# MT-3/MT-4 RADIO SYSTEMS

# UHF AMPLIFIER
# INSTRUCTION MANUAL
## UT-3 / UT-4
## 406 - 470 MHz

Covers models: UT-3/400 Amplifier
UT-4/400 Amplifier



Issue: Peliminary
Issue Date: October 98
Printing Date: October 98
Part No.: IM23D-UT34400AMP

Previous Issue: N/A
Previous Issue Date: N/A

Daniels Electronics Ltd.
Victoria, B.C.
PRINTED IN CANADA

Reviewed By:

Quality Assurance:

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|---|---|---|
| Name | Signature | Date |

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.

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# 1 GENERAL

## 1.1 Introduction

The UT-3/400 Amplifier provides the final stage of RF amplification and filtering for the entire UHF Transmitter UT-3 406 -512 MHz family. The amplifier has four distinct frequency ranges: 406 to 430 MHz, 450 to 470 MHz, 470 to 490 MHz and 490 to 512 MHz as well as two distinct output power ranges: 0.5 to 2.0 Watts and 2.0 to 8.0 Watts. The UT-3/400 Amplifier is housed in a machined aluminum case that ensures optimum RF shielding, provides a good ground, and also acts as a heatsink.

Additionally, the UT-3/400 Amplifier is equipped with output power and VSWR sensing lines which can be individually configured as open collector or linear outputs. The internal VSWR sensor protects the amplifier from high antenna VSWR by approximately halving the amplifier's RF gain when a VSWR overload condition is present.

Output filtering for the UT-3/400 Amplifier is provided by the UT-3/400 Lowpass Filter Board. The lowpass filter assembly is mounted in a separate compartment of the amplifier case in order to provided maximum attenuation of harmonic and other spurious signals.

Refer to Section 4 for the UT-3 406 - 512 MHz UHF amplifier and lowpass filter component layouts and schematic diagrams

## 1.2 Performance Specification

| | |
|---|---|
| Type: | MT-3 series UHF Amplifier module. |
| Compatibility: | MT-3 series Transmitter Main Board. |
| Frequency Range: | 406 to 430 MHz, 450 to 470 MHz, 470 to 490 MHz or 490 to 512 MHz. |
| RF Power Output: | adjustable 0.5 to 2.0 Watts or 2.0 to 8.0 Watts |
| RF power Input: | nominal level adjustable from +4 dBm to +10 dBm, held within +/- 2 dB of nominal. |
| Ouput Impedance and VSWR: | 50 Ω, Type N connector; 3:1 max. VSWR. |
| Input /Output Isolation: | > 60 dB |
| Duty Cycle: | 100%: Continuous operation from -40˚ C to +60˚C. |

| | |
|---|---|
| Harmonic Emissions: | Less than -80 $dB_C$ . |
| Transmitter Mismatch Protection: | 20:1 VSWR at all phase angles. |
| Transmitter Alarm: | Forward power sense and reverse VSWR;<br>- open collector output (separate or 'OR'ed configuration);<br>-linear output (separate lines only). |
| Operating Temperature Range: | -30˚ C to +60˚ C, optional -40˚ C temperature test. |
| Operating Humidity: | 95% RH (non-condensing) at +25˚ C. |
| Operating Voltage: | +13.8 Vdc Nominal (range +11 to +16 Vdc),<br>+9.5 Vdc Regulated. |
| Transmit Current: | 0.7 Amp typical; 1.1 Amp maximum |
| Amplifier Standby Current: | less than 0.5 mA. |
| Amplifier Enable: | Active to ground. |
| Amplifier Enable Response: | typically overdamped, rising to within 90% of full power within 5 msec; maximum (underdamped) overshoot of 30%. |

# 2 THEORY OF OPERATION

## 2.1 Amplifier Operation

The operation of the UT-3/400 Amplifier varies slightly according to whether the amplifier is a low power (0.5-2.0 W) or a high power (2.0-8.0 W) version. The low power amplifier does not use transistor Q1 to boost the output power; consequently, it does not require the +13.8 Vdc supply. In both versions the power control circuitry monitors the RF output power of amplifier U4 and keeps the power constant. Therefore, the output power from the high power amplifier will change as the unregulated +13.8 Vdc supply varies. Note that the frequency band does not change how the amplifier operates; it only changes a few component values in the RF circuitry.

Power for the UT-3/400 Amplifier is provided from the MT-3 Transmitter Board. The +13.8 Vdc supply (if required) is continuously connected to the amplifier; whereas, the +9.5 Vdc supply is always switched by the transmitter's PTT circuitry. The UT-3/400 Amplifier will not consume any power from the +13.8 Vdc supply until +9.5 Vdc is switched on for the amplifier's circuitry and an RF input signal is present. The synthesizer or crystal control module controls the +9.5 Vdc to the amplifier's circuitry; switching it on by grounding the amplifier's input enable line. The synthesizer will ground the input enable line only when the synthesizer's RF signal is phase locked. This prevents unwanted spurious emissions during transmitter start-up. A typical start-up sequence is listed below:

1) +13.8 Vdc is always present
2) the transmitter is keyed on
3) +9.5 Vdc is switched on by the PTT circuitry and the synthesizer or crystal control module PTT line is pulled low
4) an RF signal is output to the amplifier
5) the amplifier's input enable line is activated
6) the amplifier outputs RF power

## 2.2 Power Requirements

Typical current requirements for the UT-3/400 Amplifier at different power levels are given in the Table 2-1 below. The current drawn from the +9.5 Vdc supply should never exceed 1.2 Amps and the current drawn from the +13.8 Vdc supply should never exceed 1.5 Amps.

