TECHNOTE 002
POWER SUPPLY SEQUENCING ON THE PWR001 TRIPLE OUTPUT MODULE

An investigation in to the operation of the Clockworks supply

Rev 1.0

18-Feb-2019

Signal Processing

http://clk.works/

Products covered:

PWR001 triple output supply module

1. TABLE OF CONTENTS

1 INTRODUCTION

This report looks at the power sequencing of the Rev 1 PWR001 module, which is based on a Meanwell +/-15V converter and a CUI 3.3V converter module. This work was done as part of the engineering validation of the design.

There are two related Technotes for the PWR001 module:

- TN001: Power supply noise sensitivity
- TN003: Power supply noise impact. This looks at the impact of the PWR001 noise on a simple op-amp buffer circuit to see if there are issues beyond what the PSRR would suggest.

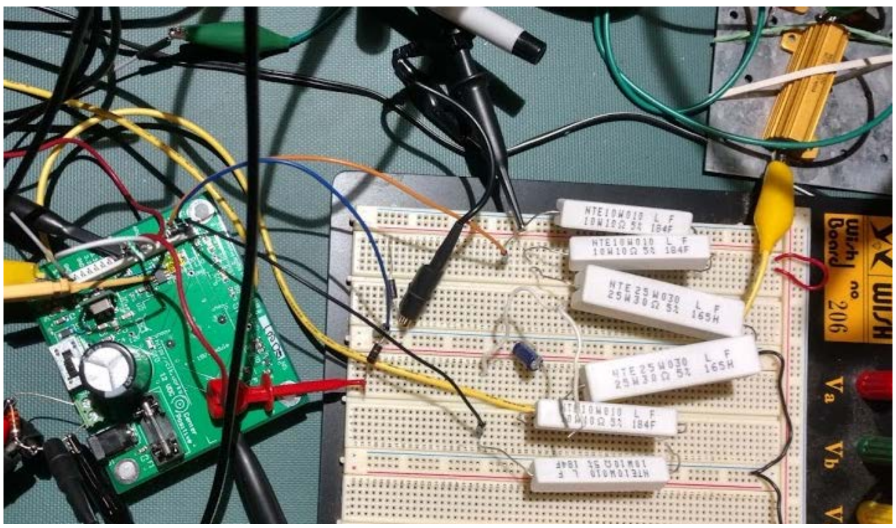

Figure 1 Test system configuration. Nobody said it would pretty.

For details about the supply please see the schematic. For details about the SignalBlox connectors for power please see the System Design Guide. Both are available from [https://clk.works/.](https://clk.works/)

1.1 SUMMARY

- The Meanwell module's +15 and -15 outputs track each other well.
- The 3.3V supply will be stable by the time the +/-15V supplies are stable.
- The PWRGOOD signal will go active (3.3V) about 70 msec after power is applied.
- Efficiency of supplies matches datasheet (around 75%).

- Peak in-rush current is around 7A but lasts < 1 msec when measured with a bench supply. A lower power supply may go in to current limiting.
- On loss of power, under full load, +/- 15V will hold up for 9 msec.
- 3.3V will hold up for considerably longer, but the intent is that the controller detect PWRGOOD going low and quickly ramp down the volume and activate the system's MUTE relays to avoid output anomalies.
- Due to switch bounce it's possible that POWERGOOD may blip active during shutdown. The control software should implement a separate software debounce of this signal.

1.2 TESTED DEVICE

1.2.1 POWER MODULE

Clockworks triple output supply model PWR001, SN # E0001.

ECOs:

- Meanwell PowerModule ECO (footprint flipped, module mounts to back)
- 3.3V GND pin connection (pad isn't connected to ground in rev 1)
- Local +12V to TL7712 VCC pin (was wired to input 12V in rev 1)

ANAPOWERn line grounded so analog output will turn on when power applied.

1.2.2 PRIMARY SUPPLY

There were used for providing 12V to the DUT.

- MASTECH HY3005F-3 bench supply
- Meanwell GST60A12-P1J

1.3 TEST EQUIPMENT

Siglent SDS1204X-E oscilloscope with Rev 8.1.6.1.24R2 software

2 POWER ON

This was tested with an 8 ohm load on the 3.3V (1.4W) and 75 ohm on the 15V supplies (3W each).

