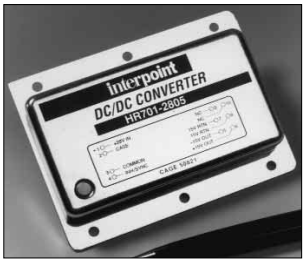
FEATURES

- **–40°C to + 85°C operation**
- **19 to 40 VDC input**
- Fully Isolated
- Optocoupler feedback
- Fixed frequency, 245 kHz typical
- Topology – Push-Pull Forward
- 50 V for up to 50 ms transient protection
- Inhibit/sync function
- Indefinite short circuit protection
- Remote sense on single models
- Up to 84% efficiency

DC/DC CONVERTERS
28 VOLT INPUT

HR700 SERIES
70 WATT



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

Size (max.): 3.20 x 2.46 x 0.595 inches
(81.3 x 62.5 x 15.11 mm)
See Section B8, case L, for dimensions.
Weight: 140 grams typical
Screening: Standard only.
See Section B9 for screening description.

DESCRIPTION

HR700 Series DC/DC converters offer up to 70 watts of power from single, dual, or triple outputs in one package. The converters combine the small size and high reliability of hybrid-based components, the high efficiency of switching regulators, and the isolation, regulation, and low noise characteristics of linear regulators.

SMALL SIZE

The HR700 converters are manufactured using techniques that provide very small size and low profile components. Each converter uses less than eight square inches of board areas and is 0.595 inches high or less. The overall power density is 20 watts per cubic inch.

HIGH RELIABILITY

Assembled using thick-film technology, the HR700 parts use the same manufacturing procedures and quality controls that we apply to converters designed for commercial airliners, the space shuttle, advanced fighter aircraft, and other high reliability applications. The steel cases are hermetically sealed in a dry nitrogen environment and are guaranteed a maximum leak rate of less than 10^{-3} atm-cc/sec. All devices are 100% electrically tested.

HIGH PERFORMANCE

The HR700 series parts are high efficiency, low noise, pulse-width modulated converters which use a quasi-square wave forward converter design with a nominal switching frequency of 245 kHz. Isolation between input an output is provided with a transformer in the forward power loop and a wide band, temperature insensitive, optical link in the feedback control loop. Short circuit protection is provided by detecting peak primary switching current on a cycle basis and limiting it to approximately 130% of the full load input current. This method results in quick and positive current limiting under short circuit conditions.

HR700 Series DC/DC converters are designed to provide full power operation over the input voltage range of 19 to 40 VDC. Operation below an input of 19 volts is possible with derated output power. Outputs are available as 5, 12, and 15 VDC single, dual and triple outputs. The converters typically provide greater than 80% efficiency over the entire input range. Line regulation is typically within 0.1% and load regulation within 0.2%.

LOW NOISE

The HR700 Series converters offer low noise on both the input and output lines. A two section, four pole, LC input filter is included to provide very low reflected line ripple current. Output ripple is maintained at less than 50 mV p-p for single and dual models and 85 mV p-p for triple output models.

INHIBIT/SYNC FEATURE

An inhibit/sync pin is standard on all models of the HR700 Series converters. The pin serves as both an output inhibit and as a synchronization input. In the inhibit mode an open collector TTL compatible low (<0.8 V) will disable internal switching thereby inhibiting the unit's output. Inhibiting in this manner results in an extremely low quiescent current.

HR700 SERIES
70 WATT

DC/DC CONVERTERS

ABSOLUTE MAXIMUM RATINGS

Output Power
- 60 to 70 watts depending on model

Lead Soldering Temperature (10 sec per lead)
- 300°C

Storage Temperature Range (Case)
- –55°C to +125°C

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range
- 19 to 40 VDC continuous (see Derating)

Case Operating Temperature (Tc)
- –40°C to +85°C full power

SYNC AND INHIBIT

Sync In (245 to 370 kHz.)
- Duty cycle 70% min, 98% max.
- Logic low 0.8V max
- Logic high 4.5 V min
- Referenced to input common
- If sync is not used, leave unconnected

Inhibit TTL Open Collector
- Logic low (output disabled)
  Inhibit pin current 1 mA max
- Referenced to input common
- Logic high (output enabled)
  V = ≥ 4.5V

