

Powerful Optical Modulator Driver Family for Metro and Long Haul 40G/100G Applications

by Hittite Microwave

During the past several years, Hittite Microwave has introduced a broad family of wideband optical modulator driver amplifiers to serve the exploding fiber optic data transmission market. As the demand for bandwidth increases from service providers, data centers, and enterprise networks, these power efficient, small form factor, and cost effective optical solutions will be required for use in metro, regional and long haul applications. Fiber optic modulator driver solutions from Hittite uniquely combine the attributes of compact size and reduced power dissipation, while addressing customer needs for advanced features and a selection of packaging formats. With products available in bare die and in surface mount technology (SMT) compatible formats, modulator driver solutions from Hittite are enabling some of the highest density and lowest cost fiber optic modules of today. See [Table 1](#) for a performance summary table of Hittite's latest modulator driver products.

For Very Short Reach (VSR) and Gigabit Ethernet (GbE) applications, the HMC871LC5 operates from DC to 20 GHz and is optimized for driving electroabsorption (EA) optical modulators. The HMC871LC5 operates with supply rails from +5V to +8V, while delivering 15 dB of gain and low additive jitter of 300 fs RMS for 10

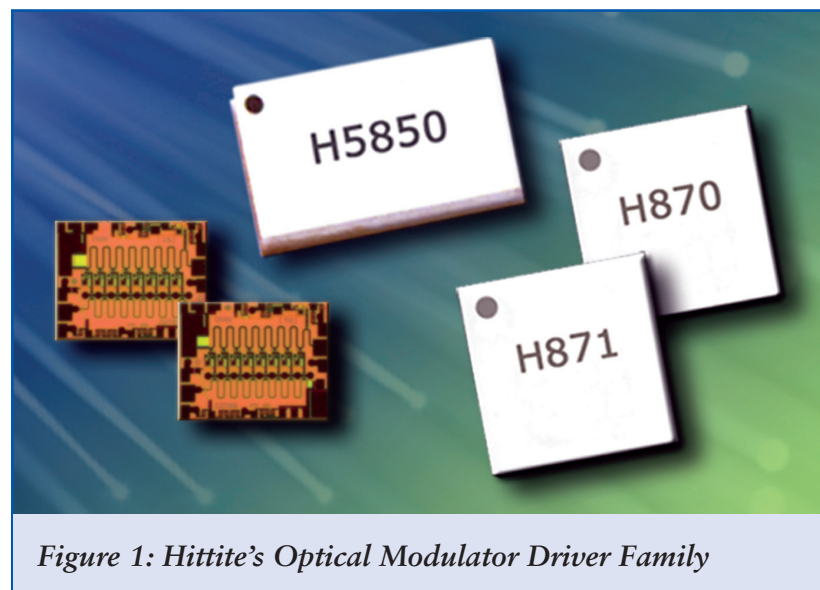


Figure 1: Hittite's Optical Modulator Driver Family

Gbps operation. Gain flatness is excellent at 0.5 dB, while the saturated output swing is 4 Vp-p, and the output swing cross point is adjustable. The HMC871LC5 provides VSR and Gigabit Ethernet designers with scalable power dissipation for varying output drive requirements. For example, the HMC871LC5 consumes less than 0.25W with 2.5 Vp-p output swing and less than 0.6W with 4 Vp-p output. The HMC871LC5 is also ideal for SONET OC-192 and SDH-STM-64 transmission systems.

For longer haul, higher output swing applications, the HMC870LC5 operates from DC to 20 GHz, and is designed specifically for driving Lithium Niobate (LiNbO₃) Mach-Zehnder (MZ) optical modulators. The HMC870LC5 operates with supply rails from +3.3V to +7V, while delivering 18 dB of gain and low additive

jitter of 300 fs RMS under 10 Gbps operation. Gain flatness is excellent at 0.5 dB, while the saturated output swing is 8 Vp-p, and the output swing cross point is adjustable. The adjustable output swing of the HMC870LC5 provides metro and long haul designers with a scalable power dissipation solution. The HMC871LC5 consumes less than 0.4W with 3.6 Vp-p output swing, and less than 1W with 8.5 Vp-p output. The HMC870LC5 is also ideal for 10 Gbps non-return-to-zero (NRZ) and 40 Gbps differential quadrature phase shift keying (DQPSK) applications.

