The ATM Forum
Technical Committee

Conformance ATS for Available Bit Rate (ABR) Source and Destination Behaviors

AF-TEST-TM-0157.000
January, 2001

Conformance ATS for Available Bit Rate (ABR) Source and Destination Behaviours

AF-TEST-TM-0157.000
January, 2001

The ATM Forum
Worldwide Headquarters
1000 Executive Parkway, Suite 220
St. Louis, MO 63141
Tel: +1 314 205 0200
Fax: +1 314 576 7960

Contents

1. INTRODUCTION 1

2. SCOPE 1

3. TEST CONFIGURATION 1

4. ASSUMPTIONS ON THE CAPABILITIES OF TESTERS AND SYSTEMS UNDER TEST 3

5. TEST COVERAGE 3

6. TEST CASE DESCRIPTION 6

6.1 T1 - INITIAL FRM CELL 6
6.2 T2 - TURNING AROUND AN FRM CELL 7
6.3 T3 - DATA TRANSMISSION AND FRM CELL 7
6.4 T4 - ADDITIVE INCREASE OF ACR TO PCR 8
6.5 T5 - REDUCING ACR BY ER 9
6.6 T6 - DESTINATION FORCED NO ACR INCREASE 10
6.7 T7 - REDUCING ACR TO ICR 11
6.8 T8 - MAINTAINING DATA RATE WITH NO CHANGE IN ACR 11
6.9 T9 - MULTIPLICATIVE DECREASE OF ACR TO MCR 12
6.10 T10 - CONGESTION INDICATION IN BRM 13
6.11 T11 -TURNING AROUND FRM CELLS WITH VARYING EFCI VALUES 14
6.12 T12 - INTERNAL AND EXTERNAL CONGESTION 15
6.13 T13 - INTERNAL AND EXTERNAL CONGESTION - DESTINATION GENERATED BRM 16
6.14 T14 - SOURCE RESTS EFCI BIT 17
6.15 T15 - SOURCE SETS CLP=0 18
6.16 T16 - LIMIT ON OUT-OF-RATE CELL RATE 18
6.17 T17 - IN-RATE FRM CELL RATE 19
6.18 T18 - FRM CELL SPACING 20
6.19 T19 - THE FIRST BRM SINCE THE LAST FRM 20
6.20 T20 - RM CELL FORMAT 21
6.21 T21 - SOURCE RESETS EFCI BIT 22

7. PROTOCOL IMPLEMENTATION EXTRA INFORMATION FOR TESTING (PIXIT) PROFORMA FOR THE ABR ATS 23

8. PIXIT QUESTIONS 24

9. REFERENCES 25

10. THE ABR ABSTRACT TEST SUITE 26

1. Introduction

This document comprises an Abstract Test Suite (ATS) [2] for the Available Bit Rate (ABR) rate control scheme as specified in sections 5.10.1 through 5.10.5 of the ATM Forum Traffic Management (TM) Specification V4.1 [1]. This ATS is specified in the test specification language called Tree and Tabular Combined Notation (TTCN) [3] and uses ASN.1 to define the Protocol Data Units (PDUs).

Section 2 includes the scope of the ATS. Sections 3 and 4 include information about the test methodology and test assumptions, while Sections 5 and 6 describe the test cases. Sections 7 and 8 include the Protocol Implementation eXtra Information for Testing (PIXIT) proforma and Section 10 includes the test suite.

2. Scope

This comprises a conformance abstract test suite (ATS) for the Available Bit Rate (ABR) - Source and Destination rate control scheme as specified in sections 5.10.1 through 5.10.5 of the ATM Forum Traffic Management (TM) Specification V4.1 [1]. This conformance test suite is intended to test the behaviors of an end system, both as the traffic source and destination, and does not test switch behavior (Section 5.10.6), VS/VD behavior (Section 5.10.7), ABR point-to-multipoint behavior (Section 5.10.8), or support for ABR virtual paths (Section 5.10.9).

3. Test Configuration

Since the rate control scheme specifies the end-to-end behaviors of two end systems as well as the network switching nodes in between them, the test system must emulate the operations of all of these components.

For this test suite, the Distributed test method, defined in ISO/IEC 9646-1 [2], is applied. There are two Points of Control and Observation (PCOs): one beneath the Lower Tester and one at the upper service boundary of the implementation under test (IUT). The ABR service test system consists of two main components: Lower Tester (LowerT) and Upper Tester (UpperT) shown in Figures 1 and 2. Figure 1 shows the roles the Lower Tester and Upper Tester play in an actual networking environment, while Figure 2 shows the system setup in a testing environment, including a coordination control function (CON) between the Lower Tester and Upper Tester.

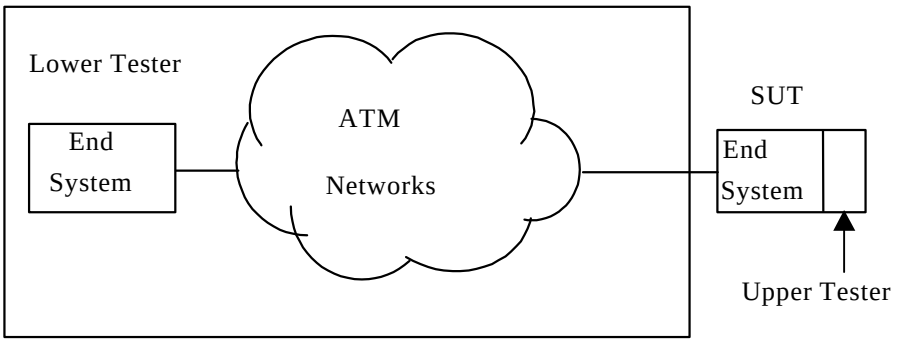


Figure 1. The Role of the Lower and Upper Testers Emulating Network Components

The Lower Tester is connected to the system under test (SUT) through the SUT's ATM physical interface. It simulates the operation of the end system which communicates with the SUT, and switching nodes. The Upper Tester resides on the SUT and emulates the operation of applications on the SUT. The coordination control (CON) provides the means for the Lower Tester to communicate with the Upper Tester, to initiate an ABR connection and to generate data cells. It is needed to generate ATM cells through the ATM layer interface with precise timing control to force the ABR rate control implementation through its state transitions.

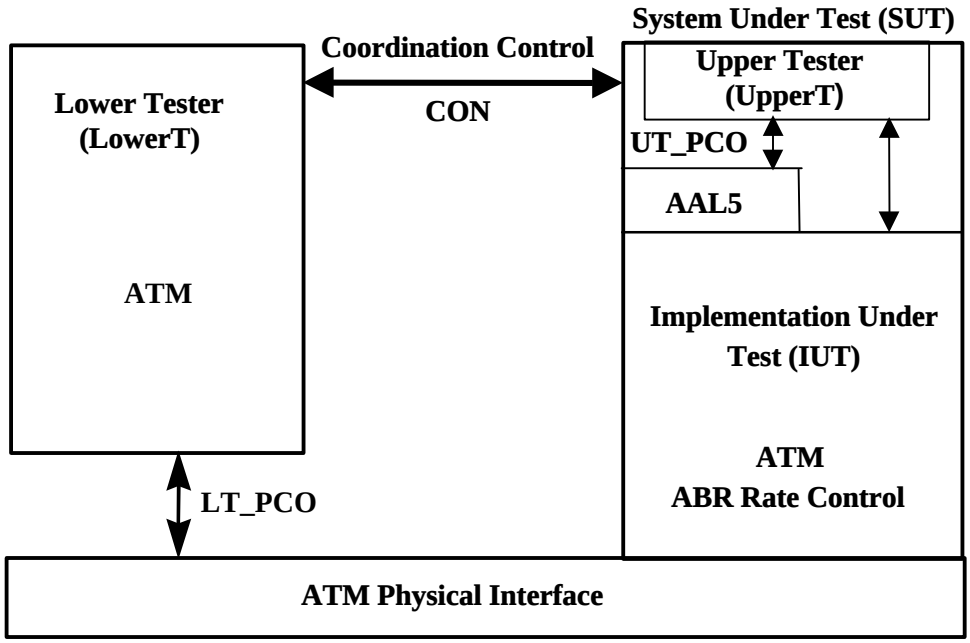


Figure 2. Test Configuration for ABR Rate Control Scheme

The Lower Tester transmits and examines ATM cells in and out of the IUT, including Resource Management (RM) cells at the Lower Tester Point of Control and Observation (LT_PCO). It examines the contents of RM cells sent by the IUT to determine if the IUT adjusts its Allowed Cell Rate (ACR) as required.

The UpperT transmits ATM cells through the Upper Tester Point of Control and Observation (UT_PCO). It sends one or a sequence of cells at a time as required by the test case. The ATM Adaptation Layer Type 5 (AAL5) shown in Figure 2 is optional. If the SUT has an exposed interface between the ATM and AAL layers, then the Upper Tester can be installed to replace AAL5 and send ATM cells directly to the ATM layer; otherwise the Upper Tester can reside above the AAL5 layer and send messages to the AAL5 layer which will in turn segment the messages into ATM cells. In this case, the length of AAL5 Protocol Data Unit must be set to 40 bytes so that each AAL5 PDU will be sent in one ATM cell (see Test Suite Constant, UT_Datalen). This ATS is written in a way that each message sent from the Upper Tester could be an AAL5 PDU or an ATM cell PDU. Timing and number of cells arriving at the ATM layer are critical factors in the successful execution of the test cases.

Coordination or synchronization between the Lower Tester and Upper Tester could be done in two ways: (1) establish a special virtual circuit between the Lower Tester and Upper Tester, or

(2) set up an external connection through, for example, a serial interface between the Lower Tester and SUT.

4. Assumptions on the Capabilities of Testers and Systems Under Test

1. Connection Setup - It is assumed that an ABR service connection can be established from the SUT to the Lower Tester, and that the ABR service parameters satisfy the condition MCR < ICR < PCR.
2. Upper Tester - The SUT must be capable of installing an Upper Tester that can send and receive ATM cells (or AAL5 PDUs) on command.
3. Synchronization of Upper Tester and Lower Tester - A synchronization procedure must be available between the Upper Tester and Lower Tester. Note that all verdicts of pass and failure are to be produced by the Lower Tester.
4. Test Case Sequencing - All test cases are to be executed in sequence. The preamble of each test case is the successful completion of all of the noted preceding test cases. If the ABR service parameters cannot satisfy the conditions in assumption 1 above, then:
   - If ICR=PCR, run test case T5 as preamble to T3. The BRM sent in T3 should have ER=(PCR+MCR)/2.
   - If ICR=MCR, run test case T4 as preamble to T8 until ACR=(PCR+MCR)/2.

In case a test case fails, you may elect to continue, provided that the conditions listed in the preamble of the next test case holds true. However, it is recommended that the test be terminated, and the error corrected so that the test cases may continue to be executed in order.

5. Test Coverage

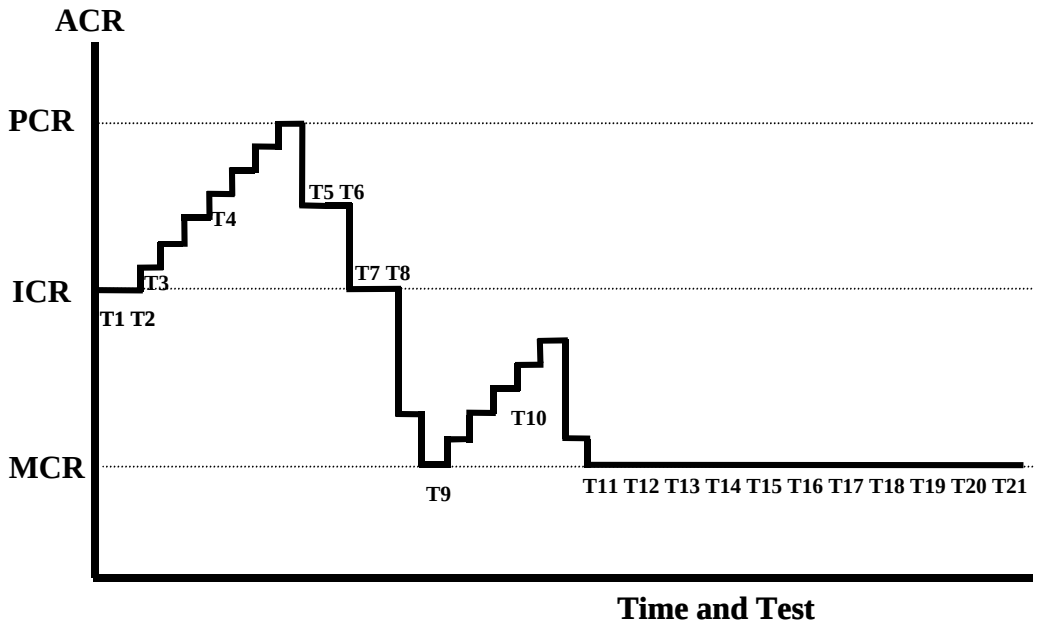
Test case generation approach attempts to generate a tour of every state transition in the end system with the various values of variables and parameters, such as ACR, CI, NI, and DIR. The tour starts at the initial state when an ABR connection has just been set up and all ABR parameters, such as PCR, ICR, MCR, RIF, CDF and Nrm have been specified. The Upper Tester sends the first ATM cell, and in response, the IUT must send a Forward Resource Management (FRM) cell indicating ACR=ICR. Simultaneous bi-directional traffic is tested by sending an FRM cell from the Lower Tester to which the IUT must respond with a Backward Resource Management (BRM) cell. This is followed by verifying that the IUT will send an FRM cell after Nrm-1 data cells are transmitted, and the sequence of test cases proceed to bring the ACR to PCR through the additive increase process, and force it down first to ICR, then to MCR by sending BRM cell with lower ER, or by not returning the FRM.

The condition in which the Upper Tester generates data at a very low rate is also tested, forcing the IUT to generate FRM cells at every Trm interval, and keeping the ACR unchanged or reduced.

The next set of tests are for the network congestion conditions. The test suite first lets the Lower Tester send BRM cells with the NI or CI bits set, and then test the congestion on the direction of the data path from the Lower Tester to the IUT by setting the EFCI bit on data cells sent from the Lower Tester. It is expected that the IUT, operating as the destination end system, will notify the source by returning the FRM cells from Lower Tester (or BRM) with the CI bit set to 1. The IUT is forced to have multiple BRM cells waiting for transmission and is expected to either drop all but one BRM cell or to update all BRM cells waiting transmission.

Finally, the IUT is forced into an internal congestion condition, by sending data from the Lower Tester and by disabling the Upper Tester from receiving data. The setting of the BN, CI and NI bits in the BRM cells is observed. This condition may not be realizable on all implementations.

Figure 3 shows the changes of the ACR as the testing progresses from test case T1 to T21.



T1 - Coming out of idle, rate is ICR
T2 - Turn around an FRM, set DIR=1
T3 - NI=0, CI=0, BN=0; ACR increased
T4 - Repeat T3 till rate reaches PCR
T5 - BRM with ER = (PCR+ICR)/2
T6 - BRM with NI=1, rate is unchanged
T7 - BRM is missing, rate is reduced
T8 - Outstanding FRMs <= CRM-1
T9 - Outstanding FRMs > CRM
T10 - First BN=0,NI=0, CI=0 then set CI=1
T11 - Translate EFCI=1 to CI=1
T12 - IUT Source congested, Source sets CI=1
T13 - Congested Source generates own BRM
T14 - Source resets EFCI on all data cells
T15 - Source sets CLP=0 on all data cells
T16 - Out of rate RM cells < TCR
T17 - One RM cell is sent every Nrm cells
T18 - Mrm data cells are sent before next FRM
T19 - First BRM sent ahead of data cells
T20 - Check RM cell format
T21 - Check if EFCI is saved

Figure 3. Change of ACR on the Test Tour

The change in ACR is verified by examining the contents of the CCR field in the FRM cells from the IUT. The test suite makes provisions to verify that the IUT is in fact transmitting data cells at the claimed ACR rate, however, it is only an approximation of the real rate.

The Traffic Management specification V4.1 allows out-of-rate RM cells (including FRM and BRM) to be transmitted at any time as an option. Since it does not affect the operation of the SUT, the Lower Tester will not send those cells, and if it receives any, it treats such cells as normal RM cells.

Table 1 - Source Behavior Test Coverage, and Table 2 - Destination Behavior Test Coverage summarize the current coverage of the relevant ABR requirements by the test suite.

