

SPECIFICATIONS

(All physical dimensions specified at 23 C)

PRECISION INNER-CONDUCTOR ROD (0900-9508)

Material: Centerless-ground, stress-relieved, silver-layered brass rod.
Outer Diameter: 0.24425 inch.
Diameter Accuracy: ± 65 microinches.
Uniformity of Diameter: ± 25 microinches.
Surface Finish: 20 microinches, maximum.
Length: 27 inches (686 mm).
Straightness: 0.002 inch per foot.
Net Weight: 7 ounces (200 grams).

PRECISION OUTER-CONDUCTOR TUBING (0900-9509)

Material: Precision-forged, silver-lined, stress-relieved, brass tubing.
Outer Diameter: 0.830 inch.
Inner Diameter: 0.5625 inch.
Nominal Wall Thickness: 0.134 inch.
Inner Diameter Accuracy: ± 140 microinches.
Inner Surface Finish: 30 microinches.
Length: 27 inches (686 mm).
Straightness of Inner Diameter: 0.005 inch per foot.
Net Weight: 2½ pounds (1.2 kilogram).

0900-9508, -9509

PRECISION COAXIAL ROD 0900-9508 AND TUBING 0900-9509

FEBRUARY 1966

FORM 0900-0150B

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

This stock is intended for use with Type 900-BT Precision Coaxial Connectors in the fabrication of custom air lines and components, such as sliding-loads and adjustable short-circuits, and in any other application which requires precise diameters, excellent surface finish, or low-loss characteristics in material of appreciable length. The rod, brass with a layer of silver approximately 0.0005 inch thick, is ground to a finished diameter of 0.24425 inch, ± 65 microinches. The tubing, also brass with a layer of silver on the inside approximately 0.0005 inch thick, has a 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 140 microinches. Both are

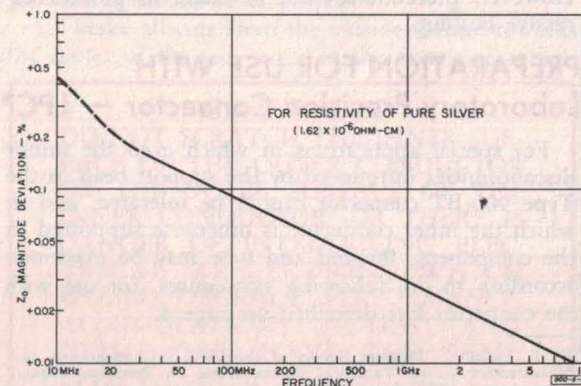


Figure 1. Skin effect characteristic-impedance error as a function of frequency

stress-relieved (to minimize diameter changes due to machining) and straightened. Rod and tubing are supplied in 27-inch lengths, specially packed to retard tarnishing.

APPLICATIONS

The rod and tubing can be used to make precise, air-dielectric, coaxial transmission line. The characteristic impedance of a transmission line made of this material, at frequencies where skin depth is negligible, is 50 ± 0.0325 ohms, or $\pm 0.065\%$. The skin-depth deviation in characteristic impedance as a function of frequency is shown to the left.

There is a practical limit (16.5 in. or 45.5 cm) to the length of the precision air line (including a pair of Type 900-BT connectors) that can be made of this material, because of inner-conductor sag. For instance, the characteristic-impedance error for a 16.5-inch section of line whose center conductor is 0.005 inch off center is 0.046%, and the error increases exponentially as the length increases (refer to the graph below). The characteristic impedance of a coaxial transmission line with an eccentric inner conductor is given by the following equation:

$$Z_0 = A \cosh^{-1} \left[\frac{b}{2a} \left(1 - 4 \frac{\epsilon^2}{b^2} \right) + \frac{a}{2b} \right]$$

where

$A = 59.9368$

b = coaxial-line outer conductor ID

a = coaxial-line inner conductor OD

ϵ = amount of center-conductor eccentricity

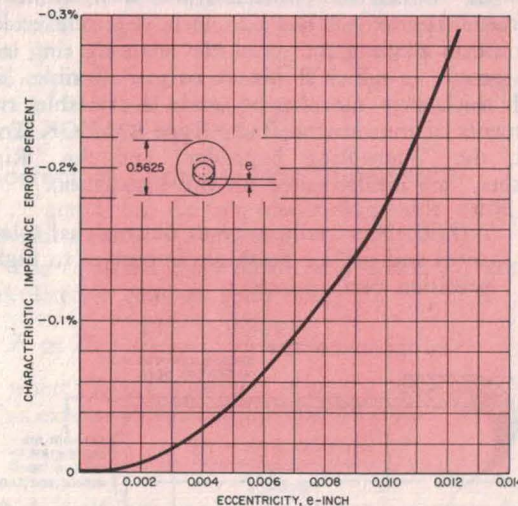


Figure 2. Characteristic-impedance error vs sag in inner conductor

The sag at the middle

$$\epsilon \cong \frac{l^4}{15 \times 10^6} \text{ inch}$$

where l is the length of the inner conductor in inches. If the error due to the sag is too great for the length of transmission line desired, mount the transmission line vertically to avoid the sag.

The Precision Rod and Tubing can also be used with Type 900-BT connectors to make precision time-delay standards for delays of up to 1.5 nanoseconds (for a 45.5-cm total length).

PREPARATION FOR USE WITH TYPE 900-BT CONNECTOR

Prepare tubing and rod stock to the dimensions shown in the section drawing to fabricate center and outer conductors so that the Type 900-BT Precision Coaxial Connector(s) can be mounted as required. Complete mounting instructions are supplied with each connector.

If the over-all dimension of the device under construction will not permit the use of the full 0.875-inch machined section on the outer conductor, at either or both ends, a shorter section (0.625-inch minimum) can be used. However, installation of the connector retaining ring becomes more difficult, because the coupling nut is in the way. A 1-inch metal tube of $\frac{1}{32}$ -inch wall thickness and with an inside diameter approximately 0.625 inch is recommended for use in pushing the connector retaining ring into the groove in which it fits. A narrow, flexible, $\frac{1}{32}$ -inch thick strip can also be used. If available, two elements of the General Radio Type 874-TOK Tool Kit, the "Front-Ring Expander" and the "Ring Pusher," are ideally suited for this installation.

NOTE Strict adherence to dimensional tolerances and surface finish are important to high-precision performance.

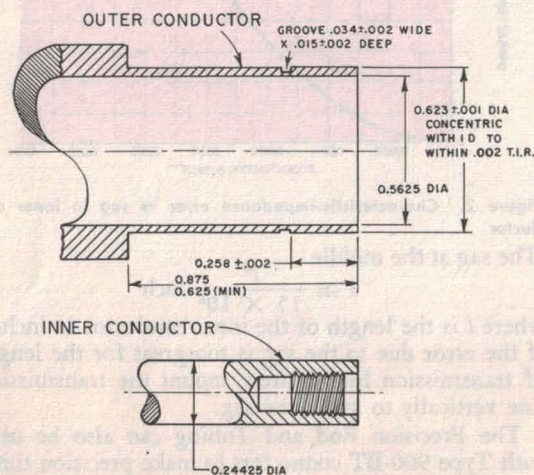


Figure 3. Machining for use with Type 900-BT connector.

RECOMMENDED MACHINING TECHNIQUES—TYPE 900-BT

NOTE In trimming either rod or tubing, bear in mind that the front faces must lie in the same plane, $+0.0000$, -0.0005 , when they are mounted in the coaxial device.

INNER-CONDUCTOR ROD — In order to minimize diameter changes due to machining, the following procedures should be employed:

1. Make all cuts from the outside surface towards the center of the rod, *never* in the reverse direction, or the surface plating may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true, and the surface smooth and flat to within 0.0002 inch.
2. To machine the tapped hole, proceed as follows:
 - a. Drill a 0.128-inch diameter hole, $\frac{3}{8} \pm \frac{1}{64}$ inch deep.
 - b. Bore $0.140 \begin{smallmatrix} +0.002 \\ -0.000 \end{smallmatrix}$ inch diameter $\frac{3}{8}$ -inch deep (minimum) and observe concentricity with OD to within 0.002 TIR (Total Indicated Runout).
 - c. Bore $0.162 \begin{smallmatrix} +0.000 \\ -0.005 \end{smallmatrix}$ inch diameter 0.065-inch deep, concentric with OD to within 0.002 TIR.
 - d. Tap with 3-flute, sharp, 8-32NC tool, $\frac{1}{4}$ -inch deep (minimum).
 - e. Finish the 0.162-inch bore, as required, concentric with OD to within 0.002 TIR, to clear any sections raised by the tap.

OUTER CONDUCTOR TUBING — In order to minimize diameter changes due to machining, and to obtain the best concentricity, observe the following procedure:

- A.** Cut the tubing 0.25 inch longer than required. In both ends, machine centers that have a 60° pitch and a depth of $\frac{1}{16} \pm \frac{1}{64}$. Chuck the piece on the centers and turn the outer diameters at the ends down to $0.810 \begin{smallmatrix} +0.001 \\ -0.000 \end{smallmatrix}$. Figure 3 shows the minimal area to be turned down.

B. Trim the tubing to the required length, plus 0.002 ± 0.001 . Make all cuts to full length from the inside diameter outwards, *never* in the reverse direction, or the plating on the inner diameter may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true.

C. To turn down the outer diameter:

- a. Set the speed to approximately 2000 rpm.
- b. Limit the cut to 6 mils.
- c. Use a light cutting pressure and no lubrication.
- d. Turn down the end in three steps:
 - (1) to 0.690 inch;
 - (2) to 0.630 inch;
 - (3) to 0.623 ± 0.001 inch* (final dimension).

D. To machine the groove, use a sharp tool, 0.017-inch wide, and make the groove in two plunge cuts with minimum pressure, to reduce the spinning-in effect on the inner diameter under the groove.

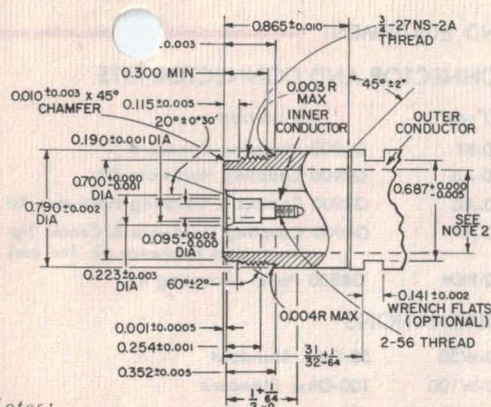
SURFACE PROTECTION

The silver lining on the inner conductor and on the inner surface of the outer conductor may tarnish and increase loss at microwave frequencies. To retard this effect, it is recommended that a gold flashing of from 4 to 10 microinches in thickness be applied. However, precautions must be taken to prevent excessive buildup.

PREPARATION FOR USE WITH Laboratory Precision Connector — LPC*

For special applications in which even the minor discontinuities introduced by the support bead in the Type 900-BT connector cannot be tolerated, and in which the inner conductor is otherwise supported in the component, the rod and tube may be machined according to the following procedures, for use with the connector kits described on page 4.

*D. F. Fossum, "Progress Report of the IEEE Instrumentation and Measurement Group Technical Subcommittee on Precision Coaxial Connectors," IEEE Transactions on Instrumentation and Measurement, Vol. IM-13, pp. 285-291; December 1964.



Notes:

1. All dimensions are in inches.
2. With care in machining, diameter changes under machined portion can be kept $< 50 \mu\text{in.}$
3. Surface finish to 25 microinches on end surfaces.
4. With care in machining, diameter changes over holes in inner conductor can be kept $< 30 \mu\text{in.}$

Figure 4. Machining dimensions.

MACHINING TECHNIQUES—LPC

NOTE: In trimming the rod, bear in mind that the front face must lie in the same plane as the tubing; $+0.0000$, -0.0010 in., when the rod is mounted in the coaxial device.

INNER-CONDUCTOR ROD — In order to minimize diameter changes due to machining, the following procedures should be employed:

1. Make all cuts from the outside surface towards the center of the rod, *never* in the reverse direction,

CAUTION

DO NOT SCRATCH THE INNER SURFACE OF THE OUTER CONDUCTOR OR THE OUTER SURFACE OF THE INNER CONDUCTOR, OR THERE IS DANGER OF INTRODUCING ELECTRICAL REFLECTIONS WHICH WOULD DEGRADE PERFORMANCE. ACCUMULATIONS OF DUST AND GRIME CAN HAVE THE SAME EFFECT.

or the surface plating may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true.

For use with the Type 900-AP Kit—

- (1) Drill a hole, 0.110 ± 0.002 inch in diameter, $31/32 \pm 0.001$ inch deep.
- (2) Bore 0.140 ± 0.001 inch diameter, $29/32 \pm 1/64$ inch deep, and observe concentricity with OD to within 0.001 TIR (Total Indicated Runout).
- (3) Chamfer lead to 0.110-inch diameter hole with 0.008 ± 0.002 -inch wide by $80^\circ \pm 5^\circ$ included-angle chamfer.

For use with the Type 900-AC Kit—

Machine the insert hole (see Figure 4).

OUTER CONDUCTOR TUBING — In order to minimize diameter changes due to machining, and to obtain the best concentricity, observe the following procedure:

A. Cut the tubing 0.25 inch longer than required. In both ends, machine centers that have a 60° pitch and a depth of $1/16 \pm 1/64$. Chuck the piece on the centers and turn the outer diameters at the ends down to 0.810 ± 0.001 , Figure 4 shows the minimal area to be turned down.

B. Trim the tubing to the required length, plus 0.002 ± 0.001 . Make all cuts to final length from the inside diameter outwards, *never* in the reverse direction, or the plating on the inner diameter may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true.

Turn down the outer diameter to the dimensions shown in Figure 4, as follows:

- (1) Set the lathe to turn at approximately 2000 rpm.
- (2) Limit the cut to 6 mils.
- (3) Use a light cutting pressure and no lubrication.
- (4) Chase the $3/4$ -27NS-2A threads with a single-point tool.

TUBING EXTERIOR FINISH

While the interior surface of the tubing is precision finished, the exterior has an unfinished appearance,

since the tubing is raw stock intended for further machining. Upon completion of all machining operations, the remaining unworked exterior surface may be turned down slightly to achieve a finished appearance.

CAUTION

AVOID ANY DIPPING OR CLEANING PROCESS, AS THE INTERIOR SURFACE COULD BE DAMAGED.

Rewrap and seal unused portions in the paper sheath provided; the sheath is chemically treated to retard tarnishing.

SKIN-EFFECT CORRECTIONS

The characteristic impedance of lines fabricated from this material is nominally 50 ohms, assuming zero skin depth. The characteristic impedance and the electrical length of these lines may be corrected for the skin effect, in critical applications, by the use of the expressions given below. The specific manner in which the characteristic impedance is corrected depends upon the particular application.

Corrected Characteristic Impedance

A graph for the impedance-magnitude error, or deviation from 50 ohms, is given in Figure 1.

The corrected characteristic impedance, Z_c , can be calculated in complex form from

$$Z_c \cong Z_0 + \frac{(1-j) 0.0284}{\sqrt{f_{\text{GHz}}}} \%$$

where: Z_0 is the nominal value, 50 ohms $\pm 0.05\%$. This expression is an approximation from

$$Z_c = Z_0 \left[1 + \frac{(1-j) 0.000568}{\sqrt{f_{\text{GHz}}}} \right]^{1/2}$$

which itself is an approximation that is accurate down to 1 MHz.

The graph is a plot of

$$|Z_c| \text{ Error} = \left\{ 50 \left[\left| 1 + \frac{(1-j) 0.000568}{\sqrt{f_{\text{GHz}}}} \right|^{1/2} - 1 \right] \right\}$$

expressed as a percentage of 50 ohms.

Data in the graph is given only for frequencies above 30 MHz, because below this frequency the current penetrates into the brass, and accurate calculation is not possible. The dotted portion is the estimated error in the composite medium.

Corrected Electrical Length

The corrected electrical line length, L_c , can be calculated from

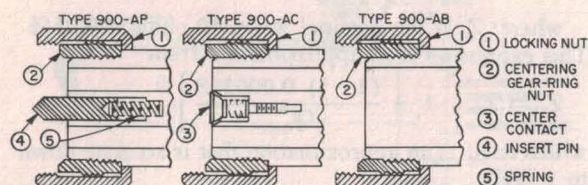
$$L_c = L_0 + \frac{0.0284}{\sqrt{f_{\text{GHz}}}} \%$$

where: L_0 is the nominal electrical length, which is obtained from the physical length by use of the velocity-of-propagation value of 2.99687. This velocity takes into account the exact speed of light, the dielectric constant of air at standard pressure and temperature, and a relative humidity of 60%.

These corrections are based upon the skin-depth in pure silver (resistivity of 1.62×10^{-6} ohm-cm). The actual resistivity of the silver layer in this material lies between 1.62×10^{-6} ohm-cm and 1.72×10^{-6} ohm-cm. In the worst case, the correction term can be in error by 3%, because the error varies directly as the square root of the resistivity; this error is negligible.

GR900 LABORATORY PRECISION CONNECTOR KITS

Three kits are available for custom fabrication of air lines and terminations compatible with the GR900 Connector.



GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 900-LB PRECISION SLOTTED LINE

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

CONSULT YOUR GENERAL RADIO CATALOG FOR DETAILS

GENERAL RADIO COMPANY • WEST CONCORD, MASSACHUSETTS 01781

• NEW ENGLAND: 22 Baker Avenue
West Concord, Mass: 01781

• METROPOLITAN NEW YORK: Broad Avenue at Linden
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Cleveland, Ohio 44129

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Mountain View, California 94040

• LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038

• CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302

• TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada

DESCRIPTION

This Type 900-AB kit contains the attaching hardware of a GR900 connector required to make up one Laboratory Precision Connector (LPC) assembly. The term LPC was originated by a subcommittee of the IEEE on standardization of precision coaxial connectors to describe a connector that requires no dielectric support. Actually, the connector inner- and outer-conductor contact surfaces are integral with the component.

This version of the LPC does not have a GR900 inner-conductor contact. It depends for electrical contact on its connection with the GR900 (Type 900-BT) General Precision Connector (GPC) or with an LPC connector assembled from a Type 900-AC kit. Such a contacting means is achieved because the spring-loaded GR900 inner-conductor contact needs only to butt against any flat smooth surface for proper connection.

APPLICATIONS

Typical component or test-section types that can employ this kit are described below. Precision coaxial air line components can be constructed if the kit is mounted on General Radio Precision Rod (P/N 0900-9508) and Precision Tubing (P/N 0900-9509) as the basic coaxial inner and outer conductors, respectively. These items are intended for use in the fabrication of custom GR900 air-line elements that require precise diameter, excellent surface finish, and low-loss characteristics. Rod and tubing, available in 26-inch lengths specially packed to retard tarnish, possess critical surface dimensions and finish.

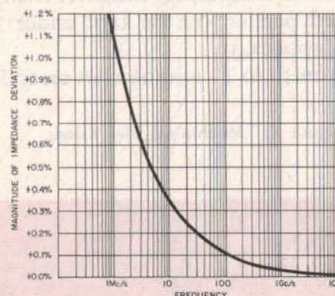


Figure 1. Skin-effect characteristic impedance error as a function of frequency for GR900 line.

The characteristic impedance of a transmission line made of this material, at frequencies where skin depth is negligible, is 50 ± 0.0325 ohms, or $\pm 0.065\%$. The skin-depth deviation in characteristic impedance as a function of frequency is shown in Figure 1.

There is a practical physical limit to the length of the precision air line that can be made of this material, because of inner-conductor sag. For instance, the characteristic-impedance error for an incremental section whose center conductor is 0.005 inch off center is 0.046%, and the error increases exponentially as the length increases.

The physical length of the air line (exactly one wavelength long), taking into account the velocity of light and the dielectric constant of air, can be computed as follows:

$$l = \frac{29.9687}{f_{Ge}} \text{ cm}, = \frac{11.7987}{f_{Ge}} \text{ inch.}$$

The minimum length is 5.0 cm.

1. PRECISION SHORT CIRCUITS

Short-circuit terminations, with the reference plane set back from zero to about 15 cm, can be assembled with this kit. The limitation on the set-back is determined by sag of the inner conductor, which should not exceed 0.005 inch.

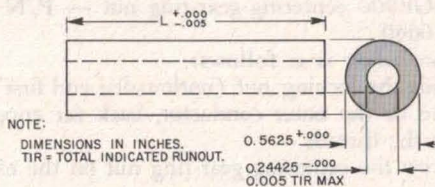


Figure 2. Dielectric sample fabrication for measurement inside GR900 custom air line.

2. DIELECTRIC SAMPLE HOLDER

The GR900 Rod and Tubing stock can be assembled with a pair of connector kits into an air-line dielectric-material sample holder. As such, it can be used with the Type 900-LB Precision Slotted Line to measure the dielectric constant and dielectric loss of materials that can be fabricated into cylindrical samples, with a hole through the center (see Figure 2). Measurements can be conveniently made over a frequency range of 300 Mc/s to 9.0 Gc/s and over the entire range of dielectric constants and losses normally

900-AB

TYPE 900-AB

LABORATORY PRECISION

CONNECTOR KIT

FEBRUARY 1965

Form 0900-0280A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

encountered. Because of the low and uniformly distributed losses of the slotted line and the custom air lines, accurate measurements can be made of the loss in the lowest-loss materials presently available.

The shape of the sample is dictated by the use of the GR900 air line as the sample holder. The tolerances on diameters should be held as tight as possible to prevent air gaps between the dielectric material and the inner and outer conductors.

CAUTION

RIGID MATERIAL MAY SCRATCH OR WARP THE AIR LINE IF FORCE-LOADED.

The length of the dielectric sample must be equal to, or slightly less than, the length of the air line. If it is not convenient to make the sample in one piece the full length of the air line, several shorter segments may be stacked to achieve the required total length. There must be no air gap between segments, however, which means that the butting surfaces must be flat and perpendicular to the axis.

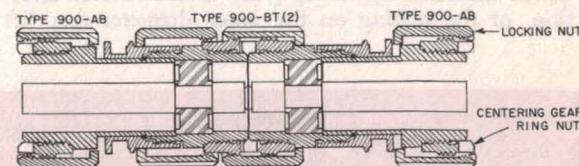


Figure 3. Representative two-port test section fabricated with the Type 900-AB Connector Kit.

3. AIR-LINE SECTIONS

The GR 900 Rod and Tubing stock can be used with this connector kit to assemble two-port test sections that have dielectric support or other internal means of supporting the inner conductor, as shown in Figure 3.

This kit cannot be used to mate with the Type 900-LZ Reference Air Line series, because they can mate only with a connector with a contact in its inner conductor. The General Radio Type 900-AC Kit is identical except that it includes, in addition, the contact required for applications involving the Type 900-LZ Reference Air Line or the Type 900-AP kit.

RECOMMENDED MACHINING TECHNIQUES

NOTE

In trimming the rod, bear in mind that the front face must lie in the same plane as the tubing, $+0.0000$, -0.0010 in., when the rod is mounted in the coaxial device.

INNER-CONDUCTOR ROD

In order to minimize diameter changes due to machining, the following procedures should be employed:

Trim to length. Make all cuts from the outside surface towards the center of the rod, *never* in the reverse direction, or the surface plating may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true, and the surface smooth and flat to within 0.0002 inch.

OUTER CONDUCTOR

In order to minimize diameter changes, the following machining procedures should be employed:

A. Trim to length. Make all final cuts from the inside diameter outwards, *never* in the reverse direction, or the plating on the inner diameter may lift

at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true.

B. Turn down the outer diameter to the dimensions shown in Figure 4, as follows:

- (1) Set the lathe to turn at approximately 2000 rpm.
- (2) Limit the cut to 6 mils.
- (3) Use a light cutting pressure and no lubrication.
- (4) Chase the 3/4-27NS-2A threads with a single-point tool.

SURFACE PROTECTION

The silver lining on the inner conductor and on the inner surface of the outer conductor may tarnish and increase loss at microwave frequencies. To retard this effect, it is recommended that a gold flashing of from 4 to 10 microinches in thickness be applied. However, precautions must be taken to prevent excessive buildup.

ASSEMBLY

Use the Type 900-AB Air Line Connector Kit to complete the test section. The kit consists of the following parts (sufficient for one end):

1. GR900 locking nut — P/N 0900-2090
2. GR900 centering-gear-ring nut — P/N 0900-6040

The procedure is as follows:

A. Slide the locking nut (unthreaded end first) over the end of the outer conductor, back far enough to expose the threads.

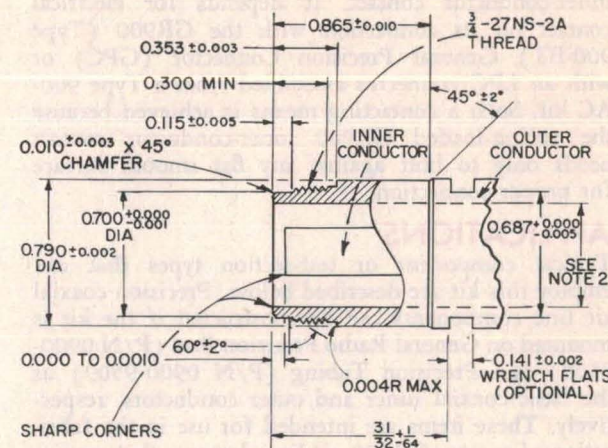
B. Screw the centering-gear-ring nut on the exposed threads.

C. Tighten the gear ring to 3 foot pounds; the special wrench (P/N 0900-1035) of the Type 900-TOK Tool Kit is recommended. Hold the device at the flats with the open-end wrench (P/N 0900-6355).

D. Thread the locking nut over the gear-ring nut.

CAUTION

DO NOT SCRATCH THE INNER SURFACE OF THE OUTER CONDUCTOR OR THE OUTER SURFACE OF THE INNER CONDUCTOR, OR THERE IS DANGER OF INTRODUCING ELECTRICAL REFLECTIONS WHICH WOULD DEGRADE PERFORMANCE.



NOTES:

1. All dimensions are in inches.
2. With care in machining, diameter changes under machined portion can be kept under 50 microinches (approx.).
3. Surface finish to 25 microinches on end surfaces.

Figure 4. Machining dimensions.

GENERAL RADIO COMPANY WEST CONCORD, MASSACHUSETTS 01781

- | | | | | | |
|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------|
| ● METROPOLITAN: Broad Avenue at Linden
NEW YORK: Ridgefield, New Jersey 07637 | ● PHILADELPHIA: Fort Washington Industrial Park
Fort Washington, Pennsylvania 19034 | ● SYRACUSE: Pickard Building, East Molloy Road
Syracuse, New York 13211 | ● WASHINGTON: Rockville Pike at Wall Lane
and BALTIMORE: Rockville, Maryland 20852 | ● CLEVELAND: 5579 Pearl Road
Cleveland, Ohio 44129 | ● ORLANDO: 113 East Colonial Drive
Orlando, Florida 32801 |
| ● CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302 | ● DALLAS: 2501-A West Mockingbird Lane
Dallas, Texas 75235 | ● LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038 | ● SAN FRANCISCO: 1186 Los Altos Avenue
Los Altos, California 94022 | ● TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada | ● MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada |

DESCRIPTION

This Type 900-AC kit contains the attaching hardware of a GR900 connector required to make up one Laboratory Precision Connector (LPC) assembly. The term LPC was originated by a subcommittee of the IEEE on standardization of precision coaxial connectors to describe a connector that requires no dielectric support. Actually, the connector inner- and outer-conductor contact surfaces are integral with the component.

This version of the LPC mates particularly with the Type 900-LZ Reference Air Line series. It also mates with the standard GR900 (Type 900-BT) General Precision Connector (GPC) and LPC connectors made with the Type 900-AB and -AP kits.

APPLICATIONS

Typical component or test-section types that can employ this kit are described below. Precision coaxial air line components can be constructed if the kit is mounted on General Radio Precision Rod (P/N 0900-9508) and Precision Tubing (P/N 0900-9509) as the basic coaxial inner and outer conductors, respectively. These items are intended for use in the fabrication of custom GR900 air-line elements that require precise diameter, excellent surface finish, and low-loss characteristics. Rod and tubing, available in 26-inch lengths specially packed to retard tarnish, possess critical surface dimensions and finish.

The characteristic impedance of a transmission line made of this material, at frequencies where skin depth

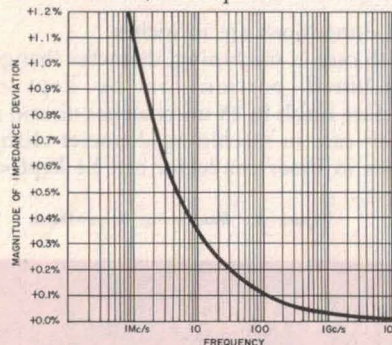


Figure 1. Skin-effect characteristic impedance error as a function of frequency for GR900 line.

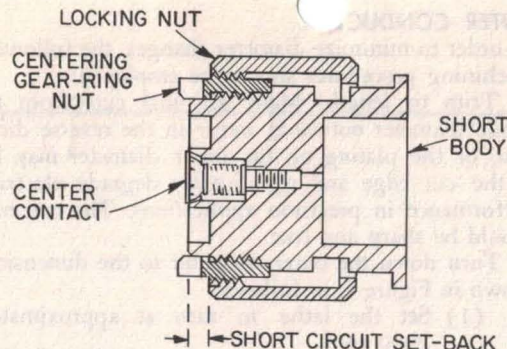


Figure 2. Short-circuit termination with set-back reference plane fabricated with Type 900-AC Kit.

is negligible, is 50 ± 0.0325 ohms, or $\pm 0.065\%$. The skin-depth deviation in characteristic impedance as a function of frequency is shown in Figure 1.

There is a practical physical limit to the length of the precision air line that can be made of this material, because of inner-conductor sag. For instance, the characteristic-impedance error for an incremental section whose center conductor is 0.005 inch off center is 0.046%, and the error increases exponentially as the length increases.

The physical length of the air line (exactly one wavelength long), taking into account the velocity of light and the dielectric constant of air, can be computed as follows:

$$l = \frac{29.9687}{f_{\text{Gc}}} \text{ cm}, = \frac{11.7987}{f_{\text{Gc}}} \text{ inch.}$$

The minimum length is 5.0 cm.

1. PRECISION SHORT CIRCUITS

Short-circuit terminations, with the reference plane set back from zero to about 15 cm, can be assembled with this kit (see Figure 2). The limitation on the set-back is determined by sag of the inner conductor, which should not exceed 0.005 inch.

2. DIELECTRIC SAMPLE HOLDER

The GR900 Rod and Tubing stock can be assembled with a pair of connector kits into an air-line dielectric-material sample holder. As such, it can be used with the Type 900-LB Precision Slotted Line to measure the dielectric constant and dielectric loss of materials

900-AC

TYPE 900-AC LABORATORY PRECISION CONNECTOR KIT

FEBRUARY 1965

Form 0900-0285A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

that can be fabricated into cylindrical samples, with a hole through the center (see Figure 3). Measurements can be conveniently made over a frequency range of 300 Mc/s to 9.0 Gc/s and over the entire range of dielectric constants and losses normally encountered. Because of the low and uniformly distributed losses of the slotted line and the custom air lines, accurate measurements can be made of the loss in the lowest-loss materials presently available, i.e., $\tan \delta = 0.0003$.

The shape of the sample is dictated by the use of the GR900 air line as the sample holder. The tolerances on diameters should be held as tight as possible to prevent air gaps between the dielectric material and the inner and outer conductors. In fact, a light press fit is most desirable.

CAUTION

**RIGID MATERIAL MAY SCRATCH
OR WARP THE AIR LINE IF FORCE-
LOADED.**

The length of the dielectric sample must be equal to, or slightly less than, the length of the air line. If it is not convenient to make the sample in one piece the full length of the air line, several shorter segments may be stacked to achieve the required total length. There must be no air gap between segments, however, which means that the butting surfaces must be flat and perpendicular to the axis.

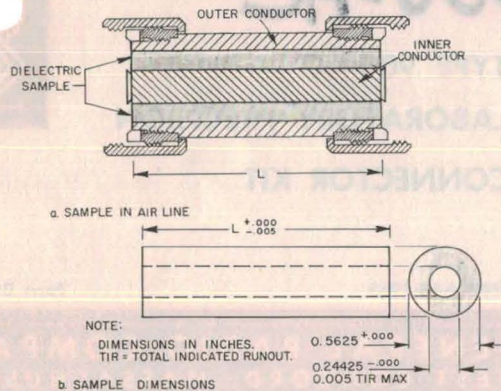


Figure 3. Dielectric sample fabrication for measurement inside GR900 custom air line.

3. AIR-LINE SECTIONS

The GR900 Rod and Tubing stock can be used with this connector kit to assemble two-port test sections that have dielectric support or other internal means of supporting the inner conductor.

MACHINING TECHNIQUES

NOTE

In trimming the rod, bear in mind that the front face must lie in the same plane as the tubing, $+0.0000$, -0.0010 in., when the rod is mounted in the coaxial device.

INNER-CONDUCTOR ROD

In order to minimize diameter changes due to machining, the following procedures should be employed:

A. Trim to length. Make all cuts from the outside surface towards the center of the rod, *never* in the reverse direction, or the surface plating may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true, and the surface smooth and flat to within 0.0002 inch.

B. Machine the insert hole (see Figure 4).

OUTER CONDUCTOR

In order to minimize diameter changes, the following machining procedures should be employed:

A. Trim to length. Make all final cuts from the inside diameter outwards, *never* in the reverse direction, or the plating on the inner diameter may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true.

B. Turn down the outer diameter to the dimensions shown in Figure 4, as follows:

- (1) Set the lathe to turn at approximately 2000 rpm.
- (2) Limit the cut to 6 mils.
- (3) Use a light cutting pressure and no lubrication.
- (4) Chase the 3/4-27NS-2A threads with a single-point tool.

SURFACE PROTECTION

The silver lining on the inner conductor and on the inner surface of the outer conductor may tarnish and increase loss at microwave frequencies. To retard this effect, it is recommended that a gold flashing of from 4 to 10 microinches in thickness be applied. However, precautions must be taken to prevent excessive buildup.

ASSEMBLY

Use the Type 900-AC Air Line Connector Kit to complete the test section. The kit consists of the following parts (sufficient for one end):

1. GR900 locking nut — P/N 0900-2090
2. GR900 centering-gear-ring nut — P/N 0900-6040
3. Center contact — P/N 0900-2000

The procedure is as follows:

A. Slide the locking nut (unthreaded end first) over the end of the outer conductor, back far enough to expose the threads.

B. Screw the centering-gear-ring nut on the exposed threads.

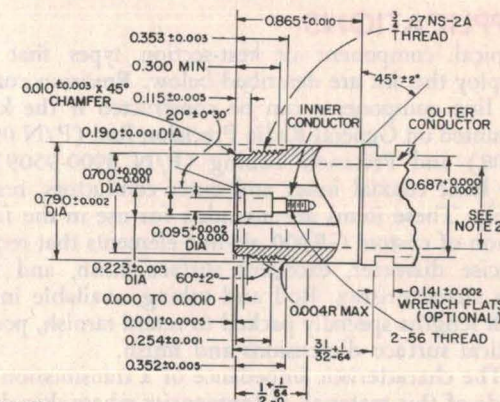
C. Tighten the gear ring to 3 foot pounds; the special wrench (P/N 0900-1035) of the Type 900-TOK Tool Kit is recommended. Hold the device at the flats with the open-end wrench (P/N 0900-6355).

D. Thread the locking nut over the gear-ring nut.

E. Thread the center contact into the assembly and tighten lightly with a 1/16" Allen wrench.

CAUTION

DO NOT SCRATCH THE INNER SURFACE OF THE OUTER CONDUCTOR OR THE OUTER SURFACE OF THE INNER CONDUCTOR, OR THERE IS DANGER OF INTRODUCING ELECTRICAL REFLECTIONS WHICH WOULD DEGRADE PERFORMANCE.



NOTES:

1. All dimensions are in inches.
2. With care in machining, diameter changes under machined portion can be kept $< 50 \mu\text{in}$.
3. Surface finish to 25 microinches on end surfaces.
4. With care in machining, diameter changes over holes in inner conductor can be kept $< 30 \mu\text{in}$.

Figure 4. Machining dimensions.

GENERAL RADIO COMPANY WEST CONCORD, MASSACHUSETTS 01781

- | | | | | | |
|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------|------------------------------------------------------------------------------------|
| ● METROPOLITAN: Broad Avenue at Linden
NEW YORK: Ridgefield, New Jersey 07657 | ● PHILADELPHIA: Fort Washington Industrial Park
Fort Washington, Pennsylvania 19034 | ● SYRACUSE: Pickard Building, East Mallory Road
Syracuse, New York 13211 | ● WASHINGTON: Rockville Pike at Wall Lane
and BALTIMORE: Rockville, Maryland 20852 | ● CLEVELAND: 5579 Pearl Road
Cleveland, Ohio 44129 | ● ORLANDO: 113 East Colonial Drive
Orlando, Florida 32801 |
| ● CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302 | ● DALLAS: 2501-A West Mockingbird Lane
Dallas, Texas 75235 | ● LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038 | ● SAN FRANCISCO: 1186 Los Altos Avenue
Los Altos, California 94022 | ● TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada | ● MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada |

DESCRIPTION

This Type 900-AP kit contains the attaching hardware of a GR900 connector required to make up one Laboratory Precision Connector (LPC) assembly. The term LPC was originated by a subcommittee of the IEEE on standardization of precision coaxial connectors to describe a connector that requires no dielectric support. Actually, the connector inner- and outer-conductor contact surfaces are integral with the component.

This version of the LPC does not have a GR900 inner-conductor contact. It depends for both support and contact on its connection with a GR900 (Type 900-BT) General Precision Connector (GPC) or an LPC assembled from a Type 900-AC connector kit. Both of these latter connector types have a centering hole in which the Type 900-AP insert pin is held by its spring to provide inner-conductor support.

APPLICATIONS

Typical component or test-section types that can employ this kit are described below. Precision coaxial air line components can be constructed if the kit is mounted on General Radio Precision Rod (P/N 0900-9508) and Precision Tubing (P/N 0900-9509) as the basic coaxial inner and outer conductors, respectively. These items are intended for use in the fabrication of custom GR900 air-line elements that require precise diameter, excellent surface finish, and low-loss characteristics. Rod and tubing, available in 27-inch lengths specially packed to retard tarnish, possess critical surface dimensions and finish.

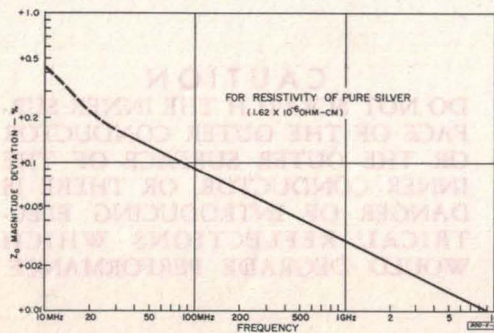


Figure 1. Skin-effect characteristic impedance error as a function of frequency for GR900 line.

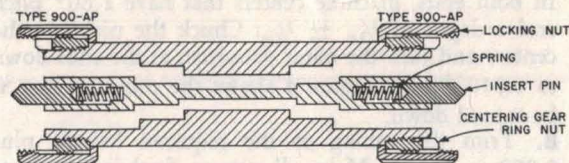


Figure 2. Representative air line configuration that can be fabricated with the Type 900-AP Connector Kit.

