Turn-on & Turn-off Times of a Power Supply

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Abstract:

Regulated power supplies are found in electronics laboratories, and in virtually every electronic circuit. They are either switching power supplies, which are quite efficient but rather complex and prone to generate EMI (electro-magnetic interference), or linear power supplies, which are simpler but often highly inefficient. One parameter of a power supply is how quickly it comes on line after being turned on. This dV/dt will affect the current that flows into a capacitive (or tungsten filament) load, and may determine whether certain types of oscillators will start. Most oscillators will start faster, and are more likely to begin sustained oscillations, if the power to which they are connected is turned on quickly.

Equipment:

- Agilent 54600 - Series Oscilloscope
- Any 2-Output Power Supply

Circuit Explanation:

The regulated dual power supply shown below will be monitored. By putting the oscilloscope in single-shot mode, and by triggering on the rise of voltage on Channel 1, the turn-on dV/dt of both the positive and negative adjustable supplies can be captured when the push button switch is pushed to ON.

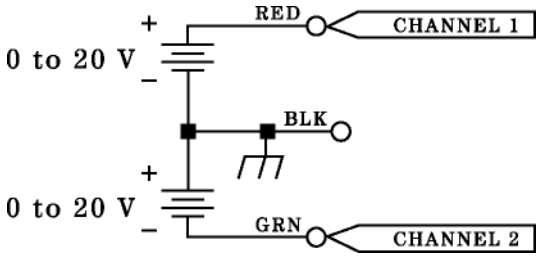


Figure 1

Procedure A - Observing And Measuring ± 20 V Supplies:

1) Set (by eye is fine) the PS 503A variable supplies for about ±16 V. Turn both current limit controls fully CCW (minimum current). Connect Channels 1 and 2, using 10X probes, as shown.

2) Refer to the information in Figure 2 for oscilloscope control settings, and adjust your oscilloscope accordingly. The trigger level is not critical, but should be somewhere around +1 V or +2 V.

3) Turn on the power supply output by pushing the **ON** button **IN**. The sweep of the oscilloscope should be triggered once, and a new trace recorded (see Figure 2 for a typical display). You will have to press the **Run** hardkey after each trigger to "arm" the sweep again.

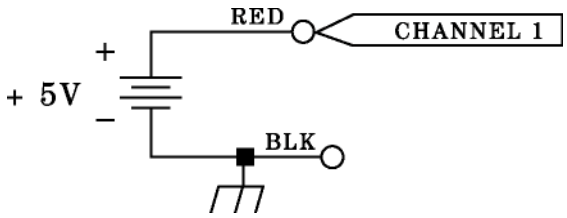
4) Press the **Stop** hardkey, then press the **Display** hardkey followed by the **Vectors On** softkey. Vectors On essentially "connects the dots", giving a better display of the trace for Channel 2. Notable is the pre-trigger information to the left of the trigger time. In other words, even though the oscilloscope had not yet triggered as the rising voltage of the positive power supply neared the trigger voltage, the analog-to-digital converter in the oscilloscope was sampling the power supply output continuously and feeding it into its memory. When the trigger finally occurred, the "sweep" finished and the contents of the memory (containing both pre- and post-trigger information) were frozen. Record turn-on times in the table below.

5) Press the **Run** hardkey, set the trigger level to about +15 V, and change the trigger slope to negative. See Figure 3. Turn off the power supply output by pushing the **ON** button again so that it comes **OUT**. The sweep of the oscilloscope should be triggered once, and a new trace recorded (see Figure 2 for a typical display). Record turn-off times in the table below.

Power Supply	Turn-on Time	Turn-off Time
+20V (Red)		
- 20V (Green)		

Procedure B - Observing And Measuring + 5 V Supply:

1) Connect Channel 1 to the +5 V supply. Refer to the information in Figure 4 for oscilloscope control settings, and adjust your oscilloscope accordingly. The trigger level is not critical, but should be somewhere around +0.5 V.

