Compliance Test Report for ANSI/TIA-968-B Telephone Terminal Equipment Technical Requirements for Connection of Terminal Equipment to the Telephone Network

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Report Number:	1027ADT_1700101G1_TIA968
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File Number:	ADT110405
Equipment Name(s):	Adtran SHDSL ATM NIM
Equipment Model Number(s):	1700101G1
Equipment Description:	SHDSL ATM Network Interface Module for Netvanta Router Family
Test Specification(s):	ANSI/TIA-968-B
Result*:	Complies
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Approved by:	Martin Garwood Laboratory Manager

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* See Report Summary page for further details and any conditions.

Table of Contents

Table of Contents **2**
Report Summary **3**
Details of Test Sample(s) and Modifications **4**
Possible Test Case Verdicts **4**
ANSI/TIA-968-B Test Results **5**
APPENDIX A: Photographic Record of Sample(s) **17**
APPENDIX B: Common Requirements **19**
4.1 Environmental Simulation *19*
4.2 Leakage Current *19*
4.3 Hazardous Voltage *19*
APPENDIX C: SHDSL and ESHDSL Modes (5.3.4) **20**
Total Average Power *20*
Power Spectral Density *21*
DSL Transverse Balance (5.3.4.2 SHDSL) *37*
DSL Longitudinal Output Voltage (5.3.4.3 SHDSL) *38*

Report Summary

The Adtran SHDSL ATM Network Interface Module was supplied for ANSI/TIA-968-B testing by Adtran Networks Pty Ltd of Melbourne VIC Australia.

The DUT was a SHDSL ATM Network Interface Module for the Netvanta Family of routers. It was equipped with one RJ45 SHDSL port that can be configured for 2-wire or 4-wire operation.

The DUT supported a number of data transmission rates from 192 kbps to 3840 kbps using 16-TCPAM line code, and from 3904 kbps to 5696 kbps using 32-TCPAM line code (as specified in G.991.2).

A Netvanta Model 6310 Router was used as the SHDSL module's (DUT's) host for TIA968 testing.

The Adtran SHDSL ATM Network Interface Module **COMPLIES** with all the relevant mandatory tested clauses of ANSI/TIA-968-B.

Conditions of Compliance:

- Product must be configured to SHDSL Annex A mode.

Details of Test Sample(s) and Modifications

Sample #	Details
1	**Version Information:** BOOT ROM VER. A4.03.00 APP CODE VER. A4.04.07_PP3 SHDSL CS VER. 1.1-1.5.5__007 ET 36S *Note: Configured to SHDSL Annex A mode **Host Router:** Netvanta 6310 Part No: 4700100G1 (Serial No: CFG0802495) O.S. Version: A4.05.00.E System Image: NV6300A_A4_05_00_E.biz

Possible Test Case Verdicts

- Test case does not apply to the test object ····· N(A)
- Test object does meet the requirements ····· P(ass)
- Test object does not meet the requirements ····· F(ail)
- Test was not performed ····· NT (not tested)
- Noted ····· ND

ANSI/TIA-968-B Test Results

ANSI/TIA-968-B			
Clause	**Requirements**	**Remarks**	**Verdict**
1	**SCOPE, PURPOSE, AND APPLICATION**		**ND**
1.1	**SCOPE**		**ND**
1.2	**PURPOSE**		**ND**
1.3	**APPLICATION**		**ND**
2	**NORMATIVE REFERENCES**		**ND**
3	**TERMS AND DEFINITIONS**		**ND**
3.1	**DEFINITIONS**		**ND**
3.2	**ACRONYMS & ABBREVIATIONS**		**ND**
4	**COMMON REQUIREMENTS**		**P**
4.1	**ENVIRONMENTAL SIMULATION**		**P**
4.1.1	Mechanical shock:	DUT installed in chassis designed for rack mounting.	N
4.1.1.1	Hand-held items normally used at head height: 18 random drops from a height of 1.5 meters onto concrete covered with 3 mm asphalt tile or similar surface.		N
4.1.1.2	Table (desk)-top equipment 0–5 kg: Six random drops from a height of 750 mm onto concrete covered with 3 mm asphalt tile or similar surface.		N
4.1.1.3	The drop tests specified in 4.1.1 shall be performed as follows: The unit shall be positioned prior to release to ensure as nearly as possible that for every six drops there is one impact on each of the major surfaces and that the surface to be struck is approximately parallel to the impact surface.		N
4.1.2	Telephone line surge – Type A:		P
4.1.2.1	Metallic: Two metallic voltage surges (one of each polarity) shall be applied between any pair of connections on which lightning surges may occur; this includes:	See appendix B.	P
	a) tip to ring;		P
	b) tip-1 to ring-1; and		N
	c) For a four-wire connection that uses simplex signaling, tip to ring-1 and ring to tip-1.		N

4.1.2.1.1	The surge shall have an open circuit voltage waveform in accordance with figure 2 having a front time (tf) of 6 µs minimum to 10 µs maximum, and a decay time (td) of 560 µs minimum to 860 µs maximum. It shall have a short circuit current wave shape in accordance with figure 3 having a front time (tf) of 5 µs minimum to 10 µs maximum, and a decay time (td) of 560 µs minimum to 760 µs maximum. The peak voltage shall be 800 V minimum to 880 V maximum, and the peak short circuit current shall be 100 A minimum to 115 A maximum.		P
4.1.2.1.2	Surges shall be applied as follows:		P
	a) With the equipment in all states that can affect compliance with the requirements of this Standard. If an equipment state cannot be achieved by normal means of power, it shall be achieved artificially;		P
	b) With equipment leads not being surged (including telephone connections, auxiliary leads, and terminals for connection to non-approved equipment) terminated in a manner that occurs in normal use;		ND
	c) Under reasonably foreseeable disconnection of primary power sources, with primary power cords plugged and unplugged, if so configured.		ND
4.1.2.2	Longitudinal: Two longitudinal voltage surges (one of each polarity) shall be applied to any pair of connections on which lightning surges may occur. This includes the tip-ring pair and the tip-1—ring-1 pair, to earth grounding connections, and to all leads intended for connection to non-approved equipment, connected together. Surges shall be applied as follows:	See appendix B.	P
	a) With the equipment in all states that can affect compliance with the requirements of this Standard. If an equipment state cannot be achieved by normal means of power, it shall be achieved artificially;		P
	b) With equipment leads not being surged (including telephone connections, auxiliary leads, and terminals for connection to non-approved equipment) terminated in a manner that occurs in normal use;		ND
	c) Under reasonably foreseeable disconnection of primary power sources, as for example, with primary power cords plugged and unplugged.		ND
4.1.2.3	Failure modes resulting from application of Type A telephone line surges: Regardless of operating state, equipment and circuitry are allowed to be in violation of the transverse balance requirements of section 5 and, for terminal equipment connected to local area data channels, the longitudinal voltage requirements of subclause 5.2.1.4.3, if:	Traverse balance was not violated.	P

	a) Such failure results from an intentional, designed failure mode that has the effect of connecting telephone or auxiliary connections with earth ground; and,		ND
	b) If such a failure mode state is reached, the equipment is designed so that it would become substantially and noticeably unusable by the user, or an indication is given (e.g., an alarm), in order that such equipment can be immediately disconnected or repaired.		ND
4.1.2.2.1	The surge shall have an open circuit voltage waveform in accordance with figure 2 with a front time (tf) of 6 µs minimum to 10 µs maximum, and a decay time (td) of 160 µs minimum to 260 µs maximum. It shall have a short circuit current wave shape in accordance with figure 3 having a front time (tf) of 5 µs minimum to 10 µs maximum, and a decay time (td) of 160 µs minimum to 210 µs maximum. The peak voltage shall be 1500 V minimum to 1650 V maximum, and the peak short circuit current shall be 200 A minimum to 230 A maximum.		P
4.1.3	Telephone line surge – Type B:		P
4.1.3.1	Metallic: Two metallic voltage surges (one of each polarity) shall be applied to equipment between any pair of connections on which lightning surges may occur; this includes:	See appendix B.	P
	a) tip to ring;		P
	b) tip-1 to ring-1; and		N
	c) for a 4-wire connection that uses simplex signaling, tip to ring-1 and ring to tip-1.		N
	The surge shall have an open circuit voltage waveform in accordance with figure 2 having a front time (tf) of 9 µs ± 2.7 µs and a decay time (td) of 720 µs ± 144 µs and shall have a short circuit current wave shape in accordance with figure 3 having a front time (tf) of 5 µs ± 1.5 µs and a decay time (td) of 320 µs ± 64 µs. The peak voltage shall be at least 1000 V minimum to 1100 V maximum, and the peak short circuit current shall be at least 25 A minimum to 27.5 A maximum. The wave shapes are based on the use of ideal components in figure 1 with S2 in position M. Surges shall be applied:		P
	a) With the equipment in all states that can affect compliance with the requirements of this Standard. If an equipment state cannot be achieved by normal means of power, it shall be achieved artificially.		P
	b) With equipment leads not being surged (including telephone connections, auxiliary leads, and terminals for connection to non-approved equipment) terminated in a manner that occurs		ND

	in normal use.		
	c) Under reasonably foreseeable disconnection of primary power sources, as for example, with primary power cords plugged and unplugged.		ND
4.1.3.2	Longitudinal: Two longitudinal voltage surges (one of each polarity) shall be applied to any pair of connections on which lightning surges may occur. This includes the tip-ring pair and the tip-1 ring-1 pair to earth grounding connections and to all leads intended for connection to non-approved equipment, connected together. Surges shall be applied as follows:	See appendix B.	P
	a) With the equipment in all states that can affect compliance with the requirements of this Standard. If an equipment state cannot be achieved by normal means of power, it shall be achieved artificially.		P
	b) With equipment leads not being surged (including telephone connections, auxiliary leads, and terminals for connection to non-approved equipment) terminated in a manner that occurs in normal use.		ND
	c) Under reasonably foreseeable disconnection of primary power sources, as for example with primary power cords plugged and unplugged.		ND
	For each output lead of the surge generator, with the other lead open, the surge shall have an open circuit voltage waveform in accordance with figure 2 having a front time (tf) of 9 µs ± 2.7 µs and a decay time (td) of 720 µs ± 144 µs and shall have a short circuit current wave shape in accordance with figure 3 having a front time (tf) of 5 µs ± 1.5 µs and a decay time (td) of 320 µs ± 64 µs. The peak voltage shall be 1500 V minimum to 1650 V maximum, and the peak short circuit current shall be 37.5 A minimum to 41.3 A maximum. The wave shapes are based on the use of ideal components in figure 1 with S2 in position L.		P
4.1.3.3	Failure modes resulting from application of Type B telephone line surges: Approved terminal equipment and approved protective circuitry shall withstand the energy of Type B surge without causing permanent opening or shorting of the interface circuit and without sustaining damage that will affect compliance with this Standard.	DUT was not damaged.	P
4.1.4	Power line surge:		P
4.1.4.1	Six power line surges (three of each polarity) shall be applied between the phase and neutral terminals of the AC power line while the equipment is being powered. The surge shall have an open circuit voltage waveform in accordance with figure 2 having a front time (tf) of 1 µs	See appendix B.	P

	minimum to 2 µs maximum, and a decay time (td) of 10 µs minimum to 19 µs maximum, and shall have a short circuit current wave shape in accordance with figure 3 with a front time (tf) of 1 µs minimum to 2 µs maximum, and a decay time (td) of 10 µs minimum to 19 µs maximum. The peak voltage shall be 2500 V minimum to 2750 V maximum, and the peak short circuit current shall be 1000 A minimum to 1250 A maximum. Surges shall be applied:		
4.1.4.2	Failure modes resulting from application of power line surge. Approved terminal equipment and approved protective circuitry shall comply with all the criteria in this Standard, both prior to and after the application of the power line surge specified in 4.1.4, notwithstanding that this surge may result in partial or total destruction of the equipment under test.		P
4.2	**LEAKAGE CURRENT LIMITATIONS** Leakage current shall not exceed 10 mA peak at any time during the 90 second test interval described below when the 50-60 Hz AC test voltage in table 1 is applied between the test points in table 1. The 10 mA peak maximum leakage current limitation may be increased as described in 4.2.6 to accommodate cable capacitance associated with multi-unit equipment. The test voltage in table 1 assumes that the terminal equipment has a rated input voltage of less than 250 volts. This Standard does not address leakage current requirements applicable to terminal equipment with a rated input voltage of greater than 250 volts.	See appendix B.	**P**
4.2.1	Test interval: The 90 second leakage current test interval shall consist of a 30 second time period during which the test voltage applied between the points in table 1 is gradually increased from zero to the maximum value listed in table 1 followed immediately by a 60-second time period during which the test voltage is maintained at the value listed in table 1.		ND
	(a) All telephone connections; (b) All power connections; (c) All possible combinations of exposed conductive surfaces on the exterior of such equipment or circuitry including grounding connection points, but excluding terminals for connection to other terminal equipment; (d) All terminals for connection to approved protective circuitry or non-approved equipment; (e) All auxiliary lead terminals; (f) All E&M lead terminals, and (g) All PR, PC, CY1 and CY2 leads.		ND
	Table 1 - Voltage Applied for Various Combinations of		ND

<table>
<tr><td></td><td>Electrical Connections
<table>
<tr><th>Voltage Source Connected Between:</th><th>AC Value*</th></tr>
<tr><td>(a) and (b)</td><td>1500</td></tr>
<tr><td>(a) and (c)</td><td>1000</td></tr>
<tr><td>(a) and (d)</td><td>1000</td></tr>
<tr><td>(a) and (e)</td><td>1000</td></tr>
<tr><td>(a) and (f)</td><td>1000</td></tr>
<tr><td>(a) and (g)</td><td>1000</td></tr>
<tr><td>(b) and (c)</td><td>1500</td></tr>
<tr><td>(b) and (d)</td><td>1500</td></tr>
<tr><td>(b) and (e)</td><td>1500</td></tr>
<tr><td>(b) and (f)</td><td>1500</td></tr>
<tr><td>(b) and (g)</td><td>1500</td></tr>
<tr><td>(c) and (e)</td><td>1000</td></tr>
<tr><td>(c) and (f)</td><td>1000</td></tr>
<tr><td>(d) and (e)</td><td>1000</td></tr>
<tr><td>(d) and (f)</td><td>1000</td></tr>
<tr><td>(e) and (f)</td><td>1000</td></tr>
</table>
*Value to which test voltage is gradually increased.</td><td></td><td></td></tr>
<tr><td>4.2.2</td><td>Equipment states:</td><td></td><td>ND</td></tr>
<tr><td>4.2.3</td><td>Treatment of filters on telephone leads:</td><td></td><td>ND</td></tr>
<tr><td>4.2.4</td><td>Removal of intentional DC path to ground used for protection purposes:</td><td></td><td>ND</td></tr>
<tr><td>4.2.5</td><td>Exclusion for intentional DC conducting path to ground:</td><td></td><td>ND</td></tr>
<tr><td>4.2.6</td><td>Multiple unit equipment interconnected by cables:</td><td></td><td>ND</td></tr>
<tr><td>4.2.7</td><td>RF filters and surge protectors on the line side of power supplies:</td><td></td><td>ND</td></tr>
<tr><td>4.3</td><td>HAZARDOUS VOLTAGE LIMITATIONS</td><td></td><td>P</td></tr>
<tr><td>4.3.1</td><td>General requirement:
Under no condition of failure of approved terminal equipment or approved protective circuitry that can be conceived to occur in the handling, operation or repair of such equipment or circuitry, shall the open circuit voltage on telephone connections exceed 70 V_P after one second, except for voltages for network control signaling, alerting and supervision.</td><td>See appendix B.</td><td>P</td></tr>
</table>

4.3.2	Connection of non-approved equipment to approved terminal equipment or approved protective circuitry:		P
4.3.3	Non-hazardous voltage source		ND
4.3.4	Intentional paths to ground (as required by clause 4.1):		N
4.3.5	Other hazardous voltage limitations:		N
4.4	**BILLING PROTECTION**		**N**
4.4.1	Call duration requirements on data equipment: For data equipment connected to the public switched network, or to tie trunks, or to private lines that access the public switched network, approved data terminal equipment and approved protective circuitry shall comply with the following requirements when answering an incoming call, except in off-hook states in which the signals are transmitted and/or received by electro-acoustic transducers only. This is applicable to approved terminal equipment and approved protective circuitry employed with digital services where such digital services are interconnected with the analog telephone network.		N
4.4.2	Voice and data equipment on-hook signal requirements: For approved voice and data equipment connected to the public switched network, or to tie trunks, or to private lines that access the public switched network, approved protective circuitry and approved terminal equipment shall comply with the following on-hook signal requirements:		N
4.4.2.1	The total power delivered into a two-wire loop simulator circuit or into the transmit and receive pairs of a four-wire loop simulator or into a 600 ohms termination (where appropriate) in the on-hook state by analog voice-band equipment shall not exceed -55 dBm within the voice band. Approved protective circuitry shall also assure that for any input level up to 10 dB above the overload point, the power to a two-wire loop simulator circuit or the transmit and receive pairs of a four-wire loop simulator circuit or into a 600 ohms termination (where appropriate) does not exceed the above limits.		N
4.4.2.2	The total power delivered into a two-wire loop simulator circuit or into the transmit and receive pairs of a four-wire loop simulator circuit, in the on-hook state, by reverse-battery equipment shall not exceed -55 dBm within the voice band, unless the equipment is arranged to inhibit in-coming signals.		N
4.4.2.3	On-hook requirements for approved subrate and 1.544Mbps digital terminal equipment.		N
4.4.3	Signaling interference requirements:		N
4.4.4	Other billing protection requirements:		N

