ETAP IEC Short-Circuit

The ETAP V&V process for the IEC Short-Circuit program has over 1100 test case scenarios that are run before each ETAP release. The following cases are excerpts from the Short-Circuit IEC 3-phase and unbalanced short-circuit results.

Short-Circuit IEC Comparison Case # 1

Comparison of ETAP Short-Circuit IEC Calculations against Published Example

Excerpts from Validation Cases and Comparison Results (TCS-SCIEC-082)

Highlights

- Comparison of ETAP unbalanced fault results against published results in IEC Standard 60909-4 2021 Example-4 from Section 9 [1].
- Compares system results for high and medium voltage systems.
- Compares the initial symmetrical current (I”k).
- Compares the peak current (Ip) for both method B and C.
- Compares the maximum steady state current value (Ik max).
- Compares both balanced 3-phase and unbalanced LG results.

System Description

This is 3-phase system operating at 50Hz. The Utility connection is operating at 380 kV. The utility connection transformers are two 350 MVA (primary winding rating) with 350 MVA 120 kV secondary and 50 MVA 30 kV tertiary windings. The system has two PowerStation units. One is operating at 21 kV and is rated for 150 MVA. The second unit is operating at 10.5 kV and is rated for 100 MVA (Figure:1). This document is an excerpt from TCS-SCIEC-082 [2]

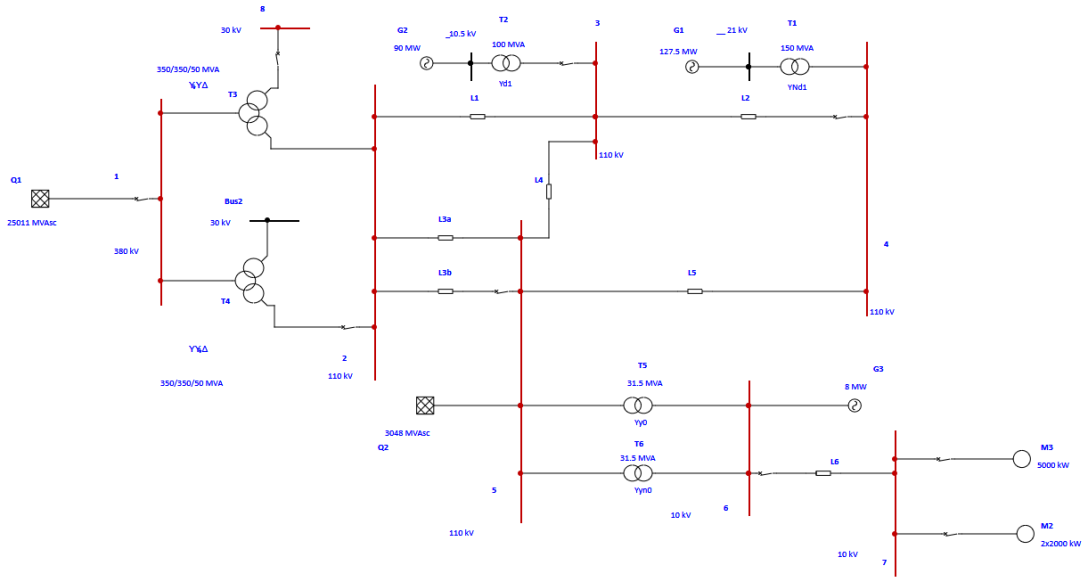

Figure 1: ETAP One line diagram showing the example from section 9 of IEC60909-4-2021

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Comparison of Results

The following tables of comparison show the differences between ETAP Results and those published in the IEC Standard IEC 60909-4 2021 Section 9. Please note that the percent difference for the initial symmetrical current (I”k) is less than 0.002 % in most cases.

The maximum allowed deviation in the peak current values is less than 0.6% for Bus4 due to the meshed contribution handling and evaluation of R/X based on Method B or C.

For Fault at Bus "1', Ib symm = I"k as per the standard.

Ik values are equal to I"kMO (I"k in ETAP) based on 11.2.7 of IEC 60909-0:2016.

Ip50Hz at fault location "7" includes 1.15*51.3864 kA in the standard.

Table 1: Comparison of ETAP 3-phase short-circuit IEC results against IEC Standard example for I”k, Ip and Ik.

	IEC	ETAP		IEC	ETAP		IEC	ETAP		IEC	ETAP		IEC	ETAP	
Bus	**I"K (kA)**	**I"k**	**%Diff**	**Ip(b) (kA)**	**Ip(b)**	**%Diff**	**Ip©**	**Ip©**	**%Diff**	**Ib**	**Ib**	**%Diff**	**Ik (kA)**	**Ik**	**%Diff**
1	40.6447	40.645	0.001	100.58	100.578	0.001	100.568	100.576	0.008	40.645	40.643	-0.005	40.635	40.635	0.000
2	31.7831	31.782	-0.004	80.512	80.509	-0.004	80.6079	80.696	0.110	31.57	31.567	-0.010	31.663	31.662	-0.003
3	19.673	19.672	-0.005	45.825	45.824	-0.002	45.8111	45.976	0.361	19.388	19.388	-0.001	19.623	19.623	-0.002
4	16.2277	16.227	-0.004	36.804	36.803	-0.003	36.8427	37.040	0.535	16.017	16.015	-0.003	16.196	16.195	-0.005
5	33.1894	33.187	-0.007	83.627	83.621	-0.007	83.4033	83.591	0.225	32.795	32.792	-0.011	32.997	32.995	-0.006
6	37.5629	37.563	-0.000	99.191	99.19	-0.001	98.1434	99.275	1.153	34.028	33.994	-0.101	34.356	34.356	-0.001
7	25.5895	25.589	-0.002	59.094	59.094	0.000	51.6899	51.893	0.393	23.212	23.224	0.051	22.276	22.276	0.001
8	13.5778	13.578	-0.001	36.92	36.92	0.000	36.9227	36.685	-0.645	13.578	13.578	-0.002	13.573	13.573	-0.003

Table 2: Comparison of ETAP unbalanced short-circuit IEC results against IEC Standard example for I”k and Ip.

	IEC	ETAP		IEC	ETAP	
Bus	**I"K LG**	**I"K LG**	**%Diff**	**Ip© LG**	**Ip© LG**	**%Diff**
2	15.9722	15.972	**-0.001**	40.5086	40.553	**0.11**
3	10.4106	10.41	**-0.006**	24.2424	24.33	**0.361**
4	9.0498	9.049	**-0.009**	20.5463	20.655	**0.529**
5	17.0452	17.045	**-0.001**	42.8337	42.931	**0.227**

Reference

[1] “Short-circuit currents in three-phase a.c. systems – Part 0: Calculation of currents” , IEC-60909-0-2016 edition 2.0. ISBN 978-2-8322-3158-6.

[2] ETAP Short Circuit IEC V&V Documents, Case Number TCS-SCIEC-082.

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