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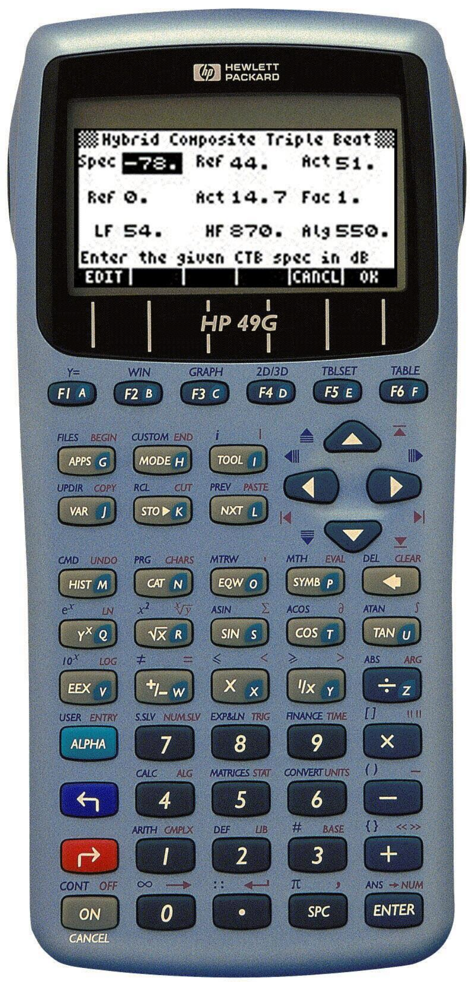
HP49G CATV Library

CATV Broadband and Fiber Optic Engineering Functions



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CATV Broadband and Fiber Optic Engineering Functions

Overview

This library contains engineering functions useful to those working in the CATV and/or broadband communications industries. The library was developed on the Hewlett-Packard HP49G scientific graphing calculator using the built in development tools and is written almost entirely in SysRPL (System Reverse Polish Lisp). SysRPL is a lower level language than the standard UserRPL, and as such has advantages not only in code size and speed but also in the fact that it allows greater capability and versatility.

Disclaimer & Copyright

This program is freeware, so no registration or licensing fees apply. You may freely distribute this program to anyone, as long as this document is included.

The author assumes no responsibility whatever for any damage or data loss caused by this program. No program (of any consequence) can be considered to be truly free of bugs.

Because this program was developed in SysRPL for the HP49G, it will not run on the HP48G/X series calculators.

If you have any suggestions or find any bugs in the code, please contact me per email at mailto:simonclivehughes@hotmail.com.

Credits

Thanks goes to ACO for the HP49G and the superb development tools that they have provided, as well as to Jim Donnelly for his work “An Introduction to HP 48 System RPL and Assembly Language Programming” and to Eduardo Kalinowski for his tutorial “Programming in System RPL”.

Special thanks also to Steen Schmidt for his fabulous program InFormBuilder, and to the many members of the comp.sys.hp48 news group.

Requirements & Installation

You need to copy the library (which is distributed at this time as a directory called CatvLib) to the calculator and store it in the HOME directory.

Library Details

The CATV Library encompasses functions and programs that are used by RF Circuit/Network Designers to determine unit and cascaded distortions and noise performance and to calculate fiber optic parameters etc. Additionally, the library contains routines for determining common coaxial cable attenuations, linear sloped levels and contains a number of conversions used by the industry.

Wherever possible, advantage is made of the INFORM and CHOOSE routines to provide an easy to use and quick graphic interface.

Implementation

The library is designed in a manner that uses GUI “front ends” for almost all functions.

Figure 1 Example GUI interfaces.

All of the INFORM and CHOOSE boxes are implemented using pure SysRPL which allows them to run very fast compared with regular UserRPL.

In each directory, the leftmost soft key is EXIT, which is a very short SysRPL program which, when pressed quickly, performs an UPDIR command, and if pressed and held down a bit longer, performs a HOME command.

Each function of the library is detailed in this document as to which variables are used and what input is expected.

Source Code

Because these programs are being distributed in a directory form, the user has direct access to the SysRPL code. Users are encouraged to examine the code and modify it as they see fit. This must be done carefully, of course, as all non-UserRPL programming may produce the dreaded “Try To Recover Memory?” message!

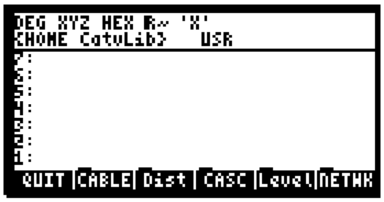
PLEASE NOTE that the author does not wish to act as a resource for programming assistance. All code modification is done at the users risk. The author assumes no responsibility whatever for any damage or data loss caused by third-party modifications to this program.

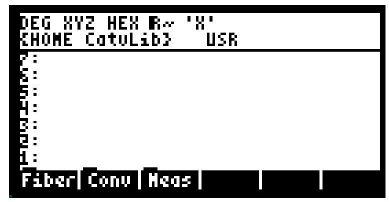
Structure

CatvLib is set up in directories that encompass the logical functions for different categories.

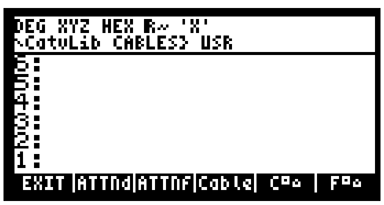
Here are screen shots of the directory structures:

Main Directory



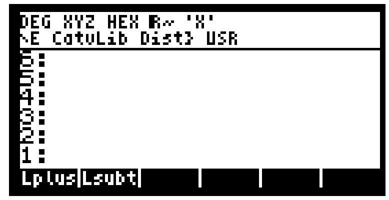


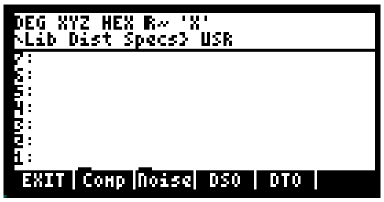
Cable Directory

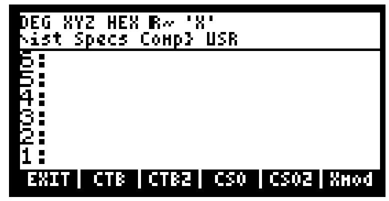


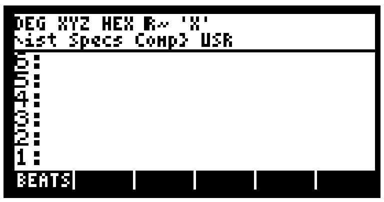
Category	**Function**	**Description**
Coax Cable	ATTNd	Given nominal shield outside diameter and a frequency, calculates approximate loss per 100 feet
Coax Cable	ATTNf	Given a loss at a frequency, calculates approximate loss at another frequency
Coax Cable	Cable	Given a frequency, presents a CHOOSE box with many cables. Selecting a cable yields the approximate attenuation for that frequency.
Coax Cable	C°Δ	Given loss at °C temperature, calculates approximate loss at another °C temperature
Coax Cable	F°Δ	Given loss at °F temperature, calculates approximate loss at another °F temperature

Distortions Directory









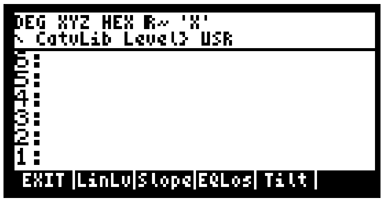
Category	Function	Description
Distortion	L10+	Adds two dB values at 10 log
Distortion	L10-	Subtracts one dB value from another at 10 log
Distortion	L20+	Adds two dB values at 20 log
Distortion	L20-	Subtracts one dB value from another at 20 log
Distortion	Lplus	Adds two dB values at x log
Distortion	Lsubt	Subtracts one dB value from another at x log
Distortion	CTB	Calculates unit Composite Triple Beat spec
Distortion	CTB2	Calculates hybrid unit Composite Triple Beat spec
Distortion	CSO	Calculates unit Composite Second Order spec
Distortion	CSO2	Calculates hybrid unit Composite Second Order spec
Distortion	XMOD	Calculates unit Cross Modulation spec
Distortion	DSO	Calculates unit Discrete Second Order spec
Distortion	DTO	Calculates unit Discrete Third Order spec

Distortion	NF	Calculates unit Noise Figure
Distortion	CNR	Calculates unit Carrier-to-Noise ratio
Distortion	CIN	Calculates the Composite Intermodulation Noise
Distortion	CCNR	Calculates the Composite Carrier-to-Noise ratio
Distortion	CNdig	Calculates the likely worst-case C/N for a non-analog-video signal.
Distortion	BEATS	Given total number of channels and a given channel, calculates the number of beats

Cascade Directory

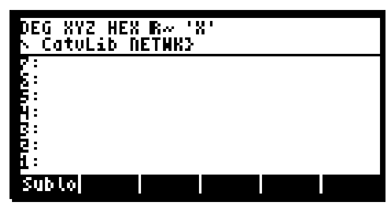
Category	Function	Description
Cascade Analysis	PERF	Calculates complete unit and cascaded amp performance
Cascade Analysis	Anlys	Performs a cascade analysis given fiber link and cascaded amplifier specifications

Levels Directory



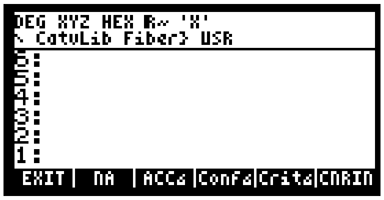
Category	Function	Description
Levels	LinLv	Given known levels at a low and high frequency, and a desired frequency, calculates the overall slope, slope and level at a desired different (intermediate) frequency.
Levels	Slope	Given a known level at a high frequency, the low and high frequency and the slope between them, calculates the slope, delta and level at a desired different (lower or higher) frequency.
Levels	EQLoss	Calculates the cable loss from an equalizer at a desired frequency.
Levels	Tilt	Calculates the equivalent cable loss from a tilt.

