Behringer RX1202FX 12-channel mixer repair

A. M., of Port Macquarie, NSW had to go into full sleuth mode to fix the power supply of a fancy mixer. Several parts had failed, and not just the usual culprits...

The RX1202FX is a rack-mountable 12-channel mixer with an integrated effects unit, designed by Behringer in Germany but made in China. The mixer arrived with no signs of life at all. My initial thought was that it was likely due to a failed power supply or fuse.

Of course, a failed fuse is usually a symptom of another problem and replacing the fuse won't necessarily fix it.

The mains fuse is located in an integrated IEC socket. Prising this open and testing the fuse showed the fuse to be intact, so a more a time-consuming repair would be required.

Opening the unit up revealed a front panel PCB, rear panel PCB and a small switch-mode power supply. The front and rear PCBs are connected via three ribbon cables, glued in place with hot glue. The power supply is mounted vertically between the front and rear panels with an output connector linking to the rear PCB.

Removing the power supply board involved undoing two screws, disconnecting the output connector on the rear PCB and desoldering the mains input cable from the rear panel switch and Neutral connection.

As is usual with a switch-mode supply, your mind immediately jumps to the capacitors as the source of the fault. I thought it would be an easy repair; just replace the dried-up electrolytics and it will work again.

Visual inspection of the supply, once it was removed from its aluminium heatsink/mounting frame, did not reveal any catastrophic damage, but did show it provided multiple supply rails and was designed by Behringer (many equipment switch-mode power supplies are generic devices made by third parties).

An internet search indicated that this supply was used in a few different Behringer mixers, but a complete replacement supply did not seem to be available. The search did yield a schematic, though; the commentary with the schematic was not in English so it may or may not have been an official diagram.

But it did match the part numbers and values and general configuration of the supply, and indicated the output voltages. The PCB silkscreen gave the component values as well as part numbers but not the output voltages.

Powering the supply up outside the mixer showed that all the supply rails were absent and the big input filter capacitor stayed charged once the mains had been removed. Being bitten by the 340V DC on these capacitors is something you always remember and good quality capacitors with no load can hold a charge for a long time.

The capacitor keeping its charge was a clue that the primary side of the supply was not switching. The two small electros on the primary side are were wedged between the large filter capacitor and the transformer. Both tested OK with the ESR meter and measured a reasonable capacitance in circuit.

All the surface-mount resistors on the primary side of the supply seemed to match both the schematic and their values, measured close to the markings on the PCB, except for R5. This is a 10kΩ surface-mount resistor between the X pin on the switching regulator IC (a seven-pin TOP245YN) and ground.

I desoldered R5 to check it further. It was apparent that the regulator had an internal short between the control input pins, damaging R5; strangely, the switching device had not failed. My previous experience with these devices is that the output device usually fails short-circuit.

While awaiting a replacement regulator, I decided to check the rest of the PCB and found both the 100nF X2 capacitors on the input filter to be under 10nF. While you would not expect that to stop the supply working, replacing them is easy and the designer of the supply put them there for a reason, so I did so.

The replacement regulator arrived and was duly fitted. The excitement of powering the supply up again was short lived when the 15V rails were sitting at 21V and the 12V rail was sitting at 19V. The 5V rail was correct; it was regulated off the transformer secondary with its own 7805 linear regulator, so this was to be expected.

At this point, at least the primary side of the supply appeared to be working correctly; no smoke, no explosions, just a little too much voltage on the secondary.

After sleeping on the problem, I thought that maybe the excessive output was due to a lack of load; after all, once in the mixer, the supply would always be loaded by the rest of the circuitry and the voltage would drop.

A dummy load was hastily knocked up from some resistors and the supply fired up again. This slightly reduced the loaded rails but they were still nowhere near 15V and 12V.

Clearly, the feedback path between the low voltage section of the supply and the control TOP245Y was not acting to regulate the output voltage. As is common on this type of supply, the feedback path consists of a voltage divider off the 15V rail, a TL431 shunt regulator and a 4N35 optocoupler to isolate the signal between the primary and secondary.

The voltage divider and filter capacitors all tested within acceptable tolerances and the reference pin on the shunt regulator voltage was close to the expected value given in the data sheet. Static tests with a multimeter suggested that the optocoupler had not catastrophically failed.

