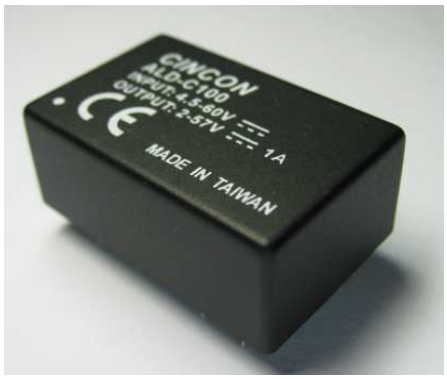
MDL/ALD/DLD SERIES DC-DC LED DRIVER

Application Note V10 November 2014

DC-DC LED DRIVER WITH DALI INTERFACE MODULE
MLD SERIES
ALD SERIES
DLD SERIES

MLD

ALD



DLD

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MDL/ALD/DLD SERIES DC-DC LED DRIVER

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Content

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1. Introduction

MLD series is a constant current LED DC driver, DALI compatible with multiple outputs. ALD series is a constant current LED DC drive, DALI compatible with single outputs. DLD series is a constant current LED DC drive. For example tube light, panel light, down light, Hi-bay, flood light and street light. When you look at multiple outputs model, MLD are available with output current 700mA, 1000mA and 1400mA. When you look at single output model, ALD and DLD provides output current 350mA, 700mA,1000mA and 1400mA. MLD, ALD and DLD also features short circuit protection, compact size, high reliability and very high efficiency 96% (typical).

2. Features

2-1. MLD Series

- Wide Input Range
- LED Driver Current up to 1400mA
- Compatible to the DALI Standard
- Provides Multi-cannel of LED Lighting Synchronization Controls
- Constant Current Dimming Control (PWM mode)
- Option Auxiliary Power

2-2. ALD Series

- LED Driver Current up to 1400mA
- Constant Current Output
- High Efficiency up to 95%
- Continuous Short Circuit Protection
- DIP24 package
- High Reliability
- IP67 Protection

2-3. DLD Series

- LED Driver Current up to 1400mA
- Constant Current Output
- Digital PWM Dimming
- Analog Dimming Control
- High Efficiency up to 96%
- Continuous Short Circuit Protection
- DIP16 package and Wired Version
- High Reliability
- IP67 Protection

3. Technical Specifications For MLD Series

(All specifications are typical at nominal input, full load at 25℃ unless otherwise noted.)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage		MLD4-C140	10	28	36	V_{dc}
		MLD6-C140	10	28	36	
		Others	4.5	48	60	
Operating Temperature	see derating curve	All	-40		+71	℃
Storage Temperature		All	-55		+105	℃
Temperature Coefficient	Tc=0℃ to 50℃	All			±0.05	%/℃

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Voltage Range		MLD4-C140	10	28	36	V_{dc}
		MLD6-C140	10	28	36	
		Others	4.5	48	60	
Input Under Voltage Lockout						
Turn-On Voltage Threshold		MLD4-C140 MLD6-C140		8.0		V_{dc}
		Others		4.0		
Turn-Off Voltage Threshold		MLD4-C140 MLD6-C140		6.9		V_{dc}
		Others		3.7		
Input Surge Voltage	1 second	MLD4-C140 MLD6-C140			50	V_{dc}
		Others			65	

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Operating Voltage	V_{in}=Nominal Vin, I_o=I_{o_max} Tc=25℃	MLD4-C070	2		57	Vdc
		MLD4-C100	2		57	
		MLD4-C140	8		33	
		MLD6-C070	2		57	
		MLD6-C100	2		57	
		MLD6-C140	8		33	
Output Rated Current	V_{in}=Nominal V_{in}, Full Load Tc=25℃	MLD4-C070		700*4		mA
		MLD4-C100		1000*4		
		MLD4-C140		1400*4		
		MLD6-C070		700*6		
		MLD6-C100		1000*6		
		MLD6-C140		1400*6		

