

Methods of Applying KT7 Motor Circuit Controllers

This information is provided to aid in proper system design and utilization of the new KT7 Motor Circuit Controller in North American applications. Be sure to consider all applicable local and national codes for your particular installation.

Methods of Applying KT7 Motor Circuit Controllers

The KT7 Motor Circuit Controller provides Class 10 overload protection, as well as, current limiting short-circuit protection for individual motor loads. KT7s are also approved for use as circuit breakers (per IEC 947-6-2) for applications outside of North America. In the United States and Canada, however, they are UL/CSA listed as Manual Starters with optional approvals for Motor Disconnecting and Group Motor applications.

KT7 Motor Circuit Controllers are also UL/CSA listed as Manual Combination (Type E) Starters eliminating the requirement for additional short-circuit protection in many applications. This reduces both panel space and cost in multi-motor installations and eliminates the restrictive NEC/CEC rules that pertained to Manual Starters used in Group Motor applications.

The following information is provided to aid in proper system design and utilization of the capabilities of the new KT7 Motor Circuit Controller in North American applications. Please be sure to consider all applicable local and national codes for your particular installation.

Circuit Breaker Applications – IEC

KT7 Motor Circuit Controllers are current limiting IEC circuit breakers (IEC 947-6-2) that also provide Class 10 motor overload protection. Additionally, they meet IEC requirements for applications such as:

- Disconnecter (IEC 947-2)
- Main Switch (IEC 204-1)
- Emergency Off (IEC 204-1)
- Revision Service Switch (IEC 947)

KT7 Motor Circuit Controllers cannot be applied in North America as circuit breakers, since they do not meet the UL specifications for circuit breakers (UL 489).

Manual Starter Applications — UL/CSA

KT7 Motor Circuit Controllers are an excellent choice for manual starting applications. As UL/CSA listed manual motor controllers, they provide motor overload protection, however, a separate short-circuit protective device must still be used. The fuse or circuit breaker used for the short-circuit protection may be sized to the maximum allowable per NEC Article 430-52 in the U.S., and CEC Rule 28-200 in Canada. The KT7 as a manual motor starter is available in a general purpose enclosure, water tight enclosure or Type 7/9 enclosure. Undervoltage or shunt trip relays are also available.

**Traditional Group Motor Applications
UL/CSA**

KT7 Motor Circuit Controllers are also UL/CSA listed as manual starters for use in Group Motor installations. This listing (and application) has been the most popular in the United States because of the reduced panel space and cost savings it provides.

NEC article 430-52 states that each motor must have a Branch Circuit Protective Device (BCPD) consisting of a fused disconnect, fuse block & set of fuses, or a circuit breaker. A typical circuit is illustrated in Figure 1.

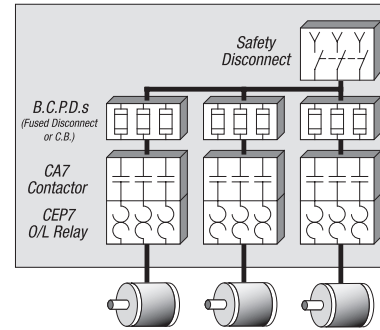


Figure 1
Classic Group Motor Circuit (NEC 430-52)

Even though this method is highly effective and widely used, it has several drawbacks.

- Breakers or fuse blocks for each motor circuit are expensive
- The panel space required to house many components like this is substantial
- Installations of this type are labor intensive and therefore more costly

NEC 430-53 [CEC 28-206] however, provides several exceptions to 430-52 [CEC 28-204] that allow you to connect a group of motors under one BCPD. These exceptions can be found under:

- 430-53(a) - For Motors 1 HP or Less
- 430-53(b) - The Smallest Motor is Protected
- 430-53(c) - Other Group Installations

For example, Figure 2 illustrates how a circuit would look utilizing provision (a) or (b) above. What was once three branch circuits, with three BCPD's, is now one branch circuit with one BCPD.

