Application Note

R&S® DB CALCULATOR

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Note:

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Contents

1 Overview

30 dBm + 30 dBm = 60 dBm? It is well known that it is not as easy as that. If we convert these logarithmic power levels to linear values, we get 1 W + 1 W = 2 W. This is 33 dBm and not 60 dBm. In addition, already, we face some trouble: we just want to do a simple calculation, but we need to start thinking about the correct formulas and we need to start converting values. In fact, this is not difficult, but it can be annoying.

This application note can be regarded as a spin-off of the widely read application note “dB or not dB?” [1]. As an extension to “dB or not dB?” this application note supplies a software tool that can do a variety of calculations for you. For example, this software can be used to add or subtract an arbitrary number of powers, convert power and voltage units from the linear to the logarithmic scale (and vice versa), convert linear power and voltage ratios to decibels, and convert a voltage standing wave ratio (VSWR) to other linear and logarithmic reflection quantities.

In detail, this application software comprises five independent calculation tools:

dBm Calculator:
This tool helps to add or subtract powers expressed in watts or expressed as power levels in dBm.

Voltage Calculator:
This tool helps to add RMS voltages.

Unit Converter:
This tool converts power units and voltage units.

dB Converter:
This tool converts a linear power or voltage ratio to dB.

VSWR Converter:
This tool converts between different reflection quantities such as VSWR and return loss.

2 Installation

To install the R&S dB Calculator software on your Windows PC, start the installer executable "dBCalculator_x64_[X.X.X.X].exe" supplied with this application note. The installer will guide you through the installation process.

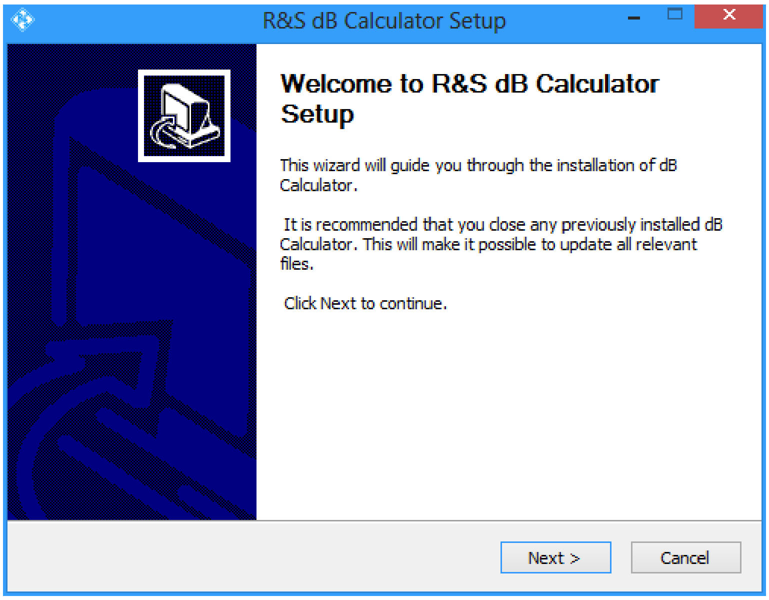


Figure 1: Installer for the R&S®dB Calculator software

The software for macOS can be obtained from the App Store.

PC Software Requirements:

The operating system of your PC can be Microsoft® Windows® 7, 8, 8.1, 10, 11 or macOS 10.10 or higher.

3 General

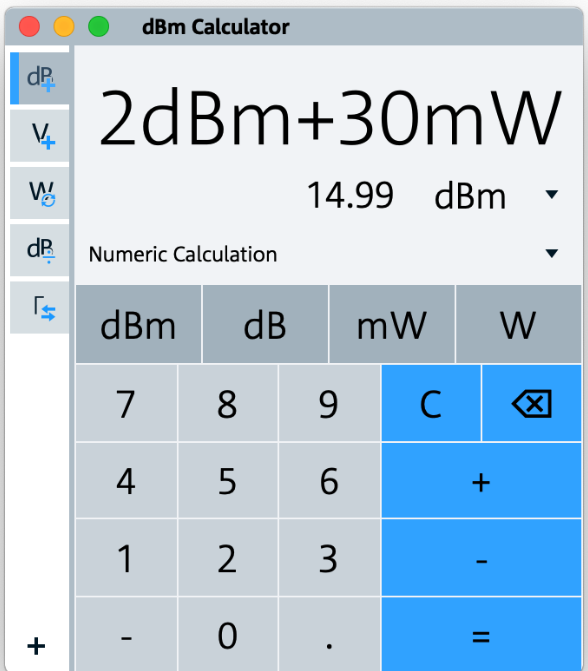
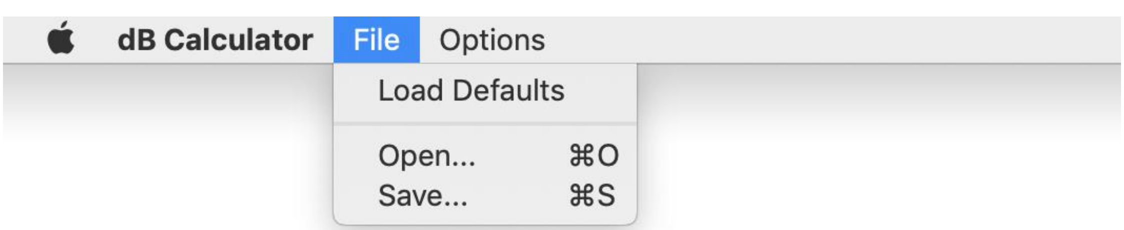


Figure 2: Graphical user interface of the application software.

Graphical user interface (GUI):

File:



Load Defaults Resets the settings of the current calculation tool to its default settings

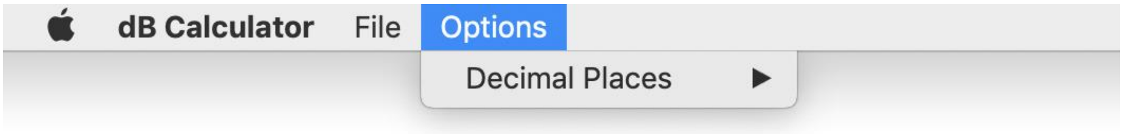
Open Loads a saved settings file for the current calculation tool

⌘O / Ctrl+O

Save Saves the settings of the current calculation tool to a file

⌘S / Ctrl+S

Options:

