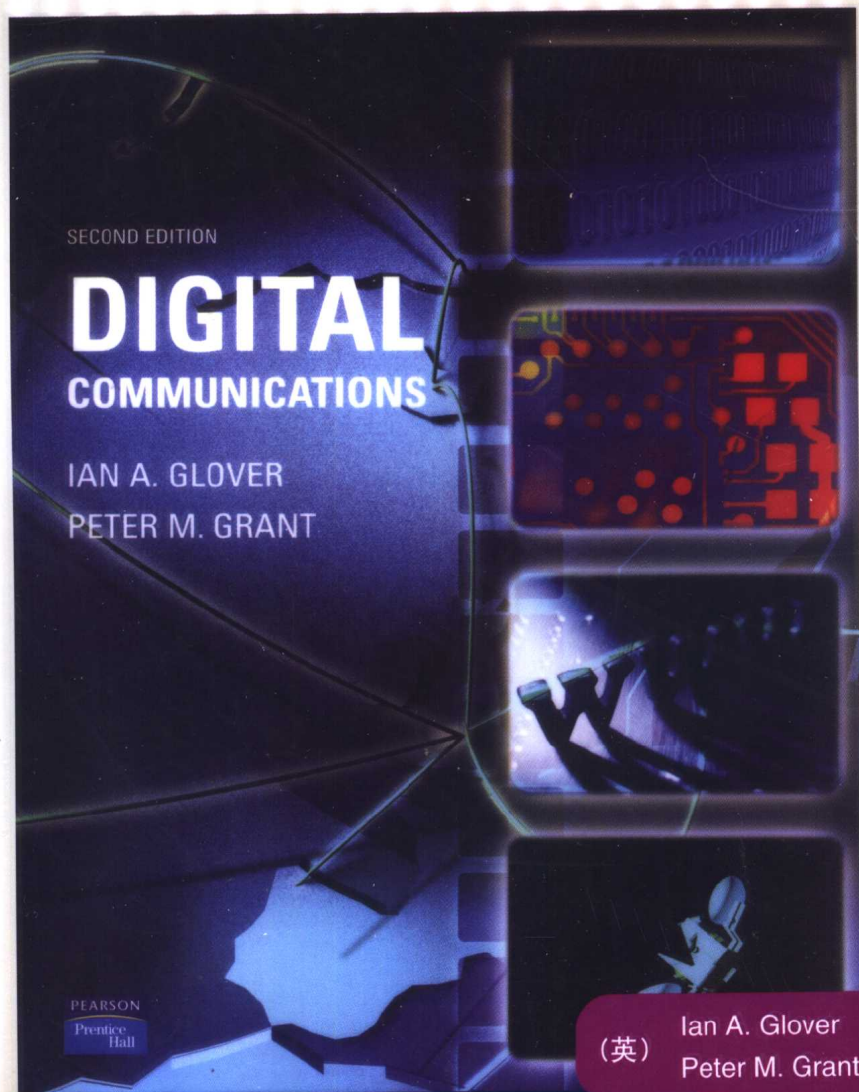




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数字通信

(英文版·第2版)



(英) Ian A. Glover 著
Peter M. Grant



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Digital Communications

(Second Edition)

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Preface

Digital communications is a rapidly advancing applications area. Significant current activities are in the development of mobile communications equipment for personal use, in the expansion of the available bandwidth (and hence information carrying capacity) of the backbone transmission structure through developments in optical fibre, and in the ubiquitous use of networks for data communications.

The aim of this book is fourfold: (1) to present the mathematical theory of signals and systems as required to understand modern digital communications equipment and techniques, (2) to apply and extend these concepts to information transmission links which are robust in the presence of noise and other impairment mechanisms, (3) to show how such transmission links are used in fixed and mobile data communication systems for voice and video transmission, and (4) to introduce the operating principles of modern communications networks formed by the interconnection of many transmission links using a variety of topological structures.

The material is set in an appropriate historical context. Most of the chapters include substantive numerical examples to illustrate the material developed and conclude with problem questions which have been designed to help readers assess their comprehension of this material.

In Chapter 1, we summarise the history of communication systems and introduce some basic concepts such as accessing, modulation, multiplexing, coding and switching, for line and radio transmission. Chapter 1 also includes a review of the advantages of digital communications systems over the older analogue systems which they are now, largely, replacing.