Table 2-1 UT-3/400 Amplifier Current Consumption

| **0.5 to 2.0 Watt Amplifier** | | **2.0 to 8.0 Watt Amplifier** | | |
|---|---|---|---|---|
| Output Power | +9.5 Vdc Supply Current | Output Power | +9.5 Vdc Supply Current | +13.8 Vdc Supply Current |
| 0.5 W | 0.65 A | 2.0 W | 0.64 A | 0.51 A |
| 1.0 W | 0.87 A | 4.0 W | 0.79 A | 0.75 A |
| 1.5 W | 1.02 A | 6.0 W | 0.89 A | 0.93 A |
| 2.0 W | 1.17 A | 8.0 W | 1.04 A | 1.10 A |

**Note:** Current consumption measured at 470 MHz

## 2.3 RF Circuitry

The RF circuitry consists of several blocks: a 5 dB input pad (R1, R2, and R3), an RF amplifier module (U4), an output power boosting transistor (Q1), three directional couplers (TL1, TL3, and TL4), and the UT-3/400 Lowpass Filter. The heart of the UT-3/400 Amplifier is RF amplifier module U4. This module amplifies a 1 mW signal up to a maximum of 2.0 W, at the antenna connector, for a low power unit. In high power units, the output of U4 is further amplified by Q1 to a maximum of 8.0 Watts at the antenna connector. Capacitors C17 and C24 provide tuning for transistor Q1's input and output match. Although the input match and the output match for Q1 are tunable, the networks have been made broadband so that the high power amplifiers will operate over the same frequency range as the low power amplifiers. The frequency band of the UT-3/400 Amplifier is determined by the operating frequency range of the RF amplifier module U4. Directional couplers (TL1, TL3, and TL4) are used to sample forward and reverse power. The sampled power is used by the sensing and power control circuits to control the amplifier's operation. The final step in the RF path is output filtering and, as mentioned earlier, this is done by the UT-3/400 Lowpass Filter.

### 2.3.1 UT-3/400 Lowpass Filter

The UT-3/400 Lowpass Filter is a 50 ohm, 9 pole, reciprocal filter with a 3 dB cutoff frequency of approximately 512 MHz. The lowpass filter assembly attenuates the desired signal's harmonics as well as any other out-of-band emissions so that a 'clean' RF signal is output to the antenna connector.

## 2.4 Power Control Circuitry

The UT-3/400 Amplifier employs a closed loop power control which uses a sample of the forward RF power to control the gain of RF amplifier U4. Op-amp U1b compares the sampled RF voltage to the output power setpoint and generates an error signal which Q3 uses to control the voltage on U4's gain control pin. The output power setpoint is determined by R7, the Output Power Adjust potentiometer.

In low power amplifiers jumper JU5 is installed and the forward power is sampled by TL3, D6, C27, R18, L11, R19, and C28. In high power amplifiers jumper JU5 is not installed and the forward power is sampled by TL1, D5, C14, R13, L6, R12, and C15. In both high power and low power amplifiers, the power control circuitry keeps the output power of U4 constant. Therefore, in high power amplifiers, the amplifier's output power will fluctuate with variations in the +13.8 Vdc supply voltage.

## 2.5 Power Sensing Circuitry

The UT-3/400 Amplifier is equipped with output power and VSWR sensing lines which can be individually configured as open collector or linear outputs. In open collector configuration, the output is active low, that is, when a fail condition is detected (not enough output power or too high antenna VSWR) the open collector transistor is turned on. In linear configuration, a voltage proportional to the sensed output power or antenna VSWR is output.

Both the Output Power Alarm setpoint and the VSWR Alarm setpoint are individually adjustable; however, the Output Power Alarm setpoint must always be adjusted before the VSWR Alarm setpoint. This is because the Output Power Alarm setpoint is used as a reference by the VSWR Alarm circuitry.

### 2.5.1 Output Power Sense

The output power sense circuitry uses directional coupler TL3 to sample some of the forward power. The sampled power is rectified by diode D6 and capacitor C27 and then amplified by op-amp U3b. Op-amp U3b's amplification is controlled by R21, the output power alarm adjust potentiometer. The amplified voltage is then output directly in linear operation (JU1 installed, JU2 not installed) or compared to +6.3 Vdc by op-amp U1a which then drives transistors Q5 and Q6 for open collector operation (JU1 not installed, JU2 installed).

In open collector configuration, Q6 (the open collector output transistor) is turned on when an alarm condition occurs. The adjustment range for the output power alarm can vary depending on the setting of R21 (the Output Power Alarm Adjust potentiometer).

### 2.5.2 VSWR Sense

The VSWR sense circuitry uses directional coupler TL4 to sample some of the power reflected from the antenna terminal. The reflected power is rectified by diode D7 and capacitor C33 and then amplified by op-amp U2b. Op-amp U2b's amplification is controlled by R36, the VSWR Alarm Adjust potentiometer. The amplified voltage is then output directly in linear operation (JU4 installed, JU3 not installed) or compared to the output power alarm setpoint by op-amp U3a which then drives transistor Q7 for open collector operation (JU4 not installed, JU3 installed).

In open collector configuration, Q7 (the open collector output transistor) is turned on when an alarm condition occurs. The adjustment range for the VSWR Alarm can depending on the setting of R36 (the VSWR Alarm Adjust potentiometer).

### 2.5.3 VSWR Overload

The VSWR overload circuit protects the UT-3/400 Amplifier from excessive antenna VSWR by reducing the amplifier's gain (output power) when an overload condition occurs. The VSWR overload circuit (R38 to R41, R8, U2a, and Q4) is an extension of the VSWR sense circuit and operates the same as the VSWR sense open collector circuit. The VSWR Overload Adjust potentiometer (R38) reduces the voltage level of the VSWR Alarm Setpoint. The voltage set by R38 is the compared to the output power alarm setpoint by op-amp U2a which then drives transistor Q4. When transistor Q4 turns on, signaling an overload condition, resistor R8 is grounded which reduces the output power setpoint. Reducing the output power setpoint lowers the UT-3/400 Amplifier's gain and protects the amplifiers from excessive current draw resulting from high antenna VSWR.

The VSWR overload circuit's range of adjustment depends on the setting of the VSWR Alarm Adjust potentiometer (R36). The VSWR overload transistor Q4 can be activated at the same point at which the VSWR alarm becomes active or the VSWR overload circuit can be disabled by turning R38 completely counterclockwise.

# 3 UT-3/400 AMPLIFIER ALIGNMENT

## 3.1 General

Connections to the power supply, alarm and transmit enable lines (ENA), are clearly marked on the amplifier case. The amplifier is enabled when the enable line (ENA) is grounded.
If the amplifier is installed in the transmitter, alignment is simplified by using an SR-3 Subrack, SM-3 System Monitor, and RF extender cable to provide transmitter power and signal interconnection (see the Transmitter Main Board Manual for details). For complete transmitter alignment, the Transmitter Main Board, Synthesizer, Amplifier, and Audio Processor should be tuned in the aforementioned order. Please refer the corresponding manuals for each module.

