2.0 OPERATIONAL DESCRIPTION

This section should include any operational or technical descriptions regarding how the device operates, is modulated, or meets specific requirements. Some examples of operational descriptions include:

2.1 General Description

The MMDS Outdoor Transmitter OTX02-250 (shown in Section 4.0, Figure 3) is a solid-state broadband transmitter that converts VHF input signal of 222 to 408 MHz to a microwave signal of 2.5 to 2.686 GHz.

The OTX02-250 transmitter consists of the following assemblies:

1. **Upconverter Assembly** – for converting the incoming VHF signal to microwave. The upconverter assembly contains all components necessary for upconversion, i.e. local oscillator, mixer, as well as bandpass and notch filters.
2. **Predistortion Linearity Assembly** – Transmitter linearity is significantly improved by the addition of a linearity enhancement circuit to the microwave power amplifier. The better the linearity, the lower the composite triple beat (CTB) distortion.
3. **Power Amplifier** – The amplification is accomplished with minimum distortion by a state of the art Gallium Arsenide FET microwave power amplifier with an established field reliability record. The power amplifier is protected from failure due to overheating by an internal temperature sensor. The sensor circuit automatically switches off the amplifier D.C. power when the amplifier temperature exceeds 158° F (70° C).
4. **Power Supply System** – The OTX02-250 utilizes two AC/DC power supplies. One provides +12 VDC power to the power amp, and the other provides +12 VDC power to all other devices.
5. **Monitoring and Diagnostic Circuits** –The output of the OTX02-250 can be continuously monitored without interruption of service with a standard field strength meter. Diagnostic DC voltages can also be continuously monitored via a multipin connector. Both test points are located on the bottom of the OTX02-250.
6. **VHF Processor Module** – The VHF input to the transmitter is sent to the VHF Processor Module. This is a level set attenuator. The VHF signal is then sent to the upconverter mixer.
7. **Low Noise Amplifier with AGC** – The OTX02-250 has a LNA with a built in attenuator circuit. The attenuator is controlled by a composite AGC module. The output of the OTX02-250 is keep at a constant level regardless of ambient temperature changes
8. **Fan Assembly** – The OTX02-250 is cooled by a +12 VDC fan controlled by a thermostat mounted on the heat sink.

The OTX02-250 transmitter can be equipped to operate on either 120 or 240 VAC at 50 or 60 Hz. This option is specified by customer request, and each unit is shipped according to this specification.

2.2 Technical Specifications

OTX02-250

<table>
<tr><th colspan="2">Transmitter</th></tr>
<tr><td>Input Frequency[2]:</td><td>222 to 408 MHz</td></tr>
<tr><td>Nominal Input Level for 12 TV:</td><td>+29 dBmV (-19.8 dBm)</td></tr>
<tr><td>Output Frequency[2]:</td><td>2.5 to 2.686 GHz</td></tr>
<tr><td>Output Level for 50 dB C/CTB:
(measured with CW carriers)[3]</td><td>
<table>
<tr><th>Channels</th><th>Average Power dBm/Channel</th><th>Peak Power dBm/Channel</th><th>C/N (dB)</th></tr>
<tr><td>9</td><td>31.5</td><td>34.0</td><td>64.5</td></tr>
<tr><td>12</td><td>30.0</td><td>32.5</td><td>63.0</td></tr>
<tr><td>18</td><td>28.0</td><td>30.5</td><td>61.0</td></tr>
<tr><td>24</td><td>26.0</td><td>28.5</td><td>59.0</td></tr>
<tr><td>30</td><td>25.0</td><td>27.5</td><td>58.0</td></tr>
</table>
</td></tr>
<tr><td>Local Oscillator Frequency[2:]</td><td>2278 MHz</td></tr>
<tr><td>Frequency Response:</td><td>±1.5 dB</td></tr>
<tr><td>Frequency Stability:</td><td>0.0005%</td></tr>
<tr><td>Input Return Loss:</td><td>15 dB</td></tr>
<tr><td>Input Connector:</td><td>Type "F" Female</td></tr>
<tr><td>Output Return Loss:</td><td>18 dB</td></tr>
<tr><td>Output Connector:</td><td>Type "N" Female</td></tr>
<tr><td>Temperature Range:</td><td>-40° to 122°F (-40° to 50°C)</td></tr>
<tr><td>Humidity:</td><td>100% max.</td></tr>
<tr><td>Primary Power:</td><td>120/240 VAC, 50/60Hz (per customer specification)</td></tr>
<tr><td>Power Consumption:</td><td>840 VA RMS</td></tr>
<tr><td>Mounting:</td><td>Antenna Pole Mount</td></tr>
<tr><td>Weight:</td><td>160 lb. (72.5 kg)</td></tr>
<tr><td>Dimensions:</td><td>24" W x 24" H x 15" D
(61 W x 61 H x 38.1cm D)</td></tr>
</table>

[1] Specifications subject to change without prior notice.
[2] Other frequencies available.
[3] The C/CTB with modulated carriers is approximately 6 dB better than with CW carriers.

