

32-Channel Serial-to-Parallel Converter with Open-Drain Outputs

Features

- 100 mA Minimum Sink Current
- 16 MHz Shift Register Speed
- Polarity and Blanking Inputs
- CMOS-Compatible Inputs

Applications

- Inkjet and Electrostatic Print Heads
- AC-Electroluminescent Displays
- Microelectromechanical Systems (MEMS) Applications

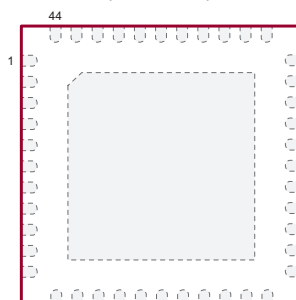
General Description

The HV5523 is a low-voltage serial to high-voltage parallel converter with open-drain outputs. This device is designed as a driver for AC electroluminescent displays. It can also be used in any application requiring multiple-output high-voltage current sinking capabilities, such as driving inkjet and electrostatic print heads, plasma panels, vacuum fluorescent and large matrix LCD displays.

This device consists of a 32-bit Shift register, 32 latches and control logic to perform the polarity selection and blanking of the outputs. Data are shifted through the Shift register on the high-to-low transition of the clock. The HV5523 shifts counter clockwise when viewed from the top of the package. A data output buffer is provided for cascading devices. This output reflects the current status of the last bit of the Shift register. Operation of the Shift register is not affected by the $\overline{LE}$ (latch enable), $\overline{BL}$ (blanking) and the $\overline{POL}$ (polarity) inputs. Transfer of data from the Shift register to the latch occurs when the $\overline{LE}$ (latch enable) input is high. The data in the latch is stored when $\overline{LE}$ is low.

Package Type

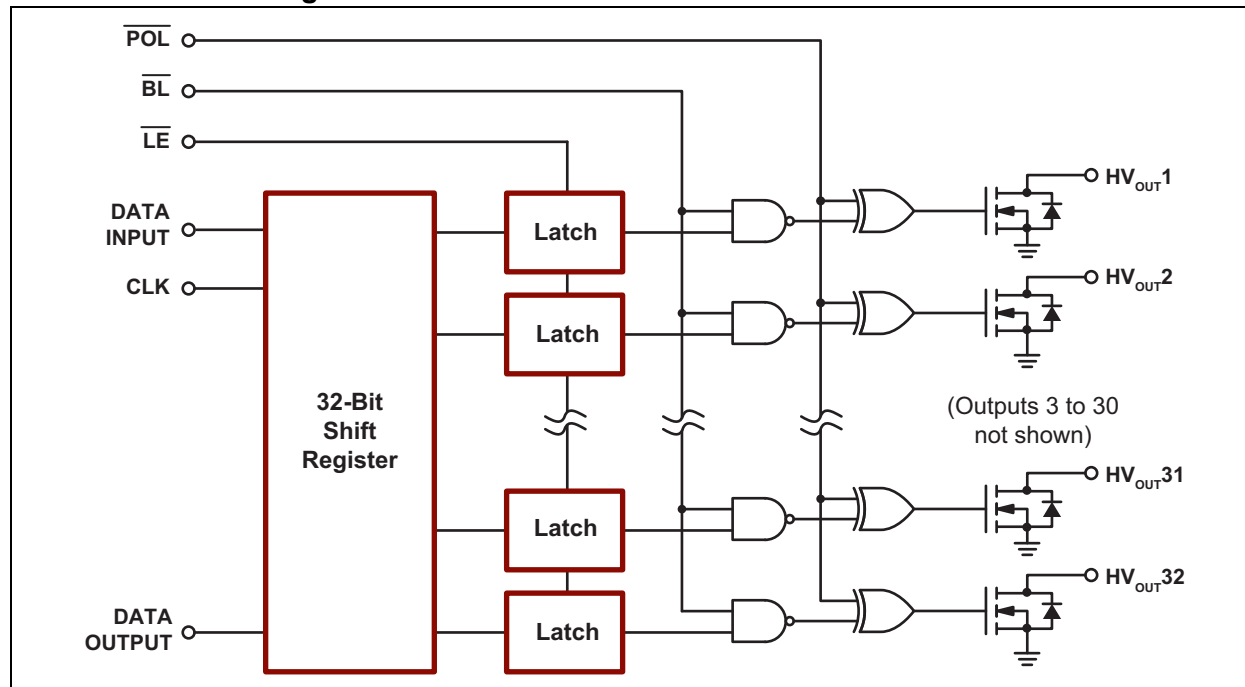
44-lead QFN
(Top view)



