
Characterization Report on Fiber Optic “Light to Logic” Receiver with Clock Recovery

Application Note 1134

RGR1551

Introduction

The RGR1551 receiver is a high performance, cost effective module for serial optical data communications applications specified for a signal rate of 155 Mb/s. It is designed to provide an ATM/SONET/SDH compliant link for 155 Mb/s long reach applications. The module is intended for single mode fiber, operates at a nominal wavelength of 1300 nm and is supplied in an industry standard 20 pin package. It incorporates Hewlett-Packard's high performance, reliable, long wavelength optical devices and proven circuit technology to give long life and consistent service.

The receiver includes an InGaAs PIN photodiode and a transimpedance amplifier ac coupled to a PLL based clock recovery circuit. The Clock and Data outputs are retimed complementary PECL.

A complementary CMOS compatible low light alarm is also provided.

The characterization was performed in accordance with Bellcore Specification TA-NWT-000983.

Summary

- **The characterization demonstrates that the RGR1551 complied with the Product Specification**
- **Typical Receiver Sensitivity: -36.5 dBm**
- **RGR1551 - SONET/SDH Compliant**

This report details the characterization work performed on the RGR1551 receiver. The report evaluates the RGR1551 performance under all conditions against target parameters in the product specification. The following parameters were evaluated over the supply voltage range at -40°C, +25°C and +85°C:

- Sensitivity
- Receiver Supply Current
- Alarm On
- Alarm Off
- Alarm Hysteresis
- Maximum Input
- Jitter Tolerance.

Additionally, Clock/Data alignment results are presented.

A reference standard device which was not exposed to the environmental stress was reviewed daily to confirm measurement repeatability.

Definition of Terms

Sensitivity (dBm)

This measures the minimum received optical power which returns a bit error rate of 1×10^{-10} when operated at 155.52 Mb/s, with a pseudo random data pattern signal with worst case consecutive intersymbol duration.

Receiver Supply Current (mA)

This is the current supplied to the receiver at the stated supply voltage excluding the PECL termination resistors.

Alarm On (dBm)

This is the optical power level that causes the device's Signal Detect circuit to switch on (logic “low”) due to optical signal loss.

Alarm Off (dBm)

This is the optical power level that causes the device's Signal Detect circuit to switch off (logic “high”) when the optical power increases above Alarm On level.

Alarm Hysteresis (dB)

This is the difference between the Signal Detect Threshold value and the value at which the signal detect voltage returns to the “high state” in response to an increased optical signal.

Maximum Input (dBm)

This test checks the device functions at high optical power levels. This is carried out by taking the optical input power to the maximum level for the device and then measuring the bit error rate for 3 seconds. This should be error free to pass.

Jitter Tolerance (UIp-p)

Jitter amplitude required to increase by 1 dB, the guaranteed input signal level at which the RGR1551 will operate with a BER of 1×10^{-10} .

Temperature (°C)

The tests were conducted in a controlled environment with an

approximate airflow of 2m/s, to ensure that the devices under test had settled to the required temperature $\pm 1^\circ\text{C}$.

Characterization

General

Figure 1 depicts the Typical Test Configuration used to collect data presented in the report.

The characterization of the RGR1551 was performed using 10 devices. They were evaluated at 4.75 V, 5 V and 5.25 V over the operating temperature range (-40°C , $+25^\circ\text{C}$ and $+85^\circ\text{C}$) to confirm compliance with the product specification at the supply

voltage extremes.

The following parameters were recorded for each device:

- Sensitivity
- Receiver Supply Current
- Alarm On
- Alarm Off
- Alarm Hysteresis
- Maximum Input
- Jitter Tolerance.

Only summaries of the results are shown in this report. All results are available for inspection at Hewlett-Packard.

