# ICL8810 116 W AC-DC reference design with IPD80R280P7

## For battery charger with 115 V AC to 230 V AC nominal input and 30 V to 58 V constant current (CC) output up to 2 A load current

ER_2308_PL21_2309_093427




## About this document

### Scope and purpose

This document is an engineering report for the 116 W AC-DC converter reference design (orderable part number: REF_ICL8810_116W_BPA), which uses Infineon's ICL8810 flyback controller and IPD80R280P7 MOSFET.

This reference design board can be used for battery charging applications by adding both the battery safety switch and the charging profile control circuits externally. See the test setup and safety information section of this document for more information.

### Intended audience

This document is intended for power supply design engineers, application engineers, and users of the 116 W AC-DC reference design board.

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# 1 Test setup and safety information

This AC-DC reference design is a flyback converter with secondary-side regulated (SSR) constant current (CC) output. The CC output set-point is adjustable with a 0 to 3 V analog input signal.

As shown in Figure 1, to use this reference design board for battery charging application testing, you must add both the battery safety switch and the charging profile control circuits externally, which work according to the board and battery specification.

***Attention:*** ***For safety reasons, it is prohibited to connect this reference design board to any battery without adding the battery safety switch and charging profile control circuits externally.***

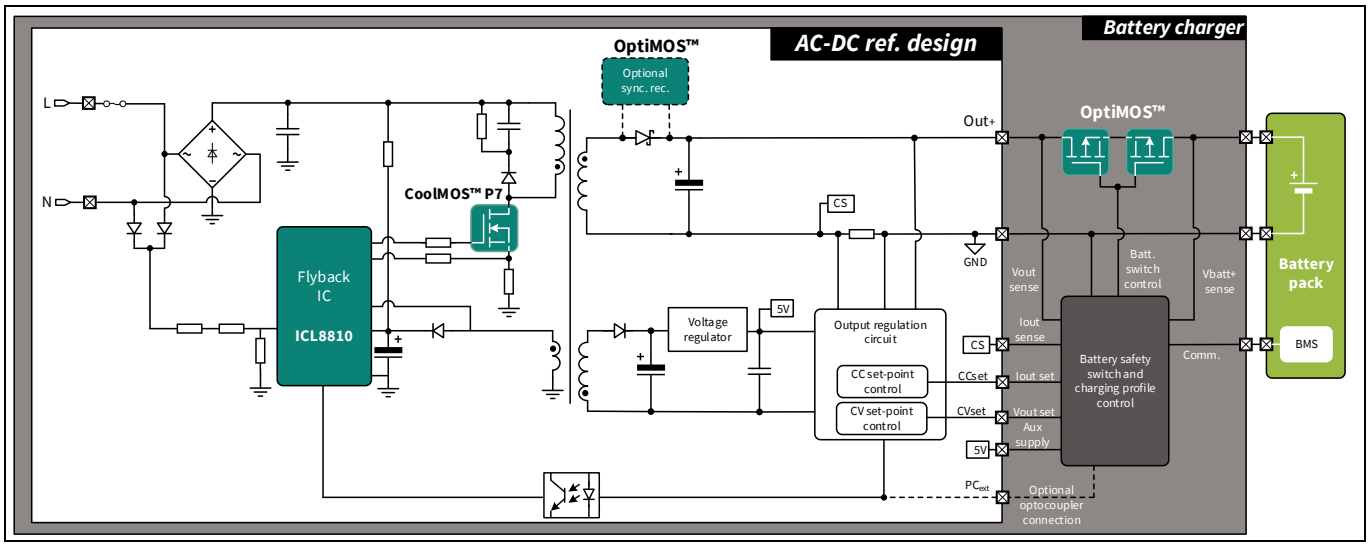



**Figure 1** **Test setup of AC-DC reference design with connections to external battery safety switch and charging profile control circuits, for battery charging application testing**

Alternatively, a test setup using the electronic load (in constant voltage/CV mode) and DC source (for adjusting the CC set point) can be done based on Figure 2.




**Figure 2** **Test setup with electronic load and adjustable CC set point using DC source**

***Attention:*** ***Dangerous voltages are present on this reference design. Do not operate the board unless you are trained to handle high-voltage (HV) circuits. Do not leave this board unattended when it is powered up.***

## Test setup and safety information

For EMI testing with full output power of 116 W, the test setup in Figure 3 is recommended.




**Figure 3 EMI test setup with full output power**

For no-load system standby power measurement, the test setup in Figure 4 is recommended.




**Figure 4 No-load system standby power test setup**

# 2 Design features

- Secondary-side regulation (SSR), with adjustable constant current (CC) output set-point from 0 to 2 A
- Supports wide output load range from 24 to 58 V (see Board specifications for details)
- High efficiency and low EMI with quasi-resonant (QR) valley switching
- Cost-effective flyback MOSFET with high performance, using CoolMOS™ P7 in SOT-223 package
- Full power efficiency more than 91 percent at 230 $V_{RMS}$ AC input
- Four-point average efficiency more than 89 percent at high-line input voltage range and full power output
- Burst mode with reduced gate driver output voltage for lower standby power
- System standby power less than 300 mW for whole input voltage and range
- Power factor more than 0.9 for the whole input voltage range and full power output
- Harmonic current emissions under the limits specified by IEC 61000-3-2 Class A
- Adaptive brown-out level triggering based on bus voltage ripple to better protect primary components from overheating and saturation with higher brown-out level at higher power transfer
- Comprehensive set of protections: internal overtemperature protection (OTP), output overvoltage protection (OVP), $V_{CC}$ OVP, primary-side overcurrent protection (OCP), brown-in and brown-out protection
- Soft-start to reduce component stress during turn-on

# 3 Board specifications

Table 1 lists the electrical specifications of the evaluation board.

**Table 1 Electrical specifications**

| Specification | Symbol | Value | Unit |
|---|---|---|---|
| Normal operational AC input voltage | V AC | 90 to 264 | VRMS |
| Normal operational AC input frequency | $F_{line}$ | 47 to 63 | Hz |
| CC output set-point | $I_{out,setpoint}$ | 0 to 2.0 | A |
| CC output set-point control voltage (see Figure 5 for details) | $CC_{set}$ | 0 to 3 | V |
| Output load range ($I_{out,setpoint}$ = 0 to 4 A) | $V_{load,CV}$ | 24 to 58 | V |
| Input power under no-load condition (V AC = 230 $V_{RMS}$; $F_{line}$ = 50 Hz; output open) | $P_{in,no-load}$ | < 240 | mW |
| Input power under no-load condition (V AC = 115 $V_{RMS}$; $F_{line}$ = 50 Hz; output open) | $P_{in,no-load}$ | < 100 | mW |
| Steady-state output voltage limit under no-load condition | $V_{out,FB,limit}$ | 64 | V |
| Efficiency at full output power (V AC = 230 $V_{RMS}$; output voltage = 58 V; $I_{out,setpoint}$ = 2.0 A) | η | 91.2 | % |
| Efficiency at full output power (V AC = 115 $V_{RMS}$; output voltage = 58 V; $I_{out,setpoint}$ = 2.0 A) | η | 89.1 | % |
| Four-point average efficiency – high-line low (V AC = 176 $V_{RMS}$; output voltage = 58 V; $I_{out}$ = 0.5 A, 1 A, 1.5 A, and 2 A) | $η_{avg,4-point1}$ | 88.9 | % |
| Four-point average efficiency – high-line high (V AC = 264 $V_{RMS}$; output voltage = 58 V; $I_{out}$ = 0.5 A, 1 A, 1.5 A, and 2 A) | $η_{avg,4-point2}$ | 89.0 | % |
| Four-point average efficiency – low-line low (V AC = 90 $V_{RMS}$; output voltage = 58 V; $I_{out}$ = 0.5 A, 1 A, 1.5 A, and 2 A) | $η_{avg,4-point1}$ | 87.6 | % |
| Four-point average efficiency – low-line high (V AC = 130 $V_{RMS}$; output voltage = 58 V; $I_{out}$ = 0.5 A, 1 A, 1.5 A, and 2 A) | $η_{avg,4-point2}$ | 89.0 | % |

