

# VC-714

# LVPECL, LVDS Crystal Oscillator

### Features

- 40 fs<sub>RMS</sub> Phase Jitter Typical, 12 kHz to 20 MHz
- 3rd OT or Fundamental Crystal Design
- Extended Operating Temperature Range: –40°C to +125°C
- 100 MHz to 312.5 MHz Output Frequencies
- Excellent Power Supply Rejection Ratio
- · Glitch Free Output upon Power-Up and Enable
- Hermetically Sealed 7 mm x 5 mm Ceramic Package
- Product is Compliant to RoHS Directive and Fully Compatible with Lead-Free Assembly (Excluding Solder Dipped, \_SNPB, Option)

### Applications

- · Medical, Ultrasound
- Ethernet, GbE, SynchE
- · Fibre Channel
- PON
- · Clock Source for A/Ds, D/As, FPGAs
- · Test and Measurement
- Storage Area Network

**Phase Noise Plot** 

### **General Description**

Microchip's VC-714 crystal oscillator is a quartz-stabilized, low phase jitter, differential output oscillator that is hermetically sealed in a 7 mm x 5 mm ceramic package.

### **Block Diagram**





FIGURE 0-1: RMS Jitter, 40 fs<sub>RMS</sub> at 156.25 MHz, over 12 kHz to 20 MHz.

© 2021 - 2022 Microchip Technology Inc.

### DS20006509C-page 1

# 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage	
Enable Disable Voltage	-0.3V to V <sub>DD</sub> + 0.3V
ESD Rating, Human Body Model (Note 1)	
ESD Rating, Charged Device Model (Note 1)	
Storage Temperature (T <sub>S</sub> )	–40°C to +125°C
Junction Temperature (T <sub>1</sub> )	+150°C

**† Notice:** Stresses in excess of the Absolute Maximum Ratings can permanently damage the device. Functional operation is not implied at these or any other conditions in excess of conditions represented in the operational sections of this data sheet. Exposure to Absolute Maximum Ratings for extended periods may adversely affect device reliability.

**Note 1:** Although ESD protection circuitry has been designed into the VC-714, proper precautions should be taken when handling and mounting. Microchip employs a Human Body Model (HBM) and a Charged Device Model (CDM) for ESD susceptibility testing and design protection evaluation. ESD thresholds are dependent on the circuit parameters used to define the model. Although no industry standard has been adopted for the CDM, a standard resistance of 1.5 kΩ and capacitance of 100 pF is widely used and therefore can be used for comparison purposes.

# ELECTRICAL CHARACTERISTICS, LVPECL OPTION

Parameter	Sym.	Min.	Тур.	Max.	Units	Conditions	
Cumple ) (alterna (blata d)	M	2.375	2.5	2.625	V	Ordening Option	
Supply voltage (Note 1)	V <sub>DD</sub>	3.135	3.3	3.465	V	Ordering Option	
Current Consumption	I <sub>DD</sub>	_	_	70	mA	—	
Frequency							
Nominal Frequency	f <sub>N</sub>	100	_	320	MHz	Ordering Option	
			_	±25			
Stability (Note 2)	_		_	±50	ppm	Ordering Option	
		_	_	±100			
Outputs							
Output Logic Level High (Note 3)	V <sub>OH</sub>	V <sub>DD</sub> – 1.085	—	V <sub>DD</sub> – 0.860	N		
Output Logic Level Low (Note 3)	V <sub>OL</sub>	V <sub>DD</sub> – 1.810	_	V <sub>DD</sub> – 1.620	V	V <sub>DD</sub> = +2.5V	
Output Logic Level High (Note 3)	V <sub>OH</sub>	V <sub>DD</sub> – 1.085	_	V <sub>DD</sub> – 0.880	N	N - 12 0V	
Output Logic Level Low (Note 3)	V <sub>OL</sub>	V <sub>DD</sub> – 1.810	_	V <sub>DD</sub> – 1.620		V <sub>DD</sub> = +3.3V	
Output Rise and Fall Time (Note 3)	t <sub>r</sub> /t <sub>f</sub>			400	ps	—	
Load	_	50Ω	into V <sub>DD</sub> – 2	2.0V	_	_	

**Note 1:** The VC-714 power supply should be filtered. For example, a 10  $\mu$ F, 0.1  $\mu$ F, and 0.01  $\mu$ F capacitor.

