

ISO/IEC TS 11801-9903:2021-03 (E)

Information technology - Generic cabling systems for customer premises - Part 9903: Matrix modelling of channels and links

Contents	Page
FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	9
2 Normative references	9
3 Terms, definitions and abbreviated terms	9
3.1 Terms and definitions.....	9
3.2 Symbols and abbreviated terms	10
4 Matrix model.....	11
5 Matrix definition.....	11
5.1 General.....	11
5.2 Quadriports.....	11
5.3 Matrix port definition for a two-pair system representative for modelling purposes.....	11
5.4 Operational scattering matrix	12
5.5 General naming convention.....	12
5.6 S-matrix	13
5.7 Passivity	13
5.8 Operational reflection loss matrix.....	14
5.9 Transmission matrix (T-matrix).....	14
5.10 S-matrix of cabling	14
6 Calculation with matrices using limit lines	15
7 Extracting limit lines	15
8 General case using mixed-mode matrices.....	16
8.1 General.....	16
8.2 M-parameters	16
9 Submatrix DD	17
9.1 General.....	17
9.2 Equations to extract the cabling limit lines	17
9.2.1 General	17
9.2.2 Operational attenuation	17
9.2.3 Near-end crosstalk	17
9.2.4 Attenuation to far-end crosstalk ratio	17
9.2.5 Reflection (RL)	18
10 Component values to be used as input to the model	18
10.1 General.....	18
10.2 Cable	19
10.2.1 General	19
10.2.2 Wave attenuation.....	19
10.2.3 Near-end crosstalk	19
10.2.4 Far-end crosstalk.....	19
10.2.5 Reflection	20

10.3	Connections.....	21
10.3.1	General	21
10.3.2	As a point source of disturbance.....	21
10.3.3	As a transmission line.....	21
11	Submatrices CC, CD and DC.....	22
11.1	General.....	22
11.2	Submatrix CD	22
11.3	Submatrix DC	22
11.4	Submatrix CC	22
Annex A	(informative) Matrix conversion formulas.....	23
A.1	Overview.....	23
A.2	Formulas.....	23
A.2.1	Mixed-mode to T-matrix	23
A.2.2	T-matrix to M-matrix	23
A.2.3	Conversion matrices	23
Annex B	(normative) Channel and permanent link models for balanced cabling	25
B.1	General.....	25
B.2	Insertion loss	25
B.2.1	Insertion loss of the channel configuration	25
B.2.2	Insertion loss of the permanent link configurations.....	26
B.2.3	Assumptions for insertion loss	26
B.3	NEXT.....	27
B.3.1	NEXT of the channel configuration.....	27
B.3.2	NEXT of the permanent link configurations	27
B.3.3	Assumptions for NEXT.....	28
B.4	ACR-F	31
B.4.1	ACR-F of the channel configuration	31
B.4.2	ACR-F for the permanent link configurations.....	31
B.4.3	Assumptions for ACR-F	32
B.5	No Return loss	32
B.5.1	Return loss of the channel and permanent link configurations.....	32
B.5.2	Assumptions for the return loss circuit analysis method	33
B.6	PS ANEXT link modelling.....	36
B.6.1	General	36
B.6.2	PS ANEXT between connectors.....	36
B.6.3	PS ANEXT between cable segments	36
B.6.4	Principles of link modelling	36
B.7	PS AACR-F link modelling	37
B.7.1	General	37
B.7.2	PS AFEXT between connectors	37
B.7.3	PS AACR-F between cable segments	37
B.7.4	Principles of link modelling	37
B.7.5	Impact of PS AACR-F in channels and links with substantially different lengths	38
B.8	Component assumptions for modelling purposes.....	41
Annex C	(informative) Terms and definitions.....	43
C.1	Comparison of namings	43
C.2	General.....	44

C.3	Background of terms and definitions	44
C.3.1	Operational attenuation	44
C.3.2	Operational transfer function (T_B)	46
C.3.3	Image or wave transfer function (T)	46
C.3.4	Insertion transfer function of a two-port (T_{BI})	46
C.3.5	Insertion transfer function (T_{BI}) measured with a vector network analyser	46
C.3.6	Operational reflection loss transfer function ($T_{ref} = S_{ref}$) of a junction.....	46
	Bibliography.....	48
	Figure 1 – Link configurations of ISO/IEC 11801-1.....	7
	Figure 2 – Matrix definition of a 4-port two twisted pair system	12
	Figure 3 – Operational scattering parameters example from port 2	12
	Figure 4 – Transmission matrix concatenation showing an example of a 2-connector permanent link	14
	Figure 5 – Graphical example of a NEXT calculation showing statistical results (red) and final calculation (blue)	16
	Figure 6 – One pair M-matrix showing the submatrices	16
	Figure 7 – 100 m cable return loss without reflection at both ends	20
	Figure 8 – 100 m cable return loss with a reflection of 0,03 at both ends (6Ω mismatch, ~23 dB return loss at 1 MHz).....	21
	Figure A.1 – X matrices	24
	Figure B.1 – Example of computation of NEXT with higher precision.....	28
	Figure B.2 – Example of increased impact of PS AFEXT.....	38
	Figure C.1 – Defining the operational attenuation and the operational transfer functions of a two-port	45
	Figure C.2 – Defining the reflection transfer functions and the return loss of a junction.....	47
	Table 1 – All four ports operational scattering parameter definition	12
	Table 2 – Equal S-parameters for real components.....	13
	Table B.1 – Insertion loss deviation	26
	Table B.2 – Modelling assumptions for cable transmission parameters	41
	Table B.3 – Model input assumptions used in the statistical calculation (Class E_A).....	41
	Table B.4 – Model input assumptions used in the statistical calculation (Class F_A).....	42
	Table C.1 – Comparison of naming in ISO/IEC 11801-1 and ISO/IEC TS 11801-9903.....	43