	Additional billing protection requirements are given in subclause 5.1.13.4 for analog DID interfaces and in 5.2.4.9 for DS1 and ISDN PRI interfaces.		
4.5	**ENCODED ANALOG CONTENT**		**N**
4.5.1	Encoded analog content limits:		N
4.5.2	Zero level decoder requirements:		N
4.6	**CONNECTORS &WIRING CONFIGURATIONS**		**ND**
4.6.1	Introduction: Connection of terminal equipment to the telephone network shall be made through a connector conforming to TIA-1096-A or by direct attachment to wiring installed by the provider(s) of wire line telecommunications including, but not limited to, splicing, bridging, twisting, and soldering. Hardware used to mount, protect, and enclose standard jacks is not described in this Standard or TIA-1096-A. The only requirement on connecting blocks, housings, dust covers, outdoor boxes, and the like that contain standard network jacks is that they shall accept standard plugs with cordage.		ND
4.6.2	Wiring configurations: The connectors specified in TIA-1096-A shall be wired in accordance with any of the applicable wiring configurations provided in T1.TR.5-1999. The applicable connector and connector wiring configuration for approved TE shall be identified in consumer instructions and product approval documentation.		ND
4.6.2.1	Universal Service Ordering Code: A universal service ordering code (USOC) is specified in T1.TR.5-1999 for each wiring configuration. These USOCs are generic service ordering codes that are used or recognized by most wireline carriers. If a customer wishes to have the wireline carrier install a jack or wiring configuration, the appropriate USOC needs to be specified when the customer requests service installation.		ND
4.6.2.2	Default connector wiring configuration: In the absence of a request for a specific type of jack and wiring configuration, wireline carriers will typically install a 6-position non-keyed jack with the RJ11W (for wall mounted equipment) or RJ11C (for all other equipment) wiring configuration shown in fig. 5.		ND
4.6.3	Multi-line, private branch exchange (PBX), and key telephone systems:		ND
4.7	**ALLOWABLE NET AMPLIFICATION BETWEEN PORTS**		**N**
4.7.1	General:		N

4.7.2	Allowable net amplification between network interface ports:		N
4.7.3	Allowable net amplification between ports for other approved TE and network interface ports:		N
4.7.4	Single frequency (SF) guard band:		N
4.7.5	SF cut-off:		N
5	**INTERFACE REQUIREMENTS**		**P**
5.1	**ANALOG VOICE BAND INTERFACE REQUIREMENTS**		**N**
5.2	**LADC AND DIGITAL INTERFACE REQUIREMENTS**		**N**
5.2.1	Local area data channel (LADC):		N
5.2.2	Subrate digital and PSDS Type I interfaces:		N
5.2.3	PSDS Type II and Type III interfaces:		N
5.2.4	DS1 and ISDN PRI terminal equipment:		N
5.3	**ISDN & DSL INTERFACE REQUIREMENTS**		**N**
	ISDN and DSL terminal equipment shall be tested while transmitting maximum power and maximum PSD levels at all frequencies over which the equipment can transmit data when deployed. Equipment shall be tested under steady state conditions, after all start-up and initialization procedures have been completed, and while the equipment is transmitting data.		ND
5.3.1	Basic rate ISDN (BRI) and IDSL		N
5.3.2	ADSL, ADSL2, ADSL2+, and reach extended ADSL2 (READSL2) modes:		N
5.3.3	ADSL2 and ADSL2+ all digital mode:		N
5.3.4	SHDSL, ESHDSL:	See appendix C.	P
5.3.4.1	SHDSL, ESHDSL signal power limitations:		P
5.3.4.1.1	Total power for SHDSL and extended SHDSL (ESDSL) shall not exceed +14 dBm into 135 ohms.		P
5.3.4.1.2	The power spectral density (PSD) of the signal transmitted by SHDSL shall not exceed the following PSD mask (SHDSLM(f)): The in-band PSD for 0 < f < 1.5 MHz shall be measured with a 10 kHz resolution bandwidth (RBW).		P

$$SHDSL_M(f) = \begin{cases} \frac{K_{SHDSL}}{135} \times \frac{1}{f_{sym}} \times \frac{\left[\sin\left(\frac{\pi f}{f_{sym}}\right)\right]^2}{\left(\frac{\pi f}{f_{sym}}\right)^2} \times \frac{1}{1+\left(\frac{f}{f_{3db}}\right)^{12}} \times 10^{\frac{MaskedOffsetdB(f)}{10}}, & f < f_{int} \\ 0.5683 \times 10^{-4} \times f^{-1.5}, & f_{int} \le f \le 1.1MHz \end{cases}$$

where *MaskedOffsetdB(f)* is defined as:

$$MaskedOffsetdB(f) = \begin{cases} 1 + 0.4 \times \frac{f_{3dB} - f}{f_{3dB}}, & f < f_{3dB} \\ 1, & f \ge f_{3dB} \end{cases}$$

f_{int} is the frequency where the two functions governing $SHDSL_M(f)$ intersect in the range 0 to f_{sym}. K_{SHDSL}, f_{sym}, f_{3dB}, and the line bit rate *LBR* are defined in table 38.

At frequencies above 1.1 MHz, the conformance criteria of T1.417-2003 clause 6.1 shall apply with $P_T(f)$ = -110 dBm/Hz and $P_M(f)$ = -90 dBm/Hz.

Table 38 – SHDSL symmetric PSD parameters

Line Bit Rate *LBR* (Kbps)	K_{SHDSL}	f_{sym} (ksymbols/s)	f_{3dB}
LBR ≠ 1544 or 1552	7.86	*LBR* / 3	1.0 x f_{sym} / 2
LBR = 1544 or 1552	8.32	*LBR* / 3	0.9 x f_{sym} / 2

5.3.4.1.3

The power spectral density (PSD) of the signal transmitted by extended SHDSL (ESHDSL) shall meet the following requirements:

For symmetric PSDs using 16-TCPAM payload data rates greater than or equal to 2320 Kbit/s, and for symmetric PSDs using 32-TCPAM payload data rates greater than or equal to 768 Kbit/s, the measured transmit PSD of each STU-R shall not exceed the PSD masks specified in this subclause (PSDMASKSHDSL(f)).

The in-band PSD for 0 < f < 2.0 MHz shall be measured with a 10 kHz resolution bandwidth.

$$PSDMASK_{SHDSL}(f) = \begin{cases} \frac{K_{SHDSL}}{135} \times \frac{1}{f_{sym}} \times \frac{\left[\sin\left(\frac{\pi f}{Nf_{sym}}\right)\right]^2}{\left(\frac{\pi f}{Nf_{sym}}\right)^2} \times \frac{1}{1+\left(\frac{f}{f_{3dB}}\right)^{2 \times Order}} \times 10^{\frac{MaskedOffsetdB(f)}{10}}, & f < f_{int} \\ -90 \text{ dBm/Hz peak, with max power in the } [f, f+1\text{MHz}] \text{ window of } [10\log_{10}(0.5683 \times 10^{-4} \times f^{-1.5}) + 90] \text{ dBm}, & f_{int} \le f \le 3.184 \text{ MHz} \\ -90 \text{ dBm/Hz peak, with max power in the } [f, f+1\text{MHz}] \text{ window of } -50 \text{ dBm}, & 3.184 \text{ MHz} \le f \le 12 \text{ MHz} \end{cases}$$

where *MaskedOffsetdB(f)* is defined as:

$$MaskedOffsetdB(f) = \begin{cases} 1 + 0.4 \times \frac{f_{3dB} - f}{f_{3dB}}, & f < f_{3dB} \\ 1 \text{ dB}, & f \ge f_{3dB} \end{cases}$$

f_{int} is the frequency where the two functions governing $PSDMASK_{SHDSL}(f)$ intersect in the range 0 to f_{sym}. K_{SHDSL}, *Order*, *N*, f_{sym}, and f_{3dB} are defined in tables 39 and 40. *R* is the payload bit rate. The variables *f*, f_{sym}, f_{int}, and f_{3dB} in the equations are in units of Hz.

P

<table>
<tr><td></td><td>

Table 39 – Symmetric PSD parameters, 16-TCPAM

Payload bit rate, R (Kbit/s)	KSHDSL	Order	N	fsym (ksymbol/s)	f3 dB
2320 ≤ R ≤ 3840	7.86	6	1	$(R + 8)/3$	$1.0 \times f_{sym}/2$

Table 40 – Symmetric PSD parameters, 32-TCPAM

Payload bit rate, R (Kbit/s)	K_{SHDSL}	Order	N	f_{sym} (ksymbol/s)	f_{3dB}
768 ≤ R ≤ 5696	7.86	6	1	$(R + 8)/4$	$1.0 \times f_{sym}/2$

NOTE – The criteria for extended SHDSL (ESHDSL) are derived from ITU-T Recommendation G.991.2 (2003), Annex F.

</td><td></td><td>ND</td></tr>
<tr><td>5.3.4.2</td><td>

SHDSL, ESHDSL transverse balance limitations:

SHDSL and ESHDSL equipment's transverse balance shall equal or exceed the values in figure 36 over the entire range of frequencies as defined in table 41.

The metallic impedance used for the transverse balance measurements for SHDSL and ESHDSL shall be 135 ohms. The metallic voltage for test is 0.367V. For 0.2 to 12 kHz the longitudinal termination (RL) shall be 500 ohms, and above 12 kHz the longitudinal termination (RL) shall be 90 ohms.

Transverse balance testing is described in TIA TSB-31-C. An illustrative test circuit for transverse balance conformance testing is shown in figure 37. Testing is done with the TE transmitter turned off.

Table 41 – Frequency ranges of transverse balance requirements for SHDSL and ESHDSL equipment

Interface	Frequency range (kHz)	Longitudinal termination (R_L) (ohms)	Metallic termination (R_M) (ohms)
SHDSL	0.2 to 490	90 or 500	135
ESHDSL	0.2 to 761	90 or 500	135

</td><td></td><td>P</td></tr>
<tr><td>5.3.4.3</td><td>

SHDSL, ESHDSL longitudinal output voltage limitations: Using the illustrative longitudinal output voltage measurement circuit in figure 46, SHDSL and ESHDSL equipment shall limit longitudinal output voltage to the values shown in table 42.

For this requirement, the operating band is the range of frequencies between the upper and lower -30 dB points (relative to peak PSD) of the signal pass band as determined from the PSD masks defined in 5.3.4.1.2 and 5.3.4.1.3. There is no requirement for frequencies below the operating band.

Table 42 – Maximum longitudinal output voltage limit for SHDSL and ESHDSL

Applicable frequency range	Maximum longitudinal output voltage (rms) in all 4 KHz bands averaged over a minimum period of 1 second (see Note)
Operating band	-50 dBV (or -51.3 dBV using a 3 kHz bandwidth)
From upper -30 dB (relative to peak PSD) frequency to 4 × the upper -30 dB frequency	-80 dBV (or -81.3 dBV using a 3 kHz bandwidth)

</td><td></td><td>P</td></tr>
<tr><td>5.3.5</td><td>HDSL2 and SMC4:</td><td></td><td>N</td></tr>
<tr><td>5.3.6</td><td>HDSL4:</td><td></td><td>N</td></tr>
</table>

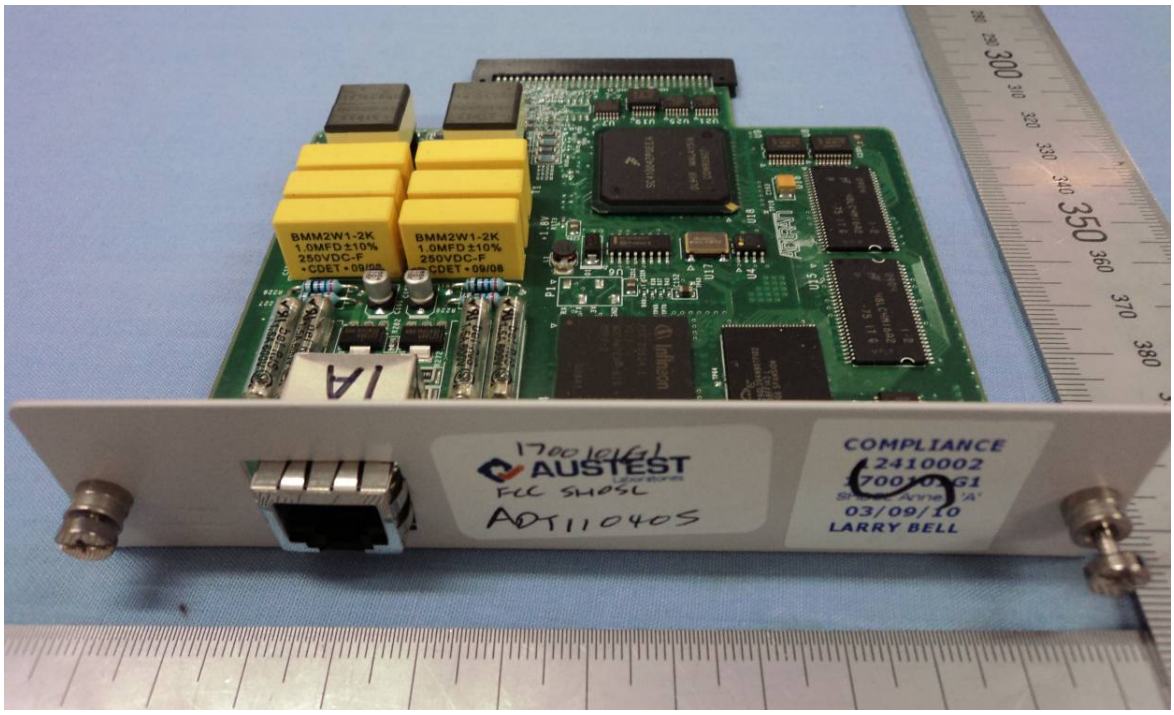
5.3.7	SDSL:		N
5.3.8	SMC6, VDSL and VDSL2:		N
5.3.9	SMC 2, SMC 3, SMC 7, SMC 8, and other DSL:		N
6	**SPECIAL CASES**		**N**
6.1	**COMPONENT APPROVAL**		**N**
6.2	**SERIES DEVICES**		**N**

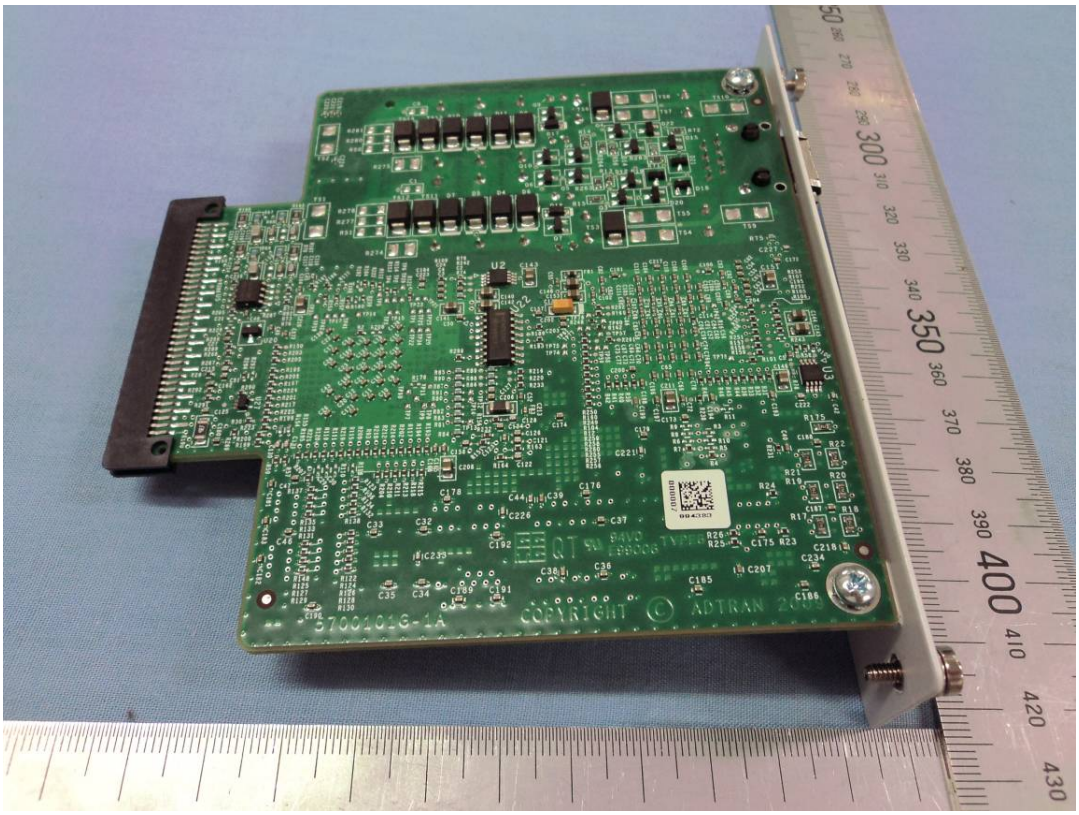
***** End of Report Body *****

APPENDIX A: Photographic Record of Sample(s)






BMM2W1-2K
1.0MFD ±10%
250VDC-F
CDET • 09/08
BMM2W1-2K
1.0MFD ±10%
250VDC-F
CDET • 09/08
AUSTEST
COMPLIANCE
03/09/10
LARRY BELL