## Board specifications

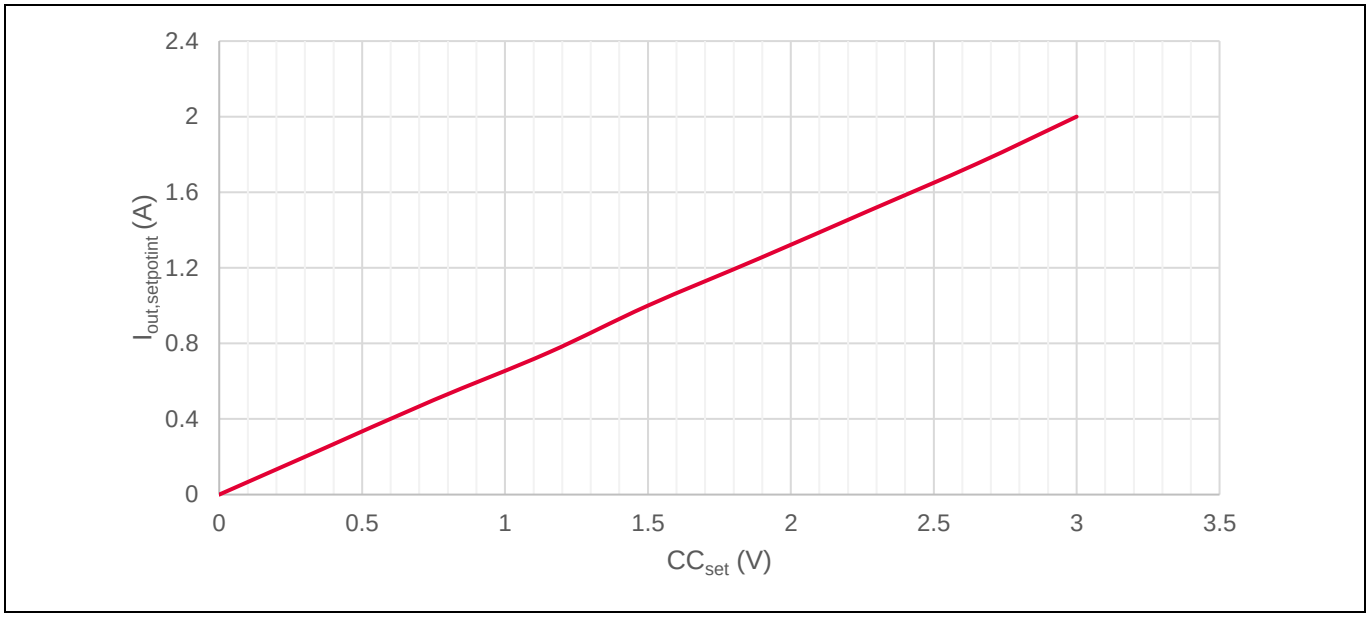



**Figure 5 $I_{out,setpoint}$ control based on $CC_{set}$ input signal**

# 4 Schematic and PCB layout

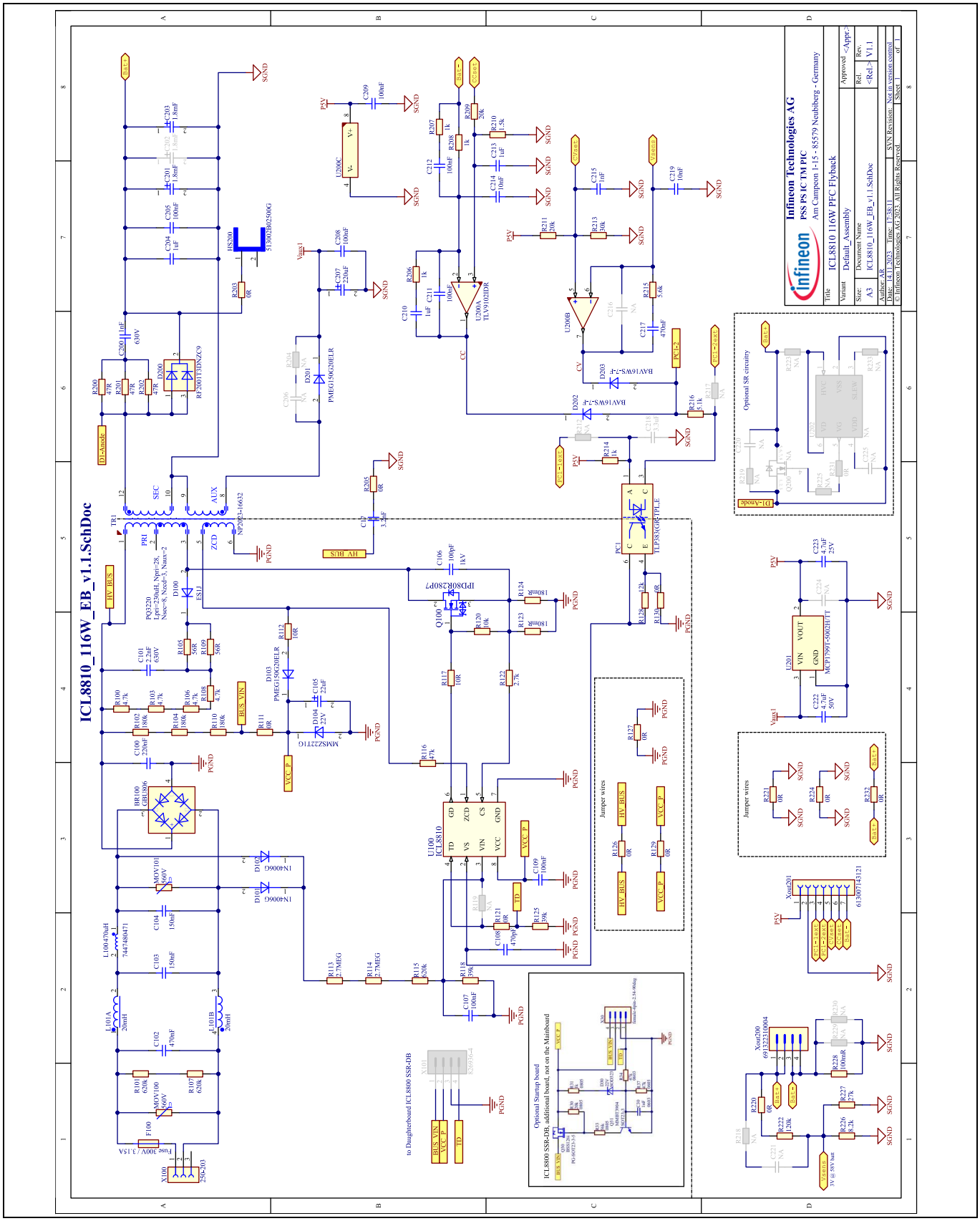



**Figure 6 Reference design board schematic**

## Schematic and PCB layout

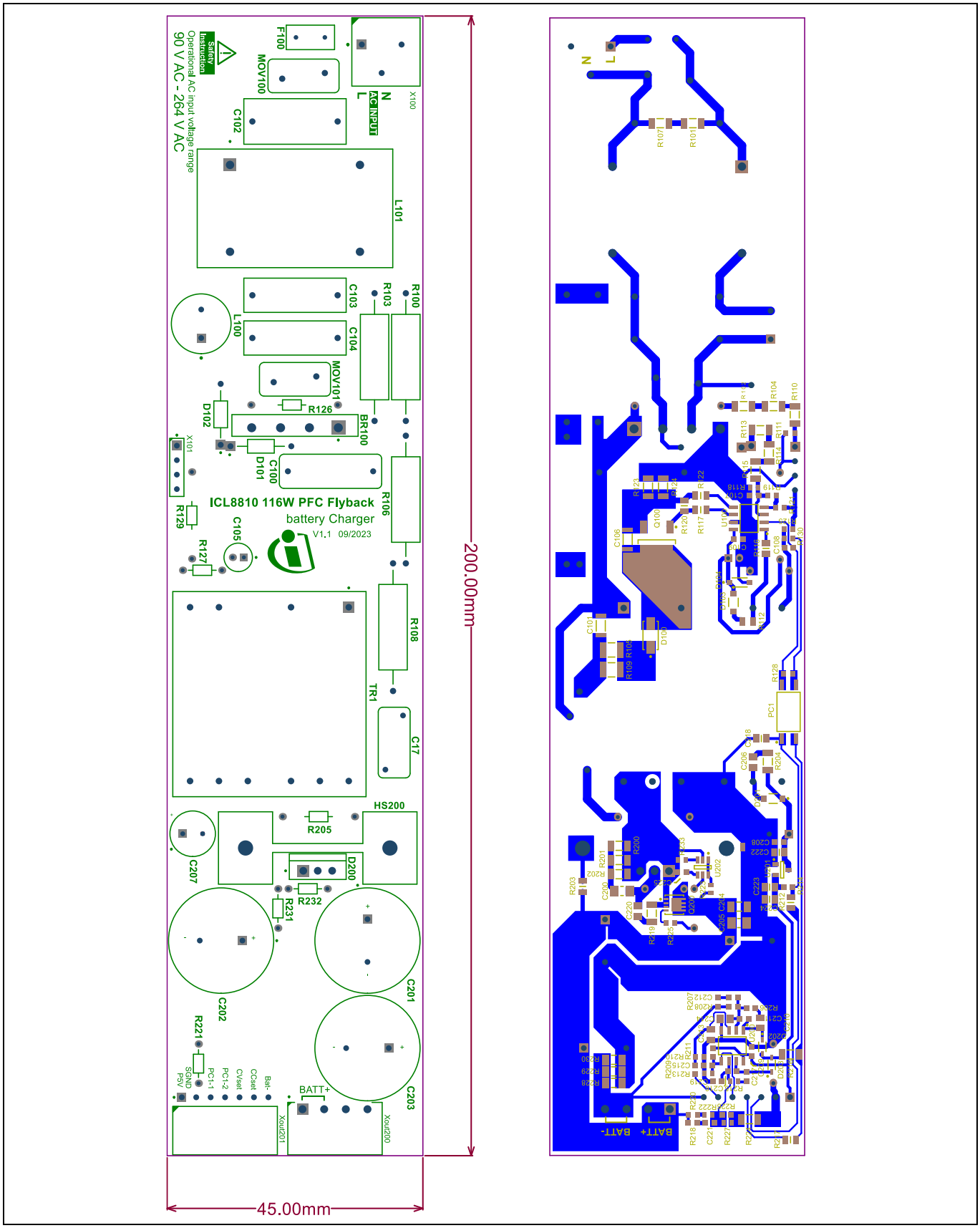



**Figure 7 PCB top (left) and bottom (right) layout of the reference design board**

# 5 Performance

The results shown in this section are based on the evaluation of a single board at room temperature.

