# GN2014A XFP Tx Signal Conditioner with VCSEL Driver

## Features

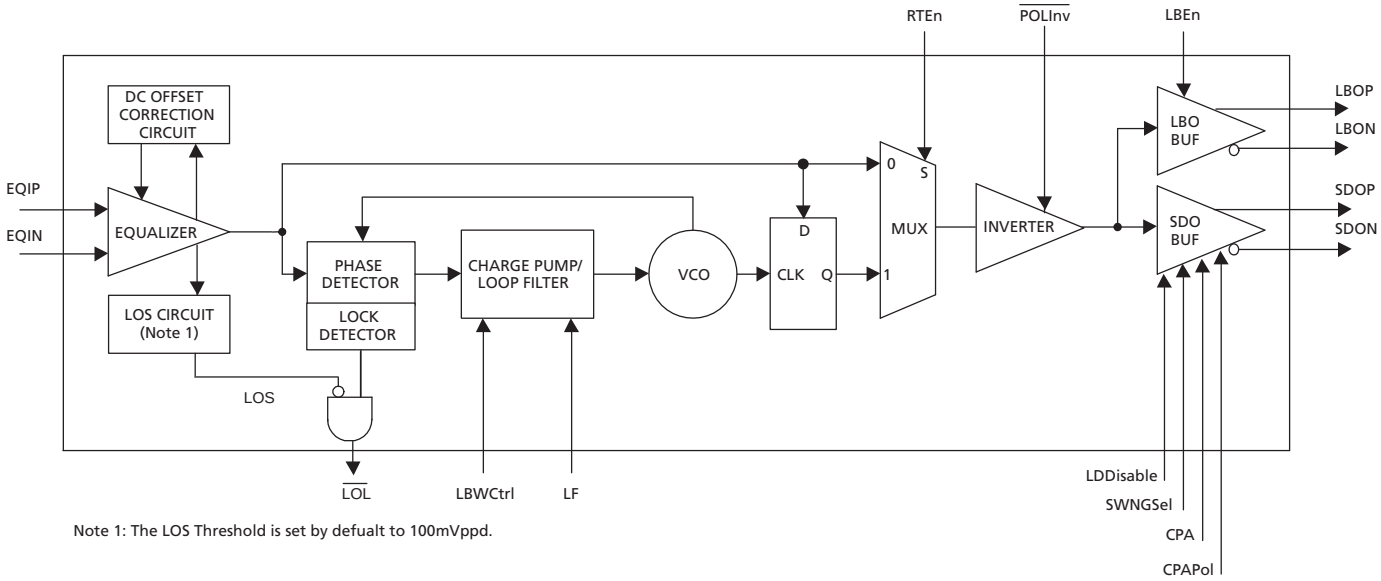
- XFP Datacom Compliant Transmit Signal Conditioner
- Integrated VCSEL driver with Cross Point Adjust functionality to optimize optical performance
- Single 3.3V supply
- Power dissipation: 300mW (typical, assuming 700mVppd data output amplitude)
- Multi-rate operation: 9.95Gb/s – 11.3Gb/s
- No reference clock required
- Laser shut down option
- Automatic input offset correction
- On chip 100Ω differential I/O termination
- Loss of Lock indicator
- Loopback differential output
- CDR Bypass Option
- Bit Inversion capability

## Applications

- Transmit path signal conditioner for XFP and SFP+ transceiver modules

## General Description

The GN2014A is a transmit path signal conditioner with integrated VCSEL driver designed to offer power and cost savings relative to external laser driver solutions. The GN2014A provides integrated modulation and eye shaping capability while maintaining pin compatibility with previous generation parts.




Note 1: The LOS Threshold is set by defualt to 100mVppd.

