

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller

Order code: REF-ICL5102HV-U150W

### About this document

#### Scope and purpose

ICL5102HV is a superior 980 V integrated combo controller IC to control and drive the two-stage PFC + LLC/LCC topologies. These topologies are increasingly popular in LED lighting, battery chargers and other power supply applications at low or medium power levels. A High Voltage (HV) 150 W, 3 A PFC + LCC dimmable LED driver has been designed to demonstrate the performance of ICL5102HV. The output stage of the LCC converter is equipped with Synchronous Rectification (SR) for better efficiency.

This document briefly introduces the feature set of ICL5102HV and then reports on the performance of this HV demonstration board across its wide operating range.

#### Intended audience

This document is intended for anyone who uses this ICL5102HV demonstration board, either for their own application tests or as a reference for a new ICL5102HV-based development.

### Table of contents

|                                                            |           |
|------------------------------------------------------------|-----------|
| <b>About this document.....</b>                            | <b>1</b>  |
| <b>Table of contents.....</b>                              | <b>1</b>  |
| <b>1 IC introduction.....</b>                              | <b>3</b>  |
| 1.1 Features.....                                          | 3         |
| 1.2 Protection mechanisms with auto-restart reaction ..... | 3         |
| <b>2 Board description.....</b>                            | <b>4</b>  |
| 2.1 Electrical specifications .....                        | 4         |
| 2.2 Schematics and layout.....                             | 5         |
| 2.3 Board set-up .....                                     | 9         |
| <b>3 Electrical performance .....</b>                      | <b>10</b> |
| 3.1 Efficiency, power factor and THD .....                 | 11        |
| 3.2 PFC performance.....                                   | 13        |
| 3.2.1 Start-up.....                                        | 13        |
| 3.2.2 Steady-state .....                                   | 14        |
| 3.3 LCC performance.....                                   | 16        |
| 3.3.1 Start-up.....                                        | 16        |
| 3.3.2 Steady-state .....                                   | 17        |
| 3.4 Response to load step .....                            | 17        |
| <b>4 Thermal performance .....</b>                         | <b>18</b> |

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**Table of contents**

**5     EMI .....19**

**6     Magnetic components.....20**

**7     Bill of Materials (BOM) .....26**

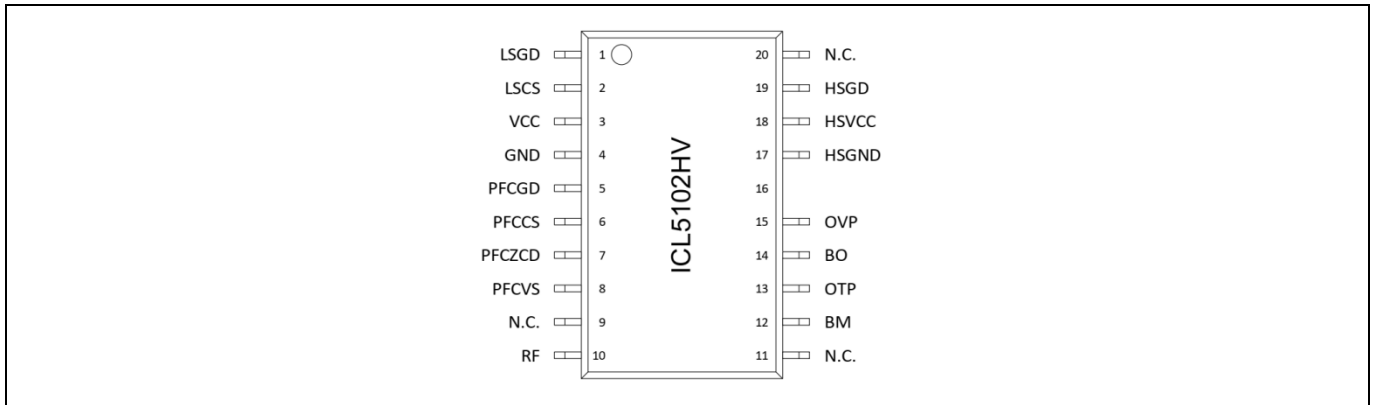
**8     Reference .....29**

**Revision history.....30**

## IC introduction

### 1 IC introduction

ICL5102HV is the HV version of ICL5102. Its integrated HV half-bridge driver can handle 900 V (recommended value) thanks to Infineon's coreless transformer technology, which also exhibits supreme robustness against dV/dt and negative voltage peak. Sealed in a PG-DSO-19-1 package Figure 1, ICL5102HV has its pin-16 left open for sufficient clearance distance. The features of ICL5102HV are summarized as follows.



**Figure 1 ICL5102HV pin map (PG-DSO-19-1 package)**

#### 1.1 Features

- 900 V (recommended value) integrated high-side MOSFET driver
- Integrated two-stage combo controller allows for a reduced number of external components, and optimizes the Bill of Materials (BOM) and form factor
- PFC controller with Critical Conduction Mode (CrCM) and Discontinuous Conduction Mode (DCM)
- Resonant Half-Bridge (HB) controller with fixed or variable switching frequency control
- Maximum 500 KHz HB switching frequency and soft-start frequency up to 1.3 MHz
- Resonant HB Burst Mode (BM) ensures power limitation and low standby power at less than 300 mW
- Supports universal AC input voltage (90 to 480 V<sub>rms</sub>) nominal
- Excellent system efficiency up to 94 percent
- THD optimization ensures low harmonic distortion down to 30 percent nominal load

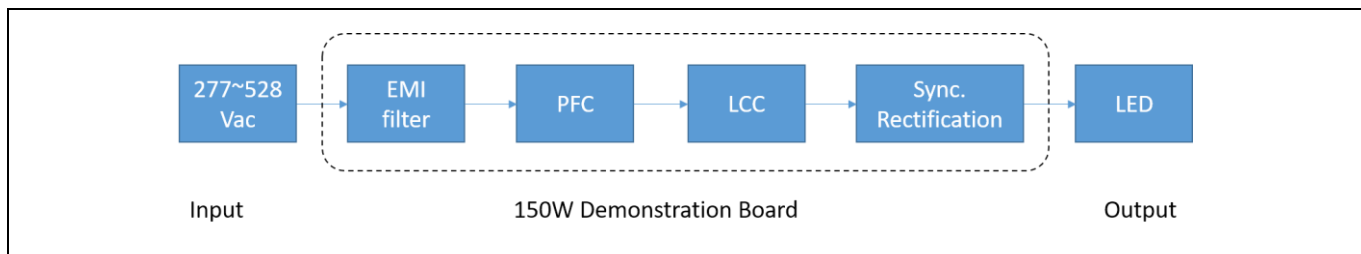
#### 1.2 Protection mechanisms with auto-restart reaction

- Input brown-out protection
- PFC bus Over-Voltage Protection (OVP)
- PFC Over-Current Protection (OCP)
- Output OVP, OCP/short-circuit protection, Output Over-Power (OPP)/over-load protection
- Capacitive mode protection
- External Over-Temperature Protection (OTP)

## Board description

## 2 Board description

This 150 W demonstration board is developed for industrial lighting applications with line-to-line input voltage ( $277\text{ V}_{\text{rms}} \sim 528\text{ V AC}$ ). The system architecture of this design is given in Figure 2.



**Figure 2 System architecture**

Key features of this demonstration board are:

- Boost PFC + LCC topology for wide output voltage range
- 800 V bus voltage to cover  $528\text{ V}_{\text{rms}}$  maximum input voltage
- Single-side PCB (70  $\mu\text{m}$ /2 oz copper thickness) for cost savings
- Galvanically isolated 0 to 10 V analog dimming
- SR at LCC output for better efficiency (based on IR11688S)
- Current transformer used to pass the LCC transformer output current information to its primary side (faster control response)

Note that ICL5102HV, like ICL5102, has BM operation; however, this mode is not used for the light load operation in this demonstration.

### 2.1 Electrical specifications

Table 1 lists the key electrical specifications of this demonstration board.

**Table 1 Key electrical specifications**

| Item                      | Symbol                | Min.       | Typ.       | Max.       | Unit             | Remarks                                                           |
|---------------------------|-----------------------|------------|------------|------------|------------------|-------------------------------------------------------------------|
| AC input voltage          | $V_{\text{in.ac}}$    | 277        | 380 to 480 | 528        | $V_{\text{rms}}$ |                                                                   |
| Input frequency           | $f_{\text{in}}$       | 47         |            | 63         | Hz               |                                                                   |
| Inrush current            | $I_{\text{in.pk}}$    |            |            | 35         | $A_{\text{pk}}$  |                                                                   |
| Total Harmonic Distortion | THD                   |            |            | 10 percent | –                | 50 percent load, 380 $V_{\text{rms}}$                             |
|                           |                       |            |            | 15 percent | –                | 50 percent load, 480 $V_{\text{rms}}$                             |
| Efficiency                | $\eta$                | 92 percent |            |            | –                | 100 percent load at 380 $V_{\text{rms}}$ and 480 $V_{\text{rms}}$ |
| Rated LED voltage         | $V_{\text{LED}}$      | 17         |            | 48         | V DC             |                                                                   |
| Full LED current          | $I_{\text{LED.full}}$ | 2.97       |            | 3.03       | A                | $V_{\text{dim}} = 10\text{ V}$                                    |
| LCC frequency range       | $f_{\text{LCC}}$      | 40         |            | 130        | kHz              |                                                                   |

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller



### Board description

|                 |                              |  |  |         |         |                                     |
|-----------------|------------------------------|--|--|---------|---------|-------------------------------------|
| Line regulation | $\Delta I_{\text{out.line}}$ |  |  | $\pm 1$ | Percent | Current regulation                  |
| Load regulation | $\Delta V_{\text{out.Load}}$ |  |  | $\pm 1$ | Percent | $I_{\text{LED}} = 1$ to 100 percent |
| EMI             | EN 55015                     |  |  |         |         |                                     |
| Harmonics       | EN 61000-3-2 class C         |  |  |         |         |                                     |

## 2.2 Schematics and layout

Figure 3-Figure 5 illustrate the schematics and layout of this board. On the top side of this single-side PCB are through-hole components only. The copper thickness is 70  $\mu\text{m}$  (2 oz).

