

**ERI Technical Proposal for**  
**CONNOISSEUR MEDIA**  
**Diplexed FM Antenna and Combiner for**  
**WRTS (FM), Erie, and WRKT, North East, Pennsylvania**

**ERI Technical Proposal 20170502-321**

**System Description:**

ERI SHPX Series Diplexed FM Antenna, Model SHPX-6AC-SP with 100 feet of 3-1/8-inch rigid transmission line, 180 feet of existing 3-inch Air HELIAX and a two station FM channel combiner. This proposal also includes installation and field services to set up the combiner and provide an intermodulation products report to demonstrate compliance with FCC 73.317.

Operating Frequencies:..... 103.7 MHz and 104.9 MHz  
Effective Radiated Power (ERP):..... 50 kW and 4.5 kW analog, plus 10% HD Radio  
Transmission Line Length and Type:..... 100 feet of 3-1/8-inch rigid line and 180 feet of existing 3-inch Air HELIAX  
Combiner:..... FM Tee Combiner System

**Antenna Summary:**

*Diplexed FM Antenna*  
Model SHPX-6AC-SP, 6-bay center fed, full wavelength spaced  
Factory tuned to multiplex 103.7 MHz and 104.9 MHz  
Maximum VSWR: 1.15:1 with double slug field tuning<sup>1</sup>  
112.7517-inch bay-to-bay spacing  
3-1/8-inch EIA, 50 ohm, input flange

**Combiner Summary:**

*FM Channel Combiner*  
Model TB83-4/80-4/3 780/783 Series FM Tee Combiner:  
Factory tuned to multiplex 103.7 MHz and 104.9 MHz

Module types:

103.7 MHz	783-4 Four Section Band Pass Filter Module, floor mounted. 3-1/8-inch input with single port directional coupler. Convection cooled.
104.9 MHz	780-4 Four Section Band Pass Filter Module with optional non-adjacent coupling loop, floor mounted. 1-5/8-inch input with single port directional coupler. Convection cooled.

Floor mounted "U" shaped configuration  
3-1/8-inch Combined Output with Dual Port Directional Coupler  
Typical Input VSWR: Less than 1.07:1<sup>2</sup>

<sup>1</sup> For multi-slug tuning and system reliability, 100-feet of 3-1/8-inch, 50 ohm, rigid transmission line (20-foot sections) is required for multi-slug tuning in order to guarantee meeting this VSWR specification.

<sup>2</sup> With combiner terminated with a 50 ohm RF load.

Electronics Research, Inc. • 7777 Gardner Road • Chandler, IN 47610-9219 • USA  
+1 812 925-6000 (tel) • +1 812 925-4030 (fax)

Your Single Source for Broadcast Solutions™ • Call Toll-free at 877 ERI-LINE • Visit Online at [www.eriinc.com](http://www.eriinc.com)

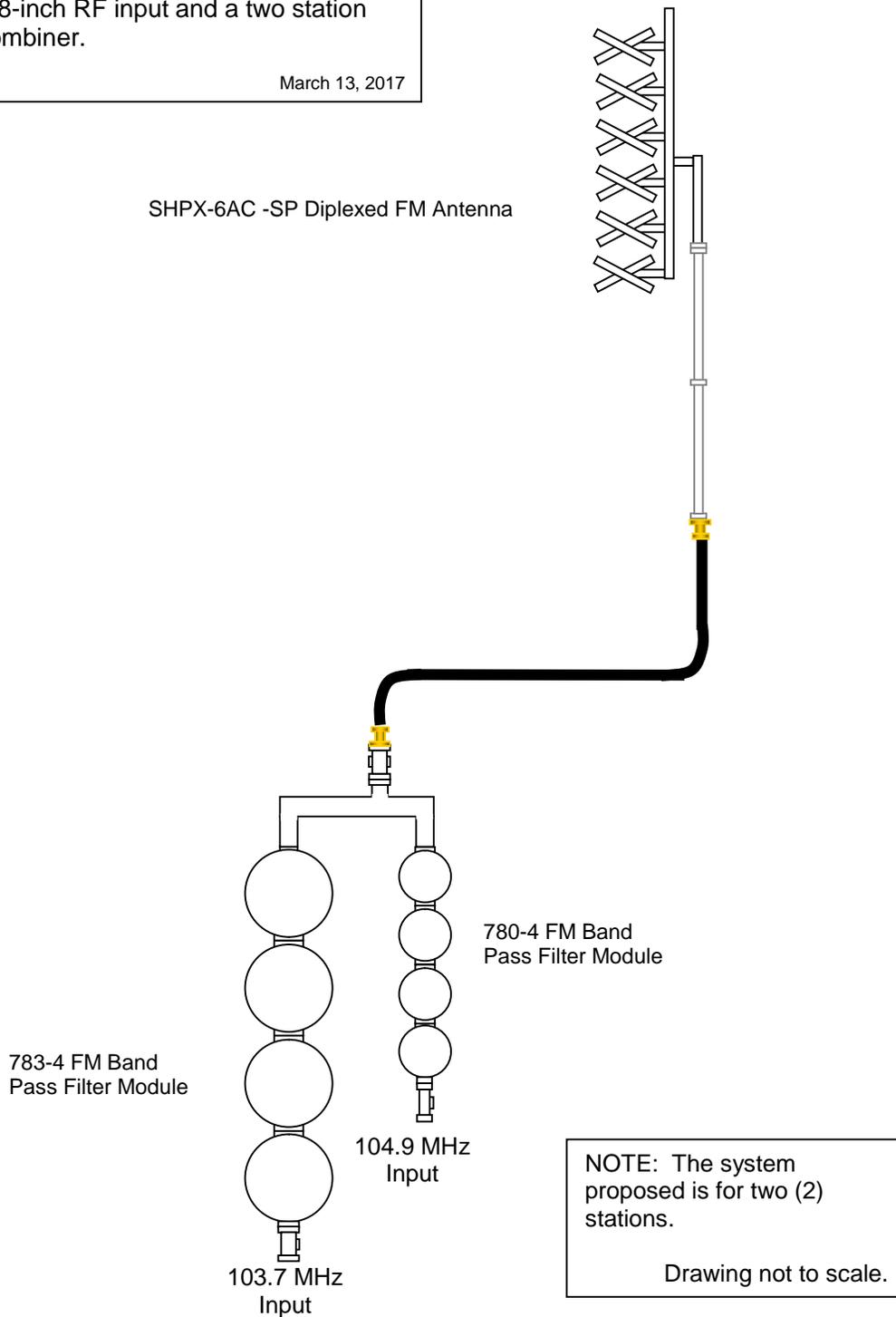
## Simplified Block Diagram

### SHPX-6AC-SP Diplexed FM Antenna

SHPX-6AC-SP Master FM Antenna with a single 3-1/8-inch RF input and a two station FM Tee combiner.