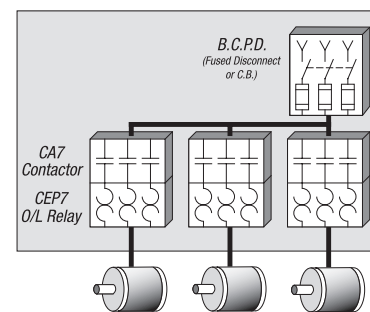


Figure 2
NEC Article 430-53 circuitry without KT7

Methods of Applying KT7 Motor Circuit Controllers (continued)

It appears that the exceptions in 430-53 address the expensive drawbacks to having one BCPD for each motor. Expensive fuses (or circuit breakers) have been eliminated. Panel space has been significantly reduced, as well as, the labor to install the circuit.

Unfortunately, NEC 430-53 (a) or (b) [CEC 28-602 (3)(b)] limits the group to a few small motors. However, by applying the KT7 under 430-53 (c) (Figure 3), the problems associated with 430-53 (a) and (b) are overcome.

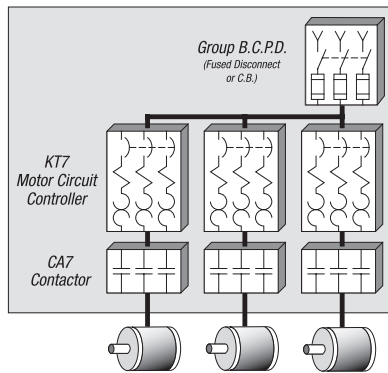


Figure 3
Article 430-53 Circuitry With KT7

- Only one fuse block (or circuit breaker) is used as the BCPD
- Panel size has been significantly reduced
- Wiring and installation time has been significantly reduced
- We have assured protection against low level faults that the BCPD would pass
- Larger horsepower motors can be grouped with smaller ones

Group Installation under 430-53(c) requires that the BCPD be calculated and either supplied within the control panel or, if mounted externally, the BCPD value must be specified by a label within the panel. Always refer to the NEC code before applying the KT7 in Group Motor Installations.

As stated earlier, Group Installations are the most popular applications for KTA Motor Circuit Controllers in North America. They greatly reduce cost when compared to using fuses or circuit breakers in each motor branch circuit.

Motor Disconnecting Applications - UL/CSA

The new KT7 Motor Circuit Controllers are also UL/CSA listed as manual motor controllers with the optional approval “Suitable for use as a motor disconnect.” This UL Listing (UL508, Part III) is new in 1999 and allows KT7s to meet the requirements for applications as “at-motor” disconnects. All manual starters used in such applications must be marked as “Suitable for use as a motor disconnect”. The KT7 can be used in an enclosure with a lockable handle as a manual motor starter and is an approved means of motor disconnect.

Under the provisions of UL508 Part III, a Manual Motor Controller can be labeled “Suitable for use as motor disconnect” and does not require compliance with UL 98 Disconnect Rules. The primary difference between UL98 and UL 508 Part III is that the Manual Motor Controller must bear a maximum KAIC rating. This rating must be considered in the application of KT7 as a motor disconnect.

Corresponding to this new section of UL, the NEC code Article 430-109 a1b6 [CEC 28-602 (3)(b)] permits the use of a manual motor controller when installed between the BCPD and the motor.

Self-Protected Manual Combination Starter Applications (Type E) - UL/CSA

UL508, Part IV, Sections A–E (17th Edition) cover combination motor controllers that provide a disconnecting means, a load switching means, overload and short-circuit protection all incorporated within the same device or assembly. Under these provisions, the new KT7 Motor Circuit Controllers, with improved current limiting and breaking capacity (KAIC rating), are now UL/CSA Listed as self-protected (Construction Type E) manual combination motor controllers. This Type E rating eliminates the need for individual branch fuses (per UL 198) or a thermal-magnetic circuit breaker or magnetic-only circuit breaker (per UL 489) as the Branch Circuit Protection Device (BCPD). See Figure 4.

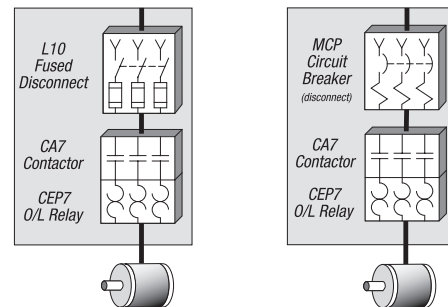


Figure 4
Classic Combo Starter (NEC Article 430-52)

Further, the Type E rating eliminates the need for a disconnecting means (per UL 98) for enclosed and dead-front switches or UL 1087 molded case switches or UL 489 molded case circuit breakers.

