VoCom Products
RF Amplifiers

Instruction Manual
for Model
VVC300-XXRF
Amplifiers

THE FOLLOWING INSTRUCTIONS ARE FOR USE BY QUALIFIED RF SERVICE PERSONNEL ONLY. SERVICE PERFORMED ON VOCOM'S AMPLIFIERS MAY VOID THE MANUFACTURER'S WARRANTY

VoCom Products Company, L.L.C.

Quality since 1979

TABLE OF CONTENTS

VVC300-XXRF
RF POWER AMPLIFIER

SECTION 1: OPERATING INSTRUCTIONS

GENERAL:

To effectively use the VVC300-XXRF RF power amplifier, the operation capabilities of the unit must be known. This section describes input/output connections and environmental operating conditions. Understand the operating of limitations of the amplifier before installation is attempted.

OPERATING VOLTAGES:

Warning:	This unit is designed for operation from 13.8 volts DC negative ground systems. The chassis must be kept at earth potential. The negative (black) DC power lead is connected directly to the chassis. Operation in positive ground systems may cause injury.

All power measurements and specifications are met at 13.8 volts DC as measured at the DC input terminals. For best performance, a regulated power supply is recommended. Operating voltage range is from 12.0-14.0 volts. Power will be reduced slightly at DC voltages below 13.8 volts. Operation a 14.0 volts or higher is to be avoided as this will significantly reduce transistor life.

POWER CORD IDENTIFICATION:

Four 6 gauge cables extend from the amplifier. The RED leads are to be connected to the POSITIVE power supply terminal. The BLACK leads are to be connected to the NEGATIVE power supply terminal and earth ground. Use caution not to reverse the DC polarity and do not connect to an AC power line. Two power supplies maybe used. Set each at the same voltage.

OPERATING TEMPERATURE:

The amplifier may be operated when the ambient air is between O and 50 degrees centigrade. If operated in a closed cabinet, verify that the air temperature flowing over the heat sink is in this range. The amplifier/power supply combination may generate over 1500 watts of heat. The amplifier is cooled by convection flow across the heat sink fins of the unit. Maintain a minimum of 4 inches clearance. A thermal shut-off circuit is provided that will interrupt the DC power input to the first RF stage should the heat sink rise above 60 degrees C. Operation in confined areas may cause the unit to shut-off thermally. Installations where thermal cut-off occurs frequently should be avoided. The unit may be stored in temperatures between -20 and + 70 degrees centigrade.

Keep the fan intakes free of dust.

TROUBLE SHOOTING:

LOW POWER OUTPUT:

The most common amplifier problem is low power output. If the installation test shown in Section 3 is run the power input/output specification on the nameplate should be met, especially when working into a dummy load, since this is essentially the test run at the factory.

If working with BIRD wattmeters, remember that the power output reading is specified at +/-5% of full scale. In other words, a wattmeter with a 100w element gives readings of +/-5 watts when the wattmeter is reading full scale. Mid-scale readings have much lower accuracy. Always use an element closest to full scale for maximum accuracy. Treat your element with extreme care. Dirty or dropped elements always read low.

Make sure that your power supply is adjusted to 13.8 volts. The input/output powers specified on the nameplate were taken at 13.8 volts. Measure the voltage at the amplifier terminals to be sure all the DC connections are tight and that the amplifier is seeing 13.8 volts during operation. Check the manufacturer's ratings to be sure the CONTINUOUS rating of the power supply is sufficient to power the amplifier. If the power supply is slumping, the amplifier output will go down with the voltage.

Look at the drive power while the amplifier is operating. Many exciters will put out different powers into even slightly different loads. Low drive power will produce low output power. Do not assume that your exciter output power with the exciter running into a dummy load will be the same as when the exciter is running the amplifier. A strong RF field can sometimes cause an exiciter to increase or decrease power as well as go spurious. In-band spurious signals maybe amplified. The change in signal level will show up on the input wattmeter. RF fields can also cause linear power supplies to fall out of regulation. This should be seen on a voltmeter (CAUTION: RF can effect digital voltmeters, too.)