The HMC870LC5 and HMC871LC5 exhibit group delay flatness within ± 15 ps from 1 GHz to 12 GHz signal frequency, feature edge rates of 20 ps, and exhibit excellent output slew capability over the full -40 °C to +85 °C temperature range. These

GaAs pHEMT MMIC modulator drivers incorporate RF I/Os that are internally matched to 50 Ohms, require a minimal number of external components and are housed in convenient leadless, ceramic 5 x 5 mm SMT packages. These SMT packaged optical modulator drivers support operation to 20 Gbps and also function well in broadband test & measurement applications. The output eye diagram shown in [Figure 2](#) demonstrates the performance of the HMC870LC5 with a supply rail equal to 3.3V, and an input waveform of 11.25 Gbps at 0.5 Vp-p.

For module applications which require high performance modulator drivers in bare die form, Hittite offers the HMC1050 and HMC1051 GaAs pHEMT MMIC distributed amplifiers which are rated for operation to 30 GHz. The HMC1050 modulator driver/wideband amplifier provides 14 dB of gain, and +14 dBm of output power at 1 dB gain compression. When stimulated with 32Gbps 2³¹-1 PRBS NRZ data, an output voltage swing of 2.8 Vp-p is obtained from a 500 mVp-p input signal. The HMC1050 is suitable for a variety of wideband electronic warfare systems and test & measurement applications including NRZ applications up to 32 Gbps, and may also be used as a pre-driver or a receive chain gain block.

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Data Rate Max. (Gbps)	Function	Gain (dB)	Group Delay Variation (ps)	Additive Jitter (ps)	Output Voltage Max. (Vp-p)	Package	ECCN Code	Part Number
22.5	8 Vpp Optical Modulator Driver	18	± 15	0.3	8	LC5	EAR99	HMC870LC5
22.5	3 Vpp Optical Modulator Driver	15	± 15	0.3	3	LC5	EAR99	HMC871LC5
32	3 Vpp Optical Modulator Driver, Die, with PDF	14	± 5	0.3	3	Chip	EAR99	HMC1050
32	8 Vpp Optical Modulator Driver, Die, with PDF	16	± 5	0.3	8	Chip	EAR99	HMC1051
NEW! 32	8 Vpp Optical Modulator Driver, SMT Package	32	± 7	0.25	8	BGA	EAR99	HMC5850BG

Table 1: Performance summary table for Hittite's Optical modulator Driver Family

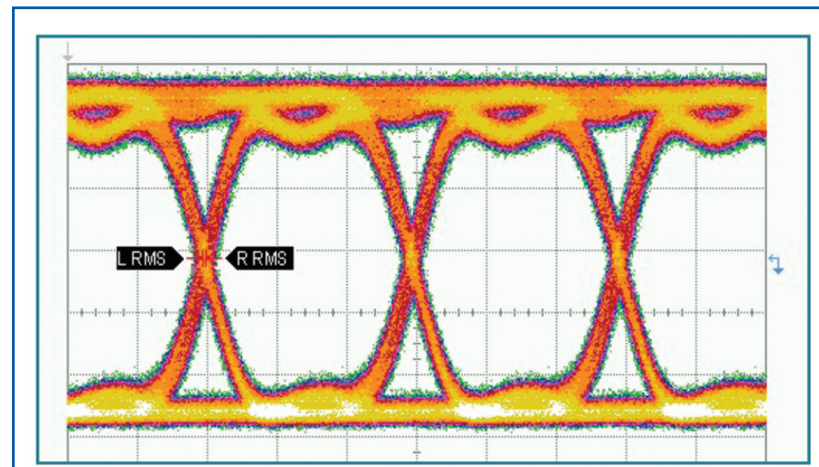
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The HMC1051 modulator driver/wideband amplifier provides 16 dB of gain, and +20 dBm of output power at 1 dB gain compression. When stimulated with 32 Gbps 2^{31} -1 PRBS NRZ data, an output voltage swing of 8.0 V_{p-p} is achieved with a 1.25 V_{p-p} input signal. The HMC1051 is suitable for a variety of wideband electronic warfare systems and test & measurement applications including NRZ transmission rates to 32 Gbps.

Both the HMC1050 and the HMC1051 operate from a range of supply rail values from +5V to +7V, while their integrated peak-detect function (PDF) allows output power stability for calibration and field monitoring. These compact MMIC die incorporate RF input / output ports which are internally matched to 50 Ohms for simplified integration into multi-chip-modules (MCMs). Both the HMC1050 and HMC1051 are intended for driving a Mach-Zehnder optical modulator with electrical NRZ data.

In order to address the most demanding fiber optic and networking applications, Hittite has released the industry's lowest power and smallest form factor SMT packaged optical modulator driver solution. The HMC5850BG operates from DC to 30 GHz, and was developed specifically for 40 Gbps and 100 Gbps Mach-Zehnder optical modulator driver applications. The HMC5850BG 40/100G optical modulator driver is a highly integrated and highly efficient modulator driver solution. Next generation 100G optical dense wavelength division multiplexing (DWDM) networks will benefit from the HMC5850BG which consumes 35% less power and is 40% smaller than competing solutions; furthermore, these benefits are realized with no compromise in system performance.

