



PHI-CON

60 W DC-DC Converter P60D-Series

- 4:1 wide input voltage range
- High efficiency up to 93 %
- Over current protection
- Over voltage protection
- Over temperature protection
- Continuous short circuit protection
- Adjustable output voltage
- On/Off - remote control input
- Standard package 2" x 1"



Model guide

Type	Input voltage		Input current		Output voltage [V _{DC}]	Output current		Efficiency typ. [%]	Capacity load [μF] max
	nominal [V _{DC}]	range [V _{DC}]	no load [mA] max.	full load [mA] typ.		[mA] min.	[mA] max.		
P60D2405S	24	9...36	25	2700	5.0	0	12000	92.5	30000
P60D2412S	24	9...36	25	2700	12.0	0	5000	92.5	5800
P60D2415S	24	9...36	25	2690	15.0	0	4000	93	3900
P60D4805S	48	18...75	25	1345	5.0	0	12000	93	30000
P60D4812S	48	18...75	25	1350	12.0	0	5000	92.5	5800
P60D4815S	48	18...75	25	1345	15.0	0	4000	93	3900
P60D2412D	24	9...36	40	2750	±12.0	0	±2500	91	2 x 3900
P60D2415D	24	9...36	50	2745	±15.0	0	±2000	91	2 x 2400
P60D4812D	48	18...75	40	1375	±12.0	0	±2500	91	2 x 3900
P60D4815D	48	18...75	50	1375	±15.0	0	±2000	91	2 x 2400

Specifications

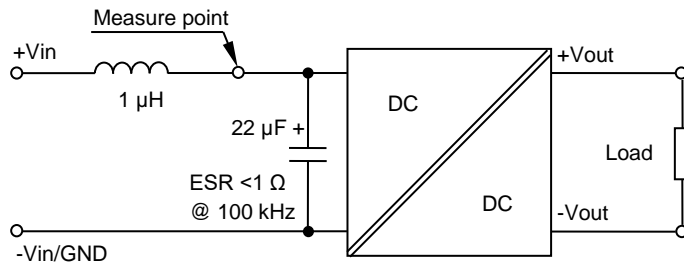
Input	
Start up voltage	P60D24xxx: 8.6 V, typ. P60D48xxx: 17.8 V, typ.
Under voltage lockout	P60D24xxx: 7.9 V, typ. P60D48xxx: 16 V, typ.
Start up time at Vin nominal and constant resistive load	60 ms, typ.
Input Filter	Pi- type
Input reflected ripple current	20 mA _{p-p} , typ (see figure 1)
Remote control input Pin 3 (see figure 4a & 4b)	"On" 3.0...12 V or open input "Off" 0...1.2 V
Input idle current at Ctrl "Off"	5 mA, typ.
Isolation input to output	
Isolation voltage, Input to output or to case, 1 minute tested	1600 V _{DC} , min.
Resistance	10 ³ Ω, min.
Capacitance	2200 pF, typ.
Output	
Voltage tolerance	±1 %
Voltage trim range	±10 %, max. (see figure 5)
Line regulation	± 0.5 %, max.
Load voltage regulation @ 0...100% load change	Single output: ± 0.5 % Dual output: ± 1 %
Dual output cross deviation	± 5 % @ 75 % load difference
Ripple and noise (at 20 MHz BW)	100 mV _{p-p} , max. (see figure 2)
Over voltage protection with Z-diode clamp	P60Dxx05x: 6.2 V P60Dxx12x: 15 V P60Dxx15x: 20 V
Over current protection	140 %, max. of full load
Short circuit protection	Continuous, hiccup, automatic restart
Temperature coefficient	± 0.02 % / °C
Transient recovery time	250 μs, typ. @ 25 % load change steps
Transient response deviation	± 3 %, max. @ 25 % load change steps

