

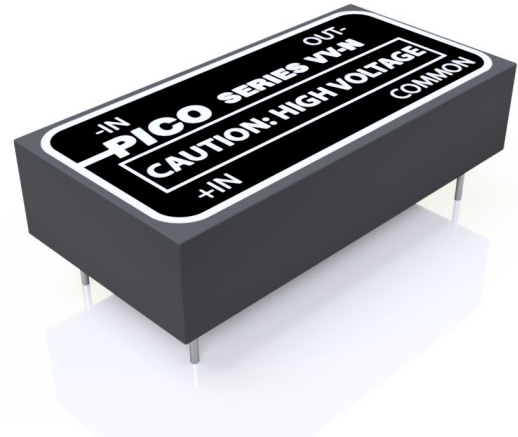
# Series VV (100-10kV)

10W Isolated/Non-isolated Proportional High Voltage DC-DC Converter



## PRODUCT OVERVIEW

The VV series are unregulated DC-DC converters in a low 0.500" profile package footprint with up to 10,000V single output models. They can operate over the temperature range of -25°C to +70°C without derating, a heat sink or active cooling.



## FEATURES

- Up to 10W output power
- Output voltage is proportional to input voltage
- Up to 10,000V output models
- Wide input voltage range
- Through hole mounting
- Transformer Isolated modules
- No heat sink or derating required

Contact Pico for part number of available options:

- Expanded operating temp: -55°C to +85°C
- Select screening per MIL-STD-883:
  - Stabilization Bake
  - Temperature Cycle
  - Burn-In
- Special Input Voltage, Output Voltage, Isolation Voltage or Output Power

28	VV	10	-P
INPUT VOLTAGE RANGE	SERIES NAME	MAX. OUTPUT VOLTAGE	OUTPUT ISOLATION (≥6000V OUTPUT VOLT.)
<p>5 = 2/3.5 - 5V</p> <p>9 = 3.5/4 - 9V</p> <p>12 = 4 - 12V</p> <p>15 = 5 - 15V</p> <p>24 = 6 - 24V</p> <p>28 = 7 - 28V</p> <p>48 = 14 - 48V</p>	VV	<p>0.1 = 100V</p> <p>0.2 = 200V</p> <p>0.3 = 300V</p> <p>0.4 = 400V</p> <p>0.5 = 500V</p> <p>0.6 = 600V</p> <p>0.7 = 700V</p> <p>0.8 = 800V</p> <p>0.9 = 900V</p> <p>1 = 1000V</p> <p>2 = 2000V</p> <p>3 = 3000V</p> <p>4 = 4000V</p> <p>5 = 5000V</p> <p>6 = 6000V</p> <p>7 = 7000V</p> <p>8 = 8000V</p> <p>9 = 9000V</p> <p>10 = 10,000V</p>	<p>BLANK = ISOLATED</p> <p>-P = NON-ISOLATED POSITIVE OUTPUT</p> <p>-N = NON-ISOLATED NEGATIVE OUTPUT</p>

**MODEL LIST - ISOLATED OUTPUT**

Pico Part Number	Input Voltage		Output Voltage		Output Current		Output Power [W]	Efficiency <sup>(1)</sup> [%] typ.	Output Ripple <sup>(3)</sup> [%]
	Min. [VDC]	Max. [VDC]	Min. V <sub>IN</sub> [VDC]	Max. V <sub>IN</sub> [VDC]	Min. <sup>(2)</sup> [mA]	Max. <sup>(3,4)</sup> [mA]			
5VV0.1	3.5	5	47	100	3	60	6	74	5
5VV0.2			55	200	1.5	30	6	74	3
5VV0.3			60	300	1	20	6	74	
5VV0.4			65	400	0.75	15	6	74	
5VV0.5			70	500	0.6	12	6	74	
5VV0.6			75	600	0.5	10	6	74	
5VV0.7			78	700	0.43	8.6	6	74	
5VV0.8			80	800	0.38	7.5	6	74	
5VV0.9			85	900	0.33	6.7	6	74	
5VV1	2	5	100	1000	0.3	6	6	76	2
5VV2			250	2000	0.15	3	6	76	
5VV3			300	3000	0.1	2	6	76	
5VV4			550	4000	0.069	1.375	5.5	78	
5VV5			850	5000	0.055	1.1	5.5	78	
5VV6			625	6000	0.042	0.833	5	79	
5VV7			1100	7000	0.036	0.714	5	77	
5VV8			1750	8000	0.031	0.625	5	76	
5VV9			1400	9000	0.028	0.556	5	75	
5VV10			2150	10,000	0.025	0.5	5	75	
9VV0.1	4	9	30	100	3.5	70	7	74	5
9VV0.2			60	200	1.75	35	7	74	3
9VV0.3			90	300	1.17	23.3	7	74	
9VV0.4			120	400	0.88	17.5	7	74	
9VV0.5			150	500	0.7	14	7	74	
9VV0.6			205	600	0.58	11.7	7	74	
9VV0.7			240	700	0.5	10	7	74	
9VV0.8			274	800	0.44	8.8	7	74	
9VV0.9			308	900	0.39	7.8	7	74	
9VV1	3.5	9	75	1000	0.35	7	7	82	2
9VV2			200	2000	0.175	3.5	7	82	
9VV3			400	3000	0.117	2.333	7	78	
9VV4			625	4000	0.088	1.75	7	82	
9VV5			1075	5000	0.06	1.2	6	82	
9VV6			2000	6000	0.05	1	6	82	
9VV7			2250	7000	0.043	0.857	6	80	
9VV8			2500	8000	0.038	0.75	6	79	
9VV9			2900	9000	0.033	0.667	6	77	
9VV10			3100	10,000	0.03	0.6	6	76	

