

High-Speed $\pm 100\text{V}$ 2.5A Two-or-Three-Level Ultrasound Pulsers

Features

- High-Density Integration AC-coupled Pulser
- 0V to $\pm 100\text{V}$ Output Voltage
- $\pm 2.5\text{A}$ Source and Sink Minimum Pulse Current
- Up to 35 MHz Operating Frequency
- 2 ns Matched Delay Times
- 2.5V, 3.3V or 5V CMOS Logic Interface
- Built-in Two-terminal Low-noise Interface for HV7361
- Low Power Consumption and No Floating Power Supply Rails or Decoupling Capacitors

Applications

- Medical Ultrasound Imaging
- Piezoelectric Transducer Drivers
- Ultrasound Industrial NDT
- Pulse Waveform Generator

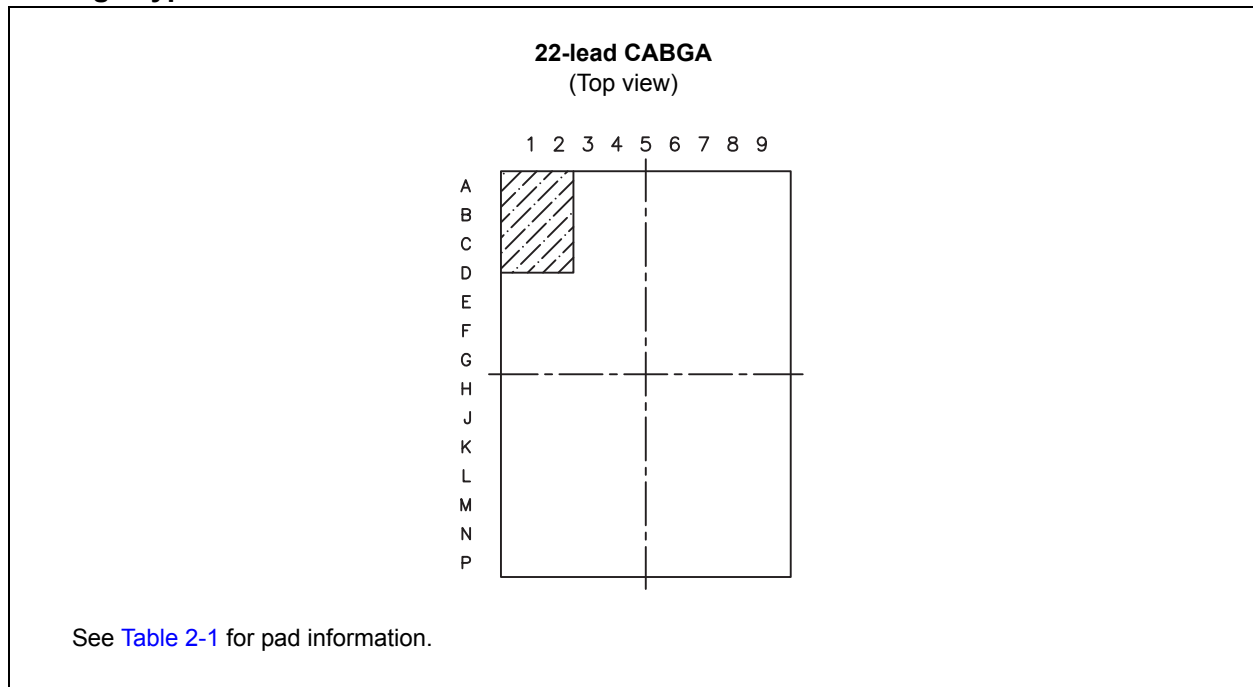
General Description

The HV7360/HV7361 are high-voltage and high-speed pulse generators with built-in, fast return-to-zero damping Field-Effect Transistors (FETs). An added feature to HV7361 is an integrated two-terminal low-noise T/R switch. These integrated circuits are designed not only for portable medical ultrasound image devices but also for NDT and test equipment applications.

Both the HV7360/HV7361 are composed of controller logic interface circuits, level translators and AC-coupled Metal Oxide Semiconductor Field-Effect Transistor (MOSFET) gate drivers. They also have high-voltage and high-current P-channel and N-channel MOSFETs as output stages.

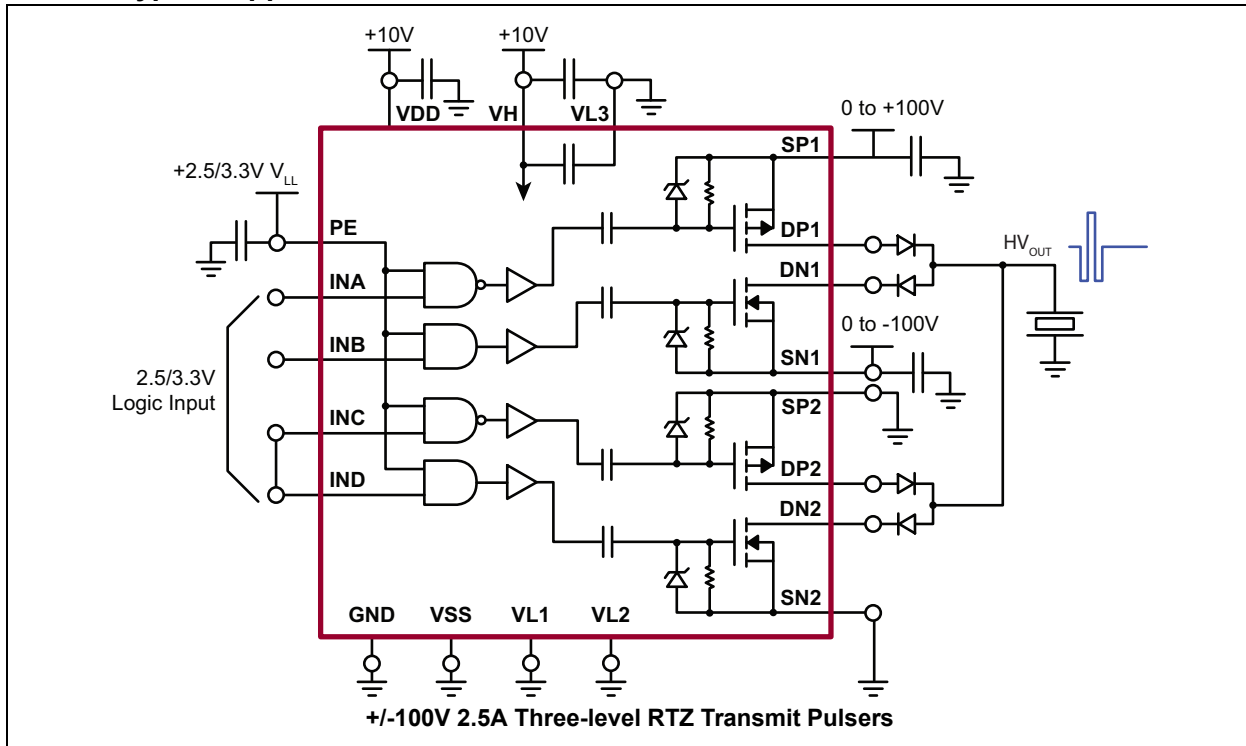
The peak output currents of each channel are guaranteed to be over $\pm 2.5\text{A}$ with up to $\pm 100\text{V}$ of pulse swing. The AC coupling topology for the gate drivers not only saves two floating voltage supplies but also makes the PCB layout easier.