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller

### Board description

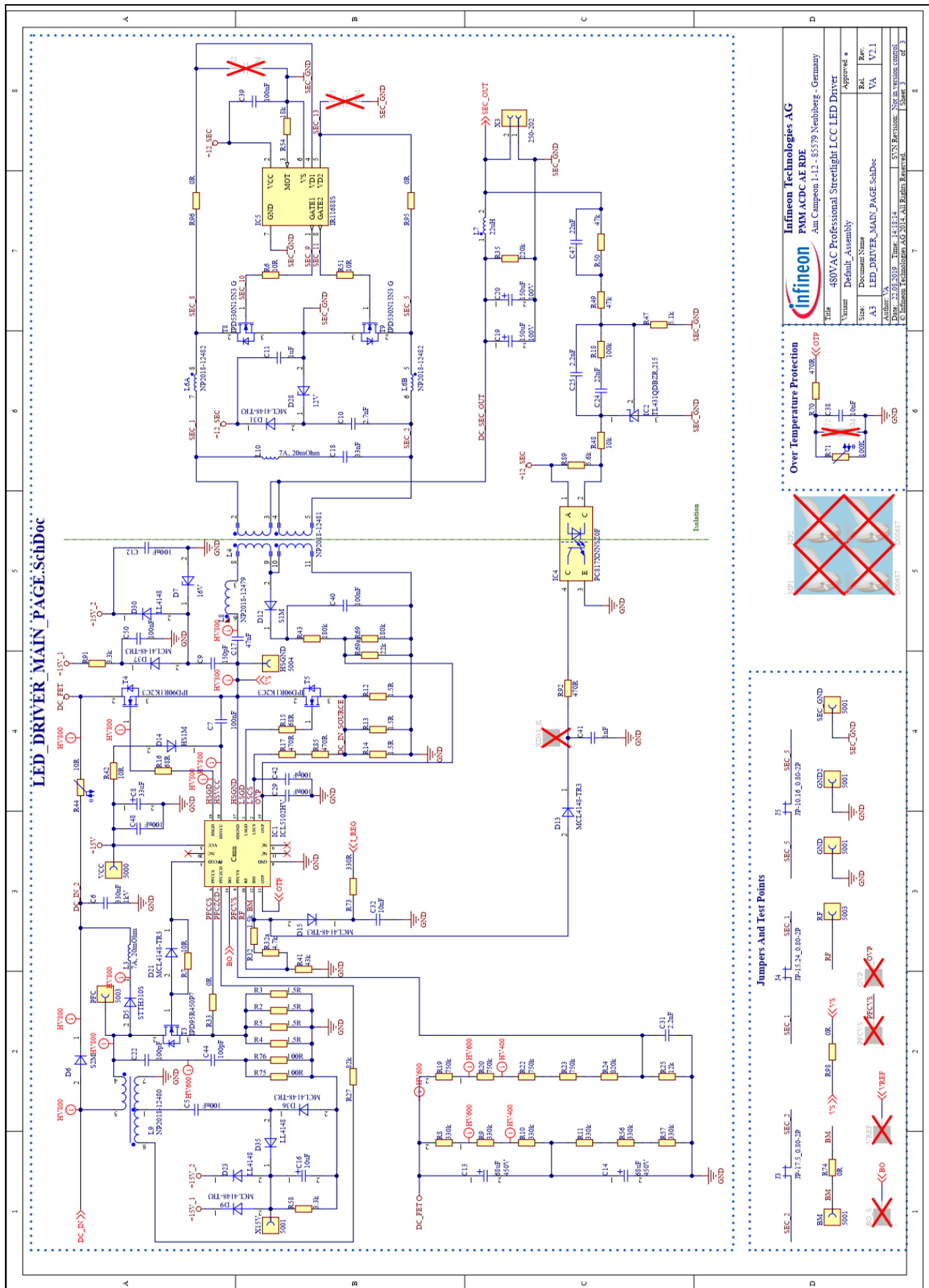
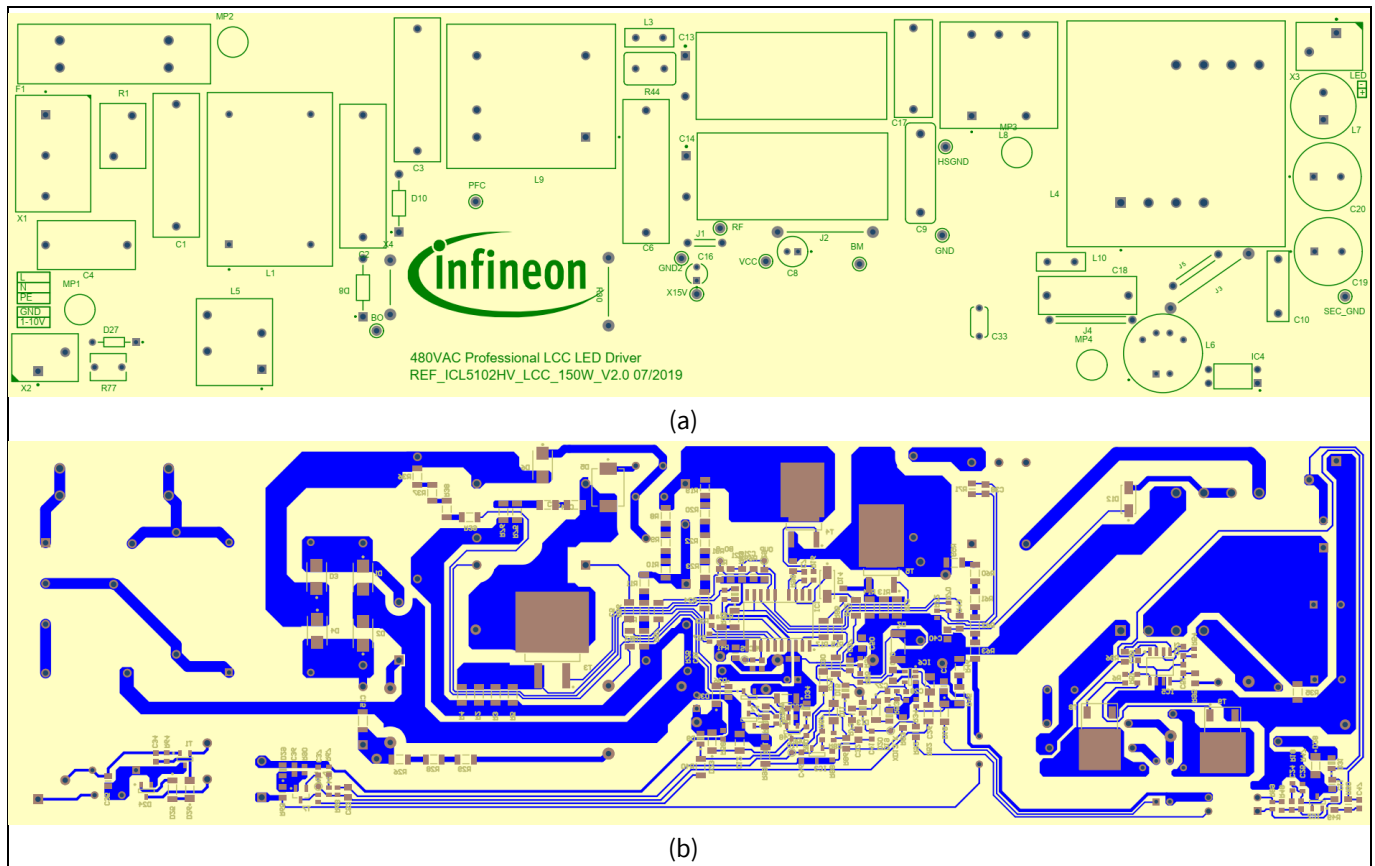


Figure 3 Schematics – power stage





# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller



### Board description

### 2.3 Board set-up

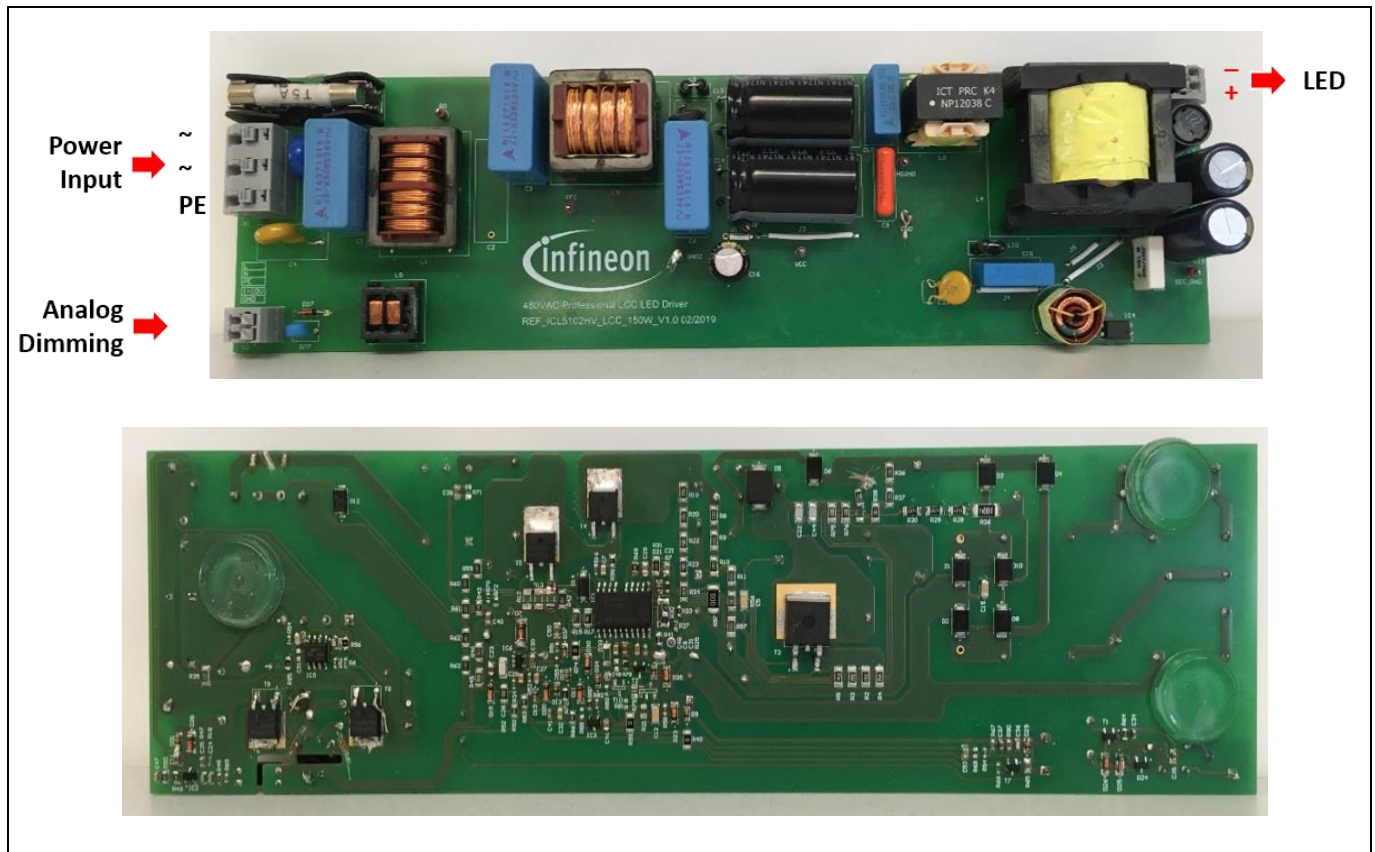
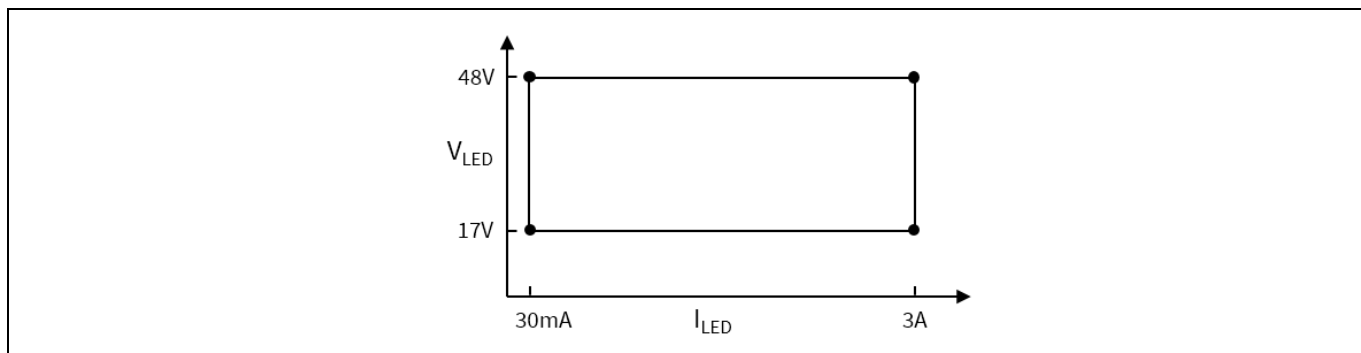


Figure 6 Board set-up

## Electrical performance

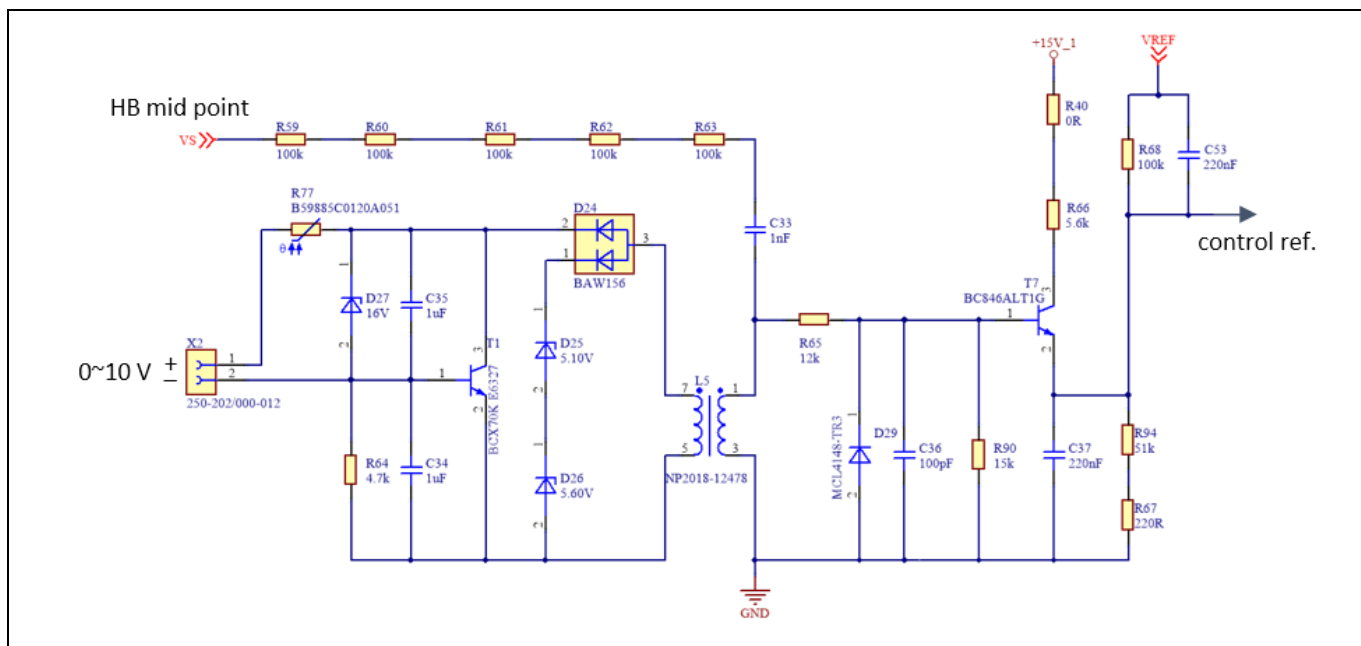
### 3 Electrical performance

The demonstration board is designed to be a dimmable window LED driver. The LED operating window is shown in Figure 7. The LED voltage and current range from 48 to 17 V and 3 A to 30 mA (100 ~ 1 percent), respectively.



