New probe helps minimize power consumption of wireless devices

Modern oscilloscopes offer just about everything an electronics designer needs: large bandwidths, automatic digital protocol decoding and a broad range of analysis capabilities. However, these instruments are reaching their limits when it comes to optimizing the power consumption of IoT modules or measuring very small signals. The R&S®RT-ZVC multi-channel power probe solves this problem.

Long battery life is a key convenience feature in mobile devices, Internet of Things (IoT) modules and wearables. To minimize power consumption, many of these products are optimized for very low quiescent currents; they consume additional power only during periods of activity, which are typically short. A very high dynamic range is therefore required to measure the total power consumption. Often, multiple measurement channels are needed since the various modules used in the electronic circuits of complex products are active at varying times. The R&S®RT-ZVC 02/04 multi-channel power probe addresses these applications and can additionally measure signals in the microvolt range.

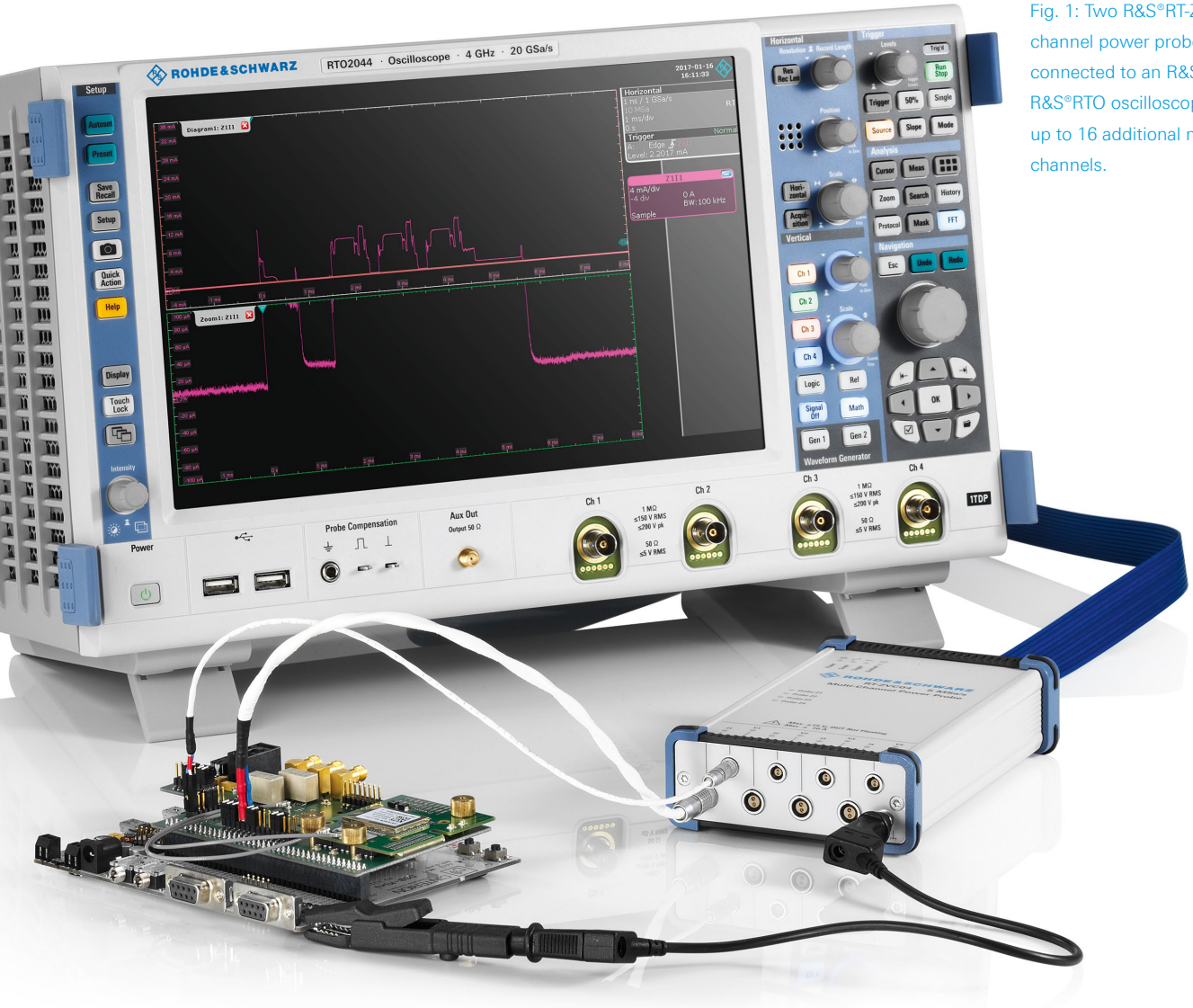


Fig. 1: Two R&S®RT-ZVC multi-channel power probes can be connected to an R&S®RTE or R&S®RTO oscilloscope to provide up to 16 additional measurement channels.

Highly sensitive acquisition system with 18-bit resolution

The R&S®RT-ZVC 02/04 multi-channel power probes (Figs. 1 and 2) comprise an acquisition system with a very high dynamic range for measuring up to four currents and four voltages (Fig. 3). In each current and voltage channel, an 18-bit A/D converter acquires signals at a rate of 5 Msample/s at 1 MHz analog bandwidth. As a result, short current and voltage pulses are easily captured over a wide dynamic range. When measuring very small signals, a variable, digital low-pass filter can be activated to reduce system noise.

