



ON Semiconductor®

www.onsemi.com

50 W / 60 W Direct AC LED Driver Analog Dimming Evaluation Board User's Manual

EVAL BOARD USER'S MANUAL

50 W / 60W Direct AC LED Driver Analog Dimming

This manual covers the specification, theory of operation, testing and construction of the NCL30170 evaluation board. The NCL30170 evaluation boards demonstrate 50 W / 60 W Analog dimming with accurate current regulation and low THD performance.

Table 1.

Input Voltage	108 – 132 V ac	Low line ADIM
	198 – 264 V ac	High line ADIM
Line Frequency	50 Hz / 60 Hz	
Output Power	50 W / 60 W	Low line : 50 W High line : 60 W
Power Factor (Maximum LED Output)	0.95	Min
THD (Nominal Input Voltage)	13%	Max
Line Regulation	± 2%	
Analog Dimming range	< 5 %	
Start Up Time	< 200 ms	Typ.
Percent Flicker	< 30%	With E-cap
Lighting Surge	CM: ± 2.0 kV (Line to PE) DM: ± 2.0 kV (Line to Neutral)	ANSI/IEEE C62.41-1991 Class A
EMI	Conducted	9 kHz – 30 MHz

Key Features

- 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 < 5 %
- Excellent Phase-cut dimmer compatibility
- Protections
 - ◆ Input Over Voltage Protection
 - ◆ Thermal Shut Down
 - ◆ Sensing Resistor Short Protection

Schematic for Low Line 50 W ADIM

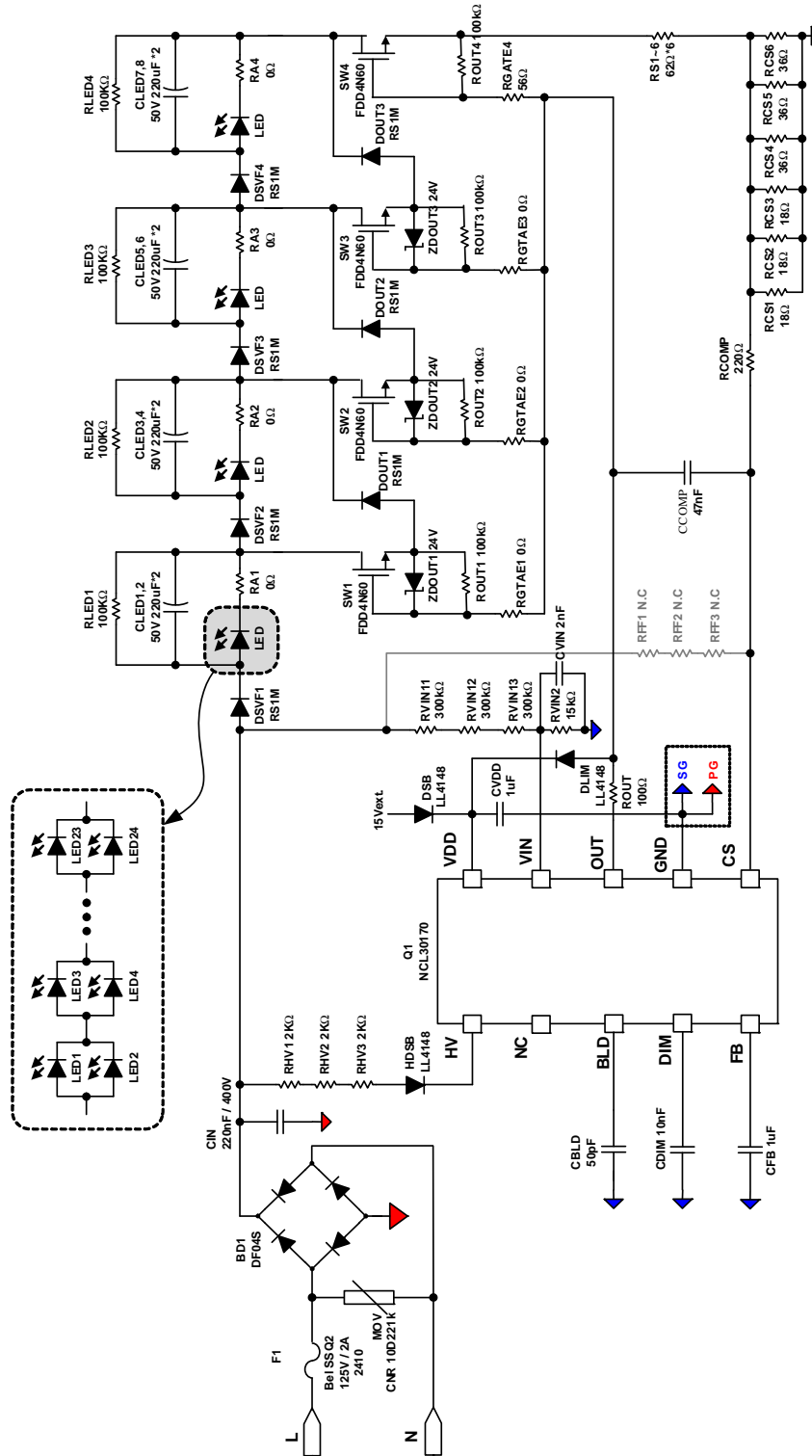


Figure 1. Schematic for Low Line 50 W ADIM

EVBUM2617/D

Table 2. BILL OF MATERIALS FOR LOW LINE (BOM)

