PMJ 4718 T 3.3-V Input

30-A, 3.3-V Input Non-Isolated
Wide-Output Adjust Power Module

POLA code: PTH03030 W

NOMINAL SIZE = 1.37 in x 1.12 in
(34,8 mm x 28,5 mm)

Features

- Up to 30-A Output Current
- 3.3-V Input Voltage
- Wide-Output Voltage Adjust (0.8 V to 2.5 V)
- 135 W/in³ Power Density
- Efficiencies up to 93 %
- On/Off Inhibit
- 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
- Over-Temperature Shutdown
- 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 PMJ 4718T is a series of high-current non-isolated power modules from Ericsson Power Modules. The product is characterized by high efficiencies, and up to 30 A of output current, while occupying a mere 1.64 in² of PCB area. In terms of cost, size, and performance, the series provides OEM's with a flexible module that meets the requirements of the most complex and demanding mixed-signal applications. These include the most densly populated, multi-processor systems that incorporate high-speed DSP's, micro-processors, and ASICs.

The series uses double-sided surface mount construction and provides high-performance step-down power conversion from a 3.3-V input bus voltage. The output voltage of the PMJ 4718T 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™. Auto-Track simplifies power-up and power-down supply voltage sequencing in a system by enabling modules to track each other, or any other external voltage.

Each model also includes an on/off inhibit, output voltage adjust (trim), and margin up/down controls. An output voltage sense ensures tight load regulation, and an output over-current and thermal shutdown feature provide for protection against external load faults.

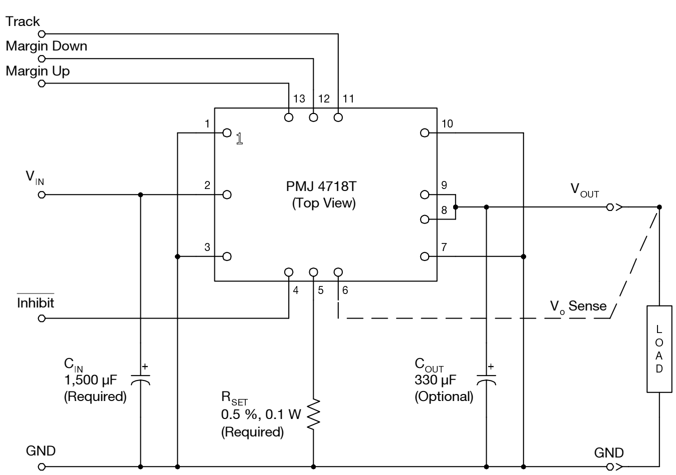
Package options inlude both through-hole and surface mount configurations.

Pin Configuration

Pin	Function
1	GND
2	V_{in}
3	GND
4	Inhibit *
5	V_o Adjust
6	V_o Sense
7	GND
8	V_{out}
9	V_{out}
10	GND
11	Track
12	Margin Down *
13	Margin Up *

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

Standard Application



Rset = Required to set the desired output voltage higher than 0.8 V (see spec. table for values).
C_{in} = Required 1,500 µF capacitor.
C_{out} = Optional 330 µF capacitor.

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Product Table (PMJ 4718T 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 /30 A	75 W	P	Horiz. T/H	PMJ 4718T 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	16 pcs	/B	PMJ 4718T P /B

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 2.5 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.

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

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 *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 accomodated 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.

Point-of-Load Alliance

30-A, 3.3-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	—	85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 (i)	°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 Suffix S 20-2000 Hz Suffix H	— —	10 20	— —	G's
Weight	—		—	10	—	grams
Flammability	—	Meets UL 94V-O				

Notes: *(i) 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_{out} =2 V, C_{in} =1,500 µF, C_{out} =0 µF, and I_o =$I_o$max)

			PMJ 4718T			
Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Output Current	I_o	0.8 V ≤ V_o ≤ 2.5 V, 60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	30 (1) 30 (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	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 ≤ T_a ≤ +85 °C	—	—	±3 (3)	%V_o
Efficiency	η	I_o =20 A R_{SET} = 2.21 kΩ V_o = 2.5 V R_{SET} = 4.12 kΩ V_o = 2.0 V R_{SET} = 5.49 kΩ V_o = 1.8 V R_{SET} = 8.87 kΩ V_o = 1.5 V R_{SET} = 17.4 kΩ V_o = 1.2 V R_{SET} = 36.5 kΩ V_o = 1.0 V	— — — — — —	93 92 91 89 87 85	— — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth	—	30	—	mVpp
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	45	—	A
Transient Response	 t_{tr} ΔV_{tr}	1 A/µs load step, 50 to 100 % $I_o$max, C_{out} =330 µF Recovery Time V_o over/undershoot	 — —	 70 100	 — —	 µSec mV
Margin Up/Down Adjust	V_o adj		—	± 5	—	%
Margin Input Current (pins 12 /13)	I_{IL} margin	Pin to GND	—	– 8 (4)	—	µA
Track Input Current (pin 8)	I_{IL} track	Pin to GND	—	—	–130 (5)	µA
Track Slew Rate Capability	dV_{track}/dt	C_{out} ≤ C_{out}(max)	—	—	1	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 2.2	2.45 2.4	2.8 —	V
Inhibit Control (pin4) Input High Voltage Input Low Voltage	 V_{IH} V_{IL}	Referenced to GND	 V_{in} –0.5 –0.2	 — —	 Open (5) 0.8	V
Input Low Current	I_{IL} inhibit	Pin to GND	—	–130	—	µA
Input Standby Current	I_{in} inh	Inhibit (pin 4) to GND, Track (pin 11) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	275	300	325	kHz
External Input Capacitance	C_{in}		1,500 (6)	—	—	µF
External Output Capacitance	C_{out}	Capacitance value non-ceramic ceramic	0 0	330 (7) —	16,500 (8) 300	µF
		Equiv. series resistance (non-ceramic)	4 (9)	—	—	mΩ
Reliability	MTBF	Per Bellcore TR-332 50 % stress, T_a =40 °C, ground benign	2.8	—	—	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 Vout + 0.5 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 Vdc.
(5) This control pin has an internal pull-up to the input voltage Vin. 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. For further information, consult the related application note.
(6) A 1,500 µF electrolytic input capacitor is required for proper operation. The capacitor must be rated for a minimum of 900 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 mΩ as the minimum when using max-ESR values to calculate.

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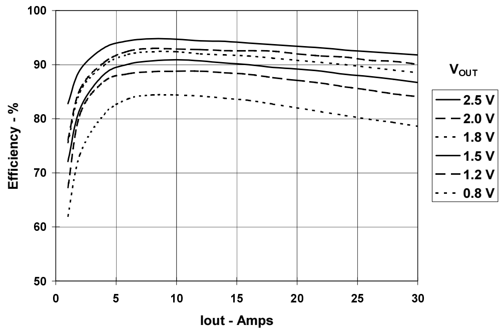
Typical Characteristics

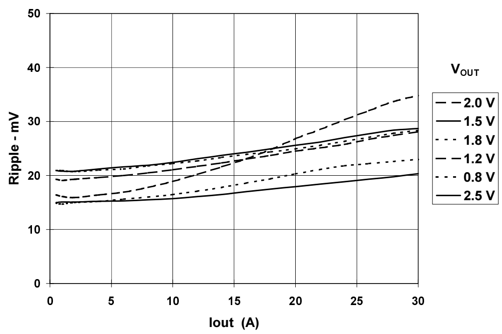
30-A, 3.3-V Input Non-Isolated
Wide-Output Adjust Power Module

