Agilent HFCT-594xL / G Characterization Report for Single Mode Laser Small Form Factor Transceivers for Short Reach ATM, SONET OC-48 / SDH STM-16

Application Note 1235

Introduction

The HFCT-5942L/G is a SONET/SDH compliant 2.5 Gb/s optical transceiver intended for use over 0°C to +70°C temperature range. It is supplied in the industry standard 2 x 10 DIP style package.

The HFCT-5941L/G is supplied in the industry standard 2 x 5 DIP style package. It has the same functionality as the HFCT-5942L/G but does not offer the following monitoring functions:

– Laser bias monitor (B_{MON})
– Rear facet monitor (P_{MON})
– Photo detector bias monitor (VpdRX)

This report details the characterization of 25 HFCT-5942L/G transceivers over its rated operating temperature and supply voltage limits. These modules were characterized at 0°C, +25°C and +70°C at supply voltages of 3.1 V, 3.3 V and 3.5 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 1.5 m patchcord terminated with an FC/PC connector into a large area detector. This measurement allows for the loss of the LC connector. The module was modulated at 2.488 Gb/s using a 2^{23}-1 pseudo random bit sequence (PRBS).

Extinction Ratio (dB)
This is the ratio of optical power in a ‘1’ or ‘on’ logic state to the optical power in a ‘0’ or ‘off’ logic state. The ER is measured using a 2^{23}-1 PRBS at 2.488 Gb/s data rate with an Agilent 83480A Digital Communications Analyzer running on an automatic algorithm.

Transmitter Supply Current (mA)
This is the current supplied to the transmitter at the relevant supply voltage including that drawn by the internal termination resistance network.

Wavelength (nm)
The mean wavelength as measured by an Agilent 70950A optical spectrum analyzer. The transmitter is modulated with a 2^{23}-1 PRBS at 2.488 Gb/s.

Spectral Width (nm)
Spectral width is defined as the RMS width containing all modes with energy greater than 20 dB down from the peak wavelength.

Eye Margin Test (%)
The eye mask is measured using an Agilent 83480A communications analyzer with an optical input module through a 2.488 Gb/s 4th order Bessel filter as defined in SONET/SDH standards. The measurements are made using a 2.488 Gb/s 2^{23}-1 PRBS pattern.

Optical Output Rise and Fall Times (ps)
The rise and fall time is the transition time between 10% to 90% of its peak-peak amplitude. This is measured using a 2.488 Gb/s 2^{23}-1 PRBS on an unfiltered waveform.

Transmitter Power Supply Noise Rejection
Modules were measured using test fixtures fitted with the power supply filter shown in Figure 1. Wideband noise was introduced through a signal generator and the optical eye was viewed using an Agilent 83480A Digital Communications Analyzer with a SONET/SDH eye mask applied. The noise to the device is increased until the eye mask margin is reduced to 10%.

Jitter Generation (mUI)
Jitter Generation (peak to peak and rms) is measured using an OmniBER 37718A. The measurements are made using a SONET STS48C scrambled pattern with a 2^{23}-1 PRBS payload.

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Laser Bias Monitor (mV)
The laser bias monitor output (B_{MON}) is obtained by probing between B_{MON}+ and B_{MON}– and is given in mV. The module was modulated at 2.488 Gb/s using a 2^{23}-1 PRBS.

Rear Facet Monitor (mV)
The laser rear facet monitor output (P_{MON}) is obtained by probing between P_{MON}+ and P_{MON}– and is given in mV. The module was modulated at 2.488 Gb/s using a 2^{23}-1 PRBS.

Receiver Parameters

Sensitivity (dBm)
This measures the receiver sensitivity with a 2^{23}-1 PRBS input signal compliant to SDH/ SONET recommendations. An Agilent 83430A optical source with a 10 dB extinction ratio was used as the test laser. The sensitivity is the minimum optical input power that the receiver can recover a signal with an error rate of 1E-^{10}. A 2.488 Gb/s 2^{23}-1 PRBS is applied to the Tx simultaneously from a second pattern generator to simulate duplex operation.

Receiver Supply Current (mA)
This is the receiver supply current at the stated supply voltage including that drawn by the internal bias resistor network.

Signal Detect Level High (V)
The measured voltage referenced to ground at the signal detect output during an ‘on’ state.

Signal Detect Level Low (V)
The measured voltage referenced to ground at the signal detect output during an ‘off’ state.

Signal Detect Deassert (dBm)
This is the point at which the signal detect flags low to indicate a loss of signal due to low optical power.