March 13, 2017

SHPX-6AC -SP Diplexed FM Antenna



## Preliminary Power Analysis

	<i>Analog</i>	
<b>Call Letters:</b>	WRTS (FM), Erie, PA	
<b>Frequency:</b>	103.7 MHz	
<b>ERP:</b>	50.000 kW	16.990 dBk
<b>Polarization:</b>	Circular	
<b>Antenna RMS Gain:</b>	3.308 Numeric	5.196 dB
<b>Antenna Input Power:</b>	15.115 kW	11.794 dBk
<b>Peak Voltage:</b>	1,229 volts	
<b>Transmission Line Type - Tower Rigid Match:</b>	3-1/8-inch rigid line	
<b>Tower Rigid Match Length:</b>	100 feet	30.5 meters
<b>Tower Rigid Match Attenuation:</b>	0.098 dB/100-feet	
<b>Transmission Line Type - HELIAX Run:</b>	3-inch Air HELIAX	
<b>HELIAX Run Length:</b>	180 feet	54.9 meters
<b>HELIAX Run Attenuation:</b>	0.144 dB/100-feet	
<b>Line Loss:</b>	-1.296 kW	0.357 dB
<b>Line Efficiency:</b>	92.104%	
<b>Power Output from Combiner:</b>	16.411 kW	12.151 dBk
<b>Peak Voltage:</b>	1,281 volts	
<b>Combiner Losses:</b>	-2.002 kW	0.500 dB
<b>Transmitter Power Output:</b>	18.413 kW	12.651 dBk
<b>Call Letters:</b>	WRKT (FM), North East, PA	
<b>Frequency:</b>	104.9 MHz	
<b>ERP:</b>	4.500 kW	6.532 dBk
<b>Polarization:</b>	Circular	
<b>Antenna RMS Gain:</b>	3.289 Numeric	5.171 dB
<b>Antenna Input Power:</b>	1.368 kW	1.361 dBk
<b>Peak Voltage:</b>	370 volts	
<b>Transmission Line Type - Tower Rigid Match:</b>	3-1/8-inch rigid line	
<b>Tower Rigid Match Length:</b>	100 feet	30.5 meters
<b>Tower Rigid Match Attenuation:</b>	0.099 dB/100-feet	
<b>Transmission Line Type - HELIAX Run:</b>	3-inch Air HELIAX	
<b>HELIAX Run Length:</b>	180 feet	54.9 meters
<b>HELIAX Run Attenuation:</b>	0.145 dB/100-feet	
<b>Line Loss:</b>	-0.118 kW	0.360 dB
<b>Line Efficiency:</b>	92.045%	
<b>Power Output from Combiner:</b>	1.486 kW	1.721 dBk
<b>Peak Voltage:</b>	386 volts	
<b>Combiner Losses:</b>	-0.106 kW	0.300 dB
<b>Transmitter Power Output:</b>	1.593 kW	2.021 dBk
<b>Combined power into transmission line:</b>	17.897 kW	1,667 volts
<b>Combined power into antenna:</b>	16.483 kW	1,599 volts

## Diplexed FM Antenna System

### SHPX Series ROTOTILLER<sup>®3</sup> FM Antenna

#### Features

- Low VSWR
- Internal feed
- Fully pressurized
- Series fed radiating elements
- Circular polarization
- Welded feed connections
- Superior VSWR band width
- High input power capacity
- Custom modifications are available
- Corrosion resistant construction
- Modular construction facilitates easy installation and repair
- Minimal weather related VSWR problems
- Beam tilt and/or null fill available
- Half-wave spacing between elements available
- Rugged brass construction
- Stainless steel support brackets and hardware
- Radomes or deicing heaters not normally required for radial ice less than ½-inch
- Radomes or deicing heaters are available
- Custom designed antenna supports; poles or Lambda™ tower sections are also available from ERI



ERI's original and distinctive design combines the exceptional engineering features of an internally fed, fully pressurized system with superior fabrication characterized by totally welded feed connections, rugged brass material and TIG welding. ERI antennas are unchallenged in quality and dependability. ERI is the only manufacturer to use large diameter outer conductors and a completely enclosed, pressurized, internal series feed system. The result is a simple and reliable method of coupling power to the elements. Unlike competing designs, ERI series fed antennas do not require a troublesome secondary current loop for element excitation with all the resulting disadvantages. All ERI antennas include brackets for mounting on leg, pole, or face mounting (up to 42-inch uniform cross section tower); brackets for other mounting configurations are optionally available. The ROTOTILLER series FM antenna's unique design consists of two series fed, bent dipole elements which form a space phased, circularly polarized radiator. The antenna's configuration and the large diameter of the radiating elements contribute to the excellent bandwidth of the antenna system, and also inhibits corona discharge.

The horizontally polarized horizontal plane azimuth pattern of the SHPX series antenna is omnidirectional within  $\pm 2$  dB when the antenna is pole or Lambda mounted atop a tower. Side mounting the antenna on a typical tower structure will affect the azimuth pattern. ERI offers a pattern measurement service to assist in determining the effect of the mounting structure on the antenna's pattern. Using ERI's pattern optimization service the pattern's circularity may be improved through the addition of parasitically excited elements.

NOTE: The VSWR specifications apply over a frequency  $\pm 200$  kHz from the tuning point of the antenna. Where radomes or deicing heaters are not used, this tuning point is customarily set 200 kHz above the station operating frequency to provide improved performance under icing conditions. Parasitic elements tend to reduce the VSWR bandwidth of the antenna.

<sup>3</sup> ROTOTILLER is a registered trademark of Electronics Research, Inc.

**CONNOISSEUR MEDIA**

**Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania**

Utilize the ERI advantage. Combine an ERI antenna with an ERI Lambda Mounting Structure, Pattern Measurement. Assure yourself of the best antenna/tower interaction. ERI's Pattern Measurement service will provide the crucial answers concerning the relationship between the antenna mounting orientation and antenna pattern. Lambda Sections are designed to achieve optimum antenna performance while reducing weight and wind loads. Only ERI can offer you an antenna/tower/installation package that will achieve your highest expectations in a demanding FM market.

**Preliminary Specifications**

**Electrical Specifications**

Model Number:	SHPX-6AC-SP	
Bay to Bay Spacing:	1.0 Lambda	
Input Feed:	Center fed	
Operating Frequencies:	103.7 MHz 104.9 MHz	
Polarization:	Clockwise Circular	
Interbay Transmission Line:	3-1/8-inch	
RF Input:	3-1/8-inch EIA Flange, female	
Input Power Rating:	39.0 kW	
Element Type:	SHPX "A" Series	
Azimuth Pattern Circularity:	±2.0 dB in free space	
Power Gain:	103.7 MHz	3.308 numeric (5.196 dBd)
	104.9 MHz	3.289 numeric (5.171 dBd)
VSWR at Antenna Input:	1.15:1 or less, with field matching 1.25:1 or less, pole or LAMBDA™ Mounting Section 1.50:1 or less, side mounted without field matching	
Electrical Beam Tilt:	0.0 degrees	
First Null Fill:	2.1%	
Second Null Fill:	0%	
Icing Protection:	Optional radomes available Optional electrical deicers available	

**Mechanical Specifications**

Antenna Length:	49.16 feet	(14.98 meters)
Antenna Aperture:	46.98 feet	(14.32 meters)
Vertical Tower Aperture Recommended:	59.16 feet	(18.03 meters)
Antenna Weight:		
Antenna only:	702 pounds	(318.43 kilograms)
Antenna with ½-inch radial ice:	1182 pounds	(536.16 kilograms)
Antenna with radomes:	1002 pounds	(454.51 kilograms)
Antenna with radomes and ½-inch radial ice:	1932 pounds	(876.36 kilograms)
Antenna CaAa:		
Antenna only:	32.3 square feet	(3.00 square meters)
Antenna with ½-inch radial ice:	42.8 square feet	(3.98 square meters)
Antenna with radomes:	58.0 square feet	(5.39 square meters)
Antenna with radomes and ½-inch radial ice:	68.8 square feet	(6.39 square meters)

**Mechanical Specification Notes:**

(1) All loads calculated in accordance with the ANSI/TIA-222 standard. (2) Provided effective wind areas, CaAa, do NOT include potential wind shielding/interference due to the interaction with the supporting structure (i.e. does not include Ka factor). (3) Listed antenna weights and effective wind areas include the antenna radiating elements, feed harnessing, and standard leg mounting brackets. Special mounting bracket loads for face-mounted and/or pole standoff mounted systems are NOT included. Final design loads will vary for specific projects and should be verified by an ERI representative when precise loading is required.

