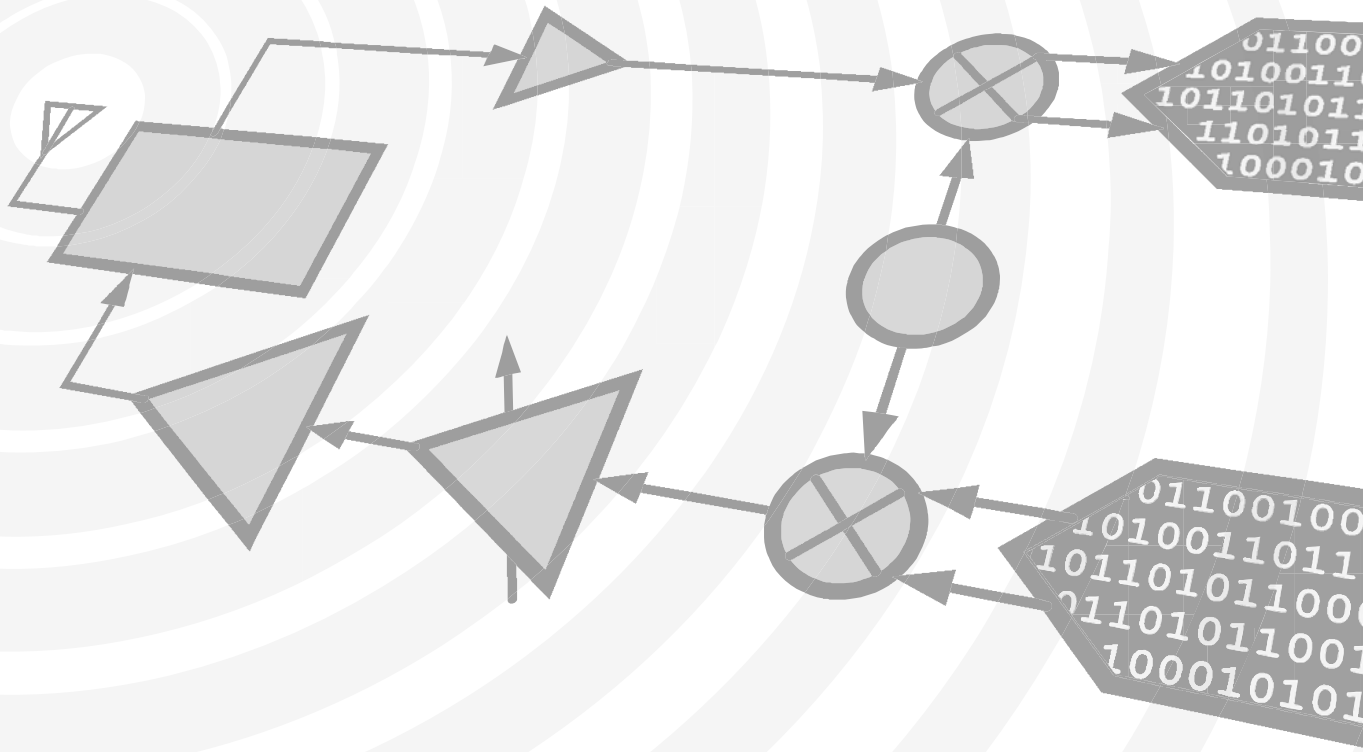
ANALOG DEVICES

Hittite
MICROWAVE PRODUCTS
FROM ANALOG DEVICES

# Analog Devices Welcomes Hittite Microwave Corporation

**NO CONTENT ON THE ATTACHED DOCUMENT HAS CHANGED**



www.analog.com

www.hittite.com

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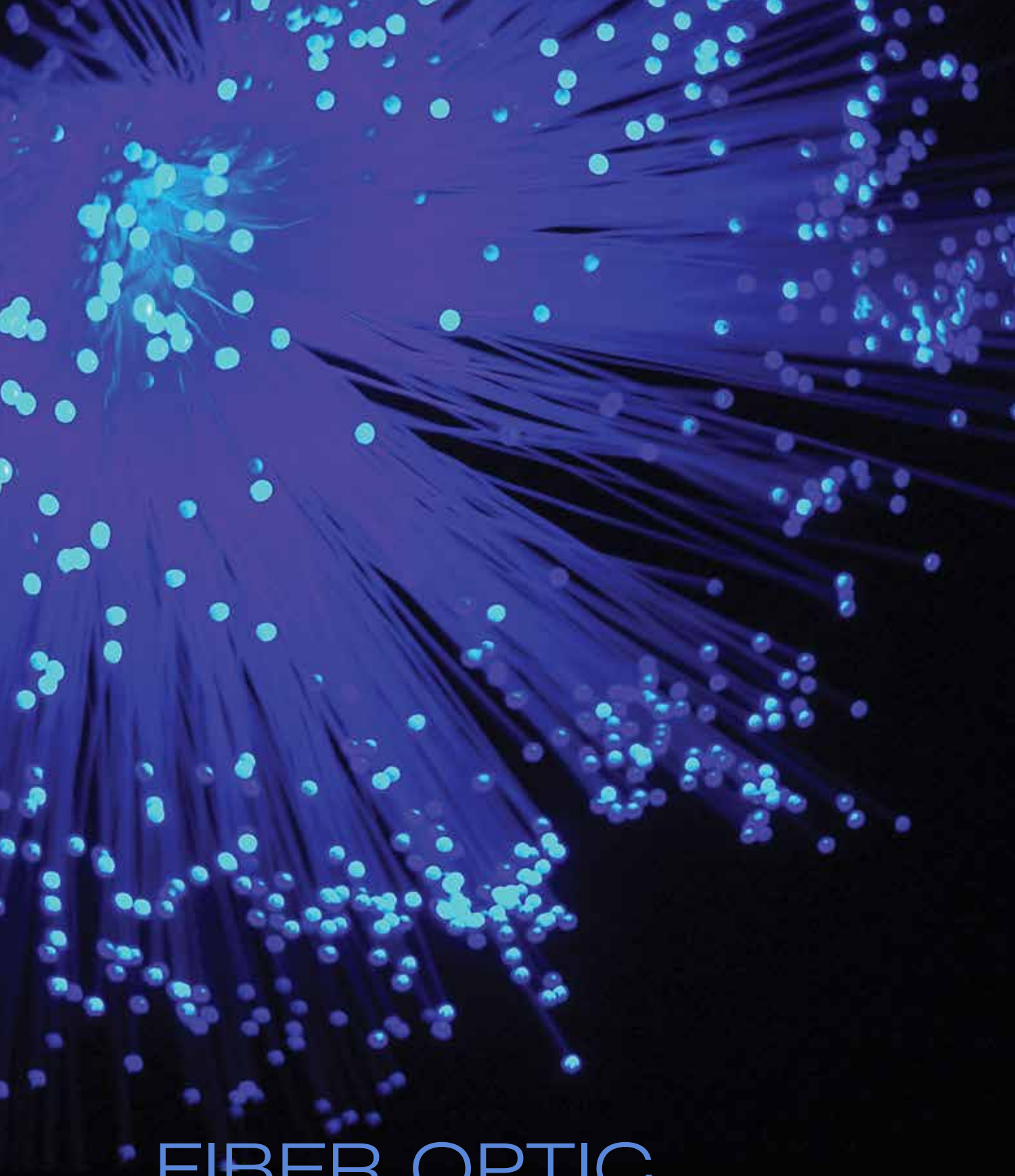


