Auber Instruments, Inc.
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Instruction manual

Digital Solid State Relay Power Regulator with Build-in SSR

DSPR2

Version 1.0
(August 2014)

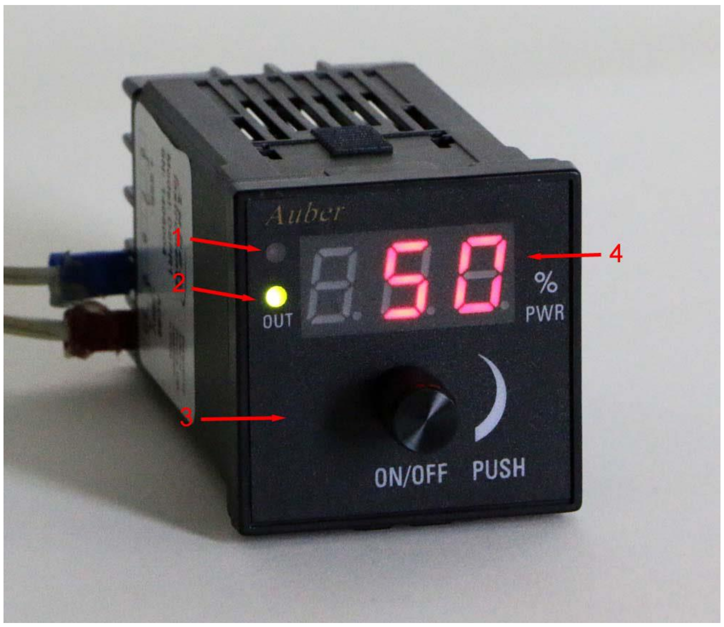

Figure 1. The front panel of a Digital SSR Power Regulator (DSPR2).

A. Front Panel

1. Standby power light. It stays on when the DSPR2 is connected to AC power but the not turned on.
2. Output indicator. It is synchronized with control output (terminal 6 and 7). When it is lit, the heater or cooler is energized.
3. Rotary switch. Push it once to turn the regulator on or off. Turn it clockwise to increase the output power; turn it counter-clockwise to reduce the output power. This switch is also used to set the control mode. Please see section D for details.
4. Display window. During the normal operation, the number represent the percentage of power output on the SSR.

B. Wiring

The back terminals of DSPR2 is shown in Figure 2. Connect terminal 9 and 10 to the AC power. The controller has a build-in SSR for small AC loads. Please refer to Figure 3 in the section E for wiring.

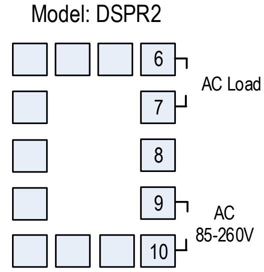

Figure 2. Wiring terminals of DSPR2.

C. Operation

The standby LED will lit once this regulator is connect to the AC power. Push the rotary switch once to turn on the unit. A number will be shown in the window, which indicates the percentage of power you want the regulator to output. This number is the same as the percentage at which the regulator is being turned off last time. Turn the nub to increase or to reduce the power. Each click of rotation will increase or reduce the value by 1%. If you want to quickly increase the output percentage, continuously rotate the nub can accelerate the increment of the percentage value. When you want to stop sending the power, push the nub once to turn off the regulator.

D. Selecting Power Regulating Mode

This regulator offers two regulating modes: burst firing mode and time proportional mode (Please see the appendix for the difference between this two modes). The unit is shipped with burst firing mode as the default mode. This mode will give user the best result for controller a small heater. But if this regulator is used to control a device that does not like the high firing frequency, the time proportional mode should be selected.

Here is how to change the power regulating mode:
Turn on the regulator, adjust the output percentage to "0". Press and hold the nub for 5 seconds until the LED display shows letter "M" on the left and letter “E” on the right. Release the nub. Now, if you turn the nub clockwise, “E” will change to “P”; if you turn the nub counterclockwise, the “P” will change to “E”. Here “E” represents the burst firing mode, “P” is the Time Proportional mode. So, turn the nub clockwise so that “P” is displayed. Then push the nub again, the controller is prompted to another display mode, with letter “T” on the left and a number on the right. The number is the cycle time in seconds. You can select the number by rotating the nub. When a proper cycle time is selected, push the nub again to confirm and exit. Now the regulator is set to the time proportional mode.

