GE
Industrial Solutions

ArcWatch™ ON GUARD

Guide to Low Voltage System Design and Selectivity

imagination at work

DET-654C

Contents

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Foreword

GE's application publications on instantaneous selectivity, Guide to Instantaneous Selectivity (DET-760), available in the Publications Library at www.geelectrical.com) lists GE low voltage circuit breakers and the short circuit current to which they are selective. DET-537 includes legacy products, and is built essentially around the capabilities of the MicroVersaTrip Trip Unit utilized in GE devices for many years. This publication should prove useful in verification of existing installations or in add-to-existing work.

DET-760 includes the newer EntelliGuard family of trip units and features a more streamlined method of data presentation. The data contained within DET-760 reflects the capabilities of GE's ArcWatch solution, a set of technologies that produce always-on and automatic arc flash protection without sacrificing selective coordination. Product innovation, rigorous testing and real-world experience have improved GE's selectivity solutions, as evidenced in the newer DET-760 publication.

Following the introduction of coordination requirements in Articles 700 and 701 in the 2005 edition of the NEC, users, designers and suppliers adjusted their design and procurement patterns to meet the then new NEC selectivity requirements. Because the regulations are interpreted differently by different AHJs, all involved responded to a variety of interpreted requirements.

While there is still no uniform interpretation of these requirements, many Authorities Having Jurisdiction (AHJs) in the United States are enforcing instantaneous (sometimes referred to as .01 second or "full") selectivity requirements for "Emergency" and "Required and Standby" systems. Most AHJ's have, for many years, enforced the selectivity requirements in Article 620 for Elevators and similar equipment and are therefore familiar with the concept.

Today, GE will confidently provide design assistance and selective solution quotations for the majority of customer applications, regardless of the local AHJ interpretations.

The data in DET-537 and DET-760 continues to be the most comprehensive representation of selective circuit breaker pairings that GE offers. These publications convey the essentials of selective system applications in a more easily used context. Always make sure to use the latest revision of this or any other publications; The most current version can be found on GE's website.

Introduction
What is selectivity?

The electrical design industry has historically required electrical system circuit breaker selections and settings be validated with a short circuit and coordination study performed by a licensed engineer. These studies assure that circuit breakers are capable of interrupting the available current and would operate "selectively."

Traditionally, "selectivity" in a low voltage electrical system meant that the long time and short time portions of time-current curves (TCCs) would be selective, i.e. the circuit breaker closest to the fault would trip first, maximizing the amount of the electrical distribution system left in service. In most cases, the circuit breaker instantaneous overcurrent (IOC) TCCs would not be selective "on paper," as they typically overlap.

In Figure 1A, there is no "instantaneous selectivity" apparent on the TCC, as the instantaneous portion (below 0.1 seconds) of the curves show all three breaker characteristics overlapping. The long time and short time characteristics (above 0.1 seconds) do not overlap and are therefore selective. In Figure 1B, the 1600 amp AKR and Spectra F200 circuit breakers are selective, as the instantaneous function of the AKR is not used, so there is no overlap of these two characteristics.

Traditionally, selectivity between molded case circuit breakers (MCCBs) and insulated case circuit breakers (ICCBs) was considered effective even if there was overlap of TCCs in the instantaneous region. The most prevalent type of fault, the line to ground arcing fault, often limits the fault current magnitude enough that the upstream circuit breaker IOC function does not operate. If the fault is removed promptly, the likelihood of it escalating into a multi-phase, bolted type fault is very low. As a result, for a large majority of faults, the traditional long time, short time selectivity has been sufficient to produce selective operation of circuit breakers.

The 2005, 2008, 2011, and 2014 NEC extend the selectivity requirement to all possible fault types and magnitudes for certain critical electrical circuits, i.e., those typically fed from automatic transfer switches (ATS). These circuits and requirements are those discussed in the following NEC articles:

- Article 620: Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Lifts, 620.62 Selective Coordination
- Article 645: Information Technology Equipment, 645.27 Selective Coordination
- Article 695: Fire Pumps, 695.3(C)(3) Selective Coordination
- Article 700: Emergency Systems (Legally Required), 700.28 Selective Coordination
- Article 701: Legally Required Standby Systems, 701.27 Selective Coordination
- Article 708: Critical Operations Power Systems, 708.54 Selective Coordination

Figure 1A

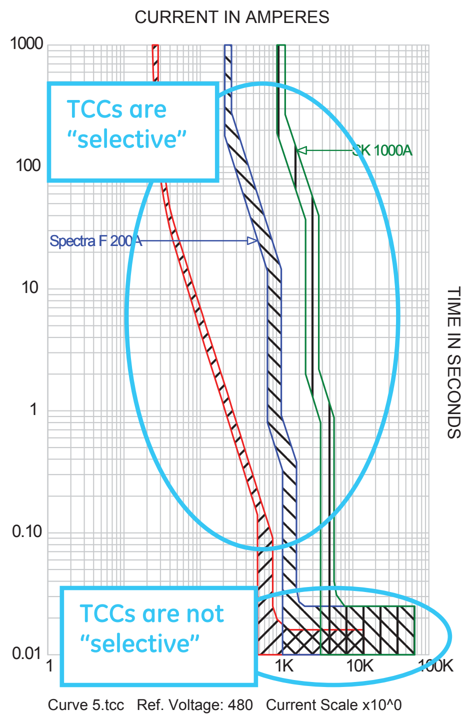
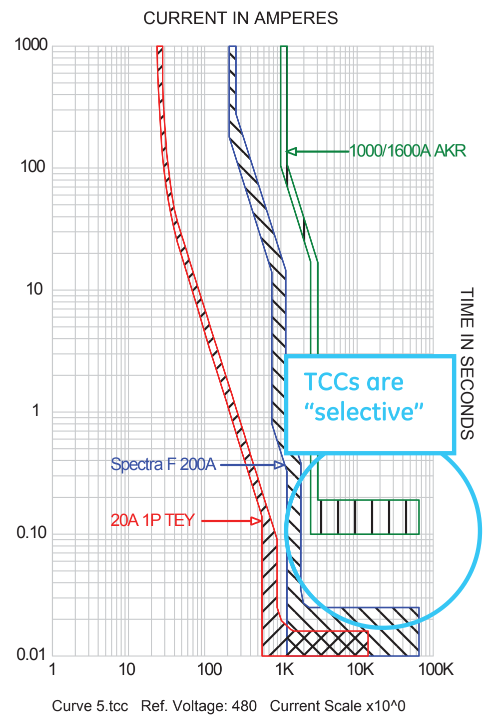


Figure 1B



These requirements state that overcurrent protective devices (OCPD) must be "fully selective." In other words, given the range of available interrupting currents, any given pair of overcurrent devices covered by the NEC Articles referenced above must behave in a coordinated fashion as defined in NEC Article 100:

> "Coordination (Selective). Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the selection and installation of overcurrent protective devices and their ratings or settings for a full range of available overcurrents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents."

The NEC requirements are desirable design goals, given the adverse consequences of larger than necessary power outages within critical circuits. However, there are other design considerations that these requirements seem to preclude, i.e., arc flash and the specifics of phase and ground fault overcurrent coordination. The ability of fully selective designs to provide sufficient protection to such important, sensitive equipment as generators or automatic transfer switches may be affected.

This publication uses the information on instantaneously selective breaker pairings contained in DET-760 as a base, and goes on to discuss specific tactics for developing fully selective electrical distribution designs. Though instantaneous selectivity is possible in many cases, it is not always easily accomplished with the considerations mentioned above. It has long been the responsibility of the licensed engineer of record to assess all performance requirements and produce a balanced, practical design. The NEC further defines this responsibility by stating that "Selective coordination shall be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems..."

National Electric Code (NEC) Requirements

NEC Articles 620, 645, 695, 700, and 701 requirements for Coordination read:

> "... overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices."

Article 620.62 reads:

> "... the overcurrent protective devices in each disconnecting means shall be selectively coordinated with any other supply side overcurrent protective devices"

This wording does not exempt ground fault protection from selectivity, nor does it exempt selectivity with the normal side supply sources. Even though these requirements found in the Special Conditions chapter of the NEC dealing with Emergency Systems, Legally Required Systems and Critical Operations Power Systems (COPS), it states the emergency overcurrent protective devices must be selectively coordinated with all supply side overcurrent protective devices. This terminology implies that selectivity with both normal and emergency supply sources is required for both phase and ground fault OCPDs. **(Note: The AHJ has the final word on interpretation of the NEC and other applicable code language. It is important to use their interpretation when designing and quoting selective systems.)** Full selective coordination in systems with ground fault protection is beyond the intended scope of this publication.

To date, a large variety of interpretations of the NEC requirements have been made. Numerous state and local AHJs have excluded these "Coordination" requirements from their enforcement codes or have modified them. At the time this publication was written, the most mentioned alternative to the NEC "full selectivity" requirement is the "0.1 second rule." This definition of selectivity has been adopted by some AHJs, including, most notably, Florida's Agency for Health Care Administration (AHCA / NFPA99). This interpretation has been further formalized by specific inclusion of "0.1 second" Selective Coordination in NFPA99 – Health Care Facilities Code, and in NEC Article 517 which pertains specifically to Health Care Facilities.

The AHCA / NFPA99 requirements are broader than those in the NEC as they apply to the entire facility, not just critical circuits. Therefore, faults on non-critical portions of the system will not result in an unwanted shutdown of critical circuits because of non-selective breaker operations. This standard is often criticized because it only requires selectivity down to 0.1 seconds. However, it represents the long-standing design practices employed by electrical systems designers. The AHCA / NFPA99 requirements, which allow the overlap of OCPD IOC functions, result in reduced clearing times and associated reduction in arc flash energy, and require selective coordination for the entire facility.

The AHCA / NFPA99 0.1 second allowance does have sound engineering basis. It is probable that most system faults are line to ground arcing faults on branch circuits. These faults will probably fall beneath the IOC threshold of the larger circuit breakers above the branch circuit breaker nearest the fault. Ground faults in parts of a system with high short circuit currents may be quite high in magnitude. Sensitive ground fault protection is often sufficient to sense and clear arcing ground faults well below IOC levels of upstream devices. Two levels of selective ground fault protection have been required in certain hospital systems by NEC Article 517 for many years.

It is important to note that "full selectivity" is often facilitated by increasing trip time delays and increasing pickup thresholds in upper tier OCPDs. Allowing instantaneous protection to be applied throughout the system improves protection and decreases arc flash hazard. The impact of designing for full selectivity in systems that require "live work" should be studied and understood so optimized design decisions can be made and hazards identified.

The first words of NEC, Article 90.1, Purpose, are: **"(A) Practical Safeguarding.** The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity. This Code is not intended as a design specification or an instruction manual for untrained persons" Historically, the NEC started by establishing protection requirements for low voltage loads, cables, transformers, etc. This has always been and continues to be the Code's first priority. While Articles requiring "fully selective" systems are consistent with the "Practical Safeguarding "requirements, these Articles do not take precedence over competing protection and design needs.

Interpretations of the selectivity requirements of the NEC code vary significantly. Some interpretations require full selectivity through the critical circuits, to both the normal and emergency supplies. Others require critical circuit breakers to be selective to the automatic transfer switch (ATS) using the normal supply short circuit current, then continue the selectivity only to the emergency supply above the ATS using the emergency source short circuit current. A third popular interpretation requires selectivity through critical circuits to the emergency supply only. (Please note that the short circuit current from the emergency source is often much less in magnitude than the normal supply.) Where this is the case, designers have more selective breaker pair choices and the potential ability to reduce the size and cost of a selective system solution.

Some AHJ's require selectivity of critical circuits to be addressed, but leaves the extent of the requirement to the discretion of the licensed professional engineer of record. This allows the engineer to balance other design requirements, such as arc flash, with selectivity needs.

When designing a system for selectivity per NEC requirements, it is important to know exactly how the AHJ has defined selectivity requirements and how they are verified and enforced.

Selective System Design Considerations

Ground Fault Protection

Some selectivity requirement interpretations of the Code exclude ground fault protection because it is not specifically addressed in Article 620, 700, 701 or 708. Article 100 defines "Coordination" as:

> "Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the selection and installation of overcurrent protective devices and their ratings or settings for the full range of overcurrents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents."

"Overcurrent" is defined as:

> "Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault."

Ground fault selectivity is not expressly mentioned in Articles 620, 700, 701, and 708, however, article 517.17C (Ground Fault Protection – Health Care Facilities) includes the following:

> "Separation of ground fault protection time-current characteristics shall conform to manufacturer's recommendations and shall consider all required tolerances and disconnect operating time to achieve 100 percent selectivity."

There is however no requirement that specifically describes ground fault selectivity with downstream phase fault protection.

Traditionally, the shape of a ground fault protection characteristic applied on low voltage circuit breakers would be called a "definite time" or "L-shaped" characteristic. (Note: Often, ground fault relays or ground fault protection integrated with circuit breaker trips will offer a way to cut off the bottom left corner of the "L." This cut-off corner is usually in the shape of an I2t=K diagonal line on the TCC.)

Typical GF protection characteristics are illustrated in the low voltage circuit breaker phase and ground protection characteristics below. Their dissimilar shapes make selective coordination difficult at best. The NEC (Article 230.95) requires that ground fault protection be applied on solidly grounded 480 volt service entrances, 1000 amperes and larger.

Hospitals and other healthcare facilities with critical care or life support equipment are required to have a second level of ground fault protection beneath the service entrance (NEC Article 517.17(B)). The NEC-stipulated maximum ground fault pick-up setting is 1200 amperes and clearing time is limited by a requirement that a 3000A fault must be cleared in one second or less (Article 230.95(A)). Emergency system supply sources are exempted from these requirements.

Figure 2A is a one line diagram with two levels of ground fault protection as required by NEC Article 517. Figure 2B diagrams the selective device settings for this one-line diagram. Ground fault relay settings for the 4000A main and 1200A branch feeder are selective and at the maximum allowed by the NEC. The next device below the 1200A branch is a 250A OCPD. Note that there is significant overlap between the ground fault relays and the 250A device TCCs.

Traditional system designs would size the 250A OCPD to 600A or possibly 800A, making this non-selective situation worse. In this and many similar situations involving phase and ground fault protection, this system would not be fully selective for ground faults, as an upstream OCPD could trip sooner than the downstream OCPD.

MCCB Layer Limitations - Riser / Feed Through Lug Panels

Some traditional electrical system designs have utilized a "waterfall" of electrical distribution panels of declining ampacities, i.e., a series of progressively smaller electrical distribution panels connected to larger upstream panels. This concept is popular because it allows the size and cost of the distribution panels and feeder cables to be reduced further from the service entrance point. While this has been a satisfactory practice when long time and short time selectivity is considered, the practice increases the difficulty of achieving "fully selective" solutions.

For "fully selective" designs, it is desirable to limit the number of selective circuit breaker layers as there are a limited number of selective molded case circuit breaker (MCCB) pairings available. If you consult GE's (or other manufacturers') circuit breaker instantaneous selectivity tables, you will usually find three or, in some circumstances, four layers of molded case circuit breakers that can be made fully selective.

With a limited number of fully selective MCCB layers in mind, the best electrical distribution design strategy is to limit the number of selective layers by utilizing feed-through lugs or riser panels of the same ampacity when sub-panels are required. When feeder cables and panels are all the same ampacity, only one layer of protection is required to protect them.

In doing so, the tradeoff is the elimination of a local main circuit breaker. Some designs will utilize a main disconnect at each panel to allow local isolation of a panel. Care must be exercised if a molded case switch (MCS) is used as a main disconnect. The MCS will have an IOC override in the switch to protect it from damage resulting from high magnitude fault currents. This instantaneous override must be considered as part of the selectively coordinated system.

