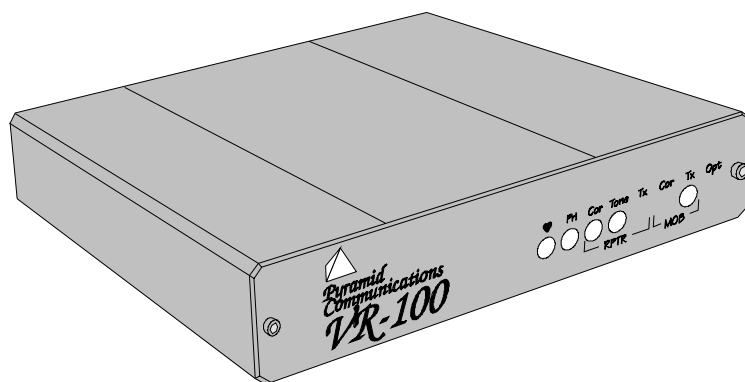


*Pyramid
Communications*

15182 Triton Lane #102 Huntington Beach CA 92649

***VR-100
Vehicular
Repeater***



Revision D Aug 25 1994

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Specifications

General:

Operation:	Motorola PAC/RT® compatible plus trunking.
Modes:	Priority, non-priority disabled, test mode.
Indicators:	8 high brightness LEDs, handheld queueing tones.
Interface:	9 pin "D" connector with 6 ft. cable.
Adjustments:	Receive sensitivity, transmit dev., squelch threshold, local mic sens., lock tone decode frequency, lock tone dev., local speaker audio.
Jumpers:	COR polarity, on-air polarity, enable/disable polarity, Tx audio flat/de-emph., Rx audio flat/pre-emph.
CTCSS:	DIP switch selectable, 37 EIA tones + 69.3 & 97.4

Power Requirements:

DC supply:	13.6 VDC ±25% negative ground.
Standby:	80 mA.
Receive:	250 mA.
Transmit:	1.5 A.

Physical:

Dimensions:	5.275"W x 6"L x 1.12"H.
Weight:	18 oz.
Case:	One piece extruded aluminium.

Transmitter:

Frequency Range:	450-470 MHz
RF Power:	0.25-2W adjustable
Tx Spurious:	-50dbc
Stability:	5ppm
FM Noise:	-55db
Audio dist:	<5%
Tx sens:	50mV-2.5V RMS
Lock Tone:	Jumper selectable: 832.5 or 847.5Hz
FCC TA:	LRUVR-100U Parts 22, 90

Receiver:

Frequency Range:	450-470 MHz
Sensitivity:	.4µV for 12db Sinad
Mod Acceptance:	±7.5kHz
Selectivity:	70db
Spurious/image rej.:	60db
IMD response:	65db
Stability:	5ppm
Lock Tone detect:	Tunable: 820 Hz to 930 Hz, 1% bandwidth
Local Rx Audio:	400mW into 8 Ohms

Specifications Subject to Change without notification

Introduction

The Pyramid Communications model VR-100 is a microprocessor controlled low power vehicular repeater. It is designed to interface between a high power mobile radio and a low power UHF handheld. If the radio operator is out of the vehicle and the mobile radio is receiving a transmission, the VR-100 will repeat the signal to the users handheld. The user may also transmit back to the VR-100 via the handheld, and their transmission will be repeated back to the base by the high power mobile radio, effectively extending the range of the low power handheld. On-board logic control by the microprocessor ensures that only one vehicle will become active as the repeater, should several vehicles arrive at the same scene. The logic also handles cases where the priority vehicle leaves the scene (or fails), or another priority vehicle arrives from a different site.

The model VR-100 is fully compatible with Motorola PAC/RT® systems, as well as GE Ericsson and Standard EX-10/ CTS-20 radios. Additionally, the VR-100 supports connection to LTR® or Motorola trunking radios, local mic audio repeat (local PTT from the mobile is repeated to the HT's), and local speaker audio for HT-Base transmissions.

Designed to interface to a wide variety of mobile radios, the VR-100 has input and output adjustments for Rx audio sensitivity, mobile Tx deviation, COR polarity and threshold, local mic sensitivity, local speaker audio, on-air detect polarity, enable/disable polarity and audio response selections for flat or 6db/octave for both Tx and Rx audio paths. There are also jumper selections for lock tone frequency, priority sample rate, conventional/trunking operation and a built in test mode.

