PowerApps Validation Document – Short Circuit Calculations

(Comparison with Standard Published Results)

1 Introduction

The objective of this document is to compare the results from PowerApps software with those of published results.

2 Short Circuit Calculations Validation Examples

Comparison of short circuit calculations of PowerApps is made with respect to other published references considering the following factors

- Z bus for sequence networks
- Post fault bus voltages, and currents

2.1 3-Bus Short Circuit Calculations Example

This example is taken from the text book "Analysis of Faulted Power Systems", Paul.M.Anderson (Wiley-IEEE Press, July 1995). The text book results are available with limited decimal accuracy. PowerApps results are used upto 5 decimal accuracy places. This precision difference between PowerApps and the published reference results in some differences in the results.

2.1.1 Comparison of the Impedance Matrix (Z bus)

2.1.1.1 Positive Sequence Z bus

Z Matrix for the Positive Sequence Network (3 Bus System)							
		Reference		**PowerApps**		**Difference**	
FromBus	ToBus	R	X	R	X	R	X
BUS1	BUS1	0.00000	0.1047	0.0000	0.1047	0.0000	0.00000
BUS1	BUS2	0.00000	0.0840	0.0000	0.0840	0.0000	0.00000
BUS1	BUS3	0.00000	0.0763	0.0000	0.0763	0.0000	0.00000
BUS2	BUS2	0.00000	0.1122	0.0000	0.1122	0.0000	0.00000
BUS2	BUS3	0.00000	0.0928	0.0000	0.0928	0.0000	0.00000
BUS3	BUS3	0.00000	0.0990	0.0000	0.0990	0.0000	0.00000

2.1.1.2 Zero Sequence Z bus

Z Matrix for the Zero Sequence Network (with mutual coupling) (3 Bus System)							
		Reference		**PowerApps**		**Difference**	
FromBus	ToBus	R	X	R	X	R	X
BUS1	BUS1	0.00000	0.1157	0.0000	0.1157	0.0000	0.00000
BUS1	BUS2	0.00000	0.0546	0.0000	0.0546	0.0000	0.00000
BUS1	BUS3	0.00000	0.0200	0.0000	0.0200	0.0000	0.00000
BUS2	BUS2	0.00000	0.0831	0.0000	0.0831	0.0000	0.00000
BUS2	BUS3	0.00000	0.0200	0.0000	0.0200	0.0000	0.00000
BUS3	BUS3	0.00000	0.0200	0.0000	0.0200	0.0000	0.00000

2.1.2 Comparison of Sequence Voltages- 3 Phase Faults

Comparison for 3 phase faults (3 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
BUS1	BUS1	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	GROUND	Positive	1.0000	0.0000	1.00000	0.00000	0.00000	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS2	Positive	0.1973	0.0000	0.19730	0.00000	0.00000	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS3	Positive	0.2713	0.0000	0.27130	0.00000	0.00000	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
BUS2	BUS2	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS1	Positive	0.2513	0.0000	0.25133	0.00000	-0.00003	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS3-ckt1	Positive	0.1731	0.0000	0.17310	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS3-ckt2	Positive	0.1731	0.0000	0.17310	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
BUS3	BUS3	Positive	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	GROUND	Positive	1.0000	0.0000	1.0000	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS1	Positive	0.2295	0.0000	0.22953	0.0000	-0.00003	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2-ckt1	Positive	0.0626	0.0000	0.0626	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2-ckt2	Positive	0.0626	0.0000	0.0626	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000

