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TND6316/D

Direct AC LED Driver with Bluetooth Wireless Dimming Control

- NCL30170 Power Scalable Direct AC LED Driver IC
- RSL10 Bluetooth® 5 Radio System-on-Chip (SoC)

Overview

This manual covers the specification, theory of operation, testing and construction of the NCL30170 reference design by the dimming signal from the RSL10. The NCL30170 reference design demonstrate 20 W analog dimming with accurate current regulation and low THD performance.

Key Features

- Accurate Constant LED Current Regulation
- Excellent Power Factor and THD with Sinusoidal Current Shape
- Wide PWM Dimming Range < 1%
- Accurate Constant LED Current across Input Voltage Range
- Selectable LED Channel Counts Using Advanced Topology
- Excellent Power Factor and THD with Sinusoidal Current Shape
- Wide Analog Dimming Range < 6%
- Protections:
 - ◆ Input Over Voltage Protection
 - ◆ Thermal Shut Down
 - ◆ Sensing Resistor Short Protection

Specifications

Table 1. SPECIFICATIONS TABLE

Parameter	Value	Comments
Input Voltage	108–132 Vac	Low line ADIM
	198–264 Vac	High line ADIM
Line Frequency	50 Hz/60 Hz	
Output Power	20 W	Typ.
Power Factor (Maximum LED Output)	0.99	Min.
THD (Nominal Input Voltage)	7%	Max.
Line Regulation	±2%	
Analog Dimming Range	< 6%	
Start Up Time	< 200 ms	Typ.
Percent Flicker	< 30%	With E-cap



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REFERENCE DESIGN

AC Direct LED: ON's Proprietary Auto Commutation Topology

NCL30170 controls multiple LED channels in new Direct AC Drive topology. As shown the configuration, all switches are controlled by one amplifier and blocking Diodes (D_{OUT1} , D_{OUT2}) are connected between previous channel MOSFET source and next channel MOSFET drain.

As input voltage increases, the HV diodes are turned off one by one in auto commutation of the ambient switches.

Therefore, one main amplifier controls all the channel current with one reference. The amplifier CS shaping reference $V_{CS(SHA-REF)}$, is sinusoidal so that the input current is optimally sinusoidal with 0.99 pF and less than 10% THD compared to the conventional parallel topology which hardly meets THD in class C due to the stepped input current.

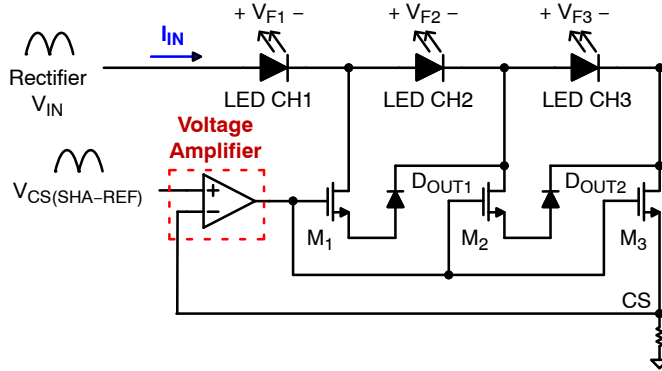


Figure 1. ON's Proprietary Direct AC LED Driver Topology

Bluetooth Controller: ON's Bluetooth Radio System-on-Chip

RSL10 is an ultra-low-power, highly flexible multi-protocol 2.4 GHz radio specifically designed for use in high-performance wearable and medical applications. With its Arm® Cortex®-M3 Processor and LPDSP32 DSP core, RSL10 supports Bluetooth low energy technology and 2.4 GHz proprietary protocol stacks, without sacrificing power consumption.

The RSL10 Evaluation Board is used for evaluating the RSL10 SoC and for application development. The board provides access to all input and output connections via 0.1" standard headers. The on-board communication interface circuit provides communication to the board from a host PC. The communication interface translates RSL10 SWJ-DP debug port signals to the USB of the host PC. There is also an on-board 4-bit level shifter for debugging; it translates the I/O signal level of RSL10 to the 3.3 V digital logic level.

