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HP AppCAD - A Software Collection for Calculating Microwave Exercises

The keen response to my description of the CAD software "Puff" (1) encouraged me to take note of a further PC program which is interesting and helpful: HP AppCAD.

HP AppCAD comes on three 360K diskettes, which contain a comprehensive selection of HP semiconductor data and calcula-

tion programs for commonly-occurring microwave problems.

Fig. 1 shows the main menu. As you move the cursor on the left-hand side of the screen from line to line, a brief description appears on the right (Fig.2).

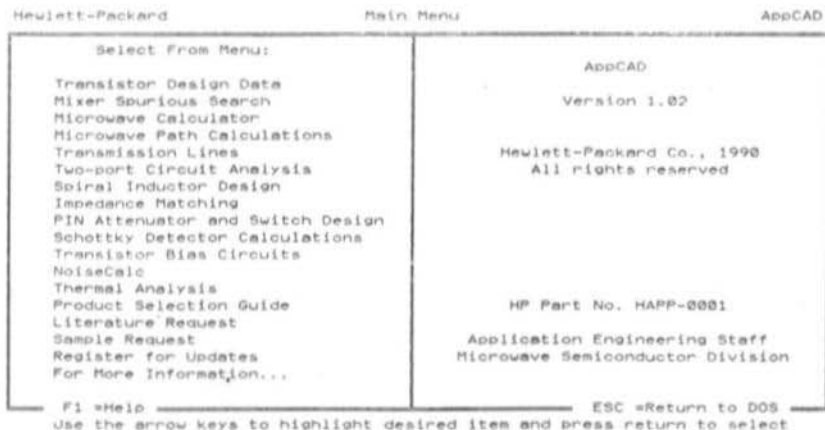


Fig.1



Hewlett-Packard Main Menu AppCAD

Select From Menu:

Transistor Design Data
 Mixer Spurious Search
 Microwave Calculator
 X Microwave Path Calculations X
 Transmission Lines
 Two-port Circuit Analysis
 Spiral Inductor Design
 Impedance Matching
 PIN Attenuator and Switch Design
 Schottky Detector Calculations
 Transistor Bias Circuits
 NoiseCalc
 Thermal Analysis
 Product Selection Guide
 Literature Request
 Sample Request
 Register for Updates
 For More Information...

■ Microwave Path Calculations
 This module calculates the S/N system performance resulting from these factors:
 ■ Receiver noise figure
 ■ Antenna gain
 ■ Transmitter power
 ■ Path distance
 ■ Frequency
 ■ Line losses
 Systems Covered:
 ■ One-way (Communication)
 ■ Two-way (Radar)

F1 =Help ESC =Return to DOS
 Use the arrow keys to highlight desired item and press return to select

Fig.2

Hewlett-Packard Communications System AppCAD

Power Out: 100 W Dist: 999 Km Ant Noise Temp: 90.0 9K
 Cable Loss: 0.1 dB Freq: 2.4 GHz Antenna Gain: 19.0 dB
 Antenna Gain: 10.0 dB Cable Loss: 1.0 dB
 Receiver Gain: 24.0 dB
 Receiver NF: 1.2 dB
 Bandwidth: 2.4 KHz

Effective Radiated Power: 9.8×10^{-11} Watts
 Power at Rcvr Input: 0.6×10^{-11} Watts
 Rcvr Noise Temperature: 92.3 9K
 S/N Ratio at Rcvr Output: 59.0 dB

F1 =Help F2 =Compute F3 =Units ESC =Quit
 Enter transmitter antenna gain.

Fig.3

Hewlett-Packard Microwave Calculator AppCAD

Mismatch Error Limits

SWR1 = 1.15
SWR2 = 2.10

Max SWR 2.42

Max Phase Error ± 1.42 deg

Max Mismatch + 0.212 dB
Error - 0.217 dB

Reflectometer

Coupler Directivity = 35 dB

	Min	Meas	Max
SWR	1.78	1.86	1.93
Ref1 Coefficient	0.28	0.30	0.31
Return Loss (dB)	10.96	10.43	9.94
Mismatch Loss (dB)	0.36	0.41	0.36

dB to Ratios

dB = 6.00

Voltage Ratio = 2.00 E 00
Power Ratio = 4.00 E 00

Conversion Table

SWR = 1.81
Ref1 Coeff = 0.28
Return Loss = 10.80 dB
Mismatch Loss = 0.37 dB

F1 =Help F2 =Compute F3 =Toggle ESC =Quit
 Use the arrow keys to highlight desired item and press return to select

Fig.4



This module performs some basic calculations relating to PIN diode switch and attenuator design. For switch design, insertion loss and isolation are computed from typical diode parameters. For attenuators, resistor values and the power dissipated in those resistors (PIN diodes) are computed.

