Table 64—Transformers

(a) Typical Per Unit R and X Values for Indoor, Open Dry-Type 150 °C Rise Transformers Rated from 15–2500 kVA, Three-Phase, 2.5–15 kV Primaries, 208, 240, 480, 600 V Wye or Delta Secondaries

kVA	HV (kV)	LV (kV)	% Z	X/R	R	X
15	2.5–15	208Y-600	3.00	0.5	0.027	0.013
30	2.5–15	208Y-600	5.00	1.0	0.035	0.035
45	2.5–15	208Y-600	5.00	1.0	0.035	0.036
75	2.5–15	208Y-600	5.50	2.0	0.025	0.049
112.5	2.5–15	208Y-600	4.50	1.5	0.025	0.037
150	2.5–15	208Y-600	4.50	2.0	0.020	0.040
225	2.5–15	208Y-600	5.00	2.5	0.019	0.046
300	2.5–15	208Y-600	5.00	2.8	0.017	0.047
500	2.5–15	208Y-600	5.00	4.0	0.012	0.049
750	2.5–15	208Y-600	5.75	2.0	0.026	0.051
1000	2.5–15	208Y-600	5.75	2.5	0.021	0.053
1000	2.5–15	480Y	8.00	3.8	0.021	0.077
1500	2.5–15	208Y-600	5.75	3.3	0.017	0.055
2000	2.5–15	208Y-600	5.75	4.0	0.014	0.056
2500	2.5–15	208Y-600	5.75	4.3	0.013	0.056

(b) Typical Per Unit R and X Values for Indoor, Open Dry-Type 150 °C Rise Transformers Rated from 25–500 kVA, Single-Phase, 5 and 15 kV Primaries, 120/240 V Wye or Delta Secondaries

kVA	HV (kV)	LV (kV)	% Z	X/R	R	X
25	5		4	2	0.018	0.036
to	to	120/240	to	to		
500	15		6	4	0.015	0.058

(c) Typical Range of Per Unit Values for Indoor, Open Dry-Type 150 °C Rise Transformers Rated from 15–500 kVA, Three-Phase, 480 V Primary, 208 V Wye Secondary

kVA	% Z	X/R	R	X
15	4.5	0.41	0.042	0.017
to	to	to		
500	5.9	2.09	0.025	0.053

Table 65—Approximate Impedance Data — Insulated Conductors — 60 Hz
(Ω/1000 feet Each Conductor)

Size AWG or kCM	Resistance (25 °C)				Reactance — 600 V — THHN			
	Copper		Aluminum		Several 1/C		1 Multicond.	
	Metal	Nonmet.	Metal	Nonmet.	Mag.	Nonmag.	Mag.	Nonmag.
14	2.5700	Same	4.2200	Same	0.0493	0.03914	0.0351	0.0305
12	1.6200	Same	2.6600	Same	0.0468	0.0374	0.0333	0.0290
10	1.0180	Same	1.6700	Same	0.0463	0.0371	0.0337	0.0293
8	0.6404	Same	1.0500	Same	0.0475	0.0380	0.0351	0.0305
6	0.4100	Same	0.6740	Same	0.0437	0.0349	0.0324	0.0282
4	0.2590	Same	0.4240	Same	0.0441	0.0353	0.0328	0.0285
2	0.1640	0.1620	0.2660	Same	0.0420	0.0336	0.0313	0.0273
1	0.1303	0.1290	0.2110	Same	0.0427	0.0342	0.0319	0.0277
1/0	0.1040	0.1020	0.1680	Same	0.0417	0.0334	0.0312	0.0272
2/0	0.0835	0.0812	0.1330	Same	0.0409	0.0327	0.0306	0.0266
3/0	0.0668	0.0643	0.1060	0.1050	0.0400	0.0320	0.0300	0.0261
4/0	0.0534	0.0511	0.0844	0.0838	0.0393	0.0314	0.0295	0.0257
250	0.0457	0.0433	0.0722	0.0709	0.0399	0.0319	0.0299	0.0261
300	0.0385	0.0362	0.0602	0.0592	0.0393	0.0314	0.0295	0.0257
350	0.0333	0.0311	0.0520	0.0507	0.0383	0.0311	0.0388	0.0311
400	0.0297	0.0273	0.0460	0.0444	0.0385	0.0308	0.0286	0.0252
500	0.0244	0.0220	0.0375	0.0356	0.0379	0.0303	0.0279	0.0250
600	0.0209	0.0185	0.0319	0.0298	0.0382	0.0305	0.0278	0.0249
750	0.0174	0.0185	0.0264	0.0301	0.0376	0.0301	0.0271	0.0247
1000	0.0140	0.0115	0.0211	0.0182	0.0370	0.0296	0.0260	0.0243

NOTE — Increased resistance of conductors in magnetic raceway is due to the effect of hysteresis losses. The increased resistance of conductors in metal nonmagnetic raceway is due to the effect of eddy current losses. The effect is essentially equal for steel and aluminum raceway. Resistance values are acceptable for 600 V, 5 kV, and 15 kV insulated conductors.

Size AWG or kCM	Reactance — 5 kV				Reactance — 15 kV			
	Several 1/C		1 Multicond.		Several 1/C		1 Multicond.	
	Mag.	Nonmag.	Mag.	Nonmag.	Mag.	Nonmag.	Mag.	Nonmag.
8	0.0733	0.0586	0.0479	0.0417				
6	0.0681	0.0545	0.0447	0.0389	0.0842	0.0674	0.0584	0.0508
4	0.0633	0.0507	0.0418	0.0364	0.0783	0.0626	0.0543	0.0472
2	0.0591	0.0472	0.0393	0.0364	0.0727	0.0582	0.0505	0.0439
1	0.0571	0.0457	0.0382	0.0332	0.0701	0.0561	0.0487	0.0424
1/0	0.0537	0.0430	0.0360	0.0313	0.0701	0.0561	0.0487	0.0424
2/0	0.0539	0.0431	0.0350	0.0305	0.0661	0.0529	0.0458	0.0399
3/0	0.0521	0.0417	0.0341	0.0297	0.0614	0.0491	0.0427	0.0372
4/0	0.0505	0.0404	0.0333	0.0290	0.0592	0.0474	0.0413	0.0359
250	0.0490	0.0392	0.0324	0.0282	0.0573	0.0458	0.0400	0.0348
300	0.0478	0.0383	0.0317	0.0277	0.0557	0.0446	0.0387	0.0339
350	0.0469	0.0375	0.0312	0.0274	0.0544	0.0436	0.0379	0.0332
400	0.0461	0.0369	0.0308	0.0270	0.0534	0.0427	0.0371	0.0326
500	0.0461	0.0369	0.0308	0.0270	0.0517	0.0414	0.0357	0.0317
600	0.0439	0.0351	0.0290	0.0261	0.0516	0.0413	0.0343	0.0309
750	0.0434	0.0347	0.0284	0.0260	0.0500	0.0400	0.0328	0.0301
1000	0.0421	0.0337	0.0272	0.0255	0.0482	0.0385	0.0311	0.0291

NOTE — These are only representative figures. Reactance is affected by cable insulation type, shielding, conductor outside diameter, conductor spacing in three-conductor cable, etc. In commercial buildings, medium-voltage impedances normally do not affect short-circuit calculations significantly.

melting TCCs for a representative line of solid-material power fuses. These curves should indicate the tolerance in terms of time or current. These curves should further indicate whether the fuse is non-damageable, that is, whether it can carry without damage the designated current for a time that immediately approaches the time indicated by the curve. Total-clearing TCC curves for these two types of fuses are shown in Figure 6-10 and Figure 6-11, respectively.

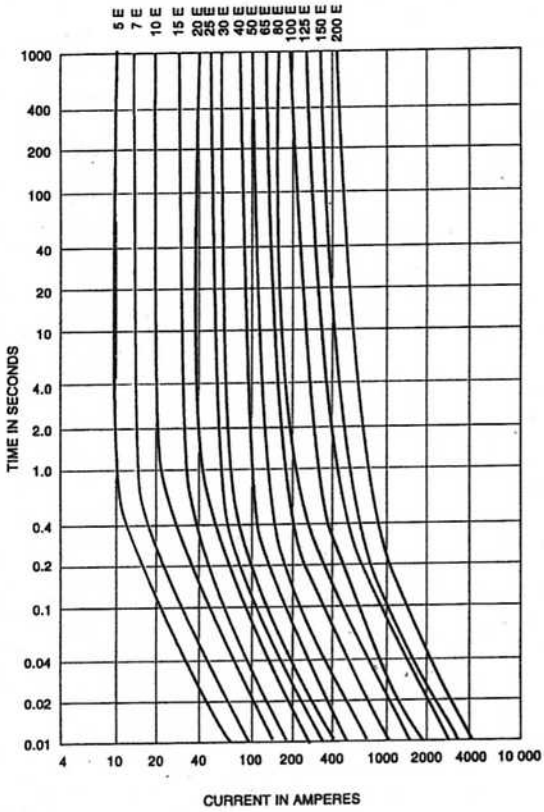


Figure 6-8—Typical minimum-melting TCC curves for high-voltage current-limiting power fuses

Because the minimum-melting TCC curve is based on no initial load current through the fuse, this curve should be modified to recognize the reduction in melting time due to load current. This modification permits more precise coordination with other overcurrent protective devices nearer the load. Further aids are available in the form of curves that show the temporary reduction in melting characteristics if the fuse has been carrying a heavy emergency overload, or if the fuse has been applied in a location with an exceptionally high ambient temperature.

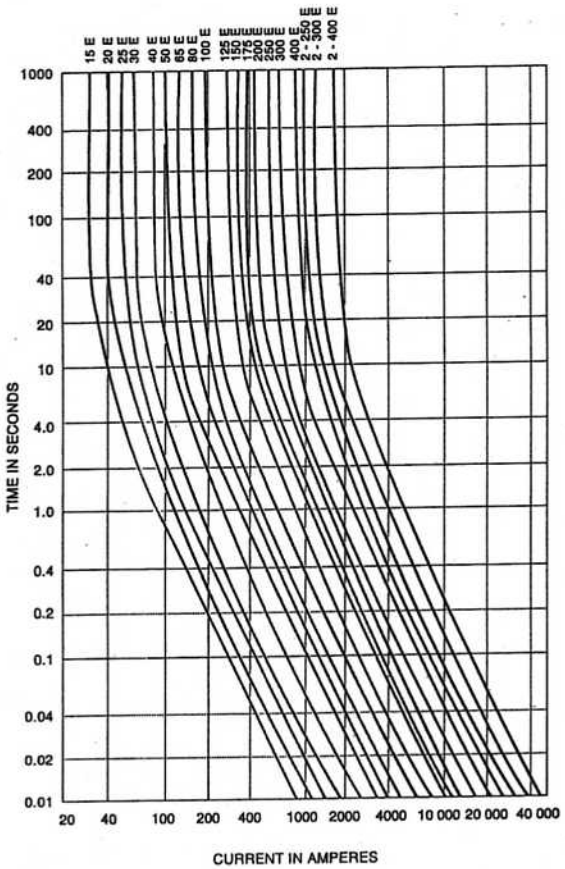


Figure 6-9—Typical minimum-melting TCC curves for medium and high-voltage solid-material power fuses

If the fuse is susceptible to a permanent change in melting TCC when exposed to currents for times less than the minimum-melting time, the manufacturer's published "safety-zone" allowance or "setback curve" should be used in any coordination scheme.

Fuses discussed in 6.3.3.3, which can interrupt upon command, have small tolerances, are fast-acting at high fault currents, are nondamageable, and do not require modification of the curves due to pre-loading or ambient temperature. Nonetheless, they should not be installed in locations where the ambient temperature exceeds 55 ßC without consulting the manufacturer.

Maximum system protection and maximum backup protection for load-side devices require use of the smallest ampere rating of fuse that meets the requirements stated in 6.4.1.2. In addition, the cumulative transformer magnetizing inrush of all transformers downstream of the fuse should be considered. Fuses having a small tolerance and utilizing nondamageable

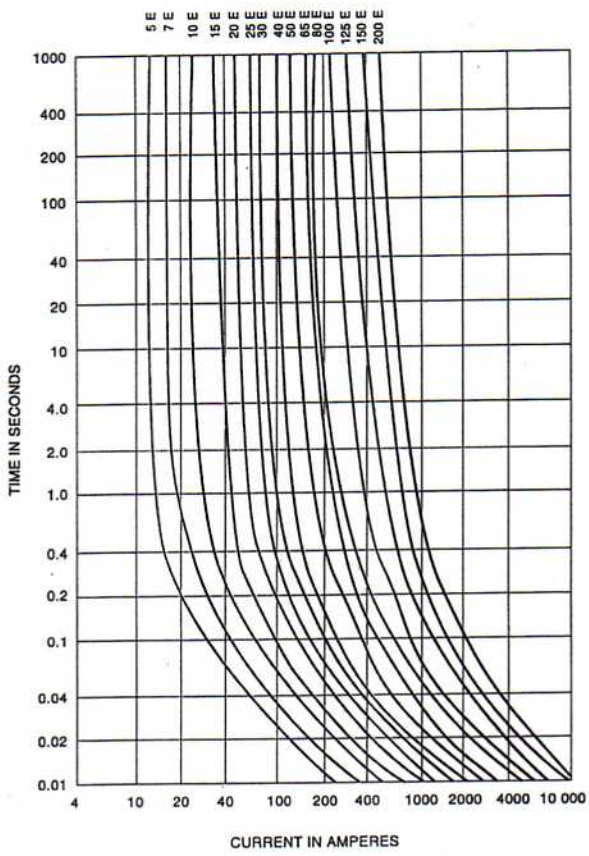


Figure 6-10—Typical total-clearing TCC curves for high-voltage current-limiting power fuses (see Figure 6-8)

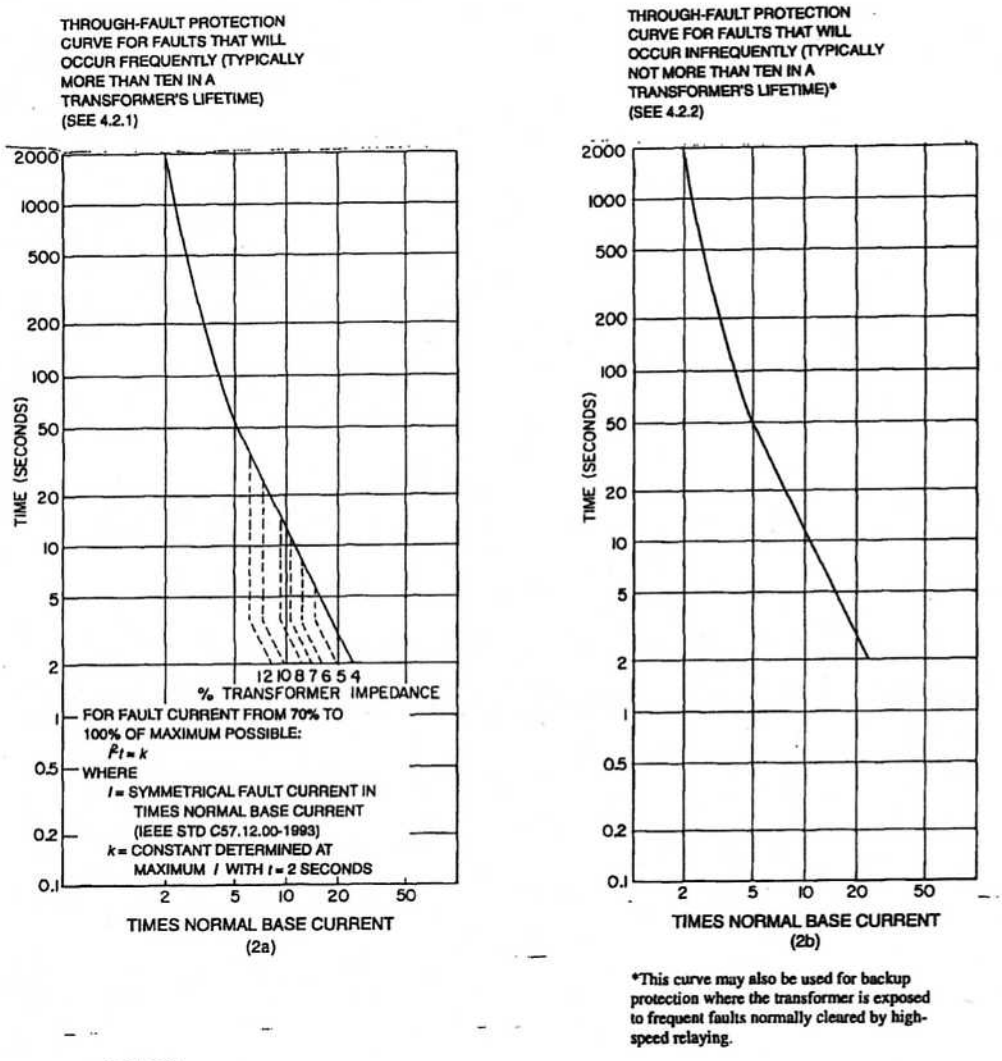
elements are best suited to accurate selective application. The effort required to make a precise selection of fuse ampere rating and speed characteristics is small compared to the benefits obtained in overall system overcurrent protection.

6.4.2.2 Transformer protection

6.4.2.2.1 Inrush points

In selecting fuses for transformer protection, the following practices are recommended to avoid nuisance fuse operation:

a) When a transformer is energized, magnetizing inrush current flows through the fuses. When selecting the current rating, the minimum-melting TCC (adjusted for pre-load, ambient temperature, and, if applicable, damageability) should lie to the right of the magnetizing inrush points. The rules of thumb for these points are 12 times the full-



NOTES
1—Sample $I^2t = k$ curves have been plotted for selected transformer short circuit impedances as noted in 2a.
2—Low current values of 3.5 and less may result from overloads rather than faults. An appropriate loading guide should be referred to for specific allowable time durations.

Figure 2—Category II transformers
501 to 1667 kVA single-phase
501 to 5000 kVA three-phase

4.2.1 Faults that occur frequently

Figure 2a, reflecting both thermal and mechanical damage considerations, should be applied as a protection curve for faults that will occur frequently (typically more than ten in the life of a transformer). Part of the curve is dependent upon the transformer short-circuit impedance for fault currents above 70% of the maximum possible and is keyed to the I^2t of the worst-case mechanical duty (maximum fault current for 2s) as shown by the dashed curves for a few selected impedances. The remaining portion matches the thermal protection curve for faults below the 70% level.

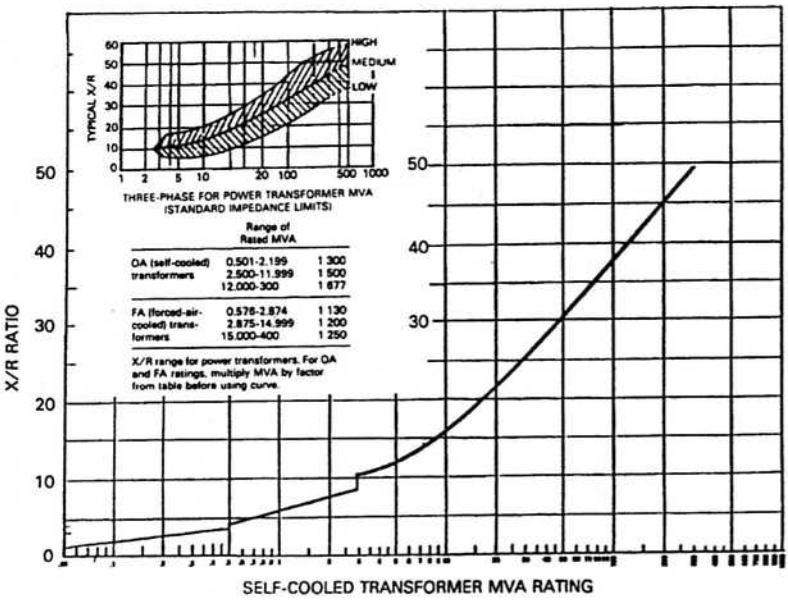


Figure 1-38—Typical *X/R* ratio of transformers

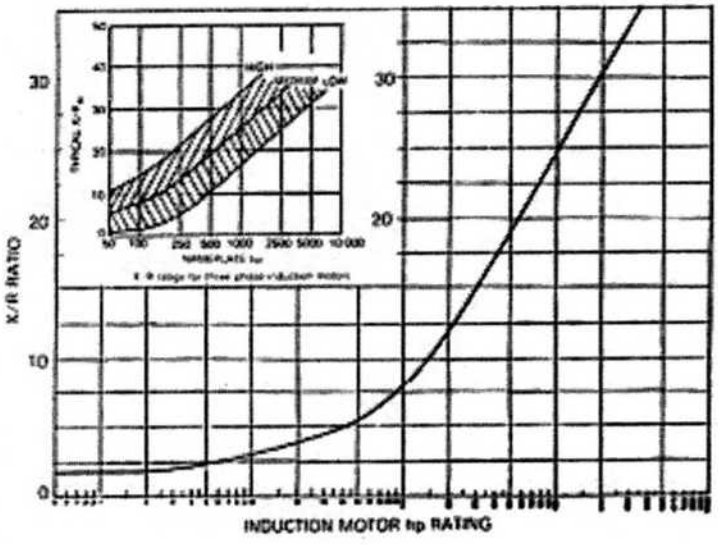


Figure 1-39—Typical *X/R* ratio of induction motors

TABLA PARA CALCULAR LA CAIDA DE TENSION

TABLA Nº 7.05

CAIDA DE TENSION POR AMPERIO Y POR 100 METROS DE CIRCUITO 3 FASES - 3 HILOS - 60 Hz.

Calibre AWG/MCM	Ducto de Aluminio o de Acero	Conductor de Aluminio Factor de Potencia (%)			Conductor de Cobre Factor de Potencia (%)		
		80	90	100	80	90	100
12	ALUMINIO ACERO	1,391 1,398	1,558 1,562	1,716 1,716	0,889 0,892	0,994 0,994	1,093 1,089
10	ALUMINIO ACERO	0,879 0,883	0,981 0,984	1,079 1,079	0,561 0,564	0,627 0,627	0,682 0,682
8	ALUMINIO ACERO	0,558 0,564	0,620 0,627	0,679 0,679	0,358 0,361	0,394 0,397	0,427 0,427
6	ALUMINIO ACERO	0,364 0,368	0,404 0,404	0,436 0,433	0,236 0,239	0,259 0,263	0,276 0,276
4	ALUMINIO ACERO	0,233 0,239	0,256 0,259	0,272 0,276	0,154 0,158	0,167 0,171	0,174 0,174
2	ALUMINIO ACERO	0,151 0,154	0,164 0,167	0,174 0,171	0,102 0,105	0,108 0,112	0,108 0,112
1	ALUMINIO ACERO	0,125 0,128	0,131 0,135	0,138 0,138	0,085 0,085	0,089 0,092	0,086 0,085
1/0	ALUMINIO ACERO	0,102 0,105	0,108 0,112	0,108 0,108	0,069 0,072	0,089 0,076	0,069 0,069
2/0	ALUMINIO ACERO	0,082 0,085	0,085 0,089	0,085 0,085	0,056 0,062	0,059 0,062	0,053 0,056
3/0	ALUMINIO ACERO	0,069 0,072	0,072 0,076	0,069 0,069	0,046 0,053	0,049 0,053	0,043 0,046
4/0	ALUMINIO ACERO	0,056 0,059	0,059 0,059	0,056 0,056	0,039 0,046	0,039 0,043	0,033 0,036
250	ALUMINIO ACERO	0,049 0,053	0,049 0,053	0,046 0,046	0,036 0,039	0,036 0,039	0,029 0,031
300	ALUMINIO ACERO	0,043 0,046	0,043 0,046	0,039 0,039	0,032 0,036	0,031 0,036	0,024 0,026
350	ALUMINIO ACERO	0,039 0,043	0,039 0,043	0,033 0,033	0,029 0,033	0,028 0,031	0,020 0,023

EJEMPLOS DE APLICACION DE LA TABLA Nº 7.05

1. Un motor de 75 HP, 3 fases, 208V., 0,8 factor de potencia, 196 A, longitud del alimentador 80,77 metros, cable de aluminio THW, 350 MCM.

   Calcular la caída de tensión en porciento (%) utilizando ducto de aluminio.

$$\%\,V = \frac{K \times \text{Amperaje} \times \text{longitud}}{\text{Voltios de fase a fase}} \quad \%$$

$$K = \text{factor tomado de la tabla}$$

$$\%\,V = \frac{0{,}039 \times 196 \times 80{,}77}{208} = 2{,}97\%$$

Utilizando ducto magnético

$$\%\,V = \frac{0{,}043 \times 196 \times 80{,}77}{208} = 3{,}27\%$$

Quick Reference

Table 12-1. Industrial Circuit Breakers

Circuit Breaker Type	Continuous Ampere Rating at 40°C	No. Poles	Volts AC	Volts DC	Type of Trip ①	Federal Specification W-C-375b	UL Listed Interrupting Ratings (rms Symmetrical Amperes) AC (kV) 120	120/240	240	277	480	600	DC (kV) ② 125	250	125/250	Page Number
G-Frame																
GHB	15 – 100	1	120	125	N.I.T.U.	11a	65	—	—	—	—	—	14	—	—	12-9
GHB	15 – 100	2, 3	240	125/250		10b, 11b,	—	—	65	—	—	—	—	—	14	12-9
GHB	15 – 100	1	277	125		12b, 14b,	—	—	—	14	—	—	14	—	—	12-9
GHB	15 – 100	2, 3	480Y/277	125/250		15b	—	—	—	14	14	—	—	—	14	12-9
HGHB	15 – 30	1	277	125		12c, 13a, 13b	65	—	—	25	—	—	14	—	—	12-9
GHQ	15 – 20	1	277	—			65	—	—	14	—	—	—	—	—	12-9
GHBS	15 – 30	1, 2	480Y/277	—	—	—	65	65	—	14	—	—	—	—	—	11-16
GBHS	15 – 20	1, 2	600Y/347	—	N.I.T.U.	—	—	—	—	—	—	10	—	—	—	11-16
GD	15 – 50	2	480	125/250	N.I.T.U.	13b	—	—	65	—	14	—	—	—	10	12-8
GD	15 – 100	3	480	250		13b	—	—	65	—	22	—	—	10	—	12-8
GHC	15 – 100	1	120	125	N.I.T.U.	12c, 13a	65	—	—	—	—	—	14	—	—	12-11
GHC	15 – 100	2, 3	240	125/250		13b	—	—	65	—	—	—	—	—	14	12-11
GHC	15 – 100	1	277	125		12c, 13a	—	—	—	14	—	—	14	—	—	12-11
GHC	15 – 100	2, 3	480Y/277	125/250		13b	—	—	—	14	14	—	—	—	14	12-11
HGHC	15 – 30	1	277	125			65	—	—	25	—	—	14	—	—	12-11
New E125 Frame																
E125B	15 – 125	1	277	250	N.I.T.U.	—	35	—	25	18	—	—	10	—	—	12-16
		2, 3, 4	480			—	—	—	25	—	18	—	—	10	—	
E125E	15 – 125	2, 3, 4	600Y/347	250	N.I.T.U.	—	—	—	35	—	25	18	10	10	—	12-16
E125S	15 – 125	1	347	250	N.I.T.U.	—	100	—	85	35	—	—	35	—	—	12-16
		2, 3, 4	600Y/347			—	—	—	85	—	35	22	—	35	—	
E125H	15 – 125	1	347	250	N.I.T.U.	—	200	—	100	65	—	—	42	—	—	12-17
		2, 3, 4	600Y/347			—	—	—	100	—	65	25	—	42	—	
F-Frame																
ED	100 – 225	2, 3	240	125	N.I.T.U.	12b	—	—	65	—	—	—	10	—	—	12-21
EDH	100 – 225	2, 3	240	125		14b	—	—	100	—	—	—	10	—	—	12-21
EDC	100 – 225	2, 3	240	125		1	—	—	200	—	—	—	10	—	—	12-21
EHD	15 – 100	1	277	125	N.I.T.U.	13a	—	—	—	14	—	—	10	—	—	12-21
EHD	15 – 100	2, 3	480	250		13b	—	—	18	—	14	—	—	10	—	12-21
FDB	15 – 150	2, 3	600	250	N.I.T.U.	18a	—	—	18	—	14	14	—	10	—	12-22
FDB	15 – 150	4	600	250		③	—	—	18	—	14	14	—	10	—	12-22
FD	15 – 150	1	277	125	N.I.T.U.	13a	—	—	—	35	—	—	10	—	—	12-22
FD	15 – 225	2, 3	600	250		22a	—	—	65	—	35	18	—	10	—	12-22
FD	15 – 225	4	600	250		③	—	—	65	—	35	18	—	10	—	12-22
HFD	15 – 150	1	277	125	N.I.T.U.	13a	—	—	—	65	—	—	10	—	—	12-22
HFD	15 – 225	2,3	600	250		22a	—	—	100	—	65	25	—	22	—	12-22
HFD	15 – 225	4	600	250		③	—	—	100	—	65	25	—	22	—	12-22
FDC	15 – 225	2, 3	600	250	N.I.T.U.	24a	—	—	200	—	100	35	—	22	—	12-22
FDC	15 – 225	4	600	250		③	—	—	200	—	100	35	—	22	—	12-22
New J250 Frame																
J250E	63 – 250	2, 3, 4	600	250	I.T.U.	—	—	—	65	—	25	18	—	10	—	12-28
J250S	63 – 250	2, 3, 4	600	250	I.T.U.	—	—	—	85	—	35	18	—	22	—	12-28
J250H	63 – 250	2, 3, 4	600	250	I.T.U.	—	—	—	100	—	65	25	—	22	—	12-28

① N.I.T.U. is non-interchangeable trip unit and I.T.U. is interchangeable trip unit.
② Two-pole circuit breaker, or two poles of three-pole circuit breaker at 250V DC.
③ Not defined in W-C-375b.

