

# Surgeologic Surge Protective Devices (SPDs)



## ANSI/IEEE C62.41.1, C62.41.2 & C62.45 Surge Performance Testing

Test performance values contained within this document are representative of Square D™ brand Surgeologic™ Surge Protective Devices (SPDs) when tested in accordance with the waveforms as defined in the ANSI/IEEE C62.41.2 – 1991 and 2002 standards.

The testing was conducted inside the Schneider Electric industry certified surge laboratory. Standard testing processes and procedures were followed.

The representative unit from each group (listed in italics) was tested in all of its modes of operation (L-N, L-G, N-G, L-L) and the let-through voltage recorded for each of the modes. The tables in this document provide these measured let-through values. The actual plots can be provided upon request.

**TEST SETUP AND INFORMATION**

**Connection**

- All integral and external panel type products (IMA, EMA) were connected using #6 AWG wire.
- Hard-Wired Assembly (HWA) products were connected using #10 AWG wire.

**Surge Injection Phase Angle**

The transient was injected at the 90° point of the sine wave unless otherwise noted.

**Dynamic Testing**

All testing was dynamic, applying the respective nominal system voltages.

**Measurements**

Measurements were taken with:

- 6" of lead outside the panels for external type products (EMA)
- 6" of lead from the nipple for the hard wired type products (HWA)
- Backplane connection points for the Internal/Integral (IMA) products

**Let-Through Values**

- Recorded let-through values are the averaged value across the similar modes of a 3-phase system +/-10%. (L-N = Ave(L1L2L3-N), L-G = Ave(L1L2L3-G), L-L = Ave(L1L2, L2L3, L1L3))
- All let-through values are peak values referenced from the zero reference point or zero crossing (See Fig. 1).

**Note**

The voltage peak to which an SPD limits an incoming surge has been given or has taken on many different names, including: clamping voltage, surge residual, surge remnant, protection level, let through voltage and Voltage Protection Level (VPR). Even though all these terms are technically correct it is important when making any product comparison to understand how a manufacturer may be representing their performance numbers.

**Table 1: Standard 0.5 micro second – 100 kHz Ring Wave**

Category	Peak Voltage (kV)	Peak Current (kA)	Effective
A1*	2	0.067	30 Ohms
A	6	0.2	30 Ohms
B	6	0.5	12 Ohms

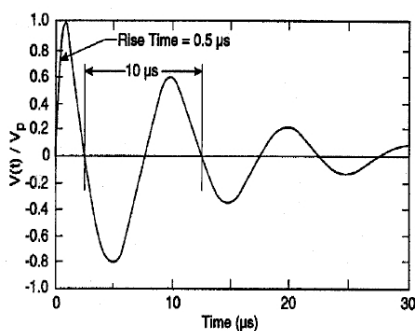
\*A1-Ringwave used on sine wave tracking systems only

**Table 2: Standard 1.2/50 micro second – 8/20 micro second Combination Wave**

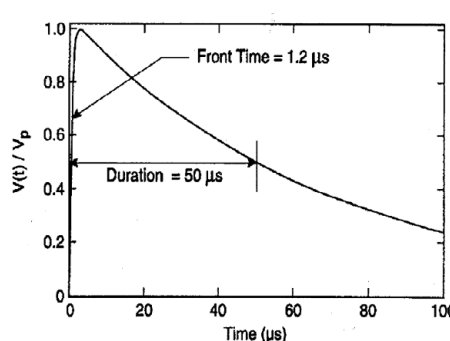
Category C	Voltage Peak (kV)	Peak Current (kA)
C (low)	6 (Minimum)	3 (Actual)
C (high)*	10 (Minimum)	10 (Actual)

\*C (high) impulse testing was conducted at 20 kV, 10 kA

**Figure 1**



**Figure 2**



**Let-Through Definition**

For the purpose of this document we have also introduced the term “True Let-Through” (see Figure 3). True Let-Through we have defined as the amount of surge voltage above the nominal system voltage. If this value is needed for specification purposes it can be easily obtained by a simple calculation:

$$TLTV=LTV-Vnom$$

- LTV – Let-Through Voltage
- TLTV – True Let-Through Voltage
- Vnom – Peak value of the nominal AC voltage

**Example**

An SPD used in a 120 Vac system with a Let-Through voltage of 370 Vac will have a “True Let-Through” voltage of:  $370(LTV) - 170(Vnom) = 200 V$ .