Output Rated Power/Channel	V_{in}=Nominal V_{in}, V_o=2-57Vdc Io=I_{o_max}.	MLD4-C070 MLD6-C070			40	W
		MLD4-C100 MLD6-C100			57	
	V_{in}=Nominal V_{in}, V_o=8-33Vdc Io=I_{o_max}.	MLD4-C140 MLD6-C140			46.2	
Output Constant Current Accuracy	3V<V_{in}-V_{out}<30V_{dc} to keep current accuracy	All			±5	%
Current Load Regulation	measured from high line to low operating voltage	All			±5	%
Current Line Regulation	measured from high line to low line	All			±5	%
Output Voltage Ripple and Noise						
Peak-to-Peak	24V_{dc} V_o=XXV_{dc}, 20MHz bandwidth 0.1uF ceramic with 100% output current	MLD4-C140 MLD6-C140			500	mV
	36V_{dc} V_o=XXV_{dc}, 20MHz bandwidth 0.1uF ceramic with 100% output current	Others			500	
Auxiliary Power	Vin>21V_{dc}			18	22.5	V
Start-Up Time	Vin=Nominal, Full Load	All			60	ms
DALI Control	Output Current Range	All	10		100	%

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load		All		96		%

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency		MLD4-C140 MLD6-C140	50	500		KHz
		Others		300		
Operating Humidity		All	10		95	%
Operating Altitude		All			3000	m
Vibration	2G 60min./1cycle, period for 3hours, 3 axes	All	0		500	Hz
Shock	half sine, 6 axes	All			30	g
MTBF	Ambient temperature is 25℃ per MIL-HDBK-217F	All		TBD		K hours
Weight		MLD4-CXXX		145		grams
		MLD6-CXXX		160		

4. Technical Specifications For ALD Series

(All specifications are typical at nominal input, full load at 25℃ unless otherwise noted.)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage		ALD-C140	10	28	36	V_{dc}
		Others	4.5	48	60	
Operating Temperature	see derating curve	All	-40		+85	℃
Storage Temperature		All	-55		+125	℃
Temperature Coefficient	Tc=0℃ to 50℃	All			±0.05	%/℃

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Voltage Range		ALD-C140	10	28	36	V_{dc}
		Others	4.5	48	60	
Input Under Voltage Lockout						
Turn-On Voltage Threshold		ALD-C140		8.0		V_{dc}
		Others		4.0		
Turn-Off Voltage Threshold		ALD-C140		6.9		V_{dc}
		Others		3.7		
Input Surge Voltage	1 second	ALD-C140			50	V_{dc}
		Others			65	

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Operating Voltage	V_{in}=Nominal Vin, I_o=I_{o_max} Tc=25℃	ALD-C035	2		57	Vdc
		ALD-C070	2		57	
		ALD-C100	2		57	
		ALD-C140	8		33	
Output Rated Current	V_{in}=Nominal V_{in}, Full Load Tc=25℃	ALD-C035		350		mA
		ALD-C070		700		
		ALD-C100		1000		
		ALD-C140		1400		
Output Rated Power	V_{in}=Nominal V_{in}, V_o=2-57Vdc Io=I_{o_max}.	ALD-C035			20	W
		ALD-C070			40	
		ALD-C100			57	
	V_{in}=Nominal V_{in}, V_o=8-33Vdc Io=I_{o_max}.	ALD-C140			46.2	
Output Constant Current Accuracy	3V<V_{in}-V_{out}<30V_{dc} to keep current accuracy	All			±5	%
Current Load Regulation	measured from high line to low operating voltage	All			±5	%
Current Line Regulation	measured from high line to low line	All			±5	%
Output Voltage Ripple and Noise						
Peak-to-Peak	36V_{dc} V_o=XXV_{dc}, 20MHz bandwidth 0.1uF ceramic with 100% output current	ALD-C035			300	mV
		ALD-C070 ALD-C100			500	
	24V_{dc} V_o=XXV_{dc}, 20MHz bandwidth 0.1uF ceramic with 100% output current	ALD-C140			500	

