

## FEATURES

## HIGHLIGHTS

- Digital PLL locks to Ethernet physical layer clocks
- Provides clocks for 1 Gigabit Ethernet and QSGMII
- Internal Digitally Controlled Oscillator supports IEEE 1588 clock generation
- Jitter generation <0.65 ps RMS (10 kHz to 20 MHz) meets jitter requirements of 1 GbE PHYs and QSGMII

## MAIN FEATURES

- Digital PLL synchronizes with Ethernet connected synchronization sources
- DPLL bandwidth of 1.2 Hz
- DPLL holdover accuracy is  $1.1 \times 10^{-5}$  ppm and instantaneous holdover accuracy is  $4.4 \times 10^{-8}$  ppm
- Input references are monitored for frequency offset and activity
- DPLL holdover, free run and hitless reference switching can be forced by the host processor or can be automatically controlled by an internal state machine

- Internal DCO has resolution of 0.01105 ppb and can be controlled by an external processor via I2C interface for IEEE 1588 clock generation
- One Analog PLL for jitter attenuation
- IN1, IN2 and IN3 accept single ended reference clocks whose frequencies can be 25 MHz, 125 MHz or 156.25 MHz
- OUT1 outputs a differential clock with frequency of 125 MHz or 156.25 MHz
- OUT2 to OUT6 output differential clocks all with the same frequency of 125 MHz or 156.25 MHz
- OUT7 outputs a free-running LVCMOS clock with frequency of 25 MHz

## OTHER FEATURES

- I2C microprocessor interface mode
- IEEE 1149.1 JTAG Boundary Scan
- Single 3.3 V operation with 5 V tolerant CMOS I/Os
- 1mm ball pitch CABGA green package

