

**If You don't comply, It Will Interfere  
With Your Sales!**

***EMC and RFI***

***PSMA Safety and Compliance***

***Restrictive Materials***

***APEC 2020***

***New Orleans, LA***

***19 March 2020***



# Product Testing

- Gather the standards that are to be applied to your product
- Read the standards and obtain an understanding of what the standard tests mean
  - FCC and IEC standards
  - SAE (Automotive)
  - IES (Illuminating Engineering Society)
- Test house
  - UL, Intertek, CSA, etc.
- Obtain equipment to perform the test
  - Purchase.
  - Rent, Lease
- Pre-compliance testing in house
  - 2019 EMC TESTING GUIDE ([www.interferencetechnology.com](http://www.interferencetechnology.com))
  - Ken Wyatt-(Developing in-house EMC troubleshooting and pre-compliance test lab)

# Purpose of the presentation

- Present the subject of EMC and RFI for what to consider
- Safety and materials standards too
- Provide a review of know regulations and what these regulation may require
- Provide a simple list of standards

# Subjects

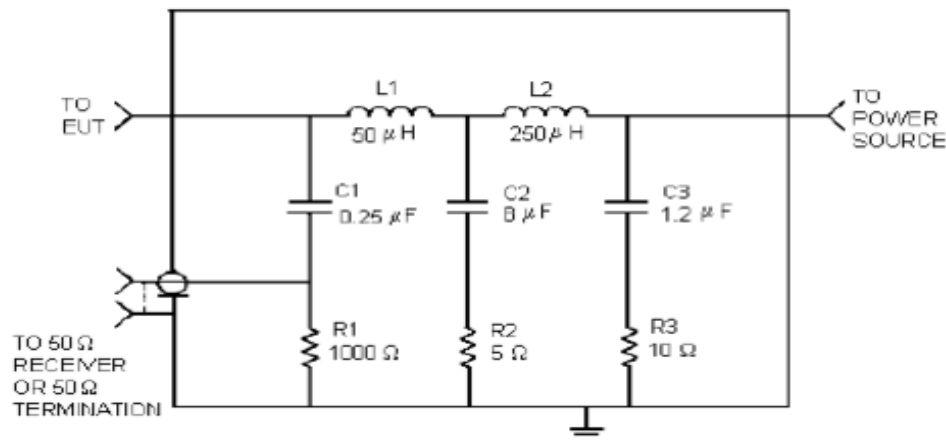
- Radiated Emissions
  - Line conducted
    - FCC Part15
    - IEC CISPR 22
  - Radiated
    - FCC Part 15
    - IEC CISPR 22
    - ISM Bands and ISM Band Limits
  - PFC (considered radiation)
  - Flicker (considered radiation)
- Immunity (SUSCEPTIBILITY)
  - Line Transients
  - RF
  - ESD, Static discharge
  - AC Line Drop Out (Capacitor Hold Up time)
- Restrictive Material
  - RoHS
  - California Proposition 65
  - China

# Safety

- Industrial
- 62368
- 60950
- UL508
- Medical
- 60601 3<sup>rd</sup> edition safety
- (4<sup>th</sup> edition EMC)