12

Table 12-1. Industrial Circuit Breakers (Continued)

Circuit Breaker Type	Continuous Ampere Rating at 40°C	No. Poles	Volts AC	Volts DC	Type of Trip ①	Federal Specification W-C-375b	UL Listed Interrupting Ratings (rms Symmetrical Amperes) AC (kV) 120	120/240	240	277	480	600	DC (kV) ② 125	250	125/250	Page Number
J-Frame																
JDB	70 – 250	2, 3	600	250	N.I.T.U.	22a	—	—	65	—	35	18	—	10	—	12-34
JD	70 – 250	2, 3, 4	600	250	I.T.U.	22a	—	—	65	—	35	18	—	10	—	12-33
HJD	70 – 250	2, 3, 4	600	250	I.T.U.	22a	—	—	100	—	65	25	—	22	—	12-33
JDC	70 – 250	2, 3, 4	600	250	I.T.U.	22a	—	—	200	—	100	35	—	22	—	12-33
K-Frame																
DK	250 – 400	2, 3	240	250	N.I.T.U.	14b	—	—	65	—	—	—	—	10	—	12-44
KDB	100 – 400	2, 3	600	250	N.I.T.U.	23a	—	—	65	—	35	25	—	10	—	12-44
KD	100 – 400	2, 3, 4	600	250	I.T.U.	23a	—	—	65	—	35	25	—	10	—	12-41, 12-42, 12-46, 12-47
CKD	100 – 400	2, 3, 4	600	250	I.T.U.	23a	—	—	65	—	35	25	—	10	—	12-45, 12-48, 12-49
HKD	100 – 400	2, 3, 4	600	250	I.T.U.	23a	—	—	100	—	65	35	—	22	—	12-41, 12-42, 12-46, 12-47
CHKD	100 – 400	2, 3, 4	600	250	I.T.U.	23a	—	—	100	—	65	35	—	22	—	12-45, 12-48, 12-49
KDC	100 – 400	2, 3, 4	600	250	I.T.U.	23a	—	—	200	—	100	50	—	22	—	12-41, 12-42, 12-46, 12-47
L-Frame																
LDB	300 – 600	2, 3	600	250	N.I.T.U.	23a	—	—	65	—	35	25	—	22	—	12-59
LD	300 – 600	2, 3, 4	600	250	I.T.U.	23a	—	—	65	—	35	25	—	22	—	12-56, 12-57, 12-61
CLD	300 – 600	2, 3, 4	600	250	I.T.U.	23a	—	—	65	—	35	25	—	22	—	12-58, 12-64
HLD	300 – 600	2, 3, 4	600	250	I.T.U.	23a	—	—	100	—	65	35	—	25	—	12-56, 12-57, 12-61
CHLD	300 – 600	2, 3, 4	600	250	I.T.U.	23a	—	—	100	—	65	35	—	25	—	12-58, 12-64
LDC	300 – 600	2, 3, 4	600	250	I.T.U.	23a	—	—	200	—	100	50	—	25	—	12-56, 12-57, 12-62
CLDC	300 – 600	2, 3, 4	600	250	I.T.U.	23a	—	—	200	—	100	50	—	25	—	12-58, 12-65
M-Frame																
MDL	300 – 800	2, 3	600	250	I.T.U.	23a	—	—	65	—	50	25	—	22	—	12-71, 12-72
CMDL	300 – 800	2, 3	600	250	I.T.U.	23a	—	—	65	—	50	25	—	22	—	12-73
HMDL	300 – 800	2, 3	600	250	I.T.U.	23a	—	—	100	—	65	35	—	25	—	12-71, 12-72
CHMDL	300 – 800	2, 3	600	250	I.T.U.	23a	—	—	100	—	65	35	—	25	—	12-73
N-Frame																
ND	600 – 1200	3, 4	600	—	N.I.T.U.	23A	—	—	65	—	50	25	—	—	—	12-79, 12-91
CND	600 – 1200	3, 4	600	—	N.I.T.U.	23A	—	—	65	—	50	25	—	—	—	12-85, 12-93
HND	600 – 1200	3, 4	600	—	N.I.T.U.	23A	—	—	100	—	65	35	—	—	—	12-81, 12-91
CHND	600 – 1200	3, 4	600	—	N.I.T.U.	23A	—	—	100	—	65	35	—	—	—	12-87, 12-93
NDC	600 – 1200	3, 4	600	—	N.I.T.U.	23A	—	—	200	—	100	50	—	—	—	12-83, 12-91
CNDC	600 – 1200	3, 4	600	—	N.I.T.U.	23A	—	—	200	—	100	50	—	—	—	12-89, 12-93

① N.I.T.U. is non-interchangeable trip unit and I.T.U. is interchangeable trip unit.
② Two-pole circuit breaker, or two poles of three-pole circuit breaker at 250V DC.

Table 12-1. Industrial Circuit Breakers (Continued)

Circuit Breaker Type	Continuous Ampere Rating at 40°C	No. Poles	Volts AC	Volts DC	Type of Trip ①	Federal Specification W-C-375b	UL Listed Interrupting Ratings (rms Symmetrical Amperes) AC (kV) 120	120/240	240	277	480	600	DC (kV) ② 125	250	125/250	Page Number
R-Frame																
RD 1600	800 – 1600	3, 4	600	—	N.I.T.U.	24a	—	—	125	—	65	50	—	—	—	12-100
CRD 1600	800 – 1600	3, 4	600	—	N.I.T.U.	24a	—	—	125	—	65	50	—	—	—	12-103
RD 2000	1000 – 2000	3, 4	600	—	N.I.T.U.	24a	—	—	125	—	65	50	—	—	—	12-100
RD 2500	1000 – 2500	3, 4	600	—	N.I.T.U.	24a	—	—	200	—	65	50	—	—	—	12-100
CRD 2000	1000 – 2000	3, 4	600	—	N.I.T.U.	24a	—	—	125	—	65	50	—	—	—	12-103
RDC 1600	800 – 1600	3, 4	600	—	N.I.T.U.	25a	—	—	200	—	100	65	—	—	—	12-102
CRDC 1600	800 – 1600	3, 4	600	—	N.I.T.U.	25a	—	—	200	—	100	65	—	—	—	12-103
RDC 2000	1000 – 2000	3, 4	600	—	N.I.T.U.	25a	—	—	200	—	100	65	—	—	—	12-102
RDC 2500	1000 – 2500	3, 4	600	—	N.I.T.U.	25a	—	—	200	—	100	65	—	—	—	12-102
CRDC 2000	1000 – 2000	3, 4	600	—	N.I.T.U.	25a	—	—	200	—	100	65	—	—	—	12-103
Current Limit-R Current Limiting Circuit Breakers — Non-Fused Type																
FCL	15 – 100	2, 3	480	—	N.I.T.U.	—	—	—	200	—	150	—	—	—	—	12-129
LCL	125 – 400	2, 3	600	—	N.I.T.U.	—	—	—	200	—	200	100	—	—	—	12-130
TRI-PAC Current Limiting Circuit Breakers — Fused Type																
FB	15 – 100	2, 3	600	250	N.I.T.U.	16a, 16b, 17a, 26a	—	—	200	—	200	200	—	—	100	12-132
LA	70 – 400	2, 3	600	250	I.T.U.	16a, 16b, 17a, 26a	—	—	200	—	200	200	—	—	100	12-133
NB	300 – 800	2, 3	600	250	I.T.U.	16b, 17a, 26a	—	—	200	—	200	200	—	—	100	12-135
PB	600 – 1600	2, 3	600	250	I.T.U.	17a, 26a	—	—	200	—	200	200	—	—	100	12-137

① N.I.T.U. is non-interchangeable trip unit and I.T.U. is interchangeable trip unit.
② Two-pole circuit breaker, or two poles of three-pole circuit breaker at 250V DC.

12

Contents

F-Frame

Typical F-Frame Breaker

Product Description

- All Cutler-Hammer F-Frame Circuit Breakers by Eaton Corporation are HACR rated.
- All circuit breakers 10 through 50 amperes are suitable for HID (high intensity discharge) use.
- All F-Frame circuit breakers are suitable for reverse feed use.

Technical Data and Specifications

Table 12-25. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	Number of Poles	Interrupting Capacity (kA Symmetrical Amperes)					
		Volts AC (50/60 Hz)				Volts DC ①	
		240	277	480	600	125	250 ②③
ED	2, 3	65	—	—	—	10	—
EDH	2, 3	100	—	—	—	10	—
EDC	2, 3	200	—	—	—	10	—
EHD	1	—	14	—	—	10	—
	2, 3	18	—	14	—	—	10
FDB	2, 3, 4	18	—	14	14	—	10
FD	1	—	25	—	—	10	—
	2, 3, 4	65	—	35	18	—	10
HFD	1	—	65	—	—	10	—
	2, 3, 4	100	—	65	25	—	22
FDC	2, 3, 4	200	—	100	35	—	22

① DC ratings apply to substantially non-inductive circuits.
② 2-pole circuit breaker, or two poles of 3-pole circuit breaker.
③ Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 22 kA.

Table 12-26. IEC 157-1 (P1) Interrupting Capacity Ratings (P1)

Circuit Breaker Type	Number of Poles	Interrupting Capacity (kA Symmetrical Amperes)					
		Volts AC (50/60 Hz)				Volts DC ④	
		220, 240	380, 415	440	500	125	250 ⑤⑥
ED	2, 3	65	—	—	—	10	—
EDH	2, 3	100	—	—	—	10	—
EDC	2, 3	200	—	—	—	10	—
FDB	2, 3, 4	18	14	14	14	—	10
FD	1	25	—	—	—	10	—
	2, 3, 4	65	35	35	18	—	10
HFD	1	65	—	—	—	10	—
	2, 3, 4	100	65	65	25	—	22
FDC	2, 3, 4	200	100	100	35	—	22

④ DC ratings apply to substantially non-inductive circuits.
⑤ 2-pole circuit breaker, or two poles of 3-pole circuit breaker.
⑥ Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 22 kA.

12

Dimensions/Weights

Table 12-27. Dimensions in Inches (mm)

Number of Poles	Width	Height	Depth
1	1.38 (35.1)	6.00 (152.4)	3.38 (86.0)
2	2.75 (70.0)	6.00 (152.4)	3.38 (86.0)
3	4.13 (105.0)	6.00 (152.4)	3.38 (86.0)
4	5.50 (139.7)	6.00 (152.4)	3.38 (86.0)

Table 12-28. Approximate Shipping Weight, Lbs. (kg)

Breaker Type	Number of Poles			
	1	2	3	4
ED, EDH, EDC	—	3 (1.4)	4.5 (2.0)	—
EHD, FDB, FD, HFD, FDC	2 (.9)	3 (1.4)	4.5 (2.0)	6 (2.7)

Product Selection

This information is presented only as an aid to understanding Catalog Numbers. It is not to be used to build Catalog Numbers for circuit breakers or trip units.

Table 12-29. Circuit Breaker Catalog Numbering System

FDC 3 100 L

Circuit Breaker Type	Number of Poles	Trip Amperes	Suffix
EHD	1 = 1 Pole	010	E = 100% Protected (4-Pole only) Neutral Pole
FDB	2 = 2 Poles	015	EH = 50% Protected (4-Pole only)
FD	3 = 3 Poles	020	K = High Magnetic Molded Case Switch
HFD	4 = 4 Poles	025	L = Line and Load Terminals
FDC		030	S = Stainless Steel Terminals
		035	V = 50°C Calibration
		040	W = Without Terminals
		045	Y = Line Terminals Only
		050	Z = Aluminum Terminals (≤ 100 Amperes)
		060	
		070	
		080	
		090	
		100	
		110	
		125	
		150	
		175 (FD, HFD, FDC, 2-, 3-, 4-Pole Only)	
		200 (FD, HFD, FDC, 2-, 3-, 4-Pole Only)	
		225 (FD, HFD, FDC, 2-, 3-, 4-Pole Only)	

EDC 3 200 L

Circuit Breaker Type	Number of Poles	Trip Amperes	Suffix
ED	2 = 2-Pole	100	L = Line and Load Terminals
EDH	3 = 3-Pole	125	W = Without Terminals
EDC		150	Y = Line Terminals Only
		175	Z = Aluminum Terminals (100 Amperes)
		200	
		225	

Product Selection

Table 12-30. Types ED, EDH and EDC Thermal-Magnetic Circuit Breakers with Non-interchangeable Trip Units Suitable for Reverse Feed

Maximum Continuous Ampere Rating at 40°C	240V AC Maximum, 125V DC (Includes Terminals on Load End Only)											
	65 kAIC at 240V AC				100 kAIC at 240V AC				200 kAIC at 240V AC			
	Type ED				Type EDH				Type EDC Current Limiting			
	2-Pole		3-Pole		2-Pole		3-Pole		2-Pole		3-Pole	
	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $
100	ED2100	357.	ED3100	885.	EDH2100	850.	EDH3100	1,280.	EDC2100	1,200.	EDC3100	1,655.
125	ED2125	357.	ED3125	885.	EDH2125	850.	EDH3125	1,280.	EDC2125	1,200.	EDC3125	1,655.
150	ED2150	357.	ED3150	885.	EDH2150	850.	EDH3150	1,280.	EDC2150	1,200.	EDC3150	1,655.
175	ED2175	357.	ED3175	885.	EDH2175	850.	EDH3175	1,280.	EDC2175	1,200.	EDC3175	1,655.
200	ED2200	357.	ED3200	885.	EDH2200	850.	EDH3200	1,280.	EDC2200	1,200.	EDC3200	1,655.
225	ED2225	357.	ED3225	885.	EDH2225	850.	EDH3225	1,280.	EDC2225	1,200.	EDC3225	1,655.

Table 12-31. Type EHD Thermal-Magnetic Circuit Breakers with Non-interchangeable Trip Units

Maximum Continuous Ampere Rating at 40°C	277V AC Maximum, 125V DC		480V AC Maximum, 250V DC			
	14 kAIC at 277V AC		14 kAIC at 480V AC			
	Type EHD (Includes Terminals on Load End Only)					
	1-Pole		2-Pole		3-Pole	
	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $
10 ①	EHD1010	123.	EHD2010	387.	EHD3010	498.
15	EHD1015 ②	123.	EHD2015	387.	EHD3015	498.
20	EHD1020 ②	123.	EHD2020	387.	EHD3020	498.
25	EHD1025	123.	EHD2025	387.	EHD3025	498.
30	EHD1030	123.	EHD2030	387.	EHD3030	498.
35	EHD1035	123.	EHD2035	387.	EHD3035	498.
40	EHD1040	123.	EHD2040	387.	EHD3040	498.
45	EHD1045	123.	EHD2045	387.	EHD3045	498.
50	EHD1050	123.	EHD2050	387.	EHD3050	498.
60	EHD1060	123.	EHD2060	387.	EHD3060	498.
70	EHD1070	238.	EHD2070	505.	EHD3070	600.
80	EHD1080	238.	EHD2080	505.	EHD3080	600.
90	EHD1090	238.	EHD2090	505.	EHD3090	600.
100	EHD1100	238.	EHD2100	505.	EHD3100	600.

① Not UL listed. 5 kAIC interrupting rating.
② UL listed for SWD applications, see NEC Article 240-83(d).

12

Discount Symbol CB-2

Table 12-32. Type FD Thermal-Magnetic Circuit Breakers with Non-interchangeable Trip Units

Max. Cont. Ampere Rating at 40°C	600V AC Maximum, 250V DC						277V AC Maximum, 125V DC		600V AC Maximum, 250V DC					
	14 kAIC at 600V AC						25 kAIC at 277V AC		25 kAIC at 480V AC					
	Type FDB (Includes Terminals on Load End Only)						Type FD (Includes Terminals on Load End Only)							
	2-Pole		3-Pole		4-Pole		1-Pole		2-Pole		3-Pole		4-Pole	
	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $
10 ①	FDB2010	435.	FDB3010	570.	FDB4010	910.	FD1010	299.	—	—	—	—	—	—
15	FDB2015	435.	FDB3015	570.	FDB4015	910.	FD1015 ②	299.	FD2015	735.	FD3015	865.	FD4015	1,360.
20	FDB2020	435.	FDB3020	570.	FDB4020	910.	FD1020 ②	299.	FD2020	735.	FD3020	865.	FD4020	1,360.
25	FDB2025	435.	FDB3025	570.	FDB4025	910.	FD1025	299.	FD2025	735.	FD3025	865.	FD4025	1,360.
30	FDB2030	435.	FDB3030	570.	FDB4030	910.	FD1030	299.	FD2030	735.	FD3030	865.	FD4030	1,360.
35	FDB2035	435.	FDB3035	570.	FDB4035	910.	FD1035	299.	FD2035	735.	FD3035	865.	FD4035	1,360.
40	FDB2040	435.	FDB3040	570.	FDB4040	910.	FD1040	299.	FD2040	735.	FD3040	865.	FD4040	1,360.
45	FDB2045	393.	FDB3045	570.	FDB4045	910.	FD1045	299.	FD2045	735.	FD3045	865.	FD4045	1,360.
50	FDB2050	435.	FDB3050	570.	FDB4050	910.	FD1050	299.	FD2050	735.	FD3050	865.	FD4050	1,360.
60	FDB2060	435.	FDB3060	570.	FDB4060	1,110.	FD1060	299.	FD2060	735.	FD3060	865.	FD4060	1,360.
70	FDB2070	565.	FDB3070	695.	FDB4070	1,110.	FD1070	335.	FD2070	855.	FD3070	975.	FD4070	1,495.
80	FDB2080	565.	FDB3080	695.	FDB4080	1,110.	FD1080	335.	FD2080	855.	FD3080	975.	FD4080	1,495.
90	FDB2090	565.	FDB3090	695.	FDB4090	1,110.	FD1090	335.	FD2090	855.	FD3090	975.	FD4090	1,495.
100	FDB2100	565.	FDB3100	695.	FDB4100	1,110.	FD1100	335.	FD2100	855.	FD3100	975.	FD4100	1,495.
110	FDB2110	1,260.	FDB3110	1,565.	FDB4110	2,495.	FD1110	760.	FD2110	1,915.	FD3110	2,205.	FD4110	3,080.
125	FDB2125	1,260.	FDB3125	1,565.	FDB4125	2,495.	FD1125	760.	FD2125	1,915.	FD3125	2,205.	FD4125	3,080.
150	FDB2150	1,260.	FDB3150	1,565.	FDB4150	2,495.	FD1150	760.	FD2150	1,915.	FD3150	2,205.	FD4150	3,080.
175	—	—	—	—	—	—	—	—	FD2175	1,920.	FD3175	2,205.	FD4175	3,080.
200	—	—	—	—	—	—	—	—	FD2200	1,920.	FD3200	2,205.	FD4200	3,080.
225	—	—	—	—	—	—	—	—	FD2225	1,920.	FD3225	2,205.	FD4225	3,080.

① Not UL listed. 5 kAIC interrupting rating.
② UL listed for SWD applications, see NEC Article 240-83(d).

Table 12-33. Types HFD and FDC Thermal-Magnetic Circuit Breakers with Non-interchangeable Trip Units

Max. Cont. Ampere Rating at 40°C	277V AC Maximum, 125V DC		600V AC Maximum, 250V DC						600V AC Maximum, 250V DC					
	65 kAIC at 277V AC		65 kAIC at 480V AC						100 kAIC at 480V AC					
	Type HFD (Includes Terminals on Load End Only)								Type FDC Current Limiting (Includes Terminals on Load End Only)					
	1-Pole		2-Pole		3-Pole		4-Pole		2-Pole		3-Pole		4-Pole	
	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $
15	HFD1015 ③	366.	HFD2015	885.	HFD3015	1,140.	HFD4015	1,940.	FDC2015	1,325.	FDC3015	1,710.	FDC4015	2,910.
20	HFD1020 ③	366.	HFD2020	885.	HFD3020	1,140.	HFD4020	1,940.	FDC2020	1,325.	FDC3020	1,710.	FDC4020	2,910.
25	HFD1025	366.	HFD2025	885.	HFD3025	1,140.	HFD4025	1,940.	FDC2025	1,325.	FDC3025	1,710.	FDC4025	2,910.
30	HFD1030	366.	HFD2030	885.	HFD3030	1,140.	HFD4030	1,940.	FDC2030	1,325.	FDC3030	1,710.	FDC4030	2,910.
35	HFD1035	366.	HFD2035	885.	HFD3035	1,140.	HFD4035	1,940.	FDC2035	1,325.	FDC3035	1,710.	FDC4035	2,910.
40	HFD1040	366.	HFD2040	885.	HFD3040	1,140.	HFD4040	1,940.	FDC2040	1,325.	FDC3040	1,710.	FDC4040	2,910.
45	HFD1045	366.	HFD2045	885.	HFD3045	1,140.	HFD4045	1,940.	FDC2045	1,325.	FDC3045	1,710.	FDC4045	2,910.
50	HFD1050	366.	HFD2050	885.	HFD3050	1,140.	HFD4050	1,940.	FDC2050	1,325.	FDC3050	1,710.	FDC4050	2,910.
60	HFD1060	366.	HFD2060	885.	HFD3060	1,140.	HFD4060	1,940.	FDC2060	1,325.	FDC3060	1,710.	FDC4060	2,910.
70	HFD1070	427.	HFD2070	1,130.	HFD3070	1,400.	HFD4070	2,445.	FDC2070	1,690.	FDC3070	2,095.	FDC4070	3,600.
80	HFD1080	427.	HFD2080	1,130.	HFD3080	1,400.	HFD4080	2,445.	FDC2080	1,690.	FDC3080	2,095.	FDC4080	3,600.
90	HFD1090	428.	HFD2090	1,130.	HFD3090	1,400.	HFD4090	2,445.	FDC2090	1,690.	FDC3090	2,095.	FDC4090	3,600.
100	HFD1100	427.	HFD2100	1,130.	HFD3100	1,400.	HFD4100	2,445.	FDC2100	1,690.	FDC3100	2,095.	FDC4100	3,600.
110	HFD1110	1,001.	HFD2110	2,510.	HFD3110	3,120.	HFD4110	4,405.	FDC2110	3,780.	FDC3110	4,685.	FDC4110	6,610.
125	HFD1125	1,001.	HFD2125	2,510.	HFD3125	3,120.	HFD4125	4,405.	FDC2125	3,780.	FDC3125	4,685.	FDC4125	6,610.
150	HFD1150	1,005.	HFD2150	2,510.	HFD3150	3,120.	HFD4150	4,405.	FDC2150	3,780.	FDC3150	4,685.	FDC4150	6,610.
175	—	—	HFD2175	2,720.	HFD3175	3,120.	HFD4175	4,370.	FDC2175	3,780.	FDC3175	4,685.	FDC4175	6,610.
200	—	—	HFD2200	2,720.	HFD3200	3,120.	HFD4200	4,370.	FDC2200	3,780.	FDC3200	4,685.	FDC4200	6,610.
225	—	—	HFD2225	2,720.	HFD3225	3,120.	HFD4225	4,370.	FDC2225	3,780.	FDC3225	4,685.	FDC4225	6,610.

③ UL listed for SWD applications, see NEC Article 240-83(d).

Discount Symbol CB-1

Molded Case Switches

Molded Case Switches are used as compact switches in applications requiring high current switching capabilities. Molded case switches are constructed of circuit breaker components and are of the high instantaneous automatic type. Molded case switches are listed in accordance with Underwriters Laboratories, Inc., Standard UL 1087.

Line and Load Terminals

Line and Load Terminals provide wire connecting capabilities for specific ranges of continuous current ratings and wire types. Except as noted, terminals comply with Underwriters Laboratories, Inc., Standards UL 486A and UL 486B. Unless otherwise specified, F-Frame circuit breakers are factory equipped with load terminals only.

Ordering Information

F-Frame circuit breakers and molded case switches have load terminals only as standard equipment. When standard line-end terminals (same as standard load-end terminals) are required, add Suffix **L** to the circuit breaker Catalog Number. When non-standard or optional line and/or load terminals are required, order by style number. Specify if factory installation is required.

Table 12-34. Molded Case Switches

Maximum Continuous Ampere Rating at 40°C	Complete Circuit Breaker with Load Side Terminals Only					
	480V AC Maximum, 250V DC		600V AC Maximum, 250V DC			
	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $	Catalog Number	Price U.S. $
2-Pole						
100	**EHD2100K**	476.00	**FD2100K**	535.00	**HFD2100K**	635.00
150	—	—	**FD2150K**	1,135.00	**HFD2150K**	1,175.00
225	—	—	**FD2225K**	1,135.00	**HFD2225K**	1,175.00
3-Pole						
100	**EHD3100K**	570.00	**FD3100K**	665.00	**HFD3100K**	955.00
150	—	—	**FD3150K**	1,240.00	**HFD3150K**	1,780.00
225	—	—	**FD3225K**	1,240.00	**HFD3225K**	1,780.00
4-Pole						
100	—	—	**FD4100K**	930.00	**HFD4100K**	1,335.00
150	—	—	**FD4150K**	1,665.00	**HFD4150K**	2,280.00
225	—	—	**FD4225K**	1,665.00	**HFD4225K**	2,280.00

Note: Molded Case Switches may open above 1800 amperes.

