

Agilent HFBR-5905/5905A

Characterization Report for MT-RJ

Duplex Multimode Transceiver

Application Note 1260

Introduction

The HFBR-5905 family transceiver is designed to provide a SONET OC-3 (SDH STM-1) compliant link for 155 Mb/s applications and intended for use over 0 °C to +70 °C temperature range for the HFBR-5905 or over -40 °C to +85 °C temperature range for the HFBR-5905A.

This report details the characterization of HFBR-5905 transceivers over the rated temperature and supply voltage limits. These modules were characterized at -40 °C, 0 °C, +25 °C, +70 °C and +85 °C at supply voltages of 3.13 V, 3.3 V and 3.47 V.

Definition of terms

The following terms are used in this document and are explained and defined below:

Transmitter Parameters

Output Power (dBm)

The optical output power is an averaged measurement using a 2 m MT-RJ patchcord terminated with an SC connector into a large area detector. This measurement allows for the loss of the MT-RJ Connector. The module was modulated at 155 Mb/s using a 1010 data pattern.

Extinction Ratio (%)

This is the ratio of optical power in a “0” or “off” state to the optical power in a “1” or “on” state. The ER is measured using a 1010 data pattern at 155 Mb/s.

Transmitter Supply Current (mA)

This is the current supplied to the transmitter at the relevant supply voltage including that drawn by the test fixture but excluding that drawn by the termination resistance network.

Wavelength (nm)

The mean wavelength as measured by an optical spectrum analyzer. The transmitter is modulated with a 2⁷-1 PRBS at 155 Mb/s.

Spectral Width (nm)

Spectral width is defined as the Full Width Half Maximum (FWHM) as measured by an optical spectrum analyzer.

Receiver Parameters

Sensitivity (dBm)

This measures the receiver sensitivity with a 2²³-1 PRBS input signal. The sensitivity is the minimum optical input power that the receiver can recover a signal with an error rate of 1 x 10⁻¹⁰.

Receiver Supply Current (mA)

This is the receiver supply current at the stated supply voltage excluding that drawn by the termination resistance network of the evaluation board.

Signal Detect Levels (V)

This is the measured voltage through 50 ohms, referenced to V_{CC} -2 V at the signal detect output. Signal Detect is high during an ‘On’ state and low during an ‘Off’ state. Table 1 shows that Signal Detect levels are within data sheet specifications.

Signal Detect De-assert (dBm)

This is the point at which the signal detect flags low to indicate a loss of signal due to low optical power.



SD De-assert and Assert Times (μs)

The time taken for a high to low transition after the optical input signal is removed or applied respectively. Table 2 shows that Signal Detect Assert and De-assert times are within data sheet specifications.

Receiver Power Supply Noise Rejection

Modules were measured using test fixtures fitted with the power supply filter shown in Figure 1. Broadband noise, representing switching currents in a typical digital system, was introduced into the power supply and the eye width was measured. Eye width, in this case, is defined as the time around the center of the eye, in which the bit error rate is better than 10^{-9} .

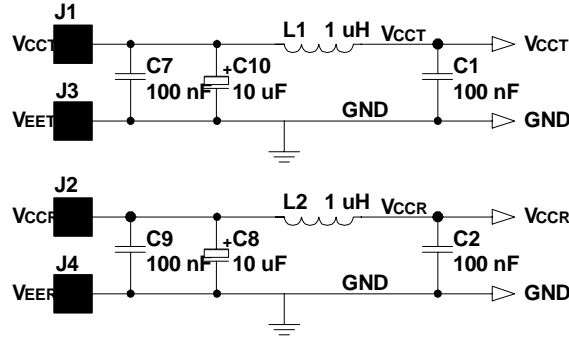


Figure 1. MSA Power Supply Filter

Table 1 - HFBR-5905/5905A Minimum, Mean and Maximum measured Signal Detect Low and High voltages over operating temperature (-40 °C to +85 °C) and voltage (3.13 V to 3.47 V).