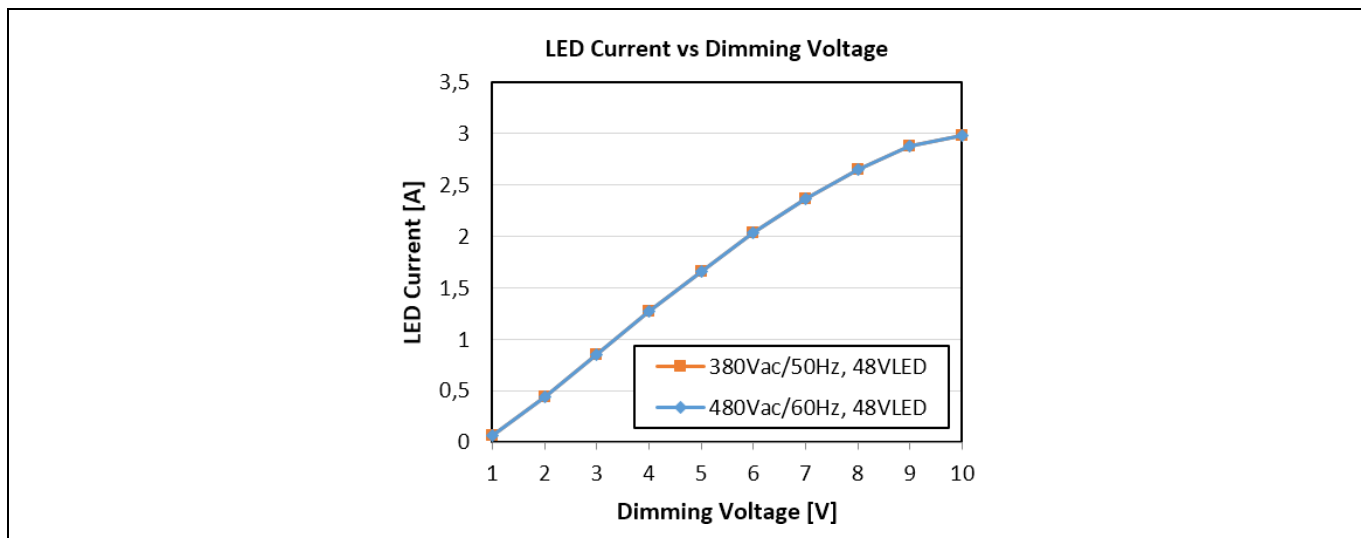
**Figure 7 Output operating window**

This LED current is tuned via a galvanically isolated 0 to 10 V dimming circuit. This circuit is illustrated in Figure 8. The dimming curve is given in Figure 9.



**Figure 8 Galvanically isolated 1 to 10 V dimming circuit**

## Electrical performance

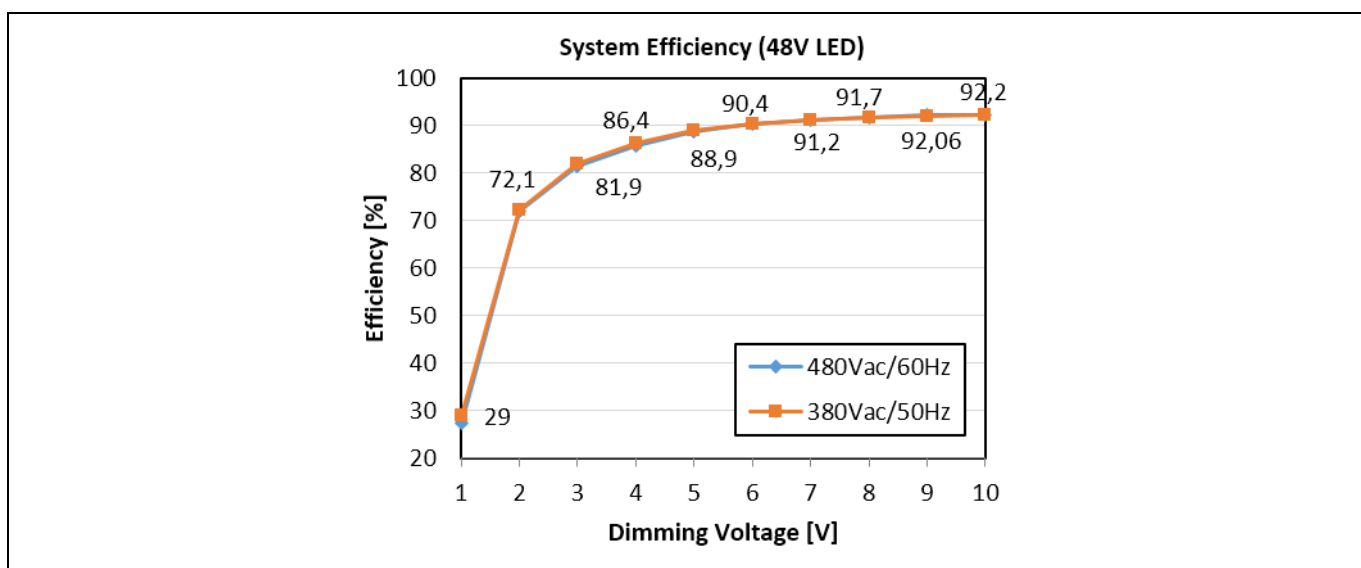


**Figure 9 Dimming curve**

The electrical performance of this demonstration board is shown on the system level (efficiency, power factor and THD), PFC part and LCC part. The start-up behavior, load regulation and steady-state are demonstrated both for the PFC stage and the LCC stage.

### 3.1 Efficiency, power factor and THD

The efficiency, power factor and THD are presented below in a range of input voltage and load conditions. First, the system efficiency is presented in Figure 10 at 380 V<sub>rms</sub> and 480 V<sub>rms</sub> at full load range. At the maximum LED current, the system efficiency is 92.2 percent.

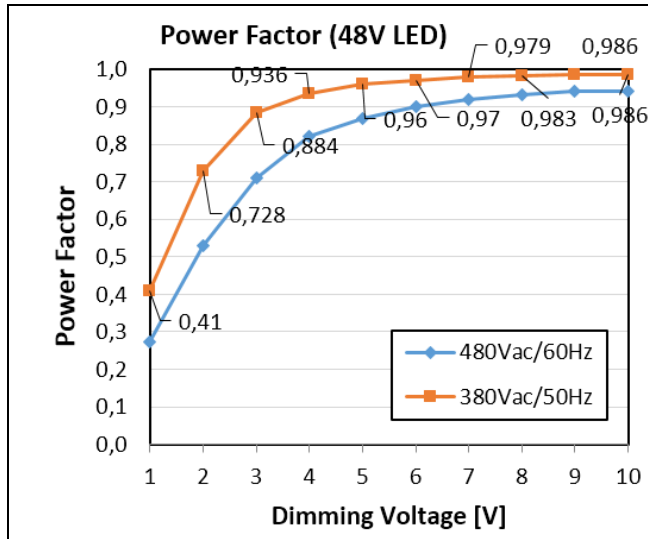


**Figure 10 System efficiency**

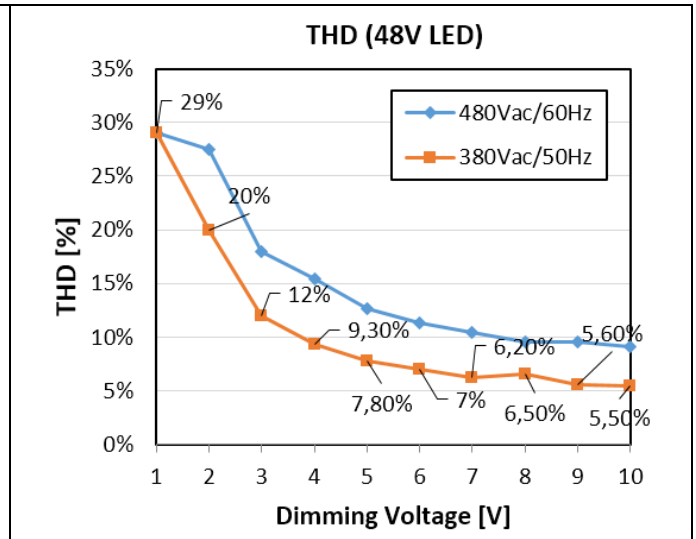
ICL5102 and ICL5102HV have dedicated internal circuits for THD minimization, which makes THD the best-in-class. They operate the PFC with two modes: CrCM at medium and high load, and DCM at light load. The on-time of the PFC MOSFET in these two modes is controlled to minimize the THD and harmonics.

In the specified wide input voltage range, the power factor and THD are optimized for the 380 V<sub>rms</sub>/50 Hz input. At this condition, the power factor can be kept above 0.88 and the THD below 12 percent when the LED current is higher than 30 percent of full load (Figure 11 and Figure 12).

**Electrical performance**



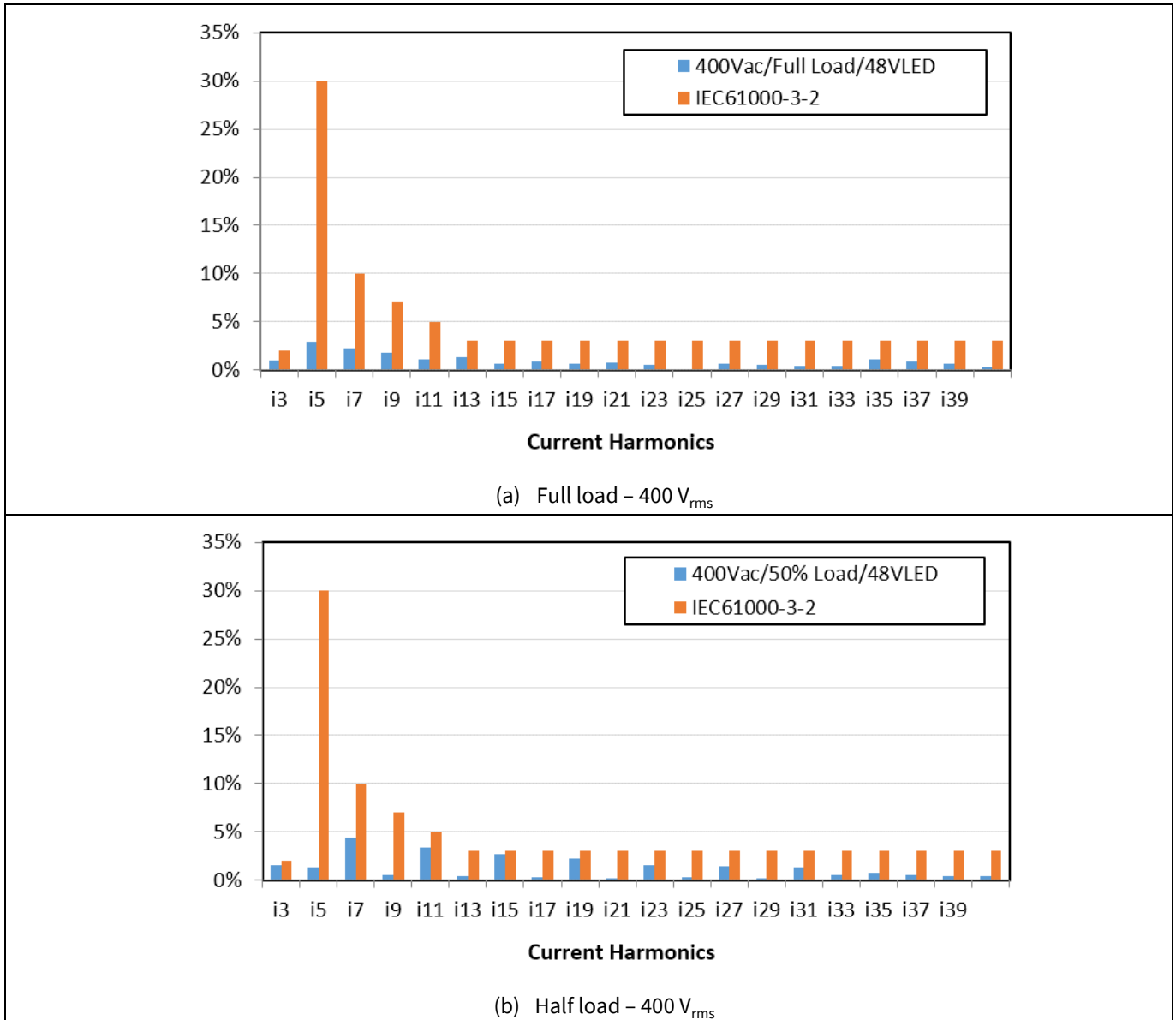
**Figure 11 Power factor in full load range**



**Figure 12 THD in full load range**

The input current harmonics spectrum at full load and half load is shown in Figure 13. It can be seen that the harmonics comply with IEC 61000-3-2:2019 class C.