2: Includes calibration tolerance, operating temperature, supply voltage variations, aging, and IR reflow.

- 3: Figure 1-1 defines the test circuit and Figure 1-2 defines these parameters.
- 4: Duty Cycle is measured as On/Time Period.
- 5: Measured using an Agilent E5052 Signal Source Analyzer at 25°C.
- **6:** Outputs will be enabled if Enable/Disable is left open. There is an oscillation detection circuit that ensures glitch free output upon power-up or enable.
- 7: In order to reduce current, the pull-up resistance is higher when V<sub>DD</sub> is set to ground.

# **ELECTRICAL CHARACTERISTICS, LVPECL OPTION (CONTINUED)**

Parameter	Sym.	Min.	Тур.	Max.	Units	Conditions	
Duty Cycle (Note 4)	DC	45	_	55	%	—	
		—	-75	—		10 Hz	
		—	-110	—		100 Hz	
			-133	_		1 kHz	
Phase Noise, 3.3V, 156.25 MHz	*		-141	_	dDo/Uz	10 kHz	
(Note 5)	ΨN	—	-160	—		100 kHz	
		—	-163	—		1 MHz	
			-163	_		10 MHz	
			-164	_		20 MHz	
Phase Jitter, 156.25 MHz, 12 kHz to 20 MHz (Note 5)	фյ	_	40	60	fs	_	
Enable/Disable	_						
Outputs Enabled (Note 6)	V <sub>IH</sub>	0.7 * V <sub>DD</sub>		—	V	—	
Outputs Disabled	V <sub>IL</sub>			0.3 * V <sub>DD</sub>	V	—	
Disable Time	t <sub>D</sub>			200	ns	—	
E/D Pull-Up Resistance (Note 7)		0.5		2	MΩ	E/D = GND	
E/D Pull-Up Resistance	_	30	_	150	kΩ	$E/D = V_{DD}$	
Start-Up Time	t <sub>SU</sub>	—	_	10	ms	—	
		-10		70			
	-	-40	_	85	°C	Ordenian Ortion	
Operating temperature	<sup>I</sup> OP	-40	_	105			
		-40	_	125			

**Note 1:** The VC-714 power supply should be filtered. For example, a 10 µF, 0.1 µF, and 0.01 µF capacitor.

2: Includes calibration tolerance, operating temperature, supply voltage variations, aging, and IR reflow.

**3:** Figure 1-1 defines the test circuit and Figure 1-2 defines these parameters.

- 4: Duty Cycle is measured as On/Time Period.
- 5: Measured using an Agilent E5052 Signal Source Analyzer at 25°C.
- **6:** Outputs will be enabled if Enable/Disable is left open. There is an oscillation detection circuit that ensures glitch free output upon power-up or enable.
- 7: In order to reduce current, the pull-up resistance is higher when V<sub>DD</sub> is set to ground.





© 2021 - 2022 Microchip Technology Inc.

# **ELECTRICAL CHARACTERISTICS, LVDS OPTION**

Parameter	Sym.	Min.	Тур.	Max.	Units	Conditions	
		2.375	2.5	2.625			
Supply Voltage (Note 1)	V <sub>DD</sub>	3.135	3.3	3.465	V	Ordering Option	
				35		2.5V	
Current Consumption	IDD			35	mA	3.3V	
Frequency							
Nominal Frequency	f <sub>N</sub>	100	_	320	MHz	Ordering Option	
		_	_	±25			
Stability (Note 2)	—	_	_	±50	ppm	Ordering Option	
		_	_	±100			
Outputs							
Output Logic Level High (Note 3)	V <sub>OH</sub>	_	1.43	1.6			
Output Logic Level Low (Note 3)	V <sub>OL</sub>	0.9	1.10	_	V	_	
Output Amplitude		±247	±350	±454	mV	—	
Differential Output Error	_	_	_	50	mV	_	
Offset Voltage	_	1.125	1.25	1.375	V	_	
Offset Voltage Error			_	50	mV	—	
Output Leakage Current, Outputs Disabled	_	_	_	30	μA	_	
Output Rise and Fall Time (Note 3)	t <sub>r</sub> /t <sub>f</sub>	— — 30		300	ps	—	
Load	_	10	0Ω Different	tial	_	—	
Duty Cycle (Note 4)	DC	45	_	55	%	_	
			-75	_		10 Hz	
			-110	—		100 Hz	
			-133	—		1 kHz	
Phase Noise, 3.3V, 156.25 MHz		_	-141	_		10 kHz	
(Note 5)	ΦN		-158	—	aBC/HZ	100 kHz	
		_	-162	—		1 MHz	
			-163	—		10 MHz	
			-163			20 MHz	
Phase Jitter, 156.25 MHz, 12 kHz to 20 MHz (Note 5)	фј	_	40	60	fs	_	

**Note 1:** The VC-714 power supply should be filtered. For example, a 10 µF, 0.1 µF, and 0.01 µF capacitor.

2: Includes calibration tolerance, operating temperature, supply voltage variations, aging, and IR reflow.