The first plot shows that the +/- 15V supplies track each other.

The second plot shows the 3.3V supply timing relative to the PowerGood signal. PowerGood should not be treated as a reset as the intent of that signal is to indicate loss of primary input power to the control processor so that it can gracefully mute the outputs before analog power fails.

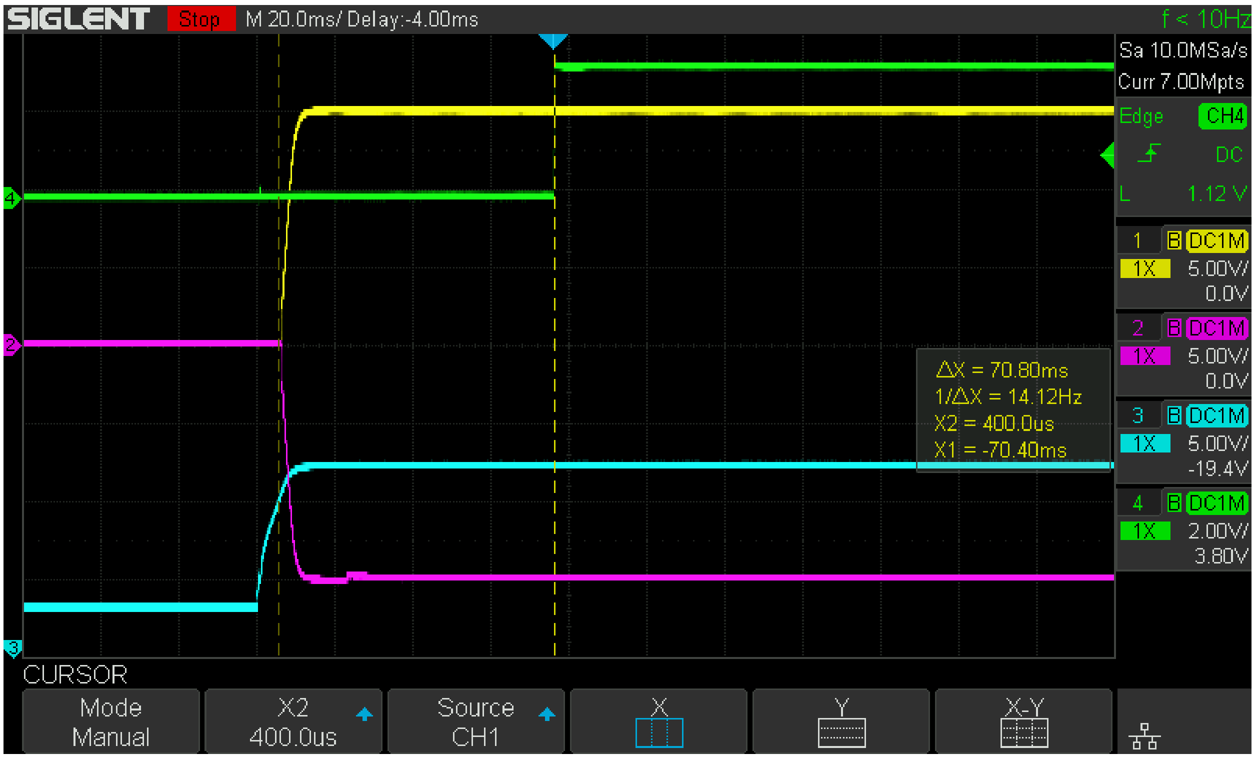

Figure 2 +15V (ch1) Yellow, -15V (ch2) Magenta, 12V in (ch3) Blue, PowerGood (ch4) Green

