

PMF 4218 T 3.3-V Input



10-A, 3.3-V Input Non-Isolated Step-Down Switching Power Module

POLA code: PTH03060 W



NOMINAL SIZE = 1 in x 0.62 in
(25,4 mm x 15,75 mm)

Features

- Up to 10-A Output Current
- 3.3-V Input Voltage
- Wide-Output Voltage Adjust (0.8 V to 2.5 V)
- Efficiencies up to 96 %
- 114 W/in³ Power Density
- On/Off Inhibit
- Output Voltage Sense
- Pre-Bias Startup
- Margin Up/Down Controls
- Under-Voltage Lockout
- Auto-Track™ Sequencing⁽¹⁾
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- Operating Temp: -40 to +85 °C
- DSP Compatible Output Voltages
- Safety Agency Approvals: UL 1950, CSA 22.2 950, EN60950 VDE (Pending)
- Point-of-Load Alliance (POLA) Compatible

Note: ⁽¹⁾ Auto-Track™ is a trademark of Texas Instruments

Description

The PMF 4218T non-isolated power module is small in size but big on performance and flexibility. Its high output current, compact footprint, and industry-leading features offers system designers a versatile module for powering complex multi-processor digital systems.

This product employs double-sided surface mount construction and provides high-performance step-down power conversion for up to 10 A of output current from a 3.3-V input bus voltage. The output voltage is adjustable and can be set to any value over the range, 0.8 V to 2.5 V, using a single resistor.

This series includes Auto-Track™ Sequencing. Auto-Track simplifies the task of supply voltage sequencing in a power system by enabling modules to track each other, or any external voltage, during power up and power down.

Other operating features include an on/off inhibit, margin up/down controls, and the ability to start up into an existing output voltage or prebias. To ensure tight load regulation, an output voltage sense is also provided. A non-latching over-current trip serves as load fault protection.

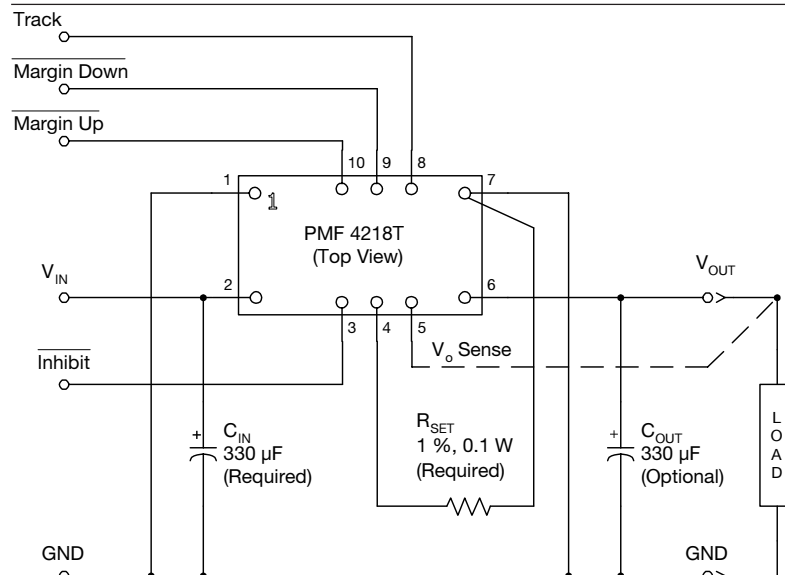
Target applications include complex multi-voltage, multi-processor systems that incorporate the industry's high-speed DSPs, micro-processors and bus drivers.

Pin Configuration

Pin	Function
1	GND
2	V _{in}
3	Inhibit *
4	V _o Adjust
5	V _o Sense
6	V _{out}
7	GND
8	Track
9	Margin Down *
10	Margin Up *

* Denotes negative logic:
Open = Normal operation
Ground = Function active

Standard Application



R_{set} = Required to set the output voltage to a value higher than 0.8 V. (See spec. table for values)
C_{in} = Required 330 µF capacitor
C_{out} = Optional 330 µF capacitor

10-A, 3.3-V Input Non-Isolated Step-Down Switching Power Module

Product Table (PMF 4218 T x)⁽¹⁾

V _{in}	V _o /I _o max	P _o max	Package Code ⁽¹⁾	Description	Ordering No.
2.95-3.65 V	0.8-2.5 V /10 A	25 W	P	Horiz. T/H	PMF 4218 T x ⁽¹⁾
			S	SMD, Standard	

⁽¹⁾ Replace "x" in the Ordering No. with Package Code.

Ordering Information

Delivery Option	M.o.q.	Suffix	Example
Tray	36 pcs	/B	PMF 4218T P /B
Tape & Reel ⁽²⁾	250 pcs	/C	PMF 4218T S /C

⁽²⁾ Tape & Reel available only for SMD packages

Pin Descriptions

V_{in}: The positive input voltage power node to the module, which is referenced to common GND.

V_{out}: The regulated positive power output with respect to the GND node.

GND: This is the common ground connection for the V_{in} and V_{out} power connections. It is also the 0 VDC reference for the control inputs.

Inhibit: The Inhibit pin is an open-collector/drain negative logic input that is referenced to GND. Applying a low-level ground signal to this input disables the module's output and turns off the output voltage. When the Inhibit control is active, the input current drawn by the regulator is significantly reduced. If the Inhibit pin is left open-circuit, the module will produce an output whenever a valid input source is applied.

Vo Adjust: A 0.1 W 1 % resistor must be directly connected between this pin and pin 7 (GND) to set the output voltage to a value higher than 0.8 V. The temperature stability of the resistor should be 100 ppm/°C (or better). The set point range for the output voltage is from 0.8 V to 3.6 V. The resistor value required for a given output voltage may be calculated from the following formula. If left open circuit, the output voltage will default to its lowest value. For further information on output voltage adjustment consult the related application note.

$$R_{set} = 10 \text{ k}\Omega \frac{0.8 \text{ V}}{V_{out} - 0.8 \text{ V}} - 2.49 \text{ k}\Omega$$

The specification table gives the preferred resistor values for a number of standard output voltages.

Vo Sense: The sense input allows the regulation circuit to compensate for voltage drop between the module and the load. For optimal voltage accuracy Vo Sense should be connected to V_{out}. It can also be left disconnected.

Track: This is an analog control input that enables the output voltage to follow an external voltage. This pin becomes active typically 20 ms after the input voltage has been applied, and allows direct control of the output voltage from 0 V up to the nominal set-point voltage. Within this range the output will follow the voltage at the Track pin on a volt-for-volt basis. When the control voltage is raised above this range, the module regulates at its set-point voltage. The feature allows the output voltage to rise simultaneously with other modules powered from the same input bus. If unused, this input should be connected to V_{in}. *Note: Due to the under-voltage lockout feature, the output of the module cannot follow its own input voltage during power up. For more information, consult the related application note.*

Margin Down: When this input is asserted to GND, the output voltage is decreased by 5% from the nominal. The input requires an open-collector (open-drain) interface. It is not TTL compatible. A lower percent change can be accommodated with a series resistor. If unused, this input may be left unconnected. For further information, consult the related application note.

Margin Up: When this input is asserted to GND, the output voltage is increased by 5%. The input requires an open-collector (open-drain) interface. It is not TTL compatible. The percent change can be reduced with a series resistor. If unused, this input may be left unconnected. For further information, consult the related application note.

10-A, 3.3-V Input Non-Isolated Step-Down Switching Power Module

Environmental & Absolute Maximum Ratings (Voltages are with respect to GND)

Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Track Input Voltage	V_{track}		-0.3	—	$V_{in} + 0.3$	V
Operating Temperature Range	T_a	Over V_{in} Range	-40 ⁽ⁱ⁾	—	85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 ⁽ⁱⁱ⁾	°C
Storage Temperature	T_s	—	-40	—	125	°C
Mechanical Shock		Per Mil-STD-883D, Method 2002.3 1 msec, ½ Sine, mounted	—	500	—	G's
Mechanical Vibration		Mil-STD-883D, Method 2007.2 20-2000 Hz	—	20	—	G's
Weight	—		—	3.7	—	grams
Flammability	—	Meets UL 94V-0				

Notes: (i) For operation below 0 °C the external capacitors must have stable characteristics. Use either a low ESR tantalum, Os-Con, or ceramic capacitor.
(ii) During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum.

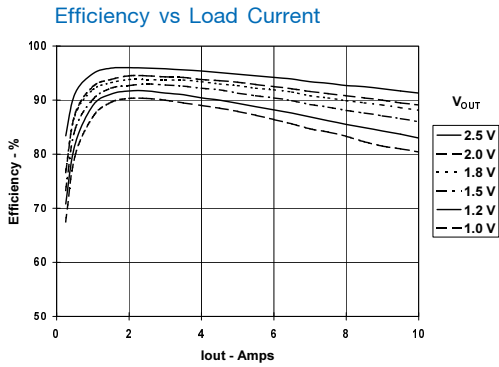
Specifications (Unless otherwise stated, $T_a = 25$ °C, $V_{in} = 3.3$ V, $V_o = 2$ V, $C_{in} = 330$ μ F, $C_{out} = 0$ μ F, and $I_o = I_o(max)$)

Characteristics	Symbols	Conditions	PMF 4218T			Units
			Min	Typ	Max	
Output Current	I_o	$0.8\text{ V} \leq V_o \leq 2.5\text{ V}$, 60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	10 ⁽¹⁾ 10 ⁽¹⁾	A
Input Voltage Range	V_{in}	Over I_o range	2.95 ⁽²⁾	—	3.65	V
Set-Point Voltage Tolerance	$V_o\ tol$		—	—	± 2 ⁽³⁾	% V_o
Temperature Variation	$\Delta R_{Reg\ temp}$	-40 °C < T_a < +85 °C	—	± 0.5	—	% V_o
Line Regulation	$\Delta R_{Reg\ line}$	Over V_{in} range	—	± 10	—	mV
Load Regulation	$\Delta R_{Reg\ load}$	Over I_o range	—	± 12	—	mV
Total Output Variation	$\Delta R_{Reg\ tot}$	Includes set-point, line, load, -40 °C $\leq T_a \leq$ +85 °C	—	—	± 3 ⁽³⁾	% V_o
Efficiency	η	$I_o = 7\text{ A}$ RSET = 2.21 k Ω $V_o = 2.5\text{ V}$ RSET = 4.12 k Ω $V_o = 2.0\text{ V}$ RSET = 5.49 k Ω $V_o = 1.8\text{ V}$ RSET = 8.87 k Ω $V_o = 1.5\text{ V}$ RSET = 17.4 k Ω $V_o = 1.2\text{ V}$ RSET = 36.5 k Ω $V_o = 1.0\text{ V}$	— — — — — —	93 92 91 89 87 85	— — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth	—	25	—	mV _{pp}
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	20	—	A
Transient Response	t_{tr} ΔV_{tr}	1 A/ μ s load step, 50 to 100 % $I_o(max)$, $C_{out} = 330$ μ F Recovery Time V_o over/undershoot	— —	70 100	— —	μ Sec mV
Margin Up/Down Adjust	ΔV_o margin		—	± 5	—	%
Margin Input Current (pins 9 /10)	I_{in_margin}	Pin to GND	—	-8 ⁽⁴⁾	—	μ A
Track Input Current (pin 8)	I_{in_track}	Pin to GND	—	—	-130 ⁽⁵⁾	μ A
Track Slew Rate Capability	dV_{track}/dt	$C_{out} \leq C_{out(max)}$	—	—	1	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 2.2	2.45 2.40	2.8 —	V
Inhibit Control (pin3) Input High Voltage Input Low Voltage Input Low Current	V_{IH} V_{IL} $I_{in_inhibit}$	Referenced to GND Pin to GND	$V_{in} - 0.5$ -0.2	— —	Open ⁽⁵⁾ 0.6	V μ A
Input Standby Current	I_{in_inh}	Inhibit (pin 3) to GND, Track (pin 8) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	275	300	325	kHz
External Input Capacitance	C_{in}		330 ⁽⁶⁾	—	—	μ F
External Output Capacitance	C_{out}	Capacitance value non-ceramic ceramic Equiv. series resistance (non-ceramic)	0 0 4 ⁽⁹⁾	330 ⁽⁷⁾ —	5,500 ⁽⁸⁾ 300	μ F m Ω
Reliability	MTBF	Per Bellcore TR-332 50 % stress, $T_a = 40$ °C, ground benign	5.7	—	—	10 ⁶ Hrs