CONNOISSEUR MEDIA

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania



Electronics Research, Inc.  
7777 Gardner Road  
Chandler, In. 47610

Figure 1

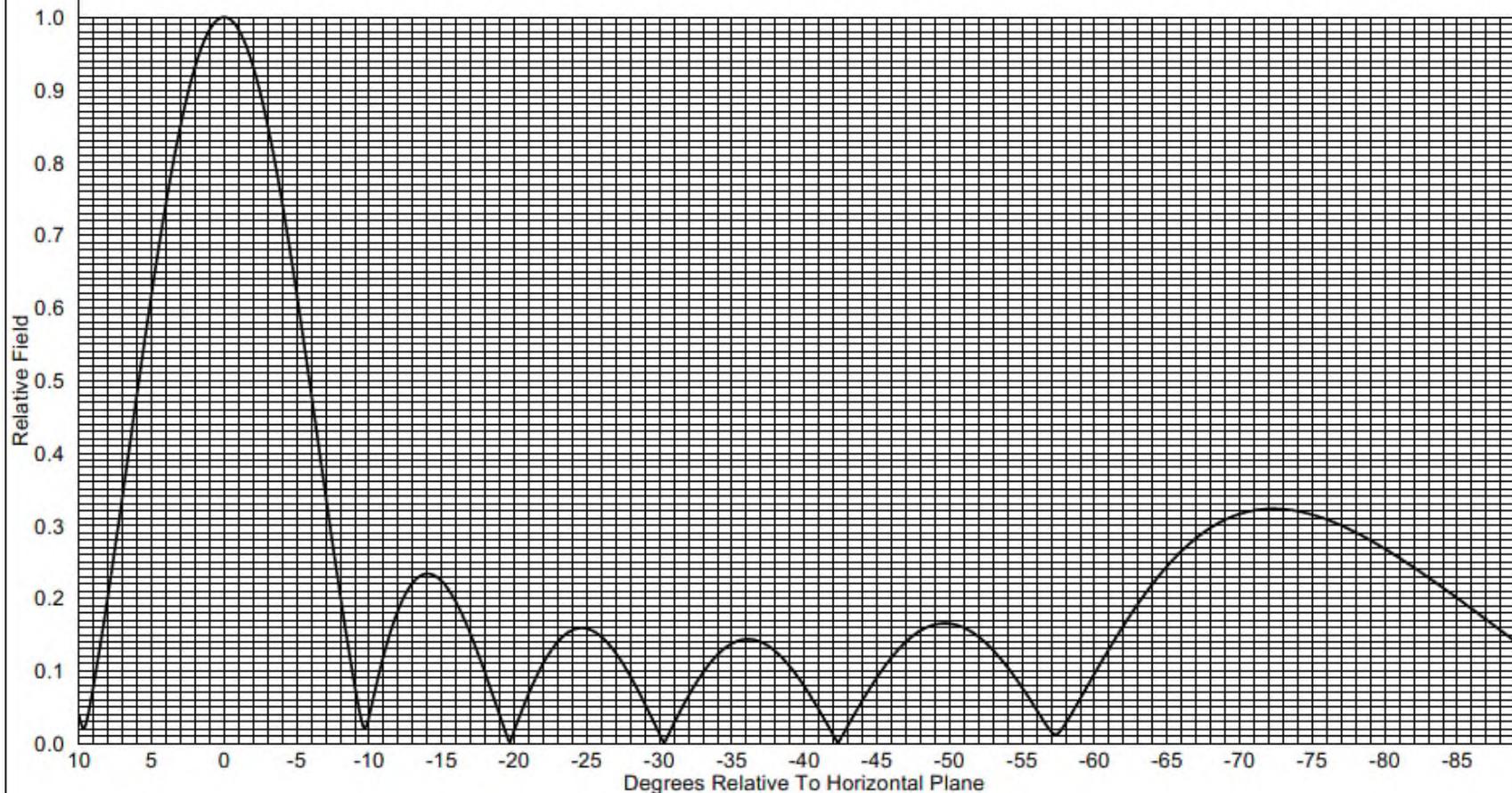
---Theoretical---

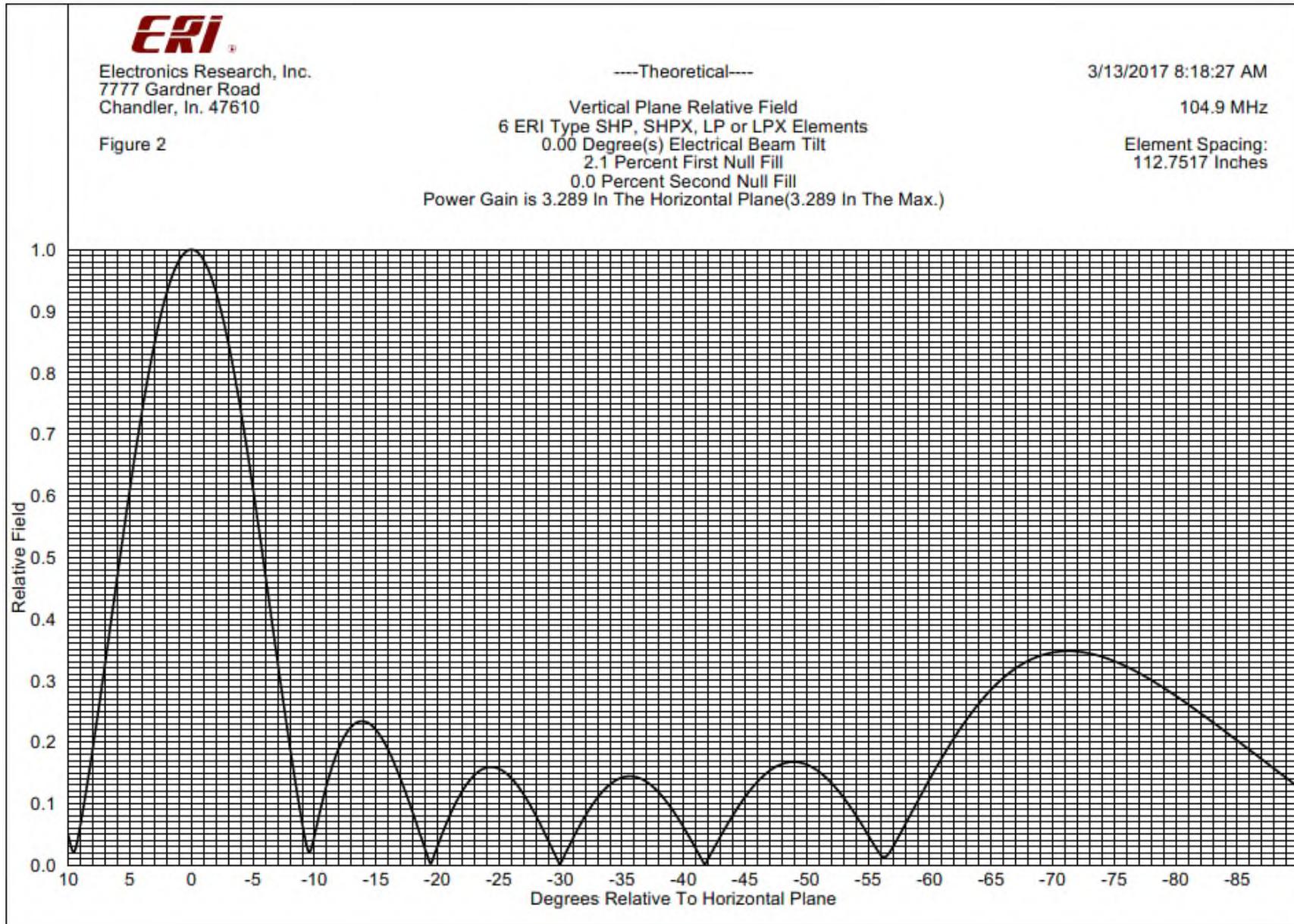
3/13/2017 8:17:19 AM

Vertical Plane Relative Field  
6 ERI Type SHP, SHPX, LP or LPX Elements  
0.00 Degree(s) Electrical Beam Tilt  
2.1 Percent First Null Fill  
0.0 Percent Second Null Fill  
Power Gain is 3.308 In The Horizontal Plane(3.308 In The Max.)

103.7 MHz

Element Spacing:  
112.7517 Inches

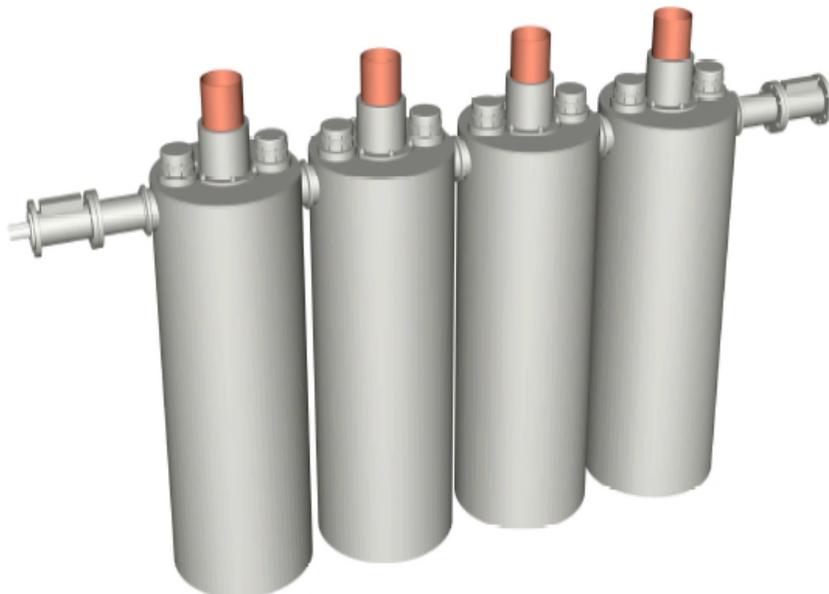




## ERI 780-4 FM Band Pass Filters

### Features

- Cylindrical construction provides better mechanical and electrical stability than square or rectangular cavities
- Factory tuned to customer's specified channel, yet can be easily field converted to any FM channel
- Minor adjustments of cavity resonant frequency can be made during full power operation of filters
- High stability temperature compensated cavities
- ERI filters are loop coupled and fixed with bolted connections to couple cavities
- No Teflon or other insulating material used in the coupling between cavities, eliminating a primary point of failure, present in competitor's designs.
- Loop coupling provides an adjustment (without disassembly) at the input and output of each cavity
- Marman clamp connection allows close cavity placement
- Ability to change frequency quickly and with a minimum of disassembly
- Filter can be easily broken down for shipment and placement
- Temperature indicator provided on all filter sets
- Optional non-adjacent coupling and group delay compensation available
- Easily assembled floor standing units (hardware for ceiling suspension available on request)



780-4 FM Band Pass Filter

ERI FM filters and combiners have served the broadcast industry for over 40 years. The basic building block of ERI's combiner and multiplexers system is a unique filter cavity. Only ERI offers a cylindrical cavity and all internal components in the RF path are silver plated. The result is an extremely efficient (low loss) and stable filter. ERI filters include a unique bellows temperature compensation assembly which maintains filter performance from a cold start to normal operating temperature without causing high transmitter VSWR. Only ERI filters incorporate a loop coupled design that allows more control over the filter pass band and offers performance superior to what can be achieved with the iris coupled cavities used by other manufacturers.

