GN2014A XFP Tx Signal Conditioner with VCSEL Driver

Features

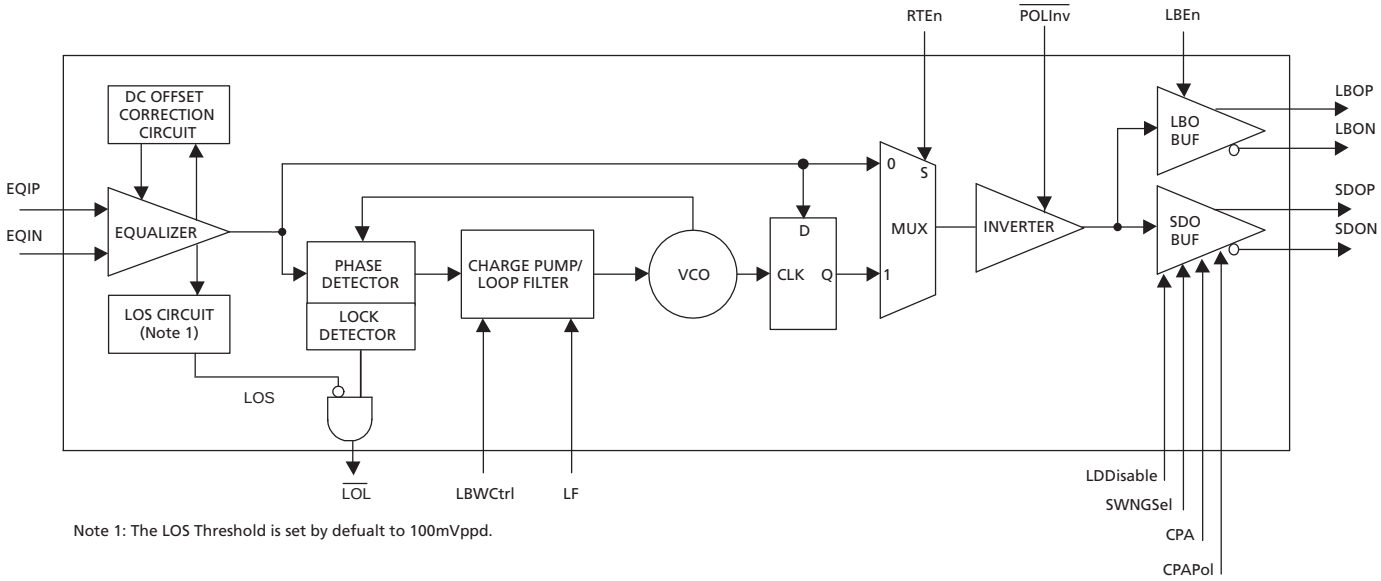
- XFP Datacom Compliant Transmit Signal Conditioner
- Integrated VCSEL driver with Cross Point Adjust functionality to optimize optical performance
- Single 3.3V supply
- Power dissipation: 300mW (typical, assuming 700mVppd data output amplitude)
- Multi-rate operation: 9.95Gb/s – 11.3Gb/s
- No reference 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

