HV209

12-Channel High Voltage Analog Switch

Features

- HVCMOS® Technology for High Performance
- Operating Voltage of Up to 200V
- Output On-resistance Typically 22Ω
- Integrated Bleed Resistors on the Outputs
- 5.0V to 12.0V CMOS Logic Compatibility
- Very Low-quiescent Current Consumption (-10 µA)
- -58 dB Typical OFF-isolation at 5.0 MHz
- Low Parasitic Capacitance
- Excellent Noise Immunity
- Flexible High Voltage Supplies

Applications

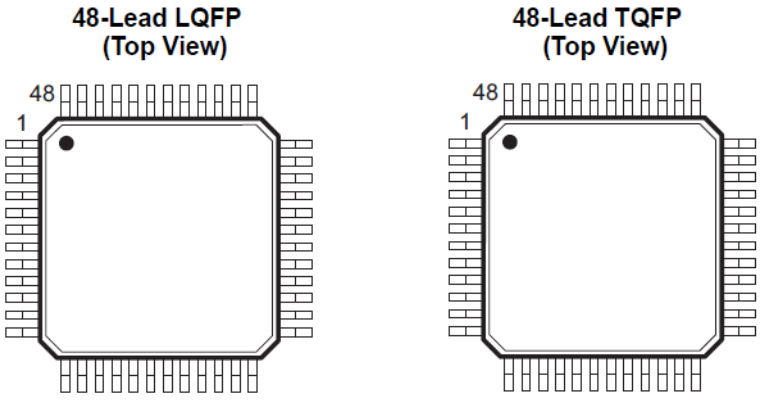
- Medical Ultrasound Imaging
- NDT Metal Flaw Detection
- Piezoelectric Transducer Drivers

Description

The HV209 is a 200V low charge injection 12-channel high voltage analog switch configured as 6 SPDT analog switches intended for medical ultrasound applications.

Bleed resistors are integrated on the output switches to eliminate the charge built up on the piezoelectric transducers.The bleed resistors are at a nominal value of 35 kΩ. Using HVCMOS technology, this device combines high voltage bilateral DMOS switches and low power CMOS logic to provide efficient control of high voltage analog signals. The outputs are configured as single-pole double-throw analog switches. Data is shifted into a 6-bit shift register using an external clock. The $\overline{LE}$ latches the shift register data into the individual switch latches. A logic HI connects a switch common YX to SWX. A logic LOW connects YX to $\overline{SWX}$. A logic HI in CL resets all switches to SWX simultaneously.

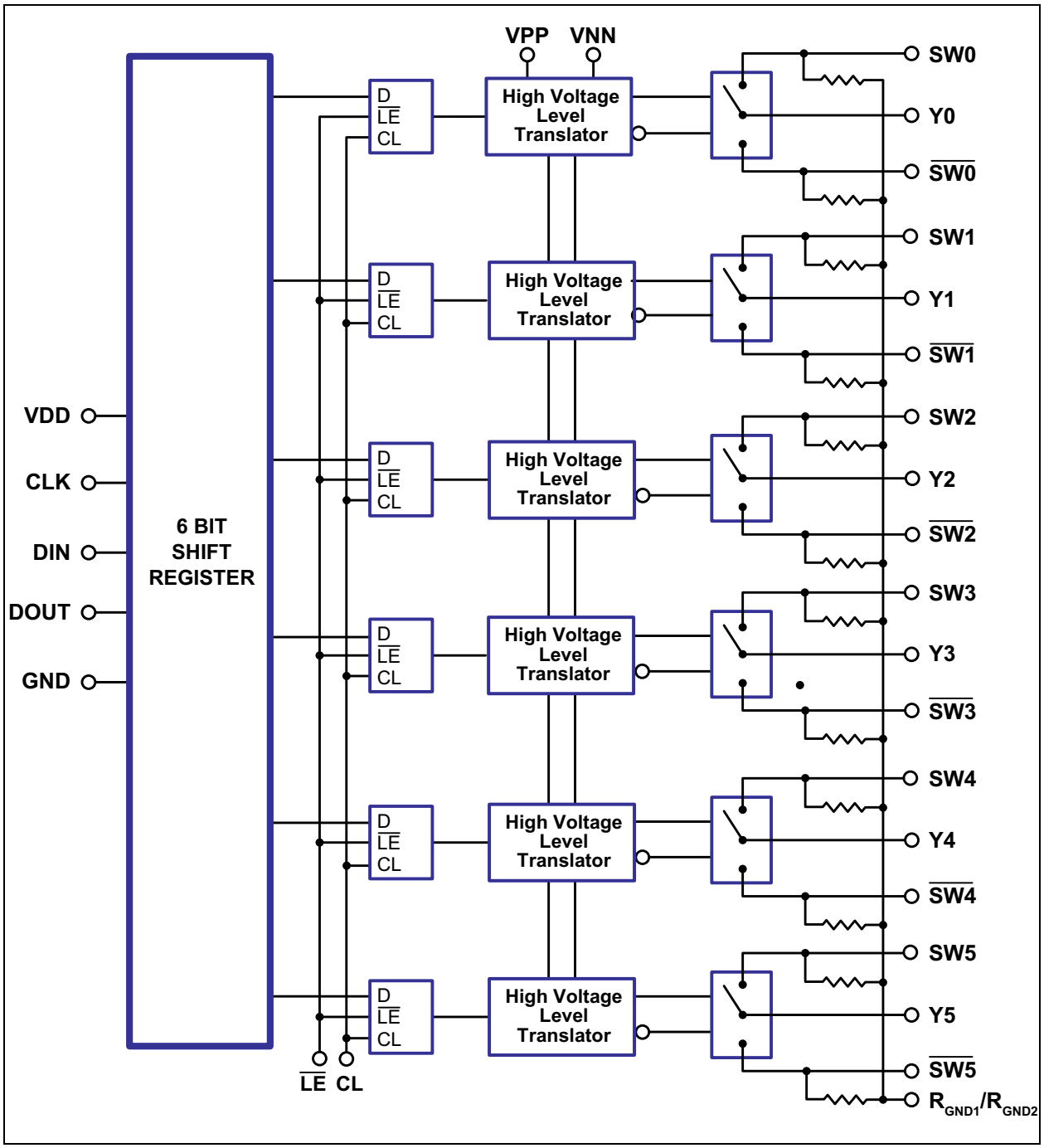
Package Types†



See Table 2-1 for pin information.