### Electrical performance



**Figure 13** Input current harmonics at 400 V<sub>rms</sub> at (a) full load and (b) half load compared with IEC61000-3-2 class C

## 3.2 PFC performance

The start-up and steady-state performance of the PFC are shown below.

### 3.2.1 Start-up

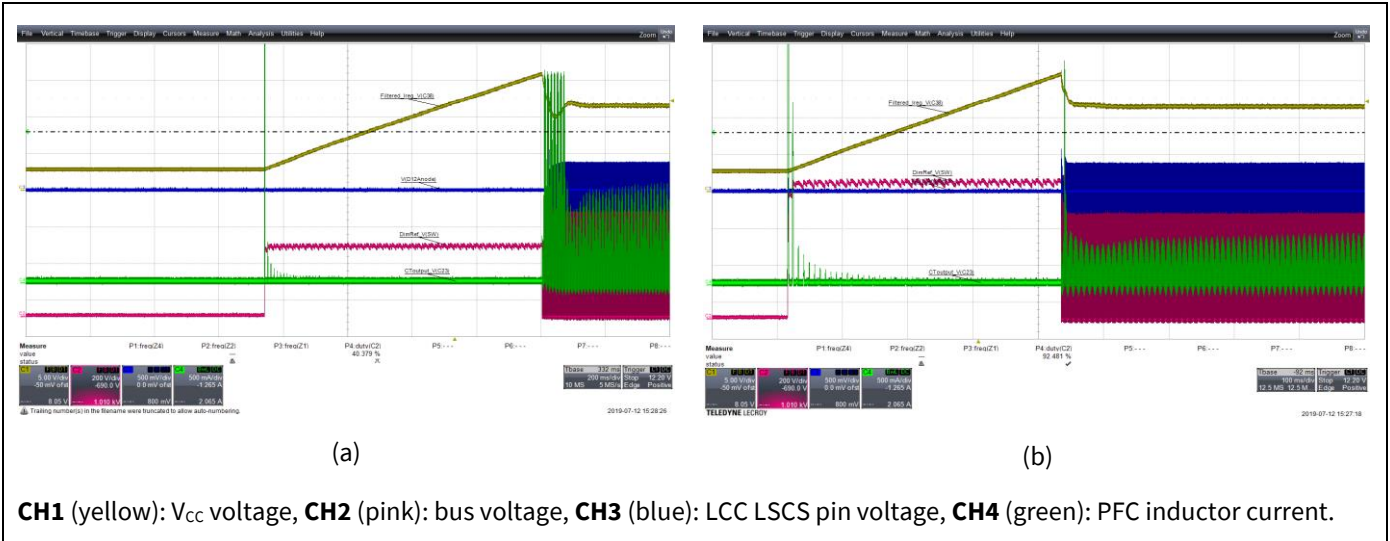
ICL5102HV starts to work once the V<sub>CC</sub> pin is higher than 16 V and stops when it is lower than 9 V. This design utilizes pull-up resistors to raise the V<sub>CC</sub> voltage at start-up. This is a cost-effective solution when the input voltage range is narrow or the time-to-light is not critical. However, for applications with wide input voltage, a HV start-up circuit is proposed in [1], which is efficient and speeds up start-up.

The waveforms of the start-up process at minimum and maximum input voltage are given in Figure 14.

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller

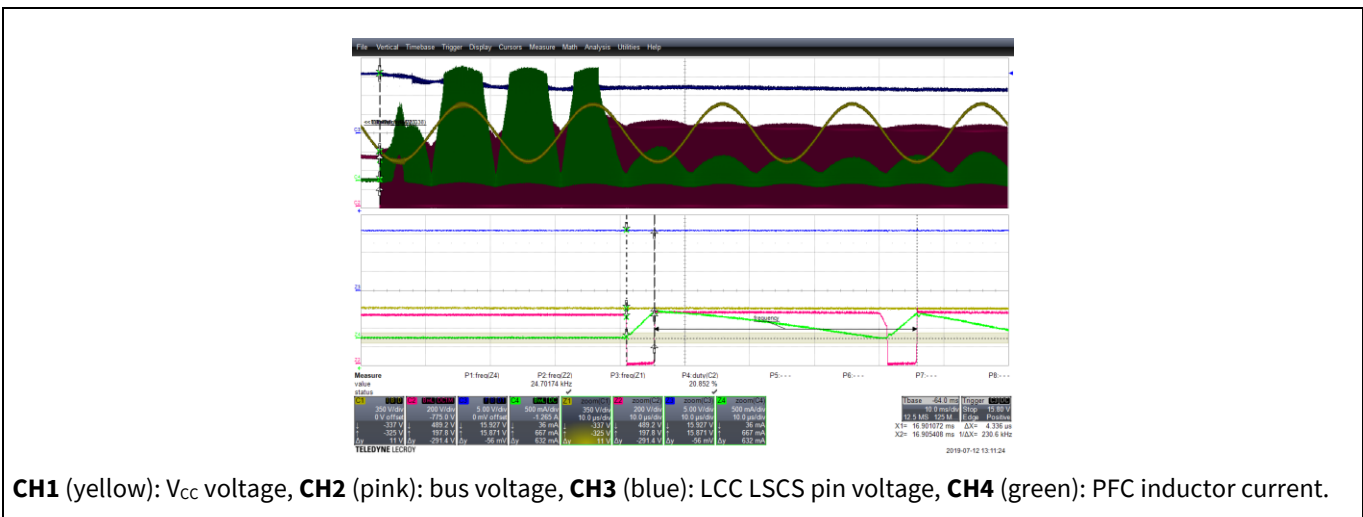
### Electrical performance



**Figure 14 Start-up process at 277 V<sub>rms</sub> (a) and 528 V<sub>rms</sub> (b) with full load (48 V LED, 3 A)**

After start-up, the on-time of the PFC MOSFET increases gradually until the bus voltage reaches 75 percent of its reference value. Then, the internal control loop dominates the bus control. The initial on-time depends on the BO pin 14 voltage; in other words, it is mains voltage dependent. This is to ensure the PFC power is constant at start-up despite varying input voltage.

Figure 15 illustrates this start-up process at 380 V<sub>rms</sub>. In the process of gradual on-time increase, the boost inductor current will be limited by IC threshold and Current Sensing (CS) resistors between the PFCCS pin and ground.



**Figure 15 Start-up process at 380 V<sub>rms</sub> with full load (48 V LED, 3 A)**

### 3.2.2 Steady-state

The PFC and LCC waveforms in the steady-state at 277 V<sub>rms</sub>, 380 V<sub>rms</sub>, 480 V<sub>rms</sub> and 528 V<sub>rms</sub> are shown in Figure 16-Figure 19, where CH1 (yellow) is the mid-point voltage of the LCC HB, CH2 (pink) is the drain-source voltage of the PFC MOSFET ( $V_{DS}$ ), CH3 (blue) is the voltage of the LCC CS resistor (pin LSCS) and CH4 (green) is the PFC inductor current.

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller



### Electrical performance

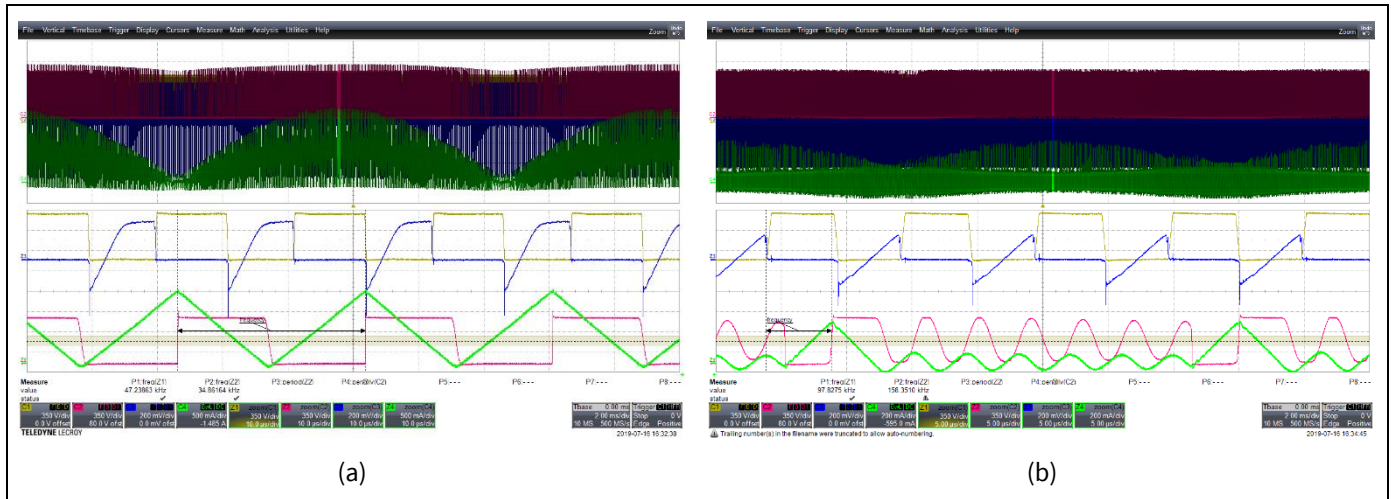


Figure 16 Waveforms of PFC and LCC at 277 V<sub>rms</sub> at V<sub>dim</sub> = 10 V (a) and V<sub>dim</sub> = 1 V (b) with 48 V LED

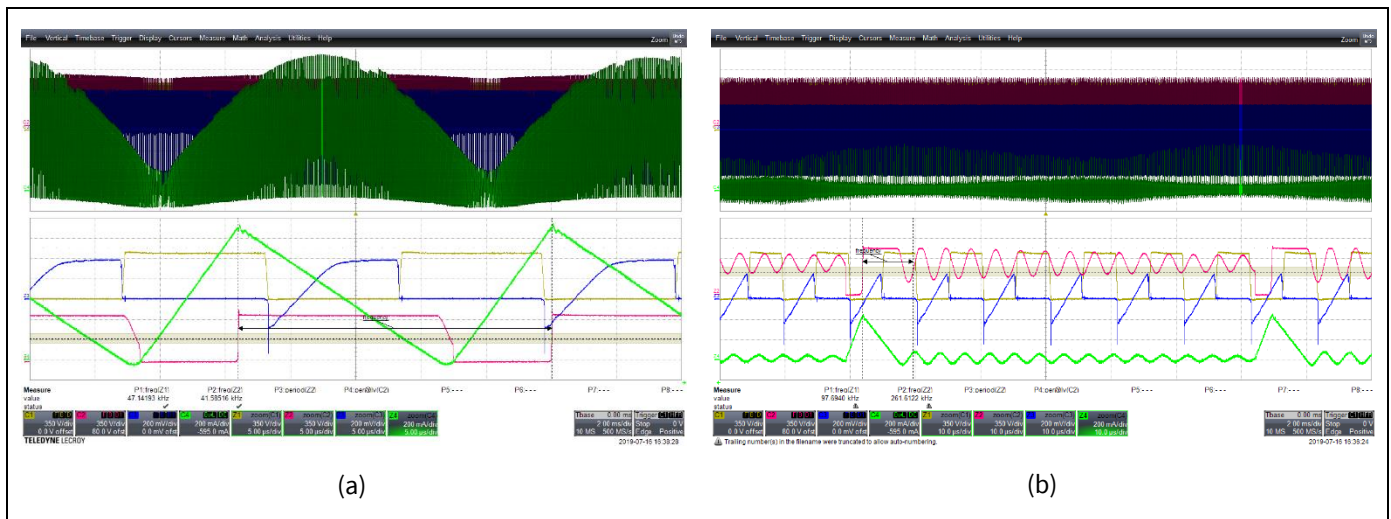


Figure 17 Waveforms of PFC and LCC at 380 V<sub>rms</sub> at V<sub>dim</sub> = 10 V (a) and V<sub>dim</sub> = 1 V (b) with 48 V LED