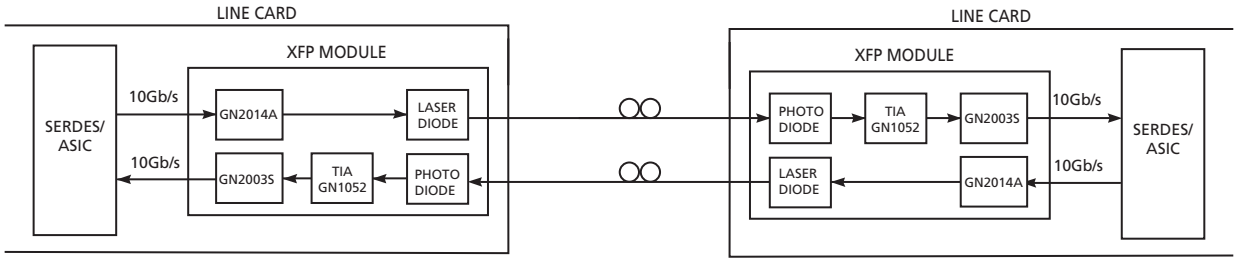


Figure B: Typical Usage

Contents

1. Pin Configuration and Descriptions

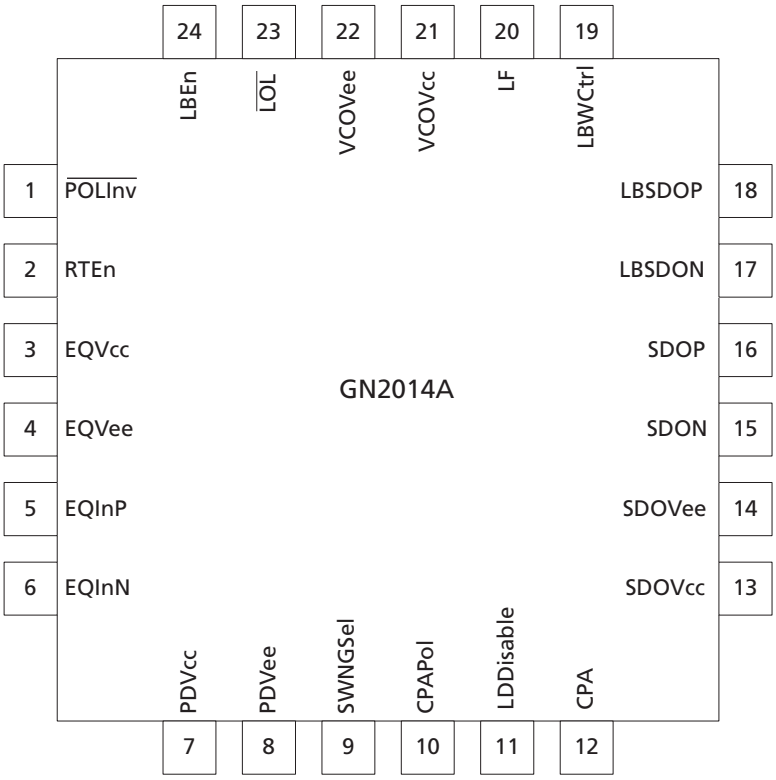


Figure 1-1: GN2014A Pin Configuration

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.