SD Deassert and Assert Times (µs)
The time taken for a high to low transition or a low to high transition after the optical input signal is removed or applied respectively. Measured with -18 dBm of optical power at the receiver input.

Receiver Power Supply Noise Rejection
Modules were measured using test fixtures fitted with the power supply filter shown in Figure 1. Wideband noise was introduced through a signal generator and the receiver measured for 1 dB sensitivity degradation.

Overload (dBm)
The maximum optical signal power to the receiver such that the recovered data has an error rate of 1E-^{10}.

Receiver Photo Detector Bias (µA)
The receiver photo detector bias output (I_{PDRX}) is obtained by the current between Pin 1 and V_{CC}. The current is given in µA at -18 dBm optical input power using a 2.488 Gb/s, 2^{23}-1 PRBS test pattern.

Receiver Data Output (mV)
The peak to peak amplitude of the data outputs of the receiver are measured single ended. This is measured using an incoming 2.488 Gb/s, 2^{23}-1 PRBS test pattern.

Receiver Data Rise and Fall Time (ps)
The rise and fall time is the transition time between 20% and 80% of the signal peak to peak amplitude. This is measured using an incoming 2.488 Gb/s, 2^{23}-1 PRBS.

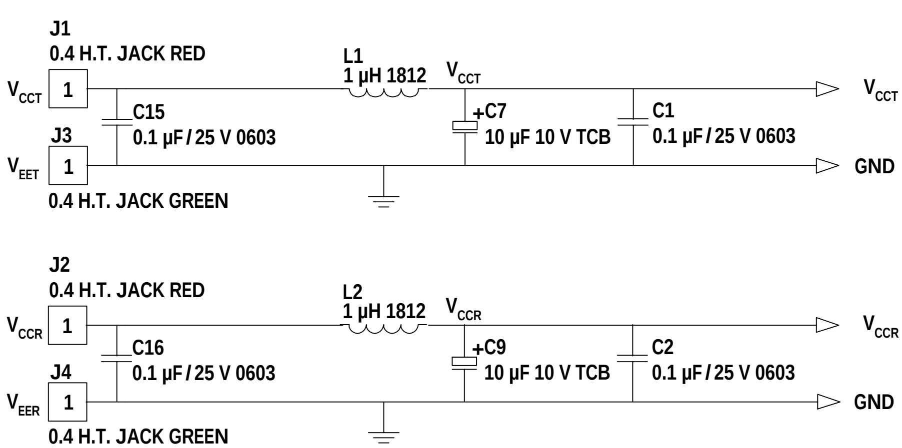

Figure 1. Power Supply Filter

Results Summary

Voltage Dependence

Tables 1a, b and c show the HFCT-594xL/G has negligible dependence on supply voltage limits of 3.1 V to 3.5 V for major parameters over the operating temperature range (0°C, +70°C).

Table 1a - V_{CC} = 3.1 V

Test Parameters	Units	Measured		
		Mean	Minimum	Maximum
Transmitter				
Icc	mA	93.3	80.0	108.0
Tx Output	dBm	-6.3	-6.9	-5.5
Mean Wavelength	nm	1325.1	1302.6	1343.6
Spectral Width	nm	1.7	1.2	2.0
Extinction Ratio	dB	12.3	11.0	13.2
Eye mask margin filtered	%	20.7	16.0	25.0
Jitter pk-pk	mUI	26.0	12.0	44.0
Jitter RMS	mUI	2.7	1.0	6.0
Unfilt. rise time	ps	50.0	33.3	69.0
Unfilt. fall time	ps	222.4	144.4	250.0
I Bias monitor	mV	80.8	28.9	139.3
Pmon monitor	mV	33.7	26.4	44.6
Receiver				
Icc	mA	111.2	108.0	115.0
Sensitivity	dBm	-25.6	-26.1	-25.2
Data Logic pk-pk	mV	709.5	686.0	734.0
SD TTL high level	V	3.0	3.0	3.0
SD TTL low level	V	0.1	0.1	0.2
SD Deasserted level	dBm	-28.8	-29.3	-28.3
SD Asserted level	dBm	-27.4	-27.8	-27.0
Hysteresis	dB	1.4	1.3	1.5
PIN Bias	µA	25.9	23.8	28.0