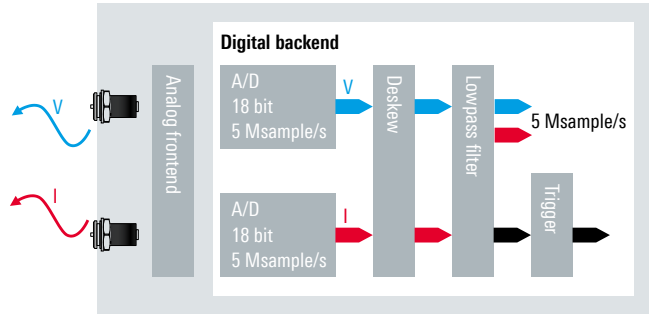
Measured data is transferred to an R&S®RTE or R&S®RTO oscilloscope via the digital logic interface and displayed time-synchronously with the analog channels. Nearly all of the oscilloscope's measurement and analysis functions are also available for use on the R&S®RT-ZVC channels. A trigger unit integrated into the probe allows triggering on any input signal.

Internal and external shunts for current measurement

Three switchable built-in shunts provide full-scale current measurement ranges from 4.5 µA to 10 A (Fig. 3). The probe has differential inputs. Each input can operate at any potential within ±15 V. The shunts are fully calibrated and exhibit a measurement uncertainty as low as 0.2 %.

For full flexibility, designers can also use an external shunt, which should ideally be integrated in the test design right from the start. External shunts are supported by a dedicated operating mode and make it possible to tailor the measurement range to the actual application. Switchable gain factors provide additional flexibility with respect to the measurement range.

Digital acquisition system



Current measurement ranges

	Shunt
±4.5 µA; ±45 µA	10 kΩ
±4.5 mA; ±45 mA	10 Ω
±4.5 A; ±10 A	10 mΩ
±45 mV; ±450 mV (depending on shunt value)	external

Voltage measurement ranges

±1.88 V
±3.75 V
±7.5 V
±15 V

Fig. 3: The R&S®RT-ZVC probe's digital acquisition system provides 18-bit resolution, a 5 Msample/s sampling rate and 1 MHz bandwidth. Each voltage and current input pair forms a high dynamic range power measurement system.

Fig. 2: The R&S®RT-ZVC is available with 2 × 2 and 2 × 4 channels.