Corresponding to this UL Type E rating, NEC code (Article 430-52 c6) now allows a self-protected combination controller to be used as the BCPD instead of the classic devices listed in Table 430-152.

Simply stated this new Type E listing allows the KT7 Manual Combination Motor Controllers to be used as short-circuit protection, overload protection and as the motor disconnect on motor branch circuits. See Figure 5.

Methods of Applying KT7 Motor Circuit Controllers (continued)

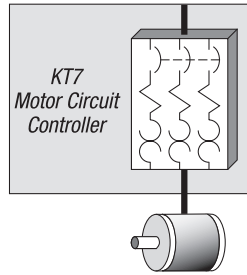


Figure 5
KT7 Manual Motor Controller and “At motor” Disconnect

It should be noted that KT7 Manual Motor Circuit Controller, when listed as self-protected (Type E) device, is rated for Wye-connected power systems for voltages above 240 volts (i.e. 480Y / 277 volts common in the United States or 600Y / 347 volts common in Canada).

Effective July 16, 2001

UL made changes to its specifications for self-protected Type E combination controllers. Among them is a required increase in space between line side terminals, which directly affects KT7 controllers in specific applications.

KT7 controllers used as Branch Circuit Protection Devices (BCPDs) in Type E applications will be required to meet the new specifications, provided they were produced after July 16, 2001. KT7s produced prior to that date (including those currently in inventory) may be sold and installed without alteration. KT7 controllers applied as manual motor starters, or part of a group installation, are exempt from the new requirement, regardless of production date.

- *KT7 controllers produced prior to July 16, 2001, will be used in CL7, CK7, enclosed KT7, CX7, or any custom control panel without the new terminal adaptors, as allowed by UL, until inventory is depleted.*
- *All CL7, CK7, enclosed KT7 and CX7 starters assembled with new KT7 controllers (with locking notch) in our Houston or Mississauga facilities will include the new terminal adaptors. No list price change will be made to these assemblies.*
- *When applicable, all assemblies shipped from the factory will be Type E compliant with the change effective July 16, 2001.*

Individual Combination Starter Applications

The next logical step is to combine a CA7 contactor to the new (Type E) self-protected manual combination KT7 controller. The KT7 starter provides the overload and short circuit protection, as well as, the disconnecting function for the motor, while the CA7 contactor allows for remote operation via pushbuttons. By contrast, the traditional fusible combination starter consists of an L10 fusible disconnect switch, short-circuit protection (alternately an MCP or MCCB), a contactor for remote

operation and a CEP7 overload relay (see Figure 4). The KT7 Type E manual controller + CA7 contactor combination can now be compared with a traditional fusible or circuit breaker Combination Starter including the means of disconnect.

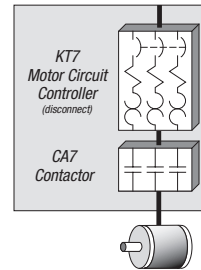


Figure 6
Type E Combo Motor Controller (starter) and “At motor” Disconnect (NEC Article 430-52 (c6))

Multi-motor Starter Combination Applications

The KT7 Construction Type E rating also eliminates concern for all of the NEC 430-53 [CEC 28-206] rules for installations involving multiple motor starters in a single control panel. The result is maximum flexibility and minimum panel size without the restrictive and cumbersome rules involved with typical multi-motor (Group Installation) applications.

This means that the main fuses or circuit breaker are no longer necessary to meet the requirement of a Group Installation Branch

Circuit Protection Device (BCPD). A non-fused disconnect may be needed to meet the safety disconnect rules for the multi-motor starter control panel. It is important to separate the code requirements for BCPD’s from the safety codes requiring a panel disconnect to be “in sight and within 50 feet” to protect the maintenance electrician. KT7s perform the function of BCPD’s under the Type E combination motor controller approval and may simply be selected according to the motor full-load current with consideration for the potential fault-current.

