TPO CALCULATION FOR JCM RADIO- WDBA-LP 105.5 Mhz
Prepared on April 18, 2017

Attenuation Calculated for each Antenna System Component:
2 Bay SWR FMEC Antenna, Half Wave Spaced= -1.58 db
100 Feet Andrews 7/8" Heliax= -0.37 db
200 Feet Andrews 1/2" Heliax= -1.34 db
30 Feet Total of Belden RG-8/U Coax= -1.48 db
17 Amphenol Type N Connectors @ -0.15 db each= -2.55 db
Telewave TWPC-1005-2 Bandpass Filter= -2.00 db

Total Antenna System Attenuation= -9.32 db

TPO Multiplication Factor= Antilog (9.32/10)= 8.55

TPO needed for 6 Watts ERP= 6 x 8.55= **51.3 Watts**

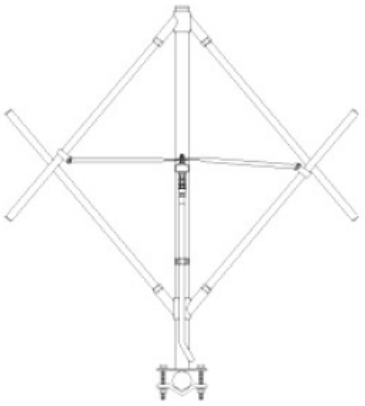
Justification for the 17 Amphenol Type N Connectors:
SWR FMEC 2 Bay Harness= 5 Connectors (See attached)
RG-8/U to 1/2" Heliax Junction= 2 Connectors
1/2" to 7/8" Heliax Junction= 2 Connectors
7/8" to RG-8/U Junction= 2 Connectors
Telewave TWPC-1005-2 Bandpass Filter= 4 Connectors (See attached)
Rack Bulkhead Passthru= 2 Connectors

Total Type N Connectors= 17

This calculation was prepared in accordance with industry standard engineering practices and numerical data from the manufacturer's data sheets, which are attached.

Signed and certified,
Joseph K. Bizzaro, BSEE
Consulting Engineer

FMEC SERIES
CIRCULAR POLARIZED
LOW POWER FM ANTENNAS



Product Specifications:

Frequency Range	88 – 108 MHz
Polarization	Circular
Power Rating	500 Watts per bay
System Input	Type N Male
VSWR	1.3:1 ± 150 kHz
Bay Dimensions	H 43.50" / W 38.5" / D 19"

Features:

•**BUILT WITH LOW POWER BROADCASTERS IN MIND.** Stations or translators that require circular, horizontal, or vertical polarizations.

•**POWER RATING.** Each bay is rated at 500 watts with a maximum power of 2 kW for four bays.

•**RUGGED CONSTRUCTION.** Each bay is constructed from rugged, heavy wall copper and naval brass. All joints are tig-welded.

•**PRESSURIZATION NOT REQUIRED.**

•**CUSTOM DIRECTIONAL PATTERNS.** FM directional antennas designed to the customer's specified mounting structure and FCC filing documentation are available.

•**WEATHERIZATION (OPTIONAL).** Radomes or electrical deicers available for areas that experience periods of heavy icing and/or snow conditions.

•**STANDARD MOUNTING BRACKETS.** Fits up to 4" tower leg or pipe. Supplied with antenna.

•**WARRANTY.** 2-year limited warranty on defects and workmanship to the original purchaser.

