

8-Channel High-Speed Unipolar 1.5A 150V Ultrasound Pulser

Features

- High-Density Integrated Ultrasound Transmitter
- 0V to +150V Output Voltage
- $\pm 1.5\text{A}$ Minimum Source and Sink Current
- $\pm 300\text{ mA}$ Current in CW Mode
- Up to 18 MHz Operating Frequency
- Matched Delay Times
- Built-in Gate Driver Floating Voltage Regulator
- 2.5V to 3.3V CMOS Logic Interface

Applications

- Portable Medical Ultrasound Imaging
- Piezoelectric Transducer Drivers
- Non-Destructive Testing
- Pulse Waveform Generator

General Description

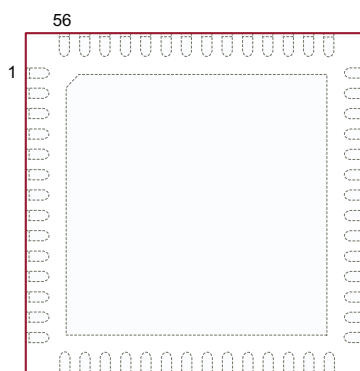
The HV7355 is an 8-channel unipolar high-voltage high-speed pulse generator. It is designed for medical ultrasound applications. This high-voltage and high-speed integrated circuit can also be used for other piezoelectric, capacitive or MEMS sensors in ultrasonic non-destructive detection and sonar ranger applications.

The HV7355 consists of a controller logic interface circuit, level translators, MOSFET gate drivers and high-current P-channel and N-channel MOSFETs as the output stage for each channel.

The output stages of each channel are designed to provide peak output currents of $\pm 1.5\text{A}$ for pulsing, when $\text{MC} = 1$, with up to 150V swings. When $\text{MC} = 0$, all the output stages drop the peak current to $\pm 500\text{ mA}$ for low-voltage CW mode operation to save power. This direct coupling topology of the gate driver not only saves one high-voltage capacitor per channel but also makes the PCB layout easier.

Package Type

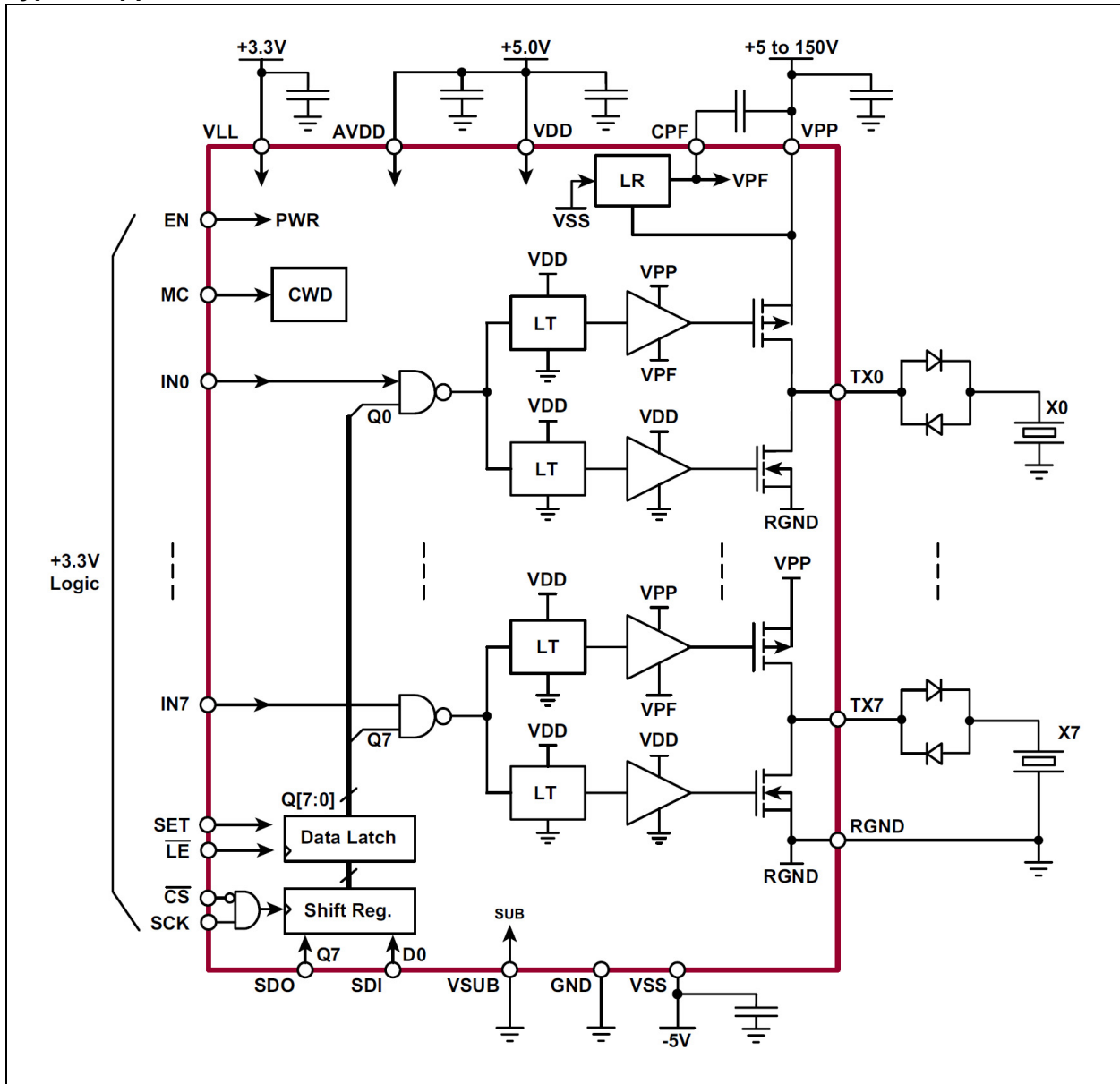
56-lead (8 X 8) VQFN
(Top view)



