HV238

16-Channel High-Voltage Analog Switch with Bleed Resistors

Features

- 220V Maximum Operating Voltage
- 22Ω Typical Output On-resistance
- Integrated Bleed Resistors on the Outputs
- 5V to 12V CMOS Logic Compatibility
- –10 µA Low-quiescent Current Consumption
- –45 dB Minimum Off Isolation at 7.5 MHz
- Low Parasitic Capacitance
- Excellent Noise Immunity
- Flexible Operating Supply Voltages

Applications

- Medical Ultrasound Imaging
- Non-destructive Evaluation

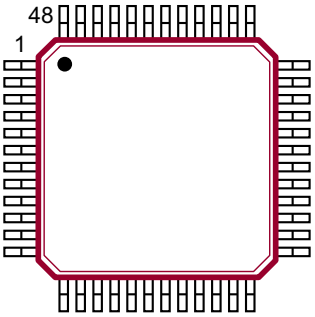
General Description

The HV238 is a 220V, 16-channel, high-voltage analog switch integrated circuit (IC) with output bleed resistors (R_{INT}). The output switches are configured as two sets of eight single-pole single-throw analog switches. It is intended to be used in applications requiring high-voltage switching controlled by low-voltage control signals, such as ultrasound imaging.

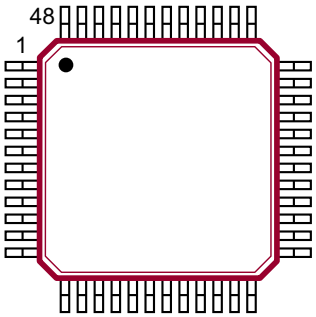
The two sets of eight analog switches are controlled by two input logic controls, $D_{IN}1$ and $D_{IN}2$. A logic high on $D_{IN}1$ will turn on switches zero to seven and a logic high on $D_{IN}2$ will turn on switches eight to 15. The bleed resistors significantly reduce voltage built up on capacitive loads, such as piezoelectric transducers connected to the outputs.

Package Type

48-lead LQFP
(Top view)

