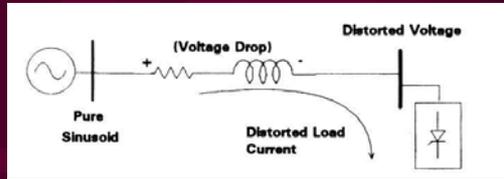
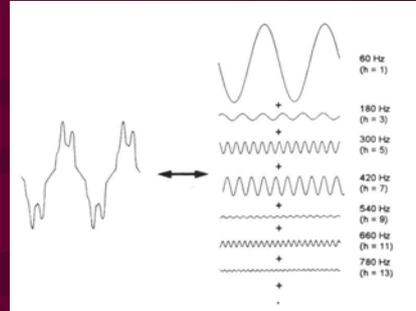
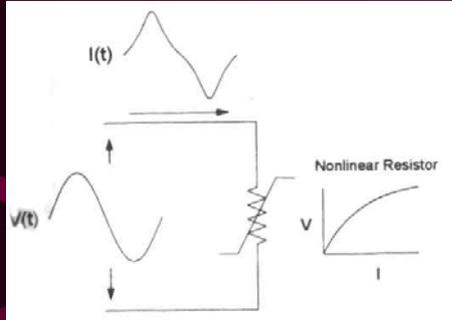
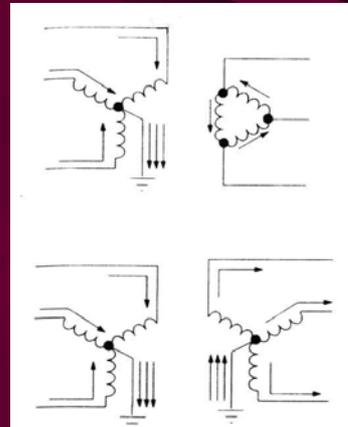
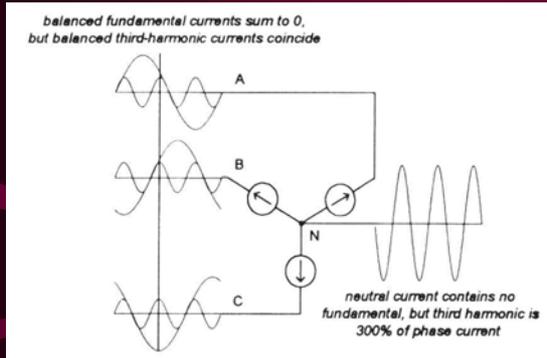


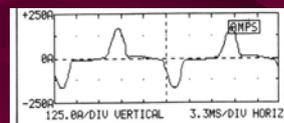
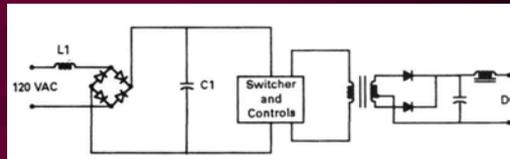
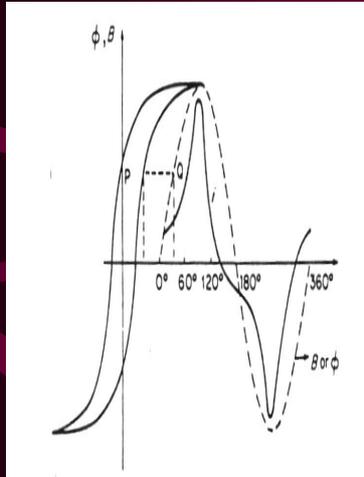
Armónicas



Armónicas Triples



Armónicas por saturación magnética y de fuente conmutada



Fundamental amp	50 A rms	Fundamental Irms	50 D Hr		
HARM	PCT	PHASE	HARM	PCT	PHASE
FUND	100.0%	-37°	2nd	0.2%	65°
3rd	0.7%	-93°	4th	0.4%	-72°
5th	3.7%	-166°	6th	0.4%	-154°
7th	1.7%	113°	8th	0.3%	112°
9th	4.4%	-46°	10th	0.1%	142°
11th	0.3%	-158°	12th	0.1%	66°
13th	2.5%	92°	14th	0.1%	66°
15th	1.9%	-61°	16th		
17th	1.8%	-151°	18th		
19th	1.1%	84°	20th		
21st	0.6%	-43°	22nd		
23rd	0.8%	-148°	24th		
25th	0.4%	64°	26th		
27th	0.2%	-26°	28th		
29th	0.2%	-122°	30th		
31st	0.2%	102°	32nd		
33rd	0.2%	56°	34th		