Part Reference	Part Description	Q'ty	Vendor	Value
Q1	NCL30170 / IC SOIC 10	1	ON Semiconductor	NCL30170
F1	fast Acting 125V 2A SSQ2 2410	1	Bel fuse	
MOV	CNR10D221K	1	ANY	
RCS1, RCS2, RCS3	RES,SMD,1/2W,3216	3	Yageo	18 Ω
RCS4, RCS5, RCS6	RES,SMD,1/2W,3216	3	Yageo	36 Ω
RHV1, RHV2, RHV3	RES,SMD,1/2W,3216	3	Yageo	2 KΩ
RVIN11,RVIN12	RES,SMD,1/2W,3216	2	Yageo	300 KΩ
RVIN13	RES,SMD,1/2W,3216	1	Yageo	220 KΩ
RVIN2	RES,SMD,1/2W,3216	1	Yageo	13 KΩ
RLED1 ~ RLED4 , ROUT1 ~ ROUT4	RES,SMD,1/2W,3216	8	Yageo	100 KΩ
ROUT	RES,SMD,1/2W,3216	1	Yageo	100 Ω
RGATE4	RES,SMD,1/2W,3216	1	Yageo	56 Ω
RCOMP	RES,SMD,1/2W,3216	1	Yageo	220 Ω
RS1 ~ RS6	RES,SMD,1/2W,3216	6	Yageo	62 Ω
CVIN	220nF / 400V	1		220 nF
CLED1 ~ CLED8	220uF / 50V	8	Samwha	220 μF
CVDD	Cap,3216 SMD,Ceramic,50V,X7R	1	Kemet	1 μF
CBLD	Cap,2012 SMD,Ceramic,25V,X7R	1	Kemet	50 pF
CDIM	Cap,2012 SMD,Ceramic,25V,X7R	1	Kemet	10 nF
CFB	Cap,2012 SMD,Ceramic,25V,X7R	1	Kemet	1 μF
CCOMP	Cap,3216 SMD,Ceramic,50V,X7R	1	Kemet	47 nF
CVIN2	Cap,3216 SMD,Ceramic,50V,X7R	1	Kemet	2 nF
DLIM	Diode,100V,150mA , Fast recovery	1	ON Semiconductor	LL4148
DSVF1 ~ DSVF4 , DOUT1 ~ DOUT3	Diode,1000V,1A , Fast recovery	7	ON Semiconductor	RS1M
DSB, HDSB	Diode,100V,150mA , Fast recovery	2	ON Semiconductor	LL4148
ZDOUT1, ZDOUT2, ZDOUT3	ZENER Diode,24V	3	ON Semiconductor	24V
BD1	Bridge Diode 400V 1A	1	ON Semiconductor	DF04S
LED1 ~ LED96	MP-3030-1100-30-80	96	LUMINUS	3 V / 240 mA
SW1, SW2, SW3, SW4	MOSFET, 600V 4A	4	ON Semiconductor	FDD4N60NZ
RGATE1-3, RA1-4	RES,SMD,1/2W,3216	30	Yageo	0 Ω
RFF1 ~ RFF3		3		Open

