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RC210 Repeater Controller

Hardware Manual

Hardware Version 3.0a

April 25, 2005

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Introduction

Congratulations on your purchase of the RC210 Repeater Controller. By harnessing the power of state-of-the-art RISC microprocessor technology in a sophisticated 3 port design and the resulting reduction in required components, the RC210 provides your repeater with a rugged, reliable and expandable controller with features usually found in controllers costing hundreds of dollars more.

The RC210 continues the Arcom tradition started with our RC-110 Repeater Controller by making updates to the operating firmware available for free to purchasers of the RC210. As updates become available, they are posted on our website and available free of charge to any RC210 owner. Installing updates requires no more than a computer running Windows 95/98/NT/2000/XP with a serial (or USB) port. With the RC210, you just download the free update and upload it into your RC210 in minutes!

Features

- Three port design - Each port may be operated independently with its own hang time, ID's and Courtesy Tones.
- Selectable Monitor Mute/Monitor Mix audio for each link port and selectable cross linking ability between ports
- Each port may be defined as half or full-duplex
- 240+ word vocabulary in real human speech. May be used in programmable ID's or other messages
- On-board DVR for recording your own custom messages over the air (may be used in any programmable message)
- Fully programmable command codes up to 8 digits each
- Automatic ID rotation with Initial and Pending ID's and timers.
- Programmable CW messages programmable dual-tone and speed, on a per port basis
- Gated audio on all ports with selectable de-emphasis - you may tap directly off the discriminator without regard for squelch action or de-emphasis on any port
- True sine wave microprocessor generated tones
- Use of low-noise, high-impedance JFET op amps for exceptional audio quality
- 40 Command Macros that can store up to 15 commands each, including other macros
- 50 Command Macros that can store up to 4 commands each, including other macros
- Each port has its own dedicated DTMF decoder
- DTMF Pad Test where entered digits are read back by the controller
- Selectable CTCSS/Carrier squelch modes on all ports.
- General purpose timers for specially timed events
- Each port may be defined to require CTCSS or not require CTCSS for DTMF operation
- Selectable Enable/Disable of DTMF on all ports
- Selectable polarity of COS and CTCSS signals on each port
- Selectable CTCSS encode control output with programmable delay dropout for controlling external CTCSS encoder on each port
- Frequency agile Remote Base operation, including transmitter offset and CTCSS selection.
- 8 A/D inputs for voltage or current measurements with 6 custom definable meter faces
- 3 auxiliary audio inputs for use with a weather receiver, autopatch or other external audio source
- A/D inputs protected against over or negative voltages
- Scheduler with 20 setpoints
- Choice of DB9 or RJ45 connectors for radio port connection.
- 5 digital inputs
- LED displays of controller status
- 7 user controllable digital outputs for remote control - expandable to 23
- Programmable timers, including hang time, timeout and ID interval
- Hardware watchdog timer
- Fan control with programmable shut off timer

Description of Features

The RC210 provides 3 radio "ports", each of which may be operated independently or in unison with the others. With simple programming, each port can be configured as follows:

A Standalone Repeater

A signal received on that port's receiver is retransmitted out that port's transmitter. Each port has its own independent hang timer, timeout timer, 10 courtesy tones and dedicated DTMF decoder, so you may operate one RC210 to control 3 independent repeaters. On command, any port may be tied to any other port for linking purposes.

Half-Duplex Or Full-Duplex Link

If a port is configured as half-duplex, a signal received on that port's receiver is NOT retransmitted out that port's transmitter. Through DTMF commands, the receiver's COS (and CTCSS signal, if so equipped) and audio is routed to either - or both - of the other ports. This is useful for linking to other sites or connecting your system to an EchoLink®, IRLP® or other such system.

Control Receiver

Because of the RC210's ability to control any Port from any other Port, there is no need for a special, dedicated control receiver port. By using the right combination of Macro Functions, you can easily and quickly disable or enable any function the RC210 is capable of performing. For example, you have a repeater on Port 1 and a link on Port 2.

Remote Base

Any port can be used for a remote base - a half-duplex (or simplex) radio connected to the repeater system that allows the repeater users to remotely operate on a different frequency/mode/band than the repeater. Frequency, transmitter offset and CTCSS may all be remotely programmed over the air. The RC210 also supports control of Kenwood mobiles that provide for DTMF control through their microphone port. The complete list of supported remote base radios can be found in Appendix A.

Regardless of how you configured a port, each one provides all signals needed for the radio connected to it (COS, transmit and discriminator audio, CTCSS encode and decode). You have a choice of either DB9's or RJ45 modular jacks as your radio port connector. COS and CTCSS decoder input polarity is selectable through easy-to-use push-pin jumper blocks, so the RC210 can accommodate just about any radio available.

Audio gating is provided on each radio port so you may obtain audio directly from the receiver's discriminator without the worry of finding a source of gated audio in the receiver. De-emphasis is also provided on each port. However if you don't need de-emphasis on any particular port, it's a simple matter to change a jumper (no soldering required) and obtain "flat" audio (20 hz to 15Khz) throughout the audio chain. The use of low-noise JFET operational amplifiers ensures good gain, high input impedance, and very clean audio.

DTMF tones are normally muted on ALL ports however you can turn off muting on a port-by-port basis. This allows for passing DTMF tones out a link.

Any port can be used for entering DTMF commands, even programming commands for other ports. Since each port has its own, dedicated DTMF decoder, a command can be entered from any port uninterrupted regardless of activity on other ports.

Many timers are provided, such as repeater transmitter hang time, timeout, ID intervals, how long the cooling fan should remain on after the transmitter unkeys, and more. These timers are remotely programmable.

The RC -210 incorporates true human speech. A custom, repeater oriented vocabulary is provided for use in IDs, alarm and other controller messages. In addition, the on-board digital voice recorder allows the recording of up to 20 custom recordings which may also be used in these messages.

All parameters of the controller can be remotely programmed using DTMF. Timers, control codes, port configuration and messages can all be changed at the whim of the repeater owner. All the command codes may be programmed to your own, special and unique code. This makes the RC210 very easy to incorporate into existing systems without users having to relearn code structures. All parameters are stored in non-volatile EEPROM, so your settings are retained even if the controller loses power.

The controller's programming is protected from unauthorized access by the use of 3 different 5-digit secret passcodes - one used for each port. Each port may be programmed independently without affecting the others.

The RC -210 represents all numbers in standard decimal notation. In other words, you don't need to worry about converting programming parameters to hexadecimal notation before actually programming anything.

There are 7 buffered general-purpose digital outputs also provided that can be used to remotely control devices at the repeater. Alternately these outputs can be programmed to perform other tasks. With the addition of simple external shift registers, these can be expanded to 64 outputs.

The controller uses flash memory to store its operating program. Just plug your computer into the RC -210's programming port and you can upload updates in minutes.

A Word About Identification

The RC210 provides an intelligent algorithm for ID sequences to minimize disruption to ongoing repeater communications, while providing entertaining messages and meeting FCC requirements for repeater identification.

