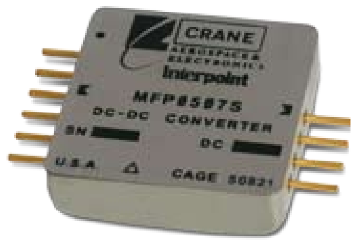
Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

MAXIMUM FLEXIBLE POWER (MFP) IN A SINGLE 7 AMP POINT OF LOAD.
A USE-ANYWHERE POWER SOLUTION FOR DIGITAL AND NON-DIGITAL SYSTEMS.



FEATURES

No external components required

- Operating temperature -70° to +150°C
- Cold start at -90°C
- Up to 92% efficiency, flat down to 30% load
- Qualified up to MIL-PRF-38534 Class K
- Radiation hardness assurance (RHA) up to level F, 300 kRad(Si) TID, available on request
- Input voltage range 3.0 to 6.0 VDC
- Input transient survivability to 15 V_{IN} for up to 1 sec.
- Inhibit and sync functions
- Current monitoring
- Current sharing pin for parallel operation
- Five pin-selectable, preset voltages:
  - 0.64, 0.8, 1.6, 2.5 and 3.3
  - Output voltage continuously adjustable from 0.64 to 3.5 V with resistors
- Indefinite output short circuit protection
- Adjustable start-up sequencing
- Remote sense and voltage margining
- Internal solid state power switch provides many benefits including inrush current limiting

HISTORY OF PROVEN PERFORMANCE

Interpoint, a Crane Co. Company, was issued its first standard microcircuit drawing (SMD) for a Class H hybrid in 1992. Our first Class K hybrid SMD was issued in 1997 and we were one of the first companies to certify manufacturing to Class K. Our Redmond site has a DSCC approved Radiation Hardness Assurance (RHA) plan. Our products are on DSCC SMDs with RHA “P”, “R,” or “F” code for 30, 100 and 300 kRad(Si), respectively.

DESCRIPTION

The MFP Series™ of DC/DC converters do not require any external components to achieve all specified performance levels. They are a high-reliability, high-efficiency point of load converter for use with a 3.3 VDC input bus or a 5 VDC input bus. The MFP0507S model has the flexibility to be set for any output voltage from 0.64 VDC to 3.5 VDC. The converter operates from an input of 3.0 to 6.0 V_{IN} with an undervoltage shutdown at 2.75 V, an overvoltage shutdown of 8.5 V and up to a 15 V transient for up to 1 second.

The non-isolated, feature-rich MFP uses a Buck converter design with synchronous rectification. The design allows the unit to operate synchronously to no output load, ensuring high efficiency at the lightest loads without switching off the synchronous devices. Important features include a solid state switch, inrush current limiting, synchronization with an external system clock and the ability to current share allowing multiple devices to supply a common load.

The MFP includes an internal house keeping supply that is active at inputs as low as 2 VDC and provides a boosted and regulated voltage supply for internal use. This internal supply is one of the reasons that this product can provide full power at very high efficiency at input voltages as low as 3 VDC. No external power source or external bias is required.

The MFP converters are designed for the large, fast transient load currents typical to digital loads. See Figure 4 for a typical connection diagram. The MFP Series is intended to be powered by a fully regulated power source.

US PATENTS

Interpoint converters may use one or more of the following US patents 5,521,807, 5,694,303 and 5,631,822.

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

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Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

Electrical Characteristics: -55 to +125°C T_C, 5 VDC V_{IN} ($V_{IN\ NOM}$), 100% load, free run, unless otherwise specified.

TABLE 1: ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITION	SYMBOL	MIN	TYP	MAX	UNITS
OPERATING TEMPERATURE	All	T_C	-70	—	+150	°C
STORAGE TEMPERATURE	All	T_{STG}	-90	—	+155	°C
MAXIMUM WEIGHT	—	—	—	—	23	grams
LEAD SOLDERING TEMPERATURE [1]	10 seconds max	—	—	—	300	°C

Table 1, Note 1. Caution: Heat from reflow or wave soldering may damage the device.
Solder pins individually with heat application not exceeding 300°C for 10 seconds per pin.

TABLE 2: INPUT SPECIFICATIONS

PARAMETER	STATE	CONDITION	FIGURE	SYMBOL	MIN	TYP	MAX	UNITS
Input Voltage Range	Continuous	—	6	V_{IN}	0	5.0	8.5	VDC
	Operating	—	6	V_{IN}	3.0	3.3 or 5.0	6.0	
	Transient [1]	—	6	$V_{IN\ TRAN}$	8.5	—	15	V
Input Under Voltage Lockout	—	—	6	—	2.2	2.5	3.0	VDC
Input Current	No Load	V_{IN} = 3 V	—	I_{IN}	—	180	230	mA
		V_{IN} = 6 V	—	I_{IN}	—	110	140	
	Disabled	V_{IN} = 3 V	—	I_{IN}	—	105	120	
		V_{IN} = 6 V	—	I_{IN}	—	50	65	
Enable/Disable (Pin 1) Input	Open Circuit Voltage	Pin 1 Open V_{IN} 3 to 6 V	5	$V_{PIN\ 1}$	1.6	—	2.3	VDC
	Threshold Unit Enabled				2.2	—	—	
	Threshold Unit Disabled	V_{IN} 3 to 6 V	5	$V_{PIN\ 1}$	—	—	1.5	
	ENABLE Pin Current Unit Disabled			$I_{PIN\ 1}$	—	—	4	mA
External Synchronization	Standard Frequency Range	—	5	—	270	—	330	kHz
	Extended Frequency Range [2]	—	—	—	270	—	600	
	Amplitude	—	—	—	3.0	5.0	6.0	V
	Duty Cycle	—	—	—	40	50	60	%
	Frequency Source Impedance	—	—	—	—	—	1.5	kOhms
Switching Frequency	-55 to +125°C	—	17	—	280	—	330	kHz
	-70 to +150°C	—	17	—	270	—	340	

Table 2, Notes:
1. 50 microsecond minimum transition time.
2. Efficiency may be reduced by up to 2% at full load due to switching losses.