The next 18 chapters are organised in four parts reflecting the four aims referred to above. Specifically Chapters 2 through 4 are devoted to a basic theory of periodic, transient and random signals and the concept of linear transmission systems. Chapters 5 through 13 cover the fundamentals of digital communications and include sampling and multiplexing, baseband line transmission, decision and information theory, cryptography and error control coding, including turbo coding. This second part also includes a description of the many bandpass modulation schemes used in modern systems, the calculation of received power and associated signal-to-noise ratio for a communications link, and an indication of how the performance of a system can be assessed by simulation, before any actual hardware construction is attempted.

Part Three, Chapters 14 through 16, describes how the principles of digital communications are applied in fixed point-to-point terrestrial, and satellite based, microwave systems, in mobile and cellular radio systems, and in video (TV) transmission and storage systems. The fourth part, Chapters 17 through 21, is devoted to communication

networks. This starts with a discussion of network topologies, access techniques and their signalling and routing protocols and architectures before moving on to queueing theory. It then progresses naturally to public networks, SDH and ISDN, the internationally agreed standard for the worldwide digital telecommunications network before finally concluding with broadcast networks, both wired and wireless local area networks. This completely revised and extended networks section in the second edition introduces the reader to a range of rapidly evolving wireless networking techniques.

To assist the reader, the book includes a list of abbreviations and also a list of notations and conventions used for the mathematical material.

An extensive reference list including key WWW addresses, standards and a bibliography is provided at the end of the book, before the index. All publications referred to in the text are compiled in this list. Each reference is identified in the text by the name(s) of the author(s) and, where necessary, the year of publication in square brackets.

The book is aimed at readers who are completing a graduate level BEng/MEng degree, or starting a postgraduate level MSc degree in Communications, Electronics or Electrical Engineering. It is assumed that these readers will have competence in the mathematical concepts required to handle comfortably the material in Part One.

The book has been compiled from lecture notes associated with final year BEng/MEng/MSc core, and optional, courses in signal theory and digital communications as provided at the Universities of Bath, Bradford and Edinburgh from 1990 to date. We have deliberately extended our coverage, however, to include some practical aspects of the implementation of digital PCM, SDH, packet speech systems, and the capability of optical and microwave long haul communication systems. With this balance between theory, applications and systems implementation we hope that this text will be useful both in academia and in the rapidly growing communications industry.

To aid the instructor and the student we provide a current erratum plus outline solutions to the majority of the end of chapter problems on the World Wide Web at the Edinburgh server address: <http://www.see.ed.ac.uk/~pmg/DIGICOMMS/index.html> or via the Pearson Education website at www.booksites.net/glover

In addition we have some further software examples in the areas of filtering, transforms and adaptive processors which are available via the above server address.

Bath and Edinburgh
June 2003

Ian Glover and Peter Grant

Acknowledgements

Parts of this book have been developed from BEng, MEng and MSc courses provided at the Universities of Edinburgh and Bradford. Three of these courses were first taught by Dr James Dripps at Edinburgh, and Professor Peter Watson and Dr Neil McEwan at Bradford, and we acknowledge their initial shaping of these courses which is reflected in the book's content and structure. We are grateful to Dr Dripps for having provided draft versions of Chapters 7 and 9 and also for giving us access to material which now forms parts of Chapters 6, 10, 17 and 18. We are grateful to Dr McEwan for providing the original versions of sections 2.5.1, 4.3.1, 4.3.2 and 4.3.3 in the form of his teaching notes. Some of the material in Chapters 2, 3, 4, 8 and 11 had its origins in notes taken during lectures delivered at Bradford by Professor Watson and Dr McEwan. We also acknowledge Dr Brian Flynn for assistance with parts of Chapter 19, Dr Angus McLachlan for providing initial thoughts on Chapter 12, Dr Tom Crawford (of Hewlett Packard, Telecomms Division, South Queensferry) for giving us access to further material for Chapter 19 and providing some initial insights into Chapter 6. We are grateful to Dr David Parish of Loughborough University of Technology, for providing an initial draft of Chapter 16, Professor Paddy Farrell (of Victoria University, Manchester) for helpful comments on Chapter 10 and Dr David Cruickshank at Edinburgh for assistance with the problem solutions which are provided on the WWW.

