



v01.0712

# HMC1032LP6GE

## CLOCK GENERATOR WITH FRACTIONAL-N PLL & INTEGRATED VCO, 125 - 350 MHz

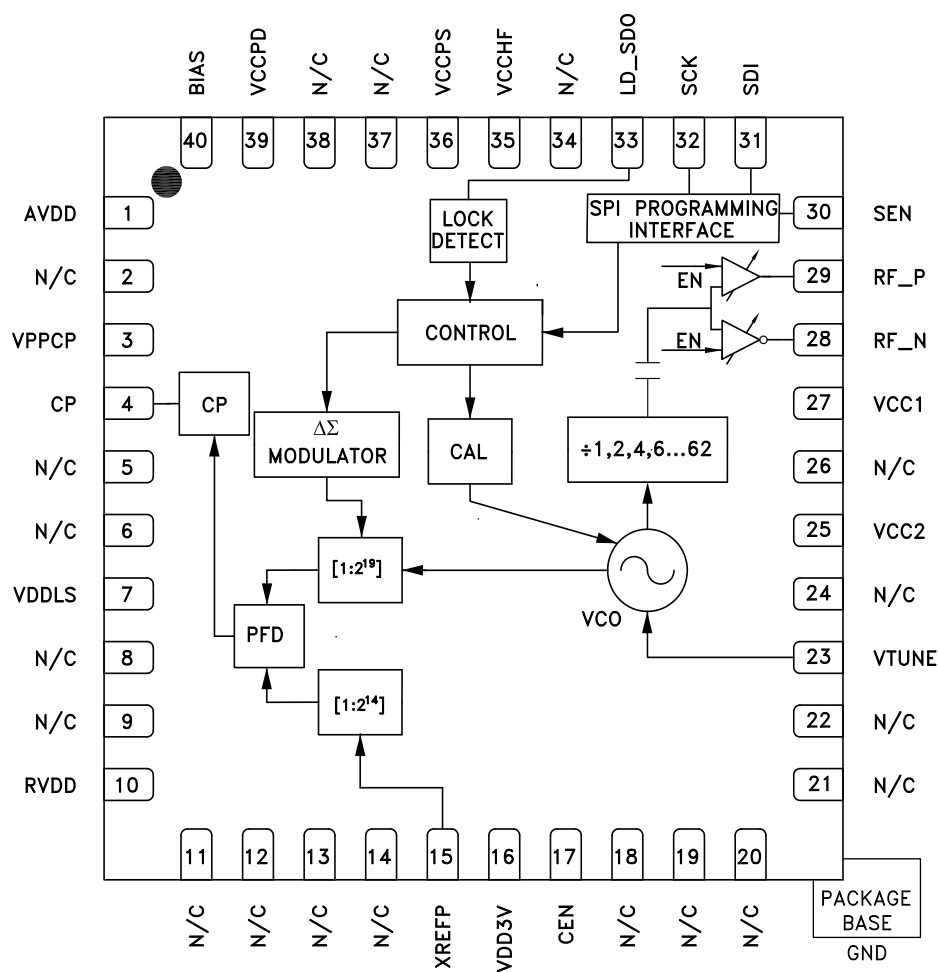
### Typical Applications

- 1G/10G Ethernet Line Cards
- OTN and SONET/SDH Applications
- High Frequency Processor Clocks
- Any Frequency Clock Generation
- Low Jitter SAW Oscillator Replacement
- Fiber Channel Interface Clocks
- Cellular/4G Infrastructure
- DDS Replacement
- Optical Modules, Transponders, Line Cards

### Features

- Frequency Range: 125 - 350 MHz
- 75 fs RMS Jitter Generation (Typical)
- Exceeds G.8251 & GR-253-CORE Jitter Specifications
- 165 dBc/Hz Phase Noise floor
- Maximum Phase Detector Rate 100 MHz
- Figure of Merit (FOM) -227 dBc/Hz
- 24-Bit Step Size, Resolution 3 Hz Typical
- Exact Frequency Mode
- Built-in Digital Self Test
- 40 Lead 6x6mm SMT Package: 36mm<sup>2</sup>

### Functional Diagram





## CLOCK GENERATOR WITH FRACTIONAL-N PLL & INTEGRATED VCO, 125 - 350 MHz

### General Description

The HMC1032LP6GE is a low-noise, wide-band clock generator IC with a fractional-N Phase Locked Loop (PLL) that features an integrated Voltage Controlled Oscillator (VCO). The device provides differential clock outputs between 125 and 350 MHz range. The HMC1032LP6GE features low noise Phase Detector (PD) and Delta-Sigma modulator, capable of operating at up to 100 MHz, permit wider loop-bandwidths with excellent spectral performance.

The HMC1032LP6GE features industry leading phase noise and jitter performance, across the operating range, that enable it to improve link level jitter performance, Bit-Error-Rates (BER) and eye diagram metrics. The superior noise floor (<-165 dBc/Hz) makes the HMC1032LP6GE an ideal source for a variety of applications –such as clock references for high speed data converters, physical layer devices (PHY), serializer/deserializer (SERDES) circuits, FPGAs and processors. The HMC1032LP6GE can also be used as reference clock and LO for 1G/10G Ethernet line cards as well as jitter attenuation and frequency translation.

The differential output of the HMC1032LP6GE includes a 2-bit output amplitude control which may be set via the SPI serial programming interface, and an output Mute function. The Delta-Sigma Modulator of the HMC1032LP6GE features Hittite's Exact Frequency Mode, which enables users to generate output frequencies with close to 0 Hz frequency error.