**MODEL LIST - ISOLATED OUTPUT**

Pico Part Number	Input Voltage		Output Voltage		Output Current		Output Power [W]	Efficiency <sup>(1)</sup> [%] typ.	Output Ripple <sup>(3)</sup> [%]
	Min. [VDC]	Max. [VDC]	Min. V <sub>IN</sub> [VDC]	Max. V <sub>IN</sub> [VDC]	Min. <sup>(2)</sup> [mA]	Max. <sup>(3,4)</sup> [mA]			
12VV0.1	4	12	30	100	4	80	8	82	5
12VV0.2			60	200	2	40	8	82	3
12VV0.3			90	300	1.33	26.7	8	82	
12VV0.4			120	400	1	20	8	82	
12VV0.5			150	500	0.8	16	8	84	
12VV0.6			176	600	0.67	13.3	8	84	
12VV0.7			205	700	0.57	11.4	8	84	
12VV0.8			235	800	0.5	10	8	84	
12VV0.9			264	900	0.44	8.9	8	84	
12VV1			100	1000	0.4	8	8	82	
12VV2	175	2000	0.2	4	8	82			
12VV3	350	3000	0.133	2.667	8	82			
12VV4	525	4000	0.088	1.75	7	83			
12VV5	1050	5000	0.06	1.2	6	83			
12VV6	1700	6000	0.05	1	6	83			
12VV7	1900	7000	0.043	0.857	6	81			
12VV8	2100	8000	0.038	0.75	6	79			
12VV9	2200	9000	0.033	0.667	6	77			
12VV10	2100	10,000	0.03	0.6	6	76			
15VV0.1	5	15	30	100	4.25	85	8.5	82	5
15VV0.2			60	200	2.13	42.5	8.5	82	3
15VV0.3			90	300	1.42	28.3	8.5	82	
15VV0.4			120	400	1.06	21.3	8.5	83	
15VV0.5			150	500	0.85	17	8.5	83	
15VV0.6			176	600	0.71	14.2	8.5	83	
15VV0.7			205	700	0.61	12.1	8.5	83	
15VV0.8			235	800	0.53	10.6	8.5	83	
15VV0.9			264	900	0.47	9.4	8.5	83	
15VV1			75	1000	0.425	8.5	8.5	83	
15VV2	200	2000	0.213	4.25	8.5	83			
15VV3	400	3000	0.133	2.667	8	83			
15VV4	600	4000	0.088	1.75	7	81			
15VV5	1050	5000	0.06	1.2	6	81			
15VV6	1700	6000	0.05	1	6	80			
15VV7	1900	7000	0.043	0.857	6	80			
15VV8	2150	8000	0.038	0.75	6	79			
15VV9	2300	9000	0.033	0.667	6	77			
15VV10	2200	10,000	0.03	0.6	6	76			

**MODEL LIST - ISOLATED OUTPUT**

Pico Part Number	Input Voltage		Output Voltage		Output Current		Output Power [W]	Efficiency <sup>(1)</sup> [%] typ.	Output Ripple <sup>(3)</sup> [%]
	Min. [VDC]	Max. [VDC]	Min. V <sub>IN</sub> [VDC]	Max. V <sub>IN</sub> [VDC]	Min. <sup>(2)</sup> [mA]	Max. <sup>(3,4)</sup> [mA]			
24VV0.1	7	24	23	100	4.5	90	9	83	5
24VV0.2			48	200	2.25	45	9	83	3
24VV0.3			70	300	1.5	30	9	83	
24VV0.4			95	400	1.13	22.5	9	83	
24VV0.5			100	500	0.9	18	9	83	
24VV0.6			132	600	0.75	15	9	83	
24VV0.7			154	700	0.64	12.9	9	83	
24VV0.8			176	800	0.56	11.3	9	83	
24VV0.9			198	900	0.5	10	9	83	
24VV1			75	1000	0.45	9	9	84	
24VV2			175	2000	0.225	4.5	9	84	
24VV3			200	3000	0.15	3	9	82	
24VV4			400	4000	0.1	2	8	82	
24VV5			1075	5000	0.06	1.2	6	82	
24VV6			1400	6000	0.05	1	6	81	
24VV7			1600	7000	0.043	0.857	6	81	
24VV8			1750	8000	0.038	0.75	6	80	
24VV9			1800	9000	0.033	0.667	6	78	
24VV10			1500	10,000	0.03	0.6	6	77	
28VV0.1			8	28	23	100	5	100	10
28VV0.2	48	200			2.5	50	10	83	3
28VV0.3	70	300			1.67	33.3	10	83	
28VV0.4	95	400			1.25	25	10	83	
28VV0.5	120	500			1	20	10	83	
28VV0.6	132	600			0.83	16.7	10	83	
28VV0.7	154	700			0.71	14.3	10	83	
28VV0.8	176	800			0.63	12.5	10	83	
28VV0.9	198	900			0.56	11.1	10	83	
28VV1	75	1000			0.5	10	10	83	
28VV2	175	2000			0.25	5	10	83	
28VV3	250	3000			0.167	3.333	10	83	
28VV4	375	4000			0.1	2	8	82	
28VV5	1100	5000			0.06	1.2	6	82	
28VV6	1350	6000			0.05	1	6	82	
28VV7	1500	7000			0.043	0.857	6	80	
28VV8	1600	8000			0.038	0.75	6	79	
28VV9	1800	9000			0.033	0.667	6	78	
28VV10	2200	10,000			0.03	0.6	6	77	