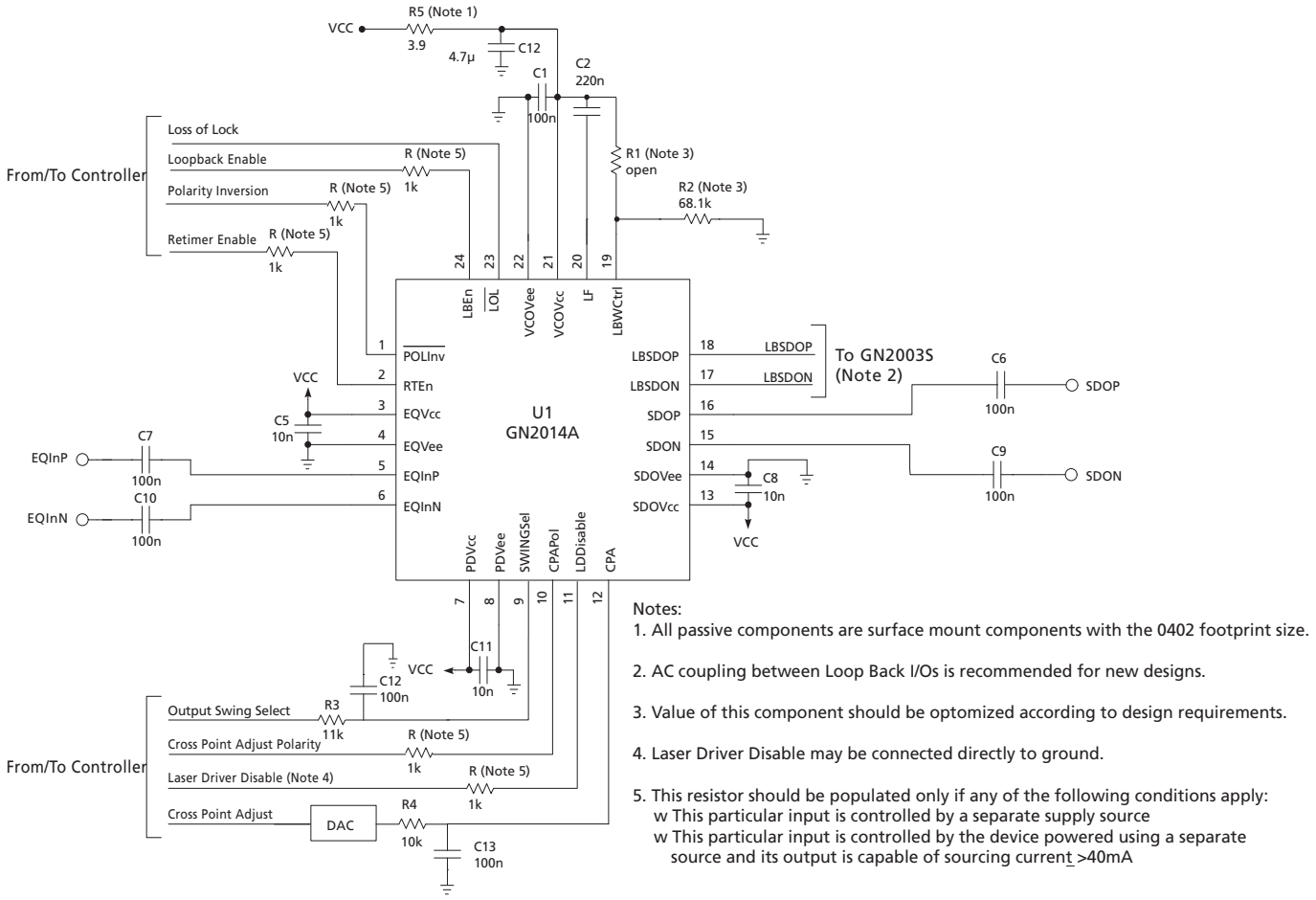
Parameter	Symbol	Min	Typ	Max	Units	Note
Input Data Rate	–	9.95	–	11.3	Gb/s	NRZ
Input Sinusoidal Jitter Tolerance	–	2.4	12.7	–	UIpp	f = 120kHz, Note 1
	–	0.07	0.6	–	UIpp	f = 4MHz
	–	0.07	0.45	–	UIpp	f = 80MHz
Equalization Gain	–	6	–	–	dB	Note 2
Jitter Transfer Bandwidth Setting Range	–	1	–	8	MHz	PRBS 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.