Low (or high) output powers can be the result of a high output SWR. Carefully check your loads and connecting cables.

NO OUTPUT POWER:

After checking the above items, be aware that there is protection circuitry. Check with the factory if you suspect that the internal protection has or is operating. As a rule, if the front panel light and fan are operating and output is zero, the SWR circuit has operated (usually with an audible click upon key-up.) If the SWR protection is operating, you would notice the output wattmeter "jump" briefly upon key up and then return to zero.

If the front panel light does not light, either the input drive isn't high enough to trigger the amplifier on or the amplifier has disconnected itself from DC power. The amplifier will reset itself when it cools down. (Some power supplies will "spring up" in voltage when a heavy load is released and settle down to normal after 100-200 milliseconds. This can damage an amplifier.)

If all else fails, give us a call. We'll be glad to help!

VVC 3OO-XXRF AMPLIFIER TUNING PROCEDURE:

This unit is factory tuned to customer specification. No tuning should be required + or - 5 MHz from the frequency stamped on the nameplate.

Field tuning voids the manufacturer's warranty. Units being moved in frequency more than 5 MHz from the nameplate frequency should be returned to the manufacturer for warranty validation.

Do not attempt tuning without 2 in-line wattmeters, one on the input side and one on the output side. Do not attempt initial tuning while connected to a voltage source above 12 volts

1. Initial tuning MUST be done at 12.0 Vdc.
2. Tighten all trimmers until turning resistance is felt. (do not adjust until tight)
3. Turn the input trimmers counter-clockwise 1/4 turn.
4. Turn all other trimmers counter-clockwise 1 full turn.
5. Apply rated drive to unit and tune input trimmer for minimum input reflected power. Adjust output trimmers for maximum output power. Maintain balance throughout procedure never turning a trimmer more than 1/8 turn without VVC300-XXRF tuning procedure.
6. Adjust combiner trimmer for maximum efficiency (RF output power divided by DC input powers.
7. Repeat above with Power supply set at 13.8 Vdc. Unit should now meet model specifications.

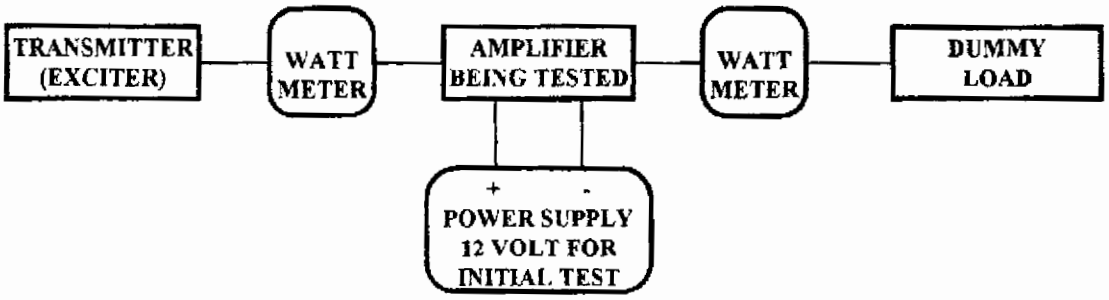
NOTE: For frequencies below 150 MHz, the 100 pf base capacitors (located along the input strip line approximately 1" from the transistors) may have to be removed. if necessary, remove them and perform standard alignment above.