E. Wiring Examples

Here is a wiring diagram of how to connect a small heater AC to this regulator.

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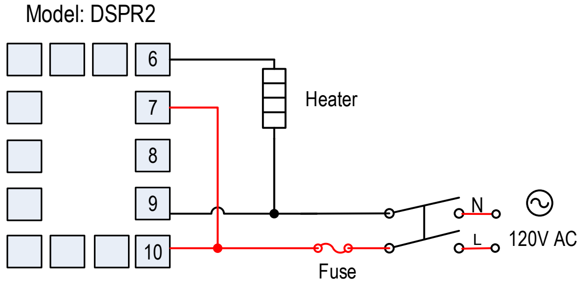

Figure 3. Wiring a small heater to the DSPR2.

Appendix

Technical talk-- how does it work?

There are three commonly used methods for AC power control.

1) Phase angle firing. In this method, the AC power control is achieved by firing the SCR at different phase angle. This is how our SSVR works. This method offer the most uniform power output. But the output is very difficult to be adjusted linearly due to the shape of the sine wave. Because of the sharp cut off, there is a potential electromagnetic interference (EMI or RFI) if there are inductive devices on the power line. Some of the inductive devices cannot be controlled by this method.

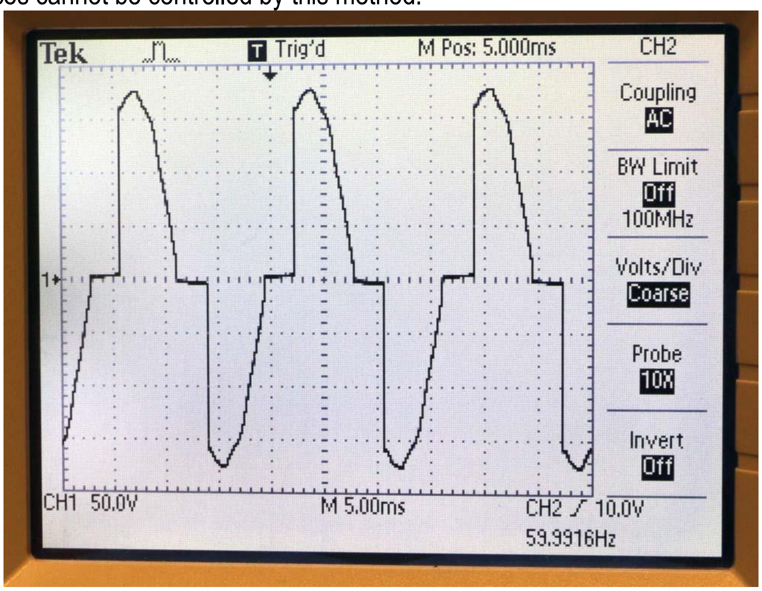

Figure 4. SSVR and TRIAC use phase-angle firing to regulate the power.

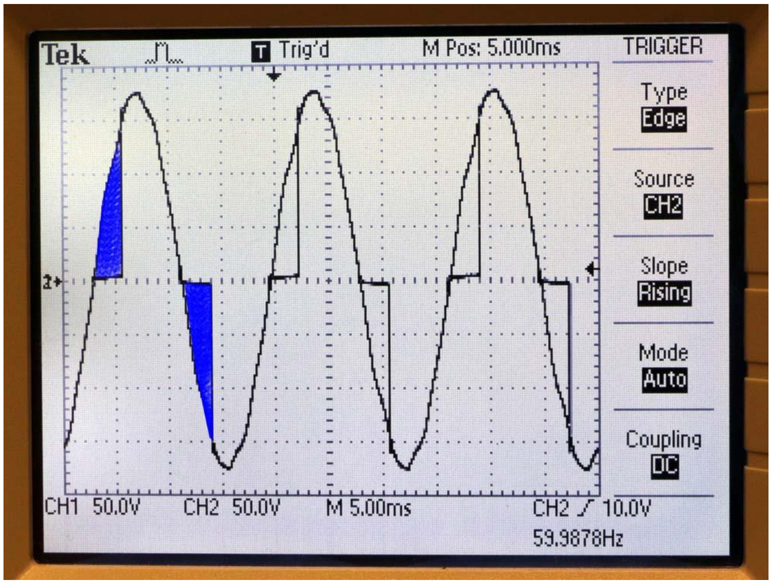

Figure 5. Original AC sine wave is overlaid with SSVR output wave form. The blue colored area shows the power output that has been blocked.