2.1.3 Comparison of Sequence Voltages- Single Line to Ground Faults

Comparison for Single phase to ground faults (3 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
BUS1	BUS1	Positive	0.6780	0.0000	0.67802	0.0000	-0.00002	0.00000
		Negative	0.3220	180.0000	0.32198	180.0000	0.00002	0.00000
		Zero	0.3560	180.0000	0.35604	180.0000	-0.00004	0.00000
	GROUND	Positive	1.0000	0.0000	1.0000	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2	Positive	0.7416	0.0000	0.74156	0.00000	0.00004	0.00000
		Negative	0.2584	180.0000	0.25844	180.00000	-0.00004	0.00000
		Zero	0.1679	180.0000	0.16791	180.00000	-0.00001	0.00000
	BUS3	Positive	0.7654	0.0000	0.76539	0.00000	0.00001	0.00000
		Negative	0.2346	180.0000	0.23461	180.00000	-0.00001	0.00000
		Zero	0.0615	180.0000	0.06152	180.00000	-0.00002	0.00000
BUS2	BUS2	Positive	0.6351	0.0000	0.63506	0	0.00004	0.00000
		Negative	0.3649	180.0000	0.36494	180	-0.00004	0.00000
		Zero	0.2701	180.0000	0.27013	180	-0.00003	0.00000
	BUS1	Positive	0.7268	0.0000	0.72678	0	0.00002	0.00000
		Negative	0.2732	180.0000	0.27322	180	-0.00002	0.00000
		Zero	0.1775	180.0000	0.17751	180	-0.00001	0.00000
	BUS3-ckt1	Positive	0.6982	0.0000	0.69823	0	-0.00003	0.00000
		Negative	0.3018	180.0000	0.30177	180	0.00003	0.00000
		Zero	0.0650	180.0000	0.06504	180	-0.00004	0.00000
	BUS3-ckt2	Positive	0.6982	0.0000	0.69823	0	-0.00003	0.00000
		Negative	0.3018	180.0000	0.30177	180	0.00003	0.00000
		Zero	0.0650	180.0000	0.06504	180	-0.00004	0.00000
BUS3	BUS3	Positive	0.5459	0.0000	0.54588	0	0.00002	0.00000
		Negative	0.4541	180.0000	0.45412	180	-0.00002	0.00000
		Zero	0.0918	180.0000	0.09175	180	0.00005	0.00000
	GROUND	Positive	1.0000	0.0000	1.0000	0.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS1	Positive	0.6501	0.0000	0.65011	0.0000	-0.00001	0.00000
		Negative	0.3499	180.0000	0.34989	180.0000	0.00001	0.00000
		Zero	0.0918	180.0000	0.09175	180.0000	0.00005	0.00000
	BUS2-ckt1	Positive	0.5743	0.0000	0.57431	0.0000	-0.00001	0.00000
		Negative	0.4257	180.0000	0.42569	180.0000	0.00001	0.00000
		Zero	0.0918	180.0000	0.09175	180.0000	0.00005	0.00000
	BUS2-ckt2	Positive	0.5743	0.0000	0.57431	0.0000	-0.00001	0.00000
		Negative	0.4257	180.0000	0.42569	180.0000	0.00001	0.00000
		Zero	0.0918	180.0000	0.09175	180.0000	0.00005	0.00000

2.1.4 Comparison of Sequence Currents- 3 Phase Faults

Comparison for 3 phase faults (3 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
BUS1	BUS1	Positive	9.5540	-90.0000	9.55408	-90.00000	-0.00008	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	GROUND	Positive	5.0000	-90.0000	5.00000	-90.00000	0.00000	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS2	Positive	2.4670	-90.0000	2.46679	-90.00000	0.00021	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS3	Positive	2.0870	-90.0000	2.08729	-90.00000	-0.00029	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
BUS2	BUS2	Positive	8.9120	-90.0000	8.91150	-90.00000	0.00050	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS1	Positive	3.1420	-90.0000	3.14159	-90.0000	0.00041	0.00000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS3-ckt1	Positive	2.8850	-90.0000	2.88496	-90.00000	0.00004	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS3-ckt2	Positive	2.8850	-90.0000	2.88496	-90.00000	0.00004	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
BUS3	BUS3	Positive	10.1020	-90.0000	10.10233	-90	-0.00033	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	GROUND	Positive	6.2500	-90.0000	6.2500	-90.0000	0.00000	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS1	Positive	1.7660	-90.0000	1.76565	-90.0000	0.00035	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2-ckt1	Positive	1.0430	-90.0000	1.04334	-90.0000	-0.00034	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2-ckt2	Positive	1.0430	-90.0000	1.04334	-90.0000	-0.00034	0.00000
		Negative	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000