SECTION 2: SPECIFICATIONS

WARNING:	Do not exceed 300 watts output. Do not exceed nameplate drive power by more than 5%. Do not exceed 14.0 volts while operating.
FREQUENCY:	144-174 MHz range. Factory set to specific frequency on ID label.
FREQUENCY RANGE:	May be operated within + or - 4 MHz of the factory set frequency without tuning.
INPUT DRIVE POWER:	As specified on amplifier ID nameplate. This is the power measured during final inspection that was required to reach 300 watts output.
MAXIMUM INPUT DRIVE POWER:	Nameplate input drive power +5%
MAXIMUM TEST OUTPUT POWER:	360 watts (Pulsed output period not to exceed 100 mS)
MAXIMUM RATED OUTPUT POWER:	Not to exceed 300 watts.
DC CURRENT DRAW:	At 13.8 Vdc, 300 watt output, output VSWR < 1.05:1: 55w drive rating or higher: 45 Amperes, typ. 100 mW-55w drive rating: 55 Amperes, typ.
MAXIMUM RATED LOAD VSWR FOR CONTINUOUS DUTY OPERATION	1.16:1 (<5% reflected power)
MAXIMUM VSWR RATING WITHOUT DAMAGE	Infinite, all phase angles. (1 hour test time at 12V, no degradation in output power upon return to normal load and temperature). VSWR or thermal protection may operate above 1.5:1 VSWR.
OUTPUT COMBINING	Wilkinson in-phase at 150w level; 500 mil-spec. 90 degree quadrature at 300w level.
QUADRATURE DUMP LOAD RATING	150w (no damage after 48 hours of operation with 1 or more defective stages)..
OUTPUT VSWR PROTECTION	Must not operate: 1.50:1; must operate: 3.00:1 or higher.
THERMAL PROTECTION	60 degrees C + /- 7 degrees C heat sink temperature. Shut off; reset upon return to normal temperature.
INPUT/OUTPUT CONNECTORS	Type N FEMALE range mount.
SPURIOUS OUTPUTS	2nd Harmonic < -65 dbc, all others < -90 dbc, Noise < -100 dbc.

Section 3.0 Installation Instructions:

3.1 BLOCK DIAGRAM:



3.2 EQUIPMENT NEEDED:

1. Exciter
2. Wattmeters (2) with slugs for full scale readings
3. Power Supply
4. Dummy Load
5. Short coaxial cables (RG-8 or better) with appropriate connectors or adapters.
6. DC ammeter
7. DC voltmeter

3.3 INSTRUCTIONS:

1. Mount equipment in permanent location. Operate the amplifier at 12 volts into a dummy load for initial tests.
2. The amplifier is of fixed gain design. In order to obtain a given output power (e.g., exactly 100 watts) the input or drive power must be adjusted. The factory test input / output powers are shown on the serial number plate for your particular amplifier.
3. You must measure input power, output power, DC voltage, and DC current draw and verify that all are within specifications . If you do not measure one of these parameters, you have not done a proper installation.
4. After proper operation into the dummy load is assured, connect the amplifier to the installation load (antenna, combiner, etc.) The output power and DC current draw should not change significantly If it does, a load SWR problem exists and must be corrected.
5. Remember the specification output power is obtained only at 13.8 volts. Initial tests at 12 volts will result in lower output powers than at 13.8 volts. A reduction in drive power from the value set at 12 volts will be required when the voltage is increased. Otherwise, higher than rated output power will result.

SECTION 4: CIRCUIT DESCRIPTION

General block diagram description:

Refer to system block diagram, figure 4. An FM (or PM or CW) signal appearing at the input connector is first detected by the RF detector located on the input/output board. This detector samples the input RF, rectifies it and operates the DC fan drivers. The fans will therefore run only when RF is present at the input. (NOTE: some very low drive amplifiers have this detection stage at the output of the amplifier). The input signal is applied to the input amplifier string. This consists of a gain module driving the 4 mid-drivers (200 mW models), or an MRF 1946 (2w-5w models).

The output of the input amplifier string is fed to the mid-drivers and then to the input port of the couplers. Each coupler splits the signal from the input amplifier string into two equal signals. The coupler has the characteristics that any difference between the reflected signals from the following stage will be dissipated as heat in the dummy termination. If one final stage goes open or short circuit or anything in between, the reflected power will never reach any other transistor. Thus each stage is isolated from it's neighbor. This isolation improves stability and prevents one bad transistor from putting any extra strain on another. Filtering is done at the 150 and 300 watt deck levels and harmonics at this point are already negligible in amplitude. Since the combining is a linear process, no signal or harmonic distortion is added at this point.

THERMAL SHUT-OFF:

A thermal switch is wired in series with the input cut-off relay, or the predriver + VCC. This is not shown on the schematic. This switch will disable the input stage if heat sink temperature rises to 80 degrees centigrade. Reset occurs upon return to normal temperature.

