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european space research and technology centre

Components Division
Radiation Analysis Group

RA 074

Radiation Analysis of

DC - DC Converters

for

Technology Research Project

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General Part Description					
Project.....	Technology Research			**Lib. ref**.....	23-01
Family.....	Hybrid			**Group**.....	DC - DC Converter
Part Type....	Interpoint MSR series				
Spec. No.....	Interpoint data sheet (see appendix)	**Issue.**	August 1990	**Rev**.....	
Amended by..		**Issue.**		**Rev**.....	
Proc. level...				**Procured by.**	
Manufacturer.	Interpoint (USA)			**Package**.....	Metal hermetic 18-pin DIP
Lot No.....	unknown			**Date Code**...	
Serial No.....	Interpoint: 0045, 0008, 0047, 0076			**Quantity**.....	4 (in total)

General Part Description					
Project.....	Technology Research			**Lib. ref**.....	23-01
Family.....	Hybrid			**Group**.....	DC - DC Converter
Part Type....	PICO AV series				
Spec. No.....	PICO data sheet (see appendix)	**Issue.**	unknown	**Rev**.....	
Amended by..		**Issue.**		**Rev**.....	
Proc. level...				**Procured by.**	
Manufacturer.	PICO Electronics (USA)			**Package**.....	Miniature encapsulated
Lot No.....	unknown			**Date Code**...	
Serial No.....	unknown			**Quantity**.....	2 (in total)

Aims and Objectives.

The aim of the test was to investigate the electrical performance, particularly the converters efficiency, under total dose radiation conditions. The objective was to design and build biasing circuitry, expose the samples to ionising radiation and perform dc characterisation at various total doses.

Radiation Source and Dosimetry.

The 1460 Curie Co-60 facility at ESTEC was used for the irradiation of the samples (1.25MeV gamma radiation). The dose rate can be varied by placing the samples at different distances from the Co-60 pellets.
For the tests performed a doserate of approximately 6 krad/h was chosen.

The dose was monitored by a Ionex Dosemaster equipped with a 0.6 cc ion probe placed at the same distance from the Co-60 pellets as the irradiated samples. The Ionex Dosemaster is calibrated to +/- 0.5%.
The time schedule for irradiation can be seen on the pages with the detailed test results.
Irradiation was carried out at room temperature.

Electrical Measurements

The electrical measurements were performed instantaneously at ESTEC using a FLUKE 8010A digital multimeter. Test parameters were:

- Input voltage
- Input current
- Output voltage
- Output current

Biasing circuitry

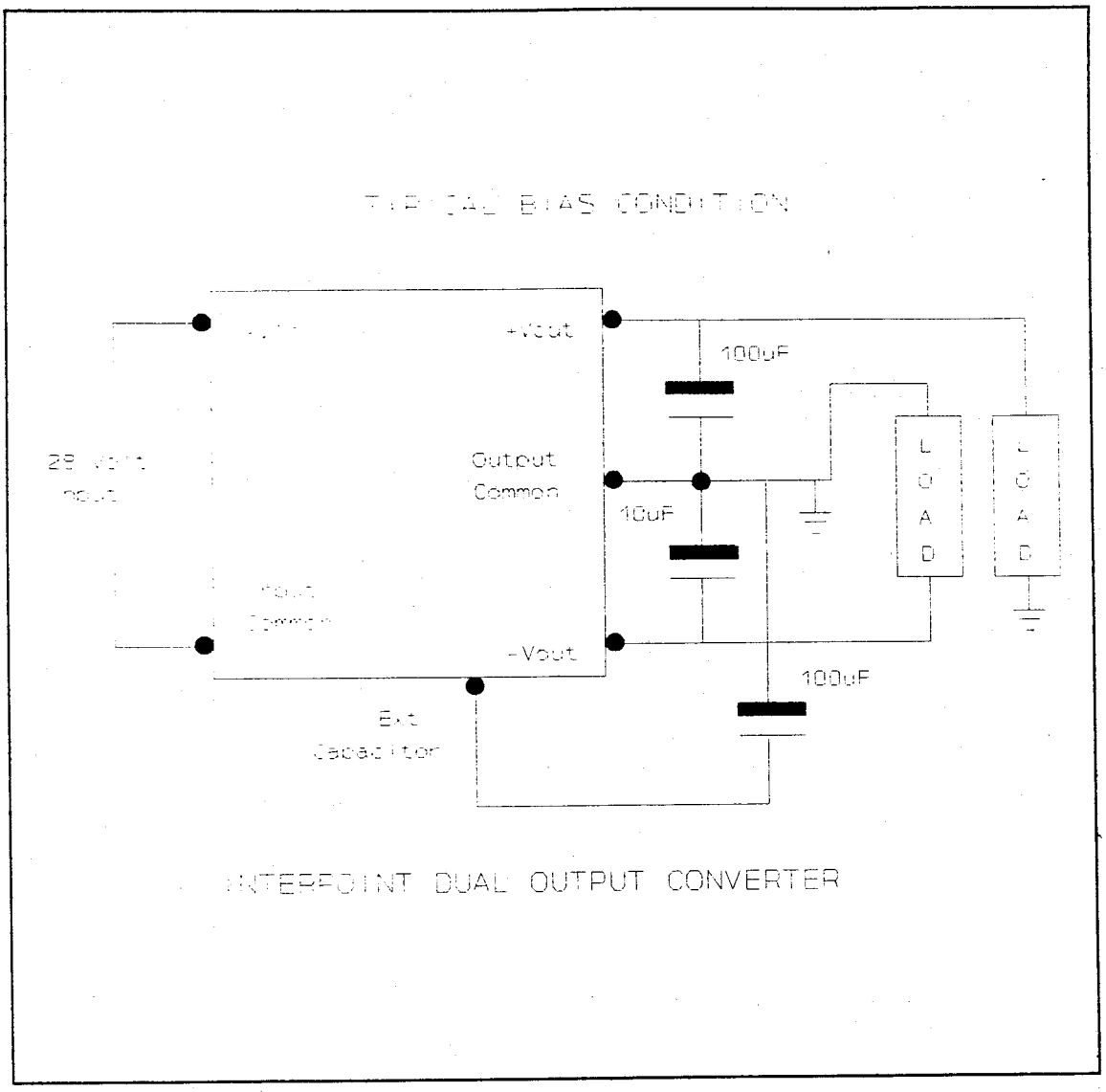
As no information was available as to which bias condition is worst case, different loads as described below were used for different INTERPOINT converters.
The two PICO converters were loaded identically.
Bias was on all the time except for the annealing periods at 38 krad and 80 krad.

4 Interpoint devices were tested with the following nominal total loadings:
2805S at 40% of maximum allowable load
2805S at 80% " "
2815D at 45% " "
2812T at 65% " "

2 Pico devices were tested with the following nominal total loadings:
28AV500 at 78% of maximum allowable load
5AV200 at 78% " "

Measurements were taken immediately after each dose step was reached. Input and output currents and voltages were measured and the subsequent efficiencies of the devices calculated. Detailed values for each dose step are appended to this report together with a graph of normalised efficiencies against total dose.

A typical bias circuit for an INTERPOINT device is shown below:



General Remarks.

Radiation testing was performed on 4 Interpoint MSR series dc-to-dc converters (2 x 2805S, 1 x 2812T, 1 x 2815D) and 2 Pico dc-to-dc converters (1 x 28AV500, 1 x 5AV200). Electrical measurements were taken at total dose steps of 5,10,15,20,30,38,80,and 105Krads. After 38 and 80Krads the samples were annealed for 14 hours at room temperature.

During the course of setting up the various operating conditions prior to irradiation, it became clear that the Interpoint devices were very sensitive :

- unbalanced loading of the dual devices has to be avoided. The main (positive) output must always have a minimum loading of about 20% of the total output. If this condition is neglected, even for a few seconds, then the device will be over stressed and fail.