## 5.1 Efficiency

The efficiency at 36 V output voltage with 2 A output current setting (CC set adjusted to 3 V) is measured at more than 90.3 percent at typical input voltage of 230 $V_{RMS}$ and more than 88 percent across the whole low-line input voltage range, as shown in Figure 8.

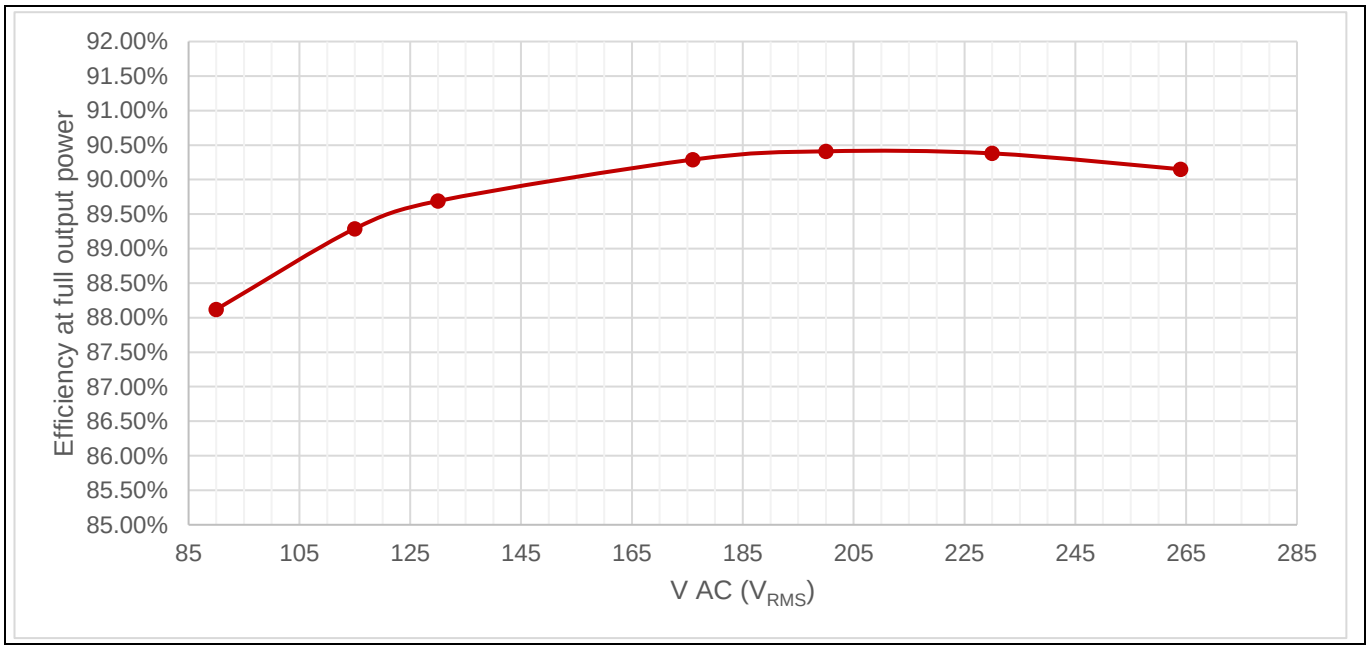



**Figure 8 Efficiency versus input voltage at 36 V and 2 A output (72 W)**

For high-line input voltage range, the efficiency at full output power (116 W) is more than 90.8 percent and 91.2 percent at typical V AC of 230 $V_{RMS}$, as shown in Figure 9.

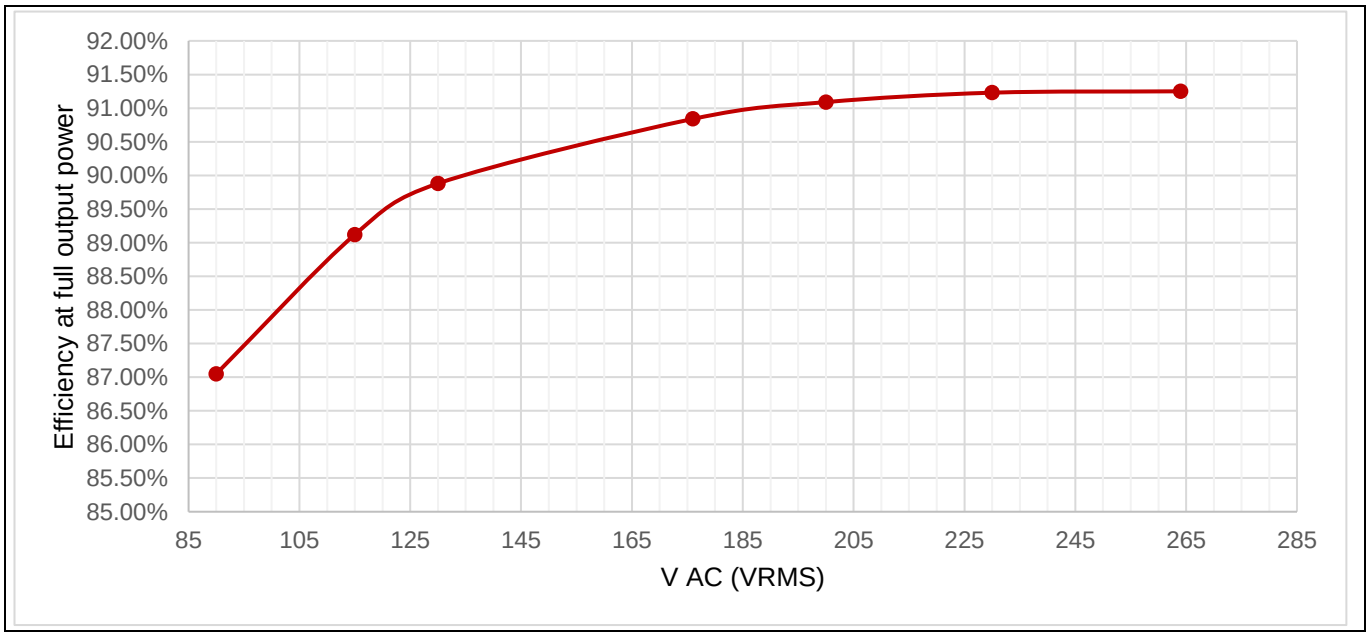



**Figure 9 Efficiency versus input voltage at 58 V and 2 A output (116 W)**

## Performance

The four-point average efficiency for 58 V output voltage for input voltage corner-cases is presented in Table 2. The measurement reveals an average efficiency value of more than 89 percent at minimum and maximum of high-line input voltage. The same measurement performed at low-line input voltage range indicates an average efficiency value of more than 87.5 percent.

**Table 2 Four-point average efficiency at 58 V output voltage in input voltage corner-cases**

| V AC ($V_{RMS}$) | Output load (V) | $I_{out,setpoint}$ (mA) | $I_{out,setpoint}$ (%) | Efficiency (%) | Four-point average efficiency (%) |
|---|---|---|---|---|---|
| 176 | 58 | 2000 | 100 | 90.83 | 89.32 |
| | | 1500 | 75 | 90.76 | |
| | | 1000 | 50 | 89.77 | |
| | | 500 | 25 | 85.93 | |
| 264 | 58 | 2000 | 100 | 91.25 | 89.00 |
| | | 1500 | 75 | 90.69 | |
| | | 1000 | 50 | 89.22 | |
| | | 500 | 25 | 84.82 | |
| 90 | 58 | 2000 | 100 | 87.04 | 87.64 |
| | | 1500 | 75 | 88.49 | |
| | | 1000 | 50 | 88.71 | |
| | | 500 | 25 | 86.31 | |
| 130 | 58 | 2000 | 100 | 89.91 | 89.00 |
| | | 1500 | 75 | 90.19 | |
| | | 1000 | 50 | 89.69 | |
| | | 500 | 25 | 86.22 | |

For an output voltage of 36 V, the four-point average efficiency is measured at more than 88 percent for the input voltage corner cases as shown in Table 3.

## Performance

**Table 3 Four-point average efficiency at 36 V output voltage in input voltage corner-cases**

| V AC ($V_{RMS}$) | Output load (V) | $I_{out,setpoint}$ (mA) | $I_{out,setpoint}$ (%) | Efficiency (%) | Four-point average efficiency (%) |
|---|---|---|---|---|---|
| 176 | 36 | 2000 | 100 | 90.31 | 88.96 |
| | | 1500 | 75 | 90.28 | |
| | | 1000 | 50 | 89.34 | |
| | | 500 | 25 | 85.92 | |
| 264 | 36 | 2000 | 100 | 90.22 | 88.01 |
| | | 1500 | 75 | 89.57 | |
| | | 1000 | 50 | 88.28 | |
| | | 500 | 25 | 83.95 | |
| 90 | 36 | 2000 | 100 | 88.12 | 88.23 |
| | | 1500 | 75 | 88.84 | |
| | | 1000 | 50 | 89.01 | |
| | | 500 | 25 | 86.93 | |
| 130 | 36 | 2000 | 100 | 89.69 | 88.90 |
| | | 1500 | 75 | 90.02 | |
| | | 1000 | 50 | 89.64 | |
| | | 500 | 25 | 86.26 | |

## 5.2 Standby power

Under no-load conditions, the input power measurement indicates a value under 120 mW at the low-line input voltage range and 300 mW at the high-line input voltage range, as shown in Figure 10 and Figure 11.

