

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



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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

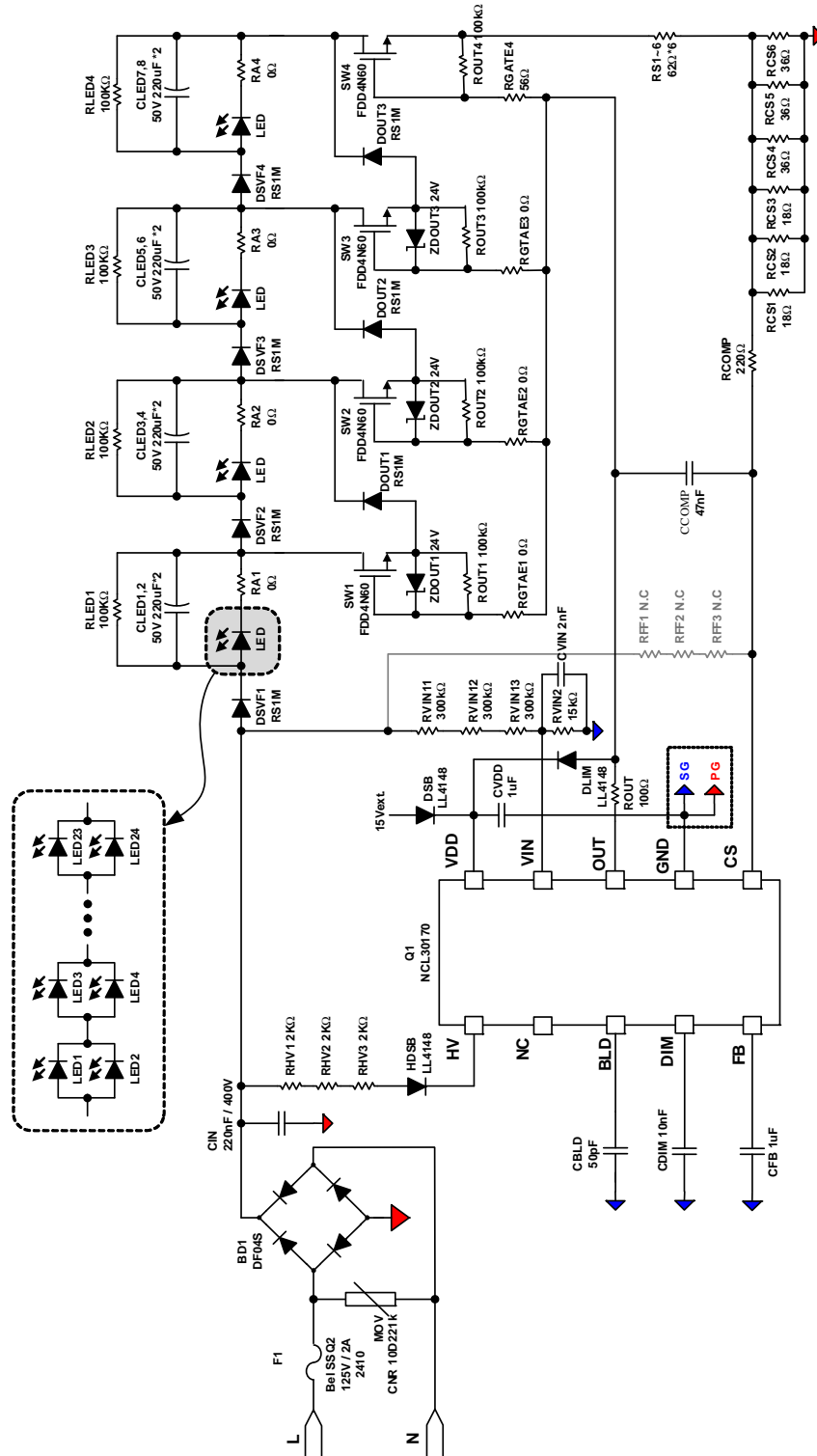


Figure 1. Schematic for Low Line 50 W ADIM

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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 K Ω
RVIN11,RVIN12	RES,SMD,1/2W,3216	2	Yageo	300 K Ω
RVIN13	RES,SMD,1/2W,3216	1	Yageo	220 K Ω
RVIN2	RES,SMD,1/2W,3216	1	Yageo	13 K Ω
RLED1 ~ RLED4 , ROUT1 ~ ROUT4	RES,SMD,1/2W,3216	8	Yageo	100 K Ω
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 μ F
CVDD	Cap,3216 SMD,Ceramic,50V,X7R	1	Kemet	1 μ F
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 μ F
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

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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

