

SYSTEMS DATA SHEET

Engine Division May 2003

U.L. Withstand and Closing Ratings for CTS/CTG Series Automatic Transfer Switches (ATS)

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SECTION 1 – THE PURPOSE OF TESTING AND UNIT RATINGS

1. Introduction

Caterpillar automatic transfer switches have been subjected to an extensive test program to show that they comply with and exceed UL 1008 standards as well as the various performance specifications used by most government agencies and major electrical engineers throughout the world. The primary test to assure the dependability of an automatic transfer switch is its ability to close into and withstand high fault currents. The purpose of this publication is to provide basic information on withstand ratings and to document the ratings the Caterpillar ATS line Series ATS's holds under UL 1008.

NFPA No. 110 (emergency and standby power systems) requires that the capacity and rating of automatic transfer switches be adequate to withstand the thermal and electromagnetic effects of short circuit currents that may arise in the electrical system. It is important to be able to compare properly the withstand current rating (WCR) of the switch to the available short circuit (fault) current of the system until the protective device clears the fault.

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If a transfer switch does not have adequate withstand capability – system failure, fire, injury to personnel or equipment damage may result. A clear understanding of the interrelationship between protective device, transfer switch and system needs is necessary for a well designed installation. Some basic information on withstand rating terms and calculations follows the enclosed rating charts.

Underwriters Laboratories (UL) is the independent testing body that has developed the standard UL 1008 which all major transfer switch manufacturers test to. UL lists products which have successfully passed a battery of witnessed tests including the withstand and close into fault tests described herein. Manufacturers that complete these tests are then permitted to label their products with the UL mark.

UL made significant changes in April of 1989 regarding the labeling requirements of transfer switches. Prior to that date there had been concern over coordination with some protective devices. UL clarified the labeling procedure and now allows for three rating categories.

- Current limiting fuse
- Specific class (trip time) of molded case breaker
- “Umbrella” or “Any Breaker” ratings that take into account all types of molded and insulated case circuit breakers; these tests are performed for a duration of 3 cycles on units 225 amps and greater, and for 1.5 cycles on 40-150 amp units (with an optional 3 cycle duration for units up to 150 amps; note the three cycle rating on 150 amp and below units is optional as UL has determined that all breakers in this size clear in less than 1.5 cycles). The “Umbrella” or “Any Breaker” rating is therefore the actual UL requirement and definition of the ATS industry 3 cycle (or 1.5 as noted) withstand and closing rating, and should not to be confused with additional, non UL 1008 labeled “withstand only” tests.

2. Caterpillar ATS Product Ratings

The CTS family of transfer switches has maintained an industry-leading role in ratings from the time of its introduction. Today all CTS products are labeled with an “umbrella” (any molded case breaker) rating as well as some higher specific breaker levels giving the consultant a free hand with system design.

The CTS/CTG switch family includes:

- | | |
|--|---------------|
| • CTS Automatic Transfer Switches | 40-4000 amps |
| • CTSD Delayed Transition Switches | 40-4000 amps |
| • CTSCT Closed Transition Switches | 100-4000 amps |
| • CBTS Transfer/Bypass Switches | 100-4000 amps |
| • CBTSD Delayed Transfer/Bypass Switches | 100-4000 amps |
| • CBTSC Closed Transition Transfer/Bypass Switches | 100-4000 amps |
| • CTG Automatic Transfer Switches | 40-3000 amps |
| • CTGD Delayed Transition Switches | 40-3000 amps |
| • CTX Automatic Transition Switches | 40-400 amps |

The following pages include the UL certified ratings and specific breaker coordination charts, withstand rating data and additional specific information.

The consulting engineer must keep in mind that unless a transfer switch bears an umbrella breaker approval for use with any molded case breaker, care must be taken to assure that the breaker specified for the installation have an equal or shorter trip time when compared to the listed devices. This would limit the application of the switch to projects within the scope of its specific breaker listing.

