EVBUM2705/D

Connected Lighting Platform User Manual (LIGHTING-1-GEVK)

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EVAL BOARD USER'S MANUAL

The following manual provides detailed information about the hardware associated with the Connected Lighting Platform.

HARDWARE OVERVIEW

The lighting development kit consist of several plug−in evaluation board building up a complete industrial lighting solution with power supply, LED driving system and Bluetooth® Low Energy connectivity through the RSL10 Control and Sense mobile app.

FEATURES

- Modular Design
- New High Power Lighting
- 2 Strings × 16 LEDs
  (121 Lumen + 95 Lumen) = 7000 Lumen
- Dual Independent LED Channel
- White Balance Control 12 bits Dimmer from 0 to Max
- 4000 Steps Dimming
- AC Source (Worldwide) or POE Input (802.3bt)
- High Efficiency Power Conversion
  (>90% at Full Load)
- iOS®/Android® Mobile App "RSL10 Sense and Control" with Multiple Features Including Energy Consumption Computation
- EMS Friendly and Low Cost PCB Layout
- Compatible with DALI Interface via UART Interface
- Software Fully Based on FreeRTOS Running on RSL10
- Debugger Port (Compatible with JLINK ULTRA Plus Debugger on RLS10 MCU and Low Cost Debugger)

ADDITIONAL RESOURCES

- Connected Lighting Platform Software Readme
- Connected Lighting Platform Getting Started Guide

CONNECTED LIGHTING MODULES

Figure 1 provides a list of the modules provided within and alongside the Connected Lighting Platform. AC/DC is the default power supply. Power Over Ethernet (PoE) is also supported as a separately orderable module (LIGHTING−POWER−POE−GEVB).

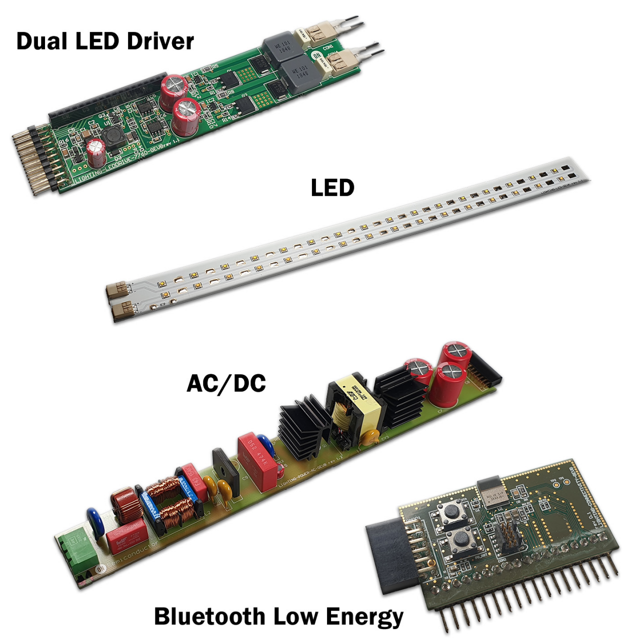

Figure 1. Connected Lighting Platform

HARDWARE DETAILS

Below is the summary table supporting core electrical parameters for the Connected Lighting Platform.

Table 1. CONNECTED LIGHTING PLATFORM CORE ELECTRICAL PARAMETERS AND REGULATIONS

Connected Lighting PlatformPn#	Parameters	
LIGHTING−1−GEVK	Topology	CV flyback with PFC
	Regulation	Constant voltage
	Vin AC [V]	90−270
	Vout DC [V]	56
	Pout max [W]	70
	Efficiency [%]	> 92% @ 70 W
	PF [–]	> 0.995 @ 70 W
	Standby Power [mW]	< 170 mW across 90−270 Vac
	PF [–]	> 0.96 @ 50% dimming
	THD [%]	Limits according IEC61000−3−2−2014
Regulations	AC/DC Power Module **layout compliance to EN60950** Safety standard	
	AC/DC Power Module, **transformer complies with reinforced isolation primary secondary according to EN61347−1 for lighting.**	
	Connected Lighting Platform (advertising mode). **Standby Power less than 200 mW according to CEC2019 standard**. Power measurements were carried out in accordance with the requirements of **IEC62301 Ed. 2: "Measurement of standby power" and EN50564:2011** in the laboratory environment, using equipment traceable to national or international standards.	
	EMC conducted emissions pass according to Lighting standard EN55015	
	AC/DC Power Module + LED Driver Module **THD Limits** according to **IEC61000−3−2−2014**	

LED Driver Module

This module holds two FL7760 LED drivers, auxiliary power supply generating 3.3V for MCU module, self−supply of op amps gathering telemetry data and as auxiliary supply for external PoE Module's logic and other new modules going forward. It features header for pluggable MCU module to enhance wireless connectivity.

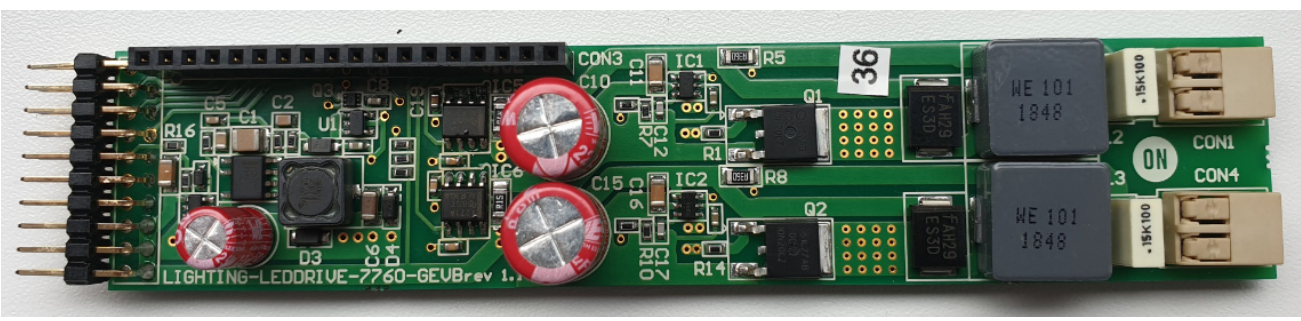

Figure 2. Overview Image of the LED Driver Module

Features:

- Dual LED driver based on FL7760
- Electrical efficiency up to 96%
- Input voltage 55 V by default
- Output: constant current 500 mA (ranging 12–60 Vdc in depending on # of LEDs)
- Telemetry data: current and voltage measurement for each LED driver
- Dimming capability down to 0.6% and 12−bit PWM resolution
- DCDC converter with PG pin and P−FET for PoE bt module
- 2 layer PCB − cost effective solution
- Default 16 LEDs in the string (voltage drop on the string ~50 V)

* Each LED driver is designed for 25 W max power, constant current operation
* Whole LED driver module consumption at 100% dimming level >50 W

The following data was measured using outlined equipment in the below table.

