DANIELS™
ELECTRONICS LTD.

UHF LOW CURRENT SYNTHESIZED RECEIVER INSTRUCTION MANUAL

UR-3/400 406 - 470 MHz

Covers Models:

UR-3/420-SNC200
UR-3/460-SNC200
UR-3/420-SWC200
UR-3/460-SWC200

IM13-UR3400CT
IM10-RX214
IM11-FE3
IM11-0S3

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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.

Contents

GENERAL INFORMATION

INTRODUCTION

The UR-3/400 Receiver is a low current, synthesized FM receiver capable of operating in 12.5 kHz (narrowband) or 25/30 kHz (wideband) channels in one of two frequency bands: 406 to 430 MHz or 450 to 470 MHz. A modular design allows each of the receiver's three internal modules; 21.4 MHz FM IF/ Audio Main Board, FE3 Front End, and OS-3 Synthesizer to be individually assembled and tested. This facilitates construction, tuning, and general receiver maintenance. The internal synthesizer module may be programmed with up to 16 channels for remote frequency control applications.

The UR-3/400 Receiver combines state of the art performance in a compact modular enclosure for applications ranging from remote mountain top repeaters to congested urban radio environments. Each receiver module is characterized by dependable, low maintenance performance under the most severe environmental conditions.

The UR-3/400 Receiver is compatible with all Daniel's subrack and base station enclosures.

MANUAL ORGANIZATION

The organization of this document reflects the modular construction of the UR-3 family of products. Each product is fully described within its respective “sub-manual”; all of which are contained within this document. Each of these sub-manuals contain:

1. A functional description and specification summary.
2. A detailed technical description (Theory of Operation).
3. Assembly, setup and alignment procedures relevant to the particular module.

Note: Material presented in a given “sub-manual” may include information related to other module versions not directly applicable to the UR-3/400 receiver family. The OS-3 synthesizer module is a prime example, having family members covering from 132 to 960 MHz.

The following sub-manuals are contained within this document cluster:

21.4 MHz FM IF/Audio Main Board Instruction Manual: This manual provides complete information on the operation of the 21.4 MHz FM IF / Audio Main Board. The bulk of the material relating to receiver operation and installation can be found within this manual. The majority of receiver options, including channel selection, are accessed through the FM IF / Audio Main Board. In addition, most of the external receiver connections are made through the FM IF / Audio Main Board.

FE3 Front End Instruction Manual: This manual provides information on alignment and operation of the FE3H Front End Module. The Front End module provides filtered low level RF signal amplification and down conversion to the IF frequency of 21.4 MHz.

Low Current Synthesizer Instruction Manual: This manual provides information on alignment and operation of the Low Current Synthesizer Module. The synthesizer module provides the low noise first local oscillator signal to the FE3 Front End module.

UR-3/400 Channel Designation Tables: This manual provides tabular frequency / channel number assignment.

UR-3/400 RECEIVER FAMILY MODELS

There are four distinct receiver models in the UR-3/400 Receiver family since the receivers can operate in the 406 to 430 MHz or the 450 to 470 MHz band and can operate in 12.5 kHz or 25/30 kHz channels. The four models are as follows:

- UR-3/420-SNC200: synthesized, 406-430 MHz, 12.5 kHz channels
- UR-3/420-SWC200: synthesized, 406-430 MHz, 25 kHz channels
- UR-3/460-SNC200: synthesized, 450-470 MHz, 12.5 kHz channels
- UR-3/460-SWC200: synthesized, 450-470 MHz, 25 kHz channels

The frequency band of operation is determined by jumper selection and tuning adjustment in the OS-3 Synthesizer and Front End modules. Channel bandwidth is determined by IF crystal and ceramic filter selections made to the FM IF/Audio Main board.