† **Notice:** The LQFP package is not recommended for new designs. Please use TQFP package as an alternative.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS†

Logic Supply, V_{DD} ..... -0.5V to +15V
Supply Voltage, V_{PP}–V_{NN} ..... +220V
Positive High Voltage Supply, V_{PP} ..... -0.5V to +200V
Negative High Voltage Supply, V_{NN} ..... +0.5V to –200V
Logic Input Voltages ..... -0.5V to V_{DD} +0.3V
Analog Signal Range, V_{SIG} ..... V_{NN} to V_{PP}
Peak Analog Signal Current/Channel 3A
Storage Temperature, T_S ..... -55°C to +150°C
Power Dissipation:
48-Lead LQFP/TQFP 1W

† **Notice:** Stresses above those listed under “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 listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Positive High Voltage Supply	V_{PP}	+40	—	V_{NN} +200	V	**Note 1**
Negative High Voltage Supply	V_{NN}	–10	—	–160	V	**Note 1**
Logic Power Supply Voltage	V_{DD}	+4.5	—	13.2	V	**Note 1**
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	
Analog Signal Voltage Peak-to-Peak	V_{SIG}	V_{NN} +10V	—	V_{PP} –10V	V	**Note 2**

Note 1: Power-up/power-down sequence is arbitrary except GND must be powered up first and powered down last.

2: V_{SIG} must be within $V_{NN} \leq V_{SIG} \leq V_{PP}$ or floating during power-up/power-down transition.

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Over recommended operating conditions unless otherwise noted.

Parameter	Sym.	0°C		25°C			70°C		Unit	Conditions	
		Min.	Max.	Min.	Typ.	Max.	Min.	Max.			
Small Signal Switch ON-resistance	R_{ONS}	—	30	—	26	38	—	48	Ω	I_{SIG} = 5 mA	V_{PP} = +40V, V_{NN} = –160V
		—	25	—	22	27	—	32	Ω	I_{SIG} = 200 mA	
		—	25	—	22	27	—	30	Ω	I_{SIG} = 5 mA	V_{PP} = +100V, V_{NN}= –100V
		—	18	—	18	24	—	27	Ω	I_{SIG} = 200 mA	
		—	23	—	20	25	—	30	Ω	I_{SIG} = 5 mA	V_{PP} = +190V, V_{NN} = –10V
		—	22	—	16	25	—	27	Ω	I_{SIG} = 200 mA	
Small Signal Switch ON-resistance Matching	ΔR_{ONS}	—	20	—	5	20	—	20	%	I_{SW} = 5 mA, V_{PP} = +100V, V_{NN} = –100V	
Large Signal Switch ON-resistance	R_{ONL}	—	—	—	15	—	—	—	Ω	V_{SIG} = V_{PP} –10V, I_{SIG} = 1A	
Output Switch Shunt Resistance	R_{INT}	—	—	20	35	50	—	—	kΩ	Output Switch to R_{GND} I_{RINT} = 0.5 mA	
DC Offset Switch OFF	V_{OS}	—	50	—	—	50	—	50	mV	No load, R_{GND} = 0V	
DC Offset Switch ON		—	50	—	—	50	—	50	mV		
Positive HV Supply Current	I_{PPQ}	—	—	—	10	50	—	—	µA	All SWs off	
Negative HV Supply Current	I_{NNQ}	—	—	—	–10	–50	—	—	µA		
Positive HV Supply Current	I_{PPQ}	—	—	—	10	50	—	—	µA	All SWs on, I_{SW} = 5 mA	
Negative HV Supply Current	I_{NNQ}	—	—	—	–10	–50	—	—	µA		
Switch Output Peak Current	I_{SW}	—	3	—	3	2	—	2	A	V_{SIG} duty cycle ≤ 0.1%	
Output Switching Frequency	f_{SW}	—	—	—	—	50	—	—	kHz	Duty cycle = 50%	
I_{PP} Supply Current	I_{PP}	—	6.5	—	—	7	—	8	mA	V_{PP} = +40V V_{NN} = –160V	50 kHz output switching frequency with no load
		—	4	—	—	5	—	5.5	mA	V_{PP} = +100V V_{NN} = –100V	
		—	4	—	—	5	—	5.5	mA	V_{PP} = +190V V_{NN} = –10V	
I_{NN} Supply Current	I_{NN}	—	6.5	—	—	7	—	8	mA	V_{PP} = +40V V_{NN} = –160V	50 kHz output switching frequency with no load
		—	4	—	—	5	—	5.5	mA	V_{PP} = +100V V_{NN} = –100V	
		—	4	—	—	5	—	5.5	mA	V_{PP} = +190V V_{NN} = –10V	
Logic Supply Average Current	I_{DD}	—	4	—	—	4	—	4	mA	f_{CLK} = 5 MHz, V_{DD} = 5V	
Logic Supply Quiescent Current	I_{DDQ}	—	10	—	—	10	—	10	µA	—	
Data Out Source Current	I_{SOR}	0.45	—	0.45	0.7	—	0.4	—	mA	V_{OUT} = V_{DD} –0.7V	
Data Out Sink Current	I_{SINK}	0.45	—	0.45	0.7	—	0.4	—	mA	V_{OUT} = 0.7V	
Logic Input Capacitance	C_{IN}	—	10	—	—	10	—	10	pF	—	

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: over recommended operating conditions V_{DD} = 5V, unless otherwise noted.

