Selective Trip Coordination with Modern Molded Case Circuit Breakers

120-240V Revision 7
120-480V Revision 14

This Journal addresses selective trip coordination techniques that may be used to demonstrate compliance with the National Electrical Code (NEC) requirements for over current protective device selective trip coordination. The traditional technique of plotting the manufacturer’s time current trip curves (TCC) for the devices under consideration is still a viable method when used properly. However, TCC plots are limited in their capability of accurately depicting selective trip coordination in the region of high levels of overcurrent that include the Instantaneous trip function of circuit breakers. This limited capability is the reason that circuit breaker manufacturers have developed alternate techniques including the coordination tables in this Journal.

In 2010 the National Electrical Manufacturers Association (NEMA) published ABP 1-2010, a white paper developed, as stated in the document Forward, “… in response to the requirements in the National Electrical Code for selective coordination in order to assist engineers in designing selectively coordinated power systems using low-voltage circuit breakers.” This white paper is the most comprehensive presentation to date of information related to, and the interpretation of, the capabilities of low-voltage circuit breakers and techniques of their proper application to achieve desired levels of selective trip coordination. This Journal was developed in accordance with the principles presented in ABP 1-2010 and Siemens recommends this paper as reference for a more through understanding of the subject. NEMA ABP 1-2010 is available from ‘www.nema.org’ as a free download, and may be used in accordance with NEMA Copyright.

One important aspect of NEMA ABP 1-2010 is a discussion of the use of modern circuit breaker trip curves and the proper interpretation of TCC tolerance bands. Section 3.2 explains that due to the improved techniques employed in modern low-voltage circuit breakers, it is no longer necessary to allow white space between their trip curve bands to ensure selective coordination between them. Even if the outer edges of the bands touch, the included clearing times and tolerances ensure that the two devices will selectively coordinate. This principle is applied to circuit breaker pairs listed in the coordination tables below and is noted in Table Note #4 on the following pages.

Another important aspect of the published TCC is the minimum operating time shown. For many years it has been common practice in the electrical industry that the minimum time shown on the TCC is 0.01 seconds. This practice has been common on the part of many circuit breaker manufacturers, fuse manufacturers, and coordination software publishers. All TCC examples in ABP 1-2010 start at 0.01 seconds. In accordance with
that practice and in light of recent testing of circuit breakers, Siemens recommends that 0.01 seconds be the minimum time considered. Some older trip curves published originally under the “ITE” name and subsequently as “Siemens”, show a minimum time of 0.001 seconds. These trip curves should be truncated at 0.01 seconds for selective trip coordination and application purposes.

The following Selective Trip Coordination Table shows the maximum values of short circuit current, at the downstream breaker, that will allow selective trip coordination between the two Siemens circuit breakers. As further industry experience in this area becomes available and further testing is conducted, updates to the table will be published. Please contact your Siemens representative for the latest information.

**The following steps will assure the best use of the Selective Trip Coordination Table:**

1. Conduct a short circuit study to determine the available fault current values at each level of the system where coordination is critical. This allows the most cost effective selection of breakers to achieve the necessary selective trip coordination. A higher available fault current value will necessitate a larger and more expensive upstream circuit breaker. Accurate short circuit current will also mean more accurate arc-flash energy calculations.

2. Trip coordination is assured up to the value shown in the “Branch Coordination Level” column. A short circuit study will be the best source of the maximum available fault current to be compared to the current value shown in this field. Selective trip coordination is assured where the maximum available fault current value is less than this “Branch Coordination Level”. Faults occurring at the maximum calculated values are very rare so this is a conservative approach. The system designer may elect to consider other factors to balance the needs of system protection and coordination at various anticipated levels of current.

If the branch available fault current is not known, the main breaker maximum available fault current value may be used. This is a very conservative approach and may result in the least cost effective solution. For many systems the distribution transformer let-through value will provide a conservative available fault current for this use. The published data for the transformer should be consulted.