For theory of operation and register map refer to the [“PLLs with Integrated VCOs - RF VCOs Operating Guide”](#). To view the Operating Guide, please visit [www.hittite.com](http://www.hittite.com) and choose HMC1032LP6GE from the “Search by Part Number” pull down menu.

### Electrical Specifications, VPPCP, VDDL, VCC1, VCC2 = 5V; RVDD, AVDD, DVDD3V, VCCPD, VCCHF, VCCPS = 3.3V Min & Max Specified across Temperature -40 °C to 85 °C

| Parameter                           | Condition                                                        | Min.                    | Typ. | Max.    | Units |
|-------------------------------------|------------------------------------------------------------------|-------------------------|------|---------|-------|
| RF Output Characteristics           |                                                                  |                         |      |         |       |
| Output Frequency                    |                                                                  | 125                     |      | 350     | MHz   |
| Output Specifications               |                                                                  |                         |      |         |       |
| Output Voltage                      | Single-Ended Swing (peak-to-peak), 50 Ohm termination            | 0.25                    |      | 1.35    | Vpp   |
| Output Amplitude Control            | Gain Setting = 00, F=350 MHz                                     |                         | 330  |         | mVpp  |
|                                     | Gain Setting = 01, F=350 MHz                                     |                         | 450  |         | mVpp  |
|                                     | Gain Setting = 10, F=350 MHz                                     |                         | 675  |         | mVpp  |
|                                     | Gain Setting = 11, F=350 MHz                                     |                         | 1.01 |         | Vpp   |
| Output Common Mode Voltage          |                                                                  | AC Coupling Recommended |      |         |       |
| VCO Output Divider                  |                                                                  |                         |      |         |       |
| VCO RF Divider Range                | 1,2,4,6,8,...,62                                                 | 1                       |      | 62      |       |
| PLL RF Divider Characteristics      |                                                                  |                         |      |         |       |
| 19-Bit N-Divider Range (Integer)    | Max = 2 <sup>19</sup> - 1                                        | 16                      |      | 524,287 |       |
| 19-Bit N-Divider Range (Fractional) | Fractional Nominal Divide Ratio Varies (-3 / +4) Dynamically Max | 20                      |      | 524,283 |       |
| REF Input Characteristics           |                                                                  |                         |      |         |       |
| Max Ref Input Frequency             |                                                                  |                         |      | 350     | MHz   |
| Ref Input Voltage                   | AC Coupled <sup>[1]</sup>                                        | 1                       | 2    | 3.3     | Vp-p  |
| Ref Input Capacitance               |                                                                  |                         |      | 5       | pF    |
| 14-Bit R-Divider Range              |                                                                  | 1                       |      | 16,383  |       |

[1] Measured with 100 Ω external termination. See [Hittite PLL w/ Integrated VCOs Operating Guide](#) Reference Input Stage section for more details.

[2] Slew rate of greater or equal to 0.5 ns/V is recommended, see [PLL with Integrated RF VCOs Operating Guide](#) for more details. Frequency is guaranteed across process voltage and temperature from -40 °C to 85 °C.

[3] This maximum phase detector frequency can only be achieved if the minimum N value is respected. eg. In the case of fractional feedback mode, the maximum PFD rate = f<sub>vco</sub>/20 or 100 MHz, whichever is less.

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**CLOCK GENERATOR WITH FRACTIONAL-N PLL  
& INTEGRATED VCO, 125 - 350 MHz**
**Electrical Specifications (Continued)**