To further enhance system reliability ERI FM filter systems do not include air filters that require replacement. In filter system designed to handle higher FM power levels the forced air cooling option uses a high reliability motorized fans that are mounted on each cavity and requires no additional floor space and does not require filtering. These band pass filters sets are available for protection from undesirable intermodulation products. They can also be configured to combine multiple FM channels in branch or constant impedance configurations.

**CONNOISSEUR MEDIA****Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania****780-4 Series FM Band Pass Filter Specifications:**

Model:	780-4
Input and Output Connector:	1-5/8-inch or 3-1/8-inch EIA flange
Power Handling Capability:	15 kW with forced air cooling
Band Pass Filter Size and Weight:	48-inches H x 15-inches W x 78-inches L, 387 lbm 121.92-cm H x 38.10-cm W x 198.12-cm L, 175.54 kg
Frequency <sup>4</sup> :	All FM Broadcast Channels (88 to 108MHz)
VSWR <sup>1</sup> :	<1.06:1
Insertion Loss <sup>2</sup> :	<0.35 dB without GDC Module <0.60 dB with high level GDC Module
Group Delay <sup>3</sup> :	<75 nsec overall variation $\pm$ 150 kHz

1) When terminated in 50-Ohm resistive load.

2) Loss values will be somewhat greater for frequency separations 2.0 MHz or less.

4) 0.8 MHz or from any adjacent port signal frequency.

Specifications presented are typical, total system performance may vary. In a continuing effort to improve products, ERI reserves the right to change specifications and features.

CONNOISSEUR MEDIA

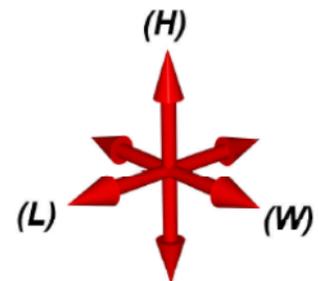
Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

Weight: 387 lbm  
175.54 kg

Length (L): 78-inches  
198.12-cm

Width (W): 15-inches  
38.10-cm

Height (H): 48-inches  
121.92-cm



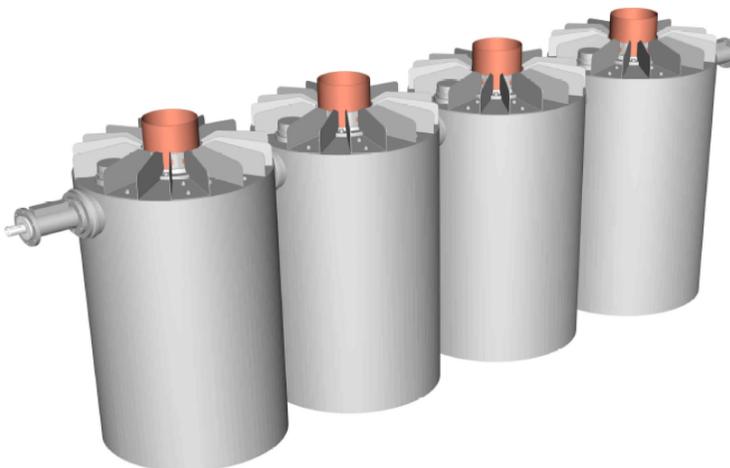
**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 780-4 Series Band Pass Filter Module**