Section 5: Proper Amplifier Set-Up

The life of an amplifier is dependent on many factors, but probably the most important is initial set-up. Let's look at some typical cases demonstrating amplifier life. These examples are based on the VoCom 800 MHz 140 watt amplifier.

Case 1: Run it "wide open."

Power Input:	200 mWatts
Power Output:	185 watts
Current Draw:	62A at 13.8 volts

Power consumed 62 X 13.8 =	855.6
Power output =	185.0
Power dissipated as heat	670.6 watts

Assuming a junction to case thermal resistance of 1.16 degree C per watt, and 7 transistors in this design. 1.16 X 670.6/7 + 60 = 171.1 degree C junction temperature. The 60 in the above equation is an assumed heat sink temperature. Motorola has published data on MTBF (see for example, AN-790) For the MRF 847 used in this amplifier this equates to an MTBF of a little over 10 years. Converting MTBF to % failures per year this equates to a 10% Failure rate per year PER DEVICE. In an amplifier with seven devices, **Motorola predicts a 70% failure rate per year if the amplifier is operated at this point.**

Case 2: Recommended operating point

Power input:	200 mWatts
Power Output:	140 watts
Current Draw:	40 A at 13.8 volts

Power consumed: 40 X 13.8 =	552
Power output =	150
Heat dissipated =	402 watts

Following a similar calculation, the MTBF per device is 2000 years. In an amplifier with 7 devices the 5 % failure rate per year would be only 0.35%. The extra 35 watts is very costly in terms of amplifier lifetime.

Conclusion: Set up the amplifier carefully. Measure the current draw and adjust the drive for the best efficiency. At VoCom, we carefully choose our power levels at each stage of amplification to obtain total failure rates below 0.5% per year even in amplifiers with MRF transistors. But it's up to you to set them up properly.