Parameter	Sym.	0°C		+25°C			+70°C		Unit	Conditions
		Min.	Max.	Min.	Typ.	Max.	Min.	Max.		
Set-up Time before $\overline{LE}$ Rises	t_{SD}	150	—	150	—	—	150	—	ns	—
Time Width of $\overline{LE}$	t_{WLE}	150	—	150	—	—	150	—	ns	—
Clock Delay Time to Data Out	t_{DO}	—	150	—	—	150	—	150	ns	—
Time Width of CL	t_{WCL}	150	—	150	—	—	150	—	ns	—
Set-up Time Data to Clock	t_{SU}	15	—	15	8	—	20	—	ns	—
Hold Time Data from Clock	t_H	35	—	35	—	—	35	—	ns	—
Clock Frequency	f_{CLK}	—	5	—	—	5	—	5	MHz	50% duty cycle, $f_{DATA} = f_{CLK}/2$
Turn ON Time	t_{ON}	—	5	—	—	5	—	5	µs	$V_{SIG} = V_{PP} - 10V$, R_L = 10 kΩ
Turn OFF Time	t_{OFF}	—	5	—	—	5	—	5	µs	$V_{SIG} = V_{PP} - 10V$, R_L = 10 kΩ
Maximum V_{SIG} Slew Rate	dv/dt	—	20	—	—	20	—	20	V/ns	V_{PP} = +40V, V_{NN} = –160V
		—	20	—	—	20	—	20	V/ns	V_{PP} = +100V, V_{NN} = –100V
		—	20	—	—	20	—	20	V/ns	V_{PP} = +190V, V_{NN} = –10V
OFF Isolation	K_O	–30	—	–30	–33	—	–30	—	dB	f = 5 MHz, 1 kΩ//15 pF load
		–58	—	–58	—	—	–58	—	dB	f = 5 MHz, 50Ω load
Switch Crosstalk	K_{CR}	–60	—	–60	–70	—	–60	—	dB	f = 5 MHz, 50Ω load
Output Switch Isolation Diode Current	I_{ID}	—	300	—	—	300	—	300	mA	300 ns pulse width, 2% duty cycle
OFF Capacitance SW to GND	$C_{SG(OFF)}$	5	17	5	12	17	5	17	pF	0V, f = 1 MHz
ON Capacitance SW to GND	$C_{SG(ON)}$	25	50	25	38	50	25	50	pF	0V, f = 1 MHz
Output Voltage Spike	$+V_{SPK}$	—	150	—	—	150	—	150	mV	R_{LOAD} = 50Ω
	$-V_{SPK}$	—	150	—	—	150	—	150	mV	

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Temperature Range						
Operating Free-air Temperature	T_A	0	—	+70	°C	
Storage Temperature	T_S	-55	—	+150	°C	
Package Thermal Resistances						
48-Lead LQFP	θ_{JA}	—	52	—	°C/W	
48-Lead TQFP	θ_{JA}	—	42	—	°C/W	

2.0 PIN DESCRIPTION

The description of pins in the 48-Lead TQFP and 48-Lead LQFP packages are listed on Table 2-1. The locations of the pads are listed in **Package Types**†.

TABLE 2-1: 48-LEAD TQFP/LQFP PIN FUNCTION TABLE

Pin Number	Function	Pin Number	Function
1	N/C	25	$\overline{SW5}$
2	SW0	26	Y5
3	Y0	27	SW5
4	$\overline{SW0}$	28	N/C
5	N/C	29	$\overline{SW3}$
6	SW2	30	Y3
7	Y2	31	SW3
8	$\overline{SW2}$	32	N/C
9	N/C	33	$\overline{SW1}$
10	SW4	34	Y1
11	Y4	35	SW1
12	$\overline{SW4}$	36	N/C
13	N/C	37	RGND1
14	N/C	38	N/C
15	N/C	39	DOUT
16	VNN	40	VDD
17	N/C	41	DIN
18	N/C	42	CLR
19	N/C	43	$\overline{LE}$
20	N/C	44	CLK
21	VPP	45	GND
22	N/C	46	N/C
23	N/C	47	N/C
24	N/C	48	RGND2

3.0 FUNCTIONAL DESCRIPTION

3.1 Test Circuits

Figure 3-1 to Figure 3-6 show the test circuits for HV209.