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

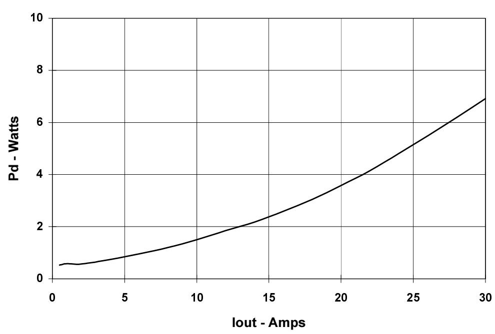
Efficiency vs Load Current



Output Ripple vs Load Current

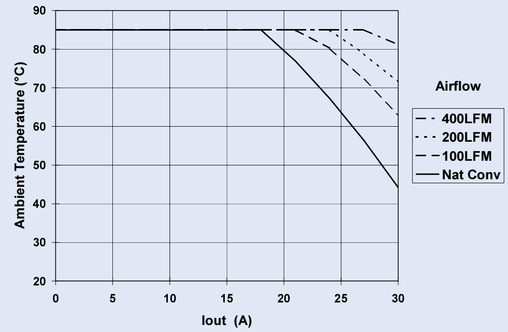


Power Dissipation vs Load Current



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

All Output Voltages



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.*

PMJ 5918 T 5-V Input

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

POLA
Point-of-Load Alliance

POLA code: PTH05030 W

NOMINAL SIZE = 1.37 in x 1.12 in
(34,8 mm x 28,5 mm)

Features

- Up to 30 A Output Current
- 5-V Input Voltage
- Wide-Output Voltage Adjust (0.8 V to 3.6 V)
- 180 W/in³ Power Density
- On/Off Inhibit
- Efficiencies up to 94 %
- Pre-Bias Startup
- Margin Up/Down Controls
- Under-Voltage Lockout
- Auto-Track™ Sequencing[1]
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- Over-Temperature Protection
- 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 PMJ 5918T is a series of high-current non-isolated power modules from Ericsson Power Modules. This product is characterized by high efficiencies, and up to 30 A of output current, while occupying a mere 1.64 in² of PCB area. In terms of cost, size, and performance, the series provides OEM's with a flexible module that meets the requirements of the most complex and demanding mixed-signal applications. These include the most densly populated, multi-processor systems that incorporate high-speed DSP's, microprocessors, and ASICs.

The series uses double-sided surface mount construction and provides high-performance step-down power conversion from a 5-V input bus voltage. The output voltage of the PMJ 5918T 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™. Auto-Track simplifies power-up and power-down supply voltage sequencing in a system by enabling modules to track each other, or any other external voltage.

Each model also includes an on/off inhibit, output voltage adjust (trim), and margin up/down controls. An output voltage sense ensures tight load regulation, and an output over-current and thermal shutdown feature provide for protection against external load faults.

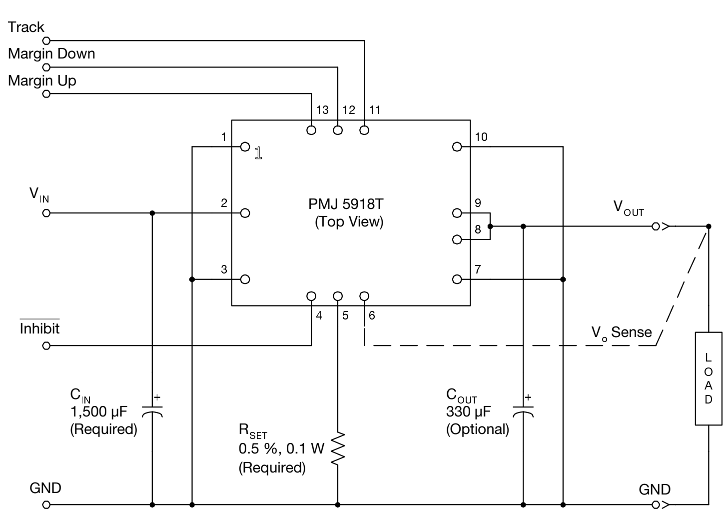
Package options inlude both through-hole and surface mount configurations.

Pin Configuration

Pin	Function
1	GND
2	V_{in}
3	GND
4	Inhibit *
5	V_o Adjust
6	V_o Sense
7	GND
8	V_{out}
9	V_{out}
10	GND
11	Track
12	Margin Down *
13	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 1,500 µF capacitor.
C_{out} = Optional 330 µF capacitor.

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Product Table (PMJ 5918 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 /30 A	108 W	P	Horiz. T/H	PMJ 5918 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	16 pcs	/B	PMJ 5918T P /B

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.

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

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 *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 accomodated 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.

30-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	—	85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 (i)	°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 Suffix S 20-2000 Hz Suffix H	— —	10 20	— —	G's
Weight	—		—	10	—	grams
Flammability	—	Meets UL 94V-O				

Notes: *(i) During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum.*

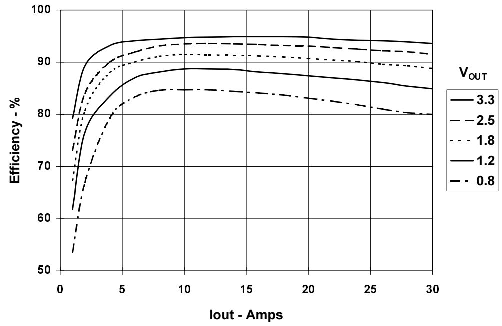
Specifications (Unless otherwise stated, T_a =25 °C, V_{in} =5 V, V_{out} =3.3 V, C_{in} =1,500 µF, C_{out} =0 µF, and I_o =$I_o$max)

			PMJ 5918T			
Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Output Current	I_o	0.8 V ≤ V_o ≤ 3.6 V 60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	30 (1) 30 (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 ≤ T_a ≤ +85 °C	—	—	±3	$\%V_o$
Efficiency	η	I_o =20 A R_{SET} = 698 Ω V_o = 3.3 V R_{SET} = 2.21 kΩ V_o = 2.5 V R_{SET} = 5.49 kΩ V_o = 1.8 V R_{SET} = 8.87 kΩ V_o = 1.5 V R_{SET} = 17.4 kΩ V_o = 1.2 V R_{SET} = 36.5 kΩ V_o = 1.0 V	— — — — — —	94 93 90 89 87 86	— — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth	—	40	—	mVpp
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	47	—	A
Transient Response	 t_{tr} ΔV_{tr}	1 A/µs load step, 50 to 100 % $I_o$max, C_{out} =330 µF Recovery Time V_o over/undershoot	 — —	 70 100	 — —	 µSec mV
Margin Up/Down Adjust	V_o adj		—	± 5	—	%
Margin Input Current (pins 12 /13)	I_{IL} margin	Pin to GND	—	– 8 (3)	—	µA
Track Input Current (pin 11)	I_{IL} track	Pin to GND	—	—	–130 (4)	µA
Track Slew Rate Capability	dV_{track}/dt	C_{out} ≤ 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 (pin4) Input High Voltage Input Low Voltage	 V_{IH} V_{IL}	Referenced to GND	 V_{in} –0.5 –0.2	 — —	 Open (4) 0.8	V
Input Low Current	I_{IL} inhibit	Pin to GND	—	–130	—	µA
Input Standby Current	I_{in} inh	Inhibit (pin 4) to GND, Track (pin 11) open	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	275	300	235	kHz
External Input Capacitance	C_{in}		1,500 (5)	—	—	µF
External Output Capacitance	C_{out}	Capacitance value non-ceramic ceramic	0 0	330 (6) —	16,500 (7) 300	µF
		Equiv. series resistance (non-ceramic)	4 (8)	—	—	mΩ
Reliability	MTBF	Per Bellcore TR-332 50 % stress, T_a =40 °C, ground benign	2.8	—	—	10^6 Hrs