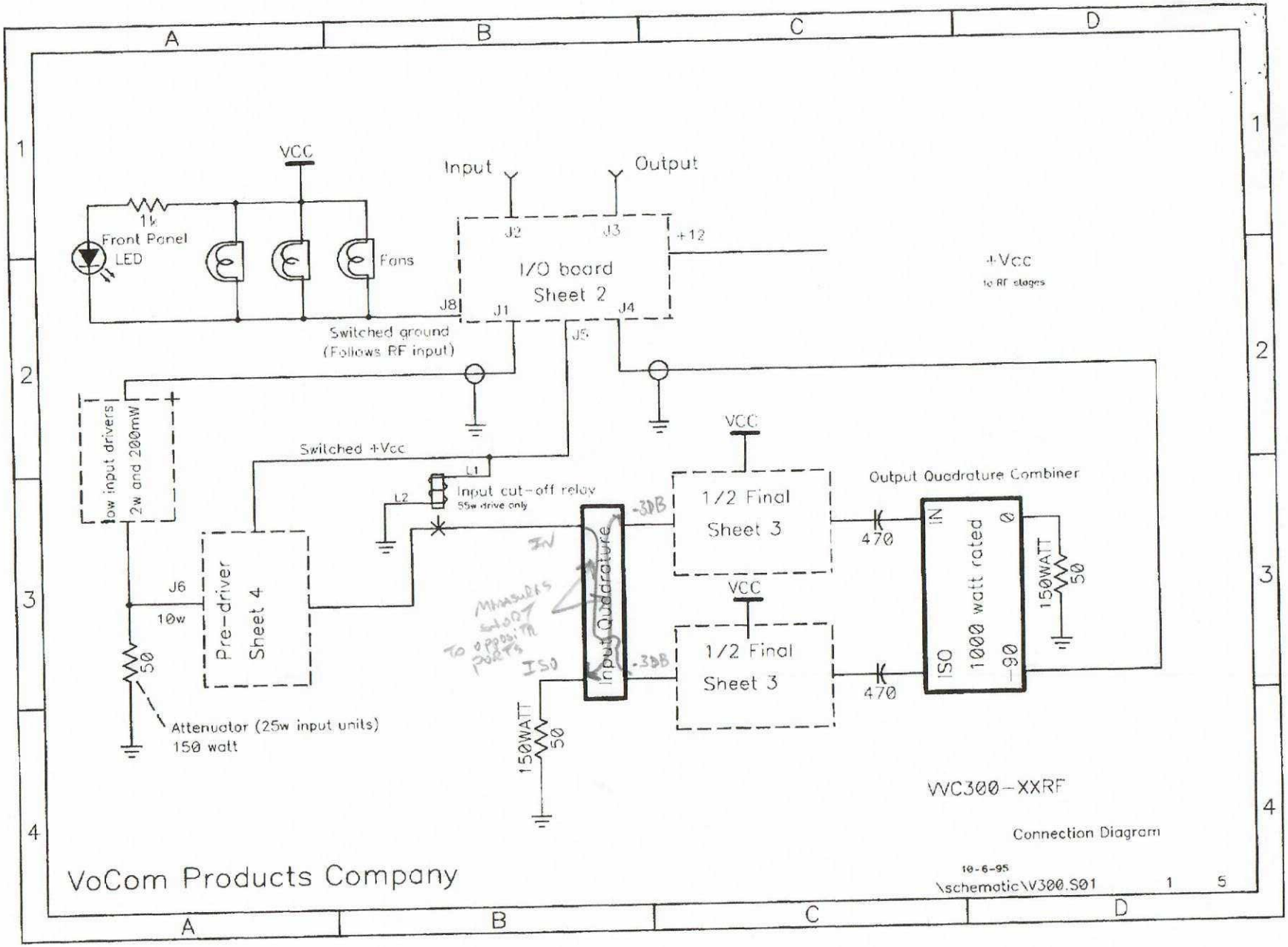
SECTION 6: APPLICATION NOTE

There are a number of low power fixed output exciters on the market and it has come to our attention that may users are reducing the output power of these exciters by de-tuning them.

NEVER REDUCE THE POWER INPUT TO THE AMPLIFIER BY DETUNING ANY STAGE OF EITHER THE EXCITER OR THE AMPLIFIER!

De-tuning the exciter will almost certainly cause it to produce spurious in-band signals. These spurious signals will be amplified by the amplifier. If they are high enough in level, amplifier damage may result not to mention FCC involvement. If drive reduction is necessary to keep the amplifier within operating limits, always use a power attenuator if the exciter does not have a power control!

In a emergency, a power attenuator may be constructed out of a length of RG-58 or smaller coax (see cable attenuation specs for your frequency). Also be aware that we can adjust the drive requirement at the factory to match the fixed output exciter.