The characteristic impedance of a transmission line made of this material, at frequencies where skin depth is negligible, is 50 ± 0.0325 ohms, or $\pm 0.065\%$. The skin-depth deviation in characteristic impedance as a function of frequency is shown in Figure 1.

There is a practical limit (11.81 in. or 30 cm.) to the length of the precision air line that can be made of this material, because of inner-conductor sag. For instance, the characteristic-impedance error for an incremental section whose center conductor is 0.005 inch off center is 0.046%, and the error increases exponentially as the length increases.

The physical length of the air line (exactly one wavelength long), taking into account the velocity of light and the dielectric constant of air, can be computed as follows:

$$l = \frac{29.9687}{f_{\text{GHz}}} \text{ cm}, = \frac{11.7987}{f_{\text{GHz}}} \text{ inch.}$$

The minimum length is 5.0 cm.

1. AIR-LINE SECTIONS

The GR900 Rod and Tubing stock can be used with this connector kit to assemble two-port test sections that have no dielectric support to center the inner conductor. Examples of such test sections are stepped or tapered transitions from one line size to another (see Figure 2). Other uses include the fabrication of reference air lines of any characteristic impedance, in lengths from 5 to 30 cm. The lines can be exactly the same electrical length as an unknown component or test section to permit continuous frequency substitution measurements*.

2. DIELECTRIC SAMPLE HOLDER

The GR900 Rod and Tubing stock can be assembled with a pair of connector kits into an air-line dielectric-material sample holder. As such, it can be used with

900-AP

TYPE 900-AP LABORATORY PRECISION CONNECTOR KIT

FEBRUARY 1966

Form 0900-0295B

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

the Type 900-LB Precision Slotted Line to measure the dielectric constant and dielectric loss of materials that can be fabricated into cylindrical samples, with a hole through the center (see Figure 3). Measurements can be conveniently made over a frequency range of 300 MHz to 8.5 GHz and over the entire range of dielectric constants and losses normally encountered. Because of the low and uniformly distributed losses of the slotted line and the custom air lines, accurate measurements can be made of the loss in the lowest-loss materials presently available, i.e., $\tan \delta = 0.0003$.

The shape of the sample is dictated by the use of the GR900 air line as the sample holder. The tolerances on diameters should be held as tight as possible to prevent air gaps between the dielectric material and the inner and outer conductors. In fact, a light press fit is most desirable.

CAUTION

**RIGID MATERIAL MAY SCRATCH
OR WARP THE AIR LINE IF FORCE-
LOADED.**

The length of the dielectric sample must be equal to, or slightly less than, the length of the air line. If it is not convenient to make the sample in one piece the full length of the air line, several shorter segments may be stacked to achieve the required total length. There must be no air gap between segments, however, which means that the butting surfaces must be flat and perpendicular to the axis.

*Refer to Operating Instructions, Type 900-LB Precision Slotted Line, Section 4, General Radio Company.

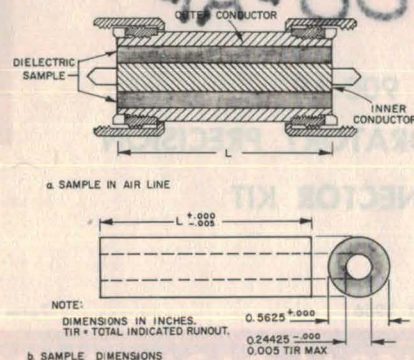


Figure 3. Dielectric sample fabrication for GR900 custom air line.

MACHINING TECHNIQUES

NOTE

In trimming the rod, bear in mind that the front face must lie in the same plane as the tubing, $+0.0000$, -0.0010 in., when the rod is mounted in the coaxial device.

INNER-CONDUCTOR

In order to minimize diameter changes due to machining, the following procedures should be employed:

A. Trim to length. Make all cuts from the outside surface towards the center of the rod, *never* in the reverse direction, or the surface plating may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true, and the surface smooth and flat to within 0.0002 inch.

B. Machine the insert hole (see Figure 4).

- (1) Drill a hole, 0.110 ± 0.002 inch in diameter, $31/32 \pm 1/64$ inch deep.
- (2) Bore 0.140 ± 0.001 inch diameter, $29/32 \pm 1/64$ inch deep, and observe concentricity with OD to within 0.001 TIR (Total Indicated Runout).
- (3) Chamfer lead to 0.110 -inch diameter hole with 0.008 ± 0.002 -inch wide by $80^\circ \pm 5^\circ$ included-angle chamfer.

OUTER CONDUCTOR

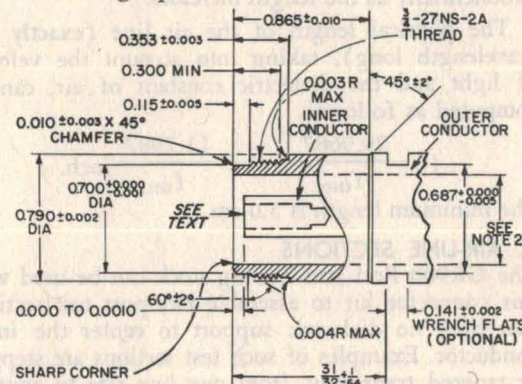
In order to minimize diameter changes, the following machining procedures should be employed:

A. Cut the tubing 0.25 inch longer than required. In both ends, machine centers that have a 60° pitch and a depth of $1/16 \pm 1/64$. Chuck the piece on the centers and turn the outer diameters at the ends down to 0.810 ± 0.001 ; Figure 4 shows the minimal area to be turned down.

B. Trim the tubing to the required length, plus 0.002 ± 0.001 . Make all cuts to final length from the inside diameter outwards, *never* in the reverse direction, or the plating on the inner diameter may lift at the cut edge and significantly degrade electrical performance in precision applications. The cut edge should be sharp and true.

C. Turn down the outer diameter to the dimensions shown in Figure 4, as follows:

- (1) Set the lathe to turn at approximately 2000 rpm.
- (2) Limit the cut to 6 mils.
- (3) Use a light cutting pressure and no lubrication.
- (4) Chase the $3/4$ -27NS-2A threads with a single-point tool.



NOTES:

1. All dimensions are in inches.
2. With care in machining, diameter changes under machined portion can be kept $< 50 \mu\text{in}$.
3. Surface finish to 25 microinches on end surfaces.
4. With care in machining, diameter changes over holes in inner conductor can be kept $< 30 \mu\text{in}$.

Figure 4. Machining dimensions.

SURFACE PROTECTION

The silver lining on the inner conductor and on the inner surface of the outer conductor may tarnish and increase loss at microwave frequencies. To retard this effect, it is recommended that a gold flashing of from 4 to 10 microinches in thickness be applied. However, precautions must be taken to prevent excessive buildup and to exclude gold from the holes in the inner conductor.

ASSEMBLY

Use the Type 900-AP Air Line Connector Kit to complete the test section. The kit consists of the following parts (sufficient for one end):

1. GR900 locking nut — P/N 0900-2090
2. GR900 centering-gear-ring nut — P/N 0900-6040
3. Centering pin — P/N 0900-6565
4. Inner-contact spring — P/N 0900-6560

The procedure is as follows:

A. Slide the locking nut (unthreaded end first) over the end of the outer conductor, back far enough to expose the threads.

B. Screw the centering-gear-ring nut on the exposed threads.

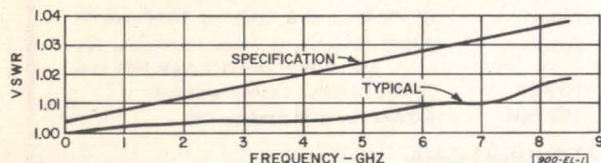
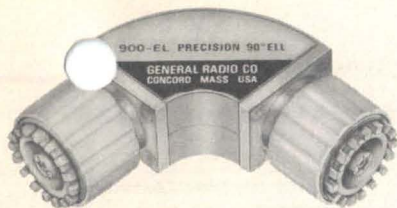
C. Tighten the gear ring to 3 foot pounds; the special wrench (P/N 0900-1035) of the Type 900-TOK Tool Kit is recommended. Hold the device at the flats with the open-end wrench (P/N 0900-6355).

D. Thread the locking nut over the gear-ring nut.

E. Insert the spring and centering pin and bottom the assembly to seat it.

CAUTION

DO NOT SCRATCH THE INNER SURFACE OF THE OUTER CONDUCTOR OR THE OUTER SURFACE OF THE INNER CONDUCTOR, OR THERE IS DANGER OF INTRODUCING ELECTRICAL REFLECTIONS WHICH WOULD DEGRADE PERFORMANCE.



GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-EL Precision 90° Ell comprises two GR900 connectors and a coaxial line of square cross section, the axis of which forms a 90° circular segment. Coplanar compensation is introduced at the junctions of the normal- and square-cross-section lines, so that low VSWR performance is achieved over the full 0–8.5-GHz frequency range.

Owing to transmission-line curvature, the electrical length of the ell, which is nominally 10 cm, increases

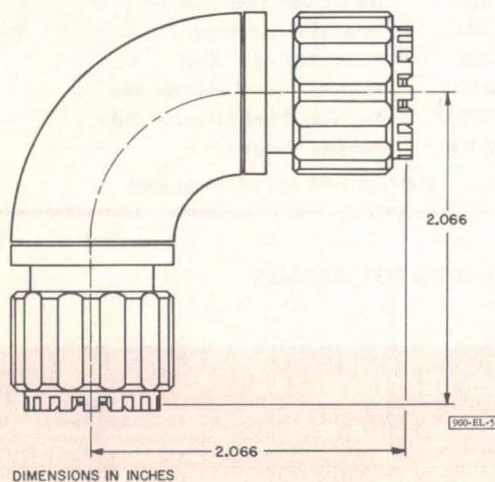
with increasing frequency, as shown. The physical mating dimensions of the ell are also illustrated.

The centering gear rings in both connectors on the ell can be rotated over the span of one gear tooth. Thus, they afford sufficient flexibility at these junctions to permit convenient arrangement of components in a coaxial measurement set-up. There is some danger that the rotational feature in the GR900 junction could damage critical mating surfaces. If the mating surfaces are kept clean, and the rotational adjustment is made before the locking nut is tightened, no damage will occur.

CAUTION

Do not rotate junctions at either end of the ell after the connector locking nut has been tightened.

Use of the elbow for liquid dielectric measurements with the precision slotted line.



Physical length of the elbow.

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

Characteristic Impedance: $50\Omega \pm 0.4\%$ at frequencies where skin effect is negligible.

VSWR: Less than $1.004 + 0.004 f_{\text{GHz}}$.

Electrical Length: $[10.00 + 0.0014 (f_{\text{GHz}})^2 \pm 0.02]$ cm.

Insertion Loss: Less than $0.017 \sqrt{f_{\text{GHz}}} \text{ dB}$.

Maximum Voltage: 1500 V peak.

Maximum Power: 10kW up to 1 MHz; $10 \text{ kW}/\sqrt{f_{\text{MHz}}}$ above 1 MHz.

Mating Dimensions: 2.066 in. (5.246 cm) from center line of one connector to reference plane of second connector.

Over-all Dimensions: $2\frac{1}{16} \times 2\frac{1}{16} \times \frac{7}{8}$ in. (68, 68, 22mm).

Net Weight: 10 oz. (280 g).

Type 900-EL

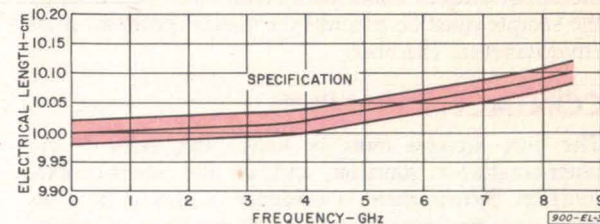
PRECISION 90° ELL

50 OHMS

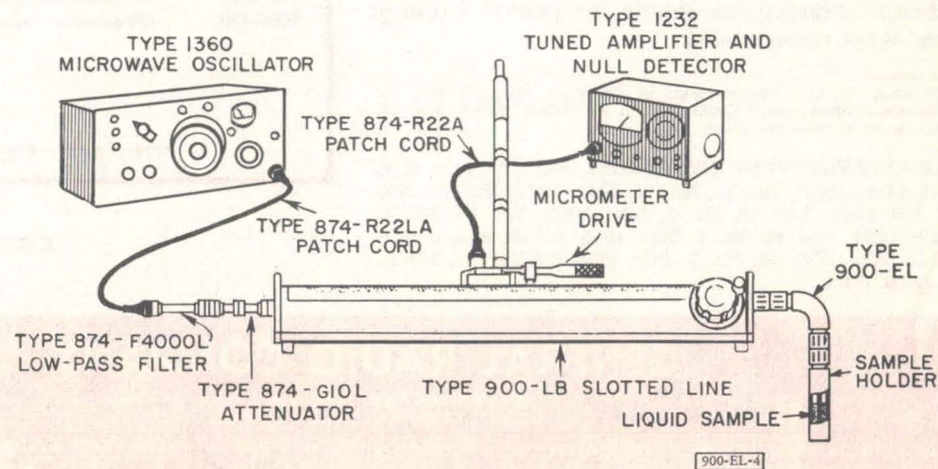
JANUARY 1967

FORM 0900-0147A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



Variation of the electrical length of the elbow with respect to frequency.



APPLICATIONS

The Type 900-EL precision ell furnishes a 90° bend for a transmission-line path while introducing only very small reflections. It can be used in power-dividing circuits, in phased-array feed systems, and in precision phase- or attenuation-measuring systems, where complex interconnections with a minimum of reflection and phase distortion are required.

In conjunction with the Type 900-LB Precision Slotted Line and a dielectric-sample holder, the Type 900-EL provides a means of measurement of the dielectric constant and loss tangent of liquid dielectrics, since the sample holder can be used in a vertical position.¹ The ell also simplifies measurements on dielectric samples under temperature variations, when the sample must be placed in a vertical position in an environmental chamber.

CONTACT CLEANING

The butt surfaces must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. The recommended solvents to be used in cleaning are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, and petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended.

¹Gilmore, J. F., "Measurements of Dielectric Materials with the Precision Slotted Line," General Radio *EXPERIMENTER*, Vol. 40, No. 5, May 1966, pp 12-19.

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan. 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965; Vol. 40, No. 5, May, 1966. All above in reprint E115. Also; Vol. 40, No. 7, July, 1966 and Vol. 40, No. 8, August 1966.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJA	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJA	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QNJA	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Precifix 7 mm
900-QSCJA	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJA	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-EL	Precision 90° Ell
900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9507	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

CONSULT YOUR GENERAL RADIO CATALOG FOR DETAILS

GENERAL RADIO COMPANY • WEST CONCORD, MASSACHUSETTS 01781

• NEW ENGLAND: 22 Baker Avenue
West Concord, Mass. 01781

• METROPOLITAN NEW YORK: Broad Avenue at Linden
Ridgefield, New Jersey 07657

• SYRACUSE: Pickard Building, East Molloy Road
Syracuse, New York 13211

• PHILADELPHIA: Fort Washington Industrial Park
Fort Washington, Pennsylvania 19034

• WASHINGTON and BALTIMORE: 11420 Rockville Pike
Rockville, Maryland 20852

• CLEVELAND: 5579 Pearl Road
Cleveland, Ohio 44129

• DALLAS: 2600 Stemmons Freeway, Suite 210
Dallas, Texas 75207

• ORLANDO: 113 East Colonial Drive
Orlando, Florida 32801

• SAN FRANCISCO: 626 San Antonio Road
Mountain View, California 94040

• LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038

• CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302

• TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada

SPECIFICATIONS



Frequency Range: 0-8.5 GHz.
Attenuation: 6.00 ± 0.2 dB 0-5 GHz.
 6.00 ± 0.3 dB 5-8.5 GHz.
SWR: 1.01 to 1 GHz; $1.00 + .01 \times f_{\text{GHz}}$ above 1 GHz.
Characteristic Impedance: 50 Ω .
Dc Resistance: $50.0 \Omega \pm 0.3\%$ when terminated in 50.0 Ω .
CW Power: 1.0 W continuous.
Peak Power: 500 W with 1 W average.
Temperature Coefficient: Less than .0001 dB/ $^{\circ}$ C/dB.
Dimensions: 3-3/4 X 1-3/4 X 1-1/16 inches, (95 X 45 X 27) mm.
Net Weight: 11 oz. (310) g.

GR900® PRECISION COAXIAL COMPONENTS

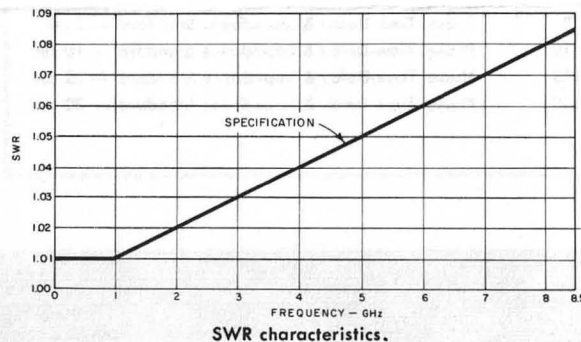
DESCRIPTION

The 900-G6 Precision Fixed Attenuator is a 6-dB coaxial attenuator equipped with GR900 Precision Connectors and featuring very low VSWR, accurate attenuation, and flat frequency response, along with the repeatability of the GR900 connector. The VSWR and attenuation specifications are shown above.

The attenuating element is a high-stability deposited metal-film resistor on a beryllium-oxide substrate.

WARNING

The attenuator should not be disassembled since toxic dust can result if the resistor is accidentally crushed.



APPLICATIONS

Impedance Matching

The low VSWR of the 900-G6 Attenuator makes it ideal as a matching device in wideband measurements and eliminates the need for tuners in many point-by-point measurements. For example, it can be used to match generator or detector ports of a hybrid or directional coupler used in a reflectometer system. It can be used in precision insertion-loss measurements for matching generator or detector. In slotted-line measurements, a 900-G6 can be used to match the generator or to reduce the VSWR of an isolator output port. In systems where large amounts of attenuation are required, it can be used with a GR900 Adaptor to reduce the VSWR of a secondary pad. It can be used with a pair of GR900 Adaptors to make a low VSWR attenuator with many different output connectors.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

General Radio



Type 900-G6

PRECISION COAXIAL ATTENUATOR—6 dB

50 OHMS

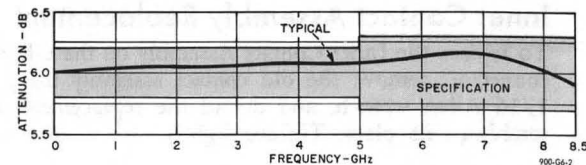
MARCH 1973

FORM 0900-0193B

CONCORD, MASSACHUSETTS

Attenuation Standard

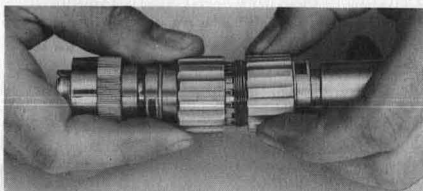
The 900-G6 Precision Fixed Attenuator is an accurate standard of attenuation in rf substitution measurements. The response is within ± 0.3 dB of the nominal value over the frequency range and five calibrated values are supplied. As a calibration standard, the 900-G6 can itself be accurately calibrated because of the low VSWR and because it is equipped with GR900 Connectors that are repeatable within $\pm .002$ dB.



Attenuation Characteristics

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

Inner Contact Assembly Replacement

To replace the Inner Contact Assembly on the GR900 connector, remove the old contact assembly using a 1/16 Allen wrench, and thread the replacement assembly in its place. Tighten lightly.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeat-

ability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.

GR900® COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC-Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Precifix 7 mm
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-Q9	Connects to binding posts

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector (RG-9/U)
900-C58	GR900 Precision Cable Connector (RG-58/U)
900-PKM	GR900 Panel Mounting Kit
900-PKMR	GR900 Panel Mounting Kit (Rotatable)
900-L3	Phase, Time-Delay & Impedance Standard — 3 cm
900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

* Reg. Trademark, Omni-Spectra, Inc., Southfield, Mich.



General Radio

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 • GR COMPANIES • Grason-Stadler • Time/Data • Techware Computing Corp. • GR ASSOCIATE • Micronetic Systems Inc.



SPECIFICATIONS

Frequency Range: 0- 8.5 GHz.
Attenuation: 6.00 ± 0.2 dB 0-5 GHz.
 6.00 ± 0.3 dB 5-8.5 GHz.
SWR: 1.01 to 1 GHz; $1.00 + .01 \times f_{\text{GHz}}$ above 1 GHz.
Characteristic Impedance: 50 Ω .
Dc Resistance: $50.0 \Omega \pm 0.3\%$ when terminated in 50.0 Ω .
CW Power: 1.0 W continuous.
Peak Power: 500 W with 1 W average.
Temperature Coefficient: Less than .0001 dB/ $^{\circ}$ C/dB.
Dimensions: 3-3/4 X 1-3/4 X 1-1/16 inches, (95 X 45 X 27) mm.
Net Weight: 11 oz. (310) g.

GR900® PRECISION COAXIAL COMPONENTS

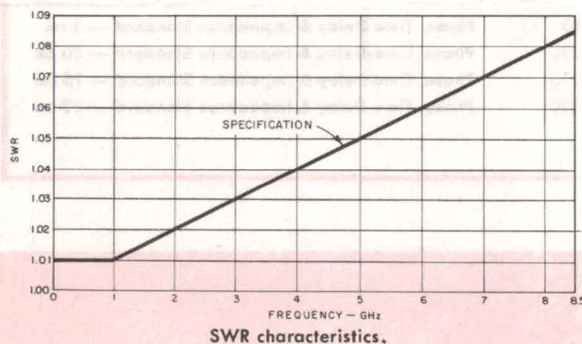
DESCRIPTION

The 900-G6 Precision Fixed Attenuator is a 6-dB coaxial attenuator equipped with GR900 Precision Connectors and featuring very low VSWR, accurate attenuation, and flat frequency response, along with the repeatability of the GR900 connector. The VSWR and attenuation specifications are shown above.

The attenuating element is a high-stability deposited metal-film resistor on a beryllium-oxide substrate.

WARNING

The attenuator should not be disassembled since toxic dust can result if the resistor is accidentally crushed.



APPLICATIONS

Impedance Matching

The low VSWR of the 900-G6 Attenuator makes it ideal as a matching device in wideband measurements and eliminates the need for tuners in many point-by-point measurements. For example, it can be used to match generator or detector ports of a hybrid or directional coupler used in a reflectometer system. It can be used in precision insertion-loss measurements for matching generator or detector. In slotted-line measurements, a 900-G6 can be used to match the generator or to reduce the VSWR of an isolator output port. In systems where large amounts of attenuation are required, it can be used with a GR900 Adaptor to reduce the VSWR of a secondary pad. It can be used with a pair of GR900 Adaptors to make a low VSWR attenuator with many different output connectors.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

General Radio



Type 900-G6

PRECISION COAXIAL ATTENUATOR—6 dB

50 OHMS

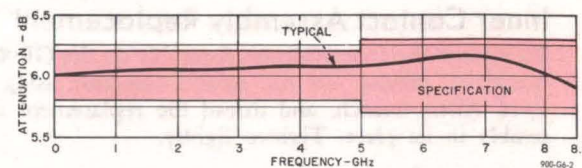
MARCH 1973

FORM 0900-0193E

CONCORD, MASSACHUSETTS

Attenuation Standard

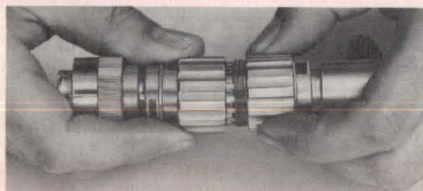
The 900-G6 Precision Fixed Attenuator is an accurate standard of attenuation in rf substitution measurements. The response is within ± 0.3 dB of the nominal value over the frequency range and five calibrated values are supplied. As a calibration standard, the 900-G6 can itself be accurately calibrated because of the low VSWR and because it is equipped with GR900 Connectors that are repeatable within $\pm .002$ dB.



Attenuation Characteristics

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

Inner Contact Assembly Replacement

To replace the Inner Contact Assembly on the GR900 connector, remove the old contact assembly using a 1/16 Allen wrench, and thread the replacement assembly in its place. Tighten lightly.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeat-

ability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.

GR900® COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC-Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Precifix 7 mm
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-Q9	Connects to binding posts

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector (RG-9/U)
900-C58	GR900 Precision Cable Connector (RG-58/U)
900-PKM	GR900 Panel Mounting Kit
900-PKMR	GR900 Panel Mounting Kit (Rotatable)
900-L3	Phase, Time-Delay & Impedance Standard — 3 cm
900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

* Reg. Trademark, Omni-Spectra, Inc., Southfield, Mich.



General Radio

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 • GR COMPANIES • Grason-Stadler • Time/Data • Techware Computing Corp. • GR ASSOCIATE • Micronetic Systems Inc.

SPECIFICATIONS



Frequency Range: DC to 9 Gc.
Characteristic Impedance: 50 ohms $\pm 0.1\%$.
VSWR: Less than $1.0013 + 0.0013 \times f_{Mc}$, including connectors.
Repeatability: Within 0.05%
Leakage: Better than 130 db below signal.
Insertion Loss: Less than $0.012 \sqrt{f_{Mc}}$ db.
Voltage: 3000 volts peak.
Power: 20 kilowatts up to 1 Mc; 20 kw/ $\sqrt{f_{Mc}}$ above 1 Mc.

Electrical Length: 10.00 ± 0.02 cm, between mating surfaces of Type 900-BT connectors.

DC Contact Resistance (each end): Inner conductor, less than 0.5 milliohm; outer conductor, less than 0.07 milliohm.

Dimensions: Length, 4 inches (102 mm); maximum diameter, $1\frac{1}{16}$ inch (27 mm).

Net Weight: $6\frac{1}{2}$ ounces (185 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Type 900-L10 10CM PRECISION COAXIAL AIR LINE

50 OHMS

OCTOBER 1963

FORM 0900-0200A

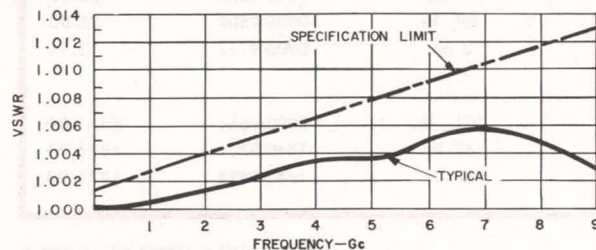
GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

PRECISION COAXIAL ELEMENTS

DC TO MICROWAVE

DESCRIPTION

The Type 900-L10 Precision Air Line is a section of precision coaxial transmission line fitted with a Type 900-BT Precision Coaxial Connector at each end. The inner- and outer-conductor diameters of the air line are held to extremely close dimensional tolerances: the inner conductor to ± 65 microinches, with variations less than ± 25 microinches along a given rod; the outer conductor to ± 140 microinches. The basic material of the Type 900-L10 air line is brass with a layer of silver at the conducting surfaces. The silver is protected from tarnishing by a gold plating.

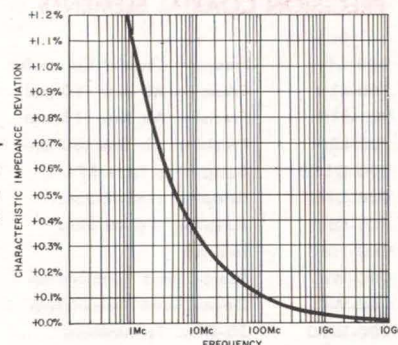


VSWR characteristics of the Type 900-L10 Air Line.

APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly

Skin-effect characteristic impedance error as a function of frequency, Type 900-L10.



by the conductor diameters. In this application, the Type 900-L10 air line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of reflection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured

reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-L10 air line is an odd multiple of a quarter-wavelength:

$n\lambda/4$	Frequency-Gc	$n\lambda/4$	Frequency-Gc
1	0.75	7	5.25
3	2.25	9	6.75
5	3.75	11	8.25

The Type 900-L10 air line can also be used as a precision time-delay standard of 333.7 picoseconds. The line is held to an electrical length variation of ± 0.012 centimeter, which is equivalent to a ± 0.4 picosecond delay difference.

When terminated in a Type 900-WN Precision Short-Circuit Termination or a Type 900-WO Precision Open-Circuit Termination, a Type 900-L10 provides a well-defined reactance standard.

Also, the Type 900-L10 air line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the connectors should be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the inner and outer

connectors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the connectors for nicks or protrusions (however minor) on the butting surfaces of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted.

REFERENCES

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1 January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," Instrument Society of America, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

PRECISION COAXIAL ELEMENTS AND EQUIPMENT

TYPE 900-LB PRECISION SLOTTED LINE

A 50-cm, coaxial slotted line terminated in a Type 900-BT connector (with the same VSWR characteristics as the connector from 300 Mc to 9 Gc). It has a characteristic impedance of 50 ohms $\pm 0.1\%$, scale accuracy of $\pm(0.1 \text{ mm} + 0.05\%)$, and a constancy of probe pickup of $\pm 0.5\%$. Residual VSWR is less than $1.001 + 0.001 \times f_{\text{Gc}}$. Supplied complete with vernier-drive carriage, adjustable probe, tuning stub, and crystal detector.

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

This complete system automatically and accurately plots VSWR's from 1.001 to 1.20 as well as positions of minima and reference plane. It consists of a Type 900-LB Slotted Line linked to a Type 1521-SL Slotted Line Recorder, which drives the probe carriage of the line and synchronously and faithfully provides a permanent plot of the detector output.

ORDERING INFORMATION

PRECISION COAXIAL ELEMENTS

Type	
900-BT	Precision Coaxial Connector
900-L10	Precision Air Line (10 cm)
900-L15	Precision Air Line (15 cm)
900-L30	Precision Air Line (30 cm)
900-Q874	Adaptor to Type 874
900-QNJ	Adaptor, type-N Jack
900-QNP	Adaptor, type-N Plug
900-TOK	Tool Kit
900-WN	Short-Circuit Termination
900-WO	Open-Circuit Termination
900-W50	50-Ohm Termination
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

Length inches	Net Weight*	Code Number	Price
1 1/16	2 oz.	0900-9405	\$35.00
4	6 1/2 oz.	0900-9605	85.00
6	10 oz.	0900-9607	90.00
12	15 oz.	0900-9613	100.00
2 7/16	3 1/2 oz.	0900-9883	45.00
2 1/4	3 1/2 oz.	0900-9711	50.00
2 5/16	4 oz.	0900-9811	50.00
—	2 lb.	0900-9902	95.00
1 1/16	2 1/2 oz.	0900-9971	9.00
1 1/16	2 oz.	0900-9981	9.00
2	3 1/2 oz.	0900-9953	60.00
27	7 oz.	0900-9508	25.00
27	2 1/2 lb.	0900-9509	35.00
—	3 oz.	0900-9782	3.50

PRECISION COAXIAL EQUIPMENT

900-LB	Precision Slotted Line	10 3/4 lb.	0900-9651	\$575.00
1640-A	Slotted Line Recorder System (60 cps)	67 lb.	1640-9701	1875.00
1640-AQ1	Slotted Line Recorder System (50 cps)	67 lb.	1640-9494	1875.00

*To convert ounces to grams, multiply by 28; pounds to kg, divide by 2.2.

Prices subject to change without notice.

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GENERAL RADIO COMPANY

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• SAN FRANCISCO: 1186 Los Altos Ave.
Los Altos, Cal.

• MONTREAL: Office 395, 1255 Laird Blvd.
Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Frequency Range: DC to 9 Gc.
Characteristic Impedance: 50 ohms $\pm 0.1\%$.
VSWR: Less than $1.0013 + 0.0013 \times f_{Gc}$, including connectors.
Repeatability: Within 0.05%
Leakage: Better than 130 db below signal.
Insertion Loss: Less than $0.016 \sqrt{f_{Gc}}$ db.
Voltage: 3000 volts peak.
Power: 20 kilowatts up to 1 Mc; 20 kw/ $\sqrt{f_{Mc}}$ above 1 Mc.

Electrical Length: 15.00 ± 0.02 cm, between mating surfaces of Type 900-BT connectors.
DC Contact Resistance (each end): Inner conductor, less than 0.5 milliohm; outer conductor, less than 0.07 milliohm.
Dimensions: Length, 6 inches (153 mm); maximum diameter, $1\frac{1}{8}$ inch (27 mm).
Net Weight: 10 ounces (285 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

900-L15
 Type 900-L15

15CM PRECISION COAXIAL AIR LINE

50 OHMS

OCTOBER 1963

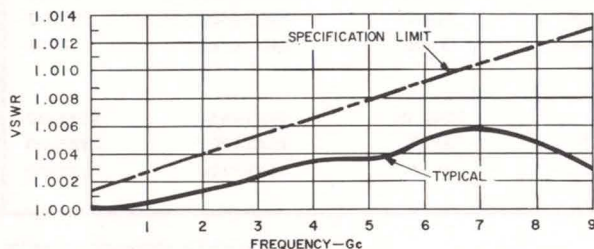
FORM 0900-0210A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

PRECISION COAXIAL ELEMENTS DC TO MICROWAVE

DESCRIPTION

The Type 900-L15 Precision Air Line is a section of precision coaxial transmission line fitted with a Type 900-BT Precision Coaxial Connector at each end. The inner- and outer-conductor diameters of the air line are held to extremely close dimensional tolerances: the inner conductor to ± 65 microinches, with variations less than ± 25 microinches along a given rod; the outer conductor to ± 140 microinches. The basic material of the Type 900-L15 air line is brass with a layer of silver at the conducting surfaces. The silver is protected from tarnishing by a gold plating.

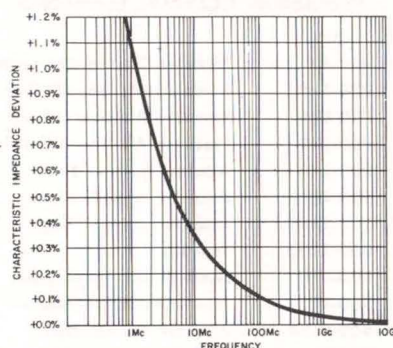


VSWR characteristics of the Type 900-L15 Air Line.

APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly

Skin-effect characteristic impedance error as a function of frequency, Type 900-L15.



by the conductor diameters. In this application, the Type 900-L15 air line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of reflection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured

reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-L15 air line is an odd multiple of a quarter-wavelength:

$n\lambda/4$	Frequency - Gc	$n\lambda/4$	Frequency - Gc
1	0.50	9	4.50
3	1.50	11	5.50
5	2.50	13	6.50
7	3.50	15	7.50

The Type 900-L15 air line can also be used as a precision time-delay standard of 500.6 picoseconds. The line is held to an electrical length variation of ± 0.012 centimeter, which is equivalent to a ± 0.4 picosecond delay difference.

When terminated in a Type 900-WN Precision Short-Circuit Termination or a Type 900-WO Precision Open-Circuit Termination, a Type 900-L15 provides a well-defined reactance standard.

Also, the Type 900-L15 air line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the connectors should be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the inner and outer

conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the connectors for nicks or protrusions (however minor) on the butting surfaces of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted.

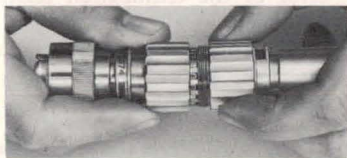
REFERENCES

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1 January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," Instrument Society of America, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

PRECISION COAXIAL ELEMENTS AND EQUIPMENT

TYPE 900-LB PRECISION SLOTTED LINE

A 50-cm, coaxial slotted line terminated in a Type 900-BT connector (with the same VSWR characteristics as the connector from 300 Mc to 9 Gc). It has a characteristic impedance of 50 ohms $\pm 0.1\%$, scale accuracy of $\pm (0.1 \text{ mm} + 0.05\%)$, and a constancy of probe pickup of $\pm 0.5\%$. Residual VSWR is less than $1.001 + 0.001 \times f_{\text{Gc}}$. Supplied complete with vernier-drive carriage, adjustable probe, tuning stub, and crystal detector.

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

This complete system automatically and accurately plots VSWR's from 1.001 to 1.20 as well as positions of minima and reference plane. It consists of a Type 900-LB Slotted Line linked to a Type 1521-SL Slotted Line Recorder, which drives the probe carriage of the line and synchronously and faithfully provides a permanent plot of the detector output.

ORDERING INFORMATION

PRECISION COAXIAL ELEMENTS

Type		Length inches	Net Weight*	Code Number	Price
900-BT	Precision Coaxial Connector	1 3/4	2 oz.	0900-9405	\$35.00
900-L10	Precision Air Line (10 cm)	4	6 1/2 oz.	0900-9605	85.00
900-L15	Precision Air Line (15 cm)	6	10 oz.	0900-9607	90.00
900-L30	Precision Air Line (30 cm)	12	15 oz.	0900-9613	100.00
900-Q874	Adaptor to Type 874	2 3/4	3 1/2 oz.	0900-9883	45.00
900-QNJ	Adaptor, type-N Jack	2 1/4	3 1/2 oz.	0900-9711	50.00
900-QNP	Adaptor, type-N Plug	2 3/4	4 oz.	0900-9811	50.00
900-TOK	Tool Kit	—	2 lb.	0900-9902	95.00
900-WN	Short-Circuit Termination	1 1/4	2 1/2 oz.	0900-9971	9.00
900-WO	Open-Circuit Termination	1 1/4	2 oz.	0900-9981	9.00
900-W50	50-Ohm Termination	2	3 1/2 oz.	0900-9953	60.00
0900-9508	Precision Inner-Conductor Rod	27	7 oz.	0900-9508	25.00
0900-9509	Precision Outer-Conductor Tube	27	2 1/2 lb.	0900-9509	35.00
0900-9782	Adaptor Flange	—	3 oz.	0900-9782	3.50

PRECISION COAXIAL EQUIPMENT

900-LB	Precision Slotted Line	10 3/4 lb.	0900-9651	\$575.00
1640-A	Slotted Line Recorder System (60 cps)	67 lb.	1640-9701	1875.00
1640-AQ1	Slotted Line Recorder System (150 cps)	67 lb.	1640-9494	1875.00

*To convert ounces to grams, multiply by 28; pounds to kg, divide by 2.2.

Prices subject to change without notice.

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• SAN FRANCISCO: 1186 Los Altos Ave.
Los Altos, Cal.

• MONTREAL: Office 395, 1255 Laird Blvd.
Town of Mount Royal, Quebec, Canada



SPECIFICATIONS



Frequency Range: Dc to 8.5 GHz.

Characteristic Impedance: 50 ± 0.0325 ohms or $\pm 0.065\%$ in air section at frequencies where skin depth is insignificant.

VSWR: Less than $1.0013 + 0.0013 \times f_{\text{GHz}}$, including connectors.

VSWR Repeatability: Within 0.0005 or 0.05%.

Leakage: Better than 130 dB below signal.

Insertion Loss: Less than $0.004 \sqrt{f_{\text{GHz}}}$ dB.

Voltage: 3000 V peak.

Power: 20 kW up to 1 MHz; $20 \text{ kW}/\sqrt{f_{\text{MHz}}}$ above 1 MHz.

Capacitance: 2.00 ± 0.01 pF.

