PP

Propagation Prediction

Version 1.6

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Contents

1 Introduction

PP is a program designed to predict HF propagation from 2–50 MHz. It is based on an algorithm named MINIFTZ which was developed by the FTZ Darmstadt in 1987. MINIFTZ uses tabulated values from the CCIR Atlas of Ionospheric Characteristics to generate a field strength prognosis for a given circuit, depending on the location of the two stations, time of day and time of the year, the sunspot number, transmitter power, antenna gain and vertical radiation angle of the transmitting antenna.

The original BASIC program MINIFTZ4 was transferred into a PASCAL program by Helmut Klein, OE1TKW. The graphical user interface and some additional enhancements were done by myself. To make clear that this is a different program, the name was changed to PP, short for "Propagation Prediction".

PP runs on any IBM compatible PC with a minimum of 350 kB memory and a CGA, EGA or VGA graphics adapter. VGA is recommended as it gives best resolution. The adapter is automatically detected by the program.

A color monitor is very advantageous when several curves are displayed in the diagram at the same time, showing expected field strengths for different frequency bands. In case only a monochrome monitor is used, the program can be configured to use different symbols for the curves.

A mouse is supported but not necessary. A math coprocessor (80x87) is detected and used automatically by the program.

2 Files on the disk

The software consists of several files. These are packed in form of a so-called "self-extracting archive" on the disk. Just use the command INSTALL to install the files on your disk:

```
C:\>a:

A:\>install
```

This will install all files in the C:
PP directory. If you want to move the software to another place in the directory tree, keep all files in a single directory. Take the original disk and put it in a safe place.

The following files must exist so that PP can start:

PP.EXE	program file
FTZMUF2.DAT	data file
PP.CFG	configuration file
MESSAGES.DAT	system messages

The following files are used by the program if they exist:

LOCATION.DAT	QTH Data
WWV.DAT	PacketCluster WWV spots to calculate SF/SSN

The following files are generated by PP:

PP.STA	status file. Saves most recent calculation parameters
PP.OUT	simple output file as generated be the original MINIFTZ program
PP.RAW	raw data to be used for your own plot processing

3 Starting the program

Start PP by entering PP on the command line. PP.EXE may be located anywhere on the file system as long as the path to it is either given in the PATH environment variable or is fully specified. The directory where PP.EXE is located is called PPDIR in this document.

The program is being loaded into memory and starts. It first loads system messages from MESSAGES.DAT, reads the configuration file PP.CFG and – if it exists – the status file PP.STA. If PP.CFG is not found the program will use default values. You can also specify the name of a configuration file to be used instead of PP.CFG. So you can use different configurations for high bands, low bands, 50 MHz etc.

There are now English and German message files. Copy either MSG.D or MSG.E to MESSAGES.DAT to make the program speak your language.

According to what is declared in the config file, the program now is expecting your input. Basically, the following data is prompted:

1. Date (Day, Month, Year)
2. Sunspot Number or Solar Flux
3. Location of Transmitting and Receiving Station
4. Transmitter Power
5. Gain of transmitting antenna
6. Probability for this calculation
7. Propagation Path (Long Path/Short Path)
8. Minimum vertical radiation angle of TX antenna

9. Frequencies

(1) If `AD=YES` (Auto Date) is specified in the config file, you are not prompted for the date but the program rather uses the internal system clock of your computer.

(2) If the config switch `SF` is set to `YES` the program will prompt for solar flux instead of sunspot number. Solar Flux is the solar noise measured on 2300 MHz. This data is broadcasted hourly by WWV 18 minuted past every hour. Also when you are doing a `SH/WWV` command on your local PacketCluster node, you will see Solar Flux data.

If you enter "?" when prompted for Solar Flux and if there is a file specified by the `WN` parameter, which contains WWV data in PacketCluster output format, you can select solar data from within a window. You can keep this file up to date yourself by occasionally logging to this file when doing a SH/WWV command on your local PacketCluster.

Another configuration command, `AW` allows you to let the program automatically select the most recent entry in the WWV data file.

(3) Selecting station locations can be done in two ways:

1. You enter a prefix. If this prefix is found in the file `LOCATION.DAT` location data will be automatically inserted including the full name of the country, city name etc.

   If you enter a prefix which is not found in the database, the program will prompt you for latitude, longitude and time zone.
2. If you enter a question mark instead of a regular prefix, a window will pop up from which you can select a location. You can walk around in the file using the cursor keys, PgUp, PgDn. By pressing single characters you will jump to the beginning of a character block. For example, by entering "L", the program will proceed to the L prefix block and you will see L prefixes (LA, LX, LY, LZ etc.). You select a location by by moving the cursor to a specific entry and pressing Return.