If the repeater has not been in use for a period of time and a new user keys the repeater, the controller will ID after he unkeys with one of the three Initial ID messages (these messages automatically rotate). This message could say "Welcome" followed by the callsign, or some other such "friendly" message.

After the Initial ID is finished, the Pending ID timer starts to run. After it times out, it looks to see if any repeater activity has occurred since the Initial ID played. If there has been activity and no user is currently talking, the Pending ID is played. Otherwise, the controller waits for no user and then will send the Pending ID message.

Specifications

Microprocessor:	Atmel ATmega128 RISC processor running at 16 Mhz
Program Memory:	128K Bytes - Flash EEPROM
Running Memory:	4K Bytes RAM, 4K Bytes EEPROM
Speech Method:	ISD 4003 series VoiceCorder© IC
Logic Inputs:	Low < .8 volts High: 5 volts max
Analog Inputs:	0 - 5 vdc maximum
Logic Outputs:	90v @ 500 ma open collector
Audio Inputs:	High impedance >10K
Audio Outputs:	up to 6 volts p-p
Power Requirement:	11.5 to 15V dc @ 60 ma.
Operating Temp:	-15 to +55 degrees C (5 to 150 degrees F)
Board size:	9.0 x 5.2 inches (9.0 x 5.4 inches including connectors)
Connectors:	Phoenix 4 pin power connector (mating plug included with RC210) DB-25 female for I/O and A/D. Radio ports are DB9 or RJ45

Hardware Reference

Power

The RC210 requires anywhere from +11.5 to +15 vdc at 60 ma. This voltage source should be clean, filtered DC. Power connection is made through a Phoenix power connector and the mating plug is included with the RC210. There is no need to worry about using a fuse, as the RC210 is protected by an on-board, self-resetting fuse. Once the overload condition is cleared, the fuse will automatically reset.

Table 1 shows the connections.

Table 1

Pin Number	Description
1	+11.5 to 15 V DC @ 60 ma
2	Battery backup
3	Digital Gnd
4	Analog Gnd

Note: Pin 1 is closest to the DB25 I/O connector

There are two grounds provided to prevent digital noise from appearing on the audio channels - digital ground and analog ground. It is important that these two grounds are kept separate and run directly to the negative (-) terminal of the power source (**BOTH GROUND CONNECTION MUST BE MADE**). The battery backup pin may be used to insure the controller remains powered during power outages. This will allow the RC210 to continue to function and the on-board real time clock will not lose time. If this connection is made, the RC210 automatically and instantaneously switches power.

Carrier Operated Switch

The signal from the receiver which indicates that a signal is present is called COS. The RC210 can accommodate a COS signal that presents either a logic high (5 to 15 volts dc) or a logic low (< .8 vdc) when a signal is present. Table 2 shows the settings of the corresponding jumpers.

Table 2

Jumper	Description	Pins 1 & 2	Pins 2 & 3
JP1	Port 1 CTCSS	Active Low	Active High
JP2	Port 1 COS	Active Low	Active High
JP3	Port 2 CTCSS	Active Low	Active High
JP4	Port 2 COS	Active Low	Active High
JP5	Port 3 CTCSS	Active Low	Active High
JP6	Port 3 COS	Active Low	Active High

The RC210 presents a high impedance on its logic inputs (>10K ohms), you can choose a point in the receiver without concern that the controller will "load it down". These specifications apply to all logic inputs used with the RC210.

Sub-Audible Tone Decoder

In addition to the COS signal, the controller can optionally use a signal derived from an external CTCSS (*continuous tone controlled squelch switch*) decoder on each port. If this option is used, the controller can be commanded to require users to use sub-audible tone with their transmissions on that port. The RC210 accommodates either a logic high (5 to 15 vdc) or a logic low (< .8 v) when a valid tone is detected. This is set using the jumper settings, as shown in Table 2.

Push-To-Talk

The controller provides a solid-state switch closure to ground, capable of sinking 500 ma from a positive source at a voltage of up to 100 vdc. This should accommodate just about any radio on the market.

Receiver Audio And De-Emphasis

Audio from the receivers needs to be supplied to the controller and is controlled by a crosspoint switch matrix under microprocessor control. Each receiver's audio is routed to the appropriate transmitter(s) as needed.

The audio circuitry in the controller allows for a variety of signal levels and impedances. It is capacitively coupled, which means that a dc level may be present on the signal provided. The level is internally adjustable, so a fairly wide range of levels is acceptable, but for best results the level should be between .5 and 2.5 volts peak-to-peak. This should accommodate just about any receiver.

The input impedance is high (>10K) , so that audio may be picked off anywhere inside the receiver without loading problems. Supplied audio does not need to be de-emphasized nor gated, as the controller takes care of this for you. If you choose a point inside the receiver that is already de-emphasized, you can remove the jumper to disable the controller's de-emphasis circuitry. In this case the controller's audio input stage will provide flat audio. Table 3 shows how to configure these jumpers

Table 3

JUMPER	PORT #	DE-EMPHASIS	FLAT
JP7	1	ON	OFF
JP8	2	ON	OFF
JP9	3	ON	OFF

Transmitter Audio

Audio is supplied from the controller to the various transmitters. This audio consists of receiver, speech and tone audio, switched and mixed under control of the CPU in the controller.

The audio is high level and medium impedance, so it's easy to find a good place to inject it into the transmitter. The high level minimizes hum and noise pickup and may be knocked down at the transmitter if necessary. However the level is internally adjustable and this option should rarely be necessary. The output is capacitively coupled, so you connect it without concern of dc voltage at the point of connection to the transmitter.

DTMF Decoders

Each port has its own dedicated DTMF decoder, with each decoder being connected full time to its respective port. DTMF may be entered at any time from any port without regard to activity on the other ports. The controller will store the commands and act on them in the order they were received. Each decoder may be configured to require CTCSS in order to function or not require CTCSS.

Indicator LEDs

LED's are provided for monitoring all the Port's COS, CTCSS, PTT and Valid DTMF signals. These can be useful for setting up and verifying operation of these various signals and are marked directly on the PC board. In order to reduce power consumption when the LEDs do not have to be powered up, the push-on jumper on JP13 may be removed. If mounting the RC210 in a cabinet, a switch may be connected to JP13 to allow the operator to conveniently turn the LEDs on and off as needed.

Auxiliary Audio Inputs

These inputs allow you to add external audio devices without using one of the radio ports. For example, you could connect a weather receiver to one and be able to monitor weather conditions on demand. If the weather receiver has an output that is triggered when a S.A.M.E. Alert is issued, you can use one of the Alarm inputs on the RC210 to automatically trigger one (or all) of the transmitters.

The Auxiliary Audio Inputs do not provide any means for adjusting their level, so you must provide this capability in your interface between your audio source and the RC210. The impedance of these inputs is approximately 20K and the level should be adjusted to approximately 100 mv peak-to-peak.