PERFORMANCE SPECIFICATIONS

Type:	MT-3 Series Synthesized Receiver
Family:	UR-3/400-S
Compatibility:	MT-2 and MT-3 Series Radio Systems
Frequency Range:	406 to 430 MHz or 450 to 470 MHz
System Impedance:	50 Ω (Type N connector)
Frequency Generation:	Synthesizer Module (Internal)
Channel Spacing:	12.5 kHz or 25 kHz
Channel Selection:	In 12.5 kHz increments selected through four internal BCD rotary switches
Number of Channels: control lines	Preset capability for 16 channel memory selectable through four external logic
Channel Switching Range:	±1 MHz
Emission Designation:	16K0F3E; 20/25 kHz channel
Reference Sensitivity:	Better than -116 dBm (.350 µV) for 12 dB SINAD Typically -118 dBm for 12 dB SINAD
Local Oscillator Frequency Stability:	±1 ppm; -30°C to +60°C. (Optional -40°C to +60°C) Provision for external 10.0 MHz reference input
First IF	21.4 MHz, 8 pole crystal filter
Second IF	455 kHz, 10 element ceramic filter
Adjacent Channel Selectivity:	Greater than 65 dB; 12.5 kHz channel. Greater than 70 dB; 25 kHz channel.
Spurious Response Immunity:	85 dB; 20 kHz channel.
Intermodulation Rejection:	Greater than 70 dB; 25 kHz signal separation. Greater than 95 dB; 10 MHz signal separation.
Antenna conducted spurious:	Less than -85 dBm from 455 kHz to 1 GHz
Hum and Noise:	Greater than 45 dB unsquelched (Narrow Band) Greater than 50 dB unsquelched (Wide Band)
Signal Displacement Bandwidth	Greater than ± 3.5 kHz, 20/25 kHz channel
(Radio Frequency Displacement)	(TIA/EIA-603)
Audio Output:	• 600 Ω balanced or unbalanced line output • De-emphasis output, +3 dBm maximum level • Flat response output, +3 dBm maximum level • 2 Watt high level 8 Ω audio output • 3.5 Watt high level 4 Ω audio output • Provided by System Monitor or SR-3 Subrack
Audio Distortion:	• Less than 2.0% THD at +25°C • Less than 3.0% THD, -30°C to +40°C • Less than 6.0% THD, -40°C to +60°C

De-emphasized Audio Response:	+2.0 to -3.0 dB (2.5 kHz to 3 kHz) Narrow Band +2.0 to -3.0 dB (300 Hz to 3 kHz) Wide Band
Flat Audio Response:	+1.0 to -1.0 dB; (300 Hz to 3 kHz)
Received Signal Strength Indicator:	1.0 Vdc to 5.0 Vdc linear output over 60 dB input signal level change
Receiver Attack Time:	Less than 10 ms
Receiver Closing Time:	Less than 10 ms
Squelch Hysteresis:	Adjustable from 2 dB to 20 dB
Squelch Threshold:	Adjustable from -123 to -105 dBm
Squelch Operation:	Noise based (standard) or optionally configured RSSI controlled
Front Panel Controls:	Receiver power On (Norm) / Off
	Squelch Disable (Push-button)
COR Interface:	• 2 amp, 50 V open drain power MOSFET • 100 mA, 30V opto-isolator (optional) • 2 amp, form C electro-mechanical relay (Optional)
Supply Voltage:	+9.5 Vdc (Supplied by SR-3 Subrack or SM-3 System Monitor Supply)
Supply Current:	Normal programmed options less than 100 mA
Operating Temperature Range:	-30°C to +60°C Standard -40°C to +60°C Optional Environmental Testing
Operating Humidity:	95% RH (non-condensing) at +25°C
IC Approval:	Complies with Industry Canada specification RSS-119 Issue 5
FCC ID:	H4JUR-3-400-SN

INTERNALLY SELECTABLE OPTIONS (STANDARD)

Voice Band Filter:	A jumper selectable 7 pole active filter that may be inserted in the de-emphasis or flat audio path. The filter exhibits sharp roll-off below 300 Hz and finds primary use in the removal of low frequency CTCSS tones from the repeat audio path.
Subtone Filter:	A jumper selectable 4 pole, low pass active filter with a cutoff frequency of 250 Hz. This filter provides clean CTCSS output with higher frequency (voice modulation) components removed. Useful for driving certain external tone decoders etc.
RSSI Squelch:	Receiver squelch triggered by the received signal strength indicator (RSSI) output. Provides up to 60 dB of squelch threshold range for specialized receiver applications. This squelch operating mode is more temperature and modulation sensitive than the standard noise based method.