VCC
Input
Output
1k
Front Panel LED
Fans
J2
J3
+12
I/O board Sheet 2
J8
J1
J4
J5
+Vcc
to RF stages
Switched ground (Follows RF input)
low input drivers 2w and 200mW
Switched +Vcc
L1
L2
Input cut-off relay
55w drive only
VCC
1/2 Final Sheet 3
Output Quadrature Combiner
-3DB
IN
470
IN
ISO
0
-90
1000 watt rated
150WATT
50
J6
10w
Pre-driver Sheet 4
50
Attenuator (25w input units)
150 watt
Input Quadrature
ISO
150WATT
50
VWC300-XXRF
Connection Diagram
VoCom Products Company
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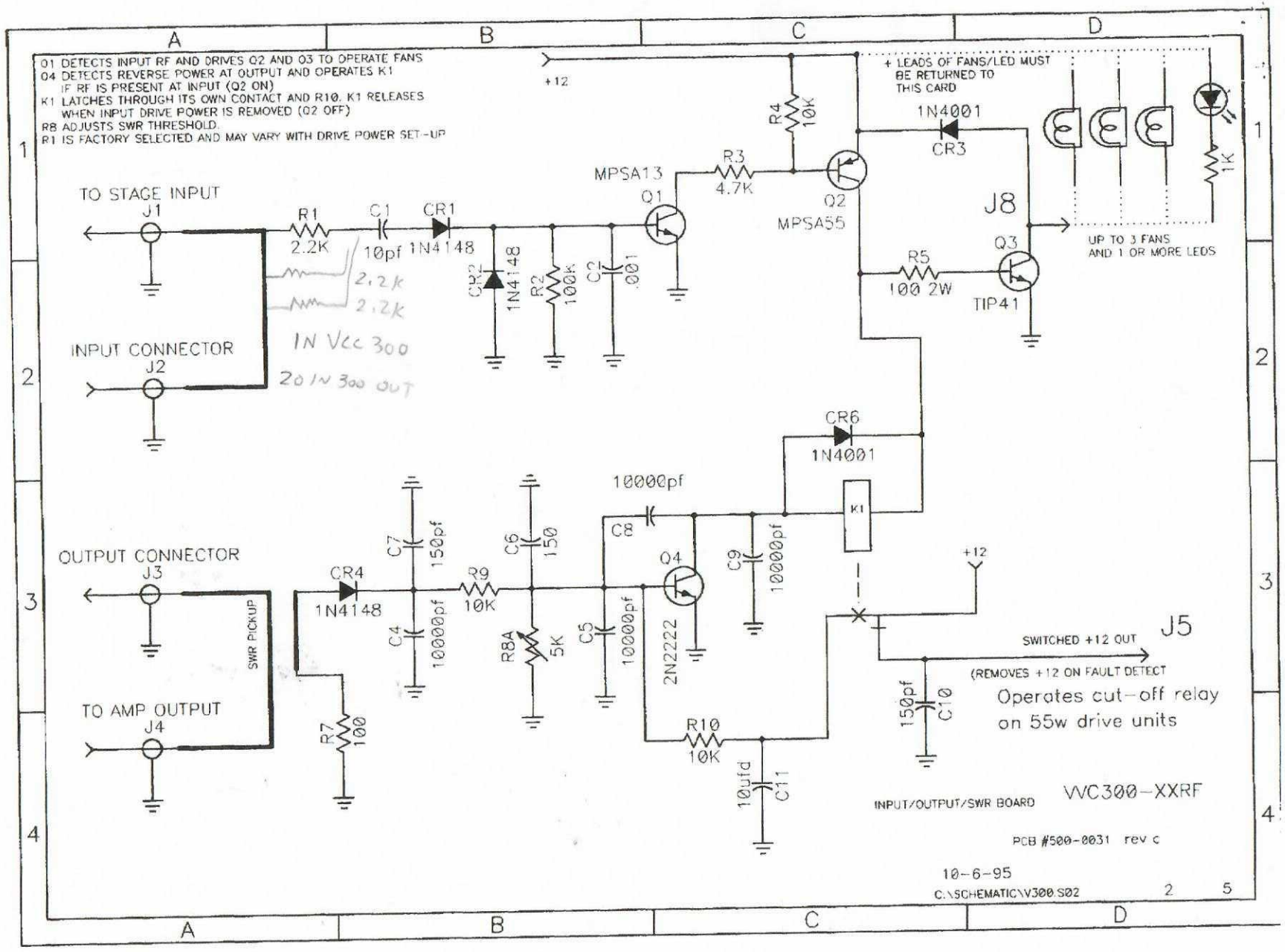
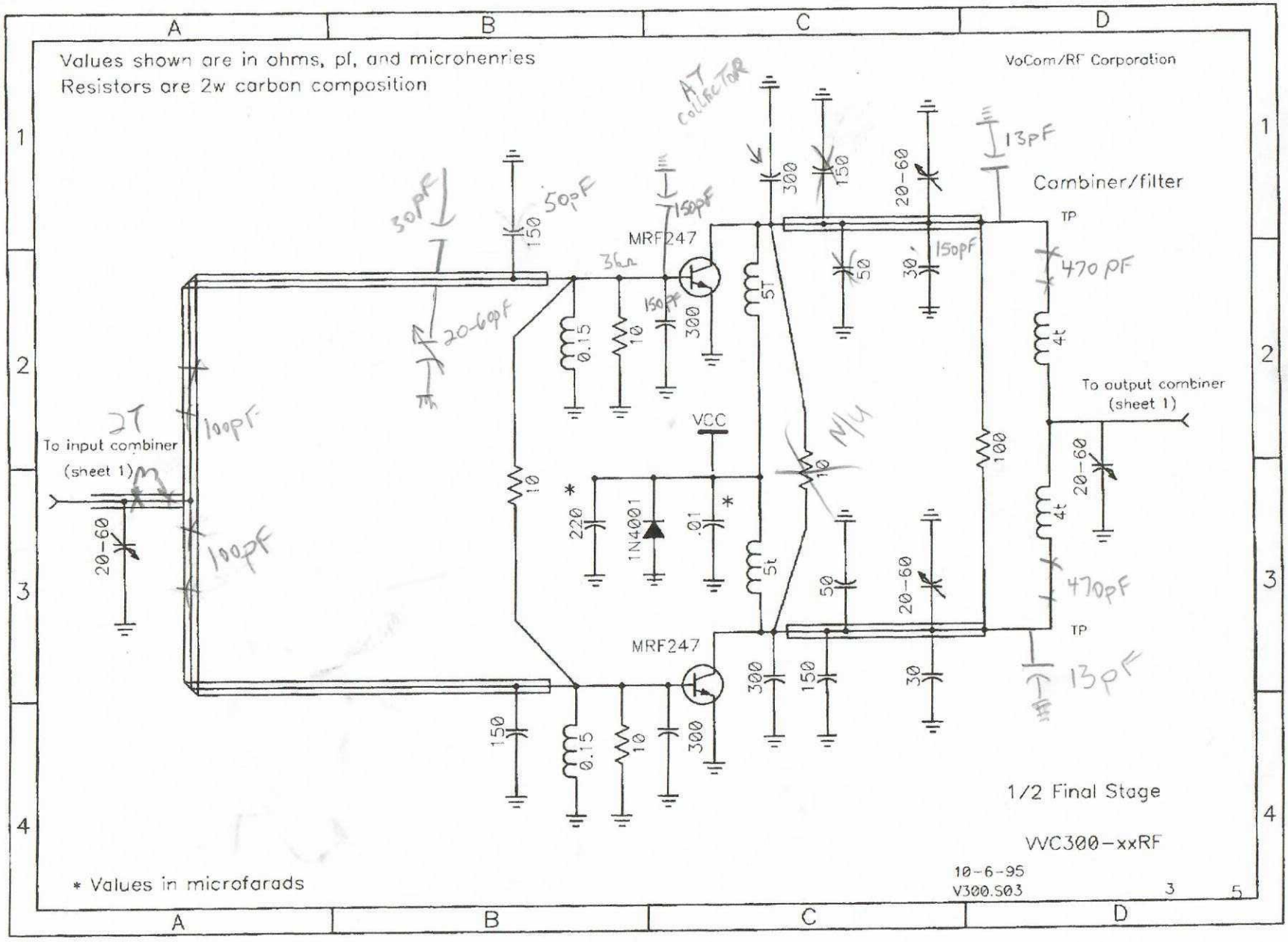
1
5