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



Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

GND, RGND, and Substrate Voltage, V_{SUB}	0V
Positive Logic Supply, V_{LL}	-0.5V to +7V
Positive Logic and Level Translator Supply, V_{DD}	-0.5V to +7V
Negative Level Translator and LR Supply, V_{PP}	+0.5V to -7V
High-voltage Positive Supply, V_{PP}	-0.5V to +160V
V_{PP} - V_{TXx} Voltage	-0.5V to +160V
V_{TXx} -RGND Voltage	-0.5V to +160V
All Logic Input PIN_x , NIN_x and EN Voltages	-0.5V to +7V
Operating Junction Temperature, T_J	-40°C to +125°C
Storage Temperature, T_S	-65°C to +150°C
ESD Rating (Note 1)	ESD Sensitive

† **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: Devices are ESD sensitive. Handling precautions are recommended.

OPERATING SUPPLY VOLTAGES AND CURRENT (EIGHT ACTIVE CHANNELS)

Electrical Specifications: $V_{LL} = +3.3V$, $V_{ADD} = V_{DD} = +5V$, $V_{SS} = -5V$, $V_{PP} = +150V$, $T_A = 25^\circ C$ unless otherwise indicated.						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Logic Voltage Reference	V_{LL}	2.37	3.3	3.47	V	
Internal Voltage Supply	V_{DD}	4.5	5	5.5	V	
Positive Gate Driver Supply Voltage	V_{PP}	V_{DD}	—	+150	V	
Negative Low-Voltage Supply Voltage	V_{SS}	-5.5	-5	-4.5	V	
Gate Driver Floating Voltage	V_{PF}	—	5	—	V	
V_{LL} Current EN = Low	I_{LL}	—	2	10	μA	
V_{DD} Current EN = Low	I_{DDQ}	—	50	150	μA	f = 0 MHz
V_{DD} Current EN = High	I_{DDEN}	—	1	4	mA	f = 0 MHz
V_{DD} Current MC = High	I_{DDEN}	—	160	—	mA	f = 5 MHz, continuous,
V_{DD} Current MC = Low	I_{DDENCW}	—	12	—	mA	no load
V_{SS} Current EN = Low	I_{SSQ}	—	5	20	μA	
V_{SS} Current EN = High	I_{SSEN}	—	1	4	mA	f = 0 MHz
V_{SS} Current MC = High	I_{SSEN}	—	95	—	mA	f = 5 MHz, continuous, no load
V_{SS} Current MC = Low	I_{SSENCW}	—	50	—	mA	
V_{PP} Current EN = Low	I_{PPQ}	—	2	10	μA	
V_{PP} Current EN = High	I_{PPEN}	—	200	450	μA	f = 0 MHz
V_{PP} Current MC = High	I_{PPEN}	—	370	—	mA	f = 5 MHz, continuous, no load
V_{PP} Current MC = Low	I_{PPENCW}	—	300	—	mA	