If the input RF level is not changed, adjustments to the output power and alarm thresholds may be made without removing the amplifier cover. However, in the case of a complete amplifier alignment, the amplifier should be separated from the Transmitter Main Board and the amplifier cover removed to expose all amplifier circuitry. All jumpers and test points are clearly marked.

## 3.2 Repair Note

The UT-3/400 Transmitter is mainly made up of surface mount devices which should not be removed or replaced using an ordinary soldering iron. Removal and replacement of surface mount components should be performed only with specifically designed surface mount rework and repair stations complete with ElectroStatic Dissipative (ESD) protection.

When removing Surface Mount Solder Jumpers, it is recommended to use solder braid in place of manual vacuum type desoldering tools when removing jumpers. This will help prevent damage to the circuitboards.

## 3.3 Recommended Test Equipment List

Alignment of the transmitter requires the following test equipment or its equivalent.

| | |
|---|---|
| Dual Power Supply: | Regulated +9.5 Vdc at 0.1 A. |
| | Regulated +13.8 Vdc at 2 A - Topward TPS-4000 |
| Oscilloscope / Multimeter: | Fluke 97 Scopemeter |
| Current Meter: | Fluke 75 multimeter |
| Radio communications test set : | Marconi Instruments 2955R |
| VSWR 3:1 mismatch load: | JFW 50T-035-3.0:1 |
| coaxial test cable set | three 50 Ω cables of incremental length 20 to 40 cm |
| Alignment Tool: | Johanson 4192 |

It is recommended that the radio communications test set be frequency locked to an external reference (WWVH, GPS, Loran C) so that the high stability oscillator may be accurately set to within its ±1 ppm frequency tolerance.

## 3.4 Printed Circuitboard Numbering Convention

To ease troubleshooting and maintenance procedures, Daniels Electronics Limited has adopted a printed circuitboard (PCB) numbering convention in which the last two digits of the circuitboard number represent the circuitboard version. For example:

- PCB number 43-912010 indicates circuitboard version 1.0;
- PCB number 50002-02 indicates circuitboard version 2.0.

All PCB's manufactured by Daniels Electronics are identified by one of the above conventions.

## 3.5 Standard Factory Settings and Jumper Configuration

The UT-3/400 Amplifier is factory configured as follows:

- Open collector configuration for Output Power Alarm (3 dB drop).
- Open collector configuration for Antenna VSWR Alarm (VSWR ≥ 3:1).
- Output power of 2 Watts or 6 Watts for low and high power amplifiers respectively.

The corresponding jumper settings are:

| | | |
|---|---|---|
| • Jumper JU1: | not installed | Output power alarm - linear output |
| • Jumper JU2: | installed | Output power alarm - open collector output |
| • Jumper JU3: | installed | Antenna VSWR alarm - open collector output |
| • Jumper JU4: | not installed | Antenna VSWR alarm - linear output |
| • Jumper JU5: | installed | Low power (2 W) transmitters |
| • Jumper JU5: | not installed | High power (8 W) transmitters |

## 3.6 UT-3/400 Amplifier Alignment

### 3.6.1 General

The UT-3/400 Amplifier is a frequency sensitive module that is factory assembled to operate in one of four frequency bands: 406 to 430 MHz, 450 to 470 MHz, 470 to 490 MHz or 490 to 512 MHz. The amplifier is available in a low power version, 0.5 to 2.0 Watts output power, and a high power version, 2.0 to 8.0 Watts output power. Both amplifier versions require 5 dBm of input power and in both versions the amplifiers output power is continuously adjustable over the its respective power range. The UT-3/400 Amplifier provides Output Power and Antenna VSWR Alarm outputs which can be configured for open collector output or linear operation. The

amplifier's output power level, alarm levels, and tuning for the transistor matching circuit in the high power version can be set without detaching the amplifier from the transmitter board. However, if the output power alarm or the Antenna VSWR alarm output configuration requires changing, the UT-3/400 Amplifier must be detached from the MT-3 Transmitter Board. Refer to section 4 page 2 "UT-3/400 Amplifier Component Layout" for the location of solder jumpers JU1 to JU5.

### 3.6.2 UT-3/400 Amplifier Adjustment

The Amplifier alignment consists of two adjustment procedures; (i) a general set up (section 3.6.2.1) procedure which sets up the proper bias conditions for the RF transistors and (ii) the RF threshold adjustments which set up the desired alarm threshold levels as well as the RF output power. The general alignment procedure is required following major repair operations, changes in RF input levels or large changes in operating frequency (greater than ± 1.0 MHz).

The RF output and alarm threshold level adjustments are more easily accessible so that fine adjustments can be made in the field. Depending on user requirements, the RF alarm threshold levels should be checked whenever a significant change in operating frequency (± 0.5 MHz) is made. As the antenna VSWR alarm is dependent on the output power alarm, the output power alarm should always be set first. The order of adjustment should be:

The adjustment procedures for the high power and the low power version amplifiers are identical after the matching for transistor Q1 is tuned in the high power version. As the antenna VSWR alarm is dependent on the output power alarm, the output power alarm should always be set first. The order of adjustment should be:

1) High Power Amplifiers Only — Tune the transistor matching circuit at the desired frequency and power.
2) Set the desired output power alarm level (section 3.6.2.2).
3) Set the desired output power level (section 3.6.2.3).
4) Set the desired Antenna VSWR alarm level (section 3.6.2.4).
5) Set the desired overload condition level (section 3.6.2.5).

Details for the preceding four steps are outlined below.

#### 3.6.2.1 General Set-Up

1 Connect the transmitter's antenna output connector to the type N input of the radio communications test set through a short section of low loss 50 Ω coaxial cable.

2 Turn all four (4) of the adjustment potentiometers (R7, R21, R36, and R38) fully counterclockwise.

3 Turn on the power to the transmitter.

4 For high power amplifier units, follow steps 5 to 7 below. For low power amplifiers, skip to the Output Power Alarm procedure.

5 Tune the output matching capacitor for maximum output power. This should be approximately 8 Watts.

6 For single frequency applications, tune the input matching capacitor so that +9.5 Vdc current is minimized without sacrificing output power. For wideband applications it is best to tune the amplifier at the highest frequency in the band of interest and then tune the input matching capacitor so that the +9.5 Vdc current never exceeds 1.2 amps over the desired frequency band.

7 For single frequency applications, re-peak the output matching capacitor. For wideband applications it is best to tune the amplifier at the highest frequency in the band of interest and then re-peak the output matching capacitor so that the +13.8 Vdc current never exceeds 1.5 amps over the desired frequency band.