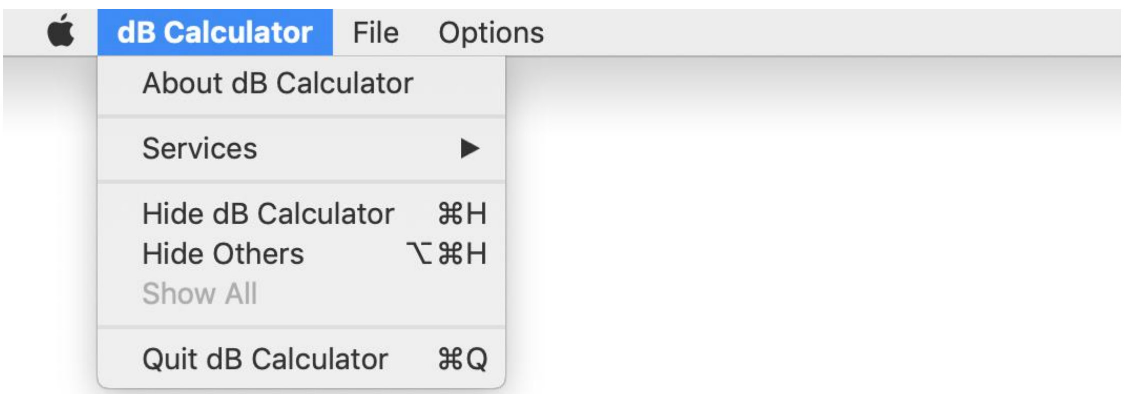


Decimal Places

Sets the number of decimal places for the result display (not for computation!) to either 0, 1, 2, 3 … or 10.

Exception: logarithmic values (e.g. dBm or dBV) are always displayed with two decimal places.

dB Calculator / Help:



About dB Calculator	Displays information about the program version and installed drivers on the remote PC. This information can be copied to clipboard by pressing the button at the bottom of the System Information page.
Services	Menu for adding services to the application. (Only available on macOS)
Hide dB Calculator	Hides the application. (Only available on macOS)
Hide Other ⌘H	Hides all windows but this. (Only available on macOS)
Show All ⌥⌘H	Shows all hidden windows. (Only available on macOS)
Quit dB Calculator ⌘O / Ctrl+O	Quits the application. When quitting the application, the major settings are saved automatically. When the application is opened the next time, the latest settings are restored.

Tool bar:

The tool bar shows five icons. Clicking on an icon opens the corresponding calculation tool (see Figure 2).

Supported input formats:

Numerical values can be inserted as

0.0123, 5400

12.3E-3, 5.4E3, 5.4E+3

12.3e-3, 5.4e3, 5.4e+3

12.3m, 5.4k

Supported SI Prefixes	
Symbol	Value
f	10^{-15}
p	10^{-12}
n	10^{-9}
u (for µ)	10^{-6}
m	10^{-3}
k	10^{+3}
M	10^{+6}
G	10^{+9}
T	10^{+12}
P	10^{+15}

The decimal separator can be either "." or ",". This means, 0.0123 and 0,0123 are both valid inputs.

Spaces are ignored, e.g. 1.23 E-3 mW and 1.23E-3mW are both valid inputs.

4 dBm Calculator

By means of this tool, power values can be added or subtracted.

4.1 Usage

Powers P in watts are added (or subtracted) as $x\ mW + y\ mW = (x + y)\ mW$. For the sake of convenience, the user can also enter power levels Lp in dBm. Since dBm is a logarithmic unit, power levels Lp must not be added linearly like other numerical data. Therefore, the tool converts the power levels Lp to powers P, adds them as $x\ mW + y\ mW = (x + y)\ mW$, and finally converts them back to power levels in dBm.

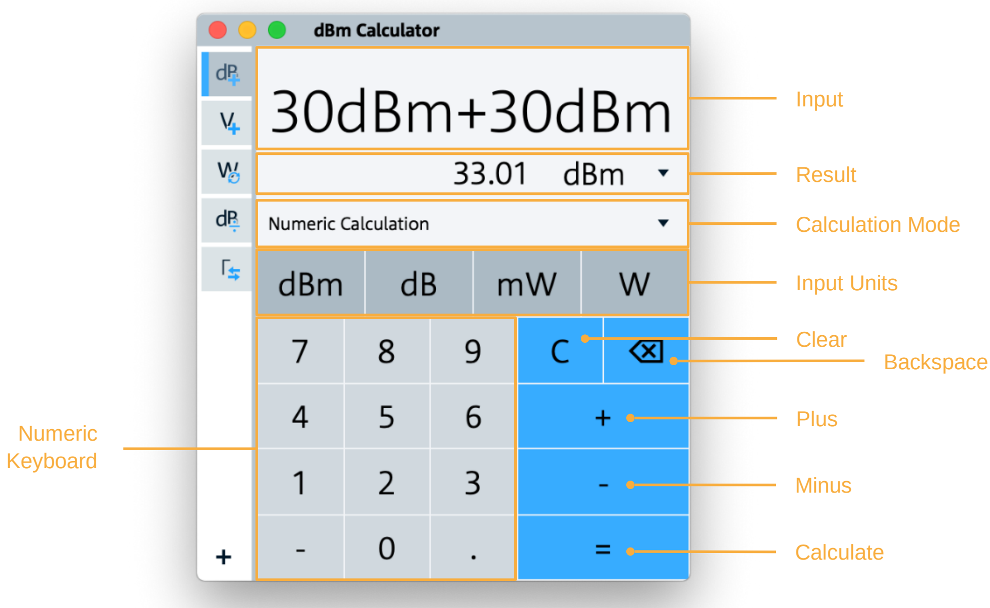


Figure 3: GUI of the dBm Calculator.[1]

► Type in your expression.

– You can either use the buttons of the GUI or the keyboard of your computer (to use the keyboard, click into the input field).

– The “⌫ ” button deletes one digit; the “C” button deletes the whole entry.

– Do not forget to enter units. The “dBm”, “dB”, “mW” and “W” buttons can be used to enter the respective units. The unit “dBW” and “µW” are also supported. These units can be mixed for the benefit of usability, e.g.

```
1W+30dBm-100mW
```

[1] Strictly speaking, the shown expression is mathematically forbidden; however, the tool allows this entry to meet the situations encountered in practical work. The calculation itself is done mathematically correct.

– A minus sign after an operator will be interpreted as an algebraic sign for the dBm value, e.g.

```
1dBm+-2dBm
```

will add 1 dBm = 1.259 mW and -2 dBm = 0.631 mW to 1.89 mW = 2.76 dBm.

– SI prefixes can only be used with the SI unit watt, e.g.

```
2uW+2nW
```

– If no units are entered, the SW will perform simple algebra, e.g. the following entry will give -4.

```
1+2-3-5+1
```

– The entered expression is executed term-by-term from left to right. You can use brackets to change the order of execution.

```
1W+(1W-3dB)
```

► The result will be automatically shown while typing. If you press the "=" button or "Enter" the result will move to the input field.

– The result is displayed in the result field, e.g.

```
31.76 dBm ▾
```

– The result is displayed in appropriate units. The unit is selectable.

– If "invalid input" is displayed, check the entered expression for missing plus/minus operators, wrong units/SI prefixes, and ambiguous inputs. You can use brackets to avoid ambiguous expressions.

