Series **PHA**

500 to 2000W Non-Isolated Regulated Power Factor Corrected Modules

PICO Electronics, Inc.

PRODUCT OVERVIEW

The Power Factor Corrected Modules are the perfect front ends for your universal AC single or 3-phase input to DC output applications. The standard 4.6” x 2.5" x 0.5" full brick or 2.5” x 2.3” x 0.5” half brick footprint is one of the smallest on the market today in this power range. Providing a 365V regulated DC output, it can be used as a front end for PICO's FD/MD/LFD/LMD/LPD/ PD/HPD series of DC-DC converters to step down further ranging from 3.3V to 350V. Many laser and motor applications can use the 365V output directly.

FEATURES

- Up to 0.99 Power Factor
- Single or three-phase input (HPHA2)
- Meets EN/IEC 610000-3-2
- Up to 2kW output power in a full brick size
- Non-isolated & Regulated 365V output
- Operating Frequency sync feature (HPHA1/HPHA2)
- Enable DC/DC delay turn on feature (HPHA1/HPHA2)
- Fixed operating frequency
- Compatible with other Pico DC-DC converters providing isolated for 3.3 to 350V outputs

Contact Pico for part number of available options:

- Expanded operating temp: -40°C to +85°C
- Select screening per MIL-STD-883:
  - Stabilization Bake
  - Temperature Cycle
  - Burn-In
- Special Input Voltage, Output Voltage, or Output Power

HPHA1

SERIES NAME

LPHA1 = 250W Output Power

PHA1 = 500W Output Power

HPHA1 = 1000W Output Power

HPHA2 = 2000W Output Power

SPECIFICATIONS (220VAC/60Hz, Full Load, T_A = +25°C, 1 hour warm up unless otherwise specified)

INPUT

Parameter	Condition		Min.	Typ.	Max.	Units
Input Voltage Range	All models	Single-phase input - Refer to Output Power	85	220	250	VAC
	HPHA1 & HPHA2	Three-phase input	166	208	250	VAC
Input Frequency			47	60	440	Hz
Peak Inrush Current (1)	LPHA1 & PHA1 with 2.5Ω inrush thermistor	115VAC Input	-	-	65	A
		230VAC Input	-	-	130	
	HPHA1 & HPHA2	115VAC Input	-	-	102	
		230VAC Input	-	-	203	
Input Fuse Recommendation	LPHA1 with external 2.5Ω inrush thermistor		5A, Rated Voltage ≥ Input Voltage			
	PHA1 with external 2.5Ω inrush thermistor		10A, Rated Voltage ≥ Input Voltage			
	HPHA1 & HPHA2	Single-phase Input	15A, Rated Voltage ≥ Input Voltage			
		Three-phase Input	10A on each input line, Rated Voltage ≥ Input Voltage			
Input Thermistor Recommendation	LPHA1 & PHA1		-	2.5	-	Ω
	HPHA1 & HPHA2		Intergrated Thermistor			

Note 1: For LPHA1 & PHA1, 2.5Ω inrush thermistor is required on the input.

OUTPUT

Parameter	Condition		Min.	Typ.	Max.	Units
Load Regulation	10-100% load		-	-	3	±%
Output Power (Refer to Derating Graph)	HPHA2	166-250VAC three-phase input	-	-	2000	W
		220-250VAC single-phase input	-	-	2000	
		220-170VAC single-phase input	Derate 0.5% power per VAC input			
		170VAC single-phase input	-	-	1500	
		170-110VAC single-phase input	Derate 0.55% power per VAC input			
		110VAC single-phase input	-	-	1000	
	HPHA1	166-250VAC three-phase input or 110-250VAC input	-	-	1000	
	PHA1	110-250VAC input	-	-	500	
	LPHA1	110-250VAC input	-	-	250	
	All models	110-85VAC input	Derate 1.2% power per VAC input			
Output Voltage Tolerance	Nominal V_{IN}, Full Load		-	-	2	±%
Ripple	LPHA1 with 450V, ≥250µF output electrolytic capacitor		-	-	10	Vp-p
	PHA1 with 450V, ≥470µF output electrolytic capacitor		-	-	10	
	HPHA1 with 450V, ≥800µF output electrolytic capacitor		-	-	10	
	HPHA2 with 450V, ≥1200µF output electrolytic capacitor		-	-	10	

Note 2: Electrolytic capacitor is required on the output.

ENVIRONMENTAL

Parameter	Condition	Min.	Typ.	Max.	Units
Operating Temperature Range	Baseplate	0	-	+85	°C
Storage Temperature Range	Baseplate	-55	-	+105	°C
Cooling	Conduction through baseplate				

SPECIFICATIONS (220VAC/60Hz, Full Load, T_A = +25°C, 1 hour warm up unless otherwise specified)

GENERAL

Parameter	Condition		Min.	Typ.	Max.	Units
Power Factor	50 to 100% load, 47 to 60Hz Input	Single-phase input	0.99	-	-	
		Three-phase input	0.95	-	-	
Efficiency	HPHA1 & HPHA2	110VAC Input	90	-	-	%
		170-250VAC Input or 3-phase Input	95	-	-	
	All other models		90	-	-	
Operating Frequency			-	100	-	kHz
Isolation Voltage	Input/output to baseplate		2121	-	-	VDC
	Input to output		None			
Size (L x W x H)	LPHA1		2.5 x 2.3 x 0.5 (63.5 x 58.4 x 12.7)			inches (mm)
	All other models		4.6 x 2.5 x 0.5 (116.9 x 63.5 x 12.7)			
Weight	LPHA1		-	112	-	grams
	PHA1, HPHA1 & HPHA2		-	231	-	
Case	Aluminum baseplate and Glass Reinforced Polymer					
Potting	Vacuum Impregnated Epoxy					
Tube Packaging (W x H x L)	Series LPHA1, HPHA1 & HPHA2		2.595 x 1.135 x 20 (65.913 x 28.829 x 101.6)			inches (mm)
	PHA1		2.595 x 1.105 x 20 (65.913 x 28.067 x 101.6)			

PROTECTIONS & FEATURES

Parameter	Condition	Min.	Typ.	Max.	Units
Overtemperature	PHA1, HPHA1 & HPHA2	90	-	100	°C
Enable Pin [3]	HPHA1 & HPHA2	Connect directly to the shutdown pin of Pico's DC-DC converters.			
Synchronization Pin [4]	HPHA1 & HPHA2	Connect directly to the sync pin of Pico's HPHA1 or HPHA2.			

