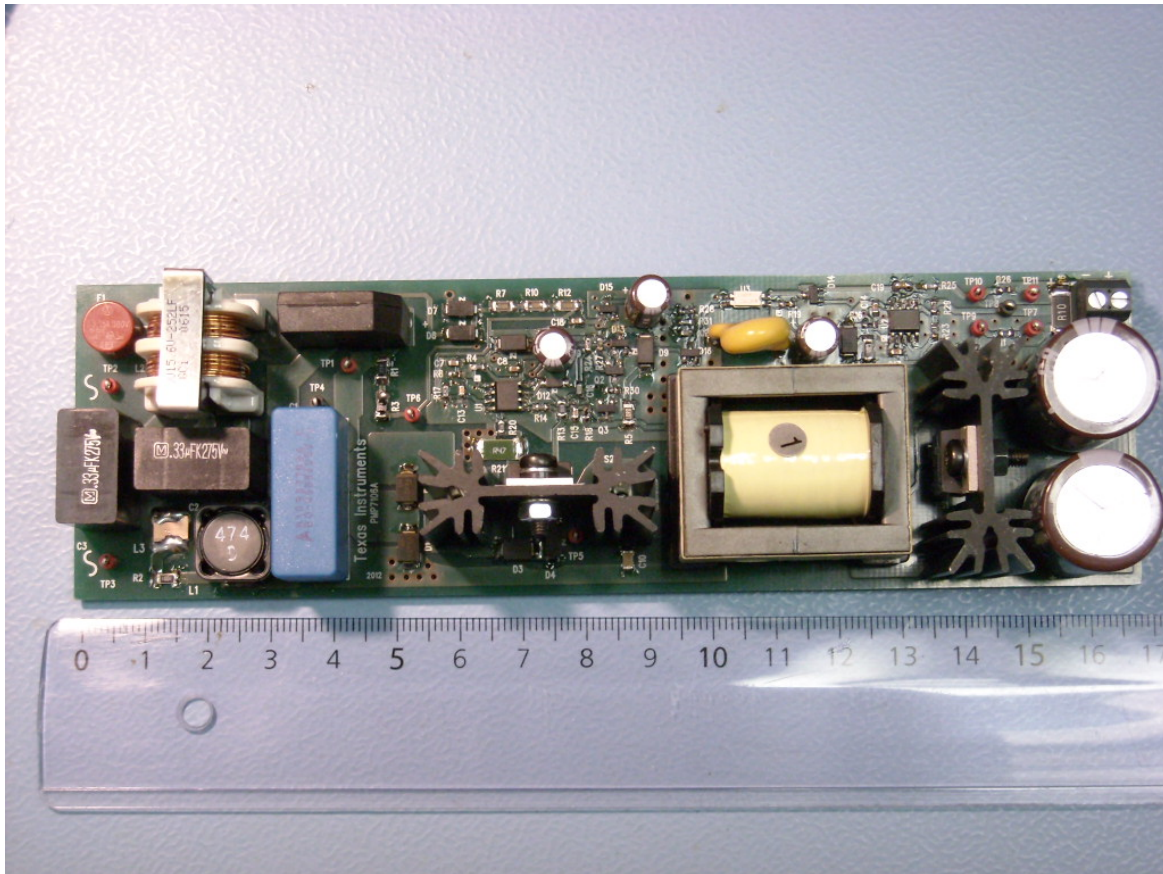


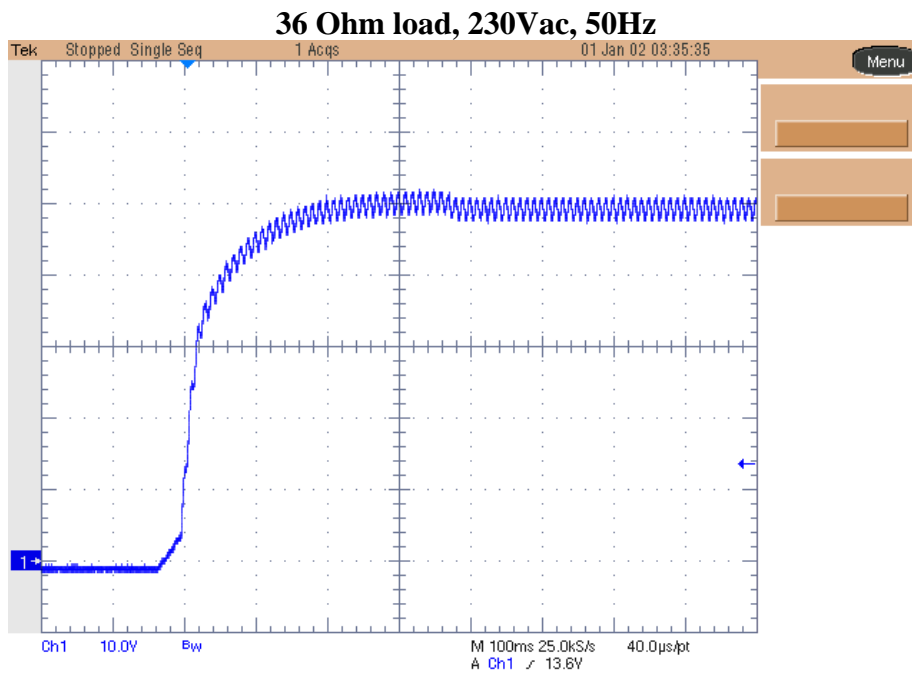
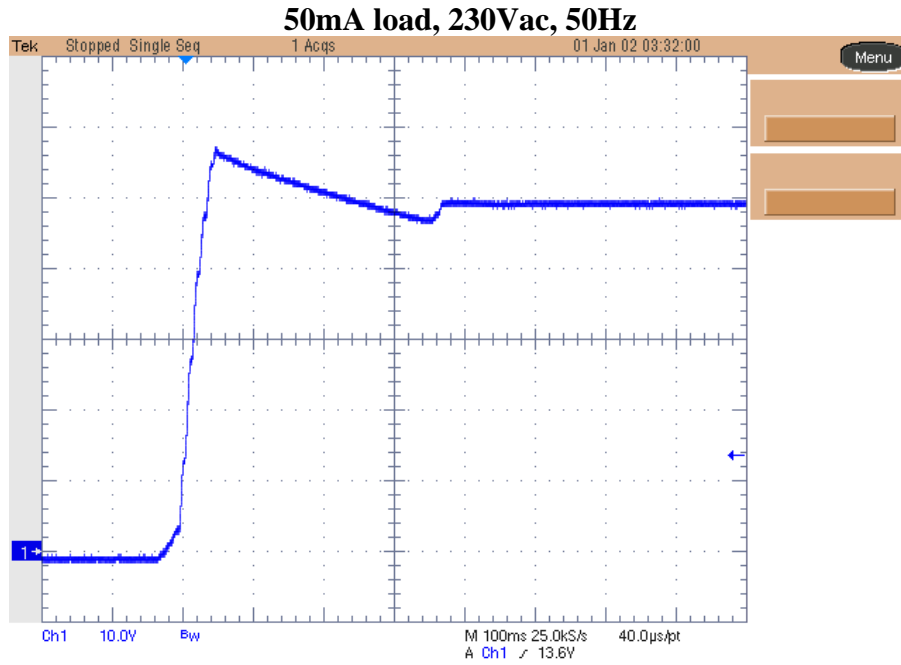
**PHOTO OF THE PROTOTYPE:**