Begin by making a selection from the menu below.

```

X Series Switch X
  Shunt Switch
  PI Attenuator
  Bridged Tee Atten
  
```

ESC =Quit

Fig.5

* Use Pg Up and Pg Dn to scroll the diode catalog

Hewlett-Packard Pin Diode	R_s (OHMS)	I_f (mA)	C_T (pF)	V_r (V)	Package
5082-3304	0.9	100	0.300	50	CERAMIC

Frequency (GHz) = 2.40

System Z_0 (ohms) = 50

Insertion Loss (dB) = 0.07

Isolation (dB) = 7.7

F1 =Help F2 =Compute ESC =Quit

Enter frequency for isolation computation.

Fig.6

The Hewlett-Packard Selection Guide is a menu driven program designed to help the user in selecting the correct part for a particular application. Catalog information current as of January 1990.

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Selection Guide Main Menu
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Schottky Diodes
PIN Diodes
Step Recovery Diodes
Noise Diode
X Transistors
Hybrid Amplifiers
Silicon MMIC Amplifiers
GaAs MMIC Products
Hi-Speed Decision Circuit
Integrated Products
  
```

XESC=Quit Selection Guide

Use the arrow keys to highlight desired item and press return to select

Fig.7



After clicking there then appears, for example, a circuit of a communication system with characteristic data, of which one can enter one or more data and the rest is then calculated by pressing F2 (Fig.3). This happens in a twinkling!

Pressing F1 causes explanatory text to appear, with F3 you can change units - for instance between km, nmi and smi, or between kHz, MHz and GHz, or between mils and micrometres.

In the communication system in Fig.3 it happens that a maximum distance of only

999km can be entered. Anyone wishing to calculate satellite path distances will have to double the distance several times and use some mental arithmetic (2).

The "Microwave Calculator" (Fig.4) comprises four independent modules for calculating or recalculating commonly used values.

Clicking "PIN Attenuator and Switch Design" involves more effort. With the brief explanation pops up a selection window (Fig.5); clicking on "Series Switch" brings up a brief data sheet from which you can turn up the appropriate PIN diode from the HP

Hewlett-Packard	Transistor Selection Guide	Description	AppCAD
What is your application?		Hewlett-Packard offers silicon NPN bipolar transistors for amplifier and oscillator applications. <ul style="list-style-type: none"> ■ Cutoff Frequency (Ft) up to 6 GHz ■ Output Power up to 30 dBm ■ Noise Figure 2.3 db at 2 GHz 	
<input checked="" type="checkbox"/> Amplifier <input type="checkbox"/> Oscillator			
Path			
F1 Backup F2 Start Over ESC Selection Guide Main Menu Use the arrow keys to highlight desired item and press return to select			

Fig.8

Hewlett-Packard	Transistor Selection Guide	Description	AppCAD
Amplifier Type ?		■ LNA Noise figure and frequency of operation is the primary consideration in selecting a part for this application. ■ General Purpose This group contains devices recommended for applications where noise figure or output power are not a major concern. ■ Power Amplifier Higher P1db devices are included in this group. Transistors suitable for lower level driver stages are also recommended. HP's highest output device is less than 1 watt. All devices are tested in class A operation.	
