

(54) 가 xDSL

(,)가
가
가 . , .

2

, , , , DSL, , ,

, 가 , .

, (PSTN) 1 (location) 2 ,
(, 0 - 4KHz) 가 . 300 PSTN
(bps)
PSTN , 가 ,
(,) 가 가 (ITU
, ITU - T V.34) 33,600 bps
PSTN 4KHz .

가 가 (MB)가 . V.34

, 4KHz (local twisted wire pair)
, DSL, ADSL, VDSL, HDSL,
SHDSL, SDSL(xDSL) DSL(Digital Subscriber Line)
xDSL

xDSL , /
,
, 가
(, CAT3 CAT5) , xDSL

xDSL 가 , xDSL 가 가 .

, (end) / 가 (xDSL) () (startup) (initialization)

, (, 0 - 4 KHz) xDSL , , - , , .

DSL 가 xDSL (requirements) 가 가 xDSL 가 xDSL (preferen

ce)(,) (,) .

ssues) 가 (regulatory i (exponentially)

1996 (ILEC) (CLEC) (metallic) 가 .

(termination) , () , ISDN xDSL(ADSL, VDSL, HDSL, SHDSL, SDSL) . (Carterphone) , () (,) (CPE) . CPE , 가 .

(, ,) / 가 , 가 / (,) . 가 .

, , ()
 , ITU - T , 2

1) Recommendation V.8(09/94) - "Procedures for Starting Sessions of Data Transmission over the General Switched Telephone Network";

2) Recommendation V.8bis(08/96) - "Procedures for the Identification and Selection of Common Modes of Operation Between Data Circuit - terminating Equipments(DCE) and Between Data Terminal Equipments(DTE) over the General Switched Telephone Network".

, () (negotiate)
 ,
 (full duplex)(V.8) 가 (half duplex)(V.8bis) 가 . xDSL
 SL , 가 가 가
 (procedures)가 ,
 (backward compatibility)

, 가
 () (activating station/calling station) - xDSL DTE, DC
 E ;

(answering station) - PSTN(GSTN) DTE, DCE
 ;

(carrier set) - xDSL PSD ;

CAT3 - 16 MHz . 10
 가 /LAN ;

CAT5 - 100 MHz ;

(communication methods) - , , ;

(downstream) - xTU - C xTU - R ;

Galf - 81₁₆ 가 (octet); , HDLC 1 (ones complement);

(initiating signal) - ;

(initiating station) - DTE, DCE ;

(invalid frame) - (transparency octet) , 4 ;

- ;

(metallic local loop) - 5, ;

- ;

(responding station) - ;

(session) - ;

- - (tone based transmission) ;

(signaling family) - (carrier spacing frequency) ;

(splitter) - 2 ;

- (가)가 ;

- , [ACT(1)] (NA) - ;

(terminal) - ;

- xTU - R xTU - C .

가 .

ACK - Acknowledgement Message;

ADSL - Asymmetric Digital Subscriber Line;

CCITT - International Telegraph and Telephone Consultative Committee;

CDSL - Consumer Digital Subscriber Line;

DSL - Digital Subscriber Line;

FSK - Frequency Shift Keying;

GSTN - General Switched Telephone Network(PSTN);

HDSL - High bit rate Digital Subscriber Line;

HSTU - C - handshaking portion of the xDSL central terminal unit(xTU - C);

HSTU - R - handshaking portion of the xDSL remote terminal unit(xTU - R);

ISO - International Organization for Standardization;

ITU - T - International Telecommunication Union - Telecommunication Standardization Sector;

NAK - Negative Acknowledgement Message;

NTU - Network Termination Unit(Customer premise end);

POTS - Plain Old Telephone Service;

PSD - Power Spectral Density;

PSTN - Public Switched Telephone Network;