Full Wave Spaced
Electrical and Mechanical Specifications

Bays	Power Rating (watts)	Power Gain	dB Gain	Net. Weight (lbs)	Windload (lbs)
1	500	0.441	-3.556	15	35
2	1000	0.959	-0.182	35	85
3	1500	1.495	1.746	50	120
4	2000	2.044	3.105	65	155
5	2000	2.590	4.133	80	190
6	2000	3.160	4.997	95	225
8	2000	4.311	6.346	110	260
10	2000	5.456	7.369	130	295

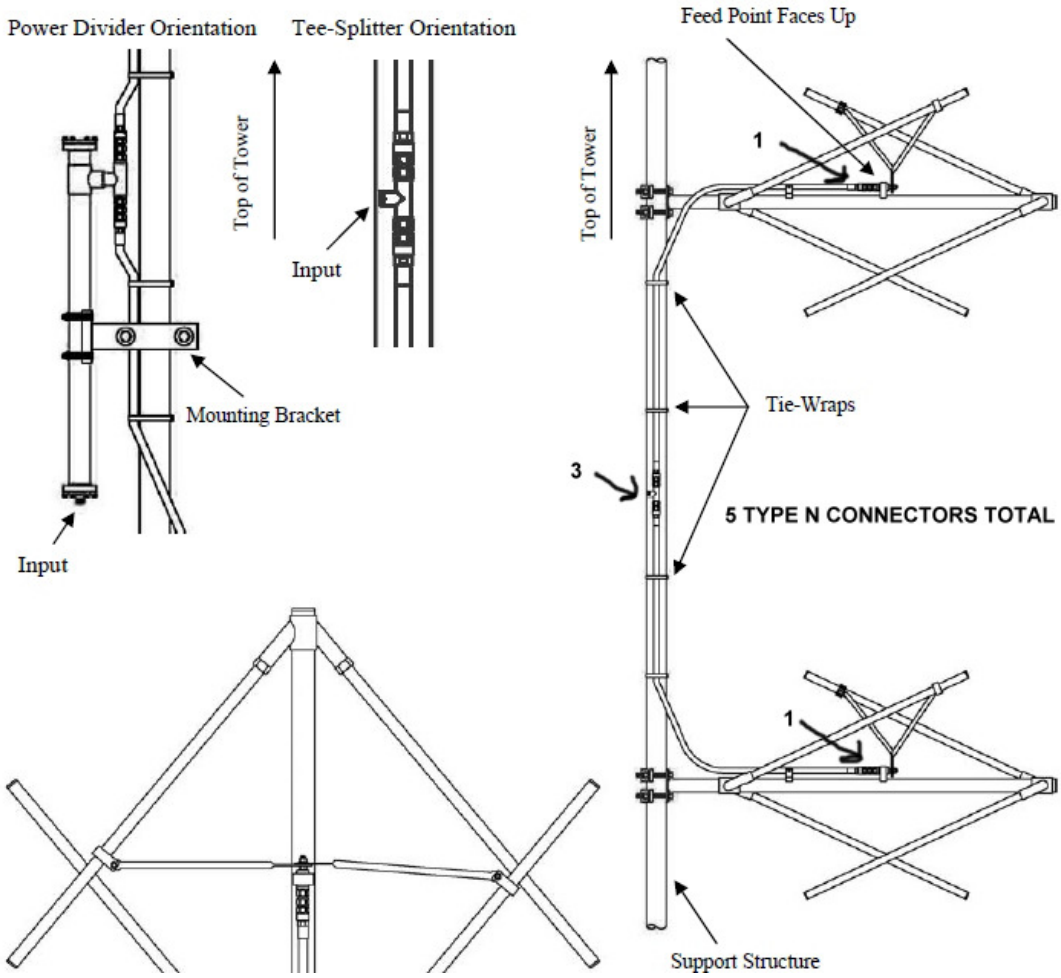
Half Wave Spaced
Electrical and Mechanical Specifications

Bays	Power Rating (watts)	Power Gain	dB Gain	Net. Weight (lbs)	Windload (lbs)
1	500	0.441	-3.556	15	35
2	1000	0.695	-1.580	35	85
3	1500	1.012	0.052	50	120
4	2000	1.313	1.183	65	155
5	2000	1.623	2.103	80	190
6	2000	1.924	2.842	95	225
8	2000	2.528	4.028	110	260
10	2000	3.129	4.954	125	295

2 Bay Installation

Considerations:

1. Your FMEC two bay antenna includes jumpers, tie-wraps, and weatherproofing kit.
2. Your FMEC two bay antenna may be fed with either a Tee-Splitter or Power Divider.
3. Note the direction and orientation of feed points, feed arms, power divider, hardware, and jumpers.
4. Standard mounting bracket fits from 1" to 4" tower leg or pole.
5. SWR, LP. reserves the right to change product specifications at any time.