<input type="checkbox"/> Low Noise (LNA) <input type="checkbox"/> General Purpose <input type="checkbox"/> Power (& driver stages)			
Path			
Amplifier			
F1 Backup F2 Start Over ESC Selection Guide Main Menu Use the arrow keys to highlight desired item and press return to select			

Fig.9



Hewlett-Packard	Transistor Selection Guide	Description	AppCAD
Package Type ? <ul style="list-style-type: none"> • Low Cost Ceramic • Ceramic • Surface Mount X • Plastic • Chip 		<ul style="list-style-type: none"> • Low Cost Ceramic <p>This is a hermetic high volume 100 mil package (100x) with tin plated leads.</p>	
Path Amplifier: Low Noise Max Frequency is: 2.4 GHz		<ul style="list-style-type: none"> • Ceramic <p>This includes the HPAC-100 and HPAC-70 packages with gold plated leads. Both are hermetic packages.</p> <ul style="list-style-type: none"> • Surface Mount <p>Includes SOT-143 and SOT-23 non-hermetic packages for automatic insertion equipment.</p> <ul style="list-style-type: none"> • Plastic <p>Includes the 85 mil diameter stripline packages (HPAC-86/85).</p>	
F1 Backup		F2 Start Over	ESC Selection Guide Main Menu

Fig.10

Hewlett-Packard	Transistor Selection Guide	Description	AppCAD										
Recommended Device(s): HXTR-3685		<ul style="list-style-type: none"> • Package: Plastic Stripline (HPAC-85) 											
Path Amplifier: Low Noise Max Frequency is: 2.4 GHz Plastic		<ul style="list-style-type: none"> • Electrical Parameters <table border="1"> <thead> <tr> <th>P/N</th> <th>NF dB</th> <th>GA dB</th> <th>P1dB dBm</th> <th>G1dB dB</th> </tr> </thead> <tbody> <tr> <td>HXTR-3685</td> <td>1.8 typ</td> <td>16.4 typ</td> <td>16.3 typ</td> <td>13.3 typ</td> </tr> </tbody> </table> <p>Noise figure is at 1 GHz and $V_{ce} = 10V$, and $I_c = 10$ ma. P1dB is at 1 GHz, 10V 15 ma. The device is also available in the HPAC-86 with similar electrical specs. The HXTR-3685 has the leads formed for surface mount applications.</p> <p>See catalog for outline drawing.</p>	P/N	NF dB	GA dB	P1dB dBm	G1dB dB	HXTR-3685	1.8 typ	16.4 typ	16.3 typ	13.3 typ	
P/N	NF dB	GA dB	P1dB dBm	G1dB dB									
HXTR-3685	1.8 typ	16.4 typ	16.3 typ	13.3 typ									
F1 Backup		F2 Start Over	ESC Selection Guide Main Menu										

Fig.11

Hewlett-Packard	NoiseCalc	AppCAD
INTRODUCTION		
<p>This module calculates various performance parameters for a sub-system block diagram such as a receiver. This type of analysis allows system planning for the tradeoffs of important characteristics such as noise figure (sensitivity), gain distribution, dynamic range, signal levels, and intermodulation products. A sensitivity analysis is also provided to assess individual stage NF and Gain contributions to overall NF. System performance may be evaluated at different temperatures with the input of temperature coefficients for NF and Gain for each stage.</p>		
Page 1		
PgDn Next page		Enter Start Calculation
		Esc AppCAD Main Menu

Fig.12

Hewlett-Packard
AppCAD2 - 22 - 1991
NoiseCalc (v1.02)

Title: _____

Stage:	1	2		
Noise Figure (dB)	1.00	5.00		
Gain (dB)	15.00	-6.00		
