

## Contents

Generic Requirements Notice of Disclaimer . . . . .	iii
Contents . . . . .	v
List of Figures . . . . .	xi
List of Tables . . . . .	xiii
Preface . . . . .	xv
1. Introduction . . . . .	1-1
1.1 Purpose . . . . .	1-1
1.2 Reason for Reissue . . . . .	1-1
1.3 Scope . . . . .	1-2
1.4 Applicability of Technical Specifications . . . . .	1-2
1.5 Alternate Arrangements . . . . .	1-2
1.6 Document Organization . . . . .	1-3
1.7 Requirements Terminology . . . . .	1-3
1.8 Requirement Labeling Conventions . . . . .	1-4
1.8.1 Numbering of Requirement and Related Objects . . . . .	1-4
1.8.2 Requirement, Conditional Requirement, and Objective Object Identification . . . . .	1-5
2. General Information . . . . .	2-1
2.1 Cross-Connects . . . . .	2-1
2.2 End User-to-End User Special Access Service . . . . .	2-2
3. Technical Information . . . . .	3-1
3.1 Scope . . . . .	3-1
3.2 Joint Engineering . . . . .	3-1
3.3 American National Standards References . . . . .	3-1
4. DS1 Service . . . . .	4-1
4.1 DS1 Interface . . . . .	4-1
4.1.1 Transmission Rate . . . . .	4-1
4.1.2 Line Code . . . . .	4-1
4.1.3 Termination . . . . .	4-3
4.1.4 Test Access . . . . .	4-3
4.1.5 Pulse Amplitude . . . . .	4-4
4.1.6 Pulse Shape . . . . .	4-4
4.1.7 Power Level . . . . .	4-4
4.1.8 Pulse Imbalance . . . . .	4-4
4.1.9 Jitter . . . . .	4-4
4.1.10 Loss . . . . .	4-5
4.1.11 Cable Characteristics . . . . .	4-6
4.2 DS1 Frame Format . . . . .	4-6
4.2.1 Superframe (SF) Format . . . . .	4-6
4.2.2 Extended Superframe (ESF) Format . . . . .	4-11
4.2.3 Free (Unframed) Format . . . . .	4-15
4.2.4 Maintenance . . . . .	4-15

4.3 DS1 Applications . . . . .	4-15
4.3.1 Unchannelized . . . . .	4-15
4.3.2 24 Channels at 64 kb/s . . . . .	4-16
4.3.3 24 Channels with Robbed-bit Signaling Channel . . . . .	4-16
4.3.4 ISDN Primary Rate Access (PRA) . . . . .	4-16
4.3.5 24 Channels with ISDN Basic Access Signal . . . . .	4-17
4.3.6 44/48 Channels Using 32-kb/s ADPCM . . . . .	4-17
4.3.7 23 Channels at 64 kb/s with Overhead Channel . . . . .	4-17
4.3.8 Asynchronous Transfer Mode (ATM) . . . . .	4-17
4.4 Clear Channel Capability (CCC) . . . . .	4-18
4.4.1 B8ZS Line Code . . . . .	4-18
4.4.2 Zero-Byte Time Slot Interchange (ZBTISI) . . . . .	4-18
4.5 DS1 Performance . . . . .	4-19
4.5.1 Accuracy Objective . . . . .	4-19
4.5.2 Availability Objectives . . . . .	4-19
4.5.3 DS1 Performance Tests . . . . .	4-19
4.6 DS1 Optional Features . . . . .	4-21
4.6.1 Automatic Facility Protection Switching (AFPS) . . . . .	4-21
4.6.2 Remote Transfer Arrangement . . . . .	4-22
4.6.3 Central Office Multiplexing . . . . .	4-22
4.7 Synchronization . . . . .	4-23
5. DS1C Service . . . . .	5-1
5.1 DS1C Interface . . . . .	5-1
5.1.1 Transmission Rate . . . . .	5-1
5.1.2 Line Code . . . . .	5-1
5.1.3 Pulse Density . . . . .	5-1
5.1.4 Termination . . . . .	5-3
5.1.5 Test Access . . . . .	5-3
5.1.6 Pulse Shape . . . . .	5-3
5.1.7 Power Level . . . . .	5-3
5.1.8 Pulse Imbalance . . . . .	5-4
5.1.9 Jitter . . . . .	5-4
5.1.10 Loss . . . . .	5-4
5.1.11 Cable Characteristics . . . . .	5-5
5.2 DS1C Frame Format . . . . .	5-5
5.2.1 Frame Overhead . . . . .	5-5
5.2.2 Alarm Signals . . . . .	5-7
5.3 DS1C Application: M1C Multiplex Format - 2 DS1 Channels . . . . .	5-8
5.4 DS1C Performance . . . . .	5-8
5.5 DS1C Optional Features . . . . .	5-8
6. DS2 Service . . . . .	6-1
6.1 DS2 Interface . . . . .	6-1
6.1.1 Transmission Rate . . . . .	6-1
6.1.2 Line Code . . . . .	6-1
6.1.3 Termination . . . . .	6-1
6.1.4 Test Access . . . . .	6-3