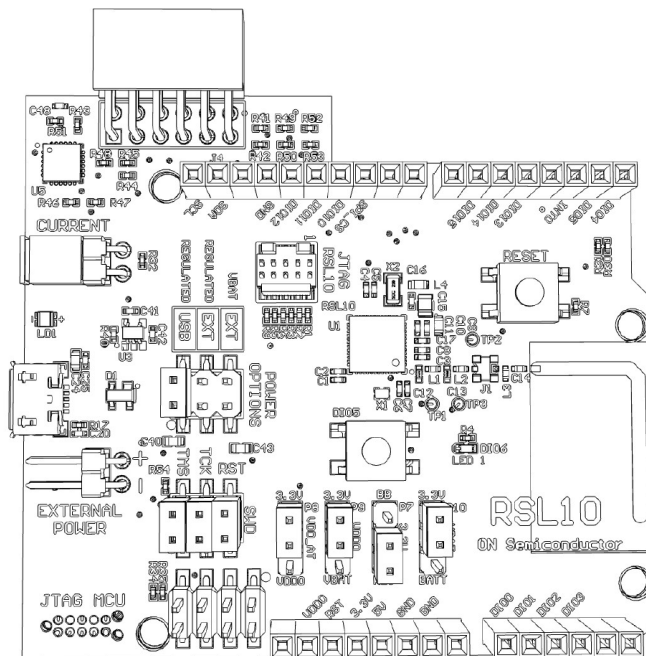
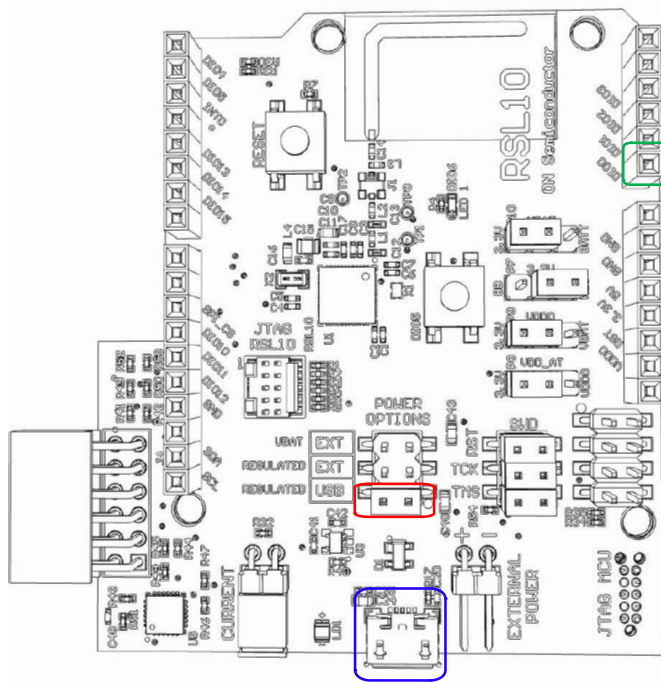


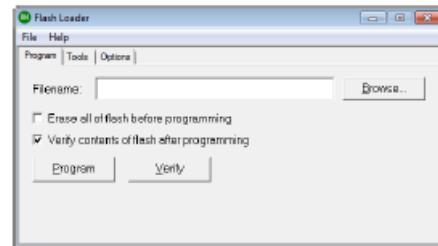
Figure 2. RSL10 Evaluation Board

Evaluation Board Connections

Program Install on RSL10 Evaluation Board



(a) RSL10 EVB Set



(b) Flash Loader Program for Installing Hex File

Figure 3. Hex File Installing

To set the board for testing of RSL10, follow the procedure below to hex file installing.

1. Connect the jumper connector to the USB port.
2. Connect the USB port to PC and start hex file loading to RSL10 EVB.
3. Check if PWM signal output is completed after loading.

When run the stand-alone flash loader with no command-line options, it operates in graphical mode. In this mode, the flash loader displays the graphical user interface shown in Figure 3. To use the RSL10 EVB, the J-link program must be updated to the latest version. The flash loader program and the NCL30170 hex file can be downloaded from the ON Semiconductor website.