| Parameter                                                    | Condition                                                                  | Min. | Typ. | Max. | Units  |
|--------------------------------------------------------------|----------------------------------------------------------------------------|------|------|------|--------|
| <b>Phase Detector (PD) [2]</b>                               |                                                                            |      |      |      |        |
| PD Frequency Fractional Mode B                               | [3]                                                                        | DC   |      | 100  | MHz    |
| PD Frequency Fractional Mode A (and Register 6 [17:16] = 11) |                                                                            | DC   |      | 80   | MHz    |
| PD Frequency Integer Mode                                    |                                                                            | DC   |      | 125  | MHz    |
| <b>Charge Pump</b>                                           |                                                                            |      |      |      |        |
| Output Current                                               |                                                                            | 0.02 |      | 2.54 | mA     |
| Charge Pump Gain Step Size                                   |                                                                            |      | 20   |      | μA     |
| PD/Charge Pump SSB Phase Noise                               | 50 MHz Ref, Input Referred                                                 |      |      |      |        |
| 1 kHz                                                        |                                                                            |      | -143 |      | dBc/Hz |
| 10 kHz                                                       | Add 1 dB for Fractional                                                    |      | -150 |      | dBc/Hz |
| 100 kHz                                                      | Add 3 dB for Fractional                                                    |      | -153 |      | dBc/Hz |
| <b>RF_P, RF_N</b>                                            |                                                                            |      |      |      |        |
| Output Rise Time                                             | Measured from 20% to 80% of Output Signal, F=350 MHz<br>Gain Setting = 00  |      |      | 150  | ps     |
|                                                              | Measured from 20% to 80% of Output Signal, F=350 MHz<br>Gain Setting = 11  |      |      | 250  | ps     |
| Output Fall Time                                             | Measured from 80% to 20% of Output Signal, F=350 MHz<br>Gain Setting = 00  |      |      | 150  | ps     |
|                                                              | Measured from 80% to 20% of Output Signal, F=350MHz<br>Gain Setting = 11   |      |      | 250  | ps     |
| Output Duty Cycle                                            | Measured at 50% of Output Signal. F=350 MHz,<br>F=312.5 MHz & F=155.52 MHz | 47.5 |      | 52.5 | %      |
| <b>Logic Inputs</b>                                          |                                                                            |      |      |      |        |
| Vsw                                                          | Switching threshold for logic levels                                       | 40   | 50   | 60   | % DVDD |
| <b>Logic Outputs</b>                                         |                                                                            |      |      |      |        |
| VOH Output High Voltage                                      |                                                                            |      | DVDD |      | V      |
| VOL Output Low Voltage                                       |                                                                            |      | 0    |      | V      |
| Output Impedance                                             |                                                                            | 100  |      | 200  | Ω      |
| Maximum Load Current                                         |                                                                            |      |      | 1.5  | mA     |
| <b>Power Supply Voltages</b>                                 |                                                                            |      |      |      |        |
| 3.3V Supplies                                                | AVDD, VCCHF, VCCPS, VCCPD, RVDD, DVDD                                      | 3.0  | 3.3  | 3.5  | V      |
| 5V Supplies                                                  | VPPCP, VDDCP, VCC1, VCC2                                                   | 4.8  | 5    | 5.2  | V      |
| <b>Power Supply Currents</b>                                 |                                                                            |      |      |      |        |
| +5V Analog Charge Pump                                       | VPPCP, VDDCP                                                               |      | 8    |      | mA     |
| +5V VCO Core & VCO Buffer                                    | fo/1 Mode VCC2                                                             |      | 105  |      | mA     |
|                                                              | fo/N Mode VCC2                                                             |      | 80   |      | mA     |
| +5V VCO Divider & RF/PLL Buffer                              | fo/1 Mode VCC1                                                             |      | 25   |      | mA     |
|                                                              | fo/N Mode VCC1                                                             | 80   |      | 100  | mA     |
| +3.3V                                                        | AVDD, VCCHF, VCCPS, VCCPD, RVDD, DVDD3V                                    |      | 52   |      | mA     |
| Power Down - Crystal Off                                     | Reg 01h=0,<br>Crystal Not Clocked                                          |      | 10   |      | μA     |
| Power Down - Crystal On, 100 MHz                             | Reg 01h=0,<br>Crystal Clocked 100 MHz                                      |      | 5    |      | mA     |

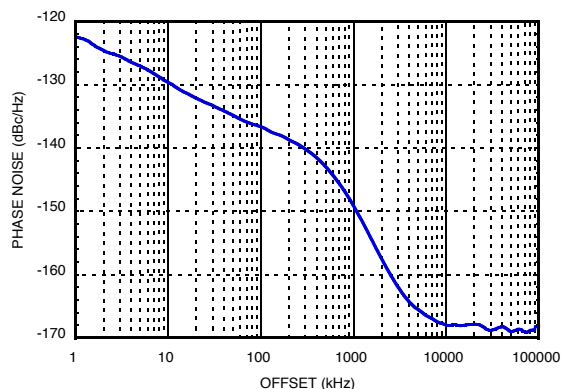

**CLOCK GENERATOR WITH FRACTIONAL-N PLL  
& INTEGRATED VCO, 125 - 350 MHz**
**Electrical Specifications** (Continued)

| Parameter                         | Condition                                                                                                                             | Min. | Typ. | Max. | Units  |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|------|------|------|--------|
| <b>Power on Reset</b>             |                                                                                                                                       |      |      |      |        |
| Typical Reset Voltage on DVDD     |                                                                                                                                       |      | 700  |      | mV     |
| Minimum DVDD Voltage for No Reset |                                                                                                                                       | 1.5  |      |      | V      |
| Power on Reset Delay              |                                                                                                                                       |      | 250  |      | µs     |
| <b>Figure of Merit</b>            |                                                                                                                                       |      |      |      |        |
| Floor Integer Mode                | Normalized to 1 Hz                                                                                                                    |      | -230 |      | dBc/Hz |
| Floor Fractional Mode             | Normalized to 1 Hz                                                                                                                    |      | -227 |      | dBc/Hz |
| Flicker (Both Modes)              | Normalized to 1 Hz                                                                                                                    |      | -268 |      | dBc/Hz |
| Phase Jitter RMS                  | Measured at 155.52 MHz,<br>Integration Bandwidth:<br>12 kHz to 20 MHz, 50 MHz<br>reference, fractional mode                           |      | 116  |      | fs     |
| Phase Jitter RMS                  | Measured at 350 MHz,<br>Integration Bandwidth:<br>12 kHz to 20 MHz<br>Charge Pump (CP) Current<br>set at 2.54 mA, 50 MHz<br>reference |      | 75   |      | fs     |

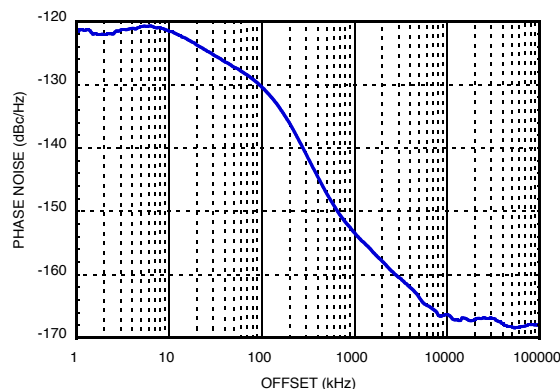


# CLOCK GENERATOR WITH FRACTIONAL-N PLL & INTEGRATED VCO, 125 - 350 MHz

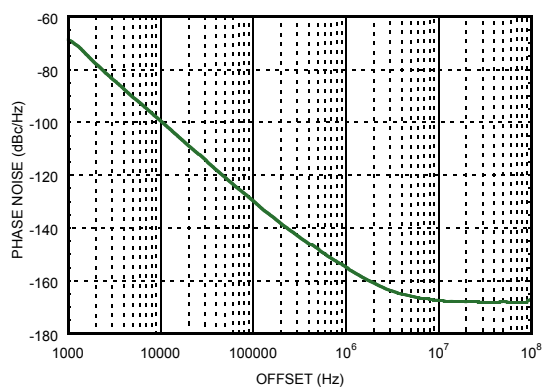
**Figure 1. Typical Closed Loop  
Integer Phase Noise @ 312.5 MHz [1]**