Schematic for High Line 60 W ADIM

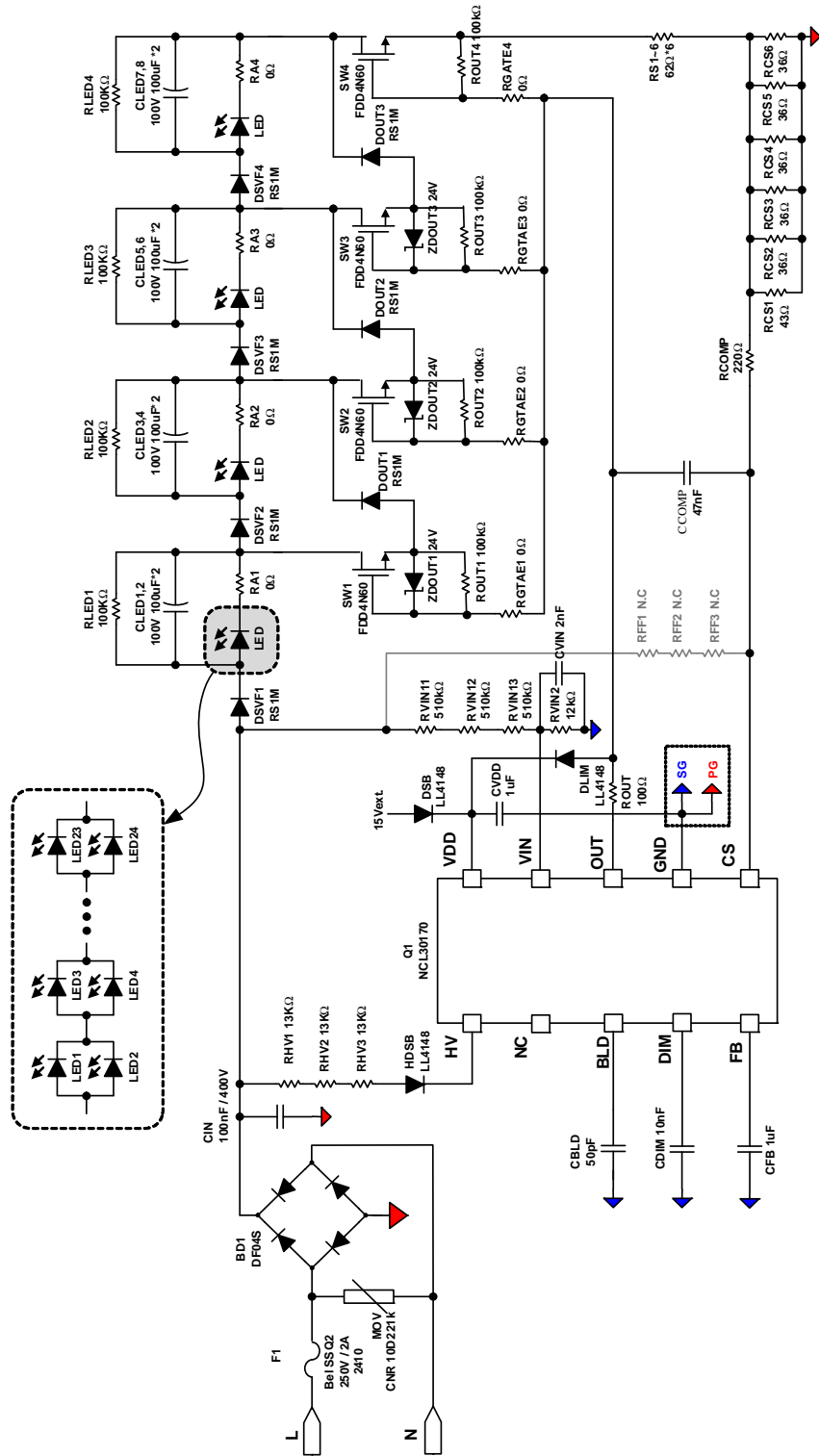


Figure 2. Schematic for High Line 60 W ADIM

EVBUM2617/D

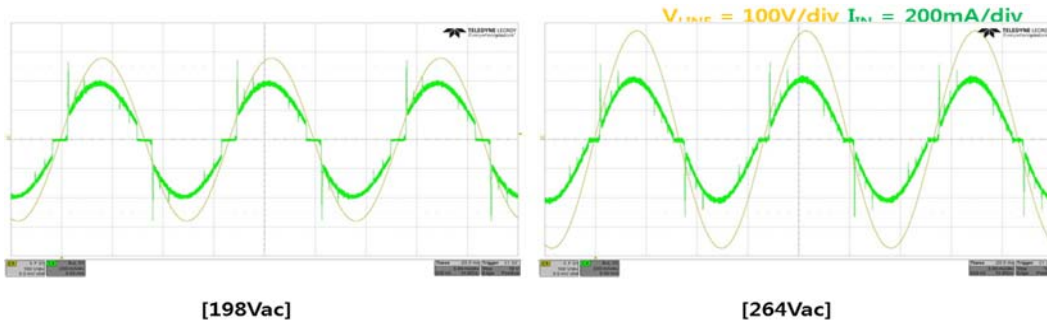
Table 3. BILL OF MATERIALS FOR HIGH LINE (BOM)