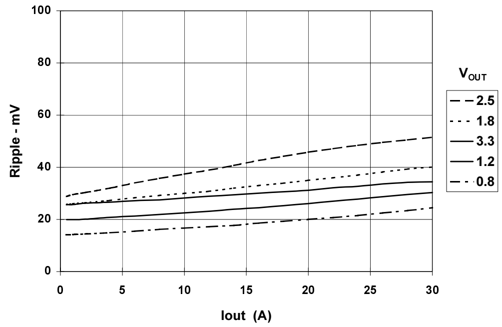
Notes:
(1) See SOA curves or consult factory for appropriate derating.
(2) The set-point voltage tolerlance is affected by the tolerance and stability of R_{SET}. The stated limit is unconditionally met if R_{SET} has a tolerance of 1 % with 100 ppm/°C or better temperature stability.
(3) A small low-leakage (<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 Vin. 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. For further information, consult the related application note.
(5) A 1,500 µF electrolytic input capacitor is required for proper operation. The capacitor must be rated for a minimum of 900 mA rms of ripple current.
(6) An external output capacitor is not required for basic operation. Adding 330 µF 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 mΩ as the minimum when using max-ESR values to calculate.

Characteristic Data; V_{in} =5 V *(See Note A)*

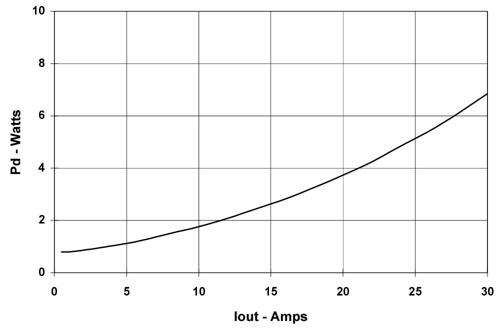
Efficiency vs Load Current



Output Ripple vs Load Current

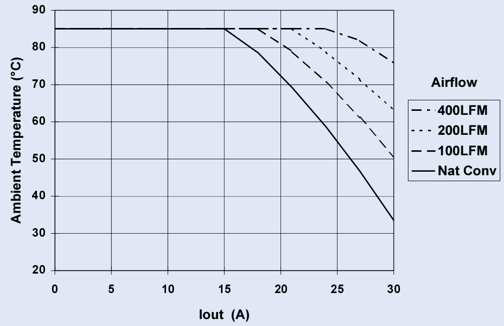


Power Dissipation vs Load Current



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

Over Output Voltage Range



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.*

Capacitor Recommendations for the PMJ 4718T & PMJ 5918T Series of Power Modules

Input Capacitor

The recommended input capacitor(s) is determined by the 1,500 µF [(1)] minimum capacitance and 900 mArms minimum ripple current rating.

Ripple current and <100 mΩ equivalent series resistance (ESR) values are the major considerations, along with temperature, when designing with different types of capacitors. Unlike polymer tantalum, conventional tantalum capacitors have a recommended minimum voltage rating of 2 × (maximum DC voltage + AC ripple). This is standard practice to ensure reliability.

For improved ripple reduction on the input bus, ceramic capacitors may be used to complement electrolytic types and 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 most suitable. These capacitors provide adequate decoupling over the frequency range, 2 kHz to 150 kHz, and are suitable when ambient temperatures are above 0 °C. For operation 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 mΩ (7 mΩ 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 becomes less effective. To further improve the reflected input ripple current or the output transient response, multilayer ceramic capacitors can also be added. Ceramic capacitors have very low ESR and their resonant frequency is higher than the bandwidth of the regulator. 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 °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 when determining their power dissipation and surge current capability. 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 1-1 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 100kHz) 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 Capacitors for PTH Products in High-Performance Applications."*

Table 2-1: Input/Output Capacitors

Capacitor Vendor, Type: Series (Style)	Capacitor Characteristics y					Quantit		
	Working Voltage	Value (µF)	Max. ESR at 100 kHz	Max. Ripple Current @85 ˚C (I rms)	Physical Size (mm)	Input Bus	Output Bus	Vendor Part Number
Panasonic:								
FC (Radial)	10 V	560	0.090 Ω	>900 mA	10×12.5	3	1	EEUFC1A561
	16 V	1500	0.043 Ω	1690 mA	16×15	1	1	EEUFC1C152S
FK (SMD)	16 V	1500	0.060 Ω	1100 mA	12.5×13.5	1	1	EEVFK1C152Q
	10 V	2200	0.060 Ω	1100 mA	12.5×13.5	1	1	EEVFK1A222Q
United Chemi-con								
FX, Oscon (Radial)	6.3 V	1000	0.013 Ω	4935 mA	10×10.5	2	≤2	6FX1000M
PXA, (Poly-Aluminum (SMD.)	6.3 V	820	0.010 Ω	5500 mA	10×12.2	2	≤2	PXA6.3VC820MJ12TP
LXZ, Aluminum (Radial)	10 V	680	0.090 Ω	>900 mA	10×12.5	3	1	LXZ10VB681M10X12LL
	10 V	1000	0.068 Ω	1050 mA	10×16	2	1	LXZ10VB102M10X16LL
Nichicon, Aluminum:								
HD (Radial)	6.3 V	1000	0.053 Ω	1030 mA	10×12.5	2	1	UHD0J102MPR
PM (Radial)	10 V	1500	0.050 Ω	1060 mA	16×15	1	1	UPM1A152MHH6
Sanyo, Os-con:								
SP (Radial)	10 V	470	0.015 Ω	>4500 mA	10×10.5	3 [1]	≤3	10SP470M
SVP (SMD)	6.3 V	820	0.012 Ω	>5440 mA	10×12.7	2	≤2	6SVP820M
Panasonic, Poly-Aluminum:								
WA (SMD)	6.3 V	560	0.020 Ω	5100 mA	10×10.2	3	≤4	EEFWA0J561P
S/SE (SMD)	6.3 V	180	0.005 Ω	4000 mA	7.3×4.3×4.2	N/R	≤1	EEFSE0J181R
AVX, Tantalum:								
TPS (SMD)	10 V	470	0.045 Ω	1723 mA	7.3L	3 [1]	≤5	TPSE477M010R0045
	10 V	470	0.060 Ω	1826 mA	×5.7W ×4.1H	3 [1]	≤5	TPSV477M010R0060
Kemet (SMD):								
T520, Poly-Tant	6.3 V	470	0.018 Ω	>1200 mA	4.3W	3 [1]	≤5	T520X477M006SE018
T530, Poly-Tant/Organic	10 V	330	0.015 Ω	>3800 mA	×7.3L	5	≤3	T530X337M010AS
	6.3 V	470	0.012 Ω	4200 mA	×4.0H	3 [1]	≤2	T530X477M006AS
Vishay-Sprague					7.2L ×6W			
595D, Tantalum (SMD)	10 V	470	0.100 Ω	1440 mA	×4.1H	3 [1]	≤5	595D477X0010R2T
94SA, Os-con (Radial)	16 V	2200	0.015 Ω	9740 mA	16×25	1	≤3	94SA108X0016HBP
Kemet, Ceramic X5R (SMD)	16 V	10	0.002 Ω	—	1210 case	1 [2]	≤5	C1210C106M4PAC
	6.3 V	47	0.002 Ω		3225 mm	1 [2]	≤5	C1210C476K9PAC
Murata, Ceramic X5R (SMD)	6.3 V	100	0.002 Ω	—	1210 case	1 [2]	≤3	GRM32ER60J107M
	6.3 V	47			3225 mm	1 [2]	≤5	GRM32ER60J476M
	16 V	22				1 [2]	≤5	GRM32ER61C226K
	16 V	10					≤5	GRM32DR61C106K
TDK, Ceramic X5R (SMD)	6.3 V	100	0.002 Ω	—	1210 case	1 [2]	≤3	C3225X5R0J107MT
	6.3 V	47			3225 mm	1 [2]	≤5	C3225X5R0J476MT
	16 V	22				1 [2]	≤5	C3225X5R1C226MT
	16 V	10					≤5	C3225X5R1C106MT

(1) Total capacitance of 940 µF is acceptable based on the combined ripple current rating.