- mechanical switching : in order to determine the inrush current of the devices a mechanical switch was used on the supply input side. Switching the devices in this manner also caused three converters to be destroyed. The mechanism for this failure is not understood but the unavoidable switch bounce with such a method must be suspect. As a result, this method for checking the inrush current was abandoned. The devices do in fact have an output enable but this was not used as the aim was to emulate the application circuit which uses supply switching.

- The manufacturers data sheet claims that the devices are short-circuit protected, but an accidental short circuit of 1 second duration on an output after 80Krads caused the device (2805S) to fail.

- The Pico devices, having only a single output, did not pose any problems. These devices were not switched and care was taken that the devices were never powered up without output loads being present.

Test Results.

In general no major changes in performance were observed for any of the devices up to the maximum total dose of 105Krads.

Input current - virtually unchanged with the exception of a small increase for the Interpoint 2812T at 105Krads.

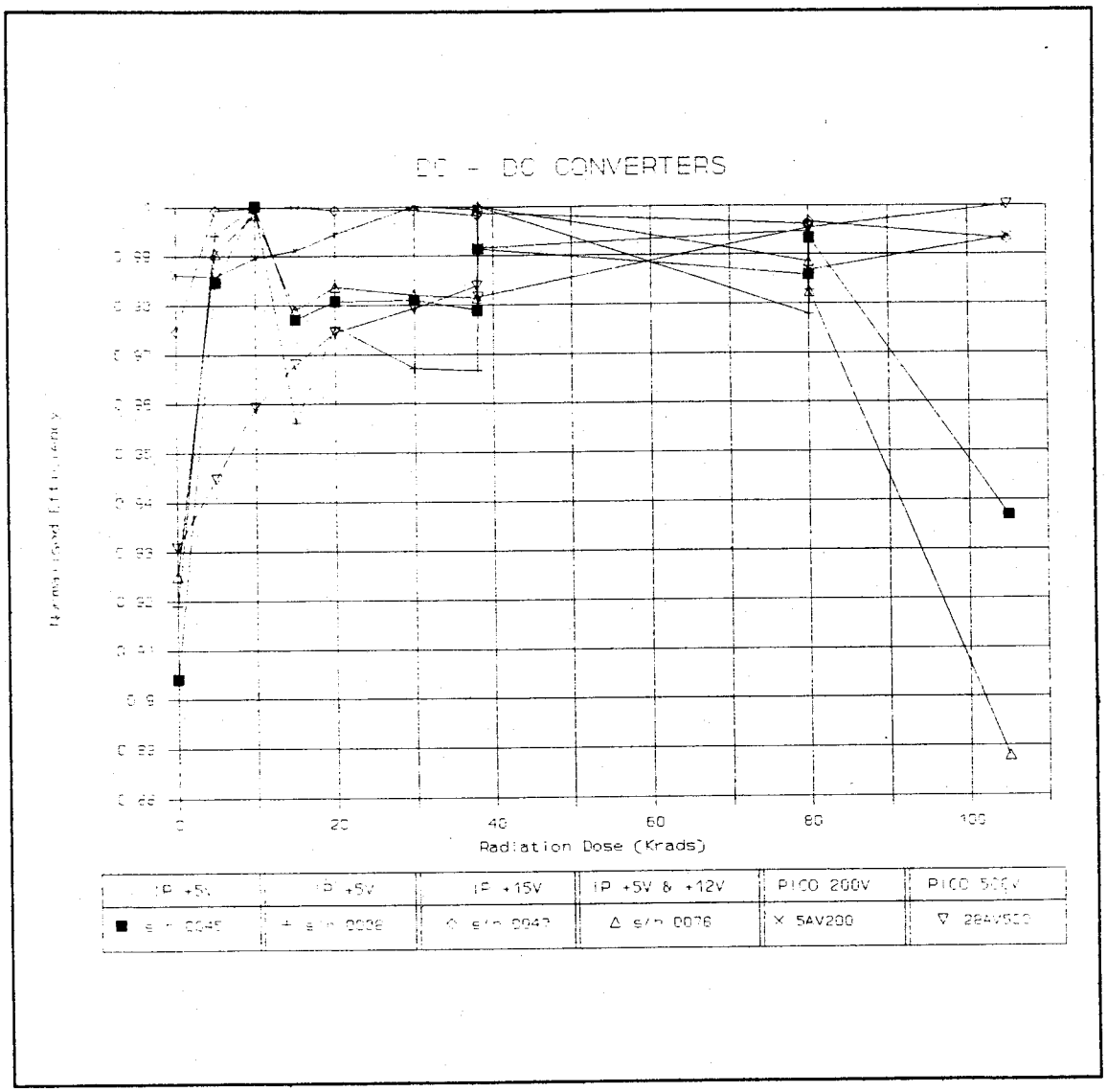
Output voltage - Interpoint devices very stable; remaining within manufacturers specification. Slight decrease for the Pico devices, particularly the 5AV200.

Output current - overall very stable, although minor variations were observed during testing. Tendency for output current to decrease at higher total doses.

* It should be noted that the somewhat confusing pre-irradiation values are probably due to the devices not reaching their steady-state operating temperatures when the measurements were taken.

Conclusion.

The majority of the devices exhibited a change in efficiency of less than 5% up to the test limit at 105Krads, and no change was greater than 12%. Excluding the 0Krad measurements, all devices were within a 5% change up to 80Krads. As the output voltages remained very stable no problems can be seen for applications up to a total dose of 80Krads.



Normalised efficiencies versus total dose of the tested converters.
Caution should be taken when interpreting the measurement at 0 krads as the converters were not yet at normal operating temperature then.

The following pages show the detailed numerical test results.

DC → DC CONVERTERS

DC - DC Converters :			17/9/91	Time :09:00			
Vin1 : 28.0			Dose : 0Krad				
Vin2 : 5.00			Doserate : -				
Interpoint			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	98.6	282	4.99	2.76	1.41	51.0
+ 5 V	660 mA	S/N 0008	180	535	4.98	5.04	2.66	52.8
Interpoint			Dual O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.4	58.3	14.97	2.67	0.87	32.7
-15 V	60 mA		95.4	60.3	15.05	2.67	0.91	34.0
Interpoint			Triple O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		117.5	15.57	12.06	3.29	0.19	5.71
-12 V	16 mA	SN 0076	117.5	16.04	12.05	3.29	0.19	5.87
+ 5 V	380 mA		117.5	330	5.00	3.29	1.65	50.15
PICO			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			258	4.67	204	1.29	0.95	73.85
28AV500			47.1	1.54	506	1.32	0.78	60.0

DC → DC CONVERTERS

DC - DC Converters :			17/9/91	Time :10:10
Vin1 : 28.0			Dose : 5Krad	
Vin2 : 4.99			Doserate : 6Krad/hr	

Interpoint			Single O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	97.6	304	4.99	2.73	1.52	55.5
+ 5 V	660 mA	S/N 0008	179.5	576	4.99	5.03	2.87	57.2

Interpoint			Dual O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.0	59.4	14.97	2.66	0.889	68.3
-15 V	60 mA		95.0	61.7	15.05	2.66	0.929	68.3

Interpoint			Triple O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		116.7	15.57	12.06	3.27	0.188	66.1
-12 V	16 mA	SN 0076	116.7	16.22	12.05	3.27	0.195	66.1
+ 5 V	380 mA		116.7	354	5.02	3.27	1.777	66.1

PICO	Single O/P Devices					
	I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200	257	4.65	204	1.282	0.949	73.96
28AV500	46.2	1.53	507	1.29	0.776	59.96

DC → DC CONVERTERS

DC - DC Converters :			17/9/91				Time :11:15	
Vin1 : 28.0			Dose : 10Krad					
Vin2 : 4.99			Doserate : 6Krad/hr					
Interpoint			Single O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	98.3	311	4.99	2.75	1.55	56.4
+ 5 V	660 mA	S/N 0008	181.5	587	4.98	5.08	2.92	57.5
Interpoint			Dual O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.1	59.8	14.97	2.67	0.895	68.36
-15 V	60 mA		95.1	61.4	15.07	2.66	0.925	68.36
Interpoint			Triple O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		117.4	15.67	12.06	3.29	0.189	66.6
-12 V	16 mA	SN 0076	117.4	16.11	12.05	3.29	0.194	66.6
+ 5 V	380 mA		117.4	360	5.02	3.29	1.807	66.6
PICO			Single O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			256	4.65	204	1.28	0.949	74.2
28AV500			45.5	1.53	507	1.27	0.776	60.9