Table 1. Source Behavior Test Coverage

Source Behavior Test Coverage (Section 5.10.4, Traffic Management Specification Version 4.1, af-tm-0121.000)																
S.1	S.2	S.3.a.i	S.3.a.ii	S.3.b.i	S.3.b.ii	S.3.c	S.4	S.5	S.6	S.7	S.8	S.9	S.10	S.11	S.12	S.13
T1	T1	T3,T4,T7,T8,T9, T18	T3,T4,T9,T17	T2,T4,T19	T4,T19	T4	T15	T3,T7	T8,T9	T8,T9	T3,T4,T5,T6,T10	T5	T20	T16	T14	Note 4

Table 2. Destination Behavior Test Coverage

Destination Behavior Test Coverage (Section 5.10.5, Traffic Management Specification Version 4.1, af-tm-0121.000)									
D.1	D.2	D.2.a	D.2.b	D.3.a	D.3.b	D.3.c	D.4	D.5	D.6
T11,T21	T2	T11	T12	T11	T11	T11	T11	T13	Note 5

NOTES:

1) Individual numbered Source and Destination behavior requirements, such as S.x.y.x and D.x.y.z, are each a combination of one or more requirements. The constituent requirements cannot always be tested with the same test case since the IUT may need to be in a different state for each test.
2) Source behavior requirement S.13 and Destination behavior D.6 are not covered by the current version of the test suite.
3) To test a given behavior, it may be necessary to execute more than one test case.
4) S.13 requirement deals with the "use-it-or-lose-it" policy feature which is optional. A test case to cover this requirement was intentionally omitted but may be added after test case T21 when the need is identified.
5) D.6 requirement was intentionally not covered because this requirement is not testable. The tester cannot force the IUT to use CLP=1 or CLP=0. According to D.6, cells sent with CLP=1 may be returned with either CLP=0 or CLP=1. The test suit will only support returning CLP=0 RM cells, but test cases will continue execution if the IUT returns either CLP=0 or CLP=1 cells.

6. Test Case Description

Each test case contains a test purpose and a test body. The test purpose states the intended test objective; the comments include the reference using the notation S.n.x.i or D.n.x.i which refers to the applicable rule number in the Source (S) and Destination (D) Behaviors, in sections 5.10.4 and 5.10.5, respectively, in the Traffic Management specification V4.1 [1] document. The test body specifies the behavior of the IUT and tester and provides the criteria for a "Pass" verdict.

In this section, arrow graphs are provided to show the exchange of messages between the Upper Tester, the IUT, and the Lower Tester.

> NOTE: In case of inconsistencies between the descriptive section and the graphical TTCN, the TTCN shall be used.

When the Upper Tester is required to send data, the action "send *n* data cells" means either 1) the Upper Tester sends *n* ATM cells consecutively at a rate faster than the PCR rate (with no pause between cells), or 2) the Upper Tester sends a Service Data Unit (SDU) to the AAL5 whose length is (48 * n - (length of the AAL5 trailer)) bytes. In the later case, the AAL5 implementation must segment the PDU into ATM cells and forward them to the IUT as in 1).

Unless explicitly stated in the test procedures, the following are the default values for testing:

- When an FRM cell is sent, either from the IUT or from the LowerT, if the content of a field is not explicitly specified, then its value is assumed to be as follows:
  DIR=0, BN=0, CI=0, NI=0, ER=PCR, MCR=MCR Parameter, QL=0, and SN=0.
- When a BRM is sent, either from the IUT or from the LowerT, the contents are to be copied from the corresponding FRM except DIR=1. In addition when the LowerT returns a BRM, then the ER field will be set to ER=PCR.
- For IUT generated BRM cells, for those fields not specified, their values are expected to be the same values as the FRM cells, except MCR=0, DIR=1, and BN=1.

6.1 T1 - Initial FRM Cell

Test Purposes: Verify that after connection setup, when the IUT has data to send, then it sends an FRM cell first. (S.1 and S.2)

Preamble: Setup an ABR service connection from the SUT to the LowerT. (Save the values of MCR, ICR, PCR, and Nrm for the direction from IUT to LowerT.)

Test Procedure:

a) UpperT sends one data cell.
b) LowerT waits for an FRM from the IUT.
Pass if an FRM with CCR ≤ ICR, and CI,DIR,NI=0 is received by LowerT from the IUT.

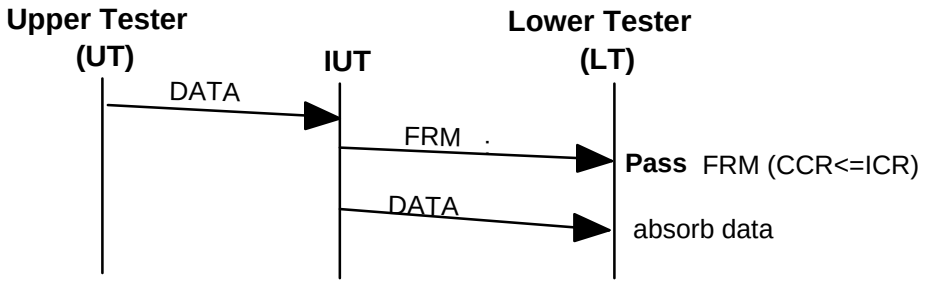


Figure 4. Test Case T1

6.2 T2 - Turning Around an FRM Cell

Test Purposes: Verify that the IUT turns around an FRM from the LowerT with contents unchanged except the DIR (=1) bit. (D.2 and S.3.b.ii)

Preamble: Test case T1. (IUT Status: 1) ACR ≤ ICR; 2) n_cells_needed=Nrm-2; n_cells_sent=1; 3) n_FRM_out=1).

Test Procedure:
a) Send an FRM from the LowerT.
b) LowerT waits for the IUT to turn around the FRM.
Pass the test if a BRM is received from the IUT with expected contents.

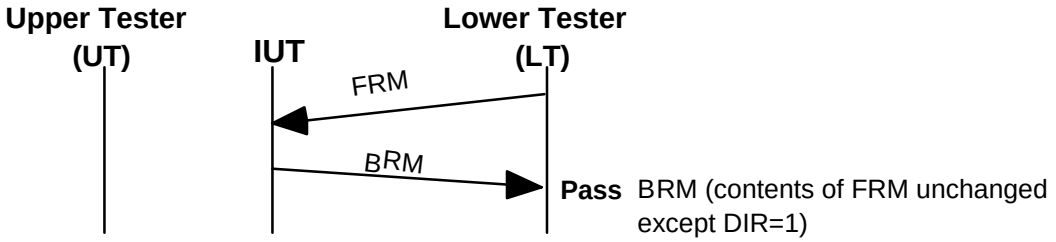


Figure 5. Test Case T2

6.3 T3 - Data Transmission and FRM Cell

Test Purposes: Verify that a) after the IUT receives a BRM with BN=0, it will set its ACR=ACR+RIF*PCR (S.8), and b) after sending Nrm-1 cells, it will send an FRM with CCR ≤ ACR (S.3.a, S.5).

Preamble: Test case T2. (IUT Status: 1) ACR ≤ ICR; 2) n_cells_needed=Nrm-3; n_cells_sent=2; 3) n_FRM_out=1).

Test Procedure:
a) LowerT sends a BRM (with ER=PCR), returning the previous FRM. Set a test variable previous_CCR= CCR in the FRM received in T1.
b) UpperT sends Nrm-2 data cells.
c) The IUT must send Nrm-3 data cells, followed by an FRM, and then one more data cell.
Pass the test if the following condition holds:
previous_CCR < CCR in current FRM ≤ previous_CCR+RIF*PCR

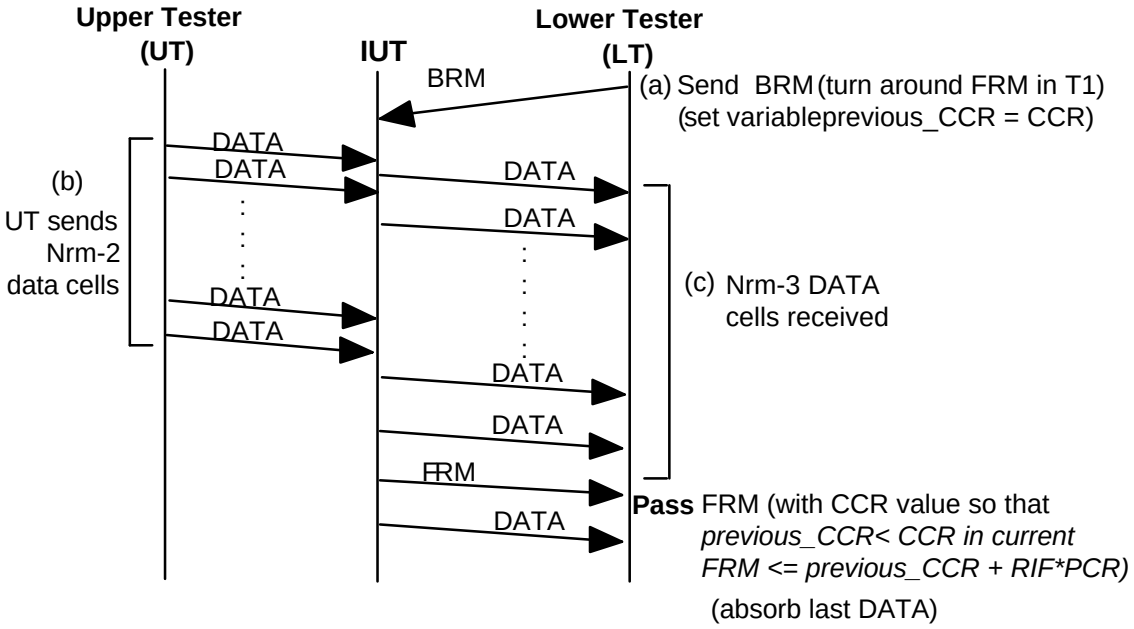


Figure 6. Test Case T3.

6.4 T4 - Additive Increase of ACR to PCR

Test Purpose: Verify that while transmitting data and FRM cells according to (S.3), the IUT will increase the ACR by RIF*PCR up to a value ≤ PCR as each FRM is returned by the LowerT (S.8).

Preamble: Test Case T3. (IUT Status: 1) ACR was increased from ICR by RIF*PCR once; 2) n_cells_needed=Nrm-2; n_cells_sent=1; 3) n_FRM_out=1). previous_CCR contains the CCR value from test case T3.

Test Procedure:

a) LowerT sends a BRM (with ER=PCR), turning around the previous FRM. Set a test variable previous_CCR= CCR in the previous FRM.
b) UpperT sends Nrm-1 data cells.
c) The IUT must send Nrm-2 data cells, followed by an FRM, and then one more data cell. The CCR in the received FRM must satisfy the condition:
   previous_CCR < CCR in current FRM ≤ previous_CCR+RIF*PCR
d) Repeat steps a)-c) until the CCR (in FRM) = PCR or CCR = previous_CCR. Each time set previous_CCR = CCR.

Pass the test if CCR ≤ PCR.

Optional: Measure the interval in step c) between the receipt of the first data cell and the FRM cell. The actual data rate (*Nrm-1)/interval* should approximate the rate in CCR of the previous FRM received.

Note: An IUT may pass this test even if it does not increase ACR near PCR. However, the vendor should check the implementation of the additive increase function.

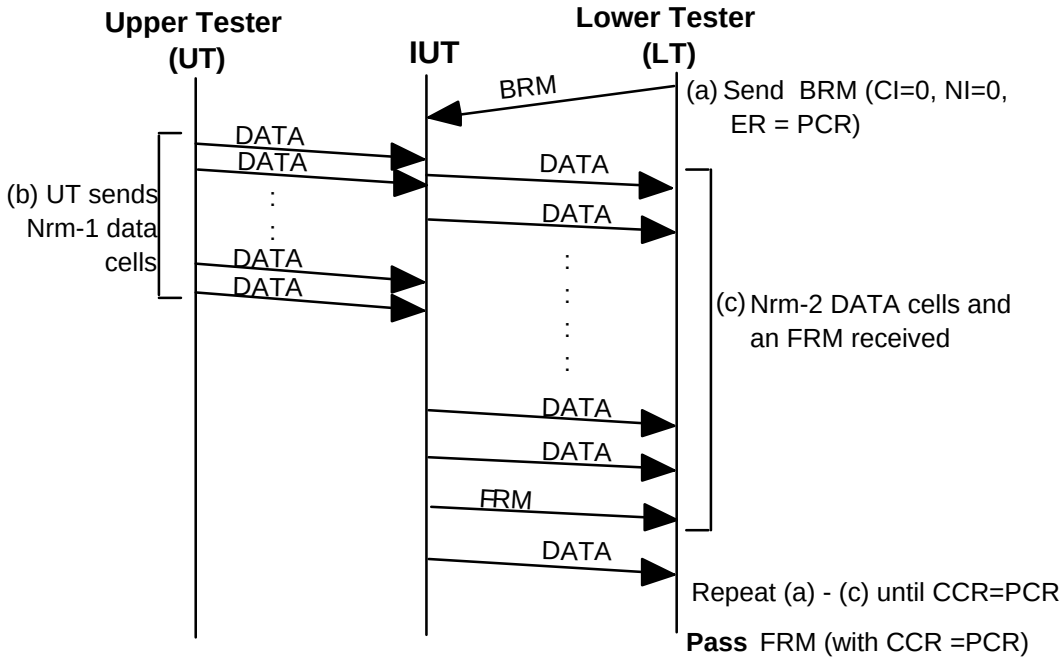


Figure 7. Test Case T4

6.5 T5 - Reducing ACR by ER

Test Purpose: Verify that the IUT, when receiving a BRM with lower rate in the ER field, will reduce its ACR to the value of ER. (S.8 and S.9).

Preamble: Test case T4. (IUT Status: 1) ACR=PCR* ≤ PCR where PCR* is the value saved in previous_CCR from T4; 2) n_cells_needed=Nrm-2; n_cells_sent=1; 3) n_FRM_out=1). Assume PCR*>ICR.

Test Procedure:

a) Send a BRM from the LowerT with CI=0 and NI=1, and ER= (PCR* + ICR)/2.
b) UpperT sends Nrm-1 data cells.
c) The IUT must send Nrm-2 data cells, followed by an FRM, and then one more data cell.
Pass the test if the CCR in FRM is set to the value of (PCR* +ICR)/2.

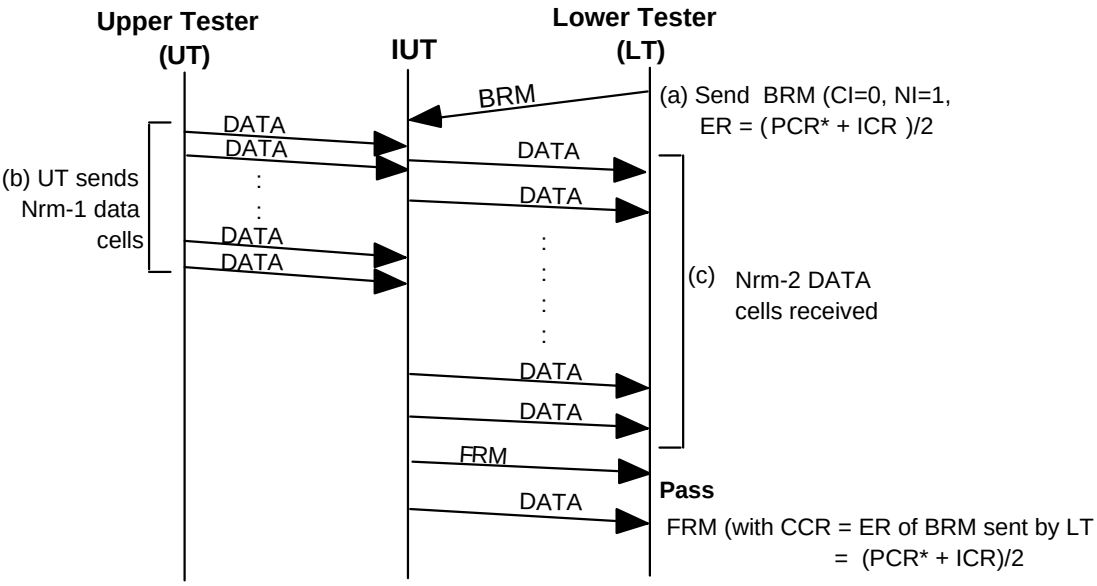


Figure 8. Test Case T5.

6.6 T6 - Destination Forced No ACR Increase

Test Purpose: Verify that the IUT will maintain its current ACR when receiving a BRM with NI=1. (S.8)

Preamble: Test case T5. (IUT Status: 1) ACR=(PCR* + ICR/2) where PCR* is the highest value of ACR reached in T4; 2) n_cells_sent=1, n_cells_needed-Nrm-2; 3) n_FRM_out=1).

Test Procedure:

a) LowerT sends a BRM from the LowerT with NI=1 and ER=PCR,CI=0.
b) UpperT sends Nrm-1 data cells.
c) LowerT waits for Nrm-2 data cells and an FRM with CCR=(PCR* + ICR/2) sent by the IUT.
Pass the test if an FRM with no increase in the ACR.

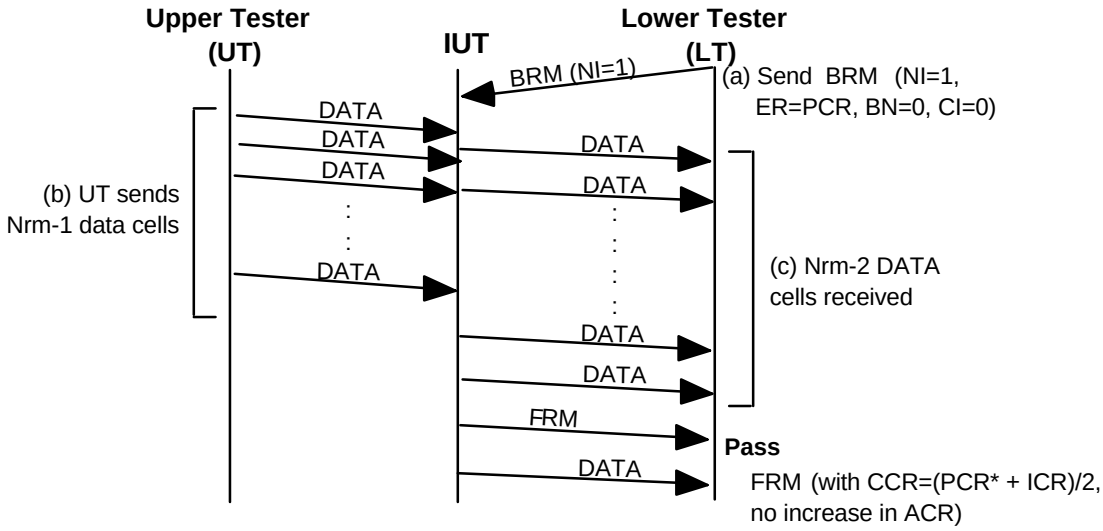


Figure 9. Test Case T6.