Package Type

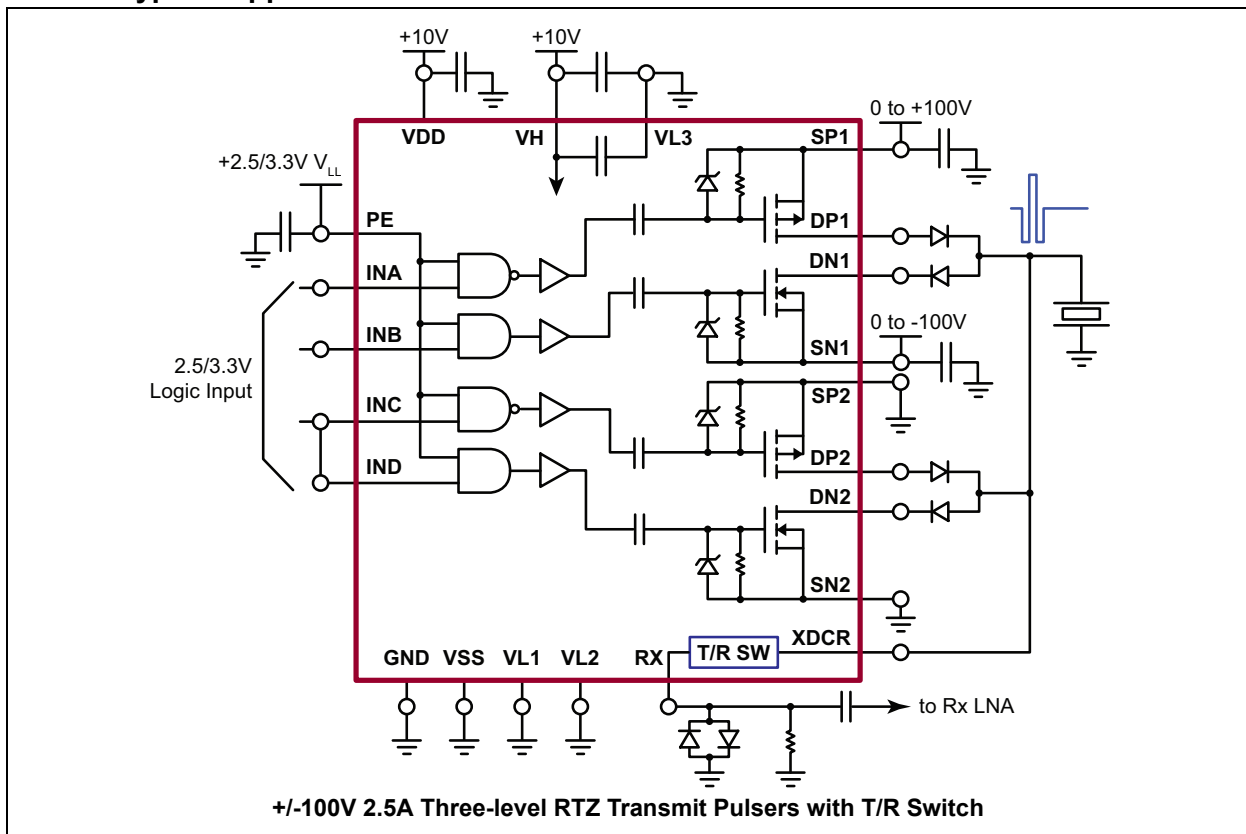


HV7360/HV7361

HV7360 Typical Application Circuit



HV7361 Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Chip Power Supply Voltage, $V_{DD}-V_{SS}$	-0.5 to +12.5V
Output High Supply Voltage, V_H	$V_L-0.5$ to $V_{DD}+0.5V$
Output Low Supply Voltage, V_L	$V_{SS}-0.5V$ to $V_H+0.5V$
Low-side Supply Voltage, V_{SS}	-6V to +0.5V
Differential High Voltage, $V_{SP1}-V_{SN1}$, $V_{SP2}-V_{SN2}$	+220V
Positive High Voltage, $V_{SP1,2}$	-0.5V to +110V
Negative High Voltage, $V_{SN1,2}$	+0.5V to -110V
All Logic Input Voltages	$V_{SS}-0.5V$ to GND +5.5V
Rx to XDCR Differential Drop	±140V
Coupling Capacitor Breakdown Voltage	±110V
Maximum Junction Temperature, T_J	125°C
Operating Ambient Temperature, T_A	-40°C to +85°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.