Start-Up Time	Vin=Nominal, Full Load	All			60	ms
DALI Control	Output Current Range	All	10		100	%

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load		All		96		%

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency		ALD-C140	50	500		KHz
		Others		300		
Operating Humidity		All	10		95	%
Operating Altitude		All			3000	m
Vibration	2G 60min./1cycle, period for 3hours, 3 axes	All	0		500	Hz
Shock	half sine, 6 axes	All			30	g
MTBF	Ambient temperature is 25℃ per MIL-HDBK-217F	All		TBD		M hours
Weight		All		18		grams

5. Technical Specifications For DLD Series

(All specifications are typical at nominal input, full load at 25℃ unless otherwise noted.)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage		DLD-C140	10	28	36	V_{dc}
		Others	4.5	48	60	
Operating Temperature	see derating curve	All	-40		+85	℃
Storage Temperature		All	-55		+125	℃
Temperature Coefficient	Tc=0℃ to 50℃	All			±0.05	%/℃

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Voltage Range		DLD-C140	10	28	36	V_{dc}
		Others	4.5	48	60	
Input Under Voltage Lockout						
Turn-On Voltage Threshold		DLD-C140		8.0		V_{dc}
		Others		4.0		
Turn-Off Voltage Threshold		DLD-C140		6.9		V_{dc}
		Others		3.7		
Input Surge Voltage	1 second	DLD-C140			50	V_{dc}
		Others			65	

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Operating Voltage	V_{in}=Nominal Vin, I_o=I_{o_max} Tc=25℃	DLD-C035	2		57	V_{dc}
		DLD-C070	2		57	
		DLD-C100	2		57	
		DLD-C140	8		33	
Output Rated Current	V_{in}=Nominal V_{in}, Full Load Tc=25℃	DLD-C035		350		mA
		DLD-C070		700		
		DLD-C100		1000		
		DLD-C140		1400		
Output Rated Power	V_{in}=Nominal V_{in}, V_o=2-57Vdc Io=I_{o_max}.	DLD-C035			20	W
		DLD-C070			40	
		DLD-C100			57	
	V_{in}=Nominal V_{in}, V_o=8-33Vdc Io=I_{o_max}.	DLD-C140			46.2	
Output Constant Current Accuracy	3V<V_{in}-V_{out}<30V_{dc} to keep current accuracy	All			±5	%
Current Load Regulation	measured from high line to low operating voltage	All			±5	%
Current Line Regulation	measured from high line to low line	All			±5	%
Output Voltage Ripple and Noise						
Peak-to-Peak	36V_{dc} V_o=XXV_{dc}, 20MHz bandwidth 0.1uF ceramic with 100% output current	DLD-C035			300	mV
		DLD-C070 DLD-C100			500	
	24V_{dc} V_o=XXV_{dc}, 20MHz bandwidth 0.1uF ceramic with 100% output current	DLD-C140			500	

Start-Up Time	Vin=Nominal, Full Load	All			60	ms

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load		All		96		%

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency		DLD-C140	50	500		KHz
		Others		300		
Operating Humidity		All	10		95	%
Operating Altitude		All			3000	m
Vibration	2G 60min./1cycle, period for 3hours, 3 axes	All	0		500	Hz
Shock	half sine, 6 axes	All			30	g
MTBF	Ambient temperature is 25℃ per MIL-HDBK-217F	All		TBD		M hours
Weight		All		18		grams

PWM Dimming SPECIFICATIONS (Leave Open if not Use)

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage Range	TTL logic compatibility	All		5		V_{dc}
Threshold Voltage		All				
Module On		All		1.75		V_{dc}
Module Off		All		0.5		V_{dc}
Switching Frequency		All			1	KHz
Output Current Range		All	10		100	%
Minimum On Time		All		100		ns

Analogue Dimming SPECIFICATIONS (Leave Open if not Use)

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Control Voltage Range		DLD-C140	1		5	V_{dc}
		Others	1.25		5	V_{dc}
Analogue Pin Drive Current		All			0.4	mA

6. Main Features and Functions

6.1 Operating Temperature Range

The highly efficient design of MLD series module has resulted in their ability to operate within ambient temperature environments from -40℃ to 71℃. The derating curve was drawn from the MLD module.