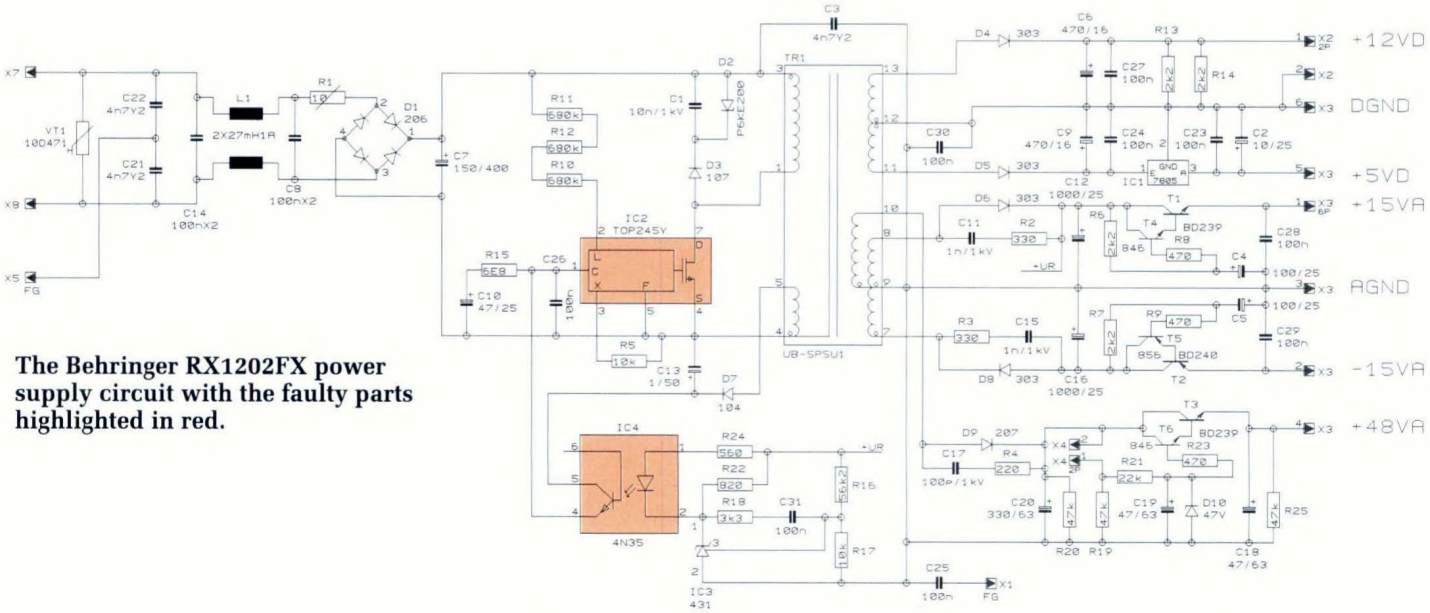
At this point, it was tempting to load the parts "shotgun" and replace everything on the board that had not already been replaced, as this would be quicker than further analysis and fault finding. But having heard stories of failed optocouplers and there being a general distrust of them amongst some parts of the design community, plus having plenty of spares, I rolled the dice and decided to replace the 4N35.

This was the magic that finally reduced the rail voltages to within normal limits. The unanswered questions now are about the chain of events which caused the supply to fail; was there a long-term over-voltage condition before it finally failed? Could this have damaged other parts of the mixer?

Due to the length of the interconnecting cables within the mixer, the only way to test the other boards was to fully reassemble the unit. Once assembled, the mixer powered up correctly and the expected LEDs on the front panel lit up. The next test involved injecting a sinewave into each channel and looking at the output on the oscilloscope and checking the response of the controls.

This was a time-consuming job on a 12-channel mixer but it revealed no apparent damage with a clear sinewave on each output matching the input, allowing for the effect of the controls. A final test with some music and an amplifier was anticlimactic, with all controls working as expected.

The reason for the failure of the switchmode regulator and optocoupler will have to remain a mystery. I speculate that the reduced capacitance of the input filter capacitors could have made the supply susceptible to mains-born transients, even though it appears well protected with



The Behringer RX1202FX power supply circuit with the faulty parts highlighted in red.

a metal oxide varistor (MOV) across the input.