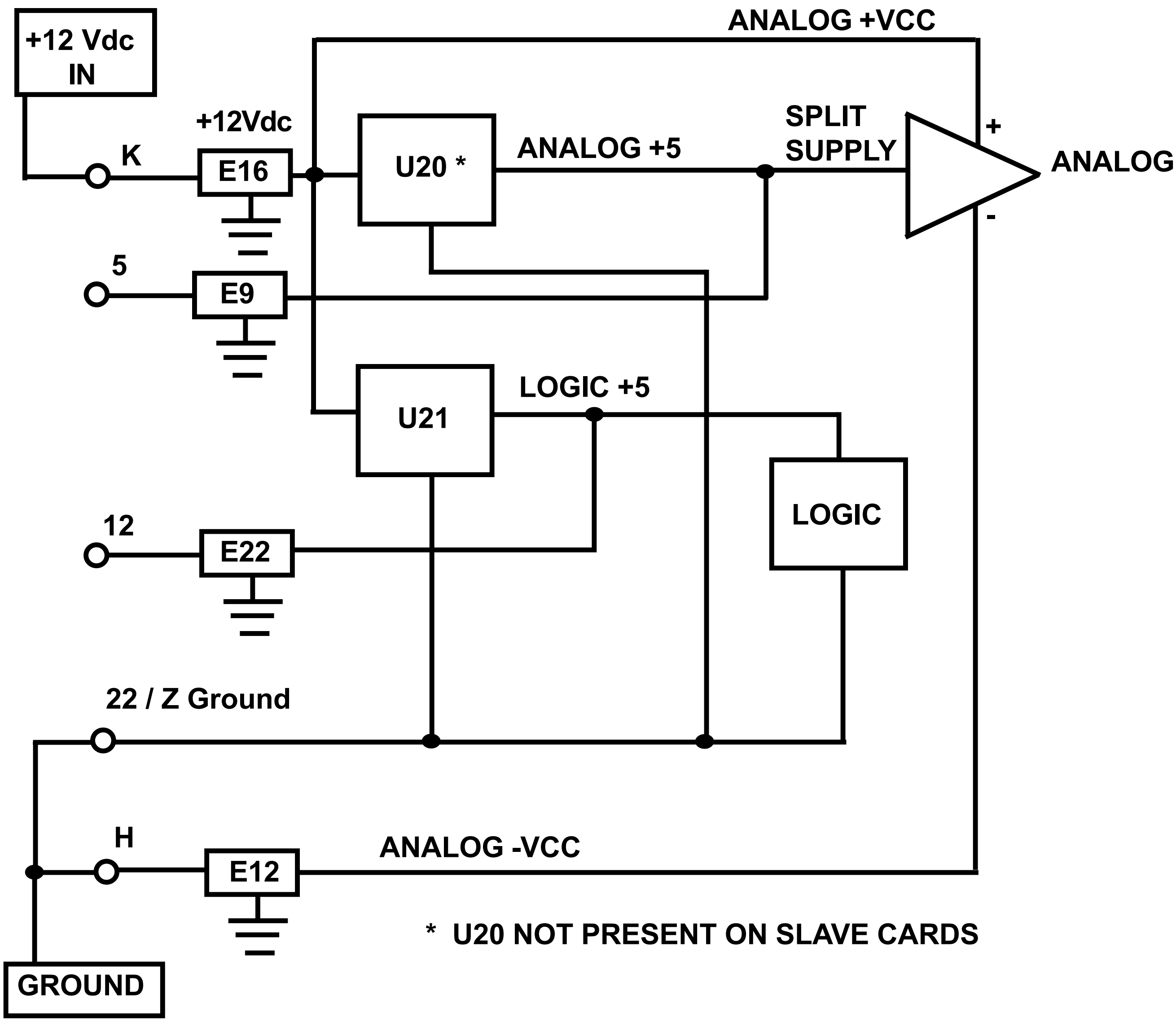
***Method 3:***

Adjust all test point levels to 8.4 V with *maximum input level.

Note: Any limiting of the linking equipment will result in mis-voting. If using RF links, keep the link transmitter out of limiting by setting the link transmitter limiter to the maximum allowed. Set the audio coupling (gain) so that the maximum input level at the receiver will not drive the transmitter deviation near limiting. I.E.: With a 6 kc signal into the receiver, deviation on the link should be only 3.5 to 4 kc out the transmitter.  Most transmitters start limiting below 5kc, so to stay out of limiting / compression, reduce the gain in the linking equipment.