General	
Switching frequency	225 kHz, typ.
Standard in accordance with	EN-, IEC-, UL-, ULc 60950-1 EN-, IEC, UL-, ULc 62368-1
Radiated emissions	EN55032 level A (see fig. 3)
Conducted emissions	EN55032 level A (see fig. 3)
ESD	IEC61000-4-2 pref. criteria A
Radiated immunity	IEC61000-4-3 pref. criteria A
Fast transient (see figure 3)	IEC61000-4-4 pref. criteria A
Surge (see figure 3)	IEC61000-4-5 pref. criteria A
Conducted immunity	IEC61000-4-6 pref. criteria A
PFMF	IEC61000-4-8 pref. criteria A
Reliability calculated (MIL-HDBK-217 F) @ 25 °C	MTBF > 210 000 h
Environmental	
Operating ambient temperature	-40 ...85 °C (with derating) -40 ...50 °C (without derating)
Storage temperature	-55 ...125 °C
Thermal impedance	P60DxxxxS(D): 9.5 K/W, typ. P60DxxxxSK(DK): 8.5 K/W, typ.
Cooling	Air convection 35..60 LFM (16...33 cm/s)
Maximum case temperature	110 °C, max.
Over temperature protection	at 115 °C case, typ
Storage humidity	95 %, non condensing
Physical	
Dimensions	Without heat sink: 50.8 x 25.4 x 12 mm With heat sink: 50.8 x 25.4 x 18.1 mm
Weight	P60DxxxxS(D): 45 g P60DxxxxSK(DK): 56 g
Case material	Copper
Potting material	Epoxy, UL94V-0 rated
RoHS compliant	yes
Absolute maximum ratings	
Input surge voltage 100 ms max.	P60D24xx: 50 V _{DC} P60D48xx: 100 V _{DC}
Soldering temperature	≤ 260 °C, ≤ 10 s, ≥ 1.5 mm distance from case

Part number designation key									
PHI-CON	Output power		Series designation	Input voltage range		Output voltage		Output configuration	
P	60	60 W	D	24	9...36 V	5	5 V	S	single output
				48	18...75 V	12	12 V	D	dual output
						15	15 V	SK	single output heat sink
								DK	dual output heat sink

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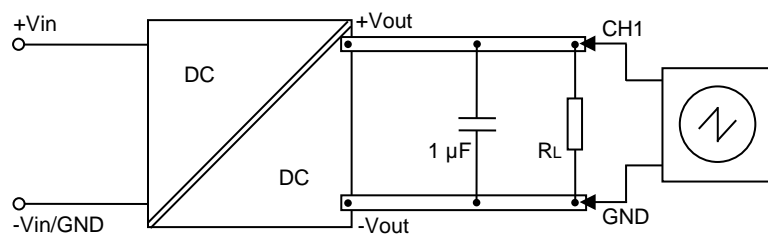
Figure 1 Input reflected ripple current measure circuit



The input reflected ripple current is measured through a source inductor 1 µH and a source capacitor C_{in} 22 µF, ESR < 1 Ω at 100 kHz at nominal input voltage and full load.

Figure 2 Output ripple & noise measure circuits

Single output



Dual output

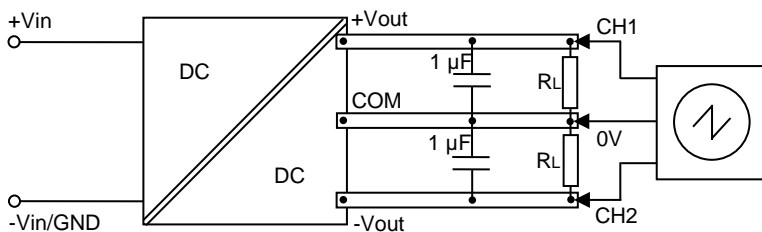
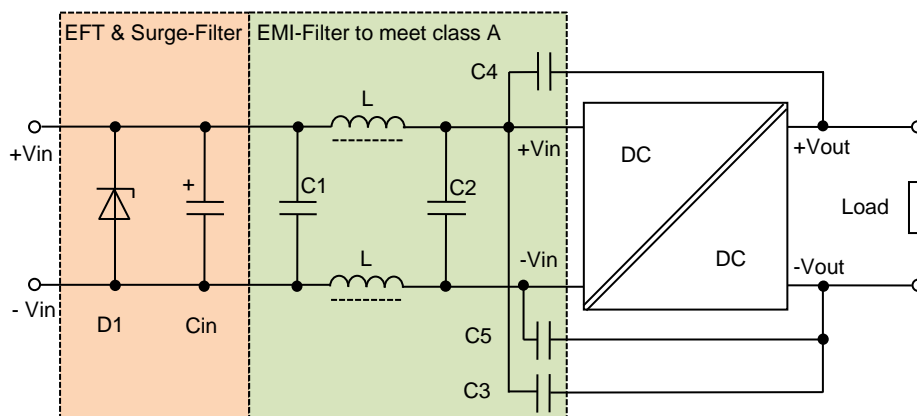


