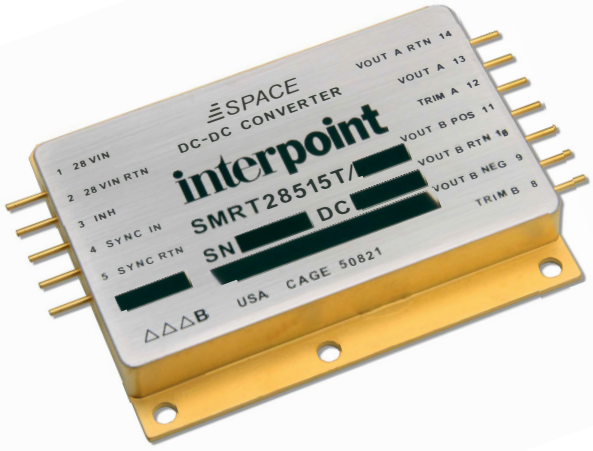
SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

FEATURES

- Radiation tolerant space DC-DC converter
  - Single event effects (SEE) LET performance to 86 MeV cm^2/mg
  - Total ionizing dose (TID) guaranteed per MIL-STD-883 method 1019, radiation hardness assurance (RHA) P = 30 krad(Si), L = 50 krad(Si), R = 100 krad(Si)
  - 50 - 300 rad(Si)/sec dose rate (Condition A)
  - 10 mrad(Si)/sec dose rate (Condition D)
- Built in MIL-STD-461 EMI filter
- Output trim from 51% to 125% of nominal
- Operating temperature -55° to +125°C
- Input voltage range 19 to 56 volts
- Transient protection 80 volts for 120 ms
- Fully isolated, 5 port isolation
- Magnetic feedback
- Fixed high frequency switching
- Remote sense
- Inhibit function
- Synchronization input
- Indefinite short circuit protection
- Meets MIL-STD-704A transient standards
- Soft-start function limits inrush current during start-up



MODELS OUTPUT VOLTAGE (V)		
SINGLE	DUAL	TRIPLE
3.3	Vout A 5 V, Vout B 5 V	+3.3 & ±12
5	Vout A 5 V, Vout B 12 V [1]	+3.3 & ±15
8.7	Vout A 5 V, Vout B 15 V [1]	+5 & ±7
12	Vout A 12 V, Vout B 12 V	+5 & ±12
15	Vout A 15 V, Vout B 15 V	+5 & ±15

1. "Vout A 5 V, Vout B 12 V" and "Vout A 5 V, Vout B 15 V" are configured from the SMRT28507T triple output model. Please see "Triple Output Models Configured as Dual Outputs" on page 3.

DESCRIPTION

The Interpoint® SMRT Series™ of DC-DC converters offers up to 35 watts of power in a radiation tolerant design. The low profile SMRT converters are manufactured in our fully certified and qualified MIL-PRF-38534 Class K production facility and packaged in hermetically sealed steel cases. They are ideal for use in programs requiring high reliability, small size, and high levels of radiation hardness assurance.

The SMRT converters are switching regulators which use a two-phase, phase shifted flyback design with a nominal switching frequency of 300 kHz. Tight regulation is maintained with advanced constant frequency pulse width modulation design techniques. The SMRT's feed-forward compensation and discontinuous topologies provide high levels of input-to-output ripple rejection. See Figure 20 on page 33, Figure 35 and Figure 36 on page 36 and Figure 55 and Figure 56 on page 41.

Two independent feedback loops are used to regulate the dual and triple outputs, one feedback loop regulates the two-phased single output. Each set of outputs is electrically isolated from the other and from the input. This product configuration eliminates cross regulation effects between output sets.

Configurations:

- Single Output: One dual-phase output
- Dual Output: Two isolated single-phase outputs
- Dual Output configured from a triple: Main output is one voltage, the auxiliaries are spanned for double the auxiliary output. Refer to "Triple Output Models Configured as Dual Outputs" on page 3.
- Triple Output: One single-phased output (Main) isolated from one single-phase dual output (± Auxiliary)

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Undervoltage Lockout
The converters have an undervoltage lockout that will allow power conversion at approximately 17 volts on a rising input voltage and a conversion shut-down on a falling voltage at approximately 14.5 volts.

Inhibit Function
The SMRT Series incorporates an inhibit terminal that can be used to disable internal switching. It is not recommended to tie the Inhibit pin of an SMRT directly to the Inhibit pin of another converter as the SMRT Inhibit pin can sink current. When pulling multiple inhibit signals low, a separate interface is recommended for each SMRT. The converter is inhibited when the Inhibit pin is pulled low (0.4 volts). In the inhibit mode the inhibit pin current requirement is less than ~2 mA. The converter resumes normal operation when an open circuit is applied to the Inhibit pin or the Inhibit pin is open (unconnected). The open circuit voltage of the Inhibit pin is 5 to 6 volts. To enable the converter use an open collector on the Inhibit pin or leave it unconnected.

Synchronization
The Sync Input pin is isolated which allows Sync Return pin to be tied to the primary side, secondary side, or float with respect to all inputs and outputs. Input current into this pin is limited by a series 1 k ohm resistance.

Radiation Tolerance
The SMRT DC-DC converters are designed to provide continuous normal operation through radiation levels associated with space missions and in tactical and strategic military environments. The RHA level R converters will operate normally in radiation environments with up to 100 krad(Si) total dose and will not exhibit low dose rate (LDR) effects at 10 mrad(Si)/sec dose rate up to a TID of 100 krad.

These levels of radiation tolerance make the SMRT converters suitable for electronics in programs where operation in high radiation environments is required.

Screening
SMRT converters offer screening options to space prototype (0), or Class E and radiation hardness assurance (RHA) levels P - 30 krad(Si), L - 50 krad(Si) or R - 100 krad(Si). Single event effects (SEE) LET performance to 86 MeV cm^2/mg. See Table 26 through Table 28 for more information.

EMI
The SMRT has a built-in EMI input filter which brings the conducted emissions into compliance with both methods of MIL-STD-461, revisions C-CE03 and D-/E-/F-CE102.

Electrostatic Discharge (ESD) Sensitivity
Per MIL-PRF-38534, the SMRT Series converters are rated to ESD class 3B defined as sensitivity equal to, or greater than, 8000 volts.

Sense
Tight load regulation is maintained via wide bandwidth magnetic feedback and through the use of remote sense on single output models and V_{OUT} A on dual output models. The sense pin function allows a remote connection for the voltage regulation circuit to compensate for voltage drops between the converter and the point of use.

Note that if the sense pins are connected but the output voltage pins are not, the converter may be damaged.

The maximum voltage drop from the output to the sense pin is shown in Table 1 below.

NOMINAL OUTPUT VOLTAGE (V) [1]	MAX VOLTAGE DROP (V)	MAX VOLTAGE AT CONVERTER (V_{MAX}) [1]
3.3 [2]	0.58	3.88
5	1.0	6.0
8.7 [2]	1.9	10.58
12	2.68	14.68
15	3.36	18.36

Table 1: Maximum Voltage Drop Using Remote Sense
Single and Dual Models only

Notes
1. Do not exceed maximum voltage.
2. The sense pin function for 3.3 and 8.7 is only available on single output models.

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Output Voltage Trim

There are two possible methods for output voltage trim. Trim can be achieved using the provided trim pin or in some cases the sense pin. The preferred method is the use of the trim pin. Every converter in the SMRT family provides a trim pin that allows at least one output to be adjusted. See Table 3 and Table 4 for maximum adjust range for each output voltage. The single output models provide a trim pin and remote sense. The dual output models allow remote sense on V_{OUT} A and have a trim pin on the V_{OUT} B. The triples have a trim pin on the V_{OUT} A (main)and a single trim pin for both V_{OUT} B auxiliaries.

For outputs without a trim pin, the output at the converter can be adjusted up by adding resistance in series with the sense pin.

See Table 2 for a summary of trim features and see below for details on the trim features. See Formula 1 for trimming down when using a trim pin, Formula 2 for trimming up when using a trim pin and Formula 3 when trimming up using Sense A pin on a dual output model.

NOTE: Do not exceed maximum current rating when trimming down.
NOTE: Do not exceed maximum power rating when trimming up.

Voltage Adjust Feature	Singles	Duals	Triples
Trim Pin (Formulas 1 and 2)	Trim and Sense Pin	Trim B	Trim A, Trim B ±
Sense Pin (Formula 3)	—	Sense A	—

Table 2: Trim and Sense Voltage Adjust

Triple Output Models Configured as Dual Outputs

The “Vout A 5 V, Vout B 12 V” and “Vout A 5 V, Vout B 15 V” are configured from the SMRT28507T triple output model. In addition to being used as a triple, the SMRT28507T can be configured as a dual. When used as a dual, the 5 volt output would be one output and the span voltage of the +/- 7 volt auxiliaries would be the other output.

The span voltage is the voltage across the auxiliaries. To achieve a +14 volt output, use the -7 volt output for system ground and the +7 volt output as the +14 volt output. Output common (pin 10) would be left floating (not connected to the load). To achieve a -14 volt output, use the +7 volt output as “system ground” and the -7 volt output as the -14 volt output. Output common (pin 10) would be left floating (not connected to the load).

Trim B (pin 8) trims both auxiliary outputs which can be trimmed to a desired voltage using the trim formulas in Table 3 or Table 4 on page 6. The 14 volt span voltage can be trimmed from approximately 11 to 16.4 volts using the trim function. When trimming use Figure 1 or Figure 2 for trim connections for Vout B based on the triple models.

When using the span voltage the maximum load capacitance across the span voltage is reduced to half the value stated in the Electrical Characteristics tables.

The auxiliary outputs of all triple models can be used in the same manner. The +/-12 volt auxiliary can be used to achieve 24 volts, and the +/-15 volt can be used to achieve 30 volts. The auxiliary outputs can then be trimmed to a more desirable value.

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Output Voltage Trim Details Trim Down

The output voltage trim pin function is implemented with a resistor between the trim pin and either the output voltage pin or the sense pin. Figure 1 show the connections for the trim resistor (R_T).

Caution: The sense pins must always be connected to all of the output voltage pins of the same polarity.

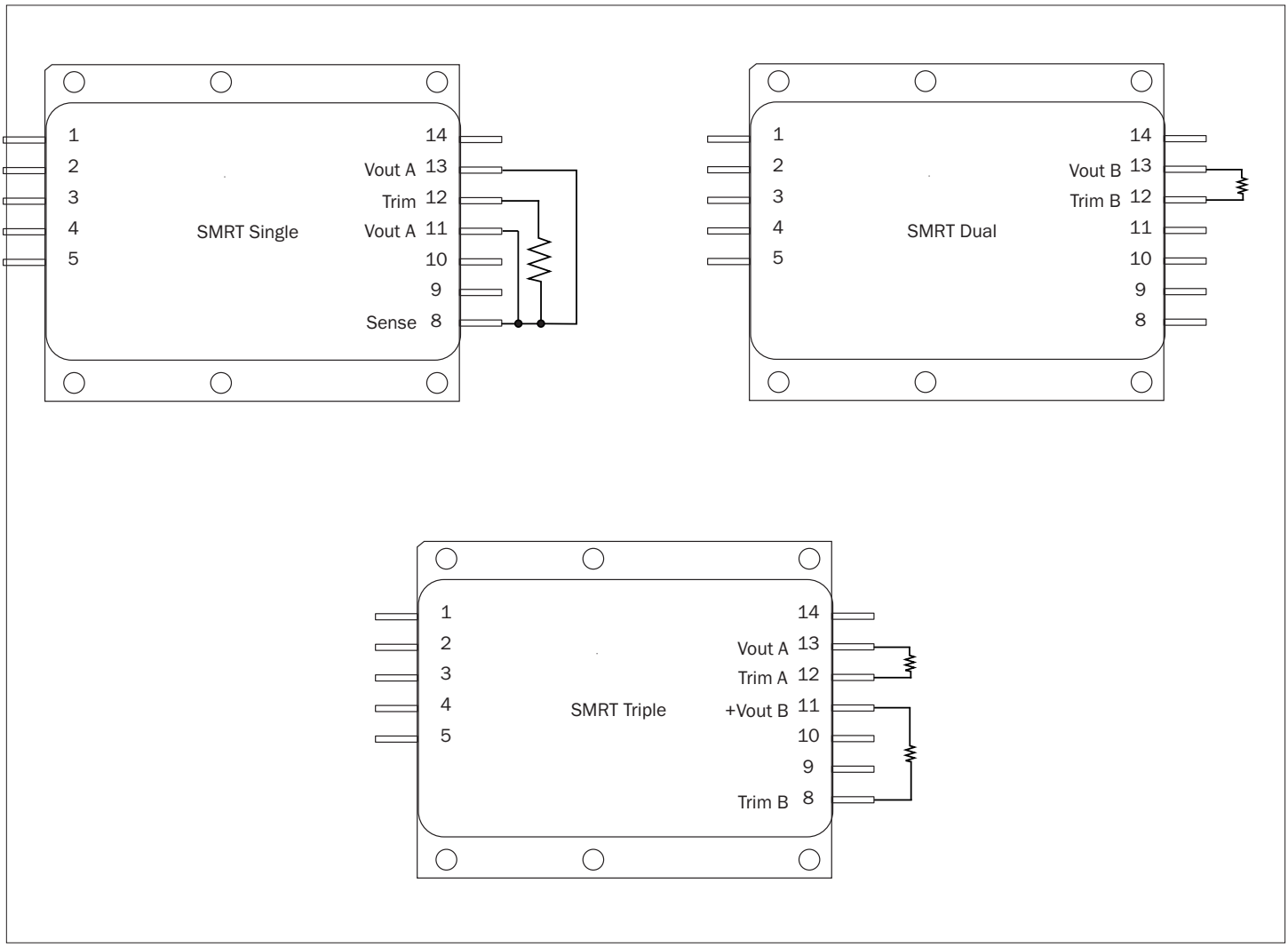

Figure 1: Trim Down Diagrams

For single output models, when trimming down, the Sense Return (pin 9) must be connected to Vout A Return (pins 10 and 14).

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Output Voltage Trim Details Trim Up

The output voltage trim pin function is implemented with a resistor between the trim pin and either the output voltage pin or the sense pin. Figure 2 show the connections for the trim resistor (R_T).

Caution: The sense pins must always be connected to all of the output voltage pins of the same polarity.

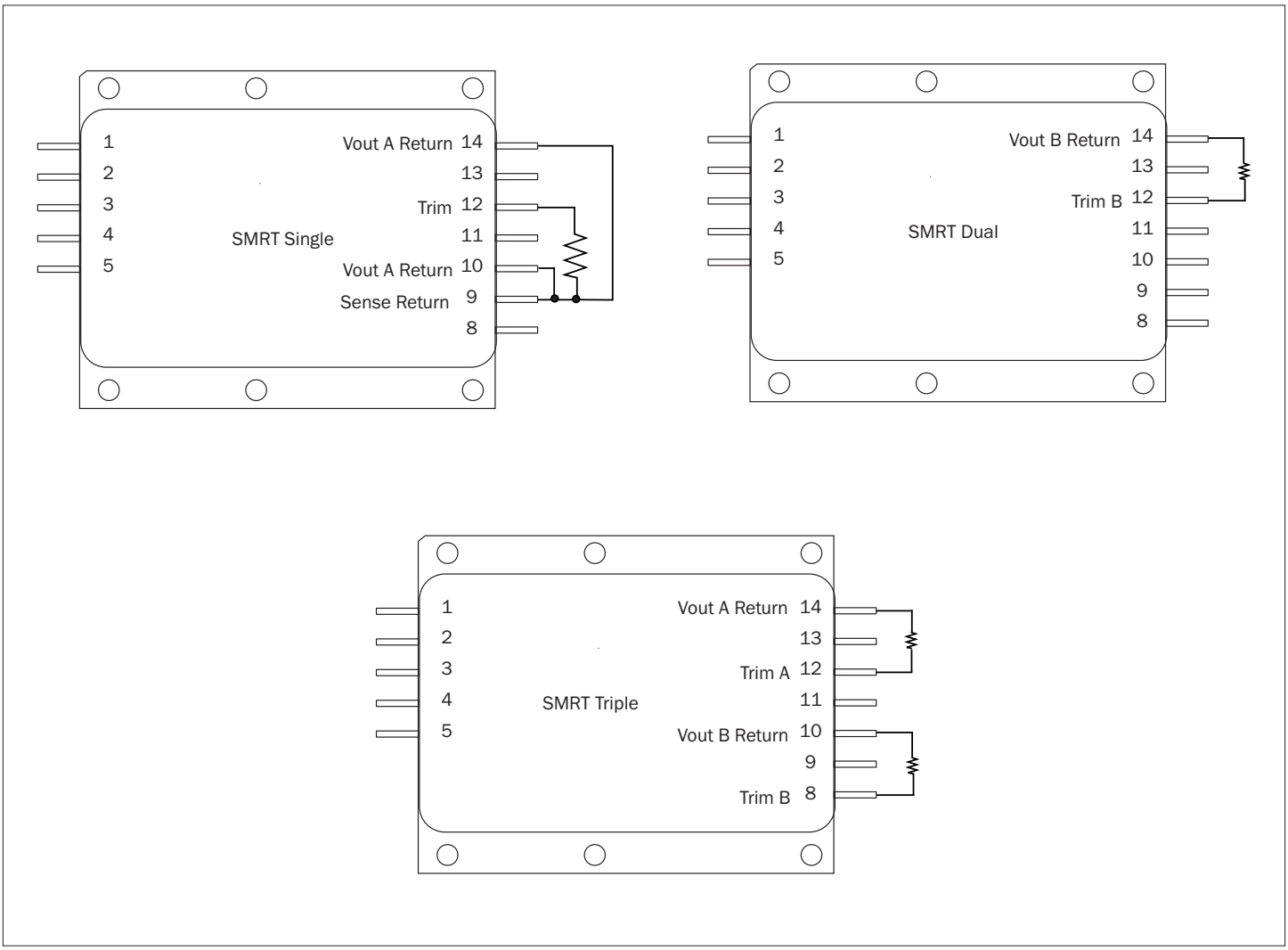

Figure 2: Trim Up Diagrams

For single output models, when trimming up, the Sense (pin 8) must be connected to Vout A (pins 11 and 13).