We would like to thank all those colleagues at the Universities of Bradford and Edinburgh who have provided detailed comments on sections of this text. Thanks must also go to the many students who have read and commented on earlier versions of this material, helped to refine the end of chapter problems and particularly Yoo-Sok Saw and Paul Antoszczyszyn who generously provided figure material for Chapter 16.

Special thanks are due to Joan Burton, Liz Paterson, Diane Armstrong and Beverly Thomas for their perseverance over several years in typing the many versions of the individual chapters, as they have evolved from initial thoughts into their current form. We also acknowledge Bruce Hassall's generous assistance with the preparation of the final version of the text in the appropriate typefont and text format.

Finally we must thank our respective families, Nandini and Sonia, and Marjory, Lindsay and Jenny for the considerable time that we required to write this book.

Ian Glover and Peter Grant, 1998

Second edition

This second edition has been further developed from BEng, MEng and MSc courses provided at the Universities of Edinburgh, Bath and Bradford. We acknowledge Professor Keith Blow from the University of Birmingham for updates to Chapter 12, Professor Mike Woodward of Bradford University for preparing the revised Chapter 17 (now chapter 19), Professor Simon Shepherd also of Bradford University for reading and commenting on the new material on encryption in Chapter 9, Dr Robert Watson at Bath for preparing the new section in Chapter 10 on turbo coding and the Bluetooth section in Chapter 21, the generous assistance of John Martin, also from Bath, for providing access to all his material on networks for enhancing Part Four of this revised text and Dr David Cruickshank at Edinburgh for continued assistance with the problem solutions which are provided on the WWW.

We would like to thank all those colleagues at the Universities of Bath and Edinburgh who have again provided detailed comments on sections of this text. Thanks must also go to the many students who continue to read, comment and suggest improvements to the chapter contents and also the solutions to the problem questions. Thanks are also due to the many instructors worldwide who have emailed us with positive comments and suggestions.

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Finally we must thank our respective families, Nandini and Sonia, and Marjory for our time spent writing and revising this book.

Ian Glover and Peter Grant, 2003

Abbreviations

AAL	ATM adaptation layer
ABM	Asynchronous balanced mode
ABR	Available bit rate
AC	Alternating current (i.e. sinusoidal signal), access control, area code
ACF	Autocorrelation function
ACK	Acknowledgement
ACL	Asynchronous connectionless
ACSE	Association control service element
A/D or ADC	Analogue to digital converter
ADCCP	Advanced data communications control procedure
ADM	Add and drop multiplexer, adaptive delta modulation
ADPCM	Adaptive differential pulse code modulation
ADSL	Asymmetric digital subscriber line (transmissions)
AFI	Authority & format identifier
AGC	Automatic gain control
AI	Adaption interface
AIA	Active interference avoidance
AK-TPDU	Acknowledgement TPDU
ALOHA	(not an abbreviation but Hawaiian for 'hello')
AM	Amplitude modulation
AMI	Alternate mark inversion
AMPS	Advanced mobile phone system (USA)
AN	Access network
ANS	Abstract syntax notation
ANSI	American National Standards Institute
AP	Access point
APCO	(US) associated public safety communications office
APD	Avalanche photodiode
APK	Amplitude/phase keying
ARM	Asynchronous response mode
ARPANET	Advanced Research Projects Agency Network
ARQ	Automatic repeat request
ASCII	American Standard Code for Information Interchange
ASIC	Application specific integrated circuit

ASK	Amplitude shift keying
ASN	Abstract syntax notation
ATM	Asynchronous transfer mode, automatic teller machine
AU	Administrative unit
AUG	AU group
AUI	Attachment unit interface
AWG	American wire gauge
BA	Basic (rate) access (in ISDN)
BASK	Binary amplitude shift keying
BCH	Bose–Chaudhuri–Hocquenghem
BCJR	Bahl, Cocke, Jelinek, Raviv (algorithm)
BER	Bit error ratio/rate
BFSK	Binary frequency shift keying
BFWA	Broadband fixed wireless access
BICI	Broadband (or B-ISDN) intercarrier interface
BIM	Broadcast interface module
BIS	Boundary/border IS
B-ISDN	Broadband ISDN
BL	Baseband layer
BMV	Branch metric value
BNA	Broadcast network adaptor
BO _{ilo}	Back-off (input/output)
BPI	Baseline privacy interface
B-PON	Broadband passive optical network
BPSK	Binary phase shift keying
BRL	Bluetooth radio layer
BRZ	Bipolar return to zero
BS	Base station
BSS	Broadcast satellite service, basic service set
BT	British Telecom
CAC	Connection access control
CAP	Carrierless amplitude and phase (modulation)
CASE	Common application service element
CATV	Community antenna TV
CC	Central controller
CCIR	Comité Consultatif International des Radiocommunications
CCITT	Comité Consultatif International Télégraphique et Téléphonique
CCK	Complementary code keying
CCRE	Commitment, concurrency and recovery element
CCS7	Common channel signalling system No. 7
CC-TPDU	Connection confirm TPDU
CD	Cumulative distribution, compact disc, collision detection
CDMA	Code division multiple access

