Technical Feasibility of DTE Power and 1000BASE-T

Test Results

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1000BASE-T Test Matrix

- **BER with and without power**

- **Signal Integrity with and without power**
  - ➢ **Peak differential output voltage and level accuracy (Clause 40.6.1.2.1)**
  - ➢ **Maximum output droop (Clause 40.6.1.2.2)**
  - ➢ **Differential output templates (Clause 40.6.1.2.3)**
  - ➢ **Transmitter timing jitter (Clause 40.6.1.2.5)**
  - ➢ **Transmit clock frequency (Clause 40.6.1.2.6)**
  - ➢ **Common-mode noise rejection (Clause 40.6.1.3.3)**

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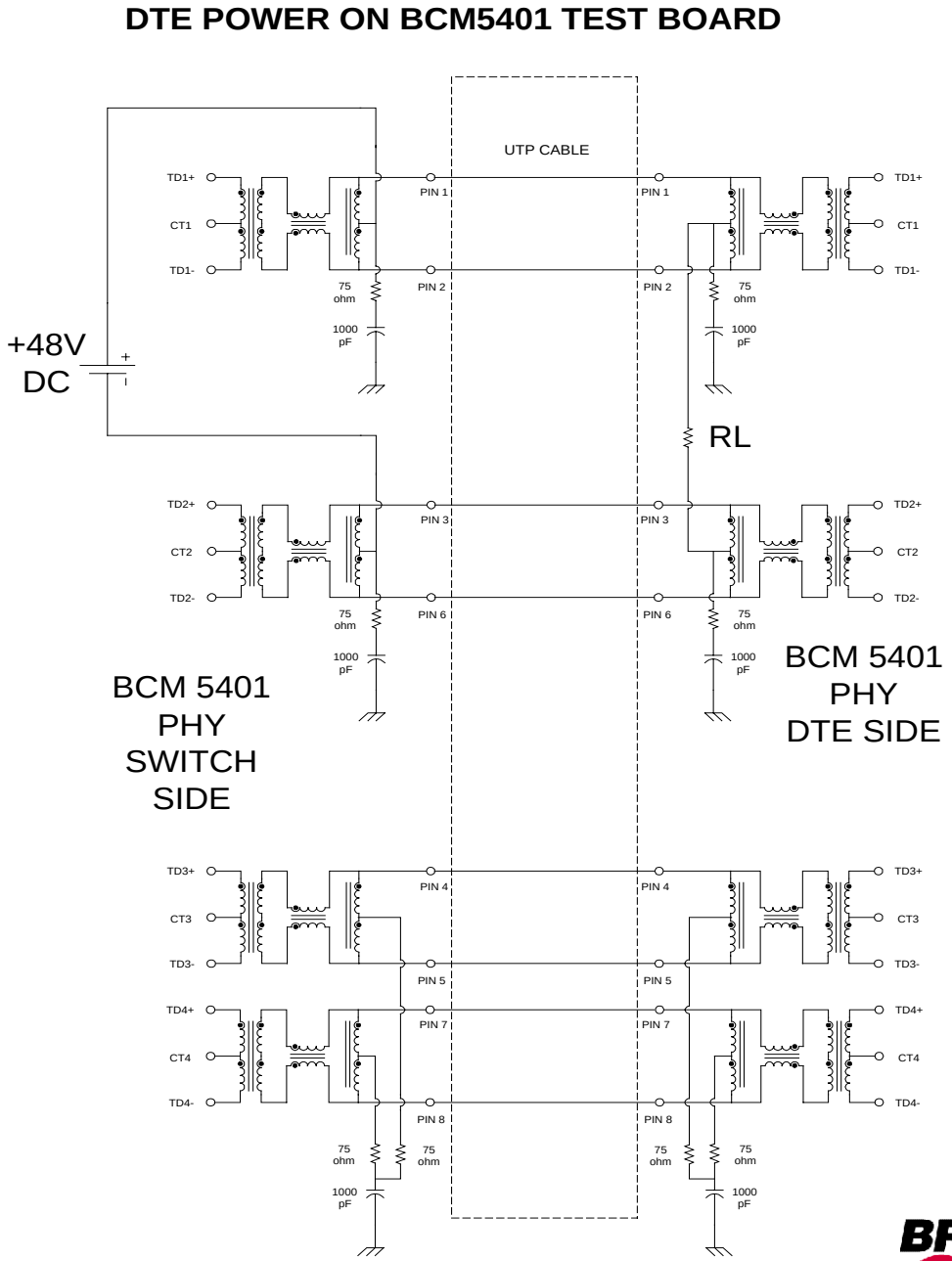
Unit Under Test Setup



Note: USING PULSE H5007 MAGNETIC

BER Test Conditions

Resistance	Number of Resistors in series	Resistor value
160 ohm	8	20Ω 5% 5W
480 ohm	24	20Ω 5% 5W

Condition	Operating Speed	DTE power	Use in Test
1	1000Base-T	V = 0V, I = 0A	Electrical and BER
2	1000Base-T	V = 48V, I = 0A	Electrical and BER
3	1000Base-T	V = 48V, I = 100mA	Electrical and BER
4	1000Base-T	V = 48V, I = 300mA	Electrical and BER

Cable	Length (m)	Cable Type	Impedance (Ω)
1	4	CAT 5	100
2	9	CAT 5	100
3	14	CAT 5	100
4	24	CAT 5	100
5	44	CAT 5	100
6	64	CAT 5	100
7	84	CAT 5	100
8	104	CAT 5	100
9	124	CAT 5	100
10	144	CAT 5	100
11	154	CAT 5	100
12	159	CAT 5	100

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BER Test Results

- **~74 millions frames transmitted and received at each cable length, at each current level**
- **8.9E+10 bits transmitted/received at each cable length, at each current level**
- **No errors received at any condition**
- **BER <1.1E-11 demonstrated for all condition**

No affect of DTE power on BER

OPERATING MODE	DTE power	CABLE (m)	ERRORS
1000Base-T	V = 0V, I = 0A	4 to 159	0
1000Base-T	V = 48V, I = 0A	4 to 159	0
1000Base-T	V = 48V, I = 100mA	4 to 159	0
1000Base-T	V = 48V, I = 300mA	4 to 159	0

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Bit Error Data for V= 0V & I = 0A

	Rev	Temp (C)	OVDD(v)	LVDD(v)	DVDD(v)	AVDD(v)	Length	M / S mode	Frames Sent	KB Sent	Frames Recv	KB Recv	Bad Frames	Missing Frames	BER	Link Dropout
UUT	B0	68	3.30	1.80	2.5	2.5	4	Slave	74,884,851	11,157,843	74,402,026	11,085,902	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	4		74,402,026	11,085,902	74,884,851	11,157,843	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	9	Slave	74,881,206	11,157,300	74,405,582	11,086,432	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	9		74,405,582	11,086,432	74,881,206	11,157,300	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	14	Slave	74,881,158	11,157,292	74,402,001	11,085,898	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	14		74,402,001	11,085,898	74,881,158	11,157,293	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	24	Slave	74,881,174	11,157,295	74,402,057	11,085,906	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	24		74,402,057	11,085,906	74,881,174	11,157,295	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	44	Slave	74,855,514	11,153,472	74,365,774	11,080,500	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	44		74,365,774	11,080,500	74,855,514	11,153,472	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	64	Slave	74,778,910	11,142,058	74,279,385	11,067,628	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	64		74,279,385	11,067,628	74,778,910	11,142,058	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	84	Slave	74,862,317	11,154,485	74,399,824	11,085,574	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	84		74,399,824	11,085,574	74,862,317	11,154,485	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	104	Slave	73,961,998	11,020,338	73,482,859	10,948,946	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	104		73,482,859	10,948,946	73,961,998	11,020,338	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	124	Slave	74,634,509	11,120,542	74,202,184	11,056,125	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	124		74,202,184	11,056,125	74,634,509	11,120,542	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	144	Slave	73,795,938	10,995,595	73,312,477	10,923,559	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	144		73,312,477	10,923,559	73,795,938	10,995,595	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	154	Slave	74,961,123	11,169,207	74,481,438	11,097,734	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	154		74,481,438	11,097,734	74,961,123	11,169,207	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	159	Slave	74,670,267	11,125,870	74,192,640	11,054,703	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	159		74,192,640	11,054,703	74,670,267	11,125,870	0	0	0.00E+00	No

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Bit Error Data for V= 48V & I = 0A

	Rev	Temp (C)	OVDD(v)	LVDD(v)	DVDD(v)	AVDD(v)	Length	M / S mode	Frames Sent	KB Sent	Frames Recv	KB Recv	Bad Frames	Missing Frames	BER	Link Dropout
UUT	B0	68	3.30	1.80	2.5	2.5	4	Slave	74,881,270	11,157,309	74,402,036	11,085,903	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	4		74,402,036	11,085,903	74,881,270	11,157,309	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	9	Slave	74,881,184	11,157,296	74,405,574	11,086,431	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	9		74,405,574	11,086,431	74,881,184	11,157,296	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	14	Slave	74,881,227	11,157,303	74,402,058	11,085,907	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	14		74,402,058	11,085,907	74,881,227	11,157,303	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	24	Slave	74,881,196	11,157,298	74,405,657	11,086,443	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	24		74,405,657	11,086,443	74,881,196	11,157,298	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	44	Slave	73,882,098	11,008,433	73,402,905	10,937,033	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	44		73,402,905	10,937,033	73,882,098	11,008,433	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	64	Slave	74,884,827	11,157,839	74,401,968	11,085,893	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	64		74,401,968	11,085,893	74,884,827	11,157,839	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	84	Slave	74,881,184	11,157,296	74,405,574	11,086,431	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	84		74,405,574	11,086,431	74,881,184	11,157,296	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	104	Slave	74,882,077	11,157,429	74,401,971	11,085,894	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	104		74,401,971	11,085,894	74,882,077	11,157,429	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	124	Slave	74,881,185	11,157,297	74,402,002	11,085,898	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	124		74,402,002	11,085,898	74,881,185	11,157,297	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	144	Slave	74,641,352	11,121,561	74,162,110	11,050,154	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	144		74,162,110	11,050,154	74,641,352	11,121,561	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	154	Slave	74,881,174	11,157,295	74,405,722	11,086,453	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	154		74,405,722	11,086,453	74,881,174	11,157,295	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	159	Slave	74,881,270	11,157,309	74,402,036	11,085,903	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	159		74,402,036	11,085,903	74,881,270	11,157,309	0	0	0.00E+00	No

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Bit Error Data for V= 48V & I = 100mA

	Rev	Temp (C)	OVDD(v)	LVDD(v)	DVDD(v)	AVDD(v)	Length	M / S mode	Frames Sent	KB Sent	Frames Recv	KB Recv	Bad Frames	Missing Frames	BER	Link Dropout
UUT	B0	68	3.30	1.80	2.5	2.5	4	Slave	74,922,659	11,163,476	74,445,680	11,092,406	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	4		74,445,680	11,092,406	74,922,659	11,163,476	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	9	Slave	74,881,248	11,157,306	74,402,101	11,085,913	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	9		74,402,101	11,085,913	74,881,248	11,157,306	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	14	Slave	74,881,227	11,157,303	74,402,058	11,085,907	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	14		74,402,058	11,085,907	74,881,227	11,157,303	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	24	Slave	74,881,196	11,157,298	74,405,657	11,086,443	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	24		74,405,657	11,086,443	74,881,196	11,157,298	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	44	Slave	73,882,098	11,008,433	73,402,905	10,937,033	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	44		73,402,905	10,937,033	73,882,098	11,008,433	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	64	Slave	74,884,827	11,157,839	74,401,968	11,085,893	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	64		74,401,968	11,085,893	74,884,827	11,157,839	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	84	Slave	74,881,184	11,157,296	74,405,574	11,086,431	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	84		74,405,574	11,086,431	74,881,184	11,157,296	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	104	Slave	74,882,077	11,157,429	74,401,971	11,085,894	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	104		74,401,971	11,085,894	74,882,077	11,157,429	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	124	Slave	74,881,185	11,157,297	74,402,002	11,085,898	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	124		74,402,002	11,085,898	74,881,185	11,157,297	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	144	Slave	74,641,352	11,121,561	74,162,110	11,050,154	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	144		74,162,110	11,050,154	74,641,352	11,121,561	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	154	Slave	74,881,174	11,157,295	74,405,722	11,086,453	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	154		74,405,722	11,086,453	74,881,174	11,157,295	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	159	Slave	74,881,270	11,157,309	74,402,036	11,085,903	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	159		74,402,036	11,085,903	74,881,270	11,157,309	0	0	0.00E+00	No