# FIBER OPTIC

## SOLUTIONS TO 100 GBPS

Hittite
MICROWAVE CORPORATION

■ 40G / 100G Long-Haul and Metro Networks ■ 100G Optical Ethernet Solutions ■ 32G Fiber Channel, Infiniband-EDR ■ 100G Active Optical & Copper Cables ■ Network & Storage Systems ■ Timing and Frequency Generation ■ Broadband Test & Measurement

# FIBER OPTIC
## COMMUNICATIONS

Having built a strong reputation for technical innovation and product quality, **Hittite Microwave** has developed a broad portfolio of fiber optic and networking products. Our products meet the demanding requirements of high-speed communication and test applications.

**Table of Contents**

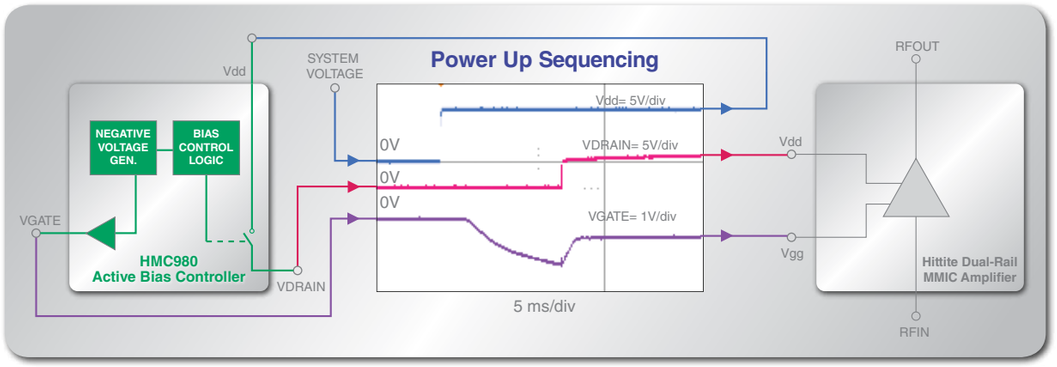

Active Bias Controller . . . . . 4
Broadband Time Delay . . . . . 6
Clock & Timing ICs . . . . . 8
Crosspoint Switch . . . . . 10
High Speed Logic . . . . . 12
Optical Modulator Driver . . . . . 14
Signal Conditioner . . . . . 16
Transimpedance Amplifier . . . . . 18
Worldwide Sales . . . . . Back Cover


Hittite MICROWAVE CORPORATION

# ACTIVE BIAS CONTROLLER

**HMC980**
**High Current, Accepts +5.0 to +16.5V Supply Range**

- Automatic gate voltage adjustment – *No calibration required*
- Ideal for both enhancement and depletion mode devices
- Able to sink or source up to 4 mA of gate current
- Internal negative voltage generation
- Over/Under current alarm with built-in hysteresis




| Part Number | Supply Range (V) | Function | VDRAIN Range (V) | IDRAIN Bias Current (mA) | IGATE Drive Current (mA) | VGATE Range (V) | Over/Under IDRAIN Current Alarm | Package |
|---|---|---|---|---|---|---|---|---|
| **HMC920LP5E** | 5 to 16.5 | Active Bias Controller | 3 to 15 | 0 to 500 | -4 to 4 | -2.5 to 2.5 | Yes | LP5 |
| **HMC980** | 5 - 16.5 | Active Bias Controller | 5 - 16.5 | 50 - 1600 | -4 to +4 | -2.46 to +2.04 | Yes | Chip |
| **HMC980LP4E** | 5 to 16.5 | Active Bias Controller | 5 to 16.5 | 50 to 1600 | -4 to 4 | -2.46 to +2.04 | Yes | LP4 |
| **HMC981** | 4 to 12 | Active Bias Controller | 4 to 12 | 20 to 200 | -0.8 to +0.8 | -2.5 to +2.0 | – | Chip |
| **HMC981LP3E** | 4 to 12 | Active Bias Controller | 4 to 12 | 0 to 200 | -0.8 to +0.8 | -2.5 to +2.5 | – | LP3E |

