

SMRT28 Single, Dual and Triple Space DC/DC Converters

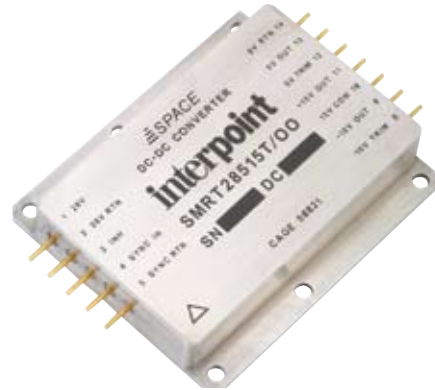
28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

FEATURES

Built in MIL-STD-461 EMI filter

Output trim from 51% to 124% of nominal

- Operating temperature -55° to +125°C
- Qualified to MIL-PRF-38534 Class H and K
- Radiation hardness assurance (RHA) to level F 300 kRad(Si)
- Input voltage range 19 to 56 VDC
- Transient protection 80 V for 120 ms
- Fully isolated, 5 port isolation
- Dual magnetic feedback
- Fixed high frequency switching
- Remote sense
- Inhibit function
- Synchronization input
- Indefinite short circuit protection
- Radiation tolerant to
 - 1×10^{12} protons/cm² neutron or proton fluence
 - 10^{11} rad(Si)/sec dose rate
 - 3×10^5 rad(Si) total dose
 - SEE - LET to 80 MeV cm²/mg
- Meets MIL-STD-704A transient standards



MODELS	
VDC OUTPUT	
SINGLE	DUAL
3.3	±5
5	±12
8.7	±15
12	
15	
TRIPLE	
+3.3 & ±12	
+3.3 & ±15	
+5 & ±7	
+5 & ±12	
+5 & ±15	

DESCRIPTION

The SMRT28 Series™ of DC/DC converters offers up to 35 watts of power in a radiation tolerant design. The low profile SMRT28 converters are manufactured in Interpoint's fully certified and qualified MIL-PRF-38534 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 hardening assurance.

The SMRT28 converters are switching regulators which use a two-phase, phase shifted flyback design with a nominal switching frequency of 300 kHz. Close regulation is maintained with advanced constant frequency pulse width modulation design techniques. The SMRT28's feed-forward compensation and discontinuous topologies provide high levels (80 dB peak) of input-to-output ripple rejection.

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 two-phase single output
- Dual Output: Two single-phase single outputs
- Triple Output: One single-phase independent Main output and one single-phase dual output. (± Auxiliary output)

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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 SMRT28 Series incorporates an inhibit terminal that can be used to disable internal switching. It is not recommended to tie the Inhibit pin of an SMRT28 directly to the Inhibit pin of another converter as the SMRT28 Inhibit pin can sink current. When pulling multiple inhibit signals low a separate interface is recommended for each SMRT28. The converter is inhibited when the inhibit pin is pulled low (0.4 V). In the inhibit mode the inhibit pin current requirement is less than ~2 mA. The converter resumes normal operation when a high (≥ 2.4 V) signal or open circuit is applied to the inhibit pin. The open circuit voltage of the inhibit is 5 to 6 volts. Although open circuit is the preferred method for the enabled state, up to 10 volts may be applied to the inhibit pin.

SYNCHRONIZATION

The Sync Input is isolated which allows Sync Return 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.

OUTPUT VOLTAGE TRIM

The output voltage of each set can be trimmed from 51% to 125% of nominal (varies by model, see trim instructions on page 4). The following are “sets” of voltages in relation to trim:

- Triple output models: Main output is one set, the dual outputs are another set.
- Dual outputs: Each output is a “set.”
One set can be trimmed using the trim pin, the other set can be trimmed (up only) using the positive sense pin.
- Single: One set

RADIATION TOLERANCE

The SMRT28 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 converters will operate normally in radiation environments with up to 1×10^{12} neutrons per square centimeter neutron fluence, 10^{11} rad(Si) per second dose rate, and 3×10^5 rad(Si) total dose.

These levels of radiation tolerance make the SMRT28 converters suitable for electronics in programs where operation in high radiation environments is required.

At the highest dose rate (10^{11} rad(Si)/sec dose rate) there will be an upset resulting in a dip in the voltage. This is non-destructive to the unit. The converter will operate through the upset.

SCREENING

SMRT28 converters offer the following screening options: Space Prototype (O), Class H, or Class K. Radiation tolerant to Radiation Hardness Assurance (RHA) levels of “-” (O), “P”, “R” or “F”, per MIL-PRF-38534. Interpoint model numbers use an “O” in the RHA designator position to indicate the “-” (dash) Radiation Hardness Assurance level of MIL-PRF-38534, which is defined as “no RHA”. See Screening Tables 1, 2 and 3 for more information.

EMI

The SMRT28 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.

SENSE

Tight load regulation is maintained via wide bandwidth magnetic feedback and through the use of remote sense on single output models and one output (Output “A”) of the dual units. The sense feature can be used to adjust the output voltage by connecting a resistor between the positive sense line and the positive output.

SENSE ADJUST INSTRUCTIONS FOR OUTPUT A ON DUAL MODELS ADJUST UP ONLY

(See trim tables on page 4 for more options)

$$R_{\text{ADJUST}} = 240 \left(\frac{V_{\text{out}} - V_{\text{nom}}}{V_{\text{max}} - V_{\text{out}}} \right)$$

V_{out} = desired output voltage

V_{nom} = nominal unadjusted output voltage

V_{max} = maximum achievable output voltage

5V $V_{\text{max}} = 6.0$ V

12V $V_{\text{max}} = 14.68$ V

15V $V_{\text{max}} = 18.36$ V

Note: R_{ADJUST} should be connected between Sense A (pin 8) and Vout A (pin 11).

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OPERATING CONDITIONS AND CHARACTERISTICS

Input Voltage Range

- 19 to 56 VDC continuous
- 80 V for 120 ms transient

Output Power

- Up to 35 watts depending on model

Lead Soldering Temperature (10 sec per pin)

- 300°C

Storage Temperature Range (Case)

- -65°C to +150°C

Case Operating Temperature (Tc)

- -55°C to +125°C full power
- -55°C to +135°C absolute

Derating Output Power/Current

- Linearly from 100% at 125°C to 0% at 135°C

Power Dissipation (Pd)

- 20 to 31 W

Output Voltage Temperature Coefficient

- 100 ppm/°C max

Current Limit

- 125% of full load typical

Isolation at 25°C

- 100 megohm minimum at 500 V

Audio Rejection

- 50 dB typical

Conversion Frequency

- 300 kHz typ 270 kHz min, 330 kHz max

Radiation (will operate through)

- 1×10^{12} neutrons/cm² neutron or proton fluence
- Radiation dose rate 10^{11} rad(Si) /sec
- Total dose up to 300 kRad(Si)
- SEE - LET to 80 MeV cm²/mg

SYNC AND INHIBIT

Sync

- Input frequency 270-330 kHz
- Duty cycle 20% min, 80% max
- 2.5 V p-p minimum amplitude
- 10 V p-p maximum amplitude
- Sync circuit is floating and isolated
- If sync is used at lower end of the range, full load operation is not guaranteed.

Inhibit

- Converter disabled (active low)
 - INH referenced to input common
 - Active low, pulled to 0.4 V or lower
 - Inhibit pin current ≤ 2 mA
- Converter enabled (active high)
 - Active high >2.4 V
 - Not to exceed 10 V
 - Open pin voltage 5 to 6 V

MECHANICAL AND ENVIRONMENTAL

Size (maximum)

- 2.705 x 2.205 x 0.400 inches (68.71 x 56.01 x 10.16 mm)
 - See case S for dimensions.

