

# Application Note

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## **RF Insertion Loss Repeatability Testing of RF300 and RF303 Relays**

### **THE PRODUCT**

**RF300 and RF303 high signal repeatability, double pole double throw (DPDT), ultraminiature, RF TO-5 relay.**

### **KEY FEATURE**

**The RF300 and RF303 have a characterized bandwidth to an impressive 3 GHz and provide improved RF signal repeatability of  $\pm 0.1$  dB or better over the entire bandwidth. They are ideal for low level RF and DC signal switching.**

### **APPLICATIONS**

**Attenuators, tuning and precision measurement circuits, filters and amplifiers.**

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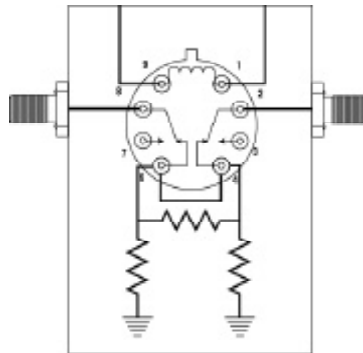
## METHODOLOGY FOR DETERMINING REPEATABILITY IN A SWITCHABLE ATTENUATOR CIRCUIT

### RF REPEATABILITY TEST

Thirty-six (36) RF300-12 relays were tested to develop repeatability data for one million cycles of operation. The relays were tested as described below over a frequency range of 0.3 MHz to 3 GHz.

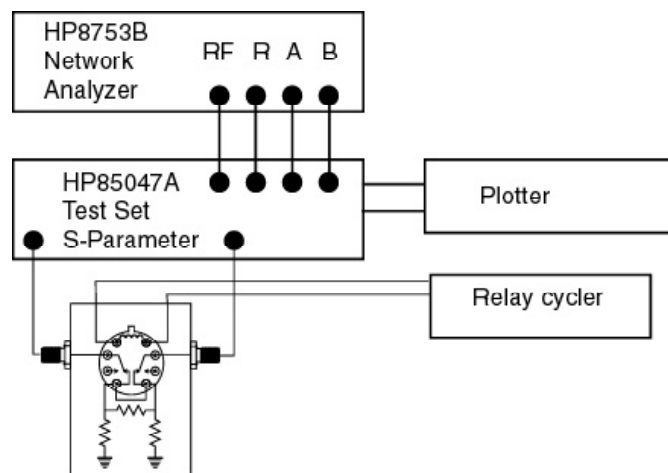
### RELAY UNDER TEST

RF300-12 relays were soldered to .031 inch thick, two sided, copper clad, PTFE test boards. The periphery of the header and cover flanges were soldered to the ground plane of the circuit board. The moving contacts (terminals 2 and 8) were connected to SMA connectors serving as input/ output ports. The normally closed contacts (terminals 4 and 6) were connected in series. The normally open contacts (terminals 3 and 7) were connected to a 20 dB attenuator, p (pi) resistor network, as shown in Figure 1.



**Figure 1**

Repeatability Test Board for Relay Under Test (RUT)



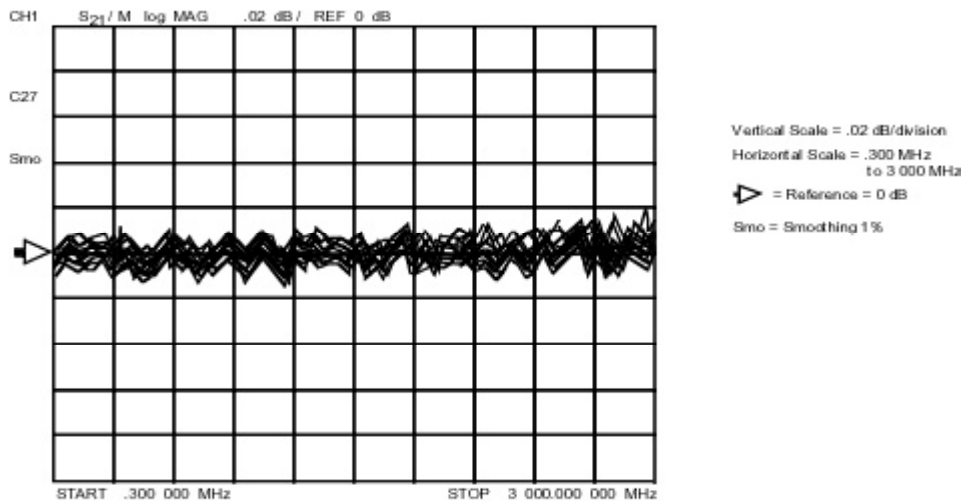
**Figure 2**  
Test Set Up

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## TEST METHOD

With the relay coil de-energized, the insertion loss of the RUT was measured and stored in the network analyzer's memory. This measurement is the total insertion loss of the relay's two normally closed contacts and any insertion loss contributions from the circuit board and the two SMA connectors and served as the base line measurement. The relay was then cycled 100 times having every tenth cycle plotted.