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TABLE 2: INPUT SPECIFICATIONS (CONTINUED)

PARAMETER	STATE	CONDITION	FIGURE	SYMBOL	MIN	TYP	MAX	UNITS
Power Dissipation	No Load	—	—	—	—	—	0.7	W
	Full Load		—	—	—	1.24	1.83	
	Fault Power Output Short		—	—	—	—	2.5	
Input Ripple Current	$V_{1\ (0.8V)}$	V_{IN} = 3 20 Hz - 20 MHz	—	$I_{IN\text{-}RIP}$	—	200	—	mA p-p
	$V_{1\ (0.8V)}$	V_{IN} = 6 V 20 Hz - 20 MHz	_		—	200	_	
	$V_{4\ (3.3V)}$		_		—	200	—	
	I_{RMS}	Average	—	—	—	60	—	mA_{RMS}

TABLE 3: OUTPUT SPECIFICATIONS

PARAMETER	STATE	CONDITION	FIGURE	SYMBOL	MIN	TYP	MAX	UNITS
Operating Voltage Accuracy	V_1 0.8, 25°C	50% Load	4 Callout 1	V_1	0.778	0.800	0.822	VDC
	V_1 0.8, -55 to +125°C				0.770		0.830	
	V_1 0.8, -70 to +150°C				0.762		0.838	
	V_2 1.6, 25°C		4 Callout 1	V_2	1.566	1.600	1.634	VDC
	V_2 1.6, -55 to +125°C				1.550		1.650	
	V_2 1.6, -70 to +150°C				1.534		1.666	
	V_3 2.5, 25°C		4 Callout 1	V_3	2.453	2.500	2.548	VDC
	V_3 2.5, -55 to +125°C				2.428		2.573	
	V_3 2.5, -70 to +150°C				2.403		2.598	
	V_4 3.3, 25°C		4 Callout 1	V_4	3.241	3.300	3.360	VDC
	V_4 3.3, -55 to +125°C				3.208		3.393	
	V_4 3.3, -70 to +150°C				3.175		3.426	
Load Regulation V_{OUT} V_1, V_2, V_3, V_4	25°C	I_O 50% Load to Full	—	$V_{R\ LOAD}$	—	—	20	mV
	-55 to +125°C				—		20	
	-70 to +150°C				—		TBD	
Line Regulation V_{OUT} V_1, V_2, V_3, V_4	25°C	V_{IN} 3 to 6 V	—	$V_{R\ LINE}$	—	—	20	mV
	-55 to +125°C				—		20	
	-70 to +150°C				—		TBD	
Total Regulation V_{OUT} (Calculated) V_1, V_2, V_3, V_4	-55 to +125°C	50% Load to Full	—	$V_{R\ TOTAL}$	-3.00	±1.5	3.00	%
	-70 to +150°C				-4.00	±2.5	4.00	

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

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TABLE 3: OUTPUT SPECIFICATIONS (CONTINUED)

PARAMETER	STATE	CONDITION	FIGURE	SYMBOL	MIN	TYP	MAX	UNITS
Output Ripple and Noise V_1, V_2, V_3, V_4	25°C	20 Hz to 20 MHz	12 and 13	$V_{OUT-RIP}$	—	25	50	mV p-p
	-55 to +125°C				—	30	60	
	-70 to +150°C				—	40	80	
Output Current	V_1 0.8, -55 to +125°C	V_{IN} = 3 to 6 V	9	I_{OUT}	0	—	7.0	A
	V_1 0.8, -70 to +150°C				0	—	6.0	
	V_2 1.6, -55 to +125°C				0	—	6.4	
	V_2 1.6, -70 to +150°C				0	—	4.0	
	V_3 2.5, -55 to +125°C				0	—	5.0	
	V_3 2.5, -70 to +150°C				0	—	4.0	
	V4 3.3, -55 to +125°C				0	—	5.0	
	V_4 3.3, -70 to +150°C				0	—	4.0	
Output Power	V_1 0.8, -55 to +125°C	V_{IN} = 3 to 6 V	9	P_{OUT}	0	—	5.6	W
	V_1 0.8, -70 to +150°C				0	—	4.8	
	V_2 1.6, -55 to +125°C				0	—	10.2	
	V_2 1.6, -70 to +150°C				0	—	6.4	
	V_3 2.5, -55 to +125°C				0	—	12.5	
	V_3 2.5, -70 to +150°C				0	—	10.0	
	V_4 3.3, -55 to +125°C				0	—	16.5	
	V_4 3.3, -70 to +150°C				0	—	13.2	
External Load Capacitance	—	—	—	—	—	—	5000	μF
Efficiency	V_1 0.8, 25°C	—	1	EFF_1	66.7	73	—	%
	V_1 0.8, -55 to +125°C				63.5	—	—	
	V_1 0.8, -70 to +150°C				—	—	—	
	V_2 1.6, 25°C		1	EFF_2	80.4	84	—	%
	V_2 1.6, -55 to +125°C				78.4	—	—	
	V_2 1.6, -70 to +150°C				—	—	—	
	V_3 2.5, 25°C		1	EFF_3	86.8	89	—	%
	V_3 2.5, -55 to +125°C				85.4	—	—	
	V_3 2.5, -70 to +150°C				—	—	—	
	V_4 3.3, 25°C		1	EFF_4	89.5	92	—	%
	V_4 3.3, -55 to +125°C				88.5	—	—	
	V_4 3.3, -70 to +150°C				—	—	—	

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

Electrical Characteristics: -55 to +125°C T_C, 5 VDC V_{IN} ($V_{IN\ NOM}$), 100% load, free run, unless otherwise specified.

TABLE 3: OUTPUT SPECIFICATIONS (CONTINUED)

PARAMETER	STATE	CONDITION	FIGURE	SYMBOL	MIN	TYP	MAX	UNITS
Turn On Peak Deviation V_1, V_2, V_3, V_4	Enable		—	—	—	—	50	mV pk
	Step Start	V_{IN} 0 to $V_{IN\text{-}NOM}$		—	—	—	50	
Turn On Settling Time to 2%, V_1, V_2, V_3, V_4	Release of Inhibit/Enable	I_{IN} 0 to Max	—	—	—	4	7	ms
	Step Start	V_{IN} = 0 to 6 V		—	—	4	7	
Output Load Transient Response	V_{IN} 3.3V (settle to 2%)	I_O 50 - 100% @ 1 A / µs	14 and 15	—	—	—	250	µs
	V_{IN} 5V (settle to 2%)			—	—	—	250	
Load Transient Peak Deviation V_1, V_2, V_3, V_4	V_{IN} 3.3V (settle to 2%)	I_O 50 - 100% @ 1 A / µs	14 and 15	—	—	—	250	mV pk
	V_{IN} 5V (settle to 2%)				—	—	250	
Output Voltage Trim V_1, V_2, V_3, V_4	–	See Table 7 in the Pin 7 and 8, TRIM section						
Remote Sense	Positive Output difference from V_{OUT} to V_{SENSE}	—	4	—	—	—	0.20	VDC
Voltage Margining	Positive Output difference from V_{OUT} to V_{SENSE}	—	—	—	—	—	0.20	VDC
Sequence Time Delay	See Table 6 in the PIn 1, ENABLE section							