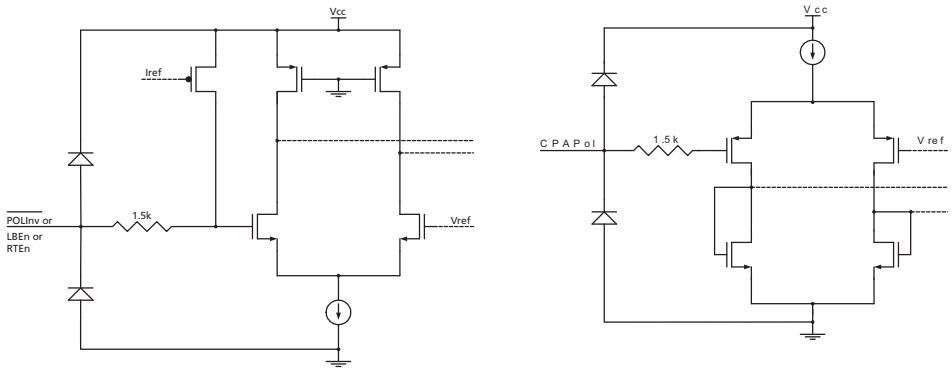


Figure 3-2: GN2014A Control Input Equivalent Circuits

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 0 → Inverted Polarity (SDOP/LBSDOP = EQInN and SDON/LBSDON = EQInP) 1 → Normal Polarity (SDOP/LBSDOP = EQInP and SDON/LBSDON = EQInN)
2	RTEn	Retimer Enable Control Input 0 → CDR Bypassed 1 → CDR In Path
10	CPAPol	Cross Point Adjust Polarity Control Input 0 → Negative Cross Point Adjust 1 → Positive Cross Point Adjust
24	LBEn	Loop Back Enable Control Input 0 → Loop Back Disabled (Data available only on SDOP/SDON) 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 1 → Laser Driver power down (Default) 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.

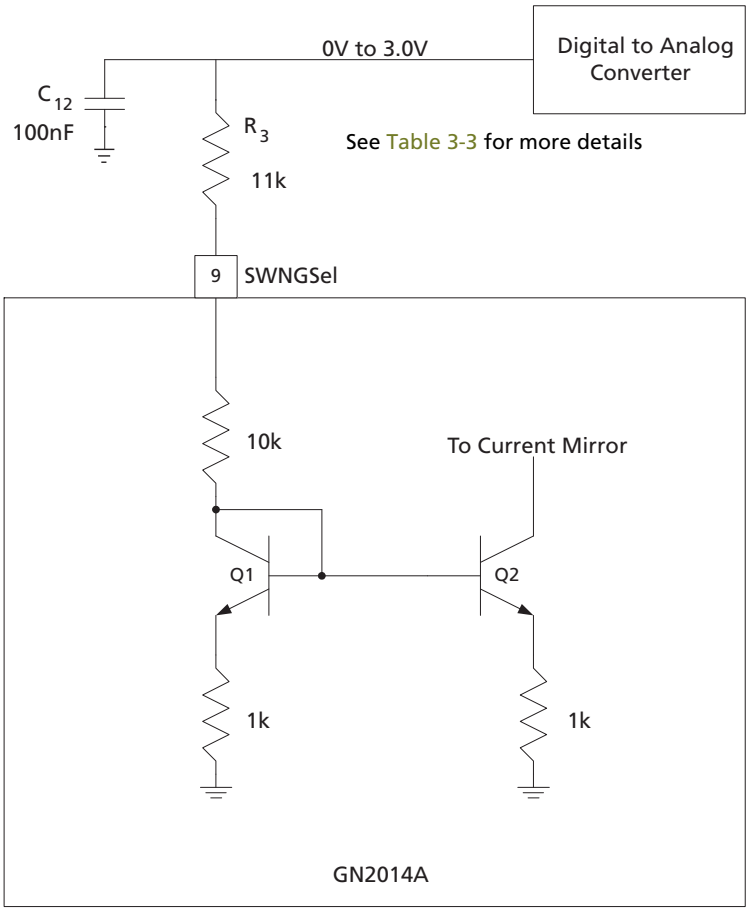


Figure 3-3: GN2014A SWNGSel Control Application Circuit

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.

