

Six-Pair N-Channel and P-Channel Enhancement-Mode MOSFET

Features

- High-voltage Vertical DMOS Technology
- Integrated Gate-to-Source Resistor
- Integrated Gate-to-Source Zener Diode
- $\pm 3.5A$ at 50V Typical Peak Output
- Low Threshold, Low On-resistance
- Low Input and Output Capacitance
- Fast Switching Speeds
- Electrically Isolated N-channel and P-channel MOSFET Pairs

Applications

- High-voltage Pulsers
- Amplifiers
- Buffers
- Piezoelectric Transducer Drivers
- General Purpose Line Drivers
- Logic-level Interfaces

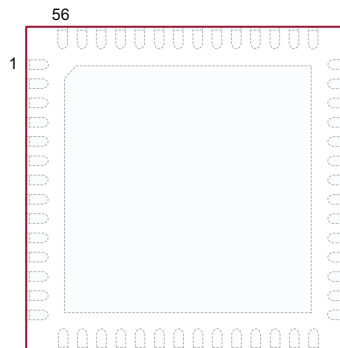
General Description

The TC8020 consists of six pairs of high-voltage, low-threshold N-channel and P-channel MOSFETs in a 56-lead VQFN package. All MOSFETs have integrated the output drain high-voltage diodes, gate-to-source resistors, and gate-to-source Zener diode clamps which are desired for high-voltage pulser applications. The complimentary, high-speed, high-voltage, gate-clamped N-channel and P-channel MOSFET pairs utilize an advanced vertical DMOS structure and a well-proven silicon-gate manufacturing process. This combination produces a device with the power handling capabilities of bipolar transistors and the high input impedance and positive temperature coefficient inherent in MOS devices. Characteristic of all MOS structures, these devices are free from thermal runaway and thermally induced secondary breakdown.

Microchip's vertical DMOS FETs are ideally suited to a wide range of switching and amplifying applications where very low threshold voltage, high breakdown voltage, high input impedance, low input and output capacitance, and fast switching speeds are desired.

Package Type

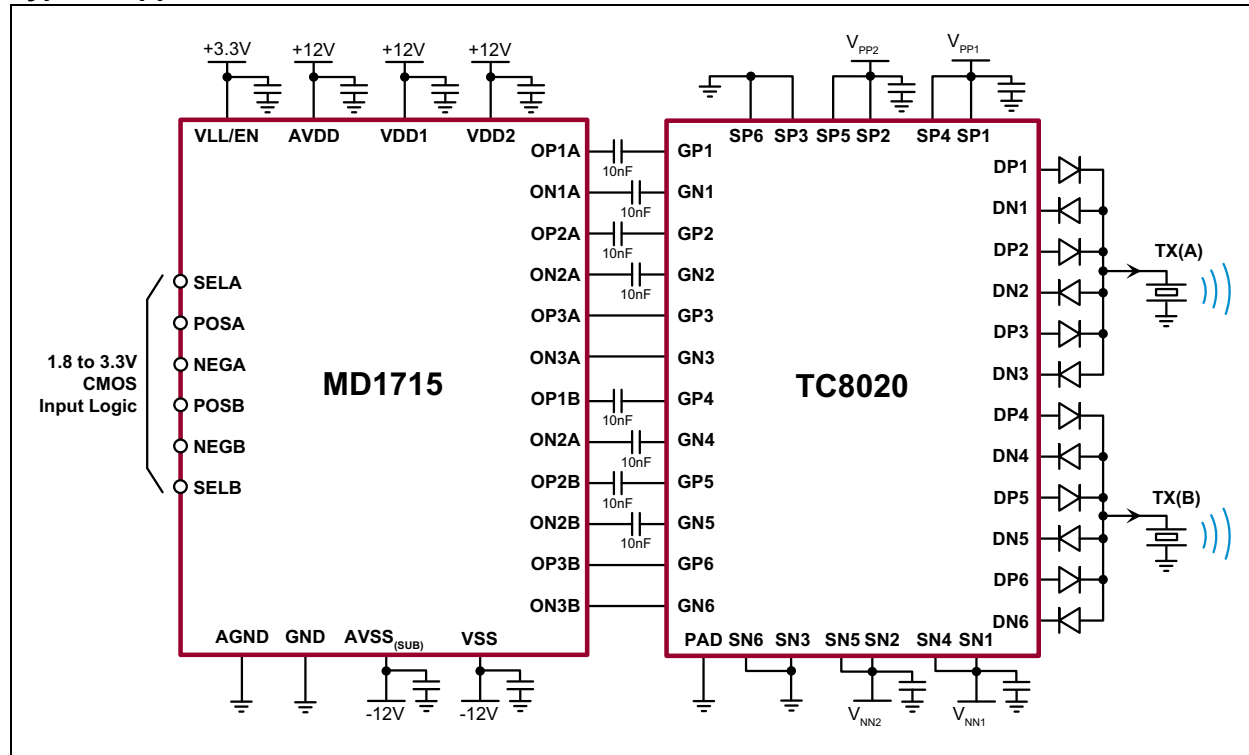
56-lead VQFN
(Top view)