PERFORMANCE

Test Data – Analog Dimming Mode

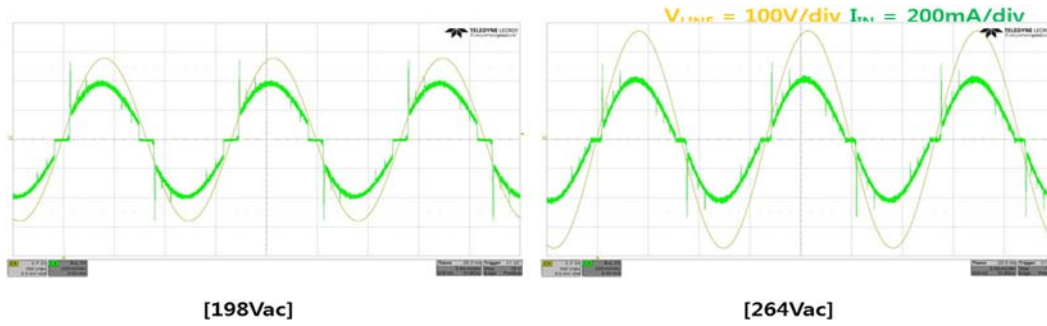


Figure 3. Normal Operation for High Line ADIM

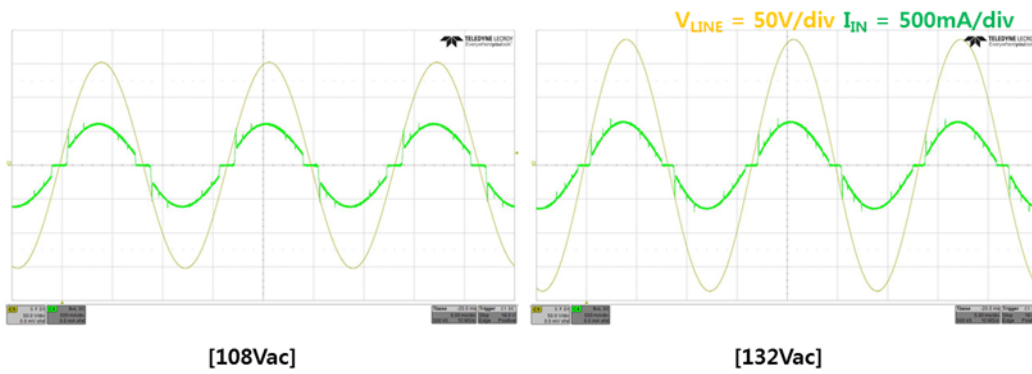


Figure 4. Normal Operation for Low Line ADIM

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	992	10.336	120	50.727	0.992	9.737
264	74.5	0.992	9.638	132	56.032	0.992	9.654

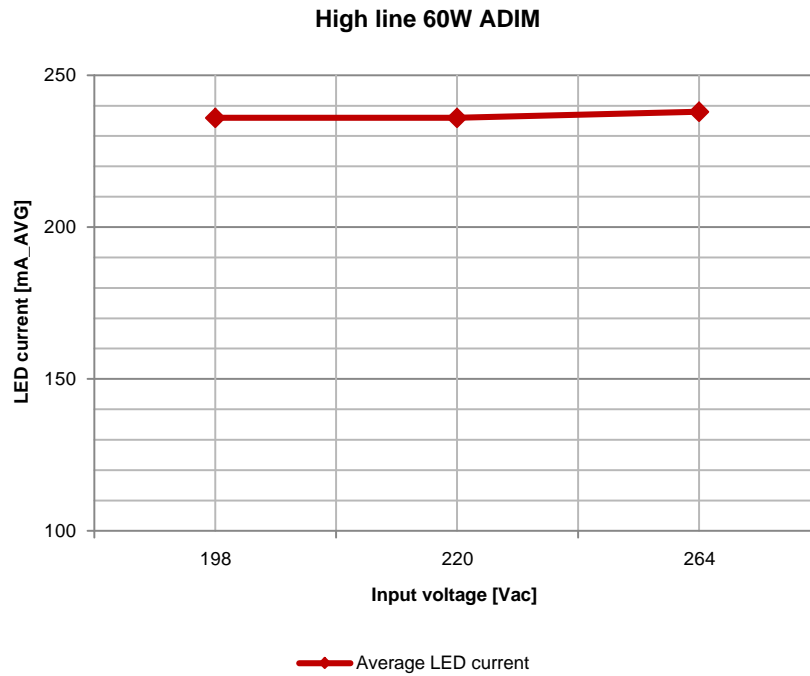


Figure 5. Line Regulation Performance for High Line (ADIM)

