

**BELL SYSTEM PRACTICES**  
**Outside Plant Construction**  
**and Maintenance**

**SECTION G72.228**  
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**AT&T Co Standard**

# **CABLE TESTING**

## **COMBINING LOADING UNITS IN TANDEM AND IN PARALLEL**

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### **1. GENERAL**

1.01 Because of the shortage of new loading units, it may occasionally be expedient to combine 44-25 units in tandem to give 88-50 loading or to combine 174-63 units in parallel to give approximately 87-31 (non-standard) loading. Two units are connected in tandem by connecting each conductor at the IN side of one unit to a conductor at the OUT side of another unit. This is illustrated in Fig. 1, Page 4. Two units are connected in parallel by connecting each conductor at the IN side of one unit to a conductor at the IN side of another unit and by making similar connections at the OUT side. This is illustrated in Fig. 2, Page 5.

1.02 When loading units are combined in tandem or parallel the within-quad crosstalk coupling they introduce in the circuits involved may be considerably different from that which would result from using the coils in the normal manner. This section provides testing and splicing procedures for minimizing the crosstalk introduced by the coils in the tandem and parallel conditions. The tests required are similar to the usual open-circuit capacitance unbalance tests employed in cable testing, and the method of selecting pairs of loading units and of connecting them in tandem or parallel is similar to that employed in determining cable quad connections from capacitance unbalance measurements.

1.03 In order to load a number of quads with loading units connected in tandem or in parallel, there must be available at each loading point twice as many of the original type of loading units as there are quads to be loaded. Each pair of these units connected together in tandem or in parallel as covered in this section should be considered as a single unit for purposes of connection to the cable quads.

1.04 Due to the complications involved in splicing, it is advisable to avoid combining loading units that are in separate cases unless the stubs of the cases are connected to the main cable within the same splice.

1.05 In order to guard against future inadvertent rearrangement of tandem or parallel connections, a tag should be placed in each splice before it is wrapped, giving the following information:

Tandem (or parallel) loading unit connections have been made in this splice. If necessary to open them, restore original connections, wire for wire.

1.06 If loading units combined in tandem or in parallel are employed in only part of a repeater section, and standard units of the same nominal "weight" in the remainder, it would be expected that the return loss of the repeater section would be impaired to a moderate extent.

1.07 For fault-location purposes it is of course necessary to know the resistance inserted in a pair of wires by each loading unit. When combined units are employed some precaution should be taken to insure that the proper resistance values are made a part of the cable records. Tandem units insert approximately twice the resistance, and parallel units approximately half the resistance, that individual units would insert in either side circuits or phantom circuits.

## 2. APPARATUS REQUIRED

2.01 The following apparatus is required:

4A or 3A Capacity Unbalance Set with leads and telephone receivers (See Section G72.230)

11A Oscillator or the equivalent  
(See Section G72.235)

107A Amplifier or the equivalent  
(See Section G72.280)

Test boards

Splicing Tools and Material

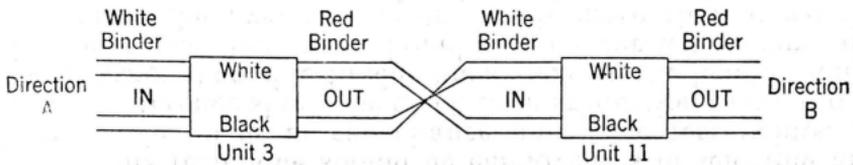
### 3. CAPACITANCE UNBALANCE MEASUREMENTS

- 3.01 Capacitance unbalance measurements are required for either tandem or parallel connection of loading units.
- 3.02 Connect the apparatus for capacitance unbalance measurements and check the "zeros" of the Capacity Unbalance Set as covered in Section G72.225.
- 3.03 Both the IN (white binder) and OUT (red binder) stub cable quads associated with each loading unit involved should be disconnected from the main cable before the units are tested and combined.
- 3.04 The splicer should board the IN and OUT quads in separate test boards, plainly marked IN and OUT, respectively. The IN quads should be boarded at random, and the OUT quads identified electrically and boarded in corresponding order. Since errors are sometimes made in connecting the conductors to the units inside the load coil case, the WHITE and BLACK pairs in the OUT group should be identified electrically with the corresponding pairs in the IN group. The tips and rings of all pairs, both IN and OUT, should be identified and marked by cutting the wires LONG and SHORT, respectively. To facilitate testing, it is advisable to skin the IN pairs, but it is preferable to leave the ends of the OUT wires insulated until after the initial measurements have been made on all units.
- 3.05 Measure the capacitance unbalances within each unit from the IN side, taking precaution that the OUT conductors of the unit are not touching each other or any conductor of another unit. Three measurements are required for each quad, phantom-to-white, phantom-to-black, and side-to-side. The results of the measurements should be entered on Form E-988 in the column for Direction A.
- 3.06 In selecting and splicing the units to be combined, the same technique should be employed as in selecting and splicing cable quads at capacitance unbalance test points. In general, preference should be given to the reduction of phantom-to-side, rather than side-to-side unbalances in the loading units. This preference, however, should not be carried beyond the point where the average side-to-side is more than twice the average phantom-to-side reading. Form E-988 may be used conveniently for recording measurements, splicing instructions and expected results.

