

## Understanding Electromagnetic Interference (EMI)

### What is EMI?

Electromagnetic Interference (EMI) is electrical or radio frequency noise that is unintentionally generated back onto the AC power or on the airwaves. Another term commonly used is Radio Frequency Interference (RFI) which is a subset of EMI, but specific to the frequencies used for radio transmissions. EMI is an unfortunate side effect of modern high speed digital signal processing. If it is incorporated into a high power application such as switching power supplies and digital lighting ballast we now have high frequency combined with high power and can generate significant EMI. Lighting is specifically an issue because it is present everywhere, our homes, scientific laboratories, hospitals, outdoors, etc. Further complicating the matter is the increased quantity of equipment that may be susceptible to EMI such as computers, cellular phones, precision laboratory equipment, hospital equipment, and implantable/portable medical equipment (pacemakers, defibrillators, infusion pumps, electric wheelchairs, and medical alert devices). One other area of concern is interference with communications on established bandwidths that are reserved for communications such as aviation, radio, TV, emergency, and military.

### How can EMI be dangerous?

Some of the equipment functions and communications are absolutely critical and can be life endangering if they do not functioning properly. Obviously it is important for all of these devices to be able to work in harmony with each other while in relatively close proximity. To bring order to all of this chaos it is unavoidably necessary to have design standards and agencies to enforce it, thus the Federal Communications Commission (FCC) at least here in the U.S. The FCC does have standards that specifically address EMI for high frequency lighting, CFR Title 47 Part 18.303 and 18.307 for maximum allowable emitted and conducted EMI. For critical equipment there will also be susceptibility/immunity requirements to assure that they can tolerate some degree of EMI exposure.

EMI concerns are the reason airlines would not allow passengers to use electronic devices at key points in the flight program. In the past there was a time period you were not allowed to use a cellular in a hospital and especially near critical areas such as the ICU. There have been many reports of EMI related incidents over the years, most 10 to 20 years ago when these issue where not as greatly appreciated as they are today. The key point with EMI is that with the increasing number and density of high frequency, high speed devices, be it wired or wireless, it makes these EMI standards and compliance to them paramount for everything to work in harmony. If manufacturers do not comply, the potential for unintended equipment interactions will exist. This creates an environment for which enforcement by government agencies such as the FCC is necessary to assure these EMI levels are not exceeded.



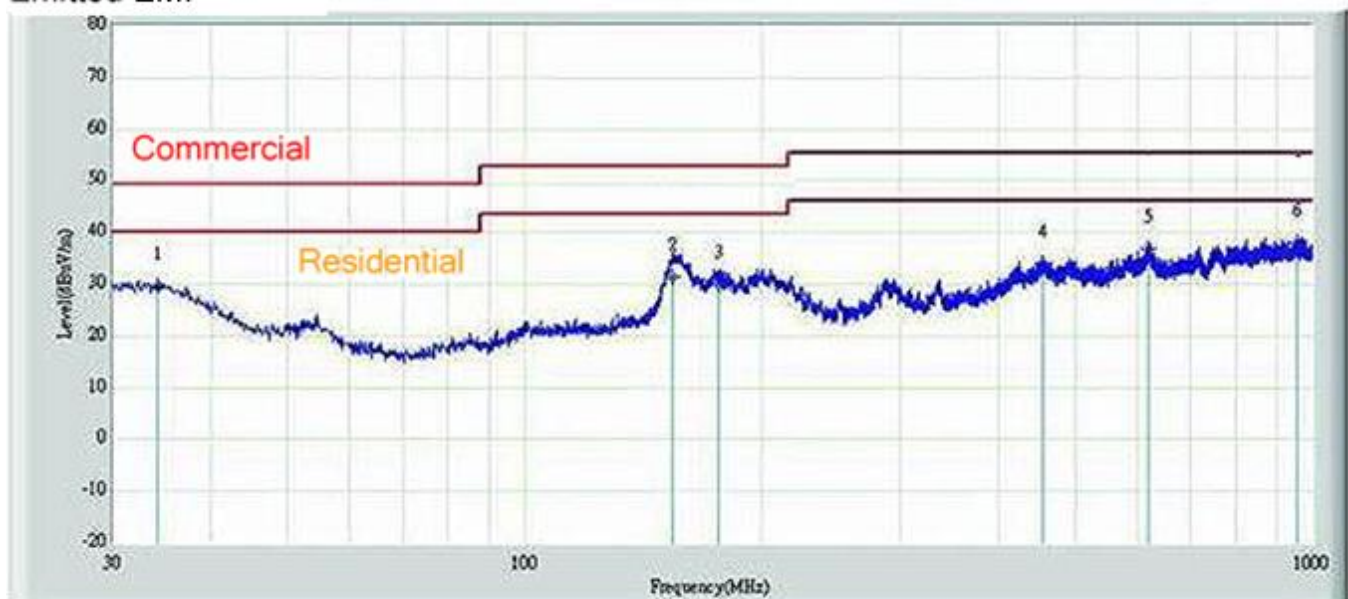
## The Types of EMI and the Standards Manufacturers must Operate Within.

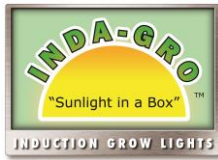
**EMITTED EMI (Ref. 18.303):** These are emissions that are broadcast onto the airwaves. These types of emission are primarily a problem for communications devices as they can interfere with the airwave transmissions. Standard remedies are to use shielded cables and connections and a conductive Faraday cage containment of the device. FCC limits are specified at 30 meters, but the more common test distance is at 3 meters. Attenuation follows a 1/d relationship so testing at 3 meters will allow for 10 times the intensity that would be present at 30 meters (this is consistent with the FCC code). Lab reports are generally presented on a dB scale  $dB = 20\text{Log}_{10}(V/V_{ref})$  rather than absolute voltage as specified by the FCC.

Freq (MHz)	Emitted EMI Frequency Ranges		
	FCC at 30 meters ( $\mu\text{V}/\text{m}$ )	Test at 3 meters ( $\mu\text{V}/\text{m}$ )	Test at 3 meters $\text{dB}(\mu\text{V}/\text{m}) @ 1 \mu\text{V}/\text{m ref}$
<b>Residential</b>			
30 - 88	10	100	40
88 - 216	15	150	43.5
216 - 1000	20	200	46.0
<b>Commercial</b>			
30 - 88	30	300	49.5
88 - 216	50	500	54
216 - 1000	70	700	56.9

When equipment is tested for Emitted EMI the blue line shows the level of EMI it produced. The stepped lines correspond to the allowable limit frequency values as shown above. In this case the equipment would be suitable for either a residential or commercial installation as none of the blue line values exceed the allowable limits.

Emitted EMI





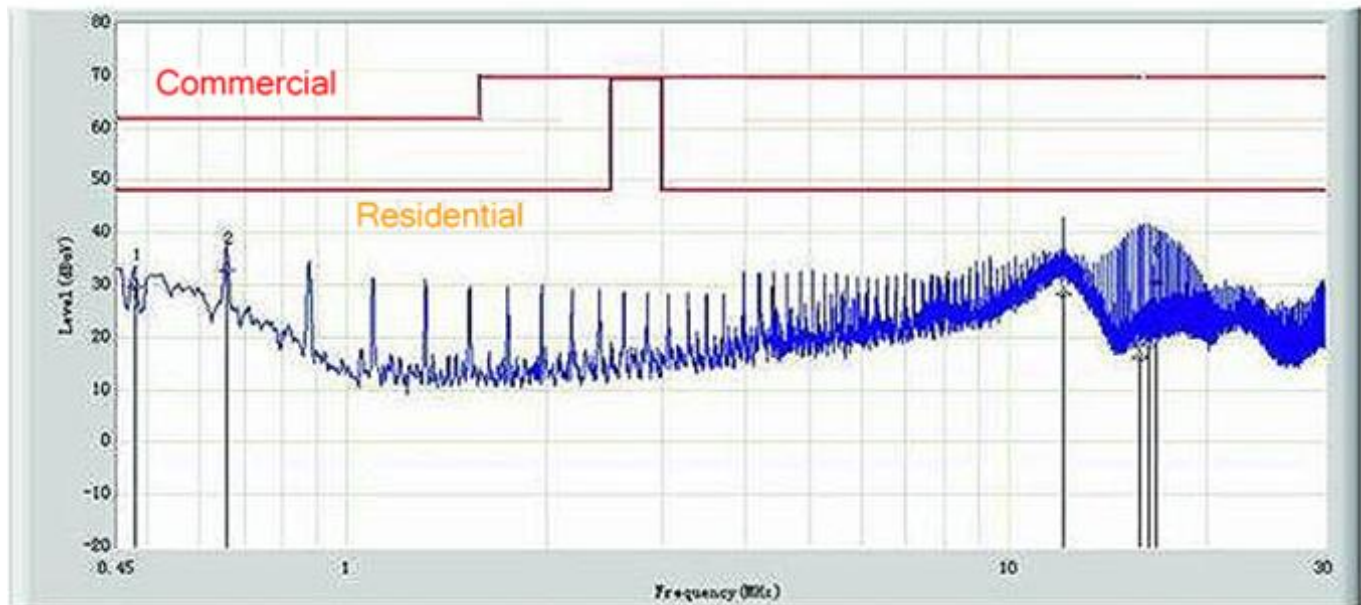
**CONDUCTED EMI (Ref. 18.307)** These are emissions that are directly conducted back on the AC power lines via the power line connection of the device. This can be a problem for other devices connected to the main AC line as this noise is directed fed into the device via the power cord. This issue is cumulative as emission from multiple devices will add up. Standard remedy is to add electrical filtration circuits to the power input section of the device. Below are the FCC limits for consumer products for household use.