6.1.5	Pulse Shape	6-3
6.1.6	Power Level	6-3
6.1.7	Pulse Imbalance	6-3
6.1.8	Jitter	6-3
6.1.9	Loss	6-4
6.1.10	Return Loss	6-4
6.1.11	Cable Characteristics	6-4
6.2	DS2 Frame Format	6-4
6.2.1	Frame Overhead	6-5
6.2.2	Alarm Signals	6-8
6.3	DS2 Application: M12 Multiplex Format - 4 DS1 Channels	6-8
6.4	DS2 Performance	6-8
6.5	DS2 Optional Features	6-9
7	DS3 Service	7-1
7.1	DS3 Interface	7-1
7.1.1	DS3 Transmission Rate	7-1
7.1.2	Line Code	7-3
7.1.3	Termination	7-3
7.1.4	Test Access	7-3
7.1.5	Pulse Shape	7-4
7.1.6	Power Level	7-5
7.1.7	Pulse Imbalance	7-5
7.1.8	Jitter	7-5
7.1.9	Loss	7-6
7.2	DS3 Frame Format	7-8
7.2.1	Frame Overhead	7-8
7.2.2	Application Identification Channel Signal	7-10
7.2.3	Alarm and Status Signals	7-10
7.2.4	Performance Monitoring	7-12
7.3	DS3 Application: M23 Multiplex Format - 7 DS2 Channels	7-13
7.4	DS3 Application: DS3 C-Bit Parity - 28 DS1 Channels	7-15
7.4.1	C-Bit Utilization	7-15
7.5	DS3 Application: Unchannelized	7-25
7.5.1	Far-End Alarm Signal	7-25
7.6	DS3 Performance	7-25
7.6.1	Accuracy Objective	7-25
7.6.2	Availability Objectives	7-26
7.6.3	DS3 Performance Tests	7-26
7.7	DS3 Optional Features	7-27
8	STS-1 Service	8-1
8.1	STS-1 Interface	8-1
8.1.1	STS-1 Transmission Rate	8-1
8.1.2	Line Code	8-1
8.1.3	Termination	8-1
8.1.4	Test Access	8-4
8.1.5	Pulse Shape	8-4

