Rohde & Schwarz HMC8043 PSU

Review and Teardown

A new 3-channel 100-watt power supply — how does it stack up?

By **Martin Cooke**

First Impressions

Bench power supplies aren't really pieces of kit that get your pulse racing, they just sit there doing their job, in some cases giving gentle background heating to keep the lab warm in the winter and providing enough ballast to stop your bench wobbling about too much. The traditional bench top power supply always came with a sturdy handle on the top to give you a clue that inside is some serious ironwork and that this beast is going to be heavy. But that was all yesterday; buy a power supply today and it doesn't look much different from any other piece of test gear; covered in buttons with a TFT display and the chances are you can wrap your hand around it and pick it up one-handed. That's true of the HMC8043 three channel 100-watt bench power supply from Rohde & Schwarz I received for reviewing.

The front panel layout is restrained and efficient, consistent with their current compact range of test equipment; users of the HMC8012 multimeter will be familiar with the almost identical layout.

The output terminals along the front panel do not include an Earth post. Setting up the functions via the front panel buttons and bright TFT display is fairly intuitive and did not require too much recourse to the operator's manual. Voltage designations on German equipment often use capital *U* instead of *V*. This indicates 'difference' and is best taken to mean *Potential Difference* (PD) which is a voltage difference not referenced to ground potential. Most power supplies don't differentiate between *PD* and *V* but technically *PD* is more accurate and underlines the fact that the outputs of the HMC8043 are fully floating and can withstand a common mode voltage of up to 250 V.

Testing

Turning outputs on/off shows a well behaved output voltage waveform with no tendency to overshoot or undershoot with various loads. The internal processor is monitoring key presses and controls the output appropriately. The output voltage can be adjusted in mV and the current limit in mA or 100 micro-amps steps for levels less than 1 A. A track option allows all the channels to track together in terms of their voltage and current settings. Each channel of the HMC8043 can be programmed to operate in constant voltage or constant current mode and has an impressive range of protection mechanisms including over-voltage, over-current and over-power protection. Electronic fuse values can also be defined for each channel along with a fuse delay from 10 ms to 10 s to avoid channel dropout at start up inrush. Fusing can be interlinked between channels. In addition to displaying voltage and current readings the instantaneous and accumulated power delivered to the load in W/s in can also be logged. This gives a useful indication of the power requirements and expected battery life particularly if the circuit switches between sleep and active modes.

The three isolated outputs allow the freedom to assign the available 100 W as you wish: connect all three in parallel to give 0-30 V at around 3 A or in series to give 0-99 V at around

1 A output. In this mode it makes sense to set the channels to track so that they share the load. When more than two outputs are connected in series it is possible to exceed the maximum 33 V reverse voltage allowable at the input terminals. This will occur with a load connected, when one of the channels in the series chain turns off due to a low current limiting setting. To ensure the input reverse voltage is not exceeded connect a maximum of two channels only in series.
The most important characteristic of a power supply is the reliability of the output voltage. Working on an expensive prototype you don't want sudden load changes to cause the supply to fluctuate and damage components. Turning outputs on/off using the front panel buttons shows a well behaved output voltage level (**Figure 1**) with no tendency to overshoot or undershoot with various loads. Fan noise was only evident during periods of high power operation. Switched-mode supplies tend to be electrically noisy especially when operating at low load. The HMC8043 showed excellent performance, falling within the 4 mV_{pp} ripple given in the specification.
A situation likely to catch out any microcontroller equipment is a hard turn-off caused by power outage or switch-off at the wall outlet. Unless the raw AC input is monitored closely the microcontroller doesn't get enough warning and the control loop may go unstable as voltage drops. The Rohde & Schwarz HMC8043 reacts to this situation by superimposing an 8-ms (worst case) output spike of around 1.1 V on the output DC level before the voltage falls away (**Figure 2**). This feature may pose a problem for sensitive low voltage circuits; a 3.3-V or 1.8-V system would see its supply peak at around 4.4 V and 2.9 V respectively, and underlines the importance of including on-board regulation on any expensive prototype circuitry to protect against this type of event.