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Output Voltage Trim Details (continued)

TRIM DOWN USING TRIM PIN, ALL MODELS

To trim the output voltage lower than the nominal set point, connect R_{TRIM} (R_T) as shown in Figure 1. The value of R_{TRIM} is calculated by the following equation:

V_{NOM}	R_{TRIM} (k)	V_{MIN}	% of V_{NOM}
3.3	3500	3.18	96
5 single and triple	4520	4.16	83
5 dual	7040	4.38	88
7	8020	5.47	78
8.7	9040	6.13	70
12	11030	7.05	58
15	12900	7.65	51

Table 3: Trim Down Constants when Using Trim Pin

Formula 1: Trim Down Using Trim Pin

$$R_{TRIM} = K \left(V_{OUT} - V_{MIN} \right) / \left(V_{NOM} - V_{OUT} \right)$$

Where:

K = Multiplication constant from Table 3

V_{OUT} = Desired output voltage (must be greater than V_{MIN})

V_{MIN} = Minimum output voltage from Table 3

V_{NOM} = Nominal set point voltage of the converter

CAUTION:

-Do not exceed maximum current rating when trimming down.

-Do not make any connections between TRIM B, pin 8, and VOUT B Negative, pin 9. Any connection between the two can cause the auxiliary voltages to go excessively high and can damage the converter.

TRIM UP USING TRIM PIN, ALL MODELS

To trim the output voltage higher than the nominal set point, connect R_{TRIM} as shown in Figure 2. The value of R_{TRIM} is calculated by the following equation:

V_{NOM}	R_{TRIM} (k)	V_{MAX}	% of V_{NOM}
3.3	3000	3.70	112
5 single and triple	3000	6.26	125
5 dual	5280	5.82	116
7	5300	8.27	118
8.7	5300	10.46	120
12	5300	14.69	122
15	5300	18.54	124

Table 4: Trim Up Constants when Using Trim Pin

Formula 2: Trim Up Using Trim Pin

$$R_{TRIM} = K \left(V_{MAX} - V_{OUT} \right) / \left(V_{OUT} - V_{NOM} \right)$$

Where:

K = Multiplication constant from Table 4

V_{OUT} = Desired output voltage (must be less than V_{MAX})

V_{MAX} = Maximum output voltage from Table 4

V_{NOM} = Nominal set point voltage of the converter

CAUTION:

-Do not exceed maximum power rating when trimming up.

-Do not make any connections between TRIM B, pin 8, and VOUT B Negative, pin 9. Any connection between the two can cause the auxiliary voltages to go excessively high and can damage the converter.

TRIM UP USING SENSE A PIN ON DUAL MODELS ONLY

Trim Up V_{OUT} A

In addition to remote sensing, the Sense A pin may be used to increase the regulated output voltage at the V_{OUT} A pin. This is accomplished by attaching a resistor (R_{ADJUST}) between the Sense A (pin 8) and the V_{OUT} A (pin 11). The value of R_{ADJUST} is calculated by the following equation:

V_{NOM}	R_{TRIM} (k)	V_{MAX}	% of V_{NOM}
5	1	6.00	120
12	0.98	12.98	108
15	1.134	16.13	107.5

Table 5: Trim Up Constants when Using Sense Pin on Output A of Dual Output Models

Formula 3: Trim Up Using Sense A Pin

$$R_{ADJUST} = 240 \left(V_{OUT} - V_{NOM} \right) / \left(K + \left(V_{NOM} - V_{OUT} \right) \right)$$

Where:

V_{OUT} = Desired output voltage (must be less than V_{MAX})

V_{NOM} = Nominal set point voltage of the converter

V_{MAX} = Maximum achievable output voltage

CAUTION:

Do not exceed maximum power rating when trimming up.

When using the Sense A (pin 8) to trim up, the Sense Return A (pin 9) must be connected to Vout Return A (pin 10).

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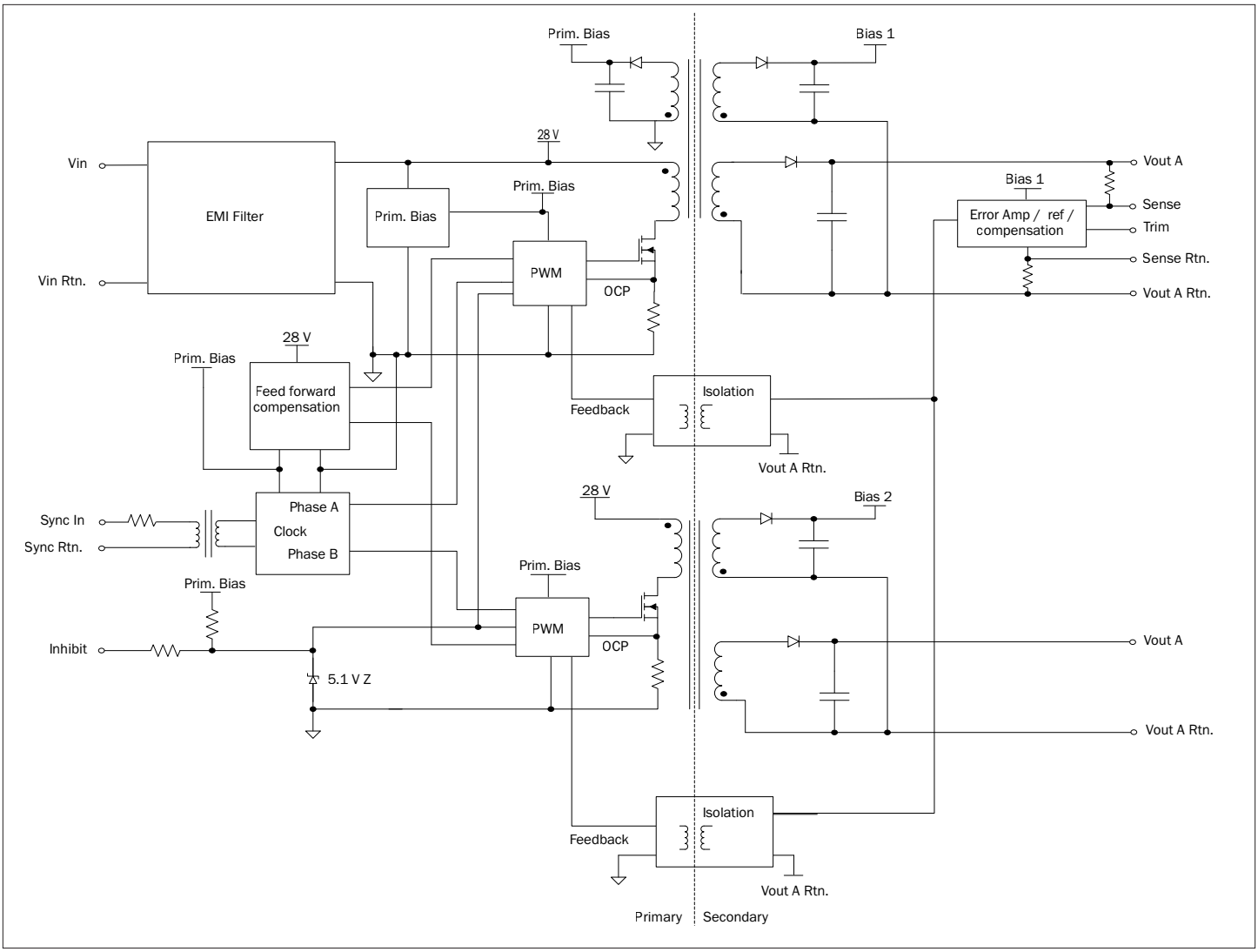

FIGURE 3: SMRT SINGLE BLOCK DIAGRAM

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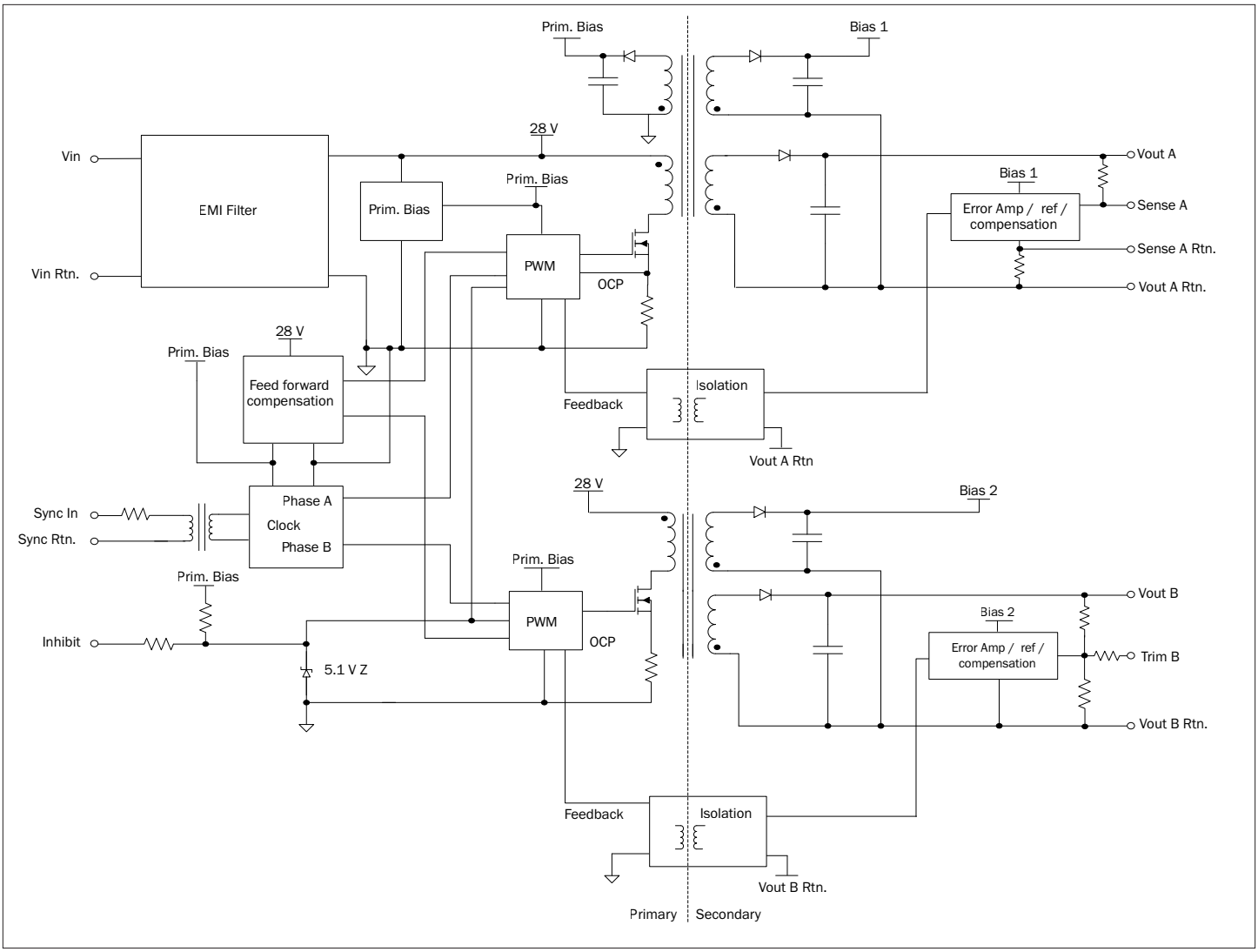

FIGURE 4: SMRT DUAL BLOCK DIAGRAM

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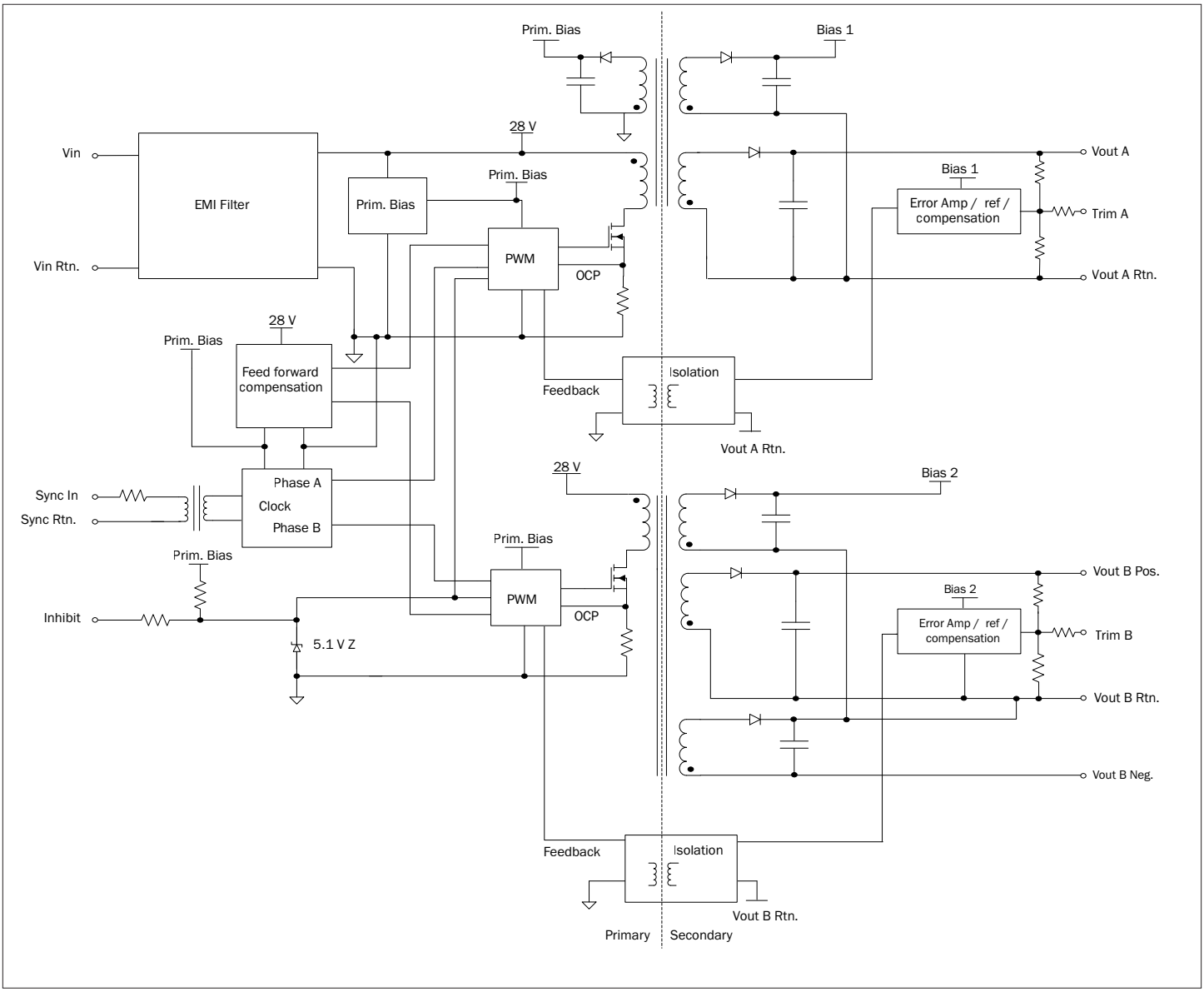

FIGURE 5: SMRT TRIPLE BLOCK DIAGRAM

SMRT Single, Dual and Triple Space DC-DC Converters

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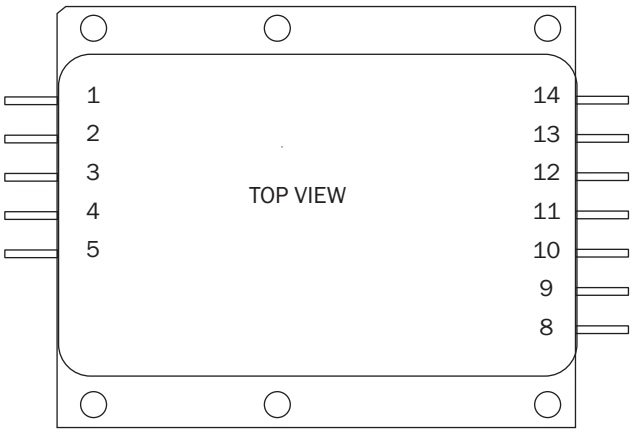
PIN OUT			
Pin	**Single Output**	**Dual Output**	**Triple Output**
1	Vin	Vin	Vin
2	Vin Return	Vin Return	Vin Return
3	Inhibit	Inhibit	Inhibit
4	Sync In	Sync In	Sync In
5	Sync Return	Sync Return	Sync Return
8	Sense	Sense A	Trim B
9	Sense Return	Sense A Return	Vout B Negative
10	Vout A Return [1]	Vout A Return	Vout B Return
11	Vout A [1]	Vout A	Vout B Positive
12	Trim	Trim B	Trim A
13	Vout A [1]	Vout B	Vout A
14	Vout A Return [1]	Vout B Return	Vout A Return

1. To meet specifications for Single Output models, Vout A pins (11 and 13) must be tied together and Vout A Return pins (10 and 14) must be tied together.