DC → DC CONVERTERS

DC - DC Converters :			17/9/91	Time :12:30			
Vin1 : 28.0			Dose : 15Krad				
Vin2 : 4.99			Doserate : 6Krad/hr				
Interpoint			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	99.0	306	4.99	2.77	1.53	55.1
+ 5 V	660 mA	S/N 0008	184.0	569	4.98	5.15	2.83	55.0
Interpoint			Dual O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.1	59.7	14.97	2.66	0.89	68.4
-15 V	60 mA		95.1	61.5	15.08	2.66	0.93	68.4
Interpoint			Triple O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		117.6	15.64	12.06	3.29	0.19	65.3
-12 V	16 mA	SN 0076	117.6	16.13	12.06	3.29	0.19	65.3
+ 5 V	380 mA		117.6	353	5.01	3.29	1.77	65.3
PICO			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			255	4.65	203.5	1.27	0.95	74.4
28AV500			45.0	1.53	506	1.26	0.77	61.4

DC → DC CONVERTERS

DC - DC Converters :			17/9/91			Time :13:50	
Vin1 : 28.0			Dose : 20Krad				
Vin2 : 4.99			Doserate : 6Krad/hr				
Interpoint			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	98.3	305	4.99	2.75	1.52	55.3
+ 5 V	660 mA	S/N 0008	181.9	574	4.98	5.09	2.86	56.1
Interpoint			Dual O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.1	59.5	14.97	2.66	0.89	68.3
-15 V	60 mA		95.1	61.6	15.08	2.66	0.93	68.3
Interpoint			Triple O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		117.5	15.59	12.06	3.29	0.19	65.6
-12 V	16 mA	SN 0076	117.5	16.18	12.06	3.29	0.195	65.6
+ 5 V	380 mA		117.5	354	5.02	3.29	1.77	65.6
PICO			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			253	4.64	203	1.26	0.94	74.6
28AV500			44.7	1.53	506	1.25	0.77	61.8

DC → DC CONVERTERS

DC - DC Converters :			17/9/91			Time :15:35	
Vin1 : 28.0			Dose : 30Krad				
Vin2 : 4.99			Doserate : 6Krad/hr				
Interpoint			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	98.6	306	4.99	2.76	1.53	55.3
+ 5 V	660 mA	S/N 0008	182.5	572	4.97	5.11	2.84	55.6
Interpoint			Dual O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.1	59.7	14.97	2.66	0.89	68.3
-15 V	60 mA		95.1	61.4	15.08	2.66	0.93	68.3
Interpoint			Triple O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		117.7	15.64	12.05	3.29	0.19	65.5
-12 V	16 mA	SN 0076	117.7	16.13	12.06	3.29	0.195	65.5
+ 5 V	380 mA		117.7	354	5.02	3.29	1.77	65.5
PICO			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			251	4.63	203	1.25	0.94	75.0
28AV500			44.1	1.52	505	1.23	0.77	62.2

DC → DC CONVERTERS

DC - DC Converters :			17/9/91				Time :17:00
Vin1 : 28.0			Dose : 38Krad				
Vin2 : 4.99			Doserate : 6Krad/hr				
Interpoint			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	98.3	305	4.98	2.75	1.52	55.2
+ 5 V	660 mA	S/N 0008	182.6	572	4.97	5.11	2.84	55.6
Interpoint			Dual O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.2	59.6	14.97	2.66	0.892	68.3
-15 V	60 mA		95.2	61.5	15.08	2.66	0.927	68.3
Interpoint			Triple O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		117.5	15.59	12.05	3.29	0.188	65.5
-12 V	16 mA	SN 0076	117.5	16.18	12.06	3.29	0.195	65.5
+ 5 V	380 mA		117.5	353	5.02	3.29	1.772	65.5
PICO			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			250	4.62	202.5	1.25	0.936	75.0
28AV500			43.9	1.52	505	1.23	0.768	62.4

DC → DC CONVERTERS

DC - DC Converters :			18/9/91			Time :09:15	
Vin1 : 28.0			Dose : 38Krad+16h annealing				
Vin2 : 5.00			Doserate : 6Krad/hr				
Interpoint			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	97.7	307	4.98	2.736	1.529	55.9
+ 5 V	660 mA	S/N 0008	180.8	586	4.97	5.062	2.912	57.5
Interpoint			Dual O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.2	59.7	14.97	2.66	0.89	68.3
-15 V	60 mA		95.2	61.5	15.07	2.66	0.93	68.3
Interpoint			Triple O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		117.4	15.80	12.05	3.29	0.19	66.75
-12 V	16 mA	SN 0076	117.4	16.30	12.06	3.29	0.20	66.75
+ 5 V	380 mA		117.4	360	5.02	3.29	1.81	66.75
PICO			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			252	4.62	202.5	1.26	0.94	74.25
28AV500			44.0	1.52	505	1.23	0.77	62.3

DC → DC Converters

DC - DC Converters :			18/9/91			Time :16:40	
Vin1 : 28.0			Dose : 80Krad				
Vin2 : 4.99			Doserate : 6Krad/hr				
Interpoint			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	97.4	305	4.97	2.728	1.516	55.6
+ 5 V	660 mA	S/N 0008	181.4	576	4.96	5.079	2.857	56.3
Interpoint			Dual O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.4	59.6	14.97	2.67	0.892	68.1
-15 V	60 mA		95.4	61.5	15.08	2.67	0.927	68.1
Interpoint			Triple O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		118.3	15.65	12.05	3.312	0.188	66.0
-12 V	16 mA	SN 0076	118.3	16.13	12.06	3.312	0.195	66.0
+ 5 V	380 mA		118.3	359	5.02	3.312	1.802	66.0
PICO			Single O/P Devices				
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			246	4.57	200.5	1.23	0.916	74.6
28AV500			43.3	1.52	504	1.21	0.766	63.2

DC → DC Converters

DC - DC Converters :			19/9/91				Time :10:10	
Vin1 : 28.0			Dose : 80Krad+16h annealing					
Vin2 : 5.00			Doserate : 6Krad/hr					
Interpoint			Single O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	97.3	307	4.97	2.728	1.53	56.0
+ 5 V	660 mA	S/N 0008	180.8	577	4.96	5.06	2.857	56.5
Interpoint			Dual O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.4	59.6	14.97	2.67	0.892	68.15
-15 V	60 mA		95.4	61.6	15.07	2.67	0.927	68.15
Interpoint			Triple O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		118.2	15.56	12.05	3.312	0.187	65.6
-12 V	16 mA	SN 0076	118.2	16.21	12.06	3.312	0.195	65.6
+ 5 V	380 mA		118.2	356	5.02	3.312	1.787	65.6
PICO			Single O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			248	4.57	200.5	1.24	0.916	73.9
28AV500			43.3	1.52	504	1.21	0.766	63.2

* +5 V (660mA) s/n 0008 killed at 80Krad by short circuit during measurements.

DC → DC Converters

DC - DC Converters :			19/9/91			Time :14:20
Vin1 : 28.0			Dose : 104.25Krad			
Vin2 : 4.99			Doserate : 6Krad/hr			
Interpoint			Single O/P Devices			
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+ 5 V	320 mA	S/N 0045	98.6	294	4.96	2.76	1.46	52.8
+ 5 V	660 mA	S/N 0008						
Interpoint			Dual O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+15 V	100 mA	S/N 2447	95.7	59.7	14.97	2.68	0.89	67.9
-15 V	60 mA		95.7	61.4	15.08	2.68	0.93	67.9
Interpoint			Triple O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
+12 V	16 mA		126.5	15.62	12.03	3.54	0.19	59.3
-12 V	16 mA	SN 0076	126.5	16.16	12.02	3.54	0.19	59.3
+ 5 V	380 mA		126.5	342	5.02	3.54	1.72	59.3
PICO			Single O/P Devices					
			I_{IN}	I_{OUT}	V_{OUT}	P_{IN}	P_{OUT}	% Eff.
5AV200			244	4.55	199.5	1.22	0.91	74.5
28AV500			43.1	1.52	504	1.21	0.766	63.5

SUPPLEMENT

Radiation Testing of Interpoint MTO2812T DC-DC converter

A supplement to document RA074 (Radiation analysis of DC-DC converters for Technology Research Programme) from Radiation Analysis Group (mailcode QCA), Components Division, ESTEC.