In addition to this factor, many transfer switch manufacturers perform additional withstand tests on selected products. These additional tests may be either for a higher current value or a longer duration than their standard UL Listed ratings. The consultant must determine the applicability of these tests and take careful note of the fact that these levels are normally not UL labeled ratings.

Rating Summary Chart

Certified Withstand and Closing Ratings in Symmetrical RMS Amperes at 480 Volts AC

CTS/CTG Series Switches Rated for Total Systems or Motor Loads		Withstand and Closing Current Ratings per UL 1008					
Caterpillar Model*	UL 1008 Switch Rating	Withstand and Closing Ratings when Coordinated with any Current Limiting Fuse		Specific Coordinated Breaker Rating		Any Breaker Rating	Minimum UL 1008 Ratings
		Max. Fuse Size Amps	Max. Circuit Amps	Max. Circuit Breaker Size Amps	Max. Circuit Amps	Max. Circuit Amps	
CTS (2)	40	50	200,000	400	30,000	10,000	5,000
CTS (2)	80	100	200,000	400	30,000	10,000	5,000
CTS (2)	100	125	200,000	400	30,000	10,000	5,000
CTS (2)	150	200	200,000	400	30,000	10,000	10,000
CTS (2)	200	300	200,000	400	30,000	10,000	10,000
CTS (2)	225	300	200,000	800	50,000	35,000	10,000
CTS (2)	260	350	200,000	800	50,000	35,000	10,000
CTS (2)	400	600	200,000	800	50,000	35,000	10,000
CTS	600	750	200,000	800	65,000	50,000	12,000
CTS	800	1200	200,000	1200	65,000	50,000	16,000
CTS	1000	1250	200,000	1600	85,000	50,000	20,000
CTS	1200	1500	200,000	1600	85,000	50,000	24,000
CTS	1600	2000	200,000	2500	100,000	100,000	32,000
CTS	2000	2500	200,000	2500	100,000	100,000	40,000
CTS	3000	4000	200,000	4000	100,000	100,000	60,000
CTS	4000	6000	200,000	5000	100,000	100,000	80,000
CBTS (2)	100	125	200,000	800	50,000	35,000	5,000
CBTS (2)	150	200	200,000	800	50,000	35,000	10,000
CBTS (2)	225	300	200,000	800	50,000	35,000	10,000
CBTS (2)	260	350	200,000	800	50,000	35,000	10,000
CBTS (2)	400	600	200,000	800	50,000	35,000	10,000
CBTS	600	750	200,000	800	65,000	50,000	12,000
CBTS	800	1000	200,000	1600	85,000	50,000	16,000
CBTS	1000	1250	200,000	1600	85,000	50,000	20,000
CBTS	1200	1500	200,000	1600	85,000	50,000	24,000
CBTS	1600	2500	200,000	2500	100,000	100,000	32,000
CBTS	2000	2500	200,000	2500	100,000	100,000	40,000
CBTS	3000	4000	200,000	4000	100,000	100,000	60,000
CBTS	4000	6000	200,000	5000	100,000	100,000	80,000
CTSD (2)	40	50	200,000	150	50,000	35,000	5,000
CTSD (2)	80	100	200,000	150	50,000	35,000	5,000
CTSD (2)	100	125	200,000	150	50,000	35,000	5,000
CTSD (2)	150	200	200,000	400	50,000	35,000	10,000
CTSD (2)	225	300	200,000	400	50,000	35,000	10,000
CTSD (2)	260	350	200,000	400	50,000	35,000	10,000
CTSD (2)	400	600	200,000	800	50,000	35,000	10,000

- * Caterpillar Model:
- CTSD 600 amp – 4000 amp – Ratings identical to CTS Series
 - CTSD and CBTSD 100 amp – 4000 amp – Ratings identical to CBTS Series
 - CTG, CTGD and CTX ratings identical to applicable sizes above

- NOTES:
1. For each rating attained in above table, heat run was performed after the overload and endurance tests.
 2. These models also listed for 100% tungsten lamp loads.
 3. All transfer switches are rated in coordination with the protective device installed.
Lower rated devices than those shown may be utilized and the system rated accordingly.
 4. Consult Caterpillar for CSA and IEC ratings.

