RTCA DO160-G

- avionic test standard -
at a glance

Environmental conditions and test procedures for airborne equipment, section 16: Power input

The relating standards:
RTCA DO-160
MIL-STD-704
Airbus ABD 0100.1.8.(A380)
Airbus ABD 0100.1.8.1.(A350)
Boeing 787B3
AMD24/C

THE SCOPE OF THE STANDARD

The DO-160G standard defines test conditions and procedures for AC and DC electrical power applied to the terminals of the equipment under test. It covers the following power supplies:

AC supply networks

- $115V_{rms}$ fixed frequency 400Hz
- $230V_{rms}$ fixed frequency 400Hz
- $115V_{rms}$ variable frequency including 400Hz
- $230V_{rms}$ variable frequency including 400Hz

DC supply networks

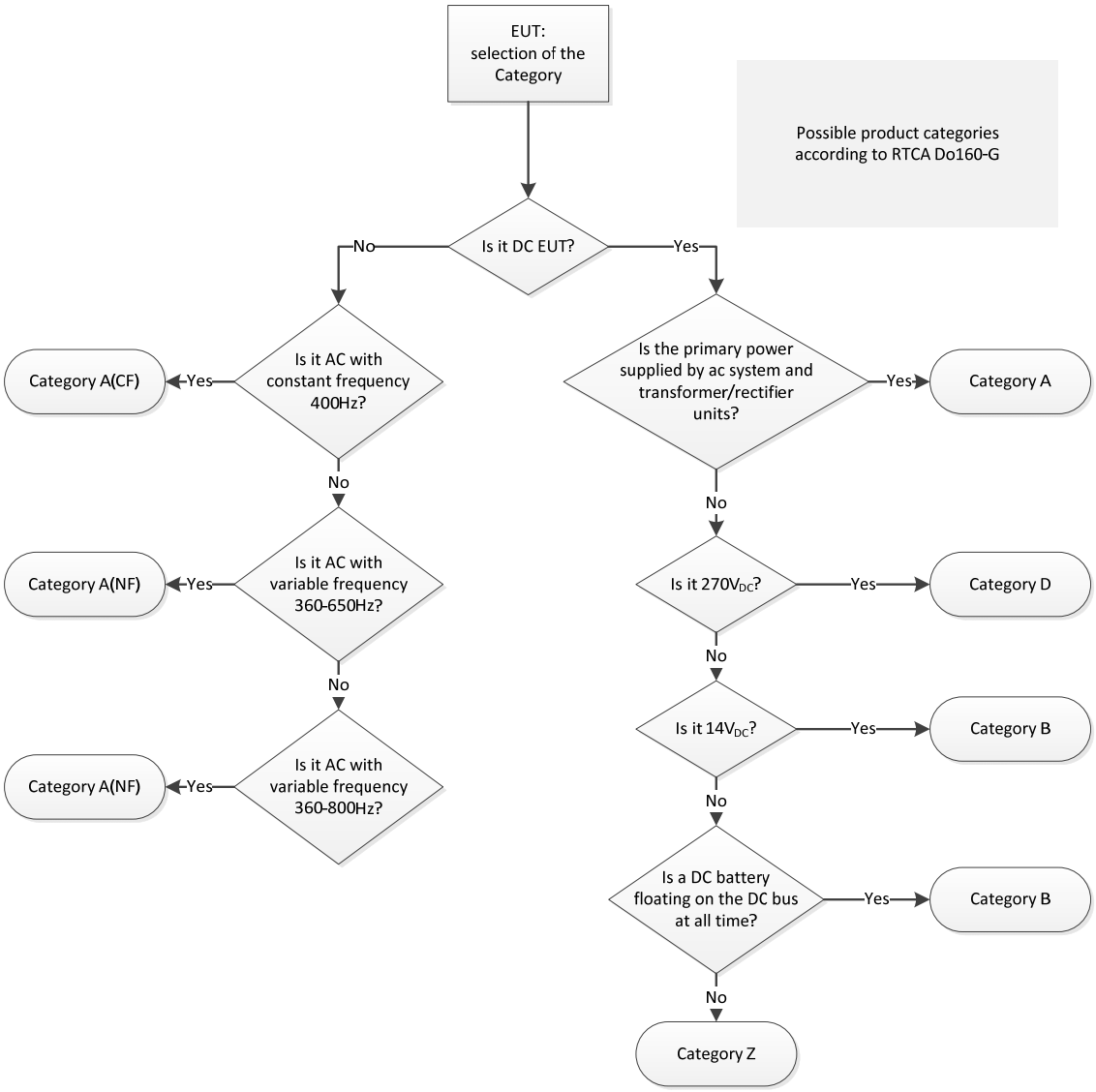
- $14V_{DC}$
- $28V_{DC}$
- $270V_{DC}$

PRODUCT CATEGORIES:

Products for use on aircraft systems are classified into product categories depending on the connected power supply network:
Equipment for use on aircraft electrical systems with primary power from…

A(CF):	AC system with constant frequency 400Hz
A(NF):	AC system with narrow variable frequency 360Hz … 650Hz
A(WF):	AC system with wide variable frequency 360Hz … 800Hz
A:	28V DC system, primary power generated by AC system with transformer-rectifier units an optional DC battery may float on the bus
B:	14V or 28V DC system, supplied by engine driven alternators/rectifiers or DC generators a DC battery with significant capacity is floating on the bus at all time
D:	270V DC system, primary power generated by AC system with transformer-rectifier units
Z:	28V DC system, supplied by variable speed generators (use instead of category A or B) Z shall be acceptable when either - the DC supply does not have a battery floating on the bus - the control or protective equipment disconnects the battery from the DC bus - the battery capacity is small compared with the capacity of the DC generators

SELECTION OF PRODUCT CATEGORY AND RELATING TEST PROCEDURE:



TEST DESIGNATIONS:

H: AC DISTORTION TESTS
L: AC CURRENT MODULATION CONTROL TESTS
P: AC POWER FACTOR TESTS
R: DC CURRENT RIPPLE TESTS
I: AC OR DC INRUSH CURRENT TESTS

STANDARD TEST TOLERANCES

- For nominal voltages ≥100V AC or DC
  ± 1.0% of the test voltage or ±- 1.0% of the nominal voltage
- For nominal voltages <100V AC or DC
  ± 2.0% of the test voltage or ±- 2.0% of the nominal voltage
- All time durations ± 10% of the specified value
- All rise/fall times <1.5msec between 10% and 90% points of the transition
- All frequencies ± 1.0% of the specified value

STANDARD ELECTRICAL POWER INPUT PARAMETERS

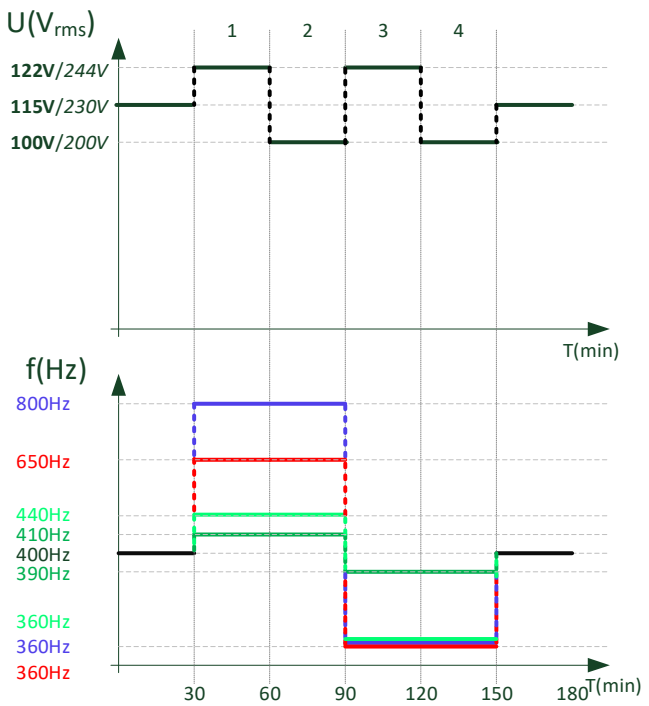
- **Phase sequence**: A, B, C
- **Phase displacement**: 120°±4° for A(CF) and A(NF), 120°±6° for A(WF)
- **Phase unbalance**: <6V_{rms} for A(CF) and A(NF), <8V_{rms} for A(WF)
- **Voltage waveform crest factor** 1.41 ± 0.15
- Max. voltage **total harmonic distortion**: <8% for A(CF) and A(NF), <10% for A(WF)
- Max. voltage **individual harmonic content**: <6% for A(CF) and A(NF), <8% for A(WF)
  refer to DO-160 16.5.1.8.1.
- Voltage waveform **DC content** 0 ± 0.20V_{DC}

PART 1: AC supply tests: DO-160: 16.5.

DO-160: 16.5.1 – NORMAL OPERATING CONDITIONS AC

DO-160: 16.5.1.1. - VOLTAGE AND FREQUENCY – STEADY STATE PERFORMANCE

Single phase equipment tests **A(CF), A(NF) and A(WF)**



Testing time 30min for each test

Normal conditions:

Test	Voltage (V_{rms})	Frequency (Hz)		
		A(CF)	**A(NF)**	**A(WF)**
1	**122** / *244*	410	650	800
2	**100** / *200*	410	650	800
3	**122** / *244*	390	360	360
4	**100** / *200*	390	360	360

Emergency conditions:

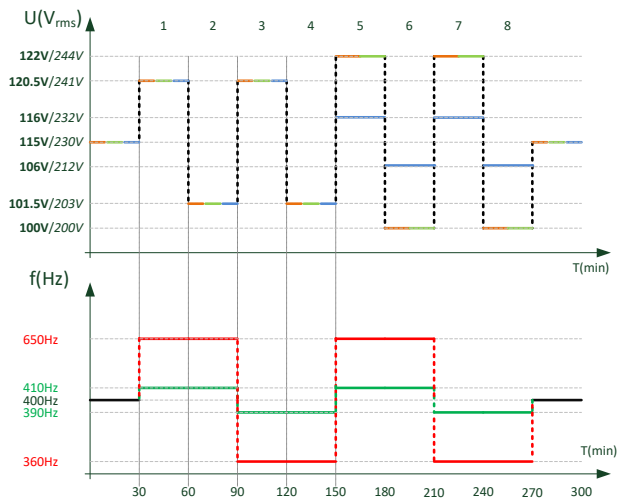
Test	Voltage (V_{rms})	Frequency (Hz)		
		A(CF)	**A(NF)**	**A(WF)**
1	**122** / *244*	440	n.a.	n.a.
2	**100** / *200*	440	n.a.	n.a.
3	**122** / *244*	360	n.a.	n.a.
4	**100** / *200*	360	n.a.	n.a.