See [Table 2-1](#) for pin information.

HV5523

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Supply Voltage, V_{DD} (Note 1)	–0.5V to +7V
Output Voltage, HV_{OUT} (Note 1)	–0.5V to +230V
Logic Input Levels (Note 1)	–0.5V to $V_{DD} + 0.5V$
Ground Current (Note 2)	1.5A
Maximum Junction Temperature, $T_{J(MAX)}$	+125°C
Storage Temperature, T_S	–65°C to +150°C
Continuous Total Power Dissipation:	
44-lead QFN (Note 3)	3.4W

† **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.

Note 1: All voltages are referenced to V_{SS} .

2: Duty cycle is limited by the total power dissipated in the package.

3: 1 oz. 4-layer 3" x 4" PCB

RECOMMENDED OPERATING CONDITIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Logic Supply Voltage	V_{DD}	4.5	—	5.5	V	
High-Voltage Output	HV_{OUT}	–0.3	—	+220	V	
High-Level Input Voltage	V_{IH}	0.8 V_{DD}	—	V_{DD}	V	
Low-Level Input Voltage	V_{IL}	0	—	0.2 V_{DD}	V	
Clock Frequency	f_{CLK}	—	—	16	MHz	
Operating Ambient Temperature	T_A	–40	—	+85	°C	

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Over recommended operating conditions unless otherwise noted.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
V_{DD} Supply Current	I_{DD}	—	—	25	mA	$f_{CLK} = 16\text{ MHz}$, $f_{DATA} = 8\text{ MHz}$
Quiescent V_{DD} Supply Current	I_{DDQ}	—	—	100	μA	$D_{IN} = 0V$, all input logic pins = 0V, all outputs off
Off-State Output Current	$I_{O(OFF)}$	—	—	10	μA	All outputs high, all switches parallel
High-Level Logic Input Current	I_{IH}	—	—	1	μA	$V_{IH} = V_{DD}$
Low-Level Logic Input Current	I_{IL}	—	—	–1	μA	$V_{IL} = 0V$
High-Level Output Data Out	V_{OH}	$V_{DD} - 1V$	—	—	V	$I_{DOUT} = -10\text{ mA}$
Low-Level Output Voltage	HV_{OUT}	V_{OL}	—	15	V	$I_{HVOUT} = +100\text{ mA}$
	Data Out		—	1	V	$I_{DOUT} = +10\text{ mA}$
HV_{OUT} Clamp Voltage	V_{OC}	—	—	–1.5	V	$I_{OL} = -100\text{ mA}$