**MODEL LIST - ISOLATED OUTPUT**

Pico Part Number	Input Voltage		Output Voltage		Output Current		Output Power [W]	Efficiency <sup>(1)</sup> [%] typ.	Output Ripple <sup>(3)</sup> [%]
	Min. [VDC]	Max. [VDC]	Min. V <sub>IN</sub> [VDC]	Max. V <sub>IN</sub> [VDC]	Min. <sup>(2)</sup> [mA]	Max. <sup>(3,4)</sup> [mA]			
48VV0.1	15	48	27	100	4	80	8	81	5
48VV0.2			50	200	2	40	8	81	3
48VV0.3			73	300	1.33	26.7	8	81	
48VV0.4			98	400	1	20	8	81	
48VV0.5			140	500	0.8	16	8	84	
48VV0.6			154	600	0.67	13.3	8	84	
48VV0.7			180	700	0.57	11.4	8	84	
48VV0.8			205	800	0.5	10	8	84	
48VV0.9			208	900	0.44	8.9	8	84	
48VV1			15	48	75	1000	0.4	8	
48VV2	200	2000			0.2	4	8	80	
48VV3	450	3000			0.133	2.667	8	80	
48VV4	400	4000			0.1	2	8	80	
48VV5	1075	5000			0.06	1.2	6	80	
48VV6	1600	6000			0.05	1	6	80	
48VV7	1700	7000			0.043	0.857	6	79	
48VV8	1850	8000			0.038	0.75	6	79	
48VV9	2000	9000			0.033	0.667	6	78	
48VV10	2200	10,000			0.03	0.6	6	77	

Note 1: Tested at maximum input voltage and full output load.

Note 2: Maintain minimum 5% of rated load to prevent a voltage surge.

Note 3: For  $\leq 900V$  output models, a  $0.1\mu F$ , 2kV high quality ceramic capacitor is required across the output.

Note 4: Unit is capable of sourcing max output current over the entire output voltage range.

Note 5: For isolated models, input ground and output ground is not connected internally. Input ground and output ground can not be connected anywhere in the circuit.

## MODEL LIST - NON-ISOLATED POSITIVE OUTPUT

Pico Part Number	Input Voltage		Output Voltage		Output Current		Output Power [W]	Efficiency <sup>(1)</sup> [%] typ.	Output Ripple <sup>(3)</sup> [%]
	Min. [VDC]	Max. [VDC]	Min. V <sub>IN</sub> [VDC]	Max. V <sub>IN</sub> [VDC]	Min. <sup>(2)</sup> [mA]	Max. <sup>(3,4)</sup> [mA]			
5VV6-P	2	5	+625	+6000	0.042	0.833	5	79	2
5VV7-P			+1100	+7000	0.036	0.714		77	
5VV8-P			+1750	+8000	0.031	0.625		76	
5VV9-P			+1400	+9000	0.028	0.556		75	
5VV10-P			+2150	+10000	0.025	0.5		75	
9VV6-P	3.5	9	+2000	+6000	0.05	1	6	82	2
9VV7-P			+2250	+7000	0.043	0.857		80	
9VV8-P			+2500	+8000	0.038	0.75		79	
9VV9-P			+2900	+9000	0.033	0.667		77	
9VV10-P			+3100	+10000	0.03	0.6		76	
12VV6-P	4	12	+1700	+6000	0.05	1	6	83	2
12VV7-P			+1900	+7000	0.043	0.857		81	
12VV8-P			+2100	+8000	0.038	0.75		79	
12VV9-P			+2200	+9000	0.033	0.667		77	
12VV10-P			+2100	+10000	0.03	0.6		76	
15VV6-P	5	15	+1700	+6000	0.05	1	6	80	2
15VV7-P			+1900	+7000	0.043	0.857		80	
15VV8-P			+2150	+8000	0.038	0.75		79	
15VV9-P			+2300	+9000	0.033	0.667		77	
15VV10-P			+2200	+10000	0.03	0.6		76	
24VV6-P	7	24	+1400	+6000	0.05	1	6	81	2
24VV7-P			+1600	+7000	0.043	0.857		81	
24VV8-P			+1750	+8000	0.038	0.75		80	
24VV9-P			+1800	+9000	0.033	0.667		78	
24VV10-P			+1500	+10000	0.03	0.6		77	
28VV6-P	8	28	+1350	+6000	0.05	1	6	82	2
28VV7-P			+1500	+7000	0.043	0.857		80	
28VV8-P			+1600	+8000	0.038	0.75		79	
28VV9-P			+1800	+9000	0.033	0.667		78	
28VV10-P			+2200	+10000	0.03	0.6		77	
48VV6-P	15	48	+1600	+6000	0.05	1	6	80	2
48VV7-P			+1700	+7000	0.043	0.857		79	
48VV8-P			+1850	+8000	0.038	0.75		79	
48VV9-P			+2000	+9000	0.033	0.667		78	
48VV10-P			+2200	+10000	0.03	0.6		77	

Note 1: Tested at maximum input voltage and full output load.