The eight LED front panel status indicators confirm proper CPU operation, priority status, and mobile/repeater COR and PTT status.

Functional Description

The VR-100 operates on UHF simplex frequencies; the handhelds transmit CTCSS but are carrier squelch receive. The VR-100 has CTCSS on receive only. The repeater should be connected to a VHF high band or low band mobile for best operation. Connection to a UHF mobile is possible, provided there is enough separation in the mobile transmit and the VR-100 receive frequencies. Also, antennas for the VR-100 and the mobile radio should be located as far apart as practical, and with vertical separation if possible. Additionally, bandpass filters and notch cavities may be used to reduce interference between the mobile and VR-100.

When the user leaves the vehicle, they activate the VR-100 via their mobile radio front panel or a separate switch. When the mobile radio is receiving carrier and proper tone, the VR-100 will begin transmitting on the handheld's receive frequency. The user is able to hear and respond to all radio traffic, including other handhelds at the site. The VR-100 will cease transmission periodically to check for handheld activity. If the VR-100 detects proper carrier and tone from a handheld, it will key the mobile radio and repeat the users transmission. In this way, the handheld is given priority and may respond during repeater hang time. The VR-100 has a 3 minute time-out timer in the base to handheld direction. If the base transmits to the mobile for more than 3 minutes, the VR-100 will send an error tone to the handheld, unkey the repeater and remain idle until the base ceases transmissions.

When the VR-100 is first activated, it will transmit a short "lock tone" that alerts the user that the system is functioning. It will then assume the priority status and be ready to repeat any base to handheld or handheld to base transmissions. If another unit arrives at the same site and is activated, it too will transmit the "lock tone"; when the first VR-100 detects the lock tone from the second unit, it will increment it's priority counter and will no longer repeat any transmissions. This process will continue for each unit that arrives at the scene, creating a priority hierarchy for up to 256 vehicles.

Even though the other VR-100's are not at priority status, they will continue to monitor the channel for activity. If the priority unit were to leave the scene or become disabled, the other units will detect the condition to repeat and determine that there is no priority unit repeating the transmission. They will then begin decrementing their priority counters until one of them reaches the priority status and begins repeating

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the transmission. Since the VR-100's are all at different priority counts, only one will reach priority status and begin transmitting. The other units will sense the priority repeater and cease decrementing their counters, preserving the priority hierarchy.

If another unit were to arrive from a different scene and it is still the active priority, there will be two active repeaters on the air when a condition to repeat exists. When one of the VR-100's unkeys to check for handheld activity, it will detect the presence of the other active VR-100 and increment its priority counter and cease transmission. This is the self clearing mode to prevent radio "collisions".

If the user were to key the mobile radio locally and his VR-100 is the priority, the VR-100 will detect the local mic PTT and repeat the transmission to the other handhelds at the site so that they would not miss half of the transmission.

If the users wish to communicate HT-HT without accessing the mobile repeater, they may transmit on the same frequency without CTCSS encode. The repeater will only respond to carrier *and* tone from the handhelds.

Trunking Operation

When the model VR-100 is connected to a trunking radio and the user wishes to access the system from the handheld, they key their handheld briefly then release. The VR-100 will key the mobile radio for 200mS, during which time it monitors the mobile's transmitter for an on-air condition. If it does not see the radio transmit at all (system is busy), it will retry every 5 seconds until successful or time out (30 Sec). It will also send a "busy" tone to the handheld every 5 seconds to indicate the progress of the call attempt. If unsuccessful after 30 seconds, the VR-100 will transmit an error tone to alert the user that the call attempt failed.

When the VR-100 detects that the mobile is transmitting, it will continue to monitor the on-air line until the transmitter remains keyed for at least 250 mS to ensure that the radio is not merely handshaking or retrying. After successful acquisition of a voice channel, it will continue to hold the mobile PTT active for 2 seconds and transmit a go-ahead blip to the handheld user. The user then keys their handheld to speak on the voice channel. If the user does not key up within the 2 second period, the VR-100 will unkey the mobile and send the error tone as before.