**Figure A: GN2014A Block Diagram**

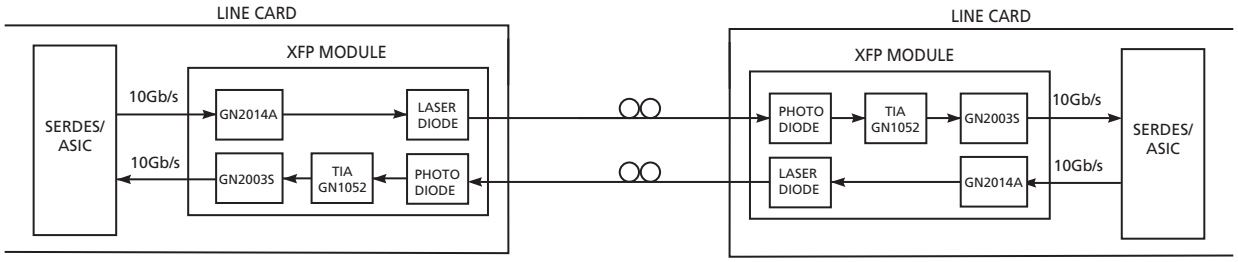



**Figure B: Typical Usage**

# Contents

# 1. Pin Configuration and Descriptions

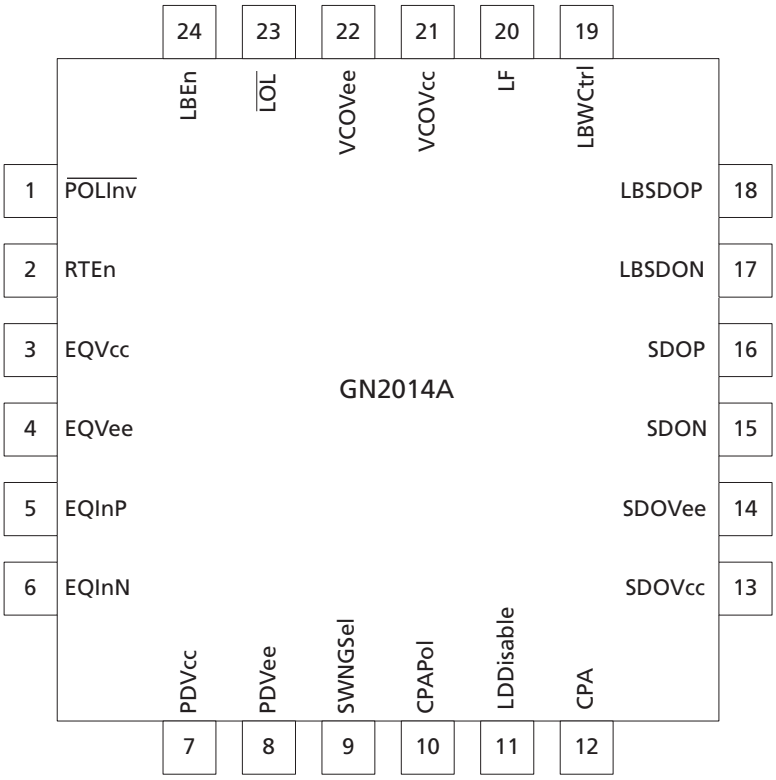



Figure 1-1: GN2014A Pin Configuration

**Table 1-1: Pin Descriptions**

| Pin# | Pin Symbol | Description |
|---|---|---|
| 1 | $\overline{\text{POLInv}}$ | SDO Output Polarity Inversion Control Input |
| 2 | RTEn | Retimer Enable Control Input |
| 3 | EQVcc | Equalizer Power Supply |
| 4 | EQVee | Equalizer Ground |
| 5 | EQInP | Serial Data Input (Positive) |
| 6 | EQInN | Serial Data Input (Negative) |
| 7 | PDVcc | CDR Power Supply |
| 8 | PDVee | CDR Ground |
| 9 | SWNGSel | Serial Data Output Amplitude Select Control Input |
| 10 | CPAPol | Cross Point Adjust Polarity |
| 11 | LDDisable | Laser Driver Power Down |

**Table 1-1: Pin Descriptions (Continued)**

| Pin# | Pin Symbol | Description |
|---|---|---|
| 12 | CPA | Cross Point Adjust |
| 13 | SDOVcc | SDO Output Buffer Power Supply |
| 14 | SDOVee | SDO Output Buffer Ground |
| 15 | SDON | Serial Data Output (Negative) |
| 16 | SDOP | Serial Data Output (Positive) |
| 17 | LBSDON | Loop Back Serial Data Output (Negative) |
| 18 | LBSDOP | Loop Back Serial Data Output (Positive) |
| 19 | LBWCtrl | PLL Loop Bandwidth Control Input |
| 20 | LF | PLL Loop Filter Capacitor |
| 21 | VCOVcc | VCO Power Supply |
| 22 | VCOVee | VCO Ground |
| 23 | $\overline{\text{LOL}}$ | Loss of Lock Monitor Output |
| 24 | LBEn | Loop Back Enable Control Input |

# 2. Electrical Characteristics

**Table 2-1: Absolute Maximum Ratings**

| Parameter | Value |
|---|---|
| Supply Voltage, $V_{CC}$ | -0.3V to 3.6V |
| Input Voltage Range | -0.3 to $V_{CC}$+0.3 |
| ESD Protection (including high-speed I/Os) | 2kV (HBM) |
| Operating Temperature Range, $T_C$ | -40°C to 95°C |
| Reflow Profile (Tmax) | 255°C + 5°C (3 sec) |
| Storage Temperature | -40°C to 100°C |

NOTE: Stress above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not applied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

# 2.1 DC Electrical Characteristics

### Table 2-2: DC Electrical Characteristics

$V_{CC}$ = +2.8V to +3.47V, $T_C$ = -40°C to 95°C. Typical values are at $V_{CC}$ = +3.3V and $T_A$ = 25°C, unless otherwise specified.
Note: mVppd refers to mV peak-to-peak differential value.