## APPLICATIONS

- Industrial Automation
- Power Systems

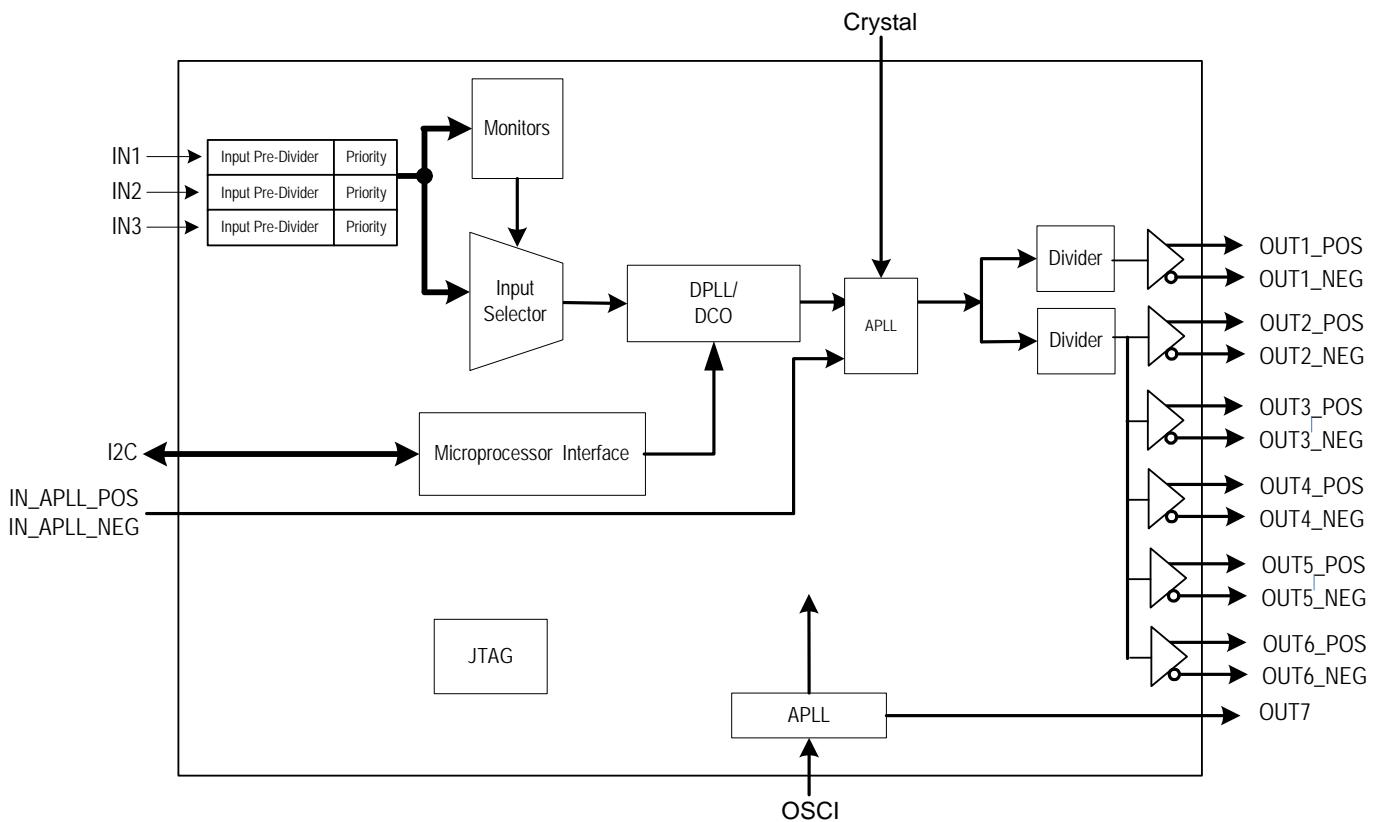


Figure 1. Functional Block Diagram

IDT and the IDT logo are trademarks of Integrated Device Technology, Inc.  
IEEE 1588™ is a trademark of its respective owner

## DESCRIPTION

The IDT8V89316 Ethernet PLL for Industrial Automation and Power Systems is used to synchronize equipment with synchronization sources using the Ethernet physical layer; it can also be used by external IEEE 1588 clock recovery servos to synthesize IEEE 1588 clocks. The IDT8V89316 low jitter output clocks can be used to directly synchronize 1 Gigabit Ethernet PHYs and QSGMII devices.

The IDT8V89316 synchronization functions are provided by a Digital PLL (DPLL) with an embedded clock synthesizer. The DPLL accepts three single ended reference inputs that can operate at 25 MHz, 125 MHz or 156.25 MHz. The references are continually monitored for loss of signal and for frequency offset per user programmed thresholds. The active reference for the DPLL is determined by forced selection or by automatic selection based on user programmed priorities and locking allowances and based on the reference monitors.

The DPLL supports four primary operating modes: Free-Run, Locked, Holdover and Digitally Controlled Oscillator (DCO) Control. In Free-Run mode the DPLL generates a clock based on the master clock alone. In Locked mode the DPLL filters reference clock jitter with the selected bandwidth. In Locked mode the long-term DPLL frequency accuracy is the same as the long term frequency accuracy of the selected input reference. In Holdover mode the DPLL uses frequency data acquired while in Locked mode to generate accurate frequencies when input references are not available. In DCO Control Mode the DPLL

control loop is opened and the DCO can be used by an algorithm (e.g. IEEE 1588 clock servo) running on an external processor to synthesize clock signals.

The IDT8V89316 requires a 12.8 MHz master clock for its reference monitors and other digital circuitry. The frequency accuracy of the master clock determines the frequency accuracy of the DPLL in Free-Run mode. The frequency stability of the master clock determines the frequency stability of the DPLL in Free-Run mode and in Holdover mode. Refer to the IDT application note "Recommended Crystal Oscillators for IDT's Network Synchronization WAN-PLL™" for guidance.

