Technical Specification

DHB75W110 Series

4:1 Input 1/2nd Brick 75Watts Railway DC/DC Converters

FEATURES

- Wide input range: 43-160VDC
- 75W isolated outputs
- Efficiency up to 89%
- Fixed outputs from 5, 12, 15 and 24VDC
- Adjustable Vout (±10%)
- Fixed switching frequency, predicted EMI
- Stable @ no-load operation
- Remote On/Off control
- 3000VAC I/O isolation
- Industry standard 1/2nd brick footprint (2.40" × 2.28" × 0.50")
- Extensive self-protection, UVLO, OVP,OTP,OCP and short circuit protection
- Operating temperature range: -40°C to +100°C
- Fully encapsulated, high reliability
- Flexible extra heat-sink mount type
- Compliance with EN50155 standard

PRODUCT OVERVIEW

The DHB75W110 series use advanced power processing, control and packaging technologies to provide the high performance, flexibility, reliability and cost effectiveness of a mature power converter. Wide range input of 43-160V (110V nominal) that complies with the European EN50155 standard for electronic equipment used on railway rolling stock. Fully encapsulated package technology provides outstanding thermal, vibration & shock performance, is ideal for railway applications where power modules must meet rugged environment requirements.

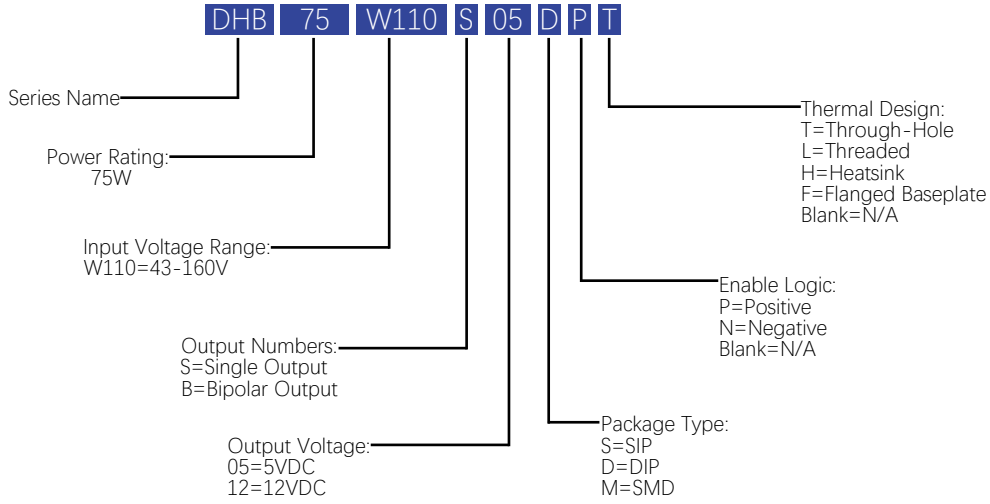
A wealth of self-protection features included input undervoltage lockout, over temperature shutdown, over current protection with "hiccup" auto-restart technique, provides indefinite short-circuit protection, along with output OVP. Threaded or through holes are provided to allow easy mount or the addition of a heat sink for extended temperature operation. The operation temperature is -40°C to 100°C, the module delivers full output power @ 100°C case temperature.

The DHB75W110 series are designed to safety standards IEC/EN 62368 and EN 50155.

Models Selections

Basic Models	Input Voltage [VDC]	Input Voltage Range [VDC]	Output Voltage [VDC]	Output Current [A]	Efficiency typ. [%]	Capacitive Load Max [μF]	Package [inch]
DHB75W110S05	110	43-160	5	15	88	10000	2.40×2.28×0.50
DHB75W110S12	110	43-160	12	6.2	89	5600	
DHB75W110S15	110	43-160	15	5	88	3300	
DHB75W110S24	110	43-160	24	3.1	89	2700	

Model Numbering



Absolute Maximum Ratings

Parameters	Conditions	Min.	Typ.	Max.	Units
Input Voltage Continuous		-0.7		160	VDC
Input Voltage Transient	< 100ms			180	VDC
On/Off Remote Control Voltage	Referred to -Vin	0		75	VDC
On/Off Remote Control Current		0	0.25	1	mA
Operating Baseplate Temperature		-40		100	°C
Operating Environment Temperature		-40		85	°C
Storage Temperature Range		-55		125	°C
Soldering Temperature	Wave Soldering < 10s			260	°C

Safety and EMC Compliance

Conducted Emission	EN50121-3-2	With external filter
Radiated Emission	EN50121-3-2	With external filter
Conducted Susceptibility	IEC/EN61000-4-6	10Vrms Criteria A
Radiated Susceptibility	IEC/EN61000-4-3	10V/m Criteria A
EFT	IEC/EN61000-4-4	±2KV Criteria A (With external filter)
Surge	IEC/EN61000-4-5	±2KV Criteria A (With external filter)
ESD	IEC/EN61000-4-2	±6KV Contact ±8KV Air Criteria A

General Specifications

Parameters	Conditions	Min.	Typ.	Max.	Units
Isolation Voltage	Input to output	3000			VAC
	Input to case	2250			VAC
	Output to case	1500			VAC
Isolation Resistance (Viso=500VDC)	Input to output	100			MΩ
	Input to case	100			MΩ
	Output to case	100			MΩ
Isolation Capacitance	Input to output	1000	2200		pF
Isolation Safety Rating	Basic insulation				
Switching Frequency			300		KHz
Start-up Delay	From start-up threshold recover to 10% Vout		30	60	mS
Rise Time	From 10% Vout to 90% Vout capacitive load		20	50	mS
Remote On/Off Control					
"P" suffix					
Positive Logic, ON state		3.0		75	VDC
Positive Logic, OFF state		0		1.2	VDC
"N" suffix					
Negative Logic, ON state		0		1.2	VDC
Negative Logic, OFF state		3.0		75	VDC
Remote Control Current		0	0.25	1.5	mA
Vibration	IEC61373:1999 Category I, Class B, Body mounted				
Shock	IEC61373:1999 Category I, Class B, Body mounted				