## ERI 783-4 FM Band Pass Filters

### Features

- Cylindrical construction provides better mechanical and electrical stability than square or rectangular cavities
- Factory tuned to customer's specified channel, yet can be easily field converted to any FM channel
- Minor adjustments of cavity resonant frequency can be made during full power operation of filters
- High stability temperature compensated cavities
- ERI filters are loop coupled and fixed with bolted connections to couple cavities
- No Teflon or other insulating material used in the coupling between cavities, eliminating a primary point of failure, present in competitor's designs.
- Loop coupling provides an adjustment (without disassembly) at the input and output of each cavity
- Marman clamp connection allows close cavity placement
- Ability to change frequency quickly and with a minimum of disassembly
- Filter can be easily broken down for shipment and placement
- Temperature indicator provided on all filter sets
- Optional non-adjacent coupling and group delay compensation available
- Easily assembled floor standing units (hardware for ceiling suspension available on request)



ERI FM filters and combiners have served the broadcast industry for over 40 years. The basic building block of ERI's combiner and multiplexers system is a unique filter cavity. Only ERI offers a cylindrical cavity and all internal components in the RF path are silver plated. The result is an extremely efficient (low loss) and stable filter. ERI filters include a unique bellows temperature compensation assembly which maintains filter performance from a cold start to normal operating temperature without causing high transmitter VSWR. Only ERI filters incorporate a loop coupled design that allows more control over the filter pass band and offers performance superior to what can be achieved with the iris coupled cavities used by other manufacturers.

To further enhance system reliability ERI FM filter systems do not include air filters that require replacement. In filter system designed to handle higher FM power levels the forced air cooling option uses a high reliability motorized fans that are mounted on each cavity and requires no additional floor space and does not require filtering. These band pass filters sets are available for protection from undesirable intermodulation products. They can also be configured to combine multiple FM channels in branch or constant impedance configurations.

**CONNOISSEUR MEDIA****Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania****783-4 Series FM Band Pass Filter Specifications:**

Model:	783-4
Input and Output Connector:	3-1/8-inch or 6-1/8-inch EIA flange
Power Handling Capability:	20 kW with convection cooled 35 kW with forced air cooling
Band Pass Filter Size and Weight:	Convection Cooled 50-inches (127 cm) H x 23-inches (58.42 cm) W x 108-inches (274.32 cm) L, 580 lbm (263.08 kg) Forced Air Cooling 58-inches (147.32 cm) H x 23-inches (58.42 cm) W x 108-inches (272.16 cm) L, 600 lbm (233.68 kg)
Frequency <sup>4</sup> :	All FM Broadcast Channels (88 to 108MHz)
VSWR <sup>1</sup> :	<1.1:1, maximum
Insertion Loss <sup>2</sup> :	<0.20 dB without GDC Module <0.45 dB with high level GDC Module
Frequency Band Width to 30 dB Limit:	±1.0 MHz
Group Delay <sup>3</sup> :	<75 nsec overall variation ±150 kHz <25 nsec overall variation ±150 KHz with optional Group Delay Compensation

1) When terminated in 50-Ohm resistive load.

2) Loss values will be somewhat greater for frequency separations 2.0 MHz or less.

3) Group delay correction required for frequency separations 0.8 MHz or less and recommended for frequency separations of 2.0 MHz or less.

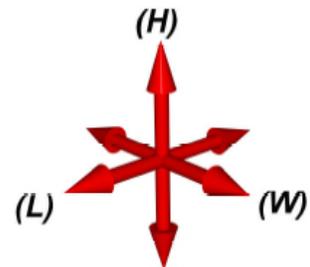
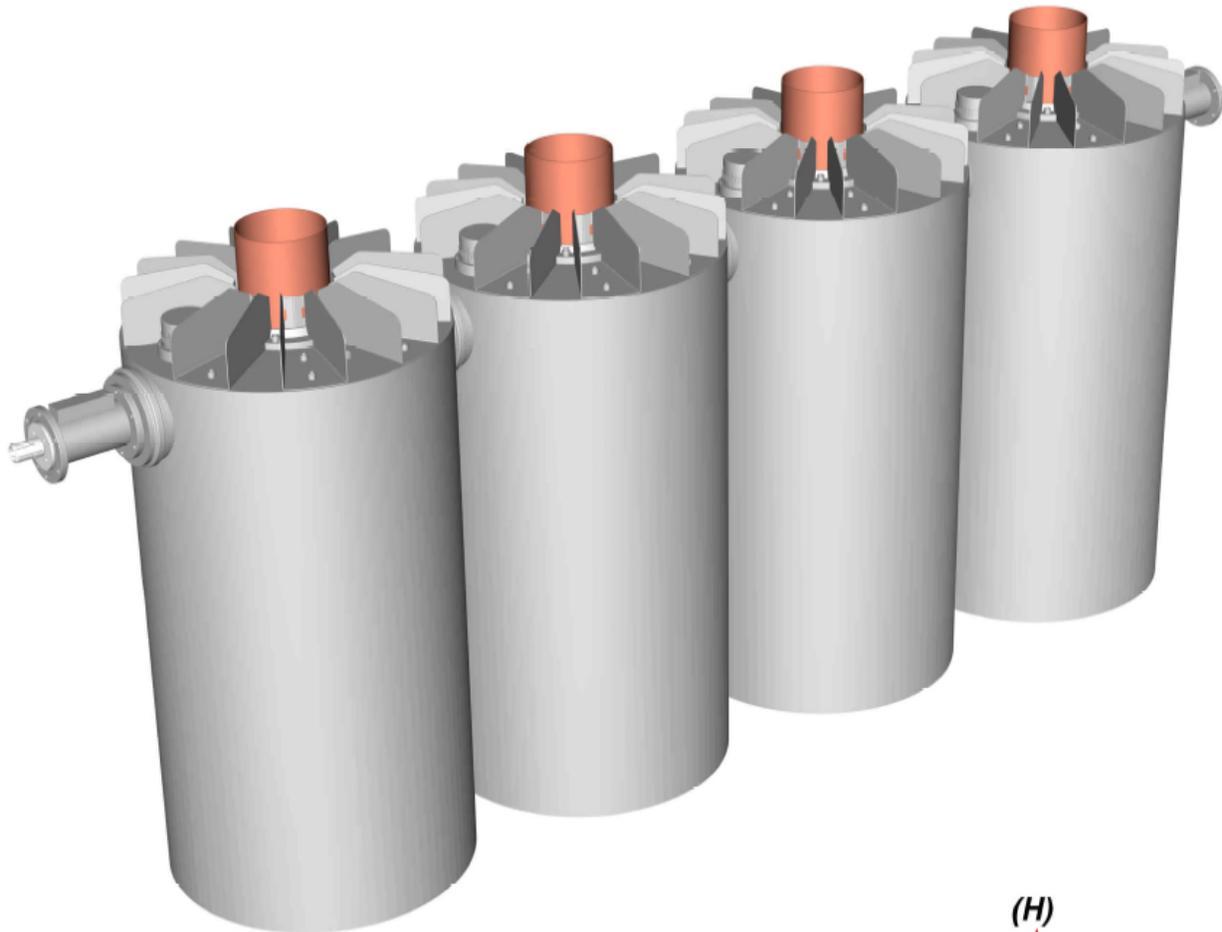
4) 0.8 MHz or from any adjacent port signal frequency.