2) Time proportional firing. A fixed cycle time needs to be defined in this method. Then, the controller or regulator adjusts the on time during each cycle to achieve the power control. For example, if the cycle time is 1 second, turn on the power for 0.25 second for every 1 second means a 25% power output. Most of PID controllers use this method to control SSRs. This is also how the manual mode of Auber's PID controller works, except the cycle time has to be 2 second or longer.

Using this method, the user can linearly adjust output. But the power output is pulsed at each cycle. The shortest cycle time for most PID is either 1 or 2 second. Therefore, power is pulsed at 1 or 2 seconds. When heating a liquid, heat is not transferred as smooth as the phase-angle fire method.

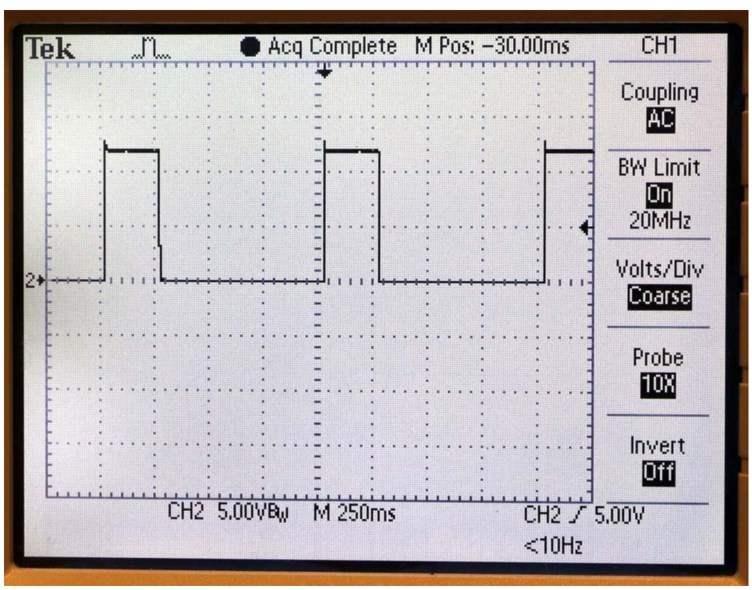

Figure 6. A 25% output control signal from a DSPR when it is operating in the time proportional firing mode. Cycle time is 1 second. The output signal is 250 millisecond (ms) on, and 750 ms off during each cycle period.

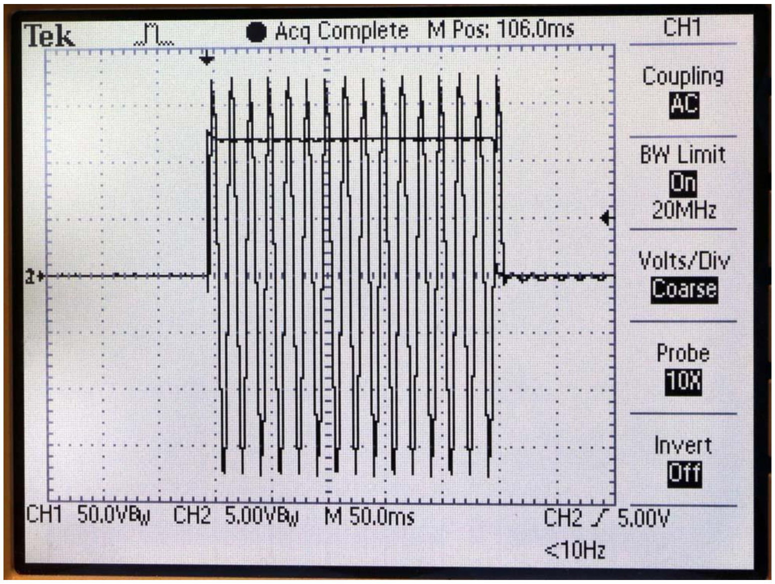

Figure 7. The control signal and SSR output waveform overlaid. When the DC signal (Channel 2, square wave) is on, the AC power can go through (Channel 1). When the DC signal drop to zero, the AC power is blocked.

3) Burst firing. This method is similar to time proportional firing (section 2). But in contrast to the time proportional mode, where the SSR is fired once for each fixed cycle period (which are usually 2 seconds or longer), the regulator will find the minimum cycle time to achieve the desired output percentage. The on pulse can be as short as one AC cycle. So power is distributed more evenly over cycle time. This leads to of a more uniform power output. Several PID controllers on the market use this mode. Our DSPR also uses this approach as the default mode to regulate power.