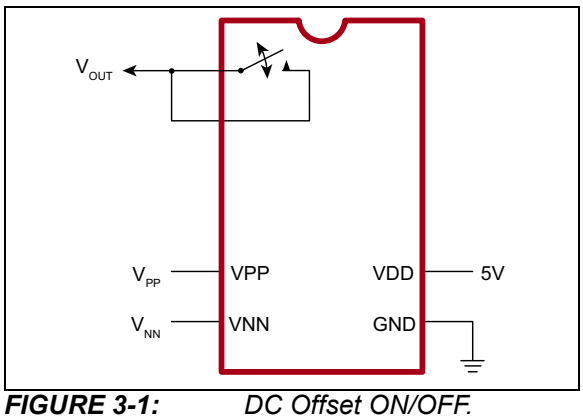


FIGURE 3-1: *DC Offset ON/OFF.*

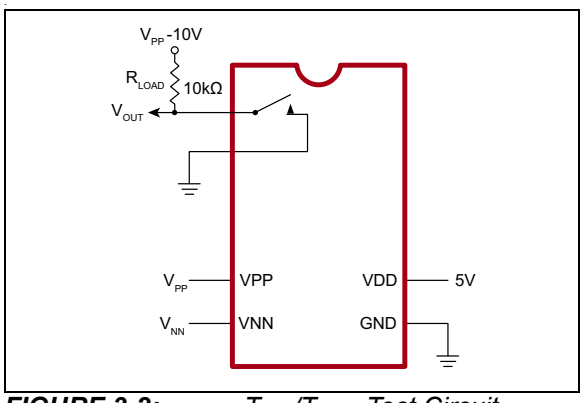


FIGURE 3-2: *T_{ON}/T_{OFF} Test Circuit.*

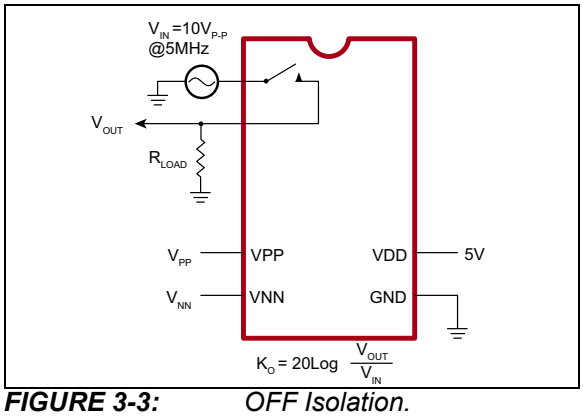


FIGURE 3-3: *OFF Isolation.*

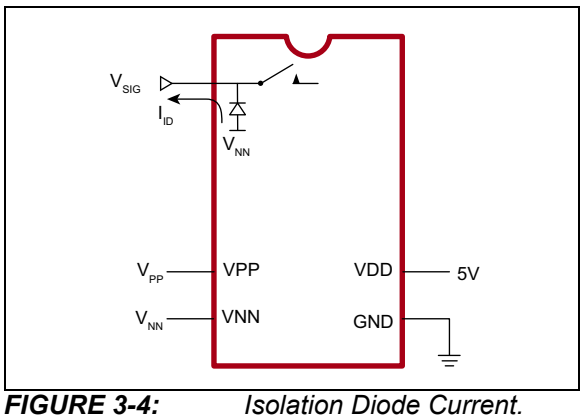


FIGURE 3-4: *Isolation Diode Current.*

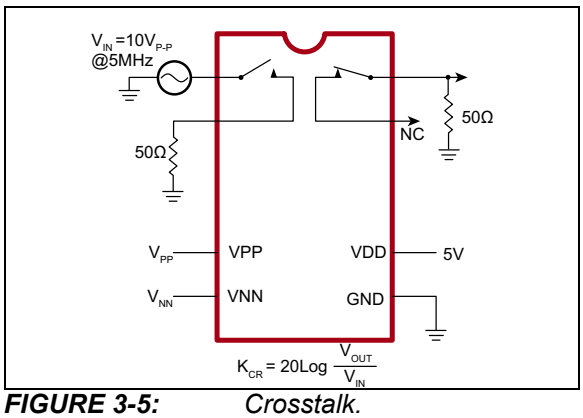


FIGURE 3-5: *Crosstalk.*

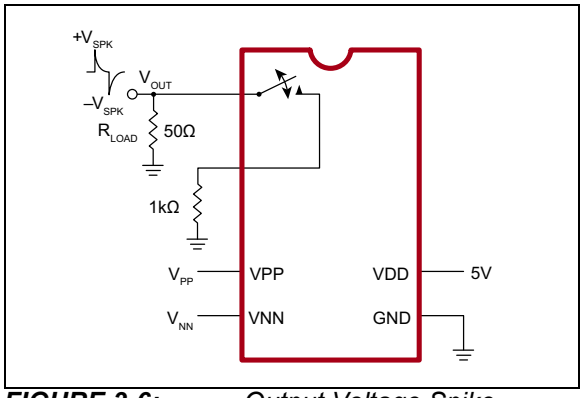


FIGURE 3-6: *Output Voltage Spike.*

TABLE 3-1: LOGIC TRUTH TABLE

Data Inputs						LE	CL	Switch States					
D0	D1	D2	D3	D4	D5			Y0	Y1	Y2	Y3	Y4	Y5
L						L	L	$\overline{SW0}$					
H						L	L	SW0					
	L					L	L		$\overline{SW1}$				
	H					L	L		SW1				
		L				L	L			$\overline{SW2}$			
		H				L	L			SW2			
			L			L	L				$\overline{SW3}$		
			H			L	L				SW3		
				L		L	L					$\overline{SW4}$	
				H		L	L					SW4	
					L	L	L						$\overline{SW5}$
					H	L	L						SW5
X	X	X	X	X	X	H	L	Hold Previous State					
X	X	X	X	X	X	X	H	$\overline{SW0}$	$\overline{SW1}$	$\overline{SW2}$	$\overline{SW3}$	$\overline{SW4}$	$\overline{SW5}$