2.1.5 Comparison of Sequence Currents- Single Line to Ground Faults

Comparison for Single phase to ground faults (3 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
BUS1	BUS1	Positive	3.0760	-90.0000	3.07623	-90.0000	-0.00023	0.00000
		Negative	3.0760	-90.0000	3.07623	-90.0000	-0.00023	0.00000
		Zero	3.0760	-90.0000	3.07623	-90.0000	-0.00023	0.00000
	GROUND	Positive	1.6100	-90.0000	1.6099	-90.0000	0.00010	0.00000
		Negative	1.6100	-90.0000	1.6099	-90.0000	0.00010	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2	Positive	0.7940	-90.0000	0.79426	-90.00000	-0.00026	0.00000
		Negative	0.7940	-90.0000	0.79426	-90.00000	-0.00026	0.00000
		Zero	1.3440	-90.0000	1.34379	-90.00000	0.00021	0.00000
	BUS3	Positive	0.6720	-90.0000	0.67207	-90.0000	-0.00007	0.00000
		Negative	0.6720	-90.0000	0.67207	-90.0000	-0.00007	0.00000
		Zero	1.7320	-90.0000	1.73244	-90.0000	-0.00044	0.00000
BUS2	BUS2	Positive	3.2520	-90.0000	3.25213	-90.0000	-0.00013	0.00000
		Negative	3.2520	-90.0000	3.25213	-90.0000	-0.00013	0.00000
		Zero	3.2520	-90.0000	3.25213	-90.0000	-0.00013	0.00000
	BUS1	Positive	1.1460	-90.0000	1.14648	-90.0000	-0.00048	0.00000
		Negative	1.1460	-90.0000	1.14648	-90.0000	-0.00048	0.00000
		Zero	0.6620	-90.0000	0.66157	-90.0000	0.00043	0.00000
	BUS3-ckt1	Positive	1.0530	-90.0000	1.05282	-90.0000	0.00018	0.00000
		Negative	1.0530	-90.0000	1.05282	-90.0000	0.00018	0.00000
		Zero	1.5110	-90.0000	1.51116	-90.0000	-0.00016	0.00000
	BUS3-ckt2	Positive	1.0530	-90.0000	1.05282	-90.0000	0.00018	0.00000
		Negative	1.0530	-90.0000	1.05282	-90.0000	0.00018	0.00000
		Zero	1.0790	-90.0000	1.0794	-90.0000	-0.00040	0.00000
BUS3	BUS3	Positive	4.5880	-90.0000	4.5877	-90.0000	0.00030	0.00000
		Negative	4.5880	-90.0000	4.5877	-90.0000	0.00030	0.00000
		Zero	4.5880	-90.0000	4.5877	-90.0000	0.00030	0.00000
	GROUND	Positive	2.8380	-90.0000	2.83827	-90.0000	-0.00027	0.00000
		Negative	2.8380	-90.0000	2.83827	-90.0000	-0.00027	0.00000
		Zero	4.5880	-90.0000	4.5877	-90.0000	0.00030	0.00000
	BUS1	Positive	0.8020	-90.0000	0.80182	-90.0000	0.00018	0.00000
		Negative	0.8020	-90.0000	0.80182	-90.0000	0.00018	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2-ckt1	Positive	0.4740	-90.0000	0.4738	-90.0000	0.00020	0.00000
		Negative	0.4740	-90.0000	0.4738	-90.0000	0.00020	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000
	BUS2-ckt2	Positive	0.4740	-90.0000	0.4738	-90.0000	0.00020	0.00000

Comparison for Single phase to ground faults (3 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
		Negative	0.4740	-90.0000	0.4738	-90.0000	0.00020	0.00000
		Zero	0.0000	0.0000	0.0000	0.0000	0.00000	0.00000

2.1.6 Conclusion

Conclusion: Considering the limited precision of results from the reference, it is clearly seen that the results of PowerApps matches well with those of the published results in the reference

2.2 6-Bus Short Circuit Calculations Example

This example is taken from the text book "Analysis of Faulted Power Systems", Paul.M.Anderson (Wiley-IEEE Press, July 1995). The text book results are available with limited decimal accuracy. PowerApps results are used upto 5 decimal accuracy places. This precision difference between PowerApps and the published reference results in some differences in the results.

2.2.1 Comparison of the Impedance Matrix (Z bus)

2.2.1.1 Positive Sequence Z bus

Z Matrix for the Positive Sequence Network (6 Bus System)							
		Reference		PowerApps		Difference	
FromBus	ToBus	R	X	R	X	R	X
BUS1	BUS1	0.02253	0.21503	0.02253	0.21503	0.00000	0.00000
BUS1	BUS2	-0.00609	0.04974	-0.00609	0.04974	0.00000	0.00000
BUS1	BUS3	0.02635	0.16117	0.02635	0.16117	0.00000	0.00000
BUS1	BUS4	0.02254	0.17266	0.02254	0.17266	0.00000	0.00000
BUS1	BUS5	0.02118	0.12825	0.02118	0.12825	0.00000	0.00000
BUS1	BUS6	0.01831	0.16379	0.01831	0.16379	0.00000	0.00000
BUS2	BUS2	0.04422	0.38094	0.04422	0.38094	0.00000	0.00000
BUS2	BUS3	-0.01594	0.15713	-0.01594	0.15713	0.00000	0.00000
BUS2	BUS4	-0.00786	0.13434	-0.00786	0.13434	0.00000	0.00000
BUS2	BUS5	-0.00698	0.22306	-0.00698	0.22306	0.00000	0.00000
BUS2	BUS6	0.00023	0.15223	0.00023	0.15223	0.00000	0.00000
BUS3	BUS3	0.16244	0.73912	0.16244	0.73912	0.00000	0.00000
BUS3	BUS4	0.14333	0.53368	0.14333	0.53368	0.00000	0.00000
BUS3	BUS5	0.06192	0.27007	0.06192	0.27007	0.00000	0.00000
BUS3	BUS6	0.07295	0.32786	0.07295	0.32786	0.00000	0.00000
BUS4	BUS4	0.13269	0.57694	0.13269	0.57694	0.00000	0.00000
BUS4	BUS5	0.06506	0.27818	0.06506	0.27818	0.00000	0.00000
BUS4	BUS6	0.06881	0.34726	0.06881	0.34726	0.00000	0.00000
BUS5	BUS5	0.16569	0.80649	0.16569	0.80649	0.00000	0.00000
BUS5	BUS6	0.13256	0.46538	0.13256	0.46538	0.00000	0.00000