### Conducted EMI Frequency Ranges

Freq (MHz)	$\mu V$	dB( $\mu V$ ) @ 1 $\mu V$ ref
<b>Residential</b>		
0.45 - 2.51	250	48
2.51 - 3.0	3000	69.5
3.0 - 30	250	48
<b>Commercial</b>		
0.45 – 1.6	1000	60
1.6 – 30	3000	69.5

When equipment is tested for Conducted EMI the blue line shows the level of EMI it produced. The stepped lines correspond to the allowable limit frequency values as shown above. In this case the equipment would be suitable for either a residential or commercial installation as none of the blue line values exceed the allowable limits.

### Conducted EMI





## How do Inda-Gro products perform within these guidelines?

Our products are tested and fall within FCC guidelines of International Standard L 47-CFR-18 for both Residential and Commercial installations of Electrodeless Fluorescent Lamps for general/horticultural lighting Electromagnetic Compatibility (EMC) purposes.

### 1.0 Test Description and Standards

The objective of these tests to demonstrate compliance with the standards EN55015, EN61000-3-2, EN61000-3-3 and EN61547 for general lighting EMC purposes and to maintain those compliance values throughout the life of the product.

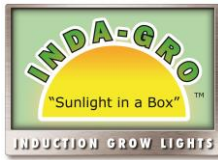
The tests performed are in accordance with **EN55015**, Limits and Methods of measurement of radio disturbance characteristics for electrical lighting and similar equipment, and **EN61000-3-2**, Electromagnetic compatibility (EMC) – part 3-2: Limits – Limits for harmonic current emissions up to and including 16A per phase and **EN61000-3-3** (EMC)—Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems for equipment with rated current  $\leq 16A$  per phase and not subject to conditional connection, and **EN61547**, equipment for general lighting purposes – EMC immunity requirements.

**1.2 Model Tested:** Pro-420-PAR

### **1.3 Equipment Under Test (EUT) Setup and Operation Mode**

All the test data has been collected, reduced and analyzed within this report in accordance with Immunity requires the following as specific performance criteria for the EUT:

- A. The EUT shall continue to operate as intended during and after the test to minimum performance levels.
- B. The EUT shall be tested as it would be used in normal field applications and under full power conditions.
- C. The EUT was configured to measure its highest possible emission/immunity level. The test modes were adapted according to typical installation standards.



## 2.0 Summary of Test Results

Standards	Description of Test Item	Result
EN55015	Disturbance Voltages	Compliant
	Radiated Electromagnetic Disturbances (Frequency range 9kHz to 30MHz)	Compliant
	Radiated Electromagnetic Disturbances (Frequency range 30MHz to 300MHz)	Compliant
EN61000-3-2	Harmonic Current Emission	Compliant
EN61000-3-3	Voltage Fluctuation and Flicker	Compliant
EN61547	Electrostatic Discharge Immunity in accordance with IEC 61000-4-2	Compliant
	Radio Frequency Electromagnetic Field Immunity in accordance with IEC 61000-4-3	Compliant
	Electrical Fast Transient Burst Immunity accordance with IEC 61000-4-4	Compliant
	Surges Immunity in accordance with IEC 61000-4-5	Compliant
	Injected Currents Immunity in accordance with IEC 61000-4-6	Compliant
	Power-frequency Magnetic Field Immunity in accordance with IEC 61000-4-6	N/A
	Voltage Dips/Interruptions Immunity in accordance with IEC 61000-4-11	Compliant

## 3.0 Disturbance Voltages

### **3.1 Measurement Uncertainty**

Base on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of any conducted emissions measurement is  $\pm 2.88$  dB. T

Testing is conducted under the description of EN55015, According to Clause 5.3.2.2, 6 and 8.3.1

### **3.2 Testing Equipment**

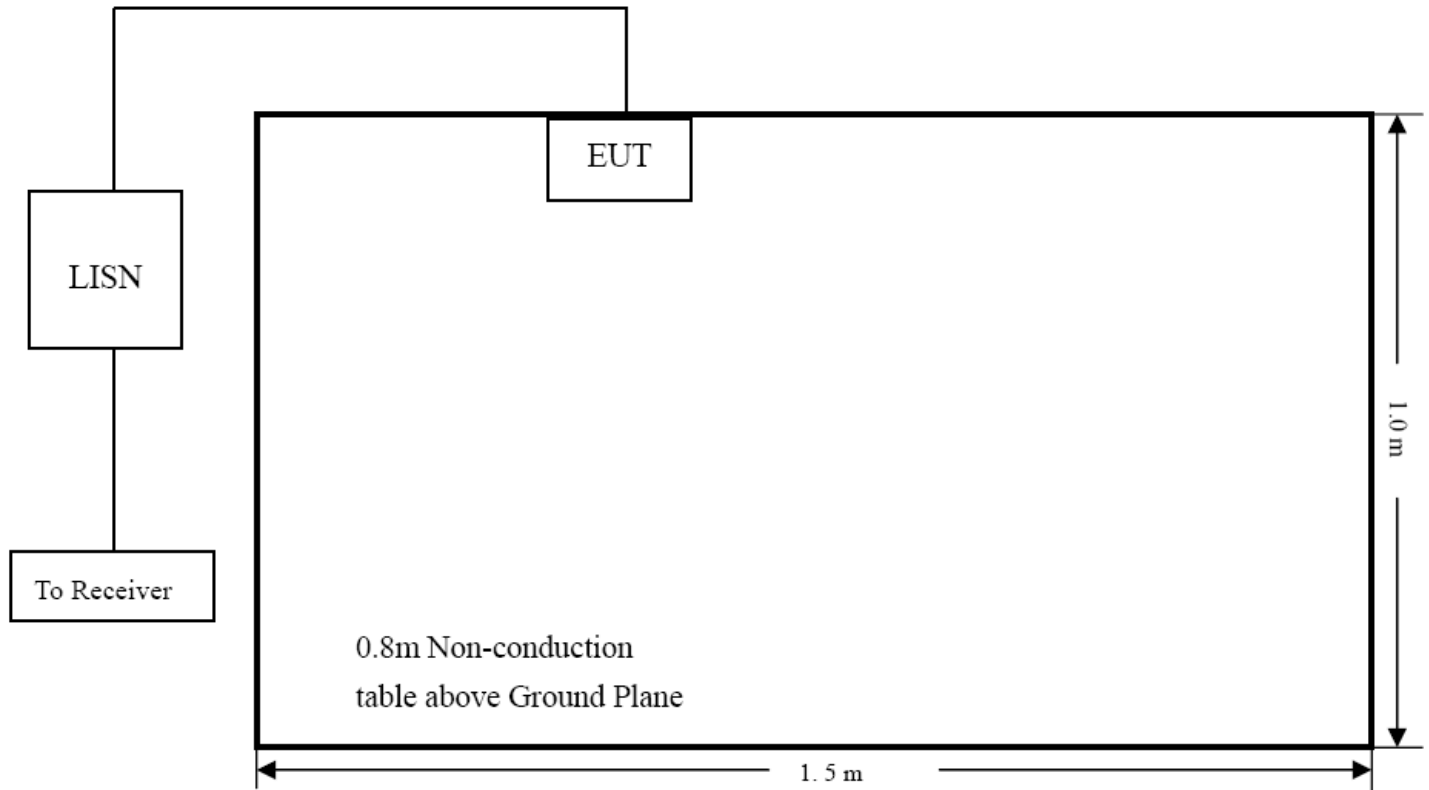
Description	Manufacturer	Model
EMI Test Receiver	Rohde & Schwarz	ESPI
LISN	Schwarzbeck	NSLK8126
Pulse Limiter	Rohde & Schwarz	ESH3-Z2
Current Probe	FCC	F-33-4



### 3.3 Test Procedure

Test is conducting under the description of EN55015, According to Clause 5.3.2.2,6 & 8.3.1

### 3.4 Basic Test Setup Block Diagram



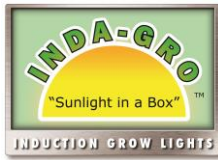
### 3.5 Environmental Conditions

Temperature: 22°C  
Relative Humidity: 55%  
ATM Pressure: 1015 mbar

### 3.6 Summary of Test Results/Plots

According to the data in section 3.7 the **EUT complied with the EN55015** conducted margin for a lighting device, with the **worst** margin reading of:

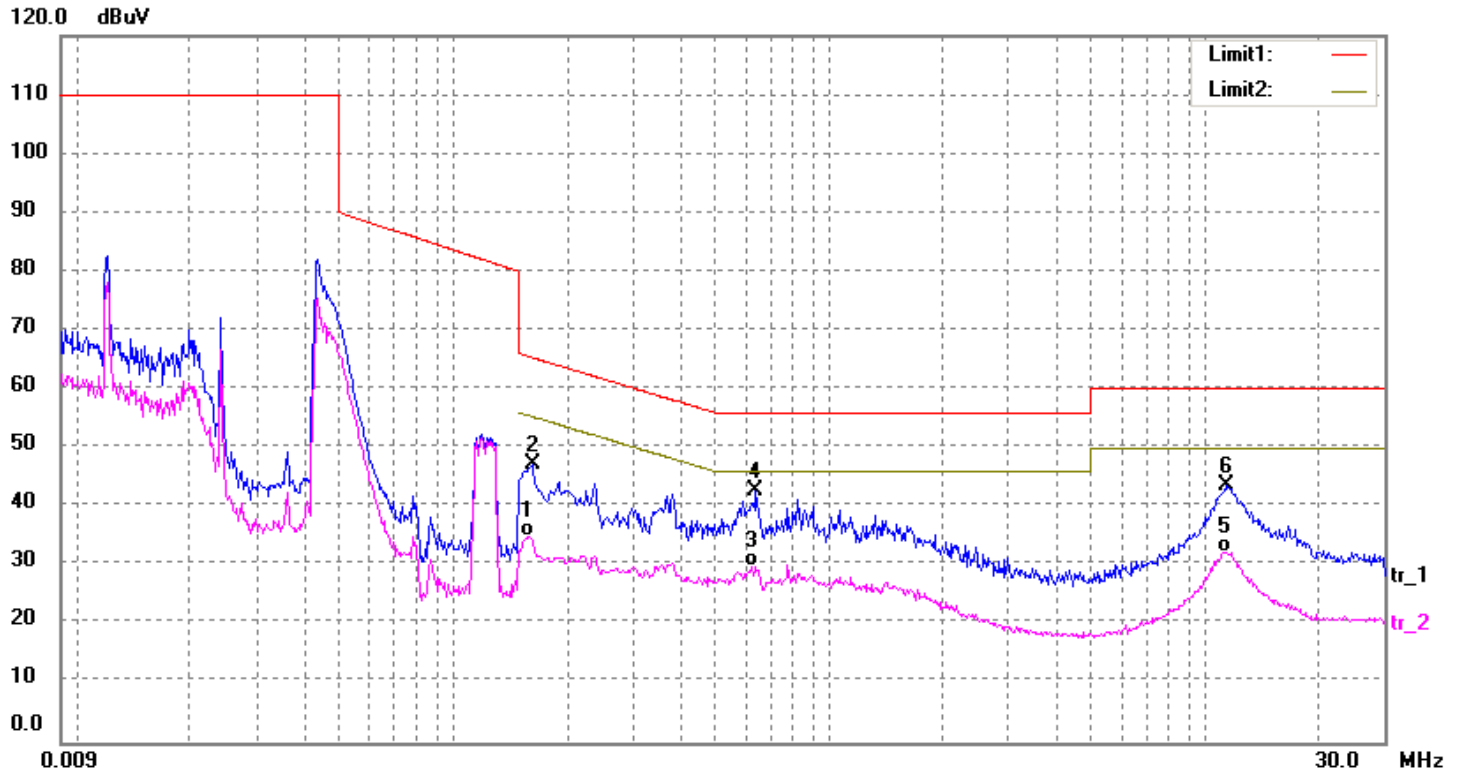
**-13.13 dB @ 0.6380 MHz om the LINE mode, PEAK detector, 0.009-30MHz**



### 3.7 Conducted Emissions Test Data – Plot of Disturbance Voltage Data

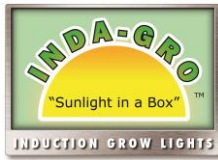
EUT: A.C. Supplied Electronic Ballast for Electrodeless Fluorescent Lamp  
 Tested Model: Pro-420-PAR  
 Operating Condition: TM1  
 Comment: AC 220V/60Hz

Test Specification: Line

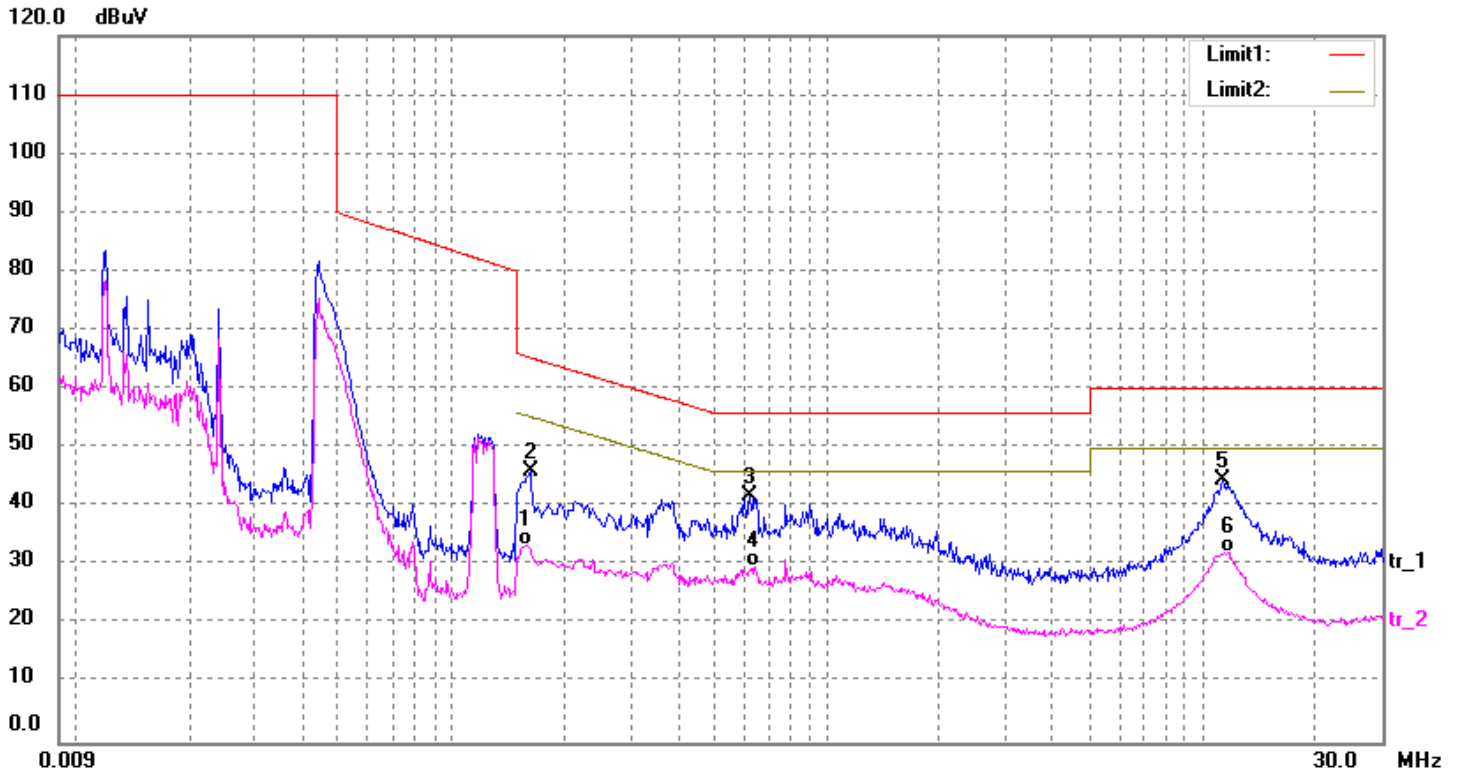


No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1580	25.57	9.50	35.07	55.57	-20.50	AVG
2	0.1620	37.71	9.50	47.21S	65.36	-18.15	peak
3	0.6260	20.33	9.63	29.96	46.00	-16.04	AVG
4*	0.6380	33.23	9.64	42.87	56.00	-13.13	peak
5	11.3260	22.05	10.27	32.32	50.00	-17.68	AVG
6	11.4220	33.40	10.28	43.68	60.00	-16.32	peak



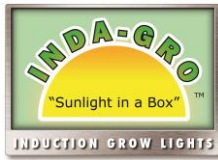


Test Specification: Neutral



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1580	23.97	9.50	33.47	55.57	-22.10	AVG
2	0.1620	36.62	9.50	46.12	65.36	-19.24	peak
3*	0.6220	32.08	9.62	41.70	56.00	-14.30	peak
4	0.6460	20.27	9.65	29.92	46.00	-16.08	AVG
5	11.2460	34.41	10.25	44.66	60.00	-15.34	peak
6	11.6540	22.05	10.33	32.38	50.00	-17.62	AVG





## **4.0 Radiated Electromagnetic Disturbances (9kHz to 30MHZ)**

### **4.1 Measurement Uncertainty**

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of any radiated emissions measurement is  $\pm 3.6$  dB.

### **4.2 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
EMI Test Receiver	Rohde & Schwarz	ESPI
Triple Loop Antenna	Schwarzbeck	HXYZ9170

### **4.3 Test Procedure**

Test is conducted under the description of EN 55015, According to Clause 4.4

### **4.4 Test Result**

Testing according to limit tables and plots. Emissions below 10 dB are not reported.

