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COMMON SYSTEMS
TRANSMISSION MEASURING
MILLIWATT DISTRIBUTING CIRCUIT
USING 71 TYPE MILLIWATT REFERENCE GENERATOR

CHANGES

D. Description of Changes

D.1 CAD 8 was added to cover wiring to the 71C generator using a connector. The connector is used in place of wire-wrap connections when the generator is removed from its mounting and reinstalled.

D.2 An addition was made to Table C.

BELL TELEPHONE LABORATORIES, INCORPORATED

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COMMON SYSTEMS
TRANSMISSION MEASURING
MILLIWATT DISTRIBUTING CIRCUIT
USING 71-TYPE MILLIWATT REFERENCE GENERATOR
(71A, 71B, AND 71C MILLIWATT REFERENCE GENERATOR)
(71D AND 71E NETWORK PANELS)

CHANGES

B. Changes in Apparatus

B.1 In Fig. 1:

Apparatus	Superseded	Superseded by
1 - Pot., R6 KS-13790,L1	250 ohms	500 ohms
1 - Res, R5 221A	1000 ohms	619 ohms

Added

1 - Varistor, VR1, 100D

B.2 In Fig. 8:

Apparatus	Superseded	Superseded by
1 - Res, R1 1870 ohms	221A	RCL Electronics #R287 or equivalent. Temp coef: +500 ±50 ppm/C

B.3 In Fig. 9:

Removed	Replaced by (in Fig. 8)
1 - Resistance Lamp, RT3, Type 13N	1 - Resistor, R24, KS-14603,L3A, 162 ohms
	1 - Resistor, R25, KS-13491, L1, 2700 ohms
	1 - Transistor, Q2, Type 2N1501

D. Description of Changes

D.1 Options P and Q were added in Fig. 1 to cover apparatus changes B.1. Option P was previously shown and not rated Mfr Disc. Option Q was added to obtain a higher generator output level. Varistor VR1 was added to temperature-compensate the generator output level.

D.2 Options R and S were added in Fig. 8 and 9 to cover apparatus changes B.2 and B.3. R24, R25, and Q2 of option S replace RT3 to more effectively regulate output level of the 71C generator for changes in supply voltage. Option S of R1, replacing option R, adds temperature compensation of the generator output level.

D.3 In Circuit Note 111, reference to Fig. 6 and 10 was eliminated and those drawings requiring +0.5 dbm were included. Fig. 10 was rated Mfr Disc.

D.4 Note 303 was modified to provide an exception to connecting an output circuit to direct current.

D.5 Notes 207, 309, and 310 were added and Note 302 was modified.

D.6 An addition was made to Table C.

D.7 Fig. 8 and 9 and associated CADs 3 and 4 were rated Mfr Disc.

D.8 Resistors R21, R22, and R23 of Fig. 11 were changed from KS-16311,L2 to KS-16311, L1.

D.9 In CADs 6 and 7 notation was added that straps may be put on either side of terminal strip.

BELL TELEPHONE LABORATORIES, INCORPORATED

DEPT 2194-PJK-BCB

COMMON SYSTEMS TRANSMISSION MEASURING MILLIWATT DISTRIBUTION CKT USING 71 TYPE MILLIWATT REFERENCE GENERATOR

SECTION I - GENERAL DESCRIPTION

1. GENERAL

1.1 This circuit covers the 71B portable and 71A and 71C rack-mounted milliwatt reference generators. The latter include the distributing circuits for four milliwatt outlets using the 71A and for fifty milliwatt outlets using the 71C with associated network panels. These are shown as follows:

Figure 1 - The basic generator circuit as used in the 71A rack-mounted arrangement.

Figure 2 - A complete circuit of the 71B portable version.

Figure 4 to 7 - 600 and 900-ohm adjustable and nonadjustable milliwatt distributing networks.

Figure 8 - The basic generator circuit as used in the 71C rack-mounted arrangement.

1.2 The milliwatt generators are used to provide a reference power for calibrating portable test equipment, including transmission measuring sets, amplifier rectifier detectors and meters with DB scales based on one milliwatt. They are also used for testing voice channels of transmission systems, trunks, lines, circuits and networks.

1.3 The 71A generator may supply testing power to a maximum of five outlets simultaneously. The 71C generator may supply testing power to a maximum of fifty-one outlets simultaneously. Each outlet must always be terminated at the proper impedance. The nominal output power from each outlet is one milliwatt (0 dbm) in a 600-ohm or a 900-ohm terminating resistance. The 71B generator has one 600-ohm and one 900-ohm outlet.