# POWER SUPPLY WIRING

The power suppy should be +11.5 to 12.5 Vdc regulated. The 4RV/2 requires the power wiring as follows: +12 pins 9 / K. Ground must be tied to Z / 22 / H.




**Pin 5 = Analog split supply out to slave cards**
**Pin 12 = +5v Logic out, not tied to slave**

# EXPANDING PAST 4 CHANNELS

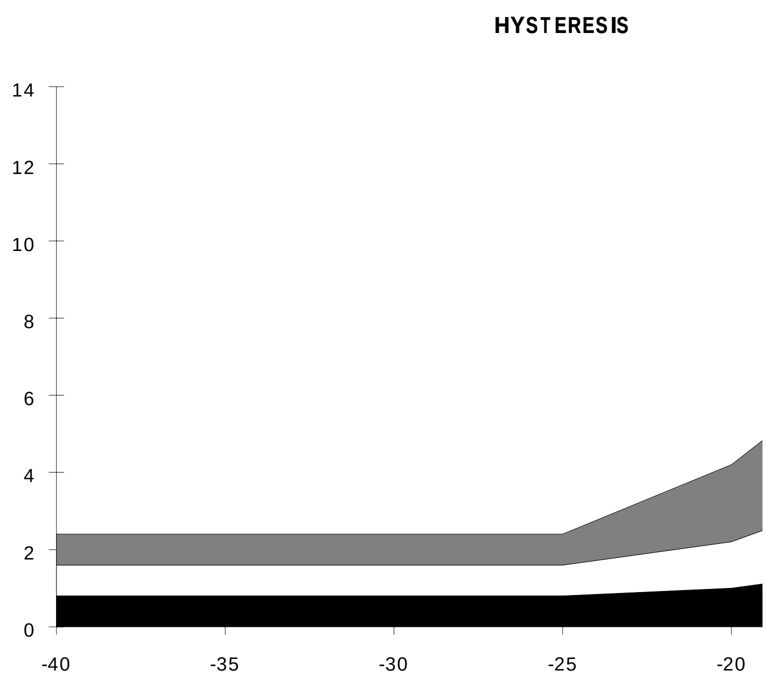
To expand past 4 channels the following pins need to be connected between 4RV/2 Master and slave cards:
Pins 2, 5, H, J , 9, Z, 22, 21, Y.

Reference page 23 for the list of parts that are removed on slave cards. *

# HYSTERESIS OPTIONS

The 4RV/2 has a socket for an optional hysteresis resistor pack RX32 next to U6. The chart bellow displays the hysteresis curves for all the recommended options. The "NORM" curve has been optimized for best overall results in almost every condition. Increases in the hysteresis will reduce voting but also reduce the effectiveness of the system. This was made an option to make the 4RV/2 as versatile as possible.

The resistor packs are 4 separate resistors in an in-line 0.1" package. The Physical layout shows the resistors as separate components.



# VOTE-LOCK OPTIONS

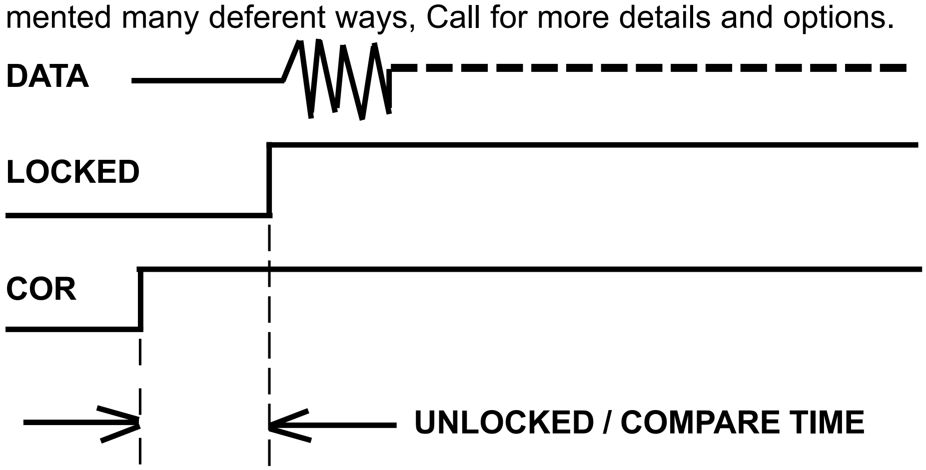
The 4RV/2 has a new *"Vote-Lock"* option. The lock option will vote freely for the first second / seconds. The factory setting is approximately 1 second. After that time, the channel voted at that time will stay voted throughout the transmission or until the locked channel COR is removed. At that time the best remaining channel will then vote and stay voted. This allows for a "Single" vote mode, versus a "Continuous" voter mode. This is used when voting during a transmission is not permitted such as during data transmissions.