Adjusting the Output Voltage of the PMJ 4718T & PMJ 5918T Wide-Output Adjust Power Modules

The V_o *Adjust* control (pin 4) sets the output voltage of the PTH03030W and PTH05030W products to a value higher than 0.8 V. The adjustment range of the PT03030W (3.3-V input) is from 0.8 V to 2.5 V [1], and the PTH05030W (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* pins [2]. 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.

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

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 kΩ	2.502 V
2 V	4.12 kΩ	2.010 V
1.8 V	5.49 kΩ	1.803 V
1.5 V	8.87 kΩ	1.504 V
1.2 V	17.4 kΩ	1.202 V
1 V	36.5 kΩ	1.005 V
0.8 V	Open	0.8 V

Figure 1-1; V_o Adjust Resistor Placement

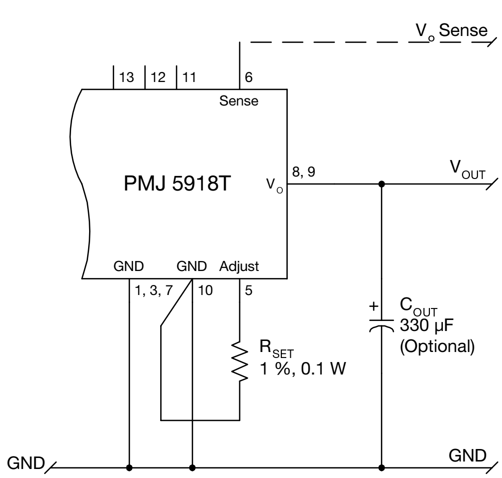


Table 1-2; Output Voltage Set-Point Resistor Values

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

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/°C (or better). Place the resistor as close to the regulator as possible. Connect the resistor directly between pins 5 and 10 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.

PMJ 8x18 x 12-V Input

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

POLA code: PTH12030 W/L

NOMINAL SIZE = 1.37 in x 1.12 in
(34,8 mm x 28,5 mm)

Features

- Up to 26 A Output Current
- 12-V Input Voltage
- Wide-Output Voltage Adjust (1.2 V to 5.5 V)/(0.8 V to 1.8 V)
- Efficiencies up to 94 %
- 235 W/in³ Power Density
- On/Off Inhibit
- Output Voltage Sense
- Pre-Bias Startup
- Margin Up/Down Controls
- Dual-Phase Topology
- Auto-Track™ Sequencing(1)
- Under-Voltage Lockout
- Output Over-Current Protection (Non-Latching, Auto-Reset)
- Over-Temperature Protection
- Operating Temp: –40 to +85 °C
- Safety Agency Approvals:UL/cUL 60950, EN60950 VDE (Pending)
- Point-of-Load Alliance (POLA) Compatible

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

Description

The PMJ 8x18 x is a series of high-current non-isolated power module from Ericsson Power Modules. This product is characterized by high efficiencies, and up to 26 A of output current, while occupying a mere 1.64 in² of PCB area. In terms of cost, size, and performance, the series provides OEM's with a flexible module that meets the requirements of the most complex and demanding mixed-signal applications. These include the most densly populated, multi-processor systems that incorporate high-speed DSP's, microprocessors, and ASICs.

The series uses double-sided surface mount construction and provides high-performance step-down power conversion from a 12-V input bus voltage.

The output voltage of the L-suffix parts can be set to any value over the range, 1.2 V to 5.5 V. The T-suffix parts have an adjustment range of 0.8 V to 1.8 V. The output voltage is set using a single resistor.

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

Each model also includes an on/off inhibit, output voltage adjust (trim), and margin up/down controls, and the ability to start up into an existing prebias. An output voltage sense ensures tight load regulation, and an output over-current and thermal shutdown feature provide for protection against external load faults.

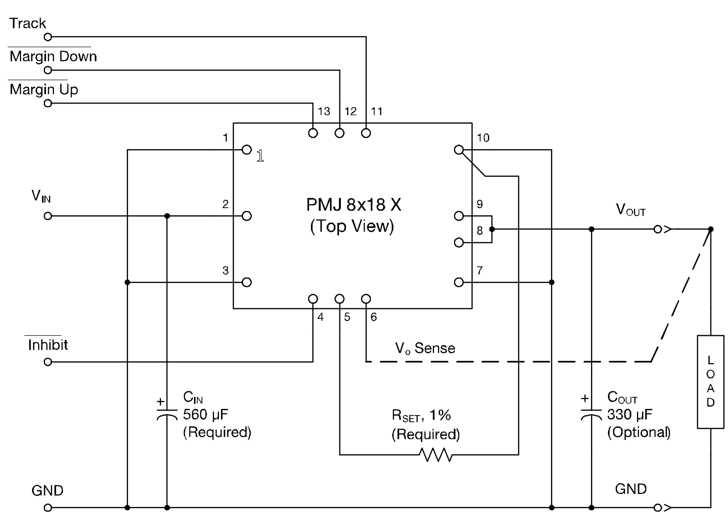
Package options inlude both through-hole and surface mount connfigurations.

Pin Configuration

Pin	Function
1	GND
2	V_{in}
3	GND
4	Inhibit *
5	V_o Adjust
6	V_o Sense
7	GND
8	V_{out}
9	V_{out}
10	GND
11	Track
12	Margin Down *
13	Margin Up *

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

Standard Application



Rset = Required to set the output voltage to a value higher than the lowest value. (See spec. table for values)
C_{in} = Required electrolytic 560 µF
C_{out} = Optional 330 µF electrolytic

Product Table (PMJ 8118 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 /26 A	143 W	P	Horiz. T/H	PMJ 8118 L x[1]
			S	SMD, Standard	

[1] Replace "x"in the Ordering No. with Package Code.

Product Table (PMJ 8418 T x)[1]

V_{In}	V_O / I_O max	P_O max	Package Code(1)	Description	Ordering No.
10.8-13.2 V	0.8-1.8 V /26 A	46.8 W	P	Horiz. T/H	PMJ 8418 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	16 pcs	/B	PMJ 8418T P /B

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% resistor must be connected directly between this pin and GND (pin 7) to set the output voltage of the module higher than its lowest value. The temperature stability of the resistor should be 100 ppm/°C (or better). The set point range is 1.2 V to 5.5 V for L-suffix devices, and 0.8 V to 1.8 V for T-suffix devices. The resistor value required for a given output voltage may be calculated using a formula. If left open circuit, the module output voltage will default to its lowest value. For further information on output voltage adjustment consult the related application note.

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 *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 accomodated 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.