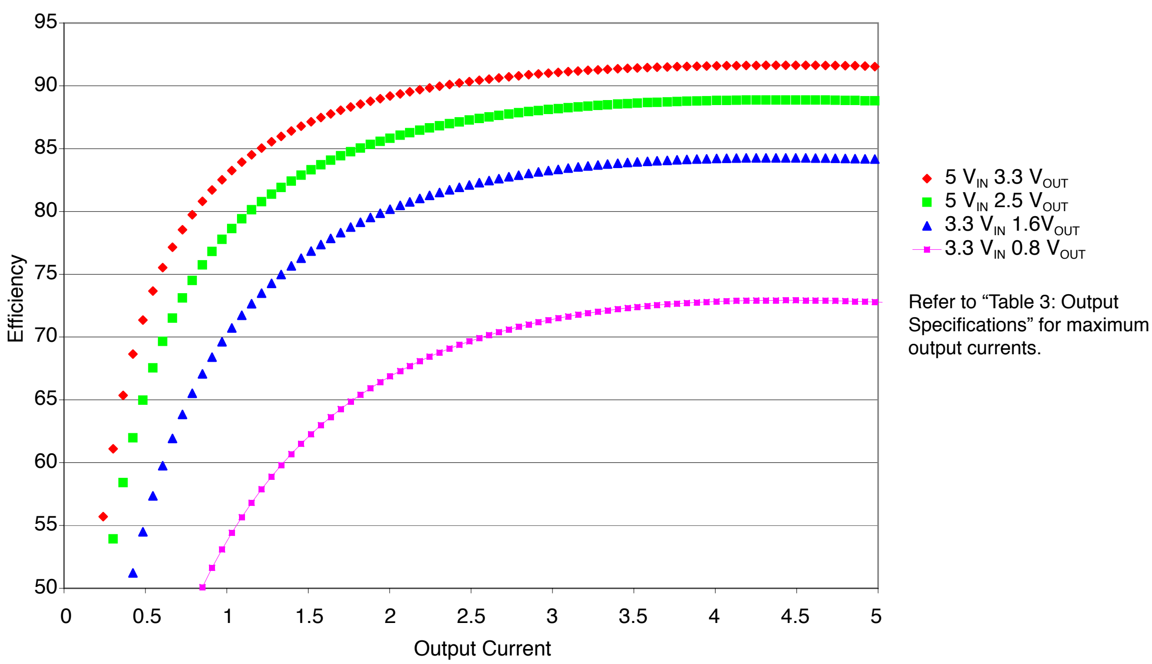

FIGURE 1: EFFICIENCIES

Maximum Flexible Power (MFP) Single Output Point of Load

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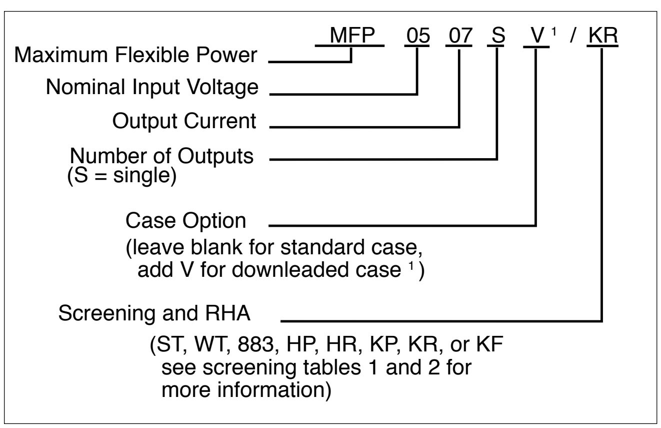
PIN OUT

Pin Number	Designation	Function	If Pin is not Used
1	ENABLE	Enable, provides remote turn on and off	Leave open
2	+V IN	Positive Input	Always used
3	V IN COM	Input Common	Always used
4	SYNC	Synchronization	Leave open
5	SENSE	Sense, voltage drop compensation	Connect to + V_{OUT} pin 10
6	SHARE	Current Share, parallel operation, or current monitor	Leave open
7	TRIM A	Preset Output Voltage and Trim	See Figure 4 and Table 7
8	TRIM B	Preset Output Voltage and Trim	See Figure 4 and Table 7
9	V OUT COM	Output Common (also SENSE Return)	Always used
10	+V OUT	Positive Output	Always used

TABLE 4: MFP0507S PIN OUT

MODEL NUMBERING KEY



Model Numbering Key Note:
1. Downleaded case V is a future option which will be announced when available.

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

MECHANICAL INFORMATION

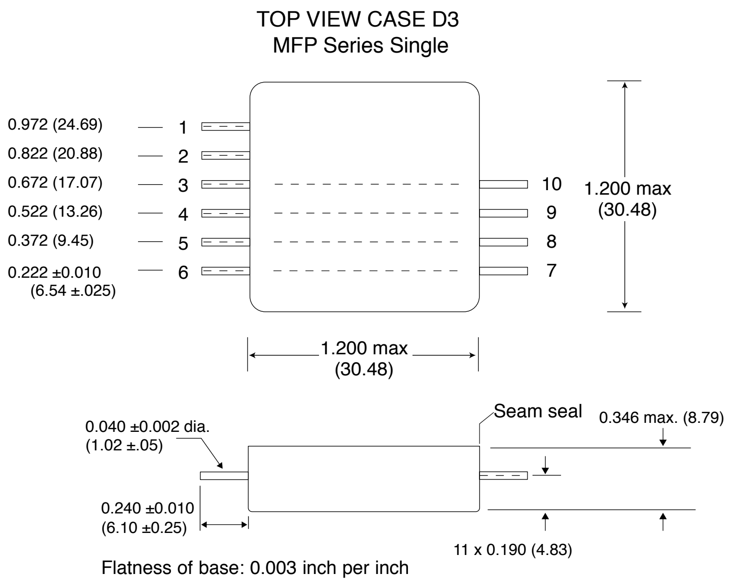


FIGURE 2: MFP0507S CASE DIMENSIONS

Size (nominal)
- Single 1.195 x 1.195 x 0.340

Materials
- Header - Cold Rolled Steel / Nickel
- Cover - Kovar/Nickel
- Pins - 3:1 Cu Cored alloy 52/Gold over Nickel
- Compression glass seal

Case dimensions in inches (mm) Tolerance ±0.005 (0.13) for three decimal places. ±0.01 (0.3) for two decimal places unless otherwise specified. Please refer to the numerical dimensions for accuracy.

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THERMAL AND MOUNTING CONSIDERATIONS

Thermal Considerations

The MFP is designed to be mounted close to the point-of-use which, in many cases, may be on a printed circuit board. The high efficiency of the MFP reduces the issues normally associated with the converter's internal dissipation. The maximum internal dissipation occurs when the product is configured as a 3.3 volt output at full load. This condition will result in a dissipation of not more than 1.83 watts. This dissipation is nearly uniformly distributed over the base area of 1.4 square inches. Full load power loss is largely independent of output voltage, for instance at 0.8 volts and full load the internal power loss maximum is again 1.83 watts.

In order to determine the cooling or heat sinking requirements in the application, the maximum product power dissipation should be calculated from the product efficiency and output power. Graphs and tabled values in the specification table can be used to find the efficiency given the input voltage, selected output voltage and output load. The internal dissipation, difference between output and input power, can be calculated from the equation below.
where:

P_{OUT} = output power

ε = efficiency

$$P_{DISS} = P_{OUT} (1 - \varepsilon) / \varepsilon$$

Φ = thermal resistance of converter attachment to board

$$\Delta T = P_{DISS} \times \Phi$$

$$T_{CASE} = T_{BASE} - \Delta T$$

Many applications will not require special efforts at cooling, however, this depends on ambient temperatures, adjacent components, and other factors.