Dynamic-Load Testing

A 0.7-ohm resistor switched in parallel with a 7-ohm resistor was used to test the performance of the supply driving a dynamic load. The resulting DC output level is shown as the upper trace in **Figure 3** with the switching waveform shown as the lower trace. The voltage output is set to 0.700 V and the output current turned up to maximum to ensure that any control mechanism didn't limit the output current. The output characteristics show excellent recovery to the dynamic load with well controlled voltage damping and good phase margin.

The Bob Pease Test

An article written by Bob Pease many years ago told of when he designed a linear regulator chip while working at National Semiconductor. He thought he had taken care of output protection in the design until a co-worker produced a woodworking rasp and asked him to rake it across the outputs. Apparently

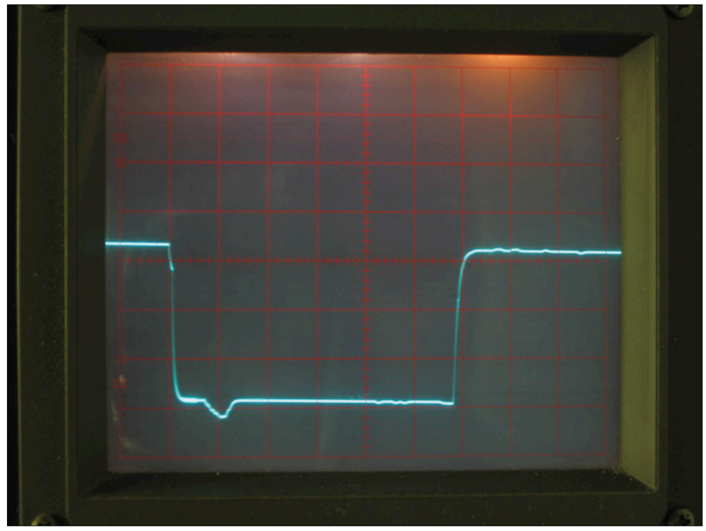

Figure 1. Output voltage 1.800 V soft turn off and on (using front panel push buttons). 500 ms/div, 0.5 V/div. load = 7 ohms with 1.5 microfarads. Captured on a 10 MHz scope.

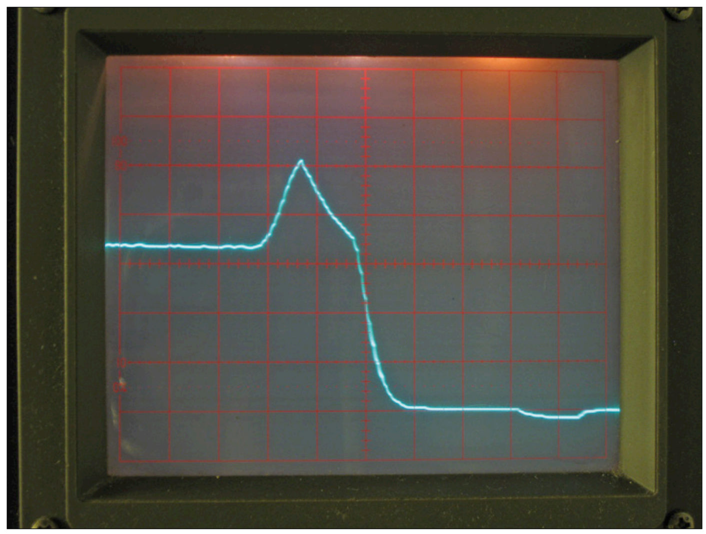

Figure 2. Output voltage 1.800 V hard turn off (power fail) 20 ms/div, 0.5 V/div. load = 7 ohm with + 1.5 microfarads cap (increasing capacitive load to 220 microfarads showed slight improvement (reduced peak)). Captured on a 10 MHz scope.