Specifications presented are typical, total system performance may vary. In a continuing effort to improve products, ERI reserves the right to change specifications and features.

NOTE: Filter sets include a single port fixed directional coupler at the filter input and a dual port directional coupler at the output.

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

Weight:	580 lbm	263.08 kg
Length (L):	108-inches	274.32 cm
Width (W):	23-inches	58.42 cm
Height (H):	50-inches	127.00 cm

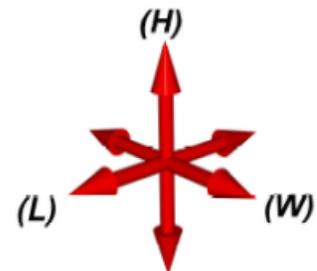
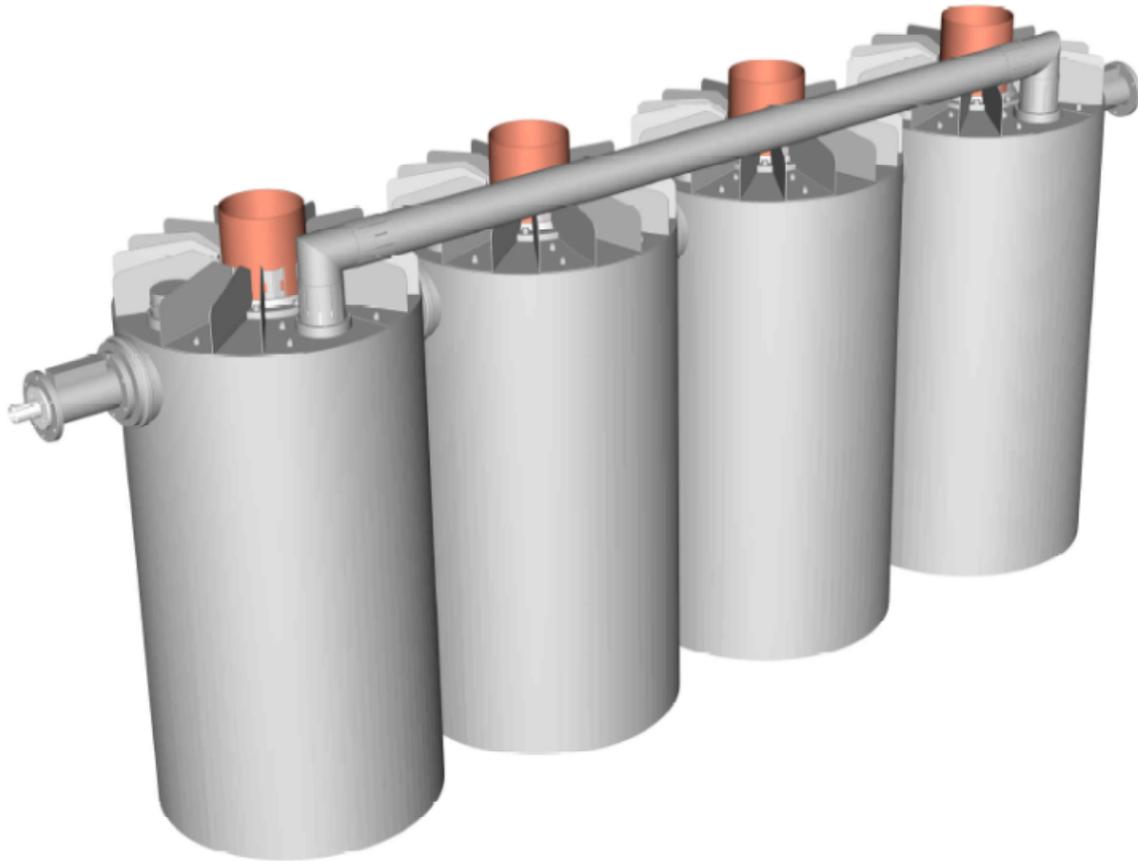


**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 783-4 Series Band Pass Filter Module**

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

Weight:	590 lbm	267.62 kg
Length (L):	108-inches	274.32 cm
Width (W):	23-inches	58.42 cm
Height (H):	50-inches	127.00 cm



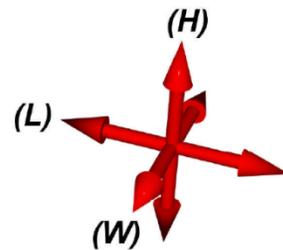
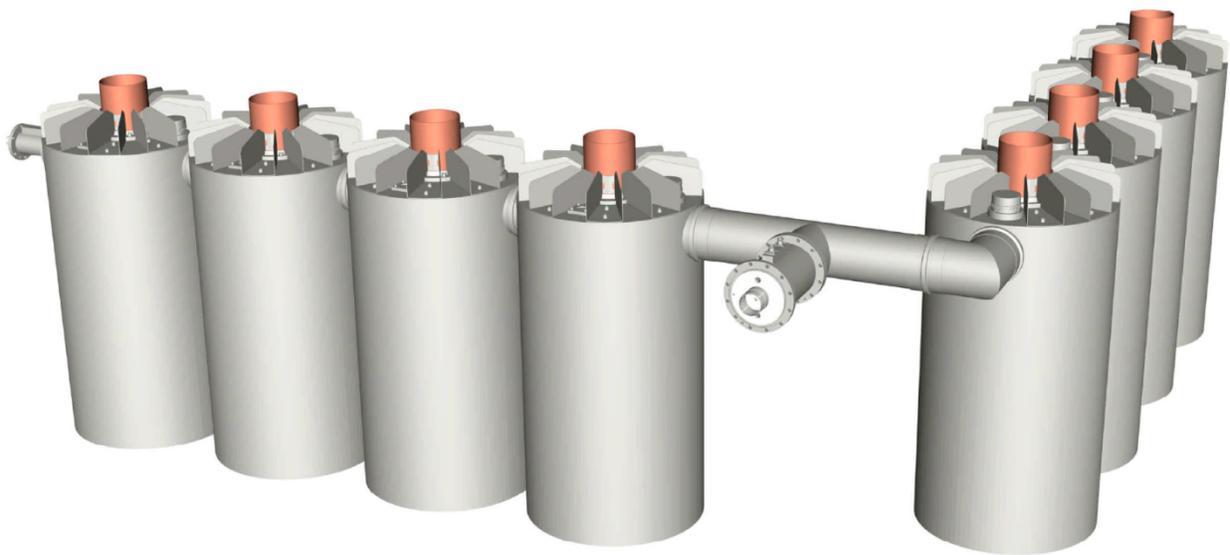
**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 783-4 Series Band Pass Filter with Non-Adjacent Coupling Loop Option**

CONNOISSEUR MEDIA

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

Weight:	1,366 lbm	619.61 kg
Length (L):	154-inches	391.16 cm
Width (W):	130-inches	330.20 cm
Height (H):	50-inches	127.00 cm