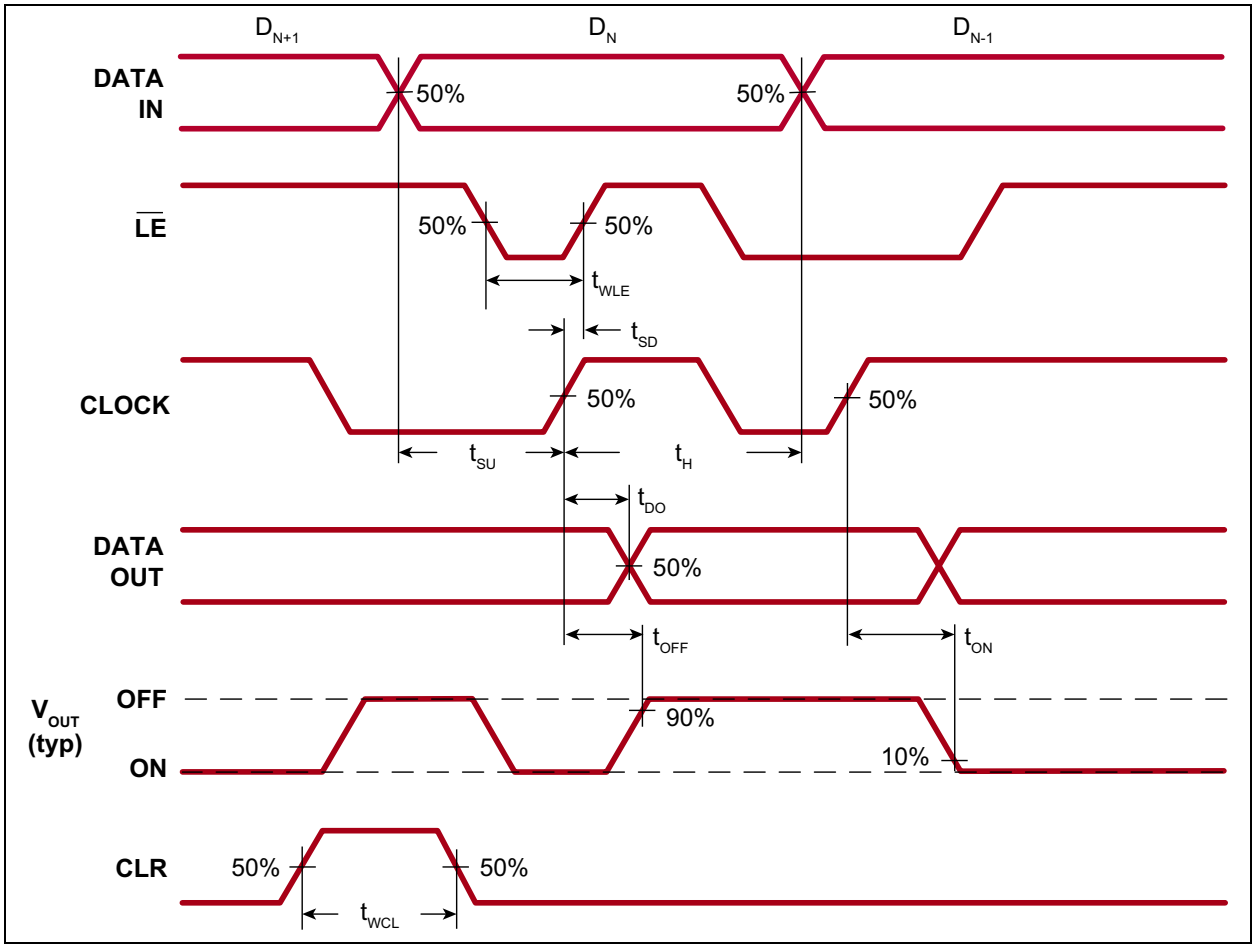


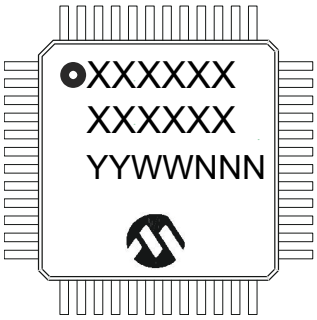
FIGURE 3-7: *Logic Timing Waveforms*

4.0 PACKAGING INFORMATION†

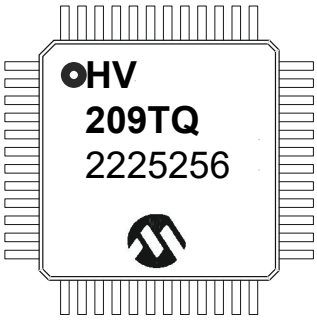
4.1 Package Marking Information

† **Notice:** The LQFP package is not recommended for new designs. Please use TQFP package as an alternative.