**CONTACT INFORMATION**

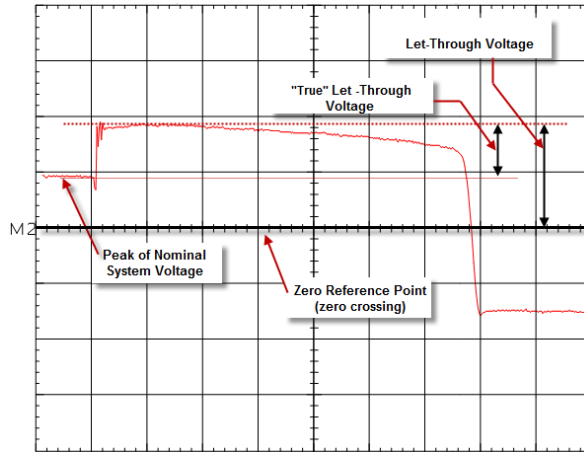
For additional information or supporting documentation regarding these tests please contact the SurgeLogic Technical Assistance Group.

Telephone: (800) 577-7353  
 Email: spdtag@schneider-electric.com

**Table 3: Test Equipment**

Manufacturer	Description	Model	Serial #	Last Cal.	Cal. Due
Tektronix	Oscilloscope	TDS3054B	B010034	3-24-2010	3-24-2011
Tektronix	High Voltage Probe	P0615A	B050063	3-24-2010	3-24-2011
Tektronix	High Voltage Probe	P0615A	B050064	3-23-2010	3-23-2011
Pearson	Current Transformer	101	108855	6-22-2010	6-22-2011
Pearson	Current Transformer	101	108856	7-19-2010	7-19-2011
Fluke	Digital Multi-meter	175	78590012	4-25-2010	4-25-2011
Haefley	Surge Generator	20430	Calibrated before each use		
Haefley	Surge Generator	P-8000	Calibrated before each use		

**Figure 3**



**INTERNAL/INTEGRAL MODELS (IMA SERIES)**

Voltages measured at the backplane

**Table 4: 120/240V and 208Y/120V 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
369	375	399		420	428	455		429	428	468		607	627	650	

Internal (panelboards/switchboards/ switchgear)	I-Line Plug-on	QMB Plug-on	MCC	Busway
TVS1/IMA12 TVS1/IMA16 TVS1/IMA24 TVS2/IMA12 TVS2/IMA16 TVS2/IMA24	HL1/IMA12 HL1/IMA16 HL1/IMA24 HL2/IMA12 HL2/IMA16 HL2/IMA24 FI1/IMA12 FI1/IMA16 FI1/IMA24 FI2/IMA12 FI2/IMA16 FI2/IMA24	QMB2/IMA12 QMB2/IMA16 QMB2/IMA24	MCC2/IMA12 MCC2/IMA16 MCC2/IMA24	PIU2/IMA12 PIU2/IMA16 PIU2/IMA24

**Table 5: 120/240V and 208Y/120V 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
384	387	355	670	408	392	391	723	427	416	407	743	583	520	523	863

Internal (panelboards/switchboards/ switchgear)
TVS1/IMA32 TVS1/IMA48 TVS2/IMA32 TVS2/IMA48

**Table 6: 240/120V High-leg Delta 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
369	375	355		420	428	391		429	428	407		607	627	523	
668	655	355		783	703	391		767	763	407		990	990	523	

Row 1 = 120 V leg, Row 2 = 240 V leg

Internal (panelboards/switchboards/ switchgear)	I-Line Plug-on	QMB Plug-on	MCC	Busway
TVS3/IMA12 TVS3/IMA16 TVS3/IMA24	HL3/IMA12 HL3/IMA16 HL3/IMA24 FI3/IMA12 FI3/IMA16 FI3/IMA24	QMB3/IMA12 QMB3/IMA16 QMB3/IMA24	MCC3/IMA12 MCC3/IMA16 MCC3/IMA24	PIU3/IMA12 PIU3/IMA16 PIU3/IMA24

**INTERNAL/INTEGRAL MODELS (IMA SERIES)**

**Table 7: 240/120V High-leg Delta 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
384	387	356	670	408	392	400	723	427	416	423	743	583	520	523	863
635	628	356	903	683	680	400	945	727	707	423	1008	873	890	523	1070

Row 1 = 120 V leg, Row 2 = 240 V leg

**Internal**  
(panelboards/switchboards/  
switchgear)

TVS3/IMA32  
TVS3/IMA48

**Table 8: 480Y/277V 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
780	773	793		823	827	780		913	880	930		1057	1070	1160	