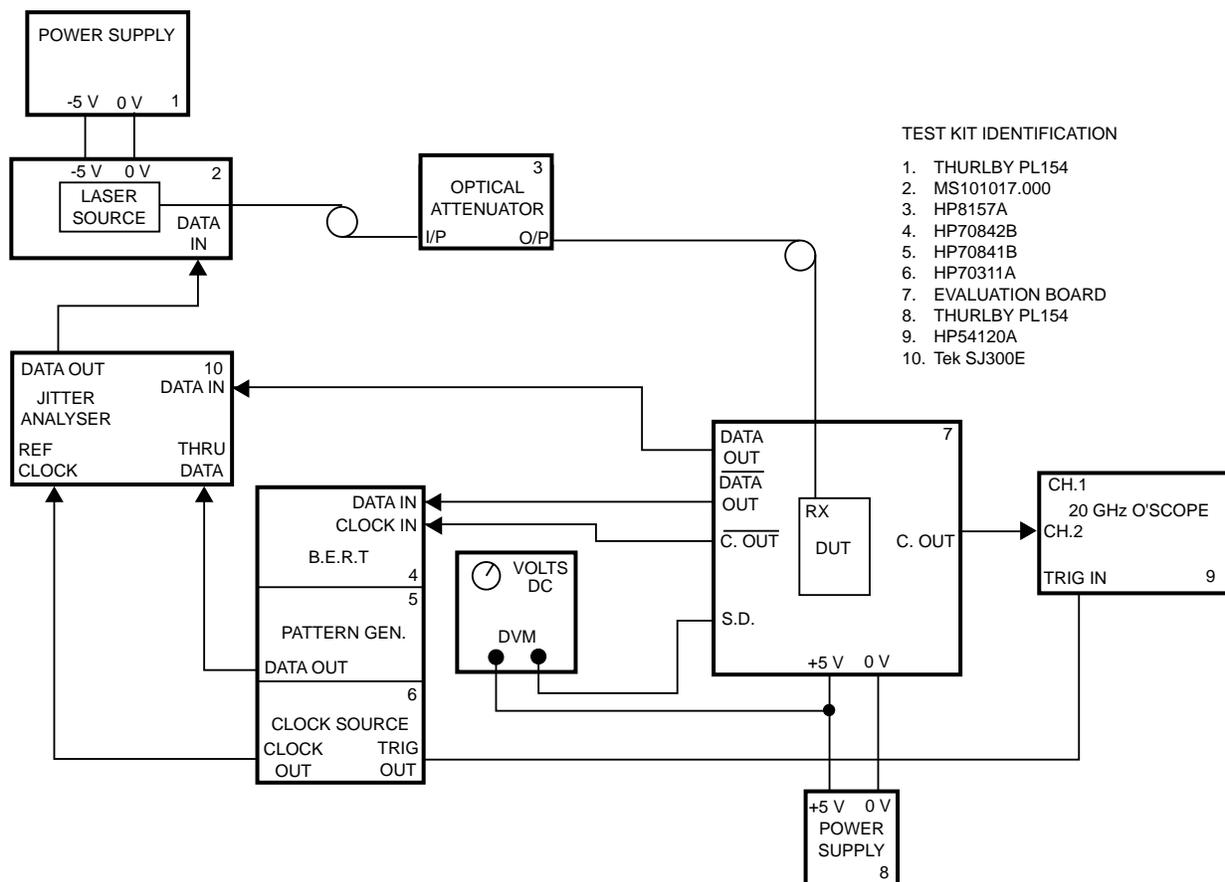


Figure 1. Typical Test Configuration

Results

Table 1 reports results from the extreme single point and mean measurements against the Product Specification over the supply range voltages (4.75 and 5.25 V) and the operating temperature range (-40°C, +25°C and +85°C).

These results demonstrate that the RGR1551 remains within the product specification at the extreme supply voltages over the operating temperature range. Appendix A contains a more

complete set of data featuring results taken for each parameter at all the possible combinations of voltage and temperature.

Table 2 reports the extreme single point and mean measurements against the Product Specification at 5.0 V over the operating temperature range (-40°C, +25°C and +85°C). These results demonstrate that the RGR1551 remains within the product specification at 5.0 V over the operating temperature range.

Appendix B contains a more complete set of data featuring results taken for each parameter. Results of each specific measurement are held on file at Hewlett-Packard.

Table 1. RGR1551 Maximum, minimum and mean measured parameters at $V_{CC} = 4.75$ V and 5.25 V over the operating temperature range compared to product specification limits.

Parameter	Unit	Min.	Mean	Max.	Product Specification	
					Min.	Max.
Sensitivity	dBm	-37.10	-36.62	-36.00	-	-35.0[1]
Receiver Supply Current	mA	84.00	99.71	114.00	-	130
Alarm On	dBm	-38.40	-37.78	-36.60	-45.0	-36.0
Alarm Off	dBm	-36.99	-36.50	-35.99	-	-36.0
Alarm Hysteresis	dB	1.25	1.36	1.46	0.5	7.0
Maximum Input	dBm	Pass	Pass	Pass	-7.0	-
Jitter Tolerance	UIp-p	Pass	Pass	Pass	ITU-T Compliant	

Note: 1. End of life specification.