The highly efficient design of ALD and DLD series module has resulted in their ability to operate within ambient temperature environments from -40℃ to 85℃. The derating curve was drawn from the ALD and DLD module.

6.2 Short Protection

The MLD, ALD and DLD Series provide fully continuous short-circuit protection. The unit will auto recover until the short circuit is removed.

7. Safety and Emissions

- CE
- EMI EN55015 Class B
- EMS EN61547, EN61000-4-2, 3, 4, 6, 8

8. Applications

8.1 Power De-Rating Curves

The operating temperature range of MLD series is -40℃ to 71℃. When operating the MLD series, proper derating is needed. The maximum ambient temperature under any operating condition should not exceed 71℃.The following chart is the derating curve of MLD series.

The operating temperature range of ALD and DLD series is -40℃ to 85℃. When operating the MLD series, proper derating is needed. The maximum ambient temperature under any operating condition should not exceed 85℃.The following chart is the derating curve of ALD and DLD series.

■ MLD Series Power De-Rating Curves

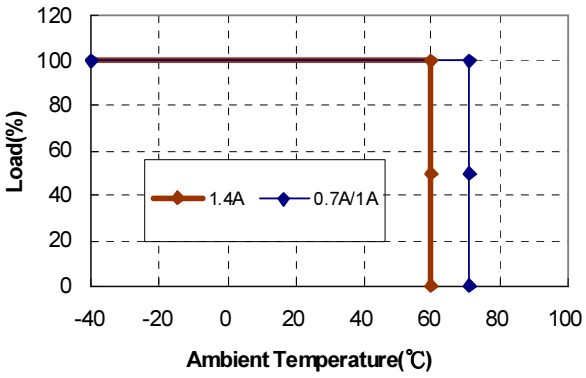


Figure 1. Typical Output power of MLD

■ ALD Series Power De-Rating Curves

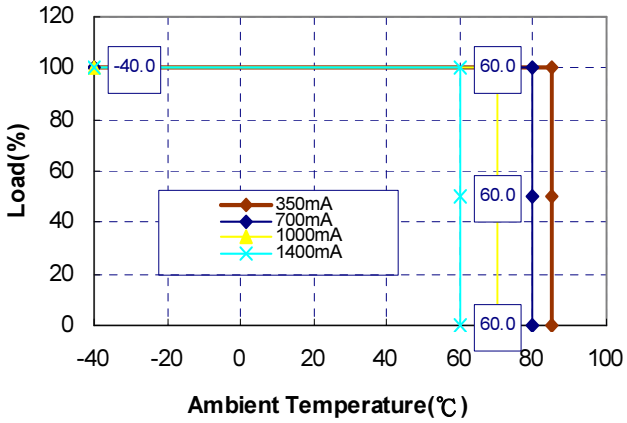


Figure 2. Typical Output power of ALD

■ DLD Series Power De-Rating Curves

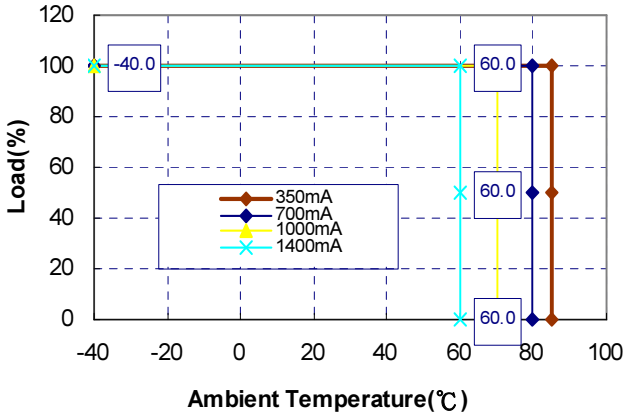


Figure 3. Typical Output power of DLD

8.2 Test Set-Up

The basic test set-up to measure parameters such as efficiency, line regulation and load regulation is shown in Figure 4

