

## FM PLANNER™ TECHNICAL SOFTWARE

FM PLANNER™ is new, Windows® based technical software used to reduce operator effort and risk when planning or evaluating FM broadcast systems. The software includes the required technical specification database for many standard types of FM broadcast antennas and transmission lines, and eliminates most of the catalogs, lookups, and manual calculations normally needed for this task.

The program has provisions for calculating peak and average powers for in-band, on-channel (IBOC) digital transmissions, and will permit entering digital power either in peak or average values, as well as allow specification of the ratio between analog and digital power.

The input screen uses an intuitive, logical layout that speeds the design process. Several input fields use drop-down selection boxes to provide a list of legitimate, available entries applying to that data field. Extensive error testing during the data entry process reduces the possibility of choosing incorrect or incompatible components. A sample input screen is shown below, with the entries used to generate the printed program outputs following in this document.

### FM PLANNER™ Input Screen

Legal User: Your Name Here	FM PLANNER™ TECHNICAL SOFTWARE v1.0	© Copyright 2001 Richard J. Fry
ID# 100		
<i>Enter data in shaded cells. Clear invalid entries only with DELETE.</i>		
1. Station Call Letters:	KLOD	<i>(Delete all data for entry number 11 below if a standard antenna is used.)</i>
2. Location (City, State):	Grunt, AR	
3. Frequency:	92.5 MHz	
4. Effective Radiated Power (ERP):	100.000 kW Analog	
A:D (avg) = 22.0 dB	2.512 kW Digital Peak ;	
IBOC Pk:Avg = 6.0 dB	22 dB A:D = 0.631kW avg	
5. Antenna OEM:	Harris	
<i>(from vendor list shown at the right...)</i>	N/A	
Other Antenna OEM:		
6. Number of Bays:	8	
7. Bay Spacing:	1 wavelength	
8. Antenna Feed Point:	Center	
9. Antenna Nomenclature:	SKH-8AC	
10. Height of Rad. Center above Ground Level:	984.0 feet	
11. Special Antenna Gain:		X
a. Element Rel. Field @ -90°:		o
b. Beam Tilt:		%
c. Fill, Null 1:		%
d. Fill, Null 2:		%
e. Bay Spacing:		wavelength
12. Trans. Line OEM:	Andrew	Andrew
<i>(choose from vendors shown at the right...)</i>		Cablewave/RFS
		Dielectric
		Myat
13. Line Type:	Flex-Air	
14. Line Diameter:	4.000 inches	
15. Length, horiz. run:	20.0 feet	
16. Force total line length to:		feet
17. Miscellaneous Losses		
a. IBOC Combiner:	0.46 dB, Analog	
b. Bandpass/Notch/Other:	10.00 dB, Digital	
c. FM Multiplexer:		dB (A&D)
d. Isocoupler:		dB (A&D)
<b>Calculated TPO:</b>	33.596 kW Analog	
	7.591 kW Digital (pk)	
	1.907 kW Digital (avg)	
<b>Advisories / Warnings</b>	<b>Units</b>	
Coax rating OK at this operating power.	English	
Radiation 6.56 feet AGL OK for all access.		
Antenna input pwr +5% = 24.56kW; VSWR limit = 5.34		

A professional-appearing FM System Summary is generated automatically from the input screen data, with comprehensive details about the FM system analysis process and results. The Summary may be printed using standard Windows® print routines, or, with the necessary Windows® software may be faxed from the user's PC directly to a client. The Summary is a valuable supporting document or exhibit to accompany proposals and technical submissions. An example of the System Summary appears on the next page.

**FM SYSTEM SUMMARY**

FM PLANNER™

1-Feb-01 / ID# 100

**FOR: KLOD; Grunt, AR**

By: Your Name Here

I. The computer calculations in Section II were made to assist you in choosing your transmitter, antenna, and transmission line. A description of the calculation approach is given in the bulleted list below.