The OTX02-250 Transmitter consists of the following circuits or modules:

1. Upconverter Section
2. Microwave Predistortion Assembly
3. Power Amplifier
4. Power Supply System
5. Diagnostic Circuits.
6. Low Noise Amplifier With AGC
7. Fan Assembly

In addition, microwave isolators and filters are used as necessary to ensure the stability and purity of transmitted signals.

2.3 Upconverter Section

The Upconverter Section is comprised of the following major functional circuits or modules:

1. Hybrid Local Oscillator
2. Upconverter/ Mixer
3. Filter Assembly
4. VHF Processor Module

Hybrid Local Oscillator - The local oscillator consists of a crystal oscillator, frequency multiplier, and a band pass filter all encapsulated in solid 6061-T6 aluminum. The frequency of the oscillator is 2278 MHz. The frequency stability of the oscillator is .0005%. The output of the local oscillator provides pump power to the signal upconverter. The local oscillator is powered by +12 VDC.

Upconverter Mixer - The translation from VHF to microwave frequencies takes place here. The mixer is also called an "upper sideband upconverter". The desired output of the upconverter is a signal at a frequency, which is the sum of the local oscillator, and VHF input frequencies. The upconverter also generates unwanted signals that have to be filtered out, among them the "lower sideband", LO leakage, and others.

Filter Assembly - There are two filters. The group bandpass filter is tuned to pass the upper sideband. The notch filter is tuned to attenuate the local oscillator leakage without affecting the output signal.

VHF Processor Module – The VHF signals are sent to the Processor module first. The processor changes the impedance of the VHF signals from 75 ohms to 50 ohms, and the processor has a level set attenuator so minor level changes can be made.

2.4 Microwave Predistortion Network

Predistortion Linearizer Network enhances the linearity of the amplifier by generating distortion products equal in amplitude but with opposite phase to those generated in the power amplifier, thus canceling a significant amount of the distortion. The signal coming into the predistortion network is split into two circuits by a quadrature hybrid. The linear circuit consists of a variable attenuator, a linear amplifier, and a line stretcher. The non-linear circuit consists of a variable attenuator, a non-linear amplifier, another variable

attenuator, and a line stretcher. The outputs of these two circuits are recombined by another quadrature hybrid.

The phase shifters are adjusted so that the output of the non-linear amplifier is out of phase with the output of the power amplifier. The non-linear attenuators control the amount of distortion generated in the non-linear amplifier.

2.5 Power Amplifier

The power amplifier is self-contained, separately manufactured unit with a 1 dB compression point of 100 Watts (50 dBm). The addition of the pre-distortion network increases the 1 dB compression point to 250-Watts average. The total gain of the amplifier is approximately 50 dB. In addition to the microwave circuits, the amplifier includes DC voltage regulator circuits and output RF monitoring circuits. The power amplifier requires +12 VDC @ 45 amps.

2.6 Power Supplies

Two power supplies are used in the OTX02-250. A 12VDC @ 600 watts power supply is used for the power amplifier. The other power supply is a 12 VDC @ 200 watts which is used to power everything else.

2.7 Diagnostic Circuits

VHF Monitor - There is one monitor connector on the bottom of the enclosure. The transmitter's output at VHF can be viewed at the OUTPUT MONITOR". The "OUTPUT MONITOR" selects the VHF spectrum downconverted from a sample of the microwave output of the power amplifier. The downconversion is performed by an internal MMDS downconverter with the same LO as the compact transmitter.

DC Monitor - Certain test points in the transmitter can be monitored externally at the "Remote Monitor" output multi-pin connector. The output connector is designed for use with diagnostic test boxes such as the Cable AML DTB-1, the WRM-2, or the RM-2A. The test points and corresponding connector pin connections are shown in the Transmitter Block Diagram.

The DC diagnostics are connected to the output connector through a signal conditioning circuit. The signal conditioning circuit is a network of resistors that provides short circuit protection for the transmitter diagnostics sources.