4.2 Formulas

Before the powers are added all level inputs (i.e. dBm-values) are converted to power values (i.e. mW-values) using the following formula:

$$P/mW = 10^{\frac{L_P/dBm}{10}}$$

Logarithmic ratios given in dB are added according to the following formula:

$$xdB + ydB = (x + y)dB$$

Logarithmic ratios given in dB are added to the power levels according to the following formula:

$$xdBm + ydB = (x + y)dBm$$

Note that adding a dB-value to a dBm-value corresponds to multiplying a power in watts with a dimensionless factor. For example, 3 dBm + 3 dB = 6 dBm is the same as 2 mW · 2 = 4 mW which equals a power level of 6 dBm.

4.3 Note

The calculation tool allows adding power levels Lp such as 30 dBm + 30 dBm which is strictly speaking forbidden. However, the tool allows this user input to meet the situations encountered by engineers in practical work. This unique feature makes it easier for the user to do calculations since the conversion to powers is done automatically "in the background". The user obtains mathematically correct results with minimum effort.

4.4 Application Example

An example test setup consists of two signal sources. The first signal generator outputs a mobile communications signal with a power level of Lp = -12.5 dBm. The second signal generator outputs an interfering CW signal with Lp = 0 dBm. Both signals are added by means of a combiner that has an overall loss of 4.4 dB in this setup. The combined signal shall be applied to a device that can handle a maximum input power of 0.2 mW according to its specification. Is the signal level too high for the device?

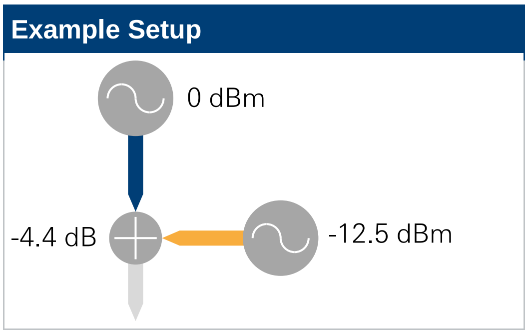
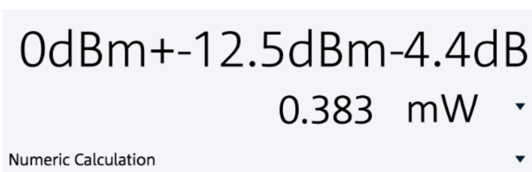


Figure 4: Example Setup

The following expression corresponds to the example setup: The answer is yes, 0.38 mW is too much input power for the device.



5 Voltage Calculator

By means of this tool, RMS voltages can be added.

5.1 Background

We consider two signals S1 and S2 with RMS voltages V1 and V2, respectively. When the signals S1 and S2 are added (mathematically), then the RMS voltage of the resulting signal S3 will depend on the correlation of the signals S1 and S2.

In case of two AC voltages of same frequency, the voltages S1 and S2 will add as $\sqrt{V1^2 + V2^2 - 2 \cdot V1 \cdot V2 \cdot \cos(180° - \varphi)} = V3$, where φ is the phase angle between the voltage vectors V1 and V2 (Fig 6). This formula is deduced from the geometric interpretation of vector addition using the law of cosines.

Vector addition

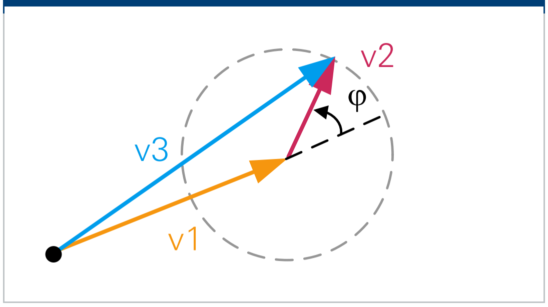


Figure 5: Vector addition

If S1 and S2 are sine signals with different frequencies as shown on Figure 6, then the voltages V1 and V2 are uncorrelated. A special case is if S1 and S2 are sine signals of the same frequency (correlated) but orthogonal. In this case, the phase angle is 90°. Their values will add as in an uncorrelated case, hence in both cases

$$\sqrt{V1^2 + V2^2} = V3$$

In contrast, if V1 and V2 are correlated voltages, e.g. two sine signals with identical frequencies, the resulting voltage V3 depends on the phase between the signals as shown above. If the phase angle is 0° as shown on **Fehler! Verweisquelle konnte nicht gefunden werden.**, then voltages will add as

$$\sqrt{V1^2 + V2^2 + 2 \cdot V1 \cdot V2} = V3$$

Example: S1 has an RMS value of 2.0 V and S2 of 1.0 V. S3 will then have an RMS value of 2.24 V in case the signals are uncorrelated and 3.0 V in case the signals are correlated with a phase angle of 0°.