TYPICAL CHARACTERISTICS

Output Voltage Temperature Coefficient
- 150 ppm/°C, typical

Input to Output Capacitance
- 160 pF, typical

Isolation
- 100 megohm minimum at 500 V

Conversion Frequency
- Free run mode 245 kHz, typical

Inhibit Pin Voltage (unit enabled)
- 4.5 to 5.5 V

DERATING OUTPUT POWER/CURRENT AND INPUT VOLTAGE

Temperatures are referenced to the temperature at the converter's baseplate
- Linearly derate output power/current from 100% at 85°C to 0% at 125°C.
- Above 105°C linearly derate steady state input voltage to 33 volts at 125°C.
- Indefinite short circuit protection is not guaranteed above 85°C case.
- Operation below an input voltage of 19 volts, including operation in MIL-STD-704E emergency power conditions, is possible with derated output power. See Figures 10 and 11.

Electrical Characteristics: 25°C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

SINGLE OUTPUTS		HR701-2805			HR701-2812			HR701-2815			
PARAMETER	**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN.**	**TYP**	**MAX**	**UNITS**
OUTPUT VOLTAGE	FULL LOAD	4.90	5.00	5.10	11.75	12.00	12.25	14.75	15.00	15.25	VDC
OUTPUT CURRENT	V_{IN} = 19 TO 40	—	—	12.00	—	—	5.83	—	—	4.67	A
OUTPUT POWER	Tc = –55°C TO +85°C	—	—	60	—	—	70	—	—	70	W
OUTPUT RIPPLE	FULL LOAD BW ≤ 2 MHz	—	30	100	—	30	100	—	30	100	mV p-p
LINE REGULATION	V_{IN} = 19 TO 40	—	10	30	—	10	30	—	10	30	mV
LOAD REGULATION	NO LOAD TO FULL	—	10	30	—	10	30	—	10	30	mV
INPUT VOLTAGE		19	28	40	19	28	40	19	28	40	VDC
INPUT CURRENT	NO LOAD INHIBITED	— —	75 30	100 35	— —	70 30	100 35	— —	70 30	100 35	mA
INPUT REFL. RIPPLE	FULL LOAD BW ≤10 MHz	—	10	50	—	10	50	—	10	50	mA p-p
EFFICIENCY		77	80	—	80	83	—	80	83	—	%
STARTUP DELAY	WITH LOW IMPEDANCE SOURCE	—	5	10	—	8	10	—	8	10	ms

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Electrical Characteristics: 25°C Tc, 28 VDC Vin, 100% load, free run, unless otherwise specified.