CAUTION:
For Triple output models, do not make any connections between TRIM B (pin 8) and V_{OUT} B Negative (pin 9). Any connection between the two can cause the auxiliary voltages to go excessively high and can damage the converter.

TABLE 6: PIN OUT



For dimensions see Figure 66 on page 43.

FIGURE 6: PIN OUT

PINS NOT IN USE	
Inhibit	Leave unconnected
Sync In	Connect to Sync Return
Sense Lines (Single and Dual)	Must be connected to appropriate outputs
Trim	Leave unconnected

TABLE 7: PINS NOT IN USE

SMRT Single, Dual and Triple Space DC-DC Converters

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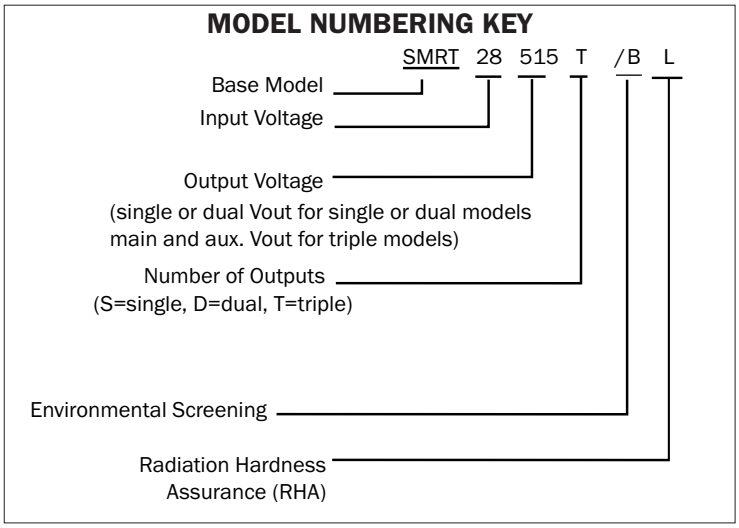

FIGURE 7: MODEL NUMBERING KEY

MODEL NUMBER OPTIONS

TO DETERMINE THE MODEL NUMBER ENTER ONE OPTION FROM EACH CATEGORY IN THE FORM BELOW.

CATEGORY	Base Model and Input Voltage	Output Voltage [1]	Number of Outputs [2, 3]	Screening [4, 7]	RHA [5]
OPTIONS	SMRT28	3R3, 05, 8R7, 12, 15	S	O	O
		05, 12, 15	D	B	L
		3R312, 3R315, 507, 512, 515	T		P
					R
FILL IN FOR MODEL # [6]	SMRT28	_____	_____	/ _____	_____

Notes
1. Output Voltage: An R indicates a decimal point. 3R3 is 3.3 volts out. The 3R3 output voltage is only available in single and triple output models. The 3R312 and 3R315 triple output converters are +3.3 volt main and ±12 or ±15 volt auxiliaries. The 507 triple output converter is +5 main and ±7 volt auxiliaries. The 512 and 515 triple output converters are +5 volt main and ±12 or ±15 volt auxiliaries.
2. Number of Outputs: S is a single output, D is a dual output, and T is a triple output
3. All triple models can be configured as a dual output. See "Triple Output Models Configured as Dual Outputs" on page 3.
4. Screening: A screening level of O is a Space Prototype and is only used with RHA O. See Table 26 on page 44 for more information.
5. RHA: Interpoint model numbers use an “O” in the RHA designator position to indicate the “-” (dash) RHA level of MIL-PRF-38534, which is defined as “no RHA.” RHA O is only available with screening level O. See Table 27 on page 45 for more information.
6. If ordering by model number add a “-Q” to request solder dipped leads (SMRT2805S/EKR-Q).
7. See Table 26 for Class "B" screening.

TABLE 8: MODEL NUMBER OPTIONS

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TABLE 9: OPERATING CONDITIONS - ALL MODELS, 25° CASE, 28 VIN, UNLESS OTHERWISE SPECIFIED.

		ALL MODELS			
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
LEAD SOLDERING TEMPERATURE [1]	10 SECONDS MAX.	—	—	300	°C
STORAGE TEMPERATURE [1]		-65	—	+150	°C
CASE OPERATING TEMPERATURE	FULL POWER	-55	—	+125	°C
	ABSOLUTE [1]	-55	—	+135	
DERATING OUTPUT POWER/CURRENT [1]	LINEARLY	From 100% at 125°C to 0% at 135°C			
ESD RATING [1, 2] MIL-PRF-38534, 3.9.5.8.2	MIL-STD-883 METHOD 3015 CLASS 3B	—	—	≥ 8000	V
ISOLATION: INPUT TO OUTPUT, INPUT TO CASE, OUTPUT TO CASE [3]	@ 500 VDC	100	—	—	Megohms
UNDERVOLTAGE LOCKOUT [1]	RISING V_{IN} (TURN ON)	13.07	—	16.37	V
	FALLING V_{IN} (TURN OFF)	12.26	—	15.80	
OUTPUT POWER LIMIT [4]	% OF FULL LOAD	—	145	—	%
AUDIO REJECTION [1]		—	50	—	dB
SWITCHING FREQUENCY	INPUT FREQUENCY	270	—	330	kHz
SYNCHRONIZATION [5]	DUTY CYCLE [1]	20	—	80	%
SYNC IS FLOATING AND ISOLATED	ACTIVE LOW	—	—	0.8	V
	ACTIVE HIGH [1]	2.5	—	10	
	REFERENCED TO	SYNC RETURN			
	IF NOT USED	CONNECT TO SYNC RETURN			
INHIBIT ACTIVE LOW (OUTPUT DISABLED) DO NOT APPLY A VOLTAGE TO THE INHIBIT PIN	INHIBIT PIN PULLED LOW [1, 6]	—	—	0.4	V
	INHIBIT PIN SOURCE CURRENT [1]	—	—	2	mA
	REFERENCED TO	INPUT COMMON			
INHIBIT ACTIVE HIGH (OUTPUT ENABLED) DO NOT APPLY A VOLTAGE TO THE INHIBIT PIN	INHIBIT PIN CONDITION	OPEN COLLECTOR OR UNCONNECTED			
	OPEN PIN VOLTAGE [1]	5	—	6	V

For mean time between failures (MTBF) contact Applications Engineering at powerapps@craneae.com

Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Passes 8000 volts.
3. Isolation is tested with the all input pins (referenced to input common) tied together, and all output pins (referenced to output common) tied together. They are tested for isolation input to output, input to case and output to case. Discharge the pins after each test.
4. At the output power limit point the output voltage will start to drop as the output current increases in order to limit the output power. Triple outputs: The over-current limit will trigger when the sum of the auxiliary currents reaches 145% (typical value) of the maximum rated "total" current of the auxiliary outputs.
5. If sync is used at lower end of range, full load operation is not guaranteed.
6. Tested with Inhibit pin at 0 volts.

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TABLE 10: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

SINGLE OUTPUT MODELS		SMRT283R3S			SMRT2805S			SMRT288R7S			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE		3.23	3.30	3.37	4.90	5.00	5.10	8.52	8.70	8.87	V
OUTPUT CURRENT		—	—	6.97	—	—	6.0	—	—	4.0	A
OUTPUT POWER		—	—	23	—	—	30	—	—	35	W
OUTPUT RIPPLE	T_C = 25°C	—	—	250	—	—	180	—	—	160	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	280	—	—	200	—	—	200	
LINE REGULATION [2]	V_{IN} = 19 TO 50	—	5	30	—	5	30	—	5	30	mV
LOAD REGULATION	NL - FL	—	5	40	—	5	40	—	5	40	mV
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	—	3.6	4.7	—	5.3	8.3	—	9.1	V
INPUT VOLTAGE	CONTINUOUS	19	28	56	19	28	56	19	28	56	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	80	—	—	80	
INPUT CURRENT	NO LOAD	—	—	110	—	—	110	—	—	115	mA
	INHIBITED	—	—	50	—	—	50	—	—	50	
INPUT RIPPLE CURRENT [3]	10 kHz - 20 MHz	—	10	50	—	10	50	—	10	50	mA p-p
EFFICIENCY	T_C = 25°C	61	64	—	67	71	—	74	75.5	—	%
	T_C = -55°C to +125°C	60	—	—	66	—	—	72	—	—	
LOAD FAULT [4, 5]	POWER DISSIPATION	—	—	31	—	—	28	—	—	25	W
	RECOVERY [1]	—	—	25	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [5, 6, 7]	TRANSIENT	—	—	±450	—	—	±450	—	—	±450	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	—	—	4	ms
STEP LINE RESPONSE [1, 5, 8]	TRANSIENT	—	—	±500	—	—	±500	—	—	±600	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	—	—	4	ms
START-UP [5, 9]	DELAY	—	—	35	—	—	25	—	—	25	ms
	OVERSHOOT	—	—	50	—	—	50	—	—	95	mV pk
CAPACITIVE LOAD [1, 10]	T_C = 25°C	—	—	5000	—	—	5000	—	—	5000	µF

Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts input.
3. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
4. Maximum power dissipation when output is shorted.
5. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value.
6. Step load test is performed at 10 microseconds typical.
7. Half load to/from full load.
8. Step line test is performed at 100 microseconds ± 20 microseconds.
9. Measured from release of inhibit or input voltage step.
10. Unconditionally stable, start-up delay increased.

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TABLE 11: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

SINGLE OUTPUT MODELS		SMRT2812S			SMRT2815S			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE		11.76	12.00	12.24	14.70	15.00	15.30	V
OUTPUT CURRENT		—	—	2.92	0	—	2.33	A
OUTPUT POWER		—	—	35	0	—	35	W
OUTPUT RIPPLE	T_C = 25°C	—	—	160	—	—	140	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	200	—	—	180	
LINE REGULATION [2]	V_{IN} = 19 TO 50	—	5	30	—	5	30	mV
LOAD REGULATION	NL - FL	—	5	40	—	5	40	mV
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	10.9	—	13.1	14.0	—	16.0	V
INPUT VOLTAGE	CONTINUOUS	19	28	56	19	28	56	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	80	
INPUT CURRENT	NO LOAD	—	—	110	—	—	110	mA
	INHIBITED	—	—	50	—	—	50	
INPUT RIPPLE CURRENT [3]	10 kHz - 20 MHz	—	10	50	—	10	50	mA p-p
EFFICIENCY	T_C = 25°C	76	78	—	76	80	—	%
	T_C = -55°C TO +125°C	75	—	—	75	—	—	
LOAD FAULT [4, 5]	POWER DISSIPATION	—	—	20	—	—	20	W
	RECOVERY [1]	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [5, 6, 7]	TRANSIENT	—	—	±575	—	—	±575	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE [1, 5, 8]	TRANSIENT	—	—	±700	—	—	±700	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms
START-UP [5, 9]	DELAY	—	—	25	—	—	25	ms
	OVERSHOOT	—	—	120	—	—	150	mV pk
CAPACITIVE LOAD [1, 10]	T_C = 25°C	—	—	5000	—	—	5000	µF

Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts input.
3. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
4. Maximum power dissipation when output is shorted.
5. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value.
6. Step load test is performed at 10 microseconds typical.
7. Half load to/from full load.
8. Step line test is performed at 100 microseconds ± 20 microseconds.
9. Measured from release of inhibit or input voltage step.
10. Unconditionally stable, start-up delay increased.

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TABLE 12: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

DUAL OUTPUT MODELS		SMRT2805D			SMRT2812D			SMRT2815D			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	VOUT A	4.90	5.00	5.10	11.76	12.00	12.24	14.70	15.00	15.30	V
	VOUT B	4.90	5.00	5.10	11.76	12.00	12.24	14.70	15.00	15.30	
OUTPUT CURRENT [2]	VOUT A	—	—	3.0	—	—	1.46	—	—	1.17	A
	VOUT B	—	—	3.0	—	—	1.46	—	—	1.17	
OUTPUT POWER [2]	VOUT A	—	—	15	—	—	17.5	—	—	17.5	W
	VOUT B	—	—	15	—	—	17.5	—	—	17.5	
OUTPUT RIPPLE	T_C = 25°C	—	—	180	—	—	150	—	—	140	mV p-p
10 kHz - 20 MHz, ± V_{OUT}	T_C = -55°C TO +125°C	—	—	200	—	—	350	—	—	300	
LINE REGULATION [3]	V_{IN} = 19 TO 50	—	—	30	—	5	25	—	5	30	mV
LOAD REGULATION	NL - FL	—	5	40	—	5	50	—	5	40	mV
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.6	—	5.4	10.9	—	13.1	14.0	—	16.0	V
INPUT VOLTAGE	CONTINUOUS	19	28	56	19	28	56	19	28	56	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	80	—	—	80	
INPUT CURRENT	NO LOAD	—	—	110	—	—	100	—	—	110	mA
	INHIBITED	—	—	50	—	—	50	—	—	50	
INPUT RIPPLE CURRENT [4]	10 kHz - 20 MHz	—	10	50	—	10	50	—	10	50	mA p-p
EFFICIENCY	T_C = 25°C	67	70	—	76	76	—	76	80	—	%
	T_C = -55°C TO +125°C	66	—	—	75	—	—	75	—	—	
LOAD FAULT [5, 6]	POWER DISSIPATION	—	—	28	—	—	20	—	—	20	W
	RECOVERY [1]	—	—	25	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [6, 7, 8]	TRANSIENT	—	—	±450	—	—	±450	—	—	±575	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	2	—	—	3	ms
STEP LINE RESPONSE [1, 6, 9]	TRANSIENT	—	—	±500	—	—	±1000	—	—	±700	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	3	—	—	4	ms
START-UP [6, 10]	DELAY	—	—	25	—	—	20	—	—	25	ms
	OVERSHOOT	—	—	50	—	—	350	—	—	150	mV pk
CAPACITIVE LOAD [1, 11, 12]	T_C = 25°C	—	—	5000	—	—	5000	—	—	5000	µF

Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. The specified maximum current/power is available from each output.
3. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts input. Applies to both outputs.
4. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
5. Maximum combined power dissipation when both outputs are shorted simultaneously.
6. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value.
7. Step load test is performed at 10 microseconds typical.
8. Half load to/from full load.
9. Step line test is performed at 100 microseconds ± 20 microseconds.
10. Measured from release of inhibit or input voltage step.
11. Applies to each output.
12. Unconditionally stable, start-up delay increased.