| Parameter | Symbol | Min | Typ | Max | Units | Note |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | -15% | 3.3 | +5% | V | – |
| Power Consumption | – | – | 300 | 485 | mW | – |
| **CML Input Specifications** | | | | | | |
| Input Amplitude | $V_{IN}$ | 120 | – | 1000 | mVppd | Note 1, Note 2 |
| Input Termination | – | 80 | 100 | 120 | Ω | Differential |
| **CML SDO Output Specifications** | | | | | | |
| Output Amplitude | – | 300 (3mA mod current) | – | 1500 (15mA mod current) | mVppd | Controlled using Voltage to SwingSel, LDDisable = LOW |
| Output Termination | – | 80 | 100 | 120 | Ω | Differential |
| Output with LDDisable = HIGH | – | – | – | 100 | µAppd | – |
| Swing Select Input Current | – | 0 | – | 150 | µA | Required for 0 – 1400mVppd output range |
| CPA Input Current | – | – | – | 250 | µA | Required for up to 25% change |
| **CML LBSDO Output Specifications** | | | | | | |
| Output Amplitude | $V_{0LB}$ | 160 | 195 | 300 | mVppd | AC coupled with the LBSDI from GN2003S |
| Output Termination | – | 80 | 100 | 120 | Ω | Differential |
| Output Buffer Switching Current | $I_{OLB}$ | – | 3.9 | – | mA | – |
| **Control Logic Input Specifications** | | | | | | |
| Input Low Voltage | $V_{IL}$ | 0 | – | 0.8 | V | – |
| Input High Voltage | $V_{IH}$ | 2.0 | – | $V_{CC}$ | V | – |
| Input Low Current | $I_{IL}$ | – | -100 | – | µA | $V_{IL}$ = 0V |
| Input High Current | $I_{IH}$ | – | 100 | – | µA | $V_{IH}$ = +3.3V, $V_{CC}$ = 3.3V |

Notes:

1. XFP MSA Revision 4.0 (Table 17).
2. If input signal is below 100mV threshold, LOL may trigger.

## 2.2 AC Electrical Characteristics

### Table 2-3: AC Electrical Characteristics

$V_{CC}$ = +2.8V to +3.47V, $T_C$ = -40°C to 95°C. Typical values are at $V_{CC}$ = +3.3V and $T_A$ = 25°C, unless otherwise specified.
Note: mVppd refers to mV peak-to-peak differential value.

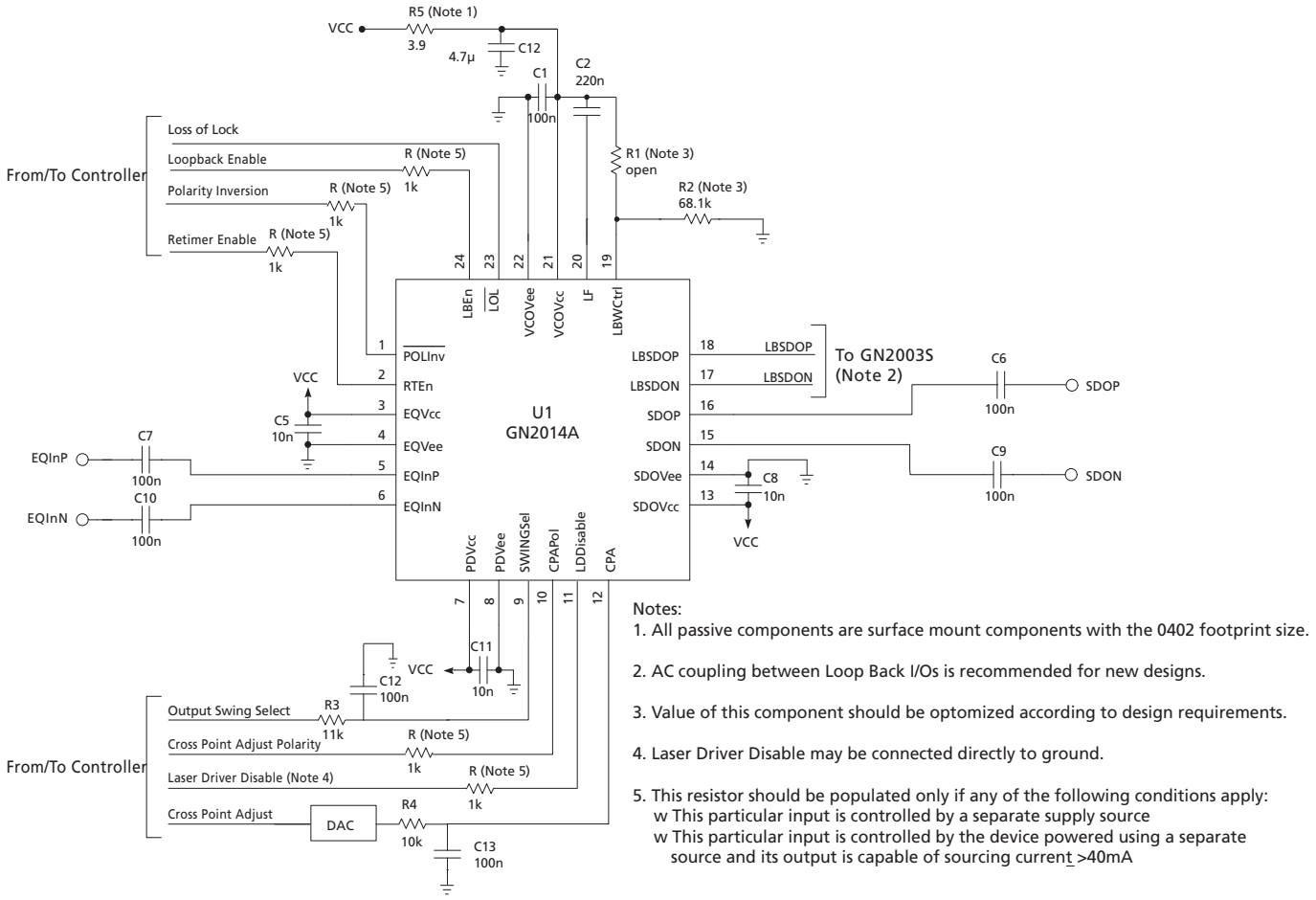
| Parameter | Symbol | Min | Typ | Max | Units | Note |
|---|---|---|---|---|---|---|
| Input Data Rate | – | 9.95 | – | 11.3 | Gb/s | NRZ |
| Input Sinusoidal Jitter Tolerance | – | 2.4 | 12.7 | – | UIpp | f = 120kHz, Note 1 |
| | – | 0.07 | 0.6 | – | UIpp | f = 4MHz |
| | – | 0.07 | 0.45 | – | UIpp | f = 80MHz |
| Equalization Gain | – | 6 | – | – | dB | Note 2 |
| Jitter Transfer Bandwidth Setting Range | – | 1 | – | 8 | MHz | PRBS $2^{31}$-1 Data (Note 3) |
| Jitter Peaking | – | – | – | 0.03 | dB | All Frequencies (with 8MHz LBW) |
| Total Output Jitter | – | – | 0.1 | 0.15 | UIpp | – |
| SDO Output Rise/Fall Time | tr, tf | – | – | 30 | ps | 20% - 80% |
| Lock Time | – | – | 10 | 20 | ms | – |