The clock synthesized by the IDT8V89316 DPLL is passed through a voltage controlled crystal oscillator (VCXO) based jitter attenuating analog PLL (APLL). The APLL drives independent dividers that have differential outputs. The APLL uses an external crystal resonator with resonant frequencies equal to the APLL base frequency divided by 25. The output clocks generated by the APLL exhibits jitter below 0.65ps RMS over the integration range 10 kHz to 20 MHz.

The IDT8V89316 generates a 25MHz single ended output that is based on the free running 12.8 MHz master clock. The frequency accuracy and the frequency stability of this 25 MHz clock are determined by the master clock.

## 1 PIN ASSIGNMENT

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
A	NC	VDDAO	OUT6_NEG	NC	NC	IC1	IC1	TDI	IC1	IC2	OSCI	TMS	IC1	TRST	A
B	NC	VSSAO	OUT6_POS	VSSAO	NC	IC1	IC1	TDO	VSSA	TCK	VSSA	VSSA	VSSDO	VDDDO	B
C	NC	VDDAO	NC	NC	IC1	IC1	VDDDO	VSSDO	VDDA	VSSA	VDDA	VDDA	INT_REQ	IC1	C
D	VSSAO	VSSAO	NC	VSSAO	VDDAO	IC1	VSSD	VDDO	IC1	VDDA	VSSA	VDDA	IC1	IC1	D
E	OUT5_NEG	OUT5_POS	VSSAO	VSSAO	VSSAO	IC3	VSSD	VDDO	IC1	VSSA	VDDA	VSSA	IC1	IC1	E
F	VDDAO	VSSAO	VSSAO	VSSAO	VDDAO	VSSAO	VSSD	VDDO	VSSD	VDDO	IC1	VDDDO	OUT7	VSSDO	F
G	VSSAO	VDDAO	VSSAO	VSSAO	VSSAO	VSSD	VDDO	IC1	VDDO	VSSD	IC1	IC1	IC1	IC1	G
H	VDDAO	VSSAO	VDDAO	VSSAO	VSSAO	VSSAO	VSSD	VDDO	VSSD	VDDO	IC1	IC1	RST	IN1	H
J	OUT4_NEG	OUT4_POS	VDDAO	VSSAO	VDDAO	VSSAO	VDDAO	VSSAO	VSSA	VDDA	DPLL_LOCK	IC1	IN2	IN3	J
K	VSSAO	VSSAO	VSSAO	VDDAO	VSSAO	VDDAO	VSSAO	VSSD	VDDO	VSSD	IC1	IC1	I2C_SCL	I2C_SDA	K
L	OUT3_NEG	OUT3_POS	VDDAO	VSSAO	VSSAO	VSSAO	VSSAO	I2C_AD1	I2C_AD2	CAP1	VSSA	CAP2	VSSA	CAP3	L
M	VDDAO	VSSAO	VSSAO	VSSAO	VDDAO	VSSAO	VDDAO	VSSAO	VSSA	VSSA	VSSA	NC	NC	NC	M
N	VSSAO	OUT2_POS	VSSAO	OUT1_POS	VSSAO	IN_APPL_POS	IC2	IC2	VSSA	XTAL_OUT	VSSA	IC1	VSSAO	VSSA	N
P	VDDAO	OUT2_NEG	VSSAO	OUT1_NEG	VDDAO	IN_APPL_NE	IC2	IC2	VDDA	XTAL_IN	VDDA	IC1	IC1	VDDA	P
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Key:															
	Diff Outputs	Outputs	Inputs	Power	Ground										

Figure 2. Pin Assignment (Top View)