OPERATING SUPPLY VOLTAGES AND CURRENT

Electrical Specifications: GND = 0V, $V_H = V_{DD} = +10V$, $V_L = V_{SS} = 0V$, $V_{PE} = 3.3V$, $V_{PP} = +100V$, $V_{NN} = -100V$, $T_A = 25^\circ C$ unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Logic Supply Voltage Range	V_{LL}	2.25	—	3.63	V	
Supply Voltage	$V_{DD}-V_{SS}$	4.75	—	11.5	V	$4V \leq V_{DD} \leq 11.5V$
Low Side Supply Voltage	V_{SS}	-5.5	—	0	V	
Gate Drive High-side Voltage	V_H	$V_{SS}+4$	—	V_{DD}	V	$V_H-V_L \geq 4V$
Gate Drive Low-side Voltage	V_L	V_{SS}	—	$V_{DD}-4$	V	
Output Positive High Voltage	$V_{SP1,2}$	0	—	100	V	
Output Negative High Voltage	$V_{SN1,2}$	-100	—	0	V	
V_{DD} Quiescent Current	I_{DDQ}	—	50	—	µA	No input transitions, PE = 0
V_H Quiescent Current	I_{HQ}	—	2	—	µA	
V_{DD} Quiescent Current	I_{DDQ}	—	1	—	mA	No input transitions, PE = 1
V_H Quiescent Current	I_{HQ}	—	2	—	µA	
V_{DD} Average Current	I_{DD}	—	4	—	mA	One channel on at 5 MHz, no load
V_H Average Current	I_H	—	10	—	mA	
Input Logic Voltage High	V_{IH}	$V_{PE}-0.3$	—	V_{PE}	V	For logic inputs INA, INB, INC and IND
Input Logic Voltage Low	V_{IL}	0	—	0.3	V	
Input Logic Current High	I_{IH}	—	—	1	µA	
Input Logic Current Low	I_{IL}	—	—	1	µA	
PE Input Logic Voltage High	V_{PEH}	1.7	3.3	5.25	V	For logic input PE
PE Input Logic Voltage Low	V_{PEL}	0	—	0.3	V	
PE Input Impedance to GND	R_{INPE}	100	—	—	kΩ	

HV7360/HV7361

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: GND = 0V, $V_H = V_{DD} = +10V$, $V_L = V_{SS} = 0V$, $V_{PE} = 3.3V$, $V_{PP} = +100V$, $V_{NN} = -100V$, $T_A = 25^\circ C$ unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Input or PE Rise and Fall Time	t_{irf}	—	—	10	ns	Logic input edge speed requirement
Input to Output Delay	t_{d1-4}	—	7.5	—	ns	$R_{LOAD} = 1\Omega$
Output Rise and Fall Time	$t_{r/f1-2}$	—	9.5	—	ns	$C_{LOAD} = 330\text{ pF}$, $R_{LOAD} = 2.5\text{ k}\Omega$
Rise and Fall Time Matching	Δt_{rf}	—	2	—	ns	Channel to channel
Propagation Matching	Δt_{dC2C}	—	1	—		
Propagation Delay Matching	Δt_{dD2D}	—	± 2	—	ns	Device to device delay match
PE On-time	t_{PE-ON}	—	—	5	μs	$V_{PE} = 1.7 \sim 5.25V$, $V_{DD} = 7.5 \sim 11.5V$, $-20 \sim 85^\circ C$
PE Off-time	t_{PE-OFF}	—	—	4		
Output to MOSFET Gate Cap	C_{OG}	—	10	—	nF	100V X7S
V_H to V_{L3} Decoupling Cap	C_{VH}	—	0.22	—	μF	16V X7R

ELECTRICAL CHARACTERISTICS

Electrical Specifications: GND = 0V, $V_H = V_{DD} = +10V$, $V_L = V_{SS} = 0V$, $V_{PE} = 3.3V$, $V_{PP} = +100V$, $V_{NN} = -100V$, $T_A = 25^\circ C$ unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
PULSER AND DAMPING P-CHANNEL MOSFET						
DC PARAMETER						
Drain-to-source Breakdown Voltage	BV_{DSS}	-200	—	—	V	$V_{GS} = 0V$, $I_D = -2\text{ mA}$
Gate Threshold Voltage	$V_{GS(th)}$	-1	—	-2.4	V	$V_{GS} = V_{DS}$, $I_D = -1\text{ mA}$
Change in $V_{GS(th)}$ with Temperature	$\Delta V_{GS(th)}$	—	—	4.5	mV/ $^\circ C$	$V_{GS} = V_{DS}$, $I_D = -1\text{ mA}$
Gate-to-source Shunt Resistor	R_{GS}	10	—	50	k Ω	$I_{GS} = 100\text{ }\mu A$, if applied
Gate-to-source Zener Voltage	V_{ZGS}	13.2	—	25	V	$I_{GS} = -2\text{ mA}$, if applied
Zero-gate Voltage Drain Current	I_{DSS}	—	—	-10	μA	$V_{DS} = \text{Maximum rating}$, $V_{GS} = 0V$
		—	—	-1	mA	$V_{DS} = 0.8\text{ maximum rating}$, $V_{GS} = 0V$, $T_A = 125^\circ C$
ON-state Drain Current	$I_{D(ON)}$	-1.2	—	—	A	$V_{GS} = -5V$, $V_{DS} = -25V$
		-2.3	-2.5	—		$V_{GS} = -10V$, $V_{DS} = -50V$
Static Drain-to-source ON-state Resistance	$R_{DS(ON)}$	—	—	8.5	Ω	$V_{GS} = -5V$, $I_D = -150\text{ mA}$
		—	—	7		$V_{GS} = -10V$, $I_D = -1A$
Change in $R_{DS(ON)}$ with Temperature	$\Delta R_{DS(ON)}$	—	—	1	%/ $^\circ C$	$V_{GS} = -10V$, $I_D = -1\text{ mA}$
AC PARAMETER						
Forward Transconductance	G_{FS}	400	—	—	mmho	$V_{DS} = -25V$, $I_D = -500\text{ mA}$
Input Capacitance	C_{ISS}	—	75	—	pF	$V_{GS} = 0V$, $V_{DS} = -25V$, $f = 1\text{ MHz}$
Common Source Output Capacitance	C_{OSS}	—	21	—		
Reverse Transfer Capacitance	C_{RSS}	—	6.5	—		
DIODE PARAMETER						
Diode Forward Voltage Drop	V_{SBD}	—	—	1.8	V	$V_{GS} = 0V$, $I_{SD} = 500\text{ mA}$
Reverse Recovery Time of Body Diode	t_{rrBD}	—	300	—	ns	
PULSER AND DAMPING N-CHANNEL MOSFET						
DC PARAMETER						
Drain-to-source Breakdown Voltage	BV_{DSS}	200	—	—	V	$V_{GS} = 0V$, $I_D = 2\text{ mA}$
Gate Threshold Voltage	$V_{GS(th)}$	1	—	2.4	V	$V_{GS} = V_{DS}$, $I_D = 1\text{ mA}$