- ◆ Uses standard gain data for 1, 0.75, 0.667, and 0.5 wavelength-spaced antennas, as supplied by the manufacturer. Non-standard gains may be used as entered from the keyboard.
- ◆ Calculates the minimum tower height needed to side mount the antenna at the indicated radiation center height above ground level, and elevations of the top and bottom antenna bays.
- ◆ Insures that the bottom antenna bay is elevated at least one wavelength above the tower base.
- ◆ Calculates the length of transmission line needed assuming a 2-1/2 meter (8.2 foot) exit height from the tower, plus the horizontal run length specified, plus 5% extra for safety margin during installation.
- ◆ If rigid transmission line is selected, displays the recommended section length for the frequency.
- ◆ Calculates loss in selected transmission line for the exact FM channel assignment. Accuracy of transmission line loss data is within 0.5% of the manufacturer's published data and standard conditions.
- ◆ Tests power rating of the selected transmission line at a load VSWR of 1.5:1 on the operating frequency, and displays the result. Andrew VSWR derate uses their formula, other transmission line is derated by the 1:1 rating/VSWR. Air dielectric transmission line is assumed (choice of air or foam for 1/2", 5/8", and 7/8" flexible coax).
- ◆ Displays the system VSWR limit permissible for the transmission line to remain within its published ratings at the system operating power (if greater than 1.0 VSWR).
- ◆ Tests system RF power density at a two meter (6.56 foot) elevation above level ground, and displays result. Uses the power radiated by the highest amplitude sidelobe of the antenna (typical data), and the appropriate formula from Bulletin 65 of the Office of Engineering and Technology of the Federal Communications Commission. The far-field elevation pattern is calculated and used in the analysis.
- ◆ Displays the TPO needed to achieve a given effective radiated power (ERP) for the frequency, antenna gain, type and length of transmission line, and miscellaneous loss selected.

II. System Calculations **(data for confirmation by your engineering staff or consulting engineer).**

FREQUENCY:	92.5 MHz	Total Length with	1,041 feet
ERP, maximum:	100.000 kW Analog	20 foot horiz. run	
	2.512 kW Digital (pk)	Loss per 100 feet:	0.110 dB
	0.631 kW Digital (avg)	Loss, total:	1.141 dB
ANTENNA:	Harris SKH-8AC	Loss, avg. power:	7.024 kW
Input Power:	23.240 kW Analog	Efficiency:	76.90 %
	0.584 kW Digital (pk)	Rating, 1.5VSWR:	49.9 kW, avg
	0.147 kW Digital (avg)	VSWR Limit:	5.34
No. of Bays:	8	MISCELLANEOUS LOSSES	
Bay Spacing:	1 wavelength	IBOC Combiner:	0.46 dB Analog
Beam Tilt:	0 °		10.00 dB Digital
Fill, Null 1:	0 %	Bandpass/Notch/Other:	0.00 dB (A&D)
Fill, Null 2:	0 %	FM Multiplexer:	0.00 dB (A&D)
Gain, maximum:	4.303 X	Isocoupler:	0.00 dB (A&D)
Length:	74.2 feet		
Feed Point:	Center	<b>TX POWER OUTPUT:</b>	<b>33.596 kW Analog</b>
Min. Tower Height:	1,026.0 feet		<b>7.591 kW Digital (pk)</b>
Top Bay HAGL:	1,021.1 feet		<b>1.907 kW Digital (avg)</b>
Rad. Center HAGL:	984.0 feet		
Bottom Bay HAGL:	946.9 feet		

*Digital Pk:Avg = 6dB; Analog:Digital (avg) = 22dB*

TRANSMISSION LINE

Manufacturer: Andrew  
 Type: Flexible, air insulated  
 Diameter: 4 inches

SYSTEM TEST RESULTS

- Coax rating OK at this operating power.
- Radiation 6.56 feet AGL OK for all access.

## RF Power Density Analysis

FM PLANNER™ generates the elevation pattern for the standard antenna array parameters selected on the input screen, and uses that data in the formulas of OET Bulletin 65 to calculate the highest power density for the defined system. User warnings are provided to guide the system designer in the evaluation and control of RF radiation hazards. A notation is made on the System Summary printed output page of the degree to which the system meets current FCC guidelines.