COPYRIGHT © ADTRAN

APPENDIX B: Common Requirements

4.1 Environmental Simulation

TIA-968	Description	Limit	Verdict
4.1.2.1	Tip/Ring Metallic Surge A, +/- Power on	800 V	P
	Tip/Ring Metallic Surge A, +/- Power off	800 V	P
4.1.2.2	Longitudinal Surge A, +/- Power on	1500 V	P
	Longitudinal Surge A, +/- Power off	1500 V	P
4.1.3.1	Tip/Ring Metallic Surge B, +/- Power on	1000 V	P
	Tip/Ring Metallic Surge B, +/- Power off	1000 V	P
4.1.3.2	Longitudinal Surge B, +/- Power on	1500 V	P
	Longitudinal Surge B, +/- Power off	1500 V	P
4.1.4	Phase/Neutral, 3 surges +, 3 surges -	2500 V	P

4.2 Leakage Current

TIA-968	Description	Limit	Result	Verdict
4.3	Telephone to surfaces 1000 VAC	<= 10 mA	-	P
	Telephone to power 1500VAC	<= 10 mA	-	P
	Telephone to aux 1000 VAC	<= 10 mA	-	P
	Power to surfaces 1500 VAC	<= 10 mA	-	P
	Power to aux. 1500 VAC	<= 10 mA	-	P

4.3 Hazardous Voltage

TIA-968	Description	Limit	Result	Verdict
4.3.1	SHDSL wire pair	<= 70 Vp	< 15Vp	P
	SHDSL wire to earth	<= 70 Vp	< 10Vp	P

APPENDIX C: SHDSL and ESHDSL Modes (5.3.4)

Total Average Power

PRE-ENVIRONMENTAL

Line Rate (kbps)	T.A.P. (V RMS)	T.A.P. (dBm)	Limit (dBm)
192	1.739	13.50	14.0
768	1.768	13.65	14.0
1152	1.776	13.69	14.0
1536	1.779	13.70	14.0
2048	1.795	13.78	14.0
2624	1.787	13.74	14.0
3072	1.791	13.76	14.0
3264	1.782	13.71	14.0
3648	1.788	13.74	14.0
3840	1.782	13.71	14.0
3904	1.796	13.78	14.0
4096	1.79	13.75	14.0
4608	1.8	13.80	14.0
5120	1.784	13.72	14.0
5376	1.775	13.68	14.0
5696	1.766	13.64	14.0

POST ENVIRONMENTAL

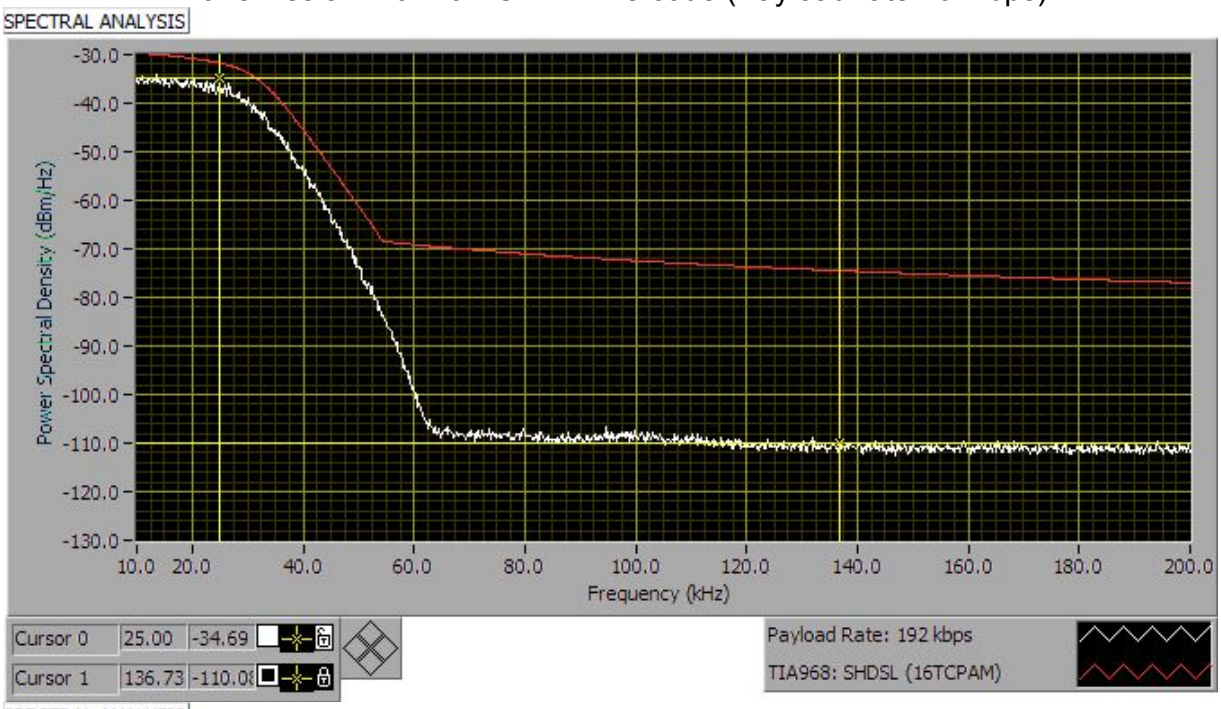
Line Rate (kbps)	T.A.P. (V RMS)	T.A.P. (dBm)	Limit (dBm)
192	1.754	13.58	14.0
768	1.784	13.72	14.0
1152	1.787	13.74	14.0
1536	1.789	13.75	14.0
2048	1.805	13.83	14.0
2624	1.793	13.77	14.0
3072	1.797	13.79	14.0
3264	1.789	13.75	14.0
3648	1.795	13.78	14.0
3840	1.788	13.74	14.0
3904	1.803	13.82	14.0
4096	1.796	13.78	14.0
4608	1.799	13.80	14.0
5120	1.788	13.74	14.0
5376	1.778	13.70	14.0
5696	1.769	13.65	14.0

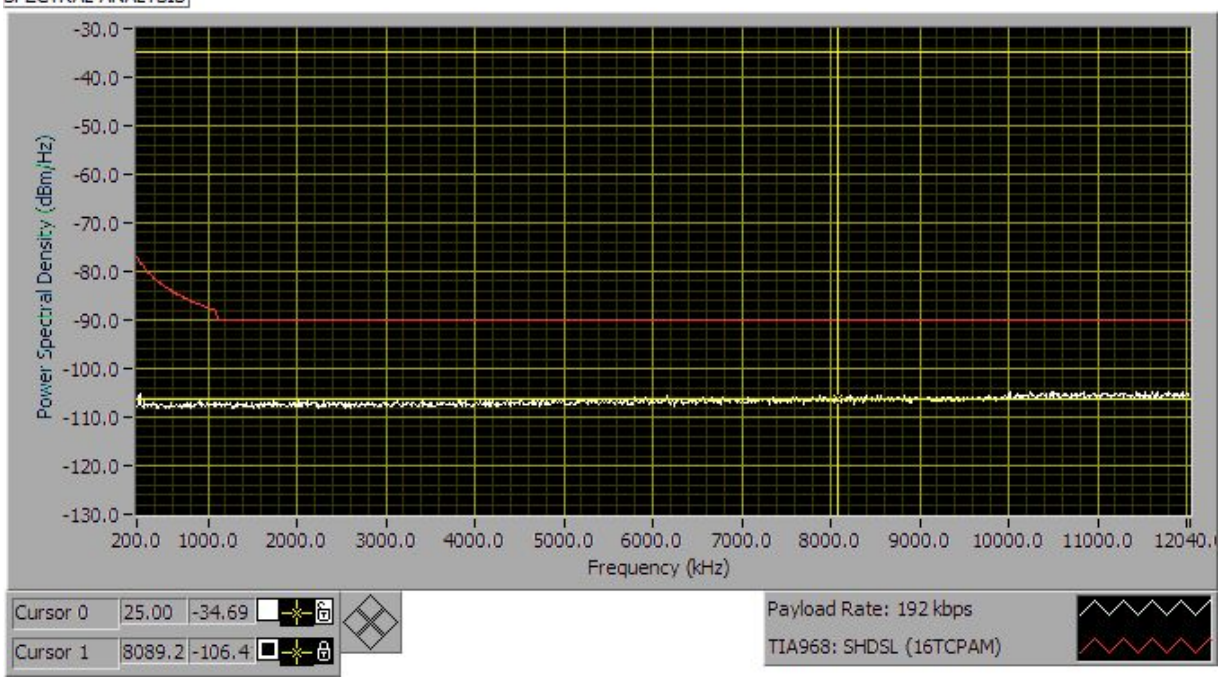
Power Spectral Density

NOTE: Transmission results before and after environmental tests were the same.

POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10kHz)

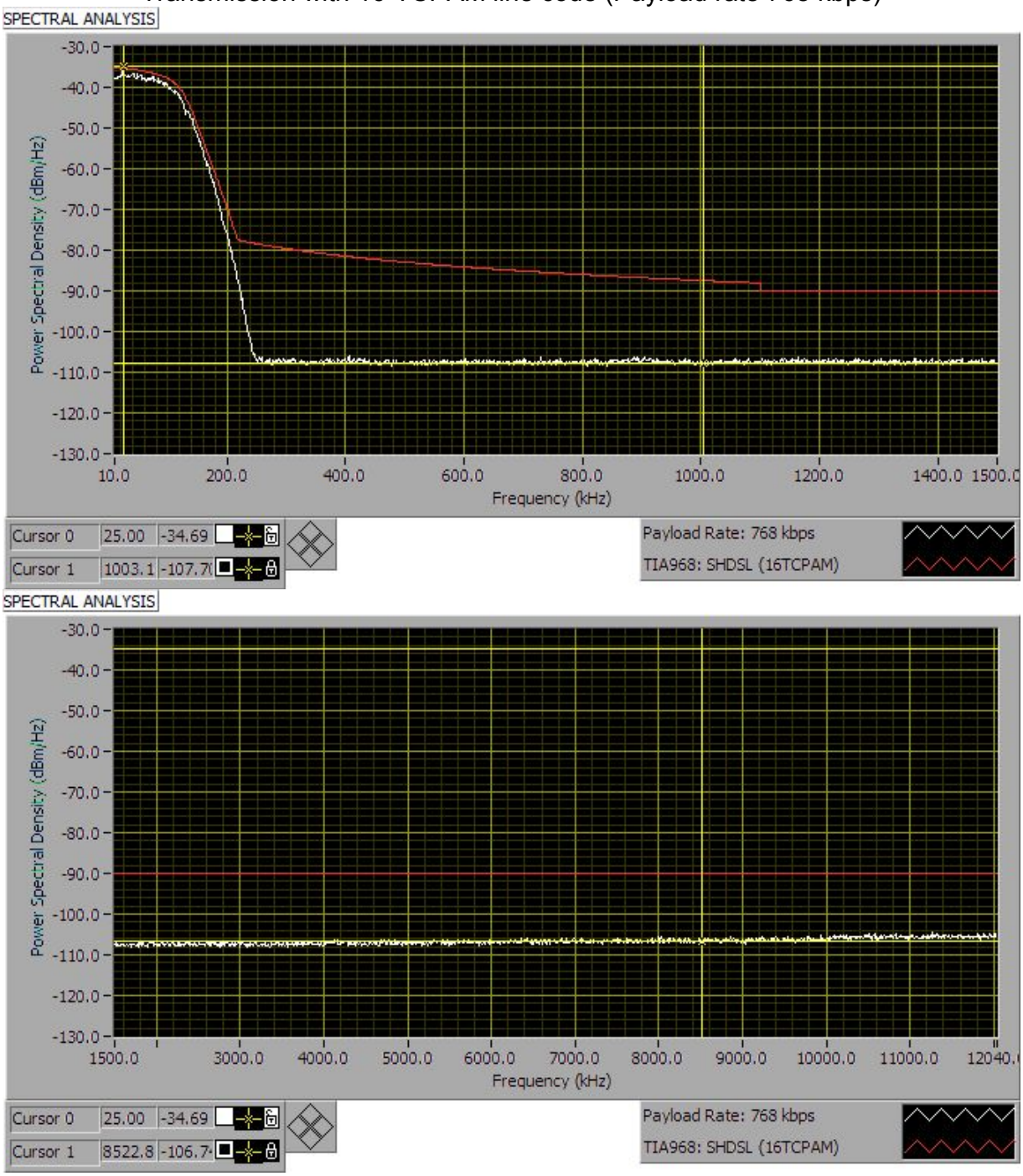
Transmission with 16-TCPAM line code (Payload rate 192kbps)





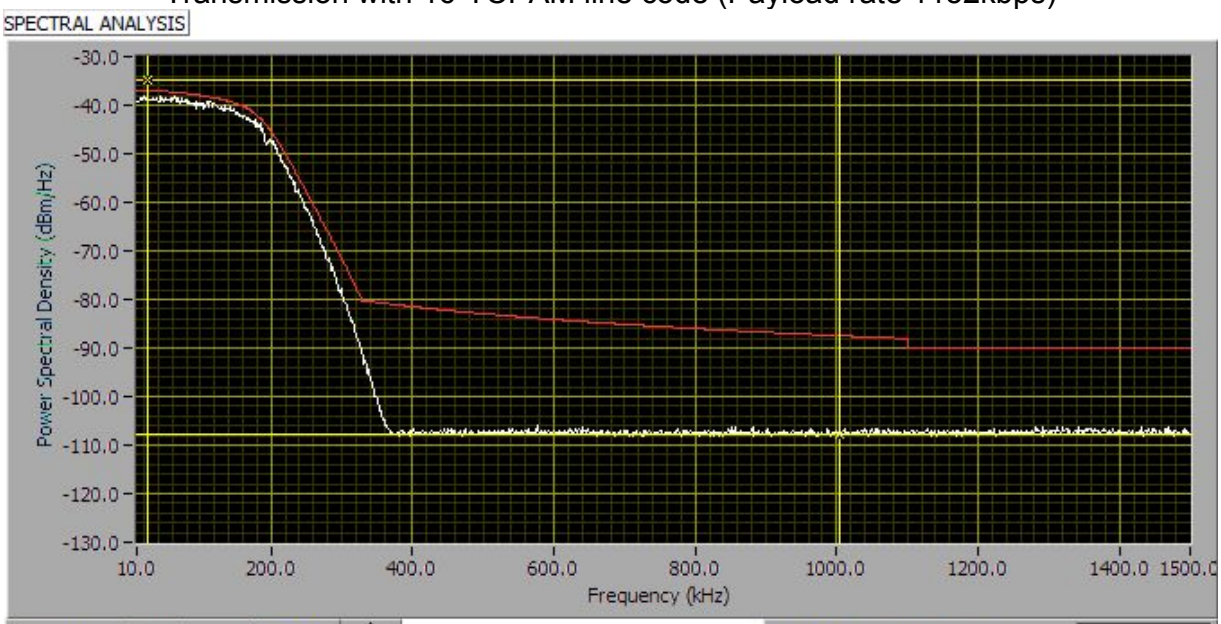
POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10kHz)

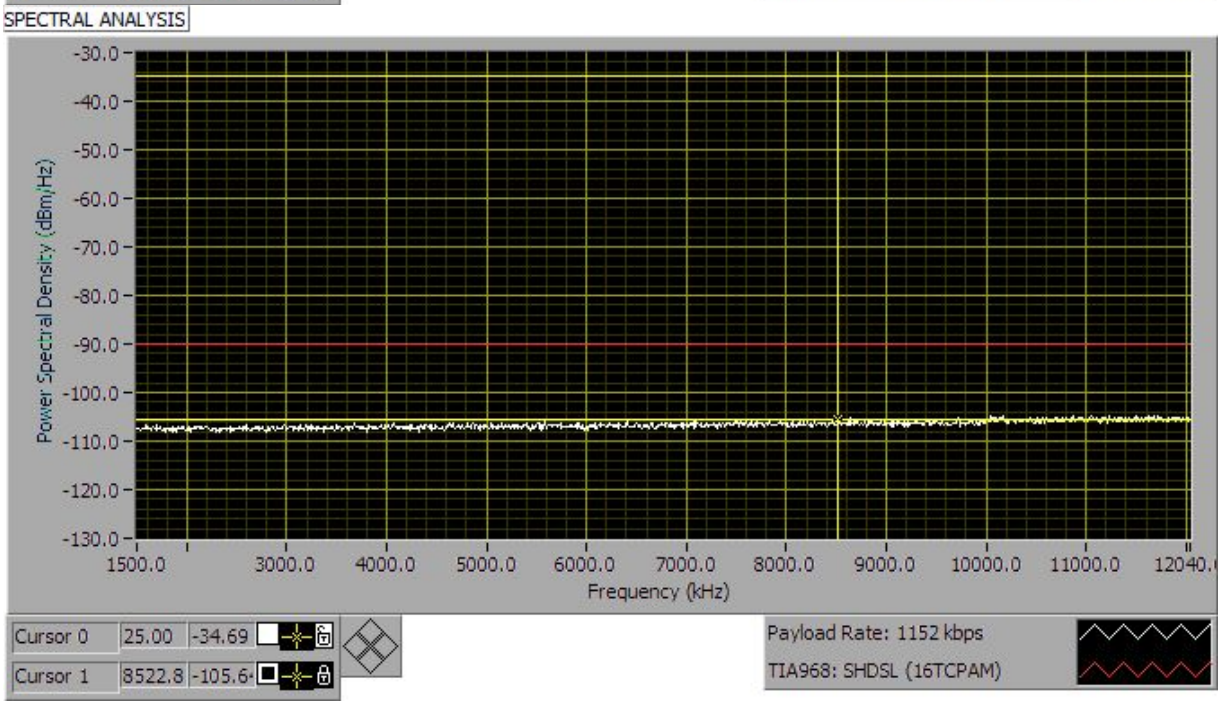
Transmission with 16-TCPAM line code (Payload rate 768 kbps)



POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

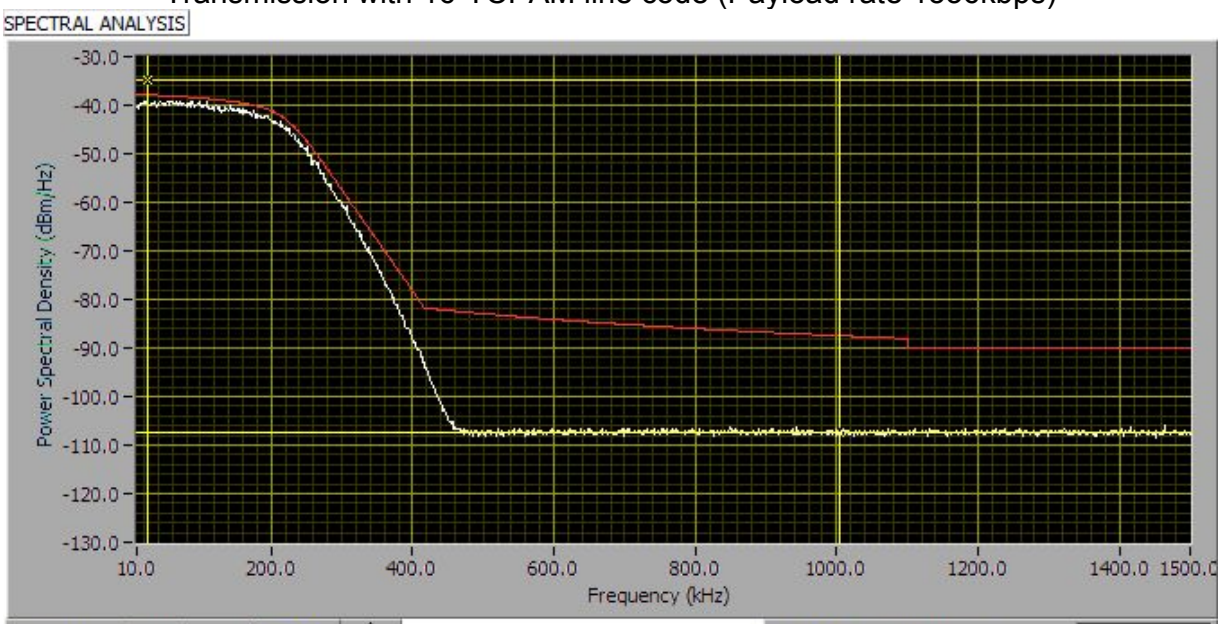
Transmission with 16-TCPAM line code (Payload rate 1152kbps)

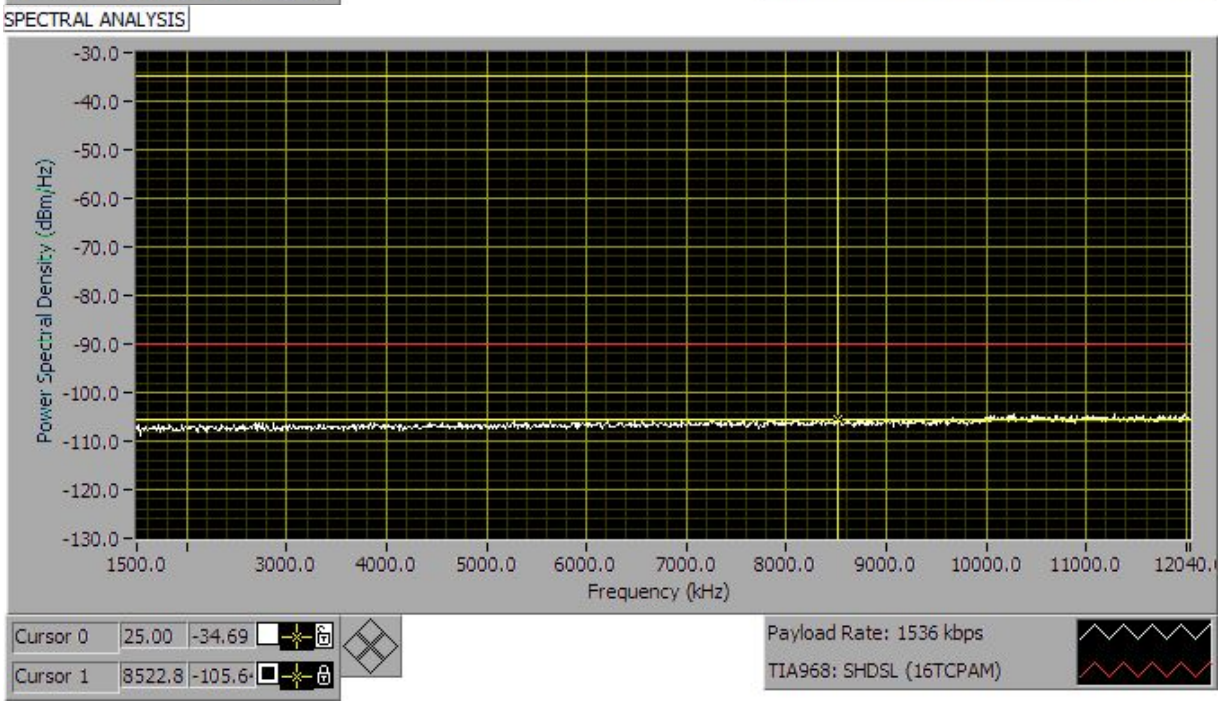




POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

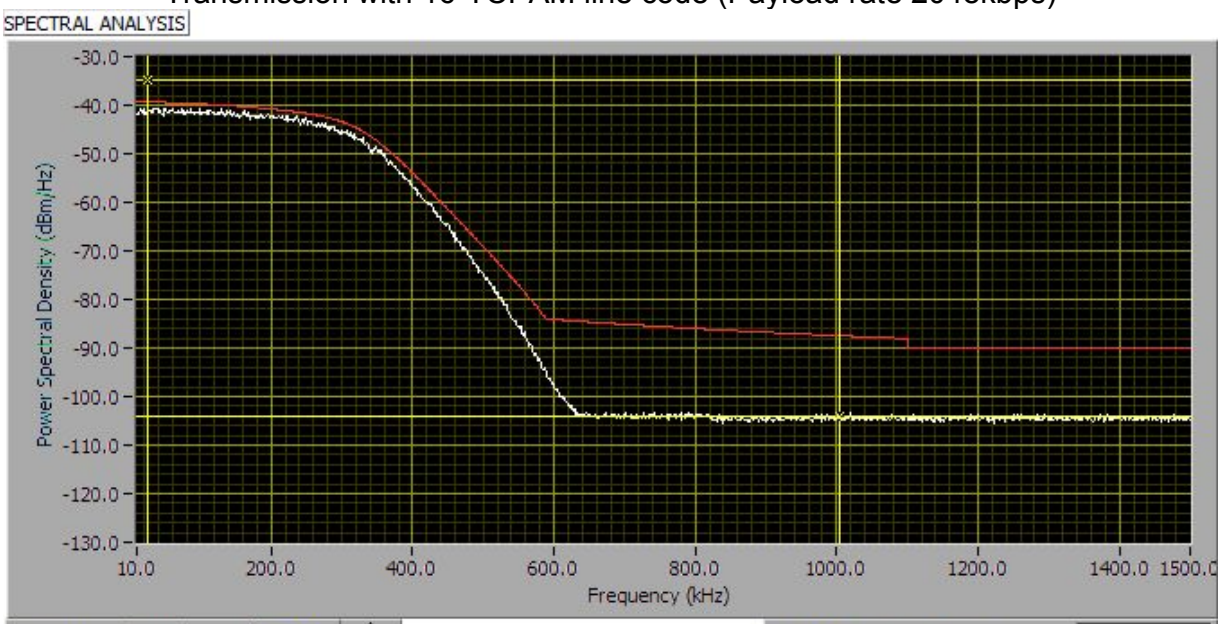
Transmission with 16-TCPAM line code (Payload rate 1536kbps)

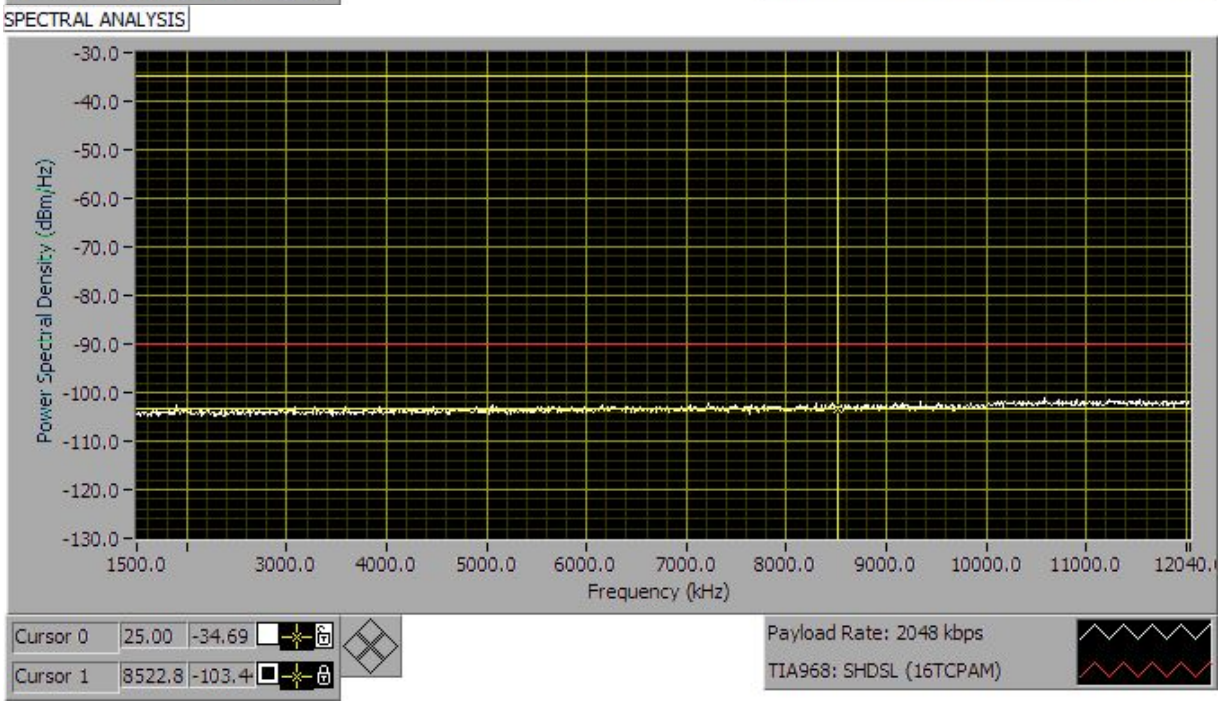




POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

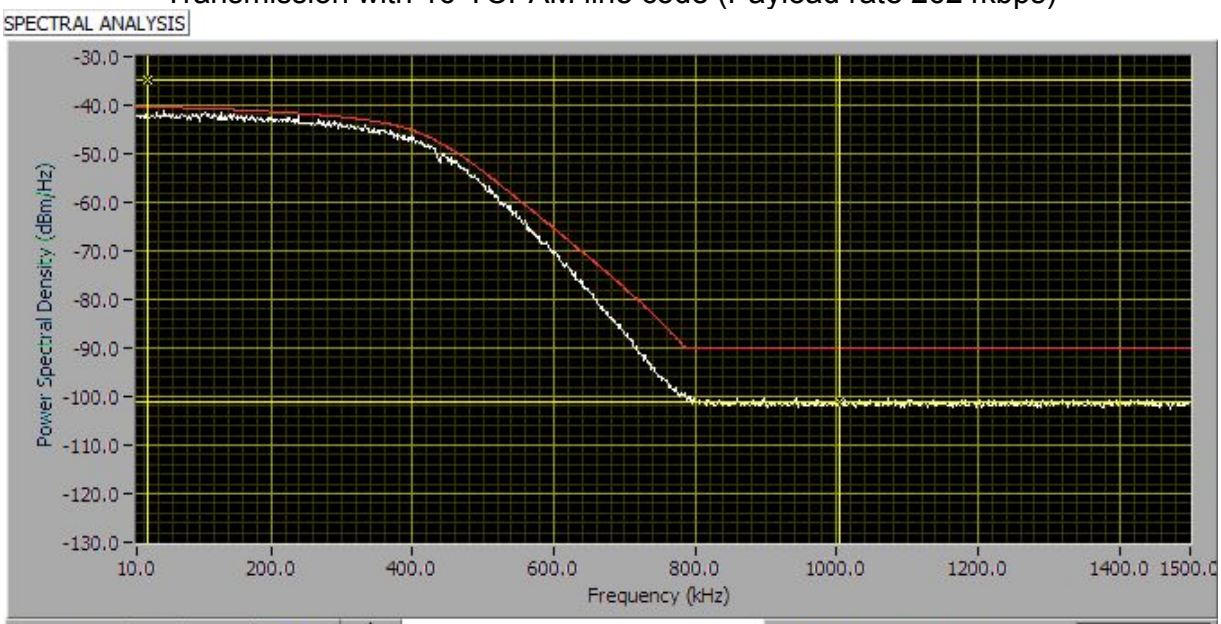
Transmission with 16-TCPAM line code (Payload rate 2048kbps)