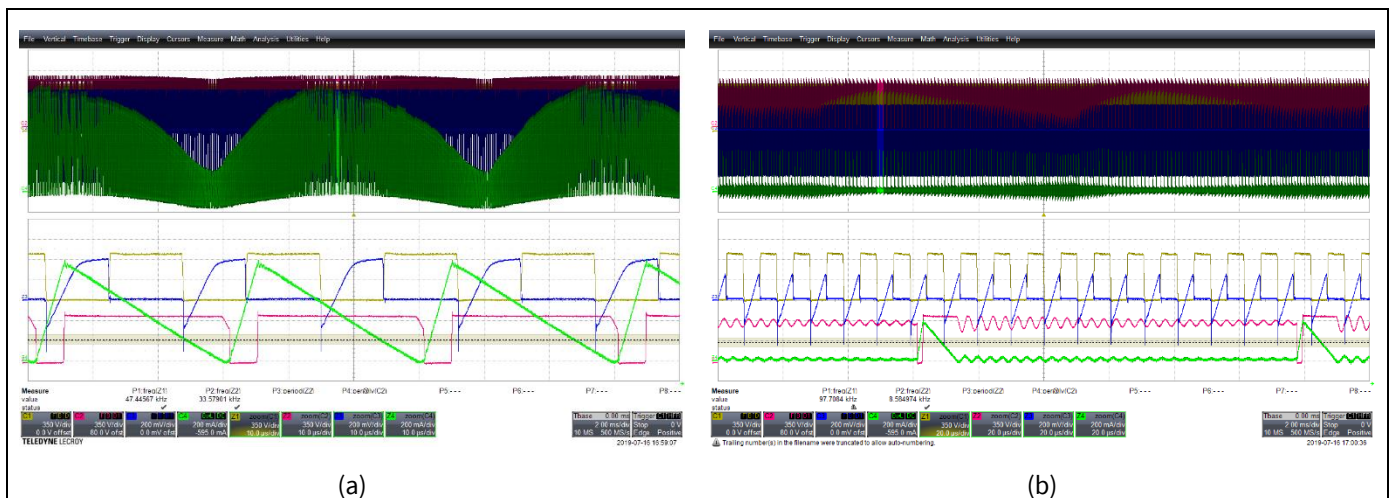


Figure 18 Waveforms of PFC and LCC at 480 V<sub>rms</sub> at V<sub>dim</sub> = 10 V (a) and V<sub>dim</sub> = 1 V (b) with 48 V LED

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller

### Electrical performance

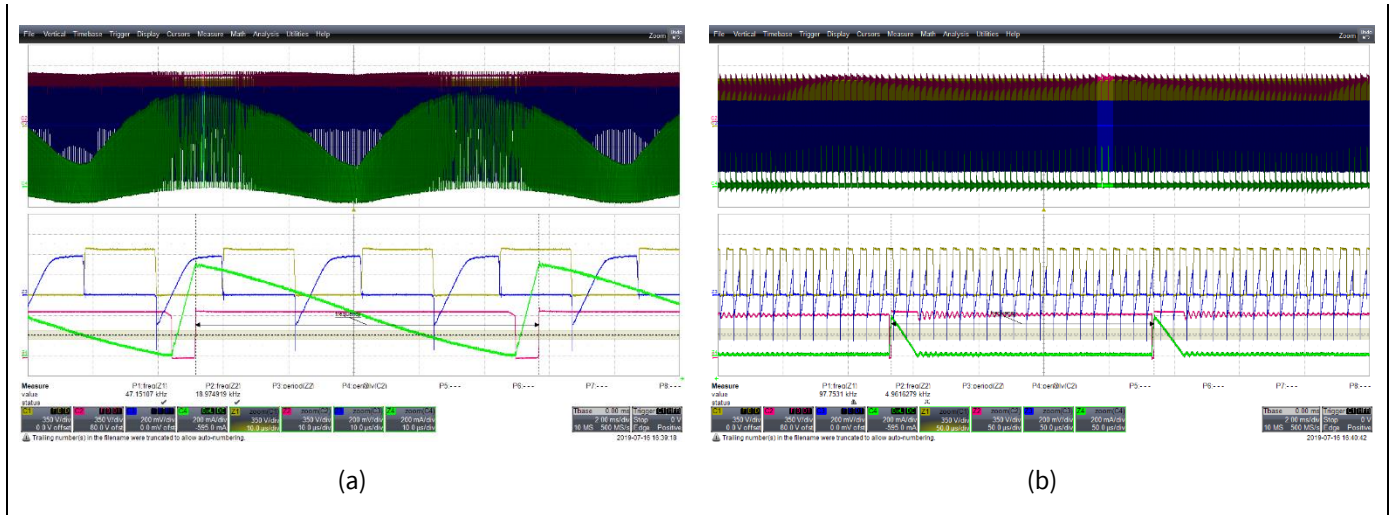


Figure 19 Waveforms of PFC and LCC at 528 V<sub>rms</sub> at V<sub>dim</sub> = 10 V (a) and V<sub>dim</sub>

## 3.3 LCC performance

### 3.3.1 Start-up

As for ICL5102, ICL5102HV is equipped with the same soft-start mechanism for the HB stage. Figure 20 shows the start-up behavior of the LCC stage.

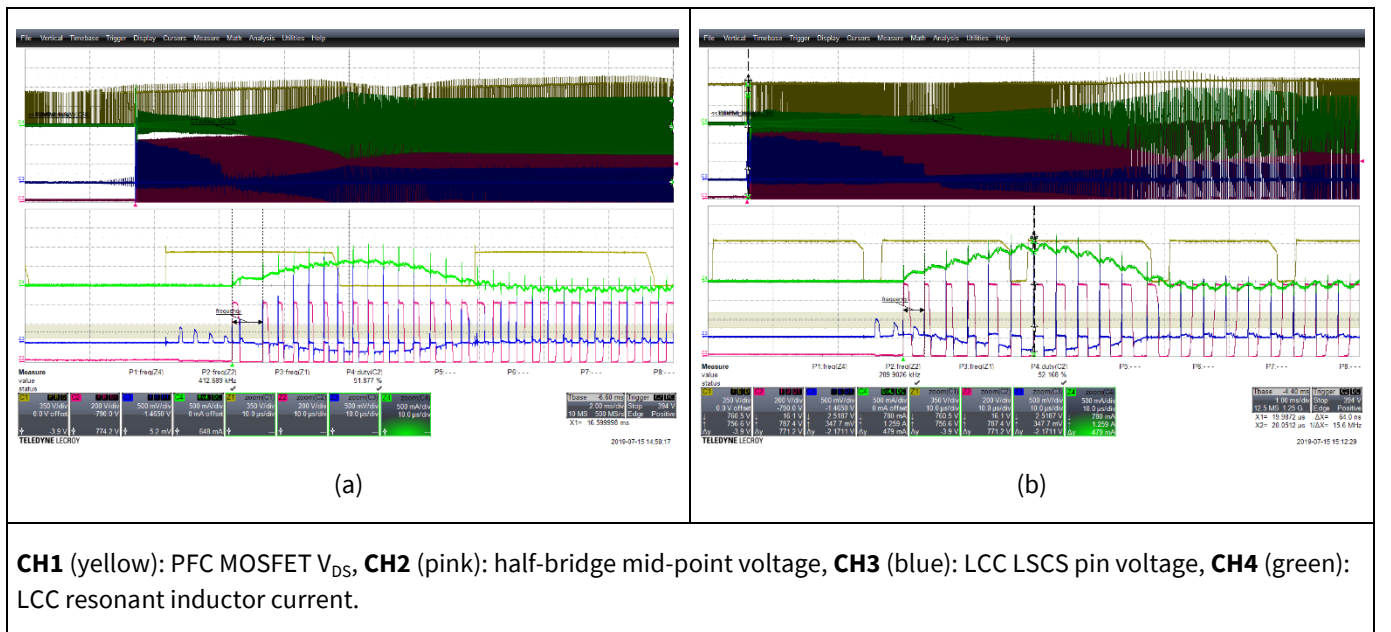


Figure 20 LCC start-up behavior at 380 V<sub>rms</sub> (a) and 528 V<sub>rms</sub> (b) with full load (48 V, 3 A)

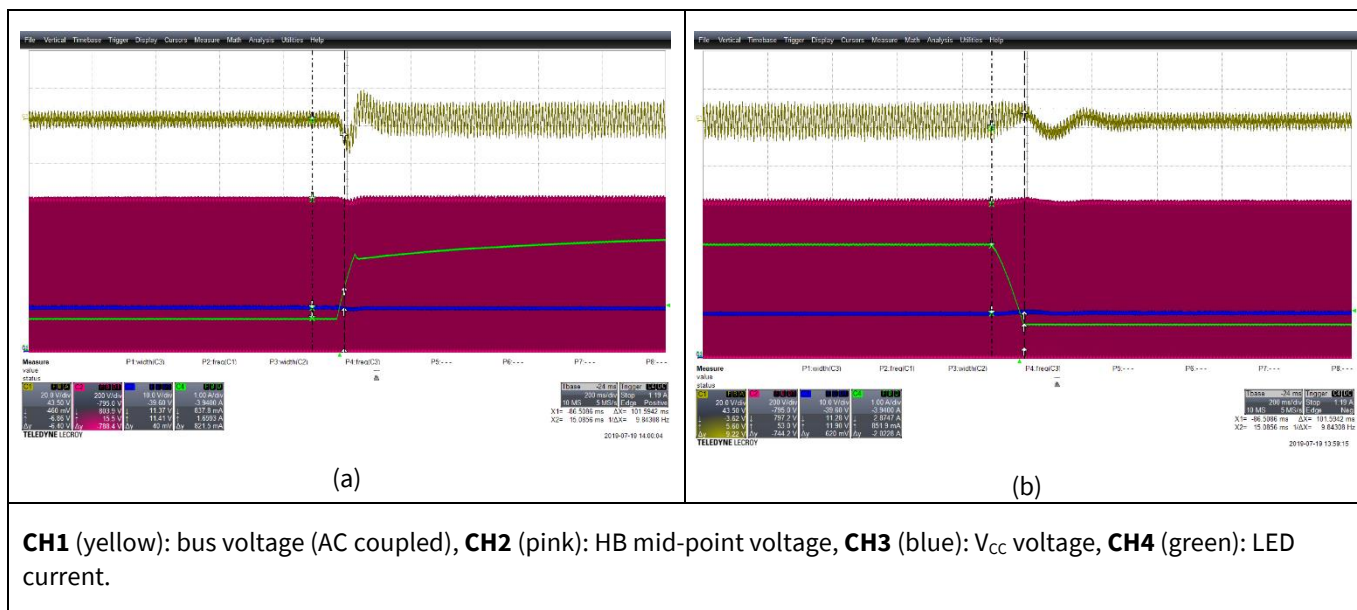
## Electrical performance

### 3.3.2 Steady-state

The steady-state waveforms of the LCC stage can be found in Figure 16-Figure 19. The sweep frequency is designed in the range of 45 to 130 kHz.

### 3.4 Response to load step

The responses to the large load step are recorded in Figure 21. It can be seen that the LED current changes swiftly and without ringing, and the bus voltage is far from triggering the bus OVP.