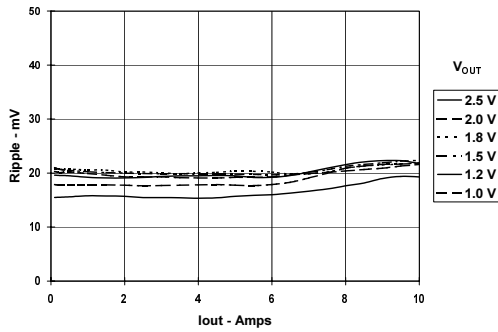
Notes: (1) See SOA curves or consult factory for appropriate derating.
(2) The minimum input voltage is equal to 2.95 V or $V_{out} + 0.5\text{ V}$, whichever is greater.
(3) The set-point voltage tolerance is affected by the tolerance and stability of R_{SET} . The stated limit is unconditionally met if R_{SET} has a tolerance of 1 % with 100 ppm/°C or better temperature stability.
(4) A small low-leakage (<100 nA) MOSFET is recommended to control this pin. The open-circuit voltage is less than 1 V_{dc}.
(5) This control pin has an internal pull-up to the input voltage V_{in} . If it is left open-circuit the module will operate when input power is applied. A small low-leakage (<100 nA) MOSFET is recommended for control.
(6) A 330 μ F input capacitor is required for proper operation. The capacitor must be rated for a minimum of 500 mA rms of ripple current.
(7) An external output capacitor is not required for basic operation. Adding 330 μ F of distributed capacitance at the load will improve the transient response.
(8) This is the calculated maximum. The minimum ESR limitation will often result in a lower value. Consult the application notes for further guidance.
(9) This is the typical ESR for all the electrolytic (non-ceramic) output capacitance. Use 7 m Ω as the minimum when using max-ESR values to calculate.

10-A, 3.3-V Input Non-Isolated Step-Down Switching Power Module

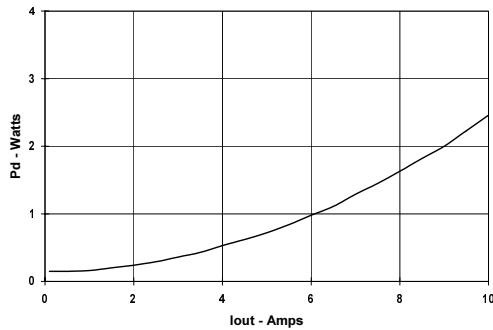
Characteristic Data; $V_{in} = 3.3V$ (See Note A)



Output Ripple vs Load Current

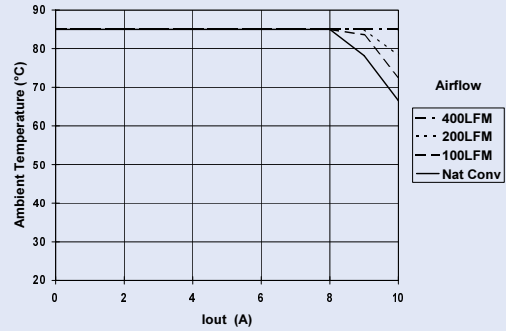


Power Dissipation vs Load Current

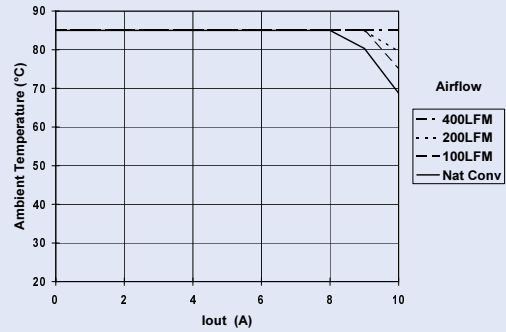


Safe Operating Area; $V_{in} = 3.3V$ (See Note B)

Output Voltage = 2.5 V



Output Voltage = 1.0V



Note A: Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the Converter.
 Note B: SOA curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures. Derating limits apply to modules soldered directly to a 4-layer PCB with 1 oz. copper.

PMF 5318 T 5-V Input



10-A, 5-V Input Non-Isolated
Wide-Output Adjust Power Module

POLA code: PTH05060 W



NOMINAL SIZE = 1 in x 0.62 in
(25,4 mm x 15,75 mm)

Features

- Up to 10-A Output Current
- 5-V Input Voltage
- Wide-Output Voltage Adjust (0.8 V to 3.6 V)
- Efficiencies up to 96 %
- 150 W/in³ Power Density
- On/Off Inhibit
- Output Voltage Sense
- Pre-Bias Startup
- Margin Up/Down Controls
- Under-Voltage Lockout
- Auto-Track™ Sequencing⁽¹⁾
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- Operating Temp: -40 to +85 °C
- DSP Compatible Output Voltages
- Safety Agency Approvals: UL 1950, CSA 22.2 950, EN60950 VDE (Pending)
- Point-of-Load Alliance (POLA) Compatible

Note: ⁽¹⁾ Auto-Track™ is a trademark of Texas Instruments

Description

The PMF 5318T non-isolated power module is small in size but big on performance and flexibility. Its high output current, compact footprint, and industry-leading features offers system designers a versatile module for powering complex multi-processor digital systems.

This product employs double-sided surface mount construction and provides high-performance step-down power conversion for up to 10 A of output current from a 5-V input bus voltage. The output voltage is adjustable and can be set to any value over the range, 0.8 V to 3.6 V, using a single resistor.

This series includes Auto-Track™ Sequencing.

Auto-Track simplifies the task of supply voltage sequencing in a power system by enabling modules to track each other, or any external voltage, during power up and power down.

Other operating features include an on/off inhibit, margin up/down controls, and the ability to start up into an existing output voltage or prebias. To ensure tight load regulation, an output voltage sense is also provided. A non-latching over-current trip serves as load fault protection.

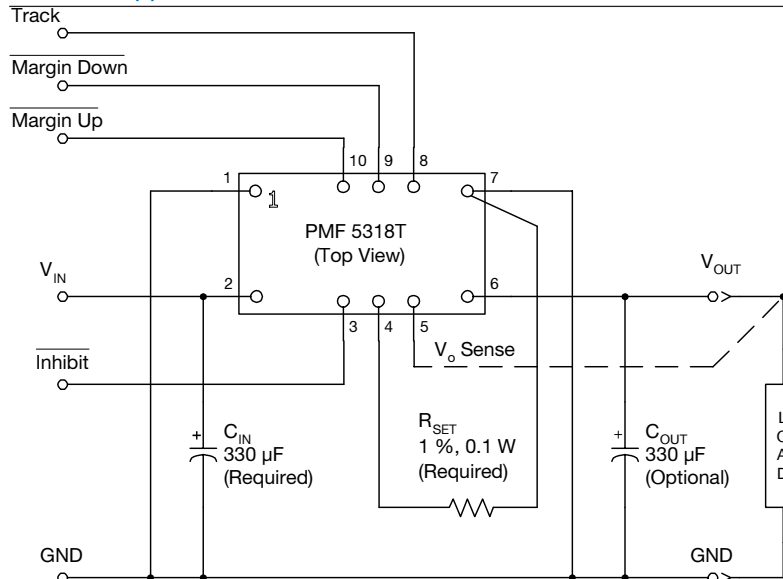
Target applications include complex multi-voltage, multi-processor systems that incorporate the industry's high-speed DSPs, micro-processors and bus drivers.

Pin Configuration

Pin	Function
1	GND
2	V _{in}
3	Inhibit *
4	V _o Adjust
5	V _o Sense
6	V _{out}
7	GND
8	Track
9	Margin Down *
10	Margin Up *

* Denotes negative logic:
Open = Normal operation
Ground = Function active

Standard Application



R_{set} = Required to set the output voltage to a value higher than 0.8 V. (See spec. table for values)

C_{in} = Required 330 µF capacitor
C_{out} = Optional 330 µF capacitor

10-A, 5-V Input Non-Isolated Wide-Output Adjust Power Module

Product Table (PMF 5318 T x)⁽¹⁾

V_{in}	V_o/I_o max	P_o max	Package Code ⁽¹⁾	Description	Ordering No.
4.5-5.5 V	0.8-3.6 V /10 A	36 W	P	Horiz. T/H	PMF 5318 T x ⁽¹⁾
			S	SMD, Standard	

⁽¹⁾ Replace "x" in the Ordering No. with Package Code.

Ordering Information

Delivery Option	M.o.q.	Suffix	Example
Tray	36 pcs	/B	PMF 5318T P /B
Tape & Reel ⁽²⁾	250 pcs	/C	PMF 5318T S /C

⁽²⁾ Tape & Reel available only for SMD packages

Pin Descriptions

Vin: The positive input voltage power node to the module, which is referenced to common *GND*.

Vout: The regulated positive power output with respect to the *GND* node.

GND: This is the common ground connection for the *Vin* and *Vout* power connections. It is also the 0 VDC reference for the control inputs.

Inhibit: The Inhibit pin is an open-collector/drain negative logic input that is referenced to *GND*. Applying a low-level ground signal to this input disables the module's output and turns off the output voltage. When the *Inhibit* control is active, the input current drawn by the regulator is significantly reduced. If the *Inhibit* pin is left open-circuit, the module will produce an output whenever a valid input source is applied.

