AN136

16-125661

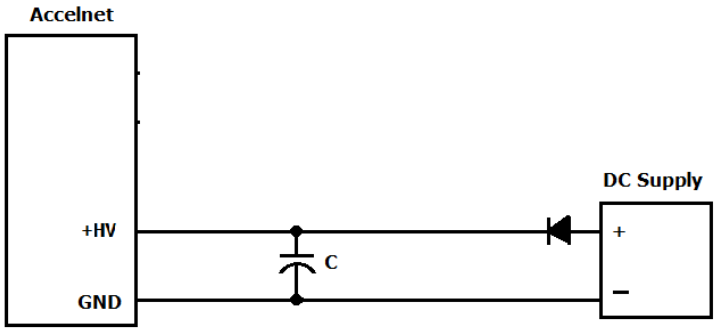
Accelnet External Regen

Introduction

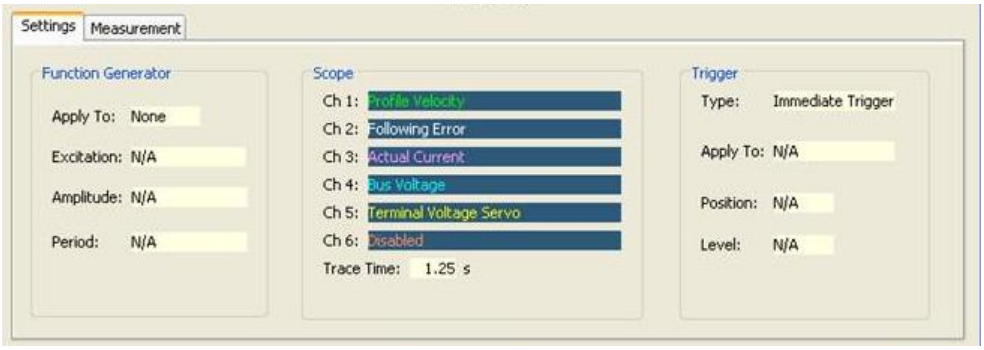
A simple reverse energy dissipator can be made from a solid-state relay, resistor, and diode. Control is via a drive output configured for regen and programmed to turn ON/OFF at set voltage points. It is important to determine how much energy must be dissipated. One way is to add capacitance to the bus then monitor the voltage during regeneration. If the drive has enough headroom below the over voltage shutdown the data can be captured. Then we can calculate the energy by taking ½ C V^2 before and after regeneration. This will help us size the regen resistor.

Testing for Energy

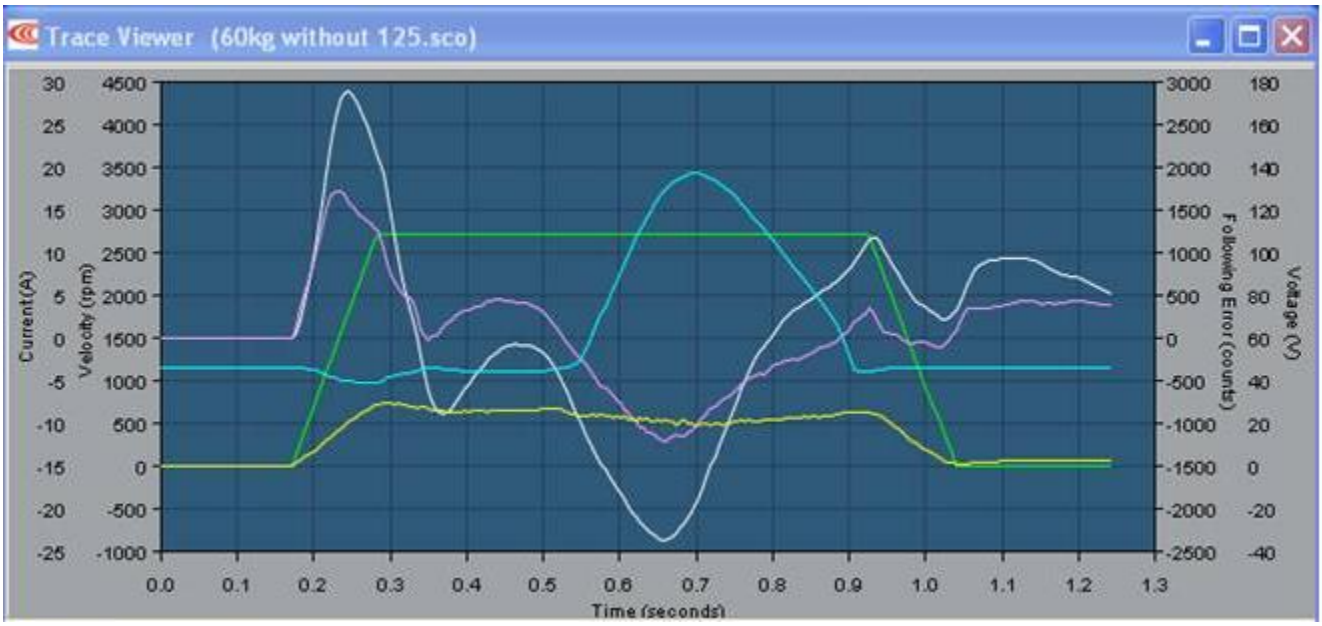
In this example an external 1000uF cap rated for 200V, a rectifier diode 5A rated 100V (some switchers will crowbar their outputs if the voltage goes above some limit), and a drive with over voltage shutdown larger than the regen voltage. Accelnet ADP-180-18 is used for testing at 48Vdc.



