

## **Trapped Charge Example for Cable Energization**

Written for PSCAD v4.5 and V4.6.

This example shows how to perform a simple trapped charge study during high voltage cable energization (Figure 1).

Cable energization and Trapped Charge study



Figure 1: Overall power system for trapped charge study during cable energization

*Figure 2* shows the Timed Breaker Logic. The breaker B1 is close initially to energize the cable and then opens at 0.2s to intrupt the current. It reenergized the cable at a time equal to "Bt".



Figure 2: Breaker B1 and the measured signals

The multiple run feature of PSCAD is used to change the closing time (Bt) in this study to see the worst case senario.

In this way, PSCAD will run a number of simulations (97 in this example), with a slightly different closing time (Bt) for the breaker at each run (Figure 3). The trapped voltage (Vtrapp), the breaker voltage (Vbrk) and the voltage at the station (Vstation), and the surge arrester energy (Energy) are measured during a simulation run and saved in a file named "Results.out".



## Station voltage



Figure 3: The Trapped voltage, the breaker voltage, the station voltage, and the energy of the surge arrester are measured during a simulation run and saved in a file named "Results.out"



The criteria to select the optimum run is based on the maximum value of the surge aresstor energy (fourth input chanel shown in Figure 4). There can be othere criteria for the optimum run depending on what is the purpose of the study.

	🖳 Multiple Run 🛛 🕅			
Rec	Recording Data Configuration 🔹			
🗄 21 🗃 🗳 🐖				
▲ General				
	Number of Channels to Record for Each Run	5		
	Output File Name	Results.out		
	Do you want to Identify the Optimal Run?	Yes		
	Select Channel for Basis of Optimal Run	4		
	Criteria for Identification of Optimal Run?	Maximum		
	Number of Divisions for Prob. Density Output Plots:	10		

🖳 Multiple Run 💽				
Re	Recording Channels Information			
•	21 🚰 📑 🛷 🦇			
⊿	Channel 1			
1	Channel 1 Data Type	Real		
	Auto Processing of Channel 1?	Maximum( X )		
	Label for Channel 1:	Max_Vs		
4	Channel 2			
	Channel 2 Data Type	Real		
	Auto Processing of Channel 2?	Maximum( X )		
	Label for Channel 2:	Max_Vt		
4	Channel 3			
	Channel 3 Data Type	Real		
	Auto Processing of Channel 3?	Maximum( X )		
	Label for Channel 3:	Max_Vb		
4	Channel 4			
	Channel 4 Data Type	Real		
	Auto Processing of Channel 4?	Maximum( X )		
	Label for Channel 4:	Energy		
4	Channel 5			
	Channel 5 Data Type	Real		
	Auto Processing of Channel 5?	Maximum( X )		
	Label for Channel 5:	Time		

Figure 4: The multiple run settings for the recording chanels; results are available at the file named "Results.out"

Once the simulation is completed, the results are available in the Results.out file.



In the output file, we can find that the maximum energy and voltage occur at Run# 97 and Bt = 0.2164s (Figure 5).

The optimum	occurred for run #	78 and has 1	been repeated for t	the last run below:		
Run #	Var # 1	Max_Vs	Max_Vt	Max_Vb	Energy	Time
97	0.2164000000	397.0885368	397.1265571	398.9488877	745.2044930	0.2164000000

Figure 5: Simulation results are available at the output file named "Results.out"

The snapshot feature can be used to save simulation time. Once the simulation reaches a steady-state condition before switching actions, a snapshot can get from the simulation to start the simulation from that point rather than from the beginning. In this way, simulation time can be saved, and results can be obtained in a shorter simulation time.

The steps for snapshot are:

1. Disable the Multiple-run Component (Figure 6).



Figure 6: Disabling the Multiple-run Component



2. Set a snapshot at 0.18 sec (Project Settings of the case) (Figure 7).

Pro	Project Settings - SimpleTrappChargExample2			
	General Runtime Simulatio	on Dynamics Mapping Fortran Link		
	Duration of run (sec)	0.2		
	Solution time step (uS)	10.0		
	Channel plot step (uS)	50.0		
	Startup Method:	Input file:		
	Standard 💌	Browse		
	Save channels to disk?	Output file:		
Ι.	No	noname.out		
	TO 10 1 1/1			
1	Timed Snapshot(s):	Snapshot file: Time		
(	Single, (once only)	Snapshot file: Time Snap1.snp [0.18		
(	Single, (once only)	Snapshot file: Time Snap 1.snp 0.18		
(	Single, (once only) Run Configuration: Standalone	Snapshot file:         Time           Snap 1.snp         0.18           # roms         1		
(	Single, (once only)  Run Configuration:  Standalone  Remove time offset when  Send only the output chai  Start simulation manually t  Enable component graphi	Snapshot file: Time Snap1.snp # runs 1 starting from snapshot. nnels that are in use. to allow use of integrated debugger. ics state animation.		

Figure 7: Setting snapshot

- 3. Run the case to make the snapshot file named "Snap1.snp".
- 4. Enable the Multiple-run Component (Figure 8).

Vstation	Ţ	1 Meas-Enab
💀 Multiple Run	×	P 2 V1
Multiple Run Configuration		• <i>\$ ~</i>
8≣ 2↓ ☞ 급		9-9
⊿ General		
Number of Signals to Control for This Multiple Run:	1	Multiple
This Multiple Run Enabled or Disabled?	Enabled	- Run
# of Std Deviations for defining min,max using the Normal Dis	t. (1-10): 2.0	
Initial Seed for Random Variations	Automatic	
Initial Seed Value	23309	
▲ Variable 1		

Figure 8: Enabling the Multi-run Component



5. Set the case startup from the snapshot, and change the simulation time to 0.4 sec (in the Project Settings of the case) (Figure 9).

Project Settings - SimpleTrappChargExample2		
General Runtime Simulation Dynamics Mapping Fortran Link		
Time Settings		
Duration of run (sec)	0.4	
Solution time step (uS)	10.0	
Channel plot step (uS)	50.0	
Startup Method:	Input file:	
From snapshot file	C:\Users\agoharrizi\Doci Browse	
Save channels to disk?	Output file:	
No	noname.out	
Timed Snapshot(s):	Snapshot file: Time	
None 🗨	Snap1.snp 0.18	
Run Configuration:	# runs	
Standalone	1	
Remove time offset when	starting from snapshot.	
Send only the output char	nnels that are in use.	
☐ Start simulation manually to allow use of integrated debugger.		
Enable component graphics state animation.		
ОК	Cancel Help	

Figure 9: Setting the simulation start-up from the snapshot

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