Weight (maximum)

- 100 grams maximum

Screening

Space Prototype, Class H, or Class K are radiation tolerant to Radiation Hardness Assurance (RHA) levels of “-” (O), “P”, “R”, or “F” per MIL-PRF-38534. Interpoint model numbers use an “O” in the RHA designator position to indicate the “-” (dash) Radiation Hardness Assurance level of MIL-PRF-38534, which is defined as “no RHA”.

See Screening Tables 1, 2 and 3 for more information. Available configurations: OO, HP, HR, KP, KR, KF

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TRIM TABLES

TRIM DOWN

Singles

R_{TRIM} should be connected between the **Trim** pin and **Positive Sense** pin.

Duals

R_{TRIM} should be connected between the **Trim B** pin and **Positive Vout B** pin. This only trims output B, output A can use the sense pin to trim up only. See page 2 for instructions on trimming up output A.

Triples

R_{TRIM} should be connected between the **Trim A** pin and **Positive Vout A** pin to adjust the Main output.

R_{TRIM} should be connected between the **Trim B** pin and **Positive Vout B** pin to adjust the Auxiliary outputs.

$$R_{TRIM} = K \left(\frac{V_{out} - V_{min}}{V_{nom} - V_{out}} \right)$$

V_{out} = Desired Voltage; K/V_{min}/V_{nom} from table below.

V _{NOM}	K	V _{MIN}	% OF V _{NOM}
3.3	3500	3.18	96
5.0	4520	4.16	83
7.0	8020	5.47	78
8.7	9040	6.13	70
12	11030	7.05	58
15	12900	7.65	51

TRIM UP

Singles

R_{TRIM} should be connected between the **Trim** pin and **Sense Return** pin.

Duals

R_{TRIM} should be connected between the **Trim B** pin and **Vout B Return** pin. This only trims output B, output A can use the sense pin to trim up only.

Triples

R_{TRIM} should be connected between the **Trim A** pin and **Vout A Return** pin to adjust the Main outputs.

R_{TRIM} should be connected between the **Trim B** pin and **Vout B Return** pin to adjust the Auxiliary outputs.

$$R_{TRIM} = K \left(\frac{V_{max} - V_{out}}{V_{out} - V_{nom}} \right)$$

V_{out} = Desired Voltage; K/V_{max}/V_{nom} from table below.

V _{NOM}	K	V _{MAX}	% OF V _{NOM}
3.3	3000	3.70	112
5.0	3000	6.26	125
7.0	5300	8.27	118
8.7	5300	10.46	149
12	5300	14.69	122
15	5300	18.54	124

Note: Do not exceed maximum current rating when trimming down,

Note: Do not exceed maximum power rating when trimming up.

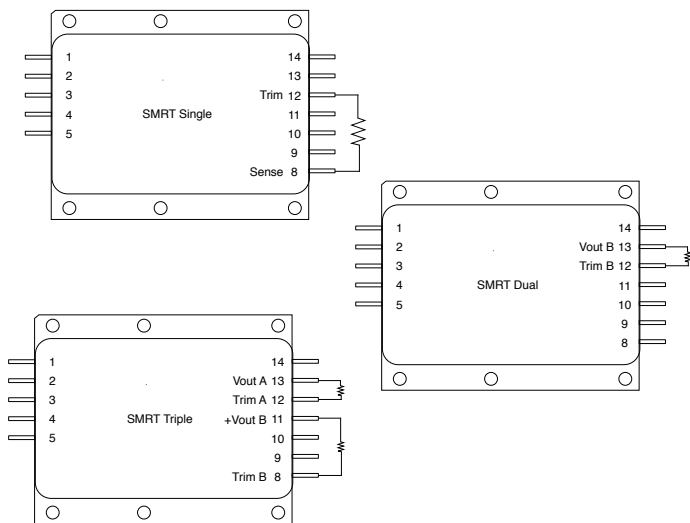


FIGURE 1: TRIM DOWN DIAGRAMS

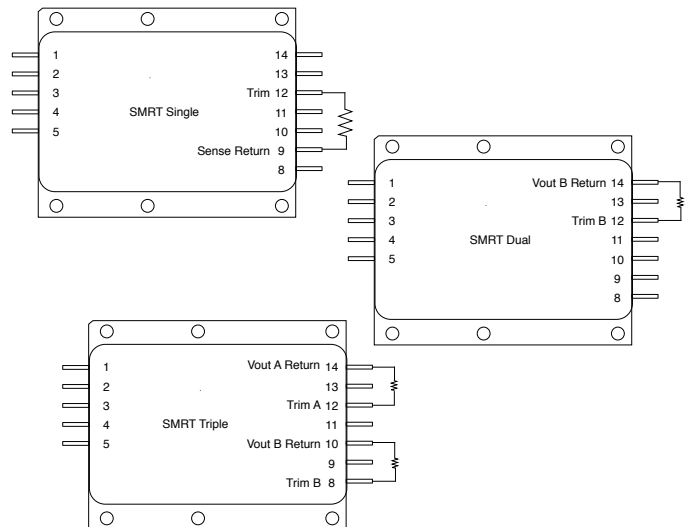


FIGURE 2: TRIM UP DIAGRAMS

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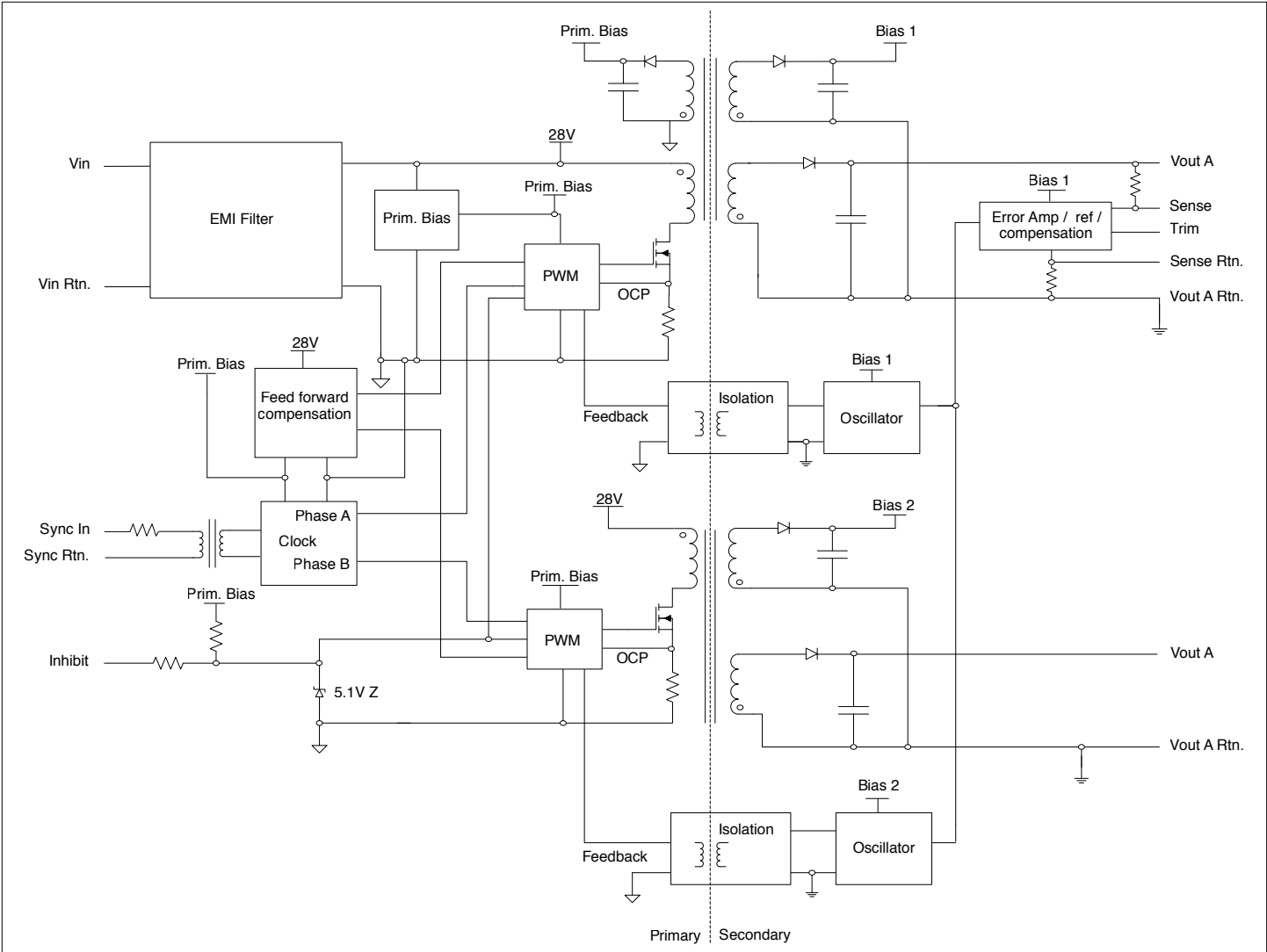


