ISOLATED DC-DC CONVERTER ECLB40W-110 SERIES APPLICATION NOTE

Approved By:

Department	Approved By	Checked By	Written By
Research and Development Department	Enoch	Astray/James Jacky	Joyce
Quality Assurance Department	Ryan	Benny	

Content

ECLB40W-110 33-40W Isolated DC-DC Converters

Application Note V13 November 2018

1. Introduction

The ECLB40W series offer 40 watts of output power in a 2.05x1.20x0.4 inches copper packages. The ECLB40W series has a 4:1 wide input voltage range of 43-160 VDC, and provides a precisely regulated output. This series has features such as high efficiency, 3000VDC of isolation and allows an ambient operating temperature range of –40°C to 85°C (de-rating above 45 °C). The modules are fully protected against input UVLO (under voltage lock out), output over-current, over-voltage and over-temperature and short circuit conditions. Furthermore, the standard control functions include remote on/off and adjustable output voltage. All models are very suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. DC-DC Converter Features

- 40W Isolated Output
- Efficiency to 91%
- 2.05”X1.2X0.4” Six-Sided Shield Metal Case
- 4:1 Input Range
- Regulated Outputs
- Fixed Switching Frequency
- Input Under Voltage Protection
- Over Current Protection
- Remote On/Off
- Low No Load Power Consumption
- Continuous Short Circuit Protection
- No Tantalum Capacitor Inside
- UL60950-1 2nd (Basic Insulation) Approval
- Meets EN50155 with External Circuits
- Fire & Smoke Meets EN45545-2
- 3000m Operating Altitude

3. Electrical Block Diagram

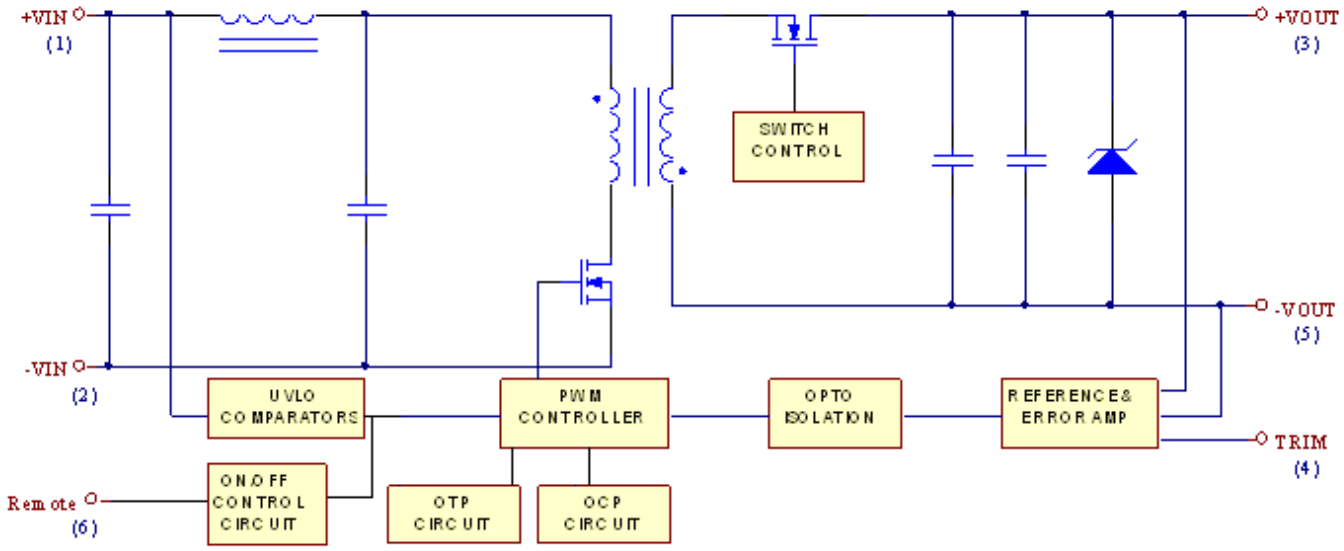


Figure 1 Electrical Block Diagram for Single Output Modules

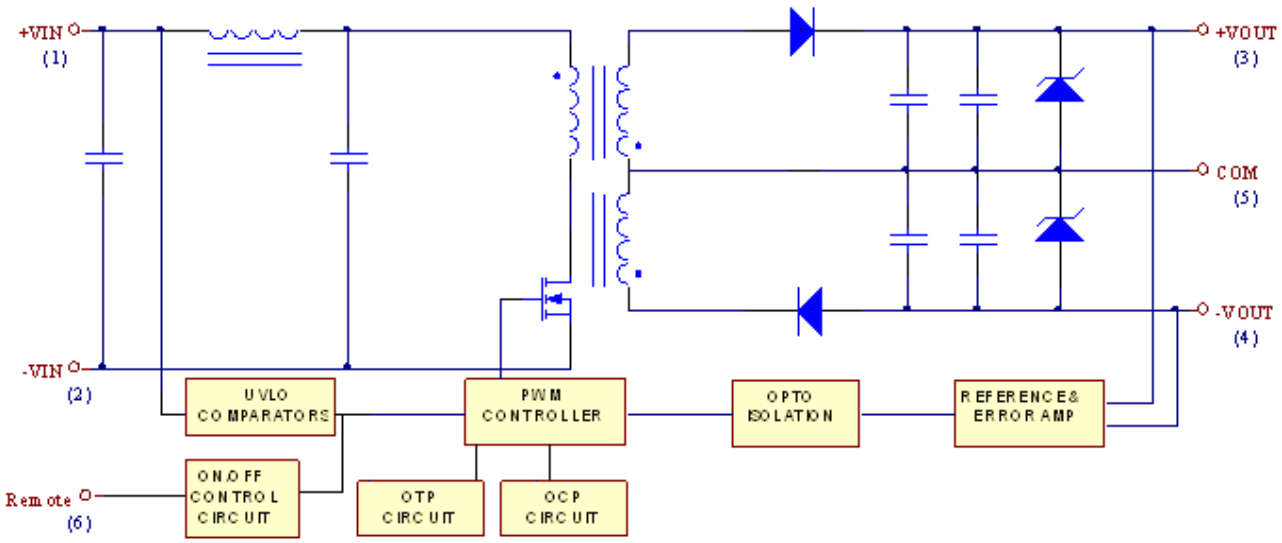


Figure 2 Electrical Block Diagram for Dual Output Modules

4. Technical Specifications

(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						
Continuous		All	-0.3		160	Vdc
Transient	100ms	All			200	Vdc
Operating Ambient Temperature	Derating, above 60℃	All	-40		+85	℃
Case Temperature		All			105	℃
Storage Temperature		All	-55		+125	℃
Input/Output Isolation Voltage	1 minute	All	3000			Vdc