In many cases the minimum frame MCCB will only coordinate at relatively low levels of fault current. If the level of selective coordination between the two circuit breakers initially selected is insufficient for the available fault current at that point in the system, the tables may be used to find an alternate upstream circuit breaker that will allow a higher level of coordination. This will usually involve a larger frame size or different type of circuit breaker such as an insulated case or power breaker.
## Selective Trip Coordination Table

**TABLE NOTES:**
1. Coordination is assured up to the value of current shown in the "Branch Coordination Level" field.
2. If the available fault current at the branch is unknown, coordination is assured when the available fault current at the main is less than or equal to the value shown in the "Branch Coordination Level" field.
3. If the main breaker has an Instantaneous setting it must be set at maximum, branch Instantaneous must be set below "Branch Coordination Level" including bandwidth tolerances.
4. Coordination in the thermal range is also achieved, including instances where the tolerance bands touch but do not overlap. Electronic trip units must be adjusted for Long Time and Instantaneous functions (also Short Time if so equipped). As shipped, factory settings are at minimum values. Electronic trip mains must be adjusted to near maximums, standard trip curve coordination overlay techniques may be used for exact settings.
5. Applicable voltage range is marked for each chart.
6. In some cases the level of selectivity stated is for series rated pairs. When the same pair is used in a fully rated design, and if the level of selectivity given was higher than the fully rated AIC rating of the downstream device, selectivity is also assumed for levels up to the AIC rating of the downstream device for the same pair.
6. Consult literature for voltage and AIC ratings.

**Breaker Type Key:**
Breaker types are as shown in the table, except those called out specifically as ED, FD, JD, LD, LMD and MD. For those specific call outs:

'ED' includes the following types: ED4, ED6, HED4, CED6  
'FD' includes the following types: FXD6-A, FD6-A, FD6, HFD6, HFXD6, CFD6  
'JD' includes the following types: JXD2-A, JXD6-A, JD6-A, JD6, JXD6, HJD6-A, HJD6, HJXD6-A, HJXD6, CJD6-A  
'LD' includes the following types: LXD6-A, LD6-A, LD6, LXD6, HLXD6-A, HLXD6, LDL6-A, HLXD6, CLD6-A  
'LMD' includes the following types: LMD6, LMXD6, HLMD6, HLMXD6  
'MD' includes the following types: MD6, MXD6, HMD6, HMXD6, CMD6

For VL family circuit breakers, unless the type designation in the table includes the rating level, all AIC level models for that type and frame are included. For example, ‘HFG’ would include only that AIC level, but ‘FG’ would apply to NFG, HFG, and LFG. If there is no trip unit reference, all trip unit types apply, i.e. 525, 545, 555, 576 and 586. If electronic only applies it is so noted, i.e. NG-545(555), and would include all electronic trip units.

* Electronic trip units are available in this type. When the type and size noted is used with an electronic trip unit, selective coordination is achieved as long as the thermal bands of the upstream and downstream devices do not overlap (they may touch), and the instantaneous is in the high setting.
<table>
<thead>
<tr>
<th>Main Amps</th>
<th>Main Breaker</th>
<th>Branch Coordination Level</th>
<th>1, 2, and 3 Pole Branch Breakers</th>
</tr>
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<tr>
<td></td>
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<td>200-400A JD, LD</td>
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# Voltage range 120-480 Vac. Rev. 14

## Main Breakers

<table>
<thead>
<tr>
<th>Main Amps</th>
<th>Main Breaker</th>
<th>Branch Coordination Level</th>
<th>1, 2, and 3 Pole Branch Breakers</th>
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<tbody>
<tr>
<td>125A</td>
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* Electronic trip units are available in this type. When the type and size noted is used with an electronic trip unit, selective coordination is achieved as long as the thermal bands of the upstream and downstream devices do not overlap (they may touch), and the instantaneous is in the high setting.
### Voltage range 120-480 Vac. Rev. 14

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<th>Main Amps</th>
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|           | MG-52S 800/600A | 15-125 HED6, HEB, HEG | |
|           | SMD6 800/600A | 70-250A FD            | 200-300A JD6-A, HJD6-A, HLD6-A, LXD6-
|           | SMD6 800/600A | 35kA 15-125 NEB, NEG | 42kA 15-125 HED4-
|           | NG-545,555,576,586,1000/600A | 70-250A FD | 200-300A JD6-A, JXD6-A, LD6, LXD6-
|           | LMD, HLMD 600A | 42kA 15-125 HED4 | 25kA 15-125 ED6-
|           | LD, HLD, CLD 600A | 14kA 15-100A BQD, CQD | |
|           | LD, HLD, CLD 600A | 14kA 15-100A BQD, CQD | |

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