8.1.6 Power Level . . . . .	8-4
8.1.7 Jitter . . . . .	8-5
8.1.8 Cable Characteristics . . . . .	8-5
8.2 STS-1 Frame Format . . . . .	8-5
8.2.1 STS-1 Frame Structure . . . . .	8-5
8.2.2 Transport Overhead . . . . .	8-5
8.2.3 Synchronous Payload Envelope . . . . .	8-5
8.3 STS-1 Performance . . . . .	8-9
8.3.1 Accuracy Objectives . . . . .	8-10
8.3.2 Availability Objectives . . . . .	8-10
8.3.3 STS-1 Performance Tests . . . . .	8-10
8.4 Synchronization . . . . .	8-12
9. DS4NA Service . . . . .	9-1
9.1 DS4NA Interface . . . . .	9-1
9.1.1 Transmission Rate . . . . .	9-1
9.1.2 Line Code . . . . .	9-1
9.1.3 Termination . . . . .	9-1
9.1.4 Test Access . . . . .	9-4
9.1.5 Pulse Shape . . . . .	9-4
9.1.6 Power Level . . . . .	9-5
9.1.7 Jitter . . . . .	9-5
9.1.8 Loss . . . . .	9-5
9.1.9 Cable Characteristics . . . . .	9-6
9.2 DS4NA Frame Format . . . . .	9-6
9.2.1 Frame Overhead . . . . .	9-6
9.2.2 Alarm Signals . . . . .	9-8
9.2.3 Maintenance Channels . . . . .	9-8
9.2.4 Performance Monitoring . . . . .	9-8
9.3 DS4NA Application: M34 Multiplex Format - 3 DS3 Channels . . . . .	9-9
9.3.1 Alarms (Alarm Indication Signal [AIS]) . . . . .	9-10
9.3.2 Maintenance Channels . . . . .	9-10
9.4 DS4NA Performance . . . . .	9-12
9.5 DS4NA Optional Features . . . . .	9-12
10. STS-3 Service . . . . .	10-1
10.1 STS-3 Interface . . . . .	10-1
10.1.1 STS-3 Transmission Rate . . . . .	10-1
10.1.2 Line Code . . . . .	10-1
10.1.3 Termination . . . . .	10-1
10.1.4 Test Access . . . . .	10-4
10.1.5 Pulse Shape . . . . .	10-4
10.1.6 Power Level . . . . .	10-4
10.1.7 Jitter . . . . .	10-4
10.1.8 Cable Characteristics . . . . .	10-4
10.2 STS-3 Frame Format . . . . .	10-5
10.2.1 STS-3 Frame Structure . . . . .	10-5
10.2.2 Concatenated STS-1s . . . . .	10-5

10.3 STS-3c Performance . . . . .	10-7
10.3.1 Accuracy Objectives . . . . .	10-8
10.3.2 Availability Objectives . . . . .	10-8
10.3.3 STS-3c Performance Tests . . . . .	10-8
10.4 Synchronization . . . . .	10-10
11. Network Channel Interface (NCI) Codes and Combinations . . . . .	11-1
11.1 NCI Code Components . . . . .	11-1
11.1.1 Number of Wires . . . . .	11-1
11.1.2 Protocol Code . . . . .	11-1
11.1.3 Nominal Reference Impedance . . . . .	11-2
11.1.4 Protocol Option . . . . .	11-2
11.2 NCI Code Selection . . . . .	11-2
References . . . . .	References-1
Telcordia Documents . . . . .	References-1
Other Documents . . . . .	References-1
Reference Note . . . . .	References-3
To Contact Telcordia Customer Service . . . . .	References-3
To Order Documents From Outside Telcordia . . . . .	References-3
To Order Documents Within Telcordia . . . . .	References-3
Glossary . . . . .	Glossary-1
Acronyms . . . . .	Acronyms-1