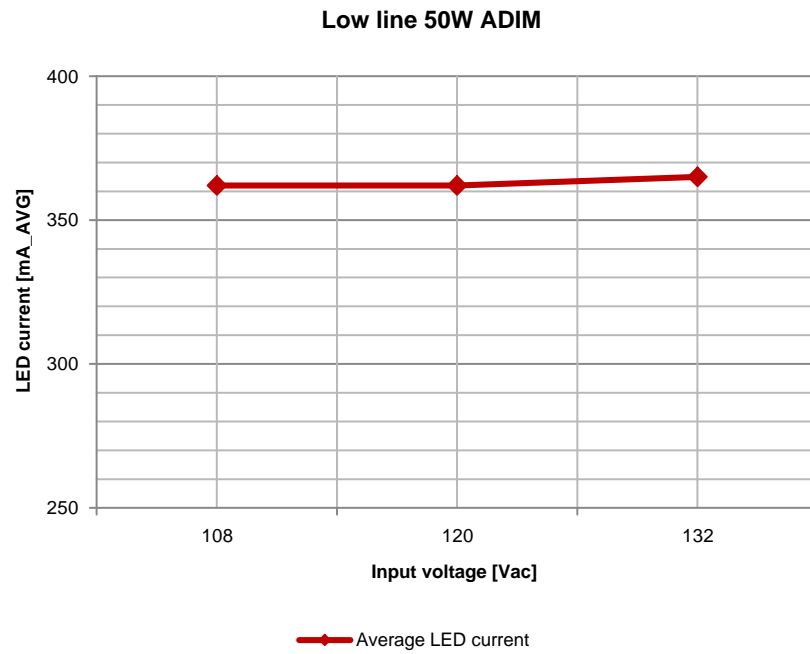


Figure 6. Line Regulation Performance for Low Line (ADIM)