The Interpoint MTO series DC-DC converters are triple output devices (for details see attached specification sheets) differing from the Interpoint MSR series as follows;

1. The maximum output power is 15 Watts compared to the 4W output of the MSR (3.2 W for the triple output devices).
2. The operating frequency of the MTO is 250KHz, that of the MSR 80KHz.
3. MTO devices convert power by pulse width modulation as opposed to the flyback energy storage regulation used by the MSR type.
4. The efficiencies at half-power are 80% for the MTO, 75% for the MSR.
5. The MTO requires no external capacitors, and has a flange for mounting.

An Interpoint MTO2812T was tested under continuous irradiation in the 1460 Curie Co-60 facility at ESTEC at a dose rate of about 5Krad per hour, monitored by an Ionex Dosemaster. It was continuously biased at around 28V, and loaded to give 54% of maximum current at the 5V output and 65% of maximum current at the +/- 12V outputs. The ammeter monitoring the current from the 5V output constituted part of the load, and was never removed.

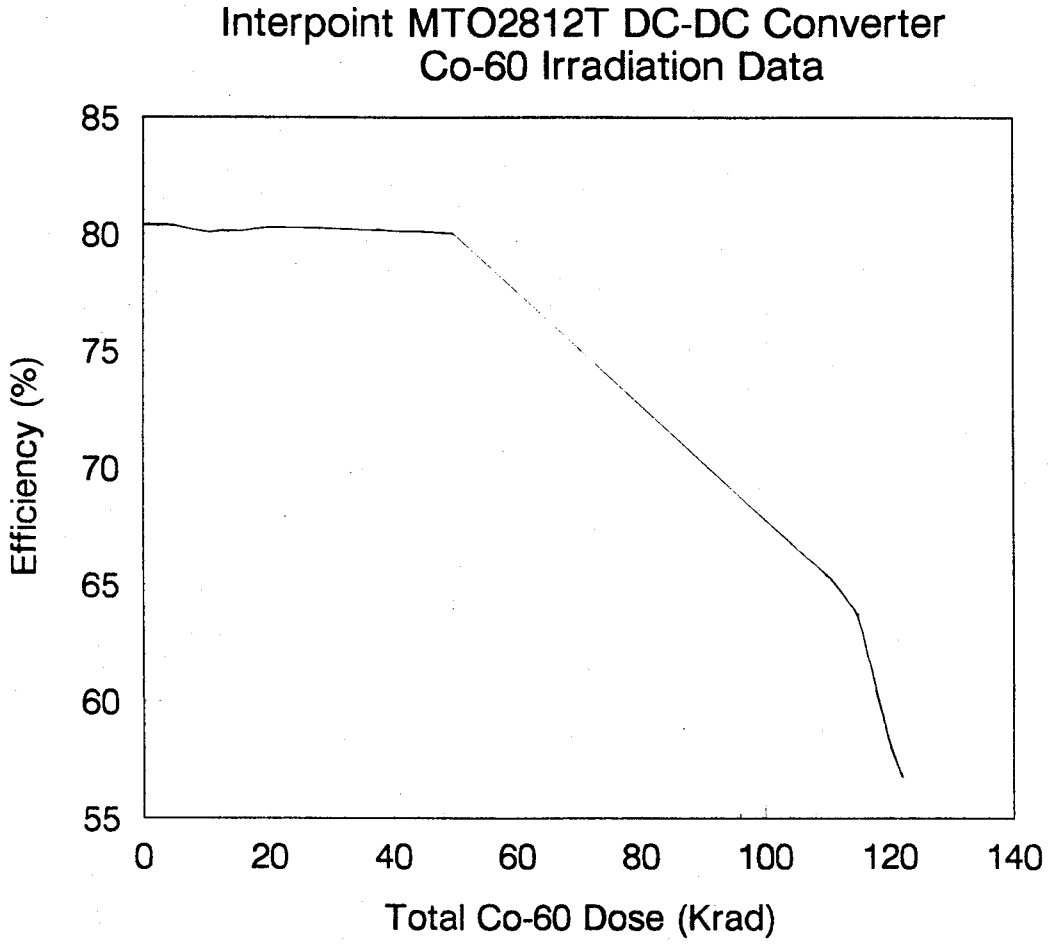
Irradiation was stopped at 122Krad, and the device was left to anneal under power for 2.5 hours.

Results

Tabulated and graphical results are attached. To summarize;

1. **No significant change in any parameter was seen up to 50Krad.**
2. At about 107 Krad, efficiency had dropped to about 66%.
3. Over this dose, a continuous decrease in efficiency was seen.
4. **The only parameter that changed significantly was the input current drawn ie. power conversion appeared to be satisfactory throughout.**

A closer examination of the change in efficiency between 108Krad and 122Krad, as measured by the current drawn, showed that the rate of change is by no means uniform. The annealing, similarly measured, is approximately linear for 90 minutes, after which little change was observed.



Normalised efficiency vs. total dose of MTO2812T

Tabulated test results for Interpoint MTO2812T DC-DC converter

INTERPOINT MTO 2812T CONVERTER – IRRADIATION DATA

		pre-	Total Dose : constant load : e 84.5 Rad/min																Anneal time			
Dose (krad)		0	0.3	1.0	5.0	10.	15.	20.	25.	30.	40.	50.	106.7	110.0	115.0	120.0	122.0		1 min	1 hour	1.5 hr	24 hr
Input	Current @ 28.26V mA	381	379.4	379.7	380	379.7	380.0	379.8	379.8	379.3	380.0	380.0	458.7	471.5	476.5	520.3	534.6		535.0	512.0	488.5	486.5
	Power (W)	10.75	10.72	10.72	10.73	10.73	10.74	10.74	10.74	10.72	10.74	10.74	12.96	13.32	13.47	14.70	15.11		15.12	14.84	13.815	13.78
5V Output	Voltage (V)	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.00	5.00	5.00	4.99	4.99		4.99	4.99	5.00	5.00
	Current (mA)	1093	1087	1087	1087	1086	1086	1087	1087	1087	1087	1087	1085	1085	1084	1085	1085		1086	1085	1084	1086
	Power (W)	5.476	5.446	5.446	5.446	5.441	5.441	5.446	5.446	5.445	5.444	5.443	5.421	5.421	5.416	5.416	5.414		5.420	5.417	5.416	5.427
+12V Output	Voltage (V)	12.04	12.03	12.03	12.03	12.03	12.03	12.03	12.03	12.03	12.03	12.03	12.04	12.04	12.04	12.03	12.02		12.02	12.01	12.04	12.04
	Current (mA)	130.5	130.5	130.4	130.5	129.9	130.6	130.6	130.5	130.5	130.5	130.5	130.4	130.4	130.0	130.5	130.4		130.2	129.6	129.8	130.6
	Power (W)	1.571	1.570	1.569	1.570	1.563	1.571	1.571	1.570	1.570	1.570	1.570	1.570	1.569	1.565	1.569	1.567		1.565	1.556	1.563	1.572
-12V Output	Voltage (V)	-12.05	-12.04	-12.05	-12.05	-12.03	-12.05	-12.05	-12.05	-12.05	-12.05	-12.05	-12.06	-12.05	-12.05	-12.04	-12.04		-12.04	-12.05	-12.06	-12.06
	Current (mA)	132.9	132.7	132.8	133	131.8	132.2	132.7	133.3	131.7	132.6	131.5	131.6	133.2	132.9	131.8	132.8		133.0	133.4	132.5	132.5
	Power (W)	1.601	1.598	1.600	1.603	1.588	1.593	1.599	1.606	1.586	1.597	1.584	1.586	1.605	1.602	1.587	1.598		1.601	1.607	1.597	1.597
Total Output Power (W)		8.642	8.614	8.615	8.619	8.592	8.605	8.616	8.622	8.601	8.611	8.597	8.577	8.595	8.583	8.572	8.579		8.586	8.64	8.576	8.596
Efficiency (%)		80.4	80.35	80.36	80.33	80.07	80.12	80.26	80.27	80.21	80.15	80.0	66.97	65.49	63.72	58.3	56.79		56.65	59.65	62.08	62.48
Normalised Fo 0.36rad		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.82	0.81	0.79	0.73	0.71		0.71	0.74	0.77	0.78