Table 1b - V_{CC} = 3.3 V

Test Parameters	Units	Measured		
		Mean	**Minimum**	**Maximum**
Transmitter				
Icc	mA	100.0	77.0	124.0
Tx Output	dBm	-6.1	-7.5	-5.0
Mean Wavelength	nm	1325.4	1302.9	1347.2
Spectral Width	nm	1.4	0.8	2.1
Extinction Ratio	dB	12.6	10.1	15.7
Eye mask margin filtered	%	21.0	13.0	25.0
Jitter pk-pk	mUI	26.4	9.0	54.0
Jitter RMS	mUI	2.4	1.0	7.0
Unfilt. rise time	ps	43.7	27.0	74.0
Unfilt. fall time	ps	229.1	165.0	265.5
I Bias monitor	mV	86.2	21.6	166.7
Pmon monitor	mV	33.7	17.0	50.8
Receiver				
Icc	mA	116.2	112.0	121.0
Sensitivity	dBm	-25.3	-26.3	-24.5
Data Logic pk-pk	mV	736.7	695.0	778.0
SD TTL high level	V	3.2	3.1	3.2
SD TTL low level	V	0.1	0.1	0.2
SD Deasserted level	dBm	-28.6	-29.7	-27.5
SD Asserted level	dBm	-27.2	-28.5	-26.3
Hysteresis	dB	1.4	1.1	1.7
PIN Bias	µA	24.9	22.2	28.8

Table 1c - V_{CC} = 3.5 V

Test Parameters	Units	Measured		
		Mean	Minimum	Maximum
Transmitter				
Icc	mA	98.2	84.0	113.0
Tx Output	dBm	-6.3	-6.9	-5.5
Mean Wavelength	nm	1325.4	1302.9	1344.1
Spectral Width	nm	1.8	1.3	2.2
Extinction Ratio	dB	12.8	11.4	13.5
Eye mask margin filtered	%	20.7	13.0	25.0
Jitter pk-pk	mUI	27.9	14.0	43.0
Jitter RMS	mUI	3.0	1.0	6.0
Unfilt. rise time	ps	46.6	33.0	68.0
Unfilt. fall time	ps	221.5	149.0	247.0
I Bias monitor	mV	80.8	27.8	145.0
Pmon monitor	mV	33.7	26.4	44.6
Receiver				
Icc	mA	122.1	119.0	126.0
Sensitivity	dBm	-25.7	-26.1	-25.5
Data Logic pk-pk	mV	738.5	715.0	762.0
SD TTL high level	V	3.4	3.4	3.4
SD TTL low level	V	0.1	0.1	0.2
SD Deasserted level	dBm	-29.1	-29.6	-28.5
SD Asserted level	dBm	-27.7	-28.0	-27.2
Hysteresis	dB	1.4	1.3	1.6
PIN Bias	µA	26.9	24.9	29.1

Overall Performance

Tables 2a, b and c show a summary of parametric performance at a nominal 3.3 V supply over the temperature range 0°C, +25°C and +70°C. The results show that all parameters were within data sheet limits.

Table 2a - Temperature = 0°C

Test Parameters	Units	Mean	Min	Max	Limits	
					Min	Max
Transmitter						
Icc	mA	86.0	77.0	94.0		175
Tx Output	dBm	-6.0	-7.0	-5.0	-10	-3
Mean Wavelength	nm	1310.12	1302.90	1314.80	1260	1360
Spectral Width	nm	1.30	0.85	1.70		4
Extinction Ratio	dB	12.9	11.2	15.7	8.2	
Eye mask margin filtered	%	23	19	25		
Jitter pk-pk	mUI	17.4	9.0	33.0		70
Jitter RMS	mUI	1.2	1.0	3.0		7
Unfilt. rise time	ps	42.3	27.0	74.0		
Unfilt. fall time	ps	228.1	177.8	265.5		
I Bias monitor	mV	31.27	21.60	40.10		400
Pmon monitor	mV	34.08	17.37	50.84	10	100
Receiver						
Icc	mA	113.5	112.0	116.0		140
Sensitivity	dBm	-25.6	-26.3	-25.1		-18
Data Logic pk-pk	mV	746	715	778	575	800
SD TTL high level	V	3.179	3.174	3.186	2.0	
SD TTL low level	V	0.143	0.121	0.172		0.8
SD Deasserted level	dBm	-28.9	-29.7	-28.1	-35	
SD Asserted level	dBm	-27.4	-28.5	-26.7		
Hysteresis	dB	1.5	1.2	1.7	0.5	4
PIN Bias	µA	24.52	22.23	27.60		
Overload	dBm	1.3	-0.3	2.0	-3	
Data Rise Time	ps	129.2	126.8	131.0		150
Data Fall Time	ps	120.2	118.0	123.0		150
SD Deassert Time (ON to OFF)	µs	2.0	1.5	2.9		100
SD Assert Time (OFF to ON)	µs	1.6	1.5	1.7		100