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: GND = 0V, $V_H = V_{DD} = +10V$, $V_L = V_{SS} = 0V$, $V_{PE} = 3.3V$, $V_{PP} = +100V$, $V_{NN} = -100V$, $T_A = 25^\circ C$ unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Change in $V_{GS(th)}$ with Temperature	$\Delta V_{GS(th)}$	—	—	-4.5	mV/°C	$V_{GS} = V_{DS}$, $I_D = 1\text{ mA}$
Gate-to-source Shunt Resistor	R_{GS}	10	—	50	k Ω	$I_{GS} = 100\text{ }\mu A$
Gate-to-source Zener Voltage	V_{ZGS}	13.2	—	25	V	$I_{GS} = 2\text{ mA}$
Zero Gate Voltage Drain Current	I_{DSS}	—	—	10	μA	$V_{DS} = \text{Maximum rating}$, $V_{GS} = 0V$
		—	—	1	mA	$V_{DS} = 0.8\text{ maximum rating}$, $V_{GS} = 0V$, $T_A = 125^\circ C$
ON-state Drain Current	$I_{D(ON)}$	1.3	—	—	A	$V_{GS} = 5V$, $V_{DS} = 25V$
		2.3	2.5	—		$V_{GS} = 10V$, $V_{DS} = 50V$
Static Drain-to-source ON-state Resistance	$R_{DS(ON)}$	—	—	6.5	Ω	$V_{GS} = 5V$, $I_D = 150\text{ mA}$
		—	—	6		$V_{GS} = 10V$, $I_D = 1A$
Change in $R_{DS(ON)}$ with Temperature	$\Delta R_{DS(ON)}$	—	—	1	%/°C	$V_{GS} = 10V$, $I_D = 1A$
AC PARAMETER						
Forward Transconductance	G_{FS}	400	—	—	mmho	$V_{DS} = 25V$, $I_D = 500\text{ mA}$
Input Capacitance	C_{ISS}	—	56	—	pF	$V_{GS} = 0V$, $V_{DS} = 25V$, $f = 1\text{ MHz}$
Common Source Output Capacitance	C_{OSS}	—	13	—		
Reverse Transfer Capacitance	C_{RSS}	—	2	—		
DIODE PARAMETER						
Diode Forward Voltage Drop	V_{SBD}	—	—	1.8	V	$V_{GS} = 0V$, $I_{SD} = 500\text{ mA}$
Reverse Recovery Time of Body Diode	t_{rBD}	—	300	—	ns	

HV7361 T/R SWITCH CHARACTERISTICS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Breakdown Voltage from XDCR to Rx	B_{VA-B}	± 130	—	—	V	$I_{A-B} = \pm 1\text{ mA}$
Switch-on Resistance from XDCR to Rx	R_{SW}	—	15	—	Ω	$I_{A-B} = \pm 5\text{ mA}$
V_{A-B} Trip Point to Turn Off	V_{TRIP}	—	± 1	± 2	V	
Switch Turn-off Voltage	V_{OFF}	—	± 2	—	V	$I_{A-B} = \pm 1\text{ mA}$
Switch-off Current	$I_{A-B(OFF)}$	—	± 200	± 300	μA	$V_{A-B} = \pm 130V$
Peak Switching Current	I_{PEAK}	—	± 60	—	mA	
Turn-off Time	T_{OFF}	—	—	20	ns	
Turn-on Time	T_{ON}	—	—	20	ns	
Switch-on Capacitance from A to B or B to A	$C_{SW(ON)}$	—	21	—	pF	SW = On
Switch-off Capacitance from A to B or B to A	$C_{SW(OFF)}$	—	15	—	pF	$V_{SW} = 25V$
Small Signal Bandwidth	BW	—	100	—	MHz	$R_{LOAD} = 50\Omega$

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TEMPERATURE SPECIFICATIONS

Electrical Characteristics: Unless otherwise noted, for all specifications $T_A = T_J = +25^\circ\text{C}$.						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Maximum Junction Temperature	T_J	—	—	125	$^\circ\text{C}$	
Operating Temperature	T_A	-40	—	+85	$^\circ\text{C}$	
PACKAGE THERMAL RESISTANCE						
22-Lead CABGA	θ_{JA}	—	106	—	$^\circ\text{C/W}$	

POWER-UP AND POWER-DOWN SEQUENCE 1

Power-up		Power-down	
Step	Description	Step	Description
1	V_{LL}	1	PE inactive
2	V_{DD} , V_H , V_{SS} and V_L with signal logic low	2	V_{PP} and V_{NN} off
3	V_{PP} and V_{NN}	3	V_{DD} , V_H , V_{SS} and V_L off
4	PE active	4	V_{LL} off

Note 1: Powering up or down in any arbitrary sequence will not cause any damage to the device. The power-up sequence and power-down sequence are only recommended to minimize possible inrush current.

LOGIC CONTROL TABLE

PE	Input Pulse				Output MOSFETs			
	INA	INB	INC	IND	SP1 to DP1	DN1 to SN1	SP2 to DP2	DN2 to SN2
1	1	X	X	X	ON	X	X	X
	X	1	X	X	X	ON	X	X
	X	X	1	X	X	X	ON	X
	X	X	X	1	X	X	X	ON
	0	X	X	X	OFF	X	X	X
	X	0	X	X	X	OFF	X	X
	X	X	0	X	X	X	OFF	X
	X	X	X	0	X	X	X	OFF
0	X	X	X	X	OFF	OFF	OFF	OFF

2.0 PAD DESCRIPTION

Table 2-1 details the description of pads in HV7360/HV7361. Refer to **Package Type** for the location of pads.

