

IEEE P802.3cg 10BASE-T1S Increased Transmit Voltage

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Purpose

- The purpose of this presentation is to:
 - Describe changes necessary in IEEE P802.3cg Draft 2.1 for the addition of an increased transmit voltage option for 10BASE-T1S
 - Engineered solution
 - Auto-Negotiated

Comment #441

- Comment
 - Market potential would benefit by 10BASE-T1S having an optional increased voltage level similar to 10BASE-T1L. Applications in elevators, lighting, and industrial automation have use for increased reach, higher node count, and improved immunity. Existing non-Ethernet systems with substantially similar modulation schemes have been successfully deployed within emissions limits.
- Proposed Change
 - Add an optional 2.4 Vpp differential transmit level as an auto-negotiated option for point-point and an engineered option for both point-point and multidrop.

Benefits of a 2.4 Vpp Transmit Mode

- Applications in elevators, lighting, and industrial automation have use for increased reach, higher node count, and improved immunity
- A higher transmit voltage means:
 - We can tolerate increased IL, yielding increased reach
 - RL is the same, but harder to meet for point-to-point links
 - MC can be more strict, or stay the same (useful for applications with less strict emissions requirements than automotive)
 - MDI impedance limit for total capacitance (C_{tot}) increases
- Reuses existing text and document structure from 10BASE-T1L and creates more consistency between the two PHYs

Summary of Changes

- Add text to 147.5.4.1 Transmitter output voltage to define 2.4 Vpp transmit mode
- Add 7.6 dBm/Hz to transmitter PSD and insertion loss
 - Multiplying voltage by 2.4 implies adding $20 \log_{10}(2.4) = 7.6$
- Add receiver electrical specifications to allow tolerance to 2.4 Vpp in all cases
- Edits to PMA and Auto-Negotiation registers and PICs to parallel 10BASE-T1L

Agenda

- Adding 2.4 Vpp transmit mode requires small changes in many places
- We will walk through the required changes in this sequence:
 - Transmitter
 - Receiver
 - Link Segment
 - Mixing Segment
 - PMA Registers
 - Auto-Negotiation
 - PICs

TRANSMITTER

Transmitter output voltage

- Pg. 184, Line 54
- 147.5.4.1 Transmitter output voltage
- Change from:
 - The transmitter output voltage shall be $1\text{ V} \pm 20\%$ peak-to-peak differential.
- To:
 - The transmitter output voltage shall be $2.4\text{ V} \pm 20\%$ peak-to-peak differential (for the 2.4 Vpp operating mode) and $1.0\text{ V} \pm 20\%$ peak-to-peak differential (for the 1.0 Vpp operating mode). Transmitter output voltage can be set using the management interface or by hardware default set-up. Additionally, Auto-Negotiation can be used to find a common transmitter output voltage for two PHYs operating in point-to-point mode.

The transmitter output voltage can be selected by setting bit 1.2299.12 (10BASE-T1S PMA control register) of the PHY Management register set as described in 45.2.1.186f.6. If MDIO is not implemented, a similar functionality shall be provided by another interface.

When Auto-Negotiation is present and enabled and both PHYs advertise an increased transmit ability, if at least one PHY requests the 10BASE-T1S increased transmit level, then both PHYs shall use the 2.4 Vpp operating mode. In all other cases both PHYs shall use the 1.0 Vpp operating mode.

Transmitter Power Spectral Density (PSD)

- Pg. 185, Line 43
- 147.5.4.3 Transmitter Power Spectral Density (PSD)
- Change from:
 - The upper and lower limits are given in Equation (147–1) and Equation (147–2), and shown in Figure 147–15.
- To:
 - For the 1.0 V_{pp} differential transmit amplitude, the upper and lower PSD limits are given in Equation (147–1) and Equation (147–2), and shown in Figure 147–15.

For the 2.4 V_{pp} differential transmit amplitude, the upper and lower PSD limits are given in Equation (147–1b) and Equation (147–2b), and shown in Figure 147–15b.