Time Delay: 100 ± 0.5 ps.

Electrical Length: 3.00 ± 0.010 cm, between mating surfaces of Type 900-BT connectors.

Dc Contact Resistance (each end): Inner conductor, less than 0.5 milliohm; outer conductor, less than 0.07 milliohm.

Dimensions: Length, $1\frac{1}{8}$ inch (29 mm); maximum diameter, $1\frac{1}{16}$ inch (27 mm).

Net Weight: $2\frac{1}{2}$ oz. (75g).

$0.004 \sqrt{f_{\text{GHz}}} \text{ dB}$

Type 900-L3

3CM PRECISION COAXIAL AIR LINE

50 OHMS

FEBRUARY 1968

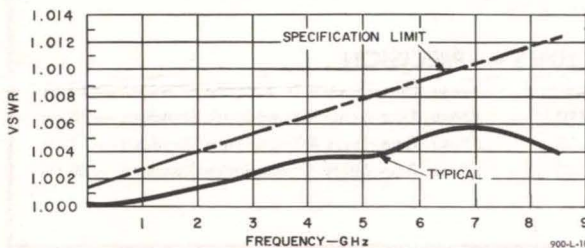
FORM 0900-0199A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-L3 Precision Air Line is a section of precision coaxial transmission line fitted with a Type 900-BT Precision Coaxial Connector at each end. The inner- and outer-conductor diameters of the air line are held to extremely close dimensional tolerances: the inner conductor to ± 65 microinches, with variations less than ± 25 microinches along a given rod; the outer conductor to ± 140 microinches. The basic material of the Type 900-L3 air line is brass with a layer of silver at the conducting surfaces. The silver is protected from tarnishing by a gold plating.



VSWR characteristics.

APPLICATIONS

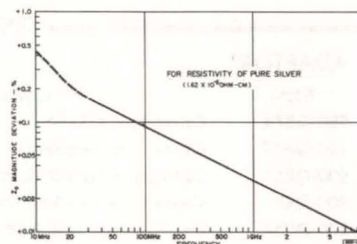
In coaxial transmission-line systems, a section of uniform transmission line is usually used as the im-

GENERAL RADIO EXPERIMENTER REFERENCES:

For a compilation of articles that have appeared since 1963, write for free reprint E115.

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Skin-effect characteristic impedance error as a function of frequency, Type 900-L3.



pedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Type 900-L3 air line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of reflection coefficient are made, one with a termination connected directly to the measuring instrument to be

calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The frequencies at which the Type 900-L3 air line is an odd multiple of a quarter-wavelength are:

$n\lambda/4$	Frequency-GHz
1	2.50
3	7.50

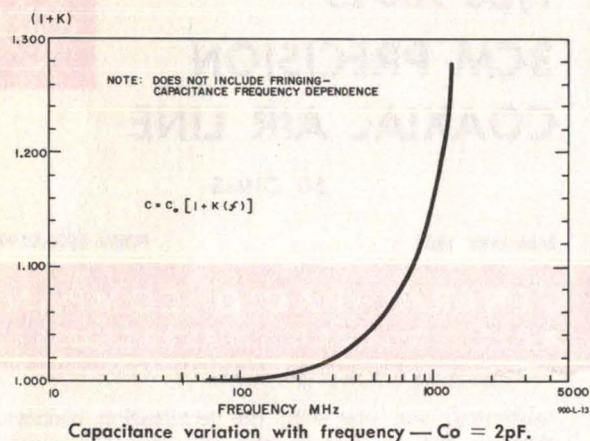
The Type 900-L3 air line can also be used as a precision time-delay standard of 100.0 picoseconds. The line is held to an electrical length variation of ± 0.010 centimeter, which is equivalent to a ± 0.5 picosecond delay difference.

When terminated in a Type 900-WN Precision Short-Circuit Termination or a Type 900-WO Precision Open-Circuit Termination, a Type 900-L3 provides a well-defined reactance standard.

It can also be used with multiple Type 900-LZ Reference Air Lines interconnected as extended air-line standards.

The Type 900-L3 is a good two-port capacitance standard. The graph shows the variation of nominal capacitance (C_0) with frequency.

Printed in U.S.A.



REFERENCES

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1, January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," Instrument Society of America, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.

J. Zorzy, "Skin-effect Corrections in Immittance and Scattering Coefficient Standards Employing Precision Air-dielectric Coaxial Lines," *IEEE PGIM Trans.*, Vol. 15, pp 358-364, December, 1966.

J. Zorzy, "The Application of Precision Transmission Lines and Precision Connectors as Accurate Immittance Standards," 1967 Conference of EEMTC, Ottawa, Canada. Free copies available from GR; ask for IN-116.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeat-

ability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use. Furthermore, in most cases, rotation does not produce any deleterious effects.

GR900® COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJA	Connects to type-BNC Plug
900-QBP	Connects to type-BNC-Jack
900-QCJA	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QNJA	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Prefix 7 mm
900-QSCJA	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJA	Connects to type-TNC Plug
000-QTNP	Connects to type-TNC Jack
900-Q9	Connects to binding posts

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector (RG-9/U)
900-C58	GR900 Precision Cable Connector (RG-58/U)
900-PKM	GR900 Panel Mounting Kit
900-PKMR	GR900 Panel Mounting Kit (Rotatable)

AIR LINES — PRECISION

900-L3	Phase, Time-Delay & Impedance Standard — 3 cm
900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

* Reg. Trademark, Omni-Spectra, Inc., Southfield, Mich.

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Mountain View, California 94040

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada

SPECIFICATIONS



Frequency Range: DC to 9 Gc.
Characteristic Impedance: 50 ohms $\pm 0.1\%$.
VSWR: Less than $1.0013 + 0.0013 \times f_{Gc}$, including connectors.
Repeatability: Within 0.05%
Leakage: Better than 130 db below signal.
Insertion Loss: Less than $0.028 \sqrt{f_{Gc}}$ db.
Voltage: 3000 volts peak.
Power: 20 kilowatts up to 1 Mc; 20 kw/ $\sqrt{f_{Mc}}$ above 1 Mc.

Electrical Length: 30.00 ± 0.02 cm, between mating surfaces of Type 900-BT connectors.

DC Contact Resistance (each end): Inner conductor, less than 0.5 milliohm; outer conductor, less than 0.07 milliohm.

Dimensions: Length, 12 inches (306 mm); maximum diameter, $1\frac{1}{16}$ inch (27 mm).

Net Weight: 15 ounces (430 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

900-L30
 Type 900-L30

30CM PRECISION COAXIAL AIR LINE

50 OHMS

OCTOBER 1963

FORM 0900-0220A

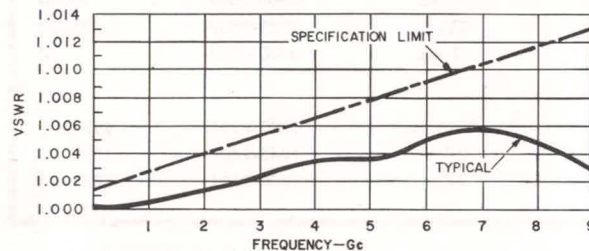
GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

PRECISION COAXIAL ELEMENTS

DC TO MICROWAVE

DESCRIPTION

The Type 900-L30 Precision Air Line is a section of precision coaxial transmission line fitted with a Type 900-BT Precision Coaxial Connector at each end. The inner- and outer-conductor diameters of the air line are held to extremely close dimensional tolerances: the inner conductor to ± 65 microinches, with variations less than ± 25 microinches along a given rod; the outer conductor to ± 140 microinches. The basic material of the Type 900-L30 air line is brass with a layer of silver at the conducting surfaces. The silver is protected from tarnishing by a gold plating.

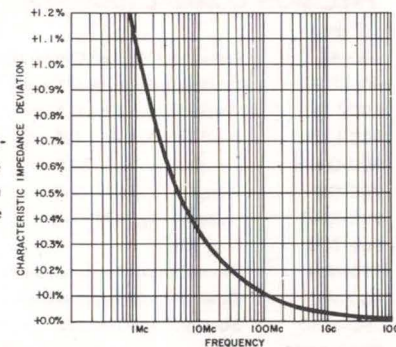


VSWR characteristics of the Type 900-L30 Air Line.

APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Type 900-L30 air line can be used to calibrate any

Skin-effect characteristic impedance error as a function of frequency, Type 900-L30.



immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of reflection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the

two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-L30 air line is an odd multiple of a quarter-wavelength:

Frequency - Gc					
0.25	1.75	3.25	4.75	6.25	7.75
0.75	2.25	3.75	5.25	6.75	8.25
1.25	2.75	4.25	5.75	7.25	8.75

The Type 900-L30 air line can also be used as a precision time-delay standard of 1001.2 picoseconds. The line is held to an electrical length variation of ± 0.012 centimeter, which is equivalent to a ± 0.4 picosecond delay difference.

When terminated in a Type 900-WN Precision Short-Circuit Termination or a Type 900-WO Precision Open-Circuit Termination, a Type 900-L30 provides a well-defined reactance standard.

The lower frequency limit of the Type 900-LB Precision Slotted Line can be extended below 300 Mc (down to 150 Mc) by using the Type 900-L30 as an extension air line.

Also, the Type 900-L30 air line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the connectors should be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the inner and outer

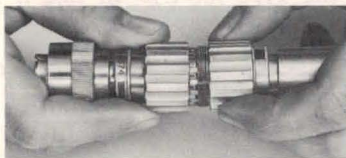
conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the connectors for nicks or protrusions (however minor) on the butting surfaces of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted.

REFERENCES

- A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.
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- J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," Instrument Society of America, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

PRECISION COAXIAL ELEMENTS AND EQUIPMENT

TYPE 900-LB PRECISION SLOTTED LINE

A 50-cm, coaxial slotted line terminated in a Type 900-BT connector (with the same VSWR characteristics as the connector from 300 Mc to 9 Gc). It has a characteristic impedance of 50 ohms $\pm 0.1\%$, scale accuracy of $\pm(0.1 \text{ mm} + 0.05\%)$, and a constancy of probe pickup of $\pm 0.5\%$. Residual VSWR is less than $1.001 + 0.001 \times f_{\text{Gc}}$. Supplied complete with vernier-drive carriage, adjustable probe, tuning stub, and crystal detector.

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

This complete system automatically and accurately plots VSWR's from 1.001 to 1.20 as well as positions of minima and reference plane. It consists of a Type 900-LB Slotted Line linked to a Type 1521-SL Slotted Line Recorder, which drives the probe carriage of the line and synchronously and faithfully provides a permanent plot of the detector output.

ORDERING INFORMATION

PRECISION COAXIAL ELEMENTS

Type		Length inches	Net Weight*	Code Number	Price
900-BT	Precision Coaxial Connector	1 1/4	2 oz.	0900-9405	\$35.00
900-L10	Precision Air Line (10 cm)	4	6 1/2 oz.	0900-9605	85.00
900-L15	Precision Air Line (15 cm)	6	10 oz.	0900-9607	90.00
900-L30	Precision Air Line (30 cm)	12	15 oz.	0900-9613	100.00
900-Q874	Adaptor to Type 874	2 1/4	3 1/2 oz.	0900-9883	45.00
900-QNJ	Adaptor, type-N Jack	2 1/4	3 1/2 oz.	0900-9711	50.00
900-QNP	Adaptor, type-N Plug	2 1/4	4 oz.	0900-9811	50.00
900-TOK	Tool Kit	—	2 lb.	0900-9902	95.00
900-WN	Short-Circuit Termination	1 1/4	2 1/2 oz.	0900-9971	9.00
900-WO	Open-Circuit Termination	1 1/4	2 oz.	0900-9981	9.00
900-W50	50-Ohm Termination	2	3 1/2 oz.	0900-9953	60.00
0900-9508	Precision Inner-Conductor Rod	27	7 oz.	0900-9508	25.00
0900-9509	Precision Outer-Conductor Tube	27	2 1/2 lb.	0900-9509	35.00
0900-9782	Adaptor Flange	—	3 oz.	0900-9782	3.50

PRECISION COAXIAL EQUIPMENT

900-LB	Precision Slotted Line	10 3/4 lb.	0900-9651	\$575.00
1640-A	Slotted Line Recorder System (60 cps)	67 lb.	1640-9701	1875.00
1640-AQ1	Slotted Line Recorder System (50 cps)	67 lb.	1640-9494	1875.00

*To convert ounces to grams, multiply by 28; pounds to kg, divide by 2.2.

Prices subject to change without notice.

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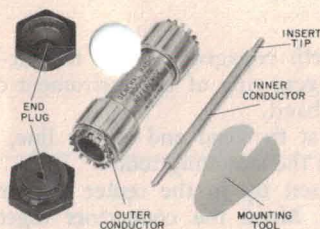
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• SAN FRANCISCO: 1186 Los Altos Ave.
Los Altos, Cal.

• MONTREAL: Office 395, 1255 Laird Blvd.
Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Insertion Loss: Less than $0.008 \sqrt{f}$ dB.

Voltage: 3000 volts peak.

Power: 20 kW up to 1 Mc/s; 20 kW/ $\sqrt{f_{Me}}$ above 1 Mc/s.

DC Contact Resistance (each end, mated with GR900): Inner conductor, < 0.5 milliohm; outer, < 0.07 milliohm.

Dimensions: Length $4\frac{1}{16}$ in.; max dia $1\frac{1}{16}$ in.

Electrical Length: 9.993 ± 0.002 cm, between end surfaces.

Net Weight: 7 ounces (200 grams).

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE. ALWAYS STORE INNER CONDUCTOR INSIDE OUTER CONDUCTOR, SUPPORTED BY END PLUGS.

Frequency Range: Dc to 9 Gc/s.

Characteristic Impedance: 50 ohms, $\pm 0.065\%$

VSWR: Less than $1.0005 + 0.0002 \times f_{Gc}$.

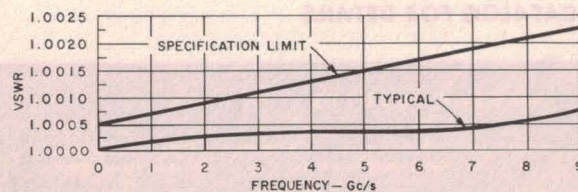
Repeatability: Within $(0.010 + 0.003 \times f_{Gc})\%$.

Leakage: Better than 130 dB below signal.

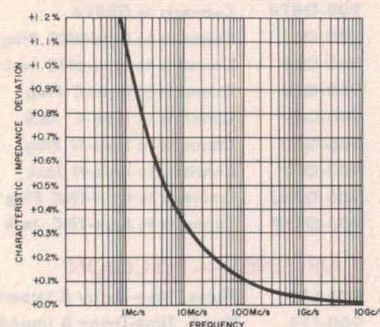
GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-LZ10 Reference Air Line is a section of precision coaxial transmission line fitted with GR900 connector coupling hardware at each end. The inner conductor, brass with a layer of silver approximately 0.001 inch thick, is ground to a finished diameter of 0.24425 inch, ± 50 microinches with variations less than 25 microinches. The outer conductor, also brass with a layer of silver on the inside approximately 0.002 inch thick, has an 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 100 microinches. Both conductors are stress relieved (to minimize diameter changes due to machining) and straightened. Inner-conductor length is held to $+0.0000$, -0.0006 inch of the outer conductor. The projecting inner-conductor insert tips are fully retractile for direct contact with the center conductor of the mating GR900 connector. Except for the coupling hardware which threads directly on the outer conductor, there are no "connector" parts as such on these air lines, hence no discontinuities.



VSWR characteristics.



Skin-effect characteristic-impedance error as a function of frequency.

APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Reference Air Line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of re-

900-LZ10

Type 900-LZ10

REFERENCE

COAXIAL AIR LINE (10 cm)

50 OHMS

OCTOBER 1964

FORM 0900-0170A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

lection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-LZ10 air line is an odd multiple of a quarter-wavelength:

$n\lambda/4$	Frequency - Gc/s	$n\lambda/4$	Frequency - Gc/s
1	0.750	7	5.250
3	2.250	9	6.750
5	3.750	11	8.250

The Type 900-LZ10 air line can also be used as a precision time-delay standard of 333.3 picoseconds. The line is held to an electrical length variation of ± 0.002 centimeter, which is equivalent to a ± 0.07 picosecond delay difference.

Terminated in a Type 900-WNC Precision Short-Circuit Termination, the Reference Air Line provides a well-defined reactance standard. The Type 900-WNC is a precision-machined, silver-plated body with GR900 coupling hardware and a center contact, needed to engage the tip and thereby support the center conductor of the reference air line. This termination places the short exactly at the contact surfaces.

A the Reference Air Line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the end surfaces must be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the end surfaces for nicks or protrusions (however minor). Save the red plastic end plugs supplied and use them to protect these surfaces. *Always store with both end plugs in place.*

REFERENCES

Operating Instructions, Type 900-LB Precision Slotted Line, General Radio Company, West Concord, Mass., 1964.

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1 January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," *Instrument Society of America*, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.



INSTALLATION

To install the Reference Air Line in a GR900 test setup, proceed as follows (see photo):

a. Thread the locking nut back off the gear ring of the GR900 connector on the measuring instrument

and slide the nut to stop, to expose the threads.

b. Carefully insert the inner conductor of the air line through the outer conductor, so that the critical surfaces don't scratch one another.

c. Grasp the line at the load end. With the slit of the mounting tool placed over the insert tip, press the tool against the gear ring, with the tip centered in the line.

d. Place the other end of the line against the instrument connector, so that the insert tip enters the center contact and the gear-ring teeth mesh.

e. Press the line against the instrument, with the

opposing sets of teeth engaged. Then the air-line locking nut on the gear ring of the instrument connector with the free hand.

f. Switch hands at the load end of the line, but maintain pressure on the mounting tool.

g. Center the insert tip in the center contact of the load connector. Move the connectors together until they almost touch the mounting tool.

h. Orient the teeth of the load connector to mesh with those of the line and remove the mounting tool.

i. Complete the installation of the load connector, as above. Retain the mounting tool.

GR900 PRECISION COAXIAL ELEMENTS

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR & CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-WO	Precision Open Circuit
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)

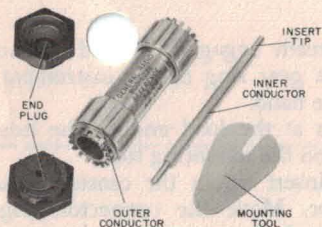
MISCELLANEOUS

900-LB	Precision Slotted Line
1640-A	Slotted Line Recorder System
900-TOK	GR900 Connector Tool Kit
900-TUA	Orthomatch Tuner
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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- CLEVELAND: 5579 Pearl Road, Cleveland, Ohio 44129
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- TORONTO: 99 Floral Parkway, Toronto 15, Ontario, Canada
- MONTREAL: Office 395 1255 Laird Boulevard, Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Insertion Loss: Less than 0.012 dB.

Voltage: 3000 volts peak.

Power: 20 kW up to 1 Mc/s; 20 kW/ $\sqrt{f_{Mc}}$ above 1 Mc/s.

DC Contact Resistance (each end, mated with GR900): Inner conductor, < 0.5 milliohm; outer, < 0.07 milliohm.

Dimensions: Length 6 in.; max dia 1 1/16 in.

Electrical Length: 14.990 \pm 0.002 cm, between end surfaces.

Net Weight: 10.5 ounces (295 grams).

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE. ALWAYS STORE INNER CONDUCTOR INSIDE OUTER CONDUCTOR, SUPPORTED BY END PLUGS.

Frequency Range: Dc to 9 Gc/s.

Characteristic Impedance: 50 ohms, $\pm 0.065\%$

VSWR: Less than 1.0005 + 0.0002 $\times f_{Gc}$.

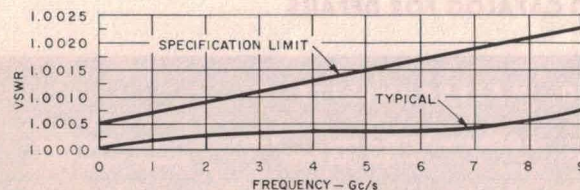
Repeatability: Within (0.010 + 0.003 $\times f_{Gc}$) %.

Leakage: Better than 130 dB below signal.

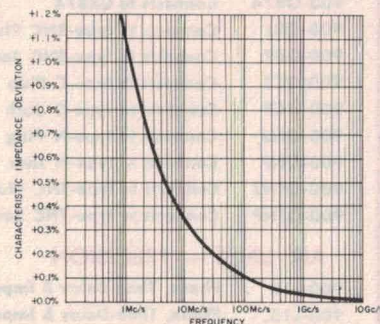
GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-LZ15 Reference Air Line is a section of precision coaxial transmission line fitted with GR900 connector coupling hardware at each end. The inner conductor, brass with a layer of silver approximately 0.001 inch thick, is ground to a finished diameter of 0.24425 inch, ± 50 microinches with variations less than 25 microinches. The outer conductor, also brass with a layer of silver on the inside approximately 0.002 inch thick, has an 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 100 microinches. Both conductors are stress relieved (to minimize diameter changes due to machining) and straightened. Inner-conductor length is held to +0.0000, -0.0006 inch of the outer conductor. The projecting inner-conductor insert tips are fully retractile for direct contact with the center conductor of the mating GR900 connector. Except for the coupling hardware which threads directly on the outer conductor, there are no "connector" parts as such on these air lines, hence no discontinuities.



VSWR characteristics.



Skin-effect characteristic impedance error as a function of frequency.

APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Reference Air Line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of re-

900-LZ15

Type 900-LZ15

REFERENCE

COAXIAL AIR LINE (15 cm)

50 OHMS

OCTOBER 1964

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flexion coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-LZ15 air line is an odd multiple of a quarter-wavelength:

$n\lambda/4$	Frequency-Gc/s	$n\lambda/4$	Frequency-Gc/s
1	0.500	9	4.500
3	1.500	11	5.500
5	2.500	13	6.500
7	3.500	15	7.500

The Type 900-LZ15 air line can also be used as a precision time-delay standard of 500.0 picoseconds. The line is held to an electrical length variation of ± 0.002 centimeter, which is equivalent to a ± 0.07 picosecond delay difference.

Terminated in a Type 900-WNC Precision Short-Circuit Termination, the Reference Air Line provides a well-defined reactance standard. The Type 900-WNC is a precision-machined, silver-plated body with GR900 coupling hardware and a center contact, needed to engage the tip and thereby support the center conductor of the reference air line. This termination places the short exactly at the contact surfaces.

the Reference Air Line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the end surfaces must be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the end surfaces for nicks or protrusions (however minor). Save the red plastic end plugs supplied and use them to protect these surfaces. *Always store with both end plugs in place.*

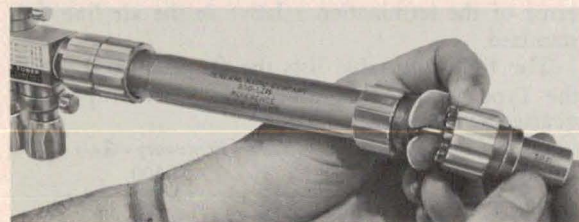
REFERENCES

Operating Instructions, Type 900-LB Precision Slotted Line, General Radio Company, West Concord, Mass., 1964.

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1 January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," *Instrument Society of America*, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.



INSTALLATION

To install the Reference Air Line in a GR900 test setup, proceed as follows (see photo):

a. Thread the locking nut back off the gear ring of the GR900 connector on the measuring instrument

and slide the nut to the stop, to expose the threads.

b. Carefully insert the inner conductor of the air line through the outer conductor, so that the critical surfaces don't scratch one another.

c. Grasp the line at the load end. With the slit of the mounting tool placed over the insert tip, press the tool against the gear ring, with the tip centered in the line.

d. Place the other end of the line against the instrument connector, so that the insert tip enters the center contact and the gear-ring teeth mesh.

e. Press the line against the instrument, with the

opposing sets of teeth engaged. Turn the air-line locking nut on the gear ring of the instrument connector with the free hand.

f. Switch hands at the load end of the line, but maintain pressure on the mounting tool.

g. Center the insert tip in the center contact of the load connector. Move the connectors together until they almost touch the mounting tool.

h. Orient the teeth of the load connector to mesh with those of the line and remove the mounting tool.

i. Complete the installation of the load connector, as above. Retain the mounting tool.

GR900 PRECISION COAXIAL ELEMENTS

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR & CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-WO	Precision Open Circuit
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)

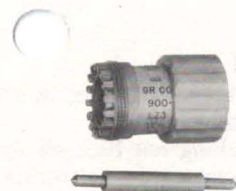
MISCELLANEOUS

900-LB	Precision Slotted Line
1640-A	Slotted Line Recorder System
900-TOK	GR900 Connector Tool Kit
900-TUA	Orthomatch Tuner
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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 ● MONTREAL: Office 395 1255 Laird Boulevard, Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Leakage: Better than 130 dB below al.
Capacitance: 2.000 ± 0.003 pF.
Time Delay: 100 ± 0.10 ps.
Insertion Loss: Less than $0.003 \sqrt{f_{\text{GHz}}}$, dB.
Voltage: 3000 V peak.
Power: 20 kW up to 1 MHz; $20 \text{ kW}/\sqrt{f_{\text{MHz}}}$ above 1 MHz.
Dc Contact Resistance (each end, mated with GR900): Inner conductor, < 0.5 milliohm; outer, < 0.07 milliohm.
Dimensions: Length $1\frac{1}{4}$ in. (32 mm); max dia. $1\frac{1}{16}$ in. (27 mm).
Electrical Length: 2.998 ± 0.002 cm, between end surfaces.
Net Weight: $2\frac{1}{2}$ oz. (75g).

Frequency Range: Dc to 8.5 GHz.

Characteristic Impedance: 50 ± 0.0325 ohms, or $\pm 0.065\%$.

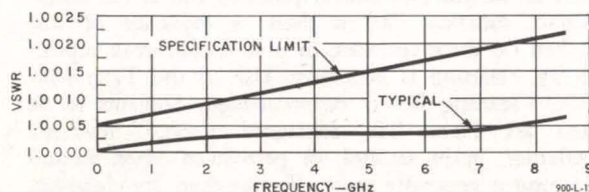
VSWR: Less than $1.0005 + 0.0002 \times f_{\text{GHz}}$.

VSWR Repeatability: Within $(0.010 + 0.003 \times f_{\text{GHz}})\%$.

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-LZ3 Reference Air Line is a section of precision coaxial transmission line fitted with GR900 connector coupling hardware at each end. The inner conductor, brass with a layer of silver approximately 0.001 inch thick, is ground to a finished diameter of 0.24425 inch, ± 50 microinches, with variations less than 25 microinches. The outer conductor, also brass with a layer of silver on the inside approximately 0.002 inch thick, has an 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 100 microinches. Both conductors are stress relieved (to minimize diameter changes due to machining) and straightened. Inner-conductor length is held to $+0.0000$, -0.0006 inch of the outer conductor. The projecting inner-conductor insert tips are fully retractile for direct contact with the center conductor of the mating GR900 connector. Except for the coupling hardware which threads directly on the outer conductor, there are no "connector" parts as such on these air lines, hence no discontinuities.

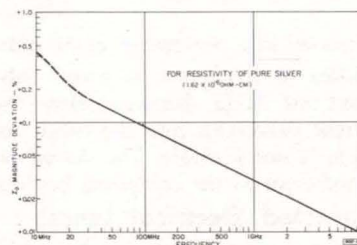


VSWR characteristics.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Skin-effect characteristic impedance error as a function of frequency.



APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Reference Air Line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a

Type 900-LZ3

REFERENCE

COAXIAL AIR LINE (3 cm)

50 OHMS

FEBRUARY 1968

FORM 0900-0122A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

quarter-wavelength long. Two measurements of reflection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The frequencies at which the Type 900-LZ3 air line is an odd multiple of a quarter-wavelength are:

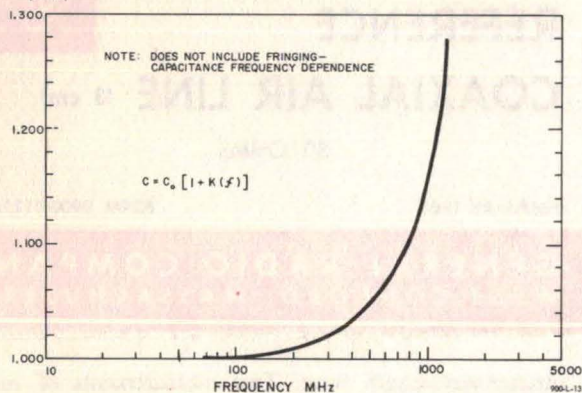
$n\lambda/4$	Frequency-GHz
1	2.500
3	7.500

The Type 900-LZ3 is particularly useful as a two-port 2pF capacitance standard. The graph shows the variation of nominal capacitance (C_0) with frequency.

The Type 900-LZ-3 air line can also be used as a precision time-delay standard of 100 picoseconds. The line is held to an electrical length variation of ± 0.002 centimeter, which is equivalent to a ± 0.07 picosecond delay difference.

Terminated in a Type 900-WNC Precision Short-Circuit Termination, the Reference Air Line provides a well-defined reactance standard. The Type 900-WNC is a precision-machined, silver-plated body with GR900 coupling hardware and a center contact, needed to engage the tip and thereby support the

center conductor of the reference air line. This termination places the short exactly at the contact surfaces. (1+K)



Capacitance variation with frequency — $C_0 = 2\text{pF}$.

Also, the Reference Air Line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements. Use of the Type 900-EL for upright support of the unit is recommended for liquid-dielectric measurements.

Save the plastic end plugs supplied and use them to protect these surfaces. *Always store with both end plugs in place.*

REFERENCES

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1, January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," Instrument Society of America, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.

J. F. Gilmore, "Measurements of Dielectric Materials with the Precision Slotted Line," *GR Experimenter*, Vol. 40, pp 12-19, May, 1966.

J. Zorzy, "Skin-effect Corrections in Immittance and Scattering Coefficient Standards Employing Precision Air-dielectric Coaxial Lines," *IEEE PGIM Trans.*, Vol. 15, pp 358-364, December, 1966.

J. Zorzy, "The Application of Precision Transmission Lines and Precision Connectors as Accurate Immittance Standards," 1967 Conference of EEMTC, Ottawa, Canada. Free copies available from GR; ask for IN-116.

SKIN-EFFECT CORRECTIONS

Both the characteristic-impedance and the electrical-length specifications of all Type 900-LZ Reference Air Lines assume zero skin-depth.

For the most critical applications, correction for the finite skin-depth can be made as follows:

The corrected characteristic impedance, Z_c , can be calculated in complex form from

$$Z_c \cong Z_0 + \frac{(1-j) 0.0284}{\sqrt{f_{\text{GHz}}}} \%$$

where: Z_0 is the nominal value, 50 ohms $\pm 0.05\%$. This expression is an approximation from

$$Z_c = Z_0 \left[1 + \frac{(1-j) 0.000568}{\sqrt{f_{\text{GHz}}}} \right]^{1/2}$$

which itself is an approximation that is accurate down to 1 MHz.

The graph is a plot of

$$|Z_0| \text{ Error} = \left\{ 50 \left| \left[1 + \frac{(1-j) 0.000568}{\sqrt{f_{\text{GHz}}}} \right]^{1/2} - 1 \right| - 50 \right\}$$

expressed as a percentage of 50 ohms.

Data in the graph is given only for frequencies above 30 MHz, because below this frequency the current penetrates into the brass, and accurate calculation is not possible. The dotted portion is the estimated error in the composite medium.

Corrected Electrical Length

The corrected electrical line length, L_c , can be calculated from

$$L_c = L_0 + \frac{0.0284}{\sqrt{f_{\text{GHz}}}} \%$$

where: L_0 is the nominal electrical length, which is obtained from the physical length by use of the velocity-of-propagation value of 2.99687. This velocity takes into account the exact speed of light, the dielectric constant of air at standard pressure and temperature, and a relative humidity of 60%.

These corrections are based upon the skin-depth in pure silver (resistivity of 1.62×10^{-6} ohm-cm). The actual resistivity of the silver layer in this material lies between 1.62×10^{-6} ohm-cm and 1.72×10^{-6} ohm-cm. In the worst case, the correction term can be in error by 3%, because the error varies directly as the square root of the resistivity; this error is negligible.

INSTALLATION

To install the Reference Air Line in a GR900 test setup, proceed as follows:

a. Thread the locking nut back off the gear ring of the GR900 connector on the measuring instrument and slide the nut to the stop, to expose the threads.

b. Carefully insert the inner conductor of the air line through the outer conductor, so that the critical surfaces don't scratch one another.

c. Grasp the line at the load end. With the slit of the mounting tool placed over the insert tip, press the tool against the gear ring, with the tip centered in the line.

d. Place the other end of the line against the instrument connector, so that the insert tip enters the center contact and the gear-ring teeth mesh.

e. Press the line against the instrument, with the opposing sets of teeth engaged. Thread the air-line locking nut on the gear ring of the instrument connector with the free hand.

f. Switch hands at the load end of the line, but maintain pressure on the mounting tool.

g. Center the insert tip in the center contact of the load connector. Move the connectors together until they almost touch the mounting tool.

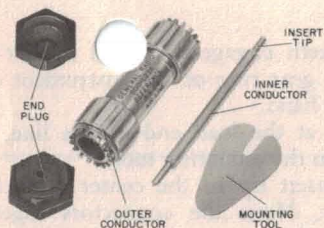
h. Orient the teeth of the load connector to mesh with those of the line and remove the mounting tool.

i. Complete the installation of the load connector, as above. Retain the mounting tool.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor, and for damage to the inner conductor.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.



SPECIFICATIONS

Insertion Loss: Less than $0.024 \sqrt{f}$ dB.

Voltage: 3000 volts peak.

Power: 20 kW up to 1 Mc/s; $20 \text{ kW} / \sqrt{f_{Mc}}$ above 1 Mc/s.

DC Contact Resistance (each end, mated with GR900): Inner conductor, < 0.5 milliohm; outer, < 0.07 milliohm.

Dimensions: Length 12 in.; max dia $1\frac{1}{16}$ in.

Electrical Length: 29.979 ± 0.002 cm, between end surfaces.

Net Weight: 20.0 ounces (555 grams).

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE. ALWAYS STORE INNER CONDUCTOR INSIDE OUTER CONDUCTOR, SUPPORTED BY END PLUGS.

900-LZ30

Type 900-LZ30



REFERENCE

COAXIAL AIR LINE (30 cm)

50 OHMS

OCTOBER 1964

FORM 0900-0180A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

Frequency Range: Dc to 9 Gc/s.

Characteristic Impedance: 50 ohms, $\pm 0.065\%$

VSWR: Less than $1.0005 + 0.0002 \times f_{Gc}$.

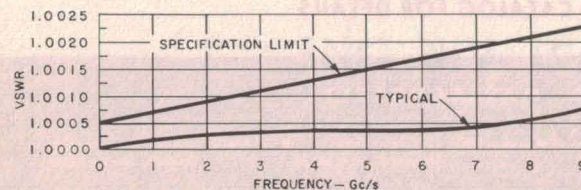
Repeatability: Within $(0.010 + 0.003 \times f_{Gc})\%$.

Leakage: Better than 130 dB below signal.

GR900 PRECISION COAXIAL COMPONENTS

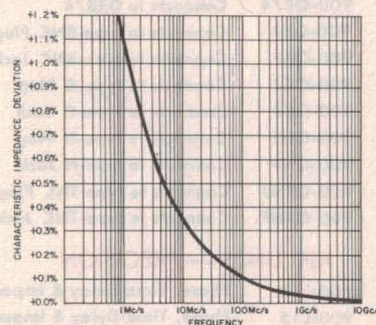
DESCRIPTION

The Type 900-LZ30 Reference Air Line is a section of precision coaxial transmission line fitted with GR900 connector coupling hardware at each end. The inner conductor, brass with a layer of silver approximately 0.001 inch thick, is ground to a finished diameter of 0.24425 inch, ± 50 microinches with variations less than 25 microinches. The outer conductor, also brass with a layer of silver on the inside approximately 0.002 inch thick, has an 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 100 microinches. Both conductors are stress relieved (to minimize diameter changes due to machining) and straightened. Inner-conductor length is held to $+0.0000$, -0.0006 inch of the outer conductor. The projecting inner-conductor insert tips are fully retractile for direct contact with the center conductor of the mating GR900 connector. Except for the coupling hardware which threads directly on the outer conductor, there are no "connector" parts as such on these air lines, hence no discontinuities.



VSWR characteristics.

Skin-effect characteristic-impedance error as a function of frequency.



APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Reference Air Line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of re-

flection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-LZ30 air line is an odd multiple of a quarter-wavelength:

Frequency - Gc/s					
0.250	1.750	3.250	4.750	6.250	7.750
0.750	2.250	3.750	5.250	6.750	8.250
1.250	2.750	4.250	5.750	7.250	8.750

The Type 900-LZ30 air line can also be used as a precision time-delay standard of 1000.0 picoseconds. The line is held to an electrical length variation of ± 0.002 centimeter, which is equivalent to a ± 0.07 picosecond delay difference.

Terminated in a Type 900-WNC Precision Short-Circuit Termination, the Reference Air Line provides a well-defined reactance standard. The Type 900-WNC is a precision-machined, silver-plated body with GR900 coupling hardware and a center contact, needed to engage the tip and thereby support the center conductor of the reference air line. This termination places the short exactly at the contact surfaces.

the Reference Air Line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the end surfaces must be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the end surfaces for nicks or protrusions (however minor). Save the red plastic end plugs supplied and use them to protect these surfaces. *Always store with both end plugs in place.*

REFERENCES

Operating Instructions, Type 900-LB Precision Slotted Line, General Radio Company, West Concord, Mass., 1964.

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1 January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," *Instrument Society of America*, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.



INSTALLATION

To install the Reference Air Line in a GR900 test setup, proceed as follows (see photo):

a. Thread the locking nut back off the gear ring of the GR900 connector on the measuring instrument

and slide the nut to the stop, to expose the threads.

b. Carefully insert the inner conductor of the air line through the outer conductor, so that the critical surfaces don't scratch one another.

c. Grasp the line at the load end. With the slit of the mounting tool placed over the insert tip, press the tool against the gear ring, with the tip centered in the line.

d. Place the other end of the line against the instrument connector, so that the insert tip enters the center contact and the gear-ring teeth mesh.

e. Press the line against the instrument, with the

opposing sets of teeth engaged. Turn the air-line locking nut on the gear ring of the instrument connector with the free hand.

f. Switch hands at the load end of the line, but maintain pressure on the mounting tool.

g. Center the insert tip in the center contact of the load connector. Move the connectors together until they almost touch the mounting tool.

h. Orient the teeth of the load connector to mesh with those of the line and remove the mounting tool.

i. Complete the installation of the load connector, as above. Retain the mounting tool.

GR900 PRECISION COAXIAL ELEMENTS

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR & CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-WO	Precision Open Circuit
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)

MISCELLANEOUS

900-LB	Precision Slotted Line
1640-A	Slotted Line Recorder System
900-TOK	GR900 Connector Tool Kit
900-TUA	Orthomatch Tuner
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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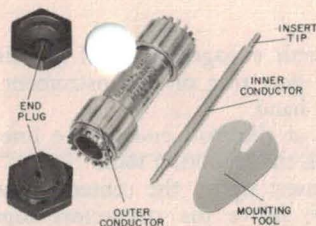
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● TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

● MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Insertion Loss: Less than $0.004 \sqrt{f}$ dB.