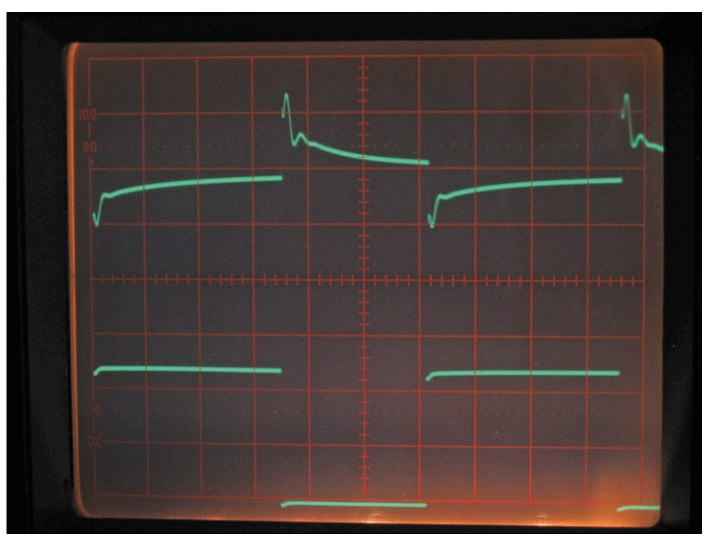

Figure 3. Dynamic Performance.
Timebase 1ms/div 200mV/div (upper trace). 5 V/div (lower trace switching waveform). A load of 0.7 ohms switched in parallel with 7 ohm shows the output takes about 600 microseconds to return within 10% of the final value. It peaks at about +0.26 V and −0.2 V around the nominal value of 0.7 V. The lower waveform is the FET switching signal of the dynamic load. The technical spec indicates 1 ms to get within ± 20 mV, I'm seeing more than 2 ms. Otherwise a well damped control loop.

the intermittent short circuit can defeat the most carefully considered protection and test the regulator control loop to the limit. Sure enough Bob returned to his workplace nursing a smouldering prototype. Lesson learned; could the HMC8043 pass the test? (**Figure 4**) Well there were sparks but in short, yes it did. The same test with three channels in series should not be attempted because the maximum reverse could be exceeded on one channel.

Device Connection Options

The version of the unit supplied is not fitted with an IEEE-488 connector (this is optional) but has a LAN connector for test environments using the newer LXI (LAN Extensions for Instrumentation) network based on Ethernet. The rear mounted USB port allows the unit to be connected to a computer where it can communicate using a virtual COM port or via USB TMC (Test and Measurement Class). Using a virtual COM port allows you to communicate via a standard terminal emulation program using the SCPI commands after the corresponding Windows drivers have been installed. Alternatively you can use the free Windows application HMExplorer which has a built-in terminal emulator function and also allows you to save screenshots, define an arbitrary waveform and store measurements.

The rear panel connector also allows the connection of an analogue control input voltage. This allows an external analogue voltage in the range from 0 to 10 V (or current from 4 to 20 mA) to control any or all of the three output channels. Assume, for example that channel 1 and 2 have been selected to be controlled by the analogue input. Using the menu the output voltage of channel 1 is set to 30 V and channel 2 to 20 V. Now as the analogue control voltage is increased from zero to 10 V the outputs from channel 1 and 2 will increase proportionally from zero to their maximum setup values.

Useful for development environments using multiple supplies, the sequence option allows turn-on of a channel to be delayed from 10 ms to 10 s after the master On/Off is activated. The analogue control input can also serve as an external trigger input which initiates pre-programmed processes in the power supply. A manual trigger pushbutton is also included on the front panel.

The *EasyArb* feature on the HMC8043 is Rohde & Schwarz's very close approximation of an arbitrary waveform generator (AWG) function. Whereas AWG is usually time-based, in the MHC8043 it can also be event-based, which is exceptional in its price class. *EasyArb* allows the output voltage level on any channel to be defined with a resolution of 10 ms, 1 mV and 1 mA. The waveform can be defined using a maximum of 512 points and can be repeated a programmed number of times or indefinitely. Entering the data by hand using the front panel buttons can be tedious; HMExplorer is the more convenient option here.

Remote Voltage Sensing

The three channel version I tested has a rear socket which amongst other signals, offers remote voltage sensing for all three outputs. This is useful to remove the voltage drop produced in the cables supplying power to the load. This feature can also be handy when the supply is used to recharge a multi-cell rechargeable battery pack. It's always a good idea to include an external diode in series with the battery pack when charging from a power supply. Without the diode, a power outage will often cause the energy stored in the multi-cell battery pack to 'bite back' and destroy the power supply output stage. The remote sense allows the battery pack voltage to be monitored directly, ignoring the non-linear voltage drop induced by the diode (**Figure 5**); the remote sense can compensate for a drop of up to 1 V max.