Table 12-35. Line and Load Terminals

Maximum Breaker Amperes	Terminal Body Material	Wire Type	AWG Wire Range	Metric Wire Range mm^2	Package of 3 Terminals	
					Catalog Number	Price U.S. $
Standard Pressure Type Terminals						
20 (EHD)	Steel	Cu/Al	14 – 10	2.5 – 4	**3T20FB** ①	6.10
100	Steel	Cu/Al	14 – 1/0	2.5 – 50	**3T100FB**	6.10
225	Aluminum	Cu/Al	14 – 4/0	25 – 95	**3TA225FD**	89.00
Optional Pressure Terminals						
50	Aluminum	Cu/Al	14 – 4	2.5 – 25	**3TA50FB** ①	6.10
100	Aluminum	Cu/Al	14 – 1/0	2.5 – 50	**3TA100FD**	6.10
200	Stainless Steel	Cu	4 – 4/0	25 – 95	**3T150FB**	25.00
225	Aluminum	Cu/Al	6 – 300 kcmil	16 – 150	**3TA225FDK** ②	89.00

① Not for use with ED, EDH, EDC breakers.

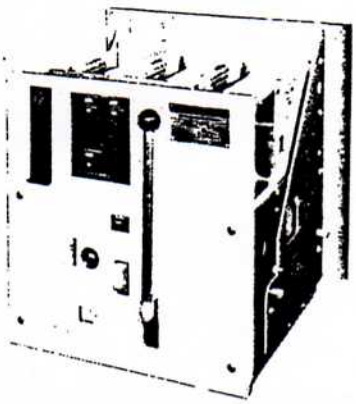
② Includes terminal shield kit. Adds approximately 3 inches (76.2) to breaker height. Available for use on 3-pole breaker only.

Circuit Breakers
DS Low Voltage Power

Fixed Switchboard Type
600 Volts Ac

Application
DS De-ion® Air Current Breakers are designed for the control and protection of low voltage Ac power distribution systems in industrial plants and electric utility auxiliaries.

They are available in five basic sizes of 2 or 3 pole design with current rating from 50 to 4000 amps for Ac applications.



Complete DS 3-Pole Breakers
With Standard Ampere Rating, Switchboard (Fixed) Type

Breaker Type	Standard Ampere Ratings
DS-206	50, 100, 150, 200, 300, 400, 600, 800
DS-416	100, 150, 200, 300, 400 600, 800, 1200, 1600
DS-420	100, 150, 200, 300, 400 600, 800, 1200, 1600, 2000
DS-632	2400, 3200
DS-840	4000

Modifications (Attachments)
Short time delay
Shunt trip attachment for manually operated breakers
Undervoltage Trip (instantaneous) or self resetting (delayed) (non-adjustable)
Auxiliary switch (4 circuit)
Overcurrent trip switch
Portable test kit
Operation counter
Ground fault tripping (3-wire system)①
Ground fault tripping (4-wire) includes neutral sensor CT for separate mounting by user①
UL labels
Electric lockout for manual breaker

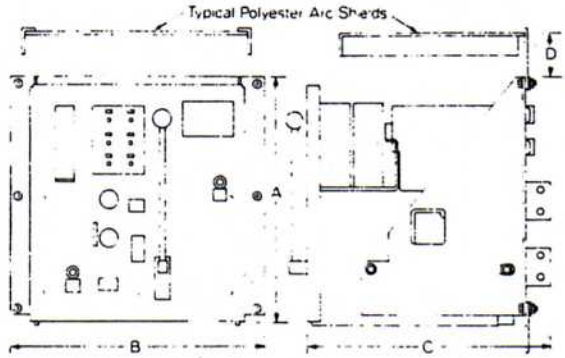
Standard Control Voltages
Dc: 48, 125, 250
Ac: 120, 240

① Amptector IA and necessary additions must be included. Amptector IIA not applicable when ground fault protection is required.

Standard Ratings of Type DS Low Voltage Air Circuit Breakers

Breaker Type DS	206	416	420	632	840
Continuous Current Amperes	800	1600	2000	3200	4000
Temperature Rise 00°C. Max.	85	85	85	85	85
600V 60 Hz Fully Rated Breaker (Amps Sym)	30,000	42,000	50,000	65,000	85,000
600V 60 Hz Selective Breaker (Amps Sym)	30,000	42,000	50,000	65,000	85,000
480V 60 Hz Fully Rated Breaker (Amps Sym)	30,000	50,000	65,000	65,000	85,000
480V 60 Hz Selective Breaker (Amps Sym)	30,000	50,000	65,000	65,000	85,000
240V 60 Hz Fully Rated Breaker (Amps Sym)	42,000	65,000	65,000	85,000	130,000
240V 60 Hz Selective Breaker (Amps Sym)	30,000	50,000	65,000	65,000	85,000

Dimensions in Inches: DS Switchboard Type (Fixed) Breaker



Type	Dimension A	B	C	D
DS-206	19.87	20.00	19.61	2.45
DS-416	19.87	20.00	19.61	2.45
DS-420	19.87	20.00	19.61	2.45
DS-632	27.25	20.00	22.30	10.00
DS-840	29.56	29.75	26.42	5.81

Specifying Information

Item	Choice of Specification
Circuit Breakers	
Type	DS-206, DS-416, DS-420, DS-632, DS-840
Number of poles	3
Type of mounting	Switchboard (fixed)
Operation	Manual or electric stored energy If electrical, specify control voltage, dc or ac, and frequency
Circuit or service	Voltage, (50 or 60 hertz) 600 volts ac max.
Sensor rating	See Table of Standard Ampere Ratings
Type of trip	Specify LI, LS or LSI. Also indicate if ground fault protection is required. (3 or 4 wire)
Optional Attachments	
Shunt trip (on manually operated breaker)	Specify control voltage, dc or ac and frequency
Undervoltage trip	Instantaneous or delayed, specify control voltage, dc or ac and frequency
Additional auxiliary switch	Specify number of "a" and "b" circuits a: closed when breaker is closed b: open when breaker is closed Note: All electrically operated breakers are supplied with one 4-circuit auxiliary switch (with two "a" and two "b" circuits)
Over-current trip switch	Manually or electrically reset
Electrical lockout	Specify voltage or potential coil
UL Listed Label	Specify if required at time of order entry

Further Information
Description: Descriptive Bulletin 32-850
Prices: Price List 33-821
Application: Application Data 32-860

SECCION 8– SISTEMA DE DISPARO AUTOMATICO DEL INTERRUPTOR DE CIRCUITOS.

8.0 GENERAL.

El interruptor de circuitos se dispara en condiciones de sobrecarga y de cortocircuito por las acciones combinadas de tres componentes:

1.- Los sensores que determinan el nivel de corriente.

2.- La unidad de disparo Amptector, de estado sólido, que ofrece una señal de disparo cuando se alcanzan niveles de corriente predeterminados.

3.- El actuador, que es en realidad el que dispara el interruptor de circuitos.

Esquemáticamente esto se representa de la forma indicada en la figura 59. Esto ofrece un sistema muy flexible, que cubre una gran variedad de características de disparo. No solo es ajustable la unidad Amptector, pero los sensores son obtenibles para una gran variedad de clasificaciones de corriente.

Las características de sobrecarga y de disparo automático para una clasificación determinada de interruptor, según la clasificación del sensor, son determinadas por los ajustes de la unidad de disparo Amptector, de estado sólido. Esta unidad también suministra un impulso de corriente de disparo al actuador. De esta forma,

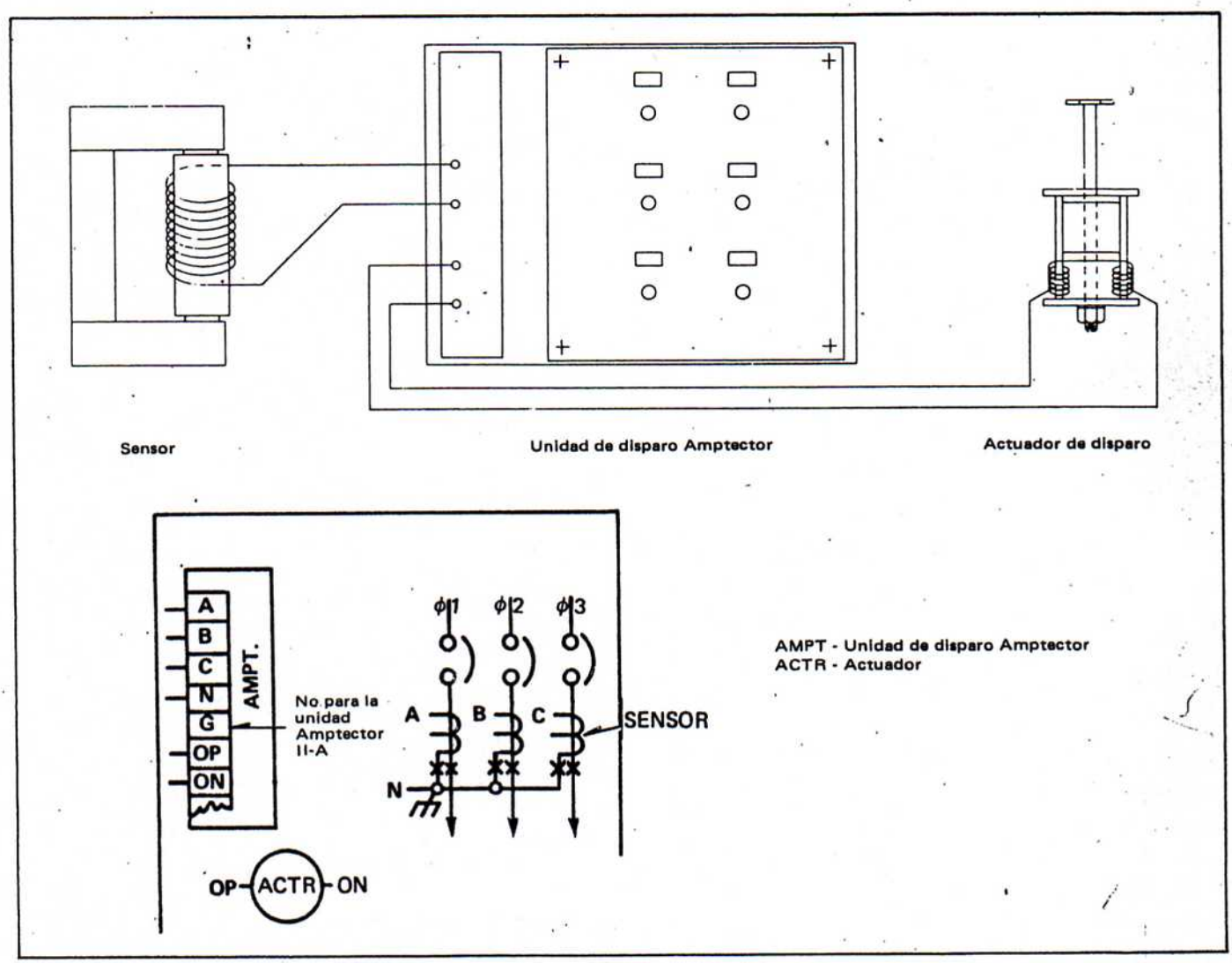


Figura 59. Ilustración esquemática del sistema de disparo

INSTRUCCIONES PARA INTERRUPTORES DE CIRCUITOS DE POTENCIA DE BAJO VOLTAJE TIPOS DS Y DSL

todas las funciones de disparo son ejecutadas por circuitos secundarios de control, sin acción mecánica o acción magnética directa entre la corriente primaria, y las partes mecánicas de disparo del interruptor.

Las unidades de disparo Amptector de estado sólido son obtenibles en dos versiones básicas; el Amptector II - A y Amptector I -A.

8.1. UNIDAD DE DISPARO AMPTECTOR II.

Se han efectuado innovaciones en el Amptector Westinghouse, y el modelo standard ahora es el Amptector II - A. Se incluyeron cambios en alambrado y terminales para ofrecer un método de prueba mediante un probador. Refiérase a la sección 8.7.6 para las pruebas con el equipo de prueba del Amptector.

Otro cambio que se efectuó fue el de modificar la larga curva de retardo a casi una función I^2T. La nueva curva muestra esta modificación. Véase la curva número 1.

El Amptector II - A es equipo standard para todos los interruptores de circuito DS y DSL. Ofrece aproximadamente funciones equivalentes a los aparatos de disparo electromagnéticos suministrados con algunos interruptores de circuito, pero con una capacidad de funcionamiento superior de los dispositivos de estado sólido. El Amptector I - A es un sistema de disparo opcional (de costo adicional) que puede ser suministrado cuando se requiera protección contra fallas a tierra, o indicadores de disparo. Ambas unidades de disparo tienen la misma confiabilidad y la capacidad de repetición inherentes en el diseño de estado sólido.

Como se muestra en la figura 5, la unidad Amptector se encuentra en la parte frontal superior del interruptor. La figura 60 muestra una vista detallada de la parte frontal de la unidad de disparo Amptector I I - A. Puede haber un total de cinco controles ajustables, ajustadas mediante un destornillador. Mediante estos controles se pueden ajustar las siguientes características:

1.- Enganche de corriente de largo retardo.
2.- Largo tiempo de retardo.
3.- Enganche de corriente de corto retardo.
4.- Corto tiempo de retardo.
5.- Enganche de corriente instantánea.

NOTA:

El término enganche según es utilizado en este caso es el valor rms de corriente al cual comienza la función de tiempo de la unidad Amptector o cuando se inicia el disparo instantáneo.

La figura 61 ilustra la unidad de disparo Amptector I I - A, sin la cubierta frontal, mostrando todas las marcas de calibración en los diales. Los rangos de los ajustes de corriente, en múltiples de clasificaciones de sensores y de retardo de tiempo son los siguientes:

1.- Enganche de largo retardo .5 a 1.25X clasificación del sensor.
2.- Retardo largo 8 a 36 seg. a 6X la clasificación del sensor.

Con estos rangos de disparo siempre ocurrirá dentro de la banda de tiempo indicada en la curva número 1, página 60. La parte inferior de la banda se denomina retardo ajustable. Si la sobrecarga disminuye en menos del tiempo de retardo reajustable, el reajuste de la unidad de disparo ocurrirá luego de unos ciclos, cuando la carga haya disminuído a menos del 90% del ajuste de enganche.

3.- Enganche de retardo corto 4 a 10X clasificación del sensor.
4.- Retardo corto .18 seg. a .50 seg. o 11 a 30 ciclos a 60 Hertz, a 2.5X ajuste de enganche.

Con estos rangos el disparo siempre ocurrirá dentro de la banda de tiempo indicada en la curva número 1, página 60, Aunque el ajuste de tiempo es contínuo, las tres bandas de tiempo son calibradas como se indica en la curva.

5.- Enganche instantáneo 4 a 12X clasificación del sensor.

Se provee tres combinaciones distintas de elementos de disparo. Estas combinaciones, con las designaciones correspondientes de modelos Amptector II - A, son las siguientes:

1.- Retardo largo instantáneo — Du (Dual)
2.- Retardo largo Retardo corto — SE (Selectivo)
3.- Retardo largo Retardo corto Instantáneo. — TR (Triple)

Cada unidad de disparo Amptector I I - A tiene un bloque de terminales accesible en el panel frontal del interruptor de circuitos.

La figura 59 muestra un diagrama de alambrado standard típico, el cual incluye el bloque de terminales de la unidad Amptector. La siguiente tabla explica las marcas de los terminales:

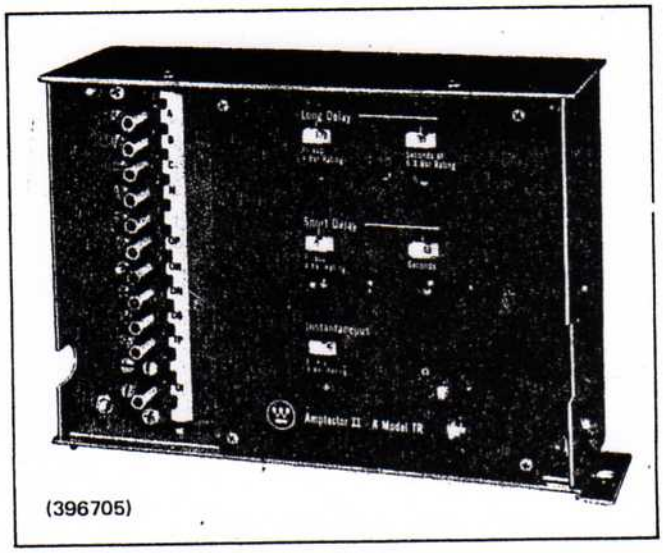
A	Fase sensor A	ON	Energía negativa*
B	Fase sensor B	DN	Punto de prueba (neutro interno)**
C	Fase sensor C	DS	Punto de prueba**
N	Sensor neutro	TP	Punto de prueba**
OP	Energía positiva	DI	Punto de prueba**

* A la bobina del actuador. ESTA BOBINA TIENE MARCA DE POLARIDAD SOBRE EL CONDUCTOR POSITIVO, LA CUAL DEBE SER OBSERVADA, DE OTRA FORMA, EL INTERRUPTOR NO TENDRA PROTECCION CONTRA SOBRECARGA O FALLA, Y PUEDE RESULTAR EN LESIONES CORPORALES Y/O EN DAÑOS SERIOS A LOS EQUIPOS.

** Los terminales marcados "Punto de prueba" tienen como función proveer conexiones para la operación del equipo de prueba.

8.2. UNIDAD DE DISPARO AMPTECTOR I - A.

Las unidades de disparo Amptector I - A cumplen con todas las funciones descritas anteriormente para las unidades de disparo Amptector Ii - A y ofrecen además lo siguiente:



(396705)

Figura 60. Unidad de disparo standard Amptector II-A, de estado sólido

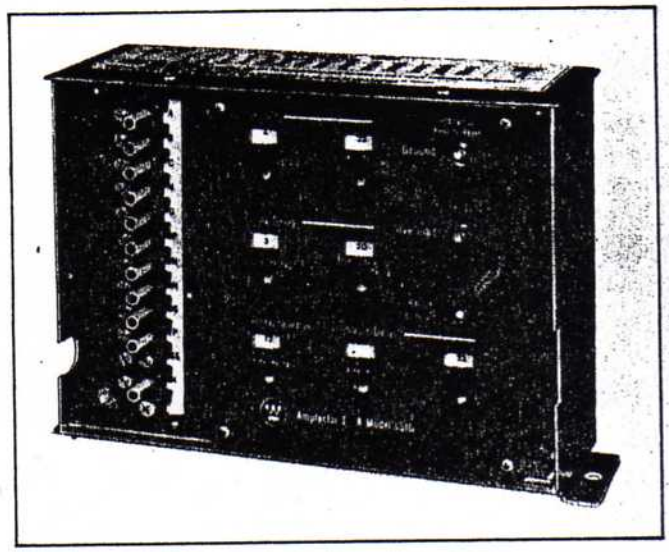


Figura 62. Unidad opcional Amptector I-A de estado sólido (396707)

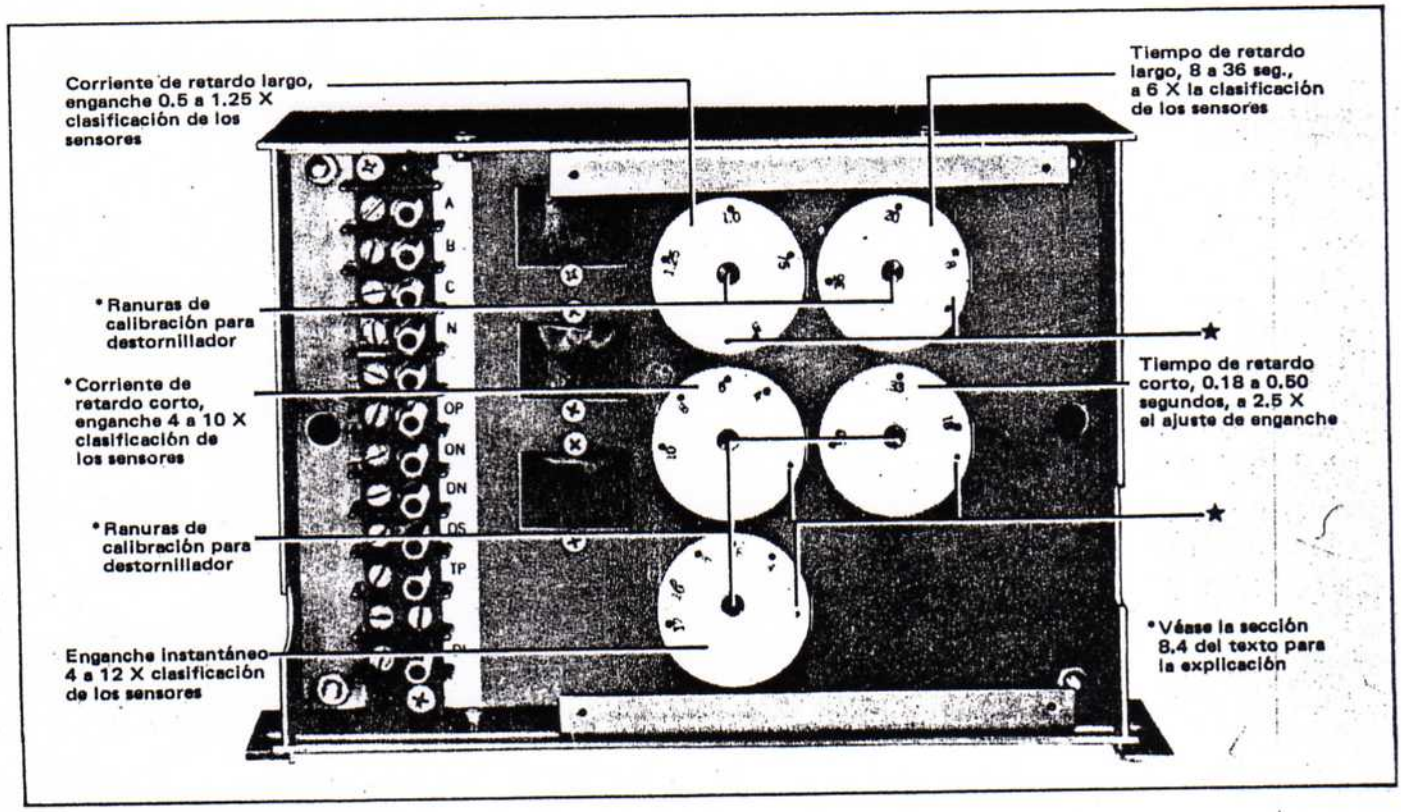


Figura 61. Unidad de disparo Amptector II-A, con la cubierta frontal removida (396704)

INSTRUCCIONES PARA INTERRUPTORES DE CIRCUITOS DE POTENCIA DE BAJO VOLTAJE TIPOS DS Y DSL

1— Ajuste opcional de protección de fallas a tierra, con indicador de operaciones reajustable.

2- Todos los Amptector I - A tienen un indicador de disparo que indica disparo de sobrecarga, y otro que indica disparo de cortocircuito. (todos los indicadores se reajustan manualmente).

La figura 62 muestra la parte frontal de la unidad Amptector I - A. Un máximo de siete controles ajustables, con ajuste de destornillador, se pueden suministrar para ajustar las siguientes características:

1.- Enganche de corriente de retardo largo.

2.- Tiempo de retardo largo

3.- Enganche de corriente de retardo corto.

4.- Tiempo de retardo corto

5.- Enganche de corriente instantánea

6.- Enganche de corriente de tierra.

7.- Tiempo de retardo de tierra.

La figura 63 es la unidad de disparo Amptector, sin el panel frontal, mostrando todas las marcas de calibración en los diales y los indicadores de disparo. Los rangos de los ajustes de corriente en múltiples de clasificación de sensores y de tiempo de retardo son los siguientes:

1.- Tiempo de retardo largo
.5 a 125X clasificación del sensor

2.- Retardo largo
4 a 36 seg., a 6X clasificación del sensor

Con estos rangos el disparo siempre ocurrirá dentro de la banda de tiempo indicada en la curva número 2, página 61. La parte inferior de la banda se denomina retardo reajustable. Si disminuye la sobrecarga antes del tiempo de retardo reajustable, ocurrirá el reajuste de la unidad de disparo Amptector, luego de unos ciclos después de que la carga haya disminuído a menos del 90% del ajuste de enganche.

3.- Enganche de retardo corto
4 a 10X clasificación del sensor

4.- Retardo corto
.18 seg. a .50 seg. o 11 a 30 ciclos a 60 Hertz, a 2.5X ajuste de enganche.

Con estos rangos el disparo siempre ocurrirá dentro de la banda de tiempo indicada en la curva número 2, en la página 61. Aunque el ajuste de tiempo es continuo las tres bandas de tiempo son calibradas como se muestra en la curva.

5.- Enganche instantáneo
4 a 12X clasificación del sensor

6.- Enganche de corriente de tierra
Véase la tabla sobre la unidad de disparo o la curva número 2.

7.- Tiempo de retardo a tierra
.22 a .50 segundos, 13 a 30 ciclos a 60 Hz.