TELEWAVE, INC.

88 - 108 MHz

TWPC-1005-1,2

TYPICAL SELECTIVITY CHARACTERISTICS

Figure 1 TWPC-1005-1 SINGLE

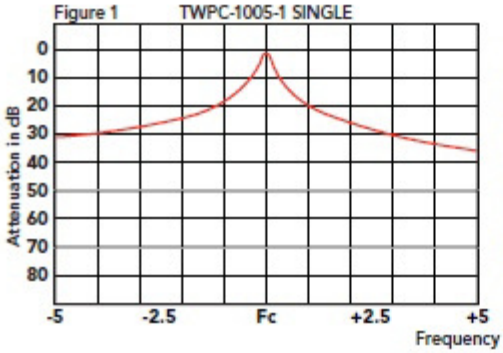
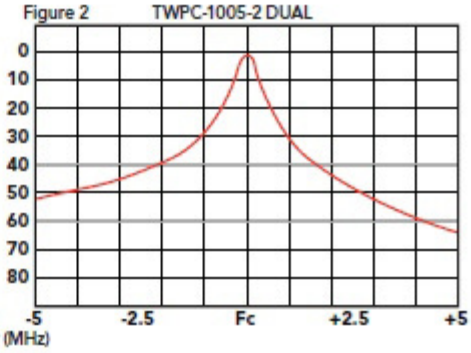


Figure 2 TWPC-1005-2 DUAL



MODEL	TWPC-1005-1	TWPC-1005-2
Insertion loss (adjustable)	0.5 to 2.0 dB	1.0 to 4.0 dB
Attenuation at 1dB insertion loss	See figure 1	See figure 2
Maximum dimensions with tuners extended in. (cm)	5 x 48 (13 x 123)	5.25 x 19 x 48 (13 x 48 x 123)
Net weight lb. (kg)	5 (2.3)	12 (5.5)
Shipping weight lb. (kg)	8 (3.6)	16 (7.3
COMMON SPECIFICATIONS		
Tuning frequency range	88-108 MHz	
Nominal impedance	50 ohms (75 ohm opt.)	
VSWR at resonance (max)	1.5:1	
Input power (max) vs. insertion loss	0.5 dB - 350 watts, 1 dB - 250 watts, 2 dB - 150 watts	
Temperature range	-30°C to +70°C	
Cavity electrical length	1/4 wavelength	
Outer conductor, end plates	6061-T6 aluminum	
Inner conductor, coupling loops	Silver plated copper	
Tuning rod	Invar	
Contactors, fingerstock	Beryllium copper	
Cavity dimensions (Diam. x H) in. (cm)	5 x 36 (13 x 91)	
Connectors	N or UHF female (opt.)	
Finish	Gray acrylic enamel	

NOTE: When ordering be sure to specify exact frequency and model number. Contact the factory if additional information or assistance is required.

TWPC-1005-1,2
BANDPASS CAVITIES

The Telewave TWPC-1005-1, and 1005-2 are 5" diameter, ¼-wavelength, high "Q" bandpass cavity filter with superior selectivity. Bandpass cavities reject all frequencies outside a narrow pass band. These cavities reduce transmitter sideband noise, and also protect receivers against desensitization.

TWPC-1005 cavities cover 88-108 MHz, and can be tuned at 50 or 75 ohms upon request. All cavities are tuned to specified frequencies prior to shipping, and no further adjustments should be required. The positive locking mechanism allows for quick field re-tuning if frequency changes become necessary.