APPENDIX A

Manufacturer's data sheets for INTERPOINT MSR series DC-DC converters

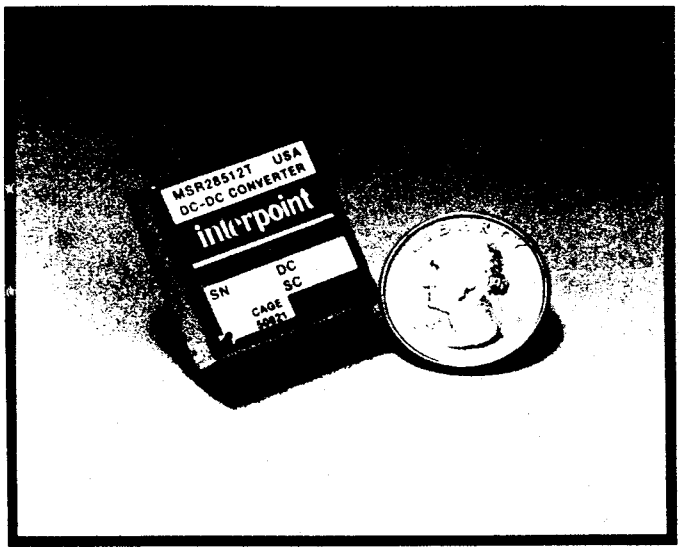
Manufacturer's data sheet for PICO AV series DC-DC converters

Manufacturer's data sheets for INTERPOINT MTO series DC-DC converters

interpoint

MSR SERIES DC-DC CONVERTERS

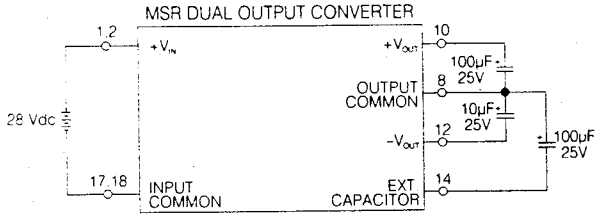
10301 Willows Road P.O. Box 97005 Redmond, WA 98073-9705 TEL: (206) 882-3100 TEL: (800) 822-8782 FAX: (206) 882-1990



- **Up to 4 watts output power**
- **16 to 32 Vdc input range**
- **Up to 75% efficiency**
- **Single, dual, and triple outputs**
- **–55°C to +85°C operation**
- **500 Vdc, 100 megohm isolation**
- **Short-circuit protection**
- **Optional environmental screening**
- **Short-term operation to 40 Vdc**

The MSR series dc-dc converters offer the high efficiencies associated with switching regulators, yet have full isolation of input and output grounds. The units are built using thick-film hybrid technology and are sealed in metal packages for military, aerospace, and other high-reliability applications. Unscreened models are solder sealed and are guaranteed to pass a gross leak test (maximum leak rate of 1×10^{-3} atm.-cc/sec.). Environmentally screened models are hermetically sealed with solder and are screened as described on the reverse. Custom versions, screened per customer specification control drawings, are also available.

The MSR series devices are flyback energy storage switching regulators, operating at a frequency of about 80 kHz. Isolation is achieved through the use of a transformer in the forward power circuit and an opto-coupler in the feedback/control loop. Models are available with single 5 volt, dual 12 or 15 volt, or triple (+5 and either ±12 or ±15) outputs with an input voltage range of 16.0 to 32.0 Vdc. Operation to 40 Vdc, at reduced efficiency, is permissible for short periods of time. Output power of up to 4 watts is available from the dual output models for either balanced or unbalanced loads; however, at least 25% of the total load should be on the positive output. The single output device can provide 3.5 watts, and the triple output can supply up to 3.2 watts. The high efficiency is almost constant over the entire input voltage range and from approximately 25% of full load to full load. This makes the unit ideal for either battery or aircraft power applications.



EXTERNAL CAPACITOR CONNECTION DIAGRAM – MSR DUAL OUTPUT MODELS

Figure 1

A TTL compatible inhibit is provided to allow power shutdown and startup from a logic input. An open circuit on the inhibit terminal (pin 15) gives normal operation, and a TTL low level shuts down the converter. Input current in the shutdown mode will be less than 5 milliamps. Current limiting is provided on each output, for indefinite short circuit protection.

Due to the high efficiency, heat sinking requirements are minimized, but due consideration should be given to removing self-generated heat when operating these devices at maximum ratings. To increase dissipation, heat conducting material (PCB, copper sheet, heat sink, etc.) should be brought into contact with the converter's baseplate. The converter can be operated at full load at a case temperature of 85°C, with the output power derated linearly to zero at 115°C.

External capacitors ARE REQUIRED on the outputs. Operating the unit without external capacitors will result in damage to the internal circuitry. Minimum recommended capacitor values are given below. Note that low ESR types (solid tantalum is the best) are required for optimum performance. The specifications on the reverse side of this data sheet are based on the use of high-quality solid tantalums. Operation with different types of capacitors will seriously affect performance.

MODEL	REQUIRED CONNECTION	MINIMUM CAPACITOR VALUE[1]
MSR2805S (SINGLE OUTPUT)	POSITIVE OUTPUT (12 AND 13) TO OUTPUT COMMON (8 AND 9)	220µF, 10V
MSR2812D[2], MSR2815D (DUAL OUTPUTS)	POSITIVE OUTPUT (10) TO OUTPUT COMMON (8)	100µF, 25V
	EXTERNAL CAPACITOR (14) TO OUTPUT COMMON (8)[3]	100µF, 25V
	NEGATIVE OUTPUT (12) TO OUTPUT COMMON (8)	10µF, 25V
MSR28512T, MSR28515T (TRIPLE OUTPUTS)	POSITIVE 5V OUTPUT (9) TO OUTPUT COMMON (6 OR 7)	220µF, 10V

1 Capacitors should be high quality, low ESR components — solid tantalum is recommended.
2 See Figure 1 for connection diagram for dual output models.
3 Place positive side of capacitor toward pin 8.

EXTERNAL CAPACITOR REQUIREMENTS — MSR MODELS

Table 1

CAUTION: Operation without external capacitors will result in permanent damage to converter.

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MSR SERIES DC-DC CONVERTERS

10301 Willows Road P.O. Box 97005 Redmond, WA 98073-9705 TEL: (206) 882-3100 TEL: (800) 822-8782 FAX: (206) 882-1990

OPERATING FREQUENCY: approx. 80 kHz
I/O ISOLATION: 100 megohm min. at 500 Vdc
I/O CAPACITANCE: 60 pF (typical)

OPERATING TEMPERATURE: -55°C to +85°C (case)
STORAGE TEMPERATURE: -55°C to +125°C
WEIGHT: 20 grams (max.)