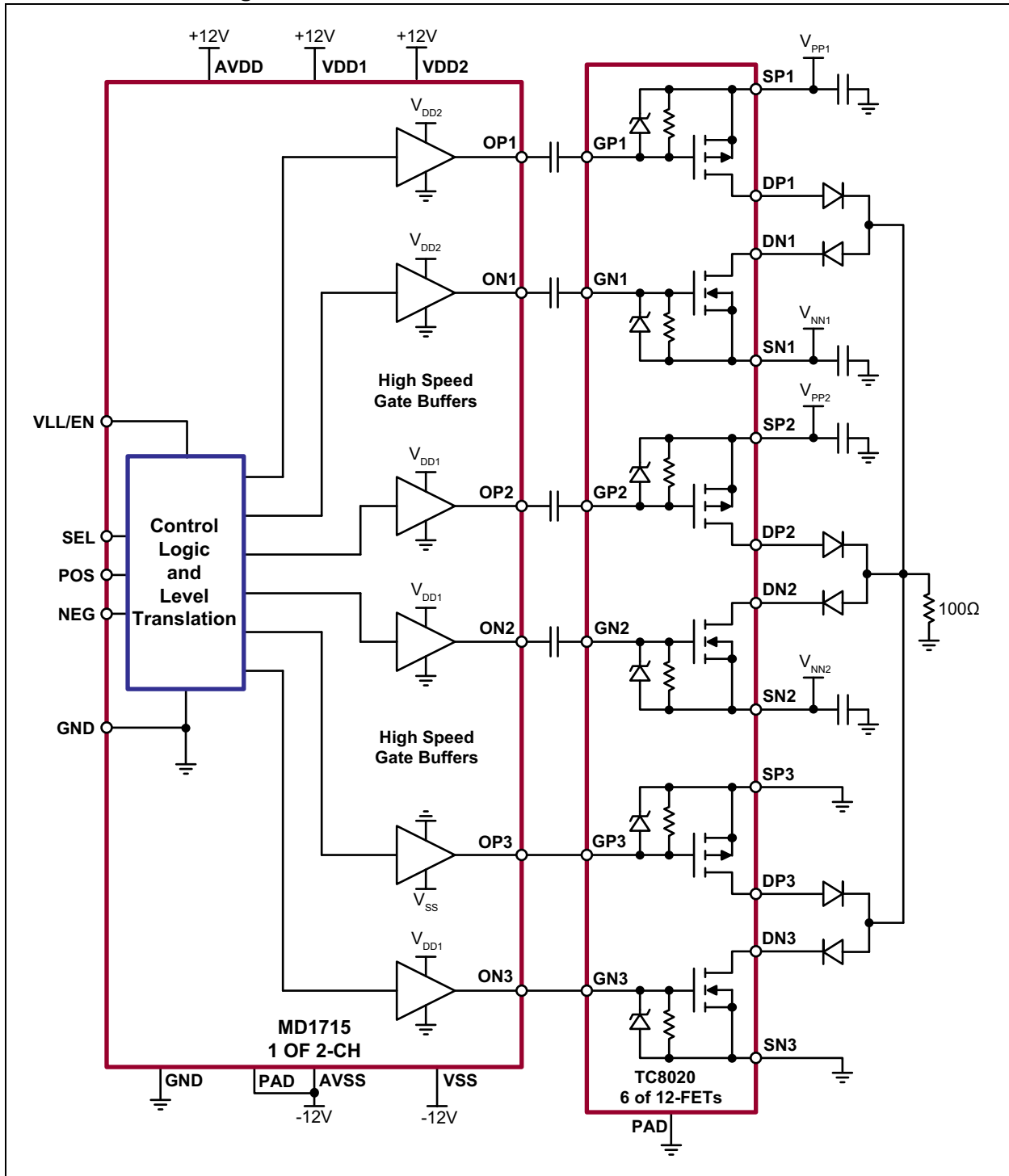
See [Table 2-1](#) for pin information.

TC8020

Typical Application Circuit



Functional Block Diagram



TC8020

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings^(†)

Drain-to-Source Voltage	BV _{DSS}
Drain-to-Gate Voltage	BV _{DGS}
Operating Ambient Temperature, T _A	–55°C to +150°C
Storage Temperature, T _S	–55°C to +150°C

† **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.

