TELEWAVE, INC.

TELEWAVE

M101-220-5TRM-19"
LOW LOSS COMBINER

Instruction Manual

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GENERAL INFORMATION

1.1 DESCRIPTION

The Model M101-220-5TRM-19" Combiner is a self-contained, field tunable, 5- channel transmitter and receiver combiner for use in the 220 MHz Trunked frequency band.

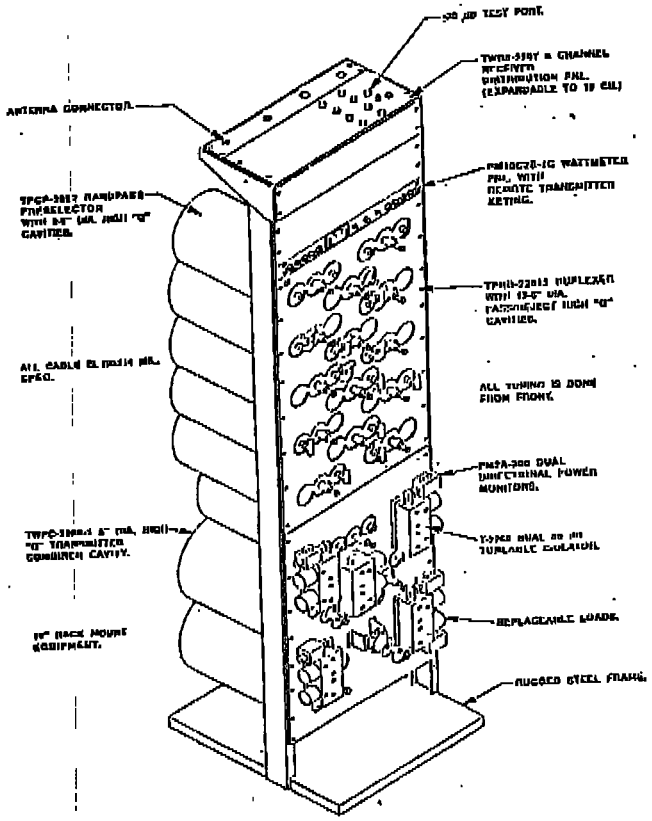
Mounted in a rugged steel frame, and utilizing highly reliable components, the combiner is designed to provide complete, trouble free service. All components are completely passive, with the exception of the solid state receiver distribution amplifier.

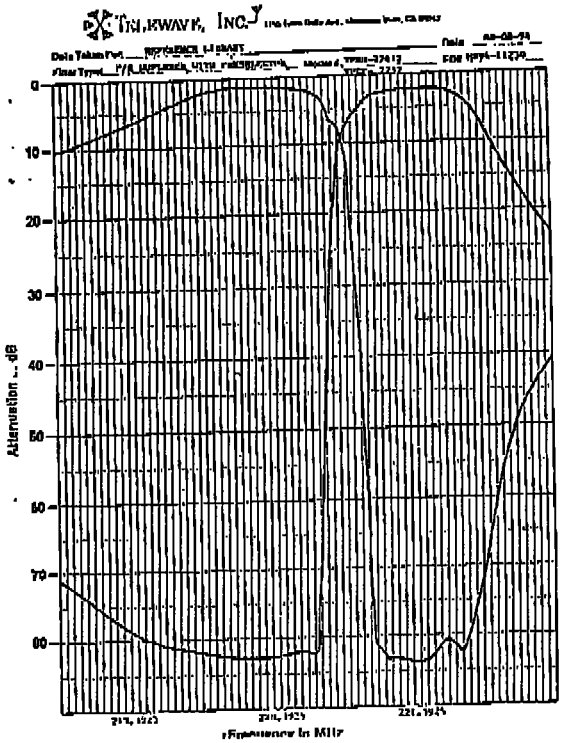
The unique capacity for channel expansion allows the user to start with as few as two channel and add additional systems without disruption to co-channel users. Model M101-220-1T expansion kit provides the components and hardware necessary for one add-on channel.

The combiner is pre-tuned at the factory and should not require adjustment in normal use. However, if an adjustment is needed, or it is desired to change an existing frequency, tuning is easily accomplished from the front of the rack. With the RF wattmeter panel installed, (Model PM-10C2S-1C) retuning is often performed without additional external test equipment. The PM10C2S-1C also provides a continuous, calibrated indication of individual channel and overall system performance, which is an invaluable tool for the technician. Connections for remote transmitter keying are provided by 10 front panel switches.

The Combiners features low transmitter insertion loss, less than 3.25 dB when frequency spacing is 150 KHz, and greater than 80 dB transmitter-to-transmitter isolation.

Other features of the TPRD-22612 Pass/Reject duplexer and the TPCP-2252 two pole pass cavity preselector that provide complete filtering to the signal distribution system for the receivers, with overall gain maintained at +4 to +6 dB through the system. All components are easily maintained from the top & front of the rack.





Model M101-220-5TRM-19

GENERAL SPECIFICATIONS

Impedance	50 Ω
Frequency	216-225 MHz
dMetering	PM10C2S-1C
Temperature	-30° C to +60° C
Weight (with Rx system)	200 lbs. (90.7 kg)
Dimensions (in)	20 W x 22 D x 72 H
(cm)	50.8 W x 55.9 D x 182.9 H

COMBINER

Insertion Loss (determined by frequency spacing)	3.0 dB @ 150 KHz (TYP.)
Tx - TX Isolation	85 dB
2nd Harmonic suppression	90 dB
Transmitter Power	150 Watts
Channels	5

Contact Telewave for conformance to non USA standards.

RECEIVER DISTRIBUTION (TWR8-220T)

System Gain	+4 to +6 dB
3rd Order Intercept	+36 dBm
Noise Figure	2.5 dB typical
Power Supply	15.0 . VDC 115/230 VAC
Power Reverting	Standard
Battery Drain @ 13.6 VDC	175 ma

DUPLEXER (TPRD-22612) with PRESELECTOR (TPCP-2252)

Frequency configuration	Full Trunking Band 220-222(USA)
Power Input	350 Watts
Insertion Loss	
Tx to Ant	2.0 dB
Ant to Rx	3.0 dB
Rx Isolation (Tx freq)	80 dB
Tx Noise Suppression (Rx Freq)	80 dB
Cavities (dia.)	5-8",12-6",2-5"
Mechanical	Fully integrated into EIA-19" rack

1.3 INPUT / OUTPUT CONNECTORS

The following connections are provided for input and output to the M101-220-5TRM-19

TOP OF RACK (all type-N Female, standard)

Inputs for transmitters (T1, T2, T3, T4, T5) — sides of bottom panel
ANT A (Rec. in on duplexed sys.) — output to transmitter antenna
RCVR. ANT (Two antenna systems) — input for receiver antenna
1,2,3,4,5,6,7,8 (on Rx Panel) — outputs to receivers
NOTE: unused ports on Rx Panel must be terminated with 50 Ohms — TELEWAVE Model: TWL-01

BACK OF PM10C2S-1C (solder posts) — connections for transmitter keying circuits (remote transmitter keying)

INITIAL INSTRUCTIONS

2.1 INSTALLATION

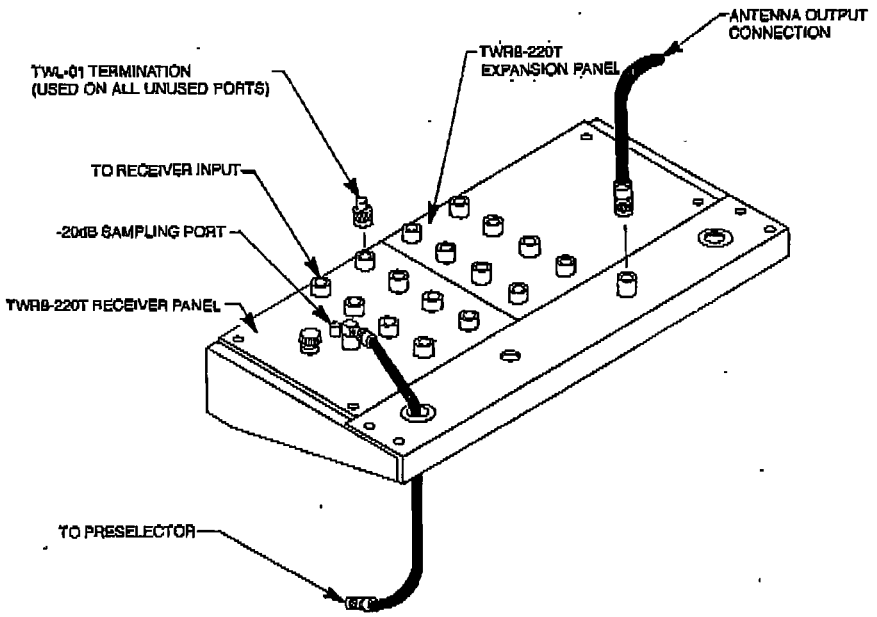
The M101-220-5TRM-19" combiner should be installed on a flat, level surface, either free standing or anchored. The combiner requires a 20" by 22" area of floor space and 72" of vertical space, not including connections to the top of the rack. Good installation practice dictates the use of a good ground return. Connect a ground strap to the mounting frame. All transmitter jumper coax cables should be of the double shielded type