Figure 2A

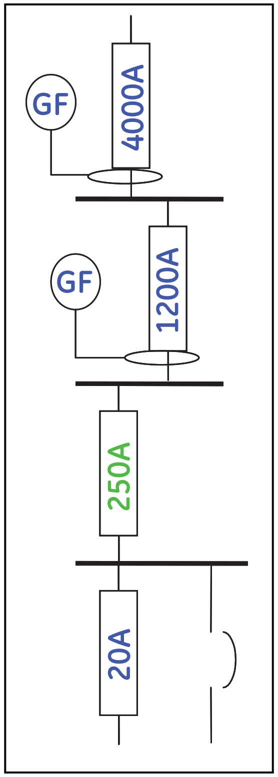
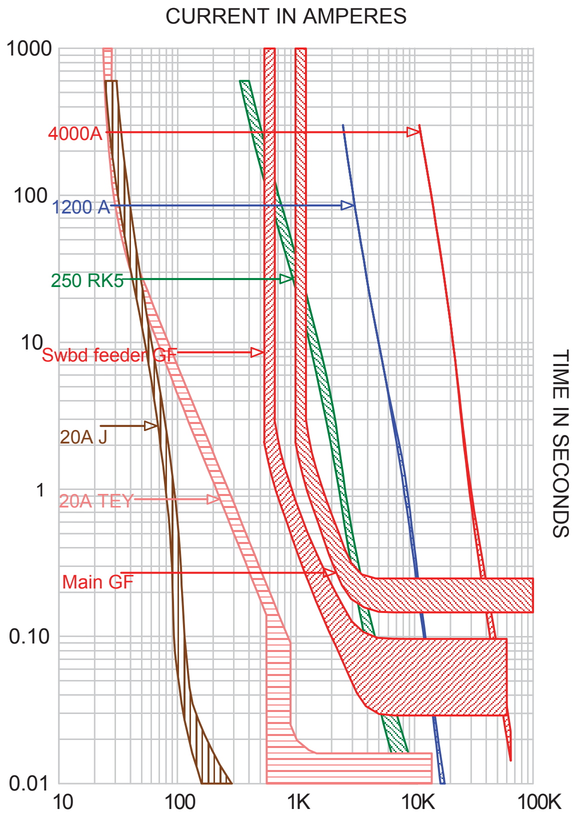
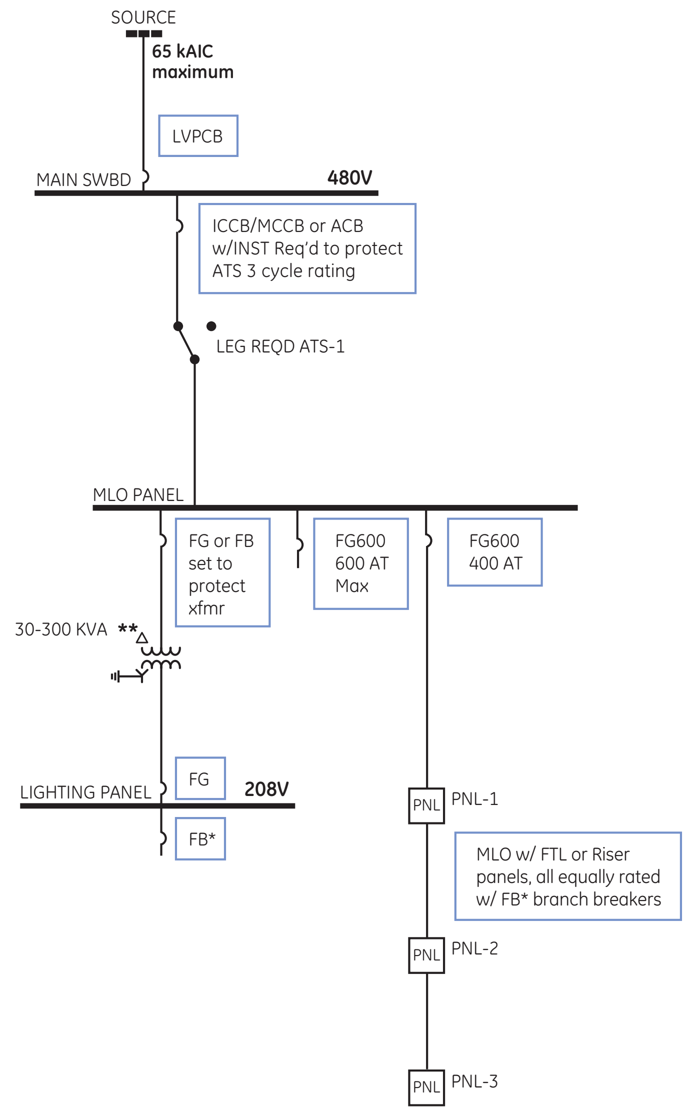


Figure 2B



In Figure 3, the 400 ampere feeder is feeding three downstream panels. With the use of riser panels of the same ampacity, only two layers of selective breakers would be needed. If a traditional design strategy of progressively smaller subpanels had been used, four layers of fully selective circuit breakers would be required for the waterfall of declining ampacities.

Figure 3 Fully Selective Circuit Breaker Options
For Systems with 65 kAIC or less



* TEY or THQ MCCBs may be used, but only if the maximum AIC specified in DET-537 is not exceeded.
** See selectivty templates for details of transformer

Automatic Transfer Switch (ATS) Protection

Most ATSs built for use in North America are manufactured in accordance with the UL 1008 standard, which references UL 489 for molded case circuit breakers. Furthermore, many ATS manufacturers provide application data specifying which MCCBs are appropriate for protecting the ATS ampacity and short circuit withstand ratings. In general, most ATSs are designed to be protected with circuit breakers that have integral IOC protection functions.

In some fully selective protection schemes, it may be necessary to protect an ATS with a low voltage power circuit breaker (LVPCB) applied without an IOC function. This may be a non-conforming application, which might require special consideration by the ATS manufacturer. Some ATS manufacturers have published withstand data on such applications, while others are considering future products with higher withstand time ratings in view of the new selectivity requirements.

GE's exclusive ArcWatch technology makes application of a LVPCB without IOC unnecessary. Instantaneous Zone Selective Interlocking (I-ZSI) provides an avenue of communication between devices, similar to traditional Short-Time/Ground Fault ZSI, but adds interlocking of the Instantaneous protection, allowing better coordination without sacrificing protection. WaveFormRecognition (WFR) allows the current limiting behavior of downstream devices to determine protection settings.

Generally speaking, GE devices equipped with an EntelliGuard family trip unit use ArcWatch to achieve selectivity with INST protection enabled.

Switchboard Protection

Switchboards, distribution panels and lighting panels utilize MCCBs, ICCBs or LVPCBs with IOC functions. Therefore, the withstand ratings of these boards and panels are usually based on 3 cycles. Similar to the ATS ratings discussed above, LVPCBs without an IOC function should not be used to protect a switchboard unless special application consideration has been given to its withstand rating. Some manufacturers have 30 cycle withstand ratings for specific switchboard designs. If selectivity requirements result in the use of LVPCBs without an IOC function or very high IOC settings, it is important to know the withstand ratings of the downstream equipment.

While GE does offer Switchboards with such a 30 cycle withstand rating (tested to ANSI C37.20), ArcWatch technology allows coordination to be achieved with INST protection enabled. This typically negates the need for a 30 cycle withstand switchboard and provides superior arc flash protection while maintaining selective coordination.

Transformer / Current Limiting Reactor Applications

Considerations for NEC "fully selective" applications focus on the selective performance of circuit breaker pairs in the IOC regions of their TCCs. Usually, higher short circuit currents limit the options for pairs of selective breakers. Consequently, some electrical designs use one-to-one ratio transformers or current limiting reactors to restrict fault current magnitudes. This works well where one of these devices can provide a small amount of series reactance to control the short circuit current to a magnitude where more options for selective breaker pairings are available. It may not be effective if two-to-one or three-to-one reductions in short circuit current magnitude would be required to make selectivity possible.

Design Tips Summary

- Note the actual calculated short circuit currents for the critical circuit buses on the bid drawings.
- Define the circuits and sources that must be made selective, according to the local AHJ (preferable), the end customer or the engineer of record.
- Limit the number of MCCB selective layers below an ATS to two if using a 1200A frame MCCB to protect the ATS.
- If ATS or switchboards are protected by an LVPCB without IOC, this equipment will require a 30 cycle short circuit withstand rating. (Typically unnecessary with GE ArcWatch equipped devices)
- Utilize main lug only (MLO) with FTL or riser panels to minimize required layers of fully selective circuit breakers.
- Increasing the frame size of an ICCB or MCCB may increase maximum short circuit current selectivity with a downstream breaker.
- Utilize ArcWatch I-ZSI for Coordination between devices 1200A and larger
- Use LVPCB's (not PBII or Spectra K) as the upstream devices in I-ZSI Coordinated Pairs
- Small lighting transformer impedance can be used to limit the secondary short circuit current, with resulting full selectivity (secondary main IOC set above the secondary short circuit current).

Continued on next page.

- For systems with 35kA short circuit current or less:
  - Utilize an LVPCB with ArcWatch I-ZSI as the service entrance main as the fifth and top layer of selective protection.
  - Utilize PB II as the fourth layer of selective protection.
  - Utilize Spectra K MCCB as the third layer of selective protection.
  - Utilize FG MCCB as the second layer of selective protection.
  - Utilize FB, TEY, THQB MCCBs (depending on short circuit current requirement and voltage at this level) as the bottom branch device layer of selective protection system.
- For systems with 65kA short circuit current or less,
  - Utilize an LVPCB with ArcWatch I-ZSI as the service entrance main as the fifth and top layer of selective protection.
  - Utilize an LVPCB with ArcWatch I-ZSI as the fourth layer of selective protection.
  - Utilize Spectra K MCCB as the third layer of selective protection.
  - Utilize FG MCCB as the second layer of selective protection.
  - Utilize FB, TEY, THQB MCCBs (depending on short circuit current requirement and voltage at this level) as the bottom branch device layer of selective protection system.
- Utilize lighting transformer TCC templates to define breaker applications for transformer protection and fully selective protection.

Selectivity for Existing Systems

Several projects have been reviewed where NEC requirements for selectivity on critical circuits have been stipulated for add-on systems within pre-existing power distribution systems. Interpretations of requirements for these situations have varied significantly.

Assuming that the critical circuits in the original system were designed to the “traditional” selective coordination requirements, adding new critical circuits under the existing system would probably result in a non-selective system. Under fault conditions in the new portion of the circuit, the upstream, pre-existing breakers would probably be non-selective, resulting in a potential shutdown of the entire new system for some faults. Where devices with instantaneous trips from different manufacturers are mixed, it is unlikely that there is enough data to determine the selectivity capability between them. The one application exception to this would be the addition of a new sub-system under an LVPCB circuit breaker that was applied without an IOC function or a circuit breaker with an IOC threshold larger than the AIC.

In some cases, a variance from the Code requirement has been requested and granted based on considerations of the difficulty in analyzing or achieving selectivity for systems involving a mix of manufacturers. If absolute adherence to the new NEC requirements for add-on systems is required, this will probably result in costly replacement of existing circuit breakers and possibly equipment. Often, fully selective circuit breaker pairings and associated equipment may be larger and more expensive than breakers and equipment designed around traditional selectivity definitions. Therefore, an expansion of the space allocated to original equipment may be required.

Arc Flash Considerations

At the core of fully selective designs based on NEC Coordination (fully selective) requirements is the concept of coordination of circuit breaker OCPD time-current characteristics. Practically, this means that the circuit breaker immediately upstream of the breaker closest to the fault will be set (delayed or desensitized) to prevent it from operating until the downstream breaker clears the fault.

Considering that a typical 1500 kVA service entrance and associated power distribution system designed for full selectivity may have five layers of coordinated circuit breakers, the time delayed response of the service entrance main breaker may be considerable. This time delay could correspond to high arc flash incident energy and a correspondingly high Hazard Risk category classification. GE ArcWatch technology significantly reduces the need for a time-delayed response and as a result, lower arc flash incident energy.

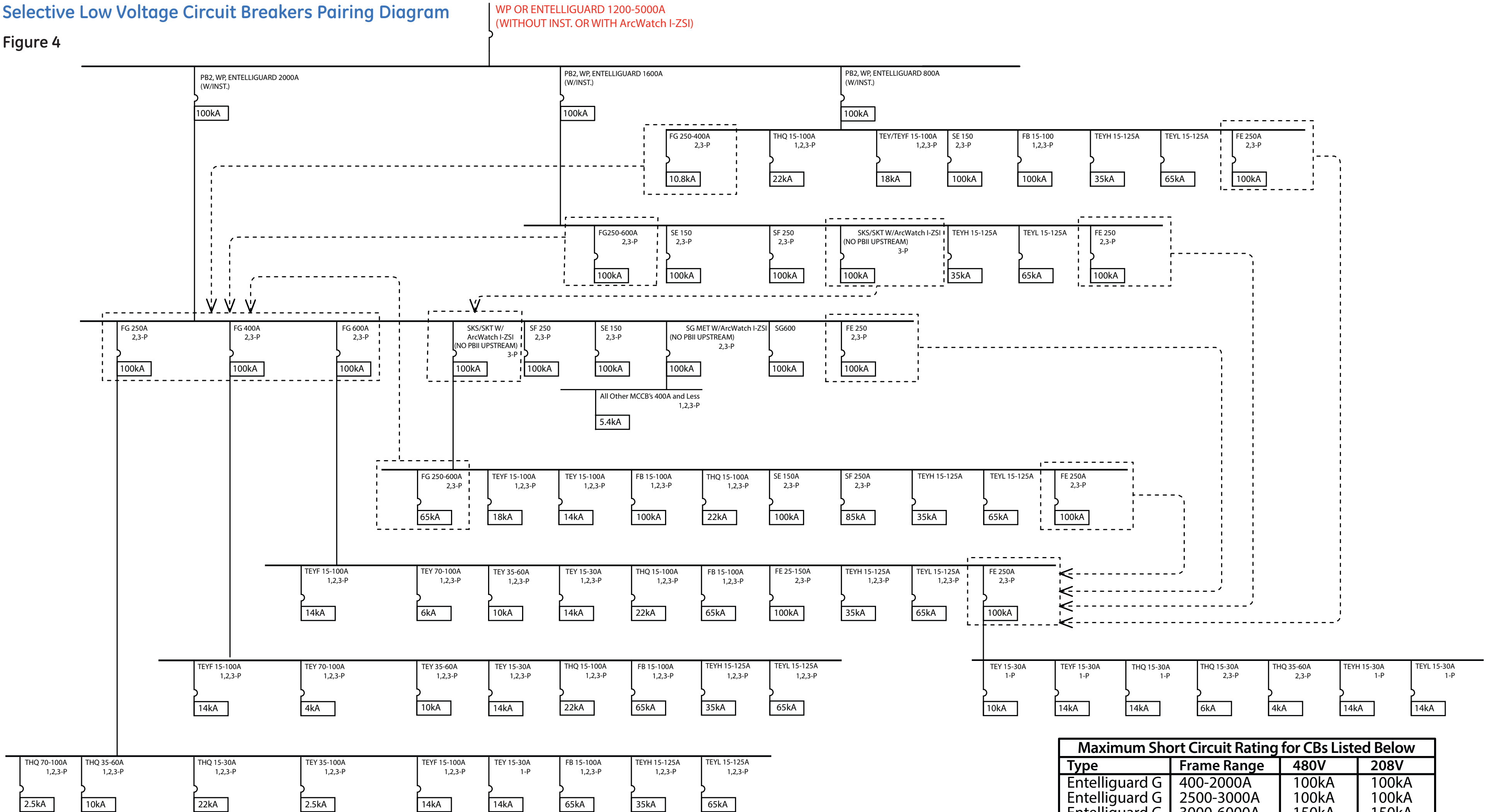
The Standard for Electrical Safety in the Workplace, NFPA70E, requires that all electrical hazards be identified by qualified personnel before work on electrical equipment is undertaken. Usually, this requires assessment of arc flash hazard. Ideally, an Arc Flash Study of the electrical system should be considered during design so that the consequences of design decisions, including those made for selectivity purposes are understood.

Increasing OCPD pickup settings, increasing IOC settings and adding time delays to obtains fully selective design can have a significant impact on available incident energy. For systems likely to be serviced while energized, these time delays may cause serious risk to personnel. High incident energy levels may force the system to be shut down before any work can be performed, or mandate the use of temporary arc flash risk mitigation measures such as remote racking or temporarily lowered INST pickup settings via Reduced Energy Let-Thru (RELT) or maintenance mode settings. Excessive energy levels and time delayed (slow) protective device response typically allow extensive fault related damage, requiring extensive down time and repair. Using the most sensitive settings possible minimizes the risk to both equipment and personnel.

The exclusive ArcWatch advanced protections embedded within the EntelliGuard family of trip units provide extensive benefits in the reduction of arc flash energy while maintaining selectivity, and as permanent protection measures allow arc flash incident energy labels to reflect their protective capabilities. Temporary and administrative measures such as RELT/maintenance mode and remote racking do not reflect continuous performance of the equipment, and cannot be factored into such labeling. Any method of achieving selectivity should include the utmost care to minimize arc flash hazard.