Vo Adjust: A 0.1 W 1 % resistor must be directly connected between this pin and pin 7 (*GND*) to set the output voltage to a value higher than 0.8 V. The temperature stability of the resistor should be 100 ppm/°C (or better). The set point range for the output voltage is from 0.8 V to 3.6 V. The resistor value required for a given output voltage may be calculated from the following formula. If left open circuit, the output voltage will default to its lowest value. For further information on output voltage adjustment consult the related application note.

$$R_{set} = 10 \text{ k}\Omega \frac{0.8 \text{ V}}{V_{out} - 0.8 \text{ V}} - 2.49 \text{ k}\Omega$$

The specification table gives the preferred resistor values for a number of standard output voltages.

VoSense: The sense input allows the regulation circuit to compensate for voltage drop between the module and the load. For optimal voltage accuracy *Vo Sense* should be connected to *Vout*. It can also be left disconnected.

Track: This is an analog control input that enables the output voltage to follow an external voltage. This pin becomes active typically 20 ms after the input voltage has been applied, and allows direct control of the output voltage from 0 V up to the nominal set-point voltage. Within this range the output will follow the voltage at the *Track* pin on a volt-for-volt basis. When the control voltage is raised above this range, the module regulates at its set-point voltage. The feature allows the output voltage to rise simultaneously with other modules powered from the same input bus. If unused, this input should be connected to V_{in} . *Note:* Due to the under-voltage lockout feature, the output of the module cannot follow its own input voltage during power up. For more information, consult the related application note.

Margin Down: When this input is asserted to *GND*, the output voltage is decreased by 5% from the nominal. The input requires an open-collector (open-drain) interface. It is not TTL compatible. A lower percent change can be accommodated with a series resistor. If unused, the input may be left unconnected. For further information, consult the related application note.

Margin Up: When this input is asserted to *GND*, the output voltage is increased by 5%. The input requires an open-collector (open-drain) interface. It is not TTL compatible. The percent change can be reduced with a series resistor. If unused, the input may be left unconnected. For further information, consult the related application note.

10-A, 5-V Input Non-Isolated Wide-Output Adjust Power Module

Environmental & Absolute Maximum Ratings (Voltages are with respect to GND)

Characteristics	Symbols	Conditions	Min	Typ	Max	Units	
Track Input Voltage	V_{track}		-0.3	—	$V_{in} + 0.3$	V	
Operating Temperature Range	T_a	Over V_{in} Range	-40 ⁽ⁱ⁾	—	85	°C	
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 ⁽ⁱⁱ⁾	°C	
Storage Temperature	T_s	—	-40	—	125	°C	
Mechanical Shock		1 msec, 1/2 Sine, mounted	—	200	—	G's	
Mechanical Vibration		20-2000 Hz					
		Mil-STD-883D, Method 2007.2	Suffix H	—	20	—	G's
		Suffix S	—	20	—	—	—
Weight	—		—	3.7	—	grams	
Flammability	—	Meets UL 94V-0					

Notes: (i) For operation below 0 °C the external capacitors must have stable characteristics. Use either a low ESR tantalum, Os-Con, or ceramic capacitor.
(ii) During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum.

Specifications (Unless otherwise stated, $T_a = 25$ °C, $V_{in} = 5$ V, $V_o = 3.3$ V, $C_{in} = 330$ μ F, $C_{out} = 0$ μ F, and $I_o = I_o(max)$)

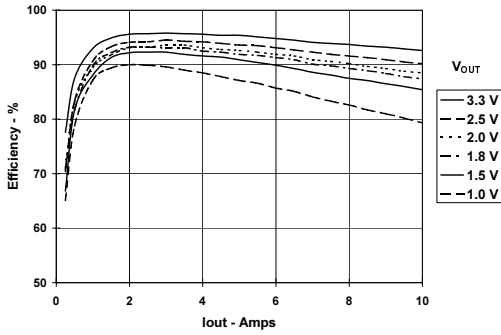
Characteristics	Symbols	Conditions	PMF 5318T			Units
			Min	Typ	Max	
Output Current	I_o	0.8 V \leq $V_o \leq$ 3.6 V, 60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	10 ⁽¹⁾ 10 ⁽¹⁾	A
Input Voltage Range	V_{in}	Over I_o range	4.5	—	5.5	V
Set-Point Voltage Tolerance	$V_o tol$		—	—	± 2 ⁽²⁾	% V_o
Temperature Variation	ΔReg_{temp}	-40 °C $< T_a <$ +85 °C	—	± 0.5	—	% V_o
Line Regulation	ΔReg_{line}	Over V_{in} range	—	± 10	—	mV
Load Regulation	ΔReg_{load}	Over I_o range	—	± 12	—	mV
Total Output Variation	ΔReg_{tot}	Includes set-point, line, load, -40 °C $\leq T_a \leq$ +85 °C	—	—	± 3 ⁽²⁾	% V_o
Efficiency	η	$I_o = 7$ A				
		RSET = 698 Ω $V_o = 3.3$ V	—	94	—	%
		RSET = 2.21 k Ω $V_o = 2.5$ V	—	92	—	
		RSET = 4.12 k Ω $V_o = 2.0$ V	—	91	—	
		RSET = 5.49 k Ω $V_o = 1.8$ V	—	90	—	
		RSET = 8.87 k Ω $V_o = 1.5$ V	—	89	—	
		RSET = 17.4 k Ω $V_o = 1.2$ V	—	86	—	
		RSET = 36.5 k Ω $V_o = 1.0$ V	—	85	—	
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth	—	25	—	mVpp
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	20	—	A
Transient Response		1 A/ μ s load step, 50 to 100 % $I_o(max)$, $C_{out} = 330$ μ F				
	t_{rr} ΔV_{rr}	Recovery Time V_o over/undershoot	— —	70 100	— —	μ Sec mV
Margin Up/Down Adjust	ΔV_o margin		—	± 5	—	%
Margin Input Current (pins 9 / 10)	I_{IL} margin	Pin to GND	—	-8 ⁽³⁾	—	μ A
Track Input Current (pin 8)	I_{IL} track	Pin to GND	—	—	-130 ⁽⁴⁾	μ A
Track Slew Rate Capability	dV_{track}/dt	$C_{out} \leq C_{out}(max)$	—	—	1	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 3.4	4.3 3.7	4.45 —	V
Inhibit Control (pin 3)		Referenced to GND				
Input High Voltage	V_{IH}		$V_{in} - 0.5$	—	Open ⁽⁴⁾	V
Input Low Voltage	V_{IL}		-0.2	—	0.6	
Input Low Current	I_{IL} inhibit	Pin to GND	—	-130	—	μ A
Input Standby Current	I_{in} inh	Inhibit (pin 3) to GND, Track (pin 8) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	275	300	325	kHz
External Input Capacitance	C_{in}		330 ⁽⁵⁾	—	—	μ F
External Output Capacitance	C_{out}	Capacitance value				
		non-ceramic	0	330 ⁽⁶⁾	5,500 ⁽⁷⁾	μ F
		ceramic	0	—	300	
		Equiv. series resistance (non-ceramic)	4 ⁽⁸⁾	—	—	μ F
Reliability	MTBF	Per Bellcore TR-332 50 % stress, $T_a = 40$ °C, ground benign	5.7	—	—	10 ⁶ Hrs

Notes: (1) See SOA curves or consult factory for appropriate derating.
(2) The set-point voltage tolerance is affected by the tolerance and stability of RSET. The stated limit is unconditionally met if RSET has a tolerance of 1 % with 100 ppm/°C or better temperature stability.
(3) A small low-leakage (<100 nA) MOSFET is recommended to control this pin. The open-circuit voltage is less than 1 Vdc.
(4) This control pin has an internal pull-up to the input voltage V_{in} . If it is left open-circuit the module will operate when input power is applied. A small low-leakage (<100 nA) MOSFET is recommended for control.
(5) A 330 μ F input capacitor is required for proper operation. The capacitor must be rated for a minimum of 500 mA rms of ripple current.
(6) An external output capacitor is not required for basic operation. Adding 330 μ F of distributed capacitance at the load will improve the transient response.
(7) This is the calculated maximum. The minimum ESR limitation will often result in a lower value. Consult the application notes for further guidance.
(8) This is the typical ESR for all the electrolytic (non-ceramic) output capacitance. Use 7 mW as the minimum when using max-ESR values to calculate.

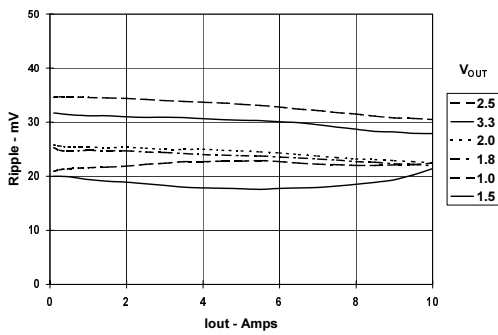
10-A, 5-V Input Non-Isolated
Wide-Output Adjust Power Module

Characteristic Data; $V_{in} = 5\text{ V}$ (See Note A)

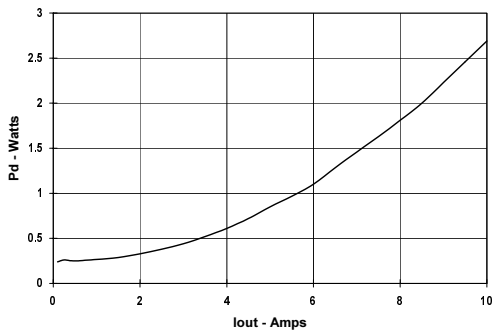
Efficiency vs Load Current



Output Ripple vs Load Current

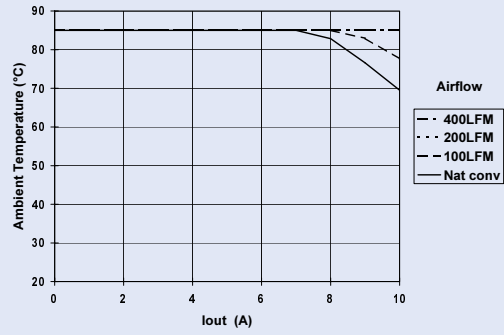


Power Dissipation vs Load Current

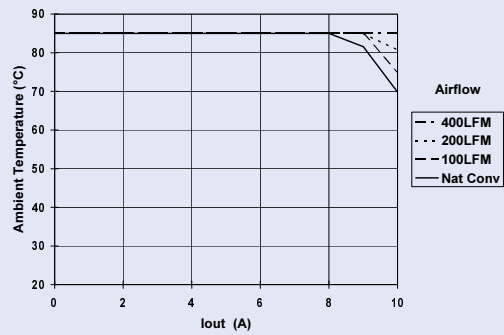


Safe Operating Area; $V_{in} = 5\text{ V}$ (See Note B)

Output Voltage = 3.3 V



Output Voltage = 1.5 V



Note A: Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the Converter.
 Note B: SOA curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures. Derating limits apply to modules soldered directly to a 4-layer PCB with 1 oz. copper.