FIGURE 3: SMRT SINGLE BLOCK DIAGRAM

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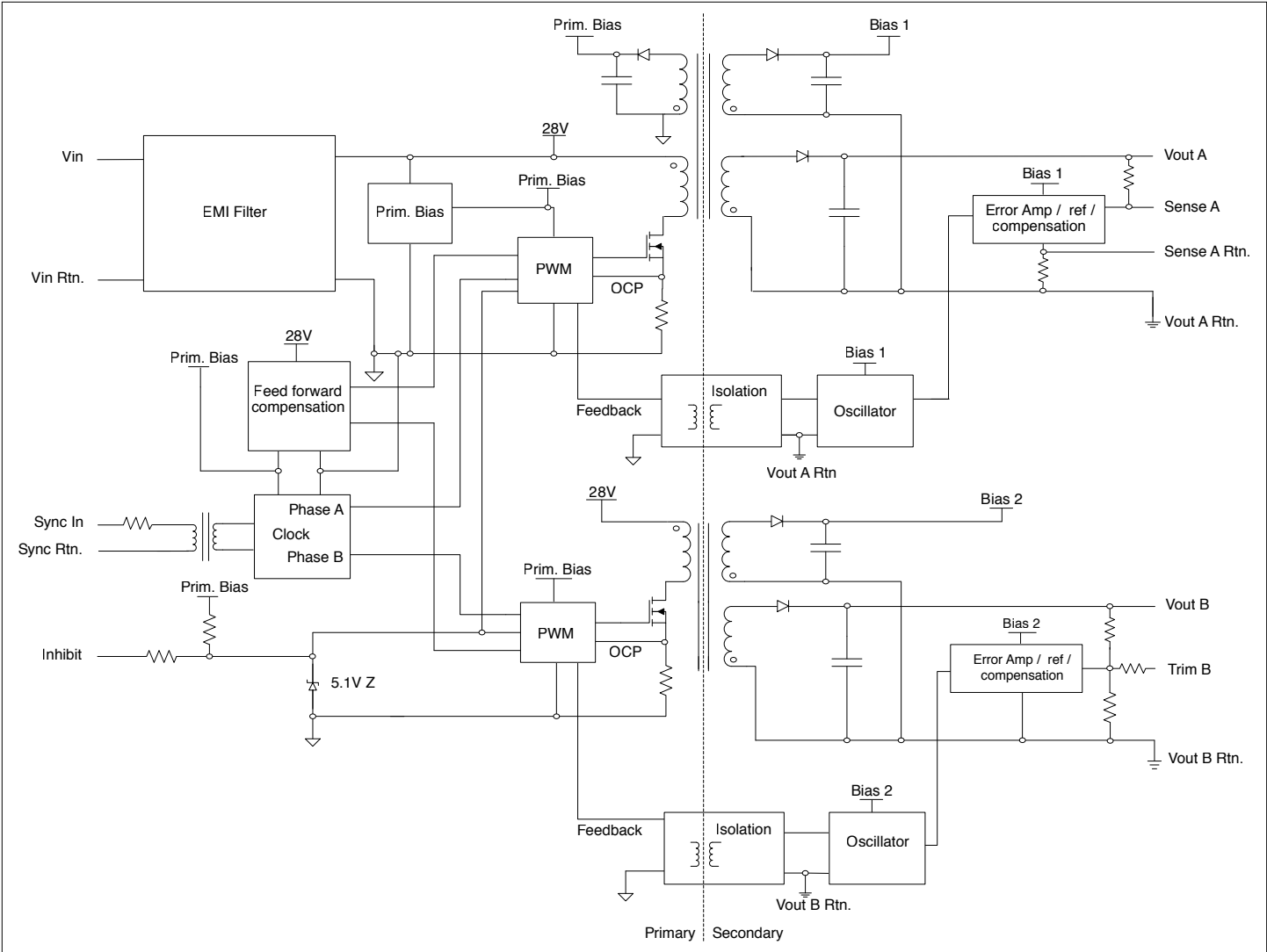