N-CHANNEL ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T _A = 25°C.						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
DC PARAMETER (Note 1)						
Drain-to-Source Breakdown Voltage	BV _{DSS}	200	—	—	V	V _{GS} = 0V, I _D = 1 mA
Gate Threshold Voltage	V _{GS(th)}	1	—	2.4	V	V _{GS} = V _{DS} , I _D = 1 mA
Change in V _{GS(th)} with Temperature	ΔV _{GS(th)}	—	—	−4.5	mV/°C	V _{GS} = V _{DS} , I _D = 1 mA (Note 2)
Gate-to-Source Shunt Resistor	R _{GS}	5	—	26	kΩ	I _{GS} = 100 μA
Gate-to-Source Zener voltage	VZ _{GS}	13.2	—	25	V	I _{GS} = 2 mA
Zero-gate Voltage Drain Current	I _{DSS}	—	—	10	μA	V _{DS} = Maximum rating, V _{GS} = 0V
		—	—	1	mA	V _{DS} = 0.8 Maximum rating, V _{GS} = 0V, T _A = 125°C (Note 2)
On-state Drain Current	I _{D(ON)}	1.2	1.8	—	A	V _{GS} = 4.5V, V _{DS} = 25V
		2	3.2	—		V _{GS} = 10V, V _{DS} = 25V
Static Drain-to-Source On-state Resistance	R _{DS(ON)}	—	6	9	Ω	V _{GS} = 4.5V, I _D = 150 mA
		—	5.3	8		V _{GS} = 10V, I _D = 1A
Change in R _{DS(ON)} with Temperature	ΔR _{DS(ON)}	—	—	1	%/°C	V _{GS} = 10V, I _D = 1A (Note 2)
AC PARAMETER (Note 2)						
Forward Transconductance	G _{FS}	400	—	—	mmho	V _{DS} = 25V, I _D = 500 mA
Input Capacitance	C _{ISS}	—	50	—	pF	V _{GS} = 0V, V _{DS} = 25V, f = 1 MHz
Common-source Output Capacitance	C _{OSS}	—	18	—		
Reverse Transfer Capacitance	C _{RSS}	—	7	—		
Turn-on Delay Time	t _{d(ON)}	—	—	10	ns	V _{DD} = 25V, I _D = 500 mA, R _{GEN} = 25Ω
Rise Time	t _r	—	—	15		
Turn-off Delay Time	t _{d(OFF)}	—	—	20		
Fall Time	t _f	—	—	15		
DIODE PARAMETER						
Diode Forward Voltage Drop	V _{SD}	—	—	1.8	V	V _{GS} = 0V, I _{SD} = 500 mA (Note 1)
Reverse Recovery Time	t _{rr}	—	300	—	ns	V _{GS} = 0V, I _{SD} = 500 mA (Note 2)

Note 1: Unless otherwise stated, all DC parameters are 100% tested at +25°C. Pulse test: 300 μs pulse, 2% duty cycle.

2: Specification is obtained by characterization and is not 100% tested.

P-CHANNEL ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T _A = 25°C.						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
DC PARAMETER (Note 1)						
Drain-to-Source Breakdown Voltage	BV _{DSS}	-200	—	—	V	V _{GS} = 0V, I _D = -1 mA
Gate Threshold Voltage	V _{GS(th)}	-1	—	-2.4	V	V _{GS} = V _{DS} , I _D = -1 mA
Change in V _{GS(th)} with Temperature	ΔV _{GS(th)}	—	—	4.5	mV/°C	V _{GS} = V _{DS} , I _D = -1 mA (Note 2)
Gate-to-Source Shunt Resistor	R _{GS}	5	—	26	kΩ	I _{GS} = -100 μA
Gate-to-Source Zener Voltage	VZ _{GS}	-13.2	—	-24	V	I _{GS} = -2 mA
Zero-gate Voltage Drain Current	I _{DSS}	—	—	-10	μA	V _{DS} = Maximum rating, V _{GS} = 0V
		—	—	-1	mA	V _{DS} = 0.8 Maximum rating, V _{GS} = 0V, T _A = 125°C (Note 2)
On-state Drain Current	I _{D(ON)}	-0.8	-1.25	—	A	V _{GS} = -4.5V, V _{DS} = -25V
		-2	-2.8	—		V _{GS} = -10V, V _{DS} = -25V
Static Drain-to-Source On-state Resistance	R _{DS(ON)}	—	7	10	Ω	V _{GS} = -4.5V, I _D = -150 mA
		—	6.5	9.5		V _{GS} = -10V, I _D = -1A
Change in R _{DS(ON)} with Temperature	ΔR _{DS(ON)}	—	—	1	%/°C	V _{GS} = -10V, I _D = -1A (Note 2)
AC PARAMETER (Note 2)						
Forward Transconductance	G _{FS}	400	—	—	mmho	V _{DS} = -25V, I _D = -500 mA
Input Capacitance	C _{ISS}	—	55	—	pF	V _{GS} = 0V, V _{DS} = -25V, f = 1 MHz
Common-source Output Capacitance	C _{OSS}	—	20	—		
Reverse Transfer Capacitance	C _{RSS}	—	8	—		
Turn-on Delay Time	t _{d(ON)}	—	—	10	ns	V _{DD} = -25V, I _D = -1A, R _{GEN} = 25Ω
Rise Time	t _r	—	—	15		
Turn-on Delay Time	t _{d(OFF)}	—	—	20		
Fall Time	t _f	—	—	15		
DIODE PARAMETER						
Diode Forward Voltage Drop	V _{SD}	—	—	-1.8	V	V _{GS} = 0V, I _{SD} = -500 mA (Note 1)
Reverse Recovery Time	t _{rr}	—	300	—	ns	V _{GS} = 0V, I _{SD} = -500 mA (Note 2)