The CME scope, configured as shown, is used to gather the data for analysis as the axis is moved. A 60kg load is applied causing regeneration. Much of the load energy is dissipated by the gearing, winding resistance, and drive dissipation but some will get back to the bus capacitance.



In this test the DC bus (indicated in blue) is pumped up to 140Vdc during regeneration. The ADP-180-18 has 136uF internal capacitance and we added the 1000uF external.

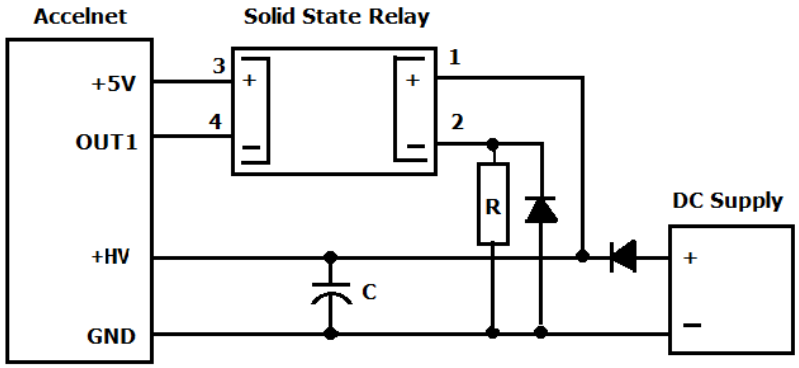


The energy in the total capacitance is ½ CV^2. At 48V that is 1136uF*48V^2/2= 1.31 Joules. At 148V there is, 1136uF*148V^2/2=12.44 Joules so the energy from the load regenerating is therefore 12.4J-1.31J=11.1 Joules.
Voltage pumping-up time is about 350ms so the Watts (Joules/s) = 11.1 Joules/0.35s = 31.8 Watts.
A resistor to dissipate that power at 48V can be found by P=V^2/R or R=V^2/P = 48V*48V/31.8W= 72 Ohms.

In practice, we want a resistor that can dissipate more than 32 W so it can dump the energy we have seen and still have some ability to dump more if needed. So, let's make the resistor 50 Ohms. This is a good value because at 48V it would dissipate~50W if run continuously.

The solid-state relay will be driven by an output that is not very fast so rating the resistor to be safe if driven constantly ON during regen will ensure that we have continuous service.

Reference Design



For the solid state relay, we used the Crydom DC60S3 Input 3.5~32Vdc and 3-7 Amp; 60 VDC; DC Output (Note that it is critical not to exceed 60Vdc on this SSR so be sure to set the ON and OFF limits correctly.)

Dale makes a nice power resistor for panel mounting in a 55W package. The HL series is available with the style 16 termination which takes Faston lugs or 09 termination for solder.

Configuring an Output ASCII parameters

An output can be configured as a "Regen Trigger". To configure the output, use parameter 0x70 for out 1, 0x71 for out 2, etc. Set the low 5 bits of the parameter to the value 10.
Use CME\tools\ASCII tool to Set RAM "s r0x70 10 0" and FLASH "s f0x70 10 0"

0x70	RF	3-5	Programmable output pin #0 configuration. The first word is a bit mapped configuration value: **Bit** **Meaning** 0-4 Output pin function: 0 - Track bits in the event status word. 1 - Track bits in the latched event status. 2 - Track bits in the manual output control register (see var 0xAB). 3 - Track bits in the trajectory status register (var. 0xC9). 4 - Go active if position is between the two positions specified in words 2,3 (low) and 4,5 (high). If bit 12 is set, commanded position is used. If bit 12 is clear, actual position is used. 5 - Go active on a low->high crossing of the position specified by words 2,3. Stay high for the number of milliseconds specified by words 4,5. If bit 12 is set, commanded position is used. If bit 12 is clear, actual position is used. 6 - Same as 5, but for high->low crossings. 7 - Same as 5, but for any crossing. 8 - Go active if motor phase angle (plus an offset) is between 0 and 180 degrees. The offset is set using the first word of extra data in units of 32k/180 degrees. 9 - Pulse output each time a position is crossed from an array of positions stored in trace memory. 10 - Use the output to trigger an external regen resister.

