

## 40-Channel Symmetric Row Driver

### Ordering Information

Device	Package Options			
	80-Lead Ceramic Gullwing	64-Lead 3-Sided Plastic Gullwing	Die in waffle pack	80-Lead Ceramic Gullwing (MIL-STD-883 Processed*)
HV7224	HV7224DG	HV7224PG	HV7224X	RBHV7224DG

\* For Hi-Rel process flows, refer to page 5-3 of the Databook.

### Features

- Processed with HVCMOS® technology
- Symmetric row drive (reduces latent imaging in ACTFEL displays)
- Output voltage up to 240V
- Low-power level shifting
- Source/Sink current 70mA (min.)
- Shift Register Speed 3MHz
- Pin-programmable shift direction (DIR, SHIFT)
- Hi-Rel processing available

### General Description

The HV72 is a low-voltage serial to high-voltage parallel converters with push-pull outputs. It is especially suitable for use as a symmetric row driver in AC thin-film electroluminescent (ACTFEL) displays.

When the data reset pin ( $DR_{IO}$ ) is at logic high, it will reset all the outputs of the internal shift register to zero. At the same time, the output of the shift register will start shifting a logic high from the least significant bit to the most significant bit. The  $DR_{IO}$  can be triggered at any time. The DIR and SHIFT pins control the direction of data shift through the device. When DIR is at logic high,  $DR_{IOA}$  is the input and  $DR_{IOB}$  is the output. When DIR is grounded,  $DR_{IOB}$  is the input and the  $DR_{IOA}$  is the output. See the Output Sequence Operation Table for output sequence. The POL and OE pins perform the polarity select and output enable function respectively. Data is loaded on the low to high transition of the clock. A logic high will cause the output to swing to  $V_{PP}$  if POL is high, or to GND if  $\overline{POL}$  is low. All outputs will be in High-Z state if OE is at logic high. Data output buffers are provided for cascading devices.

### Absolute Maximum Ratings

Supply voltage, $V_{DD}$ <sup>1</sup>	-0.5V to +7V	
Supply voltage, $V_{PP}$	-0.5V to +260V	
Logic input levels	-0.5V to $V_{DD} + 0.5V$	
Continuous total power dissipation <sup>2</sup>	Plastic	1200mW
	Ceramic	1900mW
Operating temperature range	Plastic	-40°C to +85°C
	Ceramic	-55°C to +125°C
Storage temperature range	-65°C to +150°C	
Lead temperature 1.6mm (1/16 inch) from case for 10 seconds	260°C	

**Notes:**

1. All voltages are referenced to GND.
2. For operation above 25°C ambient derate linearly to maximum operating temperature at 20mW/°C for plastic and at 19mW/°C for ceramic.

## Electrical Characteristics

(over recommended operating conditions of  $V_{DD} = 5V$ ,  $V_{PP} = 240V$ , and  $T_A = 25^\circ C$  unless noted)

### DC Characteristics

Symbol	Parameter	Min	Max	Units	Conditions	
$I_{DD}$	$V_{DD}$ supply current		10	mA	$f_{CLK} = 3MHz$	
$I_{PP}$	High voltage supply current		2.0	mA	Outputs low or High-Z	
			4.0	mA	One Output High <sup>1</sup>	
$I_{DDQ}$	Quiescent $V_{DD}$ supply current		100	$\mu A$	All $V_{IN} = GND$ or $V_{DD}$	
$V_{OH}$	High-level output	HV <sub>OUT</sub>	190	V	$I_O = -70mA$	
		Data out	4.5	V	$I_O = -100\mu A$	
$V_{OL}$	Low-level output	HV <sub>OUT</sub>		50	V	$I_O = 70mA$
		Data out		0.5	V	$I_O = 100\mu A$
$I_{IH}$	High-level logic input current		1.0	$\mu A$	$V_{IH} = V_{DD}$	
$I_{IL}$	Low-level logic input current		-1.0	$\mu A$	$V_{IL} = 0V$	
$I_{SAT}$	Saturation current HV <sub>OUT</sub>	P-Ch	-80	mA		
		N-Ch	75	mA		