Note 1: Unless otherwise stated, all DC parameters are 100% tested and at $+25^\circ\text{C}$. Pulse test: 300 μs pulse, 2% duty cycle.

2: Specification is obtained by characterization and is not 100% tested.

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature	T_A	-55	—	+150	$^\circ\text{C}$	
Storage Temperature	T_S	-55	—	+150	$^\circ\text{C}$	
PACKAGE THERMAL RESISTANCE						
56-lead VQFN	θ_{JA}	—	27	—	$^\circ\text{C/W}$	Note 1

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

2.0 PIN DESCRIPTION

Table 2-1 shows the description of pins in TC8020.
Refer to [Package Type](#) for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	GN1	Gate of N-MOSFET 1
2	GN2	Gate of N-MOSFET 2
3	NC	No Connection
4	GN3	Gate of N-MOSFET 3
5	GP3	Gate of P-MOSFET 3
6	NC	No Connection
7	SN3	Source of N-MOSFET 3
8	SN6	Source of N-MOSFET 6
9	NC	No Connection
10	GP6	Gate of P-MOSFET 6
11	GN6	Gate of N-MOSFET 6
12	NC	No Connection
13	GN5	Gate of N-MOSFET 5
14	GN4	Gate of N-MOSFET 4
15	GP5	Gate of P-MOSFET 5
16	GP4	Gate of P-MOSFET 4
17	NC	No Connection
18	SN5	Source of N-MOSFET 5
19	NC	No Connection
20	SN4	Source of N-MOSFET 4
21	NC	No Connection
22	VSUB	Die attachment substrate, must be grounded externally.
23	NC	No Connection
24	SP4	Source of P-MOSFET 4
25	NC	No Connection
26	SP5	Source of P-MOSFET 5
27	NC	No Connection
28	NC	No Connection
29	DP4	Drain of P-MOSFET 4
30	DN4	Drain of N-MOSFET 4
31	DP5	Drain of P-MOSFET 5
32	DN5	Drain of N-MOSFET 5
33	DP6	Drain of P-MOSFET 6
34	DN6	Drain of N-MOSFET 6
35	SP6	Source of P-MOSFET 6
36	SP3	Source of P-MOSFET 3
37	DP3	Drain of P-MOSFET 3
38	DN3	Drain of N-MOSFET 3
39	DP2	Drain of P-MOSFET 2
40	DN2	Drain of N-MOSFET 2

TABLE 2-1: PIN FUNCTION TABLE (CONTINUED)

Pin Number	Pin Name	Description
41	DP1	Drain of P-MOSFET 1
42	DN1	Drain of N-MOSFET 1
43	NC	No Connection
44	NC	No Connection
45	SP2	Source of P-MOSFET 2
46	NC	No Connection
47	SP1	Source of P-MOSFET 1
48	NC	No Connection
49	VSUB	Die attachment substrate, must be grounded externally.
50	NC	No Connection
51	SN1	Source of N-MOSFET 1
52	NC	No Connection
53	SN2	Source of N-MOSFET 2
54	NC	No Connection
55	GP1	Gate of P-MOSFET 1
56	GP2	Gate of P-MOSFET 2
Thermal pad		Must be grounded externally.

3.0 FUNCTIONAL DESCRIPTION

Figure 3-1 and Figure 3-2 illustrate the switching waveforms and test circuits for TC8020. See Figure 3-3 for the circuit pin layout.