Part Reference	Part Description	Q'ty	Vendor	Value
Q1	NCL30170 / IC SOIC 10	1	ON Semiconductor	NCL30170
F1	2A 250Vac MF2410F2.000TM	1	AEM	SMD
MOV	STF 10D391K	1		10Φ
RCS1	RES,SMD,1/2W,3216	1	Yageo	43 Ω
RCS2 ~ RCS6	RES,SMD,1/2W,3216	5	Yageo	36 Ω
RHV1, RHV2, RHV3	RES,SMD,1/2W,3216	3	Yageo	13 KΩ
RVIN11,RVIN12, RVIN13	RES,SMD,1/2W,3216	3	Yageo	510 KΩ
RVIN2	RES,SMD,1/2W,3216	1	Yageo	12 KΩ
RLED1 ~ RLED4 , ROUT1 ~ ROUT4	RES,SMD,1/2W,3216	8	Yageo	100 KΩ
ROUT	RES,SMD,1/2W,3216	1	Yageo	100 Ω
RCOMP	RES,SMD,1/2W,3216	1	Yageo	220 Ω
RS1 ~ RS6	RES,SMD,1/2W,3216	6	Yageo	62 Ω
CVIN	100nF / 600V	1		100 nF
CLED1 ~ CLED8	100uF / 100V	8	Samwha	100 μF
CVDD	Cap,3216 SMD,Ceramic,50V,X7R	1	Kemet	1 μF
CBLD	Cap,2012 SMD,Ceramic,25V,X7R	1	Kemet	50 pF
CDIM	Cap,2012 SMD,Ceramic,25V,X7R	1	Kemet	10 nF
CFB	Cap,2012 SMD,Ceramic,25V,X7R	1	Kemet	1 μF
CCOMP	Cap,3216 SMD,Ceramic,50V,X7R	1	Kemet	47 nF
CVIN2	Cap,3216 SMD,Ceramic,50V,X7R	1	Kemet	2 nF
DLIM	Diode,100V,150mA , Fast recovery	1	ON Semiconductor	LL4148
DSVF1 ~ DSVF4 , DOUT1 ~ DOUT3	Diode,1000V,1A , Fast recovery	7	ON Semiconductor	RS1M
DSB, HDSB	Diode,100V,150mA , Fast recovery	2	ON Semiconductor	LL4148
ZDOUT1, ZDOUT2, ZDOUT3	ZENER Diode,24V	3	ON Semiconductor	24 V
BD1	Bridge Diode 400V 1A	1	ON Semiconductor	DF04S
LED1 ~ LED96	MP-3030-2100-30-80	96	LUMINUS	6 V / 240 mA
SW1, SW2, SW3, SW4	MOSFET, 600V 4A	4	ON Semiconductor	FDD4N60NZ
RGATE1~4, RA1~4	RES,SMD,1/2W,3216	30	Yageo	0 Ω
RFF1~3		5		Open

EVBUM2617/D

PERFORMANCE

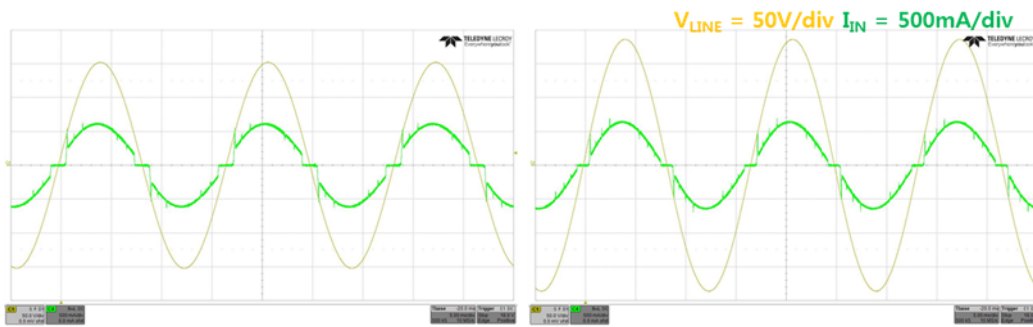
Test Data – Analog Dimming Mode



[198Vac]

[264Vac]

Figure 3. Normal Operation for High Line ADIM



[108Vac]

[132Vac]

Figure 4. Normal Operation for Low Line ADIM

Table 4. POWER FACTOR AND THD FOR INPUT VOLTAGE

60 W High Line EVB				50 W Low Line EVB			
Input Voltage [Vac]	Input Power [W]	PF	THD [%]	Input Voltage [Vac]	Input Power [W]	PF	THD [%]
198	56.41	0.991	12.967	108	45.523	0.991	11.162
230	64.01	0.992	10.336	120	50.727	0.992	9.737
264	74.5	0.992	9.638	132	56.032	0.992	9.654