Example: optimizing the battery life of IoT modules

Minimizing power consumption during the design of electronic modules and devices has become a quality-critical issue. A long battery life is crucial especially in the IoT domain, but also for medical equipment, consumer electronics such as radio headphones, and building automation products such as smoke detectors. Many of these devices typically have long quiescent phases with very low power consumption, alternating with periodic, often very brief active phases with medium or high power consumption (Fig. 4).

To minimize the average total power consumption of such devices, it is necessary to measure their power consumption during both the quiescent and the active phases. This is where the R&S®RT-ZVC multi-channel power probe comes into play. Its high vertical resolution and optional lowpass filtering deliver a very wide dynamic range. In conjunction with the broad range of measurement functions provided by modern oscilloscopes, a wide variety of analyses can be carried out. Typical measurements include average power consumption during quiescent phases and total power consumption during phases of activity (Fig. 5). The expected battery life can easily be determined based on this data.

Typical power consumption of IoT modules

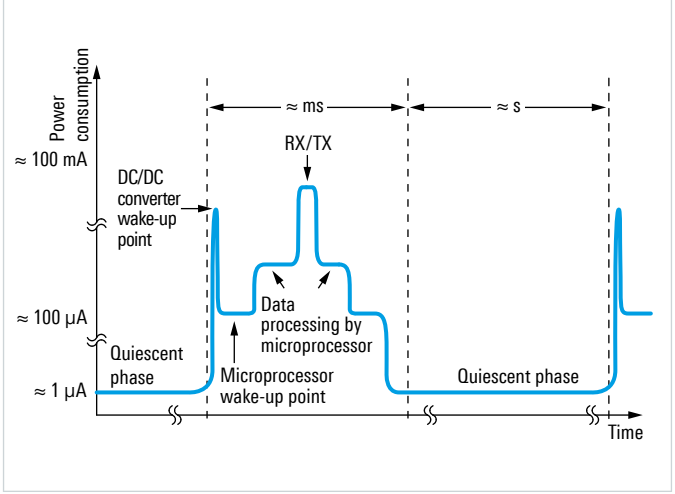
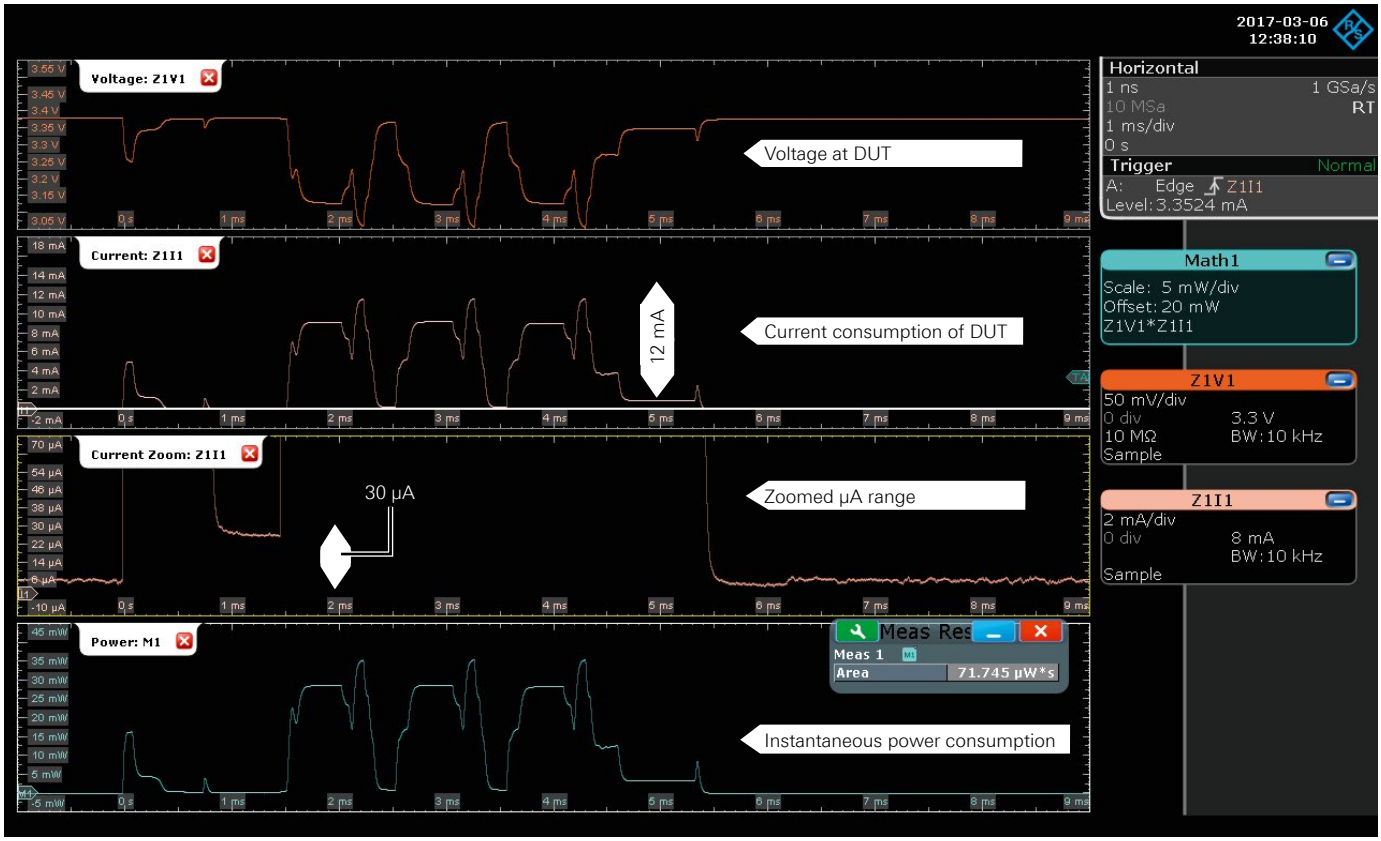