Notes:

1. At jitter frequencies <120kHz the GN2014A jitter tolerance performance exceeds the XFI module transmitter input telecom sinusoidal jitter tolerance specifications (XFP MSA Revision 4.0, Figure 16).
2. At 5.35GHz (dielectric loss)
3. 8MHz bandwidth can be obtained using the loop filter components R1, R2. The values for these components should be selected at module level.

# 3. Detailed Description

## 3.1 Typical Electrical Application Schematic




Notes:
1. All passive components are surface mount components with the 0402 footprint size.
2. AC coupling between Loop Back I/Os is recommended for new designs.
3. Value of this component should be optomized according to design requirements.
4. Laser Driver Disable may be connected directly to ground.
5. This resistor should be populated only if any of the following conditions apply:
   - This particular input is controlled by a separate supply source
   - This particular input is controlled by the device powered using a separate source and its output is capable of sourcing current >40mA

Figure 3-1: GN2014A Typical Electrical Application Schematic

The application schematic for the GN2014A is highly related to the GN2004S.

## 3.2 VCO Supply Recommendations

When the Host Board Power Supply output is used to power the GN2014A device, additional filtering for the VCOVcc supply input is recommended.

This filtering is required to improve power line noise rejection.

Typically, a 1st order RC filter provides sufficient supply noise attenuation (i.e. R5, C1 and C12 in Figure 3-1).

The capacitor C1 = 100nF

The capacitor C12 = 4.7µF

The maximum value of the resistor R5 can be calculated using the following information:

- Minimum operational voltage (after regulation and including supply noise) at the VCOVcc supply input (pin 21): $VCOVcc_{(min)} = 2.74Vdc$
- Maximum operational current into the VCOVcc supply input: $I_{VCOVcc\ (max)} = 14.9mA$

Example 3-1: Calculating Resistor Values

Vcc = 2.8Vdc.

$R5_{(max)} = (Vcc - VCOVcc_{(min)}) / I_{VCOVcc\ (max)} = 60mV / 14.9mA = 4\Omega$

The closest lower standard resistor value, which can be used for R5 is 3.9Ω.

When an external LDO voltage regulator is used to power the GN2014A device, R5 =

## 3.3 Control Interface

The GN2014A control interface consists of five inputs that determine the mode in which the device is operating:

- Polarity Inversion ($\overline{POLInv}$)
- Loop Back Enable (LBEn)
- Retimer Enable (RTEn)
- Cross Point Adjust Polarity (CPAPol)

Table 3-1 describes the conditions at these inputs to enable or disable a particular mode.

Figure 3-2 shows a simplified equivalent circuit common for all control inputs.

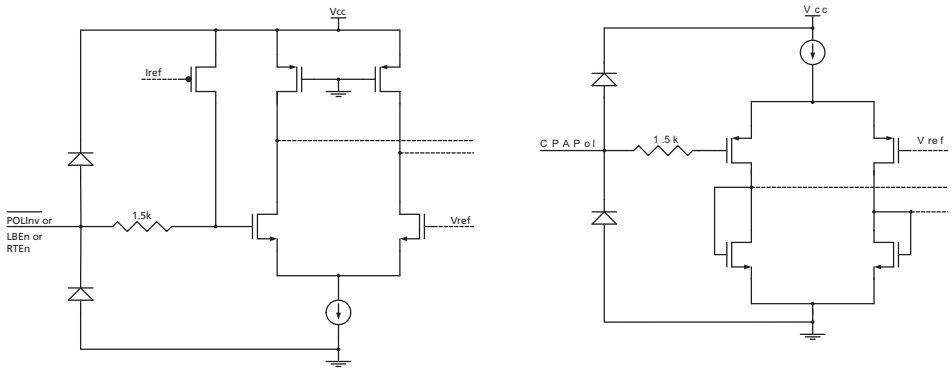



Figure 3-2: GN2014A Control Input Equivalent Circuits

When left unconnected, the $\overline{\text{POLInv}}$, LBEn and RTEn input level defaults to logic HIGH and the CPAPol input defaults to logic LOW (see Figure 7-1).