Z Matrix for the Positive Sequence Network (6 Bus System)							
		Reference		PowerApps		Difference	
FromBus	ToBus	R	X	R	X	R	X
BUS6	BUS6	0.13034	0.61119	0.13034	0.61119	0.00000	0.00000

2.2.1.2 Zero Sequence Z bus

Z Matrix for the Zero Sequence Network (with mutual coupling) (6 Bus System)							
		Reference		PowerApps		Difference	
FromBus	ToBus	R	X	R	X	R	X
BUS1	BUS1	0.36392	1.11336	0.36392	1.11336	0.00000	0.00000
BUS1	BUS2	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS1	BUS3	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS1	BUS4	-0.01120	0.11474	-0.01120	0.11474	0.00000	0.00000
BUS1	BUS5	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS1	BUS6	0.02526	0.34120	0.02526	0.34120	0.00000	0.00000
BUS2	BUS2	0.00000	0.03200	0.00000	0.03200	0.00000	0.00000
BUS2	BUS3	0.00000	0.03200	0.00000	0.03200	0.00000	0.00000
BUS2	BUS4	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS2	BUS5	0.00000	0.03200	0.00000	0.03200	0.00000	0.00000
BUS2	BUS6	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS3	BUS3	3.78000	5.29200	3.78000	5.29200	0.00000	0.00000
BUS3	BUS4	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS3	BUS5	0.00000	0.03200	0.00000	0.03200	0.00000	0.00000
BUS3	BUS6	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS4	BUS4	0.00756	0.24138	0.00756	0.24138	0.00000	0.00000
BUS4	BUS5	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS4	BUS6	-0.01706	0.05554	-0.01706	0.05554	0.00000	0.00000
BUS5	BUS5	2.82000	3.87200	2.82000	3.87200	0.00000	0.00000
BUS5	BUS6	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS6	BUS6	0.03849	0.47472	0.03849	0.47472	0.00000	0.00000

2.2.2 Comparison of Sequence Voltages- 3 Phase Faults

Comparison for 3 phase faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
BUS1	BUS1	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	GROUND	Positive	1.0000	0.0000	1.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS4	Positive	0.1960	6.0000	0.19597	5.99485	0.00003	0.0052
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS6	Positive	0.2378	1.3000	0.23781	1.26690	-0.00001	0.0331
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000

Comparison for 3 phase faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
BUS2	BUS2	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	GROUND	Positive	1.0000	0.0000	1.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS3	Positive	0.6043	-8.4000	0.60432	-8.42348	-0.00002	0.0235
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS5	Positive	0.4328	-11.3000	0.43280	-11.34716	0.00000	0.0472
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS3	BUS3	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS2	Positive	0.8044	-4.6000	0.80437	-4.64479	0.00003	0.0448
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS4	Positive	0.2726	7.1000	0.27264	7.08112	-0.00004	0.0189
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS4	BUS4	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	GROUND	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS1	Positive	0.7078	-2.3000	0.70779	-2.28840	0.00001	-0.0116
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS3	Positive	0.0752	26.8000	0.07525	26.76579	-0.00005	0.0342
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS6	Positive	0.4027	-2.6000	0.40270	-2.59165	0.00000	-0.0084
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS5	BUS5	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS2	Positive	0.7390	-4.9000	0.73901	-4.87684	-0.00001	-0.0232
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS6	Positive	0.4163	6.1000	0.41626	6.06172	0.00004	0.0383
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS6	BUS6	Positive	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000

Comparison for 3 phase faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
	BUS1	Positive	0.7380	-2.0000	0.73802	-2.01982	-0.00002	0.0198
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS4	Positive	0.4337	-1.1000	0.43366	-1.08506	0.00004	-0.0149
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS5	Positive	0.2334	12.9000	0.23335	12.90997	0.00005	-0.0100
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000