Dimming Performance

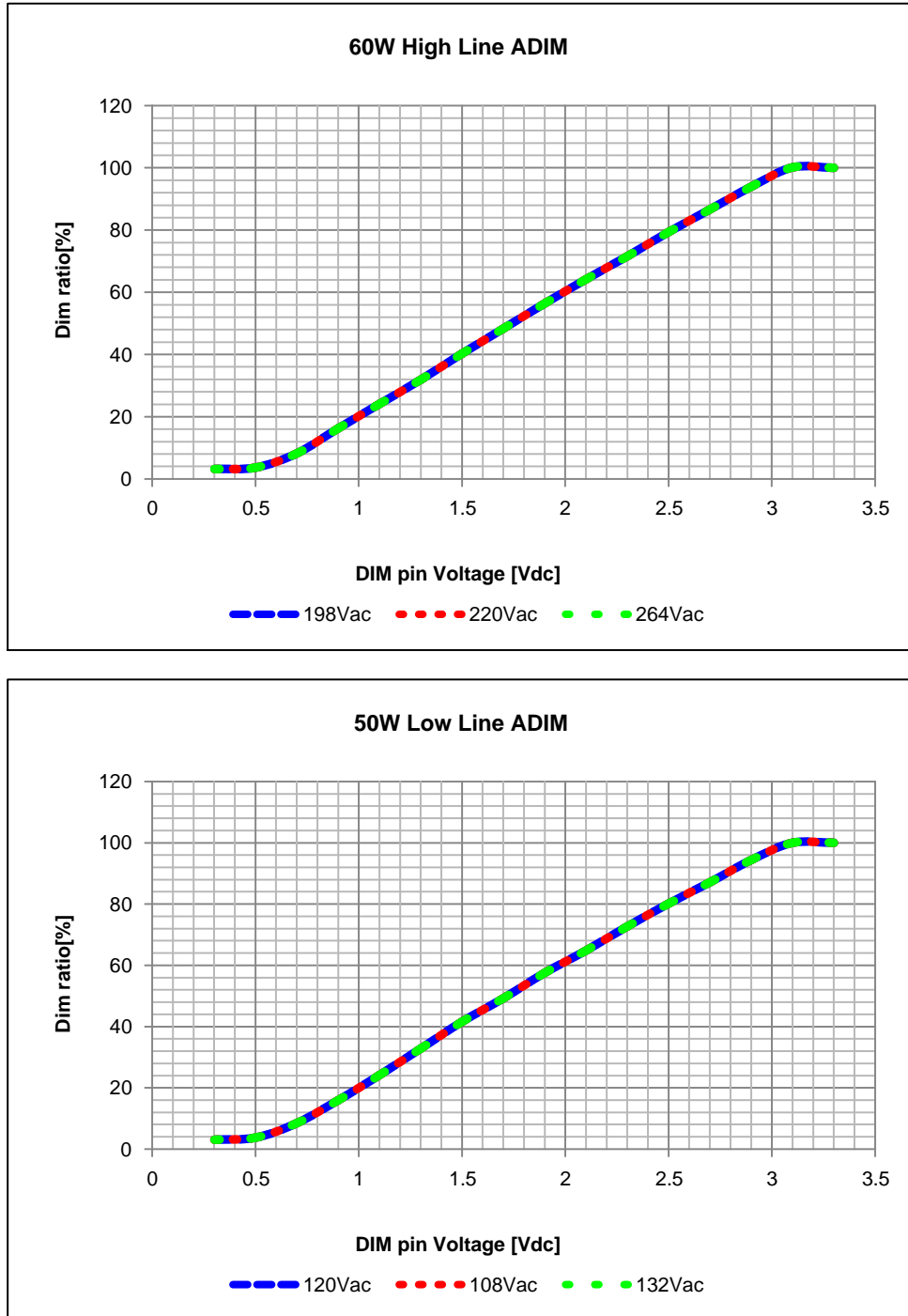


Figure 7. Dimming Curve for Analog Dimming

Percent Flicker with Electrolytic Capacitor

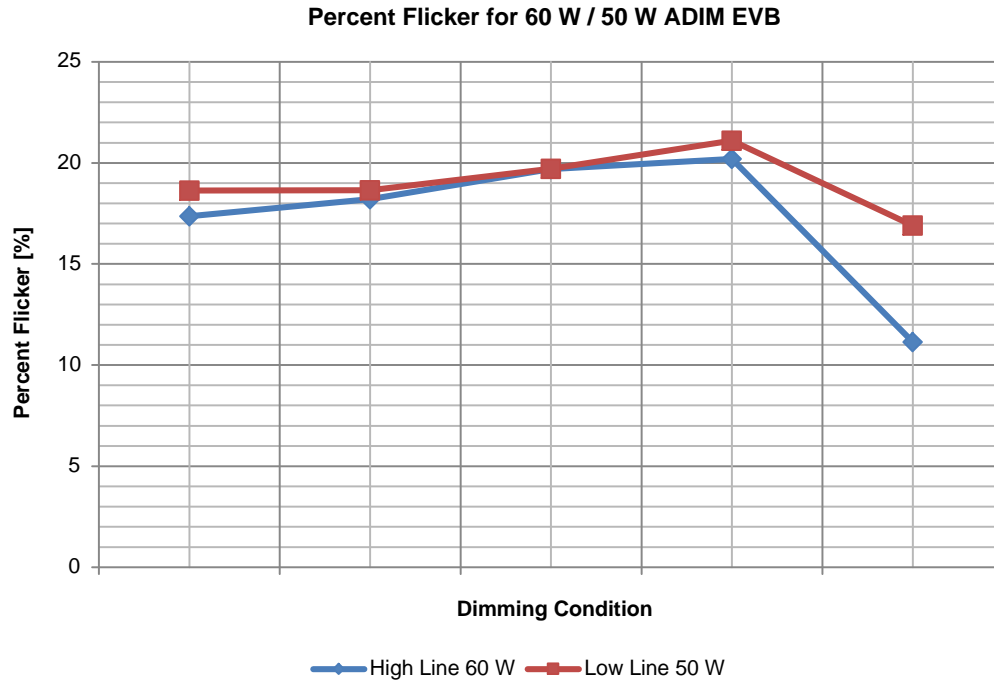
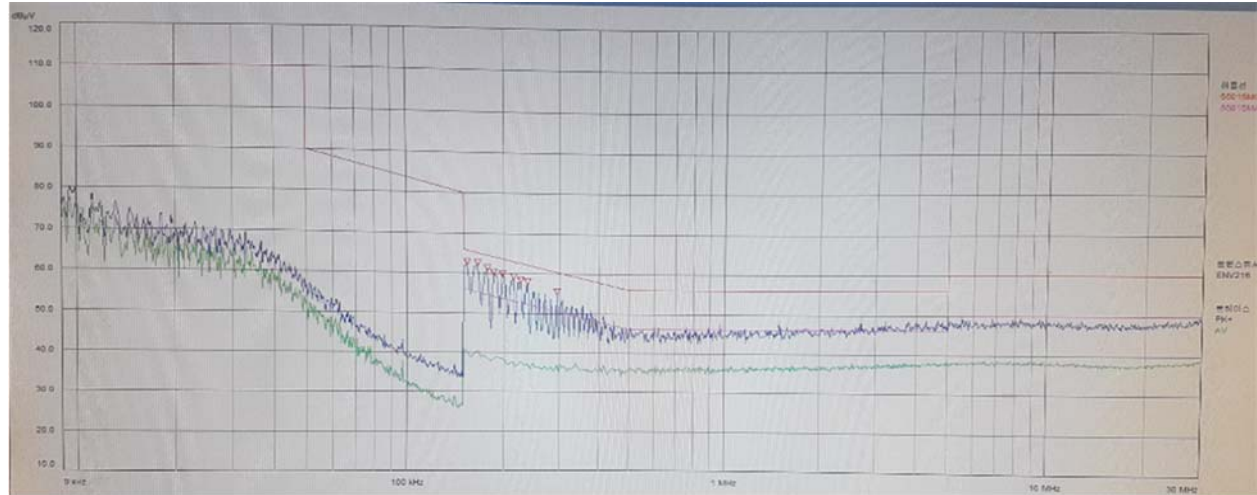
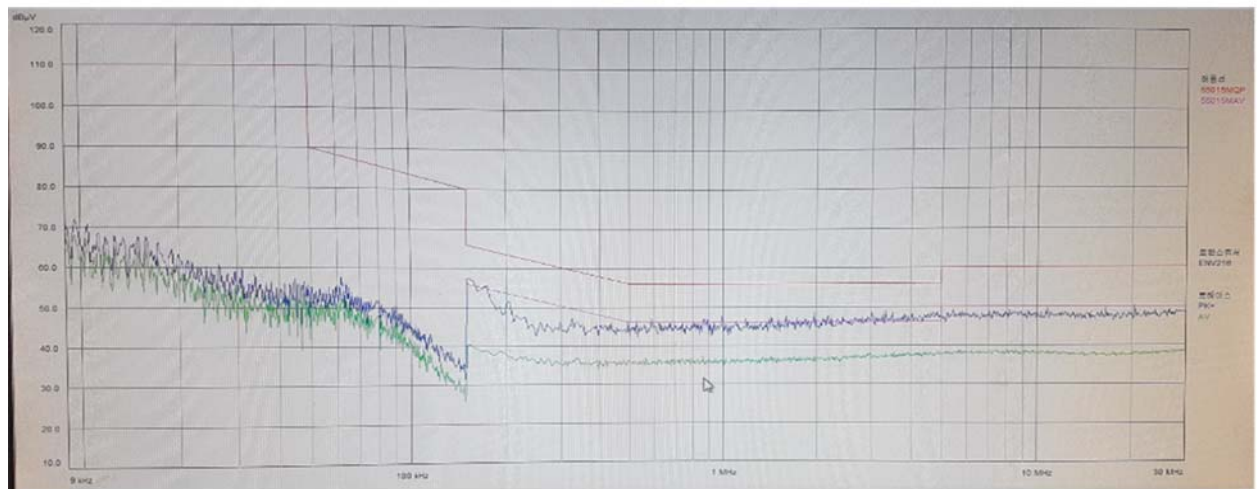