PARAMETER	CONDITIONS	MSR2805S			MSR2812D			MSR2815D			MSR28512T			MSR28515T			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
INPUT VOLTAGE	T_C = -55°C TO +85°C	16	—	32	16	—	32	16	—	32	16	—	32	16	—	32	Vdc
INPUT CURRENT	NO LOAD	—	7	10	—	10	15	—	10	15	—	10	20	—	10	20	mA
OUTPUT VOLTAGE	P_O = 2W MAIN $+I_O = -I_O$ DUAL	4.90 —	5.0 —	5.10 —	— ±11.88	— ±12.0	— ±12.12	— ±14.85	— ±15.0	— ±15.15	4.9 ±11.5	5.0 ±12.0	5.1 ±12.5	4.9 ±14.5	5.0 ±15.0	5.1 ±15.5	Vdc
OUTPUT CURRENT	V_{IN} = 16 MAIN TO 32 Vdc DUAL	— —	— —	700 —	— —	— —	— ±167	— —	— —	— ±133	10.0[1] —	— —	400 ±50.0	10.0[1] —	— —	400 ±40.0	mA
OUTPUT POWER[2]	T_C = -55°C TO +85°C	—	—	3.5	—	—	4.0	—	—	4.0	—	—	3.2	—	—	3.2	watts
EFFICIENCY	FULL LOAD	68.0	72.0	—	70.0	75.0	—	70.0	75.0	—	68.0	70.0	—	68.0	70.0	—	%
LINE REGULATION	P_O = 2W MAIN V_{IN} = 16-32 Vdc DUAL	— —	5 —	10 —	— —	— 10	— 20	— —	— 10	— 20	— —	5 3	10 6	— —	5 3	10 7.5	mV
LOAD REGULATION	MIN TO MAIN MAX LOAD DUAL	— —	25 —	50 —	— —	— 12	— 24	— —	— 12	— 24	— —	15 15	30 30	— —	15 12	30 24	mV
OUTPUT RIPPLE VOLTAGE[3]	FULL LOAD MAIN B.W. = 1 MHz DUAL	— —	75 —	150 —	— —	— 75	— 150	— —	— 75	— 150	— —	50 50	100 100	— —	50 50	100 100	mVp-p
OUTPUT VOLTAGE T.C.	T_C = -55°C TO +85°C	—	±.010	±.020	—	±.005	—	—	±.005	—	—	±.010	—	—	±.010	—	%/°C

[1] Minimum load required on main output for full power auxiliary operation.
[2] Derate output power linearly from 100% at +85°C to 0 at +115°C.
[3] External capacitors required (see Table 1 for specifications).

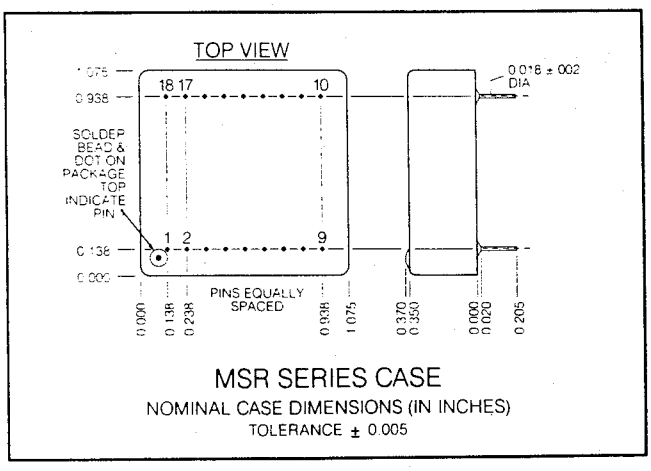
OPTIONAL ENVIRONMENTAL SCREENING

Environmental screening, referenced to MIL-STD-883, per Interpoint's in-house screening procedure, consists of the following:

- Pre-cap internal visual inspection: Per method 2017
- Stabilization bake: 24 hrs. at 125°C per method 1008 cond. B
- Temperature cycle: 10 times, -55°C to +125°C per method 1010
- Constant acceleration: 500 g per method 2001
- Fine leak: Per method 1014, cond. A
- Gross leak: Per method 1014, cond. C
- Burn-in: 96 hr. at 70°C ambient
- Final electrical test (25°C)
- Final external visual inspection: Per method 2009

To order optional screening, add suffix -/ES to model number. Example: MSR2812T/ES. On unscreened parts, the screening code block is marked with "00" or "01." On screened parts, the block is marked "ES" or "02."

METAL HERMETIC 18-PIN DIP PACKAGE



MSR SERIES CASE
NOMINAL CASE DIMENSIONS (IN INCHES)
TOLERANCE ± 0.005

DESIGNATION	2805S PIN	2812D 2815D PIN	28512T 28515T PIN
Positive input	1,2*	1,2*	1,2*
Case	4	4	4
Negative output (dual)	N/A	12	5
Output common	8,9*	8	—
Output common, main	—	—	6†
Output common, dual	—	—	7†
Positive output (dual and 2805S)	12,13*	10	8
+5 Vdc output	—	—	9
Input common	17,18*	17,18*	17,18*
External capacitor	N/A	14	N/A
Inhibit	15	15	15
OTHER PINS — NO CONNECTION			

† Pins 6 and 7 on triple output models are connected internally.
* Make external connection to both pins.

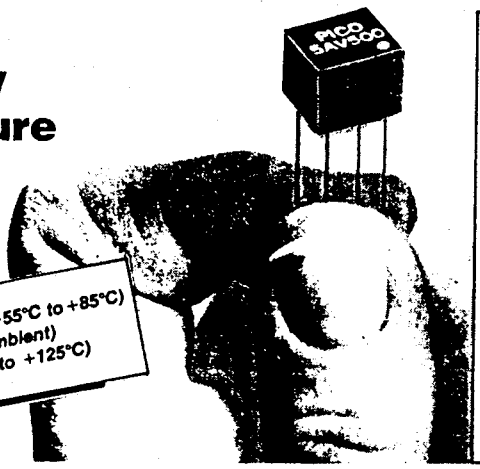
CASE AND COVER: Tin-plated Kovar; PINS: Gold-plated Kovar.

CAUTION: Heat from reflow or wave soldering may damage this part. Solder pins individually with heat application NOT exceeding 300°C for 10 seconds per pin.

SERIES AV

.400 ht. up to 500 VDC output

Hi Voltage
Hi Reliability
Ultra-Miniature
DC-DC
Converters



OPTIONS AVAILABLE
- Expanded operating temp (−55°C to +85°C)
- Stabilization Bake (125°C ambient)
- Temperature Cycle (−55°C to +125°C)
- Hi Temp, burn in

- 1.25 watt output at 70° ambient
- Ultra-miniature size 0.400" height, 4.0 grams weight, 0.1 cubic inches volume
- 4 input voltage ranges 5, 12, 24 and 28 VDC
- 100 megohm @ 1000 VDC input/output isolation
- MIL-STD 883 options available
- No heat sink or electrical derating required

This series of unregulated high voltage DC-DC converters are produced in an ultra-miniature encapsulated package. 36 different models are available. These single output isolated units will operate over the temperature range of −25° to +70°C with no heat sink or electrical derating. For military applications an operating temperature range −55°C to +85°C is available. An optional environmental screening package per MIL-STD-883 is also available.

TYPICAL CHARACTERISTICS:

Test conditions: 25°C ambient and input voltage at nominal value unless otherwise specified.

LINE REGULATION: OUTPUT IS DIRECTLY PROPORTIONAL TO THE INPUT

Input voltage range: ±10% all models

Output voltage tolerance at full load–nominal input: See chart for specific model. Please keep loaded to minimum of 10% at all times.

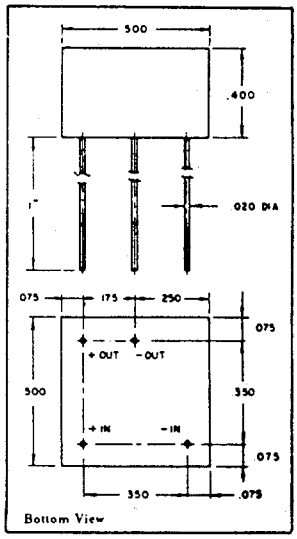
Converter frequency: 20 – 40 KHz

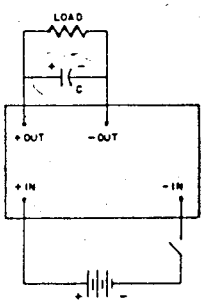
Output temperature coefficient: 0.02%/°C for all models

Operating temperature: −25°C to + 70°C ambient. No heat sink.