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TABLE 13: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT283R312T		3.3 (MAIN)			±12 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	3.23	3.30	3.37	11.76	12.00	12.24	V
	NEG. AUX.	—	—	—	-11.58	-12.00	-12.42	
OUTPUT CURRENT [2]	EITHER OUTPUT	—	—	4.5	—	±0.625	1 [1]	A
	MAX TOTAL AUX	—	—	—	—	—	1.25	
OUTPUT POWER [2]	EITHER OUTPUT	—	—	15	—	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	180	—	—	140	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	250	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	5	30	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	10	70	
LOAD REGULATION	MAIN & +AUX., NL - FL	—	5	40	—	5	40	mV
BALANCED AUX.	-AUX., NL - FL	—	—	—	—	10	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	—	3.6	±10.9	—	±13.1	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	6	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	110	—	—	—	mA
	INHIBITED	—	—	50	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	10	50	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	69	70.5	—	—	—	—	%
	T_C = -55°C TO +125°C	68	—	—	—	—	—	
LOAD FAULT [8, 9]	POWER DISSIPATION	—	—	28	—	—	28	W
	RECOVERY [1]	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [9, 10, 11, 12]	TRANSIENT	—	—	±450	—	—	±450	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE [1, 9, 13]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms

See footnotes on page 21

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TABLE 14: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT283R315T		3.3 (MAIN)			±15 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	3.23	3.30	3.37	14.70	15.00	15.30	V
	NEG. AUX.	—	—	—	-14.48	-15.00	-15.53	
OUTPUT CURRENT [2]	EITHER OUTPUT	—	—	4.5	—	±0.5	.8 [1]	A
	MAX TOTAL AUX	—	—	—	—	—	1.0	
OUTPUT POWER [2]	EITHER OUTPUT	—	—	15	—	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	180	—	—	140	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	250	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	5	30	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	10	70	
LOAD REGULATION	MAIN & +AUX., NL - FL	—	5	40	—	5	40	mV
BALANCED AUX.	-AUX., NL - FL	—	—	—	—	—	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	—	3.6	±14.0	—	±16.0	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	4	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	110	—	—	—	mA
	INHIBITED	—	—	50	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	10	50	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	70	71	—	—	—	—	%
	T_C = -55°C TO +125°C	68	—	—	—	—	—	
LOAD FAULT [8, 9]	POWER DISSIPATION	—	—	28	—	—	28	W
	RECOVERY [1]	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [9, 10, 11, 12]	TRANSIENT	—	—	±450	—	—	±450	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE [1, 9, 13]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms
START-UP [9, 14]	DELAY	—	—	35	—	—	25	ms
	OVERSHOOT	—	0	50	—	0	120	mV pk
CAPACITIVE LOAD [1, 15, 16]	T_C = 25°C	—	—	5000	—	—	1000	µF

See footnotes on page 21

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TABLE 15: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT28507T		5 (MAIN)			±7 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.90	5.00	5.10	6.86	7.00	7.14	V
	NEG. AUX.				-6.79	7.00	-7.21	
OUTPUT CURRENT [2]	MAIN AND EITHER OUTPUT	—	—	3.0	—	±1.00	1.6 [1]	A
	MAX TOTAL AUX	—	—	—	—	—	2.0	
OUTPUT POWER [2]	MAIN AND EITHER OUTPUT	—	—	15	—	±7.0	11.2 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	14	
OUTPUT RIPPLE	T_C = 25°C	—	—	180	—	—	170	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	200	—	—	300	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	—	100	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	—	150	
LOAD REGULATION	MAIN AND +AUX., NL - FL	—	5	40	—	5	150	mV
BALANCED AUX.	-AUX., NL - FL	—	—	—	—	—	350	
TOTAL REGULATION [1]	EFFECT ON NEGATIVE AUXILIARY	4.7	—	5.3	±6.53	_	±7.47	V
V_{OUT}	AGING, TEMP AND RADIATION							
CROSS REGULATION [1, 4, 5]	EFFECT ON	—	—	—	—	—	9	%
T_C = 25°C	NEGATIVE AUXILIARY							
INPUT VOLTAGE	CONTINUOUS	19	28	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	110	—	—	—	mA
	INHIBITED	—	—	50	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	10	50	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	70	71	—	—	—	—	%
	T_C = -55°C TO +125°C	69	—	—	—	—	—	
LOAD FAULT [8, 9]	POWER DISSIPATION	—	—	28	—	—	28	W
	RECOVERY [1]	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [9, 10, 11, 12]	TRANSIENT	—	—	±300	—	—	±400	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE [1, 9, 13]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	3	—	—	3	ms
START-UP [9, 14]	DELAY	—	—	25	—	—	25	ms
	OVERSHOOT	—	0	50	—	0	70	mV pk
CAPACITIVE LOAD [1, 15, 16]	T_C = 25°C	—	—	5000	—	—	1000	µF

See footnotes on page 21

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SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TABLE 16: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT28512T		5 (MAIN)			±12 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.90	5.00	5.10	11.76	12.00	12.24	V
	NEG. AUX.				-11.58	-12.00	-12.42	
OUTPUT CURRENT [2]	EITHER OUTPUT	—	—	3.0	—	±0.625	1 [1]	A
	MAX TOTAL AUX	—	—	—	—	—	1.25	
OUTPUT POWER [2]	EITHER OUTPUT	—	—	15	—	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	180	—	—	140	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	200	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	5	30	mV
V_{IN} = 19 TO 50 V	NEG. AUX.				—	20	70	
LOAD REGULATION	MAIN & +AUX., NL - FL	—	5	40	—	5	40	mV
BALANCED AUX.	-AUX., NL - FL	—	—	—	—	10	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	—	5.3	±10.9	—	±13.1	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	6	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	—	—	—	V
V_{IN} = 19 - 50 - 19	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	110	—	—	—	mA
	INHIBITED	—	—	50	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	10	50	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	69	75	—	—	—	—	%
	T_C = -55°C TO +125°C	68	—	—	—	—	—	
LOAD FAULT [8, 9]	POWER DISSIPATION	—	—	25	—	—	25	W
	RECOVERY [1]	—	—	25	—	—	25	ms
STEP LOAD RESPONSE [9, 10, 11, 12]	TRANSIENT	—	—	±450	—	—	±450	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE [1, 9, 13]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms
START-UP [9, 14]	DELAY	—	—	25	—	—	25	ms
	OVERSHOOT	—	0	50	—	0	120	mV pk
CAPACITIVE LOAD [1, 15, 16]	T_C = 25°C	—	—	5000	—	—	1000	µF

See footnotes on page 21

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TABLE 17: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT28515T		5 (MAIN)			±15 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.92	5.00	5.08	14.77	15.00	15.23	V
	NEG. AUX.				-14.70	-15.00	-15.30	
OUTPUT CURRENT [2]	EITHER OUTPUT	—	—	3.0	—	±0.5	0.80 [1]	A
	MAX TOTAL AUX	—	—	—	—	—	1	
OUTPUT POWER [2]	EITHER OUTPUT	—	—	15	—	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	180	—	—	150	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	200	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	5	25	—	—	25	mV
V_{IN} = 19 TO 50	NEG. AUX.				—	20	35	
LOAD REGULATION	MAIN & +AUX., NL - FL	—	5	50	—	5	50	mV
BALANCED AUX.	-AUX., NL - FL	—	—	—	—	—	500	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	—	5.3	±14.0	—	±16.0	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	4	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	110	—	—	—	mA
	INHIBITED	—	—	50	—	—	—	
INPUT RIPPLE CURRENT [6]	10 KHZ - 20 MHZ	—	10	50	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	72	75	—	—	—	—	%
	T_C = -55°C TO +125°C	70	—	—	—	—	—	
LOAD FAULT [8, 9]	POWER DISSIPATION	—	—	25	—	—	25	W
	RECOVERY [1]	—	—	35	—	—	35	ms
STEP LOAD RESPONSE [9, 10, 11, 12]	TRANSIENT	—	—	±250	—	—	±350	mV pk
50% - 100% - 50%	RECOVERY	—	—	1	—	—	1	ms
STEP LINE RESPONSE [1, 9, 13]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	1.5	—	—	1.5	ms
START-UP [9, 14]	DELAY	—	—	25	—	—	20	ms
	OVERSHOOT	—	0	200	—	0	350	mV pk
CAPACITIVE LOAD [1, 15, 16]	T_C = 25°C	—	—	5000	—	—	1000	µF

See footnotes on page 21

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 28 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

Notes for triple output models on Table 13 through Table 17.

1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Up to the maximum specified auxiliary output current/power is available from either auxiliary output provided the total auxiliary output current power does not exceed the maximum total current/power specified.
3. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts in. Load percentage applies to the main output and also to the sum of the auxiliaries.
4. To maintain the cross regulation specification, one of the auxiliaries must always provide a minimum of 20% of the total auxiliary power used. Negative Vout cross regulation is referenced to 50%/50% balanced loads (at 100% of total rated output power - full load).
5. Cross regulation only affects “Vout B Negative” of the auxiliaries and is measured using the following formula:
   (Vcond1-Vcond2)/Vcond1
   Vcond = “Vout B Negative” under the following loading condition:
   Vcond1: Assumes “Max Total Aux” and a balanced load (50%/50%)
   Vcond2: “Vout B Positive” = 20% of “Max Total Aux” and “Vout B Negative” = 80% of “Max Total Aux”
   OR
   “Vout B Positive” = 80% of “Max Total Aux” and “Vout B Negative” = 20% of “Max Total Aux”.
6. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
7. Efficiency measured with all outputs at full load and is the combined efficiency of all outputs.
8. Maximum power dissipation when the main is shorted with full load on the auxiliaries and when the auxiliaries are shorted with full load on the main. The total power includes the power being used in the not-shorted circuit.
9. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value
10. Step load test is performed at 10 microseconds typical.
11. The step load specification for the negative auxiliary output is guaranteed by qualification test. It is not an in-line test.
12. Half load to/from full load.
13. Step line test is performed at 100 microseconds ± 20 microseconds.
14. Measured from release of inhibit or input voltage step.
15. Applies to each auxiliary.
16. Unconditionally stable, start-up delay increased.

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 18: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

SINGLE OUTPUT MODELS		SMRT283R3S			SMRT2805S			SMRT288R7S			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE [2]		3.23	3.30	3.37	4.90	5.00	5.10	8.52	8.70	8.87	V
OUTPUT CURRENT [2]		0.28	—	6.97	0.24	—	6.0	0.16	—	4.0	A
OUTPUT POWER		0.92	—	23	1.2	—	30	1.4	—	35	W
OUTPUT RIPPLE	T_C = 25°C	—	—	250	—	—	200	—	—	200	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	280	—	—	200	—	—	200	
LINE REGULATION [2]	V_{IN} = 19 TO 50	—	—	30	—	—	30	—	—	30	mV
	V_{IN} = 19 TO 56	—	—	60	—	—	60	—	—	30	
LOAD REGULATION	5% - FL	—	—	80	—	—	70	—	—	80	mV
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	—	3.6	4.7	—	5.3	8.3	—	9.1	V
INPUT VOLTAGE	CONTINUOUS	19	50	56	19	50	56	19	50	56	V
	TRANSIENT [1] 120 ms	—	—	80	—	—	80	—	—	80	
INPUT CURRENT	NO LOAD	—	—	100	—	—	100	—	—	105	mA
	INHIBITED	—	—	55	—	—	55	—	—	55	
INPUT RIPPLE CURRENT [3]	10 kHz - 20 MHz	—	—	60	—	—	60	—	—	60	mA p-p
EFFICIENCY	T_C = 25°C	60	—	—	66	—	—	72	—	—	%
	T_C = -55°C TO +125°C	60	—	—	66	—	—	72	—	—	
STEP LOAD RESPONSE [4, 5, 6]	TRANSIENT	—	—	±450	—	—	±450	—	—	±450	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	—	—	4	ms
STEP LINE RESPONSE [1, 4, 7]	TRANSIENT	—	—	±500	—	—	±500	—	—	±600	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	—	—	4	ms
START-UP [4, 8]	DELAY	—	—	35	—	—	25	—	—	25	ms
	OVERSHOOT	—	—	50	—	—	50	—	—	95	mV pk
CAPACITIVE LOAD [1, 9]	T_C = 25°C	—	—	5000	—	—	5000	—	—	5000	µF

Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts input.
3. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
4. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value.
5. Step load test is performed at 10 microseconds typical.
6. Half load to/from full load.
7. Step line test is performed at 100 microseconds ± 20 microseconds.
8. Measured from release of inhibit or input voltage step.
9. Unconditionally stable, start-up delay increased.

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 19: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

SINGLE OUTPUT MODELS		SMRT2812S			SMRT2815S			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE		11.76	12.00	12.24	14.70	15.00	15.30	V
OUTPUT CURRENT [2]		0.116	—	2.92	0.093	—	2.33	A
OUTPUT POWER [2]		1.4	—	35	1.4	—	35	W
OUTPUT RIPPLE	T_C = 25°C	—	—	200	—	—	180	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	200	—	—	180	
LINE REGULATION [2]	V_{IN} = 19 TO 50	—	—	25	—	—	30	mV
	V_{IN} = 19 TO 56	—	—	50	—	—	60	
LOAD REGULATION	5% - FL	—	—	70	—	—	90	mV
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	10.9	—	13.1	14.0	—	16.0	V
INPUT VOLTAGE	CONTINUOUS	19	50	56	19	50	56	V
	TRANSIENT [1] 120 ms	—	—	80	—	—	80	
INPUT CURRENT	NO LOAD	—	—	100	—	—	100	mA
	INHIBITED	—	—	55	—	—	55	
INPUT RIPPLE CURRENT [3]	10 kHz - 20 MHz	—	—	60	—	—	60	mA p-p
EFFICIENCY	T_C = 25°C	72	—	—	72	—	—	%
	T_C = -55°C TO +125°C	72	—	—	72	—	—	
STEP LOAD RESPONSE [4, 5, 6]	TRANSIENT	—	—	±575	—	—	±575	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE [1, 4, 7]	V_{IN} TRANSIENT	—	—	±700	—	—	±700	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms
START-UP [4, 8]	DELAY	—	—	25	—	—	25	ms
	OVERSHOOT	—	—	120	—	—	150	mV pk
CAPACITIVE LOAD [1, 9]	T_C = 25°C	—	—	5000	—	—	5000	µF

Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts input.
3. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
4. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value.
5. Step load test is performed at 10 microseconds typical.
6. Half load to/from full load.
7. Step line test is performed at 100 microseconds ± 20 microseconds.
8. Measured from release of inhibit or input voltage step.
9. Unconditionally stable, start-up delay increased.

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 20: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

DUAL OUTPUT MODELS		SMRT2805D			SMRT2812D			SMRT2815D			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	VOUT A	4.90	5.00	5.10	11.76	12.00	12.24	14.70	15.00	15.30	V
	VOUT B	4.90	5.00	5.10	11.76	12.00	12.24	14.70	15.00	15.30	
OUTPUT CURRENT [2, 3]	VOUT A	0.12	—	3.0	0.06	—	1.46	0.05	—	1.17	A
	VOUT B	0.12	—	3.0	0.06	—	1.46	0.05	—	1.17	
OUTPUT POWER [2, 3]	VOUT A	0.60	—	15	0.70	—	17.5	0.70	—	17.5	W
	VOUT B	0.60	—	15	0.70	—	17.5	0.70	—	17.5	
OUTPUT RIPPLE	T_C = 25°C	—	—	200	—	—	170	—	—	180	mV p-p
10 kHz - 20 MHz ± VOUT	TC = -55°C TO +125°C	—	—	200	—	—	350	—	—	300	
LINE REGULATION [3]	V_{IN} = 19 TO 50	—	—	30	—	—	25	—	—	30	mV
	V_{IN} = 19 TO 56	—	—	60	—	—	25	—	—	60	
LOAD REGULATION	50 V_{IN}, 5% - FL	—	—	70	—	—	100	—	—	70	mV
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.6	—	5.4	10.9	—	13.1	14.0	—	16.0	V
INPUT VOLTAGE	CONTINUOUS	19	50	56	19	50	56	19	50	56	V
	TRANSIENT 120 ms	—	—	80	—	—	80	—	—	80	
INPUT CURRENT	NO LOAD	—	—	100	—	—	100	—	—	100	mA
	INHIBITED	—	—	55	—	—	55	—	—	55	
INPUT RIPPLE CURRENT [4]	10 kHz - 20 MHz	—	—	60	—	—	60	—	—	60	mA p-p
EFFICIENCY	T_C = 25°C	66	—	—	72	—	—	72	—	—	%
	TC = -55°C TO +125°C	66	—	—	72	—	—	70	—	—	
STEP LOAD RESPONSE [5, 6, 7]	TRANSIENT	—	—	±450	—	—	±450	—	—	±575	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	2	—	—	3	ms
STEP LINE RESPONSE [1, 5, 8]	TRANSIENT	—	—	±500	—	—	±1000	—	—	±700	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	3	—	—	4	ms
START-UP [5, 9]	DELAY	—	—	25	—	—	20	—	—	25	ms
	OVERSHOOT	—	—	50	—	—	350	—	—	150	mV pk
CAPACITIVE LOAD [1, 10, 11]	T_C = 25°C	—	—	5000	—	—	5000	—	—	5000	µF

Notes
1. Guaranteed by characterization test and/or analysis. Not a production test.
2. The specified maximum current/power is available from each output.
3. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts input. Applies to both outputs.
4. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
5. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value.
6. Step load test is performed at 10 microseconds typical.
7. Half load to/from full load.
8. Step line test is performed at 100 microseconds ± 20 microseconds.
9. Measured from release of inhibit or input voltage step.
10. Applies to each output.
11. Unconditionally stable, start-up delay increased.