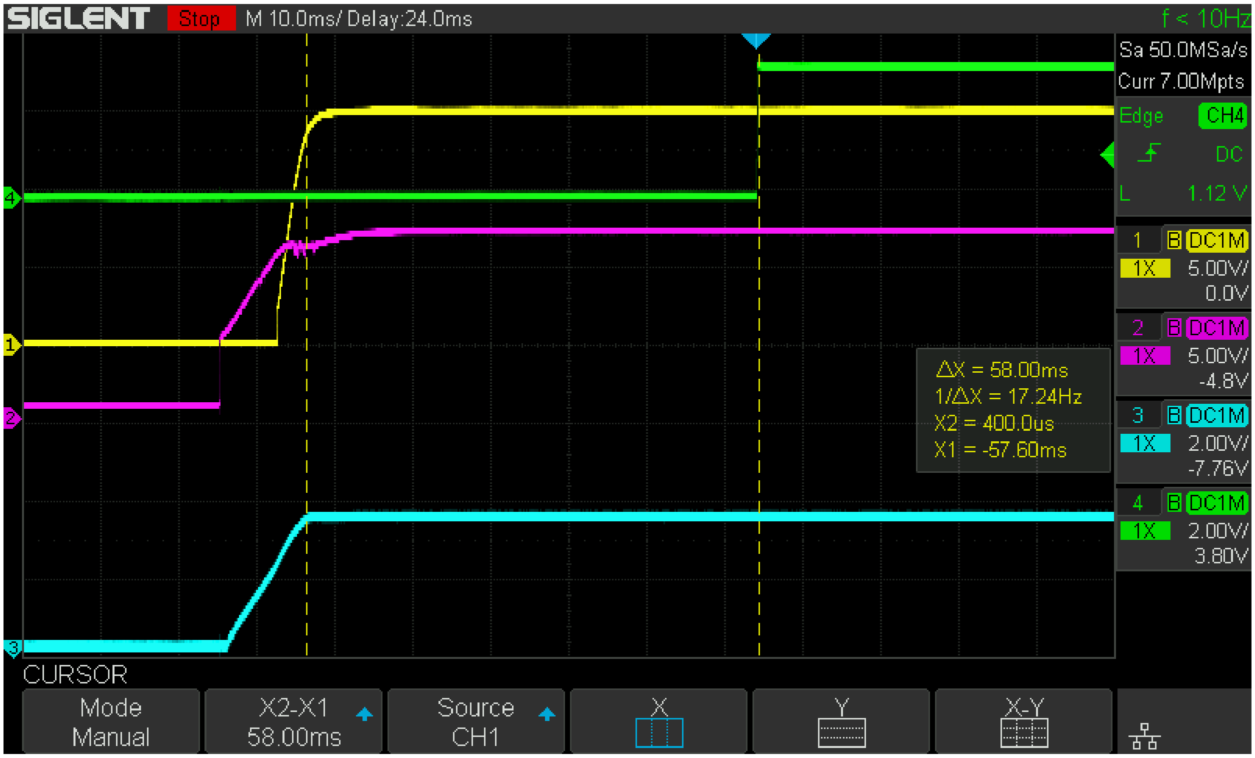

Figure 3 switched on. +15V (ch1) Yellow, -12V input (ch2) Magenta, 3,3V (ch3) Blue, PowerGood (ch4) Green

3 POWER OFF

3.1 MEDIUM LOAD

This was tested with an 8 ohm load on the 3.3V (1.4W) and 75 ohm on the 15V supplies (3W each).

In this first capture the power switch on the supply is switched, which causes a rapid drop in the 12V as measured at far side of the switch.