Q1 DETECTS INPUT RF AND DRIVES Q2 AND Q3 TO OPERATE FANS
Q4 DETECTS REVERSE POWER AT OUTPUT AND OPERATES K1
IF RF IS PRESENT AT INPUT (Q2 ON)
K1 LATCHES THROUGH ITS OWN CONTACT AND R10. K1 RELEASES
WHEN INPUT DRIVE POWER IS REMOVED (Q2 OFF)
R8 ADJUSTS SWR THRESHOLD.
R1 IS FACTORY SELECTED AND MAY VARY WITH DRIVE POWER SET-UP
+12
+ LEADS OF FANS/LED MUST BE RETURNED TO THIS CARD
1N4001
CR3
R4 10K
R3 4.7K
MPSA13
Q1
Q2
MPSA55
J8
UP TO 3 FANS AND 1 OR MORE LEDS
1K
TO STAGE INPUT
J1
R1 2.2K
C1 10pf
CR1 1N4148
2.2k
2.2k
IN Vcc 300
20 IN 300 OUT
CR2 1N4148
R2 100K
C2 .001
R5 100 2W
Q3
TIP41
INPUT CONNECTOR
J2
CR6
1N4001
K1
10000pf
C8
C7 150pf
C6 150
C4 10000pf
R9 10K
R8A 5K
C5 10000pf
Q4
2N2222
C9 10000pf
+12
OUTPUT CONNECTOR
J3
CR4
1N4148
SWR PICKUP
R7 100
TO AMP OUTPUT
J4
J5
SWITCHED +12 OUT
(REMOVES +12 ON FAULT DETECT
Operates cut-off relay on 55w drive units
150pf C10
R10 10K
10ufd C11
INPUT/OUTPUT/SWR BOARD
VVC300-XXRF
PCB #500-0031 rev c
10-6-95
C:\SCHEMATIC\V300.S02
2 5
A
B
C
D
1
2
3
4