26-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
Inhibit Input Voltage	V_{inh}		–0.3	—	7	V
Operating Temperature Range	T_a	Over V_{in} Range	–40	—	85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 (i)	°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	—	15	—	G's
Weight	—		—	10	—	grams
Flammability	—	Meets UL 94V-O				

Notes: *(i) 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_{out} =0 µF, and I_o =$I_o$max)

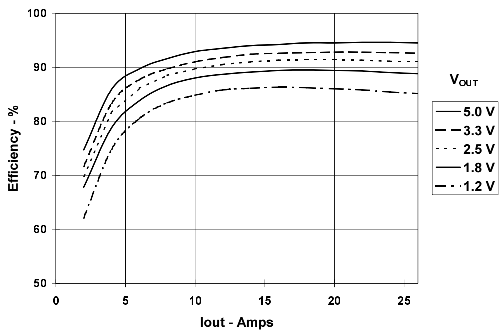
			PMJ 8118L			
Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Output Current	I_o	60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	26 (1) 26 (1)	A
Input Voltage Range	V_{in}	Over I_o range	10.2	—	13.8	V
Set-Point Voltage Tolerance	V_o tol		—	—	±2 (2)	%V_o
Temperature Variation	ΔReg_{temp}	–40 °C < T_a < +85 °C	—	±0.5	—	%V_o
Line Regulation	ΔReg_{line}	Over V_{in} range	—	±5	—	mV
Load Regulation	ΔReg_{load}	Over I_o range	—	±5	—	mV
Total Output Variation	ΔReg_{tot}	Includes set-point, line, load, –40 °C ≤ T_a ≤ +85 °C	—	—	±3 (2)	%V_o
Output Voltage Adjust Range	ΔV_{adj}	Over V_{in} range	1.2	—	5.5	V
Efficiency	η	I_o =18 A R_{SET} = 280 Ω V_o = 5.0 V R_{SET} = 2.0 kΩ V_o = 3.3 V R_{SET} = 4.32 kΩ V_o = 2.5 V R_{SET} = 11.5 kΩ V_o = 1.8 V R_{SET} = 24.3 kΩ V_o = 1.5 V R_{SET} = open cct. V_o = 1.2 V	— — — — — —	94.5 92.7 91.4 89.5 88.2 86.2	— — — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth All voltages	—	25	—	mVpp
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	50	—	A
Transient Response	 t_{tr} ΔV_{tr}	1 A/µs load step, 50 to 100 % $I_o$max, C_{out} =330 µF t_{tr} Recovery Time V_o over/undershoot	 — —	 50 150	 — —	 µSec mV
Margin Up Down Adjust	V_o adj	With V_o Adjust control	—	± 5	—	%
Margin Input Current (pins 12 /13)	I_{IL} margin	Pin to GND	—	– 8 (3)	—	µA
Track Input Current (pin 11)	I_{IL} track	Pin to GND	—	—	–0.13 (3)	mA
Track Slew Rate Capability	dV_{track}/dt	C_{out} ≤ C_{out}(max)	—	—	1	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 8	9.5 8.5	10 —	V
Inhibit Control (pin4) Input High Voltage Input Low Voltage	 V_{IH} V_{IL}	Referenced to GND	 2.5 –0.2	 — —	 Open (4) 0.5	V
Input Low Current	I_{IL} inhibit	Pin to GND	—	–0.5	—	mA
Input Standby Current	I_{in} inh	Inhibit (pin 4) to GND, Track (pin 11) to V_{in}	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	475	575	675	kHz
External Input Capacitance	C_{in}		560 (5)	—	—	µF
External Output Capacitance	C_{out}	Capacitance value non-ceramic ceramic	0 0	330 (6) —	7,150 (7) 300	µF
		Equiv. series resistance (non-ceramic)	4 (8)	—	—	mΩ
Reliability	MTBF	Per Bellcore TR-332 50 % stress, T_a =40 °C, ground benign	3	—	—	10^6 Hrs

Notes:
(1) See SOA curves or consult factory for appropriate derating.
(2) The set-point voltage rolerance is affected be 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) 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 is pulled up to an internal 5-V source. To avoid risk of damage to the module, do not apply an external voltage greater than 7 V. 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. For further information, consult the related application note.
(5) A 560 µF electrolytic input capacitor is required for proper operation. The capacitor must be rated for a minimum of 500 mArms of ripple current.
(6) An external output capacitor is not required for basic operation. Adding 330 µF 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 typcial ESR for all the electrolytic (non-ceramic) output capacitance. Use 7 mW as the minimum when using max-ESR values to calculate.

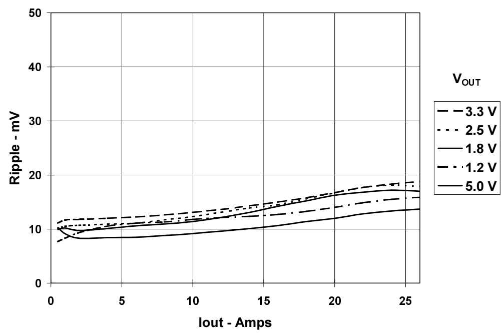
26-A, 12-V Input Non-Isolated
Wide-Output Adjust Power Module

Characteristic Data; V_{in} =12 V *(See Note A)*

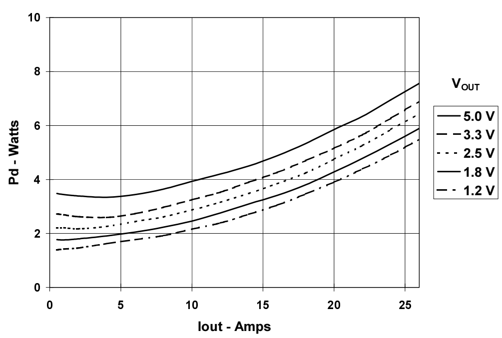
Efficiency vs Load Current



Output Ripple vs Load Current

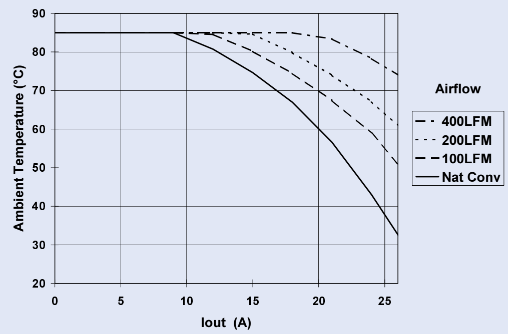


Power Dissipation vs Load Current



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

All Output Voltages



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.*

26-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
Inhibit Input Voltage	V_{inh}		–0.3	—	7	V
Operating Temperature Range	T_a	Over V_{in} Range	–40	—	85	°C
Solder Reflow Temperature	T_{reflow}	Surface temperature of module body or pins			235 (i)	°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	—	15	—	G's
Weight	—		—	10	—	grams
Flammability	—	Meets UL 94V-O				

Notes: *(i) During reflow of SMD package version do not elevate peak temperature of the module, pins or internal components above the stated maximum.*

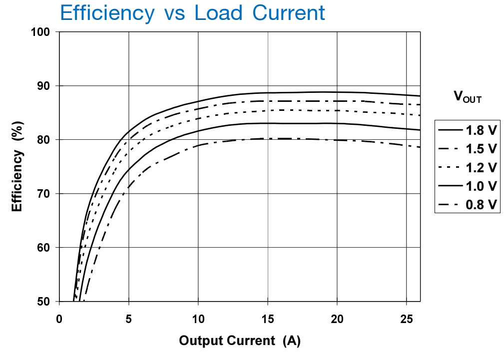
Specifications (Unless otherwise stated, T_a =25 °C, V_{in} =12 V, V_{out} =3.3 V, C_{in} =560 μF, C_{out} =0 μF, and I_o =$I_o$max)