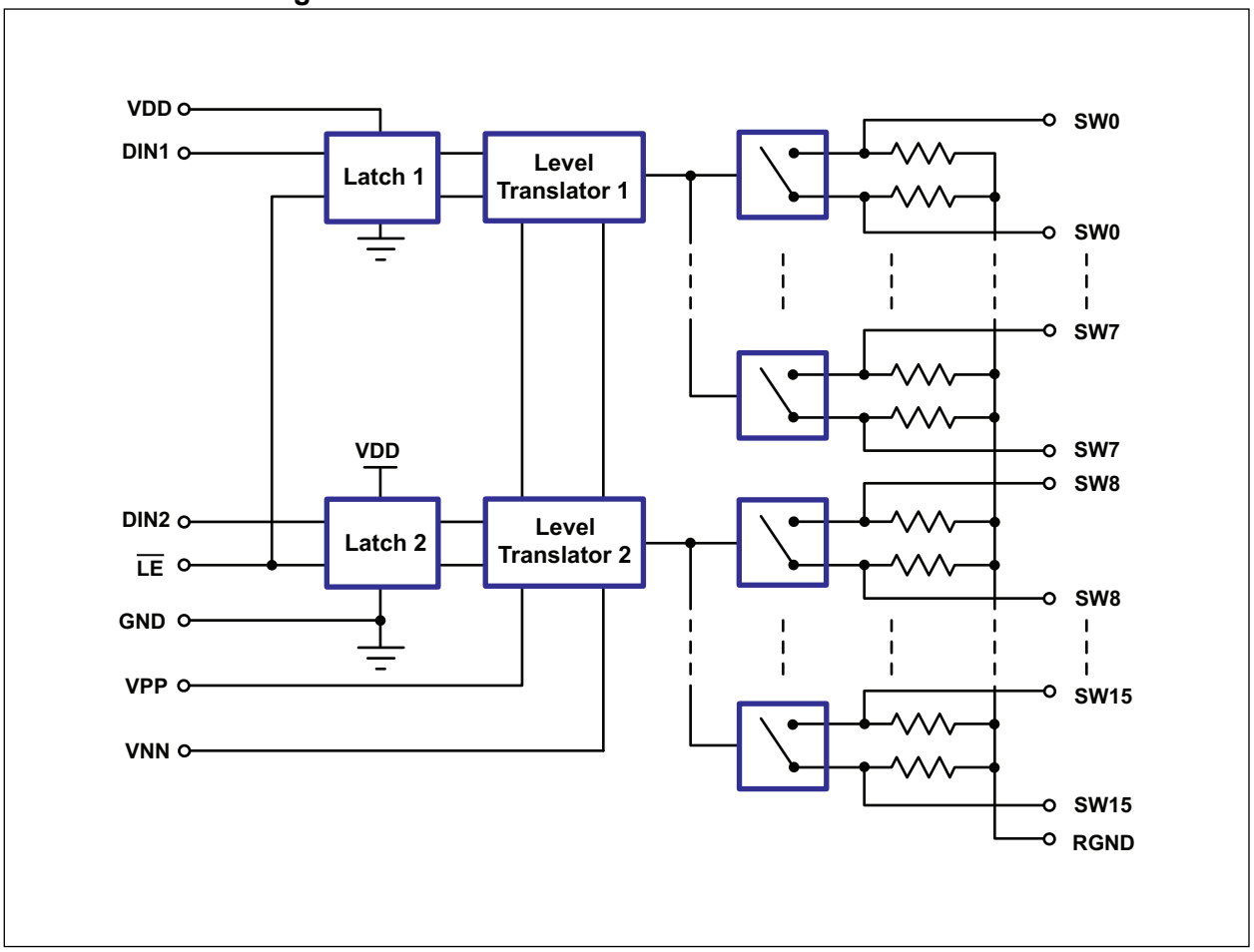


48-lead TQFP
(Top view)



See Table 2-1 for pin information.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings(†)

Logic Power Supply Voltage, V_{DD} ..... –0.5V to +15V
Supply Voltage, V_{PP}–V_{NN} 225V
High-voltage Positive Supply, V_{PP} ..... –0.5V to V_{NN}+225V
High-voltage Negative Supply, V_{NN} ..... +0.5V to –225V
Logic Input Voltage ..... –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 ..... –65°C to 150°C
Power Dissipation:
48-Lead LQFP 1W
48-Lead TQFP 1W

† **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.

RECOMMENDED OPERATING CONDITIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Logic Power Supply Voltage	V_{DD}	4.75	—	12.6	V	**Note 1**, **Note 3**
High-voltage Positive Supply	V_{PP}	50	—	110	V	**Note 1**, **Note 3**
High-voltage Negative Supply	V_{NN}	–10	—	V_{PP}-220V	V	**Note 1**, **Note 3**
High-level Input Voltage	V_{IH}	V_{DD}–1V	—	V_{DD}	V	
Low-level Input Voltage	V_{IL}	0	—	1	V	
Analog Signal Voltage Peak to Peak	V_{SIG}	V_{NN}+10V	—	V_{PP}–10V	V	**Note 2**
Operating Ambient Temperature	T_A	0	—	70	°C	

Note 1: Power-up/down sequence is arbitrary except GND must be powered up first and powered down last.
2: V_{SIG} must be $V_{NN} \le V_{SIG} \le V_{PP}$ or floating during power-up/down transition.
3: Rise and fall times of power supplies V_{DD}, V_{PP} and V_{NN} should not be less than 1 millisecond.

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise specified, all values are over operating conditions.

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	32	—	40	Ω	V_{SIG} = 0V, I_{SIG} = 5 mA	V_{PP} = +50V V_{NN} = –170V
		—	25	—	22	27	—	35		V_{SIG} = 0V, I_{SIG} = 200 mA	
		—	25	—	22	27	—	30		V_{SIG} = 0V, I_{SIG} = 5 mA	V_{PP} = +110V V_{NN} = –110V
		—	20	—	18	22	—	25		V_{SIG} = 0V, I_{SIG} = 200 mA	
Small Signal Switch On-resistance Matching	ΔR_{ONS}	20	—	5	20	—	20	20	%	V_{SIG} = 0V, I_{SIG} = 5 mA, V_{PP} = +110V, V_{NN} = –110V	
Large Signal Switch On-resistance	R_{ONL}	—	—	—	15	—	—	—	Ω	V_{SIG} = 0V, I_{SIG} = 1A	
Output Switch Shunt Resistance	R_{INT}	—	—	20	35	50	—	—	kΩ	Output Switch to R_{GND}, I_{RINT} = 0.5 mA	
Switch-off Leakage per Switch	I_{SOL}	5	—	1	10	—	15	5	µA	V_{SIG} = V_{PP}–10V, V_{NN} = +10V	
DC Offset Switch Off	V_{OS}	—	300	—	100	300	—	300	mV	No load	
DC Offset Switch On		—	500	—	100	500	—	500	mV	No load	
Quiescent V_{PP} Supply Current	I_{PPQ}	—	—	—	10	50	—	—	µA	All switches off	
Quiescent V_{NN} Supply Current	I_{NNQ}	—	—	—	–10	–50	—	—	µA	All switches off	
Quiescent V_{PP} Supply Current	I_{PPQ}	—	—	—	10	50	—	—	µA	All switches on, I_{SW} = 5 mA	
Quiescent V_{NN} Supply Current	I_{NNQ}	—	—	—	–10	–50	—	—	µA	All switches on, I_{SW} = 5 mA	
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	—	—	8.8	—	10	mA	VPP = +50V, VNN = –170V	All output switches turn on and off at 50 kHz with no load.
		—	–8.1	—	—	6.3	—	6.9		VPP = +110V, VNN = –110V	
I_{NN} Supply Current	I_{NN}	—	8.1	—	—	–8.8	—	–10	mA	VPP = +50V, VNN = –170V	All output switches turn on and off at 50 kHz with no load.
		—	5	—	—	–6.3	—	–6.9		VPP = +110V, VNN = –110V	
Logic Supply Average Current	I_{DD}	—	2	—	—	2	—	2	mA	$D_{IN}1$ = $D_{IN}2$ = 3 MHz, $\overline{LE}$ is high	
Logic Supply Quiescent Current	I_{DDQ}	—	10	—	—	10	—	10	µA	All logic inputs are static.	
Logic Input Capacitance	C_{IN}	—	10	—	—	10	—	10	pF		