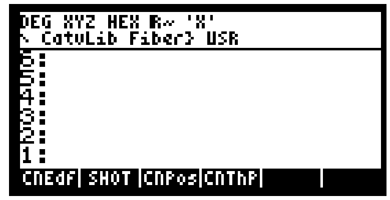
Network Directory



Category	Function	Description
Network	BPCF	Calculates Bandwidth-per-Customer in the forward direction
Network	BPCR	Calculates Bandwidth-per-Customer in the reverse direction
Network	Nsim	Calculates the number of simultaneous communications for a service.
Network	HPN	Calculates homes per node
Network	CCIR	Matrix with CCIR channel numbers & frequencies
Network	Sublow	Matrix with Sub-low VHF channel numbers & frequencies

Fiber Optics Directory





Category	Function	Description
Fiber Optics	NA	Calculates numerical aperture
Fiber Optics	ACC∠	Calculates the half-acceptance angle
Fiber Optics	Conf∠	Calculates the confinement angle
Fiber Optics	Crit∠	Calculates the critical angle
Fiber Optics	CNRIN	Calculates the contribution of source noise due to RIN (Relative Intensity Noise)
Fiber Optics	CNEdfa	Calculates Carrier-to-Noise contribution for an EDFA
Fiber Optics	SHOT	Calculates C/N of an individual carrier due to shot noise
Fiber Optics	CNPost	Calculates the carrier-to-noise of a postdetector (transimpedance) amplifier
Fiber Optics	CNThPost	Calculates the carrier-to-noise of a postdetector (transimpedance) amplifier using thermal noise input current

Conversions Directory

Category	Function	Description
Conversion	mWdBm	Given either mW or dBm, calculates the other
Conversion	mVdBV	Given either mV or dBmV, calculates the other
Conversion	mVdBm	Given either mV or dBm, calculates the other
Conversion	dBm/V	Given either dBm or dBmV, calculates the other
Conversion	dBμ/V	Given either dBμm or dBmV, calculates the other

Measurement Directory

Category	Function	Description
Measurement	GAINV	Calculates power increase in dB given mV
Measurement	GAINP	Calculates power increase in dB given mW
Measurement	LOSSV	Calculates power decrease in dB given mV
Measurement	LOSSP	Calculates power decrease in dB given mW
Measurement	Pout	Calculates power out in mW
Measurement	Pin	Calculates power in mW
Measurement	Xl	Calculates inductive reactance
Measurement	Xc	Calculates capacitive reactance

Function Reference and Examples

The following sections describe in detail the CATV Library functions. The functions are presented grouped by category.

Each function is shown (where applicable) with a screen shot of the appropriate GUI. Remember that in all cases where an INFORM box is shown for the routine, that you just call the routine to get the INFORM box.

Formulae are shown as well as stack diagrams that show what the INFORM box leaves on the stack (in most cases) for the function.

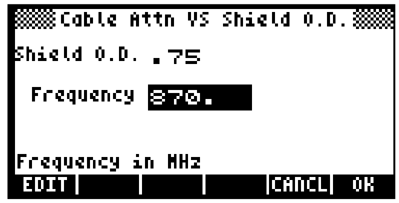
An example and instructions are provided for using the functions.

Coaxial Cable Functions

ATTNd

Description

This function calculates the approximate attenuation (in dB/100 feet) of a P3 generation coaxial cable given the nominal shield (sheath) outside diameter in inches and a specific frequency in MHz.



$$attn = \left[\frac{0.036}{D_{nom}} \right] \sqrt{f} + 0.0002 f$$

Where $attn$ = attenuation in dB per 100 feet
D_{nom} = nominal shield outer diameter in inches
f = frequency in MHz

Input Stack Diagram

Stack Level	Contents
Level 2	D_{nom}
Level 1	f

Example

If the nominal shield outer diameter of a P3 750 cable is 0.75 inches, and the wanted frequency is 870 MHz, then the attenuation per 100 feet is:

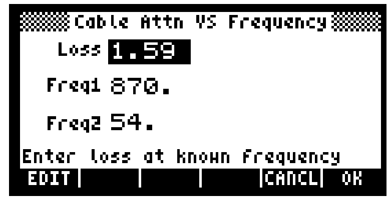
0 . 7 5 `
8 7 0 ` @@#OK@#@

The result is: 1.59

ATTNf

Description

This function calculates approximate attenuation at a desired frequency given the attenuation in dB at a known frequency in MHz.



$$attn_{f2} = attn_{f1}\sqrt{\frac{f_2}{f_1}}$$

Where $attn_{f1}$ = attenuation in dB for frequency 1
f_2 = desired frequency in MHz

Input Stack Diagram

Stack Level	Contents
Level 2	$Attn_{f1}$
Level 1	f_2

Example

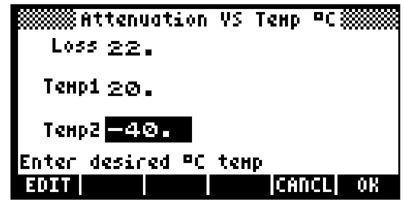
If the attenuation per 100 feet is 1.59 dB at 870 MHz, then the attenuation at the wanted frequency of 54 MHz is:

1 . 5 9 `
8 7 0 `
5 4 ` @@#OK@#@

The result is: 0.40

C°Δ

Description



Given the attenuation in dB at a known temperature in °C, this function calculates approximate attenuation at a desired temperature and the delta.

$$attn_{t2} = attn_{t1} \times ((t2 - t1)/5.6)/100$$

Where $attn_{t1}$ = attenuation in °C for temperature 1
t_2 = desired temperature in °C

Input Stack Diagram

Stack Level	Contents
Level 2	$attn_{t1}$
Level 1	t_2

Example

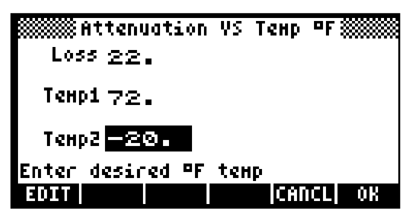
If the attenuation is 22 dB at 20 °C then the attenuation at –10 °C will be:

2 2 `
2 0 `
4 0 W ` @@#OK@#@

The result is: -2.36
19.64

F°Δ

Description



Given the attenuation in dB at a known temperature in °F, this function calculates approximate attenuation at a desired temperature and the delta.

$$attn_{t2} = attn_{t1} \times ((t2 - t1)/10)/100$$

Where $attn_{t1}$ = attenuation in °F for temperature 1
t_2 = desired temperature in °F

Follow the above example for the C°Δ function.

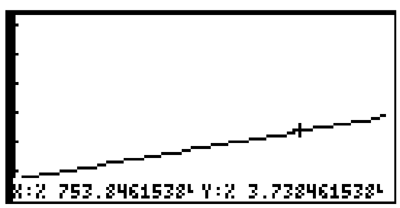
Cables

Description

This function gives access to equations that describe the approximate attenuation (per 100 feet) versus frequency for common coaxial cables; both drop cables and hard cables. Entering the losses versus frequency provided for cables from the following manufacturers created these equations:

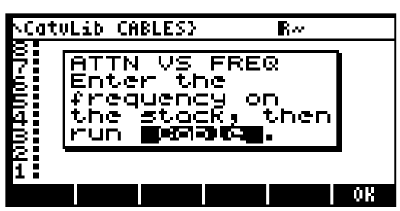
Manufacturer	Cable Sizes
CommScope Drop Cable	56, 6, 7, 11
CommScope P3 Hard Cable	412, 500, 625, 750, 875, 1000
CommScope QR Hard Cable	320, 540, 715, 860, 1125
Times Fiber Cable Drop	56, 6, 7, 11
Times Fiber Hard Drop	412, 500, 625, 750, 875, 1000
Trilogy Drop Cable	56, 6, 7, 11
Trilogy Hard Cable	440, 500, 625, 750, 1000

Curve fitting was applied to the attenuations at frequencies from 5 MHz to 1000 MHz, and equations describing the attenuation curves were derived. Many cables had very similar attenuations, such as for .625 cables, where CommScope P3 625, Trilogy 625, TFC 625 and CommScope QR 540 were all quite similar; the median values were used to create one equation that is used for all of these cables.



- Figure 2 Graph showing the attenuation at 753 MHz on the curve for RG11 drop cable. The loss is 3.74 dB per 100 feet.

To access this function, you enter a frequency at which you want the attenuation (in dB per 100 feet) and then call the Cable routine. If the routine is called without a number (frequency) on the stack, the following message will appear:



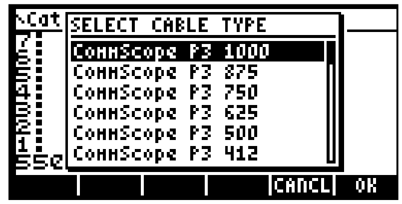
- Figure 3 Error message generated if no frequency value is entered prior to calling the routine.

Example

To determine the approximate loss at 750 MHz for a CommScope P3 1000 cable:

7 5 0 Cable

You will be presented with the following CHOOSE box shown at right. Scroll to the appropriate cable choice using the up and down arrow keys, and then press the OK soft key.



The result will be: 1.24 dB per 100 feet.

To bypass the CHOOSE box interface and access the individual cables directly, you would enter the frequency (in MHz) and then call the routine.

For example, using the above values:

7 5 0 C1000

The result will be: 1.24 dB per 100 feet.

The following table shows the appropriate routines for the different cables:

Manufacturer	Cable Sizes	Routine
CommScope, TFC, Trilogy	56	D59
CommScope, TFC, Trilogy	6	D6
CommScope, TFC, Trilogy	7	D7
CommScope, TFC, Trilogy	11	D11
CommScope QR	320	C320
CommScope P3, TFC	412	C412
Trilogy	440	C440
CommScope P3, TFC,	500	C500
CommScope QR	540	C625
CommScope P3, TFC,	625	C625
CommScope QR	715	C750
CommScope P3, TFC,	750	C750
CommScope QR	860	C1000
CommScope P3, TFC	875	C875
CommScope P3, TFC	1000	C1000
Trilogy	1000	C1125
CommScope QR	1125	C1125

Distortion Analysis Functions

L10+

Description

This function logarithmically adds two decibel values using 10log. Because the routine internally converts entries to negative values, either positive or negative numbers can be used for entries.

$$Dist_{total} = 10\log\left(10^{\frac{Dist_1}{10}} + 10^{\frac{Dist_2}{10}}\right)$$

Where $Dist_1$ = distortion 1 in dB
$Dist_2$ = distortion 2 in dB

Input Stack Diagram

Stack Level	Contents
Level 2	$Dist_1$
Level 1	$Dist_2$

Example

Add decibel values of –65 and –62 together:

6 5 `
6 2 L10+

The result is: -60.24

L10-

Description

This function logarithmically subtracts two decibel values using 10log. Because the routine internally converts entries to negative values, either positive or negative numbers can be used for entries.

$$Dist_{total} = 10\log\left(10^{\frac{Dist_1}{10}} - 10^{\frac{Dist_2}{10}}\right)$$

Where $Dist_1$ = distortion 1 in dB
$Dist_2$ = distortion 2 in dB

NOTE that when using this function, the smaller of the two numbers must be input first. E.g. to Subtract 62 dB from 60.24 dB, enter the 62.24 figure first.