**Optical Driver Amplifiers that benefit active bias controllers**

| | | | |
|---|---|---|---|
| **HMC870LC5** | **HMC1051** | **HMC5850BG** | **HMC7150LP3DE** |
| **HMC871LC5** | **HMC1068** | **HMC6282A** | **HMC7282B** |
| **HMC1050** | **HMC1069** | | |

**Ideal for power management and control in all RF, Microwave, Millimeterwave, and Fiber Optic applications**



# ACTIVE BIAS
## CONTROLLER

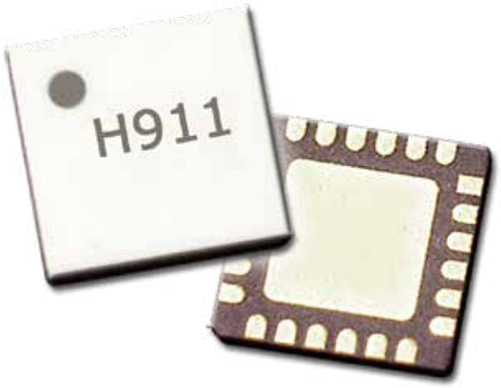
The **HMC980** is a High Current, Active Bias Controller die which is ideal for amplifier power management and control in cellular infrastructure, microwave and millimeterwave communications, fiber optic, consumer, military, space and test equipment applications.

Hittite's bias control solutions automatically adjust an amplifier's gate voltage to achieve a constant bias current over part-to-part and temperature variations. This auto-gate bias adjustment provides a significant advantage compared with discrete-based solutions since it eliminates manual calibration. Additionally, the HMC980 Active Bias Controller die offers a significant PCB area reduction by integrating negative voltage generator, automatic gate adjustment and power-up sequencing circuit blocks in a single monolithic device.

The HMC980 is designed to control amplifiers operating in Class A mode with bias currents up to 1.6A and supply voltages from 5V to 16.5V. The HMC980 Active Bias Controller die occupies less than 3.2 $mm^2$ of circuit area, requires a minimal number of external components, and incorporates an optional current alarm feature.

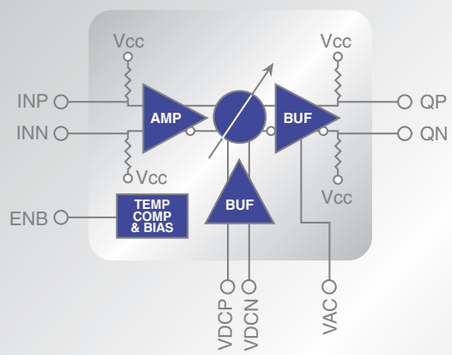
For applications which require a surface mount compatible solution, the HMC980 is also available in a 4 x 4 mm QFN plastic package as the HMC980LP4E. The HMC980 and the HMC980LP4E complement Hittite's line of DC Power Management solutions which operate with bias currents up to 2A and supplies from 3V to 16.5V.

# BROADBAND TIME DELAY

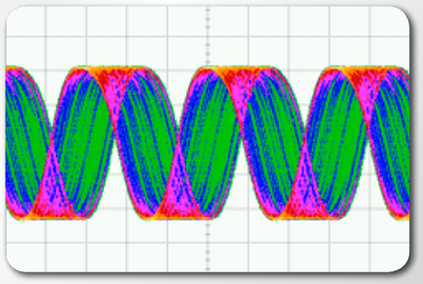



**HMC911LC4B**
**Continuous Adjustable Delay Range: 70 ps**

- Single-ended or differential operation
- Adjustable differential output voltage swing: up to 800 mVp-p
- Delay control modulation BW: 1.6 GHz
- Single supply: +3.3V




**Clock Eye Diagram, 16 GHz**



**Time Scale:** 20 ps / div
**Amplitude Scale:** 99.1 mV/div
**Test Conditions:** VCC = 3.3V, VAC = 2.6V, VDCP is varied from 2.7V to 3.3V (50% of the whole delay range)
**Input Data:** Single ended 400 mVp-p 16 GHz clock signal
**Measurement Result:** Time Delay = 37 ps

| Part Number | Data / Clock Rate (Gbps/GHz) | Function | Rise/Fall (ps) | Deterministic Jitter (ps) | Differential Output Voltage Swing (Vp-p) | DC Power Consumption (mW) | VCC Power Supply (Vdc) |
|---|---|---|---|---|---|---|---|
| **HMC877LC3** | 8 - 23 | Analog Time Delay & Phase Shifter | 10 / 11 | 0.5 - 0.95 | – | 627 | +3.3 |
| **HMC910LC4B** | 32 / 24 | Analog Time Delay | 14 / 14 | 6 | 0.1 - 0.8 | 1450 | +3.3 |
| **HMC911LC4B** | 32 / 24 | Analog Time Delay | 15 / 14 | 6 | 0.8 | 1600 | +3.3 |
| **HMC856LC5** | 28 / 28 | Digital Time Delay | 20 / 18 | <2 | 0.5 - 1.35 | 610 | -3.3 |

**Ideal for Synchronization of Clock & Data, Transponder Design, Serial Data Transmission, Broadband Test & Measurement, and RF ATE applications**



# BROADBAND
## TIME DELAY

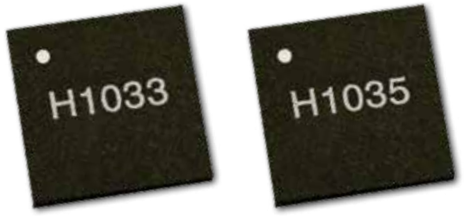
The **HMC911LC4B** is a broadband time delay with 0 to 70 ps continuously adjustable delay range. The delay control is linearly monotonic with respect to the differential delay control voltage (VDCP, VDCN), and the control input has a modulation bandwidth of 1.6 GHz.