AC ELECTRICAL CHARACTERISTICS

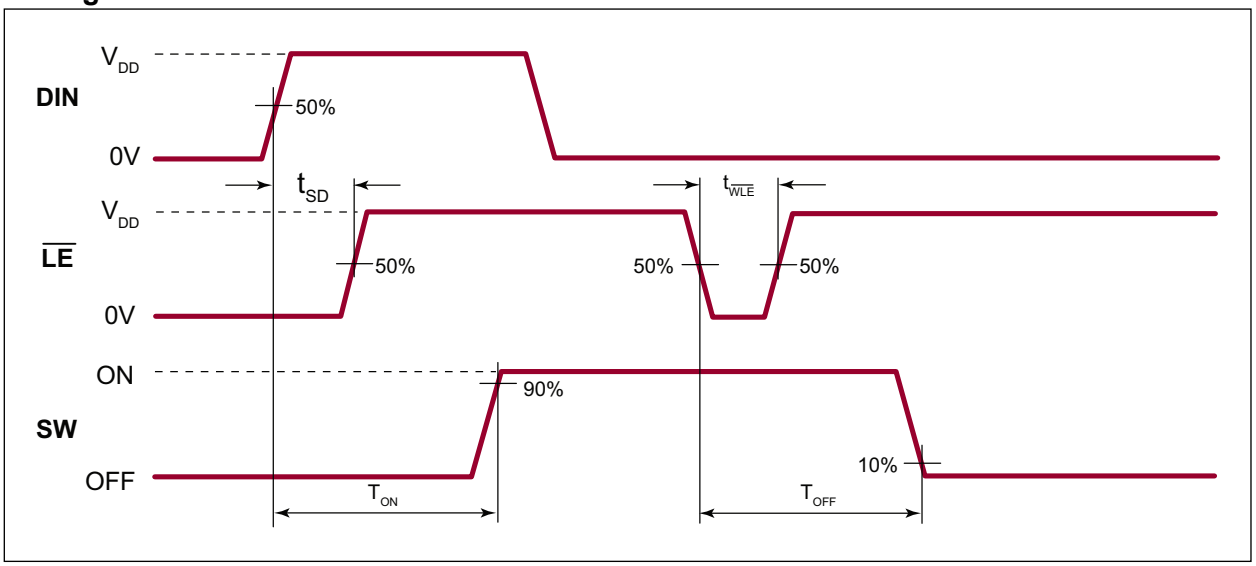
Electrical Specifications: Unless otherwise specified, all values are over operating conditions, V_{DD} = 5V.

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 D_{IN}	t_{WDIN}	150	—	150	—	—	150	—	ns	
Time Width of $\overline{LE}$	t_{WLE}	150	—	150	—	—	150	—	ns	
Turn-on Time	t_{ON}	—	5	—	—	5	—	5	µs	V_{SIG} = V_{PP}–10V, R_{LOAD} = 10 kΩ
Turn-off Time	t_{OFF}	—	5	—	—	5	—	5	µs	V_{SIG} = V_{PP}–10V, R_{LOAD} = 10 kΩ
Maximun V_{SIG} Slew Rate	dv/dt	—	20	—	—	20	—	20	V/ns	
Off Isolation	K_O	–30	—	–30	–33	—	–30	—	dB	f = 5 MHz,1 kΩ/15 pF load
		–45	—	–45	–50	—	–45	—		f = 7.5 MHz, R_{LOAD} = 50Ω load
Switch Crosstalk	K_{CR}	–45	—	–45	—	—	–45	—	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	$+V_{SPK}$	—	—	—	4	—	—	—	V	R_{LOAD} = 50Ω
	$–V_{SPK}$	—	—	—	4	—	—	—		R_{LOAD} = 50Ω