Input Stack Diagram

Stack Level	Contents
Level 2	$Dist_1$
Level 1	$Dist_2$

Example

Subtract the decibel values of –62 from –60.24:

6 0 . 2 4 `
6 2 L10-

The result is: -65.00

L20+

Description

This function logarithmically adds two decibel values using 20log. Because the routine internally converts entries to negative values, either positive or negative numbers can be used for entries.

$$Dist_{total} = 20\log\left(10^{\frac{Dist_1}{20}} + 10^{\frac{Dist_2}{20}}\right)$$

Where $Dist_1$ = distortion 1 in dB
$Dist_2$ = distortion 2 in dB

Input Stack Diagram

Stack Level	Contents
Level 2	$Dist_1$
Level 1	$Dist_2$

Example

Add decibel values of –65 and –62 together:

6 5 `
6 2 @L20+@

The result is: -57.35

L20-

Description

This function logarithmically subtracts two decibel values using 20log. Because the routine internally converts entries to negative values, either positive or negative numbers can be used for entries.

$$Dist_{total} = 20\log\left(10^{\frac{Dist_1}{20}} - 10^{\frac{Dist_2}{20}}\right)$$

Where $Dist_1$ = distortion 1 in dB
$Dist_2$ = distortion 2 in dB

NOTE that when using this function, the smaller of the two numbers must be input first. E.g. to Subtract 62 dB from 60.24 dB, enter the 62.24 figure first.

Input Stack Diagram

Stack Level	Contents
Level 2	$Dist_1$
Level 1	$Dist_2$

Example

Subtract the decibel values of –62 from –57.35:

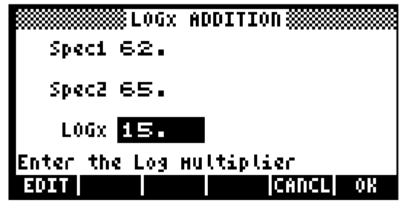
5 7 . 3 5 `
6 2 @L20-@

The result is: -65.00

Lplus

Description

This function logarithmically adds two decibel values using a log multiplier that you define. Because the routine internally converts entries to negative values, either positive or negative numbers can be used for entries.



$$Dist_{total} = x \log\left(10^{\frac{Dist_1}{x}} + 10^{\frac{Dist_2}{x}}\right)$$

Where $Dist_1$ = distortion 1 in dB
$Dist_2$ = distortion 2 in dB
x = log multiplier

Input Stack Diagram

Stack Level	Contents
Level 2	$Dist_1$
Level 1	$Dist_2$

Example

Add decibel values of –62 and –65 together at 15log:

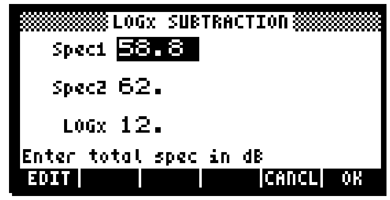
6 2 `
6 5 `
1 5 ` @@#OK@#@

The result is: `-58.81`

Lsubt

Description

This function logarithmically subtracts two decibel values using a log multiplier that you define. Because the routine internally converts entries to negative values, either positive or negative numbers can be used for entries.



$$Dist_{total} = x \log\left(10^{\frac{Dist_1}{x}} - 10^{\frac{Dist_2}{x}}\right)$$

Where $Dist_1$ = distortion 1 in dB
$Dist_2$ = distortion 2 in dB
x = log multiplier

NOTE that when using this function, the smaller of the two numbers must be input first. E.g. to Subtract 62 dB from 60.24 dB, enter the 62.24 figure first.

Input Stack Diagram

Stack Level	Contents
Level 2	$Dist_1$
Level 1	$Dist_2$

Example

Subtract the decibel values of –62 from –58.81 at 12log:

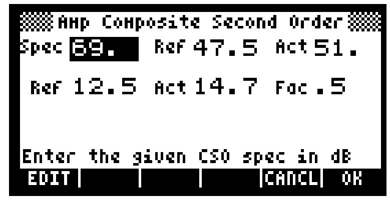
5 8 . 8 1 `
6 2 `
1 2 ` @@#OK@#@

The result is: -62.89

CSO

Description

This function calculates the unit Composite Second Order (CSO) specification.



$$CSO = spec + 2\times(actlev - reflev) - (actslp - refslp)\times slpfac$$

Where *spec* = manufacturer's (or given) CSO specification in ±dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)
actslp = actual used slope in dB
refslp = reference slope in dB (for given spec)
slpfac = slope factor in dB (amount per dB that CSO improves/degrades)

Input Stack Diagram

Stack Level	Contents
Level 6	*Spec*
Level 5	*Actlev*
Level 4	*Reflev*
Level 3	*Actslp*
Level 2	*Refslp*
Level 1	*Slpfac*

Example

Given a manufacturer's CSO spec of –69 dB at a reference output of 47.5 dBmV and a slope of 12.5 dB, and assuming that the factor by which CSO changes with slope to be 1:0.5, find the what the CSO spec will be at an output of 51 dBmV and a slope of 14.7 dB:

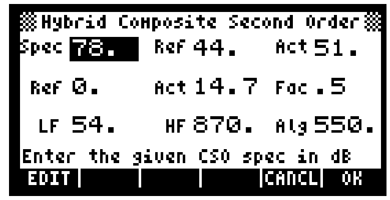
6 9 `
4 7 . 5 `
5 1 `
1 2 . 5 `
1 4 . 7 `
0 . 5 ` @@#OK@#@

The result is: -66.60

CSO2

Description

This function calculates the unit Composite Second Order (CSO) specification of a hybrid.



$$CSO = spec + (actlev - reflev) - [((actslp - refslp)/(hifreq - lowfreq)) \times (\mathrm{analog} - lowfreq) \times slpfac]$$

Where *spec* = manufacturer's (or given) CSO specification in ±dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)
actslp = actual used slope in dB
refslp = reference slope in dB (for given spec)
slpfac = slope factor in dB (amount per dB that CSO improves/degrades)
hifreq = the design high frequency in MHz
lowfreq = the design low frequency in MHz
analog = the highest analog frequency in MHz

Input Stack Diagram

Stack Level	Contents
Level 9	*spec*
Level 8	*actlev*
Level 7	*reflev*
Level 6	*actslp*
Level 5	*refslp*
Level 4	*slpfac*
Level 3	*hifreq*
Level 2	*lowfreq*
Level 1	*analog*

Example

Given a manufacturer's CSO spec of –78 dB at a reference output of 44 dBmV and a slope of 0 dB, and assuming that the factor by which CSO changes with slope to be 1:0.5, find the what the CSO spec will be at an output of 51 dBmV, a slope of 14.7 dB, the device bandwidth from 54 to 870 MHz with 550 MHz of analog channel loading:

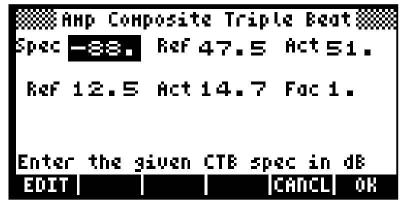
7 8 \`
4 4 \`
5 1 \`
0 \`
1 4 . 7 \`
0 . 5 \`
5 4 \`
8 7 0 \`
5 5 0 \` @@#OK@#@

The result is: -75.47

CTB

Description

This function calculates the unit Composite Triple Beat (CTB) specification.



$$CTB = spec + 2 \times (actlev - reflev) - (actslp - refslp) \times slpfac$$

Where *spec* = manufacturer's (or given) CTB specification in ±dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)
actslp = actual used slope in dB
refslp = reference slope in dB (for given spec)
slpfac = slope factor in dB (amount per dB that CTB improves/degrades)

Input Stack Diagram

Stack Level	Contents
Level 6	*spec*
Level 5	*actlev*
Level 4	*reflev*
Level 3	*actslp*
Level 2	*refslp*
Level 1	*slpfac*

Example

Given a manufacturer's CTB spec of –88 dB at a reference output of 47.5 dBmV and a slope of 12.5 dB, and assuming that the factor by which CTB changes with slope to be 1:1, find the what the CTB spec will be at an output of 51 dBmV and a slope of 14.7 dB:

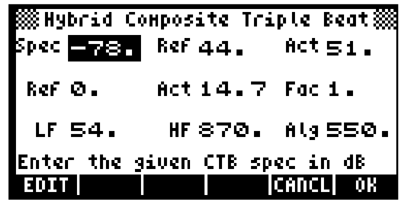
8 8 \`
4 7 . 5 \`
5 1 \`
1 2 . 5 \`
1 4 . 7 \`
1 \` @@#OK@#@

The result is: -83.20

CTB2

Description

This function calculates the unit Composite Triple Beat (CTB) specification of a hybrid.



$$CTB = spec + 2\times(actlev - reflev) - [((actslp - refslp)/(hifreq - lowfreq))\times(\text{analog} - lowfreq)\times slpfac]$$

Where *spec* = manufacturer's (or given) CTB specification in ±dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)
actslp = actual used slope in dB
refslp = reference slope in dB (for given spec)
slpfac = slope factor in dB (amount per dB that CTB improves/degrades)
hifreq = the design high frequency in MHz
lowfreq = the design low frequency in MHz
analog = the highest analog frequency in MHz