PMF 4218T & PMF 5318T

Capacitor Recommendations for the PMF 4218T & PMF 5318T Series of Power Modules

Input Capacitor

The recommended input capacitor(s) is determined by the 330 μF minimum capacitance and 500 mArms minimum ripple current rating.

Ripple current, less than 150 $\text{m}\Omega$ equivalent series resistance (ESR), and temperature are the major considerations when selecting input capacitors. Unlike polymer tantalum, regular tantalum capacitors have a recommended minimum voltage rating of $2 \times$ (maximum DC voltage + AC ripple). This is standard practice to ensure reliability.

For improved ripple reduction on the input bus, ceramic capacitors [1] may be used to complement electrolytic types to achieve the minimum required capacitance.

Output Capacitors (Optional)

For applications with load transients (sudden changes in load current), regulator response will benefit from an external output capacitance. The recommended output capacitance of 330 μF will allow the module to meet its transient response specification (see product data sheet). For most applications, a high quality computer-grade aluminum electrolytic capacitor is adequate. These capacitors provide decoupling over the frequency range, 2 kHz to 150 kHz, and are suitable for ambient temperatures above 0 $^{\circ}\text{C}$. For operation below 0 $^{\circ}\text{C}$ tantalum, ceramic or Os-Con type capacitors are recommended. When using one or more non-ceramic capacitors, the calculated equivalent ESR should be no lower than 4 $\text{m}\Omega$ (7 $\text{m}\Omega$ using the manufacturer's maximum ESR for a single capacitor). A list of preferred low-ESR type capacitors are identified in Table 1-1.

Ceramic Capacitors

Above 150 kHz the performance of aluminum electrolytic capacitors is less effective. Multilayer ceramic capacitors have very low ESR and a resonant frequency higher than the bandwidth of the regulator. They can be used to reduce the reflected ripple current at the input as well as improve the transient response of the output. When used on the output their combined ESR is not critical as long as the total value of ceramic capacitance does not exceed 300 μF . Also, to prevent the formation of local resonances, do not place more than five identical ceramic capacitors in parallel with values of 10 μF or greater.

Tantalum Capacitors

Tantalum type capacitors can be used at both the input and output, and are recommended for applications where the ambient operating temperature can be less than 0 $^{\circ}\text{C}$. The AVX TPS, Sprague 593D/594/595 and Kemet T495/

T510 capacitor series are suggested over many other tantalum types due to their higher rated surge, power dissipation, and ripple current capability. As a caution many general purpose tantalum capacitors have considerably higher ESR, reduced power dissipation and lower ripple current capability. These capacitors are also less reliable as they have lower power dissipation and surge current ratings. Tantalum capacitors that do not have a stated ESR or surge current rating are not recommended for power applications.

When specifying Os-Con and polymer tantalum capacitors for the output, the minimum ESR limit will be encountered well before the maximum capacitance value is reached.

Capacitor Table

Table 2-1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The recommended number of capacitors required at both the input and output buses is identified for each capacitor type.

This is not an extensive capacitor list. Capacitors from other vendors are available with comparable specifications. Those listed are for guidance. The RMS ripple current rating and ESR (at 100 kHz) are critical parameters necessary to insure both optimum regulator performance and long capacitor life.

Designing for Very Fast Load Transients

The transient response of the DC/DC converter has been characterized using a load transient with a di/dt of 1 A/ μs . The typical voltage deviation for this load transient is given in the data sheet specification table using the optional value of output capacitance. As the di/dt of a transient is increased, the response of a converter's regulation circuit ultimately depends on its output capacitor decoupling network. This is an inherent limitation with any DC/DC converter once the speed of the transient exceeds its bandwidth capability. If the target application specifies a higher di/dt or lower voltage deviation, the requirement can only be met with additional output capacitor decoupling. In these cases special attention must be paid to the type, value and ESR of the capacitors selected.

If the transient performance requirements exceed that specified in the data sheet, or the total amount of load capacitance is above 3,000 μF , the selection of output capacitors becomes more important. For further guidance consult the separate application note, "Selecting Output Capacitors for PMF Products in High-Performance Applications."

PMF 4218T & PMF 5318T

Table 2-1: Input/Output Capacitors

Capacitor Vendor, Type Series (Style)	Capacitor Characteristics y					Quantit		Vendor Part Number
	Working Voltage	Value (µF)	Max. ESR at 100 kHz	Max. Ripple Current at 85 °C (Irms)	Physical Size (mm)	Input Bus	Output Bus	
Panasonic, Aluminum FC (Radial) FK (SMD) FC (SMD)	10 V 25 V 16 V	330 470 330	0.117 Ω 0.080 Ω 0.150 Ω	555 mA 850 mA 670 mA	8×10 10×10.2 10×10.2	1 1 1	1 1 1	EEUFC1A331 EEVFK1E471P EEVFC1C331P
United Chemi-con PXA, Poly-Aluminum (SMD) PS, Poly-Aluminum (Radial) FX, Os-con (Radial) LXZ, Aluminum (Radial)	10 V 6.3 V 10 V 16 V	330 390 390 330	0.024 Ω 0.012 Ω 0.018 Ω 0.120 Ω	3770 mA 4770 mA 3710 mA 555 mA	10×7.7 8×11.5 8×10.5 8×12.5	1 1 1 1	≤4 ≤2 ≤3 1	PXA10VC331MJ80T P 6P5390MH 11 10FX390M LXZ16VB331M8X12L L
Nichicon, Aluminum WG (SMD) HD (Radial) PM (Radial)	25 V 16 V 16 V	330 330 330	0.150 Ω 0.072 Ω 0.120 Ω	670 mA 760 mA 625 mA	10×10 8×11.5 10×12.5	1 1 1	1 1 1	UWG1E331MNR1GS UHD1A331MPR UPM1C331MPH6
Panasonic, Poly-Aluminum: WA (SMD) S/SE (SMD)	10 V 6.3 V	330 180	0.022 Ω 0.005 Ω	4500 mA 4000 mA	10×10.2 7.3×4.3×4.2	1 2	≤4 ≤1	EEFWA1A331P EEFSE0J181R
Sanyo SP, Os-con (Radial) SVP, (SMD) TPE, Poscap (SMD)	10 V 10 V 6.3 V	470 330 330	0.015 Ω 0.017 Ω 0.025 Ω	4500 mA 3950 mA 2400 mA	10×10.5 8×12 7.3×4.3	1 1 1	≤2 ≤3 ≤4	10SP470M 10SVP330M 6TPE330ML
AVX, Tantalum TPS (SMD)	10 V 10 V	330 330	0.045 Ω 0.060 Ω	1723 mA 1826 mA	7.3L ×5.7W ×4.1H	1 1	≤5 ≤5	TPE337M010R0045 TPSV337M010R0060
Kemet, Poly-Tantalum T520, (SMD) T530, (SMD)	10 V 10 V	330 330	0.040 Ω 0.015 Ω	1800 mA >3800 mA	4.3W ×7.3L ×4.0H	1 1	1 1	T520X337M010AS T530X337M010AS
Vishay-Sprague 595D, Tantalum (SMD) 594D, Tantalum (SMD) 94SA Poly-Aluminum (Radial)	10 V 10 V 6.3 V	330 330 330	0.100 Ω 0.045 Ω 0.025 Ω	1040 mA 2360 mA 3500 mA	7.2L ×6W ×4.1H 10×10.5	1 1 1	≤5 ≤5 ≤4	595D337X0010D2T 594D337X0016R2T 94SA337X06R3FBP
Kemet, Ceramic X5R (SMD)	16 V 6.3 V	10 47	0.002 Ω	—	1210 case 3225 mm	1 1	≤5 ≤5	C1210C106M4PAC C1210C476K9PAC
Murata, Ceramic X5R (SMD)	6.3 V 6.3 V 16 V 16 V	100 47 22 10	0.002 Ω	—	1210 case 3225 mm	1 [1] 1 [1] 1 [1] 1 [1]	≤3 ≤5 ≤5 ≤5	GRM32ER60J107M GRM32ER60J476M GRM32ER61C226K GRM32DR61C106K
TDK, Ceramic X5R (SMD)	6.3 V 6.3 V 16 V 16 V	100 47 22 10	0.002 Ω	—	1210 case 3225 mm	1 [1] 1 [1] 1 [1] 1 [1]	≤3 ≤5 ≤5 ≤5	C3225X5R0J107MT C3225X5R0J476MT C3225X5R1C226MT C3225X5R1C106MT

[1] A ceramic capacitor may be used to compliment electrolytic types at the input to further reduce high-frequency ripple current.

PMF 4218T & PMF 5318T

Adjusting the Output Voltage of the PMF 4218T & PMF 5318T Wide-Output Adjust Power Modules

The V_o Adjust control (pin 4) sets the output voltage of the PMF 4218T and PMF 5318T products to a value higher than 0.8 V. The adjustment range of the PMF 4218T (3.3-V input) is from 0.8 V to 2.5 V¹, and the PMF 5318T (5-V input) from 0.8 V to 3.6 V. For an output voltage other than 0.8 V a single external resistor, R_{set} , must be connected directly between the V_o Adjust and GND pins². Table 2-1 gives the preferred value of the external resistor for a number of standard voltages, along with the actual output voltage that this resistance value provides.