PHYSICAL SPECIFICATIONS

Physical Dimensions:	Width: 7.1 cm (2.8 in)	Height: 12.8 cm (5.05 in)	Depth: 19 cm (7.5 in)
Module Weight:	1.0 kg (2.2 lbs)		
Corrosion Prevention:	Anodized aluminum construction. Stainless steel hardware. Selectively conformal coated glass epoxy 2 and 4 layer printed circuit boards. Gold plated module connectors.		
Module Design:	Compact Eurostandard modular design. Plug-in modules mate with Daniels standard M3 repeater subrack. Subracks / modules comply with IEEE 1101, DIN 41494 and IEC 297-3 (mechanical size / modular arrangement).		
External Connections:	RF Connection: type N connector located on the receiver module front panel. Motherboard Connections (Audio, Power, and Control) are made through a 48 pin, gold plated, type F connector on the rear of the transmitter module. User connection made through mated “mother board” assembly of the repeater subrack. Type F standard connector complies with DIN 41612 Level 2 (200 mating cycles, 4 day 10 ppm SO2 gas test with no functional impairment and no change in contact resistance).		
Handle Text Colour:	Black		

SYSTEM OVERVIEW

RECEIVER OPERATION

A UR-3/400 Receiver family is constructed using three primary modules; the FE3 Front-End module, the MT-3 Receiver FM IF/Audio Main Board and the OS-3 Synthesizer (refer to UR-3 Receiver Block Diagram). All modules are integrated together by the FM IF/audio Main Board to provide a working receiver.

The FE3 Front-End combines a low noise bipolar amplifier with a cascaded, multiple pole, high selectivity helical resonator filter structure. The mixer is also located within this module. The module has inputs for the RF signal (Front Panel N connector), local oscillator input signal, and an output for the 21.4 MHz IF signal which connects directly to the FM IF / Audio Main Board. Interconnections are made using quick connect SMB style connectors. A high selectivity narrow bandwidth of approximately 5 MHz, combined with high ultimate out-of-band signal rejection, greatly improves receiver spurious response and wideband intermodulation attenuation. The FE3 Front-End module covers the 406-430 MHz and 450-470 MHz bands. Tuning within each frequency band is provided through five ferrite core slug adjustment points.

The MT-3 Receiver FM IF/Audio Main Board processes the low level 21.4 MHz RF signal from the FE3 Front-End. This processing includes; selective crystal filtering, IF amplification, second frequency conversion to 455 kHz, and final audio FM demodulation / amplification.

The board provides a high degree of receiver flexibility by providing a number of different audio paths, audio levels, and control interconnect options.

The OS-3 Synthesizer Module produces a low distortion, high stability, RF signal covering the frequency band of 406 - 470 MHz. It achieves a ±1 ppm frequency stability from -40°C to +60°C with its own internal reference, or it can be slaved to an external reference signal of desired stability.

FREQUENCY SELECTION

Receiver channel selection is achieved by setting a decimal number on four BCD frequency select switches, FSW1 through FSW4. These rotary switches are located on the FM IF/Audio Main Board and are made accessible by removing the outer receiver cover. The switch settings are scanned by the synthesizer module when the receiver is first powered up, and the desired local oscillator frequency is generated. Refer to the following equations or the Channel Designation Tables for simplified channel number and frequency information.

For UR-3/420 (406-430MHz) models:

Subtract the base frequency from the Receiver frequency, then divide the result by channel increment.

Example: Base frequency is 384.6MHz. The Receiver frequency is 421.05MHz. The channel number is:

((421.05MHz - 384.6MHz) / 12.5kHz) = 2916

To determine the frequency for channel number 2916:

((2916 x 12.5kHz) + 384.6MHz = 421.05MHz

For UR-3/460 (450-470 MHz) models:

Subtract the base frequency from the Receiver frequency, then divide the result by channel increment.

Example: Base frequency is 427.4MHz. The Receiver frequency is 468.325MHz. The channel number is:

((468.325MHz - 427.4MHz) / 12.5kHz) = 3274

To determine the frequency for channel number 3274:

((3274 x 12.5kHz) + 427.4MHz = 468.325MHz

Alternatively, a frequency and channel lookup table is available in the ‘Channel Designation Table’ manual for the UR-3/400.

A channel can be selected from a set of 15 (maximum possible) factory programmed channels by the four channel select lines available at the rear ‘F’ connector on the Receiver Main Board. A single user selectable channel is set by switches located on the Receiver Main Board. See the Receiver Main Board Manual for details.

RECEIVER ASSEMBLY AND ADJUSTMENT

All modules and the front panel are mounted on the Receiver Main Board which then forms a single assembly. The FE3 Front End is attached with two front panel screws and one screw through the rear F connector. Removal is required to access the Synthesizer for tuning. An enclosure is formed by an extruded aluminum shell that slides over the Receiver Main Board. The enclosure is completed by the installation of side and front panel screws (see Receiver Main Board Manual for parts lists).