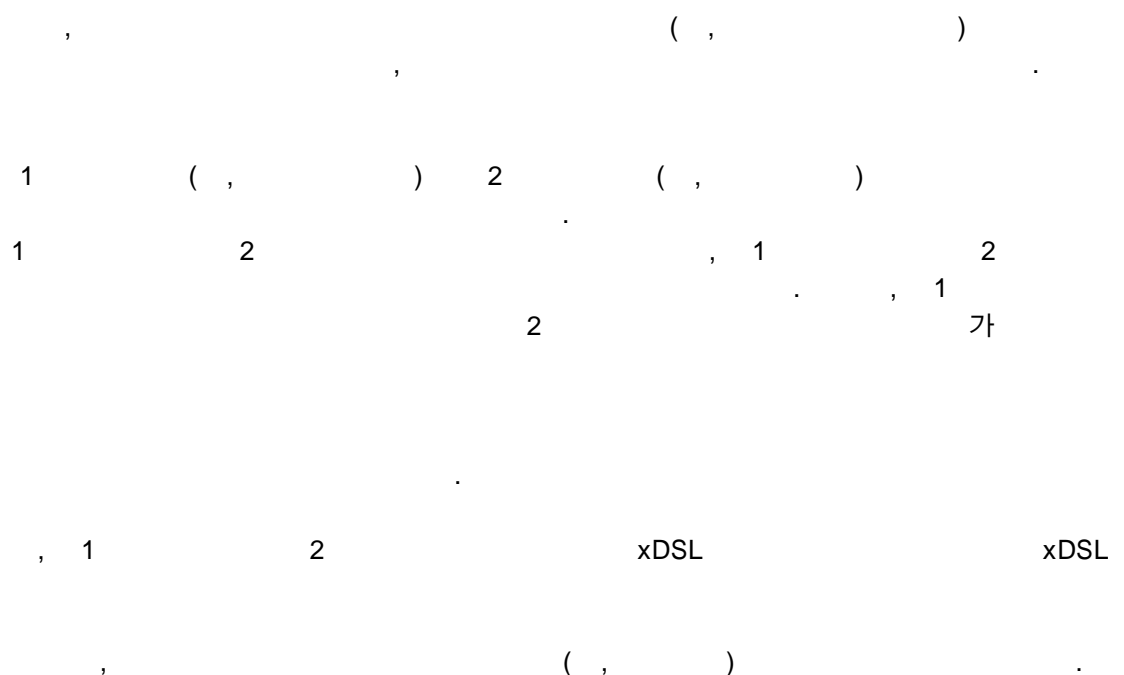
RADSL - Rate Adaptive DSL;

VDSL - Very high speed Digital Subscriber Line;

xDSL - any one of the various types of Digital Subscriber Line(DSL);

xTU - C - central terminal unit of an xDSL;

xTU - R - remote terminal unit of an xDSL.



1 (,) 2 (,) (, xDSL)
) 1 2 가 , 2
 . , 1 2
 가 .

4KHz .

1
 (,) (predetermined) 2 (,) 1
 , 1 2 가 1
 , 2 가 1
 , 1 2 가 , 2
 2 가 , 2
 가 , , .

1 2 xDSL .

1
 .

1 2 가 ,
 2 , 1 2 3
 가 ,
 .

4KHz .

1 (,
) 2 (,) , 1 2
 , 2 가 1
 , 가 ,
 2 가 1
 2 가 2 ,
 가 .

1 2 xDSL(, xDSL) .
 , 가 (4KHz
) .

가 1

가 .

, 1 1 2 , 2

, 1 2 , 2

. 가 1 , 1

2 가 . 1 2 가 2

가 , 1 1 2

가 .

, 1 2 xDSL(, xDSL)

. 가 (,)

. 4KHz .

, 1) 가 (

, 1 - ; 1 - 2 , 1 2

1 - ; 가 2 2 가

2 - ; 1 2

. 2

, 1 - , 1

, 2 - ; 1

2 - ; 2 가

2 가 - , 1 1

가 .

, 1 2 xDSL . ,

가 .

가 , 1

.

가

1

2

(, xDSL)

가

1

2

가

- ITU "Procedures For Starting Sessions Of Data Transmission Over The General Switched Telephone Network" V.8(09/04);
- ITU "Procedures for the Identification and Selection of Common Modes of Operation Between Data Circuit - Terminating Equipments(DCEs) and Between Data Terminal Equipments(DTEs) over the General Switched Telephone Network" V.8bis(08/96);
- ITU "Procedure For the Allocation of CCITT Defined Codes for Non - standard Facilities" T.35;
- ITU "A Modem Operating at Data Signaling Rates of Up To 33,600 bit/s for Use on the General Switched Telephone Network And on Leased Point - to - Point 2 - Wire Telephone - Type Circuits" V.34(10/96).

1999 1 8 US Provisional Application No. 60/115,294
가 .