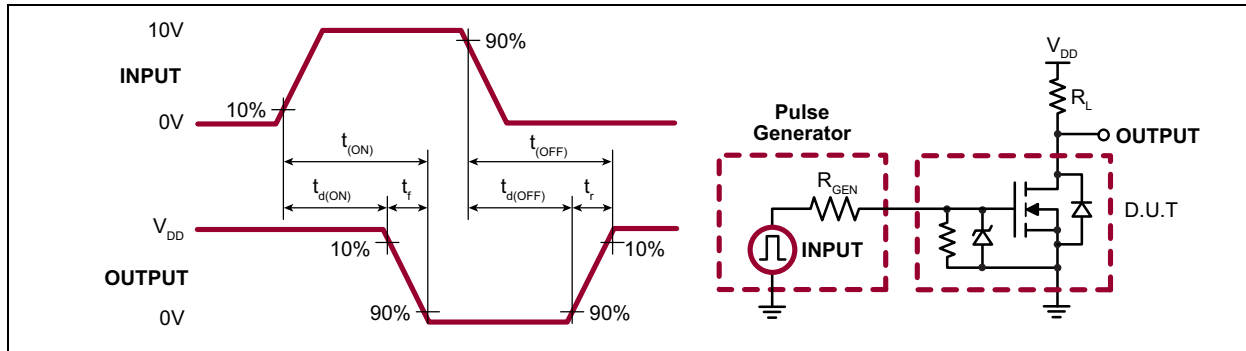


FIGURE 3-1: N-channel Switching Waveforms and Test Circuit.

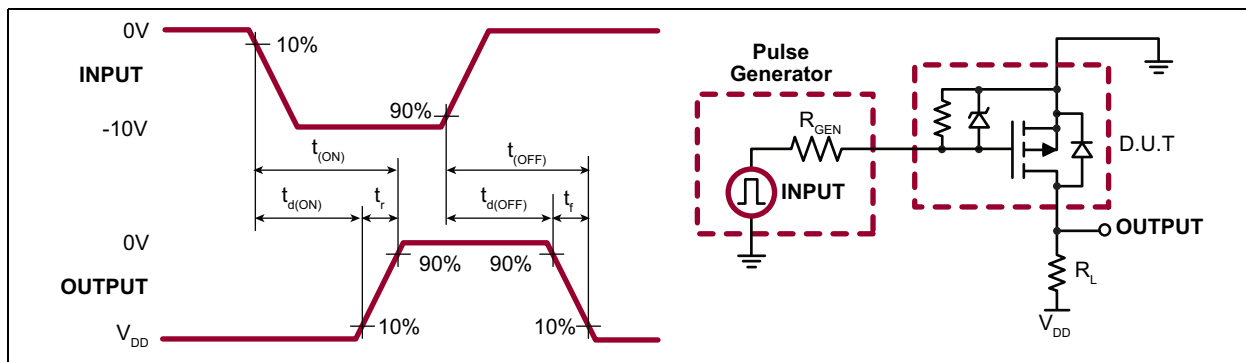


FIGURE 3-2: P-channel Switching Waveforms and Test Circuit.