Table 2. RGR1551 Maximum, minimum and mean measured parameters at $V_{CC} = 5.0$ V over the operating temperature range compared to product specification limits.

Parameter	Unit	Min.	Mean	Max.	Product Specification	
					Min.	Max.
Sensitivity	dBm	-37.00	-36.64	-36.15	-	-35.0[1]
Receiver Supply Current	mA	99.00	102.55	107.00	-	130
Alarm On	dBm	-38.20	-37.79	-36.60	-45.0	-36.0
Alarm Off	dBm	-36.75	-36.53	-36.17	-	-36.0
Alarm Hysteresis	dB	1.25	1.36	1.46	0.5	7.0
Maximum Input	dBm	Pass	Pass	Pass	-7.0	-
Jitter Tolerance	UIp-p	Pass	Pass	Pass	ITU-T Compliant	

Note: 1. End of life specification.

Recovered Clock and Data Alignment

Clock and Data alignment is measured as the time difference between the 50% amplitude levels on the falling edges of the clock and data output waveforms. This measurement was performed on five RGR1551 modules. Typical results of 192 ps at +25°C was recorded.

Jitter Tolerance

A typical jitter tolerance plot for the RGR1551 at -40°C, +25°C and +85°C is shown in Figure 2. The tolerance was measured with a module power supply of 5 V and is the jitter amplitude required to increase by 1 dB the input signal level at which the module will operate with a BER of 1×10^{-10} .

Conclusions

The RGR1551 characterization was completed and showed that all the critical parameters met the Product Specification.

Figure 2a. -40°C, 5 V

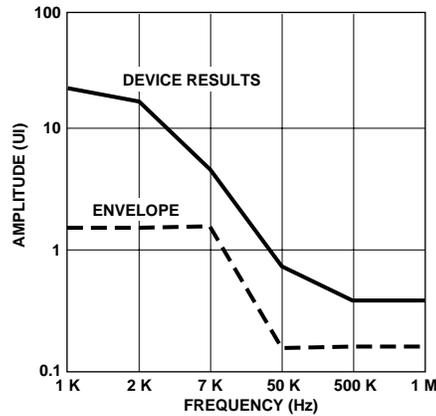


Figure 2b. +25°C, 5 V

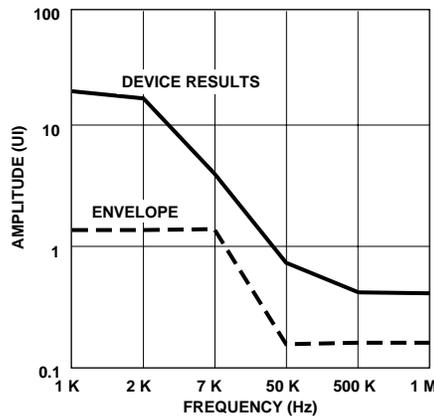


Figure 2c. +85°C, 5 V

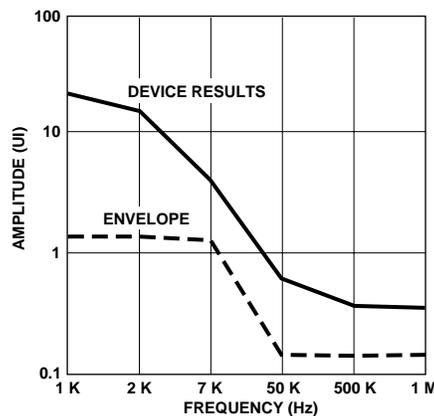


Figure 2. Jitter Tolerance for a typical device at (a) -40°C, (b) +25°C, and (c) +85°C at a supply voltage of 5 V

Appendix A. RGR1551 (10 devices) measured at +25°C, -40°C and +85°C at 4.75 V.