Input Stack Diagram

Stack Level	Contents
Level 9	*spec*
Level 8	*actlev*
Level 7	*reflev*
Level 6	*actslp*
Level 5	*refslp*
Level 4	*slpfac*
Level 3	*hifreq*
Level 2	*lowfreq*
Level 1	*analog*

Example

Given a manufacturer's CTB spec of –78 dB at a reference output of 44 dBmV and a slope of 0 dB, and assuming that the factor by which CTB changes with slope to be 1:1, find the what the CTB spec will be at an output of 51 dBmV, a slope of 14.7 dB, the device bandwidth from 54 to 870 MHz with 550 MHz of analog channel loading:

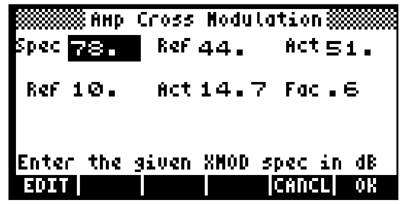
```
7 8 `
4 4 `
5 1 `
0 `
1 4 . 7 `
1 `
5 4 `
8 7 0 `
5 5 0 ` @@#OK@#@
```

The result is: -72.93

XMOD

Description

This function calculates the unit Cross Modulation (XMOD) specification.



$$XMOD = spec + 2\times(actlev - reflev) - (actslp - refslp)\times slpfac$$

Where *spec* = manufacturer's (or given) XMOD specification in ±dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)
actslp = actual used slope in dB
refslp = reference slope in dB (for given spec)
slpfac = slope factor in dB (amount per dB that XMOD improves/degrades)

Input Stack Diagram

Stack Level	Contents
Level 6	*spec*
Level 5	*actlev*
Level 4	*reflev*
Level 3	*actslp*
Level 2	*refslp*
Level 1	*slpfac*

Example

Given a manufacturer's XMOD spec of –78 dB at a reference output of 44 dBmV and a slope of 12.5 dB, and assuming that the factor by which XMOD changes with slope to be 1:0.6, find the what the XMOD spec will be at an output of 51 dBmV and a slope of 14.7 dB:

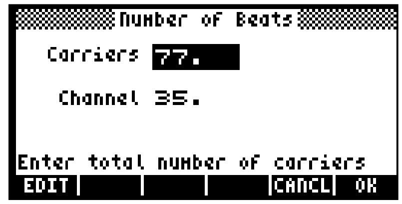
7 8 `
4 4 `
5 1 `
1 0 `
1 4 . 7 `
0 . 6 ` @@#OK@#@

The result is: -66.82

BEATS

Description

This function calculates the number of Composite Triple Beats that fall on a specific channel.



$$Beats = \frac{N^2}{4} + \frac{1}{2} \times (N - M) \times (M - 1)$$

Where *N* = the total number of carriers
M = the channel number of interest

Input Stack Diagram

Stack Level	Contents
Level 2	*N*
Level 1	*M*

Example

Find the number of triple beats on channel 35 in a system with 77 carriers:

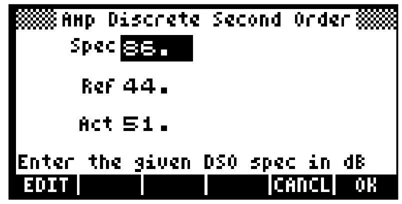
7 7 `
3 5 ` @@#OK@#@

The result is: `2,196.25`

DSO

Description

This function calculates the unit Discrete Second Order (DSO) specification.



$$DSO = spec - (actlev - reflev)$$

Where *spec* = manufacturer's (or given) DSO specification in ±dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)

Input Stack Diagram

Stack Level	Contents
Level 3	*spec*
Level 2	*actlev*
Level 1	*reflev*

Example

Given a manufacturer's DSO spec of –86 dB at a reference output of 44 dBmV, find the what the DTO spec will be at an output of 51 dBmV:

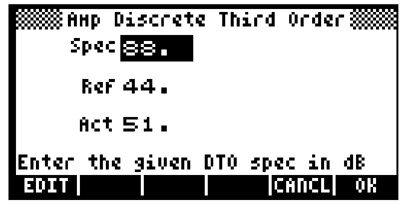
8 6 \`
4 4 \`
5 1 \` @@#OK@#@

The result is: `-79.00`

DTO

Description

This function calculates the unit Discrete Third Order (DTO) specification.



$$DTO = spec - 2 \times (actlev - reflev)$$

Where *spec* = manufacturer's (or given) DTO specification in ±dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)

Input Stack Diagram

Stack Level	Contents
Level 3	*spec*
Level 2	*actlev*
Level 1	*reflev*

Example

Given a manufacturer's DSO spec of –88 dB at a reference output of 44 dBmV, find the what the DTO spec will be at an output of 51 dBmV:

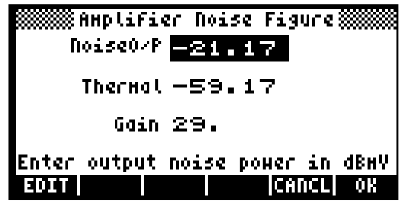
8 8 \`
4 4 \`
5 1 \` @@#OK@#@

The result is: -74.00

NF

Description

This function calculates the unit Noise Figure (nf) specification.



$$NF = noiseop - \left(thermal_{noise} + gain\right)$$

Where *noiseop* = manufacturer's (or given) CTB specification in ±dB
$thermal_{noise}$ = the thermal noise in dBmV
gain = device gain in dB

Input Stack Diagram

Stack Level	Contents
Level 3	*noiseop*
Level 2	$thermal_{noise}$
Level 1	*gain*

Example

Given a NoiseO/P of –21.17 dB, the thermal noise of –59.17 dB and a gain of 29 dB find the noise figure:

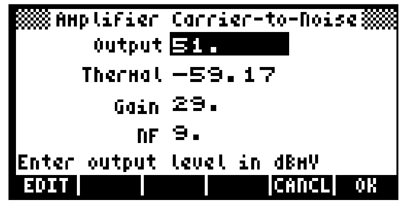
2 1 . 1 7 \ `
5 9 . 1 7 \ `
2 9 ` @@#OK@#@

The result is: 9

CNR

Description

This function calculates the unit Carrier-to-Noise ratio (CNR) specification.



$$CNR = output - (-59.17) + gain + nf$$

Where *output* = device output level in dBmV
gain = device gain in dB
nf = device noise figure in dB

Input Stack Diagram

Stack Level	Contents
Level 3	*output*
Level 2	*gain*
Level 1	*nf*

Example

Given an output of 51 dBmV, the thermal noise of –59.17 dB and a gain of 29 dB and a noise figure of 9 dB, find the CNR:

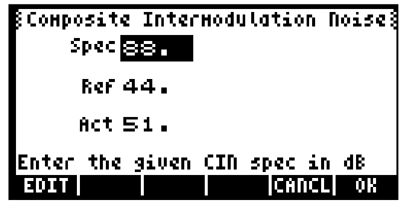
5 1 `
5 9 . 1 7 \ `
2 9 `
9 ` @@#OK@#@

The result is: 72.17

CIN

Description

This function calculates the total Composite Intermodulation Noise ratio (CIN) specification.



$$CIN = spec + 2\times(actlev - reflev)$$

Where *spec* = Composite Intermodulation Noise spec in dB
actlev = actual used output level in dBmV
reflev = reference level in dBmV (for given spec)

Input Stack Diagram

Stack Level	Contents
Level 3	*spec*
Level 2	*actlev*
Level 1	*reflev*

Example

Given a CIN spec of –88 dB at a reference output of 44 dBmV, find the CIN at an output of 51 dBmV:

8 8 \`
4 4 \`
5 1 \` @@#OK@#@

The result is: -74.00

CCNR

Description

This function calculates the unit Composite Carrier-to-Noise ratio (CCNR) specification.

$$CCNR = \left(CNR_{ana\log} \oplus CIN_{total} : 10\log\right)$$

Where CNR_{analog} = Analog Carrier-to-Noise contribution in dB
CIN_{total} = Composite Intermodulation Noise contribution in dB

Use the L10+ routine for this function.

Input Stack Diagram

Stack Level	Contents
Level 2	CNR_{analog}
Level 1	CIN_{total}

Example

Given an analog CNR of –65 dB and the CIN from the digital signals at –62 dB, find the CCNR:

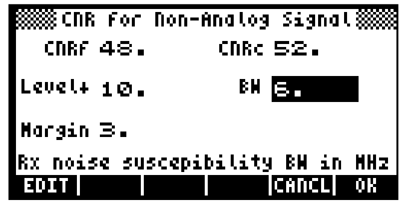
6 5 `
6 2 L10+

The result is: -60.24

CNdig

Description

This function calculates the likely worst-case C/N for a non-analog-video signal.



$$C/N_{digital} = \left(C/N_s \oplus C/N_d : 10\log\right) - S - 10\log\left(\frac{B}{4}\right) - \text{margin}$$

Where

C/N_s = the analog video C/N in the fiber supertrunk
C/N_d = the analog video C/N in the coaxial distribution
S = the suppression of digital signal levels relative to analog video (in dB)
B = the noise susceptibility bandwidth of the digital receiver (in MHz)
margin = the expected variation from design performance due to aging, P/V, and operational tolerances (in dB)

Input Stack Diagram

Stack Level	Contents
Level 5	C/N_s
Level 4	C/N_d
Level 3	S
Level 2	B
Level 1	*margin*

Example

If C/N_s is 48 dB and C/N_d is 52 dB, with the digital signals run 10 dB below the analog video, the bandwidth is 6 MHz, and we allow a 3-dB margin, find the worst-case $C/N_{digital}$:

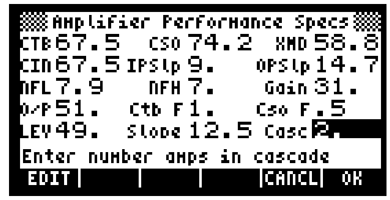
4 8 `
5 2 `
1 0 `
6 `
3 ` @@#OK@#@

The result is: 31.78

Cascade Analysis Functions

PERF

Description



This function, given the manufacturer's specs for CTB, CSO, XMOD, CIN, low and high frequency NF, input and output slope, gain and rated output level and then additionally the actual user output level, slope, and factors for CTB and CSO slope compensation, it calculates the actual unit CTB, CSO, XMOD, CIN and LF and HF CNR specifications of the amplifier.