Note 2: Maintain minimum 5% of rated load to prevent a voltage surge.

Note 4: Unit is capable of sourcing max output current over the entire output voltage range.

Note 6: For non-isolated positive models, output COM terminal must be connected to input positive or input negative externally. Output will be positive voltage and non-isolated from input. Module is internally transformer isolated.

## MODEL LIST - NON-ISOLATED NEGATIVE OUTPUT

Pico Part Number	Input Voltage		Output Voltage		Output Current		Output Power [W]	Efficiency <sup>(1)</sup> [%] typ.	Output Ripple <sup>(3)</sup> [%]
	Min. [VDC]	Max. [VDC]	Min. V <sub>IN</sub> [VDC]	Max. V <sub>IN</sub> [VDC]	Min. <sup>(2)</sup> [mA]	Max. <sup>(3,4)</sup> [mA]			
5V6-N	2	5	-625	-6000	0.042	0.833	5	79	2
5V7-N			-1100	-7000	0.036	0.714		77	
5V8-N			-1750	-8000	0.031	0.625		76	
5V9-N			-1400	-9000	0.028	0.556		75	
5V10-N			-2150	-10,000	0.025	0.5		75	
9V6-N	3.5	9	-2000	-6000	0.05	1	6	82	2
9V7-N			-2250	-7000	0.043	0.857		80	
9V8-N			-2500	-8000	0.038	0.75		79	
9V9-N			-2900	-9000	0.033	0.667		77	
9V10-N			-3100	-10,000	0.03	0.6		76	
12V6-N	4	12	-1700	-6000	0.05	1	6	83	2
12V7-N			-1900	-7000	0.043	0.857		81	
12V8-N			-2100	-8000	0.038	0.75		79	
12V9-N			-2200	-9000	0.033	0.667		77	
12V10-N			-2100	-10,000	0.03	0.6		76	
15V6-N	5	15	-1700	-6000	0.05	1	6	80	2
15V7-N			-1900	-7000	0.043	0.857		80	
15V8-N			-2150	-8000	0.038	0.75		79	
15V9-N			-2300	-9000	0.033	0.667		77	
15V10-N			-2200	-10,000	0.03	0.6		76	
24V6-N	7	24	-1400	-6000	0.05	1	6	81	2
24V7-N			-1600	-7000	0.043	0.857		81	
24V8-N			-1750	-8000	0.038	0.75		80	
24V9-N			-1800	-9000	0.033	0.667		78	
24V10-N			-1500	-10,000	0.03	0.6		77	
28V6-N	8	28	-1350	-6000	0.05	1	6	82	2
28V7-N			-1500	-7000	0.043	0.857		80	
28V8-N			-1600	-8000	0.038	0.75		79	
28V9-N			-1800	-9000	0.033	0.667		78	
28V10-N			-2200	-10,000	0.03	0.6		77	
48V6-N	15	48	-1600	-6000	0.05	1	6	80	2
48V7-N			-1700	-7000	0.043	0.857		79	
48V8-N			-1850	-8000	0.038	0.75		79	
48V9-N			-2000	-9000	0.033	0.667		78	
48V10-N			-2200	-10,000	0.03	0.6		77	

Note 1: Tested at maximum input voltage and full output load.

Note 2: Maintain minimum 5% of rated load to prevent a voltage surge.

Note 4: Unit is capable of sourcing max output current over the entire output voltage range.

Note 7: For non-isolated negative models, output COM terminal must be connected to input positive or input negative externally. Output will be negative voltage and non-isolated from input. Module is internally transformer isolated.

## SPECIFICATIONS (Max. $V_{IN}$ , Full Load, $T_A = +25^{\circ}\text{C}$ , 1 hour warm up unless otherwise specified)

### INPUT

Parameter	Condition	Min.	Typ.	Max.	Units	
Input Voltage Range	5V input models	$\leq 900\text{V}$ Output models	3.5	5	5	
		$\geq 1\text{kV}$ output models	2			
	9V input models	$\leq 900\text{V}$ Output models	4	9	9	
		$\geq 1\text{kV}$ output models	3.5			
		12V input models	4	12	12	VDC
		15V input models	5	15	15	
		24V input models	7	24	24	
		28V input models	8	28	28	
	48V input models	15	48	48		

### OUTPUT

Parameter	Condition	Min.	Typ.	Max.	Units	
Line Regulation	Output voltage is proportional to input voltage					
Output Voltage Tolerance	Nominal $V_{IN}$ , Full Load	5V models	-	-	5	$\pm\%$
		All other models	-	-	3	$\pm\%$

### ENVIRONMENTAL

Parameter	Condition	Min.	Typ.	Max.	Units
Operating Temperature Range	Ambient without derating	-25	-	+70	$^{\circ}\text{C}$
Storage Temperature Range	Ambient	-55	-	+125	$^{\circ}\text{C}$
Temperature Coefficient		-	0.02	-	$\%/^{\circ}\text{C}$
Cooling	Free Air Convection				