Installation

Before installing the VR-100, ensure that the RF and repeater sections are properly aligned per the tuning procedure beginning on page 8 of this manual. Additionally, ensure that the VR-100 jumpers are properly configured for use with the particular mobile radio that it will be connected to:

- JP1 Controls the polarity of the remote enable/disable feature of the VR-100. If the remote enable line (pin 3 of P1) goes low to activate the repeater, set JP1 to the (-) position. If pin 3 goes high, set JP1 to the (+) position. If pin 3 is not used and you wish to have the repeater active at all times set JP1 to the (-) position and ground pin 3.
- JP2 Controls the polarity of the mobile COR line. Before setting this jumper, COR threshold adjustment (RV5) should be made as described in the alignment section of this manual on page 9. If the mobile COR line goes more positive in the presence of carrier, set JP2 to the (+) position or to the (-) position if the line goes more negative during carrier.
- JP3 Controls the polarity of the on-air detect line (pin 9 of P1). ***This line is only used in trunking applications.*** If the transmitter sense line goes more positive during transmit, set JP3 to the (+) position, otherwise set JP3 to the (-) position. ***If using a trunking radio, ensure that JP6 is also shorted.***
- JP4 Controls the audio response of the mobile transmit signal. If pin 2 of P1 is connected to the mobile transmitter audio path ***before pre-emphasis***, JP4 should be set to ***de-emph.*** in order to correct for the pre-emphasized audio coming from the handheld. If pin 2 is connected ***after pre-emphasis***, set JP4 to ***flat.***
- JP5 Controls the VR-100 lock tone encode frequency. If JP5 is ***open*** (default) the lock tone frequency is ***832.5*** Hz. If JP5 is ***shorted***, the lock tone frequency is ***847.5***.
- JP6 If the VR-100 is connected to a conventional radio, leave JP6 open. If connected to a trunking radio, short JP6. If JP6 is shorted, ensure that pin 9 of P1 is connected to a point in the radio that indicates the radio is transmitting and ensure that JP3 is configured properly.

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- JP7** During base to handheld transmissions, the VR-100 will periodically unkey the repeater to check for handheld activity. JP7 enables the priority sampling. If open, the VR-100 *will not* priority sample. If JP7 is shorted, the VR-100 will sample at 1 second intervals.
- JP8** Used only for testing and alignment of the VR-100. If shorted, the VR-100 transmitter is active and the lock tone is sent continuously. For normal operation, ensure that JP8 is open.
- JP9** Controls the audio response of the repeater transmit signal. If pin 6 of P1 is connected to the mobile's discriminator or a point in the receiver *before de-emphasis*, JP9 should be set to *flat*. If pin 6 is connected *after de-emphasis*, set JP9 to *pre-emph.* in order to correct the audio for the handheld receiver.

Make the connections between the mobile radio and the VR-100 cable as follows:

Pin 1: Ground. Connect the the radio's chassis or ground plane.
(Black/Shield)

Pin 2: Mobile transmit audio. Connect to the mobile transmit audio path or tone input. If connected before pre-emphasis, ensure that JP4 is set to de-emph. If connected after pre-emphasis, set JP4 to flat.

Pin 3: Remote enable/disable. Connect to the radios auxiliary output or a separate switch to remotely enable or disable the repeater. If this line goes high to activate the repeater, ensure that JP1 is set to the (+) position. If this line goes to ground, set JP1 to the (-) position. If not used ground pin 3 and set JP1 to the (-) position; the repeater will be active any time there is 12 VDC at pin 5.

Note: This line *does not* have a pull up resistor; if connected to an open collector or dry contact output, add a 10K resistor between pin 3 and pin 5 of P1 on the VR-100 main PCB.

Pin 4: Mobile PTT output. Connect to mic PTT on the mobile radio, or a line that goes active low to transmit. This line is also used to sense local mic PTT in order to repeat the local mic audio to the handhelds.