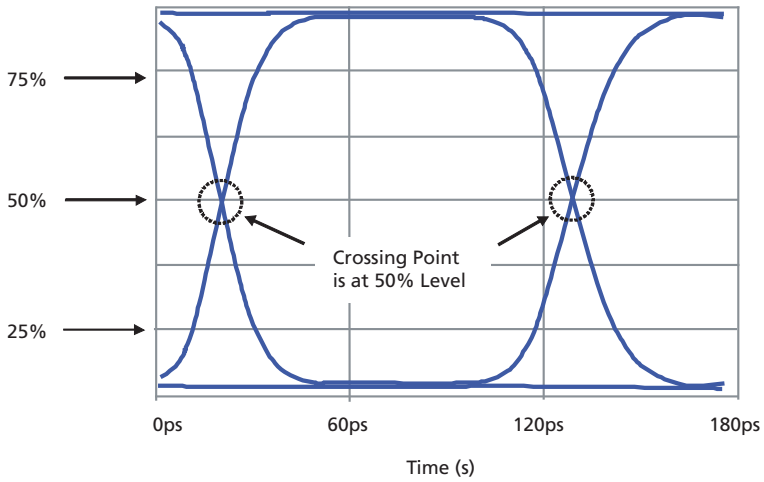


Figure 3-4: GN2014A Output Signal with CPA voltage set to 0.8V

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.

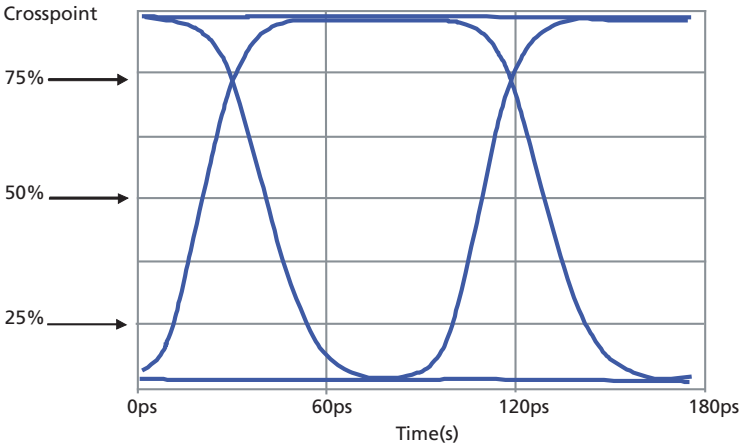


Figure 3-5: GN2014A Output Signal when CPA Polarity control input is set HIGH, CPA = 3.1V

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.

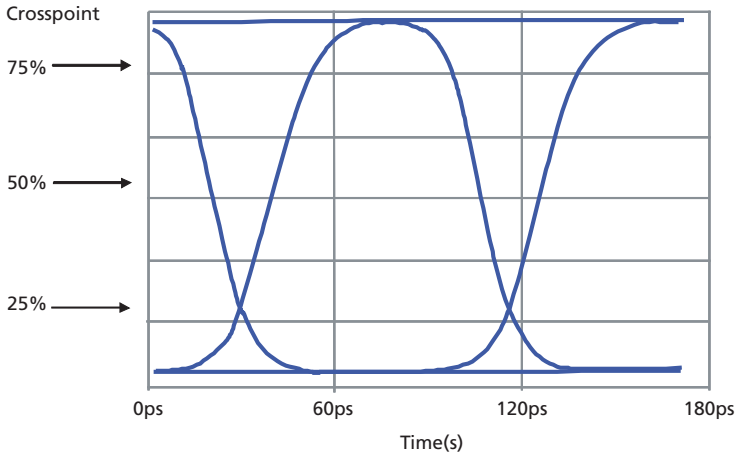


Figure 3-6: GN2014A Output Signal when CPA Polarity control input is set LOW, CPA = 3.1V

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.

