Title	**Preliminary Reference Design Report 50 W Flyback Converter with Two Independently Regulated Outputs Using InnoMux™2-EP IMX2378F-H415**
Specification	90 VAC – 265 VAC Input; 12 V / 1.67 A and 24 V / 1.25 A Outputs
Application	Multi-Output PSU for Appliance and Industrial
Author	Applications Engineering Department
Document Number	RDR-1043
Date	31 May 2024
Revision	1.0

Summary and Features

Unique single-stage multi-output, flyback architecture enabling:-

- High efficiency across wide-input line voltage
- Independently regulated 12 V and 24 V outputs
  - Both output voltages are regulated to ±1% accuracy
- Low no-load consumption
  - Less than 50 mW across line
- Comprehensive protection features
  - Output overvoltage (OVP)
  - Output power limit set independently for each output
  - Accurate thermal protection with hysteretic overtemperature shutdown
  - Input voltage monitor with accurate brown-in/brown-out and overvoltage

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Introduction

This document is an engineering report describing a flyback offline power supply intended for appliance, industrial and smart meter applications, utilizing the IMX2378F-H415 from the InnoMux2-EP family of ICs.

The power supply has two Constant Voltage (CV) outputs: 1.67 A, 12 V and 1.25 A, 24 V. It can deliver a total maximum output power of 50 W, with universal mains input (from 90 VAC to 265 VAC). This design shows the high efficiency and accurate output regulation that is possible due to the controller's multiplexing power control algorithm and high level of integration.

This report is a preliminary summary. To receive additional information including bill of materials, printed circuit board (PCB) layout, computer performance data and test setup, contact your local PI representative.

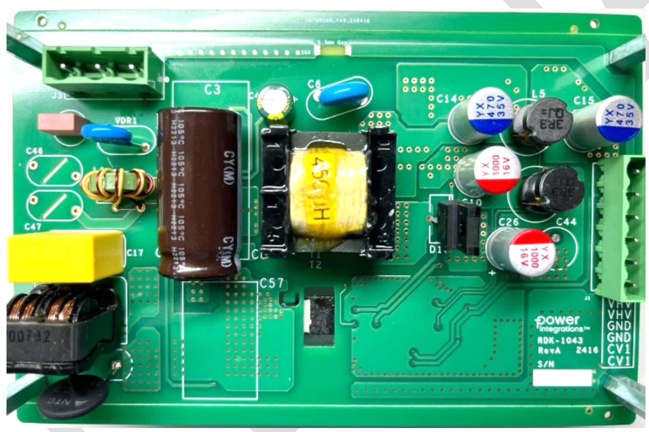


Figure 1 – Populated Circuit Board Photograph, Top.

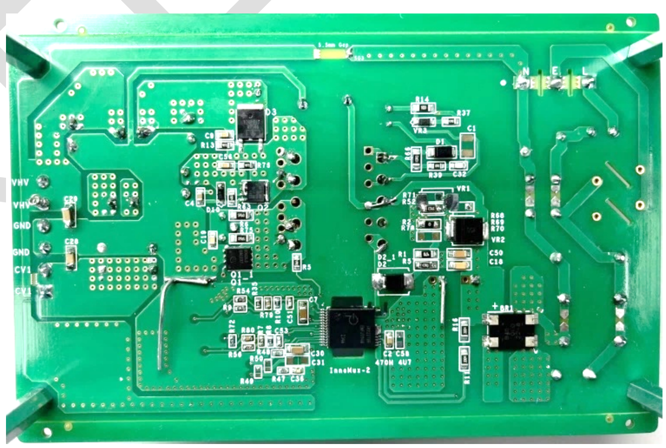


Figure 2 – Populated Circuit Board Photograph, Bottom.

1 Power Supply Specification

The table below represents the minimum acceptable performance of the design.

