General Description

The 83908-02 is a low skew, high performance 1-to-8 Crystal Oscillator//Crystal-to-LVCMOS fanout buffer. The 83908-02 has selectable single-ended clock or two crystal-oscillator inputs. There is an output enable to disable the outputs by placing them into a high-impedance state.

Guaranteed output and part-to-part skew characteristics make the 83908-02 ideal for those applications demanding well defined performance and repeatability.

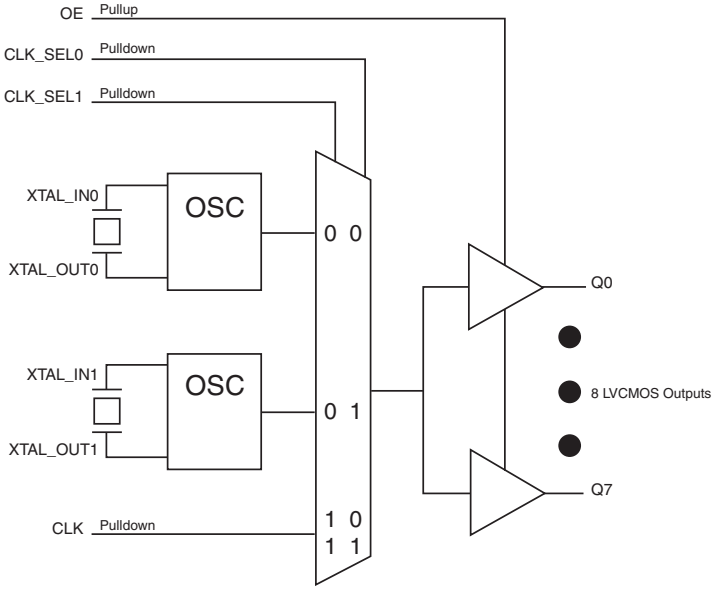
Features

- Eight LVCMOS / LVTTL outputs, 19Ω typical output impedance at $V_{DD} = V_{DDO} = 3.3V$
- Two crystal oscillator input pairs
  One LVCMOS / LVTTL clock input
- Crystal input frequency range: 10MHz – 40MHz
- Output frequency: 200MHz (maximum)
- Output skew: 70ps (maximum) at $V_{DD} = V_{DDO} = 3.3V$
- Part-to-part skew: 700ps (maximum) at $V_{DD} = V_{DDO} = 3.3V$
- RMS phase jitter @ 25MHz output, using a 25MHz crystal, (12kHz – 10MHz): 0.39ps (typical) at $V_{DD} = V_{DDO} = 3.3V$
- RMS phase noise at 25MHz

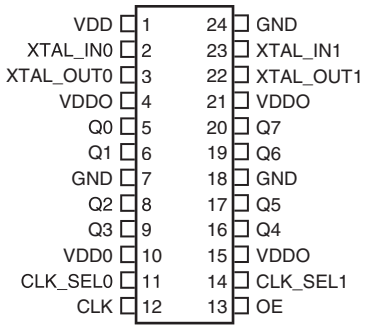
Offset	Noise Power
100Hz	-111.4 dBc/Hz
1kHz	-139.9 dBc/Hz
10kHz	-157.3 dBc/Hz
100kHz	-157.5 dBc/Hz

- Power Supply Voltage Modes:
  Core / Output
  3.3V / 3.3V
  3.3V / 2.5V
  3.3V / 1.8V
  2.5V / 2.5V
  2.5V / 1.8V
- 0°C to 70°C ambient operating temperature
- Lead-free (RoHS 6) packaging

Block Diagram



Pin Assignment



83908-02

24-Lead, 173-MIL TSSOP
4.4mm x 7.8mm x 0.925mm package body
G Package
Top View

Pin Descriptions and Pin Characteristics

Table 1. Pin Descriptions

Number	Name	Type		Description
1	V_{DD}	Power		Power supply pin.
2, 3	XTAL_IN0, XTAL_OUT0	Input		Crystal oscillator interface. XTAL_IN0 is the input. XTAL_OUT0 is the output.
4, 10, 15, 21	V_{DDO}	Power		Output supply pins.
5, 6, 8, 9, 16, 17, 19, 20	Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7	Output		Single-ended clock outputs. LVCMOS/LVTTL interface levels.
7, 18, 24	GND	Power		Power supply ground.
11, 14	CLK_SEL0, CLK_SEL1	Input	Pulldown	Clock select inputs. See Table 3, *Input Reference Function Table.* LVCMOS/LVTTL interface levels.
12	CLK	Input	Pulldown	Single-ended clock input. LVCMOS/LVTTL interface levels.
13	OE	Input	Pullup	Output enable. When LOW, outputs are in high-impedance state. When HIGH, outputs are active. LVCMOS/LVTTL interface levels.
22, 23	XTAL_OUT1, XTAL_IN1	Input		Crystal oscillator interface. XTAL_IN1 is the input. XTAL_OUT1 is the output.

NOTE: *Pullup* and *Pulldown* refer to internal input resistors. See Table 2, *Pin Characteristics,* for typical values.