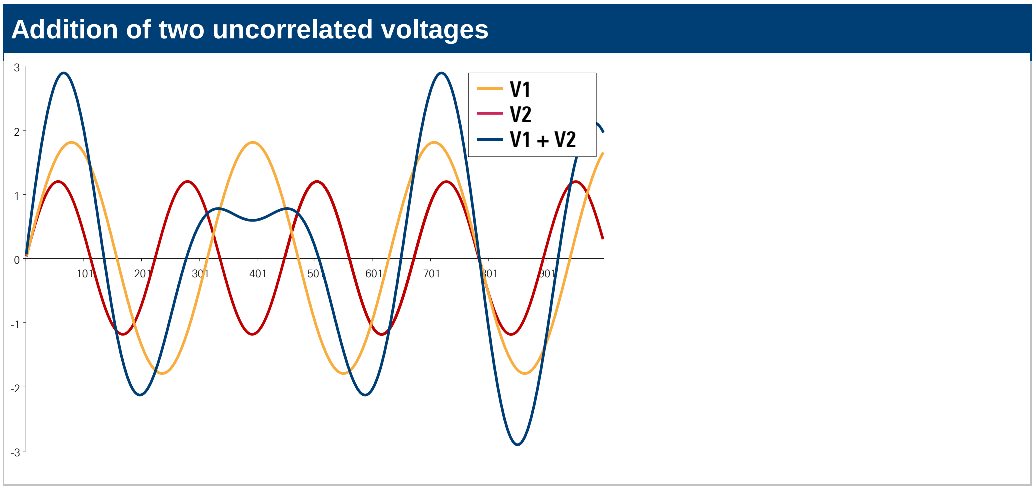


Figure 6: Addition of two uncorrelated voltages

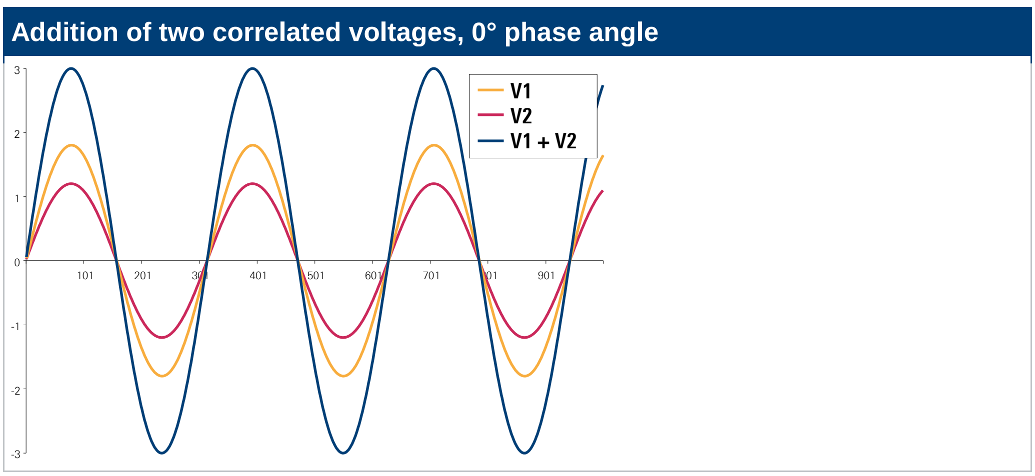


Figure 7: Addition of two correlated voltages, 0° phase angle

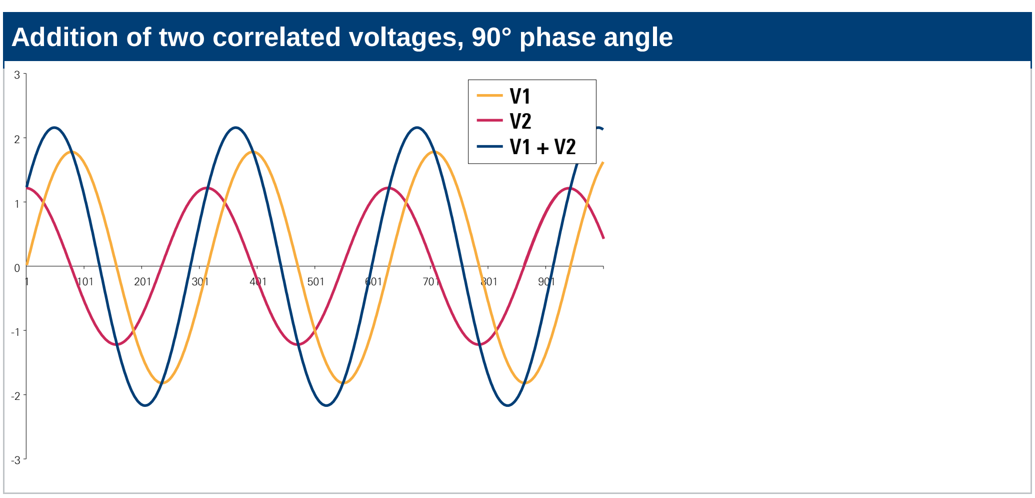


Figure 8: Addition of two correlated voltages, 90° phase angle

Often, it is also important to know the peak voltage of S3 in addition to the RMS value. The theoretical peak level is calculated as

$$V1_{peak} + V2_{peak} = V3_{peak}$$

in case of signals without correlation. The same applies for correlated signals if the phase angle is 0°. In both cases, the result for the previous example voltages of 2 Vpk and 1.0Vpk is 3 Vpk. An example for differing amplitudes and a 90° phase between voltages is shown in Figure 8.

For two correlated signals, the value is obviously 0 V if the phase of the two otherwise identical sine signals is 180° apart. For this and any other phase angle and/or amplitude

$$\sqrt{V1_{peak}^2 + V2_{peak}^2 - 2 \cdot V1_{peak} \cdot V2_{peak} \cdot \cos(180° - \varphi)} = V3_{peak}$$

provides the result.

This is the same as for RMS voltages on the previous page and hence the software application does not consider correlated peak voltages separately.

5.2 Usage

If you want to use the Voltage Calculator tool to merely do a numerical calculation, select the “Peak Voltages” mode. Then, the voltage values will be added as $xV + yV = (x + y)V$.

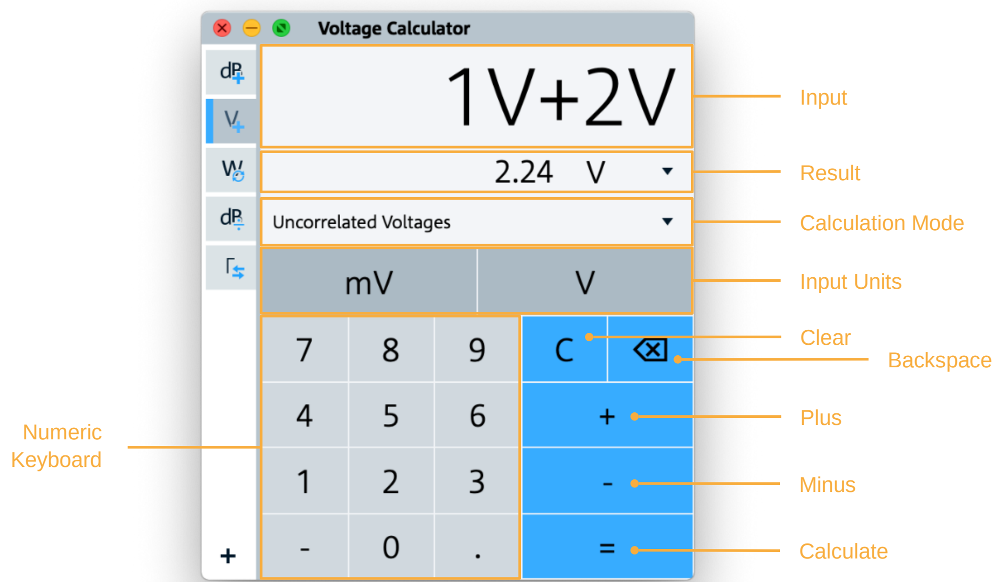


Figure 9: GUI of the Voltage Calculator

- ► Select if the RMS voltages to be added are correlated or uncorrelated or if the peak voltage is to be calculated. For correlated voltages enter the phase angle in degrees.
- ► Type in your expression.
  - – You can either use the buttons of the GUI or the keyboard of your computer (to use the keyboard, click into the input field).
  - – The “⌫ ” button deletes one digit, the “C” button deletes the whole entry.
  - – Don’t forget to enter units, e.g.

    2V+1V

    The “mV” and “V” buttons can be used to enter the respective units.
  - – SI prefixes can be used with the SI unit volt, e.g.

    1mV+1kV

– If no units are entered, the SW will perform simple algebra, e.g. the entry “1+2-3-5+1” will give “-4”.

– The entered expression is executed term-by-term from left to right. You can use brackets to change the order of execution.

1V-(0.5V+0.2V)

► Press the “=” button or press “Ctrl+Enter” (shortcut) to see the result.

– The result is displayed in the result field, e.g.

3.03 V ▾

– The unit can be changed.