In data systems, a front porch or quiet window on the beginning *"n"* seconds will allow the voter to determine the best channel, after the predetermined time, the voter would lock on that channel to prevent any interruption of the data transmission.

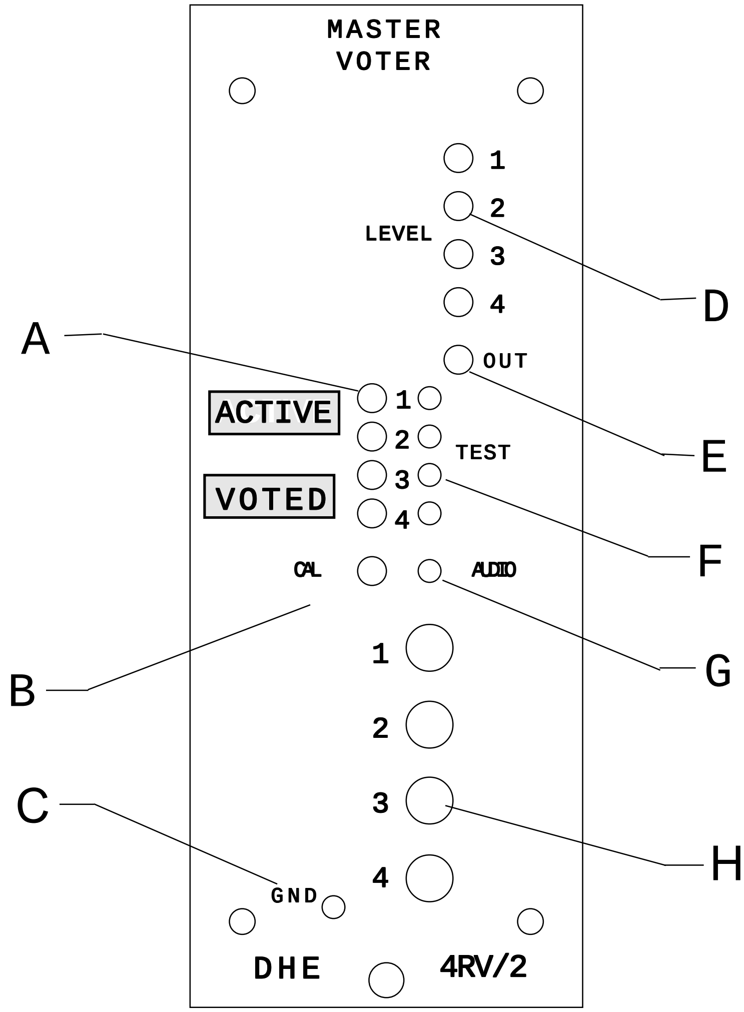
The factory implemented unlocked time is approximately 1 second.  To enable the "Vote-Lock" mode ground pin 1 on the voter edge connector. On the 4RVMB there originally no provision for the *"Vote-Lock"* mode. Therefore no connection is made to this pin. In systems with more than 4 channels these pins must be tied together to operate correctly. The values of R7 (220K) and C12 (10uF) determine the lock timing. R7 can be reduced in value decreasing lock timing. R7 can be between 220k to 10k. C12 should not exceed 20uF.

Each 4 channel card keeps track of the unlocked time independently starting when any COR input to that card comes active. This would be the standard use of the *"Vote-Lock"* function built into the 4RV/2.