If product cooling is required for safe operation convention and/or conduction can be used. Thermal considerations require that the base of the MFP be maintained at a safe temperature of less than the maximum rating. All components internal to the MFP are bonded to the metal base of the package. The base is the surface that is important if conduction cooling is used. It is a good practice to bond the device to the PCB or mounting surface with a thermally conductive pad. Such pads provide some degree of conduction cooling to the mounting surface depending on the amount of voiding at the interface. In the case of the side leaded MFP package, this thermal pad will firmly locate the device to the surface so that the lead connections only manage the electrical requirements and not the mechanical requirements.

In Figure 3 below, the thermal rise internal to the MFP can be seen to be only 6°C. This low thermal rise gives the end user more flexibility in board design options to meet applicable derating guidelines.

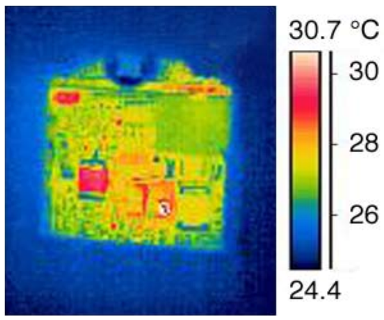

Figure 3: Infrared Image,
MFP at Full Load with 6 V_{IN}, 3.3 V_{OUT}

Maximum Flexible Power (MFP) Single Output Point of Load

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THERMAL AND MOUNTING CONSIDERATIONS (cont.)

Mounting Considerations

Interpoint recommends Chomeric's double-sided adhesive materials for attachment of the MFP to a circuit board or metal surface.

Because of the MFP's efficiency the thermal characteristics of the Chomeric materials are not required even though the Chomeric material provides good thermal conductivity.

The following information refers to products attached using Chomeric double-sided adhesive.

Vibration Testing

The MFP was tested in Random vibration using both the T1680 and T404 to mount the units to an aluminum vibration fixture. Testing was performed to the most severe level in MIL-STD-883 Method 2026; Condition 2, Letter K, overall G_{RMS} 51.1, for 15 minutes per axis, 3 axes and passed. No mounting detachment occurred.

Application

Recommended size for the adhesive tapes is 1.18 x 1.18 inches. Application of the tapes is a matter of peeling the release liners and attaching to the MFP and circuit board respectively. See Chomeric's data sheets and application notes for details. The T404 material does require higher application pressure. The T1680 material is specifically made for low pressure attachment of hybrids, ceramic and flat packages.

Removal

Refer to Chomeric's application notes for Thermattach Tape.

Specifications

Refer to Table 5: Chomeric Material Specifications for thermal conductivity, temperature range and out-gassing.

Table 5: Chomeric Material Specifications

MATERIAL	THERMAL CONDUCTIVITY	TEMPERATURE RANGE	OUTGASSING DATA	MOUNTING APPLICATION
	W/M-K	˚C	%TML/%CVCM	
CHO-THERM 1671 (Note 2)	2.6	-60 to +200	0.76 0.07	Rougher surfaces
CHO-THERM T1680 (Note 1)	0.65	-60 to +200	1.27 0.23	Smooth surfaces
THERMATTACH T404 (Note 1)	0.4	-30 to +125	None	Smooth surfaces

Table 5, Notes:

1. Chomeric's Thermattach Tape T404 and Cho-Therm T1680 are two excellent choices for circuit board mounting. Both have a Kapton insulating barrier with pressure sensitive adhesive (PSA) on both sides.
2. Chomerics Cho-Therm 1671 is a good choice for mounting on rougher surfaces. This material has a fiberglass barrier with PSA on one side. It can be obtained with PSA on both sides if needed.

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

PIN FUNCTIONS AND APPLICATIONS

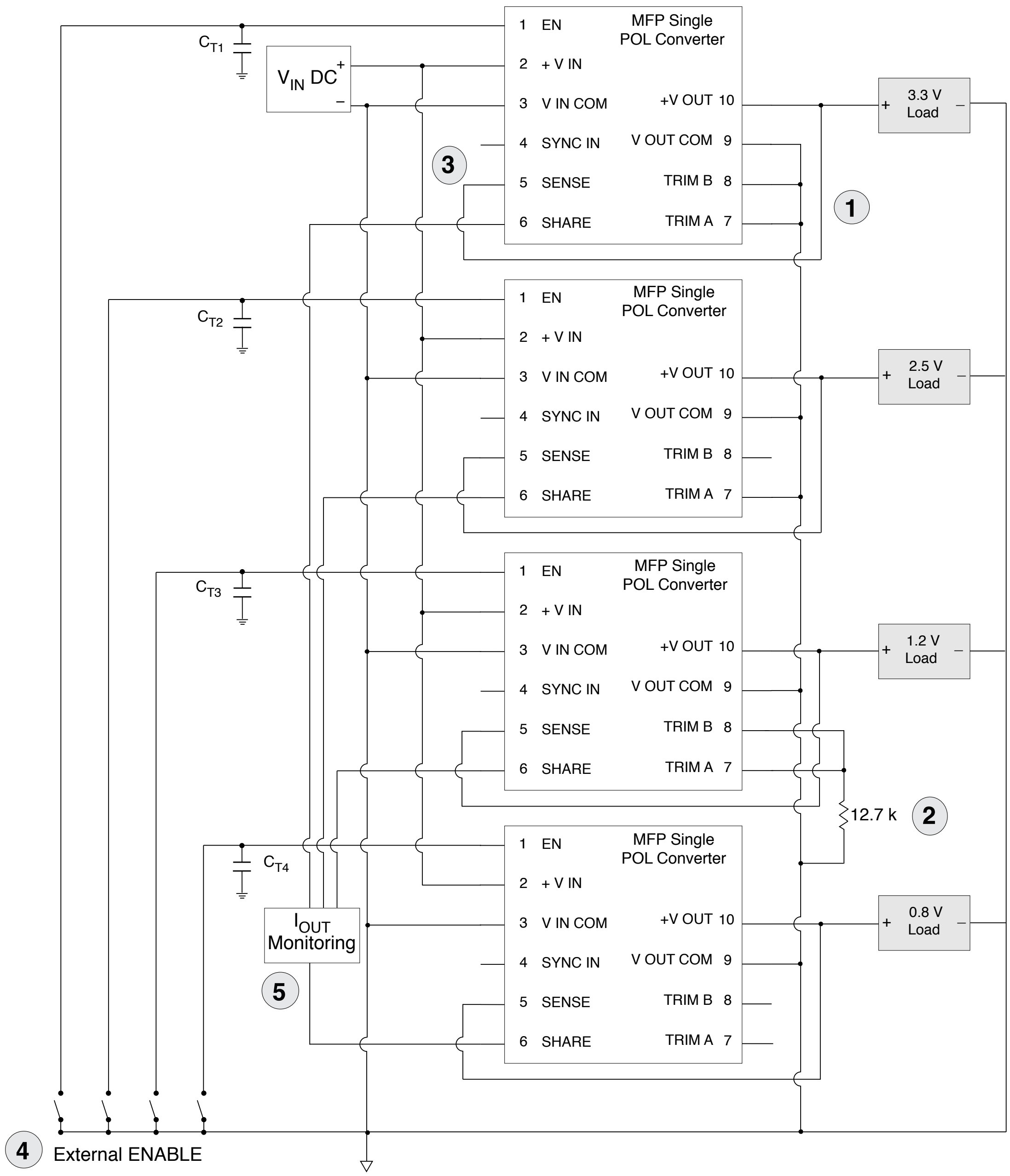


FIGURE 4: TYPICAL CONNECTION DIAGRAM USING ENABLE, TRIM, SENSE, AND I_{OUT} MONITORING

For more information:

- (1) (2) Pins 7 and 8, TRIM section
- (3) Pin 5, Remote SENSE section
- (4) Pin 1, ENABLE section, sequencing. Table 6 lists C_T values.
- (5) Pin 6, SHARE section

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

PIN FUNCTIONS AND APPLICATIONS

Pin 1: ENABLE Function

The MFP provides an enable pin that will allow normal power conversion to occur if left open or unconnected. The ENABLE pin allows remote turn-on and turn-off control of the MFP. Connecting this pin to ground will disable power conversion, resulting in no output voltage and greatly reduced current consumption. The MFP ENABLE function will work with an open collector device connected to the pin or with a logic high voltage from a digital device as long as the logic high voltage is greater than the minimum voltage listed in the specification for enabled operation. The enable pin is active high at > 0.8 V or with a floating input.

Sequencing: The start-up of the MFP can be delayed with the addition of an external capacitor connected to the ENABLE pin. This feature is useful in sequencing the start-up of multiple point of load converters in a system requiring a specific startup sequence for various low-voltage loads. The startup delay is roughly equal to 1 millisecond per microfarad of capacitance. More precise external capacitance values can be found in Table 6 where it can be seen that there is a variation in startup delay time as the input voltage varies. The listed delay is from the beginning of application of power to the beginning of internal power conversion. There will be an additional delay as the power converter begins a normal start-up sequence and ramps to final output voltage.

Pin 4: SYNC

The MFP includes a synchronization feature, a key capability in low noise system design. The internal conversion oscillator can be synchronized with a system clock or with a bus voltage source. The MFP is designed to synchronize with a 300 kHz system but can be synchronized with sources up to 600 kHz, a frequency range used by many DC/DC converters. A synchronized system prevents the generation of low frequency sub harmonics in the audio range. The synchronization input amplitude can range from 3 VDC to 6 VDC. Figure 17 illustrates the relationship between operating frequency, temperature and input voltage.

The external synchronization timing cycle can be varied cycle to cycle for systems employing spread-spectrum clocking or for slave sharing clock interleaving. The DC level of the sync pin (pin 4) can be used to detect the state of the input voltage protection switch.

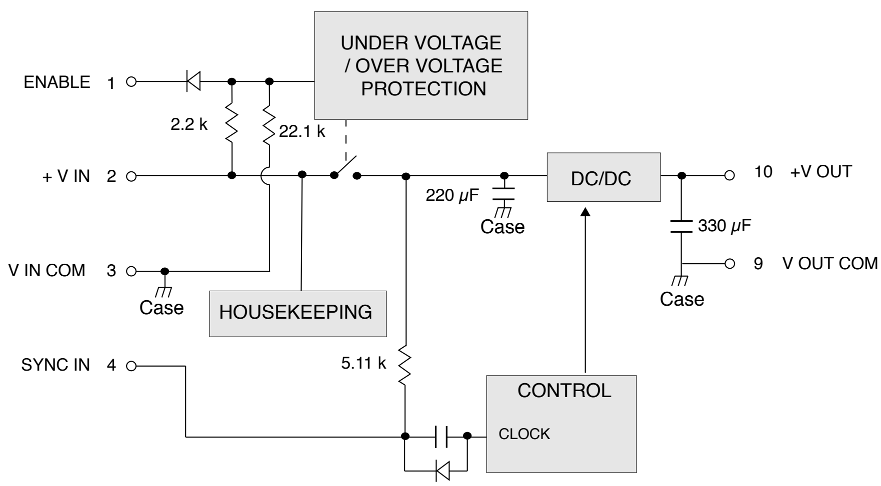


Figure 5: ENABLE and SYNC Equivalent Circuit

Table 6: Enable Capacitance Values for Start-Up Delay

ENABLE CAPACITANCE: DELAY FROM ENABLE RELEASE TO START OF OUTPUT RISE (25°C)											UNITS
CAPACITANCE (C_T)	0.22	0.33	0.47	0.68	1.0	1.5	2.2	3.3	4.7	6.8	10	μF
V_{IN} 3.3 V	0.8	1.1	1.6	2.2	3.1	4.6	6.7	1.0	14.1	20.2	29.7	ms
V_{IN} 5.0 V	0.4	0.5	0.7	0.9	1.3	1.8	2.6	3.9	5.5	7.8	11.4	ms

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

PIN FUNCTIONS AND APPLICATIONS

Pins 2 and 3: $+V_{IN}$ and V_{IN} Common

Input Voltage
The input voltage range for normal operating conditions is 3.0 to 6.0 VDC (Figure 6). For input ripple current see page 17, Figures 10 and 11.

The V_{IN} Common pin is connected to V_{OUT} Common and case ground. The input and output should share the same ground plane in the power system design.

Additional Input Block Features

Input Under and Over Voltage Protection
The MFP includes a solid state switch on the input section. This switch opens for fault conditions including input voltages below the minimum and transient voltages above the maximum. The safe operating range includes ground and extends to 8.5 VDC indefinitely and up to 15 volts as a time limited transient. The switch will only close when certain internal conditions are met, including the proper operation of the internal housekeeping supply and a safe input voltage range.

No Single Point Failure
The solid state switch (SSS) can be used to provide one additional level of reliability: "no single point failure" will result in a connection from input voltages to output loads. The SSS can be opened by grounding of the ENABLE Pin. The status of the SSS can be determined by detecting the voltage on the SYNC pin. A logic low on this pin indicates that the SSS is open.

No External Bias Required
An internal housekeeping supply that is active at inputs as low as 2 VDC provides a boosted and regulated voltage supply for internal use. This internal supply is one of the reasons that this product can provide full power at very high efficiency at input voltages as low as 3 VDC. No external power source or external bias is required.

Input Reflected Noise and Inrush Current Limit
Substantial input capacitance is included and the input solid state switch previously described is designed to provide associated inrush current limiting. The substantial input capacitance and high SSS provide a "pi" filter configuration that results in very low reflected ripple current. The very low input noise and inrush limiter make the MFP unique among point of load converters.