High line 60W ADIM

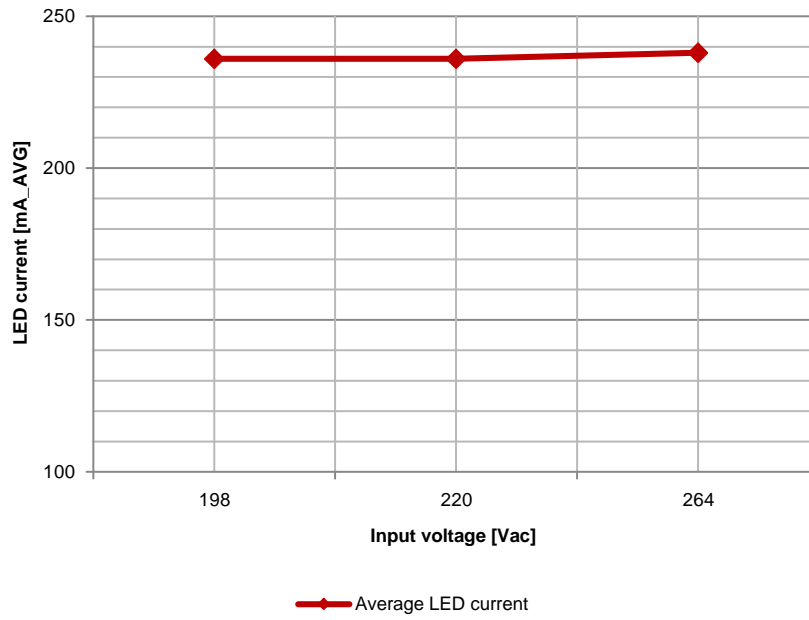


Figure 5. Line Regulation Performance for High Line (ADIM)

Low line 50W ADIM

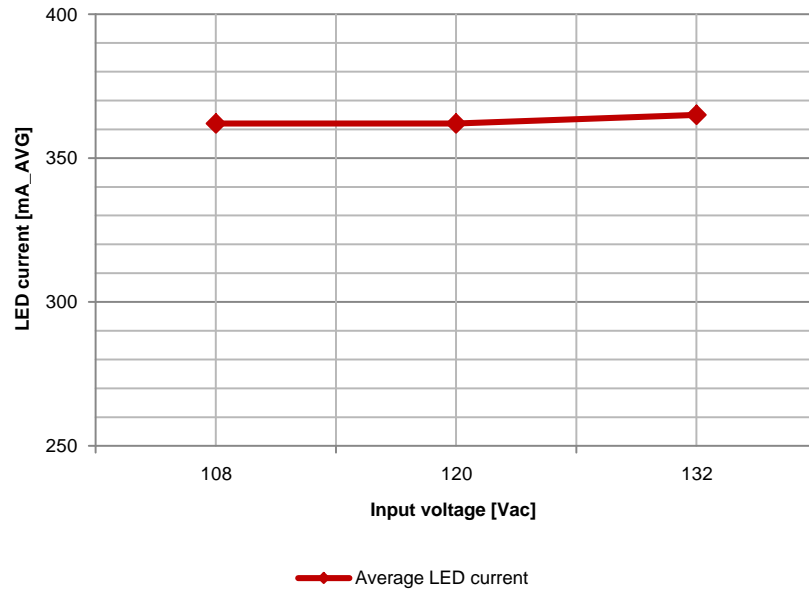


Figure 6. Line Regulation Performance for Low Line (ADIM)