CD-ROM	Compact disc read-only memory
CDT	Credit (flow control)
CDV	Cell delay variation
CELP	Codebook of excited linear prediction
CEPT	Confederation of European PTT Administrations
CFMSK	Continuous frequency minimum shift keying
CIR	Carrier to interference ratio
CLNP	Connectionless network layer (IP) protocol
CLNS	Connectionless network layer service
CLR	Cell loss ratio
CM	Cable modem
CMCI	Cable modem computer interface
CMI	Coded mark inversion
CMIP	Common management information protocol
CMIR	Carrier modulated IR
CMOS	Complementary metal oxide silicon (transistor)
CMRI	Cable modem return path interface
CMTRI	Cable modem telephone return path interface
CMTS	Cable modem termination system
CN	Core network
CNR	Carrier-to-noise ratio
CODEC	Coder/decoder
CONP	Connection-oriented network protocol
CONS	Connection-oriented network service
CPD	Centre point detection
CPN	Customer premises network
CP(S)M	Continuous phase (shift) modulation
CR	Call request
CRC	Cyclic redundancy check
CRT	Cathode-ray tube
CR-TPDU	Connection request TPDU
CS	Carrier sense, circuit switched, convergence sub-layer
CSDN	Circuit switched data network
CSMA/CD	Carrier sense multiple access/collision detection
CSPDN	Circuit switched packet data network
CTD	Cell transfer delay
CTS	Clear-to-send
CW	Continuous wave
D	Data
DA	Demand assigned
DAC	Digital to analogue converter
DASS	Digital access signalling system
DAT	Digital audio tape
DAVIC	Digital video broadcast-cable/digital audio video council

DBS	Direct broadcast satellite
DC	Direct current
D/C	Downconverter
DCCE	Digital cell centre exchange
DCE	Data communication equipment
DCF	Distributed coordination function
DCT	Discrete cosine transform
DDSSC	Digital delivered services switching centre
DECT	initially Digital European cordless telecommunications now Digital enhanced cordless telecommunications
DEPSK	Differentially encoded phase shift keying
DES	Data encryption standard
DFB	Distributed feedback (laser)
DFS	Discrete Fourier series, dynamic frequency selection
DFT	Discrete Fourier transform
DHCP	Dynamic host configuration protocol
DI	Distribution interface
DIUC	Downlink internal usage code
DLC	Data-link controller
DL-MAP	Downlink map
DM	Delta modulation
DMIR	Direct modulation IR
DMPSK	Differential <i>M</i> -symbol phase shift keying
DMSU	Digital main switching unit
DMT	Digital multitone
DNS	Domain name system
DOCIS	Data over cable service interface specification
DPCM	Differential pulse code modulation
DPNSS	Digital private network signalling system
DPRS	DECT packet radio service
DPSK	Differential phase shift keying
DQDB	Distributed queue dual bus
DRFSI	Downstream RF site interface
DSB	Double sideband
DSI	Digital speech interpolation
DSL	Digital subscriber line
DSMX	Digital system multiplexor
DSP	Digital signal processing, domain specific part
DSR	Data set ready
DSS1	Digital subscriber signalling No. 1
DSSS	Digital subscriber signalling system, direct sequence spread spectrum
DTE	Data terminal equipment
DTI	Department of Trade and Industry (UK)
DTP	Distributed transaction processing