Input Specifications

Parameters	Conditions	Min.	Typ.	Max.	Units
Operating Voltage Range		43	110	160	VDC
Start-up Threshold		39		43	VDC
Under Voltage Shutdown		37		41	VDC
Input Current @ No Load			50	150	mA
Input Current @ Min. Line	Vin=Min.line, Iout=Full load			2	A
Input Current @ Shutdown Mode			15	50	mA
Reflect Ripple Current (Peak-Peak)	Measured at input pin with 10μH inductor and 22μF capacitance		60	100	mA
Recommended Input Fuse				5	A
Recommended External Input Capacitance	1μF CBB and 22μF E-cap used in combination	15	22		μF

Output Specifications					
Parameters	Conditions	Min.	Typ.	Max.	Units
Output Power				75	W
Vout Accuracy	50% Load, Vin nom	-1.5		+1.5	% of V
Adjustable Range ①	Trim up/ Trim down	-10		+10	% of Vout
Line Regulation	Vin=43-160VDC, half load	-0.2		+0.2	%
Load Regulation	Vin=110VDC, load=50%-100% or 100%-50% of full load	-0.5		+0.5	%
Temperature Coefficient		-0.02		+0.02	% of Vout /°C
Total Regulation		-2		+2	%
Thermal Shutdown		100	105	115	°C
Over Voltage Protection ②	Hiccup	115		140	%Vout
Over Current Protection	Hiccup	110		160	%Iout
Short Circuit Protection	Hiccup				
Remote Sense Voltage ③				10	%
Minimum Load	No minimum load requirement				

Output Specifications					
Parameters		Modules			
		S05	S12	S15	S24
Output Voltage Normal(VDC)		5.0	12	15	24
Ripple & Noise Max. (mV pk-pk) ④		100	120	150	240
Dynamic Load Peak Deviation (%Vout) ⑤		±5	±5	±5	±5
Dynamic Load Response (μS) ⑥		200	220	220	100
Capacitive Load (μF)	Min	0	220	100	100
	Max	10000	5600	3300	2700

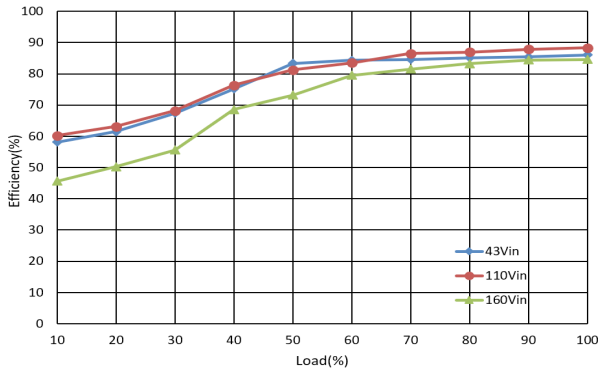
Notes
①②③⑤ For DHB75W110S05 mode, the input voltage range is from 50 to 160VDC, the other output type mode, input voltage range is from 43 to 160VDC.
④ Ripple & noise is tested with certain filter parameters, please see output ripple & noise in technical notes on page 13 for more details.
⑥ Load is set from 75%-100%-75% of Imax, di/dt=0.1A/μS, please refer to dynamic waveforms in performance data on page 8 for details.

All specifications are tested at 25 ℃ ambient temperature, nominal input voltage, rated output current conditions unless otherwise specified.

Performance Data

EFFICIENCY VS LOAD

DHB75W110S05



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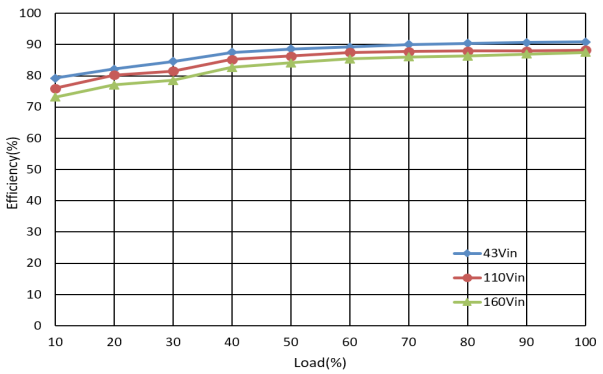

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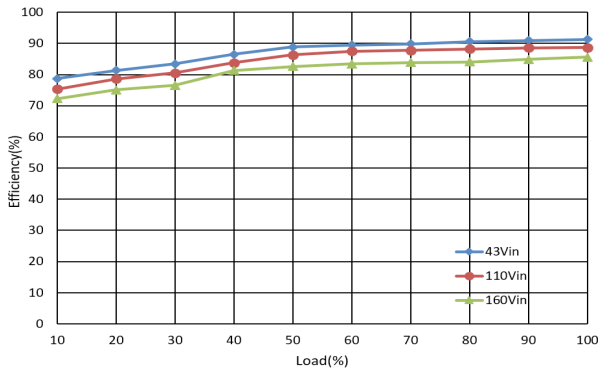