5.3 Formulas

The following formulas are used to add voltages (see the appendix for details):

► Uncorrelated RMS voltages ($f_{uv} \rightarrow \mathbb{R}$):

$$f_{uv}(V1, V2, \cdots, Vn) \coloneqq \sqrt{\sum_{i=1}^{n} Vi} = \sqrt{V1^2 + V2^2 + V3^2 + \cdots + Vn^2}$$

► Correlated voltages ($f_{cv} \rightarrow \mathbb{R}$):
Two voltages V1 and V2:

$$f_{cv}(V1, V2) \coloneqq \sqrt{V1^2 + V2^2 - 2 \cdot V1 \cdot V2 \cdot \cos(180° - \varphi)}$$

φ is the phase angle between the voltage vectors v1 and v2 (**Fehler! Verweisquelle konnte nicht gefunden werden.** A). For correlated sinusoidal peak voltages, multiply the RMS input value V1 and V2 with 1.4141 to get V1pk and V2pk in order to obtain a PEAK result.

More than two voltages:

$$f_{cv}(V1, V2, \cdots, Vn) \coloneqq \sqrt{f(V1, \cdots, Vn-1)^2 + Vn^2 - 2 \cdot f(V1, \cdots, Vn-1) \cdot Vn \cdot \cos(180° - \varphi)}$$

e.g. three voltages V1, V2 and V3:

$$V = \sqrt{\begin{matrix} V1^2 + V2^2 - 2 \cdot V1 \cdot V2 \cdot \cos(180° - \varphi) + V3^2 \\ -2 \cdot \sqrt{V1^2 + V2^2 - 2 \cdot V1 \cdot V2 \cdot \cos(180° - \varphi)} \cdot V3 \cdot \cos(180° - \varphi) \end{matrix}}$$

φ is the phase angle between the voltage vectors vx and v3 (**Fehler! Verweisquelle konnte nicht gefunden werden.** B). It is the same as between v1 and v2.

Vector addition of two vectors (left) and three vectors (right)

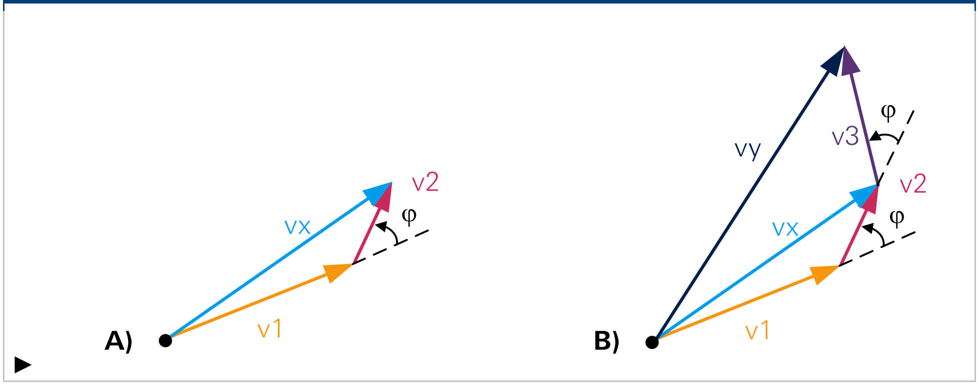


Figure 10: Vector addition of two vectors (left) and three vectors (right)

► Peak voltage ($f_{pv} \to \mathbb{R}$, uncorrelated only):

$$f_{pv}(V1, V2, \cdots, Vn) := \sum_{i=1}^{n} Vi = V1_{peak} + V2_{peak} + \cdots + Vn_{peak}$$

6 Unit Converter

This tool converts several units. It is possible to

– convert powers into logarithmic levels – e.g. W ⇔ dBm
– convert between powers and voltages – e.g. W ⇔ V
– convert voltages into logarithmic levels – e.g. V ⇔ dBV

6.1 Usage.

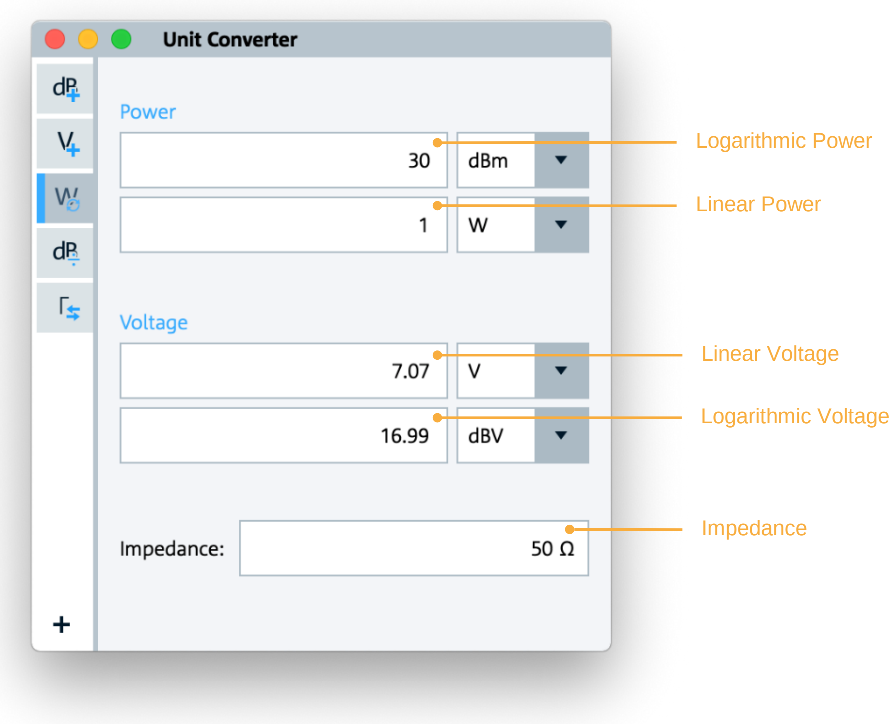
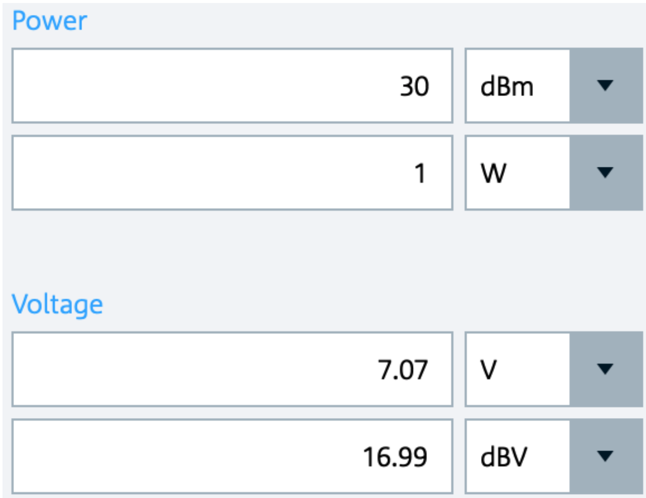


Figure 11: GUI of the Unit Converter

► Type in the value you want to convert, e.g.