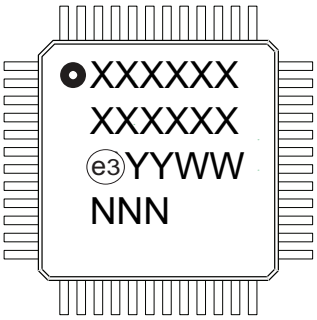
48-Lead TQFP



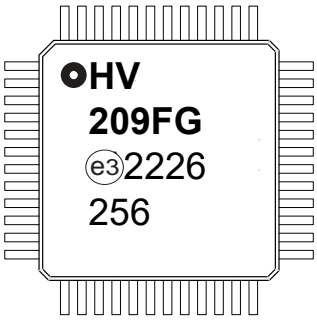
Example



48-Lead LQFP



Example

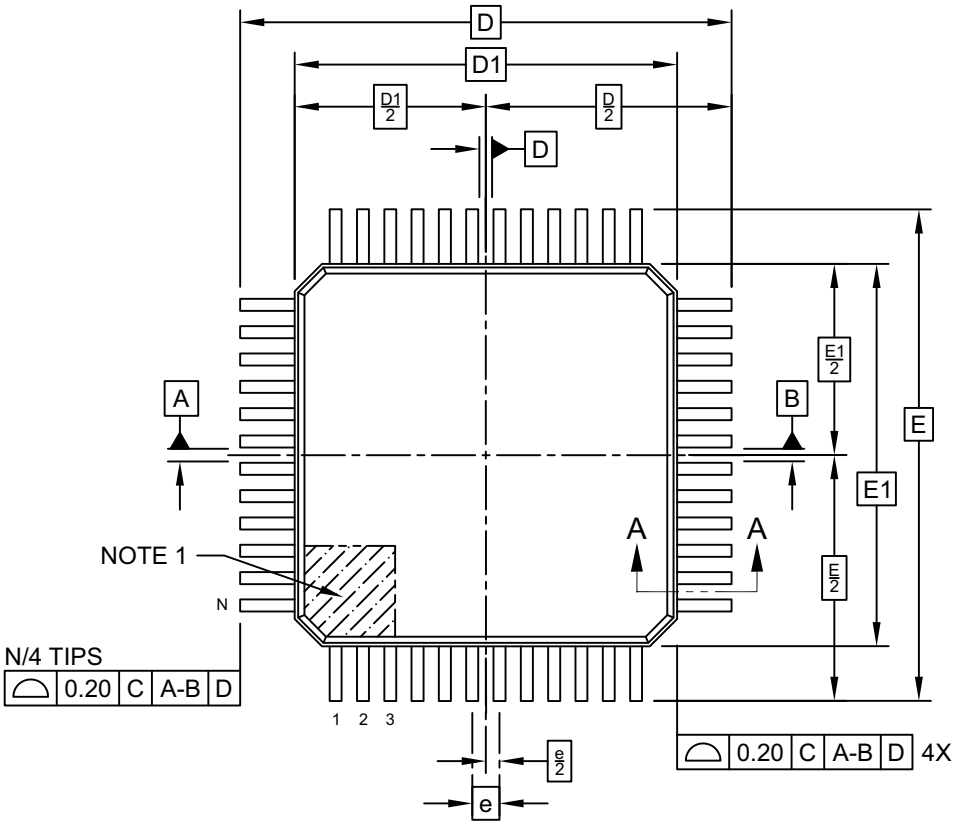


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package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

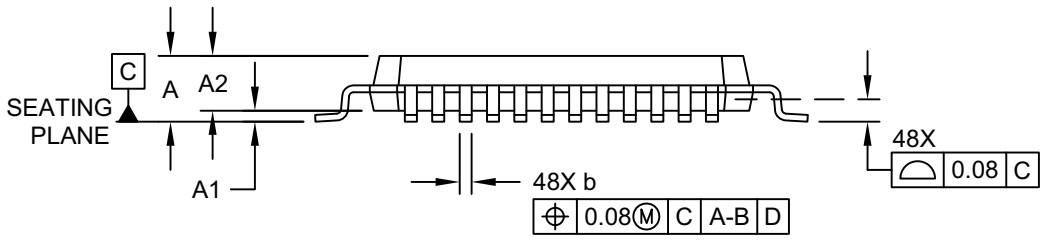
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

48-Lead Plastic Thin Quad Flatpack (Y8X) - 7x7x1.0 mm Body [TQFP]

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



TOP VIEW

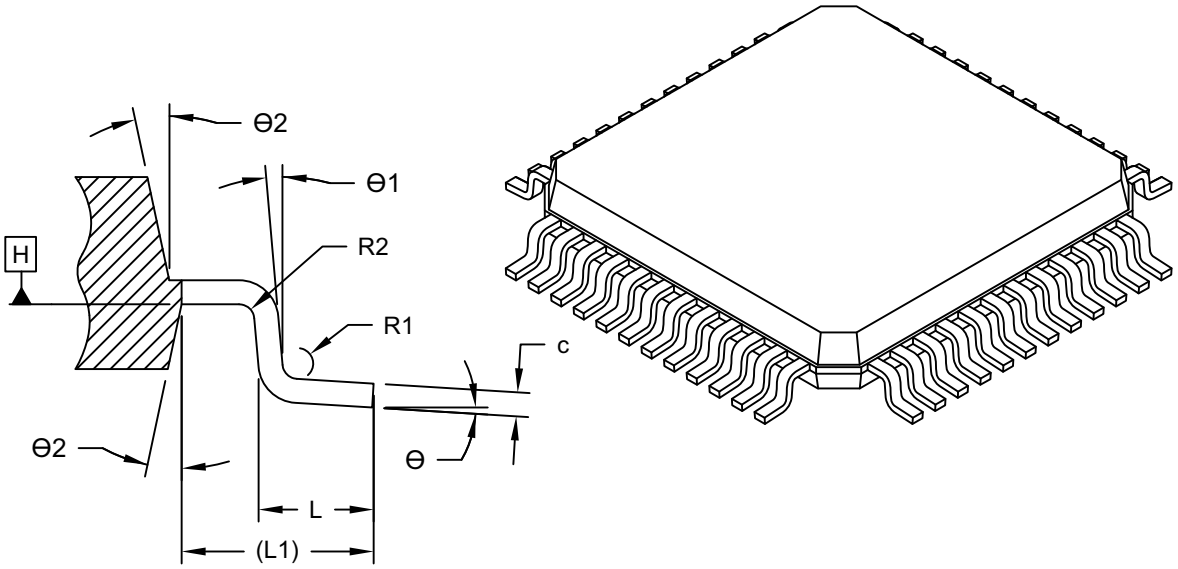


SIDE VIEW

Microchip Technology Drawing C04-300-Y8X Rev D Sheet 1 of 2

48-Lead Plastic Thin Quad Flatpack (Y8X) - 7x7x1.0 mm Body [TQFP]

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



SECTION A-A

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		48	
Pitch	e		0.50 BSC	
Overall Height	A	-	-	1.20
Standoff	A1	0.05	-	0.15
Molded Package Thickness	A2	0.95	1.00	1.05
Overall Length	D		9.00 BSC	
Molded Package Length	D1		7.00 BSC	
Overall Width	E		9.00 BSC	
Molded Package Width	E1		7.00 BSC	
Terminal Width	b	0.17	0.22	0.27
Terminal Thickness	c	0.09	-	0.16
Terminal Length	L	0.45	0.60	0.75
Footprint	L1		1.00 REF	
Lead Bend Radius	R1	0.08	-	-
Lead Bend Radius	R2	0.08	-	0.20
Foot Angle	θ	0°	3.5°	7°
Lead Angle	θ1	0°	-	-
Mold Draft Angle	θ2	11°	12°	13°