Variadores de velocidad de CC y CA

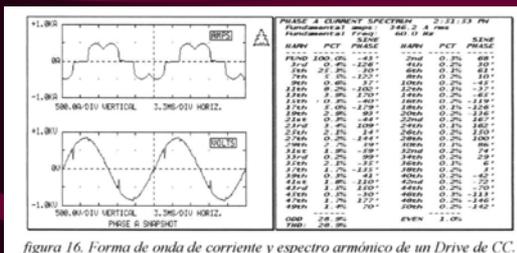


figura 16. Forma de onda de corriente y espectro armónico de un Drive de CC.

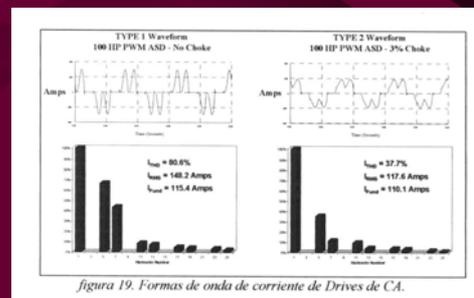
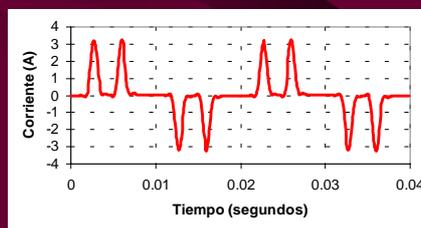
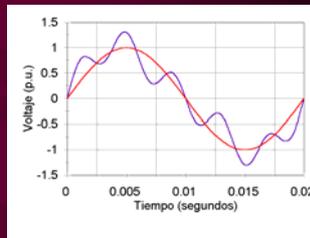


figura 19. Formas de onda de corriente de Drives de CA.

Armónicas

- Principales características:
 - Permanentes
 - Índice de distorsión, THD
- Quién las genera:
 - Cargas no-lineales
 - Imprecisiones de su origen
- Quién las sufre:
 - EE y usuarios en general
 - Usualmente no dañan equipos
- Su transmisión:
 - Siguen el camino de menor Z
- Soluciones:
 - Reducir contaminación
 - Instalar equipos mitigadores



Efectos en capacitores y transformadores

TABLE 5.1 Example Capacitor Evaluation
Recommended practice for establishing capacitor capabilities when supplied by nonsinusoidal voltages (IEEE Standard 18-1986)

Capacitor bank data:			
Bank rating:	1,200	kvar	
Voltage rating:	13,800	V (LL)	
Operating voltage:	13,800	V (LL)	
Supplied compensation:	1,200	kvar	
Fundamental current rating:	50.2	A	
Fundamental frequency:	60	Hz	
Capacitive reactance:	158,700	Ω	

Harmonic distribution of bus voltage:				
Harmonic no.	Frequency (Hz)	Volt. mag., V_n (% of fund.)	Volt. mag., V_n (V)	Line current, I_n (% of fund.)
1	60	100.00	7967.4	100.00
3	180	0.00	0.0	0.00
5	300	4.00	318.7	20.00
7	420	3.00	239.0	21.00
11	660	0.00	0.0	0.00
13	780	0.00	0.0	0.00
17	1020	0.00	0.0	0.00
19	1140	0.00	0.0	0.00
21	1260	0.00	0.0	0.00
23	1380	0.00	0.0	0.00
25	1500	0.00	0.0	0.00

Wolt distortion (THD):	5.00 %
rms capacitor voltage:	7977.29 V
Capacitor current distortion:	29.00 %
rms capacitor current:	52.27 A

Capacitor bank limits:			
	Calculated (%)	Limit (%)	Exceeds limit
Peak voltage	107.0	120	No
rms voltage	100.1	110	No
rms current	104.1	180	No
kvar	104.3	135	No