2.2 TOP PANEL CONNECTIONS

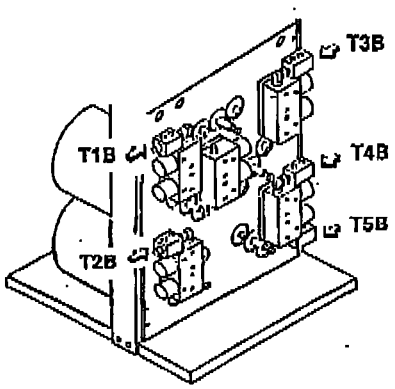
The TPCP-2252 Bandpass Preselector is shipped with an interconnection cable from the preselector to the receiver distribution panel. It is removed for shipping and must be reconnected in order to use the receiver multicoupler. Any substitution of this cable is not recommended, because the length is a predetermined value which affects the operating characteristics of the receiver system. The cable connects between the output of preselector and the ANT. IN on the receiver distribution panel.

The receiver antenna is connected next, as shown: Connecting the receiver distribution panel into a 115-VAC power source provides instant operation to the receiver system. The phono jack on the bottom side of the RX panel can be connected to a +12V DC source for battery backup.

The transmitter antenna normally connects to the ANT- A positive if a single, common antenna is to be used for all 5 transmitters. Some systems will utilize 1 transmitter antenna and 1 receiver antenna in which case, the Tee harness on the duplexer can be removed and the receiver antenna connected to the preselector side of the duplexer.



The final connections are to the transmitters. Each transmitter input is clearly marked with the exact frequency assigned to it. Care should be taken to observe the indicated frequencies when connecting transmitters. An incorrect transmitter input to the combiner may result in overheating of the isolator load terminations,



2.3 PM10C2S-1C WATTMETER CONNECTIONS

Connections for up to ten power monitors and two antennas are provided with the PM-10C2S-1C via phono jacks located on the back of the wattmeter panel. They allow for 10 transmitter input monitors and 2 antenna output monitors. Each monitor is selected via a 12-position rotary switch located on the front of the panel. Standard 6' stereo phono plug cables are used to make the connections from the wattmeter panel to the power monitors. Black plugs correspond to forward power measurement jacks, and red plugs correspond to reflected power measurement jacks on both the wattmeter panel and the power monitors. Viewed from the rear of the wattmeter panel, the correct connections are made as shown:

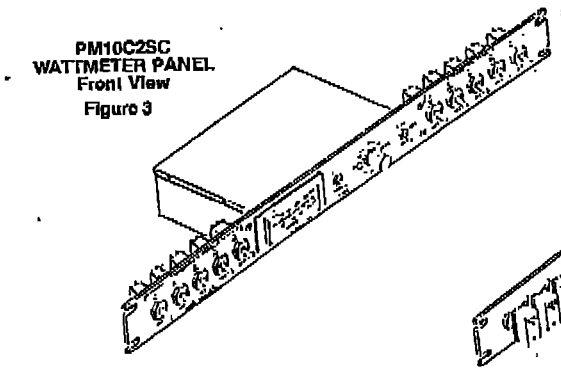


Figure 3

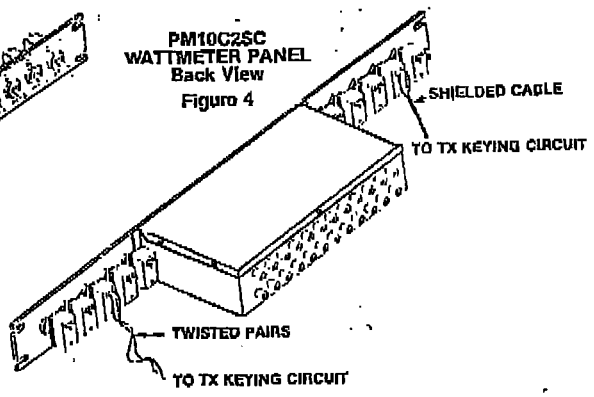
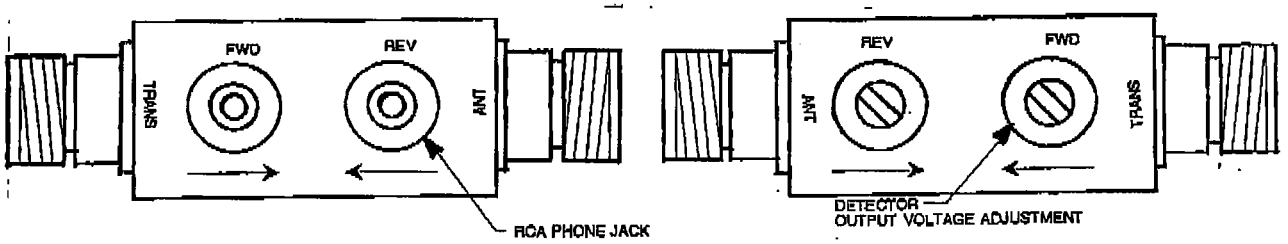


Figure 4

Each power monitor has a forward power indicating jack and reflected power indicating jack. The jacks are located to the rear of each power monitor, and the correct connections are made as shown:



Connections for 10 remote transmitter keying switches are provided by the PM10C2S-1C. A simple 2-wire hook-up (RF shielded or twisted pairs), from the keying circuit of each transmitter to the solder terminals on the switches located on the back side of the wattmeter panel, completes the connections. A floating ground for each keyer is provided for transmitters requiring such a circuit.

3.1 THE RECEIVER MULTICOUPLER

The receiver portion of the combiner is ready to operate when connected to a suitable antenna and to the proper receivers. Connecting the power cord from the receiver distribution panel to a 115 VAC, 47-440 Hz source will provide instant operation to the unit. There is no power switch associated with the system.

All receiver connections are identical, thus any particular receiver may be connected to any of the 8 receiver outputs. It is necessary to terminate unused ports with 50 Ohm terminations Telewave part #TWL-01

There are no tuning adjustments to make to the receiver system.

3.2 THE TRANSMITTER COMBINER

A. OPERATION WITHOUT THE PM10C2S1C INSTALLED

Connect a suitable wattmeter into the antenna line and observe the reading as one transmitter is keyed up. Record the reading, unkey the transmitter and insert the wattmeter into the transmitter line. Key the transmitter and record the new reading. In most cases, the observed RF power indication at the antenna port will be approximately one half of the power at the transmitter port of the combiner. A good rule of thumb is the input power at the antenna port should meet or exceed 50% of the input power at the transmitter port. This figure corresponds to 3.0 dB or less of insertion loss through the system.

The formula is given:

$$\frac{\text{POWER AT ANTENNA PORT (WATTS)}}{\text{POWER AT TRANSMITTER PORT (WATTS)}} \times 100 \geq 50\%$$

Record the reflected power observed at the transmitter port and compare it to the forward power previously recorded. The reflected power should be less than 2% of the forward power. This figure corresponds to a transmitter input V.S.W.R. of less that 1.3:1.

