# MFJ-4403 Transceiver Voltage Conditioner

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We can't always count on a transceiver's dc voltage source to be clean. In particular, noisy power sources are probably more prevalent during portable operations such as Field Day and DXpeditions, and in automotive (mobile) environments. The MFJ-4403 Transceiver Voltage Conditioner was designed to provide dc voltage protection for transceivers subjected to virtually any dc power situation.

## Features

The MFJ-4403 draws its own power from the dc voltage source. Normal dc operating current is 250 mA. Key features include:

- Reverse polarity protection — A reverse voltage input is blocked from the MFJ-4403 output.
- Transient suppression — Voltage transients are clamped at 15 V dc maximum with a 75 A transient suppressor. Long duration high voltage transients will cause the MFJ-4403 input fuse to blow.
- Short circuit protection — Internal automotive fuses protect both the source and connected equipment.
- Noise and ripple filtering — A 4 F (yes, 4 farad) super-capacitor bank made from six 25-farad series-connected capacitors, in conjunction with traditional high frequency filter capacitors, ensures that the cleanest possible dc voltage is applied to your equipment.
- Input and output dc connections are Anderson Powerpole connectors (Figure 8).

A 15 A input fuse provides protection for less-than-adequate power sources and wiring when operating low-current, or high-peak-current, low-duty-cycle, modes. For high-duty-cycle modes and a properly sized power supply, the 15 A input fuse should be replaced with a 25 A fuse. As the MFJ-4403 includes a 4 F capacitor bank, you could conceivably see currents in the hundreds of amps for a few milliseconds if you accidentally short circuit the output. The 25 A output fuse protects a short from causing serious damage.

A power resistor is used both for current limiting during the charging of the capacitor bank, and for discharging the capacitor bank when the MFJ-4403 is turned off. The discharge function is provided because the charged capacitor bank can provide a *huge* amount of energy should it be shorted inadvertently when you think everything is off.

Reverse-voltage protection is provided by a combination of a relay and a reverse protection diode. If a negative voltage is applied to the input, the relay cannot operate, and so no reverse voltage can appear across the capacitor bank or the output. The REVERSE POLARITY LED indicates a negative input voltage condition.

Damaging voltage spikes can occur in automotive environments, and with dirty or failing power supplies. A high-current clamping diode limits any spike to 15 V dc (nominal), and blows the input fuse if the clamped overvoltage persists for a few seconds. The 15 V clamping diode can handle 70 A without damage. Of course, the capacitor bank also serves to momentarily clamp any overvoltage condition because a sudden voltage change over a short period of time results in a high current pulse that can also blow the input fuse.

And finally, the super-capacitor bank provides outstanding filtering of any noise or ripple on the dc input. Smaller value capacitors take care of any high frequency noise that might make it by the super-capacitors. An interesting side effect of this capacitor bank is that you can power a 100 W SSB transceiver from an automotive accessory socket (what we used to call a cigarette lighter socket). We will look at this in more detail a little later.

## Operation

After connecting your dc source to the dc input connector and turning off any connected equipment, push the ON button. The CHARGING and POWER LEDs light and a current-limited charge of the capacitor bank begins. The high value of the MFJ-4403 capacitor bank requires that the capacitors must be pre-charged before you can operate any equipment — connecting a dc source directly to a discharged capacitor bank of this value will short the power supply output! After about one minute the current limiting resistor is shorted by the relay, the CHARGING LED extinguishes, and your connected equipment can be turned on. Incidentally, if any connected equipment is turned on during the pre-charge cycle, the pre-charge cycle will not complete and little voltage will be available for the equipment. A high-current diode in series with the pre-charging resistor keeps reverse voltage from finding its way to the output via the pre-charging circuit.

### Bottom Line

If you are ever concerned about the "cleanliness" of a power supply feeding your transceiver, or if you want to ensure that your mobile dc-power source is perfectly filtered, the MFJ-4403 may be just what you are looking for.


**Figure 8** — MFJ-4403 input/output connections.

When you want to cease operation, turn off any connected equipment and push the ON/OFF pushbutton on the MFJ-4403. The internal power resistor is connected across the capacitor bank and discharges the capacitors in about one minute.

## Performance

There is a pre-charge timing strap option on the printed circuit board, but it isn't mentioned in the manual. You should connect across these pins if you have an input voltage less than about 13.25 V dc. Normally the pins should not be strapped as you want the capacitor bank charged as close to the input voltage as possible before operating. With the timing pins strapped, the pre-charge worked well down to 12.25 V dc.

I first looked at pre-charge times. With the timing pins unstrapped, the pre-charge time was 55 seconds at 14.2 V dc, 65 seconds at 13.8 V dc, approximately 2 minutes at 13.5 V dc, and 3.5 minutes at 13.25 V dc. The pre-charge would not reliably complete below 13.25 V dc unless the precharge pins are strapped.