Figure 3a Recommended circuit to meet (EFT) IEC61000-4-4, (Surge) IEC61000-4-5 and (EMI) EN55032

Single output P60DxxxxS



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Figure 3b Recommended circuit to meet (EFT) IEC61000-4-4, (Surge) IEC61000-4-5 and (EMI) EN55032

Dual output P60DxxxxD

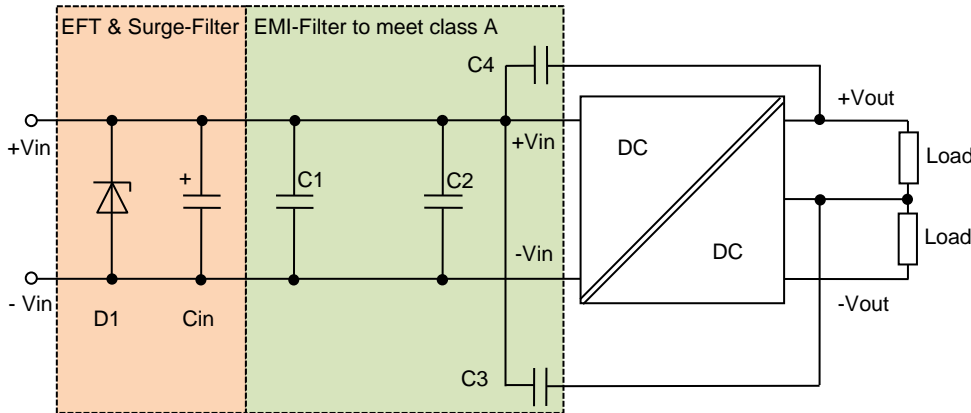


Table to Figure 3a and 3b								
Converter	D1 (TVS)	Cin	C1 (MLCC)	L	C2 (MLCC)	C3 (MLCC)	C4 (MLCC)	C5 (MLCC)
P60D24xxS	58 V, 3 kW	330 μ F, 100 V	4.7 μ F, 50 V	12 μ F	4.7 μ F, 50 V	470 pF, 2 kV	1 nF, 2 kV	1 nF, 2 kV
P60D48xxS	120 V, 3 kW	330 μ F, 100 V	1.5 μ F, 100 V	12 μ F	1.5 μ F, 100 V	470 pF, 2 kV	1 nF, 2 kV	1 nF, 2 kV
P60D24xxD	58 V, 3 kW	330 μ F, 100 V	4.7 μ F, 50 V	-	4.7 μ F, 50 V	220 pF, 2 kV	1.5 nF, 2 kV	1.5 nF, 2 kV
P60D48xxD	120 V, 3 kW	330 μ F, 100 V	1.5 μ F, 100 V	-	1.5 μ F, 100 V	220 pF, 2 kV	1.5 nF, 2 kV	1.5 nF, 2 kV

Figure 4a On / Off remote control circuit for positive logic

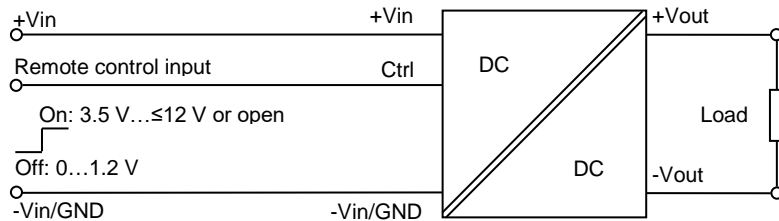


Figure 4b On / Off remote control circuit for inverse logic

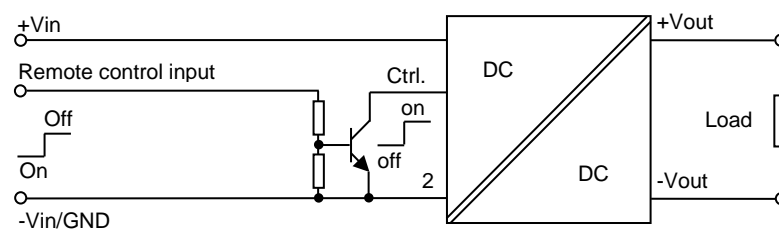
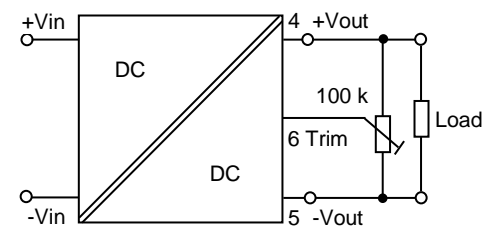


Figure 5 Trimming circuit. Only at single output models possible. Maximum trim range $\pm 10\%$.