The formula is given:

$$\frac{\text{REFLECTED POWER AT TRANSMITTER INPUT(WATTS)}}{\text{FORWARD POWER AT TRANSMITTER INPUT (WATTS)}} \times 100 \leq 2\%$$

Repeat the process for each transmitter channel, recording the forward and reflected power at the transmitter port and the forward power at the antenna port. Confirming the measurements for all transmitter channels completes the check out of the transmitter combiner.

B. OPERATION WITH THE PM-10C2S-1C WATTMETER INSTALLED

Checkout of the combiner is greatly simplified with the addition of the PM10C2S-1C wattmeter. The work becomes an easy 10-15 minute, one man job.

The technician merely keys each transmitter in turn, directly from the wattmeter console, and observes the readings of antenna power and forward/reflected transmitter power. All of the readings are selected by a convenient rotary switch and single forward/reflected toggle switch. Time consuming records of the measurements are not necessary, since a simple turn of the switch quickly shows all the measurements for easy comparison.

Additionally, the PM10C2S-1C wattmeter may be used to check the condition of the transmitter antenna and feedline. Observing the reflected power present at the antenna input and comparing it to the forward power at the same point yields a method for determining the antenna system V.S.W.R

The formula is given:

$$\frac{\text{REFLECTED POWER AT ANTENNA PORT (WATTS)}}{\text{FORWARD POWER AT ANTENNA PORT (WATTS)}} \times 100 \leq 4\%$$

The figure of 4% represents a VSWR of approximately 1.5:1 present at the antenna input of the combiner confirming these measurements completes the check out of the combiner.

3.3 THE M101-220-1T EXPANSION KIT

Check out of the expansion kit(s) after installation into the M101-220 combiner requires repeating the power measurements for all transmitter channels, as well as the new channel(s). Follow the steps previously described in section 3.2, and when all measurements have been confirmed, the check out is completed.

CIRCUIT DESCRIPTION

4.1 INTRODUCTION

Figure 4-1 shows a diagram of the basic M101-220-5TRM-19", figure 4-2 shows a diagram of the transmitter section and figure 4-3 shows a diagram of the receiver section. The diagrams will be described first, then the details within each section. References will be made to circuit diagrams which follow the descriptions at the end of Section 4.

4.2 DESCRIPTION OF THE BASIC M101-220-5TRM-19 TRANSMITTER SYSTEM

Because of the nature of transmitted and received signals in the VHF band and the regulations governing their use, it is necessary to provide a system of filtering and protection for both transmitters and receivers which operate in vicinities relative to each other, and which may cause detectable interference to or from the systems employed. Additionally, it is desirable for the filtering and protection system to introduce as little signal loss and degradation, consistent with the above requirements. Flexibility in design, ability for future expansion, serviceability, initial costs, and costs to operate are all prime factors for consideration.

To achieve these goals, the combiner duplexer employs as its basic method of filtering and combining, the system of ferrite/cavity coupling. In this design, the 50-Ohm output of each transmitter is fed to a dual ferrite isolator, Model T2260, which prevents reflected and unwanted external signals from appearing at the transmitter's output circuit. In this way, interference due to intermodulation products is prevented. The T2260 dual ferrite isolators are 50-Ohm devices which pass the transmitter signals, with a minimum of loss, to the quarter-wavelength resonant cavities, Model TWPC-2208.

The resonant cavities act as highly selective Bandpass filters, presenting a narrow 50-Ohm path at the transmitter frequency and dropping off sharply towards a short circuit for all other frequencies. The output of the cavities of 5 channels are connected to a common point, using a Model TW5-450 Junction, via three-quarter-wavelength cables. The critical cable-lengths transform the off-resonance short circuit of each cavity to a nearly <u>open</u> circuit condition and thus, the only path of true 50-Ohm impedance for the transmitted signals is towards the TW5-220 Junctions and its output port.

At this point the transmitter signals are combined, the losses on each channel are minimal, and the filtering and protection for each channel is assured.

4.3 DESCRIPTION OF THE T2260 DUAL FERRITE ISOLATOR

The T2260 is a non-reciprocal device that features low loss in the forward direction and high loss or isolation in the reverse direction. RF power fed to the input of the isolator is magnetically circulated to the output port with approximately .5 dB insertion loss. Any power entering the output port of the isolator is magnetically circulated to a third port which is terminated with a 50-Ohm load. Because the power absorption of one load is not Absolute, a forth port, also terminated, is employed to further reduce the level of the reflected signal, thus preventing the appearance of the unwanted signal at the isolator input port and the associated transmitter. Attenuation of signals in the reverse direction is greater than 65 dB.

The T2260 Isolator is tunable for optimum performance at a desired frequency in the band. Tuning ports 1, 2, 3, and 4 are provided to establish in-phase 50-Ohm Bandpass at the transmitter frequency, and ports 5 and 6 are provided to establish high reverse isolation on frequency. Before making any adjustments, refer to tuning instructions supplied for the T2260 Isolators located at the end of Section 4.

NOTE: The T2260 Isolator is a broadband device in respect to both forward insertion loss and reverse isolation. It is not normally necessary to make adjustments to the Isolator, except when changing transmitter frequencies. Because adjustments may affect the performance of the combiner as a whole, it is recommended that the isolators be left unchanged from their factory setting.

The T2260 isolators have 2 replaceable 35-Watt loads. Loss or disconnection of the transmitter antenna for prolonged periods may result in damage to these loads, in which case they can be quickly replaced in the system with new loads.

4.4 DESCRIPTION OF THE TWPC-2208 HIGH-Q CAVITY.

The TWPC-2208 Cavity is a 50-Ohm matching device for the on-channel frequency and provides effective filtering of transmitter sideband noise. Off frequency, the cavity impedance is reduced towards a short circuit, and thereby eliminates most of the interference associated with FM transmitting equipment.

In typical operation, the TWPC-2208 cavity provides nearly 30 dB of signal attenuation at 5 MHz off resonance, with an insertion loss of 1 dB.

Tuning the TWPC-2208 cavity involves loosening the locking nut and rotating the threaded tuning shaft (1/4-28 cap nut) at the center of the cavity. Turning the shaft clockwise lowers the resonant frequency; turning it counter-clockwise raises the resonant frequency.

The coupling loops are an integral part of the input and output ports of the cavity. System performance may be affected if the 3 screws securing them are loosened or removed. Because the settings affect the performance of the combiner as a whole, and because they have been optimized at the factory, it is recommended that the coupling loops be left unchanged from their factory settings.

4.5 DESCRIPTION OF THE TW5-220 JUNCTION

The TW6-220 Junctions provide a central point where 5 of the transmitter signals are joined together. Each signal coming to the junction sees high impedances at the other transmitter arms of the junction due to the off-frequency characteristics of the TWPC-2208 cavities and the transforming effect of the three-quarter-wavelength critical cables. Because of this effect present at the junction, transmitter signals see a matched 50-Ohm path only to the antenna port of the TW6-220 junction and thus almost all the signal is transferred to the antenna port with a mismatch loss of only a few tenths of a dB.

4.6 DESCRIPTION OF THE BASIC RECEIVER DISTRIBUTION SYSTEM

The TWR8-220 employs as its basic method of receiver filtering and multicoupling, the principals of pre-selection, pre-amplification, and distribution.

In this design, the signal from the receiver antenna is fed into a series of 6 pass-type cavity filters per preselector which are optimized to provide high attenuation for all sources of interference outside the selected pass window; the insertion loss at the desired receiver frequencies is typically 3 dB or less. This pass-type preselector design has distinct advantages over the notch-type, since the latter can only attenuate a selected, narrow band of frequencies, and can be troublesome when frequency changes become necessary.

The preselected receiver frequencies of the preselector model TPCP-2252 and TPRP-22612 are fed into the TWR8-220 receiver distribution panel where they are amplified by a predetermined amount and distributed to the 8 receiver ports. The actual signal gains at the receiver ports are approximately +4 dB to + 6 dB relative to the level of the signals appearing at the antenna input of the duplexer.

4.7 DESCRIPTION OF THE TPRD-22612 DUPLEXER & TPCP-2252 PRESELECTOR

The duplexer consist of 12 - 6" diameter pass/reject cavities. Six cavities make up the transmitter sideband filter and six cavities make up the preselector. There are 2 additional 5" diameter bandpass cavities that provide extra filtering for TV channel 13. All cavities are quarter-wave-length resonators. All tuners are conveniently located at the front of the rack for field retuning.