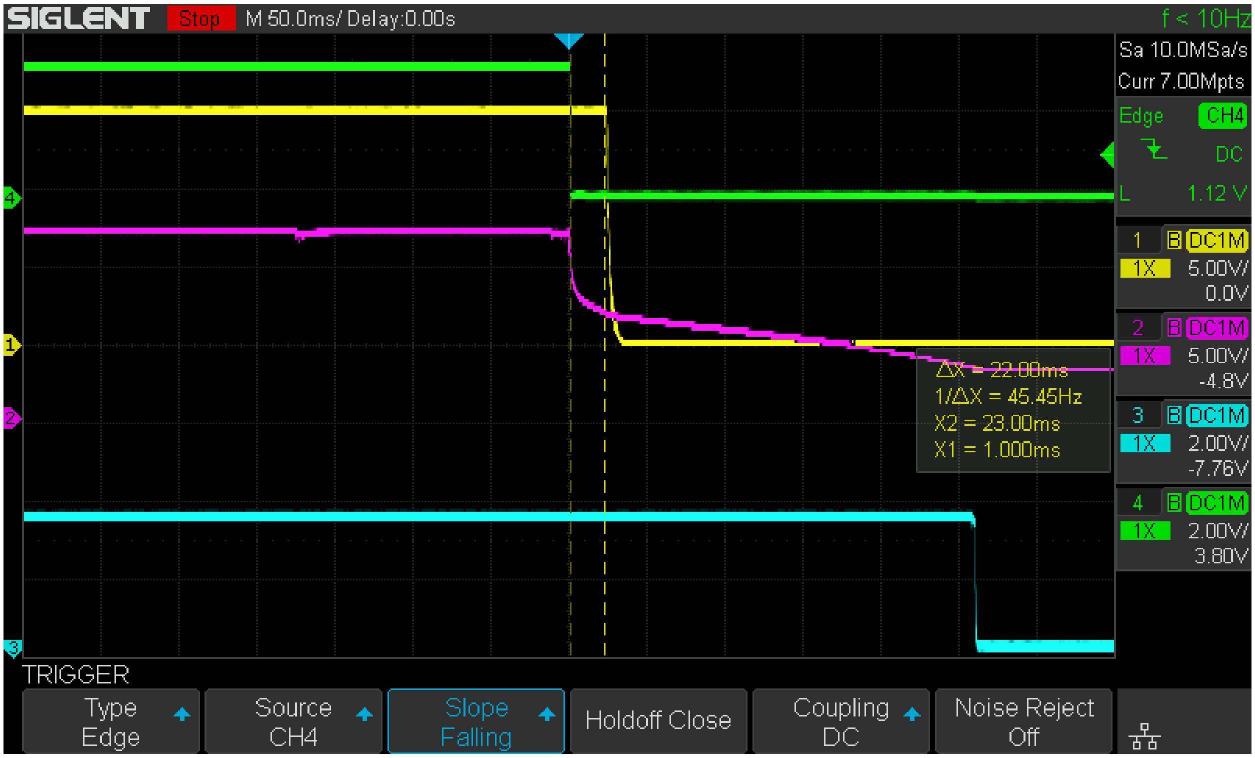

Figure 4 Switched to off. +15V (ch1) Yellow, -12V input (ch2) Magenta, 3,3V (ch3) Blue, PowerGood (ch4) Green

In the next plot the AC plug is removed from the supply (a Meanwell GAT60A12) which causes the 12V to drop more slowly, which has the effect of reducing the time that the 15V supplies are stable after the PowerGood signal goes inactive.