2.2.3 Comparison of Sequence Voltages- Single Line to Ground Faults

Comparison for Single phase to ground faults (6 Bus System)								
			Reference* Limited Precision Output		PowerApps		Difference* (most of the differences are due to limited precision results in published reference)	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
BUS1	BUS1	Positive	0.86650	-1.40000	0.86645	-1.37913	0.00005	-0.02087
		Negative	0.13540	-171.10000	0.13541	-171.14099	-0.00001	0.04099
		Zero	0.73360	176.70000	0.73359	176.74076	0.00001	-0.04076
	GROUND	Positive	1.00000	0.00000	1.00000	0.00000	0.00000	0.00000
		Negative	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
		Zero	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	BUS4	Positive	0.89200	-0.90000	0.89196	-0.90262	0.00004	0.00262
		Negative	0.10910	-172.60000	0.10906	-172.59721	0.00004	-0.00279
		Zero	0.07220	-159.60000	0.07220	-159.58361	0.00000	-0.01639
	BUS6	Positive	0.89800	-1.00000	0.89803	-0.96934	-0.00003	-0.03066
		Negative	0.10320	-171.50000	0.10322	-171.53621	-0.00002	0.03621
		Zero	0.21430	-169.40000	0.21427	-169.39297	0.00003	-0.00703
BUS2	BUS2	Positive	0.51990	0.20000	0.51991	0.24441	-0.00001	-0.04441
		Negative	0.48010	179.70000	0.48010	179.73532	0.00000	-0.03532
		Zero	0.04010	-173.60000	0.04006	-173.64301	0.00004	0.04301
	GROUND	Positive	1.00000	0.00000	1.00000	0.00000	0.00000	0.00000
		Negative	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Comparison for Single phase to ground faults (6 Bus System)								
			Reference* Limited Precision Output		PowerApps		Difference* (most of the differences are due to limited precision results in published reference)	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
		Zero	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	BUS3	Positive	0.80780	-3.00000	0.80778	-2.95260	0.00002	-0.04740
		Negative	0.19770	-167.90000	0.19772	-167.85150	-0.00002	-0.04850
		Zero	0.04010	-173.60000	0.04006	-173.64301	0.00004	0.04301
	BUS5	Positive	0.72450	-3.10000	0.72452	-3.13358	-0.00002	0.03358
		Negative	0.27940	-171.90000	0.27938	-171.85024	0.00002	-0.04976
		Zero	0.04010	-173.60000	0.04006	-173.64301	0.00004	0.04301
BUS3	BUS3	Positive	0.91010	-1.90000	0.91006	-1.94303	0.00004	0.04303
		Negative	0.09560	-161.20000	0.09558	-161.16592	0.00002	-0.03408
		Zero	0.82140	175.70000	0.82139	175.69123	0.00001	0.00877
	BUS2	Positive	0.98410	-0.70000	0.98415	-0.69925	-0.00005	-0.00075
		Negative	0.01990	-143.00000	0.01995	-142.97959	-0.00005	-0.02041
		Zero	0.00400	-148.80000	0.00404	-148.77110	-0.00004	-0.02890
	BUS4	Positive	0.93320	-1.20000	0.93318	-1.19535	0.00002	-0.00465
		Negative	0.06980	-163.80000	0.06979	-163.80404	0.00001	0.00404
		Zero	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS4	BUS4	Positive	0.58400	1.30000	0.58398	1.34297	0.00002	-0.04297
		Negative	0.41640	178.10000	0.41640	178.11639	0.00000	-0.01639
		Zero	0.16990	-170.70000	0.16986	-170.72622	0.00004	0.02622
	GROUND*	Positive	0.00000	0.00000	0.00000	0.00000	This output is not directly available in PowerApps. The flow given in reference is available as transformer flow in PowerApps	
	*Transformer Neutral Grounding	Negative	0.00000	0.00000	0.00000	0.00000		
		Zero	0.00000	0.00000	0.00000	0.00000		
	BUS1	Positive	0.87780	-0.50000	0.87780	-0.50618	0.00000	0.00618
		Negative	0.12250	-176.40000	0.12248	-176.36985	0.00002	-0.03015
		Zero	0.08110	-163.40000	0.08109	-163.35625	0.00001	-0.04375
	BUS3	Positive	0.61280	2.50000	0.61284	2.51304	-0.00004	-0.01304