TABLE 2-1: PAD FUNCTION TABLE

Pad Location	HV7360 Symbol	HV7361 Symbol	Description
A1	GND	GND	Driver and level translator circuit ground return (0V)
A2	IND	IND	Damping N-FET control signal logic input, controlling N-FET2
A3	INC	INC	Damping P-FET control signal logic input, controlling P-FET2
A4	V _{SS}	V _{SS}	Negative voltage power supply (0V)
A6	V _{DD}	V _{DD}	Positive voltage supply (+10V), should connect to an external decoupling cap to V _{SS} (0V)
A7	INB	INB	Pulsing N-FET control signal logic input, controlling N-FET1
A8	INA	INA	Pulsing P-FET control signal logic input, controlling P-FET1
A9	PE	PE	Drive power enable Hi = On, Low = Off, logic '1' voltage reference input (+2.5V to +3.3V)
B2	V _{L2}	V _{L2}	Gate-drive negative voltage power supply (0V)
B8	V _{L1}	V _{L1}	Gate-drive negative voltage power supply (0V)
F4	V _H	V _H	Gate-drive positive voltage power supply (+10V)
F7	V _{L3}	V _{L3}	V _H to V _L decoupling cap. The trace connecting V _{L1} , V _{L2} , and V _{L3} (0V) to ground plane should be as short as possible.
G4	NC	—	No connection for HV7360
	—	RX	T/R switch output for HV7361
P1	SP2	SP2	Source of P-FET2, positive high voltage power supply (0V to +100V) or GND
P2	DP2	DP2	Drain of P-FET2, transmit pulser output
P3	DN2	DN2	Drain of N-FET2, transmit pulser output
P4	SN2	SN2	Source of N-FET2, negative high voltage power supply (0V to -100V) or GND
P5	NC	—	No connection for HV7360
	—	XDCR	T/R switch input for HV7361
P6	SP1	SP1	Source of P-FET1, positive high voltage power supply (0V to +100V)
P7	DP1	DP1	Drain of P-FET1, transmit pulser output
P8	DN1	DN1	Drain of N-FET1, transmit pulser output
P9	SN1	SN1	Source of N-FET1, negative high voltage power supply (0V to -100V)

HV7360/HV7361

3.0 FUNCTIONAL DESCRIPTION

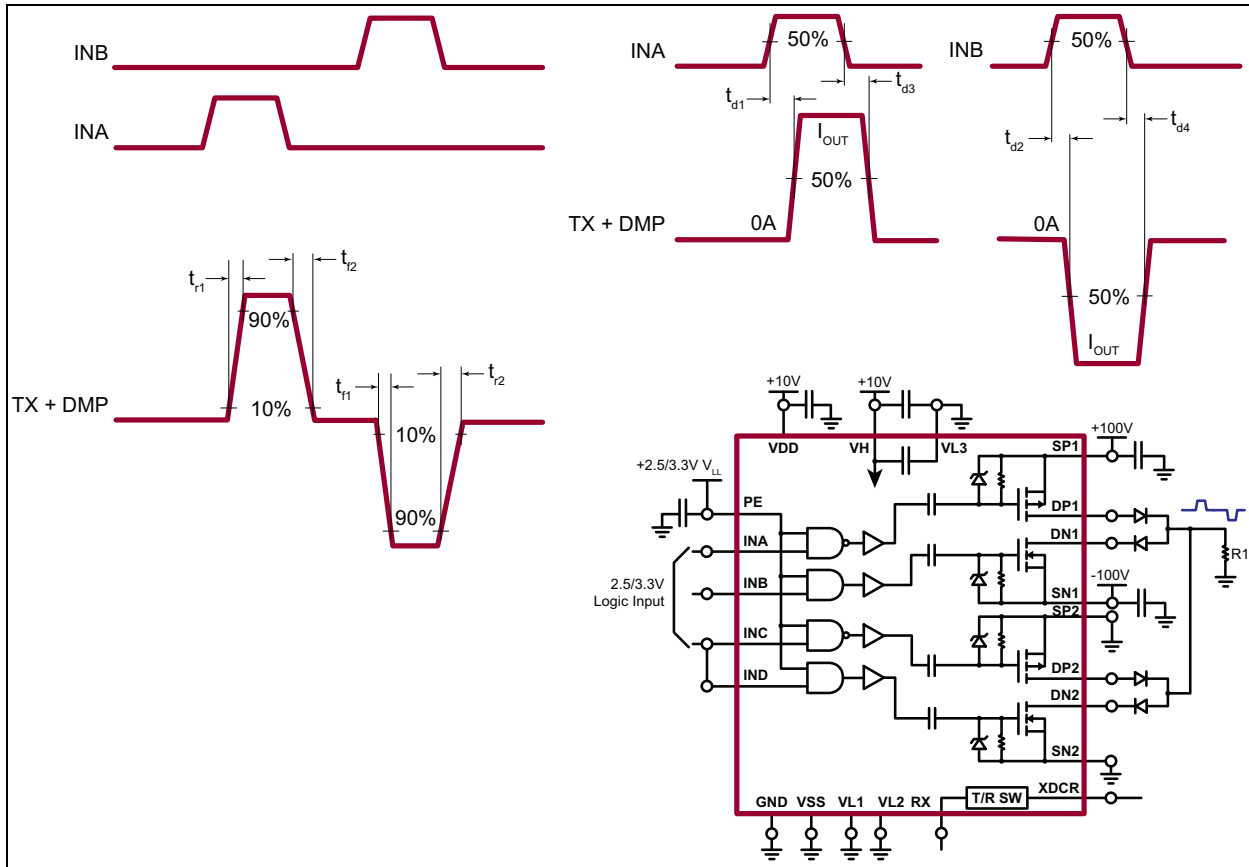


FIGURE 3-1: Pulser Timing Test for HV7360/HV7361.