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature	T_A	0	—	70	°C	
Storage Temperature	T_S	–65	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
48-lead LQFP	θ_{JA}	—	38.41	—	°C/W	
48-lead TQFP	θ_{JA}	—	39.83	—	°C/W	

Timing Waveforms



TRUTH FUNCTION TABLE

$D_{IN}2$	$D_{IN}1$	$\overline{LE}$	SW0 to SW7	SW8 to SW15
L	L	L	OFF	OFF
L	H	L	ON	OFF
H	L	L	OFF	ON
H	H	L	ON	ON
X	X	H	Hold Previous State	

2.0 PIN DESCRIPTION

The description of pins in HV238 are listed in Table 2-1.
Refer to **Package Type** for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	VNN	High-voltage negative supply
2	NC	No connection
3	VPP	High-voltage positive supply
4	NC	No connection
5	DIN1	Data input
6	$\overline{LE}$	Latch enable logic input, low active
7	DIN2	Data input
8	NC	No connection
9	NC	No connection
10	VDD	Logic supply voltage
11	GND	Ground
12	NC	No connection
13	RGND	Ground for bleed resistor
14	SW15	SW terminal of switch 15
15	SW15	SW terminal of switch 15
16	SW14	SW terminal of switch 14
17	SW14	SW terminal of switch 14
18	SW13	SW terminal of switch 13
19	SW13	SW terminal of switch 13
20	SW12	SW terminal of switch 12
21	SW12	SW terminal of switch 12
22	SW11	SW terminal of switch 11
23	SW11	SW terminal of switch 11
24	NC	No connection
25	SW10	SW terminal of switch 10
26	SW10	SW terminal of switch 10
27	SW9	SW terminal of switch 9
28	SW9	SW terminal of switch 9
29	SW8	SW terminal of switch 8
30	SW8	SW terminal of switch 8
31	SW7	SW terminal of switch 7
32	SW7	SW terminal of switch 7
33	SW6	SW terminal of switch 6
34	SW6	SW terminal of switch 6
35	SW5	SW terminal of switch 5
36	SW5	SW terminal of switch 5
37	SW4	SW terminal of switch 4

TABLE 2-1: PIN FUNCTION TABLE (CONTINUED)

Pin Number	Pin Name	Description
38	NC	No connection
39	SW4	SW terminal of switch 4
40	NC	No connection
41	SW3	SW terminal of switch 3
42	SW3	SW terminal of switch 3
43	SW2	SW terminal of switch 2
44	SW2	SW terminal of switch 2
45	SW1	SW terminal of switch 1
46	SW1	SW terminal of switch 1
47	SW0	SW terminal of switch 0
48	SW0	SW terminal of switch 0

3.0 FUNCTIONAL DESCRIPTION

3.1 Test Circuits

Figure 3-1 to Figure 3-8 show the test circuits for HV238.