(4) Output power is to be specified in kilowatts (kW). Maximum power limit is 2 MW. By stating the `XP` parameter in the configuration file, you will not be prompted for TX power.

(5) Transmit antenna gain is to be specified in dBi, dB over an isotropic radiator. Limits are –60 dBi and +30 dBi. If the configuration parameter `XG` (fixed gain) is stated in the configuration file, no questions will be asked here.

(6) You can chose if you want 10%, 50% or 90% reliability.

- 10% means that the calculated field strength are reached only on 10% of all days of a month. These are very optimistic predictions.
- 90% means that the prognosis is correct or better on 27 days per month. These are very pessimistic predictions.
- With a reliability of 50%, the prediction will be too pessimistic for 15 days per month and too optimistic for the other 15.

When `XC` is stated in the configuration file, you are not prompted to enter reliability.

(7) This parameter is always prompted. If you enter "L" or "l", the propagation for the long path is calculated, otherwise short path is assumed.

(8) Enter the minimum vertical radiation angle which the program should use. Propagation modes utilizing lower angles are skipped. On HF the minimum radiation angle is between 3°and 25°. Limits are 0°and 90°. When stating the `XA` parameter in the configuration file, the minimum angle is not prompted.

(9) Frequencies. You can enter a maximum of eleven different frequencies. Enter each frequency on a single line. By entering a blank line, the input of frequencies is terminated. By using the configuration command `XF` you can save yourself from entering the same frequencies all over again.

All parameters are being saved in a status file (`PP.STA`) and can be recalled later. Only the parameters of the last calculation are saved, however. The status file is searched only in the `PPDIR` directory. If no status file is found, a new one is created.

4 Output

The printout produced by the original program MINIFTZ4 is also generated by PP. It is written to the file `PP.OUT`. You get two printable pages. The first page contains field strength predictions for the given parameters. Additionally, the table shows MUF and FOT and field strength at FOT. Another output file, `PP.RAW`, contains only raw values. On every line there is: time of day (0-23 UTC), Frequency (MHz), field strength (dB$\frac{\mu V}{m}$) and antenna voltage (dBm).

MINIFTZ predicts field strength in dB over 1 $\frac{\mu V}{m}$. A given field strength generates different antenna voltages at different frequencies. The graphics display can be switched between field strength and antenna voltage. Hereby, the receiving antenna gain is used according to the `RX` statement in the configuration file.

The antenna voltage U_{Ant} in dBm is calculated by field strength E, wavelength λ and gain of the receiving antenna G_{RX}:

$$U_{\mathrm{Ant}} = 0.132 E \lambda \sqrt{G_{\mathrm{RX}}}$$

This results from the following expression using power density S

$$S = EH = \frac{E^2}{Z_0} \qquad \text{with} \quad Z_0 = 377\Omega$$

and the receiving antenna's area A

$$A = 1.64 \frac{\lambda^2}{4\pi} G_{\mathrm{RX}}$$

where the form factor of 1.64 corresponds with the gain of the half wave dipole (2.15 dB) over the isotropic radiator.

The resulting open circuit power N is

$$N = SA$$

and a perfect impedance match yields the antenna voltage U_{Ant} at 50Ω. Converting to dBm you get:

$$U_{\mathrm{Ant}}/\mathrm{dBm} = 45 - 20\log f/\mathrm{Hz} + E/\mathrm{dB}\frac{\mu\mathrm{V}}{\mathrm{m}}$$

This formula is evaluated in the following table for five classic amateur radio bands.

S Value	1	3	5	7	9
dBm	–121.0	–109.0	–97.0	–85.0	–73.0
3.5 MHz	–35.1	–23.1	–11.1	+0.9	+12.9
7 MHz	–29.1	–17.1	–5.1	+6.9	+18.9
14 MHz	–23.1	–11.1	+0.9	+12.9	+24.9
21 MHz	–20.6	–8.6	+4.4	+16.4	+28.4
28 MHz	–17.1	–5.1	+6.9	+18.9	+30.9

Field strength in $\mathrm{dB}\frac{\mu\mathrm{V}}{\mathrm{m}}$ for a receiving antenna with a gain of 0 $\mathrm{dB_D}$ = 2.15 dBi. On the low bands, noise plays the most important role in propagation forecast.

Example: The field strength of a S9 signal on 7 MHz is +18.9 $\mathrm{dB}\frac{\mu\mathrm{V}}{\mathrm{m}}$. If the receiving antenna gain is 0 dBi (isotropic radiator), the tabulated values must be increased by 2.15 dB.