Note: *To disable local mic repeat, remove D4.*

Pin 5: 12 VDC input. Connect to the radio's switched 12V supply.
(Red)

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Pin 6: Mobile receiver audio. Connect this line to the mobile receive audio path before the volume control. If pin 6 is connected before de-emphasis ensure that JP9 is set to flat. If pin 6 is connected after de-emphasis, set JP9 to pre-emph.
(Yellow)

Pin 7: Mobile COR detect. This line is used to indicate when the VR-100 should repeat the transmission to the handheld. Connect to a logic point in the mobile that indicates proper tone and carrier have been detected or the audio unmute line. If this line goes more positive during an unmute condition, set JP2 to the (+) position. If pin 7 goes more negative during unmute, set JP2 to the (-) position. RV5 should also be set for the midway voltage between mute and unmute. Example: If connected to a logic line that goes between 0 and 5 VDC, set RV5 (pin 12 of U3) for 2.5 V. If pin 7 goes between 5.6 and 7.2 VDC, set RV5 for 6.4 VDC.
(Violet)

Pin 8: Local mic audio. When the user keys the mobile radio and the VR-100 connected to it is the priority unit, the local mic audio can be repeated to the handhelds. Connect this line to a point in the mobile transmitter audio path after pre-emphasis but before limiting or filtering. RV6 sets the sensitivity level.
(Brown)

Note: *To disable local mic repeat, remove D4.*

Pin 9: On-air detect. Used only in trunking applications to indicate when the mobile transmitter is actually on the air. This is not the same as mobile PTT. Connect radio PTT on the logic board or to switched transmitter B+. If pin 9 goes positive during transmit, set JP3 to the (+) position. If pin 9 goes to ground during transmit, set JP3 to the (-) position.
(Grey)

Install the VR-100 in the vehicle using the supplied mounting bracket and hardware. The bracket is secured to the housing using four 8-32 x 1/4" machine screws. **Do not use screws longer than 1/4"** for mounting the VR-100 to the bracket or circuit damage may result.

Alignment

In order to properly align the VR-100, you will need two service monitors and the mobile radio that the repeater will be installed with. Refer to figures 1 and 2 for alignment points.

Dis-assemble the repeater by removing the two allen-head screws on the rear panel, the phillips screw on the bottom and sliding the main circuit board out of the housing with the rear panel attached. Connect one service monitor to the VR-100 BNC jack and the other to the mobile antenna jack; connect the cable from the mobile radio to the VR-100. Turn on the mobile and active the VR-100. Adjust the squelch control on the RF board (R115) so that the repeater *COR* LED on the front panel is off.

RF Alignment

Important: The case of the VR-100 is integral to the heat sink for the RF module and voltage regulators. Do not transmit at *full power* for extended periods of time with the PCB removed from the case or damage may result!

1. Short jumper JP8 on the VR-100 main PCB. With a DC voltmeter at TP01 on the RF board, adjust L203 and L204 for a *maximum* reading.
2. Move the voltmeter to TP02 on the RF board; adjust L203, L204, L205 and L206 for a *maximum* reading.
3. Move the voltmeter to TP03 on the RF board; adjust L205, L206, L207 and L208 for a *maximum* reading.
4. Move the voltmeter to TP04 on the RF board; adjust R232 to midway. Adjust C244 and C247 for a *minimum* reading at TP04. Adjust R232 for 2 Watts. Adjust C205 for the transmit frequency ± 100 Hz. Remove the short from JP8 on the VR-100 main PCB.
5. Set the service monitor connected to the VR-100 to generate the repeater receive frequency with a 1kHz tone at ± 3 kHz deviation. Connect a Sinadder to TP 1 on the VR-100 main PCB. Adjust the signal generator output level for a reading of 12db Sinad.
6. Adjust L112, L113, C147, C151, L101, C104 and L104 in that order for a *maximum* Sinad reading at TP 1. Re-adjust the signal generator output level as necessary to maintain a usable reading.
7. Adjust C136 on the RF board for a *maximum* Sinad reading.