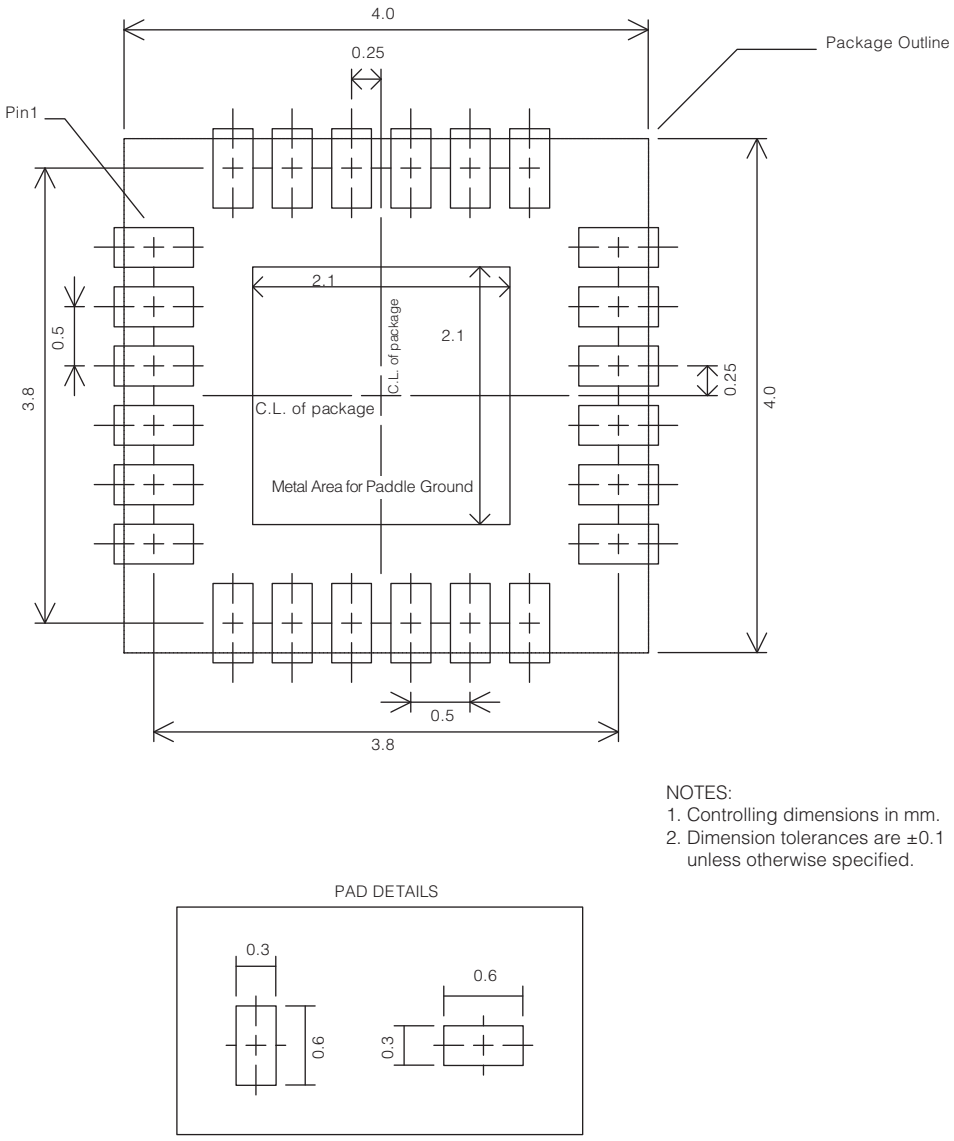


Figure 4-1: GN2014A Footprint