Table 2. Pin Characteristics

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
C_{IN}	Input Capacitance			4		pF
R_{PULLUP}	Input Pullup Resistor			51		kΩ
$R_{PULLDOWN}$	Input Pulldown Resistor			51		kΩ
C_{PD}	Power Dissipation Capacitance (per output)	V_{DDO} = 3.465V		7		pF
		V_{DDO} = 2.625V		7		pF
		V_{DDO} = 2.0V		6		pF
R_{OUT}	Output Impedance	V_{DDO} = 3.3V ±5%		19		Ω
		V_{DDO} = 2.5V ±5%		21		Ω
		V_{DDO} = 1.8V ±0.2V		32		Ω

Function Table

Table 3. Input Reference Function Table

Control Inputs		Reference	
CLK_SEL1	CLK_SEL0		
0	0	XTAL0 enabled (default)	XTAL1 disabled
0	1	XTAL1 enabled	XTAL0 disabled
1	0	CLK enabled	XTAL0 and XTAL1 disabled
1	1	CLK enabled	XTAL0 and XTAL1 disabled

Absolute Maximum Ratings

NOTE: Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of the product at these conditions or any conditions beyond those listed in the *DC Characteristics or AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

Item	Rating
Supply Voltage, V_{DD}	4.6V
Inputs, V_I	-0.5V to V_{DD} + 0.5V
Outputs, V_O	-0.5V to V_{DDO} + 0.5V
Package Thermal Impedance, θ_{JA}	87.8°C/W (0 mps)
Storage Temperature, T_{STG}	-65°C to 150°C

DC Electrical Characteristics

Table 4A. Power Supply DC Characteristics, V_{DD} = V_{DDO} = 3.3V ±5%, T_A = 0°C to 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		3.135	3.3	3.465	V
I_{DD}	Power Supply Current	No Load & XTALx selected			30	mA
		No Load & CLK selected			1	mA
I_{DDO}	Output Supply Current	No Load & CLK selected			1	mA

Table 4B. Power Supply DC Characteristics, V_{DD} = 3.3V ±5%, V_{DDO} = 2.5V ±5%, T_A = 0°C to 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Power Supply Current	No Load & XTALx selected			30	mA
		No Load & CLK selected			1	mA
I_{DDO}	Output Supply Current	No Load & CLK selected			1	mA

Table 4C. Power Supply DC Characteristics, V_{DD} = 3.3V ±5%, V_{DDO} = 1.8V ±0.2V, T_A = 0°C to 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		3.135	3.3	3.465	V
V_{DDO}	Output Supply Voltage		1.6	1.8	2.0	V
I_{DD}	Power Supply Current	No Load & XTALx selected			30	mA
		No Load & CLK selected			1	mA
I_{DDO}	Output Supply Current	No Load & CLK selected			1	mA

Table 4D. Power Supply DC Characteristics, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = 0°C$ to $70°C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		2.375	2.5	2.625	V
V_{DDO}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Power Supply Current	No Load & XTALx selected			20	mA
		No Load & CLK selected			1	mA
I_{DDO}	Output Supply Current	No Load & CLK selected			1	mA

Table 4E. Power Supply DC Characteristics, $V_{DD} = 2.5V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = 0°C$ to $70°C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Core Supply Voltage		2.375	2.5	2.625	V
V_{DDO}	Output Supply Voltage		1.6	1.8	2.0	V
I_{DD}	Power Supply Current	No Load & XTALx selected			20	mA
		No Load & CLK selected			1	mA
I_{DDO}	Output Supply Current	No Load & CLK selected			1	mA

Table 4F. LVCMOS/LVTTL DC Characteristics, $T_A = 0°C$ to $70°C$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage		$V_{DD} = 3.3V \pm 5\%$	2.2		$V_{DD} + 0.3$	V
			$V_{DD} = 2.5V \pm 5\%$	1.6		$V_{DD} + 0.3$	V
V_{IL}	Input Low Voltage		$V_{DD} = 3.3V \pm 5\%$	-0.3		1.3	V
			$V_{DD} = 2.5V \pm 5\%$	-0.3		0.9	V
I_{IH}	Input High Current	CLK, CLK_SEL[0:1]	$V_{DD} = 3.3V$ or $2.5V \pm 5\%$			150	µA
		OE	$V_{DD} = 3.3V$ or $2.5V \pm 5\%$			5	µA
I_{IL}	Input Low Current	CLK, CLK_SEL[0:1]	$V_{DD} = 3.3V$ or $2.5V \pm 5\%$	-5			µA
		OE	$V_{DD} = 3.3V$ or $2.5V \pm 5\%$	-150			µA
V_{OH}	Output High Voltage; NOTE 1		$V_{DDO} = 3.3V \pm 5\%$	2.6			V
			$V_{DDO} = 2.5V \pm 5\%$	1.8			V
			$V_{DDO} = 1.8V \pm 0.2V$	1.2			V
V_{OL}	Output Low Voltage; NOTE 1		$V_{DDO} = 3.3V \pm 5\%$			0.6	V
			$V_{DDO} = 2.5V \pm 5\%$			0.5	V
			$V_{DDO} = 1.8V \pm 0.2V$			0.4	V

NOTE 1: Outputs terminated with 50Ω to $V_{DDO}/2$. See Parameter Measurement section, *Load Test Circuit diagram.*

Table 5. Crystal Characteristics

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation			Fundamental		
Frequency		10		40	MHz
Equivalent Series Resistance (ESR)				50	Ω
Shunt Capacitance				7	pF
Drive Level				1	mW