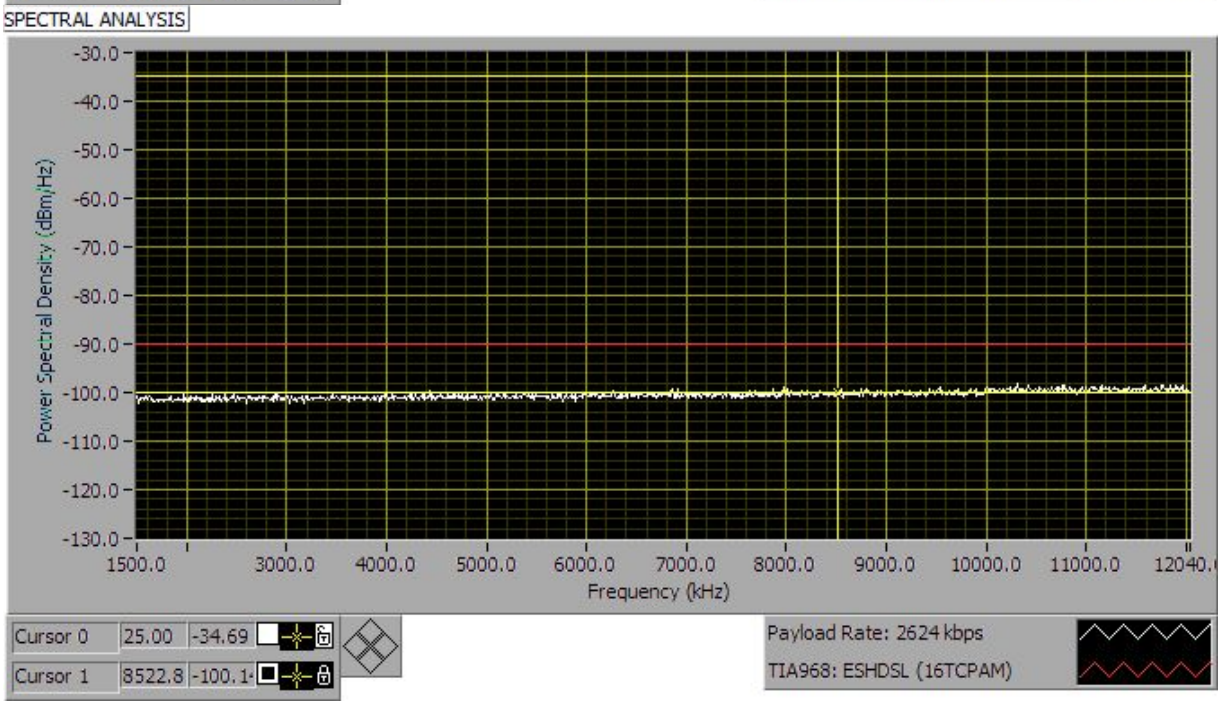




POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

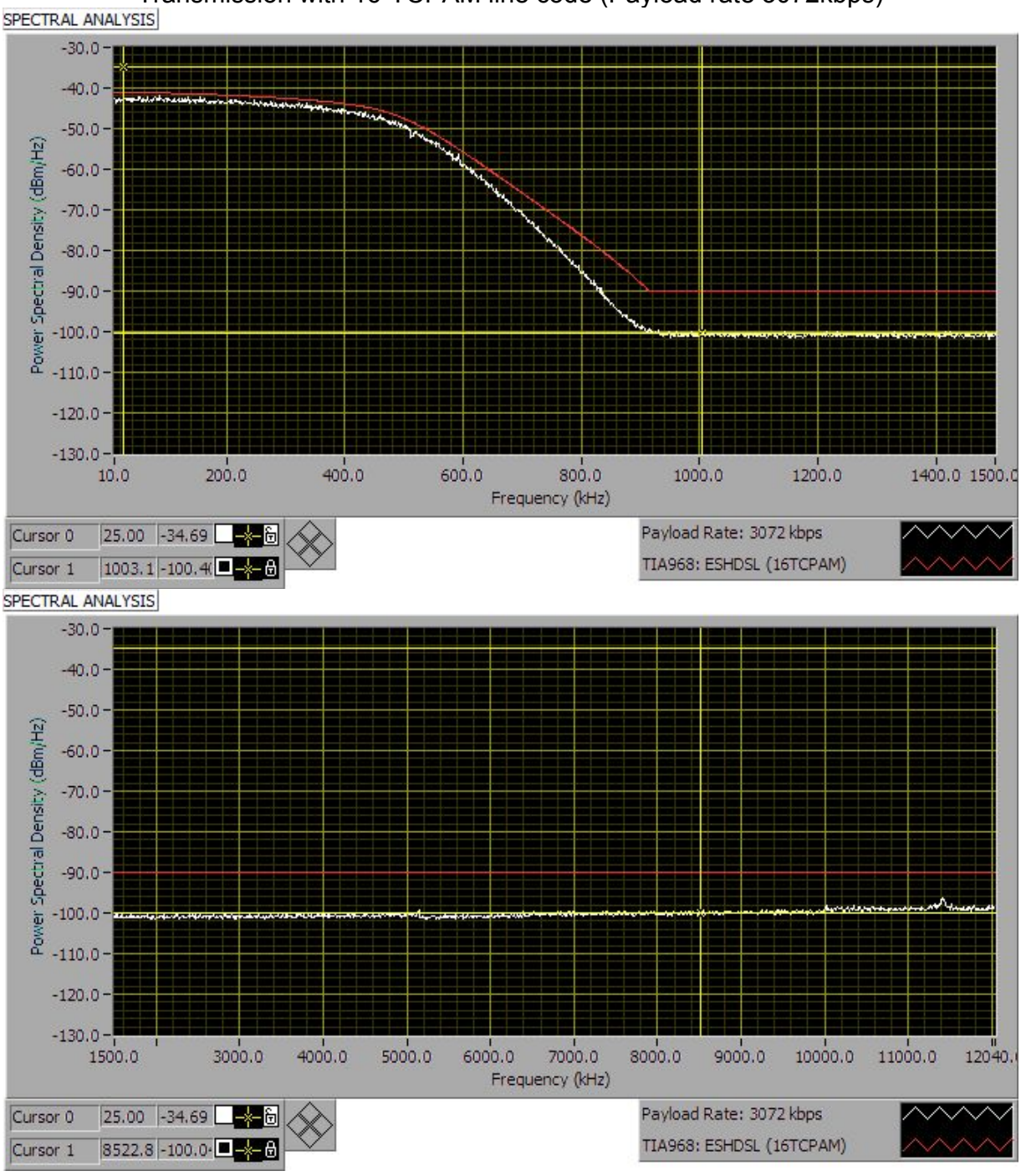
Transmission with 16-TCPAM line code (Payload rate 2624kbps)





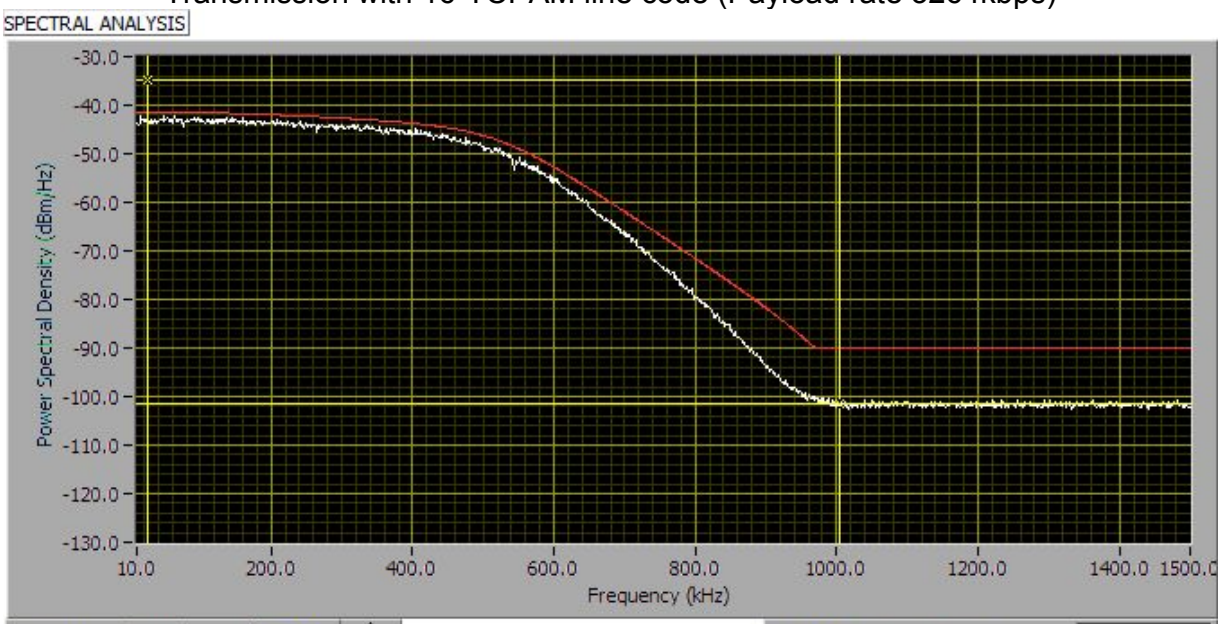
POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

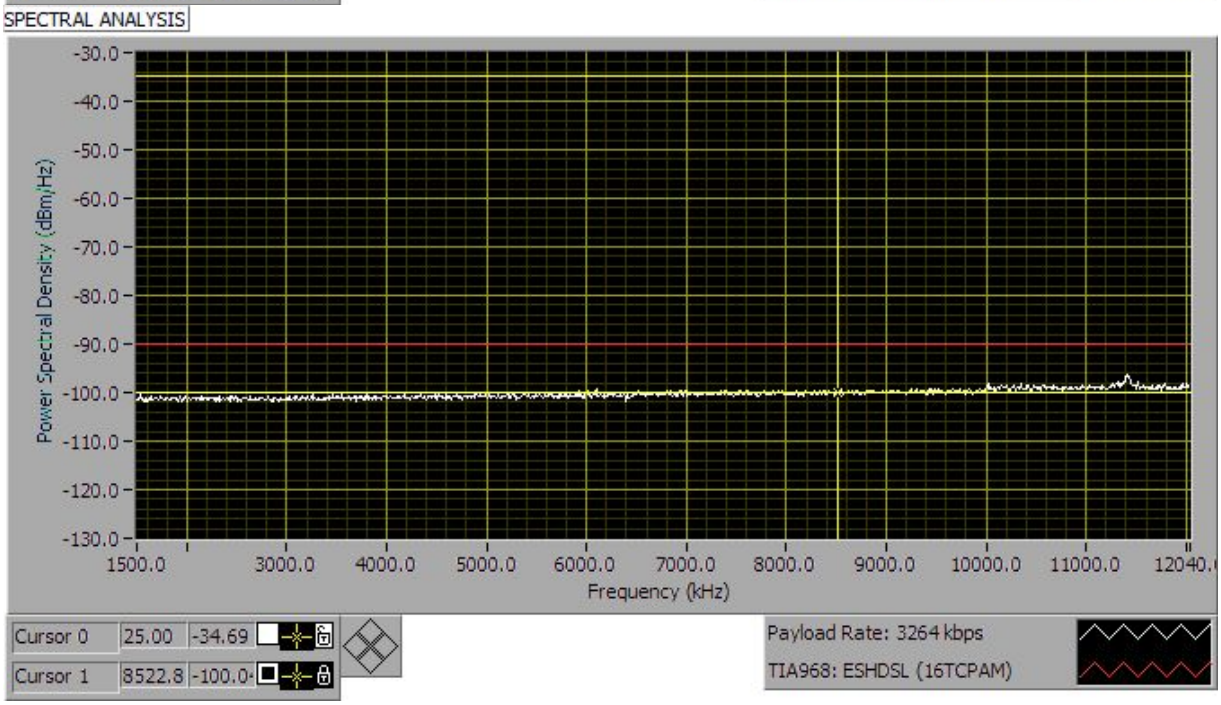
Transmission with 16-TCPAM line code (Payload rate 3072kbps)



POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

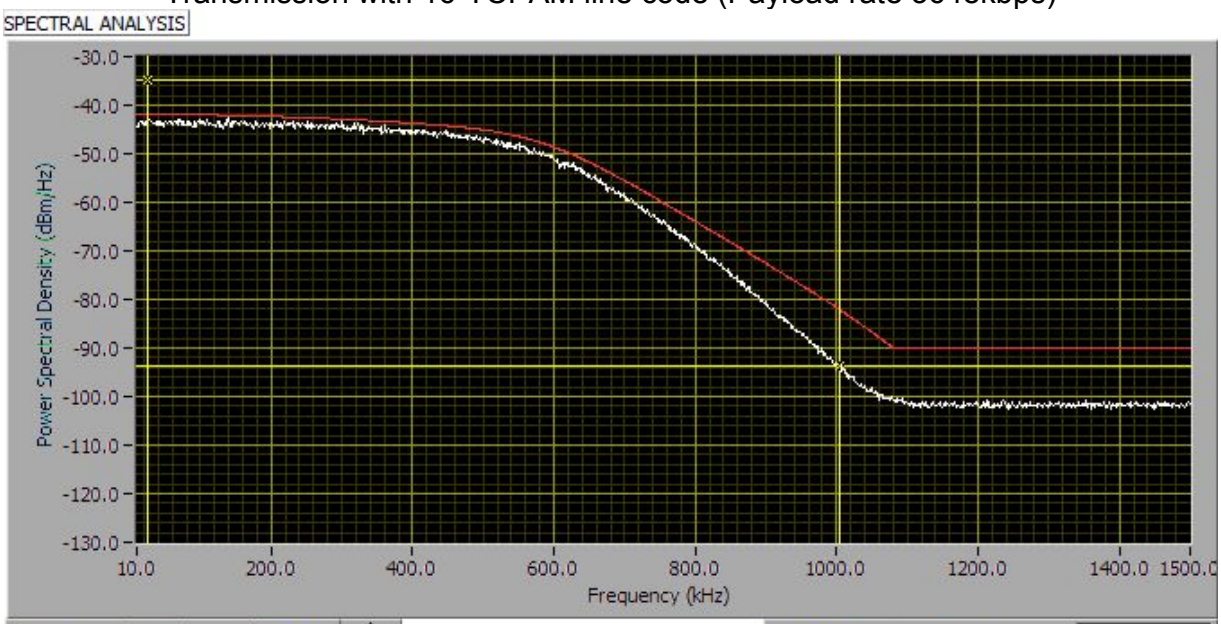
Transmission with 16-TCPAM line code (Payload rate 3264kbps)

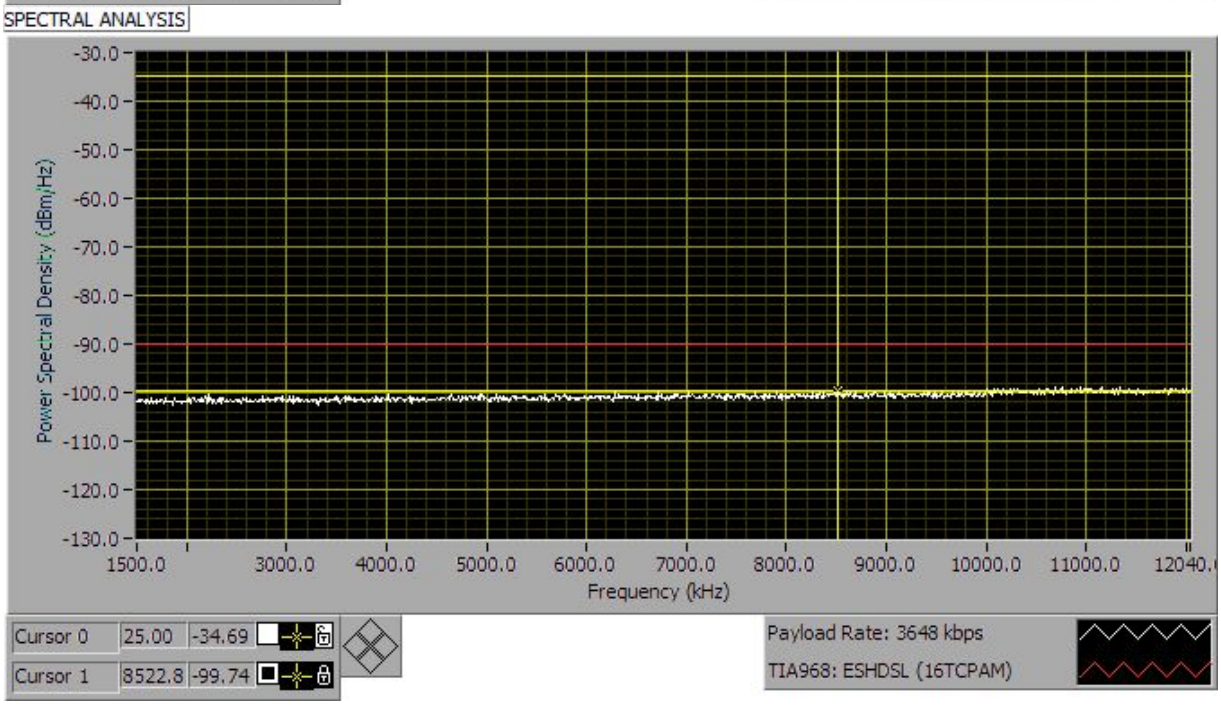




POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

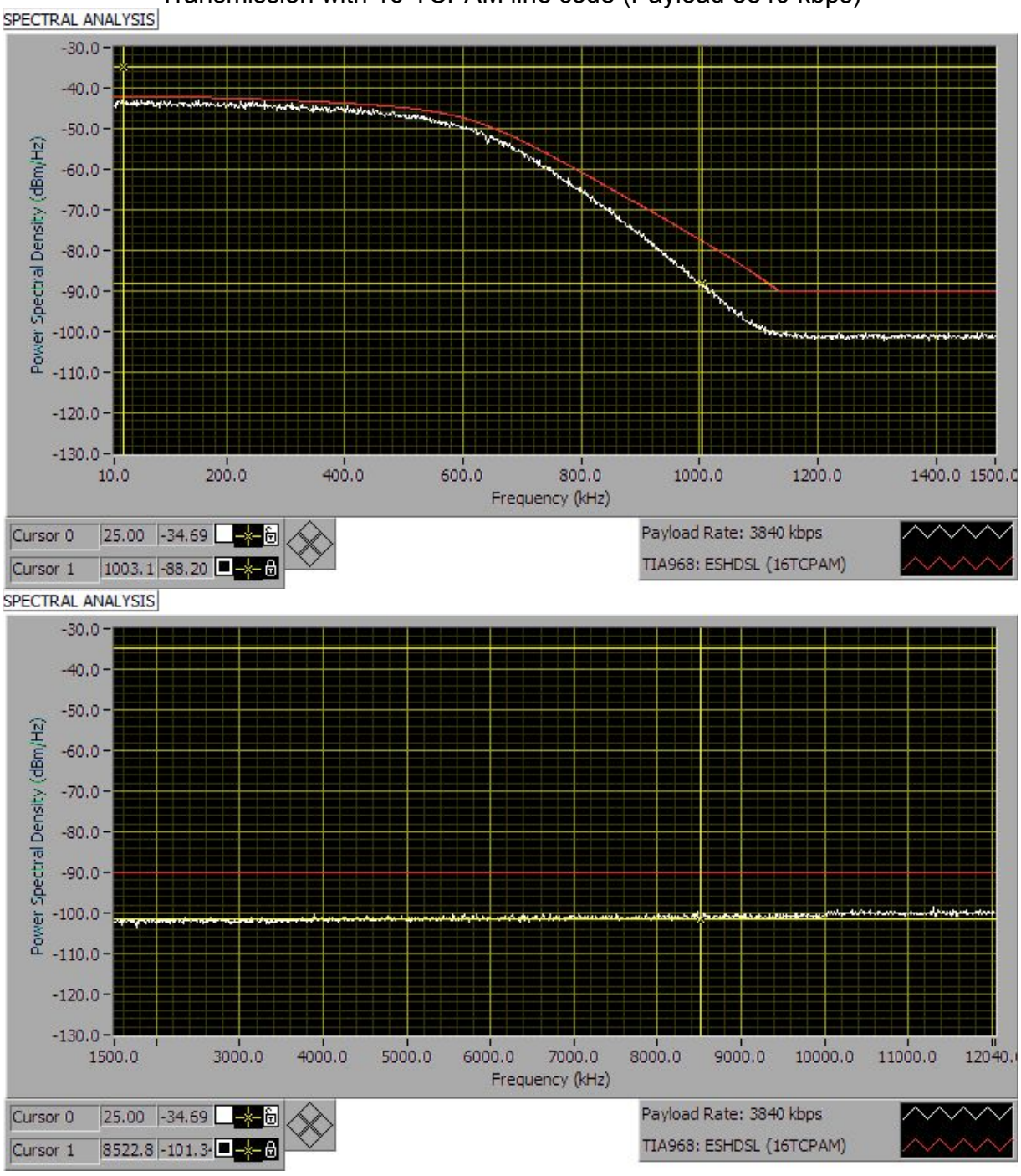
Transmission with 16-TCPAM line code (Payload rate 3648kbps)