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Input Voltage		All	43	110	160	Vdc
Input Under Voltage Lockout						
Turn-On Voltage Threshold		All	38.5	40V	41.5	V_{dc}
Turn-Off Voltage Threshold		All	36.5	38V	39.5	V_{dc}
Lockout Hysteresis Voltage		All		2		V_{dc}
Maximum Input Current	100% Load, Vin=43V	All		1100		mA
No-Load Input Current	Vin=110V	All		6		mA
Inrush Current (I^2t)	As per ETS300 132-2	All			0.1	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All			30	mA

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Vin=nominal input, Io= $Io_{max.}$	Vo=3.3V Vo=5.0V Vo=12V Vo=15V Vo=±12V Vo=±15V Vo=±24V	3.2505 4.925 11.82 14.775 ±11.82 ±14.775 ±23.64	3.3 5 12 15 ±12 ±15 24	3.3495 5.075 12.18 15.225 ±12.18 ±15.225 ±24.36	Vdc
Output Voltage Balance	Vin=nominal input, Io=$Io_{max.}$	Dual			±1.0	%
Output Voltage Regulation						
Load Regulation	Io=full load to min. Load	Single Dual			±0.5 ±1.0	%
Line Regulation	Vin=high line to low line, full Load	All			±0.2 ±0.2	%
Cross Regulation	Load cross variation 10%/100%	Dual			±5	%
Temperature Coefficient	Tc=-40℃ to 85℃	All			±0.02	%/℃
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, Measured with 1uF MLCC	Vo=3.3V Vo=5.0V			100	mV
		Vo=12V Vo=15V Vo=±12V Vo=±15V			150	
		Vo=±24V			200	

OUTPUT CHARACTERISTIC

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Output Current Range		Vo=3.3V	0		10000	mA
		Vo=5.0V	0		8000	
		Vo=12V	0		3333	
		Vo=15V	0		2666	
		Vo=±12V	0		±1667	
		Vo=±15V	0		±1333	
		Vo=±24V	0		±833	
Output DC Current-Limit Inception	Vo=90% $V_{O, nominal}$	All	110	135	165	%
Maximum Output Capacitance	Full load (resistive)	Vo=3.3V	0		10000	uF
		Vo=5.0V	0		8000	
		Vo=12V	0		3300	
		Vo=15V	0		2700	
		Vo=±12V	0		1650	
		Vo=±15V	0		1350	
		Vo=±24V	0		850	

DYNAMIC CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	75% to 100% of Io.max. di/dt=0.1A/us	All			±5	%
Setting Time (within 1% Vo nominal)		All			250	us
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off Control	Von/off to 10%Vo, set	All		7		ms
Turn-On Delay Time, From Input	Vin, min. to 10%Vo, set	All		7		ms
Output Voltage Rise Time	10%Vo, set to 90%Vo, set	Single		8		ms
		Dual		18		

EFFICIENCY

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	Vin=Nominal Vin, Tc=25°C	Vo=3.3V		88%		%
		Vo=5.0V		88.5%		
		Vo=12V		90%		
		Vo=15V		91%		
		Vo=±12V		88%		
		Vo=±15V		88.5%		
		Vo=±24V		89%		

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input to Output	1 minutes	All			3000	Vdc
Isolation Resistance		All	1000			MΩ
Isolation Capacitance	Input/Output	All		1500		pF
	Output/Case			1000		

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency		All		250		KHz
On/Off Control, Positive Remote On/Off logic						
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	All	0		1.2	V
Logic High (Module On)	Von/off at Ion/off=0.1uA	All	3.5 or Open Circuit		75	V
On/Off Control, Negative Remote On/Off logic						
Logic Low (Module Off)	Von/off at Ion/off=1.0mA	All	3.5 or Open Circuit		75	V
Logic High (Module On)	Von/off at Ion/off=0.1uA	All	0		1.2	V
ON/OFF Current (for both remote on/off logic)	Ion/off at Von/off=0.0V	All		0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic high, Von/off=15V	All			30	uA
Off Converter Input Current	Shutdown input idle current	All		4	10	mA
Output Voltage Trim Range	Pout=maximum rated power	All	-10		+10	%
Output Over Voltage Protection	Zener or TVS clamp	Vo=3.3V Vo=5.0V Vo=12V Vo=15V Vo=±12V Vo=±15V Vo=±24V		3.9 6.2 15 18 ±15 ±18 ±30		Vdc
Over-Temperature Shutdown		All		110		°C

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
MTBF	Io=100%of Io.max.; Ta=25℃ per MIL-HDBK-217F	All		905		K hours
Weight		All		36		grams
Case Material	Aluminum					
Base plate Material	PCB FR4					
Potting Material	UL 94V-0					
Pin Material	Base: Copper Plating: Nickel with Matte Tin					
Shock/Vibration	MIL-STD-810F / EN61373					
Humidity	95% RH max. Non Condensing					
Altitude	3000m Operating Altitude, 12000m Transport Altitude					
Thermal Shock	MIL-STD-810F					
EMI	Meets EN55011, EN55022 & EN50155 with external input filter, see 7.2 EN55032					Class A
ESD	EN61000-4-2 Level 3: Air ±8kV, Contact ±6kV					Perf. Criteria A
Radiated immunity	EN61000-4-3 Level 3: 80~1000MHz, 20V/m					Perf. Criteria A
Fast Transient	EN61000-4-4 Level 3: On power input port, ±2kV, external input capacitor required, see 7.1					Perf. Criteria A
Surge	EN61000-4-5 Level 3: Line to line, ±1kV					Perf. Criteria A
Conducted immunity	EN61000-4-6 Level 3: 0.15~80MHz, 10V					Perf. Criteria A

5. Main Features and Functions

5.1 Operating Temperature Range

The ECLB40W series converters can be operated by a wide ambient temperature range from -40℃ to 85℃ (de-rating above 60℃). The standard model has a copper case and case temperature can not over 105℃ at normal operating.

5.2 Remote On/Off

The remote on/off input feature of the converter allows external circuitry to turn the converter on or off. Active-high remote on/off is available as standard. The converter is turned on if the remote on/off pin is high (>3.5Vdc to 75Vdc or open circuit). Setting the pin low (0 to <1.2Vdc) will turn the converter “Off”. The signal level of the remote on/off input is defined with respect to “-Vin”. If not using the remote on/off pin, leave the pin open (module will be on).

5.3 UVLO (Under Voltage Lock Out)

Input under voltage lockout is standard on the ECLB40W unit. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.

5.4 Over Current Protection

All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into hiccup mode protection.

5.5 Over Voltage Protection

The over-voltage protection consists of a zener diode to limiting the out voltage.