TABLE 5.2 Simplified Example C57.110 Transformer Evaluation and K-Factor Computation

Site: Example Plant
Example Transformer

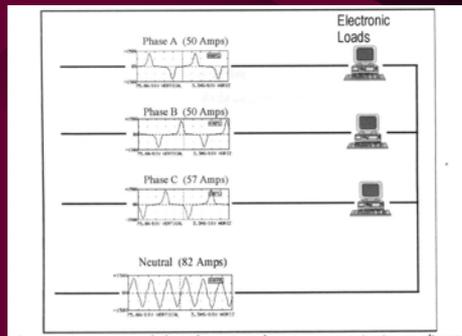
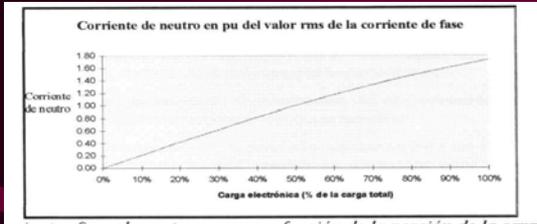
Harmonic distribution of transformer load current:

Harmonic	Current (%)	Frequency (Hz)	Current (pu)	I^2	$I^2 \times h^2$
1	100.000	60	1.000	1.000	1.000
3	1.600	180	0.016	0.000	0.002
5	26.100	300	0.261	0.068	1.703
7	5.000	420	0.050	0.003	0.123
9	0.300	540	0.003	0.000	0.001
11	8.900	660	0.089	0.008	0.958
13	3.100	780	0.031	0.001	0.162
15	0.200	900	0.002	0.000	0.001
17	4.800	1020	0.048	0.002	0.666
19	2.600	1140	0.026	0.001	0.244
21	0.100	1260	0.001	0.000	0.000
23	3.300	1380	0.033	0.001	0.576
25	2.100	1500	0.021	0.000	0.276
Totals:				1.084	5.712

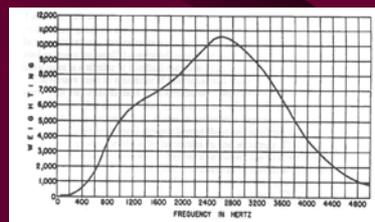
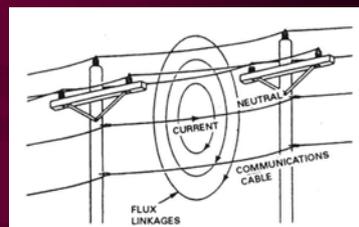
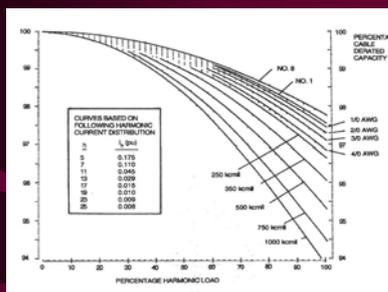
K factor: 5.3

Standard derating (ANSI/IEEE C57.110-1986): 0.87 pu
Assumed eddy-current loss factor (F_{ECR}) = 8%

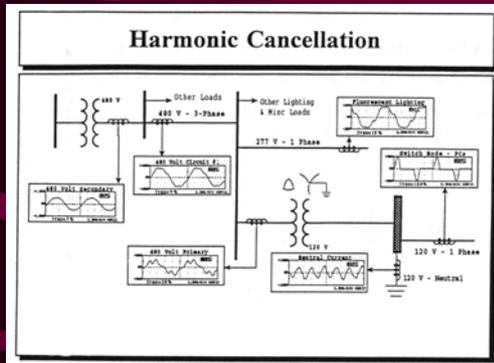
Carga "electrónica"



Efecto sobre conductores, fusibles y teléfonos



Efecto de cancelación



Example from actual measurements:

120 Volt Circuit: Electronics Loads - THD = 104%

Neutral current = 165% of RMS Phase current

Primary of 480/208 Volt Transformer - THD = 30%

480 Volt Lighting Circuit - THD = 15%

480 Volt Supply to Lighting and Electronics - THD = 9%

Total 480 Volt Current to Facility - THD = 7%