These cavities feature calibrated adjustable coupling, and insertion loss can be easily set from 0.5 dB to 2 dB or more to improve selectivity. This allows cavity response to be optimized for any operating environment. At densely populated sites, the TWPC-1005-2 dual cavity filter provides greater selectivity with minimum insertion loss. Multiple cavities can also provide a wider passband when required. Mounting rails are provided for all multiple-cavity filters.

Excellent frequency stability is achieved by the use of a specially machined compensator and Invar rod. The pass frequency is temperature stable from -30°C to +70°C. Telewave Ground Loop technology places the center conductor of each coupling loop at DC ground potential for lightning protection and noise reduction.

Heavy duty materials are used throughout each cavity to insure high performance and long life. Cavity top plates are machined from ¼-inch aluminum, and are heliarc welded to the cavity body at the high current point for improved conductivity and strength. This allows Telewave cavities to handle up to 350 watts, depending on insertion loss.

Rigid foam inserts support the tuner assembly allowing vertical or horizontal mounting. Similar metals and alodined aluminum help prevent galvanic corrosion. Silver plated tuners and beryllium copper finger stock provide non-corrosive low loss contact, and ensure reliable, long-term performance.

TWPC-1005-1

TWPC-1005-2

Type N Specifications

Amphenol®

ELECTRICAL

Impedance	50 ohms
Frequency range	0-11 GHz
Voltage rating	1,500 volts peak
Dielectric withstanding voltage	2,500 volts rms.
VSWR (MIL-C-39012 cable connectors)	M39012 straight connectors: 1.3 max. 0-11 GHz M39012 right angle: 1.35 max. 0-11 GHz
Other	Contact resistance: center contact 1.0 milliohm outer contact 0.2 milliohm RF leakage: -90 dB minimum at 3 GHz Insertion loss: .15 dB maximum at 10 GHz Insulation resistance: 5000 megohms minimum

MECHANICAL

Mating	5/8-24 threaded coupling
Cable affixment (braid or jacket)	All crimps: hex braid crimp. Clamps: screw-thread nut and braid clamp
Cable affixment (center conductor)	Crimp: crimp or solder All others: solder only
Captivated contact	All crimps. Others, where specified.
Cable retention	Crimps: 60-120 lbs. Clamps: 30-70 lbs.

MATERIAL

Contacts	Male: brass; Female: phosphor bronze or beryllium copper. Silver or gold plated
Other metal parts	Brass: ASTROplate® finish except M39012 silver.

ENVIRONMENTAL

Temperature range	TFE -65°C to + 165°C Copolymer of Styrene: - 55°C to + 85°C
Weatherproof	All series N with gaskets are weatherproof
Hermetic seals	Pass helium leak test of 2 X 10^{-8} cc/sec
Pressurized Shock	Compression seal MIL-Std. 202 method 213
Vibration	MIL-Std. 202 method 204 (test cond. B)
Moisture resistance	MIL-Std. 202 method 106
Corrosion	MIL-Std. 202 method 101 (test cond. B)
Temperature cycling	MIL-Std. 202 method 102 (test cond. C)
Altitude	MIL-Std. 202 method 105 (test cond. C)

MILITARY SPECIFICATIONS

HELIAX® Coaxial Cables

7/8" Foam Dielectric, LDF Series – *50-ohm*

LDF5-50A

Description	Type No.
Cable Ordering Information	
Standard Cable	
7/8" Standard Cable, Standard Jacket	LDF5-50A
Fire Retardant Cable	
7/8" Fire Retardant Jacket (CATVR)	LDF5RN-50A
Low VSWR and Specialized Cables	
7/8" Low VSWR, specify operating band	LDF5P-50A-(**)