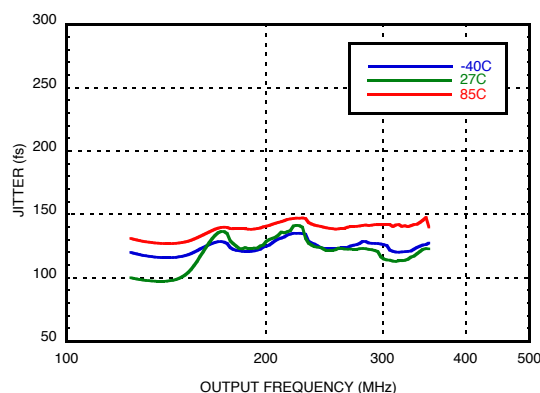
**Figure 2. Typical Closed Loop  
Fractional Phase Noise @ 312.5 MHz [2]**



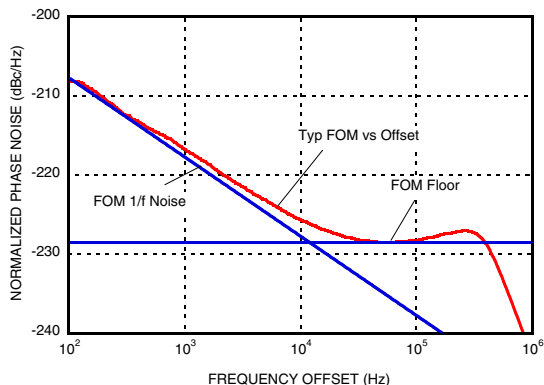
**Figure 3. Free Running Phase Noise [3]**



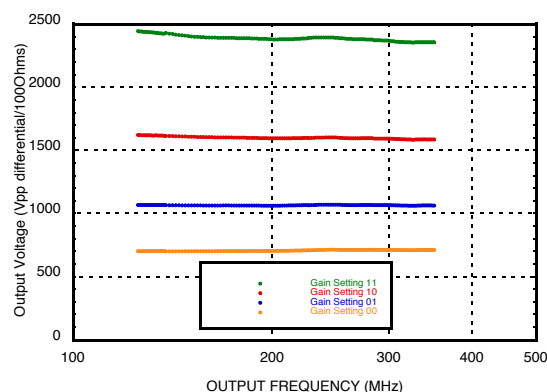
**Figure 4. Integrated RMS Jitter [4]**



**Figure 5. Figure of Merit**



**Figure 6. Typical Output Voltage**



[1] The PN plot is measured with a 50 MHz Crystal Oscillator, RMS Jitter is 72 fs with 12 kHz to 20 MHz Integrated Bandwidth

[2] The PN plot is measured with a 50 MHz Crystal Oscillator, RMS Jitter is 120 fs with 12 kHz to 20 MHz Integrated Bandwidth

[3] Free Running Phase Noise @ f<sub>out</sub> = 350 MHz

[4] RMS Jitter data is measured in fractional mode with 100 kHz Loop bandwidth using 50 MHz reference frequency from 1 kHz to 20 MHz integration bandwidth.

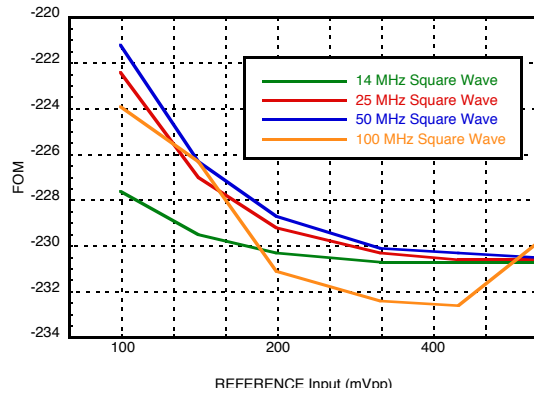
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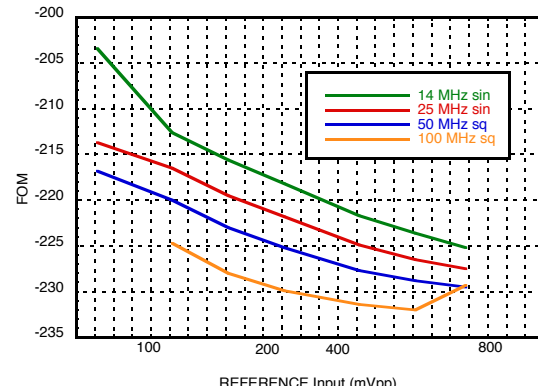