### GENERAL

Parameter	Condition	Min.	Typ.	Max.	Units	
Operating Frequency	Min $V_{IN}$ to max $V_{IN}$	$\leq 900\text{V}$ output models	8	-	25	kHz
		$\geq 1\text{kV}$ output models	15	-	25	
Isolation Voltage	Input to output, model dependent	1500	-	3600	VDC	
Insulation Resistance		100	-	-	$\text{M}\Omega$	
Size (L x W x H)		2.25 x 1.125 x 0.5 (57.15 x 28.575 x 12.7)			inches (mm)	
Weight		-	45	-	grams	
Case	Glass Reinforced Polymer					
Potting	Vacuum Impregnated Epoxy					
Box Packaging (W x L x H)	8 x 7.5 x 1.5 (203.2 x 190.5 x 38.1) or 12 x 9 x 1.5 (304.8 x 228.6 x 38.1)				inches (mm)	

### 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

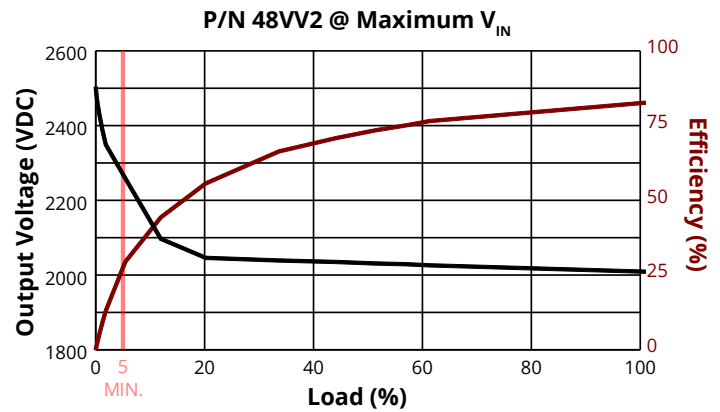
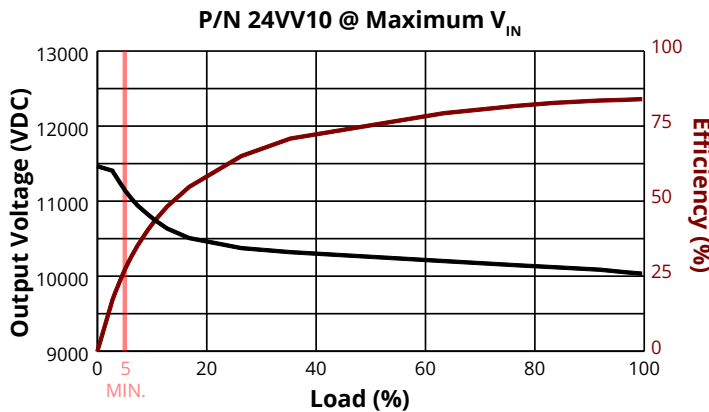
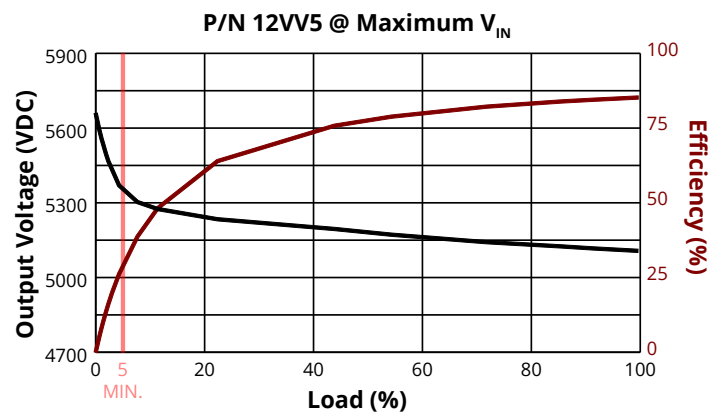
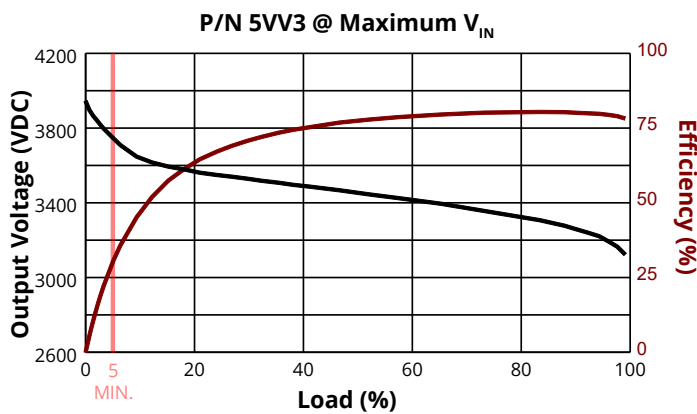


