Miniature circuit breakers 10kA type NBN, NCN, NDN

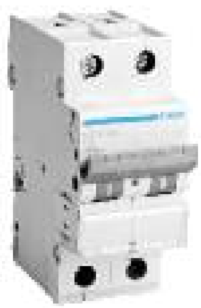
Description
- Protects circuits against overload & short circuit faults
- Provides isolation to downstream circuits

Technical data
- Conforms to
  IEC 60898-1:2002
  IS/IEC 60898-1:2002
- ISI marking
- CE marking
- Ratings - 0.5 to 63 A
- No. of poles - 1P, 2P, 3P & 4P
- Tripping curves - B, C & D
- Breaking capacity
  10kA (as per IEC 60898-1)
- Suitable for isolation as per IEC 60947

Features & benefits
- Positive Contact Isolation ensuring complete protection to user
- Ergonomined toggle for comfort switching
- Insulated safety shutter for finger touch proof terminal
- Laser marking to ensure permanent information
- Front product labeling for displaying of load information
- Energy Limiting Class 3 to ensure low let through energy to limit thermal & mechanical stress on cables
- Direct mounting of wide range of accessories like OV, UV, ST, AX, AL, OV + UV release

Connection
25sq mm rigid cables
16sq mm flexible cables


NCN110N


NCN220N


NCN316N


NCN432N

Description	Modules	In (Amp)	B Curve	C Curve	D Curve
1P	1	0.5		**NCN100N**	**NDN100N**
	1	1		**NCN101N**	**NDN101N**
	1	2		**NCN102N**	**NDN102N**
	1	3		**NCN103N**	**NDN103N**
	1	4		**NCN104N**	**NDN104N**
	1	6	**NBN106N**	**NCN106N**	**NDN106N**
	1	10	**NBN110N**	**NCN110N**	**NDN110N**
	1	16	**NBN116N**	**NCN116N**	**NDN116N**
	1	20	**NBN120N**	**NCN120N**	**NDN120N**
	1	25	**NBN125N**	**NCN125N**	**NDN125N**
	1	32	**NBN132N**	**NCN132N**	**NDN132N**
	1	40	**NBN140N**	**NCN140N**	**NDN140N**
	1	50	**NBN150N**	**NCN150N**	**NDN150N**
	1	63	**NBN163N**	**NCN163N**	**NDN163N**
2P	2	0.5		**NCN200N**	**NDN200N**
	2	1		**NCN201N**	**NDN201N**
	2	2		**NCN202N**	**NDN202N**
	2	3		**NCN203N**	**NDN203N**
	2	4		**NCN204N**	**NDN204N**
	2	6	**NBN206N**	**NCN206N**	**NDN206N**
	2	10	**NBN210N**	**NCN210N**	**NDN210N**
	2	16	**NBN216N**	**NCN216N**	**NDN216N**
	2	20	**NBN220N**	**NCN220N**	**NDN220N**
	2	25	**NBN225N**	**NCN225N**	**NDN225N**
	2	32	**NBN232N**	**NCN232N**	**NDN232N**
	2	40	**NBN240N**	**NCN240N**	**NDN240N**
	2	50	**NBN250N**	**NCN250N**	**NDN250N**
	2	63	**NBN263N**	**NCN263N**	**NDN263N**
3P	3	0.5		**NCN300N**	**NDN300N**
	3	1		**NCN301N**	**NDN301N**
	3	2		**NCN302N**	**NDN302N**
	3	3		**NCN303N**	**NDN303N**
	3	4		**NCN304N**	**NDN304N**
	3	6	**NBN306N**	**NCN306N**	**NDN306N**
	3	10	**NBN310N**	**NCN310N**	**NDN310N**
	3	16	**NBN316N**	**NCN316N**	**NDN316N**
	3	20	**NBN320N**	**NCN320N**	**NDN320N**
	3	25	**NBN325N**	**NCN325N**	**NDN325N**
	3	32	**NBN332N**	**NCN332N**	**NDN332N**
	3	40	**NBN340N**	**NCN340N**	**NDN340N**
	3	50	**NBN350N**	**NCN350N**	**NDN350N**
	3	63	**NBN363N**	**NCN363N**	**NDN363N**
4P	4	0.5		**NCN400N**	**NDN400N**
	4	1		**NCN401N**	**NDN401N**
	4	2		**NCN402N**	**NDN402N**
	4	3		**NCN403N**	**NDN403N**
	4	4		**NCN404N**	**NDN404N**
	4	6	**NBN406N**	**NCN406N**	**NDN406N**
	4	10	**NBN410N**	**NCN410N**	**NDN410N**
	4	16	**NBN416N**	**NCN416N**	**NDN416N**
	4	20	**NBN420N**	**NCN420N**	**NDN420N**
	4	25	**NBN425N**	**NCN425N**	**NDN425N**
	4	32	**NBN432N**	**NCN432N**	**NDN432N**
	4	40	**NBN440N**	**NCN440N**	**NDN440N**
	4	50	**NBN450N**	**NCN450N**	**NDN450N**
	4	63	**NBN463N**	**NCN463N**	**NDN463N**