DTR	Data terminal ready
DT-TPDU	Data TPDU
DUP	Data user part
DV	Data/voice (packet)
DVB	Digital video broadcast
DVD	Digital video disc
DVR	Digital video recorder
ECMA	European Computer Manufacturers Association
ED	End delimiter
EDFA	Erbium doped fibre amplifier
EDGE	Enhanced data rate for GPRS evolution
EFT	Electronic funds transfer
EFTPOS	Electronic funds transfer at point of sale
EIA	Electronic Industries Association
EIRP	Effective isotropic radiated power
EM	Encrypted message
EMI	Electromagnetic interference
ENQ	Enquiry
EOT	End of transmission
EOW	Engineering order wire
ER	Error reporting (flag)
ERD	End routing domain
ERMES	European Radio Message System
ES	End system
ESD	Energy spectral density
ES-IS	End system to intermediate system
ETSI	European Telecommunications Standards Institute (formerly CEPT)
ESS	Extended service set
EY-NPMA	Elimination yield non pre-emptive priority multiple access
FCC	Federal Communications Commission
FCS	Frame check sequence
FDDI	Fibre distributed data interface
FDM	Frequency division multiplex
FDMA	Frequency division multiple access
FECC	Forward error correction coding
FET	Field effect transistor
FEXT	Far end crosstalk
FFSK	Fast frequency shift keying
FFT	Fast Fourier transform
FH	Frequency hopped (transmission)
FHS	Frequency hop synchronisation
FH(SS)	Frequency hopped (spread spectrum)
FIFO	First in first out

FILO	First in last out
FIR	Finite impulse response
FIRO	First in random out
FM	Frequency modulation
FP	Final permutation
FPGA	Field programmable gate array
FPLMTS	Future public land mobile telecommunications system
FS	Fourier series
FSK	Frequency shift keying
FSPL	Free space path loss
FT	Fourier transform
FTAM	File transfer access and management
FTTB	Fibre to the building/business
FTTC	Fibre to the kerb
FTTCab	Fibre to the cabinet
FTTH	Fibre to the home
FZ	Fresnel zone

GAN	Global area network
GFI	General format identity
GMSK	Gaussian (filtered) minimum shift keying
GoS	Grade of service
GPRS	General packet radio system
GPS	Global positioning system
GSC	Group switching centre
GSM	originally Groupe Spéciale Mobile now Global System for Mobile communications

HACE	Higher order automatic cross-connect equipment
HALO	High altitude long operation
HAP	High altitude platform
HCI	Host controller interface
HDB	High density bipolar
HDLC	High level DLC
HDSL	High speed digital subscriber loop
HDTV	High definition television
HEO	High earth orbit
HF	High frequency
HFC	Hybrid fibre coax
HIHE	Highly inclined highly elliptical (orbit)
HIPERACCESS	ETSI HIPERLAN variant
HIPERLAN	High performance local area network
HomePNA	Home phone line network association
HPA	High power amplifier
HSCSD	High speed circuit switched data

HSLAN	High speed LAN
HUMAN	High rate unlicensed MAN
I	Inphase (signal component), information
ICSDS	Interactive channel satellite distribution system
I+D	Integrate and dump
ID	Identity
IDEA	International data encryption algorithm
IDI	Initial domain identifier
IDN	Integrated digital network
IDP	Initial domain port
IDRP	Interdomain routing protocol
ISDL	ISDN DSL
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate frequency
IFA	Intermediate frequency amplifier
IFS	Inter frame space
IIM	Interactive network module
IIR	Infinite impulse response
ILD	Injection laser diode
INA	Interaction network adaptor
INMARSAT	International Maritime Satellite Consortium
INTELSAT	International Telecommunications Satellite Consortium
IP	Intermodulation product, internet protocol, initial permutation
IPSS	International packet switched service
IR	Infrared, interdomain routing
IS	Intermediate system
ISC	International switching centre
ISDN	Integrated services digital network
ISI	Intersymbol interference
IS-IS	Intermediate system to intermediate system
ISM	Industrial scientific and medical (frequency band)
ISO	International Organisation for Standardisation
ISO-PP	ISO presentation protocol
ISO-SP	ISO session (layer) protocol
ISP	Internet service provider, intermediate services port
ISUP	ISDN user part
ITU	International Telecommunication Union
IWU	Interworking unit
JANET	Joint Academic Network
JPEG	Joint Photographic Experts Group
JTAM	Job transfer access and management
L2CAP	Logical link control and adaption