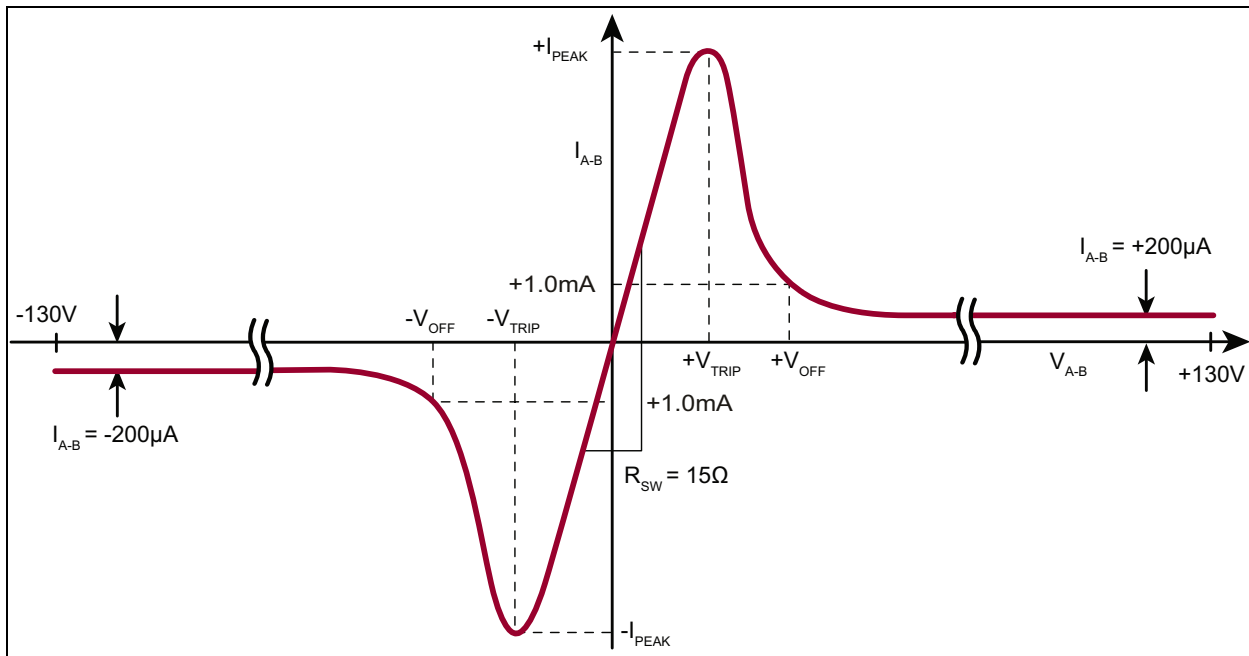


FIGURE 3-2: T/R Switch I-V curve for HV7361.

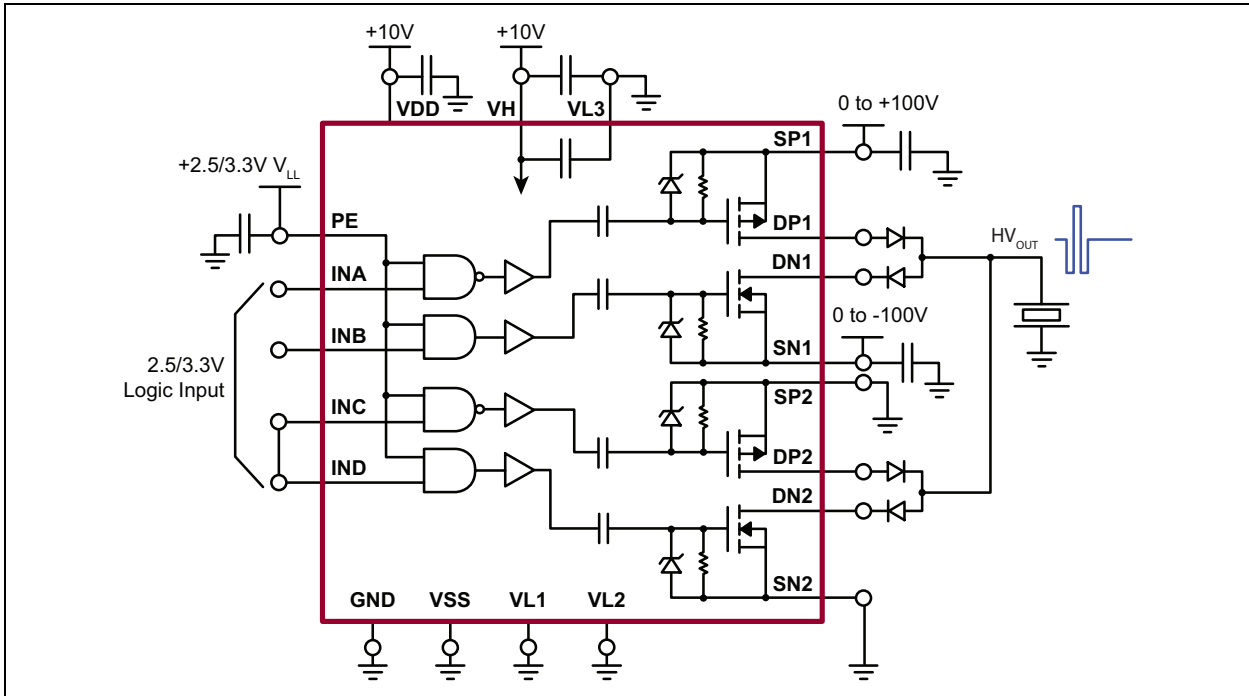


FIGURE 3-3: Typical Bipolar One-channel Three-level Ultrasound Transmitter Application Circuit for HV7360/HV7361.