For other output voltages the value of the required resistor can either be calculated using the following formula, or simply selected from the range of values given in Table 2-2. Figure 2-1 shows the placement of the required resistor.

$$R_{set} = 10 \text{ k}\Omega \cdot \frac{0.8 \text{ V}}{V_{out} - 0.8 \text{ V}} - 2.49 \text{ k}\Omega$$

Table 1-1; Preferred Values of R_{set} for Standard Output Voltages

V_{out} (Standard)	R_{set} (Pref'd Value)	V_{out} (Actual)
3.3 V ¹	698 Ω	3.309 V
2.5 V	2.21 k Ω	2.502 V
2V	4.12 k Ω	2.010 V
1.8 V	5.49 k Ω	1.803 V
1.5 V	8.87 k Ω	1.504 V
1.2 V	17.4 k Ω	1.202 V
1V	36.5 k Ω	1.005 V
0.8 V	Open	0.8 V

Figure 1-1; V_o Adjust Resistor Placement

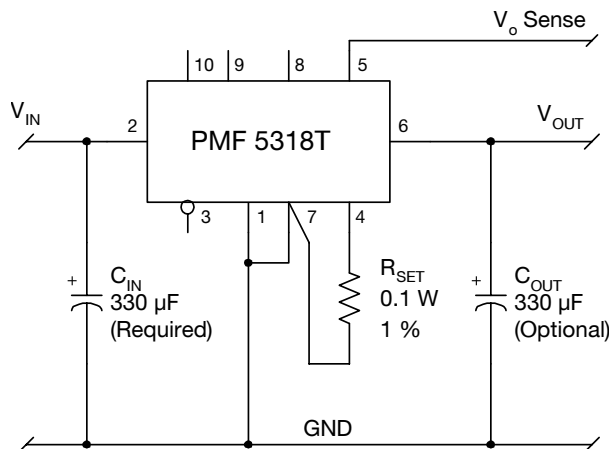


Table 1-2; Output Voltage Set-Point Resistor Values

V_a Req'd	R_{set}	V_a Req'd	R_{set}
0.800	Open	2.00	4.18 k Ω
0.825	318 k Ω	2.05	3.91 k Ω
0.850	158 k Ω	2.10	3.66 k Ω
0.875	104 k Ω	2.15	3.44 k Ω
0.900	77.5 k Ω	2.20	3.22 k Ω
0.925	61.5 k Ω	2.25	3.03 k Ω
0.950	50.8 k Ω	2.30	2.84 k Ω
0.975	43.2 k Ω	2.35	2.67 k Ω
1.000	37.5 k Ω	2.40	2.51 k Ω
1.025	33.1 k Ω	2.45	2.36 k Ω
1.050	29.5 k Ω	2.50	2.22 k Ω
1.075	26.6 k Ω	2.55	2.08 k Ω
1.100	24.2 k Ω	2.60	1.95 k Ω
1.125	22.1 k Ω	2.65	1.83 k Ω
1.150	20.4 k Ω	2.70	1.72 k Ω
1.175	18.8 k Ω	2.75	1.61 k Ω
1.200	17.5 k Ω	2.80	1.51 k Ω
1.225	16.3 k Ω	2.85	1.41 k Ω
1.250	15.3 k Ω	2.90	1.32 k Ω
1.275	14.4 k Ω	2.95	1.23 k Ω
1.300	13.5 k Ω	3.00	1.15 k Ω
1.325	12.7 k Ω	3.05	1.07 k Ω
1.350	12.1 k Ω	3.10	988 Ω
1.375	11.4 k Ω	3.15	914 Ω
1.400	10.8 k Ω	3.20	843 Ω
1.425	10.3 k Ω	3.25	775 Ω
1.450	9.82 k Ω	3.30	710 Ω
1.475	9.36 k Ω	3.35	647 Ω
1.50	8.94 k Ω	3.40	587 Ω
1.55	8.18 k Ω	3.45	529 Ω
1.60	7.51 k Ω	3.50	473 Ω
1.65	6.92 k Ω	3.55	419 Ω
1.70	6.4 k Ω	3.60	367 Ω
1.75	5.93 k Ω		
1.80	5.51 k Ω		
1.85	5.13 k Ω		
1.90	4.78 k Ω		
1.95	4.47 k Ω		

Notes:

1. Modules that operate from a 3.3-V input bus should not be adjusted higher than 2.5 V.
2. Use a 0.1 W resistor. The tolerance should be 1 %, with temperature stability of 100 ppm/ $^{\circ}$ C (or better). Place the resistor as close to the regulator as possible. Connect the resistor directly between pins 4 and 7 using dedicated PCB traces.
3. Never connect capacitors from V_o Adjust to either GND or V_{out} . Any capacitance added to the V_o Adjust pin will affect the stability of the regulator.

PMF 8518 L 12-V Input



10-A, 12-V Input Non-Isolated
Wide-Output Adjust Power Module

POLA code: PTH12060 W



NOMINAL SIZE = 1 in x 0.62 in
(25,4 mm x 15,75 mm)

Features

- Up to 10-A Output Current
- 12-V Input Voltage
- Wide-Output Voltage Adjust (1.2 V to 5.5 V)
- Efficiencies up to 95 %
- 225 W/in³ Power Density
- On/Off Inhibit
- Output Voltage Sense
- Margin Up/Down Controls
- Under-Voltage Lockout
- Auto-Track™ Sequencing⁽¹⁾
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- Operating Temp: -40 to +85 °C
- Safety Agency Approvals: UL 1950, CSA 22.2 950, EN60950 VDE (Pending)
- Point-of-Load Alliance (POLA) Compatible

Note: ⁽¹⁾ Auto-Track™ is a trademark of Texas Instruments

Description

The PMF 8518L is a non-isolated power module, and part of a new class of complete DC/DC converters from Ericsson Power Modules. These modules are small in size, and a feature-rich alternative for applications requiring up to 10 A of load current.

Its small footprint, (1 in × 0.62 in) and industry leading features makes this module suitable for space conscious digital systems that incorporate multiple processors.

The PTH12060W module operates from a 12-V input bus voltage to provide step-down power conversion to any output voltage over the range, 1.2 V to 5.5 V. The output voltage is set using a single resistor.

This product includes Auto-Track™ Sequencing. Auto-Track greatly simplifies the task of supply voltage sequencing in a power system, by enabling modules to track each other, or any other external voltage, during power up and power down.

Other features include an on/off inhibit and margin up/down controls. An output voltage sense ensures tight load regulation. A non-latching over-current trip protects against load faults.

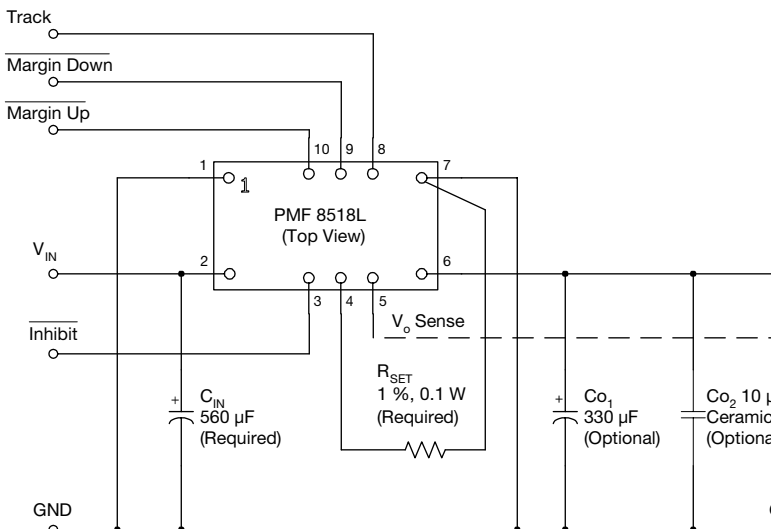
Target applications are complex digital systems that incorporate the industry's latest high-speed DSPs, ASICs, FPGAs, micro-processors, and bus drivers.

Pin Configuration

Pin	Function
1	GND
2	V _{in}
3	Inhibit *
4	V _o Adjust
5	V _o Sense
6	V _{out}
7	GND
8	Track
9	Margin Down *
10	Margin Up *

* Denotes negative logic:
Open = Normal operation
Ground = Function active

Standard Application



R_{set} = Required to set the output voltage to a value higher than 1.2 V. (See specification table for values)

C_{in} = Required 560 µF capacitor

C_{o1} = Optional 330 µF capacitor

C_{o2} = Optional 10 µF ceramic capacitor

10-A, 12-V Input Non-Isolated
Wide-Output Adjust Power Module

Product Table (PMF 8518 L x)⁽¹⁾

V_{in}	V_o/I_o max	P_o max	Package Code ⁽¹⁾	Description	Ordering No.
10.8-13.2 V	1.2-5.5 V / 10 A	55 W	P	Horiz. T/H	PMF 8518 L x ⁽¹⁾
			S	SMD, Standard	

⁽¹⁾ Replace "x" in the Ordering No. with Package Code.

Ordering Information

Delivery Option	M.o.q.	Suffix	Example
Tray	36 pcs	/B	PMF 8518L P /B
Tape & Reel ⁽²⁾	250 pcs	/C	PMF 8518L S /C

⁽²⁾ Tape & Reel available only for SMD packages

Pin Descriptions

Vin: The positive input voltage power node to the module, which is referenced to common *GND*.

Vout: The regulated positive power output with respect to the *GND* node.

GND: This is the common ground connection for the *Vin* and *Vout* power connections. It is also the 0 VDC reference for the control inputs.

Inhibit: The Inhibit pin is an open-collector/drain negative logic input that is referenced to *GND*. Applying a low-level ground signal to this input disables the module's output and turns off the output voltage. When the *Inhibit* control is active, the input current drawn by the regulator is significantly reduced. If the *Inhibit* pin is left open-circuit, the module will produce an output whenever a valid input source is applied.

Vo Adjust: A 1 % 0.1 W resistor must be directly connected between this pin and pin 7 (*GND*) to set output voltage to a value higher than 1.2 V. The temperature stability of the resistor should be 100 ppm/°C or better. The set point range is from 1.2 V to 5.5 V. The resistor value required for a given output voltage may be calculated from the following formula. If left open circuit the output voltage will default to its lowest value. For further information on output voltage adjustment consult the related application note.

$$R_{set} = 10 \text{ k}\Omega \cdot \frac{0.8 \text{ V}}{V_{out} - 1.2 \text{ V}} - 1.82 \text{ k}\Omega$$

The specification table gives the preferred resistor values for a

number of standard output voltages.

VoSense: The sense input allows the regulation circuit to compensate for voltage drop between the module and the load. For optimal voltage accuracy *Vo Sense* should be connected to *Vout*. It can also be left disconnected.

Track: This is an analog control input that enables the output voltage to follow an external voltage. This pin becomes active typically 20 ms after the input voltage has been applied, and allows direct control of the output voltage from 0 V up to the nominal set-point voltage. Within this range the output will follow the voltage at the *Track* pin on a volt-for-volt basis. When the control voltage is raised above this range, the module regulates at its set-point voltage. The feature allows the output voltage to rise simultaneously with other modules powered from the same input bus. If unused, this input should be connected to V_{in} . *Note: Due to the under-voltage lockout feature, the output of the module cannot follow its own input voltage during power up. For more information, consult the related application note.*

Margin Down: When this input is asserted to *GND*, the output voltage is decreased by 5% from the nominal. The input requires an open-collector (open-drain) interface. It is not TTL compatible. A lower percent change can be accommodated with a series resistor. For further information, consult the related application note.

Margin Up: When this input is asserted to *GND*, the output voltage is increased by 5%. The input requires an open-collector (open-drain) interface. It is not TTL compatible. The percent change can be reduced with a series resistor. For further information, consult the related application note.

10-A, 12-V Input Non-Isolated
Wide-Output Adjust Power Module

Environmental & Absolute Maximum Ratings (Voltages are with respect to GND)

Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Track Input Voltage	V_{track}		-0.3	—	$V_{in} + 0.3$	V
Operating Temperature Range	T_a	Over V_{in} Range	-40 ⁽ⁱ⁾	—	85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 ⁽ⁱⁱ⁾	°C
Storage Temperature	T_s	—	-40	—	125	°C
Mechanical Shock		Per Mil-STD-883D, Method 2002.3 1 msec, ½ Sine, mounted	—	500	—	G's
Mechanical Vibration		Mil-STD-883D, Method 2007.2 20-2000 Hz	—	20	—	G's
Weight	—		—	5	—	grams
Flammability	—	Meets UL 94V-0				

Notes: (i) For operation below 0 °C the external capacitors must have stable characteristics. Use either a low ESR tantalum, Os-Con, or ceramic capacitor.
(ii) During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum.