## 2 PIN DESCRIPTION

Table 1: Pin Description

Name	Pin No.	I/O	Type	Description <sup>1</sup>
Global Control Signal				
OSCI	A11	I	CMOS	OSCI: Crystal Oscillator Master Clock A nominal 12.8000 MHz clock provided by a crystal oscillator is input on this pin. It is the master clock for the device.
RST	H13	I pull-up	CMOS	RST: Reset A low pulse of at least 50 $\mu$ s on this pin resets the device. After this pin is high, the device will still be held in reset state for 500 ms (typical).
Input Clock				
IN1	H14	I pull-down	CMOS	IN1: Input Clock 1 Either a 25 MHz, 125 MHz or 156.25 MHz is input on this pin.
IN2	J13	I pull-down	CMOS	IN2: Input Clock 2 Either a 25 MHz, 125 MHz or 156.25 MHz is input on this pin.
IN3	J14	I pull-down	CMOS	IN3: Input Clock 3 Either a 25 MHz, 125 MHz or 156.25 MHz is input on this pin.
IN_APPL_POS	N6	I pull-down	LVPECL/ LVDS	IN_APPL_POS / IN_APPL_NEG: Input Clock APLL
IN_APPL_NEG	P6	I pull-up/ pull-down	LVPECL/ LVDS	Direct input clock to APLL.
Output Clock				
OUT1_POS	N4	O	LVPECL	OUT1_POS / OUT1_NEG: Positive / Negative Output Clock 1 A clock is differentially output on this pair of pins. It outputs either 125 MHz or 156.25 MHz
OUT1_NEG	P4			
OUT2_POS	N2	O	LVPECL	OUT2_POS / OUT2_NEG: Positive / Negative Output Clock 2 A clock is differentially output on this pair of pins. One of 5 copies of either 125 MHz or 156.25 MHz.
OUT2_NEG	P2			
OUT3_POS	L2	O	LVPECL	OUT3_POS / OUT3_NEG: Positive / Negative Output Clock 3 A clock is differentially output on this pair of pins. One of 5 copies of either 125 MHz or 156.25 MHz.
OUT3_NEG	L1			
OUT4_POS	J2	O	LVPECL	OUT4_POS / OUT4_NEG: Positive / Negative Output Clock 4 A clock is differentially output on this pair of pins. One of 5 copies of either 125 MHz or 156.25 MHz.
OUT4_NEG	J1			
OUT5_POS	E2	O	LVPECL	OUT5_POS / OUT5_NEG: Positive / Negative Output Clock 5 A clock is differentially output on this pair of pins. One of 5 copies of either 125 MHz or 156.25 MHz.
OUT5_NEG	E1			
OUT6_POS	B3	O	LVPECL	OUT6_POS / OUT6_NEG: Positive / Negative Output Clock 6 A clock is differentially output on this pair of pins. One of 5 copies of either 125 MHz or 156.25 MHz.
OUT6_NEG	A3			
OUT7	F13	O	CMOS	OUT7: CMOS Output Clock 7 A free run 25 MHz clock is output on this pin.
Miscellaneous				
CAP1, CAP2, CAP3	L10, L12, L14	Output	Analog	CAP1, CAP2 and CAP3: Analog Power Filter Capacitor connection 1 to 3 Connect a 10uF capacitor in parallel with a low ESR 100nF capacitor between these pins and VSS1
XTAL_IN	P10	Input	Analog	Crystal oscillator input. Crystal oscillator input for APLL.
XTAL_OUT	N10	Output	Analog	Crystal oscillator output. Crystal oscillator output for APLL.
Lock Indication Signals				
DPLL_LOCK	J11	O	CMOS	DPLL lock indicator. This pin goes high when DPLL is locked.

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description <sup>1</sup>
Microprocessor Interface				
INT_REQ	C13	O	CMOS	<b>INT_REQ: Interrupt Request</b> This pin is used as an interrupt request. The output characteristics are determined by the HZ_EN bit (b1, 0CH) and the INT_POL bit (b0, 0CH).
I2C_SCL	K13	I	Open Drain	<b>I2C_SCL: Serial Clock Line</b> In I2C mode, the serial clock is input on this pin.
I2C_SDA	K14	I/O	Open Drain	<b>I2C_SDA: Serial Data Input/Output</b> In I2C mode, this pin is used as the input/output for the serial data.
I2C_AD1	L8	I pull-up	CMOS	<b>I2C_AD1: Device Address Bit 1</b> In I2C mode, I2C_AD[2:0] pins are the address bus of the microprocessor interface.
I2C_AD2	L9	I pull-up	CMOS	<b>I2C_AD2: Device Address Bit 2</b> In I2C mode, I2C_AD[2:0] pins are the address bus of the microprocessor interface.
JTAG (per IEEE 1149.1)				
TRST	A14	I pull-down	CMOS	<b>TRST: JTAG Test Reset (Active Low)</b> A low signal on this pin resets the JTAG test port. This pin should be connected to ground when JTAG is not used.
TMS	A12	I pull-up	CMOS	<b>TMS: JTAG Test Mode Select</b> The signal on this pin controls the JTAG test performance and is sampled on the rising edge of TCK.
TCK	B10	I pull-down	CMOS	<b>TCK: JTAG Test Clock</b> The clock for the JTAG test is input on this pin. TDI and TMS are sampled on the rising edge of TCK and TDO is updated on the falling edge of TCK. If TCK is idle at a low level, all stored-state devices contained in the test logic will indefinitely retain their state.
TDI	A8	I pull-up	CMOS	<b>TDI: JTAG Test Data Input</b> The test data is input on this pin. It is clocked into the device on the rising edge of TCK.
TDO	B8	O	CMOS	<b>TDO: JTAG Test Data Output</b> The test data is output on this pin. It is clocked out of the device on the falling edge of TCK. TDO pin outputs a high impedance signal except during the process of data scanning. This pin can indicate the interrupt of DPLL selected input clock fail, as determined by the LOS_FLAG_ON_TDO bit (b6, 0BH).
Power & Ground				
VDDD	D8, E8, F8, F10, G7, G9, H8, H10, K9	Power	-	Digital Core Power - +3.3V DC nominal
VDDDO	B14, C7, F12	Power		Digital Output Power - +3.3V DC nominal
VDDA	C9, C11, C12, D10, D12, E11, J10, P9, P11, P14	Power		Analog Core Power - +3.3V DC nominal
VDDAO	A2, C2, D5, F1, F5, G2, H1, H3, J3, J5, J7, K4, K6, L3, M1, M5, M7, P1, P5	Power		Analog Output Power - +3.3V DC nominal
VSSD	D7, E7, F7, F9, G6, G10, H7, H9, K8, K10	Ground	-	Ground
VSSDO	B13, C8, F14	Ground	-	Ground
VSSA	B9, B11, B12, C10, D11, E10, E12, J9, L11, L13, M9, M10, M11, N9, N11, N14	Ground	-	Analog Ground

Table 1: Pin Description (Continued)

Name	Pin No.	I/O	Type	Description <sup>1</sup>
VSSAO	B2, B4, D1, D2, D4, E3, E4, E5, F2, F3, F4, F6, G1, G3, G4, G5, H2, H4, H5, H6, J4, J6, J8, K1, K2, K3, K5, K7, L4, L5, L6, L7, M2, M3, M4, M6, M8, N1, N3, N5, N13, P3	Ground	-	Analog Output Ground
Others				
IC1	A6, A7, A9, A13, B6, B7, C5, C6, C14, D6, D9, D13, D14, E9, E13, E14, F11, G8, G11, G12, G13, G14, H11, H12, J12, K11, K12, N12, P12, P13	-	-	IC1: Internal Connection Internal Use. These pins should be left open for normal operation.
IC2	A10, N7, N8, P7, P8	-	-	IC2: Internal Connection Internal Use. These pins should be left open for normal operation.
IC3	E6	-	-	IC3: Internal Connection Internal Use. This pin should be left open for normal operation.
NC	A1, A4, A5, B1, B5, C1, C3, C4, D3, M12, M13, M14	-	-	NC: Not Connected These pins should be left open for normal operation.

Note:

1. All the unused input pins should be connected to ground; the output of all the unused output pins are don't-care.

## 2.1 RECOMMENDATIONS FOR UNUSED INPUT AND OUTPUT PINS

### 2.1.1 INPUTS

#### Control Pins

All control pins have internal pull-ups or pull-downs; additional resistance is not required but can be added for additional protection. A 1kΩ resistor can be used.

#### Single-Ended Clock Inputs

For protection, unused single-ended clock inputs should be tied to ground.

#### Differential Clock Inputs

For applications not requiring the use of a differential input, both \*\_POS and \*\_NEG can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from \_POS to ground.

#### XTAL Inputs

For applications not requiring the use of a crystal oscillator input, both \_IN and \_OUT can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from \_IN to ground.

### 2.1.2 OUTPUTS

#### Status Pins

For applications not requiring the use of a status pin, we recommend bringing out to a test point for debugging purposes.

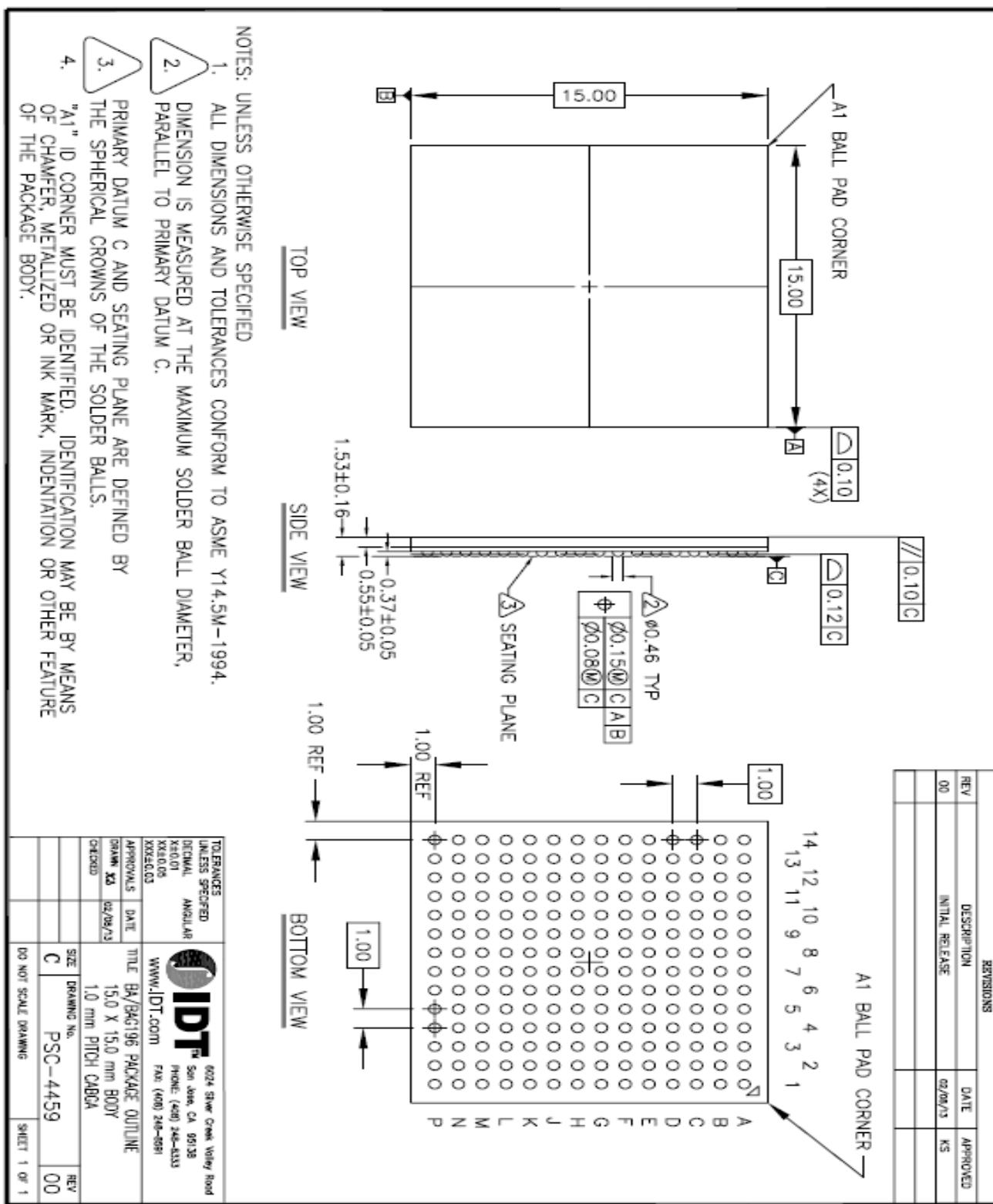
#### Single-Ended Clock Outputs

All unused single-ended clock outputs can be left floating, or can be brought out to a test point for debugging purposes.

#### Differential Clock Outputs

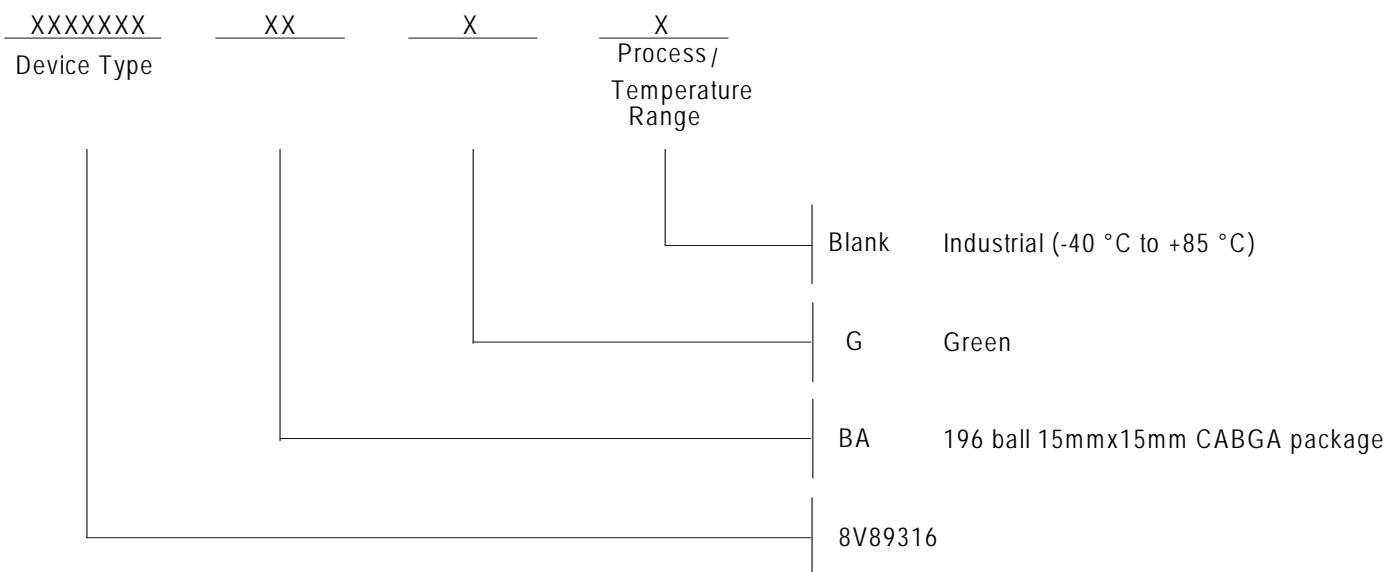
All unused differential outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

## PACKAGE DIMENSIONS



**Figure 3. 196-Pin BAG Package Dimensions**

## ORDERING INFORMATION



## REVISION HISTORY

IDT Confidential

## IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES ("RENESAS") PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

### Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

### Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

### Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit [www.renesas.com/contact-us/](http://www.renesas.com/contact-us/).