# ANSI C63.4-2014 LISN

ANSI C63.4-2014  
American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

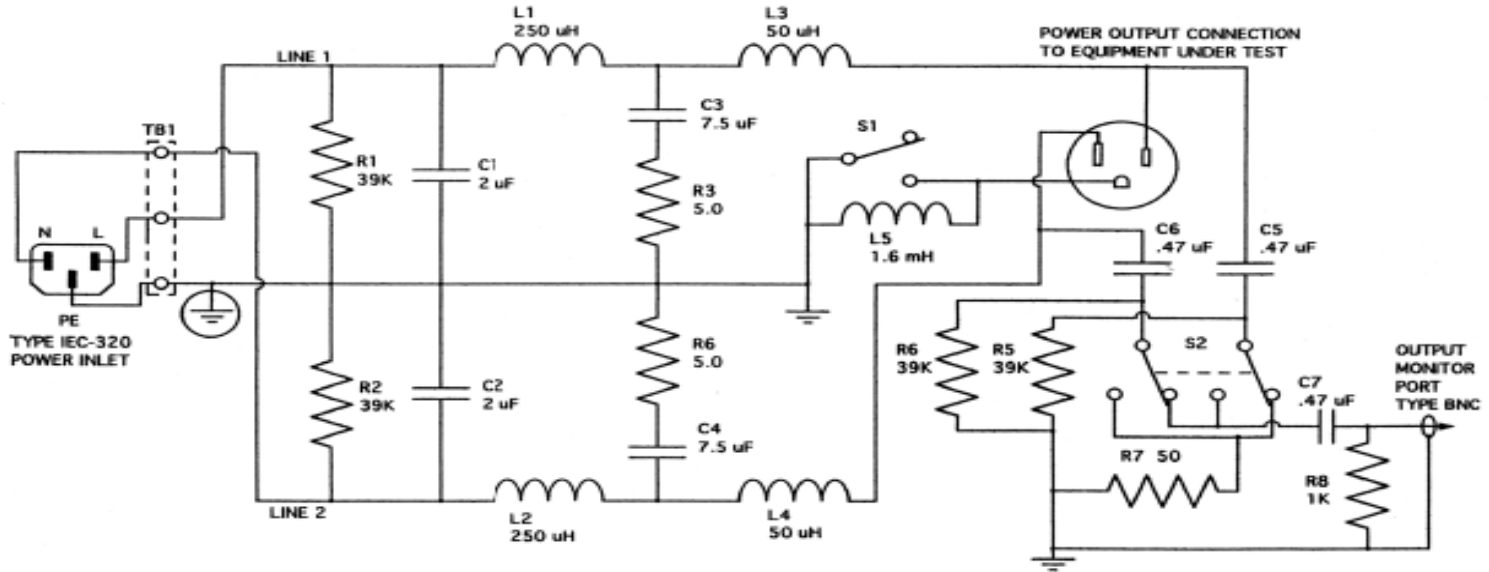


\*IF CAREFULLY CONSTRUCTED, THIS NETWORK CAN BE USED ABOVE 150 kHz TO AS HIGH AS 30 MHz

How2Power – Newsletter – Oct 2017

Understanding LISNs Is Essential To EMI Pre-Compliance Testing

# Model 3810-2 LISN



C3 and C4 can have different values depending upon the manufacturer

Dual 50 uH LISN

# ISM Bands FCC Part18

## Subpart C—Technical Standards

### § 18.301 Operating frequencies.

ISM equipment may be operated on any frequency above 9 kHz except as indicated in §18.303. The following frequency bands, in accordance with §2.106 of the rules, are allocated for use by ISM equipment:

ISM frequency	Tolerance
6.78 MHz .....	±15.0 kHz
13.56 MHz .....	±7.0 kHz
27.12 MHz .....	±163.0 kHz
40.68 MHz .....	±20.0 kHz
915 MHz .....	±13.0 MHz
2,450 MHz .....	±50.0 MHz
5,800 MHz .....	±75.0 MHz
24,125 MHz .....	±125.0 MHz
61.25 GHz .....	±250.0 MHz
122.50 GHz .....	±500.0 MHz
245.00 GHz .....	±1.0 GHz

NOTE: The use of the 6.78 MHz ±15 kHz frequency band is subject to the conditions of footnote 524 of the Table of Allocations. See §2.106.



# EMC and RFI

- North America
  - FCC Radiated and Line conducted
    - Part 15
    - 450 KHz lower frequency
    - Part 18 is ISM Bands
    - UL/IEC 60601
    - ANSI IEEE C62.41
- Europe
  - CISPR 11 and CISPR 22
  - 150 KHz lower frequency

# FCC Limits

<i>FCC Class A Conducted EMI Limit</i>	
<i>Frequency of Emission (MHz)</i>	<i>Conducted Limit (<math>\mu</math>V)</i>
0.45 – 1.6	1000
1.6 – 30.0	3000

<i>FCC Class B Conducted EMI Limit</i>	
<i>Frequency of Emission (MHz)</i>	<i>Conducted Limit (<math>\mu</math>V)</i>
0.455 – 1.6	250
1.6 – 30.0	250