Selective Low Voltage Circuit Breakers Pairing Diagram

Figure 4



Maximum Short Circuit Rating for CBs Listed Below			
Type	**Frame Range**	**480V**	**208V**
Entelliguard G	400-2000A	100kA	100kA
Entelliguard G	2500-3000A	100kA	100kA
Entelliguard G	3000-6000A	150kA	150kA
Wave Pro	500-3200A	100kA	100kA
Wave Pro	800-2000A	65kA	65kA
PBII	800-2000A	100kA	150kA
PBII	3000-4000A	150kA	200kA
SK	800-1200A	100kA	200kA
FG	250-600A	200kA	200kA
FE	25-250A	100kA	200kA
SE	30-150A	100kA	200kA
SF	250A	100kA	200kA
SG	400-600A	100kA	200kA
FB	15-100A	150kA	200kA
TEY	15-125A	65kA	100kA
THQ	15-100A	–	10kA
THHQ	15-100A	–	22kA

Selectivity tables are available in DET-760 Guide to Instantaneous Selectivity

GE Circuit Breaker / Equipment Combinations

Table 1

Breakers		Equipment													
		Enclosure Mounted	A-Series II Panelboards				A-Series II Powerpanel	Spectra Powerpanels	Switchboards			Evolution	Switchgear		
			AQ	AE	AD	AS			Spectra	AV-3	PB II		AKD10	Entellisys (1)	AKD20
Main	WavePro without IOC								✓	✓	✓		✓		✓
	WavePro with IOC								✓	✓	✓		✓		✓
	EntelliGuard G without IOC										✓			✓	✓
	EntelliGuard G with IOC										✓	✓		✓	✓
	Power Break II								✓	✓	✓	✓			
	Spectra K		✓	✓	✓	✓		✓	✓			✓			
	Record Plus FG		✓	✓	✓	✓		✓	✓			✓			
	Record Plus FE		✓	✓	✓	✓									
Feeder	WavePro without IOC								✓				✓		✓
	WavePro with IOC								✓				✓		✓
	EntelliGuard G without IOC													✓	✓
	EntelliGuard G with IOC											✓		✓	✓
	Power Break II	✓							✓		✓	✓			
	Spectra K	✓						✓	✓	✓		✓			
	Record Plus FG							✓	✓			✓			
	Record Plus FE						✓	✓	✓			✓			
	Record Plus FB				✓		✓	✓	✓			✓			
	TEY D/H/L					✓									
	TEY & TEYF	✓		✓			✓	✓	✓			✓			
	THQ	✓	✓				✓	✓	✓			✓			

(1) - Uses EntelliGuard or EntelliGuard E Breaker with Entellisys Messenger

Appendix

Selective Time–Current Curve Templates

The followed time-current curves were composed with the following objectives:

1. Achieve full selectivity (LT, ST and IOC) between each pair of circuit breakers applied
2. Provide required NEC transformer protection
3. Provide recommended ANSI through fault protection of transformers
4. Provide the secondary power panel protection in accordance with its ampacity

(Note: To be "fully selective," there must be no overlap of the long time and short time characteristics of an upstream and downstream circuit breaker pair. If the IOC function of this pair of breakers overlap, then their instantaneous selectivity must be identified as selective in the manufacturer's instantaneous overcurrent selectivity application literature.)

While it may be desirable to have the primary and secondary main circuit breakers selective with one another, it is not usual when applying MCCBs to protect transformers. In the NEC, a specific exception exists to exempt selectivity requirements from the primary and secondary mains. The branch circuit breakers shown are the largest possible breakers and trips that will be fully selective with both the upstream primary and secondary main transformer circuit breakers. If selectivity between the branch breakers and the upstream secondary main is not apparent because of IOC TCC overlap, the application is fully selective based on the tabular pairing cited in DET-760, GE Overcurrent Device Instantaneous Selectivity Tables.

One other item of note is that the maximum AIC values shown in DET-760 are symmetrical values. All analysis and testing done to validate these numbers were done with the appropriate standard based X/R value and corresponding asymmetrical offset. The equivalent symmetrical value was placed in the tables. It has long been standard practice to terminate the IOC function on a TCC at the maximum asymmetrical value of fault current, as IOC functions are often responsive to the peak value of current.

The partial system templates diagrammed on the following TCCs were laid out and modeled based on a maximum fault current of 65 kA at 480V, with an X/R ratio of 4.9. Transformer impedances used are the minimum for which a full selectivity solution could be achieved. Also noted on the TCCs are the typical GE transformer impedances for aluminum wound, 150°C rated transformers. In every case, the impedance diagrammed is equal to or less than the typical GE value. To make the solution as conservative as possible, no or negligible cable impedances were included in the short circuit calculations.

While Article 450 of the NEC requires that transformers be properly protected from overcurrent conditions, it allows several alternative approaches to achieve protection. For 480V to 120/208V lighting transformers, 15 kVA and larger, the protection requirements are described in Table 450.3B of the NEC. The two options described are to use a circuit breaker as the primary main rated at no more than 250% of the primary ampere rating and a secondary main circuit breaker rated at no more than 125% of the secondary. (Note: See NEC Table 450.3 and associated notes for additional application allowances and restrictions.) It is also permissible to use only a primary main circuit breaker rated at no more than 125% of the primary ampacity.

In general, since the ANSI "through" fault protection criteria is a recommendation, it is desirable to have the ANSI protection characteristic to the right of the primary and secondary circuit breaker TCCs. However, it is the standard practice that adequate protection is still provided if most of the ANSI characteristic is to the right of the secondary main TCC.

In the TCCs that follow, A is always the transformer primary main and B is the secondary main circuit breaker.

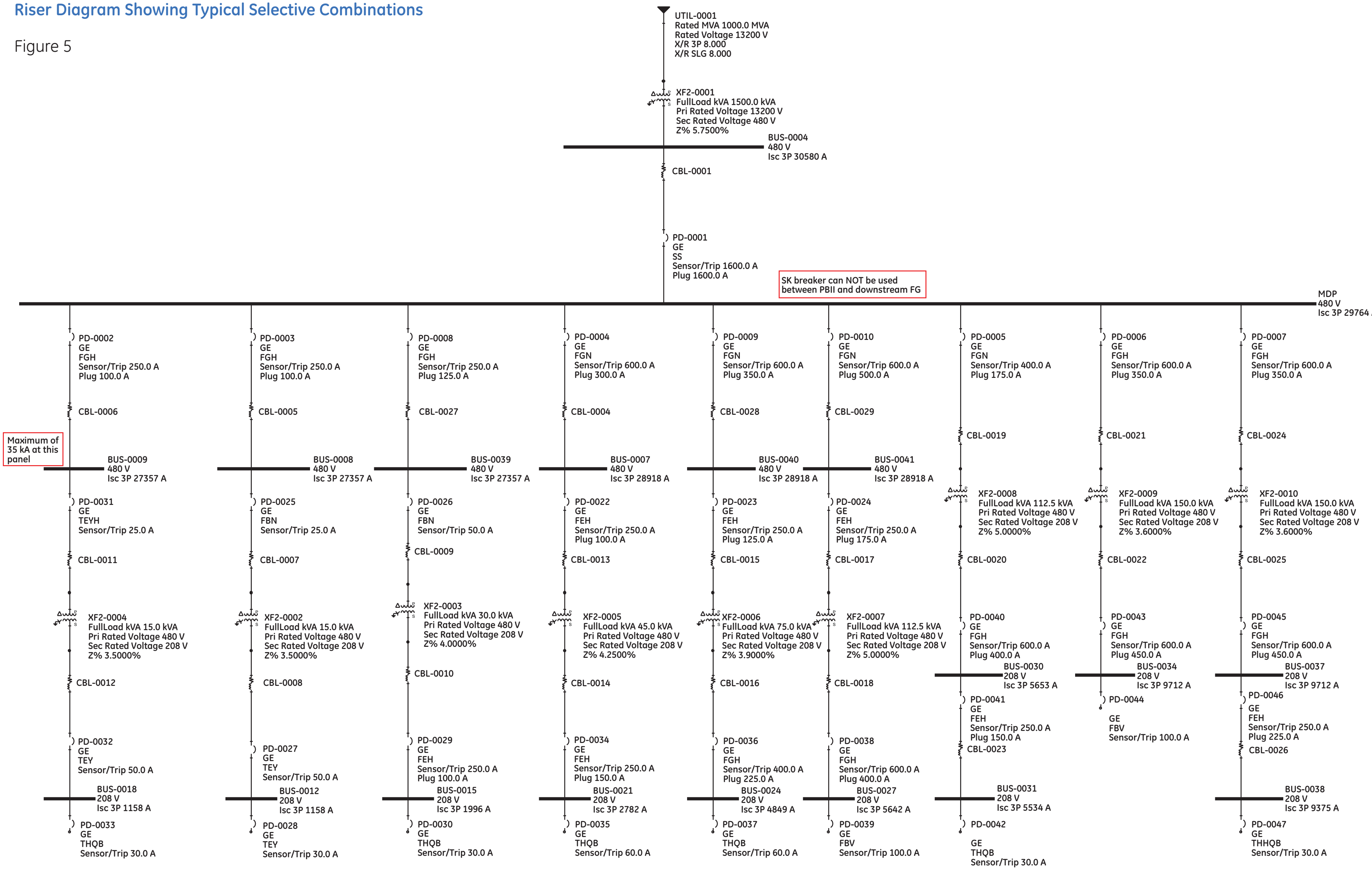
TCC Color Code

Black = Branch
Pink = Largest
Red = Main
Blue = Primary Feeder
Brown = Upstream

Throughout the Time Current Curve Templates we refer to DET-760 Guide to Instantaneous Selectivity. Please go to our website for the most recent version of this publication.

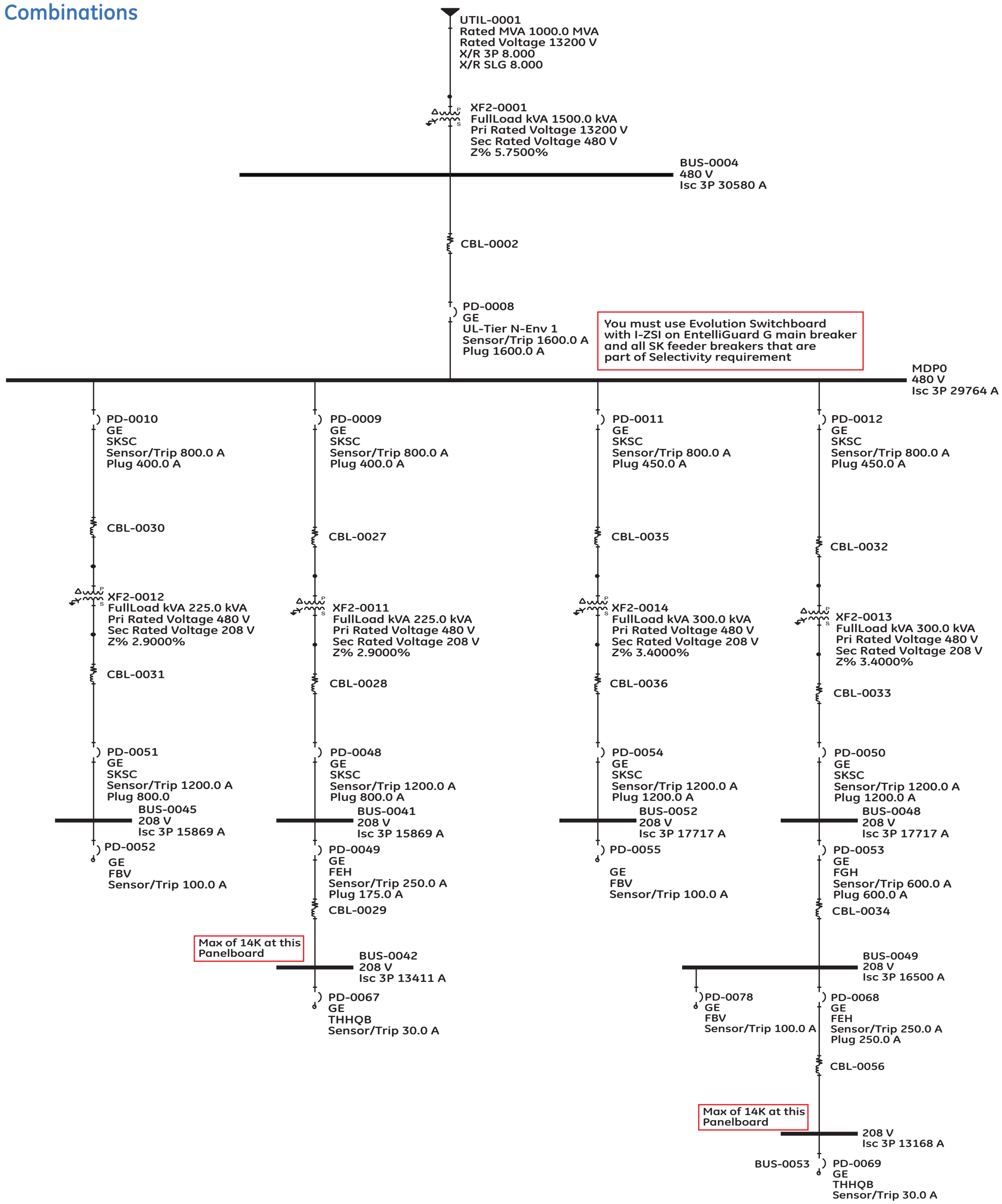
Riser Diagram Showing Typical Selective Combinations

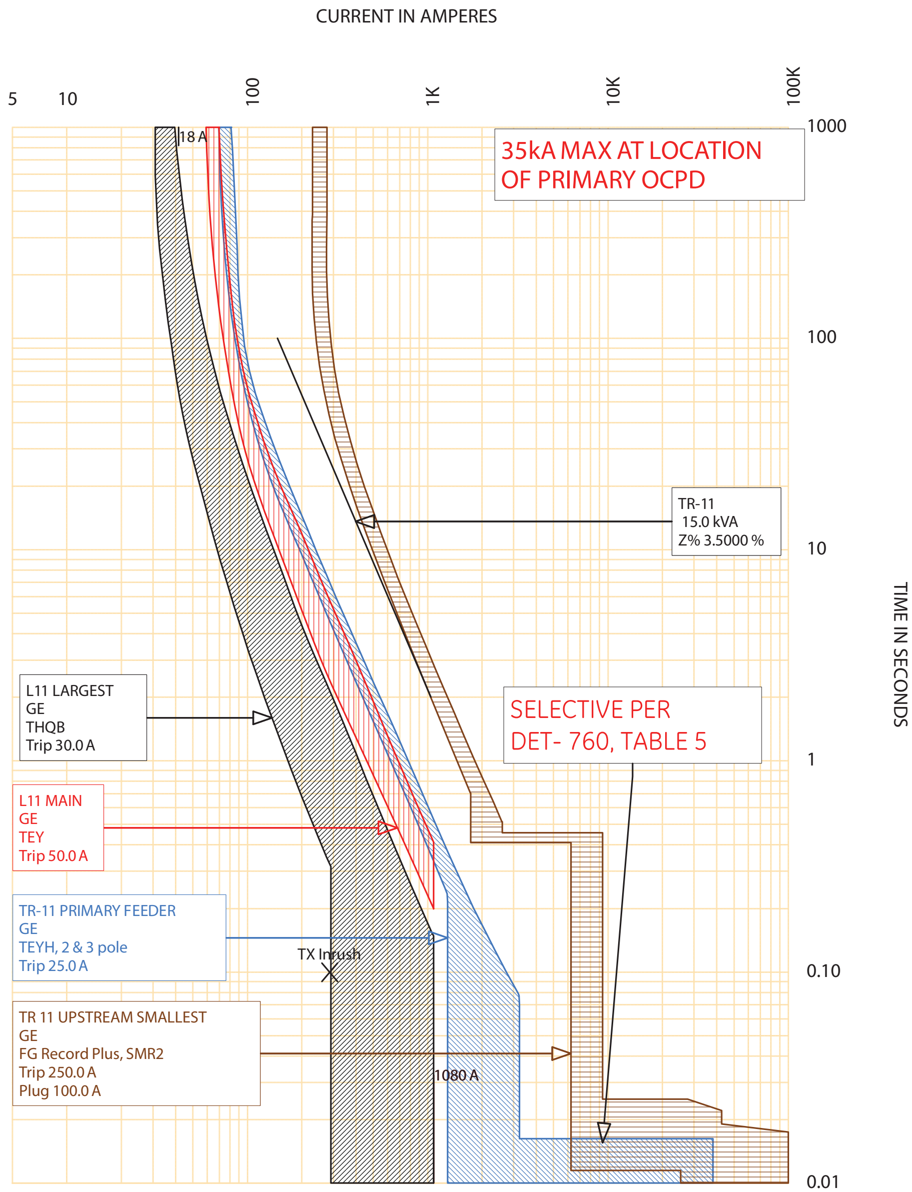
Figure 5



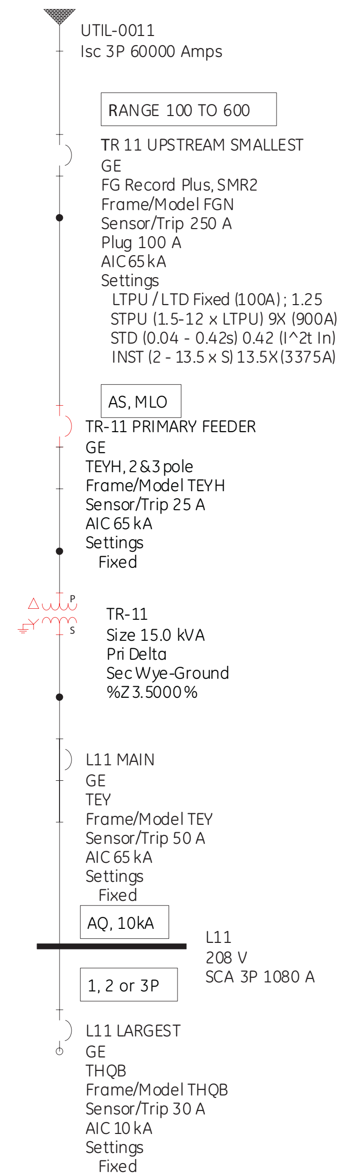
Riser Diagram Showing Typical Selective Combinations