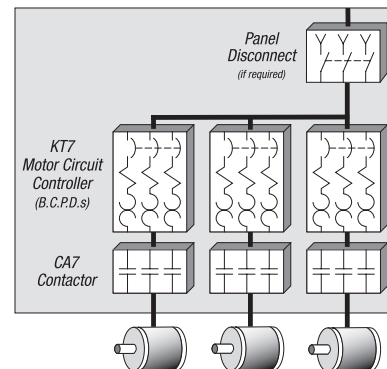


Figure 7
Multi-motor Starter Panel using KT7 as Type E Combo Starter (B.C.P.D.s) per NEC Article 430-52 (c6)

Methods of Applying KT7 Motor Circuit Controllers *(continued)*

Short-circuit Coordination

The concept of Type 1 and Type 2 coordination are European based but are certainly not new to the North American market. Fuse companies have been at the forefront of advancing the concepts and advantages of Type 2 protection. An appreciation for the advancements offered by self-protected combination motor controllers like KT7 must start with a firm understanding of Type 1 and Type 2 protection versus Construction Type E standards.

Type 1

- Under short-circuit conditions, the contactor or starter shall cause no danger to persons or installation.
- Damage to the contactor and the overload relay is acceptable.
- It may not be suitable for further service without repair and replacement of parts.

A UL listing of a device or combination of devices like a contactor and an overload relay would be equivalent to Type 1 coordination in European (IEC) terminology.

Type 2

- Under short-circuit conditions, the contactor or starter shall cause no danger to persons or installation and shall be suitable for further use.
- The risk of contact welding is recognized, in which case the manufacturer shall indicate the measures to be taken in regards to maintenance of the equipment.

Most of the above is European terminology that has worked its way into North American terminology.

UL508E is the UL “Outline of Investigation for Type 2 Coordination.” It is important to note that UL508E is NOT the same as Construction Type E Self-protected Combination Motor Controllers (which falls under the UL508 Safety Standard for Industrial Control in Section 76 as we have outlined). This means that UL does not give a “Listing” under UL508E but rather is a performance standard and not a safety issue. Companies who publish Type 2 coordination application tables in accordance with investigation procedures outlined in UL508E must be backed by self certified tests to verify compliance.

Type 1 and Type 2 coordination have historically been applied to the combination of a circuit breaker or a set of fuses protecting a contactor (i.e.: CA7) and an overload (i.e.: CEP7 or CT7). If you select a particular UL approved contactor and UL Approved overload from the standard selection tables in our catalog then you have Type 1 coordination. Similarly, when you combine a CA7 contactor with a KT7 Type E Manual Self-protected Combination Controller by selecting from standard KT7 selection tables then you may only have Type 1 protection for the combination. If your customer wants Type 2 protection then we supply coordination tables. You must go to the Type 2 protection tables in the technical section of the KT7 literature to insure Type 2 protection.

Type E

Construction Type E Self-protected Combination Motor Controllers

- Do not require branch circuit short circuit protective device (fuse or circuit breaker) upstream
- Includes coordinated overload and short circuit protection
- No welding of contacts is allowed
- Incorporates a motor disconnect rating
- Includes an endurance standard after interrupting a short-circuit exceeding that specified for Type 2 (UL508E).

This means the test for self-protected combination controllers is more stringent than Type 2; therefore, many people refer to Type E with implication not only to the construction type as defined under UL508 Part III Table 76.2 and applied in accordance with NEC 430-52C Option 6 but also to the type of coordinated short-circuit protection achieved.

Short-circuit coordination is about the level of damage allowed to the control equipment under a short circuit condition and the speed of operation is the key to current limitation.

Suitability for Tap Conductor Protection

For several years, the industry has been applying manual motor circuit controllers in Group Installations under NEC 430-53C. Many of you have been aware of the vagueness of the current NEC with respect to NEC 430-53D concerning “Single Motor Taps.” The 2002 NEC added a new provision which clarifies the sizing of wires in a Group Installation where the wires feeding each motor circuit controller is considered to be a tap conductor