1.4 The rack-mounted generators are powered by the central office battery. The portable unit is powered by a 45-volt dry cell battery of a heavy duty size. This dry cell is packaged with the oscillator unit in a metal container.

SECTION II - DETAILED DESCRIPTION

1. GENERAL

1.1 The circuits shown in Figures 1 and 2 (71A and 71B) are similar. Where no difference exists, the circuit of Figure 1 is described. Where differences exist, both circuits are described. Designations of components in Figure 2 are higher by twenty than the corresponding components in Figure 1. Figure 8 (71C) is described separately.

2. SPECIFIC

2.1 71A and 71B Operation

2.11 The transistor oscillator (Fig. 1 and 2) is of the Hartley type designed to operate with a nominal supply voltage of approximately 45V. The frequency of oscillation is determined by the tuned circuit of network (Z1) which is resonant at 1000 cps ±1%. Resistor (R1) determines the amount of feedback from the emitter of the transistor to the LC network. The value of (R1) is chosen to obtain that critical amount of feedback which permits the peak AC base voltage to equal the DC collector-to-base voltage. When the base is at collector potential, limiting occurs, thus stabilizing the oscillating amplitude. Capacitors (C1 and C2) provide the necessary bypassing.

2.12 The amplitude of oscillation is directly dependent upon the DC voltage applied between base and collector of the transistor. This DC voltage is regulated by diodes (CR1 and CR3) or (CR1, CR2 and CR3) and is established at the correct value by adjustment of potentiometer R6. One setting is adequate for a supply voltage range of greater than 10V, and should be changed only when necessary on subsequent occasions, and then only when suitably accurate means of checking this power of one milliwatt in 600 ohms is available. Adjustment procedure is given in Chart 1, BSP Section E40.376.01 (A702.629.01). Resistor (R4) serves to limit current through the diodes, and (R3), through the transistor. (R2) makes the oscillating amplitude almost completely insensitive to battery voltage changes.

2.13 600- and 900-ohm output taps are provided on the secondary of transformer (T1). The impedance looking toward the transformer is approximately 6 ohms for the full winding. Because it is low, each outlet operates from nearly the open circuit voltage of the transformer.

2.2 71C Operation

2.21 The oscillator circuit (Fig. 8) is basically of the Hartley configuration designed to operate with a nominal supply voltage of 48V. The frequency of oscillation is determined by the tuned circuit consisting of network (Z1), which is resonant at 1000 cps ±1%. The 71C oscillator differs from the standard Hartley configuration by the insertion of resistor (R1) in the feedback path between the transistor emitter and the center tap of the tuned network. Resistor (R1) limits the positive feedback to a level which prevents the collector diode of the transistor from being driven deeply into saturation. The value of resistor (R1) is chosen to limit the feedback to that level which just permits the peak AC base voltage to equal the DC collector-to-base voltage. Thus, when the base is at collector potential, limiting occurs which stabilizes the oscillating amplitude. Capacitors (C1 and C2) provide the necessary bypassing.

2.22 The amplitude of oscillation is directly dependent upon the DC voltage applied between the base and collector of the transistor (Q1). This DC voltage is regulated by diodes (CR1, CR2 and CR3). (R5) varies the base-to-collector voltage and provides a range of output level adjustment of approximately 0.6 db. The Adjustment procedure is given in Chart 1, BSP Section E40.377.01 (A702.630.01).

2.23 Temperature compensation is provided by thermistor (RT1). **Resistor (R2) limits current** through the transistor and resistor (R6) limits current through diode (CR1). Resistor (R4) is part of the voltage divider, consisting of (R3, R4, R5, and RT1), which determines the transistor base-to-collector voltage. Resistor (RT3), a 13 type Resistance Lamp, limits the current through (CR2 and CR3). Resistors (R11 through R18) serve as an artificial load to maintain the oscillator load at approximately 24 ohms (equivalent to 50 distributing networks). Their connections are determined by the number of 600-ohm and/or 900-ohm outlets connected to the oscillator and are outlined in Figure 9.

2.24 The two secondary windings of transformer (T1) are paralleled to provide a low impedance output. The impedance looking towards the transformer is approximately 1.15 ohms.

2.3 Generator Output Circuits

2.31 The 71A generator in Figure 1 is provided with one jack outlet on the front panel. While the primary purpose of this outlet is for calibration of the generator, it may also be used for routine tests. It is built out to 600 ohms with (R10, R11 and R13), and terminated in 600 ohms by (R12). The 600-ohm terminating resistance, R12, is lifted off the outlet jack when the outlet is used.