The following plot is generated automatically from the standard input data, and may be printed using standard Windows® print routines.

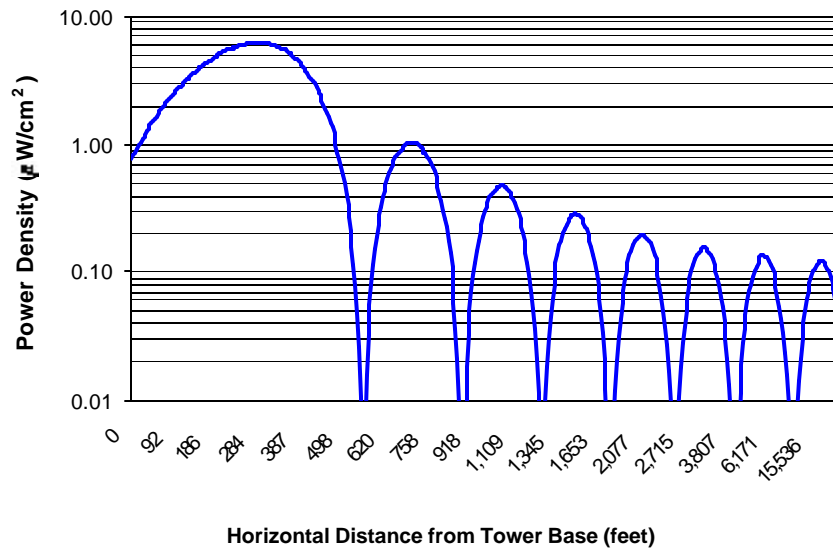
### Power Density Plot (example)

**Your LOGO Here**

**KLOD, Grunt, AR**

Antenna: Harris SKH-8AC	R/C Height AGL: 984 feet
Bay Spacing: 1 wavelength	Max. ERP per polarization: 100.000 kW Analog
Element Field @ -90: 10% (avg.)	0.631 kW Digital (avg)
Far-field Pattern Assumed	Date of Study: 1-Feb-01 / ID# 100

**Theoretical Power Density per OET Bulletin 65**  
**Calculated for 2 meters (6.56 feet) Above Level Terrain**  
 FCC limits: Uncontrolled Access =<200; Controlled Access =<1,000.



*Calculation only for review and acceptance of station engineer or consultant.*

Plot provided by: Your Name Here

FMPLANNER™

## Transmission Line Planning

The main transmission line system components and quantities are shown in generic form automatically by FM PLANNER™. In addition, the pressurization volumes of the transmission line and antenna are show together in a table, for antennas composed of various EIA line sizes. This simplifies the selection of the required pressurization system. An example of this output data is shown on the next page.

**TRANSMISSION LINE COMPONENTS**

FM PLANNER™

1-Feb-01 / ID# 100

**FOR: KLOD; Grunt, AR**

By: Your Name Here

**NOTE:** Items listed below are typical, only. Exact types and quantities are site dependent, and supplied as ordered.

**Main Transmission Line**

<b>Manufacturer:</b>	Andrew	<b>Frequency:</b>	92.5 MHz
<b>Type:</b>	Flexible, air insulated	<b>Loss for 1041 feet</b>	1.141 dB
<b>Diameter:</b>	4 inches	<b>Efficiency:</b>	76.90 %
<b>Total Line Length:</b>	1041 feet	<b>Coax Rating at</b>	
<b>Calculated Vertical Run:</b>	969.2 feet	<b>1.5:1 VSWR:</b>	49.9 kW
<b>Horizontal Run:</b>	20.0 feet	<b>Input Power:</b>	30.410 kW

<b>For rigid line systems...</b>	
<b>Section Length: N/A feet</b>	
<b>No. of Vertical Sections:</b>	N/A
<b>No. of Horizontal Sections:</b>	N/A
<b>Spares (suggest two, min.):</b>	N/A
<b>Total Sections:</b>	0

<b>Power Loss:</b>	7.024 kW
<b>VSWR Limit for</b>	
<b>Input Power:</b>	5.34
<b>Total Length</b>	
<b>Basis:</b>	Calculated.*

\* includes 5% for installation variations.