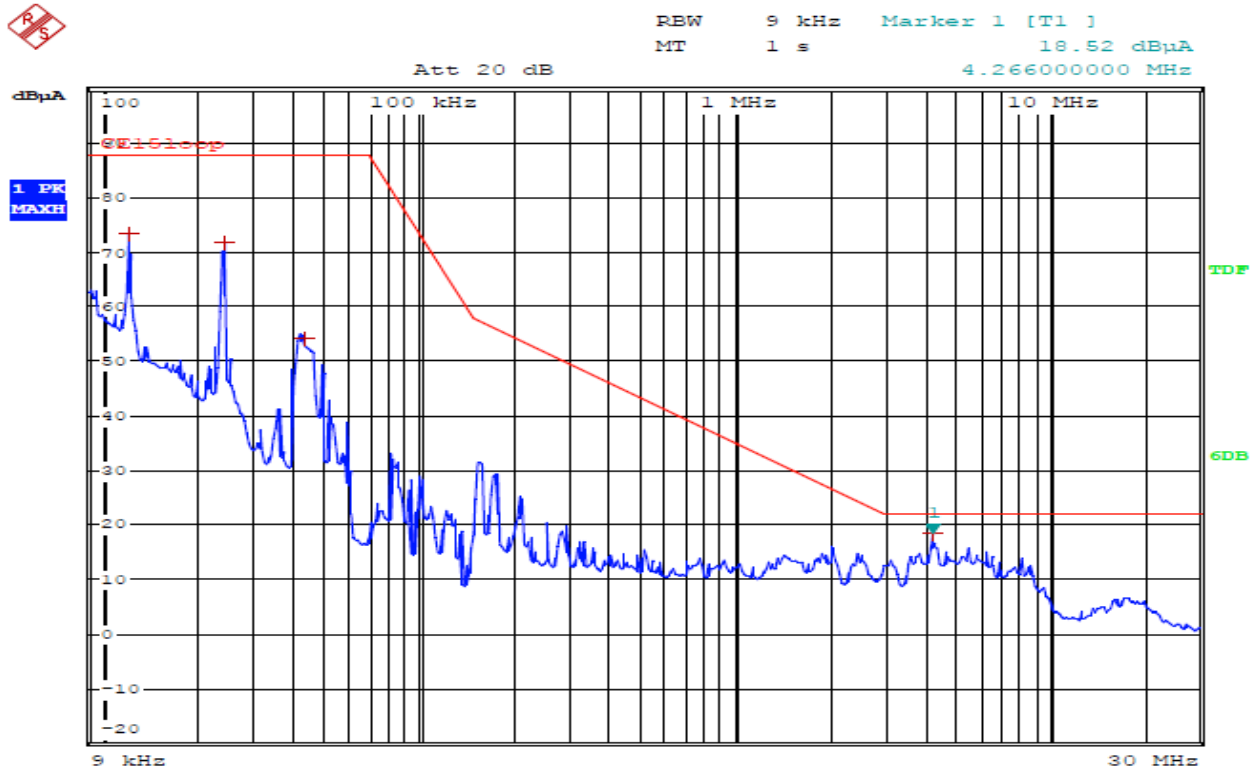
**Test Results: Pass**



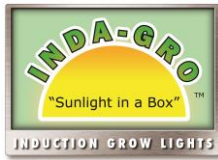
### 4.5 Plot of Electromagnetic Disturbances Test Data

EUT: A.C. Supplied Electronic Ballast for Electrodeless Fluorescent Lamp  
 Tested Model: Pro-420-PAR  
 Operating Condition: TM1  
 Comment: AC 220V/60Hz

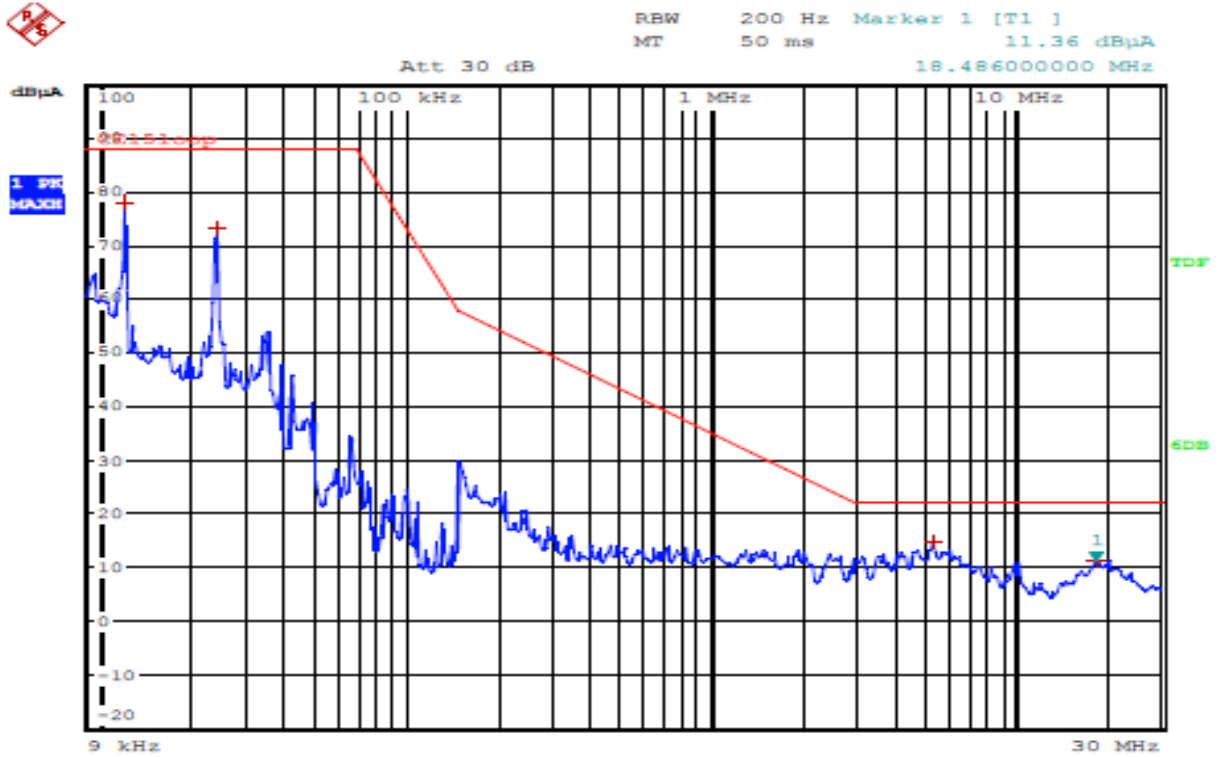
Test Specification: X



EDIT PEAK LIST (Prescan Results)			
TRACE		FREQUENCY	LEVEL dBµA
Trace1:	CE15loop		
Trace2:	---		
Trace3:	---		
1	Max Peak	11.96 kHz	73.47
1	Max Peak	23.96 kHz	71.85
1	Max Peak	43.08 kHz	54.05
1	Max Peak	4.266 MHz	18.52
			DELTA LIMIT dB
			-14.52
			-16.15
			-33.94
			-3.47