Table 2. EQUIPMENT UTILIZED FOR GETTING THE MEASURED DATA

Type of Equipment	Model
DC source	Chroma 61012P−80−60
Power analyzer	Textronix PA3000

Table 3. EFFICIENCY OF THE LED DRIVER MODULE VS. NUMBER OF LEDS CONNECTED IN THE STRING

Number of LEDs	16	15	14
η [%]	96	94.8	93.8

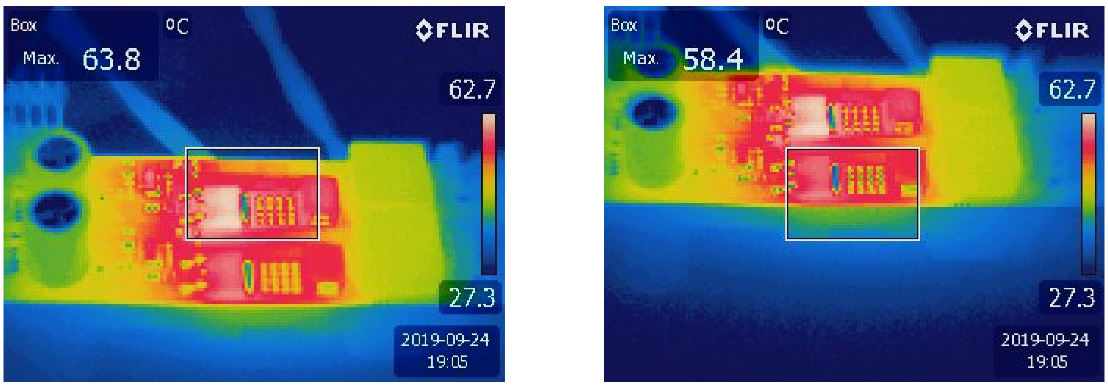

Figure 3. Thermal Image of Power Transistors (Both Channels Active, 16 LEDs in the String – Power 55 W)

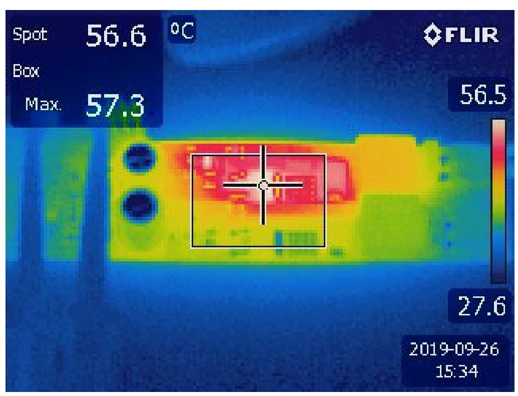

Figure 4. Thermal Image of Power Transistor (Single Channel active, 15 LEDs in the String – Power 27 W)

AC/DC POWER MODULE

This module holds two FL7740 PSR flyback controller with PFC, acting as a power front end module to deliver desired energy output for LED driver board and LEDs themselves.

Features:

- Topology: PFC flyback, Constant Voltage output FL7740
- Simulation model of the flyback system available (Simetrix)
- Vin AC: 90–270 V
- Pout electrical: 70 W
- Vout DC: 55 V
- Power Factor >0.99 at full load
- Efficiency >91%
- Single layer PCB – cost effective solution

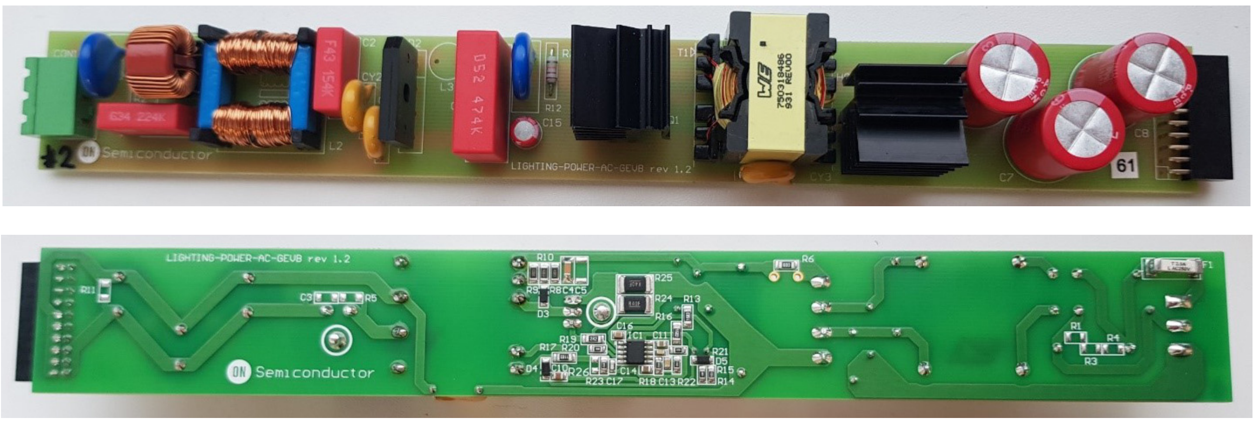

Figure 5. Overview Image of the ACDC Isolated PFC Front – End Module

The following data was measured using outlined equipment in the below table.

Table 4. EQUIPMENT UTILIZED FOR GETTING THE MEASURED DATA

Type of Equipment	Model
DC source	Chroma 61012P–80–60
Power analyzer	Tektronix PA3000
AC power source	Agilent 6811B
Power analyzer	Tektronix PA3000
Electronic load	Chroma 6147A

EFFICIENCY AND POWER LOSSES OF THE POE MODULE

The following conditions were taken to provide measurement results:

- Output power Pout ~ 70 W
- Electronic load: Chroma 6147A used channel 3 as CLH (constant current high mode → 1.27 A)