# CLOCK GENERATOR WITH FRACTIONAL-N PLL & INTEGRATED VCO, 125 - 350 MHz

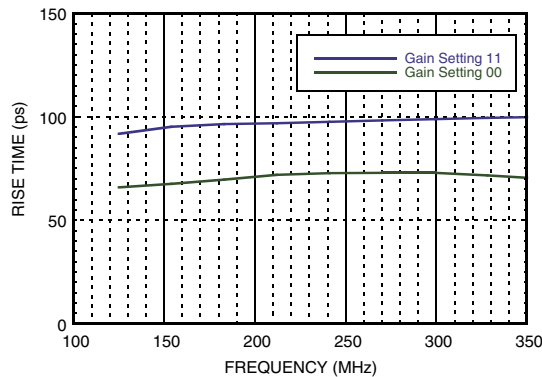
**Figure 7. Reference Input Sensitivity, Square Wave [5]**



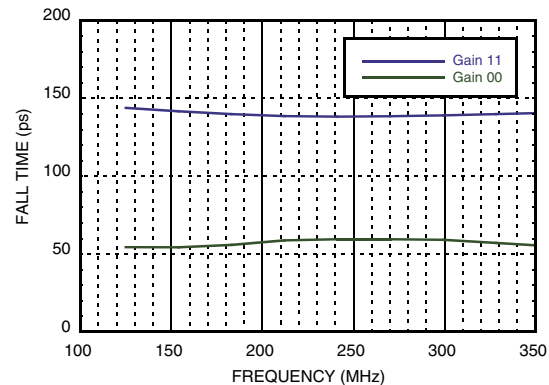
**Figure 8. Reference Input Sensitivity Sinusoid Wave [6]**



**Figure 9. Output Rise Time**



**Figure 10. Output Fall Time**



## Loop Filter Configuration Table

| Loop Filter BW (kHz) | C1 (pF) | C2 (nF) | C3 (pF) | C4 (pF) | R2 (kΩ) | R3 (kΩ) | R4 (kΩ) | Loop Filter Design |
|----------------------|---------|---------|---------|---------|---------|---------|---------|--------------------|
| 250                  | 3.9     | 15      | N/A     | N/A     | 2.7     | 0       | 0       |                    |
| 135                  | 91      | 33      | 91      | 91      | 0.82    | 1       | 1       |                    |
| 74                   | 150     | 27      | 220     | 220     | 0.82    | 1       | 1       |                    |

[5] Measured from a 50 Ω source with a 100 Ω external resistor termination. See [PLL with Integrated RF VCOs Operating Guide](#) Reference Input Stage section for more details. Full FOM performance up to maximum 3.3 Vpp input voltage.

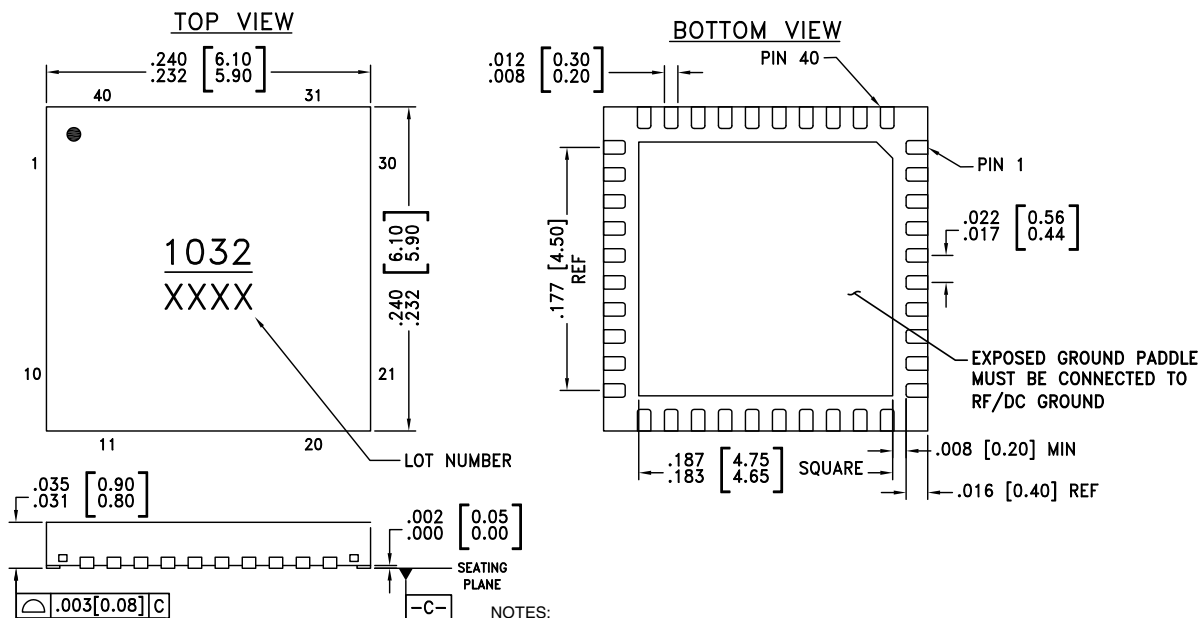
[6] Measured from a 50 Ω source with a 100 Ω external resistor termination. See [PLL with Integrated RF VCOs Operating Guide](#) Reference Input Stage section for more details. Full FOM performance up to maximum 3.3 Vpp input voltage.