Description	Symbol	Min	Typ.	Max	Units	Comment
Input						
Voltage	V_{IN}	90		265	VAC	3 Wire Input
Frequency	f_{LINE}	47	50/60	64	Hz	
Output						
Output Voltage 1	V_{OUT1}	11.8	12	12.2	V	±5%
Output Ripple Voltage 1	$V_{RIPPLE1}$			240	mV	±1%, 20 MHz Bandwidth
Output Current 1	I_{OUT1}	0		1.67	A	
Output Voltage 2	V_{OUT2}	23.7	24	24.3	V	±5%
Output Ripple Voltage 2	$V_{RIPPLE2}$			480	mV	±2%, 20 MHz Bandwidth
Output Current 2	I_{OUT2}	0		1.25	A	
Total Output Power						
Output Power	P_{OUT}		50		W	
Efficiency						
Full Load	η		90		%	Measured at 230 VAC, 25 ºC
Standby Input Power				<0.3	W	Measured at 230 VAC 25 ºC, 5 V 30 mA
Environmental						
Ambient Temperature	T_{AMB}	0		40	ºC	Free Convection, Sea Level

Table 1 – Power Supply Specifications

2 Simplified Schematic

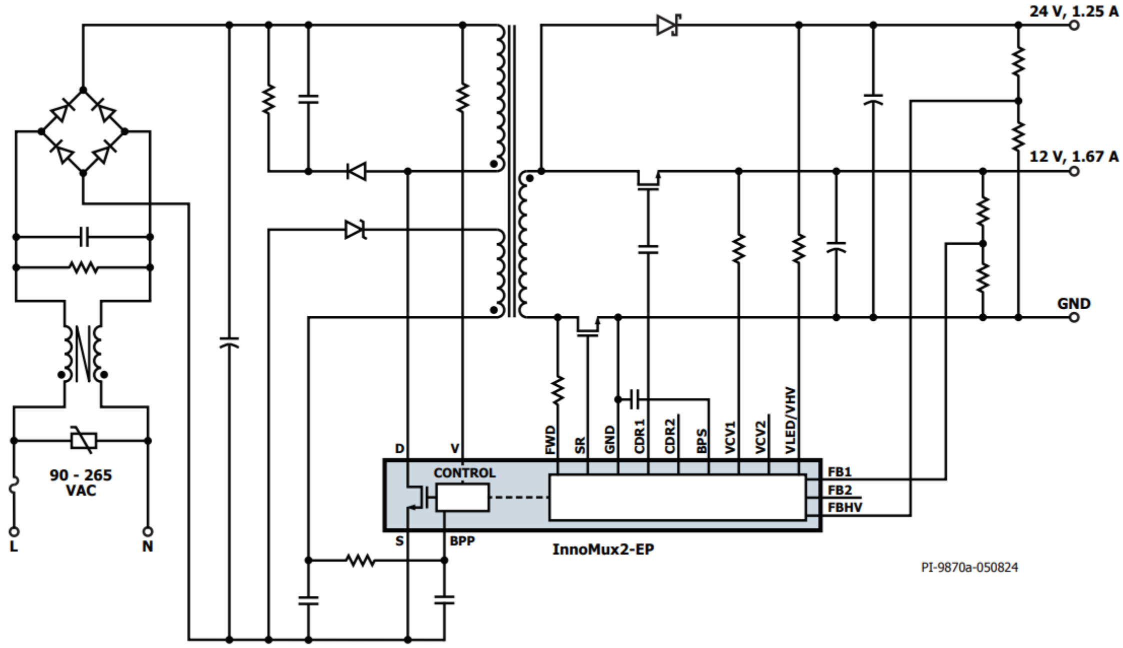


Figure 3 – Simplified Schematic Showing Key Circuit Elements

3 Preliminary Performance Information

Full Load Efficiency vs. Line

Full load efficiency vs. line voltage is shown below. Nominal line voltages (90 VAC, 115 VAC, 230 VAC, 265 VAC).