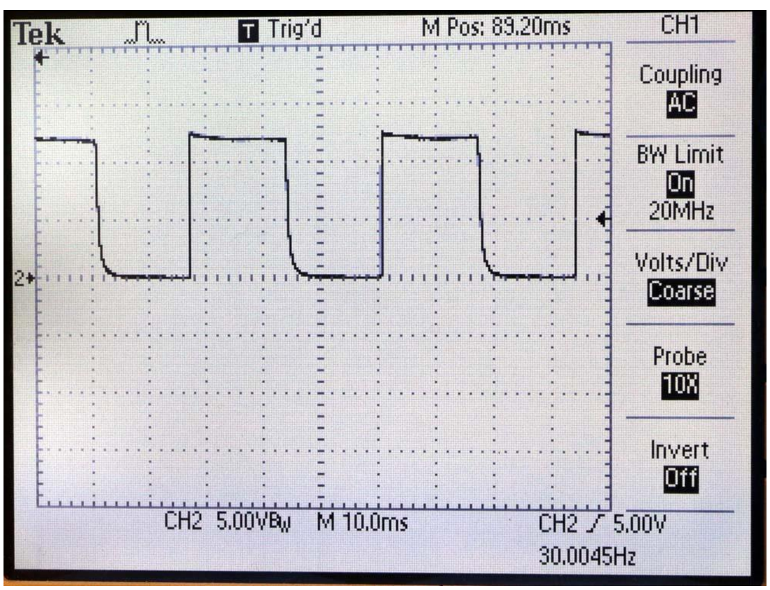

Figure 8. A 50% output control signal from DSPR when it is operating in the bust firing mode. Each pulse is 16.67 ms long, which is the same as a 60 Hz AC cycle. So one pulse on and one pulse cycle off is equal to 50% output.

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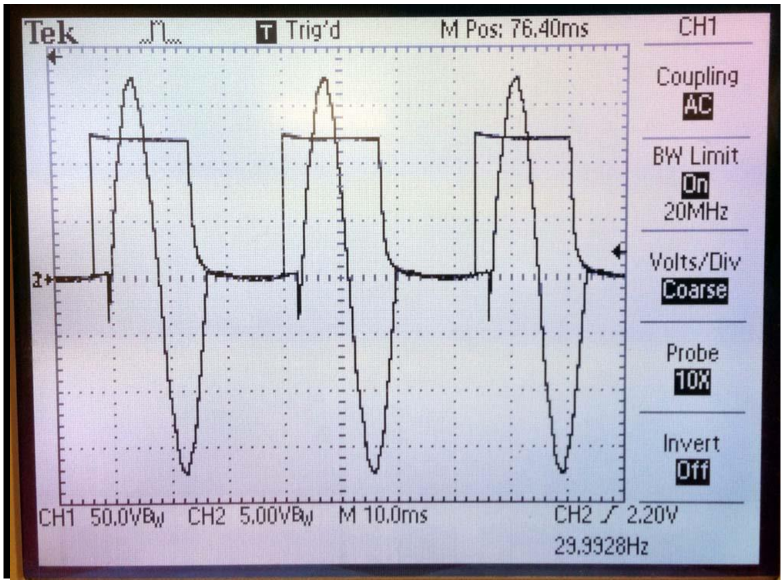

Figure 9. The DSPR control signal and SSR output waveform overlaid. The DSPR detects the frequency and phase of the AC power line, so that the pulse width and firing time is synchronized with AC cycle. The detection causes a small delay for the pulse generation. So the SSR will not be fired at the first zero crossing where the pulse is generated. It will fire the second and third zero crossing to pass a full AC cycle.

It should be noted that the output of burst firing mode (see section 3 in appendix) is not as uniform as in phase-angle mode (see section 1 in appendix). Since the percentage of the output can be an odd number, the number of pulses for a short period of time may not be equal to the next period. This small variation is not noticeable for resistive load (such as heater), but it can be noticeable when regulating a blower or a motor. For instance, when regulated by a DSPR, the rotational speed of a blower may not be perfectly constant for each period of time; however, the resulted fluctuation of the air flow is insignificant. Thus the air flow can be adjusted linearly over a range.