This routine of measuring and plotting insertion loss over the frequency range produces a family of curves like the one shown in Figure 3. An "ideal" result would be no change or variation in insertion loss. The spread of the data is a measure of the repeatability of the relay's normally closed contacts during this increment of the relay's life.



**Figure 3**  
Repeatability Plot

The RUT was then cycled without load on the contacts for 100,000 cycles. After cycling, a new base line measurement was taken and repeatability plot generated using the method described above. A repeatability plot was generated every 100,000 cycles until one million cycles were accumulated.

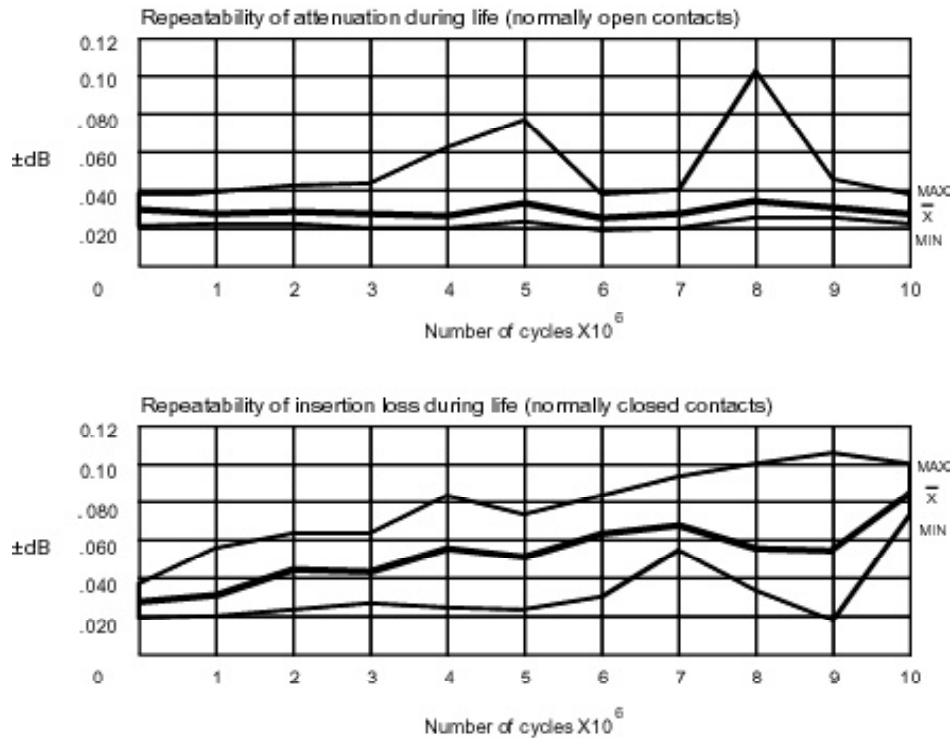
The same general method was used to measure the repeatability of the attenuated path. This time the relay was energized and the insertion loss of the two normally open contacts and the attenuator resistor network were used as the reference point.

## TEN MILLION CYCLE REPEATABILITY

The 10 million cycle data was accumulated in the same manner described in the RF Repeatability Test section, except, the data is based upon results for ten (10) RF300-12 relays and a repeatability plot generated every one million cycles until data for 10 million cycles were accumulated. The shaded area in figure 4 indicates the range of the repeatability test results at each one million cycle increment. The hashed

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line running through the center of the shaded area ( x ) is the average repeatability.



**Figure 4**  
Ten Million Cycle Repeatability

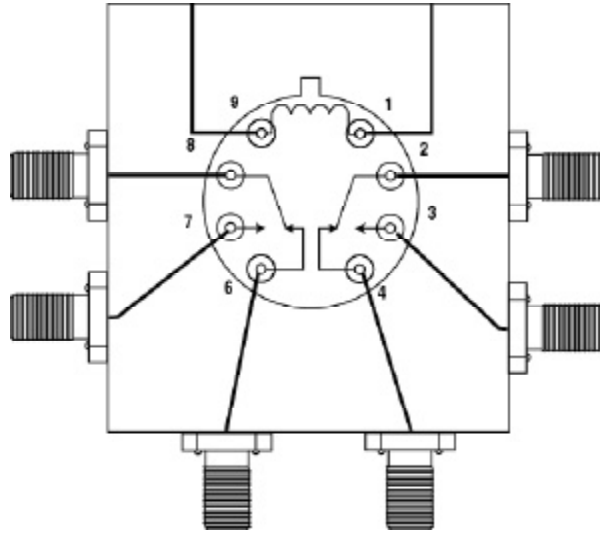
## METHODOLOGY FOR DETERMINING RF PERFORMANCE