AC Electrical Characteristics

Table 6A. AC Characteristics, $V_{DD} = V_{DDO} = 3.3V \pm 5\%$, $T_A = 0°C$ to $70°C$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency	w/external XTAL		10		40	MHz
		w/external CLK				200	MHz
tp_{LH}	Propagation Delay, Low to High; NOTE 1			1.4	2.0	2.6	ns
*t*sk(o)	Output Skew; NOTE 2					70	ps
*t*sk(pp)	Part-to-Part Skew; NOTE 2, 3					700	ps
*t*jit(θ)	RMS Phase Jitter, Random; NOTE 4		25MHz, Integration Range: 12kHz – 10MHz		0.39		ps
t_R / t_F	Output Rise/Fall Time		20% to 80%	200		800	ps
odc	Output Duty Cycle	w/external XTAL	$f \leq 38.88$MHz	45		55	%
		w/external CLK	$f \leq 133$MHz	47		53	%
t_{EN}	Output Enable Time; NOTE 5					10	ns
t_{DIS}	Output Disable Time; NOTE 5					10	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE 1: Measured from the $V_{DD}/2$ of the input to $V_{DDO}/2$ of the output.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at $V_{DDO}/2$.
NOTE 4: Phase jitter is dependent on the input source used.
NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

Table 6B. AC Characteristics, V_{DD} = 3.3V ±5%, V_{DDO} = 2.5V ±5%, T_A = 0°C to 70°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency	w/ external XTAL		10		40	MHz
		w/ external CLK				200	MHz
tp_{LH}	Propagation Delay, Low to High; NOTE 1			1.5	2.1	2.7	ns
*t*sk(o)	Output Skew; NOTE 2					70	ps
*t*sk(pp)	Part-to-Part Skew; NOTE 2, 3					700	ps
*t*jit(θ)	RMS Phase Jitter, Random; NOTE 4		25MHz, Integration Range: 12kHz – 10MHz		0.42		ps
t_R / t_F	Output Rise/Fall Time		20% to 80%	200		800	ps
odc	Output Duty Cycle	w/ external XTAL	$f \leq$ 38.88MHz	45		55	%
		w/ external CLK	$f \leq$ 133MHz	47		53	%
t_{EN}	Output Enable Time; NOTE 5					10	ns
t_{DIS}	Output Disable Time; NOTE 5					10	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE 1: Measured from the V_{DD}/2 of the input to V_{DDO}/2 of the output.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at V_{DDO}/2.
NOTE 4: Phase jitter is dependent on the input source used.
NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

Table 6C. AC Characteristics, V_{DD} = 3.3V ±5%, V_{DDO} = 1.8V ±0.2V, T_A = 0°C to 70°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency	w/ external XTAL		10		40	MHz
		w/ external CLK				200	MHz
tp_{LH}	Propagation Delay, Low to High; NOTE 1			1.6	2.4	3.2	ns
*t*sk(o)	Output Skew; NOTE 2					70	ps
*t*sk(pp)	Part-to-Part Skew; NOTE 2, 3					700	ps
*t*jit(θ)	RMS Phase Jitter, Random; NOTE 4		25MHz, Integration Range: 12kHz – 10MHz		0.43		ps
t_R / t_F	Output Rise/Fall Time		20% to 80%	200		800	ps
odc	Output Duty Cycle	w/ external XTAL	$f \leq$ 38.88MHz	45		55	%
		w/ external CLK	$f \leq$ 133MHz	47		53	%
t_{EN}	Output Enable Time; NOTE 5					10	ns
t_{DIS}	Output Disable Time; NOTE 5					10	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE 1: Measured from the V_{DD}/2 of the input to V_{DDO}/2 of the output.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at V_{DDO}/2.
NOTE 4: Phase jitter is dependent on the input source used.
NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

Table 6D. AC Characteristics, $V_{DD} = V_{DDO} = 2.5V \pm 5\%$, $T_A = 0°C$ to $70°C$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency	w/ external XTAL		10		40	MHz
		w/ external CLK				200	MHz
tp_{LH}	Propagation Delay, Low to High; NOTE 1			1.7	2.4	3.1	ns
*t*sk(o)	Output Skew; NOTE 2					70	ps
*t*sk(pp)	Part-to-Part Skew; NOTE 2, 3					700	ps
*t*jit(θ)	RMS Phase Jitter, Random; NOTE 4		25MHz, Integration Range: 12kHz – 10MHz		0.44		ps
t_R / t_F	Output Rise/Fall Time		20% to 80%	200		800	ps
odc	Output Duty Cycle	w/ external XTAL	$f \leq 38.88$MHz	45		55	%
		w/ external CLK	$f \leq 133$MHz	47		53	%
t_{EN}	Output Enable Time; NOTE 5					10	ns
t_{DIS}	Output Disable Time; NOTE 5					10	ns