DUAL AND TRIPLE OUTPUTS		HR702-2812			HR702-2815			HR703-28512			HR703-28515			
PARAMETER	**CONDITION**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
OUTPUT VOLTAGE	FULL LOAD MAIN	—	—	—	—	—	—	4.90	5.05	5.15	4.90	4.95	5.10	VDC
	FULL LOAD DUAL	±11.75	±12.00	±12.25	±14.75	±15.00	±15.25	±11.50	±11.80	±12.10	±15.05	±15.30	±15.75	
OUTPUT CURRENT[1, 2]	V_{IN} = 19 TO 40 MAIN	—	—	—	—	—	—	—	4.0	10.0	—	4.0	10.0	A
	V_{IN} = 19 TO 40 DUAL	—	2.92	5.5	—	2.33	4.4	—	1.67	4.2	—	1.33	3.33	
OUTPUT POWER[1, 2]	MAIN	—	—	—	—	—	—	—	20	50	—	20	50	W
	±DUAL	—	35	66.5	—	35	66.5	—	20	50	—	20	50	
	TOTAL	—	—	70	—	—	70	—	—	60	—	—	60	
OUTPUT RIPPLE	FULL LOAD MAIN	—	—	—	—	—	—	—	50	100	—	50	100	mV p-p
	BW ≤ 2 MHz DUAL	—	30	100	—	30	100	—	50	100	—	50	100	
LINE REGULATION	V_{IN} = 19 TO 40 MAIN	—	—	—	—	—	—	—	2	25	—	2	25	mV
	V_{IN} = 19 TO 40 DUAL	—	10	30	—	10	30	—	100	225	—	100	225	
LOAD[3] REGULATION	NO LOAD TO FULL MAIN	—	—	—	—	—	—	—	5	30	—	5	30	mV
	NO LOAD TO FULL DUAL	—	25	50	—	25	50	—	480	750	—	300	600	
CROSS[4] REGULATION	DUAL $+P_O$ = 3 W TO 35 W, $-P_O$ = 35 W	—	1.5	3.0	—	1.5	3.0	—	—	—	—	—	—	%
	DUAL $+P_O$ = 20 W TO 50 W, $-P_O$ = 50 W TO 20 W	—	2.0	4.0	—	2.0	3.5	—	—	—	—	—	—	
CROSS[5] REGULATION	MAIN $+P_O$ = 30 W, DUAL $+P_O$ = 3 W TO 27 W, $-P_O$ = 27 W TO 3 W	—	—	—	—	—	—	—	2.3	6.0	—	2.3	5.0	%
	MAIN $+P_O$ = 3 W TO 30 W, DUAL $\pm P_O$ = 15 W	—	—	—	—	—	—	—	5.4	9.0	—	5.0	7.0	
INPUT VOLTAGE		19	28	40	19	28	40	19	28	40	19	28	40	VDC
INPUT CURRENT	NO LOAD	—	75	100	—	75	100	—	85	115	—	60	115	mA
	INHIBITED	—	25	35	—	25	35	—	30	35	—	30	35	
INPUT REFL. RIPPLE	FULL LOAD BW ≤10 MHz	—	15	50	—	15	50	—	15	50	—	15	50	mA p-p
EFFICIENCY		80	83	—	80	83	—	79	84	—	79	84	—	%
STARTUP DELAY		—	15	25	—	15	25	—	6	10	—	6	10	ms

Notes
1. On dual output models the maximum combined output power is 70 watts. A maximum of 95% (66.5 W) is available from any single output.
2. On triple output models the maximum combined output power is 60 watts. A maximum of 50 watts is available from a single output.
3. Balanced loads
4. Regulation effect on the negative dual output during the defined conditions.
5. Regulation effect on both dual outputs during the defined conditions.

THERMAL MANAGEMENT

CALCULATING MAXIMUM AMBIENT TEMPERATURE

The HR700 Series of DC/DC converters has an upper operating temperature of + 85°C at the baseplate of the case. The degree of heat sinking required to remain within this limit may be determined from Figure 1 which shows the maximum allowed internal power dissipation (P_{DISS} vs. ambient temperature for various heat sink thermal resistances. P_{DISS} may be calculated as:

$P_{DISS} = P_{OUT}$ / efficiency – P_{OUT}

The efficiency for all combinations of P_{OUT} and V_{IN} for the various models may be obtained from the graphs on the preceding pages.

Example: Converter = HR702-2815, T_{AMB} = 70°C,

V_{IN} = 28 VDC, P_{OUT} = 45 watts

Efficiency = 85% (From Figure 7)

P_{DISS} = (45 / 85) – 45 = 7.95 watts

From Figure 1 we can see that this situation will require thermal resistance of approximately 4.5°C / watt.

Conversely we may also find the maximum ambient temperature which can be tolerated if we know the heat sink thermal resistance.

Example: Converter = HR701-2805, V_{IN} = 28 VDC, P_{OUT} = 45 W.

Thermal Resistance = 3°C / watt.

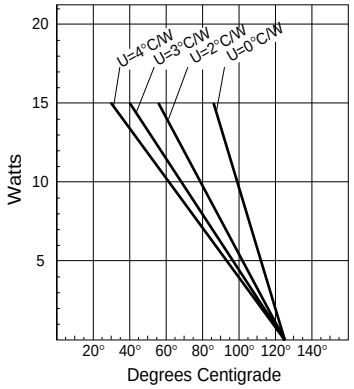
Efficiency = 83.5% (From Figure 3)

P_{DISS} = (45 / 0.835) – 45 = 8.89 watts.

From Figure 1 we can see that the maximum allowed ambient temperature is approximately 75°C.