Repeater Alignment

1. Set the mobile service monitor to generate mode and RF output for 1mV with a 1 kHz tone at ± 3 kHz deviation on the mobile receive frequency. Set the VR-100 service monitor to the transmit monitor mode.
2. **Mobile COR Threshold:** With a positive voltmeter probe at pin 13 of U3 (VR-100), measure and record the voltage when the mobile signal generator is both on and off. Move the voltmeter probe to pin 12 of U3 and adjust RV5 for the midway point of the 2 measurements taken at pin 13. Set JP2 to the (+) position if the voltage at pin 13 went more positive when the signal generator was on, otherwise, set JP2 to the (-) position.
3. **Repeater modulation limiting:** Open JP7. Set RV1 on the VR-100 main PCB fully clockwise. Turn the mobile signal generator on and confirm that the VR-100 is keyed and the mobile *COR* and *Rptr PTT* LEDs are on. Adjust R205 on the RF board for ± 4.5 kHz as read on the service monitor connected to the VR-100. Adjust RV1 on the VR-100 main circuit board for ± 3 kHz deviation. Confirm that when the mobile signal generator deviation is reduced to ± 2 kHz and ± 1 kHz, the VR-100 deviation tracks with it. Increase the mobile signal generator deviation to ± 5 kHz and confirm that the VR-100 deviation does not exceed ± 4.5 kHz. Set JP7 per the installation section, page 6.
4. **Lock Tone Deviation:** Turn off the mobile signal generator and short JP8 on the VR-100 main circuit board. Adjust RV3 for ± 3 kHz deviation as read on the service monitor connected to the VR-100. Remove the short from jumper JP8.
5. **Local Mic Repeat Level:** Set the service monitor connected to the mobile to the monitor mode; key the mobile radio, inject a 1kHz tone into the mic audio circuit and adjust the audio level to produce ± 3 kHz deviation. Confirm that the VR-100 is also transmitting and adjust RV6 on the main PCB for ± 3 kHz deviation as read on the service monitor connected to the VR-100. Unkey the mobile radio.
6. **Receive Audio Level:** Set the service monitor connected to the VR-100 to the generate mode and inject an RF signal at 1mV with a 1kHz tone at ± 3 kHz deviation. Connect a scope probe to TP1 on the main PCB. Adjust R122 on the RF PCB for 1VPP as read at TP1.

7. **Lock tone decode frequency:** Move the scope probe to TP2 and change the service monitor modulation frequency to 832.5 Hz. Adjust RV4 for a *maximum* reading at TP2. Confirm that the *PRI* LED is off on the front panel. Return the modulation frequency to 1kHz.
8. **Mobile transmit audio level:** Set the 6 position DIP switch for the system CTCSS frequency as determined in table 1. Turn on the service monitor CTCSS modulation at ± 750 Hz deviation. Confirm that the *Rptr CTCSS* and *Mobile PTT* LEDs are on, and the mobile is keyed. Adjust RV2 on the VR-100 main PCB for ± 3 kHz deviation as read on the service monitor connected to the mobile.
9. **Repeater Squelch level:** Turn off the CTCSS deviation and reduce the signal output to .25uV. Adjust R115 on the RF board so that the *Rptr COR* LED is just off. Confirm that the LED comes on when the signal generator level is increased to .4uV.
10. **Local speaker level:** Increase the signal generator output level to 1mV. Connect an 8 Ohm speaker to J1 of the VR-100 and adjust RV7 on the main PCB for the desired receive audio level.

Tone	1	2	3	4	5	6	Tone	1	2	3	4	5	6
67.0	0	0	0	0	0	0	131.8	1	1	0	1	1	0
69.3	0	0	0	1	1	0	136.5	1	0	0	1	1	1
71.9	1	0	0	0	0	0	141.3	1	1	0	1	1	1
74.4	0	0	0	0	0	1	146.2	1	0	1	0	0	0
77.0	1	1	0	0	0	0	151.4	1	1	1	0	0	0
79.7	0	0	0	0	1	0	156.7	1	0	1	0	0	1
82.5	1	0	0	0	0	1	162.2	1	1	1	0	0	1
85.4	0	0	0	0	1	1	167.9	1	0	1	0	1	0
88.5	1	1	0	0	0	1	173.8	1	1	1	0	1	0
91.5	0	0	0	1	0	0	179.9	1	0	1	0	1	1
94.8	1	0	0	0	1	0	186.2	1	1	1	0	1	1
97.4	0	0	0	1	0	1	192.8	1	0	1	1	0	0
100.0	1	1	0	0	1	0	203.5	1	1	1	1	0	0
103.5	1	0	0	0	1	1	210.7	1	0	1	1	0	1
107.2	1	1	0	0	1	1	218.1	1	1	1	1	0	1
110.9	1	0	0	1	0	0	225.7	1	0	1	1	1	0
114.8	1	1	0	1	0	0	233.6	1	1	1	1	1	0
118.8	1	0	0	1	0	1	241.8	1	0	1	1	1	1
123.0	1	1	0	1	0	1	250.3	1	1	1	1	1	1
127.3	1	0	0	1	1	0	No Tone	0	0	1	1	1	1