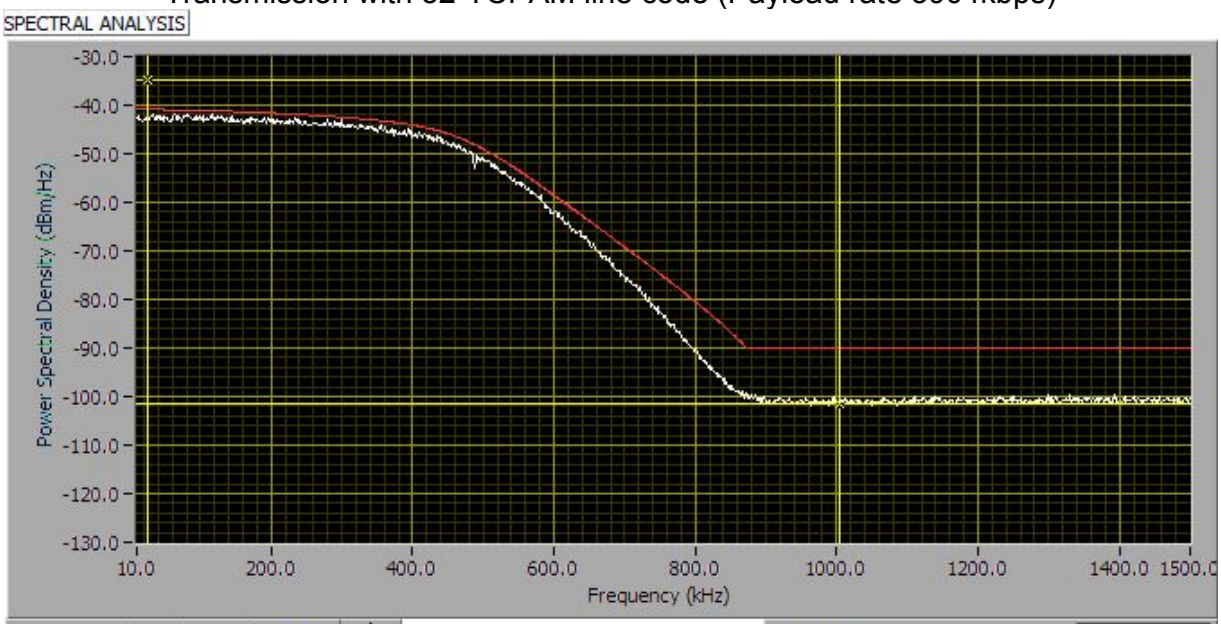
POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

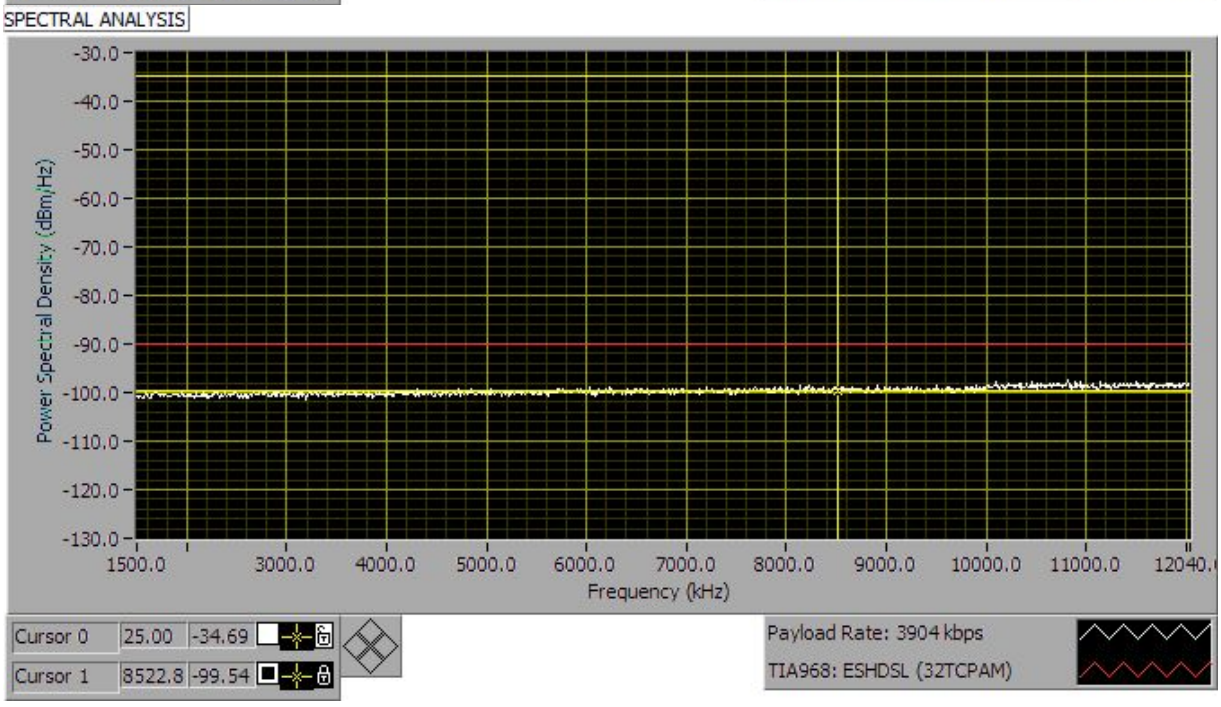
Transmission with 16-TCPAM line code (Payload 3840 kbps)



POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

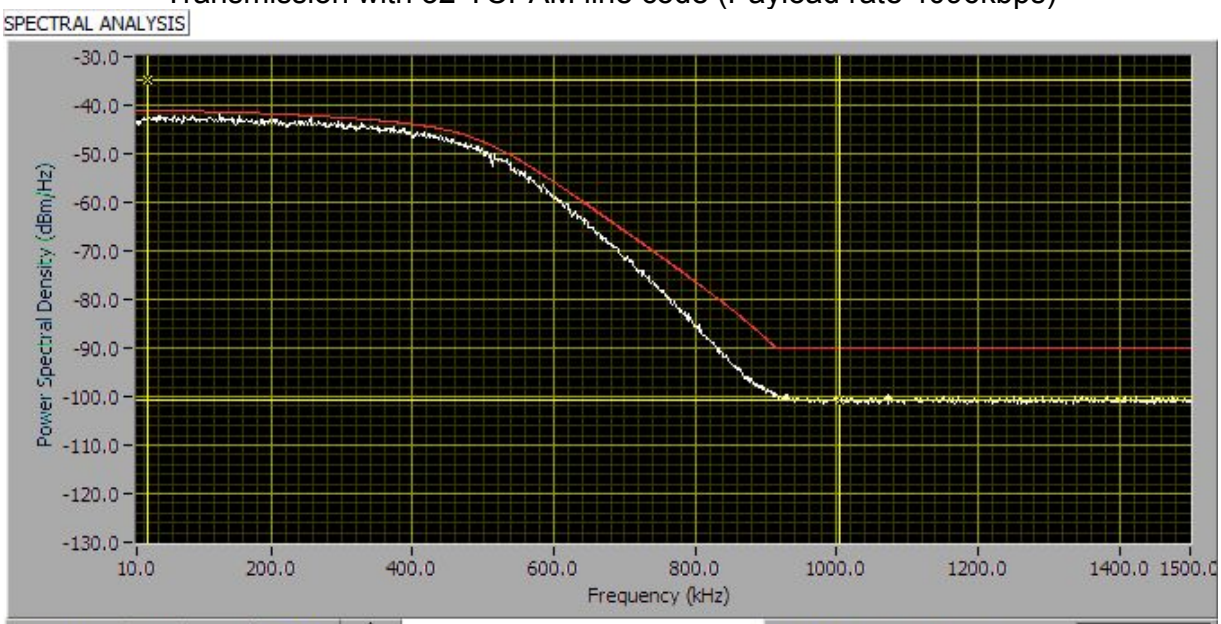
Transmission with 32-TCPAM line code (Payload rate 3904kbps)

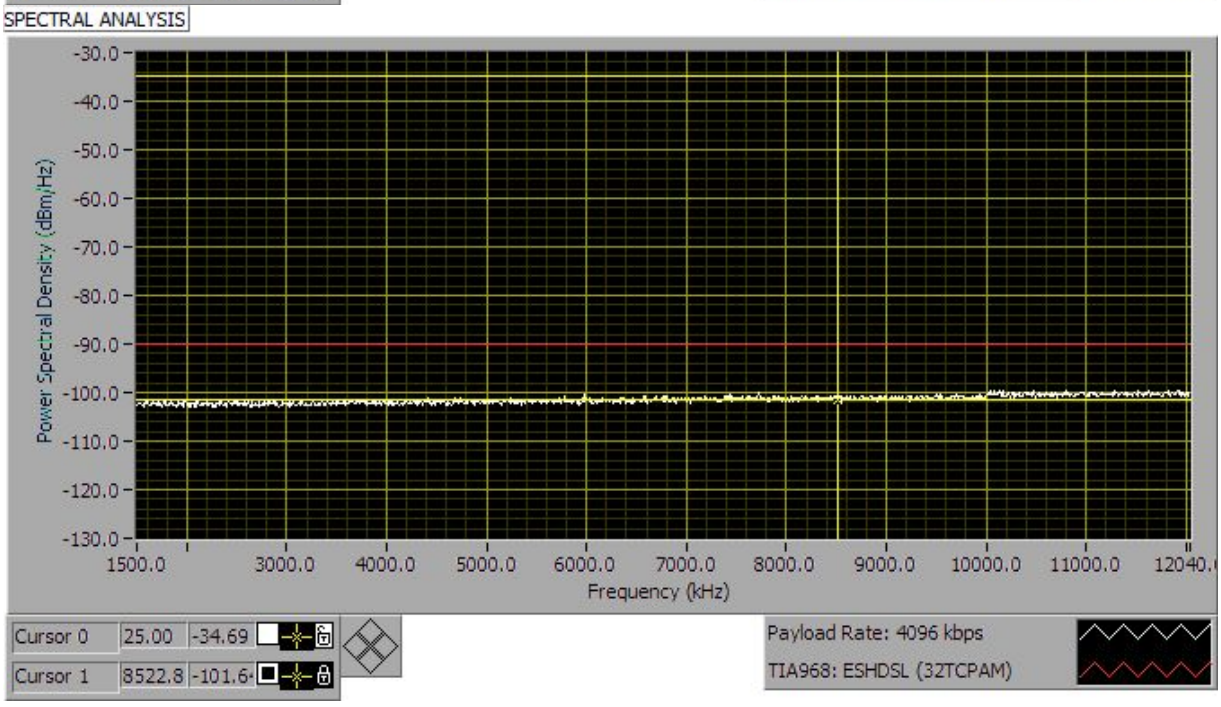




POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

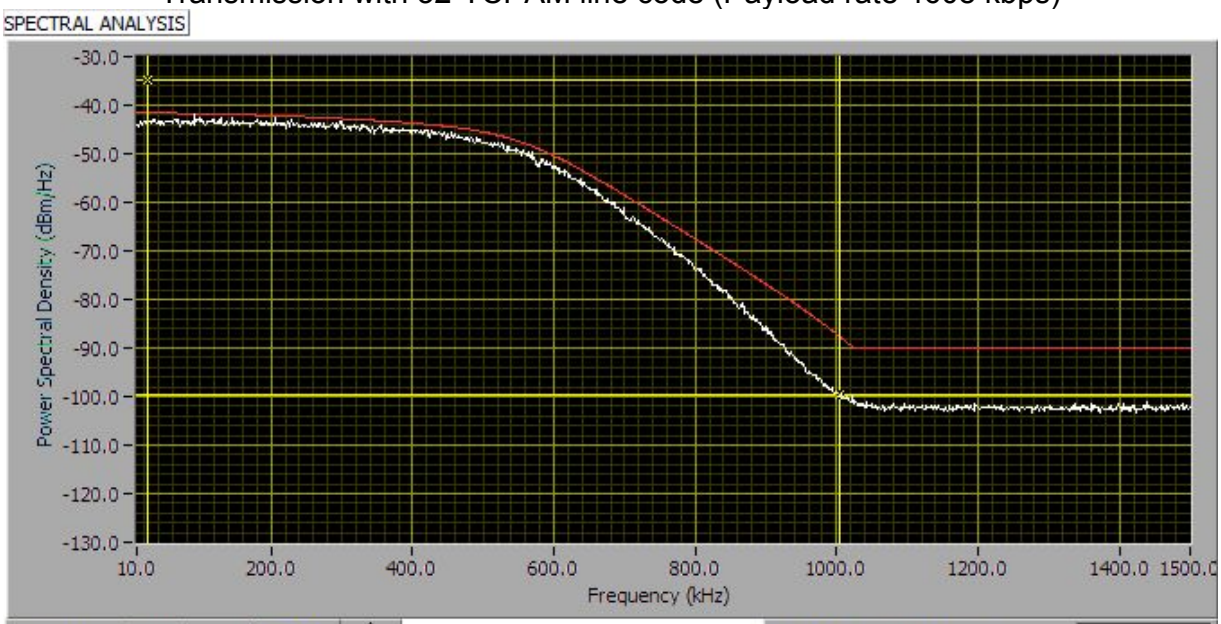
Transmission with 32-TCPAM line code (Payload rate 4096kbps)

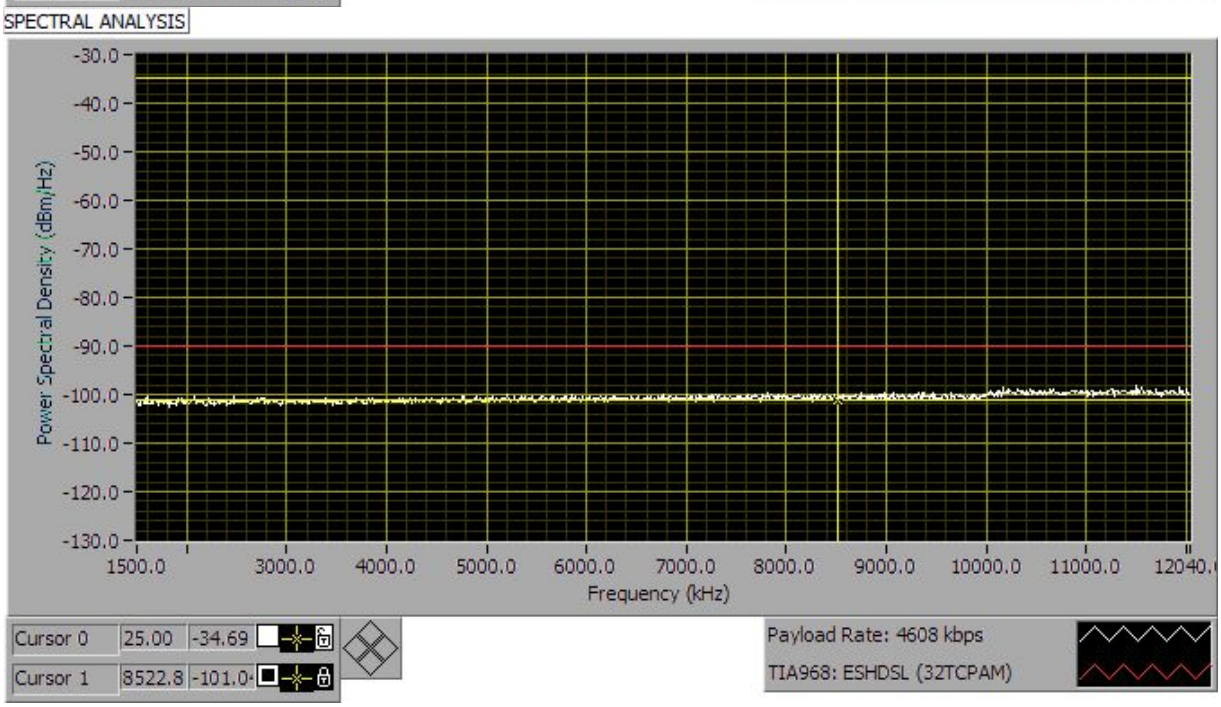




POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

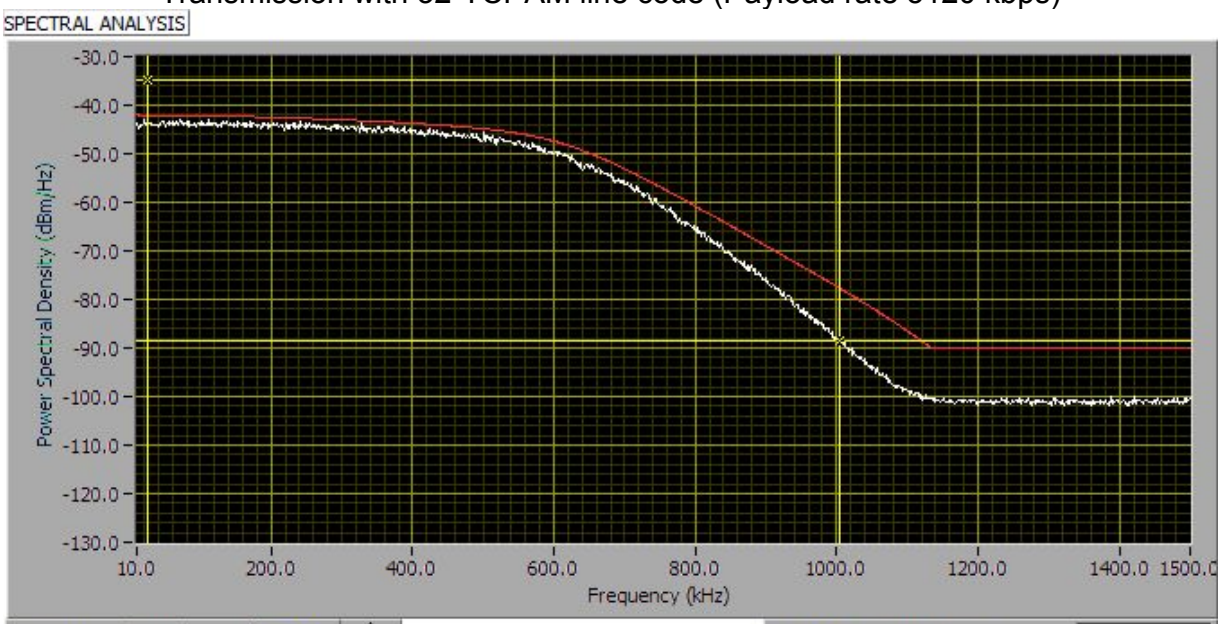
Transmission with 32-TCPAM line code (Payload rate 4608 kbps)

