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MOTOR CO-ORDINATION STARTER

Short circuit co-ordination - the choice is yours

INTERNATIONAL QUALITY MANAGEMENT SYSTEM
ISO9002 NATA CERTIFIED

NHP ELECTRICAL ENGINEERING PRODUCTS PTY LTD
A.C.N. 004 304 812

Switchgear selection for greater safety and dependability with proven component co-ordination

What is wrong with the way switchgear is usually selected?

It is usually assumed that, provided a component of switchgear is chosen on the basis of its kW or current rating and according to its utilisation category, then all will be well.

There is an increasing awareness however, that this is not so. Additional consideration is necessary, namely "How will the components work together under all possible situations?"

What can go wrong?

To ascertain this, a comprehensive series of tests is necessary. It is not just a case of looking up tables.

Many uncontrollable effects can result from poor component co-ordination.

For example:

- ❑ Nuisance fuse blowing or circuit breaker tripping during starting.
- ❑ Uncontrollable arcing inside contactors which may even develop into a full blown arcing fault.
- ❑ Welded contacts.
- ❑ Distorted overloads failing to detect motor overloads.
- ❑ Repair and replacement costs are high.
- ❑ Production losses.
- ❑ Loss of profitability.

And why?

During a motor run up, the high inrush current during starting can blow an undersized fuse or trip the circuit breaker thereby preventing the drive from even starting effectively.

Even at relatively low fault levels the electromagnetic forces created by the fault current can cause the contacts of a contactor to lift. This causes heating or even mild arcing which melts the contact material on the surface of the contacts. At the instant the Short Circuit Protective Device (SCPD) interrupts the current, the pressure of the springs re-close the contacts. Under these conditions contact welding can occur resulting in loss of control and possibly a single phase condition when the power is restored.

Furthermore the let-through current of the SCPD can also cause excessive distortion of the bi-metal strip in the overload. This can prevent restoration of the bi-metal strip to its original configuration on cooling, destroying its protection characteristics.

Such damage is not readily evident and can consequently lead to nuisance tripping of the overload or motor failure at some time in the future, depending on the degree of damage to the overload elements.

Good component design can improve short circuit performance and provide reliable operation under abnormal conditions.

Excellent design enables the CA 6-105 contactor to reach its full AC 3 rating for type 2 co-ordination with both fuses and circuit breakers.

What is co-ordination

The motor starter consists of a combination of contactor, overload relay and Short Circuit Protection Device (SCPD) being either fuses or circuit breakers.

During motor starting and at normal loading, the overload relay protects both the motor and cables by tripping the contactor in a time inversely proportional to the current. However, under short circuit conditions, the response time would be too long and the fuses or circuit breakers must takeover to interrupt the fault current therefore limiting energy passed through the starter components. When this is successfully achieved, the combination is said to be co-ordinated.

It is a requirement of the Australian Standard AS 3947.4.1 that combination motor starters are capable of withstanding the effects of load side short circuits. Some damage to the combination is permitted, but this must be confined and not present a risk to the operator, or damage equipment adjacent to the starter.

Contactors and thermal overload relays only have limited ability to withstand the high current associated with a fault such as an internal motor short. Their design is optimised for performance at much lower currents and to design in the ability to control or withstand high fault levels would add to costs and possibly reduce its performance at normal levels.

The standards

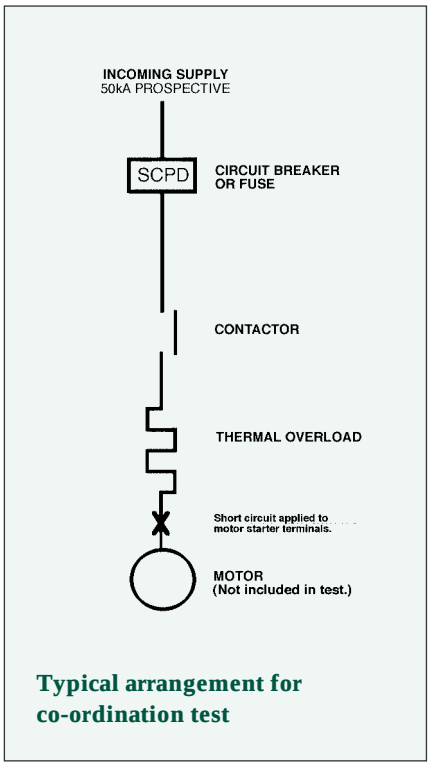
The requirements of several standards can be applied to these combination units. The Wiring Rules, AS 3000, are concerned mainly with setting standards for the fixed wiring. In this regard the concern is the wiring between the protection device and the motor.

As motors can experience short term overloading the current rating of a fuse can be up 4 times and a circuit breaker 2.5 times the full load rating of the motor. The Wiring Rules allow the overload protection and the short circuit protection to be provided by different devices. This allows magnetic only circuit breakers, or back-up type fuses, to be used in conjunction with a contactor/thermal overload relay configuration.

Isolating switches must also be provided in the motor or control circuit. These are to be in clear view of any person working on the motor, or provided with a locking device.

AS 3947.4.1 specifies testing requirements for the combination of components required to perform the motor control and protection functions.

If the equipment has been mounted in a switchboard it is possible to meet the testing requirements of AS 3439.1 short circuit withstand of the outgoing circuit at the same time as the tests to AS 3947.4.1 are performed.



Typical arrangement for co-ordination test

Both standards look at the performance of the equipment when a fault occurs on the outgoing circuit. It is accepted in these standards that some damage may be sustained by the components of the starter when subjected to short circuit conditions.