			PMJ 8418 T			
Characteristics	Symbols	Conditions	Min	Typ	Max	Units
Output Current	I_o	60 °C, 200 LFM airflow 25 °C, natural convection	0 0	— —	26 (1) 26 (1)	A
Input Voltage Range	V_{in}	Over I_o range	10.2	—	13.8	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	—	±5	—	mV
Load Regulation	ΔReg_{load}	Over I_o range	—	±5	—	mV
Total Output Variation	ΔReg_{tot}	Includes set-point, line, load, –40 °C ≤ T_a ≤ +85 °C	—	—	±3 (2)	%V_o
Output Voltage Adjust Range	ΔV_{adj}	Over V_{in} range	0.8	—	1.8	V
Efficiency	η	I_o =18 A R_{SET} = 130 Ω V_o = 1.8 V R_{SET} = 3.57 kΩ V_o = 1.5 V R_{SET} = 12.1 kΩ V_o = 1.2 V R_{SET} = 32.4 kΩ V_o = 1.0 V R_{SET} = open cct. V_o = 0.8 V	— — — — —	89 87 85 83 80	— — — — —	%
V_o Ripple (pk-pk)	V_r	20 MHz bandwidth	—	15	—	mV_{pp}
Over-Current Threshold	I_o trip	Reset, followed by auto-recovery	—	50	—	A
Transient Response		1 A/μs load step, 50 to 100 % $I_o$max, C_{out} =330 μF				
	t_{tr} ΔV_{tr}	Recovery Time V_o over/undershoot	— —	50 150	— —	μSec mV
Margin Up Down Adjust	V_o adj	With V_o Adjust control	—	±5	—	%
Margin Input Current (pins 12 /13)	I_{IL} margin	Pin to GND	—	– 8 (3)	—	μA
Track Input Current (pin 11)	I_{IL} track	Pin to GND	—	—	–0.13 (3)	mA
Track Slew Rate Capability	dV_{track}/dt	C_{out} ≤ C_{out}(max)	—	—	1	V/ms
Under-Voltage Lockout	UVLO	V_{in} increasing V_{in} decreasing	— 8	9.5 8.5	10 —	V
Inhibit Control (pin4)		Referenced to GND				
Input High Voltage Input Low Voltage	V_{IH} V_{IL}		2.5 –0.2	— —	Open (4) 0.5	V
Input Low Current	I_{IL} inhibit	Pin to GND	—	–0.5	—	mA
Input Standby Current	I_{in} inh	Inhibit (pin 4) to GND, Track (pin 11) to V_{in}	—	10	—	mA
Switching Frequency	f_s	Over V_{in} and I_o ranges	475	575	675	kHz
External Input Capacitance	C_{in}		560 (5)	—	—	μF
External Output Capacitance	C_{out}	Capacitance value non-ceramic ceramic	0 0	330 (6) —	7,150 (7) 300	μF
		Equiv. series resistance (non-ceramic)	4 (8)	—	—	mΩ
Reliability	MTBF	Per Bellcore TR-332 50 % stress, T_a =40 °C, ground benign	3	—	—	10^6 Hrs

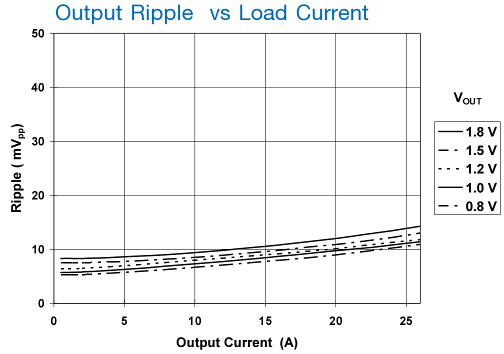
Notes:
(1) See SOA curves or consult factory for appropriate derating.
(2) The set-point voltage rolerance is affected be the tolerance and stability of R_{SET}. The stated limit is unconditionally met if R_{SET} has a tolerance of 1% with 100 ppm/°C or better temperature stability.
(3) A small low-leakage (<100 nA) MOSFET is recommended to control this pin. The open-circuit voltage is less than 1 Vdc.
(4) This control pin is pulled up to an internal 5-V source. To avoid risk of damage to the module, do not apply an external voltage greater than 7 V. 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. For further information, consult the related application note.
(5) A 560 μF electrolytic input capacitor is required for proper operation. The capacitor must be rated for a minimum of 500 mArms of ripple current.
(6) An external output capacitor is not required for basic operation. Adding 330 μF 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 typcial ESR for all the electrolytic (non-ceramic) output capacitance. Use 7 mW as the minimum when using max-ESR values to calculate.

Characteristic Data; V_{in} =12 V *(See Note A)*

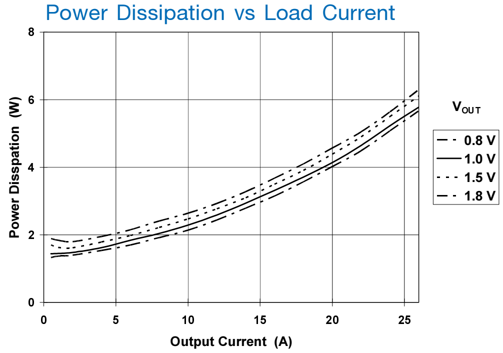
Efficiency vs Load Current



Output Ripple vs Load Current

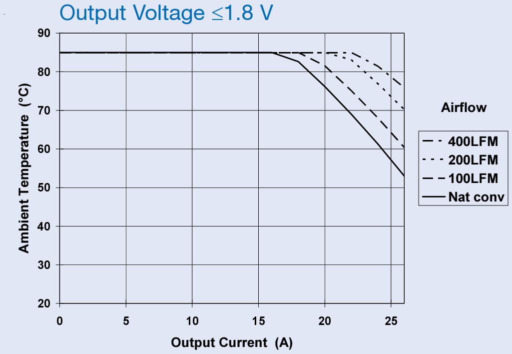


Power Dissipation vs Load Current



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

Output Voltage ≤1.8 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 in. ´ 4 in. double-sided PCB with 1 oz. copper.*

Capacitor Recommendations for the PMJ 8x18 x Series of Power Modules

Input Capacitor

The recommended input capacitor(s) is determined by the 560 µF [3] minimum capacitance and 500 mArms minimum ripple current rating.

Ripple current, less than 100 mΩ equivalent series resistance (ESR), and temperature are major considerations when selecting input capacitors. Unlike polymer-tantalum capacitors, regular tantalum capacitors are not recommended for the input bus. These capacitors require a recommended minimum voltage rating of 2 × (max. DC voltage + AC ripple). This is standard practice to ensure reliability. There were no tantalum capacitors, with sufficient voltage rating, found to meet this requirement. [1] When the operating temperature is below 0 °C, the ESR of aluminum electrolytic capacitors increases. For these applications Os-Con, polymer-tantalum, and polymer-tantalum types should be considered.

Adding one or two ceramic capacitors to the input will further reduce high-frequency reflected ripple current. [4]

Output Capacitors (Optional)

For applications with load transients (sudden changes in load current), regulator response will benefit from 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 when ambient temperatures are above 0 °C. For operation 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 mΩ (7 mΩ 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 only be used 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 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 reduced power dissipation and surge current ratings. Tantalum capacitors that have no 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 1-1 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.