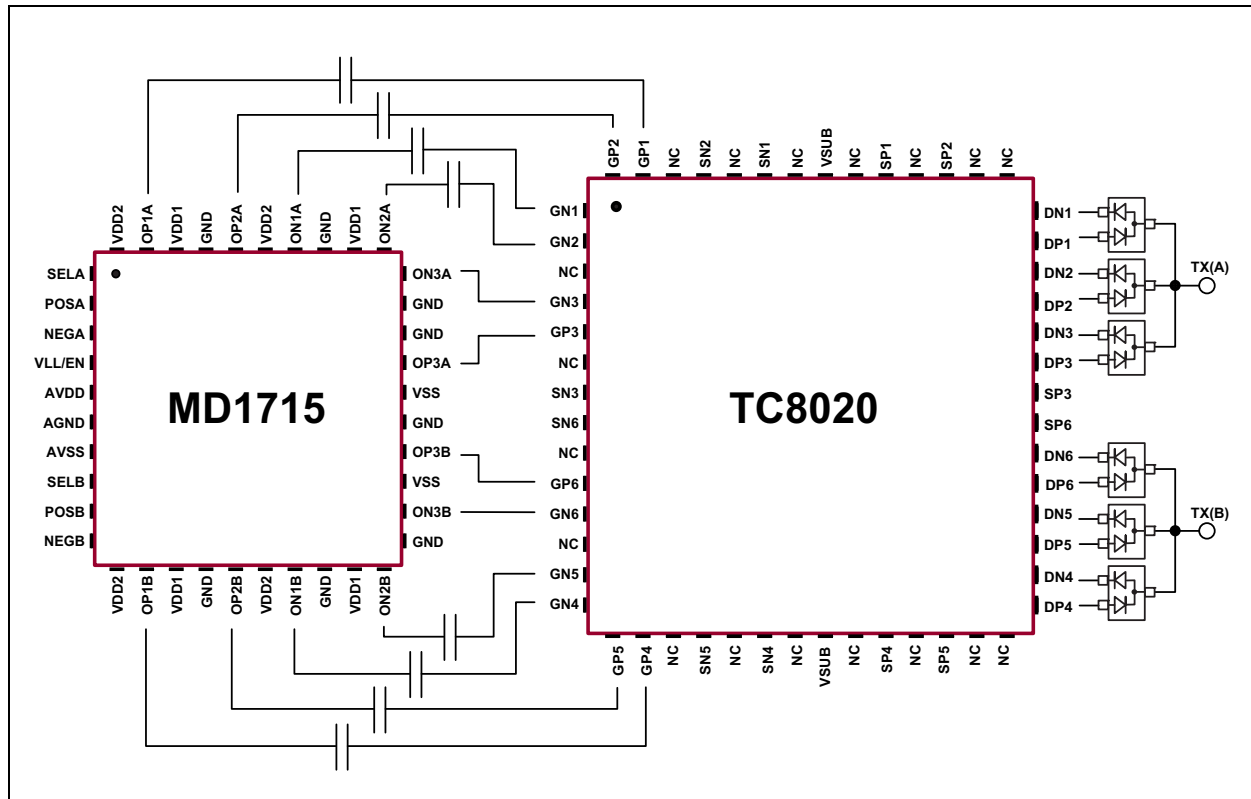


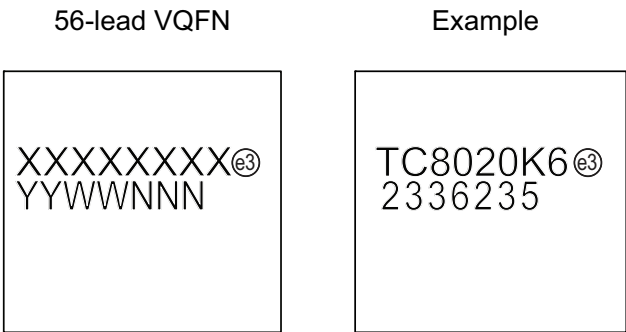
FIGURE 3-3: *Circuit Pin Layout.*

TABLE 3-1: PRODUCT SUMMARY

BV_{DSS}/BV_{DGS} (V)		$R_{DS(ON)}$ (Maximum) (Ω)	
N-Channel	P-Channel	N-Channel	P-Channel
200	−200	8	9.5