Se suministran seis distintas combinaciones de los elementos de disparo mencionados anteriormente. Estas combinaciones con las designaciones correspondientes de modelos Amptector I - A son las siguientes:

1.-	Retardo largo instantáneo	LI
2.-	Retardo largo instantáneo aterrado	LIG
3.-	Retardo largo retardo corto	LS

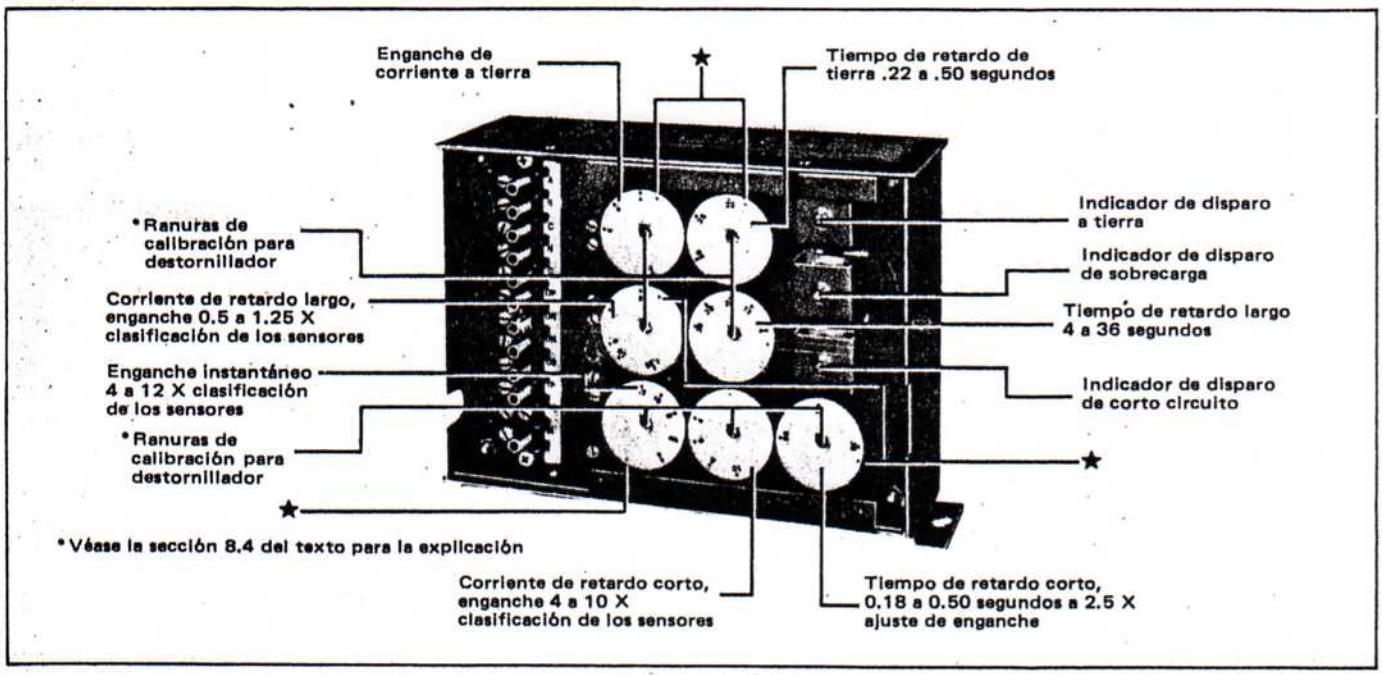
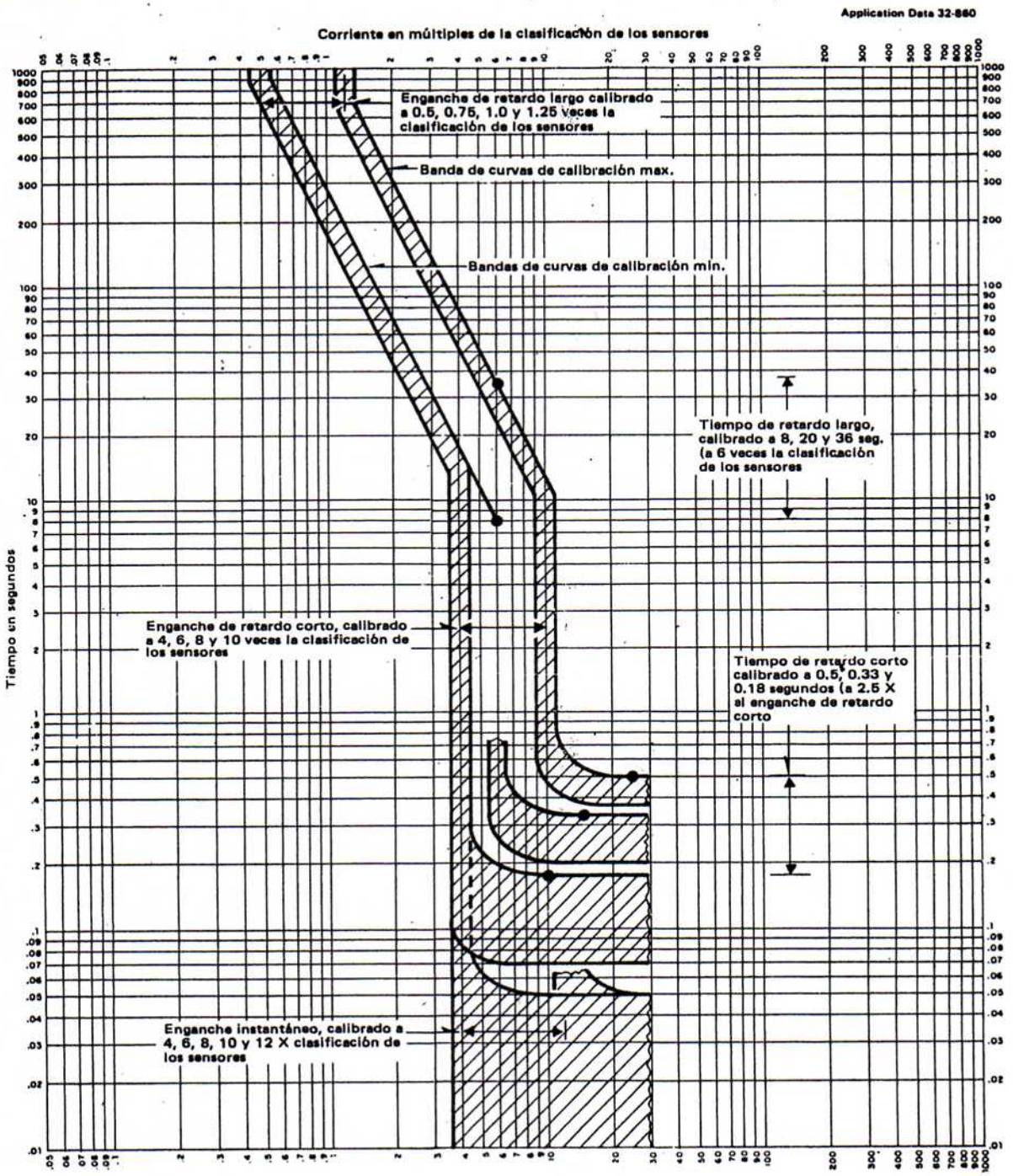


Figura 63. Unidad de disparo Amptector I-A con cubierta frontal removida (396706)

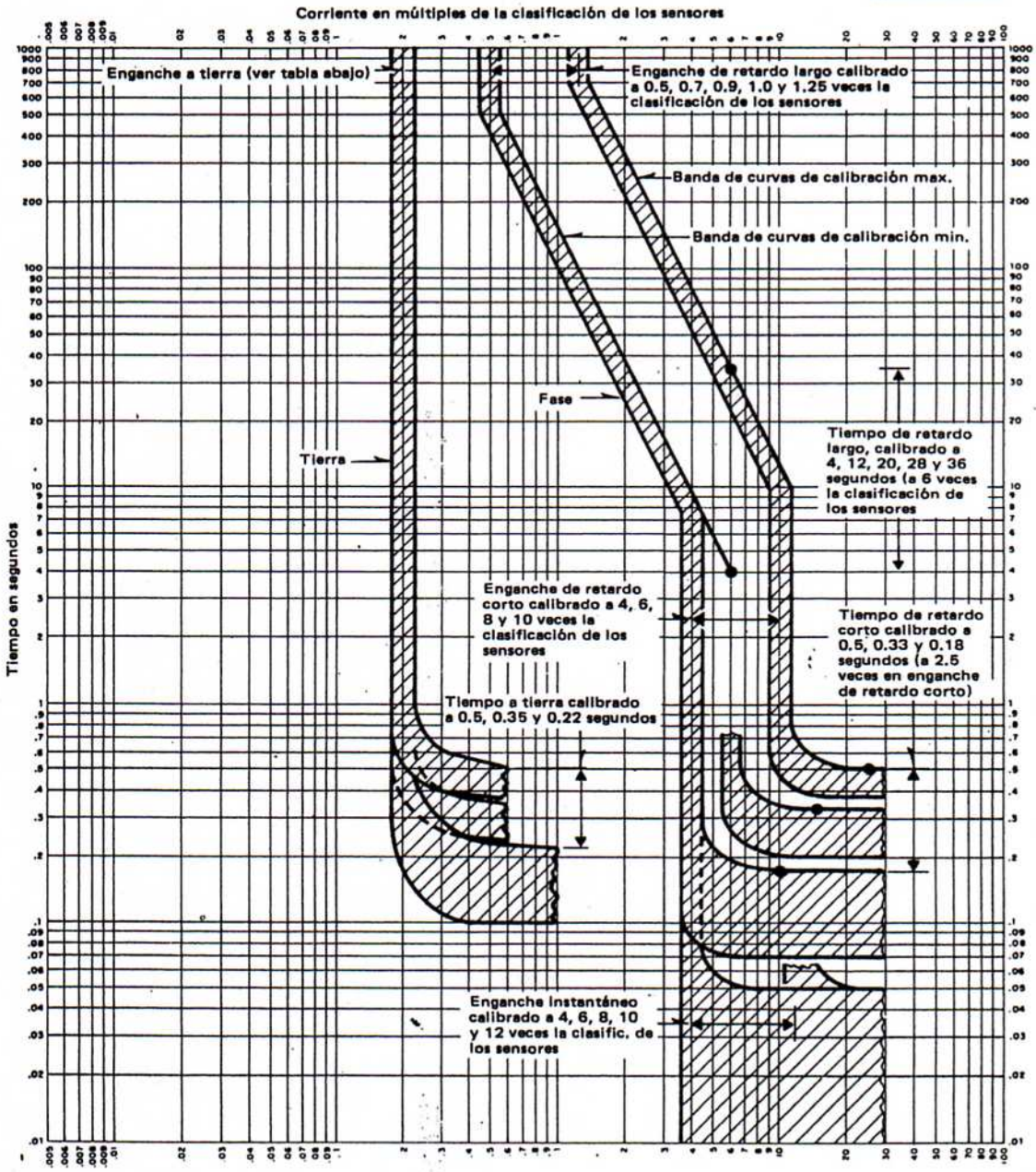
CURVA No. 1. Amptector II-A - Características de tiempo-corriente



INSTRUCCIONES PARA INTERRUPTORES DE CIRCUITOS DE POTENCIA DE BAJO VOLTAJE TIPOS DS Y DSL

CURVA No. 2. Amptector I-A - Características de tiempo-corriente

Application Data 32-880



Amptector I-A

Valor de enganche a tierra - Amperios															
Ajuste del dial	Clasificación de los sensores														Corr. secund. ①
	50	100	150	200	300	400	600	800	1200	1600	2000	2400	3200	4000	
A	13	57	60	85	80	110	145	180	260	330	400	530	640	800	1 0
B	18	67	75	85	110	150	205	260	385	505	600	770	1000	1200	1 5
C	27	75	85	100	130	185	250	325	480	625	760	960	1200	N A	1 9
D	33	100	120	145	200	270	385	500	730	970	1200	N A	N A	N A	3 0

Todos los valores de enganche pueden variar ± 10%

① La corriente de este valor desde el secundario de un transformador externo causará que funcione el elemento de aterramiento. El enganche del elemento de tierra también puede ser probado utilizando este valor. Todos los sensores deben estar desconectados durante pruebas.

4.- Retardo largo
retardo corto aterrado LSG

5.- Retardo largo
retardo corto instantáneo
aterrado LSIG

6.- Retardo largo
retardo corto
instantáneo LSI

Cada unidad de disparo Amptector I - A tiene un bloque de terminales equipado con terminales de enchufe de prueba, accesible en el panel frontal del interruptor de circuitos. Esto permite la inspección en el campo, de las calibraciones y de la operación utilizando un suministro de energía externa.

Puede obtenerse un equipo de prueba de suministro de energía, especialmente diseñado con enchufes que corresponden con los terminales de enchufe de prueba de la unidad de disparo Amptector; y su operación se describe en la sección 8.7.6 de este folleto de instrucciones.

La figura 59 muestra un diagrama de alambrado standard, que incluye el bloque de terminales de la unidad de disparo Amptector. La siguiente tabla explica las marcas en los terminales:

A Fase sensor A
B Fase sensor B
C Fase sensor C
N Sensor neutro
G Aterrado
OP Energía positiva*
ON Energía negativa*
DN Punto de prueba (neutro interno)*
DS Punto de prueba**
TP Punto de prueba**
OSS Señal de sobrecarga del suiche de la unidad auxiliar
DI Punto de prueba*

* A la bobina del actuador. ESTA BOBINA TIENE MARCA DE POLARIDAD SOBRE EL CONDUCTOR POSITIVO, LA CUAL DEBE OBSERVARSE. DE OTRA FORMA, EL INTERRUPTOR NO TENDRA PROTECCION CONTRA SOBRECARGAS O FALLAS, LO QUE PUEDE RESULTAR EN LESIONES CORPORALES Y/O DAÑOS SEVEROS A LOS EQUIPOS.

** Los terminales marcados "punto de prueba" tienen como función proveer conexiones para la operación del equipo de prueba.

8.2.1. Protección de fallas a Tierra.

Cuando la unidad de disparo Amptector I - A incluye protección de corriente a tierra, debe ser considerado el tipo de conexión al circuito. Si el neutro del sistema se encuentra aterrado pero el neutro no es conducido con los conductores de fases, la unidad de disparo tiene todo el equipo necesario para la sensitiva protección de tierras.

Si el neutro del sistema se encuentra aterrado, y se lleva un conductor neutro con los conductores de fases, es necesario pedir un sensor adicional, para el propósito de cancelar cualquier corriente residual en los conductores de fase.

Este sensor debe ser montado por separado, y debe ser localizado sobre el conducto de neutro en el punto donde éste se conecta a la barra colectora de neutro. Estos sensores son duplicados de los que se suministran en el interruptor, excepto para las clasificaciones de 2400A y 3200A, en los cuales se requiere un sensor neutral modificado.

El elemento de tierra de la unidad de disparo Amptector puede ser energizado desde una fuente externa de corriente a tierra, en lugar de una corriente a tierra desarrollada internamente. Dicha fuente externa puede ser un transformador tipo anillo a través del cual pasarían todos los conductores de corriente de carga. En el caso de un circuito trifásico de cuatro alambres, los tres conductores de fase y los conductores neutros tendrían que pasar por el transformador. La sensibilidad del elemento a tierra para este tipo de disposición dependería de la relación del transformador utilizado.

El dial de enganche de corriente a tierra en la unidad de disparo Amptector I - A tiene marcas calibradas alfabéticamente. La corriente a tierra real correspondiendo a estos puntos calibrados varía con la clasificación del sensor que se utilice. Estos valores de enganche están imprimidos sobre la caja de la unidad de disparo. El "indicador de disparo a tierra" es un émbolo metálico localizado en la esquina derecha superior de la unidad de disparo. Si la unidad de disparo ha funcionado debido a una falla a tierra, el émbolo se extenderá a través de la placa frontal de la unidad. El indicador se reajusta al empujar hacia adentro el émbolo. Si no es reajustado antes de colocar en servicio nuevamente el interruptor, la unidad de disparo funcionará normalmente, pero permanecerá una indicación falsa.

INDICADOR DE DISPARO DE SOBRECARGA.

Funciona debido a corrientes de sobrecarga menores que el valor de retardo corto o enganche instantáneo.

INDICADOR DE DISPARO DE CORTOCIRCUITO.

Funciona debido a corriente de falla en exceso de retardo corto o de enganche instantáneo.

8.3. RELEVADOR DE CORRIENTE DE CONJUNCION (DESCRIMINADOR).

Todas las unidades de disparo Amptector que no tienen elementos de disparo instantáneo (modelo SE Amptector II - A, y los modelos LS y LSG Amptector I - A) tienen un relevador de corriente" de enganche al cual nos referimos como "Descriminador". Este es un circuito en la unidad de disparo que determina en el momento de una falla si ha habido o no un movimiento de corriente en el circuito primario antes de ocurrir la falla. Si no ha habido un movimiento de corriente mesurable previo a la falla, indicando que solamente se está cerrando el interruptor de circuitos (o posiblemente que se ha cerrado un mecanismo de cortocircuito antes del interruptor), y si el flujo de corriente primaria excede aproximadamente doce veces la clasificación de los sensores, la unidad de disparo funcionará instantáneamente. Si el circuito "descriminador" determina que ha habido un flujo de corriente mesurable antes de la falla, no ocurrirá la

INSTRUCCIONES PARA INTERRUPTORES DE CIRCUITOS DE POTENCIA DE BAJO VOLTAJE TIPOS DS Y DSL

operación instantánea y el elemento de tiempo corto de retardo se hará cargo para demorar el disparo. La función de este original concepto de disparo es que se puede mantener, si se hace necesario, la selectividad y la continuidad de servicio en las secciones sin falla en el sistema, pero si no hubiere en el circuito una carga operando previamente, la función instantánea se hace cargo para limitar el daño excesivo que puede ocurrir debido a una operación retardada de disparo.

8.4. SERVICIO DE LA UNIDAD DE DISPARO AMPTECTOR.

La unidad de disparo Amptector es la inteligencia de la protección de sobrecarga ofrecida por el interruptor. Es un mecanismo que posee muchos componentes de estado sólido. Como las únicas partes movibles son los ajustes, la unidad de disparo Amptector ofrecerá un largo servicio, libre de problemas. Todos los componentes y las conexiones incluyendo un circuito impreso son revestidos para ofrecer una protección ambiental efectiva.

AL CAMBIAR LOS AJUSTES DE LA UNIDAD DE DISPARO AMPTECTOR, LOS DIALES DEBEN SER MOVIDOS SOLAMENTE MEDIANTE EL USO DE UN DESTORNILLADOR PEQUEÑO QUE ES INTRODUCIDO EN LA PLACA FRONTAL DIRECTAMENTE DEBAJO DE LA VENTANILLA DE CALIBRACION. Los ejes nunca deben ser girados aplicándoles torque directamente al dial, ya que el dial se ajusta al eje únicamente por fricción.

Si se sospecha que el dial se ha movido sobre su eje, puede verificarse al girar el eje en dirección contraria al reloj hasta su límite de recorrido. Un punto en el extremo de la calibración debe quedar alineado con la marca índice sobre la placa frontal. Véase el asterisco (*) en las figuras 61 y 63.

Si hay alguna razón para sospechar que la unidad de disparo Amptector no está funcionando correctamente, NO DEBE TOCARSE LA UNIDAD, YA QUE EL HURGAR CON EL PUEDE RESULTAR EN LA PERDIDA DE PROTECCION VITAL DE SOBRECORRIENTE.

NOTA:

La garantía de la unidad de disparo Amptector será nula si se comprueba que este fue violado.

Un probador especialmente diseñado es obtenible para verificar el funcionamiento de la unidad de disparo Amptector, sin utilizar corriente primaria. El probador puede ser enchufado en cualquier toma-corriente normal; y pasará suficiente corriente para verificar cualquier calibración de enganche. Las calibraciones de retardo de tiempo también pueden ser verificadas. Coloque los interruptores extraibles en posición desconectada antes de hacer la verificación de la unidad de disparo Amptector.

Son requeridos el manejo especial y los equipos de pruebas para efectuar servicio a los mecanismos de estado sólido. Si el uso del probador demuestra que la unidad de disparo Amptector no está funcionando correctamente, se recomienda utilizar una unidad de disparo Amptector de repuesto; y la devolución de la unidad bajo sospecha a la fábrica para su reparación.

8.5. ACTUADOR.

El actuador recibe un pulso de disparo de la unidad de disparo Amptector, y produce una fuerza mecánica que dispara el interruptor. Refiérase a las figuras 64,65 y 24 para la localización y los detalles. El actuador está hecho de un imán permanente, un disco sostenido por el imán, una vara sobre la cual actúa un resorte, una palanca para disparar el interruptor, y una palanca para reajustar mecánicamente el actuador. El imán no puede halar y reajustar el disco contra la fuerza del resorte actuando sobre la vara, pero puede sobreponerse a la fuerza del resorte cuando el disco está en contacto con la pieza polar del imán.

Un pulso de disparo de la unidad Amptector contrabalancea el efecto del imán permanente, permitiendo que el resorte separe el disco de la pieza polar del imán. Y así mover la vara para

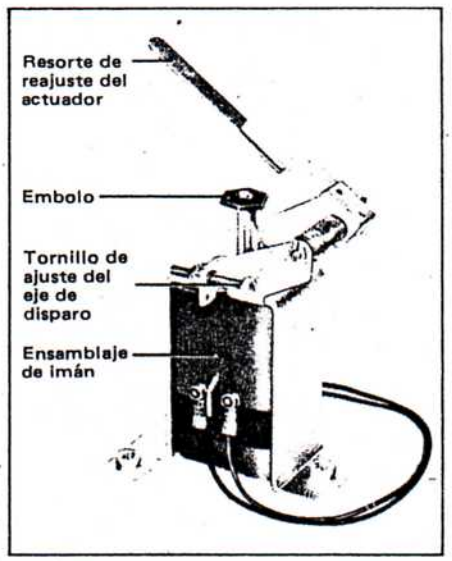


Figura 64. Actuador de disparo (391093)

actuar la palanca del eje de disparo. La palanca del eje de disparo hace girar el eje de disparo y dispara el interruptor. Al abrirse el interruptor, la clavija de la palanca de la unidad polar izquierda golpea el dedo de resorte ajustado a la palanca de reajuste; esto ofrece la asistencia requerida para mover el disco lo suficiente para cerrar el espacio de aire entre él y el imán permanente contra la fuerza de resorte. El mecanismo es reajustado cuando el disco entra en contacto con el imán. Si el disco no es reajustado completamente la palanca de disparo del eje mantendrá el mecanismo de interrupción en condición libre de disparo; y el interruptor no puede ser cerrado nuevamente.

El actuador debe ser reemplazado si no se mantiene reajustado cuando el émbolo es subido al extremo de su recorrido.

8.6. SENSORES.

Los tres sensores se localizan en la parte posterior del interruptor en los bornes inferiores, y directamente detrás de los contactos principales de desconexión. Refiérase a la figura 66. Ellos producen una energía de salida proporcional a la corriente de carga y suministran a la unidad de disparo

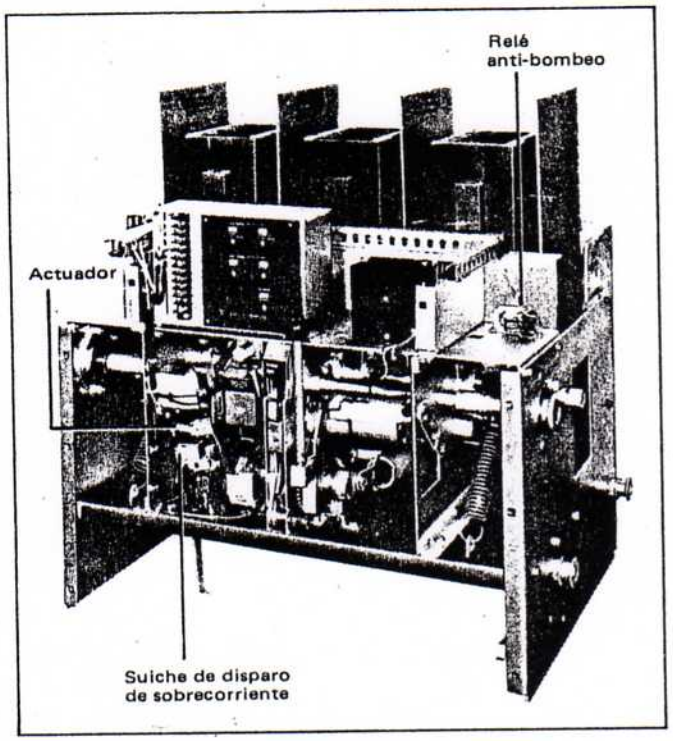


Figura 65. Interruptor DS-840 con el panel frontal removido. (391076)

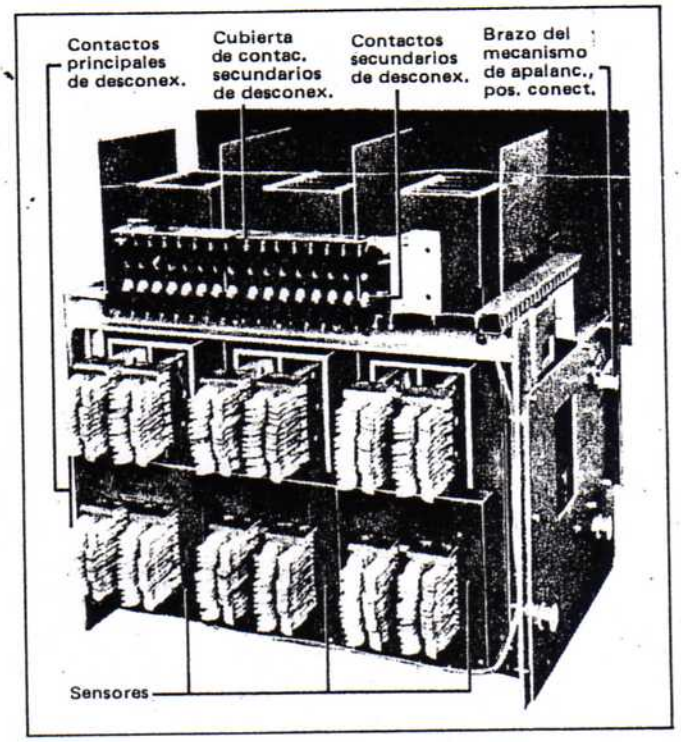


Figura 66. Interruptor DS-840. Vista posterior ilustrando los sensores. (391074)

Amptector la inteligencia y la energía para disparar el interruptor cuando se exceden las condiciones pre-seleccionadas de magnitud de corriente y de duración.

La clasificación de corriente contínua para cualquier tamaño de interruptor puede ser cambiado simplemente con cambiar los sensores. El gran alcance de enganche de corriente de largo tiempo de retardo disponible en la unidad de disparo Amptector hace que un grupo de sensores sea adecuado para un número de clasificaciones de corriente. Los controles de ajuste de la unidad de disparo Amptector son standard, y se pueden utilizar con cualquier sensor standard. Si se cambian los sensores por el cambio de condiciones de carga, etc., solamente es necesario reajustar los controles de la unidad de disparo Amptector a los nuevos valores deseados. Las clasificaciones de los sensores obtenibles se enumeran en la tabla 4.

TABLA 4. Tamaño del interruptor y clasificaciones de los sensores

Tipo de interruptor	Tamaño del armazón, amperios*	Clasificaciones de los sensores, amperios**
DS-206 ó DSL-206	800	50-100-150-200-300-400-600-800
DS-206S	800	100-150-200-300-400-600-800
DS-416, DSL-416 ó DS-416S	1600	100-150-200-300-400-600-800-1200-1600
DS-420	2000	100-150-200-300-400-600-800-1200-1600-2000
DS-632	3200	2400-3200
DS-840	4000	4000

*Clasificación de corriente contínua máxima para el interruptor.

**El valor de enganche de largo retardo de la unidad de disparo Amptector es ajustable desde un 50º/o a un 125º/o de la clasificación de los sensores, pero no debe ser ajustado más allá del 100º/o cuando se utiliza una clasificación de sensores igual al tamaño del armazón del interruptor.

8.7. ACCESORIOS OPCIONALES.

Además de ofrecer protección de sobrecargas mediante la unidad de disparo Amptector, los siguientes accesorios opcionales se suministran cuando sean necesarios.

8.7.1. Accesorio de Disparo de bajo voltaje.

El disparo de bajo voltaje ilustrado en la figura 67 es un mecanismo electromagnético que dispara el interruptor de circuitos cuando el voltaje de su bobina se reduce a un valor entre 30 y 60º/o del voltaje normal.