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Bit Error Data for V= 48V & I = 300mA

	Rev	Temp (C)	OVDD(v)	LVDD(v)	DVDD(v)	AVDD(v)	Length	M / S mode	Frames Sent	KB Sent	Frames Recv	KB Recv	Bad Frames	Missing Frames	BER	Link Dropout
UUT	B0	68	3.30	1.80	2.5	2.5	4	Slave	74,881,342	11,157,320	74,402,076	11,085,909	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	4		74,402,076	11,085,909	74,881,342	11,157,320	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	9	Slave	74,884,937	11,157,856	74,402,166	11,085,923	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	9		74,402,166	11,085,923	74,884,937	11,157,856	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	14	Slave	74,880,283	11,157,162	74,405,830	11,086,469	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	14		74,405,830	11,086,469	74,880,283	11,157,162	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	24	Slave	74,881,308	11,157,315	74,402,154	11,085,921	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	24		74,402,154	11,085,921	74,881,308	11,157,315	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	44	Slave	74,841,497	11,151,383	74,371,777	11,081,395	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	44		74,371,777	11,081,395	74,841,497	11,151,383	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	64	Slave	74,961,161	11,169,213	74,477,976	11,097,218	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	64		74,477,976	11,097,218	74,961,161	11,169,213	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	84	Slave	74,884,885	11,157,848	74,405,759	11,086,458	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	84		74,405,759	11,086,458	74,884,885	11,157,848	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	104	Slave	74,879,688	11,157,074	74,402,142	11,085,919	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	104		74,402,142	11,085,919	74,879,688	11,157,074	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	124	Slave	74,881,255	11,157,307	74,402,109	11,085,914	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	124		74,402,109	11,085,914	74,881,255	11,157,307	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	144	Slave	74,884,924	11,157,854	74,403,959	11,086,190	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	144		74,403,959	11,086,190	74,884,924	11,157,854	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	154	Slave	74,881,268	11,157,309	74,403,469	11,086,117	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	154		74,403,469	11,086,117	74,881,268	11,157,309	0	0	0.00E+00	No
UUT	B0	68	3.30	1.80	2.5	2.5	159	Slave	74,881,267	11,157,309	74,402,258	11,085,936	0	0	0.00E+00	No
Fixture	B0		3.30	1.80	2.5	2.5	159		74,402,258	11,085,936	74,881,267	11,157,309	0	0	0.00E+00	No

1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

- **Transmitter compliance to Physical Medium Attachment (PMA) sublayer electrical specifications is measured by use of defined test modes**
  - ➢per 802.3ab 40.61.2

- Peak differential output voltage and level accuracy (Clause 40.6.1.2.1)
- Maximum output droop (Clause 40.6.1.2.2)
- Differential output templates (Clause 40.6.1.2.3)
- Transmitter timing jitter (Clause 40.6.1.2.5)
- Transmit clock frequency (Clause 40.6.1.2.6)
- Common-mode noise rejection (Clause 40.6.1.3.3)

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1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

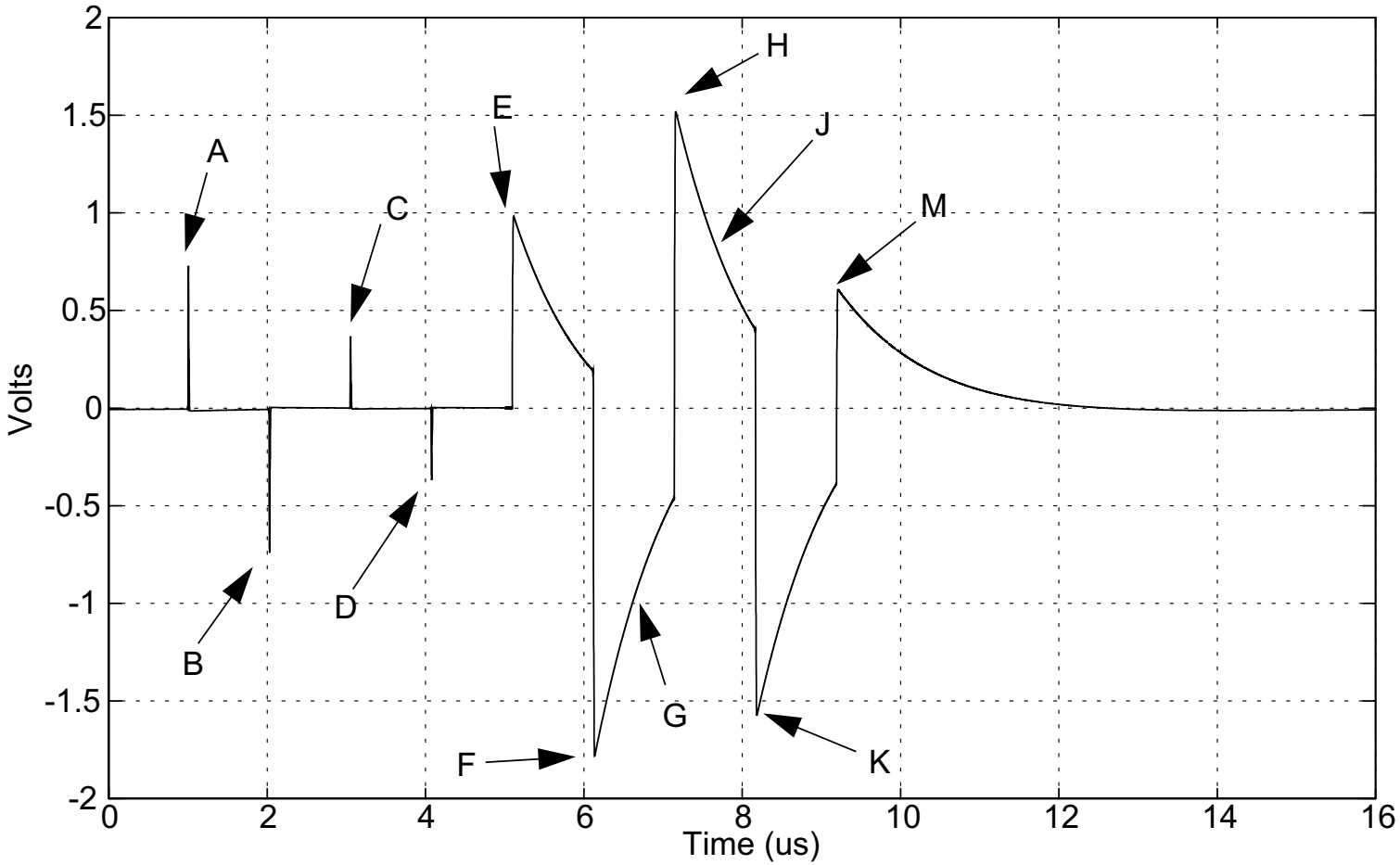

Figure 40-19—Example of transmitter test mode 1 waveform (1 cycle)

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1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

- **Clause 40.6.1.2.1 Peak differential output voltage and level accuracy**

  - **The absolute value of the peak of the waveform at points A and B, as defined in Figure 40-19, shall fall within the range of 0.67 V to 0.82 V (0.75 V +/- 0.83 dB). These measurements are to be made for each pair while operating in test mode 1 and observing the differential signal output at the MDI using transmitter test fixture 1 with no intervening cable.**

    The absolute value of the peak of the waveform at points A and B shall differ by less than 1%.

    The absolute value of the peak of the waveform at points C and D as defined in Figure 40-19 shall differ by less than 2% from 0.5 times the average of the absolute values of the peaks of the waveform at points A and B.

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1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

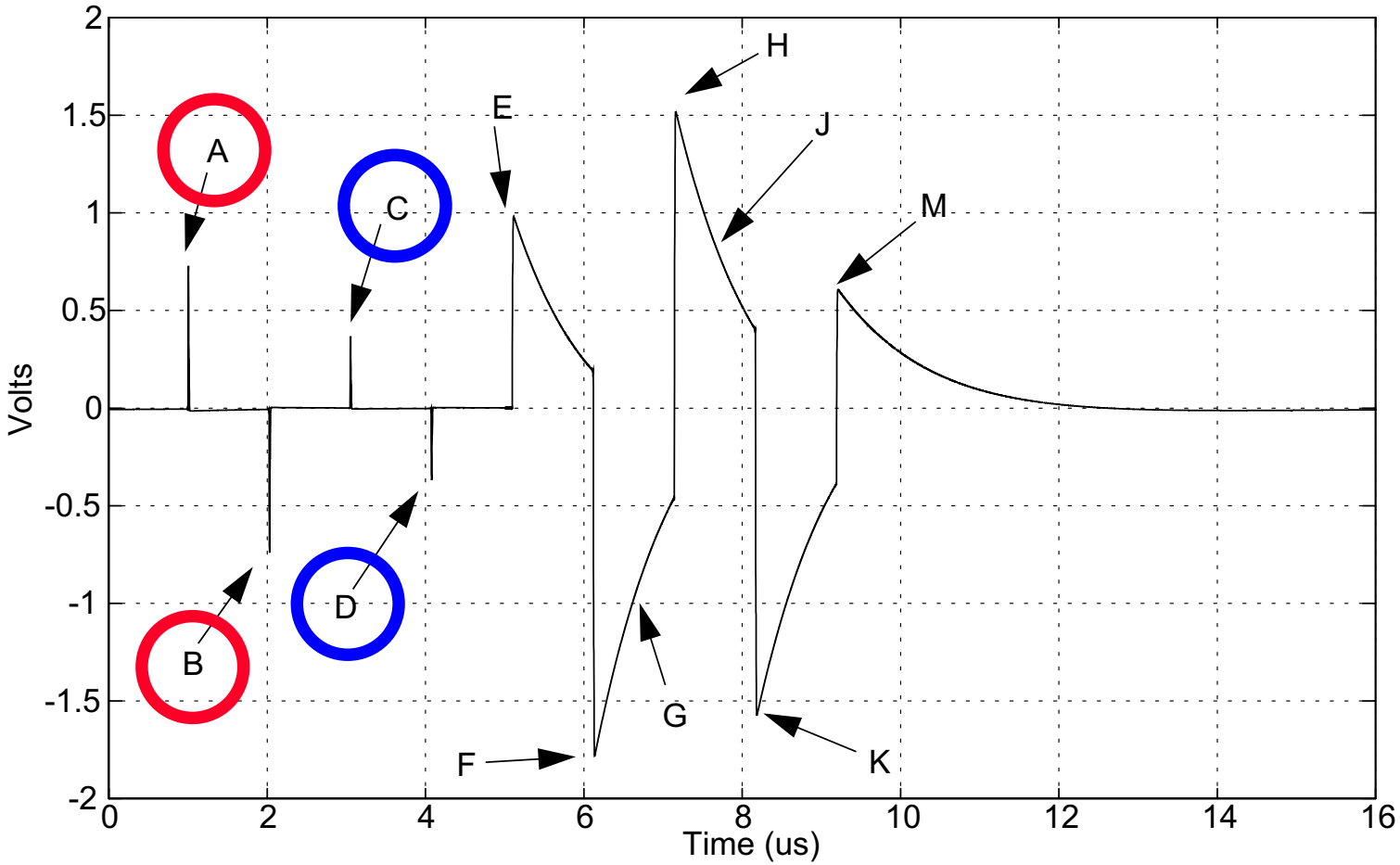
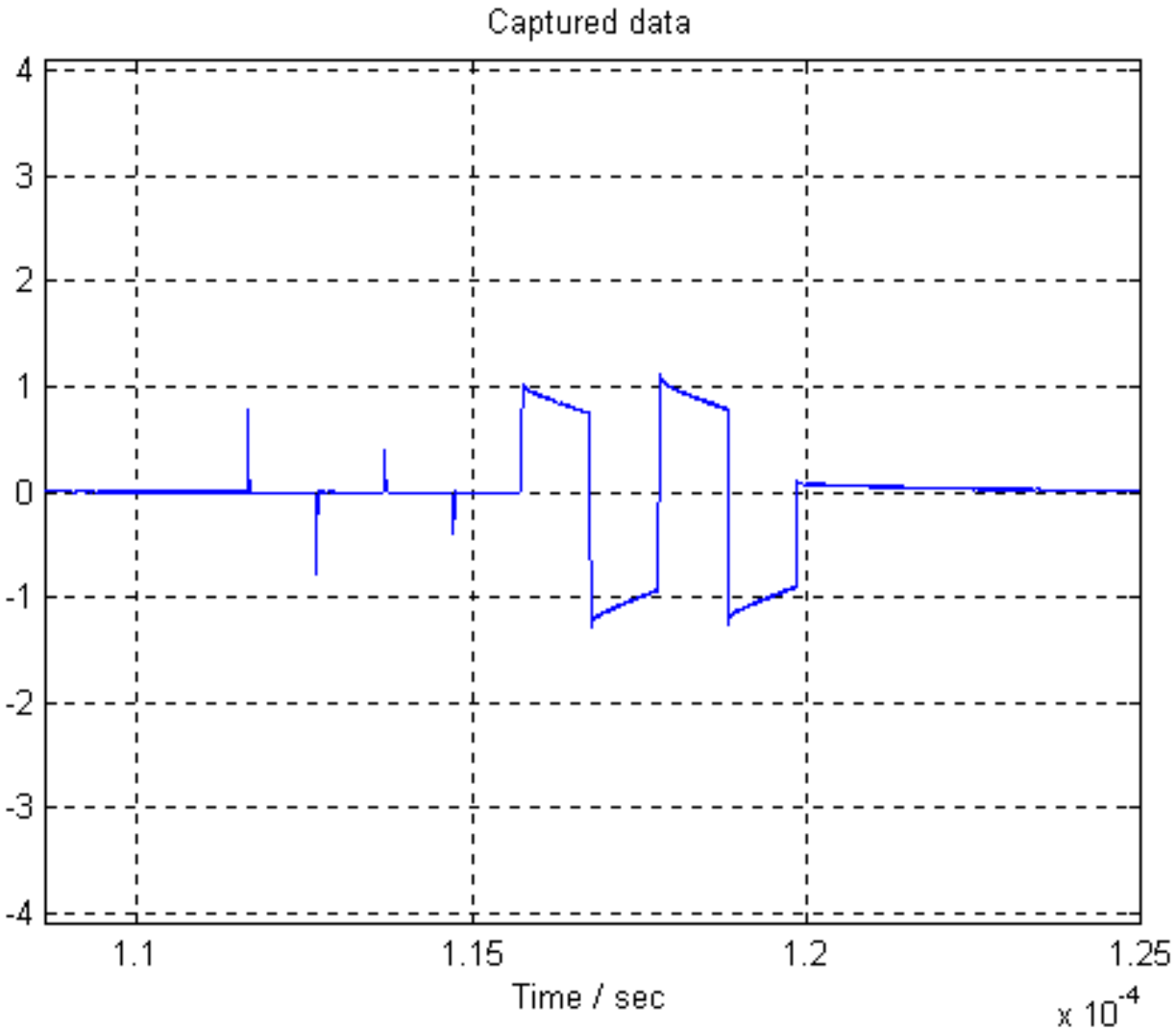