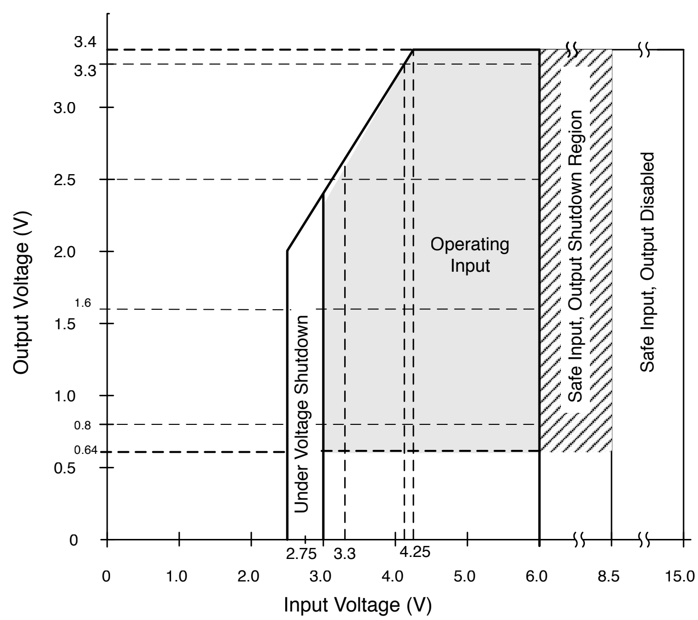


Figure 6: Input voltage vs Maximum Output Voltage

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

PIN FUNCTIONS AND APPLICATIONS

Pin 5: SENSE

The MFP includes a positive remote sense. The SENSE pin is intended to be used to maintain the desired preset voltage at the point-of-use by connecting the remote sense to the +Vout supply in close proximity to the load. Up to 0.3 volts of power line drop can be accommodated. If the SENSE pin lead is not connected to the output positive power pin, the output will rise a total of 0.4 volts.

The output voltage can be margined upward from the preset value as much as 0.2 volts by the addition of a resistor between the positive SENSE pin and the output power pin. The amount of increase in the output voltage by margining will reduce the available remote sense range by the same amount. The sum of margined voltage and voltage sense drop must be less than 0.2 volts.

Sense margining can be used to adjust V_{OUT} from 3.3 to 3.5. Connections must be made as close as possible to Common and to R_X. This method uses the SENSE pin's voltage compensation function to raise the output voltage. Therefore, there will not be an option to compensate for voltage drop at the load.

If connections have no voltage drop, the formula for the resistor is

$$R_X = \frac{1000}{\left[\frac{(0.2697)}{(V_{OUT} - 3.3)} - 1\right]} \text{ in ohms}$$

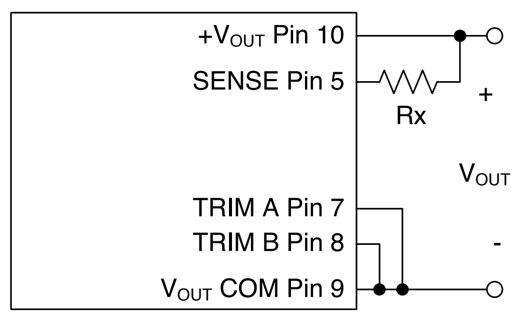


Figure 7: SENSE Pin Voltage Margining, V_{OUT} from 3.3 to 3.5 [1, 2]

Figure 7, Notes:
1. For external connections see page 11, "Figure 4: Typical Connection Diagram."
2. See page 16, "Table 7: User Configurable Outputs" for output voltages from 0.64 to 3.3.

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

PIN FUNCTIONS AND APPLICATIONS

Pin 6: SHARE

The MFP includes a current share feature that allows multiple units to operate as a single supply capable of providing a total current that is the sum of the maximum from each of the units that are operated in parallel. In connecting units in parallel, the SHARE pin is connected between units and all but one unit, the master, will have TRIM A and TRIM B pins tied to the positive SENSE pin. The master will have the TRIM pins configured for the desired output voltage while the other units in parallel will match the current and voltage of the master unit.

The SHARE pin can be used as an output current monitor because the voltage on this pin is proportional to unit current. See page 11, Figure 4, callout 5. The SHARE pin can be used to drive an MFP as a voltage controlled current source where the output current will be proportional to the applied voltage with an offset. Output currents corresponding to SHARE pin voltages are shown in Figure 16: SHARE as Monitor for Output Current. Connections for current monitoring are also shown in Figure 4.

Two connections are critical to sharing between two units. The SHARE pins of the two (or more) units must be tied together and the TRIM A and TRIM B outputs must be tied together and shorted to +Vout and SENSE for each unit that is not the Master. The master unit will be the one with the highest pre-set output voltage. In the case of Figure 8, callout 3, the master is configured with both TRIM pins open for a 0.8 V output.