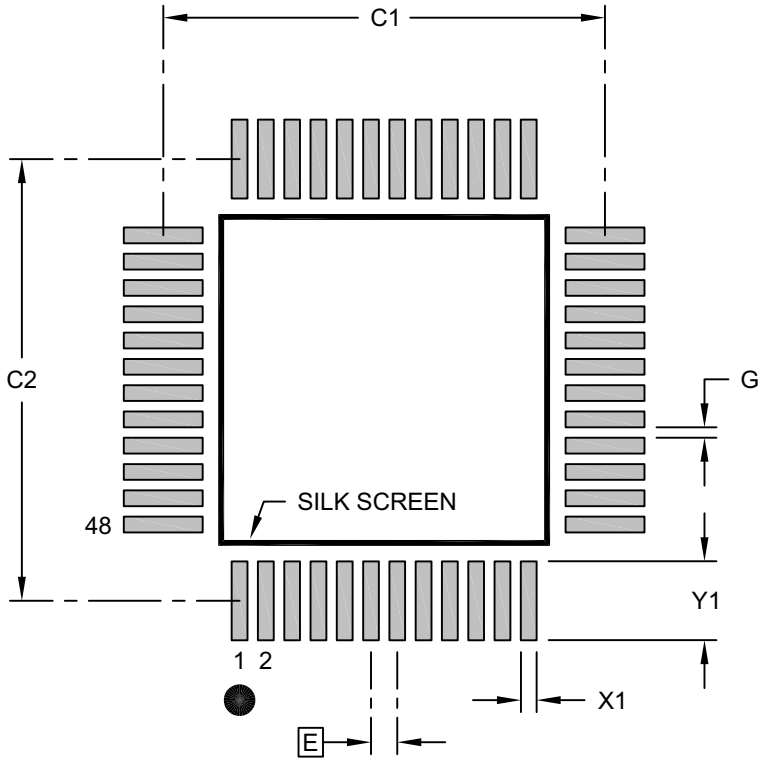
Notes:

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 C04-300-Y8X Rev D Sheet 2 of 2

48-Lead Plastic Thin Quad Flatpack (Y8X) - 7x7x1.0 mm Body [TQFP]

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.50 BSC	
Contact Pad Spacing	C1		8.40	
Contact Pad Spacing	C2		8.40	
Contact Pad Width (X48)	X1			0.30
Contact Pad Length (X48)	Y1			1.50
Distance Between Pads	G	0.20		

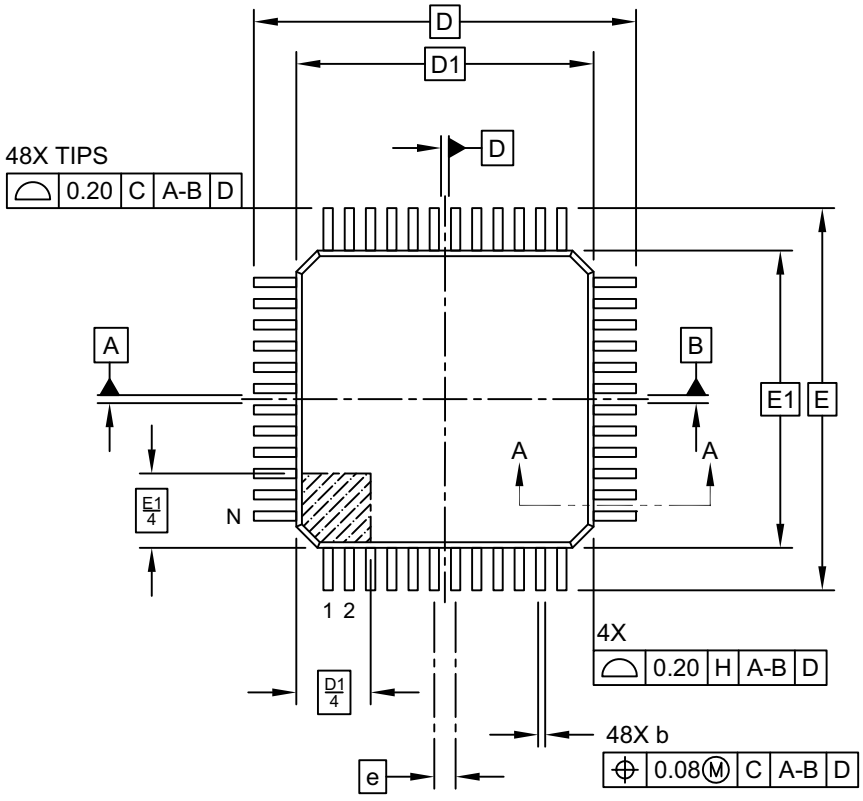
Notes:

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

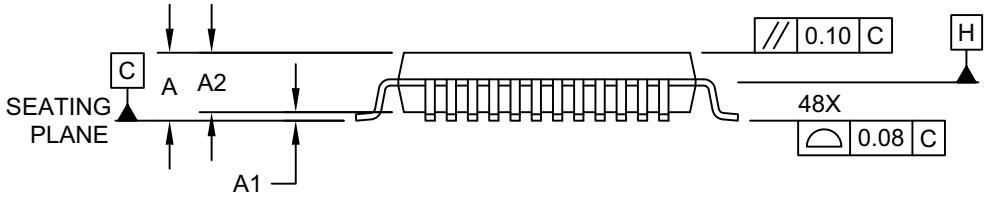
Microchip Technology Drawing C04-2300-Y8X Rev D

48-Lead Low-profile Plastic Quad Flat Pack Package (R8) -7x7 mm Body [LQFP] Supertex Legacy Package