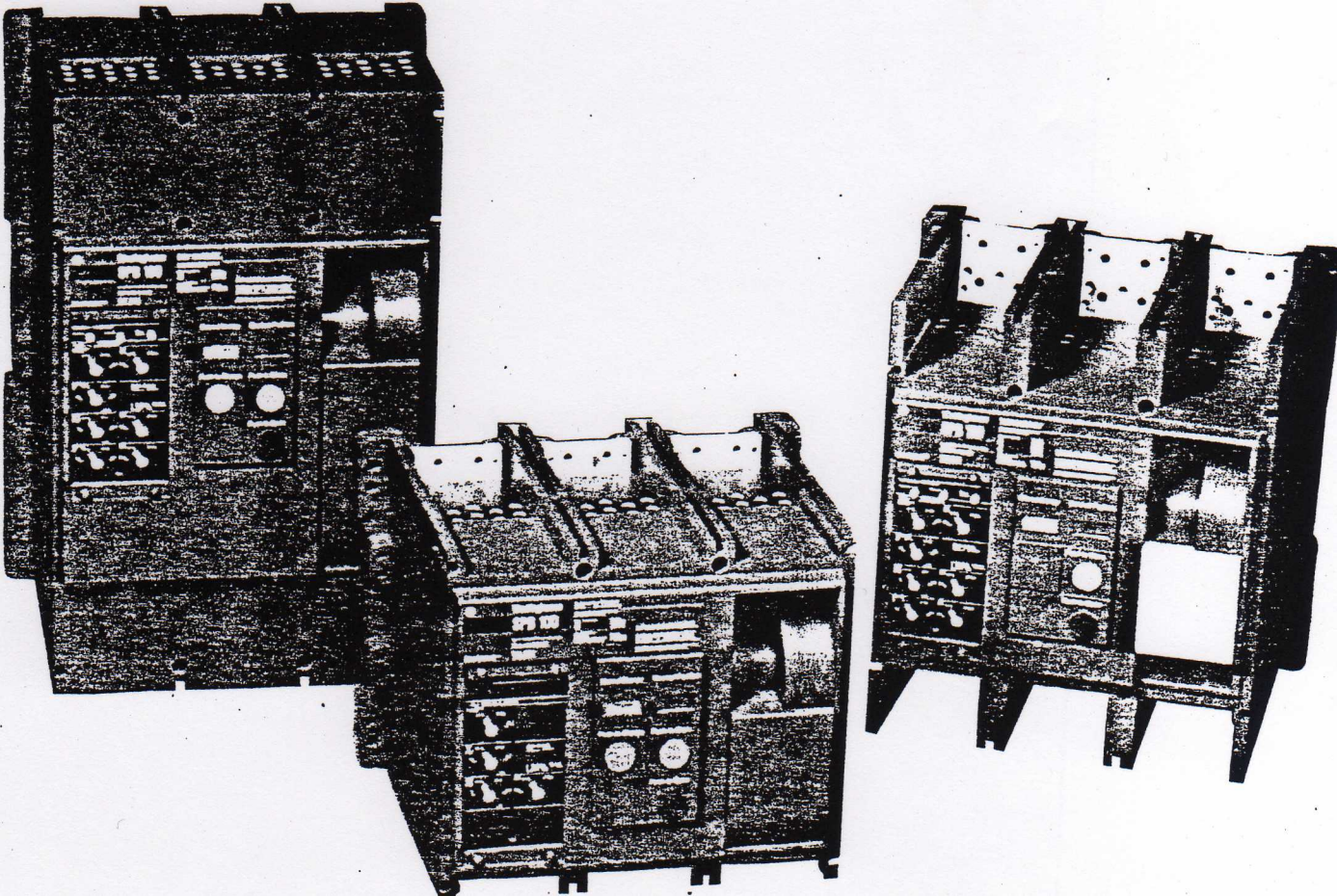
La unidad standard dispara instantáneamente. Se puede obtener

Westinghouse Electric Corporation
Low Voltage Breaker Division
Beaver, Pennsylvania U.S.A. 15009

October, 1977
New Information
Mailed to: E, D, C/1901, 1923, 2807/PL

160-3000 Continuous Amperes, 50/60 Hz;
150,000 Amperes I.C. at 480 Volts Maximum;
51,000 Amperes Short-time Rating Maximum;
UL Listed for 100% Application

Systems Pow-R Breaker With Pow-R TRIP 7



Introduction

The Westinghouse Systems Pow-R Breaker, the worlds first encased power breaker, is not just an extension of existing technology. It represents the biggest breakthrough in circuit protection since the invention of the DE-ION® principle of arc extinguishing (also a Westinghouse first) in 1927.

The Systems Pow-R Breaker is an entirely new concept in circuit protection, designed to meet the increasingly demanding parameters of today's complex distribution systems. In designing to these parameters, the Westinghouse philosophy was to first define the needs of Consulting Engineers, Switchboard Assemblers, and the end user, and then set out to meet those needs.

Application

Systems Pow-R Breakers can be applied in switchboards as mains, ties and feeder breakers. Because they combine high interrupting capacity with short-time delay tripping, Systems Pow-R Breakers can be applied in fully rated, selective systems while providing full selectivity through the applied breaker's short time rating.

Individual breakers in separate enclosures can be applied in low voltage distribution systems through 600 volts Ac, 50/60 Hertz.

In addition, the many individual design and construction features of the Systems Pow-R Breaker satisfy application requirements of a broad range of important industries.

Construction Industry

Systems Pow-R Breaker features most beneficial to the Construction Industry are:

- Underwriters' Laboratory label
- High interrupting capacity without fuses
- Increased short time ratings for system continuity
- 100% ratings
- Application flexibility of "options oriented" design
- Safety considerations for personnel and equipment
- Maximum five cycle closing
- Compact size and layout flexibility
- Compliance with various local and national codes

Offshore Industry

Application of the Systems Pow-R Breaker in this industry refers primarily to generator paralleling and Thyristor Drive Protection. In addition:

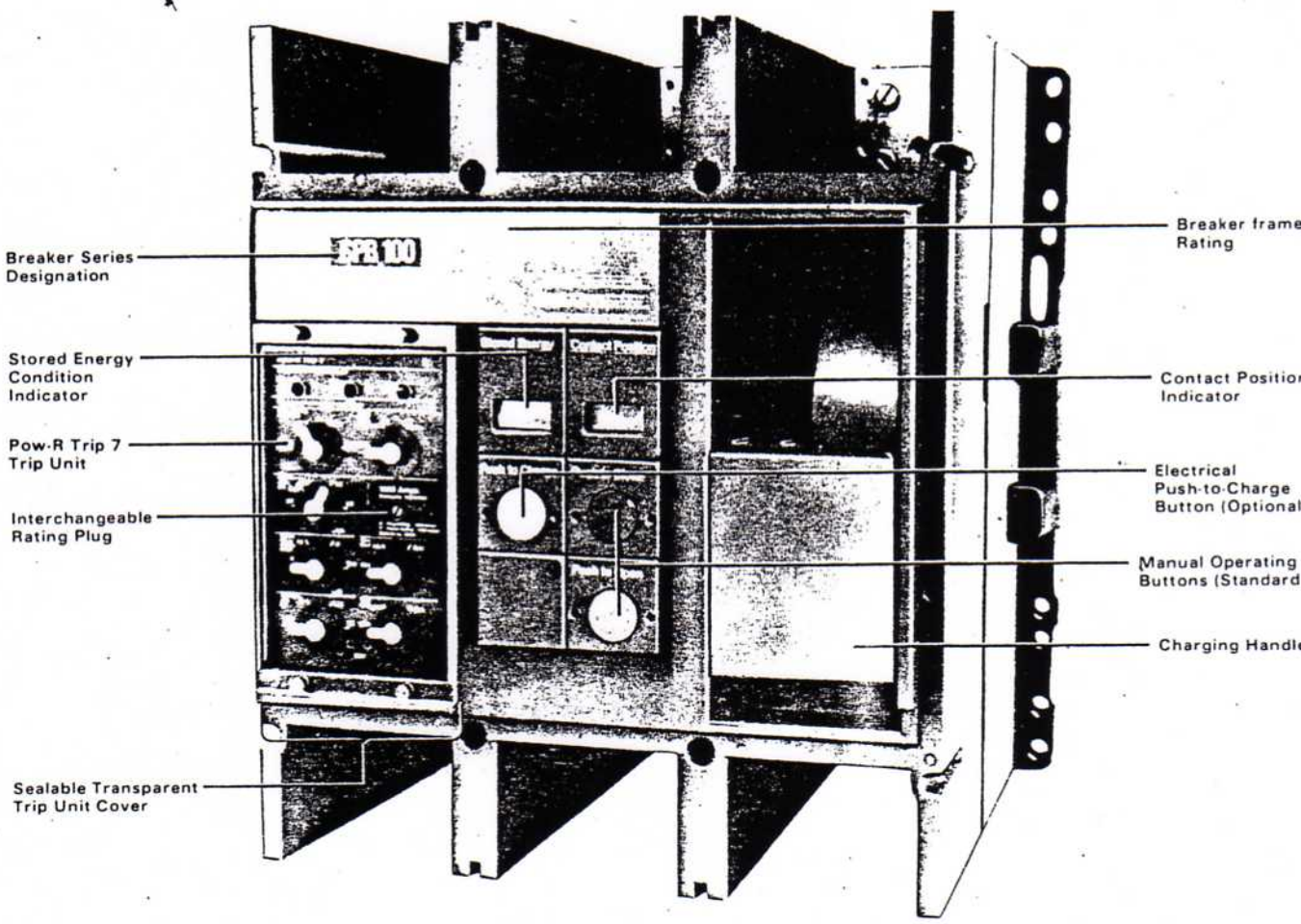
- Compact size is vital due to space limitations
- Rugged construction of the breaker and its drawout assembly is essential
- True-two step stored energy mechanism with maximum five cycle closing in either manual or electrically operated units
- Same physical size for both manual or electrically operated units

Stand-by Emergency Power Industry

This industry is primarily concerned with generator paralleling, and the following Systems Pow-R Breaker features are most beneficial:

- True two-step stored energy mechanism with maximum five cycle closing in either manually or electrically operated mode.
- Same compact size for both manual or electrically operated units
- Availability of 800 amp physical frame

Description



The Systems Pow-R Breaker family consists of three physical frame sizes: 800, 1600 and 3000 amperes. The 800 ampere frame covers ratings of 250 and 800 amps; the 1600 amp frame has a single rating of 1600 amps; and the 3000 amp frame includes ratings of 2000 and 2500 amps as well as 3000 amps. All three physical frames have the same width, depth and pole spacing with height being the only dimensional variation.

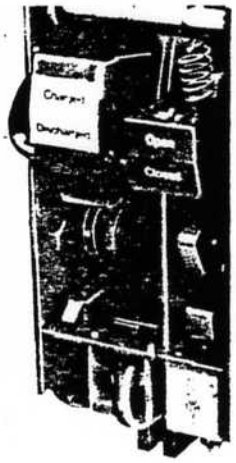
Systems Pow-R Breakers are identified by four series: SPB-50, SPB-65, SPB-100 and SPB-150. The numbers after SPB refer to the interrupting capacity in RMS symmetrical amps at 480 volts Ac without fuses. Thus, in the SPB-100 series, any breaker from 250 to 3000 amps may be supplied with a UL Listed interrupting capacity of 100,000 amps at 480 volts Ac without fuses. Complete I.C. ratings are shown in Table A.

Standard Features

UL Listing for 100% Application All Systems Pow-R Breakers are suitable for continuous operation at 100% of the frame rating. Thus, the Systems Pow-R Breaker, including the load side bus or cable, can be sized to the connected load, eliminating need for oversizing as with conventional overcurrent devices.

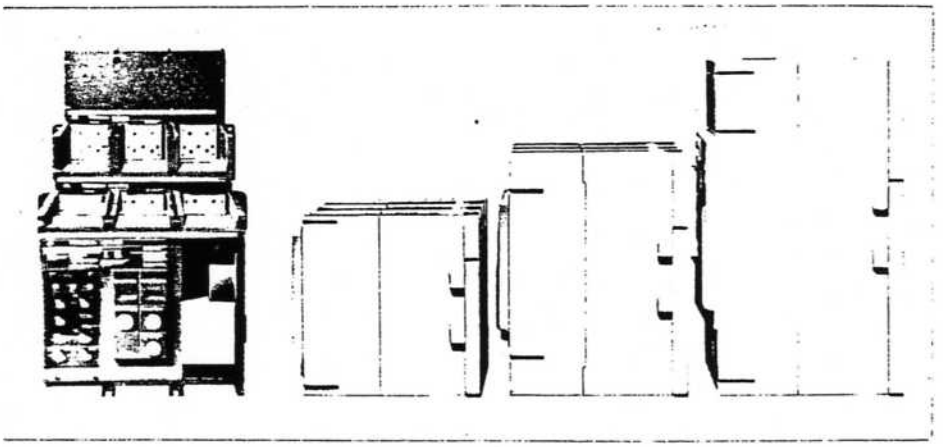
Uniform Appearance, Compact Size All Systems Pow-R Breaker ratings-160 to 3000 amperes-have same depth, width and pole spacings for both manual and electrically operated units, permitting simplified bus arrangements and layout of assemblies.

True Two-Step Stored Energy Mechanism Both mechanically and electrically operated versions feature a true two-step stored energy mechanism with no change in dimensions. This mechanism allows maximum five cycle closing usually required for generator paralleling



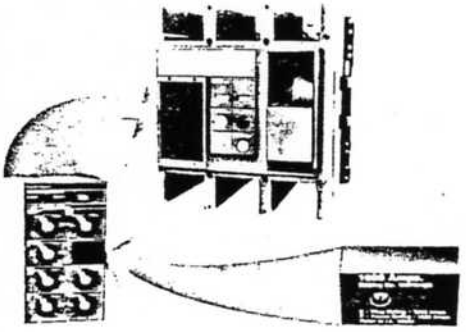
Solid State Trip Unit Pow-R Trip 7 trip units for Systems Pow-R Breakers are solid state, totally enclosed devices that plug into the front of the breaker and are interchangeable between compatible breaker frames.

Continuous Rating Rating plugs establish the nominal maximum continuous ampere rating of the breaker. They plug into the trip unit and are interchangeable between compatible trip units.



Each of the three Systems Pow-R Breaker frame sizes features the same width and depth, whether manual or electrical operated.

Safety Interlocking Systems Pow-R Breakers offer multiple layers of protective interlocking: (1) rating plugs and trip units are keyed to insure that they cannot be inserted in any trip unit or frame except the correct one: (2) attempting to remove a rating plug while the breaker is closed will trip the breaker and (3) a breaker cannot be closed unless a rating plug is installed.



Breaker Status Indicators Color coded visual indicators are provided to indicate position of contacts (Open or Closed), as well as status of closing springs (Charged or Discharged).

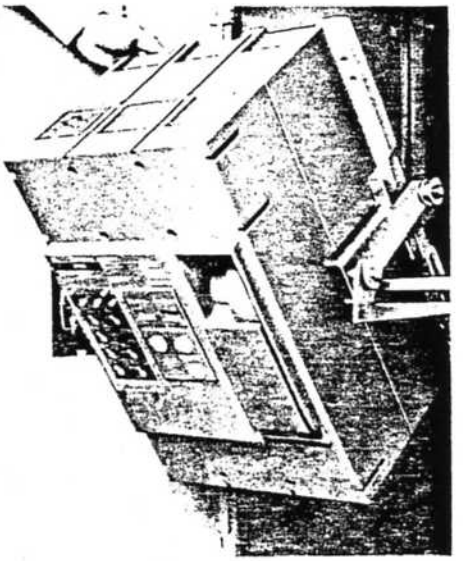
Anti-Pump Provisions to prevent unwanted closing or reclosing operations when used with a maintained closed contact in the close circuit, anti-pump provisions are provided as standard on electrically operated breakers, and can be supplied on manually operated breakers with spring release solenoid.

Common Wiring Diagram All Systems Pow-R Breakers use the same wiring diagram regardless of the number of attachments requested. The common wiring diagram simplifies the equipment assemblers' task of preparing the schematic diagram.

Durability Systems Pow-R Breakers are capable of 4000 operations at rated load followed by 4000 operations at no load without maintenance.

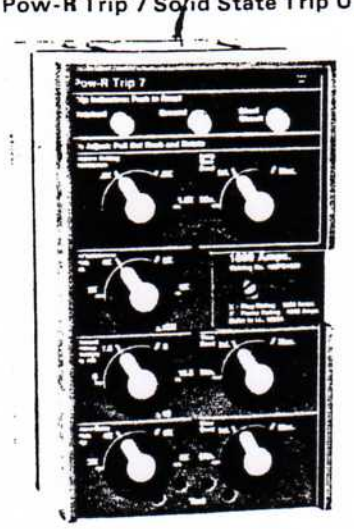
Ease of Maintenance Draw-out Systems Pow-R Breakers may be rotated 180° in fully withdrawn position for access to main and secondary disconnects. Main contacts and Pow-R Trip 7 sensor units are field replaceable.

Main contacts



Breaker being tilted out for inspection.

Operation
Pow-R Trip 7 Solid State Trip Unit



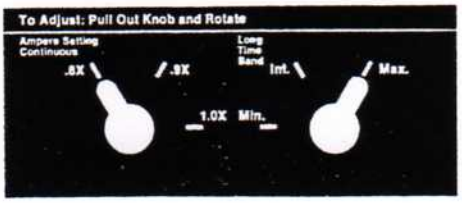
The solid state trip unit and sensor package is the heart of the Systems Pow-R Breaker. It provides the breaker's tripping function; it features up to seven time/current systems-coordination adjustments; it contains the rating plug which establishes the breaker's continuous ampere rating; and, as an option, it can provide up to three resettable visual indicators to define reason for breaker's tripping-overload, short-circuit, or ground fault. Trip units are interchangeable between compatible breaker frames.

Trip Method
Automatic breaker tripping operations are accomplished through the use of a special low-energy, flux-transfer shunt trip that requires no external control power. A conventional shunt trip device can be factory or field mounted if remote opening of the breaker is desired.

Time/Current System Coordination Adjustments
The standard Pow-R Trip 7 trip unit provides the following system coordination adjustments: adjustable ampere setting, adjustable long time delay, and adjustable instantaneous trip.

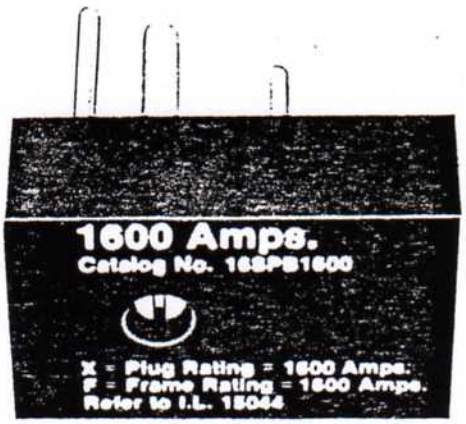
Other adjustments available in various combinations with the standard adjustments are short time pick-up, short-time delay, ground fault pick-up and ground fault delay. For selective tripping applications, the instantaneous adjustment may be omitted when the short time adjustments are selected.

All adjustments are made using non-removable, discrete step, high reliability switching plugs to assure positive, accurate adjustments.



To prevent tampering once the adjustment plugs have been set, the transparent cover over the face of the trip unit can be sealed.

Rating Plugs
The continuous ampere rating of Systems Pow-R Breakers is determined by a rating plug which is inserted in the trip unit. Rating plugs are available as listed below to permit close matching of the breaker and load side conductor to the actual load.

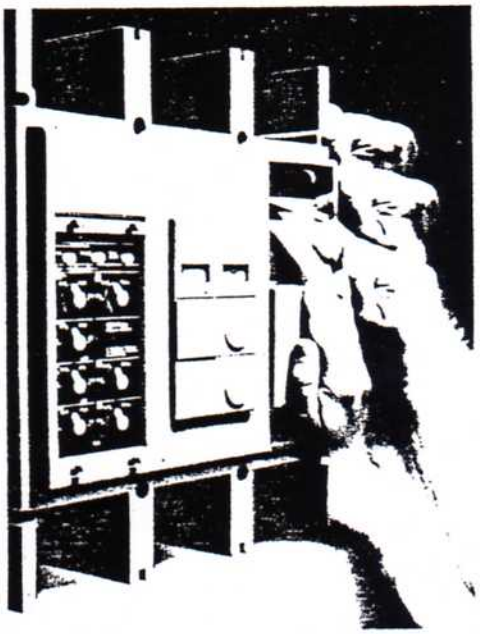


Breaker Frame Ampere Rating	Plug Ampere Ratings
250	200, 225, 250
800	300, 400, 500, 600, 700, 800
1600	1000, 1200, 1600
2000	2000
2500	2500
3000	3000

1200

The rating plug is interlocked with the tripping mechanism to automatically open the breaker when the plug is removed and the breaker remains "trip free" until the plug is replaced. Rating plugs are interchangeable between compatible trip units, and are keyed to prevent their being inserted in incorrect trip units.

Charging and Closing of Stored Energy Mechanism
The two-step stored energy system employed by the Systems Pow-R Breaker provides maximum five cycle closing either manually or electrically operated. The charging and closing actions in the mechanism utilize separate operating shafts, which allows design optimizing of the components in each portion of the mechanism.



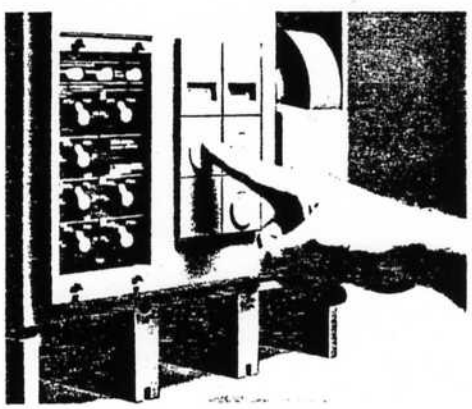
Manual charging of breaker

Manual charging, above, is accomplished by a constant-force charging handle, using four full strokes or several partial inching strokes as desired. Electrical charging by a motor-driven operator is available as an option.

Both manual and electrically operated breakers have multiple charge-close provisions which makes possible the charge-close-recharge-open-close-open sequence. As a safety feature, the stored energy can be discharged without closing the breaker.

Construction Features *Continued*
Color coded status indicators on the breaker front cover, below, indicate stored energy condition and main contacts position. The stored energy indicator will not read "charged" until the mechanism is completely charged and ready to close.

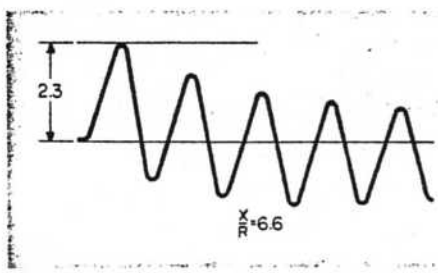
Closing operations, below, can be accomplished by a manual pushbutton on the breaker front, or by a remote close circuit using an optional spring release solenoid. Electrically operated breakers have anti-pump provisions as standard. The same anti-pump provisions are available as an option on manually operated breakers using spring release solenoids for remote closing operation.



Optional Systems Coordinating Adjustments

Short Time Ratings
Short time ratings are the key to systems coordination. Systems Pow-R Breaker short time ratings vary with the frame rating selected. Values of 25,000, 35,000 and 51,000 amps RMS Symmetrical are available (See Table 1). For selective coordination purposes, short time delay settings up to a maximum of 18 cycles (0.3 seconds) in three discreet steps are available.

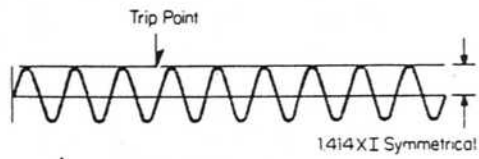
The design and test parameters of Systems Pow-R Breakers are based on a 600 volt distribution system with an X/R ratio of 6.6, which equates to a test power factor of 15%. In a system having these characteristics, the maximum peak offset in the first one-half cycle of a "worst case" condition can be as much as 2.3 times the RMS symmetrical value of the fault. By using these design parameters, no decrease in the specified short time ratings occur.



15% Power Factor Test Parameters

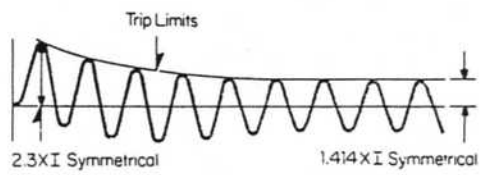
The reason that the short time rating does not decrease is the unique optional selective override circuit of the Systems Pow-R Breaker. This feature differs greatly from instantaneous override or fixed instantaneous trip circuits.

Instantaneous override or fixed instantaneous trip circuits respond only to a fixed RMS Symmetrical peak current, which equals the stated RMS symmetrical short time rating times 1.4.4 (i.e. $\sqrt{2}$). These types of circuits are not capable of making allowances for the assymetrical offset which occurs in all faults and thus result in some decrease of their short time rating. The amount of derating is a direct factor of the system power factor.



Instantaneous Override

The selective override circuit in a Systems Pow-R Breaker allows the breaker to ride thru a fully offset fault within its short time rating. Selective coordination is provided with the down stream device which clears the fault, and continuity of service is maintained for all other unfaulted feeders.



Selective Override

Note: The selective override circuit is included in the Pow-R Trip 7 only when the instantaneous adjustment is omitted. In order to take full advantage of the outstanding Short Time Ratings and selectivity built into the Systems Pow-R Breaker, it is recommended that the Instantaneous adjustment be omitted in trip units including optional Short Time Adjustments. Should the adjustable instantaneous circuit be retained, the trip unit would respond at the peak value of the symmetrical current determined by the pick up setting and system selectively would be lost at a much lower value than is otherwise possible with selective override.

Table 1: Interrupting/Short-Time Ratings

Series		SPB-50		SPB-65	SPB-100					SPB-150					
Frame Ampere Rating		250 A	800 A	1600 A	250 A	800 A	1600 A	2000 A	2500 A	3000 A	250 A	800 A	1600 A	2000 A	2500 A	3000 A
Short Time Rating①		25 KA	25 KA	35 KA	25 KA	25 KA	35 KA	35 KA	35 KA	35 KA	25 KA	25 KA	35 KA	51 KA	51 KA	51 KA
Max. Short Time Delay②		18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Interrupting	240 V	65	65	85	100	100	100	100	100	100	200	200	200	200	200	200
Capacity	480 V	50	50	65	100	100	100	100	100	100	150	150	150	150	150	150
rms symmetrical)	600 V	42	42	50	65	65	65	85	85	85	100	100	100	100	100	100

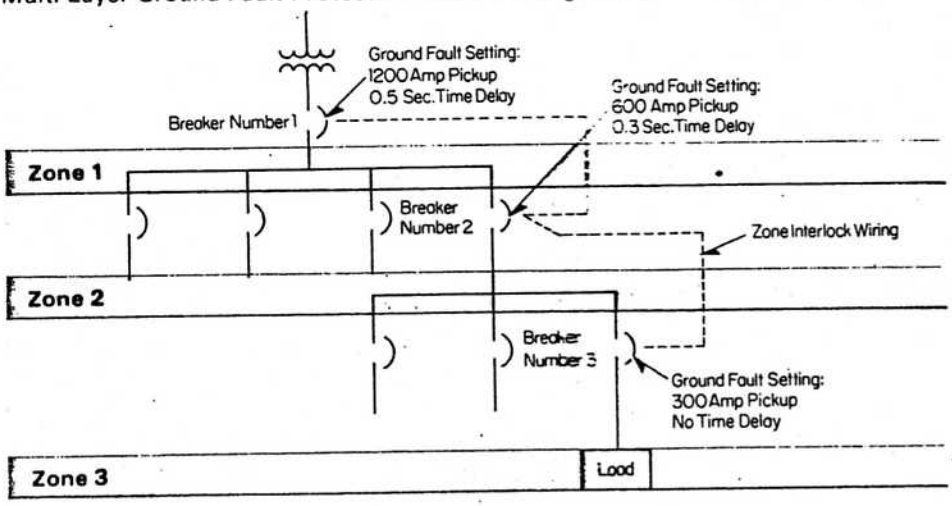
① Short-time rating (rms symmetrical amps) in 600 V, 50/60-Hz system with X/R ratio of 6.6.
② Maximum short time delay setting in cycles.