If a cascade number greater than 1 (the default) is used, then additionally, the routine also provides the cascaded specs as well.

Input Stack Diagram

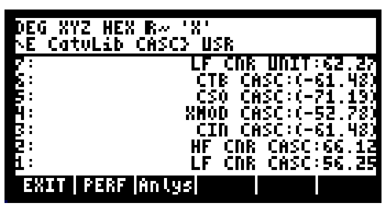
Stack Level	Contents
Level 15	*CTB Spec*
Level 14	*CSO spec*
Level 13	*XMOD spec*
Level 12	*CIN spec*
Level 11	*Input slope*
Level 10	*Output slope*
Level 9	*Low frequency noise figure*
Level 8	*High frequency noise figure*
Level 7	*Rated gain*
Level 6	*Rated output level*
Level 5	*CTB slope factor*
Level 4	*CSO slope factor (also used for XMOD)*
Level 3	*Actual output level*
Level 2	*Actual slope*
Level 1	*Cascade*

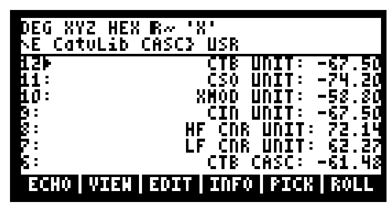
Example

Given a manufacturer's CTB spec of –67.5 dB, CSO of –74.2 dB, XMOD of –58.8 dB, CIN of –67.5 dB at a reference output of 51 dBmV and an input slope of 9 dB at the low channel and an output slope of 14.7 at the high channel, a low frequency noise figure of 7.9 dB, a high frequency noise figure of 7 dB, a gain of 31 dB and assuming that the factor by which CTB changes with slope to be 1:1, and CSO (and XMOD) by 1:0.5, find the what the specs for CTB, CSO, XMOD, CIN and the LF and HF CNR will be at an actual output of 49 dBmV, and an actual slope of 12.5 dB for a cascade of 2 amplifiers:

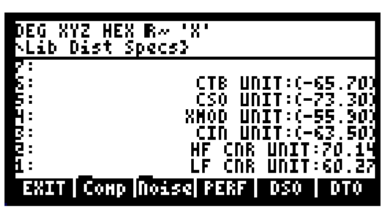
6 7 . 5 `
7 4 . 2 `
5 8 . 8 `
6 7 . 5 `
9 `
1 4 . 7 `
7 . 9 `
7 `
3 1 `
5 1 `
1 `
0 . 5 `
4 9 `
1 2 . 5 `
2 ` @@#OK@#@

The result is (press the up-arrow to see rest of the results):



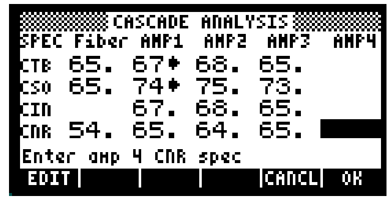


If a cascade of 1 (the default) is entered, then only the unit results are shown:



Anlys

Description



This function, given the specs for CTB, CSO, CIN, and CNR for a fiber link and up to 4 groups of amplifiers calculates the overall cascaded specifications, including CCNR (Composite CNR).

This routine assumes that the specs for each amplifier group have already been calculated (by PERF, for example). In other words, each of the amplifier groups should contain cascaded results for identical amplifiers. If the user does not have four groups, simply input the specs that are to be used and leave the remaining entries blank.

Note that the fiber link does not have an entry for CIN.

This routine assumes that CTB is cascaded at 20log, CSO at 10log, CIN at 20log (within the amplifier cascade) and CNR at 10log. The CNR is then concatenated to the CIN contribution at 10log.

Input Stack Diagram

Stack Level	Contents
Level 19	*Fiber link CTB spec*
Level 18	*Amp1 CTB spec*
Level 17	*Amp2 CTB spec*
Level 16	*Amp3 CTB spec*
Level 15	*Amp4 CTB spec*
Level 14	*Fiber link CSO spec*
Level 13	*Amp1 CSO spec*
Level 12	*Amp2 CSO spec*
Level 11	*Amp3 CSO spec*
Level 10	*Amp4 CSO spec*
Level 9	*Amp1 CIN spec*
Level 8	*Amp2 CIN spec*
Level 7	*Amp3 CIN spec*
Level 6	*Amp4 CIN spec*
Level 5	*Fiber link CNR spec*
Level 4	*Amp1 CNR spec*
Level 3	*Amp2 CNR spec*
Level 2	*Amp3 CNR spec*
Level 1	*Amp4 CNR spec*

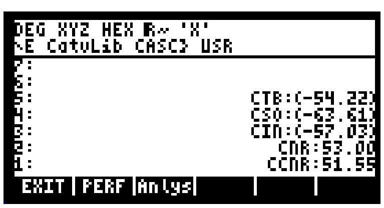
Example

Given the following specs:

SPEC	Fiber	Amp1	Amp2	Amp3	Amp4
CTB	65	67	68	65	
CSO	65	74	75	73	
CIN		67	68	65	
CNR	54	65	64	65	

6 5 `
6 7 `
6 8 `
6 5 ` ™
6 5 `
7 4 `
7 5 `
7 3 ` ™
6 7 `
6 8 `
6 5 ` ™
5 4 `
6 5 `
6 4 `
6 5 ` @@#OK@#@

The program outputs the results as shown below:



Levels Functions

Slope

Description

This function takes as input, an output level (at), a high frequency, a low frequency, a slope and an intermediate frequency. The function outputs the slope at the intermediate frequency; the amount of slope difference and the output level at the intermediate frequency.

$$slope_2 = \left(freq_1 - freq_{low}\right) \times \left(\frac{slope_1}{\left(freq_{high} - freq_{low}\right)}\right)$$

$$slope_{delta} = slope_1 - slope_2$$

$$level_2 = level_1 - slope_{delta}$$

Where

$level_1$ = the level at the high frequency in dBmV
$level_2$ = the level at the wanted frequency in dBmV
$freq_1$ = the wanted frequency in MHz
$freq_{low}$ = the low frequency in MHz
$freq_{high}$ = the high frequency in MHz
$slope_1$ = the slope between the low and high frequency in dB
$slope_2$ = the slope at the wanted frequency in dB
$slope_{delta}$ = the delta (difference) in slope between the wanted and high frequency in dB

Input Stack Diagram

Stack Level	Contents
Level 5	$level_1$
Level 4	$freq_1$
Level 3	$freq_{low}$
Level 2	$freq_{high}$
Level 1	$slope_1$

Example

Given an output at 870 MHz of 51 dBmV, a low frequency of 54 MHz, and a slope of 14.7 dB, determine the slope, slope delta and level at 550 MHz.

```
5 1 ` `
5 5 0 `
5 4 `
8 7 0 `
1 4 . 7 ` @@#OK@#@
```

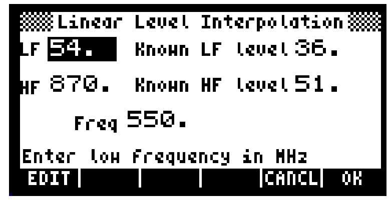
The result will show as follows:

Slope:8.94	this is the slope at 550 MHz.
Delta:(-5.76)	Delta in slope from 870 to 550 MHz.
Level:45.24	Level at 550 MHz.

LinLv

Description

This function takes as input, a level (at), a low frequency, a level at a high frequency, and an intermediate frequency. The function outputs the overall slope, the slope at the intermediate frequency; and the output level at the intermediate frequency.



$$slope_{overall} = level_{high} - level_{low}$$

$$slope_{perMhz} = \left(\frac{(level_{high} - level_{low})}{(freq_{high} - freq_{low})} \right)$$

$$slope_{delta} = slope_{perMHz} \times freq_1$$

$$level_1 = level_{LF} + slope_{delta}$$

Where

$level_1$ = the level at the wanted frequency in dBmV
$level_{low}$ = the level at the low frequency in dBmV
$level_{high}$ = the level at the high frequency in dBmV
$freq_1$ = the wanted frequency in MHz
$freq_{low}$ = the low frequency in MHz
$freq_{high}$ = the high frequency in MHz
$slope_{overall}$ = the slope between the low and high frequency in dB
$slope_{perMHz}$ = the slope per MHz of frequency in dB
$slope_{delta}$ = the slope at the wanted frequency in dB

Input Stack Diagram

Stack Level	Contents
Level 5	$Freq_{Low}$
Level 4	$Level_{Low}$
Level 3	$Freq_{High}$
Level 2	$Level_{high}$
Level 1	*Freq*

Example

Given an output at 54 MHz of 36 dBmV, output at 870 MHz of 51 dBmV, determine the overall slope, and the slope and level at 550 MHz.

5 4 `
3 6 `
8 7 0 `
5 1 `
5 5 0 ` @@#OK@#@

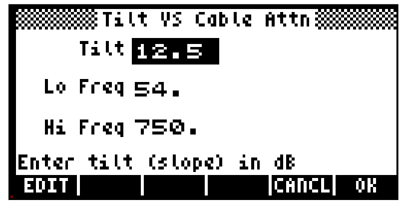
The result will show as follows:

Overall Slope:15.00	This is the overall slope from 54 to 870 MHz.
Slope at Freq:10.11	Slope from 54 to 550 MHz.
Level at Freq:46.11	Level at 550 MHz.

Tilt

Description

This function takes as input parameters, the high and low frequencies of the passband and the tilt (slope) between them. It calculates the corresponding cable loss in dB.



$$Loss = \frac{Tilt}{\left(1 - \sqrt{\frac{Freq_{Low}}{Freq_{High}}}\right)}$$

Where

Tilt = the tilt (slope) between the low and high frequencies in dB
$Freq_{low}$ = the low frequency in MHz
$Freq_{high}$ = the high frequency in MHz

Input Stack Diagram

Stack Level	Contents
Level 3	*Tilt*
Level 2	$freq_{low}$
Level 1	$freq_{high}$

Example

Calculate the cable loss at the highest frequency when the tilt (slope) is measured at 12.5 dB between 54 and 750 MHz.