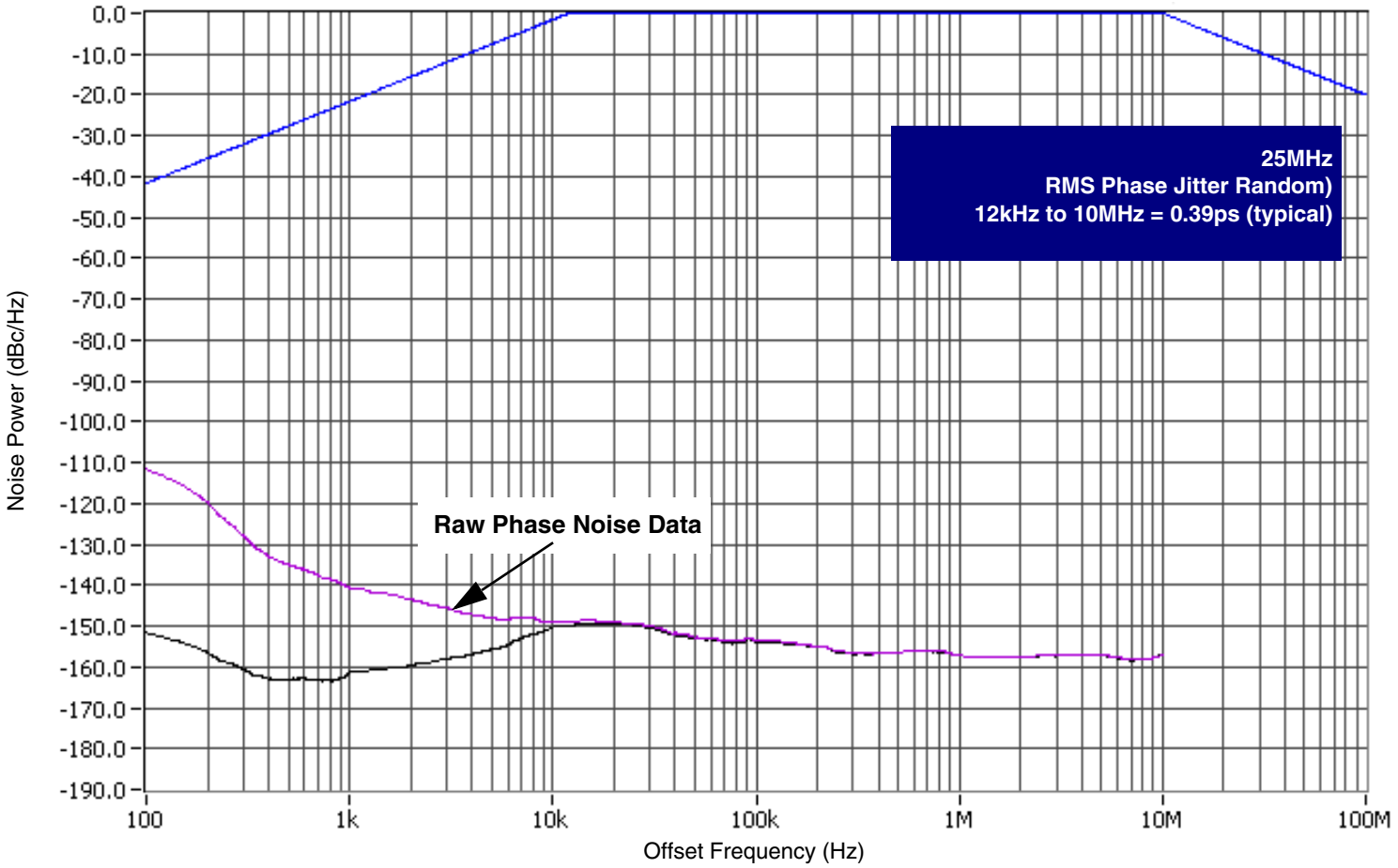
NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE 1: Measured from the $V_{DD}/2$ of the input to $V_{DDO}/2$ of the output.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at $V_{DDO}/2$.
NOTE 4: Phase jitter is dependent on the input source used.
NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

Table 6E. AC Characteristics, $V_{DD} = 2.5V \pm 5\%$, $V_{DDO} = 1.8V \pm 0.2V$, $T_A = 0°C$ to $70°C$

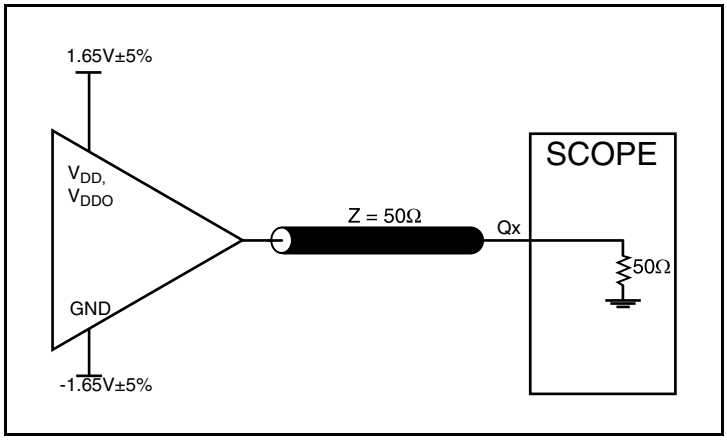
Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency	w/ external XTAL		10		40	MHz
		w/ external CLK				200	MHz
tp_{LH}	Propagation Delay, Low to High; NOTE 1			1.7	2.6	3.5	ns
*t*sk(o)	Output Skew; NOTE 2					70	ps
*t*sk(pp)	Part-to-Part Skew; NOTE 2, 3					700	ps
*t*jit(θ)	RMS Phase Jitter, Random; NOTE 4		25MHz, Integration Range: 12kHz – 10MHz		0.37		ps
t_R / t_F	Output Rise/Fall Time		20% to 80%	200		800	ps
odc	Output Duty Cycle	w/ external XTAL	$f \leq 38.88$MHz	45		55	%
		w/ external CLK	$f \leq 133$MHz	47		53	%
t_{EN}	Output Enable Time; NOTE 5					10	ns
t_{DIS}	Output Disable Time; NOTE 5					10	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.
NOTE 1: Measured from the $V_{DD}/2$ of the input to $V_{DDO}/2$ of the output.
NOTE 2: This parameter is defined in accordance with JEDEC Standard 65.
NOTE 3: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at $V_{DDO}/2$.
NOTE 4: Phase jitter is dependent on the input source used.
NOTE 5: These parameters are guaranteed by characterization. Not tested in production.