2.8 Low Noise Amplifier with AGC

The Microwave AGC Circuit consists of a Composite AGC module and a LNA with attenuator in the output stage. The purpose of the AGC circuit is to keep the output of the transmitter at a constant level.

The transmitter's output signal is sampled by the 40 dB coupler internal to the power amplifier and fed to the Composite AGC module, where it is detected by a coaxial tunnel diode detector. The detector output is then amplified and conditioned to drive the LNA with attenuator in the output stage. The microwave detector is temperature compensated to minimize output level variation with temperature.

The AGC module has one switch and three adjustments.

The AGC/MGC switch located near the middle of the module has three positions:

1) AGC. In this position, Automatic Gain Control is on.
2) OFF. In this position the attenuator is at a minimum.
3) MGC. In this position, the Manual Gain Control is on.

The three adjustments are as follows:

1) The "AGC ADJUST" is a potentiometer that adjusts the AGC threshold voltage. This sets up the output power of the transmitter at a constant output level regardless of input level variations and ambient temperature changes.
2) The "MGC ADJUST" is a potentiometer that controls the microwave attenuation when the switch is in the MGC position.
3) The "DETECTOR BALANCE" is a potentiometer that allows you to set the voltage at the detector test point to zero when there is no input signal.

The transmitter is set up with 5 dB of AGC to compensate for the output power variations due to ambient temperature changes.

2.9 Fan Assembly

The OTX02-250 has a 12VDC-powered fan to keep the components cool. A thermostat mounted next to the power amplifier controls this fan. The fan will turn on when the temperature of the heat sink exceeds 100°F.

2.10 Operation

The OTX02-250 transmitter requires no adjustments when used in the configuration recommended in the Data Manual. To properly operate the transmitter, simply apply the required AC power and input signal. The OTX02-250 transmitter can be equipped to operate on either 120 or 240 VAC at 50 or 60 Hz. This option is specified by customer request, and each unit is shipped according to these specifications.

2.11 Output Level Setting

The output power for each OTX02-250 Transmitter Unit depends entirely on the input level. If the input level at VHF is higher than the recommended value, both the output power and the CTB (Composite Triple Beat) distortion will increase. For every one dB of higher input level, there will be one dB of higher output power and two dB higher distortion.

CONSEQUENTLY, IT IS NOT RECOMMENDED TO CHANGE OR ADJUST THE TRANSMITTER OUTPUT LEVELS UNLESS THERE ARE SIGNIFICANT CHANGES IN THE NUMBER OF INPUT CHANNELS OR OTHER SYSTEM PARAMETERS.

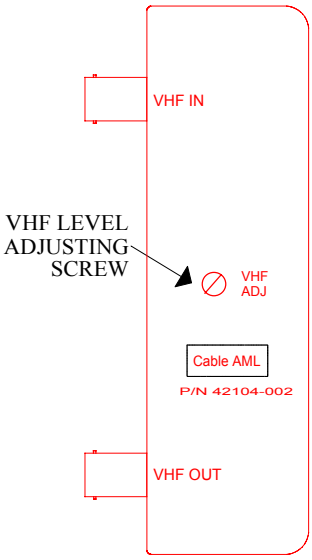

Figure 1. Output Level Adjustment.

This operation requires a microwave Power Meter and Spectrum Analyzer.

With the AGC switch on the AGC Module set to "OFF", the output level can then be set by adjusting the VHF Processor Module's level set attenuator labeled "VHF ADJ" for the required output level required by the system design. The adjusting screw is shown in Figure 1. If a power meter is not available, the transmitter output monitor reading can be used in conjunction with a table provided with the transmitter performance data sheets provided in the Data Manual.

Observe the output of the transmitter with the spectrum analyzer. Using the "VHF ADJ" set the channel levels to the desired level plus the 5 dB margin for the AGC circuit. An individual channel that is out of line with the others must be adjusted at its source. Switch the AGC from "OFF" to "AGC" and adjust the level according to the required output.

2.12 Ambient Conditions

The OTX02-250 transmitter is designed to operate with no external cooling devices. Internal cooling fans maintain component temperatures at desirable levels when ambient conditions are in the range specified in Technical Specifications.

2.13 Thermal Sensor Switch

To protect the power amplifier from overheating due to fan failure or excessive ambient temperature, an internal temperature sensor automatically cuts off AC input power to the power amplifier when the temperature exceeds a factory set threshold of 158° F (70° C). If the cause of overheating is fan failure, the failed unit should be replaced before applying power.