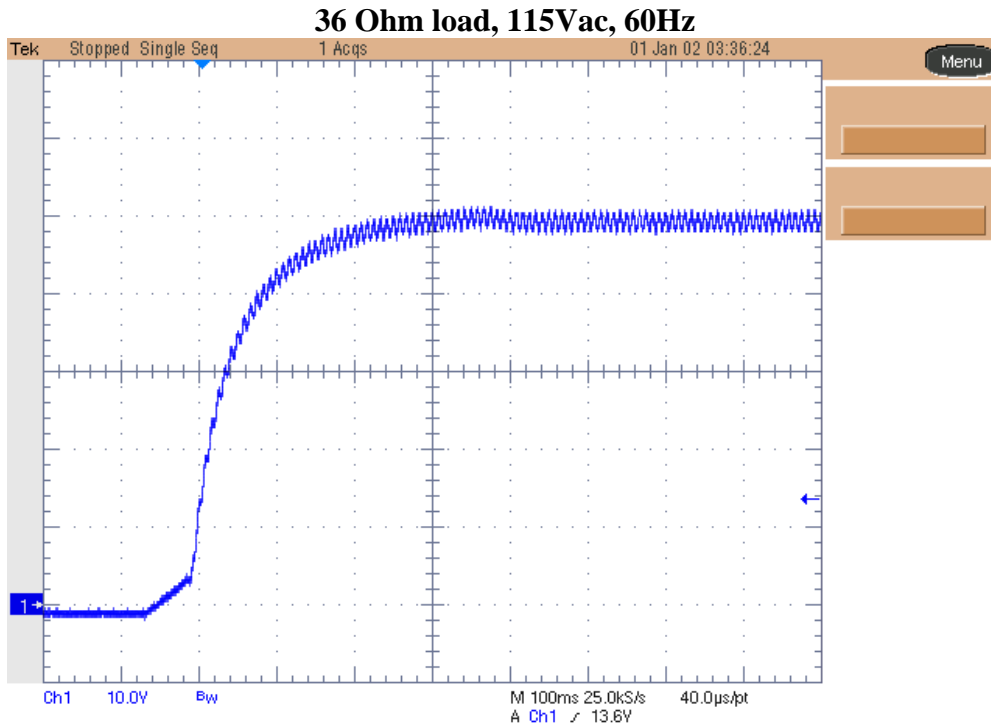
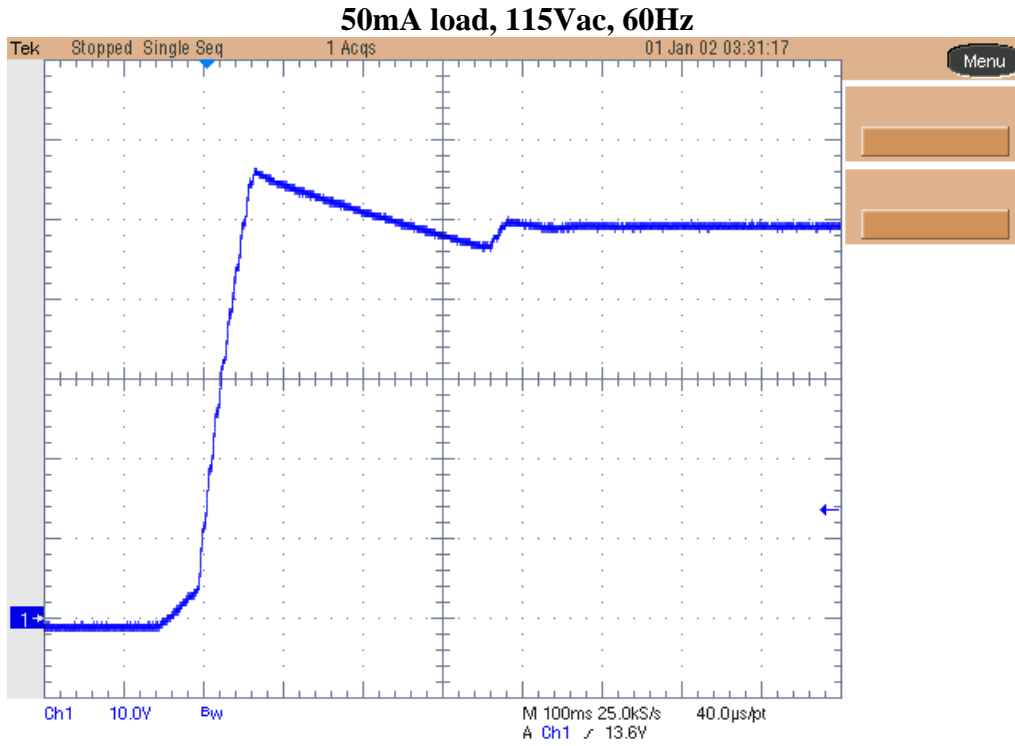


## 1 Startup

The output voltage at startup is shown in the images below. The input voltage was set to 115Vac, 60Hz and 230Vac, 50Hz and board tested with the minimum (50mA) and the maximum (36 Ohm resistor) load.