CTX Series

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Amp	Maximum Coordinated Breaker Rating	Coordinated Breaker Model Types	Current Limiting Fuse Rating	Fuse Class	Breaker Ampere Size	Fuse Size
30	240V Cutler-Hammer/ Westinghouse Square D Siemens/ITE General Electric	100A, FCL, FB TRI-PAC 150A, FD, FDC, HFD 250A, HJD, JD, JDB, JDC 400A, HKD, KD, KDB, KDC, LA TRI-PAC, DK 100A, FC, FI, FI 250A, KA, KC, KH, KI 400A, LA, LC, LE, LH, LI, LX, LXI 125A, CED6, ED6, ED4, HED4, HED6 250A, CFD6, FD6, FXD6, HFD6 400A, CJD6, HJD6, HHJD6, HHJXD6, JD6, JXD6, SCJD6, SHJD6, SJD6 100A, TB1 150A, SEL, SEP, TEL, THED, THLC1 225A, TFL, THFK, THLC2 250A, SFL, SFP 400A, SGL4, SGP4, TB4, THJK4, THLC4, TJJ, TJK4, TLB4	200,000	T, J, RK5, RK1	(Max. 350A)	200A 300A, 350A respectively
40						
70						
80						
100						
104						
150						
200						
225						
225						
250						
260						
300						
350						
400						

CTX Series (cont'd)

Amp	Maximum Coordinated Breaker Rating	Coordinated Breaker Model Types	Current Limiting Fuse Rating	Fuse Class	Breaker Ampere Size	Fuse Size
30	22,000	480V Cutler-Hammer/ Westinghouse Square D Siemens/ITE General Electric	200,000	J	(Max. 400A)	(Max. 200A)
40						
70						
80						
100						
104						
150						
200						
225						
	22,000	600V Cutler-Hammer/ Westinghouse Square D Siemens/ITE General Electric				

CTS and CTG Series (cont'd)