4.0 PACKAGING INFORMATION

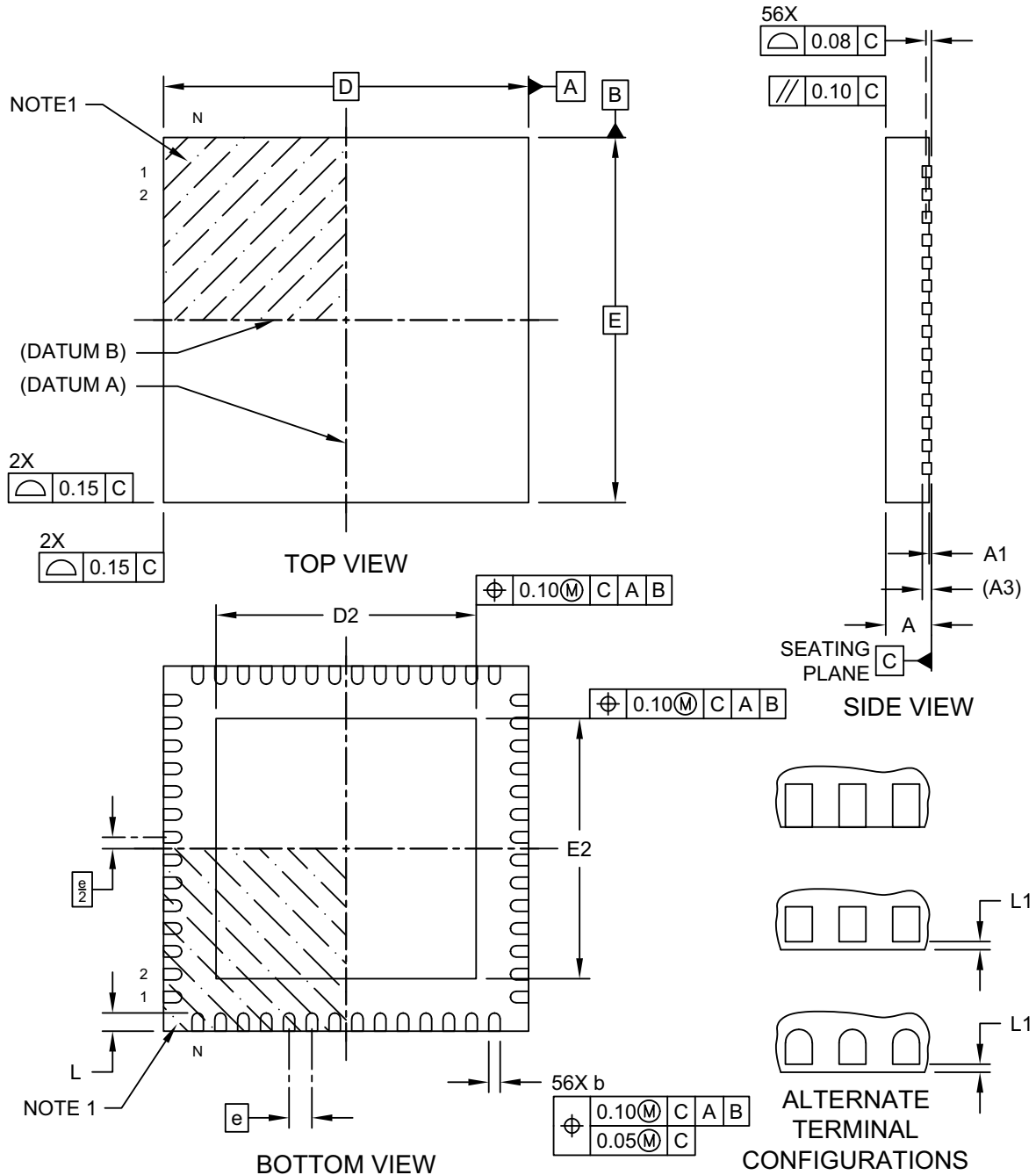
4.1 Package Marking Information



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.	

56-Lead Very Thin Quad Flat, No Lead Package (5XF) - 8x8x1.0 mm Body [VQFN] Supertex Legacy Package K6

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

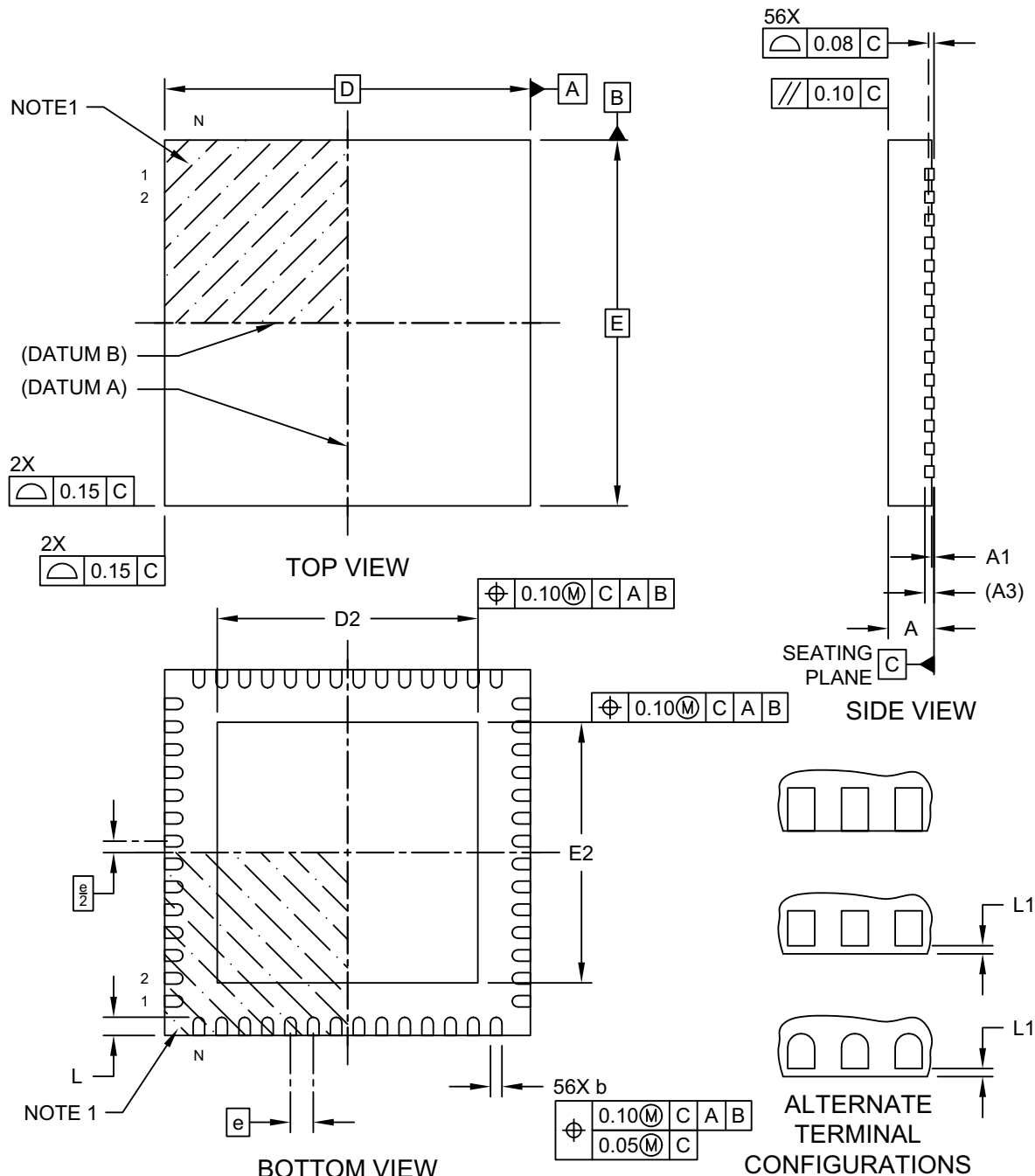


Microchip Technology Drawing C04-299-5XF Rev A Sheet 1 of 2

© 2021 Microchip Technology Inc.