The device provides a differential output voltage with constant amplitude for single-ended or differential input voltages above the input sensitivity level, while the output voltage swing may be adjusted using the VAC control pin.

HMC911LC4B features internal temperature compensation and bias circuitry to minimize delay variations with temperature. Output pins can be connected directly to a 50 Ohm to VCC terminated system, while DC blocking capacitors must be used if the terminated system input is 50 Ohms to a DC voltage other than VCC.

The HMC911LC4B is available in RoHS-compliant 4 x 4 mm SMT package.

# CLOCK & TIMING ICs

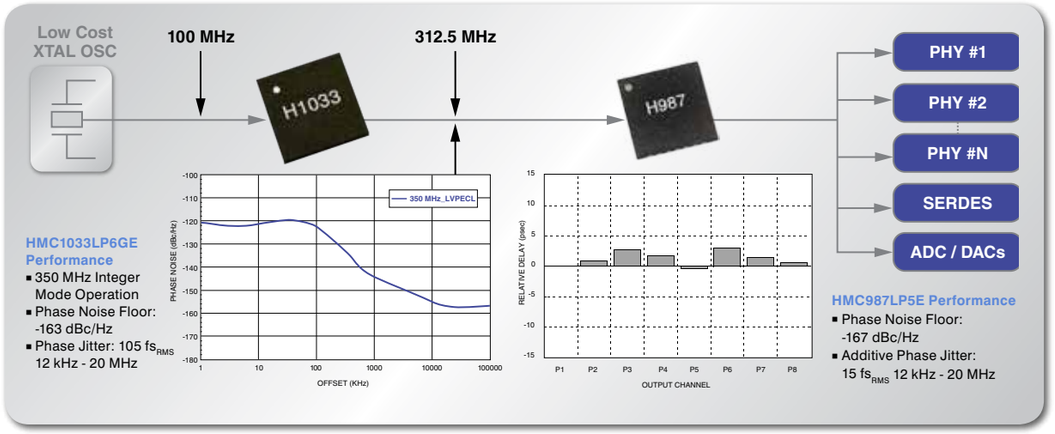


**HMC1033LP6GE / HMC1035LP6GE**
**+3.3V Clock Generators**

- <98 fs RMS jitter generation, -163 dBc/Hz phase noise floor
- 160 mA total power consumption
- "Phase Noise on Demand" feature to switch between "Power Priority" and "Performance Priority" modes
- "Exact Frequency Mode" achieves 0 Hz frequency error

**HMC987LP5E**
**1:9 Fanout Buffer, DC - 8 GHz**

- Ultra low-noise floor: -167 dBc/Hz @ 622.08 MHz
- LVPECL, LVDS, CML and CMOS compatible inputs
- Ideal for ADC/DAC applications: 65 ps rise and fall time




**Clock Distribution**

| Part Number | Max. Clock Rate (GHz) | Function | Phase Jitter (12 k - 20 MHz) | Rise/Fall Time(ps) | Channel Skew (ps) | Power Supply (V) | Package |
|---|---|---|---|---|---|---|---|
| **HMC987LP5E** | 8 | 1:9 Fanout Buffer | 8 fsRMS | 65 | 3.1 | 3.3 | LP5 |
| **HMC988LP3E** | 4 | Clock Divider & Delay Management | 13 fsRMS | 90 | 300 - 1500 Prog. Delay | 5 or 3.3 | LP3 |

**Clock Generators**

| Part Number | Max. Freq. (MHz) | Function | Typ. Phase Jitter ($fs_{RMS}$) | Phase Noise Floor (dBc/Hz) | Max. Ref. Freq. (MHz) | Typ. Power Consump. (W) | Figure of Merit (Frac/Int) (dBc/Hz) | Package |
|---|---|---|---|---|---|---|---|---|
| **HMC1031MS8E** | 500 | Integer Mode PLL (x1, x5, x10) | Defined by VCXO | Defined by VCXO | 140 | 0.005 | -208 | MS8E |
| **HMC1033LP6GE** | 550 | Clock Generator, +3.3V | 99 | -163 | 350 | 0.64 | -226 / -227 | LP6GE |
| **HMC1035LP6GE** | 2500 | Clock Generator, +3.3V | 97 | -163 | 350 | 0.57 | -226 / -227 | LP6GE |

**Ideal for Clocking ADC/DAC, SERDES, Physical Layer Devices (PHY) & FPGAs**



# CLOCK & TIMING
## INTEGRATED CIRCUITS

The **HMC1033LP6GE** is a low-noise, wide-band 3.3V clock generator IC with a fractional-N Phase Locked Loop (PLL) featuring an integrated Voltage Controlled Oscillator (VCO). The device provides differential clock outputs between 25 MHz and 550 MHz range. The low-noise Phase Detector (PD) and Delta-Sigma modulator is capable of operating at up to 100 MHz permitting wider loop-bandwidths and excellent spurious performance.