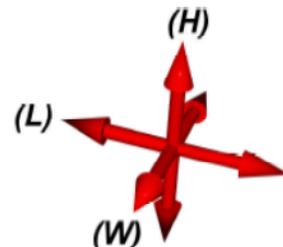


**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 783-8/6 (TB83-8/6) Series TEE Combiner ("L" Configuration)**

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

Weight:	1,366 lbm	619.61 kg
Length (L):	232-inches	589.28 cm
Width (W):	30-inches	76.20 cm
Height (H):	50-inches	127.00 cm

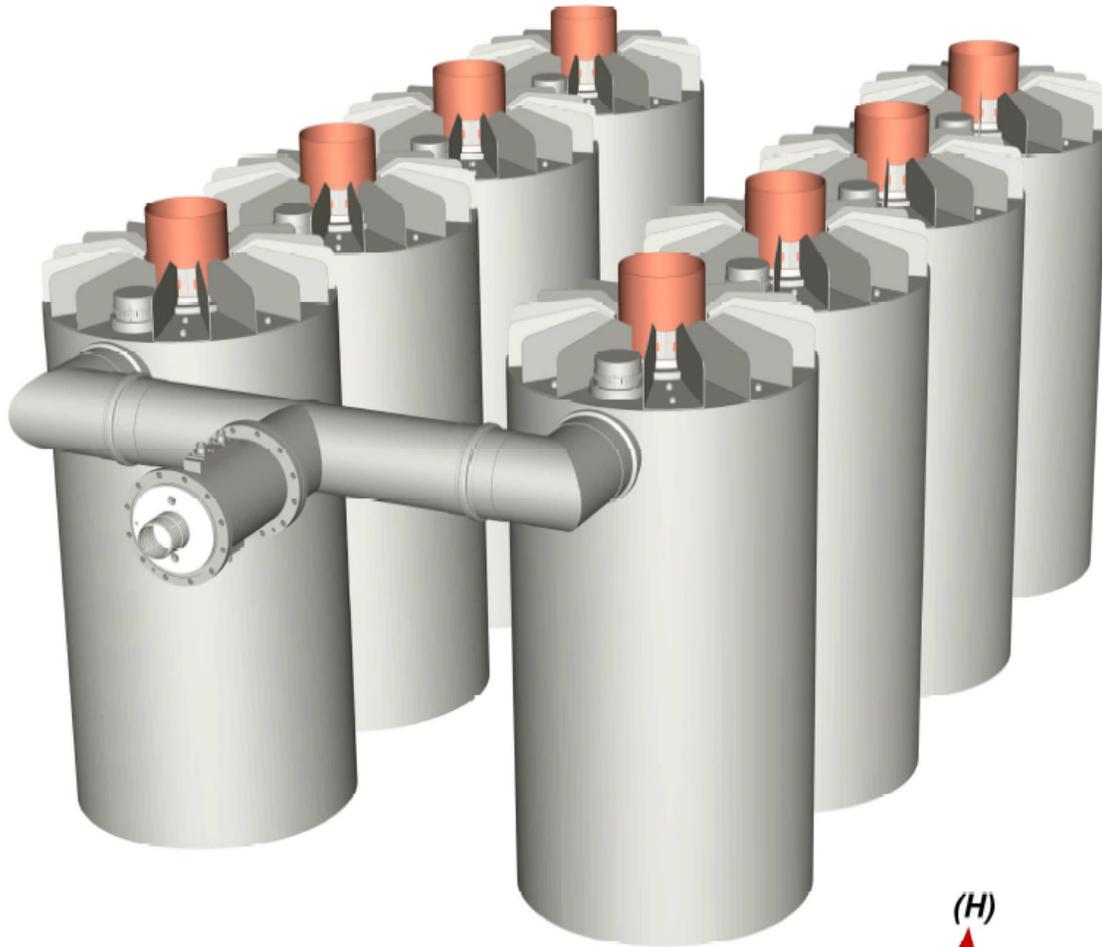


**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 783-8/6 (TB83-8/6) Series TEE Combiner (In-Line Configuration)**

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

Weight:	1,366 lbm	619.61 kg
Length (L):	125-inches	317.50 cm
Width (W):	65-inches	165.10 cm
Height (H):	50-inches	127.00 cm

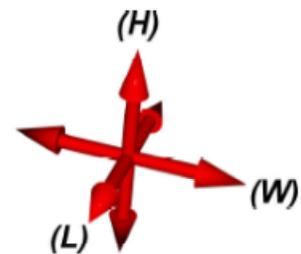
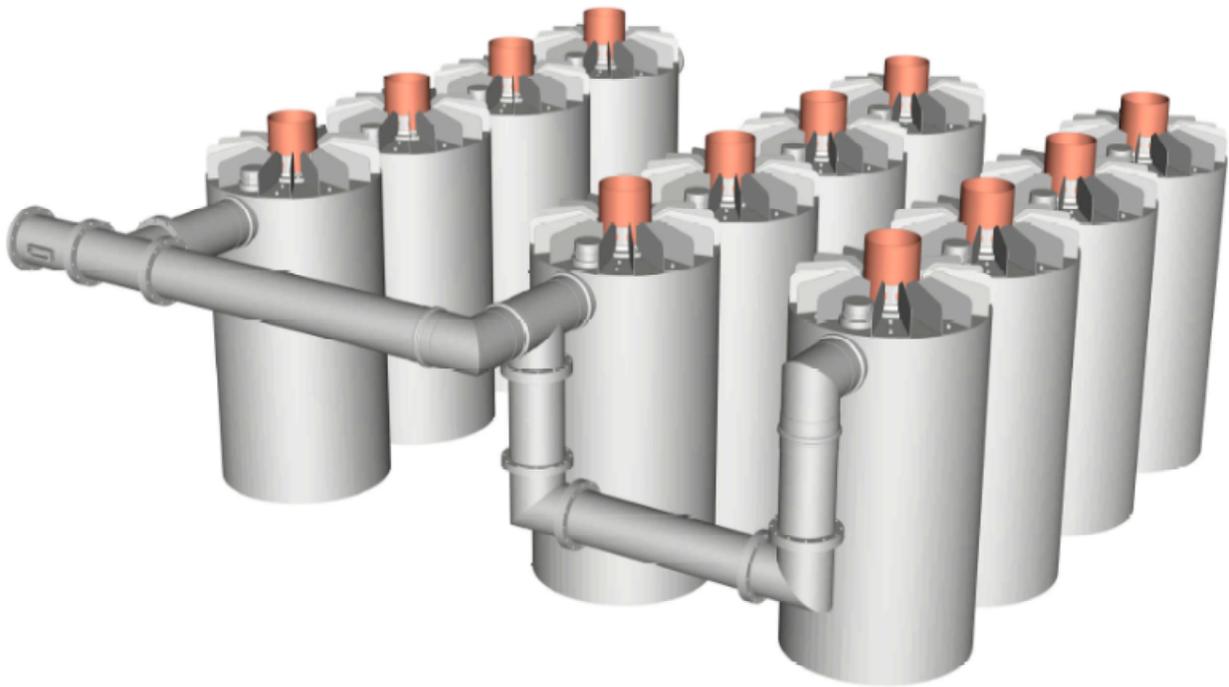