Amp	Any Breaker	Coordinated Breaker Rating	Coordinated Breaker Model Types	Current Limiting Fuse Rating	Fuse Class	Breaker Ampere Size	Fuse Size
40	10,000	22,000	600V CH/Westinghouse	200,000	T, J, RK5, RK1	(Max. 400A)	200A 300A, 350A respectively
80			150A, FDC, HFD 250A, HJD, JDC				
100			400A, HKD, KD, KDB, KDC, LA TRI-PAC, LCL 100A, FI				
150			250A, KA, KH, KI 400A, LA, LC, LE, LH, LI, LX, LXI				
200			125A, CED6 250A, CFD6, HFD6 400A, CJD6, HJD6, HHJD6, HHJXD6, JD6, JXD6, SCJD6, SHJD6, SJD6				
			Siemens/ITE				
			General Electric				
			150A, SEL, SEP, TEL, THLC1 225A, TFL, THLC2 250A, SFL, SFP 400A, SGL4, SGP4, TB4, THJK4, THLC4, TJJ, TJK4				
225	35,000	50,000	480V General Electric	200,000	T, J, RK5	(Max. 800A)	600A
260			SFL, SFP, TFL, THLC2, SGL4, SGP4, TB4, THLC4, TLB4, SGL6, SGP6, TB6, TJJ4V, TKL4V, TJJ1S-6S, SKL8, SKP8, TB8, SKH8				
400			CFD6, HFD6, CJD6, SCJD6, HHJD6, HHJXD6, SHJD6, HJD6, CLD6, SCLD6, HHLD6, HHLXD6, SHLD6, HLD6, CMD6, SCMD6, HMD6, SHMD6, HMXD6, MID6, MXD6, SMD6 KI, KC, LI, LXI, LX, LE, LC, MX, ME, MH HJD, JDC, HKD, CHKD, KDC, LCL, LA TRI-PAC, HLD, CHLD, LDC, CLDC, NB TRI-PAC CF250L, CF250H, CJ400L, CK400H, CJ400H, CK400N, CJ600H, CK800H, CK800N				
			Siemens/ITE				
			Square D				
			Cutler-Hammer/ Westinghouse Merlin Gerin				
600	50,000	65,000	Cutler-Hammer/ Westinghouse General Electric	200,000	T, J, RK5 RK1, L	(Max. 800A)	750A
800			NB TRI-PAC, DSL206, HMDL, CHMDL, HND, NDC, CHND, CNDC, HLD, CHLD, LDC, CLDC TB8, SKL8, SKP8, SGL6, SGP6, TB6, TJJ, SKL12, SKP12, TKL8S, TKL12S, TP, THP, TC, THC CMD6, SCMD6, HMD6, SHMD6, HLD6, SHLD6, CLD6, SCLD6, CND6, SCND6, HND6, SHND6 LC, LE, LI, LX, LXI, ME, MH, MX, NC, NE, NX				
			Siemens/ITE				
			Square D				
			General Electric				
1000	50,000	85,000	THP, THC, TRP, SKP12, SKP8, TB8 NC, NE, NX, PCF, PEF, PHF, PXF PC, PCC, PB TRI-PAC, NDC, CNDC, RDC, CRDC, NB TRI-PAC	200,000	L	(Max. 1600A)	1000A 1250A 1500A respectively
1200			Cutler-Hammer/ Westinghouse Merlin Gerin				
			Siemens/ITE				
			CK1000L, CM1600 CND6, SCND6, CPD6, CMD6, SCMD6				
1600, 2000	100,000	100,000	Any (Max. rated 2000, 2500, 4000, 4000, 5000 respectively)	200,000	L	(Max. 2000A 2500A, 4000A 4000A, 5000A respectively)	2000A, 2500A 4000A, 4000A 6000A respectively
2600							
3000							
4000							

CTSD and CTGD Series

Amp	Any Breaker	Coordinated Breaker Rating	Coordinated Breaker Model Types	Current Limiting Fuse Rating	Fuse Class	Breaker Ampere Size	Fuse Size
40	35,000	50,000	480V General Electric	200,000	T, J, RK5	(Max. 800A)	50A, 100A, 125A, 200A, 300A, 350A, 600A respectively
80			Merlin Gerin				
100			Siemens/ITE				
150			Square D				
225			ABB				
260			Cutler-Hammer/ Westinghouse				
400							
600	50,000	65,000	Cutler-Hammer/ Westinghouse	200,000	T, J, RK5 RK1, L	(Max. 800A)	750A
800			General Electric				
			Siemens/ITE				
			Square D				
1000	50,000	85,000	General Electric	200,000	L	(Max. 1600A)	1000A
1200			Square D				1250A
			Cutler-Hammer/ Westinghouse				1500A
			Merlin Gerin				respectively
			Siemens/ITE				
1600	100,000	100,000	CK1000L, CM1600	200,000	L	(Max. 2000A	2000A
2000			CND6, SCND6, CPD6, CMD6, SCMD6			2500A	2500A
2600			(Max. rated 2000, 2500, 4000, 4000, 5000 respectively)			4000A	4000A
3000						4000A	4000A
4000						5000A	6000A
						respectively)	respectively