Note 3: The enable pin connects directly to shutdown pin of Pico's FD/MD/LFD/LMD/LPD/PD/HPD series. It will start up the DC-DC converters after the HPHA1/HPHA2 has reached a safe operating output voltage. See application notes to use an isolated startup circuit.
Note 4: The synchronization pin allows synchronizing the switching frequencies of multiple HPHA1 or HPHA2 to reduce audible noise, ripple or EMI problems. All modules will sync to the highest opearting frequency. Units must have a common neutral and cannot be used with 3-phase inputs.
Please note: The holdup capacitor must be installed on a separate wire or PCB trace directly to +VOUT and -VOUT terminals. This will prevent a voltage spike from the inrush current to the electrolytic capacitor into the enable or sync pin and cause issues with these features. All units are not isolated between input and output. It cannot be connected to physical earth or ground, otherwise, unit will be damaged.

DESIGNED TO MEET

Test	Referenced Standard	Description
Vibration	MIL-STD-202	Method 204, Vibration, High Frequency, Condition D
Shock	MIL-STD-202	Method 213, Shock (Specified Pulse), Condition I
Humidity	MIL-STD-202	Method 106, Moisture Resistance
Altitude	MIL-STD-202	Method 105, Barometric Pressure (Reduced), Condition D

OPTIONS AVAILABLE – CONTACT PICO FOR PART NUMBER

Parameter	Referenced Standard	Description
Stabilization Bake	MIL-STD-883	Referenced Method 1008 Non-operating maximum storage temperature for 24 hours
Temperature Cycle	MIL-STD-883	Referenced Method 1010 Non-operating at temperature extremes, 15 mins/temp, 10 cycles
Burn-In	MIL-STD-883	Referenced Method 1015 Max operating temperature for 160 hours
Expanded Operating Temperature Range	-40°C to +85°C	

THERMAL RESISTANCE

$$P_{OUT} = \frac{T_C - T_A}{T_{RCA} \times (1 / \eta - 1)}$$

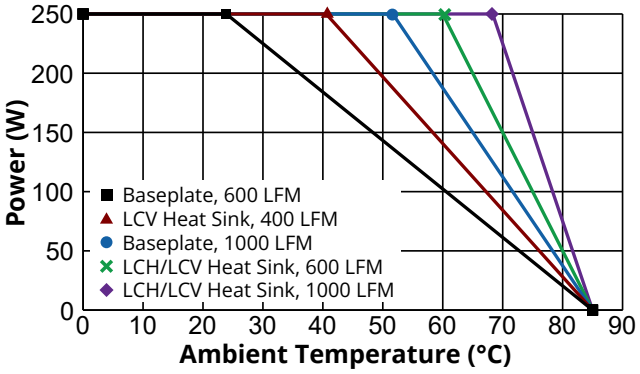
P_{OUT} = *Output Power in Watts*
η = *Efficiency*
T_C = *Case temperature in °C*
T_A = *Ambient temperature in °C*
T_{RCA} = *Thermal resistance of case to air in °C / W*

Thermal resistance of case (T_{RCA})

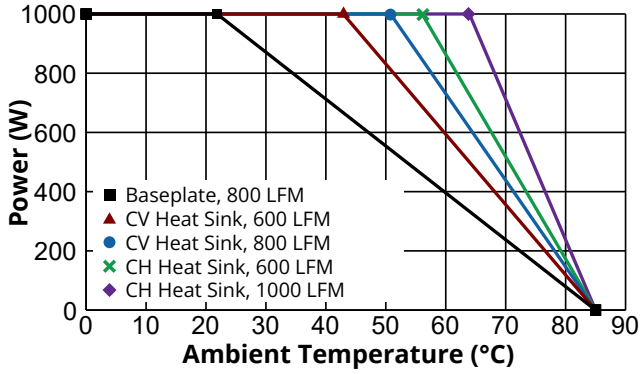
Airflow	PHA1 / HPHA1 / HPHA2			LPHA1			Units
	Baseplate only	CV Heat Sink	CH Heat Sink	Baseplate only	LCV Heat Sink	LCH Heat Sink	
Free Air	5.10	3.50	3.00	7.90	4.20	4.00	°C / W
200 LFM	2.80	1.80	1.00	4.90	1.60	1.60	
400 LFM	1.80	1.10	0.70	2.50	1.30	1.30	
600 LFM	1.40	0.80	0.55	2.20	0.90	0.90	
800 LFM	1.20	0.65	0.45	1.50	0.70	0.70	
1000 LFM	1.00	0.55	0.40	1.20	0.60	0.60	

DERATING GRAPHS (Nominal V_{IN}, Full Load, Efficiency @ Full Load)

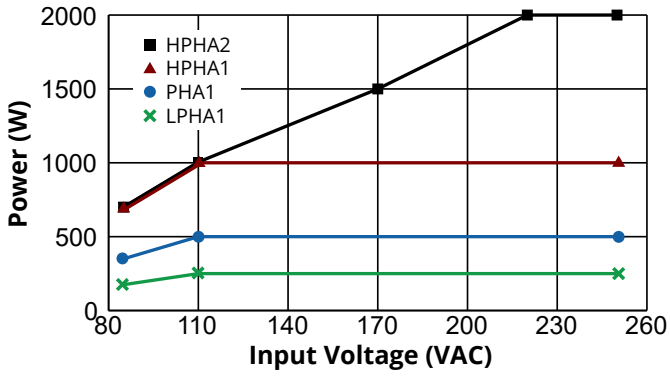
P/N LPHA1
Max. Output Power = 250W
& Efficiency at full load = 90%