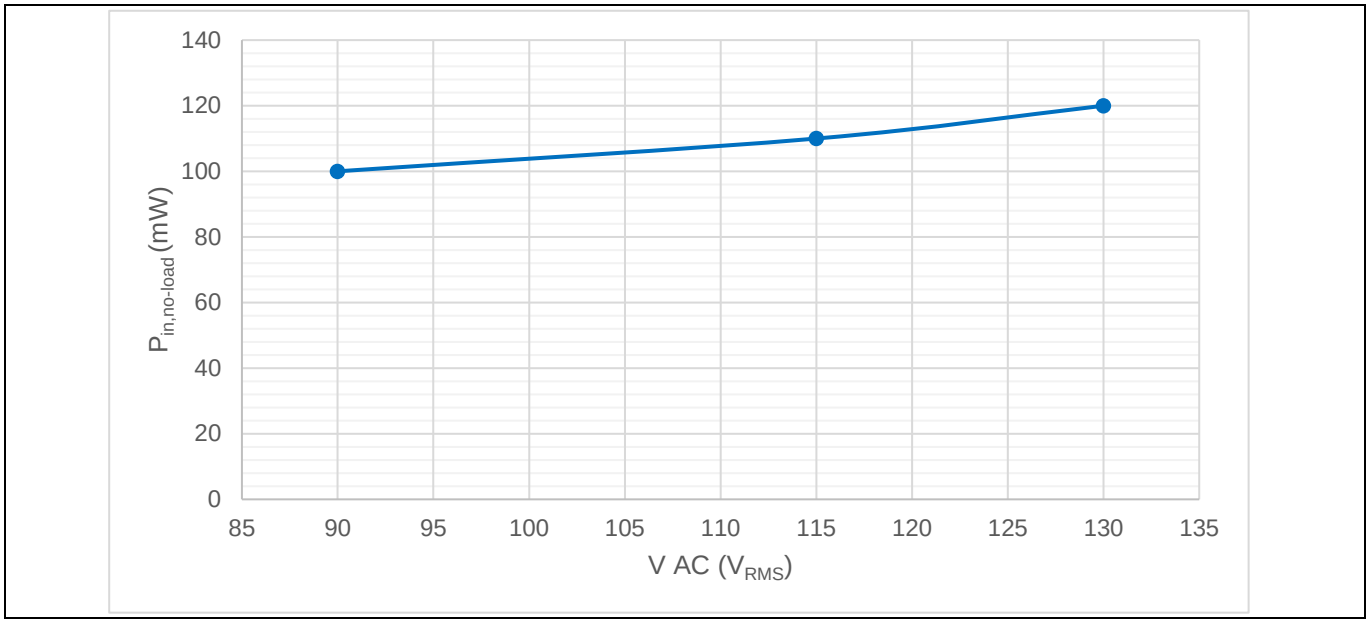



**Figure 10 Input power under no-load condition at low-line input**

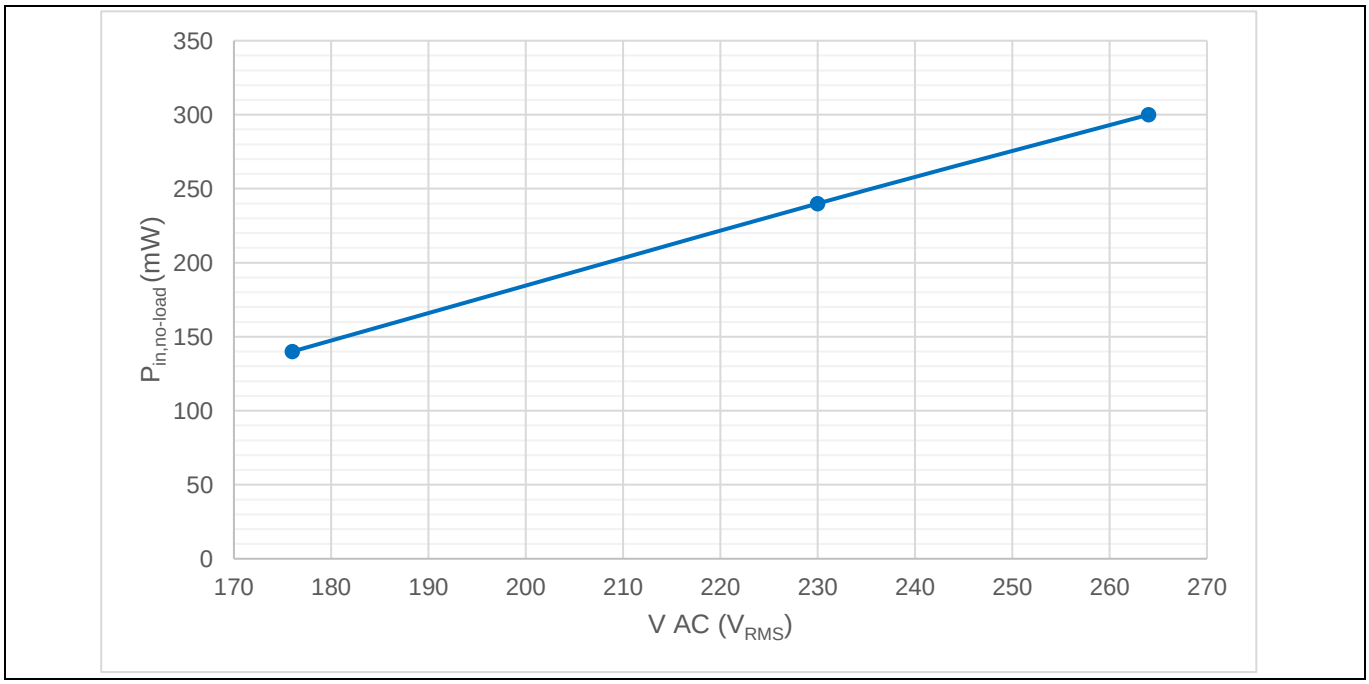



**Figure 11 Input power under no-load condition at high-line input**

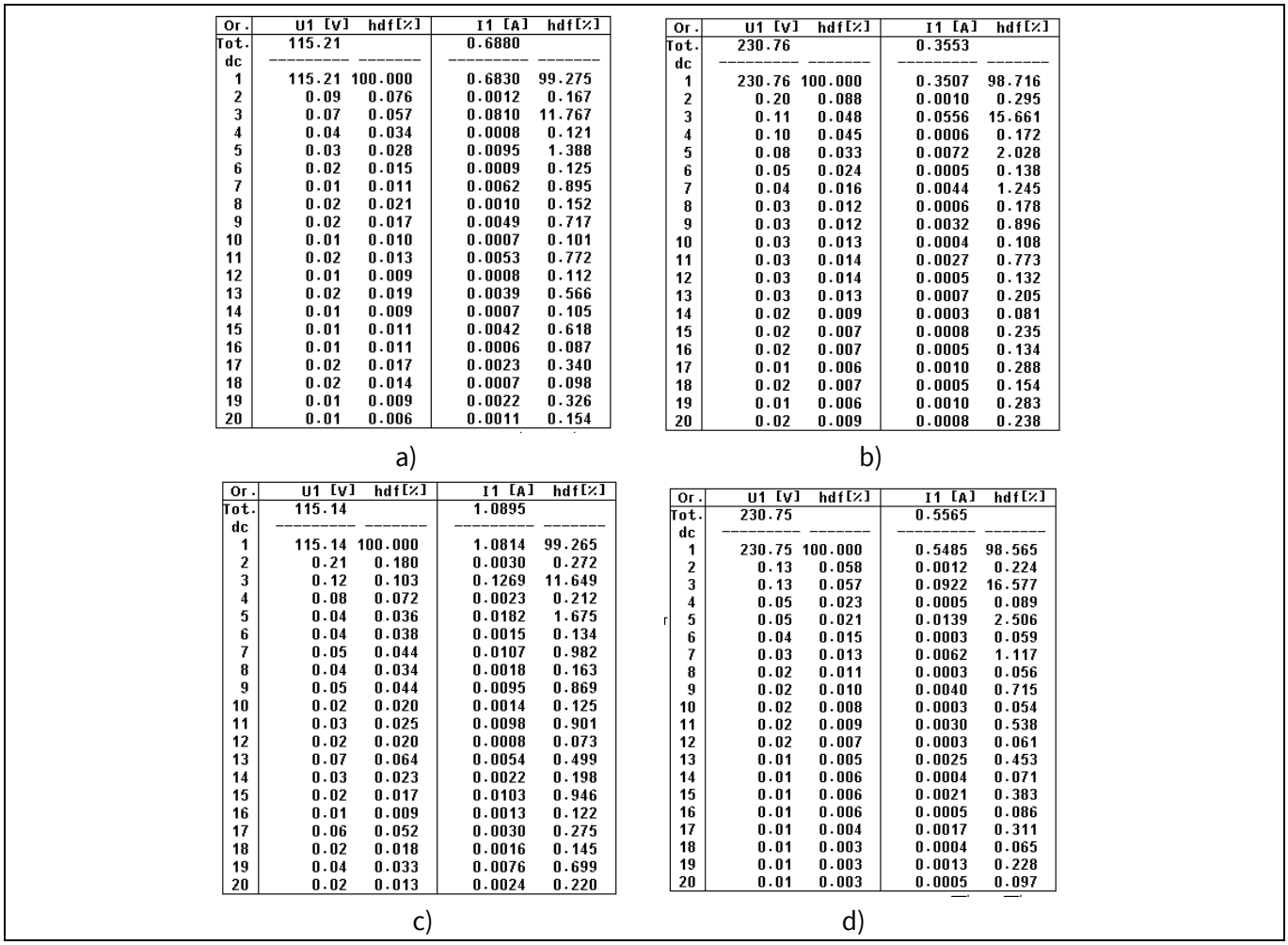
## 5.3 PFC performance

Table 4 shows the PFC performance at 58 V and 36 V output voltages at 115 V AC and 230 V AC input voltages. In all conditions the output current is set at 2 A. High power factor is achieved as shown in the measurement.