Each model features "sharp-skirt" selectivity with minimum insertion loss. For optimum performance, these Bandpass filters have been custom tailored to meet your individual requirements. (It is not advised to change the position of the calibrated coupling loops at any time.

4.6 DESCRIPTION OF THE TWR8-220 RECEIVER DISTRIBUTION PANEL

The TWR8-220T receiver distribution panel contains a narrowband low noise preamplifier, ferrite 8-way splitter, and power supply all in one fully shielded unit. The panel provides approximately +6 to +8dB of overall gain in the 200.0 to 220.0 MHz band with an input VSWR less than 2.0:1. The TWR8-220T is field expandable to 16 channels using the PS220ST expansion panel.

Each receiver port is isolated from the other ports by a minimum of 25 dB, thus the effects of receiver cable resonances and coupling between adjacent receivers are avoided.

The design of the TWR8-220T receiver distribution panel, requires that unused receiver ports be terminated with 50 Ohm loads. Use Telewave's 50 Ohms termination Model: TWL-01.

The TWR8-220 receiver distribution panel features a 2.0 dB low-noise figure (2.5 dB maximum), with a +36 dBm third-order intercept point. The power supply is conservatively rated, fuse-protected, and has full RFI filtering of the AC line cord and DC input. It provides a continuous, regulated 15 VDC source with current-limiting circuit to the amplifier. Current draw is about 83 ma. at 15 VDC. The preamp will work at 11.5 VDC but at a reduced performance.

TUNING INSTRUCTIONS

5.1 INTRODUCTION

The tuning procedures given in this section are divided into three parts, consisting of the transmitter combiner, the duplexer, the receiver multicoupler, and the power monitor. Two levels of procedures are provided for transmitter and receiver sections, one level requires only basic test equipment, and a more sophisticated level for use only when the proper equipment is available.

5.2 THE TRANSMITTER COMBINER

Tuning the combiner involves adjustments to the isolators and cavities only. The isolators are tuned for minimum insertion loss on channel and maximum reverse isolation. The cavities are tuned for best VSWR and insertion loss on channel. The isolators and cavities need not be disconnected from the system to adjust or tune.

5.2.1 THE CAVITY

Caution--Do not tune the cavities under full power as this will cause damage to the center conductor.
Tune at 10 watts or less.

LEVEL 1
Always tune the cavity before the isolator to prevent mismatching between devices.

Equipments needed:
- transmitter tuned to proper frequency In CW mode.
- 50 ohm dummy load rated a transmitter power
- inline wattmeter (optional)
- 7/16 open wrench (qty 2)

Terminate the antenna output of the combiner with the dummy load. If the duplexer is installed, disconnect the cable from the input to the duplexer and connect it to the load. Be sure that the power monitor selector switch is turned to ANT A on the wattmeter panel. Loosen the locking nut at the base of the tuning shaft on the cavity. Key the transmitter and slowly turn the tuning shaft clockwise to lower the frequency, counter - clockwise to raise it. Tune for maximum forward power and minimum reverse power at the antenna output. DO NOT adjust the coupling loops. They are set at the factory for 1.25dB of loss.

LEVEL 2
Equipment needed:
- spectrum analyzer with tracking generator
  - scan width 10KHz /div
  - 1dB resolution vertical
  - return loss bridge with 40dB directivity

Set the center frequency of the spectrum analyzer / tracking generator to the frequency of the transmiter with the scan width set to 10kHz/div. Connect the tracking generator output to the input of spectrum analyzer using two coax test cables. Adjust the generator level for a reference on the CRT with the vertical resolution set to 1dB. Without altering the output of the generator, connect the generator output to the isolator input and connect the spectrum analyzer input to the combiner output. Loosen the locking nut at the base of the tuning shaft on the cavity. Key the transmitter and slowly turn the tuning shaft clockwise to lower the frequency, counter - clockwise to raise it. Set the pass to the center of the CRT and tighten the locking nut on the cavity. Compare the Reading on the CRT to the insertion loss figure specified for the combiner. The difference between the two figures should not exceed .25dB.

NOTE: On a close spaced combiner with frequencies spaced at 150 KHz, be sure to recheck the all the cavities after the first tuning. The cavities tend to be pulled off resonance as the other cavities are tuned close to each other.

5.2.2 THE ISOLATOR

The isolator should be adjusted after the cavity has been tuned.

LEVEL 1

Equipments needed:

transmitter tuned to proper frequency in CW mode.
50 ohm dummy load rated a transmitter power
inline wattmeter
non-metallic 1/8" flat blade adjustment tool

With the dummy load connected to the output of the combiner, duplexer disconnected, key the transmitter and adjust isolator tuners 1-4 to obtain maximum power into the dummy load. It may be necessary to repeat the adjustments in order to fine tune the isolator.

LEVEL 2

Equipment needed:

spectrum analyzer with tracking generator
scan width 1MHz /div
1dB resolution vertical
return loss bridge with 40dB directivity

Set the center frequency of the spectrum analyzer / tracking generator to the frequency of the transmitter with the scan width set to 1MHz/div. Connect the tracking generator output to the input of spectrum analyzer using two coax test cables. Adjust the generator level for a reference on the CRT with the vertical resolution set to 1dB. Without altering the output of the generator, connect the generator output to the isolator input and connect the spectrum analyzer input to the combiner output. Connect the generator to the input of the isolator and the spectrum analyzer to the output of the isolator, cavity disconnected. Adjust the tuners1-4 for a symmetrical bandpass about the transmitter frequency. Insertion loss will be about .6dB or less. Connect the generator to the output of the isolator and the spectrum analyzer to the input of the isolator. Set the vertical resolution to 10dB/div. Adjust the tuners 5 & 6 for maximum attenuation at the transmitter frequency. Isolation should be greater than 80dB on frequency and 60dB across 5MHz.

Connect the return loss bridge to the tracking generator set a reference on the CRT with the test port on the bridge open. Connect the bridge to the output of the isolator and slightly adjust tuner 4 for best return loss. This should be greater than -17dB. Connect the bridge to the input of the isolator and slightly adjust tuner 1 for best return loss. This should be greater than -17dB. Reconnect the cable from the cavity to the isolator.

5.2.3 FINAL ADJUSTMENT

After completing the above steps, connect the transmitter to the proper input of the combiner and place an inline wattmeter between the second stage load termination and the isolator. Connect a dummy load to the output of the combiner and key the transmitter. Adjust the tuning shaft on each cavity for minimum power at the isolator port as determined by the wattmeter. Tighten the locking nut on the tuning shaft.

5.3 THE DUPLEXER

The bandpass/bandreject duplexer is factory tuned to have a bandpass that will cover either the group frequencies 1 - 10 or group frequencies 11 - 20. The model number on the combiner will have a **A1** on the end if it is tuned to the 1 -10 group and a **A2** on the end if it is tuned to the 11 - 20 group frequencies. This means that the pass bandwidth will be 645 KHz wide with 2 dB of insertion loss. The reject BW will also be 645 KHz wide with over 80 dB of rejection.

On **A1** models the transmitter side the pass BW will be from 220.0025 to 220.6475 MHz. The reject will be from 221.0025 to 221.6475 MHz. The receiver pass frequency will be 221. 0025 to 221.6475 MHz and the reject BW will be 220.0025 to 220.6475 MHz.

On **A2** models the transmitter pass BW will be from 220.0475 to 220.6975 MHz. The reject will be from 221.0475 to 221.6975 MHz The receiver pass frequency will be 221.0475 to 221.6975 MHz and the reject BW will be 220.0475 to 220.6975 MHz.