AS 3439.1 requires that during the tests the equipment installed in the switchboard performs in accordance to its own standard. A selection by the customer of the performance required needs to be made, as AS 3947.4.1 allows for Type "1" and Type "2" performance.

Type "1" performance requires that under short circuit conditions the starter shall not cause a danger to persons or the installation.
The starter itself may need repair.
For Type "2", after a short circuit the starter is to be suitable for further service, but contact welding is permitted.

Any weld must be easily separated – for example, by a screwdriver, without significant deformation.

In all cases it is therefore essential that the condition of the starter is checked if the short circuit protective device has operated. Type "2" co-ordination does not mean that the starter is suitable for normal operation without inspection/repair of the contacts.

Advanced Control System (ACS) Starter with CA 7 and CEP 7

Note:

IEC Standards are the basis of many Australian Standards. AS 3947.4.1 is equivalent to IEC 947.4.1 and AS 3439.1 is equivalent to IEC 439.1.

Both Australian standards list some amendments to the IEC versions.

Protective device selection

In most cases very little difference will be noticed in the service performance of a system using fuses as against circuit breakers.

The circuit breaker is easier when it comes to restoring power, but as tripping should only be the result of a system fault it is unwise to reclose the circuit breaker without finding the cause. In this regard it is normal for only a "skilled person" to attend to fuse replacement and they are more likely to check for other problems.

As the circuit breaker or fuse is operating in conjunction with separate motor overload protection, it is the contactor which responds to overload problems. This is different to a protective device on a distribution circuit. For this application the advantages of the circuit breaker's easy return to service has caused a general trend towards using circuit breakers.

Consideration should be given to preventing unskilled people from reclosing a tripped circuit breaker in a motor control application. This can be done by making the switchboard only accessible to the correct people, or by requiring the switchboard to be opened to reset the circuit breaker.

It must be assumed with both Type 1 and Type 2 co-ordination that if the short circuit protective device has operated there is a fault in the motor, or wiring to it and that the starter itself needs attention.

It is the let-through energy of the protective device which determines the damage to the starter.
As this varies greatly between different models, it is essential that only proven combinations are used.

NHP, Sprecher + Schuh and Terasaki have now conducted many tests on different combinations and these are detailed in the co-ordination tables.

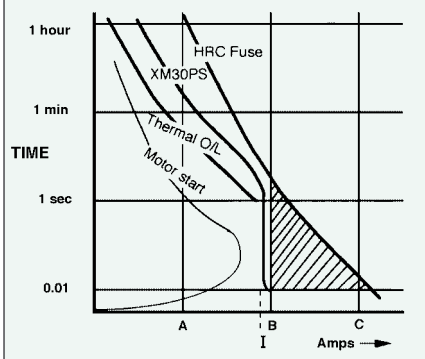
Terasaki circuit breakers for short circuit

Terasaki circuit breakers have been tested in combination with Sprecher + Schuh contactors and overloads and can be used for Type "1" and Type "2" co-ordination requirements. (Refer to following tables for actual combinations).

TemBreak

A new generation of MCCBs offering a choice of 3 series (economical, standard and high fault) and two types, ie, adjustable thermal magnetic or microprocessor based solid state OCR are available from Terasaki. Both types have common construction features and interchangeable plug-in accessories. TemBreak thermal magnetic types offer the widest adjustment range and more flexibility with 63% to 100% base current adjustment. Each MCCB is individually calibrated to ensure precision tripping on overcurrent.

Fig 1.



A - Normal CA 3 rating of contactor
B - Maximum breaking current of contactor
C - Cut-off current of fuse
I - Instantaneous tripping current of breaker

TemBreak electronic type

The rated current of the electronic type TemBreak is adjustable in 15 steps from 50% to 100% of the nominal rated current, using the base current (Io) select switch and the pickup current (I_1) setting dial.

This is one of the essential features for precise protection co-ordination and for low voltage distribution systems.

TemBreak motor protection circuit breaker

The XM30PS circuit breaker will protect contactor starters with direct connected overcurrent relays with ratings 1 amp to 12 amp in systems with up to 65kA rms prospective short circuit. The protection is due to the special current limiting effect of the XM30PS.

Motor starter protection

The XM30PS circuit breaker has been developed for motor starter protection and is suitable as the Short Circuit Protection Device (SCPD) for motor starters equipped with either direct connected or CT connected overcurrent relays.

XM30PS compared to HRC fuse

The circuit breaker tripping characteristic is more suitable for protection of starters than the HRC fuse. Unlike the HRC fuse, the breaker can be selected to trip instantaneously at a predetermined current level just lower than the maximum breaking current of the starter contactor, thus always protecting the contactor against opening fault currents higher than its capability. This can be seen from the typical breaker and fuse tripping characteristics compared to the contactor breaking capacity in figure 1.

No protection is provided by the fuse when the overcurrent is of value B to C amps should the contactor open by earth fault relay. If the breaker is used as a SCPD then protection is provided for all currents in excess of the instantaneous trip current of the breaker. Also, the circuit breaker can be tripped by earth fault relay and so prevent the risk of contactor damage due to the long delay of the HRC fuse interruption if the fault current is of a value between B and C.

Refer pages 7 to 11 for selection guide.

Sprecher + Schuh KTA 3-25 for short circuit and overload protection

KTA 3-25

Minimum space requirements

High contact rating with extreme current limiting capabilities and minimum dimensions are brought to a common denominator with ease by the KTA 3-25.

One device, four functions

The KTA 3-25 combines four functions in a single compact device:

- ❑ Short circuit protection
- ❑ Thermal protection
- ❑ Switching
- ❑ Signalling

Bringing you a whole range of sound advantages.

