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 Indoor Transmitter ITX02-2000 (shown in Section 4.0, Figure 3) is a solid-state broadband transmitter, which converts a VHF input signal of 222 to 408 MHz to a microwave signal of 2.5 to 2.686 GHz.

The ITX02-2000 transmitter is comprised of the following sub-assemblies:

1. **Driver Chassis -** for converting the incoming VHF signal to microwave. The Driver chassis contains all components necessary for up-conversion, i.e. local oscillator, mixer, as well as band pass and notch filters.
2. **Power Amplifier -** input signal is amplified to a maximum level consistent with the Carrier to Composite Triple Beat (C/CTB) specification by state of the art GaAs FET microwave power amplifiers in a parallel, power-quadrupling configuration. The power amplifiers are protected from failure due to overheating by an internal temperature sensor. The sensor circuit automatically switches off the amplifier when the amplifier temperature exceeds 167° F (75° C).
3. **Power supply system -** a redundant 12 VDC system consisting of three current sharing modules with hot-plug replacement capability. Each module has an 84 Amp capability. Only two modules are required to run the system, making the third one a built-in spare. A +5 VDC voltage regulator is used to power the power amplifier TTL circuit. The Driver chassis and fans are powered by the +12 VDC power supply.
4. **Monitoring and Diagnostic Circuits -** To facilitate operational monitoring and diagnostics of: VHF input, VHF output, Driver RF output, and Transmitter RF output. diagnostic DC voltages can also be continuously monitored with the built-in meter on the Meter Panel.
5. **On-Delay Timer Assembly** - Delays power to the amplifier. This is done to avoid a big current surge when the transmitter is first turned on.
6. **Internal Down-converter** - For ease of monitoring the Transmitter's output, a down-converter has been mounted inside. The down-converter takes a sample of the output and converts it to VHF. This VHF output signal can then be measured with a Field Strength Meter or a TV monitor.

The ITX02-2000 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

ITX02-2000

<table>
<tr><th colspan="2">Transmitter</th></tr>
<tr><td>Input Frequency[2]:</td><td>222 to 408 MHz</td></tr>
<tr><td>Input Level (80 channel loading):</td><td>+20 dBmV (-29 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>40.5</td><td>43.0</td><td>72.5</td></tr>
<tr><td>12</td><td>39.0</td><td>41.5</td><td>71.0</td></tr>
<tr><td>18</td><td>37.0</td><td>39.5</td><td>69.0</td></tr>
<tr><td>24</td><td>35.0</td><td>37.5</td><td>67.0</td></tr>
<tr><td>30</td><td>34.0</td><td>36.5</td><td>66.0</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"</td></tr>
<tr><td>Output Return Loss:</td><td>18 dB</td></tr>
<tr><td>Output Connector:</td><td>Type “N”</td></tr>
<tr><td>Temperature Range:</td><td>60° to 100°F (16° to 38°C)</td></tr>
<tr><td>Humidity:</td><td>95% 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>2500 VA RMS</td></tr>
<tr><td>Mounting:</td><td>Enclosed Equipment Rack</td></tr>
<tr><td>Weight:</td><td>450 lb. (205 kg)</td></tr>
<tr><td>Dimensions:</td><td>22” rack W x 84” H x 27” D
(55.9 cm rack W x 213.4 cm H x 68.6 cm 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 ITX02-2000 Transmitter consists of the following circuits or modules:

1. MMDS Transmitter Driver
2. Power Amplifier
3. Power Supply System (three +12 VDC current sharing modules and one +24 VDC power supply)
4. Monitoring and Diagnostic Circuits - connectors and switches.
5. On-Delay Timer Assembly.
6. Internal Down-converter.

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

2.3 MMDS Transmitter Driver

The MMDS Driver is comprised of the following major functional circuits or modules:

1. Local Oscillator (LO)
2. Up-converter/Mixer
3. Filter Assembly
4. Microwave Low Noise Amplifier
5. DC Diagnostics
6. Power Supply

Local Oscillator (LO)

The microwave *local oscillator* is a crystal oscillator and frequency multiplier encapsulated in a single enclosure. The output of the LO provides pump power to the signal up-converter. The LO is powered by a +12 VDC power supply. The long-term frequency stability of the oscillator is 5 parts per million per year.

Up-converter Mixer

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

Filter Assembly

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

Microwave Low Noise Amplifier

A Low Noise Amplifier accomplishes the amplification with minimum distortion.