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 21: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT283R312T		3.3 (MAIN)			±12 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	3.23	3.30	3.37	11.76	12.00	12.24	V
	NEG. AUX.	—	—	—	-11.58	-12.00	-12.42	
OUTPUT CURRENT [2, 3]		0.18	—	4.5	±0.04	±0.63	1 [1]	A
	MAX TOTAL AUX.	—	—	—	—	—	1.25	
OUTPUT POWER [2, 3]		0.60	—	15	0.48	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	200	—	—	150	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	250	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	—	30	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	—	70	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	60	—	—	60	mV
V_{IN} = 19 TO 56	NEG. AUX.	—	—	—	—	—	140	
LOAD REGULATION	MAIN & +AUX., 5% - FL	—	—	100	—	—	120	mV
BALANCED AUX.	-AUX., 5% - FL	—	—	—	—	—	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	—	3.6	±10.9	—	±13.1	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	6	%
INPUT VOLTAGE	CONTINUOUS	19	50	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	100	—	—	—	mA
	INHIBITED	—	—	55	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	—	60	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	67	—	—	—	—	—	%
	T_C = -55°C TO +125°C	67	—	—	—	—	—	
STEP LOAD RESPONSE [8, 9, 10, 11]	TRANSIENT	—	—	±450	—	—	±450	mV pk
50% - 100% - 50%	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE [1, 8, 12]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms
START-UP [8, 13]	DELAY	—	—	35	—	—	25	ms
	OVERSHOOT	—	—	50	—	—	120	mV pk
CAPACITIVE LOAD [1, 14, 15]	T_C = 25°C		—	5000	—	—	1000	µF

See footnotes on page 30

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 22: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT283R315T		3.3 (MAIN)			±15 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	3.23	3.30	3.37	14.70	15.00	15.30	V
	NEG. AUX.				-14.48	-15.00	-15.53	
OUTPUT CURRENT [2, 3]		0.18	—	4.5	±0.02	±0.5	0.8 [1]	A
	MAX TOTAL AUX.	—	—	—	—	—	1.0	
OUTPUT POWER [2, 3]		0.06	—	15	0.48	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	200	—	—	150	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	250	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	—	30	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	—	70	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	60	—	—	60	mV
V_{IN} = 19 TO 56	NEG. AUX.	—	—	—	—	—	140	
LOAD REGULATION	MAIN & +AUX., 5% - FL	—	—	100	—	—	120	mV
BALANCED AUX.	-AUX., 5% - FL	—	—	—	—	—	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	—	3.6	±14.0	—	±16.0	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	4	%
INPUT VOLTAGE	CONTINUOUS	19	50	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	95	—	—	—	mA
	INHIBITED	—	—	55	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	—	60	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	68	—	—	—	—	—	%
	T_C = -55°C TO +125°C	68	—	—	—	—	—	
STEP LOAD RESPONSE [8, 9, 10, 11]	TRANSIENT	—	—	±350	—	—	±350	mV pk
50% - 100% - 50%	RECOVERY	—	—	2.5	—	—	2.5	ms
STEP LINE RESPONSE [1, 8, 12]	TRANSIENT	—	—	±500	—	—	±750	mV pk
	RECOVERY	—	—	4	—	—	4	ms
START-UP [8, 13]	DELAY	—	—	35	—	—	25	ms
V_{IN} = 19 - 50 - 19	OVERSHOOT	—	—	50	—	—	150	mV pk
CAPACITIVE LOAD [1, 14, 15]	T_C = 25°C		—	5000	—	—	1000	µF

See footnotes on page 30

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 23: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT28507T		5 (MAIN)			±7 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.90	5.00	5.10	6.86	7.00	7.14	V
	NEG. AUX.				-6.79	7.00	-7.21	
OUTPUT CURRENT [2, 3]		0.12	—	3.0	±0.04	±1.00	1.6 [1]	A
	MAX TOTAL AUX.	—	—	—	—	—	2.0	
OUTPUT POWER [2, 3]		0.60	—	15	0.28	±7.0	11.2 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	14	
OUTPUT RIPPLE	T_C = 25°C	—	—	230	—	—	200	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	230	—	—	300	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	—	100	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	—	150	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	—	100	mV
V_{IN} = 19 TO 56	NEG. AUX.	—	—	—	—	—	150	
LOAD REGULATION	MAIN & +AUX., 5% - FL	—	—	100	—	—	120	mV
BALANCED AUX.	-AUX., 5% - FL	—	—	—	—	—	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	—	5.3	±6.53	—	±7.47	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	9	%
INPUT VOLTAGE	CONTINUOUS	19	50	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	95	—	—	—	mA
	INHIBITED	—	—	55	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	—	60	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	68	—	—	—	—	—	%
	T_C = -55°C TO +125°C	68	—	—	—	—	—	
STEP LOAD RESPONSE [8, 9, 10, 11]	TRANSIENT	—	—	±300	—	—	±400	mV pk
50% - 100% - 50%	RECOVERY	—	—	2	—	—	2	ms
STEP LINE RESPONSE [1, 8, 12]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms
START-UP [8, 13]	DELAY	—	—	20	—	—	20	ms
	OVERSHOOT	—	—	50	—	—	70	mV pk
CAPACITIVE LOAD [1, 14, 15]	T_C = 25°C		—	5000	—	—	1000	µF

See footnotes on page 30

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 24: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT28512T		5 (MAIN)			±12 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.90	5.00	5.10	11.76	12.00	12.24	V
	NEG. AUX.				-11.58	-12.00	-12.42	
OUTPUT CURRENT [2, 3]		0.12	—	3.0	±0.03	±0.63	1[1]	A
	MAX TOTAL AUX	—	—	—	—	—	1.25	
OUTPUT POWER [2, 3]		0.60	—	15	0.48	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	200	—	—	150	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	200	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	30	—	—	30	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	—	70	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	60	—	—	60	mV
V_{IN} = 19 TO 56	NEG. AUX.	—	—	—	—	—	140	
LOAD REGULATION	MAIN & +AUX., 5% - FL	—	—	100	—	—	120	mV
BALANCED AUX.	-AUX., 5% - FL	—	—	—	—	—	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	—	5.3	±10.9	—	±13.1	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	6	%
INPUT VOLTAGE	CONTINUOUS	19	50	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	100	—	—	—	mA
	INHIBITED	—	—	55	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHZ	—	—	60	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	70	—	—	—	—	—	%
	T_C = -55°C TO +125°C	70	—	—	—	—	—	
STEP LOAD RESPONSE [8, 9, 10, 11]	TRANSIENT	—	—	±350	—	—	±350	mV pk
50% - 100% - 50%	RECOVERY	—	—	2.5	—	—	2.5	ms
STEP LINE RESPONSE [1, 8, 12]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	4	—	—	4	ms
START-UP [8, 13]	DELAY	—	—	20	—	—	20	ms
	OVERSHOOT	—	—	50	—	—	120	mV pk
CAPACITIVE LOAD [1, 14, 15]	T_C = 25°C		—	5000	—	—	1000	µF

See footnotes on page 30

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

TABLE 25: ELECTRICAL CHARACTERISTICS: -55°C TO +125°C CASE, 50 VIN, 100% LOAD, UNLESS OTHERWISE SPECIFIED.

TRIPLE OUTPUT MODEL – SMRT28515T		5 (MAIN)			±15 (AUXILIARIES)			UNITS
PARAMETER	CONDITIONS	MIN	TYP	MAX	MIN	TYP	MAX	
OUTPUT VOLTAGE	MAIN AND POS. AUX	4.92	5.00	5.08	14.77	15.00	15.23	V
	NEG. AUX.				-14.70	-15.00	-15.30	
OUTPUT CURRENT [2, 3]		0.12	—	3.0	±0.02	±0.5	0.80 [1]	A
	MAX TOTAL AUX.	—	—	—	—	—	1	
OUTPUT POWER [2, 3]		0.60	—	15	0.30	±7.5	12 [1]	W
	MAX TOTAL AUX	—	—	—	—	—	15	
OUTPUT RIPPLE	T_C = 25°C	—	—	200	—	—	200	mV p-p
10 kHz - 20 MHz	T_C = -55°C TO +125°C	—	—	200	—	—	200	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	25	—	—	25	mV
V_{IN} = 19 TO 50	NEG. AUX.	—	—	—	—	—	35	
LINE REGULATION [3]	MAIN AND POS. AUX	—	—	50	—	—	50	mV
V_{IN} = 19 TO 56	NEG. AUX.	—	—	—	—	—	70	
LOAD REGULATION	MAIN & +AUX., 5% - FL	—	—	100	—	—	120	mV
BALANCED AUX.	-AUX., 5% - FL	—	—	—	—	—	300	
TOTAL REGULATION [1] V_{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	—	5.3	±14.0	—	±16.0	V
CROSS REGULATION [1, 4, 5] T_C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	4	%
INPUT VOLTAGE	CONTINUOUS	19	50	56	—	—	—	V
	TRANSIENT 120 ms [1]	—	—	80	—	—	—	
INPUT CURRENT	NO LOAD	—	—	100	—	—	—	mA
	INHIBITED	—	—	55	—	—	—	
INPUT RIPPLE CURRENT [6]	10 kHz - 20 MHz	—	—	50	—	—	—	mA p-p
EFFICIENCY [7]	T_C = 25°C	70	—	—	—	—	—	%
	T_C = -55°C TO +125°C	70	—	—	—	—	—	
STEP LOAD RESPONSE [8, 9, 10, 11]	TRANSIENT	—	—	±250	—	—	±350	mV pk
50% - 100% - 50%	RECOVERY	—	—	1	—	—	1	ms
STEP LINE RESPONSE [1, 8, 12]	TRANSIENT	—	—	±500	—	—	±750	mV pk
V_{IN} = 19 - 50 - 19	RECOVERY	—	—	1.5	—	—	1.5	ms
START-UP [8, 13]	DELAY	—	—	25	—	—	20	ms
	OVERSHOOT	—	—	200	—	—	350	mV pk
CAPACITIVE LOAD [1, 14, 15]	T_C = 25°C		—	5000	—	—	1000	µF

See footnotes on page 30

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE

Electrical Characteristics: -55°C to +125°C case, 50 Vin, 100% load, unless otherwise specified.

Notes for triple output models on Table 21 through Table 25.

1. Guaranteed by characterization test and/or analysis. Not a production test.
2. Up to the maximum specified auxiliary output current/power is available from either auxiliary output provided the total auxiliary output current power does not exceed the maximum total current/power specified.
3. Line regulation is tested at full load. However, to maintain regulation above 28 volts input, a minimum load is required of 0% at 28 volts input increasing linearly to 5% at 56 volts in. Load percentage applies to the main output and also to the sum of the auxiliaries.
4. To maintain the cross regulation specification, one of the auxiliaries must always provide a minimum of 20% of the total auxiliary power used. Negative Vout cross regulation is referenced to 50%/50% balanced loads (at 100% of total rated output power - full load).
5. Cross regulation only affects “Vout B Negative” of the auxiliaries and is measured using the following formula:
   (Vcond1-Vcond2)/Vcond1
   Vcond = “Vout B Negative” under the following loading condition:
   Vcond1: Assumes “Max Total Aux” and a balanced load (50%/50%)
   Vcond2: “Vout B Positive” = 20% of “Max Total Aux” and “Vout B Negative” = 80% of “Max Total Aux”
   OR
   “Vout B Positive” = 80% of “Max Total Aux” and “Vout B Negative” = 20% of “Max Total Aux”.
6. Converters meet MIL-STD-461 specification revisions for conducted emissions C-CE03 and D-/E-/F-CE-102. The actual value of input ripple current is much less, the limit in the characteristic table is based on measurement resolution.
7. Efficiency measured with all outputs at full load and is the combined efficiency of all outputs.
8. Recovery time is measured from application of the transient to point at which V_{OUT} is within 1% of V_{OUT} at final value
9. Step load test is performed at 10 microseconds typical.
10. The step load specification for the negative auxiliary output is guaranteed by qualification test. It is not an in-line test.
11. Half load to/from full load.
12. Step line test is performed at 100 microseconds ± 20 microseconds.
13. Measured from release of inhibit or input voltage step.
14. Applies to each auxiliary.
15. Unconditionally stable, start-up delay increased.

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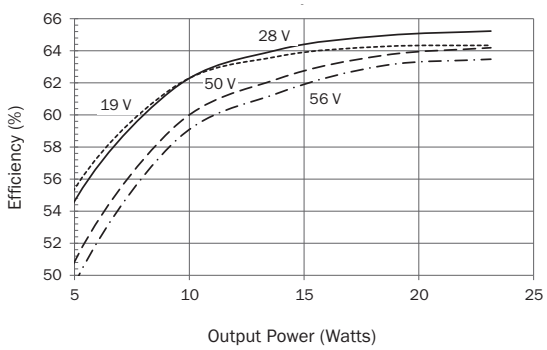
SMRT Single, Dual and Triple Space DC-DC Converters

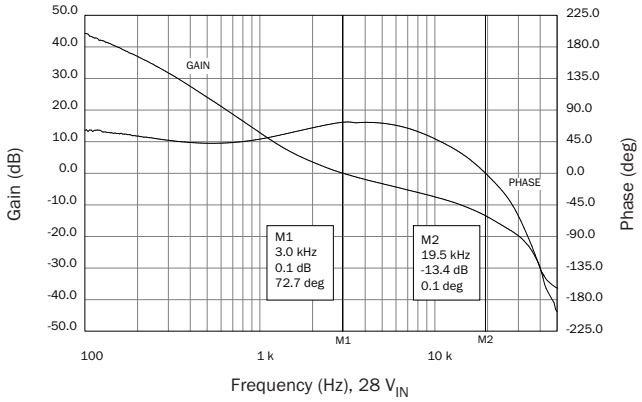
19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