5.6 Over-Temperature Protection (OTP)

The ECLB40W series converters are equipped with non-latching over-temperature protection. If the temperature exceeds a threshold of 110℃ (typical) the converter will shut down, disabling the output. When the temperature has decreased the converter will automatically restart. The over-temperature condition can be induced by a variety of reasons such as external overload condition or a system fan failure.

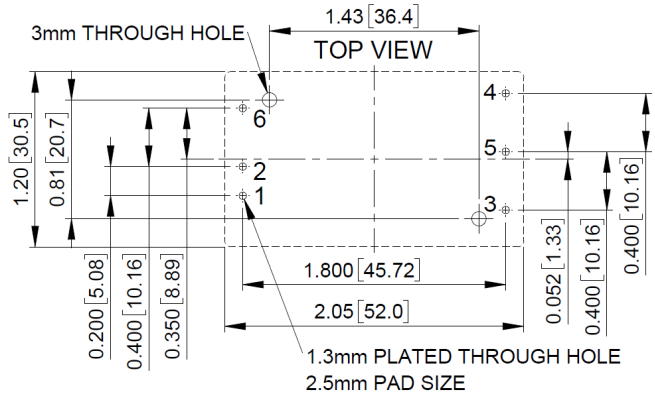
5.7 Output Voltage Adjustment

Section 6.6 describes in detail how to trim the output voltage with respect to its set point. The output voltage on all models is adjustable within the range of +10% to –10%. (Single output models only)

6. Applications

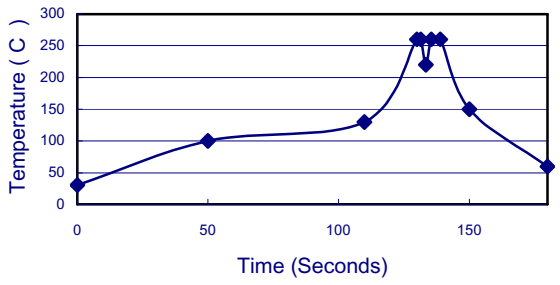
6.1 Recommended Layout PCB Footprints and Soldering Information

The system designer or the end user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown below.



Note: Dimensions are in inches (millimeters)

Lead Free Wave Soldering Profile

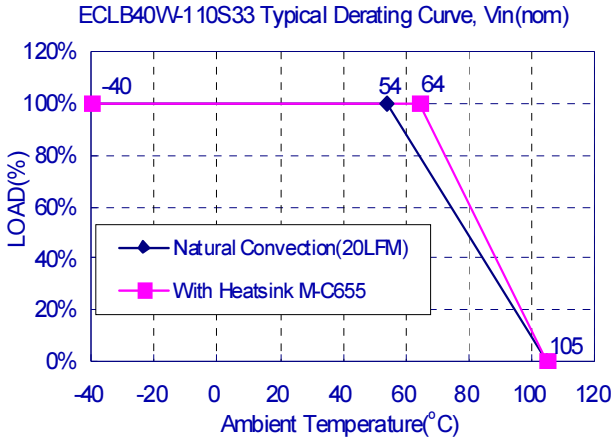


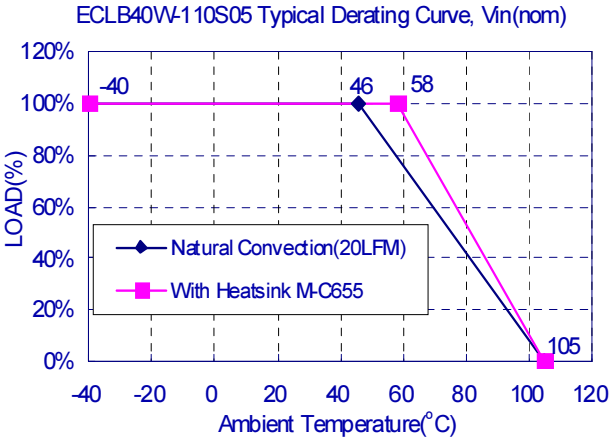
Note：

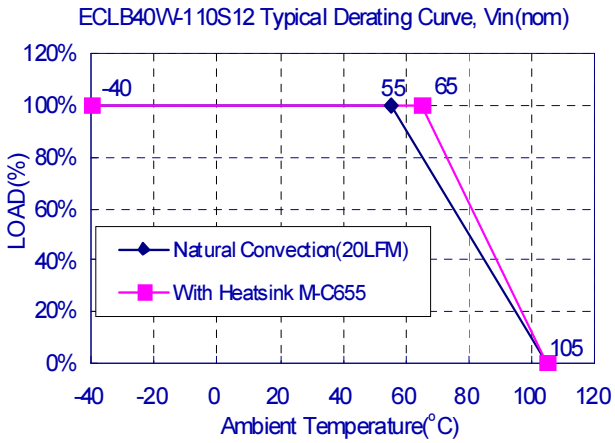
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 ℃/Sec (From 50℃ to 100℃)
3. Soaking temperature: 0.5 ℃/Sec (From 100℃ to 130℃), 60±20 seconds
4. Peak temperature: 260℃, above 250℃ 3~6 Seconds
5. Ramp up rate during cooling: -10.0 ℃/Sec (From 260℃ to 150℃)

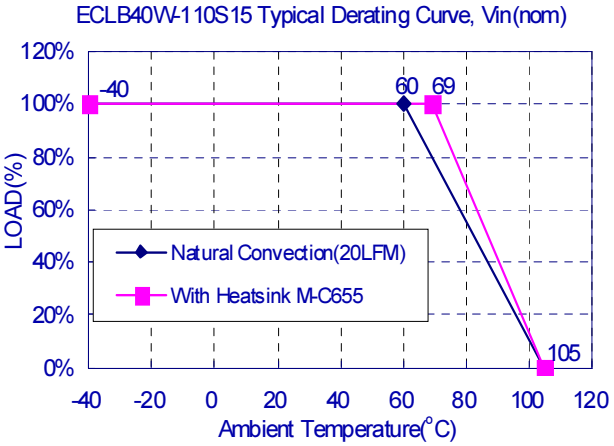
6.2 Power De-Rating Curves for ECLB40W-110 Series

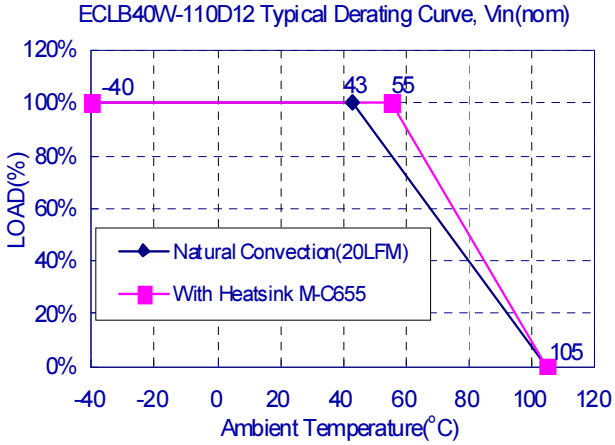
Operating Ambient temperature Range: -40℃ ~ 85℃.
Maximum case temperature under any operating condition should not exceed 105℃.
De-rating measured with nominal line. Mounted test board (86x50x1.6mm, 2Oz)by M2.5 screw