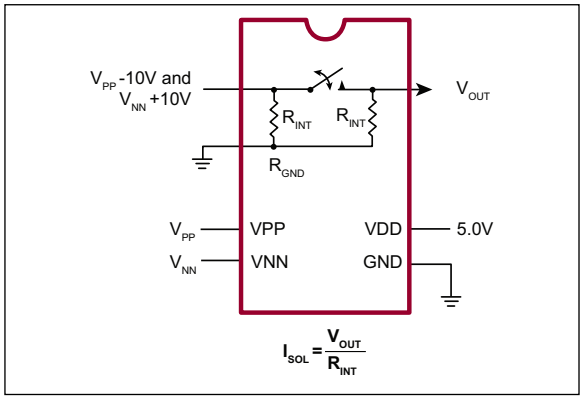


FIGURE 3-1: *Switch-off Leakage.*

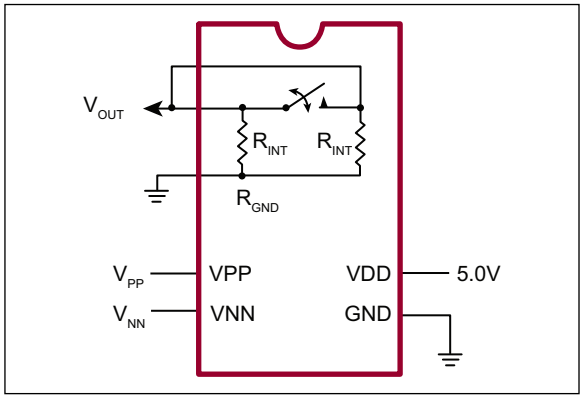


FIGURE 3-2: *DC Offset On/Off.*

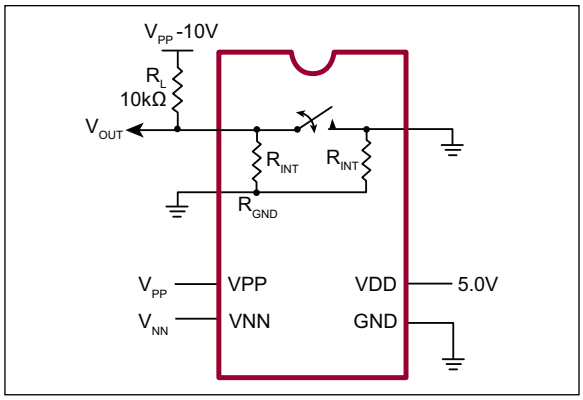


FIGURE 3-3: *T_{ON}/T_{OFF} Test Circuit.*

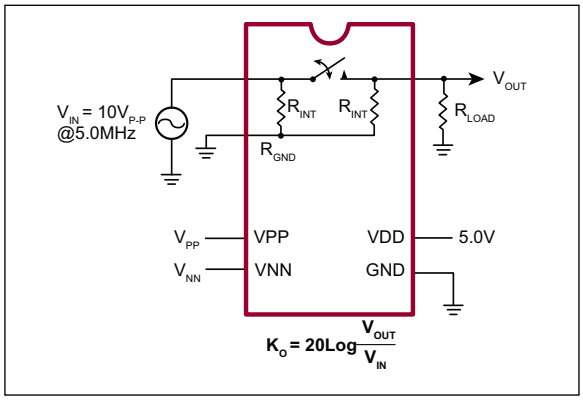


FIGURE 3-4: *Off Isolation.*

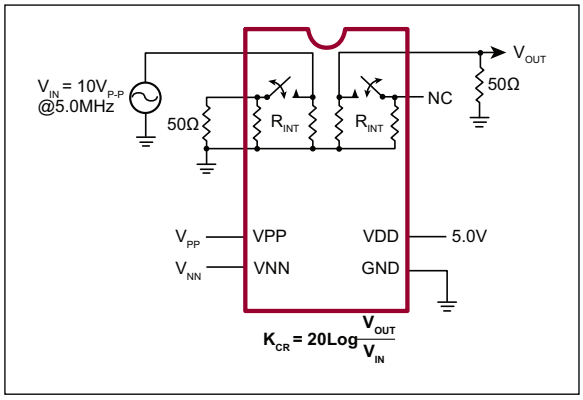


FIGURE 3-5: *Crosstalk.*

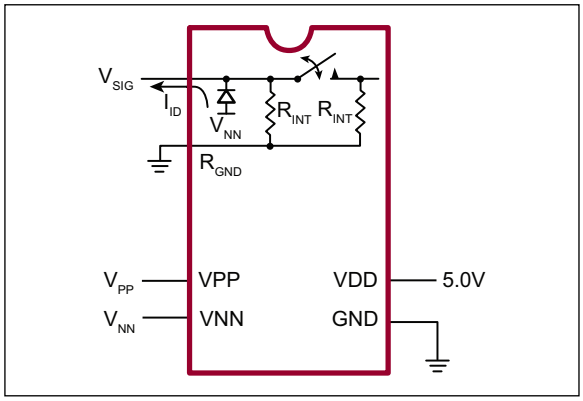


FIGURE 3-6: *Isolation Diode Current.*

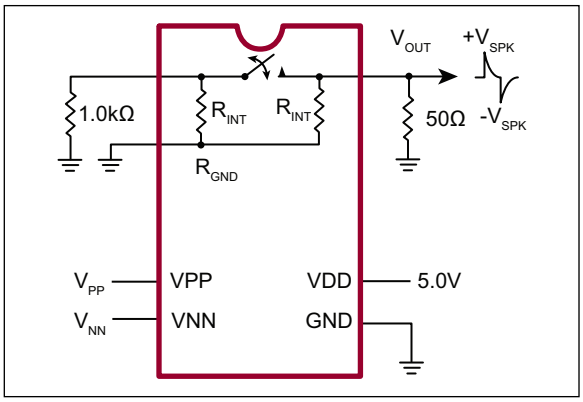


FIGURE 3-7: *Output Voltage Spike.*

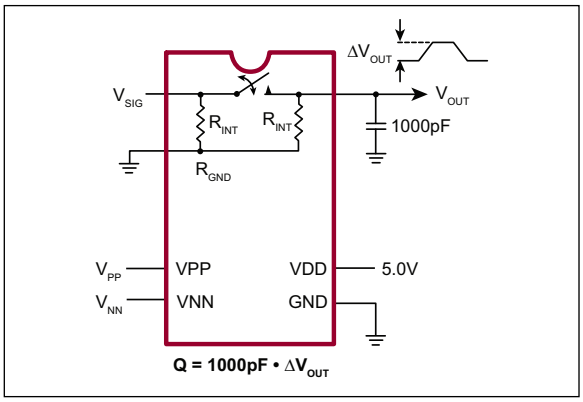
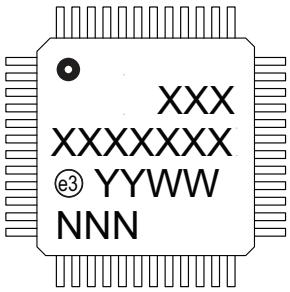