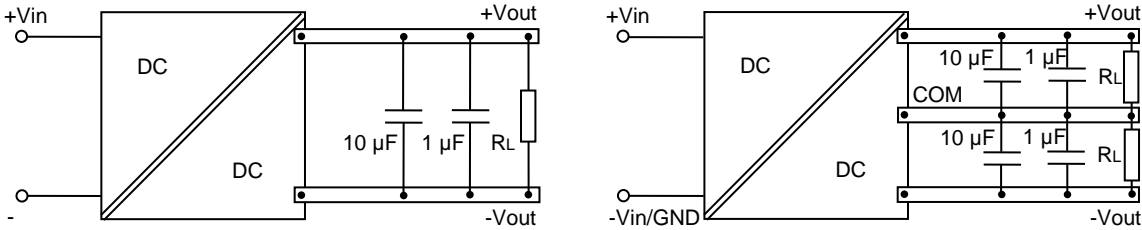




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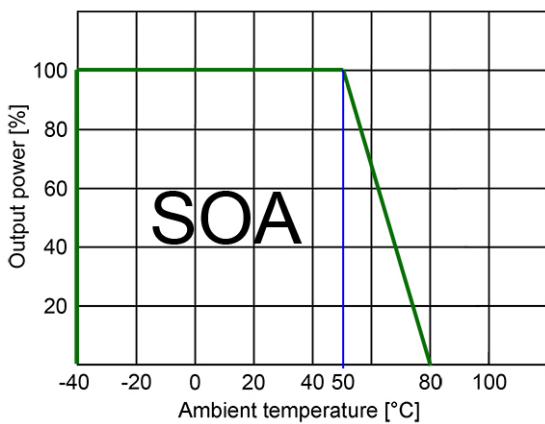
Recommended circuit with multi layer ceramic capacitors to reduce the ripple and noise output level



Save operating areas P60D2412S(D), P60D2415S(D), P60D4805S, P60D4812S(D), P60D4815S(D)