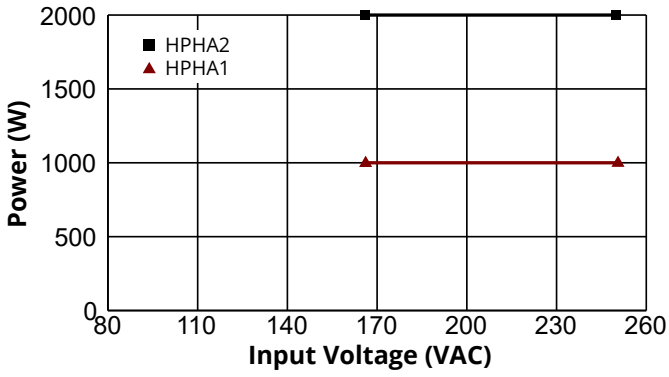
P/N HPHA1
Max. Output Power = 1000W, 3 Phase Input
& Efficiency at full load = 95%



Single Phase Input

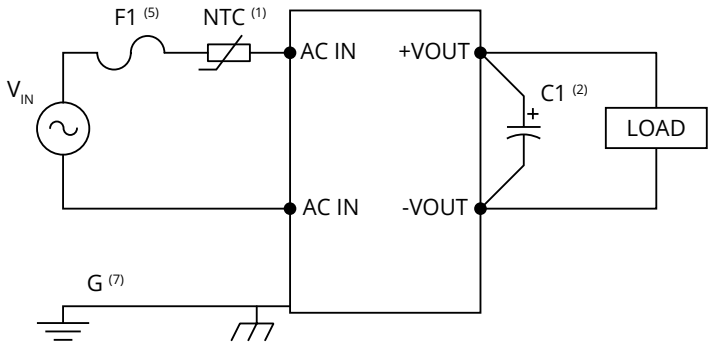


Three-Phase Input



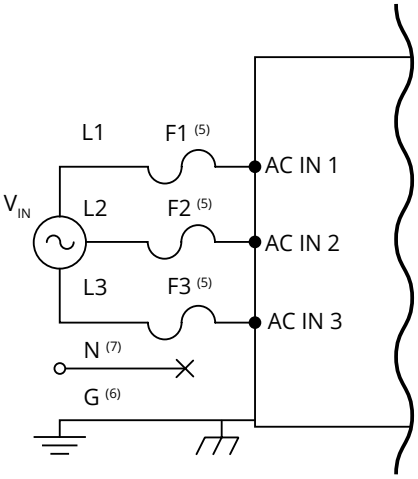
TYPICAL CONNECTION CIRCUIT

SERIES LPHA1 & PHA1

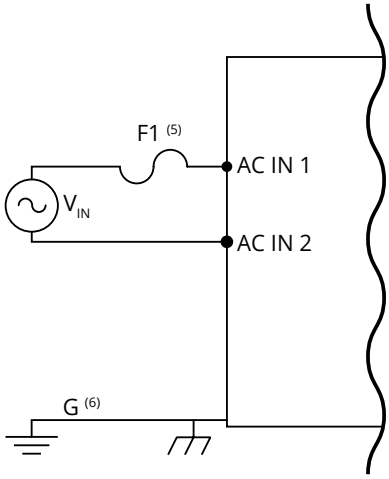


SERIES HPHA1 & HPHA2 - INPUT

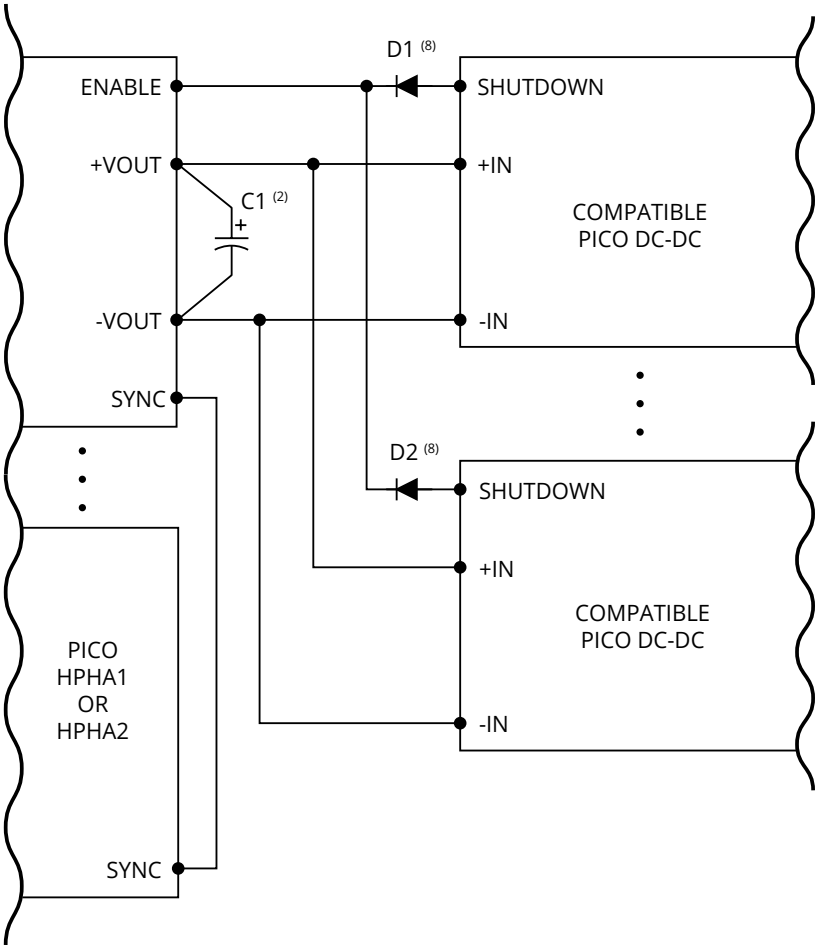
3 PHASE INPUT



SINGLE PHASE INPUT



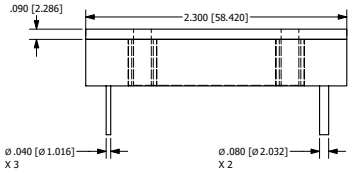
SERIES HPHA1 & HPHA2 - OUTPUT

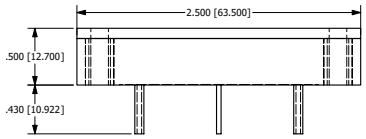


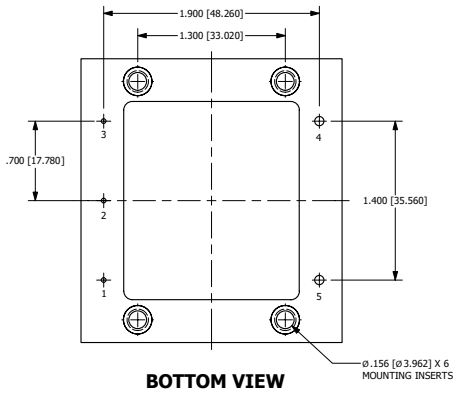
Note 1: For LPHA1 & PHA1, 2.5Ω inrush thermistor is required on the input.
Note 2: Electrolytic capacitor is required on the output.