Figure 40-19—Example of transmitter test mode 1 waveform (1 cycle)

Sample Plot
48V, 300mA



Peak differential output voltage and level accuracy (Clause 40.6.1.2.1): Test Results

V = 0V & I = 0A	Channel A	Channel B
Peak value at point A	0.745605V	0.767886V
Peak value at point B	-0.747981V	-0.761943V
Peak value at point C	0.370804V	0.384019V
Peak value at point D	-0.373757V	-0.383480V
Percent difference between A and B	0.003%	0.78%
Percent difference between 0.5*A and C	0.005%	-0.02%
Percent difference between 0.5*B and D	0.06%	-0.65%
V = 48V & I = 0A	**Channel A**	**Channel B**
Peak value at point A	0.749922V	0.753170V
Peak value at point B	-0.748748V	-0.746136V
Peak value at point C	0.372225V	0.374491V
Peak value at point D	-0.377366V	-0.374430V
Percent difference between A and B	0.16%	0.94%
Percent difference between 0.5*A and C	0.74%	0.56%
Percent difference between 0.5*B and D	-0.79%	-0.36%
V = 48V & I = 100mA	**Channel A**	**Channel B**
Peak value at point A	0.751879V	0.762798V
Peak value at point B	-0.748590V	-0.765262V
Peak value at point C	0.374133V	0.381240V
Peak value at point D	-0.376096V	-0.382229V
Percent difference between A and B	0.44%	0.32%
Percent difference between 0.5*A and C	0.48%	0.04%
Percent difference between 0.5*B and D	-0.48%	0.11%
V = 48V & I = 300mA	**Channel A**	**Channel B**
Peak value at point A	0.749615V	0.750547V
Peak value at point B	-0.743346V	-0.748557V
Peak value at point C	0.372740V	0.371404V
Peak value at point D	-0.372413V	-0.374728V
Percent difference between A and B	0.84%	0.27%
Percent difference between 0.5*A and C	0.55%	1.04%
Percent difference between 0.5*B and D	-0.20%	-0.12%

1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2 Results

- **Clause 40.6.1.2.1 Peak differential output voltage and level accuracy**
  - ➢ The absolute value of the peak of the waveform at points A and B differed by less than 1% for I= 0mA, 100mA, 300mA
    - **No significant difference**
  - ➢ ***The absolute value of the peak of the waveform at points C and D as defined in Figure 40-19 differed by less than 2% from 0.5 times the average of the absolute values of the peaks of the waveform at points A and B I= 0mA, 100mA, 300mA.***
    - **No significant difference**
- ***48V and up to 300mA has no impact on peak differential output voltage and level accuracy***

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1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

- **Maximum output droop (Clause 40.6.1.2.2)**
  - The magnitude of the negative peak value of the waveform at point G as defined in the Figure 40-19, shall be greater than 73.1% of the magnitude of the negative peak value of the waveform at point F. These measurements are to be made for each pair while in test mode 1 and observing the differential signal output at the MDI using transmit test fixture 2 with no intervening cable. Point G is defined as the point exactly 500 ns after point F. Point F is defined as the point where the waveform reaches its minimum value at the location indicated in Figure 40-17.
  - Additionally, the magnitude of the peak value of the waveform at point J as defined in Figure 40-19, shall be greater than 73.1% of the magnitude of the peak value of the waveform at point H. Point J is defined as the point exactly 500 ns after point H. Point H is defined as the point where the waveform reaches its maximum value at the location indicated Figure 40-19.

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1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

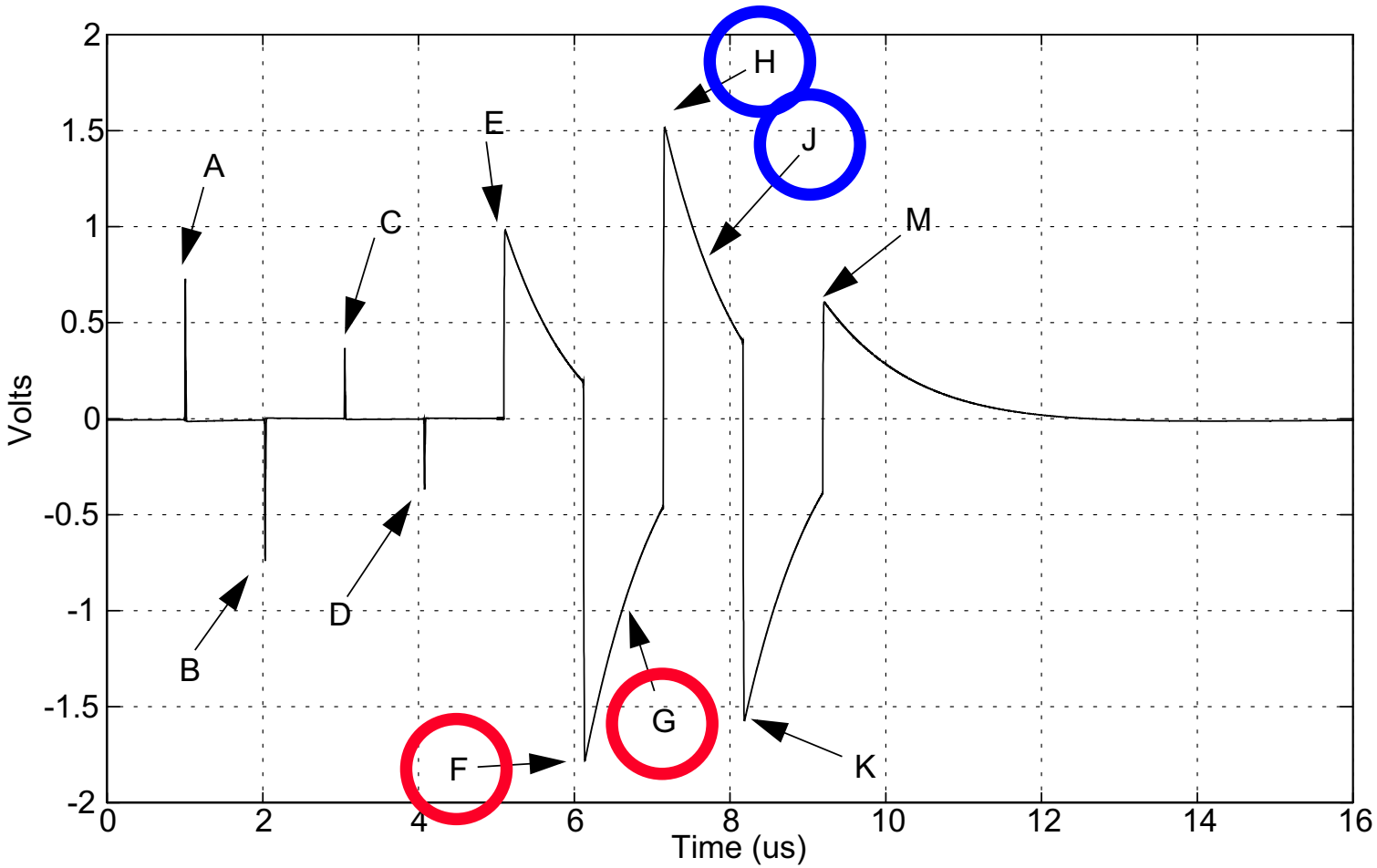
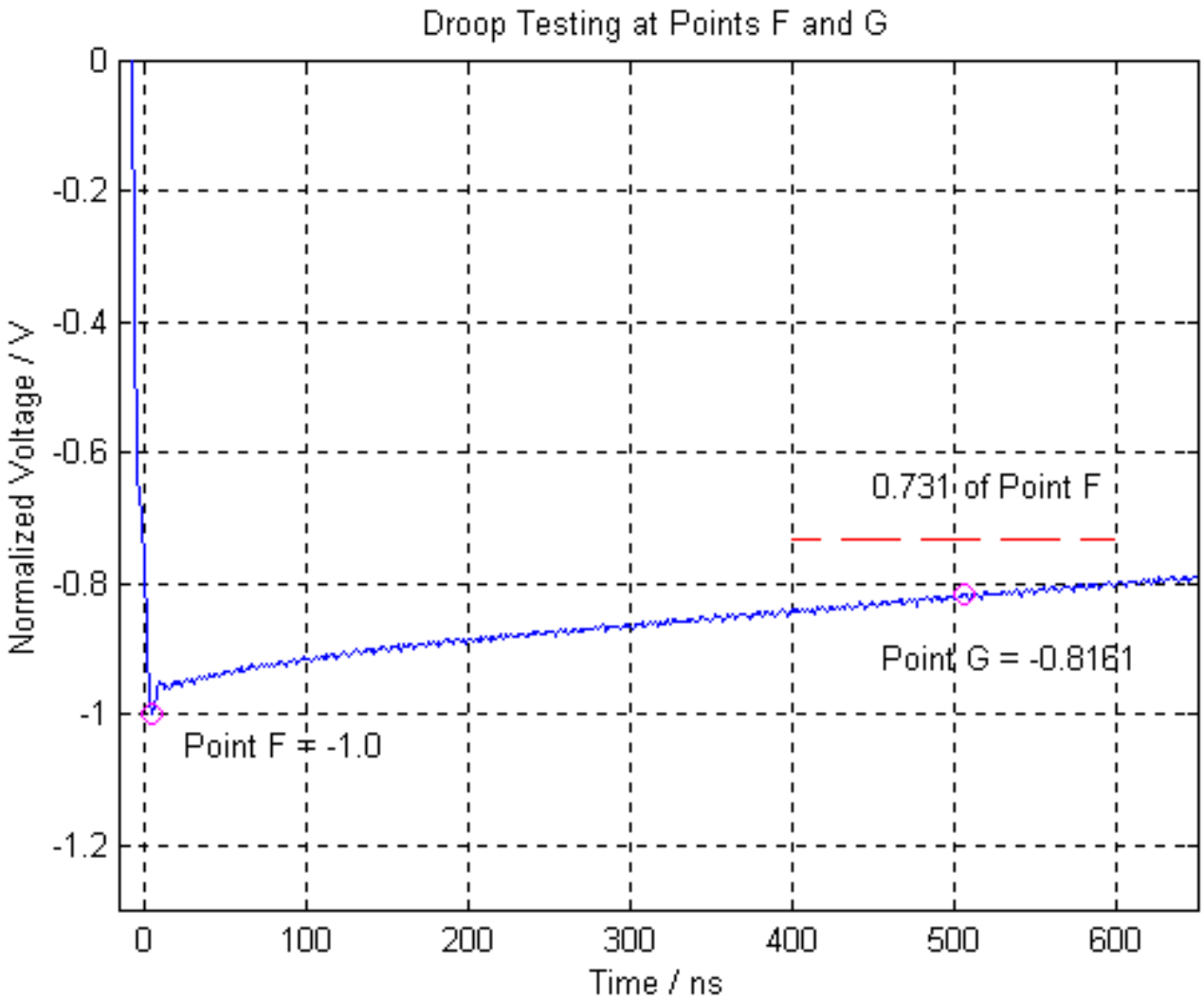
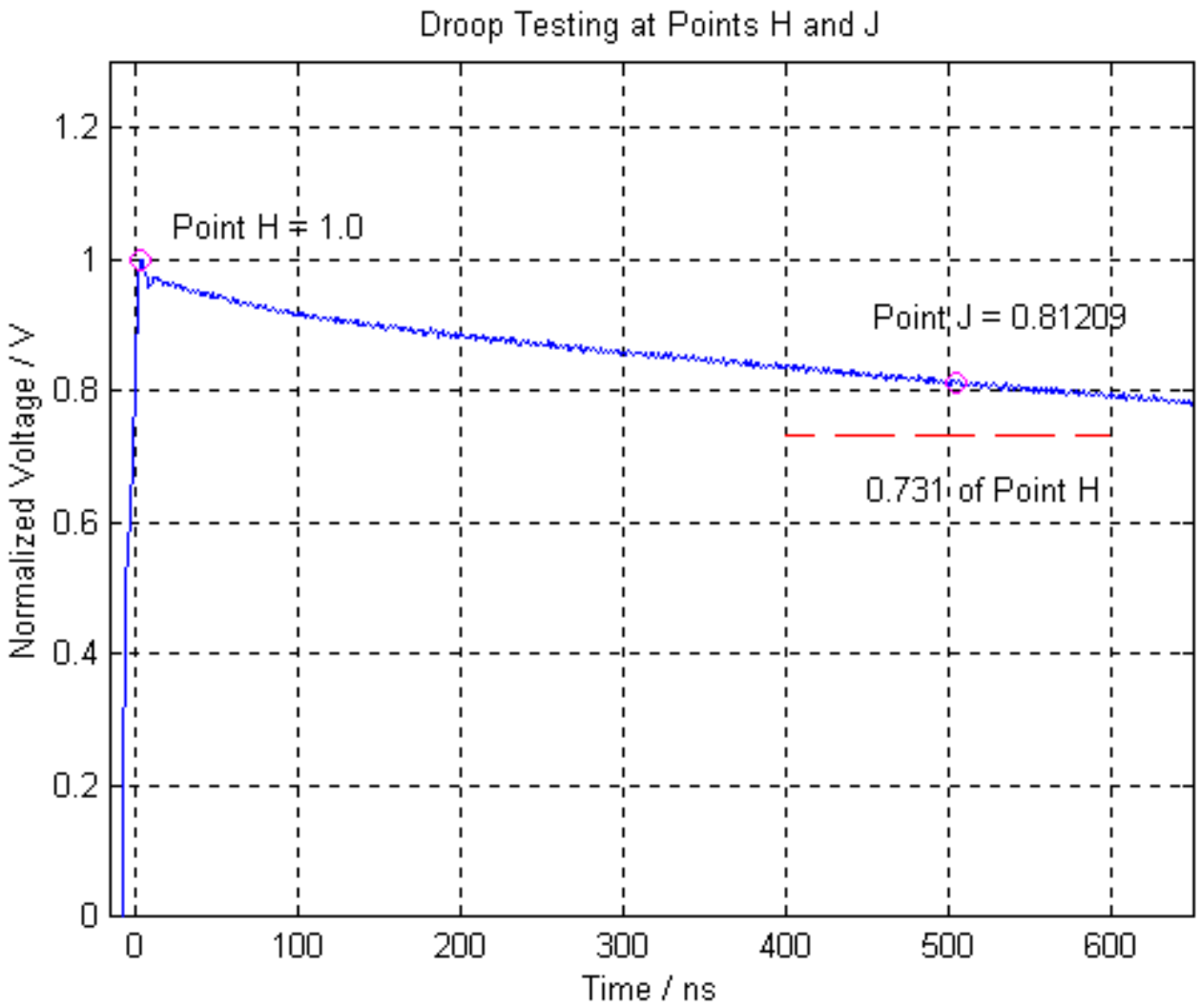