**Table 4 Power factor measurement**

| Output voltage (V) \ V AC (V) | 115 | 230 |
|---|---|---|
| 36 | 0.98 | 0.90 |
| 58 | 0.98 | 0.94 |

As shown in Figure 12, the measured harmonic currents are low to comply with IEC 61000-3-2 Class A.



a)

| Or. | U1 [V] | hdf[%] | I1 [A] | hdf[%] |
|---|---|---|---|---|
| Tot. | 115.21 | | 0.6880 | |
| dc | | | | |
| 1 | 115.21 | 100.000 | 0.6830 | 99.275 |
| 2 | 0.09 | 0.076 | 0.0012 | 0.167 |
| 3 | 0.07 | 0.057 | 0.0810 | 11.767 |
| 4 | 0.04 | 0.034 | 0.0008 | 0.121 |
| 5 | 0.03 | 0.028 | 0.0095 | 1.388 |
| 6 | 0.02 | 0.015 | 0.0009 | 0.125 |
| 7 | 0.01 | 0.011 | 0.0062 | 0.895 |
| 8 | 0.02 | 0.021 | 0.0010 | 0.152 |
| 9 | 0.02 | 0.017 | 0.0049 | 0.717 |
| 10 | 0.01 | 0.010 | 0.0007 | 0.101 |
| 11 | 0.02 | 0.013 | 0.0053 | 0.772 |
| 12 | 0.01 | 0.009 | 0.0008 | 0.112 |
| 13 | 0.02 | 0.019 | 0.0039 | 0.566 |
| 14 | 0.01 | 0.009 | 0.0007 | 0.105 |
| 15 | 0.01 | 0.011 | 0.0042 | 0.618 |
| 16 | 0.01 | 0.011 | 0.0006 | 0.087 |
| 17 | 0.02 | 0.017 | 0.0023 | 0.340 |
| 18 | 0.02 | 0.014 | 0.0007 | 0.098 |
| 19 | 0.01 | 0.009 | 0.0022 | 0.326 |
| 20 | 0.01 | 0.006 | 0.0011 | 0.154 |

b)

| Or. | U1 [V] | hdf[%] | I1 [A] | hdf[%] |
|---|---|---|---|---|
| Tot. | 230.76 | | 0.3553 | |
| dc | | | | |
| 1 | 230.76 | 100.000 | 0.3507 | 98.716 |
| 2 | 0.20 | 0.088 | 0.0010 | 0.295 |
| 3 | 0.11 | 0.048 | 0.0556 | 15.661 |
| 4 | 0.10 | 0.045 | 0.0006 | 0.172 |
| 5 | 0.08 | 0.033 | 0.0072 | 2.028 |
| 6 | 0.05 | 0.024 | 0.0005 | 0.138 |
| 7 | 0.04 | 0.016 | 0.0044 | 1.245 |
| 8 | 0.03 | 0.012 | 0.0006 | 0.178 |
| 9 | 0.03 | 0.012 | 0.0032 | 0.896 |
| 10 | 0.03 | 0.013 | 0.0004 | 0.108 |
| 11 | 0.03 | 0.014 | 0.0027 | 0.773 |
| 12 | 0.03 | 0.014 | 0.0005 | 0.132 |
| 13 | 0.03 | 0.013 | 0.0007 | 0.205 |
| 14 | 0.02 | 0.009 | 0.0003 | 0.081 |
| 15 | 0.02 | 0.007 | 0.0008 | 0.235 |
| 16 | 0.02 | 0.007 | 0.0005 | 0.134 |
| 17 | 0.01 | 0.006 | 0.0010 | 0.288 |
| 18 | 0.02 | 0.007 | 0.0005 | 0.154 |
| 19 | 0.01 | 0.006 | 0.0010 | 0.283 |
| 20 | 0.02 | 0.009 | 0.0008 | 0.238 |

c)

| Or. | U1 [V] | hdf[%] | I1 [A] | hdf[%] |
|---|---|---|---|---|
| Tot. | 115.14 | | 1.0895 | |
| dc | | | | |
| 1 | 115.14 | 100.000 | 1.0814 | 99.265 |
| 2 | 0.21 | 0.180 | 0.0030 | 0.272 |
| 3 | 0.12 | 0.103 | 0.1269 | 11.649 |
| 4 | 0.08 | 0.072 | 0.0023 | 0.212 |
| 5 | 0.04 | 0.036 | 0.0182 | 1.675 |
| 6 | 0.04 | 0.038 | 0.0015 | 0.134 |
| 7 | 0.05 | 0.044 | 0.0107 | 0.982 |
| 8 | 0.04 | 0.034 | 0.0018 | 0.163 |
| 9 | 0.05 | 0.044 | 0.0095 | 0.869 |
| 10 | 0.02 | 0.020 | 0.0014 | 0.125 |
| 11 | 0.03 | 0.025 | 0.0098 | 0.901 |
| 12 | 0.02 | 0.020 | 0.0008 | 0.073 |
| 13 | 0.07 | 0.064 | 0.0054 | 0.499 |
| 14 | 0.03 | 0.023 | 0.0022 | 0.198 |
| 15 | 0.02 | 0.017 | 0.0103 | 0.946 |
| 16 | 0.01 | 0.009 | 0.0013 | 0.122 |
| 17 | 0.06 | 0.052 | 0.0030 | 0.275 |
| 18 | 0.02 | 0.018 | 0.0016 | 0.145 |
| 19 | 0.04 | 0.033 | 0.0076 | 0.699 |
| 20 | 0.02 | 0.013 | 0.0024 | 0.220 |

d)

| Or. | U1 [V] | hdf[%] | I1 [A] | hdf[%] |
|---|---|---|---|---|
| Tot. | 230.75 | | 0.5565 | |
| dc | | | | |
| 1 | 230.75 | 100.000 | 0.5485 | 98.565 |
| 2 | 0.13 | 0.058 | 0.0012 | 0.224 |
| 3 | 0.13 | 0.057 | 0.0922 | 16.577 |
| 4 | 0.05 | 0.023 | 0.0005 | 0.089 |
| 5 | 0.05 | 0.021 | 0.0139 | 2.506 |
| 6 | 0.04 | 0.015 | 0.0003 | 0.059 |
| 7 | 0.03 | 0.013 | 0.0062 | 1.117 |
| 8 | 0.02 | 0.011 | 0.0003 | 0.056 |
| 9 | 0.02 | 0.010 | 0.0040 | 0.715 |
| 10 | 0.02 | 0.008 | 0.0003 | 0.054 |
| 11 | 0.02 | 0.009 | 0.0030 | 0.538 |
| 12 | 0.02 | 0.007 | 0.0003 | 0.061 |
| 13 | 0.01 | 0.005 | 0.0025 | 0.453 |
| 14 | 0.01 | 0.006 | 0.0004 | 0.071 |
| 15 | 0.01 | 0.006 | 0.0021 | 0.383 |
| 16 | 0.01 | 0.006 | 0.0005 | 0.086 |
| 17 | 0.01 | 0.004 | 0.0017 | 0.311 |
| 18 | 0.01 | 0.003 | 0.0004 | 0.065 |
| 19 | 0.01 | 0.003 | 0.0013 | 0.228 |
| 20 | 0.01 | 0.003 | 0.0005 | 0.097 |

**Figure 12 Harmonics current measurements: a) 115 V AC, 36 V output, b) 230 V AC, 36 V output, c) 115 V AC, 58 V output, and d) 230 V AC, 58 V output**

## 5.4 Brown-in and brown-out protection

ICL8810 features an adaptive brown-out level triggering based on bus voltage ripple.

As shown in Table 5 and Table 6, with these features, this reference design demonstrates a higher brown-out level at higher power transfer, while still ensuring sufficient hysteresis between brown-in and brown-out. As a result, ICL8810 can better protect the primary components from overheating and saturation when an input undervoltage condition occurs.