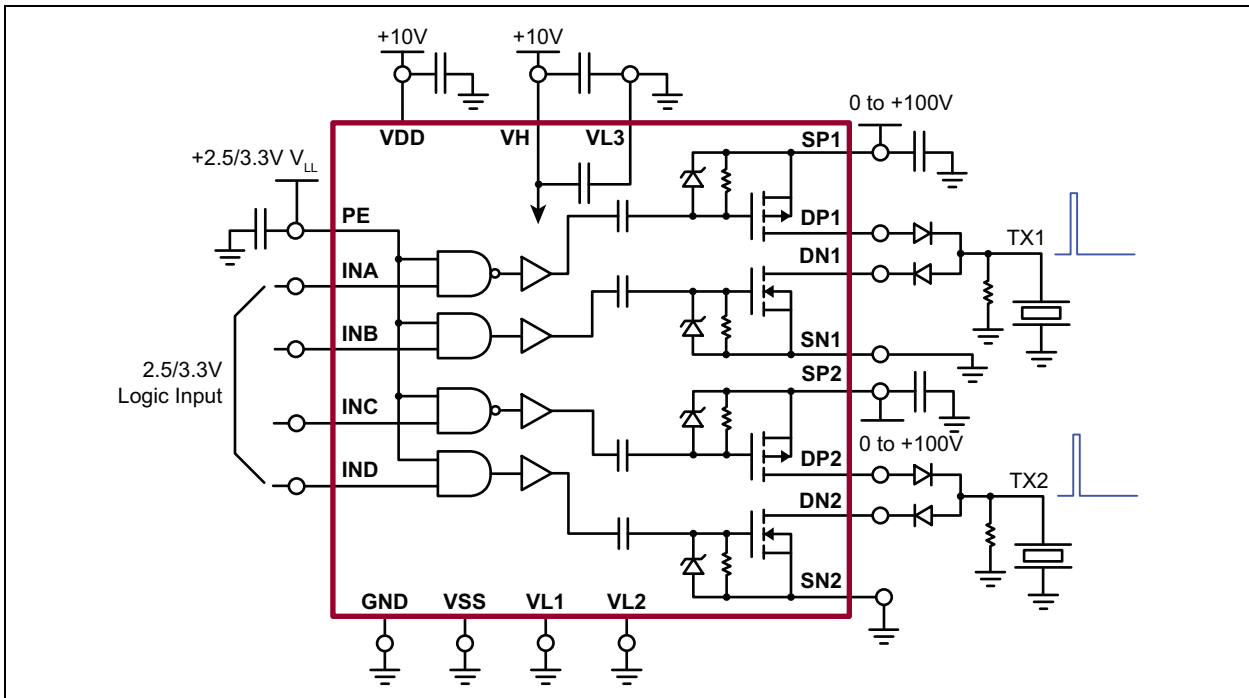


FIGURE 3-4: Typical Unipolar Two-channel Two-level Ultrasound Transmitter Application Circuit for HV7360/HV7361.

HV7360/HV7361

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

XXXXXX
XX ^(e3)
YYWWNNN

HV7360
GA ^(e3)
1724111

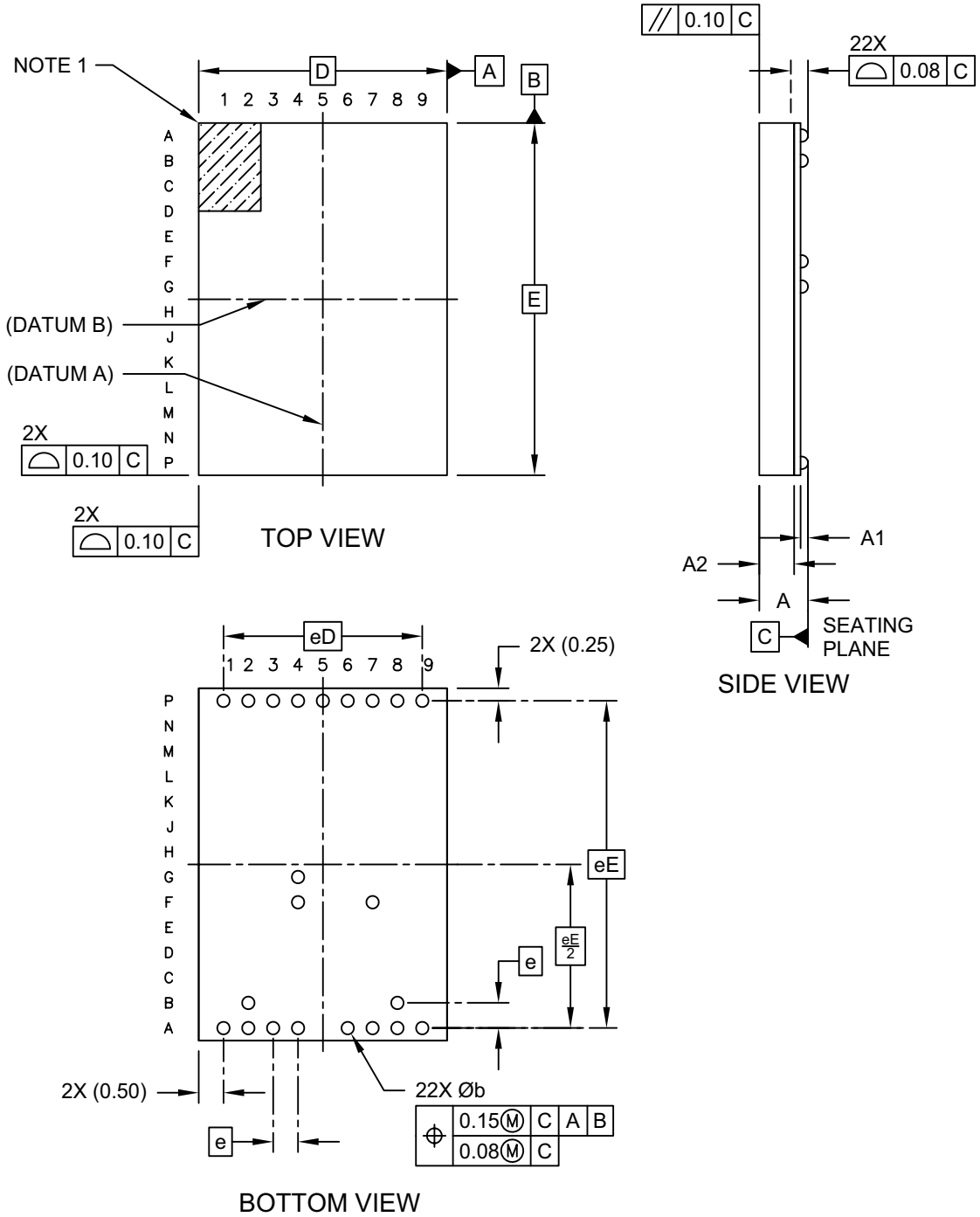
XXXXXX
XX ^(e3)
YYWWNNN

HV7361
GA ^(e3)
1718555

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.	