LEVEL 2
Equipment needed:

Vector network analyzer with 100 dB of dynamic range
Optional:
spectrum analyzer with tracking generator
scan width 100KHz /div
1dB resolution vertical
return loss bridge with 40dB directivity

It is not recommended that the duplexer be adjusted unless the technician preforming the test is skilled in using the proper test equipment. Telewave recommends using a vector network analyzer that can measure simultaneous insertion loss, frequency, and return loss. If the proper equipment is available then the cavities are adjusted like and other pass/reject duplexer, tuning the pass frequency first to the proper frequency and bandwidth and then tuning the rejection bandwidth using the tuner located on the coupling loops of each reject cavity. The maximum insertion loss on the transmitter side of the duplexer is 2.25 dB and the return loss will be greater than -16 dB. The rejection bandwidth should have over -60 dB of isolation. The receiver side will have the same insertion loss without the two pole preselector connected. With the two pole bandpass filter the insertion loss should less than 3dB.

The two pole bandpass filter located at the top of the duplexer panel is also tuned to have a pass BW of 645 KHz with -.6 dB of insertion loss at the BW edges. To tune the bandpass, disconnect the filter from the the duplexer and receiver distribution panel. Sweep the filter with the analyzer set to 100 KHz /div. sweep width and vertical resolution on 1 dB/div. Loosen the locking nut on the cavities and adjust the center tuner on each cavity for the proper bandwidth and insertion loss. Tighten the locking nuts when tuning is complete.

Once the duplexer and preselector are tuned all cabling should be connected back up and the return loss bridge on the analyzer should be connected to the antenna output and the return loss to each transmitter and receiver frequency be measured. The return loss on the transmitter frequencies should be greater than -14dB. The return loss for each receive frequency should be greater than -15 dB.

5.4 THE RECEIVER MULTICOUPLER

There is no tuning on the TWR8-220T receiver distribution panel. The unit can be tested for proper gain at the receive frequencies by using level 2 test equipment.

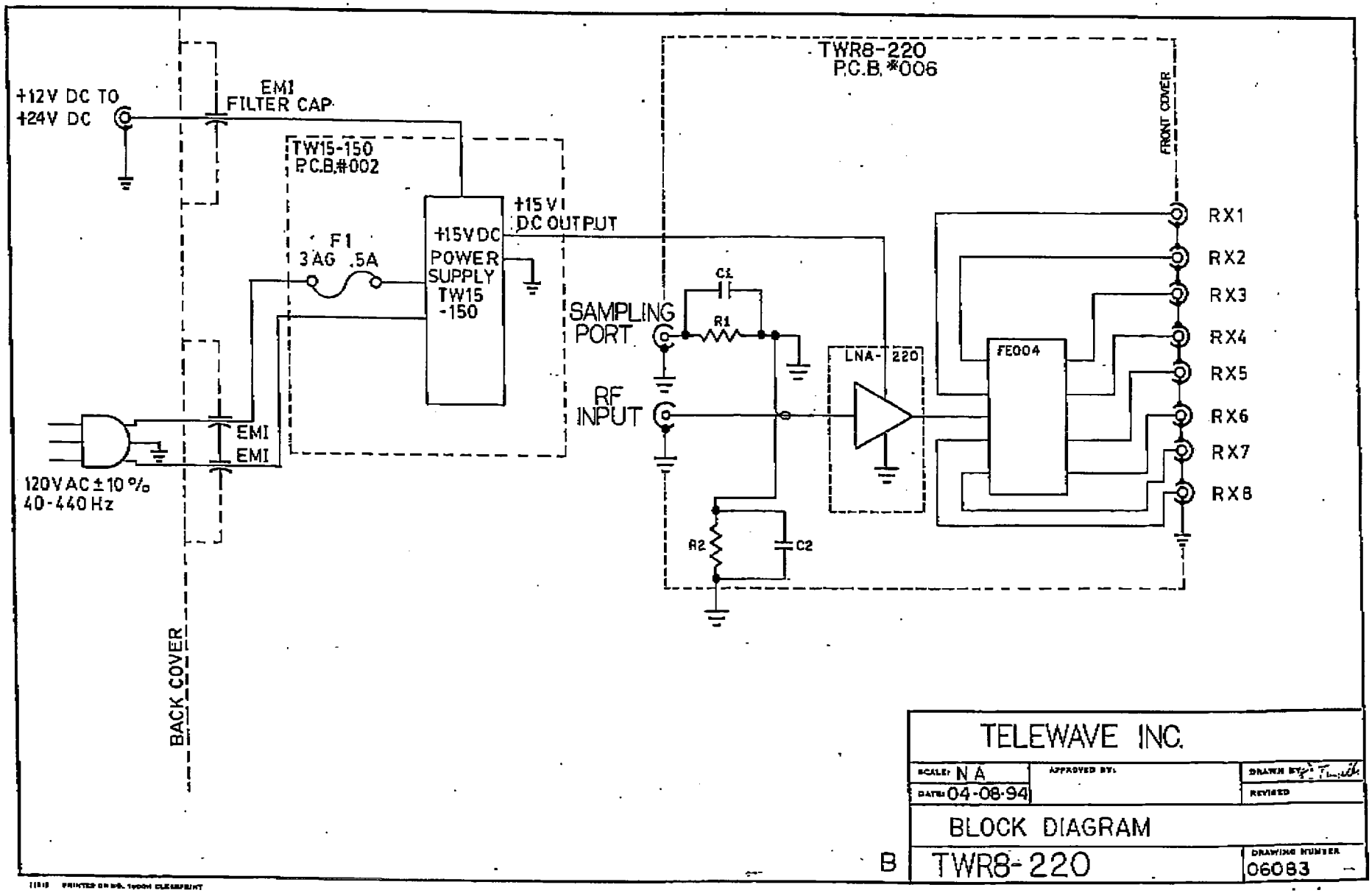
LEVEL 2
Equipment needed

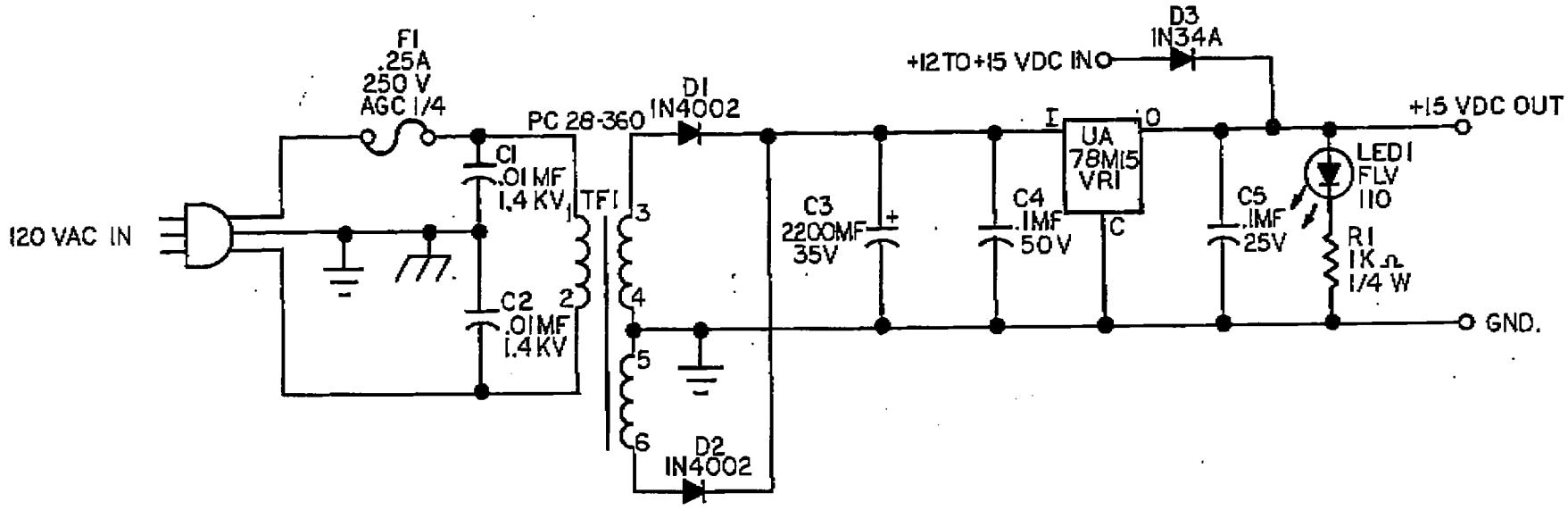
spectrum analyzer with tracking generator
scan width 100KHz /div
1dB resolution vertical
return loss bridge with 40dB directivity

Connect the coax test leads together and set a reference level on the analyzer CRT to -30 dBm. Connect the output of the sweep generator to the antenna port on the combiner. Connect the analyzer input cable to one of the channel outputs on the receiver distribution panel. Terminate all unused outputs with 50 ohms. Make sure the panel has AC or DC power applied. The system gain (duplexer and preselector installed) should be +4 to +6 dB of gain. Systems using the four pole filter preselector will have +3 to +5 dB of gain.