SI prefixes can be used with the SI units, e.g.

► Press the “Enter” key or click into a different input field to see the results.

► You can edit any input field. The results will be updated accordingly.

► If you change the units, the results will be updated.

Supported Units	
Unit	Remark
dBm	reference power level is 1 mW
dBW	reference power level is 1 W
W	SI unit
mW	
V	SI unit
mV	
dBV	reference voltage level is 1 V
dBµV	reference voltage level is 1 µV
dBu	reference voltage level is 0.775 V

► You can change the impedance by editing the corresponding input field.

6.2 Formulas

The following formulas are used for conversion (x, y and z are variables):

dBm	→	mW	$y/mW = 10^{\frac{x/dBm}{10}}$	
dBm	←	mW	$x/dBm = 10 \cdot \log_{10}(y/mW)$	
W	→	V	$z/V = \sqrt{(y/W) \cdot 50\Omega}$	(in a 50Ω system)
W	←	V	$y/W = \frac{(z/V)^2}{50\Omega}$	(in a 50Ω system)
V	→	dBV	$x/dBV = 20 \cdot \log_{10}(z/V)$	
V	←	dBV	$z/V = 10^{\frac{x/dBV}{20}}$	
V	→	dBu	$x/dBu = 20 \cdot \log_{10}\left(\frac{z/V}{0.775}\right)$	
V	←	dBu	$z/V = 0.775 \cdot 10^{\frac{x/dBu}{20}}$	
dBm	→	dBW	$y/dBW = x/dBm - 30$	
dBm	←	dBW	$x/dBm = y/dBW + 30$	
dBV	→	dBµV	$y/dB\mu V = x/dBV + 120$	
dBV	←	dBµV	$x/dBV = y/dB\mu V - 120$	
dBV	→	dBu	$y/dBu = x/dBV + 2.21$	
dBV	←	dBu	$x/dBV = y/dBu - 2.21$	
Vrms	→	Vpp	$x/V_{pp} = y/V_{rms} \cdot 2\sqrt{2}$	
Vavg	→	Vpp	$x/V_{pp} = y/V_{avg} \cdot \pi$	

Note that powers are always positive. Zero power is a special case. A value of exactly 0 W cannot be converted into a logarithmic value. The same applies to voltages. A voltage of 0 V cannot be converted into a logarithmic value.

7 dB Converter

This tool calculates the linear and logarithmic ratio of powers or voltages.

7.1 Usage

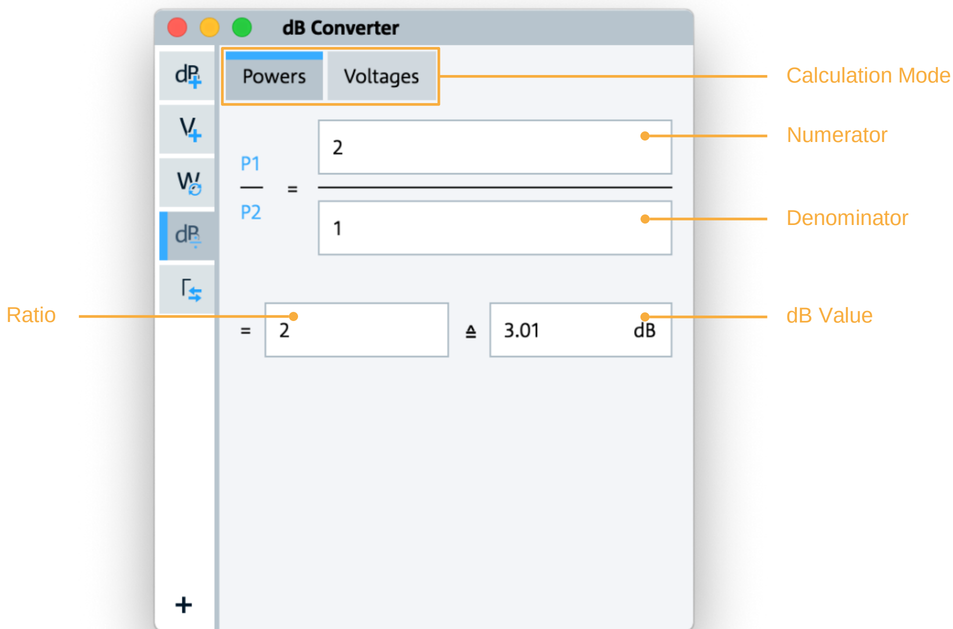
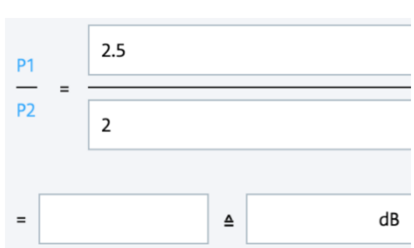
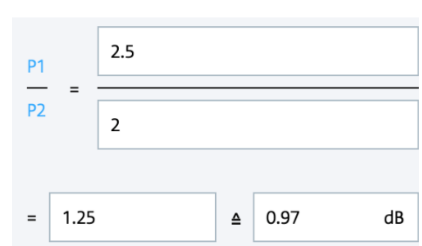


Figure 12: GUI of the dB Converter.

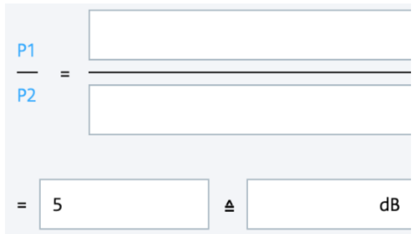
- Select if the ratio to be calculated is a ratio of powers (i.e. P1/P2) or a ratio of voltages (i.e. V1/V2).
- You can type into any of the four input fields.
- If you type into input fields P1 and P2, the linear and logarithmic ratio will be calculated, e.g.



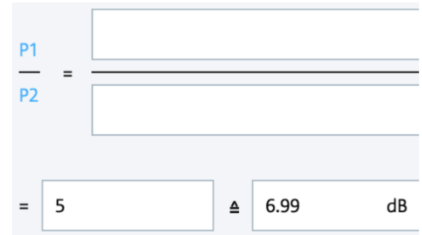
→



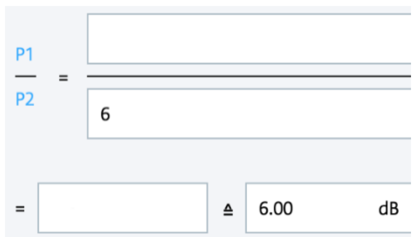
- If you type into one of the ratio input fields, the other one will be calculated, e.g.



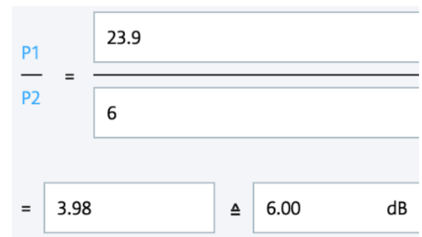
→



► If you type into one of the input fields P1 or P2 and one of the ratio input fields, the remaining fields will be calculated, e.g.