UNDervoltage AND OvERtEMpERATURE PROtECTION

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
V _{DD} Threshold	V _{UVDD}	3.4	—	4.4	V	Internal only
V _{LL} Threshold	V _{UVLL}	—	1.7	—	V	Internal only
V _{PP} –V _{PF} Threshold	V _{UVPF}	2.5	—	3.8	V	Internal only

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: V_{LL} = +3.3V, V_{ADD} = V_{DD} = +5V, V_{SS} = –5V, V_{PP} = +150V, T_A = 25°C unless otherwise indicated.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
P-CHANNEL MOSFET OUTPUT, TX0-7						
Output Saturation Current	I _{OUT}	1.4	1.6	—	A	MC = 1
Channel Resistance	R _{ON}	—	8	—	Ω	I _{SD} = 100 mA
Output Saturation Current	I _{OUT}	0.5	—	—	A	MC = 0
Channel Resistance	R _{ON}	—	18	—	Ω	I _{SD} = 100 mA
N-CHANNEL MOSFET OUTPUT, TX0-7						
Output Saturation Current	I _{OUT}	1.5	1.7	—	A	MC = 1
Channel Resistance	R _{ON}	—	3	—	Ω	I _{SD} = 100 mA
Output Saturation Current	I _{OUT}	0.5	—	—	A	MC = 0
Channel Resistance	R _{ON}	—	18	—	Ω	I _{SD} = 100 mA
LOGIC INPUT						
Input Logic High Voltage	V _{IH}	(V _{LL} –0.4)	—	V _{LL}	V	
Input Logic Low Voltage	V _{IL}	0	—	0.4	V	
Input Logic High Current	I _{IH}	—	—	1	μA	
Input Logic Low Current	I _{IL}	–1	—	—	μA	
Input Logic Capacitance	C _{IN}	—	—	5	pF	Note 1

Note 1: For design guidance only

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: V_{LL} = +3.3V, V_{ADD} = V_{DD} = +5V, V_{SS} = –5V, V_{PP} = +150V, T_A = 25°C unless otherwise indicated.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Input Data Rise or Fall Maximum Time	t _{inrf}	—	—	10	ns	Note 1
Output Rise Time	t _r	—	24	—	ns	330 pF//2.5 kΩ load (See Timing Waveforms .)
Output Fall Time	t _f	—	24	—	ns	
Output Frequency Range	f _{OUT}	—	—	18	MHz	100Ω resistor load, V _{PP} = +90V (Note 1)
Initial Enable Time	t _{EN-ON}	—	150	200	μs	2 μF on each CPF pin to 90% of V _{CPF}
Output Disable Time	t _{EN-OFF}	—	2	5	μs	At 5 MHz CW
Delay Time on Inputs Rise	t _{dr}	—	5	—	ns	V _{PP} = 25V 1Ω resistor load, 50% to 50% (See Timing Waveforms .)
Delay Time on Inputs Fall	t _{df}	—	5	—	ns	
Delay on Mode Change	t _{dm}	—	50	70	ns	
Delay Time Matching	Δt _{DELAY}	—	±2	—	ns	
Delay Jitter on Rise or Fall	t _j	—	15	—	ps	(Note 1)

Note 1: For design guidance only

AC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: $V_{LL} = +3.3V$, $V_{ADD} = V_{DD} = +5V$, $V_{SS} = -5V$, $V_{PP} = +150V$, $T_A = 25^\circ C$ unless otherwise indicated.