Note 5: Input fuse is required - See Input Fuse Recommendation.
Note 6: Physical Earth/Ground may be connected to baseplate/chassis or not connected.
Note 7: Neutral Connection - Not connected.
Note 8: Diode required for two or more Pico DC-DC modules.

MECHANICAL DRAWINGS

SERIES LPHA1 - 250W



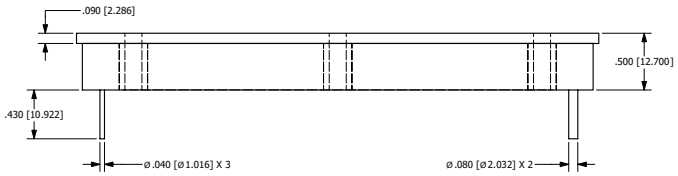


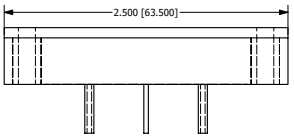


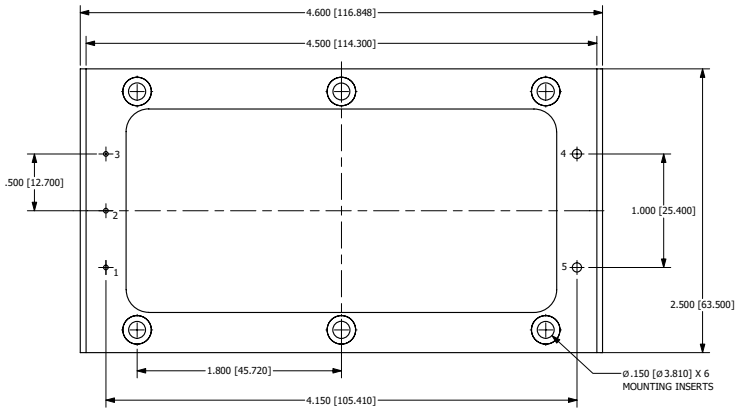
BOTTOM VIEW

PIN	FUNCTION	PIN DIAMETER
1	AC IN	.040 [1.016]
2	AC IN	.040 [1.016]
3	NC	.040 [1.016]
4	-VOUT	.080 [2.032]
5	+VOUT	.080 [2.032]

SERIES PHA1 - 500W







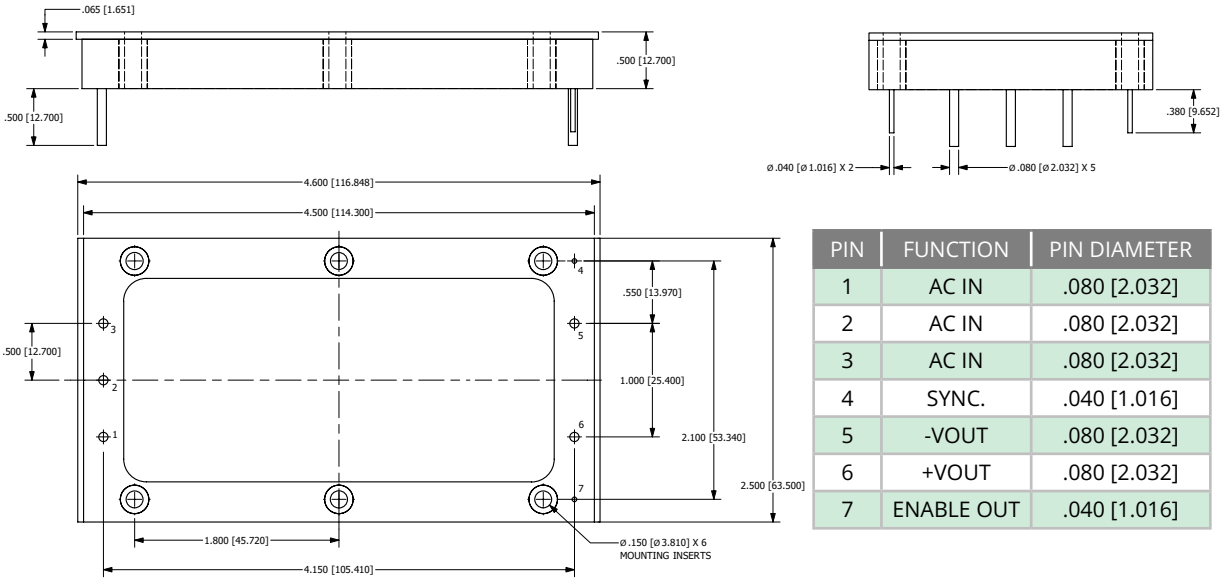
BOTTOM VIEW

PIN	FUNCTION	PIN DIAMETER
1	AC IN	.040 [1.016]
2	AC IN	.040 [1.016]
3	NC	.040 [1.016]
4	-VOUT	.080 [2.032]
5	+VOUT	.080 [2.032]