*Evaluation Board Connection of RSL10 EVB
and NCL30170 20 W Reference Design*

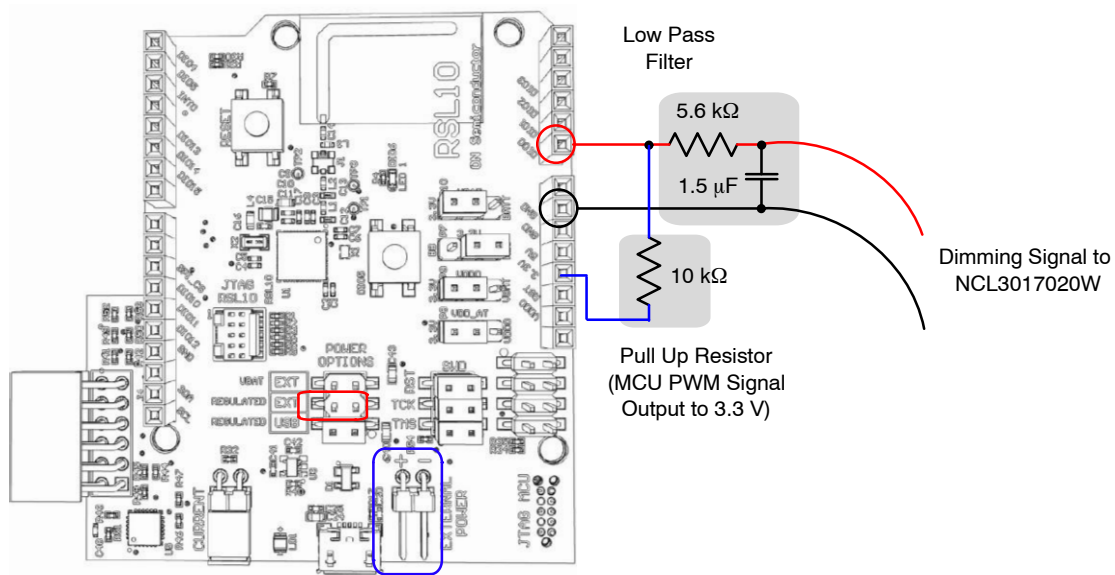


Figure 4. Connection of RSL10 EVB and NCL30170 Reference Design

RSL10 EVB with hex file installed will make a PWM signal. So a low pass filter for converting it to an analog signal should be connected as shown in Figure 4.

To set the board for testing of RSL10 EVB and NCL30170 20 W reference design, follow the procedure below.

1. Connect the jumper connector to the second EXT port.
2. Use an external power supply to supply 5 V power.

The PWM signal of RSL10 EVB is output at 3.3 V/20 kHz. When this value passes through the low pass filter, the voltage becomes less than 3.3 V at full duty, but when the NCL30170 is operated, it has the output voltage of 3.3 V by the internal current source of the DIM pin.