Economical benefits

Starting from the planning phase, the correct co-ordination of short circuit and overload protection basically simplifies planning. As a multi-function device the KTA 3-25 is moreover substantially simpler to use.

Improved safety

The exceedingly rapid, all pole short circuit release prevents damage to motors and systems. Detrimental single phasing is minimised.

Refer page 6 and 8 for selection guide.

KTA 3 Motor starter combination

KTA 3-100 (65kA)

Commencing at 25 amps the new KTA 3-100 motor curve circuit breakers provide high current limiting capabilities due to fast opening of the contacts motor sizes between 15 and 37kW and at prospective short circuit currents I_q=65kA

Features

- ❑ Short circuit protection.
- ❑ Adjustable thermal protection.
- ❑ Rotary handle.
- ❑ Separate trip signals to differentiate between:
  - – overload trip
  - – short circuit trip.

KTA 3-160...400 (65kA)

The KTA 3 range is now extended up to 400 amps by the release of the motor curve moulded case breakers from 80 amps to 400 amps.

These circuit breakers feature adjustable thermal and magnetic ranges for additional flexibility.

Standard accessory items include rotary handles, auxiliary contacts and shunt or undervoltage trip mechanisms.

Refer pages 6 and 8 for selection guide.

KTA 3-100 and KTA 3-250

Terasaki Din-T at 50kA

The 10kA Din-T miniature circuit breaker gives an amazing 50kA performance when used in the combinations shown in the co-ordination tables. For the low current ratings, the resistance of the thermal overloads assists in reducing the current to a level that the Din-T can handle with ease. For the higher ratings a Sprecher + Schuh limiter block lifts the combined performance to the 50kA level.

All the listed Din-T combinations include a rotary isolator which allows external control. To reset the starter after a short circuit, access to the breaker is required. This can be used to prevent unskilled operators from reclosing the motor starter after a fault.

It should also be remembered that whenever the circuit breaker trips, the contactor must be checked for welded contacts.

Refer page 12 for selection guide.

Fuses

Fuses have been a popular selection for providing short circuit protection for many years.

Fuses provide superior protection at high fault levels and perform well in most installations. Fuse operation during a fault is quiet and no arc products are emitted.

Fuses are often mounted in a switch fuse arrangement to provide isolation and door interlocking facilities. The NHP range of Strömberg plug-in switch fuses are designed specifically for motor control centre applications.

Refer pages 7, 9, 13 and 14 for selection guide.

Type "1" short circuit co-ordination

KTA 3-25...
KTA 3-400

Motor protection circuit breakers DOL starting
50/65kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps @ 415V	Sprecher + Schuh circuit breaker	Thermal setting range	Magnetic release response current	Contactor
0.19	0.6	KTA 3-25	0.40 - 0.63	6.9	CA 7-9
0.25	0.8	KTA 3-25	0.63 - 1	11	CA 7-9
0.37	1.1	KTA 3-25	1 - 1.6	18	CA 7-9
0.55	1.5	KTA 3-25	1 - 1.6	18	CA 7-9
0.75	1.8	KTA 3-25	1.6 - 2.5	28	CA 7-9
1.1	2.6	KTA 3-25	2.5 - 4	44	CA 7-9
1.5	3.4	KTA 3-25	2.5 - 4	44	CA 7-9
2.2	4.8	KTA 3-25	4.0 - 6.3	69	CA 7-9
3.0	6.5	KTA 3-25 + KTL 3-65	6.3 - 10	110	CA 7-9
4.0	8.2	KTA 3-25 + KTL 3-65	6.3 - 10	110	CA 7-12
5.5	11	KTA 3-25 + KTL 3-65	10 - 16	176	CA 7-16
7.5	14	KTA 3-25 + KTL 3-65	10 - 16	176	CA 7-23
9	17	KTA 3-25 + KTL 3-65	16 - 20	220	CA 7-23
11	21	KTA 3-25 + KTL 3-65	20 - 25	275	CA 7-30
15	28	KTA 3-100	25 - 40	560	CA 7-37
18.5	34	KTA 3-100	25 - 40	560	CA 7-43
22	40	KTA 3-100	25 - 40	560	CA 7-60
30	55	KTA 3-100	40 - 63	882	CA 7-72
37	66	KTA 3-100	63 - 90	1260	CA 7-85
45	80	KTA 3-100	63 - 90	1200	CA 6-105 (EI)
55	100	KTA 3-160S	100 - 125	1500	CA 6-140-EI
75	130	KTA 3-160S	125 - 160	1900	CA 6-170-EI
90	155	KTA 3-160S	125 - 160	1900	CA 6-210-EI
110	200	KTA 3-250S	160 - 200	2400	CA 6-210-EI
132	225	KTA 3-250S	200 - 250	3000	CA 6-250-EI
150	250	KTA 3-250S	200 - 250	3000	CA 6-300-EI
185	310	KTA 3-400S	250 - 320	3800	CA 6-420-EI
220	370	KTA 3-400S	320 - 400		

Notes: Combinations with KTA 3-100 and KTA 3-160S are suitable for 65kA.
Other combinations 50kA.
Some combinations achieve Type “2”.