CTSCT

Amp	Any Breaker	Coordinated Breaker Rating	Coordinated Breaker Model Types	Current Limiting Fuse Rating	Fuse Class	Breaker Ampere Size	Fuse Size
100	35,000	50,000	480V General Electric	200,000	T, J, RK5	(Max. 800A)	200A, 300A 350A, 600A respectively
150			Merlin Gerin				
225			Siemens/ITE				
260			Square D				
400			Cutler-Hammer/ Westinghouse				
600	50,000	65,000	Cutler-Hammer/ Westinghouse	200,000	T, J, RK5 RK1, L	(Max. 800A)	750A
800			General Electric				
			Siemens/ITE				
			Square D				
1000	50,000	85,000	General Electric	200,000	L	(Max. 1600A)	1000A 1250A 1500A respectively
1200			Square D				
			Cutler-Hammer/ Westinghouse				
			Merlin Gerin				
			Siemens/ITE				
1600	100,000	100,000	Any (Max. rated 2000, 2500, 4000, 5000 respectively)	200,000	L	(Max. 2000A 2500A 4000A 5000A respectively)	2000A 2500A 4000A 6000A respectively
2000							
2600							
3000							
4000							

CBTS, CBTSD and CBTSCT Series

Amp	Any Breaker	Coordinated Breaker Rating	Coordinated Breaker Model Types	Current Limiting Fuse Rating	Fuse Class	Breaker Ampere Size	Fuse Size
100	35,000	480V 50,000	General Electric Merlin Gerin Siemens/ITE	200,000	T, J, RK5	(Max. 800A)	125A 200A 300A 350A 600A respectively
150			SFL, SFP, TFL, THLC2, SGL4, SGP4, TB4, THLC4, TLB4, SGL6, SGP6, TB6, TJL4V, TKL4V, TJL1S-6S, SKL8, SKP8, TB8, SKH8 CF250L, CF250H, CJ400L, CK400H, CJ400H, CK400N, CJ600H, CK800H, CK800N CFD6, HFD6, CJD6, SCJD6, HHJD6, HHJXD6, SHJD6, HJD6, CLD6, SCLD6, HHL6, HHLXD6, SHLD6, HLD6, CMD6, SCMD6, HMD6, SHMD6, HMXD6, MID6, MXD6, SMD6 KI, KC, LI, LXI, LX, LE, LC, MX, ME, MH HJD, JDC, HKD, CHKD, KDC, LCL, LA TRI-PAC, HLD, CHLD, LDC, CLDC, NB TRI-PAC				
225			Square D Cutler-Hammer/ Westinghouse				
260			Cutler-Hammer/ Westinghouse				
400			Cutler-Hammer/ Westinghouse General Electric Siemens/ITE Square D				
600	50,000	65,000	NB TRI-PAC, DSL206, HMDL, CHMDL, HLD, CHLD, LDC, CLDC TB8, SKL8, SKP8, SGL6, SGP6, TB6, TJL, TP, THP, TC, THC CMD6, SCMD6, HMD6, SHMD6, HLD6, SHLD6, CLD6, SCLD6 LC, LE, LI, LX, LXI, ME, MH, MX, NC, NE, NX THP, THC, TRP, SKP12, SKP8, TB8 NC, NE, NX, PCF, PEF, PHF, PXF PC, PCC, PB TRI-PAC, NDC, CNDC, RDC, CRDC, NB TRI-PAC CK 1000L, CM1600 CND6, SCND6, CPD6, CMD6, SCMD6	200,000	T, J, RK5 RK1, L	(Max. 800A)	750A
800	50,000	85,000	General Electric Square D Cutler-Hammer/ Westinghouse Merlin Gerin Siemens/ITE	200,000	L	(Max. 1600A)	1000A 1250A 1500A respectively
1000							
1200							
1600	100,000	100,000	(Max. rated 2000, 2500, 4000, 5000 respectively)	200,000	L	(Max. 2000A 2500A 4000A 5000A respectively)	2000A 2500A 4000A 6000A respectively
2000							
2600							
3000							
4000							

SECTION 2 – DEFINITIONS AND CALCULATIONS

1. Purpose

Many questions arise when comparing WCR to the system fault current rating. Too often a switch is rated by a manufacturer in one set of WCR terms and the available system fault currents described with a different set of terms. The purpose of this paper is to outline the different ways switches may be rated (WCR) and systems are measured.