**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 783-8/6 (TB83-8/6) Series TEE Combiner ("U" Configuration)**

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

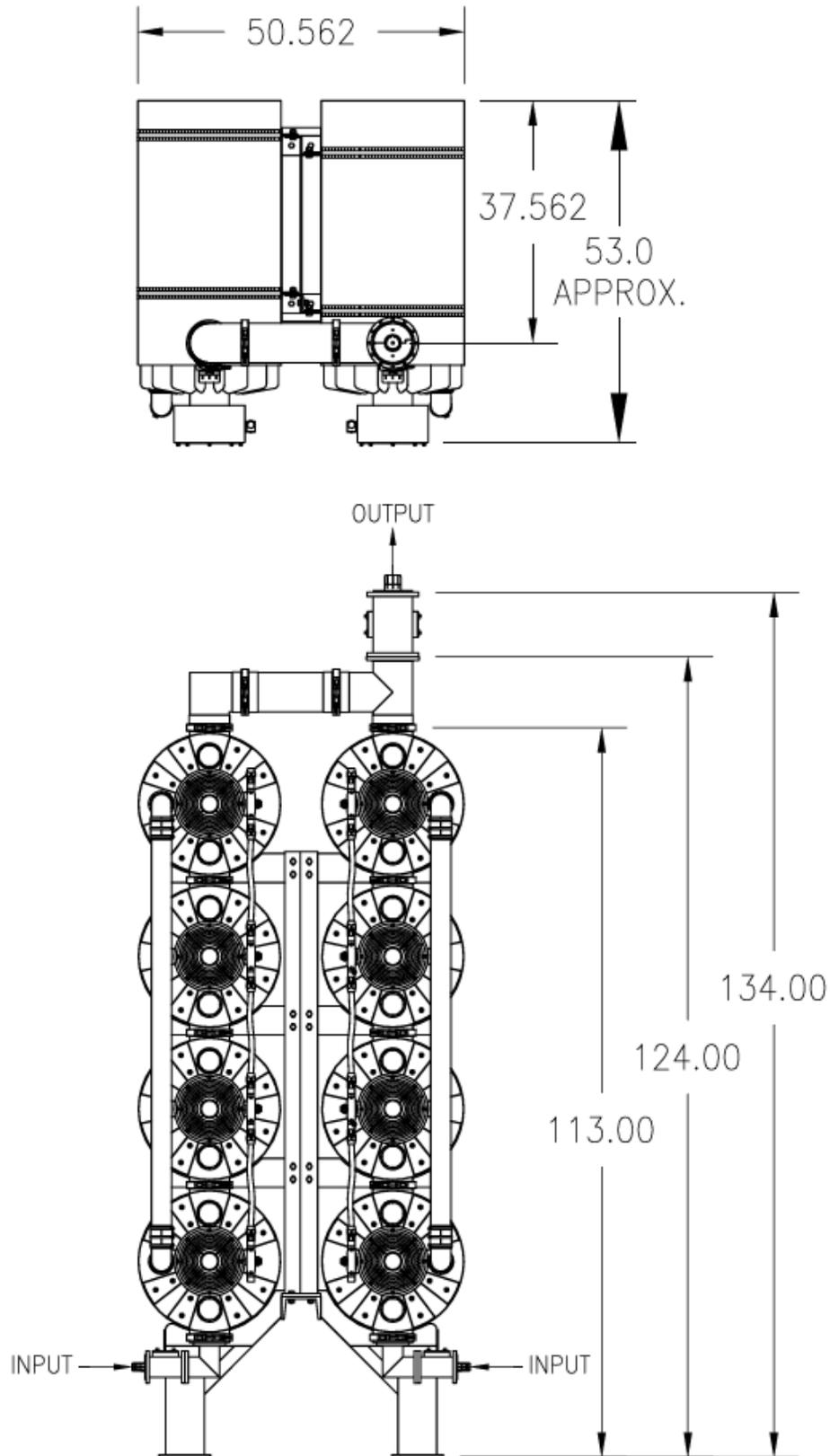
Weight:	1,890 lbm	857.29 kg
Length (L):	125-inches	317.50 cm
Width (W):	120-inches	304.8 cm
Height (H):	50-inches	127.00 cm



**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 783-12/6 (BR83-12/6) Series Branch Combiner ("E" Configuration)**

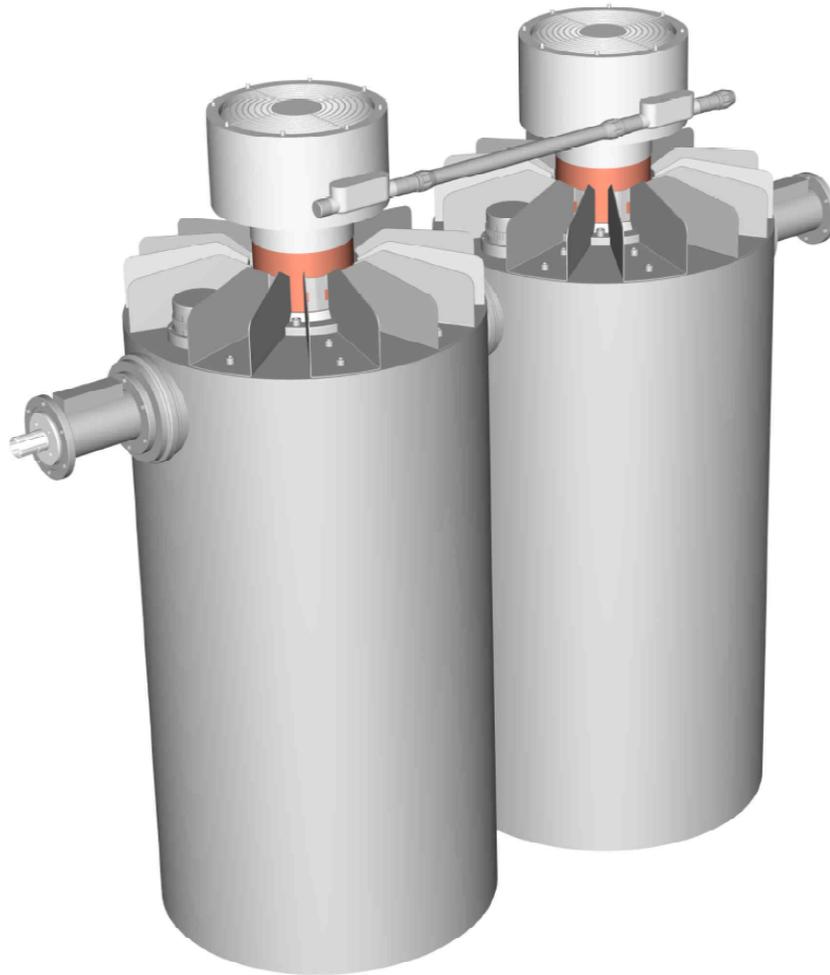
Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania



Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

**ERI 783-8/6 (TB83-8/6) Series TEE Combiner (Floor Stand Configuration). Dimensions in inches.**

Fans weigh approximately 20 lbm (9 kg) each  
0.5 amps at 115 VAC



Fans add 8-inches (20.32 cm) to height

**NOTE: DIMENSIONS & WEIGHTS ARE APPROXIMATE AND SUBJECT TO CHANGE PER TUNING.**

**ERI 783 Series Forced Air Cooling Option**

CONNOISSEUR MEDIA

Diplexed FM Antenna and Combiner for WRTS (FM), Erie, and WRKT, North East,-Pennsylvania

July 2, 2014