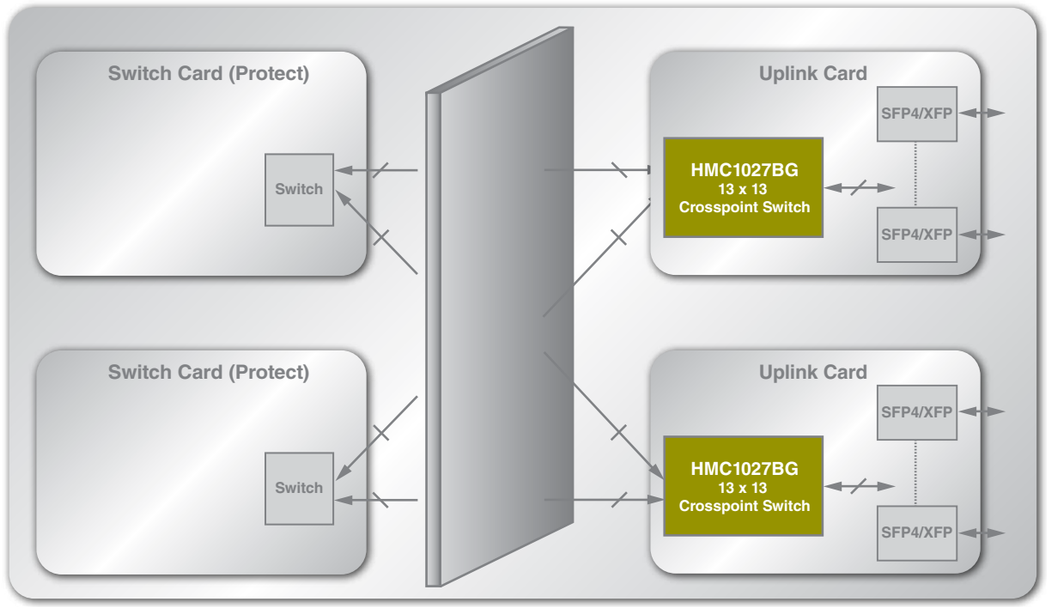
The **HMC1035LP6GE** is a low-noise, wide-band 3.3V clock generator IC, with a fractional-N Phase Locked Loop (PLL) featuring an integrated Voltage Controlled Oscillator (VCO). The device provides differential clock outputs between 25 MHz and 2500 MHz range. The low-noise Phase Detector (PD) and Delta-Sigma modulator is capable of operating at up to 100 MHz permitting wider loop-bandwidths and excellent spurious performance.

The **HMC987LP5E** 1-to-9 fanout buffer is designed for low-noise clock distribution. It is intended to generate relatively square wave outputs with rise/fall times <100 ps. The low skew and jitter outputs, combined with its fast rise/fall times, leads to controllable low-noise switching of downstream circuits such as mixers, ADCs/DACs, or SERDES devices. The noise floor is particularly important in these applications, when the clocknetwork bandwidth is wide enough to allow squarewave switching. Driven at 2 GHz, outputs have a noise floor of -166 dBc/Hz, corresponding to a jitter density of 0.6 asec/rtHz – or 50 fs over an 8 GHz bandwidth.

# CROSSPOINT SWITCH

**HMC1027BG Features**

- Low Power Operation
  - <70 mW / channel in equalization bypass mode
  - <100 mW / channel in equalization enable mode
- Single 2.5V supply operation with ability for I/O to operate at 1.8V
- Independent input and output power down options of unused channels
- Digital control via two-wire interface




| Part Number | Data Rate (Gb/s) | Function | Rise / Fall Time (ps) | Differential Output Swing (Vp-p) | DC Power Consumption/ Channel (mW) | DC Power Supply (Vdc) | Package |
|---|---|---|---|---|---|---|---|
| **HMC1027BG** | 14.2 | 13 x 13 Crosspoint Switch | 23 / 23 | 0.4 - 0.8 | <100 | 2.5V, 1.8V | BGA |
| **HMC857LC5** | 14 / 14 | 2 x 2 Crosspoint Switch | 21 / 21 | 0.5 - 1.2 | 150 | -3.3 | LC5 |

**Low-Power, High Performance, Fully Programmable**



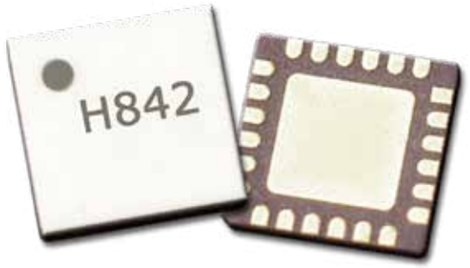
# CROSSPOINT
## SWITCH

The **HMC1027BG** is an extremely low-power, high-performance, fully programmable asynchronous 13 x 13 crosspoint switch operating with data rates up to 14.2 Gbps. It consists of a programmable input equalizer, a 13 x 13 switch, and a de-emphasis based programmable output driver. The 13 x 13 switch is fully non-blocking and it allows any input to be routed to any output, any combination of outputs, or broadcast to all outputs. The HMC1027BG performs both receive equalization (EQ) and transmit de-emphasis (DE) on all input and output channels to compensate for signal impairments due to Inter-Symbol Interference (ISI) caused by a wide variety of transmission media and channel lengths. The input equalizer can be bypassed for short links to further reduce the overall power dissipation. The 13th channel is identical to the other 12 channels and it can be used either as the 13th channel, or used for signal injection and monitoring to aid debugging during the prototyping stage.

All high-speed differential inputs and outputs of the HMC1027BG are Current Mode Logic (CML) and terminated on-chip with 50 Ohms to the positive supply, 1.8V or 2.5V, and may be DC or AC coupled. The inputs and outputs of the HMC1027BG can be operated in either single-ended or differential modes.