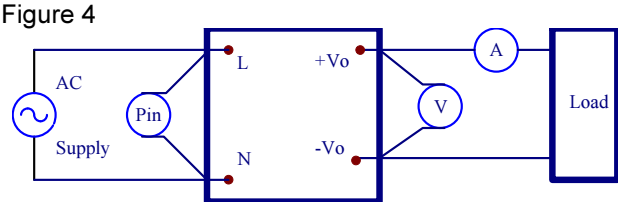


Figure 4. MLD, ALD and DLD Series Test Setup

- Efficiency
- Load regulation and line regulation

The value of efficiency is defined as:

$$\eta = \frac{Vo \times Io}{Pin} \times 100\%$$

Where: Vo is output voltage,
Io is output current,
Pin is input power,

The value of load regulation is defined as:

$$Load.reg = \frac{I_{high} - I_{low}}{I_{low}} \times 100\%$$

Where: I_{high} is the high output current of nominal input voltage

I_{low} is the low output current of nominal voltage

The value of line regulation is defined as:

$$Line.reg = \frac{I_{HL} - I_{LL}}{I_{LL}} \times 100\%$$

Where: I_{HL} is the output current of maximum input voltage at full load.

I_{LL} is the output current of minimum input voltage at full load.

8.3 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure 4. Measured method: 20MHz band width 0.1uF ceramic with 100% output current for MLD, ALD and DLD Series