Expansion Connectors

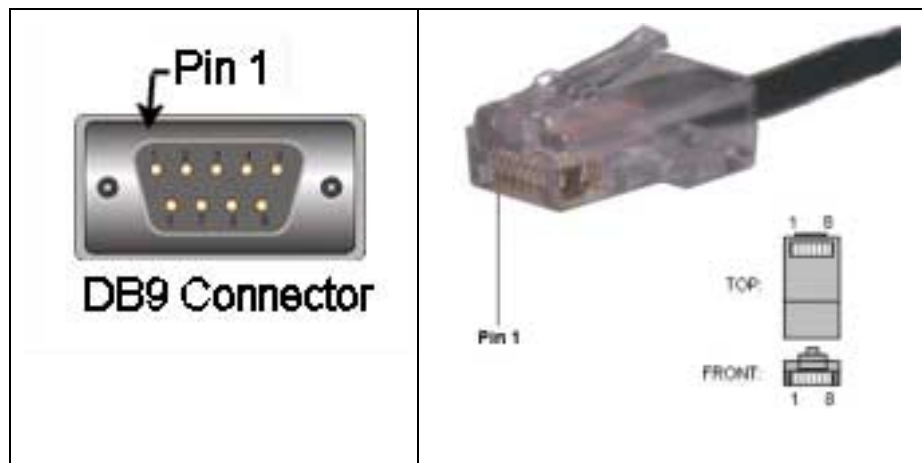
There are several pin header connectors on the PC board which allow for easy access to several data lines in the RC210.

J8 - DTMF EXPAND		J7 - I/O EXPAND		J9 - AUDIO EXPAND	
Pin 1	BCD Output Q1	Pin 1	Shift Register Data	Pin 1	Digital Gnd
Pin 2	BCD Output Q2	Pin 2	Shift Register Clock	Pin 2	Vcc (+5)
Pin 3	BCD Output Q4	Pin 3	Shift Register Latch	Pin 3	Record input to ISD
Pin 4	BCD Output Q8	Pin 4	LED Serial Data	Pin 4	Auxiliary Audio Input 3
Pin 5	Decoder Strobe Port 1	Pin 5	LED Data	Pin 5	Auxiliary Audio Input 2
Pin 6	Decoder Strobe Port 2	Pin 6	LED Clock	Pin 6	Auxiliary Audio Input 1
Pin 7	Decoder Strobe Port 3	Pin 7	Vcc (+5 Vdc)		
Pin 8	Decoder Select Port 1	Pin 8	Digital Ground		
Pin 9	Decoder Select Port 2				
Pin 10	Decoder Select Port 3				

Radio Connections

Each port connector provides all connections needed for your radios. The RC210 comes with two versions of connectors - DB9 computer style connectors or RJ45 modular jacks.

9-Pin	RJ-45	Direction	Name/Description
1	1	-----▶	CTCSS Encode Control OUT
2	2	◀-----	CTCSS Decoder Logic IN
3	3	-----▶	TX PTT radio control OUT
4	4	-----▶	TX Audio output to radio
5	5	◀-----	Audio input from radio
6	6	◀-----▶	Ground
7	7	◀-----	RX COS Logic IN
8	8	◀-----▶	Ground
9		◀-----▶	Ground



I/O Connections

The RC210 supports connecting external devices (other than radios of course) by the use of a DB25 connector. The pinout is as follows:

<u>Pin</u>	<u>Name</u>	<u>Description</u>	<u>Pin</u>	<u>Name</u>	<u>Description</u>
1	AD1	Analog Channel 1	14	UF6	Logic Output 6
2	AD2	Analog Channel 2	15	UF7	Logic Output 7
3	AD3	Analog Channel 3	16	IN1	Logic/Alarm Input 1
4	AD4	Analog Channel 4	17	IN2	Logic/Alarm Input 2
5	AD5	Analog Channel 5	18	IN3	Logic/Alarm Input 3
6	AD6	Analog Channel 6	19	IN4	Logic/Alarm Input 4
7	AD7	Analog Channel 7	20	IN5	Logic/Alarm Input 5
8	AD8	Analog Channel 8	21	VCC	+5 for ADC reference - 25 ma MAX.)
9	UF1	Logic Output 1	22	FAN	Fan Output
10	UF2	Logic Output 2	23		Future Use
11	UF3	Logic Output 3	24		Future Use
12	UF4	Logic Output 4	25	GND	Analog Ground
13	UF5	Logic Output 5			

Analog Inputs

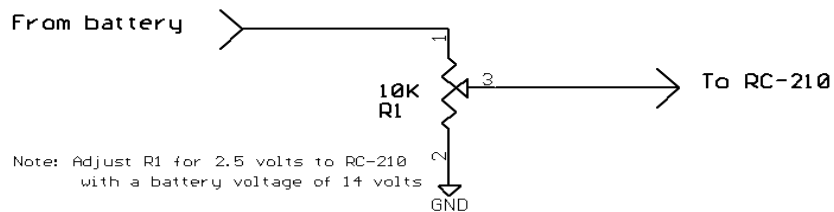
The RC210 allows you to connect external analog devices and readback their value on command. This is typically used for remote monitoring of such things as backup battery voltage, transmitter power, etc. There are 8 "meters" corresponding to the 8 Analog inputs. There are 6 meter faces you may define (this is explained in the Programming section) to any of these meters; the selection of which properly scales the reading as well as properly "announcing" the meterface when readback of the value is requested.

Volts
Amps
Watts
Degrees
MPH
Percent

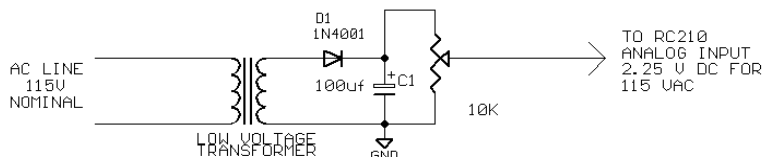
NOTE: While these inputs are protected against reasonable overload conditions, care should nevertheless be taken never to apply a voltage that exceeds +5.2v or any voltage that is below ground (negative).

Voltage

The major task involved in using a meter face is to design a sensor circuit that generates a sensor voltage in the approximate range of 0 to 5 Vdc that is linearly related to actual physical measurement, such as a 12 volt battery. A simple device to measure battery voltage would be a 10K potentiometer (pot). The actual voltages would be across the entire pot, and the sensor voltage would be taken off the wiper. To adjust the pot correctly, it might be set to produce 2.5 volts output at the wiper when 20 volts is put across the entire 10K. Since the typical battery used in a repeater is unlikely to produce 20 volts, this would be a safe "transducer" or sensor circuit for a typical 12 volt battery.



Or perhaps you'd like to monitor AC line voltage:



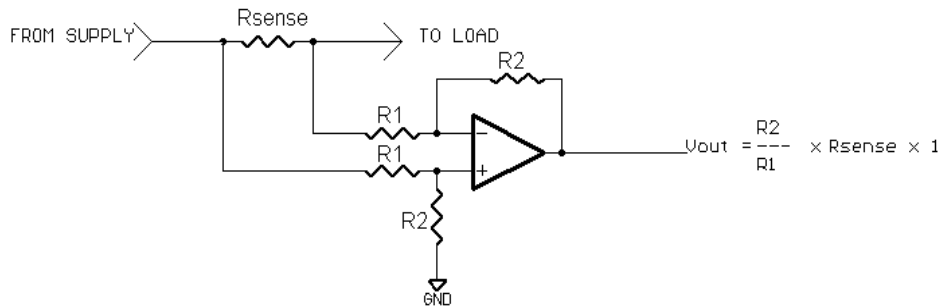
Current

Measuring current requires a circuit which develops a voltage proportional to current. This can easily be accomplished with a small value current sensing resistor and a differential type operational amplifier and 4 resistors. The output of the op amp is equal to the current times the value of the sensing resistor, times the voltage gain of the amplifier. The value of the sensing resistor that should be used depends on the maximum load current, since the voltage drop across the resistor reduces the voltage to the load. BE sure to calculate the worst case power dissipation of the resistor (I^2R) and use an appropriately rated resistor.