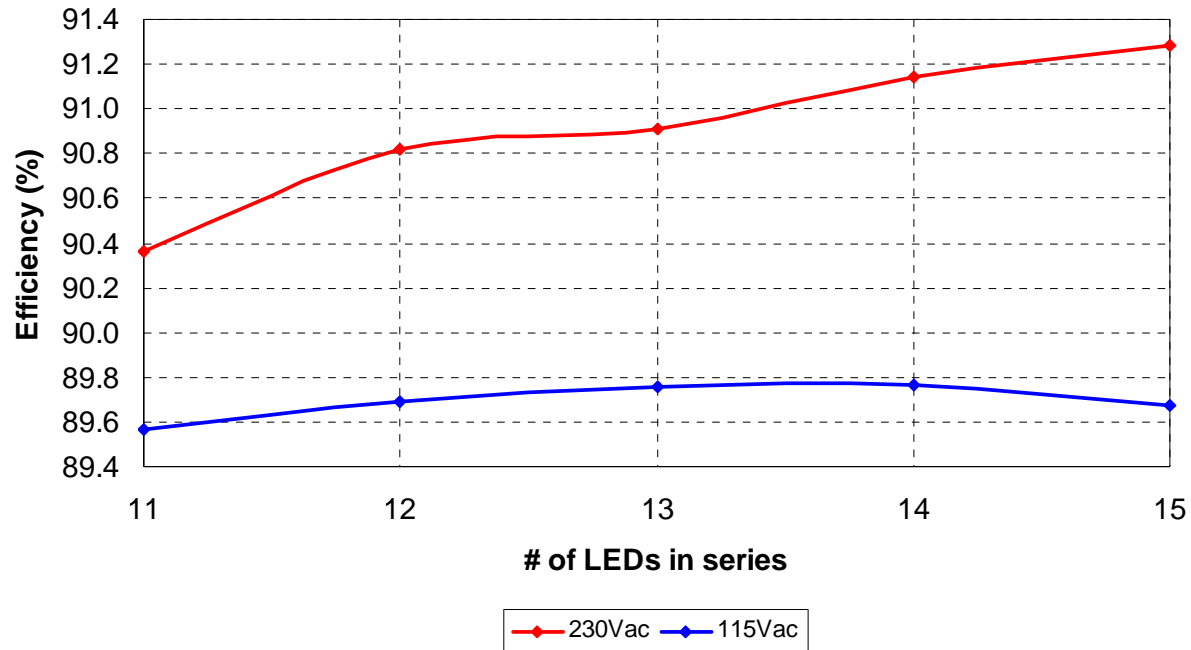
Channel 1: Output voltage (10V/div, 100ms/div, 20MHz BWL)





## 2 Efficiency

The efficiency data are shown in the tables and graph below. A variable number of LEDs, from 11 to 15, has been connected to the output and the efficiency data taken at 230Vac, 50Hz and 115Vac, 60Hz.

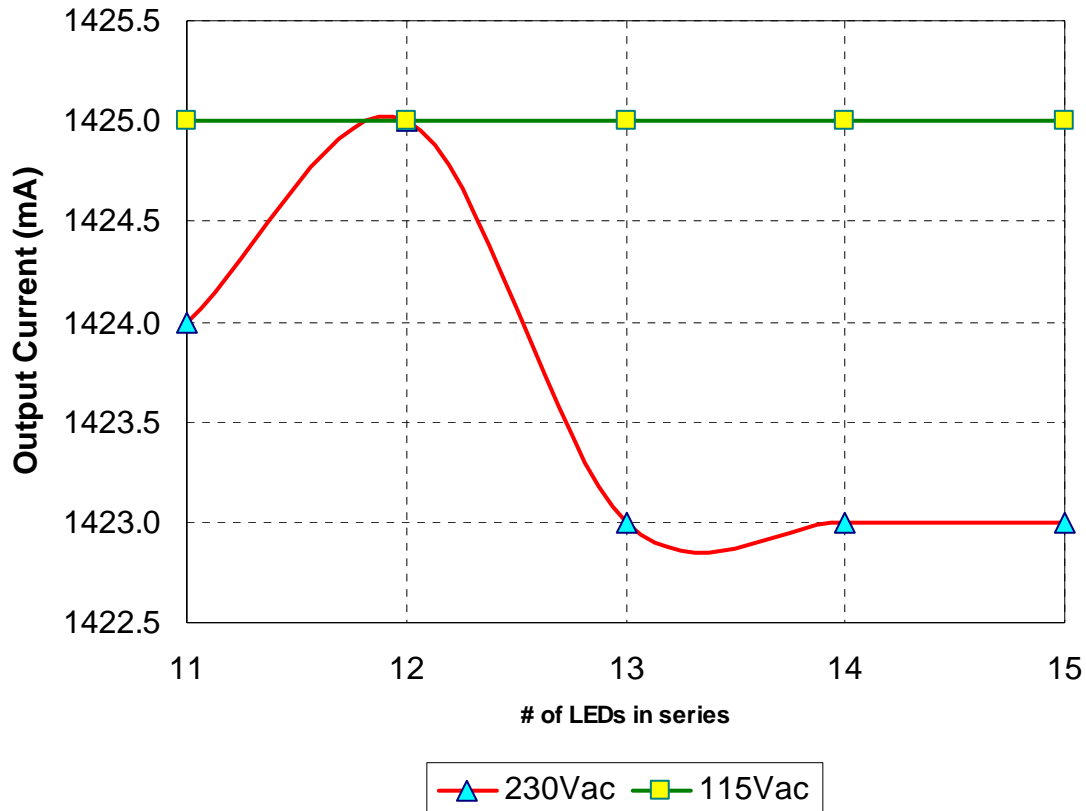


| Iout (mA) | Vout (Vdc) | Pout (W) | Vin (Vac) | Pin (W) | Ploss (W) | Eff (%) | PF    | # of LEDs |
|-----------|------------|----------|-----------|---------|-----------|---------|-------|-----------|
| 1424      | 34.99      | 49.83    | 230       | 55.14   | 5.31      | 90.36   | 88.33 | 11        |
| 1425      | 38.17      | 54.39    | 230       | 59.89   | 5.50      | 90.82   | 89.53 | 12        |
| 1423      | 41.20      | 58.63    | 230       | 64.49   | 5.86      | 90.91   | 90.58 | 13        |
| 1423      | 44.34      | 63.10    | 230       | 69.23   | 6.13      | 91.14   | 91.47 | 14        |
| 1423      | 47.43      | 67.49    | 230       | 73.94   | 6.45      | 91.28   | 92.21 | 15        |

| Iout (mA) | Vout (Vdc) | Pout (W) | Vin (Vac) | Pin (W) | Ploss (W) | Eff (%) | PF    | # of LEDs |
|-----------|------------|----------|-----------|---------|-----------|---------|-------|-----------|
| 1425      | 34.96      | 49.82    | 115       | 55.62   | 5.80      | 89.57   | 98.07 | 11        |
| 1425      | 38.15      | 54.36    | 115       | 60.61   | 6.25      | 89.69   | 98.24 | 12        |
| 1425      | 41.15      | 58.64    | 115       | 65.33   | 6.69      | 89.76   | 98.33 | 13        |
| 1425      | 44.31      | 63.14    | 115       | 70.34   | 7.20      | 89.77   | 98.44 | 14        |
| 1425      | 47.38      | 67.52    | 115       | 75.29   | 7.77      | 89.68   | 98.52 | 15        |

### 3 Output current regulation

The graph of the output current versus # of series-connected LEDs is plotted below.