TEST DATA – ANALOG DIMMING SIGNAL

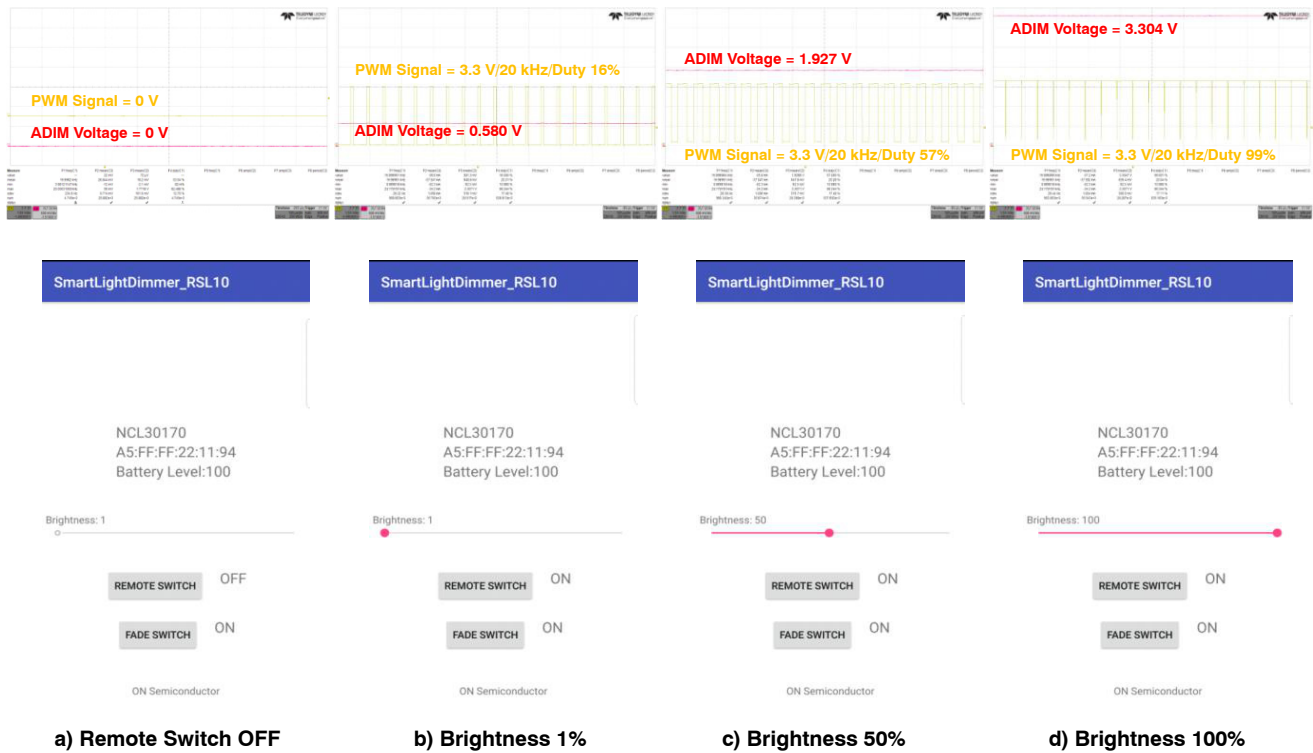


Figure 5. Dimming Signal Control by Android Application App

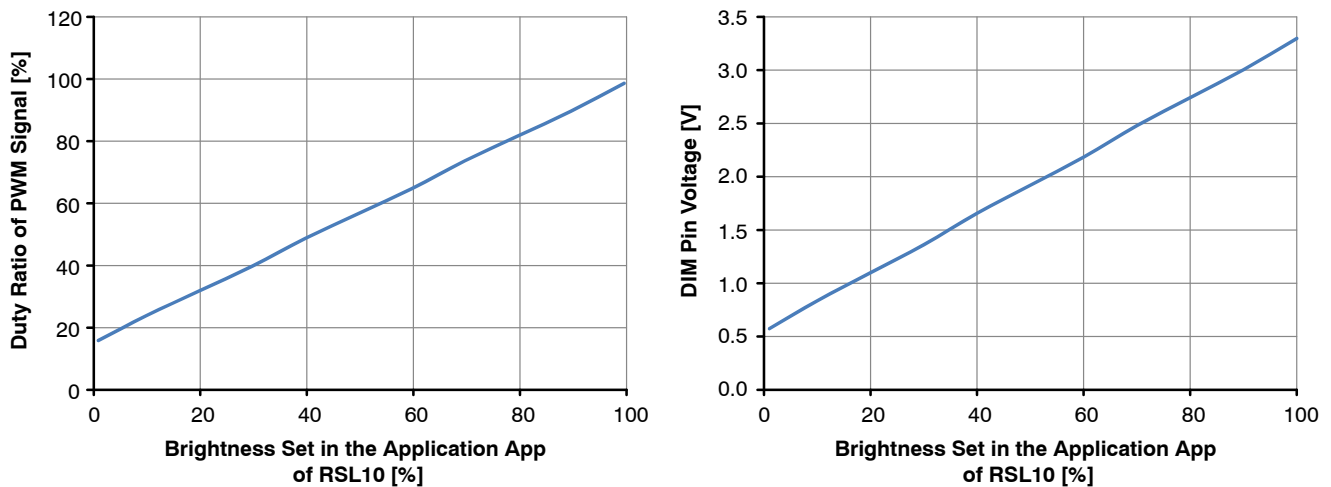


Figure 6. Brightness Set in the Android App of RSL10

TEST DATA – BASIC PERFORMANCE

All system tests conducted with Heat sink (165 mm × 145 mm × 20 mm)

