DANIELS™
ELECTRONICS LTD.

VHF 30W POWER AMPLIFIER INSTRUCTION MANUAL

AMP-3/150 136-174 MHZ

Covers Models:

AMP-3/140-30	AMP-3/160-30

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DOCUMENT CONTROL

This document has been produced, verified and controlled in accordance with Daniels Electronics' Quality Management System requirements. Please report any errors or problems to Daniels Electronics' Customer Service Department.

NOTE

The user's authority to operate this equipment could be revoked through any changes or modifications not expressly approved by Daniels Electronics Ltd. The design of this equipment is subject to change due to continuous development. This equipment may incorporate minor changes in detail from the information contained in this manual.

RF Exposure Warning

Exposure to radio frequency (RF) energy has been identified as a potential environmental factor that must be considered before a radio transmitter can be authorized or licensed. The FCC has therefore developed maximum permissible exposure (MPE) limits for field strength and power density, listed in FCC 47 CFR § 1.1310. The FCC has furthermore determined that determination of compliance with these exposure limits, and preparation of an Environmental Assessment (EA) if the limits are exceeded, is necessary only for facilities, operations and transmitters that fall into certain risk categories, listed in FCC 47 CFR § 1.1307 (b), Table 1. All other facilities, operations and transmitters are categorically excluded from making such studies or preparing an EA, except as indicated in FCC 47 CFR §§ 1.1307 (c) and (d).

Revised FCC OET Bulletin 65 (Edition 97-01) provides assistance in determining whether a proposed or existing transmitting facility, operation or device complies with RF exposure limits. In accordance with OET Bulletin 65 and FCC 47 CFR § 1.1307 (b), this Daniels Electronics Ltd. transmitter is categorically excluded from routine evaluation or preparing an EA for RF emissions and this exclusion is sufficient basis for assuming compliance with FCC MPE limits. This exclusion is subject to the limits specified in FCC 47 CFR §§ 1.1307 (b) and 1.1310. Daniels Electronics Ltd. has no reason to believe that this excluded transmitter encompasses exceptional characteristics that could cause non-compliance.

Notes:
- The FCC's exposure guidelines constitute exposure limits, not emission limits. They are relevant to locations that are accessible to workers or members of the public. Such access can be restricted or controlled by appropriate means (i.e. fences, warning signs, etc.).
- The FCC's limits apply cumulatively to all sources of RF emissions affecting a given site. Sites exceeding these limits are subject to an EA and must provide test reports indicating compliance.

RF Safety Guidelines and Information

Base and Repeater radio transmitters are designed to generate and radiate RF energy by means of an external antenna, typically mounted at a significant height above ground to provide adequate signal coverage. The following antenna installation guidelines are extracted from Appendix A to OET Bulletin 65 and must be adhered to in order to ensure RF exposure compliance:

Non-building-mounted Antennas:

Height above ground level to lowest point of antenna ≥ 10 m or
Power ≤ 1000W ERP (1640 W EIRP)

Building-mounted Antennas:

Power ≤ 1000 W ERP (1640 W EIRP)

The following RF Safety Guidelines should be observed when working in or around transmitter sites:

- Do not work on or around any transmitting antenna while RF power is applied.
- Before working on an antenna, disable the appropriate transmitter and ensure a "DO NOT USE" or similar sign is placed on or near the PTT or key-up control.
- Assume all antennas are active unless specifically indicated otherwise.
- Never operate a transmitter with the cover removed.
- Ensure all personnel entering a transmitter site have electromagnetic energy awareness training.

For more information on RF energy exposure and compliance, please refer to the following:

1) FCC Code of Regulations; 47 CFR §§ 1.1307 and 1.1310.
2) FCC OET Bulletin 65, Edition 97-01, "*Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*".
3) http://www.fcc.gov/oet/rfsafety/

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GENERAL INFORMATION

INTRODUCTION

The MT-2/MT-3/MT-4 repeater system is a VHF/UHF radio system which is characterized by high performance and reliability under the most severe environmental conditions. The total system is designed to provide dependable, low maintenance performance, even in the most difficult circumstances.