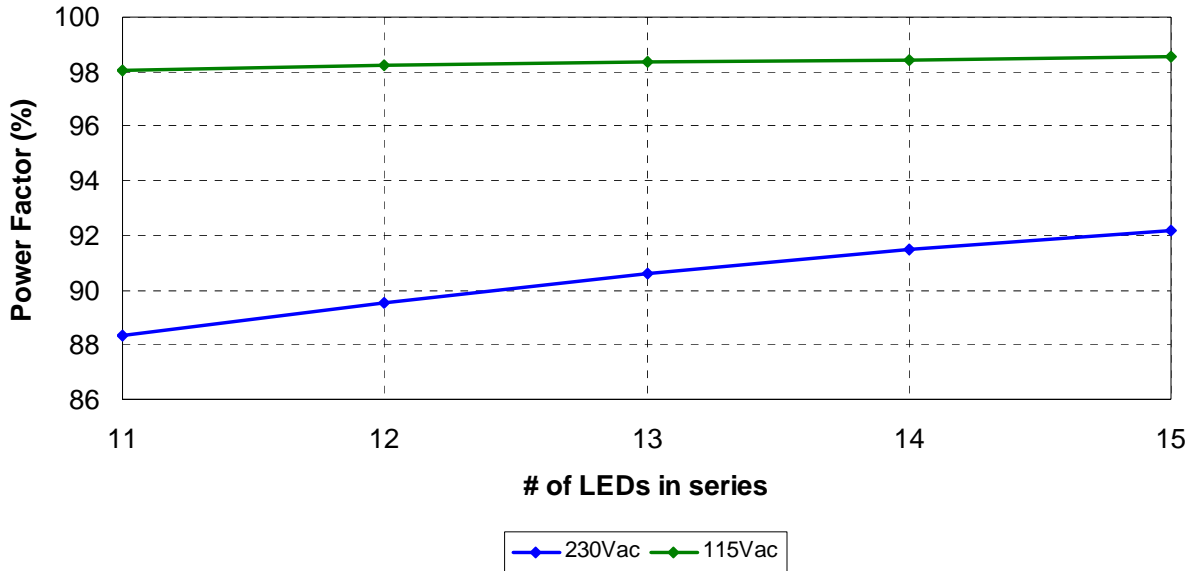


### 4 Output voltage regulation

The output voltage regulation has been measured by varying the load with a constant-resistance electronic load. The output minimum current was 46mA. Below this value the power supply enters into hiccup mode (at 115Vac) showing high output ripple voltage. Therefore it is recommended that, when the power supply is used as constant voltage generator, to have a minimum load of 50mA; from this value to the maximum, 1.4A, no voltage variation has been measured, either at 115V, 60Hz or 230V, 50Hz, and the converter delivered 50.05V constant.

### 5 Power Factor

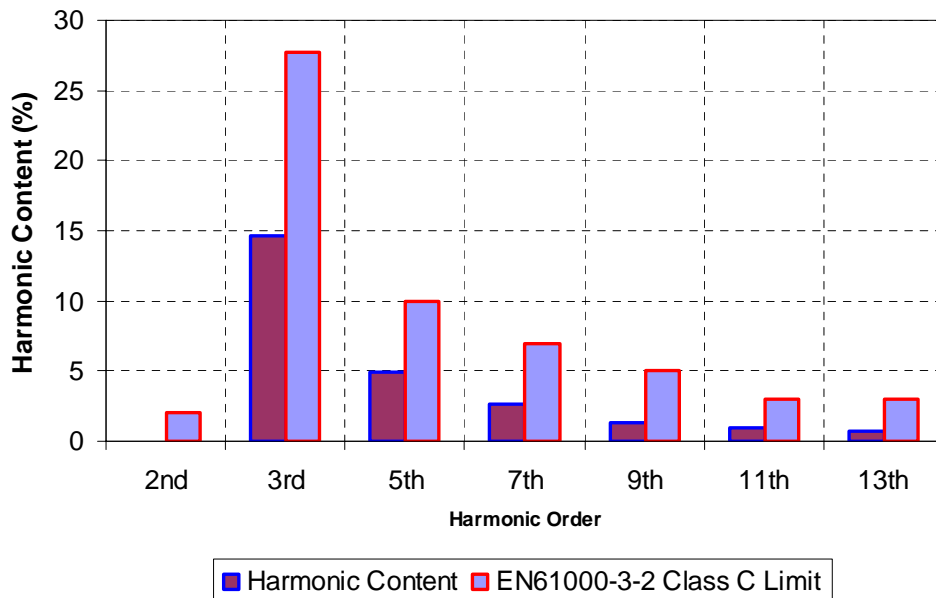
The Power Factor graph for the two input voltages is shown below:



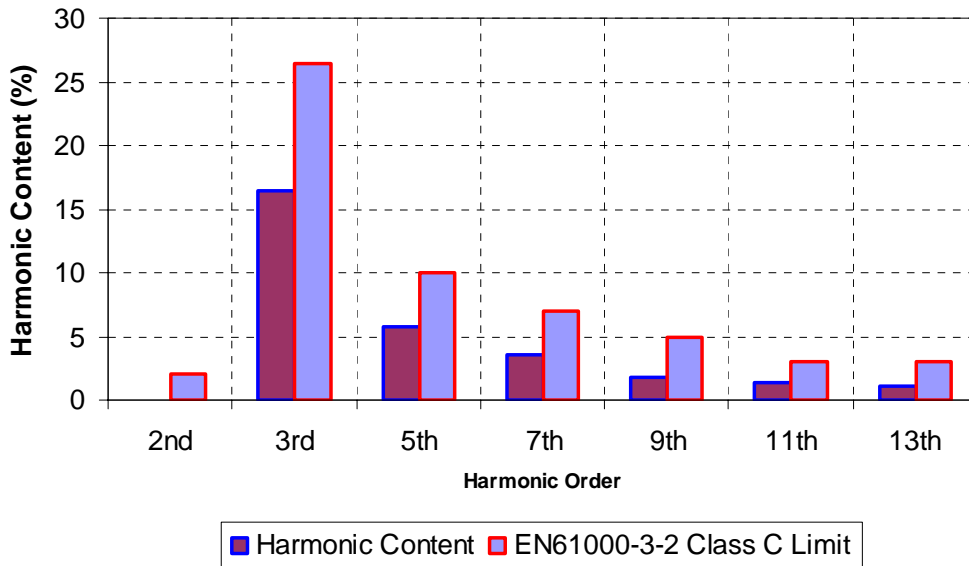
### 6 EN61000-3-2 Class C European Limits

The graphs below show the limits and measured data for two situations: 15LEDs and 11LEDs strings. The power supply complies with both power levels. The input was 230Vac.