Figure 40-19—Example of transmitter test mode 1 waveform (1 cycle)

Sample Plot
48V, 300mA



Sample Plot
48V, 300mA



Maximum output droop (Clause 40.6.1.2.2): Test Results

V = 0V & I = 0 A				
Differential Pair	Point G	Point F	Point J	Point H
1-2	-0.875267V	-1.000000V	0.879624V	1.000000V
3-6	-0.860209V	-1.000000V	0.855235V	1.000000V
V = 48V & I = 0 A				
Differential Pair	Point G	Point F	Point J	Point H
1-2	-0.869783V	-1.000000V	0.869296V	1.000000V
3-6	-0.867046V	-1.000000V	0.870198V	1.000000V
V = 48V & I = 100mA				
Differential Pair	Point G	Point F	Point J	Point H
1-2	-0.860899V	-1.000000V	0.860021V	1.000000V
3-6	-0.853620V	-1.000000V	0.846527V	1.000000V
V = 48V & I = 300mA				
Differential Pair	Point G	Point F	Point J	Point H
1-2	-0.816101V	-1.000000V	0.812091V	1.000000V
3-6	-0.818081V	-1.000000V	0.809449V	1.000000V

48V and up to 300mA has minor impact on maximum output droop; all points remain within specification

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1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

- **Differential output templates (Clause 40.6.1.2.3)**

- The voltage waveforms around points A, B, C, D defined in the Test Mode 1 waveform, after the normalization described below, shall lie within the time domain template 1 defined in Figure 40-26 and the piecewise linear interpolation between the points in Table 40-10. These measurements are to be made for each pair while in test mode 1 and observing the differential signal output at the MDI using transmitter test fixture 1 with no intervening cable. The waveforms may be shifted in time as appropriate to fit within the template.
- The waveform around point A is normalized by dividing by the peak value of the waveform at A.
- The waveform around point B is normalized by dividing by the negative of the peak value of the waveform at A.
- The waveform around point C is normalized by dividing by 1/2 the peak value of the waveform at A.
- The waveform around point D is normalized by dividing by the negative of 1/2 the peak value of the waveform at A.

- The voltage waveforms around points F and H defined in the Test Mode 1 waveform , after the normalization described below, shall lie within the time domain template 2 defined in Figure 40-26 and the piecewise linear interpolation between the points in Table 40-11. These measurements are to be made for each pair while in test mode 1 and observing the differential signal output at the MDI using transmitter test fixture 1 with no intervening cable. The waveforms may be shifted in time as appropriate to fit within the template.

- The waveform around point F is normalized by dividing by the peak value of the waveform at F.
- The waveform around point H is normalized by dividing by the peak value of the waveform at H.

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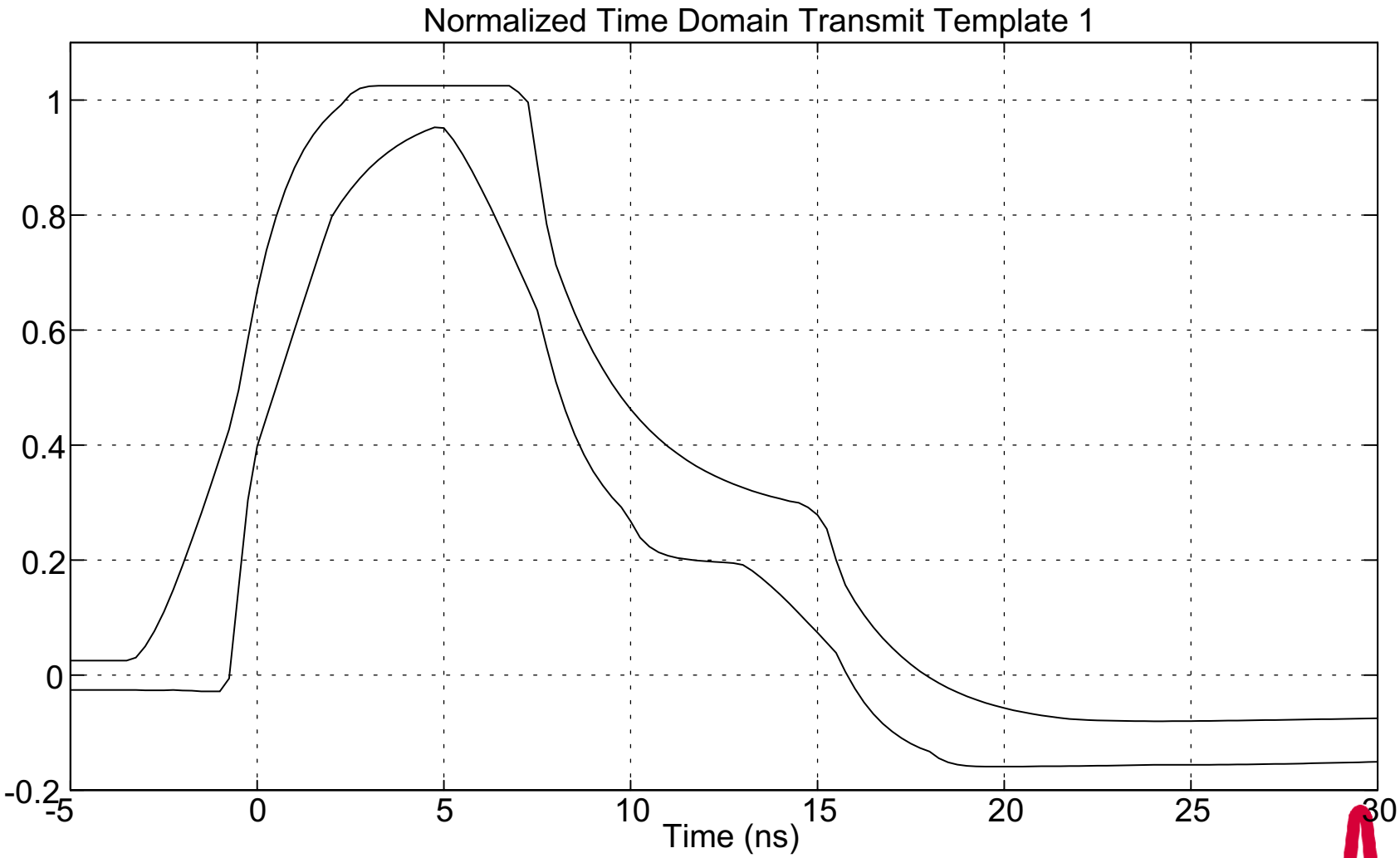
802.3ab Figure 40-26: Normalized Time Domain Template 1