The MT-2/MT-3/MT-4 series of modules are packaged in the compact Eurostandard (5”h x 2.8”w x 7.5”d) housing, and are robustly designed for urban, remote or transportable applications. Voltage stress testing is done over the range of +10 to +17 Volts DC which is followed by 24 hours of continuous operation at maximum rated power output.

When the VT-2/VT-4 transmitter is used as an exciter for the VHF AMP-3 power amplifier (PA) module, it will provide an adjustable 10 to 30 Watts RF output over the 136 to 174 MHz VHF Frequency range. When the VT-3 transmitter is used as an exciter the RF output is only adjustable from 20 to 30 Watts.

The VHF AMP-3 family contains two models (AMP-3/140 and AMP-3/160) covering two frequency bands 136 - 150 MHz and 150 - 174 MHz, respectively. The VHF AMP-3 power amplifier (PA) mates with either the MT-2 VHF transmitter exciter module, the VT-3/1xx-Sx transmitter exciter module or the VT-4x1xx-x0 transmitter exciter module.

PERFORMANCE SPECIFICATIONS

Type:	MT-3 Series Power Amplifier
Family:	AMP-3/150
Models:	AMP-3/140, AMP-3/160
Compatibility:	MT-2, MT-3 and MT-4 Series Transmitter Exciters
Frequency Range:	136 to 174 MHz
Frequency Bands:	136 to 150MHz, 150 to 174MHz
RF Input Power:	2 - 3.5 Watts (not to exceed 4W)
RF Output Power:	Adjustable: 10-30 Watts (set by MT-2 or MT-4 exciter) Adjustable: 20-30 Watts (set by MT-3 exciter)
Nominal Passband Gain:	10dB
Output Impedance:	50 Ω, Type N connector
Output Return Loss (VSWR):	Better than 21 dB (1.2)
Input Return Loss (VSWR):	Better than 18 dB (1.3)
Conducted Spurious & Harmonics:	< -80 dBc (at 30W output) Less than 0.3 uW (-35 dBm) absolute level
Operating Voltage:	+13.8 VDC nominal, range +10 to +17 VDC
Transmit Current:	3.0 to 5.0 A @ 30 W
Standby Current:	< 5 mA
Thermal:	Thermal interlock disables @ 80°C (175°F) Fan activated @ 40°C (105°F)
Duty Cycle:	Continuous (with Fan) -40°C to +60°C Operation
Exciter	VT-2, VT-3 and VT-4 4W max. output for 30 W P.A
IC TAC:	pending
FCC ID:	pending

PHYSICAL SPECIFICATIONS

Operating Temperature Range:	-30°C to +60°C, optional -40°C temperature test.		
Operating Humidity:	Up to 95% RH (non-condensing) at +25°C		
RF Connectors:	Type N Standard		
Corrosion Prevention:	Anodized aluminum construction. Stainless steel hardware.		
Physical Dimensions:	Width: 14.2 cm (5.6”)	Height: 12.8 cm (5.05”)	Depth: 19 cm (7.5”)
Weight:	2.4 kg. (5.5 lb.)		
Features:	•Heavy Duty Aluminum Heatsink; •Thermal switched Fan (at 40°C). •RF Power, High VSWR, Overload and Overtemp Indicators. •Internal, re-settable circuit breaker		

ALIGNMENT & INSTALLATION

RECOMMENDED TEST EQUIPMENT

Daniels Subrack SR-39-1 with System Monitor
Daniels Extender Card Kit EC-48RK
Power Supply Regulated 13.8VDC @ 10A
Current Meter 5.0A
DC Voltmeter
RF Coupler (eg. Bird 4275)
Wattmeter (eg. Bird 4421)
VSWR Meter (eg. Bird 4421)
Dummy Loads 50 Ohm, 3:1 (50W)
Spectrum Analyzer (eg. IFR 2975)

AMPLIFIER BOARD ALIGNMENT

Refer to the VHF 30W Power Amplifier Board Component Layout Diagram for the location of the adjustment capacitors, potentiometers, air-core coils and test points.