- 3: Figure 1-3 defines the test circuit and Figure 1-2 defines these parameters.
- 4: Duty Cycle is measured as On/Time Period.
- 5: Measured using an Agilent E5052 Signal Source Analyzer at 25°C.
- **6:** Outputs will be enabled if Enable/Disable is left open. There is an oscillation detection circuit that ensures glitch free output upon power-up or enable.
- 7: In order to reduce current, the pull-up resistance is higher when V<sub>DD</sub> is set to ground.

# **ELECTRICAL CHARACTERISTICS, LVDS OPTION (CONTINUED)**

Parameter	Sym.	Min.	Тур.	Max.	Units	Conditions	
Enable/Disable							
Outputs Enabled (Note 6)	V <sub>IH</sub>	0.7 * V <sub>DD</sub>		_	V	—	
Outputs Disabled	V <sub>IL</sub>			0.3 * V <sub>DD</sub>	V	_	
Disable Time	t <sub>D</sub>			200	ns	_	
E/D Pull-Up Resistance (Note 7)	_	0.5		2	MΩ	E/D = GND	
E/D Pull-Up Resistance	—	30	_	150	kΩ	$E/D = V_{DD}$	
Start-Up Time	t <sub>SU</sub>			10	ms	_	
		-10		70			
	-	-40	_	85	*0	Ordening Option	
Operating temperature	I <sub>OP</sub>	-40		105	C	Ordering Option	
		-40		125			

Note 1: The VC-714 power supply should be filtered. For example, a 10 µF, 0.1 µF, and 0.01 µF capacitor.

- 2: Includes calibration tolerance, operating temperature, supply voltage variations, aging, and IR reflow.
- 3: Figure 1-3 defines the test circuit and Figure 1-2 defines these parameters.
- 4: Duty Cycle is measured as On/Time Period.
- 5: Measured using an Agilent E5052 Signal Source Analyzer at 25°C.
- **6:** Outputs will be enabled if Enable/Disable is left open. There is an oscillation detection circuit that ensures glitch free output upon power-up or enable.
- 7: In order to reduce current, the pull-up resistance is higher when V<sub>DD</sub> is set to ground.



FIGURE 1-3:

LVDS Test Circuit.

# 2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

### TABLE 2-1:PIN FUNCTION TABLE

Pin Number	Pin Name	Description					
1	E/D or NC	Enable/Disable or No Connection.					
2	E/D or NC	Enable/Disable or No Connection.					
3	GND	Electrical and lid ground.					
4	f <sub>O</sub>	Output frequency.					
5	Cf <sub>O</sub>	Complementary output frequency.					
6	V <sub>DD</sub>	Supply voltage.					

### TABLE 2-2: ENABLE/DISABLE FUNCTION

E/D Pin	Output
High	Clock Output
Open	Clock Output
Low	High Impedance

# 3.0 APPLICATION DIAGRAMS

### 3.1 LVPECL Application Diagrams

The VC-714 incorporates a standard PECL output scheme, which are unterminated FET drains. There are numerous application notes on terminating and interfacing PECL logic and the two most common methods are a single resistor to ground (Figure 3-1) and a pull-up/pull-down scheme as shown in Figure 3-2. AC-coupling capacitors are optional, depending on the application and the input logic requirements of the next stage.

One of the most important considerations is terminating the Output and Complementary Outputs equally. An unused output should not be left unterminated because if one of the two outputs is left open, it will result in excessive jitter on both. PCB layout must take this and  $50\Omega$  impedance matching into account. Load matching and power supply noise are the main contributors to jitter related problems.



FIGURE 3-1: Pull-Down Resistor Termination Scheme.