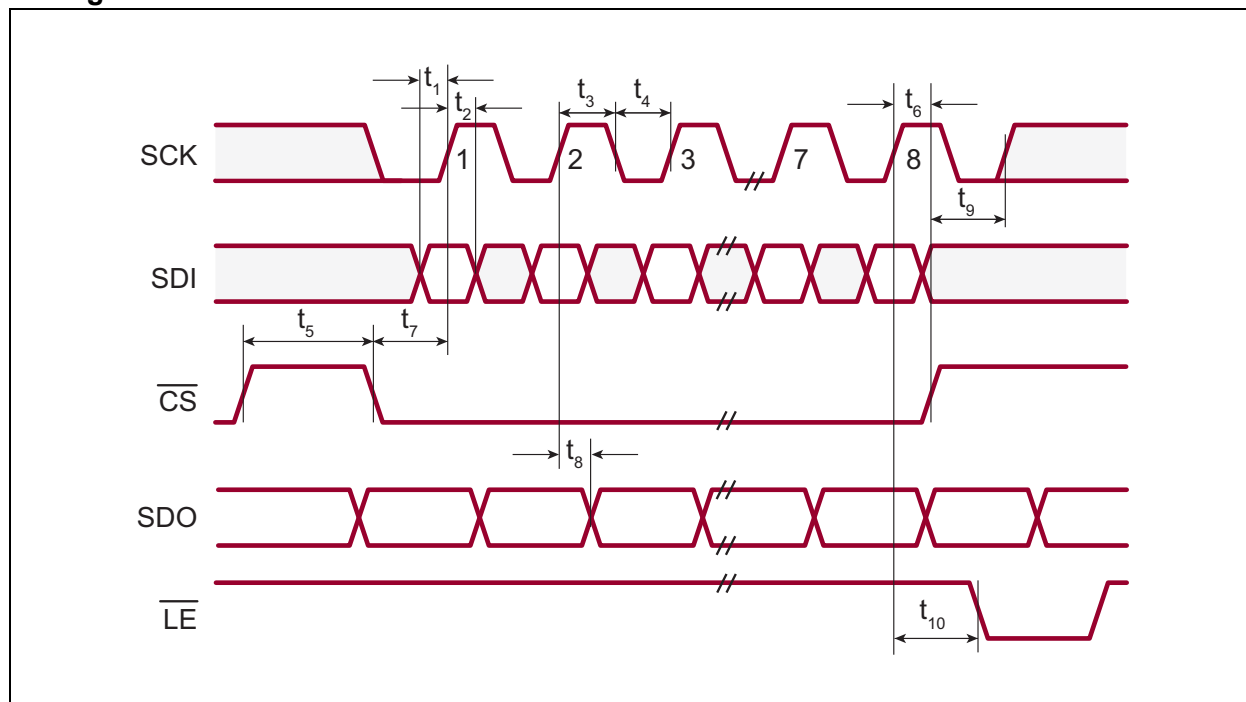
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
SERIAL DATA INTERFACE TIMING CHARACTERISTICS						
Serial Clock Maximum Frequency	f_{SCK}	25	—	—	MHz	All from/to 50% rise or fall edges (See Timing Waveforms.) (Note 1)
SDI Valid to SCK Setup Time	t_1	0	2	—	ns	
SDI Valid to SCK Hold Time	t_2	4	—	—	ns	
SCK High Time	t_3	9	—	—	ns	
SCK Low Time	t_4	9	—	—	ns	
$\overline{CS}$ Pulse Width	t_5	9	—	—	ns	
SCK High to $\overline{CS}$ High	t_6	7	—	—	ns	
$\overline{CS}$ Low to SCK High	t_7	7	—	—	ns	SDO with 100 pF to GND
SDO Delay from SCK Rise Edge	t_8	—	6.5	—	ns	
$\overline{CS}$ High to SCK Rise Edge	t_9	7	—	—	ns	
SCK High to $\overline{LE}$ Low	t_{10}	7	—	—	ns	All from/to 50% rise or fall edges (See Timing Waveforms.) (Note 1)

Note 1: For design guidance only

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Junction Temperature	T_J	-40	—	+125	$^\circ C$	
Storage Temperature	T_S	-65	—	+150	$^\circ C$	
PACKAGE THERMAL RESISTANCE						
56-lead (8 X 8) VQFN	θ_{JA}	—	21	—	$^\circ C/W$	