<i>FCC Class A 30-Meter Radiated EMI Limit</i>	
<i>Frequency of Emission (MHz)</i>	<i>Field Strength Limit (<math>\mu</math>V/m)</i>
30 – 88	30
88 – 216	50
216 – 1000	70
above 1000	70

<i>FCC Class B 3-Meter Radiated EMI Limit</i>	
<i>Frequency of Emission (MHz)</i>	<i>Field Strength Limit (<math>\mu</math>V/m)</i>
30 – 88	100
88 – 216	150
216 – 1000	200
above 1000	200

CUI Inc. Electromagnetic Compatibility Considerations for Switching Power Supplies



PSMA Safety & Compliance Committee

Jim Spangler Kevin Parmenter



# CISPR Limits

<b>CISPR Class A Conducted EMI Limit</b>		
<b>Frequency of Emission (MHz)</b>	<b>Conducted Limit (dB<math>\mu</math>V)</b>	
	<b>Quasi-peak</b>	<b>Average</b>
0.15 – 0.50	79	66
0.50 – 30.0	73	60

<b>CISPR Class B Conducted EMI Limit</b>		
<b>Frequency of Emission (MHz)</b>	<b>Conducted Limit (dB<math>\mu</math>V)</b>	
	<b>Quasi-peak</b>	<b>Average</b>
0.15 – 0.50	66 – 56*	56 – 46*
0.50 – 5.00	56	46
5.00 – 30.0	60	50

<b>CISPR Class A 10-Meter Radiated EMI Limit</b>	
<b>Frequency of Emission (MHz)</b>	<b>Field Strength Limit (dB<math>\mu</math>V/m)</b>
30 – 88	39
88 – 216	43.5
216 – 960	46.5
above 960	49.5

<b>CISPR Class B 3-Meter Radiated EMI Limit</b>	
<b>Frequency of Emission (MHz)</b>	<b>Field Strength Limit (dB<math>\mu</math>V/m)</b>
30 – 88	40.0
88 – 216	43.5
216 – 960	46.0
above 960	54.0

CUI Inc. Electromagnetic Compatibility Considerations for Switching Power Supplies



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# CISPR

CISPR 11 - industrial, scientific and medical equipment

CISPR 12- Limits and methods of measurement for the protection of off-board receivers

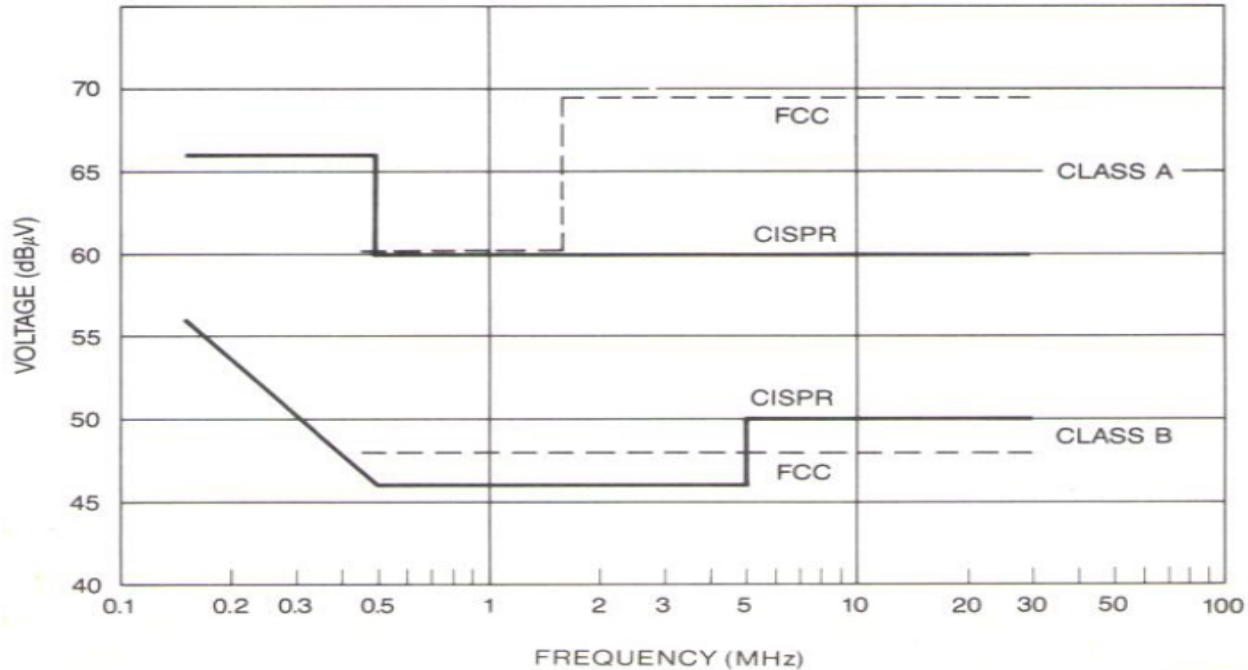
CISPR 14-1 - household appliances and electric tools