Built-in Ground Fault Protection
The Pow-R Trip 7 ground fault function features adjustable current pick-up settings to a maximum of 1200 amps, in accordance with the National Electrical Code. It also has adjustable time delays in three discreet steps with maximum breaker clearing times of 0.1, 0.3 and 0.5 seconds, and a memory circuit to compensate for the erratic nature of arcing ground faults.

External terminations that can be reconnected are provided to satisfy the grounding conditions for simple and complex distribution systems. Residual is standard. Source ground connections are applicable, as is zero sequence with external sensors, in various physical configurations to match the system requirements.

Integral Zone Selective Interlocking, a standard feature of the Systems Pow-R Breaker with Ground Fault, and available only from Westinghouse, is desirable for complex ground fault systems, such as hospitals where multiple levels of ground fault protection are required by the code.

Multi-Layer Ground Fault Protection Scheme Using Zone Selective Interlocking

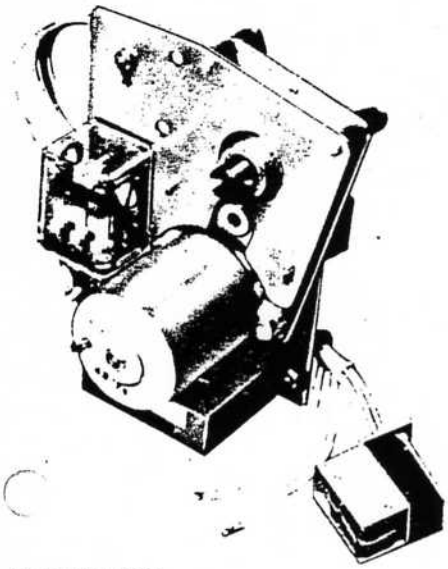


With Zone Selective Interlocking, proper system coordination is maintained for down stream faults. To minimize equipment damage while providing the greatest degree of system continuity, the Zone Selective Interlocking system locates the fault and opens the nearest upstream breaker at the minimal time setting, regardless of preset settings, without losing coordination with upstream devices. Such a loss of coordination could cause nuisance or unwanted tripping operations on the upstream devices.

Optional Features

Electrical Operation

The electrical operator is mounted internally, with the result that there is no dimensional difference between manually and electrically operated units. Manually operated breakers are easily field convertible to electrical operation by adding a plug-in motor operator. UL Listing is not voided by field installation of motor operator.

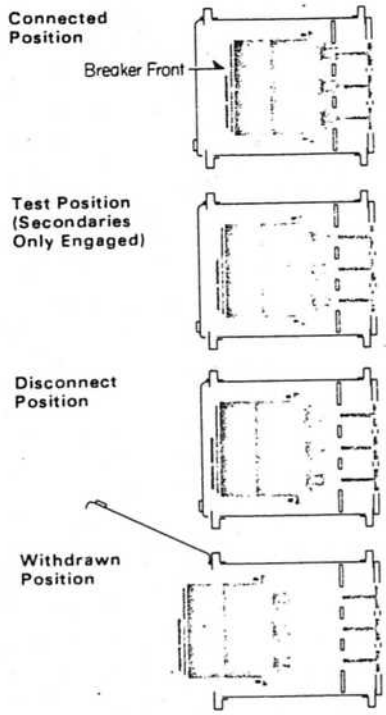


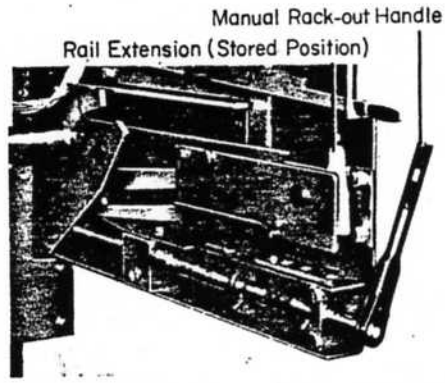
Motor Operator

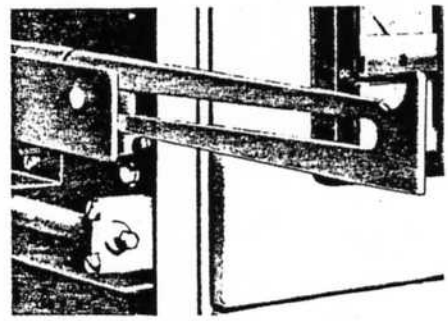
Motor operator installed in breaker

Drawout Mounting

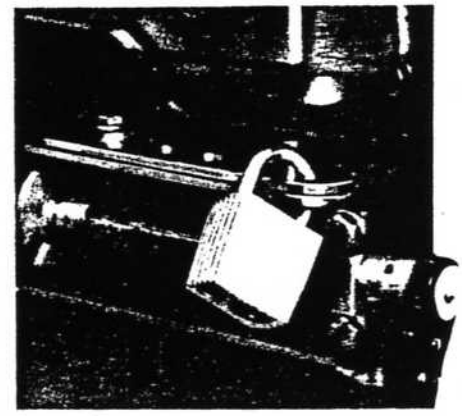
Systems Pow-R Breaker drawout assemblies consist of a stationary frame and a moving carriage with four position stops: Connected, Test, Disconnected and fully withdrawn. Extension rails, the racking mechanism and operating handle are part of the draw-out assembly and are self-contained. The draw-out mechanism is mechanically interlocked with the breaker drawout element so that the breaker cannot be racked into or out of any position with its main contacts closed or in the spring charged position.







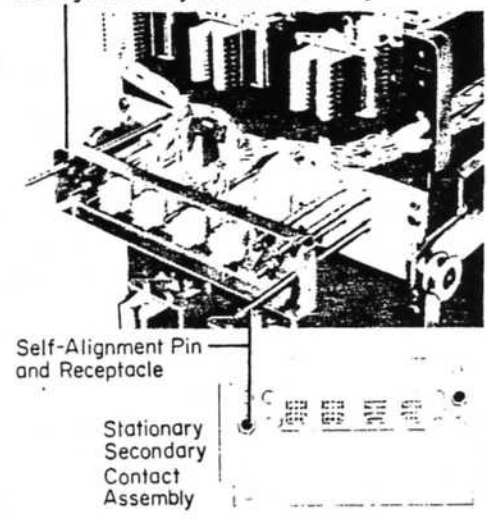
Extension rail drawn-out



Padlocking of draw-out element

- For safety, breaker draw-out elements can be padlocked in any of the three draw-out positions, as well as in a tripped open position.

Secondary contacts having a maximum of 48 points are located at the rear of the draw out element. Engagement of secondary contacts is assured by automatic self-alignment and positive contact of mating parts.



Trip Indicators

Indication of automatic trip operation is optional on Systems Pow-R Breakers. Pow-R Trip 7 trip units are available with resettable indicators that indicate the reason the breaker tripped: overload, ground fault or short circuit.

In addition, an automatic trip relay is available to indicate breaker tripping. One version of the relay indicates simply (by LED) that the breaker has tripped and also provides alarm and lock-out contacts. A second version of the relay indicates (by LED's) the cause of tripping (overload, ground fault or short circuit) as well as providing alarm and lock-out contacts.

Automatic trip relay

Door Mounted Breaker Drawout Position Indicators

An external breaker position indicator is available for mounting on the breaker cell door to provide visual indication of the drawout position of the breaker behind the door.

Breaker Connected

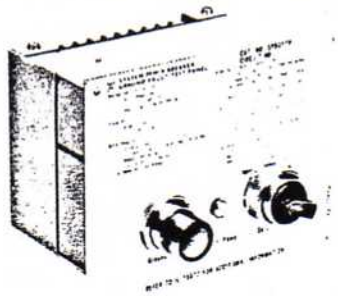
Breaker in test position

Breaker Disengaged

Accessories

In-service Testing

A small hand held test kit permits functional testing of the breaker while it is in service.



In addition, a separately mounted test panel is available for testing ground fault protective circuits.

Mechanical Interlocking

Mechanical interlocking of adjacent fixed or draw out breakers is available, as well as provision for key interlocking.

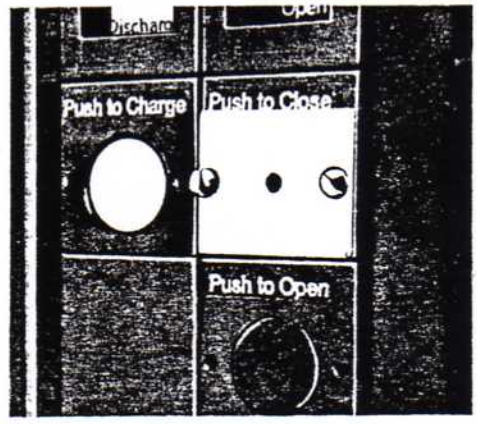
Spring Release Solenoid

For remote closing of a precharged breaker, a spring release is available. An auxillary contact to denote spring charged position remotely is another feature furnished as standard with all spring release options.

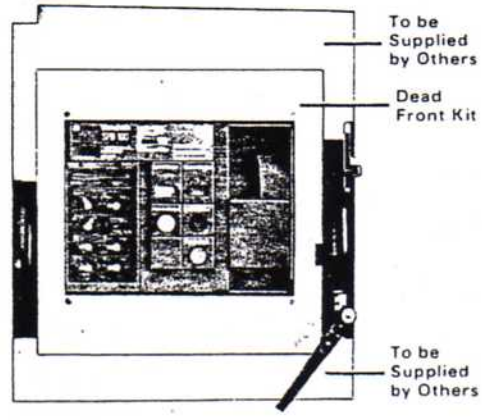
Other Available Accessories

- Shunt trip device
- Undervoltage release – Instantaneous
- Undervoltage release – Time Delay up to .5 seconds
- Auxiliary switches (six max) in combination of 2, 4 or 6 Make/Break arrangements.
- Provisions for blocking the manual "close" pushbutton
- Provisions for padlocking
- Cell switches
- UL Listed "deadfront" kit.

Padlocking push-to-open button



Manual push-to-close button blocked off

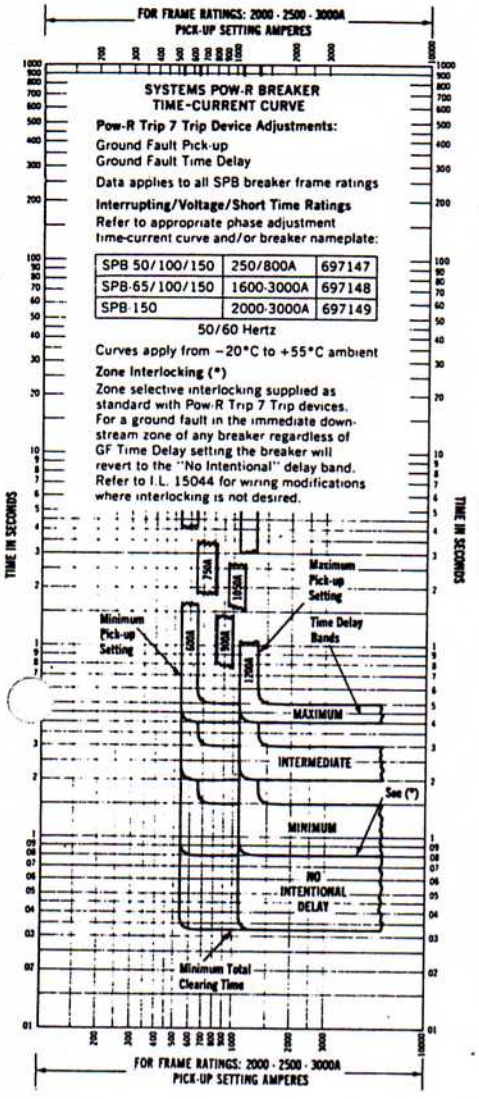


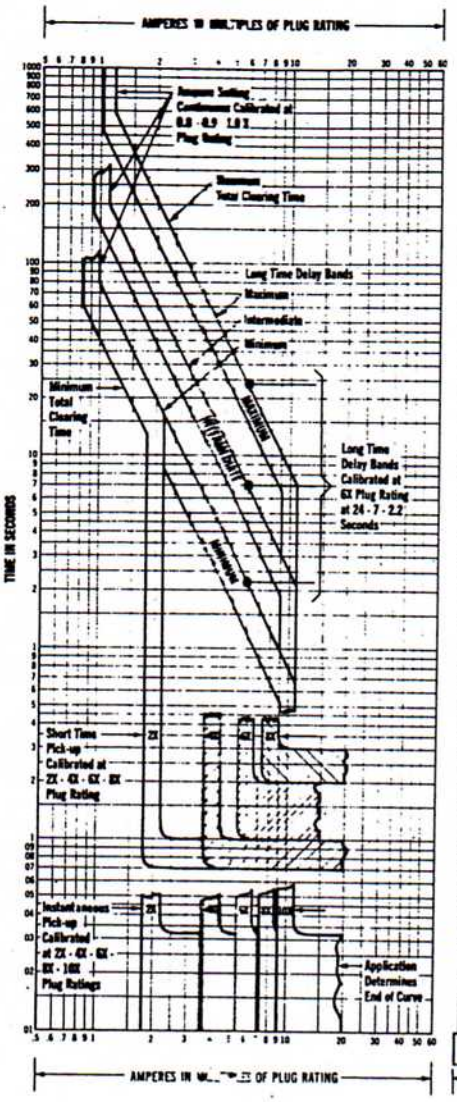
Dead-front kit in position

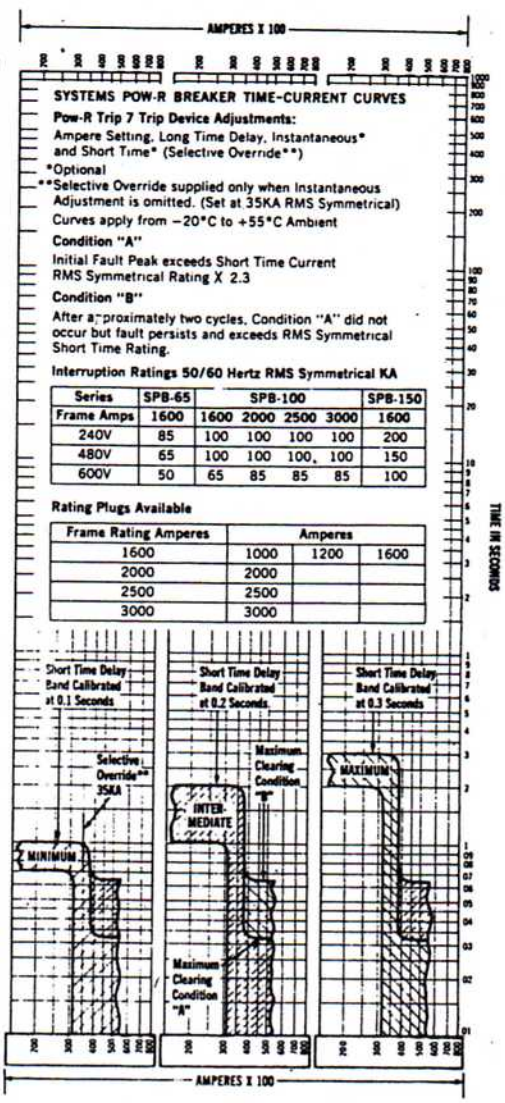
Application Information

(A) Curve Shaping Adjustments

A maximum of seven curve shaping adjustments can be obtained on the Pow-R Trip 7.







Ground Fault Adjustments

As the trip curve shows, adjustments can be made in discrete steps for:

- Ampere Setting: Adjustable in three steps; i.e. 80%, 90% and 100% of the rating plug
- Long Time Delay Bands:① Adjustable at 600% current in three settings:
  Min: 2.2 seconds
  Int: 7 seconds
  Max: 24 seconds
- Ground Time Delay Band:① Adjustable in three steps: 0.1, 0.3 and 0.5 secs. (i.e. 6, 18 and 30 cycles).
- Ground Fault Pickup: For the 250, 800 and 1200 Amp. frame there are six discrete settings based on the frame ratings: .2, .3, .4, .5, .6 and .75 times the frame rating.

Phase Adjustments

For the 2000, 2500 and 3000 Amp. frames there are five discrete settings at 600, 750, 900, 1050 and 1200 Amps.

- Short Delay Pickup: Adjustable to 2, 4, 6 or 8 times the rating plug
- Short Time Delay Bands:① Adjustable in three steps 0.1, 0.2 and 0.3 seconds (i.e. 6, 12 and 18 cycles
- Instantaneous Pickup: Adjustable at 2, 4, 6, 8 or 10 times the rating plug

① Time value adjustments are calibrated points and denote "total clearing time".

Typical Specification for the Systems Pow-R Breaker

Circuit breakers shall be encased Westinghouse Systems Pow-R Breakers.

All breakers shall be UL Listed for application in their intended enclosure for 100% of their continuous ampere rating. Frame ampere ratings shall be 250, 800, 1600, 2000, 2500, or 3000 amperes as shown on the drawings.

The amperes interrupting capacity (I.C.) and short time ratings shall be as follows:

SPB-50 (250/800 Amp. Frame)
I.C.: 50,000 amps at 480 volts
Short Time Rating: 25,000 amps (RMS Sym.)

SPB-65 (1600 Amp. Frame)
I.C.: 65,000 amps at 480 volts
Short Time Rating: 35,000 amps (RMS Sym.)

SPB-100 (250/800/1600/2000/2500/3000 Amp. Frame)
I.C.: 100,000 amps at 480 volts without fuses
Short Time Rating: 25,000 amps (RMS Sym.) for 250 and 800 amp. frame; 35,000 amps (RMS Sym.) for 1600 amp. and above.

SPB-150 (250/800/1600/1200/2500/3000 Amp. Frame)
I.C.: 150,000 amps at 480 volts without fuses
Short Time Rating: 25,000 amps (RMS Sym.) for 800 amp. frame; 35,000 amps (RMS Sym.) for 1600 amp. frame
51,000 Amps (RMS Sym.) for 2000 Amp. Frame and larger

Short time ratings shall be based on a 600 volt, 50/60 Hz system with an X/R ratio of 6.6.

A selective override circuit shall be provided on breakers having short time adjustments, but without instantaneous adjustments that will allow the breaker to be applied at its maximum interrupting capacity while providing full selectivity up to its RMS Symmetrical short time rating.

All breakers shall be provided with a true, two-step stored energy mechanism which allows closing in a maximum of 5 cycles whether the breaker is manually or motor operated. Both manual and motor operated breaker shall have identical physical dimensions. Manually operated breakers shall be field convertible to motor operation without voiding the UL label on it. As a safety feature, anti-pump provisions shall be provided as standard for motor operated breakers and optional for manual breakers with spring release solenoids. Both manual and motor operated breakers shall have multiple charge/close provisions providing the following sequence: Charge-Close-Recharge-Open-Close-Open.

The breaker control face plate shall include color coded visual indicators to indicate contact and stored energy status. Local control pushbuttons shall be provided for opening and "closing" the breaker. For motor operated breakers, a local "charge" pushbutton shall be provided as standard.

The continuous ampere rating of the breaker shall be determined by the insertion of an interchangeable rating plug that matches the load and cable requirements. The rating plug shall be interlocked with the tripping mechanism to automatically "open" the breaker when the plug is removed. The breaker shall remain "trip free" with the plug removed. In addition, rating plugs shall be keyed to prevent incorrect application between different frame ratings. Complete system selective coordination shall be provided by the addition of the following time/current curve shaping adjustments: (1) Ampere Setting (2) Long Time Delay (3) Short Time Pickup (4) Short Time Delay (5) Ground Fault Pickup (6) Ground Fault Time Delay. All adjustments shall be made using non-removable discreet step, high reliability switch plugs for precise settings. A sealable transparent cover shall be provided over the adjustments to prevent tampering.

Ground fault protection shall be provided as an integral part of the breaker. A ground fault memory circuit shall be provided to compensate for the erratic nature of arcing ground faults and provide for positive tripping actions. A residual scheme shall be used as standard for detecting ground fault currents.

Where more complex systems require alternate sensing methods, the Pow-R Trip 7 shall be reconnectable for either a source ground or zero sequence detection scheme as required. Integral Zone Selective Interlocking shall be provided as a standard feature.

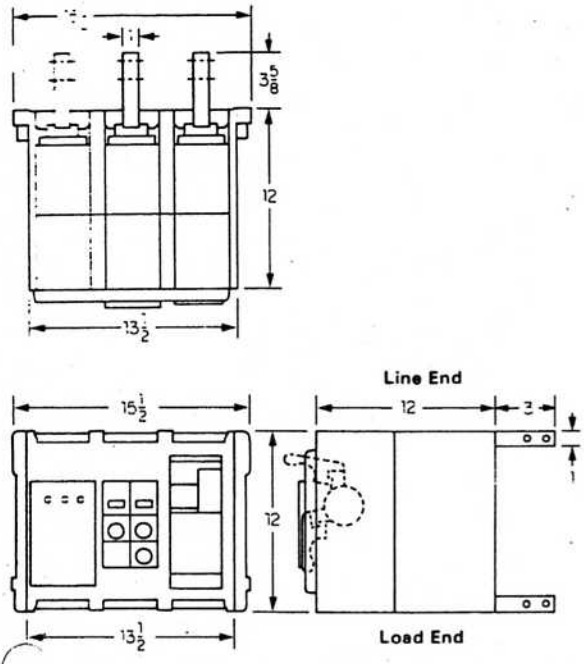
The Pow-R Trip 7 devices shall be provided with up to three visual indicators to indicate the automatic tripping mode of the breaker (i.e. Overload, Short Circuit or Ground Fault). In addition the Pow-R Trip devices shall be provided with terminals that can be wired to an optional remote auxiliary package to provide the above type of indication.

A separate mounted test panel shall be available to permit the testing of the ground fault circuit by either tripping the breaker or not tripping the breaker.

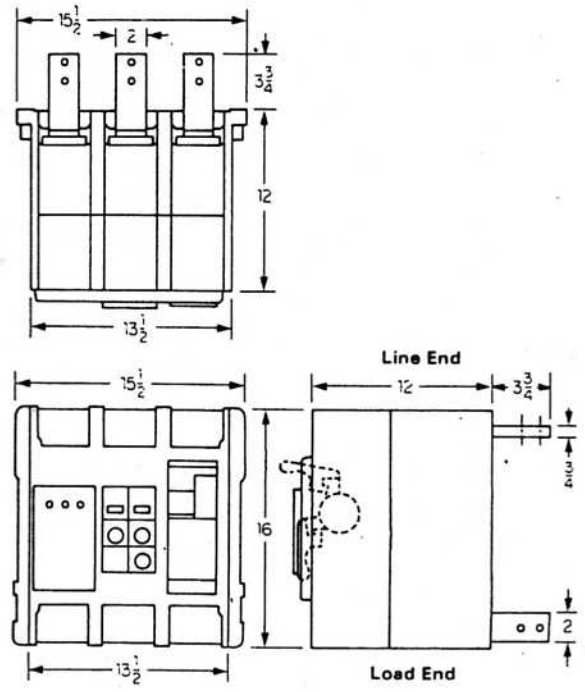
All breakers shall be provided with test points for in-service functional testing of the long time, instantaneous and ground fault circuits by means of a small hand held test kit.

The breakers shall be capable of a minimum of 4000 interruptions of rated current followed by 4000 operations at no load without maintenance. Further, the breaker shall be equipped with field replaceable contacts.