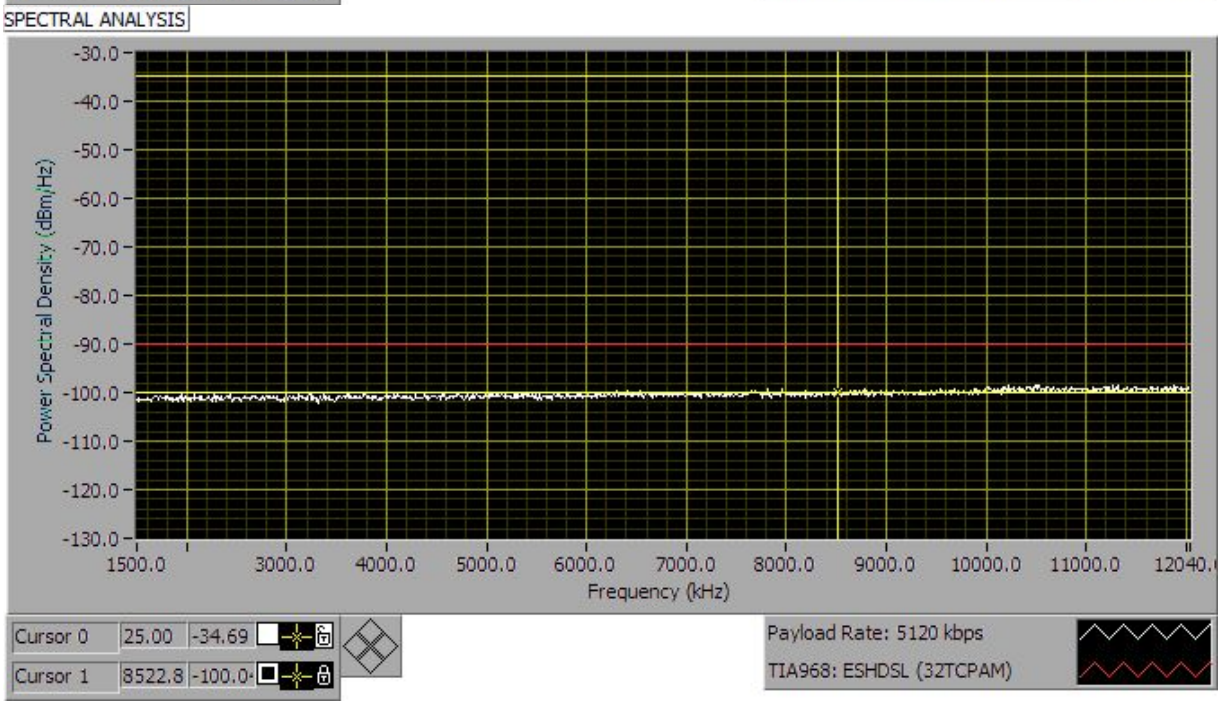




POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

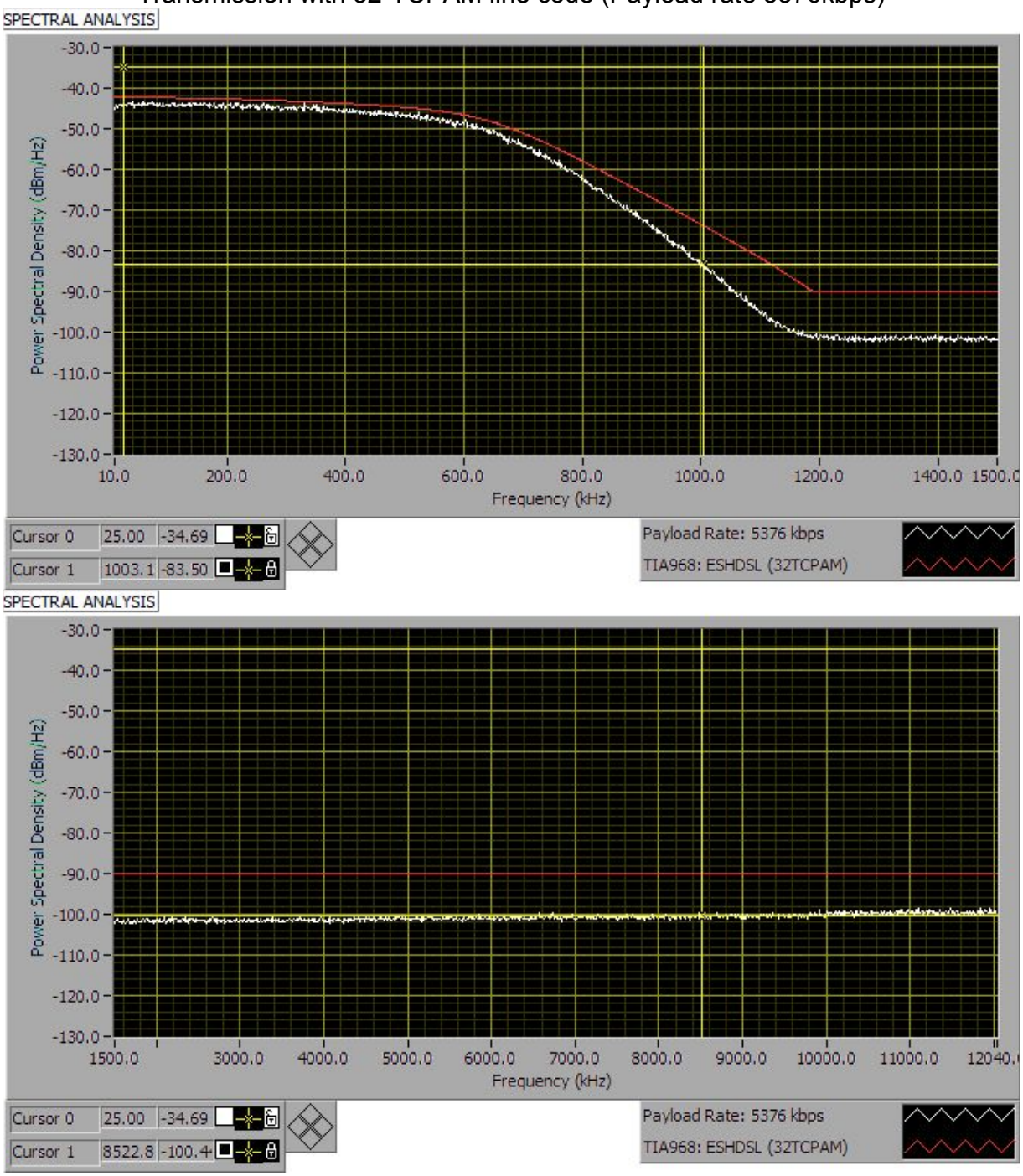
Transmission with 32-TCPAM line code (Payload rate 5120 kbps)





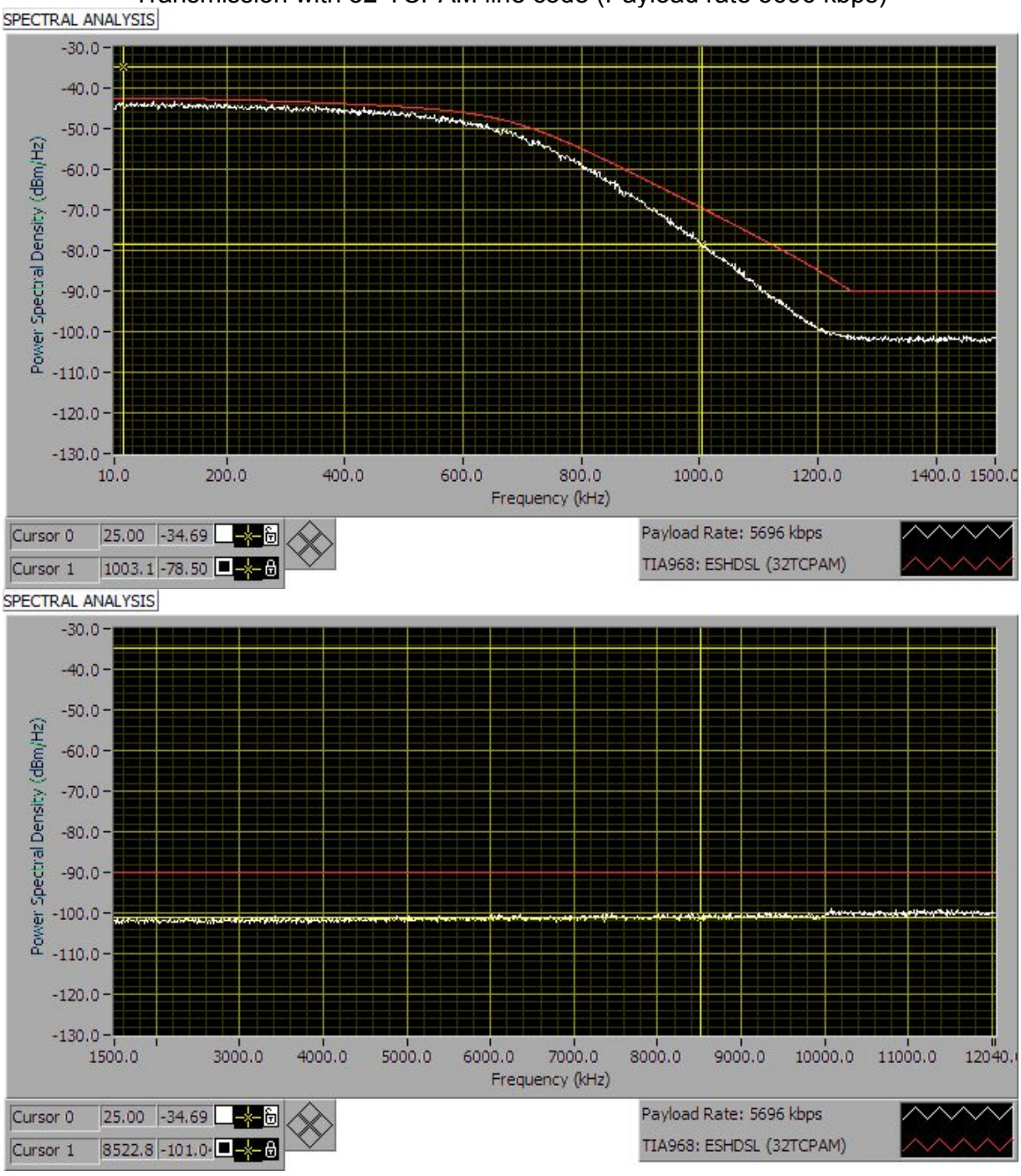
POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

Transmission with 32-TCPAM line code (Payload rate 5376kbps)



POWER SPECTRAL DENSITY (PSD) (With Bandwidth of 10 kHz)

Transmission with 32-TCPAM line code (Payload rate 5696 kbps)



DSL Transverse Balance (5.3.4.2 SHDSL)

PRE-ENVIRONMENTAL

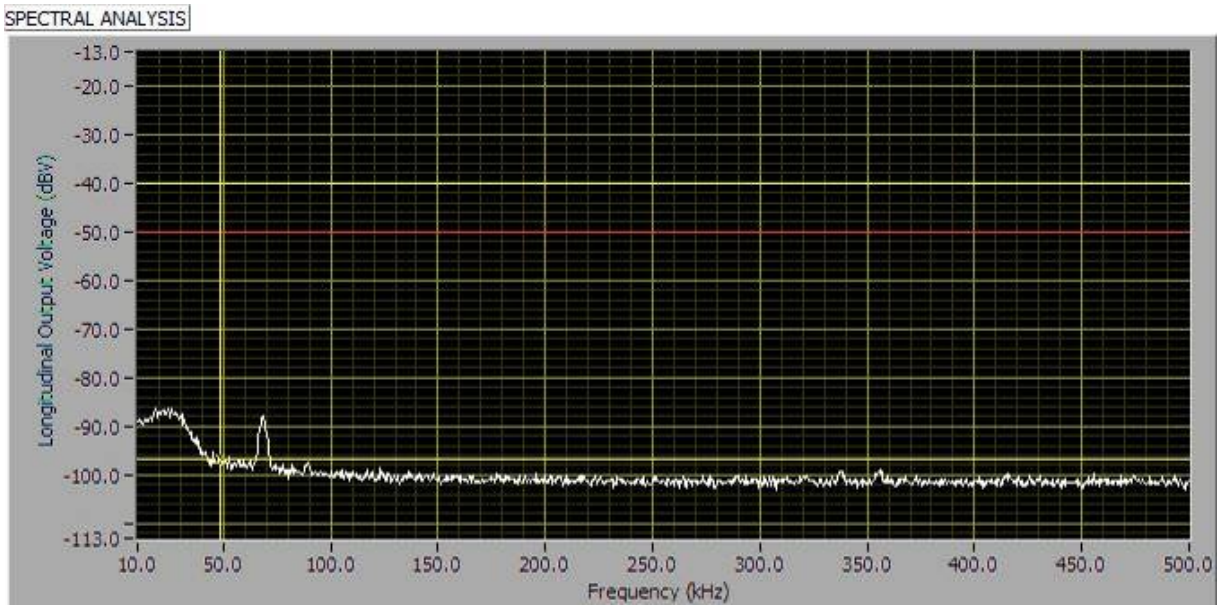
Frequency (kHz)	R_L (ohms)	Limit (dB)	Measurement (dB)	Verdict
0.2 to 12	500	40	>75	P
12 to 761	90	35	>55	P

POST ENVIRONMENTAL

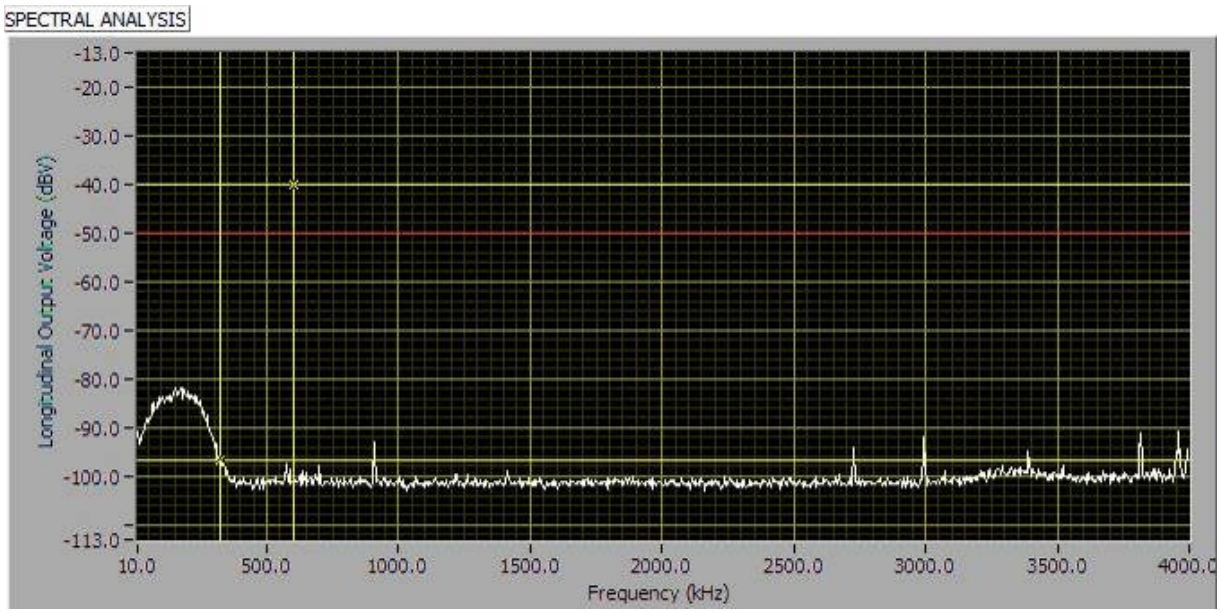
Frequency (kHz)	R_L (ohms)	Limit (dB)	Measurement (dB)	Verdict
0.2 to 12	500	40	>74	P
12 to 761	90	35	>53	P

DSL Longitudinal Output Voltage (5.3.4.3 SHDSL)