- CV1 = 12 V @ 1.67 A
- CVHV = 24 V @ 1.25 A
- NTC resistor is shorted

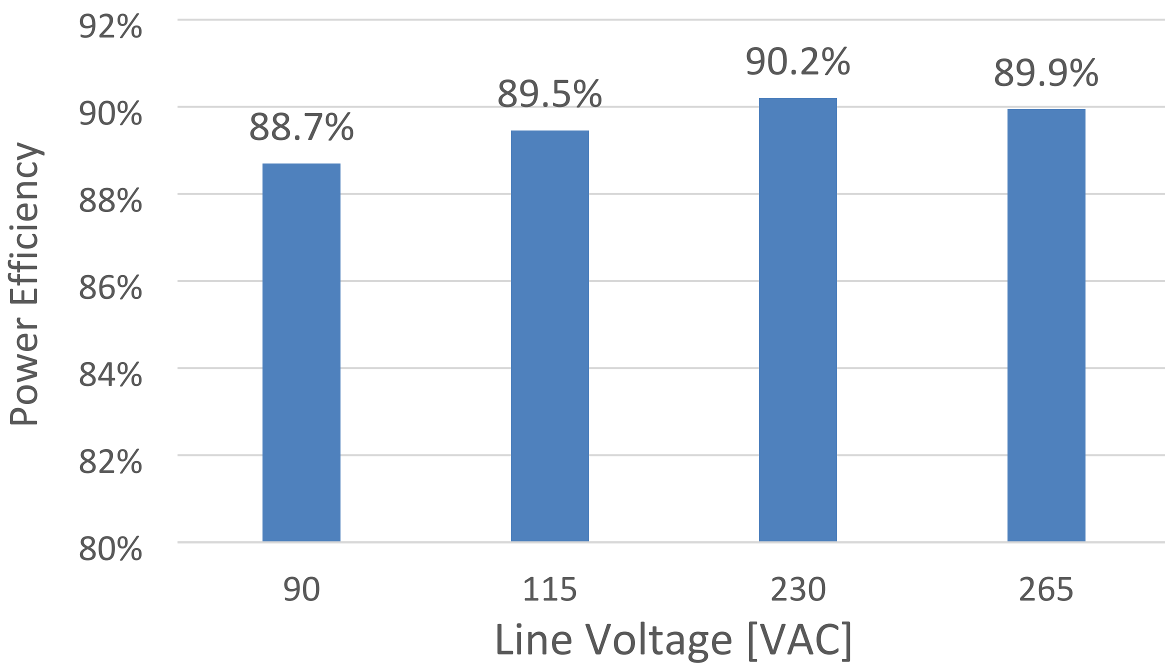


Figure 4 – Full Power Efficiency vs. Line Voltage at Room Temperature

4 Efficiency vs. Load

- Tests performed at nominal line voltages (90 VAC, 115 VAC, 230 VAC, 265 VAC).
- CV1 = 12 V @ 1.67 A (0 to 100% with 5% load increment)
- CVHV = 24 V @ 1.25 A (0 to 100% with 5% load increment)
- NTC resistor is shorted