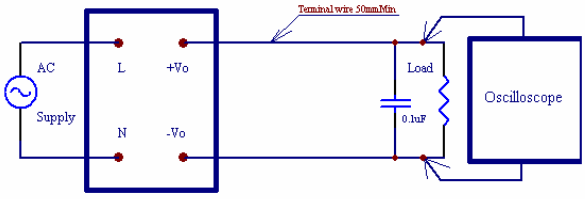


Figure 5. Output Voltage Ripple and Noise Measurement Set-Up

8.4 Dimming Control Output Installation Drawing

■ MLD Series

Example Circuit Connection of MLD4 module for driving 4 LED Luminaries

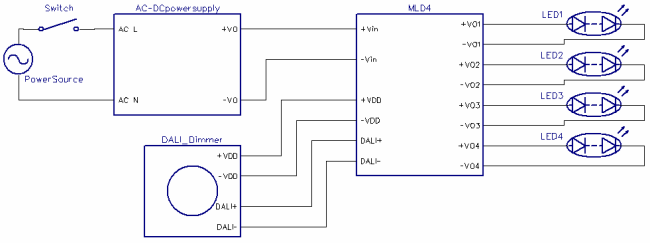


Figure 6 Installation Drawing

■ ALD Series

DALL Lighting Application

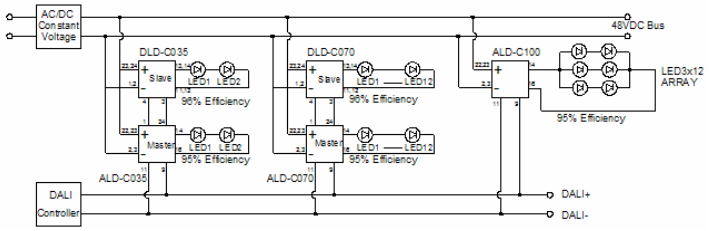


Figure 7 Installation Drawing

■ DLD Series

Lighting Application

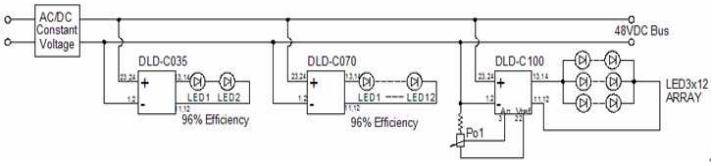


Figure 8 Installation Drawing

Lighting Wall Application

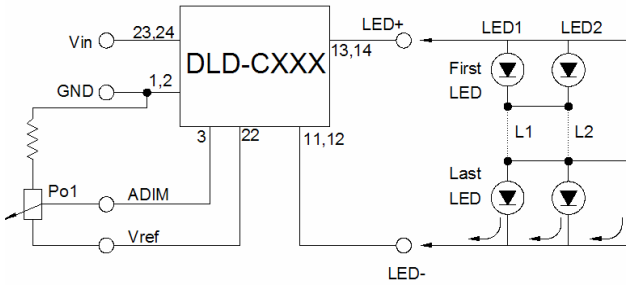


Figure 9 Installation Drawing

Dimming Controlled by Analog Voltage

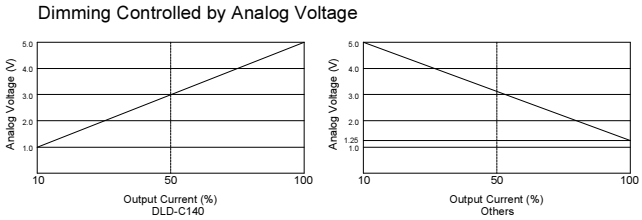
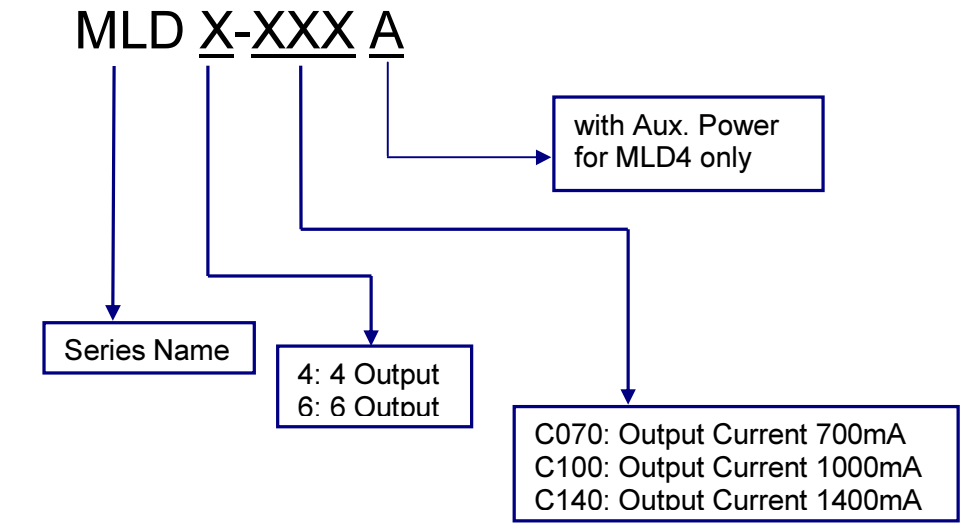
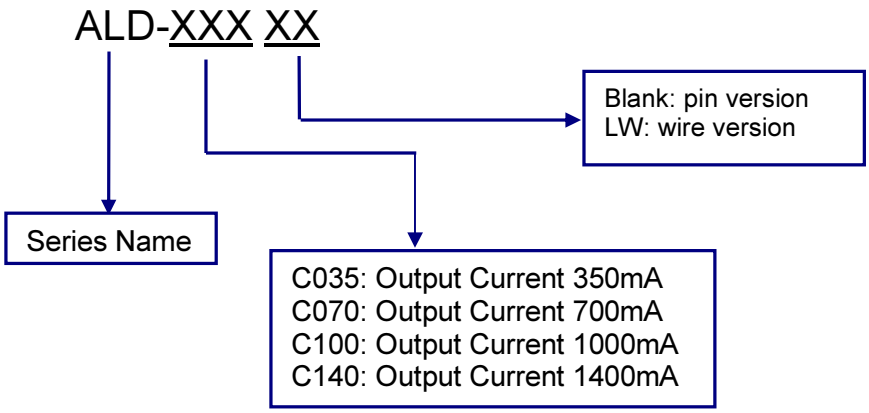
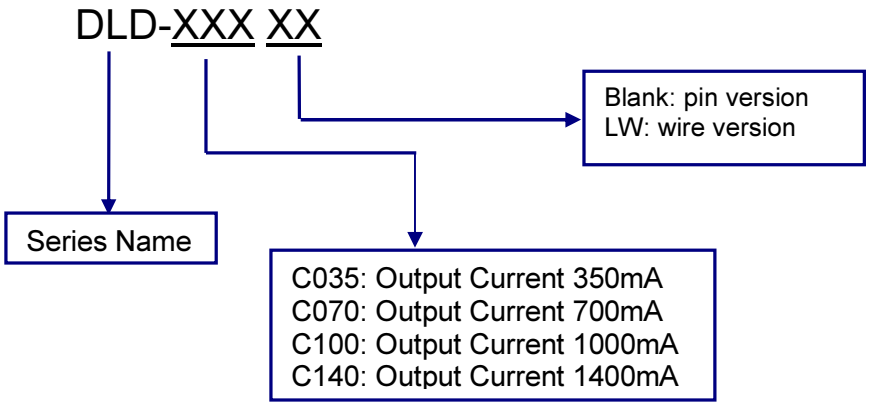