**Table 5 Brown-in test result**

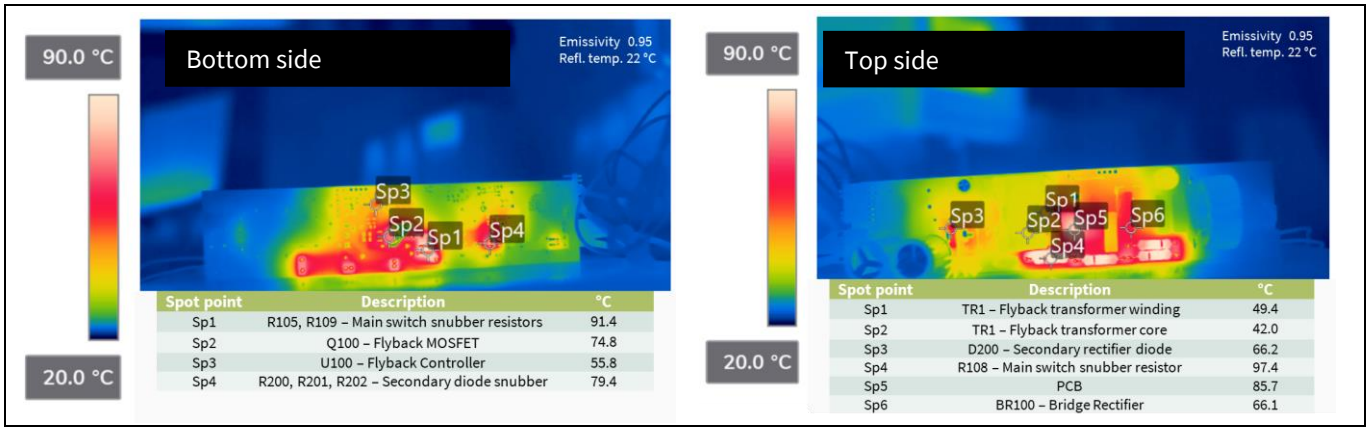
| $F_{line}$ (Hz) | Output voltage (V) | $I_{out,setpoint}$ (mA) | $I_{out,setpoint}$ (%) | Brown-in V AC ($V_{RMS}$) |
|---|---|---|---|---|
| 50 | 58 | 0 | 0 | 89.8 |
| | | 1000 | 50 | 89.9 |
| | 36 | 0 | 0 | 89.8 |
| | | 1000 | 50 | 90.1 |

**Table 6 Brown-out test result**

| $F_{line}$ (Hz) | Output load (V) | $I_{out,setpoint}$ (mA) | $I_{out,setpoint}$ (%) | Brown-out V AC ($V_{RMS}$) |
|---|---|---|---|---|
| 50 | 58 | 0 | 0 | 64.5 |
| | | 1000 | 50 | 65.1 |
| | 36 | 0 | 0 | 64.1 |
| | | 1000 | 50 | 64.9 |

## 5.5 Thermal test

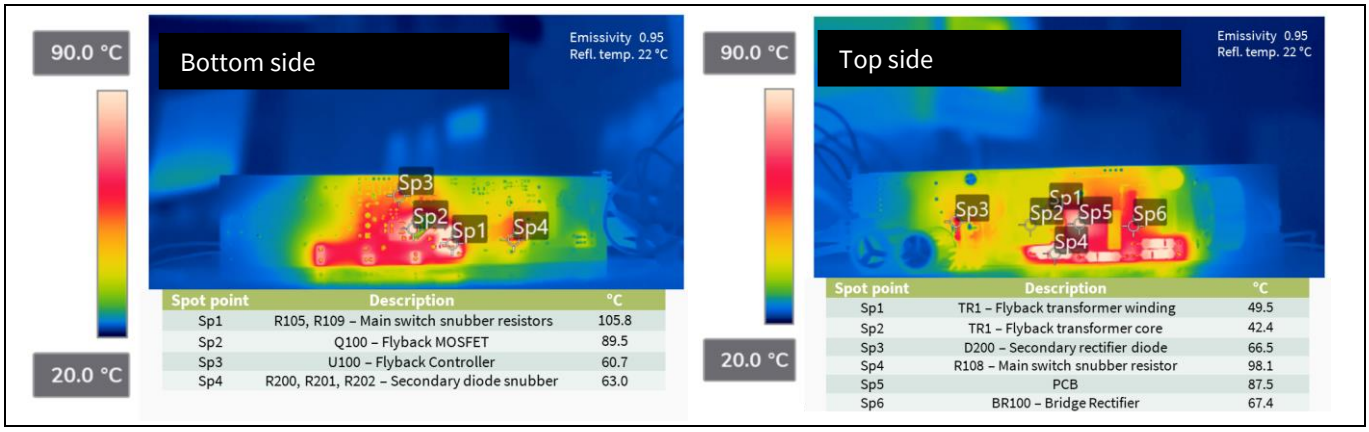
The open-frame thermal measurement is done after one hour of operation with full output power (116 W) using an infrared (IR) thermography camera. The ambient temperature is approximately 22°C.




| Spot point | Description | °C |
|---|---|---|
| Sp1 | R105, R109 – Main switch snubber resistors | 91.4 |
| Sp2 | Q100 – Flyback MOSFET | 74.8 |
| Sp3 | U100 – Flyback Controller | 55.8 |
| Sp4 | R200, R201, R202 – Secondary diode snubber | 79.4 |

| Spot point | Description | °C |
|---|---|---|
| Sp1 | TR1 – Flyback transformer winding | 49.4 |
| Sp2 | TR1 – Flyback transformer core | 42.0 |
| Sp3 | D200 – Secondary rectifier diode | 66.2 |
| Sp4 | R108 – Main switch snubber resistor | 97.4 |
| Sp5 | PCB | 85.7 |
| Sp6 | BR100 – Bridge Rectifier | 66.1 |

**Figure 13 IR thermal image at 230 V AC input**




| Spot point | Description | °C |
|---|---|---|
| Sp1 | R105, R109 – Main switch snubber resistors | 105.8 |
| Sp2 | Q100 – Flyback MOSFET | 89.5 |
| Sp3 | U100 – Flyback Controller | 60.7 |
| Sp4 | R200, R201, R202 – Secondary diode snubber | 63.0 |

| Spot point | Description | °C |
|---|---|---|
| Sp1 | TR1 – Flyback transformer winding | 49.5 |
| Sp2 | TR1 – Flyback transformer core | 42.4 |
| Sp3 | D200 – Secondary rectifier diode | 66.5 |
| Sp4 | R108 – Main switch snubber resistor | 98.1 |
| Sp5 | PCB | 87.5 |
| Sp6 | BR100 – Bridge Rectifier | 67.4 |

**Figure 14 IR thermal image at 115 V AC input**

## 5.6 Conducted emissions (EN 55022 class B)

The conducted emissions test is performed at full output power (116 W) based on EN 55022 standard Class B limits, as shown in Figure 15 and Figure 16.

The measurement equipment used for this conducted emissions test was Rohde & Schwarz HM6050-2 and Tektronix RSA503A.