AC ELECTRICAL CHARACTERISTICS

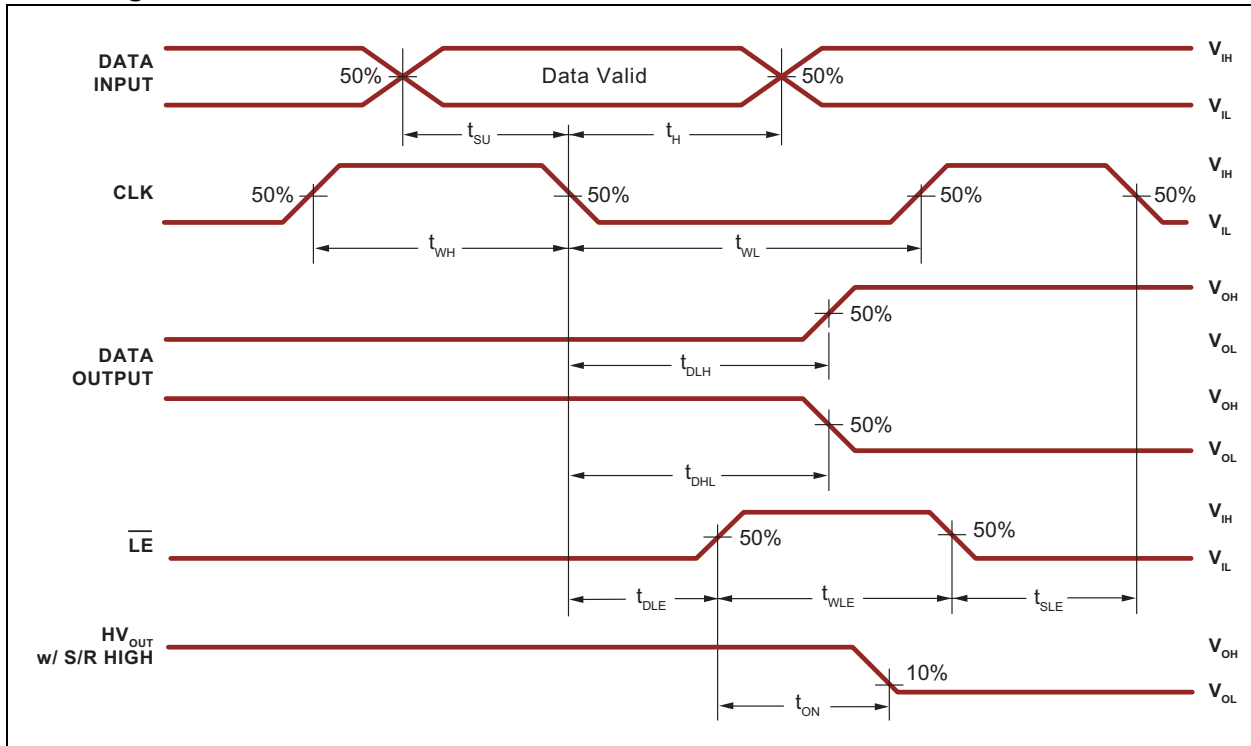
Electrical Specifications: $V_{DD} = 5V$, $T_J = 25^{\circ}C$						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Clock Frequency	f_{CLK}	—	—	16	MHz	
Clock Pulse Width, High or Low	t_{WL}, t_{WH}	31	—	—	ns	
Data Setup Time Before CLK Falls	t_{SU}	25	—	—	ns	
Data Hold Time after CLK Falls	t_H	10	—	—	ns	
Turn-On Time, HV_{OUT} from Enable	t_{ON}	—	—	400	ns	$R_L = 2\text{ k}\Omega$ to V_{PP} maximum
Delay Time Clock to Data High to Low	t_{DHL}	—	—	35	ns	$C_L = 15\text{ pF}$
Delay Time Clock to Data Low to High	t_{DLH}	—	—	35	ns	$C_L = 15\text{ pF}$
Delay Time Clock to $\overline{LE}$ Low to High	t_{DLE}	20	—	—	ns	
Width of $\overline{LE}$ Pulse	t_{WLE}	20	—	—	ns	
$\overline{LE}$ Setup Time Before Clock Falls	t_{SLE}	20	—	—	ns	
Digital Logic Input Capacitance	C_{IN}	—	—	15	pF	

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature	T_A	-40	—	+85	$^{\circ}C$	
Maximum Junction Temperature	$T_{J(MAX)}$	—	—	+125	$^{\circ}C$	
Storage Temperature	T_S	-65	—	+150	$^{\circ}C$	
PACKAGE THERMAL RESISTANCE						
44-lead QFN	θ_{JA}	—	19	—	$^{\circ}C/W$	Note 1

Note 1: 1 oz. 4-layer 3" x 4" PCB

Switching Waveforms



2.0 PIN DESCRIPTION

The details on the pins of HV5523 are listed in [Table 2-1](#). Refer to [Package Type](#) for the location of pins.

