1. GENERAL DESCRIPTION

The QF 40003/QF40004 DUAL DIRECTIONAL COUPLER is a versatile tool in microwave measurements. With its wide frequency coverage (0.1GHz ~ 2GHz), the QF40003/QF40004 can be used to separate and isolate electric signals in microwave laboratories. It is an essential part of many microwave measurement systems, Reflectometer setups, S-parameter measurements, signal mixing, power monitoring and source leveling are just a few areas in which the coupler is used.

2. SPECIFICATIONS

2.1 Frequency Range:	0.11 ~ 2GHz
2.2 Directivity on the Reflected Port:	> 30dB
2.3 Coupling (on the reflected port and incident port):	20±1dB
2.4 Coupling Variation:	<±1dB
2.5 Tracking Variation (between the reflected port and incident port):	<±1dB
2.6 Equivalent Source Reflection (on the test port):	<1.26
2.7 SWR (primary line):	<1.2
(on the incident port):	<1.2
(on the reflected port):	<1.2
2.8 Insertion loss (primary line):	<1dB
2.9 Dimensions:	426×103×29 (mm^3)
2.10 Weight:	1.57kg (net)

3. PRINCIPLES OF OPERATION

The QF40003/QF40004 Dual Directional Coupler is comprised of two individual Directional Couplers placed back to back and with common primary line as shown in Fig.1. To ensure better performance, the two 50-ohm loads are integrated in the shielded coupler which has only four ports (No.1.2.3.4) for outer connections.

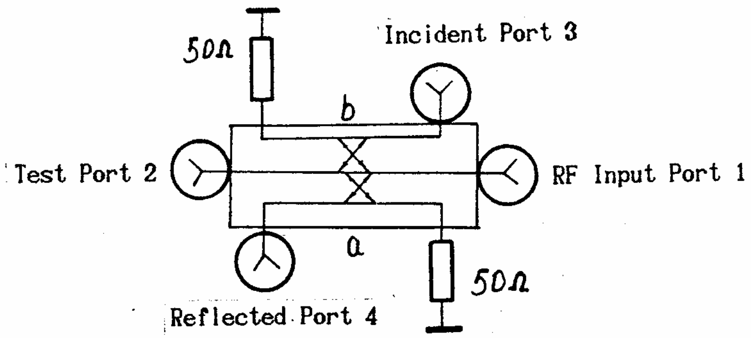

Fig. 1.

Signal separation is achieved due to its inherent directivity. When each of the ports 2,3,4 is terminated with a 50-ohm load respectively, an RF signal applied to the RF input port (1) will be fed directly to the test port (2), while a portion of the signal will be coupled to the incident port (3) and the 50-ohm internal load of the Directional Coupler (a) with a coupling coefficient of −20dB. Because of its directivity, only a small portion of the signal is coupled to the reflected port (4) and the 50-ohm internal load of the Directional Coupler (b). Conversely, if the RF signal is applied to the test port (2), besides being fed directly to the incident port (1), the signal will be coupled to the 50-ohm internal of load the Directional Coupler (b) and the reflected port (4) with a coupling coefficient of −20 dB. Therefore, the output on the incident port (3) is only directly proportional to the input on port (1), while the output on the reflected port (4) is only directly proportional to the input on port (2).

Connecting a device under test to port (2), when a signal is applied to port (1), the reflected signal from the device under test will be coupled to the incident port (4). Therefore, the ratio between the output voltage V4 at port (4) and the output voltage V3 at port (3) is the reflection coefficient ρ.

$$\rho = V_4/V_3 \qquad (1)$$

The measurement error $\Delta\rho$ caused by the directivity of the QF40003/40004 is:

$$\Delta\rho \approx A + B\rho_L + C\rho_L^2 \qquad (2)$$

where:

A=Directivity Error of the QF40003/40004

B=Calibration Error

C=Equivalent Source Reflection

ρ=True Value of the Reflection Coefficient Being Measured.

It can been seen from the formula (2) that 100% of the directivity error of the QF40003/40004 contributes to the test error $\Delta\rho$.

Assurming A=C, B=0. If the reading of SWR measured by the device with a directivity of 30 dB is 1.05, the range of true values is 1 ~ 1.2; if the reading is 1.2, the range of true values is 1.12 ~ 1.28; and if the reading is 3, the range is 2.74 ~ 3.35.

The reflection coefficient ρ given in equation (1) is a vector. An accurate measurement of the phase angle of reflection coefficient ρ is required in many cases, that is, the phase difference between V_4 and V_3 should be the phase angle of ρ. As the QF40003/QF40004 is an unsymmetrical, high-pass and equal-ripple directional coupler, the phase shift of port (3) against port (1) is 90°, and phase shift of port (2) against port (4) is also 90°. But, due to the transmission delay between the two phase references (port 1 and port 2), the initial phase difference between V_4 and V_3 is not zero, so it can' t be taken as the phase of ρ.

To solve this problem, connect a standard short (with a reflection coefficient of 1, <180°) to port (2). Then adjust the electrical length from the incident port to the indicator through a delay line between them to obtain an initial phase difference equal or less than ±4° between V_4 and V_3 over the whole frequency band.

4. STRUCTURE

Figure 2 shows the outline drawing of QF40003/QF40004 Dual Directional Coupler.