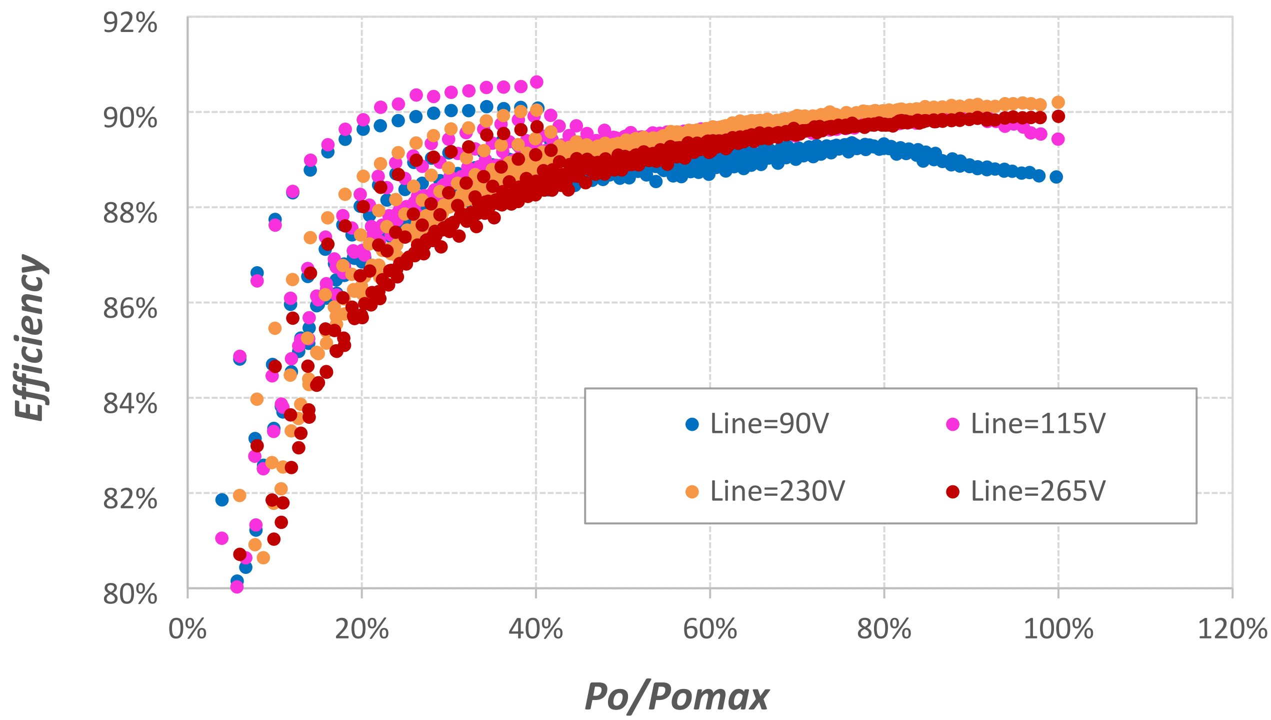


Figure 5 – Efficiency vs. Load for All Line Inputs, Room Temperature

5 Output Load Regulation

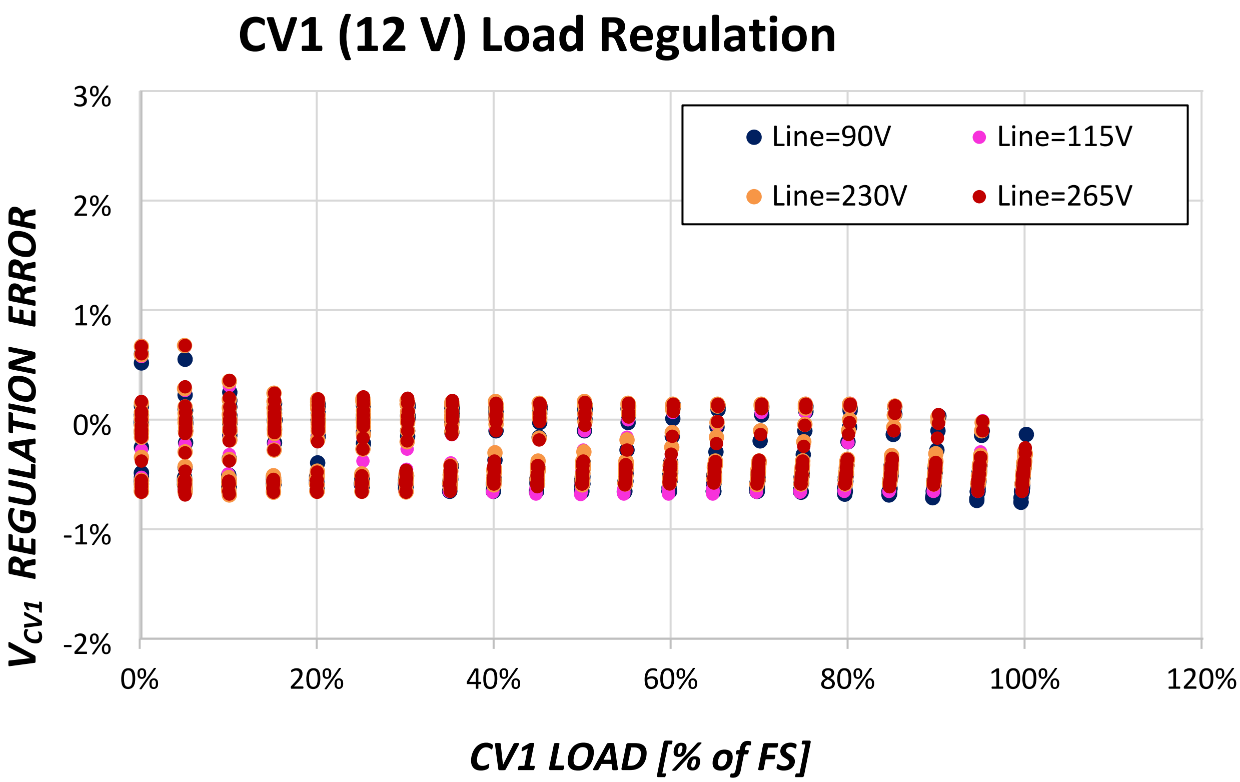


Figure 6 – CV1 Output Voltage Error vs. Output Load, Room Temperature