Programming Regen Values

Parameters 0xD8 - 0xDD are related to the regen function and need to be set correctly in RAM and FLASH to protect the external circuit.

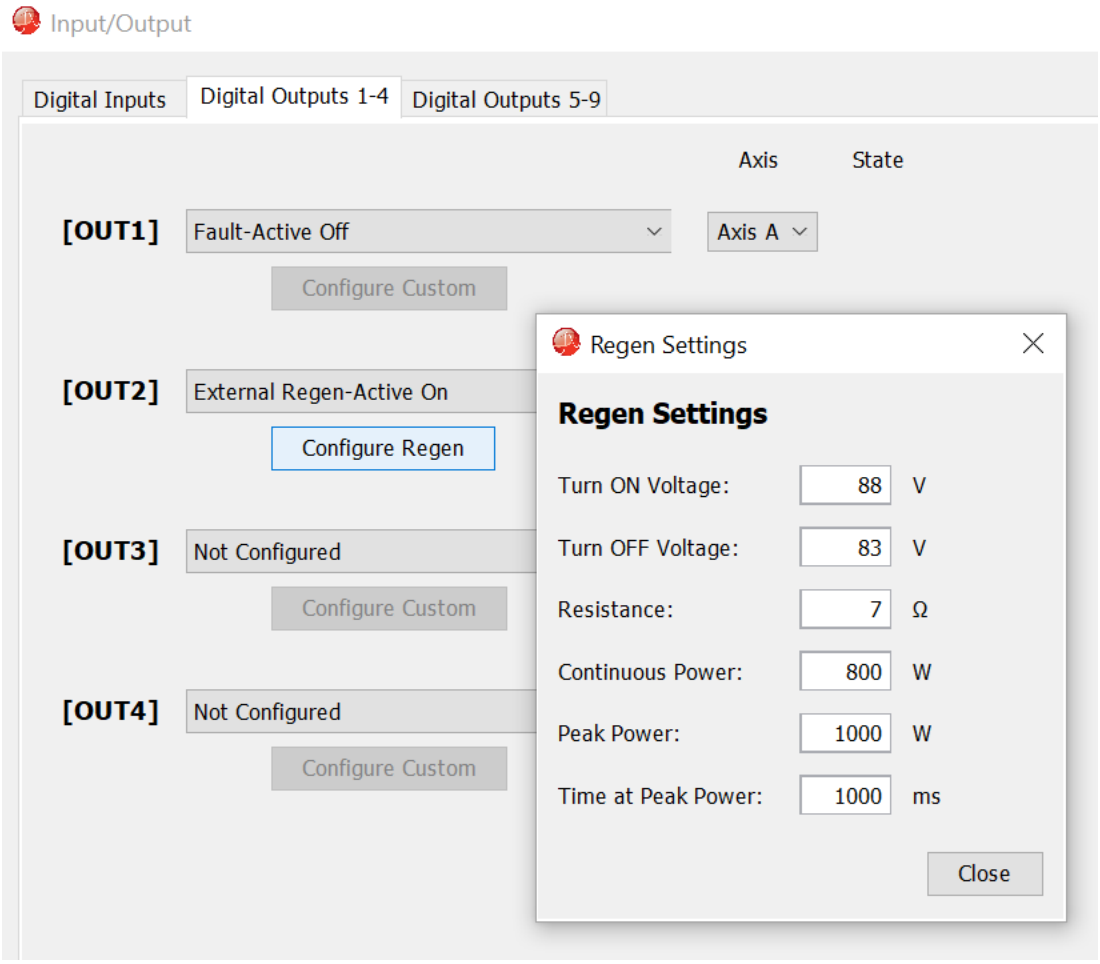
0xD8	0xD9	0x4D8	0x2150	RF	U16	Regen Resistor Resistance. Units: 0.1 Ω.
0xD9	0xDA	0x4D9	0x2151	RF	U16	Regen Resistor, Continuous Power. Units: W.
0xDA	0xDB	0x4DA	0x2152	RF	U16	Regen Resistor, Peak Power. Units: W.
0xDB	0xDC	0x4DB	0x2153	RF	U16	Regen Resistor, Time At Peak. Units: ms.
0xDC	0xDD	0x4DC	0x2154	RF	U16	Regen Turn On Voltage Units: 0.1 V.
0xDD	0xDE	0x4DD	0x2155	RF	U16	Regen Turn Off Voltage. Units: 0.1 V.

