ATIS-0100302.1989(R2006)

DIGITAL PROCESSING OF VOICE-BAND SIGNALS LINE FORMAT FOR 32-KBITS ADAPTIVE DIFFERENTIAL PULSE-CODE MODULATION (ADPCM)

AMERICAN NATIONAL STANDARD FOR TELECOMMUNICATIONS

ATIS is the leading technical planning and standards development organization committed to the rapid development of global, market-driven standards for the information, entertainment and communications industry. More than 250 companies actively formulate standards in ATIS' 20 Committees, covering issues including: IPTV, Service Oriented Networks, Home Networking, Energy Efficiency, IP-Based and Wireless Technologies, Quality of Service, Billing and Operational Support. In addition, numerous Incubators, Focus and Exploratory Groups address emerging industry priorities including "Green", IP Downloadable Security, Next Generation Carrier Interconnect, IPv6 and Convergence.

ATIS is the North American Organizational Partner for the 3rd Generation Partnership Project (3GPP), a member and major U.S. contributor to the International Telecommunication Union (ITU) Radio and Telecommunications' Sectors, and a member of the Inter-American Telecommunication Commission (CITEL). For more information, please visit < http://www.atis.org >.

AMERICAN NATIONAL STANDARD

Approval of an American National Standard requires review by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made towards their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

CAUTION NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Notice of Disclaimer & Limitation of Liability

The information provided in this document is directed solely to professionals who have the appropriate degree of experience to understand and interpret its contents in accordance with generally accepted engineering or other professional standards and applicable regulations. No recommendation as to products or vendors is made or should be implied.

NO REPRESENTATION OR WARRANTY IS MADE THAT THE INFORMATION IS TECHNICALLY ACCURATE OR SUFFICIENT OR CONFORMS TO ANY STATUTE, GOVERNMENTAL RULE OR REGULATION, AND FURTHER, NO REPRESENTATION OR WARRANTY IS MADE OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. ATIS SHALL NOT BE LIABLE, BEYOND THE AMOUNT OF ANY SUM RECEIVED IN PAYMENT BY ATIS FOR THIS DOCUMENT, WITH RESPECT TO ANY CLAIM, AND IN NO EVENT SHALL ATIS BE LIABLE FOR LOST PROFITS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES. ATIS EXPRESSLY ADVISES ANY AND ALL USE OF OR RELIANCE UPON THIS INFORMATION PROVIDED IN THIS DOCUMENT IS AT THE RISK OF THE USER.

NOTE - The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim or any patent rights in connection therewith. The patent holder has, however, filed a statement of willingness to grant license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license. Details may be obtained from the publisher.

ATIS-0100302.1989(R2006), *Digital Process of Voice-Band Signals – Line Format for 32-kbits Adaptive Differential Pulse-Code Modulation (ADPCM)*

Formerly known as T1.302-1989(R2006).

Is an American National Standard developed by the **ATIS Network Performance, Reliability, and Quality of Service Committee (PRQC)**.

Foreword

For over 20 years, Pulse-Code Modulation (PCM) at 64-kbit/s has been considered the standard for quality digital encoding of voice channels. New 32-kbit/s Adaptive Differential Pulse-Code Modulation (ADPCM) terminals have recently been made available for use in the network, which yield only slightly lower quality of speech than 64-kbit/s PCM and which permit voice-band data up to 2.4 kbit/s without significant degradation. High-speed data at 4.8 kbit/s can be accommodated when used in accordance with American National Standard for Telecommunications — Network Performance — Tandem Encoding Limits for 32-kbit/s Adaptive Differential Pulse-Code Modulation (ADPCM), ANSI T1.501-1988. These terminals use the known statistics of the voice signal and feature speech processing made possible by very-large-scale-integration (VLSI) technology. With these currently available low bit-rate voice (LBRV) terminals, it is possible to double the voice channel capacity of existing digital facilities. Various line formats are used by the various vendors of LBRV products to transport signaling in the ADPCM channel.

The purpose of this American National Standard is to standardize three line formats so that vendors can provide compatible equipment for the U.S. marketplace and so that both exchange and interexchange carriers may operate compatibly. The three line formats are Bundle, Transition, and Robbed-Bit Signaling. The algorithms that are necessary for these line formats are specified in American National Standard for Telecommunications — Digital Processing of Voice-Band Signals — Algorithms for 24-, 32-, and 40-kbit/s Adaptive Differential Pulse-Code Modulation (ADPCM), ANSI T1.303-1989. This standard, together with ANSI T1.303-1989, supersedes American National Standard for Telecommunications — Digital Processing of Voice-Band Signals — Algorithm and Line Format for 32-kbit/s Adaptive Differential Pulse-Code Modulation (ADPCM), ANSI T1.301-1987. It is expected that equipment manufacturers and carriers will utilize both ANSI T1.302-1989 and T1.303-1989.