115V nominal voltage / *230V nominal voltage*

3-phase equipment **A(CF), A(NF)** under normal conditions:

Test	Phase A/B/C Voltage (V_{rms})			Frequency (Hz)	
	Phase A	Phase B	Phase C	A(CF)	A(NF)
1	**120.5** *241*	**120.5** *241*	**120.5** *241*	410	650
2	**101.5** *203*	**101.5** *203*	**101.5** *203*	410	650
3	**120.5** *241*	**120.5** *241*	**120.5** *241*	390	360
4	**101.5** *203*	**101.5** *203*	**101.5** *203*	390	360
5	**122** *244*	**122** *244*	**116** *232*	410	650
6	**100** *200*	**100** *200*	**106** *212*	410	650
7	**122** *244*	**122** *244*	**116** *232*	390	360
8	**100** *200*	**100** *200*	**106** *212*	390	360

115V nominal voltage / *230V nominal voltage*

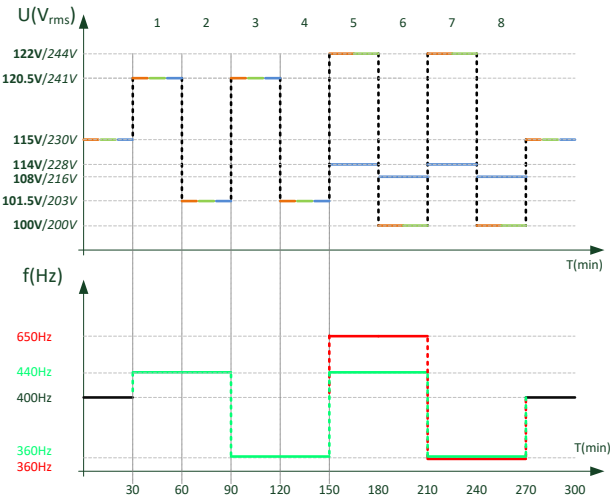


Testing time 30min for each test

3-phase equipment **A(CF), A(NF)** under emergency electrical conditions

Test	Phase A/B/C Voltage (V_{rms})			Frequency (Hz)	
	Phase A	Phase B	Phase C	A(CF)	A(NF)
1	**120.5** *241*	**120.5** *241*	**120.5** *241*	440	n.a.
2	**101.5** *203*	**101.5** *203*	**101.5** *203*	440	n.a.
3	**120.5** *241*	**120.5** *241*	**120.5** *241*	360	n.a.
4	**101.5** *203*	**101.5** *203*	**101.5** *203*	360	n.a.
5	**122** *244*	**122** *244*	**114** *228*	440	650
6	**100** *200*	**100** *200*	**108** *216*	440	650
7	**122** *244*	**122** *244*	**114** *228*	360	360
8	**100** *200*	**100** *200*	**108** *216*	360	360

115V nominal voltage / *230V nominal voltage*

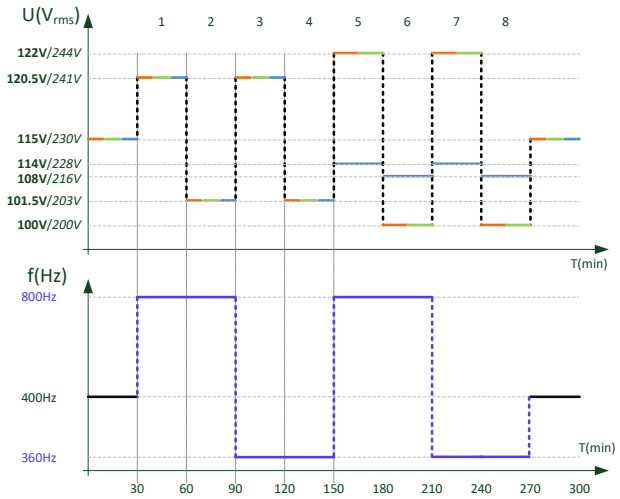


Testing time 30min for each test

3-phase equipment **A(WF)** under normal conditions:

Test	Phase A/B/C Voltage (V_{rms})			Frequency (Hz)
	Phase A	Phase B	Phase C	**A(WF)**
1	**120.5** *241*	**120.5** *241*	**120.5** *241*	800
2	**101.5** *203*	**101.5** *203*	**101.5** *203*	800
3	**120.5** *241*	**120.5** *241*	**120.5** *241*	360
4	**101.5** *203*	**101.5** *203*	**101.5** *203*	360
5	**122** *244*	**122** *244*	**114** *228*	800
6	**100** *200*	**100** *200*	**108** *216*	800
7	**122** *244*	**122** *244*	**114** *228*	360
8	**100** *200*	**100** *200*	**108** *216*	360

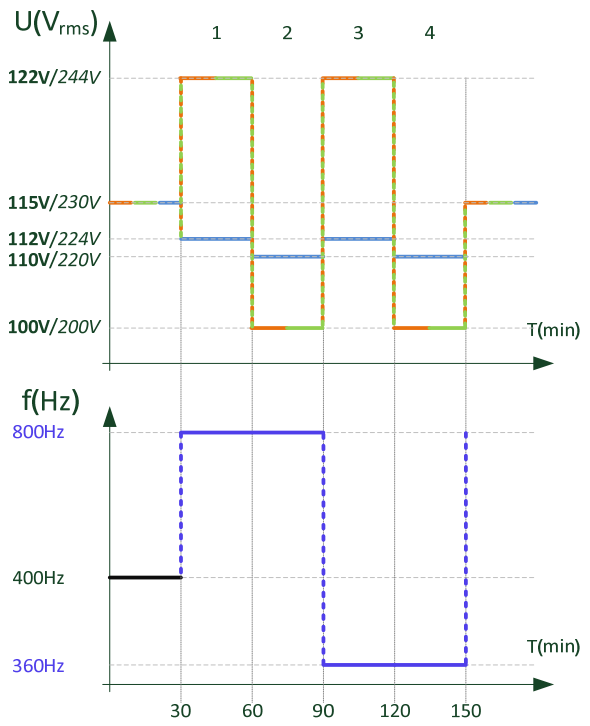
115V nominal voltage / *230V nominal voltage*



3-phase equipment **A(WF)** under emergency electrical conditions

Test	Phase A/B/C Voltage (V_{rms})			Frequency (Hz)
	Phase A	Phase B	Phase C	**A(WF)**
1	**122** *244*	**122** *244*	**112** *224*	800
2	**100** *200*	**100** *200*	**110** *220*	800
3	**122** *244*	**122** *244*	**112** *224*	360
4	**100** *200*	**100** *200*	**110** *220*	360

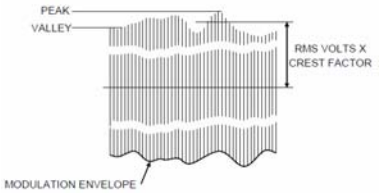
115V nominal voltage / *230V nominal voltage*



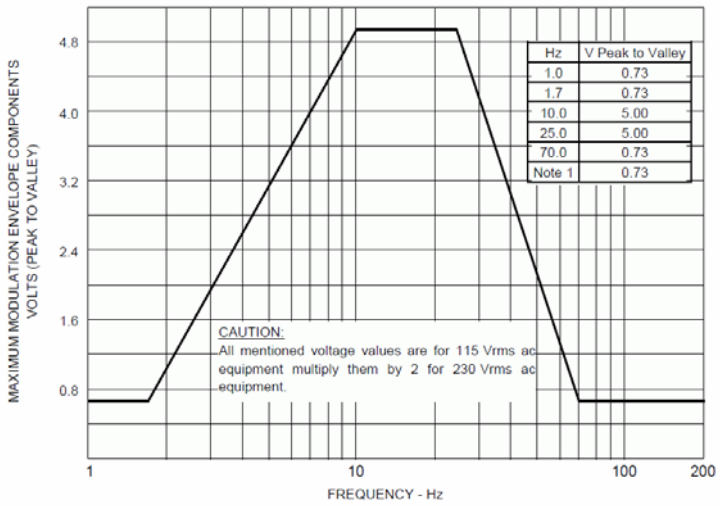
DO-160: 16.5.1.2. - VOLTAGE MODULATION AC

- Nominal voltage 115V(*230V*)
- A(CF) testing frequency 400Hz
- A(NF) testing frequency 360Hz and 650Hz
- A(WF) testing frequency 360Hz and 800Hz

Modulation characteristic:



Modulation of the voltage amplitude with a maximum peak-to-valley difference of 5.0V at 115V networks (*10.0V at 230V*)

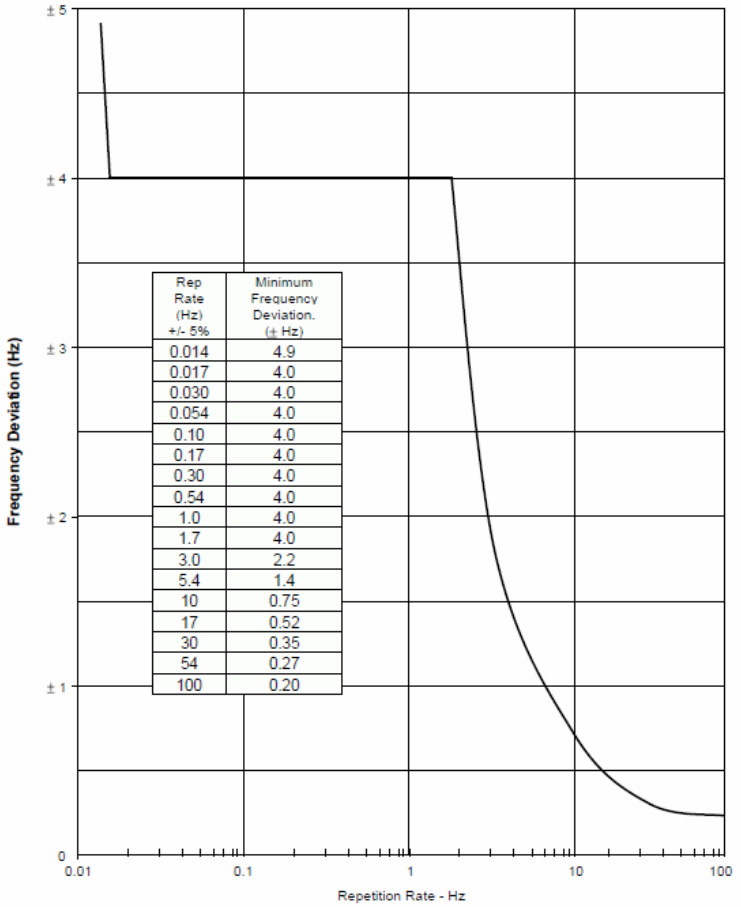


Modulation frequency component envelope- DO-160 Fig. 16-1

		Modulation Frequency (Hz)		
		A(CF)	**A(NF)**	**A(WF)**
	f1:	***400***	***360*** ***650***	***360*** ***800***
Step	V_{p-v}			
1	0.73 *1.46*	1	1	1
2	0.84 *1.46*	1.77	1.77	1.77
3	2.23 *4.2*	3.16	3.16	3.16
4	3.61 *6.6*	5.62	5.62	5.62
5	5.0 *10*	10	10	10
6	5.0 *10*	17.78	17.78	17.78
7	4.03 *8.2*	31.62	31.62	31.62
8	1.64 *3.5*	56.23	56.23	56.23
9	0.73 *1.46*	100	100	100
10	0.73 *1.46*	177.83	177.83	177.83
11	0.73 *1.46*	n.a.	(320)	(320)