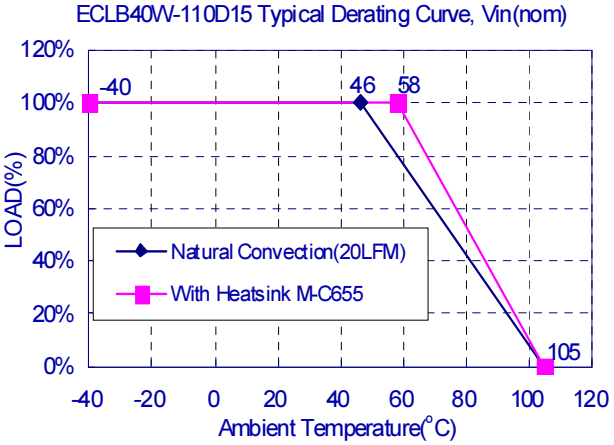


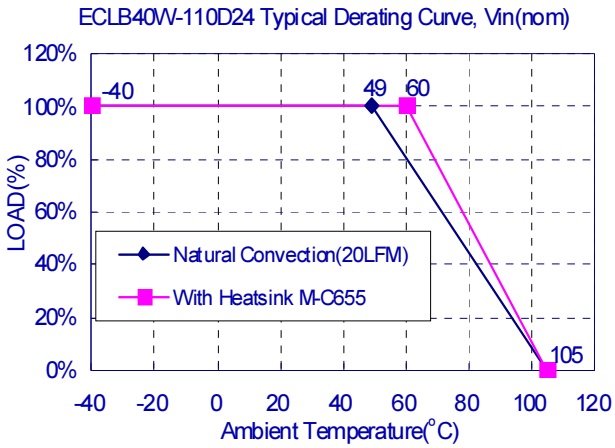












Example (without heatsink):

The ECLB40W-110S12 operating at nominal line voltage, an output current of 3.333A, and a maximum ambient temperature of 45℃.

Solution:

Given: Vin=110V_{dc}, Vo=12V_{dc}, Io=3.333A

Determine Power dissipation (P_d):

$P_d=P_i-P_o=P_o(1-\eta)/\eta$

$P_d=12\times3.333\times(1-0.9)/0.9=4.44$Watts

Determine airflow:

Airflow: Natural Convection

Check above Power de-rating curve:

Given: $P_d=4.44$W and $T_a=45$℃

Verifying: The maximum temperature rise $\triangle T = P_d \times R_{ca}=4.44\times11.25=49.95$℃

The maximum case temperature $T_c=T_a+\triangle T=94.95$℃ <105℃

Where: The R_{ca} is thermal resistance from case to ambience.

The T_a is ambient temperature and the T_c is case temperature

Example (with heatsink M-C655):

The ECLB40W-110D24 with thermal pad SZ 29.5x49.8x0.25mm and heat sink MC-655 operating at nominal line voltage, an output current of 0.833A, and a maximum ambient temperature of 60℃.

Solution:

Given: Vin=4V_{dc}, Vo=5V_{dc}, Io=12A

Determine Power dissipation (P_d):

$P_d=P_i-P_o=P_o(1-\eta)/\eta$

$P_d=48\times0.833\times(1-0.89)/0.89=4.94$Watts

Determine airflow:

Airflow: Natural Convection

Check above Power de-rating curve:

Given: P_d=4.94W and T_a=60℃

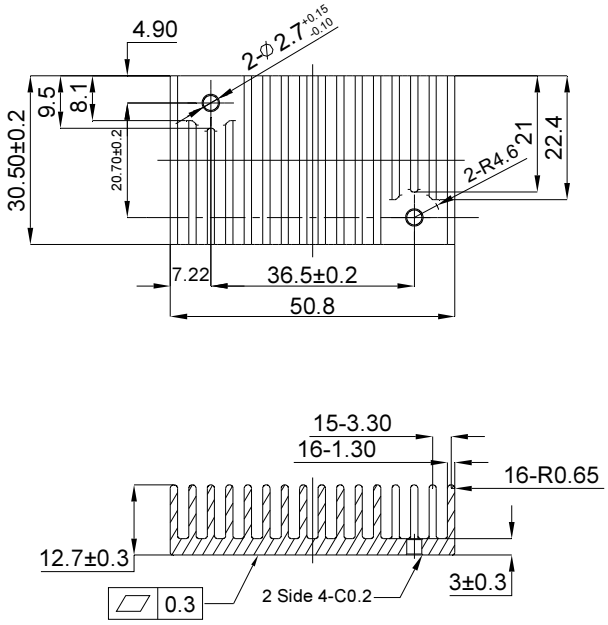
Verifying: The maximum temperature rise $\triangle T = P_d \times R_{ca}=4.94\times8.99=44.41$℃

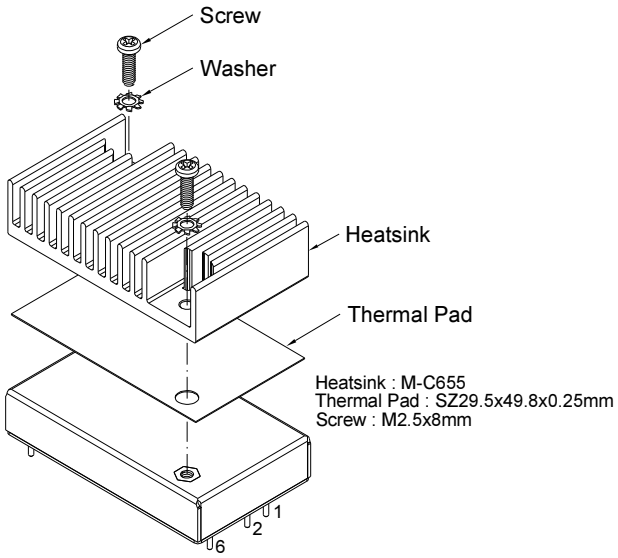
The maximum case temperature $T_c=T_a+\triangle T=104.41$℃ <105℃

Where: The R_{ca} is thermal resistance from case to ambience.