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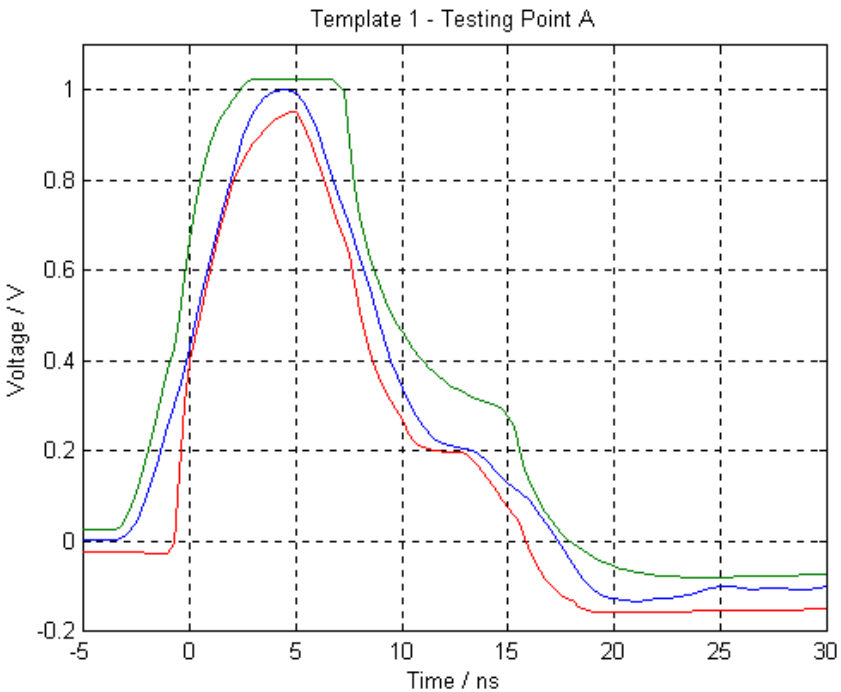
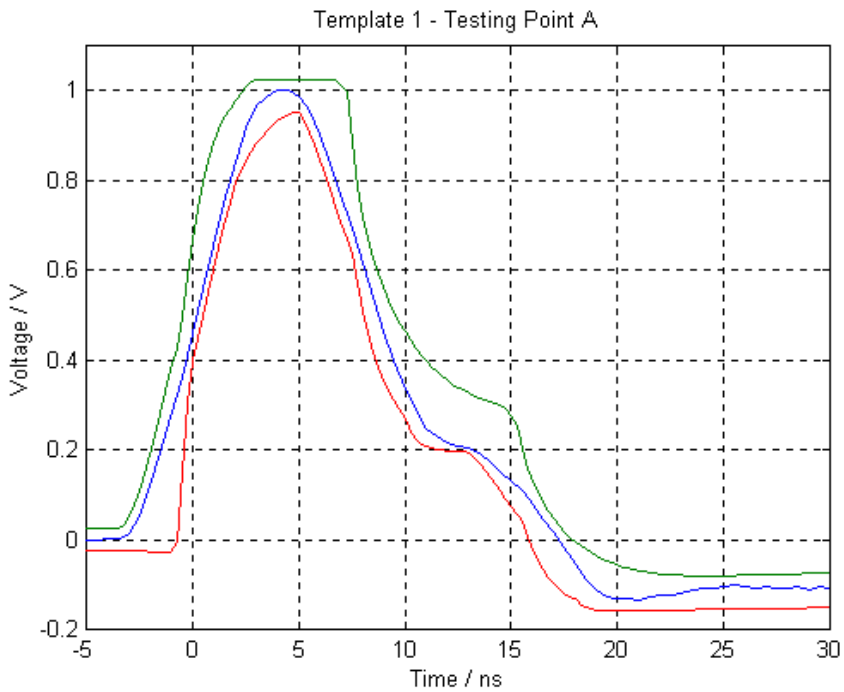
Testing Point A

48V, 300mA



V=0, I =0



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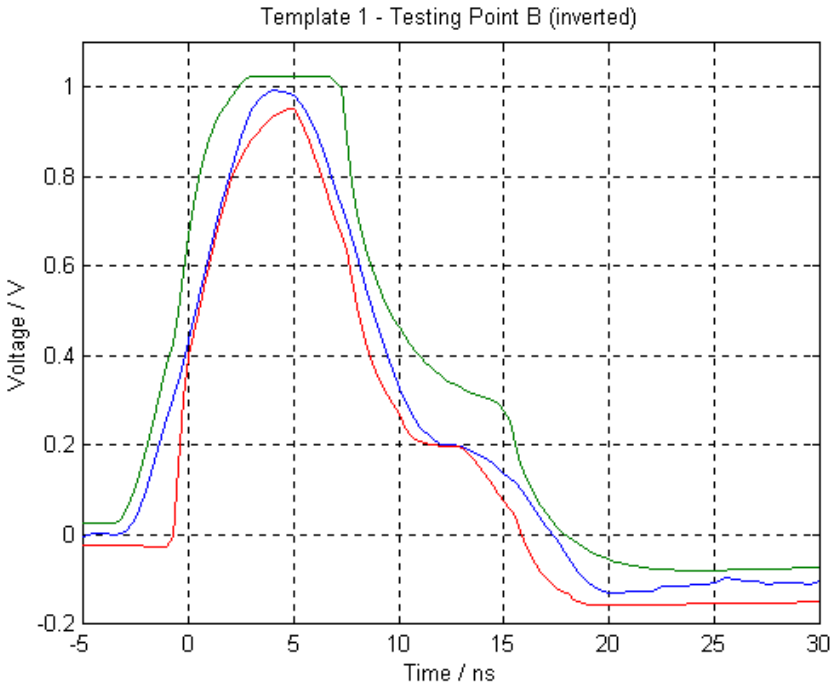
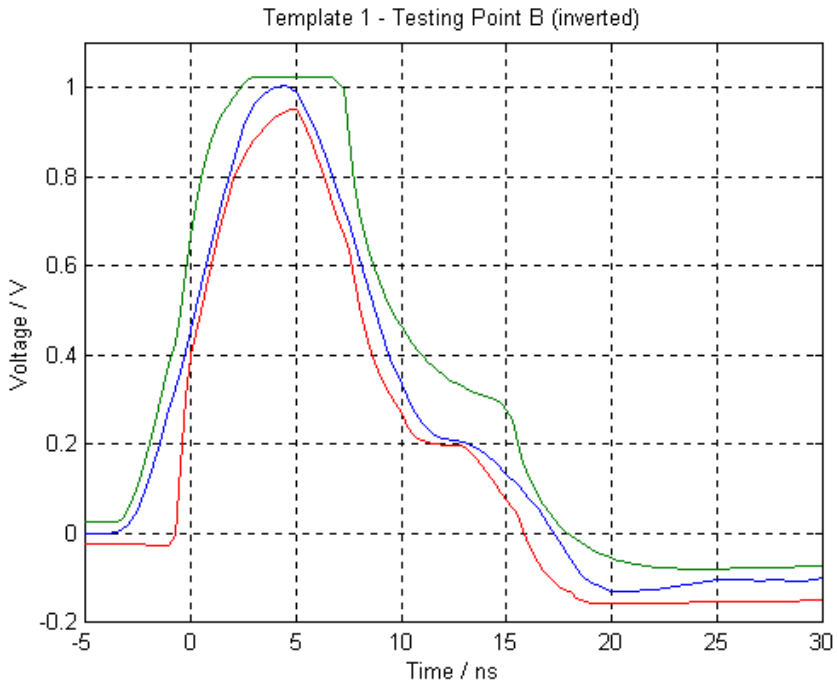
Testing Point B (inverted)

48V, 300mA V=0, I =0





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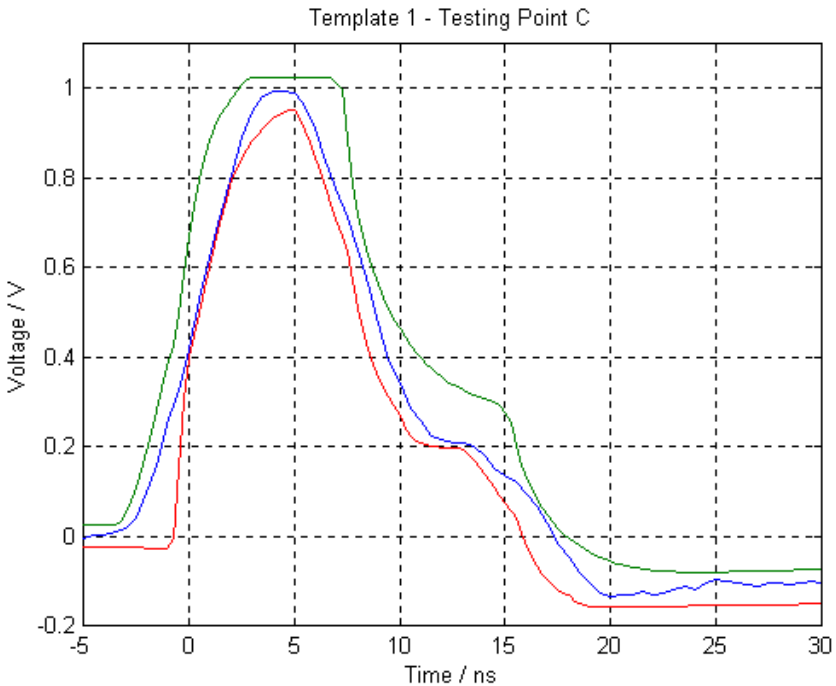
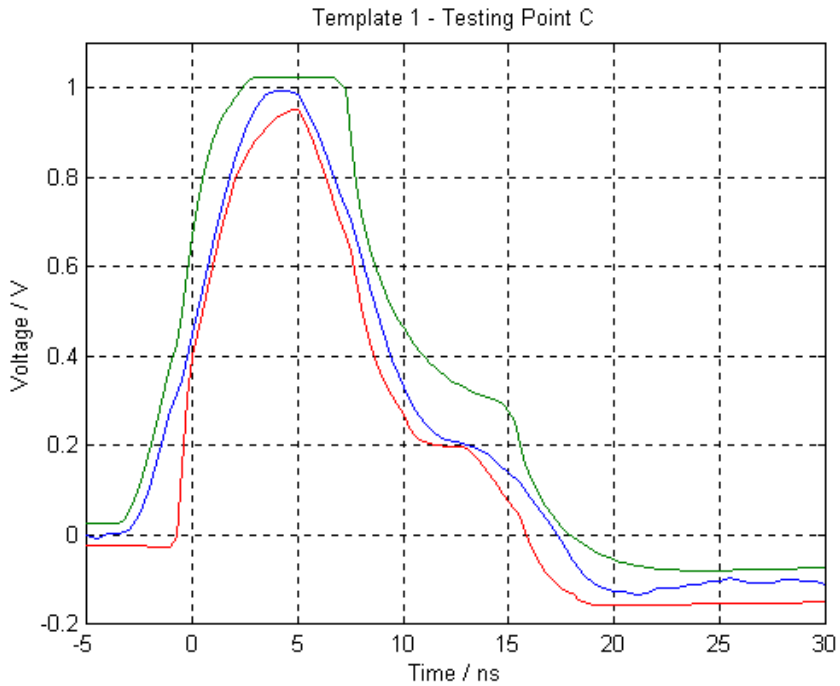
Testing Point C