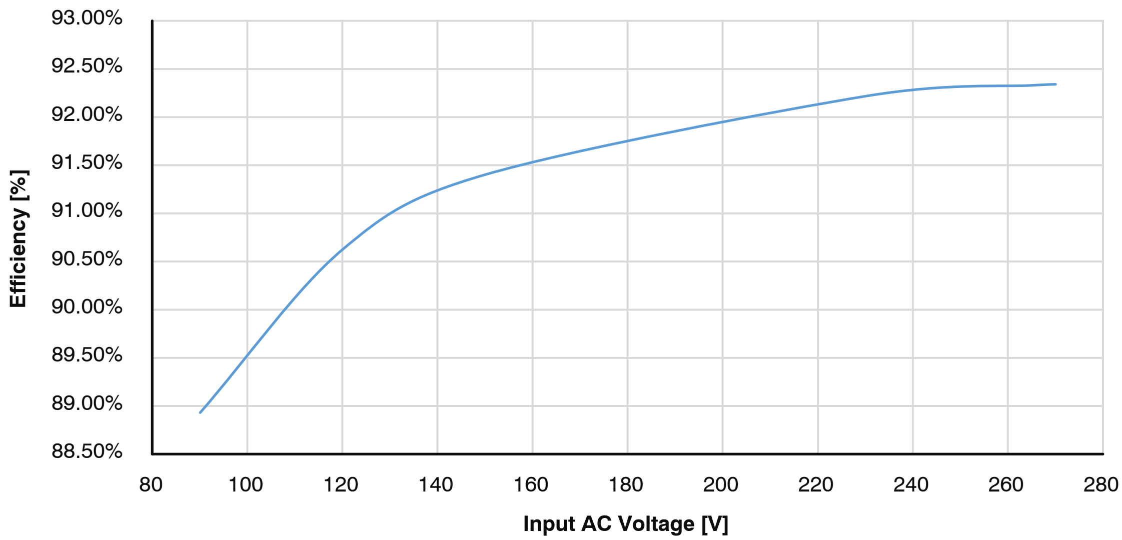

Figure 6. Efficiency Chart of the PoE Module vs. Vin AC

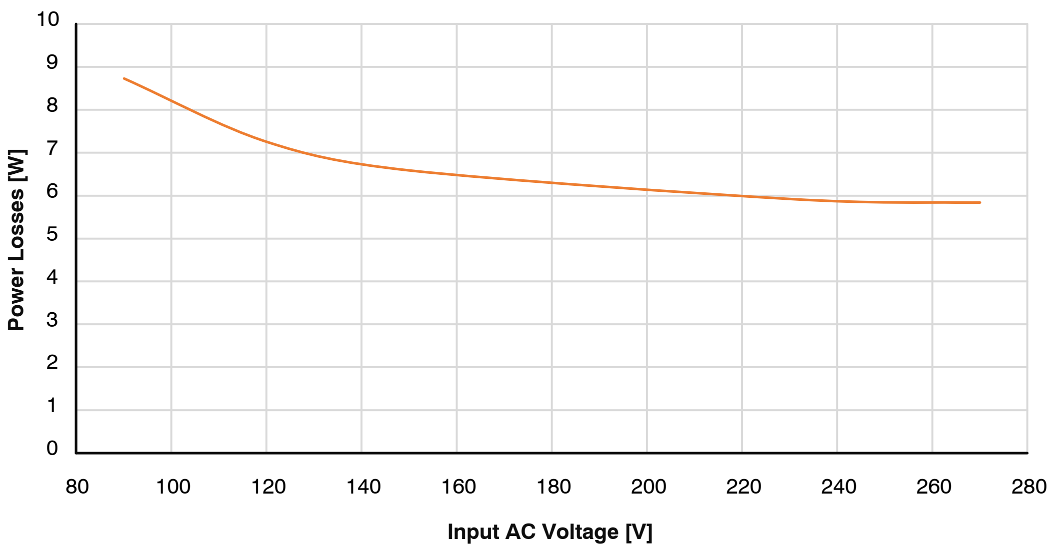

Figure 7. Power Losses Chart of the PoE Module vs. Vin AC

POWER FACTOR OF THE POE MODULE

The following conditions were taken to provide measurement results:

- Output power Pout ~ 70 W
- Electronic load: Chroma 6147A used channel 3 as CLH (constant current high mode → 1.27 A)

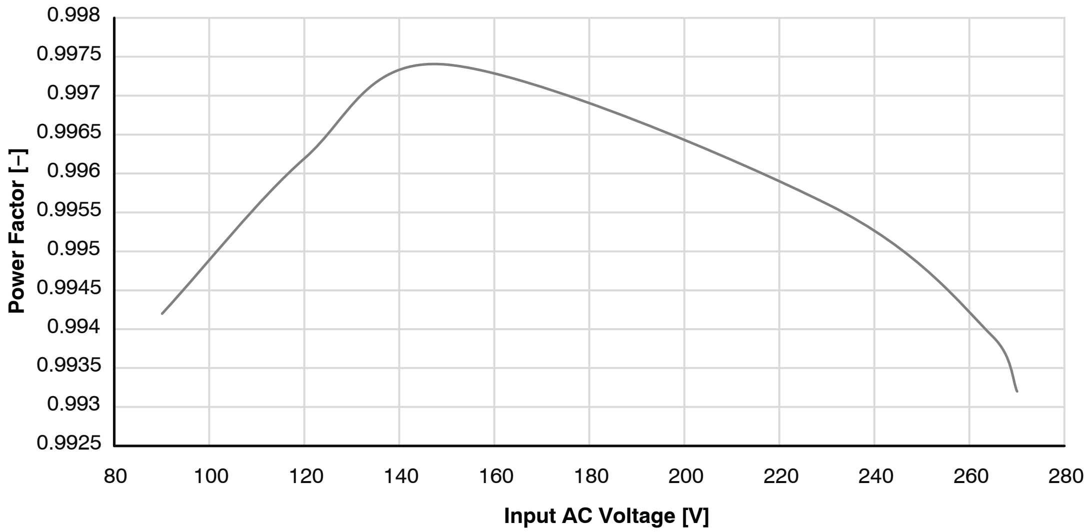

Figure 8. Power Factor Correction chart of the PoE Module vs. Vin AC

POWER FACTOR OF THE AC/DC MODULE WITH AND LED DRIVER MODULE AND LED MODULE CONNECTED

The following conditions were taken to provide measurement results:

- Output power Pout ~ 25 W
- Output dimming level ~ 50%

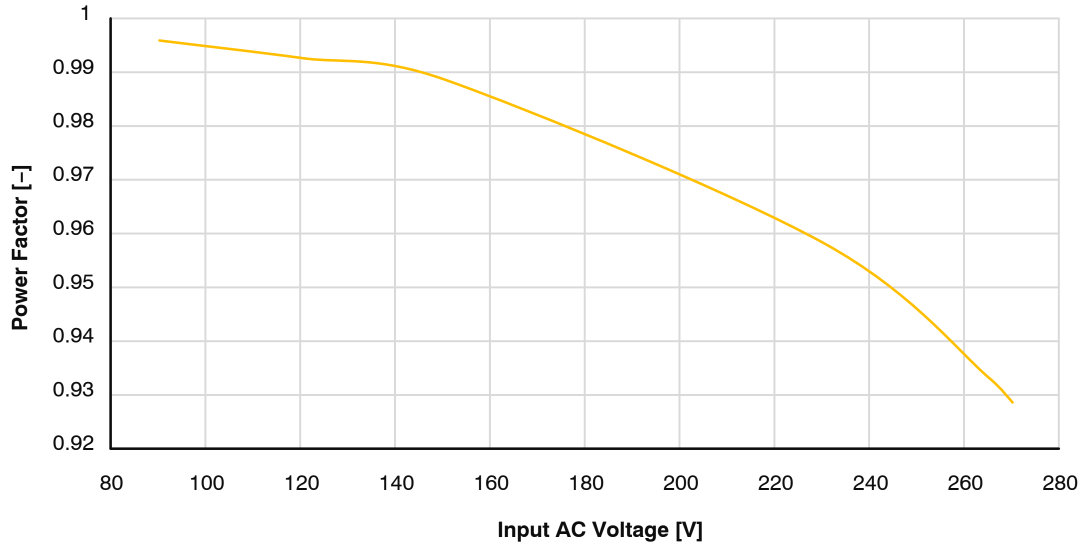

Figure 9. Power Factor Correction Chart of AC/DC Module with LED Driver Module vs. Vin AC (50% Dimming on Both Channels)

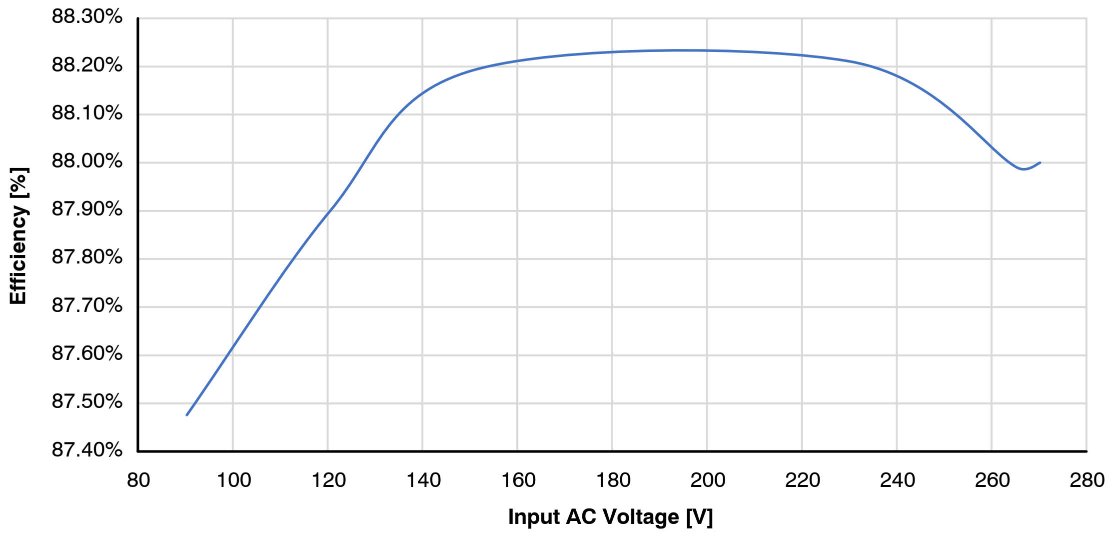

Figure 10. Efficiency Chart of AC/DC Module with LED Driver Module vs. Vin AC (50% Dimming on Both Channels)

STANDBY POWER OF THE AC/DC MODULE WITH LED DRIVER MODULE, LED AND CONNECTIVITY MODULE CONNECTED

The following conditions were taken to provide measurement results:

- Output power Pout ~ no load
- The LEDs switched off
- MCU (RSL10) module in advertising mode only

PA3000 power analyzer settings:

- The current measuring shunt connected after voltage probes due input resistance of voltage meter.
- It was used PWRVIEW Tektronix software for PA3000 for measuring standby power according IEC 62 301 standard.
- Current ranging is set at 125 mApk due pulse load, in AUTO range overcurrent event appeared.

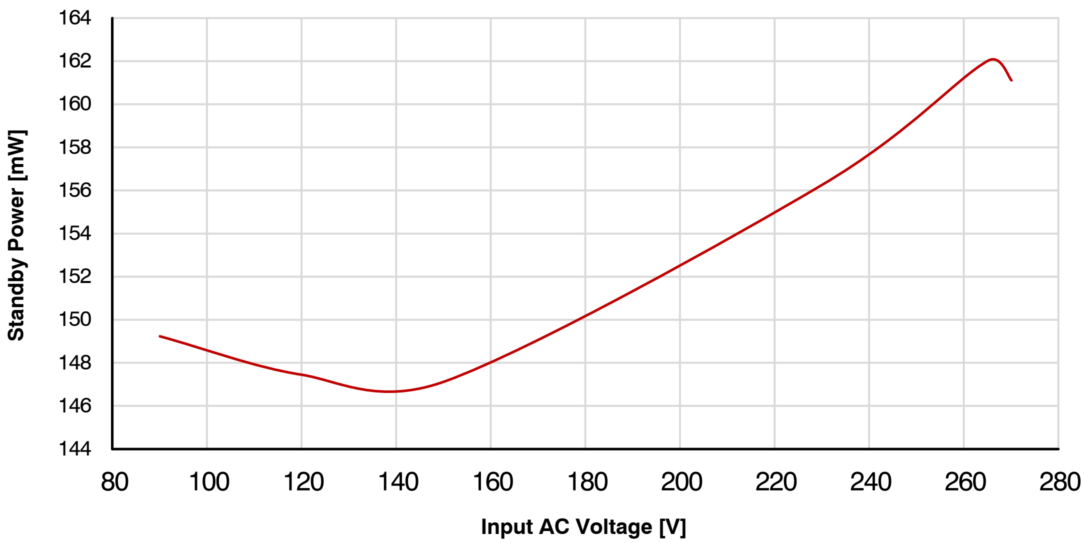

Figure 11. Standby Power Chart of AC/DC Module with LED Driver Module vs. Vin AC LEDs and Connectivity Module Connected (Advertising Mode)