Receiver alignment is performed on a module by module basis and detailed steps are provided in the respective manuals. Alignment is simplified by using an SR-3 Subrack, SM-3 System Monitor, and RF extender cable to provide receiver power and signal interconnection. Alternatively, +9.5 Vdc and +13.8 Vdc, as well as any required test signals, may be applied directly to the individual modules. Refer to the corresponding manuals for details.

Throughout the alignment procedure reference is made to a “standard signal”. This refers to an external generator signal source with FM modulation, 1 kHz tone, and 60% system deviation (3.0 kHz) connected to the receiver RF input type N connector (if a carrier frequency is not given, it can be assumed to be the selected receiver channel frequency).

Complete Receiver Alignment

A complete Receiver Alignment is performed at the factory and should not be required under normal circumstances. A large change in operating frequency, as discussed in the next section, may require complete realignment. This requires that all the receiver modules be aligned on a per module basis in the following order.

Sequence	Module	Manual Reference
(1)	Front End	Front End Manual
(2)	Synthesizer	Synthesizer Manual
(3)	Receiver Main Board	Frequency selection section in this manual or the Receiver Main Board Manual,

Complete and detailed alignment of each receiver module is provided in each associated sub-manual provided within this document package. The receiver Front End, FM IF/Audio Main Board, and Synthesizer modules may be aligned independently (preferred method) with final reconnection forming a tuned and working receiver.

Frequency Change

The receiver is initially aligned at the factory for the frequency stamped on the 'Factory Set Operating Frequency' label. This label should list the frequency at which the last complete receiver alignment was performed. For a small frequency change, a simple channel change may be all that is required. A larger frequency change may involve the realignment of other modules. A frequency change is the accumulated frequency change in relation to the frequency stamped on the label. For example, if the frequency is changed by 1 MHz from that stamped on the label, then a second frequency change of 1.5 MHz in the same direction would result in a total change of 2.5 MHz. The action taken would be on the basis of the 2.5 MHz value. Failure to perform a realignment after a large frequency change could result in unreliable receiver operation or operation that does not conform to the published specifications.

Note: It is advisable to confirm these frequency ranges with the individual module manuals, notably the front end and synthesizer, as they are subject to change with updated versions. The values in the module manuals take precedent over those tabulated.

Size of Frequency Change	Modules to be Aligned
less than ± 1.0 MHz (minor)	Receiver Main Board (Channel Change).
greater than ± 1.0 MHz (major)	Complete alignment.

Minor Frequency Change

Changes less than ± 1.0 MHz from a previously tuned working receive frequency will generally not require any adjustment. Change the channel frequency select switches and inject a standard signal at the new channel frequency. Verify that the receiver sensitivity is ≈ -118 dBm for 12 dB SINAD. Slight adjustment of the Front End tuning caps (5) may be performed to maximize sensitivity at the new frequency. Be aware that the preferred Front End tuning procedure (Refer to sub-manual IM11-FE3) requires swept frequency response measurement of the Front End filter in order to provide the maximum flat response over a range of input frequencies. The primary channel frequency is centered in the filter passband (5 MHz wide). This alignment approach is not mandatory for single channel operation.

The OS-3 Low Current Synthesizer Module PLL lock range limits multi-channel operation to ≈ ± 1.0 MHz from a tuned center frequency. A quick check of the Synthesizer module PLL control voltage at TP4, accessible through the synthesizer top cover, is advisable at all programmed frequencies. Refer to the OS-3 Low Current Synthesizer manual for instructions on accessing the synthesizer's test and adjustment points. The voltage at TP4 should range between +0.5 Vdc and +4.5 Vdc at all programmed frequencies. Measured voltages outside this range indicate a possible "out-of-lock" condition and should be avoided.

The Front End module must be removed (but left connected) from the main receiver chassis in order to access TP4. Fine Frequency TUNE adjust trimmer capacitor C5 on the synthesizer VCO may then be adjusted to position the PLL loop voltage (TP4) as close as possible to the nominal +3.5 Vdc for all programmed frequencies. For single channel operation, TP4 should be set to +3.5 Vdc.