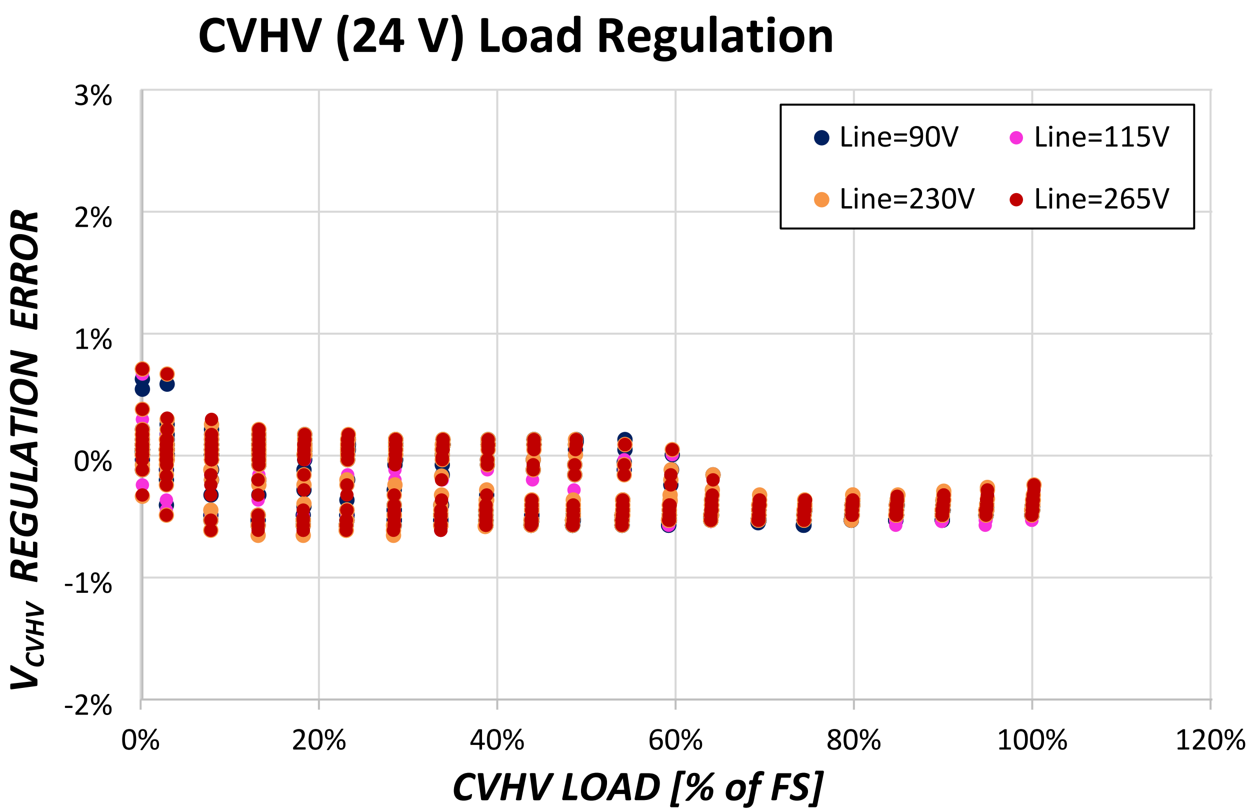


Figure 7 – CVHV Output Voltage Error vs. Output Load, Room Temperature

6 No-Load and Standby Input Power (ICVHV = 0 A)

The output power vs. input power at standby mode measurements are shown below. These were obtained for all combinations of:

- All nominal line voltages (90 V, 115 V, 230 V, 265 V)
- CVHV output = 0 A
- CV1 output = 0 mW to 350 mW

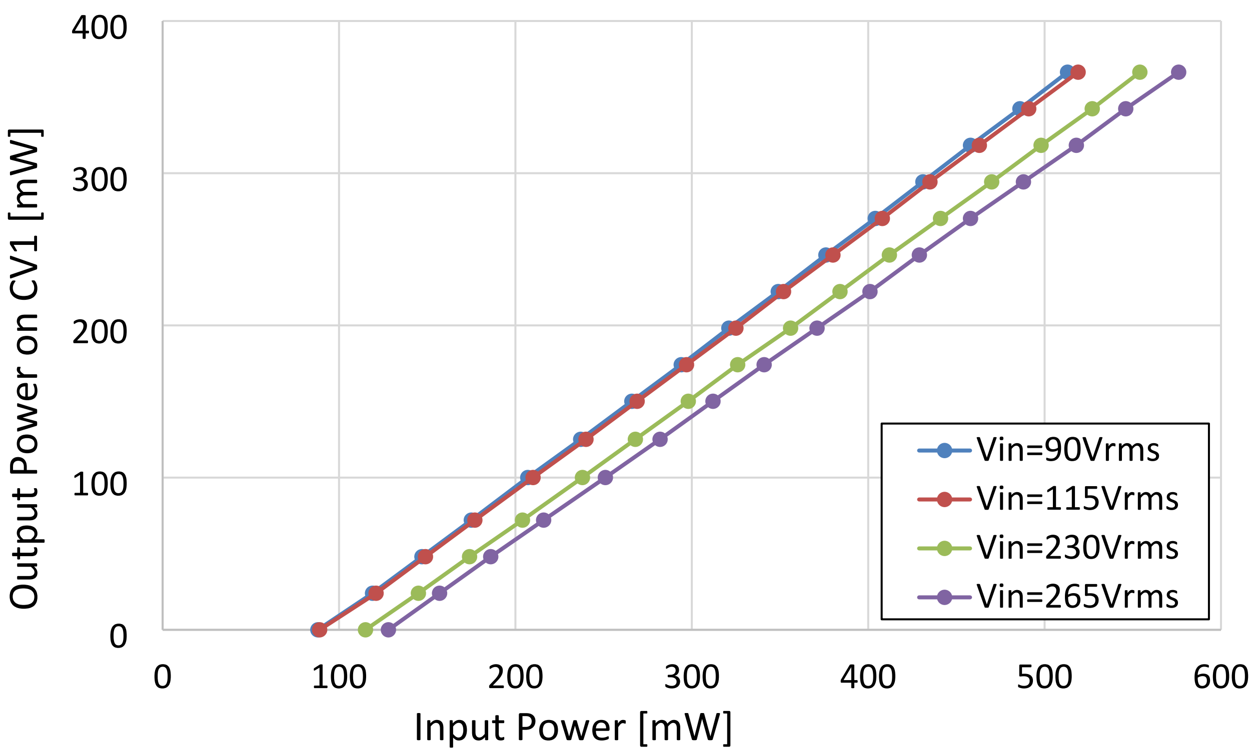
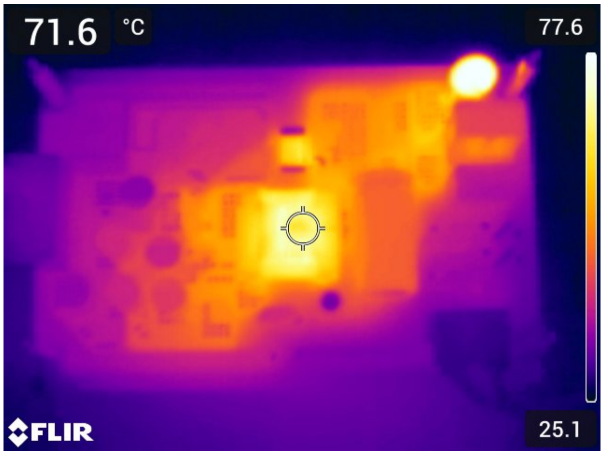


