

TRUNK TRANSMISSION DESIGN

LOSS OBJECTIVES

1. GENERAL

1.01 This section defines trunk design loss and states design loss objectives for trunks. It replaces Section AB21.025.01, Issue 1 and Section AB21.025.02, Issue 1.

1.02 Since the previous issue of this section there has been confusion between the maintenance term, Expected Measured Loss (EML), and the design term, "EML objective." This issue defines a new term, Inserted Connection Loss (ICL), which replaces "EML objective." In addition, loss objectives which have been established since the last issue have been included.

2. EXPECTED MEASURED LOSS (EML)

2.01 *The EML of a trunk is the 1000 Hz loss that is expected to be measured in the test condition. It is calculated by summing: a) all gains and losses between the outgoing switch appearance at the originating end and the outgoing switch appearance to which the trunk is connected at the terminating end, including switch pad losses present in the measuring condition, and b) test pad losses present in the measuring condition.* In the above definition, the phrase "outgoing switch appearance" includes any crossbar switch, manual switchboard jack, panel selector bank terminal or step-by-step selector or connector on which a trunk or subscriber line is terminated.

2.02 For two-way trunks, the EML depends upon the direction in which a call is originated. The EML of a two-way trunk is defined as the expected loss when the test call is originated at the circuit control office.

2.03 Trunk administration from a design viewpoint is complicated by: a) test pads and, b) switch pad arrangements in No. 4 crossbar

4-wire toll offices which permit economies through "High Loss" trunk design. For these reasons design objectives cannot be expressed in terms of EML. Therefore, a new term, *Inserted Connection Loss* (ICL), has been adopted which will permit direct comparisons of design values to design objectives. Both EML and ICL values are required on circuit layout records for Plant and Engineering purposes, respectively.

3. INSERTED CONNECTION LOSS (ICL)

3.01 *The ICL is the net 1000 Hz loss between outgoing switch appearances inserted by switching the trunk into an actual operating connection.* It is calculated by subtracting the test pad losses from the EML. In addition, with "High Loss" trunk design, the office A-pad value must also be subtracted from the EML of the "High Loss" trunk to obtain the ICL, thereby adjusting for the gain effectively transferred to the "High Loss" trunk by switching out the A pad in the connected trunk. For those trunks which do not encounter test pads in the measuring condition and do not connect to trunks which employ switch pads, the ICL is equal to the EML. Fig. 1 through 4 illustrate the relationship between ICL and EML for this and several other conditions.

3.02 This definition of trunk loss includes all office wiring and equipment losses encountered between the specified points at both the originating and terminating offices. These losses will vary from almost zero to over 1.0 dB as they depend on the type of switching equipment and the office wiring involved. It will be necessary to know these losses to a reasonable degree of accuracy to properly assign the ICL of the trunk. It is not practical, however, to account for this variability in establishing System trunk loss design objectives. An average loss has been assumed in stating ICL objectives.

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3.03 The term ICL makes it possible to clarify Via Net Loss (VNL) design values. In the past it has not always been clear whether a trunk should be classified as "operating at VNL" when its loss calculation included penalty losses (such as "B" factors associated with trunks emanating from nonbalanced offices). VNL is a theoretical derivation and does not include any penalty losses. ICL is the actual operating loss assigned to a trunk and should include penalty losses if required. A trunk can be classified as "operating at VNL" when the ICL equals the theoretical VNL.

4. INTERPRETATION OF OBJECTIVES

A. Local

4.01 The practical administration of trunk losses must recognize that some tolerance is needed in the design objectives. Expressing the objectives as a single value for each type of trunk is convenient for many purposes but is not a realistic guide for all classes of trunks in the design and assignment job. Consequently, some design loss objectives are expressed both as a single value and a range of values.

4.02 The objective losses for both local direct and tandem trunks are given as two numbers, a "nominal" and a "maximum." It is intended that these numbers be understood in a particular way, so that local trunk plant will evolve toward a distribution of losses that will give satisfactory service on all calls.

4.03 When engineering new plant, the nominal loss figure is used as an objective to determine the cable gauge and repeater requirement. These facilities should be selected so as to be able to operate the trunk at, or very close to, the nominal loss. There is *no* occasion to apply the maximum loss as a criterion in this fundamental process.