6.7 T7 - Reducing ACR to ICR

Test Purpose: Verify that the IUT will reduce ACR=ICR and send an FRM with CCR=ICR when it does not receive a BRM within time interval ADTF and Trm respectively, and when ACR>ICR and number of outstanding FRM<CRM. (S.3.a.i and S.5).

Preamble: Test case T6. (IUT Status: 1) ACR = (PCR*+ICR)/2 where PCR* is the highest ACR value reached in T4; 2) n_cells_needed=Nrm-2; n_cells_sent=1; 3) n_FRM_out=1).

Test Procedure:
a) At the LowerT start timer T after resetting it to 0.
b) Wait ADTF time.
c) UpperT send Mrm-1 data cells.
d) LowerT wait for data cells and FRM from the IUT.
Pass the test if the FRM with CCR=ICR.

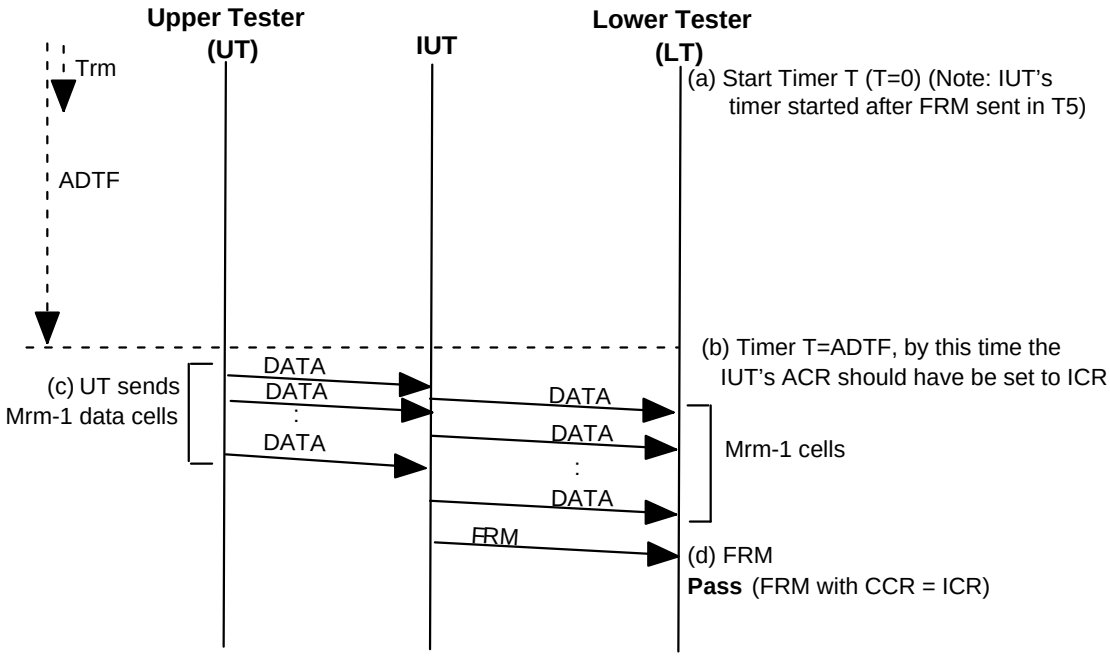


Figure 10. Test Case T7

6.8 T8 - Maintaining Data Rate with No Change in ACR

Test Purpose: Verify that the IUT will keep ACR at ICR if no more than CRM-1 FRM cells are sent by the IUT since the last BRM was received. (S.3.a.i, S.6, and S.7).

Preamble: Test case T7. (IUT Status: 1) ACR=ICR; 2) n_cells_sent=0; 3) n_FRM_out=2).

Test Procedure:
a) LowerT Sends a BRM (BN=0, CI=0, NI=1, ER=PCR) to turn around outstanding FRM cells and clear the CRM count in the IUT.

b) UpperT sends Mrm data cells.
c) LowerT waits for data cells and an FRM cell from the IUT. (The IUT shall send an FRM cell after waiting for Trm).
d) Repeat steps b) and c) CRM-1 times.
Pass the test if all FRM cells are received with CCR of all FRM cells remaining at ICR.

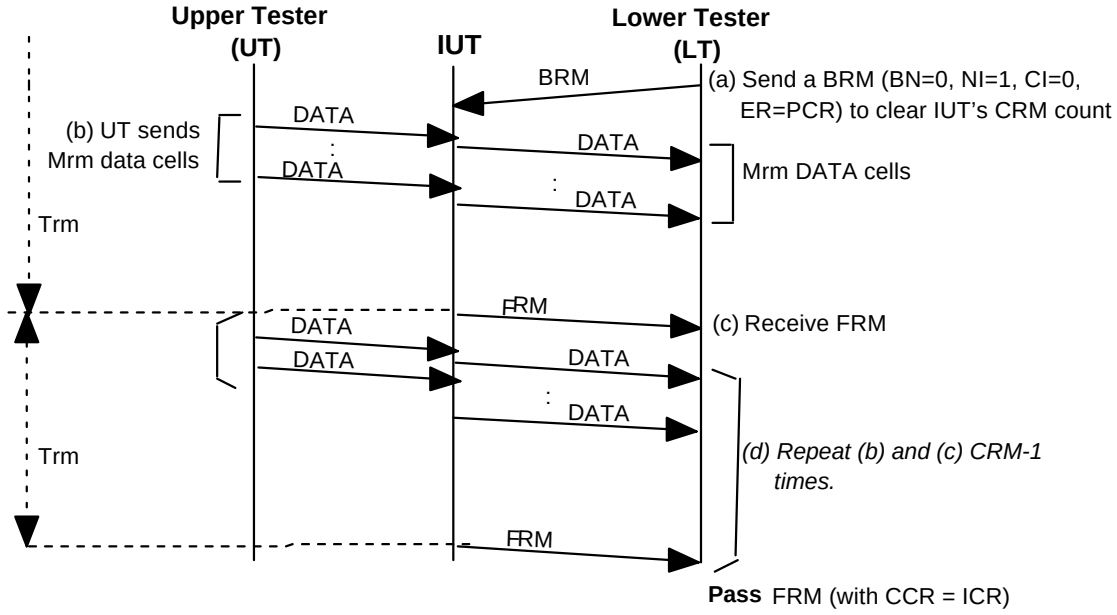


Figure 11. Test Case T8

6.9 T9 - Multiplicative Decrease of ACR to MCR

Test Purpose: Verify that the IUT will reduce its ACR by ACR*CDF, but not lower than MCR when number of outstanding FRM cells > CRM. (S.6, S.3.a, S.7).

Preamble: Test case T8. (IUT Status: 1) ACR=ICR; 2) n_cells_sent=0; 3) n_FRM_out=CRM).

Test Procedure:
a) Set previous_CCR=ICR.
b) Have the UpperT send Mrm data cells to the IUT.
c) LowerT waits for an FRM from the IUT.
The value of CCR in the received FRM must satisfy the following condition:
MCR ≤ CCR ≤ previous_CCR* (1-RDF).
d) Let previous_CCR = CCR. Repeat steps b - c until CCR=MCR twice consecutively.
Pass the test case if all conditions in steps b - d are satisfied.

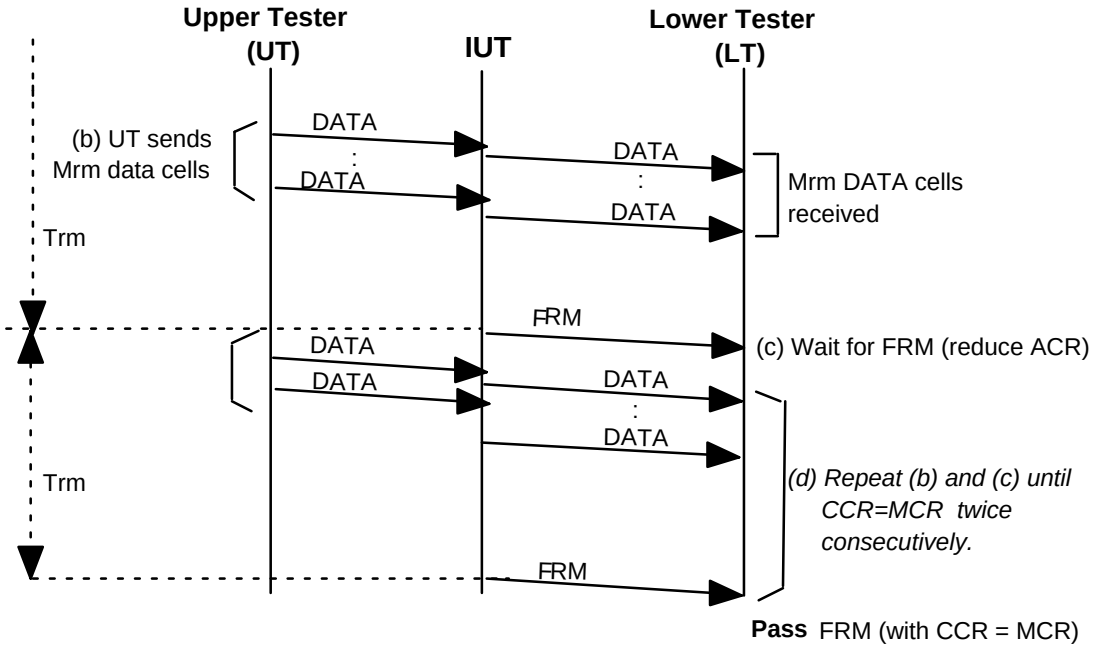


Figure 12. Test Case T9.

6.10 T10 - Congestion Indication in BRM

Test Purpose: Verify that the IUT will reduce the ACR when receiving a BRM with CI=1. (S.8).

Preamble: Test case T9. Repeat the following steps *n* times to bring up the ACR from MCR,

where $n = \left\lceil \frac{MCR * RDF}{RIF * PCR * (1 - RDF)} \right\rceil + 1$

a) LowerT sends a BRM with CI=0
b) UpperT sends Nrm-1 data cells
c) LowerT waits for data and FRM cells from the IUT.

(IUT Status: 1) ACR=MCR/(1-RDF); 2) n_cells_sent=0; 3) n_FRM_out>CRM).

Test Procedure:

a) LowerT sends a BRM with CI=1, ER=PCR, and NI=0. Save the value of CCR in the last FRM in previous_CCR.
b) UpperT sends Nrm-1 data cells.
c) LowerT waits for an FRM from the IUT.
d) The value of CCR in the received FRM must satisfy the following condition:
e) MCR ≤ CCR ≤ previous_CCR* (1-RDF).
f) Repeat steps a) and c) until an FRM is received with CCR=MCR
g) Repeat steps a) and c) one more time.

Pass the test if 1) the decrease in ACR satisfies the condition in step c) and 2) CCR=MCR in the last received FRM cell.

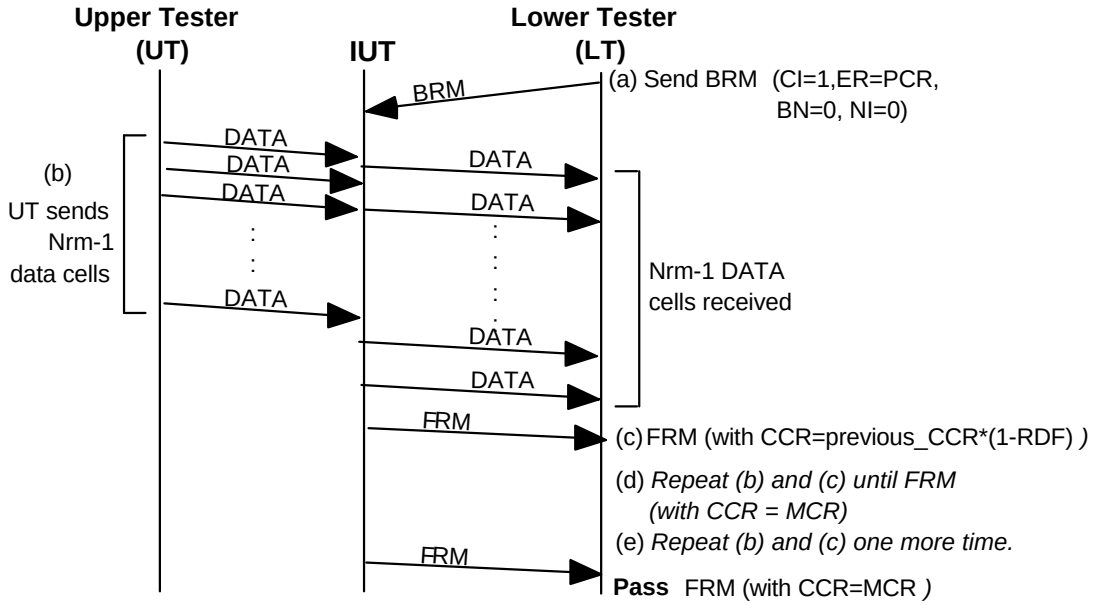


Figure 12. Test Case T10.

6.11 T11 -Turning Around FRM Cells with Varying EFCI values

Test Purpose: Verify that (1) when receiving a sequence of data with EFCI=1, the IUT will turning around an FRM cell with CI=1 (D.1 and D.2.a); and (2) when there are multiple BRM cells to be sent, either all but one are to be dropped or all of their contents be updated. (D.3 and D.4). Note: This test case may not be realizable if the IUT's value of Trm is such that Trm/MCR $\leq$ 7.

Preamble: Test case T10. (IUT Status: 1) ACR=MCR; 2) n_cells_sent=0; 3) n_FRM_out>1).

Test Procedure:

a) LowerT sends 1 data cell with EFCI=1 and send an FRM cell from the LowerT.
b) LowerT waits for a BRM (with CI=1) from the IUT.
c) LowerT starts test timer Twait (Twait = min $\left\{Trm, \frac{Nrm-1}{MCR}\right\} + \frac{1}{MCR}$).
d) UpperT send *n* data cells (where *n = max {0, max { min{ Trm * PCR, Nrm-2}, Mrm} - 7}).* The value of *n* is computed to provide sufficient DATA cells to fill the IUT's data buffer without triggering FRMs and without expiry of timer.
e) As soon as UpperT starts sending data in step d), LowerT sends 1 data cell with EFCI=1 and an FRM cell.
f) LowerT sends 1 data cell with EFCI=0 and an FRM cell.
g) UpperT sends (Nrm-1)-*n* data cells while absorbing two data cells forwarded by the IUT.
h) LowerT waits for an FRM and absorbs data cells from the IUT.
i) LowerT waits for 1 or 2 BRMs (CI=0).

Pass if 1 or 2 BRMs (with CI=0) are received before Twait expires.

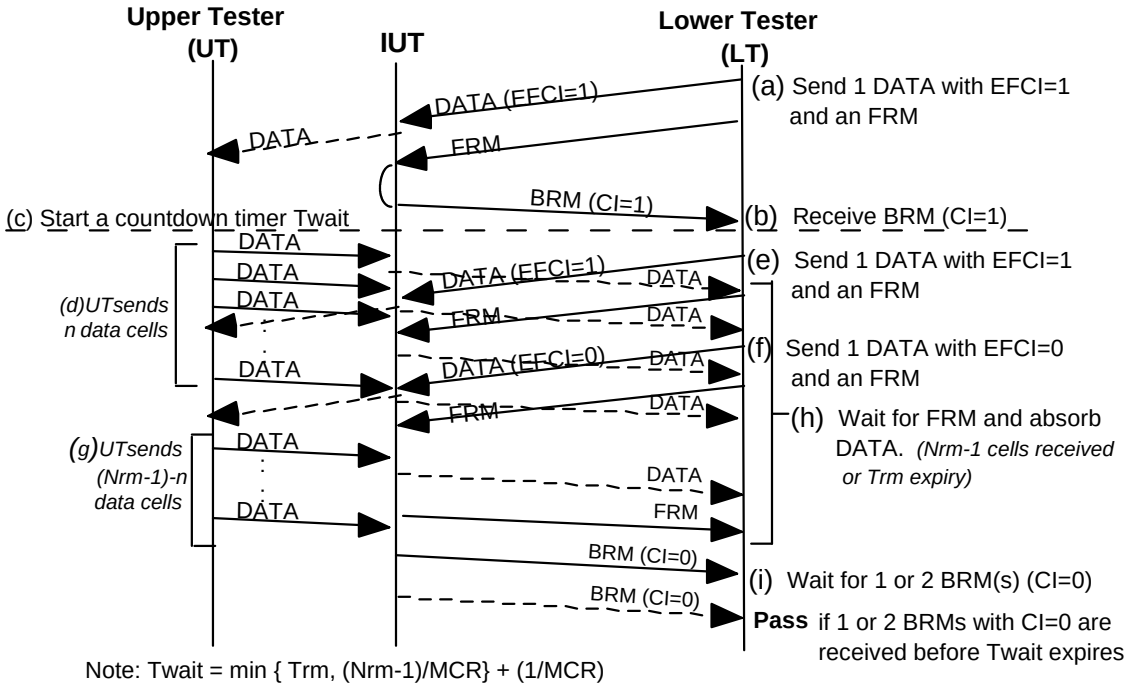


Figure 13. Test Case T11.