Upper PSD

- Pg. 185, Line 46
- 147.5.4.3.1 Upper PSD
- Change:
 - {Existing Clause Text}
- To:
 - Upper PSD limit for the 1.0 Vpp differential transmit amplitude:
{Existing Clause Text}
 - Upper PSD limit for the 2.4 Vpp differential transmit amplitude:
{Existing Clause Text, modified as follows:
Change Equation reference to 147-1b
Change Equation limits:
 from -61 to -53.4
 from -40 to -32.4
 from -75 to -67.4
}

Lower PSD

- Pg. 186, Line 1
- 147.5.4.3.2 Lower PSD
- Change:
 - {Existing Clause Text}
- To:
 - Lower PSD limit for the 1.0 Vpp differential transmit amplitude:
{Existing Clause Text}
 - Lower PSD limit for the 2.4 Vpp differential transmit amplitude:
{Existing Clause Text, modified as follows:
Change Equation reference to 147-2b
Change Equation limits:
 from -87 to -79.4
 from -47 to -39.4
}

PSD Mask

- Pg. 186, Line 10
- 147.5.4.3.3 PSD Mask
- Change:
 - {Existing Figure 147-15}
- To:
 - {Existing Figure 147-15, modified as follows:
 - Change figure description to “Figure 147-15 - PSD upper and lower limits for 1.0 V_{pp} differential transmit amplitude”}
 - {Existing Figure 147-15, modified as follows:
 - Change figure description to “Figure 147-15b - PSD upper and lower limits for 2.4 V_{pp} differential transmit amplitude”
 - Change limit lines to match 147-1b and 147-2b, and rescale figure}

RECEIVER

Receiver Electrical Specifications

- Pg. 187, Line 23
- Add new clauses:
 - 147.5.5 Receiver electrical specification
The PMA shall meet the requirements specified in the PMA Receive function defined in 147.4.3 and the electrical specifications in this section. Unless otherwise specified, these requirements shall apply to receivers in both point-to-point and multidrop mode, if supported.
 - 147.5.5.1 Receiver differential input signals
The receiver shall properly receive incoming data transmitted from a remote transmitter within the specifications defined in 147.5.4 after having passed through a link segment defined in 147.7 (point-to-point) or 147.8 (multidrop mode).
 - 147.5.5.2 Receiver 2.4 V differential input tolerance
The receiver shall withstand without damage and properly receive signals from transmitters using the 2.4 Vpp operating mode defined in 147.5.4.1.

LINK SEGMENT

Insertion Loss

- Pg. 187, Line 37
- 147.7.1 Insertion loss

- Change:
 - {Existing Clause text and Equation}

- To:
 - {Existing Clause text and Equation, modified as follows:
 - Change text preceding existing equation 147-3 to the following: “For 1.0 Vpp differential transmit amplitude, the insertion loss of each 10BASE-T1S point-to-point link segment shall meet the values determined using Equation (147–3).}

 - {Existing Clause text and Equation, modified as follows:
 - Change Equation reference to 147-3b
 - Change text preceding new equation 147-3b to the following: “For 2.4 Vpp differential transmit amplitude, the insertion loss of each 10BASE-T1S point-to-point link segment shall meet the values determined using Equation (147–3b).
 - Change Equation limits:
 - from “1.0 +” to “8.6 +”
 - from “2.6 +” to “10.2 +”
 - from “4.9 +” to “12.5 +”}

TBD

- Consider RL increased reflection due to amplitude
- Consider MC increased emissions

MIXING SEGMENT

MDI electrical specification

- Pg. 189, Line 29
- 147.9.2 MDI electrical specification
- Change:
 - “given in Table 147–3”
- To:
 - “given in Table 147-3 for 1.0 Vpp differential transmit amplitude and given in Table 147-3b for 2.4 Vpp differential transmit amplitude”

MDI electrical specification

- Pg. 190, Line 16
- 147.9.2 MDI electrical specification
- Change:
 - {Existing Table 147-3}
- To:
 - {Existing Table 147-3, modified as follows:
 - Change table description to “Table 147-3 – MDI impedance limit parameters for 1.0 Vpp differential transmit amplitude”}
 - {Existing Table 147-3b, modified as follows:
 - Change table description to “Table 147-3b – MDI impedance limit parameters for 2.4 Vpp differential transmit amplitude”
 - Change Ctot, Maximum value, from: 180 to: 430}

PMA REGISTERS

10BASE-T1S PMA control register

- Pg. 46, Line 11
- 45.2.1.186f 10BASE-T1S PMA control register (Register 1.2299)

- Change:
 - Table 45–150d

1.2299:13:12	Reserved	Value always 0	RO
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- To:

1.2299.13	Reserved	Value always zero	RO
1.2299.12	Transmit voltage amplitude control	1 = Enable 2.4 Vpp operating mode 0 = Enable 1.0 Vpp operating mode	R/W