Table 2b - Temperature = +25°C

Test Parameters	Units	Mean	Min	Max	Limits	
					Min	Max
Transmitter						
Icc	mA	92.6	83.0	101.0		175
Tx Output	dBm	-6.0	-7.1	-5.1	-10	-3
Mean Wavelength	nm	1321.14	1313.18	1325.90	1260	1360
Spectral Width	nm	1.30	0.89	1.66		4
Extinction Ratio	dB	12.1	10.6	13.9	8.2	
Eye mask margin filtered	%	22	19	26		
Jitter pk-pk	mUI	17.6	8.0	33.0		70
Jitter RMS	mUI	1.2	1.0	3.0		7
Unfilt. rise time	ps	44.5	35.6	56.0		
Unfilt. fall time	ps	223.2	194.0	250.0		
I Bias monitor	mV	53.49	39.70	64.00		400
Pmon monitor	mV	33.82	17.25	50.52	10	100
Receiver						
Icc	mA	115.4	114.0	118.0		140
Sensitivity	dBm	-25.4	-26.2	-25.0		-18
Data Logic pk-pk	mV	741	709	778	575	800
SD TTL high level	V	3.173	3.170	3.178	2.0	
SD TTL low level	V	0.124	0.107	0.146		0.8
SD Deasserted level	dBm	-28.7	-29.4	-27.9	-35	
SD Asserted level	dBm	-27.3	-28.2	-26.6		
Hysteresis	dB	1.4	1.2	1.7	0.5	4
PIN Bias	µA	24.74	21.47	28.14		
Overload	dBm	1.5	-0.3	2.0	-3	
Data Rise Time	ps	131.4	128.9	134.4		150
Data Fall Time	ps	121.9	120.0	124.4		150
SD Deassert Time (ON to OFF)	µs	2.2	1.8	2.9		100
SD Assert Time (OFF to ON)	µs	1.5	1.4	1.5		100

Table 2c - Temperature = +70°C

Test Parameters	Units	Mean	Min	Max	Limits	
					Min	Max
Transmitter						
Icc	mA	114.0	103.0	124.0		175
Tx Output	dBm	-6.0	-7.5	-5.1	-10	-3
Mean Wavelength	nm	1340.67	1332.00	1347.20	1260	1360
Spectral Width	nm	1.50	0.81	2.10		4
Extinction Ratio	dB	12.5	10.1	14.6	8.2	
Eye mask margin filtered	%	20	13	24		
Jitter pk-pk	mUI	35.4	27.0	54.0		70
Jitter RMS	mUI	3.7	2.0	7.0		7
Unfilt. rise time	ps	45.0	35.0	57.0		
Unfilt. fall time	ps	230.1	165.0	255.0		
I Bias monitor	mV	141.12	118.10	166.70		400
Pmon monitor	mV	33.33	16.98	49.83	10	100
Receiver						
Icc	mA	118.9	117.0	121.0		140
Sensitivity	dBm	-25.0	-25.8	-24.5		-18
Data Logic pk-pk	mV	727	695	759	575	800
SD TTL high level	V	3.160	3.126	3.173	2.0	
SD TTL low level	V	0.107	0.096	0.120		0.8
SD Deasserted level	dBm	-28.3	-29.1	-27.5	-35	
SD Asserted level	dBm	-27.0	-27.7	-26.3		
Hysteresis	dB	1.4	1.1	1.6	0.5	4
PIN Bias	µA	25.34	22.92	28.83		
Overload	dBm	1.6	-0.1	2.0	-3	
Data Rise Time	ps	134.8	132.0	136.7		150
Data Fall Time	ps	125.4	122.4	130.0		150
SD Deassert Time (ON to OFF)	µs	2.0	1.7	3.0		100
SD Assert Time (OFF to ON)	µs	1.4	1.3	1.5		100

Receiver power supply noise immunity

Using the power supply filter shown in Figure 1, the worst case receiver noise immunity is 230 mV at 1 MHz for 1 dB degradation in sensitivity. Figure 2 shows the average noise rejection response of 5 receivers as a function of frequency.

Transmitter power supply noise immunity

The transmitter worst case immunity is 250 mV at 1 MHz for a reduction of eye mask margin to 10%. Figure 3 shows the average noise rejection response of 5 transmitters as a function of frequency.

Conclusions

The results of this characterization exercise show that the HFCT-594xL/G meets all performance requirements.