On this model the sense voltage connection is available on the rear panel mounted 16-way connector. The special, mating connector is pictured in **Figure 6**. The unit automatically detects the sense input is active and displays shows this on the display. Ensure the remote sense is securely connected

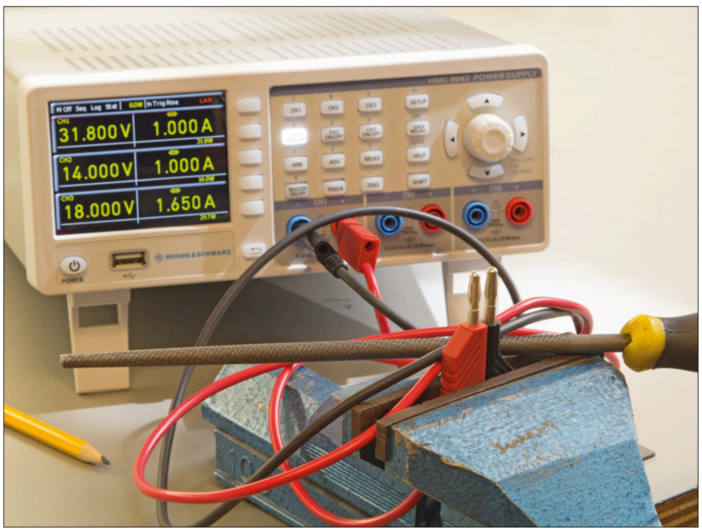

Figure 4. The Pease Test — there were sparks but it survived.

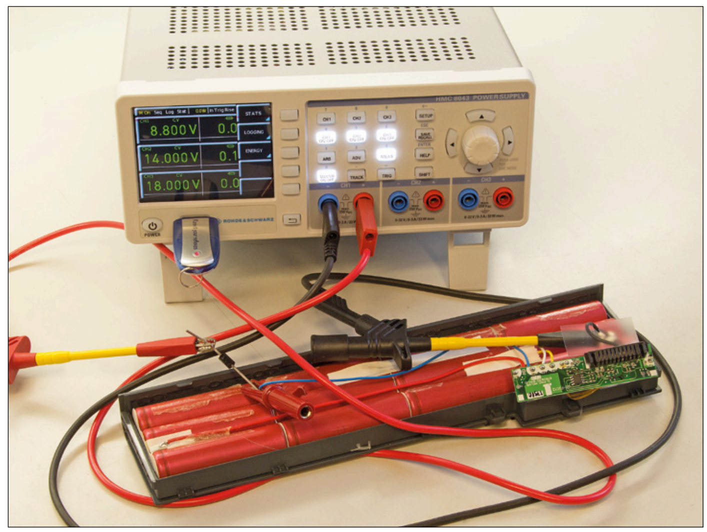

Figure 5. Battery recharging using remote sensing.

before the channel output is enabled; a flaky sense connection can cause the output voltage to fluctuate.
A logging function is also available to allow instantaneous measurements to be stored to the internal memory or a USB memory stick. The measurement interval can be defined in the setup menu. The stored values can be in either .TXT format or .CSV format so that can be input to a spreadsheet like Excel. The really exciting aspect here is that the HMC8043 and the USB stick is all you need to automatically record readings for many hours, even weeks depending only on the size of the USB stick. No remote control by a PC is necessary at any point during the measurements, and the .CSV file loaded from the stick can produce charts almost instantly using Excel. This makes charging, monitoring and condition checking of all sorts of batteries and battery packs a pleasure to do.

Teardown

Case styling is consistent with other models in Rohde and Schwartz's compact range — in fact without close scrutiny it's quite difficult to tell the difference between the HMC804X power supply and the HMC8012 DMM. The case is a steel sleeve with a perforated upper surface and a polycarbonate end plate forming the front panel. Side vents are preferable for equipment used in general lab environments; there is less likelihood of wire clippings and debris falling into the case and stacked units don't obstruct airflow. For a rack mounted installation this is less of a problem. The case size allows two HMC8043's to be fitted side by side in a 19" rack (a 1-U gap is required above this unit).
Inside the unit (**Figure 7**) is a superb, clean mechanical layout. A 2-mm thick aluminium chassis holds the main double-sided PCB which sits along the bottom of the case. The board uses SMD components which populate both sides of the board. Behind the front panel is a PCB which interfaces to the display and pushbuttons. The chassis extends up at the rear to form the instrument back panel.