56-Lead Very Thin Quad Flat, No Lead Package (5XF) - 8x8x1.0 mm Body [VQFN] Supertex Legacy Package K6

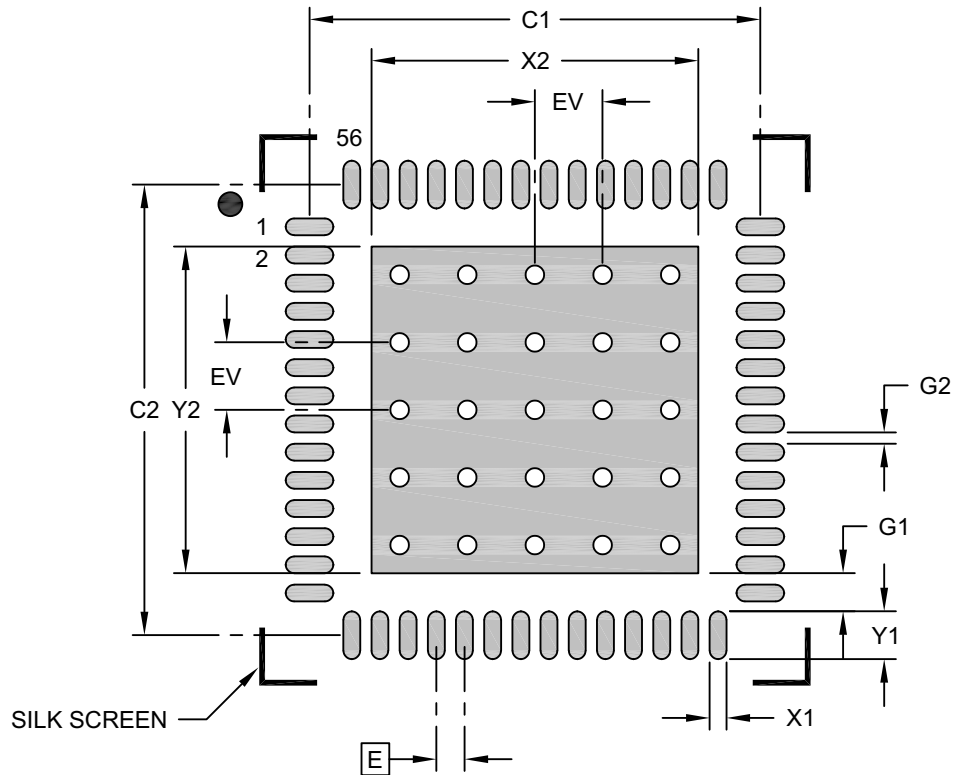
Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-299-5XF Rev A Sheet 1 of 2

56-Lead Very Thin Quad Flat, No Lead Package (5XF) - 8x8x1.0 mm Body [VQFN] Supertex Legacy Package K6

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



RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Center Pad Width	X2			5.80
Center Pad Length	Y2			5.80
Contact Pad Spacing	C1		8.00	
Contact Pad Spacing	C2		8.00	
Contact Pad Width (Xnn)	X1			0.30
Contact Pad Length (Xnn)	Y1			0.85
Contact Pad to Center Pad (Xnn)	G1	0.68		
Contact Pad to Contact Pad (Xnn)	G2	0.20		
Thermal Via Diameter	V		0.33	
Thermal Via Pitch	EV		1.20	

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-2299-5FX Rev A

TC8020

NOTES:

APPENDIX A: REVISION HISTORY

Revision B (July 2023)

- Updated package outline drawings
- Changed “56-lead QFN” to “56-lead VQFN” to align packaging specifications with the actual BQM
- Made minor text changes throughout the document

Revision A (June 2022)

- Converted Supertex Doc# DSFP-TC8020 to Microchip DS20005781A
- Changed the package marking format
- Changed the quantity of the 56-lead QFN K6 M937 media type from 2000/Reel to 3000/Reel to align packaging specification with the actual BQM
- Made minor text changes throughout the document

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-support-services>.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". 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 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 INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL 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.

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

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, Klear, 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.

© 2022-2023, Microchip Technology Incorporated and its subsidiaries.

All Rights Reserved.

ISBN: 978-1-6683-2742-5

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