Figure 3-1 shows one option to terminate LVPECL outputs and is optimized to reduce common mode noise. R1 is  $50\Omega$  for 3.3V supply voltage and  $18\Omega$  for 2.5V.



FIGURE 3-2: Pull-Up/Pull-Down Termination.

Resistor values shown are typical for 3.3V operation. For 2.5V operation, the resistor to ground is  $62\Omega$  and the resistor to supply is  $250\Omega$ . AC blocking capacitors can be used if the DC levels are incompatible.

### 3.2 LVDS Application Diagrams

One of the most important considerations is terminating the Output and Complementary Outputs equally. An unused output should not be left unterminated because if one of the two outputs is left open, it will result in excessive jitter on both. PCB layout must take this and  $50\Omega$  impedance matching into account. Load matching and power supply noise are the main contributors to jitter related problems.



**FIGURE 3-3:** LVDS-to-LVDS Connection, Internal 100Ω Resistor.

Some LVDS structures have an internal  $100\Omega$  resistor on the input and do not need additional components. AC blocking capacitors can be used if the DC levels are incompatible.



Some input structures may not have an internal  $100\Omega$  resistor on the input and will need an external  $100\Omega$  resistor for impedance matching. Also, the input may have an internal DC bias that may not be compatible with LVDS levels. AC blocking capacitors can be used.

#### 4.0 RELIABILITY

Microchip qualification will include aging at various extreme temperatures, shock and vibration, temperature cycling, and IR reflow simulation. The VC-714 family is capable of meeting the following qualification tests.

Parameter	Conditions
Mechanical Shock	MIL-STD-883, Method 2002
Mechanical Vibration	MIL-STD-883, Method 2007
Temperature Cycle	MIL-STD-883, Method 1010
Solderability	MIL-STD-883, Method 2003
Gross and Fine Leak	MIL-STD-883, Method 1014
Resistance to Solvents	MIL-STD-883, Method 2015
Moisture Sensitivity Level	MSL 1
Contact Pads	Gold (0.3 µm min., 1.0 µm max.) over Nickel
Contact Pads, _SNPB option	Tinned using solder alloy Sn63Pb37 in accordance with J-STD-006
θ <sub>JC</sub> (Bottom of Case)	30°C/W
Maximum Junction Temperature	150°C
Weight	180 mg

**TABLE 4-1: ENVIRONMENTAL COMPLIANCE** 

#### 5.0 **IR REFLOW**

Devices are built using lead-free epoxy and can be subjected to standard lead-free IR reflow conditions shown in Table 5-1. Contact pads are gold over nickel and lower maximum temperatures can also be used, such as 220°C. NOTE: Devices which have been solder dipped, \_SNPB option, will not be Pb-Free.



FIGURE 5-1:

~~	 •	 •	 •

#### **TABLE 5-1: REFLOW PROFILE**

Symbol	Minimum	Conditions	
T <sub>S(1)</sub>	200°C	250°C	Pb-Free
T <sub>S(2)</sub>	100°C	150°C	_SNPB Option
t <sub>S(1)</sub>	60 sec.	240 sec.	Pb-Free
t <sub>S(2)</sub>	60 sec.	120 sec.	_SNPB Option
t <sub>l(1)</sub>	60 sec.	150 sec.	Pb-Free
t <sub>l(2)</sub>	60 sec.	150 sec.	_SNPB Option
T <sub>p(1)</sub>	245°C	260°C	Pb-Free
T <sub>p(2)</sub>	225°C	240°C	_SNPB Option

© 2021 - 2022 Microchip Technology Inc.

## 6.0 TAPE AND REEL

Tape Dimensions (mm)							Reel Dimensions (mm)						
Dimension	w	F	Do	Ро	P1	Α	В	С	D	N	W1	W2	# per
Tolerance	Тур	Тур	Тур	Тур	Тур	Мах	Reel						
VC-714	16	7.5	1.5	4	8	180	2	13	21	55	17	21	1000





# 7.0 PACKAGING INFORMATION

### 6-Lead 7 mm x 5 mm LDFN Package Outline and Recommended Land Pattern

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



Pad Layout

<sup>© 2021 - 2022</sup> Microchip Technology Inc.

NOTES:

# APPENDIX A: REVISION HISTORY

### Revision A (May 2021)

- Converted Vectron document VC-714 to Microchip data sheet template DS20006509A.
- Minor grammatical text changes throughout.