The T_a is ambient temperature and the T_c is case temperature

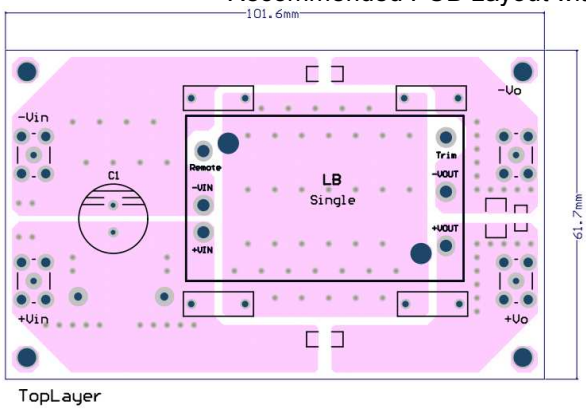
6.3 LB Heat Sinks:



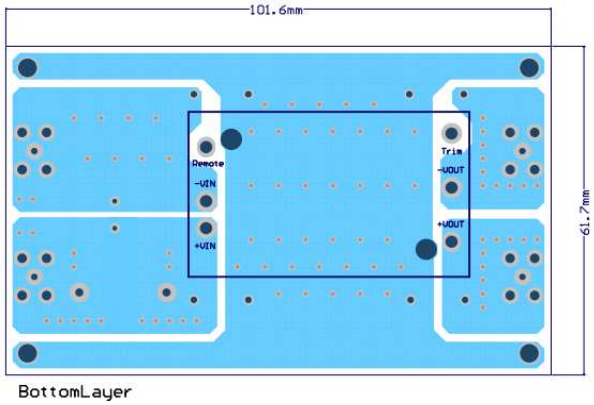


M-C655 (G6620790202)
Transverse Heat Sink
All Dimensions in mm
Thermal Pad: SZ29.5x49.8x0.25mm (G6135041753)
Screw: M2.5x8mm (G75A3300922)
Washer: (G75A5750052)
Rca: 8.99°C/W (typ.), At natural convection
Rca: 8.36°C/W (typ.), At natural convection, mounted 101.6x61.7x1.6mm 2Oz test board.

Recommended PCB Layout with de-rating. (101.6x61.7x1.6mm, 2Oz).)