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
SD Voltage Low ($V_{OL} - V_{CC}$)	V	-1.76	-1.71	-1.63	-1.84	-1.62
SD Voltage High ($V_{OH} - V_{CC}$)	V	-1.00	-0.95	-0.92	-1.045	-0.88

Table 2 - HFBR-5905/5905A Minimum, Mean and Maximum measured Signal Detect Assert and Deassert times over operating temperature (-40 °C to +85 °C) and voltage (3.13 V to 3.47 V).

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
SD Assert Time	μS	1	1	1	-	100
SD Deassert Time	μS	3	3.5	5	-	350

Results Summary
Voltage Dependence

One of the objectives of this characterization exercise was to establish the influence of voltage supply variation on transceiver performance. The summary of results shown in Tables 3a to 3c indicate that the HFBR-5905 has negligible dependence on supply voltage (within the limits of 3.14 V to 3.47 V) for major parameters over the operating temperature range of 0 °C to +70 °C. Similarly Tables 4a to 4c indicate that the HFBR-5905A has negligible dependence on supply voltage for major parameters over the operating temperature range -40 °C to +85 °C.

Table 3a - HFBR-5905 Minimum, Mean and Maximum measured parameters over operating temperature (0 °C to +70 °C) at 3.3 V.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	108	118	132	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.1	-16.5	-14.8	-19	-14
Extinction Ratio	%	-	0.015	0.076	-	0.2
Receiver						
Supply Current	mA	59	63	68	-	120
Sensitivity at eye center	dBm	-35.7	-34.7	-33.5	-	-31
SD Deassert	dBm	-39.9	-38.3	-37.0	-45	-
SD Hysteresis	dB	1.8	2.0	2.5	1.5	-

Table 3b - HFBR-5905 Minimum, Mean and Maximum measured parameters over operating temperature (0 °C to +70 °C) at 3.13 V.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	103	112	125	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.1	-16.5	-14.8	-19	-14
Extinction Ratio	%	-	0.014	0.069	-	0.2
Receiver						
Supply Current	mA	56	60	63	-	120
Sensitivity at eye center	dBm	-35.9	-34.7	-33.5	-	-31
SD Deassert	dBm	-39.7	-38.4	-37.8	-45	-
SD Hysteresis	dB	1.9	2.0	2.4	1.5	-

Table 3c - HFBR-5905 Minimum, Mean and Maximum measured parameters over operating temperature (0 °C to +70 °C) at 3.47 V.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	113	127	138	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.0	-16.5	-14.8	-19	-14
Extinction Ratio	%	-	0.015	0.080	-	0.2
Receiver						
Supply Current	mA	61	65	69	-	120
Sensitivity at eye center	dBm	-35.6	-34.6	-33.4	-	-31
SD Deassert	dBm	-40.1	-38.3	-37.8	-45	-
SD Hysteresis	dB	1.8	1.9	2.6	1.5	-

Table 4a - HFBR-5905A Minimum, Mean and Maximum measured parameters over operating temperature (-40 °C to +85 °C) at 3.3 V.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	98	115	135	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.4	-16.5	-14.2	-19	-14
Extinction Ratio	%	-	0.024	0.113	-	0.2
Receiver						
Supply Current	mA	57	62	68	-	120
Sensitivity at eye center	dBm	-35.5	-34.8	-33.7	-	-31
SD Deassert	dBm	-38.6	-38.1	-37.6	-45	-
SD Hysteresis	dB	1.7	1.9	2.1	1.5	-

Table 4b - HFBR-5905A Minimum, Mean and Maximum measured parameters over operating temperature (-40 °C to +85 °C) at 3.13 V.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	93	110	128	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.5	-16.5	-14.2	-19	-14
Extinction Ratio	%	-	0.024	0.109	-	0.2
Receiver						
Supply Current	mA	54	59	64	-	120
Sensitivity at eye center	dBm	-35.8	-34.9	-33.7	-	-31
SD Deassert	dBm	-38.6	-38.1	-37.4	-45	-
SD Hysteresis	dB	1.8	1.9	2.0	1.5	-