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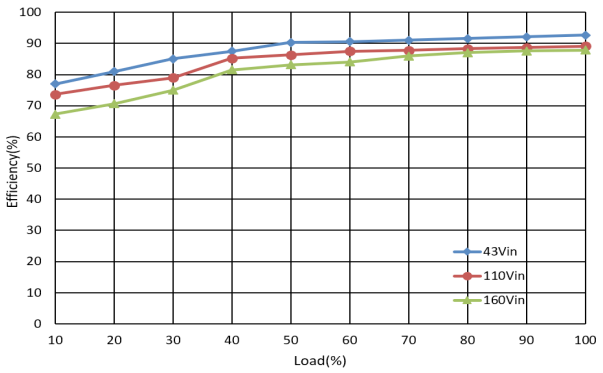
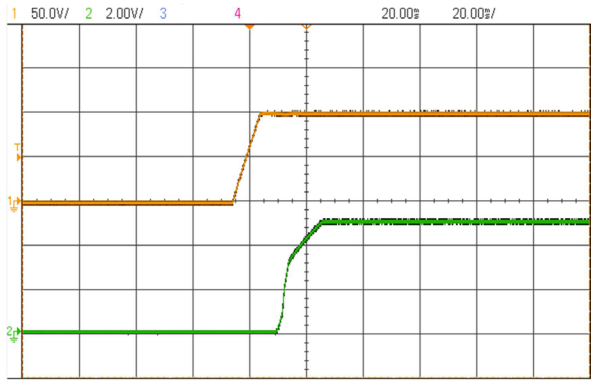


Performance Data

START UP

Ch1: Vin Ch2: Vout

DHB75W110S05



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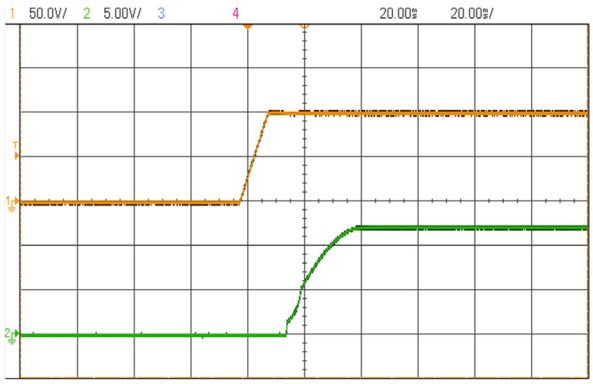

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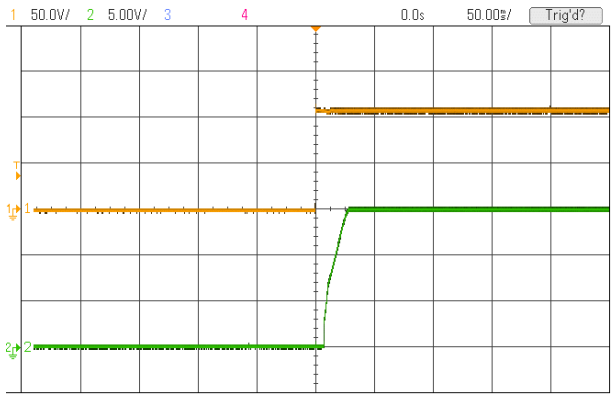

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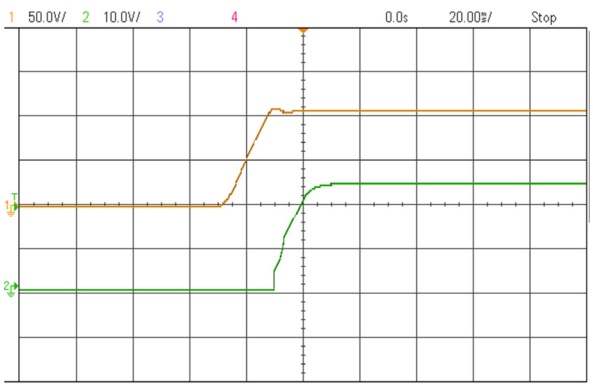
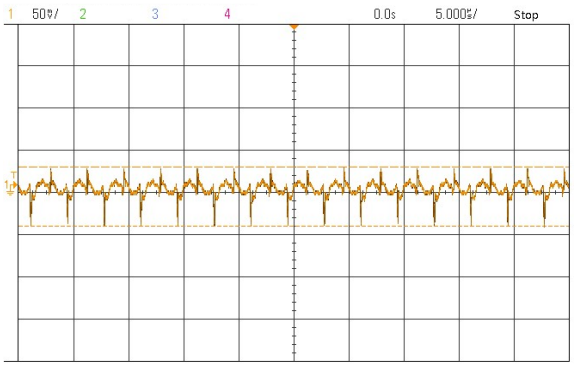


Performance Data

RIPPLE & NOISE 20MHz Bandwidth

DHB75W110S05



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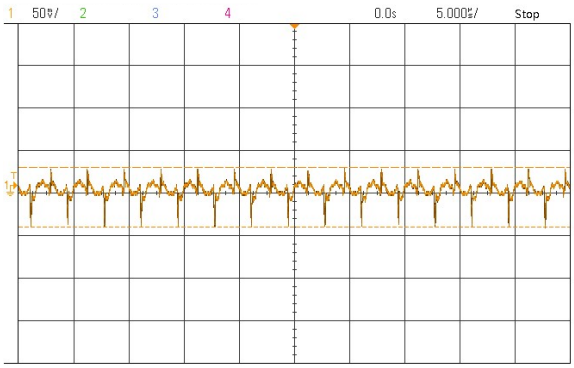

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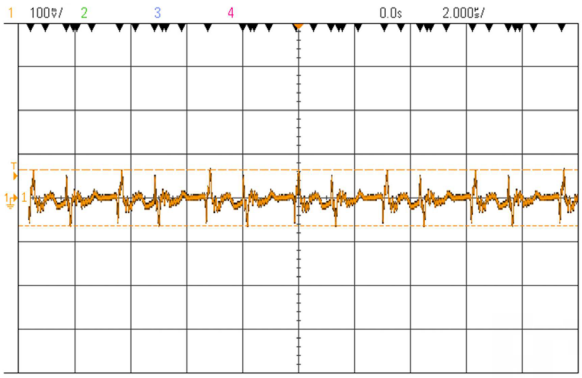