TABLE 2-1: 44-LEAD QFN PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	HV _{OUT} 11	High-voltage output
2	HV _{OUT} 12	High-voltage output
3	HV _{OUT} 13	High-voltage output
4	HV _{OUT} 14	High-voltage output
5	HV _{OUT} 15	High-voltage output
6	HV _{OUT} 16	High-voltage output
7	HV _{OUT} 17	High-voltage output
8	HV _{OUT} 18	High-voltage output
9	HV _{OUT} 19	High-voltage output
10	HV _{OUT} 20	High-voltage output
11	HV _{OUT} 21	High-voltage output
12	HV _{OUT} 22	High-voltage output
13	HV _{OUT} 23	High-voltage output
14	HV _{OUT} 24	High-voltage output
15	HV _{OUT} 25	High-voltage output
16	HV _{OUT} 26	High-voltage output
17	HV _{OUT} 27	High-voltage output
18	HV _{OUT} 28	High-voltage output
19	HV _{OUT} 29	High-voltage output
20	HV _{OUT} 30	High-voltage output
21	HV _{OUT} 31	High-voltage output
22	HV _{OUT} 32	High-voltage output
23	DATA OUT	Data output pin
24	NC	No internal connection
25	NC	No internal connection
26	NC	No internal connection
27	POL	Inverts the polarity of the HV _{OUT} pins
28	CLK	Clock pin. The Shift registers shift data on the falling edge of input clock.
29	VSS	Reference voltage, usually ground
30	VDD	Logic supply voltage
31	LE	Latch enable pin. Data is shifted from the Shift register to the latches on logic input high.
32	DATA IN	Data input pin
33	$\overline{\text{BL}}$	Blanking pin sets all HV _{OUT} pins ON or OFF, depending upon the state of polarity. See Table 3-2 .
34	N/C	No internal connection

TABLE 2-1: 44-LEAD QFN PIN FUNCTION TABLE (CONTINUED)

Pin Number	Pin Name	Description
35	HV _{OUT1}	High-voltage output
36	HV _{OUT2}	High-voltage output
37	HV _{OUT3}	High-voltage output
38	HV _{OUT4}	High-voltage output
39	HV _{OUT5}	High-voltage output
40	HV _{OUT6}	High-voltage output
41	HV _{OUT7}	High-voltage output
42	HV _{OUT8}	High-voltage output
43	HV _{OUT9}	High-voltage output
44	HV _{OUT10}	High-voltage output
Center Tab		Connect to VSS.

3.0 FUNCTIONAL DESCRIPTION

Follow the steps in [Table 3-1](#) to power up and power down the HV5523.

TABLE 3-1: POWER-UP AND POWER-DOWN SEQUENCE

Power-Up		Power-Down	
Step	Description	Step	Description
1	Connect ground.	1	Remove all inputs.
2	Apply V_{DD} .	2	Remove V_{DD} .
3	Set all inputs to a known state.	3	Disconnect ground.