To implement fully synchronized locking (on more than 4 channels) or to use a time much different than the factory setting will require an external implementation.  This implementation will require the *"Lock Enable"* pin to function as an external lock input. Remove C12 on all voter cards to provide the *"External Lock Input"*. The lock timing will now be external, based on the *COR Out* going active (grounded) and delaying a given number of milliseconds / seconds. After the timer expires, it would then ground the *"External Lock Input"* pin on all the voters simultaneously. J1 on the master has all the connections necessary to facilitate the external implementation as a piggy back card. Custom applications can be implemented many deferent ways, Call for more details and options.



# FRONT PANEL DETAIL




A - BICOLOR LED INDICATORS FOR EACH OF THE 4 CHANNELS. RED FOR RECEIVING OR ACTIVE, AND GREEN FOR VOTED.

B - RED LED FOR OPTIONAL AUDIO INPUT LEVEL SETTING.

C - GROUND TEST JACK FOR METERING TEST POINTS.

D - AUDIO INPUT LEVEL POTS.

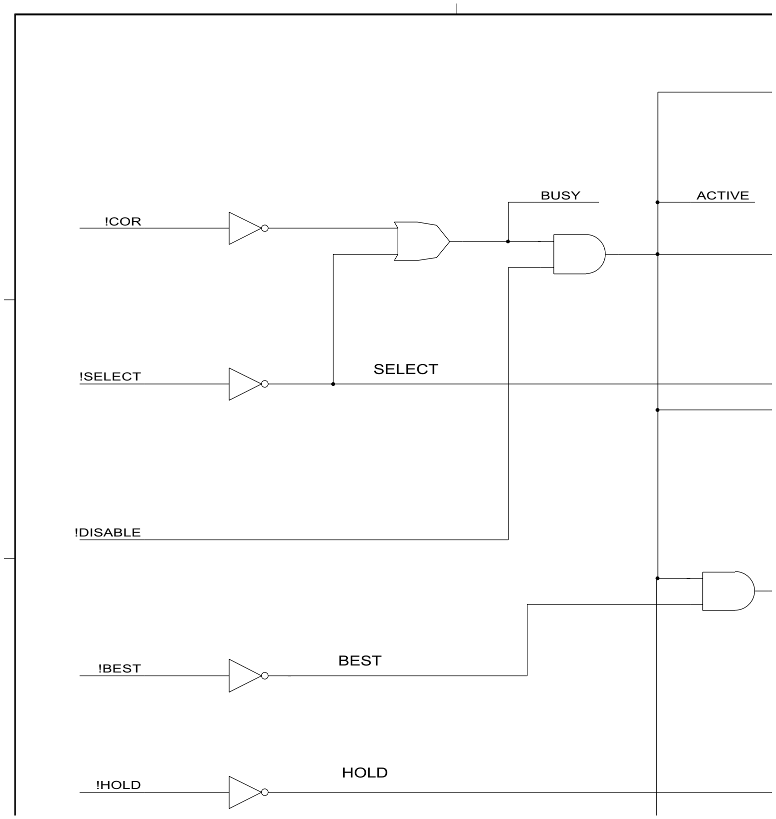
E - AUDIO MASTER OUTPUT POT, ONLY PRESENT ON THE MASTER VOTER.

F - TEST JACKS FOR LEVEL SETTING. PRESENT ON THESE JACKS ARE THE DC LEVELS PROPORTIONAL TO THE VOTER INPUT SET LEVEL. WHEN THE PROVIDED TEST PIN IS PLACED IN THE JACK THE (B) CAL. LED WILL ILLUMINATE RED WHENEVER THE INPUT LEVEL EXCEEDS THE MAXIMUM SET POINT. ONLY ONE JACK SHOULD BE METERED AT A TIME.

G - AUDIO OUTPUT TEST JACK.

H - SELECT / DISABLE SWITCHES.

# LOGIC BLOCK DIAGRAM




LOGIC EQUIVALENT DIAGRAM OF U15-U18

# EDGE CONNECTOR PINOUT

| SIGNAL NAME | EDGE PIN # |
|---|---|
| GROUND | |
| - LED BLANKING | A |
| AUDIO OUT | B |
| AUDIO CHAN B IN | C |
| AUDIO CHAN D IN | D |
| + 5V ANALOG GROUND IN/OUT | E |
| TP CHAN B OUT | F |
| GND / ANALOG -VCC | H |
| COMPARATOR BUS | J |
| + 12 V IN | K |
| RESERVED | L |
| RESERVED | M |
| RESERVED | N |
| TP CHAN D OUT | P |
| TP CHAN C OUT | R |
| DISABLE CHAN C IN | S |
| DISABLE CHAN D IN | T |
| COR CHAN B IN | U |
| COR CHAN A IN | V |
| DISABLE CHAN B IN | W |
| DISABLE CHAN A IN | X |
| COR OUT | Y |
| GROUND | Z |
| [illegible] | [illegible] |