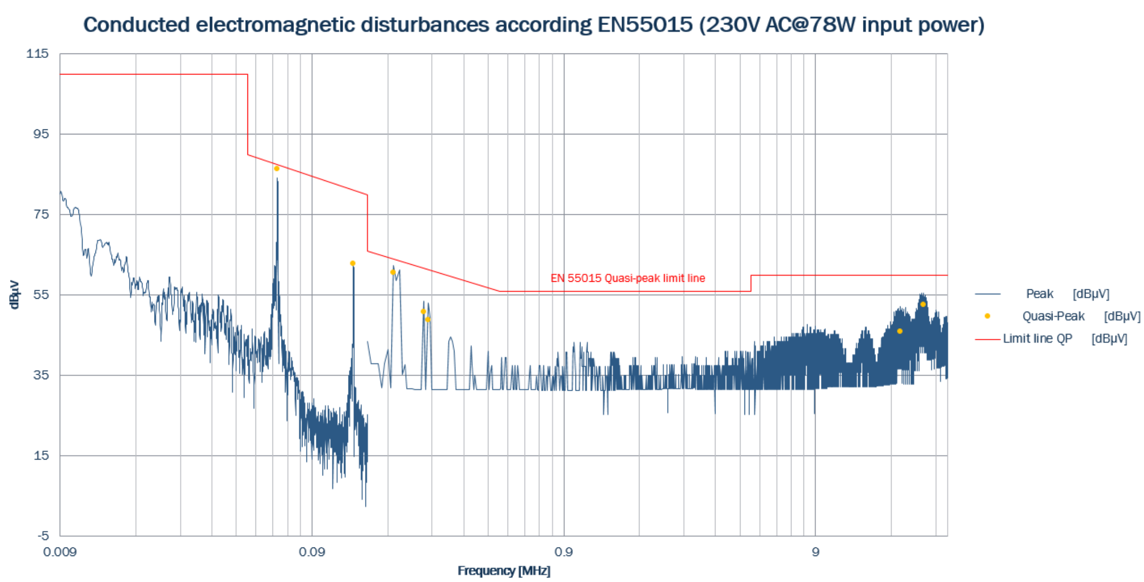

Figure 12. Conducted Electromagnetic Disturbances of AC/DC Module (230 Vac @ 78 W Input Power)

THD MEASUREMENT OF AC/DC MODULE WITH LED DRIVER, LED AND CONNECTIVITY MODULES CONNECTED

The following conditions were taken to provide measurement results:

- Output power Pout ~ 70 W (full load)
- Input voltage ~ 230 Vac

Table 5. LIMITS FOR CLASS C EQUIPMENT

Harmonic Order (*n*)	Maximum Permissible Harmonic Current Expressed as a Percentage of the Input Current at the Fundamental Frequency (%)
2	2
3	30 · λ*
5	10
7	7
9	5
11 ≤ *n* ≤ 39 (odd harmonics only)	3

*λ is the circuit power factor.

Table 6. THD MEASUREMENTS AND LIMITS ACCORDING TO IEC61000−3−2−2014

Description	Measured Values		Limits According IEC61000−3−2−2014		Results
		[mA]		[mA]	
Vrms StdResults [V]	229.323				
Arms StdResults [A]	0.332862				
Watts StdResults [W]	76.001				
PF StdResults [−]	0.995652				
Freq StdResults [Hz]	49.9973				
Magnitude H1 AmpHarms	0.3316	331.600			
Magnitude H2 AmpHarms	0.000190395	0.190	0.006632	6.632	PASS
Magnitude H3 AmpHarms	0.00375614	3.756	0.099047461	99.047	PASS
Magnitude H5 AmpHarms	0.00695188	6.952	0.03316	33.160	PASS
Magnitude H7 AmpHarms	0.00733679	7.337	0.023212	23.212	PASS
Magnitude H9 AmpHarms	0.00645216	6.452	0.01658	16.580	PASS
Magnitude H11 AmpHarms	0.0053353	5.335	0.009948	9.948	PASS
Magnitude H13 AmpHarms	0.00489365	4.894	0.009948	9.948	PASS
Magnitude H15 AmpHarms	0.00427255	4.273	0.009948	9.948	PASS
Magnitude H17 AmpHarms	0.0041269	4.127	0.009948	9.948	PASS
Magnitude H19 AmpHarms	0.0029144	2.914	0.009948	9.948	PASS
Magnitude H21 AmpHarms	0.00342138	3.421	0.009948	9.948	PASS
Magnitude H23 AmpHarms	0.0021604	2.160	0.009948	9.948	PASS
Magnitude H25 AmpHarms	0.00280645	2.806	0.009948	9.948	PASS
Magnitude H27 AmpHarms	0.00219792	2.198	0.009948	9.948	PASS
Magnitude H29 AmpHarms	0.00188446	1.884	0.009948	9.948	PASS
Magnitude H31 AmpHarms	0.00151921	1.519	0.009948	9.948	PASS
Magnitude H33 AmpHarms	0.00109966	1.100	0.009948	9.948	PASS
Magnitude H35 AmpHarms	0.000546126	0.546	0.009948	9.948	PASS
Magnitude H37 AmpHarms	0.00170337	1.703	0.009948	9.948	PASS
Magnitude H39 AmpHarms	0.000480661	0.481	0.009948	9.948	PASS

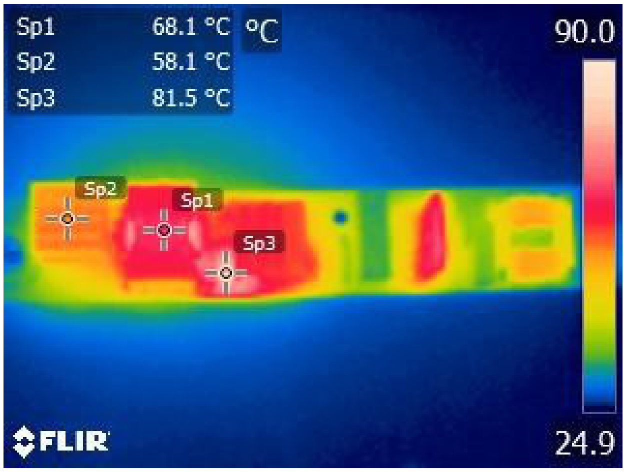

Figure 13. Thermal Camera View of AC/DC Module of Critical Components: Sp1 – Transformer, Sp2 – Secondary Diode Heatsink, Sp3 – RCD Snubber

POE MODULE

This module holds two NCP1096 IEEE 802.3bt compliant controller with PHY layer, acting as a power front end module to deliver desired energy output for LED driver board and LEDs themselves.