Figure 10 Installation Drawing

9. Part Number



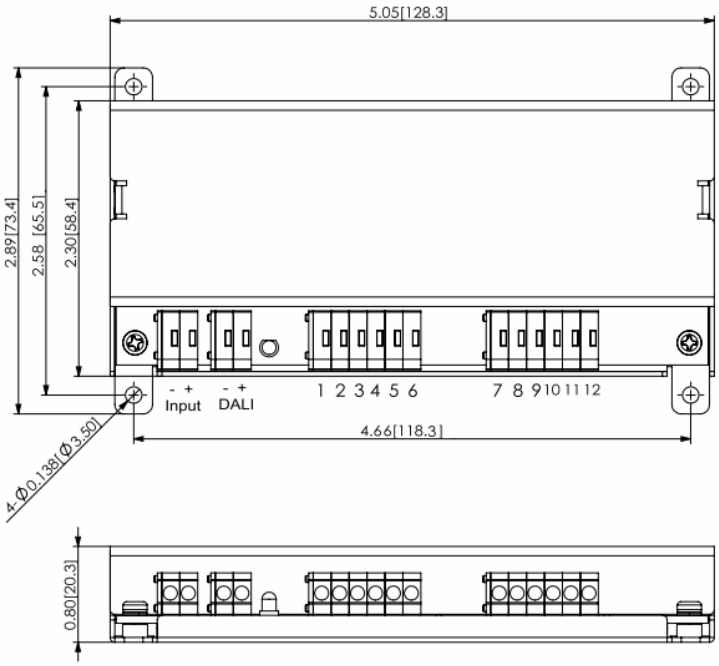




10. Mechanical Outline Diagrams

10.1 MLD Mechanical Outline Diagrams

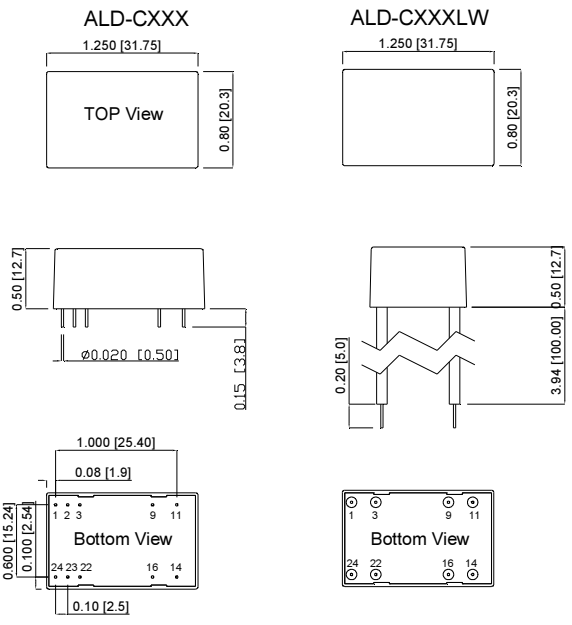
All Dimensions are in inches[mm]
Tolerances : Inches : x.xx=±0.02,x.xxx=±0.010
Millimeters : x.x=±0.5,x.xx=±0.25