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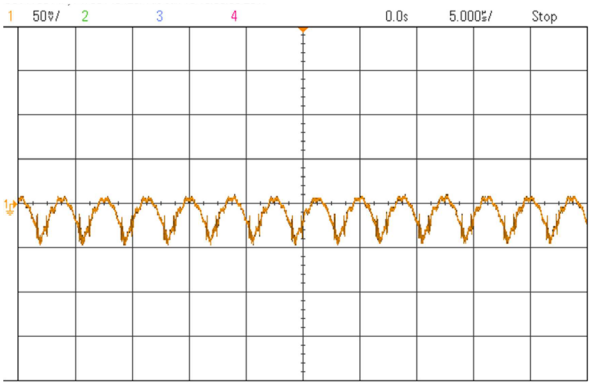
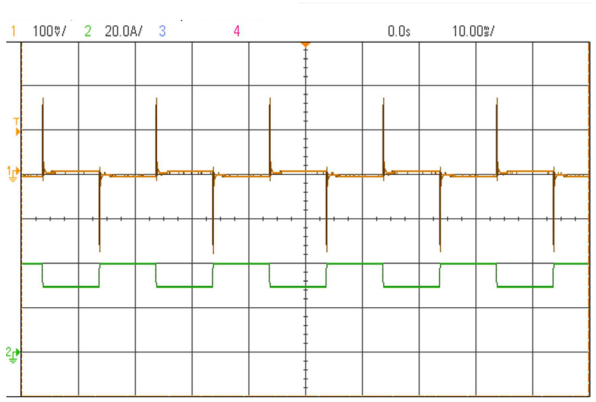


Performance Data

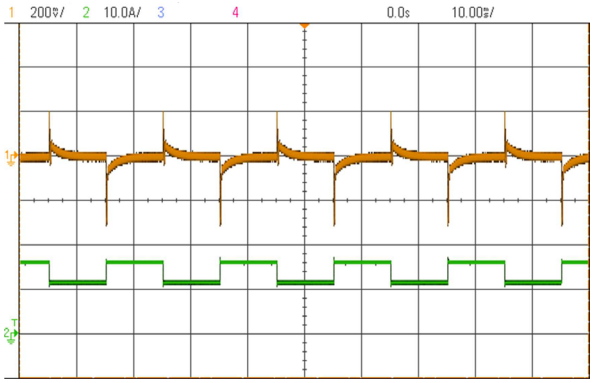
DYNAMIC RESPONSE (75%~100%~75% of I_{max}, di/dt=0.1A/μs)

Ch1: V_{out} Ch2: I_{out}

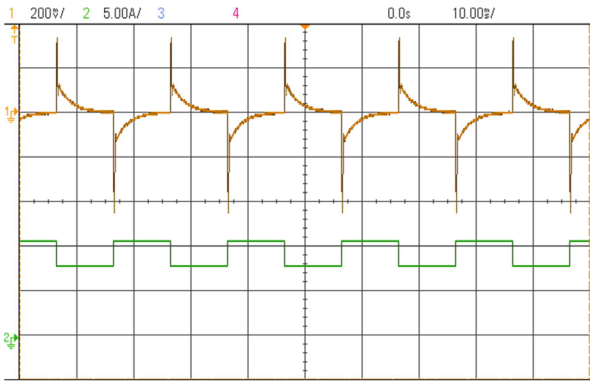
DHB75W110S05 C_{out}=220μF



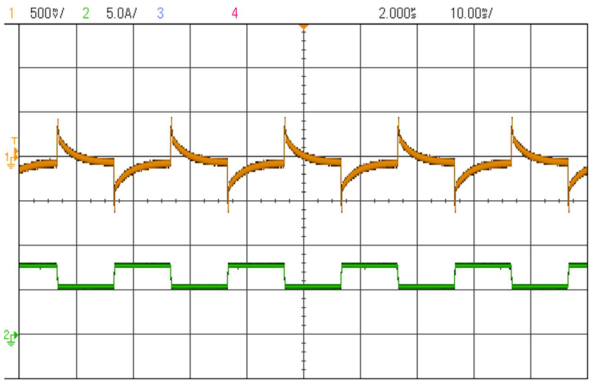
DHB75W110S12 C_{out}=220μF



DHB75W110S15 C_{out}=220μF



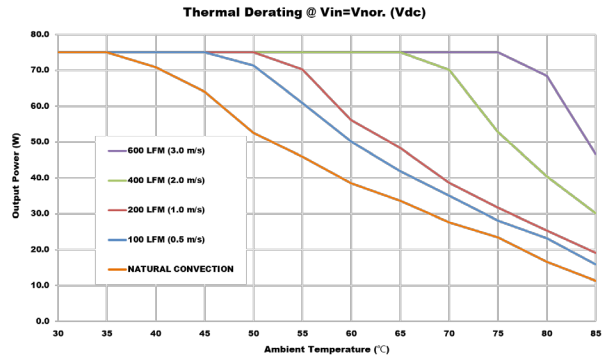
DHB75W110S24 C_{out}=110μF



Performance Data

THERMAL DERATING CURVE

DHB75W110S05



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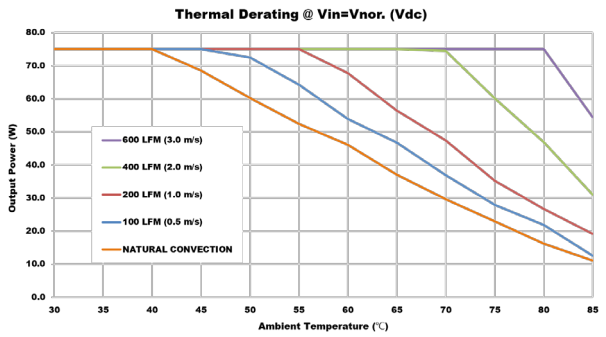