48V, 300mA

V=0, I =0





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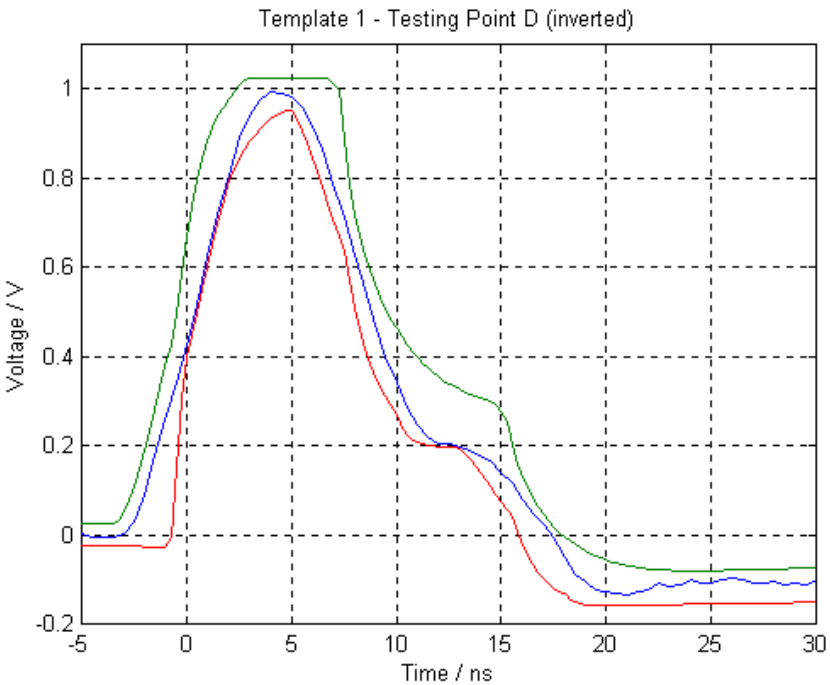
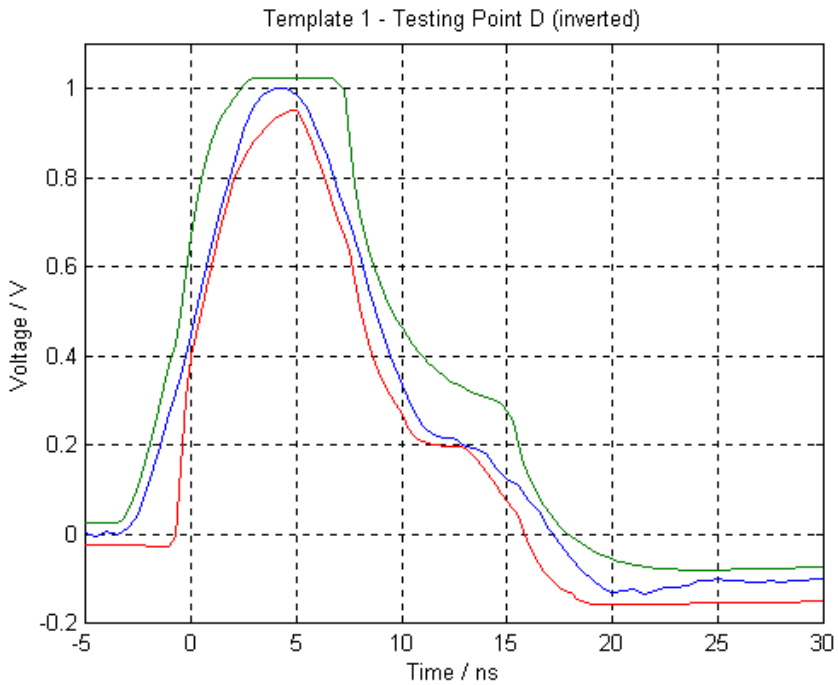
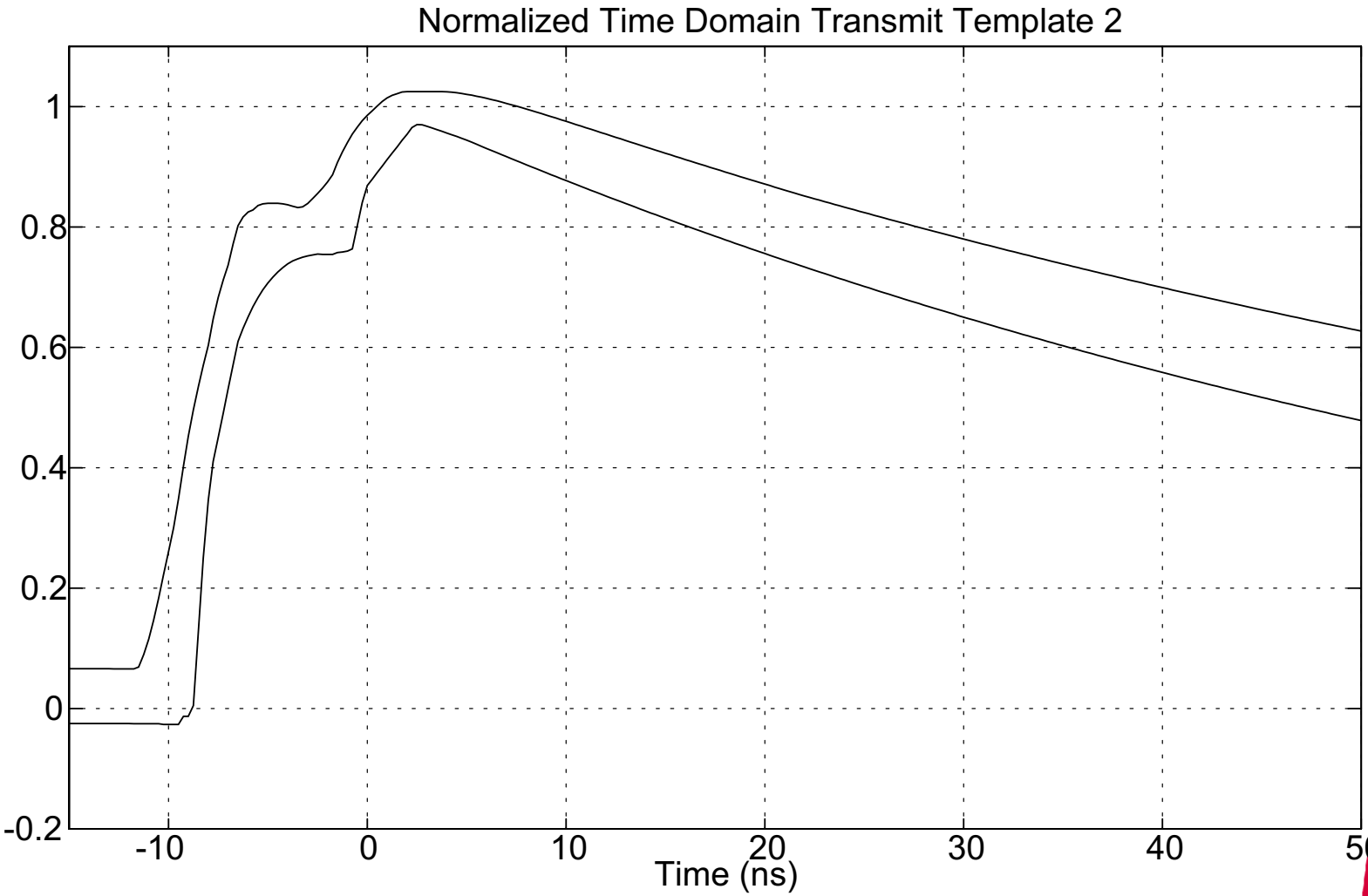
Testing Point D (inverted)