Suggestions for improvement of this standard will be welcome. They should be sent to the Exchange Carriers Standards Association, 5430 Grosvenor Lane, Bethesda, MD 20814.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Telecommunications, T1. Committee approval of the standard does not necessarily imply that all members voted for its approval. At the time it approved this standard, the T1 Committee had the following members:

Ivor N. Knight, Chair
Arthur K. Reilly, Vice-Chair
O. J. Gusella, Secretary

Organization Represented	*Name of Representative*
EXCHANGE CARRIERS	
Alltel Service Corporation	John B Kohut
Ameritech Services, Inc.	Timothy D. Timmons
	Robert Koren (Alt)
Bell Atlantic	John W Seazholtz
	Roger Nucho (Alt)
Bellcore	Ian M Lifchus
	Martin T. Sullivan (Alt)
BellSouth Services	Leonard Strickland, Jr
	William J. McNamara, III (Alt)
Centel Corporation	Joseph J Olejar, III
	James W. Weith (Alt)
Cincinnati Bell Telephone	William P. Keidel
Contel Corporation	Russell G. DeWitt
	Stephen P Welsh (Alt)

Organization Represented	Name of Representative
Exchange Carriers Standards Association . .	James L Eitel
	Timothy D Timmons (Alt)
GTE SC/Telephone Operations .	Greg L Theus
	Richard L. Cochran (Alt)
National Telephone Cooperative Association .	Joseph M. Flanigan
NYNEX Service Company . .	J Fey
	Leo Katz (Alt)
Pacific Bell	Fred Doell
	Tom Garcia (Alt)
Puerto Rico Telephone Company	Segundo Ruiz
Southern New England Telephone	H D Mulla
	J K Vij (Alt)
Southwestern Bell Telephone Company .	Joseph Mendoza
	Bob Caskey (Alt)
Telephone & Data Systems, Inc	Rudolph E Hornacek
United Telecommunications, Inc.	Harold L Fuller
	Robert P. McCabe (Alt)
United States Telephone Association . . .	Paul K Hart
	Thomas Gajeski (Alt)
U S WEST	James Dahl
	Paul Hughes (Alt)

INTEREXCHANGE CARRIERS

AT&T Communications	Henry L. Marchese
	Gerald H. Peterson (Alt)
CNCP Telecommunications	Roger M Hay
	John D Rogers (Alt)
Communications Transmission, Inc.	Walter G. Lammert
	Stephen D. Klingler (Alt)
COMSAT Corporation	Stephen J. Engelman
	Ivor N. Knight (Alt)
Contel ASC	Michael K Ward
	Kap Kim (Alt)
International Telecharge, Inc.	Alex Daspit
	Diane Harbaugh (Alt)
MCI Telecommunications Corporation	Shekhar Tiwari
	John Gurzick (Alt)
Telecom Canada	B. Houle
	D. G. Wherry (Alt)
US Sprint	Peter J. May
	Eric Scace (Alt)
Western Union Telegraph Company	Jacob Rabinowitz

MANUFACTURERS

ADC Telecommunications, Inc.	Patrick Cameron
	Nick Stanley (Alt)
Alcatel Network Systems Corporation	Kenneth P. Ray
	Stig Persson (Alt)
AMP, Inc.	Edward Kelly
	George Lawrence (Alt)
Apple Computer, Inc.	Mike Lawler
AT&T Technologies	L. A. Hohmann
	J. R Myrick, Jr (Alt)
Bowmar/ALI, Inc	Arthur Torino
	Ted Eiselen (Alt)
Digital Equipment Corporation	Robert DiMeo
	Henry Lowe (Alt)
DSC Communications Corporation	Allen Adams
	Kishan Shenoi (Alt)
ECI Telecom, Inc.	J R. Kennedy
	Ron Murphy (Alt)
Ericsson, Inc.	David Breeding
	Guy Campbell (Alt)
Fortel Corporation	Stephen V. Lyle
Fujitsu America, Inc.	Steven A. Minneman
	Roger Pandanda (Alt)
General DataComm, Inc.	Frederick Cronin
	Thomas Thompson (Alt)