Ideally, a power supply with remote sensing would be used, with the sense return after the sensing resistor. This way, the voltage drop through the sensing resistor would be compensated for by the power supply.

The 4 resistors used in the op amp circuit should be 1% metal film types. Be sure that the common mode input voltage range of the op amp will accommodate the operating voltages that result from the resistor/gain selection. For example, an LM324 or LM358 op amp, operating at a single ended supply of +12 will operate properly with input voltages between 0 and 10 volts.

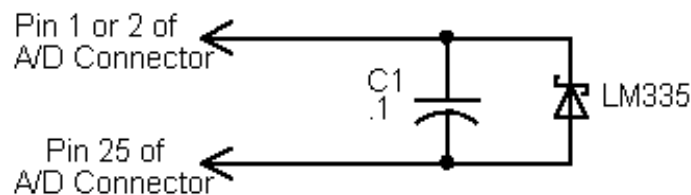
The following shows how to measure current



Measuring Temperature

It's a simple matter to measure temperature at the repeater site, using an LM335 Precision Temperature Sensor. The LM335 is electrically like a zener diode with a precision temperature/voltage characteristic. It will provide a resolution of ± 2 degrees.

There are spaces for installing resistors (R13 & R14) on the PC board that act as the reference voltage source when using an LM335 on ADC channels 1 & 2. This allows you to eliminate some external parts by installing 4.7K resistors right on the board. These resistors are not provided but if you install them, there are only 2 connections between the sensor and RC210 necessary.

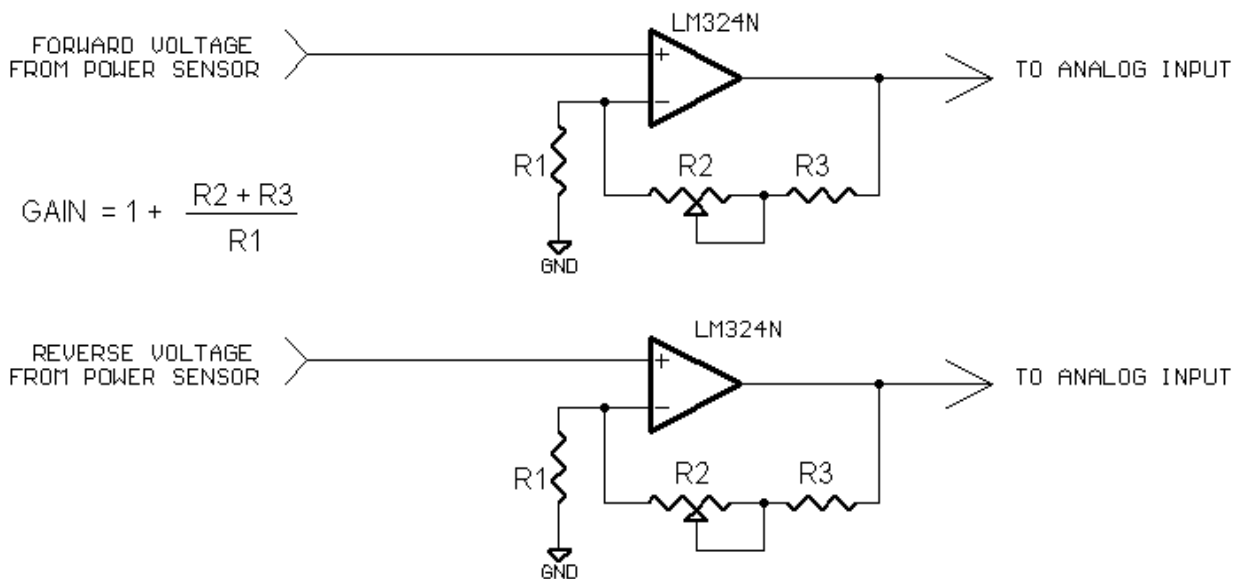


Measuring Power

Power is different than other types of measurements in that meter deflection is not linearly proportional to power level. The scale is expanded out at the low end and "compressed" at the high end. This is due to the fact that power is proportional to voltage or current squared (this is known as a *logarithmic* scale). The power meter face in the RC210 takes this into account when taking a measurement.

Many watt meters provide a dc voltage output relational to forward and reflected power. In this example, we'll show how to use these outputs to interface to the RC210.

Resistors are selected on the basis of the power level to be measured to provide 0 to 5 volt dc levels to the controller's analog inputs and should be adjusted for accurate reading at the normal power level.



Alarms

The RC210 incorporates 5 alarm logic inputs that when used with the proper sensors, can monitor various things around the repeater site. For example, you could install a switch on the door to the building, so you'd know when someone opens the door. More details may be found in the Programming Reference section of this manual.

All logic inputs are triggered on a logic low (pulled to ground) and remain triggered until that Alarm is turned off. In other words, if the trigger signal is only momentary, the Alarm will remain triggered even though the input signal returns to its non-triggered state, until it is manually (or by a macro) turned off. More details may be found in the Command Reference section of this manual.

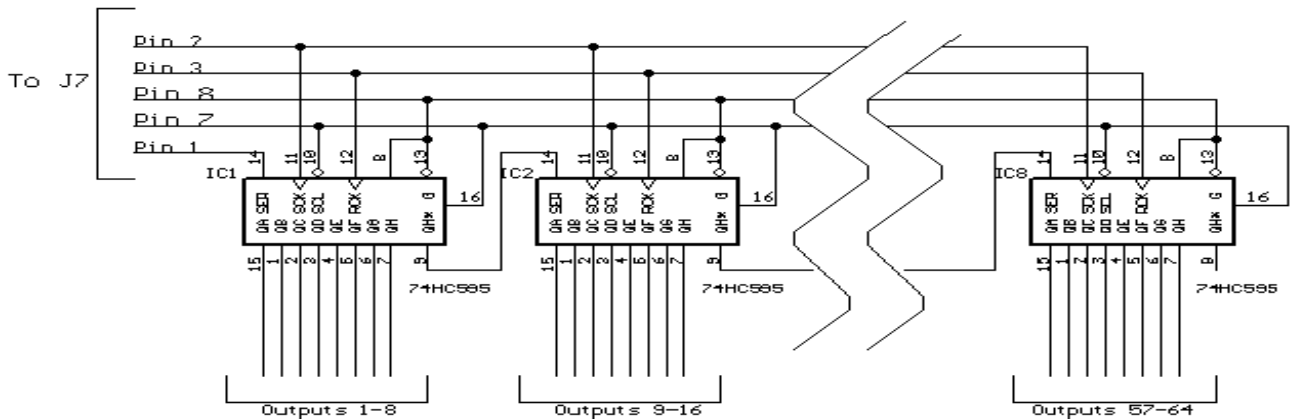
WARNING: NEVER apply more than +5 volts to any logic input pin.