FIGURE 3-8: *Charge Injection.*

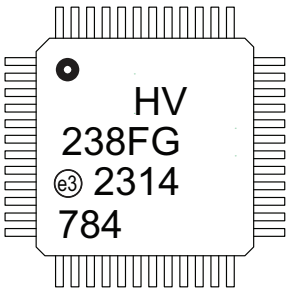
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

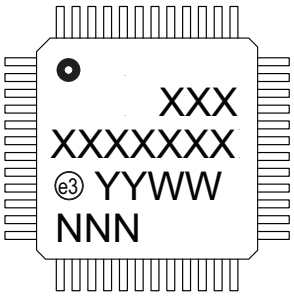
48-lead LQFP



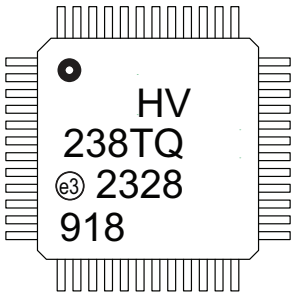
Example



48-lead TQFP



Example

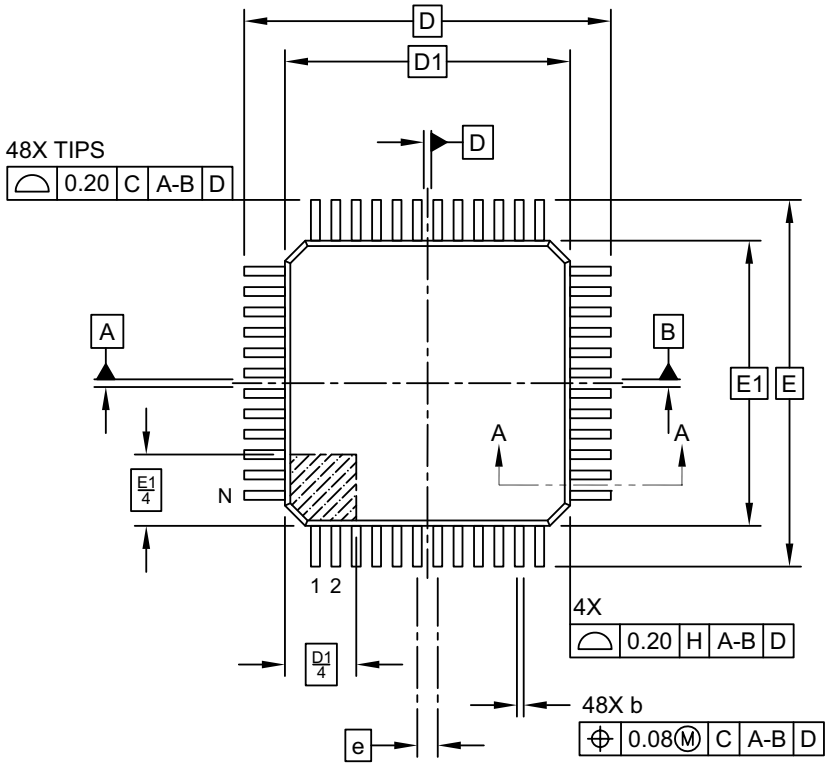


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package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

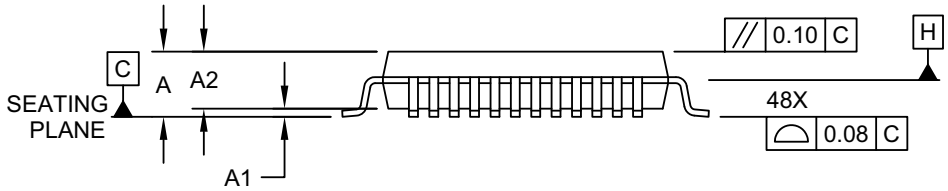
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