Dimming Performance

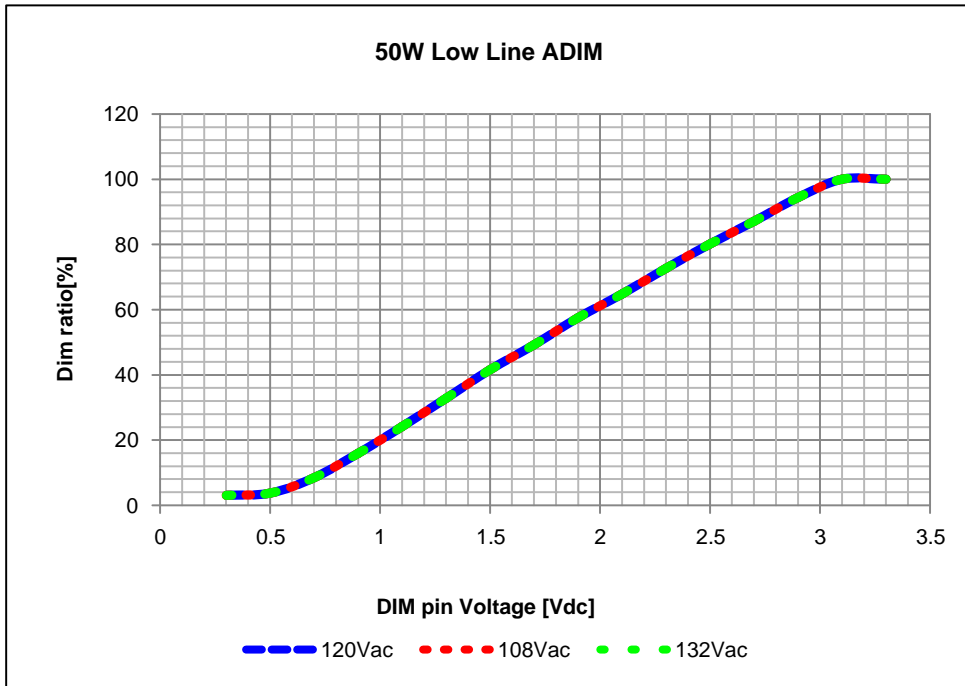
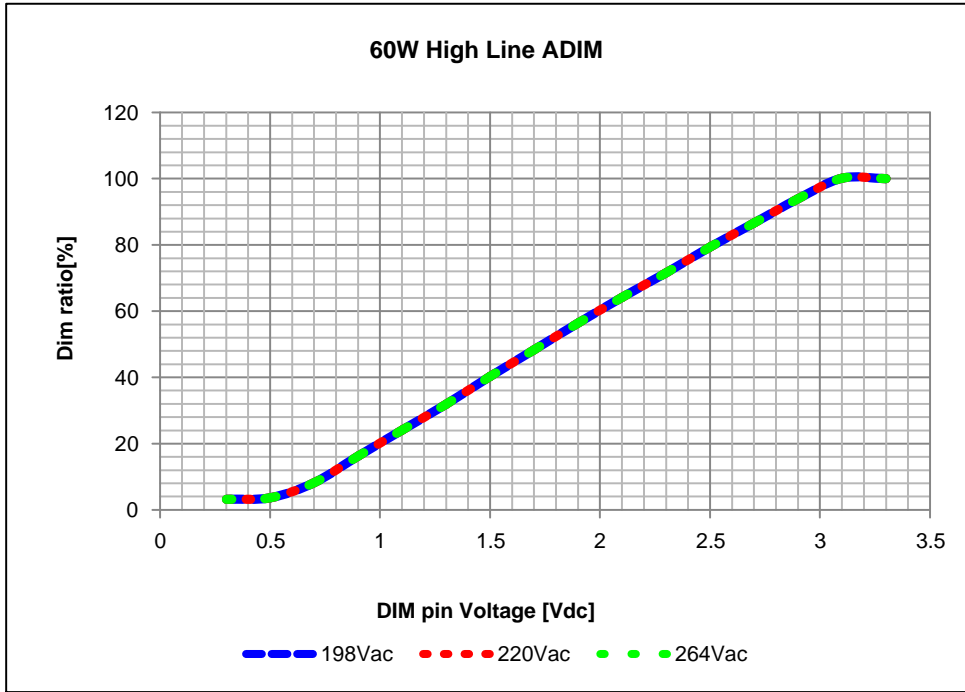