Storage temperature: −55°C to +125°C

Isolation: 100 megohms min. @ 1000V DC



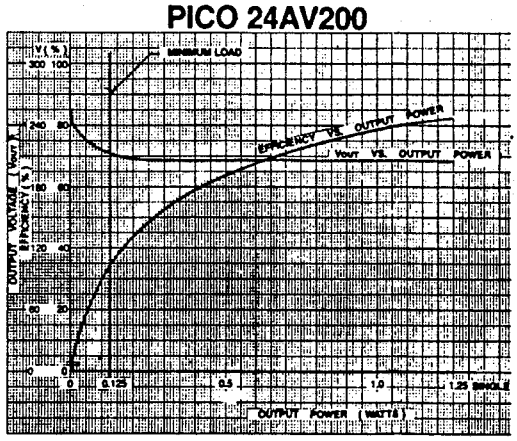


SERIE AV - SINGLE OUTPUT

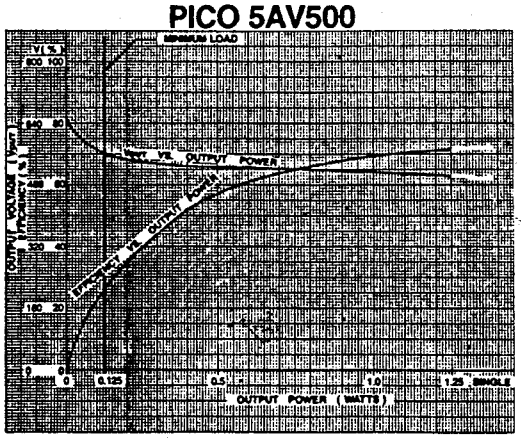
PICO PART NUMBER	INPUT VOLTAGE (V DC)	OUTPUT VOLTAGE (V DC)	MAX. LOAD CURRENT (mA)	MAX. OUTPUT POWER (watts)	EFF.● FULL LOAD TYPICAL (%)	CURRENT FULL LOAD TYPICAL (mA)	UTPUT VOLTAGE RIPPLE ● FULL LOAD (Vp-p max)	FULL LOAD OUTPUT VOLTAGE TOLERANCE (V DC)	PRICE 1–24
5AV100	5	100	12.50	1.25	78	321	0.90	±3.0	74.88
5AV150	5	150	8.30	1.25	76	329	0.90	±3.0	74.88
5AV200	5	200	6.25	1.25	75	333	0.90	±3.0	74.88
5AV250	5	250	5.00	1.25	75	333	0.90	±3.0	74.88
5AV300	5	300	4.16	1.25	70	357	1.20	±5.0	99.00
5AV350	5	350	3.57	1.25	70	357	1.20	±5.0	99.00
5AV400	5	400	3.12	1.25	70	357	1.20	±5.0	99.00
5AV450	5	450	2.77	1.25	70	357	1.50	±5.0	99.00
5AV500	5	500	2.00	1.00	70	357	1.50	±5.0	99.00
12AV100	12	100	12.50	1.25	80	130	0.90	±3.0	74.88
12AV150	12	150	8.30	1.25	79	132	0.90	±3.0	74.88
12AV200	12	200	6.25	1.25	78	134	0.90	±3.0	74.88
12AV250	12	250	5.00	1.25	75	139	0.90	±3.0	74.88
12AV300	12	300	4.16	1.25	75	139	1.20	±5.0	99.00
12AV350	12	350	3.57	1.25	75	139	1.20	±5.0	99.00
12AV400	12	400	3.12	1.25	75	139	1.20	±5.0	99.00
12AV450	12	450	2.77	1.25	75	139	1.50	±5.0	99.00
12AV500	12	500	2.00	1.00	75	139	1.50	±5.0	99.00
24AV100	24	100	12.50	1.25	76	69	0.90	±3.0	74.88
24AV150	24	150	8.30	1.25	73	71	0.90	±3.0	74.88
24AV200	24	200	6.25	1.25	73	71	0.90	±3.0	74.88
24AV250	24	250	5.00	1.25	70	74	0.90	±3.0	74.88
24AV300	24	300	4.16	1.25	73	71	1.20	±5.0	99.00
24AV350	24	350	3.57	1.25	73	71	1.20	±5.0	99.00
24AV400	24	400	3.12	1.25	73	71	1.20	±5.0	99.00
24AV450	24	450	2.77	1.25	73	71	1.50	±5.0	99.00
24AV500	24	500	2.00	1.00	73	71	1.50	±5.0	99.00
28AV100	28	100	12.50	1.25	75	60	0.90	±3.0	74.88
28AV150	28	150	8.30	1.25	76	59	0.90	±3.0	74.88
28AV200	28	200	6.25	1.25	75	60	0.90	±3.0	74.88
28AV250	28	250	5.00	1.25	70	64	0.90	±3.0	74.88
28AV300	28	300	4.16	1.25	73	61	1.20	±5.0	99.00
28AV350	28	350	3.57	1.25	73	61	1.20	±5.0	99.00
28AV400	28	400	3.12	1.25	73	61	1.20	±5.0	99.00
28AV450	28	450	2.77	1.25	73	61	1.50	±5.0	99.00
28AV500	28	500	2.00	1.00	73	61	1.50	±5.0	99.00

*Measured using 0.1 µf, 1000 Volt DC capacitor across output and maintain at least 10% of load at all times to prevent voltage surge.
Ordering Instructions: No minimum. Net 30 days F.O.B. Mt. Vernon, New York.

PICO 24AV200



PICO 5AV500



*For immediate engineering assistance or to place an order—***Call Toll Free 800-431-1064**

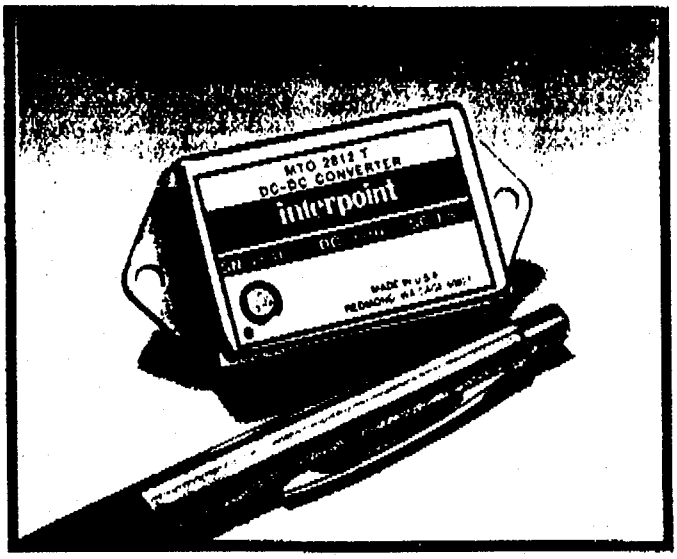
PICO Electronics, Inc.

453 N. MacQuesten Pkwy., Mt. Vernon, N.Y. 10552 • 914-699-5514 • FAX 914-699-5565

interpoint

MTO SERIES DC-DC CONVERTERS

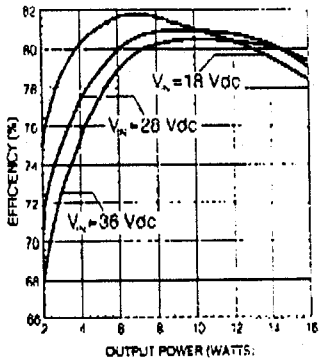
10301 Willows Road P.O. Box 97005 Redmond, WA 98073-9705 TEL: (206) 882-3100 TEL: (800) 822-8782 FAX: (206) 882-1980



- **Triple output from one package**
- **15 watts total output power**
- **16 to 36 Vdc input range**
- **Less than 2.7 sq. in. of board area**
- **Up to 79% efficiency**
- **–55°C to +85°C operation**
- **500 Vdc, 100 Megohm isolation**
- **Indefinite short-circuit protection**
- **No external components required**
- **Input ripple current filter**
- **Optional environmental screening**
- **Optional flange mount package**

The MTO series dc-dc converters offer a +5 Vdc output and either ±12 or ±15 volt outputs in a single package. These converters offer the high efficiency and wide input range of switching regulators, with the excellent regulation and low output noise typical of linear regulators. Input and output grounds are completely isolated from one another and from case ground. No external components are required for operation. The units are built using thick-film hybrid technology and are sealed in metal packages for military, aerospace, and other high-reliability applications. Unscreened models are solder sealed and are guaranteed to pass a gross leak test (maximum leak rate of 1×10^{-3} atm-cc/sec). Environmentally screened models are hermetically sealed with solder and are screened as described on reverse. Custom versions, screened per customer specification control drawings, are also available.