TABLE 3-2: FUNCTION TABLE

Function	Inputs ¹					Outputs				
	Data	CLK	$\overline{LE}$	$\overline{BL}$	$\overline{POL}$	Shift Register		High-Voltage Output		Data Out
						1	2...32	1	2...32	
All On	X	X	X	L	L	Note 2	Note 2	On	On	Note 2
All Off	X	X	X	L	H	Note 2	Note 2	Off	Off	Note 2
Invert Mode	X	X	L	H	L	Note 2	Note 2	Note 2	Note 2	Note 2
Load S/R	H or L	↓	L	H	H	H or L	Note 2	Note 2	Note 2	Note 2
Load Latches	X	H or L	↑	H	H	Note 2	Note 2	Note 2	Note 2	Note 2
	X	H or L	↑	H	L	Note 2	Note 2	Note 2	Note 2	Note 2
Transparent Latch Mode	L	↓	H	H	H	L	Note 2	Off	Note 2	Note 2
	H	↓	H	H	H	H	Note 2	On	Note 2	Note 2

Note 1: H = High logic level

L = Low logic level

X = Don't care

↓ = High-to-low transition

↑ = Low-to-high transition

2: Dependent on previous stage's state before the last CLK ↓ or last $\overline{LE}$ high

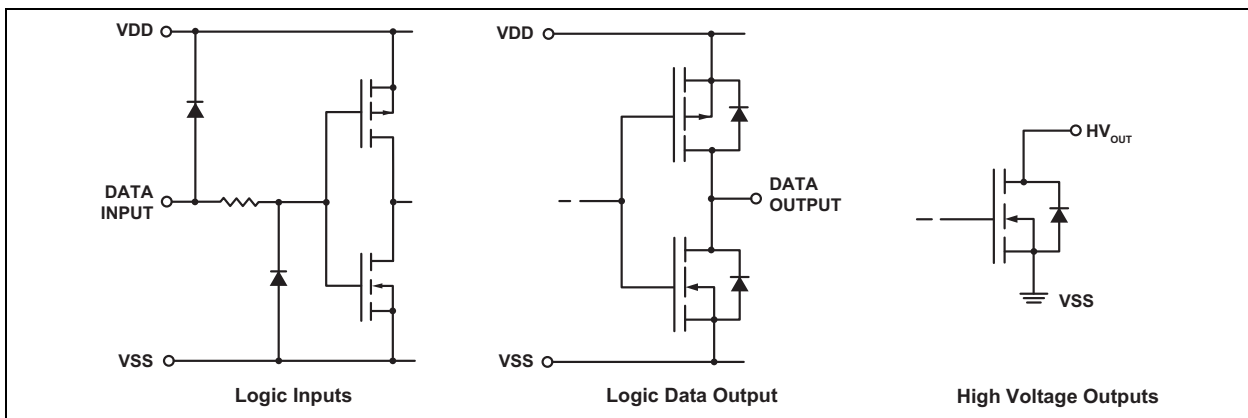
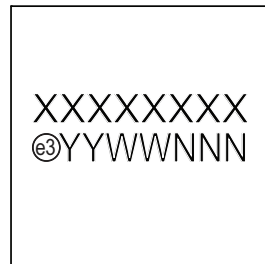


FIGURE 3-1: Input and Output Equivalent Circuits.