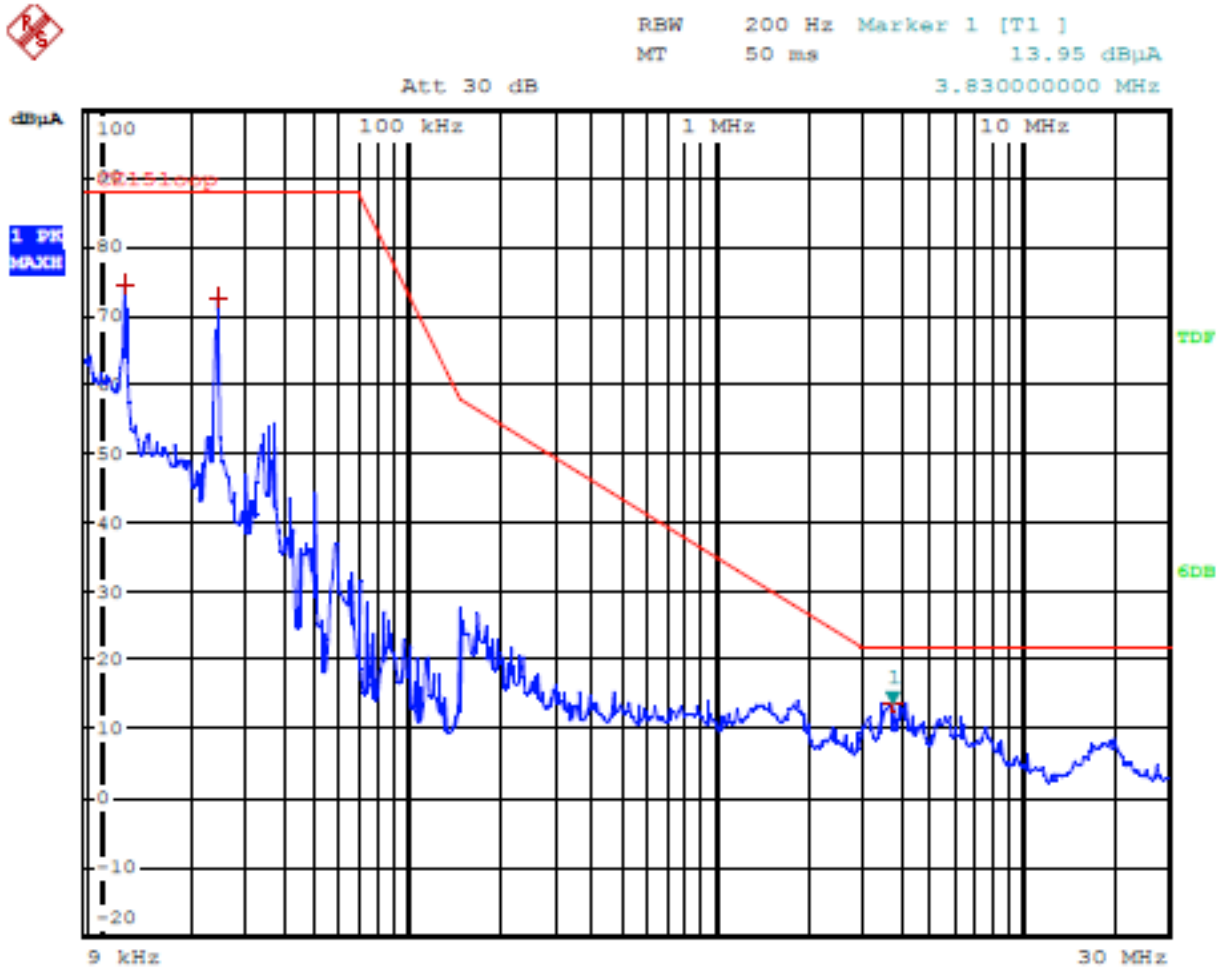
Test Specification: Y



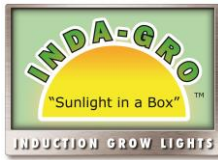
EDIT PEAK LIST (Prescan Results)				
Trace1:	CE15loop			
Trace2:	---			
Trace3:	---			
TRACE	FREQUENCY	LEVEL dBµA	DELTA LIMIT dB	
1 Max Peak	12.04 kHz	77.95	-10.04	
1 Max Peak	23.96 kHz	73.35	-14.64	
1 Max Peak	5.346 MHz	14.71	-7.29	
1 Max Peak	18.486 MHz	11.36	-10.63	



Test Specification: Z



EDIT PEAK LIST (Prescan Results)			
Trace1:	CE15loop		
Trace2:	---		
Trace3:	---		
TRACE	FREQUENCY	LEVEL dBµA	DELTA LIMIT dB
1 Max Peak	12.04 kHz	74.71	-13.28
1 Max Peak	24.04 kHz	72.66	-15.33
1 Max Peak	3.83 MHz	13.94	-8.05



## 5.0 Radiated Electromagnetic Disturbances (30MHz-300MHZ)

### 5.1 Measurement Uncertainty

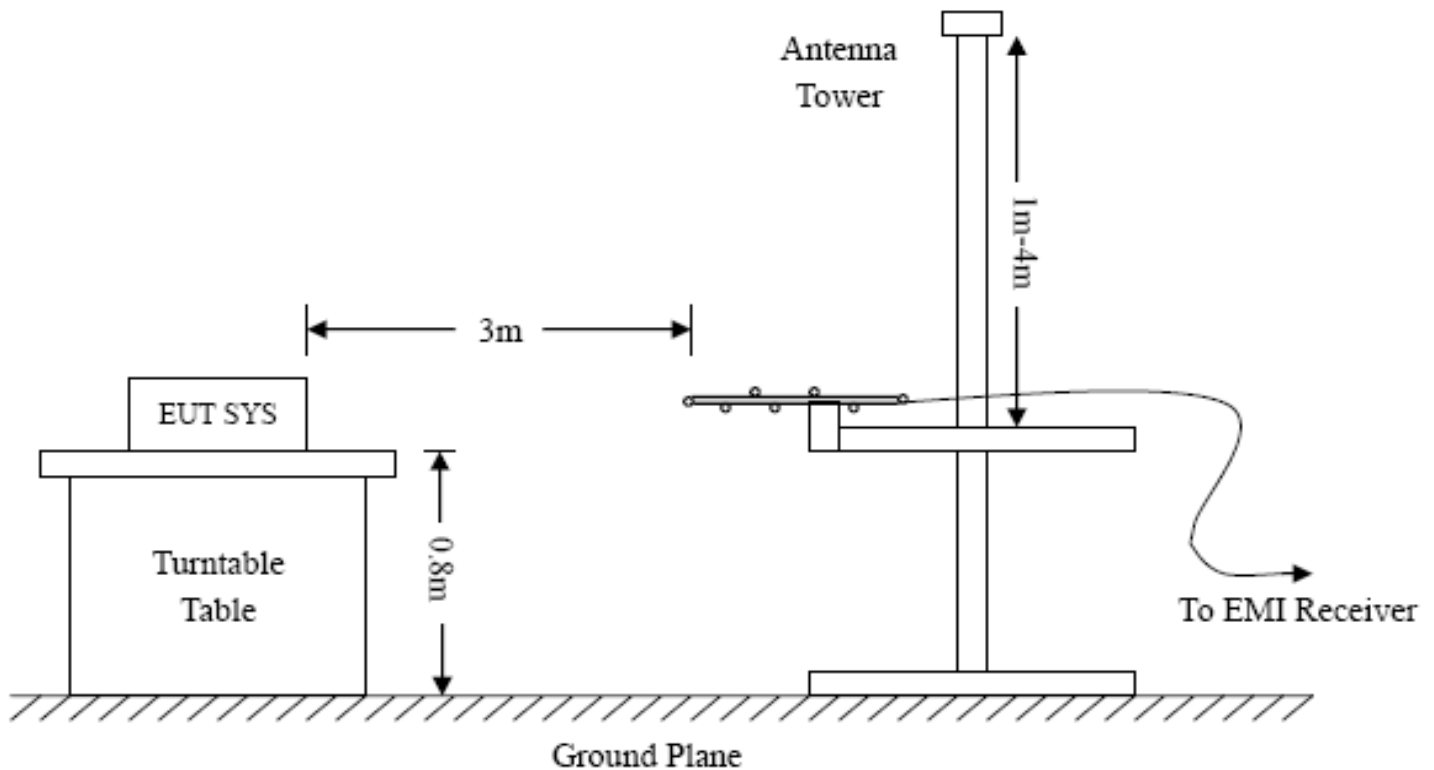
Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the best estimate of the uncertainty of any radiated emissions measurement is  $\pm 5.10$  dB.

### 5.2 Test Equipment List and Details

Description	Manufacturer	Model
Spectrum Analyzer	R&S	FSP
EMI Test Receiver	R&S	ESVB
Pre-amplifier	Agilent	8447F
Trilog Broadband Antenna	Schwarzbeck	VULB9163
Pre-amplifier	Compliance Direction	PAP-0118
Horn Antenna	ETS	3117

### 5.3 Test Procedure

Test is conducting under the description of EN55015 According to Clause 4.4.2





## 5.4 Corrected Amplitude and Margin Calculation

The corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Indicated Reading} + \text{Antenna Factor} + \text{Cable Factor} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dB $\mu$ V means the emission is 6dB $\mu$ V below the maximum limit for a lighting device. The equation for margin calculations is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{EN55015 Limit}$$

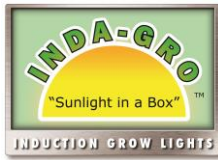
## 5.5 Environmental Conditions

Temperature: 23°C  
Relative Humidity: 5%  
ATM Pressure: 1011 mbar

## 5.6 Summary of Test Results/Plots

According to the data in section 3.5, the EUT complied with the EN55015 standards with the worst margin @:

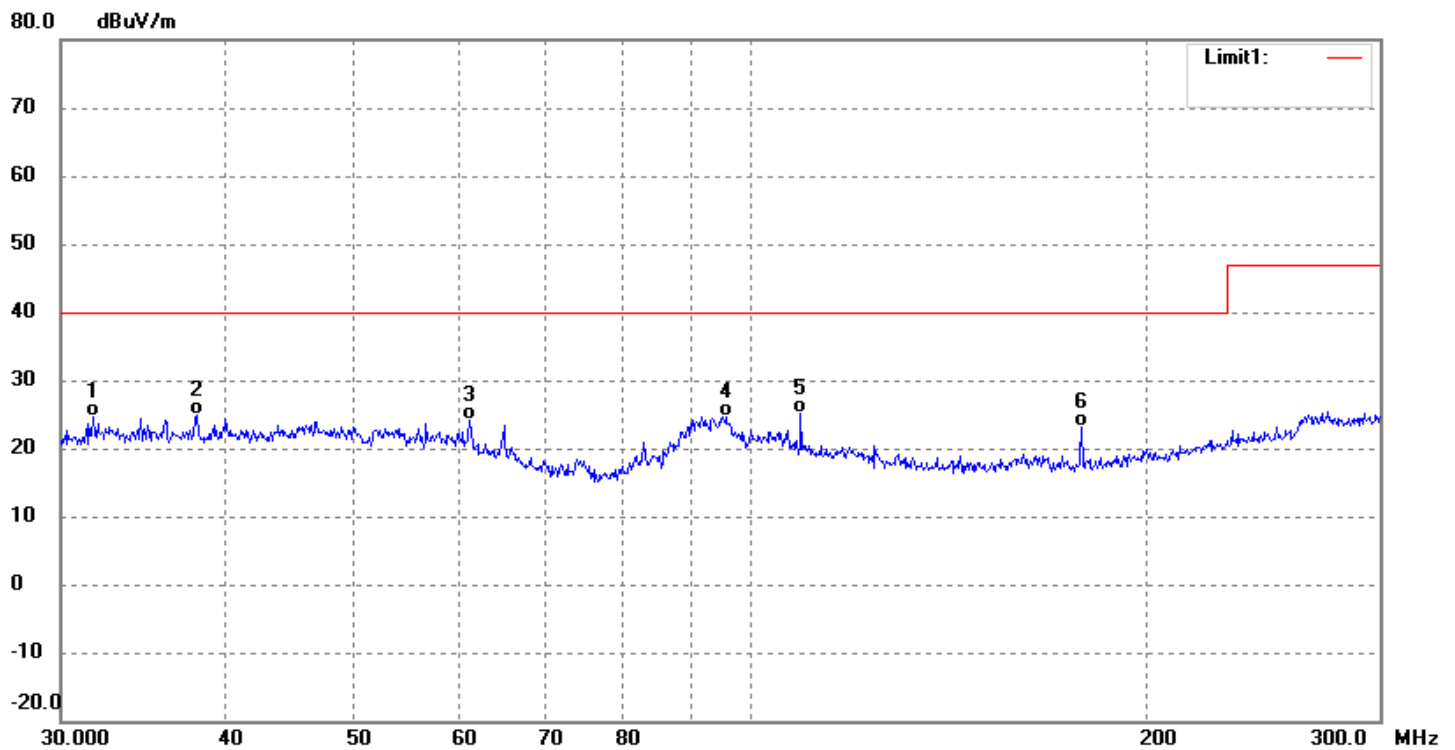
**-8.69 dB @ 92.7089 MHz in the Horizontal polarization, 30 MHz to 300 MHz, 3 Meters**