Timing Waveforms



2.0 PIN DESCRIPTION

The details on the pins of HV7355 are listed on [Table 2-1](#). Refer to [Package Type](#) for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	IN0	Input control for channels 0 to 7
2	IN1	
3	IN2	
4	IN3	
5	IN4	
6	IN5	
7	IN6	
8	IN7	
9	$\overline{\text{CS}}$	Serial interface enable, active low
10	SDI	Serial Shift register data input, MSB(D7) first, LSB(D0) last
11	$\overline{\text{LE}}$	Latch enable, active low
12	SCK	Serial Shift register clock
13	SDO	Serial Shift register data output
14	SET	Set latch data Q[7:0] = 1, regardless the Shift register inputs or LE, active high
15	MC	Output Current mode control pin (See Table 3-3 .)
16	VLL	Logic high-voltage reference input (+3.3V)
17	VSS	Negative power supply(–5V)
18	CPF	Gate driver floating voltage decoupling capacitor to VPP
19	VPP	Positive high-voltage power supply (+150V)
20	VPP	Positive high-voltage power supply (+150V)
21	VPP	Positive high-voltage power supply (+150V)
22	VPP	Positive high-voltage power supply (+150V)
23	VDD	Positive voltage supply for gate drivers (+5V)
24	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground
25	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground
26	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground
27	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground

TABLE 2-1: PIN FUNCTION TABLE (CONTINUED)

Pin Number	Pin Name	Description
28	TX7	Output for channels 0 to 7
29	TX7	
30	TX6	
31	TX6	
32	TX5	
33	TX5	
34	TX4	
35	TX4	
36	TX3	
37	TX3	
38	TX2	
39	TX2	
40	TX1	
41	TX1	
42	TX0	
43	TX0	
44	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground
45	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground
46	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground
47	RGND	Output return ground, 0V, RGND pins carry high current, must connect to load transducer ground
48	VDD	Positive voltage supply for gate drivers (+5V)
49	VPP	Positive high-voltage power supply (+150V)
50	VPP	Positive high-voltage power supply (+150V)
51	VPP	Positive high-voltage power supply (+150V)
52	VPP	Positive high-voltage power supply (+150V)
53	CPF	Gate driver floating voltage decoupling capacitor to VPP
54	GND	Logic input reference ground, 0V
55	AVDD	Positive internal voltage supply (+5V)
56	EN	Chip power enable, active high
VSUB (Thermal Pad)		Substrate bottom is internally connected to the central thermal pad on the bottom of package. It must be connected to GND (0V) externally.

3.0 FUNCTIONAL DESCRIPTION

Follow the steps below to power up and power down the HV7355:

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

Power-up		Power-down	
Step	Description	Step	Description
1	V _{SS}	1	EN and logic signal low
2	V _{LL} with logic signal low	2	V _{PP}
3	V _{DD}	3	V _{DD}
4	V _{PP}	4	V _{LL}
5	EN and logic signal go to high	5	V _{SS}

Note: Powering up or powering down in any arbitrary sequence will not damage the device. The power-up sequence and power-down sequence are only recommended to minimize possible inrush current.

TABLE 3-2: TRUTH FUNCTION TABLE (MC = X)

Logic Inputs			Output
EN	Q[7:0]	IN0–7	TX0–7
1	1111,1111	0	GND
1	1111,1111	1	V _{PP}
1	0	X	GND
0	X	X	High-Z