### 4. TANDEM CONNECTION OF LOADING UNITS

- 4.01 When two loading units have been selected for tandem connection, the lower-numbered one shall be considered as the Direction A unit, and the splicing instructions shall be

given on that basis. The red-binder side of the lower-numbered unit shall be spliced to the white-binder side of the higher-numbered unit. When spliced, the two units considered as a whole will have a white-binder and a red-binder side, with the lower-numbered unit at the white-binder side. Fig. 1 illustrates this.



SPlicing INSTRUCTIONS				
Quad A	Pairs	White	Black	Quad B
3RB	X	-	X	11WB

Splicing instructions to be read thus:  
Splice Unit 3 red binder to Unit 11 white binder,  
reverse - straight - reverse.

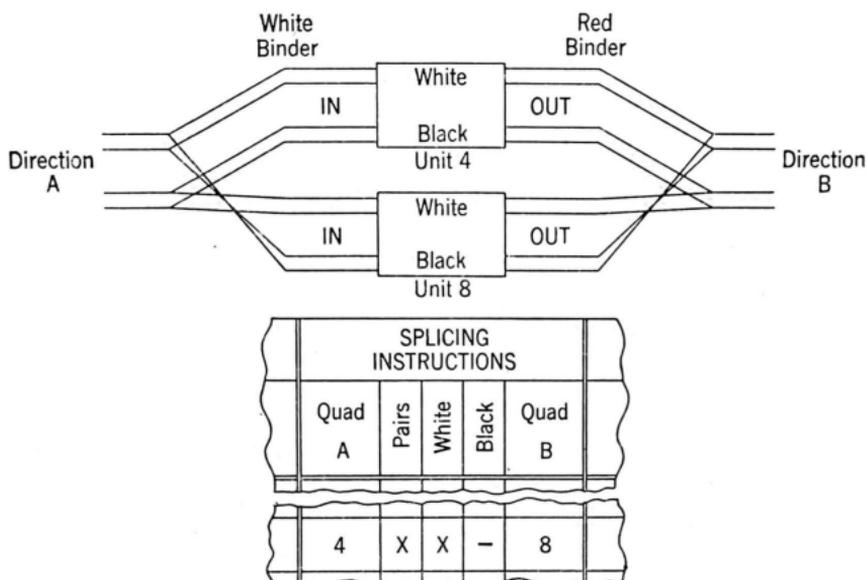
Fig. 1

4.02 Make check measurements of capacitance unbalance from the white-binder side of each pair of tandem loading units. Investigate for incorrect splicing instructions and splicing errors any pair of units whose unbalances differ from the respective computed values by more than 5 mmf.

## 5. PARALLEL CONNECTION OF LOADING UNITS

5.01 When two loading units have been selected for parallel connection, the lower-numbered unit shall be considered as the Direction A unit, and the splicing instructions shall be given on that basis. The white-binder sides of the two units shall be bridged according to the splicing directions, and the red-binder sides should be bridged in exactly the same way. Any error in splicing the white-binder or red-binder side of a pair of units will result in a serious transmission loss in one or

more of the three circuits involved. Fig. 2 illustrates the method of connecting units in parallel.



Splicing instructions to be read thus:  
Splice Unit 4 to Unit 8, reverse-reverse-straight.

**Fig. 2**

5.02 Make check measurements of capacitance unbalance from the white-binder side of each pair of units. Investigate for incorrect splicing instructions and splicing errors any pair of units whose unbalances differ from the respective computed values by more than 5 mmf.

## 6. RESULTS

6.01 If the average phantom-to-side and side-to-side unbalance readings on the combined units are roughly one-half the respective average unbalance readings on the individual units, it may be assumed that a satisfactory combining job has been done.