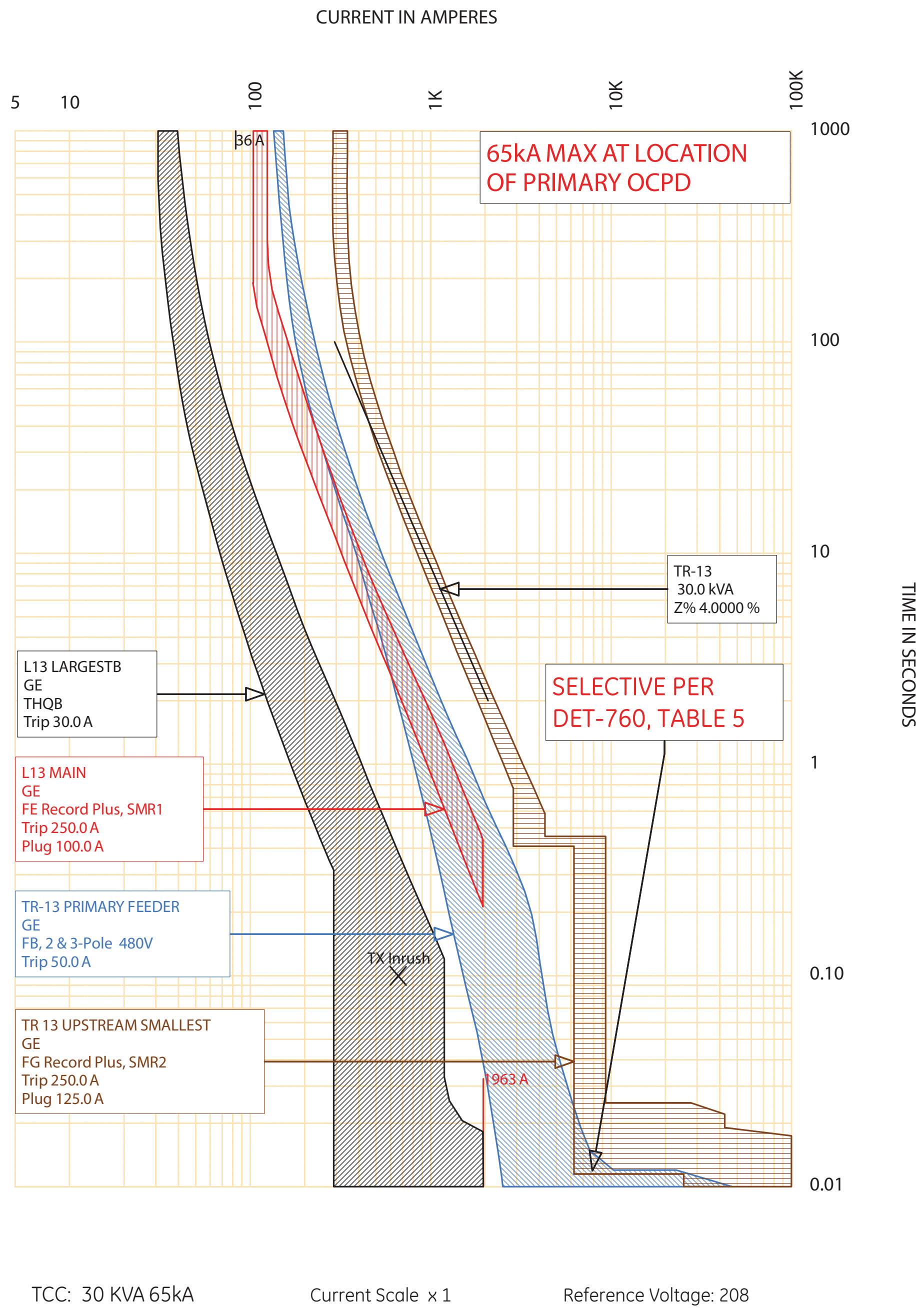
Figure 6

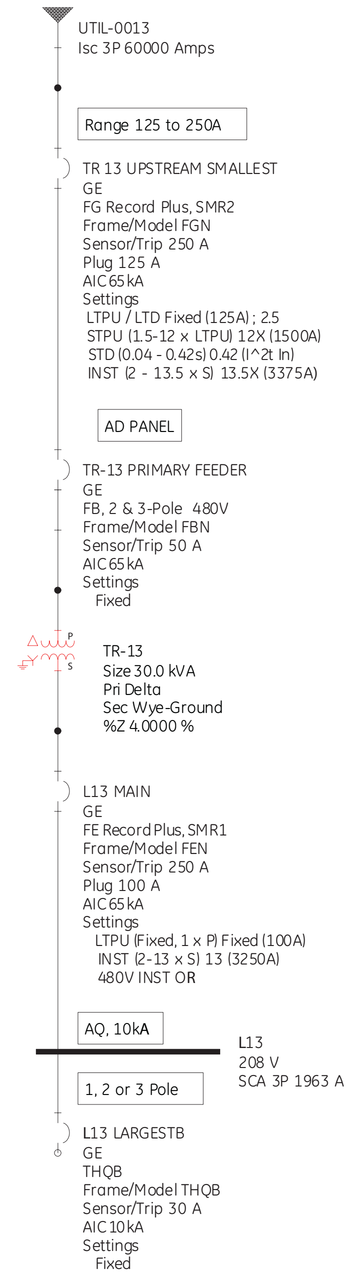


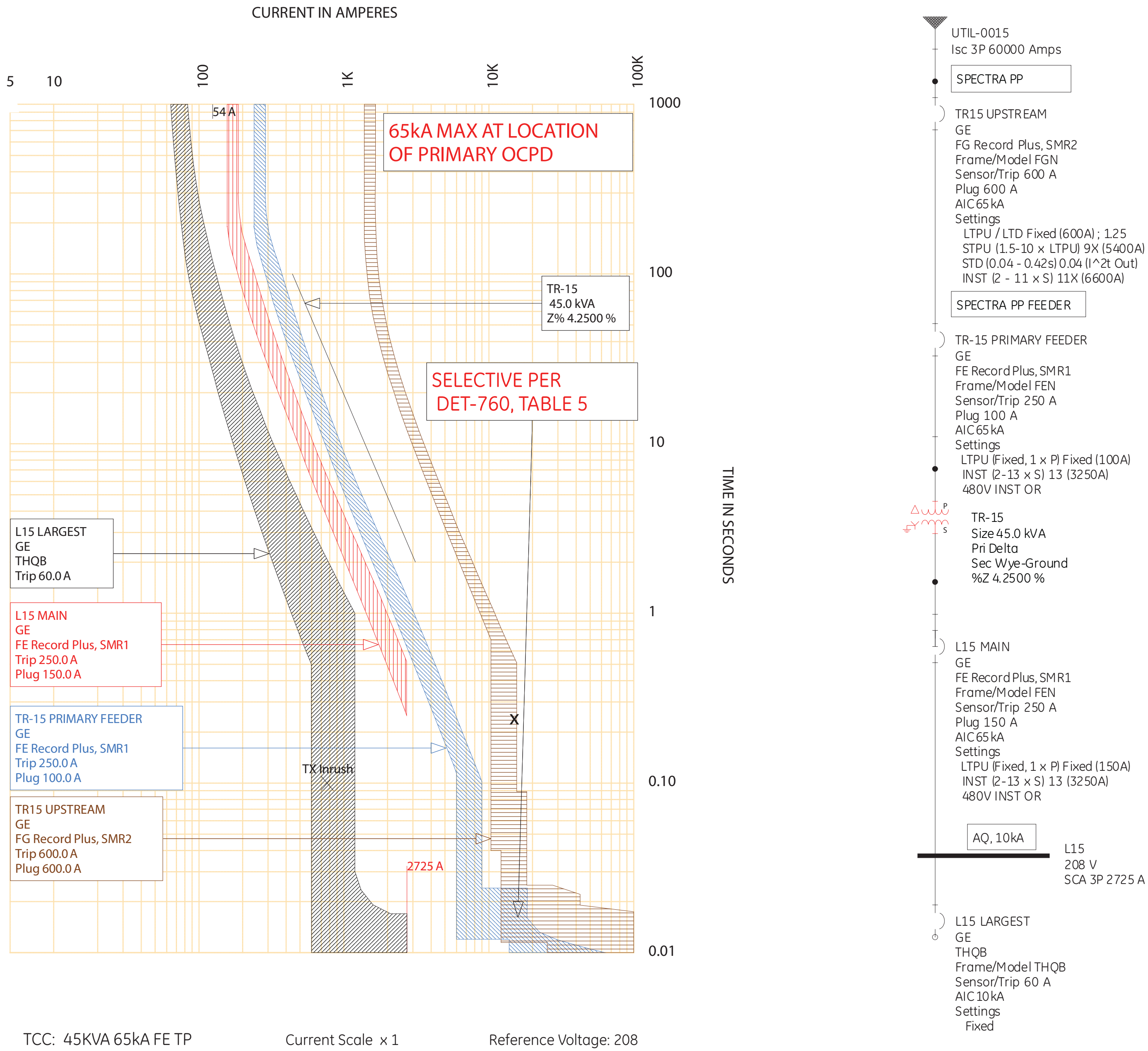


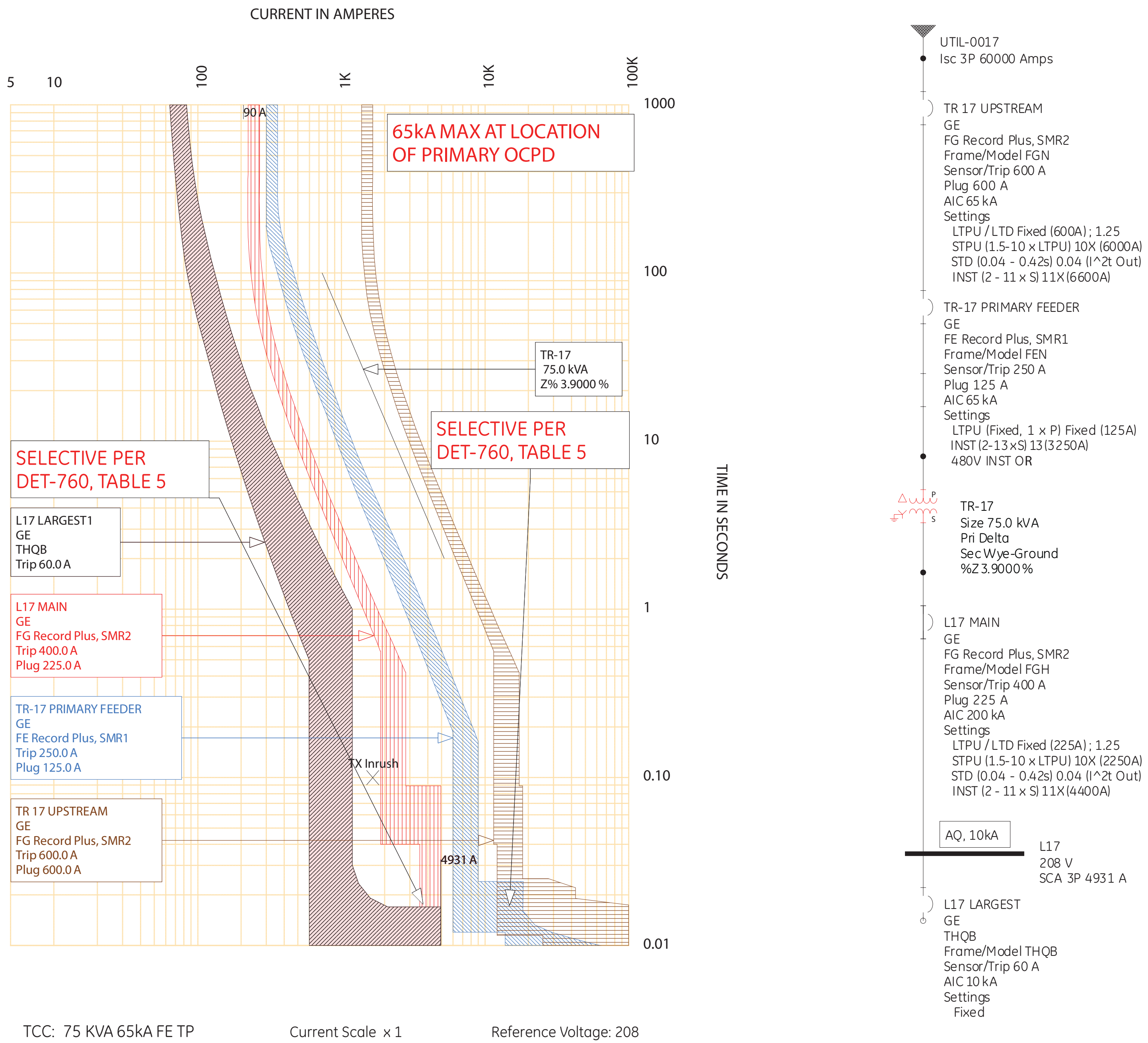
TCC: 15 KVA 35kA Current Scale x 1 Reference Voltage: 208