5.5 THE POWER MONITOR

Each power monitor is individually calibrated into the wattmeter panel using the forward and reverse level adjustments provided. A laboratory quality wattmeter of known calibration is placed is series with a power monitor, properly separated by one half-wavelength. The appropriate transmitter is keyed and the forward level adjustment is set to indicate power as determined by the laboratory wattmeter. Maximum transmitter power should be used to obtain the greatest accuracy. The power monitor is then reversed in the line and the same procedure is used to calibrate the reverse level. The antenna power monitor should be calibrated through the combiner while several transmitters are keyed simultaneously. Greater accuracy will be obtained in the fashion.


+12V DC TO
+24V DC
EMI
FILTER CAP
TW15-150
P.C.B.#002
F1
3AG .5A
+15VDC
POWER
SUPPLY
TW15
-150
+15 V
DC OUTPUT
TWR8-220
P.C.B. *006
FRONT COVER
RX1
RX2
RX3
RX4
RX5
RX6
RX7
RX8
SAMPLING
PORT
C1
R1
RF
INPUT
LNA-220
FE004
R2
C2
EMI
EMI
120VAC ±10%
40-440Hz
BACK COVER
TELEWAVE INC.
SCALE: N A
APPROVED BY:
DRAWN BY:
DATE: 04-08-94
REVISED
BLOCK DIAGRAM
B
TWR8-220
DRAWING NUMBER
06083



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   - A) CAPACITANCE IN MICROFARADS
   - B) RESISTANCE IN OHMS
   - C) RESISTORS ARE 1/4 WATT 5%
   - D) CAPACITORS ARE 20%
   - E) VOLTAGE REGULATOR IS UA 78M15

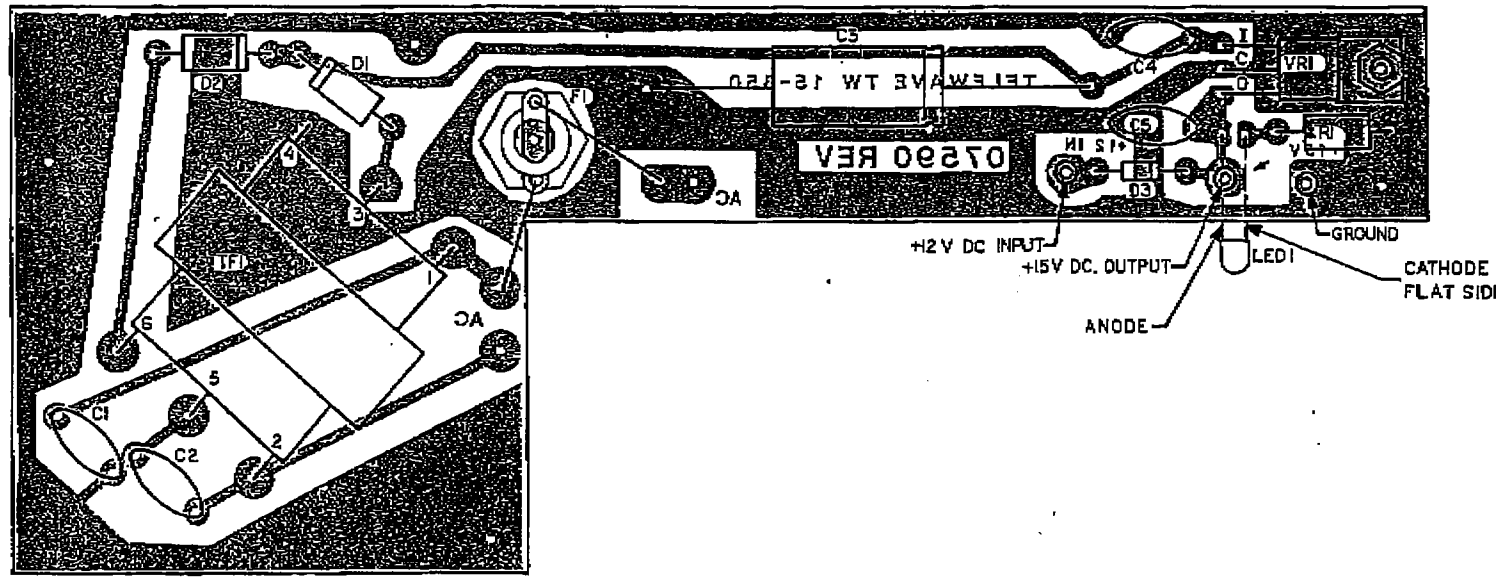
TELEWAVE, INC.
1156 TERRA BELLA, MOUNTAIN VIEW, CALIFORNIA 94043

SCALE: N/A	APPROVED BY: WJB 4-29-93	DRAWN BY R
DATE: 5/24/80		REVISED 4/28/93

SCHEMATIC: POWER SUPPLY

TW15-350 POWER SUPPLY

DRAWING NUMBER 7185 REV-F



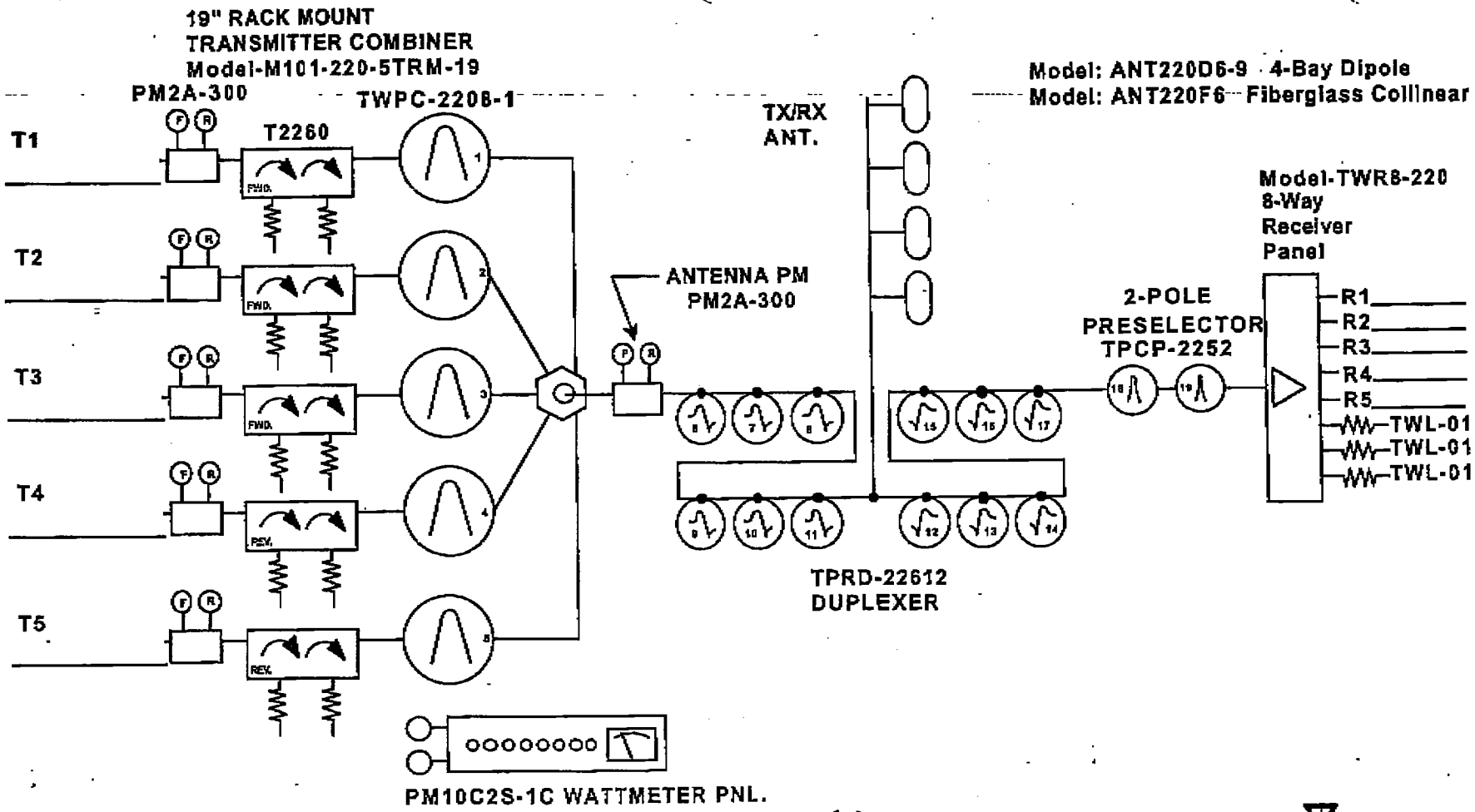
REF. DESIG.	TELEWAVE PART NO.	DESCRIPTION	QTY.
VR1	VR003	15V. VOLTAGE REGULATOR	1
FH1	FH001	FUSE HOLDER	1
C5	CA010	CAP. 1MF 25V CER. DISC	1
C4	CA009	CAP. 1MF 50V, CER. DISC	1
C3	CA001	ELCTLT. CAP.: 2200MF 35V	1
C1-C2	CA008	CAP., .01 MF 1.4 KV, CER. DISC	2
D3	DI005	DIODE IN34A	1
D1, D2	DI004	DIODE, IN4002	2
LED1	LE001	LIGHT EMITTING DIODE, RED	1
R1	RE001	RESISTOR, 1KΩ, 1/4W ±5%	1
TF1	TF001	XFMR., 2PC 28-360 FOR 120V	1
F1	FU003	1/4"250V 1/4 AMP, AGC GL., FU.	1
P.C.B.	PCB.001	P.C.B. (SEE DWG. 07590)	1