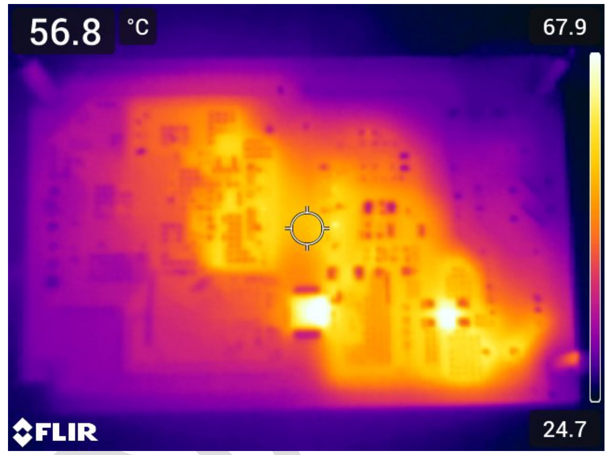
Figure 8– Standby Power Availability vs. Input Line Voltage, Room Temperature

7 Thermal Performance

No heatsinks are required for the power supply. Copper PCB area is used for cooling the InnoMux2-EP IC. No forced air-cooling was required during any test. Temperatures of the hottest components in the assembly are shown below.

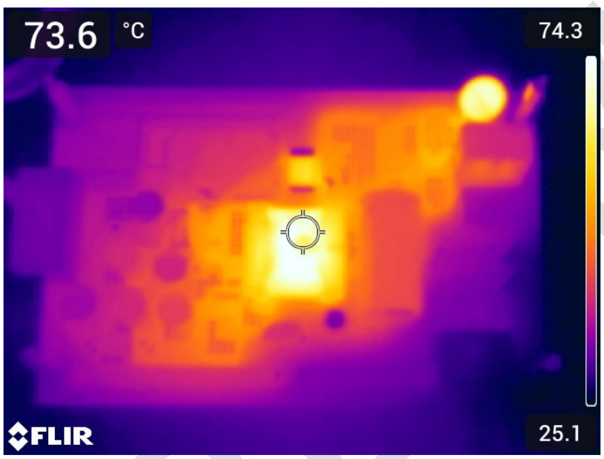


(a) Top View

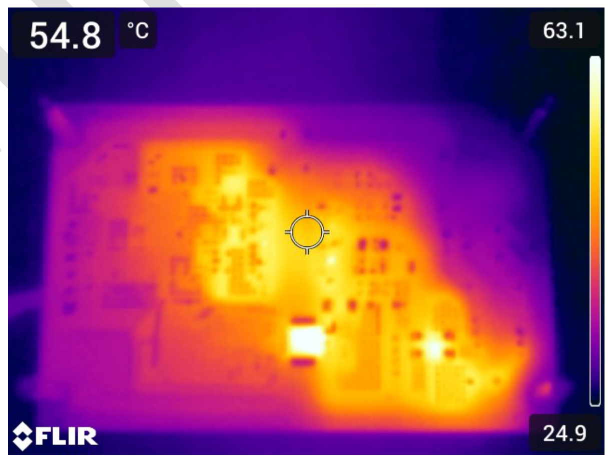


(b) Bottom View

Figure 9– Thermal Image, 90 VAC, Full Power