Note: Since the GN2014A device is specified to operate at VCC values down to 2.8V, special care must be taken when driving control inputs from a controller that uses separate supply line. Under no condition should the controller's $V_{OH}$ exceed GN2014A's VCC + 0.3V.

**Table 3-1: Operational Modes**

| Pin# | Pin Symbol | Description |
|---|---|---|
| 1 | $\overline{\text{POLInv}}$ | Serial Data Output Polarity Inversion Control Input<br>0 → Inverted Polarity (SDOP/LBSDOP = EQInN and SDON/LBSDON = EQInP)<br>1 → Normal Polarity (SDOP/LBSDOP = EQInP and SDON/LBSDON = EQInN) |
| 2 | RTEn | Retimer Enable Control Input<br>0 → CDR Bypassed<br>1 → CDR In Path |
| 10 | CPAPol | Cross Point Adjust Polarity Control Input<br>0 → Negative Cross Point Adjust<br>1 → Positive Cross Point Adjust |
| 24 | LBEn | Loop Back Enable Control Input<br>0 → Loop Back Disabled (Data available only on SDOP/SDON)<br>1 → Loop Back Enabled (Data available on SDOP/SDON and LBSDOP/LBSDON) |

### 3.3.1 GN2014A Laser Driver Power Down

LDDisable is a digital control pin which is used to shut down laser modulation when set to HIGH (default level). When set to LOW, the driver operates normally.

**Table 3-2: Control Logic Input Specifications**

| Pin # | Pin Symbol | Description |
|---|---|---|
| 11 | LDDisable | Laser Driver Power Down<br>1 → Laser Driver power down (Default)<br>0 → Laser Driver enabled |

## 3.4 GN2014A Data Output Driver Swing Control

The GN2014A Data Output amplitude is controlled using the SWNGSel control pin.

The SWNGSel control application circuit is shown in Figure 3-3.

Output voltage from a DAC, applied to the SWNGSel control input via external resistor $R_3$, is used to control the Data Output amplitude of the GN2014.

Table 3-3 shows expected GN2014A Data Output amplitude for a given SWNGSel voltage.

Note: The DAC should be able to source up to150µA of current.

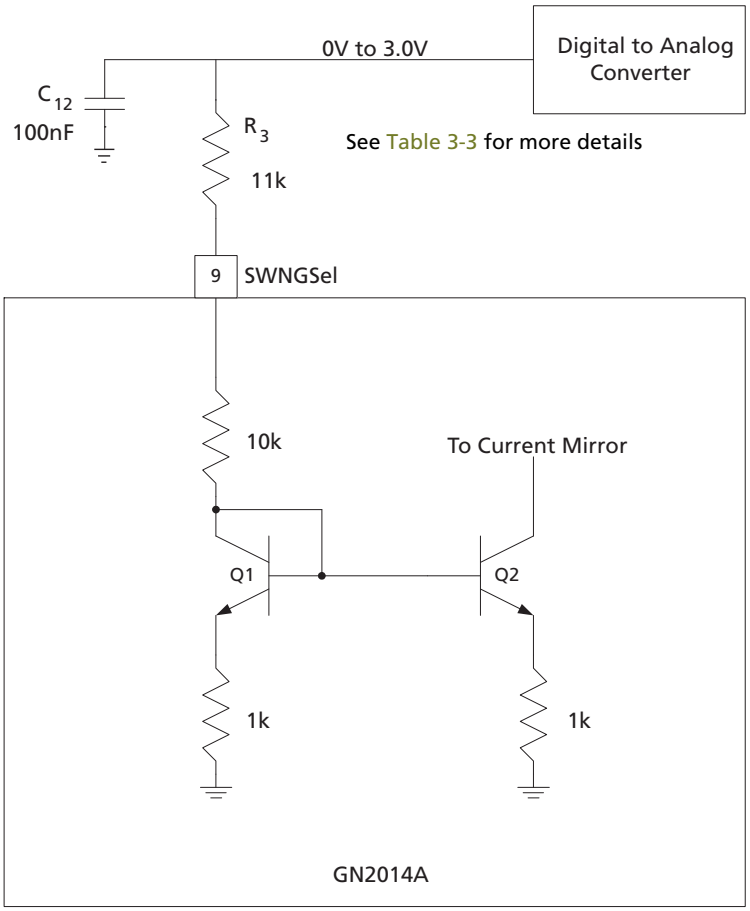



Figure 3-3: GN2014A SWNGSel Control Application Circuit

**Table 3-3: GN2014A Output Amplitude vs. Swing Select Voltage**

| Swing Select Voltage at DAC (assumes 11kΩ resistor in series) | GN2014A Output (Typical, LDDisable LOW) | Comments |
|---|---|---|
| 0-0.8 | Soft turn on | |
| 1.2V | 150mVpp single ended | 3mA modulation current |
| 1.8V | 350mVpp single ended | 7mA modulation current |
| 2.3V | 500mVpp single ended | 10mA modulation current |
| 2.8V (Recommended Max) | 750m Vpp single ended | 15mA modulation current |
| 3.3V (Reliability Max) | Not Recommended | 18mA modulation max current |

## 3.5 GN2014A Cross Point Adjust

The GN2014A cross point adjust is used to pre-distort the output signal to optimize optical performance. This is accomplished using two control pins:

1. CPAPol (Pin 10) — Controls direction of crosspoint change, digital pin
2. CPA (Pin 12) — Controls magnitude of crosspoint change, analog control

With CPA voltage set to nominal 0.8V, the output waveform will have a cross point at the 50% level, as indicated in Figure 3-4.