NOTES
a. ALL DIMENSIONS ARE IN INCHES, [ ] = MM
b. RECOMMENDED TORQUE FOR MOUNTING SCREWS: 6-9 INCH-LBS
c. EXTERNAL CAPACITOR REQUIRED ACROSS TERMINALS 4 AND 5

MECHANICAL DRAWINGS

SERIES HPHA1 - 1000W & HPHA2 - 2000W



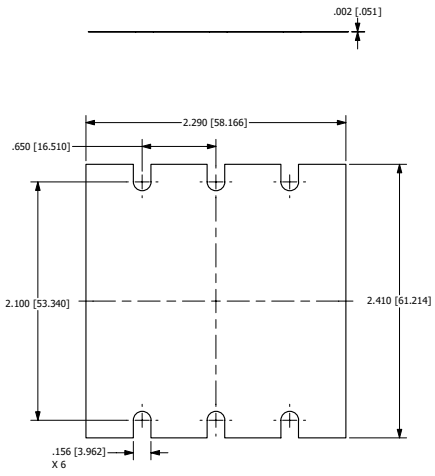
BOTTOM VIEW

PIN	FUNCTION	PIN DIAMETER
1	AC IN	.080 [2.032]
2	AC IN	.080 [2.032]
3	AC IN	.080 [2.032]
4	SYNC.	.040 [1.016]
5	-VOUT	.080 [2.032]
6	+VOUT	.080 [2.032]
7	ENABLE OUT	.040 [1.016]

NOTES
a. ALL DIMENSIONS ARE IN INCHES, [ ] = MM
b. RECOMMENDED TORQUE FOR MOUNTING SCREWS: 6-9 INCH-LBS
c. EXTERNAL CAPACITOR REQUIRED ACROSS TERMINALS 5 AND 6

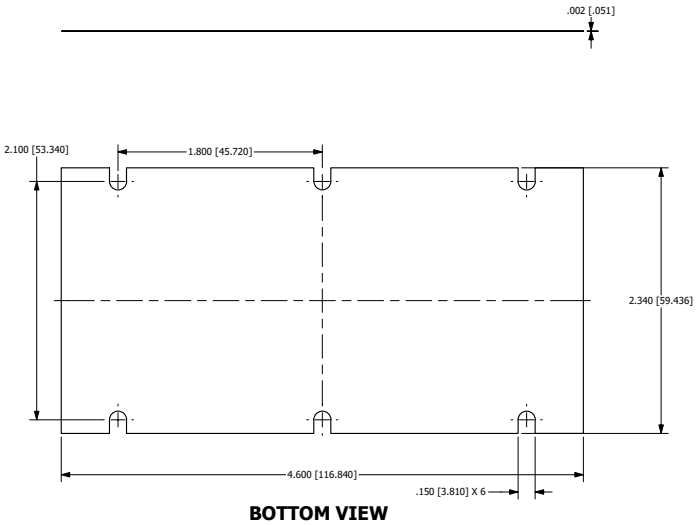
THERMAL INTERFACE

LTI - COMPATIBLE WITH LPHA1



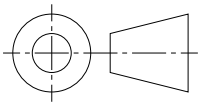
BOTTOM VIEW

TI - COMPATIBLE WITH PHA1, HPHA1 & HPHA2



BOTTOM VIEW

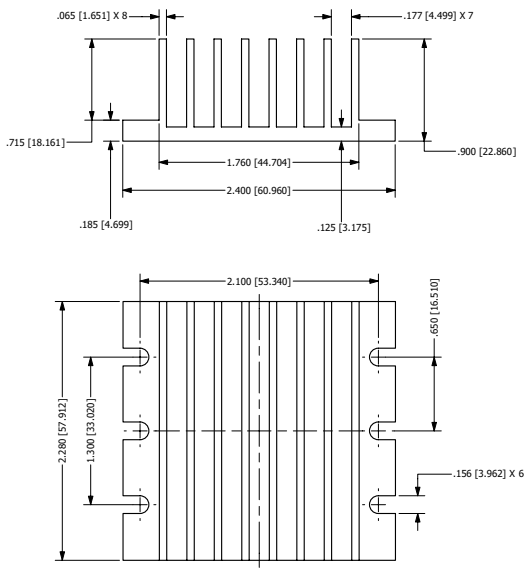
Material	Alloy Aluminum Substrate
Thermal Conductivity	1530 BTU-in/hr sq.ft °F
Coefficient of Thermal Expansion, (25-100°C)	13.1 10^{-6} in-in/°F
Brinell Hardness	23 HB
Endurance Limit	5000 PSI
Standard Thickness	0.002 inches