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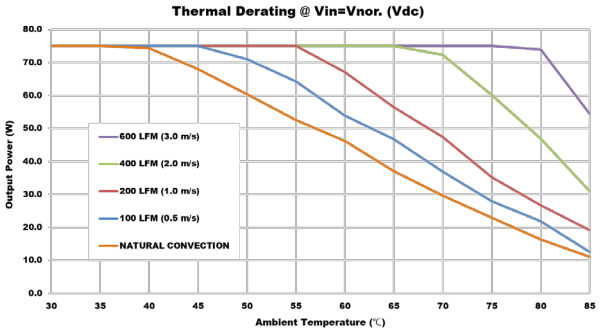

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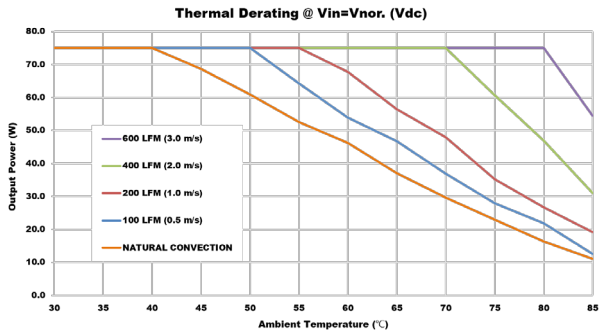
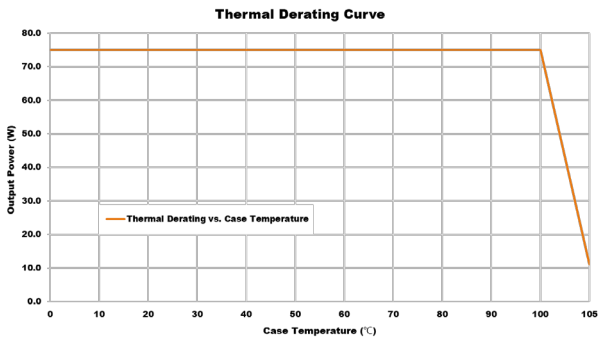
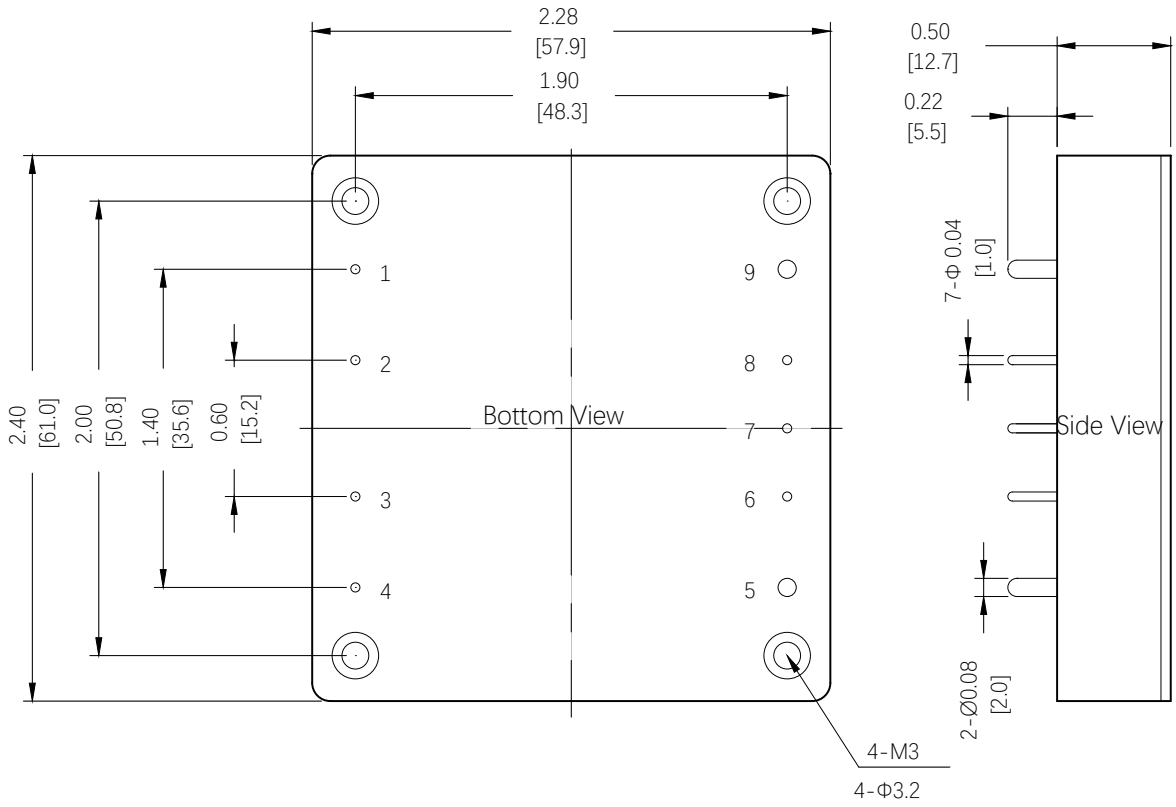


Thermal Performance vs. Case Temperature



The converter delivers its full rated power when keep the case temperature ⩽ 100℃ .

Mechanical Specifications



PIN:
PIN1, PIN2, PIN3, PIN4 PIN6, PIN7, PIN8: Φ0.04inch
Force: Applied force not exceed 4.9N
PIN5, PIN9 : Φ0.08inch
Force: Applied force not exceed 9.8N
Material: Copper alloy
Finish: Gold 3 ~ 5μm(min.) over nickel 50μm(Min.)

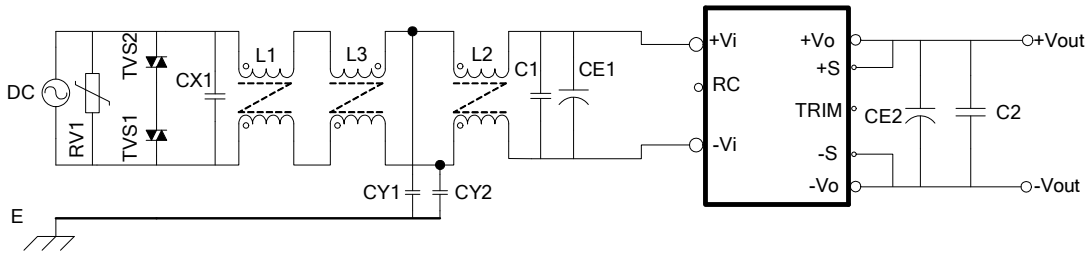
TOLERANCE:
X.XX=±0.02[0.5]
X.XXX= ±0.010[0.25]

Dimensions are in inches [mm]
Weight: ~115g.