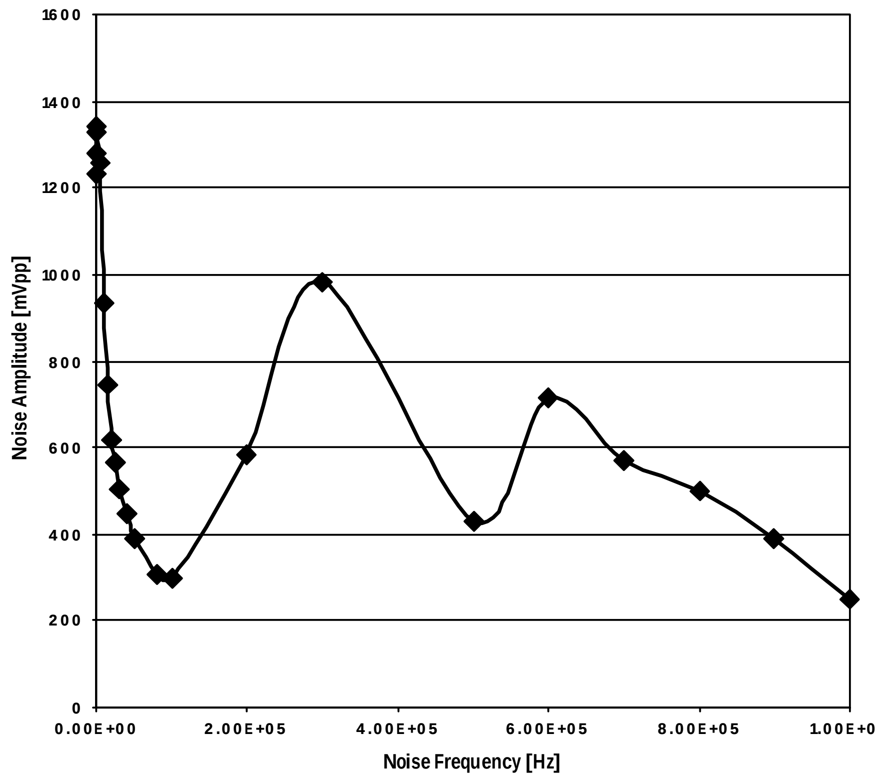

Figure 2. Receiver PSNR

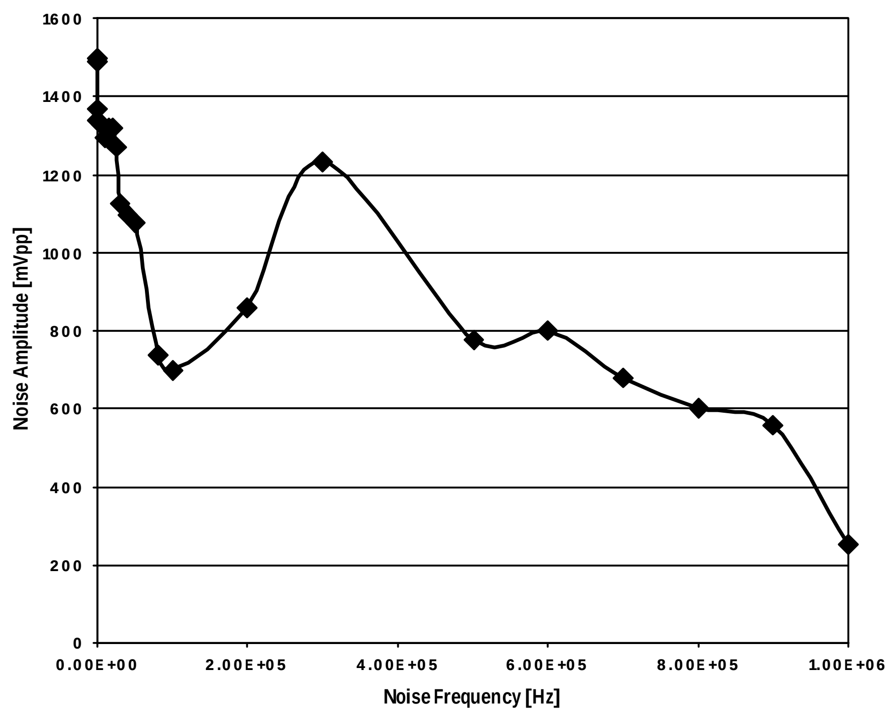

Figure 3. Transmitter PSNR

Obsoletes: 5988-3114EN
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