The low-power, high-performance and feature-rich HMC1027BG is packaged in a 169 pin and 1 mm ball pitch, 14 x 14 mm BGA package. The device uses a 2.5V core supply but the I/O can be operated at 1.8V supply to reduce the power dissipation to less than 100 mV per channel. The HMC1027BG operates over a case temperature range of -40 °C to 85 °C.

# HIGH SPEED LOGIC ICs



**HMC842LC4 Fan-Out Buffer**

- Supports Data / Clock Rates up to 45 Gbps / 28 GHz
- Fast Rise and Fall times: <12 ps
- Less than 500 fs Additive RMS Jitter
- Adjustable Differential Output Voltage Swing: 200 - 850 mVp-p

**HMC847LC5 & HMC848LC5**

- Supports Data Rates up to 45 Gbps
- Single-ended or Differential Operation
- Half Rate Clock Input
- Quarter Rate Reference Clock Output
- Fast Rise and Fall times
- Low Power Consumption: <644 mW typical

| Part Number | Data / Clock Rate (Gbps / GHz) | Function | Rise / Fall Time (ps) | Output Swing (Vp-p) | Package |
|---|---|---|---|---|---|
| HMC720LP3E | 13 / 13 | 1:2 Fanout Buffer | 19 / 18 | 0.6 - 1.1 | LP3 |
| HMC721LP3E | 13 / 13 | XOR / XNOR | 19 / 18 | 0.6 - 1.2 | LP3 |
| HMC841LC4B | 43 / 43 | D-Type Flip-Flop | 12 / 12 | 0.2 - 0.85 | LC4B |
| HMC842LC4B | 45 / 28 | 1:2 Fanout Buffer | 11 / 11 | 0.4 - 1.2 | LC4B |
| HMC843LC4B | 45 / 25 | AND / NAND / OR / NOR | 10 / 10 | 0.2 - 0.9 | LC4B |
| HMC844LC4B | 45 / 25 | XOR / XNOR | 11 / 10 | 0.2 - 8.5 | LC3C |
| HMC850LC3C | 28 / 20 | 1:2 Fanout Buffer | 16 / 15 | 0.6 - 1.1 | LC3C |
| HMC853LC3C | 28 / 28 | D-Type Flip-Flop | 15 / 14 | 0.7 - 1.3 | LC3C |
| HMC858LC4B | 14 / 14 | 2:1 Selector | 19 / 20 | 0.5 - 1.3 | LC4B |
| HMC958LC5 | 14 / 14 | 4:1 Selector | 17 / 17 | 0.5 - 1.3 | LC5 |
| HMC847LC5 | 45 / 22.5 | 4:1 Mux | 11 / 12 | 0.25 - 0.9 | LC5 |
| HMC848LC5 | 45 / 22.5 | 1:4 Demux | 25 / 21 | 0.3 - 1.0 | LC5 |
| HMC854LC5 | 28 / 14 | 4:1 Mux | 16 / 16 | 0.7 - 1.25 | LC5 |
| HMC855LC5 | 28 / 14 | 1:4 Demux | 22 / 22 | 0.45 - 1.14 | LC5 |

**Ideal for High-Speed Interface Design and Broadband Test Applications**



# HIGH SPEED LOGIC

## INTEGRATED CIRCUITS

The **HMC842LC4B** is a 1:2 Fanout Buffer designed to support data transmission rates up to 45 Gbps. The device can also operate with clock signals up to 28 GHz. During normal operation, input data (or clock) is transferred to both output channels. Differential input and output signals of the HMC842LC4B are terminated with 50 Ohms to ground on-chip, and may be either AC or DC coupled. The Outputs can be connected directly to a 50 Ohms-to-ground terminated system, while DC blocking capacitors should be used if the terminating system is 50 Ohms to a non-ground DC voltage.

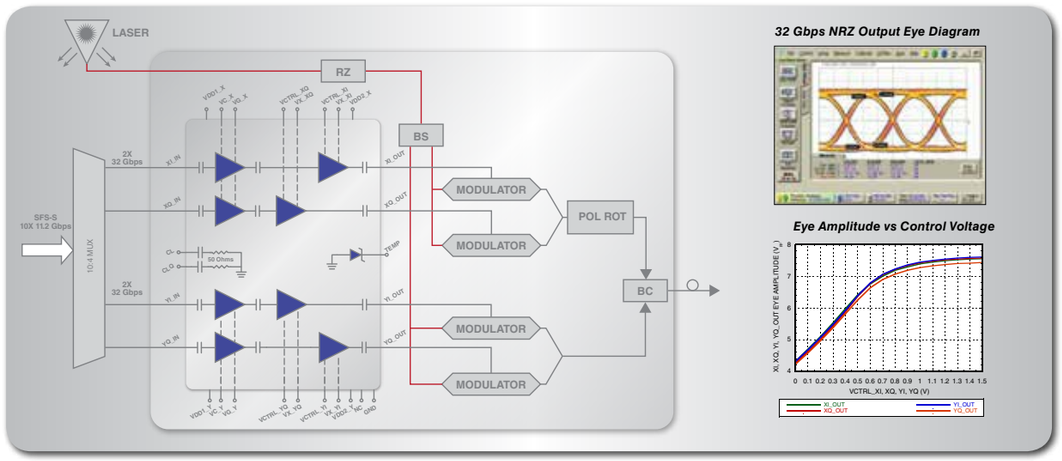
The **HMC847LC5** is a 4:1 multiplexer designed for 45 Gbps data serialization. The mux latches the four differential inputs on the transition points of the input clock. The device uses both rising and falling edges of the half-rate clock to serialize the data. A quarter-rate clock output, which is synchronous to the data output of HMC847LC5, is generated on chip.