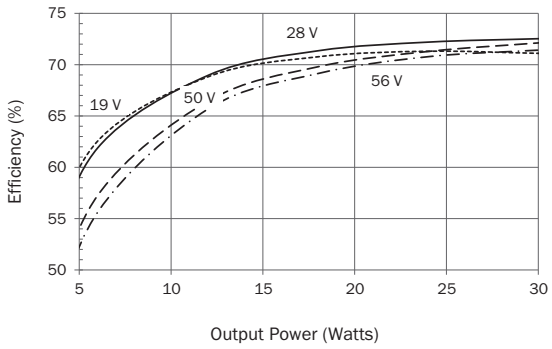
SMRT283R3S Efficiency

FIGURE 8



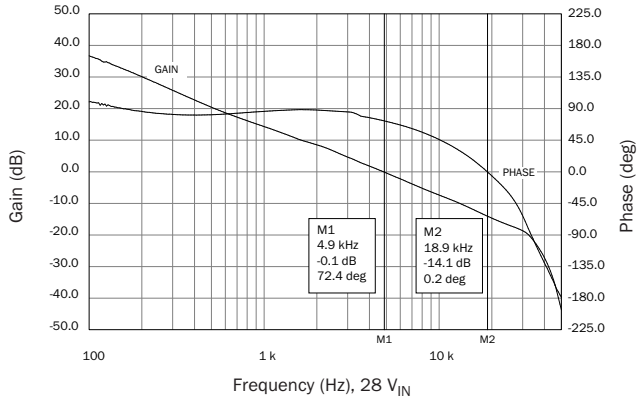
SMRT283R3S Gain Phase

FIGURE 9



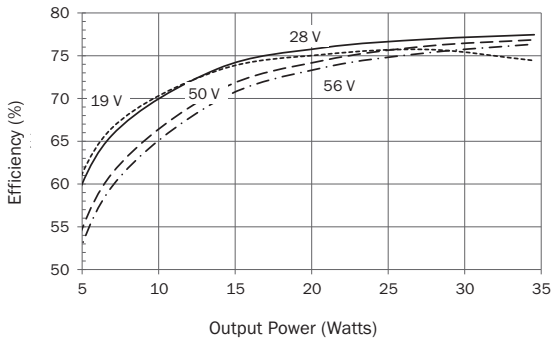
SMRT2805S Efficiency

FIGURE 10



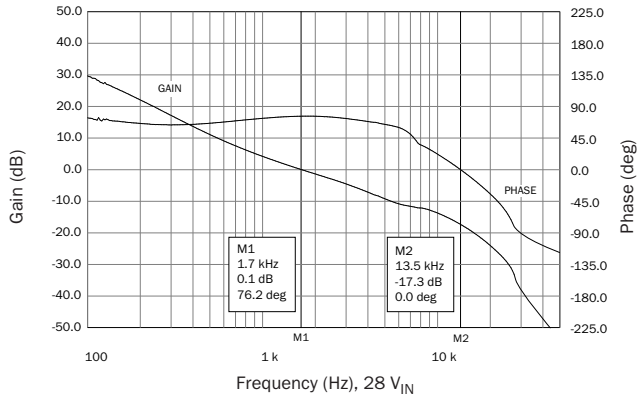
SMRT2805S Gain Phase

FIGURE 11



SMRT288R7S Efficiency

FIGURE 12



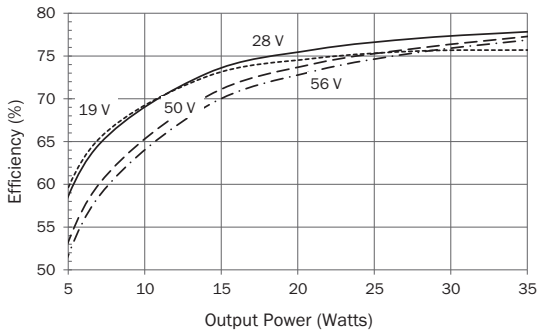
SMRT288R7S Gain Phase

FIGURE 13

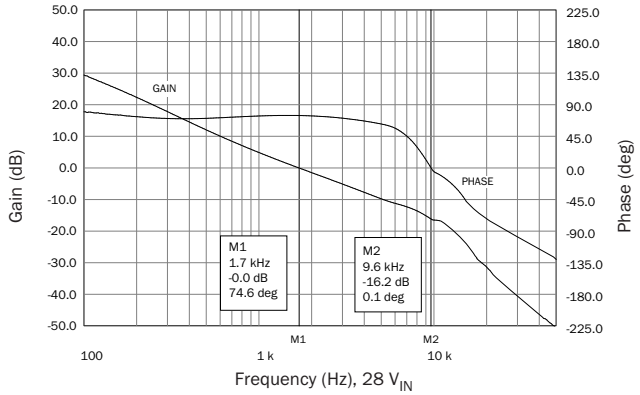
SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

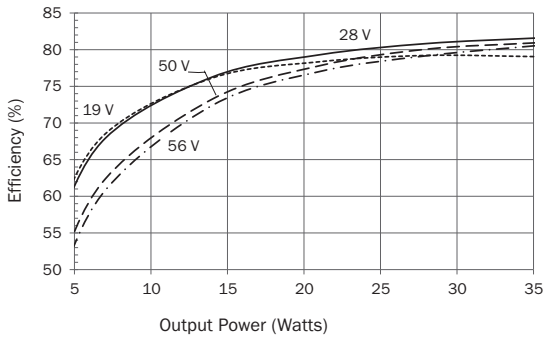
TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



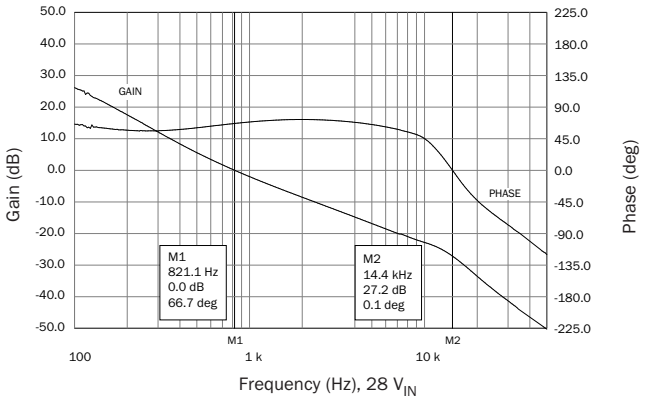
SMRT2812S Efficiency
FIGURE 14



SMRT2812S Gain Phase
FIGURE 15



SMRT2815S Efficiency
FIGURE 16

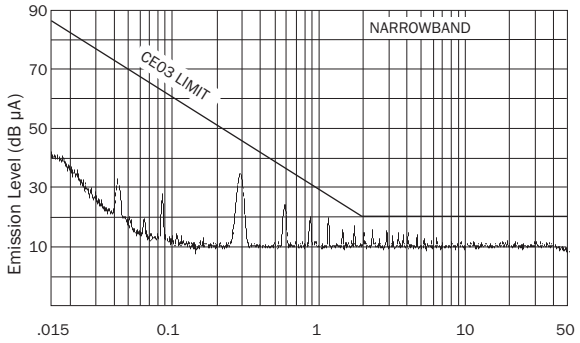


SMRT2815S Gain Phase
FIGURE 17

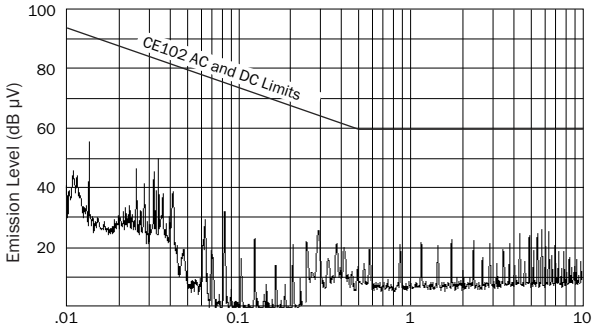
SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

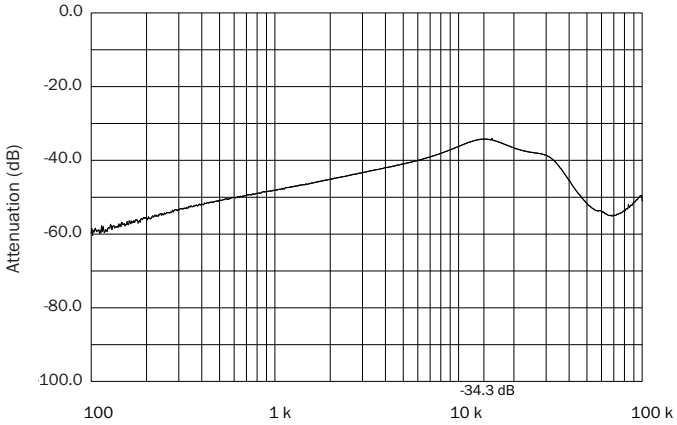
TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



Frequency (MHz), 28 V_{IN}
SMRT Single MIL-STD-461C, CE03
FIGURE 18



Frequency (MHz), 28 V_{IN}
SMRT Single MIL-STD-461 D-F, CE102
FIGURE 19

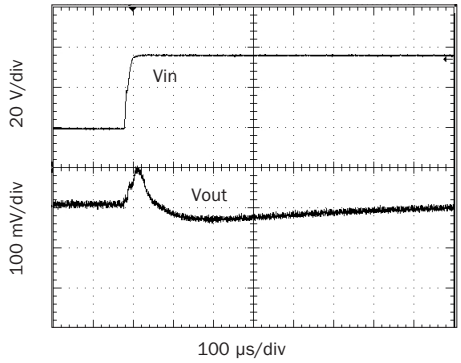


Frequency (Hz), 28 V_{IN}
SMRT Single Audio Rejection
FIGURE 20

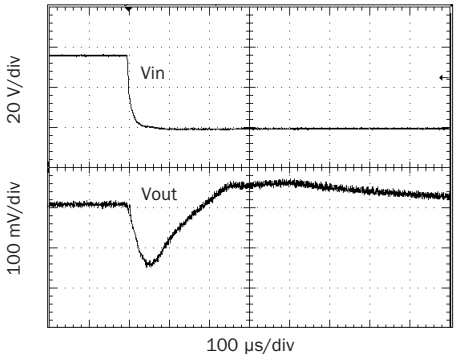
SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

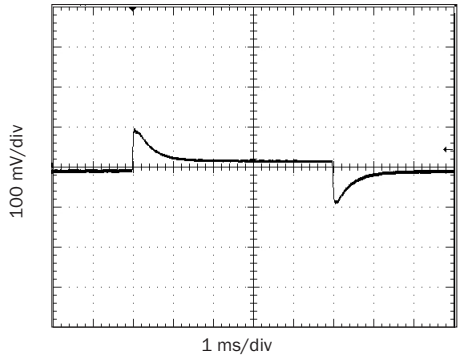
TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



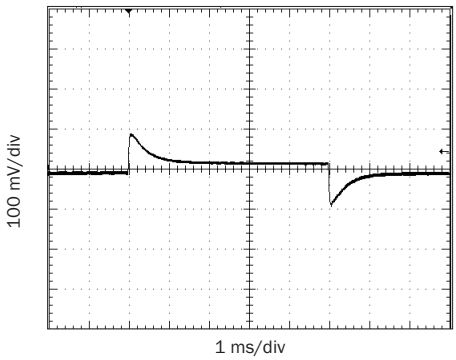
Vin 19 TO 56 V, full resistive load
SMRT2805S Representative of Single Output Line Transient
FIGURE 21



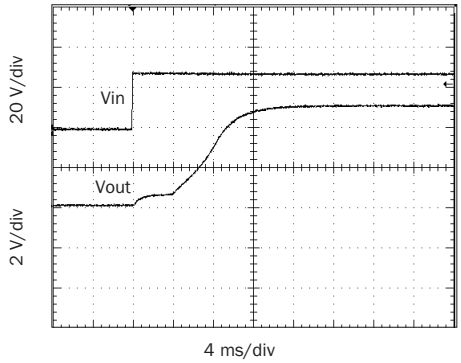
Vin 56 to 19 V, full resistive load
SMRT2805S Representative of Single Output Line Transient
FIGURE 22



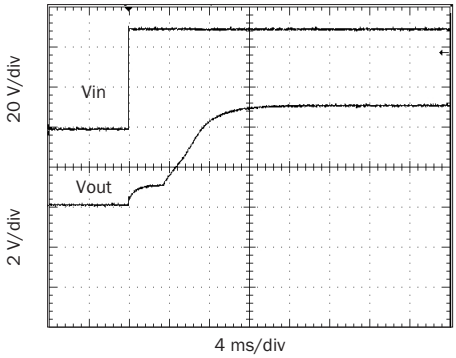
Load 50 - 100 - 50%, 28 Vin
SMRT2805S Representative of Single Output Load Transient
FIGURE 23



Load 50 - 100 - 50%, 50 Vin
SMRT2805S Representative of Single Output Load Transient
FIGURE 24



Full resistive load, 28 Vin
SMRT2805S Representative of Single Turn On Delay
FIGURE 25

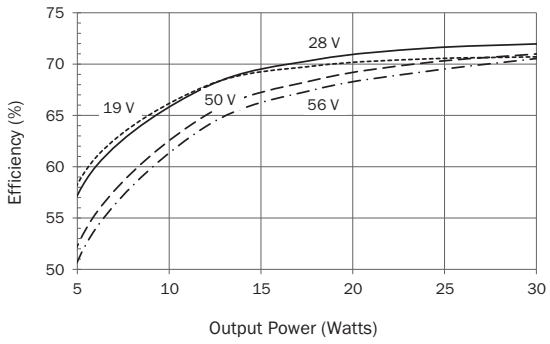


Full resistive load, 50 Vin
SMRT2805S Representative of Single Turn On Delay
FIGURE 26

SMRT Single, Dual and Triple Space DC-DC Converters

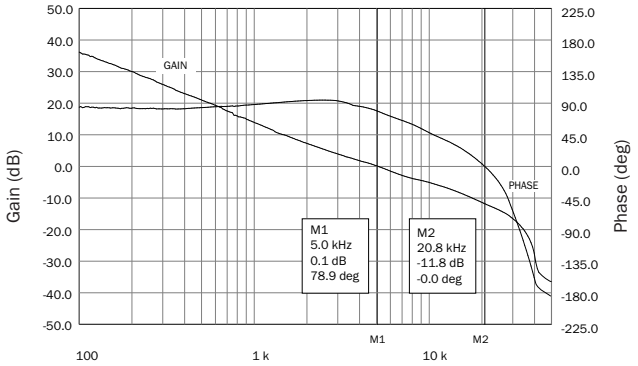
19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



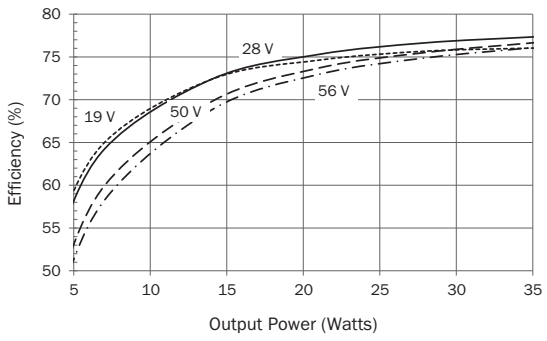
SMRT2805D Efficiency

FIGURE 27



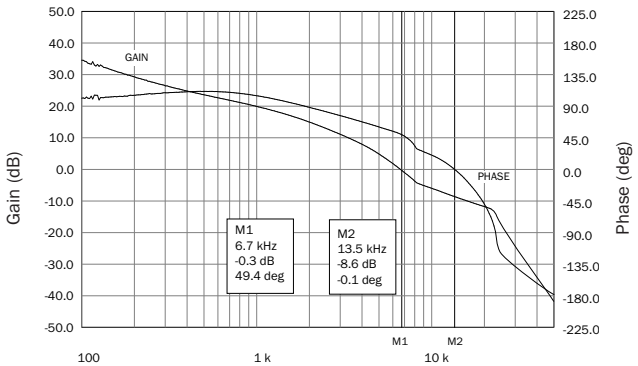
SMRT2805D Gain Phase

FIGURE 28



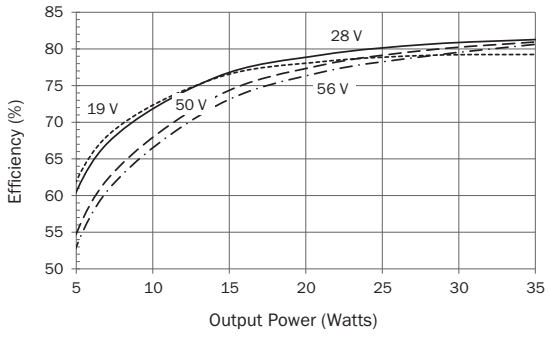
SMRT2812D Efficiency

FIGURE 29



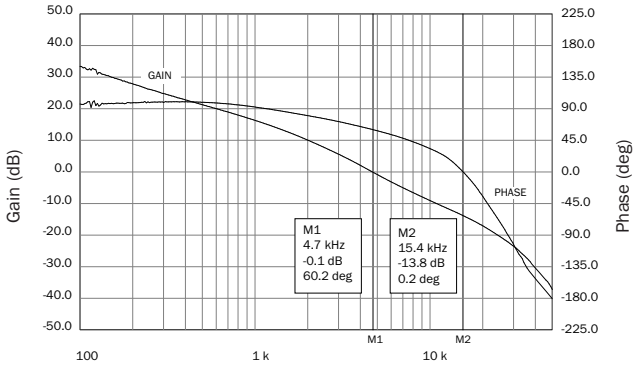
SMRT2812D Gain Phase

FIGURE 30



SMRT2815D Efficiency

FIGURE 31



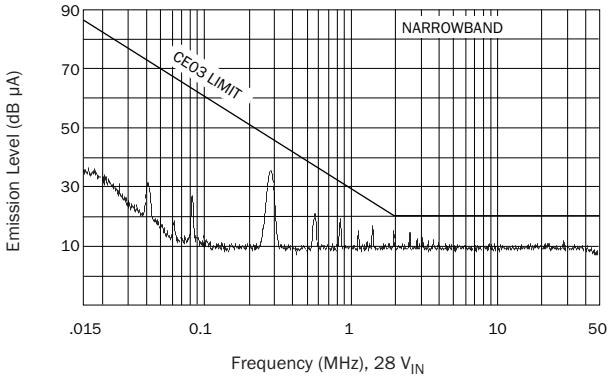
SMRT2815D Gain Phase

FIGURE 32

SMRT Single, Dual and Triple Space DC-DC Converters

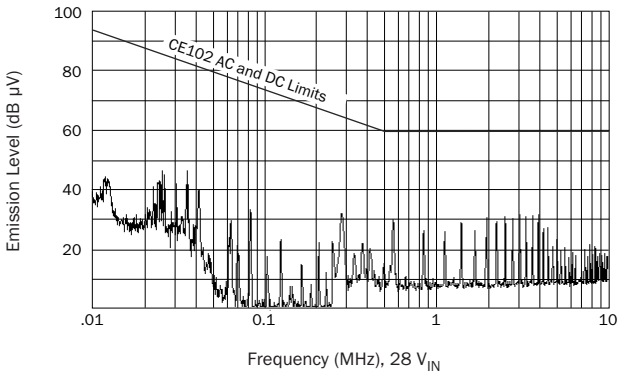
19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