5 Graphical display of the calculation

The calculated data is presented on a graphics screen. The header line contains important parameters of the prediction displayed:

- Name of the two locations (A and B)
- Bearing (A to B and B to A)
- Distance in Kilometers
- Month and year
- Sunspot number
- Probability of the prediction

- ERP in dBm

The main part of the screen is used for displaying graphs for different results. You can chose between field strength, antenna voltage and MUF/LUF/FOT. You can switch between the different screens by pressing appropriate keys on the keyboard or by clicking the buttons on the lower right side.

When using a color monitor, there are different colors for each frequency selected. Colors for the different frequencies and for the display screen can be adjusted in the configuration file `PP.CFG` Use the config commands `CS`, `CF`, `CT`, `CC` and `CB` to achieve your personal settings.

Another means of discerning the different lines is by using special symbols instead of colors. You can use this when you only have a monochrome monitor but you can also use it along with colors. The config parameter `SY` is responsible for using symbols or not — which symbols are being used can be configured with the command `SM`.

To make good use of the graphics display on your screen, the program automatically adjusts the top of the display in respect to the maximum value shown. So watch the top line when making comparisons.

To gain better understanding for propagation phenomena, the display shows daylight and night-time for both locations below the time axis. Here you can see which effects the sun has on a specific propagation path.

The time scale can be changed to local time at location A and location B by pressing the key 'T'. The display is not 100% exact, fractals of local time are not shown but you get an idea what time it is at the distant place.

If you have a mouse, you can walk around inside the diagram. The exact mouse cursor position is shown near the bottom left corner of the display. By specifying `MS=NO` in the configuration file, you can disable the mouse if you don't like it.

Using the keyboard

Function	Key
Field Strength	F or E
Antenna Voltage	U or V
MUF/LUF/FOT	M
Change Parameter	C
Print	P
Toggle local times/UTC	T
Quit program	X or Escape
Change lower border of display	Up Dn
Change upper border of display	PgUp PgDn
Back to borders standard	Return

6 Printing

Since version 1.4 of the program, graphical printouts of the calculated data are possible. This is achieved by the program `PRINTGL.EXE` which transforms HPGL into a variety of printer formats.

PP generates a HPGL plot file named `PP.PLT` by choosing the option PRINT on the menu or by pressing the key 'P' on your keyboard when in graphics mode. This file can be piped through `PRINTGL.EXE` immediately or at a later time, depending on how the CFG parameter `DP` is set. If you chose direct printing, `PRINTGL.EXE` will be called from within PP which requires enough free memory.

Printing will occur with the current settings for top and bottom limits which can be changed with PgUp, PgDn, Up and Dn keys from within the graphics mode.

As you can see from the `PRINTGL` documentation, this terrific program allows you to use a variety of different printers including dot matrix printers, laser printers and plotters. The config parameter `PT` has to be set to accommodate your printer.

Parameter `PD` allows you to select a destination for your print file. If you select LPT1 or LPT2, the printer will be tested if it is ready to print before printing starts.

7 PP.CFG

The file `PP.CFG` contains user dependent settings and configuration information. The file can be edited with a simple ASCII editor. Comments are marked with '#' at the very first line position. All other lines must consist of a valid configuration command. Don't put blanks before or after the '='.

The program looks for the configuration file in the `PPDIR` which is the directory where `PP.EXE` is found. If no configuration file can be found, default values are being used.

You can use different configuration files by supplying the name of the file on the command line. For example, you might have different files for 50 MHz, high bands and low bands. In these files you would play with config commands to modify the vertical radiation angle, transmit power, the frequency list etc. You can call PP with the 50 MHz configuration file (`50.cfg` by using the following command:

```
C:\>pp 50
```

Here is an alphabetical listing of all configuration commands.

AD *Auto_Date* (YES or NO)
With `AD=YES` date of the internal system clock is used automatically. With `AD=NO`, the user is prompted for a date with the system clock date given as a default.

AW *Auto_WWV* (YES or NO)
This parameter decides if sun activity data is to be entered interactively by the user or if the file which is specified by the WN parameter should be used.

CS *Color_Sunlight_Bar* (2 colors)
Colors for graphical daylight display.

CF *Color_Frequencies* (11 colors)
Colors for different frequencies.

CF *Color_Text* (1 colors)
Colors for text on the graphics screen.

CC *Color_Text* (1 colors)
Color for the coordinate system.

CB *Color_Buttons* (2 colors)
Colors for the button line on the right bottom of the screen.

DG *Draw_Grid* (YES or NO)
Depending on this toggle switch a grid is drawn with a line for every 10 dB and every full hour.

DP *Direct_Printing* (YES or NO)
By specifying YES, PP will try to print directly by spooling its HPGL output through the PRINTGL.EXE program. To make this work, you need to have enough free memory under DOS. Moreover, the printer must be "on line". If DP is set to NO, all HPGL commands are written to the file PP.PLT.