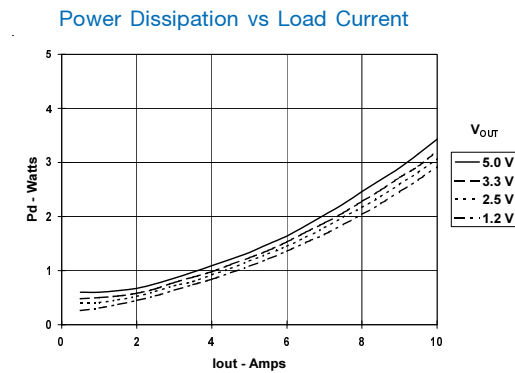
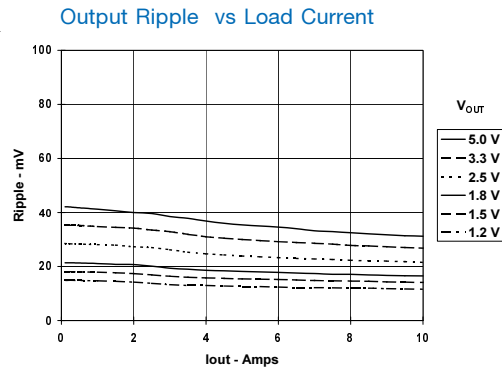
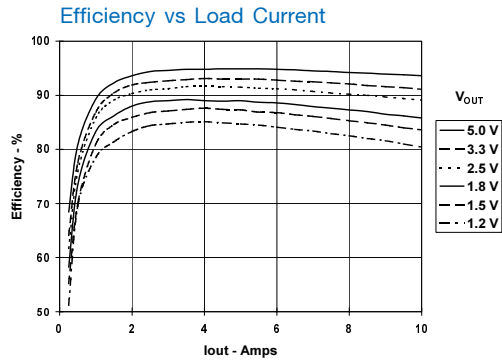
Specifications (Unless otherwise stated, $T_a = 25$ °C, $V_{in} = 12$ V, $V_{out} = 3.3$ V, $C_{in} = 560$ μF, $C_{o1} = 0$ μF, and $I_o = I_o$ max)

Characteristics	Symbols	Conditions	PMF 8518L			Units
			Min	Typ	Max	
Output Current	I_o	1.2 V ≤ V_o ≤ 5.5 V, 85 °C, 200 LFM airflow 25 °C, natural convection	0	—	10 ⁽¹⁾ 10 ⁽¹⁾	A
Input Voltage Range	V_{in}	Over I_o range	10.8	—	13.2	V
Set-Point Voltage Tolerance	V_o tol		—	—	±2 ⁽²⁾	% V_o
Temperature Variation	ΔR_{egtemp}	-40 °C < T_a < +85 °C	—	±0.5	—	% V_o
Line Regulation	ΔR_{egline}	Over V_{in} range	—	±10	—	mV
Load Regulation	ΔR_{egload}	Over I_o range	—	±12	—	mV
Total Output Variation	ΔR_{egtot}	Includes set-point, line, load, -40 °C ≤ T_a ≤ +85 °C	—	—	±3	% V_o
Efficiency	η	$I_o = 8$ A $R_{SET} = 280 \Omega$ $V_o = 5.0$ V $R_{SET} = 2.0$ k Ω $V_o = 3.3$ V $R_{SET} = 4.32$ k Ω $V_o = 2.5$ V $R_{SET} = 11.5$ k Ω $V_o = 1.8$ V $R_{SET} = 24.3$ k Ω $V_o = 1.5$ V $R_{SET} = \text{open cct}$ $V_o = 1.2$ V	—	94 92 90 87 85 83	—	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth, with $C_{o2} = 10$ μF ceramic $V_o \leq 2.5$ V $V_o > 2.5$ V	—	25 ⁽³⁾ 1 ⁽³⁾	—	mVpp % V_o
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	20	—	A
Transient Response	t_{rr} ΔV_{rr}	1 A/μs load step, 50 to 100 % I_o max, $C_{o1} = 330$ μF Recovery Time V_o over/undershoot	—	70 100	—	μSec mV
Margin Up/Down Adjust	V_o adj		—	±5	—	%
Margin Input Current (pins 9 /10)	I_{IL} margin	Pin to GND	—	-8 ⁽⁴⁾	—	μA
Track Input Current (pin 8)	I_{IL} track	Pin to GND	—	—	-0.13 ⁽⁵⁾	mA
Track Slew Rate Capability	dV_{track}/dt	$C_{out} \leq C_{out(max)}$	—	—	1	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 8.8	9.5 9	10.4 —	V
Inhibit Control (pin3) Input High Voltage Input Low Voltage	V_{IH} V_{IL}	Referenced to GND	$V_{in} - 0.5$ -0.2	— —	Open ⁽⁵⁾ 0.5	V
Input Low Current	I_{IL} inhibit	Pin to GND	—	-0.24	—	mA
Input Standby Current	I_{in} inh	Inhibit (pin 3) to GND, Track (pin 8) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	300	350	400	kHz
External Input Capacitance	C_{in}		560 ⁽⁶⁾	—	—	μF
External Output Capacitance	C_{out}	Capacitance value Equiv. series resistance (non-ceramic)	0 0 4 ⁽⁹⁾	330 ⁽⁷⁾ — —	5,500 ⁽⁸⁾ 300 —	μF n Ω
Reliability	MTBF	Per Bellcore TR-332 50 % stress, $T_a = 40$ °C, ground benign	6.4	—	—	10 ⁶ Hrs

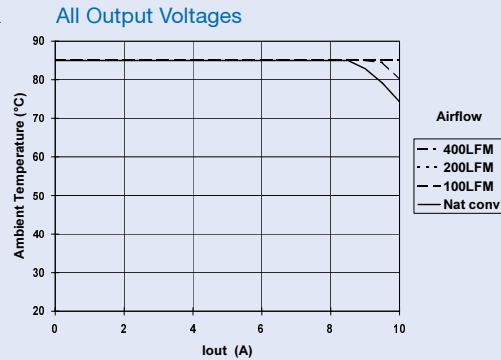
Notes: (1) See SOA curves or consult factory for appropriate derating.
(2) The set-point voltage tolerance is affected by the tolerance and stability of R_{SET} . The stated limit is unconditionally met if R_{SET} has a tolerance of 1 % with 100 ppm/°C or better temperature stability.
(3) The pk-pk output ripple voltage is measured with an external 10 μF ceramic capacitor. See the standard application schematic.
(4) A small low-leakage (<100 nA) MOSFET is recommended to control this pin. The open-circuit voltage is less than 1 Vdc.
(5) This control pin has an internal pull-up to the input voltage V_{in} (7.5 V for pin 8). If it is left open-circuit the module will operate when input power is applied. A small low-leakage (<100 nA) MOSFET is recommended for control.
(6) A 560 μF input capacitor are required for proper operation. The electrolytic capacitor must be rated for a minimum of 1050 mA rms of ripple current.
(7) An external output capacitor is not required for basic operation. Adding 330 μF of distributed capacitance at the load will improve the transient response.
(8) This is the calculated maximum. The minimum ESR limitation will often result in a lower value. Consult the application notes for further guidance.
(9) This is the typical ESR for all the electrolytic (non-ceramic) output capacitance. Use 7 mW as the minimum when using max-ESR values to calculate.

10-A, 12-V Input Non-Isolated
Wide-Output Adjust Power Module

Characteristic Data; $V_{in} = 12\text{ V}$ (See Note A)



Safe Operating Area; $V_{in} = 12\text{ V}$ (See Note B)



Note A: Characteristic data has been developed from actual products tested at 25°C. This data is considered typical data for the Converter.

Note B: SOA curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures. Derating limits apply to modules soldered directly to a 4 in. × 4 in. double-sided PCB with 1 oz. copper.

PMF 8518 L

Capacitor Recommendations for the PMF 8518L Series of Power Modules

Input Capacitor

The recommended input capacitance is determined by the 560 μF [1] minimum capacitance and 1050 mArms minimum ripple current rating. A 10- μF X5R/X7R ceramic capacitor may also be added to reduce the reflected input ripple current. The ceramic capacitor should be located between the input electrolytic and the module.

Ripple current, less than 100 m Ω equivalent series resistance (ESR) and temperature are major considerations when selecting input capacitors. Unlike polymer-tantalum capacitors, regular tantalum capacitors have a recommended minimum voltage rating of $2 \times (\text{max. DC voltage} + \text{AC ripple})$. This is standard practice to ensure reliability. No tantalum capacitors were found with sufficient voltage rating to meet this requirement. At temperatures below 0 °C, the ESR of aluminum electrolytic capacitors increases. For these applications Os-Con, polymer-tantalum, and polymer-aluminum types should be considered.

Output Capacitors (Optional)

For applications with load transients (sudden changes in load current), regulator response will benefit from external output capacitance. The value of 330 μF is used to define the transient response specification (see data sheet). For most applications, a high quality computer-grade aluminum electrolytic capacitor is adequate. These capacitors provide decoupling over the frequency range, 2 kHz to 150 kHz, and are suitable for ambient temperatures above 0 °C. Below 0 °C, tantalum, ceramic or Os-Con type capacitors are recommended. When using one or more non-ceramic capacitors, the calculated equivalent ESR should be no lower than 4 m Ω (7 m Ω using the manufacturer's maximum ESR for a single capacitor). A list of preferred low-ESR type capacitors are identified in Table 1-1.

In addition to electrolytic capacitance, adding a 10- μF X5R/X7R ceramic capacitor to the output will reduce the output ripple voltage and improve the regulator's transient response. The measurement of both the output ripple and transient response is also best achieved across a 10- μF ceramic capacitor.

Ceramic Capacitors

Above 150 kHz the performance of aluminum electrolytic capacitors is less effective. Multilayer ceramic capacitors have very low ESR and a resonant frequency higher than the bandwidth of the regulator. They can be used to reduce the reflected ripple current at the input as well as improve the transient response of the output. When used on the output their combined ESR is not critical as long as the total value of ceramic capacitance does not exceed 300 μF . Also, to prevent the formation of local resonances, do not place more than five identical ceramic capacitors in parallel with values of 10 μF or greater.

