Test generator specifications for emission and immunity tests

DM xxx/APS THREE-PHASE MAINS SIMULATION SYSTEM

Three-phase mains simulation system DM 22500/APS

For emission tests according to IEC 61000-3-2/ -3/-11/-12 and for immunity tests according to IEC 61000-4-x the DM xxx/APS three-phase mains simulation system can be used as test generator.

This is a combination of three APS amplifiers in a star configuration and allows operation of three-phase EUTs with or without neutral conductor as well as of single-phase EUTs.

The three-phase mains simulation system enables stable sinusoidal test voltages with low total harmonic distortion and low internal impedance as well as exact phase angles between the phases for emission tests in compliance with the standards.

Additionally, the arbitrary waveform generator, the fast rise and fall time and the high bandwidth of this three-phase mains simulation system support fully compliant immunity tests.

All required test generator specifications are met and, in most cases, far exceeded by the three-phase mains simulation system as you can see in the following comparison tables.

FULLY COMPLIANT

TECHNICAL DATA – COMPARISON OF THE REQUIREMENTS OF THE STANDARDS WITH THE DM xxx/APS SPECIFICATIONS

IEC 61000-3-2 (2024-03) A.2 Supply source

	Requirements of the standard	Specification of DM xxx/APS
Test voltage	230 V single-phase or 400 V three-phase ±2.0 %	0 … 300 V (RMS, phase-neutral) or 0 … 520 V (RMS, phase-phase) ±0.2 % of U_n
Frequency accuracy	50 Hz ± 0.5 %	0.0025 % of f_n
Angle between the fundamental voltage on each pair of phases of a three-phase source	120° ± 1.5°	120° ± 0.1°
Harmonic ratios of the test voltage	0.9 % for harmonic of order 3 0.4 % for harmonic of order 5 0.3 % for harmonic of order 7 0.2 % for harmonic of order 9 0.2 % for even harm. of order 2 to 10 0.1 % for harmonics of order 11 to 40	0.10 % for harmonic of order 3 0.08 % for harmonic of order 5 0.07 % for harmonic of order 7 0.05 % for harmonic of order 9 0.04 % for even harm. of order 2 to 10 0.04 % for harmonics of order 11 to 40 (loaded with a synthetic load with harmonic currents of 100% of the class B limit values)
Peak value of the test voltage	Within 1.40 times and 1.42 times of its RMS value and reached within 87° and 93° after the zero crossing	Within 1.40 times and 1.42 times of its RMS value and reached within 87° and 93° after the zero crossing

IEC 61000-3-3 (2021-03) 6.3 Test supply voltage

	Requirements of the standard	Specification of DM xxx/APS
Test supply voltage (open-circuit voltage)	230 V single-phase or 400 V three-phase ±2 %	0 … 300 V (RMS, phase-neutral) 0 … 520 V (RMS, phase-phase) ±0.2 % of U_n
Frequency accuracy	50 Hz ± 0.25 %	0.0025% of f_n
THD of supply voltage	< 3 %	< 0.2 %
$P_{st,source}$	< 0.4	< 0.1 – typically 0.02

IEC 61000-4-11 (2020-01) Table 4 – Generator specifications

	Requirements of the standard	Specification of DM xxx/APS
Output voltage at no load	As required in Table 1, ±5 % of residual voltage value	0 … 300 V (RMS) / 0 s … ∞ ±0.2 % of residual voltage value (typically for residual voltage ≥ 40 %)
Voltage change with load at the output of the generator **100 % output, 0 A to 16 A** **80 % output, 0 A to 20 A** **70 % output, 0 A to 23 A** **40 % output, 0 A to 40 A**	 Less than 5 % of U_T Less than 5 % of U_T Less than 5 % of U_T Less than 5 % of U_T	 < 0.5 % of U_T < 0.5 % of U_T < 0.5 % of U_T < 0.5 % of U_T
Output current capability	16 A RMS per phase at rated voltage 20 A @ 80 % of U_T (5 s) 23 A @ 70 % of U_T (3 s) 40 A @ 40 % of U_T (3 s)	See Table I
Peak inrush current capability	1000 A for 250 V to 600 V mains 500 A for 200 V to 240 V mains 250 A for 100 V to 120 V mains	See Table II
Instantaneous peak overshoot/undershoot of the actual voltage (100 Ω resistive load)	Less than 5 % of U_T	< 5 % – typically 2.5 %
Voltage rise (and fall) time t_r (and t_f) (100 Ω resistive load)	Between 1 µs and 5 µs	< 5 µs – typically 2.5 µs
Phase shifting	0° ... 360°	0° … 360° (any phase angle)
Phase relationship of voltage dips and interruptions with the power frequency	Less than ±10°	< ±0.1°
Zero crossing control of the generators	±10°	±0.1°