TELEWAVE, INC.
1152 TERRA BELLA, MOUNTAIN VIEW, CALIFORNIA 94043

SCALE: N/A	APPROVED BY:	DRAWN BY
DATE: 4-20-93		REVISED

COMPONENT LAYOUT

TW15-350 POWER SUPPLY — DRAWING NUMBER 05930



NOTES:

Site: _____

Customer Name: _____

TELEWAVE, INC.

1155 TERRA BELLA, MOUNTAIN VIEW, CALIFORNIA 94043

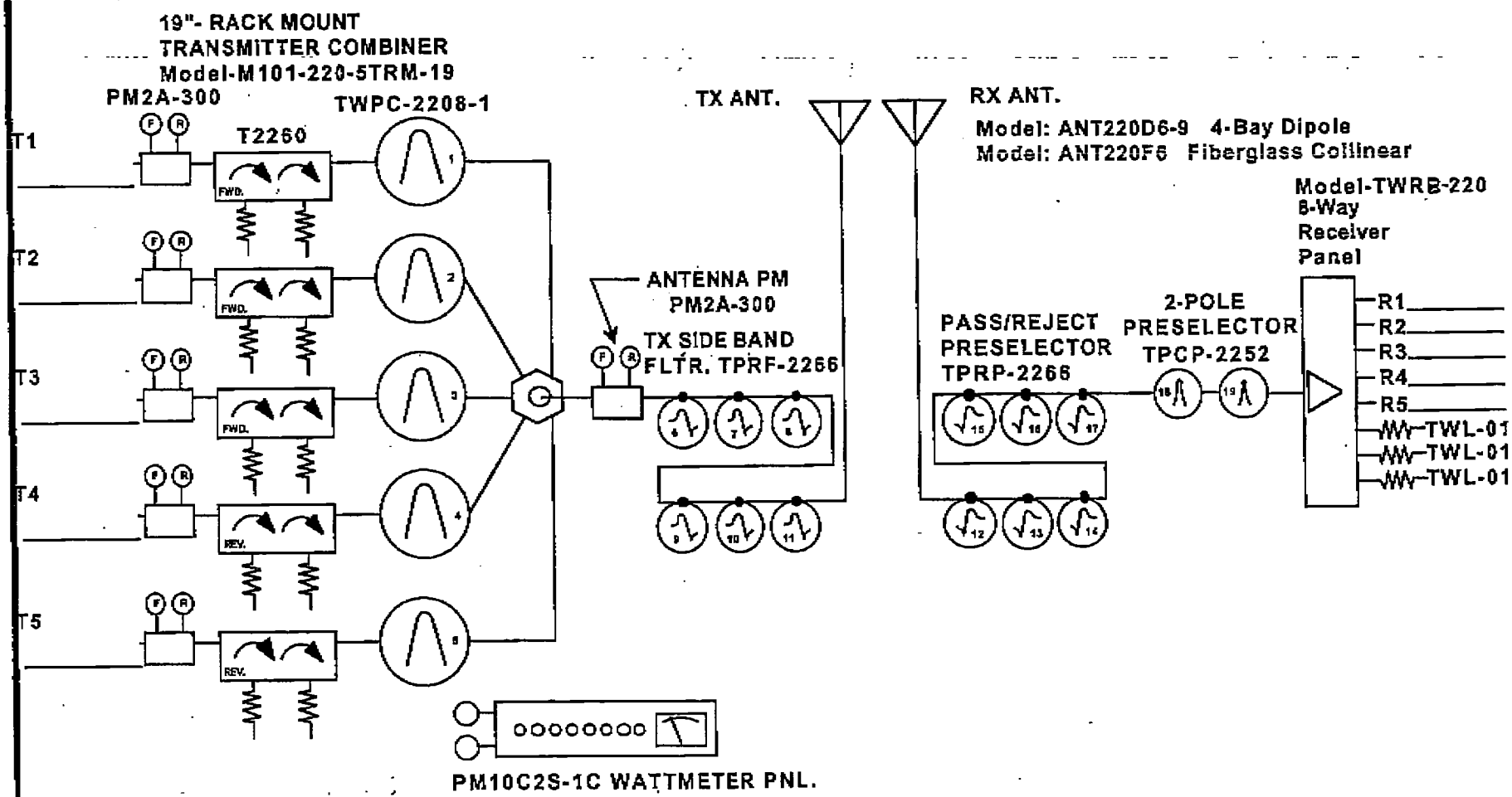
SCALE:	APPROVED BY:	DRAWN BY
DATE:		REVISED

5 CH. DPLXR. 220 MHz COMB. BLK. DIAG.

M101-220-5TRM-19"

DRAWING NUMBER 1 of 2

157157



NOTES:

Site: _____

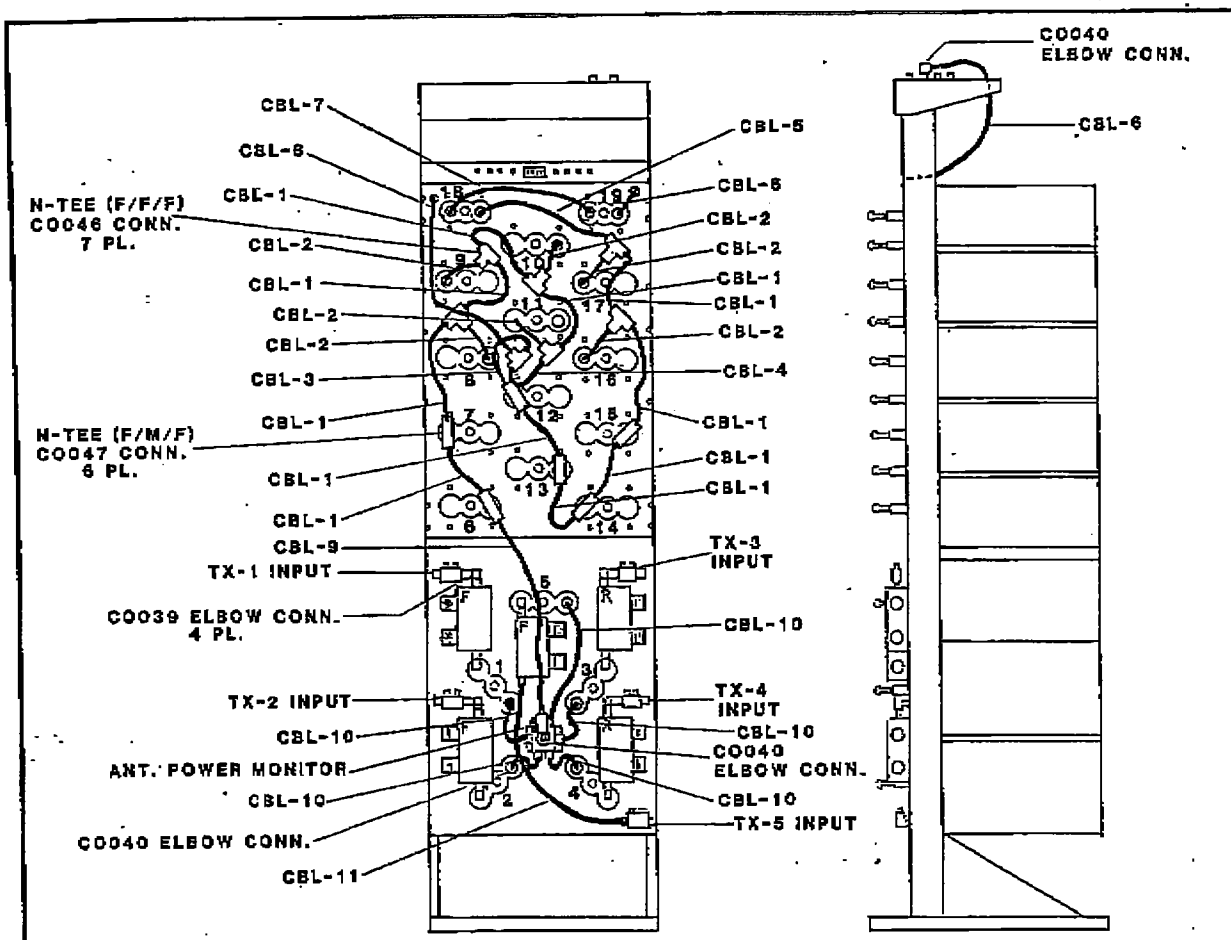
Customer Name: _____

TELEWAVE, INC.
1155 TERRA BELLA, MOUNTAIN VIEW, CALIFORNIA 94043

SCALE:	APPROVED BY:	DRAWN BY MDB
DATE:		REVISED

5 CH. 2 ANT. 220 MHz COMB. BLK. DIAG.

M101-220-5TRM-19"	DRAWING NUMBER 2 of 2



REVISIONS			
REV.	DESCRIPTION	DATE	APPV.

CABLES

REF	LENGTH
CBL-1	6.500"
CBL-2	4.000"
CBL-3	7.000"
CBL-4	8.000"
CBL-5	12.000"
CBL-6	15.000"
CBL-7	18.500"
CBL-8	38.500"
CBL-9	26.000"
CBL-10	19.875" TYP.
CBL-11	15.000"

NOTES:

1. RACK DIMENSIONS ARE: 20"W X 73"H X 22"D

TELEWAVE, INC.

SCALE: N/A	ENG. APPV. ELEC. APPV.	DRAWN BY
DATE: 08-01-94	MECH. APPV.	REVISED

TITLE: COAX CABLE LAYOUT

MODEL NO.	DWG. NO.	REV
M101-220-5TRM-19	06140	B

TELEWAVE, INC.

1155 TERRA BELLA, MOUNTAIN VIEW, CALIFORNIA 94043
(415) 968-4400 • TWX 910-3795055 • FAX (415) 968-1741

DATA TAKEN FOR:_____

BY:_____ DATE:_____

FACTORY ORDER NO:_____
DEVICE:_____
MODEL:_____
S/N:_____

	INSERTION LOSS dB	TX-TX ISOLATION dB	ANT.-TX ISOLATION dB	TX INPUT VSWR REF TO 50 OHMS	SYSTEM LOSS
TX FREQUENCY MHz					
T1A		V	V		
T2A		V	V		
T3A		V	V		
T4A		V	V		
T5A		V	V		
T1B		V	V		
T2B		V	V		
T3B		V	V		
T4B		V	V		
T5B		V	V		

	AVAILABLE GAIN dB				
RX FREQUENCY MHz					

SYSTEM LOSS INCLUDES CABLES, CONNECTORS, DUPLEXERS AND FILTERS

220-222 MHz Band Channels and Base Station Frequencies

Each channel (pair) is assigned a channel number. Table 1 lists the base station transmit channel frequencies and channel numbers. The mobile transmit frequency is 1.0 MHz higher than the base frequency.

#	frequency	#	frequency	#	frequency	#	frequency	#	frequency
1	220.0025	41	220.2025	81	220.4025	121	220.6025	161	220.8025
2	220.0075	42	220.2075	82	220.4075	122	220.6075	162	220.8075
3	220.0125	43	220.2125	83	220.4125	123	220.6125	163	220.8125
4	220.0175	44	220.2175	84	220.4175	124	220.6175	164	220.8175
5	220.0225	45	220.2225	85	220.4225	125	220.6225	165	220.8225
6	220.0275	46	220.2275	86	220.4275	126	220.6275	166	220.8275
7	220.0325	47	220.2325	87	220.4325	127	220.6325	167	220.8325
8	220.0375	48	220.2375	88	220.4375	128	220.6375	168	220.8375
9	220.0425	49	220.2425	89	220.4425	129	220.6425	169	220.8425
10	220.0475	50	220.2475	90	220.4475	130	220.6475	170	220.8475
11	220.0525	51	220.2525	91	220.4525	131	220.6525	171	220.8525
12	220.0575	52	220.2575	92	220.4575	132	220.6575	172	220.8575
13	220.0625	53	220.2625	93	220.4625	133	220.6625	173	220.8625
14	220.0675	54	220.2675	94	220.4675	134	220.6675	174	220.8675
15	220.0725	55	220.2725	95	220.4725	135	220.6725	175	220.8725
16	220.0775	56	220.2775	96	220.4775	136	220.6775	176	220.8775
17	220.0825	57	220.2825	97	220.4825	137	220.6825	177	220.8825
18	220.0875	58	220.2875	98	220.4875	138	220.6875	178	220.8875
19	220.0925	59	220.2925	99	220.4925	139	220.6925	179	220.8925
20	220.0975	60	220.2975	100	220.4975	140	220.6975	180	220.8975
21	220.1025	61	220.3025	101	220.5025	141	220.7025	181	220.9025
22	220.1075	62	220.3075	102	220.5075	142	220.7075	182	220.9075
23	220.1125	63	220.3125	103	220,5125	143	220.7125	183	220.9125
24	220.1175	64	220.3175	104	220.5175	144	220.7175	184	220.9175
25	220.1225	65	220.3225	105	220.5225	145	220.7225	185	220.9225
26	220.1275	66	220.3275	106	220.5275	146	220.7275	186	220.9275
27	220.1325	67	220.3325	107	220.5325	147	220.7325	187	220.9325
28	220.1375	68	220.3375	108	220.5375	148	220.7375	188	220.9375
29	220.1425	69	220.3425	109	220.5425	149	220.7425	189	220.9425
30	220.1475	70	220.3475	110	220.5475	150	220.7475	190	220.9475
31	220.1525	71	220.3525	111	220.5525	151	220.7525	191	220.9525
32	220.1575	72	220.3575	112	220.5575	152	220.7575	192	220.9575
33	220.1625	73	220.3625	113	220.5625	153	220.7625	193	220.9625
34	220.1675	74	220.3675	114	220.5675	154	220.7675	194	220.9675
35	220.1725	75	220.3725	115	220.5725	155	220.7725	195	220.9725
36	220.1775	76	220.3775	116	220.5775	156	220.7775	196	220.9775
37	220.1825	77	220.3825	117	220.5825	157	220.7825	197	220.9825
38	220.1875	78	220.3875	118	220.5875	158	220.7875	198	220.9875
39	220.1925	79	220.3925	119	220.5925	159	220.7925	199	220.9925
40	220.1975	80	220.3975	120	220.5975	160	220.7975	200	220.9975