HEAT SINK RECOMMENDATIONS

An HR700 Series converter in still air (other than convective currents) and with no conductive cooling paths other than through electrical connections at the pins will exhibit a thermal resistance of approximately 4°C / watt. In cases where this value proves to be too high it is recommended that additional heat sinking be supplied. The simplest method of accomplishing this is to firmly attach the converter to a PCB thereby providing a conductive thermal path. Secondly it is recommended that airflow be provided over the converter. Although each situation requires a thorough thermal analysis these two measures can reduce the thermal resistance to as low as 2°C / watt. If calculations indicate further heat sinking is required it is recommended that additional thermal mass be provided either under the base plate or on top of the converter's mounting flanges or both.



Internal Power Dissipation (max)
vs. Ambient Temperature

FIGURE 1

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PIN OUT

Pin	Single Output	Dual Output	Triple Output
1	Positive Input	Positive Input	Positive Input
2	Case Ground	Case Ground	Case Ground
3	Input Common	Input Common	Input Common
4	Inhibit/Sync In	Inhibit/Sync In	Inhibit/Sync In
5	Negative Sense	Negative Output	Negative Aux. Output
6	Positive Sense	Positive Output	Positive Aux. Output
7, 8	Output Common	Output Common	Output Common
9, 10	Positive Output	No Connection	Main (+5) Output

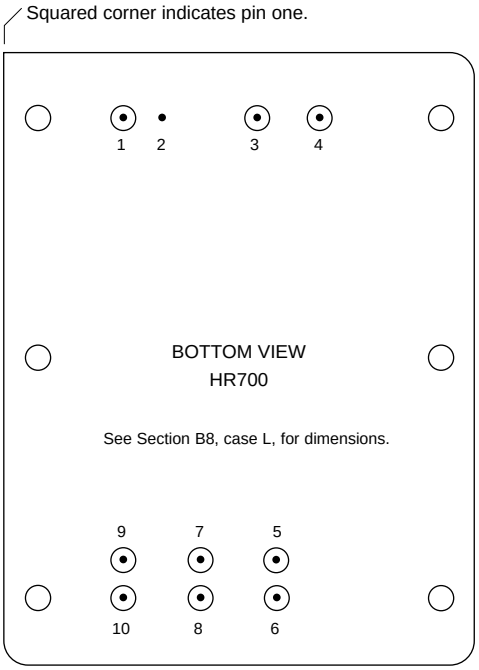
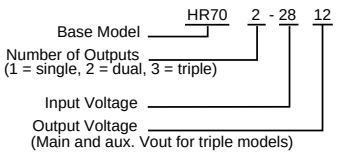


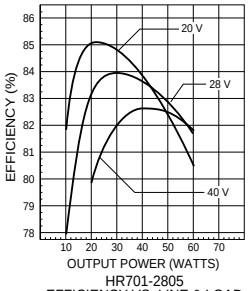
FIGURE 2: PIN OUT

MODEL NUMBERING KEY



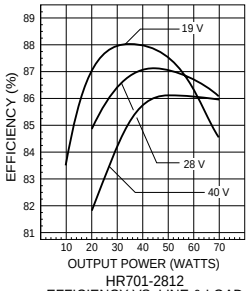
DC/DC CONVERTERS

Typical Performance Curves: 25°C Tc , 28 VDC Vin, 100% load, free run, unless otherwise specified.