6.12 T12 - Internal and External Congestion

Test Purpose: Verify that when the IUT is in internal congestion condition, it turns around a BRM cell with BN=0. In addition, it may generate a BRM with BN=1. In both cases, contents of the fields of both BRMs will be set by CI=1 and/or ER is reduced. (D.2.b)

Preamble: Test case T11. (IUT Status: 1) ACR=MCR); 2) n_cells_sent=0; 3) n_FRM_out=1).

Test Procedure:

a) Disable the UpperT from processing/accepting data from the IUT.
b) LowerT sends 1,023 data cells with EFCI=1 at the link capacity (1,023 cells represents 2.82 milliseconds of data at OC-3 rate).
c) LowerT sends an FRM cell.
d) LowerT looks for a BRM cell (with CI=1) from the IUT.
e) Repeat steps b)-d) until the last BRM cell received satisfies one of the conditions in the test purpose above for CI and ER fields.
   Pass the test if all steps are executed successfully - that is, a BRM is received with CI=1 and/or ER reduced.

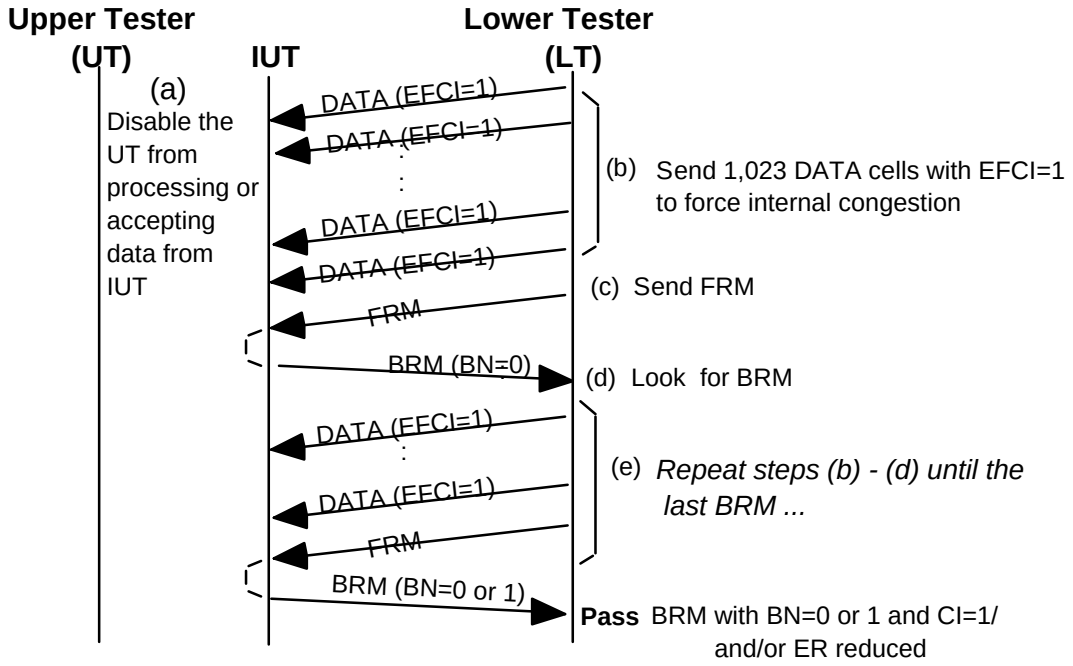


Figure 14. Test Case T12.

6.13 T13 - Internal and External Congestion - Destination Generated BRM

Test Purpose: Verify that the IUT may generate a BRM on its own when internally congested. (D.5).

Preamble: Test case T12. (IUT Status: 1) ACR=MCR; 2) n_cells_sent=0; 3) n_FRM_out=CRM). This test case can only be executed if the IUT is capable of generating unsolicited BRM cell.

Test Procedure:

a) Disable the UpperT from processing or accepting data from IUT (to cause internal congestion).
b) LowerT sends 1,023 data cells with EFCI=1 at link capacity.
c) Repeat step b) until a BRM with BN=1, and either CI=1, CI=0/NI=1, or ER reduced is received.

Pass the test if a BRM with expected contents is received.

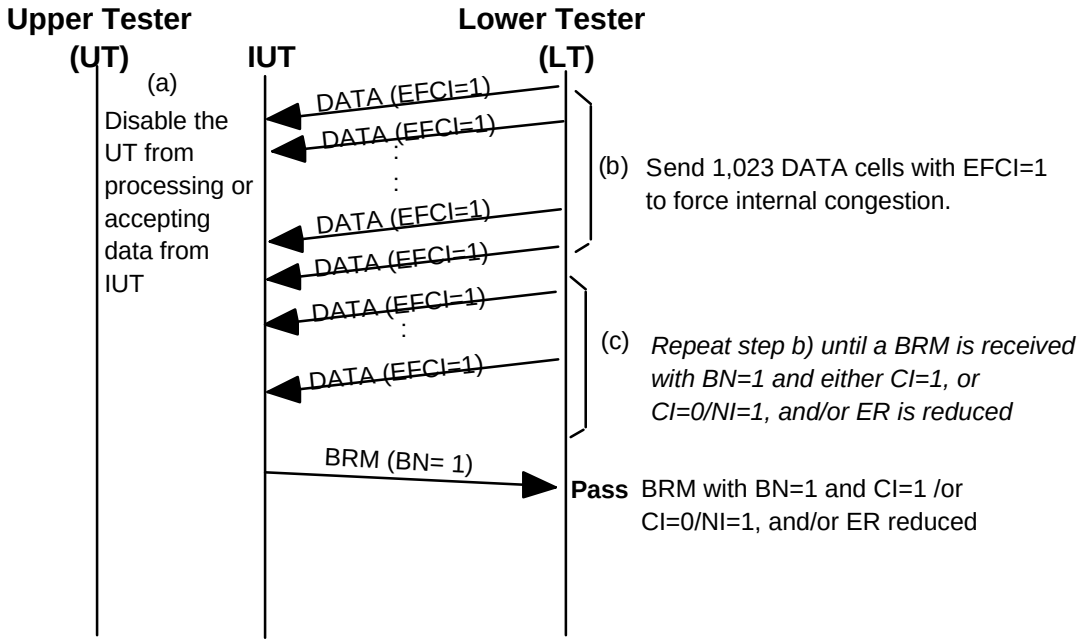


Figure 15. Test Case T13.

6.14 T14 - Source Rests EFCI Bit

Test Purposes: Verify that the source resets EFCI on every data cell it sends (S.12)

Preamble: Test Case 14. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:

a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) UpperT sends Nrm-1 (user) data cells with PTI set to '010' to the IUT.
c) LowerT receives the data cells from the IUT and checks the PTI bits.
Pass the test if all Nrm-1 data cells have PTI bits set to '000'.

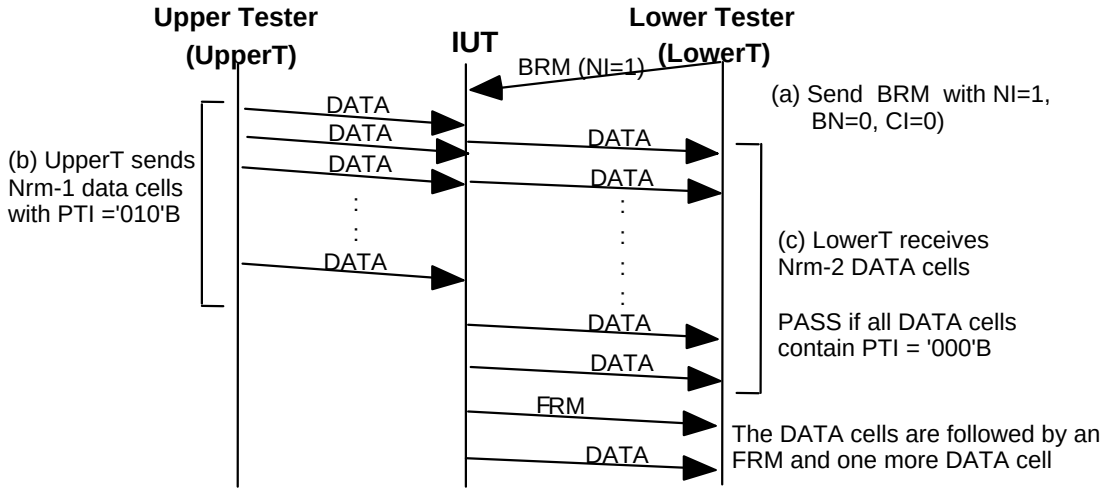


Figure 16. Test Case T14

6.15 T15 - Source Sets CLP=0

Test Purposes: Verify that the source sets CLP=0 on every data cell it sends (S.4)

Preamble: Test Case 15. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:
a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) UpperT sends Nrm-1 (user) data cells with CLP set to '1' to the IUT.
c) LowerT receives the data cells from the IUT and checks the CLP bit.
Pass the test if all Nrm-1 data cells have the PTI bit set to '0'.

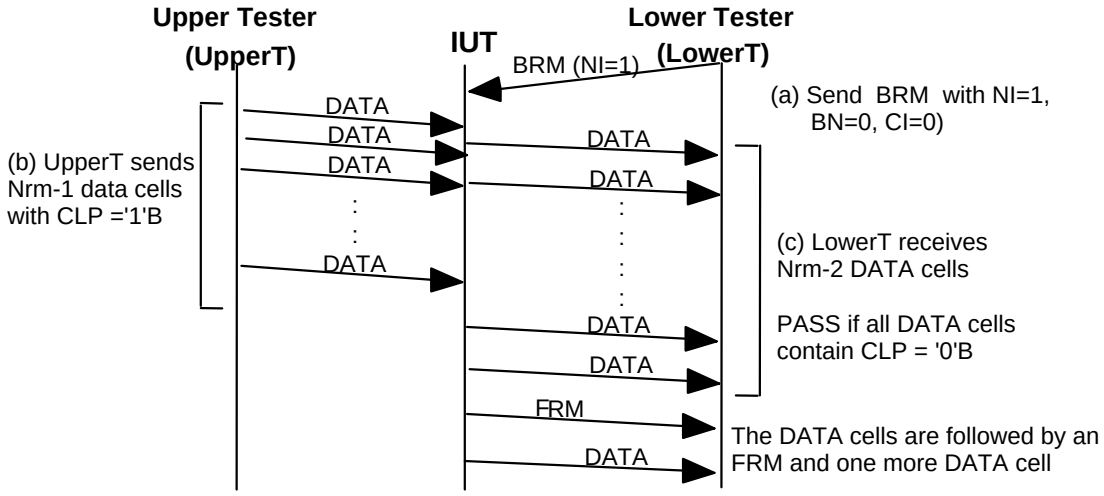


Figure 17. Test Case T15

6.16 T16 - Limit on out-of-rate Cell Rate

Test Purposes: Verify that the source does not send out-of-rate forward RM cells at a rate greater than TCR=10 cells/sec (S.11).

> **Note:** TCR is a constant fixed at 10 cells/sec (see af-tm-0121.000, Traffic Management Specification Version 4.1).

Preamble: Test Case 16. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:
a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) UpperT sends 100 times Nrm (user) data cells to the IUT.
c) LowerT receives the data cells from the IUT and checks for out-of-rate RM cells.
Pass if after 10 seconds, fewer than 10 out-of-rate RM cells are received in the data stream.

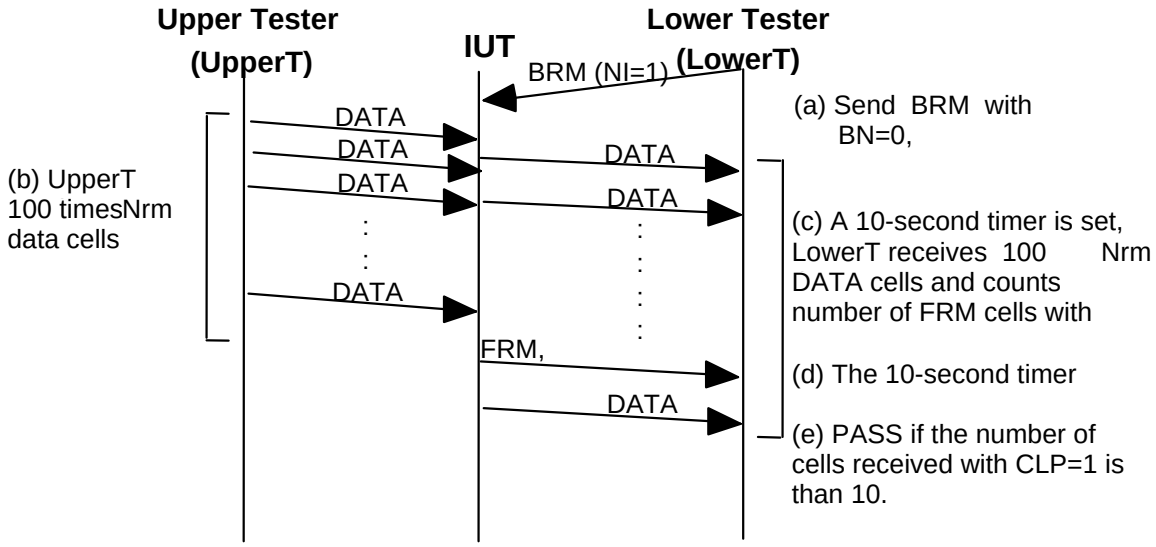


Figure 18. Test Case T16

6.17 T17 - In-rate FRM cell rate

Test Purposes: Verify that the source sends at least one in-rate forward RM cell in every Nrm consecutive in-rate cells sent (S.3.a.ii).

Preamble: Test Case 17. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:

a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) UpperT sends Nrm-1 (user) data cells to the IUT.
c) LowerT receives data cells from the IUT, counts in-rate RM cells, ignores out-of-rate RM cells.
d) Pass the test if one in-rate RM cell is received in the data stream.

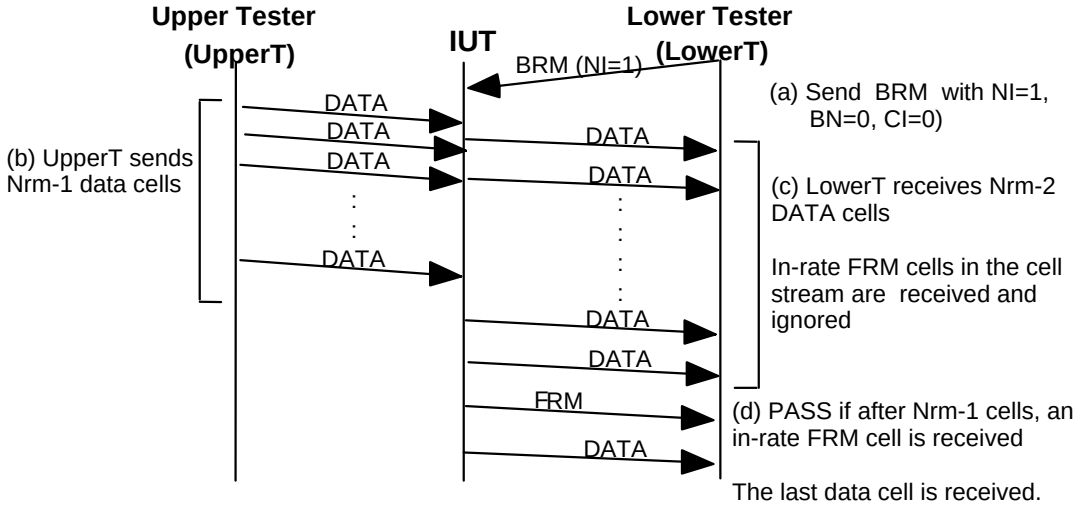


Figure 19. Test Case T17

6.18 T18 - FRM cell spacing

Test Purposes: Verify that the source sends an in-rate forward RM cell if, since the last in-rate forward RM cell, at least Mrm = 2 in-rate cells have been sent and at least Trm time has elapsed (S.3.a.i).

> **Note:** Mrm is a constant fixed at 2 (see af-tm-0121.000, Traffic Management Specification Version 4.1).

Preamble: Test Case 18. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:
a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) UpperT sends 10 times Nrm (user) data cells to the IUT.
c) LowerT receives the data cells from the IUT and counts in-rate RM cells in the cell stream but ignores out-of-rate RM cells.
d) Pass if, an in-rate RM cell is received after at least Mrm (2) in-rate RM cells were received since the last in-rate RM cell and Trm time has elapsed.