48V, 300mA V=0, I =0

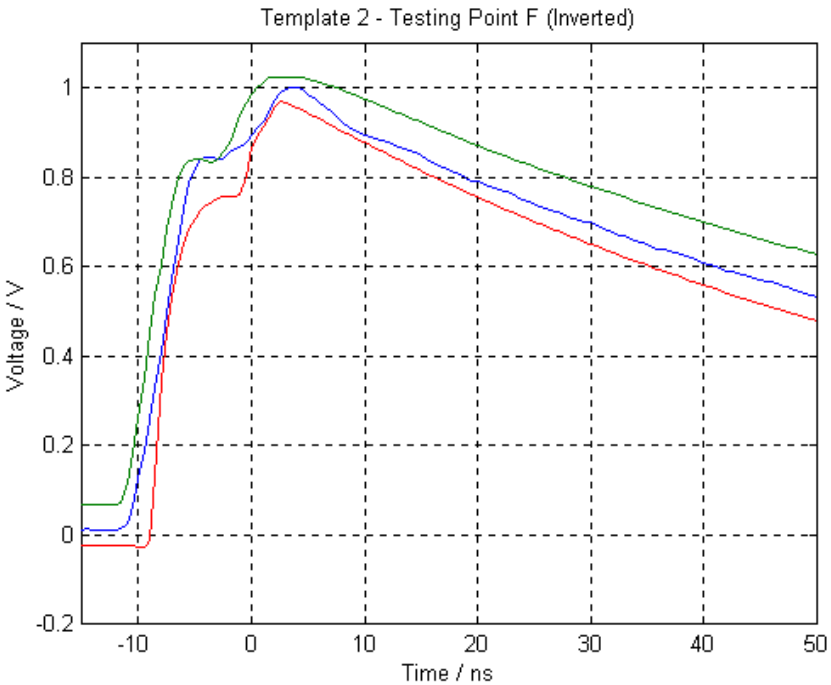


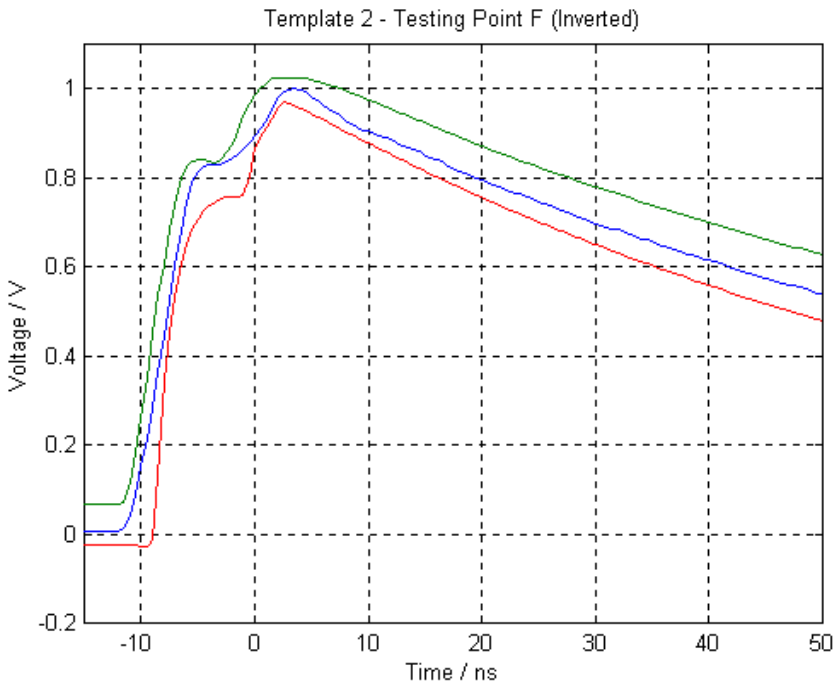


802.3ab Figure 40-26: Normalized Time Domain Template 2



Testing Point F (Inverted)
48V, 300mA V=0, I =0

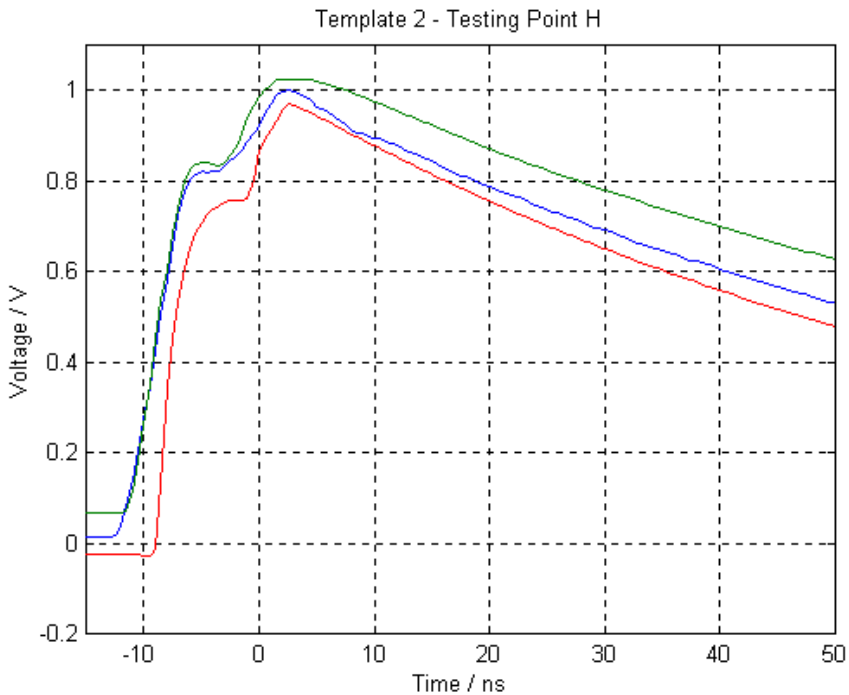


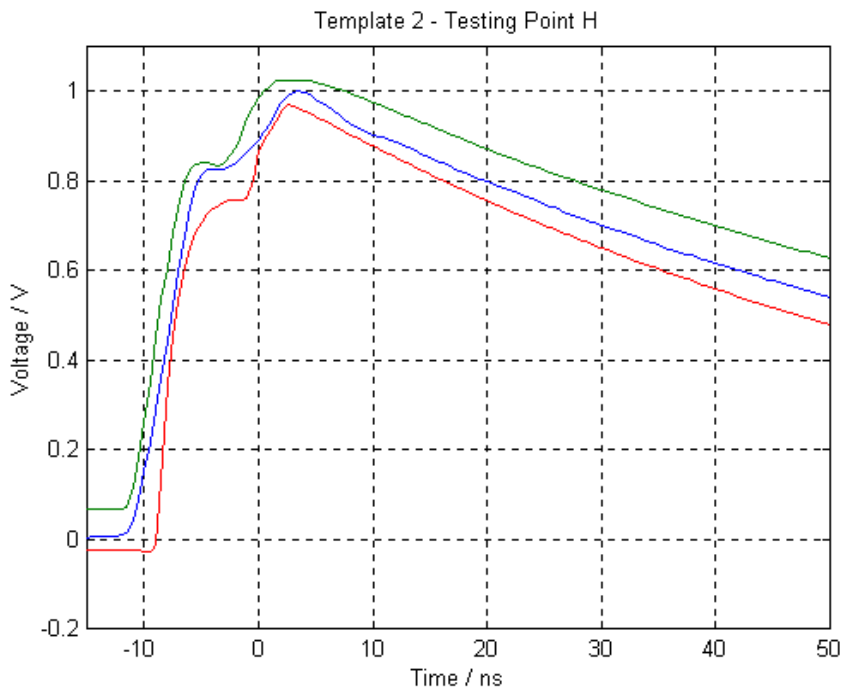


Testing Point H

48V, 300mA

V=0, I =0





1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

- **Differential output templates (Clause 40.6.1.2.3)**

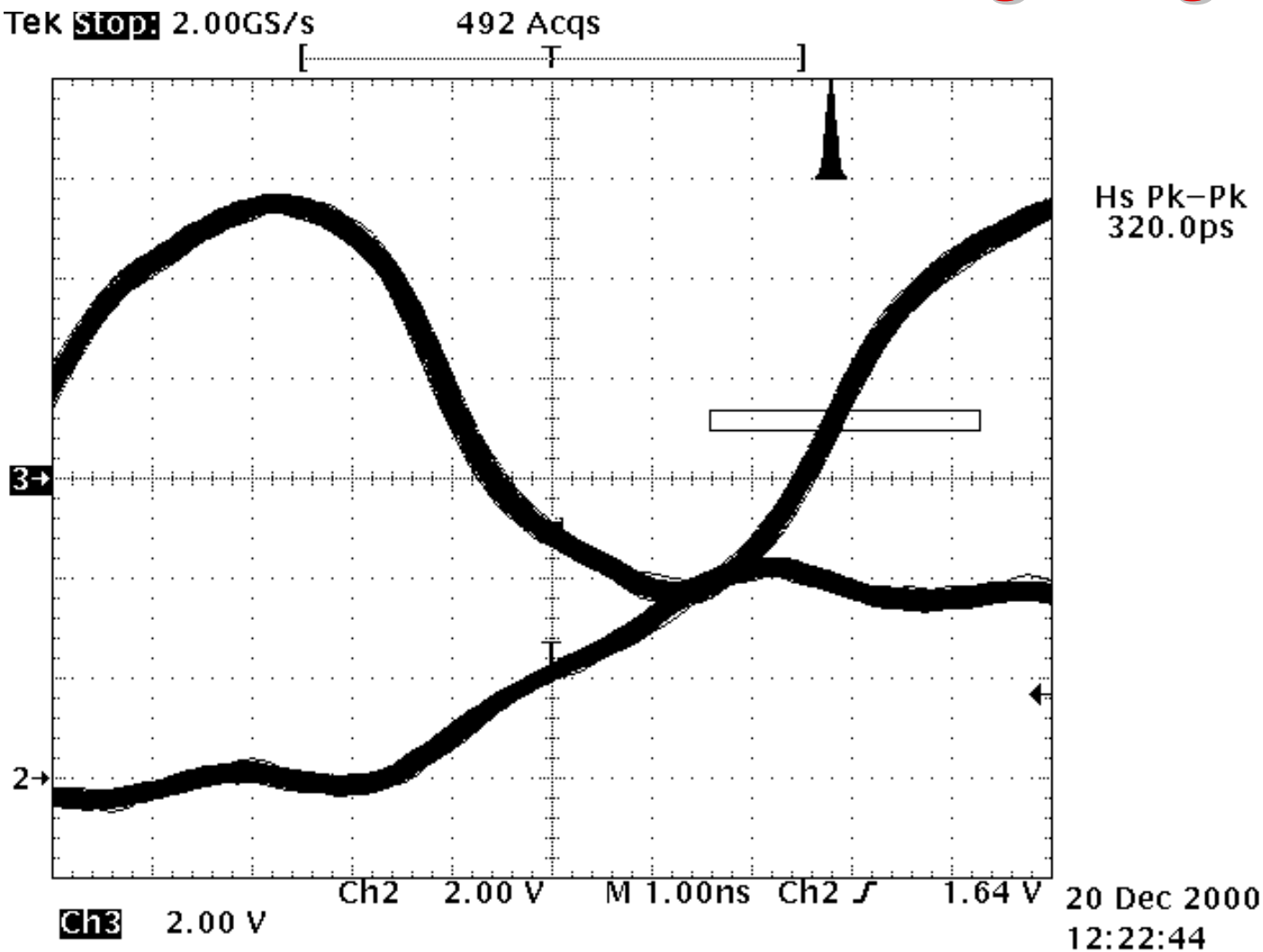
- ***Very slight shifts in transmitted waveforms observed***
- ***Waveforms remain within templates***

1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

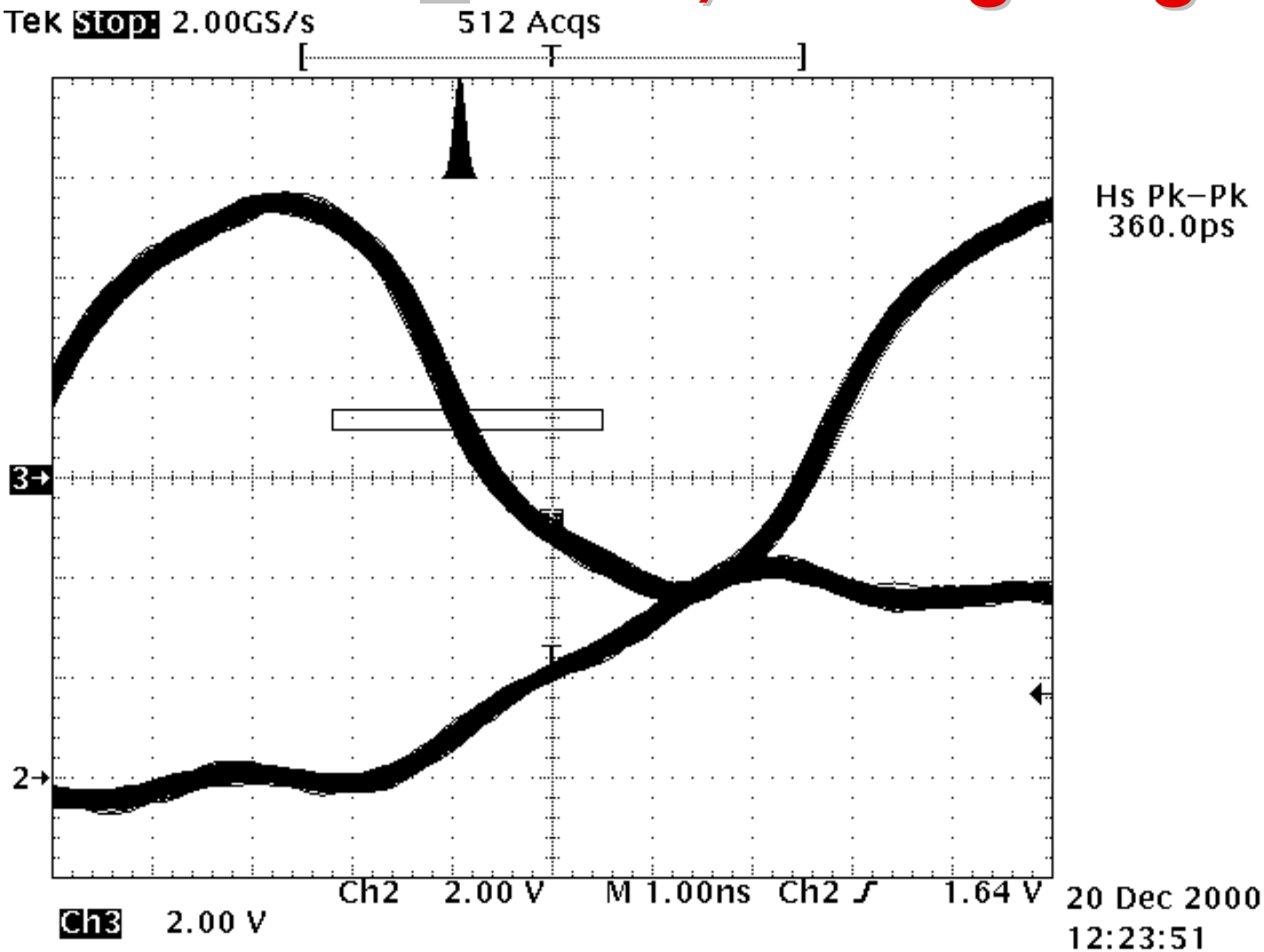
- **Transmitter timing jitter (Clause 40.6.1.2.5)**

- When in test mode 2 or test mode 3, the peak-to-peak jitter Jtxout , of the zero crossings of the differential signal output at the MDI relative to the corresponding edge of TX_TCLK is measured. The corresponding edge of TX_TCLK is the edge of the transmit test clock, in polarity and time, that generates the zero-crossing transition being measured.
- When in the normal mode of operation as the MASTER, the peak-to-peak value of the MASTER TX_TCLK jitter relative to an un-jittered reference shall be less than 1.4 ns. When the jitter waveform on TX_TCLK is filtered by a high pass filter, H jf1 (f) having the transfer function below, the peak-to-peak value of the resulting filtered timing jitter plus Jtxout ,shall be less than 0.3 ns.
- H jf1(f) = jf / (jf+ 5000) f in Hz
- When in the normal mode of operation as the SLAVE, receiving valid signals from a compliant PHY operating as the MASTER using the test channel defined in 40.6.1.1.1, with test channel port A connected to the SLAVE, the peak-to-peak value of the SLAVE TX_TCLK jitter relative to the MASTER TX_TCLK shall be less than 1.4 ns after the receiver is properly receiving the data and has set bit 10.13 of the GMII management register set to 1. When the jitter waveform on TX_TCLK is filtered by a high pass filter, H jf2 (f), having the transfer function below 1 , the peak-to-peak value of the resulting filtered timing jitter plus J txout shall be no more than 0.4 ns greater than the simultaneously measured peak-to-peak value of the MASTER jitter filtered by H jf1 (f).
- For all high pass filtered jitter measurements the peak-to-peak value shall be measured over an unbiased sample of at least 10^5 clock edges. For all unfiltered jitter measurements the peak-to-peak value shall be measured over an interval of not less than 100ms and not more than 1 second.
- H jf2(f) = jf / (jf + 32000) f in Hz