48-Lead 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

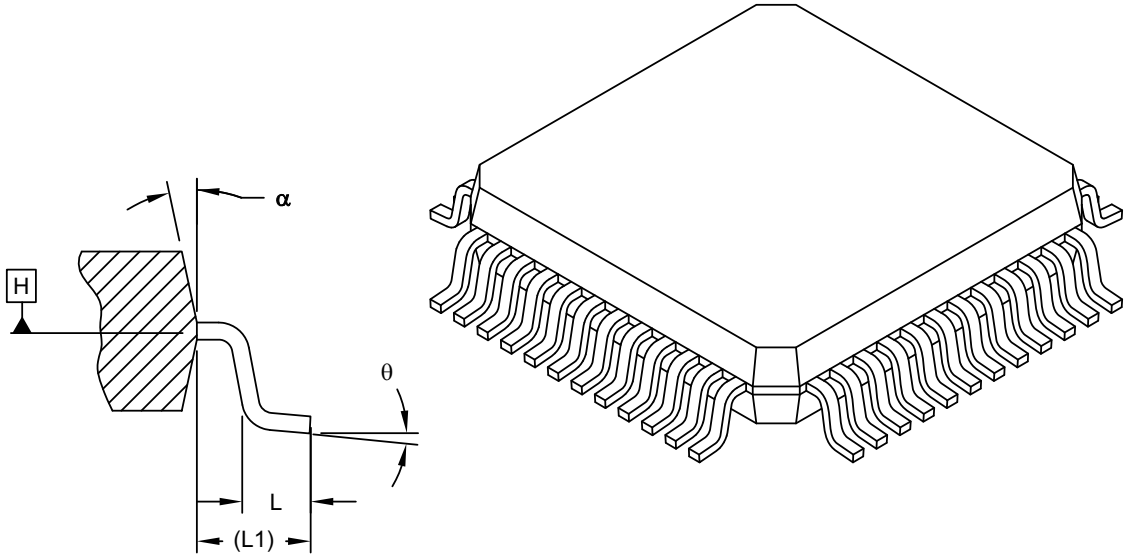


SIDE VIEW

Microchip Technology Drawing C04-278 Rev A 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

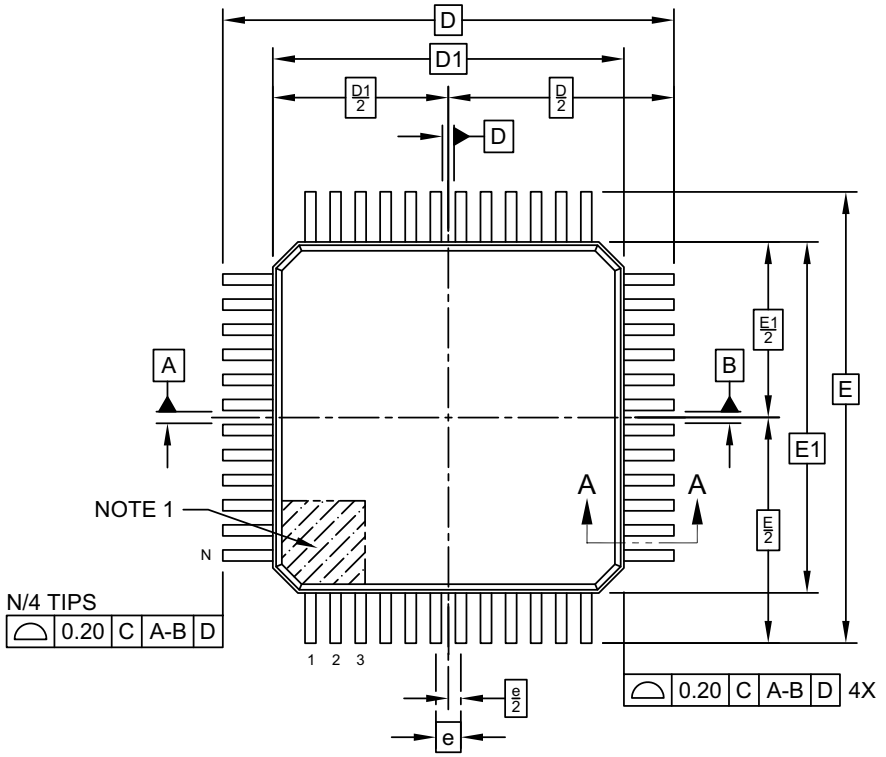
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

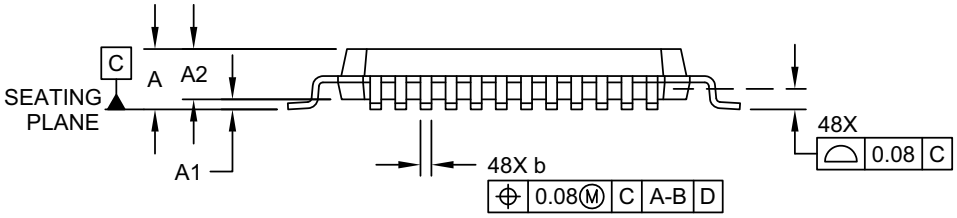
Microchip Technology Drawing C04-278 Rev A Sheet 2 of 2