Organization Represented	Name of Representative
GTE Communication Systems Corporation	Nigel J E Reynolds
Harris Corporation	Brian Jones
	David Cox (Alt)
Hekimian Laboratories, Inc	Larry E Keith
	Mike F Toohig (Alt)
Hewlett-Packard	Don C Loughry
	Richard van Gelder (Alt)
Honeywell Bull	Robert F Stover
IBM Corporation	Robert M Amy
	Ronald C Kunzelman (Alt)
Integrated Technology, Inc	Mark Lanning
	Dave Hensley (Alt)
LICOM, Inc	Maynard Graden, III
	Carl Engineer (Alt)
Mitel Corporation	Keith Richardson
	David Gleave (Alt)
Motorola, Inc	G David Forney, Jr
	David Morgan (Alt)
Myriad Concepts, Inc	Michael Kelly
	Michael Shepperd (Alt)
NEC America, Inc	Wayne Lohman
	Art Graham (Alt)
Northern Telecom, Inc	David R Cairns
	Vic Boersma (Alt)
Paradyne Corporation	R K Smith
	Wayne Moore (Alt)
Plantronics, Inc	M. Farrant
	Brian Cole (Alt)
Poynting Corporation	Kamal I Parikh
	Howard T Mason (Alt)
Racal-Milgo, Inc	Donald O'Connor
	Jack Stephenson (Alt)
Rockwell International Corporation	James T Carter, Jr
	Everett Turvey (Alt)
Siemens Communication Systems, Inc	Michael A Pierce
	Dan R Mondor (Alt)
Stromberg-Carlson Corporation	Roger Lanham
	Ron Kandell (Alt)
Telco Systems, Inc.	H. A. Carnes
	Marshall Hudson (Alt)
Telecom Solutions	M J Narasimha
	Richard T. Bobilin (Alt)
Telecommunications Techniques	Joseph A. Sciulli
	Bernard E Worne (Alt)
Telex Computer Products, Inc	Frederick Skoog
	Douglas Kendrick (Alt)
TELINQ Systems, Inc	Jeff Foust
	Robert Felice (Alt)
Timplex, Inc	Shiv Verma
	Paul Lue (Alt)
Unisys	Stanley D. Fenner
	Marvin Bass (Alt)
US Telecommunications Suppliers Association	Michael J Birck
	Paul DeLuca (Alt)
Verilink Corporation	William J Buckley
Videoconferencing Systems, Inc.	John Nuwer
	Ken Hutchison (Alt)

GENERAL INTEREST

American Broadcasting Company	Howard Meiseles
	Ken Michel (Alt)
Ashford Associates	Donald A. Ashford
BDM Corporation	Roy Bernd
Carter Hawley Hale Information Service	James A. Rothenberger
	Vic Accettura (Alt)
CBS Broadcasting Group, CBS, Inc	Stavros Hilaris
	Joseph McNulty (Alt)
Creative Communications Consulting.	Richard Bobilin
	James Boe (Alt)

Organization Represented	_Name of Representative_
Defense Communications Agency	Martin A Thompson
	Benjamin Bakke (Alt)
Federal Express Corporation	Michael E Varrassi
	Paul L Davis (Alt)
Martin-Marietta — Information and Communications	J Horrell
	Mike Maher (Alt)
National Broadcasting Company	Ronald J Gnidziejko
National Bureau of Standards	Robert Rountree, Jr
National Communications System	Charles D Bodson
	D D Wilson (Alt)
National Telecommunication & Information Administration	
Institute for Telecommunication Sciences	William F Utlaut
	Neal B Seitz (Alt)
Omnicom, Inc.	Harold C Folts
Rural Electrification Administration	M Wilson Magruder
	Gerald S Schrage (Alt)
U S General Services Administration	Thomas J Drury
	William Rinehuls (Alt)
Utilities Telecommunications Council	Frank S Law
	Shirley S Fujimoto (Alt)

At the time it approved the standard, the Technical Subcommittee T1Y1 on Specialized Subjects had the following members:

Fred C. Rossol, Chair
Marshall G. Schachtman, Vice-Chair
James D. Mills, Secretary