Comparison for Single phase to ground faults (6 Bus System)								
			Reference* Limited Precision Output		PowerApps		Difference* (most of the differences are due to limited precision results in published reference)	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
		Negative	0.38870	176.00000	0.38868	176.03580	0.00002	-0.03580
		Zero	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	BUS6	Positive	0.75100	0.00000	0.75100	0.04596	0.00000	-0.04596
		Negative	0.24900	179.90000	0.24900	179.86138	0.00000	0.03862
		Zero	0.04090	-151.90000	0.04087	-151.85441	0.00003	-0.04559
BUS5	BUS5	Positive	0.87740	-2.70000	0.87736	-2.66557	0.00004	-0.03443
		Negative	0.13020	-161.70000	0.13015	-161.73016	0.00005	0.03016
		Zero	0.75720	173.80000	0.75722	173.81328	-0.00002	-0.01328
	BUS2	Positive	0.97020	-1.10000	0.97015	-1.09402	0.00005	-0.00598
		Negative	0.03530	-148.30000	0.03528	-148.32788	0.00002	0.02788
		Zero	0.00510	-150.10000	0.00506	-150.12065	0.00004	0.02065
	BUS6	Positive	0.92600	-1.10000	0.92596	-1.14360	0.00004	0.04360
		Negative	0.07650	-166.00000	0.07649	-166.01942	0.00001	0.01942
		Zero	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
BUS6	BUS6	Positive	0.63770	1.20000	0.63772	1.16035	-0.00002	0.03965
		Negative	0.36260	178.00000	0.36265	177.95922	-0.00005	0.04078
		Zero	0.27640	-174.60000	0.27638	-174.63774	0.00002	0.03774
	GROUND*	Positive	0.00000	0.00000	0.00000	0.00000	This output is not directly available in PowerApps. The flow given in reference is available as transformer flow in PowerApps	
	*Transformer Neutral Grounding	Negative	0.00000	0.00000	0.00000	0.00000		
		Zero	0.00000	0.00000	0.00000	0.00000		
	BUS1	Positive	0.90460	-0.40000	0.90457	-0.38244	0.00003	-0.01756
		Negative	0.09560	-176.40000	0.09564	-176.38036	-0.00004	-0.01964
		Zero	0.19850	-174.20000	0.19854	-174.23712	-0.00004	0.03712
	BUS4	Positive	0.79460	0.30000	0.79463	0.31282	-0.00003	-0.01282
		Negative	0.20540	178.80000	0.20543	178.78986	-0.00003	0.01014
		Zero	0.03370	-	0.03372	-152.92593	-	0.02593

Comparison for Single phase to ground faults (6 Bus System)								
			Reference* Limited Precision Output		PowerApps		Difference* (most of the differences are due to limited precision results in published reference)	
Faulted Bus	Network Bus	Sequence	Volts (mag)	Degrees	Volts (mag)	Degrees	Volts (mag)	Degrees
				152.90000			0.00002	
	BUS5	Positive	0.72130	2.30000	0.72127	2.29409	0.00003	0.00591
		Negative	0.28080	174.10000	0.28080	174.09846	0.00000	0.00154
		Zero	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

2.2.4 Comparison of Sequence Currents- 3 Phase Faults

Comparison for 3 phase faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
BUS1	BUS1	Positive	4.6250	-84.0000	4.62512	-84.01763	-0.00012	0.0176
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	GROUND	Positive	4.1520	-85.2000	4.15227	-85.23636	-0.00027	0.0364
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS4	Positive	0.2590	-71.8000	0.25884	-71.80468	0.00016	0.0047
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS6	Positive	0.2230	-75.4000	0.22334	-75.37550	-0.00034	-0.0245
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS2	BUS2	Positive	2.6080	-83.4000	2.60758	-83.37833	0.00042	-0.0217
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	GROUND	Positive	2.0790	-86.4000	2.07928	-86.42367	-0.00028	0.0237
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS3	Positive	0.2370	-63.9000	0.23702	-63.87329	-0.00002	-0.0267
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS5	Positive	0.3090	-77.6000	0.30942	-77.56767	-0.00042	-0.0323
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS3	BUS3	Positive	1.3210	-77.6000	1.32143	-77.60518	-0.00043	0.0052
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS2	Positive	0.3150	-60.1000	0.31548	-60.09460	-0.00048	-0.0054
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000