Table 2-1: Input/Output Capacitors

Capacitor Vendor, Type Series (Style)	Capacitor Characteristics y					Quantit		
	Working Voltage	Value (µF)	Max. ESR at 100 kHz	Max Ripple Current at 85 °C (Irms)	Physical Size(mm)	Input Bus	Optional Output Bus	Vendor Part Number
Panasonic FC (Radial) FK (SMD)	25 V 25 V 25 V 35 V	330 560 470 680	0.090 Ω 0.065 Ω 0.080 Ω 0.060 Ω	>1100 mA 1205 mA >1100 mA 1100 mA	10×12.5 12.5×15 10×10.2 12.5×13.5	2 1 2 1	1 1 1 1	EEUFC1E331 EEUFC1E561S EEVFK1E471P EEVFK1V681Q
United Chemi-Con FX, Os-con (SMD) LXZ, Aluminum (Radial) PS, Poly-Aluminum(Radial) PXA, Poly-Aluminum (SMD)	16 V 16 V 25 V 16 V 16 V	330 330 680 330 330	0.018 Ω 0.090 Ω 0.068 Ω 0.014 Ω 0.014 Ω	4500 mA 760 mA 1050 mA 5060 mA 5050 m A	10×10.5 10×12.5 10×16 10×12.5 10×12.2	2 2 1 2 2	≤3 1 1 ≤3 ≤3	16FX330M LXZ25VB331M10X12LL LXZ16VB681M10X16LL 16PS330MJ12 PXA16VCMJ12
Nichicon, Aluminum HD (Radial) PM (Radial)	25 V 25 V 35 V	560 680 560	0.060 Ω 0.038 Ω 0.048 Ω	1060 mA 1430 mA 1360 mA	12.5×15 10×16 16×15	1 1 1	1 1 1	UPM1E561MHH6 UHD1C681MHR UPM1V561MHH6
Panasonic, Poly-Aluminum: WA (SMD) S/SE (SMD)	 16 V 6.3 V	 330 180	 0.022 Ω 0.005 Ω	 4100 mA 4000 mA	 10×10.2 7.3×4.3×–4.2	 2 N/R [1]	 ≤3 ≤1 [2]	 EEFWA1C331P EEFSE0J181R (V_o≤5.1V)
Sanyo TPE, Poscap (SMD) SP, Os-Con (Radial) SVP, Os-Con (SMD)	10 V 16 V 16 V	330 270 330	0.025 Ω 0.018 Ω 0.016 Ω	3000 mA >3500 mA 4700 mA	7.3L ×5.7W 10×10.5 11×12	N/R [1] 2 [3] 2	≤4 ≤3 ≤3	10TPE330M 16SP270M 16SVP330M
AVX, Tantalum, Series III TPS (SMD)	10 V 10 V	470 330	0.045 Ω 0.045 Ω	>1723 mA >1723 mA	7.3L ×5.7W ×4.1H	N/R [1] N/R [1]	≤5 [2] ≤5 [2]	TPSE477M010R0045 (V_o≤5.1V) TPSE337M010R0045 (V_o≤5.1V)
Kemet, Poly-Tantalum T520 (SMD) T530 (SMD)	 10 V 10 V 6.3 V	 330 330 470	 0.040 Ω 0.015 Ω 0.012 Ω	 1800 mA >3800 mA 4200 mA	 4.3W ×7.3L ×4.0H	 N/R [1] N/R [1] N/R [1]	 ≤5 ≤2 ≤2 [2]	 T520X337M010AS T530X337M010AS T530X477M006AS (V_o≤5.1V)
Vishay-Sprague 595D, Tantalum (SMD) 94SA, Os-con (Radial)	10 V 16 V	470 1,000	0.100 Ω 0.015 Ω	1440 mA 9740 mA	7.2L×6W ×4.1H 16×25	N/R [1] 1	≤5 [2] ≤2	595D477X0010R2T (V_o≤5.1V 94SA108X0016HBP
Kemet, Ceramic X5R (SMD)	16 V 6.3 V	10 47	0.002 Ω 0.002 Ω	—	1210 case 3225 mm	1 [4] N/R [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	N/R [1] N/R [1] 1 [4] 1 [4]	≤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	N/R [1] N/R [1] 1 [4] 1 [4]	≤3 ≤5 ≤5 ≤5	C3225X5R0J107MT C3225X5R0J476MT C3225X5R1C226MT C3225X5R1C106MT

[1] N/R –Not recommended. The voltage rating does not meet the minimum operating limits.
[2] The voltage rating of this capacitor only allows it to be used for output voltages that are equal to or less than 5.1 V.
[3] Total capacitance of 540 µF is acceptable based on the combined ripple current rating.
[4] Small ceramic capacitors may used to complement electrolytic types at the input to further reduce high-frequency ripple current.

Adjusting the Output Voltage of the PMJ 8x18 x Series of Wide-Output Adjust Power Modules

The V_o *Adjust* control (pin 4) sets the output voltage of the PMJ 8x18 product. The adjustment range is from 1.2 V to 5.5 V for the L-suffix modules, and 0.8 V to 1.8 V for T-suffix modules. The adjustment method requires the addition of a single external resistor, R_{set}, that must be connected directly between the V_o *Adjust* and *GND* pins [1]. 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. Figure 2-1 shows the placement of the required resistor.