**CLOCK GENERATOR WITH FRACTIONAL-N PLL  
& INTEGRATED VCO, 125 - 350 MHz**

**Absolute Maximum Ratings**

|                                                                      |                |
|----------------------------------------------------------------------|----------------|
| AVDD, RVDD, DVDD3V, VCCPD, VCCHF, VCCPS                              | -0.3V to +3.6V |
| VPPCP, VDDCP, VCC1                                                   | -0.3V to +5.5V |
| VCC2                                                                 | -0.3V to +5.5V |
| Operating Temperature                                                | -40°C to +85°C |
| Storage Temperature                                                  | -65°C to 150°C |
| Maximum Junction Temperature                                         | 125 °C         |
| Thermal Resistance (R <sub>TH</sub> )<br>(junction to ground paddle) | 20 °C/W        |
| Reflow Soldering                                                     |                |
| Peak Temperature                                                     | 260°C          |
| Time at Peak Temperature                                             | 40 sec         |
| ESD Sensitivity (HBM)                                                | Class 1B       |

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Outline Drawing**

**Package Information**

| Part Number  | Package Body Material                              | Lead Finish   | MSL Rating | Package Marking <sup>[1]</sup> |
|--------------|----------------------------------------------------|---------------|------------|--------------------------------|
| HMC1032LP6GE | RoHS-compliant Low Stress Injection Molded Plastic | 100% matte Sn | MSL1       | H1032<br>XXXX                  |

[1] 4-Digit lot number XXXX

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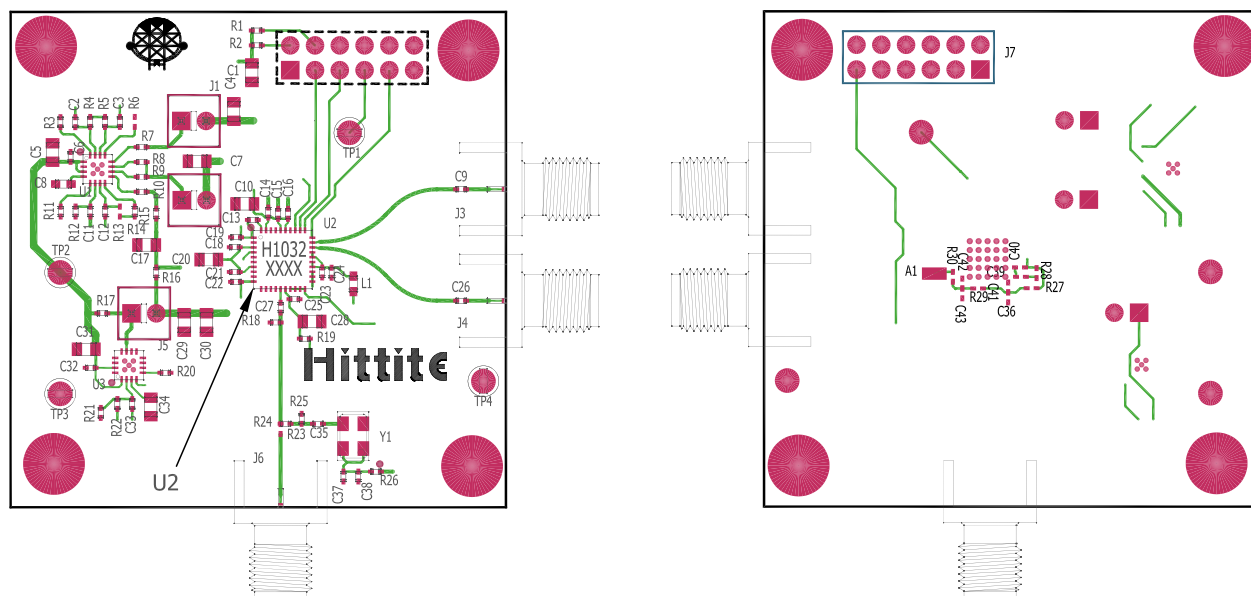
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# **CLOCK GENERATOR WITH FRACTIONAL-N PLL & INTEGRATED VCO, 125 - 350 MHz**

## **Pin Descriptions**

| Pin Number                                                | Function | Description                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                                                         | AVDD     | DC Power Supply for analog circuitry.                                                                                                                                                                                                                                                  |
| 2, 5, 6, 8, 9,<br>11 - 14, 18 - 22, 24,<br>26, 34, 37, 38 | N/C      | The pins are not connected internally; however, all data shown herein was measured with these pins connected to RF/DC ground externally.                                                                                                                                               |
| 3                                                         | VPPCP    | Power Supply for charge pump analog section                                                                                                                                                                                                                                            |
| 4                                                         | CP       | Charge Pump Output                                                                                                                                                                                                                                                                     |
| 7                                                         | VDDL5    | Power Supply for the charge pump digital section                                                                                                                                                                                                                                       |
| 10                                                        | RVDD     | Reference Supply                                                                                                                                                                                                                                                                       |
| 15                                                        | XREFP    | Reference Oscillator Input                                                                                                                                                                                                                                                             |
| 16                                                        | DVDD3V   | DC Power Supply for Digital (CMOS) Circuitry                                                                                                                                                                                                                                           |
| 17                                                        | CEN      | Chip Enable. Connect to logic high for normal operation.                                                                                                                                                                                                                               |
| 23                                                        | VTUNE    | VCO Varactor. Tuning Port Input.                                                                                                                                                                                                                                                       |
| 25                                                        | VCC2     | VCO Analog Supply 2                                                                                                                                                                                                                                                                    |
| 27                                                        | VCC1     | VCO Analog Supply 1                                                                                                                                                                                                                                                                    |
| 28                                                        | RF_N     | Negative Output Signal (Differential)                                                                                                                                                                                                                                                  |
| 29                                                        | RF_P     | Positive Output Signal (Differential) (Default = Off; Single-Ended Operation)                                                                                                                                                                                                          |
| 30                                                        | SEN      | PLL Serial Port Enable (CMOS) Logic Input                                                                                                                                                                                                                                              |
| 31                                                        | SDI      | PLL Serial Port Data (CMOS) Logic Input                                                                                                                                                                                                                                                |
| 32                                                        | SCK      | PLL Serial Port Clock (CMOS) Logic Input                                                                                                                                                                                                                                               |
| 33                                                        | LD_SDO   | Lock Detect, or Serial Data, or General Purpose (CMOS) Logic Output (GPO)                                                                                                                                                                                                              |
| 35                                                        | VCCHF    | DC Power Supply for Analog Circuitry                                                                                                                                                                                                                                                   |
| 36                                                        | VCCPS    | DC Power Supply for Analog Prescaler                                                                                                                                                                                                                                                   |
| 39                                                        | VCCPD    | DC Power Supply for Phase Detector                                                                                                                                                                                                                                                     |
| 40                                                        | BIAS     | External bypass decoupling for precision bias circuits.<br>Note: 1.920V $\pm$ 20mV reference voltage (BIAS) is generated internally and cannot drive an external load. Must be measured with 10G $\Omega$ meter such as Agilent 34410A, normal 10M $\Omega$ DVM will read erroneously. |