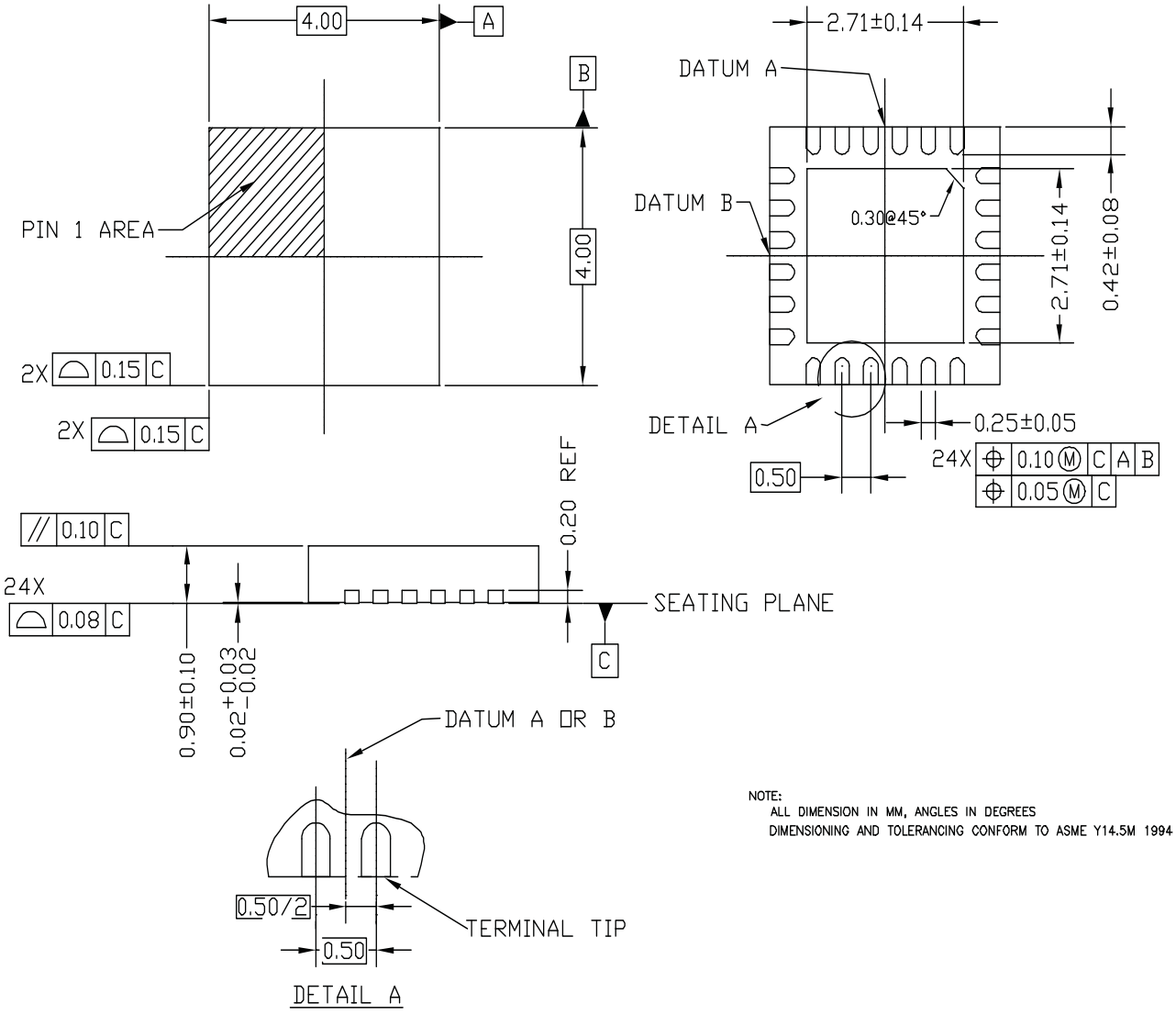
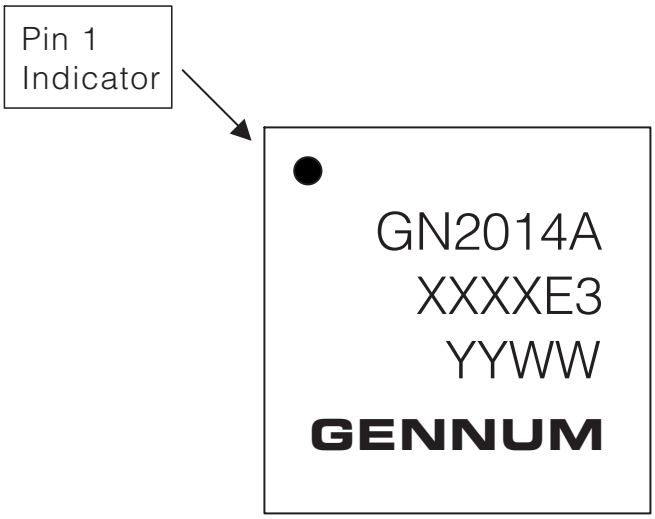