Table 4c - HFBR-5905A Minimum, Mean and Maximum measured parameters over operating temperature (-40 °C to +85 °C) at 3.47 V.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	103	120	140	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.4	-16.5	-14.2	-19	-14
Extinction Ratio	%	-	0.026	0.116	-	0.2
Receiver						
Supply Current	mA	59	65	70	-	120
Sensitivity at eye center	dBm	-35.4	-34.7	-33.6	-	-31
SD Deassert	dBm	-38.6	-38.2	-37.2	-45	-
SD Hysteresis	dB	1.7	1.9	2.0	1.5	-

Overall Performance

Tables 5a to 5e show a summary of parametric performance over voltage range 3.14 V to 3.47 V at -40 °C, 0 °C, +25 °C, +70 °C and +85 °C. The results show that all parameters were within data sheet limits.

Table 5a – HFBR-5905/5905A Minimum, Mean and Maximum measured parameters over operating voltage (3.13 V to 3.47 V) at -40 °C.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	93	99	104	-	175
Output Power (with 62.5 μm fiber)	dBm	-16.1	-15.1	-14.2	-19	-14
Extinction Ratio	%	0.001	0.001	0.001	-	0.2
Receiver						
Supply Current	mA	54	57	61	-	120
Sensitivity at eye center	dBm	-35.8	-35.3	-34.6	-	-31
SD Deassert	dBm	-38.4	-38.1	-37.7	-45	-
SD Hysteresis	dB	1.7	1.8	1.9	1.5	-

Table 5b – HFBR-5905/5905A Minimum, Mean and Maximum measured parameters over operating voltage (3.13 V to 3.47 V) at 0 °C.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	103	109	116	-	175
Output Power (with 62.5 μm fiber)	dBm	-16.3	-15.7	-14.8	-19	-14
Extinction Ratio	%	0.001	0.001	0.001	-	0.2
Receiver						
Supply Current	mA	56	60	63	-	120
Sensitivity at eye center	dBm	-35.9	-35.4	-34.9	-	-31
SD Deassert	dBm	-38.7	-38.3	-37.9	-45	-
SD Hysteresis	dB	1.8	2.0	2.1	1.5	-

Table 5c – HFBR-5905/5905A Minimum, Mean and Maximum measured parameters over operating voltage (3.13 V to 3.47 V) at +25 °C.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	108	115	123	-	175
Output Power (with 62.5 μm fiber)	dBm	-16.6	-16.2	-15.4	-19	-14
Extinction Ratio	%	0.001	0.002	0.002	-	0.2
Receiver						
Supply Current	mA	58	62	66	-	120
Sensitivity at eye center	dBm	-35.3	-34.9	-34.4	-	-31
SD Deassert	dBm	-38.6	-38.2	-37.8	-45	-
SD Hysteresis	dB	1.8	1.8	1.9	1.5	-

Table 5d – HFBR-5905/5905A Minimum, Mean and Maximum measured parameters over operating voltage (3.13 V to 3.47 V) at +70 °C.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	122	128	138	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.1	-17.6	-16.8	-19	-14
Extinction Ratio	%	0.034	0.050	0.080	-	0.2
Receiver						
Supply Current	mA	63	66	69	-	120
Sensitivity at eye center	dBm	-34.2	-33.8	-33.4	-	-31
SD Deassert	dBm	-40.1	-38.4	-37.0	-45	-
SD Hysteresis	dB	2.2	2.3	2.6	1.5	-

Table 5e – HFBR-5905/5905A Minimum, Mean and Maximum measured parameters over operating voltage (3.13 V to 3.47 V) at +85 °C.