**CLOCK GENERATOR WITH FRACTIONAL-N PLL  
& INTEGRATED VCO, 125 - 350 MHz**
**Evaluation PCB**

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Hittite upon request.

**Evaluation PCB Schematic**

To view this [Evaluation PCB Schematic](http://www.hittite.com) please visit [www.hittite.com](http://www.hittite.com) and choose HMC1032LP6GE from the "Search by Part Number" pull down menu to view the product splash page.

**Evaluation Order Information**

| Item                | Contents                                                                                                                                                                                               | Part Number         |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| Evaluation PCB Only | HMC1032LP6GE Evaluation PCB                                                                                                                                                                            | EVAL01-HMC1032LP6GE |
| Evaluation Kit      | HMC1032LP6GE Evaluation PCB<br>USB Interface Board<br>6' USB A Male to USB B Female Cable<br>CD ROM (Contains User Manual, Evaluation PCB Schematic, Evaluation Software, Hittite PLL Design Software) | EKIT01-HMC1032LP6GE |

## CLOCK GENERATOR WITH FRACTIONAL-N PLL & INTEGRATED VCO, 125 - 350 MHz

### HMC1032LP6GE Output Stage

A representative schematic for the HMC1032LP6GE output stage is given in Figure 11 below. The differential output buffer features adjustable amplitudes which can be set by the "Gain Setting" register values. The typical output amplitudes that correspond to each setting are provided in Figure 6.

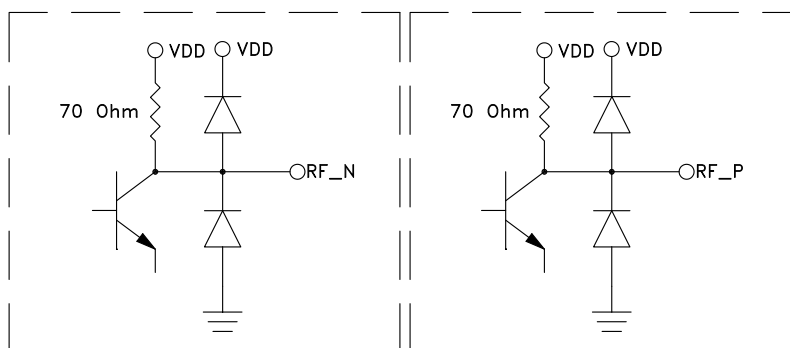


Figure 11. HMC1032LP6GE output stage

### HMC1032LP6GE Application Information

The HMC1032LP6GE features a flexible Output Frequency Range (125 MHz to 350 MHz), industry leading phase noise and phase jitter performance, excellent noise floor ( $< -170$  dBc/Hz), and a high level of integration. HMC1032LP6GE is ideal as a high frequency, low jitter processor clock, a clock source for high-frequency data converters or a reference oscillator for Physical Layer Devices (PHY).