### 3.6.2.2 Output Power Alarm (Forward Power)

Open Collector Output

* note: the output power alarm output is factory configured as an open collector output so a pull-up resistor may be required on transmitter pin B26 if one is not already present.

1 Adjust R7, the output power adjustment, to the output power at which the Output Power Alarm is to be activated.

2 Monitor transmitter pin B26, the Output Power Alarm line, and slowly turn R21, the output power alarm adjustment, clockwise until pin B26 goes low. The alarm is now set for the current output power of the transmitter.

Linear Output

1 Open the amplifier case to disable (open circuit) jumper JU2 and enable (short) jumper JU1.

2 Monitor transmitter pin B26 with a voltmeter.

3 Adjust R7, the output power adjustment, for full transmitter output power.

4 Adjust R21, the output power alarm adjustment, so that the voltmeter indicates +7.5 Vdc for full transmitter output power.

5 Turn R7, the output power adjustment, fully counterclockwise. The voltmeter should read approximately +3 Vdc.

6 Disconnect the voltmeter.

### 3.6.2.3 Output Power

1 Turn R7, the output power adjustment, clockwise to the desired transmitter output power.

### 3.6.2.4 Antenna VSWR Alarm (Reverse Power)

Open Collector Output

* note: the antenna VSWR alarm output is factory configured as an open collector output so a pull-up resistor may be required on transmitter pin Z26 if one is not already present. The output power alarm must be set first before the antenna VSWR alarm can be set.

1 Disconnect the radio communications test and terminate the transmitter with the 3:1 mismatch load.

2 Monitor pin Z26, the Antenna VSWR Alarm line, and turn R36 fully counterclockwise. Pin Z26 should be high. Slowly turn R36 clockwise until pin Z26 is pulled low. Put the 50 ohm load back on again, Pin Z26 should go high. The reverse power trip point is now set for a VSWR of 3:1.

Linear Output

1 Open the amplifier case to disable (open circuit) jumper JU3 and enable (short) jumper JU4.

2 Monitor transmitter pin Z26 with a voltmeter.

3 Disconnect the radio communications test set and terminate the transmitter with the 3:1 mismatch load.

4 Adjust R36, the VSWR alarm adjustment, so that the voltmeter indicates +5 Vdc for a 3:1 mismatch.

5 Put the 50 ohm load back on again. The voltmeter should read approximately 0 Vdc.

6 Disconnect the voltmeter.

### 3.6.2.5 Antenna VSWR Overload

1 Disconnect the radio communications test set and so that the amplifier is terminated with an open circuit.

2 Monitor the current from the +9.5 Vdc supply.

3 Adjust R38, the VSWR overload adjustment, clockwise until a noticeable drop in the +9.5 Vdc current occurs.

4 Reconnect the radio communications test set and, the +9.5 Vdc current should return to the previous level.

### 3.6.2.6 Procedure Verification

1 Verify that the current drawn from the +13.8 Vdc supply is less than 1.5 A and from the +9.5 Vdc supply is less than 1.2 A when transmitting full 8 W RF output power.