Miniature circuit breakers 80-125A, 10kA type HLF

Description
- Protects circuits against overload & short circuit faults
- Provides isolation to downstream circuits

Technical data
- Conforms to IEC 60947
- **CE marking**
- Ratings – 80A,100A &125A
- No. of poles - 1P, 2P, 3P & 4P
- Tripping curve - C

- Breaking capacity - 10kA (as per IEC 60947)
- Suitable for isolation as per IEC 60947

Features & benefits:
- MCBs handle can be locked in "off" position
- Large terminal capacity - upto 70 sq mm
- Steel reinforcement plate to improve terminal strength
- Serrations on jaws to provide better grip on cables
- Line-load reversible

- **RoHS compliant, " Green" product**
- Wide range of accessories are available

Connection capacity
- 35 sq mm flexible wire (50 sq mm possible with some cable end-caps)
- 70 sq mm rigid wire

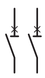
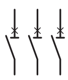
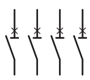
IP2X terminals

HLF199S

HLF299S

HLF399S

HLF499S

Description	In (Amp)	Modules	Catalogue No.
1P	80	1.5	**HLF180S**
	100	1.5	**HLF190S**
	125	1.5	**HLF199S**
2P	80	3	**HLF280S**
	100	3	**HLF290S**
	125	3	**HLF299S**
3P	80	4.5	**HLF380S**
	100	4.5	**HLF390S**
	125	4.5	**HLF399S**
4P	80	6	**HLF480S**
	100	6	**HLF490S**
	125	6	**HLF499S**

Miniature circuit breakers 6kA SP&N type ML

Description
- Protect circuits against overload & short circuit faults
- Provides isolation to downstream circuits

Technical data
- Conforms to IEC 60898-1
- **CE marking**
- Ratings – 6A to 40 A
- No. of poles - 1 Pole + switched neutral in one module
- Tripping curve - C

Features & benefits
- Compact design, SPN MCB in one mod (17.5mm) only
- Switched neutral provides complete isolation to downstream circuits
- Line-load reversible
- **RoHS compliant, " Green" product**
- Wide range of accessories are available

Connection
16sq mm rigid cables
10sq mm flexible cables
Prong type busbar.

IP2X terminals


ML516J

Description	Modules	In (Amp)	**Catalogue No.**
SP & N MCB	1	6	**ML506J**
	1	10	**ML510J**
	1	16	**ML516J**
	1	20	**ML520J**
	1	25	**ML525J**
	1	32	**ML532J**
	1	40	**ML540J**

Characteristics	ML	NB	NC	ND	HLF
Poles	SP+N	SP DP TP FP	SP DP TP FP	SP DP TP FP	SP DP TP FP
Rated operational voltage U_e(V)	230	230/415	230/415	230/415	230/415
Nominal Current	6-40A	6-63A	0.5-63A	0.5-63A	80-100-125A
Breaking capacity to IEC 60 898	6kA	10kA	10kA	10kA	10kA
Breaking capacity to IEC 60 947-2	-	15kA	15kA	15kA	10kA
Rated insulation voltage U_i(V)	500V	500V	500V	500V	500V
Rated impulse voltage U_{imp} (kV)	4000V	4000V	4000V	6000V	6000V
Electrical endurance					
0.5 to 32A	10000	20000	20000	20000	
40 to 63A		10000	10000	10000	
80 to 125A					4000

Power loss

The power loss of MCB's is closely controlled by the standards and is calculated on the basis of the voltage drop across the main terminals measured at rated current. The power loss of Hager circuit breakers is very much lower than that required by the Standard, so in consequences run cooler and are less affected when mounted together.