I next connected reverse voltage to the dc input. The REVERSE VOLTAGE LED lit immediately, and no negative voltage appeared at the output regardless of the position of the ON/OFF switch. When the reverse-voltage condition was corrected, the MFJ-4403 automatically reverted to normal operation.

Next I tested the input voltage clamping level. I connected a variable voltage power supply across the input and increased the voltage. I had to increase the input voltage very slowly as the capacitor bank does an outstanding job of trying to hold the voltage constant, resulting in power supply current limiting if the voltage is adjusted too rapidly. This is a desired characteristic that provides both filtering and impulse protection. With a little care, I found that clamping occurred at 15.5 V dc.

Finally I looked at power supply filtering. I previously reviewed a battery boost regulator that had ripple and noise so bad that I was afraid to connect it to my transceiver. I couldn't think of a better "dirty" voltage source for testing the MFJ-4403. First I connected the boost regulator directly to a 10 A resistive load with the input voltage set to 11 V dc, and the output set to 13.8 V dc. Figure 9 is an oscilloscope trace of the ac-coupled 13.8 V dc output across the load. As you can see, it is a pretty nasty signal. The amplitude of the ripple and noise is about 6 Vp-p! After connecting the MFJ-4403 between the boost regulator and the 10 A load, I could see absolutely no ripple or noise. The MFJ-4403 definitely does its job!

## What About That Auto Accessory Connector?

This is where I really had fun with this review. We've all been told to never power high-power ham equipment from an automobile accessory socket. MFJ states that the MFJ-4403 may be used to power a 100 W output SSB transceiver (75 W output for CW) from an accessory socket for temporary operations. The reason is that the accessory socket should be able to supply the average current required by the equipment, and the MFJ-4403 super-capacitor bank will provide the peak current necessary for low duty cycle transceiver operation. SSB and CW modes permit power from the auto accessory socket to recharge the capacitor bank during speech pauses or gaps between CW characters. MFJ does recommend making a direct connection to the car's battery for normal operation, along with the MFJ-4403 for voltage transient and filtering.

Let's look at the accessory socket possibility for powering a typical SSB/CW transceiver. *UL2089 Vehicle Battery Adapters* is the standard for low-voltage power ports. This standard limits accessory outlets to 20 A, and also states that a minimum of #12 AWG copper wire is required for 20 A. But that is the maximum current permissible, and is not necessarily what is available in most cars. I've spent quite a bit of time looking into this and have found accessory socket ratings varying from 10 to 15 A, and/or 150 to 180 W, continuous, in manuals or printed on the covers of some accessory sockets. You can also get an idea of the accessory socket current rating by looking at inverters and tire inflators that are available for use with these accessory sockets.

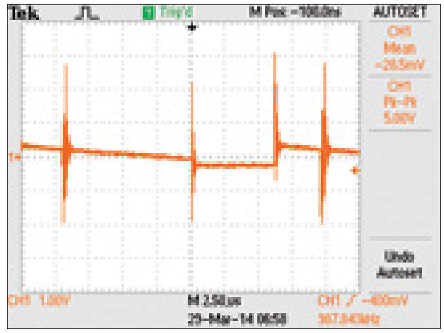

**Figure 9** — Battery boost regulator 13.8 V dc output feeding a 10 A load. The amplitude of the ripple and noise is about 6 V p-p. After connecting the MFJ-4403, the ripple and noise vanished.

Based on my research, I think that a 10 A continuous rating is probably reasonable, but you should determine this for your own vehicle. However, 10 A is much less than the peak current required by most 100 W mobile transceivers (often 20 A or so). Further, the mating accessory plug is a spring-loaded pressure contact that doesn't provide the best electrical contact for the high peak current requirement.

I tested three external accessory sockets connected to the high current output of my MFJ-4245 power supply, as well as the 7 A rated MFJ-4245 internal accessory socket. I also tested two different RadioShack cigarette lighter plugs (10 A rating) with each of these sockets (see Figure 10). The upper plug is not fused, while the lower plug includes an internal 10 A fuse.

With a 10 A load connected, I found a very consistent 0.08 Ω resistive loss (measured as 0.8 V drop) with the unfused plug/sockets, and 0.10 Ω resistive loss (measured as 1.0 V drop) with the fused plug/sockets. Then I subjected the connector pairs to a continuous 10 A current for 5 minutes. All socket and plug combinations felt cool. And all socket pins were cool to the touch. However, I found that the center pin of the fused (lower) plug was quite warm after 5 minutes. Based on my resistive loss measurements, this plug is dissipating 2 W more than the unfused plug, probably all in the extra center pin pressure contact and the fuse.

