

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 1.1X10⁻⁵ ppm and instantaneous holdover accuracy is 4.4X10⁻⁸ 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

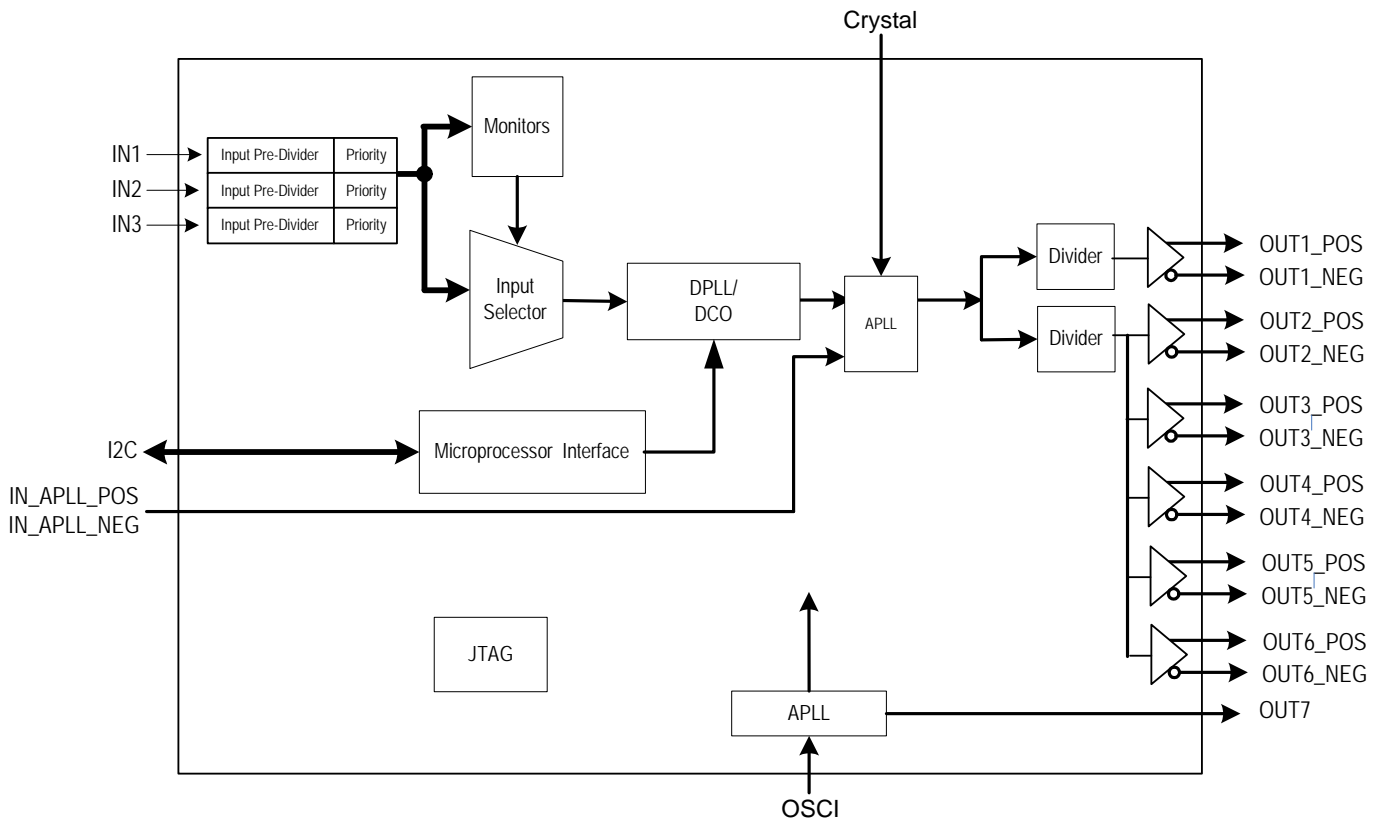


Figure 1. Functional Block Diagram

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	VDDD	IC1	VDDA	VSSA	VDDA	IC1	IC1	D
E	OUT5_NEG	OUT5_POS	VSSAO	VSSAO	VSSAO	IC3	VSSD	VDDD	IC1	VSSA	VDDA	VSSA	IC1	IC1	E
F	VDDAO	VSSAO	VSSAO	VSSAO	VDDAO	VSSAO	VSSD	VDDD	VSSD	VDDD	IC1	VDDDO	OUT7	VSSDO	F
G	VSSAO	VDDAO	VSSAO	VSSAO	VSSAO	VSSD	VDDD	IC1	VDDD	VSSD	IC1	IC1	IC1	IC1	G
H	VDDAO	VSSAO	VDDAO	VSSAO	VSSAO	VSSAO	VSSD	VDDD	VSSD	VDDD	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	VDDD	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_APLL_POS	IC2	IC2	VSSA	XTAL_OUT	VSSA	IC1	VSSAO	VSSA	N
P	VDDAO	OUT2_NEG	VSSAO	OUT1_NEG	VDDAO	IN_APLL_NEG	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 ¹
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 μ 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_APLL_POS IN_APLL_NEG	N6 P6	I pull-down I pull-up/ pull-down	LVPECL/ LVDS	IN_APLL_POS/ IN_APLL_NEG: Input Clock APLL Direct input clock to APLL.
Output Clock				
OUT1_POS OUT1_NEG	N4 P4	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
OUT2_POS OUT2_NEG	N2 P2	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.
OUT3_POS OUT3_NEG	L2 L1	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.
OUT4_POS OUT4_NEG	J2 J1	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.
OUT5_POS OUT5_NEG	E2 E1	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.
OUT6_POS OUT6_NEG	B3 A3	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.
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 10 μ F 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 ¹
Microprocessor Interface				
INT_REQ	C13	O	CMOS	INT_REQ: Interrupt Request 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	I2C_SCL: Serial Clock Line In I2C mode, the serial clock is input on this pin.
I2C_SDA	K14	I/O	Open Drain	I2C_SDA: Serial Data Input/Output In I2C mode, this pin is used as the input/output for the serial data.
I2C_AD1	L8	I pull-up	CMOS	I2C_AD1: Device Address Bit 1 In I2C mode, I2C_AD[2:0] pins are the address bus of the microprocessor interface.
I2C_AD2	L9	I pull-up	CMOS	I2C_AD2: Device Address Bit 2 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	TRST: JTAG Test Reset (Active Low) 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	TMS: JTAG Test Mode Select 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	TCK: JTAG Test Clock 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	TDI: JTAG Test Data Input The test data is input on this pin. It is clocked into the device on the rising edge of TCK.
TDO	B8	O	CMOS	TDO: JTAG Test Data Output 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 ¹
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 1k Ω 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 1k Ω 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 1k Ω 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

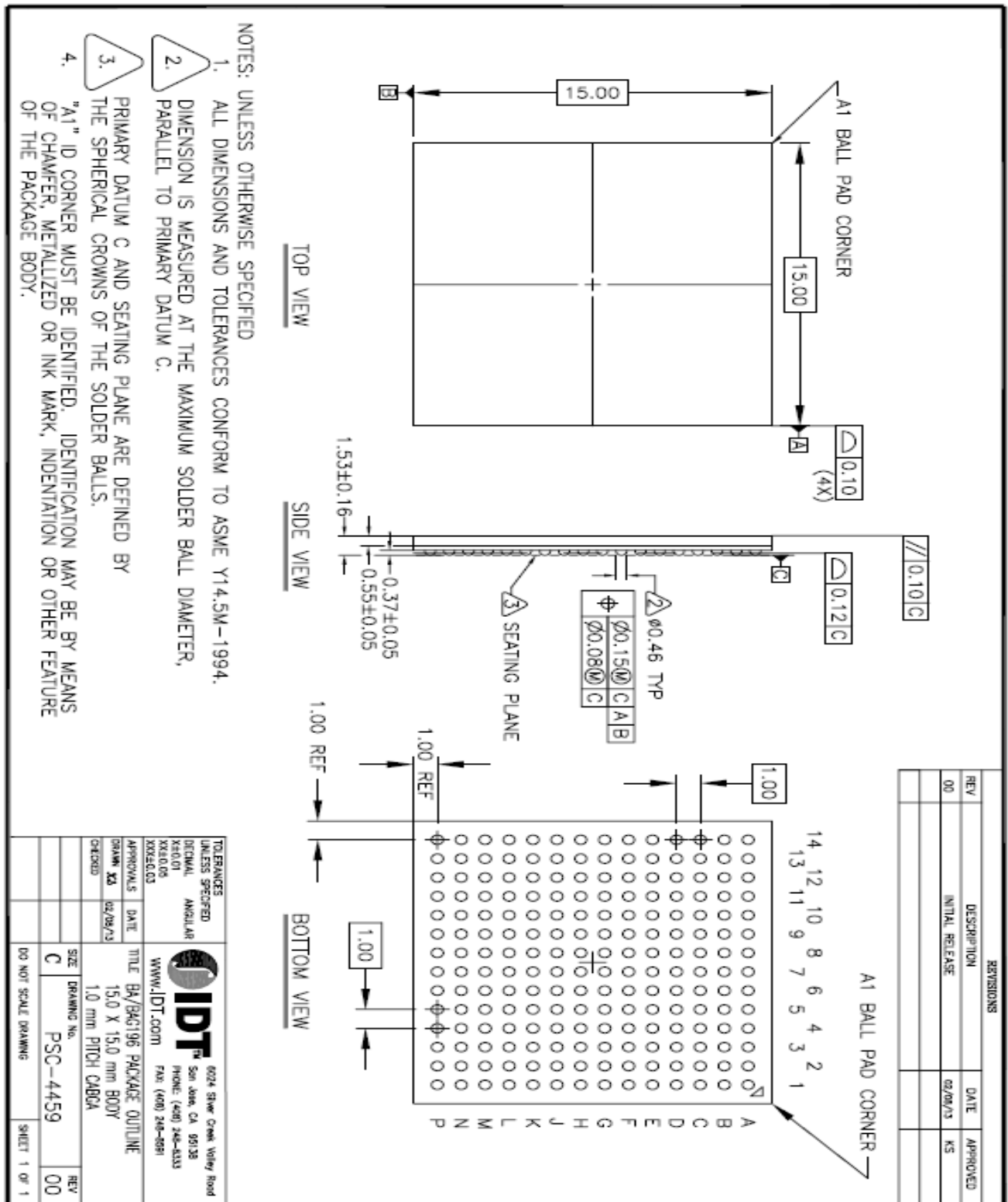
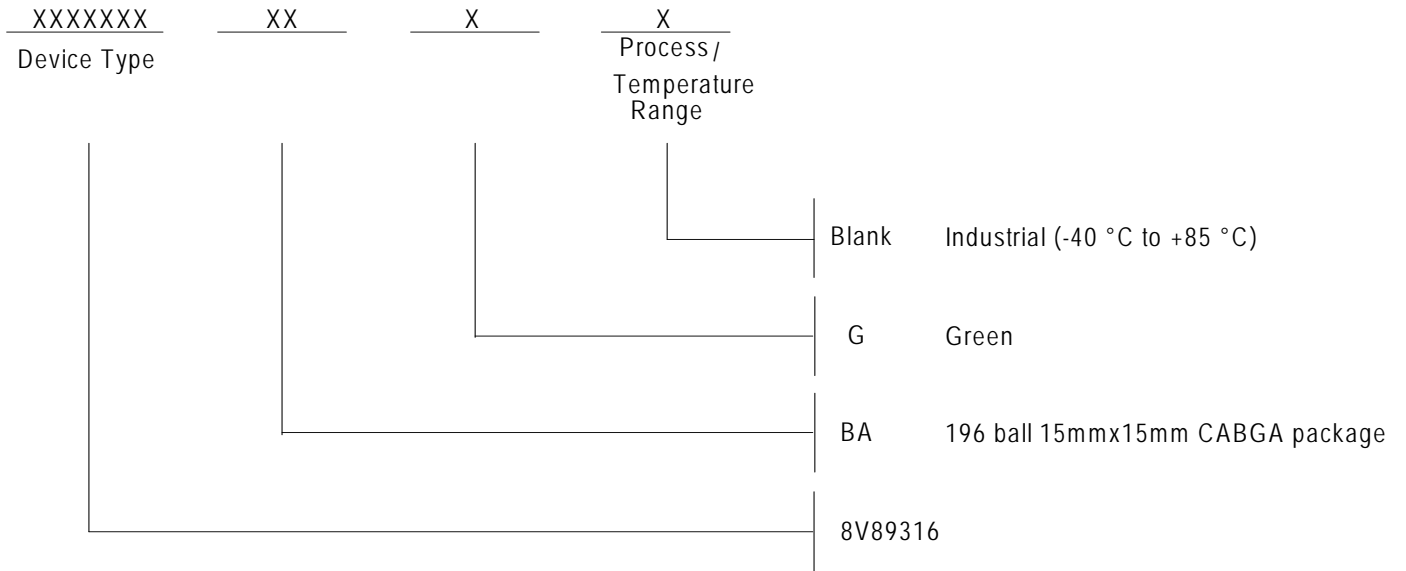


Figure 3. 196-Pin BAG Package Dimensions

ORDERING INFORMATION



REVISION HISTORY

IDT Confidential

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
 - "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
 - "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

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/

Trademarks

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