The table below gives the watts loss per pole at rated current

MCB rated current (A)	0.5	1	2	3	4	6	10	16	20	25	32	40	50	63	80	100	125
Watts loss per pole (W)	1.3	1.5	1.7	2.1	2.4	2.7	1.8	2.6	2.8	3.3	3.9	4.3	4.8	5.2	5	5.5	8

For use with DC

Because of their quick make and break design and excellent arc quenching capabilities Hager circuit breakers are suitable for DC applications.

The following parameters must be considered.

1. system voltage:
   Determined by the number of poles connected in series
2. short-circuit current:
3. tripping characteristics:
   - the thermal trip remains unchanged
   - the magnetic trip will become less sensitive requiring derating by Ö2 the ac value.

No. of poles	**1 pole**		**2 poles in series**	
Range	Max voltage	Breaking capacity L/R=15ms	Max voltage	Breaking capacity L/R=15ms
NB, NC	60V	10kA	125V	10kA
ND	125V	10kA	250V	10kA
HLF	60V	15kA	125V	15kA

NB, NC, ND						
Characteristic curve	**B**		**C**		**D**	
Magnetic trip	50Hz	dc	50Hz	dc	50Hz	dc
Irm1	3 In	4.5 In	5 In	7.5 In	10 In	15 In
Irm2	5 In	7.5 In	10 In	15 In	20 In	30 In

HLF (IEC 60-898)		
Characteristic curve	**C**	
Magnetic trip	50Hz	dc
Irm1	5 In	7.1 In
Irm2	10 In	14.1 In

Latest national & international standards covering Low Voltage Circuit Breakers provide the user with a better assurance of quality and performance by taking into account the actual operating conditions of the breaker. New definitions and symbols have been introduced which should be committed to memory. Some of those most frequently used are:

U_e : rated service voltage
U_i : rated insulation voltage (>Uemax)
U_{imp} : rated impulse withstand
I_{cm} : rated short circuit making capacity
I_{cn} : rated short circuit capacity
I_{cs} : rated service short circuit breaking capacity
I_{cu} : rated ultimate short circuit breaking capacity
I_{Dn} : rated residual operating current (often called residual sensitivity)
I_n : rated current = maximum value of current used for the temperature rise test.
Dt : trip delay of residual current devices

In addition, IEC 60898 sets out to provide a greater degree of safety to the uninstructed users of circuit breakers. It is interesting to note that the description "miniature circuit breaker" or MCB is not used at all in the standard, but no doubt both manufacturers and users will continue to call circuit breakers complying with IEC 60898 miniature circuit breakers or MCBs for some time to come.

The scope of this standard is limited to ac air break circuit breakers for operation at 50Hz or 60Hz, having a rated current not exceeding 125A and a rated short-circuit capacity not exceeding 25kA.

A rated service short-circuit breaking capacity I_{cs} is also included which is equal to the rated short-circuit capacity I_{cn} for short-circuit capacity values up to and including 6kA, and 50% of Icn above 6kA with a minimum value of 7.5kA. as the circuit-breakers covered by this standard are intended for household and similar use, Ics is of academic interest only. The rated short-circuit capacity of a MCB (I_{cn}) is the alternating component of the prospective current expressed by its r.m.s. value, which the MCB is designed to make, carry, for its opening time and to break under specified conditions. I_{cn} is shown on the MCB label in a rectangular box with the suffix 'A' and is the value which is used for application purposes. Icn (of the MCB) should be equal to or greater than the prospective short-circuit current at the point of application.

You will see from the curves that the inverse time delay characteristic which provides overload protection is the same on all three. This is because the standards required the breaker to carry 1.13 times the rated current without tripping for at least one hour and when the test current is increased to 1.45 times the rated current, it must trip within one hour, and again from cold if the last current is increased to 2.55 times the rated current the breaker must trip between 1 and 120 seconds. The inverse time delay characteristic of all MCBs claiming compliance with IEC 60898 must operate within these limits.