## SPECIFICATIONS (Max. $V_{IN}$ , Full Load, $T_A = +25^\circ\text{C}$ , 1 hour warm up unless otherwise specified)

### OPTIONS AVAILABLE - CONTACT PICO FOR PART NUMBER

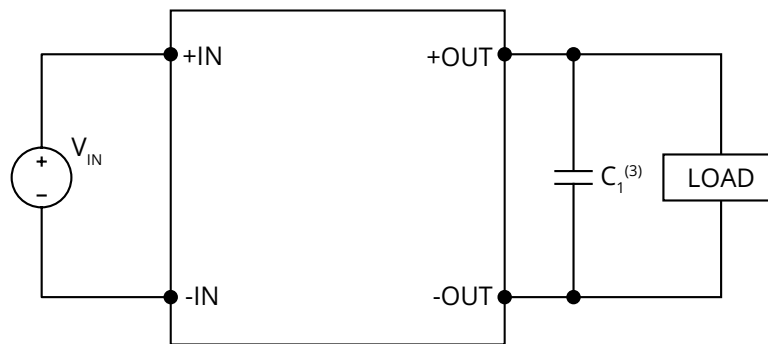
Parameter	Referenced Standard	Description
Stabilization Bake	MIL-STD-883	Referenced Method 1008 Non-operating maximum storage temperature for 24 hours
Temperature Cycle	MIL-STD-883	Referenced Method 1010 Non-operating at temperature extremes, 15 mins/temp, 10 cycles
Burn-In	MIL-STD-883	Referenced Method 1015 Max operating temperature for 160 hours
Expanded Ambient Operating Temperature		-55°C to +85°C

## DATA CURVES (Max. $V_{IN}$ , $T_A = +25^\circ\text{C}$ , 1 hour warm up unless otherwise specified)

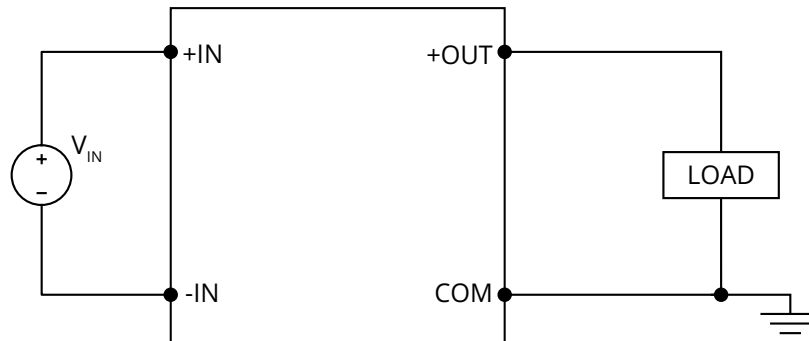


**TYPICAL CONNECTION DIAGRAM**

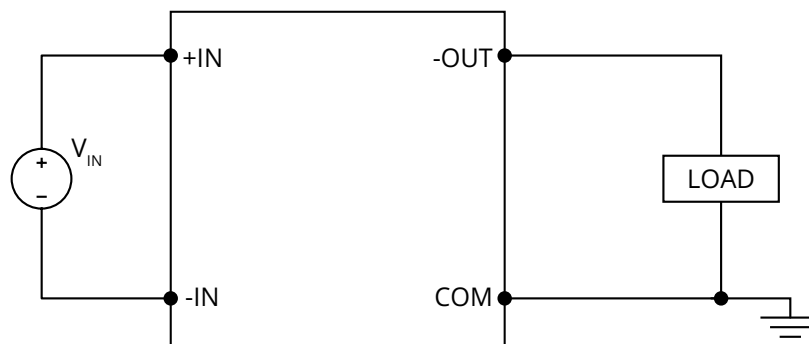
**ISOLATED MODELS**



**NON-ISOLATED POSITIVE MODELS**



**NON-ISOLATED NEGATIVE MODELS**



Note 3: For  $\leq 900V$  output models, 0.1 $\mu F$ , 2kV high quality ceramic capacitor is required across the output.

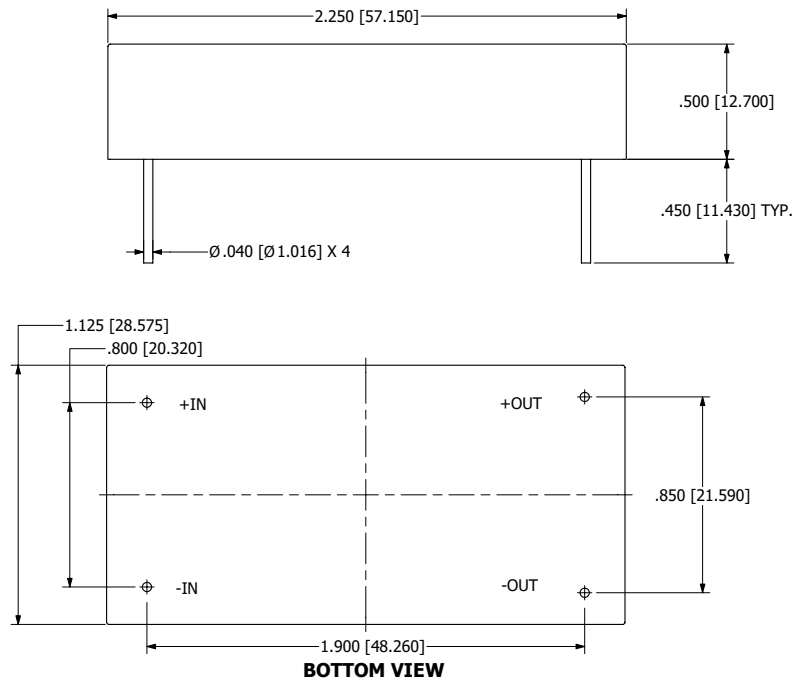
Note 5: For isolated models, input ground and output ground is not connected internally. Input ground and output ground can not be connected anywhere in the circuit.