Major Frequency Change

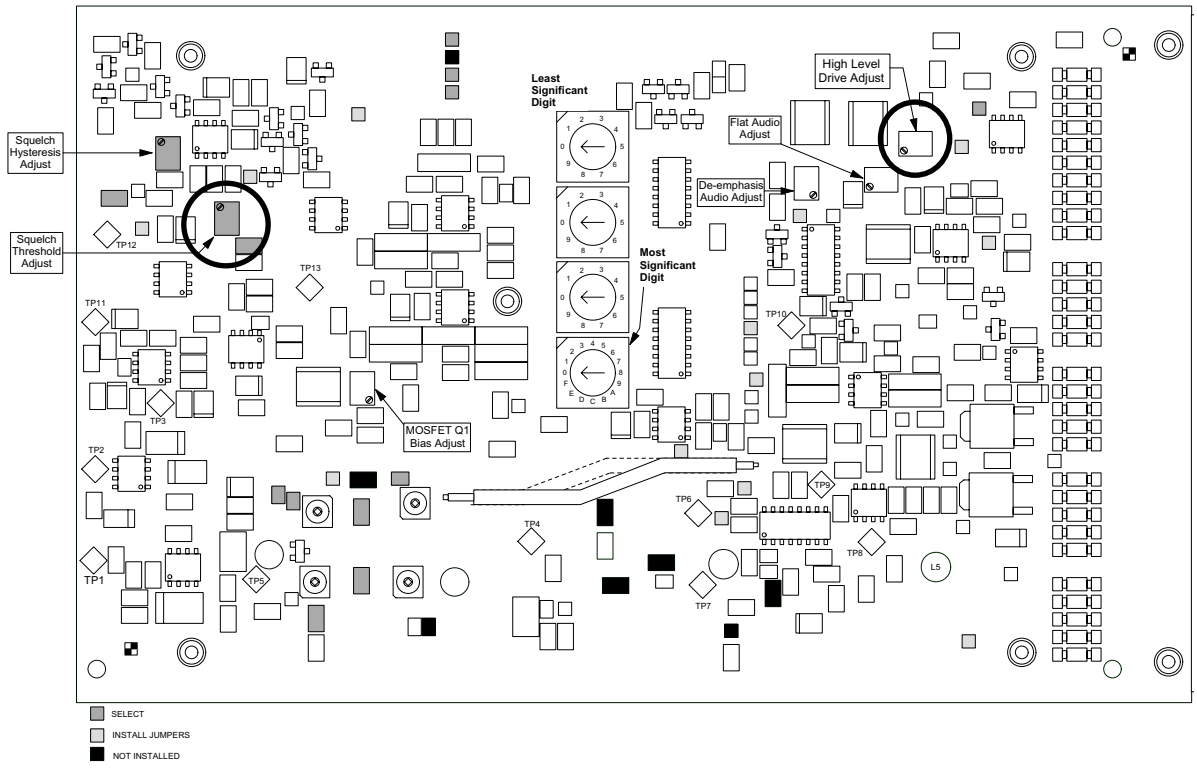
Changes greater than ± 1.0 MHz from a previously tuned working receive frequency will require complete FE3 Front End and OS-3 Low Current Synthesizer alignment as per the sub-manual documents.

Squelch and Audio Level Adjustment

Remove the receiver outer cover to expose the FM IF/Audio Main Board adjustment potentiometers. Refer to the "**Squelch and Audio Level Adjustment Locations"** diagram below for control locations.

Adjust the Squelch Threshold Adjustment potentiometer R88 for the desired trigger point. Vary the RF generator level to confirm desired squelch operation. Complete squelch alignment, including Squelch Hysteresis adjustment is provided in the FM IF/Audio Main Board sub-manual. Inject a standard signal at a -47 dBm level.

Adjust the High Level Drive Adjust potentiometer R64 to obtain the desired balanced 600Ω audio output. The factory standard level is -8 dBm with a 1.0 kHz tone at 3.0 kHz deviation. The FM IF/Audio Main Board provides varied audio output options. Complete demodulation/audio adjustment, including Flat and Filtered audio options, is detailed in the FM IF/Audio Main Board sub-manual.



REPAIR NOTE

The UR-3/400 Receiver family employs a high percentage of surface mount components 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 Discharge (ESD) protection.

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

RECOMMENDED TEST EQUIPMENT

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

Power supply - Regulated +9.5 Vdc at 2 A. Phillips PM 2811
Oscilloscope / Multimeter - Fluke 97 Scopemeter
Radio communications test set - Marconi Instruments 2965A
Alignment Tool - Johanson 8764
Alignment Tool - Johanson 8766
Alignment Tool - Johanson 4192
Alignment Tool - Coilcraft 37-1409

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 local oscillator may be accurately set to within its ±1 ppm frequency tolerance.