2.32 The 71C generator in Figure 8 is provided with one jack outlet on the front panel. Resistors (R7, R8 and R9) build out the outlet impedance to provide a 600-ohm maintenance outlet at jack (J1). Resistor (R10) is a 600-ohm terminating resistor which is connected when the test outlet is not in use. While this outlet is primarily for calibration of the generator, it may also be used as an additional outlet for routine tests.

2.33 In the portable unit shown in Figure 2, the 600-ohm outlet is built out to 600-ohms by resistors (R30, and R31) and terminated by a 600-ohm resistance, (R32). Resistor (R33) is at the time of manufacture connected across either the 600-ohm or the 900-ohm outlet whichever would have the higher output so that when connected, both will supply the same power. The 900-ohm outlet is built out to 900-ohms by (R34 and R35) and terminated by a 900-ohm resistance (R36). These terminating resistors are disconnected by opening the contacts of the jacks when the outlet is terminated by the circuit under test. The jacks are suitable for patching using a cord equipped with a 310 plug or equivalent. Contacts on the jacks serve to turn on battery power when a plug is inserted into either the 600- or 900-ohm jack.

2.34 No provision has been made for blocking DC from the generator. Separate blocking arrangements should be provided for the rack-mounted generators in offices where DC voltages are present on the circuits to be tested. The 71B generator will not be damaged by 48 volts but such connections should be avoided to insure accuracy of the output level.

2.4 Distributing Networks

2.41 The distributing networks in Figures 4, 5, 6 and 7 are designed to build out the output impedance of the 71A and 71C generators to 600 and 900 ohms. The network in Figures 6 and 7 is adjustable, providing a means of reducing the amount of resistance between the generator and the outlet to compensate for central office wiring and equipment loss. The distributing network in Figures 4 and 5 is not adjustable and may be used where the combined office wiring and equipment loss is less than 0.03 db.

2.42 Both the adjustable and nonadjustable distributing networks are used for 600- and 900-ohm circuits. Figures 4 and 6 show the networks as used in 900-ohm applications. For 600-ohm applications, terminals 3, 5 and 13, and terminals 4, 6 and 14 on the nonadjustable network are strapped as shown in Figure 5. The adjustable network is converted for 600-ohm applications by strapping terminals 3 and 5 and terminals 4 and 6 as shown in Figure 7, option D.

2.43 Adjustment of the distributing network in Figures 6 and 7 to compensate for wiring and equipment loss is made by strapping out specific values of resistance in the network which corresponds to changes of 0.02 db in 900-ohm outlets and 0.03 db in 600-ohm outlets. The range of adjustment is approximately 0.3 db in 900-ohm outlets and 0.45 db in 600-ohm outlets. The procedure for adjusting this distributing network, and the output power at individual outlets is given in BSP Section E30.223.13 (A204.474.13).

2.44 A test power level of 0.5 dbm can be obtained from the output of the adjustable distributing network (Figure 6 or 7) by connecting to the network resistors shown in Figures 10 and 11. Resistors (R19 and R20) of Figure 10 are connected to the adjustable distributing network in Figure 6 (and also to Figure 7 when Figure 7 is used for 900 ohms) to obtain 0.5 dbm from the network into 900-ohms. Resistors (R21, R22 and R23) of Figure 11 are connected to the network in Figure 7 (when Figure 7 is strapped for 600 ohms) to obtain 0.5 dbm from the network into 600 ohms. In such applications, the impedance of the 0.5 dbm outlet as seen from the termination is decreased from 900 to 795 ohms, and from 600 to 535 ohms.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.1 Output

1.11 The 71A generator is capable of supplying one milliwatt to a maximum of five outlets. In addition to the 600-ohm jack appearance on the oscillator unit, four outlets are arranged in various combinations for 600- and 900-ohm connections to remote points of test. The output is available continuously since no switch is provided.

1.12 The portable (71B) generator has a 600- and 900-ohm jack for a 310 plug.

1.13 The 71C generator is capable of supplying one milliwatt to a maximum of fifty-one outlets. In addition to the 600-ohm jack outlet on the oscillator unit, up to fifty outlets may be arranged in various combinations for 600- and 900-ohm connections to remote testing points. The output is available continuously since no switch is provided.

1.2 Supply Voltage

1.21 The 71A and 71C oscillator operate satisfactorily within the normal range of the office battery, from 45 to 52 volts.

1.22 The supply voltage for the 71B portable oscillator is provided by a 45 volt dry cell battery. Jacks labelled (BAT TEST 35V DC MIN) are provided on the side of the case for checking the battery under load.