### 5.7 Plot of Radiated Emission Test Data

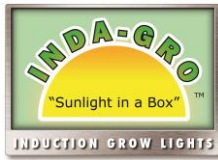
EUT: A.C. Supplied Electronic Ballast for Electrodeless Fluorescent Lamp  
 Tested Model: Pro-420-PAR  
 Operating Condition: TM1  
 Comment: AC 220V/60Hz

Test Specification: Horizontal

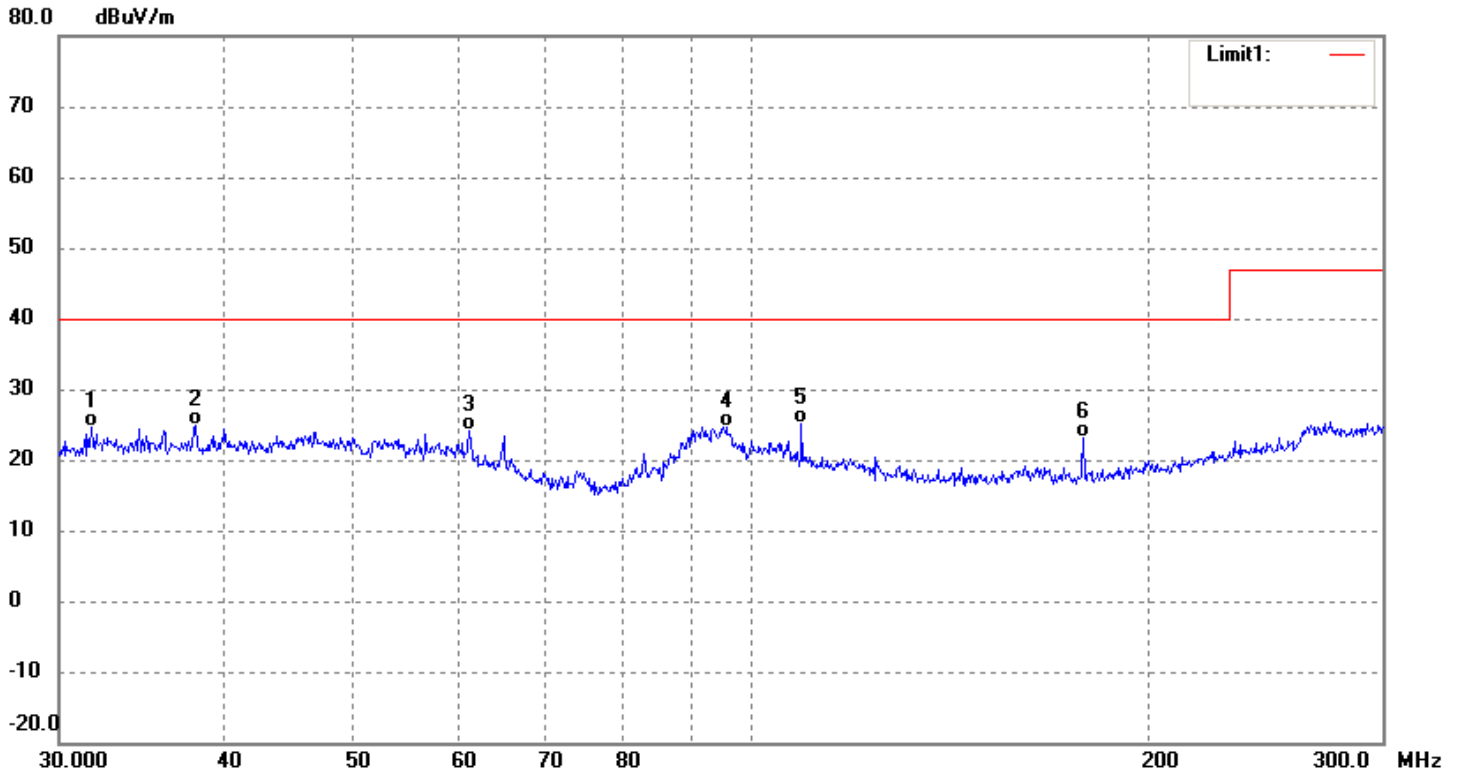


No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Detector
1	38.0296	18.08	6.72	24.80	40.00	-15.20	105	100	QP
2	65.0311	20.20	3.77	23.97	40.00	-16.03	147	100	QP
*3	92.7089	27.01	4.30	31.31	40.00	-8.69	159	100	QP
4	195.0389	21.77	3.44	25.21	40.00	-14.79	166	100	QP
5	224.9683	18.90	5.41	24.31	40.00	-15.69	171	100	QP
6	270.4713	20.16	7.75	27.91	47.00	-19.09	183	100	QP





Test Specification: Vertical



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Degree ( )	Height (cm)	Detector
1	31.7776	16.74	7.91	24.65	40.00	-15.35	102	100	QP
2	38.0296	16.07	8.91	24.98	40.00	-15.02	154	100	QP
3	61.2521	19.08	4.98	24.06	40.00	-15.94	166	100	QP
4	95.7461	19.69	5.06	24.75	40.00	-15.25	179	100	QP
*5	109.1745	19.93	5.16	25.09	40.00	-14.91	184	100	QP
6	178.2876	20.35	2.73	23.08	40.00	-16.92	194	100	QP



## **6.0 Harmonic Current Emissions**

### **6.1 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
Digital Power Analyzer	California Instruments	CTS
Power Source	California Instruments	50001X-CTS-400

### **6.2 Test Procedure**

Test is conducted under the description of EN61000-3-2

### **6.3 Test Standards**

EN61000-3-2, Clause 7.1 Limits for Class C equipment

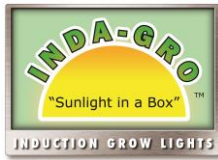
### **6.4 Environmental Conditions**

Temperature: 22°C  
Relative Humidity: 48%  
ATM Pressure: 1022 mbar

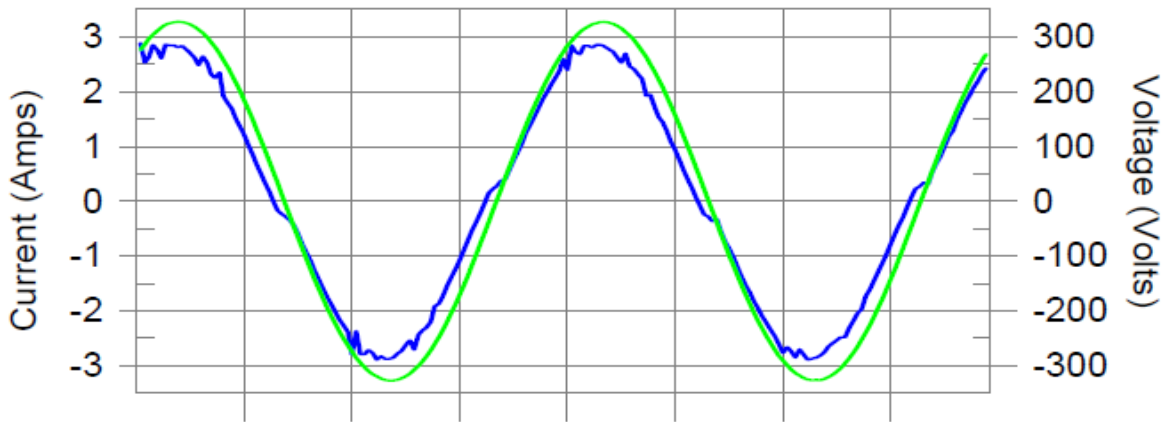
### **6.5 Harmonic Current Emissions Test Data**