This procedure assumes the use of a single subrack with an EC-48RK extender card kit for both the exciter and the power amplifier such that their internal adjustment points are easily accessible.
Step 1: Remove the top extrusion cover from the transmitter exciter. Set the exciter frequency to either 143MHz or 162MHz depending upon whether you are tuning a lowband or highband unit, respectively.

Step 2: Install one of the extender cards in the designated location for the exciter within the subrack. Connect the exciter to this extender card using the gray connector cable provided with the extender card kit.

Step 3: Refer to the 'VHF 30W Power Amplifier Exploded View' on page 15 for help on the following procedures. Remove the power amplifier 14HP case. Next, unplug the cooling fan from the control board and remove the front panel. Using suitable male connectors or a test jig, apply the following signals directly to the amplifier board:

- 13.8V : J3 - Pin1, Pin 2
  Note: Ensure an ammeter is connected in series with this line.
- Gnd : J3 - Pin 3, Pin 4
- 9.5V : J4 - Pin 4
- Gnd : J4 - Pin 8 (RF Input Sample)

Step 4: While monitoring the current on the 13.8V line and without an RF input to the power amplifier, slowly adjust the potentiometer RV1 until the current reads 230mA. As a check, measure the voltage at TP1. It should read between 2.5V and 3.0V.

Step 5: Now connect the output of the exciter to the input of the power amplifier. Connect the output of the power amplifier through a suitable RF coupler then through a power meter and finally terminate the output with a 50 Ohm load. The low power output from the RF coupler should be connected to the input of a spectrum analyzer. The spectrum analyzer should have an output tracking generator capable of putting out at least a +6dBm signal. This output should be connected to the input of the exciter amplifier which is first disconnected from the exciter's local oscillator.

Step 6: Before enabling the tracking generator, the output power of the exciter amplifier should be disabled by turning its potentiometer fully counterclockwise (~12 Turns). Now turn the exciter on by setting the front panel switch to 'Key Tx'. Set the center frequency on the spectrum analyzer to the same frequency the exciter was set to in Step 1. Next, set the span to 0 Hz and enable the tracking generator with a +6dBm output.

Step 7: While monitoring the output on the power meter and ensuring 13.8V on the PA amplifier board, slowly increase the exciter amplifier output until 30W is reached. Increase the span on the spectrum analyzer to 20MHz. Next, remove the cover on the low-pass filter shield (10601-01) on the amplifier PCB to allow access to the air-core inductors, L5 to L8. Monitoring the output response on the spectrum analyzer, tune these inductors by altering the spacing between the windings with a plastic adjusting tool for maximum flatness and gain across the desired band (136 - 150MHz for lowband, 150 - 174MHz for highband). Then capacitor C12 should be adjusted for maximum flatness and gain also.

Step 8: Set the span on the spectrum analyzer to 0 Hz and check that output VSWR is below 1.20 on the band edges and the center frequency of the band.

Step 9: As a final check, replace the low-pass filter shield and using the spectrum analyzer again, search the band (either 136 - 150MHz or 150 - 174 MHz) for any unwanted spurious emissions.

CONTROL BOARD ALIGNMENT

Refer to the VHF 30W Power Amplifier Control Board Component Layout Diagram for the location of the adjustment potentiometers and test points.

This procedure assumes the use of 1/2 wavelength RF output cables between all pieces of test equipment after the PA output for accurate power readings during mismatched load conditions.

Step 1: Once the amplifier board alignment is complete, the exciter can be turned off and its amplifier re-connected to the local oscillator. Next, the male connectors or test jig can be removed from the amplifier board and the control board along with the front panel can be re-connected to the power amplifier. The power amplifier can then be connected via the gray cable to the second extender card which should be installed in the designated location within the subrack for the power amplifier.