**Internal**  
(panelboards/switchboards/  
switchgear)

I-Line Plug-on

QMB Plug-on

MCC

Busway

TVS4/IMA12  
TVS4/IMA16  
TVS4/IMA24

HL4/IMA12  
HL4/IMA16  
HL4/IMA24  
F4/IMA12  
F4/IMA16  
F4/IMA24

QMB4/IMA12  
QMB4/IMA16  
QMB4/IMA24

MCC4/IMA12  
MCC4/IMA16  
MCC4/IMA24

PIU4/IMA12  
PIU4/IMA16  
PIU4/IMA24

**Table 9: 480Y/277V 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
750	757	793	1390	823	807	893	1450	853	853	887	1523	997	963	937	1693

**Internal**  
(panelboards/switchboards/  
switchgear)

TVS4/IMA32  
TVS4/IMA48

**INTERNAL/INTEGRAL MODELS (IMA SERIES)**

**Table 10: 600Y/347 V 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)							
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L				
983	970	1043		1053	1080	1107		1093	1113	1173		1327	1327	1437					
<b>Internal</b> (panelboards/switchboards/ switchgear)																			
				<b>I-Line Plug-on</b>				<b>QMB Plug-on</b>				<b>MCC</b>				<b>Busway</b>			
TVS8/IMA12 TVS8/IMA16 TVS8/MA24				F8/IMA12 F8/IMA16 F8/IMA24				QMB8/IMA12 QMB8/IMA16 QMB8/IMA24				MCC8/IMA12 MCC8/IMA16 MCC8/IMA24				PIU8/IMA12 PIU8/IMA16 PIU8/IMA24			

**Table 11: 600Y/347V 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
960	973	887	1793	977	1003	920	1813	1040	1083	1050	1930	1210	1197	1070	2167
<b>Internal</b> (panelboards/switchboards/ switchgear)															
TVS8/IMA32 TVS8/MA48															

**Table 12: 240V DELTA 100 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	612		453		770		563		650		756		1220		1087
<b>Internal</b> (panelboards/switchboards/ switchgear)															
TVS6/IMA10 TVS6/IMA12 TVS6/IMA16 TVS6/IMA20 TVS6/MA24															

**Table 13: 240V DELTA 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	617		427		713		513		870		820		1000		1047
<b>Internal</b> (panelboards/switchboards/ switchgear)															
TVS6/IMA32 TVS6/MA48															

**INTERNAL/INTEGRAL MODELS (IMA SERIES)**

**Table 14: 480V DELTA 100 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	857		833		1063		1000		1493		1727		1820		2200

Internal  
(panelboards/switchboards/  
switchgear)

TVS5/IMA10  
TVS5/IMA12  
TVS5/IMA16  
TVS5/IMA20  
TVS5/IMA24

**Table 15: 480V DELTA 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	910		810		1007		927		1410		1603		1707		1920

Internal  
(panelboards/switchboards/  
switchgear)

TVS5/IMA32  
TVS5/IMA48

**Table 16: 600V DELTA 100 kA - 180 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	1483		1013		1560		1164		2153		2120		2773		2533

Internal  
(panelboards/switchboards/  
switchgear)

TVS9/IMA10  
TVS9/IMA12  
TVS9/IMA16  
TVS9/IMA18

**Table 17: 600V DELTA 200 kA - 320 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	1343		990		1627		1117		1966		2013		2453		2300

Internal  
(panelboards/switchboards/  
switchgear)

TVS9/IMA20  
TVS9/IMA24  
TVS9/IMA32

**EXTERNAL PANEL MOUNT MODELS (EMA SERIES)**

Voltages measured with 6 inches of lead outside housing

**Table 18: 120/240V and 208Y/120V 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
489	496	457	833	640	679	633	993	605	621	600	943	1090	1057	1023	1640

SSP01EMA12  
SSP01EMA16  
SSP01EMA24

SSP02EMA12  
SSP02EMA16  
SSP02EMA24

**Table 19: 120/240 V and 208Y/120V 120 kA - 240 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
523	543	505	873	740	783	740	1067	673	678	667	997	1527	1497	1467	1993

SSP01EMA12D  
SSP01EMA16D  
SSP01EMA24D

SSP02EMA12D  
SSP02EMA16D  
SSP02EMA24D

**Table 20: 120/240 V and 208Y/120V 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
513	533	425	817	720	760	700	1007	663	639	619	950	1417	1257	1283	1743

SSP01EMA32  
SSP01EMA48

SSP02EMA32  
SSP02EMA48

**Table 21: 120/240 V and 208Y/120V 320 kA - 480 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
556	556	465	867	850	840	747	1107	737	743	677	1043	1680	1713	1543	2037