IEC 61000-4-13 (2015-12) Table 5 – Characteristics of the test generator

	Requirements of the standard	Specification of DM xxx/APS
Fundamental voltage - Magnitude U_1 - Frequency - Angle between phases	 Nominal mains volt. ±2 % (1 ph / 3 ph) 50 Hz ±0.5 % or 60 Hz ±0.5 % 120° ±1.5° (star connection)	 U_N ±0.2 % (1 ph / 3 ph) 50 Hz ±0.0025 % or 60 Hz ±0.0025 % 120° ±0.1° (star connection)
Preselectable individual harmonics - Order - Magnitude U_h Range Accuracy - Phase angle φ_h h = 2 to 9 Accuracy of zero phase cross.	 2 to 40 0 % to 14 % U_1 The larger of ±5.0 % U_h or 0.1 % U_1 0°; 180° ±2° of the fundamental	 2 to 500 0 % to 30 % U_1 (resulting signal ≤ 424 V (peak)) The larger of ±1.0 % U_h or 0.05 % U_1 0° … 360° (any phase angle) ±0.1° of the fundamental
Combination of harmonics	≥ 2	500
Frequencies between the harmonics - Magnitude Range Accuracy - Frequency Range Steps for adjusting f = (0,33 to 2) * f_1 f = (2 to 20) * f_1 f > 20 * f_1 Maximum error of adj. value	 0 % to 10 % U_1 The larger of ±5.0 % U_h or 0.1 % U_1 0.33 * f_1 to 40 * f_1 0.1 * f_1 0.2 * f_1 0.5 * f_1 ±0.5 % f	 0 % to 30 % U_1 (resulting signal ≤ 424 V (peak)) The larger of ±1.0 % U_h or 0.05 % U_1 0 * f_1 to 500 * f_1 Linear frequency sweep or adjustable frequency steps (better than 0.001 * f_1) ±0.1 % f

IEC 61000-4-14 (2009-08) Table 2 – Characteristics of the test generator

	Requirements of the standard	Specification of DM xxx/APS
Output voltage capability	U_n ±15 %	0 … 300 V (RMS)
Voltage accuracy	±1 %	±0.2 %
Zero crossing accuracy	250 µs at zero voltage crossover	5 µs at zero voltage crossover
Output current capability	The generator shall be able to supply enough current according to the type of EUT in the test voltage range.	See Table I
Overshoot / undershoot of the actual voltage	Less than 5 % of the change in voltage	< 5 % – typically 2.5 %
Voltage rise (and fall) time during switching	Under 1 ms	< 5 µs – typically 2.5 µs
Maximum interphase error (three-phase power supply)	2.5°	0.1°
Frequency accuracy	2.5 % of f_n (50 Hz or 60 Hz)	0.0025 % of f_n (50 Hz or 60 Hz)

IEC 61000-4-17 (2009-01) 6.1 Characteristics and performance of the generator

	Requirements of the standard	Specification of DM xxx/APS
Output voltage range	Up to 360 V	0 … 424 V (DC)
Output voltage change with load (0 to rated current)	Less than 5 %	±0.2 %
Output voltage waveform	Alternating component at power frequency or its multiple, with a sinusoid-linear character, superimposed on the d.c. voltage	Predefined and arbitrary waveforms
Output voltage tolerance	±10 %	±0.2 %
Output current (steady state)	Up to 25 A	See Table III
Peak output current capability (5ms)	+2.5/-0.5 times the steady-state current	See Table II
Ripple frequency tolerance	±1 %	±0.1 %