Voltage: 3000 volts peak.

Power: 20 kW up to 1 Mc/s; 20 kW/ $\sqrt{f_{Mc}}$ above 1 Mc/s.

DC Contact Resistance (each end, mated with GR900): Inner conductor, < 0.5 milliohm; outer, < 0.07 milliohm.

Dimensions: Length $2\frac{1}{8}$ in.; max dia $1\frac{1}{16}$ in.

Electrical Length: 4.997 ± 0.002 cm, between end surfaces.

Net Weight: 4.0 ounces (115 grams).

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE. ALWAYS STORE INNER CONDUCTOR INSIDE OUTER CONDUCTOR, SUPPORTED BY END PLUGS.

900-LZ5

Type 900-LZ5

REFERENCE

COAXIAL AIR LINE (5 cm)

50 OHMS

OCTOBER 1964

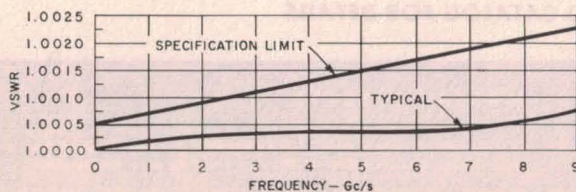
FORM 0900-0160A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

GR900 PRECISION COAXIAL COMPONENTS

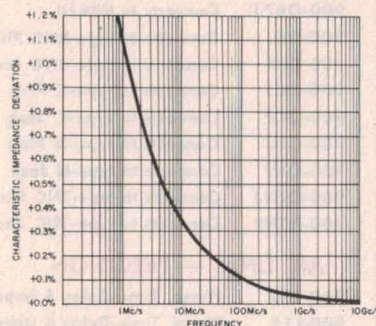
DESCRIPTION

The Type 900-LZ5 Reference Air Line is a section of precision coaxial transmission line fitted with GR900 connector coupling hardware at each end. The inner conductor, brass with a layer of silver approximately 0.001 inch thick, is ground to a finished diameter of 0.24425 inch, ± 50 microinches with variations less than 25 microinches. The outer conductor, also brass with a layer of silver on the inside approximately 0.002 inch thick, has an 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 100 microinches. Both conductors are stress relieved (to minimize diameter changes due to machining) and straightened. Inner-conductor length is held to $+0.0000$, -0.0006 inch of the outer conductor. The projecting inner-conductor insert tips are fully retractile for direct contact with the center conductor of the mating GR900 connector. Except for the coupling hardware which threads directly on the outer conductor, there are no "connector" parts as such on these air lines, hence no discontinuities.



VSWR characteristics.

Skin-effect characteristic-impedance error as a function of frequency.



APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Reference Air Line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of re-

flection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-LZ5 air line is an odd multiple of a quarter-wavelength:

$n\lambda/4$	Frequency-Gc/s
1	1.500
3	4.500
5	7.500

The Type 900-LZ5 air line can also be used as a precision time-delay standard of 166.7 picoseconds. The line is held to an electrical length variation of ± 0.002 centimeter, which is equivalent to a ± 0.07 picosecond delay difference.

Terminated in a Type 900-WNC Precision Short-Circuit Termination, the Reference Air Line provides a well-defined reactance standard. The Type 900-WNC is a precision-machined, silver-plated body with GR900 coupling hardware and a center contact, needed to engage the tip and thereby support the center conductor of the reference air line. This termination places the short exactly at the contact surfaces.

the Reference Air Line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the end surfaces must be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the end surfaces for nicks or protrusions (however minor). Save the red plastic end plugs supplied and use them to protect these surfaces. *Always store with both end plugs in place.*

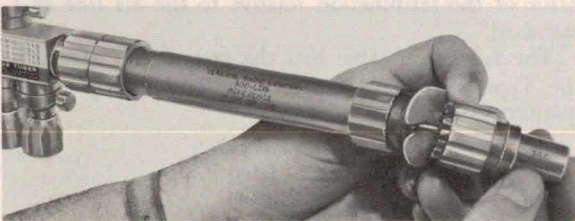
REFERENCES

Operating Instructions, Type 900-LB Precision Slotted Line, General Radio Company, West Concord, Mass., 1964.

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1, January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," *Instrument Society of America*, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.



INSTALLATION

To install the Reference Air Line in a GR900 test setup, proceed as follows (see photo):

a. Thread the locking nut back off the gear ring of the GR900 connector on the measuring instrument

and slide the nut to the stop, to expose the threads.

b. Carefully insert the inner conductor of the air line through the outer conductor, so that the critical surfaces don't scratch one another.

c. Grasp the line at the load end. With the slit of the mounting tool placed over the insert tip, press the tool against the gear ring, with the tip centered in the line.

d. Place the other end of the line against the instrument connector, so that the insert tip enters the center contact and the gear-ring teeth mesh.

e. Press the line against the instrument, with the

opposing sets of teeth engaged. Thread the air-line locking nut on the gear ring of the instrument connector with the free hand.

f. Switch hands at the load end of the line, but maintain pressure on the mounting tool.

g. Center the insert tip in the center contact of the load connector. Move the connectors together until they almost touch the mounting tool.

h. Orient the teeth of the load connector to mesh with those of the line and remove the mounting tool.

i. Complete the installation of the load connector, as above. Retain the mounting tool.

GR900 PRECISION COAXIAL ELEMENTS

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR & CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-WO	Precision Open Circuit
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)

MISCELLANEOUS

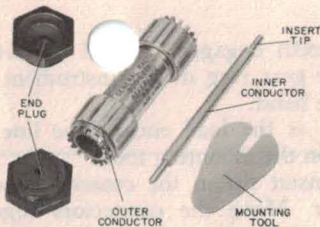
900-LB	Precision Slotted Line
1640-A	Slotted Line Recorder System
900-TOK	GR900 Connector Tool Kit
900-TUA	Orthomatch Tuner
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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SPECIFICATIONS

Insertion Loss: Less than $0.005 \sqrt{f}$ dB.

Voltage: 3000 volts peak.

Power: 20 kW up to 1 Mc/s; $20 \text{ kW} / \sqrt{f_{Mc}}$ above 1 Mc/s.

DC Contact Resistance (each end, mated with GR900): Inner conductor, < 0.5 milliohm; outer, < 0.07 milliohm.

Dimensions: Length $2\frac{1}{2}$ in.; max dia $1\frac{1}{16}$ in.

Electrical Length: 5.996 ± 0.002 cm, between end surfaces.

Net Weight: 5.0 ounces (140 grams).

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE. ALWAYS STORE INNER CONDUCTOR INSIDE OUTER CONDUCTOR, SUPPORTED BY END PLUGS.

Frequency Range: Dc to 9 Gc/s.

Characteristic Impedance: 50 ohms, $\pm 0.065\%$

VSWR: Less than $1.0005 + 0.0002 \times f_{Gc}$.

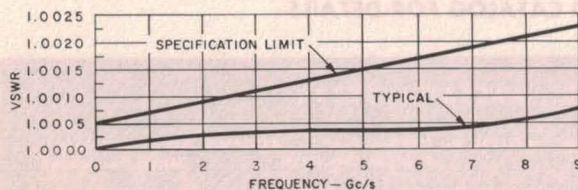
Repeatability: Within $(0.010 + 0.003 \times f_{Gc})\%$.

Leakage: Better than 130 dB below signal.

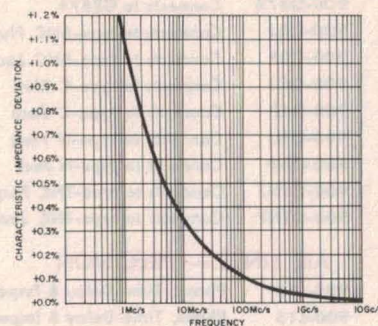
GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-LZ6 Reference Air Line is a section of precision coaxial transmission line fitted with GR900 connector coupling hardware at each end. The inner conductor, brass with a layer of silver approximately 0.001 inch thick, is ground to a finished diameter of 0.24425 inch, ± 50 microinches with variations less than 25 microinches. The outer conductor, also brass with a layer of silver on the inside approximately 0.002 inch thick, has an 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 100 microinches. Both conductors are stress relieved (to minimize diameter changes due to machining) and straightened. Inner-conductor length is held to $+0.0000$, -0.0006 inch of the outer conductor. The projecting inner-conductor insert tips are fully retractile for direct contact with the center conductor of the mating GR900 connector. Except for the coupling hardware which threads directly on the outer conductor, there are no "connector" parts as such on these air lines, hence no discontinuities.



VSWR characteristics.



Skin-effect characteristic impedance error as a function of frequency.

APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Reference Air Line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of re-

900-LZ6

Type 900-LZ6

REFERENCE

COAXIAL AIR LINE (6 cm)

50 OHMS

OCTOBER 1964

FORM 0900-0102A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

flection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-LZ6 air line is an odd multiple of a quarter-wavelength:

$n\lambda/4$	Frequency-Gc/s
1	1.250
3	3.750
5	6.250
7	8.750

The Type 900-LZ6 air line can also be used as a precision time-delay standard of 200.0 picoseconds. The line is held to an electrical length variation of ± 0.002 centimeter, which is equivalent to a ± 0.07 picosecond delay difference.

Terminated in a Type 900-WNC Precision Short-Circuit Termination, the Reference Air Line provides a well-defined reactance standard. The Type 900-WNC is a precision-machined, silver-plated body with GR900 coupling hardware and a center contact, needed to engage the tip and thereby support the center conductor of the reference air line. This termination places the short exactly at the contact surfaces.

the Reference Air Line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the end surfaces must be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the end surfaces for nicks or protrusions (however minor). Save the red plastic end plugs supplied and use them to protect these surfaces. *Always store with both end plugs in place.*

REFERENCES

Operating Instructions, Type 900-LB Precision Slotted Line, General Radio Company, West Concord, Mass., 1964.

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

A. E. Sanderson, "An Accurate Substitution Method of Measuring the VSWR of Coaxial Connectors," *The Microwave Journal*, Vol. 5, No. 1 January, 1962, pp 69-73. Available free from General Radio Co. as Reprint No. A-95.

J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," *Instrument Society of America*, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.



INSTALLATION

To install the Reference Air Line in a GR900 test setup, proceed as follows (see photo):

a. Thread the locking nut back off the gear ring of the GR900 connector on the measuring instrument

and slide the nut to the stop, to expose the threads.

b. Carefully insert the inner conductor of the air line through the outer conductor, so that the critical surfaces don't scratch one another.

c. Grasp the line at the load end. With the slit of the mounting tool placed over the insert tip, press the tool against the gear ring, with the tip centered in the line.

d. Place the other end of the line against the instrument connector, so that the insert tip enters the center contact and the gear-ring teeth mesh.

e. Press the line against the instrument, with the

opposing sets of teeth engaged. Turn the air-line locking nut on the gear ring of the instrument connector with the free hand.

f. Switch hands at the load end of the line, but maintain pressure on the mounting tool.

g. Center the insert tip in the center contact of the load connector. Move the connectors together until they almost touch the mounting tool.

h. Orient the teeth of the load connector to mesh with those of the line and remove the mounting tool.

i. Complete the installation of the load connector, as above. Retain the mounting tool.

GR900 PRECISION COAXIAL ELEMENTS

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR & CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-WO	Precision Open Circuit
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)

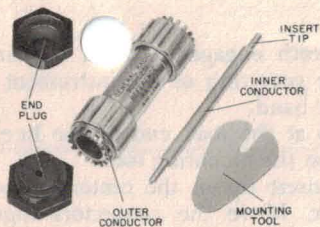
MISCELLANEOUS

900-LB	Precision Slotted Line
1640-A	Slotted Line Recorder System
900-TOK	GR900 Connector Tool Kit
900-TUA	Orthomatch Tuner
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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SPECIFICATIONS

Insertion Loss: Less than 0.006 $\sqrt{f_{Mc}}$ dB.

Voltage: 3000 volts peak.

Power: 20 kW up to 1 Mc/s; 20 kW/ $\sqrt{f_{Mc}}$ above 1 Mc/s.

DC Contact Resistance (each end, mated with GR900): Inner conductor, < 0.5 milliohm; outer, < 0.07 milliohm.

Dimensions: Length $3\frac{1}{16}$ in.; max dia $1\frac{1}{16}$ in.

Electrical Length: 7.495 ± 0.002 cm, between end surfaces.

Net Weight: 5.5 ounces (160 grams).

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE. ALWAYS STORE INNER CONDUCTOR INSIDE OUTER CONDUCTOR, SUPPORTED BY END PLUGS.

900-LZ7H

Type 900-LZ7H



REFERENCE

COAXIAL AIR LINE (7.5 cm)

50 OHMS

OCTOBER 1964

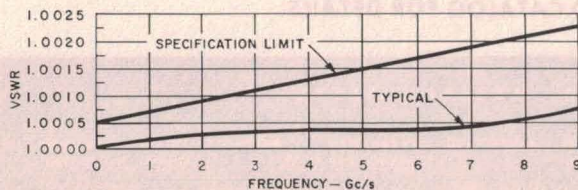
FORM 0900-0165A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

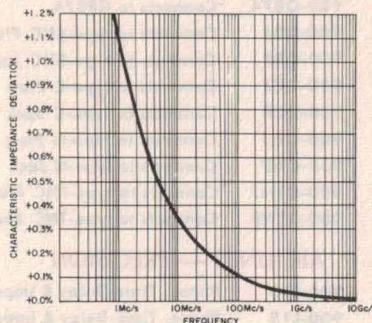
The Type 900-LZ7H Reference Air Line is a section of precision coaxial transmission line fitted with GR900 connector coupling hardware at each end. The inner conductor, brass with a layer of silver approximately 0.001 inch thick, is ground to a finished diameter of 0.24425 inch, ± 50 microinches with variations less than 25 microinches. The outer conductor, also brass with a layer of silver on the inside approximately 0.002 inch thick, has an 0.830-inch outer diameter; the inner diameter is finished to 0.5625 inch, ± 100 microinches. Both conductors are stress relieved (to minimize diameter changes due to machining) and straightened. Inner-conductor length is held to $+0.0000$, -0.0006 inch of the outer conductor. The projecting inner-conductor insert tips are fully retractile for direct contact with the center conductor of the mating GR900 connector. Except for the coupling hardware which threads directly on the outer conductor, there are no "connector" parts as such on these air lines, hence no discontinuities.



VSWR characteristics.

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Skin-effect characteristic-impedance error as a function of frequency.



APPLICATIONS

In coaxial transmission-line systems, a section of uniform transmission line is usually used as the impedance standard, since the absolute accuracy of the line's characteristic impedance is determined directly by the conductor diameters. In this application, the Reference Air Line can be used to calibrate any immittance-measuring instrument equipped with Type 900-BT connectors (slotted lines, bridges, reflectometers, etc.) with respect to the 50-ohm standard of impedance provided by the air line. Similarly, and (if required) simultaneously, the termination error can be separated from the measuring-instrument error and calibrated against the air-line standard.

Calibrations are accomplished by use of the air lines at frequencies at which they are an odd multiple of a quarter-wavelength long. Two measurements of re-

flection coefficient are made, one with a termination connected directly to the measuring instrument to be calibrated, and one with the termination connected through the air line to the measuring instrument. One-half of the vector sum of the two measured reflection coefficients is the reflection error in the measuring instrument relative to the air line as a standard. One-half of the vector difference of the two measured reflection coefficients is the reflection error of the termination relative to the air line as a standard.

The following table lists the frequencies at which the Type 900-LZ7H air line is an odd multiple of a quarter-wavelength:

$n\lambda/4$	Frequency - Gc/s	$n\lambda/4$	Frequency - Gc/s
1	1.000	7	7.000
3	3.000	9	9.000
5	5.000		

The Type 900-LZ7H air line can also be used as a precision time-delay standard of 250.0 picoseconds. The line is held to an electrical length variation of ± 0.002 centimeter, which is equivalent to a ± 0.07 picosecond delay difference.

Terminated in a Type 900-WNC Precision Short-Circuit Termination, the Reference Air Line provides a well-defined reactance standard. The Type 900-WNC is a precision-machined, silver-plated body with GR900 coupling hardware and a center contact, needed to engage the tip and thereby support the center conductor of the reference air line. This termination places the short exactly at the contact surfaces.

Printed in U.S.A.

H 751-00e

A. the Reference Air Line can be used as a dielectric sample holder for dielectric-constant and loss-tangent measurements.

For optimum performance, the end surfaces must be free of dust and grime. Use any commercial solvent to degrease the butt surfaces of the conductors, and use a mild detergent solution to remove dirt.

If satisfactory operation is not obtained, inspect the end surfaces for nicks or protrusions (however minor). Save the red plastic end plugs supplied and use them to protect these surfaces. *Always store with both end plugs in place.*

REFERENCES

Operating Instructions, Type 900-LB Precision Slotted Line, General Radio Company, West Concord, Mass., 1964.

A. E. Sanderson, "A New High-Precision Method for the Measurement of the VSWR of Coaxial Connectors," *IRE Transactions on Microwave Theory and Techniques*, Vol. MTT-9, No. 6, November, 1961, pp 524-528. Available free from General Radio Co. as Reprint No. A-92.

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J. Zorzy, "Precise Impedance Measurements with Emphasis on Connector VSWR Measurements," Instrument Society of America, Preprint No. 47.4.63, September, 1963. Available free from General Radio Co. as Reprint No. B-20.



INSTALLATION

To install the Reference Air Line in a GR900 test setup, proceed as follows (see photo):

a. Thread the locking nut back off the gear ring of the GR900 connector on the measuring instrument

and slide the nut to the stop, to expose the threads.

b. Carefully insert the inner conductor of the air line through the outer conductor, so that the critical surfaces don't scratch one another.

c. Grasp the line at the load end. With the slit of the mounting tool placed over the insert tip, press the tool against the gear ring, with the tip centered in the line.

d. Place the other end of the line against the instrument connector, so that the insert tip enters the center contact and the gear-ring teeth mesh.

e. Press the line against the instrument, with the

opposing sets of teeth engaged. Then the air-line locking nut on the gear ring of the instrument connector with the free hand.

f. Switch hands at the load end of the line, but maintain pressure on the mounting tool.

g. Center the insert tip in the center contact of the load connector. Move the connectors together until they almost touch the mounting tool.

h. Orient the teeth of the load connector to mesh with those of the line and remove the mounting tool.

i. Complete the installation of the load connector, as above. Retain the mounting tool.

GR900 PRECISION COAXIAL ELEMENTS

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
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900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR & CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-WO	Precision Open Circuit
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)

MISCELLANEOUS

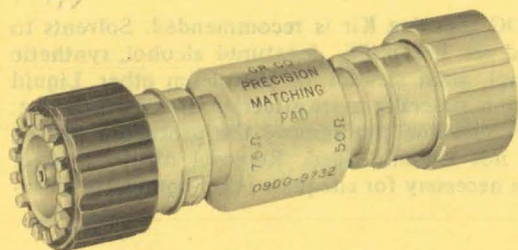
900-LB	Precision Slotted Line
1640-A	Slotted Line Recorder System
900-TOK	GR900 Connector Tool Kit
900-TUA	Orthomatch Tuner
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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 • TORONTO: 99 Floral Parkway, Toronto 15, Ontario, Canada
 • MONTREAL: Office 395 1255 Laird Boulevard, Town of Mount Royal, Quebec, Canada



Frequency: Dc to 1 GHz, usable to 8.5 GHz.

Impedance: 50 Ω and 75 Ω .

SWR: $1.003 + 0.003 f_{\text{GHz}}$ for 50- Ω side, $1.01 + 0.012 f_{\text{GHz}}$ for 75- Ω side.

Electrical: INPUT: 1 W max continuous. LEAKAGE: > 130 dB below signal. INSERTION LOSS: 5.72 dB nominal.

Mechanical: Mates with GR900-fitted equipment and components. DIMENSIONS: 1.06 in. dia X 3.75 in. long (27X95 mm). WEIGHT: 0.6 lb (0.3 kg) net, 2 lb (1 kg) shipping.

Type 900-MP_{50 to 75 Ω}

PRECISION MATCHING PAD



FEBRUARY 1972

FORM 0900-0161A

GENERAL RADIO COMPANY
CONCORD, MASSACHUSETTS

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

The 900-MP is a two-port minimum-loss network for matching 50-ohm GR900-fitted equipment to similarly fitted 75-ohm equipment. It features low SWR, low leakage, and the excellent repeatability inherent in GR900® connectors. The pad is a minimum-loss resistive network for transforming 50 Ω to 75 Ω impedance.

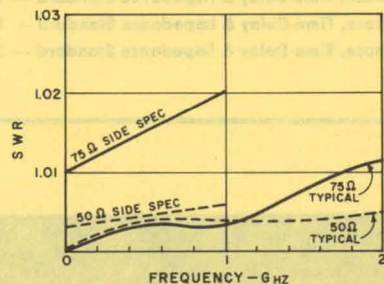
The pad is extremely well matched and has an unusually flat attenuation characteristic. The loss is 5.72 dB.

The resistance elements are high-stability metal-film units deposited on a beryllium-oxide substrate.

The connector with the dark-colored locking nut marks the 75- Ω end.

WARNING

The unit should not be disassembled since toxic dust can result if the resistor is accidentally crushed.



SWR characteristics.

APPLICATIONS

The principal application is the conversion of 50- Ω equipment to 75- Ω , particularly reflectometers (network analyzers), and attenuation-measuring equipment. Other applications are the conversion of 50- Ω detectors, sources, or pads to 75- Ω .

Reflectometer (Network Analyzer)

An example of the conversion of a reflectometer and insertion-loss measuring instrument is shown on page 2. The example shows the conversion for the 1641 Reflectometer model that covers the 20-MHz to 1.5-GHz frequency range, but applies to any network analyzer.

There is some loss of accuracy in the measurement of low SWR because of the pad loss. For example, if the equivalent directivity or isolation of the basic instrument is 43 dB (1.015 SWR), then with the insertion of the pad, the directivity is reduced to 35 dB (1.035) in the worst case. The error is insignificant if the SWR exceeds about 1.15 (23-dB return loss). The insertion-loss accuracy is essentially unaffected except in this case also there is a reduction of dynamic range because of the pad loss. The system, nevertheless, provides a useful measurement capability for 75- Ω measurements.

If there is a requirement to measure low values of SWR accurately, and the reflectometer has a detachable sidearm termination, then the reflectometer can be converted for 75 Ω by replacing this sidearm termination with a precision 75- Ω termination (GR 900-W75), and replacing the 900-MP at the "un-

known" arm with a GR 900-Q75 adaptor. The directivity or isolation of the measuring instrument is essentially unaffected in this case and there is no loss in dynamic range.

General

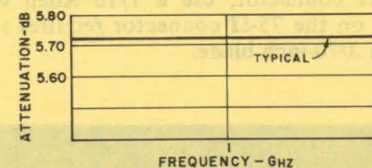
Any 50- Ω detector or source can be converted to 75 Ω with the 900-MP and appropriate adaptors.

Mating with 50- Ω Connectors

The GR 900-BT (75 Ω) connector mates nondestructively with the GR 900-BT (50 Ω) connector. A step discontinuity results and the repeatability deteriorates. The step-discontinuity capacitance is .025 pF. In a matched 75-ohm system this produces an SWR of approximately $1 + .024 \times f_{\text{GHz}}$. At 1 GHz this is 1.024 or a return loss of 38 dB.

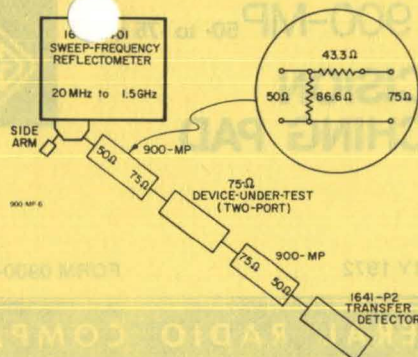
CAUTION

The CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.



Attenuation Characteristics

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.



Typical application of the matching pad, its schematic detail appears at upper right.

MATING OF TYPE 900-BT CONNECTORS

Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

Inner Contact Assembly Removal

To remove the Inner Contact Assembly on the GR900 50-Ω connector, use a 1/16 Allen wrench. The contact on the 75-Ω connector requires a screwdriver with a .070-inch blade.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type

900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE

Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.

GR900® COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-Q8J	Connects to type-BNC Plug
900-Q8P	Connects to type-BNC-Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Precifix 7 mm
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-Q9	Connects to binding posts

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector (RG-9/U)
900-C58	GR900 Precision Cable Connector (RG-58/U)
900-PKM	GR900 Panel Mounting Kit
900-PKMR	GR900 Panel Mounting Kit (Rotatable)

AIR LINES — PRECISION

900-L3	Phase, Time-Delay & Impedance Standard — 3 cm
900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

* Reg. Trademark, Omni-Spectra, Inc., Southfield, Mich.

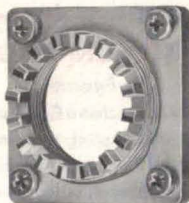


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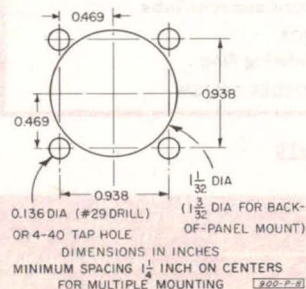
GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-PKM Panel Mounting Kit is used to convert the GR900 Precision Coaxial Connector, in both rigid-line (Type 900-BT) and flexible cable (Type 900-C9) versions, to a panel-mount configuration. The kit permits connection through an instrument panel. Or, it permits the connector to be attached to the exterior surface of a coaxial device, such as a directional coupler, when a sufficiently strong rigid-line section is not available for mounting the connector.

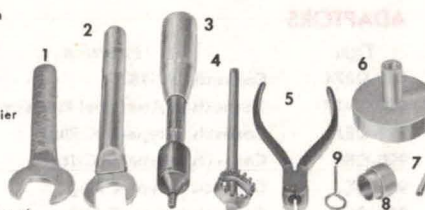
The kit consists of a GR900 centering-gear ring combined with a surface-mounting flange. In use, it is substituted for the gear ring furnished with the connector and requires also that the connector locking nut be removed. The locking nut on the mating GR900 connector obviates the need for one on this side of the junction.



Mounting surface preparation.

TYPE 900-TOK TOOL KIT

1. Open-End Wrench
2. Coupling-Nut Torque Wrench
3. Inner-Conductor Torque Wrench
4. Gear Wrench
5. Inner-Conductor Plier
6. Bead Pusher
7. Inner-Conductor Injector
8. Bead Compression Sleeve
9. Spring-Contact Wrench



CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

The conversion does not degrade connector performance and at any time the connector can be returned to its regular configuration.

SURFACE PREPARATION

The drawing shows the dimensions for holes needed in the mounting surface to accept the converted connector; possible mounting configurations are shown in the adjacent figure.

CONNECTOR PREPARATION

The centering-gear-ring and the locking-nut coupling system of the connector must be removed to make room for the kit flange. The center conductor should not be altered.

To remove the ring and nut, engage the gear-ring wrench (4) in the centering-gear ring and slide the locking nut forward, to expose the wrench flats on the connector outer conductor. Hold the outer conductor with the 11/16-inch open-end wrench (1) and unscrew the gear-ring and locking nut assembly from the connector (rotate counterclockwise). Remove the tools.

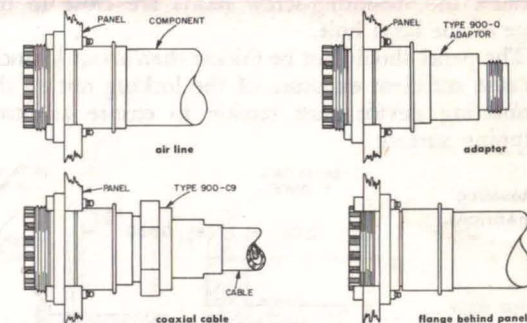
Type 900-PKM, -PKMR PANEL MOUNTING KIT

(For GR900 Connectors)

June, 1969

Form 0900-0106B

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

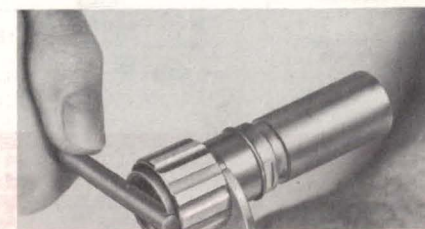


Panel-mounting configurations.

INSTALLATION

CAN PASS THROUGH HOLE (EITHER WAY)

If the component is free and can also be fitted through the 1 1/32-inch hole, then the adaptor flange should be mounted on the component first. It should be tightened to about 6-ft-lb, the release point of the torque wrench (2). The adaptor flange should then be



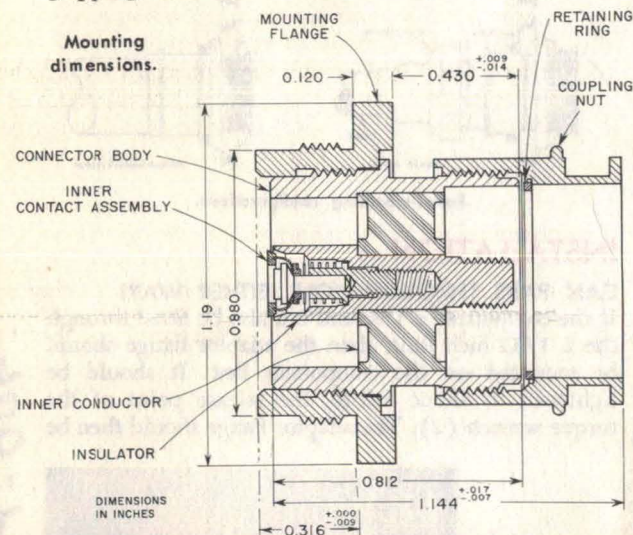
Type 900-BT
Connector
disassembly

fastened to the panel with the four screws supplied. **CANNOT PASS THROUGH HOLE (ONE WAY)** If the component must be brought in from the rear of the panel, insert it through the hole, attach the adaptor flange, and tighten the flange to about 6-ft-lb, the release point of the torque wrench (2). Fasten the flange to the panel with the four screws supplied.

SPECIAL MOUNTING

When the Type 900-PKM must be mounted on a permanently affixed component behind a panel, or for any reason the component with the Type 900-PKM installed must be mounted from behind the panel, the hole must be of $1\frac{3}{32} \pm \frac{1}{32}$ inch diameter (instead of $1\frac{1}{32}$ -inch). Some sacrifice in appearance results because the mounting-screw heads are close to the edge of the large hole.

The panel should not be thicker than about $\frac{1}{4}$ -inch, because sufficient exposure of the locking nut on the connecting device must remain to ensure adequate gripping surface.



GR900® COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC-Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-SMA Plug
900-QMMP	Connects to type-SMA Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Prefix 7 mm
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-Q9	Connects to binding posts

AIR LINES — PRECISION

900-L3	Phase, Time-Delay & Impedance Standard — 3 cm
900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ3	Ultraprecise Impedance Standard — 3 cm
900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector (RG-9/U)
900-C58	GR900 Precision Cable Connector (RG-58/U)
900-PKM	GR900 Panel Mounting Kit
900-PKMR	GR900 Panel Mounting Kit (Rotatable)

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

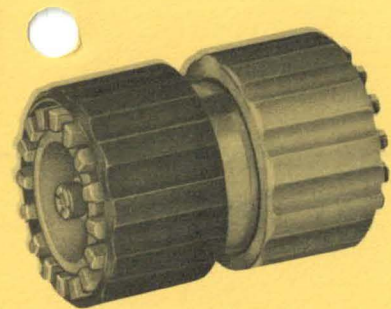
900-EL	Precision 90° Ell
900-G6	6 dB Attenuator
900-M	Component Mount
900-TOC	GR900 Connector Cleaning Kit
900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9507	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange
0900-9499	Rotatable Centering Ring

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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GENERAL RADIO COMPANY • WEST CONCORD, MASSACHUSETTS 01781

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SPECIFICATION

Frequency: Dc to 1 GHz, usable to 8.5 GHz.

Impedance: 50 Ω \pm 0.3% for 50- Ω side, 75 Ω \pm 0.5% for 75- Ω side.

Electrical: LEAKAGE: > 130 dB below signal. ELECTRICAL LENGTH: 4 \pm 0.01 cm for 50- Ω side, 0.24 \pm 0.005 cm for 75- Ω side.

Mechanical: Mates with GR900-fitted equipment and components.

DIMENSIONS: 1.06 in. dia X 1.66 in. long (26X42 mm). **WEIGHT:** 0.2 lb (0.1 kg) net, 1 lb (0.5 kg) shipping.

Type 900Q75(75 Ω)

COAXIAL ADAPTOR

50 OHMS — 75 OHMS



FEBRUARY 1972

FORM 0900-0156A

Copyright, 1972, by General Radio Company, Concord, Mass., U.S.A.

GR900® PRECISION COAXIAL COMPONENTS

GENERAL RADIO COMPANY
CONCORD, MASSACHUSETTS

DESCRIPTION

The Type 900-Q75 adaptor comprises a section of 50- Ω transmission-line 4 cm long, stepped to a short 75- Ω line terminated with the 75- Ω GR900 Connector. The step is compensated in order to make the 4-cm reference plane independent of frequency.

The adaptor offers a repeatable low-loss connection between GR900 50- Ω and GR900 75- Ω -Components, without impedance transformation. The 4-cm length ties in with the 4-cm length of the Type 900-WN4 and 900-WO4, 50- Ω short-and-open-circuit terminations. The connector with the dark-colored locking nut is the 75-ohm end.

APPLICATIONS

Reflectometer

A typical application is in the conversion to 75- Ω of the terminals of a 50- Ω impedance bridge or hybrid fitted with GR900 connectors. This is especially useful used on the reference terminal; it permits mating with a Type 900-W75 (75- Ω) Standard Coaxial Termination.

With this adaptor, 75- Ω SWR measurements can be made accurately from values of 1.00 to about

1.20. For accurate measurements above SWR = 1.20, a matching pad, e.g., GR900-MP, should be employed.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor, and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry clean-

ing; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.



General Radio

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CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Frequency Range: Dc to 7 Gc.
VSWR: Less than $1.000 + 0.015 \times f_{ge}$ up to 1 Gc; $1.010 + 0.005 \times f_{ge}$ from 1 to 7 Gc.
Leakage: Better than 110 db below signal.
Voltage: 1500 volts peak.
Power: 10 kilowatts up to 1 Mc; $10 \text{ kw}/\sqrt{f_{Mc}}$ above 1 Mc.
Electrical Length: $6.50 \pm 0.04 \text{ cm}$ (see section view).
Dimensions: Length, 2-9/16 inches (66 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 3-1/2 ounces (100 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963

(U. S. Patent No. 2,548,457)

900-Q874



Type 900-Q874

COAXIAL ADAPTOR

OCTOBER 1963

FORM 0900-0105A

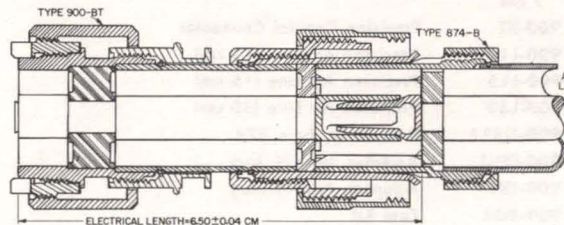
GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

PRECISION COAXIAL ELEMENTS DC TO MICROWAVE

DESCRIPTION

The Type 900-Q874 Coaxial Adaptor comprises a Type 900-BT Precision Coaxial Connector and a Type 874-BL Locking Coaxial Connector mounted on a short section of precision air line. This adaptor is intended to introduce minimum reflections, and, to this end, the Type 874-BL connector contains a new-design, fully compensated, Type 874 support bead. The adaptor mates with both locking and non-locking Type 874 connectors.

To ensure a mechanically stable, low-leakage connection, it is recommended that the mating connector be a Type 874-BL Locking Coaxial Connector. However, for those coaxial-line measurements in which the reference plane must be determined with maximum accuracy, it is recommended that the mating connector be a Type 874-B (nonlocking) connector. The reason for this recommendation is that the non-



Electrical length of Type 900-Q874.

locking connector (when properly connected) is fully engaged, with the outer-conductor fingers seating on the bead of the mating connector. The locking connector, on the other hand, is designed to provide a gap between the outer-conductor fingers and the bead of the mating connector. This gap is normally 0.020 inch but can vary from 0.006 to 0.042 inch.

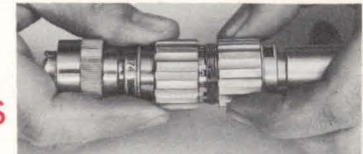
A plot of typical VSWR characteristics for the Type 900-Q874 adaptor is given (left). The electrical length of the adaptor is $6.50 \pm 0.04 \text{ cm}$, extending from the face of the Type 900-BT connector to the face of the bead in a mating Type 874-B (nonlocking) connector (see the cross-section view). This is the same position at which the short circuit is applied when a Type 874-WN Short-Circuit Termination is employed to obtain a reference.

APPLICATIONS

The Type 900-Q874 adaptor is used to connect equipment that contains Type 874 connectors with equipment that contains Type 900-BT connectors.

The Type 900-Q874 adaptor extends the usefulness of the Type 900-LB Precision Slotted Line by permitting precision measurements of low-VSWR components equipped with Type 874 connectors. This combination of slotted line and adaptor is recommended when it is necessary to make measurements on components through Type 874 connectors to better accuracies than can be achieved with the general-purpose Type 874-LBA Slotted Line.

MATING OF TYPE 900-BT CONNECTORS

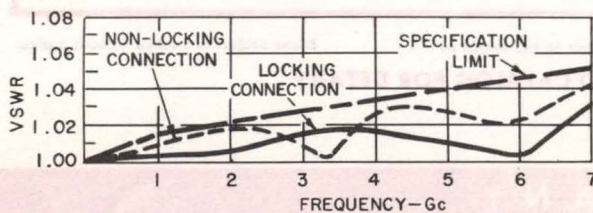


Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

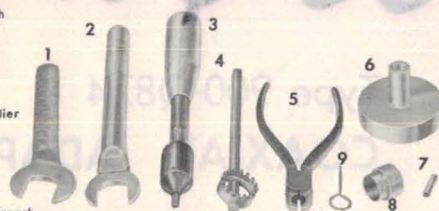


VSWR specification for Type 900-Q874 Adaptor with plots of typical performance when mated with locking and nonlocking Type 874 connectors. The adaptors are tested in pairs to the specification for a single adaptor.

900-Q874

TYPE 900-TOK TOOL KIT

1. Open-End Wrench
2. Coupling-Nut Torque Wrench
3. Inner-Conductor Torque Wrench
4. Gear Wrench
5. Inner-Conductor Plier
6. Bead Pusher
7. Inner-Conductor Injector
8. Bead Compression Sleeve
9. Spring-Contact Wrench



PRECISION COAXIAL ELEMENTS AND EQUIPMENT

TYPE 900-LB PRECISION SLOTTED LINE

A 50-cm, coaxial slotted line terminated in a Type 900-BT connector (with the same VSWR characteristics as the connector from 300 Mc to 9 Gc). It has a characteristic impedance of 50 ohms $\pm 0.1\%$, scale accuracy of $\pm(0.1 \text{ mm} + 0.05\%)$, and a constancy of probe pickup of $\pm 0.5\%$. Residual VSWR is less than $1.001 + 0.001 \times f_{\text{Gc}}$. Supplied complete with vernier-drive carriage, adjustable probe, tuning stub, and crystal detector.