PIN CONNECTIONS	
Single Output	
Pin	Function
1	-Vin
2	NC
3	RC
4	+Vin
5	+Vout
6	+Sense
7	TRIM
8	-Sense
9	-Vout

Emissions Performance

Density Power measures its products for conducted emissions against the EN50121-3-2 standards. The common mode filter is added at the output of the module, and the maximum output power of the module is 75W.Input voltage is 110VDC, EMI filter is added outside the modules and the conduction limit can meet standards.



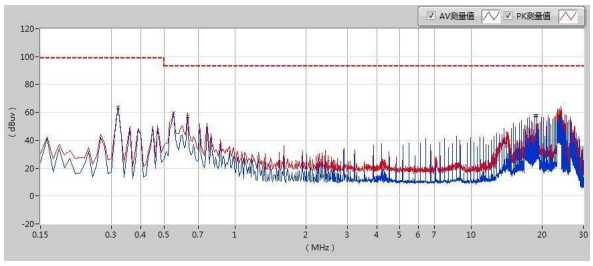
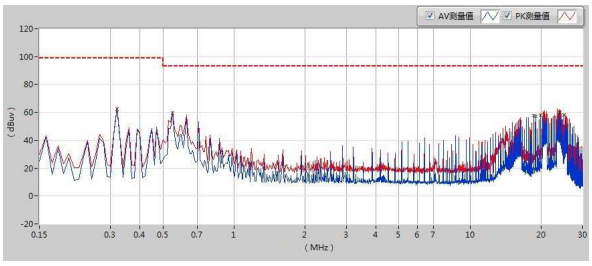
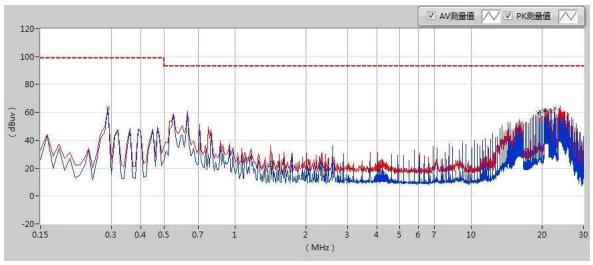
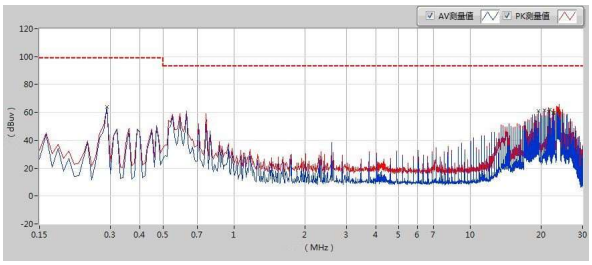
Conducted Emissions Test Circuit

Recommended Filter Parameters

REFERENCE	DESCRIPTION	REFERENCE	DESCRIPTION
CY1, CY2	472/250VAC/Y2	CX1	1μF/250VAC/X2
L1	CM:(300~700)μH@200KHz Core: A10T16x9x5c_ACME	L2	CM:(1.2~3.0)mH@200KHz Core: FS1302H-1LB_ AMORPHOUS
L3	DM: (5~20)μH@200KHz	CE1	22μF/250VDC
CE2	100μF/50V	C1	0.22μF/630V/1812
C2	1μF/50V/12100	RV1	Piezo: 201KD14J_BrightKing
TVS1, TVS2	TVS_30KPA		

Emissions Performance

Conducted Emission Test Results:

DHB75W110S05 Vin+	DHB75W110S05 Vin-
	
DHB75W110S12 Vin+	DHB75W110S12 Vin-
	
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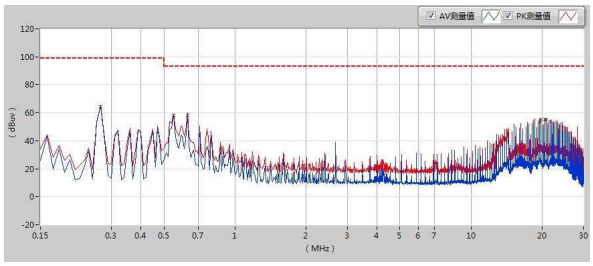
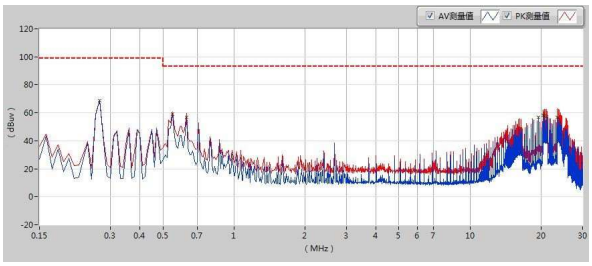
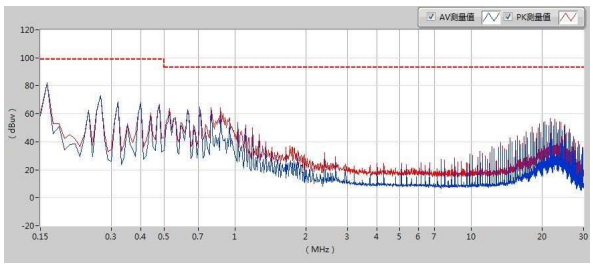
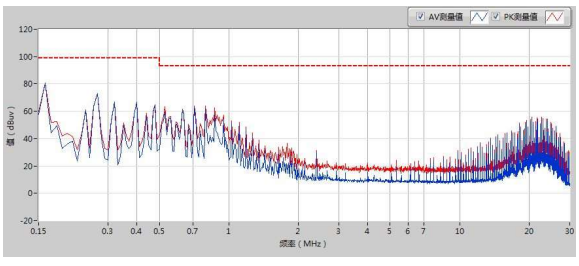
	