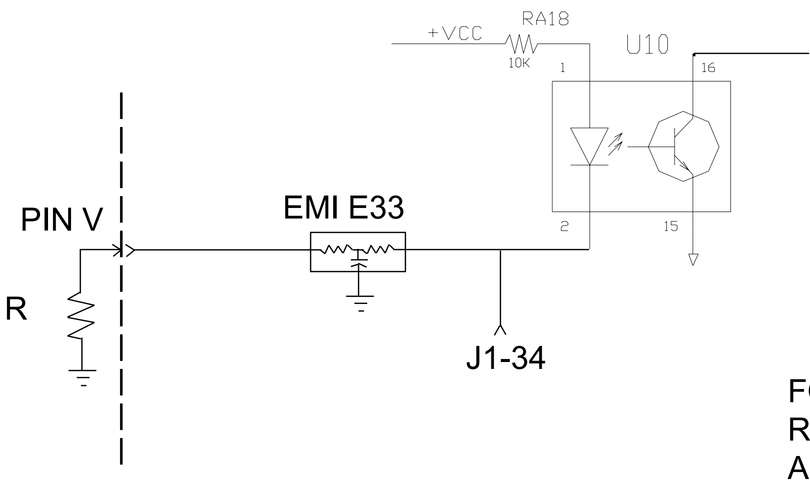
# EDGE CONNECTOR DIAGRAM

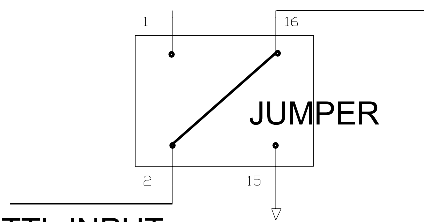
4RV VOTER CARD PINOUT
SHOWN FROM THE CONNECTOR END
CONNECTOR SIMILAR TO VECTOR R644 44 PIN 0.156" SPACING

| COMPONENT SIDE | | | FOIL SIDE |
|---|---|---|---|
| $\overline{\text{BLANKING}}$ | A | 1 | $\overline{\text{LOCK ENABLE}}$ |
| 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 |
| +5 (ANLG GND) | E | 5 | +5 (ANLG GND) |
| RCVR #2 T.P. | F | 6 | RCVR #1 T.P. |
| GROUND (ANLG -V) | H | 7 | $\overline{\text{SELECT}}$ RCVR #2 |
| COMPARATOR BUS | J | 8 | $\overline{\text{SELECT}}$ RCVR #1 |
| +12 Vdc | K | 9 | +12 Vdc |
| RESERVED | L | 10 | RESERVED |
| RESERVED | M | 11 | RESERVED |
| RESERVED | N | 12 | +5 (LOGIC VCC) |
| RCVR #4 T.P. | P | 13 | $\overline{\text{SELECT}}$ RCVR #3 |
| RCVR #3 T.P. | R | 14 | $\overline{\text{SELECT}}$ RCVR #4 |
| RCVR #3 $\overline{\text{DISABLE}}$ | S | 15 | RCVR #4 $\overline{\text{COR}}$ |
| RCVR #4 $\overline{\text{DISABLE}}$ | T | 16 | RCVR #3 $\overline{\text{COR}}$ |
| RCVR #2 $\overline{\text{COR}}$ | U | 17 | RCVR #2 $\overline{\text{VOTED}}$ |
| RCVR #1 $\overline{\text{COR}}$ | V | 18 | RCVR #1 $\overline{\text{VOTED}}$ |
| RCVR #2 $\overline{\text{DISABLE}}$ | W | 19 | RCVR #4 $\overline{\text{VOTED}}$ |
| RCVR #1 $\overline{\text{DISABLE}}$ | X | 20 | RCVR #3 $\overline{\text{VOTED}}$ |
| $\overline{\text{COR}}$ OUT | Y | 21 | AUDIO MIXER IN |
| GROUND | Z | 22 | GROUND |