Comparison for 3 phase faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
	BUS4	Positive	1.0250	-82.9000	1.02497	-82.91888	0.00003	0.0189
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS4	BUS4	Positive	1.6890	-77.0477	1.68918	-77.04765	-0.00018	0.0000
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	GROUND	Positive	0.0000	0.0000	0.00000	0.00000	This output is not directly available in PowerApps. The flow given in reference is available as transformer flow in PowerApps	
	*Transformer Neutral Grounding	Negative	0.0000	0.0000	0.00000	0.00000		
		Zero	0.0000	0.0000	0.00000	0.00000		
	BUS1	Positive	0.9350	-80.1000	0.93487	-80.08793	0.00013	-0.0121
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS3	Positive	0.2830	-63.2000	0.28289	-63.23421	0.00011	0.0342
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS6	Positive	0.4810	-79.2000	0.48124	-79.18647	-0.00024	-0.0135
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS5	BUS5	Positive	1.2150	-78.4000	1.21457	-78.39049	0.00043	-0.0095
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS2	Positive	0.5280	-71.1000	0.52833	-71.09735	-0.00033	-0.0026
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS6	Positive	0.6940	-83.9000	0.69376	-83.93828	0.00024	0.0383
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
BUS6	BUS6	Positive	1.6000	-78.0000	1.60016	-77.96199	-0.00016	-0.0380
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	GROUND*	Positive	0.00000	0.00000	0.00000	0.00000	This output is not directly available in PowerApps. The flow given in reference is available as transformer flow in PowerApps	
	*Transformer Neutral Grounding	Negative	0.00000	0.00000	0.00000	0.00000		
		Zero	0.00000	0.00000	0.00000	0.00000		
	BUS1	Positive	0.6930	-78.7000	0.69310	-78.66222	-0.00010	-0.0378
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS4	Positive	0.5180	-77.7000	0.51824	-77.67987	-0.00024	-0.0201
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000
	BUS5	Positive	0.3890	-77.1000	0.38892	-77.09003	0.00008	-0.0100
		Negative	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000

Comparison for 3 phase faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.0000

2.2.5 Comparison of Sequence Currents- Single Line to Ground Faults

Comparison for Single phase to ground faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
BUS1	BUS1	Positive	0.6260	-75.2000	0.62629	-75.15862	-0.00029	-0.04138
		Negative	0.6260	-75.2000	0.62629	-75.15862	-0.00029	-0.04138
		Zero	0.6260	-75.2000	0.62629	-75.15862	-0.00029	-0.04138
	GROUND	Positive	0.5620	-76.4000	0.56227	-76.37735	-0.00027	-0.02265
		Negative	0.5620	-76.4000	0.56227	-76.37735	-0.00027	-0.02265
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS4	Positive	0.0350	-62.9000	0.03505	-62.94568	-0.00005	0.04568
		Negative	0.0350	-62.9000	0.03505	-62.94568	-0.00005	0.04568
		Zero	0.3970	-76.1000	0.39730	-76.07782	-0.00030	-0.02218
	BUS6	Positive	0.0300	-66.5000	0.03024	-66.51649	-0.00024	0.01649
		Negative	0.0300	-66.5000	0.03024	-66.51649	-0.00024	0.01649
		Zero	0.2290	-73.6000	0.22913	-73.56461	-0.00013	-0.03539
BUS2	BUS2	Positive	1.2520	-83.6000	1.25190	-83.64301	0.00010	0.04301
		Negative	1.2520	-83.6000	1.25190	-83.64301	0.00010	0.04301
		Zero	1.2520	-83.6000	1.25190	-83.64301	0.00010	0.04301
	GROUND	Positive	0.9980	-86.7000	0.99826	-86.68834	-0.00026	-0.01166
		Negative	0.9980	-86.7000	0.99826	-86.68834	-0.00026	-0.01166
		Zero	1.2520	-83.6000	1.25190	-83.64301	0.00010	0.04301
	BUS3	Positive	0.1140	-64.1000	0.11379	-64.13797	0.00021	0.03797
		Negative	0.1140	-64.1000	0.11379	-64.13797	0.00021	0.03797
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
	BUS5	Positive	0.1490	-77.8000	0.14855	-77.83235	0.00045	0.03235
		Negative	0.1490	-77.8000	0.14855	-77.83235	0.00045	0.03235
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
BUS3	BUS3	Positive	0.1260	-58.8000	0.12630	-58.77110	-0.00030	-0.02890
		Negative	0.1260	-58.8000	0.12630	-58.77110	-0.00030	-0.02890
		Zero	0.1260	-58.8000	0.12630	-58.77110	-0.00030	-0.02890
	BUS2	Positive	0.0300	-41.3000	0.03015	-41.26052	-0.00015	-0.03948
		Negative	0.0300	-41.3000	0.03015	-41.26052	-0.00015	-0.03948
		Zero	0.1260	-58.8000	0.12630	-58.77110	-0.00030	-0.02890
	BUS4	Positive	0.0980	-64.1000	0.09797	-64.08480	0.00003	-0.01520
		Negative	0.0980	-64.1000	0.09797	-64.08480	0.00003	-0.01520
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
BUS4	BUS4	Positive	0.7030	-78.9000	0.70338	-78.93126	-0.00038	0.03126
		Negative	0.7030	-78.9000	0.70338	-78.93126	-0.00038	0.03126
		Zero	0.7030	-78.9000	0.70338	-78.93126	-0.00038	0.03126