PIN CONNECTION			
Pin	MLD4-CXXX	MLD4-CXXXA	MLD6-CXXX
1	V_{1}-	V_{1}-	V_{1}-
2	V_{1}+	V_{1}+	V_{1}+
3	V_{2}-	V_{2}-	V_{2}-
4	V_{2}+	V_{2}+	V_{2}+
5	NC	NC	V_{3}-
6	NC	NC	V_{3}+
7	NC	AUX.-	V_{4}-
8	NC	AUX.+	V_{4}+
9	V_{3}-	V_{3}-	V_{5}-
10	V_{3}+	V_{3}+	V_{5}+
11	V_{4}-	V_{4}-	V_{6}-
12	V_{4}+	V_{4}+	V_{6}+

10.2 ALD Mechanical Outline Diagrams

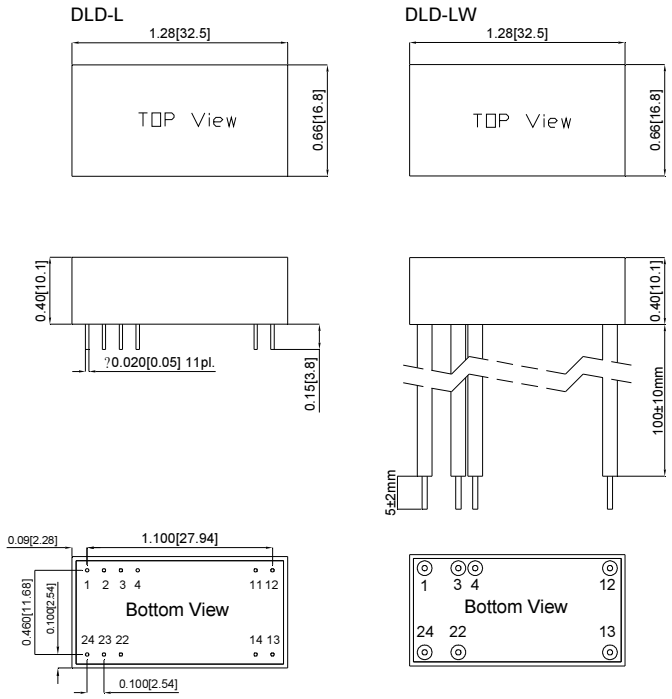
All Dimensions in Inches[mm]
Tolerance Inches:x.xx=±0.02 ,x.xxx=±0.010
Millimeters: x.x=±0.5 , x.xx=±0.25



ALD CONNECTION		
ALD-CXXX	ALD-CXXXLW	Function
1	1 (Green)	PWM/ON/OFF
2&3	3 (Black)	-V Input
9	9 (Brown)	DA
11	11 (Brown)	DA
14	14 (Yellow)	+V Output
16	16 (Blue)	-V Output
22&23	22 (Red)	+V Input
24	24 (White)	Analogue Dimming

10.3 DLD Mechanical Outline Diagrams

NOTE:Pin Size is 0.020"Inch (0.5mm) DIA ±0.05
All Dimensions In Inches(mm)
Tolerance Inches:x.xx=±0.02, x.xxx=±0.010
Millimeters:x.x=±0.5, x.xx=±0.25



DLD Connections		
DLD-CXXX	DLD-CXXXLW	Function
1&2	1(Black)	-V Input
3	3(White)	Analogue DIMming
4	4(Green)	PWM/ON/OFF
11&12	12(Blue)	-V Output
13&14	13(Yellow)	+V Output
22	22(Brown)	Vref/NP
23&24	24(Red)	+V Input

NP: No Pin for DLD-C140

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