Features:

- Power up to 90 W supporting PoE bt standard based on NCP1096
- Automatic MPS circuit to maintain power signature (Simulation model available as well)
- Green Bridge 2 rectifiers
- Output voltage ~56 V defined by PoE standard

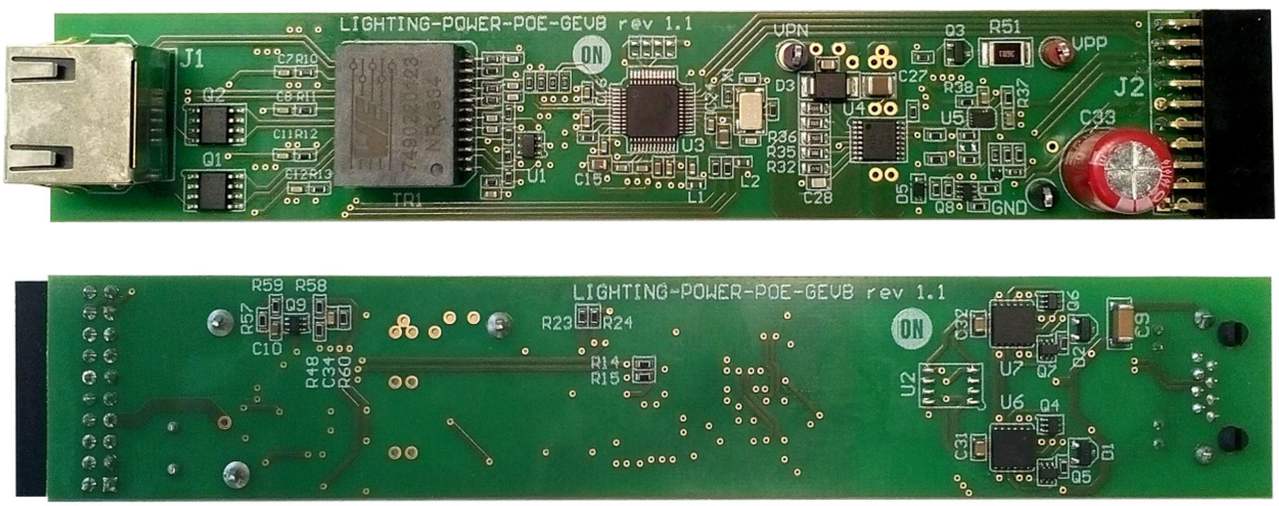

Figure 14. Overview Image of the PoE Front – End Power Module

Standalone Power Consumption of the Board

Both input power paths supplied with 56.0 V, board power output left unconnected. Impact of on board generated MPS tested as well.

Table 7. STANDALONE INPUT POWER OF THE POE BT BOARD WHEN MPS CIRCUIT ON/OFF

Board Operating Condition	P_{IN} [W]
1. on board MPS off (330 kΩ to MPS EXT Pin), no load	0.368
2. on board MPS on	0.545
3. on board MPS on, LED driver board connected	1.022
4. on board MPS off, LED driver board connected	0.837

NOTE: Power analyzer PA3000, 3 channels used, auto−zero ON, blanking OFF, averaging 10, update rate 2s. Two DC power supplies 56 V, their output voltage fine−tuned for input current 50/50 split.

Power Losses

Both input power paths supplied with 56.0 V, board power output connected to electronic load. On board MPS generator turned off.

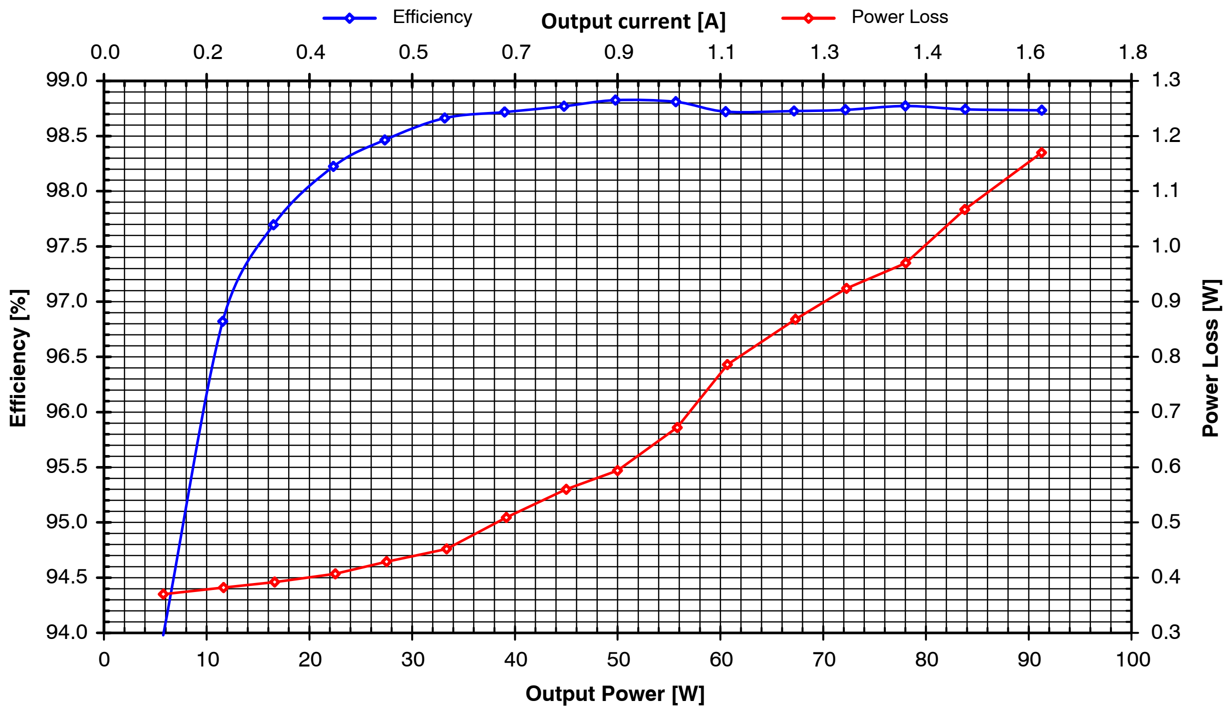

Figure 15. Power Losses and Efficiency vs. Output Power for LIGHTING−POWER−POE−GEVB

Startup and on Board Minimum Power Signature Generator

No Load Startup with on Board MPS Generator Turned OFF

As can be seen in waveforms below, PSE device processes normal startup procedure and provides power afterwards. Since there is no load at the PoE board output and Minimum Power Signature is not generated, PSE shuts off after given time (>310 ms). PSE repeats this sequence in about 3.5 s.

NOTE: Phihong POE90U−1BT PSE was used during these tests.