Test Category: Class C  
Test Margin: 100  
Test Duration: 2.5 min  
Source Qualification: Normal

**Test Results: Pass**

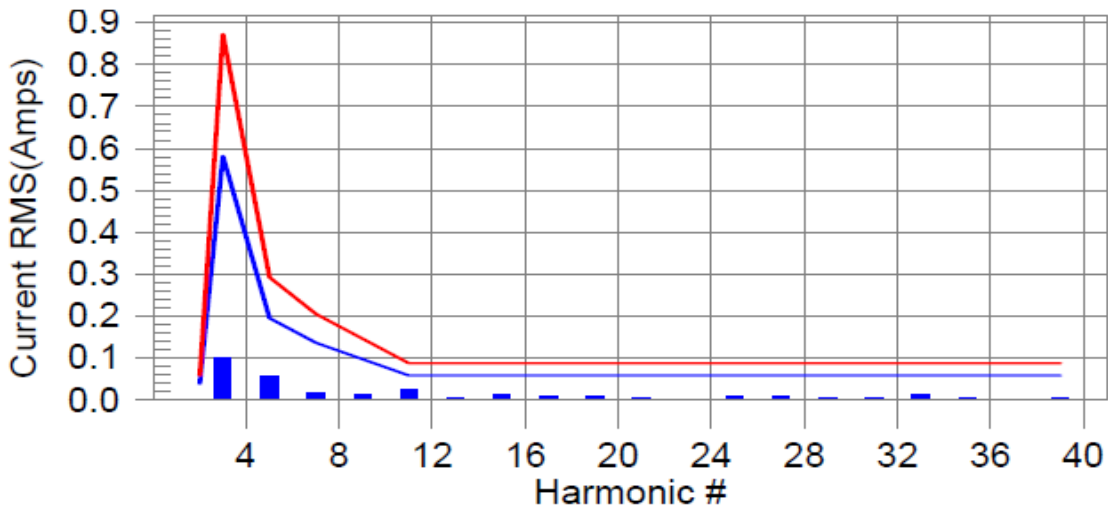


**Current & voltage waveforms**



**Harmonics and Class C limit line**

**European Limits**



**Test result: Pass Worst harmonics H11-45.38% of 100% limit. H11-30.63% of 150% limit.**



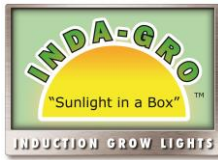
## Current Test Result Summary (Run time)

V\_RMS (Volts): 231.57  
 I\_Peak (Amps): 2.990  
 I\_Fund (Amps): 1.954  
 Power (Watts): 450.2

Frequency (Hz): 60  
 I\_RMS (Amps): 1.959  
 Crest Factor: 1.529  
 Power Factor: 0.993

Harmonics Number	Harmonics Average	100% Limit	Percent Limit	Harmonics Maximum	150% of Limit	Percentage of Limit	Status
2	0.001	0.039	0.0	0.001	0.058	0.0	Pass
3	0.100	0.582	17.1	0.101	0.873	11.59	Pass
4	0.003						
5	0.058	0.195	29.8	0.059	0.293	20.08	Pass
6	0.003						
7	0.016	0.137	11.4	0.016	0.205	7.83	Pass
8	0.002						
9	0.014	0.098	14.3	0.014	0.146	9.79	Pass
10	0.001						
11	0.027	0.059	45.5	0.027	0.088	30.63	Pass
12	0.001						
13	0.007	0.059	0.0	0.007	0.088	0.0	Pass
14	0.001						
15	0.012	0.059	21.3	0.013	0.088	14.43	Pass
16	0.001						
17	0.008	0.059	0.0	0.008	0.088	0.0	Pass
18	0.001						
19	0.008	0.059	0.0	0.008	0.088	0.0	Pass
20	0.001						
21	0.004	0.059	0.0	0.004	0.088	0.0	Pass
22	0.001						
23	0.002	0.059	0.0	0.002	0.088	0.0	Pass
24	0.001						
25	0.011	0.059	0.0	0.011	0.088	0.0	Pass
26	0.001						
27	0.010	0.059	0.0	0.011	0.088	0.0	Pass
28	0.001						
29	0.004	0.059	0.0	0.005	0.088	0.0	Pass
30	0.002						
31	0.005	0.059	0.0	0.005	0.088	0.0	Pass
32	0.001						
33	0.012	0.059	20.8	0.013	0.088	14.25	Pass
34	0.001						
35	0.005	0.059	0.0	0.001	0.088	0.0	Pass
36	0.001						
37	0.001	0.059	0.0	0.001	0.088	0.0	Pass
38	0.001						
39	0.006	0.059	0.0	0.007	0.088	0.0	Pass
40	0.001						

Note: Dynamic limits were applied to this test. The highest harmonics values in the above table may not occur at the same window as the maximum harmonics/limit ratio.



**Voltage Source Verification Data (Run time)**

**Test Results: Pass**

Highest parameter values during test:

Voltage (Vrms):	231.57	Frequency (Hz):	60
I_Peak (Amps):	2.990	I_RMS (Amps):	1.959
I_Fund (Amps):	1.954	Crest Factor:	1.529
Power (Watts):	450.2	Power Factor:	0.993

Harmonics Number	Harmonics V-rms	Limit V-rms	Percentage of Limit	Status
2	0.069	0.463	14.93	OK
3	0.635	2.084	30.46	OK
4	0.071	0.463	15.28	OK
5	0.086	0.926	9.26	OK
6	0.054	0.463	11.73	OK
7	0.032	0.695	4.55	OK
8	0.020	0.463	4.30	OK
9	0.014	0.463	3.02	OK
10	0.014	0.463	3.08	OK
11	0.015	0.231	6.44	OK
12	0.014	0.231	6.26	OK
13	0.013	0.232	5.78	OK
14	0.010	0.231	4.32	OK
15	0.013	0.232	5.47	OK
16	0.012	0.232	5.02	OK
17	0.012	0.232	5.12	OK
18	0.013	0.232	5.53	OK
19	0.011	0.231	4.71	OK
20	0.018	0.231	7.57	OK
21	0.010	0.231	4.19	OK
22	0.010	0.231	4.35	OK
23	0.009	0.231	3.86	OK
24	0.010	0.231	4.49	OK
25	0.016	0.231	6.82	OK
26	0.009	0.231	3.72	OK
27	0.017	0.232	7.26	OK
28	0.010	0.231	4.32	OK
29	0.015	0.231	6.44	OK
30	0.009	0.231	3.99	OK
31	0.012	0.232	5.36	OK
32	0.009	0.232	3.98	OK
33	0.022	0.232	9.29	OK
34	0.008	0.231	3.36	OK
35	0.013	0.232	5.77	OK
36	0.007	0.232	3.20	OK
37	0.011	0.231	4.72	OK
38	0.008	0.232	3.47	OK
39	0.016	0.232	6.92	OK
40	0.012	0.232	5.22	OK



## **7.0 Voltage Fluctuation Flicker**

### **7.1 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
Digital Power Analyzer	California Instruments	CTS
Power Source	California Instruments	50001X-CTS-400

### **7.2 Test Procedure**

Test is conducted under the description of EN61000-3-3

### **7.3 Environmental Conditions**

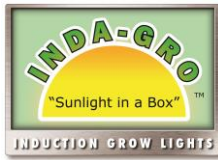
Temperature: 22°C  
Relative Humidity: 48%  
ATM Pressure: 1022 mbar

### **7.4 Voltage Fluctuation and Flicker Data**

#### **Flicker Test Summary per EN/IEC61000-3-3 (Run time)**

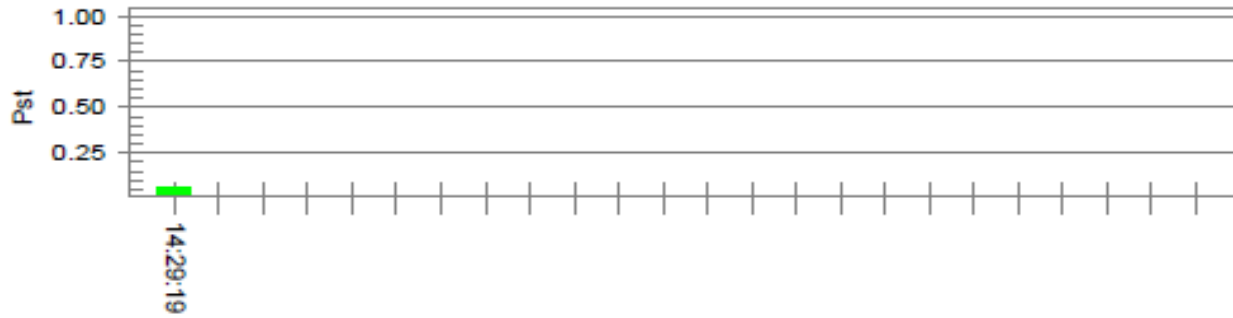
Test Category: All parameters (European limits)  
Test Margin: 100  
Test Duration: 10 min (min)  
Source Qualification: Normal