2 Turn off the power to the transmitter.

# 4 ILLUSTRATIONS AND SCHEMATIC DIAGRAMS

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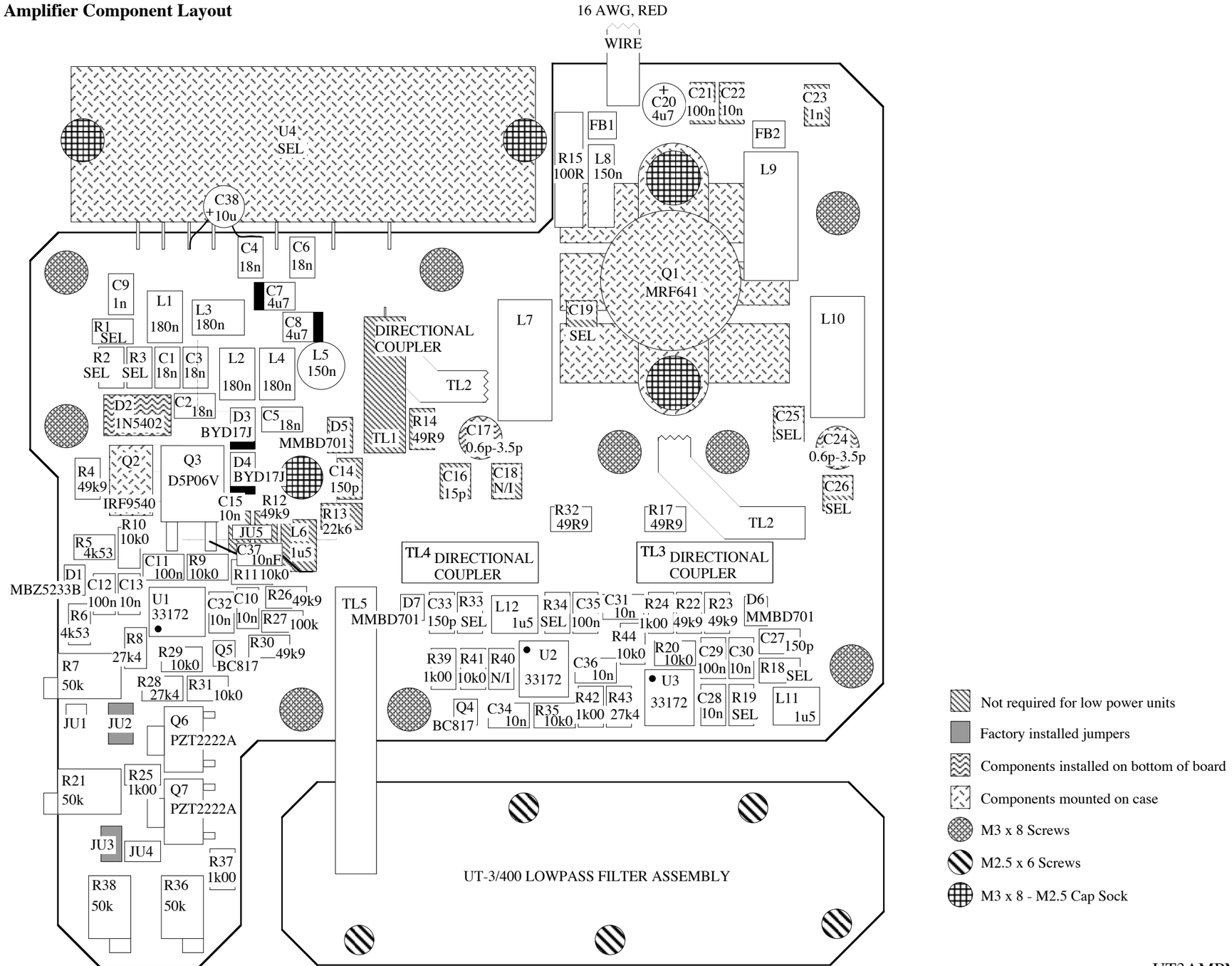
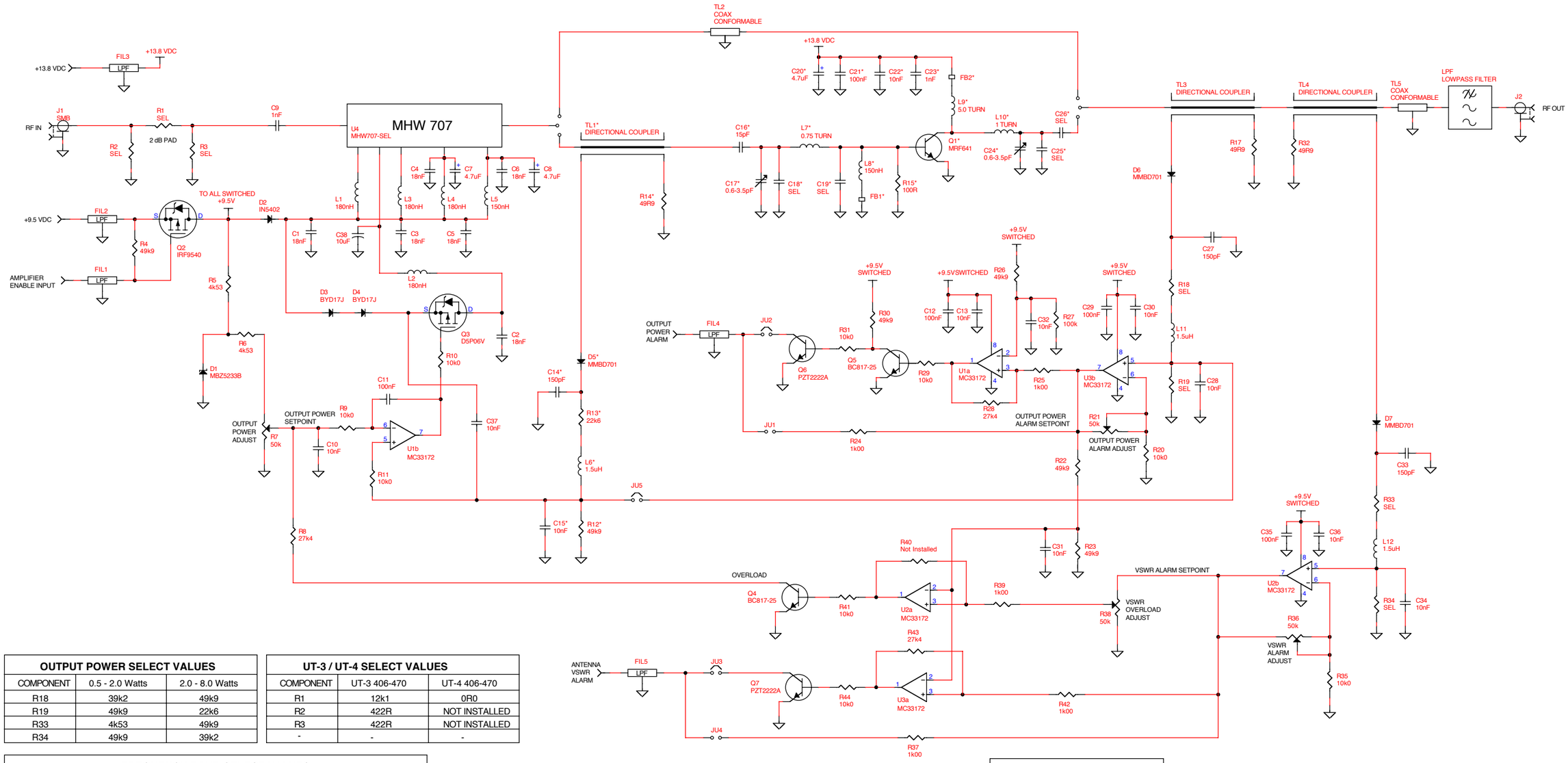
## 4.1 UT-3/UT-4 UHF Amplifier Component Layout




UT3AMPM1A

## 4.2 UT-3/UT-4 UHF Amplifier Schematic Diagram




| OUTPUT POWER SELECT VALUES | | |
|---|---|---|
| COMPONENT | 0.5 - 2.0 Watts | 2.0 - 8.0 Watts |
| R18 | 39k2 | 49k9 |
| R19 | 49k9 | 22k6 |
| R33 | 4k53 | 49k9 |
| R34 | 49k9 | 39k2 |

| UT-3 / UT-4 SELECT VALUES | | |
|---|---|---|
| COMPONENT | UT-3 406-470 | UT-4 406-470 |
| R1 | 12k1 | 0R0 |
| R2 | 422R | NOT INSTALLED |
| R3 | 422R | NOT INSTALLED |
| - | - | - |

| FREQUENCY BAND SELECT VALUES | | | | |
|---|---|---|---|---|
| COMPONENT | 406 - 430 MHz | 450 - 470 MHz | 470 - 495 MHz | 495 - 512 MHz |
| U4 | MHW707-1 | MHW707-2 | MHW707-3 | MHW707-4 |
| C19* | 47 pF | 39 pF | 30 pF | 30 pF |
| C25* | 7.5 pF | 4.7 pF | 3.0 pF | Not Installed |
| C26* | 4.7 pF | 3.0 pF | 3.0 pF | 3.0 pF |

NOTE: * denotes components only installed on high power (2.0 - 8.0 Watt) units.