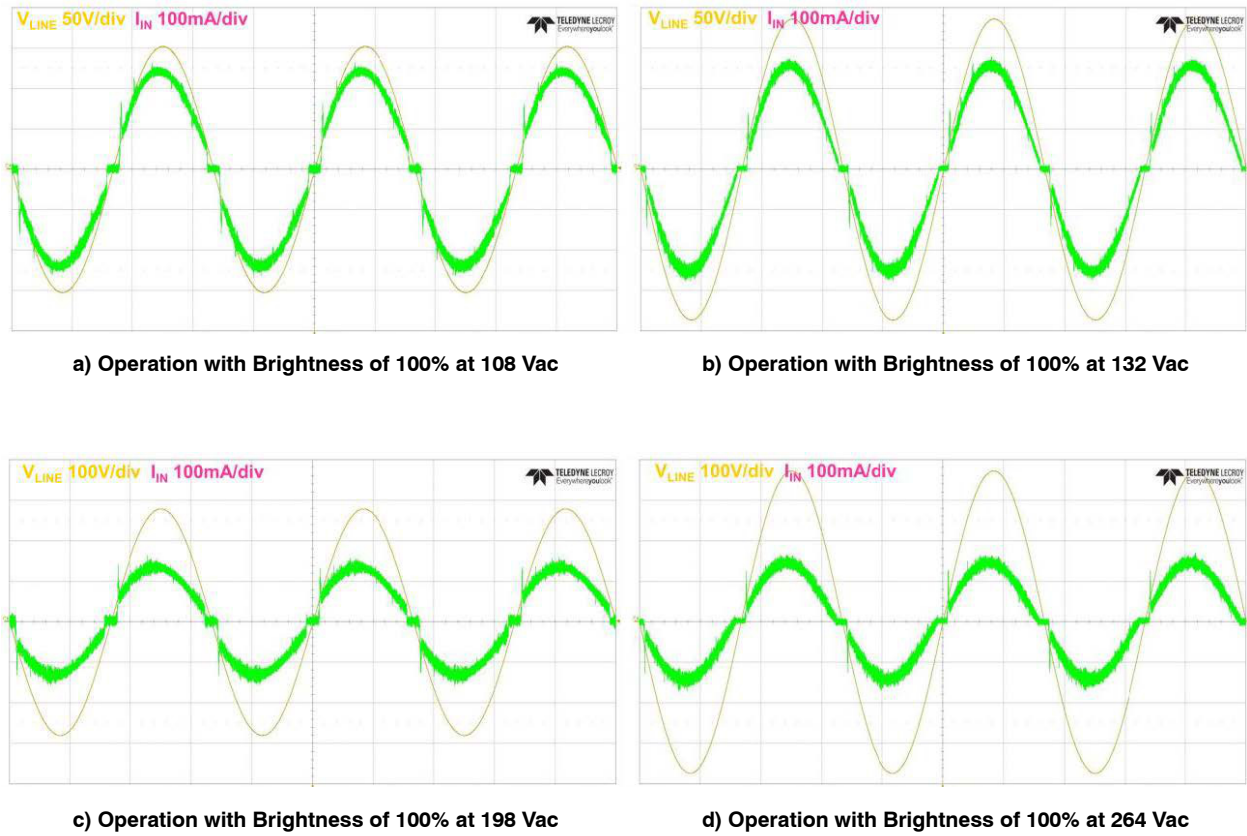


Figure 7. Basic Operation

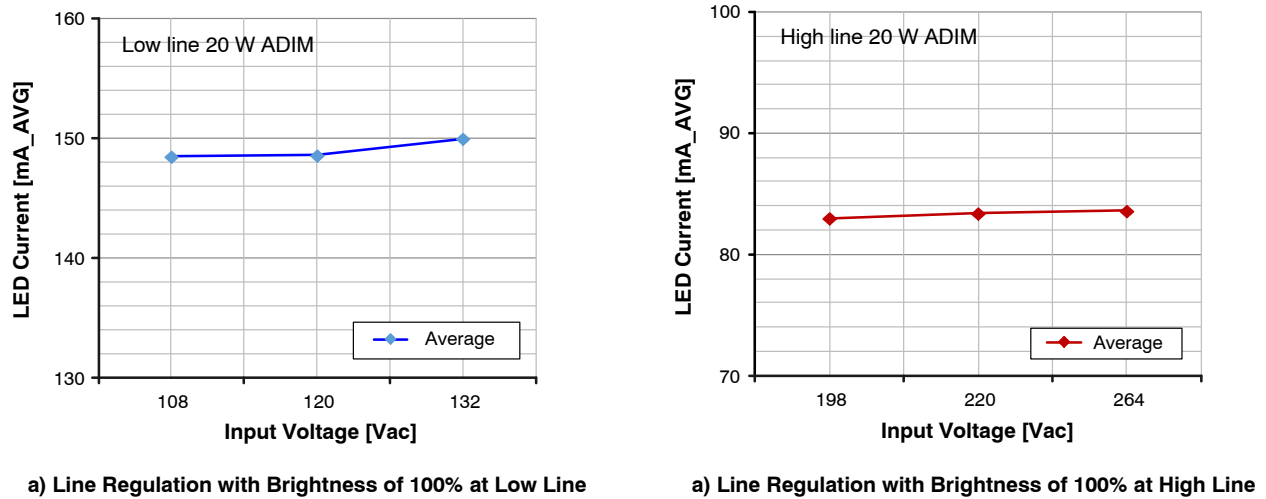
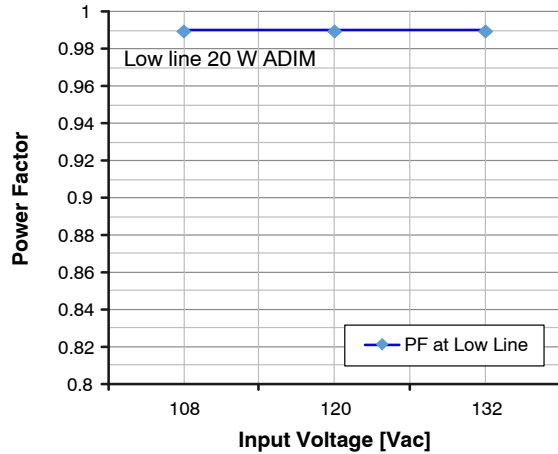


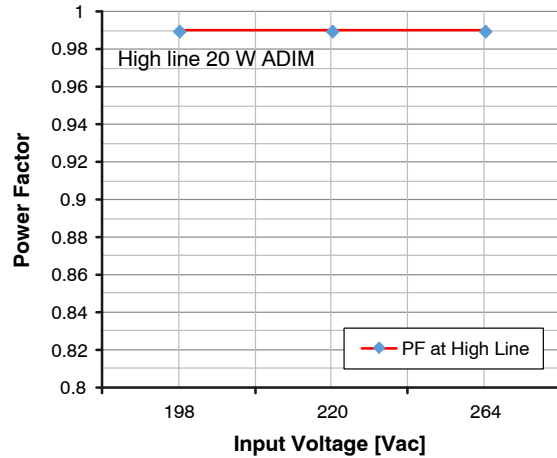
Figure 8. Line Regulation Performance

Table 2. POWER FACTOR, THD AND INPUT POWER

Input Voltage [Vac]		Input Power [W]	PF	THD [%]
Low Line	108	18.15	0.99	7.9
	120	20.32	0.99	6.7
	132	22.58	0.99	7.3
High Line	198	18.61	0.99	9.5
	220	20.86	0.99	7.9
	264	25.54	0.99	7.6

