



TECHNICAL NOTE #:	TN_VFD_GEN-006
EFFECTIVE DATE:	09/26/00
SUPERSEDES DATE:	02/01/99
ORIGINATOR:	Mark Thrash
NO. OF PAGES:	4

HARMONIC CURRENT DISTORTION CALCULATION

The following method is to quickly calculating harmonic current distortion at the input of the inverter: Given the size of the inverter (KVA) and the size of the input transformer (KVA).

PROCEDURE:

1. Locate the specific inverter model listed in the DC Link Reactor Table 1.
2. Locate the inverter equivalent AC line impedance for units with internal DC Link Reactors or externally added DC Link Reactors.
Note: If the unit does *not* have a DC Link Reactor, the inverter equivalent AC impedance value is 0%.
3. Calculate the Total Source Impedance. $Z_{SOURCE} = Z_{XFMR} + Z_{ACLR}$
Refer to example.
Note: The 'source' is considered as the input to the drive, and will include transformers, reactors, wiring, etc.
4. Add the 'Total Source Impedance value' (calculated in step 3) and 'Inverter Equivalent AC Impedance value' (found in step 2) to determine the 'Total System Impedance'.
5. Refer to the harmonics spreadsheet (Table 2) and locate the 'Total System Impedance' value (calculated above). The THD (%), Power Factor, Total Rms Input Current and recommended transformer K Factor are listed.

Definition of Terms used in the example

Z	Impedance
Z _{DRIVE}	The input impedance of the inverter
Z _{XFMR}	The total impedance of the input transformer
Z _{ACLR}	The impedance of the input line Reactor
Z _{DCR}	The impedance of the input DC Reactor
Z _{SOURCE}	The total impedance of the input source (Z _{XFMR} + Z _{ACLR})
Z _{TOTAL}	The impedance of the total electrical system (Z _{SOURCE} + Z _{DRIVE})

EXAMPLE: GP5U4110 (150Hp) Inverter with 3% Line Reactor
 Components of the System

Input transformer	AC Input	AC Inverter	
5% Impedance	Line Reactor	GP5-4110	
1500KVA	3%	150HP	

Step 1. Locate the Input Capacity of the inverter Model # GP5-4110 inverter.
 See Table 1.
 Input Capacity (170kVA)

Step 2. Locate the Inverter Equivalent AC Line Impedance. See Table 1.

$$Z_{DRIVE} = 2.5\%$$

Step 3. Calculate the total Source Impedance

$$Z_{XFMR} = Z_{XFMR} \times \frac{KVA\ DRIVE}{KVA\ XFMR}$$

$$= 5\% \times \frac{170}{1500}$$

$$Z_{XFMR} = 0.5\%$$

$$Z_{ACLR} = Z_{ACLR}$$

$$= 3.0\% \text{ (AC Line Reactor)}$$

$$Z_{SOURCE} = Z_{XFMR} + Z_{ACLR}$$

$$= 0.5\% + 3.0\%$$

$$= 3.5\%$$

Step 4. Calculate the Total System Impedance

$$Z_{TOTAL} = Z_{SOURCE} + Z_{DRIVE}$$

$$= 3.5\% + 2.5\%$$

$$= 6.0\%$$

Step 5. Find the Harmonics Distortion, Input Power Factor and the K factor of the input source.

See Table 2

Current THD% = 27.6%

Input Power Factor = 0.964

Transformer K Factor = 4

DC LINK REACTOR TABLE for 230/460 VOLT MODELS

Table 1

Model GP5/FP5/ VG5	Inverter Rated Current	Input Capacity (kVA)	DC Link Reactor Ratings		Equivalent AC Line Impedance Z_{DRIVE} (%)	Safronics Line Reactor Part Number	Total Line Impedance $Z_{DRIVE}+Z_{DCR}$ (%)		
			Amps	Inductance (mH)					
20P4	3.2	1.4	4	5	0	022-3050	2.3		
20P7	6	2.3	9	3.22	0	022-3051	2.7		
21P5	8	3.0	9	3.22	0	022-3051	3.7		
22P2	11	4.0	18	1.38	0	022-3052	2.2		
23P7	17.5	6.7	18	1.38	0	022-3053	3.4		
25P5	25	9.5	32	0.8	0	022-3054	2.8		
27P5	33	13	40	0.75	0	022-3055	3.5		
2011	49	19	62	0.61	0	022-3056	4.2		
2015	64	24	80	0.31	0	022-3057	2.8		
2018	80	30	94	0.44	5.0	DC Link Reactor Standard			
2022	96	37	113	0.33	4.5				
2030	130	50	230	0.14	2.6				
2037	160	61	290	0.12	2.7				
2045	183	70	390	0.08	2.1				
2055	224	85	390	0.08	2.5				
2075	300	110	520	0.065	2.8				
40P4	1.8	1.4	2	50	0			022-3060	6.4
40P7	3.4	2.6	4	16.6	0			022-3061	4.0
41P5	4.8	3.7	9	11.5	0	022-3062	3.9		
42P2	6.2	4.7	9	11.5	0	022-3063	5.1		
43P7	8	6.1	12	4	0	022-3063	2.3		
44P0	11	8.6	12	4	0	022-3064	3.1		
45P5	14	11	18	4.1	0	022-3065	4.1		
47P5	21	14	25	1.75	0	022-3066	2.6		
4011	27	21	32	1.62	0	022-3067	3.1		
4015	34	26	40	1.1	0	022-3068	2.7		
4018	41	31	48	1.6	4.6	DC Link Reactor Standard			
4022	52	37	61	1.3	4.8				
4030	65	50	76	1	4.6				
4037	80	61	94	0.82	4.6				
4045	80	73	94	0.66	4.6				
4055	128	98	220	0.29	2.6				
4075	165	130	290	0.22	2.6				
4110	224	170	390	0.16	2.5				
4160	302	230	520	0.12	2.6				
4185	340	260			0	Not Available			
4220	450	340			0	Not Available			
4300	605	460			0	Not Available			

Table 2

System Impedance/Harmonic Distortion (Based on Inverter Capacity)											
System Imp. /Harmonics	0.50%	1.00%	1.50%	2.00%	2.50%	3.00%	3.50%	4.00%	4.50%	5.00%	6.00%
Fundamental (%)	100	100	100	100	100	100	100	100	100	100	100
5 th (%)	72	54	46	41	38.5	35.5	33.5	32	30	29	25
7 th (%)	54	32	25	21	17.5	13.5	12	11	10	11	8
11 (%)	18	12	9	8	8	8	7.8	7.5	7.5	7	6
13 (%)	9	7	6	5.5	5.5	5.5	5.2	5	5	5	5
17 (%)	6	4	3.5	3.5	3.5	3	3	3	3	3	3
19 (%)	4	3	2.5	2.5	2.5	2.5	2.3	2.2	2.1	2	2
Input Total Harmonic Distortion (%)	92.5	64.5	53.6	47.3	43.6	40.1	37.5	35.5	33.4	32.1	27.6
Total Input Harmonic Current (%)	136.2	119.0	113.5	110.6	109.1	107.7	106.8	106.1	105.4	105	103.7
True Input Power Factor	0.734	0.840	0.881	0.904	0.917	0.928	0.936	0.942	0.948	0.952	0.964
Required XFMR K Factor	19	12	9	8	7	6	6	5	5	5	4