10BASE-T1S PMA control register

- Pg. 47, Line 28
- 45.2.1.186f 10BASE-T1S PMA control register (Register 1.2299)
- Insert heading and text, renumber and fix references:
 - 45.2.1.186f.6 Transmit voltage amplitude control (1.2299.12)

Bit 1.2299.12 is used to set the 2.4 Vpp operating mode when Auto-Negotiation enable bit 7.512.12 is set to zero or if Auto-Negotiation is not implemented. If bit 1.2299.12 is set to one the PHY shall operate in 2.4 Vpp operating mode according to 147.5.4.1. If bit 1.2299.12 is set to zero the PHY shall operate in 1.0 Vpp operating mode according to 147.5.4.1. The default value of bit 1.2299.12 is zero. This bit shall be ignored when the Auto-Negotiation enable bit 7.512.12 is set to one.

10BASE-T1S PMA status register

- Pg. 48, Line 12
- 45.2.1.186g 10BASE-T1S PMA status register (Register 1.2300)

- Change:
 - Table 45–150e

1.2300.12	Reserved	Value always 0	RO
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- To:

1.2300.12	2.4 Vpp operating mode ability	1 = PHY has 2.4 Vpp operating mode ability 0 = PHY does not have 2.4 Vpp operating mode ability	RO
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10BASE-T1S PMA status register

- Pg. 49, Line 11
- 45.2.1.186g 10BASE-T1S PMA status register (Register 1.2300)
- Insert heading and text:
 - 45.2.1.186g.6 2.4 Vpp operating mode ability (1.2300.12)

When read as a one, this bit indicates that the 10BASE-T1S PHY supports a transmit level of 2.4 Vpp differential. When read as a zero, this bit indicates that the 10BASE-T1S PHY does not support a transmit level of 2.4 Vpp differential.

AUTO-NEGOTIATION

10BASE-T1 AN control register

- Pg. 55, Line 1
- 45.2.7.25 10BASE-T1 AN control register (Register 7.526)

- Change:
 - Table 45–330a

7.526.3:0	Reserved	Value always 0	RO
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- To:

7.526.3	10BASE-T1S increased transmit/receive level advertisement	1 = Advertise that the 10BASE-T1S PHY has increased transmit level ability 0 = Do not advertise that the 10BASE-T1S PHY has increased transmit level ability	R/W
7.526.2	10BASE-T1S increased transmit level request	1 = Request 10BASE-T1S increased transmit level 0 = Do not request 10BASE-T1S increased transmit level	R/W
7.526.1:0	Reserved	Value always 0	RO

10BASE-T1 AN control register

- Pg. 56, Line 36
- 45.2.7.25 10BASE-T1 AN control register (Register 7.526)

- Insert headings and text:

- 45.2.7.25.9 10BASE-T1S increased transmit level ability advertisement (7.526.3)

If the device supports transmission with the 2.4 Vpp differential transmit output voltage mode for 10BASE-T1S, as defined in 147.5.4.1, and 2.4 Vpp differential transmit output voltage operation is desired, bit 7.526.3 shall be set to one.

- 45.2.7.25.10 10BASE-T1S increased transmit level request (7.526.2)

If the device supports transmission with the 2.4 Vpp differential transmitter output voltage for 10BASE-T1S, as defined in 147.5.4.1, and 2.4 Vpp differential transmit voltage operation is desired, bit 7.526.2 is set to one.

10BASE-T1 AN status register

- Pg. 57, Line 38
- 45.2.7.26 10BASE-T1 AN status register (Register 7.527)
- Change:
 - Table 45–330b

7.527.3:0	Reserved	Value always 0	RO
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- To:

7.527.3	10BASE-T1S link partner increased transmit level ability advertisement	1 = Link partner is advertising that the 10BASE-T1S PHY has increased transmit level ability 0 = Link partner is not advertising that the 10BASE-T1S PHY has increased transmit level ability	RO
7.527.2	10BASE-T1S link partner increased transmit level request	1 = Link partner is requesting 10BASE-T1S link partner increased transmit level 0 = Link partner is not requesting 10BASE-T1S link partner increased transmit level	RO
7.527.1:0	Reserved	Value always 0	RO

PICS

PICS: PMA/PMD management functions

- Pg. 65, Line 23
- 45.5 Protocol implementation conformance statement (PICS) proforma for Clause 45, Management Data Input/Output (MDIO) interface
- Insert PICs Items:

MM208	When bit 1.2299.12 is set to one, the 10BASE-T1S PMA transmits using the 2.4 Vpp operating mode	45.2.1.186f.6		PMA:M	Yes [] N/A []
MM209	When bit 1.2299.12 is set to zero, the 10BASE-T1S PMA transmits using the 1.0 Vpp operating mode	45.2.1.186f.6		PMA:M	Yes [] N/A []

PICS: Auto-Negotiation management functions

- Pg. 68, Line 46
- 45.5 Protocol implementation conformance statement (PICS) proforma for Clause 45, Management Data Input/Output (MDIO) interface
- Insert PICS Item:

AM106	If a 10BASE-T1S PHY supports transmission with the 2.4 Vpp transmit output voltage mode and desires to operate in 2.4 Vpp transmit output voltage mode, bit 7.526.3 is set to one	45.2.7.25.9		AN:M	Yes [] N/A []
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PICS: Major capabilities/options

- Pg. 194, Line 13
- 147.12.3 Major capabilities/options
- Insert Item:

*RTDL	2.4 Vpp operating mode	147.5.4.1		0	Yes [] No []
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PICS: PMA electrical specification

- Pg. 198, Line 9
- 147.12.4.6.2 PMA electrical specification
- Change:

PMAE12	Transmitter output voltage	147.5.4.1.1	1.0 V \pm 20 % peak-to-peak differential when measured on test mode 1	M	Yes []
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- To:

PMAE12	Transmitter output voltage	147.5.4.1.1	2.4 V \pm 20% peak-to-peak differential in the 2.4 Vpp operating mode when measured on test mode 1, 1.0 V \pm 20% peak-to-peak differential in the 1.0 Vpp operating mode when measured on test mode 1	RTDL: M	Yes [] N/A []
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PICS: PMA electrical specification

- Pg. 198, Line 18
- 147.12.4.6.2 PMA electrical specification

- Change:

PMAE15	Transmit power spectral density	147.5.4.3	Between the upper and lower masks specified in Equation (147-1) and Equation (147-2) when measured on test mode 3	M	Yes []
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- To:

PMAE15	Transmit power spectral density	147.5.4.3	Between the upper and lower masks specified in Equation (147-1) and Equation (147-2) in the 1.0 Vpp operating mode when measured on test mode 3	RTDL: M	Yes [] N/A []
			Between the upper and lower masks specified in Equation (147-1b) and Equation (147-2b) in the 2.4 Vpp operating mode when measured on test mode 3		

PICS: PMA electrical specification

- Pg. 198, Line 39
- 147.12.4.6.2 PMA electrical specification
- **Insert:**

PMAE20	Transmitter output voltage setting	147.5.4.1	Default setting chosen by Auto-Negotiation, by setting bit 1.2299.12 as described in 45.2.1.186f.6 when MDIO implemented, similar functionality provided otherwise	RTDL:O	Yes [<input type="checkbox"/> No [<input type="checkbox"/> N/A [<input type="checkbox"/>
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PICS: Point-to-point link Segment characteristics

- Pg. 199, Line 6
- 147.12.4.7 Point-to-point link Segment characteristics
- Change:

PPLS1	Insertion loss	147.7.1	See Equation (147-3)	M	Yes []
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- To:

PPLS1	Insertion loss	147.7.1	Equation (147-3) in the 1.0 Vpp operating mode Equation (147-3b) in the 2.4 Vpp operating mode	RTDL: M	Yes [] N/A []
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PICS: Point-to-point link Segment characteristics

- Pg. 199, Line 8
- 147.12.4.7 Point-to-point link Segment characteristics

- Change:

PPLS2	Return loss	147.7.2	See Equation (147-4)	M	Yes []
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- To:

PPLS2	Return loss	147.7.2	Equation (147-4) in the 1.0 Vpp operating mode Equation (147-4b) in the 2.4 Vpp operating mode	RTDL: M	Yes [] N/A []
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PICS: Point-to-point link Segment characteristics

- Pg. 199, Line 10
- 147.12.4.7 Point-to-point link Segment characteristics

- Change:

PPLS3	Mode conversion loss	147.7.3	See Equation (147-5)	M	Yes []
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- To:

PPLS3	Mode conversion loss	147.7.3	Equation (147-5) in the 1.0 Vpp operating mode Equation (147-5b) in the 2.4 Vpp operating mode	RTDL: M	Yes [] N/A []
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Conclusions

- ...

Other issues found

- 45.2.7.25.3 and 45.2.7.25.4 are nearly duplicate text with identical function
- Table 45–330a, 7.526.5, references 10BASE-T1L for PLCA in description