MECHANICAL DRAWINGS

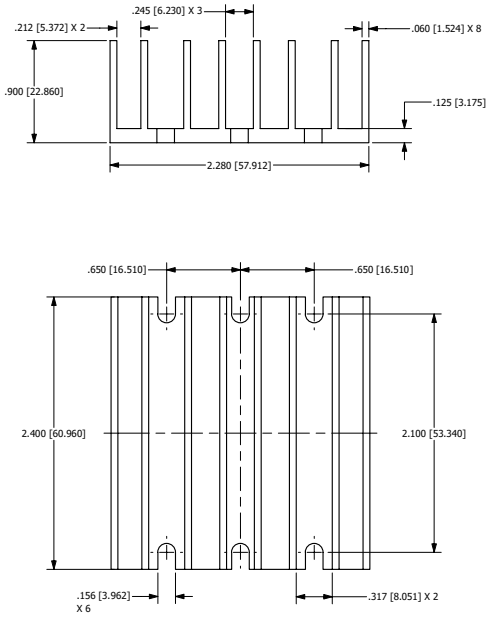
HEAT SINKS COMPATIBLE WITH LPHA1

LCV



TOP VIEW

LCH

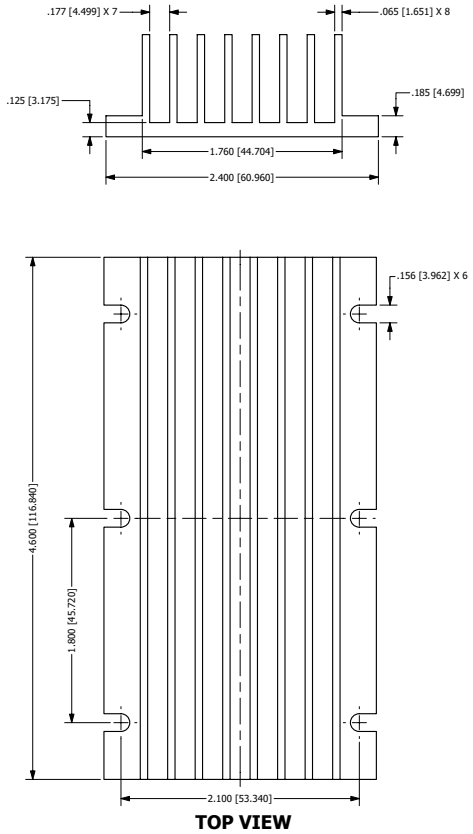


TOP VIEW

Weight: 70 grams typical

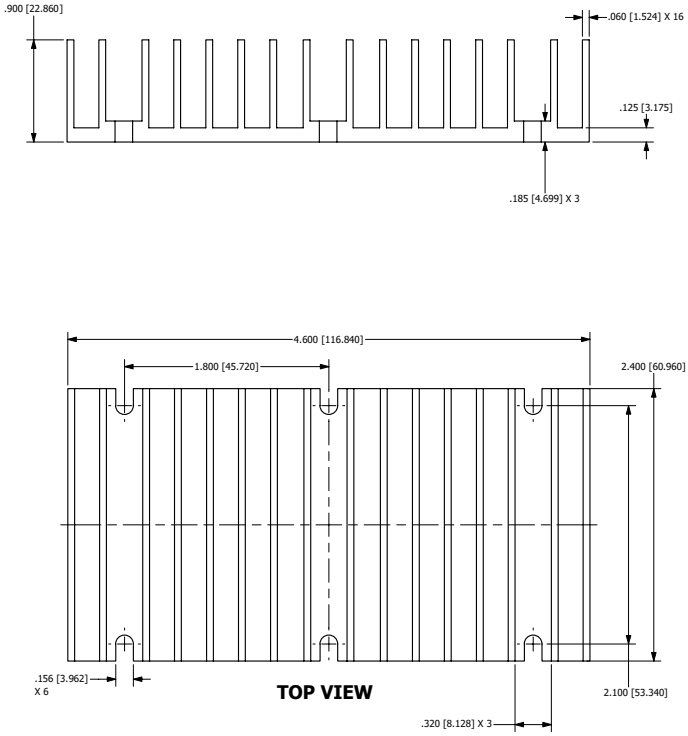
HEAT SINKS COMPATIBLE WITH PHA1, HPHA1 & HPHA2