IP3 (dBm)	0.00	16.00		
dNF/dT (dB/deg C)	0.000	0.000		
dG/dT (dB/deg C)	0.000	0.000		
Sys. Temp (deg C)	25.00		Reference Temp. (deg C)	25.00
Input Power (dBm)	-30.0		Noise Bandwidth (MHz)	1.000
Pout (dBm)	-15.0	-21.0		
dF/dF1 (dB/dB)	0.95	0.08		
dF/dGI (dB/dB)	-0.05	0.00		
Cascade Noise Figure (dB)	1.23		Cascade Gain (dB)	9.00
Noise Temperature (deg K)		94.9	Input IP3 (dBm)	-15.0
Signal-to-Noise ratio (dB)		82.8	Output IP3 (dB)	-6.03
Spur Free Dynamic Range (dB)		65.2	IM3 O/P Level (dB)	-50.95
Nominal Detectable Sig. (dB)		%-112.8		

Fig.13

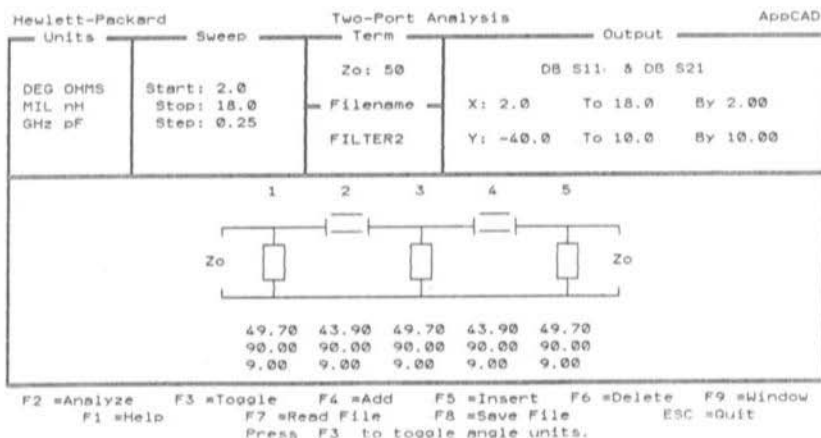


Fig.14

catalogue (Fig.6). After entering the working frequency and the impedance, the appropriate insertion and isolation attenuation values appear.

Much more comprehensive is the "Product Selection Guide". Here the choice is very broad (Fig.7) and after clicking you are led down a route (Figs.8, 9, 10) until finally one or more semiconductors for the frequency entered appear with their short-form data (Fig.11).

I printed out figures 1 to 12 using "Print Screen"; there are, however, also a pair of

modules which contain their own print option. So for example the "Noise Calculation" (Fig.12): using F5 you can print out the calculation sheet with the values entered and the results calculated (Fig.13).

The module "Two-port Circuit Analysis" permits the analysis of linear circuits with concentric or distributed circuit elements, which can be chosen from a pop-up menu. In addition data of S parameters in Touchstone format can be entered as a circuit element. For the dipole - (Fig.14) shows one of two permanently installed examples - after matching the values and units or even altering the

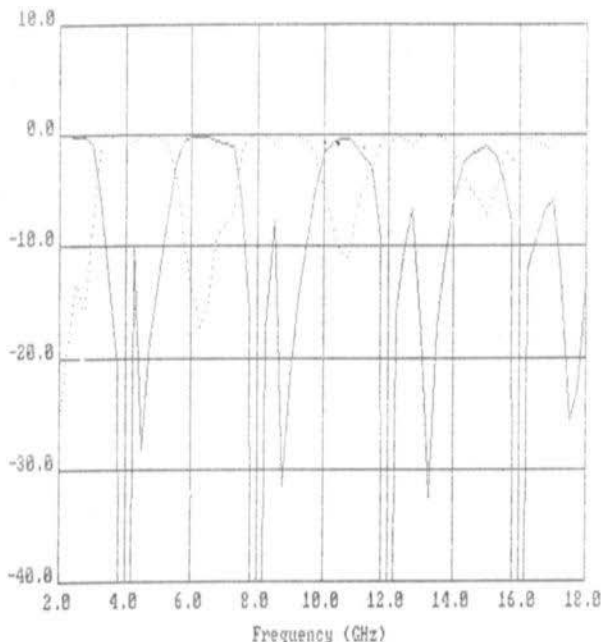


Fig.15

dipole itself, you can work out the values of S_{11} and S_{21} over the (fixed) range of 2 to 18GHz and print this in graphic form on paper using an Epson-compatible printer (Fig.15).

With this I have certainly not described all that HP AppCAD can do but at least a profile of it. It is probably clear that you need a good technical grounding: in my opinion, while the help files give useful assistance, they are no substitute for textbooks and reading. For printed circles (Spiral Inductor Design) recourse will definitely need to be made to an American textbook.

On the other hand, the selection of HP semiconductors offered is an up-to-date method of reference in a databook, which every interested person can use immediately. In addition the semiconductor S parameter data provided in Touchstone format (one complete floppy full) can be used in CAD programs. To use them in the program Puff a

conversion utility is needed, which Klaus-Juergen Schoepf DB3TB has made available.

LITERATURE

- (1) Robert E. Lentz, DL3WR: Puff - A CAD program for microwave stripline circuits VHF COMMUNICATIONS 23 (1991), pp 66-68.

Follow-up to the article 'PUFF - a CAD Program for Microwave Stripline Circuits'

The editor and publisher would like to thank readers for the many letters they received advising other CAD software programs. As soon as these come down to an amateur price level, we will mention them.