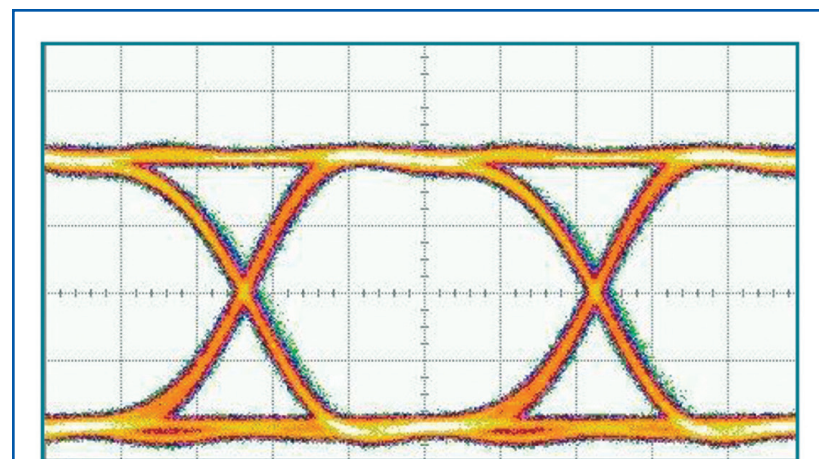
The HMC5850BG is a multi-chip module solution which delivers greater than 20 dB of gain across a wide frequency



	Measurements			
	Current	Min.	Max.	Units
Eye Amplitude	3.6	3.6	3.6	V
Rise Time	20	20	20	ps
Jitter RMS	1.893	1.87	2.072	ps

Time Scale: 30 ps/div
Amplitude Scale: 762 V/div

Figure 2: Output Eye Diagram for HMC870LC5 MZ Optical Modulator Driver at 11.25 Gbps



	Measurements			
	Current	Min.	Max.	Units
Eye Amplitude	7.94	7.94	7.94	V
Rise Time	12	12	12.22	ps
Jitter RMS	4.667	2.889	4.667	ps

Time Scale: 10.0 ps/div
Amplitude Scale: 2.00 V/div

Figure 3: Output Eye Diagram for HMC5850BG 40/100G MZ Optical Modulator Driver at 21.5 Gbps

range, enabling it to replace two separate gain stages in a 100G DWDM transmit path application. The integrated peak-detect function (PDF) allows the customer to calibrate the output level of the modulator driver and to remotely monitor the status of the transmit chain while operating in the field. With a wide supply operating range from +5V to +7V, the HMC5850BG is an environmentally friendly solution which provides long haul system designers with scalable

power dissipation options for varying output drive requirements. The HMC5850BG will consume as little as 0.9W of power with a 7 V_{p-p} output swing, or it can be driven to provide 8 V_{p-p} output swing while consuming only 1.3W. In order to assure robust operation throughout the manufacturing process, the HMC5850BG incorporates on-board ESD protection. The output eye diagram shown in Figure 3 demonstrates the performance of the HMC5850BG with V_{dd} = +6V,

and an input waveform of 0.5 V_{p-p} amplitude and a data rate of 21.5 Gbps.

The HMC5850BG modulator driver can be operated with data rates as high as 32 Gbps, and exhibits very low additive rms jitter of 230 fs. The HMC5850BG also features output swing and eye crossing adjustments, both of which can be further simplified by using Hittite's DC power management products such as the HMC981LP3E Active Bias Controller. The HMC5850BG has demonstrated successful interoperation at 32 Gbps with a high performance multiplexer (MUX) from a leading supplier.

The highly integrated HMC5850BG is a user-friendly solution which incorporates an internal bias tee, requires very few external components, and features RF input/output ports that are internally matched to 50 Ohms. This advanced modulator driver is rated for operation from -40 °C to +85 °C, and is packaged in a 9.75 mm x 6 mm x 3.29 mm laminate substrate based, ball grid array (BGA) surface-mount package.

Module designers and equipment manufacturers who are involved in the development of fiber optic and networking equipment will welcome the performance and power flexibility offered by Hittite's modulator driver solutions. Having the ability to tailor the output swing and the power consumption for each application, fiber hardware designers will find multiple applications for a single device, thereby reducing cost and simplifying component count. Samples and evaluation PC boards for all SMT packaged products are available from stock and can be ordered via the company's e-commerce site or via direct purchase order. Released data sheets are available on-line at www.hittite.com. For more information, please contact FO@hittite.com.

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