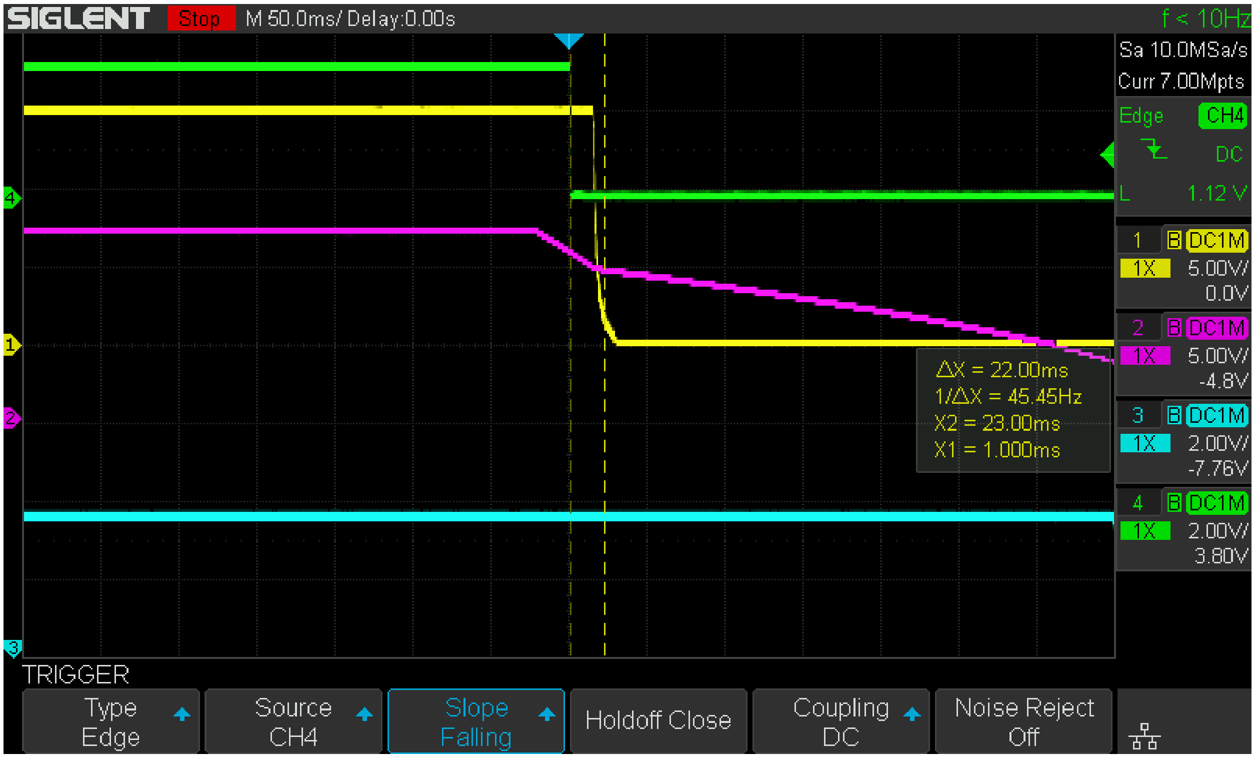

Figure 5 AC removed. +15V (ch1) Yellow, -12V input (ch2) Magenta, 3,3V (ch3) Blue, PowerGood (ch4) Green

3.2 HIGH LOAD

This was tested with an 4 ohm load on the 3.3V (2.7W) and 50 ohm on the 15V supplies (4.5W each).

In this first capture the power switch on the supply is switched, which causes a rapid drop in the 12V as measured at far side of the switch.

The holdup time on the analog supplies is now about 12 msec.