Type "1" short circuit co-ordination

TemBreak or fuse DOL starting
50/65kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps	Terasaki circuit breaker or	NHP HRC fuse	Sprecher + Schuh contactor type	Sprecher + Schuh thermal overload relay type	Setting range amps
0.37	1.1	XM30PS/1.4	NTIA-6	CA 7-9	CT 7-24	0.6 - 1.6
0.55	1.5	XM30PS/2	NTIA-6	CA 7-9	CT 7-24	0.6 - 1.6
0.75	1.8	XM30PS/2.6	NTIA-10	CA 7-9	CT 7-24	1.6 - 2.6
1.1	2.6	XM30PS/3.6	NTIA-10	CA 7-9	CT 7-24	2.4 - 4
1.5	3.4	XM30PS/5	NTIA-10	CA 7-9	CT 7-24	2.4 - 4
2.2	4.8	XM30PS/8	NTIA-16	CA 7-9	CT 7-24	4 - 6
3.0	6.5	XM30PS/8	NTIA-16	CA 7-9	CT 7-24	6 - 10
4.0	8.2	XM30PS/10	NTIA-25	CA 7-9	CT 7-24	6 - 10
5.5	11	XH125NJ/20	NTIA-32	CA 7-12	CT 7-24	10 - 16
7.5	14	XH125NJ/20	NTIS-40	CA 7-16	CT 7-24	10 - 16
11	21	XH125NJ/32	NTIS-50	CA 7-23	CT 7-24	16 - 24
15	28	XH125NJ/50	NTIS-63	CA 7-30	CT 7-45	18 - 30
18.5	34	XH125NJ/50	NTCP-80	CA 7-37	CT 7-45	30 - 45
22	40	XH125NJ/63	NTCP-80	CA 7-43	CT 7-45	30 - 45
30	55	XH125NJ/100	NTCP-100	CA 7-60	CT 7-75	45 - 60
37	66	XH125NJ/100	NTFP-160	CA 7-72	CT 7-75	60 - 75
45	80	XH125NJ/125 [1])	NTFP-160	CA 6-85	CT 7-100	70 - 90
55	100	XH125NJ/125 [1])	NTF-200	CA 6-105-(EI)	CT 6-110	85 - 110
75	130	XH250NJ/250	NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250 [1])	NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])	NTKF-315	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XH400NE/400	NTMF-355	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XH400NE/400	NTMF-355	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XH400NE/400	NTMF-400	CA 6-300-EI	CEF 1-41/42	160 - 400
185	310	XH400NE/400	NTTF-450	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XH400NE/400	NTTM-500	CA 6-420-EI/CA 5-450	CEF 1-41/42	160 - 400
250	425	XH630NE/630	NTTM-630	CA 6-420-EI/CA 5-450	CEF 1-52	160 - 630
315	530	XH630NE/630	NTLM-710	CA 5-550	CEF 1-52	160 - 630

Notes: Fuses 65kA. XH125NJ circuit breaker combinations limited to 50kA, others 65kA.
Overloads may be changed to different types eg. thermal style to electronic.
Some combinations also gives Type “2” performance.

[1]) Use “magnetic only” breaker.