NEC-430-53-D-1 restricts the wire feeding the motor circuit controller to be equal to the wire connected to the BCPD which is extremely limiting. NEC-430-53-D-2 allows reduction of the sizing of the wire leading to the BCPD to not less than 1/3 of the wire connected to the B.C.P.D. Since most 25 ampere frame motor circuit controller only allow for #10 wire maximum (which is rated for 40 amperes) per UL508A “Internal Wiring Standard”; it follows that the B.C.P.D. must be limited to 120 amperes maximum. Note that the actual FLA connected is limited to 80% of the wire rating. It has been the position of many in the industry since the introduction of motor circuit controllers in the early 1980’s that NEC 430-53D was never intended to apply to multiple motor starter control panels per NEC 430-53C part 1&3, but rather to separately mounted units with wire duct and gutter taps as described in NEC 430-53C part 2. This claim was largely based on the maximum BCPD rating given to Group Rated Controllers under UL508 which often exceed the 120 ampere wire limits. The 2002 NEC further clarified that wire size inside the multiple motor starter panel under Group Installation is covered by the provisions of Single Motor Taps under NEC430-53D.

Methods of Applying KT7 Motor Circuit Controllers *(continued)*

The 2002 NEC has new provisions for Single Motor Taps under Section 430-53D-3, which clearly provides for sizing motor circuit controller wires at 1/10 if the length does not exceed 10 feet. This means most 25 ampere frame motor circuit controller that only allow for #10 wire maximum might be as large as 400 amperes. Further that 45 ampere frame motor circuit controllers that allow for #4 wire maximum (which is rated for 105 amperes) might be as large as 1050 amperes. It should be noted that mini-bus bars are often used to inter-connect the line side of motor circuit controllers may increase the capacity of the allowable wire size.

This change in the 2002 NEC does require some additional testing of the motor circuit controller under UL508 in order to mark the device “Suitable for Tap Conductor Protection in a Group Installation.” The testing associated with single motor taps is nearly as difficult as those associated with the test for Self-protected Combination Motor Controllers (described elsewhere in this white paper). This means that the Tap Conductor Protection ratings may well align with the ratings for Self-protected Combination Motor Controllers.

It is the opinion of this writer that the strict enforcement of the wire sizing options defined by NEC 430-53D-1, -2, or -3 will force the industry to apply Self-protected Combination Motor Controllers (Construction Type E or Type F) in multiple motor starter panels under the provisions of NEC 430-52-C- 6 as opposed to applying simple Group Rated Manual Motor Circuit Controllers under Group Installations as defined under NEC 430-53-C.

Assemblies Using KT7

Since devices like KTA7 do not include a magnetic coil contactor in the assembly, they are considered to be manual motor controllers. If you are building a multi-motor starter panel you probably need to provide for remote control and so you add a contactor to the assembly. Sprecher + Schuh has combined the KT7 Self-protected Combination Controller (Construction Type E) into assemblies with appropriately sized contactors. These assemblies are available in three varieties:

- CL4 = KT7 + Connector + CA4 Mini-contactor
- CL7 = KT7 + Connector + CA7 Contactor
- CK7 = KT7 + CA7 mounted on a DIN adapter socket with terminal blocks

CL4 and CL7 use connectors (i.e: KT7-25S-PEC23) to mate the KT7 with CA4 and CA7 contactors. Sprecher + Schuh is pleased to announce that we now have cUL Approval of our –PEC and –PNC connectors. The recognition of these connectors paves the way to testing and approval of assemblies using KT7.

Type E Self-protected Combination Motor Controller Assemblies

An assembly of a Construction Type E KT7 Manual Controller plus a contactor can be tested as a Self-protected Combination Controller. This means the assembly must meet all of the same rigid standards including Type E coordination as described above. Sprecher + Schuh provides additional tables showing the KAIC ratings of CK7 starters already approved by UL as Type E assemblies as well as the CL4 & CL7 ratings that are pending UL approval at the time of this printing.

Type F Combination Motor Controllers

Manufacturers of Construction Type E controllers have been working closely with UL concerning the addition of a Construction Type F Combination Motor Controller to their specifications and test procedures. Recently UL did add Type F to UL508 Part III Section 76. Construction Type F is defined as a Type E Manual Self-protected Combination Controller combined with a magnetic contactor but allowing damage to the contactor under a short circuit. The damage allowed to the contactor is similar to that allowed to Construction Type A, B, C or D Combination Starters, which are circuit breakers, fused disconnect, magnetic only circuit breaker or motor circuit protectors (MCP) combined with a standard contactor and overload relay better known as the classic Combo Starters.