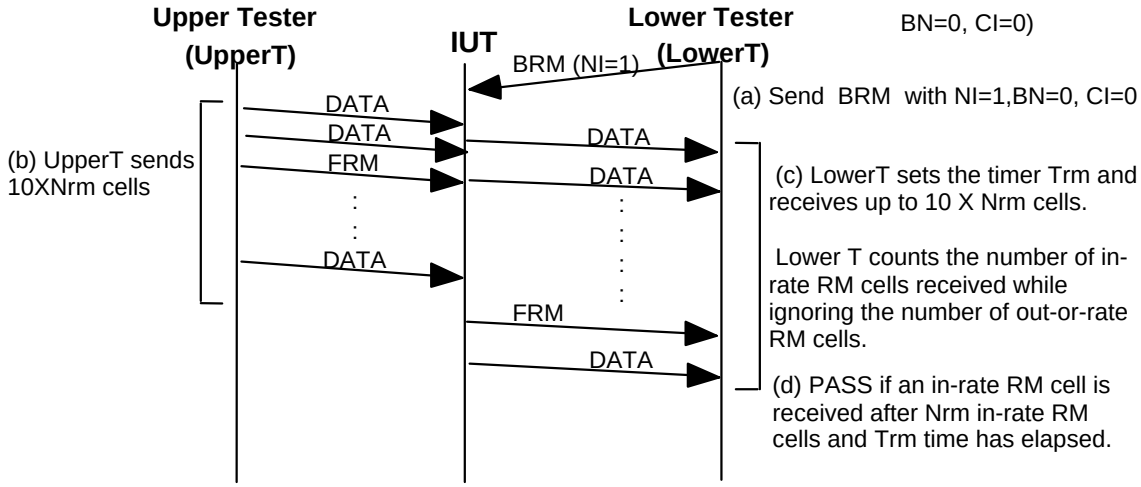


Figure 20. Test Case T18

6.19 T19 - The First BRM Since the Last FRM

Test Purposes: Verify that the first in-rate backward RM cell since the last in-rate forward RM cell is sent ahead of any data cells waiting for transmission (S.3.b).

Preamble: Test Case 19. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:
a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) UpperT sends Nrm data cells to the IUT.
c) LowerT receives the data cells and ignores out-of-rate RM cells.
d) LowerT receives the first FRM cell
e) UpperT continues to send data

f) LowerT receives at least Mrm data cells
g) Pass the test if one in-rate RM cell is received with data waiting for transmission.

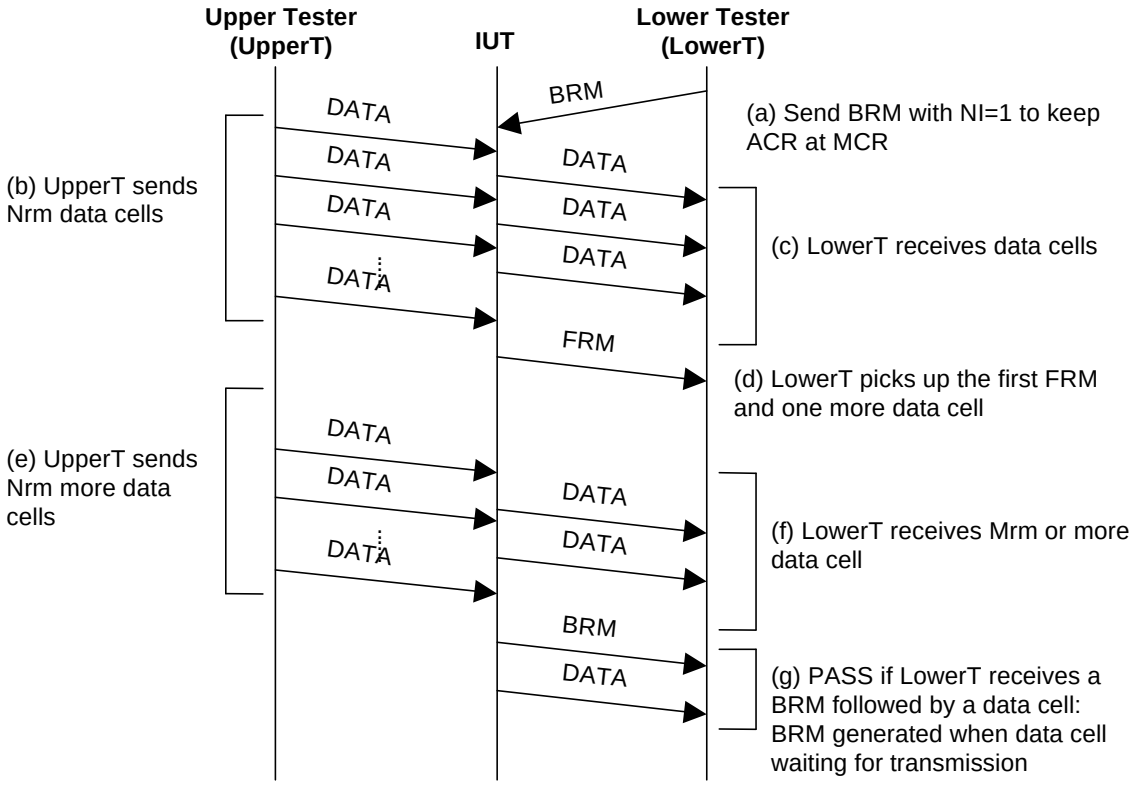


Figure 21. Test Case T19

6.20 T20 - RM Cell Format

Test Purposes: Verify RM cell format (S.10).

Preamble: Test Case 20. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:
a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) IUT returns an FRM;
c) LowerT receives an FRM and analyzes its format.

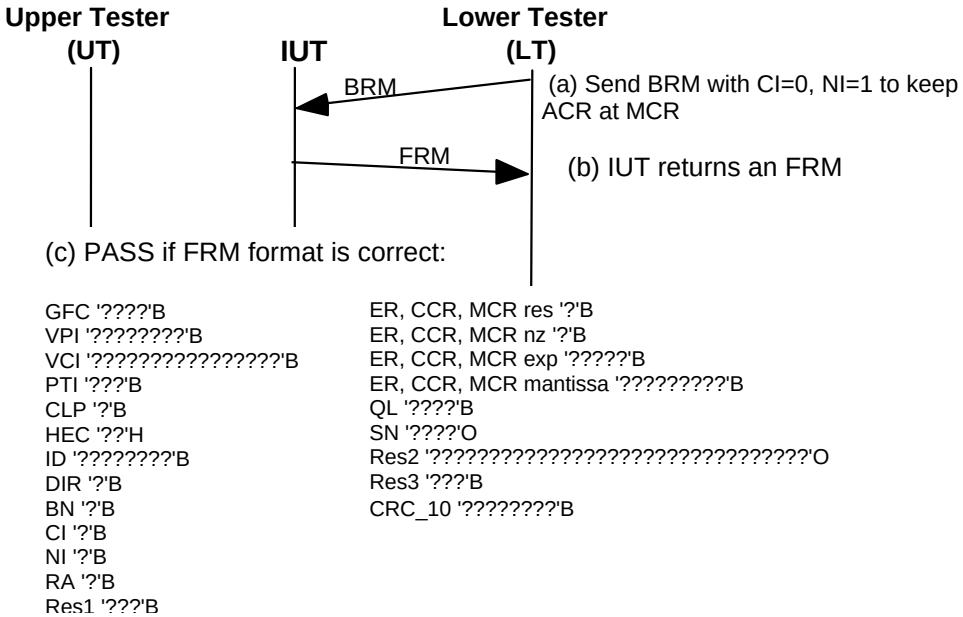


Figure 22. Test Case T20

6.21 T21 - Source Resets EFCI Bit

Test Purposes: Verify that when a destination receives a data cell, the EFCI of the data cell is saved as the EFCI state of the connection (D.1).

Preamble: Test Case 21. IUT Status: 1) ACR=MCR; 2) Ready to receive user data.

Test Procedure:
a) LowerT sends a BRM with NI=1 to the IUT to keep ACR at MCR;
b) LowerT sends a data cell with EFCI =1 to the destination;
c) LowerT receives a BRM
d) Pass if: (BN=1 and CI=1) or (BN=1 and CI=0 and NI=1) or (ER < previous ER)

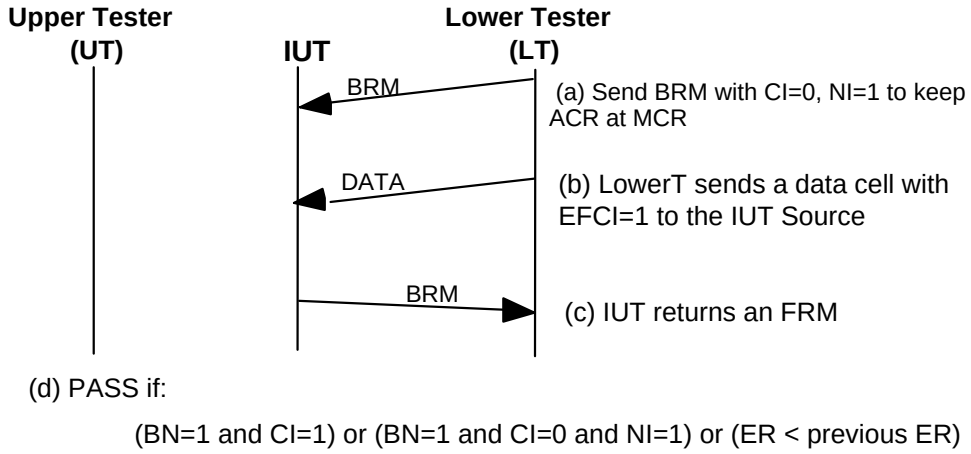


Figure 23. Test Case T21

7. Protocol Implementation eXtra Information for Testing (PIXIT) Proforma for the ABR ATS

IUT

Name:

Version:

Machine Configuration:

Operating System Identification:

IUT Identification:

PICS Reference for IUT:

Limitations of the IUT :

---

8. PIXIT Questions

Timers (TM)

Item #	Question	Value	Unit	Defaults
TM.1	What is the maximum time for the Lower Tester to wait for a message, either an ATM or RM cell, from the IUT? [Tw_val]		seconds	5
TM.2	Enter the IUT's ADTF timer value. [ADTF_val]		milliseconds	500
TM.3	Enter the IUT's Trm timer value. [Trm_val]		milliseconds	100

ABR Parameters (P)

Item #	Question	Value	Unit	Range
P.1	Enter the IUT's Peak Cell Rate (PCR). [PCR_val]		cells/second	Note 1
P.2	Enter the IUT's Minimum Cell Rate (MCR). [MCR_val]		cells/second	Note 1
P.3	Enter the IUT's Initial Cell Rate (ICR). [ICR_val]		cells/second	Note 1
P.4	Enter the IUT's maximum number of cells a source may send for each forward RM-cell (Nrm). [Nrm]		cells	2 to 256 (Default = 32)
P.5	Enter the IUT's missing RM-cell count (CRM). [CRM_val]		cells	implementation specific, normally = ceiling {TBE/Nrm}
P.6	The IUT's Rate Increase Factor (RIF) in terms of *negative power of 2*, or 2**(-n); enter the number n.(Note 2) [RIF_power]			power of 2 in the range 1/32768 to 1, but enter the "n" value here (Default is 0)
P.7	The IUT's Rate Decrease Factor (RDF) in terms of *negative power of 2*, or 2**(-n); enter the number n.(Note 2) [RDF_power]			power of 2 in the range 1/32768 to 1, but enter the "n" value here (Default is 15)
P.8	The IUT's Cutoff Decrease Factor (CDF) in terms of *negative power of 2*, or 2**(-n); enter the number n. (Note 2) [CDF_power]			CDF is 0, or a power of 2 in the range 1/64 to 1, but enter the "n" value here (Default is 4)

Note 1: Rates are signaled as 24 bit integers which have a minimum value of zero, and a maximum value of 16,777,215. However, RM-cells use a 16-bit floating point format which has a maximum value of 4,290,772,992.

Note 2: For example, enter 4 for RIF=1/16 = 1/(2**4) = 2**(-4)

Implementation Specific (I)

Item #	Question		Value
I.1	Can the IUT be forced into an internal congestion condition?	(Yes, No)	
I.2	Enter the IUT's VPI value for testing.	[VPI_val]	
I.3	Enter the IUT's VCI value for testing.	[VCI_val]	

9. References

[1] ATM Forum Traffic Management Specification Version 4.1, af-tm-0121.000 (1999).

[2] ISO/IEC 9646-1: 1994, Information technology - Open Systems interconnection - Conformance testing methodology and framework - Part 1: General concepts (see also ITU-T Recommendation X.290 (1995)).

[3] ISO/IEC 9646-3: 1998, Information technology - Open Systems interconnection - Conformance testing methodology and framework - Part 3: Tree and Tabular Combined Notation (TTCN) (see also ITU-T Recommendation X.292 (1998)).

10. The ABR Abstract Test Suite

The remaining pages specify the ABR Conformance ATS in the TTCN graphical form (TTCN.GR). The graphical form is used to facilitate human readability. Specification in machine processable TTCN.MP is given in a separate document. Specifications in either form have the necessary formal syntax to convert from one form to the other and to derive the corresponding executable test suite using a TTCN compiler.

The four parts of the ABR ATS in the TTCN.GR form follow.

Test Suite Structure

Suite Name	:	ABR
Standards Ref	:	ATM Forum Traffic Management (TM) Specification V4.0, Section 5.10 on ABR
PICS Ref	:	
PIXIT Ref	:	ATM Forum 99-0105R1 Section 6
Test Method(s)	:	Distributed
Comments	:	Test Method includes Upper Tester (UT), Lower Tester (LT), and Coordination Control (CON).

Test Case Index

Test Group Reference	Test Case Id	Selection Ref	Description	Page Nr
	T1		Verify that after connection setup, when the IUT has data to send, then it sends an FRM cell first.	
	T2		Verify that the IUT turns around an FRM from the LT with contents unchanged except the DIR (=1) bit.	
	T3		Verify that a) after the IUT receives a BRM with BN=0, it will set its ACR=ACR+RIF*PCR (S.8), and b) after sending Nrm-1 cells, it will send an FRM with CCR<=ACR.	
	T4		Verify that while transmitting data and FRM cells according to (S.3), the IUT will increase the ACR by RIF*PCR up to a value <= PCR as each FRM is returned by the LT (S.8)	
	T5		Verify that the IUT, when receiving a BRM with lower rate in the ER field, will reduce its ACR to the value of ER.	
	T6		Verify that the IUT will maintain its current ACR when receiving a BRM with NI=1.	
	T7		Verify that the IUT will reduce ACR=ICR and send an FRM with CCR=ICR when it does not receive a BRM within time interal ADT and Trm respectively, and when ACR>ICR and number of outstanding FRM<CRM.	
	T8		Verify that the IUT will keep ACR at ICR if no more than CRM-1 FRM cells are sent by the IUT since the last BRM was received.	
	T9		Verify that the IUT will reduce its ACR by ACR*CDF, but not lower than MCR when number of outstanding FRM cells>CRM.	
	T10		Verify that the IUT will reduce the ACR when receiving a BRM with CI=1.	
	T11		Verify that (1) when receiving a sequence of data with EFCI=1, the IUT will turn around an FRM cell with CI=1 (D.1 and D.2.a); and (2) when there are multiple BRM cells to be sent, either all but one are to be dropped or all of their contents be updated. (D.3 and D.4).	

Continued on next page

Continued from previous page

Test Case Index

Test Group Reference	Test Case Id	Selection Ref	Description	Page Nr
	T12	Internal_Congestion	Verify that when the IUT is in internal congestion condition, it turns around a BRM cell with BN=0. In addition, it may generate a BRM with BN=1. In both cases, contents of the fields of both BRMs will be set by CI=1 and/or ER is reduced.	
	T13	Internal_Congestion	Verify that the IUT may generate a BRM on its own when internally congested.	
	T14			
	T15			
	T16			
	T17			
	T18			
	T19			
	T20			
	T21			

Test Step Index

Test Step Group Reference	Test Step Id	Description	Page Nr
	Absorb_Data		
	Receive_Data		
	Receive_Data_FRM		
	T1_preamble		
	UNEXPECTED		
	UT_Send		
	UT_Send_Receive		

Simple Type Definitions			
Type Name	**Type Definition**	**Type Encoding**	**Comments**
HEXSTR1	HEXSTRING[1]		
INTEGER_LEN	INTEGER(0..255)		

ASN.1 Type Definition

Type Name : Header_ie

Encoding Variation :

Comments : Cell Header

Type Definition

```
SEQUENCE
 {
    GFC  BIT STRING(SIZE(4)),
    VPI   BIT STRING(SIZE(8)),
    VCI   BIT STRING(SIZE(16)),
    PTI    BIT STRING(SIZE(3)),
    CLP  BIT STRING(SIZE(1)),
    HEC  OCTET STRING(SIZE(1))
 }
```

ASN.1 Type Definition

Type Name : Rate_ie

Encoding Variation :

Comments : Exponsential form of rate information in RM cells

Type Definition

```
SEQUENCE
 {
    res  BIT STRING(SIZE(1)),
    nz   BIT STRING(SIZE(1)),
    exp BIT STRING(SIZE(5)),
    mantissa  BIT STRING(SIZE(9))
 }
```

Detailed Comments : See section 5.10.3.2 for interpretation of these fields.