FIGURE 4: SMRT DUAL BLOCK DIAGRAM

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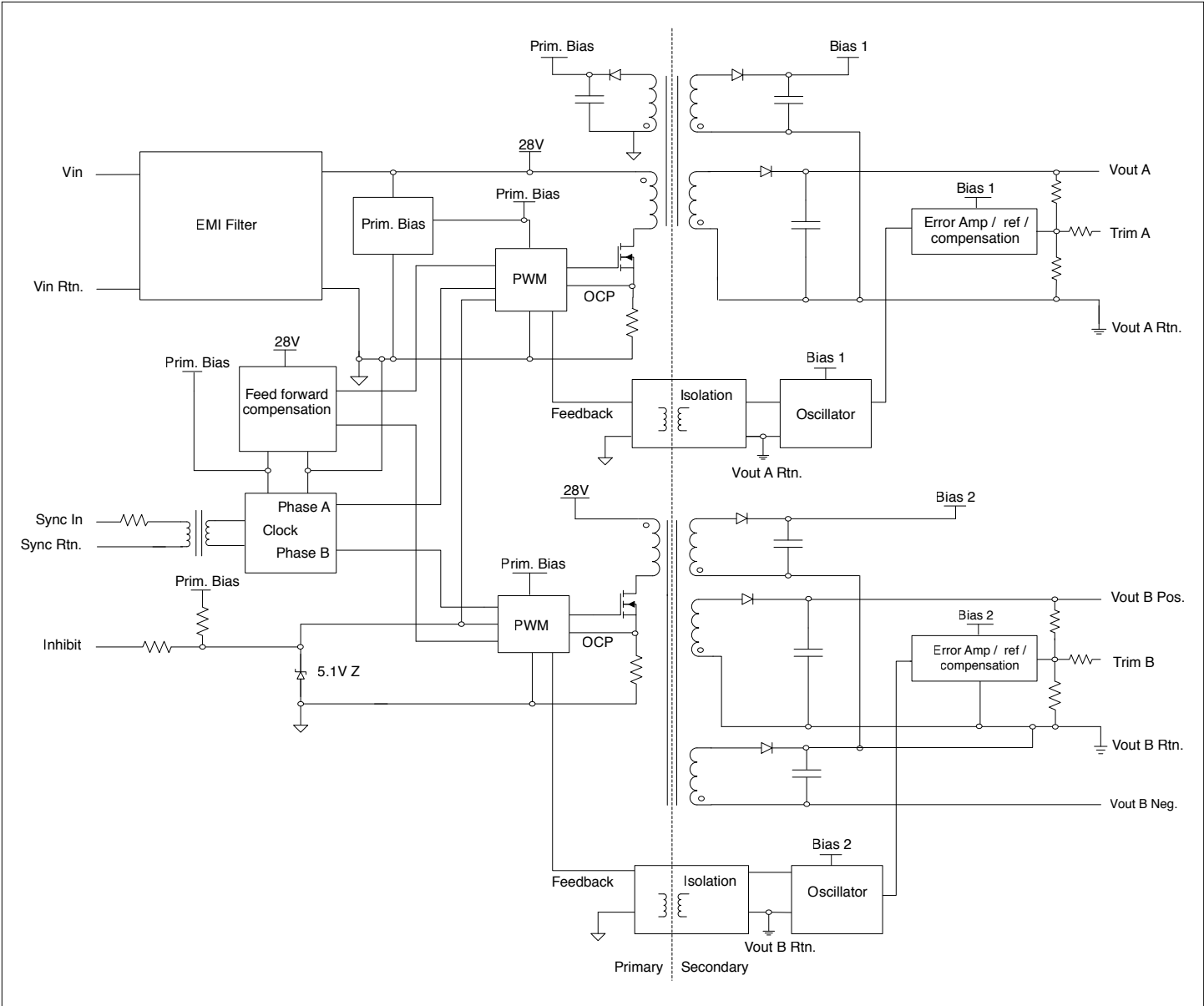


FIGURE 5: SMRT TRIPLE BLOCK DIAGRAM

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

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.

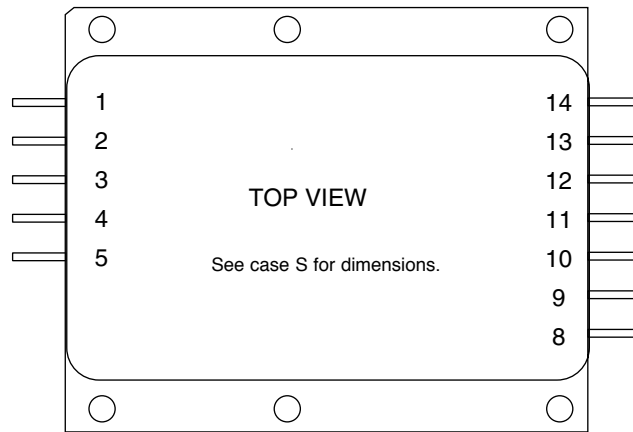


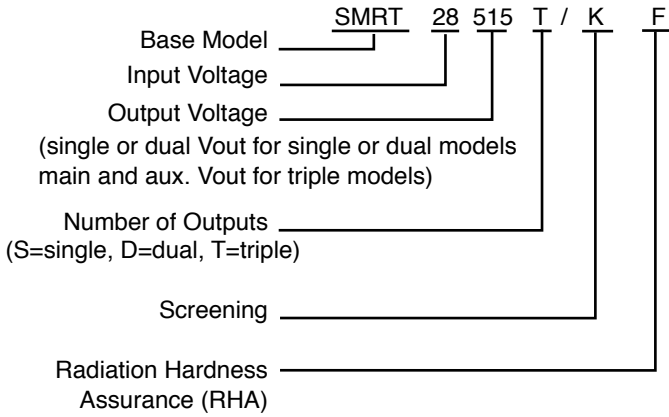
FIGURE 6: PIN OUT

PINS NOT IN USE	
Inhibit: single, dual and triple	Leave unconnected
Sync In	Connect to Sync Return
Sense Lines	Must be connected to appropriate outputs
Trim (all)	Leave unconnected

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MODEL NUMBERING KEY



SMD NUMBERS

STANDARD MICROCIRCUIT DRAWING (SMD)	SMRT28 SIMILAR PART
5962F0622001KXC	SMRT283R3S/KF
5962F0622101KXC	SMRT2805S/KF
5962F0821001KXC	SMRT2812S/KF
5962F0622201KXC	SMRT2815S/KF
5962F0622301KXC	SMRT2805D/KF
5962F0720201KXC	SMRT2812D/KF
5962F0622401KXC	SMRT2815D/KF
5962F0821101KXC	SMRT283R312T/KF
5962F0821201KXC	SMRT283R315T/KF
5962F0622501KXC	SMRT28512T/KF
5962F0622601KXC	SMRT28515T/KF

The SMD number shown is for Class K screening and Radiation Hardness Assurance (RHA) level F. See the SMD for the numbers for other screening and radiation levels. For exact specifications for an SMD product, refer to the SMD drawing. SMDs can be downloaded from: <http://www.dsccl.dla.mil/programs/smcr>

MODEL SELECTION

ON THE LINES BELOW, ENTER ONE SELECTION FROM EACH CATEGORY TO DETERMINE THE MODEL NUMBER.

CATEGORY	SMRT28 Base Model and Input Voltage	Output Voltage ¹	Number of Outputs ²	Screening ³	RHA ⁴
SELECTION	SMRT28 is the only available selection	3R3, 05, 8R7, 12, 15 05, 12, 15 3R312, 3R315, 507, 512, 515	S D T	O H K	O P R F

Notes:

- 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. 512 and 515 triple output converters are +5 volt main and ±12 or ±15 volt auxiliaries.
- Number of Outputs: S is a single output, D is a dual output, and T is a triple output
- Screening: A screening level of O is a Space Prototype and is only used with RHA O. See Screening Tables 2 and 3 for more information.
- RHA: Interpoint model numbers use an "O" in the RHA designator position to indicate the "-" (dash) Radiation Hardness Assurance level of MIL-PRF-38534, which is defined as "no RHA." RHA O is only available with Screening level O. See Screening Table 3 for more information.