1 1

$$2 \quad 1 \quad .$$

3 xTU-R xTU-C가 xTU-R

4 xTU-R xTU-C가 xTU-C

5 xTU - R xTU - C

6 xTU - R xTU - C

7 xTU - R xTU - C가 xTU - R

8 xTU - R , xTU - C가 xTU - R

9 xTU - R , xTU - C가 xTU - R

10 xTU - R xTU - C가 xTU - C

11 xTU - R , xTU - C가 xTU - C

12 xTU - R , xTU - C가 xTU - C

가 , 가

1 (central office system)(2) (re mote system)(4) 1 (5)

(2) (2) (5) MDF(main distribution f rame)(1) . MDF(1) (, 5)

(4) (4) (5) (NID) (3) . NID(3) (,)

/ , / (,), , / ()

2 1 1 (2) (4) (installation)

2 , (2) (34) (38), (test ne
 gotiation block)(46), (68), (70) (82) (. ()
 82) 가 . ()
 46) .

(34) (38) (5) .
 (46) (2), (4) (5) (condition),
 . (46) (,) (68,70) ,
 . (68) (4) ,
 (70) (4) . (68,70)
 , ADSL, HDSL, SHDSL, VDSL, CDSL (68,70)
 (46) 가 (52)
 (68) (82) . (54) (70)
 (82) .

(52) , (46) (52) (54) . (2)
 (52) , (54) .

(4) (36), (40), (48), (72),
 (66) (84) . (84) 가 (48)

(36) (40) (5) .
 (48) (2), (4) (5) .
 (72) (2) ,
 (66) (2) (56) (72)
 (84) . (50) (66) (84)

(56) , (48) (56) (50) . (4)
 (56) , (50) .

(4) (50) (2) (52)
 . (2) (54) (4)
 (56) .

(2) (4) (22,26,28,30,32) (6,10,
 14,16,18) . (6) (34,36)
 (, 0 - 4KHz) (32)
 . (4) (2) (33)
 (32) (33) ((36)) (5)
 . , (36) ,

(33)

(6,32) , ISDN . (38,40) 4KHz
 (34,36,38,40) ()

(10,14,16,18)(2) (22,26,28,30)(4) (82)
 (84)
 , (10,14,16,18) (discrete signals)()
 , (bundled),
 (10,14,16,18) RS - 232, , FireWire(IEEE - 1394), USB(Unive
 rsal Serial Bus), , (IrDA) () .
 가 , (22,26,28,30) (discrete signals)()
 , (bundled),

(2) (52) (54) (4) (5
 6) (50) , (, , ,),
 , (requirements) (,)가 .

(2), (4) (5) ,
 (46,48) , (2) (4)
 (33) (2)
 (entities) 가 , (5)
 (46,48) (42,44) , (4
 6,48) (42,44) (46,48) (2) (4)

2 ,

(2) (4) / (, CDMA,
 TDMA,)

0 Hz 4 KHz 가 PSTN .
 4 KHz
 1 25 KHz , T1E1 T1.413 ADSL 34.5 KHz
 (tone bursts)가 (precursor)

(4) (2)
(2) (4)
(52) (2)
(52) (2)
(4) (54)
(56) (training)
(duplex communication) (66,70)
(72,68) , DPSK(Differential(Binary) Phase S
hft Keying) 가 1
180 , 가 0
(arbitrary carrier phase) 가 0

(handshake procedure)가
가
(inter - modulation products) (rob
(spacing) . 4.3125 KHz 4.0 KHz (base frequency)

신호 수신지	업스트림 주파수 인덱스 (N)	다운스트림 주파수 인덱스 (N)
A43	9 17 25	40 56 64
B43	37 45 53	72 88 96
C43	7 9	12 14 64
A4	3	5
B4	4 28 34	66 67 76

(4) (limitation)

(2) (4)
(2) () (4)

(xTU - C) (2) (xTU - R) (4)
()

가

(prefix)

(suffix)가 가

TONE() -

;

TONES() - ;

TONES - REQ() -
;

FLAGS - 16 (hex character) "7E";

GALF - 16 "81"("7E").