The difference between the three types of characteristic curves designated 'B', 'C' and 'D' concerns only the magnetic instantaneous trip which provides short-circuit protection.

* For type 'B' the breaker must trip between the limits of 3 to 5 times rated current
* For type 'C' the breaker must trip between the limits of 5 to 10 times rated current, and
* For type 'D' the breaker must trip between the limits of 10 to 20 times rated current

Often manufacturers publish their MCB tripping characteristics showing the limits set by the standard and guarantee that any breakers that you purchase will operate within these limits. So great care should be taken when working with characteristics curves showing lower and higher limits - on no account should you take a mean point for application design purposes.

For cable protection applications you should take the maximum tripping time and some manufacturers publish single line characteristics curves which show the maximum tripping time. If the design problem is nuisance tripping then the minimum tripping time should be used and for desk top co-ordination studies, both lower and upper limits have to be taken into account.

Energy limiting

Energy is measured in Joules. *James Prescott Joule proved that thermal energy was produced when an electric current flowed through a resistance for a certain time, giving us the formula :-

Joules = I^2 x R x t or because we know that watts = I^2R
Joules = watts x seconds
Therefore we can say that :
One Joule = one watt second
or energy = watts x seconds = I^2R t

If the resistance (R) remains constant or is very small compared with the current (I) as in the case of short-circuit current, then energy becomes proportional to I^2t. Which is why the energy let-through of a protective device is expressed in ampere squared seconds and referred to as I^2t.

I^2t (Joule Integral) is the integral of the square of the current over a given time interval (t_0, t_1)

The I^2t characteristic of a circuit breaker is shown as a curve giving the maximum values of the prospective current as a function of time.

Manufacturers are required by the Standard to produce the I^2t characteristic of their circuit breakers.

The energy limiting characteristics of modern MCBs greatly reduce the damage that might otherwise be caused by short-circuits. They protect the cable insulation and reduce the risk of fire and other damage. Knowledge of the energy limiting characteristic of a circuit breaker also helps the circuit designer calculate discrimination with other protective devices in the same circuit.

Because of the importance energy limiting characteristic the Standards for circuit breakers for household and similar installations suggests three energy limiting classes based on the permissible I^2t (let-through) values for circuit breakers up to 32A; class 3 having the highest energy limiting performance.

All Hager MCBs are well within the limits of energy let-through set by IEC 60898 for energy limiting class 3.

The circuit breaker can have the line\load connected to either top or bottom terminals.

Temperature Derating

MCBs are designed and calibrated to carry their rated current and to operate within their designated thermal time/current zone at 30°C. Testing is carried out with the breaker mounted singly in a vertical plane in a controlled environment. Therefore if the circuit breaker is required to operate in conditions which differ from the reference conditions, certain factors have to be applied to the standard data. For instance if the circuit breaker is required to operate in a higher ambient temperature other than 30ºC it will require progressively less current to trip within the designated time/current zone,

Temperature correction

In(A)	30°C	35°C	40°C	45°C	50°C	55°C	60°C
0.5	0.5	0.48	0.46	0.44	0.42	0.40	0.38
1	1	0.96	0.92	0.88	0.84	0.80	0.76
2	2	1.92	1.84	1.76	1.68	1.60	1.52
3	3	2.88	2.76	2.64	2.52	2.40	2.28
4	4	3.84	3.68	3.52	3.36	3.20	3.04
6	6	5.76	5.52	5.28	5.04	4.80	4.56
10	10	9.60	9.20	8.80	8.40	8.00	7.60
16	16	15.36	14.72	14.08	13.44	12.80	12.16
20	20	19.20	18.40	17.60	16.80	16.00	15.20
25	25	24.00	23.00	22.00	21.00	20.00	19.00
32	32	30.72	29.44	28.16	26.88	25.60	24.32
40	40	38.40	36.80	35.20	33.60	32.00	30.40
50	50	48.00	46.00	44.00	42.00	40.00	38.00
63	63	60.48	57.96	55.44	52.92	50.40	47.88
80	80	77.60	75.10	72.60	70.00	67.20	64.40
100	100	96.60	93.10	89.40	85.60	81.60	77.50
125	125	121.90	118.90	115.70	112.40	109.10	105.60

Grouping factors

Consideration should also be given to the proximity heating effect of the breakers themselves when fully loaded and mounted together in groups. There is a certain amount of watts loss from each breaker depending on the trip rating which may well elevate the ambient air temperature of the breaker above the ambient air temperature of the enclosure.