Next I evaluated my IC-706MKIIG current requirements. This radio draws the most

**Table 4**
**IC-706MKIIG CW Transmitting Current Measurements**

| Output (W) | I-pk (A) | I key-up (A) | I avg (50% duty cycle) (A) | I avg (44% duty cycle) (A) |
|---|---|---|---|---|
| 100 | 18.6 | 4.5 (semi break-in) | 11.6 | 10.7 |
| 100 | 18.6 | 1.4 (QSK) | 10.0 | 9.0 |
| 75 | 16.5 | 4.5 (semi break-in) | 10.5 | 9.8 |
| 75 | 16.5 | 1.4 (QSK) | 8.9 | 8.0 |

**Table 5**
**IC-706MKIIG Peak Current Measurements with MFJ-4403**

| Output (W) | I-pk Input (Pwr Supply) (A) | I-pk Input (Acc Socket) (A) | I-pk Input (0.1 Ω) (A) | I-pk Input (0.2 Ω) (A) | I-pk Output (A) |
|---|---|---|---|---|---|
| 100 | 15.9 | 11.2 | 10.2 | 7.3 | 18.6 |
| 75 | 14.3 | 10.2 | 9.5 | 6.8 | 16.5 |


**Figure 10** — The reviewer's automobile accessory connectors, described in the text.

current on 20 meters (18.6 A at 100 W output), so I used this band for testing. I used CW for my tests since CW has a higher duty cycle than SSB (44% PARIS standard CW duty cycle vs 20 – 30% SSB duty cycle). Table 4 shows my measurements for key-down and a string of dits (50% duty cycle), and the estimated average current based on the PARIS standard.

As you can see, about 10 A is a good average current drain that you might see when transmitting. However, we don't want to subject the accessory socket to the 18 – 19 A peak current that is drawn on every "dit." And this high peak current will also result in a peak voltage drop of 1 – 2 V dc.

I connected the MFJ-4403 between my MFJ-4245 power supply high-current output and the transceiver and measured the input and output dc current peaks while transmitting (receive current drain is well within any accessory socket current rating and so the MFJ-4403 just provides filtering and transient protection). I used an AEMC 514 digital Hall-effect clamp-on meter for peak and average dc current readings.

Initially I was surprised to see a high MFJ-4403 input spike of almost 16 A (corresponding to the 18.6 A peak current output). Then I used an accessory plug/cable between the MFJ-4245 power supply and the MFJ-4403 dc input and saw the MFJ-4403 input current spike drop to 11.2 A. After thinking about this I realized that in a perfectly lossless system, any discharge of the capacitors will be instantly recharged by the sourcing power supply, resulting in the same input and output current. However, if there is any loss from the input dc source, the recharge current is spread out over the RC time constant due to the dc-line loss and the total capacitance. With a 4 F capacitor, even a 0.08 Ω loss results in a time constant of about ⅓ second. My bench tests are probably as close to ideal as possible, and accessory sockets and wiring in most cars probably have more loss. Therefore I ran some additional tests showing the effect of adding in very low resistive losses. The results are shown in Table 5.

From Table 5 you can see that the accessory socket output current measurements are very similar to the IC-706MKIIG average current requirements when there is just a little loss in the system. In other words, you limit peak current when using an accessory socket to power a 100 W SSB/CW transceiver because the accessory socket and associated wiring is not lossless!

So — is it safe to use an auto accessory socket to power a MFJ-4403 connected to a 100 W SSB transceiver? I will leave this decision up to you. My measurements indicate that this is viable. And I did connect my IC-706MKIIG this way to my wife's 1997 Mustang. I used a high-power dummy load and a peak-reading Bird wattmeter and verified that the transceiver put out full power on SSB.

I do have a few recommendations. First, if you build your own cable, make sure you use a quality accessory plug that is rated for at least 10 A. The plug should have two ground "ears," and it should fit firmly into the accessory socket. You should also use #14 AWG wire minimum, and preferably #12 AWG. (MFJ sells an accessory-plug-to-Powerpole cable (MFJ-5515M) with a 3 foot flexible #12 AWG cable.) Finally, you should consider this as a temporary mobile solution. For permanent solutions, connect the input to the MFJ-4403 directly to the battery.

## Conclusion

The MFJ-4403 is a very robust dc filtering and transient protection device. It is certainly something to think about adding to your mobile power supply line, and any place where there is concern about power supply cleanliness. It is even at home in your main station should you have any concerns about your power supply failing and causing a problem. My only complaint is that it does not include a ground stud. Of course, a ground stud is easy to add, and maybe MFJ will add one in the future.

*Manufacturer:* MFJ Enterprises, PO Box 494, Mississippi State, MS 39762, tel 800-647-1800; **www.mfjenterprises.com**. Price: MFJ-4403, $119.95. MFJ-5515M cable, $19.95.