In the test example the Turn ON voltage was set to 55Vdc and turn OFF 50Vdc. The resistor was set to 50 Ohms, Continuous power 55W, and Peak power 75W for 350ms. Assuming momentary 75W is okay for a cool resistor and the I^2t will protect the external resistor.
Using the CME\tools ASCII command line to set RAM and FLASH

Resistance 50 Ohms	"s r0xD8 500"	"s f0xD8 500"
Continuous 55 Watts	"s r0xD9 50"	"s f0xD9 50"
Peak 75 Watts	"s r0xDA 75"	"s f0xdA 75"
Peak time 350ms	"s r0xDB 350"	"s f0xDB 350"
Turn ON 55Vdc	"s r0xDC 550"	"s f0xDC 550"
Turn OFF 50Vdc	"s r0xDD 500"	"s f0xDD 500"

Configuring an Output using CME

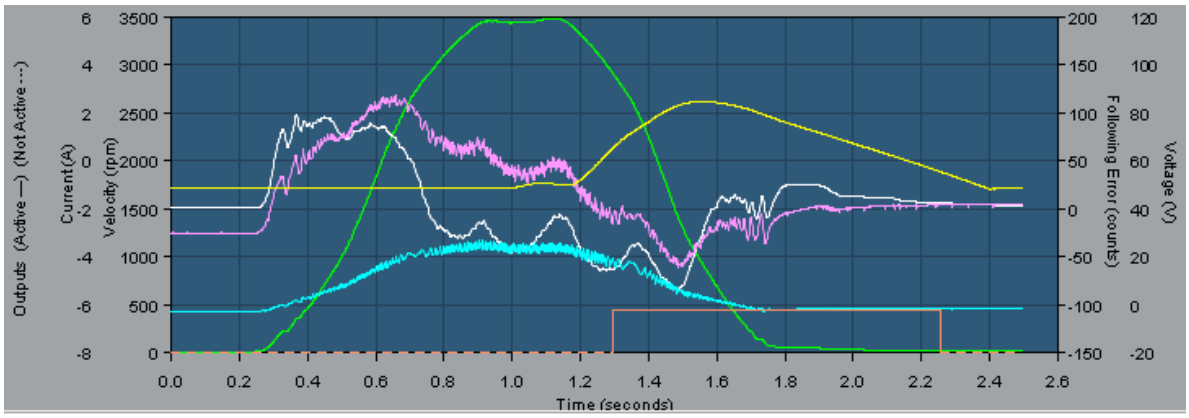
The new CME feature development allows for easy regen configuration for any DC powered drive with firmware capability.



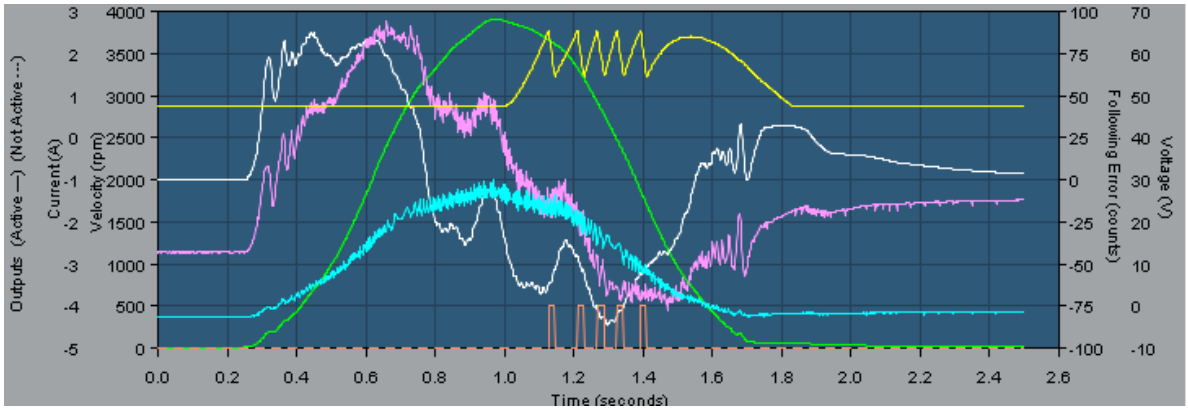
Example: Argus using 2pc Copley XTL-RA-04 regen resistors in parallel to dissipate 800W continuous. Peak Watts only limited by Ohms law I = V/R. 90V/7.5 Ohms = 12A. Watts = I^2R ~ 1k Watt.

Using CME SCOPE to test

Result of OUT1 turning ON and then OFF but no external resistor connected.



Result of regen circuit working during regeneration



Note: We must also use latest CME 8.0 or greater and latest beta firmware.

Revision History

Date	Version	Revision
1/15/2020	Rev 00	Initial release