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Electrical Characteristics: -55°C to +125°C T_C, 28 VDC V_{in}, 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	VDC
OUTPUT CURRENT ²		0	—	6.97	0	—	6.0	0	—	4.0	A
OUTPUT POWER ²	V _{IN} = 19 TO 56 VDC	0	—	23	0	—	30	0	—	35	W
OUTPUT RIPPLE	10 kHz - 20 MHz	—	—	280	—	—	200	—	—	200	mV p-p
LINE REGULATION ²	V _{IN} = 19, 50 VDC	—	5	30	—	5	30	—	5	30	mV
LOAD REGULATION		—	5	40	—	5	40	—	5	80	mV
	V _{IN} = 19, 50	—	—	90	—	—	70	—	—	80	
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	VDC
INPUT VOLTAGE	CONTINUOUS	19	28	56	19	28	56	19	28	56	VDC
	TRANSIENT ¹ 120 ms	0	—	80	0	—	80	0	—	80	V
INPUT CURRENT	INHIBITED	—	—	50	—	—	50	—	—	50	mA
	NO LOAD	—	—	110	—	—	110	—	—	115	
INPUT RIPPLE CURRENT ³	10 kHz - 20 MHz	—	10	50	—	10	50	—	10	50	mA p-p
EFFICIENCY		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
	RECOVERY	—	—	3	—	—	3	—	—	4	ms
STEP LINE RESPONSE ^{1, 5, 6}	19 - 50 - 19 V _{IN} TRANSIENT	—	—	±500	—	—	±500	—	—	±500	mV pk
	RECOVERY	—	—	4	—	—	4	—	—	4	ms
START-UP ⁸	DELAY NO LOAD AND FULL	—	—	35	—	—	25	—	—	60	ms
	OVERSHOOT	—	—	50	—	—	50	—	—	95	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	—	—	5000	—	—	5000	—	—	5000	μF

Notes

1. Guaranteed by design, not tested.

2. To maintain tight regulation over the full input voltage range a minimum load of 2% of full load should be used on all outputs.

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. Transition time ≥ 10 μs.

7. Half load to/from full load.

8. Measured from release of inhibit or input voltage step

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Electrical Characteristics: -55°C to +125°C T_C, 28 VDC V_{in}, 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	VDC
OUTPUT CURRENT ²		—	—	2.92	—	—	2.33	A
OUTPUT POWER ²	V _{IN} = 19 TO 56 VDC	0	—	35	0	—	35	W
OUTPUT RIPPLE	10 kHz - 20 MHz	—	—	200	—	—	180	mV p-p
LINE REGULATION ²	V _{IN} = 19, 50 VDC	—	5	30	—	5	30	mV
LOAD REGULATION		—	5	40	—	5	40	mV
	V _{IN} = 19, 50 VDC	—	—	90	—	—	90	
TOTAL REGULATION ¹ V _{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	10.9	—	13.1	14.0	—	16.0	VDC
INPUT VOLTAGE	CONTINUOUS	19	28	56	19	28	56	VDC
	TRANSIENT ¹ 120 ms	0	—	80	0	—	80	V
INPUT CURRENT	INHIBITED	—	—	50	—	—	50	mA
	NO LOAD	—	—	110	—	—	110	
INPUT RIPPLE CURRENT ³	10 kHz - 20 MHz	—	10	50	—	10	50	mA p-p
EFFICIENCY		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
	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE ^{1, 5, 6}	19 - 50 - 19 V _{IN} TRANSIENT	—	—	±700	—	—	±700	mV pk
	RECOVERY	—	—	4	—	—	4	ms
START-UP ⁸	DELAY NO LOAD AND FULL	—	—	25	—	—	25	ms
	OVERSHOOT	—	—	120	—	—	150	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	—	—	5000	—	—	5000	μF

Notes

1. **Guaranteed by design, not tested.**

2. To maintain tight regulation over the full input voltage range a minimum load of 2% of full load should be used on all outputs.

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. Transition time ≥10 μs.

7. Half load to/from full load.

8. Measured from release of inhibit or input voltage step

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Electrical Characteristics: -55°C to +125°C T_C, 28 VDC 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	V _{OUT} A	4.90	5.00	5.10	11.76	12.00	12.24	14.70	15.00	15.30	VDC
	V _{OUT} B	4.90	5.00	5.10	11.76	12.00	12.24	14.70	15.00	15.30	
OUTPUT CURRENT ^{2, 3}	V _{OUT} A	–	–	3.0	–	–	1.46	–	–	1.17	A
	V _{OUT} B	–	–	3.0	–	–	1.46	–	–	1.17	
OUTPUT POWER ^{2, 3} V _{IN} = 19 TO 56 VDC	V _{OUT} A	0	–	15	0	–	17.5	0	–	17.5	W
	V _{OUT} B	0	–	15	0	–	17.5	0	–	17.5	
OUTPUT RIPPLE	10 kHz - 20 MHz	–	–	200	–	–	200	–	–	180	mV p-p
LINE REGULATION ²	V _{IN} = 19, 50 VDC	–	–	30	–	5	25	–	5	30	mV
LOAD REGULATION		–	5	40	–	5	50	–	5	40	mV
	V _{IN} = 19, 50 VDC	–	–	70	–	–	100	–	–	70	
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	VDC
INPUT VOLTAGE ⁴	CONTINUOUS	19	28	56	19	28	56	19	28	56	VDC
	TRANSIENT 120 ms	0	–	80	0	–	80	0	–	80	V
INPUT CURRENT	INHIBITED ⁴	–	–	50	–	–	50	–	–	50	mA
	NO LOAD	–	–	110	–	–	110	–	–	110	
INPUT RIPPLE CURRENT ⁴	10 kHz - 20 MHz	–	10	50	–	10	150	–	10	50	mA p-p
EFFICIENCY		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
	RECOVERY	–	–	3	–	–	2	–	–	3	ms
STEP LINE RESPONSE ^{1, 6, 7}	19 - 50 - 19 V _{IN} TRANSIENT	–	–	±500	–	–	±1000	–	–	±700	mv pk
	RECOVERY	–	–	4	–	–	3	–	–	4	ms
START-UP ⁹	DELAY NO LOAD AND FULL	–	–	25	–	–	20	–	–	25	ms
	OVERSHOOT	–	–	50	–	–	350	–	–	150	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	–	–	5000	–	–	5000	–	–	5000	μF

Notes

1. **Guaranteed by design, not tested.**

2. The specified maximum current/power is available from each output.

3. To maintain tight regulation over the full input voltage range a minimum load of 2% of full load should be used on all 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 power dissipation when output is shorted.

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. Transition time ≥10 μs.

8. Half load to/from full load.

9. Measured from release of inhibit or input voltage step

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

Electrical Characteristics: -55°C to +125°C T_C, 28 VDC V_{in}, 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	VDC
	NEG. AUX.	–	–	–	-11.58	-12.00	-12.42	
OUTPUT CURRENT ^{2, 3}		–	–	4.5	0	±0.63	1 ¹	A
	TOTAL	–	–	–	–	–	1.25	
OUTPUT POWER ^{2, 3} V _{IN} = 19 TO 56 VDC		0	–	15	0	±7.5	12 ¹	W
	TOTAL	–	–	–	–	–	15	
OUTPUT RIPPLE	10 kHz - 20 MHz	–	–	200	–	–	150	mV p-p
LINE REGULATION V _{IN} = 19, 50 VDC	MAIN AND POS. AUX	–	–	30	–	5	30	mV
	NEG. AUX.	–	–	–	–	10	70	
LOAD REGULATION	MAIN AND POS. AUX	–	5	40	–	5	40	mV
	V _{IN} = 19, 50 VDC	–	–	100	–	–	120	
	NEG. AUX. ¹	–	–	–	–	10	300	
	V _{IN} = 19, 50 VDC ¹	–	–	–	–	–	400	
TOTAL REGULATION ¹ V _{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	–	3.6	±10.9	–	±13.1	VDC
CROSS REGULATION ^{1, 4, 5} T _C = 25°C	EFFECT ON NEGATIVE AUXILIARY	–	–	–	–	–	2.5	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	–	–	–	VDC
	TRANSIENT 120 ms	0	–	80	–	–	–	V
INPUT CURRENT	NO LOAD	–	–	110	–	–	–	mA
	INHIBITED	–	–	50	–	–	–	
INPUT RIPPLE CURRENT ⁶	10 kHz - 10 MHz	–	10	50	–	–	–	mA p-p
EFFICIENCY ⁷		68	–	–	–	–	–	%
LOAD FAULT ^{8, 9}	POWER DISSIPATION	–	–	28	–	–	–	W
	RECOVERY ¹	–	–	25	–	–	25	ms
STEP LOAD RESPONSE ^{9, 10, 11}	TRANSIENT	–	–	±450	–	–	±450	mV pk
	RECOVERY	–	–	3	–	–	3	ms
STEP LINE RESPONSE ^{1, 8, 9}	19 - 50 - 19 V _{IN} TRANSIENT	–	–	±500	–	–	±750	mV pk
	RECOVERY	–	–	4	–	–	4	ms
START-UP ¹¹	DELAY NO LOAD AND FULL	–	–	35	–	–	25	ms
	OVERSHOOT	–	0	50	–	0	120	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	–	–	5000	–	–	1000	μF