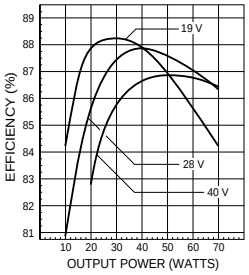
HR701-2805
EFFICIENCY VS. LINE & LOAD

FIGURE 3



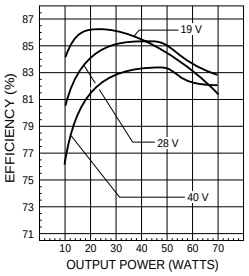
HR701-2812
EFFICIENCY VS. LINE & LOAD

FIGURE 4



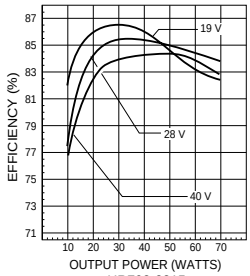
HR701-2815
EFFICIENCY VS. LINE & LOAD

FIGURE 5



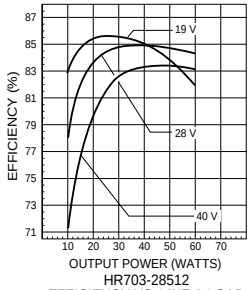
HR702-2812
EFFICIENCY VS. LINE & LOAD

FIGURE 6



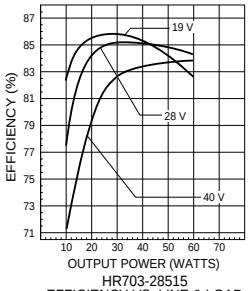
HR702-2815
EFFICIENCY VS. LINE & LOAD

FIGURE 7



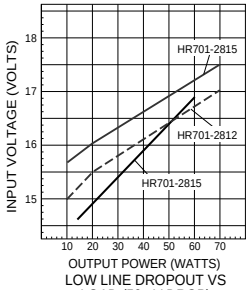
HR703-28512
EFFICIENCY VS. LINE & LOAD

FIGURE 8



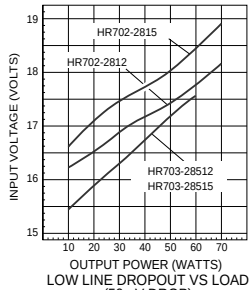
HR703-28515
EFFICIENCY VS. LINE & LOAD

FIGURE 9



LOW LINE DROPOUT VS
LOAD (50mV DROP)

FIGURE 10



LOW LINE DROPOUT VS LOAD
(50mV DROP)

FIGURE 11

20621-009-DTS Rev A DQ# 2008

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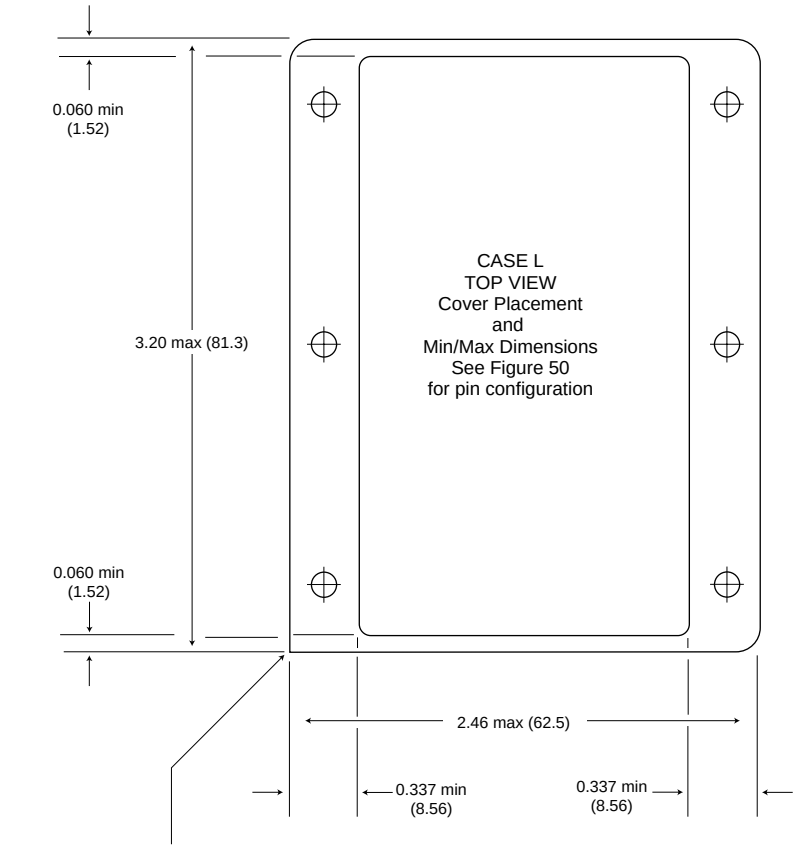

Materials

Header	Cold Rolled Steel/Nickel/Tin
Cover	Cold Rolled Steel/Nickel/Tin
Pins	#52 alloy pins 1-4, and 9-10 #52 alloy with copper core pins 5-8 ceramic seal

Case dimensions in inches (mm)

Tolerance	±0.005 (0.13) for three decimal places ±0.01 (0.2) 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.