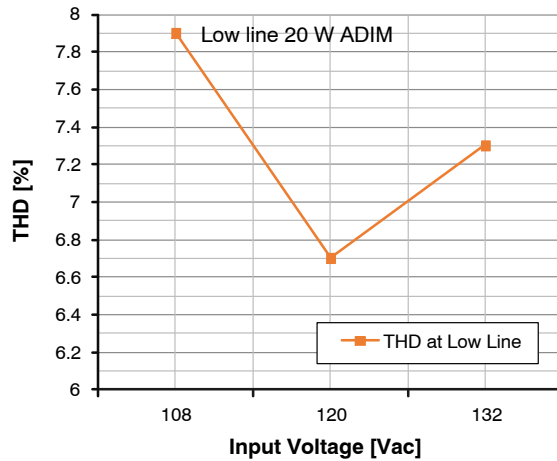


a) PF with Brightness of 100% at Low Line

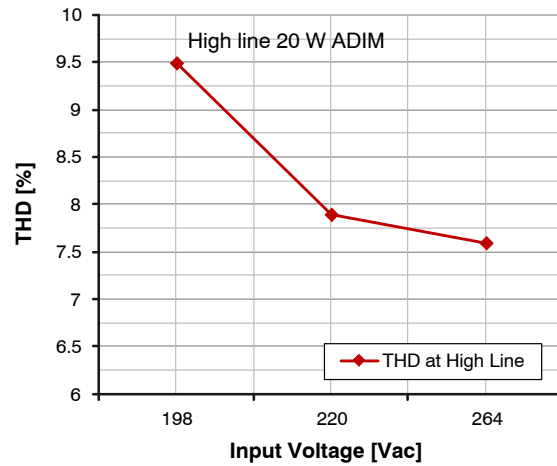


b) PF with Brightness of 100% at High Line

Figure 9. PF Performance



a) THD with Brightness of 100% at Low Line



b) THD with Brightness of 100% at High Line

Figure 10. THD Performance

TEST DATA – DIMMING PERFORMANCE

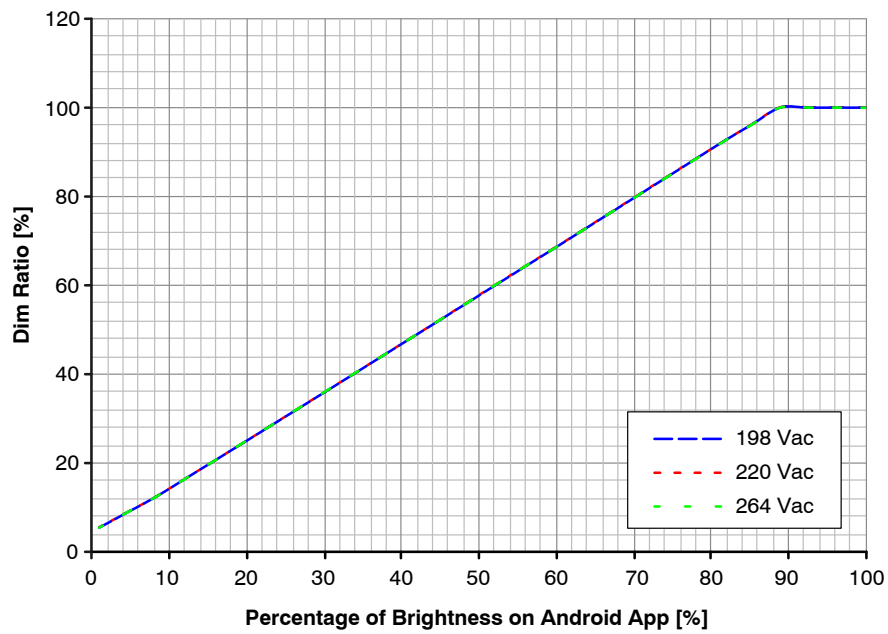
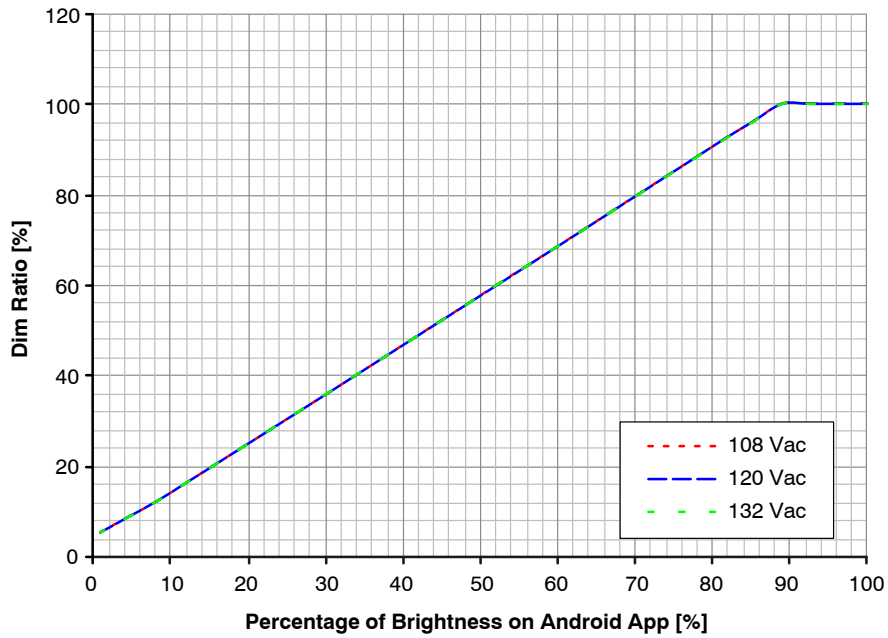