Grouping factor (rated current reduce by factor K)

No. of Units	K	HLF
n = 1	1	1
2n < 4	0.95	1
4n < 6	0.9	1
6n	0.85	1

Effects of frequency change

thermal - unchanged
magnetic - value multiplied by coefficient K

F(Hz)	17Hz-60Hz	100Hz	200Hz	400Hz
K	1	1.1	1.2	1.5

Example

Five circuit breakers are to be installed inside an enclosure in a switchroom which has an average ambient air temperature of 35°C. Each circuit breaker will be required to supply a continuous current of 20A.

From table, we would select a circuit breaker which has a rated current of 25A at 30°C and 23.5A at 35°C. This takes care of the switchroom ambient air temperature of 35°C, but we also have to take into account the grouping factor of live continuously loaded breakers mounted together in one enclosure. Table gives us a grouping factor K of 0.9. We then apply this grouping factor to the rated current at 35°C which gives us a circuit breaker rated current of 23.5 x 0.9 = 21.15A in the specified conditions

Lighting circuits

Although the MCBs prime function is the protection of lighting circuits, they are often used as local control switches as well, conveniently switching on and off large groups of luminaries in shops and factories. The MCB is well able to perform this additional task safely and effectively. Hager MCBs have an electrical endurance of 20,000 on/off operations for MCBs up to and including 32A and 10,000 on/off operations for 40, 50 and 63A MCBs.

For the protection of lighting circuits the designer must select the circuit breaker with the lowest instantaneous trip current compatible with the inrush currents likely to develop in the circuit.

High Frequency (HF) ballasts are often singled out for their high inrush currents but they do not differ widely from the conventional 50Hz. The highest value is reached when the ballast is switched on at the moment the mains sine wave passes through zero. However, because the HF system is a "rapid start" system whereby all lamps start at the same time, the total inrush current of an HF system exceeds the usual values of a conventional 50Hz system. Therefore where multiple ballasts are used in lighting schemes, the peak current increases proportionally.

Mains circuit impedance will reduce the peak current but will not affect the pulse time.

The problem facing the installation designer in selecting the correct circuit breaker is that the surge characteristic of HF ballasts vary from manufacturer to manufacturer. Some may be as low as 12A with a pulse time of 3ms and some as high as 35A with a pulse time of 1 ms. Therefore it is important to obtain the expected inrush current of the equipment from the manufacturer in order to find out how many HF ballasts can safely be supplied from one circuit breaker without the risk of nuisance tripping.

This information can then be divided into the minimum peak tripping current of the circuit breaker as shown in the Table below.

Minimum peak tripping current

Circuit breaker	Circuit breaker rated current								
type	6A	10A	16A	20A	25A	32A	40A	50A	63A
B	26	43	68	85	106	136	170	212	268
C	43	71	113	142	177	223	283	354	446
D	85	142	226	283	354	453	566	707	891

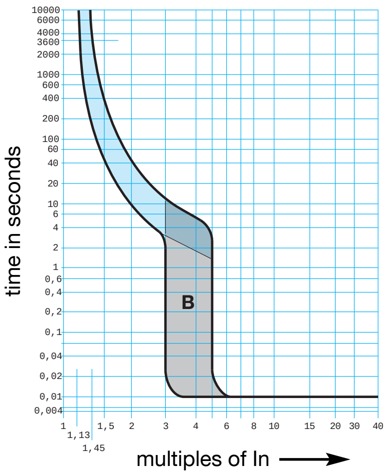
Example:

How many HF ballasts, each having an expected inrush of 20A can be supplied by a 16A type C circuit breaker? From table above, 16A type C we have a minimum peak tripping current of 113A.

