Calculating Short Circuit Current in Harmonic Mitigating Transformer Applications

The single-phase fault level will be higher than the 3-phase fault level for systems in which the low zero-sequence impedance products such as the NCE, CNCE, and/or HARMONY transformers are used. For systems fed from transformers with ratings of 75kVA or less, the fault level increase will usually not be an issue because it should remain below the typical 10,000A minimum current interrupting capacity. The increase in the single-phase fault level of "weak" systems should in fact be considered a ***positive*** *effect as it can help to quicken the operation of system protection.*

In practice, engineers generally calculate the 3-phase fault level of a system because this fault normally generates the highest current under fault conditions in low voltage systems. This is no longer the case when applying very low zero sequence impedance products such as the NCE, CNCE and HARMONY transformers to the system. The drop in zero sequence impedance results in a significant reduction in the triplen harmonic distortion but means that the *single-phase* fault level will be higher than the three-phase fault level.

Single-phase fault level is determined by Equation 1. For conservative calculations, resistance can be neglected and positive and negative sequence reactance values can be assumed to be equal. The theoretical limit is where the zero sequence reactance is equal to zero, resulting in a maximum single-phase fault level increase of 50% above the three-phase fault level simplifying the calculation as per Equation 2.

$$I_{1\phi SC} = \frac{3\dot{V}}{\dot{Z}_1 + \dot{Z}_2 + \dot{Z}_0} \qquad \text{(Equation 1)}$$

$$I_{1\phi SC} = \frac{3V}{X_1 + X_2} = \frac{3V}{2X} = 1.5 I_{3\phi SC} \qquad \text{(Equation 2)}$$

Where the subscripts 1,2,0 denote positive, negative and zero sequence values.

MIRUS Products and their Effect on System Single-Phase Fault Level

Product	Impact on single-phase fault level
NEUTRAL CURRENT ELIMINATOR™ (NCE™)	40% increase
COMBINED NEUTRAL CURRENT ELIMINATOR™ (CNCE™)	increase: 10% max. , <5% typical
5-7 ELIMINATOR™, 11-13 ELIMINATOR™, DRIVE TAMER™	no impact
Harmony-1, -2, -3, -4™ and HC/2™	See tables below

HARMONY-1™

kVA	Single-Phase Fault Level (Amps)
15	1907
30	3814
45	5721
75	9535
112.5	12746
150	16994
225	25319
300	33759
500	36205

HARMONY-2™

kVA	Single-Phase Fault Level (A) 60% Outputs	Single-Phase Fault Level (A) 100% Outputs
15	1144	1907
30	2288	3814
45	3433	5721
75	5721	9535
112.5	8581	14302
150	10197	16994
225	15191	n/a
300	20255	n/a
500	23792	n/a

HC/2™

kVA	Single-Phase Fault Level (A) 60% Outputs	Single-Phase Fault Level (A) 100% Outputs
15	1112	1853
30	2224	3706
45	3336	5560
75	5560	9266
112.5	7455	12424
150	9940	16566
225	14792	n/a
300	19722	n/a
500	21171	n/a

Sample Calculation:

75kVA, HARMONY-1™, nameplate impedance (Z_1 & Z_2) = 2.8-3.2%, Z_0= 0.95%. Full Load : 208 amps @208V

$$I_{1\phi SC} = I_{1\phi SC,pu} \times I_{RATED} = \frac{3 \times 208A}{.028 + .028 + .0095} = 9535A$$

NOTE 1: Single-Phase Fault Levels given are maximums. Actual levels will be lower due to the impedance of the primary system and conductors.

NOTE 2: The fault levels shown above are based on the lowest positive sequence impedance and zero sequence impedance published in our Technical Data Sheets.

NOTE 3: Upon request, impedances can be changed to meet specific fault level requirements.