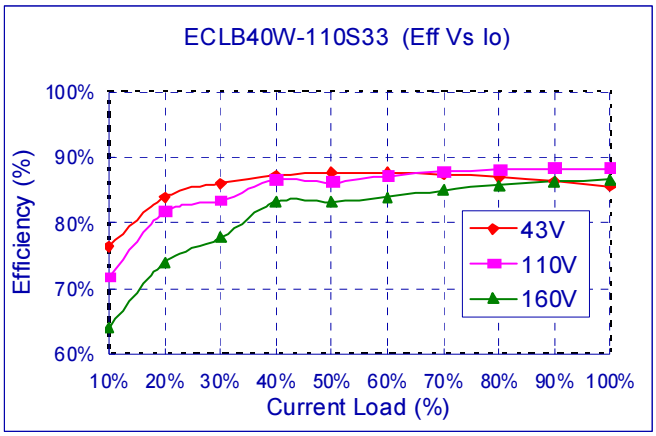


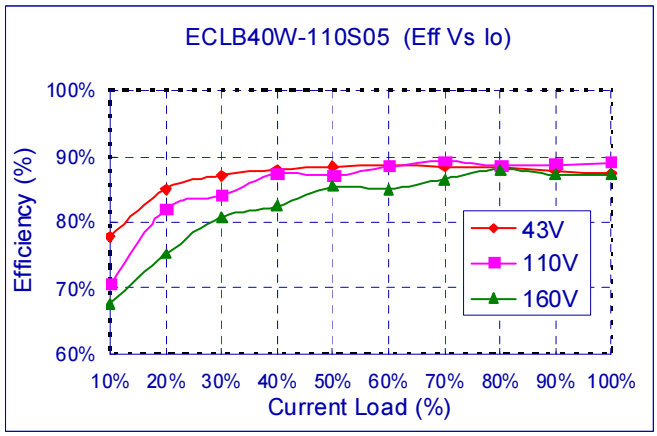
TopLayer

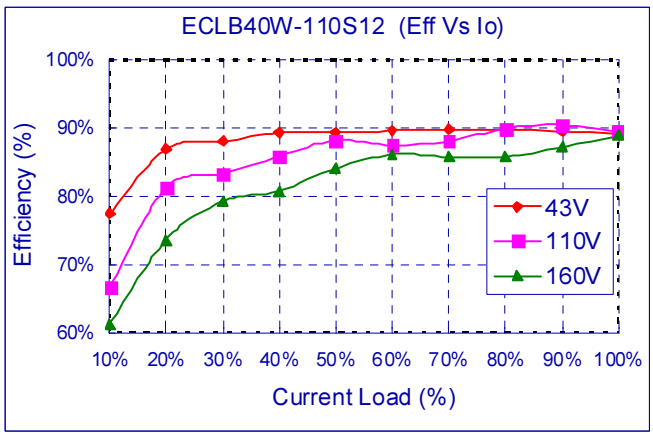


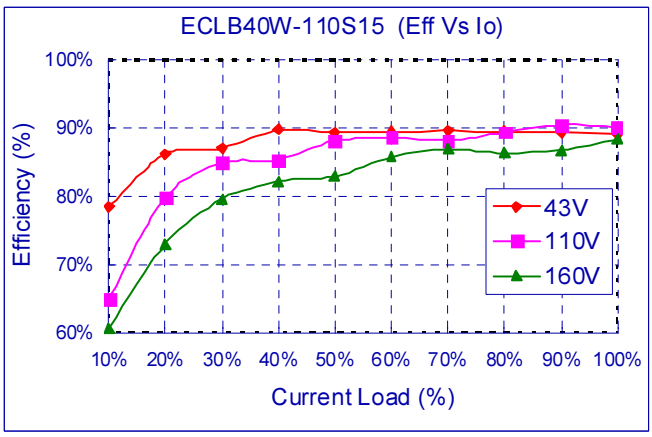
BottomLayer

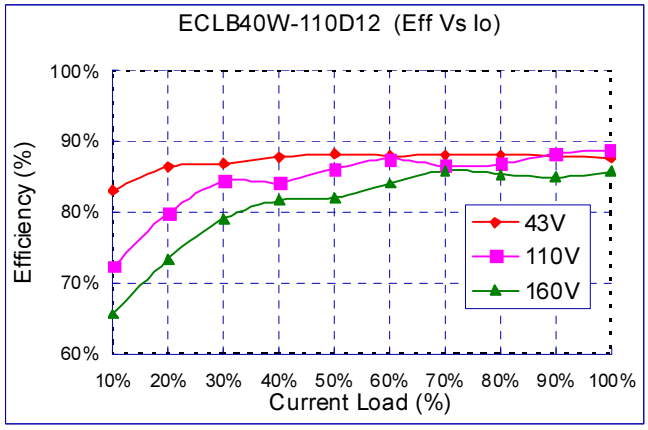
6.4 Efficiency vs. Load Curves

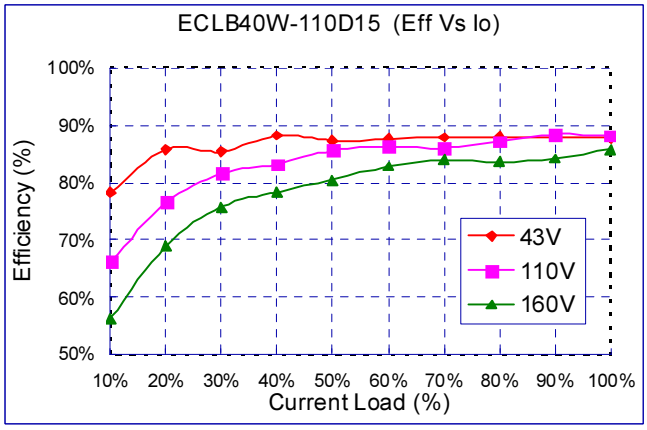


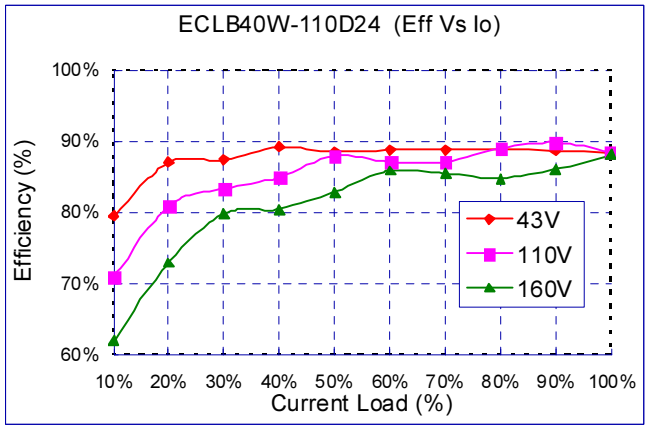








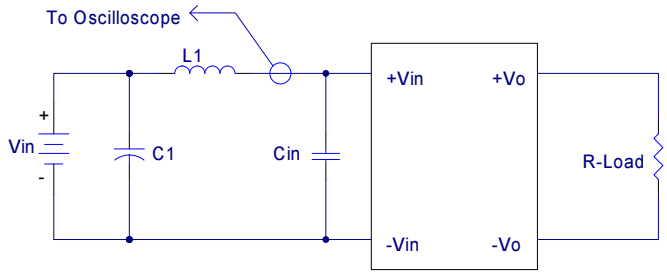




6.5 Input Capacitance at the Power Module

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown in Figure 5 represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated.

source Inductance (L1).



L1: 12uH
C1: None
Cin: 33uF ESR<0.7ohm @100KHz

Figure 5 Input Reflected-Ripple Test Setup

6.6 Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure 6. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test. We can calculate the

- Efficiency
- Load regulation and line regulation.

The value of efficiency is defined as:

$$\eta = \frac{V_O \times I_O}{V_{IN} \times I_{IN}} \times 100\%$$

Where

V_O is output voltage,
I_O is output current,
V_{IN} is input voltage,
I_{IN} is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where

V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load

The value of line regulation is defined as:

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

Where

V_{HL} is the output voltage of maximum input voltage at full load.
V_{LL} is the output voltage of minimum input voltage at full load.

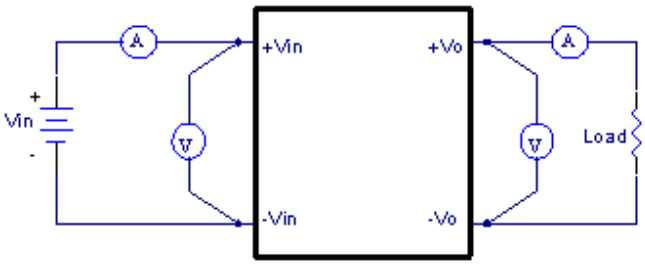


Figure 6 ECLB40W Series Test Setup

6.7 Output Voltage Adjustment

In order to trim the voltage up or down one needs to connect the trim resistor either between the trim pin and -Vo for trim-up and between trim pin and +Vo for trim-down. The output voltage trim range is ±10%. (Single output models only) This is shown in Figure 7 and 8:

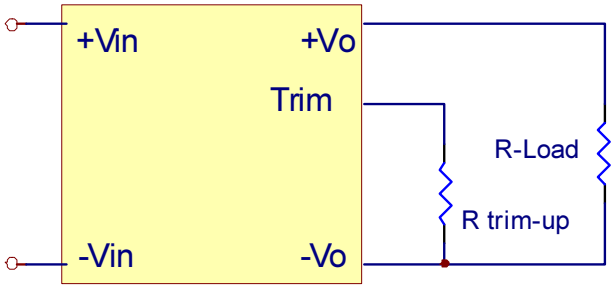


Figure 7 Trim-up Voltage Setup

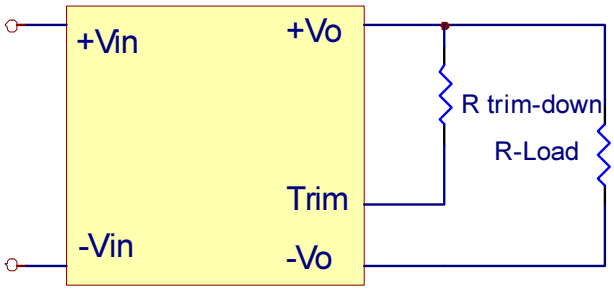


Figure 8 Trim-down Voltage Setup

1. The value of $R_{trim-up}$ defined as:

$$R_{trim-up} = \left(\frac{V_r \times R1 \times (R2 + R3)}{(V_O - V_{o,nom}) \times R2}\right) - Rt \quad (K\Omega)$$

Where

$R_{trim-up}$ is the external resistor in Kohm.
$V_{O, nom}$ is the nominal output voltage.
V_O is the desired output voltage.
R1, Rt, R2, R3 and Vr are internal to the unit and are defined in Table 1.