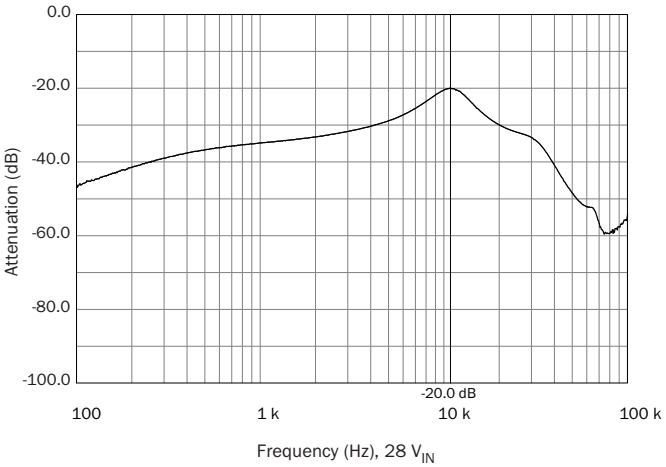
SMRT Dual MIL-STD-461C, CE03

FIGURE 33



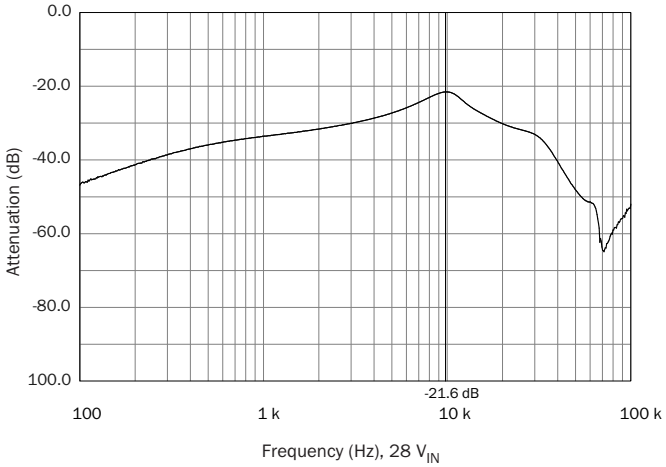
SMRT Dual MIL-STD-461 D-F, CE102

FIGURE 34



SMRT Dual Audio Rejection, Vout A

FIGURE 35



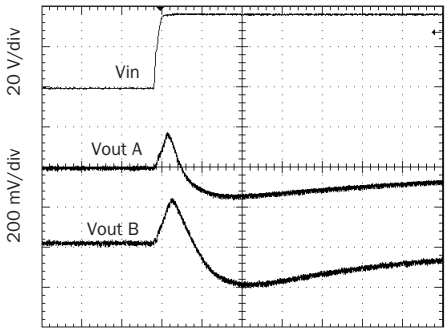
SMRT Dual Audio Rejection, Vout B

FIGURE 36

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.

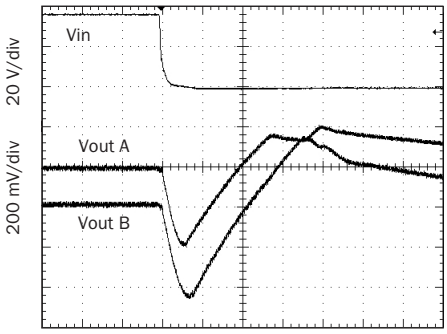


100 µs/div

Vin 19 to 56 V, full resistive load

SMRT2812D Representative of Dual Output Line Transient

FIGURE 37

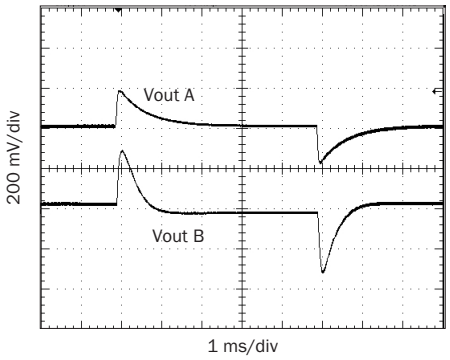


100 µs/div

Vin 56 to 19 V, full resistive load

SMRT2812D Representative of Dual Output Line Transient

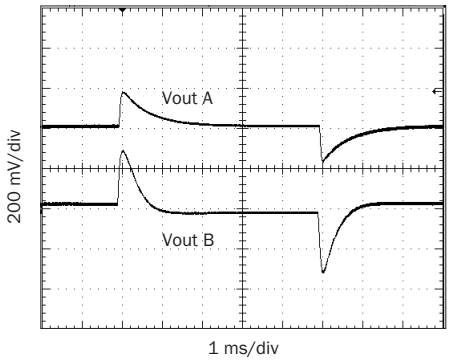
FIGURE 38



Load 50 - 100 - 50%, 28 Vin

SMRT2812D Representative of Dual Output Load Transient

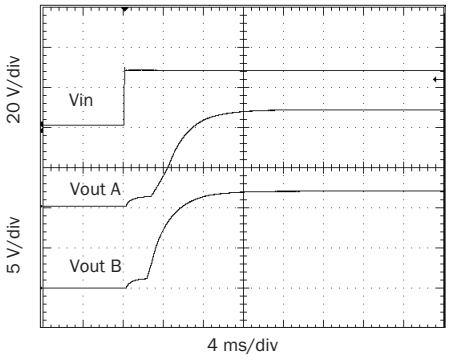
FIGURE 39



Load 50 - 100 - 50%, 50 Vin

SMRT2812D Representative of Dual Output Load Transient

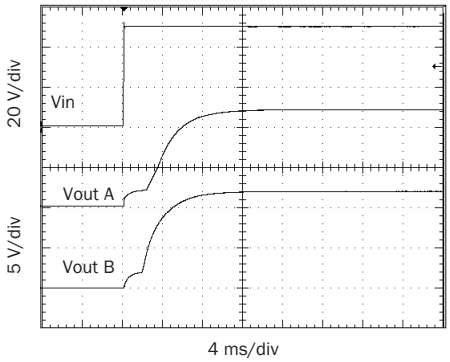
FIGURE 40



Full resistive load, 28 Vin

SMRT2812D Representative of Dual Turn On Delay

FIGURE 41



Full resistive load, 50 Vin

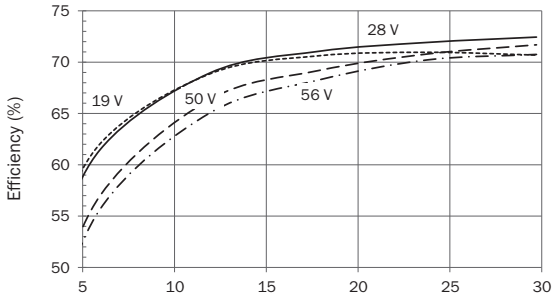
SMRT2812D Representative of Dual Turn On Delay

FIGURE 42

SMRT Single, Dual and Triple Space DC-DC Converters

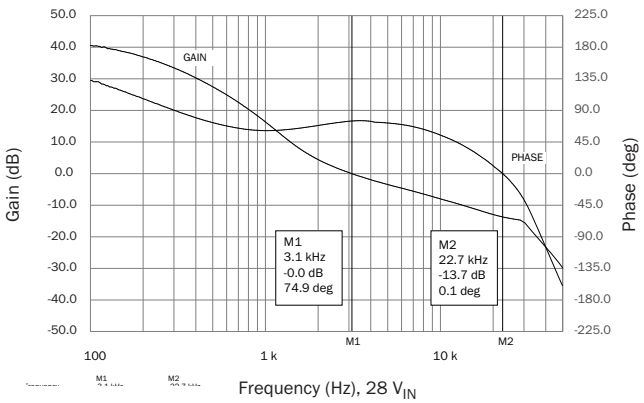
19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



SMRT283R312T Efficiency

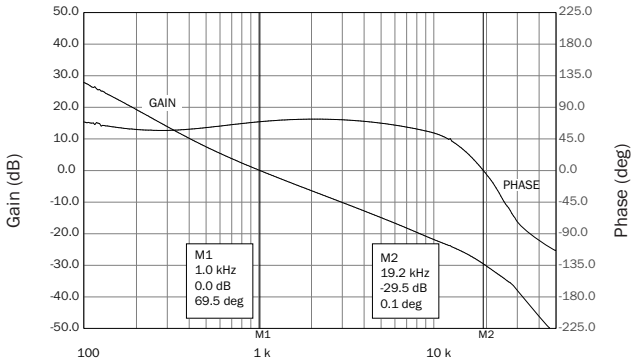
FIGURE 43



SMRT283R312T Gain Phase, Main Vout

Representative of all 3.3 V Main models

FIGURE 44



SMRT283R312T Gain Phase, +Aux

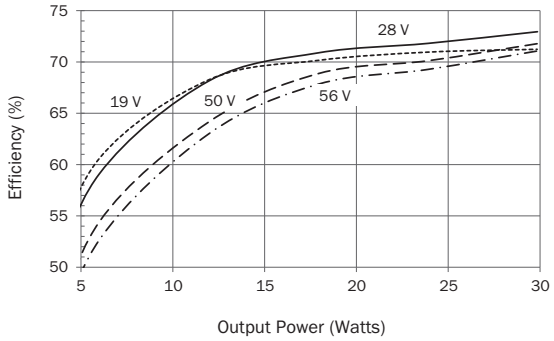
Representative of all 12 V +Aux models

FIGURE 45

SMRT Single, Dual and Triple Space DC-DC Converters

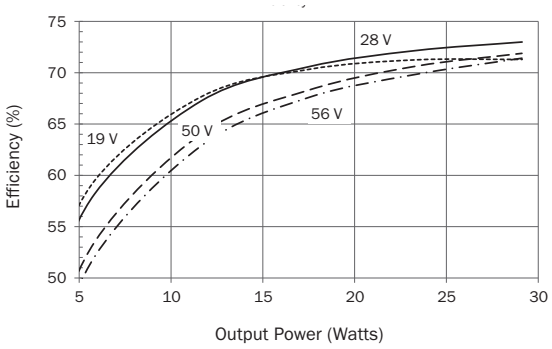
19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



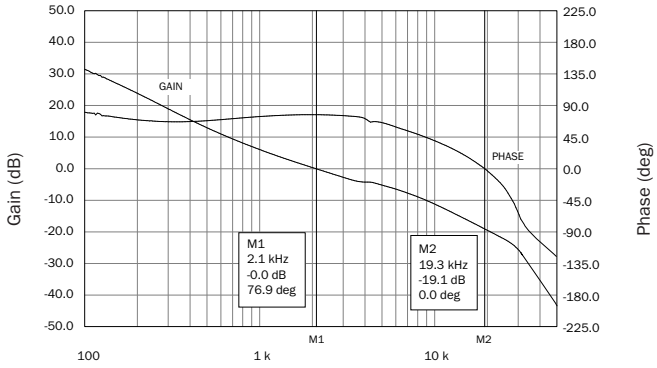
SMRT283R315T Efficiency

FIGURE 46



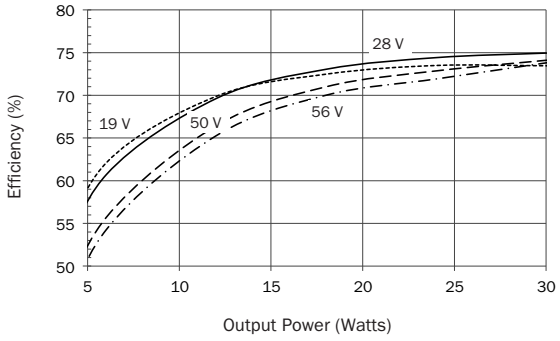
SMRT28507T Efficiency

FIGURE 47



SMRT28507T Gain Phase, +Aux

FIGURE 48



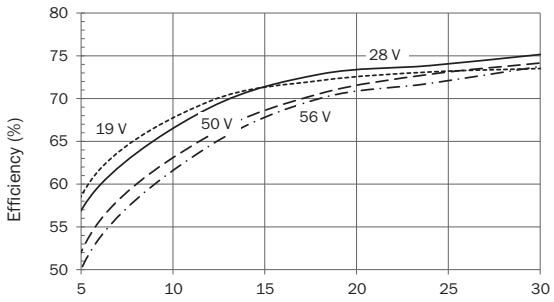
SMRT28512T Efficiency

FIGURE 49

SMRT Single, Dual and Triple Space DC-DC Converters

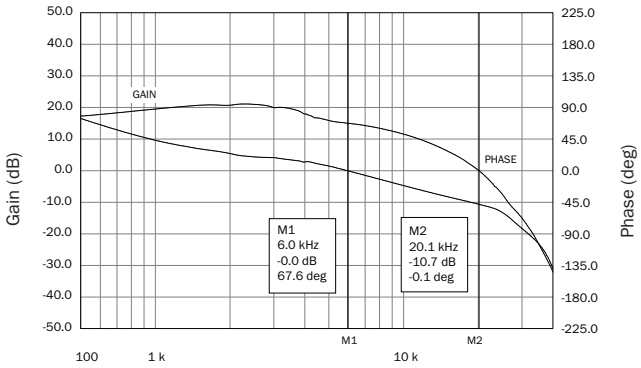
19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



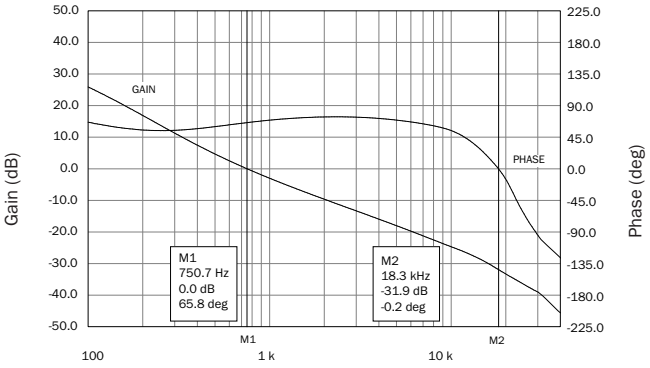
SMRT28515T Efficiency

FIGURE 50



SMRT28515T Gain Phase, Main Vout
Representative of all 5 V Main models

FIGURE 51



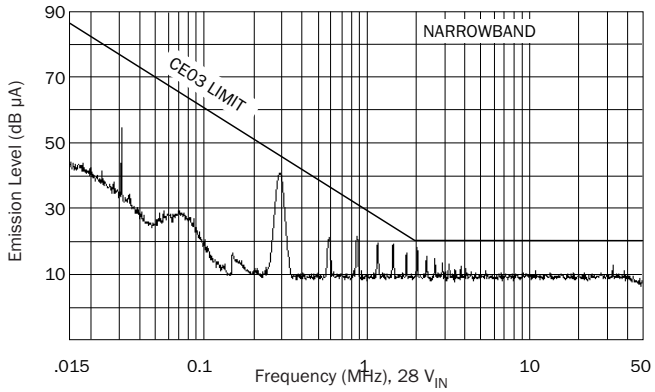
SMRT28515T Gain Phase, +Aux
Representative of all 15 V +Aux models

FIGURE 52

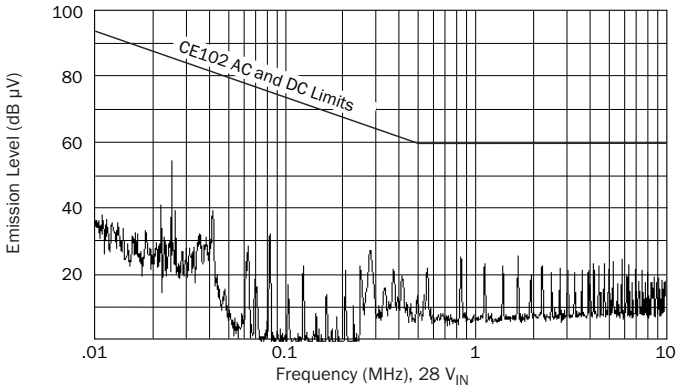
SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