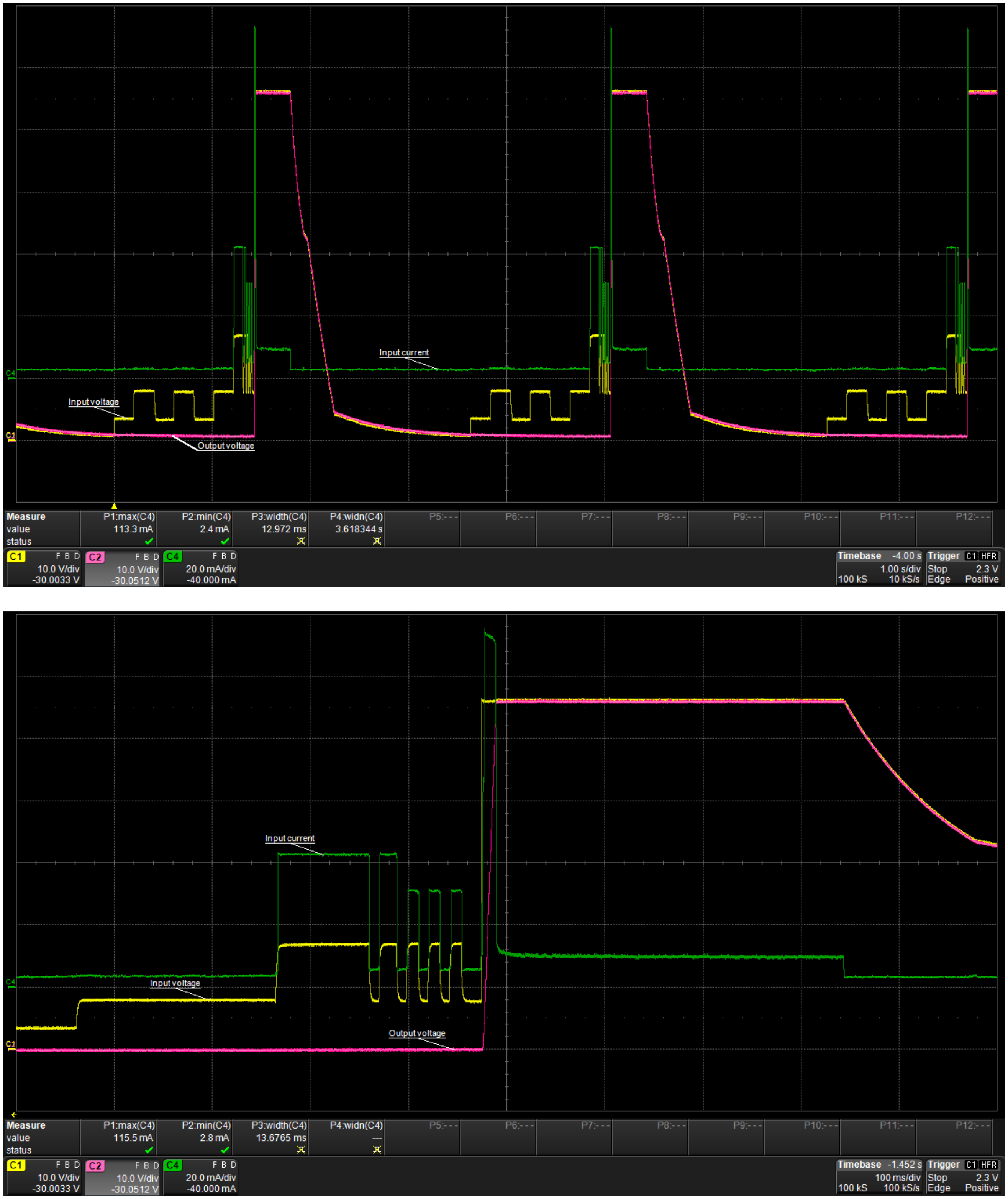

Figure 16. No Load Start−up, MPS Circuit OFF

No Load Startup with on Board MPS Generator Turned ON

With on board MPS generator activated, PSE device processes normal startup procedure and provides power afterwards. Since PSE output is now loaded by current pattern conform to Minimum Power Signature given by relevant PoE standard, PSE provides power to PoE board continuously.

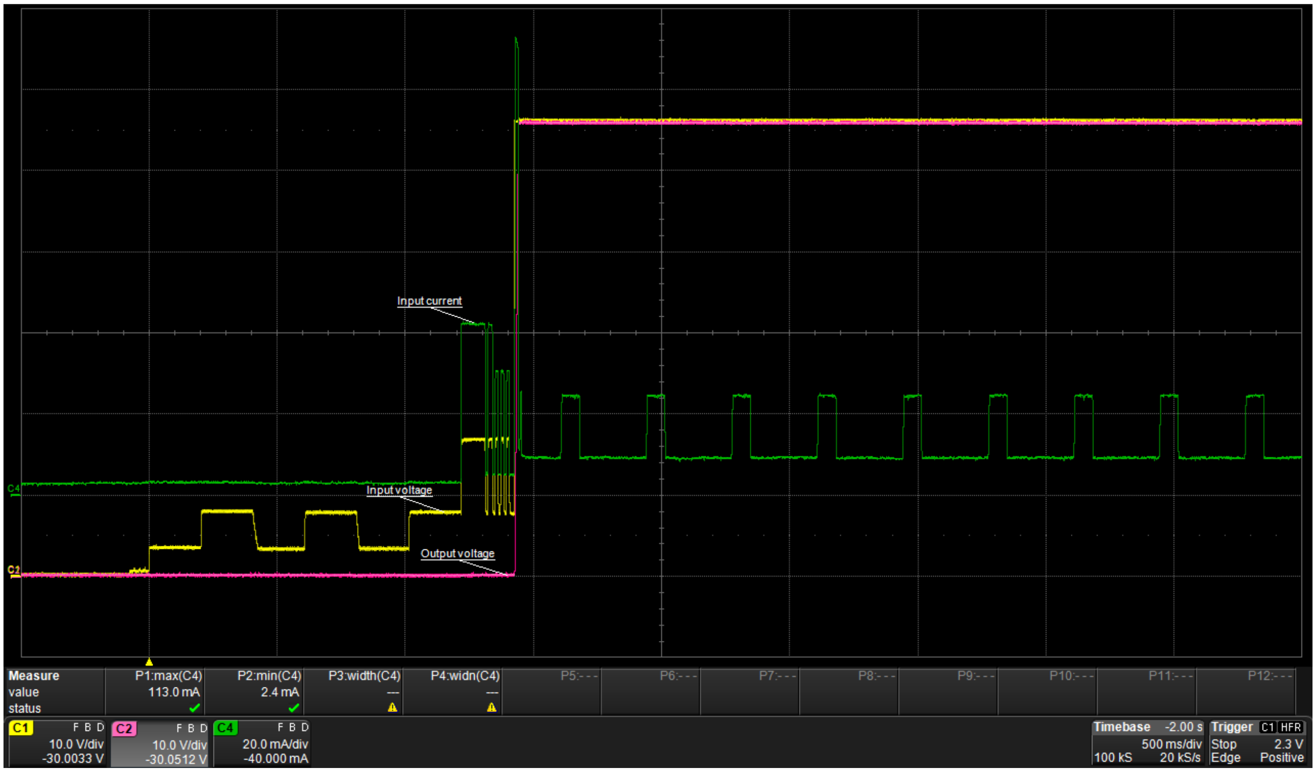

Figure 17. No Load Start−up, MPS Circuit Turned ON

On Board MPS Generator

To keep circuitry small/cheap, simple multi−vibrator has been selected for on board MPS generator. It can be deactivated by applying positive voltage to MPS_EXT pin of output connector or digitally over I^2C expander installed on board as well. Generated MPS pattern can be easily altered or completely deactivated modifying relevant RC components (see next slide) in case different pattern is needed.