Figure 11. NCL30170 with RSL10 20 W Dimming Curve

TEST DATA – PERCENT FLICKER WITH ELECTROLYTIC CAPACITOR

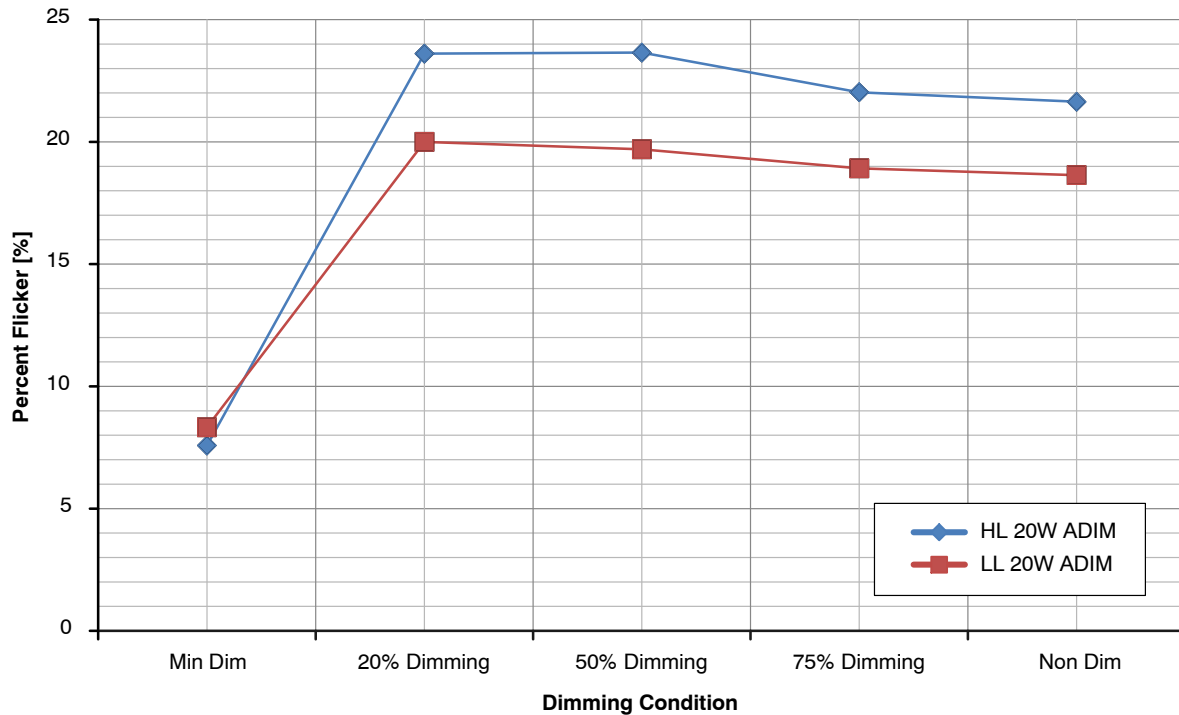


Figure 12. Percent Flicker Performance

NCL30170 AC LED Driver IC

- NCL30170: Direct AC Drive LED Driver for Power Factor Correction and Precise Constant Current Regulation ([NCL30170/D](#))


20 W Direct AC LED Driver

- TND6258: 20 W Direct AC LED Driver Analog and Phase-cut Dimming ([TND6258/D](#))

RSL10 Bluetooth 5 Radio System-on-Chip (SoC)

- RSL10 Evaluation and Development Board User's Manual ([EVBUM2529/D](#))
- [RSL10-002GEVB Gerber](#)
- RSL10 Software

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