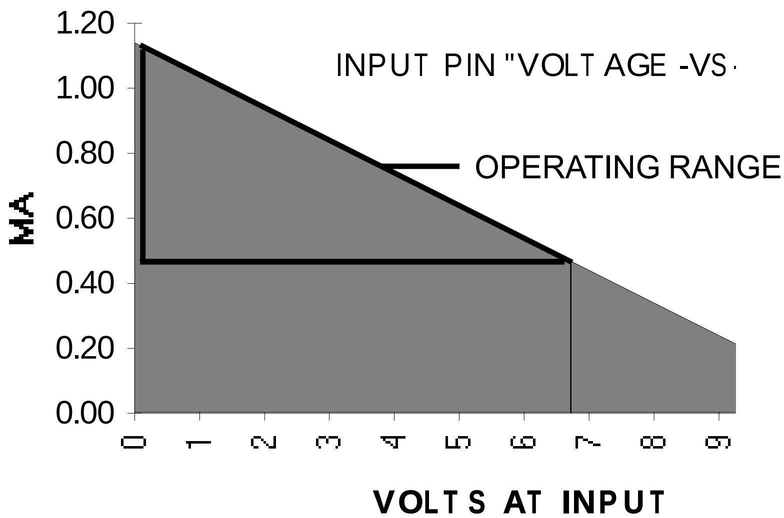
# LOGIC INPUT DETAIL

EXAMPLE CHAN A COR IN




FOR TTL INPUT
REMOVE THE OPTOISOLATOR
AND REPLACE IT WITH A
JUMPER 2-16, 4-14, 6-12, 8-10




The minimum resistance to ground to produce an active COR is 7.5k or at least 0.5 mA is required.

| | A | B | C | D |
|---|---|---|---|---|
| 1 | SIGNAL | PIN | SIGNAL | PIN |
| 2 | COR A | V | DISABLE A | X |
| 3 | COR B | U | DISABLE B | W |
| 4 | COR C | 16 | DISABLE C | S |
| 5 | COR D | 15 | DISABLE D | T |
| 6 | | | | |
| 7 | SELECT A | 8 | VOTED OUT A | 18 |
| 8 | SELECT B | 7 | VOTED OUT B | 17 |
| 9 | SELECT C | 13 | VOTED OUT C | 20 |
| 10 | SELECT D | 14 | VOTED OUT D | 19 |

# IC PIN -TO- CHANNEL TABLE

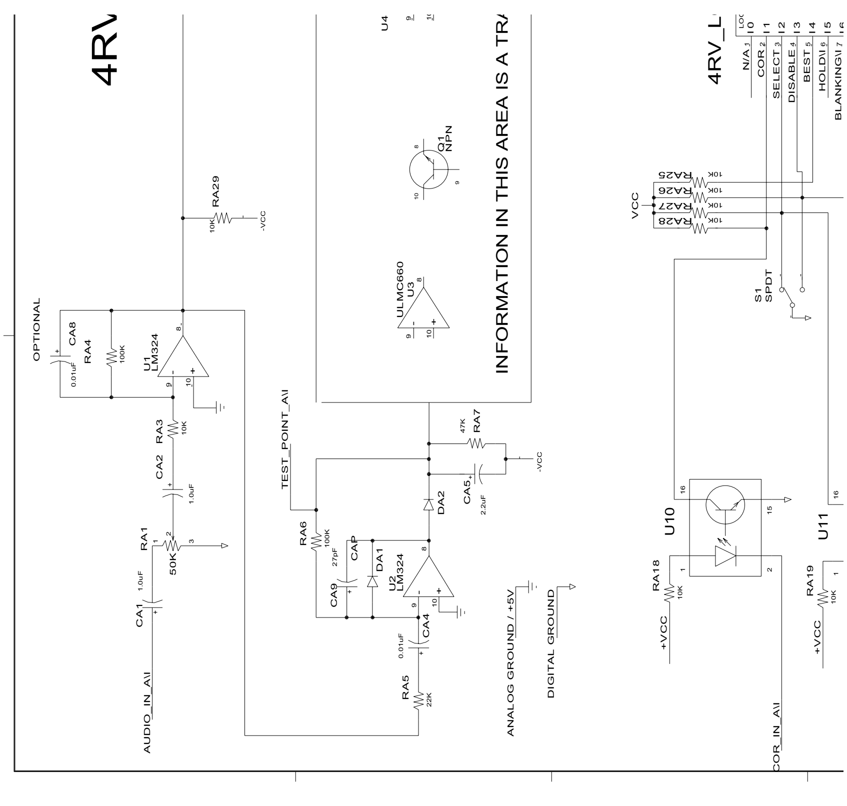
| U1,U2,U3 | LM324 |
| --- | --- |
| U4,U5 | LMC661 |
| + VCC | 4 |
| -VDD | 11 |
| CHAN A | |
| IN + | 10 |
| IN - | 9 |
| OUT | 8 |
| CHAN B | |
| IN + | 12 |
| IN - | 13 |
| OUT | 14 |
| CHAN C | |
| IN + | 3 |
| IN - | 2 |
| OUT | 1 |
| CHAN D | |
| IN + | 5 |
| IN - | 6 |
| OUT | 7 |