Values shown are in ohms, pf, and microhenries
Resistors are 2w carbon composition
VoCom/RF Corporation
Combiner/filter
To input combiner
(sheet 1)
To output combiner
(sheet 1)
MRF247
MRF247
VCC
1N4001
TP
TP
470 pF
470pF
13pF
13pF
1/2 Final Stage
VVC300-xxRF
* Values in microfarads
10-6-95
V300.S03
3 5

Values shown are in ohms, pf, and microhenries
Resistors are 2w carbon composition

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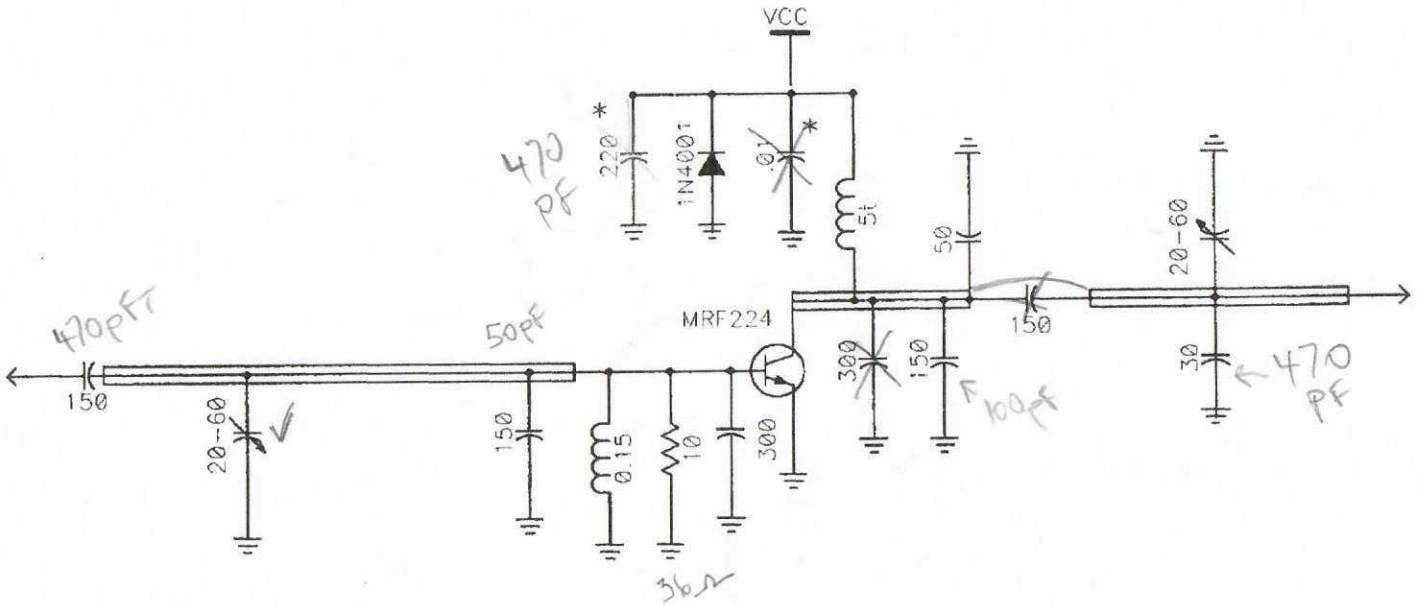

Driver Stage

VVC300-XXRF

10-6-95
V300.S03

* Values in microfarads

4 5