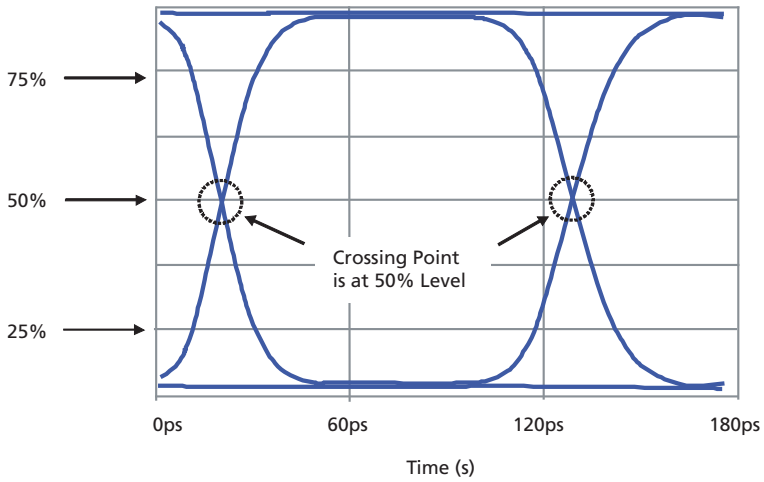



Figure 3-4: GN2014A Output Signal with CPA voltage set to 0.8V

To increase the cross point to the 75% level, the CPA polarity (pin 10:CPAPol) must be set HIGH, and the CPA voltage (pin 12:CPA) increased to 3.1V. This results in the output waveform illustrated in Figure 3-5.

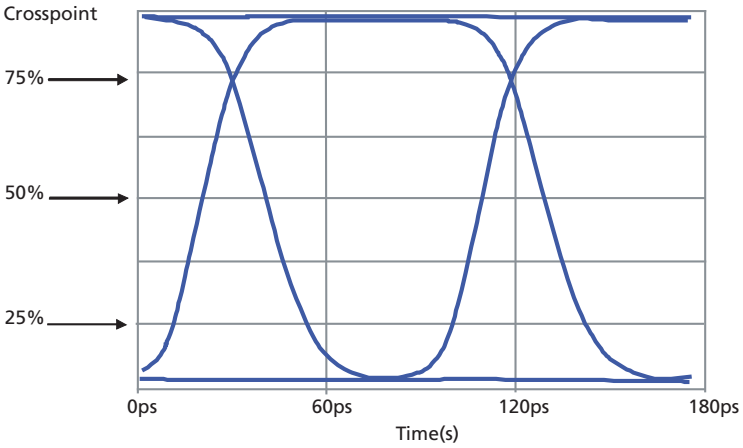



Figure 3-5: GN2014A Output Signal when CPA Polarity control input is set HIGH, CPA = 3.1V

The cross point can be set to an intermediate level between 50% and 75% by setting the CPA to a voltage between 0.8V and 3.1V.

To decrease the cross point to the 25% level, the CPA polarity (pin 10:CPAPol) must be set LOW, and the CPA voltage (pin 12:CPA) increased to 3.1V. This results in the output waveform illustrated in Figure 3-6.

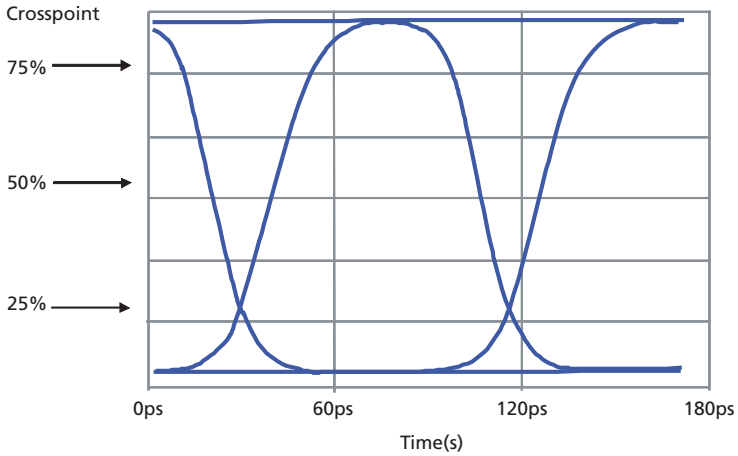



Figure 3-6: GN2014A Output Signal when CPA Polarity control input is set LOW, CPA = 3.1V

The cross point can be set to an intermediate level between 50% and 25% by setting the CPA to a voltage between 0.8V and 3.1V.