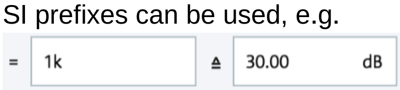
→



► Press the “Enter” key or click into a different input field to see the results.

► Enter numerical values only, i.e. no units. Exception: The units “dBm”, “dBW” and “W” are supported for the input fields P1 and P2.

► SI prefixes can be used, e.g.



► Invalid inputs will not be evaluated. For example, if a negative linear ratio or a linear ratio of 0 is entered, no logarithmic ratio will be displayed.

► You can use the “Clear” button to remove the entries of all input fields.

7.2 Formulas

The following formulas are used to convert a linear ratio to a logarithmic ratio:

– Powers:

$$R_P = \frac{P1}{P2}$$

$$L_P/dB = 10 \cdot \log_{10}\left(\frac{P1}{P2}\right) \Rightarrow L_P/dB = 10 \cdot \log_{10}(R_P)$$

– Voltages:

$$R_V = \frac{V1}{V2}$$

$$L_V/dB = 20 \cdot \log_{10}\left(\frac{V1}{V2}\right) \Rightarrow L_V/dB = 20 \cdot \log_{10}(R_V)$$

The following formulas are used to convert a logarithmic ratio to a linear ratio:

– Powers:

$$R_P = 10^{\frac{L_P/dB}{10}}$$

– Voltages:

$$R_V = 10^{\frac{L_V/dB}{20}}$$

For input values $\frac{P1}{P2} = \frac{V1}{V2}$ the following formulas describe the relation between a ratio of power quantities and a ratio of voltage quantities.

$$R_V = R_P$$

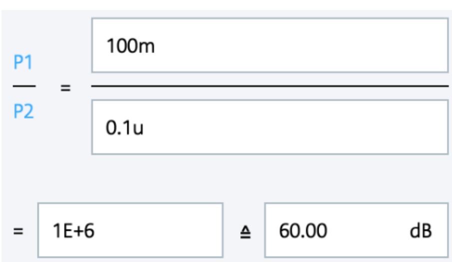
$$L_V = 2 \cdot L_P$$

Example

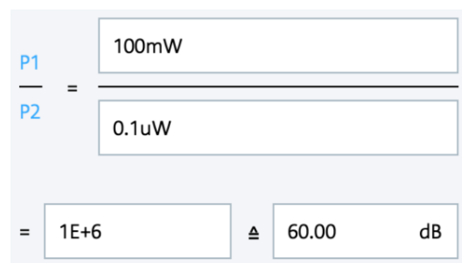
If you want to know the signal-to-noise ratio in dB, you have to calculate the logarithmic ratio of the signal power (e.g. 100 mW) to the noise power (e.g. 0.1 µW).

$$S/N = 10 \cdot \log_{10}\left(\frac{100mW}{0.1\mu W}\right)$$

To calculate this, enter the following:



or



The result is a signal-to-noise ratio of 60 dB.

8 VSWR Converter

This tool converts the following reflection quantities:

- Voltage standing wave ratio: VSWR
- Reflection coefficient: Γ
- Reflected power in % of incident power: Γ^2
- Return loss in dB: aΓ
- Mismatch loss in dB: a_m

8.1 Background

If an electrical transmission line is not terminated with its characteristic impedance (impedance mismatch), then part of the forward wave gets reflected at the load. The superposition of the forward and reflected wave results in a standing wave on the transmission line (Figure 13).

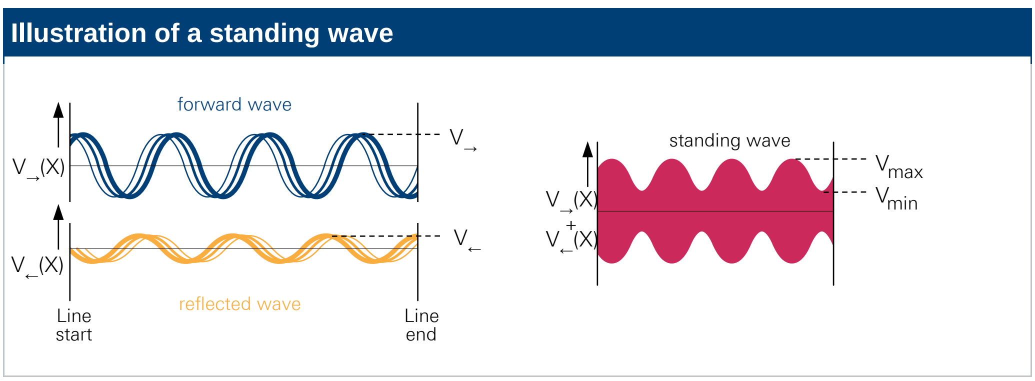


Figure 13: Illustration of a standing wave

The ratio of the maximum standing wave amplitude to the minimum standing wave amplitude is called voltage standing wave ratio (VSWR).

$$VSWR = \frac{V_{max}}{V_{min}}$$

For example, a VSWR value of 2 (i.e. 2:1) means that the maximum standing wave amplitude is two times greater than the minimum standing wave amplitude. A VSWR of 1 means zero reflection, i.e. perfect impedance matching. In contrast, if the transmission line is open-circuited, then the forward wave gets fully reflected (total reflection) and the VSWR is infinite.

The reflection coefficient is the ratio of the reflected wave amplitude to the forward wave amplitude (Figure 13).

$$\Gamma = \frac{V_{\leftarrow}}{V_{\rightarrow}}$$

A reflection coefficient of 0 means zero reflection. A reflection coefficient of 1 means total reflection.

The forward and the reflected wave carry a forward and a reflected power according to $P \propto V^2$. The symbol Γ^2 denotes the reflected power relative to the forward power.

$$\Gamma^2 = \frac{P_{\leftarrow}}{P_{\rightarrow}}$$

While Γ^2 is the ratio of the reflected to the forward power, the return loss is the inverse ratio expressed in decibels.

$$a_\Gamma/dB = 10 \cdot \log_{10}\left(\frac{P_\rightarrow}{P_\leftarrow}\right)$$

A return loss of 0 dB means total reflection. The lower the reflected power, the higher the return loss.

The mismatch loss is the ratio of the forward to the absorbed power expressed in decibels. The absorbed power is the difference between the forward and the reflected power.

$$a_m/dB = 10 \cdot \log_{10}\left(\frac{P_\rightarrow}{P_\rightarrow - P_\leftarrow}\right)$$

A mismatch loss of 0 dB means zero reflection. The higher the reflected power, the higher the mismatch loss.

All mentioned quantities (VSWR, reflection coefficient, reflected power, return loss and mismatch loss) are used as a measure of impedance matching.