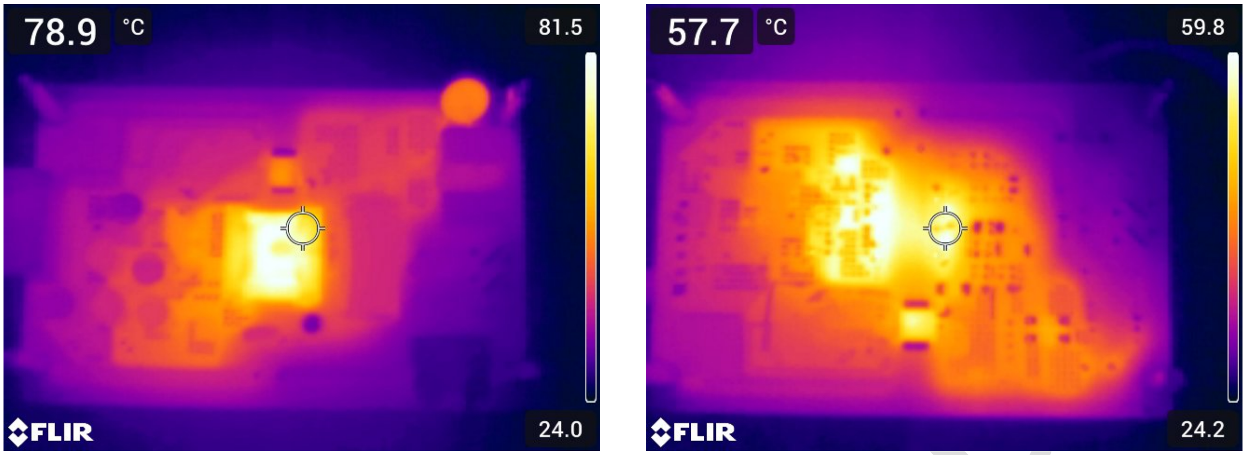


(a) Top View



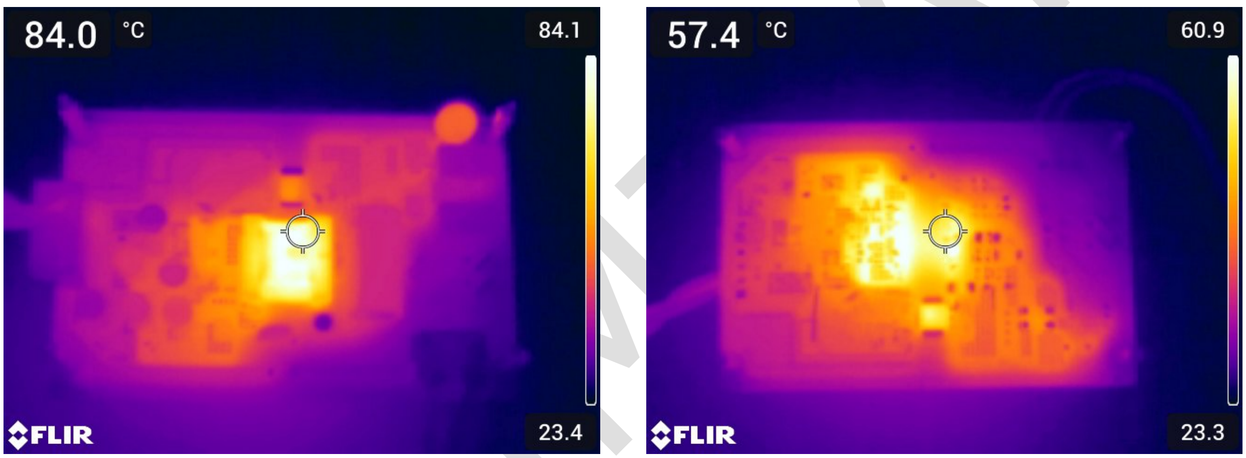
(b) Bottom View

Figure 10 – Thermal Image, 115 VAC, Full Power



(a) Top View (b) Bottom View

Figure 4 – Thermal Image, 230 VAC, Full Power



(a) Top View (b) Bottom View

Figure 5 – Thermal Image, 265 VAC, Full Power

Revision History

Date	Author	Revision	Description & Changes	Reviewed
31-May-24	Doc. Team	1.0	Preliminary Release.	Apps & Mktg

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