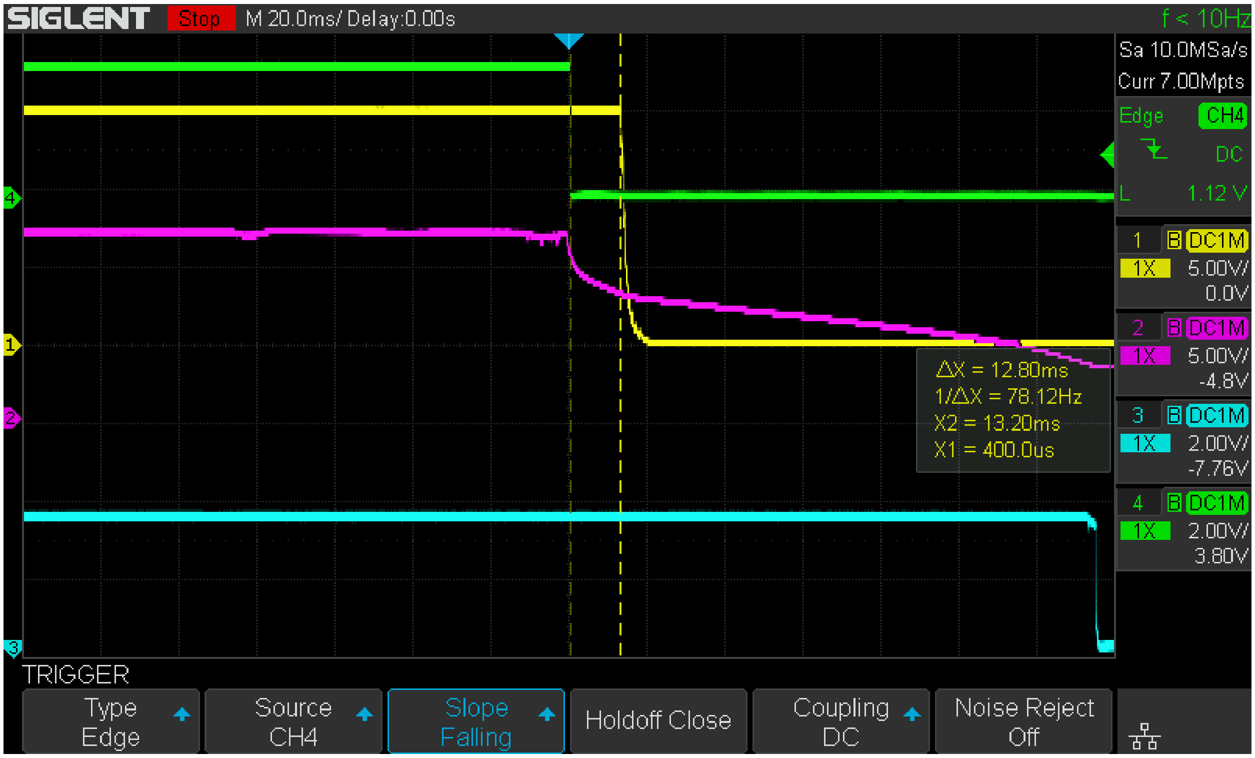

Figure 6 Switched off. +15V (ch1) Yellow, -12V input (ch2) Magenta, 3,3V (ch3) Blue, PowerGood (ch4) Green

With the AC power remove the holdup is reduced as before due to the slower dropoff of the 12V input.

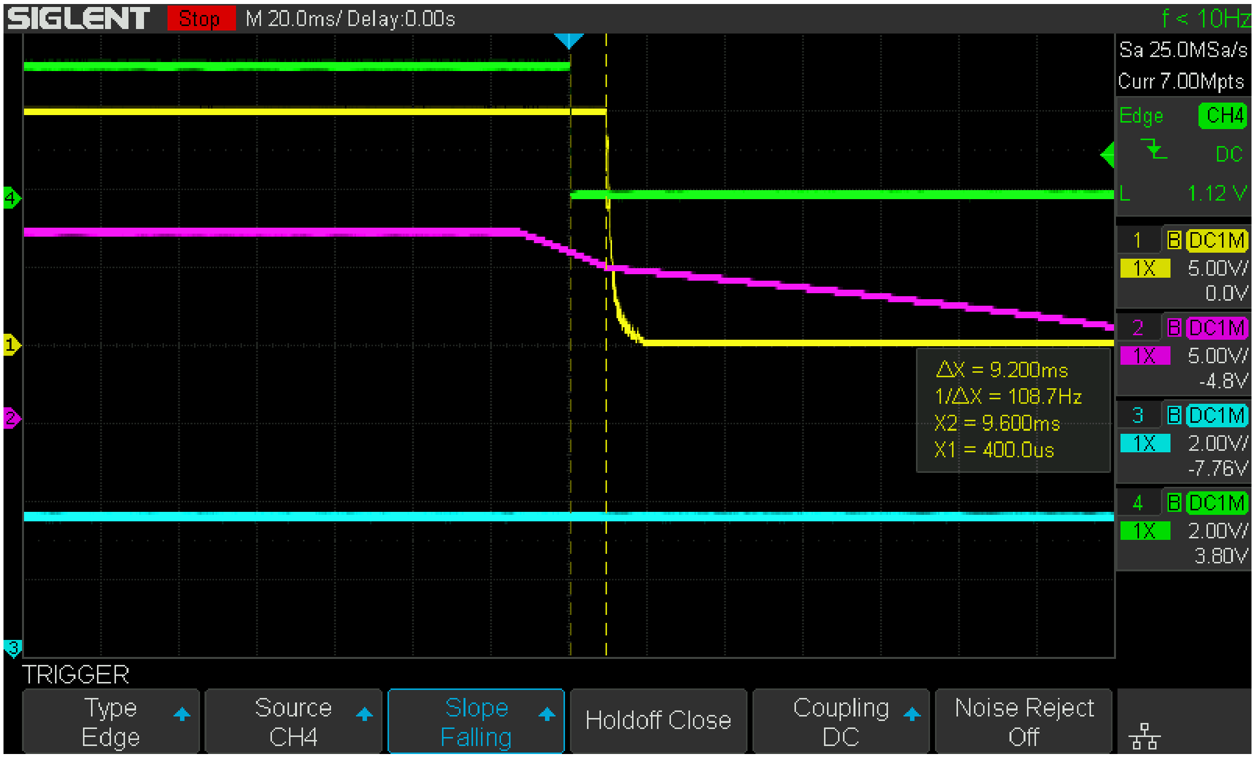

Figure 7 AC Removed, +15V (ch1) Yellow, -12V input (ch2) Magenta, 3,3V (ch3) Blue, PowerGood (ch4) Green

4 STARTUP CURRENT

A 10,000 uF cap (isolated by a diode from the 12V input) is used to maintain power to the regulators after input power is lost. While this is a simple solution it does have the downside of making the supply look like a short when power is initially applied.