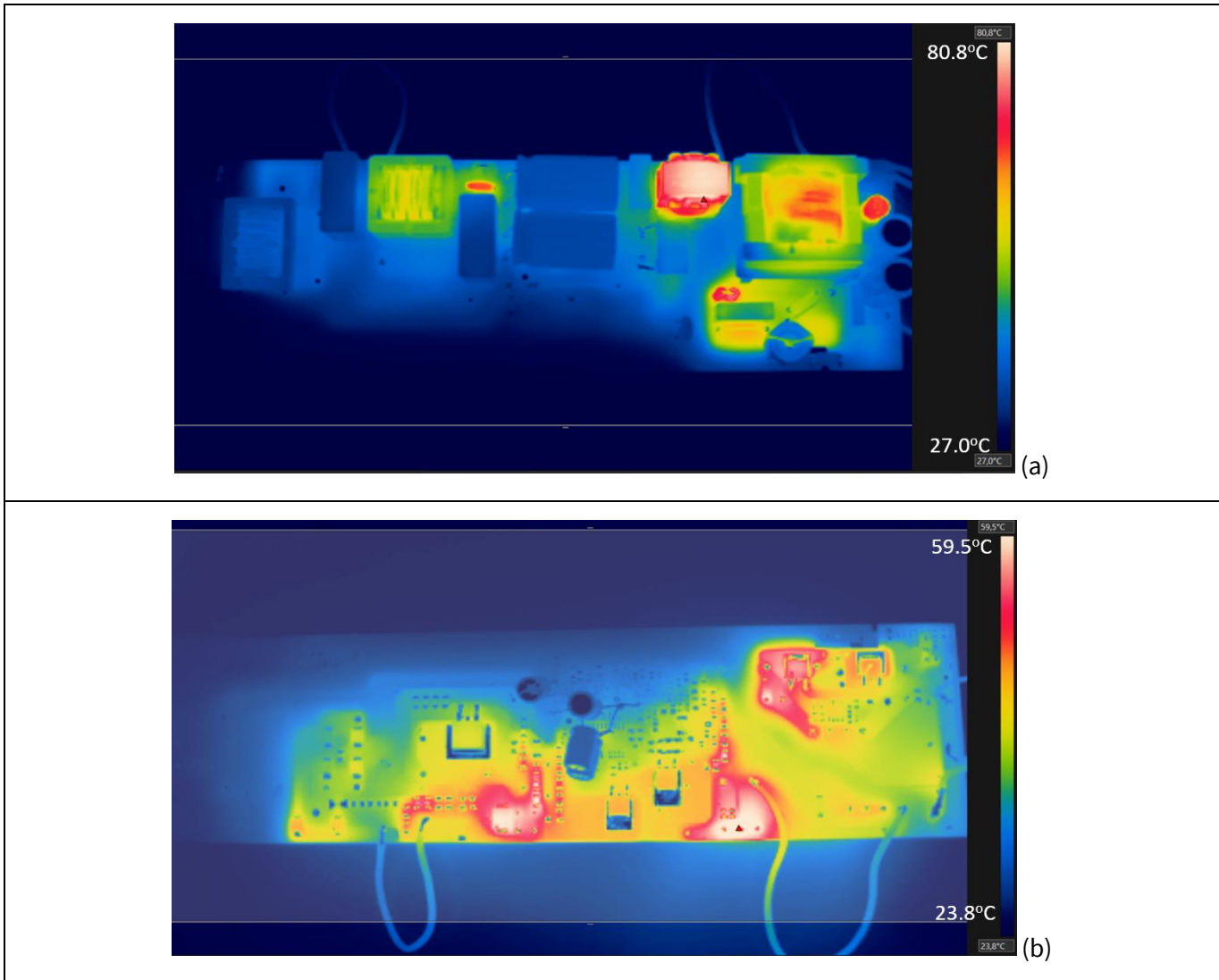


**Figure 21 Load step (a) from 1 to 3 A (b) from 3 to 1 A**

**Thermal performance**

## 4 Thermal performance

The temperature profile of the board is given below, measured at 380 V AC/50 Hz input with 48 V LED at full load (3 A), in the 23°C ambient in free air. The maximum temperature (81°C) appears at the resonant inductor of the LCC converter.



**Figure 22** Temperature profile of the board at 380 V<sub>rms</sub> input, 48 V LED with 3 A load (a) top side and (b) bottom side

EMI

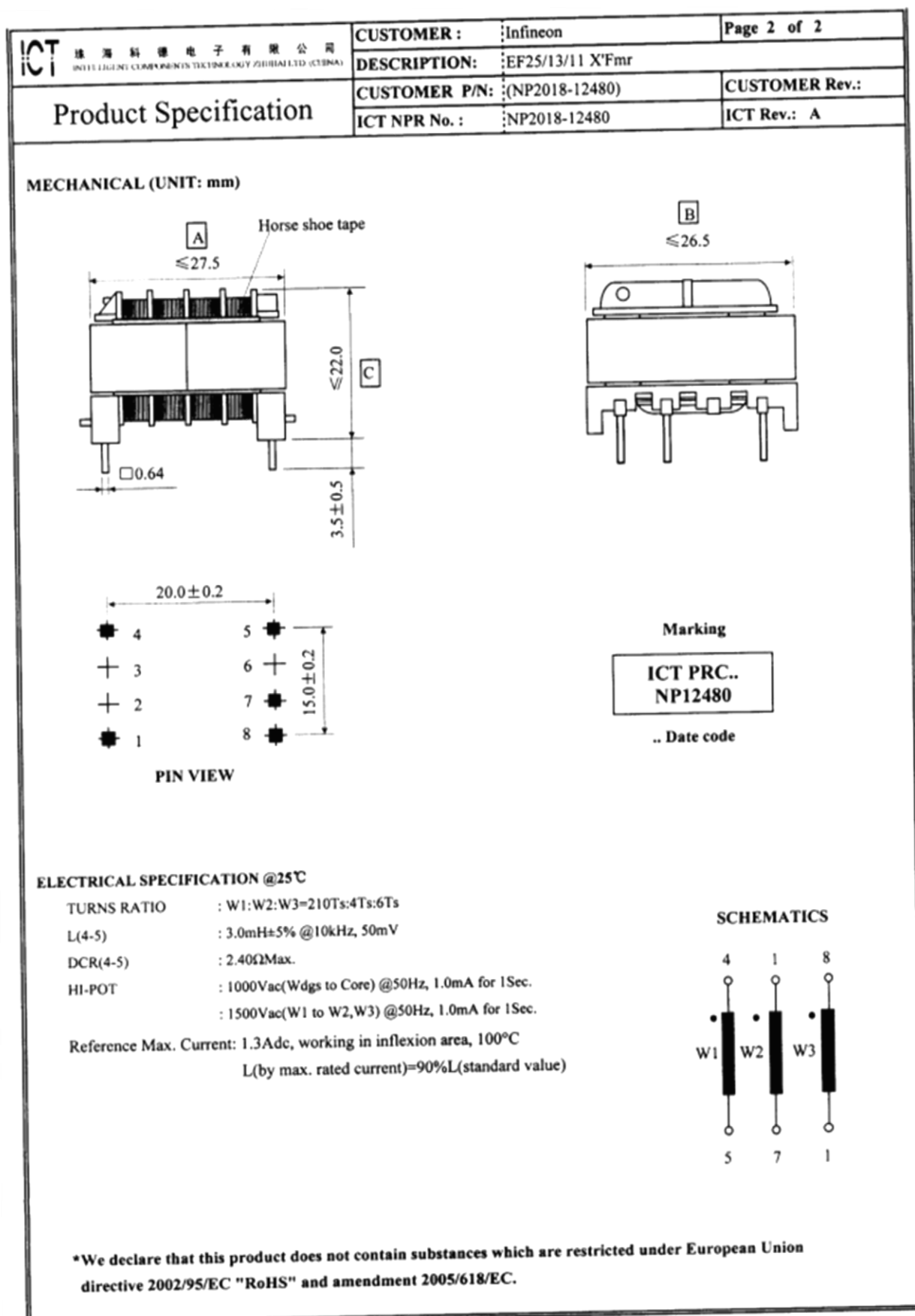
5 EMI



Figure 23 EMI spectrum at 250 V/50 Hz at full load (48 V LED, 3 A)

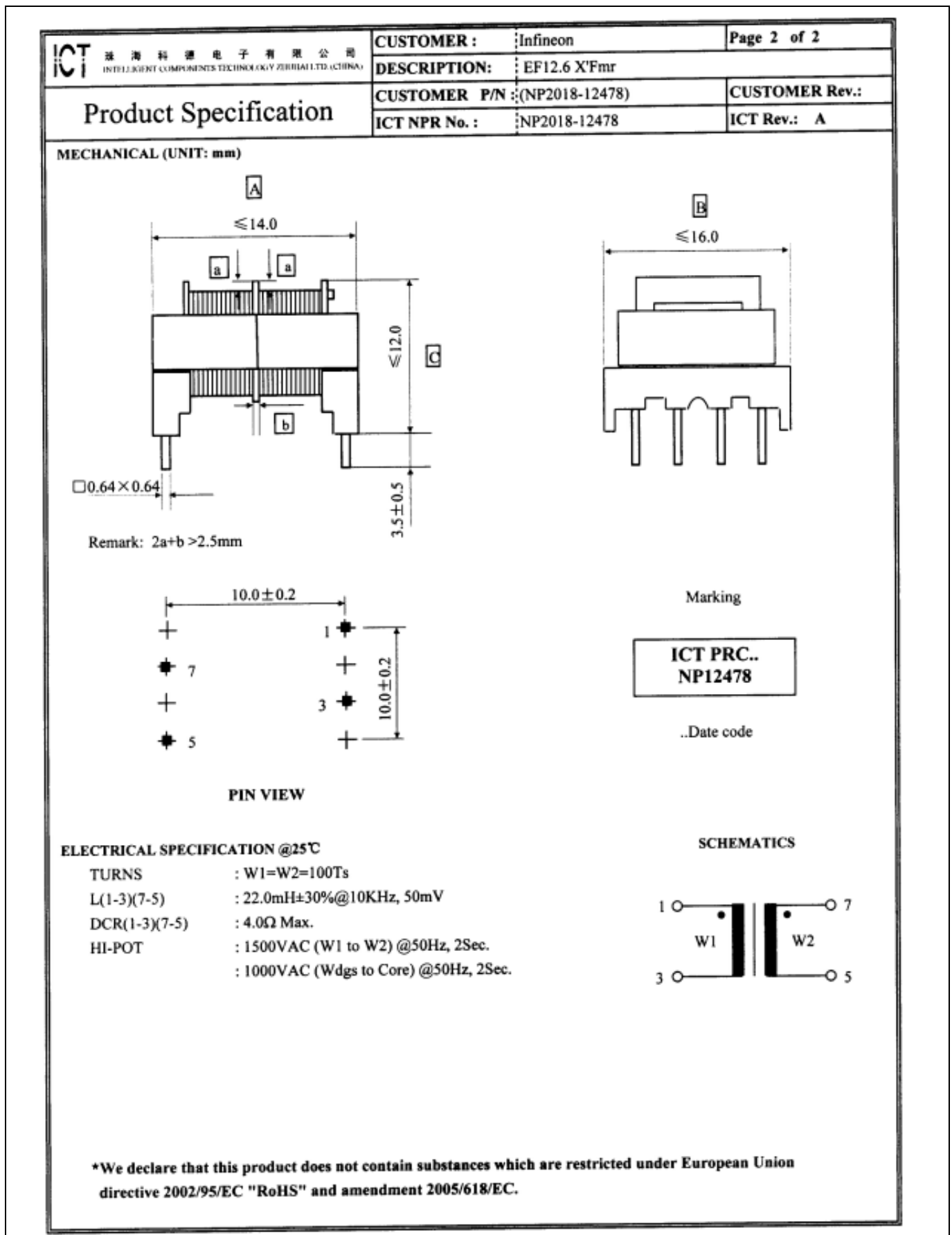
## **6 Magnetic components**

**150 W LCC LED driver demonstration board with ICL5102HV**  
**A 980 V combo PFC+ half-bridge resonant controller**  
**Magnetic components**



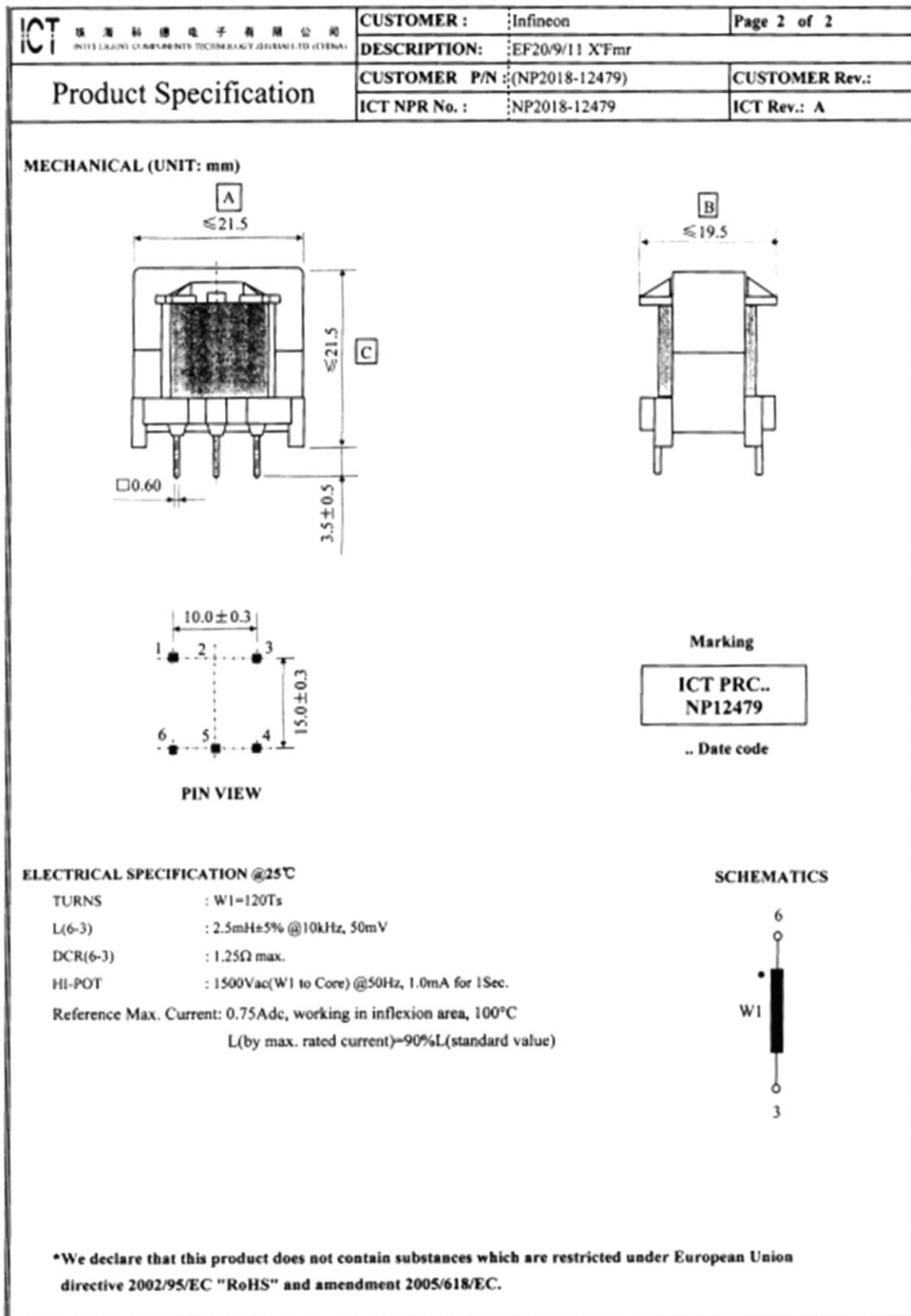
**Figure 24 Boost inductor (L9)**

**150 W LCC LED driver demonstration board with ICL5102HV**  
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**Magnetic components**