## **Revision B (August 2021)**

• Added a plus/minus (±) symbol to each value listed for Output Amplitude in the Electrical Characteristics, LVDS Option table.

### Revision C (July 2022)

- Added "\_SNPB= Tin Lead Solder Dipped" packaging type information to the Product Identification System page.
- Replaced Figure 5-1 and Table 5-1 with current data.
- · Minor text and image corrections where needed.

NOTES:

# **PRODUCT IDENTIFICATION SYSTEM**

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

<u>Device</u>	- <u>X</u>	X	<u>x</u>	- <u>X</u>	<u>x</u>	<u>x</u>	X	- <u>XXXXXXXXXX</u>	<u>xx</u>			
Part No.	Power Supply	Output	Temp. Range	Stability	E/D Logic	E/D Pir	n Custom Options	Frequency	Packaging			
Device:	VC-714:	LVPEC 6-Lead	L, LVDS Cry 7 mm x 5 m	stal Oscillator in m LDFN		a) VC-714-ECE-FAAN-200M000000TR:						
Power Supply:	E = H =	3.3VDC ±5% 2.5VDC ±5%					+85°C Temp Output Enabl Standard Opt	Range, ±25 ppm S ed, Pin 1 Enable/I ion, 200 MHz, 100	Stability, Disable, 00/Reel			
Output:	C = D =	LVPECL LVDS				b) VC-714-	<ul> <li>2-714-HDW-KAAN-125M000000TR:</li> <li>VC-714, 2.5VDC, LVDS Output, –10°C to +70°C Temp Range, ±50 ppm Stability,</li> </ul>					
Temperature Range:	E = F = G = W =	-40°C to +85 -40°C to +10 -40°C to +12 -10°C to +70	°C 5°C 5°C °C			Note 1:	Standard Op Tape and Reel in catalog part nun	tion, 125 MHz, 100 dentifier only appea	00/Reel rs in the is identifier is			
Stability:	E = F = K = S =	±20 ppm ±25 ppm ±50 ppm ±100 ppm					catalog part number description. This identifier used for ordering purposes and is not printed the device package. Check with your Microchi Sales Office for package availability with the Tape and Reel option.					
Enable/Disable Logic:	A = N =	Output Enable No E/D	ed with a Lo	gic High or Open	1							
Enable/Disable Pin:	A = B = X =	Pin 1 (Pin 2 = Pin 2 (Pin 1 = No Enable/Di	No Connect No Connect sable (Pin 1/	t) t) 2 No Connect)								
Custom Options:	N =	Standard opti	on									
Frequency:	xxxMxxx	xxx=Frequency	in MHz									
Packaging:	TR = <blank>= _SNPB=</blank>	1,000/Reel Cut Tape/ nor Tin Lead Solo	n-TR quantiti ler Dipped	es								

Note: Not all combinations of options are available. Other specifications may be available upon request.

### TABLE 1: STANDARD OUTPUT FREQUENCIES

100.000 MHz 125.000 MHz 156.250 MHz 160.000 MHz 200.000 MHz 312.500 M
---

NOTES:

### Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not
  mean that we are guaranteeing the product is "unbreakable" Code protection is constantly evolving. Microchip is committed to
  continuously improving the code protection features of our products.

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications 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. Contact your local Microchip sales office for additional support or, obtain additional support at https:// www.microchip.com/en-us/support/design-help/client-supportservices.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WAR-RANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDI-RECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSE-QUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

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

AgileSwitch, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet- Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, TrueTime, 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, Augmented Switching, BlueSky, BodyCom, Clockstudio, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, GridTime, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, IntelliMOS, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, KoD, maxCrypto, maxView, 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, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQI, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, Trusted Time, TSHARC, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, 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.

 $\ensuremath{\textcircled{\sc 0}}$  2021 - 2022, Microchip Technology Incorporated and its subsidiaries.

All Rights Reserved.

ISBN: 978-1-6683-0985-8

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

© 2021 - 2022 Microchip Technology Inc. and its subsidiaries



# 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

### DS20006509C-page 18

### 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

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

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

Germany - Garching Tel: 49-8931-9700 Germany - Haan

EUROPE

Austria - Wels

Tel: 43-7242-2244-39

Tel: 45-4485-5910

Fax: 45-4485-2829

Tel: 358-9-4520-820

Finland - Espoo

France - Paris

Fax: 43-7242-2244-393

**Denmark - Copenhagen** 

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

# Malaysia - Penang