8.2 Usage

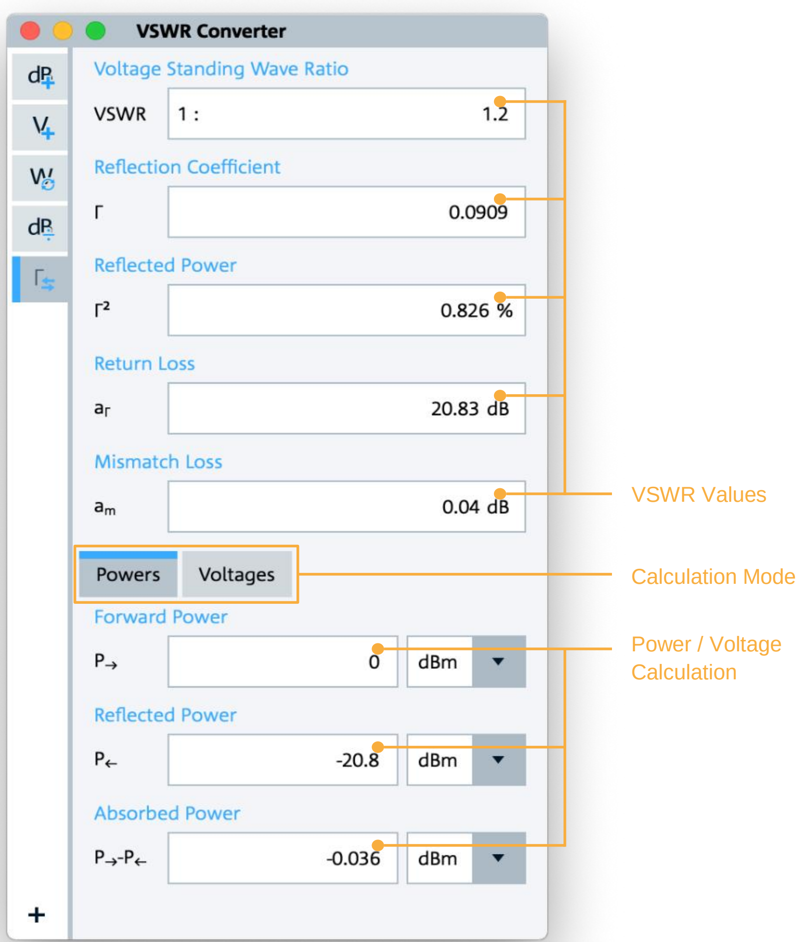
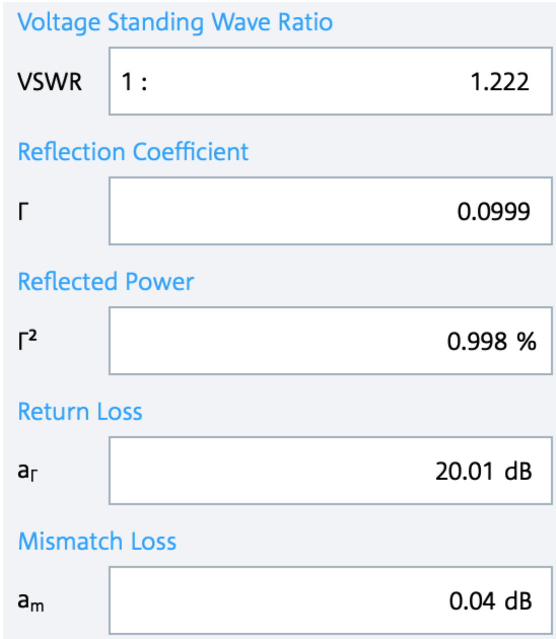


Figure 14: GUI of the VSWR Converter

– Type in the value you want to convert, e.g.



– Press the “Enter” key or click into a different input field to see the results.

– You can edit any input field. The results will be updated accordingly.

8.3 Formulas

The following formulas are used for conversion:

VSWR	→	– Γ	$\Gamma = \frac{VSWR - 1}{VSWR + 1}$
VSWR	←	Γ	$VSWR = \frac{1 + \Gamma}{1 - \Gamma}$
Γ	→	a_Γ	$a_\Gamma / dB = -20 \cdot \log_{10}(\Gamma)$
Γ	←	a_Γ	$\Gamma = 10^{\frac{a_\Gamma / dB}{-20}}$
Γ	→	a_m	$a_m / dB = -10 \cdot \log_{10}(1 - \Gamma^2)$
Γ	←	a_m	$\Gamma = \sqrt{1 - 10^{\frac{a_m / dB}{-10}}}$

9 Release Notes

Version V 1.0: Original Version

01 2010

Version V 2.0:

02 2010

- **Modified functionality:** Calculation tool “dBm Calculator” considers the combiner principle in the calculation.
- **New functionality:** New calculation tool “VSWR Converter”.

Version V 2.5:

09 2011

- **Fixed Issue:** Calculation tool “dBm Calculator” uses formula
- P = 1/n (P1 + P2 + … + Pn) instead of formula P = 1/2 (P1 + P2 + … + Pn) for adding power levels of incoherent signals.
- **New functionality:** Calculation tools “dBm Calculator” and “Voltage Calculator” support brackets.

Version V 2.6:

02 2012

- **Fixed Issue:** Calculation tool “dBm Calculator” showed wrong results in the special case when the entered expression contained dB-values and power levels in a certain order (without brackets). This bug affected incoherent powers (combiner) only.
- **Modified functionality:** Calculation tool “Voltage Calculator” explicitly designates expressions containing a minus operator as invalid if mode “uncorrelated voltages” is selected.
- **Modified functionality:** Calculation tool “Voltage Calculator” reacts immediately to a change of the phase value and updates the result. Pressing the “=” button is no longer required for updating the result.

Version V 3.0:

06 2015

- **Modified functionality:** Calculation tool ”VSWR Converter” displays the reflection coefficient no longer in % but now as an absolute value.
- The Ratio Converter has been renamed to dB Converter.
- **New functionality:** dB Calculator is available on Mac OSX**.**

Version V 3.1

12 2018

- **Modified functionality:** The user interface has been redesigned to look like it does on the Instruments.
  The application window is now resizable.
  On macOS, the look changes depending on which theme is set in macOS Settings (light / dark).
  The dBm- and the Voltage Calculator are now calculating the result while typing.
- **New functionality:** The dBm Calculator now supports the unit μW.
  The VSWR Converter can now also calculate $P\rightarrow$, $P\leftarrow$ as well as $V\rightarrow$, $V\leftarrow$.

Version V 3.2

08 2019

- **New functionality:** The Unit Converter now can calculate between V_{rms}, V_{pp}, V_{avg}.

Please note that this application note and the corresponding software "R&S dB Calculator" will be updated from time to time.

10 Abbreviations

CW Continuous wave

SI International system of units

VSWR Voltage standing wave ratio

11 Literature

[1] Rohde & Schwarz, "dB or not dB? (1MA98)".

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1GP77 | Version 8e | 10.2021
Application Note | R&S® dB Calculator
Data without tolerance limits is not binding | Subject to change