MS *Mouse_Usage* (YES or NO)
This parameter decides if a mouse which is active is being used by the program. Some people don't like mice and there are problems with Hercules video adapters — which made this parameter necessary. If there is no mouse on your computer (actually: no mouse driver like MOUSE.SYS loaded), this parameter has no influence.

MX, MY *Mouse_Sensitivity* (integer)
MX and MY parameters control the mouse speed. The smaller these values are chosen, the faster is the mouse.

NR *No_Rewrite* (YES or NO)
This parameter is used to decide if the HPGL output file PP.PLT is overwritten each time you print or if output is appended. In the latter case, PP.PLT contains several plots which can be plotted after you're done with your calculations. Then you will have to delete PP.PLT manually. NR makes sense only when DP is off (NO).

PD *Printing_Destination* (DOS Device)
This parameter controls the port where PRINTGL.EXE sends its output when printing directly from within PP. Here you specify device names like LPT1, LPT2, COM1 or COM2.

PT *Printer_Type* (Printer Type)
Select the printer type connected to your computer when printing directly from within the program. For more details see the configuration file and the PRINTGL documentation.

RF *Reference* (YES or NO)
This toggle is responsible to add S meter reference lines to the display. If it is on (YES), lines are drawn for S1, S5 and S9 units, when displaying antenna voltage.

RX *RX Gain* (a number)
Gain of the receiving antenna in dBi.

SF *Solar_Flux* (YES or NO)
Use solar flux values of sun spot number when prompting for user input. Internally, the program uses sun spot numbers but the two values can be converted back and forth.

ST *Startup_Display* (U or E)
Depending on this parameter the program starts in field strength or antenna voltage mode. You can always switch between the different displays. This variable, however, decides, which is the mode to be displayed right after the calculation is finished.

SM *Symbol_Table* (STRING)
This string contains the symbols to be used for the different lines (i.e. frequencies), apart from colors. The first symbol is used for the frequency specified first etc.

SY *Symbols* (YES or NO)
Do you want symbols to be used or just plain lines?

TC *Time Cursor* (YES or NO)
Display current time by a vertical line when this parameter is set to YES.

UT *UTC-Offset* (integer)
Difference between system time and UTC. This is used for correct time cursor display (see `TC`). Everyone living east of Greenwich has a negative offset. So Central European Time is –1.

WN *WWV_File_Name* (path and filename)
Here you can specify a file name where PP would look for solar data. As a default, PP looks for the file `WWV.DAT` in the `PPDIR`.

XA *Fixed_Angle* (a number)
Fixed vertical angle. If this parameter is specified, the user will no longer be prompted for vertical radiation angle.

XC *Fixed_PerCent* (10, 50 or 90)
Fixed prediction probability.

XF *Fixed_Frequencies* (max. 11 frequencies)
Fixed frequency table. The frequency values should be separated by blanks.

XG *Fixed_Gain* (a number)
Fixed gain of the transmit antenna in dBi.

XP *Fixed_Power* (a number)
Fixed transmitter power.

There are 16 different colors which can be specified be numbers of symbolic names:

BLK	BLU	GRN	CYA	RED	MAG	BRN	LGY
0	1	2	3	4	5	6	7
DGY	LBL	LGN	LCY	LRD	LMA	YEL	WHI
8	9	10	11	12	13	14	15

8 LOCATION.DAT

This file originally came from the PacketCluster software package which is used at DBØBCC. Unused columns were deleted. The file contains geographical coordinates for a variety of locations. If you are still not happy with it, you can add your own entries to `LOCATION.DAT` with a plain ASCII editor.

The file has a strict syntax which you have to follow. If you plan to make any changes, make a copy of the original file and keep it in a safe place.

The columns in the file `LOCATION.DAT` have the following meaning:

1. Prefix (this is the key)
2. Country name - will be displayed together with (1)
3. Latitude degrees
4. Latitude minutes
5. N or S
6. Longitude degrees
7. Longitude minutes
8. E or W
9. Local time minus UTC

All fields must be separated by blanks. Country names **must not have blanks** in them for this very reason. The entries must be in alphabetical order sorted by the first field (prefix). Keep this in mind when adding entries.

9 The future

The development of PP is now finished. Of course I will be open to your ideas and comments. As I can't keep control of it, I am not angry if you pass this program around among your friends and neighbors.

But please, please do not feed this into the packet network. We are all suffering from the un-numerous binary files flowing around in the packet network nowadays, making reasonable packet operations almost impossible.

All money received from selling of this software goes directly to the Bavarian Contest Club who supports contest related activities and installations.