IEC 61000-4-27 (2009-04) Table 2 – Characteristics of the generator

	Requirements of the standard	Specification of DM xxx/APS
Output voltage capability	U_N +15 %, -40 %	0 … 300 V (RMS)
Output voltage accuracy	±2 % of U_N	±0.2 %
Output current capability	Sufficient to supply the EUT under all test conditions	See Table I
Overshoot/undershoot of the actual voltage (100 Ω resistive load)	Less than 5 % of the change in voltage	< 5 % – typically 2.5 %
Voltage rise (and fall time) during voltage changes (100 Ω resistive load)	1 µs to 5 µs	< 5 µs – typically 2.5 µs
Total harmonic distortion of the output voltage	Less than 3 %	< 0.3 % – typically 0.1 %
Phase shifting **Phase accuracy**	0°, 120° and 240° ±30° 1° between any two phases	0° … 360° (any phase angle) 0.1°
Frequency accuracy	0.5 % of f_1 (50 Hz or 60 Hz)	0.0025 % of f_1 (50 Hz or 60 Hz)

IEC 61000-4-28 (2009-04) Table 2 – Characteristics of the generator

	Requirements of the standard	Specification of DM xxx/APS
Output voltage accuracy	±2 %	±0.2 %
Output voltage and current capability	The generator shall be able to supply enough voltage and current according to the type of EUT	0 … 300 V (RMS) / Current: see Table I
Phase accuracy for each phase	2° (0.5 % of 360°)	0.1°
Frequency accuracy	0.3 % of f_1 (50 Hz or 60 Hz)	0.0025 % of f_1 (50 Hz or 60 Hz)
Frequency capability range	f_1 ±20 %	DC … 10 kHz
Test duration accuracy	±10 %	0.0025 %

IEC 61000-4-29 (2000-08) 6.1 Characteristics and performances of the generator

	Requirements of the standard	Specification of DM xxx/APS
Output voltage range	Up to 360 V	0 … 424 V (DC)
Short interruptions, dips, and variations of the output voltage	As given in Tables 1a, 1b and 1c	0 s … ∞ (low impedance)
Output voltage variation with the load (0 to rated current)	Less than 5 %	< ±0.2 %
Ripple content	Less than 1 % of the output voltage	< 0.1 % of the output voltage
Rise and fall time of the voltage change (100 Ω resistive load)	Between 1 µs and 50 µs	< 5 µs – typically 2.5 µs
Overshoot / undershoot of the output voltage (100 Ω resistive load)	Less than 10 % of the change in voltage	< 5 % – typically 2.5 %
Output current (steady state)	Up to 25 A	See Table III

IEC 61000-4-34 (2009-11) Table 4 – Generator specifications

	Requirements of the standard	Specification of DM xxx/APS
Output voltage at no load	As required in Table 1, ±5 % of residual voltage value	0 … 300 V (RMS) / 0 s … ∞ ±0.2 % of residual voltage value (typically for residual voltage ≥ 40 %)
Voltage at the output of the generator during equipment test	As required in Table 1, ±10 % of residual voltage value, Measured as r.m.s. value refreshed each ½ cycle per IEC 61000-4-30	±1 %
Output current capability	See Annex A	See Table I
Peak inrush current capability	See Annex A	See Table II
Instantaneous peak overshoot/undershoot of the actual voltage (resistive load)	Less than 5 % of U_T	< 5 % – typically 2.5 %
Voltage rise (and fall) time t_r (and t_f) (resistive load)	Between 1 µs and 5 µs	< 5 µs – typically 2.5 µs
Phase angle at which the voltage dip begins and ends	0° to 360° with a maximum resolution of 5°	0° to 360° with a resolution of 0.001°
Phase relationship of voltage dips and interruptions with the power frequency	Less than ±5°	< ±0.1°
Zero crossing control of the generators	±10°	±0.1°