DC Diagnostics Circuit

Certain test points in the transmitter can be monitored externally at the Remote Monitor output multi-pin connector on the front panel. These 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 diagnostic sources. 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.

Power Supply

The power supply for the MMDS Driver is +12 VDC.

2.4 Power Amplifier Chains

The power amplifier consists of four GaAs FET microwave power amplifier that amplifies the input signal to a maximum level consistent with the Carrier to Composite Triple Beat (C/CTB) specification. The power amplifier is protected from failure due to overheating by an internal temperature sensor. The sensor circuit automatically switches off the amplifier input power when the amplifier temperature exceeds 167°F (75°C). The power amplifiers are arranged in a quadruple power configuration which results in an overall IP3 increase of 5 dB. The gain of the amplifiers is 56 dB with an IP3 of 69.5 dBm. The amplifiers have a TTL circuit, which enables the user to shut down the amplifiers for testing purposes. +5VDC = “ON”

2.5 Power Supply Assembly

The transmitter has a 12 VDC redundant power supply system consisting of three current-sharing modules with hot-plug replacement capability. Each module has an 84 Amp capability. Only two modules in each mainframe are needed to run the transmitter. A 24 VDC power supply powers the internal down-converter and also supplies voltage to a 5 VDC voltage regulator, which is used with the Transistor-Transistor-Logic (TTL) of the power amp. A separate +12 VDC power supply is used for the Driver.

2.6 Diagnostic Circuits[1]

The ITX02-2000 transmitter has several connectors and switches.

Connectors - there are "test point" and "monitor" output connectors on the front panel.

DC Voltage Diagnostics - DC voltage diagnostic signals can be read using the built- in meter on the front panel. The functions available on the front panel are shown below:

1. +12 VDC of Driver power supply (volts)
2. +12 VDC buss (volts)
3. Current monitor #1, see Data manual for scale factor
4. Current monitor #2, see Data manual for scale factor
5. Current monitor #3, see Data manual for scale factor
6. RF Detector at Amp #1 (volts)

1See Data Manual for nominal values of diagnostic signals.

7. RF Detector at Amp #2 (volts)
8. RF Detector at Amp #3 (volts)
9. RF Detector at Amp #4 (volts)
10. RF Detector TX Output (volts)

Amplifier Power "On/Off" Switch Panel - this panel is located behind a "blank" front panel for to protect the switches from being inadvertently switched off. For access to this panel, the "blank" front panel must be removed. The switches are intended to cut off power to the amplifiers.

2.7 On-Delay Timer Assembly

A set of relay's and timers is used to delay power to the amplifier. This is so the +12 VDC power supply has a chance to stabilize upon start up of the Transmitter.

2.8 Internal Down-converter

For ease of monitoring the Transmitter output, a down-converter has been mounted inside the Transmitter. The down-converter takes a sample of the output and converts it to VHF. This VHF output signal can then be measured with a Field Strength Meter or a TV monitor.

2.9 Output Level Setting

The output power for each ITX02-2000 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. **DO NOT EXCEED THE INPUT LEVEL SPECIFIED IN THE TRANSMITTER DATA SHEET.**

If it is not convenient to control the input level by means of external pads, it can be controlled by an internal attenuator located in the Driver Chassis.

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 IN OTHER SYSTEM PARAMETERS.

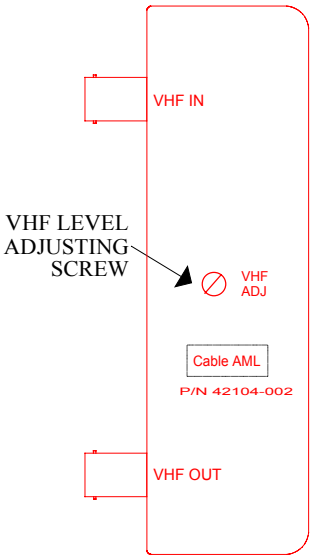

Figure 1. Output Level Adjustment.

A Microwave Power Meter or Spectrum Analyzer is required to set the Output Level. It should be connected to the transmitter output monitor connector on the front panel.

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" tuning screw, set the channel levels to the desired level. An individual channel that is out of line with the others must be adjusted at its source.

2.10 Ambient Conditions

The ITX02-2000 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.

2.11 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 input power when the temperature exceeds a factory set threshold of 167° F (75° C). If the cause of overheating is fan failure, the failed unit should be replaced prior to applying power.