Tantalum Capacitors

Tantalum type capacitors are most suited for use on the output bus, and are recommended for applications where the ambient operating temperature can be less than 0 °C. The AVX TPS, Sprague 593D/594/595 and Kemet T495/T510 capacitor series are suggested over other tantalum types due to their higher rated surge, power dissipation, and ripple current capability. As a caution many general purpose tantalum capacitors have considerably higher ESR, reduced power dissipation and lower ripple current capability. These capacitors are also less reliable as they have lower power dissipation and surge current ratings. Tantalum capacitors that do not have a stated ESR or surge current rating are not recommended for power applications.

When specifying Os-con and polymer tantalum capacitors for the output, the minimum ESR limit will be encountered well before the maximum capacitance value is reached.

Capacitor Table

Table 2-1 identifies the characteristics of capacitors from a number of vendors with acceptable ESR and ripple current (rms) ratings. The recommended number of capacitors required at both the input and output buses is identified for each capacitor type.

This is not an extensive capacitor list. Capacitors from other vendors are available with comparable specifications. Those listed are for guidance. The RMS ripple current rating and ESR (at 100 kHz) are critical parameters necessary to insure both optimum regulator performance and long capacitor life.

Designing for Very Fast Load Transients

The transient response of the DC/DC converter has been characterized using a load transient with a di/dt of 1 A/ μs . The typical voltage deviation for this load transient is given in the data sheet specification table using the optional value of output capacitance. As the di/dt of a transient is increased, the response of a converter's regulation circuit ultimately depends on its output capacitor decoupling network. This is an inherent limitation with any DC/DC converter once the speed of the transient exceeds its bandwidth capability. If the target application specifies a higher di/dt or lower voltage deviation, the requirement can only be met with additional output capacitor decoupling. In these cases special attention must be paid to the type, value and ESR of the capacitors selected.

If the transient performance requirements exceed that specified in the data sheet, or the total amount of load capacitance is above 3,000 μF , the selection of output capacitors becomes more important. For further guidance consult the separate application note, "Selecting Output Capacitors for PTH Products in High-Performance Applications."

PMF 8518 L

Table 2-1: Input/Output Capacitors

Capacitor Vendor, Type/ Series, (Style)	Capacitor Characteristics y					Quantit		Vendor Part Number
	Working Voltage	Value (µF)	Max. ESR at 100 kHz	Max. Ripple Current at 85 °C (Irms)	Physical Size (mm)	Input Bus	Optional Output Bus	
Panasonic, Aluminum FC, (Radial) FK, (SMD)	25 V	560	0.065 Ω	1205 mA	12.5×15	1	1	EEUFC1E561S
	25 V	1000	0.060 Ω	1100 mA	12.5×13.5	1	1	EEVFK1E102Q
	35 V	680	0.060 Ω	1100 mA	12.5×13.5	1	1	EEVFK1V681Q
United Chemi-Con FX, Os-con (SMD) LXZ, Aluminum (Radial) PS, Poly-Aluminum (Radial) PXA, Poly-Aluminum (SMD)	16 V	330	0.018 Ω	4500 mA	10×10.5	2	≤3	16FX330M
	16 V	330	0.014 Ω	5050 mA	10×12.5	2	≤2	16PS330MJ12
	16 V	680	0.068 Ω	1050 mA	10×16	1	1	LXZ16VB681M10X16L
	16 V	330	0.014 Ω	5050 mA	10×12.2	3	≤2	PXA16VC331MJ12
Nichicon, Aluminum PM, (Radial) HD, (Radial)	25 V	560	0.060 Ω	1060 mA	12.5×15	1	1	UPM1E561MHH6
	16 V	680	0.038 Ω	1430 mA	10×16	1	1	UHD1C681MHR
	35 V	560	0.048 Ω	1360 mA	16×15	1	1	UPM1V561MHH6
Panasonic, Poly-Aluminum: WA, (SMD) S/SE, (SMD)	16 V	330	0.022 Ω	4100 mA	10×10.2	2	≤3	EEFWA1C331P
	6.3 V	180	0.005 Ω	4000 mA	7.3×4.3×4.2	N/R [2]	≤1 [3]	EEFSE0J181R (V _o ≤5.1V)
Sanyo TPE Poscap (SMD) SP, Os-Con (Radial) SVP, Os-Con (SMD)	10 V	330	0.025 Ω	3000 mA	7.3L ×5.7W	N/R [2]	≤4	10TPE330M
	16 V	270	0.018 Ω	>3500 mA	10×10.5	2 [1]	≤3	16SP270M
	16 V	330	0.016 Ω	4700 mA	11×12	2	≤3	16SVP330M
AVX, Tantalum Series III TPS (SMD)	10 V	470	0.045 Ω	>1723 mA	7.3L ×5.7W	N/R [2]	≤5 [3]	TPE477M010R0045 (V _o ≤5.1V)
	10 V	330	0.045 Ω	>1723 mA	×4.1H	N/R [2]	≤5 [3]	TPE337M010R0045 (V _o ≤5.1V)
Kemet T520, Poly-Tantalum (SMD) T530, Poly-Tant/Organic	10 V	330	0.040 Ω	1800 mA	4.3W	N/R [2]	≤5	T520X337M010A5
	10 V	330	0.015 Ω	>3800 mA	×7.3L	N/R [2]	≤2	T530X337M010A5
	6.3 V	470	0.012 Ω	4200 mA	×4.0H	N/R [2]	≤2 [3]	T530X477M006A5 (V _o ≤5.1V)
Vishay-Sprague 595D, Tantalum (SMD) 945P, Os-con (Radial)	10 V	470	0.100 Ω	1440 mA	7.2L ×6W ×4.1H	N/R [2]	≤5 [3]	595D477X0010R2T (V _o ≤5.1V)
	16 V	270	0.018 Ω	4200 mA	10×10.5	2 [1]	≤3	945P277X0016FBP
Kemet, Ceramic X5R (SMD)	16 V	10	0.002 Ω	—	1210 case	1 [4]	≤5	C1210C106M4PAC
	6.3 V	47	0.002 Ω	—	3225 mm	N/R [2]	≤5	C1210C476K9PAC
Murata, Ceramic X5R (SMD)	6.3 V	100	0.002 Ω	—	1210 case	N/R [2]	≤3	GRM32ER60J107M
	6.3 V	47	—	—	3225 mm	N/R [2]	≤5	GRM32ER60J476M
	16 V	22	—	—	—	1 [4]	≤5	GRM32ER61C226K
	16 V	10	—	—	—	1 [4]	≤5	GRM32DR61C106K
TDK, Ceramic X5R (SMD)	6.3 V	100	0.002 Ω	—	1210 case	N/R [2]	≤3	C3225X5R0J107MT
	6.3 V	47	—	—	3225 mm	N/R [2]	≤5	C3225X5R0J476MT
	16 V	22	—	—	—	1 [4]	≤5	C3225X5R1C226MT
	16 V	10	—	—	—	1 [4]	≤5	C3225X5R1C106MT

[1] Total capacitance of 540 µF is acceptable based on the combined ripple current rating.

[2] N/R –Not recommended. The voltage rating does not meet the minimum operating limits.

[3] Ceramic capacitors may be used to compliment electrolytic types at the input to further reduce high-frequency ripple current.

PMF 8518 L

Adjusting the Output Voltage of the PMF 8518L Wide-Output Adjust Power Module

The V_o Adjust control (pin 4) sets the output voltage of the PMF 8518L product. The adjustment range is from 1.2 V to 5.5 V. To adjust the output voltage above 1.2 V a single external resistor, R_{set} , must be connected directly between the V_o Adjust and GND pins 1. Table 2-1 gives the preferred value for the external resistor for a number of standard voltages, along with the actual output voltage that this resistance value provides.

For other output voltages the value of the required resistor can either be calculated using the following formula, or simply selected from the range of values given in Table 2-2. Figure 2-1 shows the placement of the required resistor.

$$R_{set} = 10 \text{ k}\Omega \cdot \frac{0.8 \text{ V}}{V_{out} - 1.2 \text{ V}} - 1.82 \text{ k}\Omega$$

Table 1-1; Preferred Values of R_{set} for Standard Output Voltages

V_{out} (Standard)	R_{set} (Pref'd Value)	V_{out} (Actual)
5V	280 Ω	5.009 V
3.3 V	2 k Ω	3.294V
2.5 V	4.32 k Ω	2.503 V
2V	8.06 k Ω	2.010V
1.8 V	11.5 k Ω	1.801 V
1.5 V	24.3 k Ω	1.506 V
1.2 V	Open	1.200 V

Figure 1-1; V_o Adjust Resistor Placement

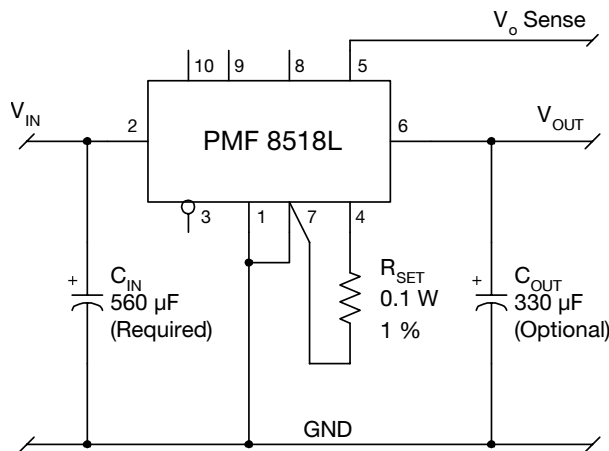


Table 1-2; Output Voltage Set-Point Resistor Values

V_a Req'd	R_{set}	V_a Req'd	R_{set}
1.200	Open	2.75	3.34 k Ω
1.225	318 k Ω	2.80	3.18 k Ω
1.250	158 k Ω	2.85	3.03 k Ω
1.275	105 k Ω	2.90	2.89 k Ω
1.300	78.2 k Ω	2.95	2.75 k Ω
1.325	62.2 k Ω	3.00	2.62 k Ω
1.350	51.5 k Ω	3.05	2.5 k Ω
1.375	43.9 k Ω	3.10	2.39 k Ω
1.400	38.2 k Ω	3.15	2.28 k Ω
1.425	33.7 k Ω	3.20	2.18 k Ω
1.450	30.2 k Ω	3.25	2.08 k Ω
1.475	27.3 k Ω	3.30	1.99 k Ω
1.50	24.8 k Ω	3.35	1.9 k Ω
1.55	21 k Ω	3.40	1.82 k Ω
1.60	18.2 k Ω	3.45	1.74 k Ω
1.65	16 k Ω	3.50	1.66 k Ω
1.70	14.2 k Ω	3.55	1.58 k Ω
1.75	12.7 k Ω	3.6	1.51 k Ω
1.80	11.5 k Ω	3.7	1.38 k Ω
1.85	10.5 k Ω	3.8	1.26 k Ω
1.90	9.61 k Ω	3.9	1.14 k Ω
1.95	8.85 k Ω	4.0	1.04 k Ω
2.00	8.18 k Ω	4.1	939 Ω
2.05	7.59 k Ω	4.2	847 Ω
2.10	7.07 k Ω	4.3	761 Ω
2.15	6.6 k Ω	4.4	680 Ω
2.20	6.18 k Ω	4.5	604 Ω
2.25	5.8 k Ω	4.6	533 Ω
2.30	5.45 k Ω	4.7	466 Ω
2.35	5.14 k Ω	4.8	402 Ω
2.40	4.85 k Ω	4.9	342 Ω
2.45	4.58 k Ω	5.0	285 Ω
2.50	4.33 k Ω	5.1	231 Ω
2.55	4.11 k Ω	5.2	180 Ω
2.60	3.89 k Ω	5.3	131 Ω
2.65	3.7 k Ω	5.4	85 Ω
2.70	3.51 k Ω	5.5	41 Ω