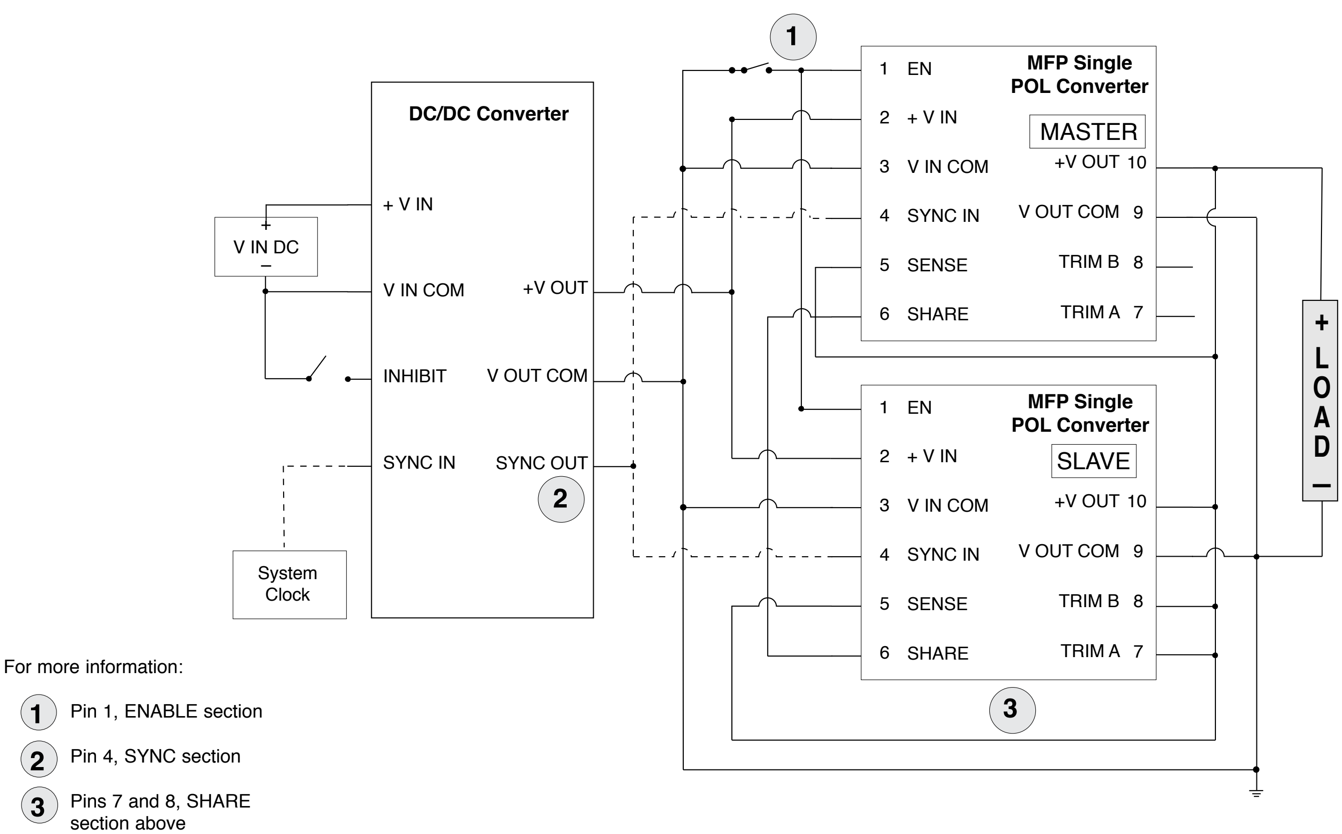


Figure 8: Typical Share Connection with Optional Sync

Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

PIN FUNCTIONS AND APPLICATIONS

PINS 7 AND 8: TRIM A AND TRIM B

Output Voltage Set and Adjustment
The MFP0507S, single output model has the flexibility to be set for any voltage from 0.64 to 3.3 VDC. The MFP includes five precision set-points that can be accomplished with pin connections alone and no trim resistor. An open circuit on both TRIM pins results in a 0.80 VDC output, grounding one or the other or both pins results in precise output voltages of 1.6 VDC, 2.5 VDC or 3.3 VDC. One other preset voltage is possible using the SENSE pin (pin 5). Connecting both trim pins to the positive SENSE pin results in 0.64 VDC. In-between values of output voltage can be set with the use of external trim resistors in series with the trim pins to ground.

Any voltage intermediate to the pre-set voltages is available by adding a trim resistor between Common and both TRIM pins. Table 7 lists available pin-configurable and adjust/trim output voltages.

OUTPUT VOLTAGE USING PIN CONFIGURATIONS OR TRIM RESISTORS			
Desired Voltage		Pin Configurable	TRIM Resistor (R_T) [1] from ground to pin 7 and 8
0.64	Fixed SENSE pin V_s	Both pins 7 and 8 connected to SENSE pin 5	—
0.8	Fixed V_1	Both pins 7 and 8 open	–
0.9	Adjust	–	57.6 k
1.0	Adjust	–	27.4 k
1.2	Adjust	–	12.7 k
1.5	Adjust	–	6.19 k
1.6	Fixed V_2	TRIM A, pin 7 open. TRIM B, pin 8 grounded	—
1.8	Adjust	—	3.57 k
2.0	Adjust	—	2.61 k
2.5	Fixed V_3	TRIM A, pin 7 grounded. TRIM B, pin 8 open	—
3.3	Fixed V_4	Both pins 7 and 8 grounded	—

TABLE 7: USER CONFIGURABLE OUTPUT VOLTAGES [1, 2]

PINS 9 AND 10: +V_{OUT} AND V_{OUT} COMMON

Due to the Buck topology, the required output voltage of the MFP must always be at least 0.8 V lower than the input. Precise values of achievable output voltages and currents as a function of V_{IN} are shown on page 15, Figure 8.

See page 17, Figures 11 and 12 for typical output ripple plots.

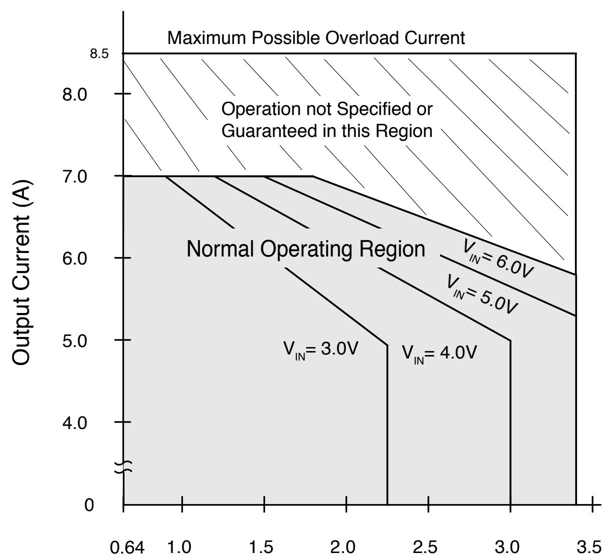


FIGURE 9: MAXIMUM RATED OUTPUT CURRENT

Table 7, Notes:
1. Formula for R_T in Table 7 for V_{OUT} below 3.3 and above 0.8 V:

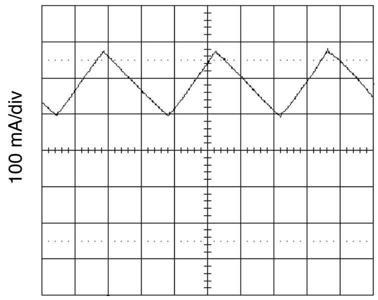
$$R_T = \frac{6.031}{V_{OUT} - 0.804} - 2.4 \quad \text{in kOhms}$$

2. See page 14, "Figure 7 SENSE Pin Voltage Margining, V_{OUT} from 3.3 to 3.5."

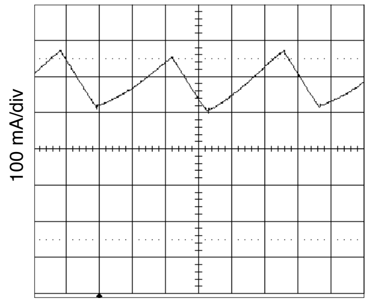
Maximum Flexible Power (MFP) Single Output Point of Load

TECHNICAL PREVIEW: MFP0507S, 3 TO 6 VDC IN, 7 AMP, DC/DC CONVERTER

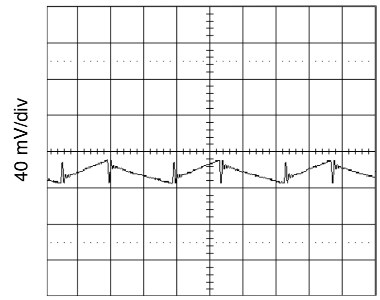
Typical Performance Curves: 25°C T_C, 5 VDC V_{IN}, 100% load, free run, unless otherwise specified.



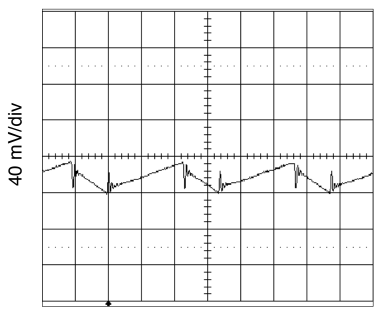
1 µs/div
3.3 V_{IN}, 1.2 V_{OUT}, 5 A load
MFP0507S Input Ripple (I_{IN})
FIGURE 10



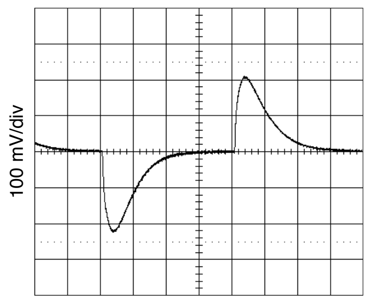
1 µs/div
5 V_{IN}, 3.3 V_{OUT}, 5 A load
MFP0507S Input Ripple (I_{IN})
FIGURE 11