Logic Outputs

The RC210 provides 7 general purpose outputs (expandable to 32) that you can use to switch electronic devices on and off at your repeater site. While these outputs are buffered by open collector transistors, care should be used so as not to exceed their ratings (90V dc @ 500 ma). If you're switching an inductive load, be sure to use a quenching diode across it. If you need more logic outputs, you can connect external shift registers and obtain up to 32 outputs. Fig 1 shows how this can be accomplished.

Only some of the stages needed to recover those functions have to be used. Each shift register used adds 8 outputs. So if you only need an additional 16 outputs (above and beyond the 7 "on-board" outputs), you only need add 2 stages. If you want all additional 64, you'll need a total of 8 shift registers (74HC595). Remember that these outputs are logic level and cannot drive loads.

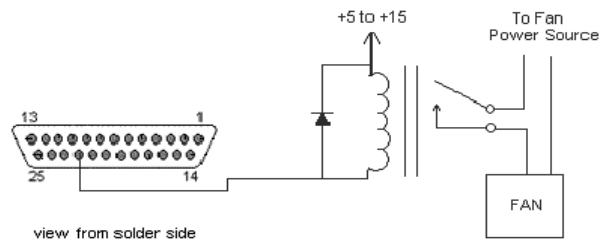
The outputs of the shift registers cannot drive outside devices directly. You will need some kind of driver in order to drive other than TTL level devices. When an output of the shift register is selected by command, that output goes to a logic high. A good option would be to use a ULN2003A Darlington array transistor array, which can drive up to half an amp (500 ma) load at a voltage of up to 90vdc.



Fan Output

The controller also provides a switched fan output that can be used to control a cooling fan for the repeater transmitter. To avoid unnecessary wear and tear on the fan, the fan only comes on when any transmitter is keyed, and remains on for 1 to 60 minutes after the last transmitter drops. The amount of time the fan remains on is selected in programming mode.

This output is not meant to drive a fan directly, but rather an external relay or driver transistor which is then used to drive the fan. Its signal is available on Pin 22 of J4, the I/O connector. When active, the Fan Output is pulled to ground. This output is an open collector therefore it will not source any voltage.



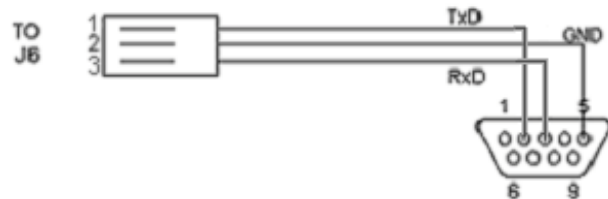
Serial Data Input/Output

The RC210 supports a variety of radios for use as a frequency agile remote base.

If the radio you plan to use with the RC210 uses RS-232 levels directly (you can normally connect your radio to a computer without the need for an external level converter), you use the RS-232 serial connector (J6) on the RC210 and the "computer" connector on your radio. In order to make this connection, you will need to fabricate a cable with a DB9 male on one end and a 3 pin header connector on the other. It is suggested you use a shielded cable.

DB9 Pin 3 Pin Header Pin J6

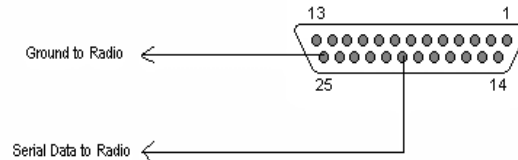
2	1 (Txd)
3	3 (Rxd)
5	2 Gnd



If your radio requires TTL level (it requires a level converter to connect to a computer), you can hook it directly to the RC210 without the need for an external converter by using J4, the A/D and I/O connector. Typical radios would be those such as the Icom IC-706MkIIg.

J4 Pin

20	Serial Data OUT to Radio
25	Ground



Note: If using this connection, you will lose the use of Alarm Input 5.

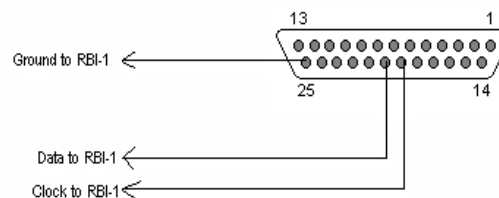
If you're using the Doug Hall RBI-1 Remote Base Interface, the connections are:

J4 Pin

19	Clock Data to RBI-1
20	Data to RBI-1

Note: If using the RBI-1, you will lose the use of Alarm Inputs 4 & 5, as they are used for sending data to the RBI-1.

Using the Kenwood TM-V7 or TM-G707 as your remote base radio, a separate hardware interface is required.



The hardware interface takes care of automatically switching the radio(s) between programming and operational modes and takes care of all other connections (such as COS, PTT and audio signals) through the 6 pin DIN packet connector. There is no need to modify the radio(s) in any way.

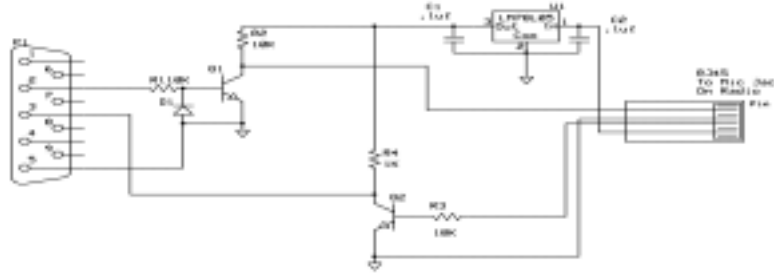
The schematic for the V7a/G707 interface may be found at the end of this manual.

Note: If using the V7 Interface, you will lose the use of User Logic Output 7

The RC210 supports the Kenwood single-band mobiles TM-271A (2 meters) and TM-471A (70 cm). Interfacing the necessary serial connections is easy. You can either purchase Kenwood's *PG-5D Programming cable* or build your own interface. Depending on your needs, you may program to use either the serial connection (RS232) on the RC210 or the I/O connector (see the RC210 Operations and Programming Manual for details on programming this selection).

If you choose to use the serial (RS232) connection, you'll need the interface shown in Figure 1.

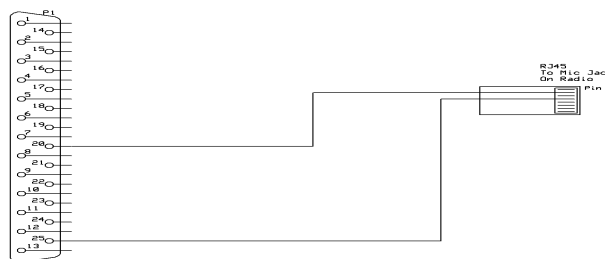
Figure 1



If you choose to use the I/O connection, you'll need the interface shown in Figure 2

Figure 2

Note: If using this connection, you will lose the use of Alarm Input 5.