Figure 8. Percent Flicker Performance

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

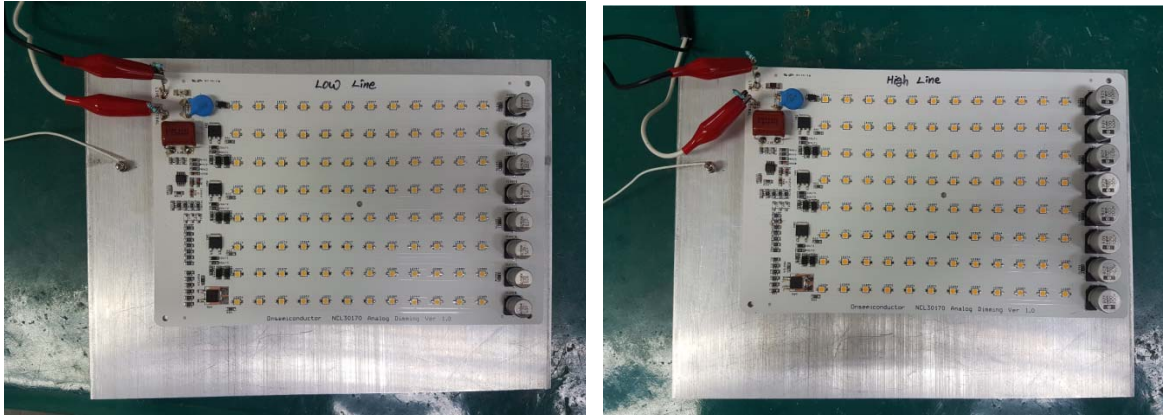


Figure 10. Surge Test (Combination wave)

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)

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