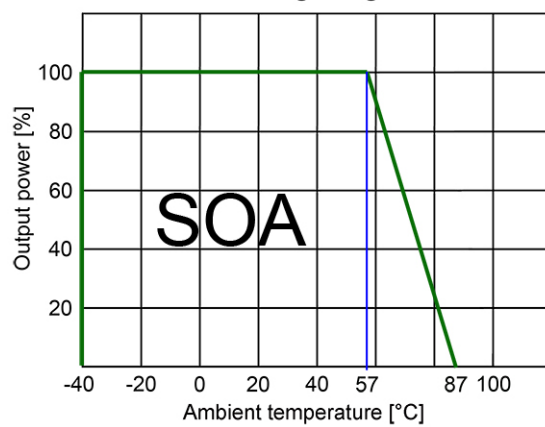
Standard version without heat sink

Derating diagram



Heat sink version

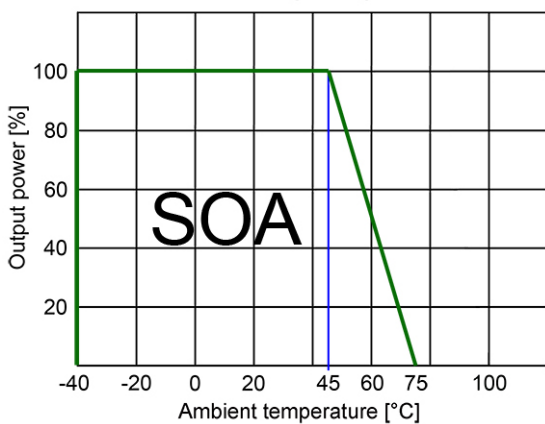
Derating diagram



Save operating areas P60D2405S

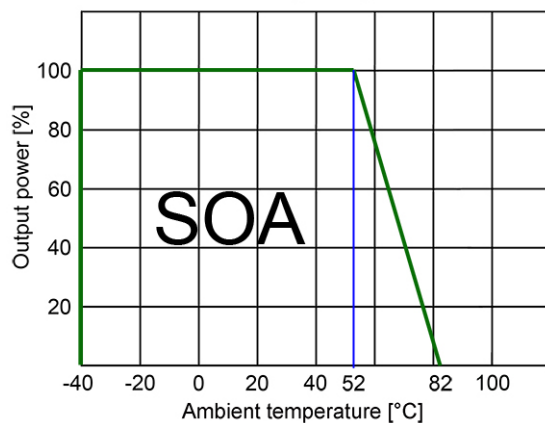
Standard version without heat sink

Derating diagram



Heat sink version

Derating diagram



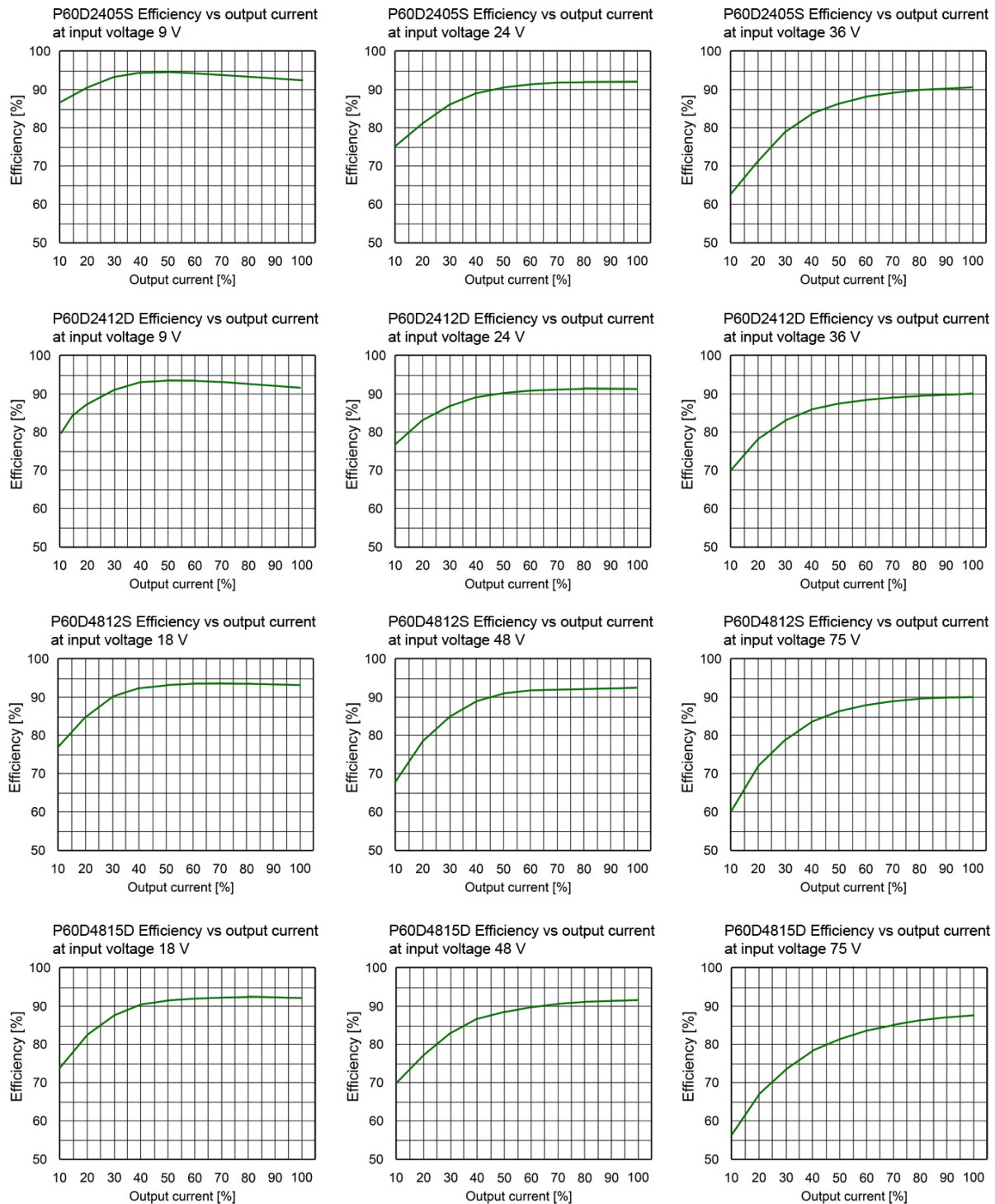
Notes.

1. All parameter are specified at 25 °C, nominal input voltage and full resistive load
2. The converters are not usable for parallel output operation and hot swap connection!