Figure 7. Dimming Curve for Analog Dimming

Percent Flicker with Electrolytic Capacitor

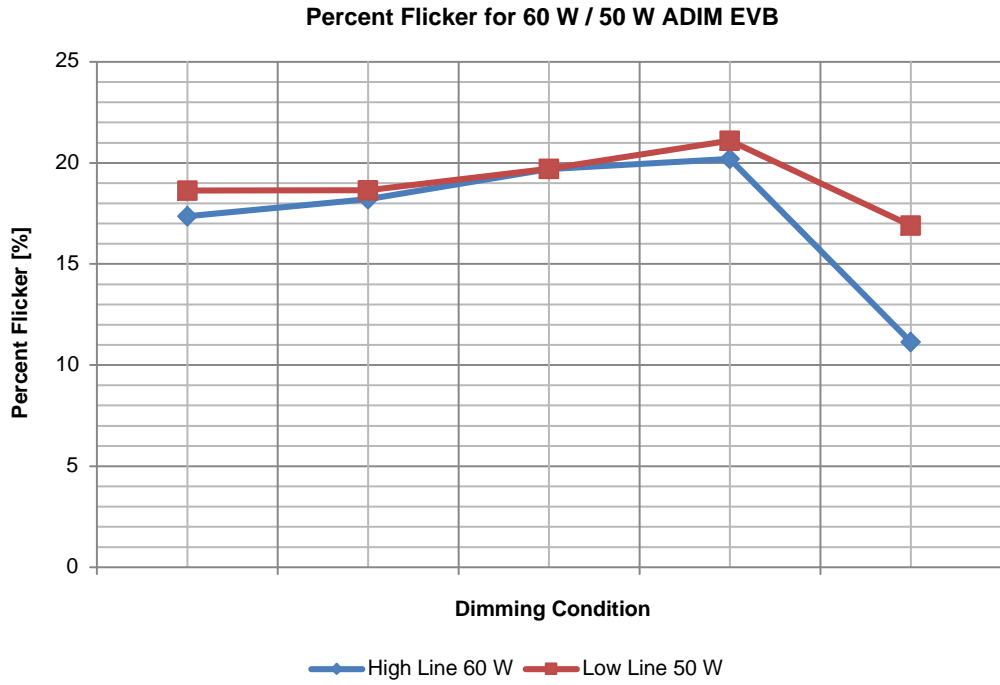
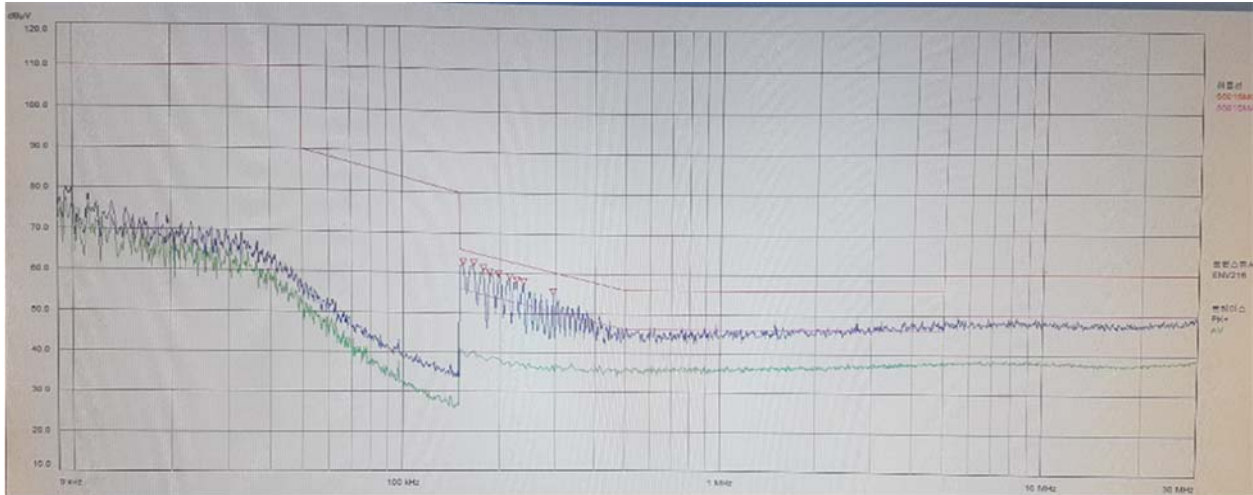
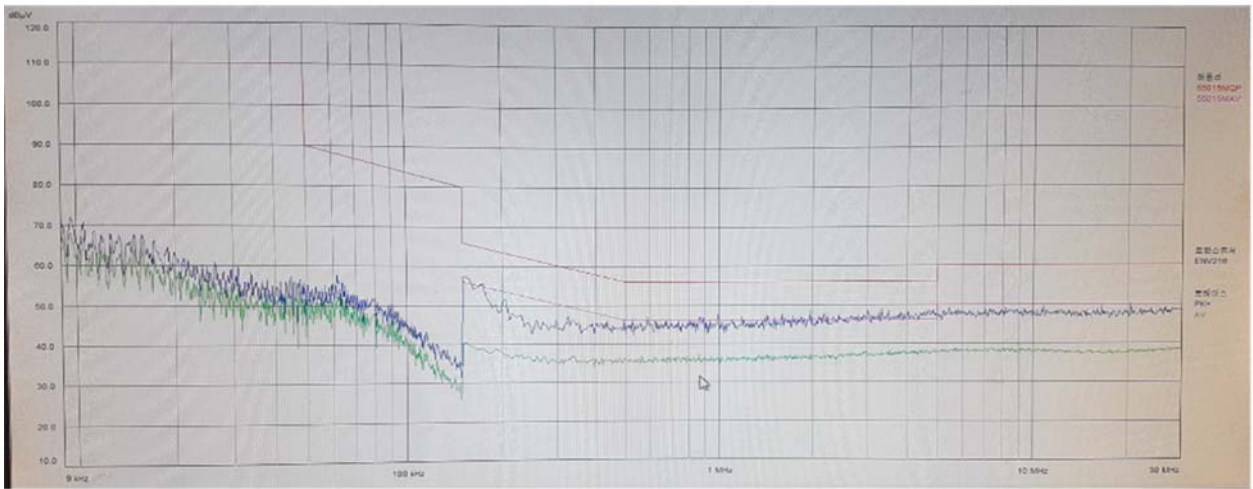


Figure 8. Percent Flicker Performance

Conducted EMI



[60W High Line ADIM]



[50W Low Line ADIM]

Figure 9. EMI Test Result for NCL30170 60 W / 50 W EVB

Surge Test

Test condition:

Boards mounted to 25 cm x 18 cm x 4.5 cm heatsink

Heatsink connected to Earth ground

DM: Differential Mode test applies surge between Line and Neutral

CM: Common Mode test applies surge between Line + Neutral connected and Earth ground