The **HMC848LC5** is a 1:4 demultiplexer designed for data deserialization up to 45 Gbps. The device uses both rising and falling edges of the half-rate clock to sample the input data in sequence, D0-D3 and latches the data onto the differential outputs. A quarter-rate clock output generated on-chip can be used to clock the data into other devices.

# OPTICAL MODULATOR DRIVER

**HMC7282B features:**

- 4.5W power dissipation for 6.5V output voltage
- Less than 330 fs additive RMS jitter
- Fully integrated compact module with GPPO interface
- Hermetically-sealed module
- Integrated temperature sensors
- Module size: 40 x 25 x 6.5 mm




| Part Number | Data Rate (Gbps) | Function | Gain (dB) | Group Delay Variation (ps) | Additive Jitter (ps) | Output Voltage Max. (Vp-p) | Package |
|---|---|---|---|---|---|---|---|
| **HMC7282B** | 32 | Quad Optical Modulator Driver | 26 | ±3 | 0.33 | 7.4 | Module |
| **HMC1068** | 32 | 32 Gbps Optical Modulator Driver, Pre-Stage | 15 | ±5 | 0.3 | 3 | Chip |
| **HMC1069** | 32 | 32 Gbps Optical Modulator Driver | 15 | ±5 | 0.3 | 7.5 | Chip |
| **HMC5850BG** | 32 | 8 Vp-p Optical Modulator Driver, SMT Package | 29 | ±7 | 0.25 | 8 | BGA |
| **HMC6620BG** | 32 | Dual Channel Optical Modulator Driver | 30 | ±4 | 0.3 | 8 | BGA |
| **HMC6282A** | 28 | Quad Optical Modulator Driver | 26 | ±4 | 0.23 | 7.5 | Module |

| Part Number | Data Rate (Gbps) | Function | Gain (dB) | Group Delay Variation (ps) | Additive Jitter (ps) | Output Voltage Max. (Vp-p) | Package |
|---|---|---|---|---|---|---|---|
| **HMC7150LP3DE** | 28 | 28 Gbps EML Driver | 13 | ±7 | 0.27 | 2.2 | LP3D |

**Ideal for Fiber Optics Transponders and Wideband Test & Measurement**



# OPTICAL MODULATOR

## DRIVER

The **HMC7282B** is a four channel optical modulator driver amplifier module and is ideal for driving external mach-zender modulators in 100 Gbps DP-QPDK applications.

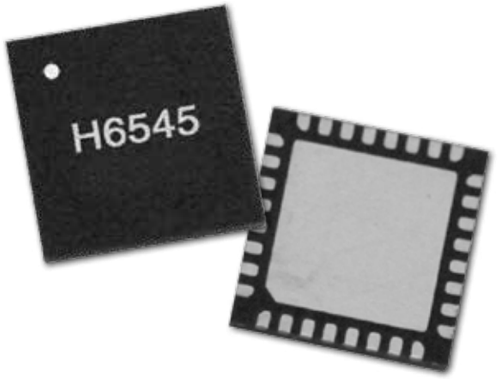
It is compliant with OIF's (Optical Interface Forum) "Integrated Polarization Multiplexed Quadrature Modulated Transmitters Implementation Agreement" and is hermetically sealed to meet stringent quality requirements of the fiber optic systems.

The device is a highly integrated connectorized module with 50 Ohm matched AC coupled RF inputs and outputs. The RF output ports are designed to withstand up to 50V DC bias voltages relative to the supply voltage in order to support varying modulator bias conditions. The supply and control voltage pins are equipped with internal de-coupling capacitors and a discrete isolated diode is incorporated in the module for temperature monitoring.

The HMC7282B can operate up to 32 Gbps and delivers up to 8 Vp-p output signal swing, exhibiting less than 0.25 psec additive jitter and ±5 psec group delay variation.

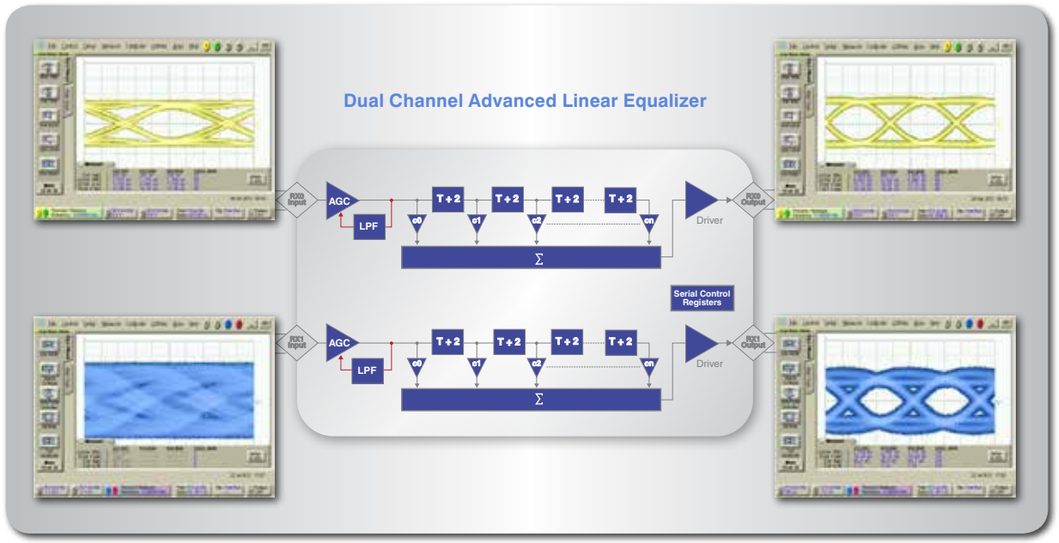
Operating on a wide supply range from 5V to 8V it features scalable power dissipation for varying output drive requirements. The HMC7282B consumes less than 4.5 W and 5.5 W, for 6.5 Vp-p and 7.5 Vp-p output voltage swing levels, respectively.