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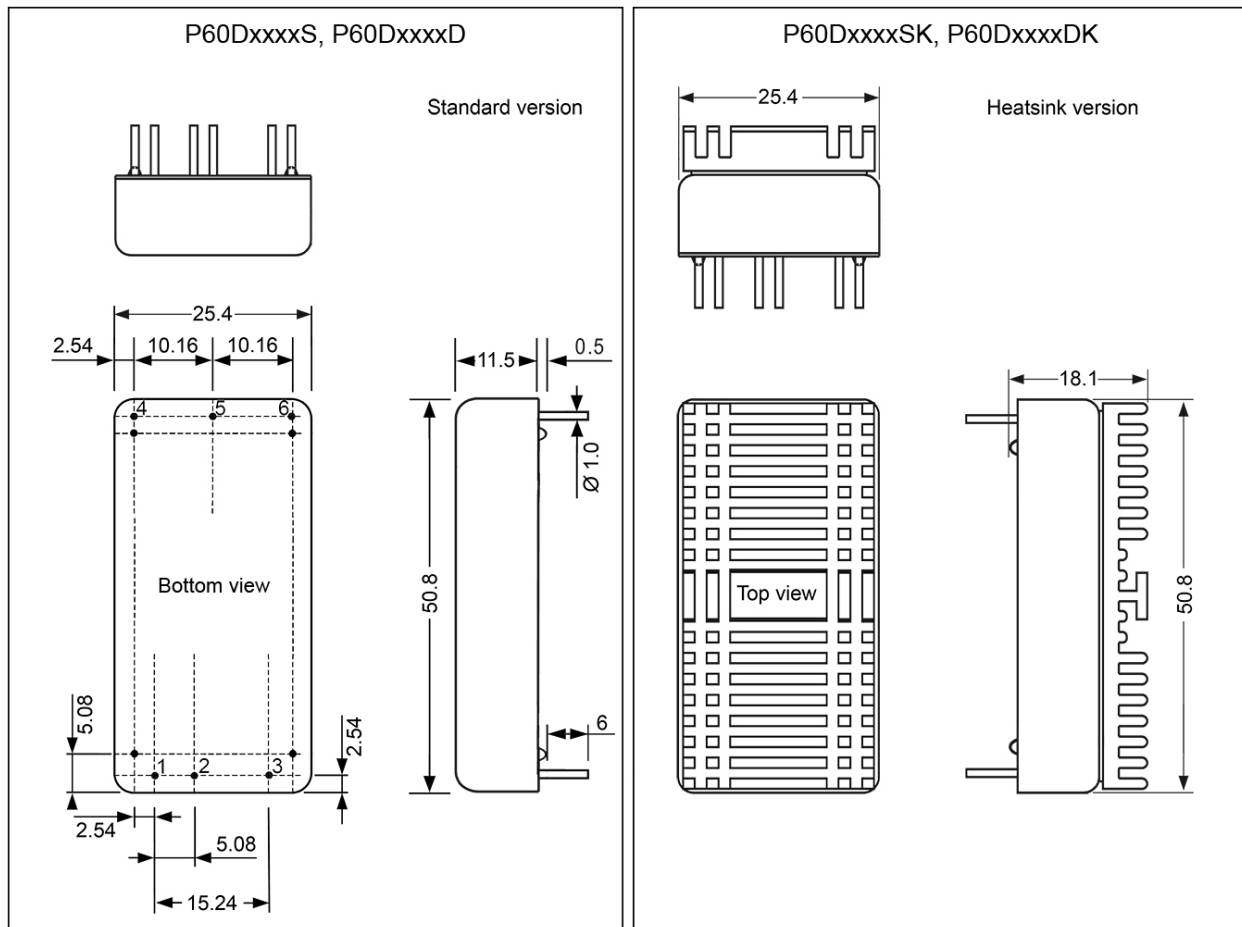




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Dimensions



Dimensions in mm

1. Pin diameter tolerance: ± 0.05 mm
2. Pin length tolerance: ± 0.35 mm
3. Pin Pitch tolerance: ± 0.35 mm
4. Case tolerance: ± 0.5 mm
5. Stand off tolerance: ± 0.1 mm

Pin assignment		
	Single out	Dual out
1	+Vin	+Vin
2	-Vin	-Vin
3	Rem. Ctrl.	Rem. Ctrl.
4	+ Vout	+ Vout
5	- Vout	Com
6	Trim	- Vout

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