Notes: See page 15

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

Electrical Characteristics: -55°C to +125°C T_C, 28 VDC V_{in}, 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	VDC
	NEG. AUX.				-14.48	-15.00	-15.53	
OUTPUT CURRENT ^{2, 3}		—	—	4.5	0	±0.5	0.8 ¹	A
	TOTAL	—	—	—	—	—	1.0	
OUTPUT POWER ^{2, 3} V _{IN} = 19 TO 56 VDC		0	—	15	0	±7.5	12 ¹	W
	TOTAL	—	—	—	—	—	15	
OUTPUT RIPPLE	10 kHz - 20 MHz	—	—	200	—	—	150	mV p-p
LINE REGULATION V _{IN} = 19, 50 VDC	MAIN AND POS. AUX	—	—	30	—	5	30	mV
	NEG. AUX.				—	10	70	
LOAD REGULATION	MAIN AND POS. AUX	—	5	40	—	5	40	mV
	V _{IN} = 19, 50 VDC	—	—	100	—	—	120	
	NEG. AUX. ¹	—	—	—	—	—	300	
	V _{IN} = 19, 50 VDC ¹	—	—	—	—	—	400	
TOTAL REGULATION ¹ V _{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	3.0	—	3.6	±14.0	—	±16.0	VDC
CROSS REGULATION ^{1, 4, 5} T _C = 25°C	EFFECT ON NEGATIVE AUXILIARY	—	—	—	—	—	2.5	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	—	—	—	VDC
	TRANSIENT 120 ms	0	—	80	—	—	—	V
INPUT CURRENT	NO LOAD	—	—	110	—	—	—	mA
	INHIBITED	—	—	50	—	—	—	
INPUT RIPPLE CURRENT ⁶	10 kHz - 10 MHz	—	10	50	—	—	—	mA p-p
EFFICIENCY ⁷		68	—	—	—	—	—	%
LOAD FAULT ^{8, 9}	POWER DISSIPATION	—	—	28	—	—	—	W
	RECOVERY ¹	—	—	25	—	—	25	ms
STEP LOAD RESPONSE ^{9, 10, 11}	TRANSIENT	—	—	±450	—	—	±450	mV pk
	RECOVERY	—	—	3	—	—	3	ms
STEP LINE RESPONSE ^{1, 8, 9}	19 - 50 - 19 V _{IN} TRANSIENT	—	—	±500	—	—	±750	mV pk
	RECOVERY	—	—	4	—	—	4	ms
START-UP ¹¹	DELAY NO LOAD AND FULL	—	—	35	—	—	25	ms
	OVERSHOOT	—	0	50	—	0	150	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	—	—	5000	—	—	1000	μF

Notes: See page 15

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

Electrical Characteristics: -55°C to +125°C T_C, 28 VDC V_{in}, 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	VDC
	NEG. AUX.				-6.79	7.00	-7.21	
OUTPUT CURRENT ^{2, 3}		–	–	3.0	0	±1.00	1.2 ¹	A
	TOTAL	–	–	–	–	–	2.0	
OUTPUT POWER ^{2, 3} V _{IN} = 19 TO 56 VDC		0	–	15	0	±7.0	11.2 ¹	W
	TOTAL	–	–	–	–	–	14	
OUTPUT RIPPLE	10 kHz - 20 MHz	–	–	230	–	–	±170	mV p-p
LINE REGULATION V _{IN} = 19, 50 VDC	MAIN AND POS. AUX	–	–	70	–	–	100	mV
	NEG. AUX.	–	–	–	–	–	150	
LOAD REGULATION	MAIN AND POS. AUX	–	5	100	–	5	250	mV
	V _{IN} = 19, 50 VDC	–	–	150	–	–	250	
	NEG. AUX. ¹	–	–	–	–	–	350	
	V _{IN} = 19, 50 VDC ¹	–	–	–	–	–	350	
TOTAL REGULATION ¹ V _{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	–	5.3	±6.53	–	±7.47	VDC
CROSS REGULATION ^{1, 4, 5} T _C = 25°C	EFFECT ON NEGATIVE AUXILIARY	–	–	–	–	–	2.5	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	–	–	–	VDC
	TRANSIENT 120 ms	0	–	80	–	–	–	V
INPUT CURRENT	NO LOAD	–	–	110	–	–	–	mA
	INHIBITED	–	–	50	–	–	–	
INPUT RIPPLE CURRENT ⁶	10 kHz - 10 MHz	–	10	50	–	–	–	mA p-p
EFFICIENCY ⁷		71	–	–	–	–	–	%
LOAD FAULT ^{8, 9}	POWER DISSIPATION	–	–	22	–	–	–	W
	RECOVERY ¹	–	–	25	–	–	25	ms
STEP LOAD RESPONSE ^{9, 10, 11}	TRANSIENT	–	–	±300	–	–	±400	mV pk
	RECOVERY	–	–	2	–	–	2	ms
STEP LINE RESPONSE ^{1, 8, 9}	19 - 50 - 19 V _{IN} TRANSIENT	–	–	±500	–	–	±750	mV pk
	RECOVERY	–	–	4	–	–	4	ms
START-UP ¹¹	DELAY NO LOAD AND FULL	–	–	20	–	–	20	ms
	OVERSHOOT	–	0	100	–	0	150	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	–	–	5000	–	–	1000	μF