- 4 modulation frequency steps per logarithmic decade according to the modulation envelope (e.g. 1Hz, 1.8Hz, 3.2Hz, 5.6Hz, 10Hz, 18Hz, 32Hz, 56Hz, 100Hz, 180Hz, 320Hz, 560Hz)
- Each frequency step to dwell for a minimum of 120s
- A(CF) modulation frequency steps from 1Hz … 200Hz
- A(NF) modulation frequency steps from 1Hz … 180Hz at 360Hz nominal frequency
- A(NF) modulation frequency steps from 1Hz … 325Hz at 650Hz nominal frequency
- A(WF) modulation frequency steps from 1Hz … 180Hz at 360Hz nominal frequency
- A(WF) modulation frequency steps from 1Hz … 400Hz at 800Hz nominal frequency

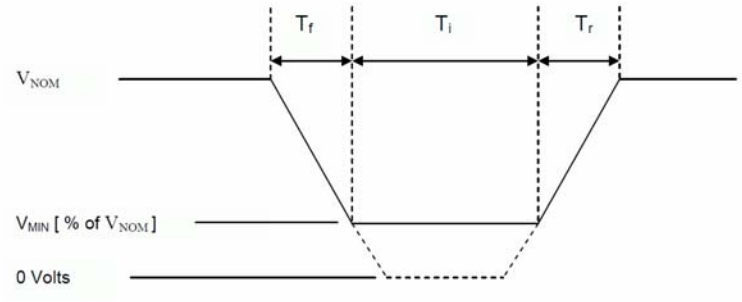
DO-160: 16.5.1.3. - FREQUENCY MODULATION AC



Rep Rate (Hz) +/- 5%	Minimum Frequency Deviation. (± Hz)
0.014	4.9
0.017	4.0
0.030	4.0
0.054	4.0
0.10	4.0
0.17	4.0
0.30	4.0
0.54	4.0
1.0	4.0
1.7	4.0
3.0	2.2
5.4	1.4
10	0.75
17	0.52
30	0.35
54	0.27
100	0.20

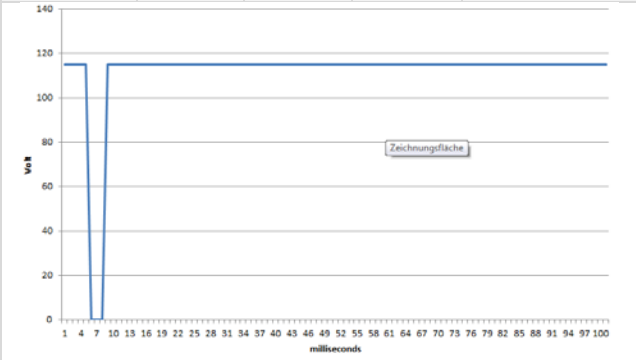
- Testing with nominal voltage 115V(*230V*)
- A(CF) Testing mean frequency 400Hz
- A(NF) testing mean frequency 360Hz and 650Hz
- A(WF) testing mean frequency 360Hz and 800Hz

DO-160: 16.5.1.4. – MOMENTARY POWER INTERRUPTIONS AC

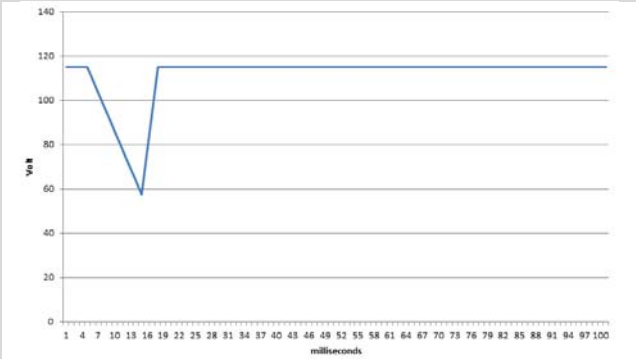
T_i: Power interrupt time T_f: Time to decay from V_{NOM} to V_{MIN} T_r: Time to rise from V_{MIN} to V_{NOM} V_{MIN}: The minimum level (as a percentage of V_{NOM}) to which the applied voltage is required to decay	

Testing frequencies: A(NF) and A(WF) equipment shall be tested with both frequencies.	A(CF) equipment:	400Hz, 115V_{rms}/ *230V_{rms}*
	A(NF) equipment:	360Hz, 115V_{rms} /*230V_{rms}*
	A(NF) equipment:	650Hz, 115V_{rms} /*230V_{rms}*
	A(WF) equipment:	360Hz, 115V_{rms} /*230V_{rms}*
	A(WF) equipment:	800Hz, 115V_{rms} /*230V_{rms}*

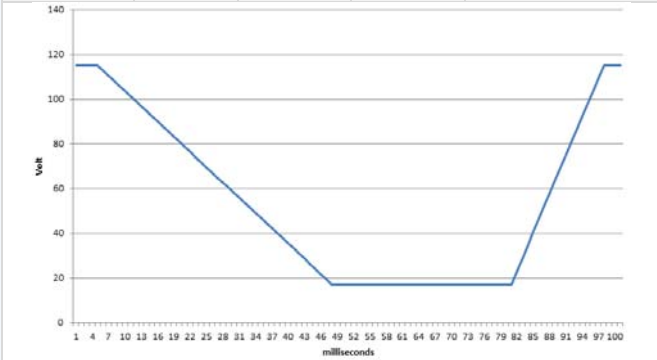
Test	*T_f(ms)*	*T_i(ms)*	*T_r(ms)*	*%V_{NOM} (V_{MIN})*
1	<1	2	<1	0



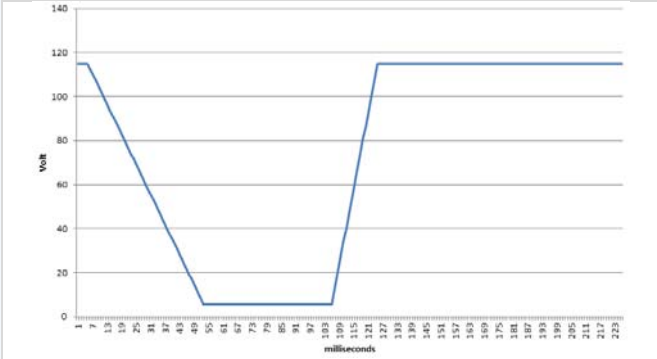
2	10	0	3	50



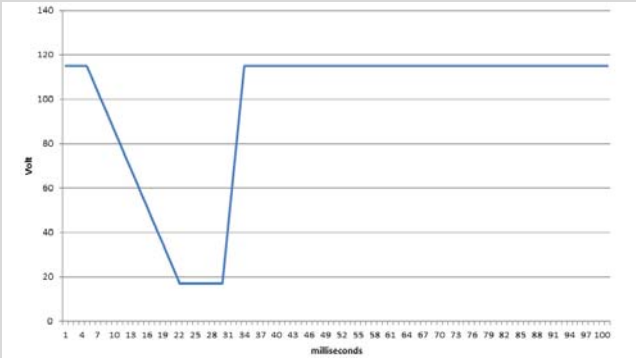
Test	*T_f(ms)*	*T_i(ms)*	*T_r(ms)*	*%V_{NOM} (V_{MIN})*
11	43	33	17	15



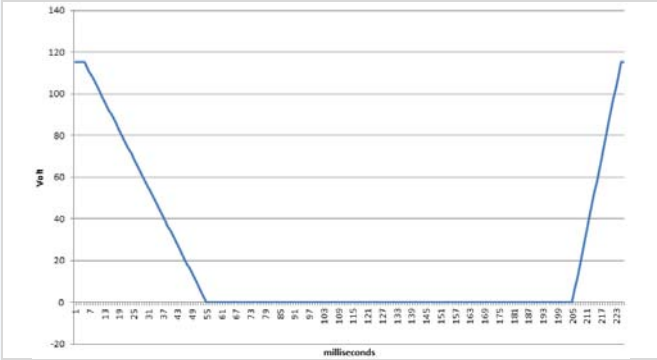
12	48	53	19	5



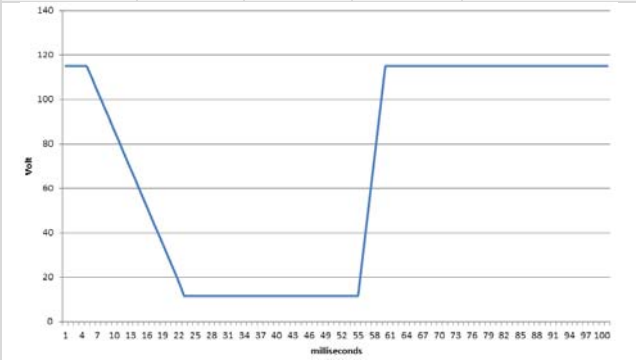
Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
3	17	8	4	15



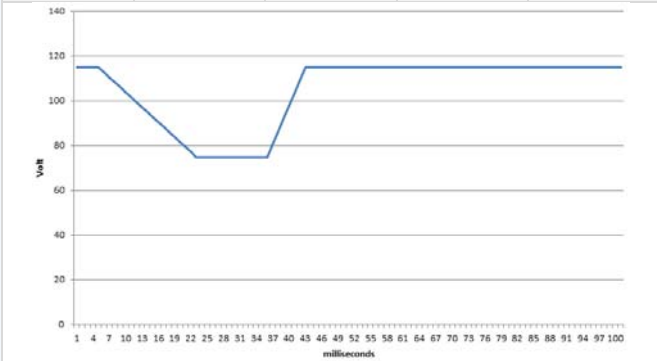
Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
13	50	150	20	0