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

This complete system automatically and accurately plots VSWR's from 1.001 to 1.20 as well as positions of minima and reference plane. It consists of a Type 900-LB Slotted Line linked to a Type 1521-SL Slotted Line Recorder, which drives the probe carriage of the line and synchronously and faithfully provides a permanent plot of the detector output.

ORDERING INFORMATION

PRECISION COAXIAL ELEMENTS

Type		
900-BT	Precision Coaxial Connector	
900-L10	Precision Air Line (10 cm)	
900-L15	Precision Air Line (15 cm)	
900-L30	Precision Air Line (30 cm)	
900-Q874	Adaptor to Type 874	
900-QNJ	Adaptor, type-N Jack	
900-QNP	Adaptor, type-N Plug	
900-TOK	Tool Kit	
900-WN	Short-Circuit Termination	
900-WO	Open-Circuit Termination	
900-W50	50-Ohm Termination	
0900-9508	Precision Inner-Conductor Rod	
0900-9509	Precision Outer-Conductor Tube	
0900-9782	Adaptor Flange	

Length inches	Net Weight*	Code Number	Price
1 1/16	2 oz.	0900-9405	\$35.00
4	6 1/2 oz.	0900-9605	85.00
6	10 oz.	0900-9607	90.00
12	15 oz.	0900-9613	100.00
2 1/16	3 1/2 oz.	0900-9883	45.00
2 1/4	3 1/2 oz.	0900-9711	50.00
2 1/16	4 oz.	0900-9811	50.00
—	2 lb.	0900-9902	95.00
1 1/16	2 1/2 oz.	0900-9971	9.00
1 1/16	2 oz.	0900-9981	9.00
2	3 1/2 oz.	0900-9953	60.00
27	7 oz.	0900-9508	25.00
27	2 1/2 lb.	0900-9509	35.00
—	3 oz.	0900-9782	3.50

PRECISION COAXIAL EQUIPMENT

900-LB	Precision Slotted Line	10 3/4 lb.	0900-9651	\$575.00
1640-A	Slotted Line Recorder System (60 cps)	67 lb.	1640-9701	1875.00
1640-AQ1	Slotted Line Recorder System (50 cps)	67 lb.	1640-9494	1875.00

*To convert ounces to grams, multiply by 28; pounds to kg, divide by 2.2.

Prices subject to change without notice.

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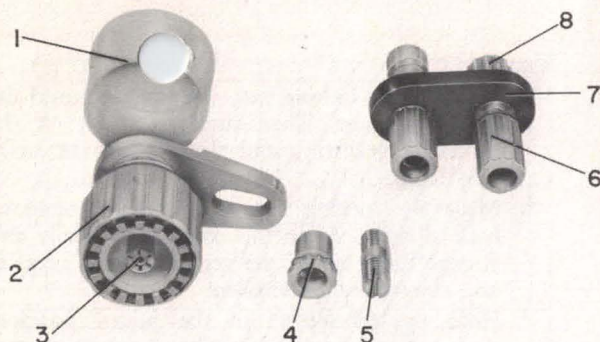


Figure 1. The 900-Q9 Adaptor.

SPECIFICATIONS

CONVERSION OF BINDING POSTS TO GR900 CONNECTOR.
Capacitance: Added by adaptor to Type 938 Binding Posts ($\frac{3}{4}$ -inch spacing) on 2-terminal bridge, typically 3.55pF, not including the 0.155pF fringing capacitance of the GR900 connector.

Inductance: Typically 4.8nH.

CONVERSION OF GR900 CONNECTOR TO BINDING POSTS.
 (Adaptor plus binding-post assembly)

Capacitance: Typically 5.2pF.

Inductance: Typically 10.9nH.

Type 900-Q9

ADAPTOR

GR900 / BINDING POSTS

JANUARY 1968

FORM 0900-0138A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

GR900® PRECISION COAXIAL COMPONENTS

900-Q9 PARTS LIST

Figure 1 Ref.	Description	Part Number
1	Protective Cap: white plastic.	0900-7190
2	Adaptor Assembly: has GR900 Precision Coaxial Connector and accepts binding-post assembly (7)	0900-2410
3	Inner-Contact Assembly: part of adaptor assembly (2).	0900-2000
4	Nut: provides connection between threaded binding-post terminal and snap-in fingers at rear of adaptor assembly (2).	0900-6123
5	Stud: replaces High terminal on instruments with $\frac{1}{4}$ -28 tapped holes. It is then connected to the adaptor assembly via the nut (4).	0900-6121
6	Binding Post: can be removed from the binding-post assembly (7) during installation by removing the thumb nut (8).	0938-2022
7	Binding-Post Assembly: $\frac{3}{4}$ -inch spaced, Type 938 binding posts. The binding posts can be mounted on adaptor assembly (2).	0900-2430
8	Thumb Nut: secures the removable binding post (6) to the binding-post assembly (7).	0900-6122

Purpose

The 900-Q9 is a dual-purpose adaptor. It provides a means to connect (with a minimum of inductance) imittance standards equipped with GR900 connectors to instruments with $\frac{3}{4}$ -inch spaced binding posts (Type 938), or with other terminals ($\frac{1}{4}$ -28 thread) spaced $\frac{3}{4}$ -to-1 inch apart. The adaptor can also be installed on instruments with GR900 connectors and provide $\frac{3}{4}$ -inch spaced binding posts (Type 938) for connection to wire-lead parts to be measured, such as capacitors, inductors, and resistors.

Description

The 900-Q9 is furnished in a plastic storage box and consists of the parts and assemblies shown in Figure 1 and listed in the accompanying parts list.

INSTALLATION

Adaptor Assembly and Installation

The 900-Q9 Adaptor can be assembled and installed as shown in Figures 2 and 3. Refer to the following paragraphs for recommended procedures.

Conversion to GR900 Connector

The adaptor can be installed on instruments with $\frac{3}{4}$ -inch spaced binding posts and on other instruments equipped with $\frac{1}{4}$ -28 threaded posts or $\frac{1}{4}$ -28 tapped holes, spaced $\frac{3}{4}$ -inch to 1-inch apart. Some of these instruments are the GR 716 Capacitance Bridges, the Boonton Radio Type 260A Q Meter, and the Boonton Electronics Model 75 Capacitance Bridge. The 900-Q9 will allow these instruments to accept precision standards equipped with GR900 Precision Coaxial Connectors, such as the GR 1405, 1406, and 1407 Standard Capacitors.

To assemble and install the adaptor, see Figures 1 and 2 (same reference numbers used in both figures), and proceed as follows:

- Remove the tops from the binding posts on the instrument (see note below). Retain the tops for future use.

NOTE

The binding posts on most GR bridges have removable tops. The standard Type 938 binding posts, however, have captive tops like those on the binding-post assembly supplied as part of the 900-Q9 Adaptor. To remove a captive top, force the top off the staked body of the post and refinish the threaded portion of the body with a $\frac{1}{4}$ -28 die.

Thread nut (4) on to the HIGH post.

- c. Snap adaptor assembly (2) in place over nut (4) as shown in Figure 2. The LOW post should be in the elongated hole in the adaptor base plate.
- d. Thread the top, previously removed in step a, on the lower post and tighten securely.

If the binding posts are $\frac{1}{4}$ -28 screws (as they are on the 260A Q Meter), remove the HIGH post screws and thread the $\frac{1}{4}$ -28 stud (5) into the instrument. Proceed with steps b, c, and d above.

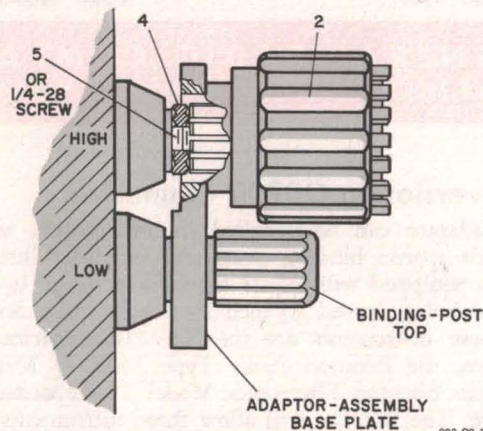


Figure 2. Conversion of binding posts to GR900 connector.

When the adaptor is used to connect two-terminal standards with a GR900 connector to three-terminal bridges, the connections are made to the HIGH and the LOW binding posts of the bridge as described in steps a through d above. No connections are made between the bridge GUARD or GROUND binding post and the adaptor or the standard. When connected to a three-terminal bridge in this manner, the capacitance added by the adaptor is approximately 4.2 pF, not including the 0.127-pF fringing capacitance of the open GR900 connector.

Conversion to Binding Posts

When properly assembled, the 900-Q9 adaptor makes available $\frac{3}{4}$ -inch spaced binding posts for installation on any instrument equipped with a GR900 connector. For example, wire-lead components can be

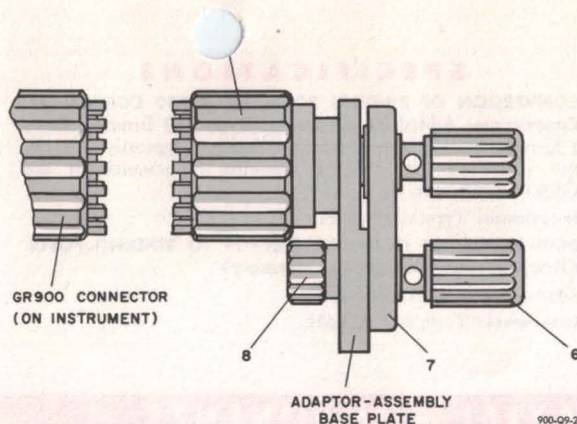


Figure 3. Conversion of a GR900 connector to binding posts

connected, via the 900-Q9, to the GR 900-LB Precision Slotted Line, the 1606-B R-F Bridge, or the GR 1609 Precision UHF Bridge.

To assemble the adaptor for this purpose, see Figures 1 and 3 (same reference numbers used in both figures), and proceed as follows:

- a. Remove thumb nut (8) from the binding-post assembly (7).
- b. Snap binding-post assembly (7) into the rear contact fingers of the adaptor assembly (2). Binding-post assembly (7) should be positioned as shown in Figure 3, with binding post (6) protruding through the elongated hole in the base plate of the adaptor assembly (2). If binding post (6) is removed during this step, align the hole in the post body to correspond with the hole in the other binding post when it is reinstalled (see Figure 3).
- c. Reinstall and tighten thumb nut (8).

Mating of GR900 Connectors

The GR900 Precision Coaxial Connector on the 900-Q9 will mate with any other GR900 connector. Since only one locking nut is used per junction, the unused nut is stored at the rear of one of the connectors. The mating procedure is as follows (see

Figure 4):

- a. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it back as far as it will go.
- b. Move the locking nut of the other connector back slightly. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.
- c. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

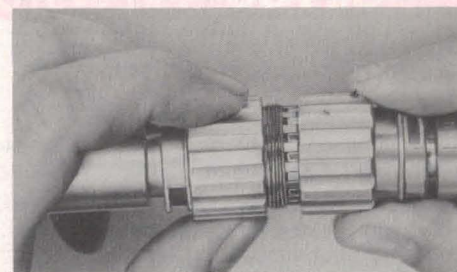


Figure 4. Mating of GR900 connectors.

MEASUREMENT CORRECTIONS

General

The capacitance added to a pair of open bridge terminals by a 900-Q9 Adaptor will vary slightly with the various configurations of different instruments. The effect of these variations on capacitance measurements may be eliminated on bridges where the initial balance is made with an open circuit by balancing the bridge with the adaptor installed on the instrument. This also eliminates the necessity for including adaptor capacitance when calculating the change in capacitance at the bridge terminals when a capacitance standard equipped with a GR900 connector is connected to the adaptor.

The chart shown in Figure 5 can be used to correct for an increase in the effective value of a capacitor that is caused by the inductance of the

TYPICAL INCREASE IN EFFECTIVE CAPACITANCE (%)

Figure 5
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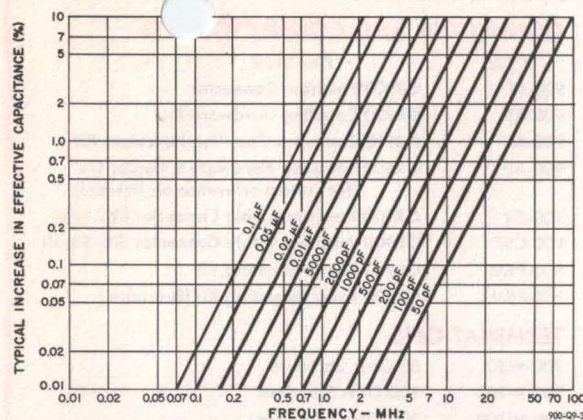


Figure 5. Typical increase in effective capacitance resulting from the inductance of a 900-Q9 installed on the binding posts of an instrument.

adaptor. This correction is for the inductance of the adaptor only, any correction for the internal inductance of the capacitor must be added.

When the 900-Q9 is used on a bridge where the initial balance may be made with the terminals shorted (such as the GR 1606, GR 916, or GR 1632), the inductance of the 900-Q9 is included in the initial and subsequent balances and, therefore, no correction is necessary.

Binding Post to GR900

The following expressions may be used to correct for the adaptor parameters when using standards equipped with GR 900 connectors for calibrating bridges and other instruments. These expressions are approximate and should be used only when the correction is small, i.e. for a correction (due to the $\omega^2 L_a C_s^2$ term in equation 1) of 3%, the error in C_e will be about 0.1%.

- (1) $C_e \approx C_s + \omega^2 L_a C_s^2 + C_a$
- (2) $R_{es} \approx R \left[1 + \omega^2 (L_{ar} C_{ar} - R^2 C_{ar}^2) \right]$
- (3) $R_{ep} \approx R + \frac{\omega L_{ar}^2}{R}$
- (4) $L_e \approx L_s + \omega^2 L_s^2 C_a + L_a$

where C_e = effective value of the capacitance standard at the bridge terminals.

C_s = value of capacitance standard at its reference plane, and at the measurement frequency.

C_a = capacitance of the adaptor (3.55 pF on 2-terminal bridge). This may be omitted from equation (1) if it was included in the initial open-circuit balance of the bridge as described above.

C_{ar} = combined capacitance of the adaptor and resistor.

R_{es} = effective series resistance at the bridge terminals.

R_{ep} = effective parallel resistance at the bridge terminals.

R = dc value of the measured resistor.

L_e = effective value of the standard, added to the adaptor.

L_s = value of the standard at the measurement frequency.

L_a = inductance of the adaptor, (4.8 nH). This may be omitted from equation (4) if it was included in the initial short-circuit balance of the bridge.

L_{ar} = combined inductance of adaptor and resistor.

$\omega = 2\pi f$.

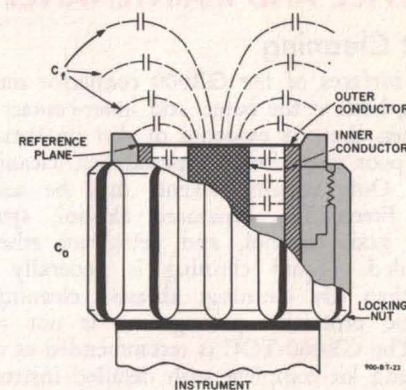


Figure 6. Open GR900 connector showing internal capacitance (C_o) and fringe capacitance (C_f).

When two coaxial connectors are properly mated, the fringe capacitance is eliminated as shown in Figure 7. The reference planes of the two connectors effectively become a single plane of reference with no stray capacitance existing between them. A second reading would include the internal capacitance (C_o) plus the added capacitance (C_s) of the standard and its connector. Thus, the fringe capacitance must be added to the difference between the two readings to obtain the true value of the standard capacitor.

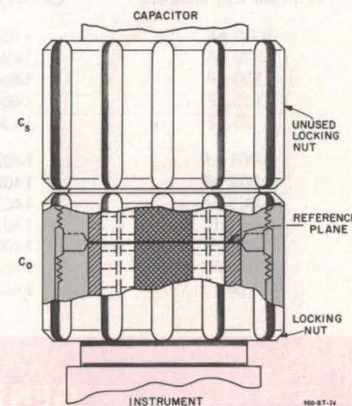


Figure 7. Two GR900 connectors indicating elimination of fringe capacitance when connectors are properly mated.

GR900 to Binding Posts

When the adaptor assembly is used to convert a GR900 connector to binding posts (on the GR 1606-B, for example), similar corrections must be made. In this arrangement, the inductance of the adaptor is about 10.9 nH and the capacitance is 5.2 pF.

Fringe Capacitance

An open coaxial connector, as shown in Figure 6, has stray (fringe) capacitance (C_f) extending beyond the reference plane. A reading with the instrument using this connector in the open-circuit state would include the internal capacitance (C_o) plus the fringe capacitance (C_f).

SERVICE AND MAINTENANCE

Contact Cleaning

The butt surfaces of the GR900 connector must be kept clean, both at the outer- and inner-contact junctions. When there is evidence of dirt on these surfaces, or poor make-break repeatability, cleaning is necessary. Only certain solvents may be used in cleaning; Freon TF, denatured alcohol, synthetic methanol, grain alcohol, and petroleum ether are recommended. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. The GR900-TOC is recommended as a suitable cleaning kit complete with detailed instructions on cleaning GR900 connectors.

Poor repeatability results also if the inner conductor of the mating connector (with contact removed) protrudes beyond the outer conductor. This should be checked if trouble occurs.

Inner Contact Assembly Replacement

To replace the Inner Contact Assembly on the GR900 connector, remove the old contact assembly using a 1/16 Allen wrench, and thread the replacement assembly in its place. Tighten lightly.

CAPACITANCE STANDARDS (COAXIAL)

Type	Nominal Capacitance	Catalog Number
1406-A	1000 pF	1406-9701
1406-B	500 pF	1406-9702
1406-C	200 pF	1406-9703
1406-D	100 pF	1406-9704
1406-E	50 pF	1406-9705
1407-A	0.001 μ F	1407-9700
1407-B	0.002 μ F	1407-9701
1407-C	0.005 μ F	1407-9702
1407-D	0.01 μ F	1407-9703
1407-E	0.02 μ F	1407-9704
1407-F	0.05 μ F	1407-9705
1407-G	0.1 μ F	1407-9706

GR900® COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJA	Connects to type-BNC Plug
900-QBP	Connects to type-BNC-Jack
900-QCJA	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM* Plug
900-QMMP	Connects to type-OSM Jack
900-QNJA	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Precifix 7 mm
900-QSCJA	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJA	Connects to type-TNC Plug
000-QTNP	Connects to type-TNC Jack
900-Q9	Connects to binding posts

AIR LINES — PRECISION

900-L3	Phase, Time-Delay & Impedance Standard — 3 cm
900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ3	Ultraprecise Impedance Standard — 3 cm
900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector (RG-9/U)
900-C58	GR900 Precision Cable Connector (RG-58/U)
900-PKM	GR900 Panel Mounting Kit
900-PKMR	GR900 Panel Mounting Kit (Rotatable)

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-EL	Precision 90° Ell
900-G6	6 dB Attenuator
900-M	Component Mount
900-TOC	GR900 Connector Cleaning Kit
900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9507	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange
0900-9499	Rotatable Centering Ring

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

* Reg. Trademark, Omni-Spectra, Inc., Southfield, Mich.

CONSULT YOUR GENERAL RADIO CATALOG FOR DETAILS

GENERAL RADIO COMPANY • WEST CONCORD, MASSACHUSETTS 01781

• NEW ENGLAND: 22 Baker Avenue
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• METROPOLITAN NEW YORK: 845 Broad Avenue
Ridgefield, New Jersey 07657

• SYRACUSE: Pickard Building, East Molloy Road
Syracuse, New York 13211

• PHILADELPHIA: Fort Washington Industrial Park
Fort Washington, Pennsylvania 19034

• WASHINGTON and BALTIMORE: 11420 Rockville Pike
Rockville, Maryland 20852

• CLEVELAND: 5579 Pearl Road
Cleveland, Ohio 44129

• DALLAS: 2600 Stemmons Freeway, Suite 210
Dallas, Texas 75207

• ORLANDO: 113 East Colonial Drive
Orlando, Florida 32801

• SAN FRANCISCO: 626 San Antonio Road
Mountain View, California 94040

• LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038

• CHICAGO: 9440 W. Foster Avenue
Chicago, Illinois 60656

• TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.
Characteristic Impedance: 50.0 Ω , nominal.
VSWR: Less than $1.003 + 0.002 \times f_{\text{GHz}}$.
Electrical Length: $5:30 \pm 0.02$ cm.

Insertion Loss: Less than $0.02 \sqrt{f_{\text{GHz}}}$ dB.

Maximum Voltage: 1000 volts, peak.

Maximum Power: 6 kW up to 1 MHz; $6 \text{ kW} / \sqrt{f_{\text{MHz}}}$ above 1 MHz.

Dimensions: Length $2\frac{1}{8}$ in. (54 mm); max. diam. $1\frac{1}{16}$ in. (27 mm).

Net Weight: $3\frac{1}{2}$ oz. (100 g).

GR EXPERIMENTER REF. Vol. 41, No. 4, April, 1967.
 OTHER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan. 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965; Vol. 40, No. 5, May, 1966. All above in reprint E115. Also: Vol. 40, No. 7, July, 1966 and Vol. 40, No. 8, August, 1966.

$$0.02 \sqrt{f_{\text{GHz}}} \text{ dB}$$

Type 900-QAP7

COAXIAL ADAPTOR 50 OHMS

(Mates with Amphenol APC-7 7-mm Connector)

MAY 1967

FORM 0900-0111A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

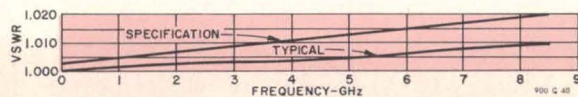
GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

This adaptor comprises a General Radio Type 900-BT Precision Coaxial Connector (General Precision Connector — GPC), a specially designed continuous transition from the GR900 (14-mm) line size to the 7-mm line size, and a Laboratory Precision Connector (LPC) in the 7-mm line size.

The 7-mm Laboratory Precision Connector consists of a coupling mechanism and a contact to mate with Amphenol APC-7 7-mm connectors. The coupling mechanism is interchangeable with that of other 7-mm precision connectors. The critical mating dimensions for the 7-mm connection, independent of the coupling mechanism, are given below. They are the dimensions proposed in the IEEE standards document on precision coaxial connectors.¹

¹See D. E. Fossum, "Progress report of the IEEE I-M Group Technical subcommittee on precision coaxial connectors," *IEEE Transactions on Instrumentation and Measurement*, Vol. IM-13, pp 285-291, Dec. 1964.



VSWR characteristics of the adaptor.

CAUTION

DAMAGE TO THE ADAPTOR CAN RESULT IF THE INNER CONDUCTOR (CONTACT REMOVED) ON THE MATING 7-mm OR 14-mm CONNECTOR PROTRUDES BEYOND THE OUTER CONDUCTOR.

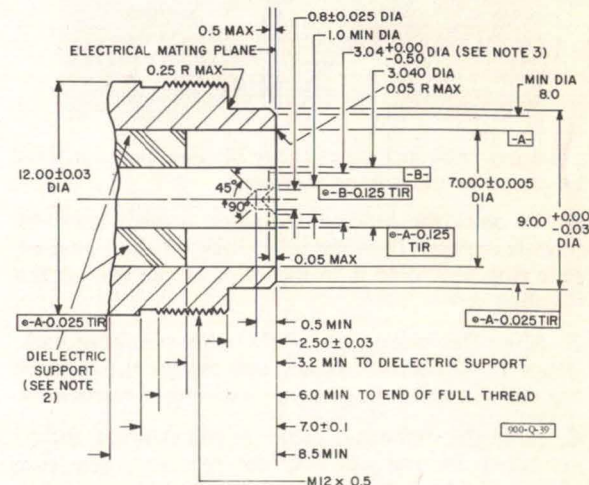
The adaptor inner conductor is positioned by the dielectric support of the GR900 connector. Since no other dielectric support is employed, the adaptor VSWR is very low.

APPLICATIONS

The Type 900-QAP7 Adaptor is used to connect equipment that contains 7-mm precision connectors with equipment that contains GR900 (14-mm) precision connectors. When the adaptor is used with a Type 900-LB Precision Slotted Line, VSWR measurements of components that are equipped with 7-mm precision connectors can be made to an accuracy of better than $1.004 + 0.003 \times f_{\text{GHz}}$ to 8.5 GHz. When the adaptor is used with a Type 900-W50 50-ohm termination, a 7-mm precision termination is assembled that has a residual VSWR of less than $1.008 + 0.007 \times f_{\text{GHz}}$ to 8.5 GHz.

CONTACT CLEANING

The butt surfaces must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these



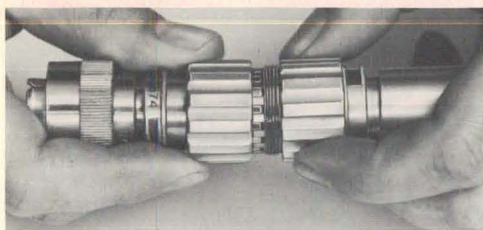
NOTES:

1. All dimensions in millimeters.
2. Inner- and outer-conductor diameters in the vicinity of the dielectric support may be varied to provide electrical compensation.
3. Center-conductor contact shown in mated coplanar position.
4. The pilot hole and countersink are shown only as a suggested means of providing support for LPC center conductor.

Critical mating dimensions for the 7-mm general precision connector.

surfaces, or poor make-break repeatability, cleaning is necessary. Only certain solvents may be used in cleaning. The recommended solvents are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, and petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJA	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJA	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QNJA	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Precifix 7 mm
900-QSCJA	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJA	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-EL	Precision 90° Ell
900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9507	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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Fort Washington, Pennsylvania 19034

• WASHINGTON and BALTIMORE: 11420 Rockville Pike
Rockville, Maryland 20852

• CLEVELAND: 5579 Pearl Road
Cleveland, Ohio 44129

• DALLAS: 2600 Stemmons Freeway, Suite 210
Dallas, Texas 75207

• ORLANDO: 113 East Colonial Drive
Orlando, Florida 32801

• SAN FRANCISCO: 626 San Antonio Road
Mountain View, California 94040

• LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038

• CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302

• TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



900 QBJ

Type 900-QBJ COAXIAL ADAPTOR

(Contains type-BNC jack)

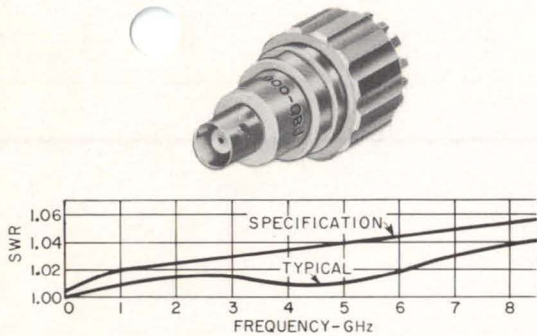
NOVEMBER 1973

FORM 0900-0135B

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

SPECIFICATIONS
Frequency Range: Dc to 8.5 GHz.
SWR: Less than $1.005 + 0.015 f_{\text{GHz}}$ to 1 GHz; $1.015 + 0.005 f_{\text{GHz}}$, 1 to 8.5 GHz.
Voltage: 500 V peak.
Power: 3 kW up to 1 MHz; $3 \text{ kW} / \sqrt{f_{\text{MHz}}}$ above 1 MHz.
Electrical Length: 5.37 ± 0.05 cm to the end of the type-BNC jack inner conductor.
Dimensions: Length, 2-1/8 inches (54 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 3½ ounces (100 grams).
GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.

CAUTION
 DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.



SWR characteristics of the adaptor.

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low SWR version of the type-BNC connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-SWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-SWR version. The inner-conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-SWR CONNECTORS

The General Radio low-SWR type-BNC connectors are designed so that a mated pair introduces a minimum SWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a

minimum gap of 0.002 inch is recommended at the inner-conductor junction.

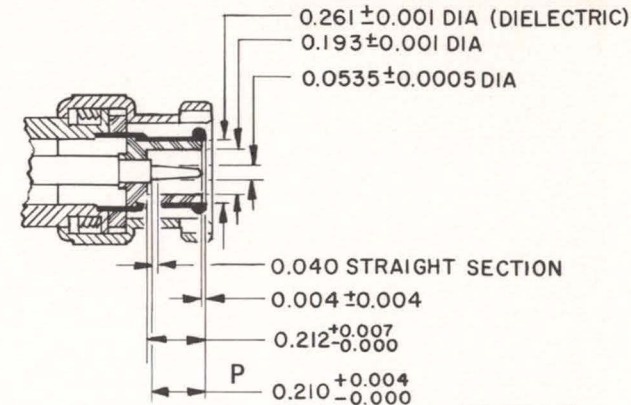
The specified SWR (see plot) of the adaptor is based on its use with a mating low-SWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-SWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-SWR connection. The drawing shows the recommended dimensions for a mating connector. The type-BNC connector mates without mechanical interference with MIL-C-39012, Class II, connectors.

If the mating connector is made so that dimension "P" is 0.210 ± 0.004 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 in. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$X_L = 0.05 \cdot f \cdot g\%$$

where X_L is the effect in percent, f is the frequency in GHz, and g is the gap in mils.



900-Q-26

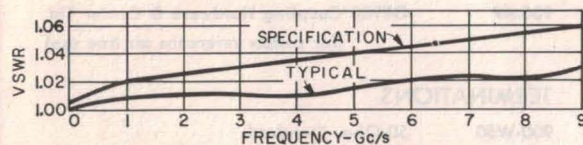
NOTES:

All dimensions in inches.
 Outer conductor has 6 slots 60° apart,
 0.015 ± 0.001 wide by 0.235 ± 0.003 deep;
 inner diameter in region of contact fingers is
 0.2650 ± 0.0005 when fingers are inserted in an
 0.3200 inner-diameter ring.

Recommended dimensions to mate adaptor.

CAUTION

Dimension "P" must not be less than 0.210 inch or excessive longitudinal forces can be exerted on the connector inner conductors.



VSWR characteristics of the adaptor.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR version of the type-BNC connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-VSWR version. The inner- and outer-conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR CONNECTORS

The General Radio low-VSWR type-BNC connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a minimum

SPECIFICATIONS
Frequency Range: Dc to 9 Gc/s.
VSWR: Less than $1.005 + 0.015 \sqrt{f}$ to 1 Gc/s; $1.015 + 0.005 \sqrt{f}$, 1 to 9 Gc/s.
Voltage: 500 volts peak.
Power: 3 kw up to 1 Mc/s; 3 kw/ $\sqrt{f_{MC}}$ above 1 Mc/s.
Electrical Length: 5.70 ± 0.03 cm to the end of the type-BNC plug outer conductor.
Dimensions: Length, $2\frac{1}{8}$ inches (54 mm); maximum diameter, $1\frac{1}{8}$ inch (27 mm).
Net Weight: $3\frac{1}{2}$ ounces (100 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37, No. 2 and 3, February - March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

CAUTION
 DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

gap of 0.002 inch is recommended at the inner-conductor junction.

The specified VSWR (see plot) of the adaptor is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-VSWR connection. The drawing shows the recommended dimensions for a mating connector.

If the mating connector is made so that dimension "J" is 0.208 ± 0.003 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.035 \cdot f \cdot g\%$$

where x_L is the effect in percent, f is the frequency in Gc/s, and g is the gap in mils.

900-QBP

Type 900-QBP

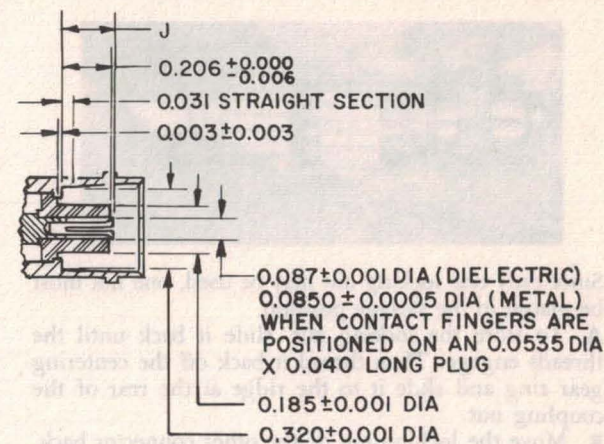
COAXIAL ADAPTOR

(Contains type-BNC plug)

SEPTEMBER 1965

FORM 0900-0145A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS



NOTES:

All dimensions in inches.

Inner conductor has 4 equally spaced slots
 0.008 ± 0.001 wide by 0.187 ± 0.005 deep.

Recommended dimensions to mate adaptor.

CAUTION

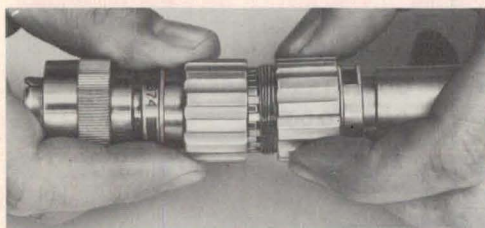
Dimension "J" must not be more than 0.208 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

APPLICATIONS

The adaptor is used to connect equipment that contains type-BNC connectors with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type-BNC connectors. The residual VSWR of such a slotted line is less than $1.006 + 0.016 f_{Gc}$ to 1 Gc/s, $1.016 + 0.006 f_{Gc}$, 1 to 9 Gc/s.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination. The VSWR of the adaptor/termination combination is less than $1.01 + 0.02 f_{Gc}$ to 1 Gc/s and $1.02 + 0.01 f_{Gc}$ from 1 to 9 Gc/s.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-Q8J	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit

TYPE 900-LB	PRECISION SLOTTED LINE
TYPE 1640-A	SLOTTED LINE RECORDER SYSTEM

CONNECTOR AND CONNECTOR KITS continued

Type	Function
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 9.0 Gc/s)
900-TUB	Tuner (0.25 - 2.5 Gc/s)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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Town of Mount Royal, Quebec, Canada



900-QCJ

Type 900-QCJ

COAXIAL ADAPTOR

(Contains type-C jack)

SEPTEMBER 1965

FORM 0900-0124A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

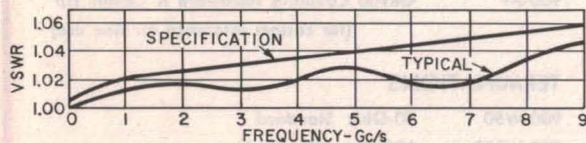
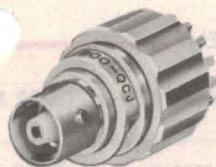
SPECIFICATIONS

Frequency Range: Dc to 9 Gc/s.
VSWR: Less than $1.005 + 0.015 \sqrt{f}$ to 1 Gc/s; $1.015 + 0.005 \sqrt{f}$, 1 to 9 Gc/s.
Voltage: 1000 volts peak.
Power: 7 kw up to 1 Mc/s; 7 kw/ $\sqrt{f_{MC}}$ above 1 Mc/s.
Electrical Length: 5.03 ± 0.05 cm to the end of the type-C jack inner conductor.
Dimensions: Length, $1\frac{1}{4}$ inches (46 mm); maximum diameter, $1\frac{1}{4}$ inch (27 mm).
Net Weight: $3\frac{1}{2}$ ounces (100 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37, No. 2 and 3, February - March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.



VSWR characteristics of the adaptor.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR version of the type-C connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-VSWR version. The inner-conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR CONNECTORS

The General Radio low-VSWR type-C connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a minimum

gap of 0.002 inch is recommended at the inner-conductor junction.

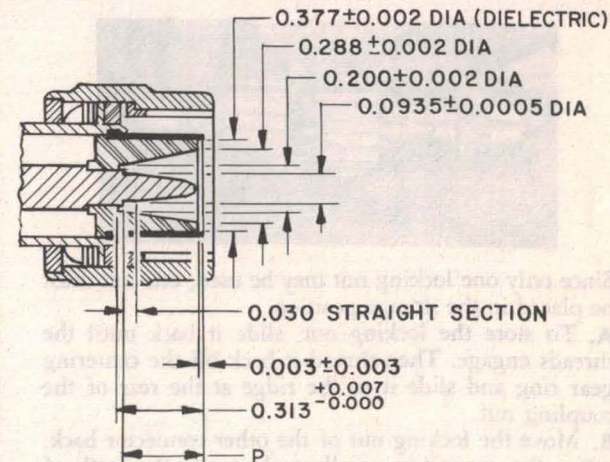
The specified VSWR (see plot) of the adaptor is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-VSWR connection. The drawing shows the recommended dimensions for a mating connector.

If the mating connector is made so that dimension "P" is 0.311 ± 0.004 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.021 \cdot f \cdot g\%$$

where x_L is the effect in percent, f is the frequency in Gc/s, and g is the gap in mils.



NOTES:

All dimensions in inches.
 Outer conductor has 6 slots, 60° apart, 0.016 ± 0.001 wide by 0.255 ± 0.005 deep;
 inner diameter in region of contact-fingers is 0.3820 ± 0.0005 when fingers are inserted in an 0.413 inner diameter ring.

Recommended dimensions to mate adaptor.

CAUTION

Dimension "P" must not be less than 0.311 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

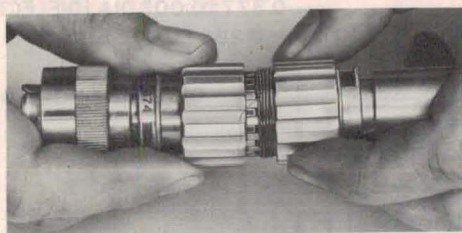
900-QCJ

APPLICATIONS

The adaptor is used to connect equipment that contains type-C connectors with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type-C connectors. The residual VSWR of such a slotted line is less than $1.006 + 0.016 f_{Gc}$ to 1 Gc/s, $1.016 + 0.006 f_{Gc}$, 1 to 9 Gc/s.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination. The VSWR of the adaptor/termination combination is less than $1.01 + 0.02 f_{Gc}$ to 1 Gc/s and $1.02 + 0.01 f_{Gc}$ from 1 to 9 Gc/s.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit

TYPE 900-LB	PRECISION SLOTTED LINE
TYPE 1640-A	SLOTTED LINE RECORDER SYSTEM

CONNECTOR AND CONNECTOR KITS continued

Type	Function
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 9.0 Gc/s)
900-TUB	Tuner (0.25 - 2.5 Gc/s)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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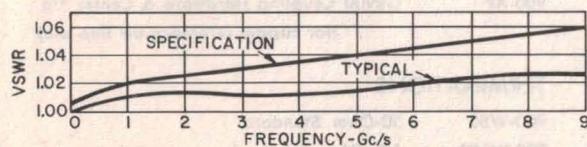
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Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



VSWR characteristics of the adaptor.