TABLE 3-3: DRIVE MODE CONTROL TABLE

MC	I _{SC} (A)	R _{onP}	R _{onN}
0	0.5	18	13
1	1.6	8	3

Note: V_{PP} = +150V, V_{DD} = +5V, V_{LL} = +3.3V, V_{SS} = -5V, V_{SUB} = 0V

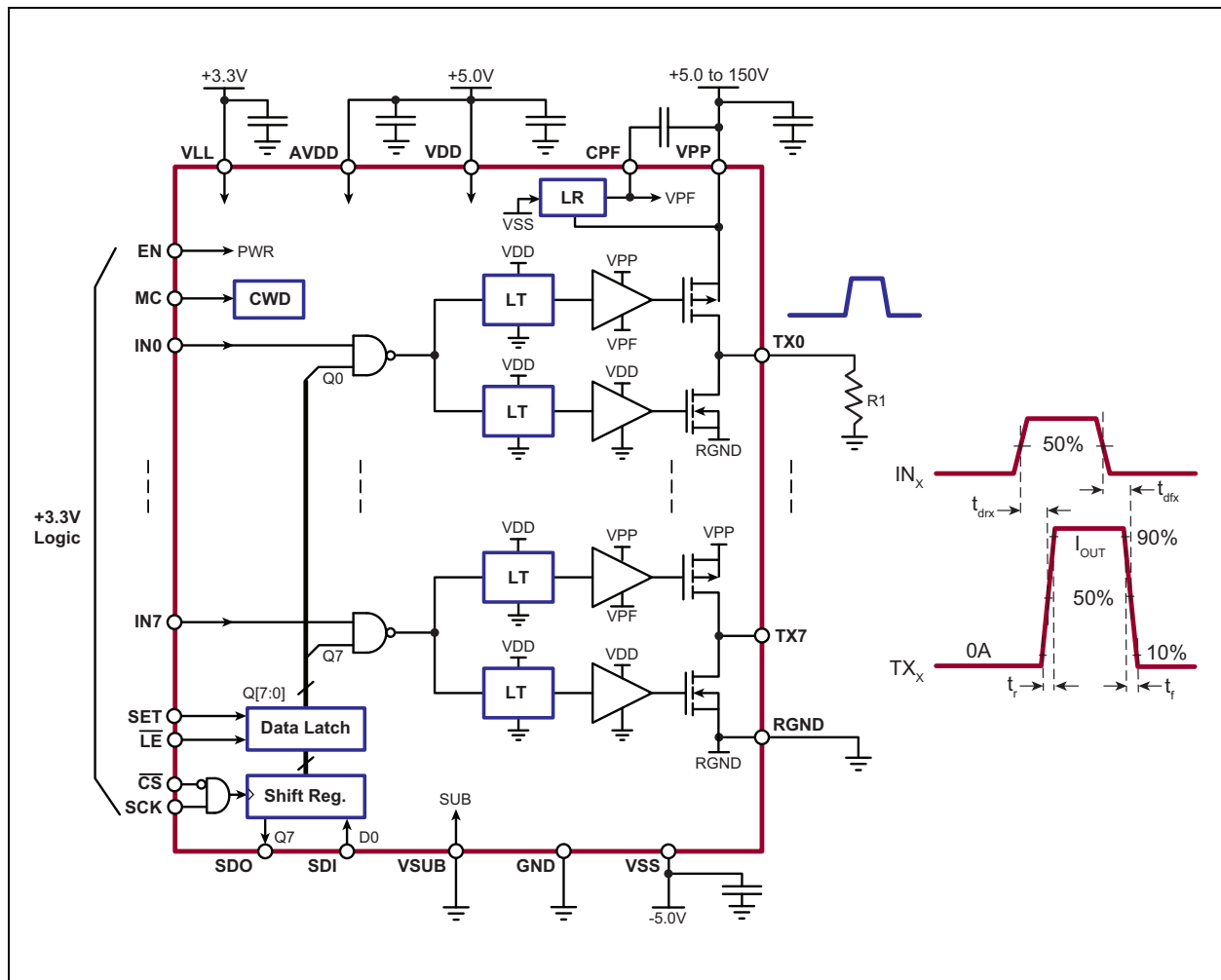


FIGURE 3-1: Output Timing Test Diagram.