15 LEDs in series



11 LEDs in series



Measured Data:

| 15 LEDs in series |       |                           |
|-------------------|-------|---------------------------|
| Harmonic Order    | %     | EN61000-3-2 Class C Limit |
| Found.            | 100.0 | //                        |
| 2nd               | 0.03  | 2.0                       |
| 3rd               | 14.58 | 27.7                      |
| 5th               | 4.93  | 10.0                      |
| 7th               | 2.67  | 7.0                       |
| 9th               | 1.31  | 5.0                       |
| 11th              | 0.92  | 3.0                       |
| 13th              | 0.73  | 3.0                       |

(30\*PF)

| 11 LEDs in series |       |                           |
|-------------------|-------|---------------------------|
| Harmonic Order    | %     | EN61000-3-2 Class C Limit |
| Found.            | 100.0 | //                        |
| 2nd               | 0.06  | 2.0                       |
| 3rd               | 16.38 | 26.5                      |
| 5th               | 5.82  | 10.0                      |
| 7th               | 3.53  | 7.0                       |
| 9th               | 1.82  | 5.0                       |
| 11th              | 1.36  | 3.0                       |
| 13th              | 1.04  | 3.0                       |

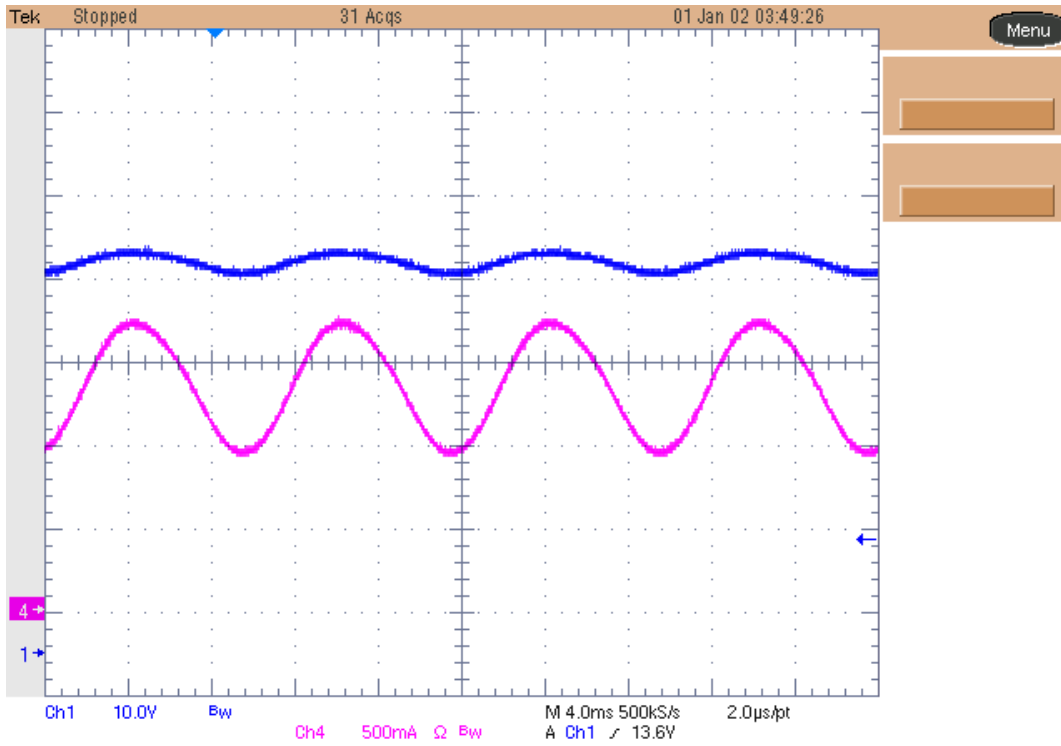
(30\*PF)

## 7 Output voltage and current ripple

The output voltage and current ripple is shown in the plot below. The input was set at 230Vac and the load was a string of 15 LEDs.

Channel 1: Output voltage (10V/div, 4ms/div, dc coupling, 20MHz BWL).

Channel 4: Output current (500mA/div, dc coupling, 20MHz BWL).

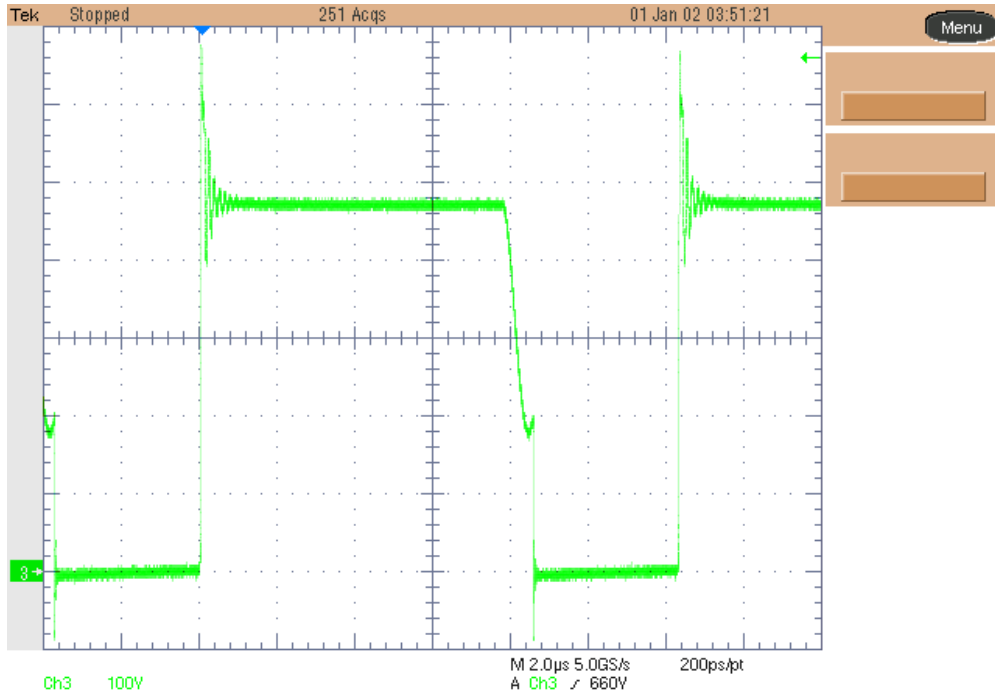




### 8 Switching Node Waveform

The image below shows the voltage on the drain of the switching node (Q1), with a 230Vac input, and 15LEDs string.

Channel 3: Drain voltage (100V/div, 2us/div, no BWL).