| HIGHEST REFERENCE DESIGNATION | | |
|---|---|---|
| C38 | D7 | FB2 |
| FIL5 | J2 | JU5 |
| L12 | Q7 | R44 |
| TL5 | U4 | |
| UNUSED REFERENCE DESIGNATORS | | |
| R16 | | |
| | | |
| | | |
| | | |

| DE DANIELS ELECTRONICS | VICTORIA B.C. | |
|---|---|---|
| TITLE: UT-3/UT-4 AMPLIFIER SCHEMATIC DIAGRAM | | |
| DATE: 23 JANUARY 1991 | DWN BY: MICHAEL GAUBE | APRVD: |
| DWG No: UT3AMPM2B | DWG REV DATE: 19 OCTOBER 1998 | |
| BOARD No: 43-931613 | BOARD REV: VERSION 1.3 | |

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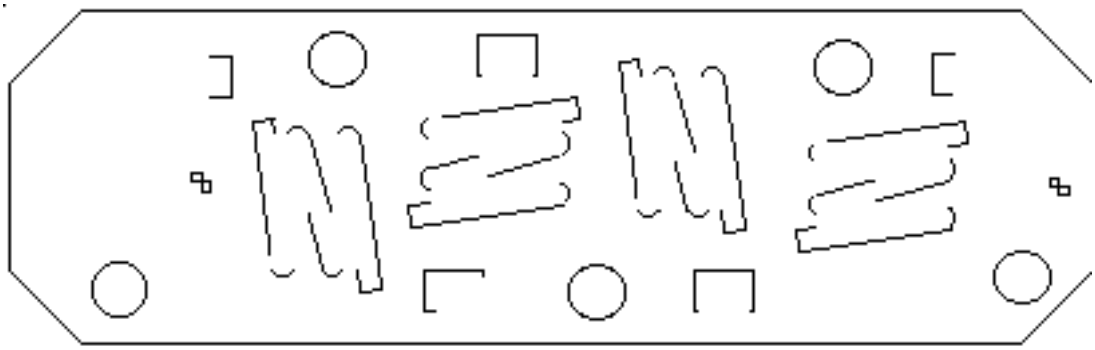
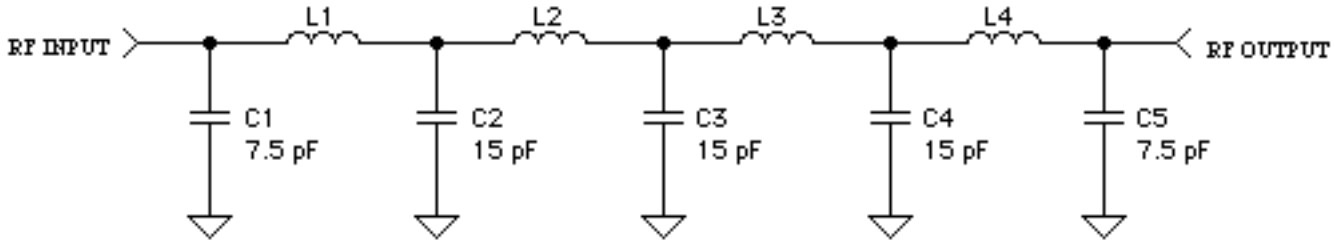
## 4.3 UT-3/400 UHF Lowpass Filter Component Layout



## 4.4 UT-3/400 UHF Lowpass Filter Schematic Diagram




| | | |
|---|---|---|
| DE DANIELS ELECTRONICS | | VICTORIAVILLE, QC |
| TITLE: UT-3/400 AMPLIFIER LOW PASS FILTER | | |
| DATE: 18 OCT 1998 | DWN: M. GAUBE | APRVD: |
| DWG No.: UT3AMPM4 | | DWG REV DATE: |
| BOARD No.: 48-981710 | | BOARD REV: VERSION 1.0 |

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# 5 PARTS LISTS

## 5.1 UT-3 / UT4 UHF Amplifier Electrical Parts List

**NOTE:** Reference Designators labeled with an asterisk (*) are used only in 2.0 - 8.0 Watts amplifiers.

| Ref Desig | Description | Part No. | |
|---|---|---|---|
| C1-C6 | CAP., SM, 18nF CER, 1206, X7R | 1008-4B183K5R | |
| C7, C8 | CAP., SM, 4.7µF TANT., 10%, 16V | 1055-5B475K16 | |
| C9 | CAP., SM, 1nF CER, 1206, C0G | 1008-3B102K1G | |
| C10 | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C11, C12 | CAP., SM, 100nF CER, 1206, X7R | 1008-5B104K5R | |
| C13 | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C14* | CAP., SM, 150pF CER, 1206, C0G | 1008-2B151J1G | |
| C15* | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C16* | CAP., SM, 15pF PORCEL., ±5%, 500V | 1036-1B2150J5 | |
| C17* | CAP. TRIM, 0.6-3.5pF VERT., >9T | 1082-C0R6003G | |
| C18* | CAP., SM, NOT INSTALLED | NOT INSTALLED | |
| C19* | CAP., SM, 47pF PORCEL., ±5%, 500V | 1036-1B2470J5 | (406-430 MHz) |
| C19* | CAP., SM, 39pF PORCEL., ±5%, 500V | 1036-1B2390J5 | (450-470 MHz) |
| C19* | CAP., SM, 30pF PORCEL., ±5%, 500V | 1036-1B2300J5 | (470-490 MHz) |
| C19* | CAP., SM, 30pF PORCEL., ±5%, 500V | 1036-1B2300J5 | (490-512 MHz) |
| C20* | CAP., 4.7µF DIP. TANT., 10%, 35V | 1054-5E475K35 | |
| C21* | CAP., SM, 100nF CER, 1206, X7R | 1008-5B104K5R | |
| C22* | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C23* | CAP., SM, 1nF CER, 1206, C0G | 1008-3B102K1G | |
| C24* | CAP. TRIM, 0.6-3.5pF VERT., >9T | 1082-C0R6003G | |
| C25* | CAP., SM, 7.5pF PORCEL., ±0.25pF | 1036-0B2759C5 | (406-430 MHz) |
| C25* | CAP., SM, 4.7pF PORCEL., ±0.25pF | 1036-0B2479C5 | (450-470 MHz) |
| C25* | CAP., SM, 3.0pF PORCEL., ±0.25pF | 1036-0B2309C5 | (470-490 MHz) |
| C25* | CAP., SM, NOT INSTALLED | NOT INSTALLED | (490-512 MHz) |
| C26* | CAP., SM, 4.7pF PORCEL., ±0.25pF | 1036-0B2479C5 | (406-430 MHz) |
| C26* | CAP., SM, 3.0pF PORCEL., ±0.25pF | 1036-0B2309C5 | (450-470 MHz) |
| C26* | CAP., SM, 3.0pF PORCEL., ±0.25pF | 1036-0B2309C5 | (470-490 MHz) |
| C26* | CAP., SM, 3.0pF PORCEL., ±0.25pF | 1036-0B2309C5 | (490-512 MHz) |
| C27 | CAP., SM, 150pF CER, 1206, C0G | 1008-2B151J1G | |
| C28 | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C29 | CAP., SM, 100nF CER, 1206, X7R | 1008-5B104K5R | |
| C30-C32 | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C33 | CAP., SM, 150pF CER, 1206, C0G | 1008-2B151J1G | |
| C34 | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C35 | CAP., SM, 100nF CER, 1206, X7R | 1008-5B104K5R | |
| C36 | CAP., SM, 10nF CER, 1206, X7R | 1008-4B103K5R | |
| C37 | CAP., 10nF FILM, MMK5, 10%,63V | 1016-4A103K63 | |
| C38 | CAP., 10µF DIP. TANT., 20%, 25V | 1054-6E106M25 | |
| D1 | DIODE, MBZ5233B 6.0V ZENER, SOT-23 | 2102-MBZ5233B | |
| D2 | DIODE, IN5402 3A RECT, DO-201AD | 2001-1N540200 | |
| D3, D4 | DIODE, BYD17J RECTIFIER, SOD-87 | 2101-BYD17J00 | |
| D5* | DIODE, MMBD701 HOT CARRIER, SOT-23 | 2105-MMBD7010 | |
| D6, D7 | DIODE, MMBD701 HOT CARRIER, SOT-23 | 2105-MMBD7010 | |