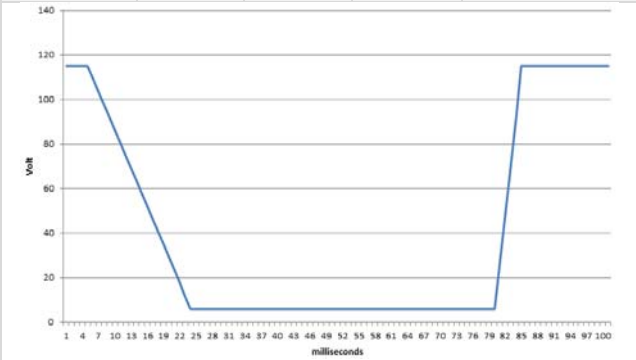
4	18	32	5	10



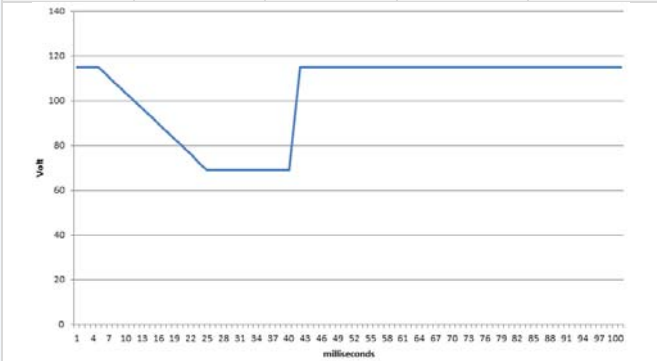
14	18	13	7	65



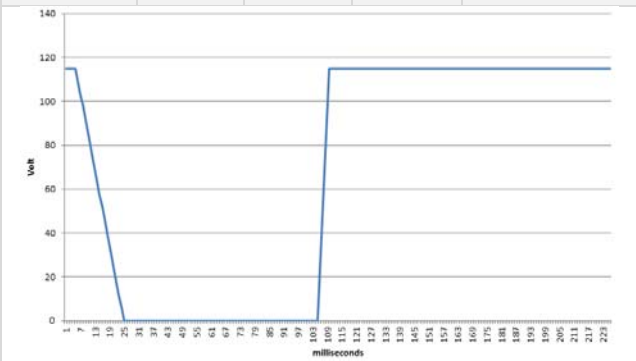
5	19	56	5	5



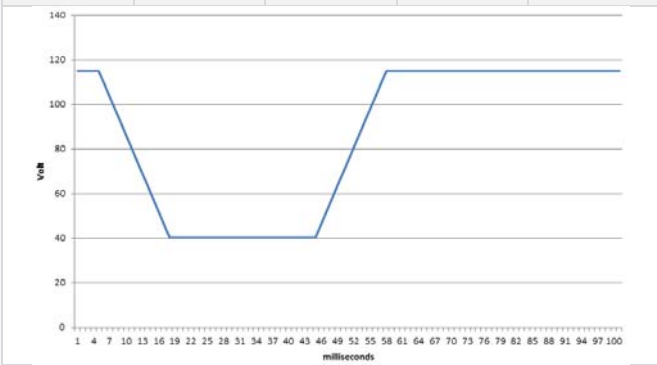
15	20	15	2	60



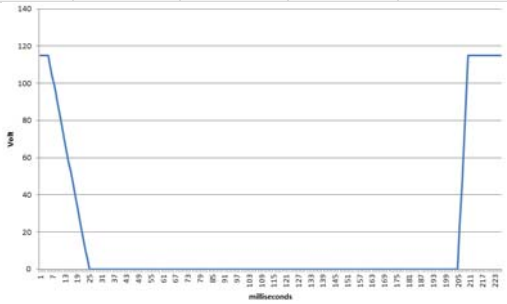
6	20	80	5	0



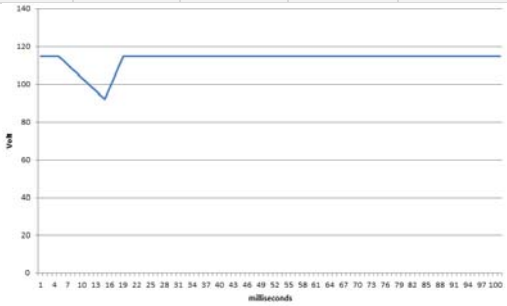
16	13	27	13	35



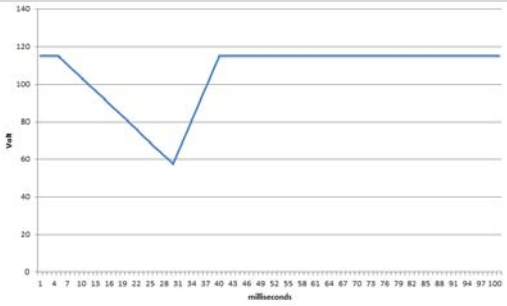
Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
7	20	180	5	0



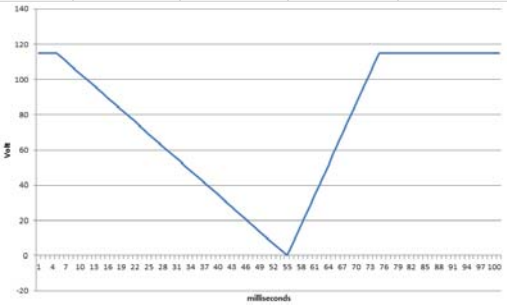
Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
8	10	0	4	80



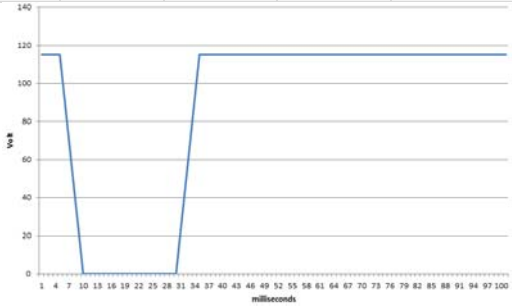
Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
9	25	0	10	50



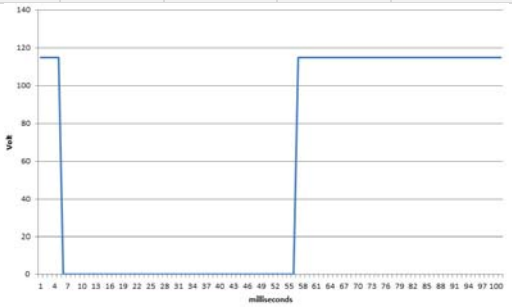
Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
10	50	0	20	0



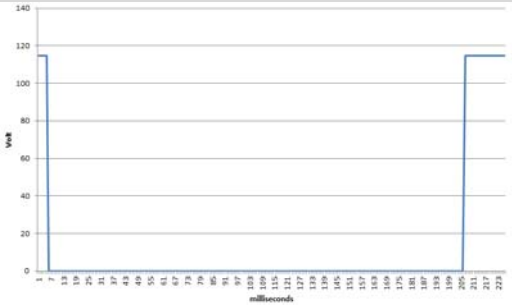
Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
17	5	20	5	0

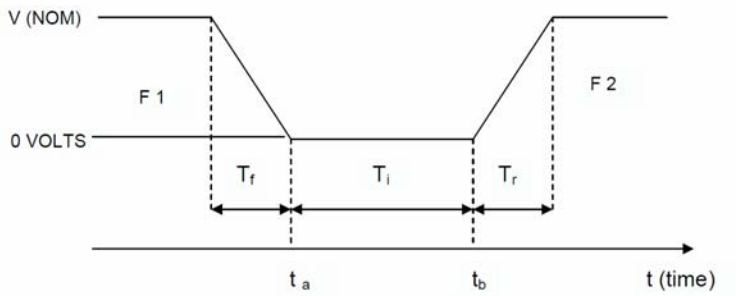


Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
18	<1	50	<1	0



Test	T_f(ms)	T_i(ms)	T_r(ms)	%V_{NOM} (V_{MIN})
19	<1	200	<1	0



ADDITIONAL TEST CONDITIONS FOR A(NF) AND A(WF) EQUIPMENT:	
T_i: time at 0V T_f: 20ms T_r: 5ms	

Test condition number	I	II	III	IV	V	VI
T_i (ms)	30	30	80	80	180	180
F1 (Hz)	360	F_{MAX}	360	F_{MAX}	360	F_{MAX}
F2 (Hz)	F_{MAX}	360	F_{MAX}	360	F_{MAX}	360

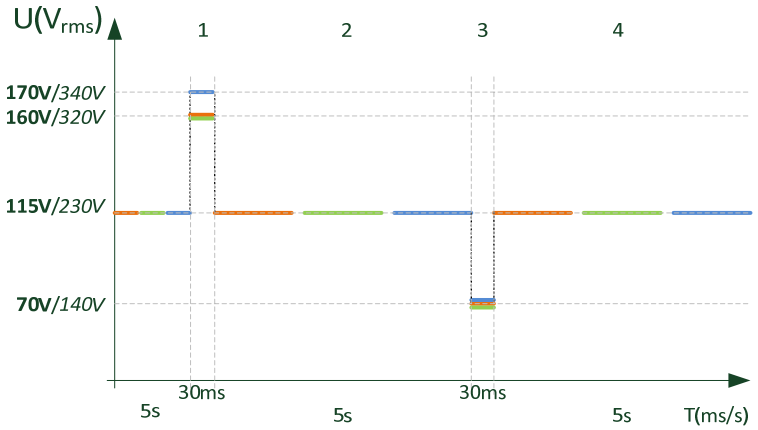
With F_{MAX} *= 650Hz for A(NF) category equipment*
F_{MAX} *= 800Hz for A(WF) category equipment*

DO-160: 16.5.1.5. – NORMAL TRANSIENTS AC

16.5.1.5.1. NORMAL SURGE VOLTAGE

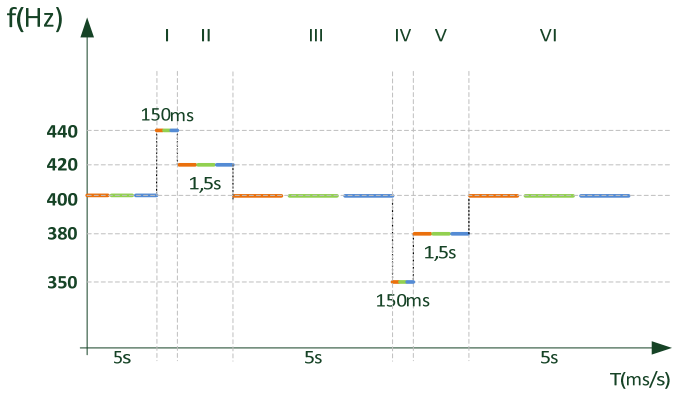
Re-Run the cycle described three times

A monitoring with a voltmeter is recommended



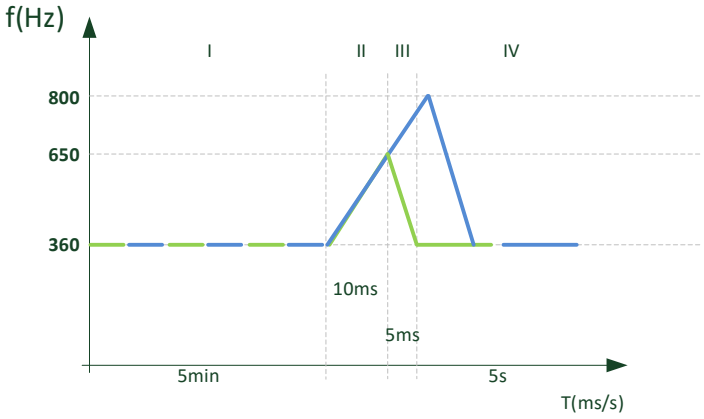
Testing frequencies:
A(CF): 400Hz, 115V_{rms} /*230V_{rms}*
A(NF): 360Hz, 115V_{rms} /*230V_{rms}*
A(NF): 650Hz, 115V_{rms} /*230V_{rms}*
A(WF): 360Hz, 115V_{rms} /*230V_{rms}*
A(WF): 800Hz, 115V_{rms} /*230V_{rms}*

Test	1	2	3	4
U_{test} A(CF) A(NF)	160V *320V*	115V *230V*	70V *140V*	115V *230V*
U_{test} A(WF)	170V *340V*	115V *230V*	70V *140V*	115V *230V*
Duration	30ms	5s	30ms	5s

16.5.1.5.2. NORMAL FREQUENCY TRANSIENTS ALL AC EQUIPMENT	
Before running the test operate the equipment with 115V_{rms} /*230*V_{rms} and 400Hz for five minutes Re-Run the cycle described three times Transition between frequencies shall occur in less than 1ms	

Test	I	II	III	IV	V	V
f_{test}	440Hz	420Hz	400Hz	350Hz	380Hz	400Hz
Duration	150ms	1.5s	5s	150ms	1.5s	5s

DO-160: 16.5.1.6. – NORMAL FREQUENCY VARIATIONS AC, A(NF) / A(WF) EQUIPMENT

Before running the test operate the equipment with 115V_{rms} /*230*V_{rms} and 400Hz for five minutes Re-Run the cycle described three times	

Test	I	II	III	IV
f_{test} A(NF)	360Hz	650Hz	360Hz	360Hz
f_{test} A(WF)	360Hz	800Hz	360Hz	360Hz
Duration	5min	2.9s 4.4s	1.45s 2.2s	5s