The MTO devices employ pulse-width modulated switching regulator techniques in the forward mode, with a nominal switching frequency of 250 kHz. Isolation is achieved through the use of a transformer in the forward power circuit and an opto-coupler in the feedback/control loop. The full load output power (15 watts) is available over the input range of 16 to 36 Vdc, and 50 volt transients less than 100 milliseconds will not impair normal operation. The MTO is designed to provide 10 watts from the +5 Vdc output, with 2.5 watts available from each of the remaining outputs. A minimum load of 50 mA is required on the +5 volt output for full rated output power on each of the auxiliary outputs.



MTO2815T
EFFICIENCY VS LINE & LOAD

Figure 1

The efficiency is high over the entire input voltage range and from approximately 25% of full load to full load (see Figure 1) making MTOs ideal for battery or aircraft power applications.

An inhibit input is provided to allow power shut-down and start-up from a logic input. An open circuit on the inhibit terminal produces normal operation, and a low level disables the converter. Input current in the inhibit mode is typically 8 mA. The convertor features a "soft-start" function which provides a controlled 20 millisecond turn-on upon application of input power or inhibit release.

An internal input filter reduces reflected ripple current. For applications that need to meet MIL-STD-461D's CE03 reflected ripple current standards, Interpoint provides separate filter/transient suppression modules (consult your Interpoint catalog or your Interpoint representative).

Automatic current limiting circuitry protects all three outputs against short circuits. This feature adjusts the converter's output current to maintain the unit below 125% of the rated maximum total power during a short circuit. In addition, separate current limiting circuitry protects each output individually against short circuit conditions.

The MTO series of converters is rated to operate at full load at a case temperature of 85°C, with the output power derated linearly to zero at 115°C (0.5W/°C). The MTOs high efficiency minimizes heat sinking requirements, but due consideration should be given to removing self-generated heat when operating the device at maximum ratings. To increase dissipation, heat conducting material (PCB, copper sheet, heat sink, etc.) may be brought into contact with the unit's baseplate.

When the MTO is used in applications requiring full-power operation for extended periods of time, or in shock and vibration environments, it is highly recommended that the flange-mount packaging option be used. This option provides improved thermal transfer capabilities as well as a mechanically secure mounting configuration. Consult the opposite side of this data sheet for package dimensions and ordering information.

interpoint

MTO SERIES DC-DC CONVERTERS

10301 Willows Road P.O. Box 97005 Redmond, WA 98073-9705 TEL: (206) 882-3100 TEL: (800) 822-8782 FAX: (206) 882-1990

CHARACTERISTICS: T_{CASE} = 25°C, V_{IN} = 28 Vdc unless otherwise specified

PARAMETER	CONDITIONS		MTO2812T MIN	MTO2812T TYP	MTO2812T MAX	MTO2815T MIN	MTO2815T TYP	MTO2815T MAX	UNITS
INPUT VOLTAGE	FULL POWER		16	28	36	16	28	36	Vdc
INPUT CURRENT	NO LOAD				30			30	mA
OUTPUT VOLTAGE	FULL POWER	Main +Aux -Aux	4.95 +11.88 -11.88	5.0 +12.0 -12.0	5.05 +12.12 -12.12	4.95 +14.85 14.85	5.0 +15.0 -15.0	5.05 +15.15 -15.15	Vdc
OUTPUT[1] CURRENT	V_{IN} = 18 to 36V	Main Aux	50[1] 0		2000 ±208	50[1] 0		2000 ±208	mA
OUTPUT[2] POWER	T_C = -55°C to +85°C	Main +Aux -Aux Total			10.0 2.5 2.5 15.0			10.0 2.5 2.5 15.0	watts
EFFICIENCY	FULL POWER		76	79		76	79		%
LINE REGULATION	FULL POWER V_{IN} = 16 to 36 V	Main Aux		0.1 0.25	0.2 0.4		0.1 0.25	0.2 0.4	%
LOAD REGULATION	MIN. LOAD TO MAX. LOAD	Main Aux		0.2 0.25	0.4 0.4		0.2 0.25	0.4 0.4	%
OUTPUT RIPPLE VOLTAGE	FULL POWER BW = 1 MHz	Main Aux			80 30			80 30	mVp-p
INPUT RIPPLE CURRENT	FULL POWER			20	50		20	50	mAp-p
TEMP COEFF OF OUTPUT VOLTAGE	-55°C to +85°C				±.015			±.015	%/°C

OPERATING TEMPERATURE RANGE: -55°C to +85° case

STORAGE TEMPERATURE RANGE: -55°C to +125°C

INPUT TO OUTPUT CAPACITANCE: 80pF (typical)

I/O ISOLATION: 100 megohm min at 500 Vdc

CONVERSION FREQUENCY: 250 kHz (typical)

WEIGHT: 53 grams (typical)

[1] Minimum load required for full output capability on auxiliary outputs. Minimum current can be reduced when dual outputs are used at reduced loads.

[2] Derate output power linearly from 100% at +85°C to 0 at +115°C.

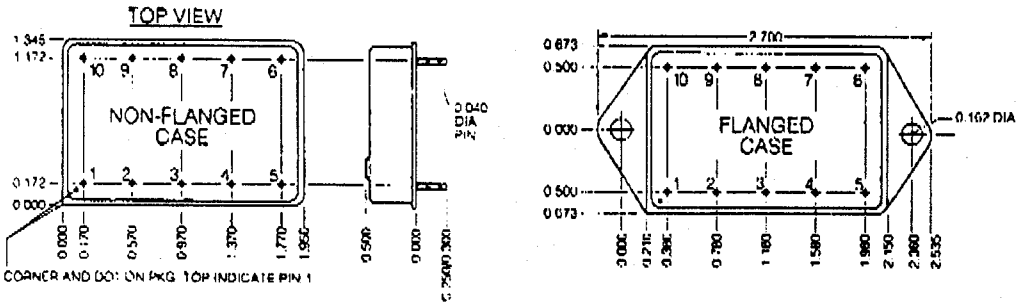
OPTIONAL ENVIRONMENTAL SCREENING

Environmental screening, referenced to MIL-STD-883, per Interpoint's in-house screening procedure, consists of the following:

- Pre-cap internal visual inspection: Per method 2017
- Stabilization bake: 24 hrs. at 125°C per method 1008 cond. B
- Temperature cycle: 10 times, -55°C to +125°C per method 1010
- Constant acceleration: 500 g per method 2001
- Gross leak: Per method 1014, cond. C
- Fine leak: Per method 1014, cond. A
- Burn-in: 96 hr. at 70°C ambient
- Final electrical test (25°C)
- Final external visual inspection: Per method 2009

To order optional screening, add suffix -/ES to model number. Example: MTO2812T/ES. On unscreened parts, the screening code block is marked with "00" or "01." On screened parts, the block is marked "ES" or "02."

METAL HERMETIC PACKAGE



MTO SERIES CASE
NOMINAL CASE DIMENSIONS (IN INCHES)
TOLERANCE ±0.005
For flanged version, add F to part number

DESIGNATION	PIN
Positive input	1
+5 Vdc output	2
Output common	3
-Aux output	4
+Aux output	5
No connection	6
Case ground	7
Inhibit input	8
No connection	9
Input common	10

CASE, PINS, AND COVER: Cold rolled steel with fused tin finish.

CAUTION: Heat from reflow or wave soldering may damage this part. Solder pins individually with heat application NOT exceeding 300°C for 10 seconds per pin.