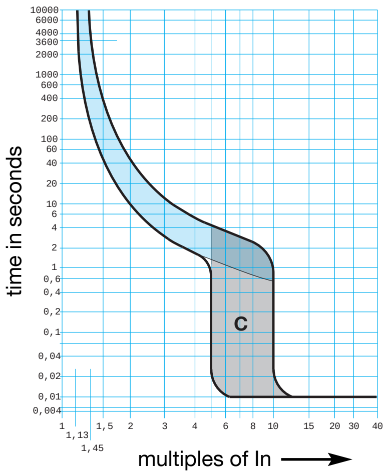
Therefore, 113 / 20 = 5

i.e. 5 ballasts can be supplied by a 16A type C circuit breaker.

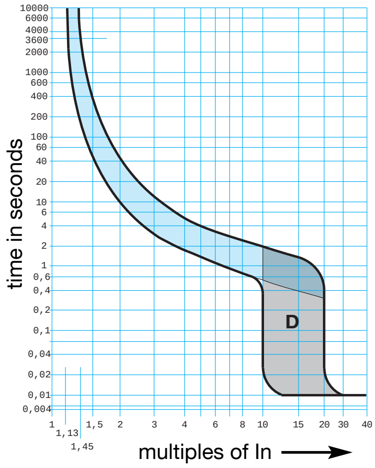
'B' curve (IEC 60898)
MCBs: NB rated 6-63A



'C' curve (IEC 60898)
MCBs: NC rated 0.5-63A
HLF rated 80-125A

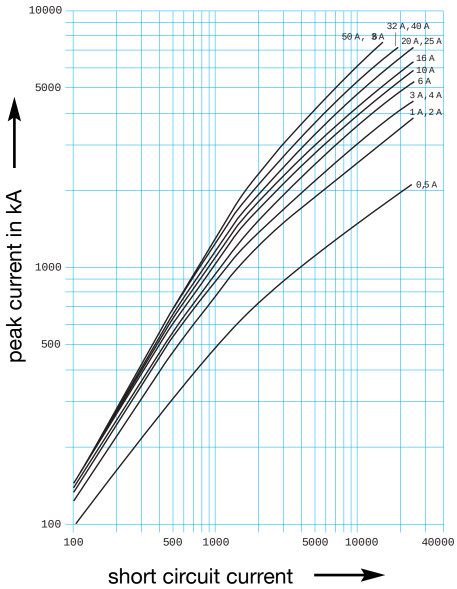


'D' curve (IEC 60898)
MCBs: ND rated 0.5-63A

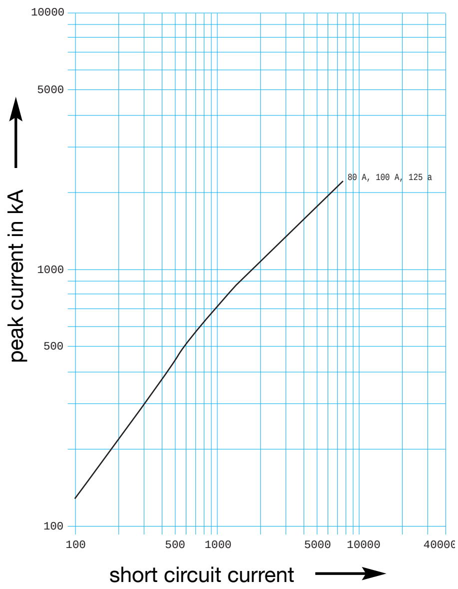


current limiting at 400V

NB NC ND

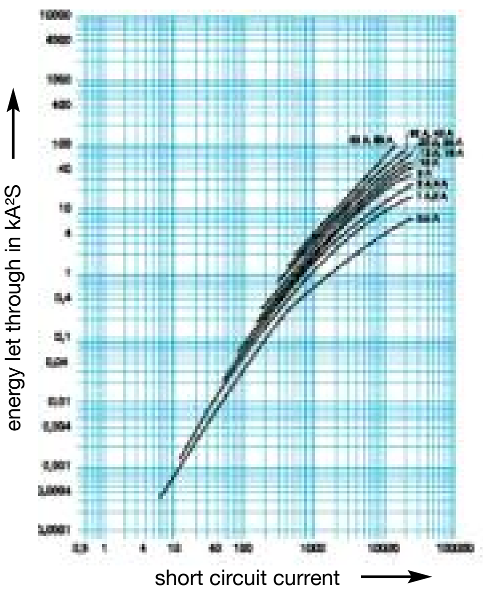


HLF



I²t characteristics

NB NC ND



HLF