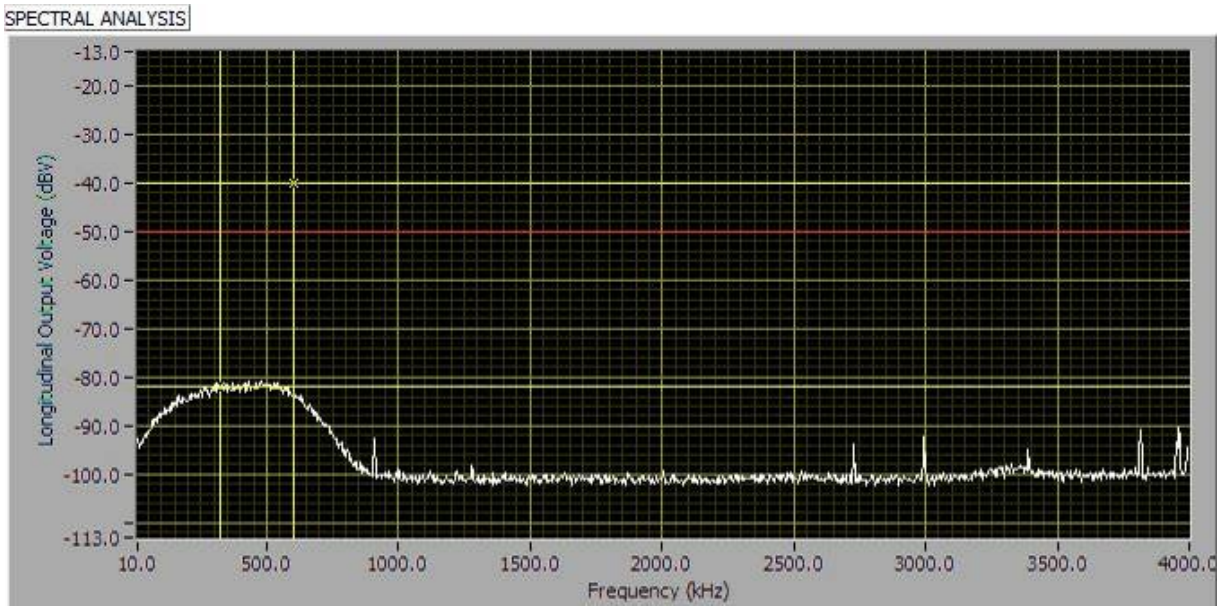
PRE-ENVIRONMENTAL - Payload rate 192kbps



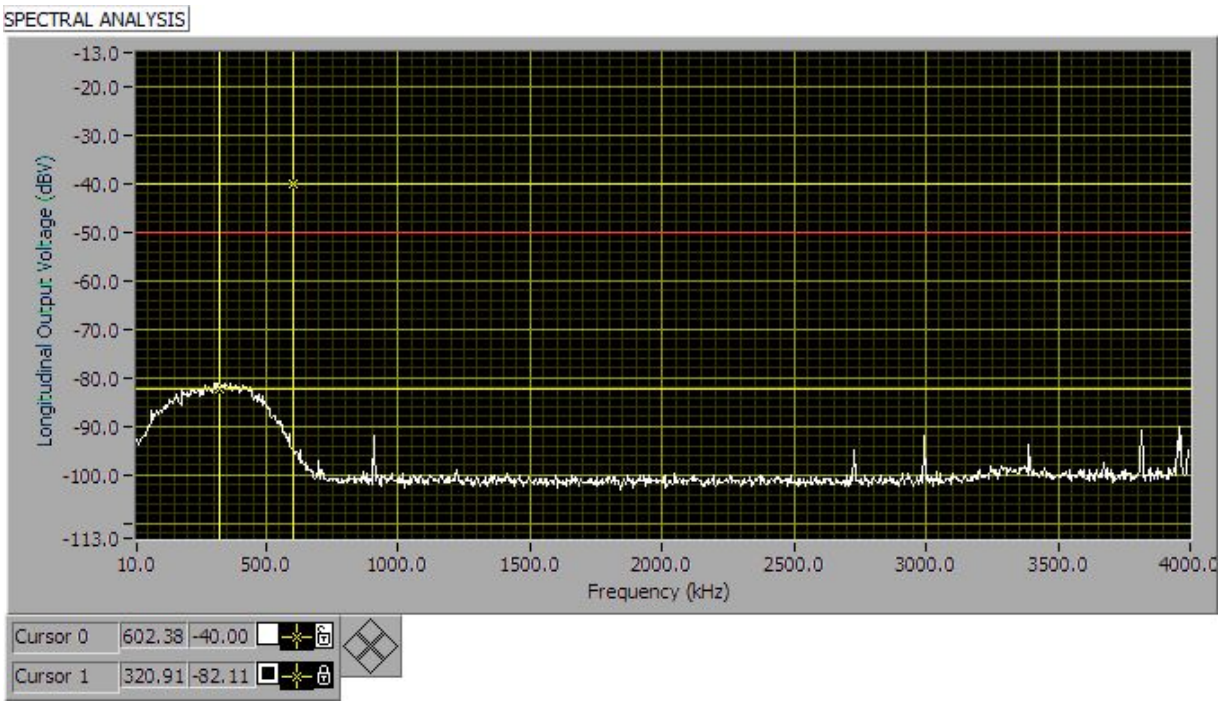
PRE-ENVIRONMENTAL - Payload rate 1536kbps



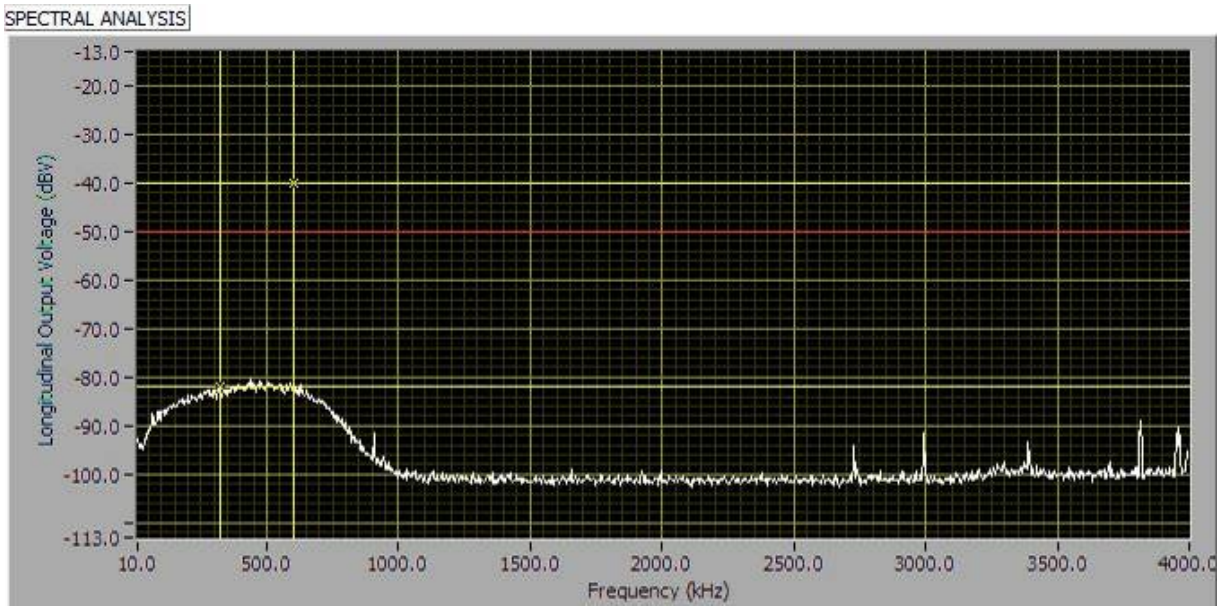
PRE-ENVIRONMENTAL - Payload rate 3840kbps



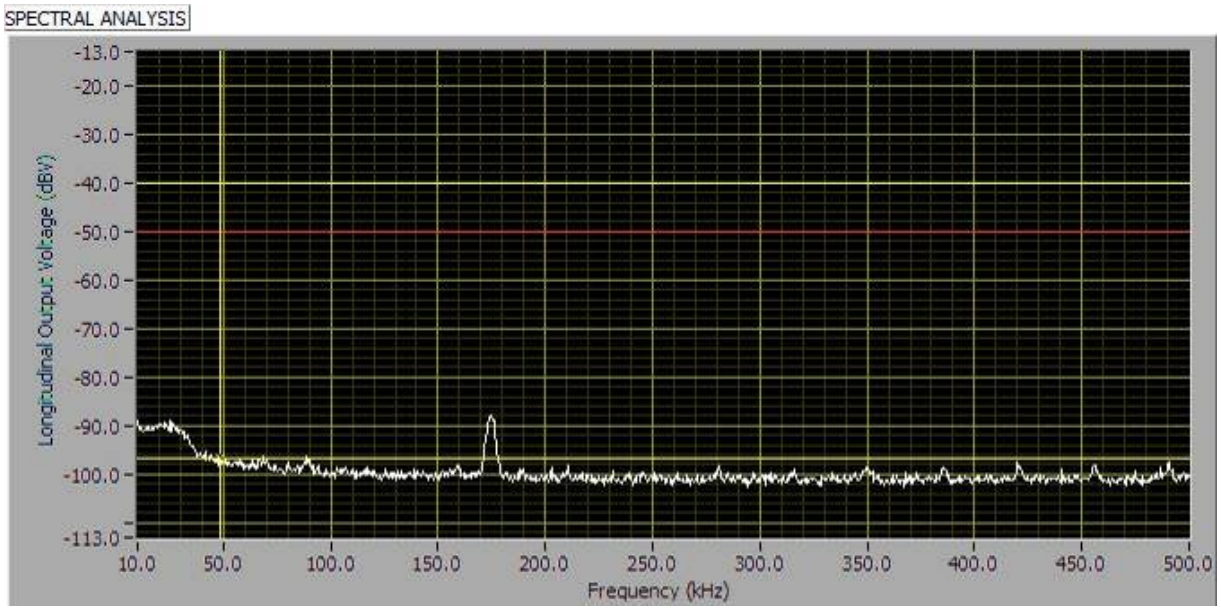
PRE-ENVIRONMENTAL - Payload rate 3904kbps



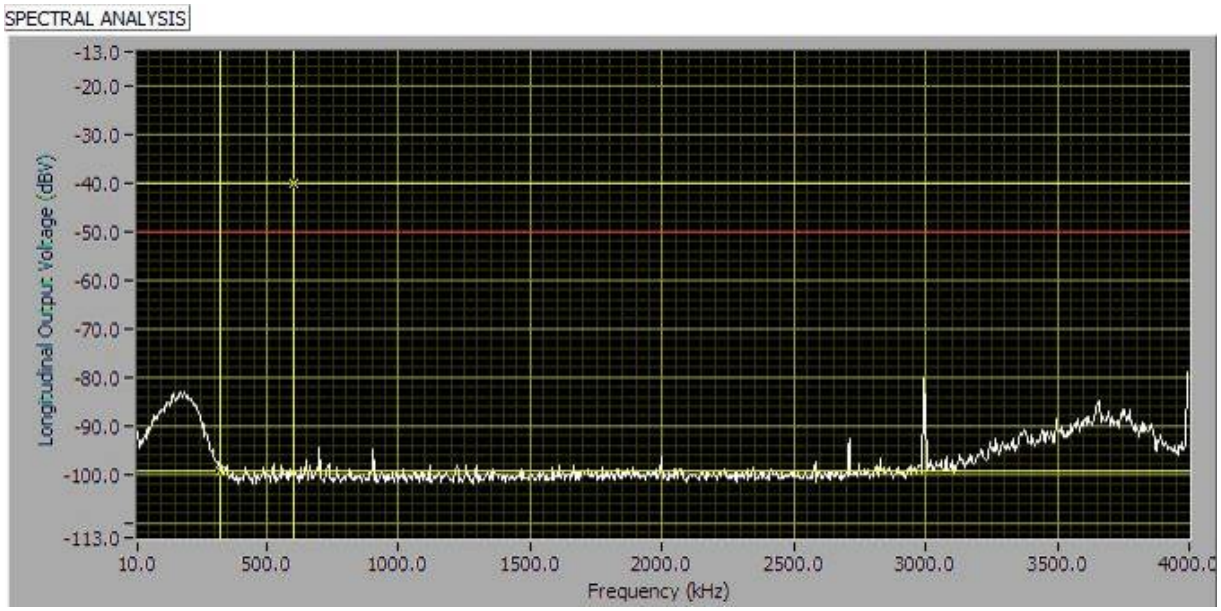
PRE-ENVIRONMENTAL - Payload rate 5696kbps



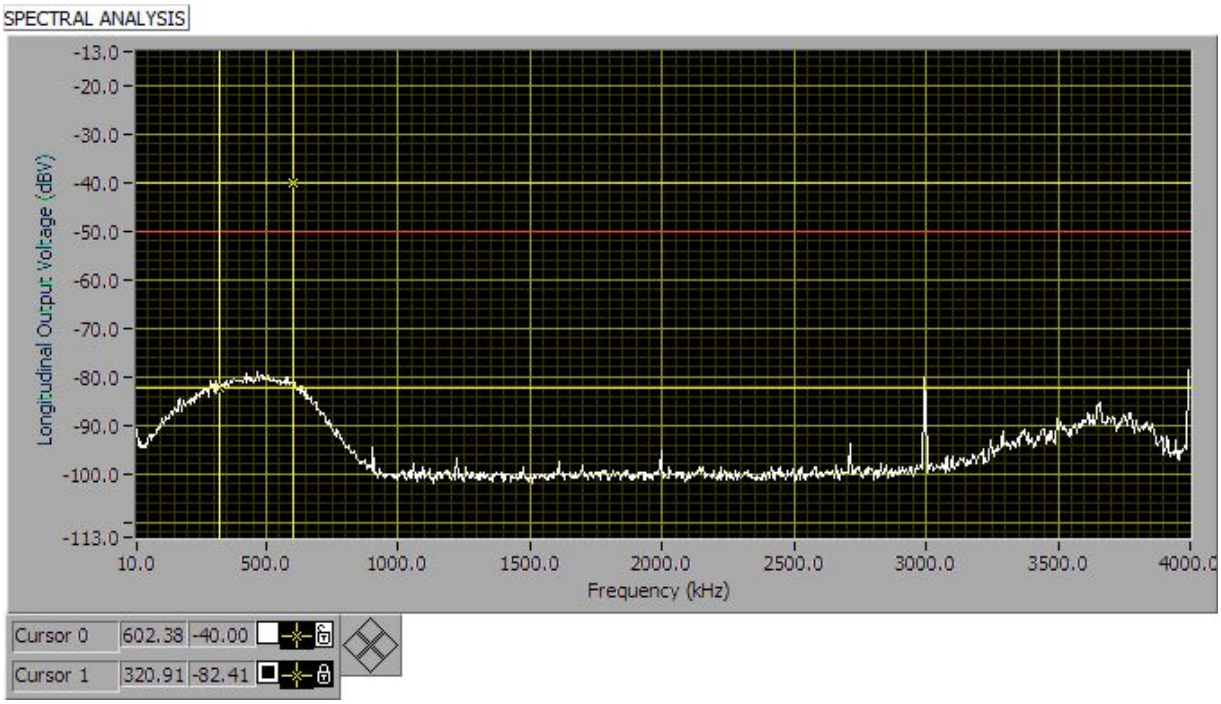
POST ENVIRONMENTAL - Payload rate 192kbps



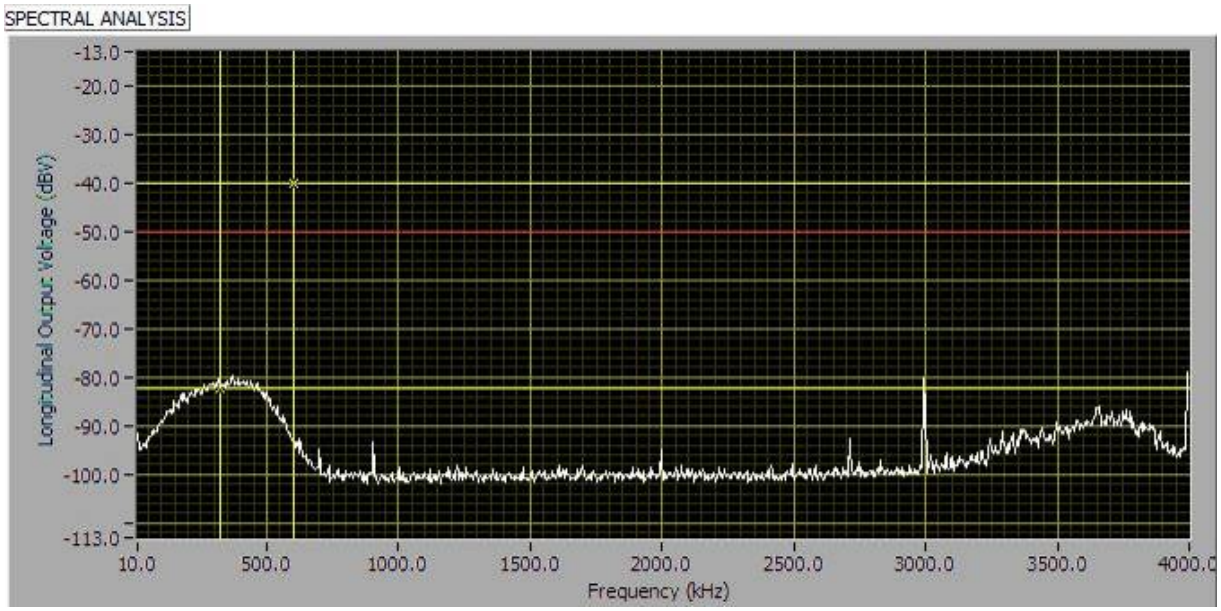
POST ENVIRONMENTAL - Payload rate 1536kbps



POST ENVIRONMENTAL - Payload rate 3840kbps



POST ENVIRONMENTAL - Payload rate 3904kbps



POST ENVIRONMENTAL - Payload rate 5696kbps