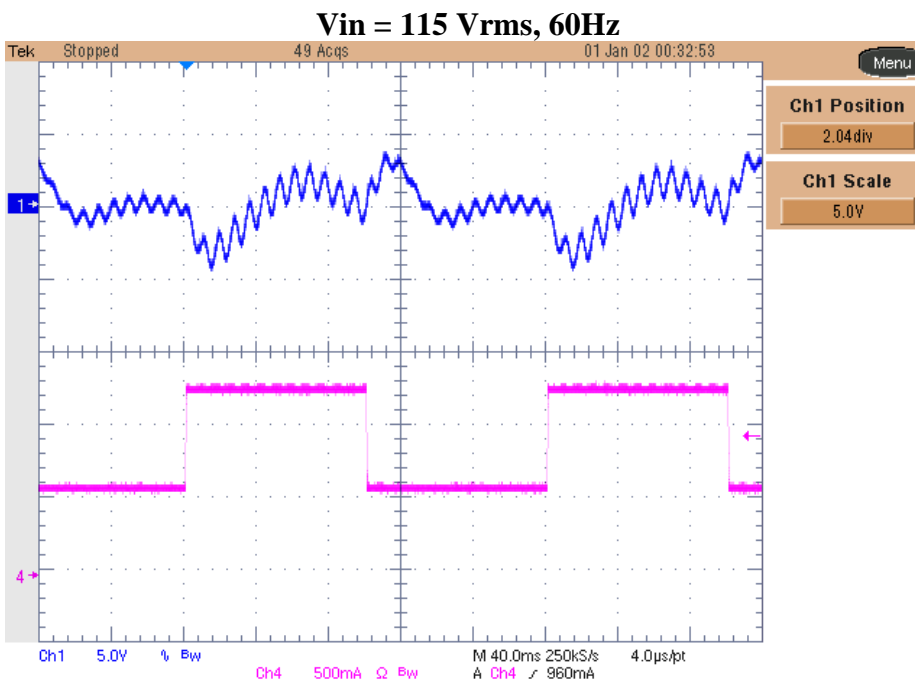
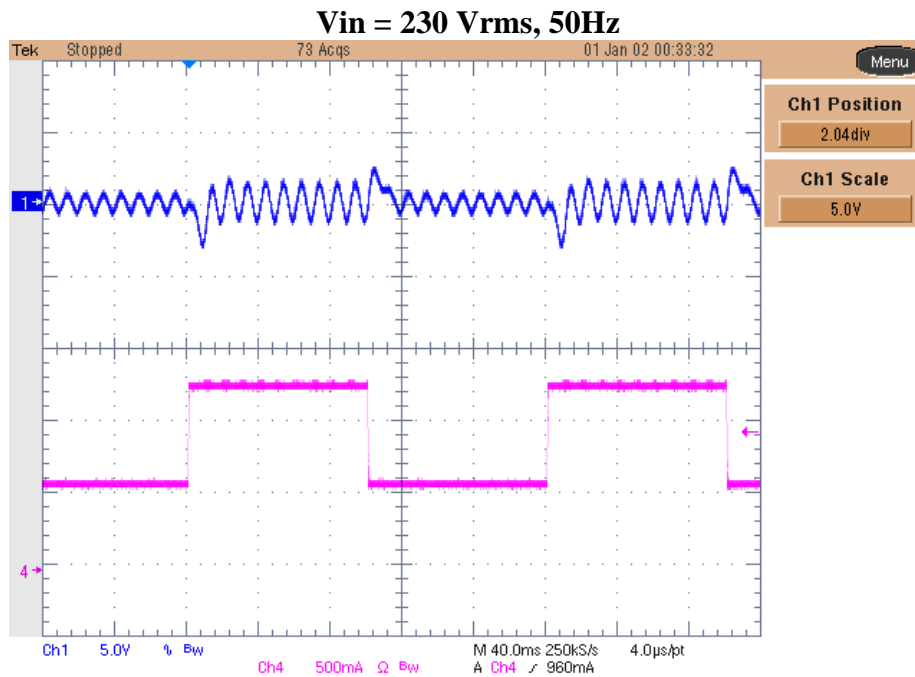


## 9 Transient response in voltage control mode

The images below show the output voltage behavior while the current was switched between 600mA and 1.3A, therefore remaining into the constant voltage control.

Channel 1: Output voltage (5V/div, 40ms/div, ac coupling, 20MHz BWL).

Channel 4: Output current (500mA/div, dc coupling, 20MHz BWL).

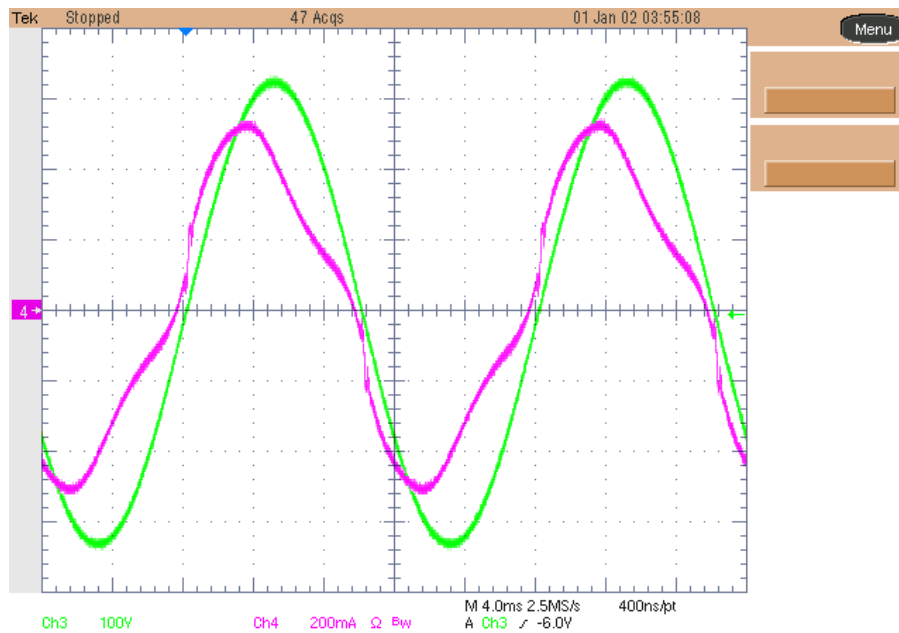


## 10 Input voltage and current waveforms

The images below show the input voltage and current while the source was set to the two different input voltages and the converter was loaded with 15LEDs.

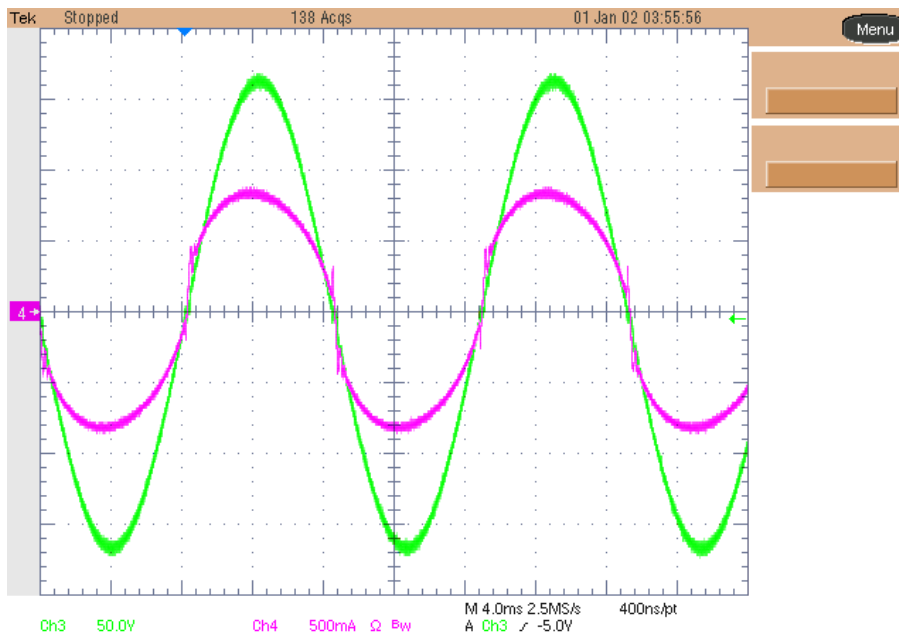
**V<sub>in</sub> = 230 V<sub>rms</sub>, 50Hz**