SSP01EMA32D  
SSP01EMA48D

SSP02EMA32D  
SSP02EMA48D



**EXTERNAL PANEL MOUNT MODELS (EMA SERIES)**

**Table 22: 240/120V High-leg Delta 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
489	496	457	833	640	679	633	993	605	621	600	943	1090	1057	1023	1640
757	773	485	1083	960	1027	677	1290	927	937	623	1250	1577	1610	1270	1905

Row 1 = 120 V leg, Row 2 = 240 V leg

SSP03EMA12  
SSP03EMA16  
SSP03EMA24

**Table 23: 240/120V High-leg Delta 120 kA - 240 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
523	543	505	873	740	783	740	1067	673	678	667	997	1527	1497	1467	1993
867	870	573	965	1147	1167	843	1402	1057	1070	757	1315	2030	2000	1693	2220

Row 1 = 120 V leg, Row 2 = 240 V leg

SSP03EMA12D  
SSP03EMA16D  
SSP03EMA24D

**Table 24: 240/120V High-leg Delta 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
513	533	425	817	720	760	700	1007	663	639	619	950	1417	1257	1283	1743
800	817	493	1075	1050	1080	813	1325	987	993	700	1258	1987	1920	1530	1987

Row 1 = 120 V leg, Row 2 = 240 V leg

SSP03EMA32  
SSP03EMA48

**Table 25: 240/120V High-leg Delta 320 kA - 480 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
556	556	465	867	850	840	747	1107	737	743	677	1043	1680	1713	1543	2037
860	853	507	1093	1173	1160	840	1405	1063	1053	737	1300	2230	2280	1797	2287

Row 1 = 120 V leg, Row 2 = 240 V leg

SSP03EMA32D  
SSP03EMA48D

**EXTERNAL PANEL MOUNT MODELS (EMA SERIES)**

**Table 26: 480Y/277V 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
840	857	860	1550	997	1013	1043	1727	997	1007	973	1723	1673	1660	1623	2513

SSP04EMA12  
SSP04EMA16  
SSP04EMA24

**Table 27: 480Y/277V 120 kA - 240 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
900	897	807	1603	1117	1040	970	1823	1060	1057	1030	1797	1990	1997	1950	2833

SSP04EMA12D  
SSP04EMA16D  
SSP04EMA24D

**Table 28: 480Y/277V 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
840	850	807	1550	1093	1063	1030	1793	1023	1017	917	1707	1917	1777	1640	2613

SSP04EMA32  
SSP04EMA48

**Table 29: 480Y/277V 320 kA - 480 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
937	973	883	1590	1193	1233	1147	1817	1093	1130	1050	1777	2230	2317	2133	2813

SSP04EMA32D  
SSP04EMA48D

**EXTERNAL PANEL MOUNT MODELS (EMA SERIES)**

**Table 30: 600Y/347V 120 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
1100	1107	1090	1967	1323	1327	1267	2180	1233	1260	1197	2167	1947	1953	1870	2967

SSP08EMA12  
SSP08EMA16  
SSP08EMA24

**Table 31: 600Y/347V 120 kA - 240 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
1167	1160	1130	2000	1397	1400	1353	2233	1350	1327	1287	2203	2373	2307	2147	3313

SSP08EMA12D  
SSP08EMA16D  
SSP08EMA24D

**Table 32: 600Y/347V 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
1123	1130	1013	1937	1323	1343	1263	2127	884	1267	1247	2107	2227	2073	1913	3027

SSP08EMA32  
SSP08EMA48

**Table 33: 600Y/347V 320 kA - 480 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
1137	1160	1050	1960	1433	1460	1343	2200	1340	1347	2187	1303	2387	2407	2207	3267

SSP08EMA32D  
SSP08EMA48D

**EXTERNAL PANEL MOUNT MODELS (EMA SERIES)**

**Table 34: 240V DELTA 100 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	663		653		790		820		1010		1016		1780		1813

SSP06EMA10  
SSP06EMA12  
SSP06EMA16  
SSP06EMA20  
SSP06EMA24

**Table 35: 240V DELTA 100 kA - 240 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	615		510		853		720		883		790		1827		1447

SSP06EMA10D  
SSP06EMA12D  
SSP06EMA16D  
SSP06EMA20D  
SSP06EMA24D

**Table 36: 240V DELTA 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	630		470		773		633		1020		1046		1873		1960

SSP06EMA32  
SSP06EMA48

**Table 37: 240V DELTA 320 kA - 480 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	603		480		653		553		1025		1040		2067		1953