CV



TOP VIEW

CH

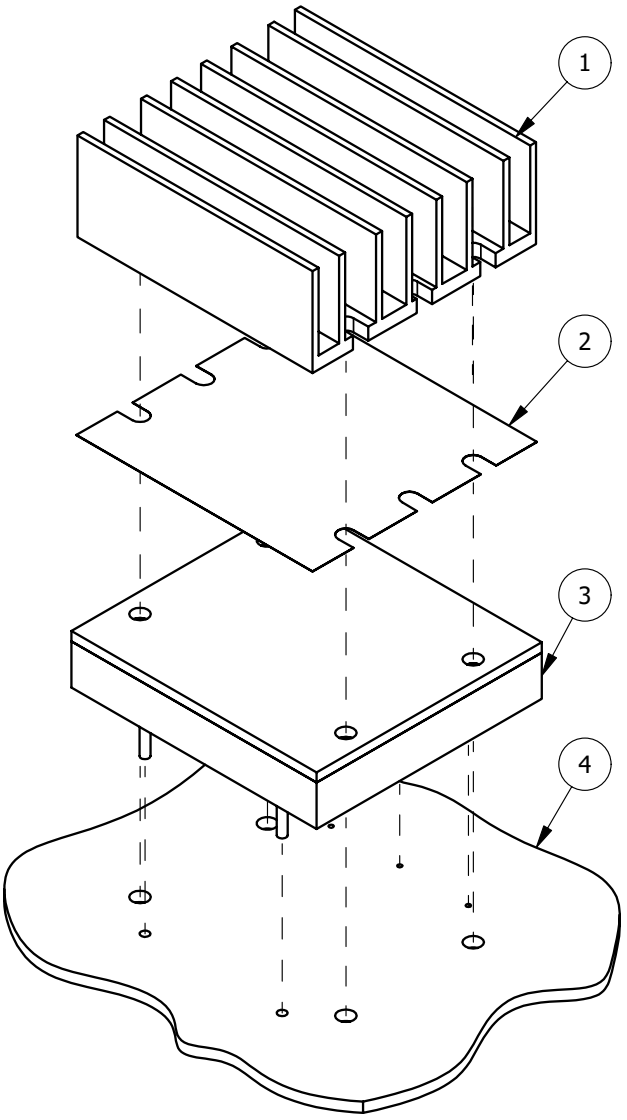


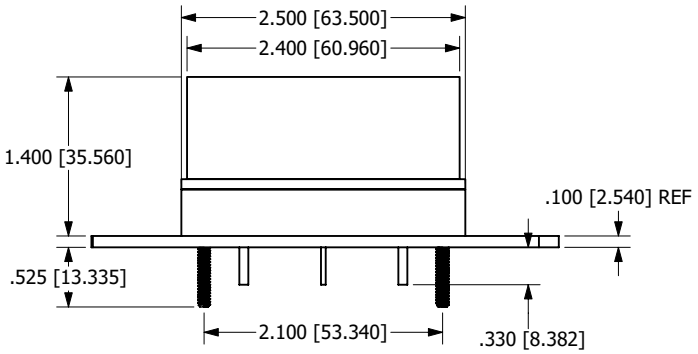
TOP VIEW

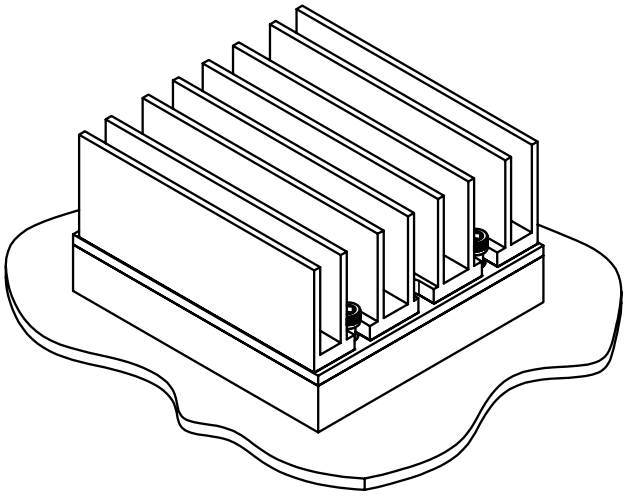
Weight: 145 grams typical

MECHANICAL DRAWINGS

SERIES LPHA1 - HEAT SINK ASSEMBLY



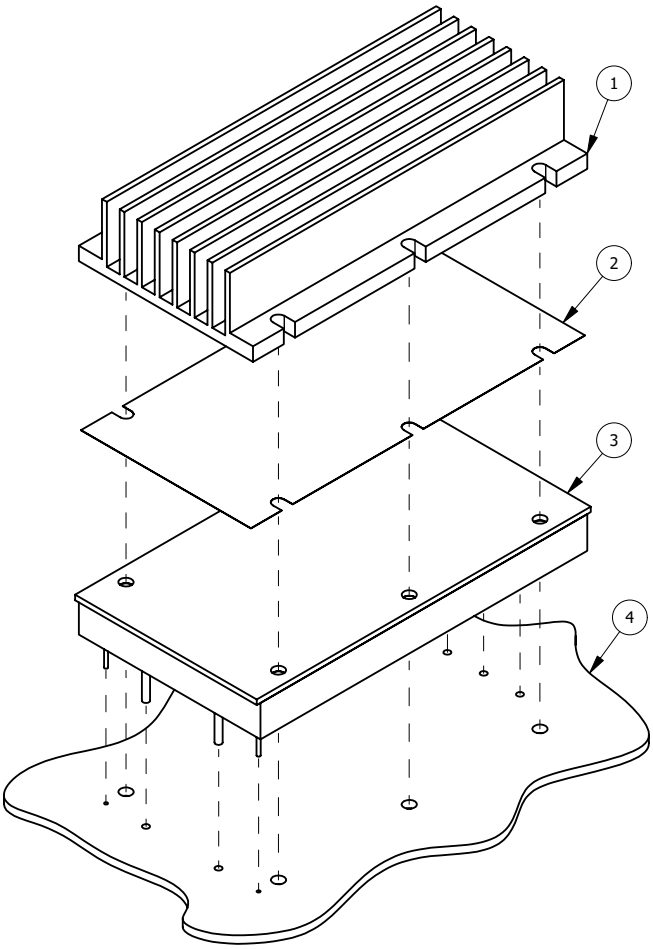


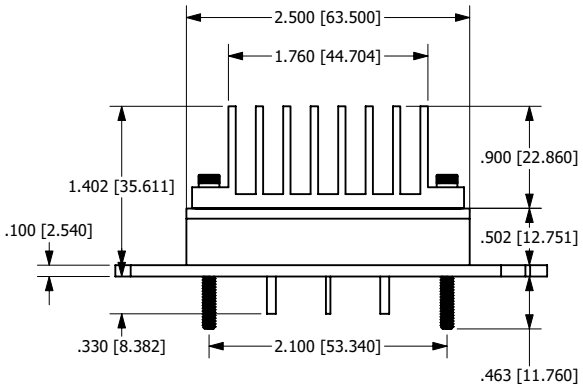


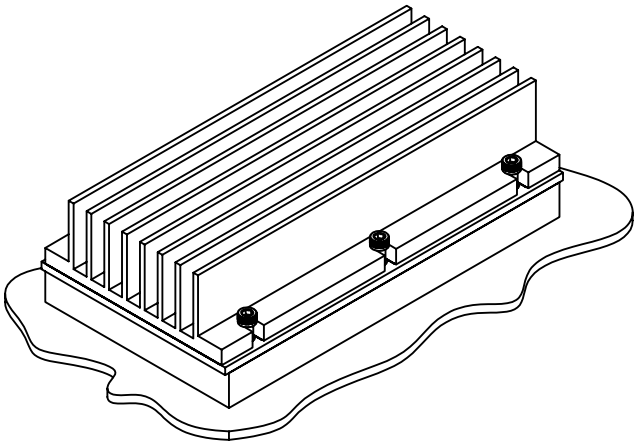
ITEM	QTY	DESCRIPTION
1	1	LCH OR LCV HEAT SINK
2	1	LTI THERMAL INTERFACE
3	1	LPHA1 MODULE
4	1	PCB