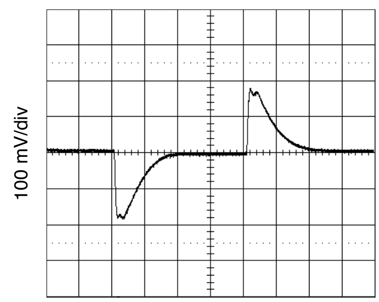
1 µs/div
3.3 V_{IN}, 1.2 V_{OUT}, 5 A load
MFP0507S Output Ripple
FIGURE 12



1 µs/div
5 V_{IN}, 3.3 V_{OUT}, 5 A load
MFP0507S Output Ripple
FIGURE 13



500 µs/div
3.3 V_{IN}, 1.2 V_{OUT}, 5 A load
MFP0507S Load Transient
FIGURE 14



500 µs/div
5 V_{IN}, 3.3 V_{OUT}, 5 A load
MFP0507S Load Transient
FIGURE 15

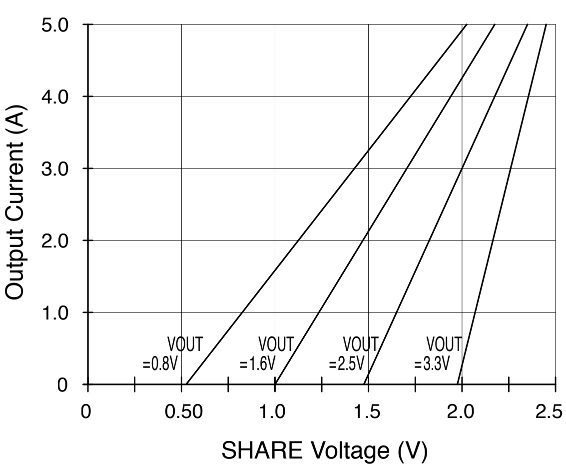


FIGURE 16: SHARE AS MONITOR FOR OUTPUT CURRENT

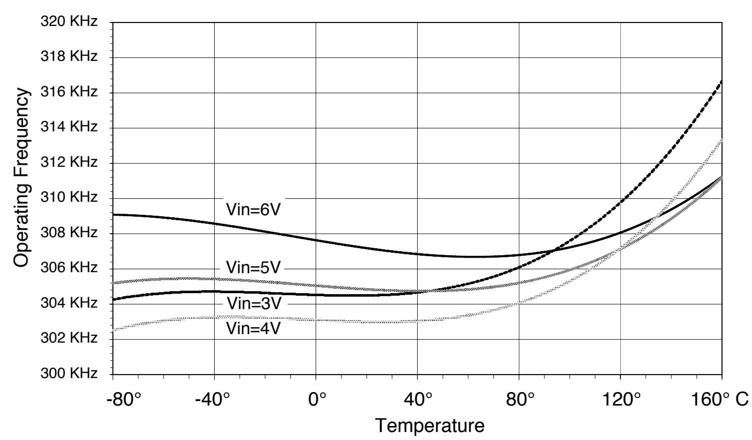


FIGURE 17: OPERATING FREQUENCY VS TEMPERATURE AND V_{IN}

This graph illustrates the performance of proprietary Interpoint technology

MIL-PRF-38534 Element Evaluation

COMPONENT-LEVEL TEST PERFORMED	/ST AND /WT NON-QML [1]		/883 AND /H CLASS H QML		/K CLASS K QML	
	M/S [2]	P [3]	M/S [2]	P [3]	M/S [2]	P [3]
Element Electrical	■		■	■	■	■
Element Visual			■	■	■	■
Internal Visual			■		■	
Temperature Cycling					■	■
Constant Acceleration					■	■
Interim Electrical					■	
Burn-in					■	
Post Burn-in Electrical					■	
Steady State Life					■	
Voltage Conditioning Aging						■
Visual Inspection						■
Final Electrical			■	■	■	■
Wire Bond Evaluation			■	■	■	■
SEM					■	
SLAM™/C-SAM: Input capacitors only Add'l test, not req. by H or K				■		■

Notes:
1. Non-QML products do not meet all of the requirements of MIL-PRF-38534.
2. M/S = Active components (Microcircuit and Semiconductor Die)
3. P = Passive components

Definitions:
Element Evaluation: Component testing/screening per MIL-STD-883 as determined by MIL-PRF-38534
SEM: Scanning Electron Microscopy
SLAM™: Scanning Laser Acoustic Microscopy
C-SAM: C - Mode Scanning Acoustic Microscopy

Screening Table 1: Element Evaluation

CLASS H AND K, MIL-PRF-38534 ENVIRONMENTAL SCREENING

	NON-QML [1]		QML [2]					
			CLASS H			CLASS K		
TEST PERFORMED	**/ST**	**/WT**	**/883**	**/HP**	**/HR**	**/KP**	**/KR**	**/KF**
Non-destruct bond pull, Method 2023				■	■	■	■	■
Pre-cap Inspection, Method 2017, 2032	■	■	■	■	■	■	■	■
Temperature Cycle (10 times)								
Method 1010, Cond. C, -55°C to +150°C, ambient		■	■	■	■	■	■	■
Constant Acceleration								
Method 2001, 3000 g (Qual 5000 g)		■	■	■	■	■	■	■
PIND, Test Method 2020, Cond. A		■	■ [3]	■ [3]	■ [3]	■	■	■
Pre burn-in test, Group A, Subgroups 1 and 4			■	■	■	■	■	■
Burn-in Method 1015, +125°C case, typical [4]								
96 hours		■						
160 hours			■	■	■			
2 x 160 hours (includes mid-BI test)						■	■	■
Final Electrical Test, MIL-PRF-38534, Group A,								
Subgroups 1 and 4: +25°C case	■							
Subgroups 1 through 6, -70°C, +25°C, +150°C case		■						
Subgroups 1 through 6, -55°C, +25°C, +125°C case			■	■	■	■	■	■
Hermeticity Test								
Gross Leak, Dip (1 x 10^{-3})	■	■						
Gross Leak, Method 1014, Cond. C			■	■	■	■	■	■
Fine Leak, Method 1014, Cond. A			■	■	■	■	■	■
Radiography, Method 2012						■	■	■
Post Radiography Electrical Test, +25°C case						■ [3]	■ [3]	■ [3]
Final visual inspection, Method 2009	■	■	■	■	■	■	■	■
RHA P: 30 kRad(Si) total dose [5]				■		■		
RHA R: 100 kRad(Si) total dose [5]					■		■	
RHA F: 300 kRad(Si) total dose [6]								■
SEE LET 85 MeV-cm^2/mg				■	■	■	■	■

Test methods are referenced to MIL-STD-883 as determined by MIL-PRF-38534.

Notes:
1. /ST (standard) and /WT (wide temperature) are non-QML products may not meet all of the requirements of MIL-PRF-38534.
2. All processes are QMP qualified and performed by QMP qualified operators.
3. Not required by DSCC but performed to assure product quality.
4. Burn-in temperature designed to bring the case temperature to +125°C minimum.
5. Includes low dose rate to the rated total dose (TID)
6. LDR to 100k TID.

SCREENING TABLE 2: ENVIRONMENTAL SCREENING

RHA options are available on request. Formal classification and jurisdiction are pending.

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