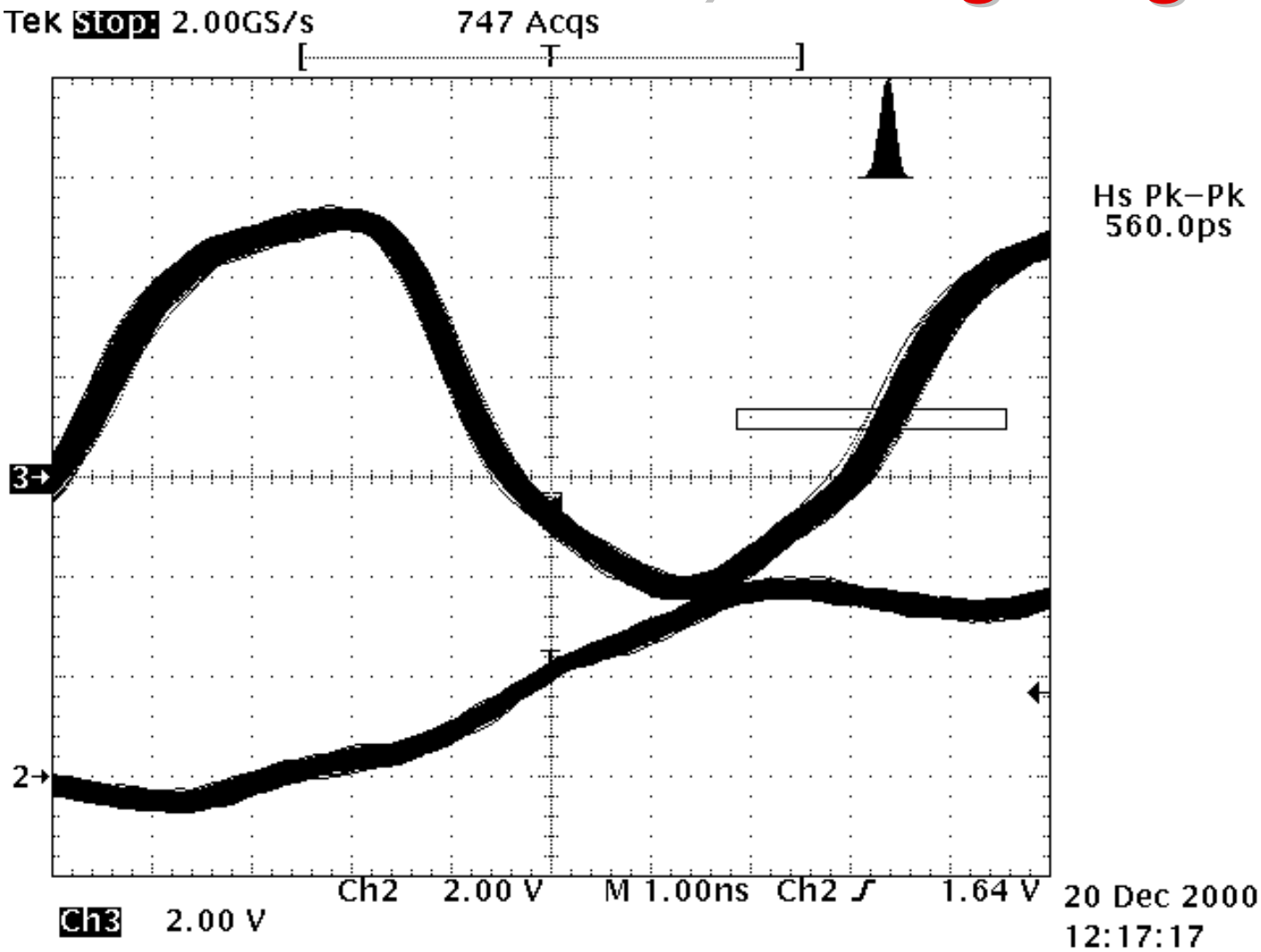
Transmit Jitter, V=48V, I=300mA
Master TX_TCLK, Rising Edge



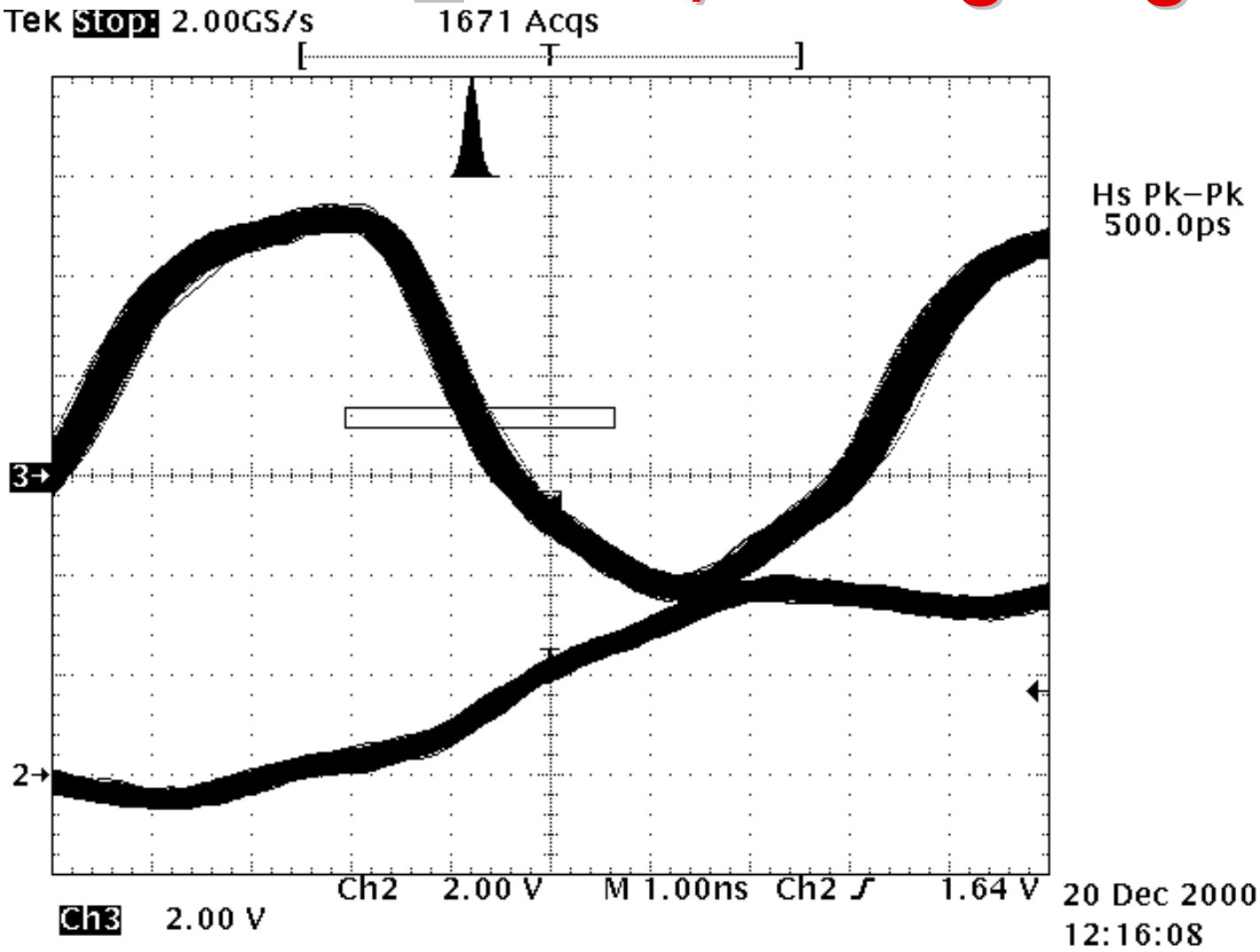
Transmit Jitter, V=48V, I=300mA
Master TX_TCLK, Falling Edge



Transmit Jitter, V=48V, I=300mA Slave TX_TCLK, Rising Edge



Transmit Jitter, V=48V, I=300mA
Slave TX_TCLK, Falling Edge



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Transmit Jitter Test Results

DTE power mode	Master TXTCLK Rising Edge	Master TXTCLK Falling Edge	Slave TXTCLK Rising Edge	Slave TXTCLK Falling Edge
V = 0V & I = 0A	320 ps	340 ps	520 ps	520 ps
V = 48V & I = 0A	340 ps	340 ps	520 ps	520 ps
V = 48V & I = 100mA	300 ps	320 ps	540 ps	540 ps
V = 48V & I = 300mA	320 ps	360 ps	560 ps	500 ps

- ***No affect of DTE power on Transmit Jitter, on either Master or Slave end***

1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

- **Transmit Clock Frequency (Clause 40.6.1.2.6)**
- The quinary symbol transmission rate on each pair of the master PHY shall be 125.00 Mhz ± 0.01%.

DTE power mode	TX_CLK high	TX_CLK low	Percentage
V = 0V & I = 0A	124,999,289	124,999,275	0.000569 %
V = 48V & I = 0A	124,999,303	124,999,292	0.000558 %
V = 48V & I = 100mA	124,999,350	124,999,234	0.000520 %
V = 48V & I = 300mA	124,999,230	124,999,200	0.000616 %

- **DTE Power has no measurable effect on clock frequency**

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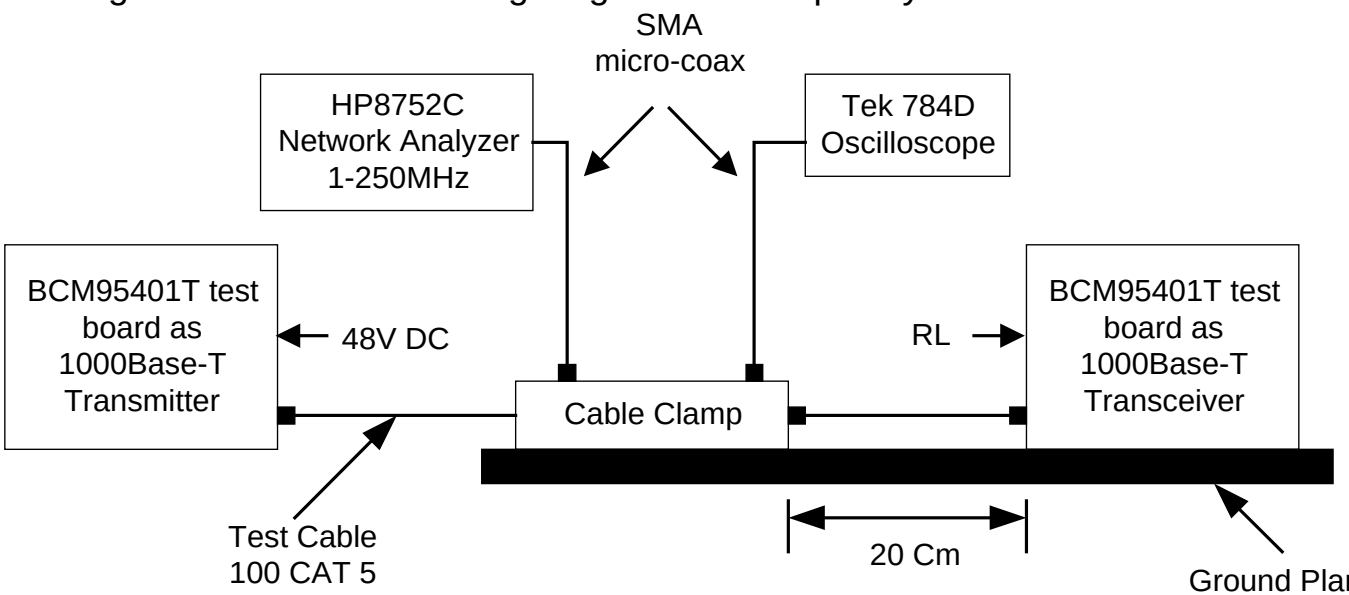
1000BASE-T Transmitter Electrical Specifications: IEEE Std 802.3ab 40.6.1.2

- **Common-mode noise rejection (Clause 40.6.1.3.3)**

- This specification is provided to limit the sensitivity of the PMA receiver to common-mode noise from the cabling system. Common mode noise generally results when the cabling system is subjected to high energy fields. The figure below shows the test configuration, which uses a capacitive cable clamp, that injects common-mode signals into a cabling system.
- A signal generator with a 50 ohm impedance is connected to one end of the clamp and an oscilloscope witha 50 ohm input is connected to the other end of the clamp. The signal generator shall be capable of providing a sine wave signal of 1 MHz to 250 MHz. The output of the signal generator is adjusted for a voltage of 1.0 Vrms (1.414 Vpeak) on the oscilloscope.
- While sending data from the transmitter the receiver shall send the proper PMA_UNITDATA.indicate messages to the PCS as the signal generator frequency is varied from 1 MHz to 250 MHz.



Common-Mode Noise Rejection (Clause 40.6.1.3.3): Test Results

Cable Length	DTE power mode	Dropped Packets	Bit Sent	Bit Error Rate
100 m CAT 5	V = 48V & I = 0A	0	2.77E+11	0.00E+00
100 m CAT 5	V = 48V & I = 100mA	0	2.77E+11	0.00E+00
100 m CAT 5	V = 48V & I = 300mA	0	2.77E+11	0.00E+00

48V and up to 300mA has no impact on common-mode noise rejection

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Conclusion

- **1000BASE-T data transmission is compatible with DTE power via MDI**

- **Recommendation:**
  802.3af include support for 1000BASE-T

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