Organization Represented	_Name of Representative_
ADC Telecommunications, Inc .	Patrick Cameron
	Jeffrey McNamee (Alt)
Amdàhl Communications, Inc. .	Farooq Raza
	Thomas Lau (Alt)
Ameritech Services, Inc	Richard J Gillitzer
	John Berkich (Alt)
Ashford Associates	Donald A. Ashford
AT&T Communications.	Anthony Schiano
	Frank J. Fiederlein (Alt)
AT&T Technologies.	Fred C. Rossol
	Duncan Sparrell (Alt)
Avanti Communications Corporation .	Paul H. Fredette
	James C Hart (Alt)
Aydin Monitor Systems..	Harry E Watkins
Base-2 Systems, Inc.	Douglas M Brady
Bell Atlantic.....	Hank Hudson
	Mark Sanders (Alt)
Bellcore	Marshall G Schachtman
	Milton Anderson (Alt)
BellSouth Services..	H. W Chen
	A G. Drott (Alt)
Canadian Broadcasting Corporation	David Bennett
	Kenneth P Davies (Alt)
Compression Labs, Inc. .	Lyle Rennick
COMSAT Corporation	Stephen J. Engelman
	Ivor N. Knight (Alt)
Contel Corporation.	Patrick E. Dobbins
	Larry Day (Alt)
Creative Communications Consulting	Richard Bobilin
	James Boe (Alt)
DSC Communications Corporation.	Moon Song
	Ronald Foster (Alt)

Organization Represented	Name of Representative
ECI Telecom, Inc	Ron Murphy
	J R. Kennedy (Alt)
Ericsson, Inc	Goran Benjamin
	Bengt Lagerstedt (Alt)
GEC Video Systems	Edward A Daly
General DataComm Industries, Inc.	John Cumerton
	Christopher Jacobsen (Alt)
GTE Communication Systems Corporation	M Gilbert
GTE SC/Telephone Operations	Norman Epstein
	Larry G Jantze (Alt)
Harris Corporation	Loren Dooley
	Tom Eames (Alt)
Integrated Telecom Corporation	Richard W Young
	David Abmayr (Alt)
Lorain Products	Richard L Haag
	Robert J. Plow (Alt)
M/A-Com Corporation	Ray Lowe
	Robert Kepley (Alt)
Martin-Marietta — Information and Communications	J Horrell
	W Fred Seigneau (Alt)
MCI Telecommunications Corporation	Thomas S Will
	M Rezvani (Alt)
Motorola, Inc	Ronald Cheung
	Tim Williams (Alt)
National Communications System	Andre Rausch
	Robert M Fenichel (Alt)
NEC America, Inc..	T Sakabe
	Hitoshi Sato (Alt)
Niravoice, Inc.	Dick Woods
	Nira Schwartz (Alt)
Northern Telecom, Inc .	David R Cairns
	Scott Shaw (Alt)
NYNEX Service Company	F T Burns
	A E DiBlanda (Alt)
Pacific Bell	Tom Garcia
	V. Nunez (Alt)
Phoenix Microsystems, Inc	Mark Hoffman
	Rae Brockman (Alt)
PictureTel Corporation	Staffan Ericsson
	Craig Clapp (Alt)
Plantronics, Inc.	Brian Cole
Racal-Milgo, Inc	Michael S Clott
	Ming-Luh Kao (Alt)
Ratelco, Inc	Alvin G. Graham
	Mark A. Resler (Alt)
Rockwell International Corporation	Charles Havens
Siemens Communication Systems, Inc	Steve Gorshe
	Michael A. Pierce (Alt)
Southern New England Telephone Company	D F Delaney
Southwestern Bell Telephone Company	Hal Holzwarth
	Bob Hall (Alt)
Telecom Canada	Lawrence C. Gooddy
	Glenn R. Schimpf (Alt)
Telecom Solutions	M. J Narasimha
	Richard T. Bobilin (Alt)
Tellabs, Inc	James L Melsa
	James D Mills (Alt)
Timeplex, Inc	Zigmunds Putnins
US Sprint	Tom Croda
	Peter J May (Alt)
U S Telephone Association (USTA)	Thomas Gajeski
	Dennis Byrne (Alt)
U S WEST	James L Eitel
	D L Kaus (Alt)
Videoconferencing Systems, Inc	John Nuwer
	Ken Hutchison (Alt)
Western Union Telegraph Company	Hans Nord

Working Group T1Y1.2, who developed this standard, had the following participants:

Marshall G Schachtman, Chair
Stephen J. Engelman, Vice-Chair
James D. Mills, Secretary