| Ref Desig | Description | Part No. | |
|---|---|---|---|
| FB1* | FERRITE BEAD, 64 MIX 3x3.5 mm OD | 1210-64030350 | |
| FB2* | FERRITE BEAD, 64 MIX 3x3.5 mm OD | 1210-64030350 | |
| FIL1, 2 | FILTER, EMI PI/5500pF, 8-32 UNC | 1302-P552D10D | |
| FIL3* | FILTER, EMI PI/5500pF, 8-32 UNC | 1302-P552D10D | |
| FIL4, 5 | FILTER, EMI PI/5500pF, 8-32 UNC | 1302-P552D10D | |
| J1 | CONN., SMB, JACK,2 HOLE FLANGE | 5120-J2SC01BG | |
| J2 | CONNECTOR, N JACK PANEL MNT, C/SNK | 5184-10923011 | |
| L1-L4 | INDUCTOR, SM, 180nH 20%, 1812 | 1255-2GR1800M | |
| L5 | CHOKE RF/MOLDED, 150nH 10%, 0.37 | 1251-2B00R15K | |
| L6* | INDUCTOR, SM, 1.5µH 10%, 1812 | 1255-3G1R500K | |
| L7* | COIL, 0.75 TURN 16AWG, 4.0 mm ID | $1220-0T751615 | |
| L8* | CHOKE RF/MOLDED, 150nH 10%, 0.25 | 1251-2A00R15K | |
| L9* | COIL/RF, 5.0 TURN 18AWG, 0.18"ID | $1220-5T001817 | |
| L10* | COIL, 1 TURN 16AWG, 4.0 mm ID | $1220-1T001617 | |
| L11, L12 | INDUCTOR, SM, 1.5µH 10%, 1812 | 1255-3G1R500K | |
| Q1* | TRANSISTOR, MRF641 470 MHz, 15W | 2025-MRF64100 | |
| Q2 | MOSFET, IRF9540 P-CHANNEL, TO-220 | 2044-IRF95400 | |
| Q3 | MOSFET, D5P06V P-CHANNEL, DPAK | 2144-D5P06V00 | |
| Q4, Q5 | TRANSISTOR, BC817-25 NPN, SOT-23 | 2120-BC817025 | |
| Q6, Q7 | TRANSISTOR, PZT2222A NPN, SOT-223 | 2120-PZT2222A | |
| R1 | RES., SM, 12R1 1206, 1%, 100ppm | 1150-1B12R1FP | (UT-3 406-470 MHz) |
| R1 | RES., SM, ZERO OHM JUMPER,1206 | 1150-0B0R0000 | (UT-4 406-470 MHz) |
| R2, R3 | RES., SM, 422R 1206, 1%, 100ppm | 1150-2B4220FP | (UT-3 406-470 MHz) |
| R2, R3 | NOT INSTALLED | NOT INSTALLED | (UT-3 406-470 MHz) |
| R4 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | |
| R5, R6 | RES., SM, 4k53 1206, 1%, 100ppm | 1150-3B4531FP | |
| R7 | POT., SM, 50k 12 TURN, SIDE ADJUST | 1172-M30503X5 | |
| R8 | RES., SM, 27k4 1206, 1%, 100ppm | 1150-4B2742FP | |
| R9-R11 | RES., SM, 10k0 1206, 1%, 100ppm | 1150-4B1002FP | |
| R12* | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | |
| R13* | RES., SM, 22k6 1206, 1%, 100ppm | 1150-4B2262FP | |
| R14* | RES., SM, 49R9 1206, 1%, 100ppm | 1150-1B49R9FP | |
| R15* | RES., 100R METAL FILM, 5%, 2W | 1105-2A0101JI | |
| R16 | UNUSED REFERENCE DESIGNATION | | |
| R17 | RES., SM, 49R9 1206, 1%, 100ppm | 1150-1B49R9FP | |
| R18 | RES., SM, 39k2 1206, 1%, 100ppm | 1150-4B3922FP | (0.5 - 2.0 Watts) |
| R18 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | (2.0 - 8.0 Watts) |
| R19 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | (0.5 - 2.0 Watts) |
| R19 | RES., SM, 22k6 1206, 1%, 100ppm | 1150-4B2262FP | (2.0 - 8.0 Watts) |
| R20 | RES., SM, 10k0 1206, 1%, 100ppm | 1150-4B1002FP | |
| R21 | POT., SM, 50k 12 TURN, SIDE ADJUST | 1172-M30503X5 | |
| R22,R23 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | |
| R24,R25 | RES., SM, 1k00 1206, 1%, 100ppm | 1150-3B1001FP | |
| R26 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | |
| R27 | RES., SM, 100k 1206, 1%, 100ppm | 1150-5B1003FP | |
| R28 | RES., SM, 27k4 1206, 1%, 100ppm | 1150-4B2742FP | |
| R29 | RES., SM, 10k0 1206, 1%, 100ppm | 1150-4B1002FP | |