2. Basic Definitions

- a. RMS Current** – The Root Mean Square which is the effective value of an alternating current. It is equal to 0.707 of the peak current for a sine wave. This is the value referred to when people say “current.”
- b. Peak Current** – The instantaneous maximum value of current – the peak current of a sine wave is 1.414 times its RMS value.
- c. Symmetrical Current** – The alternating current which is symmetrical around the zero axis of the sine wave.
- d. Asymmetrical Current** – The alternating current which is not symmetrical around the zero axis.
- e. Peak Fault Current** – The instantaneous maximum current value that occurs after the start of a fault in any phase.
- f. Available Peak Current** – Maximum possible short circuit current that may exist in a system without protective devices.
- g. Peak Let Through Current** – Maximum instantaneous current through the protective device during the total clearing time.
- h. Withstand Current Rating** – The rating that defines the ability of the switch to withstand the thermal and electromagnetic effects of short circuit currents for a set period of time.
- i. Withstand and Closing Rating** – UL 1008 test for a transfer switch’s ability to close into and withstand a fault current. These are the ratings which will actually appear on the UL label of the product.

Note: For diagrams of typical current wave forms, see **Figure 1** and **Figure 2**.

3. Available Fault Current

Available fault current information can often be supplied by the utility company. If this information is not available, approximate fault current can be calculated by knowing the transformer impedance (usually 2 to 5% of full load ampere rating of the transformer).

For a single phase system, transformer let through current is:

$$I = \frac{kVA \text{ (of trans)} \times 1000}{Z \times \text{Line Volts}}$$

Where Z is transformer impedance in percent divided by 100.

For three phase systems:

$$I = \frac{kVA \times 1000}{1.73 Z \times \text{Line Volts}}$$

Example: 500 kVA transformer
2.5% Impedance
480 Volts, 3 phase

$$\frac{500 \times 1000}{1.73 (.025) (480)} = 24,085 \text{ amps}$$

This figure is somewhat lower if a long run of cable introduces a substantial additional impedance. Available fault current determine the rating that a transfer must meet.

4. Comparison of Terms

The following values have all been used to describe identical circuit conditions:

a. Available short circuit current RMS	120,000 amps
b. Peak Let Through Current (1/2 cycle)	30,000 amps
c. Peak Asymmetrical Current	56,000 amps
d. Peak Symmetrical Current	40,000 amps
e. Withstand Rating 3 cycles RMS	28,000 amps

What do these numbers mean? They mean that a switch was tested at 28,000 amps RMS Sym for 3 cycles; the switch also had a projected peak symmetrical current of 40,000 amps for less than 1/2 cycle and a peak asymmetrical current of 56,000 amps for less than 1/2 cycle. The switch has been tested in a system that has an available capacity of 120,000 amps RMS.

How should a manufacturer rate a switch? Preferably by submitting test data which is reported as outlined by UL 1008 specifications. This data calls for RMS symmetrical readings based on specific test parameters. Other figures may be misleading.

5. Test Documents

As fault currents can occur at any level, a transfer switch must be capable of withstanding any fault current up to its maximum rating. This rating is based on the rating of the protective device in front of the unit and must be considered on that basis.

Tests show that results based on various current values and time durations, and include additional high current tests with fuses. By considering this range of values, it is possible to predict performance with different fuse characteristics or specific circuit breaker current-time curves with a given available short circuit current.

6. Interrupting Ratings

Some manufacturers of circuit breaker type automatic transfer switches list interrupting current (IC) ratings in lieu of WCR. These switches will then open on faults instead of withstanding the fault until the external protective device clears. As the transfer switch is then used to open the fault current in place of a protective device – this may leave the transfer switch with both normal and emergency open which then requires manual resetting of the breakers within the transfer switch enclosure. The circuit breakers may require factory inspection after high current interruption in accordance with common circuit breaker procedures.

WCR ratings, as opposed to IC ratings appear to offer a better choice to the system designer as he attempts to coordinate the protection of the entire system. Knowing the maximum amount and duration of fault current a switch will withstand gives the designer the information necessary for complete coordinated system design.