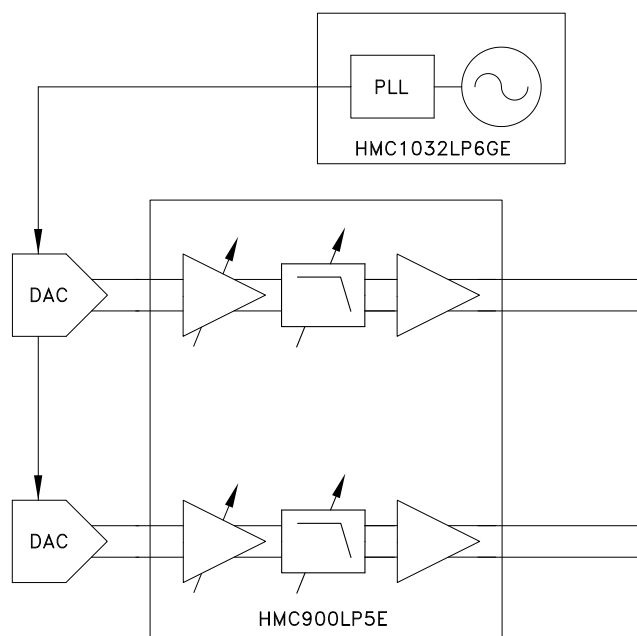
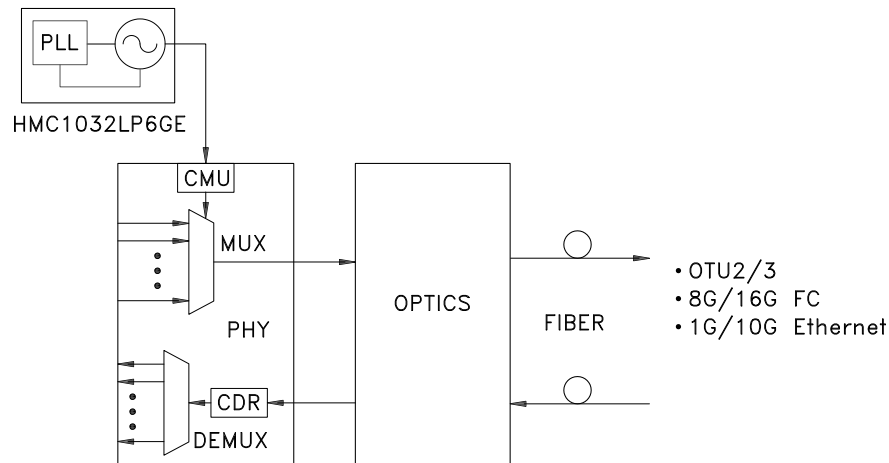
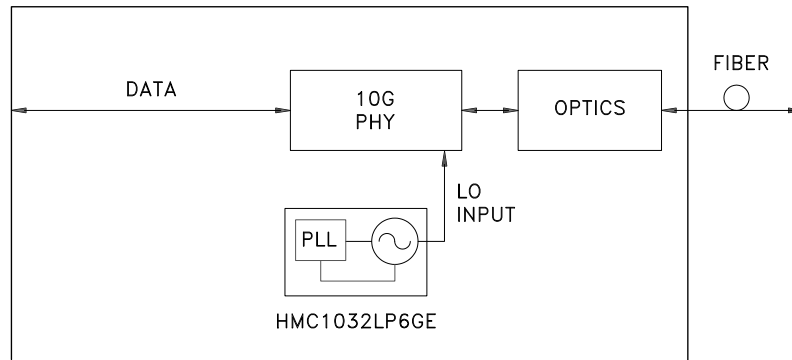


Figure 12. HMC1032LP6GE in a typical transmit chain



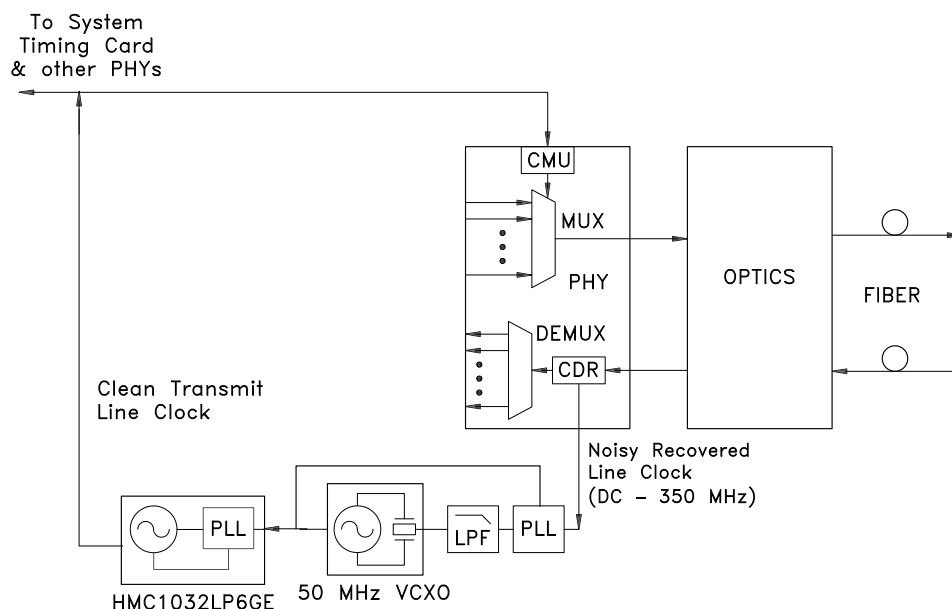
**CLOCK GENERATOR WITH FRACTIONAL-N PLL  
& INTEGRATED VCO, 125 - 350 MHz**


Figure 15. HMC1032LP6GE used in jitter attenuation application for Synchronous Ethernet & Line Timing

The HMC1032LP6GE supports common line and reference clock rates shown in the table (page 12).

**Line and Reference Clock Rates**

| OTN                       | Line Rates (Gbps) | Typical Reference Clock Rates (MHz) |
|---------------------------|-------------------|-------------------------------------|
| OTU1                      | 2.667             | 41.67                               |
| OTU2                      | 10.709            | 167.33                              |
| OTU2e                     | 11.095            | 173.36                              |
| OTU1e                     | 11.049            | 172.64                              |
| OTU2f                     | 11.317            | 176.83                              |
| OTU1f                     | 11.27             | 176.09                              |
| <b>SONET/SDH</b>          |                   |                                     |
| STS-192/STM-64            | 9.95328           | 155.52                              |
| <b>Ethernet</b>           |                   |                                     |
| 1G                        |                   | 125                                 |
| 10GE LAN                  | 10.3125           | 156.25                              |
| 10GE WAN                  | 9.95328           | 155.52                              |
| XAUI (4 x 3.125G)         | 3.125             | 156.25                              |
| <b>Fibre Channel (FC)</b> |                   |                                     |
| 8GFC                      | 8.5               | 106.25                              |
| 10GFC                     | 10.52             | 164.38                              |
| 16GFC                     | 14.025            | 212.5                               |

## Данный компонент на территории Российской Федерации

**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

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