As can be seen in waveforms below, first MPS pulse comes within 187 ms after PSE provides power. All succeeding pulse gaps are 265 ms wide, followed by 70 ms pulses.

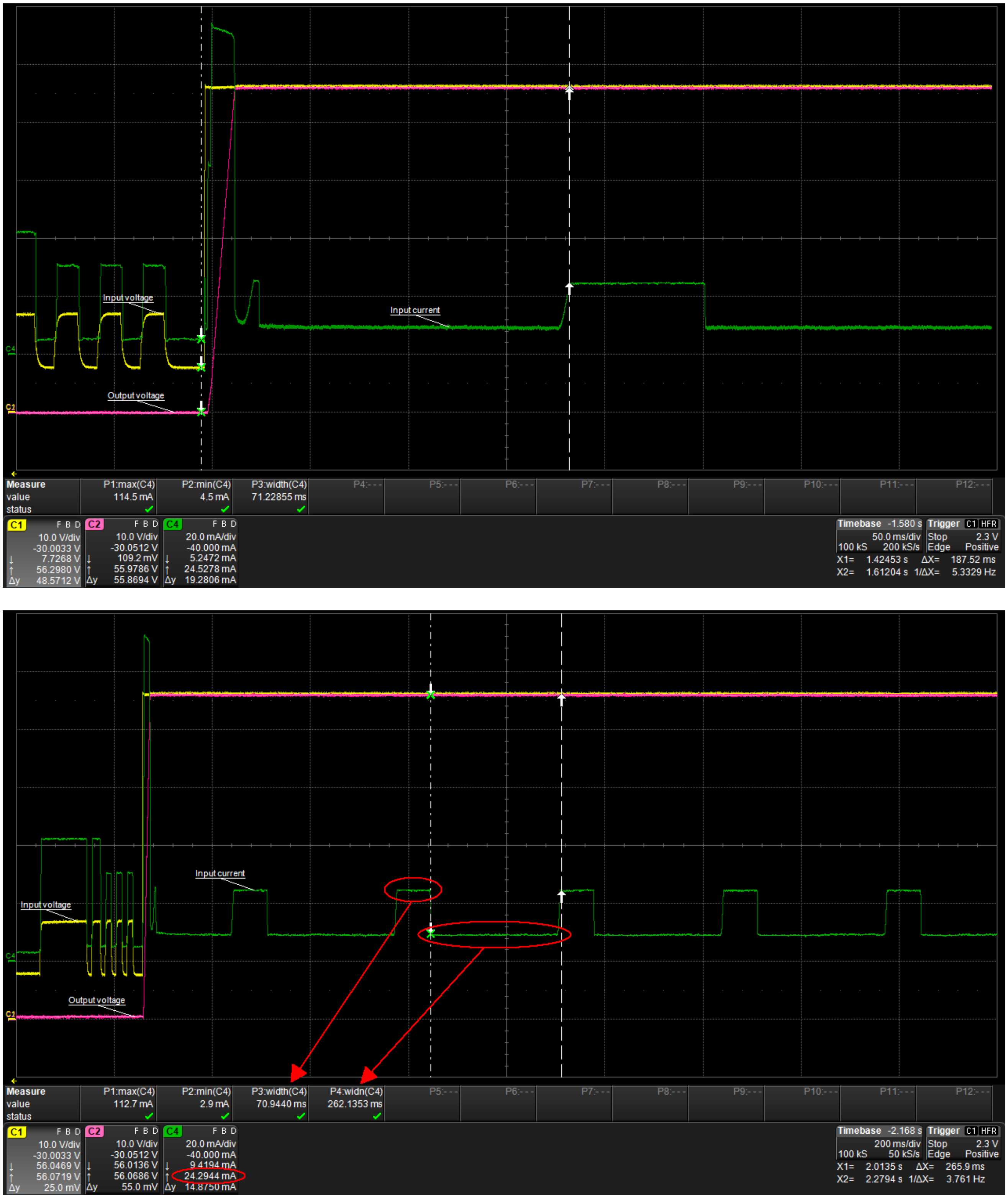

Figure 18. No Load Start−up, on Board MPS Generator

Thermal Performance

Infrared pictures captured by Flir E40 after 10 minutes of thermal stabilization at given load level (60 W/90 W). Both input power paths powered, input current split kept at 50/50. Board input voltage held at 56.0 V, ambient temperature 25°C.

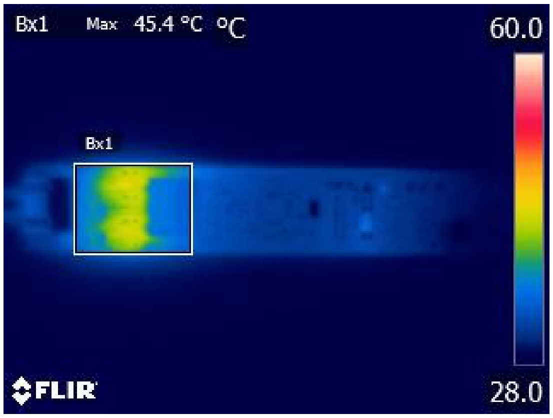

Figure 19. Board Top Side − Output Power 60 W

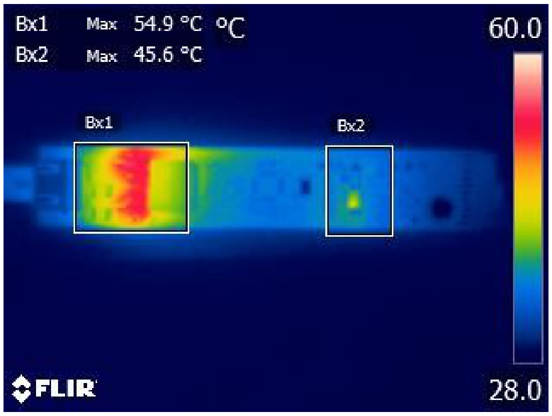

Figure 20. Board Top Side − Output Power 90 W

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