 , 3 12 2 1, 2 , 1 500ms
 , 100 ms가 , 2 500 ms 50 ms
 , / 1, 2 가
 .

xTU - R , xTU - R xTU - C가

 , . 3 xTU - R
 , . 3 ,

xTU - R (R - TONES - REQ) ()
 , 16 ms . R - TONES - REQ 가 xTU - C , xTU - C
 (C - TONES) () . C - TONES 가 xTU - R
 , xTU - R , 50ms 500ms 2 (
 , (silence)), (R - TONE1) . xTU - C가 R - T
ONE1 , C - GALF1(16 "81") . xTU - R
 C - GALF1 , R - GLAG1 (16 "7E")
R - FLAG1 가 xTU - C , xTU - C C - FLAG1 . xTU - R xT
U - C C - FLAG1 , xTU - R 1 .

xTU - C가 , xTU - R xTU - C가

4 xTU - C xTU - R , xTU - C가
 , , xTU - C (C - TONES) ()
 . C - TONES 가 xTU - R , xTU - R (R
- TONE1) . xTU - C가 R - TONE1 , xTU - C
 C - GALF1 GALFs(16 "81") . C - GALF1 GALFs 가 xTU - R
 , xTU - R R - GLAG1 (16 "7E") . R - FLAG1
 가 xTU - C , xTU - C C - FLAG1 . xTU - R C - FLAG1
 , 1 .

가

(activation sequence) 가 , / (, xTU - C xTU - R)가
 , .

()

(a) 7 , xTU - R xTU - C가 xTU - R
;

(b) 8 , xTU - R , xTU - C
xTU - R ;

(c) 9 , xTU - R , xTU - C
xTU - R ;

(d) 10 , xTU - R xTU - C가 xTU - C
;

(e) 11 , xTU - R , xTU - C
xTU - C ;

(f) 12 , xTU - R , xTU - C
xTU - C .

xTU - R R - FLAG1 R - TONE1 C - TONES
. xTU - R R - TONE1 R - FLAG1 C - TONES
.

xTU - R , xTU - R xTU - C가

7 xTU - R xTU - C가 , xTU - R
. xTU - R (R - TONES - REQ) () , ,
16 ms . R - TONES - REQ 가 xTU - C , ,
xTU - C (C - TONES) () . C - TONES 가
xTU - R , xTU - R , 50ms 500ms 2
(, (silence)). , xTU - R xTU - C가 C - TONES
, 100ms 1 (R - FLAG1)
. R - FLAG1 가 , xTU - R , 2
(R - FLAG - HD2)가 . xTU - C가 R - FLAG - HD2 , , 100ms
(C - FLAG - HD) 가 , xTU - C
, 2 (C - FLAG - HD2)가 . xTU - C 가 ACK ,
xTU - R . , xTU - C 가 ACK가 , xTU - R R - FLAG
1 , , xTU - C R - FLAG1 ,
.

xTU - R , xTU - R xTU - C

8 xTU - R , xTU - R , xTU - C
. xTU - R (R - TONES - REQ) ()
, , 16ms . R - TONES - REQ
가 xTU - C , xTU - C (C - TONES) ()
. C - TONES 가 xTU - R , xTU - R , 50ms 500ms
, 2 (, (silence)). , xTU - R
, 100ms 1 (R - FLAG1) .

xTU - C , xTU - C C - GALF ,
 C - TONES . , xTU - C C - TONES . xTU - R C -
 TONES (end) , xTU - R xTU - C가
 . , xTU - R R - GALF Glafs 2 ,
 . xTU - C R - GALF Glafs , xTU - C C - TONES ,

xTU - R , xTU - R xTU - C

9 xTU - R , xTU - R , xTU - C
 . xTU - R (R - TONES - REQ) ()
 , 16ms . R -
 TONES - REQ 가 xTU - C , xTU - C (C - TONES) ()
 . C - TONES 가 xTU - R , xTU - R , 50ms
 500ms 2 (, (silence)).
 , xTU - R , 100ms 1
 (R - TONE1) .

xTU - C , xTU - C C - TONES . x
 TU - R C - GALF ()
 , xTU - R xTU - C가 . , xTU - R
 R - GALF 2 .

xTU - C가 , xTU - R xTU - C가

10 xTU - R xTU - C가 , xTU - C
 . xTU - C (R - TONES) () . C - TONES 가
 , 50ms 500ms 2 xTU - R , xTU - R xTU -
 C가 C - TONES , 100ms 1
 (R - FLAG1) . R - FLAG1 가 , xTU - R
 , 2 (R - FLAG - HD2)가 . xTU - C가 R - FLAG - HD2 ,
 , 100ms (C - FLAG - HD) . 가
 , xTU - C , 2 (C - FLAG - HD2)가 .

xTU - C 가 ACK , xTU - R . , xTU - C 가 A
 CK가 , xTU - R R - FLAG1 , 가 , xTU - C R - FLA
 G1 , . xTU - R ACK .