**Note:**

1. Only one output can be turned on at a time.

### AC Characteristics

Symbol	Parameter	Min	Max	Units	Conditions
$f_{CLK}$	Clock frequency		3.0	MHz	
$t_{W(H/L)}$	Pulse width - clock high or low	150		ns	
$t_{SUD}$	Data set-up time before clock rises	50		ns	
$t_{HD}$	Data hold time after clock rises	50		ns	
$t_{SUC}$	HV <sub>OUT</sub> delay from clock rises (Hi-Z to H or L)		1.0	$\mu s$	$C_L = 330pF // R_L = 10k\Omega$
$t_{SUE}$	HV <sub>OUT</sub> delay from $\overline{\text{Output Enable}}$ falls		600	ns	$C_L = 330pF // R_L = 10k\Omega$
$t_{HC}$	HV <sub>OUT</sub> delay from clock rises (H or L to Hi-Z)		2.0	$\mu s$	$C_L = 330pF // R_L = 10k\Omega$
$t_{HE}$	HV <sub>OUT</sub> delay from $\overline{\text{Output Enable}}$ rises		600	ns	$C_L = 330pF // R_L = 10k\Omega$
$t_{DHL}^*$	Delay time clock to data output falls		250	ns	$C_L = 15pF$
$t_{DLH}^*$	Delay time clock to data output rises		250	ns	$C_L = 15pF$
$t_{ONF}$	HV <sub>OUT</sub> fall time		2.0	$\mu s$	$C_L = 330pF // R_L = 10k\Omega$
$t_{ONR}$	HV <sub>OUT</sub> rise time		2.0	$\mu s$	$C_L = 330pF // R_L = 10k\Omega$
$t_{POW}$	$\overline{\text{POL}}$ pulse width	3.0		$\mu s$	
$t_{OEW}$	Output Enable pulse width	3.0		$\mu s$	
	Slew rate, $V_{PP}$ or GND		45	V/ $\mu s$	One active output driving 4.7nF load

\* The delay is measured from the trailing edge of the clock but the data is triggered by the rising edge of the clock. There is an internal delay for the data output which is equal to  $t_{WH}$ . Therefore the delay is measured from the trailing edge of the clock.

# Recommended Operating Conditions

Symbol	Parameter	Min	Max	Units	
$V_{DD}$	Logic supply voltage	4.5	5.5	V	
$V_{PP}$	High voltage supply†	0	240	V	
$V_{IH}$	High-level input voltage	$0.7 V_{DD}$	$V_{DD}$	V	
$V_{IL}$	Low-level input voltage	0	$0.2V_{DD}$	V	
$f_{CLK}$	Clock frequency		3	MHz	
$I_O$	High voltage output current		$\pm 70$	mA	
$T_A$	Operating free-air temperature	Plastic	-40	+85	°C
		Ceramic	-55	+125	°C
$I_{OD}$	Allowable pulse current through output diode		$\pm 300$	mA	

**Notes:**

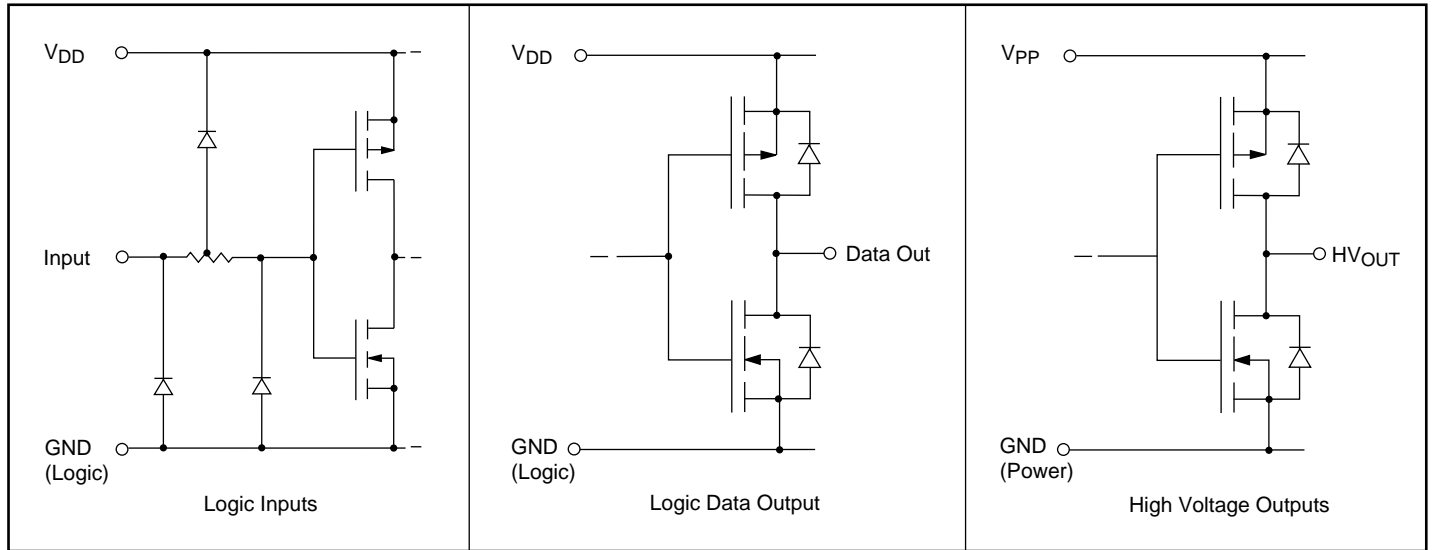
† Output will not switch at  $V_{PP} = 0V$ .