## List of Figures

Figure 4-1	DSX-1 Isolated Pulse Template and Corner Points . . . . .	4-2
Figure 4-2	Schematic Drawing of Cross-Connect for DSX-1, DSX-1C, and DSX-2 . . . . .	4-3
Figure 4-3	Insertion Loss and Phase of Typical Cable for DS1, DS1C, and DS2 . . . . .	4-8
Figure 4-4	Channelized DS1 Frame Bit Assignments . . . . .	4-9
Figure 4-5	Superframe Frame Structure . . . . .	4-10
Figure 4-6	Channelized Extended Superframe Frame Structure . . . . .	4-13
Figure 4-7	Automatic Facility Protection Switching . . . . .	4-21
Figure 4-8	Remote Transfer Arrangement . . . . .	4-22
Figure 4-9	Central Office Multiplexing (with “Fanout”) . . . . .	4-23
Figure 5-1	DSX-1C Isolated Pulse Template and Corner Points . . . . .	5-2
Figure 5-2	DS1C Frame Structure . . . . .	5-6
Figure 6-1	DSX-2 Isolated Pulse Template and Equations . . . . .	6-2
Figure 6-2	DS2 Frame Structure . . . . .	6-6
Figure 7-1	DSX-3 Isolated Pulse Template and Equations . . . . .	7-2
Figure 7-2	Cross-Connect Schematic for DSX-3 and DSX-4NA . . . . .	7-4
Figure 7-3	Insertion Loss and Phase of Typical Cable for DS3, DS4NA, STS-1, and STS-3 . . . . .	7-7
Figure 7-4	DS3 Frame Structure . . . . .	7-9
Figure 7-5	DS3 Application: M23 Multiplex Format - 7 DS2 Channels . . . . .	7-14
Figure 7-6	Q.921/LAPD Message Structure . . . . .	7-22
Figure 8-1	STS-1 Interface Isolated Pulse Mask and Equations . . . . .	8-2
Figure 8-2	STS-1 Eye Diagram . . . . .	8-3
Figure 8-3	STS-1 Frame . . . . .	8-6
Figure 8-4	STS-1 Synchronous Payload Envelope (SPE) . . . . .	8-7
Figure 8-5	STS-1 Synchronous Payload Envelope with STS-1 POH and STS-1 Payload Capacity Illustrated . . . . .	8-8
Figure 8-6	STS-1 SPE in Interior of STS-1 Frame . . . . .	8-9
Figure 9-1	DS4NA Interface Eye Diagram . . . . .	9-2
Figure 9-2	DS4NA Maximum Equipment Output Eye Diagram . . . . .	9-3
Figure 9-3	Coded Mark Inversion . . . . .	9-4
Figure 9-4	DS4NA Frame Structure . . . . .	9-7
Figure 9-5	DS4NA Application: M34 Multiplex Format - 3 DS3 Channels . . . . .	9-11
Figure 10-1	STS-3 Interface Eye Diagram . . . . .	10-2
Figure 10-2	STS-3 Maximum Equipment Output Eye Diagram . . . . .	10-3
Figure 10-3	STS-N Frame . . . . .	10-6
Figure 10-4	STS-Nc Synchronous Payload Envelope . . . . .	10-7





## List of Tables

Table 4-1	Output Jitter at Hierarchical Interfaces . . . . .	4-5
Table 4-2	Superframe Format . . . . .	4-7
Table 4-3	Extended Superframe Format . . . . .	4-14
Table 5-1	DS1C Frame Overhead Structure . . . . .	5-7
Table 6-1	DS2 Frame Overhead Structure . . . . .	6-7
Table 7-1	DS3 Frame Overhead Structure . . . . .	7-11
Table 7-2	Far-End Alarm/Status Signal Codes . . . . .	7-17
Table 7-3	Bit-Oriented Signals - C-Bit Parity Loopback Commands . . . . .	7-18
Table 7-4	Unassigned C-Bit Parity Application Codes . . . . .	7-19
Table 7-5	Path, Idle Signal, and Test Signal Identification - Message Content . . . . .	7-23
Table 9-1	DS4NA Frame Overhead Structure . . . . .	9-9
Table 11-1	Total Wires . . . . .	11-1
Table 11-2	Glossary of Protocol and Selected Options . . . . .	11-3
Table 11-3	Impedance . . . . .	11-6
Table 11-4	Compatible Interface Combinations . . . . .	11-7