** Insert suffix number from "Low VSWR Specifications" table, page 508.

Characteristics

Electrical	
Impedance, ohms	50 ± 1
Maximum Frequency, GHz	5.0
Velocity, percent	89
Peak Power Rating, kW	91
dc Resistance, ohms/1000 ft (1000 m)	
Inner	0.32 (1.05)
Outer	0.36 (1.18)
dc Breakdown, volts	6000
Jacket Spark, volts RMS	8000
Capacitance, pF/ft (m)	22.8 (75.0)
Inductance, µH/ft (m)	0.057 (0.187)
Mechanical	
Outer Conductor	Copper
Inner Conductor	Copper
Diameter over Jacket, in (mm)	1.09 (28)
Diameter over Copper Outer Conductor, in (mm)	0.98 (24.9)
Diameter Inner Conductor, in (mm)	0.355 (9.0)
Nominal Inside Transverse Dimensions, cm	2.11
Minimum Bending Radius, in (mm)	10 (250)
Number of Bends, minimum (typical)	15 (50)
Bending Moment, lb-ft (N•m)	12 (16.3)
Cable Weight, lb/ft (kg/m)	0.33 (0.49)
Tensile Strength, lb (kg)	325 (147)
Flat Plate Crush Strength, lb/in (kg/mm)	80 (1.4)

* A 75-ohm 7/8" diameter cable is available. Contact Andrew for further

Attenuation and Average Power

Frequency MHz	Attenuation dB/100 ft	Attenuation dB/100 m	Average Power, kW
0.5	0.025	0.081	91.0
1	0.035	0.115	78.6
1.5	0.043	0.141	64.1
2	0.050	0.163	55.5
10	0.112	0.366	24.6
20	0.159	0.521	17.3
30	0.195	0.641	14.1
50	0.254	0.833	10.8
88	0.340	1.12	8.08
100	0.364	1.19	7.56
108	0.378	1.24	7.26
150	0.449	1.47	6.12
174	0.486	1.59	5.66
200	0.523	1.72	5.26
300	0.649	2.13	4.24
400	0.758	2.49	3.63
450	0.808	2.65	3.41
500	0.855	2.81	3.22
512	0.866	2.84	3.17
600	0.945	3.10	2.91
700	1.03	3.37	2.67
800	1.11	3.63	2.48
824	1.13	3.69	2.44
894	1.18	3.87	2.34
960	1.23	4.02	2.24
1000	1.25	4.12	2.19
1250	1.42	4.67	1.93
1500	1.58	5.18	1.74
1700	1.70	5.56	1.62
1800	1.75	5.75	1.57
2000	1.86	6.11	1.48
2100	1.92	6.29	1.44
2200	1.97	6.46	1.40
2300	2.02	6.63	1.36
3000	2.37	7.76	1.16
3400	2.55	8.37	1.08
4000	2.81	9.23	0.978
5000	3.23	10.6	0.853

Standard Conditions:
For Attenuation, VSWR 1.0, ambient temperature 20°C (68°F).
For Average Power, VSWR 1.0, ambient temperature 40°C (104°F), inner conductor temperature 100°C (212°F); no solar loading.

HELIAX® Coaxial Cables

1/2" Foam Dielectric, LDF Series – *50-ohm*

LDF4-50A

Description	Type No.
Cable Ordering Information	
Standard Cable	
1/2" Standard Cable, Standard Jacket	**LDF4-50A**
Fire Retardant Cables	
1/2" Fire Retardant Jacket (CATVX)	**LDF4RN-50A**
1/2" Fire Retardant Jacket (CATVR)	**LDF4RN-50A**
Low VSWR and Specialized Cables	
1/2" Low VSWR, specify operating band Phase Stabilized and Phase Measured Cable	**LDF4P-50A-(**)** See page 590
Jumper Cable Assemblies – See page 584	