CISPR 15 - lighting equipment

CISPR 22 - Limits and methods of measurements of radio disturbance characteristics of information technology equipment (Similar to FCC Part15)

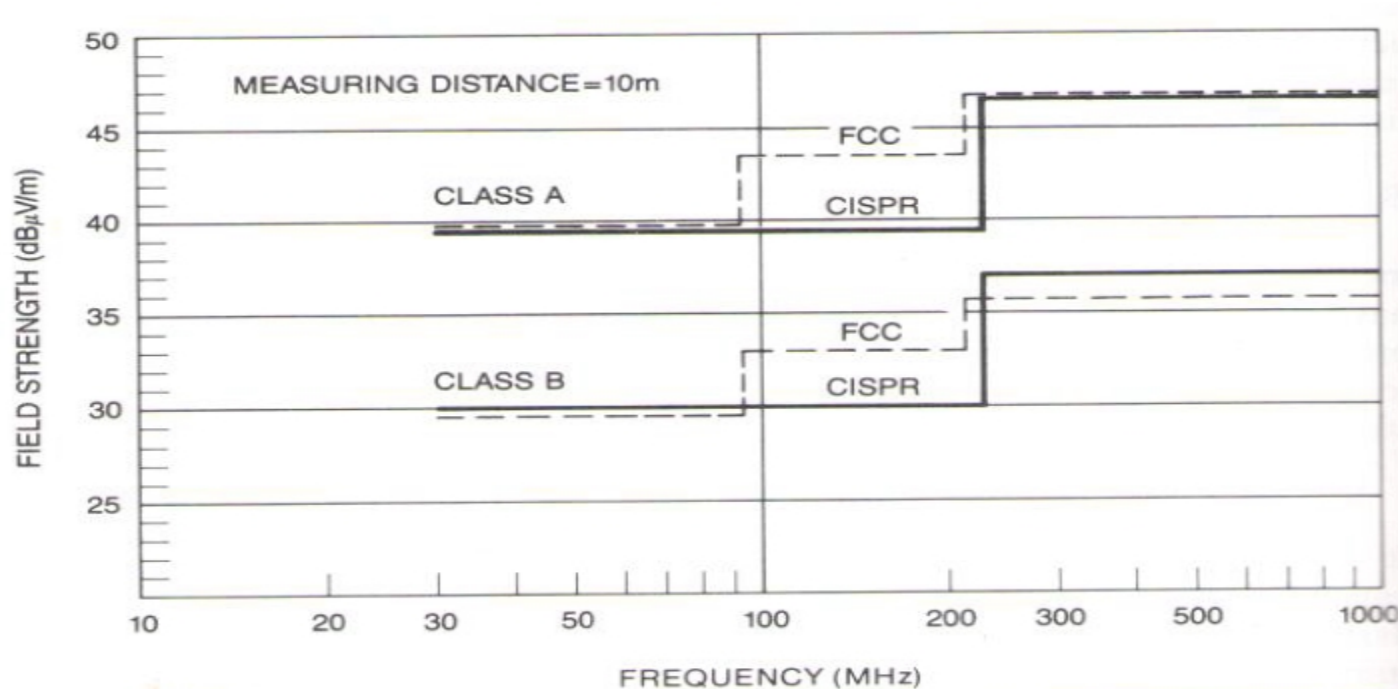
CISPR 32 - multimedia equipment

# Line Conducted Limits FCC and CISPR



Henry Ott: Noise Reduction Techniques in Electronic System 2<sup>nd</sup> Ed

# Radiated Emissions FCC & CISPR



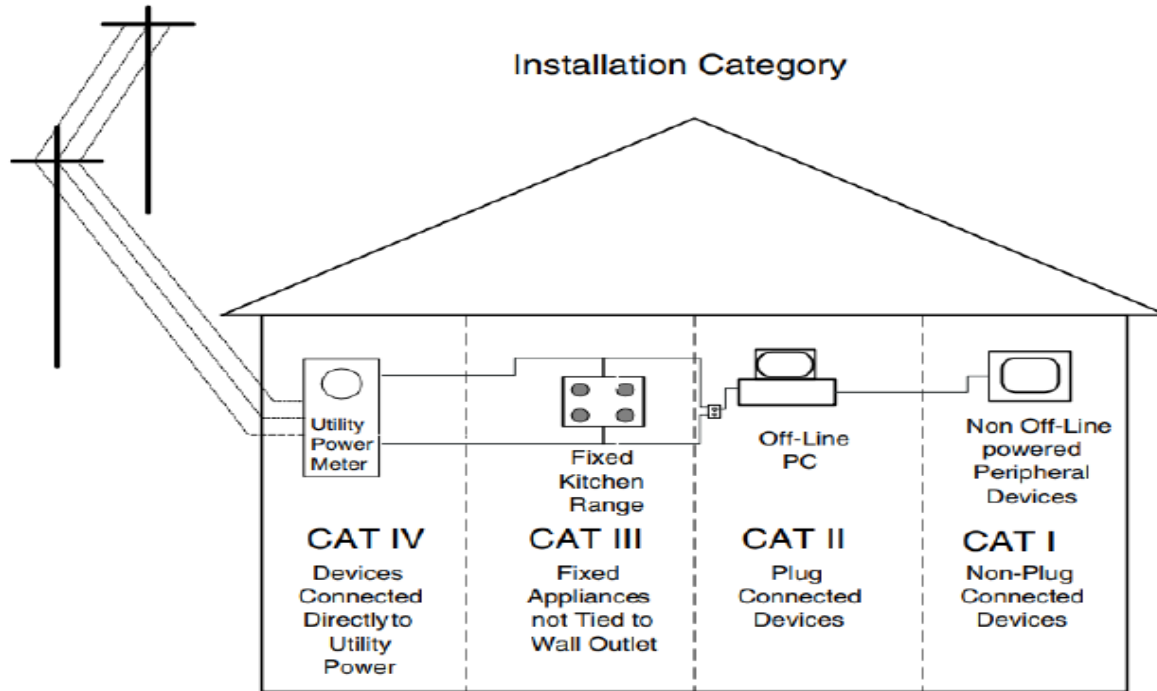
Henry Ott: Noise Reduction Techniques in Electronic System 2<sup>nd</sup> Ed

# Radiated Emission Pre-Compliance In-House Testing



2019 EMC TESTING GUIDE ([www.interferencetechnology.com](http://www.interferencetechnology.com))

# Lightning



17346

**How2Power –Dec 2018** *Proper Design of the Power Supply's Input EMI Filter Protects against Power Line Transients*



PSMA Safety & Compliance Committee

Jim Spangler Kevin Parmenter





# Transients

Table 1. IEC 664 table of impulse withstand voltages as presented in Vishay Application Note 43.<sup>[12]</sup>

UTILITY VOLTAGE PHASE TO EARTH $V_{RMS}$ OR DC	IMPULSE WITHSTAND VOLTAGES IN VOLTS FOR INSTALLATION CATEGORY $V_{IOTM}$ (FROM VISHAY VDE TABLES)			
	INSTALLATION CATEGORY I	INSTALLATION CATEGORY II	INSTALLATION CATEGORY III	INSTALLATION CATEGORY IV
50	330	500	800	1500
100	500	800	1500	2500
150	800	1500	2500	4000
300	1500	2500	4000	6000
600	2500	4000	6000	8000
1000	4000	6000	8000	12 000