Step 2: With the exciter's output still connected to the input of the power amplifier and the output of the power amplifier still connected through an RF coupler into a wattmeter and 50 Ohm load, set the transmitter to the desired frequency. Next, adjust the output power of the exciter such that the PA output is 10W. Then adjust potentiometer RV1 until LED1, or the 'RF POWER' indicator, just turns on. This threshold may be adjusted to any RF output power level between 10W and 30W.

Step 3: Set the exciter output power such that the output power from the PA is equal to that under normal operating conditions. Replace the 50 Ohm load with a suitably rated 3:1 mismatched load. Adjust potentiometer RV2 until LED2, or the 'HIGH VSWR' indicator, just turns on.

Step 4: As a check, terminate the power amplifier once again with a 50 Ohm load and ensure that LED2 is now off. If it is not off, adjust RV2 until LED2 just turns off. Doublecheck that the LED still activates when the output is terminated with a 3:1 load. This threshold may be adjusted with a 3:1 on the output of the PA anywhere from 10W to 30W out.

Step 5: Disconnect the RF termination on the PA such that the output is an open load. Activate the exciter then adjust potentiometer RV3 until LED3, or the 'OVERLOAD' indicator, just turns on. When this occurs the output power is also substantially reduced to help protect the RF transistor. If the overload LED is turning on without having to adjust RV3, power down the exciter re-adjust RV3 and re-activate the exciter. This confirms that antenna VSWR overload protection works correctly.

NOTE: The above three pots, RV1 to RV3, on the control board should be re-checked and possibly re-adjusted if any of the following changes are applied to the unit:

- The output power level is changed
- The frequency is changed
- The output cable length is changed

POWER AMPLIFIER INSTALLATION

The AMP-3/150 RF power amplifier is designed for operation with any of the Daniels MT-2, MT-3 or MT-4 VHF transmitter exciters. A complete SR-3 subrack shipped directly from the factory is normally set to the appropriate options and output power calibration as requested by the customer. These units require no tuning.

For AMP-3/150 amplfiiers shipped separately from the SR-3 subrack, install as outlined:
- Connect +13.8V DC Power Supply to subrack
- Connect the output of the exciter to the input of the VHF 30W PA with the cable provided
- Connect the antenna system (using a 1/2 wavelength cable if possible), turn on the PA and key the transmitter. The 'RF POWER' LED should light and the other three LED indicators should remain off.

The LED indicators will only illuminate when the power amplifier is on and are defined as follows:

-RF POWER - Indicates that the minimum preset RF power level is present at the power amplifier output. The threshold is internally adjustable for RF output levels in the 10-30 watt range (Factory set at 10W).

- HIGH VSWR - Alarm indicating that the load impedance mismatch is higher than the preset level. The threshold is internally adjustable for load mismatches from 2:1 to an open output (Factory set at 3:1).

Note: The proper setting of this indicator cannot be guaranteed if a non-1/2 wavelength cable is used between the output of the PA and the antenna.

- OVERLOAD - (VSWR Overload Alarm) is used to indicate that the load impedance mismatch is extremely high and could potentially damage the RF transistor. Under this condition, the gate voltage to the transistor is dropped thus reducing the RF output power and preventing damage to the MOSFET. The factory threshold level is set when the load terminal is open.

- OVER TEMP - (Over Temperature alarm) a thermostat control switch interrupts the DC supply voltage to the PA when the RF transistor body temperature exceeds 80ºC (175ºF). Utilizing circuit hysteresis, the thermostat will reset at 75ºC (167ºF).

The fan is activated automatically when the RF transistor body temperature reaches approximately +40ºC (104ºF). The fan's operating temperature range is -20ºC (68ºF) to +60ºC (140ºF). It will not operate when the ambient temperature is below -20ºC (68ºF).

REVISION HISTORY

Revision	Date	ECO	Description
1	Apr 2003		First Revision
1-1-0	Oct 2003		Complete update of manual and drawings.