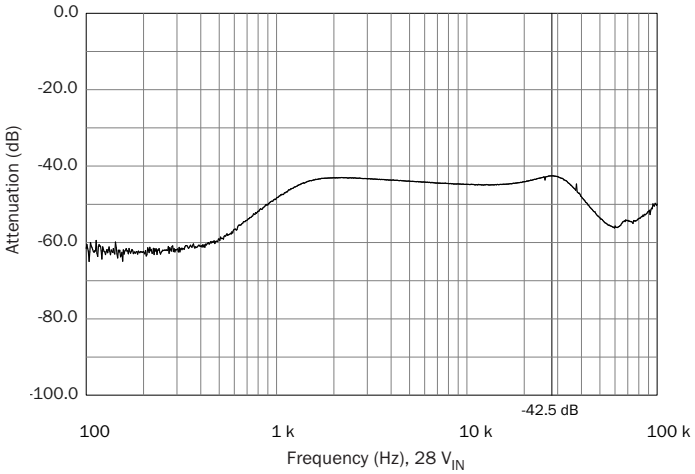
TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



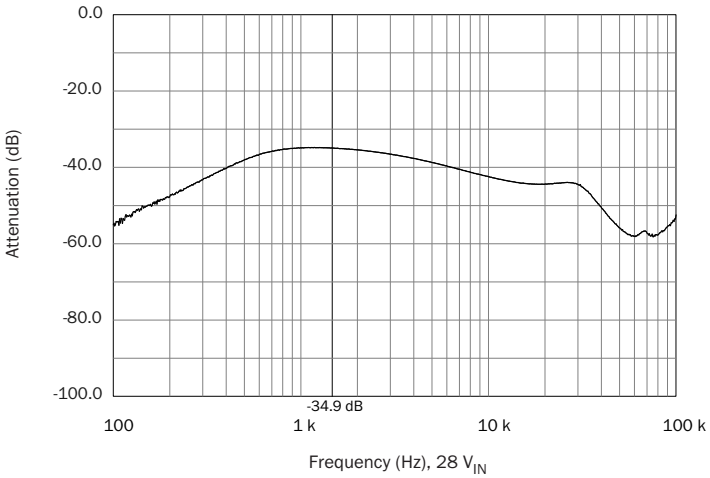
SMRT Triple MIL-STD-461C, CE03
FIGURE 53



SMRT Triple MIL-STD-461 D-F, CE102
FIGURE 54



SMRT Triple Audio Rejection, Main
FIGURE 55

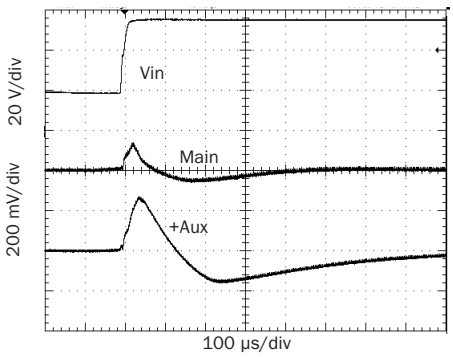


SMRT Triple Audio Rejection, +Aux
FIGURE 56

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

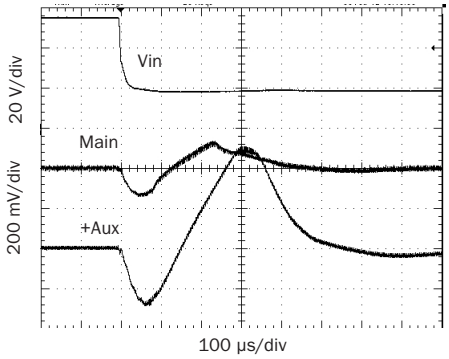
TYPICAL PERFORMANCE PLOTS: V_{IN} AS SPECIFIED, 25°C CASE, 100% LOAD, FREE RUN, UNLESS OTHERWISE SPECIFIED.
THESE ARE EXAMPLES FOR REFERENCE ONLY AND ARE NOT GUARANTEED SPECIFICATIONS.



Vin 19 to 56 V, full resistive load

SMRT283R312T Representative of Triple Output Line Transient

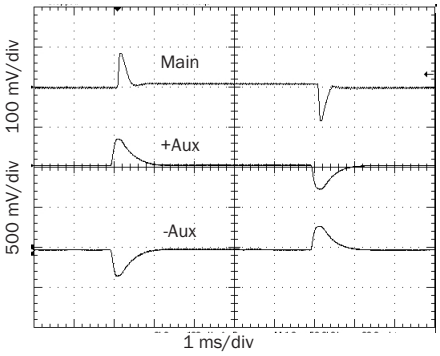
FIGURE 57



Vin 56 to 19 V, full resistive load

SMRT283R312T Representative of Triple Output Line Transient

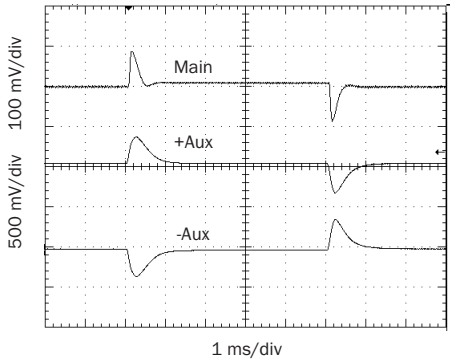
FIGURE 58



Load 50 - 100 - 50%, 28 Vin

SMRT283R312T Representative of Triple Output Load Transient

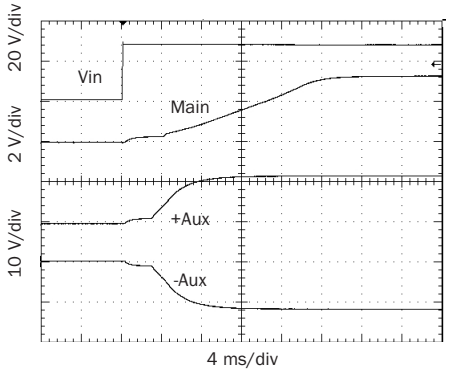
FIGURE 59



Load 50 - 100 - 50%, 50 Vin

SMRT283R312T Representative of Triple Output Load Transient

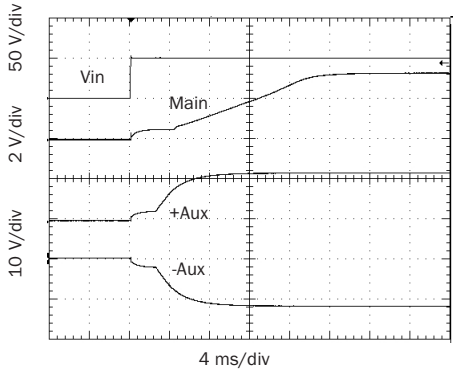
FIGURE 60



Full resistive load, 28 Vin

SMRT283R312T Representative of Triple Output Turn On Delay

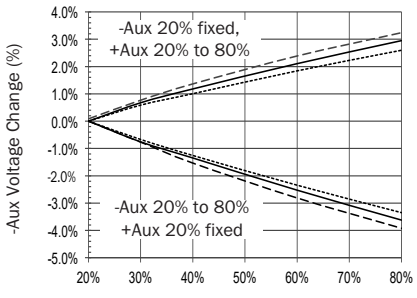
FIGURE 61



Full resistive load, 50 Vin

SMRT283R312T Representative of Triple Output Turn On Delay

FIGURE 62

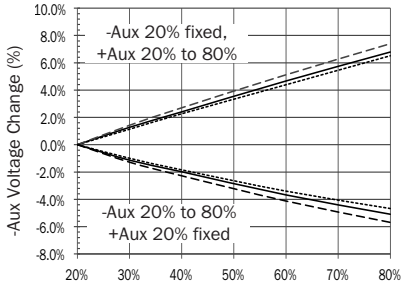


+Aux Load (%), 28 V_{IN}

····· -55°C —— 25°C – – 125°C

SMRT283R312T Cross Regulation

FIGURE 63

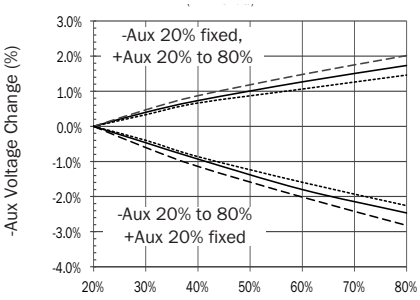


+Aux Load (%), 28 V_{IN}

····· -55°C —— 25°C – – 125°C

SMRT28507T Cross Regulation

FIGURE 64



+Aux Load (%), 28 V_{IN}

····· -55°C —— 25°C – – 125°C

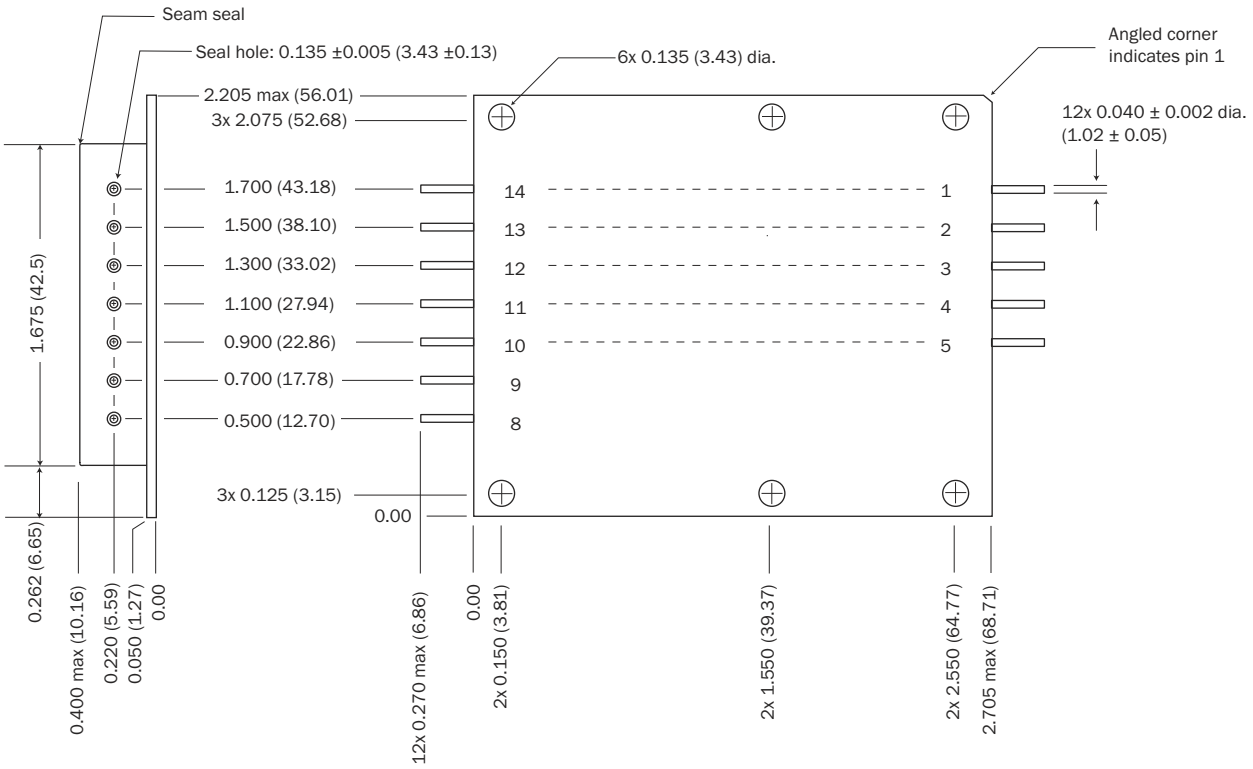
SMRT28515T Cross Regulation

FIGURE 65

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

BOTTOM VIEW CASE S



Weight: 100 gms maximum

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

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

Materials
Header Cold Rolled Steel/Nickel, Gold Plated
Cover Kovar/Nickel
Pins #52 alloy/gold, ceramic seal
Gold plating of 50 - 150 microinches included in pin diameter
Seal hole 0.123 ±0.002 (3.12 ±0.051)

Please refer to the numerical dimensions for accuracy.

FIGURE 66: CASE S

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

ELEMENT EVALUATION TABLES FOR QML PRODUCTS ARE IN "APP-009 QUALITY AND CERTIFICATION", APPENDIX A, IN COMPLIANCE WITH MIL-PRF-38534 REVISION L.
(LINK HTTPS://WWW.CRANEAE.COM/QUALITY-ASSURANCE-MODULAR-POWER)

ENVIRONMENTAL SCREENING SPACE DC-DC CONVERTERS PROTOTYPE, CLASS B AND E

	NON-QML [1]	CLASS	
TEST PERFORMED	PROTOTYPE (/0) [4]	CLASS E (/E)	CLASS B (/B) [5]
Non-destruct wire bond pull, Method 2023		■	■
Pre-cap Inspection, Method 2017, 2032	■	■	■
Temperature Cycle (10 times)			
Method 1010, Cond. C, -65°C to +150°C, ambient	■	■	■
Constant Acceleration			
Method 2001, 3000 g	■	■	■
PIND, Test Method 2020, Cond. A		■	■
Pre burn-in test, Group A, Subgroups 1 and 4	■	■	■
Burn-in Method 1015, +125°C case, typical [7]			
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, -55°C, +25°C, +125°C case		■	■
Hermeticity Test, Method 1014			
Gross Leak, Cond. B_2, Kr85		■	■
Gross Leak, Cond. C_1, fluorocarbon	■		
Fine Leak, Cond. B_1, Kr85		■	■
Fine Leak, Cond. A_2, helium	■		
Radiography, Method 2012		■	■
Post Radiography Electrical Test, +25°C case		■ [6]	■ [6]
Final visual inspection			
Method 2009 of MIL-STD-883		■	■
Magnification 1X [8]	■		

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

Notes
1. Non-QML prototype products may not meet all of the requirements of MIL-PRF-38534.
2. All processes are QML qualified and performed by certified operators.
3. Class H or K QML products that have no SMD number are marked "CHP, CHL, CHR, CKP, CKL or CKR" per MIL-PRF-38534, Table III instead of "QML".
4. "0" in the RHA designator position in Interpoint model numbers indicates DLA RHA "-" defined as no RHA.
5. Class B parts are manufactured and screened to MIL-PRF-38534 Class E requirements, but have not passed Group C requirements.
6. Not required by DLA but performed to assure product quality.
7. Burn-in temperature designed to bring the case temperature to +125°C minimum. Burn-in is a powered test.
8. Visual inspection is performed per an internal document. Product may contain cosmetic irregularities such as dents, dings, scratches, etc. that do not affect form, fit or function.

TABLE 26: ENVIRONMENTAL SCREENING SPACE DC-DC CONVERTERS PROTOTYPE, CLASS B AND E

SMRT Single, Dual and Triple Space DC-DC Converters

19 TO 56 VOLT INPUT - 23 TO 35 WATT - SPACE (CLASS B)

Space Radiation Hardness Assurance DC-DC Converters Class B, RHA [1] P, L and R

	Class B [6]		
Qualification Per MIL-STD	**/BP**	**/BL**	**/BR**
RHA P: 30 krad(Si) total dose [1, 2, 3]	■		
RHA L: 50 krad(Si) total dose [1, 2, 3]		■	
RHA R: 100 krad(Si) total dose [1, 2, 3]			■
SEE, LET 86 MeV cm^2/mg [1, 4]	■	■	■

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

Notes
1. Crane facility has a DLA approved RHA plan for Interpoint power products. Our SMD products with RHA “P”, “L” or “R” code meet DLA requirements.
2. Radiation sensitive components internal to the devices are procured with radiation guarantees or undergo radiation lot acceptance testing (RLAT) performed per condition A, method 1019 of MIL-STD-883.
3. Representative devices were initially High Dose Rate (HDR) tested using condition A of method 1019 of MIL-STD 883 to ensure RHA designator levels. Representative devices have also been Low Dose Rate (LDR) tested using condition D of method 1019 of MIL-STD-883 to the RHA designator levels. Representative devices will also be re-tested after design or process changes that can affect RHA response of this device.
4. Single event testing was performed on a converter to 86 MeV-cm^2/mg using 15 MeV/nucleon gold ions with no latch-up, burn-out, functional interrupts, or gate ruptures exhibited. Single event upsets (output voltage transients) may be present up to 86 MeV-cm^2/mg.
5. Neutron irradiation was performed on representative devices to a total fluence of 3E+11n/ cm^2 (1 MeV equivalent). A report is available upon request.
6. See Table 26 footnote[5] for Class B screening

Table 27: Space Radiation Hardness Assurance DC-DC Converters Class B, RHA P, L and R

Acronym	Definition
HDR	high dose rate
LDR	low dose rate
LET	linear energy transfer
MeV	megaelectron volts
RHA	radiation hardness assurance
SEE	single event effect
SEGR	single event gate rupture
SEL	single event latch-up
SET	single event transient
SEU	single event upset
TID	total ionizing dose

TABLE 28: RHA ACRONYMS

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