Table 1 – Rated impulse voltage for equipment energized directly from the low-voltage mains

Nominal voltage of the supply system <sup>1)</sup> based on IEC 60038 <sup>3)</sup>		Voltage line to neutral derived from nominal voltages a.c. or d.c. up to and including $V$	Rated impulse voltage <sup>2)</sup>			
Three phase	Single phase		Overvoltage category <sup>4)</sup>			
			I	II	III	IV
230/400 277/480 400/690 1 000	120-240	50	330	500	800	1 500
		100	500	800	1 500	2 500
		150	800	1 500	2 500	4 000
		300	1 500	2 500	4 000	6 000
		600	2 500	4 000	6 000	8 000
		1 000	4 000	6 000	8 000	12 000

<sup>1)</sup> See annex B for application to existing different low-voltage mains and their nominal voltages.  
<sup>2)</sup> Equipment with these rated impulse voltages can be used in installations in accordance with IEC 60364-4-443.  
<sup>3)</sup> The / mark indicates a four-wire three-phase distribution system. The lower value is the voltage line-to-neutral, while the higher value is the voltage line-to-line. Where only one value is indicated, it refers to three-wire, three-phase systems and specifies the value line-to-line.  
<sup>4)</sup> See 2.2.2.1.1 for an explanation of the overvoltage categories.

How2Power –Dec 2018 *Proper Design of the Power Supply's Input EMI Filter Protects against Power Line Transients*

# Power Factor Correction (PFC)

## IEC 61000-3-2 or IEC 555-2

### Three $\emptyset$ current in the neutral

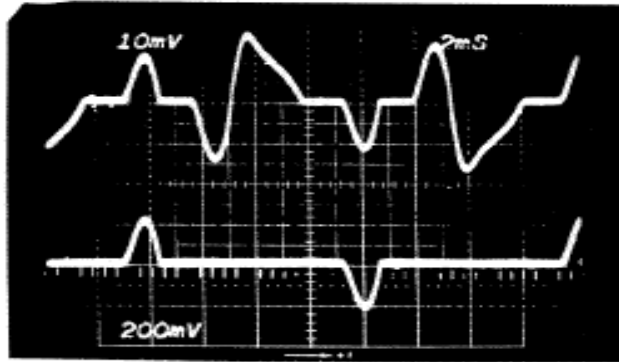
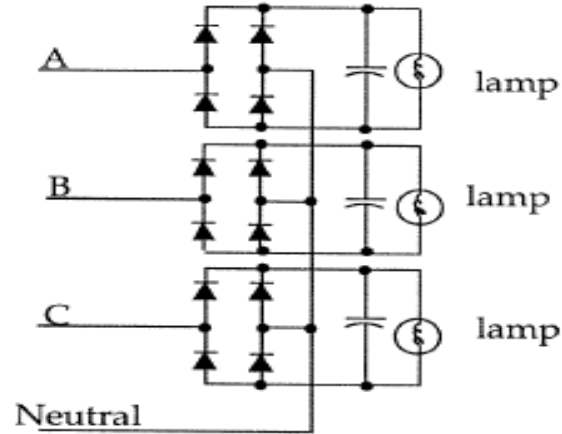