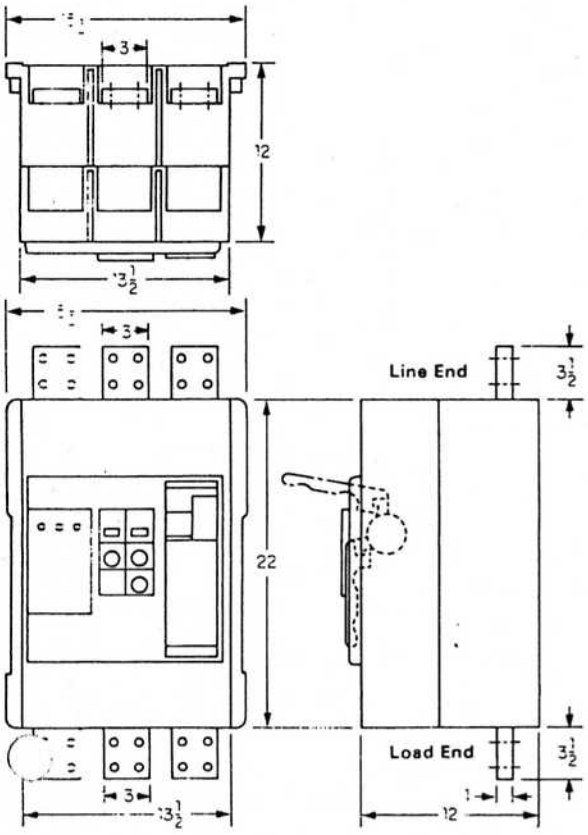
Dimensions, Inches *Not to be used for construction purposes unless approved.*
SPB Breakers, Fixed Mounted



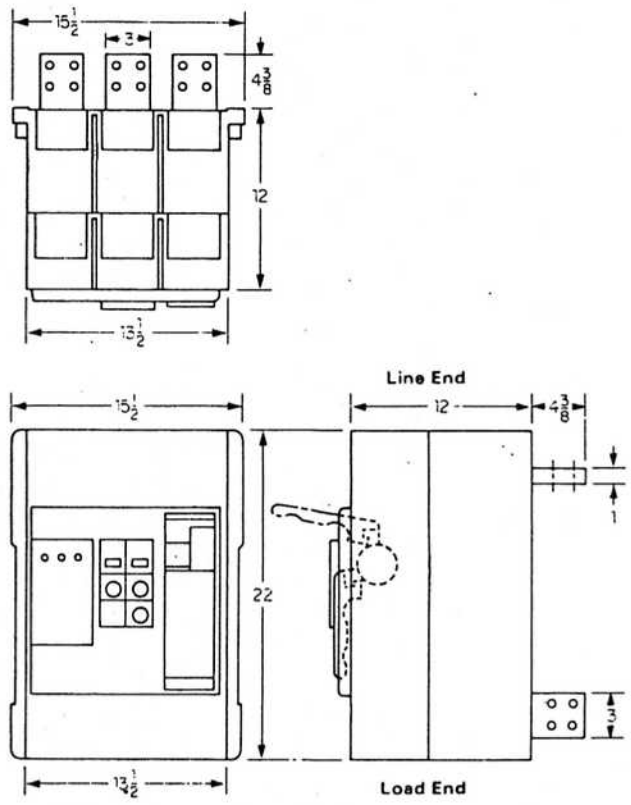
800 Amp (Fixed Front and Rear Connected)



1600 Amp (Fixed Front and Rear Connected)

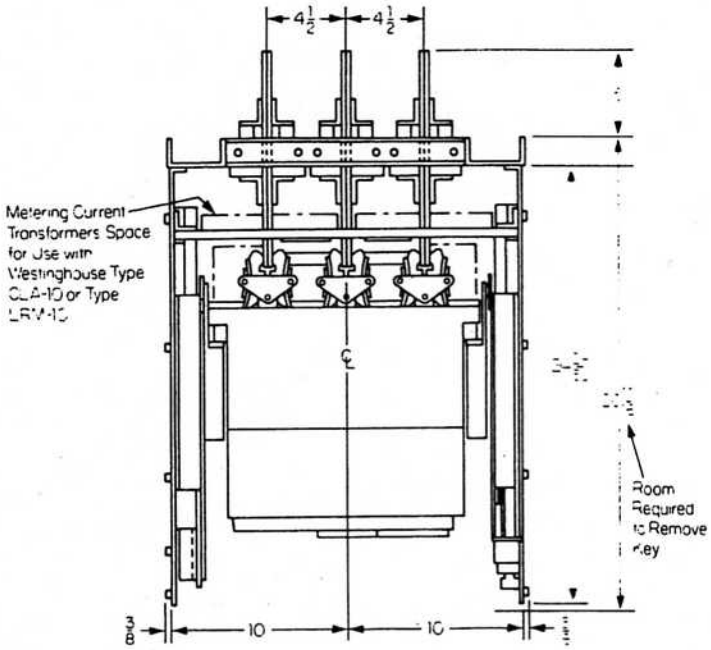


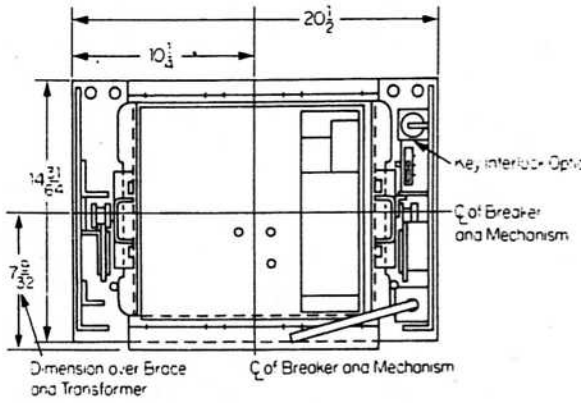
3000 Amp (Fixed Front Connected)

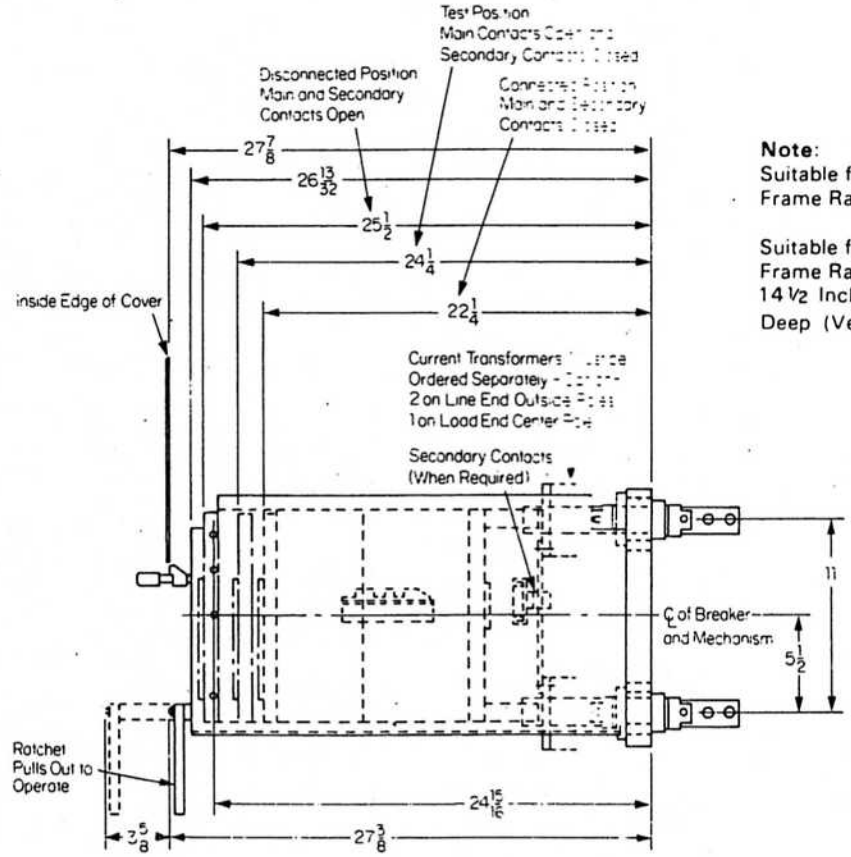


3000 Amp (Fixed Rear Connected)

Dimensions, Inches *Not to be used for construction purposes unless approved.*
SPB 800 Ampere Breaker for Drawout Mounting



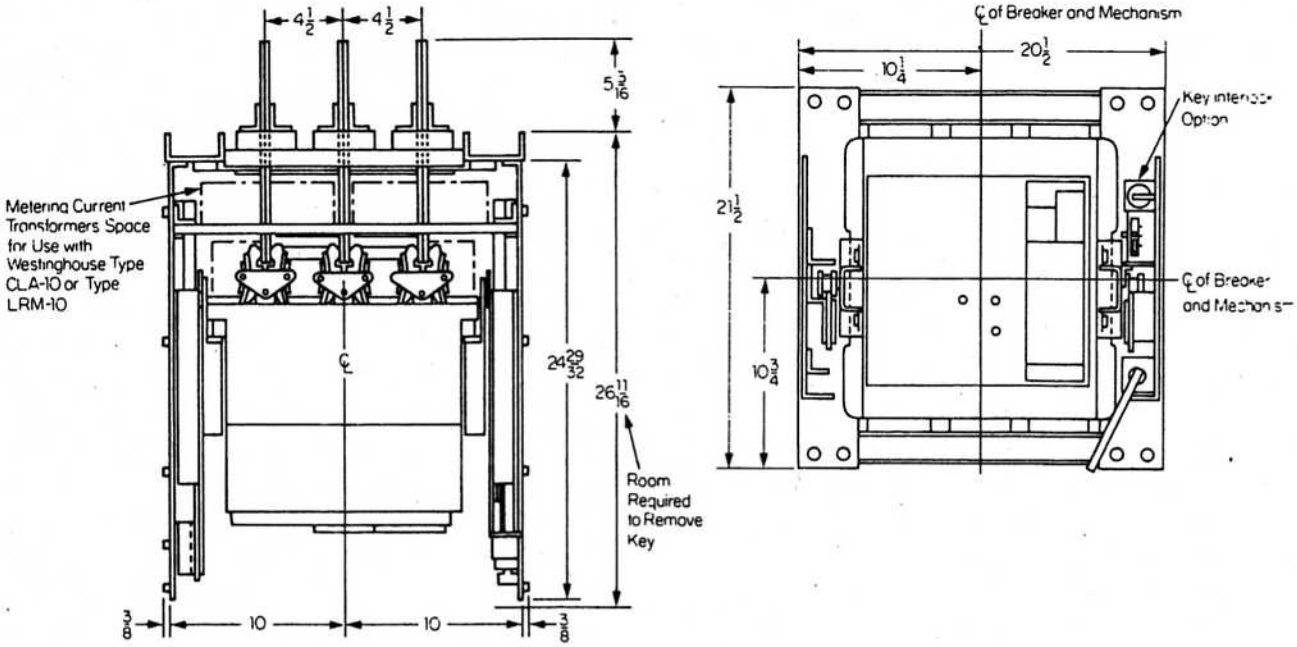


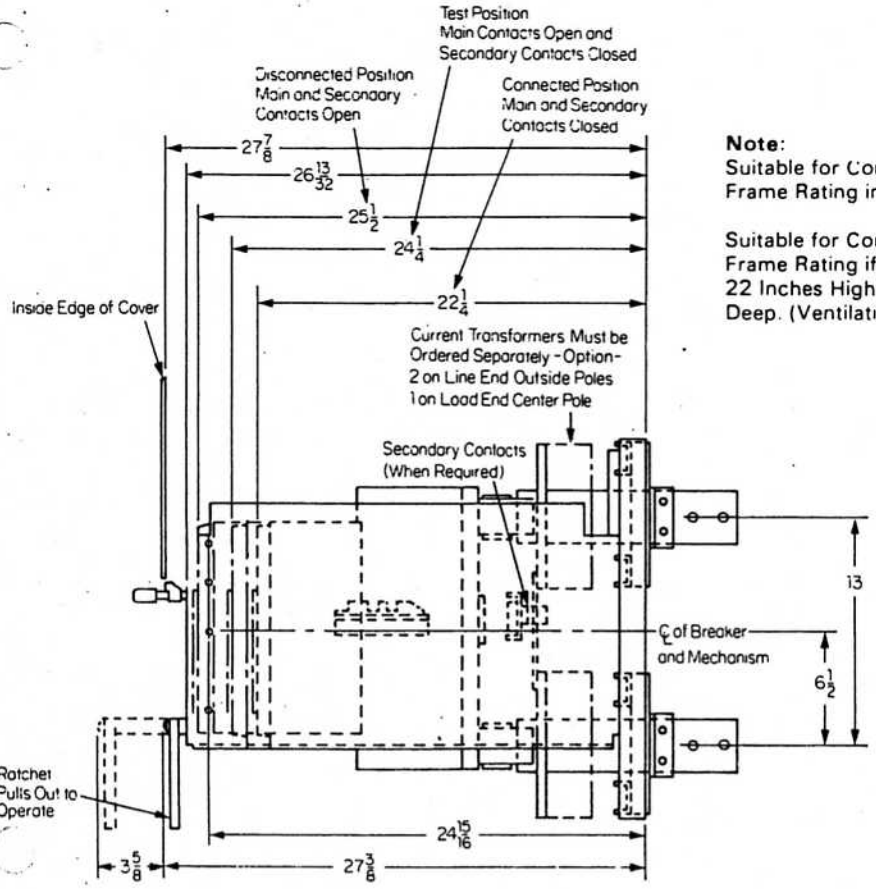


Note:
Suitable for Continuous Operation at 80% of Frame Rating in an Enclosure Without Ventilation.

Suitable for Continuous Operation at 100% of Frame Rating if Used in a Minimum Enclosure 14 1/2 Inches High X 21 Inches Wide X 33 1/2 Inches Deep (Ventilation is not Required)

Dimensions, Inches *Not to be used for construction purposes unless approved.*
SPB 1600 Ampere Breaker for Drawout Mounting

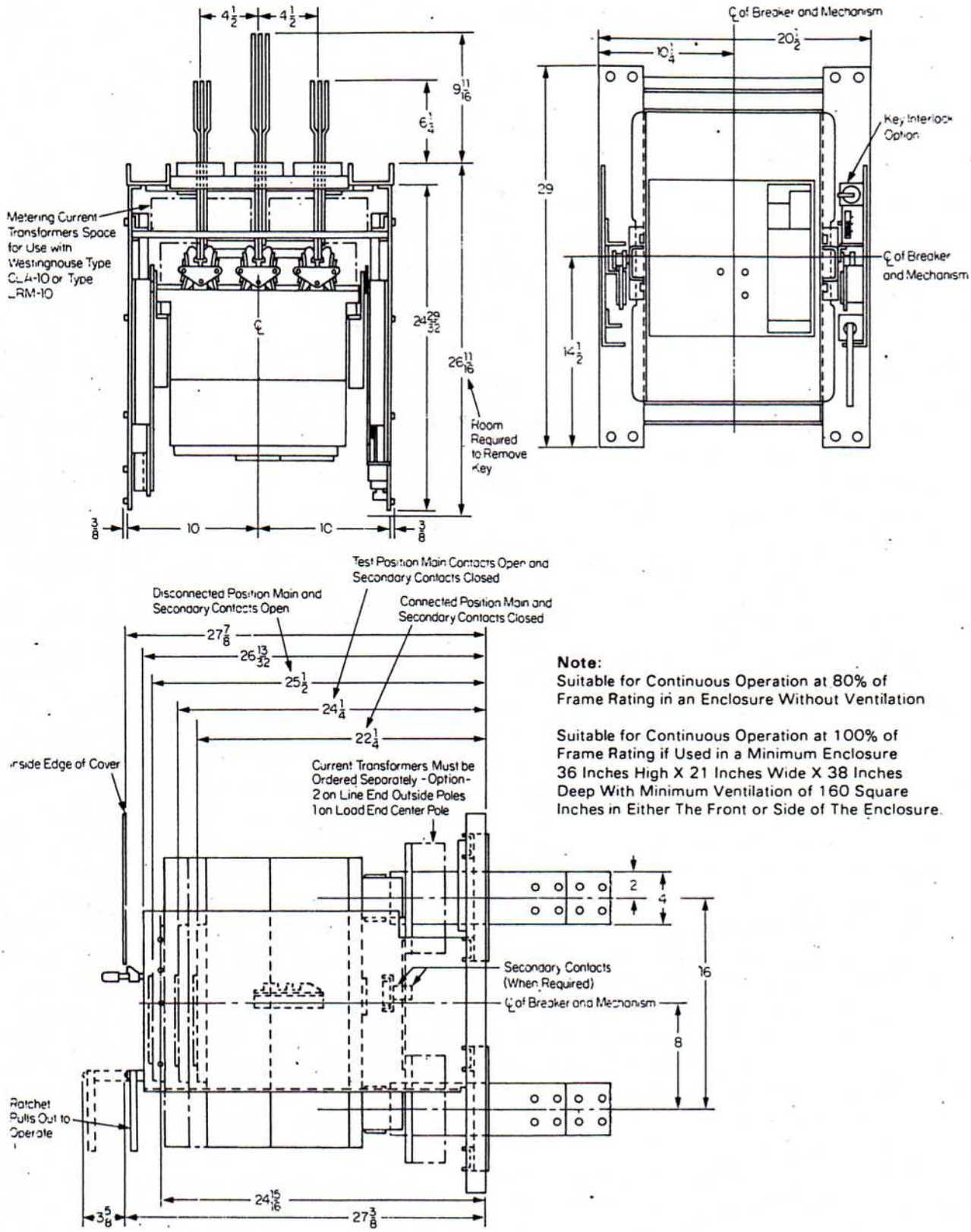




Note:
Suitable for Continuous Operation at 80% of Frame Rating in an Enclosure Without Ventilation.

Suitable for Continuous Operation at 100% of Frame Rating if Used in a Minimum Enclosure 22 Inches High X 21 Inches Wide X 33½ Inches Deep. (Ventilation is not Required)

Dimensions, Inches *Not to be used for construction purposes unless approved.*
SPB 3000 Ampere Breaker for Drawout Mounting



Note:
Suitable for Continuous Operation at 80% of Frame Rating in an Enclosure Without Ventilation

Suitable for Continuous Operation at 100% of Frame Rating if Used in a Minimum Enclosure 36 Inches High X 21 Inches Wide X 38 Inches Deep With Minimum Ventilation of 160 Square Inches in Either The Front or Side of The Enclosure.

Approximate Weights, Lbs.

Frame Rating Amperes	Fixed Mounted Breakers	Drawout Mounted Breakers	
		Drawout Element Only	Drawout Stationary Frame
250-800	100	110	85
1600	120	133	95
2000-3000	185	207	105

Further Information

List Prices: Price List 29-820

Printed in USA

Westinghouse Electric Corporation
Low Voltage Breaker Division
Beaver, Pennsylvania U.S.A. 15009

MOLDED CASE CIRCUIT BREAKERS
Circuit Breaker Selection and Interrupting Ratings

CIRCUIT BREAKER SELECTION AND INTERRUPTING RATINGS

Circuit Breaker Type	Page No.	Cont. Amp. Rating②	No. Poles	Volts Ac	Volts Dc	Federal Spec. W-C-375b	U/L Listed Interrupting Capacities RMS Symmetrical Amperes③								
							Ac Ratings Volts						Dc		
							120	120/240	240	277	480	600	125	250	125/250
QC, HQP, BAB	39, 40	15- 70	1	120/240	.....	10a, 11a, 12a	.....	10,000	.....	.....	.....	.....	.....	.....	.....
QC, HQP, BAB	39, 40	15- 125	2	120/240	.....	10a, 12a	.....	10,000	.....	.....	.....	.....	.....	.....	.....
QC, HQP, BAB	39, 40	15- 100	2, 3	240	.....	10b, 11b, 12b	.....	.....	10,000	.....	.....	.....	.....	.....	.....
QPHW, QBHW, QCHW	39	15- 100	1, 2	120/240	.....	14a	.....	22,000	.....	.....	.....	.....	.....	.....	.....
QPHW, QBHW, QCHW	39	15- 100	3	240	.....	14b	.....	.....	22,000	.....	.....	.....	.....	.....	.....
QBGF, QPGF	40	15- 30	1	120	.....	11a	10,000	.....	.....	.....	.....	.....	.....	.....	.....
QBGF, QPGF	40	15- 30	2	120/240	.....	10a, 12a	.....	10,000	.....	.....	.....	.....	.....	.....	.....
HBAW, QHPW, QHCW	59	15- 30	1, 2	120/240	.....	15a	.....	65,000	.....	.....	.....	.....	.....	.....	.....
HBAW, QHPW, QHCW	59	15- 20	3	240	.....	15b	.....	.....	65,000	.....	.....	.....	.....	.....	.....
GB, GC, GHB, GHC	40, 41	15- 100	1	120	.....	11a	65,000	.....	.....	.....	.....	.....	.....	.....	.....
GB, GC, GHB, GHC	40, 41	15- 100	2, 3	240	.....	10b, 11b, 12b, 14b, 15b	.....	.....	65,000	.....	.....	.....	.....	.....	.....
GHB, GHC	40, 41	15- 100	1	277	.....	12c, 13a	.....	.....	.....	14,000	.....	.....	.....	.....	.....
GHB, GHC	40, 41	15- 100	2, 3	277/480	.....	13b	.....	.....	.....	.....	14,000④	.....	.....	.....	.....
GHBS	40	15- 20	1	277	.....	13a	65,000	.....	.....	14,000	.....	.....	.....	.....	.....
CA	42	125- 225	2, 3	240	.....	12b	.....	.....	10,000	.....	.....	.....	.....	.....	.....
CAH	42	125- 225	2, 3	240	.....	14b	.....	.....	22,000	.....	.....	.....	.....	.....	.....
HCA	42	125- 225	2, 3	240	.....	①	.....	.....	42,000	.....	.....	.....	.....	.....	.....
DK⑤	42	250- 400	2	240	250	14b	.....	.....	65,000	.....	.....	.....	.....	10,000	.....
DK⑤	42	250- 400	3	240	.....	14b	.....	.....	65,000	.....	.....	.....	.....	.....	.....
EHD⑤	43	15- 100	1	277	125	13a	.....	.....	.....	14,000	.....	.....	10,000	.....	.....
EHD⑤	43	15- 100	2	480	250	13b	.....	.....	18,000	.....	14,000	.....	.....	10,000	.....
EHD⑤	43	15- 100	3	480	.....	13b	.....	.....	18,000	.....	14,000	.....	.....	.....	.....
FDB⑤	43	15- 150	2	600	250	18a	.....	.....	18,000	.....	14,000	14,000	.....	10,000	.....
FDB⑤	43	15- 150	3	600	.....	18a	.....	.....	18,000	.....	14,000	14,000	.....	.....	.....
FDB⑤	..	15- 150	4	600	.....	①	.....	.....	18,000	.....	14,000	14,000	.....	.....	.....
FD⑤	43	15- 150	1	277	125	13a	.....	.....	.....	25,000	.....	.....	10,000	.....	.....
FD⑤	43	15- 150	2	600	250	22a	.....	.....	65,000	.....	25,000	18,000	.....	10,000	.....
FD⑤	43	15- 150	3	600	.....	22a	.....	.....	65,000	.....	25,000	18,000	.....	.....	.....
FD⑤	..	15- 150	4	600	.....	①	.....	.....	65,000	.....	25,000	18,000	.....	.....	.....
HFD⑤	44	15- 150	1	277	125	13a	.....	.....	.....	65,000	.....	.....	10,000	.....	.....
HFD⑤	44	15- 150	2	600	250	23a	.....	.....	100,000	.....	65,000	25,000	.....	22,000	.....
HFD⑤	44	15- 150	3	600	.....	23a	.....	.....	100,000	.....	65,000	25,000	.....	.....	.....
HFD⑤	..	15- 150	4	600	.....	①	.....	.....	100,000	.....	65,000	25,000	.....	.....	.....
FDC⑤	44	15- 150	2	600	250	24a	.....	.....	200,000	.....	100,000	35,000	.....	22,000	.....
FDC⑤	44	15- 150	3	600	.....	24a	.....	.....	200,000	.....	100,000	35,000	.....	.....	.....
FDC⑤	..	15- 150	4	600	.....	①	.....	.....	200,000	.....	100,000	35,000	.....	.....	.....
JDB⑤	45	70- 250	2	600	250	22a	.....	.....	65,000	.....	25,000	18,000	.....	10,000	.....
JDB⑤	45	70- 250	3	600	.....	22a	.....	.....	65,000	.....	25,000	18,000	.....	.....	.....
JD⑤	45	70- 250	2	600	250	22a	.....	.....	65,000	.....	25,000	18,000	.....	10,000	.....
JD⑤	45	70- 250	3, 4	600	.....	22a	.....	.....	65,000	.....	25,000	18,000	.....	.....	.....
HJD⑤	46	70- 250	2	600	250	22a	.....	.....	100,000	.....	65,000	25,000	.....	22,000	.....
HJD⑤	46	70- 250	3, 4	600	.....	22a	.....	.....	100,000	.....	65,000	25,000	.....	.....	.....
JDC⑤	46	70- 250	2	600	250	22a	.....	.....	200,000	.....	100,000	35,000	.....	22,000	.....
JDC⑤	46	70- 250	3, 4	600	.....	22a	.....	.....	200,000	.....	100,000	35,000	.....	.....	.....
KDB⑤	47	100- 400	2	600	250	23a	.....	.....	65,000	.....	35,000	25,000	.....	10,000	.....
KDB⑤	47	100- 400	3, 4	600	.....	23a	.....	.....	65,000	.....	35,000	25,000	.....	.....	.....
KD⑤	47	100- 400	2	600	250	23a	.....	.....	65,000	.....	35,000	25,000	.....	10,000	.....
KD⑤	47	100- 400	3, 4	600	.....	23a	.....	.....	65,000	.....	35,000	25,000	.....	.....	.....
HKD⑤	48	100- 400	2	600	250	23a	.....	.....	100,000	.....	65,000	35,000	.....	22,000	.....
HKD⑤	48	100- 400	3, 4	600	.....	23a	.....	.....	100,000	.....	65,000	35,000	.....	.....	.....
KDC⑤	48	100- 400	2	600	250	23a	.....	.....	200,000	.....	100,000	50,000	.....	22,000	.....
KDC⑤	48	100- 400	3, 4	600	.....	23a	.....	.....	200,000	.....	100,000	50,000	.....	.....	.....

① Not defined in W-C-375b.
② See listings on pages 39 thru 63 for ampere ratings available for specific breakers.
③ Molded case switches not rated for I.C. Refer to Westinghouse.
④ 277/480 volt only.
⑤ Series C

MOLDED CASE CIRCUIT BREAKERS
Circuit Breaker Selection and Interrupting Ratings

Circuit Breaker Type	Page No.	Cont. Amp. Rating②	No. Poles	Volts Ac	Volts Dc	Federal Spec. W-C-375b	U/L Listed Interrupting Capacities RMS Symmetrical Amperes③ Ac Ratings Volts 120	120/240	240	277	480	600	Dc 125	250	125/250
LA	51	250- 600	2	600	250	21a	.....	.....	42,000	.....	30,000	22,000	.....	10,000	.....
LA	51	250- 600	3	600	.....	21a	.....	.....	42,000	.....	30,000	22,000	.....	.....	.....
HLA	60	250- 600	2	600	250	23a	.....	.....	65,000	.....	35,000	25,000	.....	10,000	.....
HLA	60	250- 600	3	600	.....	23a	.....	.....	65,000	.....	35,000	25,000	.....	.....	.....
LC	52	75- 600	2, 3		.....	21a	.....	.....	42,000	.....	30,000	22,000	.....	.....	.....
HLC	52	75- 600	2, 3	600	.....	23a	.....	.....	65,000	.....	35,000	25,000	.....	.....	.....
MC	54	400- 800	2	600	.....	21a	.....	.....	42,000	.....	30,000	22,000	.....	.....	.....
MC	54	400- 800	3	600	.....	21a	.....	.....	42,000	.....	30,000	22,000	.....	.....	.....
HMC	54	400- 800	2, 3	600	.....	23a	.....	.....	65,000	.....	50,000	25,000	.....	.....	.....
NC	55	800-1200	2, 3	600	.....	21a	.....	.....	42,000	.....	30,000	22,000	.....	.....	.....
HNC	55	800-1200	2, 3	600	.....	23a	.....	.....	65,000	.....	50,000	25,000	.....	.....	.....
PC	56, 57	1000-3000	2, 3	600	.....	25a	.....	.....	125,000	.....	100,000	100,000	.....	.....	.....
FB TRI-PAC	62	15- 100	2, 3		.....	16a, 16b 17a, 26a	.....	.....	200,000	.....	200,000	200,000	.....	.....	.....
LA TRI-PAC	62	70- 400	2, 3		.....	16a, 16b 17a, 26a	.....	.....	200,000	.....	200,000	200,000	.....	.....	.....
NB TRI-PAC	63	300- 800	2, 3	600	.....	16b, 17a, 26a	.....	.....	200,000	.....	200,000	200,000	.....	.....	.....
PB TRI-PAC	63	600-1600	2, 3	600	.....	17a, 26a	.....	.....	200,000	.....	200,000	200,000	.....	.....	.....
FCL	61	15- 100	2, 3	480	.....	①	.....	.....	200,000	.....	150,000	.....	.....	.....	.....
LCL	61	125- 400	2, 3	480	.....	①	.....	.....	200,000	.....	150,000	.....	.....	.....	.....
DA	42	250- 400	2	240	250	14b	.....	.....	22,000	.....	.....	.....	.....	10,000	.....
DA	42	250- 400	3	240	.....	14b	.....	.....	22,000	.....	.....	.....	.....	.....	.....
EB	49	15- 100	1	120	125	11a	10,000	.....	.....	.....	.....	.....	5,000	.....	.....
EB	49	15- 100	2, 3	240	125/250	10b, 11b, 12b	.....	.....	10,000	.....	.....	.....	.....	.....	5,000
EHB	49	15- 100	1	277	125	13a	.....	.....	.....	14,000	.....	.....	10,000	.....	.....
EHB	49	15- 100	2	480	250	13b	.....	.....	18,000	.....	14,000	.....	.....	10,000	.....
EHB	49	15- 100	3	480	.....	13b	.....	.....	18,000	.....	14,000	.....	.....	.....	.....
FB	49	15- 150	2	600	250	18a	.....	.....	18,000	.....	14,000	14,000	.....	10,000	.....
FB	49	15- 150	3	600	.....	18a	.....	.....	18,000	.....	14,000	14,000	.....	.....	.....
JB, KB	50	70- 250	2	600	250	19a, 20a	.....	.....	25,000	.....	22,000	14,000	.....	10,000	.....
JB, KB	50	70- 250	3	600	.....	19a, 20a	.....	.....	25,000	.....	22,000	14,000	.....	.....	.....
LB, LBB	51	125- 400	2	600	250	21a	.....	.....	42,000	.....	30,000	22,000	.....	10,000	.....
LB, LBB	51	125- 400	3	600	.....	21a	.....	.....	42,000	.....	30,000	22,000	.....	.....	.....
HFB	59	15- 30	1	277	125	13a	.....	.....	.....	65,000	.....	.....	10,000	.....	.....
HFB	59	15- 150	2	600	250	22a	.....	.....	65,000	.....	25,000	18,000	.....	10,000	.....
HFB	59	40- 100	1	277	125	13a	.....	.....	.....	25,000	.....	.....	10,000	.....	.....
HFB	59	15- 150	3	600	.....	22a	.....	.....	65,000	.....	25,000	18,000	.....	.....	.....
HKB	59	70- 250	2	600	250	①	.....	.....	65,000	.....	25,000	18,000	.....	10,000	.....
HKB	59	70- 250	3	600	.....	①	.....	.....	65,000	.....	25,000	18,000	.....	.....	.....
HLB	60	125- 400	2	600	250	23a	.....	.....	65,000	.....	35,000	25,000	.....	10,000	.....
HLB	60	125- 400	3	600	.....	23a	.....	.....	65,000	.....	35,000	25,000	.....	.....	.....