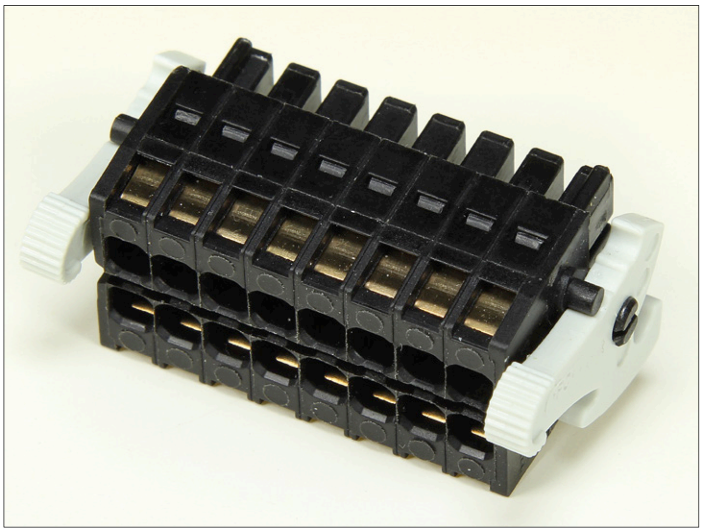

Figure 6. The special 16-way connector required for wiring up remote sensing and other applications.

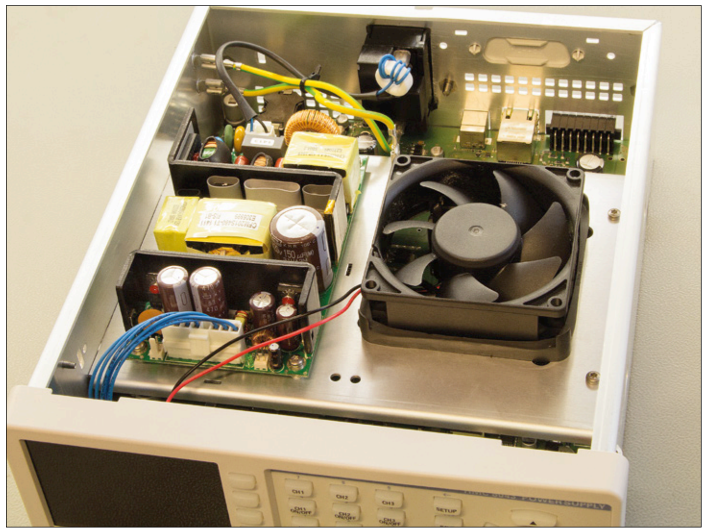

Figure 7. Inside the case. On top is the Cincon 200-W open frame AC/DC switch mode regulator supplying 48 V to the three microcontroller-controlled DC/DC convertors on the lower board.

There are no nuts to work loose and cause problems. With the unit open we can see on the upper level, a panel holding a fan and a third-party, industry standard, open-frame 200-watt AC/DC, switched-mode supply unit. This unit supplies 48 V DC to the lower PCB where it divides into three micro-controller (Microchip dsPIC DSC's) controlled DC/DC switching regulators for outputs to the front and rear panels. The PCB quality, component mounting and layout are second to none. With the front panel power switched off the main AC/DC power supply remains continually powered in standby mode until the PSU is turned off at the rear switch. In standby the unit uses just over 8 W.

How does it stack up?

Considering the high build quality and technical sophistication of the HMC8043 it's remarkable that little effort been put into the instrument documentation. On querying Rohde & Schwarz I was happy to hear though that the issue is being worked on. With all its connectivity options the HMC8043 is perfectly suited to a fully automated test environment but as we saw it also works well as a general purpose bench top power supply for use in the lab. If you are looking for a low-noise bench supply with excellent transient response a traditional standard, heavy, linear design is still hard to beat. If however you want something that can be used in an automated test environment and is programmable, lightweight, versatile and efficient with the ability to control the output to within millivolts and milli-ampères then the superbly built Rohde & Schwarz HMC8043 has plenty to offer. ⏮

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