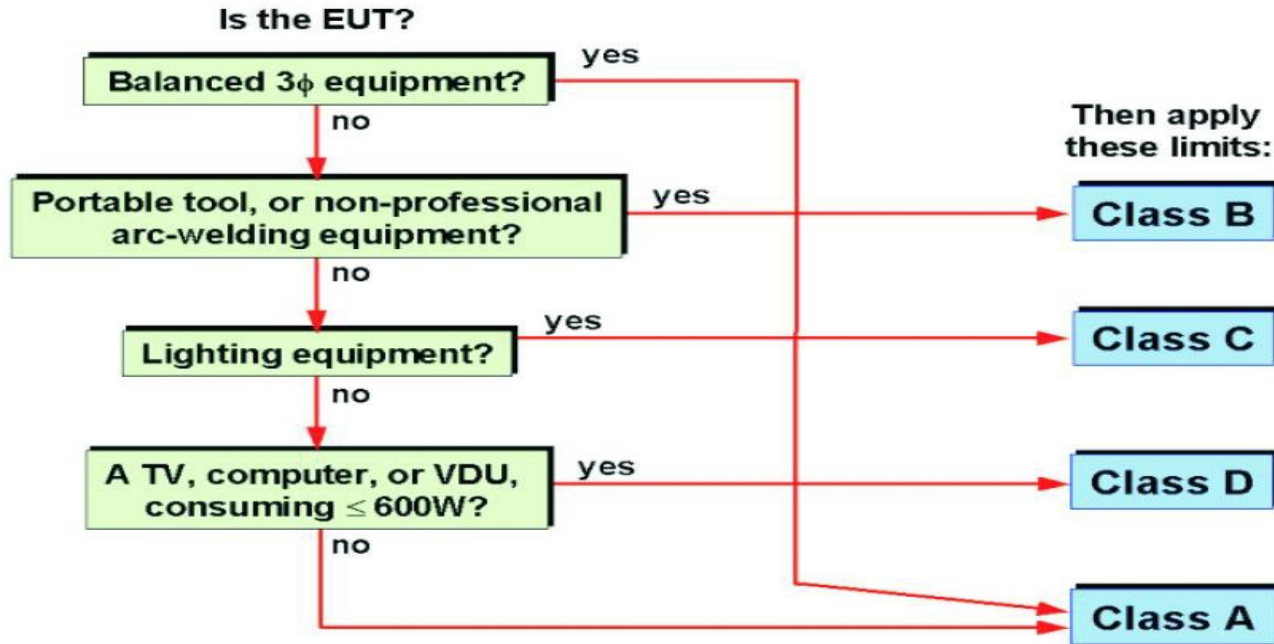
Photo of current in neutral



Schematic

*Power Factor Correction Techniques Used in Fluorescent Lamp Ballast, Industry Applications Society Oct 1991*

# Truth Table



# Class A, B, C, and D

The emissions limits in EN 61000-3-2 Ed.2:2000  
Relaxations for transitory emissions are specified in the standard

Harmonic order 'n'	Max current Class A	Max current Class B	Max current Class C (% of fundamental current)	Max current Class D (but no more than Class A)
2	1.08 Amps	1.62 A	2%	not specified
3	2.30 A	3.45 A	$30\lambda\%$	3.4 mA/Watt
4	0.43 A	0.645 A	not specified	not specified
5	1.14 A	1.71 A	10%	1.9 mA/Watt
6	0.30 A	0.45 A	not specified	not specified
7	0.77 A	1.155 A	7%	1.0 mA/Watt
$8 \leq n \leq 40$ (even)	0.23 (8/n) A	0.345 (8/n) A	not specified	not specified
9	0.40 A	0.6 A	5%	0.5 mA/Watt
11	0.33 A	0.495 A	3%	not specified
13	0.21 A	0.315 A	3%	0.35 mA/Watt
$15 \leq n \leq 39$ (odd)	0.15 (15/n) A	0.225 (15/n) A	3%	(3.85/n) mA/Watt

( $\lambda$  is the circuit power factor)

# Line Harmonic Current Measurement

- Voltech
  - Now Tektronix
- Newton's Fourth
- Yokogawa
- Itron
- Agilent Keysight
- Hioki
- Vitrek
- Chroma

# Power Line Flicker

**Power-line flicker** is a visible change in brightness of a lamp due to rapid fluctuations in the voltage of the power supply. The [voltage drop](#) is generated over the source [impedance](#) of the grid by the changing load current of an equipment or facility. These fluctuations in time generate flicker. The effects can range from disturbance to [epileptic attacks](#) of [photosensitive](#) persons. Flicker may also affect sensitive electronic equipment such as [television](#) receivers or industrial processes relying on constant electrical power

# Cause of ac line Flicker

- Large current in-rush for PFC capacitor ?
- Large current in-rush for heater
- Large current in-rush with a universal wound motor in a stall condition
- Solutions: NTC on input
- Standards:
  - IEC61000-3-3
  - IEC 61000-4-15
- Effects of flicker-
  - Incandescent lamps change intensity
  - Not seen with CFL and LED system that have a dc link capacitor