Regardless of which method you choose for remotely controlling the radio, you need to also provide the audio, PTT, etc. signals as well.

Unfortunately, the A suffix models (the ones sold in the USA) do not have a packet jack already installed and the necessary signals are not readily available from the mic jack. Fortunately however, Kenwood made these signals very easily accessible but it does require you open the radio in order to connect to them.

If you remove the cover of the radio, you will see gold plated pads near the power connections. These pads are normally used in the E model (European) to connect a pigtail, which then provides the necessary signal access for packet use. These will supply the needed connections (other than programming) to the RC210 for remote base use as well.

<u>PAD NAME</u>	<u>SIGNAL</u>
PKS	PTT (active low)
SQC	COS (active high of +5)
PR9	Receive audio *
PKD	Transmit audio *

* The characteristics of both receive and transmit audio is determined by menu selection 39, which is normally used for packet.

In the 1200 baud mode:

PR9 provides 500 mv p-to-p, deemphasized and squelch gated audio
 PKD provides preemphasized transmit audio

In 9600 mode:

PR9 provides 500 mv p-to-p, non-deemphasized and non-gated discriminator audio
 PKD provides non-emphasized transmit audio

Audio Delay Expansion Headers

Audio from the receiver buffers is routed through pin header connectors on the PC board to allow connection of the Arcom *repeater audio delay* (RAD) board. This board provides an audio delay of approx. 60 ms, which removes DTMF bursts and squelch tail crashes from the transmitted audio. If the board is not connected, there must be jumpers in place between pins (pins 2 & 3) of JP10, JP11 and JP12 to complete the audio path from receivers to the crosspoint switch.

Checking COS And PTT Operation

Once connections are made, the next step is to verify that COS and PTT are operating properly. There are a series of LED's on the RC210 that are used to indicate the status of various functions. Their function is marked on the PC board. They may be turned off to save power when you don't need them by removing the jumper from JP13. By observing the LED's, you can easily verify COS, PTT, CTCSS and DTMF operation.

Setting Audio Levels

Refer to the PCB layout at the end of this manual while making adjustments. If you do not have a signal generator or oscilloscope, you might want to explore the use of a Sound Card based Audio Spectrum Analyzer program available from InterFlex Systems Design Corporation. It can be helpful to measure audio levels, look for distortion, twist in the DTMF tones, etc.

Using a signal generator, generate a signal on the receiver's frequency with 1000 Hz modulation @ 3 Khz deviation. Keep in mind that for best quality audio and to avoid clipping, we want the minimum amount of amplification necessary. An oscilloscope should be used to measure the voltage. Following the Table 5, adjust the appropriate trimpot for a level of .75 volt peak-to-peak at the corresponding test point.

Table 5

PORT	TRIMPOT	TESTPOINT
1	"Port1 Disc"	TP1
2	"Port2 Disc"	TP2
3	"Port3 Disc"	TP3

Once the receiver levels are adjusted, it's time to adjust the transmitter audio levels. While still generating a signal on the receiver frequency, adjust the corresponding trimpot for +/- 3 Khz of the appropriate transmitter.

Table 6

PORT	TRIMPOT
1	"P1 Tx"
2	"P2 Tx"
3	"P3 Tx"

Using a radio equipped with a DTMF pad, transmit on the receiver frequency and while transmitting a DTMF tone (it is suggested you use either a "3" or a "5" for this adjustment, as these are the most difficult tones to decode. The corresponding LED should light with every DTMF key press.

Note: If you don't have access to test equipment, you can temporarily adjust the receiver buffer trimpots to the midpoint and adjust the transmit trimpots so the repeated audio "sounds the same" as does your radio when transmitting direct. But be sure to set these levels with the proper test equipment before deploying your repeater!

The Tone trimpot adjusts the level of courtesy tones and CW ID's. You should adjust it for +/- 3 Khz deviation.

The Play trimpot adjusts the level of the output of the speech chip. You can adjust this for a comfortable level while the controller is speaking (you can enter a command that causes the controller to speak in order to adjust this level).

Note: If you have set the discriminator and transmit audio levels correctly, the levels of tones and speech should be identical on all 3 ports.