Comparison for Single phase to ground faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
	GROUND	Positive	0.0000	0.0000	0.00000	0.00000	*This output is not directly available in PowerApps. The flow given in reference is available as transformer flow in PowerApps	
*Transformer Neutral Grounding. Output from PowerApps is shown as zero sequence contribution from BUS3		Negative	0.0000	0.0000	0.00000	0.00000		
		Zero	0.6390	-80.7000	0.63858	-80.72622		
	BUS1	Positive	0.3890	-82.0000	0.38928	-81.97154	-0.00028	-0.02846
		Negative	0.3890	-82.0000	0.38928	-81.97154	-0.00028	-0.02846
		Zero	0.0180	-59.3000	0.01815	-59.31260	-0.00015	0.01260
	BUS3	Positive	0.1180	-65.1000	0.11780	-65.11782	0.00020	0.01782
		Negative	0.1180	-65.1000	0.11780	-65.11782	0.00020	0.01782
*Note the comment on transformer neutral grounding flow. This output is available in PowerApps		Zero	0.6390	-80.7000	0.63858	-80.72622	0.00042	0.02622
	BUS6	Positive	0.2000	-81.1000	0.20039	-81.07007	-0.00039	-0.02993
		Negative	0.2000	-81.1000	0.20039	-81.07007	-0.00039	-0.02993
		Zero	0.0500	-62.8000	0.04998	-62.77736	0.00002	-0.02264
BUS5	BUS5	Positive	0.1580	-60.1000	0.15808	-60.12065	-0.00008	0.02065
		Negative	0.1580	-60.1000	0.15808	-60.12065	-0.00008	0.02065
		Zero	0.1580	-60.1000	0.15808	-60.12065	-0.00008	0.02065
	BUS2	Positive	0.0690	-52.8000	0.06877	-52.82751	0.00023	0.02751
		Negative	0.0690	-52.8000	0.06877	-52.82751	0.00023	0.02751
		Zero	0.1580	-60.1000	0.15808	-60.12065	-0.00008	0.02065
	BUS6	Positive	0.0900	-65.7000	0.09030	-65.66844	-0.00030	-0.03156
		Negative	0.0900	-65.7000	0.09030	-65.66844	-0.00030	-0.03156
		Zero	0.0000	0.0000	0.00000	0.00000	0.00000	0.00000
BUS6	BUS6	Positive	0.5800	-80.0000	0.58029	-80.00278	-0.00029	0.00278
		Negative	0.5800	-80.0000	0.58029	-80.00278	-0.00029	0.00278
		Zero	0.5800	-80.0000	0.58029	-80.00278	-0.00029	0.00278
	GROUND*	Positive	0.00000	0.00000	0.00000	0.00000	This output is not directly available in PowerApps. The flow given in reference is available as transformer flow in PowerApps	
*Transformer Neutral Grounding. Output from PowerApps is shown as zero sequence contribution from BUS5		Negative	0.00000	0.00000	0.00000	0.00000		
		Zero	0.46100	-84.60000	0.46063	-84.63774		
	BUS1	Positive	0.2510	-80.7000	0.25135	-80.70300	-0.00035	0.00300
		Negative	0.2510	-80.7000	0.25135	-80.70300	-0.00035	0.00300
		Zero	0.0340	-60.4000	0.03378	-60.38412	0.00022	-0.01588
	BUS4	Positive	0.1880	-79.7000	0.18794	-79.72065	0.00006	0.02065
		Negative	0.1880	-79.7000	0.18794	-79.72065	0.00006	0.02065
		Zero	0.0930	-63.8000	0.09302	-63.84890	-0.00002	0.04890
	BUS5	Positive	0.1410	-79.1000	0.14104	-79.13081	-0.00004	0.03081
*Note the comment on		Negative	0.1410	-79.1000	0.14104	-79.13081	-0.00004	0.03081

Comparison for Single phase to ground faults (6 Bus System)								
			Reference		PowerApps		Difference	
Faulted Bus	Network Bus	Sequence	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)	Fault Current PU Mag	Fault Current (Deg)
transformer neutral grounding flow. This output is available in PowerApps		Zero	0.46100	-84.60000	0.46063	-84.63774	0.00037	0.03774

2.2.6 Conclusion

Conclusion: Considering the limited precision of results from the reference, it is clearly seen that the results of PowerApps matches well with those of the published results in the reference