Note 6: For non-isolated positive models, output COM terminal must be connected to input positive or input negative externally. Output will be positive voltage and non-isolated from input. Module is internally transformer isolated.

Note 7: For non-isolated negative models, output COM terminal must be connected to input positive or input negative externally. Output will be negative voltage and non-isolated from input. Module is internally transformer isolated.

## MECHANICAL DRAWINGS

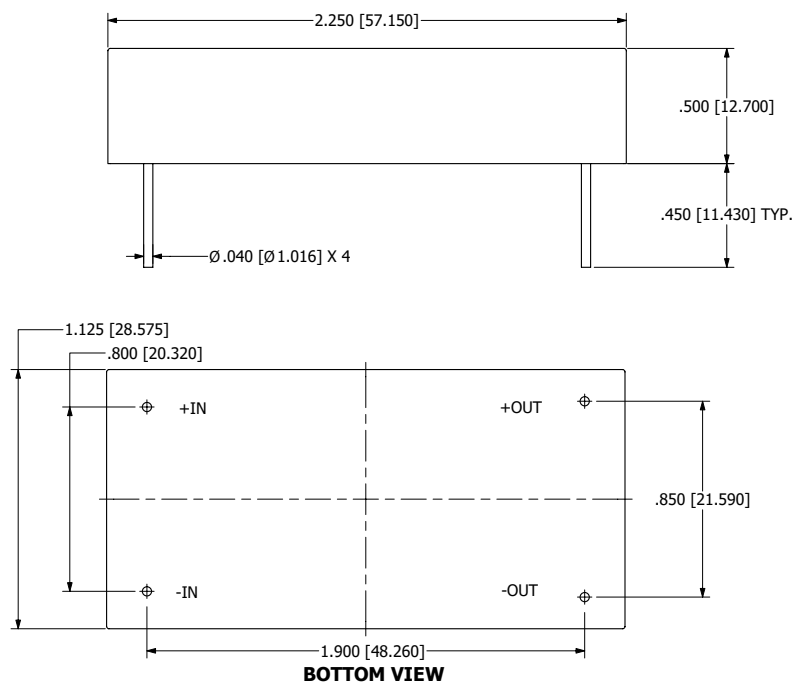
### ≤5000V OUTPUT MODELS



#### NOTES

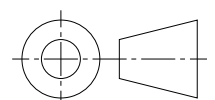
- a. ALL DIMENSIONS ARE IN INCHES, [ ] = MM
- b. INPUT GROUND AND OUTPUT GROUND MAY BE CONNECTED.

### ≥6000V ISOLATED OUTPUT MODELS



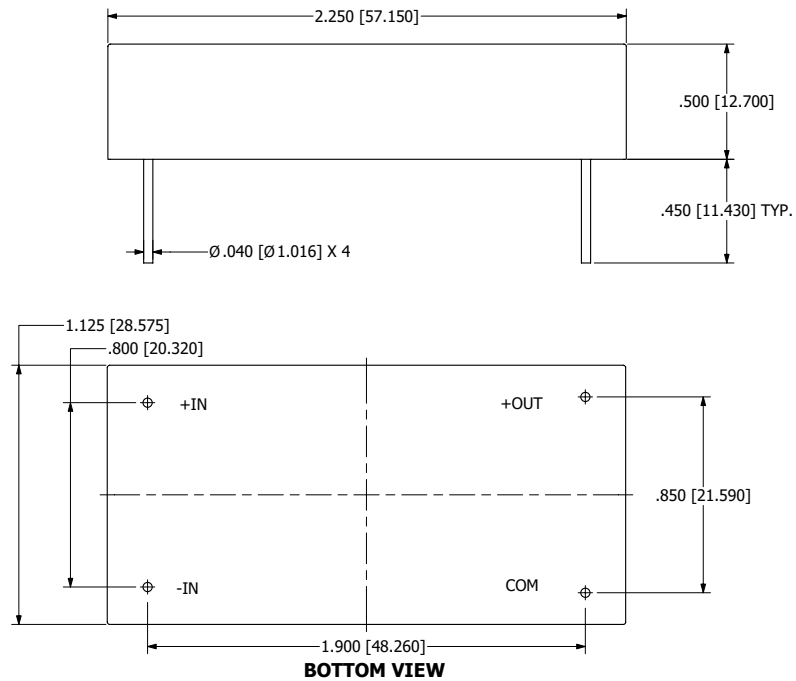
#### NOTES

- a. ALL DIMENSIONS ARE IN INCHES, [ ] = MM
- b. INPUT GROUND AND OUTPUT GROUND MUST NOT BE ANYWHERE IN THE CIRCUIT.
- c. FOR ≥6000V OUTPUT MODELS, OUTPUT IS FLOATING.