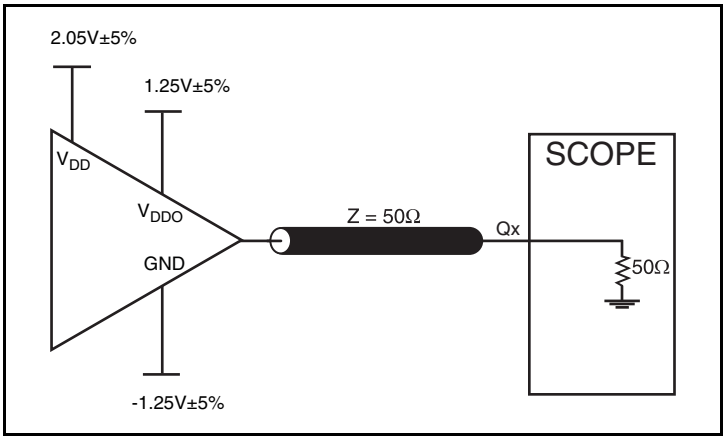
Typical Phase Noise at 25MHz @3.3V/3.3V



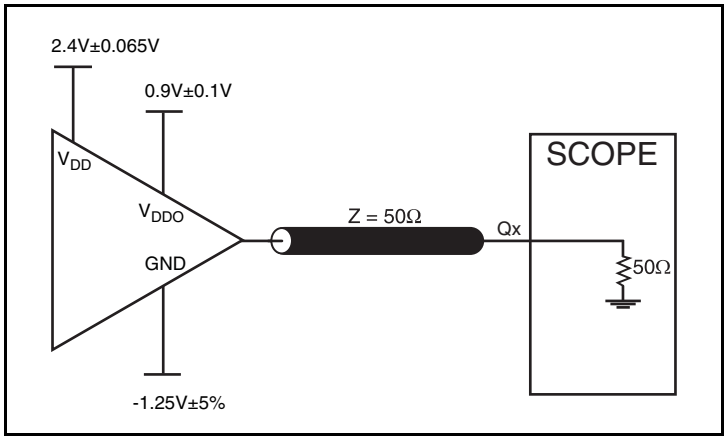
Parameter Measurement Information



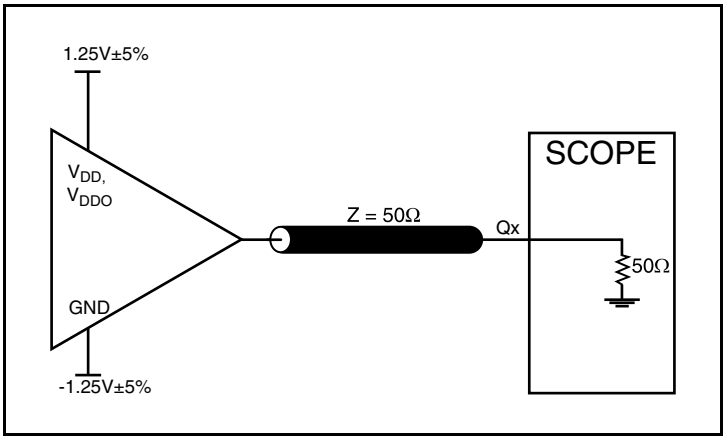
3.3V Core/3.3V LVCMOS Output Load Test Circuit



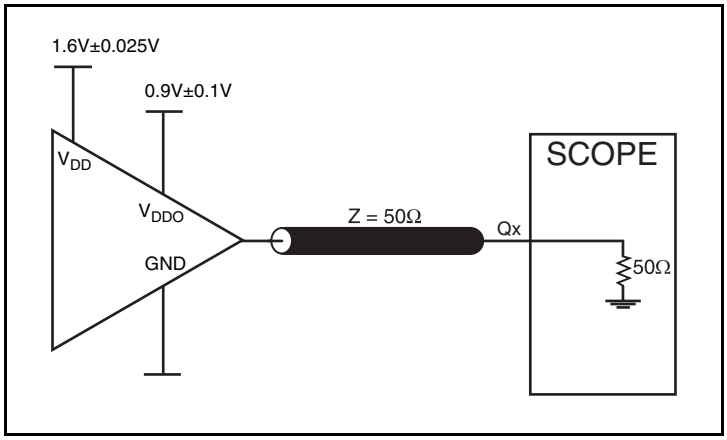
3.3V Core/2.5V LVCMOS Output Load Test Circuit