Notes: See page 15

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

Electrical Characteristics: -55°C to +125°C T_C, 28 VDC V_{in}, 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	VDC
	NEG. AUX.				-11.58	-12.00	-12.42	
OUTPUT CURRENT ^{2, 3}		–	–	3.0	0	±0.63	1 ¹	A
	MAX TOTAL AUX	–	–	–	–	–	1.25	
OUTPUT POWER ^{2, 3} V _{IN} = 19 TO 56 VDC		0	–	15	0	±7.5	12 ¹	W
	MAX TOTAL AUX	–	–	–	–	–	15	
OUTPUT RIPPLE	10 kHz - 20 MHz	–	–	200	–	–	150	mV p-p
LINE REGULATION V _{IN} = 19, 50 VDC	MAIN AND POS. AUX	–	–	30	–	5	30	mV
	NEG. AUX.				–	20	70	
LOAD REGULATION	MAIN AND POS. AUX	–	5	40	–	5	40	mV
	V _{IN} = 19, 50 VDC	–	–	100	–	–	120	
	NEG. AUX. ¹	–	–	–	–	10	300	
	V _{IN} = 19, 50 VDC ¹	–	–	–	–	–	400	
TOTAL REGULATION ¹ V _{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	–	5.3	±10.9	–	±13.1	VDC
CROSS REGULATION ^{1, 4, 5} T _C = 25°C	EFFECT ON NEGATIVE AUXILIARY	–	–	–	–	–	2.5	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	–	–	–	VDC
	TRANSIENT 120 ms	0	–	80	–	–	–	V
INPUT CURRENT	NO LOAD	–	–	110	–	–	–	mA
	INHIBITED	–	–	50	–	–	–	
INPUT RIPPLE CURRENT ⁶	10 kHz - 10 MHz	–	10	50	–	–	–	mA p-p
EFFICIENCY ⁷		68	–	–	–	–	–	%
LOAD FAULT ^{8, 9}	POWER DISSIPATION	–	–	25	–	–	–	W
	RECOVERY ¹	–	–	25	–	–	25	ms
STEP LOAD RESPONSE ^{9, 10, 11}	TRANSIENT	–	–	±450	–	–	±450	mV pk
	RECOVERY	–	–	3	–	–	3	ms
STEP LINE RESPONSE ^{1, 8, 9}	19 - 50 - 19 V _{IN} TRANSIENT	–	–	±500	–	–	±750	mV pk
	RECOVERY	–	–	4	–	–	4	ms
START-UP ¹¹	DELAY NO LOAD AND FULL	–	–	25	–	–	25	ms
	OVERSHOOT	–	0	50	–	0	120	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	–	–	5000	–	–	1000	μF

Notes: See page 15

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

Electrical Characteristics: -55°C to +125°C T_C, 28 VDC V_{in}, 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	VDC
	NEG. AUX.				-14.70	-15.00	-15.30	
OUTPUT CURRENT ^{2, 3}		–	–	3.0	0	±0.5	0.80 ¹	A
	MAX TOTAL AUX.	–	–	–	–	–	1	
OUTPUT POWER ^{2, 3} V _{IN} = 19 TO 56 VDC		0	–	15	0	±7.5	11.25 ¹	W
	MAX TOTAL AUX	–	–	–	–	–	15	
OUTPUT RIPPLE	10 kHz - 20 MHz	–	–	200	–	–	200	mV p-p
LINE REGULATION V _{IN} = 19, 50 VDC	MAIN AND POS. AUX	–	5	25	–	–	25	mV
	NEG. AUX.	–	–	–	–	20	35	
LOAD REGULATION	MAIN AND POS. AUX	–	5	50	–	5	50	mV
	V _{IN} = 19, 50 VDC	–	–	100	–	–	120	
	NEG. AUX. ¹	–	–	–	–	–	500	
	V _{IN} = 19, 50 VDC ¹	–	–	–	–	–	600	
TOTAL REGULATION ¹ V _{OUT}	ALL CONDITIONS OF LINE, LOAD, AGING, TEMP AND RADIATION	4.7	–	5.3	±14.0	–	±16.0	VDC
CROSS REGULATION ^{1, 4, 5} T _C = 25°C	EFFECT ON NEGATIVE AUXILIARY	–	–	–	–	–	2.5	%
INPUT VOLTAGE	CONTINUOUS	19	28	56	–	–	–	VDC
	TRANSIENT 120 ms	0	–	80	–	–	–	V
INPUT CURRENT	NO LOAD	–	–	110	–	–	–	mA
	INHIBITED	–	–	50	–	–	–	
INPUT RIPPLE CURRENT ⁶	10 kHz - 10 MHz	–	10	150	–	–	–	mA p-p
EFFICIENCY ⁷		70	–	–	–	–	–	%
LOAD FAULT ^{8, 9}	POWER DISSIPATION	–	–	25	–	–	–	W
	RECOVERY ¹	–	–	35	–	–	35	ms
STEP LOAD RESPONSE ^{9, 10, 11}	TRANSIENT	–	–	±250	–	–	±350	mV pk
	RECOVERY	–	–	1	–	–	1	ms
STEP LINE RESPONSE ^{1, 8, 9}	19 - 50 - 19 V _{IN} TRANSIENT	–	–	±500	–	–	±750	mV pk
	RECOVERY	–	–	1.5	–	–	1.5	ms
START-UP ¹¹	DELAY NO LOAD AND FULL	–	–	25	–	–	20	ms
	OVERSHOOT	–	0	200	–	0	350	mV pk
CAPACITIVE LOAD ¹ T _C = 25°C	UNCONDITIONALLY STABLE, START-UP DELAY INCREASED	–	–	5000	–	–	1000	μF

Notes: See page 15

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

Electrical Characteristics: -55°C to +125°C Tc, 28 VDC Vin, 100% load, unless otherwise specified.

NOTES: TRIPLE OUTPUT MODELS

1. Guaranteed by design, not tested.

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 total current/power specified .

3. To maintain tight regulation over the full input voltage range a minimum load of 2% of full load should be used on all outputs.

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 is measured under the following conditions:

Condition 1: +P_{OUT} = 20 - 80%, /- P_{OUT} = 80 - 20%

Condition 2: - P_{OUT} = 20 - 80%, /+ P_{OUT} = 80 - 20%

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.

8. Maximum power dissipation when all outputs are shorted simultaneously.

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.

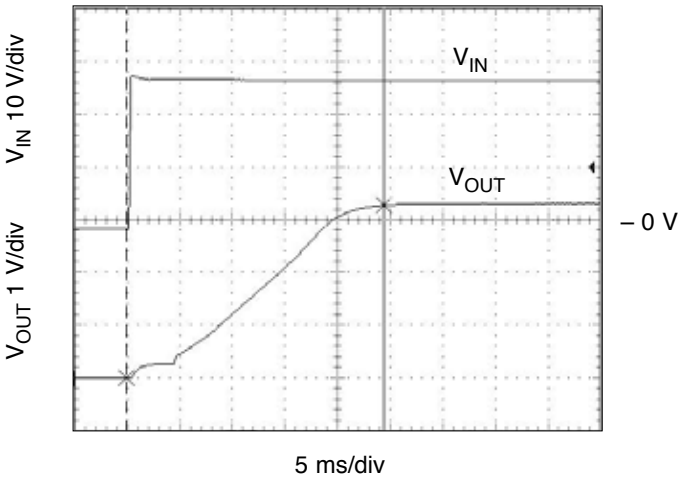
10. Transition time $\geq 10 \mu\text{s}$.