DO-160: 16.5.1.7. – VOLTAGE DC CONTENT AC

Test for single phase equipment	*Test*	I	II	III	IV
	U_{test}	$115V_{rms}$ *$230V_{rms}$*	$115V_{rms}$ *$230V_{rms}$*	$115V_{rms}$ *$230V_{rms}$*	$115V_{rms}$ *$230V_{rms}$*
	Duration	5min	30min	30min	5min
	DC offset	0	$-0.20V_{DC}$	$+0.20V_{DC}$	
Test for 3-phase equipment Each phase individual plus all phases Testing frequencies: **A(CF)**: 400Hz, $115V_{rms}$ /*$230V_{rms}$* **A(NF)**: 360Hz, $115V_{rms}$ /*$230V_{rms}$* **A(NF)**: 650Hz, $115V_{rms}$ /*$230V_{rms}$* **A(WF)**: 360Hz, $115V_{rms}$ /*$230V_{rms}$* **A(WF)**: 800Hz, $115V_{rms}$ /*$230V_{rms}$*	*Test*	I	II	III	IV
	U_{test} RST	$115V_{rms}$ *$230V_{rms}$*	$115V_{rms}$ *$230V_{rms}$*	$115V_{rms}$ *$230V_{rms}$*	$115V_{rms}$ *$230V_{rms}$*
	Duration	5min	30min	30min	5min
	DC offset R	0	$-0.20V_{DC}$	$+0.20V_{DC}$	then
	DC offset S	0	$-0.20V_{DC}$	$+0.20V_{DC}$	then
	DC offset T	0	$-0.20V_{DC}$	$+0.20V_{DC}$	then
	DC offset RST	0	$-0.20V_{DC}$	$+0.20V_{DC}$	

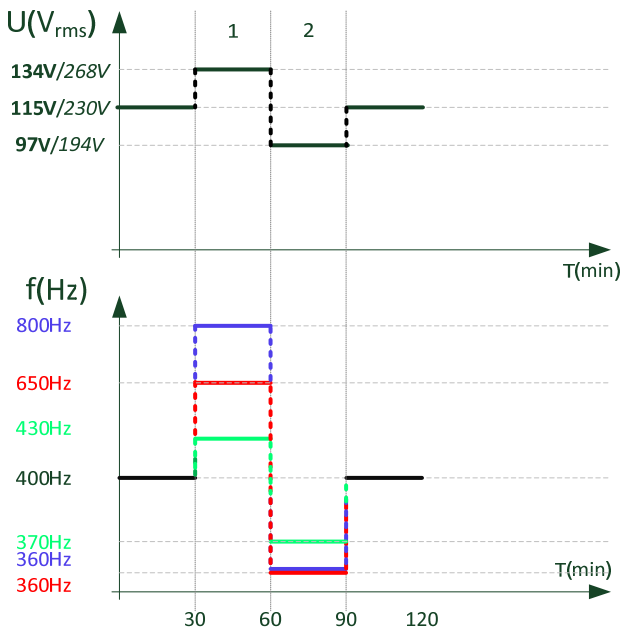
DO-160: 16.5.1.8. – VOLTAGE DISTORTION AC

Testing frequencies: **A(CF)**: 400Hz, $115V_{rms}$ /*$230V_{rms}$* **A(NF)**: 360Hz, $115V_{rms}$ /*$230V_{rms}$* **A(NF)**: 650Hz, $115V_{rms}$ /*$230V_{rms}$* **A(WF)**: 360Hz, $115V_{rms}$ /*$230V_{rms}$* **A(WF)**: 800Hz, $115V_{rms}$ /*$230V_{rms}$*		
	THD **A(CF) A(NF)**	*Max. 8%*
	THD **A(WF)**	*Max. 10%*

DO-160: 16.5.2 – ABNORMAL OPERATING CONDITIONS

DO-160: 16.5.2.1. - VOLTAGE AND FREQUENCY – STEADY STATE PERFORMANCE

Single phase equipment tests **A(CF), A(NF) and A(WF)**



Testing time 30min for each test

Abnormal conditions:

Test	Voltage (V_{rms})	Frequency (Hz)		
		A(CF)	A(NF)	A(WF)
1	**134** / *268*	430	360 650	360 800
2	**97** / *194*	370	360 650	360 800

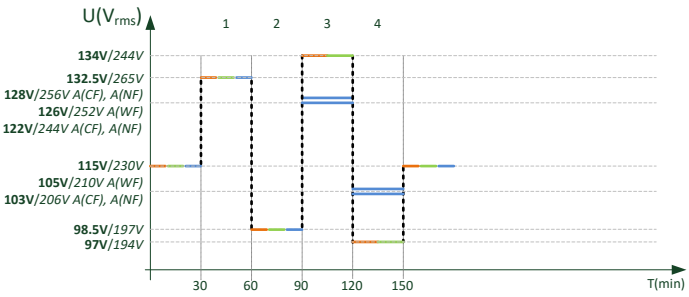
Additional requirements A(CF) only:

Test	Voltage (V_{rms})	Frequency (Hz)
		A(CF)
1	**122** / *244*	430
2	**100** / *200*	430
3	**122** / *244*	370
4	**100** / *200*	370

3-phase equipment under abnormal conditions:

Test	Phase A/B/C Voltage (V_{rms})		
	Phase A	Phase B	Phase C
1	**132.5** *265*	**132.5** *265*	**132.5** *265*
2	**98.5** *197*	**98.5** *197*	**98.5** *197*
3: A(CF), A(NF)	**134** *268*	**134** *268*	**128** *256*
3: A(WF)	**134** *268*	**134** *268*	**126** *252*
4: A(CF), A(NF)	**97** *194*	**97** *194*	**103** *206*
4: A(WF)	**97** *194*	**97** *194*	**105** *210*

115V nominal voltage / *230V nominal voltage*



Testing time 30min for each test

Testing frequencies:

A(CF): 400Hz, 115V_{rms} /*230V_{rms}*

A(NF): 360Hz, 115V_{rms} /*230V_{rms}* and 650Hz, 115V_{rms} /*230V_{rms}*

A(WF): 360Hz, 115V_{rms} /*230V_{rms}* and 360Hz, 115V_{rms} /*230V_{rms}*

Additional requirements A(CF) only:

Test	Phase A/B/C Voltage (V_{rms})			
	Phase A	Phase B	Phase C	f(Hz)
1	**120.5** *241*	**120.5** *241*	**120.5** *241*	430
2	**101.5** *203*	**101.5** *203*	**101.5** *203*	430
3	**120.5** *241*	**120.5** *241*	**120.5** *241*	370
4	**101.5** *203*	**101.5** *203*	**101.5** *203*	370

Test	Phase A/B/C Voltage (V_{rms})			
	Phase A	Phase B	Phase C	f(Hz)
5	**122** *244*	**122** *244*	**114** *228*	430
6	**100** *200*	**100** *200*	**108** *216*	430
7	**122** *244*	**122** *244*	**114** *228*	370
8	**100** *200*	**100** *200*	**108** *216*	370

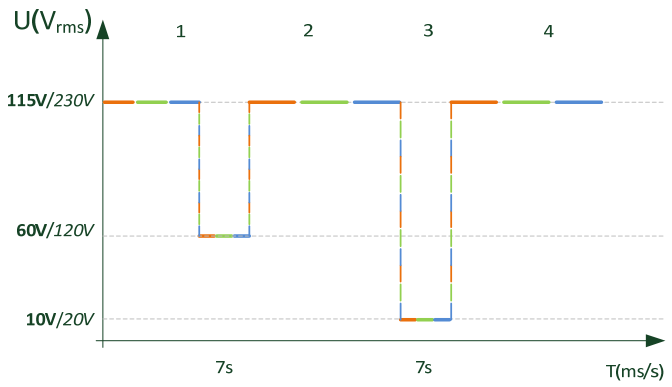
115V nominal voltage / *230V nominal voltage*

DO-160: 16.5.2.2. – MOMENTARY UNDERVOLTAGE OPERATION AC

Testing frequencies:

A(CF): 400Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(NF): 360Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(NF): 650Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(WF): 360Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(WF): 800Hz, **115V$_{rms}$** /*230V$_{rms}$*

Test	1	2
U_{test} **Phase 1** **Phase 2** **Phase 3**	**60V** *120V*	**10V** *20V*
Duration	7s	7s



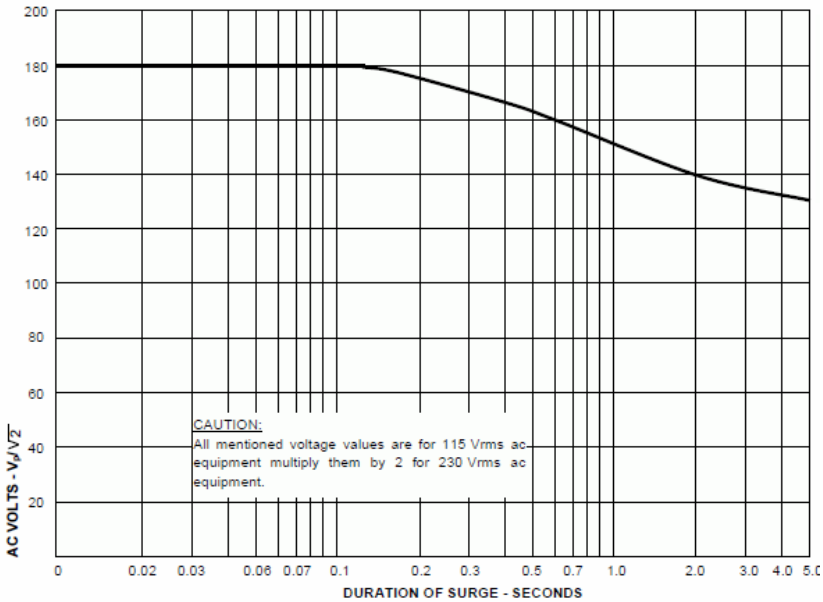
115V nominal voltage / *230V nominal voltage*

DO-160: 16.5.2.3. – ABNORMAL TRANSIENTS AC

16.5.2.3.1. ABNORMAL SURGE VOLTAGE

SURGE LIMIT	
Sec.	$Vp/\sqrt{2}$
5.0	134
3.0	135
1.0	148
0.4	168
0.2	178
0.1	180
0.01	180

Monitoring with a voltmeter is recommended



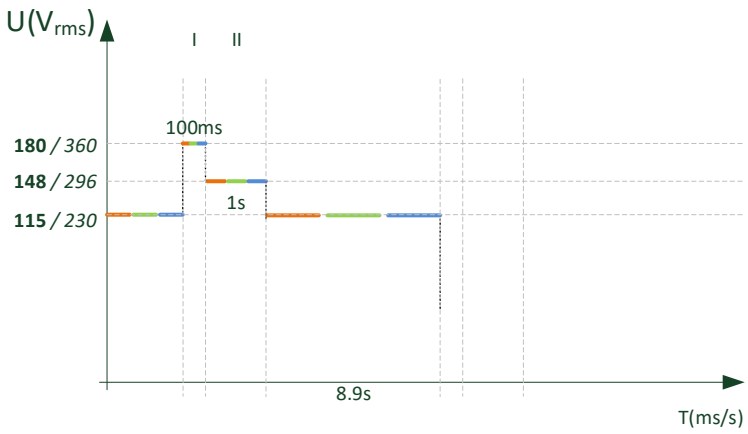
Re-Run the cycle described three times

Testing frequencies:

A(CF): 400Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(NF): 360Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(NF): 650Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(WF): 360Hz, **115V$_{rms}$** /*230V$_{rms}$*
A(WF): 800Hz, **115V$_{rms}$** /*230V$_{rms}$*

Single surge cycle:
180V$_{rms}$ for 100ms, then
148V$_{rms}$ for 1s, then
Interval pause 8.9s

3-phase test patterns:
Repeat for each phase the single surge three times with a 10s interval between two phases.
Finally run a test with surges on all phases at the same time



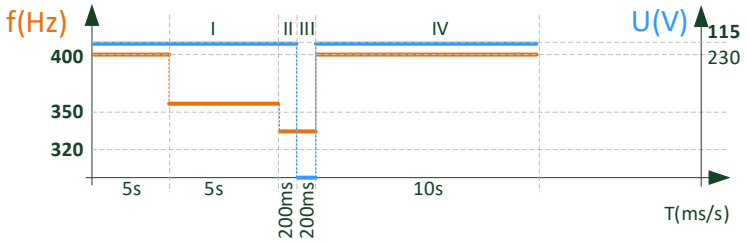
Test	PHASE A/B/C Surge Patterns		
	Phase A	Phase B	Phase C
1	**Surge**	No Surge	No Surge
2	No Surge	**Surge**	No Surge
3	No Surge	No Surge	**Surge**
4	**Surge**	**Surge**	**Surge**

16.5.2.3.2. ABNORMAL FREQUENCY TRANSIENTS ALL AC EQUIPMENT

Before running the test operate the equipment with **115V$_{rms}$** /*230V$_{rms}$* and 400Hz for five minutes. Re-Run the cycles described 3 times, transition between frequencies shall occur in less than 1ms

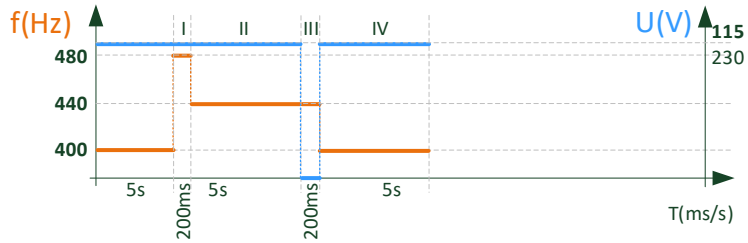
Test 1: All AC equipment

	I	II	III	IV
U_{test} (V_{rms})	115 / *230*	115 / *230*	0 / *0*	115 / *230*
f_{test}	350Hz	320Hz	320Hz	400Hz
Duration	5s	200ms	200ms	10s



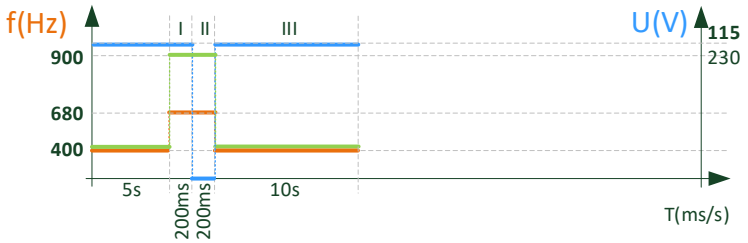
Test 2: All AC equipment

	I	II	III	IV
U_{test} (V_{rms})	115 / *230*	115 / *230*	0 / *0*	115 / *230*
f_{test}	480Hz	440Hz	440Hz	400Hz
Duration	200ms	5s	200ms	10s



Test 3: A(NF) and A(WF) AC equipment only

		I	II	III
U_{test} (V_{rms})		115 / *230*	0 / *0*	115 / *230*
f_{test}	*A(NF)*	680Hz	680Hz	400Hz
	A(WF)	900Hz	900Hz	
Duration		200ms	200ms	10s

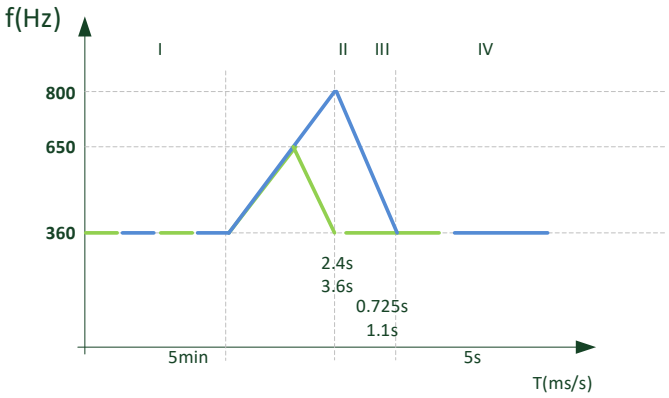


16.5.2.3.3 – ABNORMAL FREQUENCY VARIATIONS AC, A(NF) / A(WF) EQUIPMENT

Before running the test operate the equipment with **115V$_{rms}$** /*230V$_{rms}$* and 400Hz for five minutes

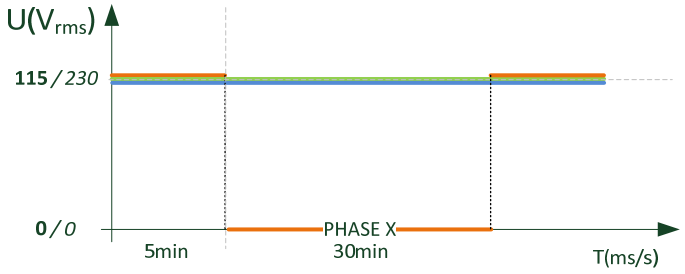
Test	I	II	III	IV
f_{test} A(NF)	360Hz	650Hz	360Hz	360Hz
f_{test} A(WF)	360Hz	800Hz	360Hz	360Hz
Duration	5min	2.4s 3.6s	0.725s 1.1s	5s

Re-Run the cycle described three times

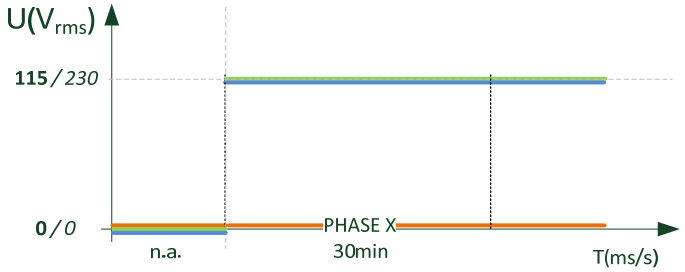


DO-160: 16.5.2.4. – LOSS OF PHASE INPUT (THREE PHASE AC ONLY)

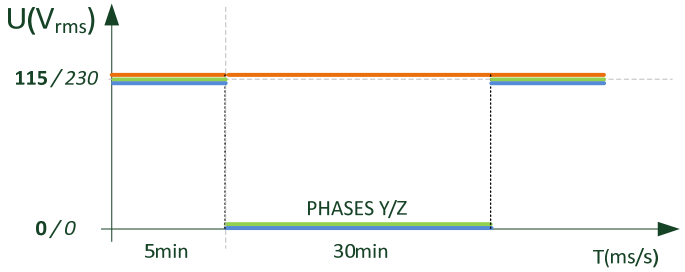
Test A	Phase (V_{rms})		
	X	Y	Z
5min	115 230	115 230	115 230
	then		
30min	0 0	115 230	115 230
	then back to		
	115 230	115 230	115 230



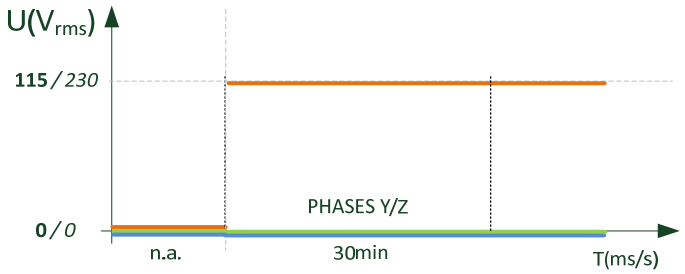
Test B	Phase (V_{rms})		
	X	Y	Z
n.a.	0 0	0 0	0 0
	then		
30min	0 0	115 230	115 230



Test C	Phase (V_{rms})		
	X	Y	Z
5min	115 230	115 230	115 230
	then		
30min	115 230	0 0	0 0
	then back to		
	115 230	115 230	115 230



Test D	Phase (V_{rms})		
	X	Y	Z
n.a.	0 0	0 0	0 0
	then		
30min	115 230	0 0	0 0



PART 2: DC supply tests: DO-160: 16.6.

DO-160: 16.6.1 – NORMAL OPERATING CONDITIONS DC

DO-160: 16.6.1.1. – VOLTAGE (Average value) DC

Nominal voltages:

Equipment category	Nominal voltage
A	$28V_{DC}$
B	$28V_{DC}$ or $14V_{DC}$
Z	$28V_{DC}$
D	$270V_{DC}$

Definition of limit voltages:

Voltage at equipment terminals	$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
Maximum	30.3	285	15.15
Minimum	22.0	235	11.0
Emergency operation	18.0	235	9.0

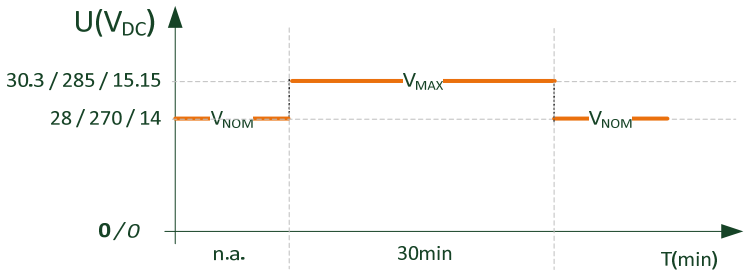
Test requirement 1:

The test may be run with abnormal levels to satisfy both normal and abnormal conditions.

Overvoltage to $\mathbf{V_{MAX}}$

Cat. A, B, Z	Cat. D	Cat. B
$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
$30.3V_{DC}$	**$285V_{DC}$**	**$15.15V_{DC}$**

for 30min



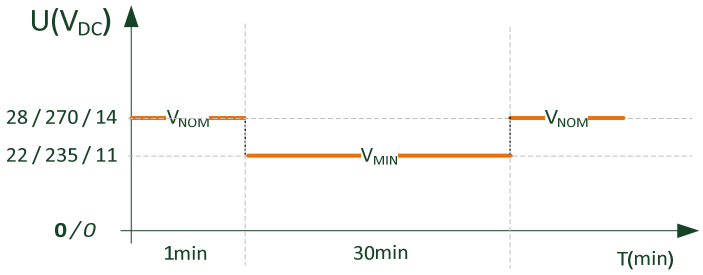
Test requirement 2:

The test can be run with abnormal levels to satisfy both normal and abnormal conditions.
For Cat. A, B and Z equipment the test may be run with emergency levels to satisfy normal, abnormal and emergency conditions.