Fig. 4: The power consumption measured on an IoT module typically exhibits long quiescent phases with very low power consumption and brief phases of high power consumption.

Fig. 5: The R&S®RT-ZVC probes provide a very high dynamic range, allowing a module's current consumption to be measured in active and quiescent condition, in this example 12 mA and 30 µA.



In the case of complex mobile devices such as cell phones or tablets, power consumption can be further reduced by disconnecting modules temporarily not needed from the power supply and activating them only when necessary. Each R&S®RTE and R&S®RTO oscilloscope supports two R&S®RT-ZVC probes, allowing current and voltage signals to be measured at eight points in parallel. The standard oscilloscope channels remain available for acquiring control signals. In this way, the power consumption of individual modules of a complex electronic system can be measured and correlated with control signals and serial control protocols.

Example: measuring very small signals

When the probe is operated with an external shunt, the current measurement input turns into a highly sensitive voltmeter. This operating mode yields the highest sensitivity, with 18-bit resolution at ±45 mV full-scale input voltage. This makes it possible to measure very small signals with low noise and high sensitivity. Fig. 6 shows a cardiac signal pulse with a voltage as low as 200 µV (V_{pp}), which the probe acquires easily with low noise.

Flexible connectivity options

The probe comes with a high-quality, shielded cable for each channel along with a set of solder-in cables and pins. Optionally available are 4 mm connector cables of different lengths as well as BNC connector cables for standard oscilloscope probes or current probes to extend the input voltage and current measurement ranges.

The R&S®RT-ZVC multi-channel power probe is available for the R&S®RTE and R&S®RTO oscilloscopes along with a model for use in combination with an R&S®CMW500 protocol tester. In configurations with an R&S®CMW500, it is possible to correlate wireless protocols with application software running on IoT devices. This means that designers can use a single power probe for oscilloscope measurements during embedded system design and subsequently for analyzing and optimizing the power consumption of these systems when developing IoT system applications.

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Fig. 6: Operating the probe with an external shunt turns the current measurement input into a highly sensitive voltmeter. As a result, even very small signals such as a 200 µV cardiac pulse can easily be measured.