22-Ball Chip Array Ball Grid Array (JY) - 5x7 mm Body [CABGA]

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

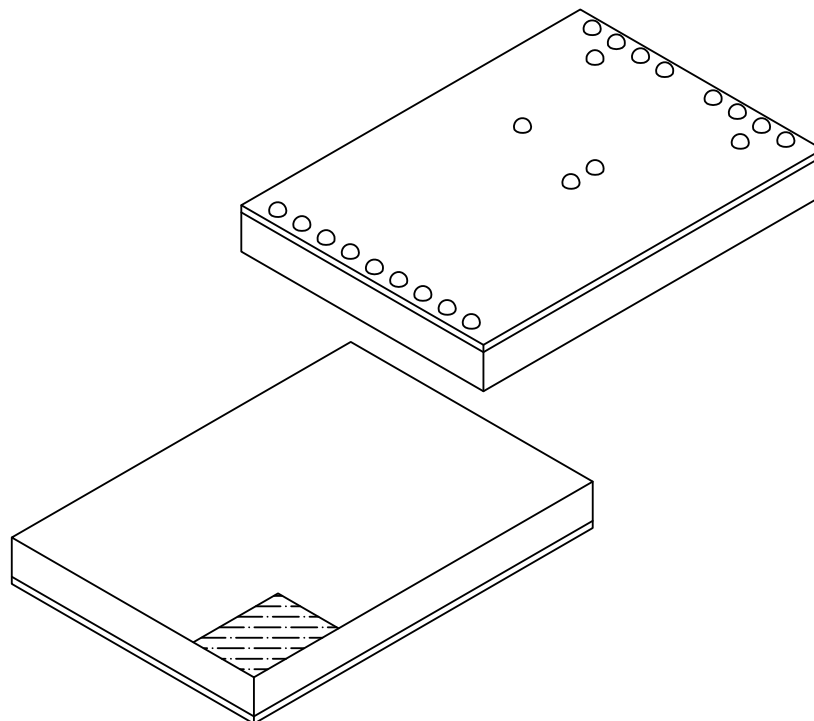


Microchip Technology Drawing C04-414A Sheet 1 of 2

HV7360/HV7361

22-Ball Chip Array Ball Grid Array (JY) - 5x7 mm Body [CABGA]

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



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Terminals	-	22		
Pitch	e	0.50 BSC		
Overall Height	A	0.91	0.98	1.05
Ball Height	A1	0.12	0.15	-
Package Thickness	A2	0.66	0.70	0.74
Overall Length	D	5.00 BSC		
Overall Terminal Pitch	eD	4.00 BSC		
Overall Width	E	7.00 BSC		
Overall Terminal Pitch	eE	6.50 BSC		
Ball Diameter	b	0.20	0.25	0.30

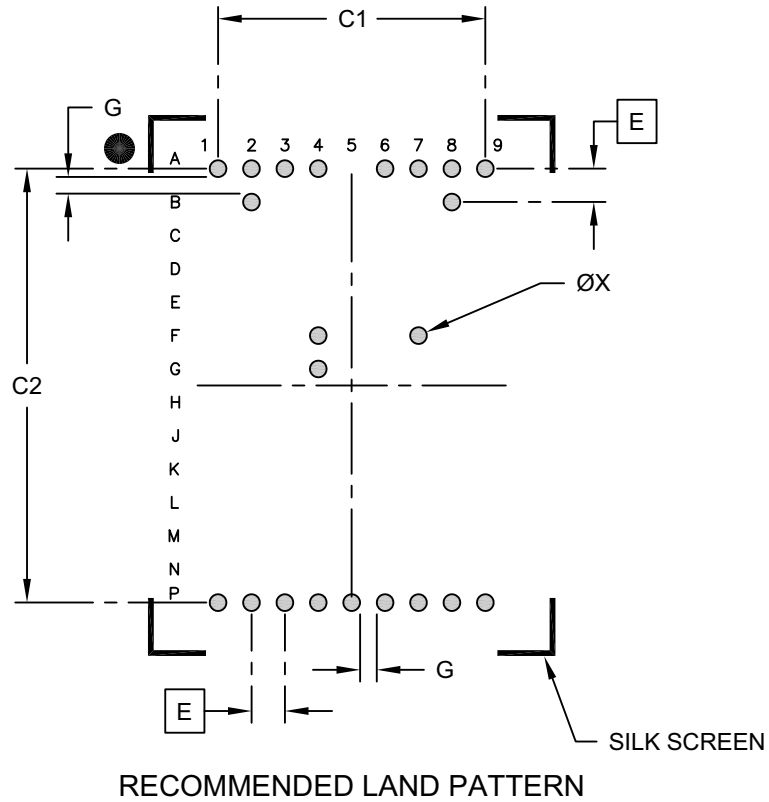
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-414A Sheet 2 of 2

22-Ball Chip Array Ball Grid Array (JY) - 5x7 mm Body [CABGA]

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



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Contact Pad Spacing	C1		4.00	
Contact Pad Spacing	C2		6.50	
Contact Pad Diameter (X22)	X		0.25	
Contact Pad to Contact Pad	G	0.20		

Notes:

- Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-2414A

HV7360/HV7361

NOTES:

APPENDIX A: REVISION HISTORY

Revision C (June 2017)

The following is the list of modifications:

- Updated the operating ambient temperature in Absolute Maximum Ratings † and in the Temperature Specifications table
- Made minor text changes throughout the document

Revision B (April 2017)

- Removed the INC to IND connection line and changed the typical high voltage supply from +200V to +100V in [Figure 3-4](#)
- Removed “HVCMOS[®] Technology for High Performance” from the Features Section
- Made minor text changes throughout the document

Revision A (June 2016)

- Converted Supertex Doc# DSFP-HV7360 and Supertex Doc# DSFP-HV7361 to Microchip DS20005570C
- Merged HV7360 and HV7361 into one document
- Replaced the 22-lead LFGA “LA” package with 22-lead CABGA “GA” package
- Made minor text changes throughout the document

HV7360/HV7361

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
Devices:	HV7360	=	High-Voltage High-Speed Pulse Generator with Built-in Fast RTZ Damping FETs		
	HV7361	=	High-Voltage High-Speed Pulse Generator with Built-in Fast RTZ Damping FETs and an Integrated Two-Terminal Low-Noise T/R Switch		
Package:	GA	=	22-lead CABGA		
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package		
Media Type:	(blank)	=	364/Tray for GA Package		

Examples:

a) HV7360GA-G: High-Voltage High-Speed Pulse Generator with Built-in Fast RTZ Damping FET, 22-lead CABGA Package, 364/Tray

b) HV7361GA-G: High-Voltage High-Speed Pulse Generator with Built-in Fast RTZ Damping FET and an Integrated Two-Terminal Low-Noise T/R Switch, 22-lead CABGA Package, 364/Tray

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

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