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



TOP VIEW

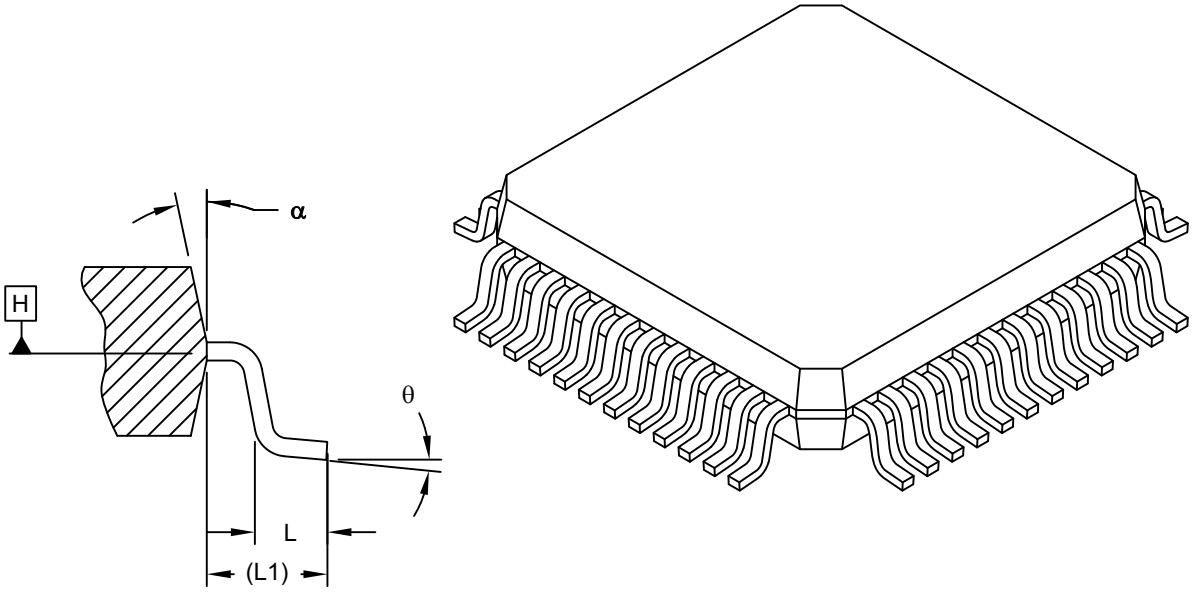


SIDE VIEW

Microchip Technology Drawing C04-278A Sheet 1 of 2

48-Lead Low-profile Plastic Quad Flat Pack Package (R8) -7x7 mm Body [LQFP] Supertex Legacy Package

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



SECTION A-A

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Leads	N		48	
Lead Pitch	e		0.50 BSC	
Overall Height	A	1.40	1.50	1.60
Standoff	A1	0.05	0.10	0.15
Molded Package Thickness	A2	1.35	1.40	1.45
Foot Length	L	0.45	0.60	0.75
Footprint	L1		1.00 REF	
Foot Angle	θ	0°	3.5°	7°
Overall Width	E		9.00 BSC	
Overall Length	D		9.00 BSC	
Molded Package Width	E1		7.00 BSC	
Molded Package Length	D1		7.00 BSC	
Lead Width	b	0.17	0.22	0.27
Mold Draft Angle Top	α	11°	12°	13°

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

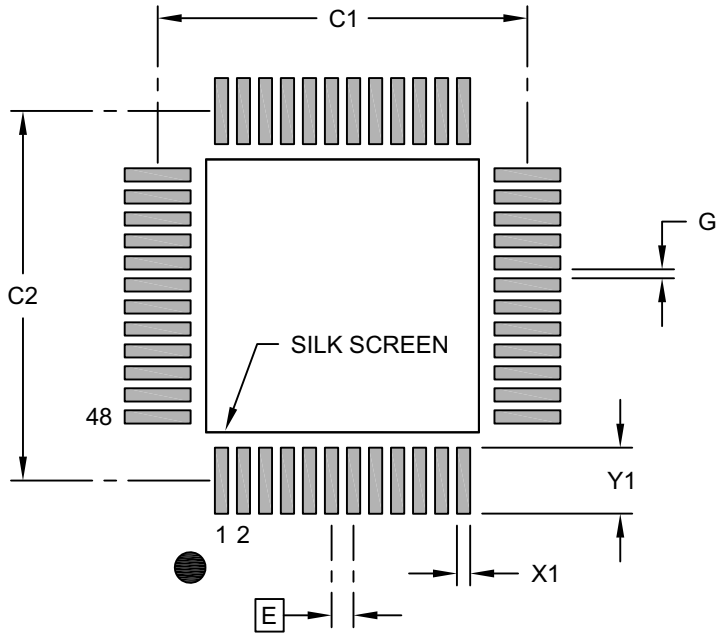
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-278A Sheet 2 of 2

48-Lead Low-profile Plastic Quad Flat Pack Package (R8) -7x7 mm Body [LQFP] Supertex Legacy Package

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.50 BSC	
Contact Pad Spacing	C1		8.40	
Contact Pad Spacing	C2		8.40	
Contact Pad Width (X48)	X1			0.30
Contact Pad Length (X48)	Y1			1.50
Contact Pad to Contact Pad (X44)	G	0.20		

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 C04-278A

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (September 2022)

- Converted Supertex Inc. Doc. # DSFP-HV209 B070213 to Microchip DS20006712A.
- Made minor edits for grammar.
- Added Applications and updated Description.
- Added 48-Lead TQFP package.
- Updated Package Marking Information.
- Added 48-Lead LQFP package notice to Package Types† and Packaging Information†.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	XX	-X
Device	Package	Environmental

Devices:	HV209:		12-Channel High Voltage Analog Switch
Packages:	FG	=	48-Lead LQFP
	TQ	=	48-Lead TQFP
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant package

Examples:

a) HV209FG-G: 12-Channel High Voltage Analog Switch, 48-Lead LQFP Package, 250/Tray

b) HV209TQ-G: 12-Channel High Voltage Analog Switch, 48-Lead TQFP Package, 250/Tray

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.

Trademarks

ISBN: 978-1-6683-1200-1

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: 45-4485-5910
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