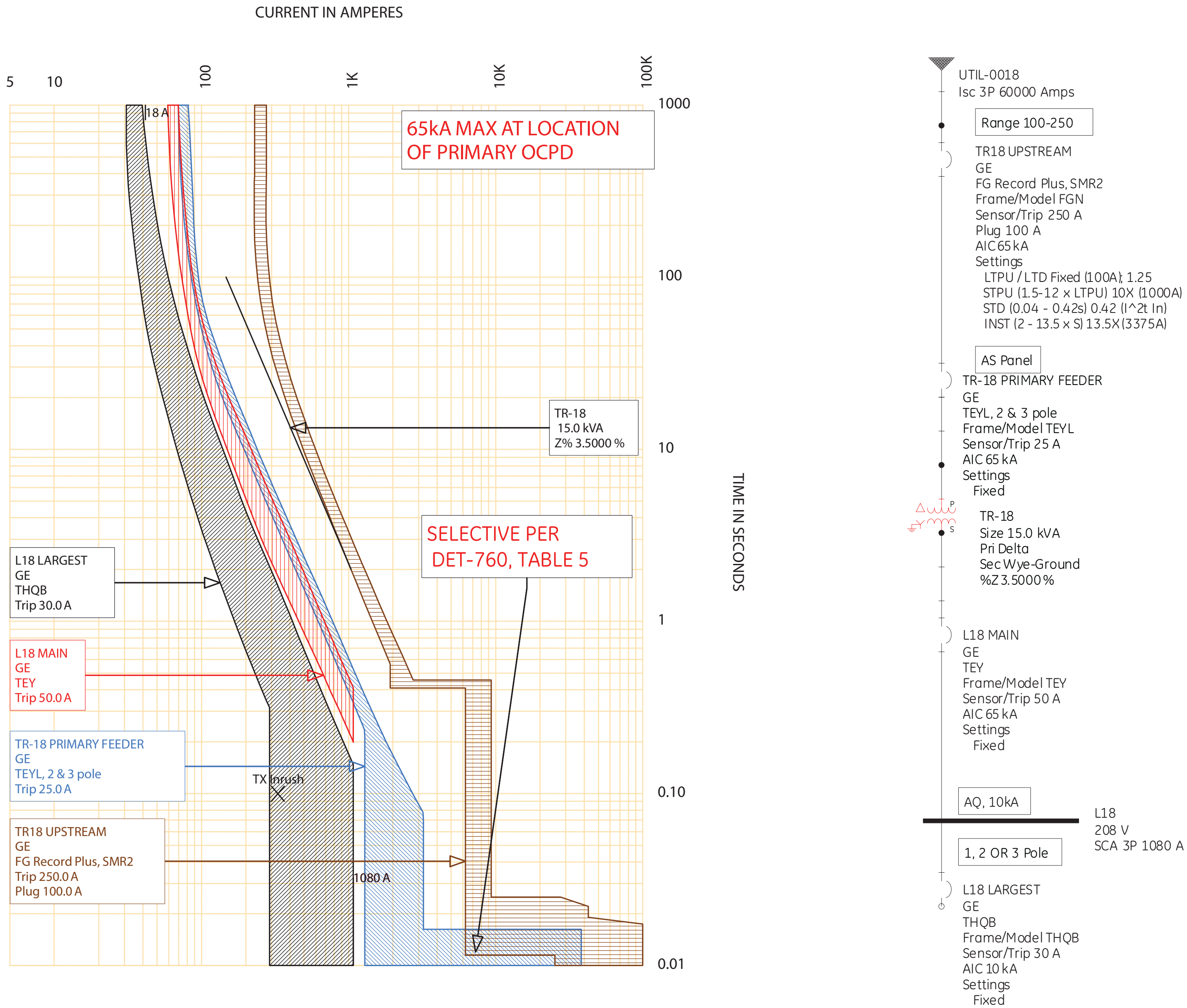



CURRENT IN AMPERES
5
10
100
1K
10K
100K
1000
100
10
1
0.10
0.01
TIME IN SECONDS
36 A
65kA MAX AT LOCATION OF PRIMARY OCPD
TR-13
30.0 kVA
Z% 4.0000 %
SELECTIVE PER DET-760, TABLE 5
L13 LARGESTB
GE
THQB
Trip 30.0 A
L13 MAIN
GE
FE Record Plus, SMR1
Trip 250.0 A
Plug 100.0 A
TR-13 PRIMARY FEEDER
GE
FB, 2 & 3-Pole 480V
Trip 50.0 A
TX Inrush
TR 13 UPSTREAM SMALLEST
GE
FG Record Plus, SMR2
Trip 250.0 A
Plug 125.0 A
1963 A
TCC: 30 KVA 65kA
Current Scale x 1
Reference Voltage: 208

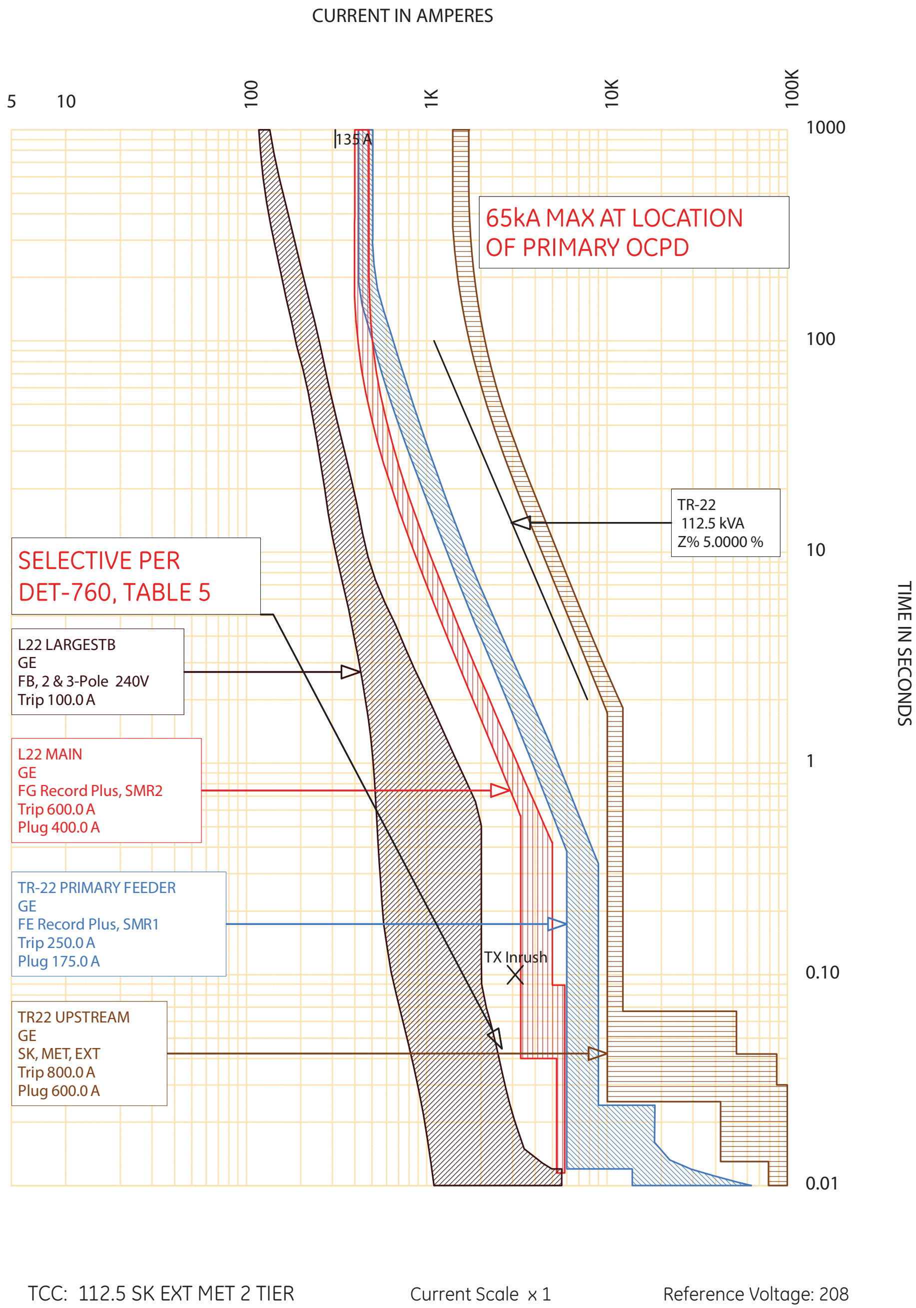

UTIL-0013
Isc 3P 60000 Amps
Range 125 to 250A
TR 13 UPSTREAM SMALLEST
GE
FG Record Plus, SMR2
Frame/Model FGN
Sensor/Trip 250 A
Plug 125 A
AIC 65 kA
Settings
LTPU / LTD Fixed (125A) ; 2.5
STPU (1.5-12 x LTPU) 12X (1500A)
STD (0.04 - 0.42s) 0.42 (I^2t In)
INST (2 - 13.5 x S) 13.5X (3375A)
AD PANEL
TR-13 PRIMARY FEEDER
GE
FB, 2 & 3-Pole 480V
Frame/Model FBN
Sensor/Trip 50 A
AIC 65 kA
Settings
Fixed
TR-13
Size 30.0 kVA
Pri Delta
Sec Wye-Ground
%Z 4.0000 %
L13 MAIN
GE
FE Record Plus, SMR1
Frame/Model FEN
Sensor/Trip 250 A
Plug 100 A
AIC 65 kA
Settings
LTPU (Fixed, 1 x P) Fixed (100A)
INST (2-13 x S) 13 (3250A)
480V INST OR
AQ, 10kA
L13
208 V
SCA 3P 1963 A
1, 2 or 3 Pole
L13 LARGESTB
GE
THQB
Frame/Model THQB
Sensor/Trip 30 A
AIC 10 kA
Settings
Fixed

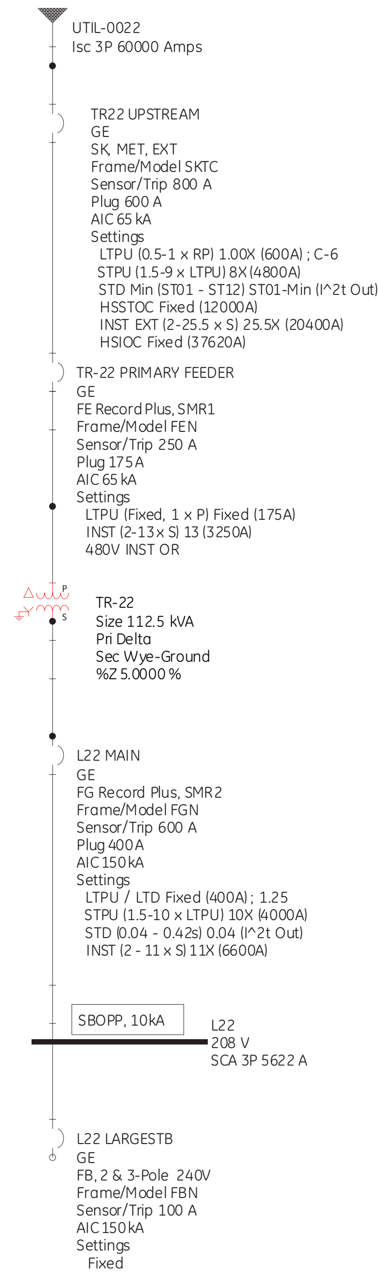

CURRENT IN AMPERES
5
10
100
1K
10K
100K
1000
100
10
1
0.10
0.01
TIME IN SECONDS
54 A
65kA MAX AT LOCATION OF PRIMARY OCPD
TR-15
45.0 kVA
Z% 4.2500 %
SELECTIVE PER DET-760, TABLE 5
L15 LARGEST
GE
THQB
Trip 60.0 A
L15 MAIN
GE
FE Record Plus, SMR1
Trip 250.0 A
Plug 150.0 A
TR-15 PRIMARY FEEDER
GE
FE Record Plus, SMR1
Trip 250.0 A
Plug 100.0 A
TR15 UPSTREAM
GE
FG Record Plus, SMR2
Trip 600.0 A
Plug 600.0 A
TX Inrush
X
2725 A
TCC: 45KVA 65kA FE TP
Current Scale x 1
Reference Voltage: 208
UTIL-0015
Isc 3P 60000 Amps
SPECTRA PP
TR15 UPSTREAM
GE
FG Record Plus, SMR2
Frame/Model FGN
Sensor/Trip 600 A
Plug 600 A
AIC 65 kA
Settings
LTPU / LTD Fixed (600A) ; 1.25
STPU (1.5-10 x LTPU) 9X (5400A)
STD (0.04 - 0.42s) 0.04 (I^2t Out)
INST (2 - 11 x S) 11X (6600A)
SPECTRA PP FEEDER
TR-15 PRIMARY FEEDER
GE
FE Record Plus, SMR1
Frame/Model FEN
Sensor/Trip 250 A
Plug 100 A
AIC 65 kA
Settings
LTPU (Fixed, 1 x P) Fixed (100A)
INST (2-13 x S) 13 (3250A)
480V INST OR
TR-15
Size 45.0 kVA
Pri Delta
Sec Wye-Ground
%Z 4.2500 %
L15 MAIN
GE
FE Record Plus, SMR1
Frame/Model FEN
Sensor/Trip 250 A
Plug 150 A
AIC 65 kA
Settings
LTPU (Fixed, 1 x P) Fixed (150A)
INST (2-13 x S) 13 (3250A)
480V INST OR
AQ, 10kA
L15
208 V
SCA 3P 2725 A
L15 LARGEST
GE
THQB
Frame/Model THQB
Sensor/Trip 60 A
AIC 10 kA
Settings
Fixed

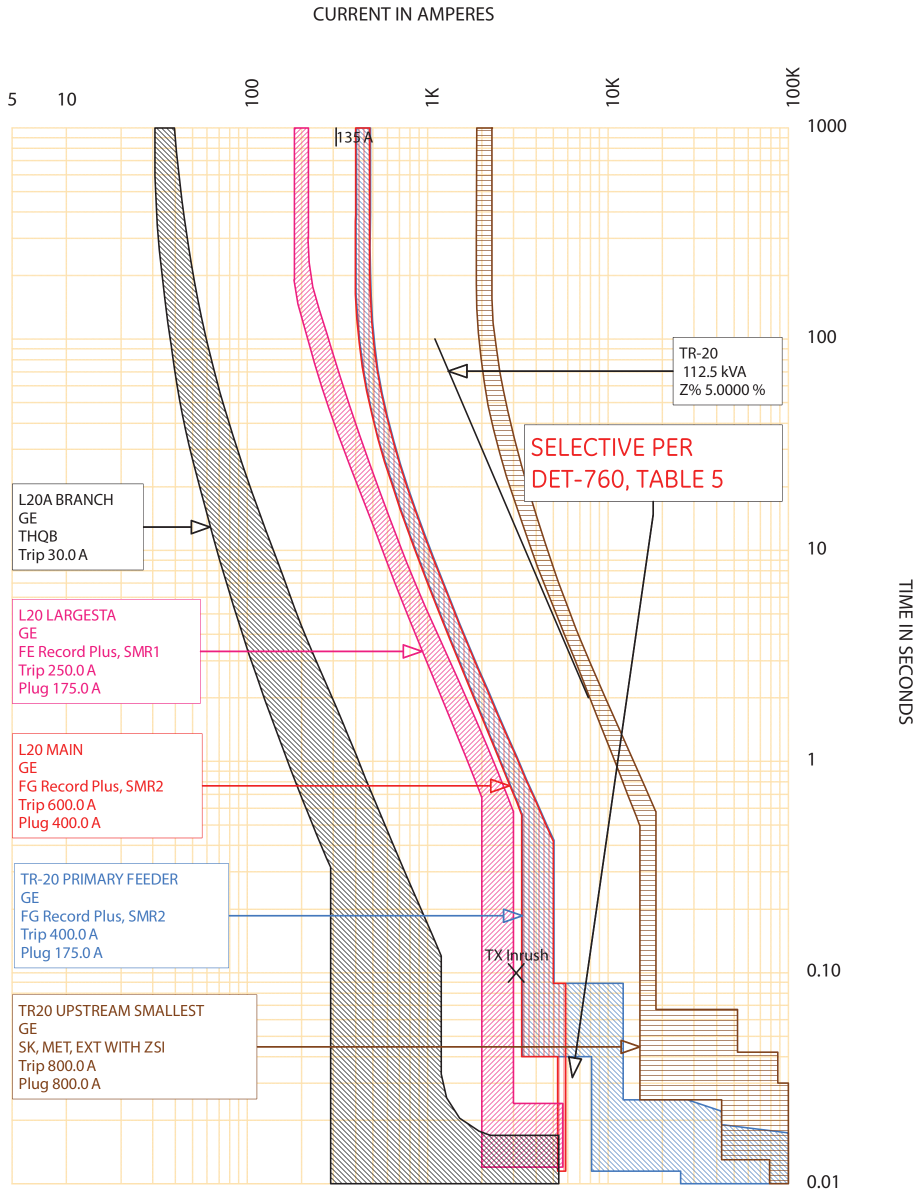

CURRENT IN AMPERES
5
10
100
1K
10K
100K
1000
100
10
1
0.10
0.01
TIME IN SECONDS
90 A
65kA MAX AT LOCATION OF PRIMARY OCPD
TR-17
75.0 kVA
Z% 3.9000 %
SELECTIVE PER DET-760, TABLE 5
SELECTIVE PER DET-760, TABLE 5
L17 LARGEST1
GE
THQB
Trip 60.0 A
L17 MAIN
GE
FG Record Plus, SMR2
Trip 400.0 A
Plug 225.0 A
TR-17 PRIMARY FEEDER
GE
FE Record Plus, SMR1
Trip 250.0 A
Plug 125.0 A
TR 17 UPSTREAM
GE
FG Record Plus, SMR2
Trip 600.0 A
Plug 600.0 A
TX Inrush
4931 A
TCC: 75 KVA 65kA FE TP
Current Scale x 1
Reference Voltage: 208
UTIL-0017
Isc 3P 60000 Amps
TR 17 UPSTREAM
GE
FG Record Plus, SMR2
Frame/Model FGN
Sensor/Trip 600 A
Plug 600 A
AIC 65 kA
Settings
LTPU / LTD Fixed (600A) ; 1.25
STPU (1.5-10 x LTPU) 10X (6000A)
STD (0.04 - 0.42s) 0.04 (I^2t Out)
INST (2 - 11 x S) 11X (6600A)
TR-17 PRIMARY FEEDER
GE
FE Record Plus, SMR1
Frame/Model FEN
Sensor/Trip 250 A
Plug 125 A
AIC 65 kA
Settings
LTPU (Fixed, 1 x P) Fixed (125A)
INST (2-13 x S) 13 (3250A)
480V INST OR
TR-17
Size 75.0 kVA
Pri Delta
Sec Wye-Ground
%Z 3.9000 %
L17 MAIN
GE
FG Record Plus, SMR2
Frame/Model FGH
Sensor/Trip 400 A
Plug 225 A
AIC 200 kA
Settings
LTPU / LTD Fixed (225A) ; 1.25
STPU (1.5-10 x LTPU) 10X (2250A)
STD (0.04 - 0.42s) 0.04 (I^2t Out)
INST (2 - 11 x S) 11X (4400A)
AQ, 10kA
L17
208 V
SCA 3P 4931 A
L17 LARGEST
GE
THQB
Frame/Model THQB
Sensor/Trip 60 A
AIC 10 kA
Settings
Fixed