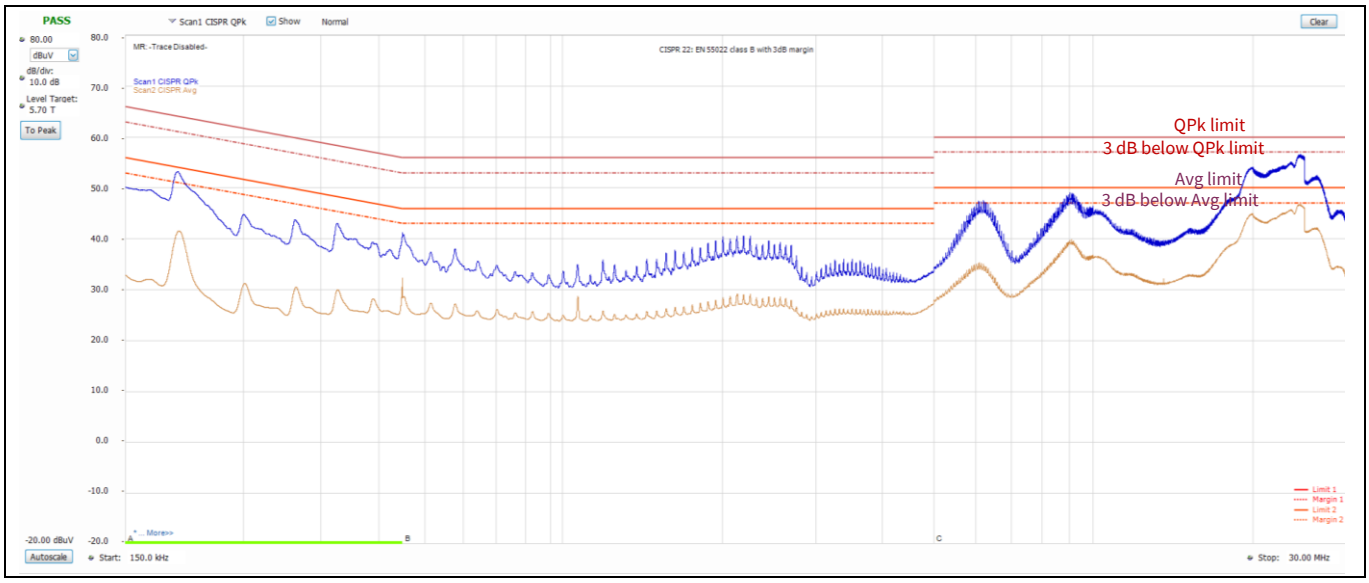



**Figure 15 Conducted emissions (live) test result at V AC = 115 $V_{RMS}$, $F_{line}$ = 50 Hz, $P_{out}$ = 116 W**

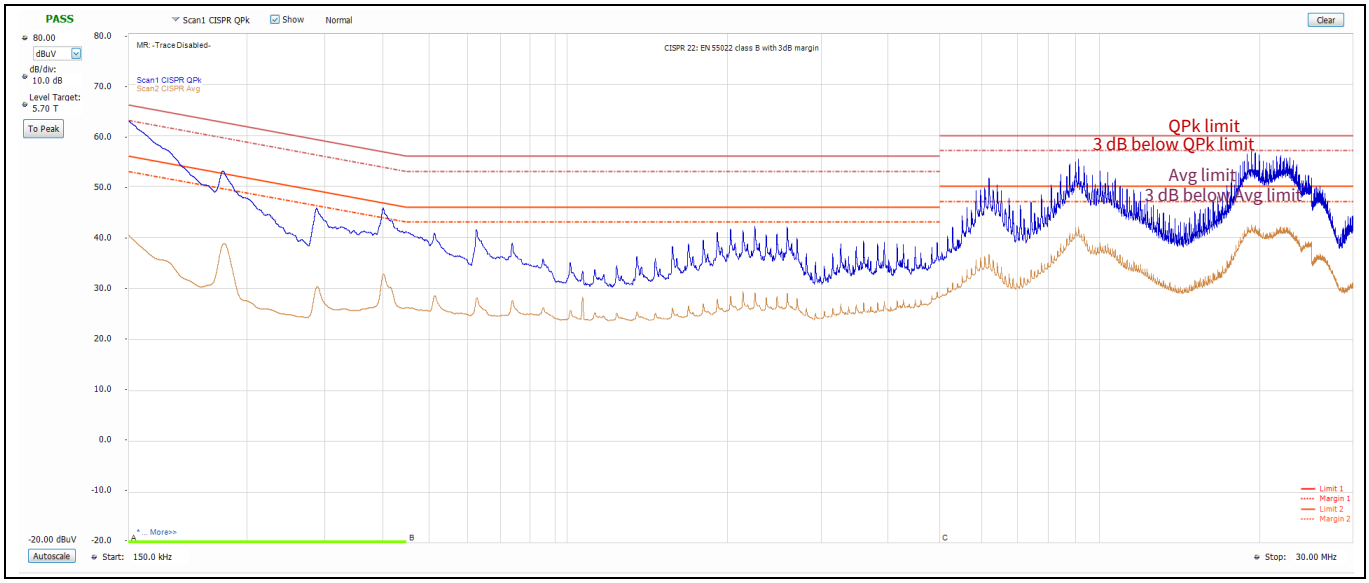



**Figure 16 Conducted emissions (live) test result at V AC = 230 $V_{RMS}$, $F_{line}$ = 50 Hz, $P_{out}$ = 116 W**

# 6 Bill of materials and transformer specifications

This section provides the bill of materials (BOM) and the transformer specifications.

## 6.1 BOM

**Table 7 BOM of the reference design board**

| Designator | Description | Part number | Manufacturer |
|---|---|---|---|
| BR100 | Dio GBU806/ / THT/ / | GBU806 | Diodes Incorporated |
| C17 | Cap 3.2nF/ / THT 9.5mm/ /20% | 440LD32-R | Vishay |
| C100 | Cap 220nF/ 630V/ THT/Radial/ /10% | 890334025027CS | Wurth Elektronik |
| C101 | Cap 2.2nF/ 630V/ 1206/ X7R/10% | GRM31AR72J222KW01 | Murata |
| C102 | Cap 470nF/ 630V/ THT/Radial/ /10% | 890324025039CS | Wurth Elektronik |
| C103, C104 | Cap 150nF/ 630V/ THT/Radial/ /10% | 890334025022CS | Wurth Elektronik |
| C105 | Cap 22uF/ 50V/ THT/Radial/ /20% | 860080672001 | Wurth Elektronik |
| C106 | Cap 100pF/ 1kV/ 1206/ C0G/5% | GRM31A5C3A101JW01 | Murata |
| C107, C109, C208, C209, C211, C212 | Cap 100nF/ 50V/ 0603/ X7R/10% | 06035C104K4Z2A | AVX |
| C108 | Cap 470pF/ 50V/ 0603/ X7R/10% | 885012206081 | Wurth Elektronik |
| C200 | Cap 1nF/ 630V/ 1206/ C0G/5% | CGA5F4C0G2J102J085AA | TDK Corporation |
| C201, C203 | Cap 1.8mF/ 80V/ THT/Radial/ /20% | EKZN800ELL182MM40S | Nippon Chemi-Con |
| C204 | Cap 1uF/ 100V/ 1206/ X7R/10% | 12061C105KAT2A | AVX |
| C205 | Cap 100nF/ 100V/ 3216 (1206)/ /10% | CGA5H2X8R2A104K115AA | TDK Corporation |
| C207 | Cap 220uF/ 35V/ THT/Radial/ /20% | 860010574011 | Wurth Elektronik |
| C210, C213 | Cap 1uF/ 50V/ 0805/ X7R/10% | GCM21BR71H105KA03 | Murata |
| C214 | Cap 10nF/ 50V/ 0805/ X7R/10% | C0805C103K5RACAUTO | Kemet |
| C215 | Cap 1nF/ 50V/ 0603/ C0G/1% | C0603C102F5GAC | Kemet |
| C217 | Cap 470nF/ 25V/ 0603/ X7R/10% | GCM188R71E474KA64 | Murata |
| C219 | Cap 10nF/ 16V/ 0603/ X7R/10% | 885012206040 | Wurth Elektronik |
| C222 | Cap 4.7uF/ 50V/ 0805/ X5R/10% | GRM21BR61H475KE51 | Murata |
| C223 | Cap 4.7uF/ 25V/ 0805/ X7R/10% | GRM21BR71E475KA73 | Murata |
| D100 | Dio ES1J/ / SMA (DO-214AC)/ / | ES1J | ON Semiconductor |
| D101, D102 | Dio 1N4006G/ / DO-41 (Case 59-10)/ / | 1N4006G | ON Semiconductor |
| D103, D201 | Dio PMEG150G20ELR/ / SOD123W/ / | PMEG150G20ELR | Nexperia |
| D104 | Dio 22V/ / SOD-123/ / | MMSZ22T1G | ON Semiconductor |
| D200 | Dio RF2001T3DNZC9/ / TO-220FN-3/ / | RF2001T3DNZC9 | ROHM Semiconductors |
| D202, D203 | Dio BAV16WS-7-F/ / SOD-323/ / | BAV16WS-7-F | Diodes Incorporated |
| F100 | Res Fuse 300V / 3.15A/ 300V/ THT/Radial/ / | SS-5H-3.15A-APH | Bussmann |

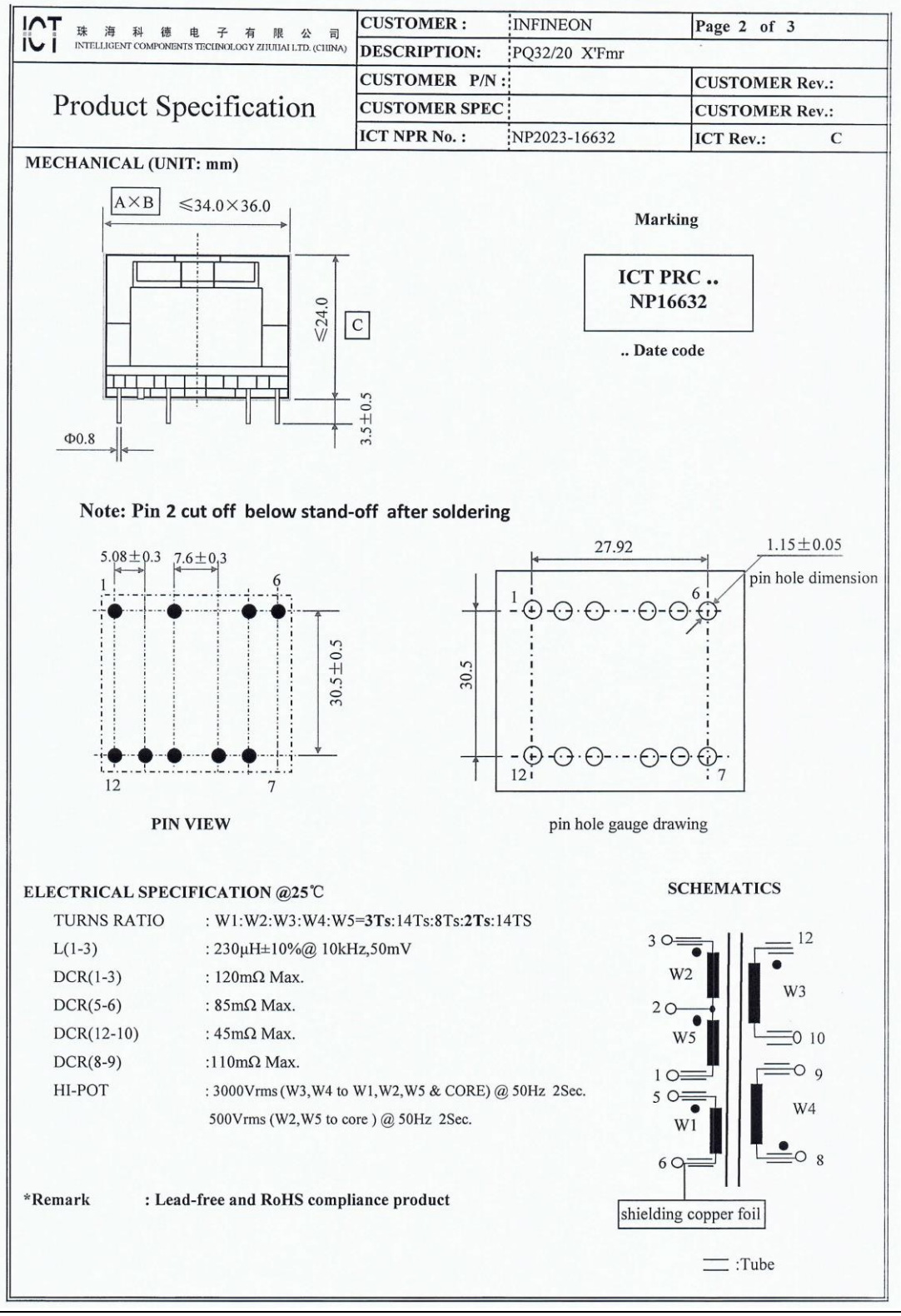
## Bill of materials and transformer specifications