It is important to point out that you start with a UL Approved Type E Manual Self-protected Motor controller and the contactor as an assembly but test to the same standards as Type 1 protection (just as you would for a Classic Type A-D Combo). UL has chosen to call this new device a Combination Motor Controller which is more exactly defined as Construction Type F under to UL508 Part III Section 76.

Note that the Type F designation ‘Combination Motor Controller’ is missing the term ‘Self-protected’ which is reserved for an assembly that is fully Type E Approved as described above. This means that Type E assemblies are superior to Type F assemblies with respect to coordinated protection. Both Type F and Type E are valid selections for customers to make an informed price versus performance choice.

Once again, if the customer wants Type 2 protection, the manufacturer must back their recommendations with self-certify testing. Sprecher + Schuh provides additional tables for the customer to select Type 2 KAIC ratings for Type F Combination Motor Controllers in the technical data section of this chapter. It might be said that Construction Type F Coordination Type 2 ratings are very close to those of Type E. It is important to note that the difference is that Type E provides the assurance of an endurance standard after interrupting a short-circuit exceeding that specified for Type 2 (UL508E).

In short, you could say that Type F1 is good, Type F2 is better and Type E is the best.

Methods of Applying KT7 Motor Circuit Controllers *(continued)*

A Note About UL1077 Mini-Circuit Breakers Summary

All too often we see UL1077 DIN rail mounted Mini-circuit breakers applied as branch circuit short-circuit protection ahead of a standard contactor and overload relay. UL1077 Supplemental Circuit Breakers were never intended to replace UL489 Approved Circuit Breakers as short-circuit protection for a motor branch circuit. It is important for customers who have been employing the use UL1077 circuit breakers to “protect” motor circuits that the practice is not approved for this purpose nor is it in compliance with NEC 430-52. Sprecher + Schuh sells UL1077 Mini-circuit breakers as well KT7 Motor Circuit controllers

and it our desire to help customers apply each in accordance with applicable codes and standards. Please reference our technical application notes for the proper application of UL1077 Mini-CBs.

There are UL489 Approved Mini-CBs in the marketplace that can be applied on 240 volt motor applications in accordance with UL and NEC. Note that these 240 volt UL489 circuit breakers are often seen improperly applied to 480 volt applications. This DOES NOT comply with UL and NEC as would the KTA7 Motor Circuit Controller, which can be applied for this purpose in applications up to 600 volts.

It should be noted that UL489 Mini-CB’s do not comply with UL508 as an overload relay. Therefore anyone applying a UL489 Mini-CB must also add a true overload relay to each motor circuit.

Neither UL1077 or UL489 Mini-CBs have the ability to interrupt a high ampere short-circuit with the speed of a KT7 Motor Circuit Controller, nor do they have the KAIC withstand rating, the ability to provide Type 2 coordination and certainly not Construction Type E approvals or level of equipment protection.

For additional information concerning the proper application of UL1077 Mini-CB’s, please refer to our White Paper located in the Mini-CB’s section of the Sprecher + Schuh catalog.

KT7 can be applied as a:

- Manual Motor Controller
- Group Installation Overload Relay
- Manual Self-Protected Combination Motor Controller (Type E)

CL4, CL7 and CK7 can be applied as a:

- Self-Protected Combination Motor Controller assembly (Type E)
- Combination Motor Controller (Type F)

The main fuses or circuit breaker are no longer necessary to meet the requirement of a Group Installation BCPD. A label within the panel specifying the BCPD outside the panel is a thing of the past. Multi-motor starter panels using the new KT7 verses Sprecher + Schuh’s previous Motor Circuit Controller (KTA3) probably won’t look much different. The real difference is the NEC rules applied to accomplish the task, along with an increased level of KAIC Type 2 protection against the possibility of a short-circuit fault.

Applying these state-of-the-art controllers properly in North America requires a working knowledge of UL, CSA, and NEC. It is our objective to assist customers in keeping pace with developments that can impact the cost effective protection of their control systems, reduce downtime and increase production for their customers. We encourage customers to contact their local Sprecher + Schuh representative or the factory to discuss issues about applications of these devices.