xTU - C가 , xTU - R xTU - C

11 xTU - C , xTU - R , xTU - C
 . xTU - C (C - TONES) ()
 . C - TONES 가 , 50ms 500ms 2 xTU -
 R , xTU - R , 100ms 1 (R - F
 LAG1) . xTU - C , xTU - C C - GALF
 , C - TONES . , xTU - C C - TONES
 , xTU - R C - TONES (end) () , xTU - C가
 . , xTU - R R - GALF 2 , . x
 TU - C R - GALF , C - TONES ,
 xTU - C가 , xTU - R xTU - C

12 xTU - C , xTU - R , xTU - C
 . xTU - C (C - TONES) ()
 . C - TONES 가 , 50ms 500ms 2 xTU -
 R , xTU - R , 100ms 1 (R -
 FLAG1) . xTU - C , xTU - C C - TO
 NES () . xTU - R C - GALF
 , (, C - TONES) . , xTU - R xTU - C가
 , R - GALF 2 , xTU - R
 , .
 , 5 xTU - R xTU - C
 (deactivating) . xTU - R(xTU - C) MS(mode selec
 t) , (16 "7E") . xTU - C(xTU - R)
 MS , xTU - C(xTU - R) , ACK(1)
 . xTU - R(xTU - C) ACK(1) , xTU - R(xTU - C) GALF (16 "
 81") , (,) , xTU - C(xTU - R)
 C(xTU - R)가 GALF , xTU - C(xTU - R)
 (,), .

6 xTU - R xTU - C (deactivating)
 . , xTU - R(xTU - C) ACK(1)
 . xTU - R(xTU - C) ACK(1) , xTU - R(xTU - C)
 (,), GALF (16 "81") , .
 xTU - C(xTU - R)가 , xTU - C(xTU - R) (,
), .
 , , xTU - C TU - R
 /
 가 , () . (, , ,)
 , , (,) .
 (,) (acceptance), (,) (rejectio

n), . , .

가 .

(Identification of Service), , , (. , , (.

(. , , (vendor) , , , 가 . , , , 가 .

, xDSL , , xDSL , , , 가 .

(interoperability) , 가 . (, V.8, V.8bis) . xDSL (resolution) . 가 .

1 (small interger variable) .

1.

세그먼트 NPar(3)s	8	7	6	5	4	3	2	1
단말에 의해 지정되지 않음	x	x	0	0	0	0	0	0
# 세그먼트(비트 6-1)	x	x	x	x	x	x	x	x
ITU-T에 의한 할당을 위해 예비됨	x	x	1	1	1	1	1	1

2 가 .

2. (duration octet)

데이터 속도 NPar(3)s	8	7	6	5	4	3	2	1
지속기간 (bits 6-1 x 5 ms)	x	x	x	x	x	x	x	x
예비됨	x	x	1	1	1	1	1	1

3 가 . 6 1 5 가 . , 32 64kbit/sec

3. - Octet2 - NPar(3)

데이터 속도 NPar(3)s	8	7	6	5	4	3	2	1
단말에 의해 지정되지 않음	x	x	0	0	0	0	0	0
데이터 속도 (비트 5-1 x 32 kbit/s)	x	x	0	x	x	x	x	x
데이터 속도 (비트 5-1 x 64 kbit/s + 1024kbit/s)	x	x	1	x	x	x	x	x
데이터 속도 1544 kbit/s	x	x	1	1	1	1	1	0
예비용	x	x	1	1	1	1	1	1

, ANSI T1.413 ITU - T V.34

, "가 (legacy)" (escape) (implici

tly) . 가 , 가 xDSL ,

가 ,

(57)

1.

1 2 ,

1 2 ;

1 2 ;

1 2

가

2.

1 ,

1 , 2

.

3.

1 ,

1 2 xDSL

.

4.

1 ,

xDSL

.

5.

1 ,

.

6.

5 ,

.

7.

1 ,

1 2 1

.

8.

7 ,

9.

1 2 ,

1 2 ;

2 - ;

1 2
가

10.

9 ,

1 , 2

11.

9 ,

1 2 xDSL

12.

9 ,

xDSL

13.

9 ,

14.

13 ,

4KHz

.

15.

9 ,

1

2

.

16.

15 ,

.

17.

,

1 2 2 - , 1

2 - ;

2 - , 2

1 - ;

가 1 1 가 1 2
2 가 , 2 2
- ;

, 2

.

18.

17 ,

1 , 2

.

19.

17 ,

1 2 xDSL

.

20.

17 ,

1

.

21.

20 ,

.

22.

17 ,

2 가 2 ,

1

2

.

23.