Type "2" short circuit co-ordination

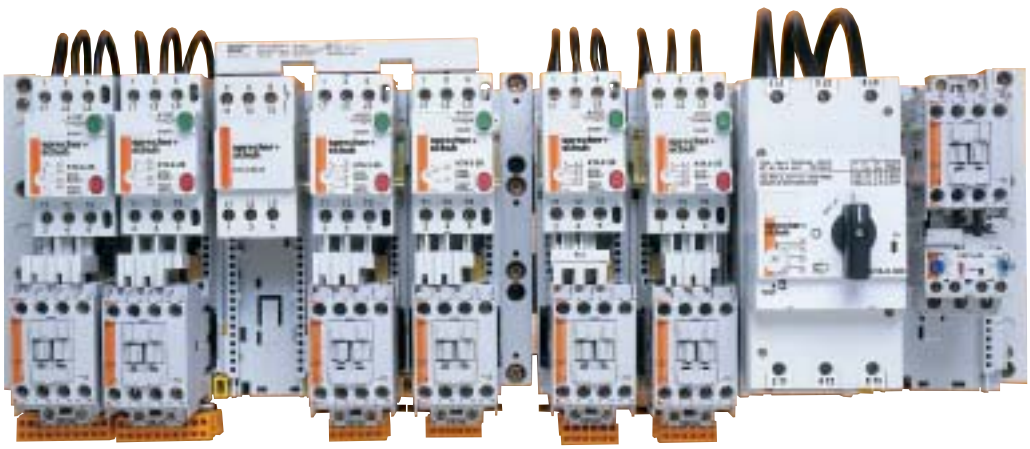
KTA 3-25...
KTA 3-400

Motor protection circuit breakers DOL starting
50/65kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps @ 415V	Sprecher + Schuh circuit breaker	Thermal setting range	Magnetic release response current	Contactor
0.19	0.6	KTA 3-25	0.40 - 0.63	6.9	CA 7-9
0.25	0.8	KTA 3-25	0.63 - 1	11	CA 7-9
0.37	1.1	KTA 3-25	1 - 1.6	18	CA 7-9
0.55	1.5	KTA 3-25	1 - 1.6	18	CA 7-9
0.75	1.8	KTA 3-25	1.6 - 2.5	28	CA 7-16
1.1	2.6	KTA 3-25	2.5 - 4	44	CA 7-16
1.5	3.4	KTA 3-25	2.5 - 4	44	CA 7-30
2.2	4.8	KTA 3-25	4 - 6.3	69	CA 7-16
3.0	6.5	KTA 3-25 + KTL 3-65	6.3 - 10	110	CA 7-16
4.0	8.2	KTA 3-25 + KTL 3-65	6.3 - 10	110	CA 7-30
5.5	11	KTA 3-25 + KTL 3-65	10 - 16	176	CA 7-30
7.5	14	KTA 3-25 + KTL 3-65	10 - 16	176	CA 7-30
11	21	KTA 3-25 + KTL 3-65	20 - 25	275	CA 7-30
15	28	KTA 3-100	25 - 40	560	CA 7-37
18.5	34	KTA 3-100	25 - 40	560	CA 7-43
22	40	KTA 3-100	25 - 40	560	CA 7-60
30	55	KTA 3-100	40 - 63	882	CA 7-72
37	66	KTA 3-100	63 - 90	1260	CA 7-85
45	80	KTA 3-100	63 - 90	1200	CA 6-105 (EI)
55	100	KTA 3-160S	100 - 125	1500	CA 6-140-EI
75	130	KTA 3-160S	125 - 160	1900	CA 6-170-EI
90	155	KTA 3-160S	125 - 160	1900	CA 6-210-EI
110	200	KTA 3-250S	160 - 200	2400	CA 6-250-EI
132	225	KTA 3-250S	200 - 250	3000	CA 6-300-EI
160	270	KTA 3-400S	250 - 320	3800	CA 6-420-EI
200	350	KTA 3-400S	320 - 400		

Notes: Combinations with KTA 3-100 and KTA 3-160S are suitable for 65kA.
Other combinations 50kA.

ACS Advanced Control System



Advanced Control System (ACS) uses KTA 3 circuit breakers and CA 7 contactors

Type "2" short circuit co-ordination

Fuse

Fuse protection DOL starting [1])
50/65kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps 415V	NHP HRC fuse to BS88	Sprecher + Schuh contactor	Sprecher + Schuh overload relay [2]) [3])	Setting range amps
0.37	1.1	NTIA-4	CA 7-9	CEP 7	1 - 2.9
0.75	1.8	NTIA-6	CA 7-9	CEP 7	1 - 2.9
1.5	3.4	NTIA-10	CA 7-9	CEP 7	1.6 - 5
2.2	4.8	NTIA-16	CA 7-9	CEP 7	3.7 - 12
4.0	8.2	NTIA-20	CA 7-9	CEP 7	3.7 - 12
5.5	11	NTIA-25	CA 7-12	CEP 7	3.7 - 12
7.5	14	NTIA-32	CA 7-16	CEP 7	12 - 32
11	21	NTIS-50	CA 7-30	CEP 7	12 - 32
15	28	NTIS-63	CA 7-30	CEP 7	12 - 37
18.5	34	NTCP-80	CA 7-37	CEP 7	12 - 37
22	40	NTCP-80	CA 7-43	CEP 7	14- 45
30	55	NTCP-100	CA 7-60	CEP 7	26 - 85
37	66	NTFP-125	CA 7-72	CEP 7	26 - 85
45	80	NTFP-160	CA 7-85	CEP 7	26 - 85
55	100	NTFP-200	CA 6-105 (EI)	CT 6-110	85 - 110
75	130	NTKF-250	CA 6-140-EI	CT 6-150	105 - 150
90	155	NTKF-250	CA 6-170-EI	CT 6-200	140 - 200
110	200	NTKM-315	CA 6-210-EI	CEF 1-41/42 [4])	160 - 400
132	225	NTMF-355	CA 6-210-EI	CEF 1-41/42 [4])	160 - 400
150	250	NTMF-355	CA 6-250-EI	CEF 1-41/42 [4])	160 - 400
185	320	NTTM-450	CA 6-300-EI	CEF 1-41/42 [4])	160 - 400
250	425	NTTM-560	CA 6-420-EI	CEF 1-52 [4])	160 - 630
320	538	NTTM-710	CA 5-550	CEF 1-52 [4])	160 - 630
380	650	NTLM-800	CA 5-700	CEF 1-11/12P [4])	300 - 1200

Notes: [1]) Fuses with equal or lower let through energy may also be used.
[2]) Thermal overloads may be used instead of electronic CEP 7.
[3]) Above 37kW overloads may also be electronic or thermal.
[4]) CET 4 may be used instead of CEF 1.

Type "2" short circuit co-ordination

TemBreak circuit breakers DOL starting
50kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh overload relay	Setting range amps
0.37	1.1	XM30PS/1.4	CA 7-9	CT 7-24-1.6	1 - 1.6
0.55	1.5	XM30PS/2	CA 7-9	CT 7-24-1.6	1 - 1.6
0.75	1.8	XM30PS/2.6	CA 7-9	CT 7-24-2.4	1.6 - 2.4
1.1	2.6	XM30PS/3.6	CA 7-16	CT 7-24-4	2.4 - 4
1.5	3.4	XM30PS/5	CA 7-16	CT 7-24-4	2.4 - 4
2.2	4.8	XM30PS/8	CA 7-16	CT 7-24-6	4 - 6
3	6.5	XM30PS/8	CA 7-30	CT 7-24-10	6 - 10
4	8.2	XM30PS/10	CA 7-30	CT 7-24-10	6 - 10
5.5	11	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
7.5	14	XH125NJ/20	CA 7-30	CT 7-24-16	10 - 16
11	21	XH125NJ/32	CA 7-30	CT 7-24-24	16 - 24
15	28	XH125NJ/50	CA 7-43	CT 7-24-30	18 - 30
18.5	34	XH125NJ/50	CA 7-43	CT 7-24-45	30 - 45
22	40	XH125NJ/63	CA 7-43	CT 7-24-45	30 - 45
30	55	XH125NJ/100	CA 6-85	CT 7-75 [2])	45 - 60
37	66	XH125NJ/100	CA 6-85	CT 7-75 [2])	60 - 75
45	80	XH125NJ/125	CA 6-105 (EI)	CT 6-90	70 - 90
55	100	XH125NJ/125 [1])	CA 6-105 (EI)	CT 6-110	85 - 110
75	130	XH250NJ/250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH250NJ/250	CA 6-170-EI	CT 6-200	140 - 200
110	200	XH250NJ/250 [1])	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XS400NE/400	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XS400NE/400	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XS400NE/400	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XS400NE/400	CA 6-420-EI	CEF 1-41/42	160 - 400
200	361	XS400NE/400	CA 5-450	CEF 1-22 [2])	160 - 400
250	425	XS630NE/630	CA 5-700	CEF 1-52 [2])	160 - 630
320	538	XS630NE/630	CA 5-700	CEF 1-52 [2])	160 - 630
380	650	XS800NE/800	CA 5-700	CEF 1-12P-1200	160-1200