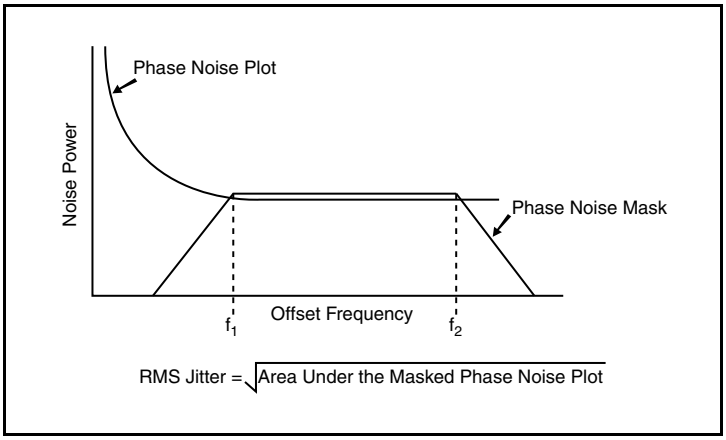
3.3V Core/1.8V LVCMOS Output Load Test Circuit



2.5V Core/2.5V LVCMOS Output Load Test Circuit

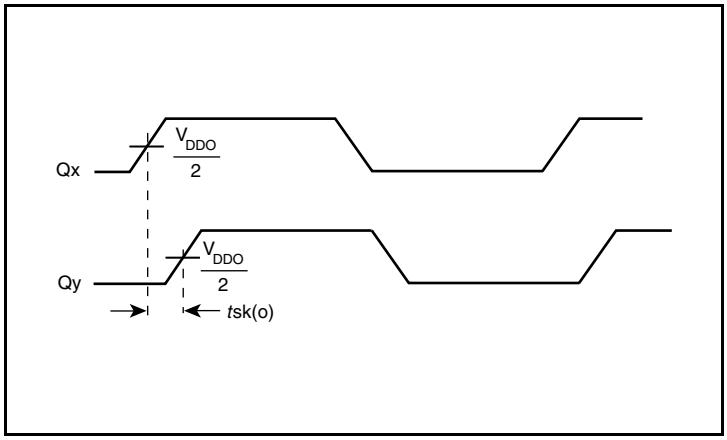


2.5V Core/1.8V LVCMOS Output Load Test Circuit

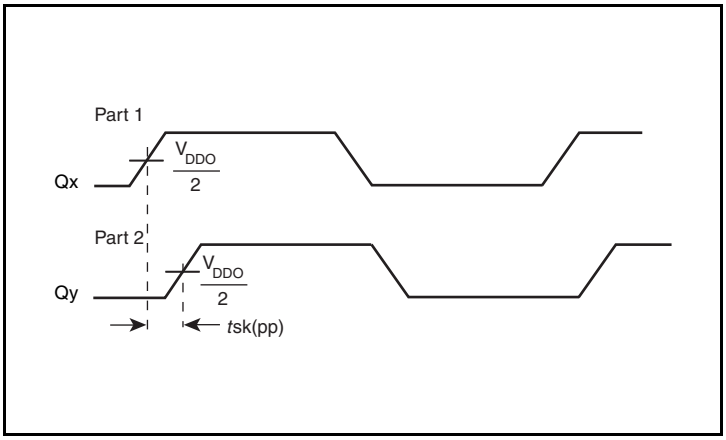


RMS Phase Jitter

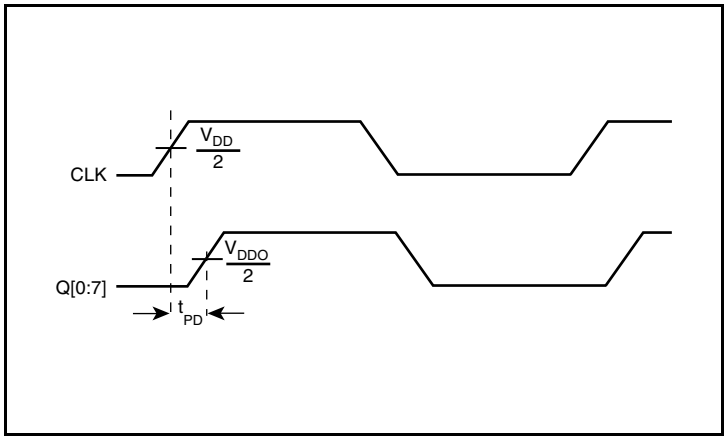
Parameter Measurement Information, continued