17 ,

.

24.

23 ,

4KHz

4KHz

.

30.

25

,

가

,

1

.

31.

,

1

1

2

-

,

1

,

2

- ;

2

-

,

2

1

- ;

가

1

-

,

가

1

2

가

- ;

2

가

2

-

,

1

1

2

1

가

-

.

32.

31

,

1

,

2

.

33.

31

,

1

2

xDSL

.

34.

31 ,

가

.

35.

34 ,

4KHz

.

36.

31 ,

가 , 1

.

37.

,

1 - , 1 2

- ;

1 2 - , 1 2 - ;

가 2
- , 1 2 가 2
- ;

2

.

38.

37 ,

1 , 2

.

39.

37

,

1

2

xDSL

.

40.

1

2

,

2

1

-

,

1

,

2

- ;

1

-

,

1

2

- ;

가

2

1

-

,

1

1

2

가

-

.

41.

40

,

1

,

2

.

42.

40

,

1

2

xDSL

.

43.

40

,

가

.

44.

43

,

4KHz

.

45.

40

,

가

,

1

.

46.

,

1

-

,

1

, 2

- ;

1

-

,

1

2

2

- ;

2

1

;

가

2

1

-

,

1

1

2

가

-

.

47.

46

,

1

,

2

.

48.

46

,

1

2

xDSL

.

49.

46 ,

가

.

50.

49 ,

4KHz

.

51.

46 ,

가

, 1

.

52.