# AC Power Line Dropout

- Function of the dc link capacitor
- Issue with some of the first IBM computers always resetting
- Universal input with PFC 3 uF/Watt for dc link capacitor (1 ac line cycle)
- With PFC use 1 uF/Watt @ 400 WVDC to 450 WVDC of load for 1.5 to 2.0 ac line cycles



# Restrictive Materials

- Restrictive Material
  - Solder and the use of Lead
  - RohS – including EU
  - California Proposition 65 – (one product is desirable so meet the most stringent ones)
  - China Rohs
  - REACH SVHC Compliance
  - four phthalates (DEHP, BBP, DBP, and DIBP)
  - WEEE
- Bill of Materials
  - Must be approved
  - Sub-contractors can not change unless approved

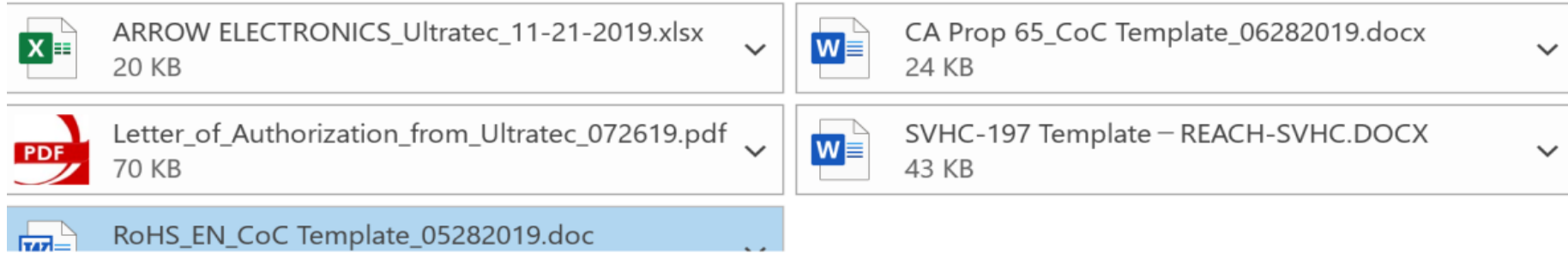
# Environmental Materials Example

- Article 33 of EU Regulation 1907/2006 (select one):
- The product(s) referenced above, as well as any articles\* contained within the product(s), DO NOT CONTAIN any of the 197 REACH SVHCs as updated by ECHA on January 15, 2019 (<http://echa.europa.eu/candidate-list-table>).
- The products(s) referenced above have been evaluated for the presence of the 197 REACH SVHCs as updated BY ECHA on January 15, 2019. The product(s) and/or articles\* contained within the product(s) CONTAIN the following SVHCs in amounts no more than 1000ppm, as provided in the table on the following page. (Table must be completed if this option is selected.)
- The products(s) referenced above have been evaluated for the presence of the 197 REACH SVHCs as updated BY ECHA on January 15, 2019. The product(s) and/or articles\* contained within the product(s) CONTAIN the following SVHCs in amounts more than 1000ppm, as provided in the table on the following page. (Table must be completed if this option is selected.)

# Environmental Materials Example

Tremendously onerous burden in the industry

Everyone wants lower prices from suppliers then the supplier is bombarded with spread sheets and requests for information.



Self service options usually disregarded – every organization has a different form and format

# Source of information

- PSMA data base ([www.pσμα.com](http://www.pσμα.com))
  - <https://www.pσμα.com/technical-forums/safety/database>
- How2Power.com
  - <http://www.how2power.com/newsletters/index.php>
- [www.interferencetechnology.com](http://www.interferencetechnology.com)
- <https://incompliancemag.com>
- [www.claigan.com](http://www.claigan.com) for restrictive materials

# Summary

- Provided a list of some EMC and RFI rules and regulation
- Provided information to be able to do in-house testing
- Provided information on sources of regulations
- Restrictive Materials must be addressed
  - RoHS – EU and China
  - Weee
  - Reach
  - Proposition 65 (California)

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