11. Half load to/from full load.

12. Measured from release of inhibit or input voltage step.

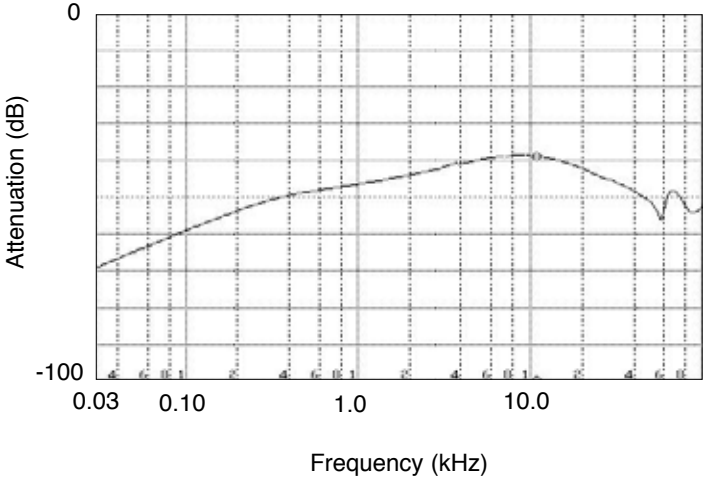
SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED



Representative of all models

FIGURE 7: Start-up delay SMRT2853R315T, Main V_{OUT} (3.3 V)



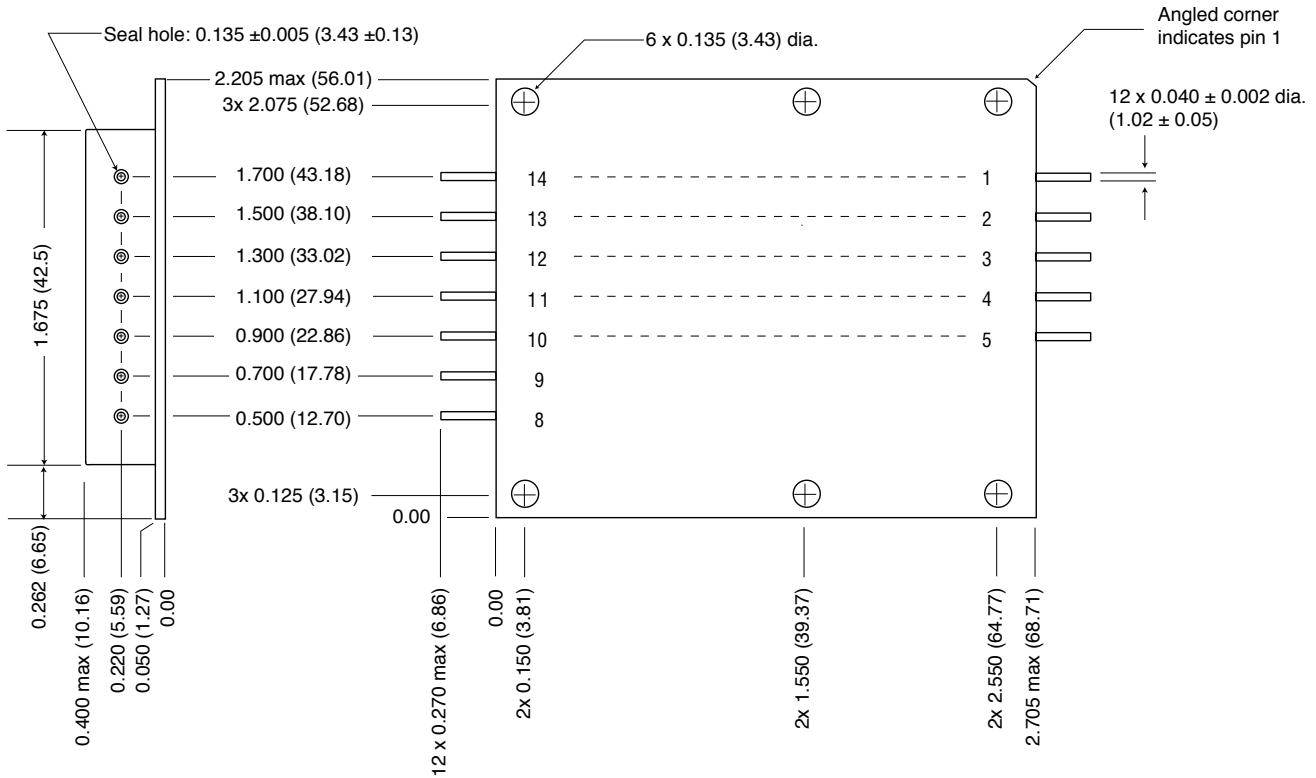
Representative of all models

FIGURE 8: Audio Rejection SMRT2805S

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

BOTTOM VIEW CASE S



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
Cover Kovar/Nickel
Pins #52 alloy/gold, ceramic seal

Case S, Rev C, 20091020
Please refer to the numerical dimensions for accuracy. All information is believed to be accurate, but no responsibility is assumed for errors or omissions. Interpoint reserves the right to make changes in products or specifications without notice.

FIGURE 9: CASE S

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

MIL-PRF-38534 ELEMENT EVALUATION

COMPONENT-LEVEL TEST PERFORMED	SPACE PROTOTYPE (O) ¹ NON-QML	/H CLASS H QML		/K CLASS K QML	
	M/S ^{2, 3}	M/S ²	P ³	M/S ²	P ³
Element Electrical	■	■	■	■	■
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				■	
C-SAM: Input capacitors only Add'l test, not req. by H or K			■		■

Notes:

1. Non-QML products may not meet all of the requirements of MIL-PRF-38534.
2. M/S = Active components (Microcircuit and Semiconductor Die)
3. P = Passive components, Class H and K element evaluation. Not applicable to Space Prototype ("O") element evaluation.

Definitions:

Element Evaluation: Component testing/screening per MIL-STD-883 as determined by MIL-PRF-38534

SEM: Scanning Electron Microscopy

C-SAM: C - Mode Scanning Acoustic Microscopy

SCREENING TABLE 1: ELEMENT EVALUATION

SMRT28 Single, Dual and Triple Space DC/DC Converters

28 VOLT INPUT – 35 WATT – SPACE QUALIFIED

CLASS H AND K, MIL-PRF-38534 ENVIRONMENTAL SCREENING AND RHA¹

TEST PERFORMED	NON-QML ²		QML ³			
	/OO	CLASS H		CLASS K		
		/HP	/HR	/KP	/KR	/KF
Non-destruct bond pull, Method 2023		■ ⁴	■ ⁴	■	■	■
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 (Qual 5000 g)	■	■	■	■	■	■
PIND, Test Method 2020, Cond. A		■ ⁴	■ ⁴	■	■	■
Pre burn-in test, Group A, Subgroups 1 and 4	■	■	■	■	■	■
Burn-in Method 1015, +125°C case, typical ⁵						
96 hours	■					
160 hours		■	■			
2 x 160 hours (includes mid-BI test)				■	■	■
Final Electrical Test, MIL-PRF-38534, Group A, Subgroups 1 through 6, -55°C, +25°C, +125°C case	■	■	■	■	■	■
Hermeticity Test						
Gross Leak, Method 1014, Cond. C	■	■	■	■	■	■
Fine Leak, Method 1014, Cond. A	■	■	■	■	■	■
Radiography, Method 2012				■	■	■
Post Radiography Electrical Test, +25°C case				■ ⁴	■ ⁴	■ ⁴
Final visual inspection, Method 2009	■	■	■	■	■	■
RHA P: 30 kRad(Si) total dose ⁶		■		■		
RHA R: 100 kRad(Si) total dose ⁶			■		■	
RHA F: 300 kRad(Si) total dose ⁶						■
SEE LET 85 MeV-cm ² /mg ⁷		■	■	■	■	■

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

- Notes:
1. Redmond site, Interpoint brand, has a DSCC approved Radiation Hardness Assurance plan. Our SMD products with RHA "P", "R" or "F" code met DSCC requirements.
 2. Space Prototypes are non-QML products and may not meet all of the requirements of MIL-PRF-38534. "O" in the RHA designator position in Interpoint model numbers indicates DSCC RHA "-" defined as no RHA.
 3. All processes are QML qualified and performed by certified operators.
 4. Not required by DSCC but performed to assure product quality.
 5. Burn-in temperature designed to bring the case temperature to +125°C minimum.
 6. High dose rate testing.
 7. No upset at the pins.

SCREENING TABLE 2: ENVIRONMENTAL SCREENING