Characterization Results at +25°C, 4.75 V

Parameter	Units	Mean	Mean -3 σ	Mean +3 σ	Minimum	Maximum
Sensitivity	dBm	-36.72	-37.10	-36.33	-36.90	-36.50
Receiver Supply Current	mA	94.09	91.10	97.08	92.00	95.00
Alarm On	dBm	-37.64	-38.64	-36.65	-37.90	-36.70
Alarm Off	dBm	-36.38	-36.74	-36.01	-36.55	-36.08
Alarm Hysteresis	dB	1.37	1.21	1.52	1.30	1.45

Characterization Results at -40°C, 4.75 V

Sensitivity	dBm	-36.83	-37.23	-36.44	-37.10	-36.65
Receiver Supply Current	mA	85.73	82.84	88.61	84.00	87.00
Alarm On	dBm	-37.68	-38.69	-36.67	-38.00	-36.70
Alarm Off	dBm	-36.41	-36.84	-35.99	-36.66	-36.18
Alarm Hysteresis	dB	1.37	1.23	1.52	1.30	1.46

Characterization Results at +85°C, 4.75 V

Sensitivity	dBm	-36.43	-37.05	-35.82	-36.85	-36.20
Receiver Supply Current	mA	99.64	96.70	102.57	97.00	101.00
Alarm On	dBm	-37.58	-38.01	-37.15	-37.80	-37.30
Alarm Off	dBm	-36.24	-36.61	-35.86	-36.40	-35.99
Alarm Hysteresis	dB	1.34	1.21	1.46	1.30	1.41

RGR1551 (10 devices) measured at +25°C, -40°C and +85°C at 5.25 V

Characterization Results at +25°C, 5.25 V

Parameter	Units	Mean	Mean -3 σ	Mean +3 σ	Minimum	Maximum
Sensitivity	dBm	-36.59	-36.91	-36.27	-36.75	-36.40
Receiver Supply Current	mA	106.73	104.14	109.31	105.00	108.00
Alarm On	dBm	-37.91	-39.20	-36.62	-38.20	-36.60
Alarm Off	dBm	-36.69	-37.05	-36.33	-36.87	-36.40
Alarm Hysteresis	dB	1.36	1.20	1.52	1.25	1.45

Characterization Results at -40°C, 5.25 V

Sensitivity	dBm	-36.77	-37.13	-36.40	-36.90	-36.60
Receiver Supply Current	mA	99.55	95.23	103.86	97.00	102.00
Alarm On	dBm	-38.01	-39.37	-36.65	-38.40	-36.65
Alarm Off	dBm	-36.78	-37.17	-36.38	-36.99	-36.54
Alarm Hysteresis	dB	1.39	1.25	1.52	1.33	1.45

Characterization Results at +85°C, 5.25 V

Sensitivity	dBm	-36.38	-37.03	-35.73	-36.80	-36.00
Receiver Supply Current	mA	112.55	109.07	116.02	110.00	114.00
Alarm On	dBm	-37.88	-38.38	-37.38	-38.09	-37.60
Alarm Off	dBm	-36.51	-36.98	-36.05	-36.74	-36.30
Alarm Hysteresis	dB	1.35	1.27	1.43	1.30	1.40

Appendix B. RGR1551 (10 devices) measured at +25°C, -40°C and +85°C at 5.0 V.
Characterization Results at +25°C, 5.0 V

Parameter	Units	Mean	Mean -3 σ	Mean +3 σ	Minimum	Maximum
Sensitivity	dBm	-36.65	-37.03	-36.26	-36.80	-36.45
Receiver Supply Current	mA	100.73	97.84	103.61	99.00	102.00
Alarm On	dBm	-37.81	-39.04	-36.58	-38.10	-36.60
Alarm Off	dBm	-36.57	-36.82	-36.33	-36.67	-36.40
Alarm Hysteresis	dB	1.37	1.20	1.54	1.26	1.46

Characterization Results at -40°C, 5.0 V

Parameter	Units	Mean	Mean -3 σ	Mean +3 σ	Minimum	Maximum
Sensitivity	dBm	-36.82	-37.14	-36.50	-37.00	-36.65
Receiver Supply Current	mA	100.73	97.84	103.61	99.00	102.00
Alarm On	dBm	-37.82	-38.99	-36.64	-38.20	-36.65
Alarm Off	dBm	-36.60	-36.96	-36.25	-36.75	-36.40
Alarm Hysteresis	dB	1.35	1.21	1.48	1.25	1.45

Characterization Results at +85°C, 5.0 V

Parameter	Units	Mean	Mean -3 σ	Mean +3 σ	Minimum	Maximum
Sensitivity	dBm	-36.45	-37.05	-35.85	-36.85	-36.15
Receiver Supply Current	mA	106.18	103.37	108.99	104.00	107.00
Alarm On	dBm	-37.75	-38.22	-37.29	-38.00	-37.50
Alarm Off	dBm	-36.40	-36.85	-35.95	-36.65	-36.17
Alarm Hysteresis	dB	1.35	1.25	1.45	1.30	1.42

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