Using a 0.5 ohm resistor as a current sense resistor[1], the startup current is show below. A bench supply is used to provide large currents. A spike of 14 amps is measured though after 1 msec has dropped down to under 2 amps.

In this test a 4 ohm load on the 3.3V (2.7W) and 50 ohm on the 15V supplies (4.5W each) was used. The stead state current from the 12V supply is 1.3A, yielding an efficiency of 75%.

The diode that isolates the cap from the input is rated for 5A continuous, with a 30A 20 msec surge rating.

[1] A somewhat high value but given the 1.3A draw and insensitivity to supply variation it made for easy data capture and analysis.

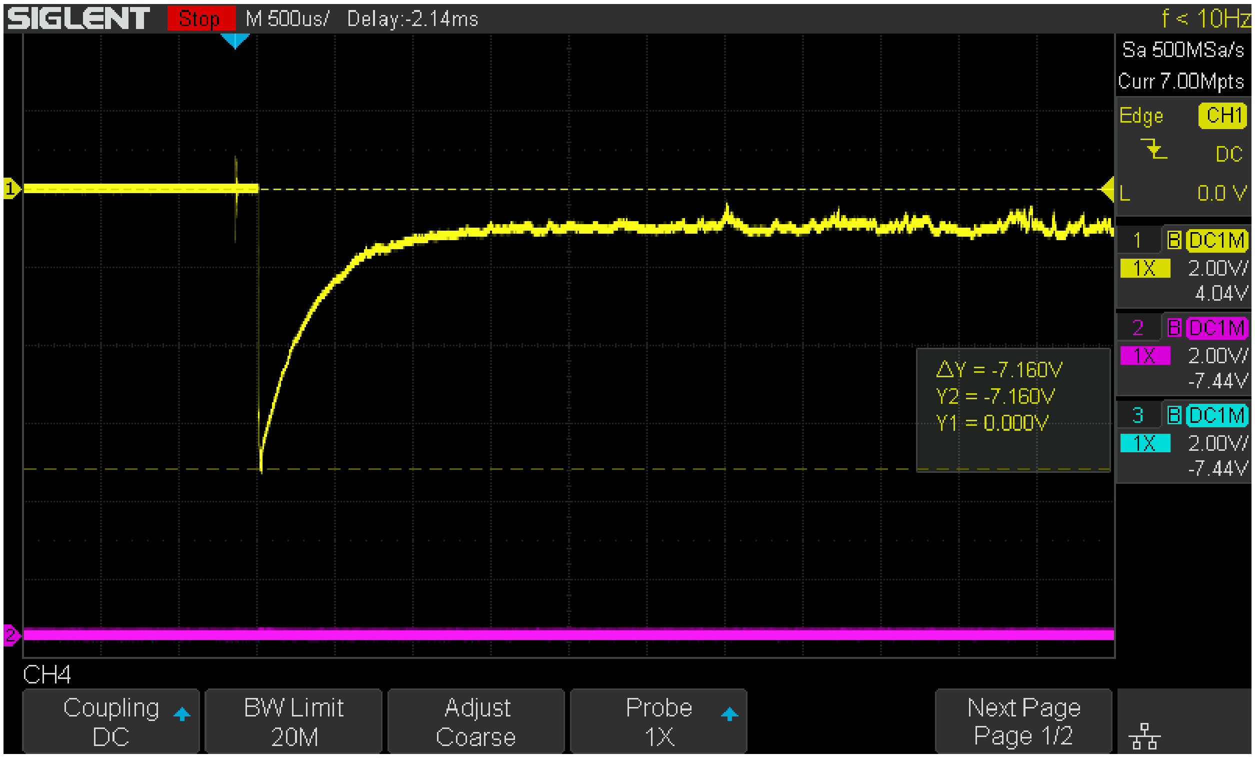

Figure 8 Startup current (inverted) (Yellow trace/ch 1) as measured across 0.5 ohm resistor

5 ODDITIES

5.1 PATHOLOGICAL CASE

The next capture shows switch bounce happening at just about the right time relative to the voltage monitor startup delay to cause a small PowerGood state before it indicates the final fail state.