4.04 Another engineering function is to establish a program to reduce the loss of existing trunks that do not meet current objectives. The criteria here are quite similar to those for new plant, except that some judgment must be

exercised in determining timing of improvement and interim use of existing cable and repeater facilities. The maximum loss objective might be used in this situation as a guide to acceptable use of interim facility arrangements. The concept of *temporary* use of maximum loss is emphasized here, as it is expected that when new plant is provided, facilities meeting the nominal objective will be selected.

4.05 Other situations may arise, in the course of engineering and assignment work, in which it is necessary to weight a choice of excess trunk loss against some other unsatisfactory service or economic condition. The objective maximum is stated, for these cases, as an upper limit to the range of losses in which judgment should be applied.

4.06 Although no minimum loss values have been established for local trunks, care should be taken in their design to ensure that noise, crosstalk and stability requirements are met.

4.07 Applying the objectives in the spirit of the above discussion will result in the desired distribution, with most losses close to the nominal objective and *only a few* trunks near, but less than the maximum value.

B. Toll

4.08 There are two basic types of trunks in the toll network — intertoll, which interconnect Class 4 or higher ranking offices and toll connecting, which connect end offices to Class 4 or higher ranking toll offices. In order to ensure that a toll connection will have the minimum possible loss consistent with satisfactory echo performance, loss is allocated among trunks according to Via Net Loss (VNL) criteria (for a discussion of VNL criteria refer to Section 010-510-100). That is, intertoll trunks should be designed to have an ICL of VNL dB and toll connecting trunks should be designed to have an ICL of VNL + 2.5 dB. Maximum values, as indicated in Table 1, have been established to control overall loss.

4.09 Alternate ICL objectives have been established to facilitate administration of toll connecting trunks and to take into account the discrete gain steps available in the repeaters used on them. Specifically, toll connecting trunks less than 15 miles of voice-frequency facilities or less than 100 miles of carrier facilities may be designed to have an ICL of 3.0 dB minimum, 4.0 dB maximum without recourse to the VNL formula. Trunks longer than these permissible lengths should be designed to have ICL's in accordance with $VNL + 2.5$ dB formula.

4.10 Where it is justified by traffic and economic considerations, it may be desirable to provide high usage toll connecting trunks from an end office to a toll office other than its normal serving toll office. The maximum ICL of 4.0 dB for toll connecting trunks does not preclude the establishment of these trunks provided they are less than 735 route miles in length and employ carrier facilities $[(4.0 - 2.5 - 0.4) / .0015 = 735 \text{ miles}]$. For trunks of this nature, which exceed 735 route miles, the maximum ICL has been extended to 5.5 dB. ***This is not to be considered as a relaxation of maximum loss objectives.*** It merely recognizes that, under these conditions, there are two or more trunks in the final route as compared to only one in the high usage route. Therefore, the single trunks in the high usage route can be permitted to have the equivalent loss of the two trunks in the final route. Trunks long enough to exceed the 5.5 dB maximum (1760 route miles) should have echo suppressors installed on them and a 3.0 dB ICL should be assigned to them. There is no danger that this will result in two echo suppressors on a connection since traffic rules specify that these trunks are only permitted to switch to a lower ranking office within the distant routing pattern.

4.11 Direct trunks which are longer than 100 route miles should also be designed according to VNL criteria. That is, the ICL should be $VNL + 5.0$ dB. The maximum loss should not exceed 8.0 dB. This also results in a maximum length of 1760 route miles beyond which echo suppressors should be employed. When echo sup-

pressors are used the ICL of the trunks should be designed to 6.0 dB.