ASN.1 Type Definition

Type Name : RMBody

Encoding Variation :

Comments :

Type Definition

```
SEQUENCE
                        {
                              ID       BIT STRING(SIZE(8)),           -- octet 6
                              DIR     BIT STRING(SIZE(1)),           -- octet 7
                              BN      BIT STRING(SIZE(1)),           -- octet 7
                              CI       BIT STRING(SIZE(1)),           -- octet 7
                              NI       BIT STRING(SIZE(1)),           -- octet 7
                              RA      BIT STRING(SIZE(1)),           -- octet 7
                              Res1   BIT STRING(SIZE(1)),           -- octet 7
                              ER      Rate_ie,                                -- octets 8&9
                              CCR   Rate_ie,                                -- octets 10&11
                              MCR   Rate_ie,                                -- octets 12&13
                              QL      OCTET STRING(SIZE(4)),      -- octets 14-17
                              SN      OCTET STRING(SIZE(4)),     -- octets 18-21
                              Res2   OCTET STRING(SIZE(30)),   -- octets 22-51
                              Res3   BIT STRING(SIZE(3))            --  octet 52
                         }
```

ASN.1 Type Definition

Type Name	:	OCTETSTR1
Encoding Variation	:	
Comments	:	

Type Definition

```
OCTET STRING(SIZE(1))
```

ASN.1 Type Definition

Type Name	:	OCTETSTRLen
Encoding Variation	:	
Comments	:	

Type Definition

```
OCTET STRING(SIZE(Len))
```

ASN.1 Type Definition

Type Name	:	BITSTR16
Encoding Variation	:	
Comments	:	

Type Definition

```
BIT STRING(SIZE(16))
```

ASN.1 Type Definition

Type Name	:	BITSTR8
Encoding Variation	:	
Comments	:	

Type Definition

```
BIT STRING(SIZE(8))
```

ASN.1 Type Definition

Type Name	:	BITSTR1
Encoding Variation	:	
Comments	:	

Type Definition

```
BIT STRING(SIZE(1))
```

ASN.1 Type Definition

Type Name	:	OCTETSTR48
Encoding Variation	:	
Comments	:	

Type Definition

```
OCTET STRING(SIZE(48))
```

ASN.1 Type Definition

Type Name	:	OCTETSTR_UT_Datalen
Encoding Variation	:	
Comments	:	

Type Definition

```
OCTET STRING(SIZE(UT_Datalen))
```

Test Suite Operation Procedural Definition

Operation Name	:	`Additive_inc(CCR:INTEGER)`
Result Type	:	`INTEGER`
Comments	:	

Description

```
Compute the expected new value of CCR using this formula:
     CCR  + (PCR_val*RIF) where RIF=(1/2**RIF_power) and CCR is the current rate
```

Detailed Comments : `This formula is used for additive increase of ACR.`

Test Suite Operation Procedural Definition

Operation Name	:	Cutoff_dec(CCR:INTEGER)
Result Type	:	INTEGER
Comments	:	

Description

```
Compute the expected value of CCR using this formula:
     CCR  * (1-CDF)
        where CDF = 1/(2**CDF_power) and CCR is the current rate
```

Detailed Comments : This formula is used for cutoff decrease of ACR when BRM is missing.

Test Suite Operation Procedural Definition

Operation Name : Eval_exp1

Result Type : INTEGER

Comments :

Description

Evaluate the following expression with sufficient precision, e.g., using floating point computation, and returning an integer result:

```
ceil (MCR_val*RDF) / (RIF*PCR_val*(1-RDF)))+1

where RDF - (1/2**RDF_power),
          RIF = (1/2**RIF_power), and
          ceil =(x)= the smallest integer greater than or equal to x
```

Detailed Comments : Used in test case T10 to bring up the ACR from MCR

Test Suite Operation Procedural Definition

Operation Name	:	Eval_exp2
Result Type	:	INTEGER
Comments	:	The result is a timer value in milliseconds.

Description

Evaluate the following expression in floating point computation:

min(Trm_val, ((Nrm-1) / MCR_val * 1000) + 1000/MCR_val

Detailed Comments : Used in test case T11

Test Suite Operation Procedural Definition

Operation Name	:	Eval_exp3
Result Type	:	INTEGER
Comments	:	Compute the number of data cells needed to fill IUT's buffer

Description

Evaluate the following expression:

max (0, max(min(Trm_val*PCR_val, Nrm-2), Mrm) - 7)

Detailed Comments : Used in test case T11

Test Suite Operation Procedural Definition

Operation Name	:	exp_to_int(RATE:Rate_ie)
Result Type	:	INTEGER
Comments	:	Convert from floating point format into integer.

Description

Convert the rate information, RATE, in floating point form (per section 5.10.3.2 of the TM Specification) for RM cells, into an integer using truncation.

Test Suite Operation Procedural Definition

Operation Name	:	Gen_CRC(RM_body:RMBody)
Result Type	:	BITSTR8
Comments	:	

Description

Gen_CRC computes the CRC value of an RM cell, provided in RM_Body, per section 5.10.3.1. of TM specification.

Test Suite Operation Procedural Definition

Operation Name	:	Gen_HEC(GFC,VPI,VCI,PTI,CLP:BITSTRING)
Result Type	:	OCTETSTR1
Comments	:	

Description

Gen_HEC computes the ATM cell header check byte of an ATM cell. The fileds of the header are passed as parameters.

Test Suite Operation Procedural Definition

Operation Name	:	Init
Result Type	:	BOOLEAN
Comments	:	To establish a control communication path and ABR connection between LT and UT

Description

(1) activate the communication path for the control channel between the LT and UT, and provide all parameters for the UT,
(2) establish an ABR connection from the UT to the LT using the VPI and VCI number and other ABR parameters supplied in the test suite parameter, and
(3) return a Boolean value "TRUE" when the operation is successful

Test Suite Operation Procedural Definition

Operation Name	:	int_to_exp(nn:INTEGER)
Result Type	:	Rate_ie
Comments	:	Convert from integer to RM cell floating point format

Description

Convert an integer, n, into the exponential (floating point) form for RM cells, per section 5.10.3.2 of TM specification. The exponential form is divided into three fields: Rate_ie.nz, Rate_ie.exp, and Rate_ie.mantissa. The reserved field Rate_ie.res must be set to 0.

Test Suite Operation Procedural Definition

Operation Name	:	Rep(In:HEXSTR1)
Result Type	:	OCTETSTRLen
Comments	:	

Description

Rep takes the one-byte hexstring in In and repeats it Len times to create an octetstring of length Len.

Test Suite Parameter Declarations

Parameter Name	Type	PICS/PIXIT Ref	Comments
ADTF_val	INTEGER	PIXIT TM.2	IUT's ADTF timer; unit is seconds
CDF_power	INTEGER	PIXIT P.8	IUT's negative power of 2 for CDF
CRM_val	INTEGER	PIXIT P.5	IUT's CRM value
ICR_val	INTEGER	PIXIT P.3	IUT's ICR value
Internal_Congest	BOOLEAN	PIXIT I.1	True if the IUT can be forced into an internal congestion condition.
MCR_val	INTEGER	PIXIT P.2	IUT's MCR value
Nrm	INTEGER	PIXIT P.4	
PCR_val	INTEGER	PIXIT P.1	IUT's PCR value
RDF_power	INTEGER	PIXIT P.7	IUT's negative power of 2 for RDF
RIF_power	INTEGER	PIXIT P.6	IUT's negative power of 2 for RIF
Tw_val	INTEGER	PIXIT TM.1	Amount of time to wait for a response from IUT;unit is milliseconds
Trm_val	INTEGER	PIXIT TM.3	IUT's Trm timer; unit is milliseconds
VCI_val	BITSTR16	PIXIT I.3	IUT's VCI value for testing
VPI_val	BITSTR8	PIXIT I.2	IUT's VPI value for testing

Test Case Selection Expression Definitions

Expression Name	Selection Expression	Comments
Internal_Congestion	Internal_Congest	Selects test cases if IUT can be forced into an internal congestion condition.

Test Suite Constant Declarations

Constant Name	Type	Value	Comments
Mrm	INTEGER	2	
UT_Datalen	INTEGER	48	Size of data from UT. If the data unit is ATM PDU, the size is 48; if it is AAL5 PDU, then it is 40.

Test Suite Variable Declarations

Variable Name	Type	Value	Comments
BN_var	BITSTR1	'0'B	variable for FRM received
CCR_exp	Rate_ie		CCR in exponent format (nz, exp, mantissa)
CCR_var	INTEGER	0	CCR in integer format, must be able to hold the maximum value of CCR
CI_var	BITSTR1	'0'B	variables for FRM received
ER_exp	Rate_ie		ER in exponential format (nz, exp, mantissa)
ER_var	INTEGER	0	ER in integer format, must be able to hold the maximum value of ER
MCR_exp	Rate_ie		MCR in exponential format (nz, exp, mantissa)
MCR_var	INTEGER	0	MCR in integer format, must be able to hold the maximum value of MCR
Mid_point	INTEGER	0	midpoint between the highest CCR reached in IUT and ICR
NI_var	BITSTR1	'0'B	variables for FRM received
ICR_var	INTEGER	0	
PCR_exp	Rate_ie		
ICR_exp	Rate_ie		

Test Case Variable Declarations

Variable Name	Type	Value	Comments
Delta	INTEGER	0	
FLAG	BOOLEAN	FALSE	
m	INTEGER	0	
n	INTEGER	0	
n_cells_sent	INTEGER	0	count # of cells from IUT
n_receive	INTEGER	0	
n_send	INTEGER	0	
new_CCR	INTEGER	0	expected new CCR from FRM
new_ER	INTEGER	0	
prev_CCR	INTEGER	0	save the value of CCR in the previous FRM from IUT
um	INTEGER	0	
un	INTEGER	0	
Len	INTEGER		
nt	INTEGER	0	

PCO Type Declarations		
PCO Type	**Role**	**Comments**
PHY_SAP	LT	
ATM_SAP	UT	

PCO Declarations			
PCO Name	**PCO Type**	**Role**	**Comments**
LT_PCO	PHY_SAP	LT	above PHY layer
UT_PCO	ATM_SAP	UT	above ATM layer

Coordination Point Declarations	
CP Name	**Comments**
CON	Coordination point between the Lower Tester and Upper Tester

Timer Declarations

Timer Name	Duration	Unit	Comments
ADTF	ADTF_val	ms	
Trm	Trm_val	ms	
Tw	Tw_val	s	Timer to wait for a response
T10s	10	s	

Test Component Declarations

Component Name	Component Role	Nr PCOs	Nr CPs	Comments
LowerT	MTC	1	1	Lower Tester
UpperT	PTC	1	1	Upper Tester

Test Component Configuration Declaration

Configuration Name : Config1

Comments : Lower Tester (LT) as Main Test Component

Components Used	PCOs Used	CPs Used	Comments
LowerT	LT_PCO	CON	Coordination Control point
UpperT	UT_PCO	CON	

Test Component Configuration Declaration

Configuration Name : Config2

Comments : Upper Tester (UT) as Parallel Tet Component

Components Used	PCOs Used	CPs Used	Comments
UpperT	UT_PCO	CON	
LowerT	LT_PCO	CON	

ASN.1 PDU Type Definition

PDU Name	:	ATM
PCO Type	:	PHY_SAP
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	

Type Definition

```
SEQUENCE
  {
     Header  Header_ie,
     Text       OCTETSTR48
  }
```

ASN.1 PDU Type Definition

PDU Name	:	DATA
PCO Type	:	ATM_SAP
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	

Type Definition

```
SEQUENCE
          {
                Text   OCTETSTR_UT_Datalen
           }
```

ASN.1 PDU Type Definition

PDU Name	:	RM
PCO Type	:	PHY_SAP
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	RM cell

Type Definition

```
SEQUENCE
    {
        Header    Header_ie,
        Body      RMBody,
        CRC_10  BIT STRING(SIZE(8))                          -- octets 52&53
     }
```

ASN.1 CM Type Definition

CM Name : CON1

Comments : Control Message for "send" commands

Type Definition

```
SEQUENCE
  {
        CON_TYPE        OCTETSTR1,
        CONTROL_LEN     INTEGER_LEN
    }
```

ASN.1 CM Type Definition

CM Name : CON2

Comments : Control Message for "send and receive" commands

Type Definition

```
SEQUENCE
  {
        CON_TYPE     OCTETSTR1,
        Send                INTEGER,
        Receive             INTEGER
    }
```

ASN.1 Constraint Declaration

Constraint Name	:	RM_Header
ASN1 Type	:	Header_ie
Derivation Path	:	
Encoding Variation	:	
Comments	:	RM Cell Header

Constraint Value

```
{
    GFC  '0000'B,
    VPI    VPI_val,
    VCI   VCI_val,
    PTI    '110'B,     --RM cell
    CLP  '0'B,
    HEC  Gen_HEC(0,VPI_val,VCI_val,'110'B, '0'B)
 }
```

ASN.1 Constraint Declaration

Constraint Name	:	ATM_Header
ASN1 Type	:	Header_ie
Derivation Path	:	
Encoding Variation	:	
Comments	:	ATM cell header

Constraint Value

```
{
    GFC  '0000'B,
    VPI    VPI_val,
    VCI   VCI_val,
    PTI    '000'B,     -- Source resets PTI to 0
    CLP  '0'B,
    HEC  Gen_HEC(0,VPI_val,VCI_val,'110'B, '0'B)
 }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	ATM_EFCI_set
PDU Type	:	ATM
Derivation Path	:	ATM_S.
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	

Constraint Value

```
{
   Header                  {
                                GFC  '0000'B,
                                 VPI    VPI_val,
                                  VCI   VCI_val,
                                    PTI    '010'B,     -- Source resets PTI to 0
                                    CLP  '0'B,
                                    HEC  Gen_HEC(0,VPI_val,VCI_val,'110'B, '0'B)
                                     },
   Text                  Rep(INT_TO_HEX(n,2), 48)
}
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	ATM_R
PDU Type	:	ATM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	

Constraint Value

```
{
    Header   ATM_Header,
    Text       ?
   }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	ATM_S
PDU Type	:	ATM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	

Constraint Value

```
{
    Header   ATM_Header,
    Text       Rep(INT_TO_HEX(n,2), 48)
   }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	CELL(nn:INTEGER)
PDU Type	:	DATA
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	PDU from the UT through UT_PCO

Constraint Value

```
{
      Text   Rep(INT_TO_HEX(nn,2), UT_Datalen)
   }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	CELL_LT
PDU Type	:	DATA
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	PDU from the LT as seen at the UT_PCO

Constraint Value

```
{
      Text      ?
   }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	FRM
PDU Type	:	RM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	FRM cell

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '0'B,                  -- octet 7
                            BN      '0'B,                   -- octet 7
                            CI       '0'B,                   -- octet 7
                            NI       '0'B,                   -- octet 7
                            RA      '0'B,                  -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      PCR_exp,             -- octets 8&9
                            CCR   ICR_exp,             -- octets 10&11
                            MCR   MCR_exp,           -- octets 12&13
                            QL       '0000'O,            -- octets 14-17
                            SN      '0000'O,             -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	FRM1
PDU Type	:	RM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	RM cell from IUT

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '0'B,                  -- octet 7
                            BN      '0'B,                   -- octet 7
                            CI       '0'B,                   -- octet 7
                            NI       '0'B,                   -- octet 7
                            RA      '0'B,                  -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      PCR_exp,             -- octets 8&9
                            CCR   ?,                        -- octets 10&11
                            MCR   MCR_exp,            -- octets 12&13
                            QL       '0000'O,             -- octets 14-17
                            SN      '0000'O,              -- octets 18-21
                            Res2    ?                     ,  -- octets 22-51
                            Res3   '000'B                 --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	FRM2(CCR_new:Rate_ie)
PDU Type	:	RM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	FRM from the LT

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '0'B,                  -- octet 7
                            BN      '0'B,                   -- octet 7
                            CI       '0'B,                   -- octet 7
                            NI       '0'B,                   -- octet 7
                            RA      '0'B,                  -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      PCR_exp,             -- octets 8&9
                            CCR   CCR_new,             -- octets 10&11
                            MCR   MCR_exp,           -- octets 12&13
                            QL       '0000'O,            -- octets 14-17
                            SN      '0000'O,             -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	RM_UNEXPECT
PDU Type	:	RM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	an out-of-rate RM (CLP=1) cell for UNEXPECTED Test Step