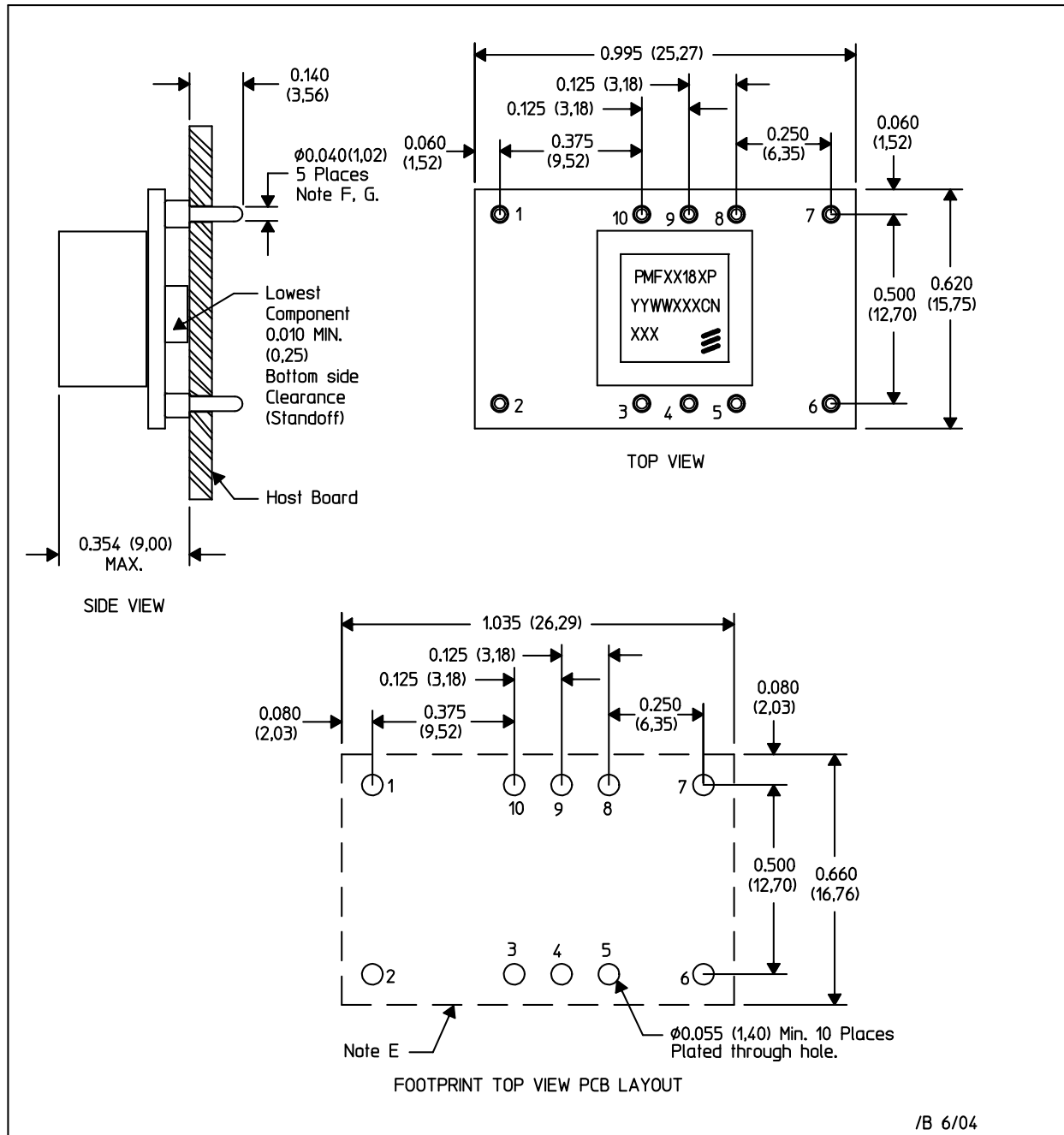
Notes:

1. Use a 0.1 W resistor. The tolerance should be 1 %, with temperature stability of 100 ppm/ $^{\circ}$ C (or better). Place the resistor as close to the regulator as possible. Connect the resistor directly between pins 4 and 7 using dedicated PCB traces.
2. Never connect capacitors from V_o Adjust to either GND or V_{out} . Any capacitance added to the V_o Adjust pin will affect the stability of the regulator.

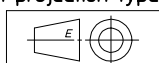
PMF Series Mechanical data

Hole mount version.

DOUBLE SIDED MODULE



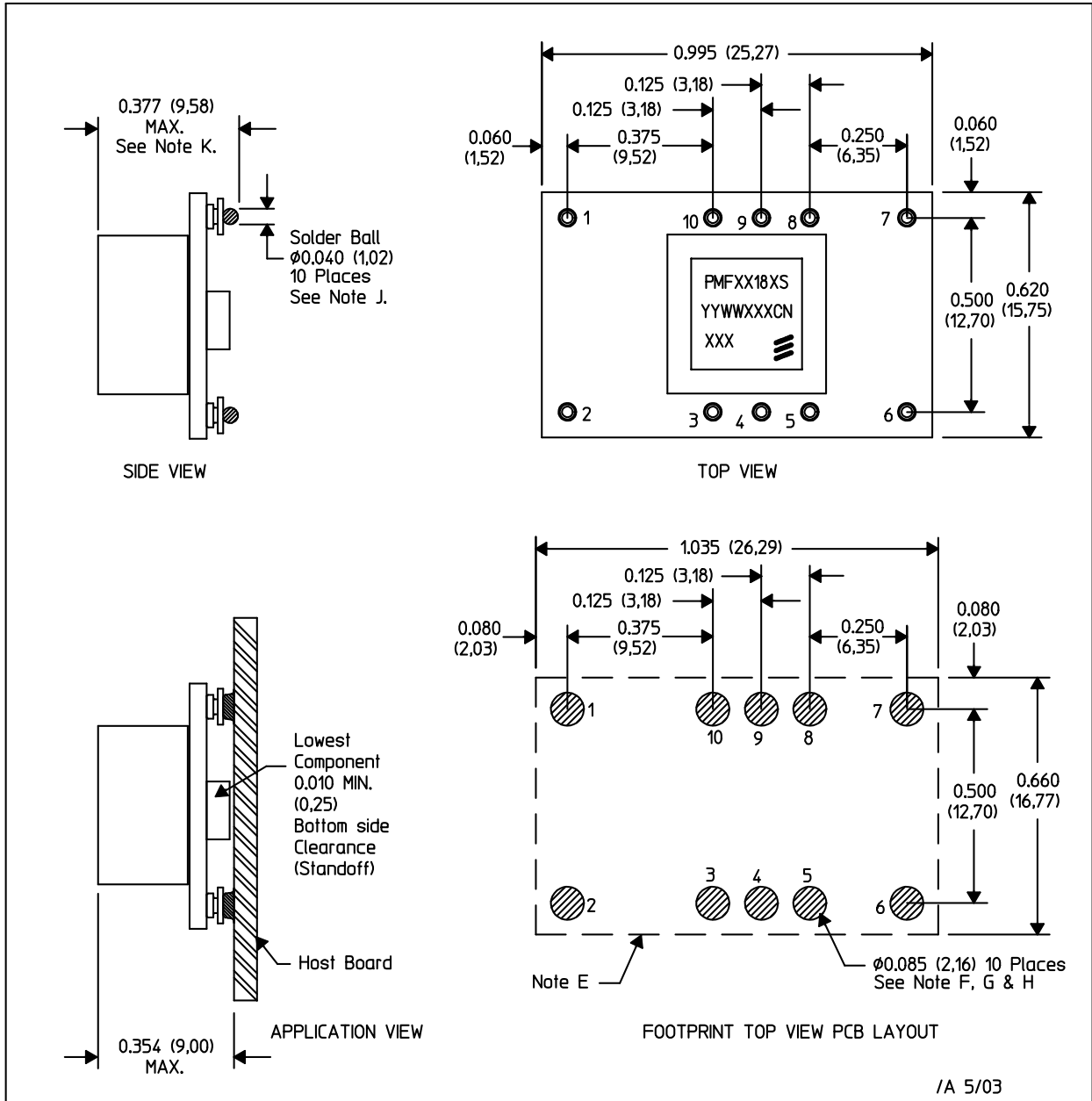
- NOTES:
- A. All linear dimensions are in inches (mm).
 - B. This drawing is subject to change without notice.
 - C. 2 place decimals are ± 0.030 ($\pm 0,76$ mm).
 - D. 3 place decimals are ± 0.010 ($\pm 0,25$ mm).
 - E. Recommended keep out area for user components.
 - F. Pins are 0.040" (1,02) diameter with 0.070" (1,78) diameter standoff shoulder.
 - G. All pins: Material - Copper Alloy
Finish - Tin (100%) over Nickel plate
 - H. European projection type is used.
 - J. Assembled parts according to Manufacturing specification 131 32-BMR 643 XXXX/1.
 - K. Assembly according to Manufacturing instruction 1510-BMR 643.
 - L. Assembly location according to Mounting drawing 1078-BMR 643 XXXX/1.



PME Series Mechanical data

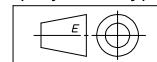
Surface mount version.

DOUBLE SIDED MODULE



- NOTES: A. All linear dimensions are in inches (mm).
 B. This drawing is subject to change without notice.
 C. 2 place decimals are ± 0.030 ($\pm 0,76$ mm).
 D. 3 place decimals are ± 0.010 ($\pm 0,25$ mm).
 E. Recommended keep out area for user components.
 F. Power pin connection should utilize two or more vias to the interior power plane of 0.025 (0,63) I.D. per input, ground and output pin (or the electrical equivalent).
 G. Paste screen opening: 0.080 (2,03) to 0.085 (2,16).
 Paste screen thickness: 0.006 (0,15).
 H. Pad type: Solder mask defined.
 J. All pins: Material - Copper Alloy
 Finish - Tin (100%) over Nickel plate
 Solder Ball - See product data sheet.

- K. Dimension prior to reflow solder.
 L. European projection type is used.



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