| U8,U9,U10 | PS2501-4 |
| --- | --- |
| U11,U12 | PIN |
| CHAN A | |
| ANODE IN | 1 |
| CATHODE IN | 2 |
| COLLECTOR OUT | 16 |
| EMITER OUT | 15 |

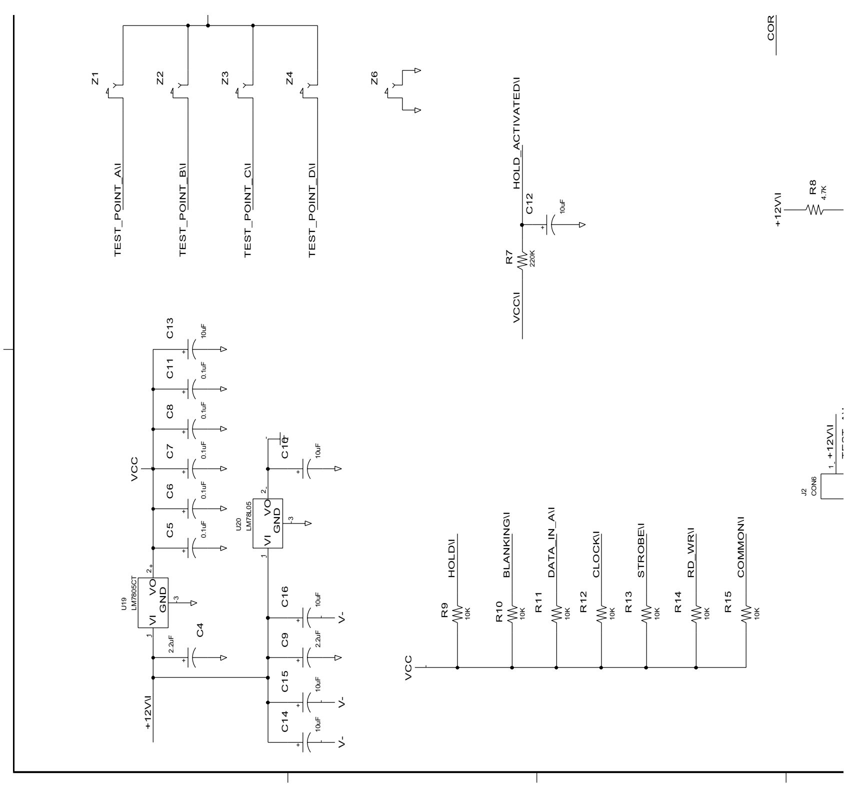
| U6 | UDN2595 |
| --- | --- |
| + VCC | 9 |
| GND | 10 |
| CHAN A | |
| IN | 1 |
| OUT | 18 |
| CHAN A | |
| IN | 2 |
| OUT | 17 |
| CHAN B | |
| IN | 3 |
| OUT | 16 |
| CHAN B | |
| IN | 4 |
| OUT | 15 |
| CHAN C | |
| IN | 5 |
| OUT | 14 |
| CHAN C | |
| IN | 6 |
| OUT | 13 |
| CHAN D | |
| IN | 7 |
| OUT | 12 |
| CHAN D | |
| IN | 8 |
| OUT | 11 |

| U7 |
| --- |
| + VCC |
| GND |
| CHAN A |
| IN |
| OUT |
| CHAN B |
| IN |
| OUT |
| CHAN C |
| IN |
| OUT |
| CHAN D |
| IN |
| OUT |
| CHAN A |
| IN |
| OUT |
| CHAN B |
| IN |
| OUT |
| CHAN C |
| IN |
| OUT |
| CHAN D |
| IN |
| OUT |