Table 1 – Trim up and Trim down Resistor Values

Model Number	Output Voltage(V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	Rt (KΩ)	Vr (V)
ECLB40W-110S33	3.3	2.74	1.8	0.27	9.1	1.24
ECLB40W-110S05	5.0	2.32	2.32	0	8.2	2.5
ECLB40W-110S12	12.0	6.8	2.4	2.32	22	2.5
ECLB40W-110S15	15.0	8.06	2.4	3.9	27	2.5

For example, to trim-up the output voltage of 5.0V module (ECLB40W-110S05) by 10% to 5.5V, R trim-up is calculated as follows:

$V_o - V_{o, nom}$ = 5.5 – 5.0 = 0.5V
R1 = 2.32 KΩ
R2 = 2.32 KΩ
R3 = 0 KΩ
Rt = 8.2 KΩ,
Vr= 2.5 V

$$R_{trim-up} = \left(\frac{2.5 \times 2.32 \times (2.32 + 0)}{0.5 \times 2.32}\right) - 8.2 = 3.4(K\Omega)$$

2.The value of $R_{trim-down}$ defined as:

$$R_{trim-down} = R1 \times \left(\frac{Vr \times R1}{(V_{o,nom} - Vo) \times R2} - 1\right) - Rt \quad (K\Omega)$$

Where

$R_{trim-down}$ is the external resistor in Kohm.
$V_{O, nom}$ is the nominal output voltage.
V_O is the desired output voltage.
R1, Rt, R2, R3 and Vr are internal to the unit and are defined in Table 1

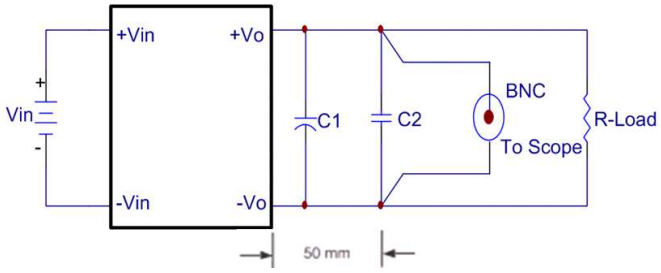
For example, to trim-down the output voltage of 5.0V module (ECLB40W-110S05) by 10% to 4.5V, R trim-down is calculated as follows:

$V_{O,nom}$ – Vo = 5.0 – 4.5 = 0.5V
R1 = 2.32 KΩ
R2 = 2.32 KΩ
R3 = 0 KΩ
Rt = 8.2 KΩ
Vr= 2.5 V

$$R_{trim-down} = 2.32 \times \left(\frac{(2.5 \times 2.32)}{0.5 \times 2.32} - 1\right) - 8.2 = 1.08 \quad (K\Omega)$$

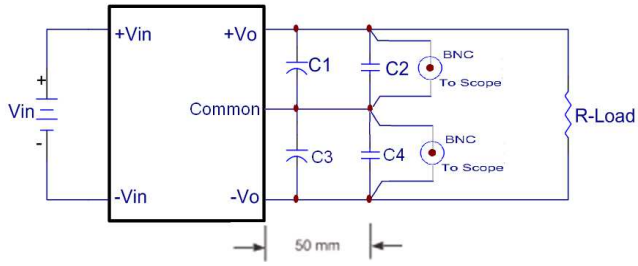
6.8 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure 9. A coaxial cable was used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements are taken with output appropriately loaded and all ripple/noise specifications are from 5Hz to 20MHz bandwidth.



ECLB40W single output module

Note: C1: none
C2: 1uF ceramic capacitor



Note: C1 & C3: None
C2 & C4: 1uF Ceramic capacitor

ECLB40W dual output module

Figure 9 Output Voltage Ripple and Noise Measurement Set-Up

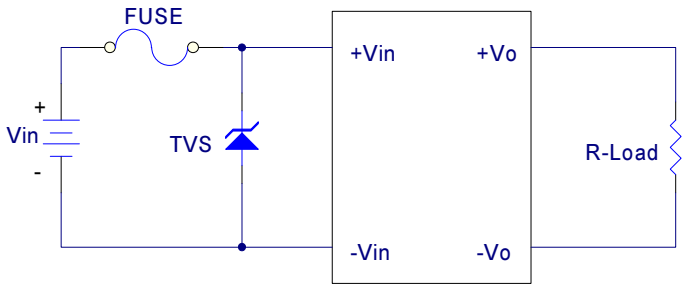
6.9 Output Capacitance

The ECLB40W series converters provide unconditional stability with or without external capacitors. For good transient response low ESR output capacitors should be located close to the point of load. These series converters are designed to work with load capacitance to see technical specifications.

7. Safety & EMC

7.1 Input Fusing and Safety Considerations.

The ECLB40W series converters have not an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. We recommended a time delay fuse 2A. Figure 10 circuit is recommended by a Transient Voltage Suppressor diode across the input terminal to protect the unit against surge or spike voltage and input reverse voltage.



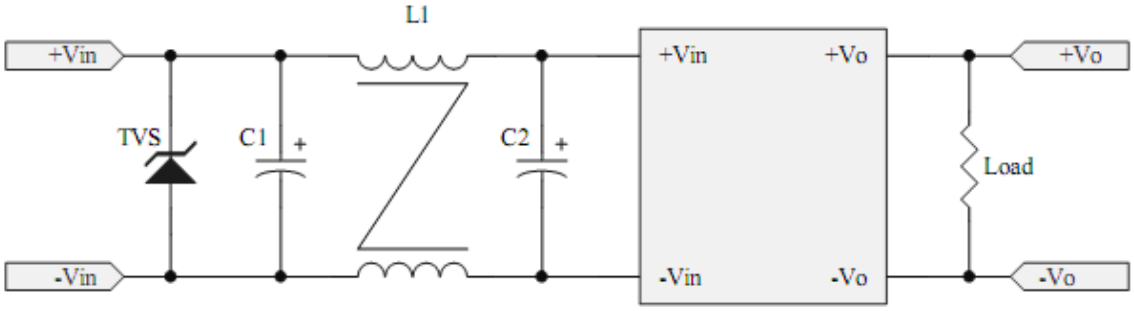
The external input TVS is required if ECLB40W-110 series has to meet EN61000-4-4, EN61000-4-5.

The ECLB40W-110 series recommended a TVS (1.5KE180A Littelfuse) to connect parallel.

Figure 10 Input Protection

7.2 EMC Considerations

(1) EMI Test standard: EN50121-3-2 Conducted, EN55011 Class A Radiated Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load