Channel 3: Input voltage (100V/div, 4ms/div); Channel 4: Input current (200mA/div)



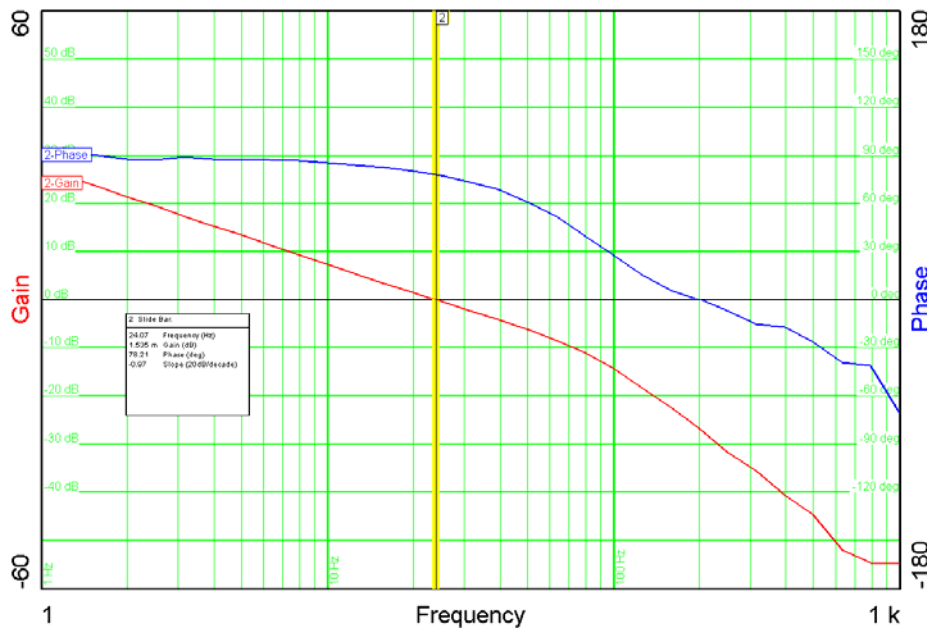
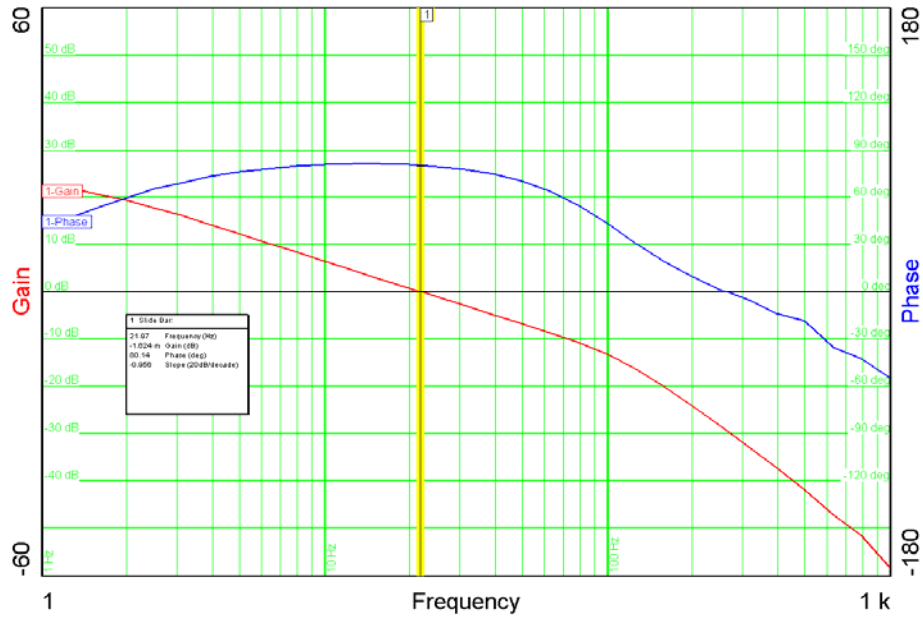
**V<sub>in</sub> = 115 V<sub>rms</sub>, 60Hz**

Channel 3: Input voltage (50V/div, 4ms/div); Channel 4: Input current (500mA/div)