**Test Results: Pass**

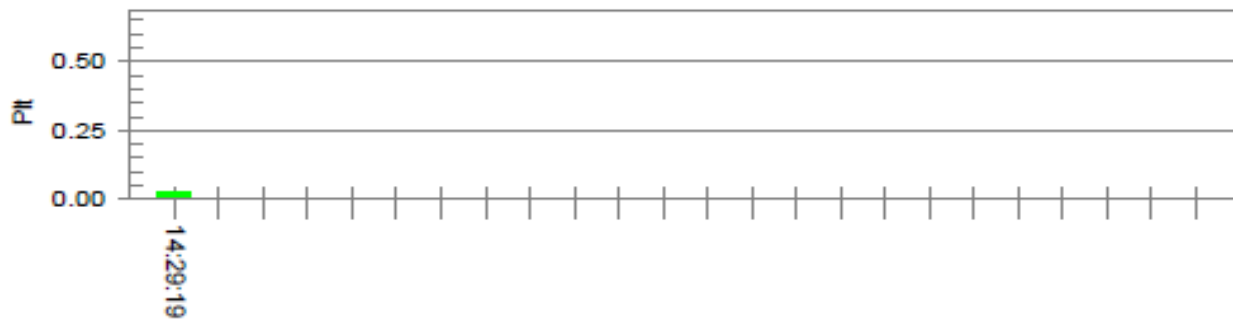


**Pst and limit line**

**European Limits**



**Plt and limit line**



**Parameter values recorded during the test:**

<b>Vrms at the end of test (Volt):</b>	<b>231.51</b>			
<b>Highest dt (%):</b>	<b>0.00</b>	<b>Test limit (%):</b>	<b>3.30</b>	<b>Pass</b>
<b>Time(mS) &gt; dt:</b>	<b>0.0</b>	<b>Test limit (mS):</b>	<b>500.0</b>	<b>Pass</b>
<b>Highest dc (%):</b>	<b>0.00</b>	<b>Test limit (%):</b>	<b>3.30</b>	<b>Pass</b>
<b>Highest dmax (%):</b>	<b>0.00</b>	<b>Test limit (%):</b>	<b>4.00</b>	<b>Pass</b>
<b>Highest Pst (10 min. period):</b>	<b>0.064</b>	<b>Test limit:</b>	<b>1.000</b>	<b>Pass</b>

**8.0 Electrostatic Discharge Immunity (ESD)**

**8.1 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
ESD Generator	TESQ AG	NSG 437

**8.2 Test Procedure**

Test is conducted under the description of IEC61000-4-2  
 Test Performance Criterion: B





### 8.3 Environmental Conditions

Temperature: 26°C  
 Relative Humidity: 55%  
 ATM Pressure: 1011 mbar

### 8.4 Electrostatic Discharge Immunity Test Data

Table 1: Electrostatic Discharge Immunity (Air Discharge)

EN61000-4-2	Test Levels (kV)									
Test Points	-2	+2	-4	+4	-6	+6	-8	+8	-15	+15
Surface	A	A	A	A	A	A	A	A	/	/

Table 2: Electrostatic Discharge Immunity (Direct Contact)

EN61000-4-2	Test Levels (kV)									
Test Points	-2	+2	-4	+4	-6	+6	-8	+8	-15	+15
Screw	A	A	A	A	/	/	/	/	/	/

Table 3: Electrostatic Discharge Immunity (Indirect Contact HCP)

EN61000-4-2	Test Levels (kV)									
Test Points	-2	+2	-4	+4	-6	+6	-8	+8	-15	+15
Front Side	A	A	A	A	/	/	/	/	/	/
Top Side	A	A	A	A	/	/	/	/	/	/
Back Side	A	A	A	A	/	/	/	/	/	/
Left Side	A	A	A	A	/	/	/	/	/	/
Right Side	A	A	A	A	/	/	/	/	/	/

Table 4: Electrostatic Discharge Immunity (Indirect Contact VCP)

EN61000-4-2	Test Levels (kV)									
Test Points	-2	+2	-4	+4	-6	+6	-8	+8	-15	+15
Front Side	A	A	A	A	/	/	/	/	/	/
Top Side	A	A	A	A	/	/	/	/	/	/
Back Side	A	A	A	A	/	/	/	/	/	/
Left Side	A	A	A	A	/	/	/	/	/	/
Right Side	A	A	A	A	/	/	/	/	/	/

**Test Results: Pass**



## **9.0 Radio-Frequency Electromagnetic Fields (R/S)**

### **9.1 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
Signal Generator	Rohde & Schwarz	SMT03
Voltage Probe	Rohde & Schwarz	URV5-Z2
Power Amplifier	AR	150W1000
Power Amplifier	AR	25S1G4AM1
Trilog Antenna	Schwarzbeck	VULB9163
Anechoic Chamber	Albatross Projects	MCDC

### **9.2 Test Procedure**

Test is conducted under the description of IEC61000-4-3  
 Test Performance Criterion: A

### **9.3 Continuous Radiated Disturbance Test Data**

Frequency step: 1% of fundamental  
 Dwell time: 1 second  
 Modulation: AM by 1 kHz sine wave with 80% modulation depth

<b>Frequency Range (MHz)</b>	<b>Field (V/m)</b>	<b>Front</b>		<b>Rear</b>		<b>Left</b>		<b>Right</b>	
		<b>VERT</b>	<b>HORI</b>	<b>VERT</b>	<b>HORI</b>	<b>VERT</b>	<b>HORI</b>	<b>VERT</b>	<b>HORI</b>
80-1000	3	A	A	A	A	A	A	A	A

**Test Results: Pass**

## **10. Electrical Fast Transients (EFT)**

### **10.1 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
Transient 2000	EMC Partner	TRA2000
Couple Clamp	EMC Partner	CN-EFT1000

### **10.2 Test Procedure**

Test is conducted under the description of IEC61000-4-4  
 Test Performance Criterion: B

### **10.3 Environmental Conditions**

Temperature: 22°C  
 Relative Humidity: 53%  
 ATM Pressure: 1011 mbar



## 10.4 Electrical Fast Transients Test Data

EN61000-4-4 Test Points		Test Levels (kV)							
		+0.5	-0.5	+1.0	-1.0	+2.0	-2.0	+4.0	-4.0
Power Supply	L1	A	A	A	A	/	/	/	/
	L2	A	A	A	A	/	/	/	/
	PE	A	A	A	A	/	/	/	/
Power Port of EUT	L1+L2	A	A	A	A	/	/	/	/
	L1+PE	A	A	A	A	/	/	/	/
	L2+PE	A	A	A	A	/	/	/	/
	L1+L2+PE	A	A	A	A	/	/	/	/

**Test Results: Pass**

## 11.0 Surges

### 11.1 Test Equipment List and Details

Description	Manufacturer	Model
Transient 2000	EMC Partner	TRA2000

### 11.2 Test Procedure

Test is conducted under the description of IEC 61000-4-5

Test Performance Criterion: B

### 11.3 Environmental Conditions

Temperature: 25°C

Relative Humidity: 53%

ATM Pressure: 1011 mbar

### 11.4 Surge Test Data

Level	Voltage	Poll	Path	Pass	Fail
1	0.5kV	±	L-N, L-PE,N-PE	A	/
2	1kV	±	L-N,L-PE,N-PE	A	/
3	2kV	±	L-PE, N-PE	A	/
4	4kV	±	L-N,L-PE,N-PE	/	/

**Test Results: Pass**



## **12.0 Injected Currents (C/S)**

### **12.1 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
CSI Immunity Tester	EMTEST	CWS500
Attenuator	EMTEST	MA-500
CDN	Luthi	L-801M2/M3

### **12.2 Test Procedure**

Test is conducted under the description of IEC61000-4-6

Test Performance Criterion: A

### **12.3 Environmental Conditions**

Temperature: 25°C

Relative Humidity: 53%

ATM Pressure: 1011 mbar

### **12.4 Continuous Conducted Disturbances Test Data**

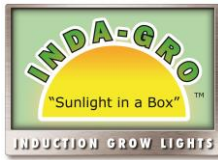
Sweep frequency range: 150kHz-80MHz

Frequency step: 1% of fundamental

Dwell time: 1 second

<b>Level</b>	<b>Voltage Level (EMF) <math>U_0</math></b>	<b>Modulation</b>	<b>Pass</b>	<b>Fail</b>
1	1	AM 80%, 1kHz sinewave	/	/
2	3	AM 80%, 1kHz sinewave	A	/
3	10	AM 80%, 1kHz sinewave	/	/
X	Special		/	/

**Test Results: Pass**



### **13.0 Voltage Dips and Interruptions**

#### **13.1 Test Equipment List and Details**

<b>Description</b>	<b>Manufacturer</b>	<b>Model</b>
Transient 2000	EMC Partner	TRA2000

#### **13.2 Test Procedure**

Test is conducted under the description of IEC 61000-4-11  
Test Performance Criterion: B/C

#### **13.3 Environmental Conditions**

Temperature: 25°C  
Relative Humidity: 50%  
ATM Pressure: 1011 mbar

#### **13.3 Voltage Dips and Interruptions Test Data**

U: Voltage dips in %  $U_t$  ( $U_t$  is rated voltage for the EUT)  
T: Test duration

<b>Level</b>	<b>U</b>	<b>T</b>	<b>Phase Angle</b>	<b>N</b>	<b>Pass</b>	<b>Fail</b>
1	30%	200ms		3	B	/
2	100%	10ms		3	A	/

**Test Result: Pass**