AC output current capability				
System	$I_{continuous}$ (each phase)	I @ 80 % of U_T (5 s)	I @ 70 % of U_T (3 s)	I @ 40 % of U_T (3 s)
DM 300/APS	0.3 A	1.0 A	1.0 A	0.9 A
DM 3000/APS	3.3 A	8.0 A	8.3 A	7.1 A
DM 3750/APS	4.2 A	10.0 A	10.4 A	8.8 A
DM 7500/APS	9.5 A	22.5 A	23.5 A	20.0 A
DM 15000/APS	19.0 A	45.0 A	47.0 A	40.0 A
DM 22500/APS	28.5 A	67.5 A	70.5 A	60.0 A
DM 30000/APS	38.0 A	90.0 A	94.0 A	80.0 A
DM 37500/APS	47.5 A	112.5 A	117.5 A	100.0 A
DM 45000/APS	57.0 A	135.0 A	141.0 A	120.0 A
DM 60000/APS	76.0 A	180.0 A	188.0 A	160.0 A
DM 75000/APS	95.0 A	225.0 A	235.0 A	200.0 A
DM 90000/APS	114.0 A	270.0 A	282.0 A	240.0 A
DM 120000/APS	152.0 A	360.0 A	376.0 A	320.0 A
DM 150000/APS	190.0 A	450.0 A	470.0 A	400.0 A
DM 180000/APS	228.0 A	540.0 A	564.0 A	480.0 A

Table I: AC output current capability

Peak inrush current capability		
System	I_{peak} (each phase)	I_{peak} (in parallel mode)
DM 300/APS	6.6 A	19.8 A
DM 3000/APS	26.4 A	79.2 A
DM 3750/APS	44.0 A	132.0 A
DM 7500/APS	88.0 A	264.0 A
DM 15000/APS	176.0 A	528.0 A
DM 22500/APS	264.0 A	792.0 A
DM 30000/APS	440.0 A	1320.0 A
DM 37500/APS	528.0 A	1584.0 A
DM 45000/APS	616.0 A	1848.0 A
DM 60000/APS	880.0 A	2640.0 A
DM 75000/APS	1056.0 A	3168.0 A
DM 90000/APS	1150.0 A	3450.0 A
DM 120000/APS	1760.0 A	5280.0 A
DM 150000/APS	2112.0 A	6336.0 A
DM 180000/APS	2300.0 A	6900.0 A

Table II: Peak inrush current capability

DC output current (steady state)				
System	I_{DC} (each phase)		I_{DC} (in parallel mode)	
	U_{DC} < 191 V	U_{DC} < 382 V	U_{DC} < 191 V	U_{DC} < 382 V
DM 300/APS	0.5 A	0.25 A	1.5 A	0.75 A
DM 3000/APS	5.2 A	2.6 A	15.6 A	7.8 A
DM 3750/APS	6.5 A	3.3 A	19.5 A	9.8 A
DM 7500/APS	13.0 A	6.5 A	39.0 A	19.5 A
DM 15000/APS	26.0 A	13.0 A	78.0 A	39.0 A
DM 22500/APS	39.0 A	19.5 A	117.0 A	58.5 A
DM 30000/APS	52.0 A	26.0 A	156.0 A	78.0 A
DM 37500/APS	65.0 A	32.5 A	195.0 A	97.5 A
DM 45000/APS	78.0 A	39.0 A	234.0 A	117.0 A
DM 60000/APS	104.0 A	52.0 A	312.0 A	156.0 A
DM 75000/APS	130.0 A	65.0 A	390.0 A	195.0 A
DM 90000/APS	156.0 A	78.0 A	468.0 A	234.0 A
DM 120000/APS	208.0 A	104.0 A	624.0 A	312.0 A
DM 150000/APS	260.0 A	130.0 A	780.0 A	390.0 A
DM 180000/APS	312.0 A	156.0 A	936.0 A	468.0 A

Table III: DC output current (steady state)

Note:
For more detailed and accurate information please refer to the appropriate datasheet of the individual amplifier.