① Not defined in W-C-375b.
② See listings on pages 39 thru 63 for ampere ratings available for specific breakers.
③ Molded case switches not rated for I.C. Refer to Westinghouse.
④ 277/480 volt only.
⑤ Series C

MOLDED CASE CIRCUIT BREAKERS
Circuit Breaker Selection Guide

CIRCUIT BREAKER SELECTION GUIDE

Standard Breaker Selection Guide

DA	BA, BAB	EB	EHB	FB	JB, KB
					
2, 3 Poles③ 250-400 Amps @40°C	**1, 2, 3 Poles 15-100 Amps @40°C**	**1, 2, 3 Poles 15-100 Amps @40°C**	**1, 2, 3 Poles 15-100 Amps @40°C**	**2, 3 Poles 15-150 Amps @40°C**	**2, 3 Poles③ 70-250 Amps @40°C**

Dimensions, Inches, 3 Pole Breakers

DA	BA, BAB	EB	EHB	FB	JB, KB
H W D 10⅛ 5½ 4 1/16	H W D 3 3 2⅜	H W D 6 4⅛ 3⅜	H W D 6 4⅛ 3⅜	H W D 6 4⅛ 3⅜	H W D 10 4⅛ 4 1/16

Ac Ratings I. C. Ratings Shown **18,000** are **Symmetrical**②; Ratings Shown 20,000 are Asymmetrical

DA	BA, BAB	EB	EHB	FB	JB, KB
240 Volts Max. Amps I. C. 25,000 and **22,000**	120/240, 240, Volts Max. Amps I. C. 120/240 Volts: 10,000 and **10,000** 240 Volts: 10,000 and **10,000**	120, 240 Volts Max. Amps I. C. 120 Volts: 10,000 and **10,000** 240 Volts: 10,000 and **10,000**	277, 480 Volts Max. Amps I. C. 240 Volts: 20,000 and **18,000** 480 Volts: 15,000 and **14,000** 277 Volts: 15,000 and **14,000**	600 Volts Max. Amps I. C. 240 Volts: 20,000 and **18,000** 480 Volts: 15,000 and **14,000** 600 Volts: 15,000 and **14,000**	600 Volts Max. Amps I. C. 240 Volts: 30,000 and **25,000** 480 Volts: 25,000 and **22,000** 600 Volts: 15,000 and **14,000**

Dc Ratings②

DA	BA, BAB	EB	EHB	FB	JB, KB
250 Volts 10,000 Amps I. C.	....	125, 125/250 Volts 5,000 Amps I. C.	125, 250 Volts 10,000 Amps I. C.	250 Volts 10,000 Amps I. C.	250 Volts 10,000 Amps I. C.

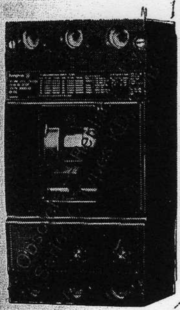
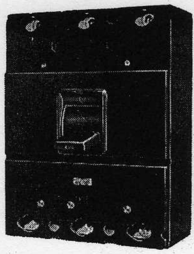
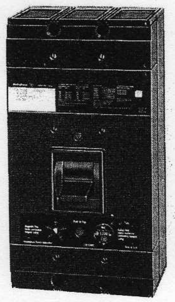
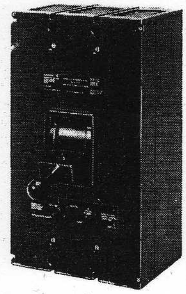
Accessories and Modifications See Catalog 29-120 for Description and Underwriters' Laboratories, Inc. Status

DA	BA, BAB	EB	EHB	FB	JB, KB
Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Ground Current Limiter Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Parallel Connections Handle Lock Devices	Moisture-Fungus Treatment Handle Lock Devices	Shunt Trip Auxiliary Switch Mechanical Interlock Center Studs Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Parallel Connections Handle Lock Devices Undervoltage Trip Alarm Switch	Shunt Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Parallel Connections Handle Lock Devices Undervoltage Trip	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Field Discharge Contact Center Studs Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Parallel Connections Handle Lock Devices	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Ground Current Limiter Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Parallel Connections Handle Lock Devices

① Not Underwriters' Laboratories, Inc. listed.
② Underwriters' Laboratories, Inc. listed.
③ 2-pole unit supplied in 3-pole frame.

CIRCUIT BREAKER SELECTION GUIDE

Standard Breaker Selection Guide

LB, LBB	LA 600	LC	MC	NC	PC, PCC
					
2, 3 Pole② 70-400 Amps @40°C	**2, 3 Poles② 250-600 Amps @40°C**	**2, 3 Poles② 75-600 Amps**	**2, 3 Poles② 400-800 Amps**	**2, 3 Poles② 800-1200 Amps**	**2, 3 Poles② 1000-3000 Amps**
Dimensions, Inches, 3-Pole Breakers					
H 10⅛ W 5½ D 4 1/16	H 10¾ W 8¼ D 4 1/16	H 10¾ W 8¼ D 4 1/16	H 16 W 8¼ D 4 1/16	H 16 W 8¼ D 5½	H 22⅛ W 12 1/16 D 9 1/16
Ac Ratings I. C. Ratings Shown **42,000** are **Symmetrical**①; Ratings Shown 50,000 are Asymmetrical					
600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts: 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts: 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts: 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts: 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 150,000 and **125,000** 480 Volts: 115,000 and **100,000** 600 Volts: 115,000 and **100,000**
Dc Ratings①					
250 Volts 20,000 Amps I. C.③	250 Volts 20,000 Amps I. C.③	....	....	....	....
Accessories and Modifications See Catalog 29-120 for Description and Underwriters' Laboratories, Inc. Status					
Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Ground Current Limiter Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Parallel Connections Handle Lock Devices	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Handle Lock Devices	Shunt Trip Auxiliary Switch Alarm Switch Mechanical Interlock Rear Connecting Studs Moisture-Fungus Treatment Enclosure Handle Mech.	Shunt Trip Auxiliary Switch Alarm Switch Mechanical Interlock Rear Connecting Studs Moisture-Fungus Treatment Enclosure Handle Mech.	Shunt Trip Auxiliary Switch Alarm Switch Mechanical Interlock Rear Connecting Studs Moisture-Fungus Treatment Enclosure Handle Mech.	Drawout Frame Shunt Trip Auxiliary Switch Alarm Switch Mechanical Interlock Moisture-Fungus Treatment Enclosure Handle Mech.

① Underwriters' Laboratories, Inc. listed.
② 2-Pole Unit supplied in 3-pole frame.
③ Ratings above 10,000 amps not UL Listed.

MOLDED CASE CIRCUIT BREAKERS
Circuit Breaker Selection Guide

High Interrupting Capacity Selection Guide

FCL Current Limit-R	LCL Current Limit-R	TRI-PAC® FB	TRI-PAC® LA	TRI-PAC® NB	TRI-PAC PB
					
2, 3 Poles② 15-100 Amps @40°C	**2, 3 Poles② 125-400 Amps**	**2, 3 Poles② 15-100 Amps @40°C**	**2, 3 Poles② 70-400 Amps @40°C**	**2, 3 Poles② 300-800 Amps⑤ @40°C**	**2, 3 Poles② 600-1600 Amps @40°C**

Dimensions, Inches, 3 Pole Breakers

H	W	D	H	W	D	H	W	D	H	W	D	H	W	D
8¾	4⅛	3⅜	16	8¼	4 1/16	8¾	4⅛	3½	16	8¼	4¾	22	8¼	5½	22⅛	12 1/16	9 1/16

Ac Rating I. C. Ratings Shown **65,000** are **Symmetrical**①; Ratings Shown 75,000 are Asymmetrical

480 Volts Max. Amps I. C. 240 Volts: **200,000** 480 Volts: **150,000**	480 Volts Max. Amps I. C. 240 Volts: **200,000** 480 Volts: **200,000**	600 Volts Max. Amps I. C. 240 Volts: **200,000** 480 Volts: **200,000** 600 Volts: **200,000**	600 Volts Max. Amps I. C. 240 Volts: **200,000** 480 Volts: **200,000** 600 Volts: **200,000**	600 Volts Max. Amps I. C. 240 Volts: **200,000** 480 Volts: **200,000** 600 Volts: **200,000**	600 Volts Max. Amps I. C. 240 Volts: **200,000** 480 Volts: **200,000** 600 Volts: **200,000**

Dc Ratings①

.....	.....	250 Volts 100,000 Amps I. C.③	250 Volts 100,000 Amps I. C.③	250 Volts⑤ 100,000 Amps I. C.③	250 Volts④ 100,000 Amps I. C.③

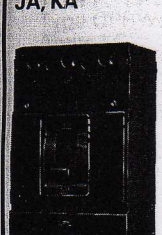
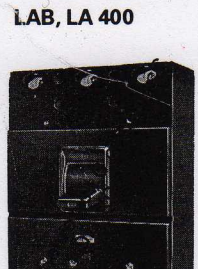
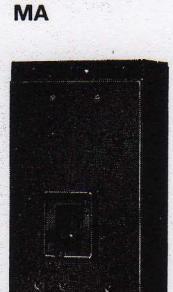
Accessories and Modifications See Catalog 29-120 for Description and Underwriters' Laboratories, Inc. Status

Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Moisture-Fungus Treatment Motor Operator	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Moisture-Fungus Treatment Motor Operator	Shunt Trip Undervoltage Trip Auxiliary Switch Mechanical Interlock Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Handle Lock Devices	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Handle Lock Devices	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Rear Connecting Studs Moisture-Fungus Treatment Motor Operator	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Moisture-Fungus Treatment Motor Operator

① Underwriters' Laboratories, Inc. listed.
② 2-pole unit supplied in 3-pole frame.
③ Based on NEMA test procedures.
④ Dc rating applies only to magnetic only breakers.
⑤ For ratings above 350 amps, Dc rating applies only to magnetic only breakers.

Circuit Breaker Selection Guide

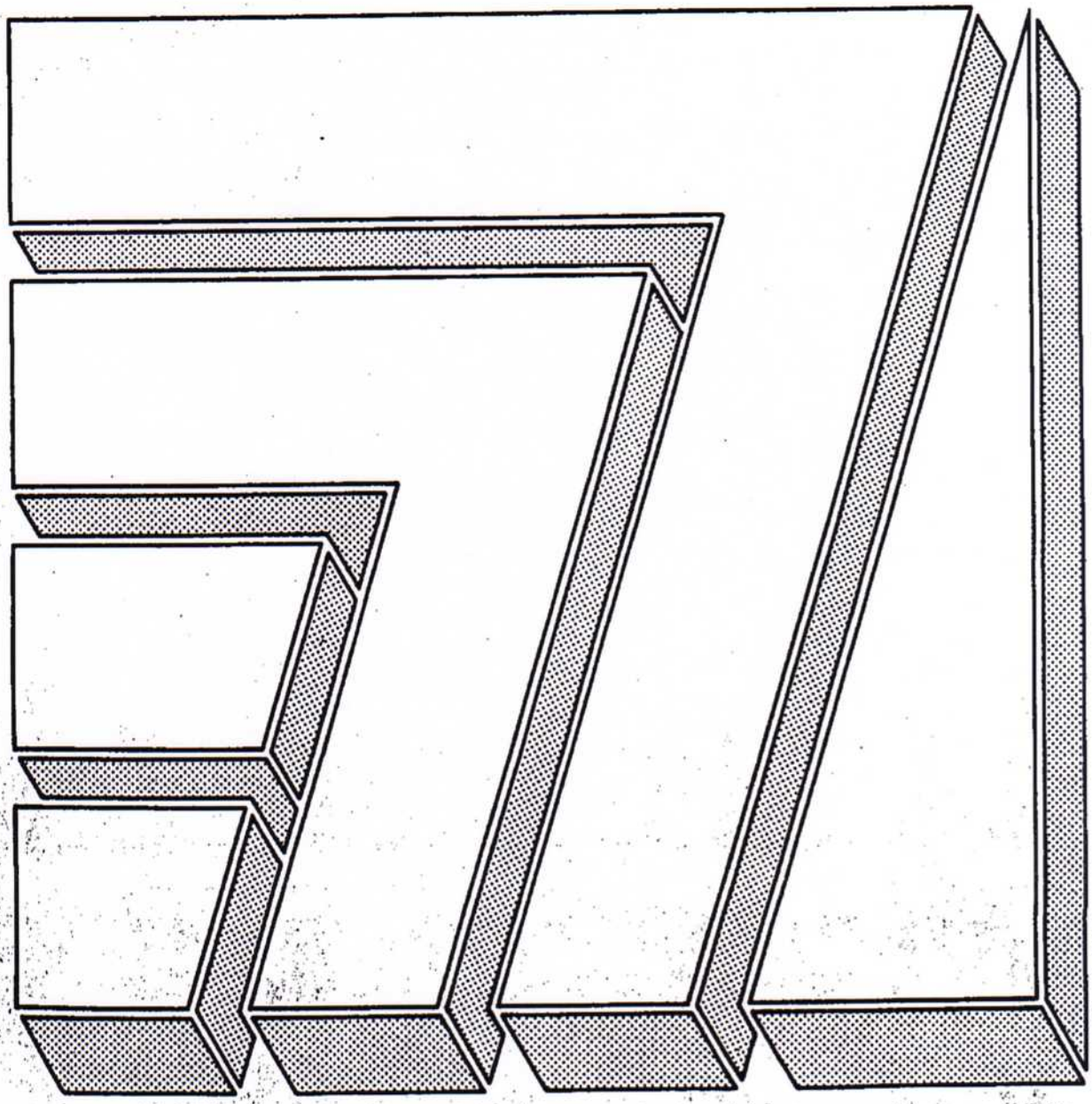
Replacement Breaker Selection Guide

JA, KA	LAB, LA 400	MA	NB	PB
				
2, 3 Poles② **70-225 Amps** **@40°C**	**2, 3 Poles②** **125-400 Amps** **@40°C**	**2, 3 Poles②** **125-800 Amps** **@40°C**	**2, 3 Poles②** **700-1200 Amps** **@40°C**	**2, 3 Poles②** **600-2500 Amps** **@40°C**
Dimensions, Inches, 3 Pole Breakers				
H W D 10⅛ 5½ 4 1/16	H W D 10¾ 8¼ 4 1/16	H W D 16 8¼ 4 1/16	H W D 16 8¼ 5½	H W D 22⅛ 12 1/16 9 1/16
AC Rating I. C. Ratings Shown **25,000** are **Symmetrical**①; Ratings Shown 30,000 are Asymmetrical.				
600 Volts Max. Amps I. C. 240 Volts: 30,000 and **25,000** 480 Volts: 25,000 and **22,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts: 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts: 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 50,000 and **42,000** 480 Volts: 35,000 and **30,000** 600 Volts: 25,000 and **22,000**	600 Volts Max. Amps I. C. 240 Volts: 150,000 and **125,000** 480 Volts: 115,000 and **100,000** 600 Volts: 115,000 and **100,000**
Dc Rating①				
250 Volts 10,000 Amps I. C.	250 Volts 20,000 Amps I. C.③	250 Volts⑥ 20,000 Amps I. C.③	250 Volts⑤ 20,000 Amps I. C.③	250 Volts⑤ 75,000 Amps I. C.③④
Accessories and Modifications See Catalog 29-120 for Description and Underwriters' Laboratories, Inc. Status				
Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Ground Current Limiter Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Parallel Connections Handle Lock Devices	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech. Handle Lock Devices	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech.	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Center Studs Rear Connecting Studs Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech.	Shunt Trip Undervoltage Trip Auxiliary Switch Alarm Switch Mechanical Interlock Moisture-Fungus Treatment Motor Operator Enclosure Handle Mech.

① Underwriters' Laboratories, Inc. listed
② 2-pole unit supplied in 3-pole frame.
③ Ratings above 10,000 amps not UL Listed.
④ Based on NEMA test procedures
⑤ Dc rating applies only to magnetic only breakers.
⑥ For ratings 700 amps and up, Dc Rating applies only to magnetic only breakers.

SIEMENS

7SK88 Static single phase inverse time overcurrent relay

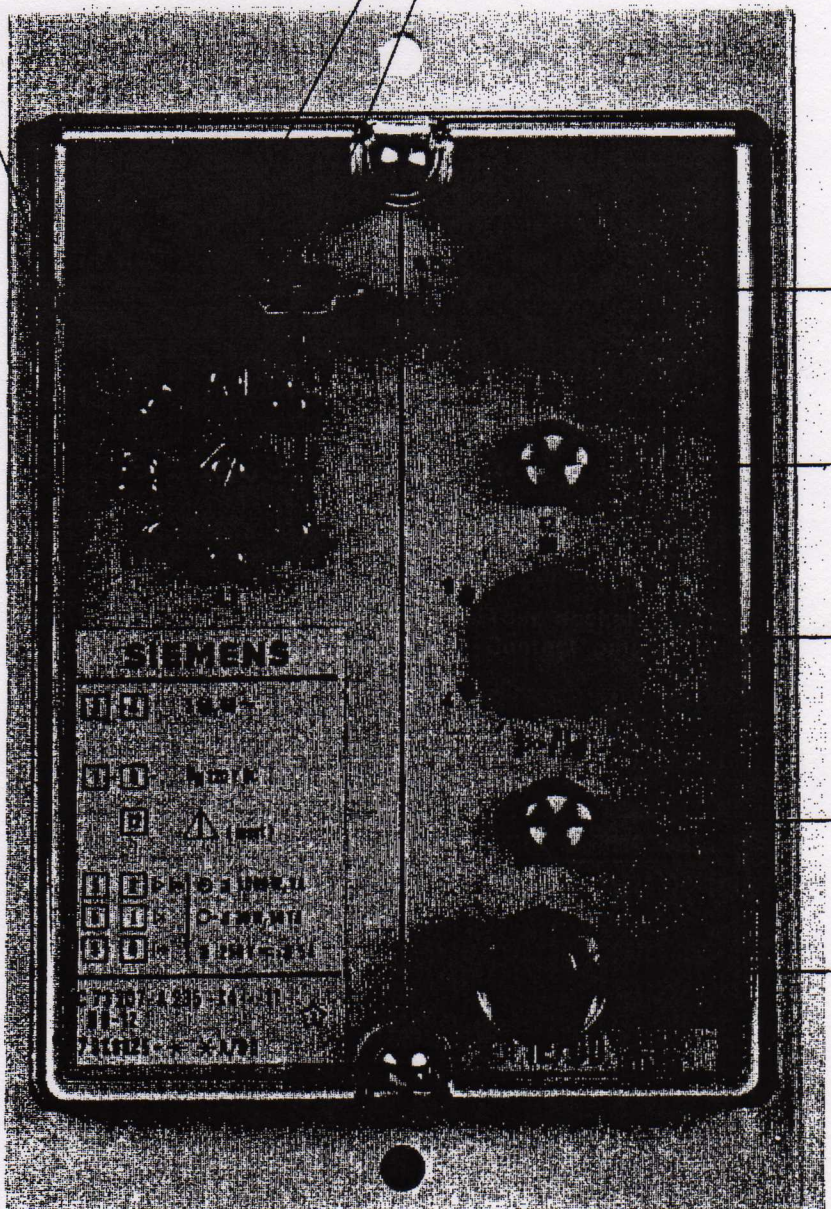


Order No. E141/247-101

(4) E14041-F7230-U211-A3-7600

current setting Jp

Contact pin



Time multiplie

Indicator J>

High set J>>

Indicator J>>

Reset

6. Setting the relay

6.1 Overcurrent element I>

Remove front cover by releasing captive screws top and bottom. Removal of the cover automatically short circuits the input from the associated current transformer and disconnects it from the internal circuits and the tripping and alarm circuits are interrupted. Thus the accessible components on the relay front are entirely volt-free. When used for phase overcurrent protection, one or two further 7SK88 relays are installed in the remaining phases. These remain operative.

The overcurrent element I> has two settings:

6.1.1 Current setting I_p

I_p (plug setting) can be selected in one of the following ranges. 0.1-0.4A, 0.2-0.8A, 0.5-2A, 1-4A, 2,5-10A, 4-16A in 7 equal steps by a rotary link on the front plate. These setting values on the front plate are given in amps. The two screws must be re-tightend carefully. The link must not be left in an open position. This setting allows the overcurrent tripping to be selected with respect to circuit rated load and current transformer ratio.

e.g.	c.t. ratio	200/5 A
	circuit full load current	120 A
	required overcurrent tripping (for example)	1.25 x full load current
	relay range	2,5 to 10 A

$$I_p = \frac{120}{200} \times 5 \times 1.25 = 3.75 \text{ A}$$

Nearest setting = 3.75 A

6.1.2 Time multiplier (TM)

Set by slotted rotary dial on the front plate; two ranges are available: 0.05 to 0.5 in steps of 0.05 (with red selector plug on PCB in position I - as set in the factory), alt. 0.55 to 1 in steps of 0.05 (with red selector plug on PCB in position II). The adhesive strip for the TM scale situated on the rear of the front plate must also be removed and fixed on the front to cover the printed letters TM into TM + 0.5. Thus the alteration of the TM-setting range is made visible.
The TM-setting allows selection of the time scale against which the inverse characteristic is set. The intermediate curves given by the 0.05 steps lie between the curves shown.

The recommended grading time between successive relays is 0.3 to 0.4 sec.

6.1.3 Current time characteristics

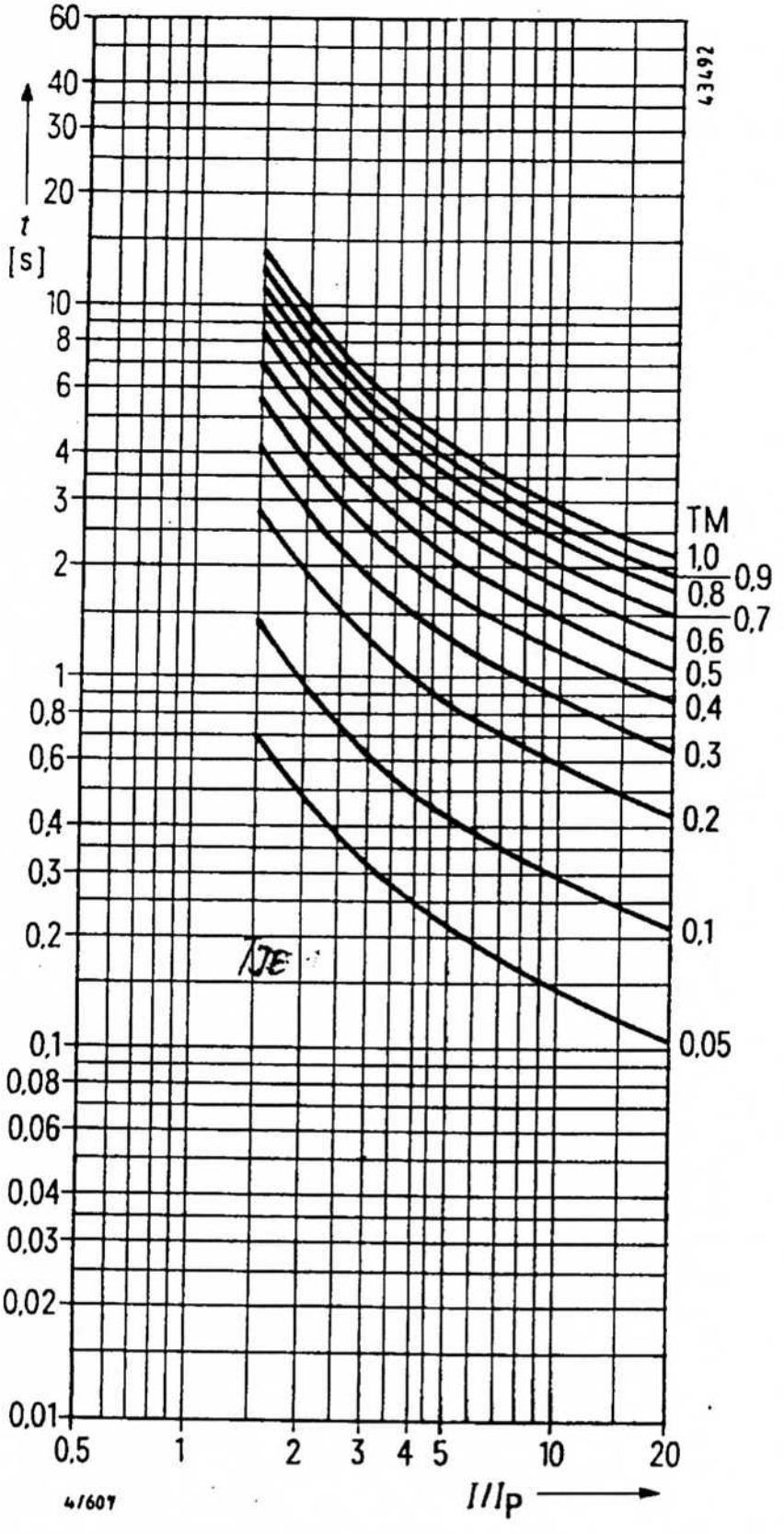
The current time characteristics $t = f(I/I_p)$ for the inverse time overcurrent relay 7SK88 are shown on page 12 to 14.

I : Current in A
I_p: Current setting in A
TM: Time multiplier adjustable on front panel, as per BS 142

The current time charateristic of 7SK88 is designed according BS142. The relay must not pick-up below 1,05 x setting. The curves are not defined acc. BS142 between 1,05 to 2 x setting.

About this demand the curves of 7SK88 are defined from 1,5 x setting. In the range between 1,15 to 1,5 x setting the relay 7SK88 is certainly tripping ,but the tripping time is not defined and different from the relay.

normal inverse (to BS 142)



6.2 High set instantaneous element I≫

When fitted, is set by slotted rotary dial on the front plate:

Range: 4 to 20 times I_p. The setting is stepless.

e.g. if I_p set at 3.75 A = 125 % circuit full load current (as in current setting example) and I≫ set on 10, then instantaneous element operates at 37.5 A (12.5 x full load current) within approx. 15 ms.

If the operating time proves to be too short, it can be extended by inserting a capacitor, on the solder tags marked C12 on the printed circuit board. A dry type tantalum capacitance is recommended (e.g. Siemens B45265 with at least 35V d.c. and tolerance ± 10 %).

The required capacitance for a particular time delay is given in the following diagram.

If the solder bridge Br.2 is inserted on the PCB then the tripping from the high set element I≫ is blocked (as delivered the bridge Br.2 is not inserted).