Undervoltage to $\mathbf{V_{MIN}}$

Cat. A, B, Z	Cat. D	Cat. B
$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
$22.0V_{DC}$	**$235V_{DC}$**	**$11.0V_{DC}$**

for 30min

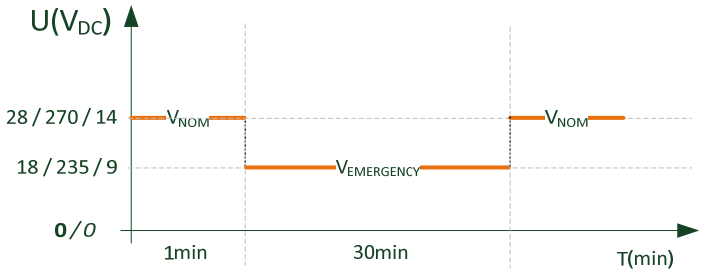


Test requirement 3:
Emergency condition

Undervoltage to **$V_{EMERGENCY}$**

Cat. A, B, Z	Cat. D	Cat. B
$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
$18.0V_{DC}$	**$235V_{DC}$**	**$9.0V_{DC}$**

for 30min

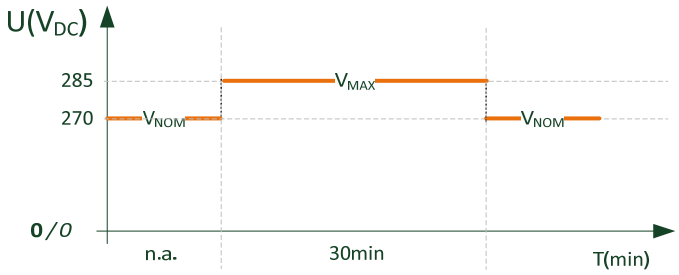


Test requirement 4:
Cat. D equipment only with positive lead connected to earth ground

Overvoltage to **V_{MAX}**

$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
$30.3V_{DC}$	**$285V_{DC}$**	**$15.15V_{DC}$**

for 30min

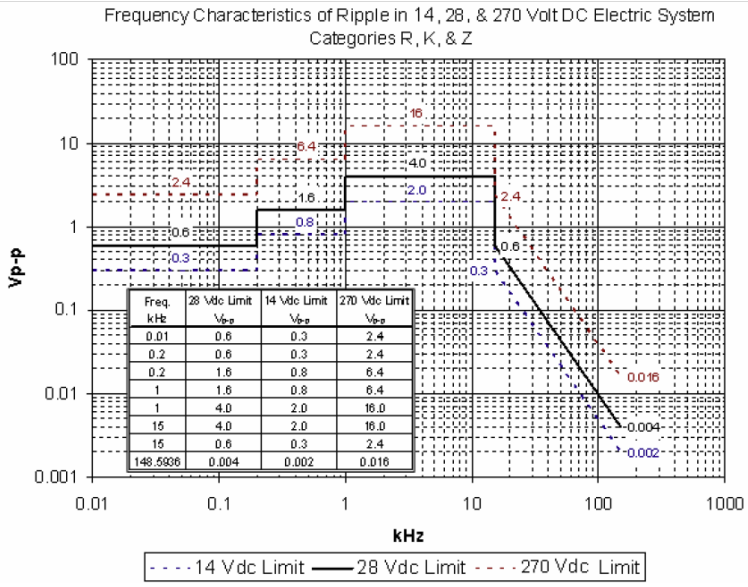


DO-160: 16.6.1.2. – RIPPLE VOLTAGE DC

Refer to Ripple definition in DO-160G chapter 18:

Audio Frequency Conducted Susceptibility

Figure 18-3

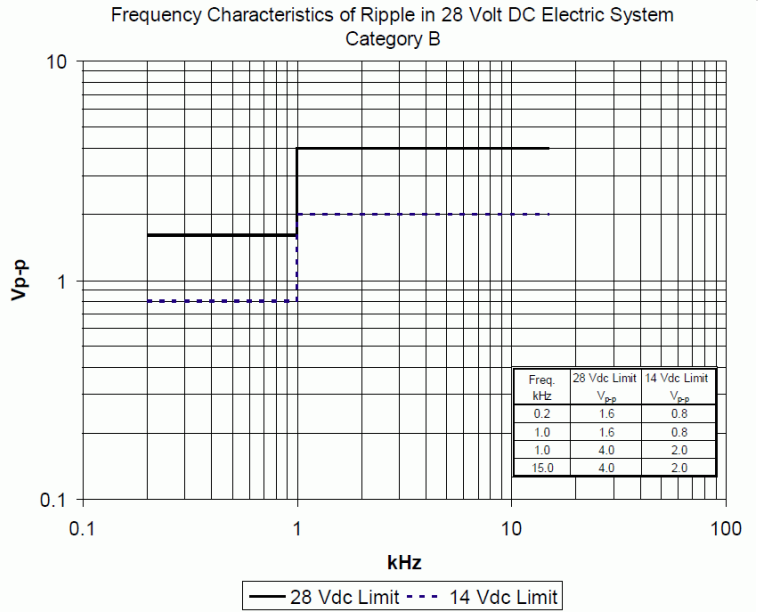


Freq. kHz	28 Vdc Limit Vp-p	14 Vdc Limit Vp-p	270 Vdc Limit Vp-p
0.01	0.6	0.3	2.4
0.2	0.6	0.3	2.4
0.2	1.6	0.8	6.4
1	1.6	0.8	6.4
1	4.0	2.0	16.0
15	4.0	2.0	16.0
15	0.6	0.3	2.4
148.5936	0.004	0.002	0.016

Refer to Ripple definition in DO-160G chapter 18:

Audio Frequency Conducted Susceptibility

Figure 18-4



Ripple is the cyclic variation about the mean level of the DC voltage during steady state DC electrical system operation.

- In $28V_{DC}$ network, the cyclic peak-to-peak DC ripple voltage will be less than $4V_{pp}$ if voltage at equipment terminals is above or equal to 22 V; if not, ripple voltage will be less than $2V_{pp}$
- In $270V_{DC}$ network, the cyclic peak-to-peak DC ripple voltage will be less than $16V_{pp}$

Test requirements for discrete frequencies:

For test equipment generating discrete ripple frequencies a minimum of 30 frequency sweep steps per decade are necessary. At each frequency step a dwell time of at least one minute is required, in summary 30 min testing time per decade. The ripple signal shall be sinusoidal and audio frequency range (e.g. 10Hz up to 30kHz)

Example: Ripple frequency sweep from 10Hz to 100Hz with 30 discrete steps

Sweep step Nr.	Ripple Frequency (Hz)	Sweep step Nr.	Ripple Frequency (Hz)	Sweep step Nr.	Ripple Frequency (Hz)
1	10.80	11	23.26	21	50.12
2	11.66	12	25.12	22	54.12
3	12.59	13	27.12	23	58.43
4	13.59	14	29.29	24	63.10
5	14.68	15	31.62	25	68.13
6	15.85	16	34.15	26	73.56
7	17.11	17	36.87	27	79.43
8	18.48	18	39.81	28	85.77
9	19.95	19	42.99	29	92.61
10	21.54	20	46.42	30	100.00

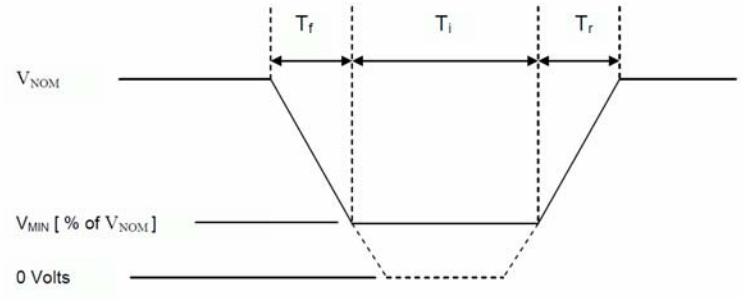
Test requirements for a continuous frequency spectrum:

For test equipment generating a continuous linear ripple frequency sweep a summary of 60 min testing time per decade shall be performed. The sweep rate is 60min/decade. The ripple signal shall be sinusoidal and audio frequency range (e.g. 10Hz up to 30kHz)

DO-160: 16.6.1.3. – MOMENTARY POWER INTERRUPTIONS DC

REQUIREMENTS FOR EQUIPMENT WITH DIGITAL CIRCUITS

T_f: Time to decay from V_{NOM} to V_{MIN}
T_i: Power interrupt time
T_r: Time to rise from V_{MIN} to V_{NOM}
V_{MIN} : The minimum level (as a percentage of V_{NOM}) to which the applied voltage is required to decay



Apply each of the listed test conditions at least twice

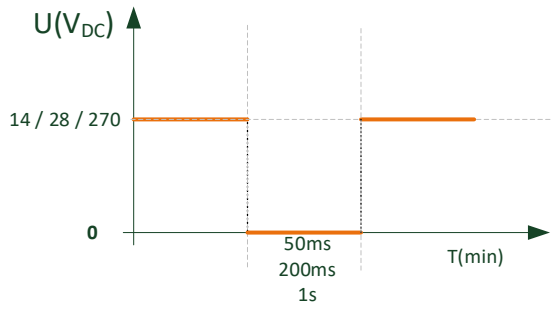
Applicable Category	A, B, D, Z				A, D, Z			D, Z	A, B, D, Z	
Test Condition	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
T_f (ms)	<1	10	17	18	19	20	20	20	10	25
T_i (ms)	<1	0	8	32	56	80	180	980	0	0
T_r (ms)	2	3	4	5	5	5	5	5	4	10
$\%V_{NOM}$ (V_{MIN})	0% ≙	50% ≙	15% ≙	10% ≙	5% ≙	0% ≙	0% ≙	0% ≙	80% ≙	50% ≙
at $28V_{DC}$	*0*	*14*	*4.2*	*2.8*	*1.4*	*0*	*0*	*0*	*22.4*	*14*
at $270V_{DC}$	*0*	*135*	*40.5*	*27*	*13.5*	*0*	*0*	*0*	*216*	*135*
at $14V_{DC}$	*0*	*7*	*2.1*	*1.4*	*0.7*	*0*	*0*	*0*	*11.2*	*7*

Applicable Category	A, D, Z				D, Z	A, B, D, Z			
Test Condition	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
T_f (ms)	50	43	48	50	50	18	20	13	5
T_i (ms)	0	33	53	150	950	13	15	27	20
T_r (ms)	20	17	19	20	20	7	2	13	5
$\%V_{NOM}$ (V_{MIN})	0% ≙	15% ≙	5% ≙	0% ≙	0% ≙	65% ≙	60% ≙	35% ≙	0% ≙
at $28V_{DC}$	*0*	*4.2*	*1.4*	*0*	*0*	*18.2*	*16.8*	*9.8*	*0*
at $270V_{DC}$	*0*	*40.5*	*13.5*	*0*	*0*	*175.5*	*162*	*94.5*	*0*
at $14V_{DC}$	*0*	*2.1*	*0.7*	*0*	*0*	*9.1*	*8.4*	*4.9*	*0*