17 ,

2

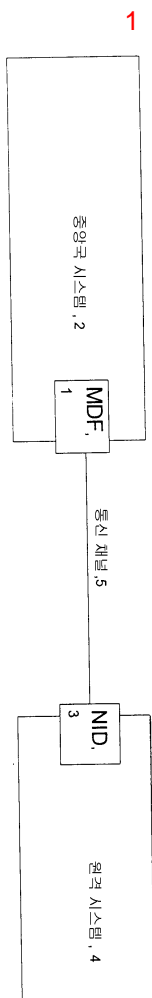
1

가

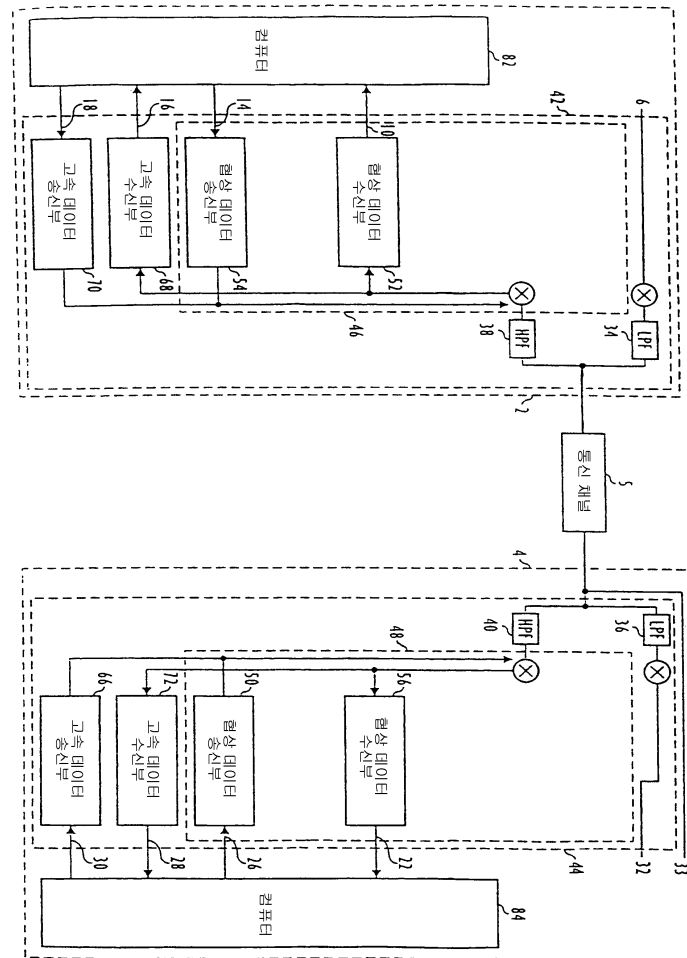
3

,

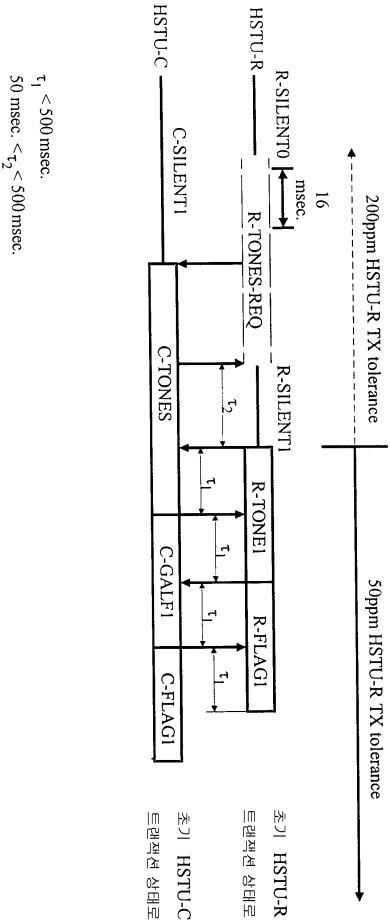
.