# SIGNAL CONDITIONER




**HMC6545LP5E applications:**

- 100 GbE line card and backplane
- 16G / 32G fiber channel
- 14G / 28G EDR infiniband
- 10G / 100G stress eye generation
- Broadband Test & Measurement
- Active copper & optical cables
- 6G / 12G SAS / SATA




| Part Number | Data Rate Max. (Gbps) | Function | Number of Taps | Input Sensitivity (mVp-p) | Tap Delay | Total Harmonic Distortion (%) | Package |
|---|---|---|---|---|---|---|---|
| **HMC6545LP5E** | 32 | Advanced Linear Equalizer | 9 | 40 | 18 | 5 | LP5 |

**Linear Programmable Equalizer for Backplane & Line Card Applications**



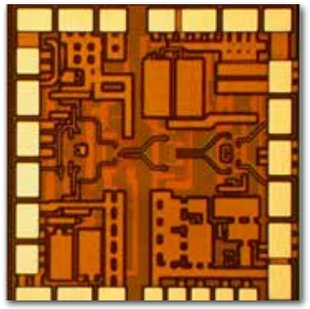
# SIGNAL CONDITIONER

The **HMC6545LP5E** is a low-power, high-performance, fully programmable dual channel asynchronous advanced linear equalizer that operates with data rates up to 32 Gbps. It is protocol and data rate agnostic.

The device can operate on the transmit path to pre-distort transmitted signal in order to invert channel distortion, or on the receiver path to equalize the distorted and attenuated received signal.

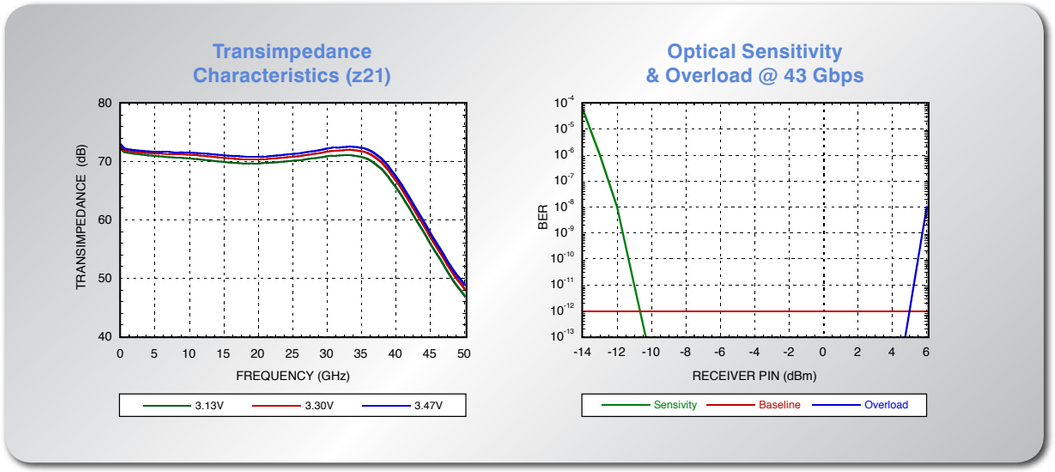
HMC6545LP5E is effective in dealing with chromatic and polarization mode dispersion and Inter-Symbol Interference (ISI) caused by wide variety of transmission media, backplane and/or fiber, and channel lengths.

# TRANSIMPEDANCE AMPLIFIER



**HMC7590 features:**

- Supports data rates up to 43 Gbps
- Internal DCA feedback with external adjustment option
- 4 kΩ differential transimpedance gain
- Low-power dissipation <300 mW
- -10.5 dBm optical input sensitivity
- +5 dBm optical overload




| Part Number | Data Rate (Gpbs) | Function | Transimpedance (kΩ) | Input Overload (mAp-p) | Small Signal Bandwidth (GHz) | Noise (pA/√Hz) | Package |
|---|---|---|---|---|---|---|---|
| **HMC799LP3E** | 0.1 - 1 | Low-noise Transimpedance Amplifier | 10 | 20 | 0.7 | 4.6 | LP3 |
| **HMC690** | 10 | Transimpedance Amplifier | 1.25 | 3 | 7.5 | 11 | Chip |
| **HMC7590** | 43 | Transimpedance Amplifier | 3.5 | 4.5 | 32 | 20 | Chip |

**Ideal for 40 GbE-FR4, 40 Gbps VSR/SFF Optical Receivers**



# TRANSIMPEDANCE AMPLIFIER

The **HMC7590** is a high-speed, high-gain, low-power limiting transimpedance amplifier (TIA) used in optical receivers with data rates up to 43 Gbps. It features low input referred noise, 36 GHz bandwidth, 4 kΩ differential small signal transimpedance and output cross point adjustment. The HMC7590 exhibits an optical input dynamic range between -10 dBm and +5 dBm while maintaining 10e-12 BER at 43 Gbps operation.

The device is available in die form, includes an on-chip VCC bypass capacitor. It requires only supply decoupling capacitor as external component.

The HMC7590 requires a single 3.3V ±5 % supply and it typically dissipates less than 300 mW. The device is characterized for operation from -5 °C to +85 °C case (IC back side) temperature.

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