SPECIFICATIONS

Frequency Range: Dc to 9 Gc/s.
VSWR: Less than $1.005 + 0.01 \sqrt{f}$ to 1 Gc/s; $1.015 + 0.005 \sqrt{f}$, 1 to 9 Gc/s.
Voltage: 1000 volts peak.
Power: 7 kw up to 1 Mc/s; 7 kw/ \sqrt{f} Mc above 1 Mc/s.
Electrical Length: 5.60 ± 0.05 cm to the end of the type-C plug outer conductor.
Dimensions: Length, $2\frac{1}{16}$ inches (53 mm); maximum diameter, $1\frac{1}{16}$ inch (27 mm).
Net Weight: $3\frac{1}{2}$ ounces (100 grams).
GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37, No. 2 and 3, February - March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

900-QCP

Type 900-QCP

COAXIAL ADAPTOR

(Contains type-C plug)

SEPTEMBER 1965

FORM 0900-0126A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR version of the type-C connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-VSWR version. The inner- and outer-conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR CONNECTORS

The General Radio low-VSWR type-C connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a minimum

gap of 0.002 inch is recommended at the inner-conductor junction.

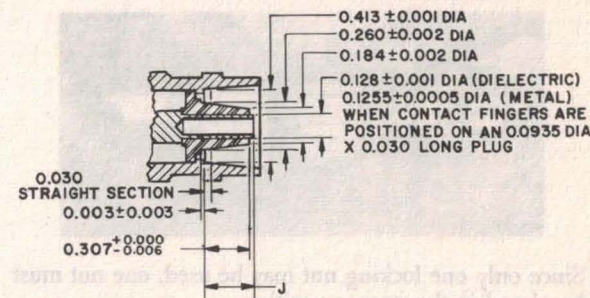
The specified VSWR (see plot) of the adaptor is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-VSWR connection. The drawing shows the recommended dimensions for a mating connector.

If the mating connector is made so that dimension "J" is 0.309 ± 0.003 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.021 \cdot f \cdot g\%$$

where x_L is the effect in percent, f is the frequency in Gc/s, and g is the gap in mils.



NOTES:

All dimensions in inches.

Inner conductor has 4 slots, equally spaced, 0.012 ± 0.001 wide by 0.210 ± 0.005 deep.

Recommended dimensions to mate adaptor.

CAUTION

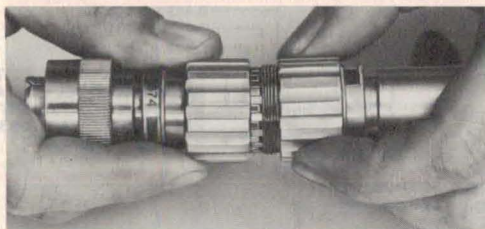
Dimension "J" must not be more than 0.309 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

APPLICATIONS

The adaptor is used to connect equipment that contains type-C connectors with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type-C connectors. The residual VSWR of such a slotted line is less than $1.006 + 0.016 f_{Gc}$ to 1 Gc/s, $1.016 + 0.006 f_{Gc}$, 1 to 9 Gc/s.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination. The VSWR of the adaptor/termination combination is less than $1.01 + 0.02 f_{Gc}$ to 1 Gc/s and $1.02 + 0.01 f_{Gc}$ from 1 to 9 Gc/s.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit

CONNECTOR AND CONNECTOR KITS continued

Type	Function
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 9.0 Gc/s)
900-TUB	Tuner (0.25 - 2.5 Gc/s)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 900-LB PRECISION SLOTTED LINE

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



SPECIFICATION

Frequency: Dc to 1 GHz.

Electrical: IMPEDANCE: 75 Ω nominal.

Mechanical: DIMENSIONS: 1.92 in. (49 mm) long; 1.06 in. (27 mm) dia. WEIGHT: 0.2 lb (0.1 kg) net, 1 lb (0.5 kg) shipping.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Type 900-QFJ (75 Ω)

COAXIAL ADAPTOR

75 OHMS



General Radio

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JULY 1972

FORM 0900-0163A

GR900® PRECISION COAXIAL COMPONENTS

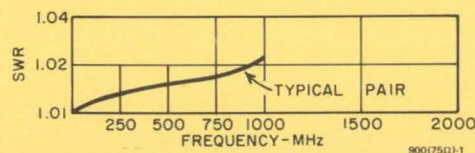
DESCRIPTION

The Type 900-QFJ Adaptor comprises a Type 900-BT Precision Coaxial Connector and a specially designed step transition from the GR900 line size to the type F. The inner contact of the type F connector is made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR TYPE F CONNECTORS

The VSWR (see plot) of the Type 900-QFJ Adaptor includes any residual reflections introduced by the Type 900-BT (75 Ω) connector, the transition section, and the type F section.

To achieve a low-VSWR connection, both connectors, that make up the type F junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used appears at the right.

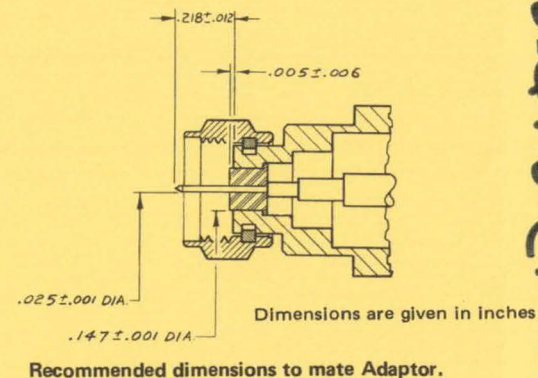


INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.



GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.



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Printed in U.S.A.



SPECIFICATION

Frequency: Dc to 1 GHz.

Electrical: IMPEDANCE: 75 Ω nominal.

Mechanical: DIMENSIONS: 1.75 in. (44 mm) long; 1.06 in. (27 mm) dia. WEIGHT: 0.2 lb (0.1 kg) net, 1 lb (0.5 kg) shipping.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Type 900-QFP (75 Ω)

COAXIAL ADAPTOR

75 OHMS



General Radio

JULY 1972

FORM 0900-0164A

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

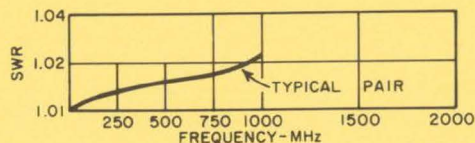
The Type 900-QFP Adaptor comprises a Type 900-BT (75 Ω) Precision Coaxial Connector, a specially designed step transition from the GR900 line size to the type-F line size, and a type-F plug.

The inner contact of the type-F connector is made of hardened beryllium-copper (gold-plated) to provide long wear and good contact.

LOW-VSWR TYPE F CONNECTORS

The VSWR (see plot) of the Type 900-QFP Adaptor includes any residual reflections introduced by the Type 900-BT (75 Ω) connector, the transition section, and the type-F section.

To achieve a low-VSWR connection, both connectors that make up the type-F junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used appears at the right.



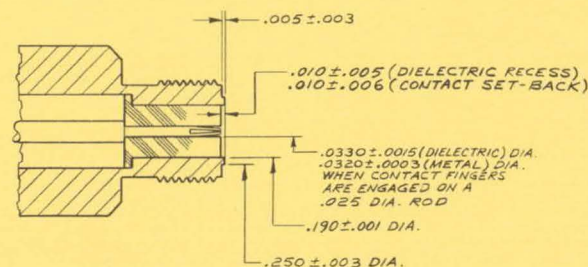
900(75Ω)-1

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.



Dimensions are given in inches

Recommended dimensions to mate Adaptor.

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.



General Radio

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CAUTION

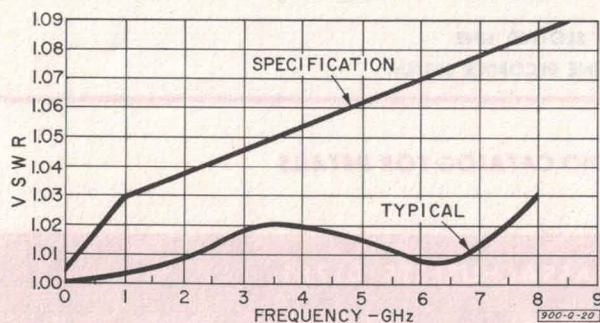
DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR connector intended to mate with the OSM miniature connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version of the type-OSM connector is compatible with the standard OSM connector and is recommended for measurement of components so equipped. It will also mate with connectors of other manufacturers including those listed in group A by



VSWR characteristics of the adaptor.

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

VSWR: Less than $1.005 + 0.025 \times f_{\text{GHz}}$ to 1 GHz; $1.022 + 0.008 \times f_{\text{GHz}}$, 1 to 8.5 GHz.

Electrical Length: 4.78 ± 0.05 cm to the outer conductor junction.

Dimensions: Length, $1\frac{7}{8}$ in. (48 mm); maximum diameter, $1\frac{1}{16}$ in. (27 mm).

Net Weight: $2\frac{1}{2}$ oz. (70 g).

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan., 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965.

Brinton* (ASM, BRM, ESCAM, MOB-50, NPM, SRM and STM). However, in the absence of military specifications covering mating dimensions, care must be taken that the mating dimensions are compatible and will not cause damage to the adaptor or the mating component.

The inner-conductor contacts of the low-VSWR connectors are made of hardened beryllium-copper (gold-plated) to provide long wear and good contact.

LOW-VSWR CONNECTORS

In order to achieve minimum reflections from the OSM junction, it is recommended that the mating connector also be a low-VSWR connector. The General Radio low-VSWR connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line. The specified VSWR (see plot) of the adaptors is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection up to the outer-conductor junction.

The drawing shows recommended dimensions for a mating connector.

*Brinton, J. B., Jr., "Miniature Coaxial Components," MICROWAVES, February 1965, p. 32.



Type 900-QMMJ

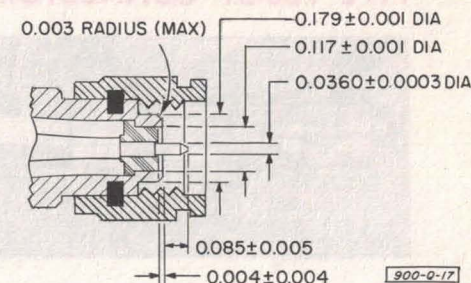
COAXIAL ADAPTOR

(Contains type-OSM jack)

FEBRUARY 1966

Form 0900-0107A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



NOTES:

All dimensions in inches.

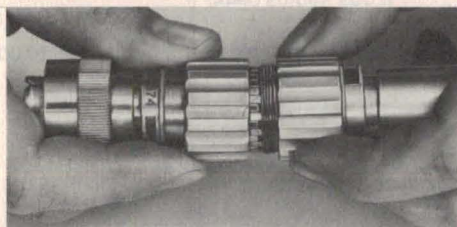
Recommended dimensions to mate adaptors.

APPLICATIONS

The adaptor is used to connect equipment that contains type-OSM connectors (and other connectors that have similar mating dimensions) with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type OSM connectors. The residual VSWR of such a slotted line is less than $1.006 + 0.026 f_{\text{GHz}}$ to 1 GHz, $1.023 + 0.009 \times f_{\text{GHz}}$, 1 to 8.5 GHz.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination for the OSM line size. The VSWR of the adaptor/termination combination is less than $1.01 + 0.03 \times f_{\text{GHz}}$ to 1 GHz and $1.027 + 0.013 \times f_{\text{GHz}}$, from 1 to 8.5 GHz.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

CONSULT YOUR GENERAL RADIO CATALOG FOR DETAILS

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CAUTION

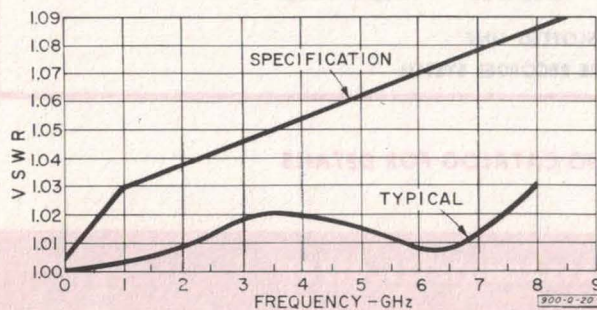
DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR connector intended to mate with the OSM miniature connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version of the type-OSM connector is compatible with the standard OSM connector and is recommended for measurement of components so equipped. It will also mate with connectors of other manufacturers including those listed in group A by



VSWR characteristics of the adaptor.

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

VSWR: Less than $1.005 + 0.025 \times f_{\text{GHz}}$ to 1 GHz; $1.022 + 0.008 \times f_{\text{GHz}}$, 1 to 8.5 GHz.

Electrical Length: 4.67 ± 0.05 cm to the outer-conductor junction.

Dimensions: Length, $1\frac{7}{8}$ in. (48 mm); maximum diameter, $1\frac{1}{16}$ in. (27 mm).

Net Weight: $2\frac{1}{2}$ oz. (70 g).

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan., 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965.

Brinton* (ASM, BRM, ESCAM, MOB-50, NPM, SRM and STM). However, in the absence of military specifications covering mating dimensions, care must be taken that the mating dimensions are compatible and will not cause damage to the adaptor or the mating component.

The inner-conductor contacts of the low-VSWR connectors are made of hardened beryllium-copper (gold-plated) to provide long wear and good contact.

LOW-VSWR CONNECTORS

In order to achieve minimum reflections from the OSM junction, it is recommended that the mating connector also be a low-VSWR connector. The General Radio low-VSWR connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line. The specified VSWR (see plot) of the adaptors is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection up to the outer-conductor junction.

The drawing shows recommended dimensions for a mating connector.

*Brinton, J. B., Jr., "Miniature Coaxial Components," MICROWAVES, February 1965, p. 32.

Type 900-QMMP

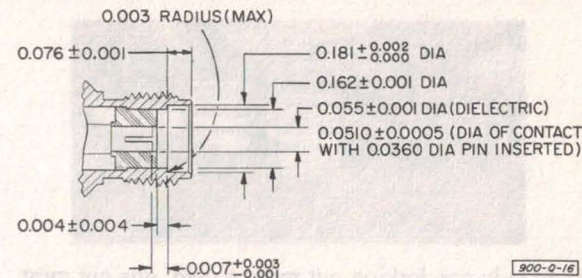
COAXIAL ADAPTOR

(Contains type-OSM plug)

FEBRUARY 1966

Form 0900-0108A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



NOTES:

All dimensions in inches.

Inner conductor has 4 equally spaced slots
 0.008 ± 0.001 wide by 0.078 ± 0.005 deep.

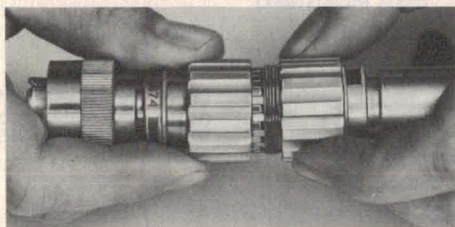
Recommended dimensions to mate adaptors.

APPLICATIONS

The adaptor is used to connect equipment that contains type-OSM connectors (and other connectors that have similar mating dimensions) with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type OSM connectors. The residual VSWR of such a slotted line is less than $1.006 + 0.026 f_{\text{GHz}}$ to 1 GHz, $1.023 + 0.009 \times f_{\text{GHz}}$, 1 to 8.5 GHz.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination for the OSM line size. The VSWR of the adaptor/termination combination is less than $1.01 + 0.03 \times f_{\text{GHz}}$ to 1 GHz and $1.027 + 0.013 \times f_{\text{GHz}}$, from 1 to 8.5 GHz.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 900-LB PRECISION SLOTTED LINE

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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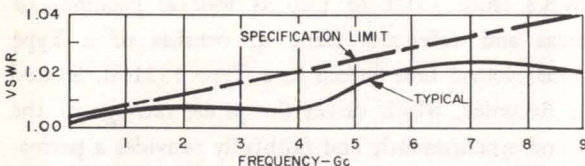
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Los Angeles, California 90038

• CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302

• TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



VSWR characteristics of the Type 900-QNJ Adaptor.

PRECISION COAXIAL ELEMENTS

DESCRIPTION

The Type 900-QNJ Adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition from the Type 900 line size to the type-N line size, and a low-VSWR version of a type-N jack connector. The absence of any discrete discontinuities in the transition between the two line sizes is a unique feature of these adaptors.

The low-VSWR version of the type-N connector is compatible with standard military type-N plug connectors, and is recommended for making measurements of components so equipped. However, in order to obtain minimum reflections from the type-N junction, it is recommended that the mating plug connection also be a low-VSWR version.

The type-N connector inner conductor is made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR TYPE-N CONNECTORS

The General Radio low-VSWR type-N connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the type-N inner-conductor junction were to butt *before* the outer-conductor

SPECIFICATIONS

Frequency Range: Dc to 9 Gc.

VSWR: Less than $1.004 + 0.004 \times$

Voltage: 1000 volts peak.

Power: 7 kilowatts up to 1 Mc; $7 \text{ kw}/\sqrt{f_{\text{Mc}}}$ above 1 Mc.

Electrical Length: 5.00 ± 0.03 cm to the end of the type-N jack inner conductor.

Dimensions: Length, 2-1/4 inches (58 mm); maximum diameter, 1-1/16 inch (27 mm).

Net Weight: 3-1/2 ounces (100 grams).

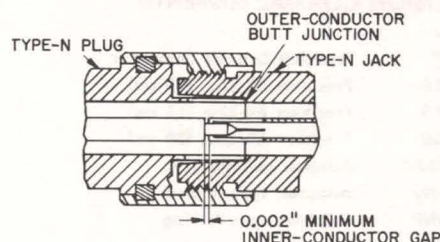
GENERAL RADIO EXPERIMENTER REFERENCES:

Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE TYPE-N CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

DC TO MICROWAVE



Recommended inner-conductor gap for a mated pair of low-VSWR version type-N connectors.

junction, a minimum gap of 0.002 inch is recommended at the inner-conductor junction, as shown in the cross-section view of a mated pair. The effect of this gap in terms of VSWR is approximately 1.001 at 1 Gc, 1.004 at 3 Gc, and 1.013 at 9 Gc. A gap of less than 0.002 inch can be used if sufficient care is taken.

The specified VSWR (see plot) of the Type 900-QNJ Adaptor is based on its use with a low-VSWR type-N plug, and includes any residual reflections introduced by the Type 900-BT connector, the transition section, and the type-N section, up to the center of the gap.

To achieve a low-VSWR connection, both connectors that make up the type-N junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used with the Type 900-QNJ Adaptor appears at the right.

900-QNJ



Type 900-QNJ

COAXIAL ADAPTOR

(Contains type-N jack)

OCTOBER 1963

FORM 0900-0125A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

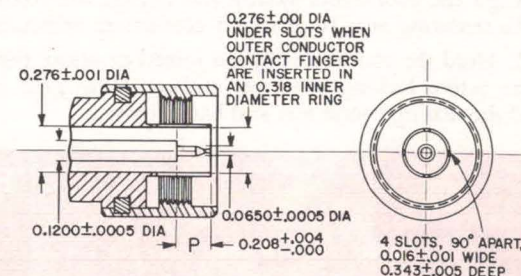
CAUTION

Dimension "P" must not be less than 0.208 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

If the mating connector is made so that dimension "P" is 0.208 ± 0.004 inch, the gap at the inner-conductor junction, when such a connector is mated with a Type 900-QNJ Adaptor should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determining what the gap actually is, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$X_L = 0.0708 \cdot f \cdot g \%$$

where X_L is the effect in percent, f is the frequency in Gc, and g is the gap in mils.



Recommended dimensions to mate Type 900-QNJ Adaptor.

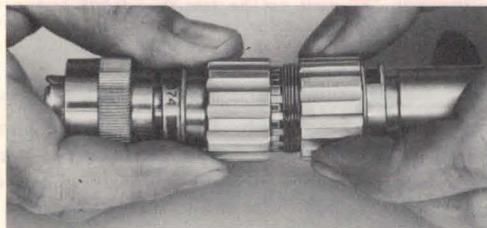
APPLICATIONS

The Type 900-QNJ Adaptor is used to connect equipment that contains type-N connectors with equipment that contains Type 900-BT connectors.

Thus, the Type 900-QNJ Adaptor, when used with a Type 900-LB Precision Slotted Line, permits accurate measurements of components that are equipped with type-N connectors.

The Type 900-QNJ Adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination for type-N transmission lines. The VSWR of the adaptor/termination combination is less than $1.009 + 0.009 \times f_{\text{Gc}}$ up to 9 Gc.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

PRECISION COAXIAL ELEMENTS AND EQUIPMENT

TYPE 900-LB PRECISION SLOTTED LINE

A 50-cm, coaxial slotted line terminated in a Type 900-BT connector (with the same VSWR characteristics as the connector from 300 Mc to 9 Gc). It has a characteristic impedance of 50 ohms $\pm 0.1\%$, scale accuracy of $\pm(0.1 \text{ mm} + 0.05\%)$, and a constancy of probe pickup of $\pm 0.5\%$. Residual VSWR is less than $1.001 + 0.001 \times f_{\text{Gc}}$. Supplied complete with vernier-drive carriage, adjustable probe, tuning stub, and crystal detector.

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

This complete system automatically and accurately plots VSWR's from 1.001 to 1.20 as well as positions of minima and reference plane. It consists of a Type 900-LB Slotted Line linked to a Type 1521-SL Slotted Line Recorder, which drives the probe carriage of the line and synchronously and faithfully provides a permanent plot of the detector output.

ORDERING INFORMATION

PRECISION COAXIAL ELEMENTS

Type	
900-BT	Precision Coaxial Connector
900-L10	Precision Air Line (10 cm)
900-L15	Precision Air Line (15 cm)
900-L30	Precision Air Line (30 cm)
900-Q874	Adaptor to Type 874
900-QNJ	Adaptor, type-N Jack
900-QNP	Adaptor, type-N Plug
900-TOK	Tool Kit
900-WN	Short-Circuit Termination
900-WO	Open-Circuit Termination
900-W50	50-Ohm Termination
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

PRECISION COAXIAL EQUIPMENT

900-LB	Precision Slotted Line
1640-A	Slotted Line Recorder System (60 cps)
1640-AQ1	Slotted Line Recorder System (50 cps)

Length inches	Net Weight*	Code Number	Price
1 1/16	2 oz.	0900-9405	\$35.00
4	6 1/2 oz.	0900-9605	85.00
6	10 oz.	0900-9607	90.00
12	15 oz.	0900-9613	100.00
2 7/16	3 1/2 oz.	0900-9883	45.00
2 1/4	3 1/2 oz.	0900-9711	50.00
2 5/16	4 oz.	0900-9811	50.00
—	2 lb.	0900-9902	95.00
1 1/16	2 1/2 oz.	0900-9971	9.00
1 1/16	2 oz.	0900-9981	9.00
2	3 1/2 oz.	0900-9953	60.00
27	7 oz.	0900-9508	25.00
27	2 1/2 lb.	0900-9509	35.00
—	3 oz.	0900-9782	3.50

*To convert ounces to grams, multiply by 28; pounds to kg, divide by 2.2.

Prices subject to change without notice.

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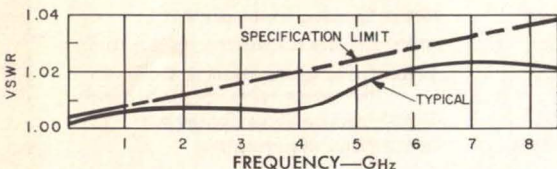
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Town of Mount Royal, Quebec, Canada



VSWR characteristics of the Type 900-QNJA Adaptor.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-QNJA Adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition from the Type-900 line size to the type-N line size, and a low-VSWR version of a type-N plug connector. The absence of any discrete discontinuities in the transition between the two line sizes is a unique feature of these adaptors.

The low-VSWR version of the type-N connector is compatible with standard, military type-N plug connectors, and is recommended for making measurements on components so equipped. However, in order to obtain minimum reflections from the type-N junction, it is recommended that the mating plug connection also be a low-VSWR version.

Both inner and outer contacts of the type-N connector are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR TYPE-N CONNECTORS

The General Radio low-VSWR type-N connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the type-N inner-conductor junction were to butt *before* the outer-conductor

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

VSWR: Less than $1.004 + 0.004 \times f$

Voltage: 1000 volts peak.

Power: 7 kilowatts up to 1 MHz; $7 \text{ kW} / \sqrt{f_{\text{MHz}}}$ above 1 MHz.

Electrical Length: $5.00 \pm 0.03 \text{ cm}$ to the end of the type-N jack inner conductor.

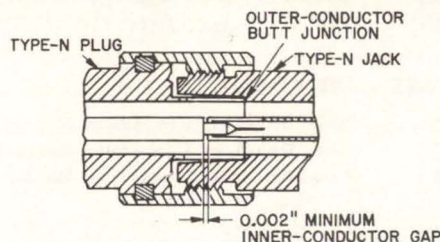
Dimensions: Length, 2-1/4 inches (58 mm); maximum diameter, 1-1/16 inch (27 mm).

Net Weight: 3-1/2 ounces (100 grams).

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan. 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965; Vol. 40, No. 5, May, 1966. Reprint E115.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE TYPE-N CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.



Recommended inner-conductor gap for a mated pair of low-VSWR version type-N connectors.

junction, a minimum gap of 0.002 inch is recommended at the inner-conductor junction, as shown in the cross-section view of a mated pair. The effect of this gap in terms of VSWR is approximately 1.001 at 1 GHz, 1.003 at 3 GHz, and 1.009 at 8.5 GHz. A gap of less than 0.002 inch can be used if sufficient care is taken.

The specified VSWR (see plot) of the Type 900-QNJA Adaptor is based on its use with a low-VSWR type-N plug, and includes any residual reflections introduced by the Type 900-BT connector, the transition section, and the type-N section, up to the center of the gap.

To achieve a low-VSWR connection, both connectors that make up the type-N junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used with the Type 900-QNJA Adaptor appears at the right.

Type 900-QNJA

COAXIAL ADAPTOR

(Contains type-N jack)

SEPTEMBER 1966

FORM 0900-0125B

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

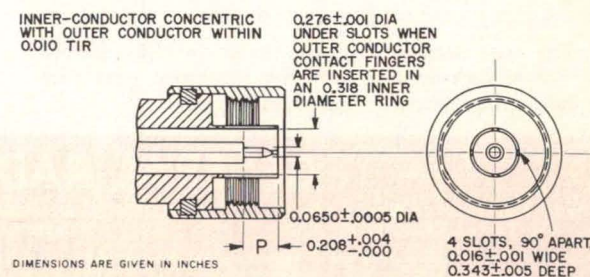
CAUTION

Dimension "P" must not be less than 0.208 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

If the mating connector is made so that dimension "P" is 0.208 ± 0.004 inch, the gap at the inner-conductor junction, when such a connector is mated with a Type 900-QNJA Adaptor should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determining what the gap actually is, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.051 \cdot f \cdot g \%$$

where x_L is the effect in percent, f is the frequency in GHz, and g is the gap in mils.



Recommended dimensions to mate Type 900-QNJA Adaptor.

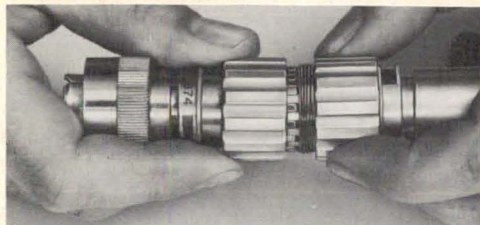
APPLICATIONS

The Type 900-QNJA Adaptor is used to connect equipment that contains type-N connectors with equipment that contains Type 900-BT connectors.

Thus, the Type 900-QNJA Adaptor, when used with a Type 900-LB Precision Slotted Line, permits accurate measurements of components that are equipped with type-N connectors.

The Type 900-QNJA Adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination for type-N transmission lines. The VSWR of the adaptor/termination combination is less than $1.009 + 0.009 \times f_{\text{GHz}}$ up to 8.5 GHz.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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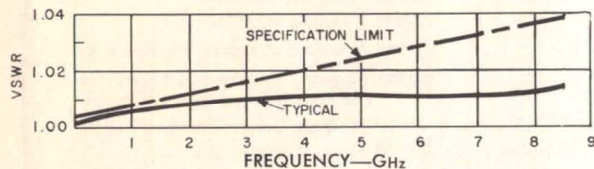
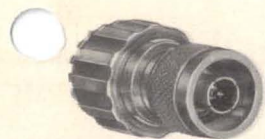
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Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



VSWR characteristics of Type 900-QNP Adaptor.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-QNP Adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition from the Type-900 line size to the type-N line size, and a low-VSWR version of a type-N plug connector. The absence of any discrete discontinuities in the transition between the two line sizes is a unique feature of these adaptors.

The low-VSWR version of the type-N connector is compatible with standard, military type-N jack connectors, and is recommended for making measurements on components so equipped. However, in order to obtain minimum reflections from the type-N junction, it is recommended that the mating jack connection also be a low-VSWR version.

Both inner and outer contacts of the type-N connector are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR TYPE-N CONNECTORS

The General Radio low-VSWR type-N connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the type-N inner-conductor junction were to butt *before* the outer-conductor junction, a minimum gap of 0.002 inch is recom-

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

VSWR: Less than $1.004 + 0.004 \times$

Voltage: 1000 volts peak.

Power: 7 kilowatts up to 1 MHz; $7 \text{ kW} / \sqrt{f_{\text{MHz}}}$ above 1 MHz.

Electrical Length: 5.50 ± 0.03 cm to end of type-N plug outer conductor.

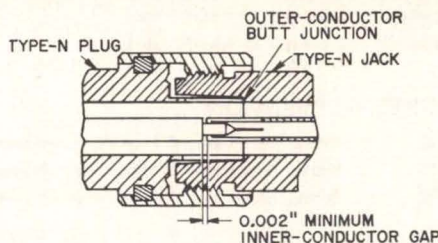
Dimensions: Length, 2-5/16 inches (59 mm); maximum diameter 1-1/16 inch (27 mm).

Net Weight: 4 ounces (115 grams).

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan. 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965; Vol. 40, No. 5, May, 1966. Reprint E115.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE TYPE-N CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.



Recommended inner-conductor gap for a mated pair of low-VSWR version type-N connectors.

mended at the inner-conductor junction, as shown in the cross-section view of a mated pair. The effect of this gap in terms of VSWR is approximately 1.001 at 1 GHz, 1.003 at 3 GHz, and 1.009 at 8.5 GHz. A gap of less than 0.002 inch can be used if sufficient care is taken.

The specified VSWR of the Type 900-QNP Adaptor (see plot above) is based on its use with a low-VSWR type-N jack, and includes any residual reflections introduced by the Type 900-BT connector, the transition section, and the type-N section, up to the center of the gap.

To achieve a low-VSWR connection, both connectors that make up the type-N junction should be of optimum design. A drawing giving recommended dimensions for a mating connector to be used with the Type 900-QNP Adaptor appears at the right.

CAUTION

Dimension "J" must not be greater than 0.206 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

Type 900-QNP

COAXIAL ADAPTOR

(Contains type-N plug)

SEPTEMBER 1966

FORM 0900-0130B

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

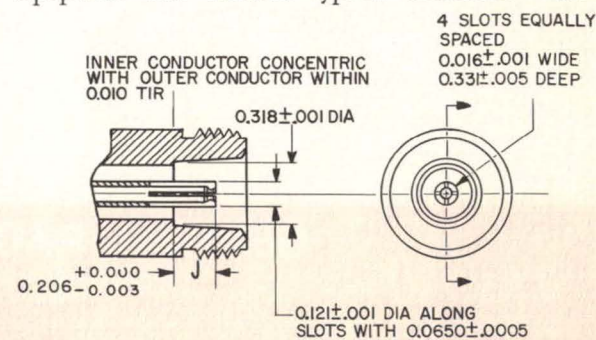
If the mating connector is made so that dimension "J" is 0.206 ± 0.003 inch, the gap at the inner-conductor junction, when such a connector is mated with a Type 900-QNP Adaptor, should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determining what the gap actually is, the inductive effect can be taken into account in measurements made through the junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.051 \cdot f \cdot g \%$$

where x_L is the effect in percent, f is the frequency in GHz, and g is the gap in mils.

APPLICATIONS

The Type 900-QNP Adaptor is used to connect equipment that contains type-N connectors with



DIMENSIONS IN INCHES

Recommended dimensions to mate Type 900-QNP Adaptor.

equipment that contains Type 900-BT connectors. Thus, the Type 900-QNP Adaptor, when used with a Type 900-LB Precision Slotted Line, permits accurate measurements of components that are equipped with type-N jacks.

The Type 900-QNP Adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination for type-N transmission lines. The VSWR of the adaptor/termination combination is less than $1.009 + 0.009 \times f_{\text{GHz}}$ up to 8.5 GHz.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 900-LB PRECISION SLOTTED LINE

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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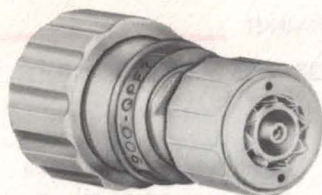
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Oak Park, Illinois 60302

• TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.
Characteristic Impedance: 50.0 Ω , nominal.
VSWR: Less than $1.003 + 0.002 \times f_{\text{GHz}}$.
Electrical Length: $5:30 \pm 0.02$ cm.

Insertion Loss: Less than $0.02 \sqrt{f_{\text{GHz}}} \text{ dB}$.

Maximum Voltage: 1000 volts, peak.

Maximum Power: 6 kW up to 1 MHz; 6 kW/ $\sqrt{f_{\text{MHz}}}$ above 1 MHz.

Dimensions: Length $2\frac{1}{8}$ in. (54 mm); max. diam. $1\frac{1}{16}$ in. (27 mm).

Net Weight: $3\frac{1}{2}$ oz. (100 g).

GR EXPERIMENTER REF. Vol. 41, No. 4, April, 1967.
 OTHER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan. 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965; Vol. 40, No. 5, May, 1966. All above in reprint E115. Also: Vol. 40, No. 7, July, 1966 and Vol. 40, No. 8, August, 1966.

less than $0.02 \sqrt{f_{\text{GHz}}} \text{ dB}$
 1000 V. peak

Type 900-QPF7

COAXIAL ADAPTOR

50 OHMS

(Mates with R & S Precifix 7-mm Connector)

JULY 1967

FORM 0900-0112A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

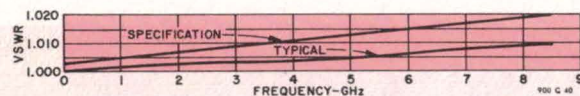
GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

This adaptor comprises a General Radio Type 900-BT Precision Coaxial Connector (General Precision Connector — GPC), a specially designed continuous transition from the GR900 (14-mm) line size to the 7-mm line size, and a Laboratory Precision Connector (LPC) in the 7-mm line size.

The 7-mm Laboratory Precision Connector consists of a coupling mechanism and a contact to mate with Rohde and Schwarz 7-mm connectors. The coupling mechanism is interchangeable with that of other 7-mm precision connectors. The critical mating dimensions for the 7-mm connection, independent of the coupling mechanism, are given below. They are the dimensions proposed in the IEEE standards document on precision coaxial connectors.¹

¹See D. E. Fossum, "Progress report of the IEEE I-M Group Technical subcommittee on precision coaxial connectors," *IEEE Transactions on Instrumentation and Measurement*, Vol. IM-13, pp 285-291, Dec. 1964.



VSWR characteristics of the adaptor.

CAUTION

ACCURACY AND REPEATABILITY CAN BE DEGRADED IF THE INNER CONDUCTOR (CONTACT REMOVED) ON THE MATING 7-mm OR 14-mm CONNECTOR PROTRUDES BEYOND THE OUTER CONDUCTOR.

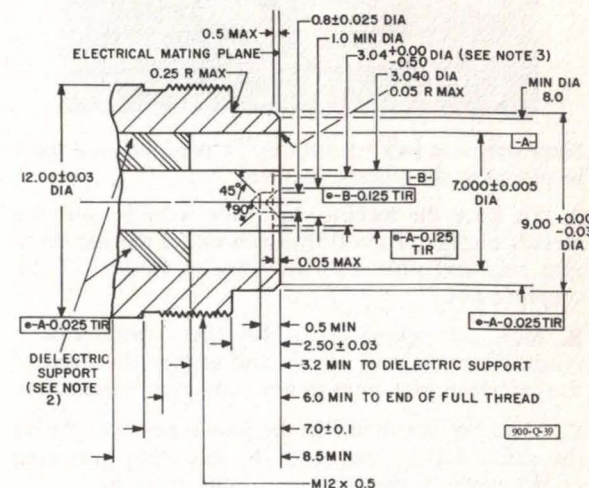
The adaptor inner conductor is positioned by the dielectric support of the GR900 connector. Since no other dielectric support is employed, the adaptor VSWR is very low.

APPLICATIONS

The Type 900-QPF7 Adaptor is used to connect equipment that contains 7-mm precision connectors with equipment that contains GR900 (14-mm) precision connectors. When the adaptor is used with a Type 900-LB Precision Slotted Line, VSWR measurements of components that are equipped with 7-mm precision connectors can be made to an accuracy of better than $1.004 + 0.003 \times f_{\text{GHz}}$ to 8.5 GHz. When the adaptor is used with a Type 900-W50 50 ohm termination, a 7-mm precision termination is assembled that has a residual VSWR of less than $1.008 + 0.007 \times f_{\text{GHz}}$ to 8.5 GHz.

CONTACT CLEANING

The butt surfaces must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these



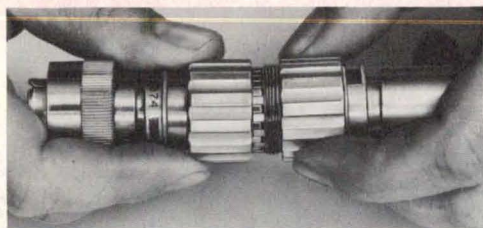
NOTES:

1. All dimensions in millimeters.
2. Inner- and outer-conductor diameters in the vicinity of the dielectric support may be varied to provide electrical compensation.
3. Center-conductor contact shown in mated coplanar position.
4. The pilot hole and countersink are shown only as a suggested means of providing support for LPC center conductor.

Critical mating dimensions for the 7-mm precision connector.

surfaces, or poor make-break repeatability, cleaning is necessary. Only certain solvents may be used in cleaning. The recommended solvents are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, and petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

1900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QAP7	Connects to Amphenol Precision 7 mm
900-QBJA	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJA	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QMMJ	Connects to type-OSM* Plug
900-QMMP	Connects to type-OSM* Jack
900-QNJA	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QPF7	Connects to Precifix 7 mm
900-QSCJA	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack
900-QTNJA	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-C9	GR900 Precision Cable Connector
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-EL	Precision 90° Ell
900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9507	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

* Reg. Trademark, Omni-Spectra, Inc., Southfield, Mich.

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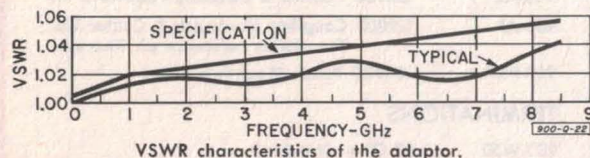
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• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR version of the type-SC connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-VSWR version. The inner- and outer conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR CONNECTORS

The General Radio low-VSWR type-SC connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a minimum

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.
VSWR: Less than $1.005 + 0.015 \sqrt{f_{\text{GHz}}}$ to 1 GHz; $1.015 + 0.005 f_{\text{GHz}}$, 1 to 8.5 GHz.
Voltage: 1000 volts peak.
Power: 7 kW up to 1 MHz; 7 kW/ $\sqrt{f_{\text{MHz}}}$ above 1 MHz.
Electrical Length: 5.03 ± 0.05 cm to the end of the type-SC jack inner conductor.
Dimensions: Length, 2 in. (51 mm); maximum diameter, 1-1/16 in. (27 mm).
Net Weight: 3 1/2 oz. (100 g).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37, No. 2 and 3, February - March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

gap of 0.002 inch is recommended at the inner-conductor junction.