### RF PERFORMANCE CURVES

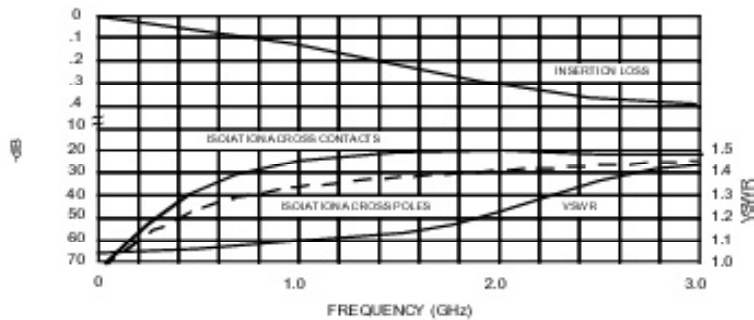
The RF performance curves (insertion loss, isolation across contacts, isolation across poles, return loss or VSWR) were generated using a HP8753B Network Analyzer and HP85047A S-Parameter Test Set. The tests were performed using 0.031 inch thick, two sided, copper clad, PTFE circuit boards, as shown in Figure 5. The periphery of the relay header and cover flanges were not soldered to the ground plane of the circuit board. RF performance characteristics were measured for each pole, except the for the isolation across poles measurement. 50 ohm termination loads were attached to the SMA connectors for those contacts not being measured. Plotted typical values shown in Figure 6 are the average readings from the two poles of five (5) RF300-12 relay samples.

The matrix shown in Table 1 identifies the specific test points of the RF performance tests.

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**Figure 5**  
RF performance Test Board for Relay Under Test



**Figure 6**  
Typical RF Performance

## IMPROVING RF PERFORMANCE

The typical RF performance curves were obtained while the relay case was seated on but not soldered to the ground plane. Grounding the case by soldering it to circuit ground will result in some parametric improvement.

The relay header flange and leads may be soldered using soldering iron, vapor phase or infrared soldering techniques.

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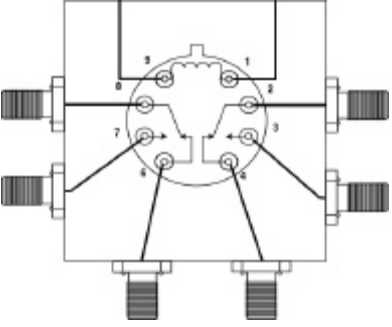
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## NOTES ON RF INSERTION LOSS REPEATABILITY DATA AND RF PERFORMANCE CHARACTERISTICS

The Rf insertion loss repeatability data and RF characteristics presented in this profile are representative values and are not intended as specification limits. Insertion loss and VSWR characteristics represent one closed contact set only.

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## RF PERFORMANCE CHARACTERISTICS TEST MATRIX

 <p>Terminals as viewed from the bottom of the relay</p>	Coil Power	Pole 1 Moving Contact	Pole 1 Normally Open Contact	Pole 1 Normally Closed Contact	Pole 2 Moving Contact	Pole 2 Normally Open Contact	Pole 2 Normally Closed Contact
Terminal number	1&9	2	3	4	6	7	8

Pole 1	Isolation (De-energized)	OFF	IN	OUT	50	50	50	50
	Isolation (Energized)	ON	IN	50	OUT	50	50	50
	Insertion Loss (De-energized)	OFF	IN	50	OUT	50	50	50
	Insertion Loss (Energized)	ON	IN	OUT	50	50	50	50
	VSWR (De-energized)	OFF	IN/OUT	50	50	50	50	50
	VSWR (Energized)	ON	IN/OUT	50	50	50	50	50

Pole 2	Isolation (De-energized)	OFF	50	50	50	50	OUT	IN
	Isolation (Energized)	ON	50	50	50	OUT	50	IN
	Insertion Loss (De-energized)	OFF	50	50	50	OUT	50	IN
	Insertion Loss (Energized)	ON	50	50	50	50	OUT	IN
	VSWR (De-energized)	OFF	50	50	50	50	50	IN/OUT
	VSWR (Energized)	ON	50	50	50	50	50	IN/OUT

Pole to Pole	Isolation (De-energized)	OFF	IN	50	50	50	50	OUT
	Isolation (Energized)	ON	IN	50	50	50	50	OUT

**Table 1**