5. TRUNK DESIGN LOSS OBJECTIVES

5.01 The ICL objectives are listed in Table 1. These objectives apply to trunks between any type of switching equipment.

- (a) ***End Office Direct Trunks*** connect any two end offices without intermediate switching point.
- (b) ***Tandem Trunks*** interconnect an end office and a local tandem office.
- (c) ***Intertandem Trunks*** interconnect two tandem offices for completion of local connections involving 4 trunks or less in tandem. They should use 4-wire trunk facilities and intertoll type trunk relay equipment.
- (d) ***Toll Connecting Trunks*** interconnect an end office and a Toll Center (Class 4) or higher ranking office. They may be used to complete toll or local traffic since the objective values for these trunks fall within the range specified for local tandem trunks.
- (e) ***Intertoll Trunks*** interconnect Toll Centers (Class 4) or higher ranking toll switching offices.
- (f) ***Secondary Intertoll Trunks*** are used to interconnect a toll switching machine and its associated switchboard in the same or adjacent building.
- (g) ***Information Trunks*** connect either end offices, local tandem offices or toll offices to operators who provide directory information to calling customers.
- (h) ***Repair Service Bureau Trunks*** connect an end office to a repair service bureau position.
- (i) ***Verification Trunks*** connect an operators position to an end office and are used to verify busy conditions on subscriber's lines.

TABLE 1
INSERTED CONNECTION LOSS

TRUNK TYPE	ICL OBJECTIVE	
A. End Office Direct		
— Less than 100 Route Miles	5.0 dB Nominal	7.0 dB Maximum
— 100 Route Miles and Longer (Note 1)	VNL + 5.0 dB	8.0 dB Maximum
B. Tandem	3.0 dB Nominal	4.0 dB Maximum
C. Intertandem	VNL	
Alternate (Note 2)	0.5 dB	
D. Toll Connecting	VNL + 2.5 dB	(Note 4) 4.0 dB Maximum
Alternate (Note 3)	3.0 dB Minimum	4.0 dB Maximum
— Longer than 735 Route Miles	VNL + 2.5 dB	5.5 dB Maximum
E. Intertoll (Note 1)		
— Final Group	VNL	1.4 dB Maximum
— High Usage and Full	VNL	2.6 dB Maximum
— Class 1 to Class 1	0	0.5 dB Maximum
F. Secondary Intertoll		
— With Gain	VNL	0.5 dB Maximum
— High Loss	0 dB	0.5 dB Maximum
G. Information Trunks		
— From End Office	5.0 dB Nominal	7.0 dB Maximum
— From Tandem Office	3.0 dB Nominal	4.0 dB Maximum
— From Toll Office	VNL + 2.5 dB	4.0 dB Maximum
H. Repair Service Bureau	5.0 dB Nominal	7.0 dB Maximum
I. Verification	5.0 dB Nominal	7.0 dB Maximum

Note 1: The table below indicates the route mileage beyond which echo suppressors are required and the ICL value which should be assigned to trunks equipped with echo suppressors. For additional information on echo suppressors, refer to AB23.026.

TYPE TRUNK	MILEAGE	ICL-dB
End Office Direct	1760	6.0
Toll Connecting	1760	3.0
Interregional Intertoll	1565	0-0.5
Class 1 to Class 1	*	0-0.5

* These trunks always require an echo suppressor.

Note 2: An objective of 0.5 dB may be applied in lieu of VNL for ease of administration.

Note 3: Alternate objectives may be applied to 2- or 4-wire cable facilities less than 15 miles and carrier facilities less than 100 miles in length.

Note 4: For the case of very short toll connecting trunks without gain devices a 2.0 dB minimum ICL is acceptable, providing that balance objectives are met. The use of 2 dB pads is prescribed as follows:

Interbuilding Trunks

ICL less than 2.0 dB

— Use 2 db pad

ICL equal to or greater than 2.0 dB

— Do *not* use 2 dB pad

Intrabuilding Trunks

— Use 2 dB pad

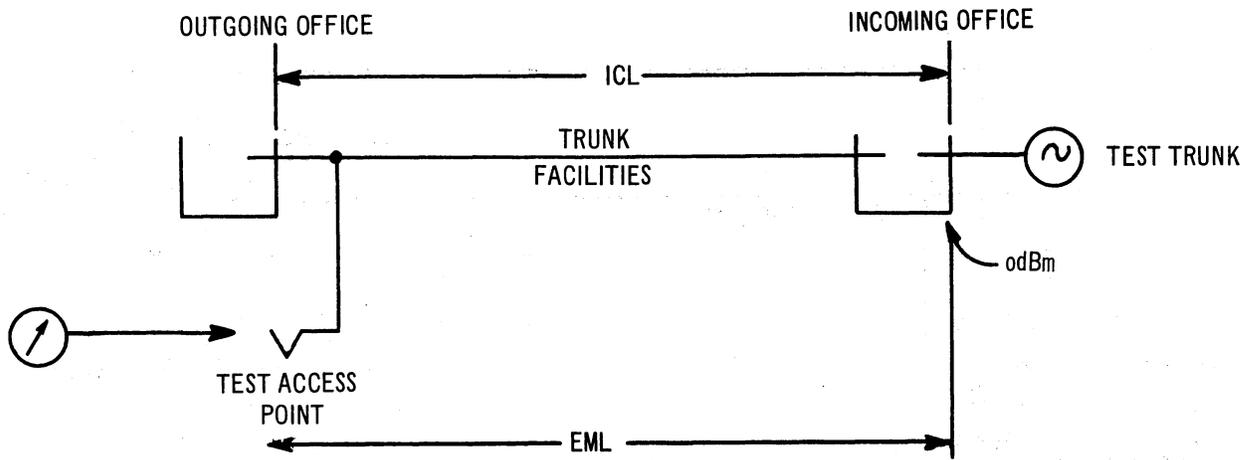


Fig. 1 - No Test or Switch Pads
ICL = EML

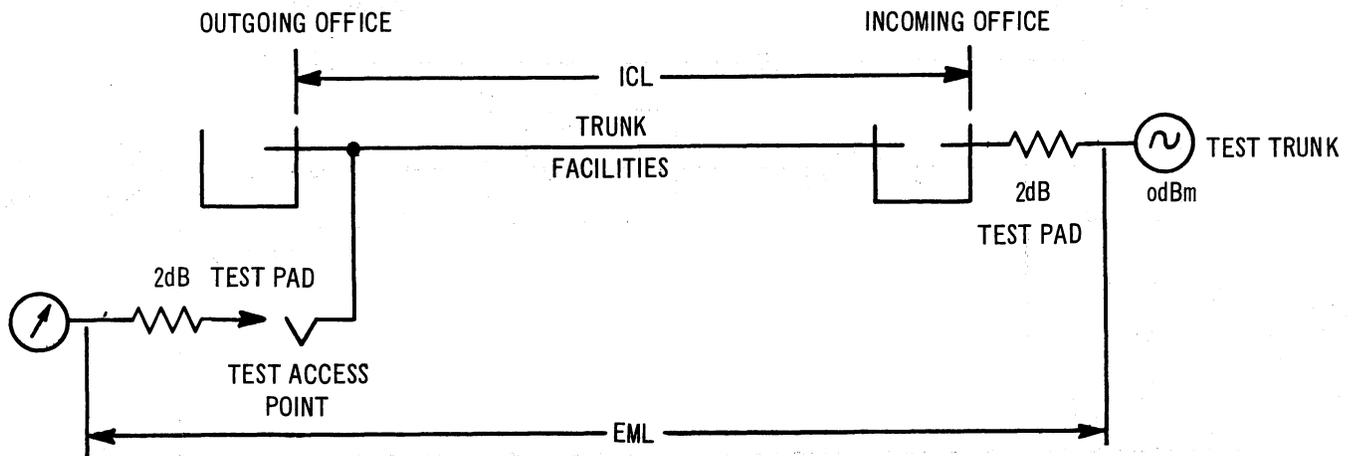


Fig. 2 - Test Pads in Measuring Path