The specified VSWR (see plot) of the adaptor is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-VSWR connection. The drawing shows the recommended dimensions for a mating connector.

If the mating connector is made so that dimension "P" is 0.311 ± 0.004 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.021 \cdot f \cdot g\%$$

where x_L is the effect in percent, f is the frequency in GHz and g is the gap in mils.

900-QSCJA



Type 900-QSCJA

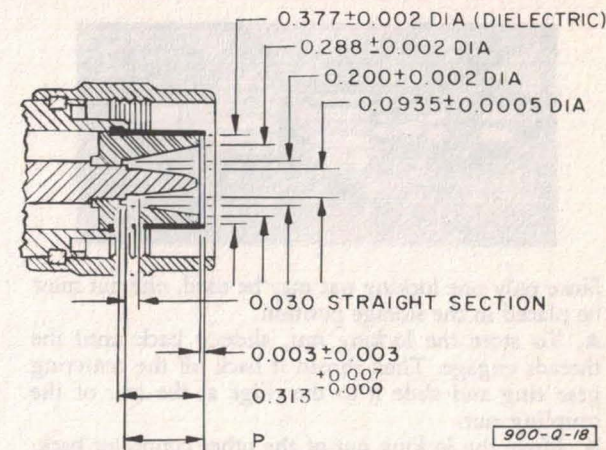
COAXIAL ADAPTOR

(Contains type SC-jack)

FEBRUARY 1966

Form 0900-0127A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS



NOTES:

All dimensions in inches.
 Outer conductor has 6 slots, 60° apart,
 0.016 ± 0.001 wide by 0.255 ± 0.005 deep;
 inner diameter in region of contact-fingers is
 0.3820 ± 0.0005 when fingers are inserted in an
 0.413 inner diameter ring.

Recommended dimensions to mate adaptor.

CAUTION

Dimension "P" must not be less than 0.311 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

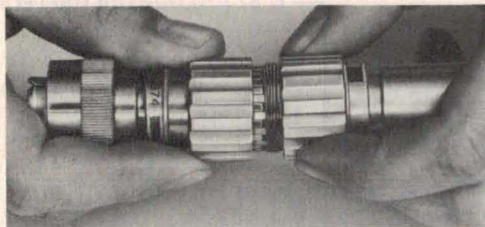
900-QSCJA

APPLICATIONS

The adaptor is used to connect equipment that contains type-SC connectors with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type-SC connectors. The residual VSWR of such slotted line is less than $1.006 + 0.016 f_{\text{GHz}}$ to 1 GHz, $1.016 + 0.006 f_{\text{GHz}}$, 1 to 8.5 GHz.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination. The VSWR of the adaptor/termination combination is less than $1.01 + 0.02 f_{\text{GHz}}$ to 1 GHz and $1.02 + 0.01 f_{\text{GHz}}$ from 1 to 8.5 GHz.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE
TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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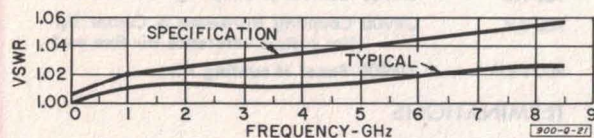
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• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



VSWR characteristics of the adaptor.

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz
VSWR: Less than $1.005 + 0.01 f_{\text{GHz}}$ to 1 GHz; $1.015 + 0.005 f_{\text{GHz}}$ 1 to 8.5 GHz.
Voltage: 1000 volts peak.
Power: 7 kW up to 1 MHz; 7 kW/ $\sqrt{f_{\text{MHz}}}$ above 1. MHz.
Electrical Length: 5.60 ± 0.05 cm to the end of the type-SC plug outer conductor.
Dimensions: Length, 2-3/16 in. (56 mm); maximum diameter, 1-1/16 in. (27 mm).
Net Weight: 3 1/2 oz. (100 g).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37, No. 2 and 3, February - March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

900-QSCP

Type 900-QSCP

COAXIAL ADAPTOR

(Contains type SC-plug)

FEBRUARY 1966

Form 0900-0128A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR version of the type-SC connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-VSWR version. The inner- and outer-conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR CONNECTORS

The General Radio low-VSWR type-SC connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a minimum

gap of 0.002 inch is recommended at the inner-conductor junction.

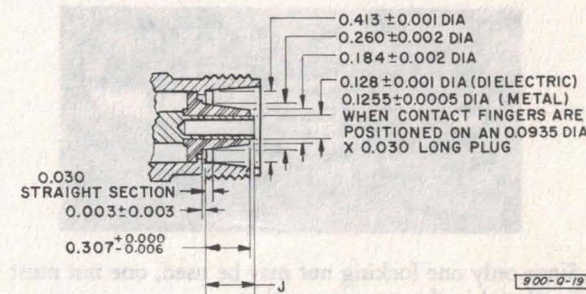
The specified VSWR (see plot) of the adaptor is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-VSWR connection. The drawing shows the recommended dimensions for a mating connector.

If the mating connector is made so that dimension "J" is 0.309 ± 0.000 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.021 \cdot f \cdot g\%$$

where x_L is the effect in percent, f is the frequency in GHz, and g is the gap in mils.



NOTES:

All dimensions in inches.

Inner conductor has 4 slots, equally spaced, 0.012 ± 0.001 wide by 0.210 ± 0.005 deep.

Recommended dimensions to mate adaptor.

CAUTION

Dimension "J" must not be more than 0.309 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

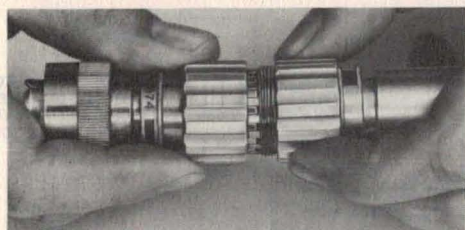
900-QSCP

APPLICATIONS

The adaptor is used to connect equipment that contains type-SC connectors with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type-SC connectors. The residual VSWR of such slotted line is less than $1.006 + 0.016 f_{\text{GHz}}$ to 1 GHz, $1.016 + 0.006 f_{\text{GHz}}$, 1 to 8.5 GHz.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination. The VSWR of the adaptor/termination combination is less than $1.01 + 0.02 f_{\text{GHz}}$ to 1 GHz and $1.02 + 0.01 f_{\text{GHz}}$ from 1 to 8.5 GHz.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 900-LB PRECISION SLOTTED LINE
TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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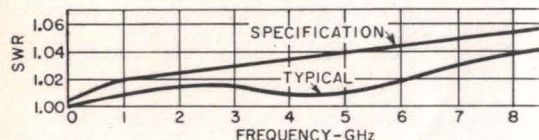
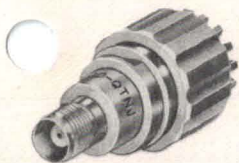
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Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



SWR characteristics of the adaptor.

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low SWR version of the type-TNC connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-SWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-SWR version. The inner-conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-SWR CONNECTORS

The General Radio low-SWR type-TNC connectors are designed so that a mated pair introduces a minimum SWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

SWR: Less than $1.005 + 0.015 f_{GHz}$ to 1 GHz; $1.015 + 0.005 f_{GHz}$, 1 to 8.5 GHz.

Voltage: 500 V peak.

Power: 3 kW up to 1 MHz; $3 \text{ kW} / \sqrt{f_{MHz}}$ above 1 MHz.

Electrical Length: $5.37 \pm 0.05 \text{ cm}$ to the end of the type-TNC jack inner conductor.

Dimensions: Length, 2-1/8 inches (54 mm); maximum diameter, 1-1/16 inch (27 mm).

Net Weight: 3½ ounces (100 grams).

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

minimum gap of 0.002 inch is recommended at the inner-conductor junction.

The specified SWR (see plot) of the adaptor is based on its use with a mating low-SWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-SWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-SWR connection. The drawing shows the recommended dimensions for a mating connector. The type-TNC connector mates without mechanical interference with MIL-C-39012, Class II, connectors.

If the mating connector is made so that dimension "P" is 0.210 ± 0.004 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 in. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$X_L = 0.05 \cdot f \cdot g\%$$

where X_L is the effect in percent, f is the frequency in GHz, and g is the gap in mils.

General Radio

Type 900-QTNJ

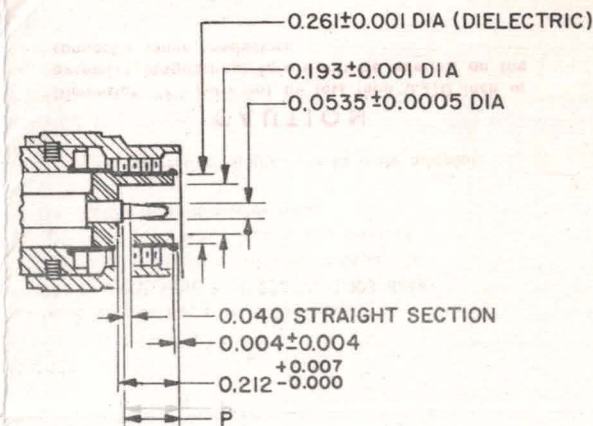
COAXIAL ADAPTOR

(Contains type-TNC jack)

JUNE, 1974

FORM 0900-0185B

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



NOTES:

All dimensions in inches.

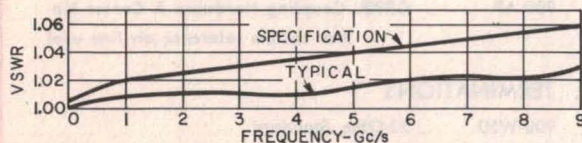
Outer conductor has 6 slots 60° apart, 0.015 ± 0.001 wide by 0.235 ± 0.003 deep; inner diameter in region of contact-fingers is 0.2650 ± 0.0005 when fingers are inserted in an 0.3200 inner-diameter ring.

Recommended dimensions to mate adaptor.

CAUTION

Dimension "P" must not be less than 0.210 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

Printed in U.S.A.



VSWR characteristics of the adaptor.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The adaptor comprises a Type 900-BT Precision Coaxial Connector, a specially designed, continuous transition between line sizes, and a low-VSWR version of the type-TNC connector. The absence of any discrete discontinuities in the transition is a unique feature of these adaptors.

The low-VSWR-version connector is compatible with standard military connectors and is recommended for measurements of components so equipped. However, for minimum reflections from the junction so formed, it is recommended that the mating connector also be a low-VSWR version. The inner- and outer-conductor contacts are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR CONNECTORS

The General Radio low-VSWR type-TNC connectors are designed so that a mated pair introduces a minimum VSWR into a 50.0-ohm transmission line when a butt joint is achieved at both outer- and inner-conductor contacts. Since damage to the adaptor inner conductor or bead (or to some other adjacent part) could result if the inner-conductor junction were to butt *before* the outer-conductor junction, a minimum

SPECIFICATIONS

Frequency Range: Dc to 9 Gc/s.
VSWR: Less than $1.005 + 0.015 \sqrt{f}$ to 1 Gc/s; $1.015 + 0.005 \sqrt{f}$, 1 to 9 Gc/s.
Voltage: 500 volts peak.
Power: 3 kw up to 1 Mc/s; 3 kw/ $\sqrt{f_{MC}}$ above 1 Mc/s.
Electrical Length: 5.70 ± 0.03 cm to the end of the type-TNC plug outer conductor.
Dimensions: Length, $2\frac{3}{8}$ inches (54 mm); maximum diameter, $1\frac{1}{8}$ inch (27 mm).
Net Weight: $3\frac{1}{2}$ ounces (100 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:

Volume 37, No. 2 and 3, February - March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

CAUTION

DAMAGE CAN RESULT TO ADAPTOR IF AN OUT-OF-TOLERANCE CONNECTOR IS ATTACHED. SEE TEXT FOR DETAILS.

gap of 0.002 inch is recommended at the inner-conductor junction.

The specified VSWR (see plot) of the adaptor is based on its use with a mating low-VSWR connector, and includes any residual reflections introduced by the Type 900-BT Connector, the transition section, and the low-VSWR connection, up to the center of the gap.

Both connectors that make up the junction should be of optimum design to achieve a low-VSWR connection. The drawing shows the recommended dimensions for a mating connector.

If the mating connector is made so that dimension "J" is 0.208 ± 0.000 inch, the gap at the inner-conductor junction should be between 0.002 and 0.009 inch. The inductance introduced by this gap in many instances can be neglected or, by determination of gap dimensions, the inductive effect can be taken into account in measurements made through the connector junction. The inductive effect normalized to 50.0 ohms is given approximately by

$$x_L = 0.035 \cdot f \cdot g\%$$

where x_L is the effect in percent, f is the frequency in Gc/s, and g is the gap in mils.

900-QTNP



Type 900-QTNP

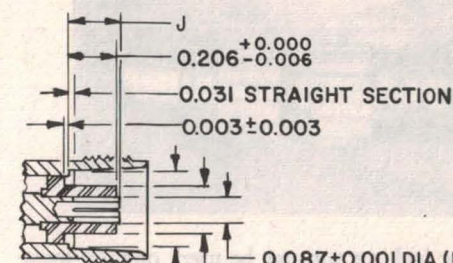
COAXIAL ADAPTOR

(Contains type-TNC plug)

SEPTEMBER 1965

FORM 0900-0190A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



NOTES:

All dimensions in inches.

Inner conductor has 4 equally spaced slots
 0.008 ± 0.001 wide by 0.187 ± 0.005 deep.

Recommended dimensions to mate adaptor.

CAUTION

Dimension "J" must not be more than 0.208 inch or excessive longitudinal forces can be exerted on the connector inner conductors.

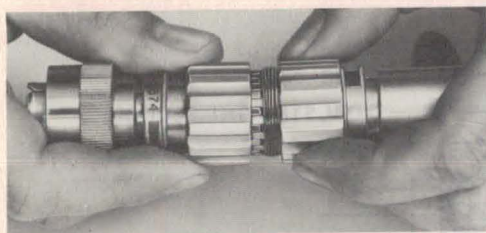
900-QTNP

APPLICATIONS

The adaptor is used to connect equipment that contains type-TNC connectors with equipment that contains GR900 connectors. Thus, when used with a Type 900-LB Precision Slotted Line, it permits accurate measurements of components that are equipped with type-TNC connectors. The residual VSWR of such a slotted line is less than $1.006 + 0.016 f_{Gc}$ to 1 Gc/s, $1.016 + 0.006 f_{Gc}$, 1 to 9 Gc/s.

The adaptor can also be used with the Type 900-W50 Termination to provide a low-reflection, 50-ohm termination. The VSWR of the adaptor/termination combination is less than $1.01 + 0.02 f_{Gc}$ to 1 Gc/s and $1.02 + 0.01 f_{Gc}$ from 1 to 9 Gc/s.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit

TYPE 900-LB	PRECISION SLOTTED LINE
TYPE 1640-A	SLOTTED LINE RECORDER SYSTEM

CONNECTOR AND CONNECTOR KITS continued

Type	Function
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 9.0 Gc/s)
900-TUB	Tuner (0.25 - 2.5 Gc/s)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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Ridgefield, New Jersey 07657

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Syracuse, New York 13211

• PHILADELPHIA: Fort Washington Industrial Park
Fort Washington, Pennsylvania 19034

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Cleveland, Ohio 44129

• DALLAS: 2600 Stemmons Freeway, Suite 210
Dallas, Texas 75207

• ORLANDO: 113 East Colonial Drive
Orlando, Florida 32801

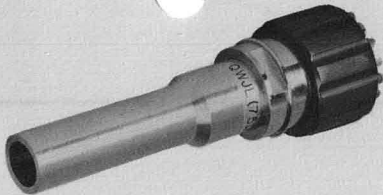
• SAN FRANCISCO: 1186 Los Altos Avenue
Los Altos, California 94022

• LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038

• CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302

• TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

• MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



SPECIFICATION

Frequency: Dc to 1 GHz

Electrical: IMPEDANCE: 75 Ω nominal.

Mechanical: DIMENSIONS: 3.4 in. (86 mm) long; 1.06 in. (27 mm) dia. WEIGHT: 0.2 lb (0.1 kg) net 1 lb (0.5 kg) shipping.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Type 900-QWJL (75 Ω)

COAXIAL ADAPTOR

75 OHMS



General Radio

JULY 1972

FORM 0900-0168A

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GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-QWJL Adaptor comprises a Type 900-BT (75 Ω) Precision Coaxial Connector, a specially designed step transition from the GR 900 line size to the Western Electric line size, and a low-VSWR version of a large Western Electric jack connector.

The inner contacts of the Western Electric connector are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR WESTERN ELECTRIC CONNECTORS

The VSWR (see plot) of the Type 900-QWJL Adaptor includes any residual reflections introduced by the Type 900-BT (75 Ω) connector, the transition section, and the Western Electric section.

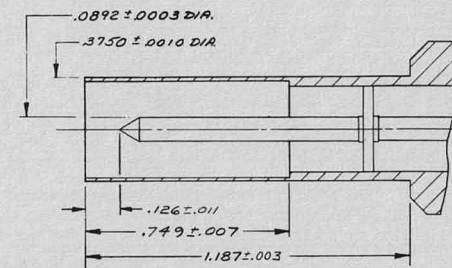
To achieve a low-VSWR connection, both connectors that make up the Western Electric junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used appears at the right.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

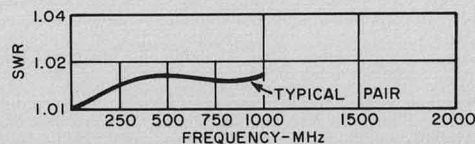
The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.



Dimensions are given in inches

Recommended dimensions to mate Adaptor.



900(75 Ω)-2

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.

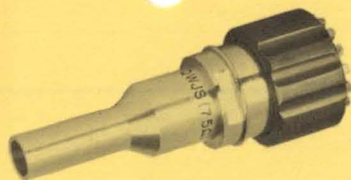


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Printed in U.S.A.



SPECIFICATION

Frequency: Dc to 1 GHz.

Electrical: IMPEDANCE: 75 Ω nominal.

Mechanical: DIMENSIONS: 2.89 in. (73 mm) long; 1.06 in. (27 mm) dia. WEIGHT: 0.2 lb (0.1 kg) net, 1 lb (0.5 kg) shipping.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Type 900-QWJS (75 Ω)

COAXIAL ADAPTOR

75 OHMS



General Radio

JULY 1972

FORM 0900-0166A

GR900® PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-QWJS Adaptor comprises a Type 900-BT (75 Ω) Precision Coaxial Connector, a specially designed step transition from the GR 900 line size to the Western Electric line size, and a low-VSWR version of a small Western Electric jack connector.

The inner contacts of the Western Electric connector are made of hardened beryllium-copper (gold-plated) to provide good spring action, long wear, and good contact.

LOW-VSWR WESTERN ELECTRIC CONNECTORS

The VSWR (see plot) of the adaptor includes any residual reflections introduced by the Type 900-BT (75 Ω) connector, the transition section, and the Western Electric section.

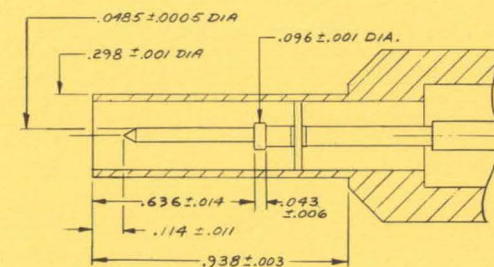
To achieve a low-VSWR connection, both connectors that make up the Western Electric junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used appears at the right.

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

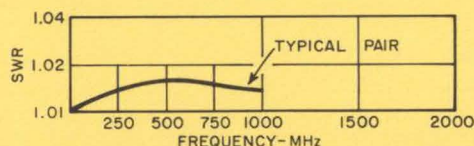
The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.



Dimensions are given in inches

Recommended dimensions to mate Adaptor.



900(75 Ω)-3

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.



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SPECIFICATION

Frequency: Dc to 1 GHz.

Electrical: IMPEDANCE: 75 Ω nominal.

Mechanical: DIMENSIONS: 2.9 in (74 mm) long; 1.06 in. (27 mm) dia. WEIGHT: 0.2 lb (0.1 kg) net 1 lb (0.5 kg) shipping.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Type 900-QWPL (75 Ω)

COAXIAL ADAPTOR

75 OHMS



General Radio

JULY 1972

FORM 0900-0169A

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GR900[®] PRECISION COAXIAL COMPONENTS

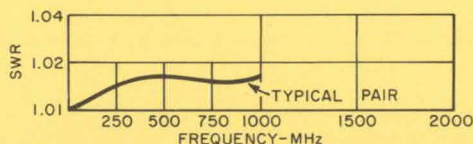
DESCRIPTION

The Type 900-QWPL Adaptor comprises a Type 900-BT (75 Ω) Precision Coaxial Connector, a specially designed step transition from the GR 900 line size to the Western Electric line size, and a low-VSWR version of a large Western Electric plug connector.

LOW-VSWR WESTERN ELECTRIC CONNECTORS

The VSWR (see plot) of the Type 900-QWPL Adaptor includes any residual reflections introduced by the Type 900-BT (75 Ω) connector, the transition section, and the Western Electric section.

To achieve a low-VSWR connection, both connectors that make up the Western Electric junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used appears at the right.



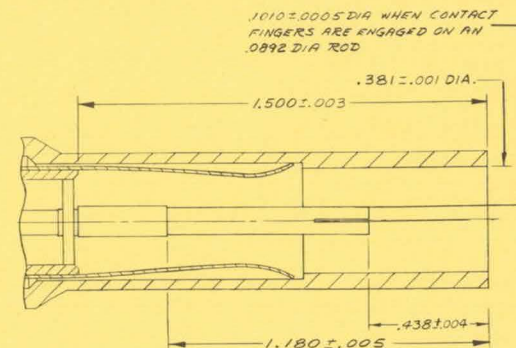
900(75 Ω)-2

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.



Dimensions are given in inches

Recommended dimensions to mate Adaptor.

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.



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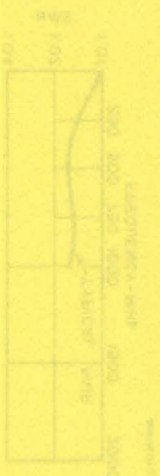
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General Radio



be used where it fits right.

recommended dimensions for a mating connector to should be of optimum design. A drawing showing the form that made up the Western Electric junction To achieve a low-VSWR connection, both connector and the Western Electric section.

For the 900-OWPL (Type 11) connector, the transition adapter includes any required reflections introduced by the 1/2W (two 900) of the Type 900-OWPL

CONNECTORS

LOW-VSWR WESTERN ELECTRIC

version of a large Western Electric plug connector. The Western Electric line size and a low-VSWR cable designed step transition from the CR 900 line 900-BT (V2 3) Precision Coaxial Connector, a case.

The Type 900-OWPL adapter comprises a Type

DESCRIPTION

CR900 PRECISION COAXIAL CONNECTOR

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Q10: 100 OHMS, 0.5 to 1.0 (1.5) and 1.0 to 1.5 (1.5) mm diameter.
Mechanical DIMENSIONS: 5/16 to 1/2 mm (1.0 to 1.5 mm)
Electrical DIMENSIONS: 15 to 20 mm (1.5 to 2.0 mm)
Frequency: DC to 1 GHz

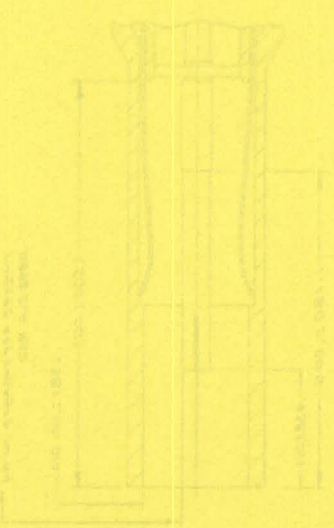
SPECIFICATION

BALANCE ELECTRICAL PERFORMANCE
AND OUTER CONDUCTORS MUST BE PRO
CAUTION

ing.
may be necessary for optimum inner-conductor clean-
ing and is not recommended. Removal of the contact
ing abrasive cleaning can remove the protective in-
cluding is generally more effective than dry clean-
ing. Cleaned with 95% denatured alcohol, synthetic
be used in place of 95% denatured alcohol, synthetic
900-OWPL. Cleaning for is recommended. Solvents to
repeatability, cleaning is necessary. Use of the Type
dirt packed on their surface or poor make-up of
the inner-conductor location. When this is extensive or
clean, gold at the outer-conductor junction and at
The butt surface of the connector must be kept
dust or grease, which could degrade performance.
tested. Inspect the connector for accumulations of
the segments have not been accidentally bent or
short contacts should be prepared to ascertain that
for and for damage to the inner conductor. The
minor) on the butt surface of the outer conductor.
CR900 connector for high or protrusions (however
It anticipated operation is not obtained, inspect the
INSPECTION AND CLEANING

NOTE: CR900 has multiple use for low
CR900-OWPL. RECOMMENDED: Copies of
recommended dimensions to users.

Dimensions are given in inches





SPECIFICATION

Frequency: Dc to 1 GHz.

Electrical: IMPEDANCE: 75 Ω nominal.

Mechanical: DIMENSIONS: 2.62 in. (67 mm) long; 1.06 in. (27 mm) dia. WEIGHT: 0.2 lb (0.1 kg) net, 1 lb (0.5 kg) shipping.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Type 900-QWPS (75 Ω ,

COAXIAL ADAPTOR

75 OHMS



General Radio

JULY 1972

FORM 0900-0167A

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GR900[®] PRECISION COAXIAL COMPONENTS

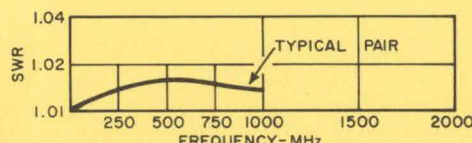
DESCRIPTION

The Type 900-QWPS Adaptor comprises a Type 900-BT (75 Ω) Precision Coaxial Connector, a specially designed step transition from the GR 900 line size to the Western Electric line size, and a low-VSWR version of a small Western Electric plug connector.

LOW-VSWR WESTERN ELECTRIC CONNECTORS

The VSWR (see plot) of the adaptor includes any residual reflections introduced by the Type 900-BT (75 Ω) connector, the transition section, and the Western Electric section.

To achieve a low-VSWR connection, both connectors that make up the Western Electric junction should be of optimum design. A drawing giving the recommended dimensions for a mating connector to be used appears at the right.



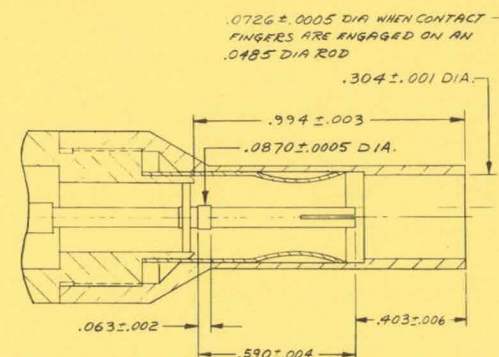
900(75 Ω)-3

INSPECTION AND CLEANING

If satisfactory operation is not obtained, inspect the GR900 connector for nicks or protrusions (however minor) on the butting surface of the outer conductor and for damage to the inner conductor. The spring contact should be inspected to ascertain that the segments have not been accidentally bent or twisted. Inspect the connector for accumulations of dust or grime, which could degrade performance.

The butt surfaces of the connector must be kept clean, both at the outer-conductor junction and at the inner-contact junction. When there is evidence of dirt packed on these surfaces, or poor make-break repeatability, cleaning is necessary. Use of the Type 900-TOC Cleaning Kit is recommended. Solvents to be used are Freon TF, denatured alcohol, synthetic methanol, grain alcohol, or petroleum ether. Liquid cleaning is generally more effective than dry cleaning; abrasive cleaning can remove the protective plating and is not recommended. Removal of the contact may be necessary for adequate inner-conductor cleaning.

NOTE Although the inner conductor is not firmly keyed to the bead and body assembly, the clamping action of the Teflon is usually sufficient to prevent rotation of the inner conductor under normal use.



Dimensions are given in inches

Recommended dimensions to mate Adaptor.

GR EXPERIMENTER REFERENCES: Copies of articles covering entire GR900 line available free. Ask for reprint E115.



General Radio

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CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan., 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

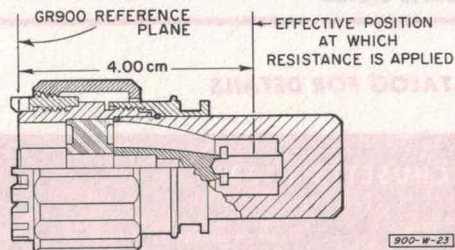
The Type 900-W100, 100-ohm Standard Termination introduces a 100-ohm resistive termination into a 50.0-ohm coaxial line. It is not a matched termination for a 100-ohm coaxial line.

The Type 900-W100 comprises a 50.0-ohm Type 900-BT Connector, a specially derived 50.0-ohm continuous transition, and a precision 100-ohm cylindrical resistor. The resistor is a highly stable, deposited-metal-film element.

APPLICATIONS

The Type 900-W100 Termination is used as a 100-ohm standard for the calibration of bridges, slotted-line systems, and reflectometers.

It is particularly suited to the calibration of bridges and complex reflection-coefficient measuring instruments. The 4-cm position beyond the connector refer-



Cross section of the termination showing effective position at which resistance value applies.

SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz

Dc Resistance: 100 ohms $\pm 0.3\%$.

Rf Resistance: $100.00 \pm (0.50 + 1.00 \times f_{\text{GHz}} \text{ to } 1 \text{ GHz}; 1.05 + 0.45 \times f_{\text{GHz}}, 1 \text{ to } 8.5 \text{ GHz})$.

Position at which resistance value applies: Beyond GR900 connector reference plane — $(4.00 \pm 0.05) \text{ cm}$ to 2GHz; $(4.02 - 0.01 \times f_{\text{GHz}} \pm 0.05) \text{ cm}$, 2 to 8.5 GHz.

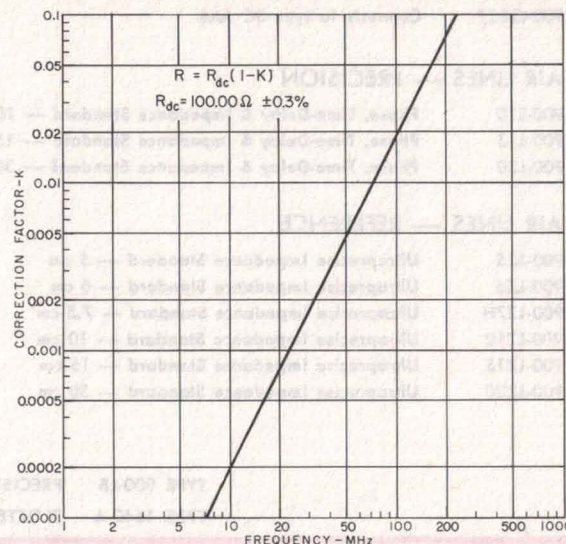
Leakage: Better than 130 dB below signal.

Maximum Power: 1 W with negligible change; 5 W without damage.

Temperature Coefficient: Less than 150 ppm/ $^{\circ}\text{C}$.

Dimensions: Length, 2 in. (51 mm); maximum diameter, 1-1/16 in. (27 mm).

Net Weight: 3 1/2 oz. (100 g).



Correction factor K for Type 900-W100 resistive component at GR900 reference plane for frequencies above 10 MHz. Below 10 MHz K is small enough to be considered negligible.

ence plane, at which the 200-ohm resistance is applied, coincides with the corresponding positions of the 0, ∞ and 200-ohm resistances of the Type 900-WN4 Short-Circuit Termination, the Type 900-WO4 Open-Circuit Termination, and the Type 900-W200 200-Ohm Standard Termination. Thus these four units

900-W100

Type 900-W100

STANDARD

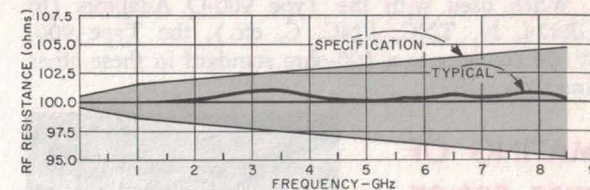
COAXIAL TERMINATION

100-OHMS

FEBRUARY 1966

Form 0900-0103A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



RF resistance (see chart).

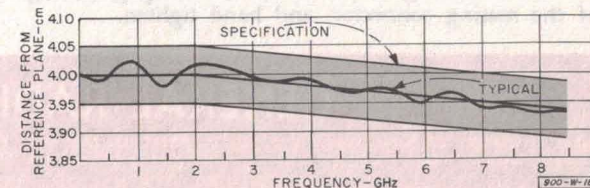
comprise a set of calibration standards.

When the Type 900-W100 is utilized to calibrate a low-frequency bridge, the reference plane (4 cm away from the GR900 connector mating plane), may not be the most convenient to use. This is particularly true for series (R, X) bridges.

The resistive component, R , of the impedance presented as a function of frequency at the connector reference plane, is given by

$$R = R_{dc} (1 - K)$$

where K is a correction factor (given in the graph).



Position at which resistance value applies (see chart).

001 W - 000e

The correction is a result of the distributed capacitance of the 4-cm length of line between the two reference planes. A calibrated dc value of resistance (R_{dc}), accurate to within 0.1%, is provided on the individual calibration chart supplied with each unit.

The Type 900-W100 can also be used in the calibration of time-domain reflectometers. It provides a 100-ohm reference level at a known point (4 cm beyond the GR900 connector reference plane) in a 50-ohm system.

Another use of the Type 900-W100 is as a calibrated mismatch with a mismatch SWR of 2. As such it provides magnitude calibration for high-frequency-bridge, slotted-line and reflectometer systems.

When used with the Type 900-Q Adaptors (to GR874, N, TNC, BNC, C, etc.), the Type 900-W100 converts to a 100-ohm standard in these other line sizes.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

TYPE 900-LB PRECISION SLOTTED LINE

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

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Fort Washington, Pennsylvania 19034

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Rockville, Maryland 20852

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Cleveland, Ohio 44129

DALLAS: 2600 Stemmons Freeway, Suite 210
Dallas, Texas 75207

ORLANDO: 113 East Colonial Drive
Orlando, Florida 32801

SAN FRANCISCO: 626 San Antonio Road
Mountain View, California 94040

LOS ANGELES: 1000 North Seward Street
Los Angeles, California 90038

CHICAGO: 6605 West North Avenue
Oak Park, Illinois 60302

TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

Dc Resistance: 200 ohms $\pm 0.3\%$.

Rf Resistance:

200.00 $\pm (1.00 + 2.00 \times f_{\text{GHz}})$ to 1 GHz;
200.00 $\pm (2.10 + 0.90 \times f_{\text{GHz}})$ 1 to 7 GHz;
200.00 ± 8.40 or $-[8.40 + 7.20 (f_{\text{GHz}} - 7)]$
7 to 8.5 GHz.

Position at which resistance value applies: Beyond GR900 connector reference plane — 0 ± 0.05 cm to 2 GHz;
(4.02 $\pm 0.01 \times f_{\text{GHz}} \pm 0.05$) cm, 2 to 8.5 GHz.

Leakage: Better than 130 dB below signal.

Maximum Power: 1 W with negligible change; 5 W without damage.

Temperature Coefficient: Less than 150 ppm/ $^{\circ}\text{C}$.

Dimensions: Length, 2 in. (51 mm); maximum diameter, 1-1/16 in. (27 mm).

Net Weight: 3 1/2 oz. (100 g).

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

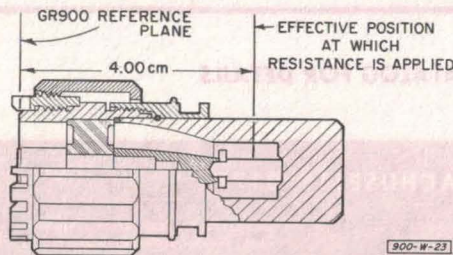
The Type 900-W200, 200-ohm Standard Termination introduces a 200-ohm resistive termination into a 50.0-ohm coaxial line. It is not a matched termination for a 200-ohm coaxial line.

The Type 900-W200 comprises a 50.0-ohm Type 900-BT Connector, a specially derived 50.0-ohm continuous transition, and a precision 200-ohm cylindrical resistor. The resistor is a highly stable, deposited-metal-film element.

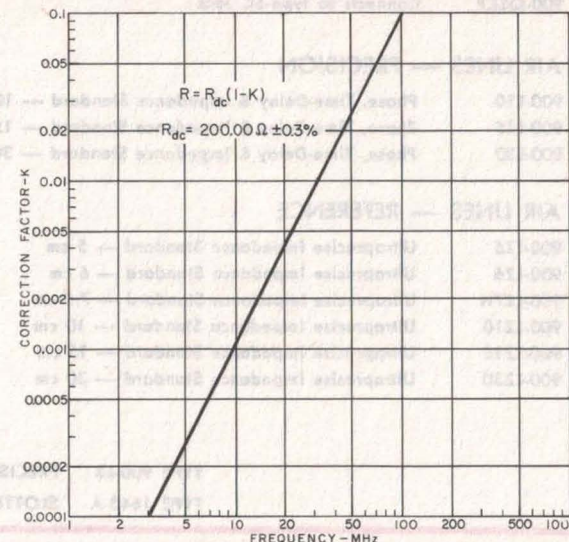
APPLICATIONS

The Type 900-W200 Termination is used as a 200-ohm standard for the calibration of bridges, slotted-line systems, and reflectometers.

It is particularly suited to the calibration of bridges and complex reflection-coefficient measuring instruments. The 4-cm position beyond the connector refer-



Cross section of the termination showing effective position at which resistance value applies.



Correction factor K for Type 900-W200 resistive component at GR900 reference plane (above 5 MHz). Below 5 MHz, K is small enough to be considered negligible.

ence plane, at which the 200-ohm resistance is applied, coincides with the corresponding positions of the 0, ∞ and 100-ohm resistances of the Type 900-WN4 Short-Circuit Termination, the Type 900-WO4 Open-Circuit Termination, and the Type 900-W100 100-Ohm Standard Termination. Thus these four units

900-W200

Type 900-W200

STANDARD

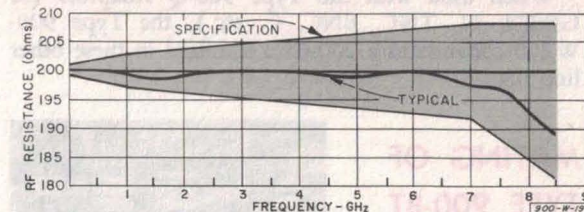
COAXIAL TERMINATION

200-OHMS

FEBRUARY 1966

Form 0900-0104A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



RF resistance (see chart).

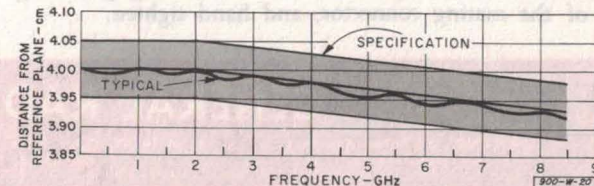
comprise a set of calibration standards.