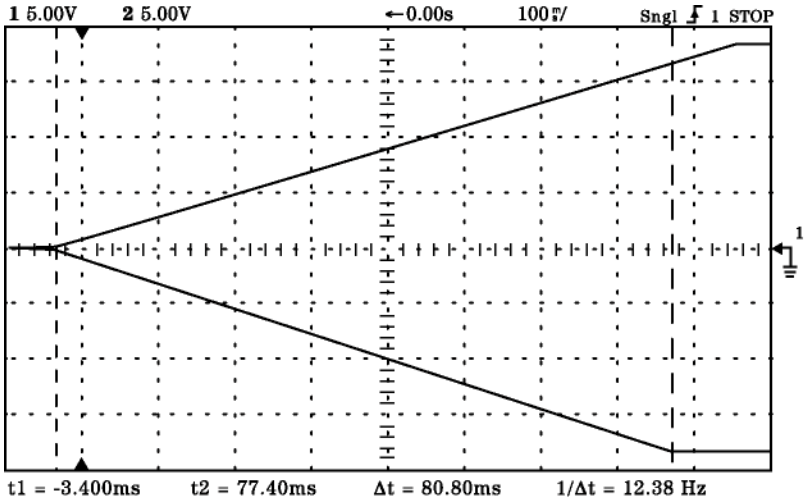


2)Turn on the power supply output by pushing the **ON** button **IN**. The sweep of the oscilloscope should be triggered once, and a new trace recorded (see Figure 4 for a typical display). You will have to press the **Run** hardkey after each trigger to "arm" the sweep again.

3) Press the **Stop** hardkey. Notable is the much shorter (by three orders of magnitude!) turn-on time, and the non-monatomic rise from 0V to +5 V. Record turn-on time in the table below.

4) Press the **Run** hardkey, set time/div to 5 ms/div, adjust the trigger level to about +4 V, and change the trigger slope to negative. See Figure 5. Turn off the power supply output by pushing the **ON** button again so that it comes **OUT**. The sweep of the oscilloscope should be triggered once, and a new trace recorded (see Figure 5 for a typical display). Record turn-off time in the table below.

Power Supply	Turn-on Time	Turn-off Time
5V		



	State	Volts/Div	Position	Couplg	BW Lim	Invert	Prove
Chan 1	On	5.000 V	0.000 V	DC	Off	Off	10:1
Chan 2	On	5.000 V	0.000 V	DC	Off	Off	10:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

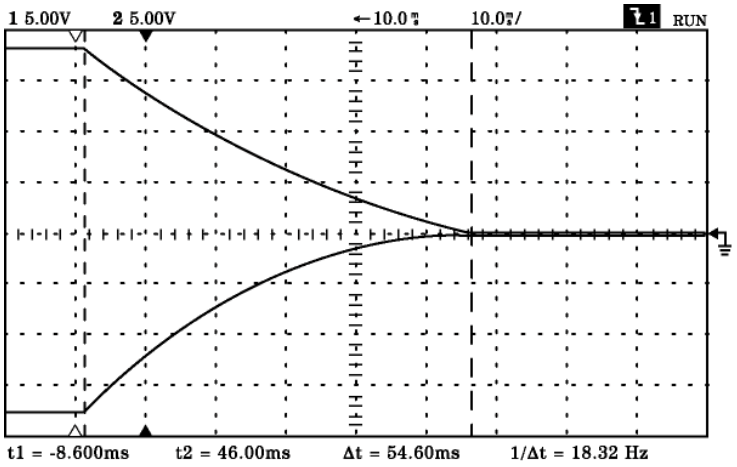
	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	10.00ms/	0.000 s	Left	----------	----------

Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	Single	Ch 1	1.250 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Cursors: t1= -3.400ms t2=77.40ms V1(1)=0.000 V V2(1)=0.000 V