**Transmission Line Installation Accessories**

For Flex Line Systems

Hoist Grips:	5	Allows one at top, and one for each 200 foot interval below.
Hangers (Kit, 10):	21	Allows one hanger per 5 feet of line.
Round Member Adptrs (Kit, 10):	42	Allows 2 per hanger.
Hardware, Hanger (Kit, 10):	21	
Grounding Kits:	7	Top, every 200 feet, and bottom of vertical run + building entry.
Connector, Gas Pass:	1	Factory attached. Include removeable inner connector.
Connector, Gas Barrier:	1	Attached on site. Include removeable inner connector.

For Rigid Line Systems

Elbow complex:	N/A
Hanger, Fixed, Heavy Duty:	N/A
Hanger, Vertical, Spring:	N/A
Lateral Brace:	N/A
Hanger, Horizontal:	N/A
Field Flange, silver solder:	N/A
Silver solder	N/A
Anchor Inner Connector:	N/A
Gas Barrier	N/A

All Systems

Wall Plate:	1	May want two (one on each side of building entry wall).
Hardware, flange:	4 sets	minimum.
"O" Rings:	4	minimum.
Tx Room Coax Items:	Per site.	Include patch panel, unpressurized line, elbows, adapters, etc.
Spares:	Per site.	Field flanges, bullets, couplings, clamps, hardware, etc.

**Pressurization System**

Include a pressurization system capable of the appropriate total volume in the table below.

KLOD System Item	Antenna Spine/Feed System		
	1-5/8"	3-1/8"	4-1/16"
Antenna :	1.25	4.33	7.51
Main Trans. Line:	72.79		
<b>TOTAL VOLUME (ft<sup>3</sup>)</b>	<b>74.0</b>	<b>77.1</b>	<b>80.3</b>

## Mixed Coax Systems

Some broadcasters want to mix the types of transmission line used to connect their transmitter system to the antenna. FM PLANNER™ provides an easy way to accommodate this, using a template where the various types and lengths can be selected, and the performance of the composite system is displayed. The net loss of the mixed coax system is automatically carried forward, and used in the calculation of transmitter output power required. Choosing under-rated coax for the system design produces the error message shown below (Section 3).

(Note: The values shown below are for demonstration purposes, and in this case were not included in the calculations on the previous pages).

Your LOGO Here

### COAX SYSTEMS WITH MIXED LINE TYPES

FM PLANNER™

1-Feb-01 / ID# 100

FOR: KLOD; Grunt, AR

By: Your Name Here

	Input Power	Power Rating at 1.5 Load VSWR	
Length (all sections connected): 950 feet	Section 1: 26.53 kW	49.9 kW	
Composite Loss: 0.999 dB	Section 2: 28.83 kW	36.5 kW	
Composite Efficiency: 79.45 %	Section 3: 29.44 kW	10.7 kW	< PROBLEM
Ant. Input Power (from Summary): 23.39 kW	Section 4: N/A kW	N/A kW	

	Section 1	Section 2	Section 3	Section 4
<b>START</b> (Antenna Input)				
Transmission Line OEM:	Andrew	Myat	Myat	Andrew
Line Type:	Flex-Air	Rigid	Rigid	Flex-Air
Diameter (inches):	4.000	3.125	1.625	0.875
Length (feet):	500	400	50	
		<i>Delete all data from 'OTHER' fields.</i>		
<b>OTHER</b>				
Manufacturer's Name:				
Name/number of Line:				
Loss per 100 feet at operating freq (dB):				
1:1 VSWR Power Rating at operating freq (kW):				
<b>Result per Section Length</b>				
Loss per 100 feet (dB):	0.110	0.090	0.179	0.354
Loss for length (dB):	0.548	0.362	0.090	0.000
Efficiency for length:	88.15%	92.01%	97.96%	100.00%
Power Rating into 1.5VSWR (kW):	49.9	36.5	10.7	5.3

----- Your company name and address here -----

FM PLANNER™ offers the technical community its most comprehensive and professional FM system planning capability. Please contact the author for further information and availability.

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