1 2 . 5 `
5 4 `
7 5 0 ` @@#OK@#@

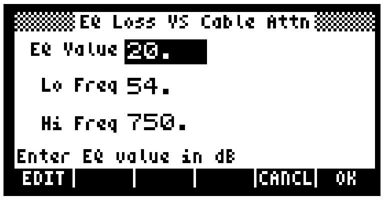
The result will show as follows:

`17.08` dB of cable loss.

EQLoss

Description

This function takes as input parameters, an equalizer value in dB, a low and a high frequency, and outputs the corresponding loss in dB of cable.



$$EQ_{Loss} = EQ_{Value} - \left(\left(EQ_{Value} \times \sqrt{\frac{freq_{low}}{freq_{high}}} \right) - 1 \right)$$

Where

EQ_{Value} = the equalizer value in dB
$Freq_{low}$ = the low frequency in MHz
$Freq_{high}$ = the high frequency in MHz

Input Stack Diagram

Stack Level	Contents
Level 3	EQ_{value}
Level 2	$freq_{low}$
Level 1	$freq_{high}$

Example

Given an equalizer equivalent to 20 dB of cable loss at 750 MHz, calculate the loss at 54 MHz:

2 0 `
5 4 `
7 5 0 ` @@#OK@#@

The result will show as follows:

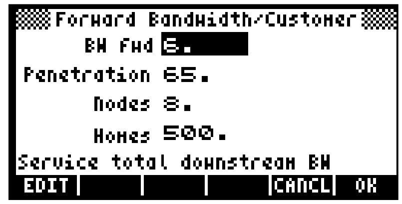
`15.63` dB of cable loss.

Network Functions

BPCF

Description

This function calculates the forward bandwidth-per-customer.



$$B_c(fwd) = \frac{B_s(fwd)}{P_s RH}$$

Where

B_c *(fwd)* = the downstream bandwidth-per-subscriber to that service
B_s *(fwd)* = the total downstream bandwidth assigned that service in MHz
P_s = the penetration of that service among homes passed
R = the number of nodes served from one downstream optical transmitter
H = the number of homes passed by the coaxial distribution lines extending from each node

Input Stack Diagram

Stack Level	Contents
Level 4	B_s
Level 3	P_s
Level 2	R
Level 1	H

Example

For a 6 MHz downstream bandwidth service, with cable penetration of 65%, eight nodes being served from a specific downstream transmitter and each node feeding 500 homes, the bandwidth-per-subscriber will be:

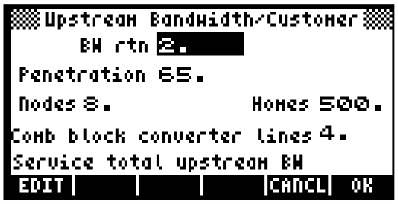
6 `
6 5 `
8 `
5 0 0 ` @@#OK@#@

The result in KHz will be: `KHz : 2.31`

BPCR

Description

This function calculates the reverse bandwidth-per-customer.



$$B_c(rev) = \frac{nB_s(rev)}{mP_sH}$$

Where

B_c *(rev)* = the upstream bandwidth-per-subscriber to that service
B_s *(rev)* = the total upstream bandwidth assigned that service
P_s = the penetration of that service among homes passed
m = the number of nodes whose signals are combined into each data receiver input
H = the number of homes passed by the coaxial distribution lines extending from each node
n = the number of independent (and equally sized) coaxial distribution lines emanating from each node whose signals are combined using block segment converters at nodes

Input Stack Diagram

Stack Level	Contents
Level 5	B_s
Level 4	P_s
Level 3	*m*
Level 2	*H*
Level 1	*n*

Example

For a 2 MHz upstream bandwidth service, with cable penetration of 65%, eight nodes being combined into a specific upstream data receiver and 500 homes passed with four legs being block combined at the nodes, the bandwidth-per-subscriber will be:

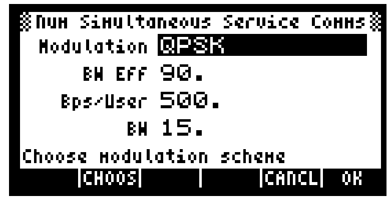
2 `
6 5 `
8 `
5 0 0
4 ` @@#OK@#@

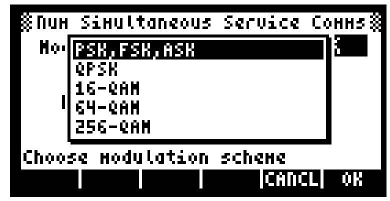
The result in KHz will be: KHz : 3.08

Nsim

Description

This function calculates the number of simultaneous communications for a service.





$$N_{simult} = \frac{(bps/Hz)\times(BW)}{(bsp/user)}$$

Where

N_{simult} = the number of simultaneous communications for a service
bps/Hz = bandwidth efficiency of the service (in bits-per-second/Hertz)
bps/user = bits-per-second/user
BW = the bandwidth allocated to the service

• Table 1 Theoretical bits/sec per Hz for various modulation types.

Modulation Type	Bps/Hz
PSK, FSK, ASK	1
QPSK	2
16-QAM	4
64-QAM	6
256-QAM	8
M-PSK	Log_2M
M-QAM	Log_2M
M-FSK	$1/(Log_2M)$

Input Stack Diagram

Stack Level	Contents
Level 4	*Modulation scheme*
Level 3	*bw eff*
Level 2	*bps/user*
Level 1	*BW*

Example

If 15 MHz is allocated to a cable modem service that is based on QPSK modulation upstream (at 90% of 2 bps/Hz – 1.8 bps/Hz) and provides 500 kbps service to each user, then N_{simult} = 54 users /node.

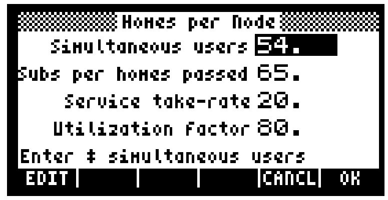
Use CHOOSE box to enter QPSK
9 0 `
5 0 0 `
1 5 ` @@#OK@#@

The result is: 54

HPN

Description

This function calculates the number of homes-per-node.



$$HPN = \frac{N_{simult}}{(Subs/HP) \times (\text{Service take - rate}) \times (\text{Utilization factor})}$$

Where

HPN = the homes-per-node
N_{simult} = the number of simultaneous communications for a service
Subs/HP = the cable penetration in percent
Service take-rate = the percentage of cable subscribers with cable modems
Utilization factor = the estimated number that would be connected simultaneously (in %)

Input Stack Diagram

Stack Level	Contents
Level 4	*Nsimul*
Level 3	*Subs/HP*
Level 2	*Service take-rate*
Level 1	*Utilization factor*

Example

If we have 54 users/node (from the above example), and if the cable penetration is 65 percent in the area and 20 percent of the cable subscribers have cable modem service and we estimate that no more than 80 percent of these would be connected simultaneously, then we could pass 520 homes.

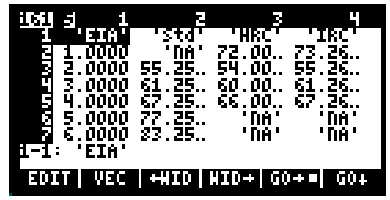
5 4 `
6 5 `
2 0 `
8 0 ` @@#OK@#@

The result is: 520

CCIR

Description

This is a matrix that contains information on channel EIA numbers, the standard frequencies and the historical references (if any).



To use, simply press the appropriate button and then hit the down arrow to edit in the Matrix Writer.

Column 1 shows the EIA channel number.

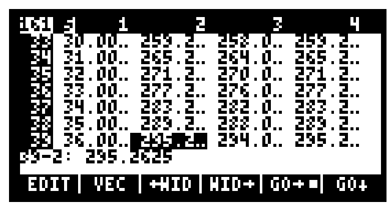
Column 2 shows the standard frequency in MHz.

Column 3 shows the historical reference (if any).

Note that it is best to have the calculator in FIX 4 mode for this function in order to see all of the significant digits.

Example

Scroll to channel 36 and see:

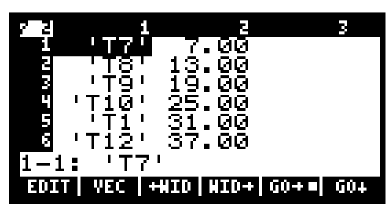


```
36.0      295.2625    W
```

Sublow

Description

This is a matrix that contains information on channel EIA numbers, the standard frequencies for the sub-low VHF band.



To use, simply press the appropriate button and then hit the down arrow to edit in the Matrix Writer.

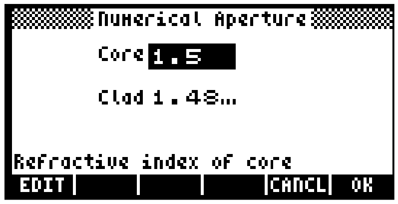
Column 1 shows the channel number.
Column 2 shows the standard frequency in MHz.