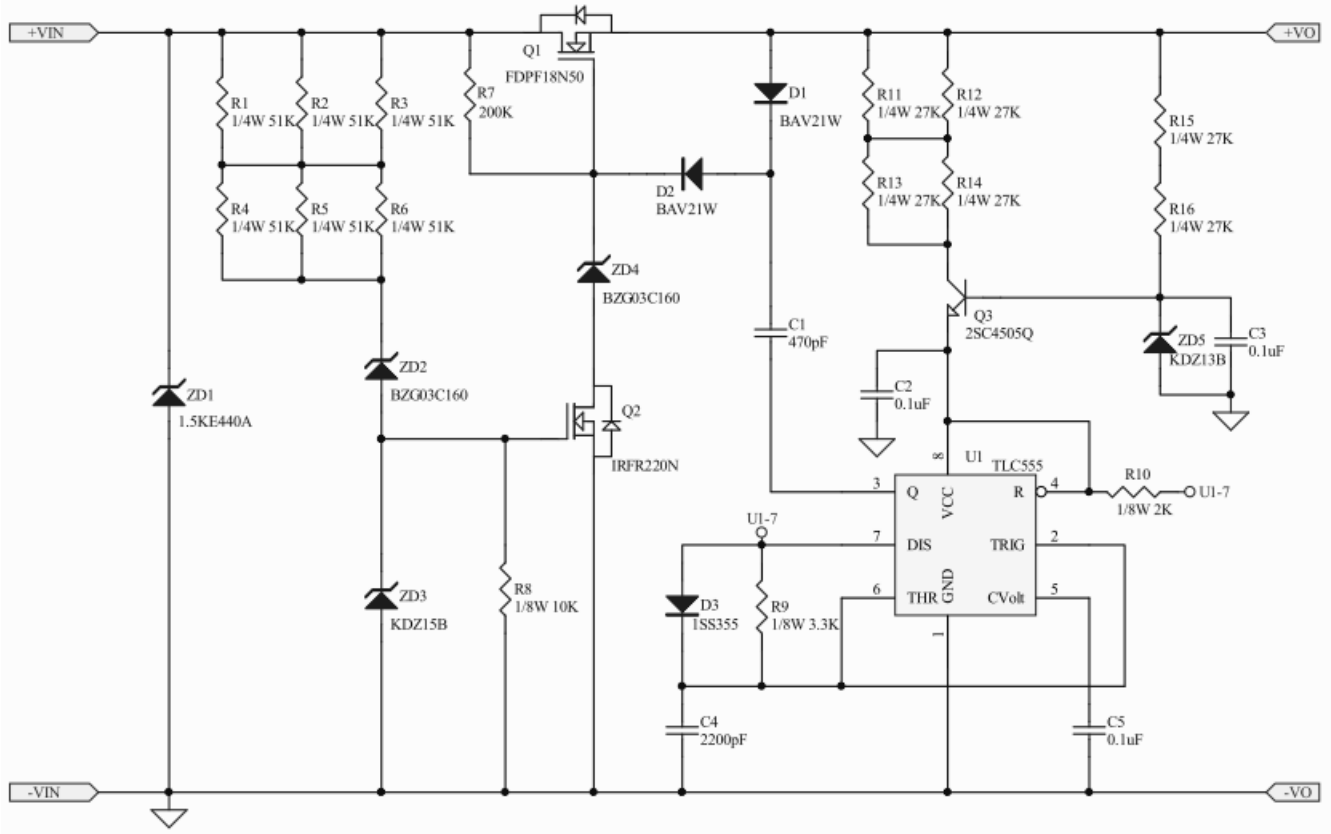


Model No.	C1	C2	L1
ECLB40W-110S33	47uF/200V	47uF/200V	2.8mH
ECLB40W-110S05	47uF/200V	47uF/200V	2.8mH
ECLB40W-110S12	47uF/200V	47uF/200V	2.8mH
ECLB40W-110S15	47uF/200V	47uF/200V	2.8mH
ECLB40W-110D12	47uF/200V	47uF/200V	2.8mH
ECLB40W-110D15	47uF/200V	47uF/200V	2.8mH
ECLB40W-110D24	47uF/200V	47uF/200V	2.8mH

Note: The C1, C2 are aluminum KXJ Series capacitors.

L1: 0.55mm*2/15T (P/N: T60006-L2012-W498, VACUUMSCHMELZE) or equivalent.

7.3 Suggested Configuration for RIA12 Surge Test



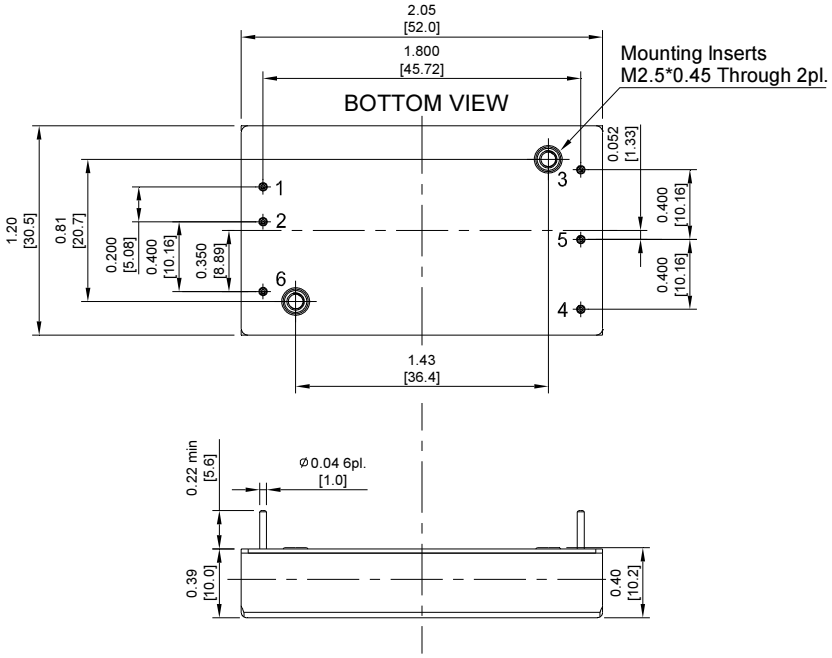
8. Part Number

ECLB40W -110 X XX X

- ECLB40W Series
- 110：Nominal Input Voltage 110VDC
- S：Single Output
  D：Dual Output
- 33：Output Voltage 3.3 VDC
  05：Output Voltage 5 VDC
  12：Output Voltage 12 VDC
  15：Output Voltage 15 VDC
  24：Output Voltage 24 VDC
- None：Positive Logic
  N：Negative Logic

9. Mechanical Specifications

NOTE: Pin Size is 0.04±0.004 Inch (1.0±0.1 mm)DIA
All Dimensions in Inches[mm]
Tolerance Inches:x.xx=±0.02 ,x.xxx=±0.010
Millimeters:x.x=±0.5 , x.xx=±0.25



PIN CONNECTION		
PIN	Single Output	Dual Output
1	+V Input	+V Input
2	-V Input	-V Input
3	+V Output	+V Output
4	Trim	-V Output
5	-V Output	Common
6	Remote On/Off	

CINCON ELECTRONICS CO., LTD.

Headquarter Office:

14F, No.306, Sec.4, Hsin Yi Rd.,
Taipei, Taiwan
Tel: 886-2-27086210
Fax: 886-2-27029852
E-mail: sales@cincon.com.tw
Web Site: http://www.cincon.com

Factory:

No. 8-1, Fu Kong Rd.,
Fu Hsing Industrial Park
Fu Hsing Hsiang,
ChangHua Hsien, Taiwan
Tel: 886-4-7690261
Fax: 886-4-7698031

Cincon American Office:

1655 Mesa Verde Ave, Ste 180,
Ventura, CA 93003
Tel: 805-639-3350
Fax: 805-639-4101
E-mail: info@cincon.com