## MECHANICAL DRAWINGS

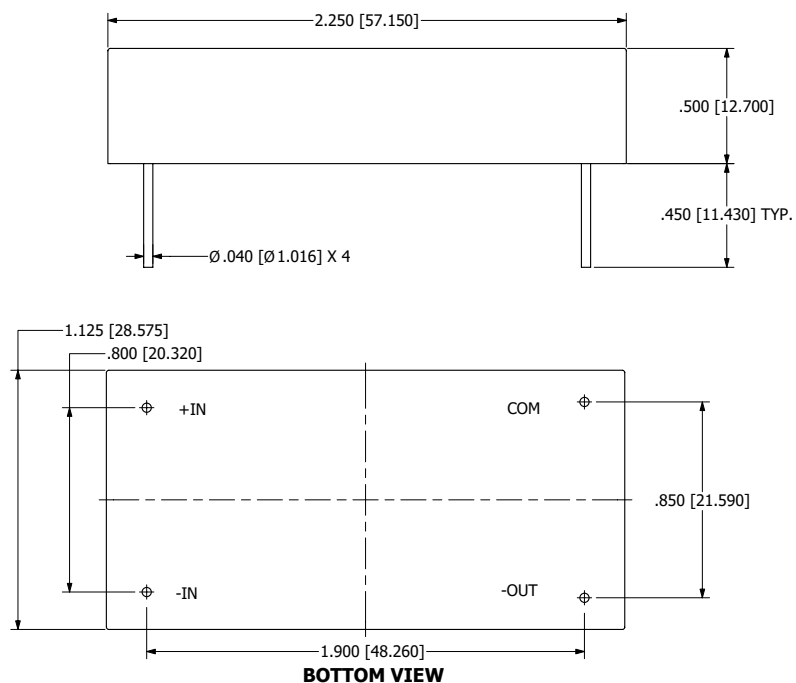
### ≥6000V NON-ISOLATED POSITIVE OUTPUT MODELS



#### NOTES

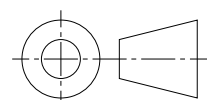
- a. ALL DIMENSIONS ARE IN INCHES, [ ] = MM
- b. COMMON OUTPUT MUST BE CONNECTED TO +IN OR -IN INPUT.
- c. OUTPUT IS POSITIVE.

### ≥6000V NON-ISOLATED NEGATIVE OUTPUT MODELS

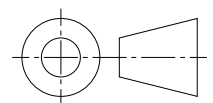
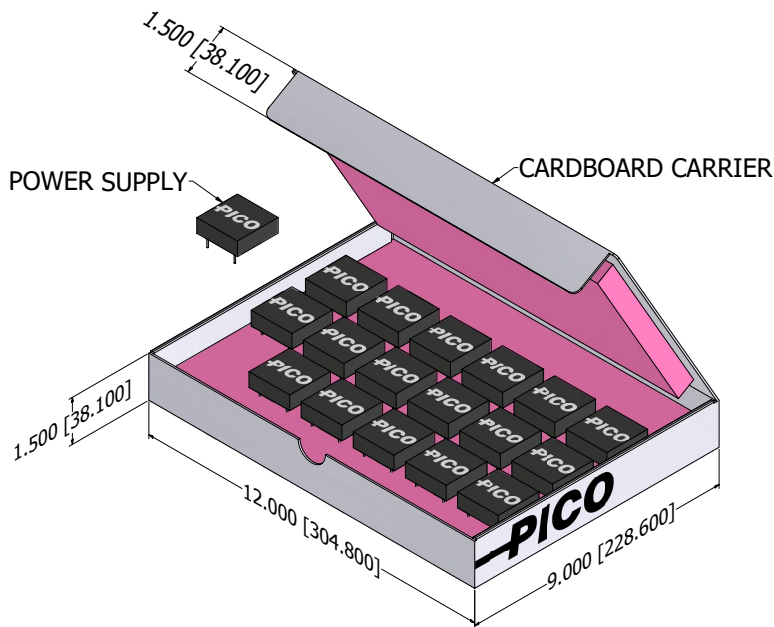
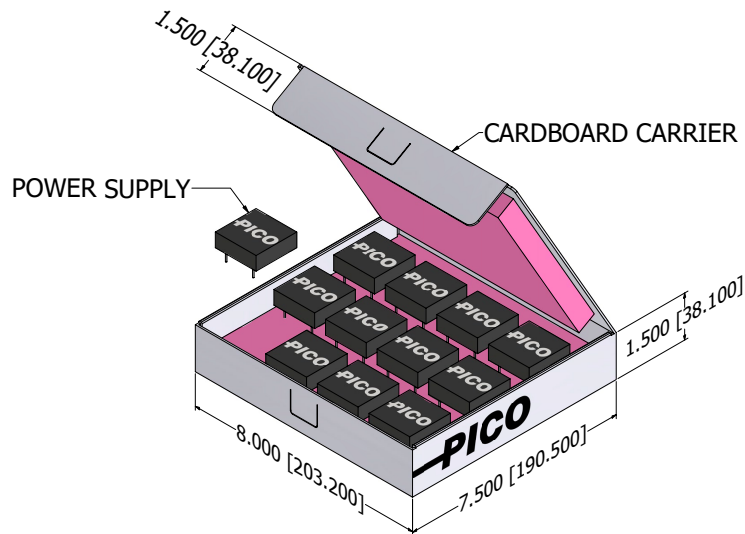


#### NOTES

- a. ALL DIMENSIONS ARE IN INCHES, [ ] = MM
- b. COMMON OUTPUT MUST BE CONNECTED TO +IN OR -IN INPUT.
- c. OUTPUT IS NEGATIVE.



**BOX PACKAGING - BULK**



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