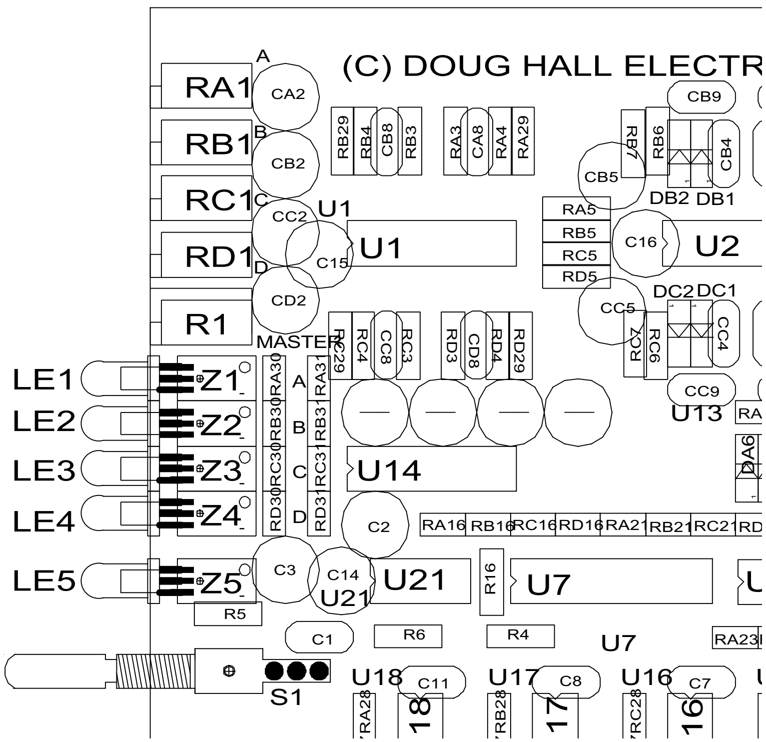
# CIRCUIT DIAGRAM, COMPARATOR



# CIRCUIT DIAGRAM, COMMON



# 4RV PARTS LAYOUT




PARTS LAYOUT

# PARTS LIST

| Part | Value | Part | Value |
|---|---|---|---|
| C1 | OPTIONAL | DA1 | 1N4148 |
| C2 * | 1.0uF | DA2 | 1N4148 |
| C3 * | 2.2uF | DA3 | 1N4148 |
| C4 | 2.2uF | DA4 | 1N4148 |
| C5 | 0.1uF | DA5 | 1N4148 |
| C6 | 0.1uF | DA6 | 1N4148 |
| C7 | 0.1uF | DB1 | 1N4148 |
| C8 | 0.1uF | DB2 | 1N4148 |
| C9 | 2.2uF | DB3 | 1N4148 |
| C10 | 10uF | DB4 | 1N4148 |
| C11 | 0.1uF | DB5 | 1N4148 |
| C12 | 10uF | DB6 | 1N4148 |
| C13 | 10uF | DC1 | 1N4148 |
| C14 | 10uF | DC2 | 1N4148 |
| C15 | 10uF | DC3 | 1N4148 |
| C16 | 10uF | DC4 | 1N4148 |
| CA1 | 1.0uF | DC5 | 1N4148 |
| CA2 | 1.0uF | DC6 | 1N4148 |
| CA4 | 0.01uF | DD1 | 1N4148 |
| CA5 | 2.2uF | DD2 | 1N4148 |
| CA6 | .01uF | DD3 | 1N4148 |
| CA7 | 10uF | DD4 | 1N4148 |
| CA8 | OPTIONAL | DD5 | 1N4148 |
| CA9 | 27PF | DD6 | 1N4148 |
| CB1 | 1.0uF | | |
| CB2 | 1.0uF | LE1 | LED |
| CB4 | 0.01uF | LE2 | LED |
| CB5 | 2.2uF | LE3 | LED |
| CB6 | .01uF | LE4 | LED |

The 4RV/2-SP Spare parts kit is available. It includes all IC's and active components in the quanaties used on one master 4RV/2 card. Also included are the optional hysteresis resistor networks.

U15-U18 are DHE programmed Gate Array Logic.