1.3 Current Drain

1.31 Current drain from 48-volt supply by the 71A office oscillator: 23 ma. at 48 volts.

1.32 Current drain from the battery by the 71B portable oscillator: 21 ma. at 45 volts.

1.33 Current drain from 48-volt supply by the 71C office oscillator: 80 ma. (± 10 ma.) at 48 volts.

2. FUNCTIONS

2.1 The 71 Type milliwatt reference generators provide sine wave 1000-cycle output of 0 dbm for transmission tests.

2.2 The 71A provides up to four outlets at either 600 or 900 ohms and operates from central office battery.

2.3 The 71B provides a 600- and a 900-ohm output including a switch for turning off the battery supply and pin jacks for test access to the dry cell battery voltage.

2.4 The 71C provides up to fifty outlets at either 600 or 900 ohms and operates from central office battery.

3. CONNECTING CIRCUITS

3.01 Transmission test line circuit - SD-98100-01, Crossbar, Manual, Panel, Step-by-Step or Toll Offices.

3.02 Sending Jack Ckts. - SD-95101-01.

3.03 Sending Pad Ckts. - SD-95147-01.

3.04 Transmission Measuring Circuits - SD-59432-01.

3.05 Noise Measuring Ckt. - SD-59433-01.

3.06 Miscellaneous Jack Ckts.

3.07 Test Line Circuit for Toll-Switching System No. 4, 4M or 4A - SD-68095-01.

3.08 Transmission Measuring and Noise Checking Ckt. - SD-95698-01.

3.09 Automatic Transmission Test and Control Ckt. - SD-68446-01.

3.10 Repeater Measuring Circuit (V1 + V3) - SD-95162-01.

3.11 1000 cps Outlets, Rec Jacks & Control - SD-95162-02.

3.12 Testing and Monitoring Circuit (Signalling) SD-96519-01.

3.13 Maintenance Circuits (TASI) - SD-59972-01.

3.14 Announcement Systems - SD-95608-01, and SD-68445-01.

3.15 Transmission and Noise Measuring Ckt. (Testboards) - SD-95900-01.

3.16 N2 Carrier Telephone Application Schem. SD-97118-01.

3.17 Jack Ckt. Toll Test Unit No. 5A.

4. CONNECTING INFORMATION

4.1 The choice of optional outlet arrangements for the 71A depends upon the connecting circuits. Distributing networks are shown on this drawing for all applications. Four networks are normally provided on the panel with the generator unit.

4.2 The choice of optional outlet arrangements for the 71C depends upon the connecting circuits. Distributing networks are shown on this drawing for all applications. The networks are normally provided in groups of five, with one or two such groups mounted on a separate panel. All networks on any one panel normally have the same impedance. A maximum of fifty networks may be provided with the 71C generator. The network panels used with 71C are designated 71D and 71E.

4.3 The connecting circuits should provide terminations for the milliwatt distributing circuit either by the circuit under test or by a resistor at all times, except the possible momentary interval of the plugging-in at a jack.

4.4 The connecting circuits should be balanced with respect to ground and should provide a reasonable close matching impedance at 1000 cycles. Transformers or blocking capacitors should be used when the connecting circuit applies dc on the tip and ring in excess of 100 microamperes.

5. SYSTEM CONSIDERATIONS (ENGINEERING GUIDES)

5.01 A guide for restricting the size of milliwatt systems to specific areas, in order to enhance administration thereof, and thereby to provide adequate stability of testing power, is outlined below. Application of the guide is not intended to be rigid but rather to indicate intent. Exceptions to it may be practicable in individual cases, particularly where good administration of the milliwatt system can be attained. In general, it is desirable that the areas indicated below have exclusive use of a milliwatt system.

(a) Toll Testboard Area, including:

(1) Toll testboard

(2) Circuit patching bay

(3) ATTC and associated test frame (if under the direct control of the plant organization responsible for the system serving the toll testboard)

(4) Equipment bays, including echo suppressors and signalling units (if under the direct control of the plant organization responsible for the system serving the toll testboard)

(b) Switching Area, including:

(1) Dialable milliwatt test lines

(2) Code 104 test lines and their equivalents

(3) Manual and automatic test frames (if under the direct control of switching equipment personnel)

(c) Manual Switchboards

(d) Voice-frequency patching bays within a well defined area. (Where several groups of patching bays are widely separated in the office, or if they are under the control of two or more plant organizations, each group of bays would have its own supply).

(e) Carrier equipment area. (If voice-frequency patching bays are located within or adjacent to these areas, they may use a common supply with the equipment area. In any case, however, the outlets from any one source should be restricted to a well defined area.

(f) Private line testboard, if not under the direct control of the toll testboard area

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