** Insert suffix number from "Low VSWR Specifications" table, page 498

Characteristics

Electrical	
Impedance, ohms	50 ± 1
Maximum Frequency, GHz	8.8
Velocity, percent	88
Peak Power Rating, kW	40
dc Resistance, ohms/1000 ft (1000 m)	
Inner	0.45 (1.48)
Outer	0.58 (1.90)
dc Breakdown, volts	4000
Jacket Spark, volts RMS	8000
Capacitance, pF/ft (m)	23.1 (75.8)
Inductance, µH/ft (m)	0.058 (0.19)
Mechanical	
Outer Conductor	Copper
Inner Conductor	Copper-Clad Aluminum
Diameter over Jacket, in (mm)	0.63 (16)
Diameter over Copper Outer Conductor, in (mm)	0.55 (14)
Diameter Inner Conductor, in (mm)	0.189 (4.6)
Nominal Inside Transverse Dimensions, cm	1.11
Minimum Bending Radius, in (mm)	5 (125)
Number of Bends, minimum (typical)	15 (50)
Bending Moment, lb-ft (N-m)	2.8 (3.8)
Cable Weight, lb/ft (kg/m)	0.15 (0.22)
Tensile Strength, lb (kg)	250 (113)
Flat Plate Crush Strength, lb/in (kg/mm)	110 (2.0)

Attenuation and Average Power Ratings

Frequency MHz	Attenuation dB/100 ft	Attenuation dB/100 m	Average Power, kW
0.5	0.045	0.149	40.0
1	0.064	0.211	35.8
1.5	0.079	0.259	29.2
2	0.091	0.299	25.3
10	0.205	0.672	11.3
20	0.291	0.954	7.93
30	0.357	1.17	6.46
50	0.463	1.52	4.98
88	0.619	2.03	3.73
100	0.661	2.17	3.49
108	0.688	2.26	3.36
150	0.815	2.67	2.83
174	0.880	2.89	2.62
200	0.946	3.10	2.44
300	1.17	3.83	1.97
400	1.36	4.46	1.70
450	1.45	4.75	1.59
500	1.53	5.02	1.51
512	1.55	5.08	1.49
600	1.69	5.53	1.37
700	1.83	6.01	1.26
800	1.97	6.46	1.17
824	2.00	6.56	1.15
894	2.09	6.85	1.10
960	2.17	7.12	1.06
1000	2.22	7.28	1.04
1250	2.51	8.23	0.921
1500	2.77	9.09	0.833
1700	2.97	9.74	0.777
1800	3.07	10.1	0.753
2000	3.25	10.7	0.710
2100	3.34	11.0	0.691
2200	3.43	11.2	0.673
2300	3.52	11.5	0.657
3000	4.09	13.4	0.565
3400	4.39	14.4	0.526
4000	4.82	15.8	0.479
5000	5.49	18.0	0.421
6000	6.11	20.1	0.378
8000	7.26	23.8	0.318
8800	7.69	25.2	0.300

Standard Conditions:
For attenuation, VSWR 1.0, ambient temperature 20°C (68°F).
For Average Power, VSWR 1.0, ambient temperature 40°C (104°F), inner conductor temperature 100°C (212°F), no solar loading.

Detailed Specifications & Technical Data

METRIC MEASUREMENT VERSION

9913F7 Coax - RG-8/U Type

Electrical Characteristics (Overall)

Nom. Characteristic Impedance:

Impedance (Ohm)
52

Nom. Inductance:

Inductance (µH/m)
0.193579

Nom. Capacitance Conductor to Shield:

Capacitance (pF/m)
73.8225

Nominal Velocity of Propagation:

VP (%)
85

Nominal Delay:

Delay (ns/m)
3.9372

Nom. Conductor DC Resistance:

DCR @ 20°C (Ohm/km)
3.6091

Nominal Outer Shield DC Resistance:

DCR @ 20°C (Ohm/km)
5.9058

Maximum VSWR:

Description	Freq. (MHz)	Start Freq. (MHz)	Stop Freq. (MHz)	Max. VSWR
		5	2250	1.43:1

Nom. Attenuation:

Freq. (MHz)	Attenuation (dB/100m)
10	1.9686
50	3.6091
100	4.9215
200	6.562
400	9.843
700	13.124
900	15.4207
1000	16.405
2000	24.6075
2250	26.248
3000	32.1538
4000	39.7001