DHB75W110S24 Vin+	DHB75W110S24 Vin-
	

Technical Notes

INPUT FUSING

Certain applications may require fuse at the inputs of power conversion components. Fuses should also be used when there is possibility of sustained input voltage reversal which is not current limited. The DHB75W110 modules are not internally fused. We strongly recommend a slow-blown fuse to be used in the ungrounded input supply line.
For safety agency approvals, the installer must install the converter in compliance with the end user safety standard.

TYPICAL APPLICATION CONNECTION

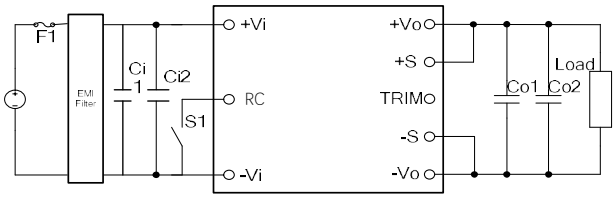


Figure 1·Typical Application Connection

Figure 1 shows the typical use of the module connection. In order to prevent the input line from causing the input oscillation, it is recommended to add the input capacitor close to the input pin of the module. Similarly, the output capacitor is added to the output of the module. Specific recommended parameters: input capacitance Ci1=22μF electrolytic capacitor, Ci2 = 1uF CBB capacitor. Output Capacitance Co1=10uF tantalum capacitor, Co2 ESR <0.1Ω.

REFLECTED RIPPLE CURRENT

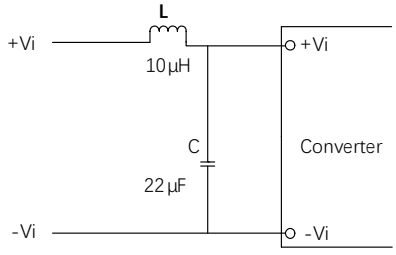


Figure 2· Reflected Ripple Current

Add LC filter at the front of the power module to reduce the interference of reflected ripple current on the DC bus, recommended value of L and C with appropriate current and voltage rating as below: L=10μH; C=22μF.

REMOTE CONTROL FUNCTION

Module Power Remote Control or called ON/OFF pin is for the user to enable or disable the output. Control use high and low level control, there are two general control logic, positive logic or negative logic control. Recommend to use optocoupler to control ON/OFF Pin as below.

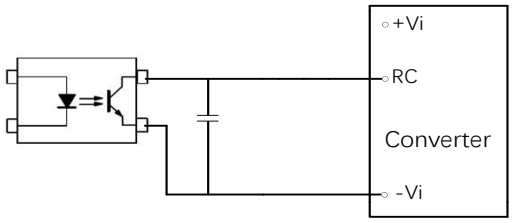


Figure 3· Remote Control

Remote Control Pin can be connected in parallel for multiple converters which with the same Remote Control characters. However, when several converters share the same remote control circuit, the total sink and source current must be taken into consideration, and make sure that the optocoupler has enough drive capability.
To reduce external PCB trace interference, it is recommended to add high frequency bypass capacitor between RC pin and -Vi, recommended capacitor value is 100-1000pF.

REMOTE COMPENSATION FUNCTION

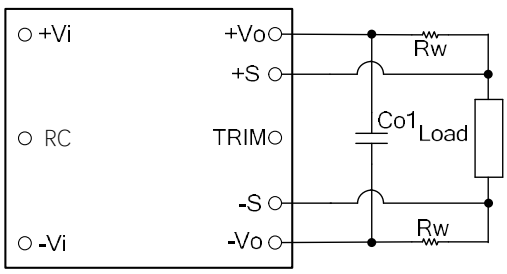


Figure 4· Remote Compensation

Technical Notes

The remote compensation function compensates for the voltage drop across the output line. Module compensation function can't exceed 10%, that is:
$[(+VO) - (-VO)]-[(+S) -(-S)] \leqslant 10\%V_{onom}$
If the remote compensation function is not used, the +Sense and +Vout pin, -Sense and -Vout pin need to be shorted directly close to the output.

OUTPUT RIPPLE & NOISE

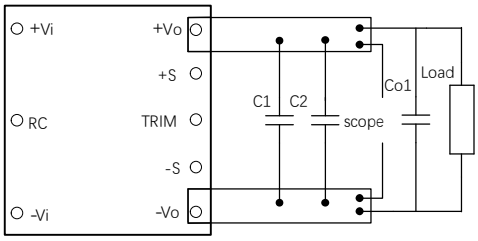


Figure 5· Output Ripple

These DHB75W110 modules' output ripple and noise is measured at the rated input voltage and output current, along with 10uF MLCC capacitor and 0.1uF MLCC used in parallel with appropriate voltage ratings and placed as C1&C2 shown in the figure above. The scope's bandwidth is set to 20MHz.
External output capacitors are required to reduce the ripple & noise. The output capacitors should be low ESR and appropriate frequency response with appropriate voltage ratings, and must be located as close to the converters as possible, also PCB layout must be taken into consideration.

INPUT UNDERVOLTAGE SHUTDOWN AND START-UP THRESHOLD

Under normal start-up conditions, module will not begin to regulate until the ramping-up input voltage exceeds the Start-Up Threshold Voltage. Once operating, module will not turn off until the input voltage drops below the Undervoltage Shutdown limit. Subsequent re-start will not occur until the input is brought back up to the Start-Up Threshold. This built in hysteresis prevents any unstable on/off situations from occurring at a single input voltage.