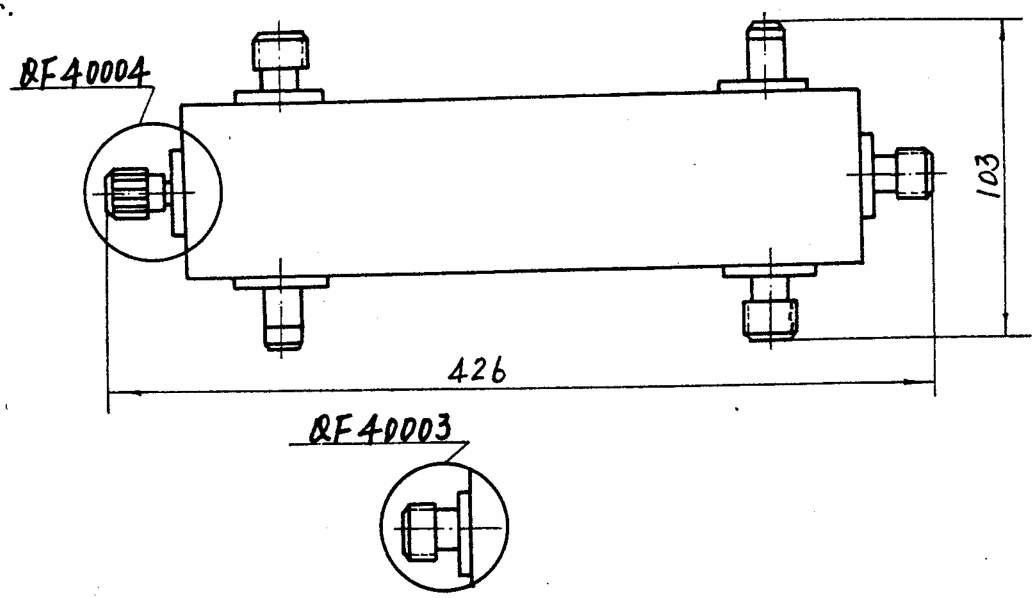

Fig. 2

A structure of copper strip lines deposited on a polystyrene substrate is adopted in the device. The three copper strips are shown in Fig 3. The substrate is mounted in a metal case with screws. The six ends of three strip lines are connected to the respective coaxial connectors or loads via strip-lines or coaxial lines. The 50Ω loads adopts a structure of suspended strip lines deposited on a ceramic substrate. To ensure reliable contact, all the contacts and coupling lines are plated with gold.

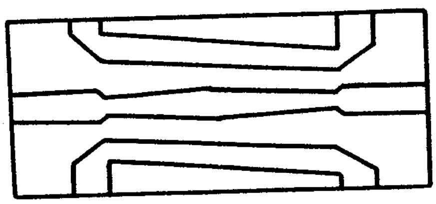

Fig. 3

5. OPERATION

5.1. The input power of RF pulse to QF40003/QF40004 Dual Directional Coupler should not be larger than 50 W; the average power should not be larger than 2 W.

5.2. The dimensions of the outer connector (N type) should conform to that given in Fig.4. Unqualified connectors will damage the connections between the connectors of the device and its strip lines.

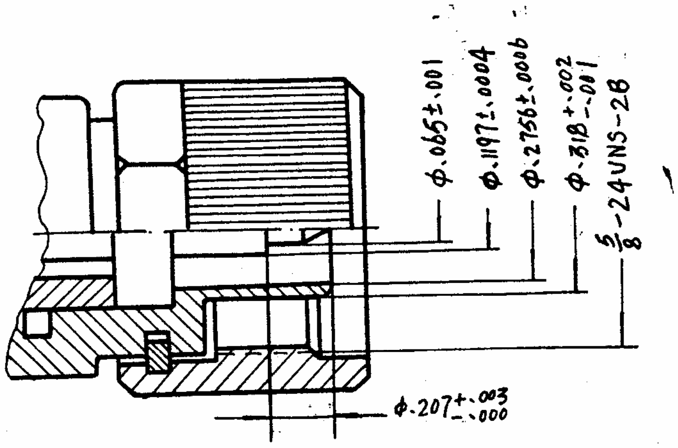

Fig. 4

5.3. To ensure high test accuracy, the connection to each port should be reliable.

5.4. When the device is used to measure phase, a delay line should be connected to port (3) according to the instruction given in section 3 " Principle of Operation " to balance the initial phase difference.

5.5. The device can be used as a single directional coupler. To eliminate any leakage, it is recommended to terminate the unused coupler with a 50-ohm load.

5.6. When the device is used as a reflectometer, it is not recommended to exchange port (1) with port (2) arbitrarily (It is required to feed a signal to port 1 only), because the directivity of Coupler (a) is better than that of Coupler (b).

5.7. The device can also be used well below 100 MHz with the directivity remains unchanged. However, the coupling coefficient between primary line and auxiliary arm will decrease by 6 dB per octave.

6. SERVICE

6.1. The device requires no special service. If a poor contact problem is found, clean the connectors with alcohol or replace the elastic contacts of the flat connectors with special tools. But it is not allowed to dismantle the device or turn the adjusting screws. Due to its special design and structure, the device should be sent back to the manufacturer for repair in case of any failure occurs in the interior of the device (e.g. an open circuit or lowed specifications).

6.2. When the device is not in use, leave the coupling sleeve extended and put on the dust shield covers. Never turn around the inner conductors of the connectors, otherwise the connection between strip lines and connectors may be broken.

6.3. The device should be put in the original packing box for storage. The store room should be well ventilated and free from corrosion of acid, alkaline and salt.

6.4. While handling, use the original packing material.