REQUIREMENTS FOR ALL DC EQUIPMENT

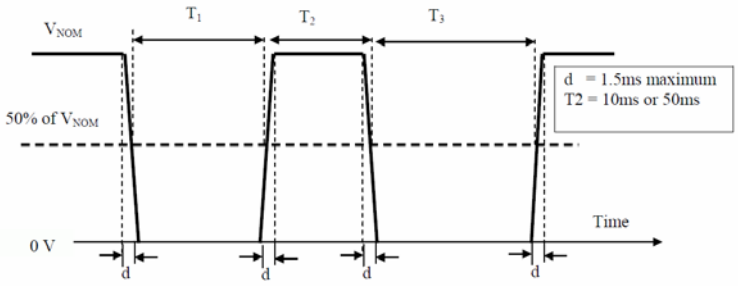
Starting from nominal voltage interrupt the power for a duration T and repeat the cycle 5 times:

Test	Duration T	Cycles	Category
1	50ms	5	All
2	200ms	5	A, D
3	1s	5	Z



REQUIREMENTS FOR EQUIPMENT WITH DIGITAL AND MEMORY CIRCUITS

- V_{NOM} Nominal voltage
- T1 Duration of 1st interrupt (measured when voltage equals 50 % of V_{NOM})
- T3 Duration of 2nd interrupt (measured when voltage equals 50 % of V_{NOM})
- Tolerance to T1, T2, T3 = ± 10% except for test conditions 1 and 2 where 9000 ms is a minimum
- rise and fall time "d" (measured between the 10% and 90% points of the waveform)



Apply each of the listed test conditions at least twice

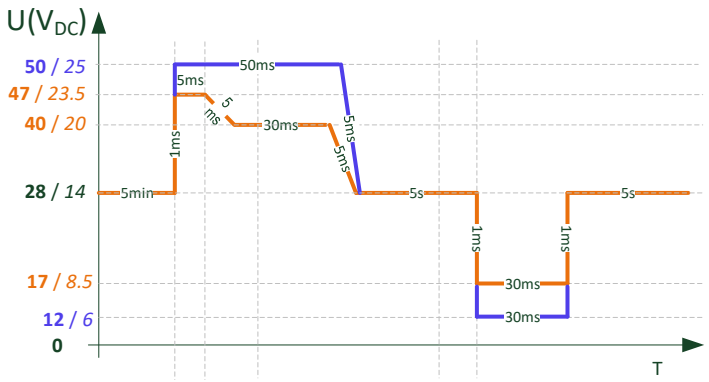
Applicable Category	A, B, D, Z				A, D, Z	A, B, D, Z	A, D, Z			A, B, D, Z
Test Condition	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
T_1 (ms)	9000	9000	10	10	10	20	20	20	20	50
T_3 (ms)	20	50	10	50	100	10	50	100	170	10

Applicable Category	A, B, D, Z	A, D, Z					
Test Condition	**11**	**12**	**13**	**14**	**15**	**16**	**17**
T_1 (ms)	50	50	50	100	100	150	150
T_3 (ms)	50	100	140	50	90	10	40

DO-160: 16.6.1.4. – NORMAL SURGE VOLTAGE DC

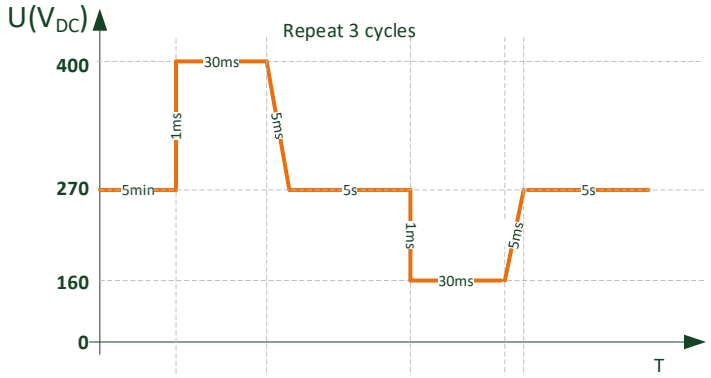
Requirements for Category A, B and Category Z equipment only:
U_{NOM} **28V$_{DC}$** and *14V$_{DC}$*

Repeat the cycle at least three times



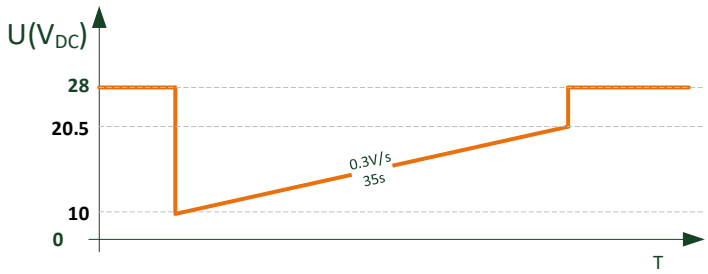
Requirements for Category D equipment only:
U_{NOM} 270V$_{DC}$

Repeat the cycle at least three times



DO-160: 16.6.1.5. – ENGINE STARTING UNDERVOLTAGE OPERATION DC

Requirements for Category B 28V$_{DC}$ and Category Z equipment only:
U_{NOM} 28V$_{DC}$



DO-160: 16.6.2 – ABNORMAL OPERATING CONDITIONS DC

DO-160: 16.6.2.1. –VOLTAGE STEADY STATE DC

Nominal voltages:

Equipment category	Nominal voltage
A	$28V_{DC}$
B	$28V_{DC}$ or $14V_{DC}$
Z	$28V_{DC}$
D	$270V_{DC}$

Definition of abnormal limit voltages:

Voltage at equipment terminals	$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
Maximum	32.2	320	16.1
Minimum	20.5	220	10.25

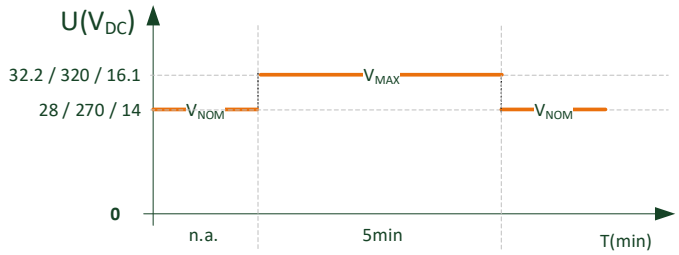
Test requirement 1:

The test may be run with abnormal levels to satisfy both normal and abnormal conditions.

Overvoltage to $\mathbf{V_{MAX}}$

Cat. A, B, Z	Cat. D	Cat. B
$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
$32.2V_{DC}$	**$320V_{DC}$**	**$16.1V_{DC}$**

for 5min



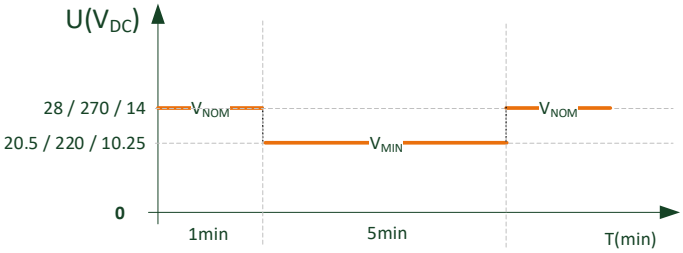
Test requirement 2:

The test can be run with abnormal levels to satisfy both normal and abnormal conditions.
For Cat. A, B and Z equipment the test may be run with emergency levels to satisfy normal, abnormal and emergency conditions.

Undervoltage to $\mathbf{V_{MIN}}$

Cat. A, B, Z	Cat. D	Cat. B
$28V_{DC}$	$270V_{DC}$	$14V_{DC}$
$20.5V_{DC}$	**$220V_{DC}$**	**$10.25V_{DC}$**

for 5min

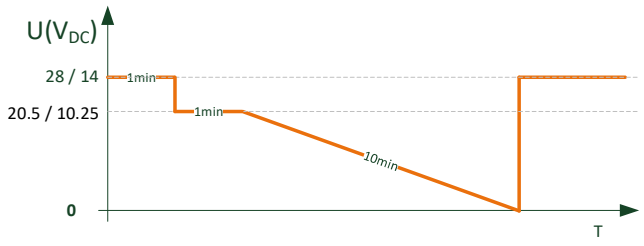


DO-160: 16.6.2.2. – LOW VOLTAGE CONDITIONS DC (Cat. B equipment only)

Undervoltage to $\mathbf{V_{MIN}}$

Cat. B	Cat. B
$28V_{DC}$	$14V_{DC}$
$20.5V_{DC}$	**$10.25V_{DC}$**

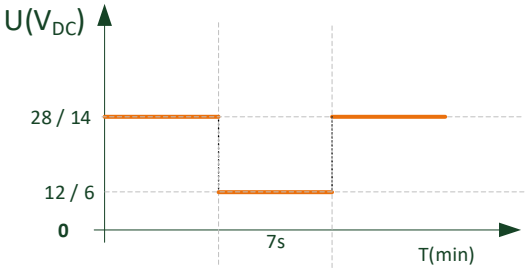
for 5min



DO-160: 16.6.2.3. –MOMENTARY UNDERVOLTAGE OPERATION DC

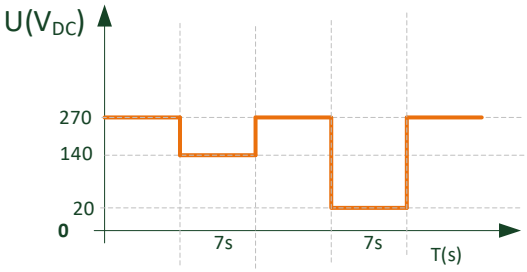
REQUIREMENTS FOR CATEGORY A, B AND Z DC EQUIPMENT ONLY

Starting from nominal voltage decrease the voltage for a duration of 7s minimum

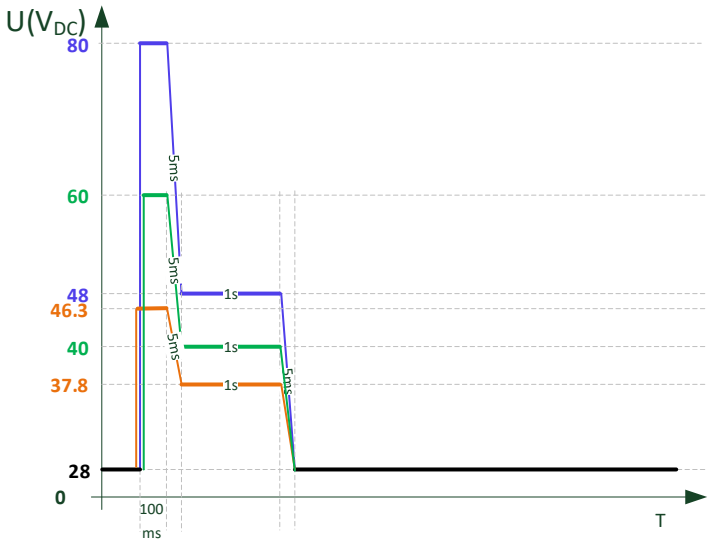


REQUIREMENTS FOR CATEGORY D DC EQUIPMENT ONLY

Starting from nominal voltage decrease the voltage for a duration of 7s minimum



DO-160: 16.6.2.4. –ABNORMAL SURGE VOLTAGE DC

• Requirements for Category Z equipment only: U_{NOM} $28V_{DC}$ • Requirements for Category A equipment only: U_{NOM} $28V_{DC}$ • Requirements for Category B equipment only: U_{NOM} $28V_{DC}$ Repeat the cycle at least three times	
• Requirements for Category D equipment only: U_{NOM} $270V_{DC}$ Repeat the cycle at least three times