Note: '0' means off

Table 1

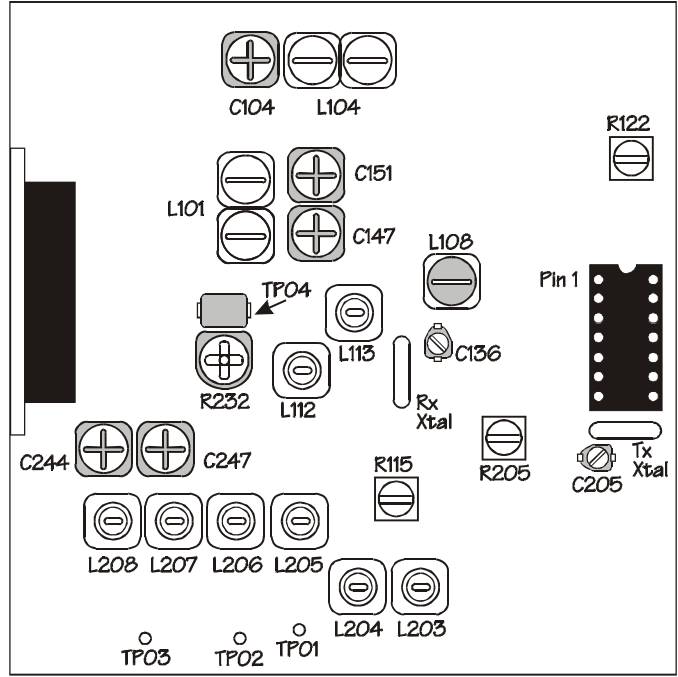


Figure 1
RF Test Points

Crystals

The model VR-100 uses a Standard Communications Corp. CU33 telemetry module for the RF section. Crystals are available from:

***Frequency Management Co.
15302 Bolsa Chica Street
Huntington Beach CA 90649
(800) 800-9825***

The crystal frequencies can be determined from the following equations:

$$Xtal_{RX} = (F_R - 21.4) / 9$$

$$Xtal_{TX} = F_T / 36$$

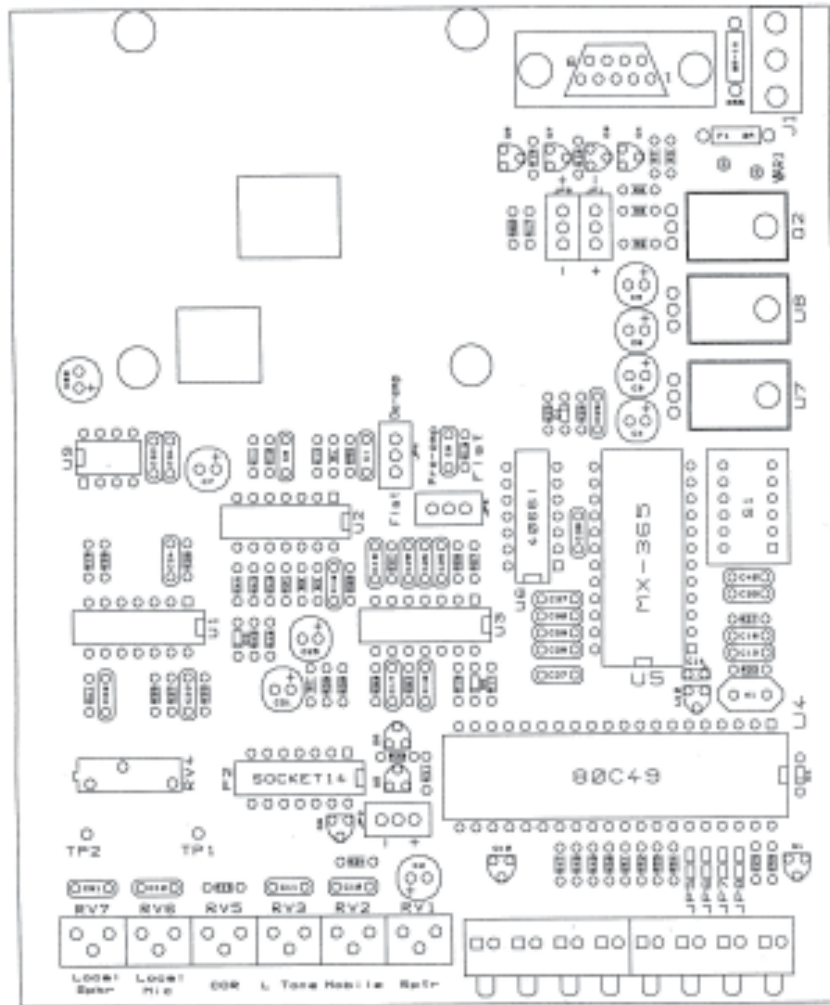
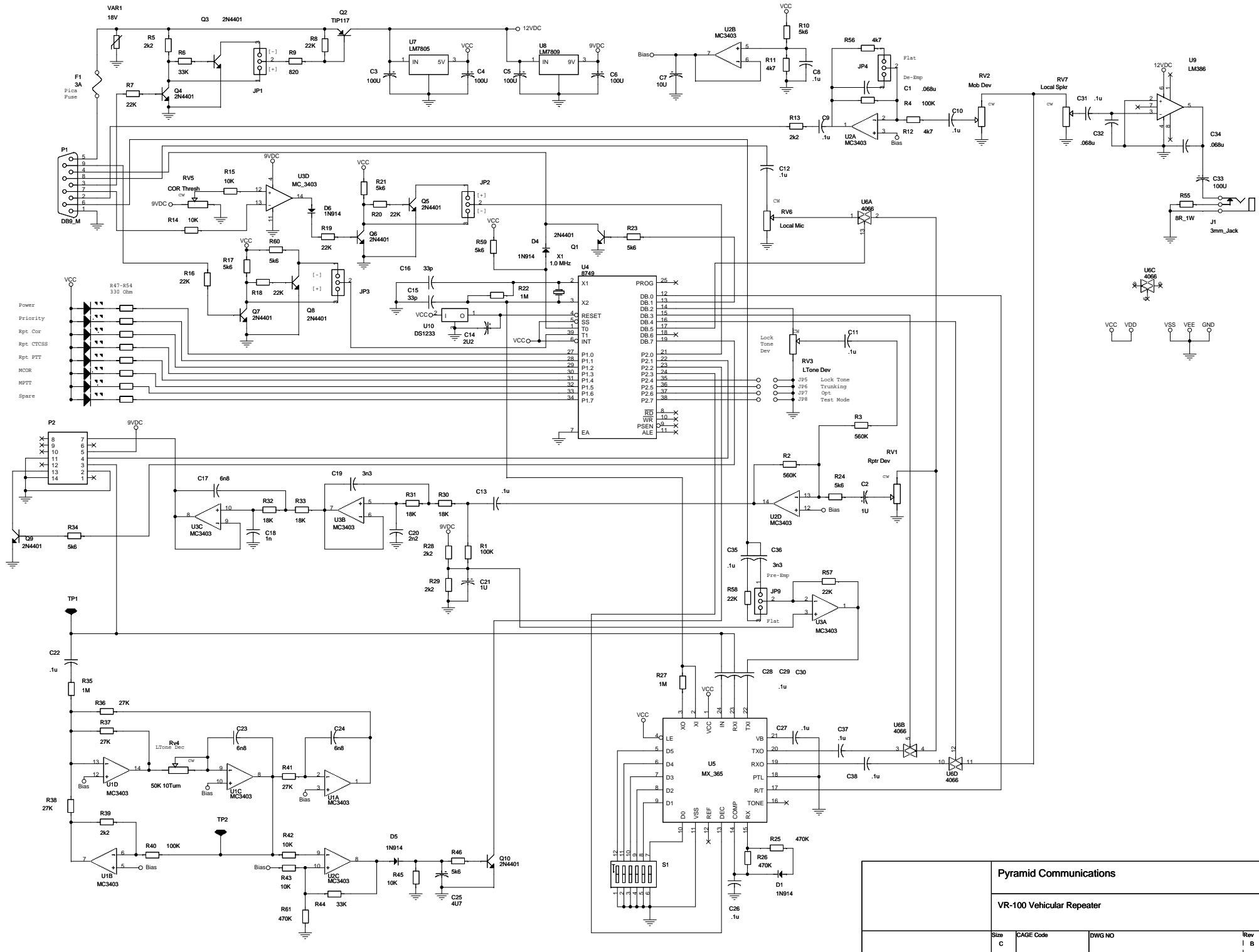