Constraint Value

```
{
   Header  {
                      GFC  '0000'B,
                      VPI    VPI_val,
                      VCI   VCI_val,
                       PTI    '110'B,     --RM cell
                       CLP  '1'B,
                       HEC  Gen_HEC(0,VPI_val,VCI_val,'110'B, '0'B)
                    },

  Body             {
                               ID       ?,           -- octet 6
                               DIR     ?,           -- octet 7
                               BN      ?,           -- octet 7
                               CI       ? ,          -- octet 7
                               NI       ? ,          -- octet 7
                               RA      ? ,          -- octet 7
                               Res1   ? ,          -- octet 7
                               ER      ?  ,         -- octets 8&9
                               CCR   ?   ,        -- octets 10&11
                               MCR   ?   ,        -- octets 12&13
                               QL      ?   ,        -- octets 14-17
                               SN      ?   ,        -- octets 18-21
                               Res2    ?  ,        -- octets 22-51
                               Res3   ?           --  octet 52
                      },

        CRC_10  ?                          -- octets 52&53

}
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	BRM1
PDU Type	:	RM
Derivation Path	:	FRM.
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	IUT turns around LT's FRM

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '1'B,                  -- octet 7
                            BN      '0'B,                   -- octet 7
                            CI       '0'B,                   -- octet 7
                            NI       '0'B,                   -- octet 7
                            RA      '0'B,                   -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      PCR_exp,             -- octets 8&9
                            CCR   ICR_exp,             -- octets 10&11
                            MCR   ?                ,            -- octets 12&13
                            QL       '0000'O,            -- octets 14-17
                            SN      '0000'O,             -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	BRM2
PDU Type	:	RM
Derivation Path	:	FRM.
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	IUT turns around LT's FRM, with CI=1

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '1'B,                  -- octet 7
                            BN      '0'B,                   -- octet 7
                            CI       '1'B,                  -- octet 7
                            NI       '0'B,                  -- octet 7
                            RA      '0'B,                  -- octet 7
                            Res1   '000'B,               -- octet 7
                            ER      PCR_exp,            -- octets 8&9
                            CCR   ICR_exp,             -- octets 10&11
                            MCR   ?,                       -- octets 12&13
                            QL       '0000'O,            -- octets 14-17
                            SN      '0000'O,             -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	BRM3(CCR_ret:Rate_ie)
PDU Type	:	RM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	LT turns around an RM from the IUT, CCR_ret is the CCR in the original FRM

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '1'B,                  -- octet 7
                            BN      '0'B,                   -- octet 7
                            CI       '0'B,                   -- octet 7
                            NI       '0'B,                   -- octet 7
                            RA      '0'B,                   -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      PCR_exp,             -- octets 8&9
                            CCR   CCR_ret,             -- octets 10&11
                            MCR   MCR_exp,           -- octets 12&13
                            QL       '0000'O,            -- octets 14-17
                            SN      '0000'O,             -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	BRM4
PDU Type	:	RM
Derivation Path	:	FRM.
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	IUT turns around LT's FRM

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '1'B,                  -- octet 7
                            BN      ?,                      -- octet 7
                            CI       ?,                        -- octet 7
                            NI       ?,                        -- octet 7
                            RA      '0'B,                   -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      ?,                       -- octets 8&9
                            CCR    ?,                       -- octets 10&11
                            MCR   ?,                        -- octets 12&13
                            QL       '0000'O,             -- octets 14-17
                            SN      '0000'O,              -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                 --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	BRM5(CCR_ret: Rate_ie; ER_val:INTEGER)
PDU Type	:	RM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	LT turns around an RM cell with NI=1 and a new ER value

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '0'B,                  -- octet 7
                            BN      '0'B,                   -- octet 7
                            CI       '0'B,                   -- octet 7
                            NI       '1'B,                   -- octet 7
                            RA      '0'B,                   -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      int_to_exp(ER_val),            -- octets 8&9
                            CCR   CCR_ret,             -- octets 10&11
                            MCR   MCR_exp,           -- octets 12&13
                            QL       '0000'O,            -- octets 14-17
                            SN      '0000'O,             -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 PDU Constraint Declaration

Constraint Name	:	BRM6(BNin, CIin, NIin:BITSTR1; ERin:INTEGER)
PDU Type	:	RM
Derivation Path	:	
Encoding Rule Name	:	
Encoding Variation	:	
Comments	:	LT turns around an FRM cell from the IUT

Constraint Value

```
{
        Header    RM_Header,            -- octets 1-5
        Body
                        {
                            ID       '00000001'B,      -- octet 6
                            DIR     '1'B,                  -- octet 7
                            BN      BNin,                   -- octet 7
                            CI       CIin,                   -- octet 7
                            NI       NIin,                   -- octet 7
                            RA      '0'B,                   -- octet 7
                            Res1   '000'B,                -- octet 7
                            ER      int_to_exp(ERin),            -- octets 8&9
                            CCR   CCR_exp,             -- octets 10&11
                            MCR   MCR_exp,           -- octets 12&13
                            QL       '0000'O,            -- octets 14-17
                            SN      '0000'O,             -- octets 18-21
                            Res2    Rep('6A'H,30),  -- octets 22-51
                            Res3   '000'B                --  octet 52
                        },
        CRC_10   ?                          -- octets 52&53
    }
```

ASN.1 CM Constraint Declaration

Constraint Name	:	send(nn:INTEGER)
CM Type	:	CON1
Derivation Path	:	
Comments	:	For LT to send a "send" command

Constraint Value

```
{
      CON_TYPE          '01'O,    --send
      CONTROL_LEN    nn           --number of cells to send
   }
```

ASN.1 CM Constraint Declaration

Constraint Name	:	SR_Cmd(ss,rr:INTEGER)
CM Type	:	CON2
Derivation Path	:	
Comments	:	For LT to send a "send and receive" control command

Constraint Value

```
{
      CON_TYPE    '02'O,    --send & receive
      Send               ss,
      Receive           rr
   }
```

ASN.1 CM Constraint Declaration

Constraint Name	:	UT_send
CM Type	:	CON1
Derivation Path	:	
Comments	:	For UT to receive a "send" command

Constraint Value

```
{
      CON_TYPE          '01'O,    --send
      CONTROL_LEN    ?         --number of cells to send
   }
```

ASN.1 CM Constraint Declaration

Constraint Name	:	UT_SR_Cmd
CM Type	:	CON2
Derivation Path	:	
Comments	:	For UT to receive a "send and receive" control command

Constraint Value