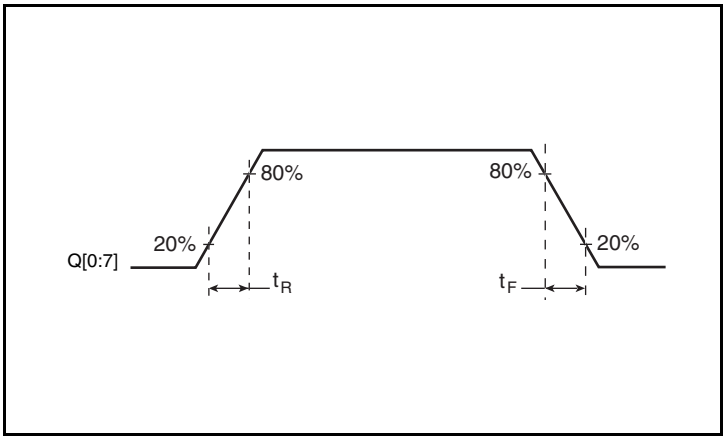
Output Skew



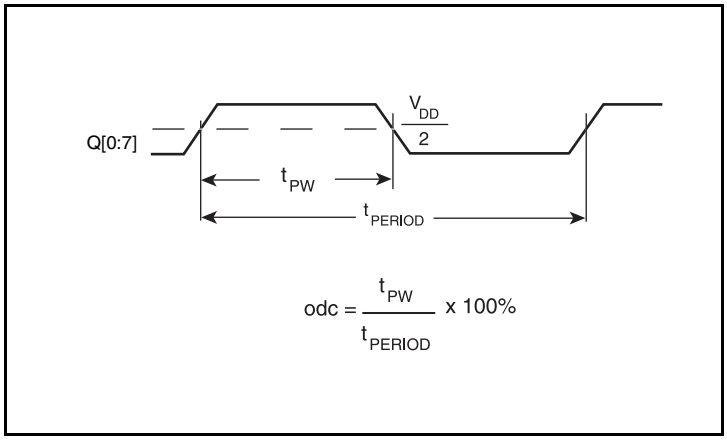
Part-to-Part Skew



Propagation Delay



Output Rise/Fall Time



Output Duty Cycle/Pulse Width/Period

Applications Information

Recommendations for Unused Input and Output Pins

Inputs:

Crystal Inputs

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

CLK Input

For applications not requiring the use of a clock input, it can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from the CLK input to ground.

LVCMOS Control Pins

All control pins have internal pullup and pulldown resistors; additional resistance is not required but can be added for additional protection. A 1kΩ resistor can be used.

Outputs:

LVCMOS Outputs

All unused LVCMOS outputs can be left floating. There should be no trace attached.

Crystal Input Interface

Figure 1 shows an example of 83908-02 crystal interface with a parallel resonant crystal. The frequency accuracy can be fine tuned by adjusting the C1 and C2 values. For a parallel crystal with loading capacitance CL = 18pF, we suggest C1 = 15pF and C2 = 15pF to start with. These values may be slightly fine tuned further to optimize the frequency accuracy for different board layouts. Slightly increasing the C1 and C2 values will slightly reduce the frequency. Slightly decreasing the C1 and C2 values will slightly increase the frequency.

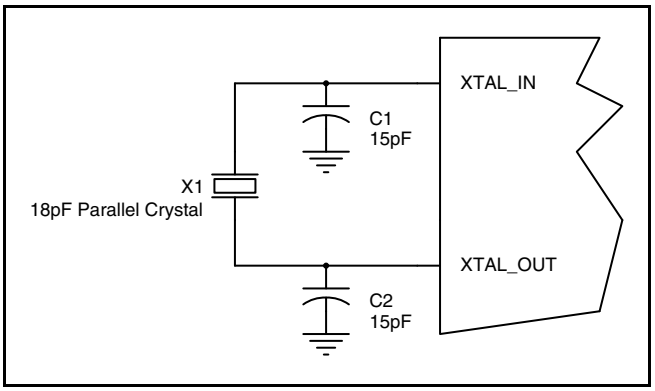


Figure 1. Crystal Input Interface

Overdriving the XTAL Interface

The XTAL_IN input can be overdriven by an LVCMOS driver or by one side of a differential driver through an AC coupling capacitor. The XTAL_OUT pin can be left floating. The amplitude of the input signal should be between 500mV and 1.8V and the slew rate should not be less than 0.2V/nS. For 3.3V LVCMOS inputs, the amplitude must be reduced from full swing to at least half the swing in order to prevent signal interference with the power rail and to reduce internal noise. *Figure 2A* shows an example of the interface diagram for a high speed 3.3V LVCMOS driver. This configuration requires that the sum of the output impedance of the driver (Ro) and the series resistance (Rs) equals the transmission line impedance. In addition, matched termination at the crystal input will attenuate the signal in half. This can be done in one of two ways. First, R1 and R2 in parallel should equal the transmission line impedance. For most 50Ω applications, R1 and R2 can be 100Ω. This can also be accomplished by removing R1 and changing R2 to 50Ω. The values of the resistors can be increased to reduce the loading for a slower and weaker LVCMOS driver. *Figure 2B* shows an example of the interface diagram for an LVPECL driver. This is a standard LVPECL termination with one side of the driver feeding the XTAL_IN input. It is recommended that all components in the schematics be placed in the layout. Though some components might not be used, they can be utilized for debugging purposes. The datasheet specifications are characterized and guaranteed by using a quartz crystal as the input.