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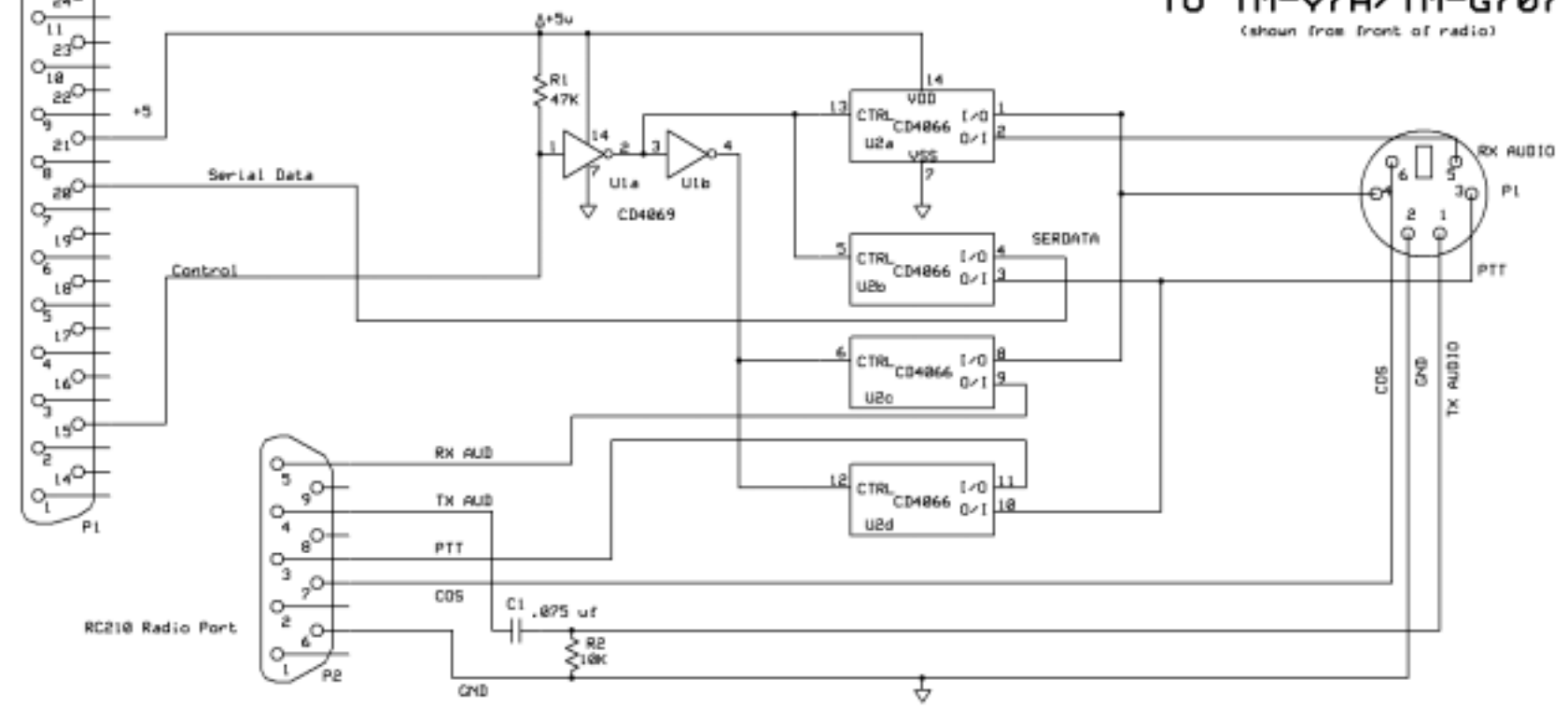
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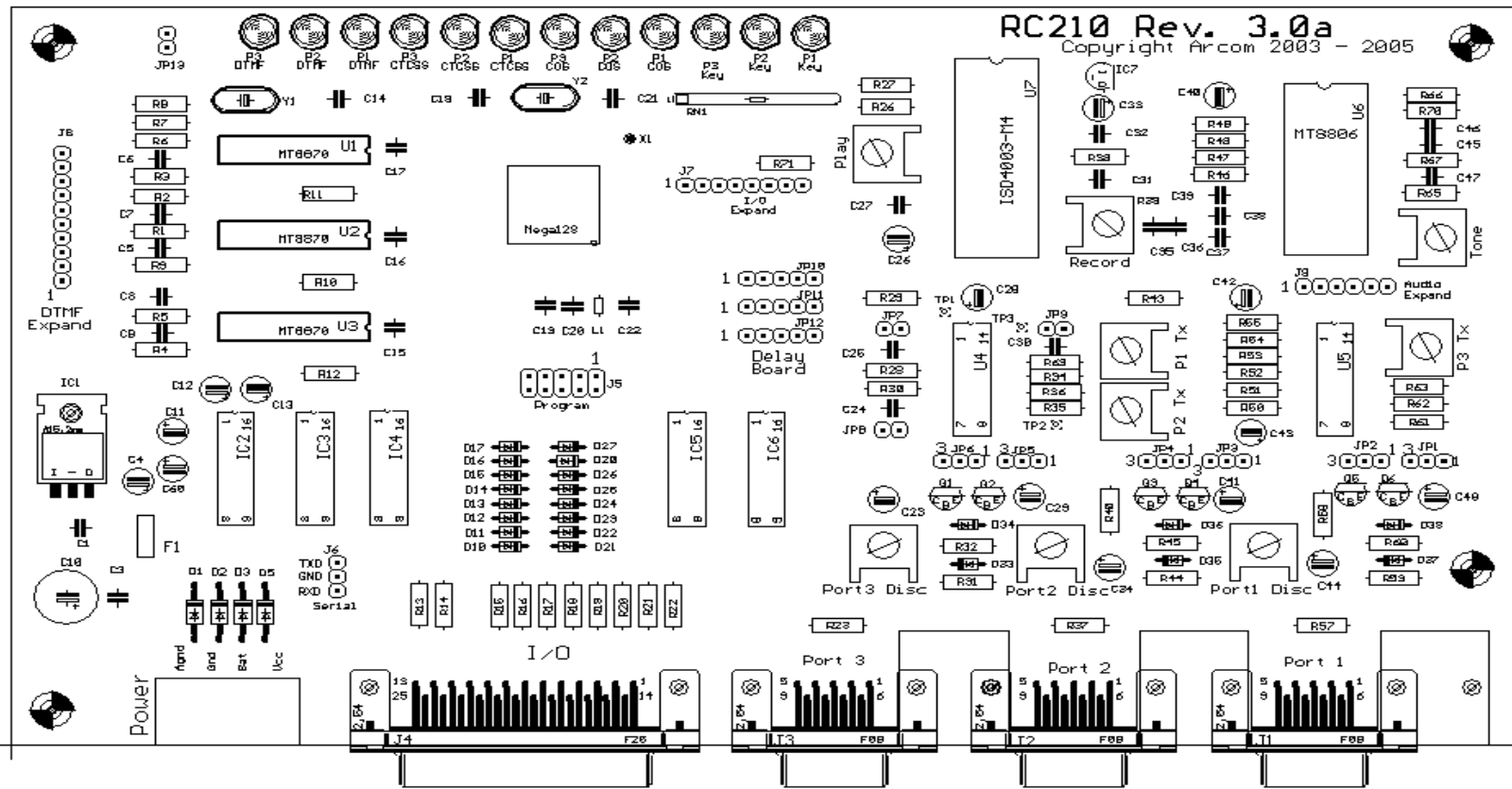
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TO RC210