LAN	Local area network
LAP-B/D	Link access protocol balanced/D-channel
LBT	Listen before talk
LC	Link controller
LCC	Logical link control
LCFS	Last come first served
LE	Local exchange
LED	Light emitting diode
LEO	Low earth orbit (satellite)
LI	Length indicator
LIFO	Last in first out
LLC	Logical link control
LLR	log-likelihood ratio
LM	Link manager
LMDS	Local multipoint distribution system
LMP	Link manager protocol
LNA	Low noise amplifier
LO	Local oscillator
LOH	Line overhead
LOS	Line of sight
LPC	Linear predictive coding
LPF	Low pass filter
LSA	Link state advertisement
LW	Long wave
LWT	Listen while talk
LZW	Lempel–Ziv (Welch) coding
MAC	Medium access control
MAN	Metropolitan area network
MAP	Manufacturers application protocol, maximum a posteriori (criterion)
MASK	M -symbol amplitude shift keying
MBC	Model based coding
MBITR	Multiband interteam radio
MCPC	Multiple channels per carrier
MCR	Minimum cell rate
MF	Multiple frequency
MFSK	Multiple frequency shift keying
MGF	Mask generation function
MHS	Message handling system
MMDS	Multichannel, multipoint distribution service
MMF	Multimode fibre
MMS	Manufacturing message service
MN	Mobile network
MODEM	Modulator/demodulator
MOS	mean opinion score (for speech quality assessment),

	metal oxide silicon (transistor)
MOTIS	Message oriented text interchange standard
MPDU	MAC layer PDU
MPE	Multipulse excitation
MPEG	Motion Picture Experts Group
MPSK	<i>M</i> -symbol phase shift keying
MQAM	<i>M</i> -symbol quadrature amplitude modulation
MS	More segments (flag)
MSC	Main switching centre
MSCIR	Multi-subcarrier modulated IR
MSK	Minimum shift keying
MSOH	Multiplexer section overhead
MSU	Message signal unit
MTA	Multimedia terminal adaptor
MTBF	Mean time between failures
MTP	Message transfer part
MVDS	Multipoint video distribution service
MW	Medium wave
NA	Not applicable
NAK	Negative acknowledgment
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organisation
NET	Network
NETS	Network entity titles
NEXT	Near end crosstalk
NICAM	Near instantaneous companded amplitude modulation
NIU	Network interface unit
NMC	Network management centres
NNI	Network–node interface
NPDU	Network protocol data unit
NPSD	Noise power spectral density
NRM	Normal response mode
NRZ	Non-return to zero
NSAP	Network service access point
NSC	Non-systematic convolutional (code)
NSDU	Network service data unit
NSF	National Science Foundation (USA)
NSI	Network side interface
NT	Network termination
NTSC	National Television Standards Committee (USA)
NUL	(packet with no user information, i.e. all zeros)
O&M	Operations and maintenance
OAEP	Optimal asymmetric encryption padding

OA&M	Operations, administration and maintenance
OAM&P	Operations, administration, maintenance and provisioning
ODN	Optical distribution network
O/E	Optical/electronic (conversion)
OFDM	Orthogonal frequency division multiplex
OLT	Optical line termination
OMC	Operation & maintenance centre
ONT	Optical network termination
ONU	Optical network unit
OOK	On-off keying
OPI	On-premises interface
OQPSK	Offset quadrature phase shift keying
OSI	Open systems interconnection
OSS	Operational support system
OSSI	Operational support system interface
PA	Preassigned, priority assertion
PABX	Private automatic branch exchange
PAD	Packet assembly and disassembly
PAL	Phase alternate line (TV)
PAM	Pulse amplitude modulation
PAN	Personal area network
PC	Personal computer, permuted choice, point code
PCF	Point coordination function
PCM	Pulse code modulation
PCN	Personal communications network
PCR	Peak cell rate
pdf	Probability density function
PDH	Plesiochronous digital hierarchy
PDN	Public data network
PDU	Protocol data unit
PEPL	Plane earth path loss
P/F	Poll/final
PGP	Pretty good privacy
PIN	Positive-intrinsic-negative (diode)
PLE	Principal local exchange
PLL	Phase locked loop
PLOAM	Physical layer OA&M
PLP	Packet level protocol
PM	Phase modulation
PMR	Private mobile radio
PMV	Path metric value
PN	Pseudo-noise
POCSAG	Post Office Code Standards Advisory Group
POF	Plastic optical fibre