SSP06EMA32D  
SSP06EMA48D

**EXTERNAL PANEL MOUNT MODELS (EMA SERIES)**

**Table 38: 480V DELTA and 480Y/277V HRG 100 kA - 240 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	860		877		1013		1060		1587		1917		2680		2320

SSP05EMA10  
SSP05EMA12  
SSP05EMA16  
SSP05EMA20  
SSP05EMA24

**Table 39: 480V DELTA and 480Y/277V HRG 100 kA - 240 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	950		943		1150		1130		1493		1750		2473		2900

SSP05EMA10D  
SSP05EMA12D  
SSP05EMA16D  
SSP05EMA20D  
SSP05EMA24D

**Table 40: 480V DELTA and 480Y/277V HRG 320 kA - 480 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	847		807		1010		1000		1487		1773		2507		2853

SSP05EMA32  
SSP05EMA48

**Table 41: 480V DELTA and 480Y/277V HRG 320 kA - 480 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	827		813		1027		1043		1510		1840		2240		2780

SSP05EMA32D  
SSP05EMA48D

**EXTERNAL PANEL MOUNT MODELS (EMA, HEMA SERIES)**

**Table 42: 600V DELTA and 600Y/347V HRG 100 kA - 180 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	1527		1060		1680		1273		2310		2206		3120		3226

SSP09EMA10  
SSP09EMA12  
SSP09EMA16  
SSP09EMA18

**Table 43: 600V DELTA and 600Y/347V HRG 100 kA - 180 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	1506		1096		1766		1316		2353		2283		3406		3246

SSP09EMA10D  
SSP09EMA12D  
SSP09EMA16D  
SSP09EMA18D

**Table 44: 600V DELTA and 600Y/347V HRG 200 kA - 320 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	1343		1007		1560		1220		2176		2206		2780		2340

SSP09EMA20  
SSP09EMA24  
SSP09EMA32

**Table 45: 600V DELTA and 600Y/347V HRG 200 kA - 320 kA with Integral Switch  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
	1377		993		1603		1177		2160		2173		3086		3286

SSP09EMA20D  
SSP09EMA24D  
SSP09EMA32D

**HARDWIRE NIPPLE MODELS (HWA SERIES)**

Voltages measured with 6 inches of lead

**Table 52: 120/240V and 208Y/120V 50 kA - 100 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
423	547	512	797	680	843	743	1070	923	1143	673	1317	1813	2093	1370	2193

TVS1HWA50X  
TVS1HWA80X  
TVS1HWA10X

TVS2HWA50X  
TVS2HWA80X  
TVS2HWA10X

**Table 53: 240/120V High-leg Delta 50 kA - 100 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
423	547	512	797	680	843	743	1070	923	1143	673	1317	1813	2093	1370	2193
577	635	515	877	870	980	720	1250	1183	1490	1603	673	2127	2393	1347	2467

Row 1 = 120 V leg, Row 2 = 240 V leg

TVS3HWA50X  
TVS3HWA80X  
TVS3HWA10X

**Table 54: 480Y/277V 50 kA - 100 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
663	960	887	1163	890	1327	1073	1660	1217	2020	1037	2100	2207	3007	1827	3173

TVS4HWA50X  
TVS4HWA80X  
TVS4HWA10X

**Table 55: 480V Delta 50 kA - 100 kA  
IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
			1163				1660				2100				3173

TVS5HWA50X  
TVS5HWA80X  
TVS5HWA10X

## HARDWIRE NIPPLE MODELS (HWA SERIES)

**Table 56: 240V Delta 50 kA - 100 kA**  
**IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
			883				1110				1387				2160

TVS6HWA50X  
 TVS6HWA80X  
 TVS6HWA10X

**Table 57: 600Y/347V 50 kA - 100 kA**  
**IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
723	1157	1107	1313	1083	1497	1277	2080	1570	2527	1303	2613	2507	3547	2093	3760

TVS8HWA50X  
 TVS8HWA80X  
 TVS8HWA10X

**Table 58: 600V Delta 50 kA - 100 kA**  
**IEEE C62.41.2-2002 Waveform Let-Through Voltages**

Category A Ringwave (6 kV, 200 A) 100 kHz				Category B Ringwave (6 kV, 500 A) 100 kHz				Category C (low) Impulse (6 kV, 3 kA)				Category C (high) Impulse (20 kV, 10 kA)			
L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L	L-N	L-G	N-G	L-L
			1313				2080				2613				3760

TVS9HWA50X  
 TVS9HWA80X  
 TVS9HWA10X

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