4.0 PACKAGE MARKING INFORMATION

4.1 Packaging Information

44-lead QFN



Example

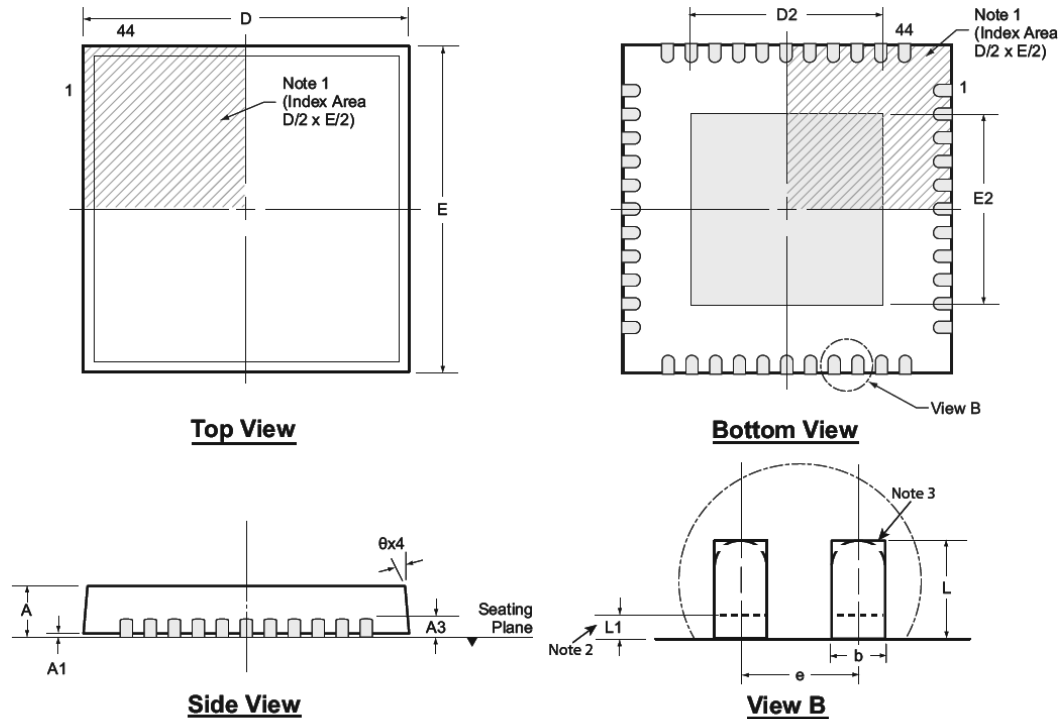


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	e3	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.

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 product code or customer-specific information. Package may or not include the corporate logo.

44-Lead QFN Package Outline (K7)

7.00x7.00mm body, 0.80mm height (max), 0.50mm pitch



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

Notes:

1. A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.
2. Depending on the method of manufacturing, a maximum of 0.15mm pullback (L1) may be present.
3. The inner tip of the lead may be either rounded or square.

Symbol		A	A1	A3	b	D	D2	E	E2	e	L	L1	θ
Dimension (mm)	MIN	0.70	0.00	0.20 REF	0.18	6.85*	5.00†	6.85*	5.00†	0.50 BSC	0.45†	0.00	0°
	NOM	0.75	0.02		0.25	7.00	5.15†	7.00	5.15†		0.55†	-	-
	MAX	0.80	0.05		0.30	7.15*	5.25†	7.15*	5.25†		0.65†	0.15	14°

JEDEC Registration MO-220, Variation WKKD-3, Issue K, June 2006

* This dimension is not specified in the JEDEC drawing.

† This dimension differs from the JEDEC drawing.

Drawings not to scale.

APPENDIX A: REVISION HISTORY

Revision A (July 2019)

- Converted Supertex Doc# DSFP-HV5523 to Microchip DS20005700A
- Changed the quantity of the 44-lead QFN K7 package from 280/Tray to 260/Tray
- Changed the quantity of the 44-lead QFN K7 M933 media type from 2000/Reel to 3000/Reel
- Made minor text changes throughout the document

HV5523

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>XX</u>	-	<u>X</u>	-	<u>X</u>
Device	Package Options		Environmental		Media Type
Device:	HV5523	=	32-Channel Serial-to-Parallel Converter with Open-Drain Outputs		
Package:	K7	=	44-lead (7x7) WQFN		
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package		
Media Type:	(blank)	=	260/Tray for a K7 Package		
	M933	=	3000/Reel for a K7 Package		

Examples:

a) HV5523K7-G: 32-Channel Serial-to-Parallel Converter with Open-Drain Outputs, 44-lead (7x7) WQFN, 260/Tray

b) HV5523K7-G-M933: 32-Channel Serial-to-Parallel Converter with Open-Drain Outputs, 44-lead (7x7) WQFN, 3000/Reel

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, PackTime, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TempTrackr, 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., SSI, 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, Microchip Technology Incorporated, All Rights Reserved.

ISBN: 978-1-5224-4790-0

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

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: 45-4450-2828
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