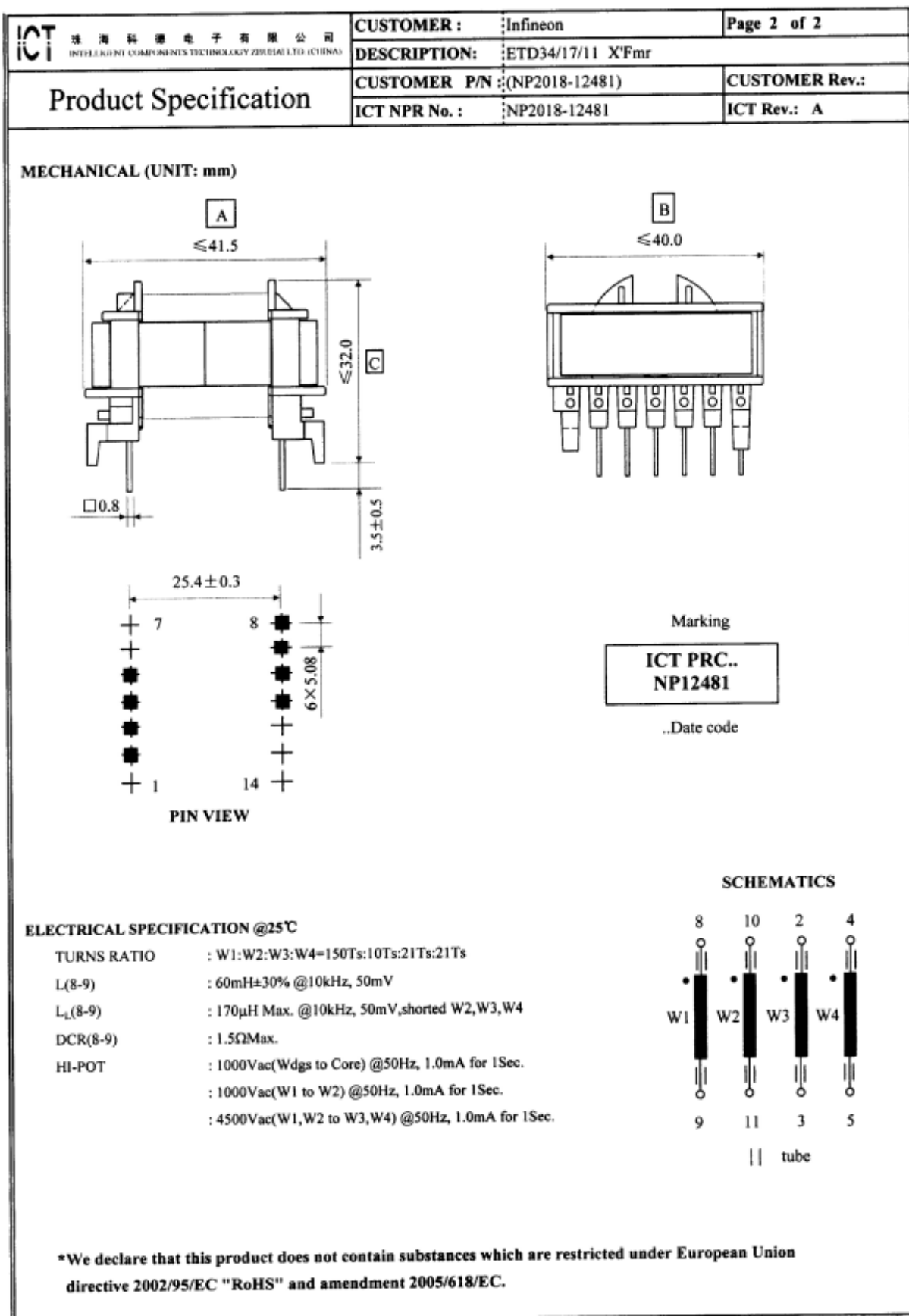


**Figure 25 Transformer in the dimming circuit (L5)**

**150 W LCC LED driver demonstration board with ICL5102HV**  
**A 980 V combo PFC+ half-bridge resonant controller**  
**Magnetic components**



**Figure 26 LCC resonant inductor (L8)**



**Figure 27 LCC transformer (L4)**

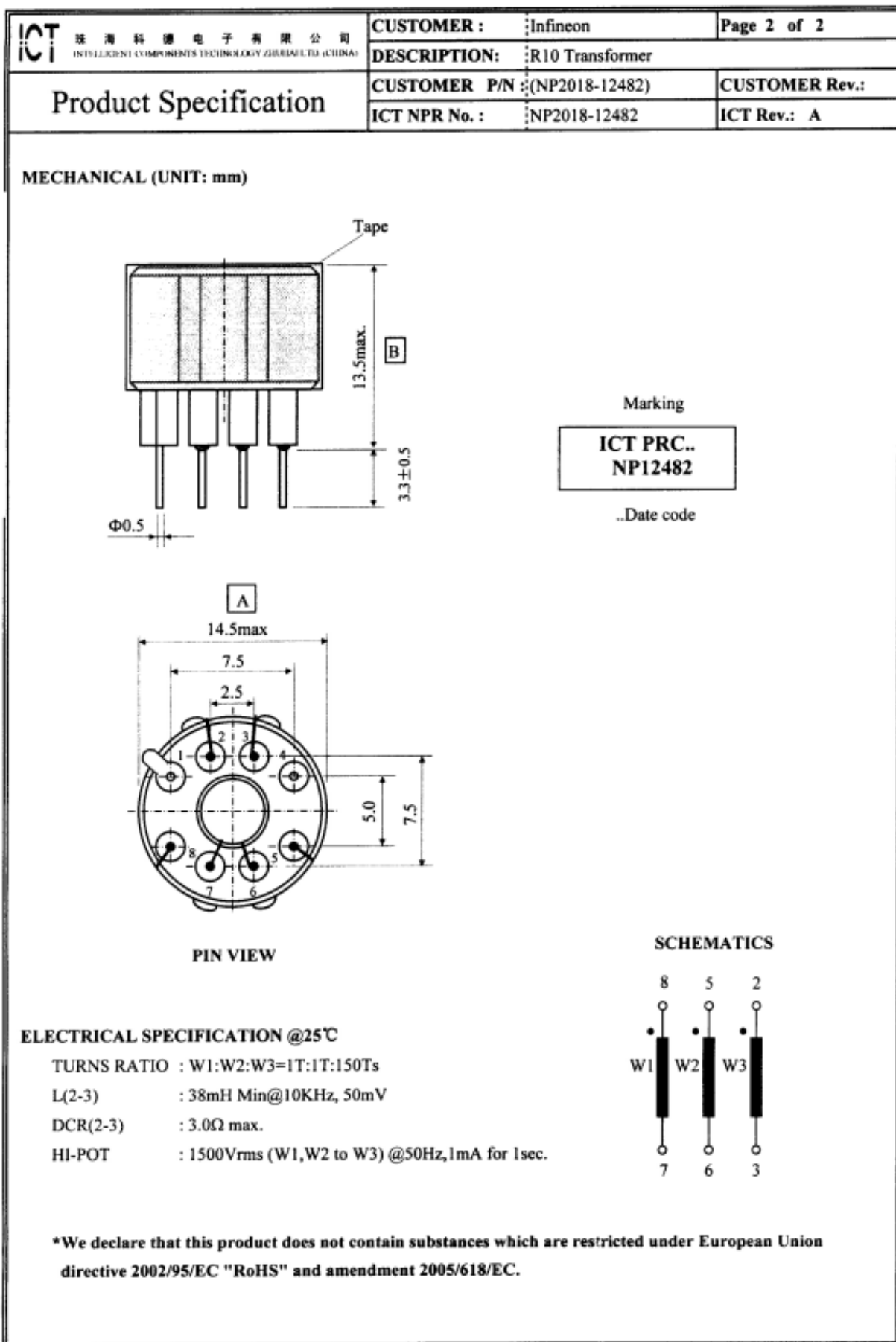


Figure 28 Current transformer (L6)

## 7 Bill of Materials (BOM)

| Part number | Quantity | Designator                                      | Description                                    |
|-------------|----------|-------------------------------------------------|------------------------------------------------|
| 1           | 5        | BM, GND, GND2, SEC_GND, X15V                    | Con 5001/ / CON-THT-TP-5001/ /                 |
| 2           | 3        | BO, PFC, RF                                     | Con 5003/ / CON-THT-TP-5003/ /                 |
| 3           | 3        | C1, C3, C6                                      | Cap 330nF/ 1kV/ THT/ /20%                      |
| 4           | 1        | C4                                              | Cap 3.3nF/ 2kV/ CAP-THT-FKP4_15P-9x16x18/ /10% |
| 5           | 1        | C5                                              | Cap 100nF/ 50V/ CAPC3216X95N/ X7R/5%           |
| 6           | 4        | C7, C39, C45, C48                               | Cap 100nF/ 50V/ 0603/ X7R/10%                  |
| 7           | 1        | C8                                              | Cap 33uF/ 35V/ Radial Type/ /20%               |
| 8           | 1        | C9                                              | Cap 150pF/ 2kV/ Radial/ /-10%                  |
| 9           | 1        | C10                                             | Cap 2.7nF/ 1kV/ Radial/ MKT/5%                 |
| 10          | 3        | C11, C23, C35                                   | Cap 1uF/ 50V/ 0805 (2012M)/ X7R/10%            |
| 11          | 1        | C12                                             | Cap 100nF/ 250V/ 1206/ X7R/10%                 |
| 12          | 2        | C13, C14                                        | Cap 68uF/ 450V/ CAPPRD750W80D1625H3700B/ /20%  |
| 13          | 1        | C15                                             | Cap 2.2nF/ 1kV/ CAPC3216X125N/ X7R/10%         |
| 14          | 1        | C16                                             | Cap 10uF/ 25V/ Radial Type/ /20%               |
| 15          | 1        | C17                                             | Cap 47nF/ 1kV/ Radial Type/ /10%               |
| 16          | 1        | C18                                             | Cap 33nF/ 1kV/ THT/ /5%                        |
| 17          | 2        | C19, C20                                        | Cap 150uF/ 100V/ RADIAL/ /20%                  |
| 18          | 1        | C21                                             | Cap 2.2nF/ 50V/ CAPC2013X70N/ X7R/5%           |
| 19          | 2        | C22, C44                                        | Cap 100pF/ 2kV/ 1206/ C0G/10%                  |
| 20          | 2        | C24, C47                                        | Cap 22nF/ 50V/ 0603/ X7R/10%                   |
| 21          | 1        | C25                                             | Cap 2.2nF/ 100V/ 0603 (1608)/ C0G/5%           |
| 22          | 1        | C26                                             | Cap 220pF/ 50V/ CAPC3216X95N/ X7R/10%          |
| 23          | 1        | C27                                             | Cap 4.7nF/ 16V/ 0603/ X7R/10%                  |
| 24          | 2        | C28, C41                                        | Cap 1nF/ 50V/ 0603/ X7R/10%                    |
| 25          | 4        | C29, C30, C40, C50                              | Cap 100nF/ 50V/ 0805/ X7R/5%                   |
| 26          | 1        | C31                                             | Cap 2.2nF/ 16V/ 0603/ X7R/10%                  |
| 27          | 2        | C32, C38                                        | Cap 10nF/ 50V/ 0805/ C0G/5%                    |
| 28          | 1        | C33                                             | Cap 1nF/ 1kV/ Radial Type/ U2J/5%              |
| 29          | 1        | C34                                             | Cap 1uF/ 16V/ 0603/ X7R/10%                    |
| 30          | 2        | C36, C42                                        | Cap 100pF/ 50V/ 0603/ C0G/1%                   |
| 31          | 1        | C37                                             | Cap 220nF/ 50V/ 0603 (1608)/ X7R/10%           |
| 32          | 1        | C46                                             | Cap 470nF/ 50V/ 0603/ X7R/10%                  |
| 33          | 1        | C53                                             | Cap 220nF/ 50V/ 0805/ X7R/10%                  |
| 34          | 5        | D1, D2, D3, D4, D6                              | Dio S2M/ 1kV/ DO-214AA/ /                      |
| 35          | 1        | D5                                              | Dio STTH310S/ 1kV/ SMC/ /                      |
| 36          | 1        | D7                                              | Dio 16V/ / MELF DO-213AB/ /                    |
| 37          | 2        | D8, D10                                         | Dio 1N4006G/ 800V/ DO-41 (Case 59-10)/ /       |
| 38          | 10       | D9, D13, D15, D19, D21, D29, D31, D34, D36, D37 | Dio MCL4148-TR3/ 100V/ MicroMELF/ /            |
| 39          | 1        | D11                                             | Dio 7.50V/ / SOD-80/ /                         |
| 40          | 1        | D12                                             | Dio S1M/ / DO-214AC (SMA)/ /                   |
| 41          | 1        | D14                                             | Dio HS1M/ 1kV/ DO-214AC (SMA)/ /               |
| 42          | 4        | D18, D23, D30, D35                              | Dio LL4148/ / SOD-80 2L/ /                     |
| 43          | 1        | D20                                             | Dio 3.3V/ / SOD80C/ /                          |