Figure 4-2: Package Information



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.

CAUTION
ELECTROSTATIC SENSITIVE DEVICES
DO NOT OPEN PACKAGES OR HANDLE EXCEPT AT A STATIC-FREE WORKSTATION

GENNUM CORPORATE HEADQUARTERS
4281 Harvester Road, Burlington, Ontario L7L 5M4 Canada
Phone: +1 (905) 632-2996
E-mail: corporate@gennum.com
Fax: +1 (905) 632-2055
www.gennum.com

OTTAWA
232 Herzberg Road, Suite 101
Kanata, Ontario K2K 2A1
Canada
Phone: +1 (613) 270-0458
Fax: +1 (613) 270-0429

CALGARY
3553 - 31st St. N.W., Suite 210
Calgary, Alberta T2L 2K7
Canada
Phone: +1 (403) 284-2672

UNITED KINGDOM
North Building, Walden Court
Parsonage Lane,
Bishop's Stortford Hertfordshire, CM23 5DB
United Kingdom
Phone: +44 1279 714170
Fax: +44 1279 714171

INDIA
#208(A), Nirmala Plaza,
Airport Road, Forest Park Square
Bhubaneswar 751009
India
Phone: +91 (674) 653-4815
Fax: +91 (674) 259-5733

SNOWBUSH IP - A DIVISION OF GENNUM
439 University Ave. Suite 1700
Toronto, Ontario M5G 1Y8
Canada
Phone: +1 (416) 925-5643
Fax: +1 (416) 925-0581
E-mail: sales@snowbush.com
Web Site: http://www.snowbush.com

MEXICO
288-A Paseo de Maravillas
Jesus Ma., Aguascalientes
Mexico 20900
Phone: +1 (416) 848-0328

JAPAN KK
Shinjuku Green Tower Building 27F
6-14-1, Nishi Shinjuku
Shinjuku-ku, Tokyo, 160-0023
Japan
Phone: +81 (03) 3349-5501
Fax: +81 (03) 3349-5505
E-mail: gennum-japan@gennum.com
Web Site: http://www.gennum.co.jp

TAIWAN
6F-4, No.51, Sec.2, Keelung Rd.
Sinyi District, Taipei City 11502
Taiwan R.O.C.
Phone: (886) 2-8732-8879
Fax: (886) 2-8732-8870
E-mail: gennum-taiwan@gennum.com

GERMANY
Hainbuchenstraße 2
80935 Muenchen (Munich), Germany
Phone: +49-89-35831696
Fax: +49-89-35804653
E-mail: gennum-germany@gennum.com

NORTH AMERICA WESTERN REGION
691 South Milpitas Blvd., Suite #200
Milpitas, CA 95035
United States
Phone: +1 (408) 934-1301
Fax: +1 (408) 934-1029
E-mail: naw_sales@gennum.com

NORTH AMERICA EASTERN REGION
4281 Harvester Road
Burlington, Ontario L7L 5M4
Canada
Phone: +1 (905) 632-2996
Fax: +1 (905) 632-2055
E-mail: nae_sales@gennum.com

KOREA
8F Jinnex Lakeview Bldg.
65-2, Bangidong, Songpagu
Seoul, Korea 138-828
Phone: +82-2-414-2991
Fax: +82-2-414-2998
E-mail: gennum-korea@gennum.com