Fiber Optic Functions

NA

Description

This function calculates the numerical aperture. Numerical aperture is the sine of half the angle over which fiber can accept light.



$$NA = \sqrt{\left(n_{core}^2 - n_{clad}^2\right)}$$

Where

N_{core} = refractive index of the core
N_{clad} = refractive index of the cladding

Input Stack Diagram

Stack Level	Contents
Level 2	N_{core}
Level 1	N_{clad}

Example

For a fiber with a refractive index of 1.485 for the cladding and 1.5 for the core:

1 . 5 `
1 . 4 8 5 ` @@#OK@#@

The result will be: 0.21

ACC∠

Description

This function calculates the half-acceptance angle. The acceptance angle is the angle over which the core of an optical fiber accepts light; usually measured from the fiber axis.

$$\theta_{\text{half-acceptance}} = \arcsin\left(n_{core} \times \sin\theta_{confinement}\right)$$

Where

n_{core} = The refractive index of the core
$\theta_{confinement}$ = the angle of confinement in degrees

Input Stack Diagram

Stack Level	Contents
Level 2	n_{core}
Level 1	$\theta_{confinement}$

Example

For a fiber with a core refractive index of 1.5 and a confinement angle of 8°, find the half-angle of acceptance:

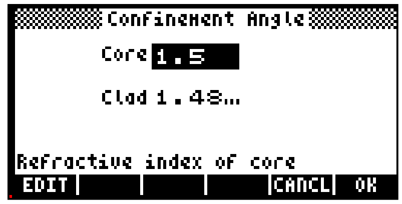
1 . 5 `
8 ` #OK#

The result will be: `12.05`

Conf∠

Description

This function calculates the confinement angle. The confinement angle is the angle at which light must strike the core-cladding boundary once it's inside the glass.



$$\theta_{confinement} = \arccos\left(\frac{n_{clad}}{n_{core}}\right)$$

Where

C/N_{RIN} = contribution of the source noise to the C/N of the signal, expressed in dB
RIN = source noise level (relative to the unmodulated light power), expressed in dB/Hz
BW = receiver noise bandwidth, in Hz, for the communications channel being evaluated
m_i = the peak modulation of the light source by the signal

Input Stack Diagram

Stack Level	Contents
Level 2	n_{clad}
Level 1	n_{core}

Example

For a fiber with a refractive index of 1.485 for the cladding and 1.5 for the core:

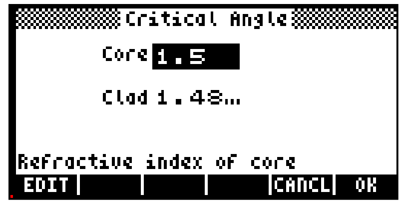
1 . 5 `
1 . 4 8 5 ` @@#OK@#@

The result will be: 8.11

Crit∠

Description

This function calculates the critical angle. The critical angle is the angle at which light in a high-refractive-index material undergoes total internal reflection.



$$\theta_c = \arcsin\left(\frac{n_{clad}}{n_{core}}\right)$$

Where

C/N_{RIN} = contribution of the source noise to the C/N of the signal, expressed in dB
RIN = source noise level (relative to the unmodulated light power), expressed in dB/Hz
BW = receiver noise bandwidth, in Hz, for the communications channel being evaluated
m_i = the peak modulation of the light source by the signal

Input Stack Diagram

Stack Level	Contents
Level 2	n_{clad}
Level 1	n_{core}

Example

For a fiber with a refractive index of 1.485 for the cladding and 1.5 for the core:

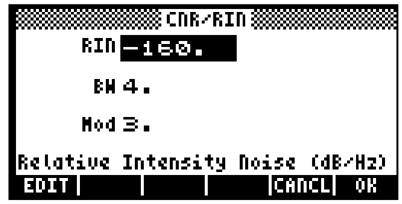
1 . 5 `
1 . 4 8 5 ` @@#OK@#@

The result will be: 81.89

CNRIN

Description

This function calculates the contribution of source noise due to RIN (relative-intensity-noise).



$$C/N_{RIN} = -RIN - 10\log(BW) + 20\log\left(\frac{m_i}{\sqrt{2}}\right)$$

Where

C/N_{RIN} = contribution of the source noise to the C/N of the signal, expressed in dB
RIN = source noise level (relative to the unmodulated light power), expressed in dB/Hz
BW = receiver noise bandwidth, in Hz, for the communications channel being evaluated
m_i = the peak modulation of the light source by the signal

Input Stack Diagram

Stack Level	Contents
Level 3	*RIN*
Level 2	*BW*
Level 1	m_i

Example

If a source has an RIN of –160 dB/Hz and it is modulated 3% (typical for a 77-channel system) by an NTSC video channel whose noise is measured in a 4-MHz bandwidth, find the approximate C/N.

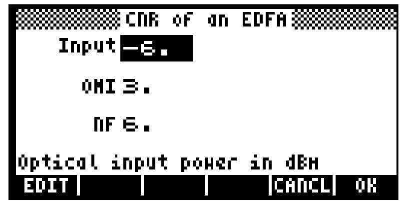
1 6 0 `
4 `
3 ` @@#OK@#@

The result is: 60.5

CNEdfa

Description

This function calculates the carrier-to-noise (C/N) of an Erbium Doped Fiber Amplifier (EDFA).



$$C/N_{EDFA} = 86.2 + P_i + 20\log(m_i) - NF_{EDFA}$$

Where

C/N_{EDFA} = the carrier-to-noise per channel (measured in a 4-MHz bandwidth) in dB
P_i = the optical input power to the EDFA in dBm
m_i = the optical modulation index (OMI) per carrier
NF_{EDFA} = the noise figure of the amplifier

Input Stack Diagram

Stack Level	Contents
Level 3	P_i
Level 2	m_i
Level 1	NF_{EDFA}

Example

For an EDFA with an input of -6 dBm, an optical modulation index (OMI) of 3% per carrier and a noise figure of 6 dB:

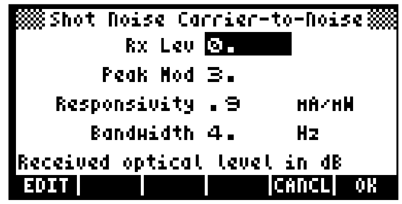
6 W `
3 `
6 ` @@#OK@#@

The result will be: 83.74

SHOT

Description

This function calculates the carrier-to-noise on an individual carrier due to shot noise in the detector. Shot noise is the noise at the optical receiver that is caused by the statistical variation in the arrival of photons.



$$C/N_{SHOT} = P_r + 20\log\left(\frac{m_i}{\sqrt{2}}\right) + 10\log(R) - 10\log(BW) + 154.94$$

Where

C/N_{SHOT} = C/N of an individual carrier due to shot noise, expressed in dB
P_r = received optical power level in dBm
m_i = the peak modulation of the light source by the signal
R = the responsivity of the receiving diode in amperes per watt (or mA/mW)
BW = noise susceptibility bandwidth, of the channel in Hz

Input Stack Diagram

Stack Level	Contents
Level 4	P_r
Level 3	m_i
Level 2	R
Level 1	BW

Example

If the OMI per carrier is 3%, the diode response is 0.9 A/W, the received optical power is 0 dBm, and the video bandwidth is 4 MHz, find the noise contribution due to shot noise:

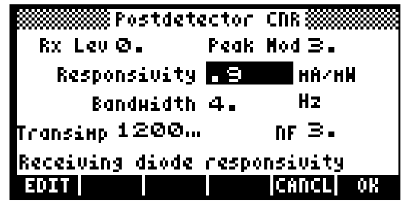
0 `
3 `
0 . 9 `
4 0 0 0 0 0 0 ` @@#OK@#@

The result is: 54.99

CNPost

Description

This function calculates the carrier-to-noise of a postdetector (transimpedance) amplifier.



$$C/N_{POSTAMP} = 2 \times P_r + 20\log\left(\frac{m_i}{\sqrt{2}}\right) + 20\log(R) - 10\log(BW) + 10\log\left(R_Z\right) - F + 137.91$$

Where

P_r = received optical power level in dBm
m_i = the peak modulation of the light source by the signal
R = the responsivity of the receiving diode in amperes per watt (or mA/mW)
BW = noise susceptibility bandwidth, of the channel in Hz
R_Z = postamplifier transimpedance in ohms
F = postamplifier noise figure in dB

Input Stack Diagram

Stack Level	Contents
Level 6	P_r
Level 5	m_i
Level 4	R
Level 3	BW
Level 2	R_Z
Level 1	F

Example

If the OMI per carrier is 3%, the diode response is 0.9 A/W, the received optical power is 0 dBm, and the video bandwidth is 4 MHz, a postamplifier with a 3-dB noise figure and a transimpedance of 1,200-ohms the noise contribution will be:

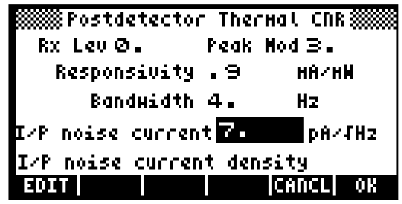
0 `
3 `
0 . 9 `
4 0 0 0 0 0 0
1 2 0 0 `
3 ` OK

The result is: 65.30

CNThPost

Description

This function calculates the carrier-to-noise of a postdetector (transimpedance) amplifier using thermal noise input current.



$$C/N_{POSTAMP} = 2\times P_r + 20\log\left(\frac{m_i}{\sqrt{2}}\right) + 20\log(R) - 10\log(BW) - 20\log(I_r) + 180$$

Where

P_r = received optical power level in dBm
m_i = the peak modulation of the light source by the signal
R = the responsivity of the receiving diode in amperes per watt (or mA/mW)
BW = noise susceptibility bandwidth, of the channel in Hz
I_r = postamplifier input noise current density in pA/√Hz.

Input Stack Diagram

Stack Level	Contents
Level 5	P_r
Level 4	m_i
Level 3	R
Level 2	BW
Level 1	I_r

Example

If the OMI per carrier is 3%, the diode response is 0.9 A/W, the received optical power is 0 dBm, and the video bandwidth is 4 MHz, a postamplifier with an input noise current of 7 pA/√Hz, the postamplifier C/N for an analog video channel will be:

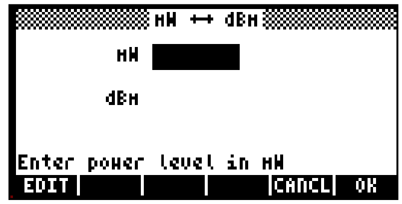
```
0 `
3 `
0 . 9 `
4 0 0 0 0 0 0
7 ` @@#OK@#@
```

The result is: 62.69

Conversion Functions

mWdBm

Description



This function, given either mW or dBm, calculates the other.

$$dBm = 10\log(mW)$$

$$mW = 10^{\frac{dBm}{10}}$$

Where

mW = power level, expressed in mW
dBm = power level, expressed in dBm

Example

Convert 200 mW into dBm:

Enter 2 0 0 into the mW dialog box entry and press:
` @@#OK@#@ (leave the dBm entry blank).