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

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

Figure 1-1; V_o Adjust Resistor Placement

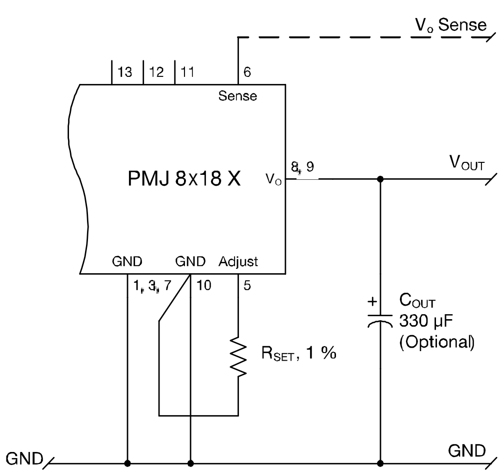


Table 1-2; Output Voltage Set-Point Resistor Values

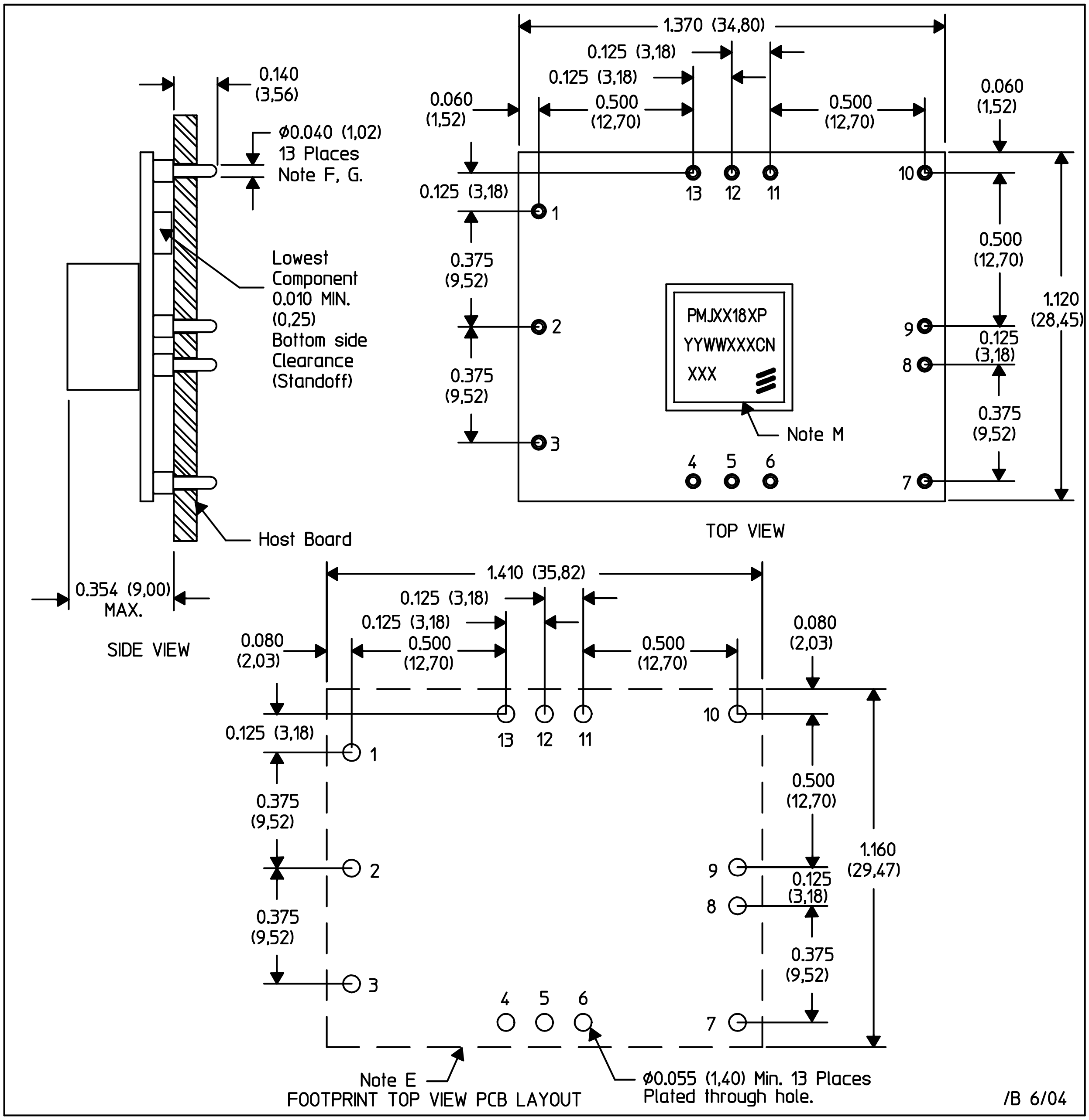
V_a Req'd	R_{set}	V_a Req'd	R_{set}
1.200	Open	2.75	3.34 kΩ
1.225	318 kΩ	2.80	3.18 kΩ
1.250	158 kΩ	2.85	3.03 kΩ
1.275	105 kΩ	2.90	2.89 kΩ
1.300	78.2 kΩ	2.95	2.75 kΩ
1.325	62.2 kΩ	3.00	2.62 kΩ
1.350	51.5 kΩ	3.05	2.5 kΩ
1.375	43.9 kΩ	3.10	2.39 kΩ
1.400	38.2 kΩ	3.15	2.28 kΩ
1.425	33.7 kΩ	3.20	2.18 kΩ
1.450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

Notes:

1. A 0.05-W rated resistor may be used. The tolerance should be 1%, with temperature stability of 100 ppm/°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.

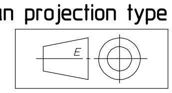
PMJ Series Mechanical data

Hole mount version. DOUBLE SIDED MODULE



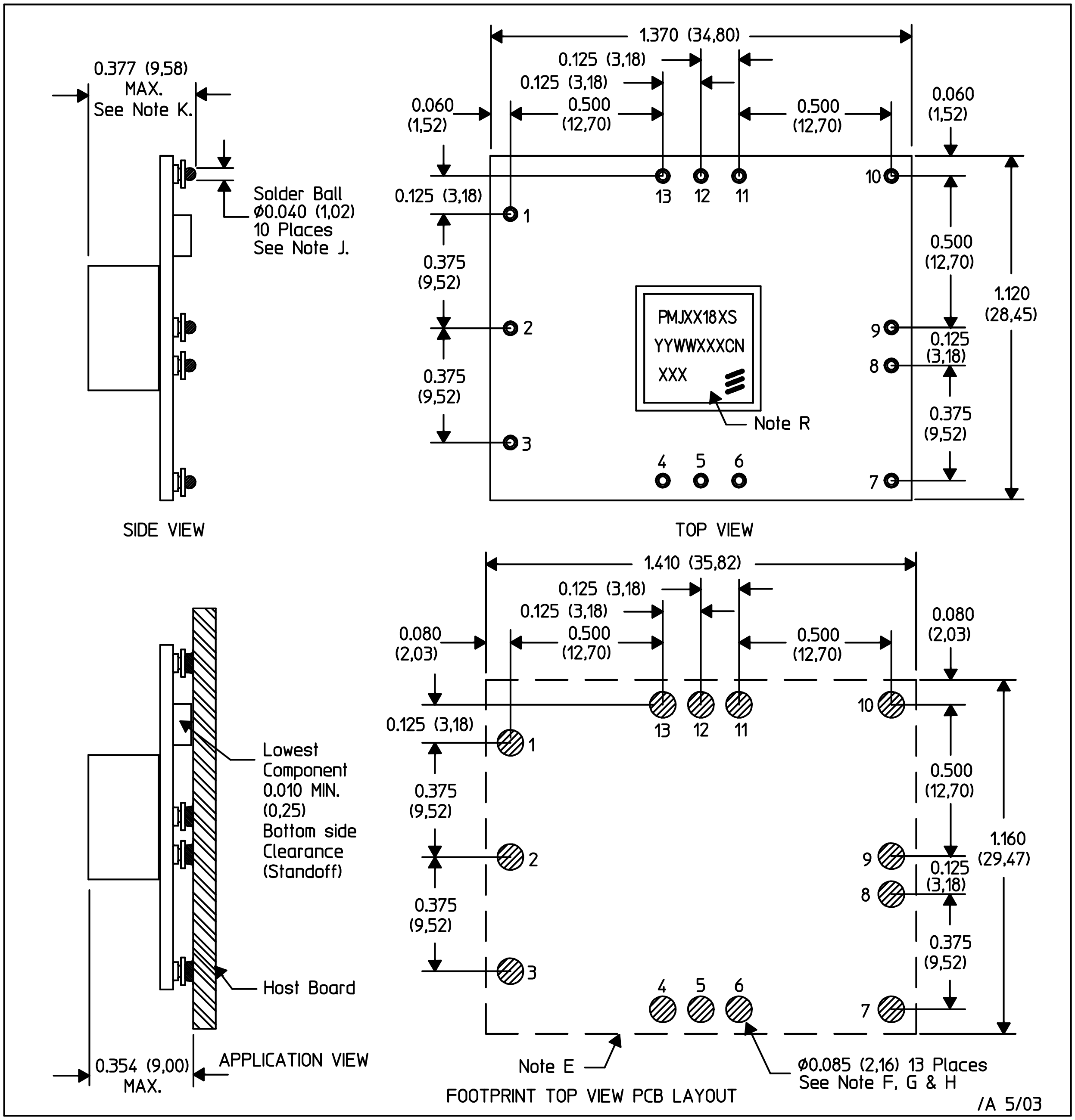
NOTES:

A. All linear dimensions are in inches (mm).
B. This drawing is subject to change without notice.
C. 2 place decimals are ±0.030 (±0,76mm).
D. 3 place decimals are ±0.010 (±0,25mm).
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.

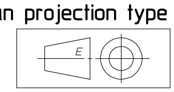


PMJ Series Mechanical data

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 (±0,76mm).
D. 3 place decimals are ±0.010 (±0,25mm).
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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