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

56-lead QFN



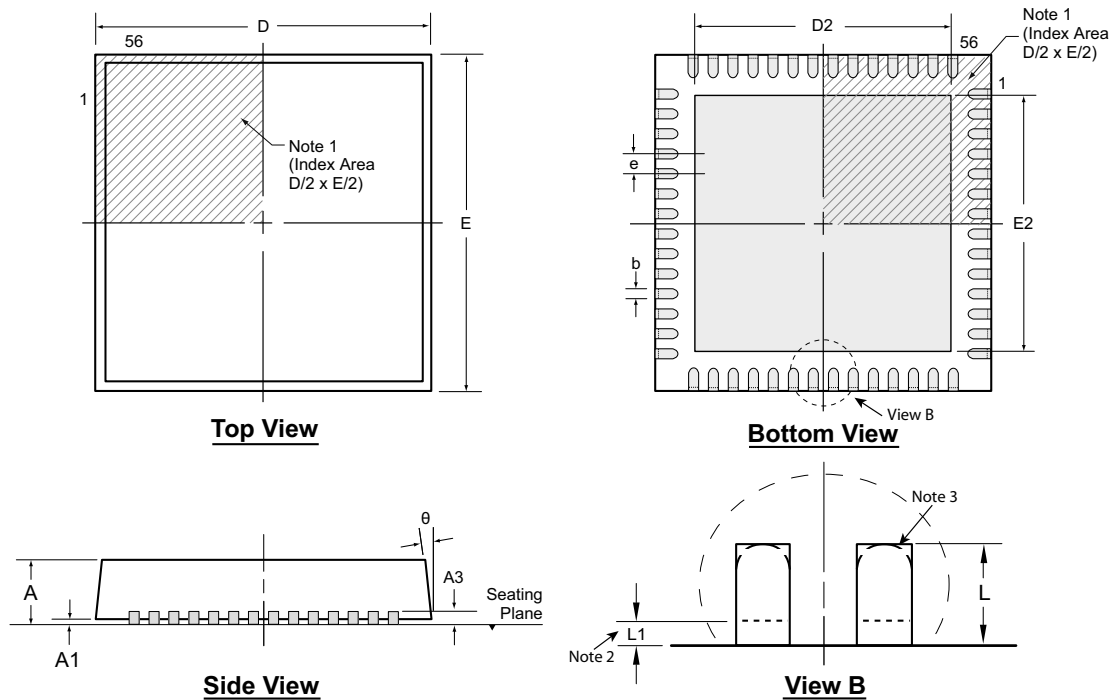
Example



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.	

56-Lead QFN Package Outline (K6)

8.00x8.00mm body, 1.00mm 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	0.80	0.00	0.20 REF	0.18	7.85*	2.75	7.85*	2.75	0.50 BSC	0.30	0.00	0°
	NOM	0.90	0.02		0.25	8.00	5.70	8.00	5.70		0.40	-	-
	MAX	1.00	0.05		0.30	8.15*	6.70†	8.15*	6.70†		0.50	0.15	14°

JEDEC Registration MO-220, Variation VLLD-2, Issue K, June 2006.

* This dimension is not specified in the JEDEC drawing.

† This dimension differs from the JEDEC drawing.

Drawings are not to scale.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (November 2018)

- Converted Supertex Doc# DSFP-HV7355 to Microchip DS20005896A
- Removed “HVC MOS[®] Technology for high performance” in the Features section
- Changed the package marking format
- Removed the 56-lead QFN K6 M937 media type
- Made minor text changes throughout the document

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: HV7355 = 8-Channel High-Speed Unipolar 1.5A 150V Ultrasound Pulser Package: K6 = 56-lead VQFN Environmental: G = Lead (Pb)-free/RoHS-compliant Package Media Type: (blank) = 250/Tray for a K6 Package					
Example: a) HV7355K6-G: 8-Channel High-Speed Unipolar 1.5A 150V Ultrasound Pulser, 56-lead VQFN, 250/Tray					

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.

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949 ==

Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, AVR, AVR logo, AVR Freaks, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, Helder, JukeBlox, KeeLoq, Kleeer, LANCheck, LINK MD, maXStylus, maXTouch, MediaLB, megaAVR, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, Prochip Designer, QTouch, SAM-BA, SpyNIC, SST, SST Logo, SuperFlash, tinyAVR, UNI/O, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, EtherSynch, Hyper Speed Control, HyperLight Load, IntellIMOS, mTouch, Precision Edge, and Quiet-Wire 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, 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, KleeerNet, KleeerNet logo, memBrain, Mindi, MiWi, motorBench, 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.

Silicon Storage Technology is a registered trademark 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.

© 2018, Microchip Technology Incorporated, All Rights Reserved.
ISBN: 978-1-5224-3838-0

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: 49-7131-67-3636

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