The result is: 23.01

Convert 23.01 dBm into mW:

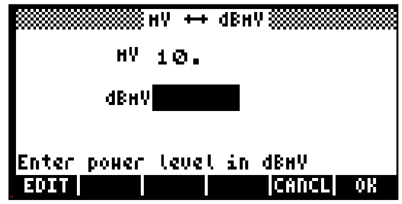
Enter 2 3 . 0 1 into the dBm dialog box entry and press:
` @@#OK@#@ (leave the mW entry blank).

The result is: 200

mVdBmV

Description

This function, given either mV or dBmV, calculates the other.



$$dBm = 20\log(mV)$$

$$mV = 10^{\frac{dBmV}{20}}$$

Where

mV = power level, expressed in mV
dBmV = power level, expressed in dBmV

Example

Convert 200 mV into dBmV:

Enter 2 0 0 into the `mV` dialog box entry and press:
` @@#OK@#@ (leave the `dBmV` entry blank).

The result is: `46.02`

Convert 46 dBmV into mV:

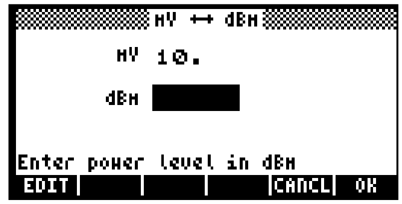
Enter 4 6 into the `dBmV` dialog box entry and press:
` @@#OK@#@ (leave the `mV` entry blank).

The result is: `199.53`

mVdBm

Description

This function, given either mV or dBm, calculates the other.



$$dBm = 20\log(mV)$$

$$mV = 10^{\frac{dBm}{20}}$$

Where

mV = power level, expressed in mV
dBm = power level, expressed in dBm

Example

Convert 200 mV into dBm:

Enter 2 0 0 into the mV dialog box entry and press:
` @@#OK@#@ (leave the dBm entry blank).

The result is: 46.02

Convert 46 dBm into mV:

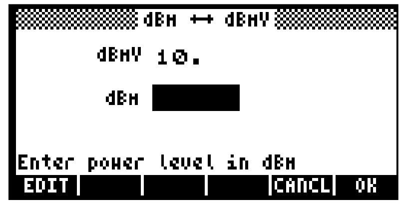
Enter 4 6 into the dBm dialog box entry and press:
` @@#OK@#@ (leave the mV entry blank).

The result is: 199.53

DBm/V

Description

This function, given either dBm or dBmV, calculates the other.



$$dBm = dBmV - 48.75$$

$$dBmV = dBm + 48.75$$

Where

dBmV = power level
dBm = power level

Example

Convert -3 dBm into dBmV:

Enter 3 W into the dBm dialog box entry and press:
` @@#OK@#@ (leave the dBmV entry blank).

The result is: -51.75

Convert –51.75 dBmV into dBm:

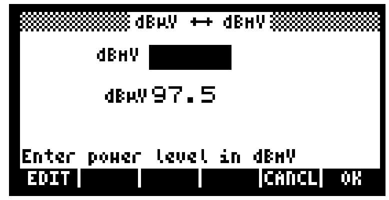
Enter 5 1 . 7 5 W into the dBmV dialog box entry and press:
` @@#OK@#@ (leave the dBm entry blank).

The result is: -3.0

DBµ/V

Description

This function, given either dBµV or dBmV, calculates the other.



$$dB\mu V = dBmV + 60$$

$$dBmV = dB\mu V - 60$$

Where

dBmV = power level
dBµV = power level

Example

Convert 97.5 dBµV into dBmV:

Enter 9 7 . 5 into the dBµV dialog box entry and press:
` @@#OK@#@ (leave the dBmV entry blank).

The result is: 37.5

Convert 37.5 dBmV into dBµV:

Enter 3 7 . 5 into the dBmV dialog box entry and press:
` @@#OK@#@ (leave the dBµV entry blank).

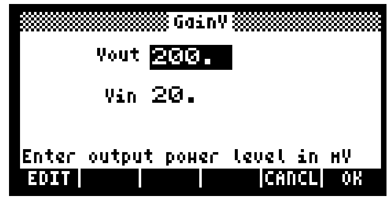
The result is: 97.5

Measurement Functions

GainV

Description

This function calculates the gain in dB given the voltage into and out of a device.



$$Gain_V = 20\log\frac{V_{out}}{V_{in}}$$

Where

V_{in} = the power input in mV
V_{out} = the power output in mV

Input Stack Diagram

Stack Level	Contents
Level 2	V_{out}
Level 1	V_{in}

Example

Given an input level of 20 mV, and an output level of 200 mV, the voltage gain, expressed in dB would be:

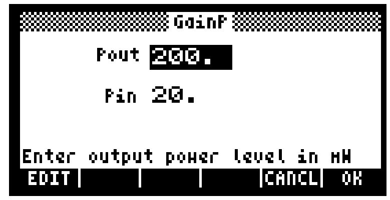
2 0 0 `
2 0 ` @@#OK@#@

The result will be: `20.00`

GainP

Description

This function calculates the gain in dB given the power into and out of a device.



$$Gain_P = 10\log\frac{P_{out}}{P_{in}}$$

Where

P_{in} = the power input in mW
P_{out} = the power output in mW

Input Stack Diagram

Stack Level	Contents
Level 2	P_{out}
Level 1	P_{in}

Example

Given an input level of 20 mW, and an output level of 200 mW, the power gain, expressed in dB would be:

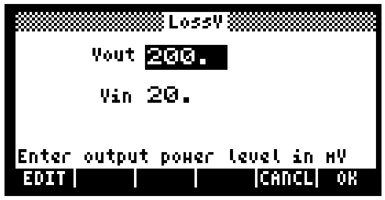
2 0 0 `
2 0 ` @@#OK@#@

The result will be: `10.00`

LossV

Description

This function calculates the loss in dB given the voltage into and out of a device.



$$Loss_V = 20\log\frac{V_{in}}{V_{out}}$$

Where

V_{in} = the power input in mV
V_{out} = the power output in mV

Input Stack Diagram

Stack Level	Contents
Level 2	V_{in}
Level 1	V_{out}

Example

Given an input level of 200 mV, and an output level of 20 mV, the voltage loss, expressed in dB would be:

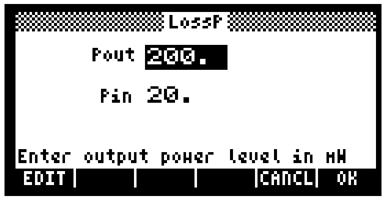
2 0 0 `
2 0 ` @@#OK@#@

The result will be: `20.00`

LossP

Description

This function calculates the loss in dB given the power into and out of a device.



$$Loss_P = 10\log\frac{P_{in}}{P_{out}}$$

Where

P_{in} = the power input in mW
P_{out} = the power output in mW

Input Stack Diagram

Stack Level	Contents
Level 2	P_{in}
Level 1	P_{out}

Example

Given an input level of 200 mW, and an output level of 20 mW, the power loss, expressed in dB would be:

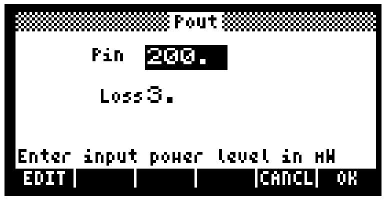
2 0 0 `
2 0 ` @@#OK@#@

The result will be: `10.00`

Pout

Description

This function calculates the power out in mW given the power in and the loss in dB of a device.



$$P_{out} = \frac{P_{in}}{10^{\frac{Loss}{10}}}$$

Where

P_{in}= the input power in mW
dB = the loss in dB

Input Stack Diagram

Stack Level	Contents
Level 2	P_{in}
Level 1	*Loss*

Example

Given an output level of 200 mW, and a loss of 3 dB, the power out, expressed in mW would be:

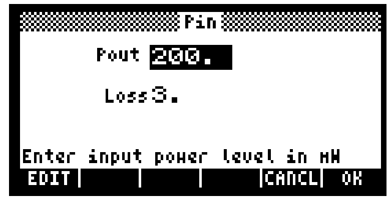
2 0 0 `
3 ` @@#OK@#@

The result will be: `100.24`

Pin

Description

This function calculates the input power in mW given the output power and the loss of a device.



$$P_{in} = P_{out} \times 10^{\frac{Loss}{10}}$$

Where

P_{in}= the output power in mW
Loss = the loss in dB

Input Stack Diagram

Stack Level	Contents
Level 2	P_{out}
Level 1	*Loss*

Example

Given an output level of 200 mW, and a loss of 3 dB, the power in, expressed in mW would be:

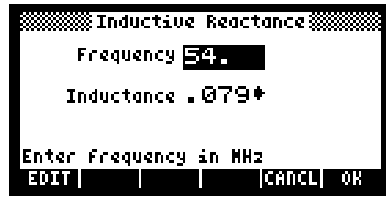
2 0 0 `
3 ` @@#OK@#@

The result will be: `399.05`

Xl

Description

This function calculates inductive reactance.



$$X_L = 2\pi fl$$

Where

f = the frequency in Hz
l = the inductance in microhenries (µh)

Input Stack Diagram

Stack Level	Contents
Level 2	f
Level 1	l

Example

Given an inductance of 0.0796 µh, the inductive reactance at 54 MHz, expressed in ohms, will be:

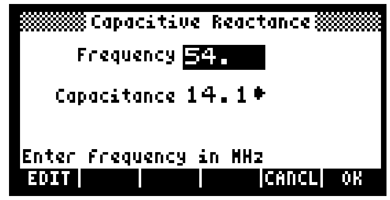
5 4 \`
. 0 7 9 6 \` OK

The result will be: `27.01`

Xc

Description

This function calculates capacitive reactance.



$$X_C = \frac{1}{2\pi fc}$$

Where

f = the frequency in Hz
c = the capacitance in picofarads (pf)

Input Stack Diagram

Stack Level	Contents
Level 2	*f*
Level 1	*c*

Example

Given an capacitance of 14.15 pf, the capacitive reactance at 54 MHz, expressed in ohms, will be:

5 4 `
1 4 . 1 5 ` @@#OK@#@

The result will be: `208.29`

Revision History

Version	Notes
1.0	Initial public release
1.1	New features: added code to EXIT functions to allow dual functionality Bug fixes: Corrected DSO and DTO routines Numerous updates to the manual