CURRENT LIMITING

The maximum current limit remains constant as the output voltage drops. However, once the impedance of the short across the output is small enough to make the output voltage drop below the specified Output DC Current Limit Shutdown Voltage, the converter turns off.
The converter then enters a "hiccup mode" where it repeatedly turns on and off until the short circuit condition is removed. This prevents excessive heating of the converter or the load board.

SHORT CIRCUIT CONDITION

When the converter is in current-limit mode, the output voltage will drop as the output current demand increases and then the converter will be shut down. If the short-circuit condition persists, another shutdown cycle will be initiated. This on/off cycling is referred to as "hiccup" mode. The hiccup cycling reduces the average output current, thereby preventing internal temperatures from rising to excessive levels. The module is capable of enduring an indefinite short circuit output condition.

OUTPUT OVERVOLTAGE PROTECTION

The output voltages are monitored for an overvoltage condition via magnetic feedback. The signal is coupled to the primary side and if the output voltage rises to a level which could be damaging to the load, the sensing circuitry will power down the PWM controller causing the output voltages to decrease. Following a timeout period the PWM will restart, causing the output voltages to ramp to their appropriate values. If the fault condition persists, and the output voltages again climb to excessive levels, the overvoltage circuitry will initiate another shutdown cycle. This on/off cycling is referred to as "hiccup" mode.

Technical Notes

THERMAL SHUTDOWN

These DHB75W110 converters are equipped with thermal shutdown circuitry. If environmental conditions cause the internal temperature of the DC-DC converter to rise above the designed operating temperature, a precision temperature sensor will power down the unit. When the internal temperature decreases below the threshold of the temperature sensor, the unit will auto restart.

TRIMMING OUTPUT VOLTAGE

DHB75W110 converters have a trim capability that allows users to adjust the output voltages. Output voltage can be trimmed up or down by a trim pin by connecting a single fixed resistor between Trim Pin and Vout+ or Vout-, the output volatge can be increased or decreased depending on its connection. The maximum output voltage adjustment range is -10% to +10%. If the trim function is not used, keep TRIM pin floating.

Trim up:

Add a fixed resistor between in TRIM and -Vo, you can achieve the output voltage up. Do not trim the converter above maximum trim limit (typically 10%) or the output over voltage protection circuit may be activated.

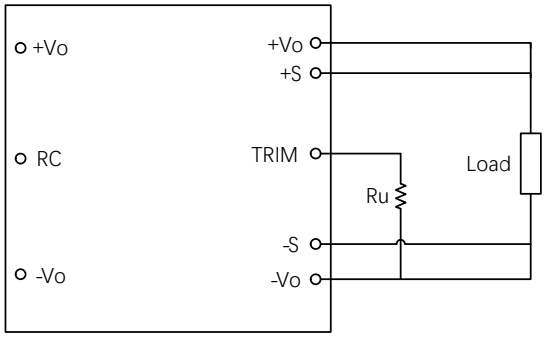


Figure 6· Trim Up Connection

Please follow up the Trim Down formula to calculate the resistor value according to the desired output voltage.

Vout=5V

$$Ru = \frac{1.24 \times [R1 \times R2 + 5.11 \times (R1 + R2) - 5.11 \times Voset \times (1 + \Delta) \times R2}{Voset \times (1 + \Delta) \times R2 - 1.24 \times (R1 + R2)}$$

Vout=12V, 15V, 24V

$$Ru = \frac{2.48 \times [R1 \times R2 + 5.6 \times (R1 + R2)] - 5.6 \times Voset \times (1 + \Delta) \times R2}{Voset \times (1 + \Delta) \times R2 - 2.48 \times (R1 + R2)}$$

"Voset "is the output voltage when TRIM is floating, " Δ% "is the change of output voltage, such as: 15V output is raised to 16.5V,
Δ% = (16.5-15) / 15 * 100% = 10%.

Trim down:

Add a fixed resistor between in TRIM and +Vo, will achieve the output voltage down. Do not exceed maximum rated output power.

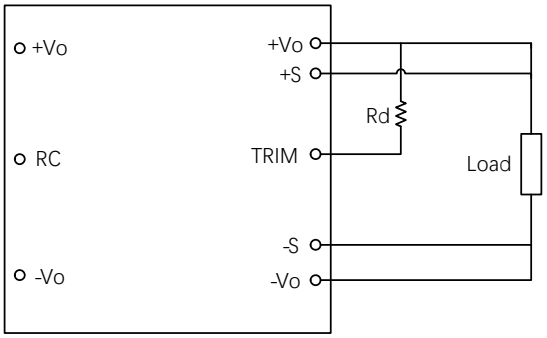


Figure 7· Trim Down Connection

Please follow up the Trim Down formula to calculate the resistor value according to the desired output voltage.

Vout=5V

$$Rd = \frac{1.24 \times 5.11 \times R1 - R2 \times (R1 + 5.11) \times [Voset \times (1 - \Delta) - 1.24}{R2 \times Voset \times (1 - \Delta) - 1.24 \times (R1 + R2)}$$

Vout=12V, 15V, 24V

$$Rd = \frac{2.48 \times 5.6 \times R1 - R2 \times (R1 + 5.6) \times [Voset \times (1 - \Delta) - 2.48]}{R2 \times Voset \times (1 - \Delta) - 2.48 \times (R1 + R2)}$$

Technical Notes

"Voset" is the output voltage when TRIM is floating, "Δ%" is the amount of change in output voltage, such as: 15V output is reduced to 13.5V, Δ% = (15-13.5) / 15 * 100% = 10%.
R1, R2 is resistance value. Value of R1, R2 is shown below:

Vout	R1	R2
5V	7.50KΩ	2.47KΩ
12V	8.91KΩ	2.32KΩ
15V	14.54KΩ	2.32KΩ
24V	20.00KΩ	2.32KΩ

Density Power Group.
Queens, New York City, New York, U.S.A