7. Advantage of RMS Symmetrical Ratings

- a. Data is consistently reported based on UL test procedures.
- b. Where time beyond the first 1/2 cycle is given, suitable decisions can be made to use circuit breakers or fuses.
- c. "Trick" reporting is eliminated.

8. Blow-On Effects of Short Circuit Currents on Contacts

Some switch designers analyze "blow-on" and "blow-off" effects and force vectors (due to electromagnetic repulsion) to claim increased WCR capability of their product. Such calculations are very rough approximations because of inherent errors in estimating "domain" size and number, current "pinch" effect and the problem of complex geometry of actual contact structures when compared to idealized models.

The only proof of a successful design are tests, uniformly performed and consistently reported all to the same criterion such as UL 1008.

Figure 1 – Waves – Symmetrical and Asymmetrical

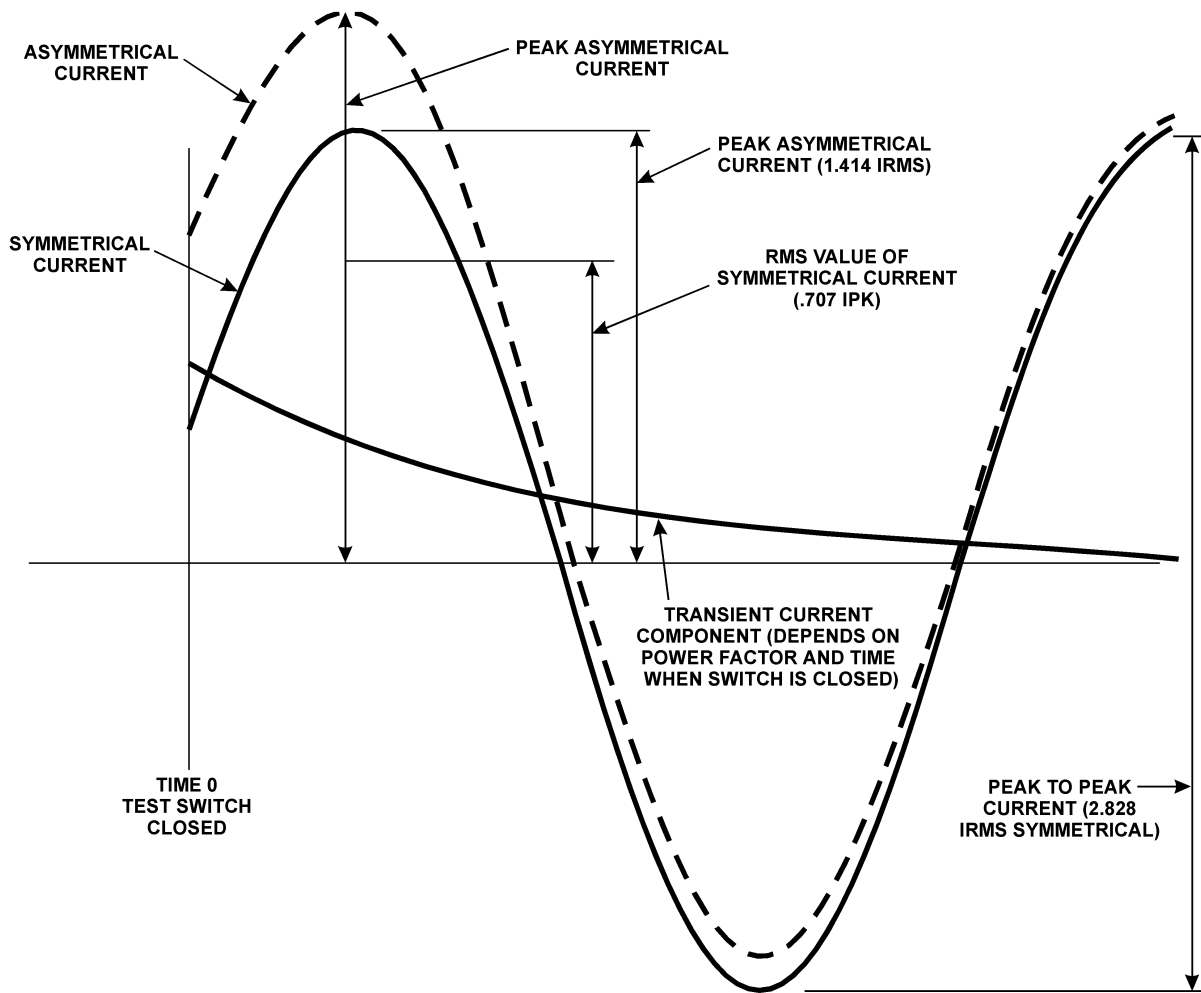
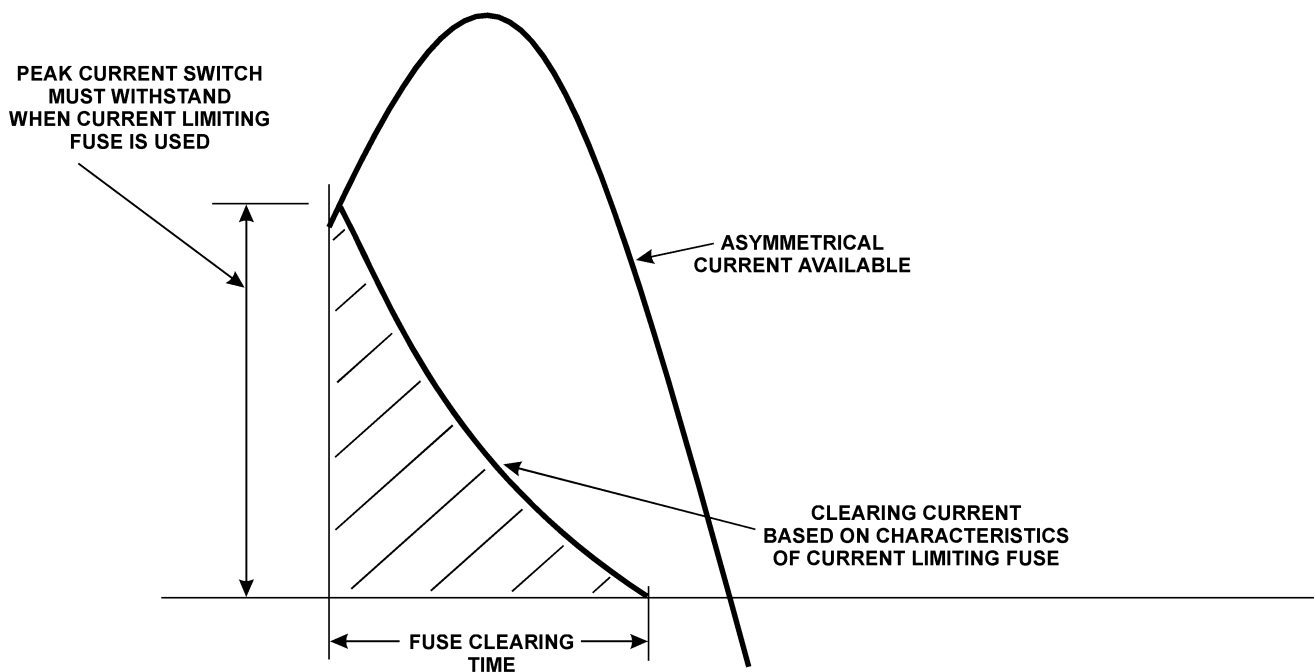


Figure 2 – Current Limiting Fuse Effects



Application Worksheet

Item Number	Available Fault Current	Ampere Rating	Circuit Protection Type	Caterpillar Transfer Switch Rating
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Notes:

AUTOMATIC TRANSFER SWITCH