```
{
      CON_TYPE    '02'O,    --send & receive
      Send               ?,
      Receive            ?
   }
```

Test Case Dynamic Behavior

Test Case Name : T1

Group :

Purpose : Verify that after connection setup, when the IUT has data to send, then it sends an FRM cell first.

Configuration : Config1

Default :

Comments : Ref: S.1 and S.2

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		+T1_preamble			setup ABR connection
2		START Tw			
3		CREATE(UpperT:UT_Send)			start the UT
4		CON!CON1	send(1)		ask UT to send 1 cell
5		LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp))	FRM1	(P)	get fields from FRM to turn around in BRM
6		[CCR_var<=ICR_var]			
7		+Absorb_Data			absorb data cell
8		?TIMEOUT Tw		F	
9		[CCR_var>ICR_var]		F	
10		?TIMEOUT Tw		F	
11		LT_PCO?OTHERWISE CANCEL Tw		F	

Detailed Comments : Do not allow for out-of-rate FRM (UNEXPECTED) in this test case.

Test Case Dynamic Behavior

Test Case Name : T2

Group :

Purpose : Verify that the IUT turns around an FRM from the LT with contents unchanged except the DIR (=1) bit.

Configuration :

Default :

Comments : Ref: D.2 and S.3.b.ii

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body))	FRM		
2		START Tw			
3	L1	LT_PCO?RM CANCEL Tw	BRM1	P	
4		+UNEXPECTED			
5		GOTO L1			
6		LT_PCO?OTHERWISE CANCEL Tw		I	
7		?TIMEOUT Tw		I	

Detailed Comments : UNEXPECTED allows for an out-of-rate (CLP=1).

Test Case Dynamic Behavior

Test Case Name : T3

Group :

Purpose : Verify that a) after the IUT receives a BRM with BN=0, it will set its ACR=ACR+RIF*PCR (S.8), and b) after sending Nrm-1 cells, it will send an FRM with CCR<=ACR.

Configuration : Config1

Default :

Comments : Ref.: S.8, S.3.a, and S.5

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2	L1	LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), n:=Nrm-3, new_CCR:=Additive_inc(CCR_var))	BRM3(CCR_exp)		
3		CON!CON1(n_cells_sent:=0,prev_CCR:=CCR_var)	send(n+1)		
4		START Tw			
5	L3	REPEAT Receive_Data UNTIL [n_cells_sent=n]			
6	L2	LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp)) CANCEL Tw	FRM1		
7		[(prev_CCR<CCR_var) AND (CCR_var<=new_CCR)]		(P)	
8		+Absorb_Data			
9		[TRUE]		F	CCR not in range
10		+UNEXPECTED			
11		GOTO L2			
12		LT_PCO?OTHERWISE CANCEL Tw		F	
13		?TIMEOUT Tw		F	
14		+UNEXPECTED			
15		GOTO L3			
16		LT_PCO?OTHERWISE CANCEL Tw		F	
17		?TIMEOUT Tw		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1)

Test Case Dynamic Behavior

Test Case Name : T4

Group :

Purpose : Verify that while transmitting data and FRM cells according to (S.3), the IUT will increase the ACR by RIF*PCR up to a value <= PCR as each FRM is returned by the LT (S.8).

Configuration : Config1

Default :

Comments : Ref.: S.3 and S.8

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2	L1	LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), n:=Nrm-2, prev_CCR:=CCR_var, new_CCR:=Additive_inc(CCR_var))	BRM3(CCR_exp)		CI,NI=1, CCR_val from last IUT's FRM
3		CON!CON1(n_cells_sent:=0, Delta:=PCR_val/100)	send(n+1)		Delta, margin of 1?
4		START Tw			
5	L3	REPEAT Receive_Data UNTIL [n_cells_sent=n]			
6	L2	LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp)) CANCEL Tw	FRM1		
7		[(prev_CCR<CCR_var) AND (CCR_var<=new_CCR)]			
8		[CCR_var>=(PCR_val-Delta)]		(P)	CCR close to PCR
9		(Mid_point:=(CCR_var+ICR_val)/2)			Save Mid_point for next test case
10		+Absorb_Data			
11		GOTO L1			
12		[(prev_CCR>=CCR_var) OR (CCR_var>new_CCR)]		F	
13		+UNEXPECTED			
14		GOTO L2			
15		LT_PCO?OTHERWISE CANCEL Tw		F	
16		?TIMEOUT Tw		F	
17		+UNEXPECTED			
18		GOTO L3			
19		LT_PCO?OTHERWISE CANCEL Tw		F	
20		?TIMEOUT Tw		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1)

Test Case Dynamic Behavior

Test Case Name : T5

Group :

Purpose : Verify that the IUT, when receiving a BRM with lower rate in the ER field, will reduce its ACR to the value of ER.

Configuration : Config1

Default :

Comments : Ref.: S.8 and S9.

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), n:=Nrm-2)	BRM5(CCR_exp,Mid_point)		CI=0,NI=1, ER=(PCR+ICR)/2
3		CON!CON1(n_cells_sent:=0)	send(n+1)		
4		START Tw			
5	L2	REPEAT Receive_Data UNTIL [n_cells_sent=n]			
6	L1	LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp)) CANCEL Tw	FRM1		
7		[CCR_var=Mid_point]		(P)	Mid_point from T4
8		+Absorb_Data			
9		[CCR_var>Mid_point]		F	
10		+UNEXPECTED			
11		GOTO L1			
12		LT_PCO?OTHERWISE CANCEL Tw		F	
13		?TIMEOUT Tw		F	
14		+UNEXPECTED			
15		GOTO L2			
16		LT_PCO?OTHERWISE CANCEL Tw		F	
17		?TIMEOUT Tw		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1)

Test Case Dynamic Behavior

Test Case Name : T6

Group :

Purpose : Verify that the IUT will maintain its current ACR when receiving a BRM with NI=1.

Configuration : Config1

Default :

Comments : Ref.: S.8

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), n:=Nrm-2)	BRM5(CCR_exp,PCR_val)		BN,CI=0, NI=1, ER=PCR
3		CON!CON1(n_cells_sent:=0)	send(n+1)		
4		START Tw			
5	L2	REPEAT Receive_Data UNTIL [n_cells_sent=n]			
6	L1	LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp)) CANCEL Tw	FRM1		
7		[CCR_var=Mid_point]		(P)	Mid_point from T4
8		+Absorb_Data			
9		[CCR_var>Mid_point]		F	Mid_point from T4
10		+UNEXPECTED			
11		GOTO L1			
12		LT_PCO?OTHERWISE CANCEL Tw		F	
13		?TIMEOUT Tw		F	
14		+UNEXPECTED			
15		GOTO L2			
16		LT_PCO?OTHERWISE CANCEL Tw		F	
17		?TIMEOUT Tw		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1)

Test Case Dynamic Behavior

Test Case Name : T7

Group :

Purpose : Verify that the IUT will reduce ACR=ICR and send an FRM with CCR=ICR when it does not receive a BRM within time interval ADTF and Trm respectively, and when ACR>ICR and number of outstanding FRM<CRM.

Configuration : Config1

Default :

Comments : Ref.: S.3.a.i and S5.

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		START ADTF			
3		?TIMEOUT ADTF (n:=Nrm-1)			
4		CON!CON1(n_cells_sent:=0)	send(n)		
5		START Tw			
6	L2	REPEAT Receive_Data UNTIL [n_cells_sent=n]			
7	L1	LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp)) CANCEL Tw	FRM1		
8		[CCR_var=ICR_val]		P	
9		[CCR_var<>ICR_val]		F	
10		+UNEXPECTED			
11		GOTO L1			
12		LT_PCO?OTHERWISE CANCEL Tw		F	
13		?TIMEOUT Tw		F	
14		+UNEXPECTED			
15		GOTO L2			
16		LT_PCO?OTHERWISE CANCEL Tw		F	
17		?TIMEOUT Tw		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1)

Test Case Dynamic Behavior

Test Case Name : T8

Group :

Purpose : Verify that the IUT will keep ACR at ICR if no more than CRM-1 FRM cells are sent by the IUT since the last BRM was received.

Configuration : Config1

Default :

Comments : Ref.: S.3.a.i, S.6 and S7.

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			IUT should have started its Trm after sending FRM in T7
2		START Trm			
3		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), n:=0,prev_CCR:=ICR_val)	BRM5(CCR_exp,PCR_val)		NI=1,ER=PCR,Reset CRM
4	L1	CON!CON1(n_cells_sent:=0)	send(Mrm)		
5	L2	LT_PCO?ATM(n_cells_sent:=n_cells_sent+1)	ATM_R		
6		[n_cells_sent<Mrm]			
7		GOTO L2			
8		?TIMEOUT Trm			wait for Trm to expire
9		LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp)) CANCEL Trm	FRM1		
10		START Trm			
11		[CCR_var<>ICR_val] CANCEL Trm		F	
12		[n>=(CRM_val-1)]			
13		CANCEL Trm		P	
14		GOTO L1			
15		LT_PCO?OTHERWISE CANCEL Trm		F	
16		?TIMEOUT Trm		F	
17		+UNEXPECTED			
18		GOTO L2			
19		LT_PCO?OTHERWISE CANCEL Trm		F	
20		?TIMEOUT Trm		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1)

Test Case Dynamic Behavior

Test Case Name : T9

Group :

Purpose : Verify that the IUT will reduce its ACR by ACR*CDF, but not lower than MCR when number of outstanding FRM cells>CRM.

Configuration : Config1

Default :

Comments : Ref.: S.3.a, S.6 and S7.

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		(m:=0, CCR_var:=ICR_val) START Trm			
3	L1	CON!CON1(n_cells_sent:=0, prev_CCR:=CCR_var)	send(Mrm)		
4	L2	LT_PCO?ATM(n_cells_sent:=n_cells_sent+1)	ATM_R		
5		[n_cells_sent<Mrm]			
6		GOTO L2			
7		?TIMEOUT Trm			wait for Trm to expire
8		LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp)) START Trm	FRM1		Restart Trm
9		[(MCR_var>CCR_var) OR (CCR_var > Cutoff_dec(prev_CCR))] CANCEL Trm		F	
10		[CCR_var=MCR_val] (m:=m+1)			
11		[m=2] CANCEL Trm		P	
12		GOTO L1			
13		GOTO L1			
14		LT_PCO?OTHERWISE CANCEL Trm		F	
15		?TIMEOUT Trm		F	
16		+UNEXPECTED			
17		GOTO L2			
18		LT_PCO?OTHERWISE CANCEL Trm		F	
19		?TIMEOUT Trm		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1) or a destination generated BRM (BRM with BN=1 (and CI or NI=1)

Test Case Dynamic Behavior

Test Case Name : T10

Group :

Purpose : Verify that the IUT will reduce the ACR when receiving a BRM with CI=1.

Configuration : Config1

Default :

Comments : Ref.: S.8

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		(m:=Eval_exp1(), CCR_exp:=int_to_exp(MCR_var))			CCR in the last FRM should be MCR
3		REPEAT Receive_Data_FRM('0'B,'0'B,'0'B,PCR_val) UNTIL [m=0]			Raise ACR from MCR with BRMs, BN,CI,NI=0
4	L1	+Receive_Data_FRM('0'B,'1'B,'0'B,PCR_val)			Lower ACR back down to MCR with BRM, CI=1
5		[(MCR_var>CCR_var) OR (CCR_var>(prev_CCR * (100-RDF_power)/100))]		F	
6		[CCR_var>MCR_val]			Continue until ACR=MCR
7		GOTO L1			
8		+Receive_Data_FRM('0'B,'1'B,'0'B,PCR_val)			One more time to ensure ACR=MCR
9		[CCR_var=MCR_val]		P	
10		[CCR_var<>MCR_val]		F	

Test Case Dynamic Behavior

Test Case Name : T11

Group :

Purpose : Verify that (1) when receiving a sequence of data with EFCI=1, the IUT will turn around an FRM cell with CI=1 (D.1 and D.2.a); and (2) when there are multiple BRM cells to be sent, either all but one are to be dropped or all of their contents be updated. (D.3 and D.4).

Configuration : Config1

Default :

Comments : Ref.: D.1, D.2.a, D.3, and D.4.

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			IUT should have started its Trm after sending FRM in T7
2		CON!CON2 (n:=Eval_exp3())	SR_Cmd(n,3)		
3		LT_PCO!ATM(CCR_exp:=exp_to_int(Additive_inc(ICR_val)))	ATM_EFCI_set		
4		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body))	FRM2(CCR_exp)		CCR>ICR
5		START Tw (Eval_exp2())			
6	L1	LT_PCO?RM	BRM2		CI=1
7		LT_PCO!ATM	ATM_EFCI_set		EFCI=1
8		LT_PCO!RM	FRM2(CCR_exp)		
9		LT_PCO!ATM	ATM_S		EFCI=0
10		LT_PCO!RM	FRM2(CCR_exp)		
11		CON!CON1	send(Nrm-1-n)		
12	L2	LT_PCO?ATM	ATM_R		Absorb all ATM cells
13		GOTO L2			
14		LT_PCO?RM	FRM1		Absrorb all FRM cells
15		GOTO L2			
16		LT_PCO?RM(ER_exp:=RM.Body.ER)	BRM1	(P)	CI=0
17	L3	LT_PCO?RM(ER_exp:=RM.Body.ER) CANCEL Tw	BRM1	P	Second BRM1 is optional
18		LT_PCO?OTHERWISE CANCEL Tw			
19		?TIMEOUT Tw			
20		+UNEXPECTED			
21		GOTO L2			
22		LT_PCO?OTHERWISE CANCEL Tw		F	

Continued on next page

Continued from previous page

Test Case Dynamic Behavior

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
23		?TIMEOUT Tw		F	
24		LT_PCO?ATM	ATM_R		
25		GOTO L1			
26		+UNEXPECTED			
27		GOTO L1			
28		LT_PCO?OTHERWISE CANCEL Tw		F	
29		?TIMEOUT Tw		F	

Detailed Comments : UNEXPECTED allows for an out-of-rate FRM (CLP=1)

Test Case Dynamic Behavior

Test Case Name : T12

Group :

Purpose : Verify that when the IUT is in internal congestion condition, it turns around a BRM cell with BN=0. In addition, it may generate a BRM with BN=1. In both cases, contents of the fields of both BRMs will be set by CI=1 and/or ER is reduced.

Configuration :

Default :

Comments : Ref: D.2.b

Selection Ref : Internal_Congestion

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		START Tw			Save ER in previous BRM
2		(n:=0,ER_var:=exp_to_int(ER_exp))			
3	L1	LT_PCO!ATM(n:=n+1)	ATM_EFCI_set		These ATM cells must be sent at the link rate
4		[n<1023]			
5		GOTO L1			
6		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body))	FRM2(CCR_exp)		
7		START Tw			
8	L2	LT_PCO?RM(new_ER:=exp_to_int(RM.Body.ER),CI_var:=RM.Body.CI)	BRM4		BN=?
9		[(CI_var='1'B) OR (new_ER<ER_var)]		P	
10		GOTO L1			
11		+UNEXPECTED			
12		GOTO L2			
13		LT_PCO?OTHERWISE CANCEL Tw		F	
14		?TIMEOUT Tw		F	

Detailed Comments : Selection Reference: Internal_Congestion. This test case is executed only if the IUT can be forced to internal congestion condition, i.e., the Test Suite Selection Expression "Internal_Congestion" is TRUE.

UNEXPECTED allows for an out-of-rate (CLP=1).

Test Case Dynamic Behavior

Test Case Name : T13

Group :

Purpose : Verify that the IUT may generate a BRM on its own when internally congested.

Configuration :

Default :

Comments : Ref: D.5

Selection Ref : Internal_Congestion

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		START Tw			
2		(n:=0)			
3	L1	LT_PCO!ATM(n:=n+1)	ATM_EFCI_set		
4		[n<1023]			
5		GOTO L1			
6		[n>=1023]			
7	L2	LT_PCO?RM(new_ER:=exp_to_int(RM.Body.ER),BN_var:=RM.Body.BN,CI_var:=RM.Body.CI,NI_var:=RM.Body.NI) CANCEL Tw	BRM4		
8		[((BN_var='1'B) AND (CI_var='1'B)) OR ((BN_var='1'B) AND (CI_var='0'B) AND (NI_var='1'B)) OR (new_ER<ER_var)]		P	
9		GOTO L1			
10		+UNEXPECTED			
11		GOTO L2			
12		LT_PCO?OTHERWISE CANCEL Tw		F	
13		?TIMEOUT Tw		F	

Detailed Comments : Selection Reference: Internal_Congestion. This test case is executed only if the IUT can be forced to internal congestion condition, i.e., the Test Suite Selection Expression "Internal_Congestion" is TRUE.

UNEXPECTED allows for an out-of-rate (CLP=1).

Test Case Dynamic Behavior

Test Case Name : T14

Group :

Purpose : Verify that the source resets EFCI on every data cell it sends (S.12)

Configuration : Config1

Default :

Comments : It is assumed that none of the switches within the ATM network between UpperT and LowerT set the EFCI bit.

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), RM.Body.NI:='1'B, n:=Nrm-2)	BRM1		
3		CON ! CON1 (n_cells_sent := 0)	send(Nrm+1)		
4	L1	REPEAT Receive_Data UNTIL [n_cells_sent = n]			
5		[ATM.Header.PTI = '000'B]		(PASS)	
6		GOTO L1			
7		LT_PCO?RM	FRM1		
8		+Absorb_Data			
9		+UNEXPECTED			
10		GOTO L1			
11		? TIMEOUT Trm		FAIL	
12		LT_PCO ? OTHERWISE CANCEL Trm		FAIL	

Test Case Dynamic Behavior

Test Case Name	:	T15
Group	:	
Purpose	:	Verify that the source sets CLP=0 on every data cell it sends (S.4)
Configuration	:	Config1
Default	:	
Comments	:	
Selection Ref	:	
Description	:	

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), n:=Nrm-2)	BRM1		
3		CON ! CON1 (n_cells_sent := 0, ATM.Header.CLP:='1'B)	send(Nrm+1)		
4	L1	REPEAT Receive_Data UNTIL [n_cells_sent = n]			
5		[ATM.Header.CLP = '0'B]		(PASS)	
6		GOTO L1			
7		LT_PCO?RM	FRM1		
8		+Absorb_Data			
9		+UNEXPECTED			
10		GOTO L1			
11		? TIMEOUT Trm		FAIL	
12		LT_PCO ? OTHERWISE CANCEL Trm		FAIL	

Test Case Dynamic Behavior

Test Case Name : T16

Group :

Purpose : Verify that the source does not send out-of-rate forward RM-cells at a rate greater than TCR=10 cells/sec (S.11)

Configuration : Config1

Default :

Comments :

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			Start UpperT.
2		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), RM.Body.NI:='1'B)	BRM1		
3		START Tw			
4		CON!CON1(n := 100*Nrm, nt := 0)	send(n)		Request UpperT to send many data cells.
5		START T10s			Start a 10-second timer. nt = 0.
6	L1	+Absorb_Data			
7		GOTO L1			
8		+UNEXPECTED			Receive out-or-rate RM
9		(nt:=nt+1)			Increment nt
10		GOTO L1			
11		?TIMEOUT T10s			10 seconds have expired.
12		[nt<10]		P	Number of out-of-rate RM cells is < 10.
13		?TIMEOUT Tw CANCEL T10s		F	
14		LT_PCO?OTHERWISE CANCEL Tw, CANCEL T10s		F	Something occurred other than an ATM cell received.

Test Case Dynamic Behavior

Test Case Name : T17

Group :

Purpose : Verify that the source sends at least one in-rate forward RM-cell in every Nrm consecutive in-rate cell sent (S.3a ii).

Configuration : Config1

Default :

Comments :

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		START Tw			
3		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), RM.Body.NI:='1'B, n:= Nrm-2)	BRM1		
4		CON!CON1 (n_cells_sent := 0)	send(n+1)		
5	L1	REPEAT Receive_Data UNTIL [n_cells_sent = n]			
6	L2	LT_PCO ? RM	FRM1	(PASS)	
7		+Absorb_Data			
8		+UNEXPECTED			
9		GOTO L2			
10		LT_PCO?OTHERWISE CANCEL Tw		FAIL	
11		?TIMEOUT Tw		FAIL	
12		+UNEXPECTED			
13		GOTO L1			
14		LT_PCO?OTHERWISE CANCEL Tw		FAIL	
15		?TIMEOUT Tw		FAIL	

Test Case Dynamic Behavior

Test Case Name : T18

Group :

Purpose : Verify that the source sends an in-rate forward RM-cell if, since the last in-rate forward RM-cell, at least Mrm = 2 in-rate RM cells have been sent and at least Trm time has elapsed (S.3a i).

Configuration : Config1

Default :

Comments :

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), RM.Body.NI:='1'B)	BRM1		
3		CON !CON1 (n_cells_sent := 0, n :=10* Nrm, m := 0)	send(n)		
4		START Trm			
5	L1	REPEAT Receive_Data UNTIL [n_cells_sent = n]			Either a DATA cell
6		LT_PCO ? RM	FRM1		or an in-rate RM is received
7		(m := m +1)			If in-rate RM, increment the count
8		[m > Mrm]			More than 2 in-rate RM cells received
9		? TIMEOUT Trm			Trm time has elapsed
10		LT_PCO ? RM	FRM1	PASS	Source has sent an in-rate RM
11		+UNEXPECTED			Out-of-rate RM cell was sent before the condition for in-rate RM cells was satisfied.
12		GOTO L1			
13		? TIMEOUT Trm		FAIL	
14		LT_PCO ? OTHERWISE CANCEL Trm		FAIL	

Test Case Dynamic Behavior

Test Case Name : T19

Group :

Purpose : Verify that the first in-rate backward RM-cell since the last in-rate forward RM-cell is sent ahead of any data cells waiting for transmission (S.3b).

Configuration : Config1

Default :

Comments :

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		START Tw			
3		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), RM.Body.NI:='1'B)	BRM1		Keep ACR at MCR
4		CON!CON1(n_cells_sent := 0, n := Nrm)	send(n)		Send Nrm cells
5		START Trm			
6	L1	LT_PCO?RM	FRM		Lower Tester picks up the first in-rate FRM cell
7		CON!CON1(n_cells_sent := 0, n := Nrm)	send(n)		
8		REPEAT Receive_Data UNTIL [n_cells_sent = n]			More cells are being received
9		[n_cells_sent > Mrm]			at least Mrm cells have been received
10		? TIMEOUT Trm			AND Trm time has elapsed
11		LT_PCO?RM	BRM1		BRM cell is sent although there are data cells to send
12		LT_PCO?ATM	ATM_R	PASS	Data cell was waiting for trasmission
13		+UNEXPECTED			Out-of-rate RM cells are ignored
14		GOTO L1			
15		LT_PCO?OTHERWISE CANCEL Tw		FAIL	
16		? TIMEOUT Tw		FAIL	

Test Case Dynamic Behavior

Test Case Name : T20

Group :

Purpose : Verify RM cell format (S.10).

Configuration : Config1

Default :

Comments :

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			Start the UpperT
2		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), RM.Body.NI:='1'B)	BRM1		
3	L1	LT_PCO ? RM	FRM1		
4		[(RM.Header.GFC = '????'B) AND (RM.Header.VPI = '????????'B) AND (RM.Header.VCI = '????????????????'B) AND (RM.Header.PTI = '110'B) AND (RM.Header.CLP = '?'B) AND (RM.Header.HEC = '??'H)]		(PASS)	
5		[(RM.Body. ID = '????????'B) AND (RM.Body. DIR = '?'B) AND (RM.Body. BN = '?'B) AND (RM.Body.CI = '?'B) AND (RM.Body.NI = '?'B) AND (RM.Body.RA = '?'B) AND (RM.Body.Res1 = '???'B)]			
6		[(RM.Body.ER.res = '?'B) AND (RM.Body.ER.nz = '?'B) AND (RM.Body.ER.exp = '?????'B) AND (RM.Body.ER.mantissa = '??????????'B)]			
7		[(RM.Body.CCR.res = '?'B) AND (RM.Body.CCR.nz = '?'B) AND (RM.Body.CCR.exp = '?????'B) AND (RM.Body.CCR.mantissa = '??????????'B)]			
8		[(RM.Body.MCR.res = '?'B) AND (RM.Body.MCR.nz = '?'B) AND (RM.Body.MCR.exp = '?????'B) AND (RM.Body.MCR.mantissa = '??????????'B)]			
9		[(RM.Body.QL = '????'B) AND (RM.Body.SN = '????'O) AND (RM.Body.Res2 = '????????????????????????????????'O) AND (RM.Body.Res3 = '???'B) AND (RM.CRC_10 = '????????'B)]			
10		GOTO L1			
11		+Absorb_Data			
12		LT_PCO ? OTHERWISE CANCEL Tw		FAIL	
13		? TIMEOUT Tw		FAIL	

Test Case Dynamic Behavior

Test Case Name : T21

Group :

Purpose : Verify that when a destination receives a data cell, the EFCI of the data cell is saved as the EFCI state of the connection (D.1).

Configuration : Config1

Default :

Comments :

Selection Ref :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CREATE(UpperT:UT_Send)			
2		START Tw			
3		LT_PCO ! ATM	ATM_EFCI_set		
4	L1	LT_PCO?RM(new_ER:=exp_to_int(RM.Body.ER),BN_var:=RM.Body.BN,CI_var:=RM.Body.CI,NI_var:=RM.Body.NI) CANCEL Tw	BRM4		
5		[((BN_var='1'B) AND (CI_var='1'B)) OR ((BN_var='1'B) AND (CI_var='0'B) AND (NI_var='1'B)) OR (new_ER<ER_var)]		P	
6		+UNEXPECTED			
7		GOTO L1			
8		LT_PCO ? OTHERWISE CANCEL Tw		FAIL	
9		? TIMEOUT Tw		FAIL	

Test Step Dynamic Behavior

Test Step Name : Absorb_Data

Group :

Objective :

Default :

Comments : LT waits for one more cell at the end of a test case.

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		START Trm			
2		LT_PCO?ATM	ATM_R		
3		LT_PCO?OTHERWISE CANCEL Tw		I	
4		?TIMEOUT Trm		I	

Test Step Dynamic Behavior

Test Step Name : Receive_Data

Group :

Objective :

Default :

Comments : LT waits for an ATM cell

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		LT_PCO?ATM (n_cells_sent:=n_cells_sent+1)	ATM_R		

Test Step Dynamic Behavior

Test Step Name : Receive_Data_FRM(BN,CI,NI:BITSTR1; ER:INTEGER)

Group :

Objective :

Default :

Comments :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		LT_PCO!RM(RM.CRC_10:=Gen_CRC(RM.Body), m:=m+1, n:=Nrm-1)	BRM6(BN,CI,NI,ER)		m counts # of times this test step is called
2		CON!CON1 START Trm	send(n)		
3	L10	LT_PCO?ATM(n:=n-1)	ATM_R		Wait for Nrm-1 cells
4		[n>0]			
5		GOTO L10			
6		LT_PCO?RM(CCR_exp:=RM.Body.CCR,CCR_var:=exp_to_int(CCR_exp))	FRM1		
7		LT_PCO?OTHERWISE		F	
8		?TIMEOUT Trm		F	
9		+UNEXPECTED			
10		GOTO L10			
11		LT_PCO?OTHERWISE		F	
12		?TIMEOUT Trm		F	

Test Step Dynamic Behavior

Test Step Name : T1_preamble

Group :

Objective :

Default :

Comments : Establish a control path and ABR connection

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		(FLAG:=Init())			
2		[FLAG=TRUE]			
3		[FLAG=FALSE]		I	

Test Step Dynamic Behavior

Test Step Name : UNEXPECTED

Group :

Objective : To allow for an out-of-rate RM (CLP=1) during testing (except test case T1).

Default :

Comments :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		LT_PCO?RM	RM_UNEXPECT		Out-of-rate RM (CLP=1)

Test Step Dynamic Behavior

Test Step Name : UT_Send

Group :

Objective : The UT sends n data cells upon receipt of a send CM from the LT, where n is in the text of the CON1 control message

Default :

Comments :

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CON?CON1(un:=CON1.CONTROL_LEN)	UT_send		
2		REPEAT Send_cells UNTIL [un=0]			
		Send_cells			
3		UT_PCO!DATA(un:=un-1)	CELL(un)		

Test Step Dynamic Behavior

Test Step Name : UT_Send_Receive

Group :

Objective :

Default :

Comments : UT receives and sends cells as commended by the LT.

Description :

Nr	Label	Behaviour Description	Constraints Ref	Verdict	Comments
1		CON?CON2(um:=0,n_send:=CON2.Send,n_receive:=CON2.Receive)	UT_SR_Cmd		
2	L10	UT_PCO?DATA(um:=um+1)	CELL_LT		receive first
3		[um<n_receive]			
4		GOTO L10			
5		[um=n_receive] (um:=0)			
6	L11	UT_PCO!DATA(um:=um+1)	CELL(um)		send
7		[m<n_send]			
8		GOTO L11			
9		CON?CON1(n_send:=CON1.CONTROL_LEN,um:=0)	UT_send		
10	L12	UT_PCO!DATA(um:=um+1)	CELL(um)		
11		[m<n_send]			
12		GOTO L12			

Detailed Comments : The receive and send operations are supposed to be done concurrently and asynchronously. To simplify the code, however, this test step does receives and sends sequentially.