To protect against this the controller software should check the PowerGood line a few times before assuming it's valid.

Figure 9 Small PowerGood pulse caused by just the right timing of events. +15V (ch1) Yellow, 12V input (ch2) Magenta, 12V local (ch3) Blue, PowerGood (ch4) Green

5.2 MAKING THE SWITCH BOUNCE MORE OBVIOUS

In all of the above plots you may have noticed the 12V input, as measured on the far side of the switch, decays rather slowly when the test case was made by throwing the switch (versus unplugging AC power). This is because that line essentially floats when the switch is off, the diode that isolated the big hold-up cap has pretty low leakage.

The only thing to discharge the small decoupling cap on the line is the voltage supervisor sense input, and that's around 40k ohms.

We can however tack in a 1K resistor to discharge the cap quickly and show the effects of the switch bounce.

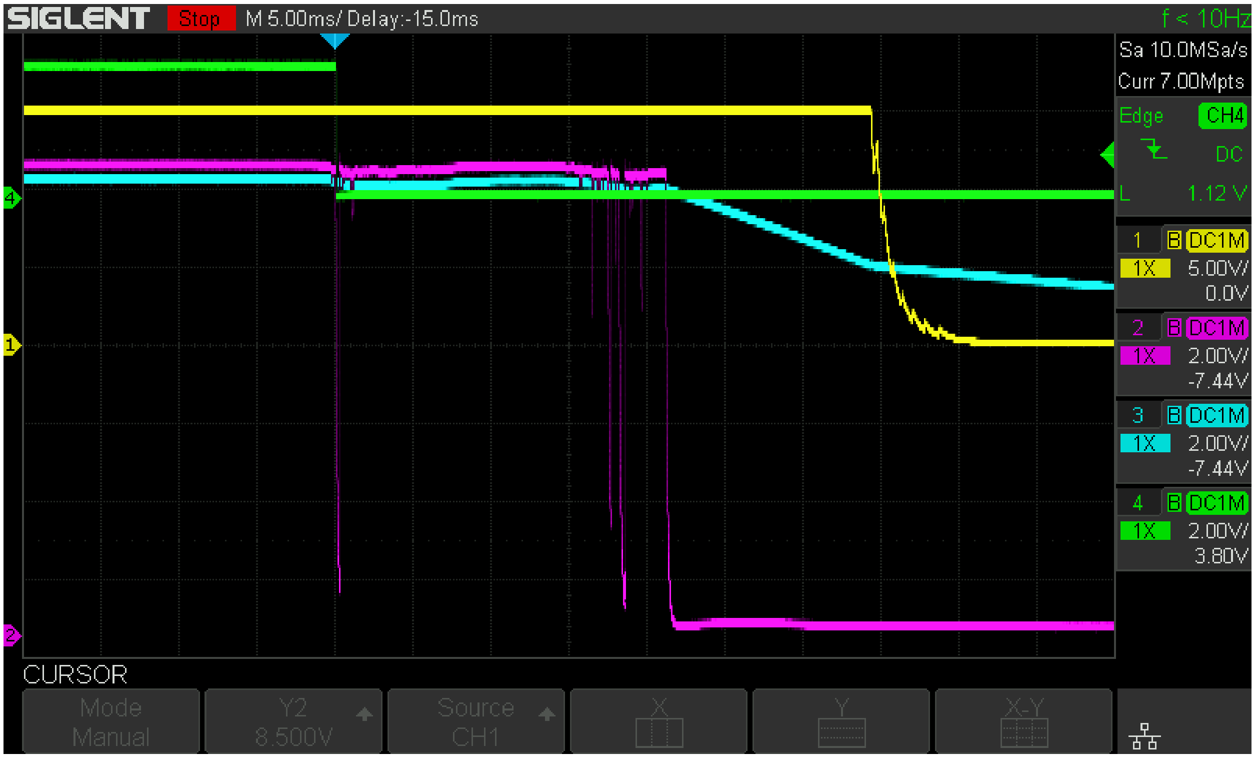

Figure 10 Modified circuit to show power switch bounce. +15V (ch1) Yellow, 12V input (ch2) Magenta, 12V local (ch3) Blue, PowerGood (ch4) Green