Notes: Overloads may be thermal or electronic.

Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.

[1]) Use 'magnetic only' breaker or next higher circuit breaker / contactor combination.

[2]) Use with separate mounting bracket.

Type "2" short circuit co-ordination

TemBreak circuit breakers DOL starting [3])
65kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps	Terasaki circuit breaker	Sprecher + Schuh contactor	Sprecher + Schuh overload relay [1]) [2])	Setting range amps
0.37	1.1	XM30PS/1.4	CA 7-9	CEP 7	1 - 2.9
0.55	1.5	XM30PS/2	CA 7-9	CEP 7	1 - 2.9
0.75	1.8	XM30PS/2.6	CA 7-9	CEP 7	1 - 2.9
1.1	2.6	XM30PS/3.6	CA 7-16	CEP 7	1.6 - 5
1.5	3.4	XM30PS/5	CA 7-16	CEP 7	1.6 - 5
2.2	4.8	XM30PS/8	CA 7-16	CEP 7	3.7 - 12
3	6.5	XM30PS/8	CA 7-30	CEP 7	3.7 - 12
4	8.2	XM30PS/12	CA 7-30	CEP 7	3.7 - 12
5.5	11	TL30F/20A	CA 7-30	CEP 7	3.7 - 12
7.5	14	TL30F/30A	CA 7-30	CEP 7	12 - 32
11	21	TL30F/30A	CA 7-30	CEP 7	12 - 32
15	28	TL100F/40	CA 7-43	CEP7	12 - 32
18.5	34	TL100F/50	CA 7-43	CEP 7	12 - 37
22	40	TL100F/60	CA 7-43	CEP 7	14 - 45
30	55	TL100F/75	CA 7-72	CEP 7	26 - 85
37	66	TL100F/100	CA 7-72	CEP 7	26 - 85
45	80	TL100F/100	CA 6-105 (EI)	CT 6-90	70 - 90
55	100	XH400NE/250	CA 6-105 (EI)	CT 6-110	85 - 110
75	130	XH400NE/250	CA 6-140-EI	CT 6-150	105 - 150
90	155	XH400NE/250	CA 6-170-EI	CT 6-200	140 - 200
110	200	XH400NE/250	CA 6-210-EI	CEF 1-41/42	160 - 400
132	225	XH400NE/400	CA 6-210-EI	CEF 1-41/42	160 - 400
150	250	XH400NE/400	CA 6-250-EI	CEF 1-41/42	160 - 400
160	270	XH400NE/400	CA 6-300-EI	CEF 1-41/42	160 - 400
200	361	XH400NE/400	CA 6-420-EI	CEF 1-41/42	160 - 400
200	361	XH400NE/400	CA 5-450 [4])	CEF 1-22	160 - 400
250	425	XH630NE/630	CA 5-700 [4])	CEF 1-52	160 - 630
320	538	XH630NE/630	CA 5-700 [4])	CEF 1-52	160 - 630
380	650	XH800NE/800	CA 5-700 [4])	CEF 1-12P-1200	160-1200

Notes: [1]) Thermal overloads can be used instead of electronic CEP 7.

[2]) Above 37kW overloads may also be electronic or thermal.

[3]) Combinations based on the overload tripping before the circuit breaker at overload currents up to the motor locked rotor current.

[4]) For CA 5 overload separately mounted.

Type "2" short circuit co-ordination

Din-T

Din-T circuit breakers with rotary isolator. DOL starting.
50kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps @ 415V	Sprecher + Schuh isolator	Terasaki circuit breaker	Sprecher + Schuh current limiter	Sprecher + Schuh contactor	Sprecher + Schuh thermal o/l relay	Thermal overload range
0.37		LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	0.6 - 1.6
0.55	1.1	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1 - 1.6
0.75	1.5	LA 7-80	Din-T 10 / 4	-	CA 7-9	CT 7-24	1.6 - 2.4
1.1	1.8	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
1.5	2.6	LA 7-80	Din-T 10 / 6	-	CA 7-23	CT 7-24	2.4 - 4
2.2	3.4	LA 7-80	Din-T 10 / 10	KTL 3-65	CA 7-23	CT 7-24	4 - 6
3	4.8	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
4	6.5	LA 7-80	Din-T 10 / 16	KTL 3-65	CA 7-23	CT 7-24	6 - 10
5.5	8.2	LA 7-80	Din-T 10 / 20	KTL 3-65	CA 7-23	CT 7-24	10 - 16
7.5	11	LA 7-80	Din-T 10 / 32	KTL 3-65	CA 7-30	CT 7-45	10 - 16
11	14	LA 7-80	Din-T 10 / 40	KTL 3-65	CA 7-30	CT 7-24	16 - 24
15	21	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	18 - 30
18.5	28	LA 7-100	Din-T 10 / 63	KTL 3-65	CA 7-37	CT 7-45	30 - 45