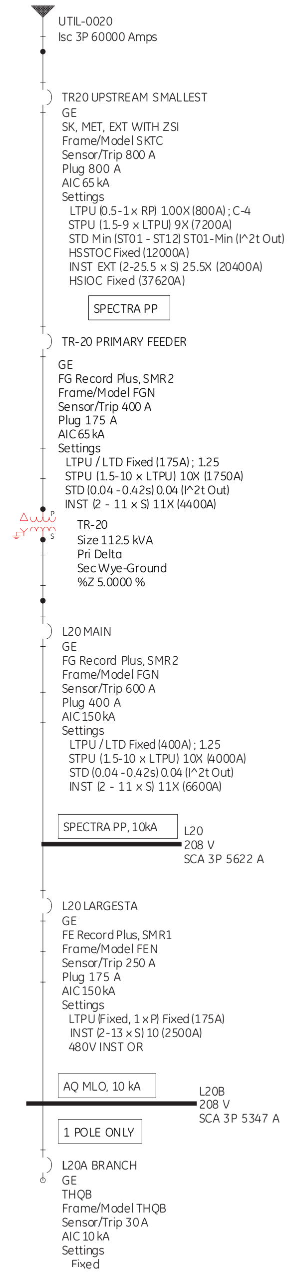


TCC: 15 KVA 65kA Current Scale x 1 Reference Voltage: 208

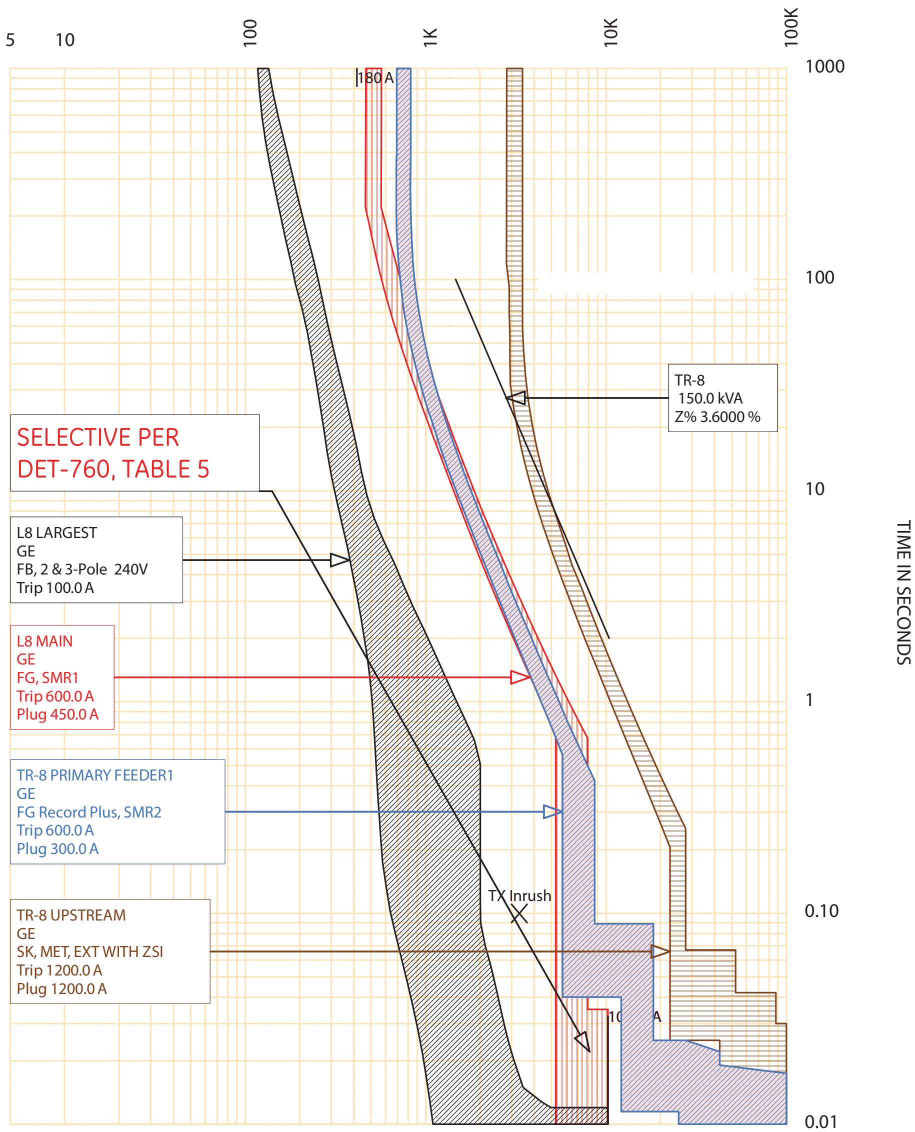

CURRENT IN AMPERES
5
10
100
1K
10K
100K
1000
100
10
1
0.10
0.01
TIME IN SECONDS
135 A
65kA MAX AT LOCATION OF PRIMARY OCPD
TR-22
112.5 kVA
Z% 5.0000 %
SELECTIVE PER DET-760, TABLE 5
L22 LARGESTB
GE
FB, 2 & 3-Pole 240V
Trip 100.0 A
L22 MAIN
GE
FG Record Plus, SMR2
Trip 600.0 A
Plug 400.0 A
TR-22 PRIMARY FEEDER
GE
FE Record Plus, SMR1
Trip 250.0 A
Plug 175.0 A
TR22 UPSTREAM
GE
SK, MET, EXT
Trip 800.0 A
Plug 600.0 A
TX Inrush
TCC: 112.5 SK EXT MET 2 TIER
Current Scale x 1
Reference Voltage: 208

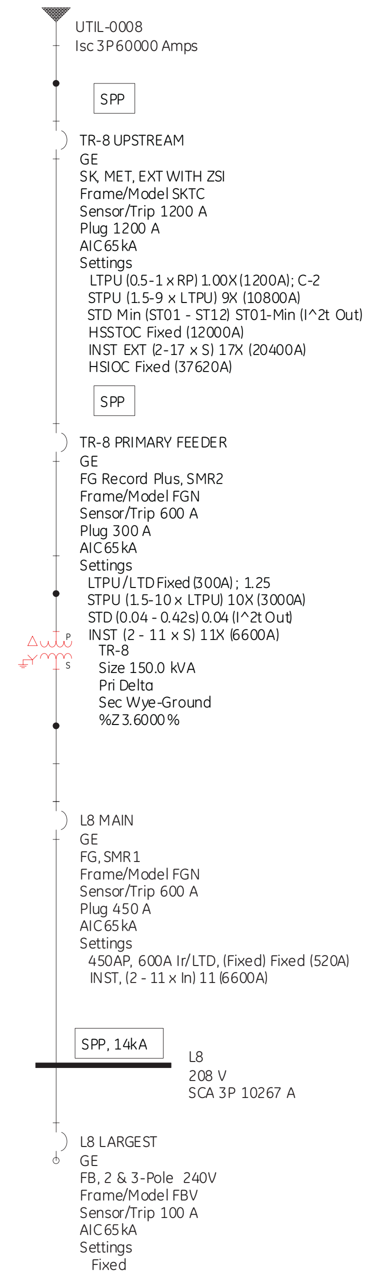

UTIL-0022
Isc 3P 60000 Amps
TR22 UPSTREAM
GE
SK, MET, EXT
Frame/Model SKTC
Sensor/Trip 800 A
Plug 600 A
AIC 65 kA
Settings
LTPU (0.5-1 x RP) 1.00X (600A) ; C-6
STPU (1.5-9 x LTPU) 8X (4800A)
STD Min (ST01 - ST12) ST01-Min (I^2t Out)
HSSTOC Fixed (12000A)
INST EXT (2-25.5 x S) 25.5X (20400A)
HSIOC Fixed (37620A)
TR-22 PRIMARY FEEDER
GE
FE Record Plus, SMR1
Frame/Model FEN
Sensor/Trip 250 A
Plug 175 A
AIC 65 kA
Settings
LTPU (Fixed, 1 x P) Fixed (175A)
INST (2-13 x S) 13 (3250A)
480V INST OR
TR-22
Size 112.5 kVA
Pri Delta
Sec Wye-Ground
%Z 5.0000 %
L22 MAIN
GE
FG Record Plus, SMR2
Frame/Model FGN
Sensor/Trip 600 A
Plug 400 A
AIC 150 kA
Settings
LTPU / LTD Fixed (400A) ; 1.25
STPU (1.5-10 x LTPU) 10X (4000A)
STD (0.04 - 0.42s) 0.04 (I^2t Out)
INST (2 - 11 x S) 11X (6600A)
SBOPP, 10kA
L22
208 V
SCA 3P 5622 A
L22 LARGESTB
GE
FB, 2 & 3-Pole 240V
Frame/Model FBN
Sensor/Trip 100 A
AIC 150 kA
Settings
Fixed



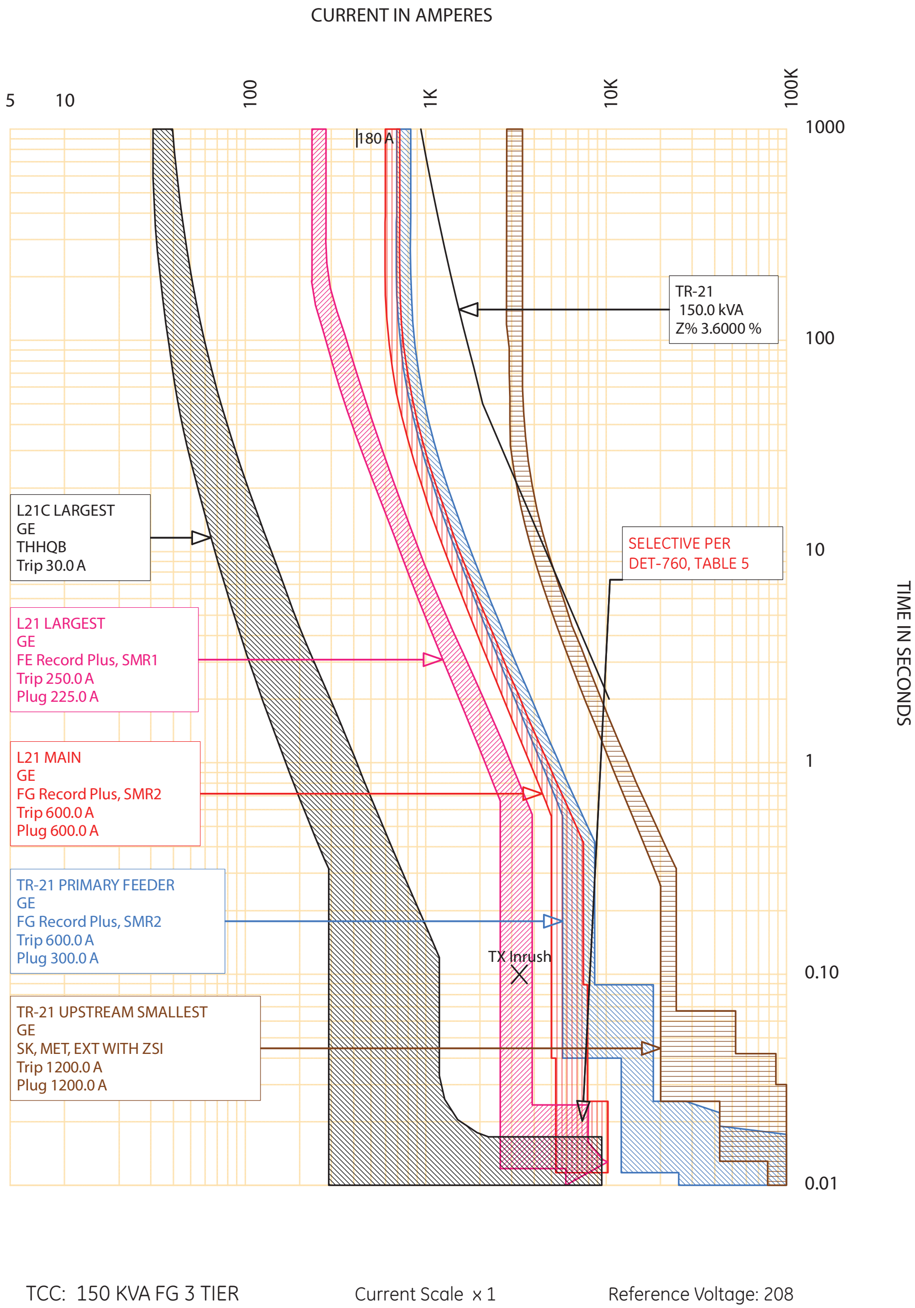


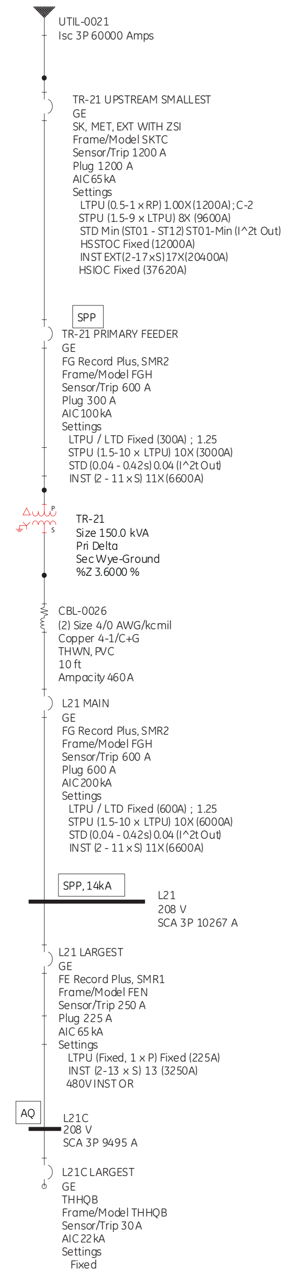
TCC: 112.5 SK EXT MET 3 TIER Current Scale x 1 Reference Voltage: 208