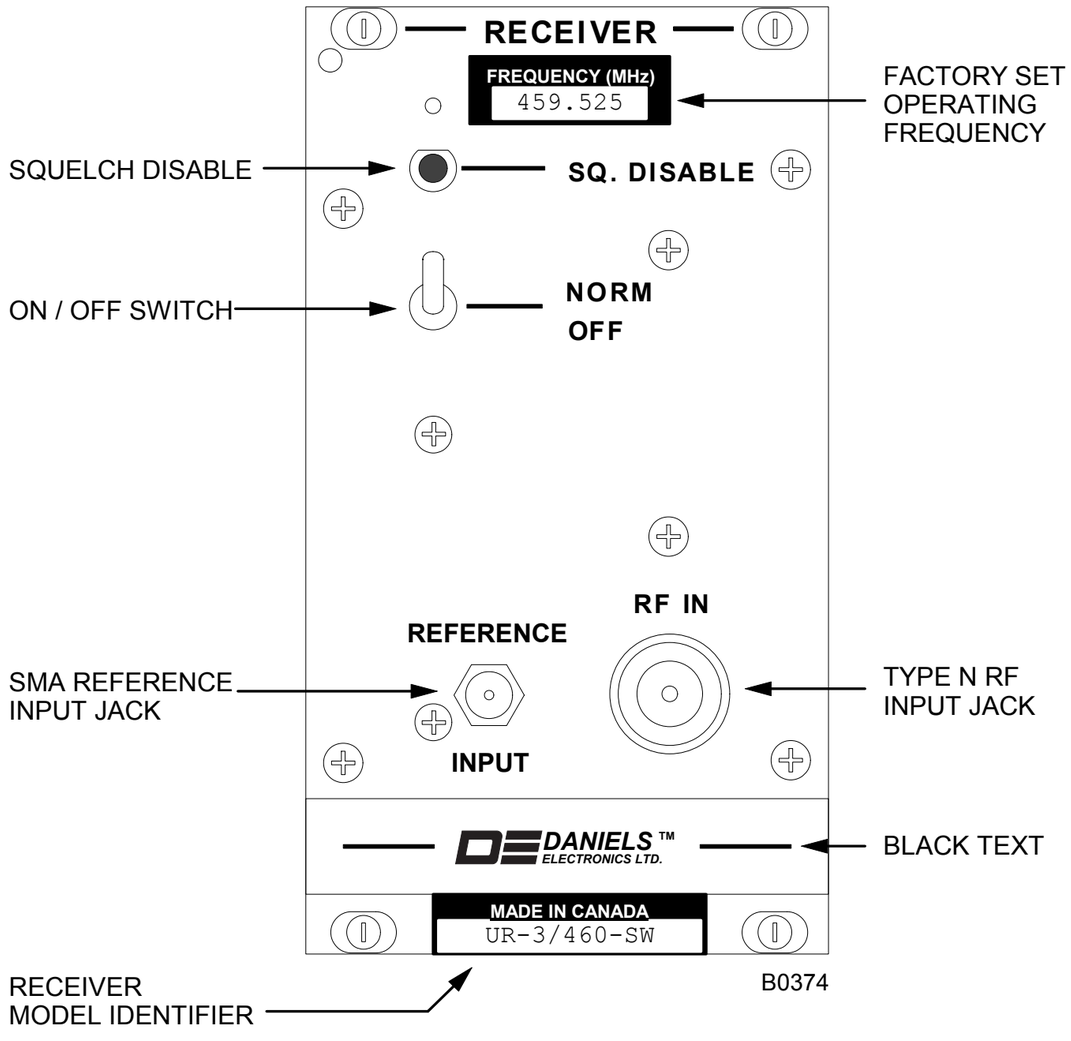
ILLUSTRATIONS AND SCHEMATICS

PRINTED CIRCUIT BOARD NUMBERING CONVENTION

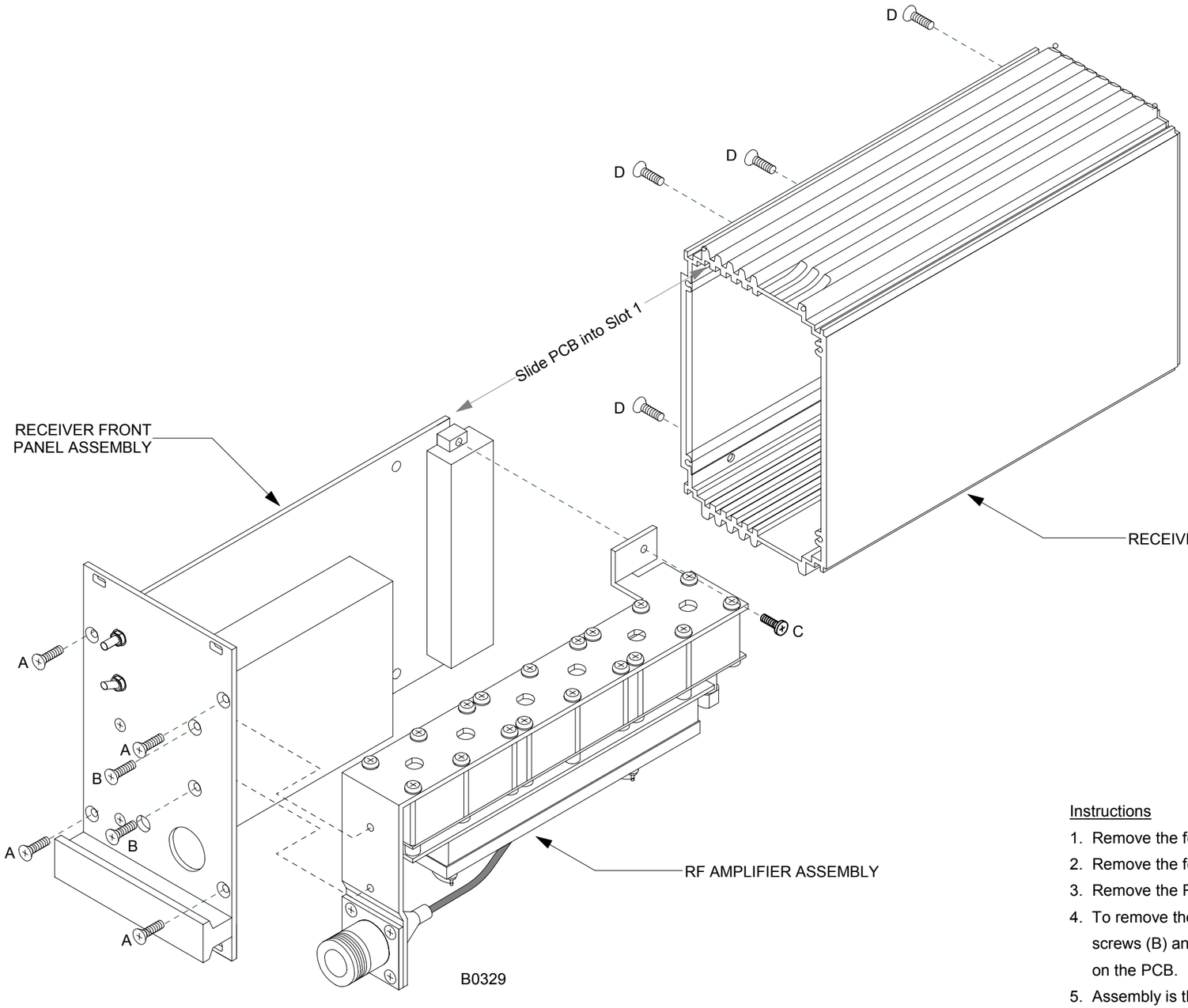
Daniels Electronics Ltd. has adopted a printed circuit board (PCB) numbering convention in which the last two digits of the circuit board number represent the circuit board version. All PCB's manufactured by Daniels Electronics Ltd. are identified by one of the following numbering conventions:

PCB number 1.0	43-912010 Indicates circuit board version
PCB number	50002-02 Indicates circuit board version 2 (no decimal version)