Type 2 co-ordination table for KTA 3 motor circuit breaker with rotary isolator. DOL starting. 50kA @ 415V to AS 3947.4.1

KTA 3-

Motor size kW	Approx. amps @ 415V	Sprecher + Schuh isolator	Sprecher + Schuh circuit type/current	Sprecher + Schuh current limiter	Sprecher + Schuh contactor type	Sprecher + Schuh thermal	Sprecher + Schuh thermal range amps
0.37		LA 7-80	KTA 3-25-1.6A	-	CA 4-5	In breaker	1 - 1.6
0.55	1.1	LA 7-80	KTA 3-25-1.6A	-	CA 4-5	In breaker	1 - 1.6
0.75	1.5	LA 7-80	KTA 3-25-2.5A	-	CA 4-5	In breaker	1.6 - 2.5
1.1	1.8	LA 7-80	KTA 3-25-4A	-	CA 4-5	In breaker	2.5 - 4
1.5	2.6	LA 7-80	KTA 3-25-4A	-	CA 4-5	In breaker	2.5 - 4
2.2	3.4	LA 7-80	KTA 3-25-6.3A	-	CA 7-16	In breaker	4 - 6.3
3	4.8	LA 7-80	KTA 3-25-10A	KTL 3-65	CA 7-16	In breaker	6.3 - 10
4	6.5	LA 7-80	KTA 3-25-10A	KTL 3-65	CA 7-16	In breaker	6.3 - 10
5.5	8.2	LA 7-80	KTA 3-25-16A	KTL 3-65	CA 7-16	In breaker	10 - 16
7.5	11	LA 7-80	KTA 3-25-16A	KTL 3-65	CA 7-16	In breaker	10 - 16
11	14	LA 7-80	KTA 3-25-25A	KTL 3-65	CA 7-23	In breaker	20 - 25

Notes: Isolator provides rotary operation for external control. May be deleted if not required.

Type "2" short circuit co-ordination

Fuse

Fuse protection star delta starters.
50 & 65kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps @ 415V	NHP HRC fuse to BS88 [1])	Sprecher + Schuh line and delta contactors	Sprecher + Schuh star point contactor	Sprecher + Schuh overload relay[2])
2.2	4.8	NTIA-10	CA 7-9	CA 7-9	CT 7-24
4	8.2	NTIA-16	CA 7-9	CA 7-9	CT 7-24
5.5	11	NTIA-20	CA 7-9	CA 7-9	CT 7-24
7.5	14	NTIA-25	CA 7-9	CA 7-9	CT 7-24
11	21	NTIA-32	CA 7-16	CA 7-9	CT 7-24
15	28	NTIS-40	CA 7-23	CA 7-12	CT 7-24
18.5	34	NTIS-50	CA 7-30	CA 7-12	CT 7-45
22	40	NTIS-63	CA 7-30	CA 7-16	CT 7-45
30	55	NTIS-63	CA 7-37	CA 7-23	CT 7-45
37	66	NTCP-80	CA 7-37	CA 7-23	CT 7-45
45	80	NTCP-100	CA 7-60	CA 7-30	CT 7-75
55	100	NTFP-160	CA 7-85	CA 7-37	CT 7-75
75	130	NTFP-160	CA 6-85	CA 7-60	CT 6-90
90	155	NTFP-160	CA 6-105-(EI)	CA 7-60	CT 6-90
110	200	NTFP-200	CA 6-105-(EI)	CA 7-72	CT 6-150
132	225	NTKF-250	CA 6-140-EI	CA 7-85	CT 6-150
150	250	NTKF-250	CA 6-170-EI	CA 6-85	CT 6-200
185	320	NTKF-315	CA 6-210-EI	CA 6-105-(EI)	CEF 1-41
250	425	NTTM-450	CA 6-300-EI	CA 6-170-EI	CEF 1-41

Note: [1]) Fuse rating based on 3.5 x FLC for 20 seconds.
[2]) Electronic CEP 7 overload may be used instead of CT 7.

Type "2" short circuit co-ordination

Fuse

Fuse protection Auto transformer and primary resistance starters
50 & 65kA @ 415V to AS 3947.4.1

Motor size kW	Approx. amps @ 415V	NHP HRC fuse to BS 88 [1])	Sprecher + Schuh line and transformer contactors	Sprecher + Schuh star point contactor	Sprecher + Schuh overload relay [2])
7.5	14	NTIA-25		CA 7-12	CT 7-24
11	21	NTIA-32	CA 7-16	CA 7-12	CT 7-24
15	28	NTIS-40	CA 7-23	CA 7-12	CT 7-45
18.5	34	NTIS-50	CA 7-30	CA 7-16	CT 7-45
22	40	NTIS-63	CA 7-37	CA 7-23	CT 7-45
30	55	NTIS-63	CA 7-43	CA 7-30	CT 7-75
37	66	NTCP-80	CA 7-60	CA 7-30	CT 7-75
45	80	NTCP-100	CA 7-72	CA 7-37	CT 7-100
55	100	NTFP-160	CA 7-85	CA 7-43	CT6-110
75	130	NTFP-160	CA 6-105-(EI)	CA 7-60	CT 6-150
90	155	NTFP-160	CA 6-140-EI	CA 7-72	CT 6-200
110	200	NTFP-200	CA 6-170-EI	CA 7-85	CEF 1-41
132	225	NTKF-250	CA 6-210-EI	CA 6-105-(EI)	CEF 1-41
150	250	NTKF-250	CA 6-250-EI	CA 6-105-(EI)	CEF 1-41
185	320	NTKF-315	CA 6-250-EI	CA 6-140-EI	CEF 1-41
250	425	NTTM-450	CA 6-300-EI	CA 6-210-EI	CEF 1-52
320	538	NTTM-560	CA 6-420-EI	CA 6-250-EI	CEF 1-52
380	650	NTTM-710	CA 5-550	CA 6-250-EI	CEF 1-11-1200P