| | | | |
|---|---|---|---|
| R30 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | |
| R31 | RES., SM, 10k0 1206, 1%, 100ppm | 1150-4B1002FP | |
| Ref Desig | Description | Part No. | |
| R32 | RES., SM, 49R9 1206, 1%, 100ppm | 1150-1B49R9FP | |
| R33 | RES., SM, 4k53 1206, 1%, 100ppm | 1150-3B4531FP | (0.5 - 2.0 Watts) |
| R33 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | (2.0 - 8.0 Watts) |
| R34 | RES., SM, 49k9 1206, 1%, 100ppm | 1150-4B4992FP | (0.5 - 2.0 Watts) |
| R34 | RES., SM, 39k2 1206, 1%, 100ppm | 1150-4B3922FP | (2.0 - 8.0 Watts) |
| R35 | RES., SM, 10k0 1206, 1%, 100ppm | 1150-4B1002FP | |
| R36 | POT., SM, 50k 12 TURN, SIDE ADJUST | 1172-M30503X5 | |
| R37 | RES., SM, 1k00 1206, 1%, 100ppm | 1150-3B1001FP | |
| R38 | POT., SM, 50k 12 TURN, SIDE ADJUST | 1172-M30503X5 | |
| R39 | RES., SM, 1k00 1206, 1%, 100ppm | 1150-3B1001FP | |
| R40 | RES., SM, NOT INSTALLED | NOT INSTALLED | |
| R41 | RES., SM, 10k0 1206, 1%, 100ppm | 1150-4B1002FP | |
| R42 | RES., SM, 1k00 1206, 1%, 100ppm | 1150-3B1001FP | |
| R43 | RES., SM, 27k4 1206, 1%, 100ppm | 1150-4B2742FP | |
| R44 | RES., SM, 10k0 1206, 1%, 100ppm | 1150-4B1002FP | |
| TL1* | COAX, DIRECTIONAL COUPLER 0.5" | 7496-30CR005T | |
| TL2 | COAX, CONFORMABLE 50 OHM, 0.083", 60 mm | 7482-5024T083 | |
| TL3, TL4 | COAX, DIRECTIONAL COUPLER 0.5" | 7496-30CR005T | |
| TL5 | COAX, CONFORMABLE 50 OHM, 0.083", 29 mm | 7482-5024T083 | |
| U1-U3 | I.C., MC33172 DUAL OP AMP, S0-8 | 2302-33172N08 | |
| U4 | AMP, RF, MHW707-1 7W, 403-440 MHz | 2257-MHW70701 | (406-430 MHz) |
| U4 | AMP, RF, MHW707-2 7W, 440-470 MHz | 2257-MHW70702 | (450-470 MHz) |
| U4 | AMP, RF, MHW707-3 7W, 470-500 MHz | 2257-MHW70703 | (470-490 MHz) |
| U4 | AMP, RF, MHW707-4 7W, 490-512 MHz | 2257-MHW70704 | (490-512 MHz) |
| PCB | UT-3/400 AMPLIFIER | 4323-15931613 | |
| LPF | UT-3/400 LOWPASS FILTER ASSEMBLY | A23-LPF-3 | |

## 5.2 UT-3/400 UHF Amplifier Mechanical Parts List

| Description | Part No. | Qty. | |
|---|---|---|---|
| CAP SCREW, 8-32 X 1/4, HEX BUTTON - 9/64 | 5806-832BH04S | 1 | (0.5 - 2.0 Watts) |
| CASE, MT-3 VHF/UHF AMPLIFIER, ALUMINUM | 3702-66102130 | 1 | |
| HEATSHRINK, 1/8" DIA, RED, 1" LENGTH | CONSUMABLE | 1 | (2.0 - 8.0 Watts) |
| INSULATOR, THERM. COND. TO-220 | 5622-1T220701 | 1 | |
| LABEL, IDENTIFICATION/TEST, FOIL | CONSUMABLE | 1 | |
| LID, CASE MT-3 AMPLIFIER, ALUMINUM | 3702-66102151 | 1 | |
| SCREW, M2 X 6, PAN/PHIL., A2 | 5812-2M0PP06S | 2 | |
| SCREW, M2 X 4, PAN/PHIL., A2 | 5812-2M0PP04S | 10 | |
| SCREW, M2.5 X 6, PAN/PHIL., A2 | 5812-2M5PP06S | 3 | |
| SCREW, M3 X 6, FLAT/PHIL., A2 | 5812-3M0FP06S | 4 | |
| SCREW, M3 X 8, PAN/PHIL., A2 | 5812-3M0PP08S | 9 | |
| SCREW, M3 X 8, CAP SOCK-M2.5 | 5816-3M0SH08S | 4 | (0.5 - 2.0 Watts) |
| SCREW, M3 X 8, CAP SOCK-M2.5 | 5816-3M0SH08S | 6 | (2.0 - 8.0 Watts) |
| SET SCREW, M3 X 3, HEX SOCKET, A2 | 5817-3M0AC03S | 1 | |
| SHOULDER WASHER, M3 0.24" OD, NYLON | 5674-120N2440 | 1 | |
| TURRET TERMINAL, 4-40 0.188L, Tn | 5053-144M188T | 1 | |
| WIRE, PVC/STRANDED 16AWG, RED, 70 mm | 7110-16S26302 | 1 | (2.0 - 8.0 Watts) |

## 5.3 UT-3/400 UHF Low Pass Filter Electrical Parts List

| Ref Desig | Description | Part No. |
|---|---|---|
| C1 | CAP., SM, 7.5pF PORCEL, ±0.25 pF | 1036-0B2759C5 |
| C2-C4 | CAP., SM, 15pF PORCEL, ±5%, 500V | 1036-1B2150J5 |
| C5 | CAP., SM, 7.5pF PORCEL, ±0.25 pF | 1036-0B2759C5 |
| L1 - L4 | COIL, 2 TURNS 16 AWG BELD, 4.0 mm ID | 1220-2T001622 |
| PCB | PCB, LPF, VT-3/150 & UT-3/400 | 4321-16931712 |

# 6 REVISION HISTORY

| ISSUE | DATE | REVISION |
|---|---|---|
| 1 | October 98 | First Issue. |