Figure 2
VR-100 Main Board

Parts List

Reference	Description	Part #
C1,C32,C34	.068 μ fd Polyester Cap	1040-683
C2,C21	1 μ fd 16V Electrolytic Cap	1032-105
C3-C6, C33	100 μ fd 16V Electrolytic Cap	1032-107
C7	10 μ fd 16V Electrolytic Cap	1032-106
C8-C13,C22,C26-C31, C35,C37,C38	.1 μ fd Polyester Cap	1040-104
C14	2.2 μ fd Tantalum Cap	1031-225
C15,C16	33pfd Ceramic Cap	1010-330
C17,C23,C24	.0068 μ fd Polyester Cap	1040-682
C18	.001 μ fd Polyester Cap	1040-102
C19,C36	.0033 μ fd Polyester Cap	1040-332
C20	.0022 μ fd Polyester Cap	1040-222
C25	4.7 μ fd 16V Electrolytic Cap	1032-475
D1,D4,D5,D6	1N914 Pin diode	5001-001
D2,D3	Right angle LED x4	6001-401
F1	3A Pica fuse	7300-030
JP1-JP4, JP9	.100" Vertical Header	7220-103
J1	3.5mm Speaker Jack	7210-350
P1	DB-9 M Right Angle PCB	7400-011
P2	14 pin dip socket	7401-014
Q1, Q3-Q10	2N4401 NPN TO92	3104-401
Q2	TIP32 PNP TO220	3200-032
RV1-RV3,RV5-RV7	10K Right Angle Pot	2101-103
RV4	50K 10 Turn Pot	2110-503
R1,R4,R40	100K 1/8 Watt Carbon Film	2008-104
R2,R3	560K 1/8 Watt Carbon Film	2008-564
R10,R17,R21,R23,R24,R34,R46,R59,R60	5.6K 1/8 Watt Carbon Film	2008-562
R7,R8,R16,R18-R20,R57,R58	22K 1/8 Watt Carbon Film	2008-223
R36,R37,R38,R41	27K 1/8 Watt Carbon Film	2008-273
R6,R44	33K 1/8 Watt Carbon Film	2008-333
R9	220 1/8 Watt Carbon Film	2008-102
R11,R12,R56	4.7K 1/8 Watt Carbon Film	2008-472
R5,R13,R28,R29,R39	2.2K 1/8 Watt Carbon Film	2008-222
R14,R15,R42,R43,R45	10K 1/8 Watt Carbon Film	2008-103
R22,R27,R35	1.0M 1/8 Watt Carbon Film	2008-105
R25,R26,R61	470K 1/8 Watt Carbon Film	2008-474
R30-R33	18K 1/8 Watt Carbon Film	2008-183
S1	6 Position DIP Switch	7410-006
U1,U2,U3	MC 3403 Quad Op-Amp	4003-403
U4	8749H Microprocessor	4008-749
U5	MX-365 CTCSS Processor	4000-365
U6	4066 Quad analog switch	4004-066
U7	5V 1A Regulator	4007-805
U8	9V 2A Regulator	4017-809
U9	LM 386 400mW Audio Amp	4000-386
U10	DS 1233 Reset Controller	4001-233
VAR1	18V MOV	4900-018
X1	1.0 MHz xtal HC49U	8001-000
	Extruded Aluminium case	7201-001
	Aluminium Endplate	7201-010
	Acrylic Front panel	7201-011
	BNC Chassis Mt. Connector	7400-010
	Ribbon Cable with 14 Pin IDC Conns.	7301-002
	6 Ft. Radio Cable with DB-9 F Conn.	7301-001
	Shorting Blocks for JP1-JP4, JP9	7400-009



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Size C	CAGE Code	DWG NO	Rev I B
Monday, January 07, 2008	Scale	Sheet	1 of 1