David W Abmayr
Milton Anderson
Sassan Babaie
Salil Banerjee
Jacques Bissinger
Kent Blette
Dick Bobilin
Luis Bonet
Peter Boreland
Douglas M Brady
William J Brinkley
Rae Brockman
Fred Burns
Peter L Bye
Hugh W Chen
Ron Cheung
Michael Clott
Brian Cole
Jon Cole
Alan Culbertson
John Cumberton
Cliff Davidow
D F Delaney
Adrian R Dennis
Jim Dolce, Jr
Gene M Durrence
Staffan Ericsson
Herbert Feder
Richard H Fish
Percy Fleming
Richard Fowler

Tom Garcia
Paul Garrett
Ronald Genereux
Mike Gilbert
Dick Gillitzer
L C Gooddy
Robert Hall
Bernard J Harris
Larry Hartshorn
Gary Heinz
Hal Holzwarth
Joel Horrell
Henry G Hudson, Jr
Melvyn Huff
D L Kaus
J R Kennedy
Bob Kepley
Tom Kilm
Raj Koneru
Bob Kubichek
Tom Lau
Trey Malpass
L A. Marshall
Bob McCabe
James L. Melsa
James Mossman
Ronald E Murphy
Ming D. Ni
Victor Nunez
Bruce A. Orford
Michael K Owens

Orni Petrushka
Tony Presti
Dave Puente
Zigmunds Putnins
Ed Quincy
Dmitry Radbel
Farooq Raza
Jack H Rieser
Charles E Rohrs
David Rondeau
Fred C Rossol
Stephen Sackel
Nick Satomi
Anthony Schiano
Krishna Shetty
Moshe Sholomovich
Sree Sistla
Moon Song
Duncan Sparrell
Tsuneo Tatara
Henry N Tenody
Dan Tomich
H E. Watkins
Milton Weiner
Tim A Williams
Phil Wilson
James D Wiseman
Dick Woods
Yoshihiko Yokoyama
Teresa Zoller

Contents

American National Standard for Telecommunications —

Digital Processing of Voice-Band Signals — Line Format for 32-kbits Adaptive Differential Pulse-Code Modulation (ADPCM)

1.1 Scope, Purpose, and Application

1.1 Scope

1.1.1 This standard applies to Adaptive Differential Pulse-Code Modulation (ADPCM) telecommunications systems where the channel pulse rate is 32 kbit/s.

NOTE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim or of any patent rights in conjunction therewith The patent holder has, however, filed a statement of willingness to grant a license under these rights on reasonable and non-discriminatory terms and conditions to applicants desiring to obtain such a license Details may be obtained from the publisher No representation or warranty is made or implied that this is the only license that may be required to avoid infringement in use of this standard.

1.1.2 This standard provides for line formats used in Bundle, Transition, and Robbed-Bit Signaling modes for transcoded channels comprising channel pulse rates of 32 kbit/s combined in a line format operating at a pulse rate of 1544 kbit/s.

Section 3 of American National Standard for Telecommunications — Digital Processing of Voice-Band Signals — Algorithms for 24-, 32-, and 40-kbit/s Adaptive Differential Pulse-Code Modulation (ADPCM), ANSI T1.303-1989, specifies the 24- and 32-kbit/s ADPCM algorithms. Therefore

the low bit-rate voice (LBRV) terminals that use the Bundle and Transition signaling line formats shall comply with the 32-kbit/s algorithm and those terminals that use the Robbed-Bit signaling line format shall comply with the 24- and 32-kbit/s algorithms as described in that section.

1.1.3 This standard provides for interface specification defining bit formats and actions associated with transcoder interfaces that use these line formats.

1.2 Purpose and Application The 48-channel transcoder provides for the conversion between two 24-channel 1544-kbit/s PCM streams (ports X and Y) and one 48-channel 1544-kbit/s ADPCM stream (port Z). In the 24-channel 1544-kbit/s streams, the voice frequency signals are coded at 64 kbit/s according to the PCM μ-law defined in CCITT Red Book Volume III, Recommendation G.711, Pulse Code Modulation (PCM) of Voice Frequencies. In the 48-channel 1544-kbit/s stream, the voice frequency signals are coded using 4 bits per channel according to the ADPCM algorithm in ANSI T1.303-1989.

Figure 1 represents the nomenclature used for the three different signal ports X, Y, and Z.

This standard contains the interface requirements associated with the line formats for 44- to 48-channel transcoders and is divided into four parts: Section 2 provides a listing of referenced