UHF LOW CURRENT RECEIVER FRONT PANEL



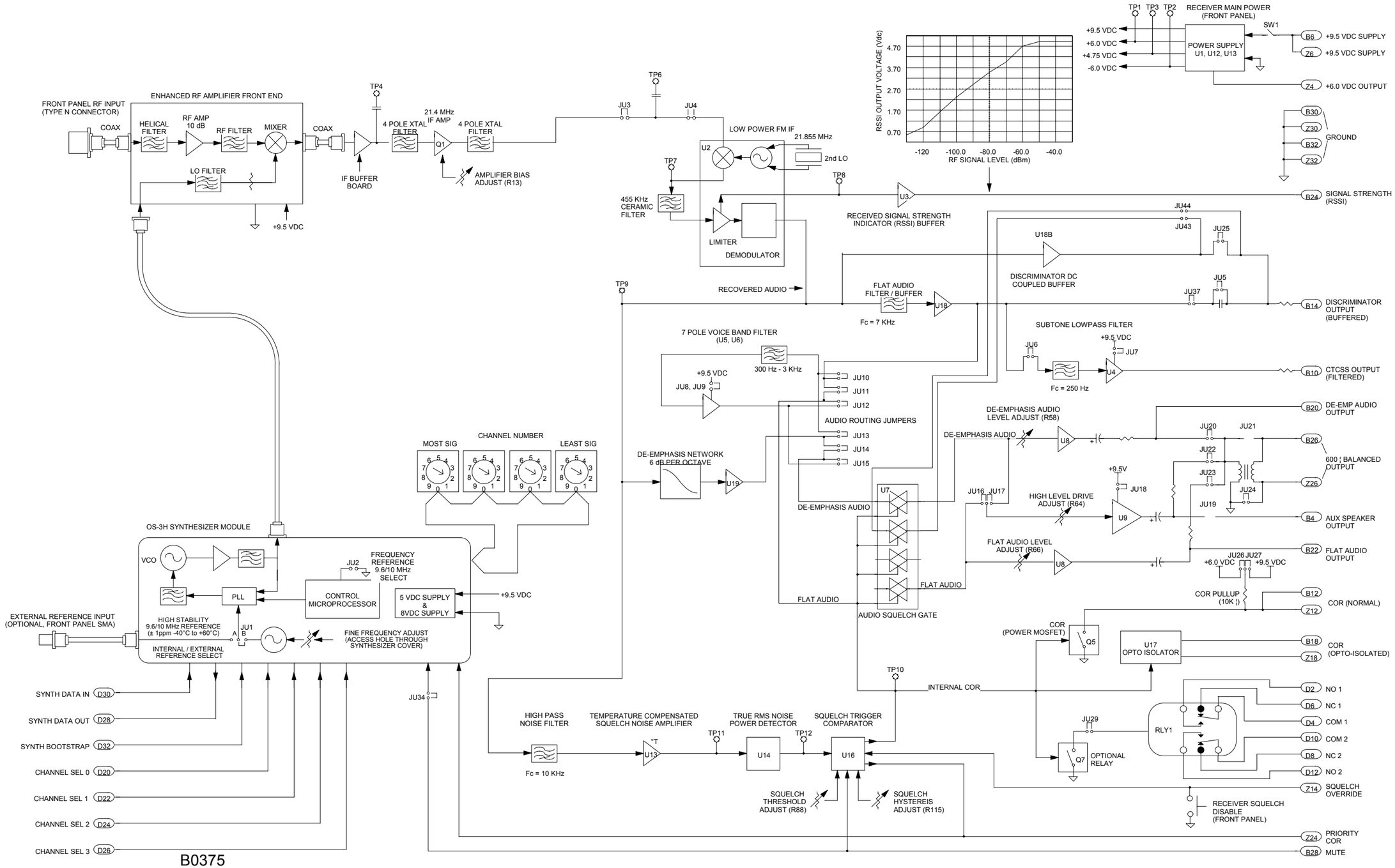
UHF LOW CURRENT RECEIVER EXPLODED VIEW



Instructions

1. Remove the four screws (D) on the side of the Receiver Case.
2. Remove the four Front Panel screws (A).
3. Remove the Receiver Case.
4. To remove the RF Amplifier Assembly, remove Front Panel screws (B) and the top screw (C) holding the F48 connector on the PCB.
5. Assembly is the reverse of steps 1 through 4.

UHF LOW CURRENT RECEIVER BLOCK DIAGRAM



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PARTS LIST

MECHANICAL PARTS LIST

Description	Part Number
LABEL,/LEXAN, 14HP, UHF: BLACK	3536-10131410

REVISION HISTORY

Revision	Date	ECO	Description
3	July 1998		Manual formatted to modular style. All previous revision history in issue 2.
3-0-1	Feb 2004		Updated document to new format
3-0-3	Feb 06		Updated the audio Distortion Specification from -34°C to -40°C on page 3