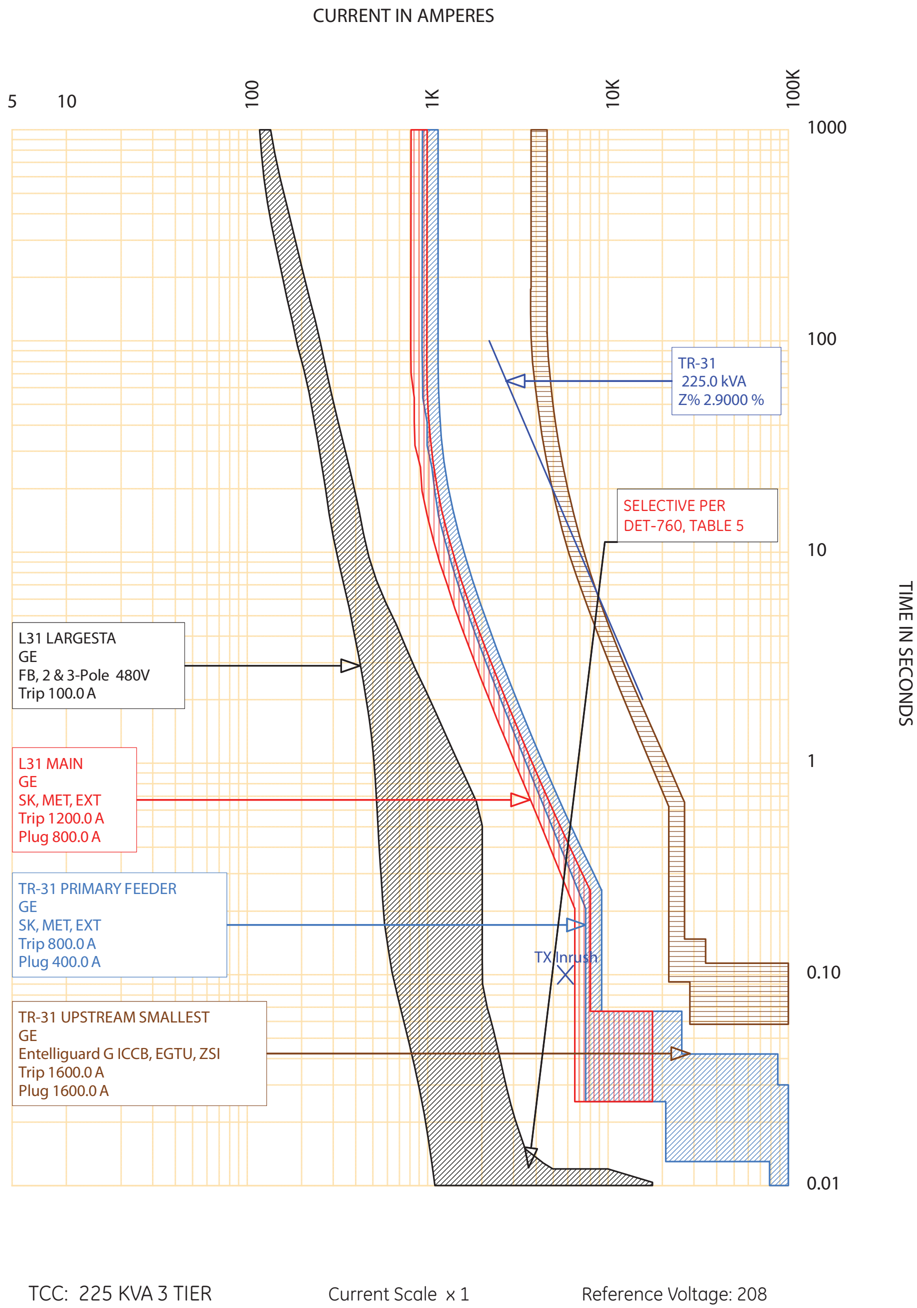


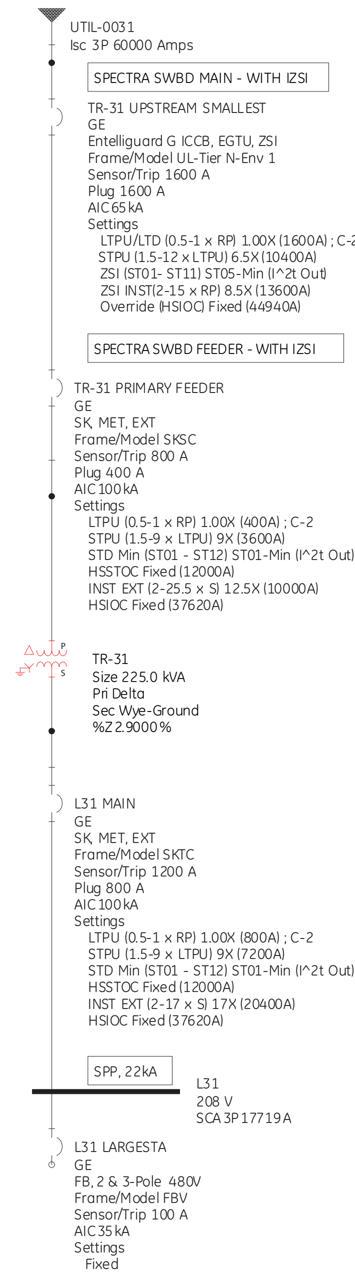


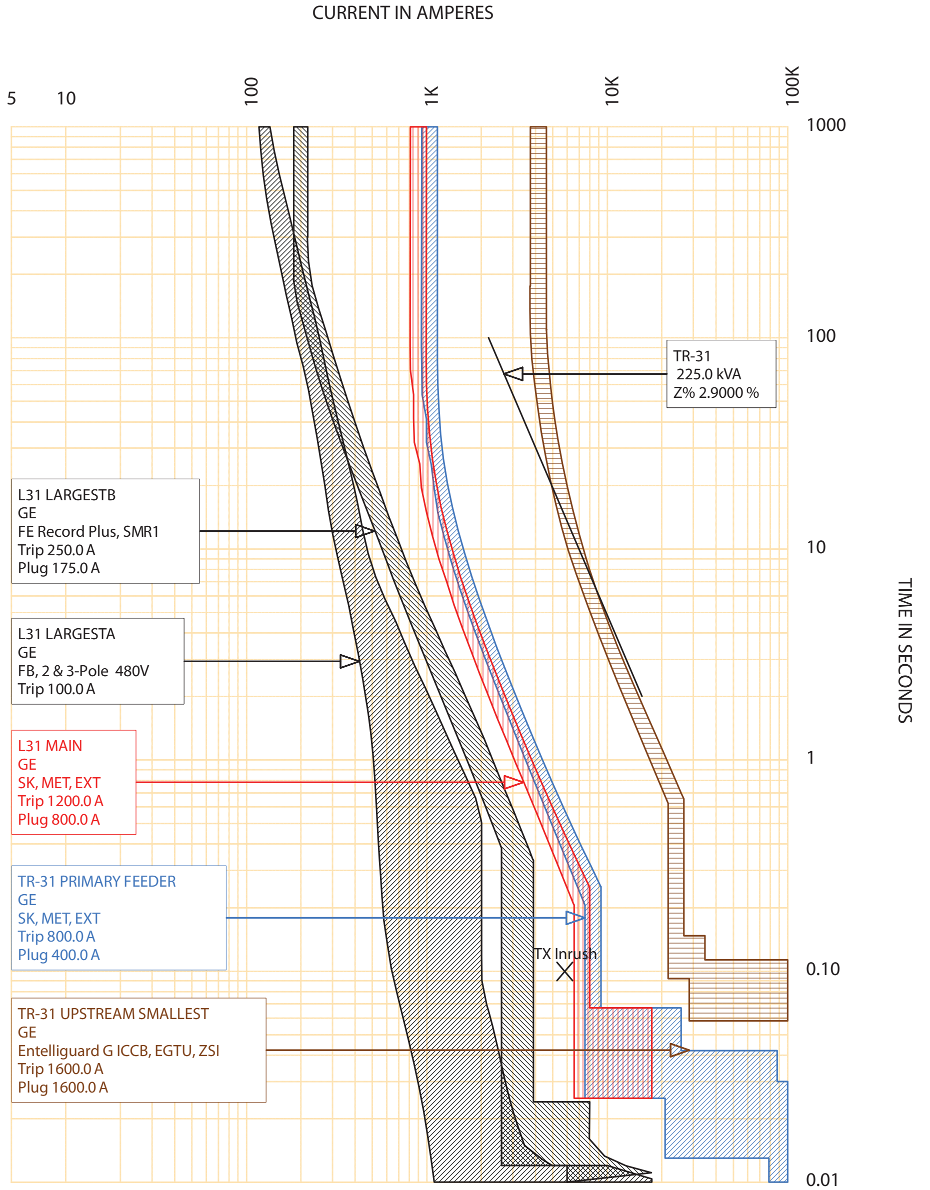
TCC: 150 KVA FG 2 TIER   Current Scale x 1   Reference Voltage: 208

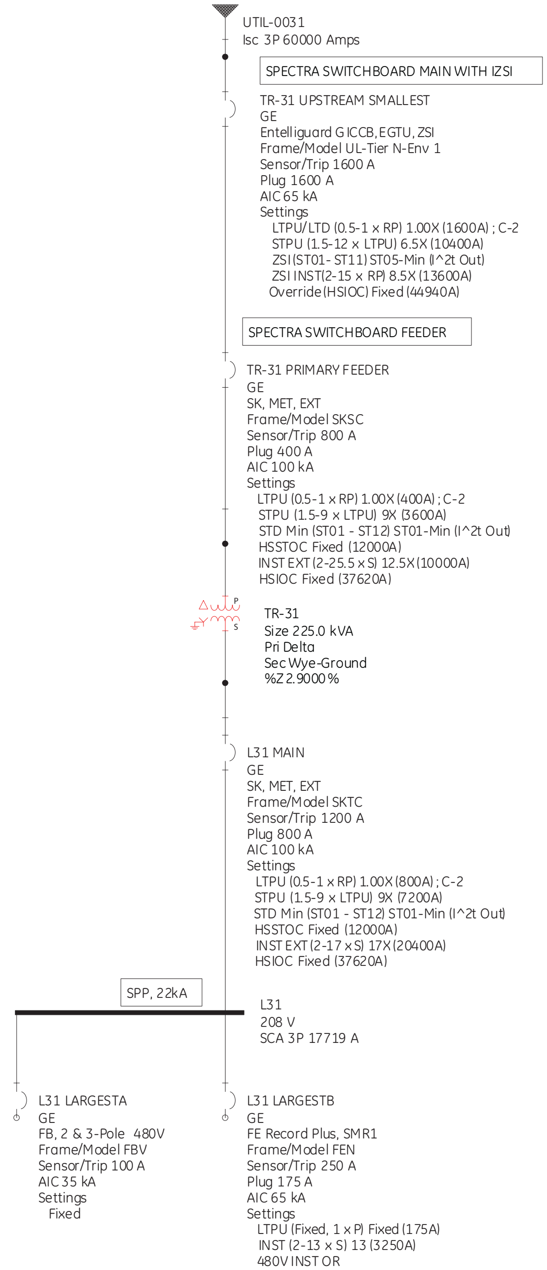

CURRENT IN AMPERES
5
10
100
1K
10K
100K
1000
100
10
1
0.10
0.01
TIME IN SECONDS
180 A
TR-21
150.0 kVA
Z% 3.6000 %
SELECTIVE PER
DET-760, TABLE 5
L21C LARGEST
GE
THHQB
Trip 30.0 A
L21 LARGEST
GE
FE Record Plus, SMR1
Trip 250.0 A
Plug 225.0 A
L21 MAIN
GE
FG Record Plus, SMR2
Trip 600.0 A
Plug 600.0 A
TR-21 PRIMARY FEEDER
GE
FG Record Plus, SMR2
Trip 600.0 A
Plug 300.0 A
TR-21 UPSTREAM SMALLEST
GE
SK, MET, EXT WITH ZSI
Trip 1200.0 A
Plug 1200.0 A
TX Inrush
TCC: 150 KVA FG 3 TIER
Current Scale x 1
Reference Voltage: 208


UTIL-0021
Isc 3P 60000 Amps
TR-21 UPSTREAM SMALLEST
GE
SK, MET, EXT WITH ZSI
Frame/Model SKTC
Sensor/Trip 1200 A
Plug 1200 A
AIC 65 kA
Settings
LTPU (0.5-1 x RP) 1.00X (1200A) ; C-2
STPU (1.5-9 x LTPU) 8X (9600A)
STD Min (ST01 - ST12) ST01-Min (I^2t Out)
HSSTOC Fixed (12000A)
INST EXT(2-17xS) 17X(20400A)
HSIOC Fixed (37620A)
SPP
TR-21 PRIMARY FEEDER
GE
FG Record Plus, SMR2
Frame/Model FGH
Sensor/Trip 600 A
Plug 300 A
AIC 100 kA
Settings
LTPU / LTD Fixed (300A) ; 1.25
STPU (1.5-10 x LTPU) 10X (3000A)
STD (0.04 - 0.42s) 0.04 (I^2t Out)
INST (2 - 11 x S) 11X (6600A)
P
S
TR-21
Size 150.0 kVA
Pri Delta
Sec Wye-Ground
%Z 3.6000 %
CBL-0026
(2) Size 4/0 AWG/kcmil
Copper 4-1/C+G
THWN, PVC
10 ft
Ampacity 460 A
L21 MAIN
GE
FG Record Plus, SMR2
Frame/Model FGH
Sensor/Trip 600 A
Plug 600 A
AIC 200 kA
Settings
LTPU / LTD Fixed (600A) ; 1.25
STPU (1.5-10 x LTPU) 10X (6000A)
STD (0.04 - 0.42s) 0.04 (I^2t Out)
INST (2 - 11 x S) 11X (6600A)
SPP, 14kA
L21
208 V
SCA 3P 10267 A
L21 LARGEST
GE
FE Record Plus, SMR1
Frame/Model FEN
Sensor/Trip 250 A
Plug 225 A
AIC 65 kA
Settings
LTPU (Fixed, 1 x P) Fixed (225A)
INST (2-13 x S) 13 (3250A)
480V INST OR
AQ
L21C
208 V
SCA 3P 9495 A
L21C LARGEST
GE
THHQB
Frame/Model THHQB
Sensor/Trip 30 A
AIC 22 kA
Settings
Fixed

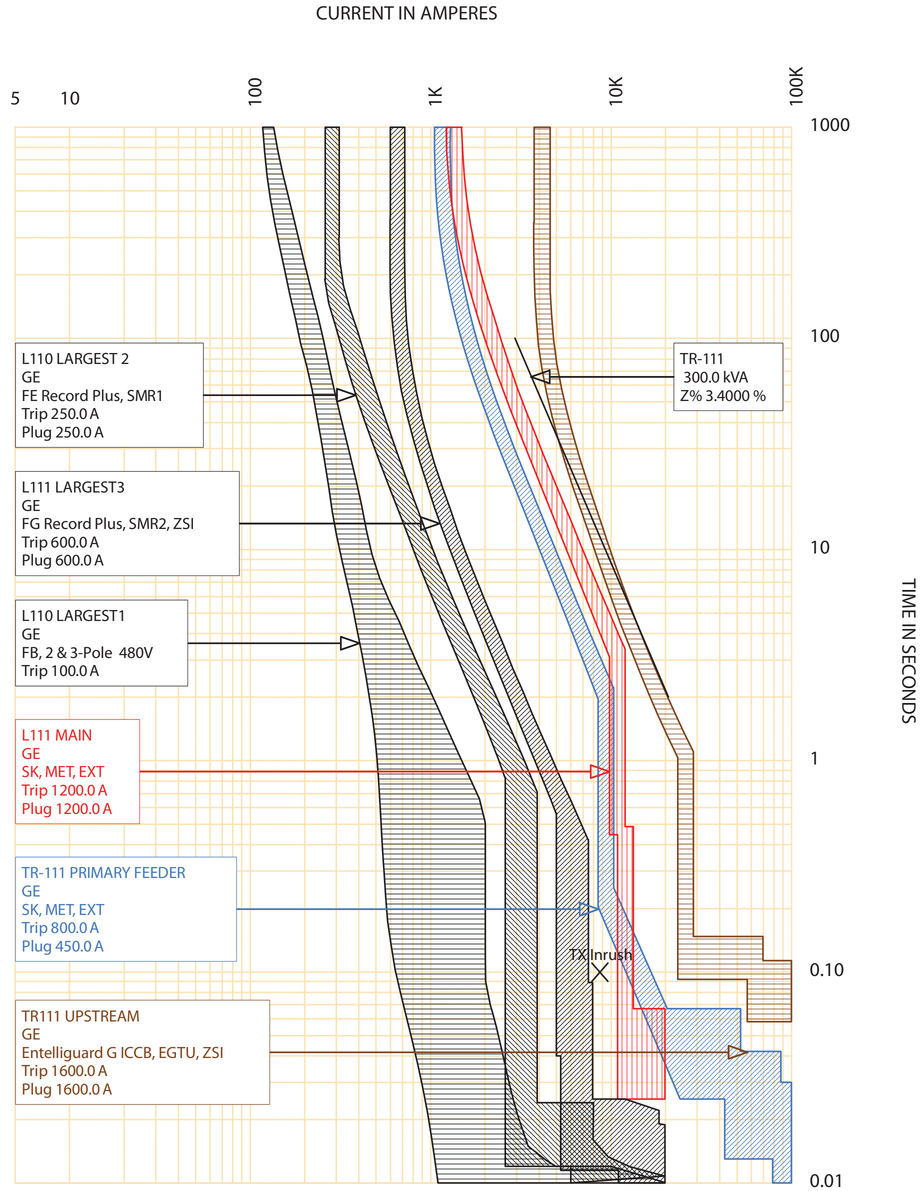

CURRENT IN AMPERES
5
10
100
1K
10K
100K
1000
100
10
1
0.10
0.01
TIME IN SECONDS
TR-31
225.0 kVA
Z% 2.9000 %
SELECTIVE PER
DET-760, TABLE 5
L31 LARGESTA
GE
FB, 2 & 3-Pole 480V
Trip 100.0 A
L31 MAIN
GE
SK, MET, EXT
Trip 1200.0 A
Plug 800.0 A
TR-31 PRIMARY FEEDER
GE
SK, MET, EXT
Trip 800.0 A
Plug 400.0 A
TX Inrush
TR-31 UPSTREAM SMALLEST
GE
Entelliguard G ICCB, EGTU, ZSI
Trip 1600.0 A
Plug 1600.0 A
TCC: 225 KVA 3 TIER
Current Scale x 1
Reference Voltage: 208