Circuit breaker protection Auto transformer and primary resistance starters.
50kA @ 415V to AS 3947.4.1

TemBreq

Motor size kW	Approx. amps @ 415V	Terasaki circuit breaker	Sprecher + Schuh line and transformer contactors	Sprecher + Schuh star point contactor	Sprecher + Schuh overload relay [2])
7.5	14	XH125NJ/20		CA 7-12	CT 7-24
11	21	XH125NJ/32	CA 7-30	CA 7-12	CT 7-24
15	28	XH125NJ/50	CA 7-30	CA 7-12	CT 7-45
18.5	34	XH125NJ/50	CA 7-30	CA 7-16	CT 7-45
22	40	XH125NJ/63	CA 7-37	CA 7-23	CT 7-45
30	55	XH125NJ/100	CA 7-43	CA 7-30	CT 7-75
37	66	XH125NJ/100	CA 7-60	CA 7-30	CT 7-75
45	80	XH125NJ/125	CA 7-72	CA 7-37	CT 7-100
55	100	XH250NJ/160	CA 7-85	CA 7-43	CT6-110
75	130	XH250NJ/250	CA 6-105-(EI)	CA 7-60	CT 6-150
90	155	XH250NJ/250	CA 6-140-EI	CA 7-72	CT 6-200
110	200	XH250NJ/250	CA 6-170-EI	CA 7-85	CEF 1-41
132	225	XS400NE	CA 6-210-EI	CA 6-105-(EI)	CEF 1-41
150	250	XS400NE	CA 6-250-EI	CA 6-105-(EI)	CEF 1-41
185	320	XS400NE	CA 6-250-EI	CA 6-140-EI	CEF 1-41
250	425	XS400NE	CA 6-300-EI	CA 6-210-EI	CEF 1-52
320	538	XS630NE	CA 6-420-EI	CA 6-250-EI	CEF 1-52
380	650	XS800NE	CA 5-550	CA 6-250-EI	CEF 1-11-1200P

Note: [1]) Fuse rating based on 3.5 x FLC for 20 seconds.
[2]) Electronic CEP 7 overload may be used instead of CT 7.

Type "2" short circuit co-ordination

TemBreak circuit breakers DOL starting
1000V to AS 3947.4.1. Short circuit current to breaker interrupting capacity.

Motor size kW	Approx. amps	Terasaki circuit breaker	kA	Sprecher + Schuh contactors	Sprecher + Schuh thermal overload relay	Setting range amps
25	20	TL100EM/40	10	CAG-80	CEF 1-11	20 -180
30	25	TL100EM/50	10	CAG-90	CEF 1-11	20 - 180
45	33	TL100EM/60	10	CA 6-85	CEF 1-11	20 - 180
55	40	TL100EM/75	10	CA 6-105-EI	CEF 1-11	20 - 180
75	55	TL100EM/100	10	CA 6-140-EI	CEF 1-11	20 - 180
90	65	TL100EM/100	10	CA 6-170-EI	CEF 1-11	20 - 180
111	80	XV400NE/250	12.5	CA 6-210-EI	CEF 1-11	20 - 180
133	95	XV400NE/250	12.5	CA 6-250-EI	CEF 1-11	20 - 180
163	115	XV400NE/250	12.5	CA 6-300-EI	CEF 1-11	20 - 180
206	145	XV400NE/250	12.5	CA 6-420-EI	CEF 1-11	20 - 180
280	200	XV400NE/400	12.5	CA 5-450	CEF 1-41	160 - 400
355	250	XV400NE/400	12.5	CA 5-550	CEF 1-41	160 - 400
500	340	XV400NE/400	12.5	CA 5-700	CEF 1-41	160 - 400
550	380	XV630PE/630	18	CA 5-860	CEF 1-41	160 - 400

Sprecher + Schuh CEF 1, CA 6 and Terasaki TemBreak circuit breakers

Type "1" or Type "2" co-ordination...?

For both types of co-ordination operator safety is assured, as well as damage to other equipment eliminated. Type "1" does allow damage to the components of the starter and this can include severe welding of contactor contacts and open circuit thermal overloads. Type "2" basically only allows welding of contactor contacts.

The specification of Type "2" does not offer a higher level of safety, nor does it allow the starter to be returned to service after a short circuit without inspection.

The starter should be capable of further service after any welds which may have occurred have been separated, but the operational life of the contactor may have been greatly reduced by arcing of the contacts.

As specifying Type "2" performance can mean larger and more expensive components are required, it can be more effective to select Type "1" and ensure that spare parts are held in stock. Using a plug-in module approach can provide rapid restoration and little reason for requiring Type "2".

If the requirements of a particular installation are carefully considered it can often be found that Type "1" co-ordination is quite adequate. A common belief is that Type "2" co-ordination will eliminate welding of contacts, but this is very difficult to guarantee under all operating conditions. In all installations the risk of contact welding must be considered in the design and operation. Failure to do this can result in substantial damage and risk to operators, as normal control and overload protection of the device can be lost.

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