When the Type 900-W200 is utilized to calibrate a low-frequency bridge, the reference plane (4 cm away from the GR900 connector mating plane), may not be the most convenient to use. This is particularly true for series (R, X) bridges.

The resistive component, R, of the impedance presented as a function of frequency at the connector reference plane, is given by

$$R = R_{dc} (1 - K)$$

where K is a correction factor (given in the graph).



Position at which resistance value applies (see chart).

00SW-00E

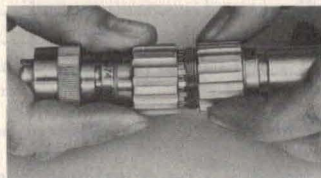
The correction is a result of the distributed capacitance of the 4-cm length of line between the two reference planes. A calibrated dc value of resistance (R_{dc}), accurate to within 0.1%, is provided on the individual calibration chart supplied with each unit.

The Type 900-W200 can also be used in the calibration of time-domain reflectometers. It provides a 200-ohm reference level at a known point (4 cm beyond the GR900 connector reference plane) in a 50-ohm system.

Another use of the Type 900-W200 is as a calibrated mismatch with a mismatch SWR of 4. As such it provides magnitude calibration for high-frequency-bridge, slotted-line and reflectometer systems.

When used with the Type 900-Q Adaptors (to GR874, N, TNC, BNC, C, etc.), the Type 900-W200 converts to a 200-ohm standard in these other line sizes.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB PRECISION SLOTTED LINE

TYPE 1640-A SLOTTED LINE RECORDER SYSTEM

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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Cleveland, Ohio 44129

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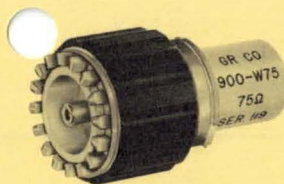
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TORONTO: 99 Floral Parkway
Toronto 15, Ontario, Canada

MONTREAL: Office 395 1255 Laird Boulevard
Town of Mount Royal, Quebec, Canada



CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

SPECIFICATIONS

Frequency Range: Dc to 9 GHz.
Leakage: Better than 130 dB below signal.
VSWR: $1.005 + 0.005 \times f_{\text{GHz}}$ up to 1 GHz.
DC Resistance: 75 ohms $\pm 0.3\%$.
Maximum Power: 1 watt with negligible change; 5 watts without damage.
Temperature Coefficient: Less than 150 ppm/ $^{\circ}\text{C}$.
Dimensions: Length, 2 inches (51 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 3-1/2 ounces (100 grams).

Type 900-W75 (75 Ω) STANDARD COAXIAL TERMINATION 75 OHMS

April 1971

Form 0900-0161A

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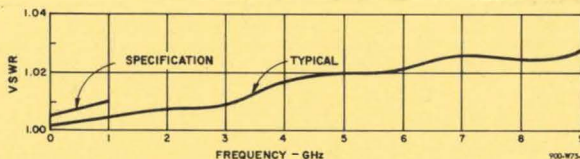
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GR900® PRECISION COAXIAL ELEMENTS DC TO MICROWAVE

GENERAL RADIO COMPANY
CONCORD, MASSACHUSETTS

DESCRIPTION

The Type 900-W75 75-Ohm Standard Termination is an extremely low-VSWR, broadband device useful from dc to 9 GHz. It comprises a specially derived, continuous transition, a precision cylindrical resistor, and a Type 900-BT (75-Ohm) Precision Coaxial Connector. The VSWR specification and a typical VSWR characteristic are shown below.



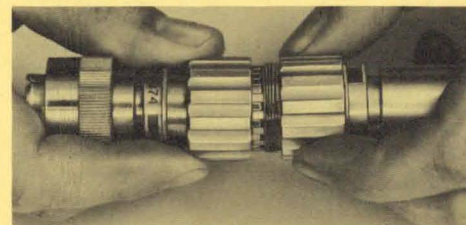
VSWR characteristic of the Type 900-W75 75-Ohm Standard Coaxial Termination.

The terminating element is a highly stable, deposited-metal-film resistor with a dc resistance of 75 ohms $\pm 0.3\%$ and a temperature coefficient of less than 150 ppm/ $^{\circ}\text{C}$. The change of resistance and VSWR versus heating due to incident power is negligible up to 1 watt. The resistors can be subjected to up to 5 watts incident power without permanent change of characteristics.

APPLICATIONS

The Type 900-W75 termination can be used for the calibration of bridges, slotted lines, and reflectometers, and as a reference termination in measurements of networks with more than one port, such as filter and isolation networks. It can be used as a precision dummy load.

MATING OF GR900® CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.



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CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

SPECIFICATIONS

Frequency Range: Dc to 9 Gc.
Reflection Coefficient: Greater than 0.999.
Location of Short Circuit: At Type 900-BT connector junction.
Leakage: Better than 130 db below signal.
Dimensions: Length, 1-1/16 inch (27 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 2-1/2 ounces (75 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963

900-WN

Type 900-WN

PRECISION

COAXIAL

SHORT-CIRCUIT TERMINATION



OCTOBER 1963

FORM 0900-0250A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

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Printed in U.S.A.

PRECISION COAXIAL ELEMENTS

DC TO MICROWAVE

DESCRIPTION

The Type 900-WN Precision Short-Circuit Termination is a very low-loss device which effectively short circuits a transmission line equipped with a Type 900-BT Precision Coaxial Connector. The reference plane of the short circuit is conveniently located at the mating plane of the connector. Extremely small ohmic losses, demonstrated by a reflection coefficient of 0.9995 (or greater) to 9 Gc, occur when the

short-circuit termination is mated with a Type 900-BT connector.

The Type 900-WN Short Circuit comprises a precision-machined, silver-plated, brass slug, gold-plated for tarnish protection, with the necessary Type 900-BT connector external hardware. The short circuit makes a butt joint with the Type 900-BT outer conductor. The flat surface of the short circuit, pressed against the inner-conductor contact of the Type 900-BT, achieves the inner-conductor junction; see the cross-section view of the mated junction. The excellent performance of this short circuit is inherent from the basic design of the Type 900-BT connector.

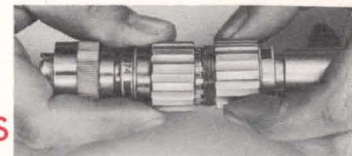
APPLICATIONS

For optimum performance, the short-circuit termination and the mating connector should be free of dust and grime. Use any commercial solvent to degrease the mating surfaces; and use mild detergent solution to remove dirt. If satisfactory operation is not obtained, inspect for nicks or protrusions (however minor) on the mating surfaces.

The Type 900-WN Precision Short-Circuit Termination is used to establish reference planes for impedance measurements made through Type 900-BT

connectors. It is also used as a low-loss short-circuit termination in measurements, including loss measurements, of networks with more than one port. When used with the Type 900-L Precision Air Lines, Type 900-WN Short Circuits provide coaxial-line reactance standards.

MATING OF TYPE 900-BT CONNECTORS



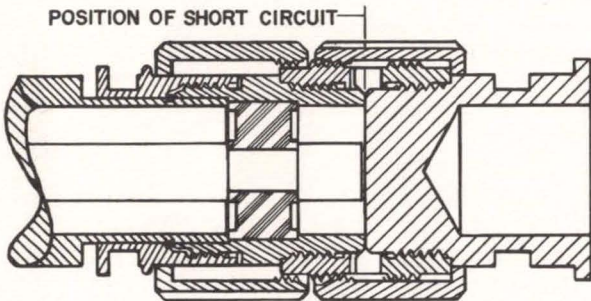
Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

POSITION OF SHORT CIRCUIT



Cross section of a Type 900-WN Short-Circuit Termination mated with a Type 900-BT connector.

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• PHILADELPHIA: 1150 York Rd., Abington, Pa.

• ORLANDO: 113 East Colonial Dr., Orlando, Fla.

• TORONTO: 99 Floral Pkwy., Toronto 15, Ont.

• WASHINGTON and BALTIMORE: Rockville Pike at Wall Lane, Rockville, Maryland

• SAN FRANCISCO: 1186 Los Altos Ave., Los Altos, Cal.

• MONTREAL: Office 395, 1255 Laird Blvd., Town of Mount Royal, Quebec, Canada



SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

Reflection Coefficient: Greater than 0.996 at GR900 connector reference plane.

Location of Short Circuit: 4.00 ± 0.01 cm beyond GR900 connector reference plane.

Characteristic Impedance of Internal Coaxial Line:

50.0 ohms $\pm 0.1\%$

Leakage: Better than 130 dB below signal.

Dimensions: Length, 2 in. (51 mm); maximum diameter, 1-1/16 in. (27 mm).

Net Weight: 4 oz. (115 g).

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan., 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965.

CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

Printed in U.S.A.

900-WN4
Type 900-WN4

PRECISION COAXIAL SHORT-CIRCUIT TERMINATION

FEBRUARY 1966

Form 0900-9975A

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS



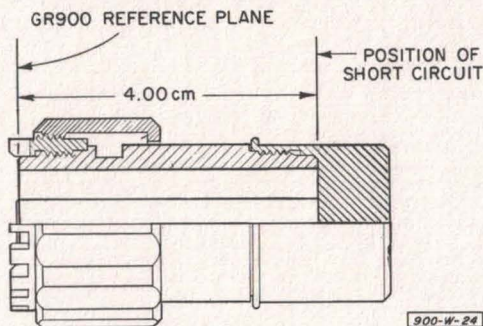
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GR900 PRECISION COAXIAL COMPONENTS

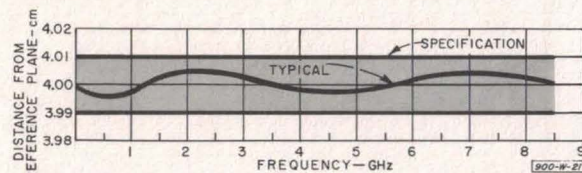
DESCRIPTION

The Type 900-WN4 Precision Short-Circuit Termination presents a low loss short circuit 4.00 cm. beyond the reference plane of the GR900 connector junction. The reflection coefficient introduced at the short circuit is greater than 0.999 and at the connector reference plane is greater than 0.996.

The outer conductor of the Type 900-WN4 is precision-forged, silver-lined brass tubing with a nominal inner diameter of 0.5625 inch. The inner con-



Cross section of a Type 900-WN4.



Position of short circuit with respect to the GR900 reference plane.

ductor is centerless-ground, silver-layered brass rod stock with a nominal 0.24425-inch diameter. The short-circuit disk is a precision-machined, silver-plated brass slug. All surfaces are gold-plated for tarnish protection.

APPLICATIONS

The Type 900-WN4 Precision Short-Circuit Termination is used with the Type 900-WO4 Precision Open-Circuit Termination to establish short- and open-circuit reference planes coincident within 0.02 cm. over the dc to 8.5 GHz frequency range. The reference planes so established are useful in direct impedance measurements, in loss measurements based on reflection measurements, in the calibration of reflection-coefficient measuring instruments and, generally, in the measurement of the scattering coefficients of multiple-port coaxial devices.

The 4.00-cm. reference plane of the Type 900-WN4 also coincides with the reference planes of the Type 900-W100, 100-ohm, and Type 900-W200, 200-ohm Standard Terminations. This group of terminations, the Types 900-WN4, -WO4, -W100, and -W200, provides calibrated resistance standards of 0, ∞ , 100 and 200 ohms. They are used to calibrate bridges and complex reflection-coefficient measuring instruments.

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SPECIFICATIONS

Frequency Range: DC to 9 Gc/s.
Reflection Coefficient: Greater than 0.999.
Location of Short Circuit: At Type 900-BT connector junction.
Leakage: Better than 130 dB below signal.
Dimensions: Length, 1-1/16 inch (27 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 2-1/2 ounces (75 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

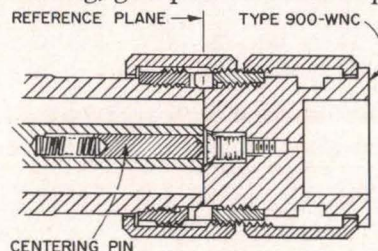
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GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

A very low-loss short circuit for the Type 900-LZ Reference Air Lines, specifically, this termination is suitable as well for any transmission line fitted with the GR900 connector. The reference plane of the short circuit occurs exactly at the reference plane of the GR900 connector. The reflection coefficient is 0.999, or greater, to 9.0 Gc/s.

The device comprises a precision-machined, silver-plated, brass slug, gold-plated for tarnish protection,



Cross section of a Type 900-WNC Short-Circuit Termination

with necessary GR900 coupling hardware. Also included is a GR900 center contact, which engages the insert pin of the beadless reference air line to support and center its inner conductor.

The short-circuit disk makes a butt contact with the outer conductor of the mating line, or connector. The spring-loaded center contact (which protrudes slightly) is compressed to make the center-conductor junction in the same plane (see the cross section view).

APPLICATIONS

For optimum performance, the short-circuit termination and the mating connector should be free of dust and grime. Use any commercial solvent to degrease the mating surfaces and to remove dirt. If satisfactory operation is not obtained, inspect for nicks or protrusions (however minor) on the mating surfaces.

The Type 900-WNC Precision Short-Circuit Termination is used to establish reference planes for

900-WNC

Type 900-WNC

PRECISION

COAXIAL

SHORT-CIRCUIT TERMINATION

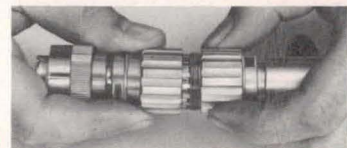


FEBRUARY 1965

FORM 0900-0251A

GENERAL RADIO COMPANY
 WEST CONCORD, MASSACHUSETTS

impedance measurements made through Type 900-LZ Reference Air Lines. This combination also provides a series of accurate coaxial-line reactance standards.



MATING OF TYPE 900-BT CONNECTORS

Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

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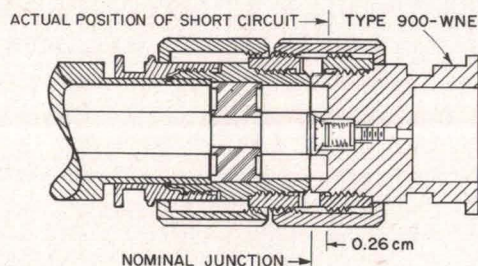
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GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

This termination is a very low-loss short circuit offset electrically 0.26 cm beyond the reference plane of the GR900 connector to match an equal offset in the Type 900-WO Precision Open-Circuit Termination. The short circuit thereby compensates for the end effect in the open circuit, to facilitate exact reference-plane duplication in precision phase and wavelength measurements. The reflection coefficient is greater than 0.998 to 9.0 Gc/s.

The device consists of a precision-machined, silver-plated, brass slug, gold-plated for tarnish protection,



Cross section of a Type 900-WNE Short-Circuit Termination mated with a Type 900-BT connector.

SPECIFICATIONS

Frequency Range: DC to 9 Gc/s.

Reflection Coefficient: Greater than 0.998.

Location of Short Circuit: 0.26 ± 0.005 cm beyond Type 900-BT connector junction.

Leakage: Better than 130 dB below signal.

Dimensions: Length, 1-1/16 inch (27 mm); maximum diameter, 1-1/16 inch (27 mm).

Net Weight: 2-1/2 ounces (75 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:

Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963; Volume 39 No. 1, January, 1965.

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with GR900 inner and outer conductors set ahead of it by 0.26 cm. The termination is fitted with necessary GR900 coupling and contact hardware and makes the junction in the usual manner. The short circuit makes a butt joint with the Type 900-BT outer conductor. The center contact, pressed against the inner-conductor contact of the Type 900-BT, achieves the inner-conductor junction; see the cross-section view of the mated junction. The excellent performance of this short circuit is inherent from the basic design of the GR900 connector.

APPLICATIONS

For optimum performance, the short-circuit termination and the mating connector should be free of dust and grime. Use any commercial solvent to degrease the mating surfaces and to remove dirt. If satisfactory operation is not obtained, inspect for nicks or protrusions (however minor) on the mating surfaces.

The Type 900-WNE Precision Short-Circuit Termination is used with the Type 900-WO Precision Open Circuit Termination to establish coincident open- and short-circuit reference planes for imped-

900-WNE

Type 900-WNE

PRECISION

COAXIAL

SHORT-CIRCUIT TERMINATION

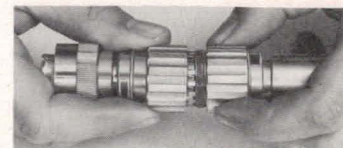


FEBRUARY 1965

FORM 0900-0252A

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ance measurements made through GR900 connectors. This combination is also useful for loss measurements based on reflection measurements, to calibrate reflection-coefficient measuring instruments. The coplanar terminations are also generally useful in the measurement of the scattering coefficients of multiple-port coaxial devices.



MATING OF TYPE 900-BT CONNECTORS

Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

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CAUTION

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PRECISION COAXIAL ELEMENTS

SPECIFICATIONS

Frequency Range: Dc to 9 Gc.
Reflection Coefficient: Greater than 0.999.
Location of Open Circuit: 0.26 ± 0.02 cm beyond Type 900-BT connector junction.
Leakage: Better than 130 db below signal.
Dimensions: Length, 1-1/16 inch (27 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 2 ounces (60 grams).

GENERAL RADIO EXPERIMENTER REFERENCES:
 Volume 37 No. 2 & 3, February-March, 1963; Volume 37 No. 11, November, 1963

Printed in U.S.A.

DC TO MICROWAVE

900-WO

Type 900-WO

PRECISION

COAXIAL

OPEN-CIRCUIT TERMINATION



OCTOBER 1963

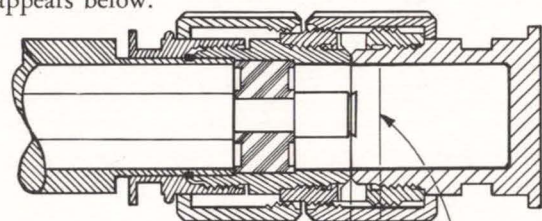
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 WEST CONCORD, MASSACHUSETTS

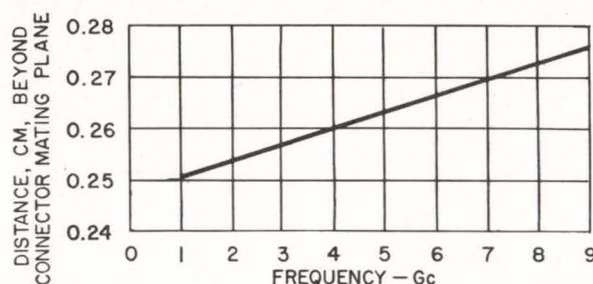
DESCRIPTION

The Type 900-WO Precision Open-Circuit Termination is a low-loss open-circuit termination equipped with a Type 900-BT Precision Coaxial Connector. This termination presents a well-shielded open circuit 0.26 centimeter from the mating plane of the Type 900-BT connector and has a reflection coefficient of 0.9995, or greater, to 9 Gc.

The Type 900-WO Open-Circuit Termination comprises a closed-end, standard-diameter outer conductor with Type 900-BT connector external mounting hardware. A cross-section view of the Type 900-WO mated with a Type 900-BT connector appears below.



Cross section of a Type 900-WO Open-Circuit Termination mated with a Type 900-BT connector.



Typical effective open-circuit position for the Type 900-WO.

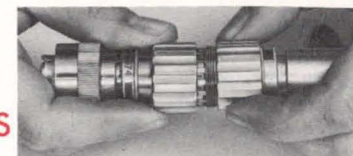
The open circuit cannot be established exactly at the mating plane of the Type 900-BT connector because of the end effect involved. This end effect can be represented closely by an additional length of line, or by a capacitance shunting the end of the line. The representation is not exact, however, and a small increase in effective electrical length occurs with an increase in frequency (see graph).

APPLICATIONS

The Type 900-WO Precision Open-Circuit Termination can be used to establish reference planes for impedance measurements made through Type 900-BT

connectors. It can also be used as a low-loss open-circuit termination in measurements, including loss measurements, of networks with more than one port. When used with the Type 900-L Precision Air Lines, Type 900-WO Open Circuits provide coaxial-line reactance standards.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

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SPECIFICATIONS

Frequency Range: Dc to 8.5 GHz.

Reflection Coefficient: Greater than 0.996 at GR900 connector reference plane.

Location of Open Circuit: 4.00 ± 0.01 cm beyond GR900 connector reference plane.

Capacitance at GR900 Connector Reference Plane: $2.673 \text{ pF} \pm 0.25\%$ below 70 MHz; at higher frequencies see correction chart.

Characteristics Impedance of Internal Coaxial Line: 50.0 ohms $\pm 0.1\%$.

Leakage: Better than 130 dB below signal.

Dimensions: Length, $2\frac{5}{16}$ in. (59 mm); maximum diameter, $1\frac{1}{16}$ in. (27 mm).

Net Weight: 4 oz. (115 g).

GR EXPERIMENTER REFERENCES. Vol. 37, No. 2 & 3, Feb.-Mar., 1963; Vol. 37, No. 11, Nov., 1963; Vol. 39, No. 1, Jan., 1965; Vol. 39, No. 6, June, 1965; Vol. 39, No. 7, July, 1965.

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GR900 PRECISION COAXIAL COMPONENTS

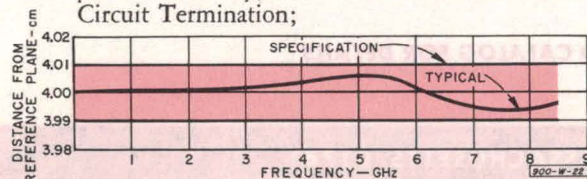
DESCRIPTION

The Type 900-WO4 Precision Open-Circuit Termination presents an open circuit 4.00 cm beyond the reference plane of the GR900 connector junction. The Type 900-WO4 comprises a Type 900-BT connector and a section of precision 50.0-ohm coaxial line. The inner conductor of the line is terminated in a small disk, the dimensions of which are such that the position of the 4.00-cm open circuit is nearly independent of frequency (± 0.01 cm) over the full 0–8.5-GHz range.

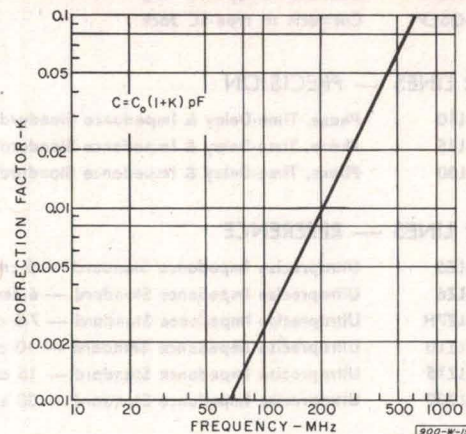
APPLICATIONS

The Type 900-WO4 Precision Open-Circuit Termination is used:

1. as a termination for Type 900-LZ Reference Air Lines;
2. to establish an open-circuit reference plane that is coincident with the short-circuit reference plane of the Type 900-WN4 Precision Short-Circuit Termination;



Position of open circuit with respect to the GR900 reference plane.



Correction factor K for Type 900-WO4.

3. to provide a reference plane coincident with the reference planes of the Type 900-W100 100-Ohm and Type 900-W200 200-Ohm Standard Terminations;
4. as a capacitance standard in the calibration of bridges.

As an open-circuit termination for the Type 900-LZ Reference Air Lines, the Type 900-WO4 provides support for the inner conductor. A Type 900-WO4, in combination with any one of the series of Type 900-LZ air lines, provides accurate incremental capac-

900 - WO4

Type 900-WO4

PRECISION COAXIAL

OPEN-CIRCUIT TERMINATION

FEBRUARY 1966

Form 0900-0261A

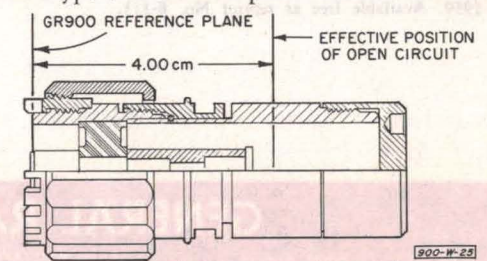
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itance calibrations for bridges and complex reflection-coefficient measuring instruments.

The effective reference plane of the Type 900-WO4 open circuit is coincident with that of the Type 900-WN4 short circuit within 0.02 cm, over the full dc to 8.5-GHz frequency range. This pair of terminations is used in loss measurements based on reflection measurements, in the calibration of impedance- or reflection-coefficient-measuring instruments and, generally, in the accurate measurement of the scattering coefficients of multiple-port coaxial devices.

The reference plane of the Type 900-WO4 is coincident to those of the Types 900-W100 and -W200 terminations, within 0.06 cm to 2 GHz and 0.20 cm to 8.5 GHz. This group of terminations is ideal for use in the calibration of bridges and complex reflection-coefficient measuring instruments.

The Type 900-WO4 Open-Circuit Termination is



Cross section of a Type 900-WO4.

also used as a capacitance standard in the calibration of bridges equipped with GR900 Connectors. The capacitance of the Type 900-WO4 presented at its GR900 connector reference plane is given by

$$C = C_0 (1 + K) \text{ pF}$$

where C_0 is the value from the accompanying calibration chart (in the range $2.673 \text{ pF} \pm 0.25\%$), and K is a correction factor. The capacitance is a result of the 4-cm length of line between the effective open-circuit reference plane and the GR900 connector reference plane. The correction is a result of the distributed nature of this capacitance; at higher frequencies the correction factor K is given in the graph.

The capacitance discussed above is the incremental capacitance introduced when a Type 900-WO4 is attached to a bridge where a guard circuit* is used to eliminate the fringing capacitance, or when a short circuit, such as a Type 900-WN, is used to establish a reference plane.

The fringing capacitance of a GR900 connector is typically $0.170 \pm 0.005 \text{ pF}$. Therefore, the incremental capacitance introduced when the initial fringing capacitance is not balanced out is given approximately by ($C_0 - 0.170 \text{ pF}$).

More accurate measurements can therefore be made using the guard circuit, where the variable fringing capacitance of the initial balance is eliminated.

This fringing capacitance varies somewhat from connector to connector, since the connector inner-conductor contact is not seated in this configuration.

*J. F. Hersh, "A Close Look at Connection Errors in Capacitance Measurements," General Radio Experimenter, Vol. 33, No. 7, July 1959. Available free as reprint No. E-113.

GR900 COAXIAL ELEMENTS AND EQUIPMENT

ADAPTORS

Type	Function
900-Q874	Connects to GR874
900-QBJ	Connects to type-BNC Plug
900-QBP	Connects to type-BNC Jack
900-QCJ	Connects to type-C Plug
900-QCP	Connects to type-C Jack
900-QNJ	Connects to type-N Plug
900-QNP	Connects to type-N Jack
900-QTNJ	Connects to type-TNC Plug
900-QTNP	Connects to type-TNC Jack
900-QMMJ	Connects to type-OSM Plug
900-QMMP	Connects to type-OSM Jack
900-QSCJ	Connects to type-SC Plug
900-QSCP	Connects to type-SC Jack

AIR LINES — PRECISION

900-L10	Phase, Time-Delay & Impedance Standard — 10 cm
900-L15	Phase, Time-Delay & Impedance Standard — 15 cm
900-L30	Phase, Time-Delay & Impedance Standard — 30 cm

AIR LINES — REFERENCE

900-LZ5	Ultraprecise Impedance Standard — 5 cm
900-LZ6	Ultraprecise Impedance Standard — 6 cm
900-LZ7H	Ultraprecise Impedance Standard — 7.5 cm
900-LZ10	Ultraprecise Impedance Standard — 10 cm
900-LZ15	Ultraprecise Impedance Standard — 15 cm
900-LZ30	Ultraprecise Impedance Standard — 30 cm

TYPE 900-LB	PRECISION SLOTTED LINE
TYPE 1640-A	SLOTTED LINE RECORDER SYSTEM

CONNECTOR AND CONNECTOR KITS

Type	Function
900-BT	GR900 Precision Connector
900-AB	GR900 Coupling Hardware Kit
900-AC	GR900 Contact & Coupling Hardware Kit
900-AP	GR900 Coupling Hardware & Center Tip (for custom reference air line use)
900-PKM	GR900 Panel Mounting Kit

TERMINATIONS

900-W50	50-Ohm Standard
900-W100	100-Ohm Standard
900-W200	200-Ohm Standard
900-WO	Precision Open Circuit
900-WO4	Open Circuit (for standards)
900-WN	Precision Short Circuit
900-WNC	Reference Line Short Circuit
900-WNE	Short Circuit (Coplanar with Type 900-WO)
900-WN4	Short Circuit (for standards)
900-WR110	Standard Mismatch (VSWR = 1.1)
900-WR120	Standard Mismatch (VSWR = 1.2)
900-WR150	Standard Mismatch (VSWR = 1.5)

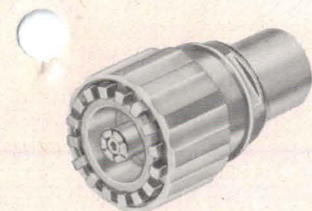
MISCELLANEOUS

900-TOK	GR900 Connector Tool Kit
900-TUA	Tuner (1.0 - 8.5 GHz)
900-TUB	Tuner (0.25 - 2.5 GHz)
0900-9508	Precision Inner-Conductor Rod
0900-9509	Precision Outer-Conductor Tube
0900-9782	Adaptor Flange

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SPECIFICATIONS

Frequency Range: Dc to 9 Gc/s.
Leakage: Better than 130 dB below signal.
Mismatch VSWR: $1.1000 \pm (0.0055 + 0.0110 \times f_{Gc/s})$
to 1 Gc/s; $0.0115 + 0.0050 \times f_{Gc/s}$, 1 to 9 Gc/s).
DC Resistance: 45.45 ohms $\pm 0.3\%$.
Maximum Power: 1 watt with negligible change; 5 watts without damage.
Temperature Coefficient: Less than 150 ppm/ $^{\circ}$ C.
Dimensions: Length, 2 inches (51 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 3 1/2 ounces (100 grams).

Printed in U.S.A.

900-WR110

Type 900-WR110

STANDARD MISMATCH

SEPTEMBER 1965

FORM 0900-0116



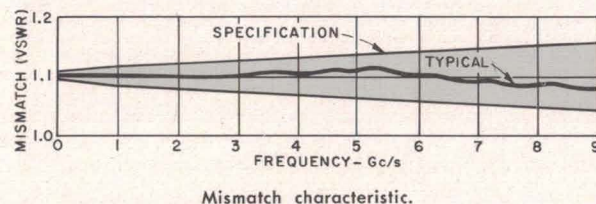
GR900 PRECISION COAXIAL COMPONENTS

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

DESCRIPTION

The Type 900-WR110 Standard Mismatch presents a nearly constant 1.10 VSWR mismatch into a 50.0-ohm system over the broad frequency range from dc to 9 Gc/s. It comprises a 50.0-ohm Type 900-BT Precision Coaxial Connector, a specially derived, continuous transition and a precision-mismatched cylindrical resistor. The position at which the mismatch is introduced into the 50.0-ohm system is approximately 4 cm back of the reference plane of the Type 900-BT connector. The mismatch specification and a typical mismatch characteristic are shown below.

The terminating element is a highly stable, deposited-metal-film resistor with a dc resistance of



45.45 ohms $\pm 0.3\%$ and a temperature coefficient of less than 150 ppm/ $^{\circ}$ C. The change of resistance and VSWR versus heating due to incident power is negligible up to 1 watt. The resistors can be subjected to up to 5 watts incident power without permanent change of characteristics.

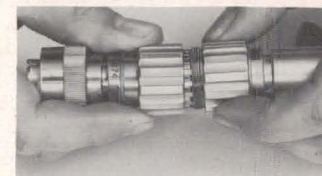
APPLICATIONS

The Type 900-WR110 Standard Mismatch is recommended for use in the calibration of reflectometers, hybrids, bridges, and slotted lines equipped with GR900 connectors. Test data is supplied with each unit so that highly accurate calibrations can be made. This mismatch is recommended for use in the calibration of slotted-line-detection systems. The mismatch standard provides a direct means of calibration, not only of the audio or i-f portions of the detector, but of the entire system, including the crystal, bolometer, rectifier or mixer.

Low-loss adaptors to the hermoprodite GR874 connector, and to various other 50-ohm connector

series (in plug and jack versions), are available to permit use of this standard in the calibration of instruments in those line sizes without serious degradation of mismatch performance.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

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CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

SPECIFICATIONS

Frequency Range: Dc to 9 Gc/s.

Leakage: Better than 130 dB below signal.

Mismatch VSWR: $1.2000 \pm (0.0060 + 0.0120 \times f_{Gc/s})$
to 1 Gc/s; $0.0125 + 0.0055 \times f_{Gc/s}$, 1 to 9 Gc/s).

DC Resistance: 41.67 ohms $\pm 0.3\%$.

Maximum Power: 1 watt with negligible change; 5 watts without damage.

Temperature Coefficient: Less than 150 ppm/ $^{\circ}$ C.

Dimensions: Length, 2 inches (51 mm); maximum diameter, 1-1/16 inch (27 mm).

Net Weight: 3 1/2 ounces (100 grams).

900-WR120



Type 900-WR120

STANDARD MISMATCH

SEPTEMBER 1965

FORM 0900-0117A

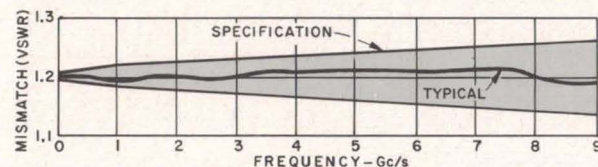
GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

GR900 PRECISION COAXIAL COMPONENTS

DESCRIPTION

The Type 900-WR120 Standard Mismatch presents a nearly constant 1.20 VSWR mismatch into a 50.0-ohm system over the broad frequency range from dc to 9 Gc/s. It comprises a 50.0-ohm Type 900-BT Precision Coaxial Connector, a specially derived, continuous transition and a precision-mismatched cylindrical resistor. The position at which the mismatch is introduced into the 50.0-ohm system is approximately 4 cm back of the reference plane of the Type 900-BT connector. The mismatch specification and a typical mismatch characteristic are shown below.

The terminating element is a highly stable, deposited-metal-film resistor with a dc resistance of



Mismatch characteristic.

41.67 ohms $\pm 0.3\%$ and a temperature coefficient of less than 150 ppm/ $^{\circ}$ C. The change of resistance and VSWR versus heating due to incident power is negligible up to 1 watt. The resistors can be subjected to up to 5 watts incident power without permanent change of characteristics.

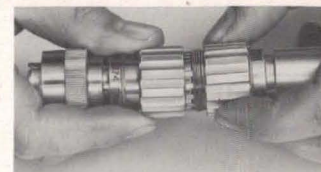
APPLICATIONS

The Type 900-WR120 Standard Mismatch is recommended for use in the calibration of reflectometers, hybrids, bridges, and slotted lines equipped with GR900 connectors. Test data is supplied with each unit so that highly accurate calibrations can be made. This mismatch is recommended for use in the calibration of slotted-line-detection systems. The mismatch standard provides a direct means of calibration, not only of the audio or i-f portions of the detector, but of the entire system, including the crystal, bolometer, rectifier or mixer.

Low-loss adaptors to the hermoprodite GR874 connector, and to various other 50-ohm connector

series (in plug and jack versions), are available to permit use of this standard in the calibration of instruments in those line sizes without serious degradation of mismatch performance.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

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Town of Mount Royal, Quebec, Canada



CAUTION

THE CONTACT SURFACES OF THE INNER AND OUTER CONDUCTORS MUST BE PROTECTED, AS NICKS OR DENTS CAN IMPAIR ELECTRICAL PERFORMANCE.

SPECIFICATIONS

Frequency Range: Dc to 9 Gc/s.
Leakage: Better than 130 dB below signal.
Mismatch VSWR: $1.5000 \pm (0.0075 + 0.0150 \times f_{Gc/s})$
to 1 Gc/s; $0.0155 + 0.0070 \times f_{Gc/s}$, 1 to 9 Gc/s).
DC Resistance: 33.33 ohms $\pm 0.3\%$.
Maximum Power: 1 watt with negligible change; 5 watts without damage.
Temperature Coefficient: Less than 150 ppm/ $^{\circ}$ C.
Dimensions: Length, 2 inches (51 mm); maximum diameter, 1-1/16 inch (27 mm).
Net Weight: 3 1/2 ounces (100 grams).

900-WR150

Type 900-WR150

STANDARD MISMATCH

SEPTEMBER 1965

FORM 0900-0118A



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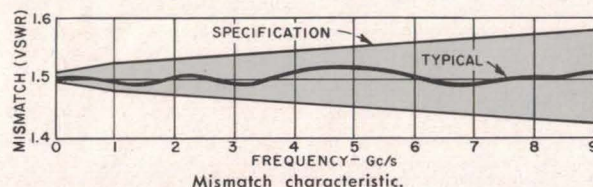
GR900 PRECISION COAXIAL COMPONENTS

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

DESCRIPTION

The Type 900-WR150 Standard Mismatch presents a nearly constant 1.50 VSWR mismatch into a 50.0-ohm system over the broad frequency range from dc to 9 Gc/s. It comprises a 50.0-ohm Type 900-BT Precision Coaxial Connector, a specially derived, continuous transition and a precision-mismatched cylindrical resistor. The position at which the mismatch is introduced into the 50.0-ohm system is approximately 4 cm back of the reference plane of the Type 900-BT connector. The mismatch specification and a typical mismatch characteristic are shown below.

The terminating element is a highly stable, deposited-metal-film resistor with a dc resistance of



33.33 ohms $\pm 0.3\%$ and a temperature coefficient of less than 150 ppm/ $^{\circ}$ C. The change of resistance and VSWR versus heating due to incident power is negligible up to 1 watt. The resistors can be subjected to up to 5 watts incident power without permanent change of characteristics.

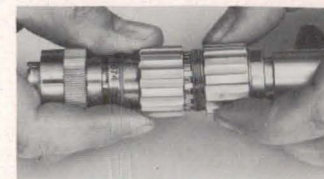
APPLICATIONS

The Type 900-WR150 Standard Mismatch is recommended for use in the calibration of reflectometers, hybrids, bridges, and slotted lines equipped with GR900 connectors. Test data is supplied with each unit so that highly accurate calibrations can be made. This mismatch is recommended for use in the calibration of slotted-line-detection systems. The mismatch standard provides a direct means of calibration, not only of the audio or i-f portions of the detector, but of the entire system, including the crystal, bolometer, rectifier or mixer.

Low-loss adaptors to the hermoprodite GR874 connector, and to various other 50-ohm connector

series (in plug and jack versions), are available to permit use of this standard in the calibration of instruments in those line sizes without serious degradation of mismatch performance.

MATING OF TYPE 900-BT CONNECTORS



Since only one locking nut may be used, one nut must be placed in the storage position.

A. To store the locking nut, slide it back until the threads engage. Then thread it back off the centering gear ring and slide it to the ridge at the rear of the coupling nut.

B. Move the locking nut of the other connector back. Align the connectors axially and engage the teeth of the centering gear rings in any convenient orientation.

C. Hold the connectors in the joined position, thread the active locking nut over the centering gear ring of the mating connector, and hand tighten.

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900-WR150