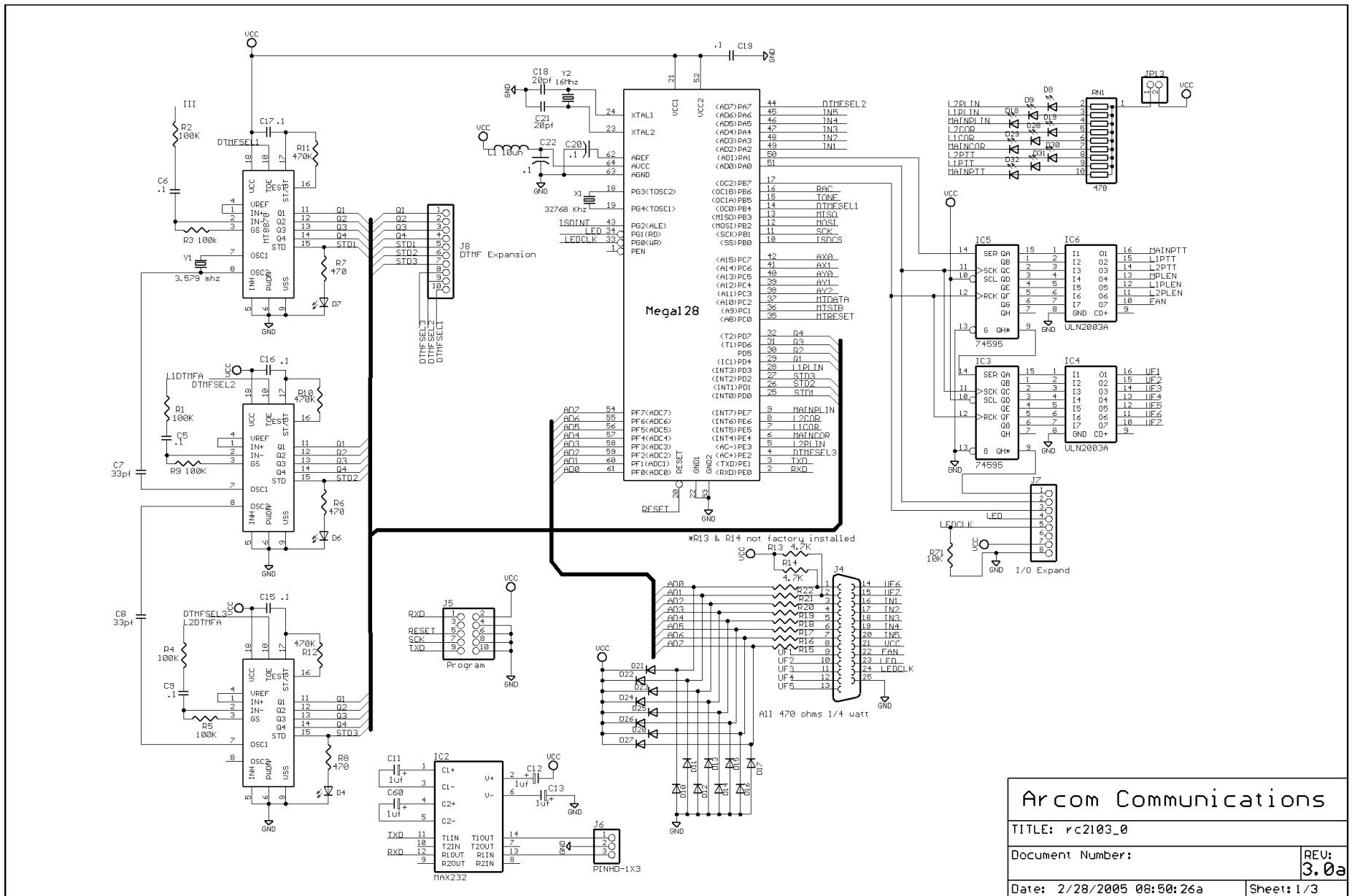
V7 Interface Board

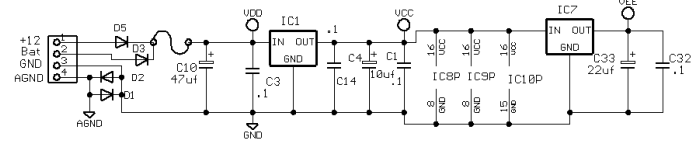
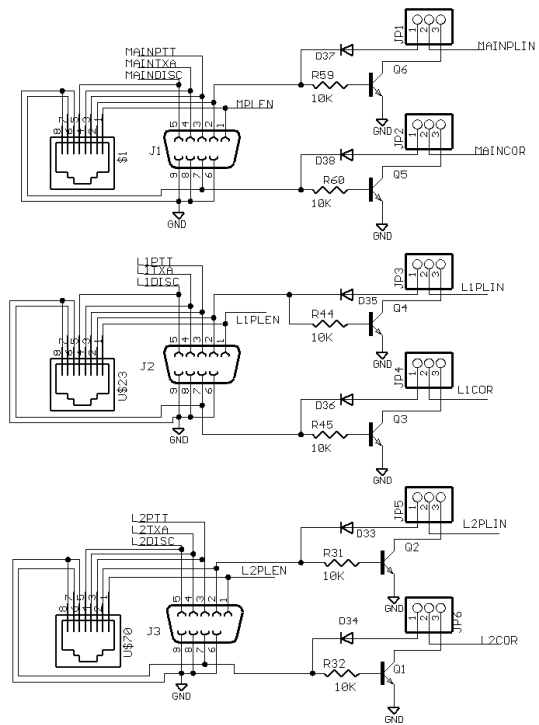
6 Pin Mini DIN
To TM-V7A/TM-G707
(shown from front of radio)





PC Board Component Placement





Arcom Communications

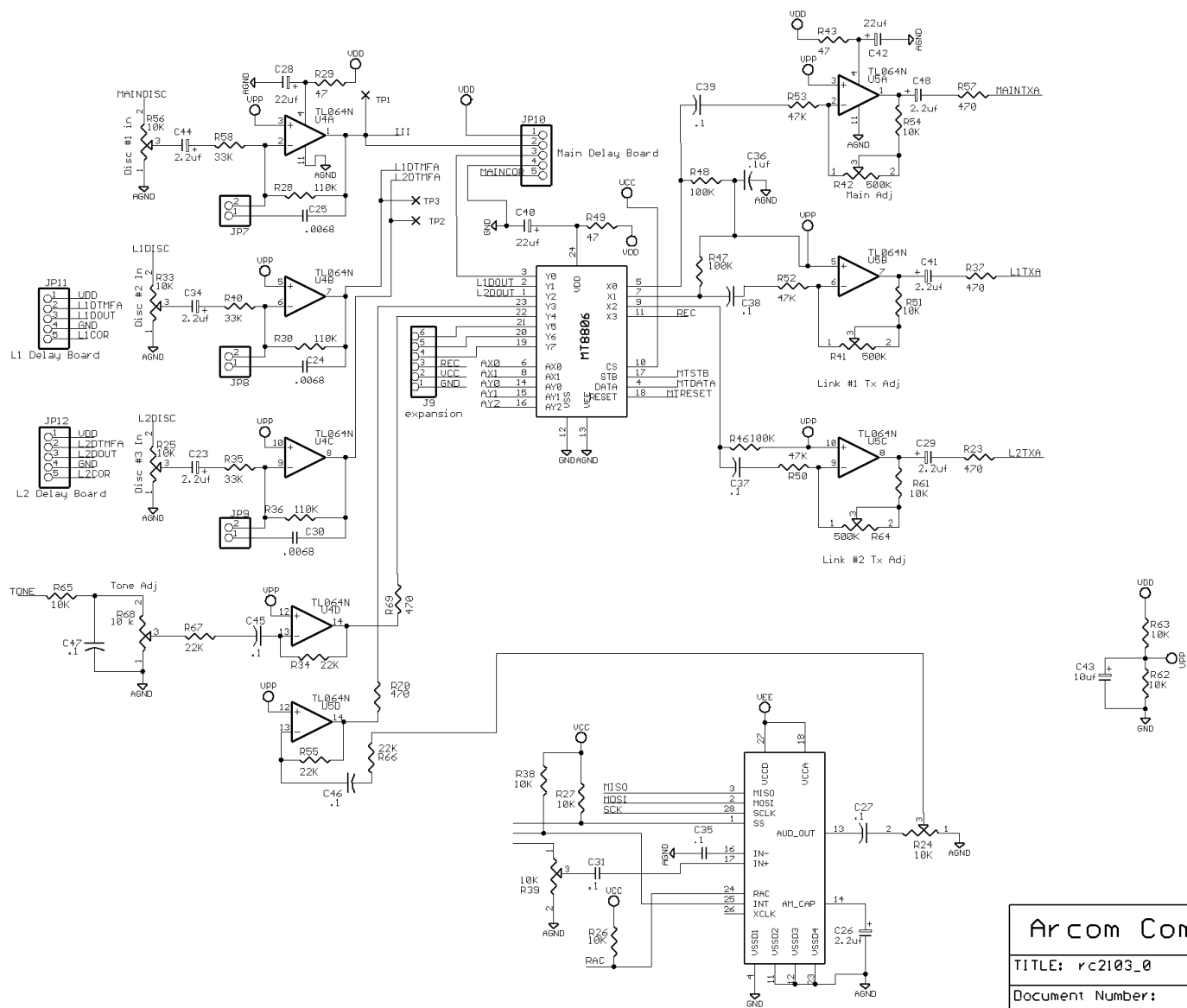
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