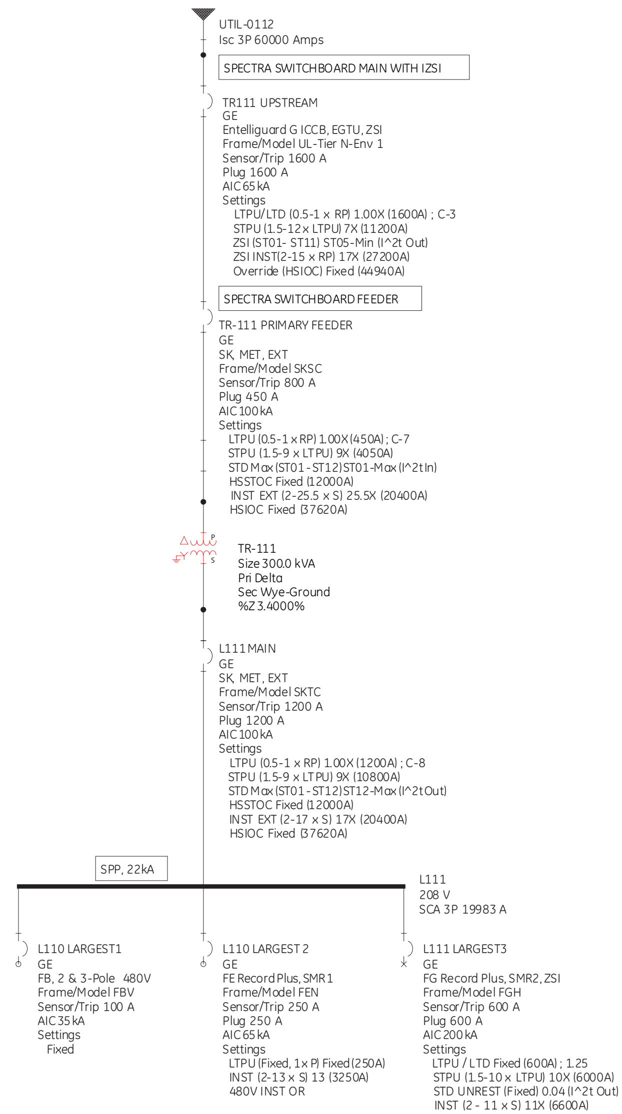

UTIL-0031
Isc 3P 60000 Amps
SPECTRA SWBD MAIN - WITH IZSI
TR-31 UPSTREAM SMALLEST
GE
Entelliguard G ICCB, EGTU, ZSI
Frame/Model UL-Tier N-Env 1
Sensor/Trip 1600 A
Plug 1600 A
AIC 65 kA
Settings
LTPU/LTD (0.5-1 x RP) 1.00X (1600A) ; C-2
STPU (1.5-12 x LTPU) 6.5X (10400A)
ZSI (ST01- ST11) ST05-Min (I^2t Out)
ZSI INST(2-15 x RP) 8.5X (13600A)
Override (HSIOC) Fixed (44940A)
SPECTRA SWBD FEEDER - WITH IZSI
TR-31 PRIMARY FEEDER
GE
SK, MET, EXT
Frame/Model SKSC
Sensor/Trip 800 A
Plug 400 A
AIC 100 kA
Settings
LTPU (0.5-1 x RP) 1.00X (400A) ; C-2
STPU (1.5-9 x LTPU) 9X (3600A)
STD Min (ST01 - ST12) ST01-Min (I^2t Out)
HSSTOC Fixed (12000A)
INST EXT (2-25.5 x S) 12.5X (10000A)
HSIOC Fixed (37620A)
TR-31
Size 225.0 kVA
Pri Delta
Sec Wye-Ground
%Z 2.9000 %
L31 MAIN
GE
SK, MET, EXT
Frame/Model SKTC
Sensor/Trip 1200 A
Plug 800 A
AIC 100 kA
Settings
LTPU (0.5-1 x RP) 1.00X (800A) ; C-2
STPU (1.5-9 x LTPU) 9X (7200A)
STD Min (ST01 - ST12) ST01-Min (I^2t Out)
HSSTOC Fixed (12000A)
INST EXT (2-17 x S) 17X (20400A)
HSIOC Fixed (37620A)
SPP, 22kA
L31
208 V
SCA 3P 17719 A
L31 LARGESTA
GE
FB, 2 & 3-Pole 480V
Frame/Model FBV
Sensor/Trip 100 A
AIC 35 kA
Settings
Fixed



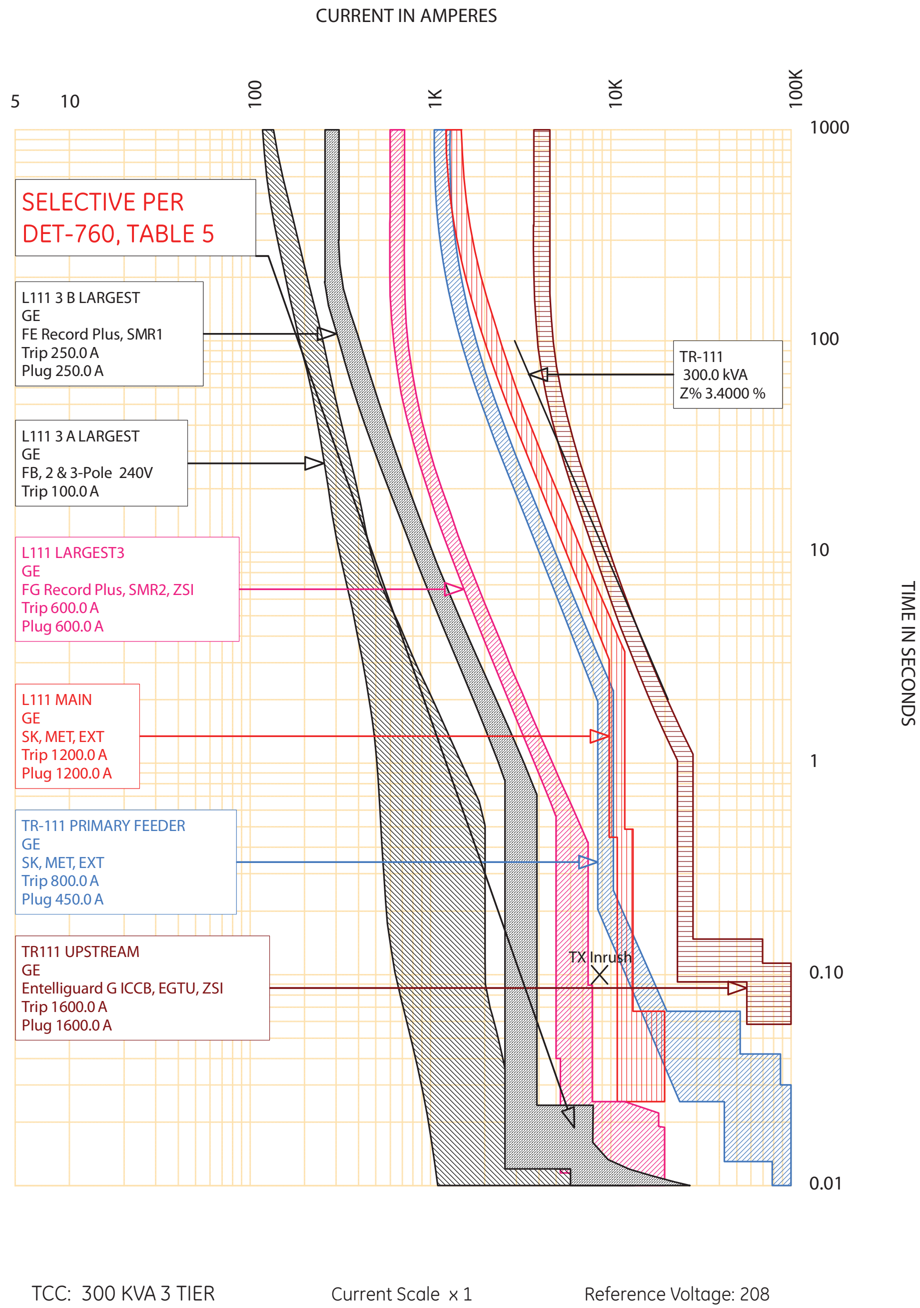


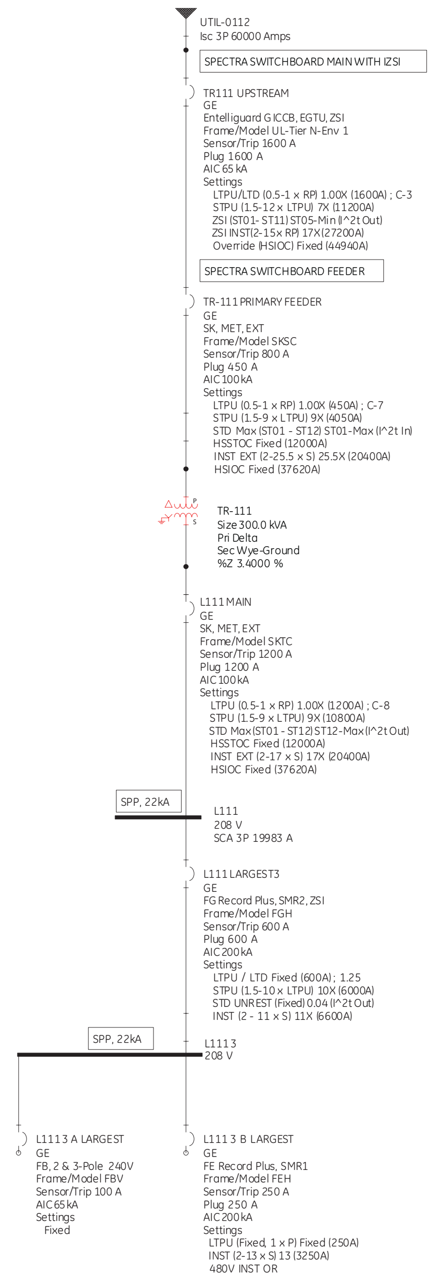
TCC: 225 KVA 2 TIER Current Scale x 1 Reference Voltage: 208





TCC: 300 KVA 2 TIER   Current Scale x 1   Reference Voltage: 208


CURRENT IN AMPERES
5
10
100
1K
10K
100K
1000
100
10
1
0.10
0.01
TIME IN SECONDS
SELECTIVE PER DET-760, TABLE 5
L111 3 B LARGEST
GE
FE Record Plus, SMR1
Trip 250.0 A
Plug 250.0 A
L111 3 A LARGEST
GE
FB, 2 & 3-Pole 240V
Trip 100.0 A
L111 LARGEST3
GE
FG Record Plus, SMR2, ZSI
Trip 600.0 A
Plug 600.0 A
L111 MAIN
GE
SK, MET, EXT
Trip 1200.0 A
Plug 1200.0 A
TR-111 PRIMARY FEEDER
GE
SK, MET, EXT
Trip 800.0 A
Plug 450.0 A
TR111 UPSTREAM
GE
Entelliguard G ICCB, EGTU, ZSI
Trip 1600.0 A
Plug 1600.0 A
TR-111
300.0 kVA
Z% 3.4000 %
TX Inrush
TCC: 300 KVA 3 TIER
Current Scale x 1
Reference Voltage: 208


UTIL-0112
Isc 3P 60000 Amps
SPECTRA SWITCHBOARD MAIN WITH IZSI
TR111 UPSTREAM
GE
Entelliguard G ICCB, EGTU, ZSI
Frame/Model UL-Tier N-Env 1
Sensor/Trip 1600 A
Plug 1600 A
AIC 65 kA
Settings
LTPU/LTD (0.5-1 x RP) 1.00X (1600A) ; C-3
STPU (1.5-12 x LTPU) 7X (11200A)
ZSI (ST01- ST11) ST05-Min (I^2t Out)
ZSI INST(2-15x RP) 17X(27200A)
Override (HSIOC) Fixed (44940A)
SPECTRA SWITCHBOARD FEEDER
TR-111 PRIMARY FEEDER
GE
SK, MET, EXT
Frame/Model SKSC
Sensor/Trip 800 A
Plug 450 A
AIC 100 kA
Settings
LTPU (0.5-1 x RP) 1.00X (450A) ; C-7
STPU (1.5-9 x LTPU) 9X (4050A)
STD Max (ST01 - ST12) ST01-Max (I^2t In)
HSSTOC Fixed (12000A)
INST EXT (2-25.5 x S) 25.5X (20400A)
HSIOC Fixed (37620A)
TR-111
Size 300.0 kVA
Pri Delta
Sec Wye-Ground
%Z 3.4000 %
L111 MAIN
GE
SK, MET, EXT
Frame/Model SKTC
Sensor/Trip 1200 A
Plug 1200 A
AIC 100 kA
Settings
LTPU (0.5-1 x RP) 1.00X (1200A) ; C-8
STPU (1.5-9 x LTPU) 9X (10800A)
STD Max (ST01 - ST12) ST12-Max (I^2t Out)
HSSTOC Fixed (12000A)
INST EXT (2-17 x S) 17X (20400A)
HSIOC Fixed (37620A)
SPP, 22kA
L111
208 V
SCA 3P 19983 A
L111 LARGEST3
GE
FG Record Plus, SMR2, ZSI
Frame/Model FGH
Sensor/Trip 600 A
Plug 600 A
AIC 200 kA
Settings
LTPU / LTD Fixed (600A) ; 1.25
STPU (1.5-10 x LTPU) 10X (6000A)
STD UNREST (Fixed) 0.04 (I^2t Out)
INST (2 - 11 x S) 11X (6600A)
SPP, 22kA
L1113
208 V
L111 3 A LARGEST
GE
FB, 2 & 3-Pole 240V
Frame/Model FBV
Sensor/Trip 100 A
AIC 65 kA
Settings
Fixed
L111 3 B LARGEST
GE
FE Record Plus, SMR1
Frame/Model FEH
Sensor/Trip 250 A
Plug 250 A
AIC 200 kA
Settings
LTPU (Fixed, 1 x P) Fixed (250A)
INST (2-13 x S) 13 (3250A)
480V INST OR

Glossary

Abbreviations

AHJ	Authority having jurisdiction
AIC	Amperes interrupting current
ATS	Automatic transfer switch
FTL	Feed through lugs
ICCB	Insulated case circuit breaker (UL Standard 489 rated)
IOC	Instantaneous overcurrent
kA	Kilo-amperes
LVPCB	Low Voltage Power Circuit Breaker (ANSI Standard C37. rated)
MCCB	Molded Case Circuit Breaker (UL Standard 489 rated)
MCS	Molded Case Switch
NEC	National Electric Code
OCPD	Overcurrent Protective Device
V	Volts
xfmr	Transformer

Terms As Used in This Publication

0.1 second selectivity
Two adjacent OCPDs are selective with one another over the full range of AIC, but only down to 0.1 seconds on the TCC. This suggests that their long time and short time characteristics are selective with one another, but that their instantaneous characteristics (that portion of the TCC below 0.1 seconds) may not be selective).

Code
National Electrical Code

Downstream / Upstream
A circuit breaker's or OCPDs location relative to the power source. For example, a main circuit breaker in a panel is closer to the power source than a (smaller sized) branch breaker in the same panel is upstream of the branch breaker. Correspondingly, the branch breaker is downstream of the main breaker in this example.

Full Selectivity
In the context of NEC Articles 700, 701 and 708, this means two adjacent OCPDs are selective with one another over the full range of available fault current magnitudes and for all types of fault current.

Layer
On a one-line diagram, circuit breaker or OCPD layers are counted from a load back to a power source. Each circuit breaker placed above another on the circuit back to the source is another layer.

DET-654C (Revision C) supersedes but does not invalidate ratings obtained from all prior revisions of DET-654.

After June 2014, DET-654C should be used exclusively to obtain new ratings.

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imagination at work