Combination wave: 3 strikes

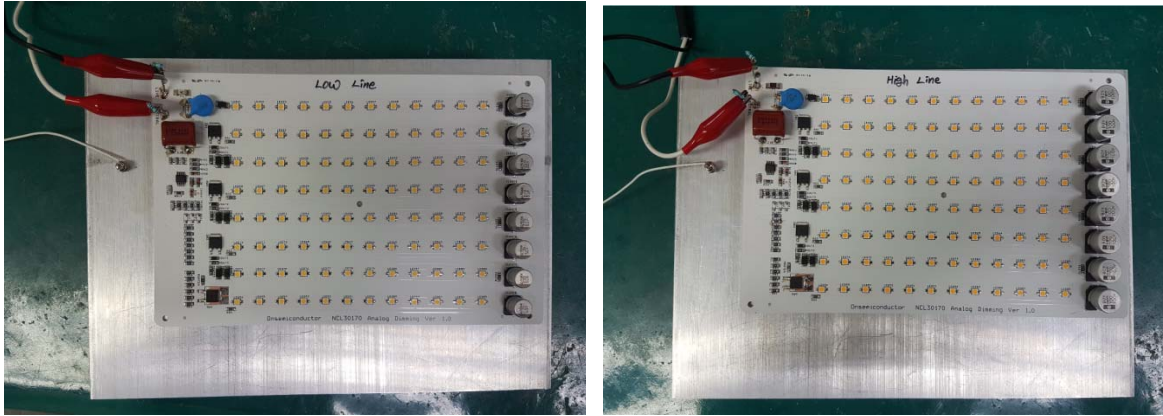


Figure 10. Surge Test (Combination wave)

Table 5. TEST RESULT FOR COMBINATION WAVE

Test EVB	Test Result	Surge Immunity Component
60 W High Line	± 2 kV passed	MOV 10D221K (10pi)
50 W Low Line	± 2 kV passed	MOV 10D391K (10pi)

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

The evaluation board/kit (research and development board/kit) (hereinafter the "board") is not a finished product and is as such not available for sale to consumers. The board is only intended for research, development, demonstration and evaluation purposes and should as such only be used in laboratory/development areas by persons with an engineering/technical training and familiar with the risks associated with handling electrical/mechanical components, systems and subsystems. This person assumes full responsibility/liability for proper and safe handling. Any other use, resale or redistribution for any other purpose is strictly prohibited.

The board is delivered "AS IS" and without warranty of any kind including, but not limited to, that the board is production-worthy, that the functions contained in the board will meet your requirements, or that the operation of the board will be uninterrupted or error free. ON Semiconductor expressly disclaims all warranties, express, implied or otherwise, including without limitation, warranties of fitness for a particular purpose and non-infringement of intellectual property rights.

ON Semiconductor reserves the right to make changes without further notice to any board.

You are responsible for determining whether the board will be suitable for your intended use or application or will achieve your intended results. Prior to using or distributing any systems that have been evaluated, designed or tested using the board, you agree to test and validate your design to confirm the functionality for your application. Any technical, applications or design information or advice, quality characterization, reliability data or other services provided by ON Semiconductor shall not constitute any representation or warranty by ON Semiconductor, and no additional obligations or liabilities shall arise from ON Semiconductor having provided such information or services.

The boards are not designed, intended, or authorized for use in life support systems, or any FDA Class 3 medical devices or medical devices with a similar or equivalent classification in a foreign jurisdiction, or any devices intended for implantation in the human body. Should you purchase or use the board for any such unintended or unauthorized application, you shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the board.

This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and may not meet the technical requirements of these or other related directives.

FCC WARNING – This evaluation board/kit is intended for use for engineering development, demonstration, or evaluation purposes only and is not considered by ON Semiconductor to be a finished end product fit for general consumer use. It may generate, use, or radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment may cause interference with radio communications, in which case the user shall be responsible, at its expense, to take whatever measures may be required to correct this interference.

ON Semiconductor does not convey any license under its patent rights nor the rights of others.

LIMITATIONS OF LIABILITY: ON Semiconductor shall not be liable for any special, consequential, incidental, indirect or punitive damages, including, but not limited to the costs of requalification, delay, loss of profits or goodwill, arising out of or in connection with the board, even if ON Semiconductor is advised of the possibility of such damages. In no event shall ON Semiconductor's aggregate liability from any obligation arising out of or in connection with the board, under any theory of liability, exceed the purchase price paid for the board, if any.

For more information and documentation, please visit www.onsemi.com.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Email Requests to: orderlit@onsemi.com

ON Semiconductor Website: www.onsemi.com

TECHNICAL SUPPORT

North American Technical Support:

Voice Mail: 1 800-282-9855 Toll Free USA/Canada

Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative