
Multiple Output MEMS PCIe Gen1/2/3/4 Clocks for Automotive

Features

- Automotive AEC-Q100 Qualified
- Complies with PCIe Gen1/2/3/4 Common Clock Spec
- Integrated MEMS Resonator Eliminates the Need for External 25 MHz Crystal
- Wide Temperature Range:
 - Automotive Grade 2: -40°C to +105°C
 - Automotive Grade 3: -40°C to +85°C
- 100 MHz HCSL/LVDS/LVCMOS Options Available
- Dedicated Output Enable (OE) Pins for Clock Outputs
- Small Footprints:
 - 14-Lead QFN (DSA557-03, Two Outputs)
 - 20-Lead VQFN (DSA557-04, Three Outputs; DSA557-05, Four Outputs)
- Excellent Shock and Vibration Immunity
 - Qualified to MIL-STD-883
- High Reliability
 - 20x Better MTF than Quartz Oscillators
- Low Current Consumption: 30% Lower than Competing Devices
- Supply Range of 2.25V to 3.63V
- Lead-Free and RoHS Compliant

Applications

- Automotive Infotainment
- Automotive ADAS
- Autonomous Driving
- In-Vehicle Network

General Description

The DSA557 series of high performance PCI Express clock generators use a proven silicon MEMS technology to provide 100 MHz differential output clocks with excellent jitter and stability over a wide range of supply voltages and temperatures. By eliminating the need for quartz or SAW technology, MEMS oscillators significantly enhance reliability and accelerate product development, while meeting stringent clock performance criteria for a variety of communications, storage, and networking applications.

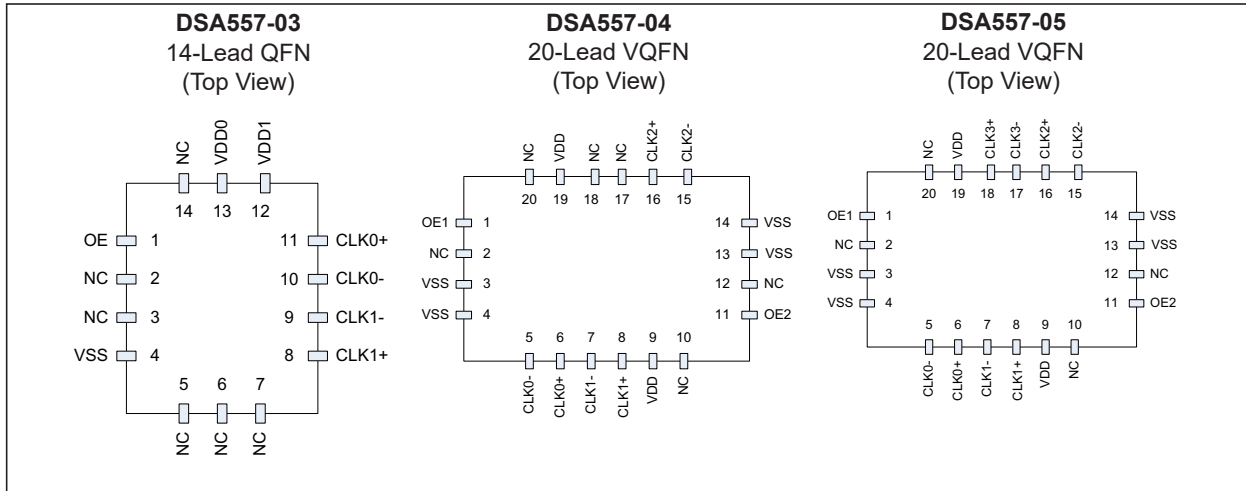
The DSA557-03/04/05 have two, three, and four 100 MHz outputs, respectively. All have output enable/disable features.

The DSA557-03 is available in a space-saving 14-lead QFN package. The DSA557-04 and DSA557-05 are available in a 20-lead VQFN.

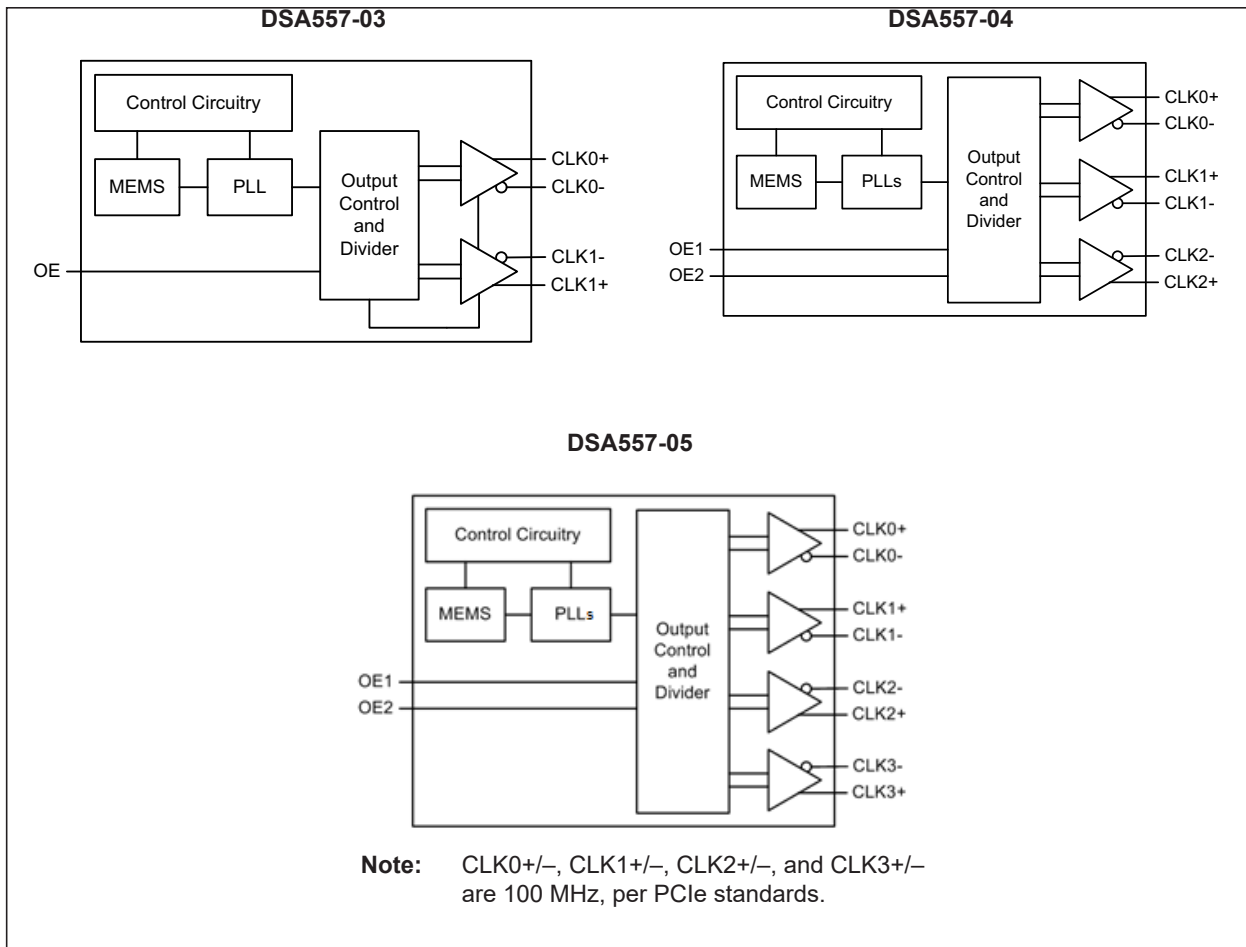
Additional LVDS and LVCMOS output formats are available in addition to the default HCSL output format.

DSA557-03/04/05

Package Types



Block Diagrams



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage	-0.3V to $V_{DD} + 0.3V$
Supply Voltage	-0.3V to +4.0V
ESD Protection on All Pins (HBM)	4 kV
ESD Protection on All Pins (CDM)	1.5 kV

† **Notice:** Stresses 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 those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise specified, T = +25°C, $V_{DD} = 3.3V$.						
Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Supply Voltage	V_{DD}	2.25	—	3.63	V	Note 1
Supply Current, DSA557-03	I_{DD}	—	21	23	mA	HCSL output, EN pin low, output disabled
		—	60	—		HCSL output, EN pin high, output enabled
Supply Current, DSA557-04	I_{DD}	—	42	46	mA	HCSL output, EN pin low, output disabled
		—	100	—		HCSL output, EN pin high, output enabled
Supply Current, DSA557-05	I_{DD}	—	42	46	mA	HCSL output, EN pin low, output disabled
		—	120	—		HCSL output, EN pin high, output enabled
Frequency Stability (including frequency variations due to initial tolerance, temp., and power supply voltage)	Δf	—	—	± 100	ppm	All temperature ranges
		—	—	± 50		
Aging - 1st Year	Δf	—	—	± 5	ppm	± 1 ppm each subsequent year
Startup Time (Note 2)	t_{SU}	—	—	5	ms	T = +25°C
Input Logic Levels						
Input Logic High	V_{IH}	$0.75 \times V_{DD}$	—	—	V	—
Input Logic Low	V_{IL}	—	—	$0.25 \times V_{DD}$	V	—
Output Disable Time (Note 3)	t_{DS}	—	—	5	ns	—
Output Enable Time	t_{EN}	—	—	20	ns	—
Enable Pull-Up Resistor (Note 4)	—	—	40	—	k Ω	Internally pulled up
HCSL Outputs (Note 5)						
Output Logic High	V_{OH}	0.725	—	—	V	$R_L = 50\Omega$
Output Logic Low	V_{OL}	—	—	0.1	V	$R_L = 50\Omega$
Peak-to-Peak Output Swing	—	—	750	—	mV	Single-Ended
Output Frequency	f_{OUT}	—	100	—	MHz	—

DSA557-03/04/05

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise specified, T = +25°C, V _{DD} = 3.3V.						
Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Transition Time (Note 6)	t _r /t _f	200	—	400	ps	20% to 80%, R _L = 50Ω, C _L = 2 pF
Output Duty Cycle	SYM	48	—	52	%	Differential
Period Jitter (Note 7)	J _{PER}	—	2.5	—	ps _{RMS}	f ₀₁ = f ₀₂ = 100 MHz
Jitter, Phase (Common Clock Architecture)	T _J	—	17	86	ps _{PP}	PCIe Gen 1.1, (Note 8) T _J = D _J + 14.069 x R _J (BER 10 ⁻¹²)
	J _{RMS-CCHF}	—	1.46	3.1	ps _{RMS}	PCIe Gen 2.1, 1.5 MHz to Nyquist, (Note 8)
	J _{RMS-CCLF}	—	0.08	3.0	ps _{RMS}	PCIe Gen 2.1, 10 kHz to 1.5 MHz, (Note 8)
	J _{RMS-CC}	—	0.313	1.0	ps _{RMS}	PCIe Gen 3.0, (Note 8)
	J _{RMS-CC}	—	0.313	0.5	ps _{RMS}	PCIe Gen 4.0, 16 GHz, (Note 8)
Integrated Phase Noise (Data Clock Architecture)	J _{RMS-DCHF}	—	2.15	4.0	ps _{RMS}	PCIe Gen 2.1, 1.5 MHz to Nyquist, (Note 8)
	J _{RMS-DCLF}	—	0.06	7.5	ps _{RMS}	PCIe Gen 2.1, 10 kHz to 1.5 MHz, (Note 8)
	J _{RMS-DC}	—	0.32	1.0	ps _{RMS}	PCIe Gen 3.0, (Note 8)
LVDS Output						
Offset Voltage	V _{OS}	1.125	1.25	1.40	V	V _{DD} = 2.5V/3.3V
V _{OS} Magnitude Change	ΔV _{OS}	—	—	50	mV	—
Output High Voltage	V _{OH}	0.9xV _{DD}	—	—	V	—
Output Low Voltage	V _{OL}	—	—	0.1xV _{DD}	V	—
Output Frequency	f _{OUT}	—	100	—	MHz	—
Differential Output Voltage	V _{OD}	275	350	475	mV _{PP}	—
V _{OD} Magnitude Change	ΔV _{OD}	—	—	40	mV	—
LVDS Output Rise/Fall Time	t _r /t _f	—	200	—	ps	20% – 80%
Output Duty Cycle	ODC	48	50	52	%	20% – 80%, R _L = 50Ω, C _L = 2 pF
Period Jitter, Peak to Peak	J _{PTP}	—	2.5	—	ps	f _{OUT} = 100 MHz, Standard Drive
Integrated Phase Noise	J _{PH}	—	0.28	—	ps _{RMS}	200 kHz to 20 MHz @ 100 MHz, T _A = +105°C
		—	0.4	—		100 kHz to 80 MHz @ 100 MHz
		—	1.7	2.0		12 kHz to 10 MHz @ 100 MHz

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise specified, T = +25°C, V_{DD} = 3.3V.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
LVC MOS Output						
Output High Voltage	V _{OH}	0.8xV _{DD}	—	—	V	±10 mA drive current
Output Low Voltage	V _{OL}	—	—	0.2xV _{DD}	V	±10 mA drive current
Output Frequency	f _{OUT}	—	100	—	MHz	—
Output Rise/Fall Time	t _r /t _f	—	1.2	—	ns	20% – 80%, C _L = 15 pF
Output Duty Cycle	ODC	48	50	52	%	f _{OUT} = 100 MHz, Standard Drive
Period Jitter	J _P TP	—	3	—	pS _{RMS}	f _{OUT} = 100 MHz, Standard Drive
Integrated Phase Noise	J _P H	—	0.3	—	pS _{RMS}	200 kHz to 20 MHz @ 100 MHz
		—	0.38	—		100 kHz to 20 MHz @ 100 MHz
		—	1.7	2.0		12 kHz to 20 MHz @ 100 MHz

- Note 1:** Each pin V_{DD} should be filtered with a 0.1 μF capacitor.
- 2:** t_{SU} is time to 100 ppm of output frequency after V_{DD} is applied and outputs are enabled.
- 3:** Output Waveform and Test Circuit figures define the parameters.
- 4:** Output is enabled if pad is floated or not connected.
- 5:** Contact Microchip for alternate output options (LVDS, LVC MOS).
- 6:** Output Waveform and Connection Diagram define the parameters.
- 7:** Period Jitter includes crosstalk from adjacent output.
- 8:** Jitter limits established by Gen 1.1, Gen 2.1, Gen 3.0, and Gen 4.0 PCIe standards.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Temperature Range	T _A	-40	—	+85	°C	Ordering Option I
		-40	—	+105	°C	Ordering Option L
Junction Operating Temperature	T _J	—	—	+150	°C	—
Storage Temperature Range	T _S	-55	—	+150	°C	—
Lead Temperature	—	—	+260	—	°C	Soldering, 40s

DSA557-03/04/05

2.0 PIN DESCRIPTIONS AND CONNECTION DIAGRAMS

The descriptions of the pins are listed in [Table 2-1](#), [Table 2-2](#), and [Table 2-3](#).

TABLE 2-1: DSA557-03 QFN-14 PIN FUNCTION TABLE

Pin Number	Pin Name	Pin Type	Description
1	OE	I	Output enable, active-high.
2	NC	N/A	Ground recommended or leave as a NC.
3	NC	N/A	Ground recommended or leave as a NC.
4	VSS	P	Ground.
5	NC	N/A	Ground recommended or leave as a NC.
6	NC	N/A	Ground recommended or leave as a NC.
7	NC	N/A	Ground recommended or leave as a NC.
8	CLK1+	O	True output of differential pair.
9	CLK1-	O	Complement output of differential pair.
10	CLK0-	O	Complement output of differential pair.
11	CLK0+	O	True output of differential pair.
12	VDD1	P	Power supply for core and output 1 (CLK1+/CLK1-)
13	VDD0	P	Power supply for output 0 (CLK0+/CLK0-)
14	NC	N/A	Ground recommended or leave as a NC.

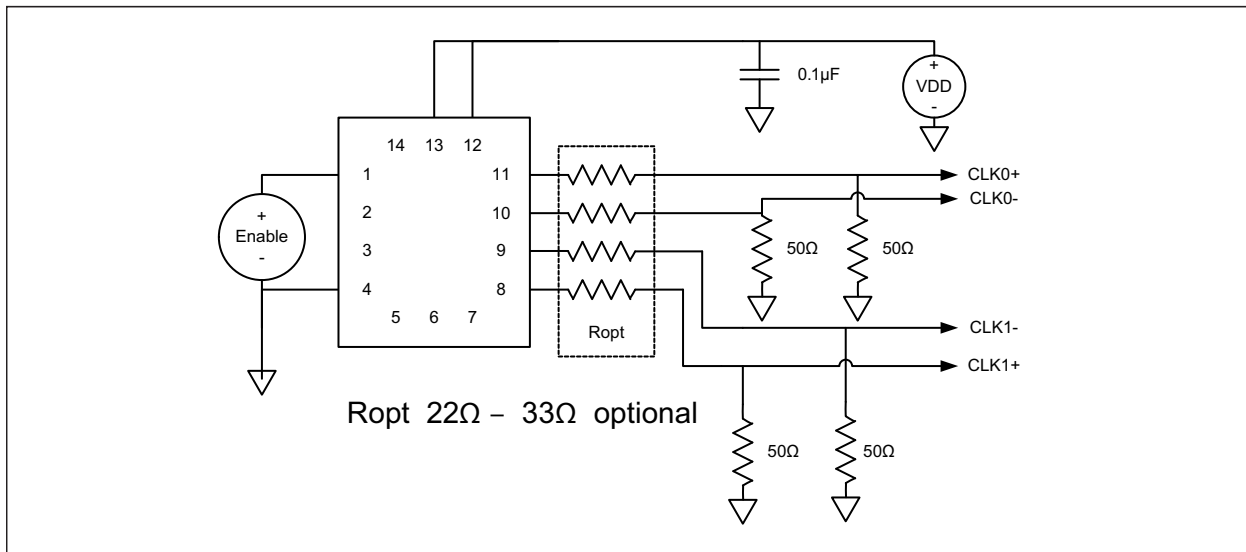


FIGURE 2-1: 14-Lead QFN Connection Diagram with Two HCSL Outputs.

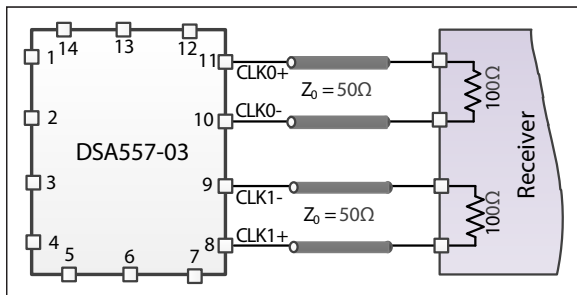


FIGURE 2-2: LVDS Outputs.

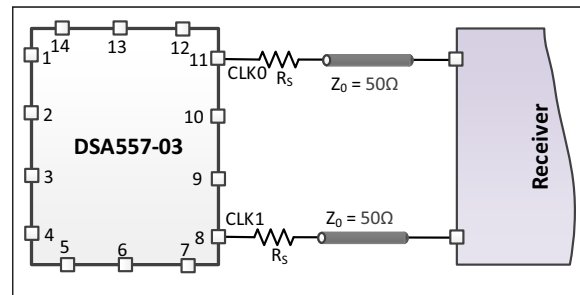


FIGURE 2-3: LVCMOS Outputs.

TABLE 2-2: DSA557-04 QFN-20 PIN FUNCTION TABLE

Pin Number	Pin Name	Pin Type	Description
1	OE1	I	Output enable, active-high. Controls CLK0.
2	NC	N/A	Leave unconnected or grounded.
3	VSS	P	Ground.
4	VSS	P	Ground.
5	CLK0-	O	Complement output of differential pair.
6	CLK0+	O	True output of differential pair.
7	CLK1-	O	Complement output of differential pair.
8	CLK1+	O	True output of differential pair.
9	VDD	P	Power supply.
10	NC	N/A	Leave unconnected or grounded.
11	OE2	I	Output enable, active-high. Controls CLK1 and CLK2.
12	NC	N/A	Leave unconnected or grounded.
13	VSS	P	Ground.
14	VSS	P	Ground.
15	CLK2-	O	Complement output of differential pair.
16	CLK2+	O	True output of differential pair.
17	NC	N/A	Leave unconnected or grounded.
18	NC	N/A	Leave unconnected or grounded.
19	VDD	P	Power supply.
20	NC	N/A	Leave unconnected or grounded.

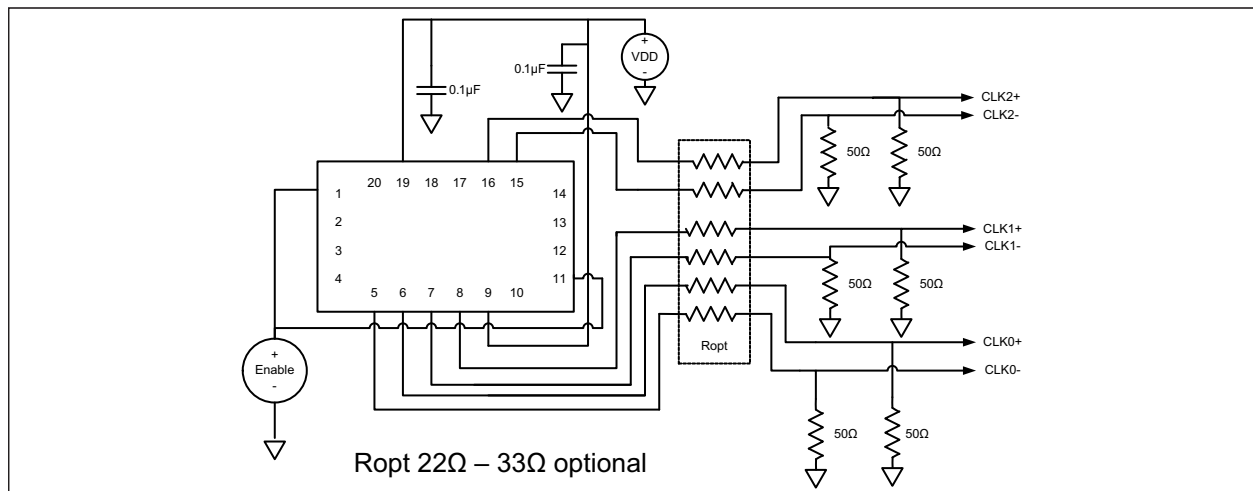


FIGURE 2-4: 20-Lead QFN Connection Diagram with Three HCSL Outputs.

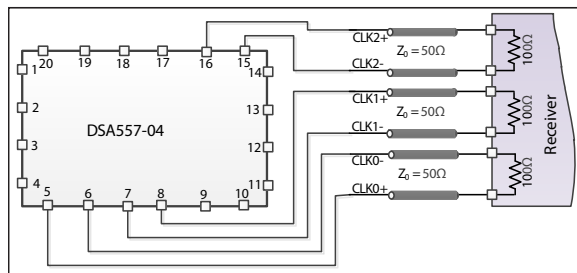


FIGURE 2-5: LVDS Outputs.

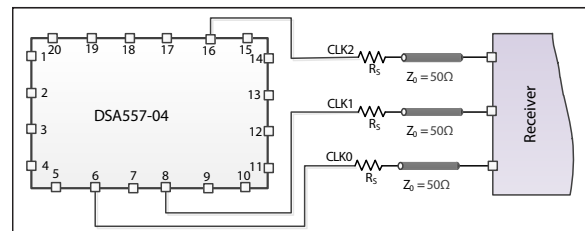


FIGURE 2-6: LVCMOS Outputs.

DSA557-03/04/05

TABLE 2-3: DSA557-05 QFN-20 PIN FUNCTION TABLE

Pin Number	Pin Name	Pin Type	Description
1	OE1	I	Output enable, active-high. Controls CLK0 and CLK1.
2	NC	N/A	Leave unconnected or grounded.
3	VSS	P	Ground.
4	VSS	P	Ground.
5	CLK0-	O	Complement output of differential pair.
6	CLK0+	O	True output of differential pair.
7	CLK1-	O	Complement output of differential pair.
8	CLK1+	O	True output of differential pair.
9	VDD	P	Power supply.
10	NC	N/A	Leave unconnected or grounded.
11	OE2	I	Output enable, active-high. Controls CLK1 and CLK2.
12	NC	N/A	Leave unconnected or grounded.
13	VSS	P	Ground.
14	VSS	P	Ground.
15	CLK2-	O	Complement output of differential pair.
16	CLK2+	O	True output of differential pair.
17	CLK3-	O	Complement output of differential pair.
18	CLK3+	O	True output of differential pair.
19	VDD	P	Power supply.
20	NC	N/A	Leave unconnected or grounded.

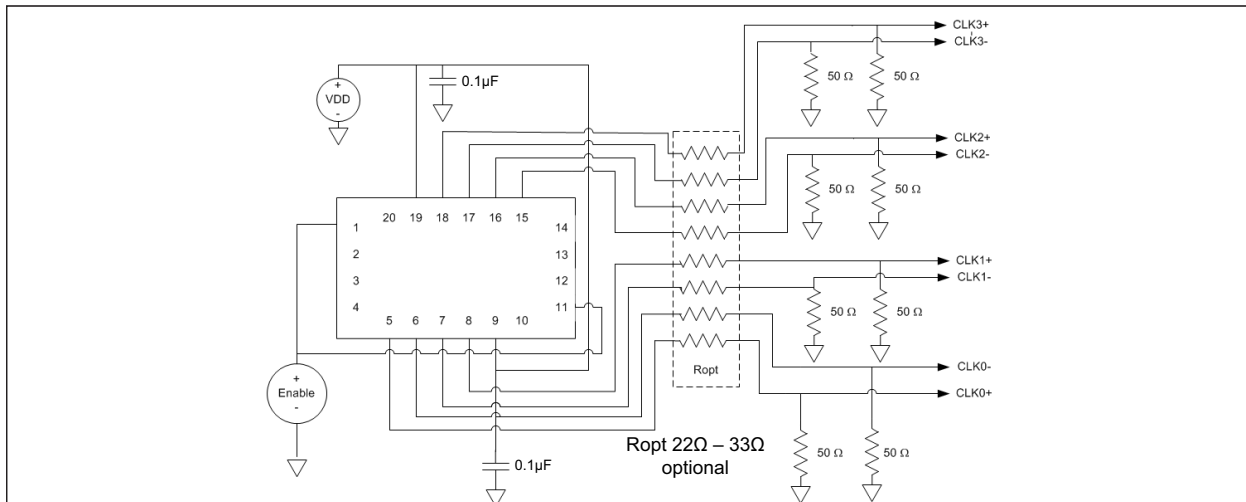


FIGURE 2-7: 20-Lead QFN Connection Diagram with Four HCSL Outputs.

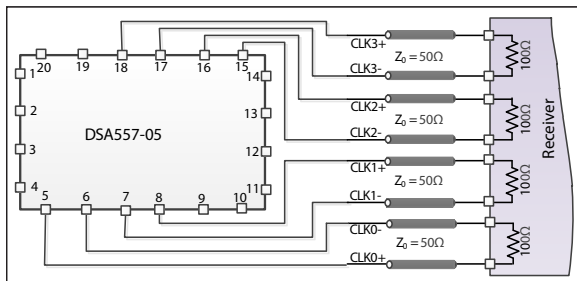


FIGURE 2-8: LVDS Outputs.

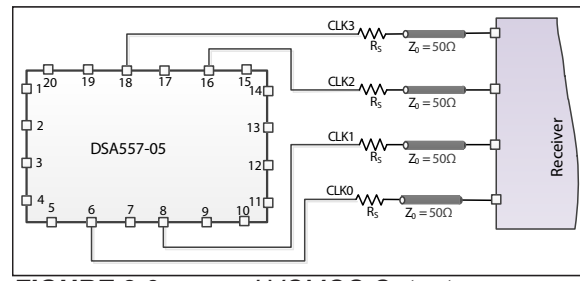


FIGURE 2-9: LVCMOS Outputs.

3.0 OUTPUT WAVEFORM

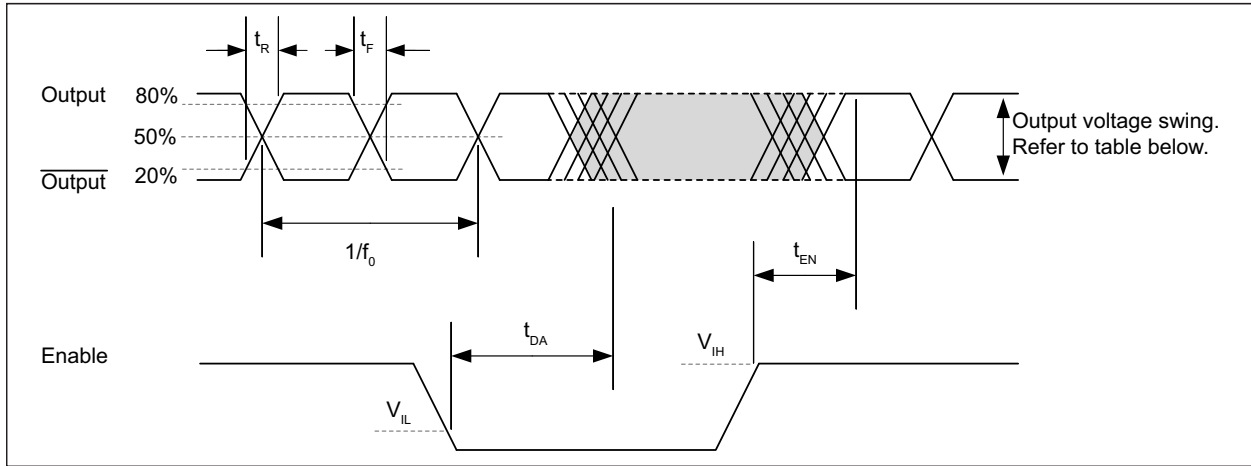


FIGURE 3-1: DSA557-03/04/05 Output Waveform.

TABLE 3-1: OUTPUT VOLTAGE SWING

Specification	V_{CM}	V_{SWING_SE} (typ.)
LVDS	1.2V	350 mV
HCSL	350 mV	675 mV

4.0 SOLDER REFLOW PROFILE

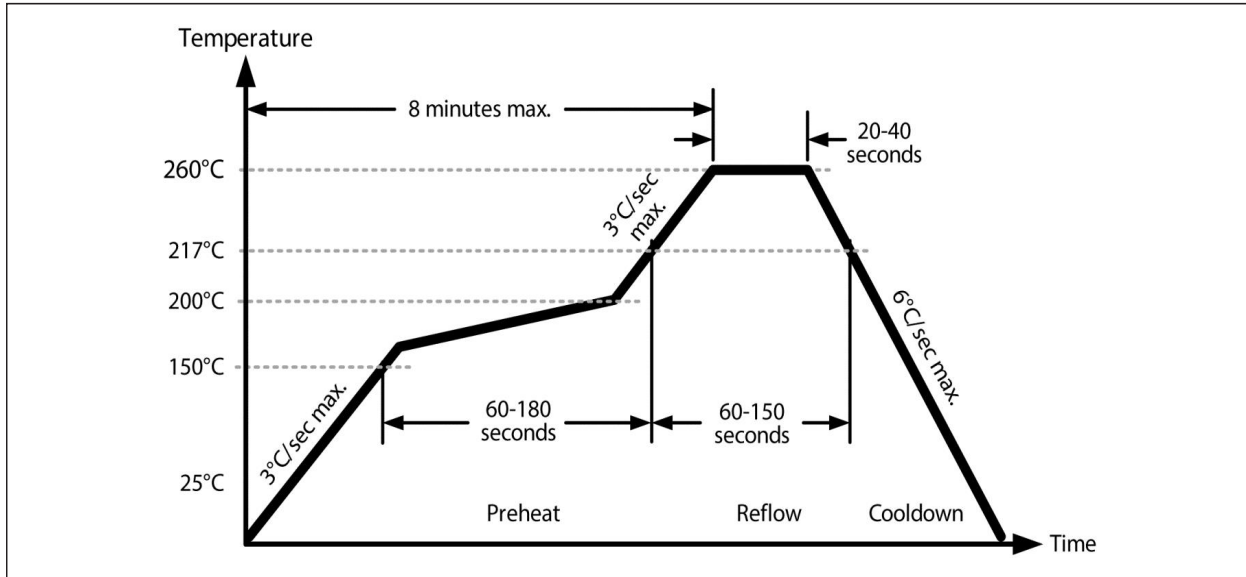


FIGURE 4-1: Solder Reflow Profile.

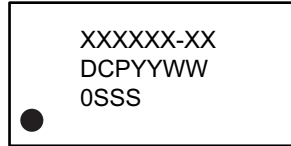
TABLE 4-1: SOLDER REFLOW

QFN-14 MSL 1 @ 260°C Refer to JSTD-020C TSSOP-16 MSL 3 @ 260°C Refer to JSTD-020C	
Ramp-Up Rate (200°C to Peak Temp.)	3°C/sec. max.
Preheat Time 150°C to 200°C	60 to 180 sec.
Time Maintained above 217°C	60 to 150 sec.
Peak Temperature	255°C to 260°C
Time within 5°C of Actual Peak	20 to 40 sec.
Ramp-Down Rate	6°C/sec. max.
Time 25°C to Peak Temperature	8 minutes max.

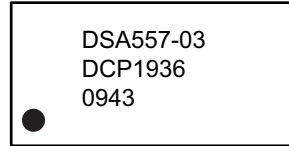
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

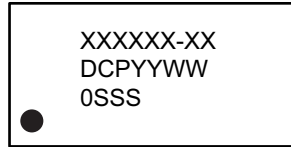
14-Lead QFN*



Example



20-Lead QFN*



Example



Legend:	XX...X	Product code
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	SSS	Alphanumeric traceability code
		Pb-free JEDEC® designator for Matte Tin (Sn)
	(e3)	This package is Pb-free. The Pb-free JEDEC designator () can be found on the outer packaging for this package. (e3)
	•, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

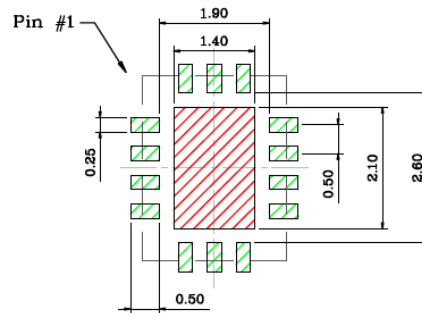
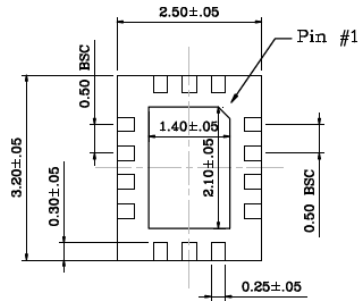
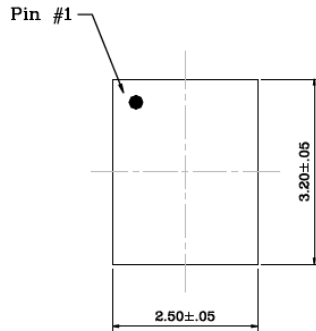
Underbar () and/or Overbar () symbol may not be to scale.

DSA557-03/04/05

TITLE

14 LEAD QFN 2.5x3.2mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	QFN2532-14LD-PL-1	UNIT	MM
-----------	-------------------	------	----



NOTE:

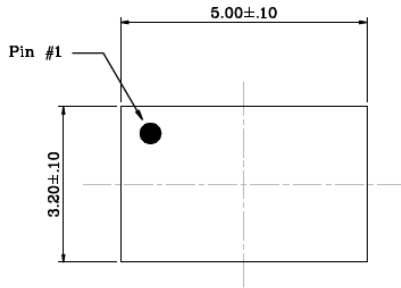
1. Green shaded rectangles in Recommended Land Pattern are solder stencil opening.
2. Red shaded rectangle in Recommended Land Pattern is keep out area.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

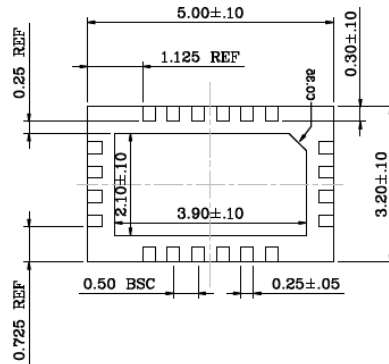
TITLE

20 LEAD QFN 5.0x3.2mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

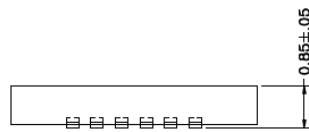
DRAWING #	QFN5032-20LD-PL-1	UNIT	MM
------------------	-------------------	-------------	----



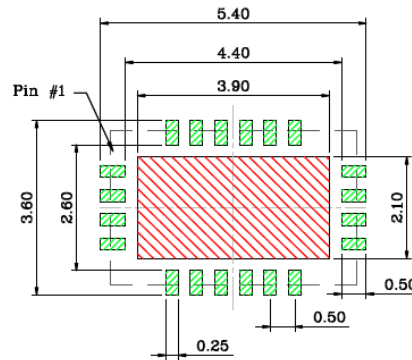
Top View



Bottom View



Side View



Recommended Land Pattern

NOTE:

1. Green shaded rectangles in Recommended Land Pattern are solder stencil opening.
2. Red shaded rectangle in Recommended Land Pattern is keep-out area.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (April 2019)

- Initial release of DSA557-03/04/05 as Microchip data sheet DS20006175A.

Revision B (May 2020)

- Updated [Product Identification System](#) section to add the Automotive Suffix to the full part number.
- Removed LVPECL option throughout data sheet.
- Added LVDS and LVCMOS information to [Electrical Characteristics](#) section.
- Added [Figure 2-2](#), [Figure 2-3](#), [Figure 2-5](#), [Figure 2-6](#), [Figure 2-8](#), and [Figure 2-9](#).

Revision C (June 2020)

- Updated Phase Jitter values in the [Electrical Characteristics](#) table.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

<u>PART No.</u>	<u>XXXX</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>X</u>	<u>XXX</u>
Device	Output Format	Package	Temp. Range	Stability	Packing Option	Automotive Suffix
<p>Device:</p> <p>DSA557-03: Two Output PCIe Clock Generator for Automotive</p> <p>DSA557-04: Three Output PCIe Clock Generator for Automotive</p> <p>DSA557-05: Four Output PCIe Clock Generator for Automotive</p>						
<p>Output Format: (Note 1)</p> <p>1 = LVCMOS</p> <p>3 = LVDS</p> <p>4 = HCSL</p>						
<p>Package:</p> <p>F = 14-Lead QFN (DSA557-03 Only)</p> <p>K = 20-Lead QFN (DSA557-04/05 Only)</p>						
<p>Temperature Range:</p> <p>L = -40°C to +105°C (Automotive Grade 2)</p> <p>I = -40°C to +85°C (Automotive Grade 3)</p>						
<p>Stability:</p> <p>0 = ±100 ppm</p> <p>1 = ±50 ppm</p>						
<p>Packing Option:</p> <p><blank>= 72/Tube (DSA557-04/05)</p> <p><blank>= 96/Tube (DSA557-03)</p> <p>T = 1000/Reel (All Package Options)</p>						
<p>Automotive Suffix: Vxx = Automotive suffix in which "xx" is assigned by Microchip. Default value is "AO" for standard automotive part.</p>						
<p>Note 1: The Output Format's arrangement is CLK3 to CLK0 (left-to-right) and may only have as many digits as that particular part allows. For example, DSA557-03 has two outputs; the part number example can only have two digits in that location. DSA557-04 can only have three and DSA557-05 can only have four.</p>						
<p>Examples:</p> <p>a) DSA557-0344FL0VAO: Two HCSL Outputs PCIe Clock Generator for Automotive, 14-Lead QFN, -40°C to +105°C Temperature Range, ±100 ppm Stability, 96/Tube, Standard Automotive</p> <p>b) DSA557-04111K11TVAO: Three LVCMOS Outputs PCIe Clock Generator for Automotive, 20-Lead QFN, -40°C to +85°C Temperature Range, ±50 ppm Stability, 1000/Reel, Standard Automotive</p> <p>c) DSA557-053344KL0VAO: Four Output PCIe Clock Generator for Automotive, (CLK3/CLK2: LVDS, CLK1/CLK0: HCSL), 20-Lead QFN, -40°C to +105°C Temperature Range, ±100 ppm Stability, 96/Tube, Standard Automotive</p> <p>Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.</p>						

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Klear, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PackeTime, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TempTracker, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, FlashTec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, Vite, WinPath, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BlueSky, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, INICnet, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQI, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2019-2020, Microchip Technology Incorporated, All Rights Reserved.

ISBN: 978-1-5224-6319-1

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.



MICROCHIP

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
<http://www.microchip.com/support>
Web Address:
www.microchip.com

Atlanta

Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX

Tel: 512-257-3370

Boston

Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago

Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas

Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit

Novi, MI
Tel: 248-848-4000

Houston, TX

Tel: 281-894-5983

Indianapolis

Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles

Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC

Tel: 919-844-7510

New York, NY

Tel: 631-435-6000

San Jose, CA

Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto

Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733

China - Beijing
Tel: 86-10-8569-7000

China - Chengdu
Tel: 86-28-8665-5511

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

China - Nanjing
Tel: 86-25-8473-2460

China - Qingdao
Tel: 86-532-8502-7355

China - Shanghai
Tel: 86-21-3326-8000

China - Shenyang
Tel: 86-24-2334-2829

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

China - Wuhan
Tel: 86-27-5980-5300

China - Xian
Tel: 86-29-8833-7252

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444

India - New Delhi
Tel: 91-11-4160-8631

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880-3770

Korea - Daegu
Tel: 82-53-744-4301

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

Malaysia - Penang
Tel: 60-4-227-8870

Philippines - Manila
Tel: 63-2-634-9065

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

Thailand - Bangkok
Tel: 66-2-694-1351

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4485-5910
Fax: 45-4485-2829

Finland - Espoo
Tel: 358-9-4520-820

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-72400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Padova
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820