| Designator | Description | Part number | Manufacturer |
|---|---|---|---|
| HS200 | Mec 513002B02500G/ / Heatsink, TO-220, 34.92mm L X 12.7mm W X 25.4mm H/ / | 513002B02500G | Aavid Thermalloy |
| L100 | Ind 470uH/ / Radial Type/ /10% | 7447480471 | Wurth Elektronik |
| L101 | Ind 20mH/ / THT/ / | 8110-RC | Bourns |
| MOV100, MOV101 | Res 560V/ 460V/ THT/ / | MOV-10D561K | Bourns |
| PC1 | TLP383(GR-TPL,E/ / TLP383/ / | TLP383 | Toshiba |
| Q100 | Tra IPD80R280P7/ / PG-TO252-3-313/ / | IPD80R280P7 | Infineon Technologies |
| R100, R103, R106, R108 | Res 4.7k/ 750V/ THT/Axial/ /5% | RR03J4K7TB | TE Connectivity |
| R101, R107 | Res 620k/ 200V/ 1206/ /1% | CRCW1206620KFK | Vishay |
| R102, R104, R110 | Res 180k/ 200V/ 1206/ /1% | CRCW1206180KFK | Vishay |
| R105, R109 | Res 56R/ 200V/ 1210/ /1% | CRCW121056R0FK | Vishay |
| R111, R121, R130, R220 | Res 0R/ 75V/ 0603/ /0R | RC0603JR-070RL | Yageo |
| R112, R117 | Res 10R/ 150V/ 0805/ /1% | RC0805FR-0710RL | Yageo |
| R113, R114 | Res 2.7MEG/ 200V/ 1206/ /1% | CRCW12062M70FK | Vishay |
| R115 | Res 620k/ 200V/ 1206/ /1% | CRCW1206620KFK | Vishay |
| R116 | Res 47k/ 200V/ 0805/ /1% | ERJ-6ENF4702V | Panasonic |
| R118 | Res 39k/ 75V/ 0603/ /1% | CRCW060339K0FK | Vishay |
| R120 | Res 10k/ 150V/ 805/ /5% | RMCF0805JT10K0 | Stackpole Electronics |
| R122 | Res 2.7k/ 150V/ 0805/ /1% | CRCW08052K70FK | Vishay |
| R123, R124 | Res 180mR/ / 1206/ /1% | KDV12FR180ET | Ohmite |
| R125 | Res 39k/ 75V/ 0603/ /1% | RC0603FR-0739KL | Yageo |
| R126, R127, R129, R205, R221, R232 | Res 0R/ / THT/Axial/ / | ZOR-12-R-52-0R | Yageo |
| R128 | Res 12k/ 50V/ 0603/ /1% | RC0603FR-0712KL | Yageo |
| R200, R201, R202 | Res 47R/ 200V/ 1206/ /1% | CRCW120647R0FKEAHP | Vishay |
| R203 | Res 0R/ 150V/ 805/ / | RMCF0805ZT0R00 | Stackpole Electronics |
| R206, R207, R208, R214 | Res 1k/ 75V/ 0603/ /1% | ERJ3EKF1001V | Panasonic |
| R209, R211 | Res 20k/ 50V/ 0603/ /1% | MCR03EZPFX2002 | ROHM Semiconductors |
| R210 | Res 1.5k/ 75V/ 0603/ /1% | RC0603FR-071K5L | Yageo |
| R213 | Res 30k/ 75V/ 0603/ /1% | CRCW060330K0FK | Vishay |
| R215 | Res 5.6k/ 75V/ 0603/ /1% | CRCW06035K60FK | Vishay |
| R216 | Res 5.1k/ 200V/ 1206/ /1% | CRCW12065K10FK | Vishay |

## Bill of materials and transformer specifications

| Designator | Description | Part number | Manufacturer |
|---|---|---|---|
| R222 | Res 120k/ 75V/ 0603/ /1% | CRCW0603120KFK | Vishay |
| R224 | Res 0R/ 200V/ 1206/ /0% | CRCW12060000Z0EA | Vishay |
| R226 | Res 8.2k/ / 0603/ /1% | CRCW06038K20FKEAC | Vishay |
| R227 | Res 27k/ 75V/ 0603/ /1% | CRCW060327K0FK | Vishay |
| R228 | Res 100mR/ / 1206/ /1% | ERJ8BWFR100V | Panasonic |
| TR1 | Tra NP2023-16632/ / THT/ / | NP2023-16632 | ICT |
| U100 | Int ICL8810/ / PG-DSO-8/ / | ICL8810 | Infineon Technologies |
| U200 | Ana TLV9102IDR/ / SOIC-8/ / | TLV9102IDR | Texas Instruments |
| U201 | Pow MCP1799T-5002H/TT/ / SOT23/ / | MCP1799T-5002H/TT | Microchip Technology |
| X100 | Con 250-203/ / THT/ / | 250-203 | WAGO |
| Xout200 | Con 691322310004/ / WR-TBL/ / | 691322310004 | Wurth Elektronik |
| Xout201 | Con 613007143121/ / THT 7 PIN 2.54 mm pitch/ / | 613007143121 | Wurth Elektronik |

## 6.2 Transformer specifications



珠 海 科 德 电 子 有 限 公 司
INTELLIGENT COMPONENTS TECHNOLOGY ZHUHAI LTD. (CHINA)

| | | |
|---|---|---|
| CUSTOMER : | INFINEON | Page 2 of 3 |
| DESCRIPTION: | PQ32/20 X'Fmr | |
| Product Specification | | |
| CUSTOMER P/N : | | CUSTOMER Rev.: |
| CUSTOMER SPEC | | CUSTOMER Rev.: |
| ICT NPR No. : | NP2023-16632 | ICT Rev.: C |

MECHANICAL (UNIT: mm)



Marking

ICT PRC ..
NP16632

.. Date code

Note: Pin 2 cut off below stand-off after soldering



PIN VIEW



pin hole gauge drawing

ELECTRICAL SPECIFICATION @25℃

| | |
|---|---|
| TURNS RATIO | : W1:W2:W3:W4:W5=**3Ts**:14Ts:8Ts:**2Ts**:14TS |
| L(1-3) | : 230μH±10%@ 10kHz,50mV |
| DCR(1-3) | : 120mΩ Max. |
| DCR(5-6) | : 85mΩ Max. |
| DCR(12-10) | : 45mΩ Max. |
| DCR(8-9) | :110mΩ Max. |
| HI-POT | : 3000Vrms (W3,W4 to W1,W2,W5 & CORE) @ 50Hz 2Sec. |
| | 500Vrms (W2,W5 to core ) @ 50Hz 2Sec. |

*Remark : Lead-free and RoHS compliance product

SCHEMATICS



**Figure 17 Flyback transformer (TR1) mechanical and electrical specifications**

## Bill of materials and transformer specifications

| | | | |
|---|---|---|---|
| ICT 珠 海 科 德 电 子 有 限 公 司 INTELLIGENT COMPONENTS TECHNOLOGY ZHUHAI LTD. (CHINA) | CUSTOMER : | INFINEON | Page 3 of 3 |
| | DESCRIPTION: | PQ32/20 X'Fmr | |
| | CUSTOMER P/N : | | CUSTOMER Rev.: |
| Product Specification | CUSTOMER SPEC: | | CUSTOMER Rev.: |
| | ICT NPR No. : | NP2023-16632 | ICT Rev.: C |

**MATERIALS:**

| | |
|---|---|
| BOBBIN | : PQ32, Vertical, 1Section, PHENOLIC (PM-9820 or T375HF) |
| CORE | : PQ32/20, TPW33 or DMR95 or PG312 or HC95 or HPP-95 or equal, GAP=2*0.29mm |
| WIRE | : (W1)Φ0.25mm, 1UEW or 2UEW, 155°C, |
| | : (W2,W5) 45*0.1mm 1UEW or 2UEW, 155°C |
| | :(W3) 35*0.1 TIW-B(LZ) or equal |
| | :(W4) 0.20mm, TIW-B or equal |
| TAPE | : 10mm width & 15mm width & 17mm width, #1350F-1 or CT280 or equal |
| TUBE | : Teflon tube, AWG#17L,AWG#26L,AWG#30L |
| GLUE | : F121A/B or TA452A/B or LO-200QA/B |
| VARNISH | : V1630FS or BC-359 or equal |
| COPPER FOIL | : 10mm width |

C

**WINDING CONSTRUCTION**

| |
|---|
| Tape: 2 layers |
| W5:45*0.1 UEW 14ts, start 2, finish 1 |
| Tape: 2 layers or 3 layers |
| W4: Φ0.2mm, TIW-B , 2ts, start 8, finish 9 |
| Tape: 3 layers |
| W3: 35*0.1mm, TIW-B(LZ) 8ts, start 12, finish 10 |
| Tape: 3 layers |
| W2:45*0.1 UEW 14ts, start 3, finish 2 |
| Tape: 2 layers |
| W1: Φ0.25mm, UEW, 3ts, start 5, finish 6 |

NOTE : one layer of tape between layer and layer for W2 winding and W5 winding

| Rev. | Change history |
|---|---|
| A | |
| B | change W1 turns from 4 to 3 and change W4 turns from 3 to 2 |
| C | correct core material and add varnish |

**Figure 18 Flyback transformer (TR1) materials and winding construction specifications**

## Revision history

| Document revision | Date | Description of changes |
|---|---|---|
| V 1.0 | 2023-11-17 | Initial release |

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