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller



### Magnetic components

|    |   |                               |                                                                       |
|----|---|-------------------------------|-----------------------------------------------------------------------|
| 44 | 1 | D24                           | Dio BAW156/ / SOT23/ /                                                |
| 45 | 1 | D25                           | Dio 5.10V/ / SOD80C/ /                                                |
| 46 | 1 | D26                           | Dio 5.60V/ / SOD-80/ /                                                |
| 47 | 1 | D27                           | Dio 16V/ / Axial DO-35 (CASE 017AG)/ /                                |
| 48 | 1 | D28                           | Dio 12V/ / SOD-80/ /                                                  |
| 49 | 1 | D33                           | Dio BAS85/ / SOD80C/ /                                                |
| 50 | 1 | F1                            | Con 0031.8231/ / THT/ /                                               |
| 51 | 1 | HSGND                         | Con 5004/ / CON-THT-TP-5004/ /                                        |
| 52 | 1 | IC1                           | Int ICL5102HV/ / SOIC127P1030X265-20_19N/ /                           |
| 53 | 2 | IC2, IC3                      | Int TL431QDBZR,215/ / SOT-23/ /                                       |
| 54 | 1 | IC4                           | Opt PC817XNNSZ0F/ / DIP-4/ /                                          |
| 55 | 1 | IC5                           | Int IR11688S/ / SOIC-8/ /                                             |
| 56 | 1 | IC6                           | Ana LM321MF/ / SOT-23-5/ /                                            |
| 57 | 1 | J1                            | Con JP-6.35_0.80-2P/ / JP-THT-JL-250-25-T/ /                          |
| 58 | 2 | J2, J3                        | Con JP-17.5_0.80-2P/ / JP-THT-1.00_2.20_17.5_0.80-2P/ /               |
| 59 | 1 | J4                            | Con JP-15.24_0.80-2P/ / JP-THT-JL-600-25-T/ /                         |
| 60 | 2 | J5, J6                        | Con JP-10.16_0.80-2P/ / JP-THT-JL-400-25-T/ /                         |
| 61 | 1 | L1                            | Tra NP2007-2745/ / THT/ /                                             |
| 62 | 2 | L3, L10                       | Ind 7A, 20mOhm/ / THT/ /                                              |
| 63 | 1 | L4                            | Tra NP2018-12481/ / THT/ /                                            |
| 64 | 1 | L5                            | Tra NP2018-12478/ / THT/ /                                            |
| 65 | 1 | L6                            | Tra NP2018-12482/ / THT/ /                                            |
| 66 | 1 | L7                            | Ind 22uH/ / THT/ /20%                                                 |
| 67 | 1 | L8                            | Tra NP2018-12479/ / THT/ /                                            |
| 68 | 1 | L9                            | Tra NP2018-12480/ / THT/ /                                            |
| 69 | 1 | R1                            | Res / 745V/ Radial/ /                                                 |
| 70 | 7 | R2, R3, R4, R5, R12, R13, R14 | Res 1.5R/ 200V/ 1206/ /1%                                             |
| 71 | 2 | R6, R51                       | Res 10R/ 150V/ 0805/ /1%                                              |
| 72 | 1 | R7                            | Res 10R/ 50V/ 0603/ /1%                                               |
| 73 | 6 | R8, R9, R10, R11, R56, R57    | Res 330k/ 200V/ 1206/ /1%                                             |
| 74 | 1 | R15                           | Res 68R/ 200V/ 1206/ /1%                                              |
| 75 | 1 | R16                           | Res 68R/ 150V/ 0805/ /1%                                              |
| 76 | 1 | R17                           | Res 470R/ 200V/ 1206/ /1%                                             |
| 77 | 3 | R18, R68, R78                 | Res 100k/ 75V/ 0603/ /1%                                              |
| 78 | 4 | R19, R20, R22, R23            | Res 750k/ 200V/ 1206/ /1%                                             |
| 79 | 1 | R21                           | Res 150R/ 150V/ 0805/ /1%                                             |
| 80 | 1 | R24                           | Res 820k/ 200V/ 1206/ /1%                                             |
| 81 | 1 | R25                           | Res 12k/ 50V/ 0603/ /1%                                               |
| 82 | 3 | R26, R28, R29                 | Res 5.6MEG/ 200V/ 1206/ /1%                                           |
| 83 | 1 | R27                           | Res 82k/ 75V/ 0603/ /1%                                               |
| 84 | 1 | R30                           | Con JP-THT-1.00_2.20_12.5_0.80-2P/ / JP-THT-1.00_2.20_12.5_0.80-2P/ / |
| 85 | 1 | R31                           | Res 130k/ 150V/ 0805/ /1%                                             |
| 86 | 1 | R32                           | Res 1.5k/ 200V/ 1206/ /1%                                             |
| 87 | 1 | R32a                          | Res 4.7k/ 200V/ 1206/ /1%                                             |
| 88 | 3 | R33, R55, R87                 | Res 0R/ 50V/ 0603/ /0R                                                |
| 89 | 1 | R34                           | Res 150k/ 75V/ 0603/ /1%                                              |
| 90 | 1 | R35                           | Res 220k/ 200V/ 1206/ /1%                                             |
| 91 | 4 | R36, R37, R38, R39            | Res 180k/ 200V/ 1206/ /1%                                             |

# 150 W LCC LED driver demonstration board with ICL5102HV

## A 980 V combo PFC+ half-bridge resonant controller



### Magnetic components

|     |   |                                      |                                                                                |
|-----|---|--------------------------------------|--------------------------------------------------------------------------------|
| 92  | 4 | R40, R74, R84, R99                   | Res 0R/ 200V/ 1206/ /0R                                                        |
| 93  | 1 | R41                                  | Res 43k/ 150V/ 0805/ /1%                                                       |
| 94  | 1 | R42                                  | Res 10R/ 200V/ 1206/ /1%                                                       |
| 95  | 2 | R43, R69                             | Res 180k/ 150V/ 0805/ /1%                                                      |
| 96  | 1 | R44                                  | Res 10R/ / Radial Type/ /20%                                                   |
| 97  | 3 | R45, R75, R76                        | Res 100R/ 200V/ 1206/ /1%                                                      |
| 98  | 1 | R46                                  | Res 180R/ 200V/ 1206/ /1%                                                      |
| 99  | 1 | R47                                  | Res 5.1k/ 75V/ 0603/ /1%                                                       |
| 100 | 1 | R48                                  | Res 10k/ 75V/ 0603/ /1%                                                        |
| 101 | 3 | R49, R50, R86                        | Res 47k/ 150V/ 0805/ /1%                                                       |
| 102 | 1 | R52                                  | Res 10k/ 200V/ 1206/ /1%                                                       |
| 103 | 1 | R53                                  | Res 56k/ 75V/ 0603/ /1%                                                        |
| 104 | 1 | R54                                  | Res 18k/ 75V/ 0603/ /1%                                                        |
| 105 | 1 | R58                                  | Res 3.3k/ 75V/ 0603/ /1%                                                       |
| 106 | 5 | R59, R60, R61, R62, R63              | Res 100k/ 200V/ 1206/ /1%                                                      |
| 107 | 1 | R64                                  | Res 4.7k/ 75V/ 0603/ /1%                                                       |
| 108 | 1 | R65                                  | Res 12k/ 150V/ 0805/ /1%                                                       |
| 109 | 3 | R66, R82, R89                        | Res 5.6k/ 75V/ 0603/ /1%                                                       |
| 110 | 1 | R67                                  | Res 220R/ 75V/ 0603/ /1%                                                       |
| 111 | 1 | R69a                                 | Res 22k/ 150V/ 0805/ /1%                                                       |
| 112 | 1 | R70                                  | Res 470R/ 75V/ 0603/ /1%                                                       |
| 113 | 1 | R71                                  | Res 100k/ / 0805/ /5%                                                          |
| 114 | 1 | R73                                  | Res 330R/ 150V/ 0805/ /1%                                                      |
| 115 | 1 | R77                                  | Pas B59885C0120A051/ / Radial/ /                                               |
| 116 | 1 | R79                                  | Res 33R/ 150V/ 0805/ /1%                                                       |
| 117 | 1 | R80                                  | Res 1k/ 75V/ 0603/ /1%                                                         |
| 118 | 1 | R81                                  | Res 560R/ 75V/ 0603/ /1%                                                       |
| 119 | 1 | R83                                  | Res 270k/ 150V/ 0805/ /1%                                                      |
| 120 | 2 | R85, R92                             | Res 470R/ 150V/ 0805/ /1%                                                      |
| 121 | 1 | R90                                  | Res 16k/ 75V/ 0603/ /1%                                                        |
| 122 | 1 | R91                                  | Res 3.3k/ 75V/ 0603/ /1%                                                       |
| 123 | 1 | R94                                  | Res 51k/ 75V/ 0603/ /1%                                                        |
| 124 | 3 | R95, R96, R98                        | Res 0R/ 150V/ 0805/ /0R                                                        |
| 125 | 1 | R97                                  | Res 1.8MEG/ 200V/ 1206/ /1%                                                    |
| 126 | 1 | T1                                   | Tra BCX70K E6327/ / SOT23/ /                                                   |
| 127 | 1 | T2                                   | Tra BC857A/ / SOT23/ /                                                         |
| 128 | 1 | T3                                   | Tra IPD95R450P7/ / PG-TO263/ /                                                 |
| 129 | 2 | T4, T5                               | Tra IPD90R1K2C3/ / PG-TO252-3/ /                                               |
| 130 | 1 | T7                                   | Tra BC846ALT1G/ / SOT23 - 3 Leads/ /                                           |
| 131 | 2 | T8, T9                               | Tra IPD530N15N3 G/ / PG-TO252-3/ /                                             |
| 132 | 2 | T10, T11                             | Tra BC817K-40/ / SOT23/ /                                                      |
| 133 | 1 | VCC                                  | Con 5000/ / CON-THT-TP-5000/ /                                                 |
| 134 | 1 | X1                                   | Con 250-603/ 1kV/ THT/ /                                                       |
| 135 | 2 | X2, X3                               | Con 250-202/ 320V/ CON-TER-THT-250-202_000-012/ /                              |
| 136 | 0 | BO_S, OVP, PFCVS, T7_E, VREF, XD13_K | Con -/ / testpad_1.00mm/ /                                                     |
| 137 | 0 | C2                                   | Cap NM/ 760V/ THT/ /20%                                                        |
| 138 | 0 | C51                                  | Cap NM/ 50V/ 0603 (1608)/ X8L/10%                                              |
| 139 | 0 | C52                                  | Cap NM/ 50V/ 0603/ X7R/10%                                                     |
| 140 | 0 | MP1, MP2, MP3, MP4                   | Mec D00687/ / M3 X 6mm Pan Head,Cross Head Metric Screw, 5.6mm X 2.4mm Head/ / |
| 141 | 0 | R72                                  | Res NM/ 75V/ 0603/ /1%                                                         |

## **8 Reference**

- [1] Engineering report: 130 W dimmable constant current LED driver using ICL5102 in PFC and LLC technology  
– [https://www.infineon.com/dgdl/Infineon-EngineeringReport\\_130W\\_dimmable\\_constant\\_current\\_LED\\_driver\\_ICL5102-AN-v02\\_00-EN.pdf?fileId=5546d4626102d35a01612de7a06b6fb3](https://www.infineon.com/dgdl/Infineon-EngineeringReport_130W_dimmable_constant_current_LED_driver_ICL5102-AN-v02_00-EN.pdf?fileId=5546d4626102d35a01612de7a06b6fb3)

**Revision history**

**Revision history**

| Document version | Date of release | Description of changes |
|------------------|-----------------|------------------------|
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