FIGURE 49: CASE L MAXIMUM DIMENSIONS

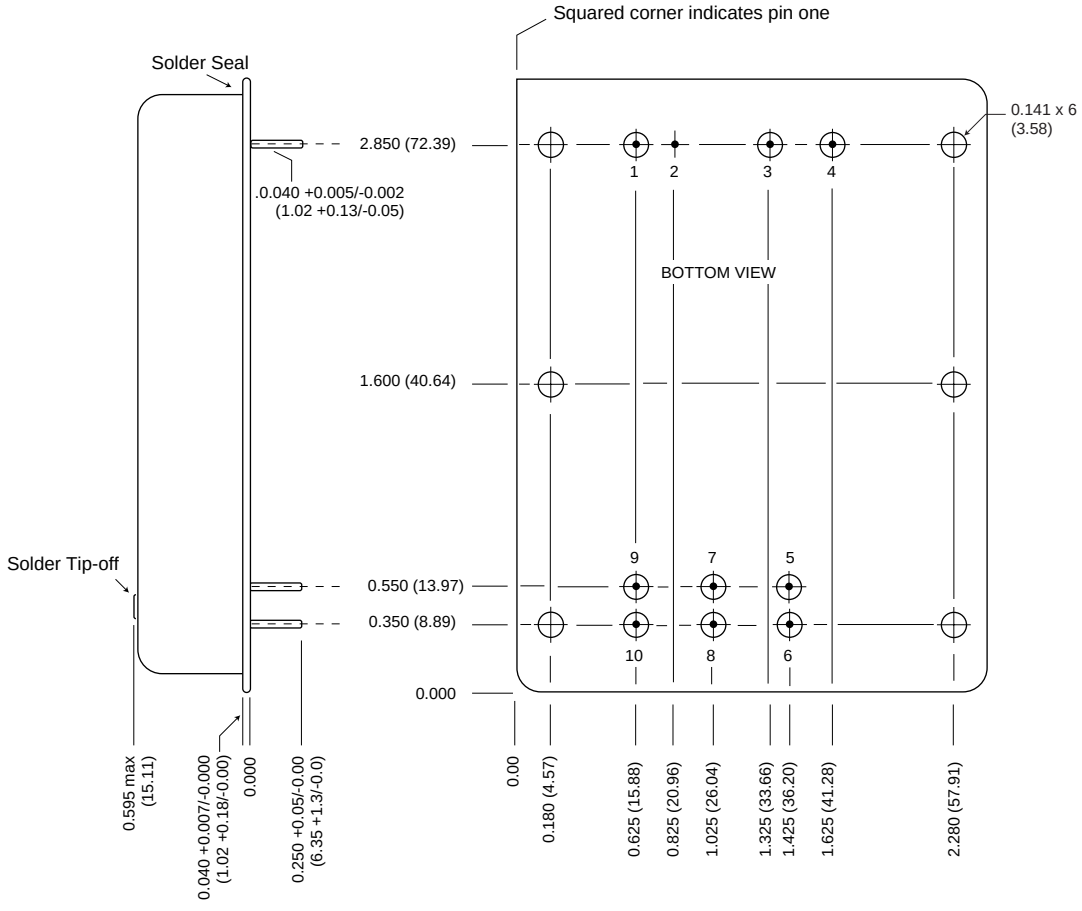

FIGURE 50: CASE L DIMENSIONS

HR PRODUCTS

TEST (HR products)	STANDARD
PRE-CAP INSPECTION Method 2017	yes
FINAL ELECTRICAL TEST MIL-PRF-38534, Group A Subgroups 1 and 4: +25°C case	yes
HERMETICITY TESTING Gross Leak, Dip (1×10^{-3})	yes
FINAL VISUAL INSPECTION Method 2009	yes

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

Applies to the following products:

HR700 Series
HR300 Series
HR150 Series
HR120 Series
HR40 Series