Note: When the CPA Control function is not used, connect CPA (pin 12: CPA) to $V_{CC}$ using a 200KΩ resistor. The CPAPol pin (pin 10: CPAPol) may be left open.

# 4. Packaging and Ordering Information

## 4.1 Package Dimensions

Figure 4-1 shows the GN2014A footprint.

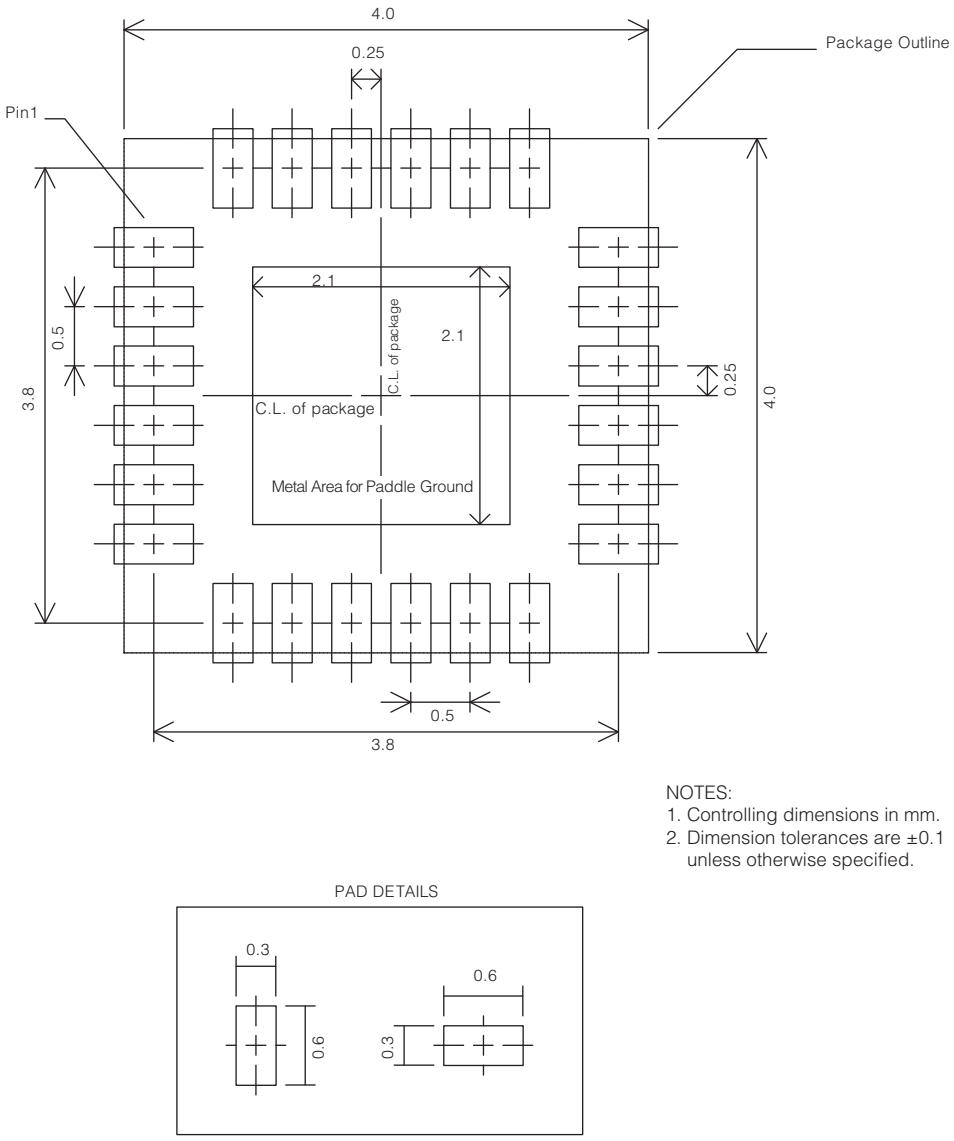



Figure 4-1: GN2014A Footprint

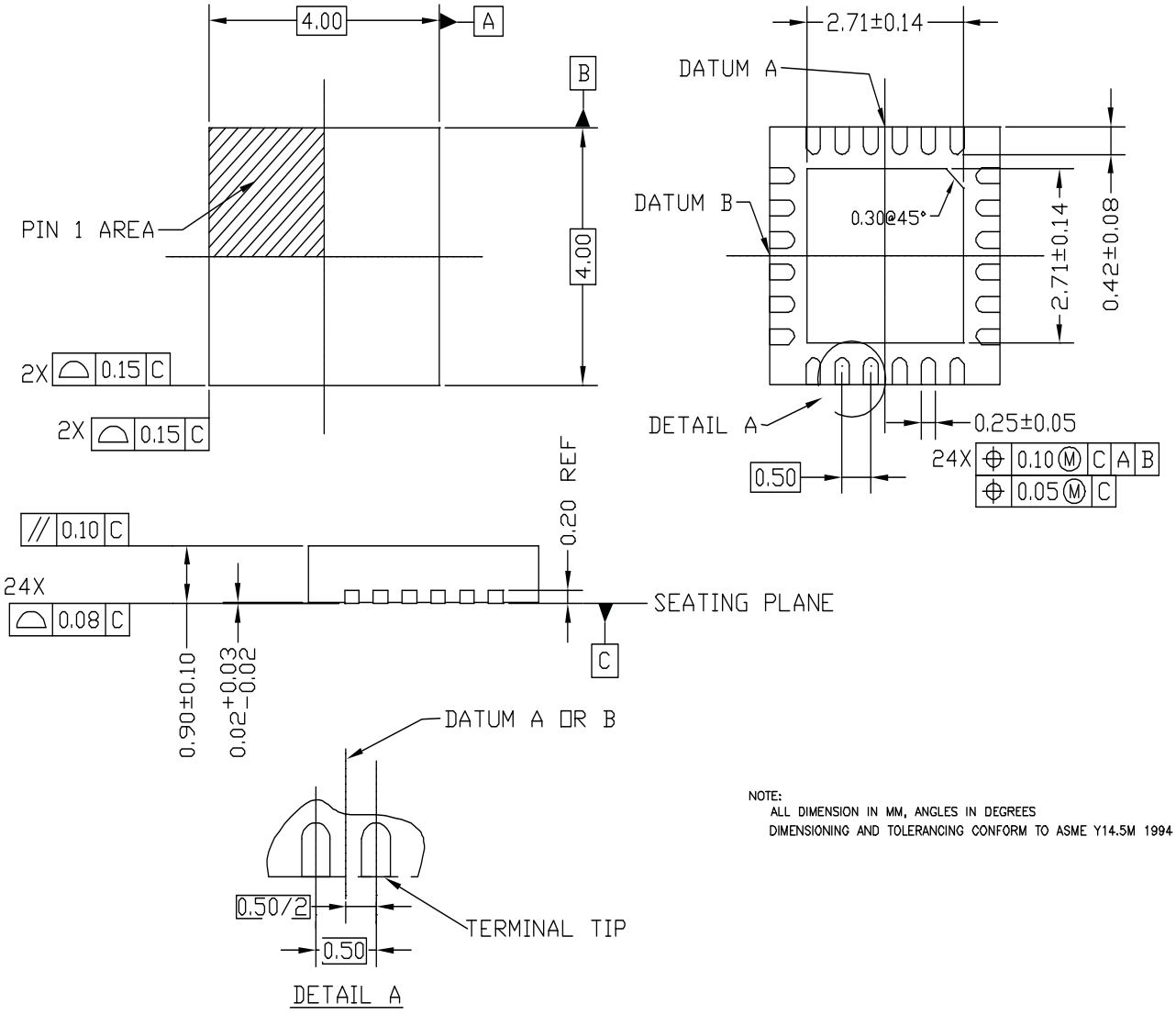
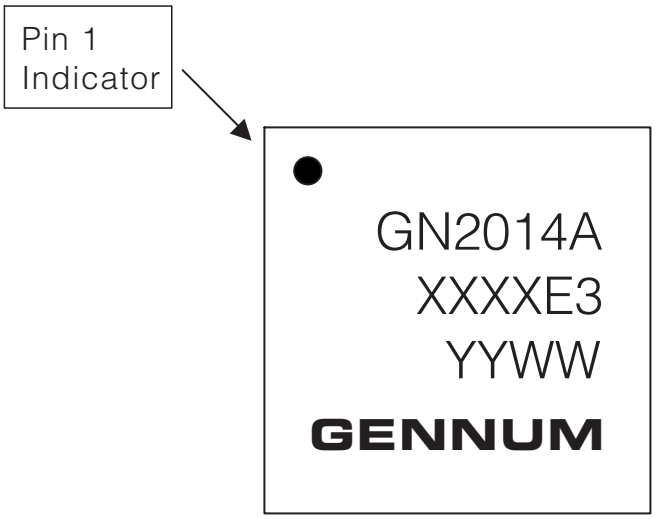



Figure 4-2: Package Information




| | |
|---|---|
| GN2014A | Package Mark |
| XXXX | Last 4 digits of work order |
| YYWW | Date Code |
| E3 | Pb-free indicator |

Figure 4-3: Package Marking

## 4.2 Ordering Information

| Part Number | Package | Case Temperature |
|---|---|---|
| GN2014ACNE3 | 24-pin QFN | -40°C to +95°C |

### Revision History

| Version | ECR | Date | Changes and / or Modifications |
|---|---|---|---|
| 3 | 144211 | February 2007 | Updated Table 8.1 |
| 4 | 144650 | March 2007 | Missing information on CPAPol |
| 5 | 145750 | June 2007 | Update ESD info, remove reference to Swing Select Control Input in Section 7 |
| 6 | 148393 | November 2007 | Close CAR #5632 |
| 7 | 152775 | October 2009 | Changed Figure 4-2: Package Information. |
| 8 | 154165 | May 2010 | Converted document back to Data Sheet. |

**DOCUMENT IDENTIFICATION**
**DATA SHEET**
The product is in production. Gennum reserves the right to make changes to the product at any time without notice to improve reliability, function or design, in order to provide the best product possible.

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DO NOT OPEN PACKAGES OR HANDLE EXCEPT AT A STATIC-FREE WORKSTATION


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