MECHANICAL DRAWINGS

SERIES PHA1, HPHA1 & HPHA2 - HEAT SINK ASSEMBLY



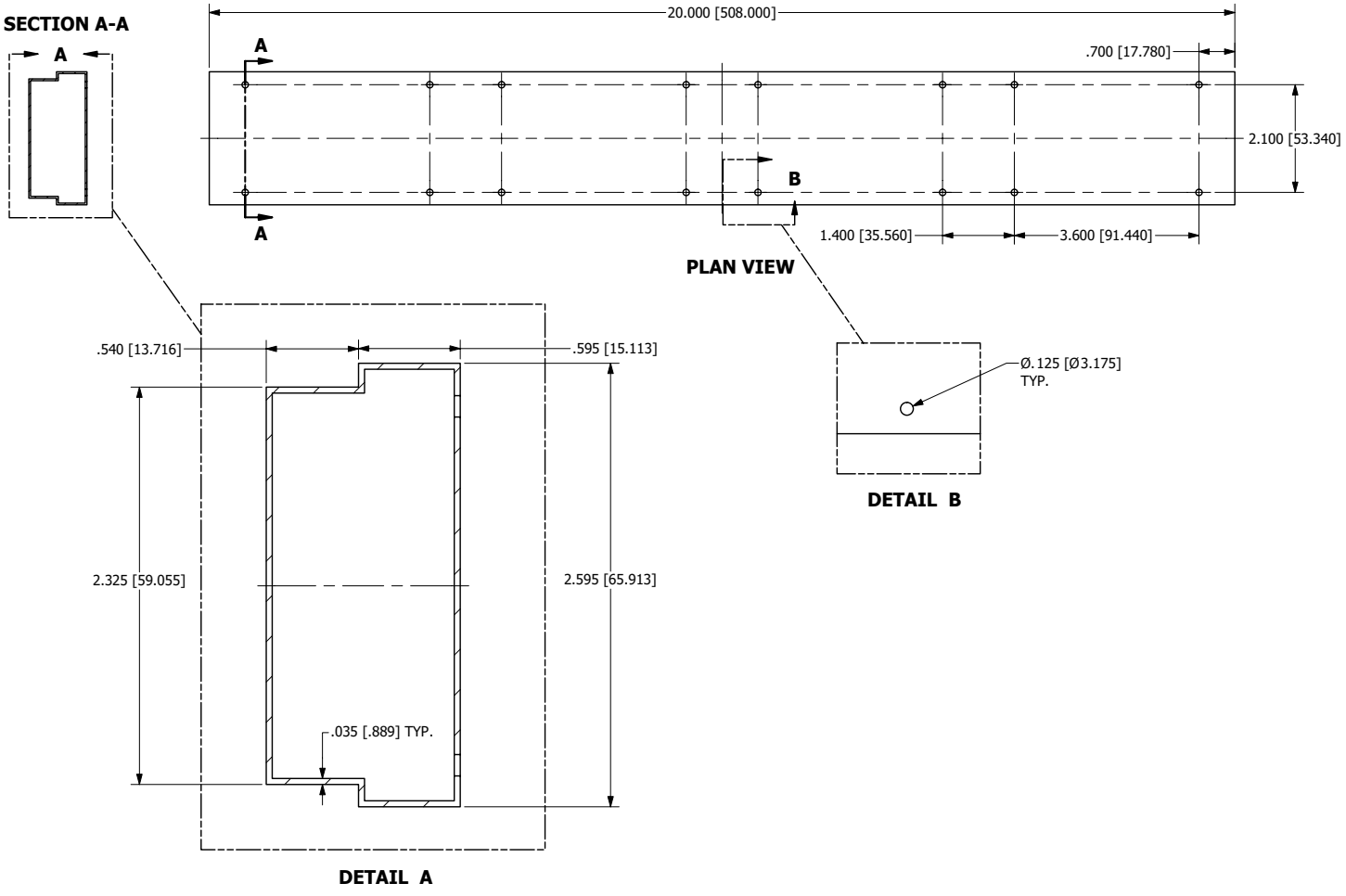


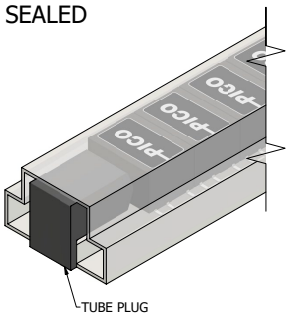


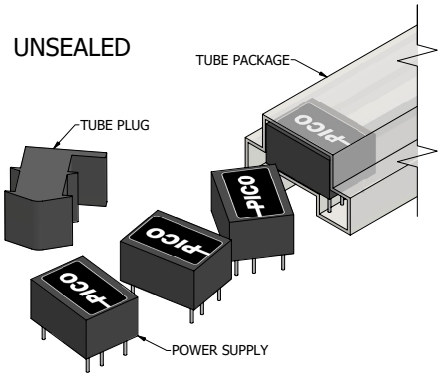
ITEM	QTY	DESCRIPTION
1	1	CH OR CV HEAT SINK
2	1	TI THERMAL INTERFACE
3	1	PHA1, HPHA1 OR HPHA2 MODULE
4	1	PCB

TUBE PACKAGING

SERIES LPHA1, HPHA1 & HPHA2







TUBE PACKAGING

SERIES PHA1