Figure 2 - ± 20 V Supplies, After Turn-on



	State	Volts/Div	Position	Couplg	BW Lim	Invert	Prove
Chan 1	On	5.000 V	0.000 V	DC	Off	Off	10:1
Chan 2	On	5.000 V	0.000 V	DC	Off	Off	10:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

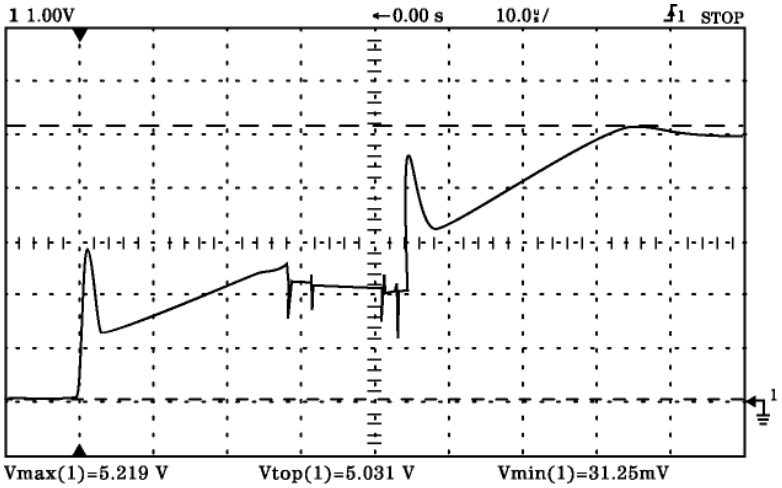
	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	10.00ms/	-10.000ms	Left	----------	----------

Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	Single	Ch 1	15.00 V	200.0ns	Neg	DC	Off	Off

Display Mode: Normal

Cursors: t1= -8.600ms t2=46.00ms V1(1)=562.5mV V2(1)=5.000 V

Figure 3 - ± 20 V Supplies, After Turn-off



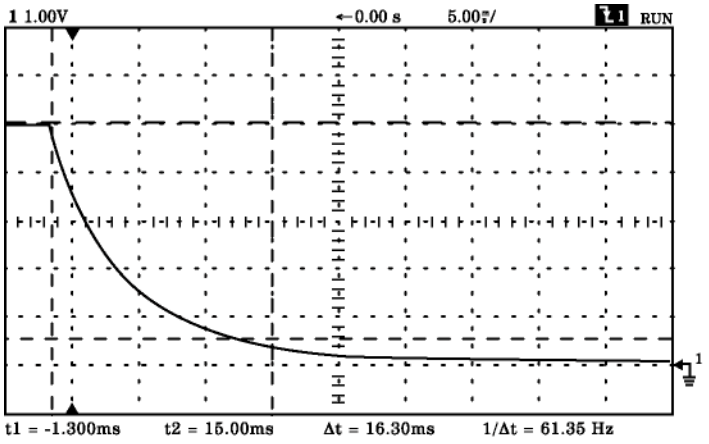
	State	Volts/Div	Position	Couplg	BW Lim	Invert	Prove
Chan 1	On	1.000 V	-3.000 V	DC	Off	Off	10:1
Chan 2	Off	5.000 V	0.000 V	DC	Off	Off	10:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	10.00us/	0.000 s	Left	----------	----------

Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	Single	Ch 1	468.8mV	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Figure 4 - +5 V Suppy, After Turn-on



	State	Volts/Div	Position	Couplg	BW Lim	Invert	Prove
Chan 1	On	1.000 V	-3.000 V	DC	Off	Off	10:1
Chan 2	Off	5.000 V	0.000 V	DC	Off	Off	10:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	5.000ms/	0.000 s	Left	----------	----------

Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	Single	Ch 1	4.094mV	200.0ns	Neg	DC	Off	Off

Display Mode: Normal

Cursors: t1= -1.300ms t2=15.00ms V1(1)=562.5mV V2(1)=5.000 V

Figure 5 - +5 V Suppy, After Turn-off