Test Parameters	Units	Min	Mean	Max	Data Sheet Limits	
					Min	Max
Transmitter						
Supply Current	mA	125	132	140	-	175
Output Power (with 62.5 μm fiber)	dBm	-18.5	-18.0	-17.4	-19	-14
Extinction Ratio	%	0.065	0.088	0.116	-	0.2
Receiver						
Supply Current	mA	63	67	70	-	120
Sensitivity at eye center	dBm	-34.7	-34.2	-33.6	-	-31
SD Deassert	dBm	-38.5	-38.1	-37.4	-45	-
SD Hysteresis	dB	1.9	2.0	2.1	1.5	-

Receiver power supply noise immunity

Using the MSA power supply filter shown in Figure 1, a $2^{23}-1$ PRBS signal at 1 MHz and a varying amplitude was injected onto the Rx V_{CC} and receiver sensitivity was monitored. The choice of signal is due to the fact that the power supply filter is particularly effective at higher frequencies, and so the most likely problem area is at lower frequencies. The PRBS signal consists of a wide spectrum below its fundamental frequency and it is a reasonable model for the switching currents that might be caused by other logic in a system. The optical input power was set to the stated limit of receiver sensitivity, -31.8 dBm.

Figure 2 shows a typical ‘Tub Diagram’ plotting BER against trigger position away from the center of the eye. Figure 3 shows a plot of the eye width for a BER of 10^{-9} as a function of the peak to peak amplitude of the noise. Power supply noise with amplitude of 500 mV does measurably degrade the eye width of the HFBR-5905 but the transceiver is still able to function, error-free with reasonable margin for the clock position.

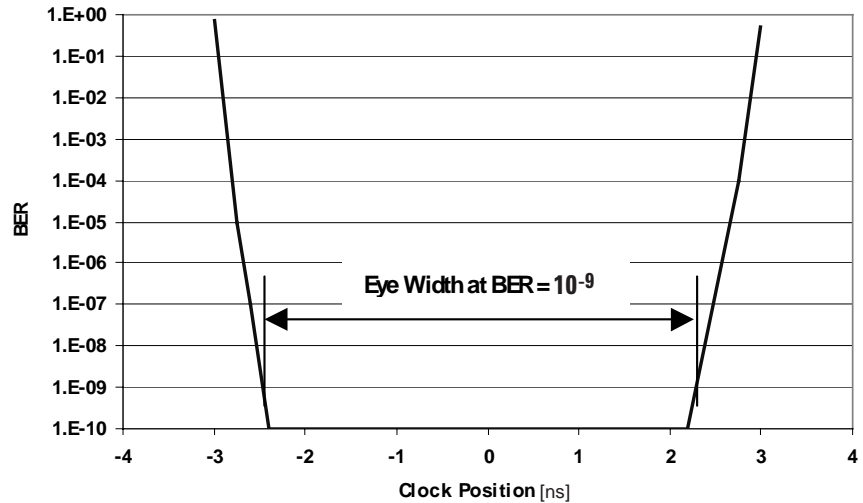


Figure 2. Typical Tub Diagram

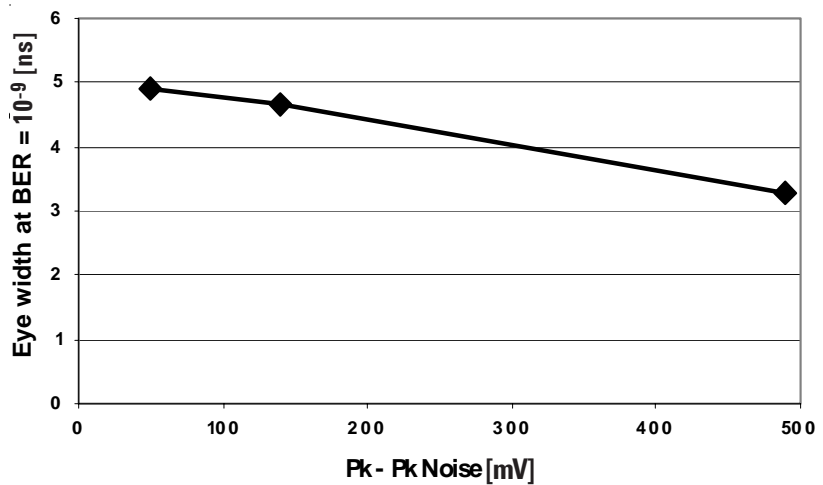


Figure 3. Receiver PSNR

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