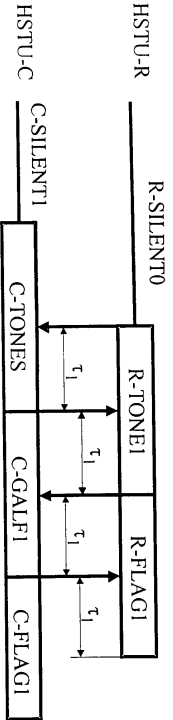
2



3



4

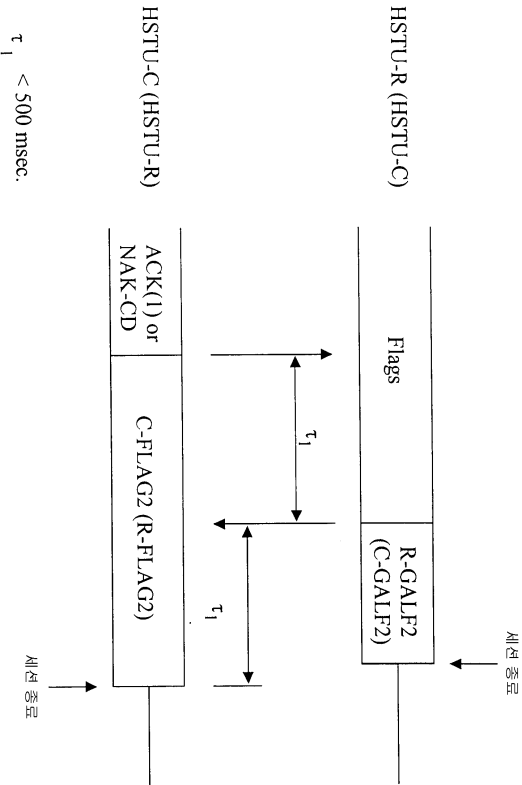


$t_1 < 500 \text{ msec.}$

초기 HSTU-R
트랜잭션 상태로

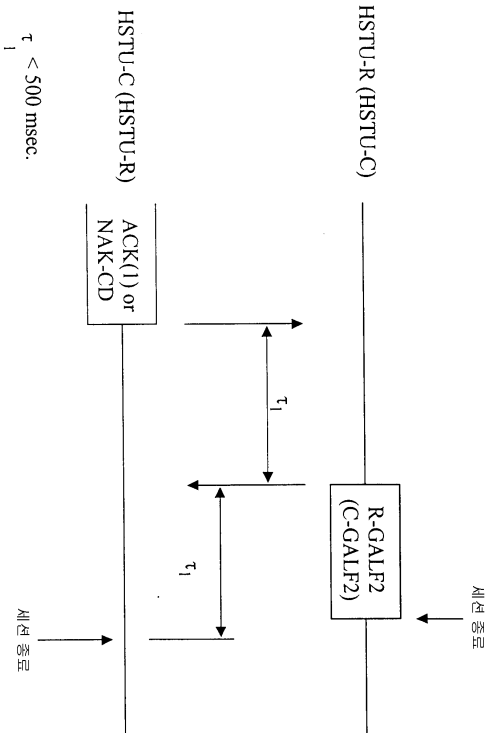
초기 HSTU-C
트랜잭션 상태로

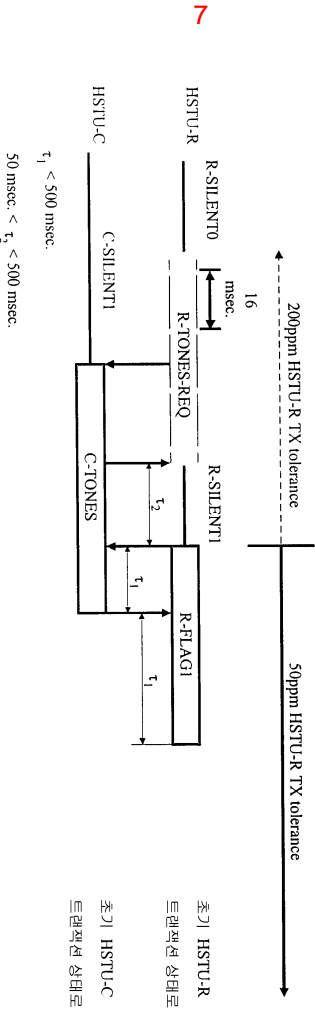
5



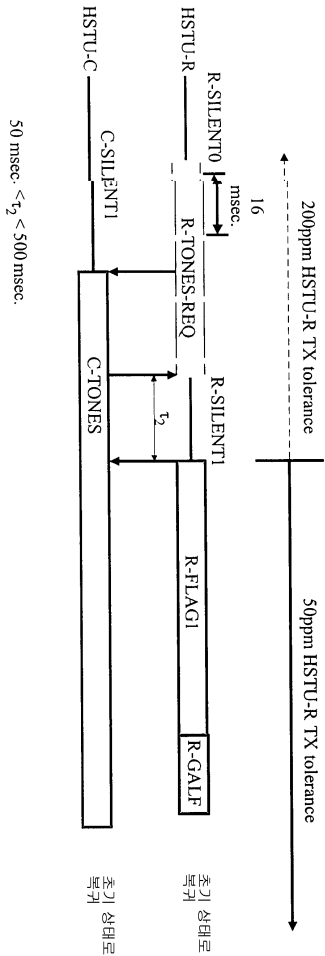
$\tau_1 < 500 \text{ msec.}$

6

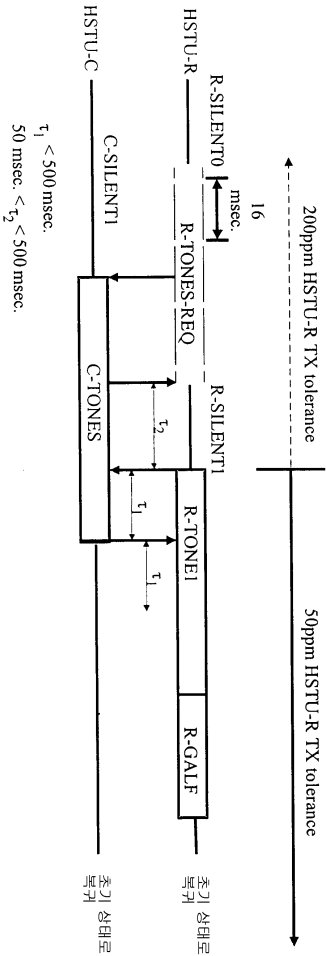




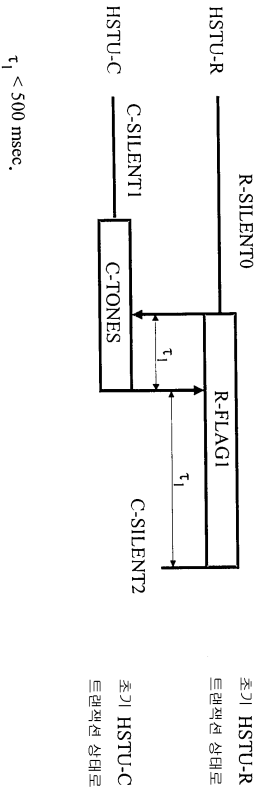
8



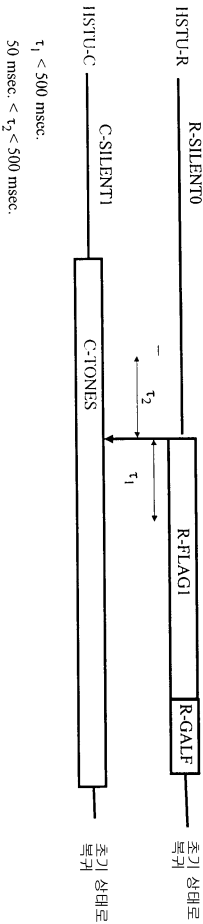
6



10



11



12