ICL = EML - Test Pad Losses

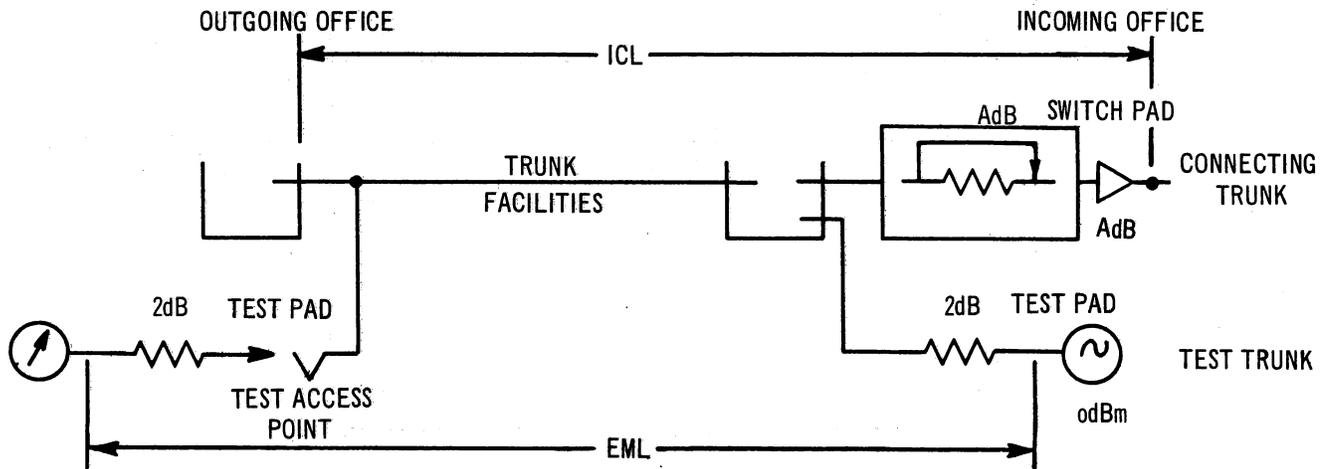


Fig. 3 – Test Pads in Measuring Path and Switch Pads in Connecting Trunk
 $ICL = EML - \text{Test Pad Losses} - \text{Switch Pad Losses}$

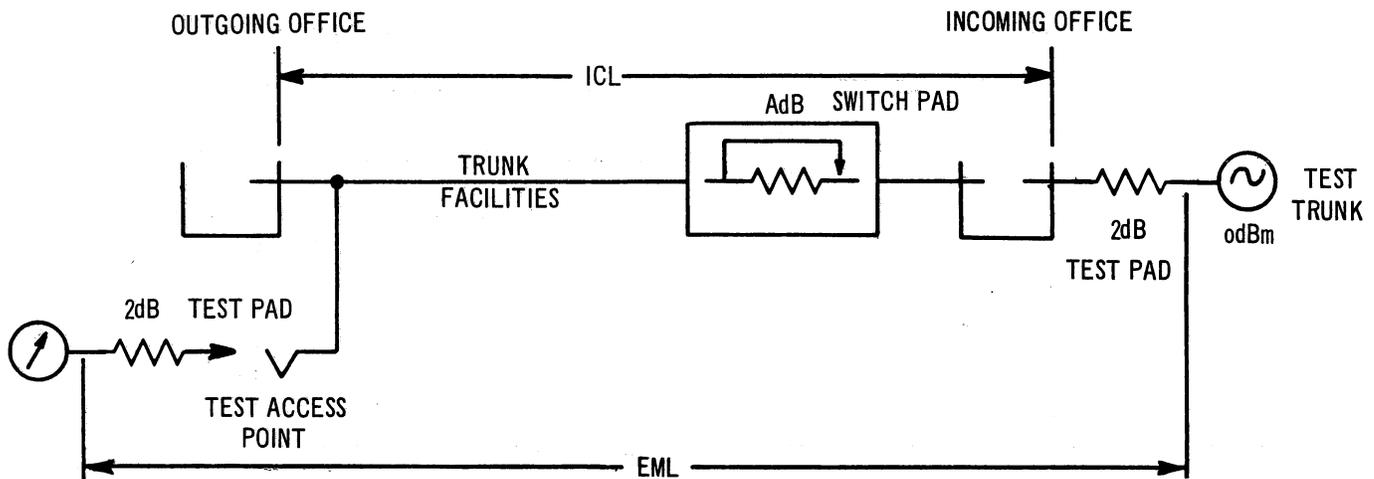


Fig. 4 – Switch Pads in Trunk and Test Pads in Measuring Path
 $ICL = EML - \text{Test Pad Losses}$