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



TOP VIEW

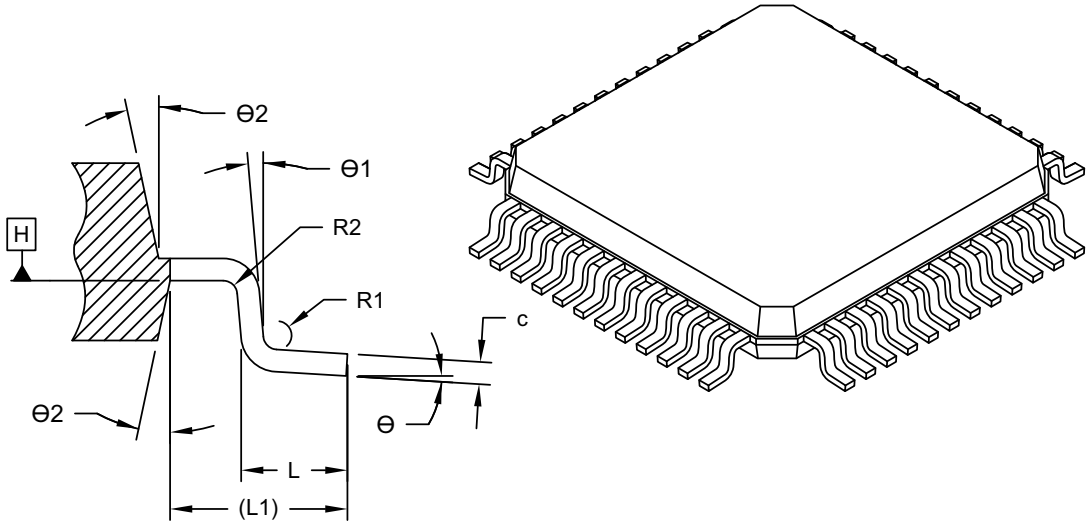


SIDE VIEW

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°

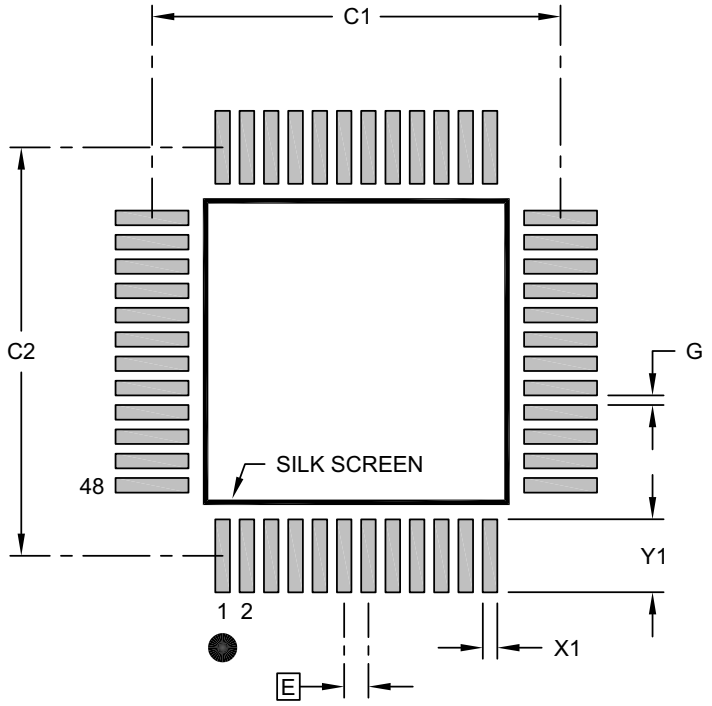
Notes:

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

APPENDIX A: REVISION HISTORY

Revision A (September 2023)

- Converted Supertex Doc #s DSFP-HV238 to Microchip DS20005821A
- Removed “HVCMOS® Technology for high performance” from the Features section
- Added the 48-lead TQFP package information
- Removed the 48-lead LQFP M931 package type to align packaging specifications with the actual BQM
- Changed the package marking format
- Updated the package marking drawings
- Made minor 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.

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Device:	HV238	=	16-Channel High-Voltage Analog Switch with Bleed Resistors
Packages:	FG	=	48-lead LQFP
	TQ	=	48-lead TQFP
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	250/Tray for an FG Package
	(blank)		250/Tray for a TQ Package

Examples:

a) HV238FG-G: 16-Channel High-Voltage Analog Switch with Bleed Resistors, 48-lead LQFP Package, 250/Tray

b) HV238TQ-G: 16-Channel High-Voltage Analog Switch with Bleed Resistors, 48-lead TQFP Package, 250/Tray

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