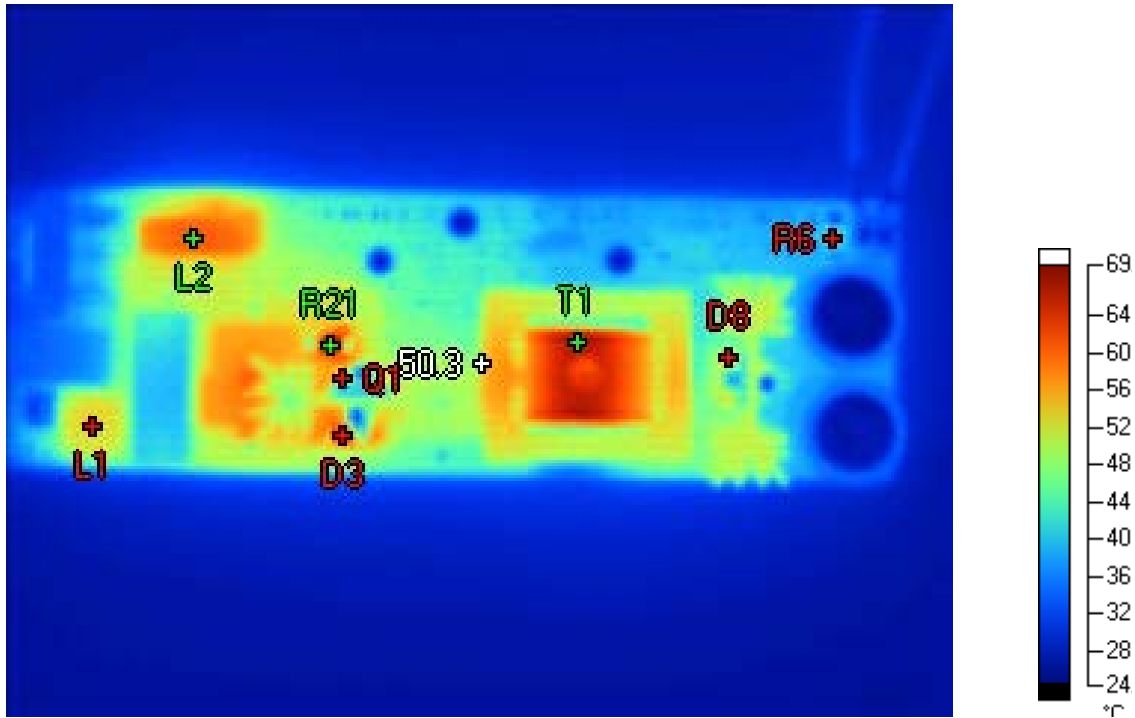
### 11 Loop Response

The graph below shows the loop response of the converter measured with a 320Vdc input, with 15LEDs connected to the output, while the lower graph shows the behavior with a 38 Ohm resistor load, allowing the converter working into constant voltage control. The worst case phase margin was 78.21 deg. The crossover frequency was respectively 22Hz and 24Hz.



## 12 Thermal Image

The graph below shows thermal image (after 60 min. running) of the converter placed horizontally on the bench. The input voltage was set to 115V, 60Hz and the converter was loaded with a 1.3A constant current.



### Image Info

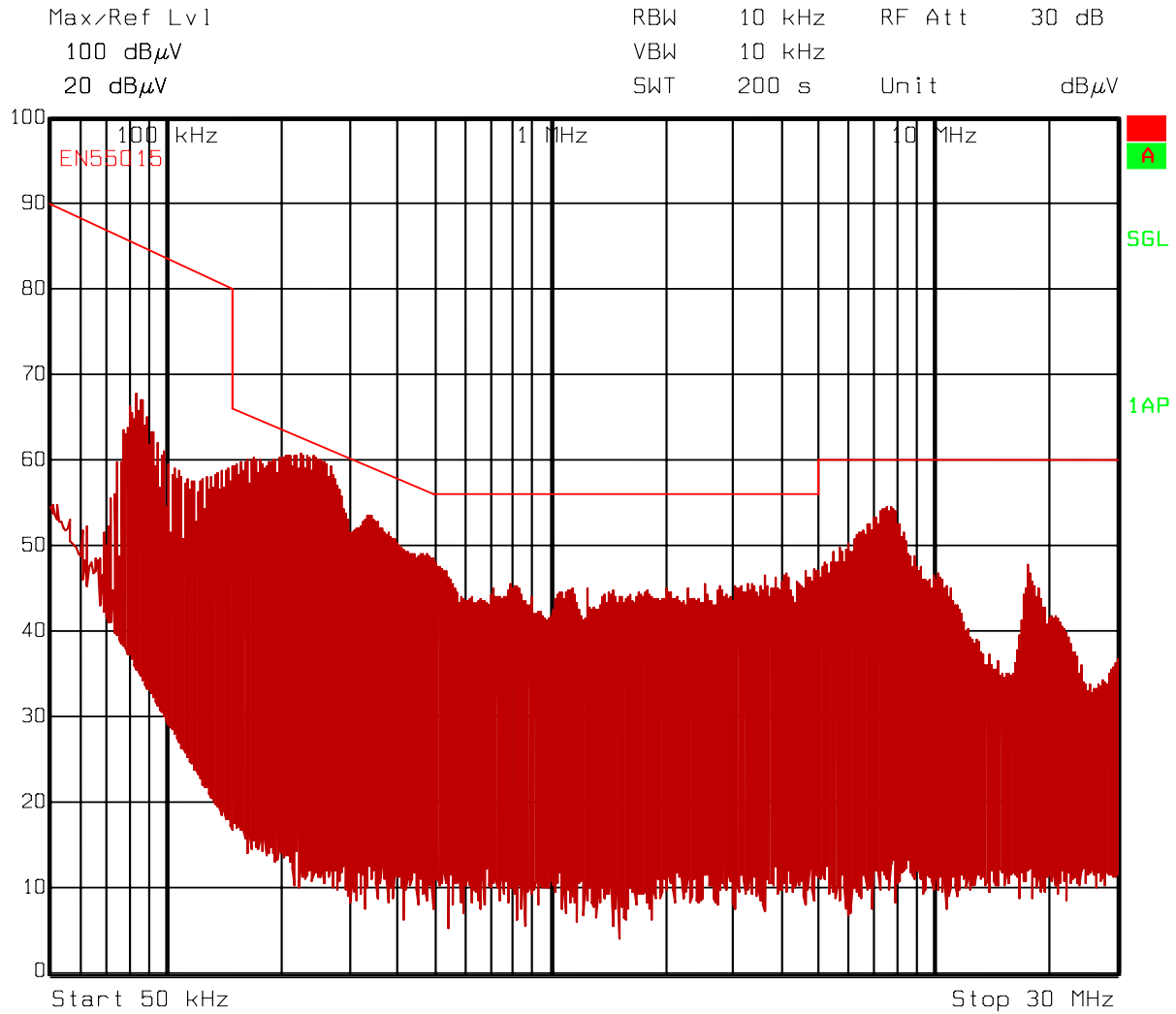
|                      |                       |
|----------------------|-----------------------|
| Average Temperature  | 34.1 °C               |
| Camera Model         | TI40FT                |
| Image Range          | 25.4 °C to 68.5 °C    |
| Image Time           | 3/14/2012 12:18:21 PM |
| Manufacturer         | Fluke                 |
| Camera Serial Number | TI40FT-070263         |

### Markers

| Label | Temperature | Emissivity | Background |
|-------|-------------|------------|------------|
| T1    | 67.8 °C     | 0.95       | 23.0 °C    |
| D8    | 52.0 °C     | 0.95       | 23.0 °C    |
| R6    | 43.0 °C     | 0.95       | 23.0 °C    |
| R21   | 67.9 °C     | 0.95       | 23.0 °C    |
| Q1    | 50.5 °C     | 0.95       | 23.0 °C    |
| D3    | 61.1 °C     | 0.95       | 23.0 °C    |
| L2    | 60.4 °C     | 0.95       | 23.0 °C    |
| L1    | 53.0 °C     | 0.95       | 23.0 °C    |

### 13 EMI Measurement

The graph below shows EMI scan taken @ 230Vac,50Hz. The converter has been supplied by means of an isolation transformer and a Hameg 6050-2 LISN and the measurement performed by a Rohde & Schwarz 9 KHz...3.5 GHz receiver. The red segment shows the EN55015 “quasi peak” limits, needed for lighting equipments.



Title: FF1o1  
Date: 13.MAR.2012 14:36:51

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