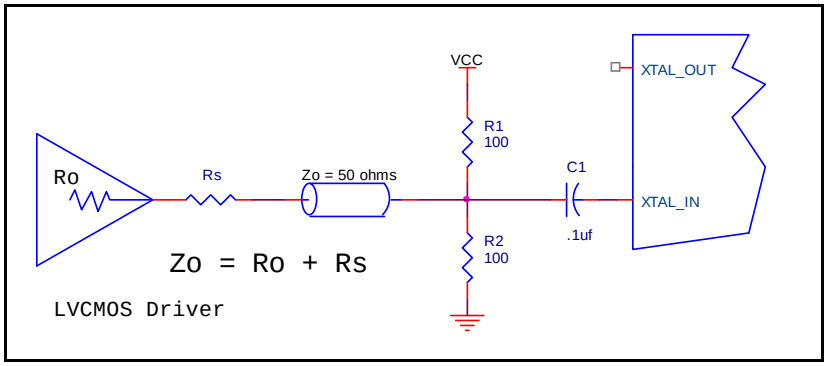


Figure 2A. General Diagram for LVCMOS Driver to XTAL Input Interface

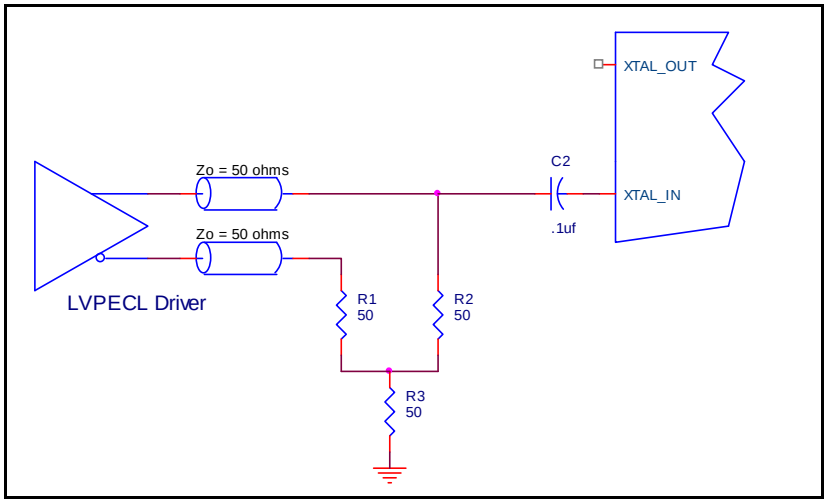


Figure 2B. General Diagram for LVPECL Driver to XTAL Input Interface

Reliability Information

Table 7. θ_{JA} vs. Air Flow Table for a 24-Lead TSSOP

θ_{JA} vs. Air Flow			
Meters per Second	**0**	**1**	**2.5**
Multi-Layer PCB, JEDEC Standard Test Boards	87.8°C/W	83.5°C/W	81.3°C/W

Transistor Count

The transistor count for 83908-02: 277

Package Outline and Package Dimensions

Package Outline - G Suffix for 24-Lead TSSOP

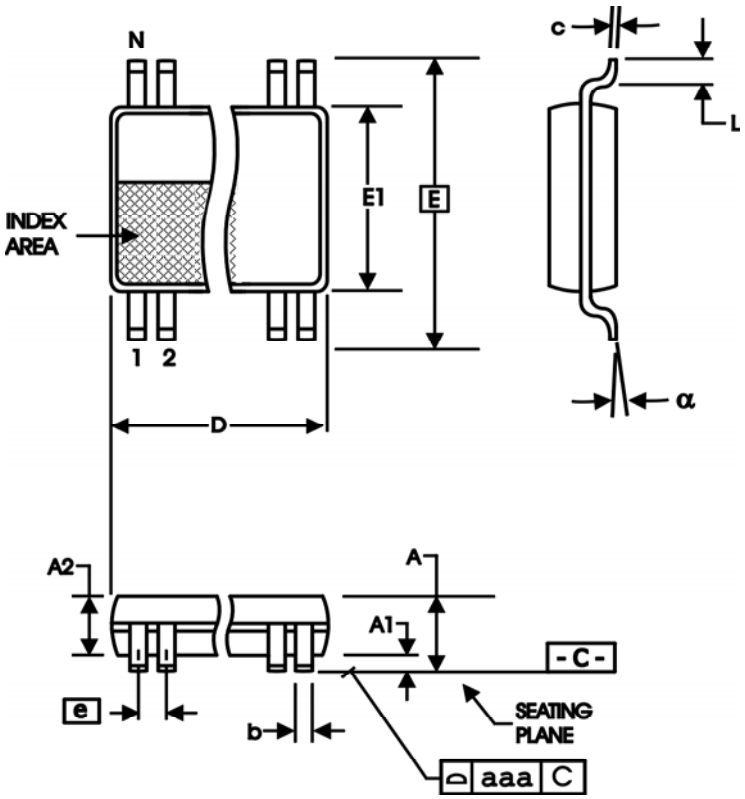


Table 8. Package Dimensions for 24-Lead TSSOP

All Dimensions in Millimeters		
Symbol	**Minimum**	**Maximum**
N	24	
A		1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	7.7	7.9
E	6.40 Basic	
E1	4.30	4.50
e	0.65 Basic	
L	0.45	0.75
α	0°	8°
aaa		0.10

Reference Document: JEDEC Publication 95, MO-153

Ordering Information

Table 9. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
83908AG-02LF	ICS83908AG02L	“Lead-Free” 24-Lead TSSOP	Tube	0°C to 70°C
83908AG-02LFT	ICS83908AG02L	“Lead-Free” 24-Lead TSSOP	Tape & Reel	0°C to 70°C

Revision History Sheet

Rev	Table	Page	Description of Change	Date
B			Deleted “ICS” prefix from part number throughout the datasheet. Updated datasheet header/footer.	4/7/16

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 Jan 2024)

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-us/.

Trademarks

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