Power-up sequence should be the following:

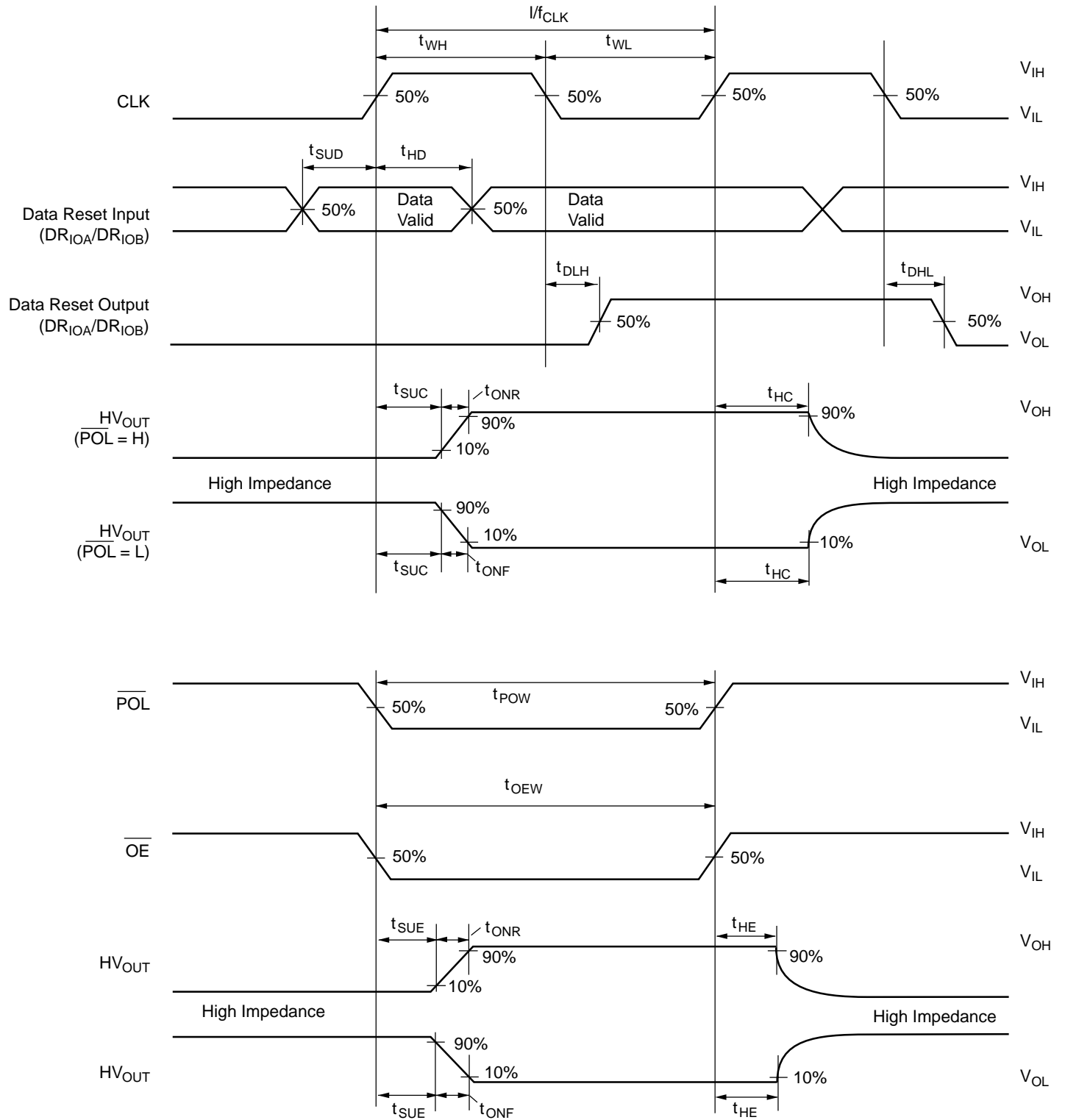
1. Connect ground.
2. Apply  $V_{DD}$ .
3. Set all inputs (Data, CLK, Enable, etc.) to a known state.
4. Apply  $V_{PP}$ .

Power-down sequence should be the reverse of the above.

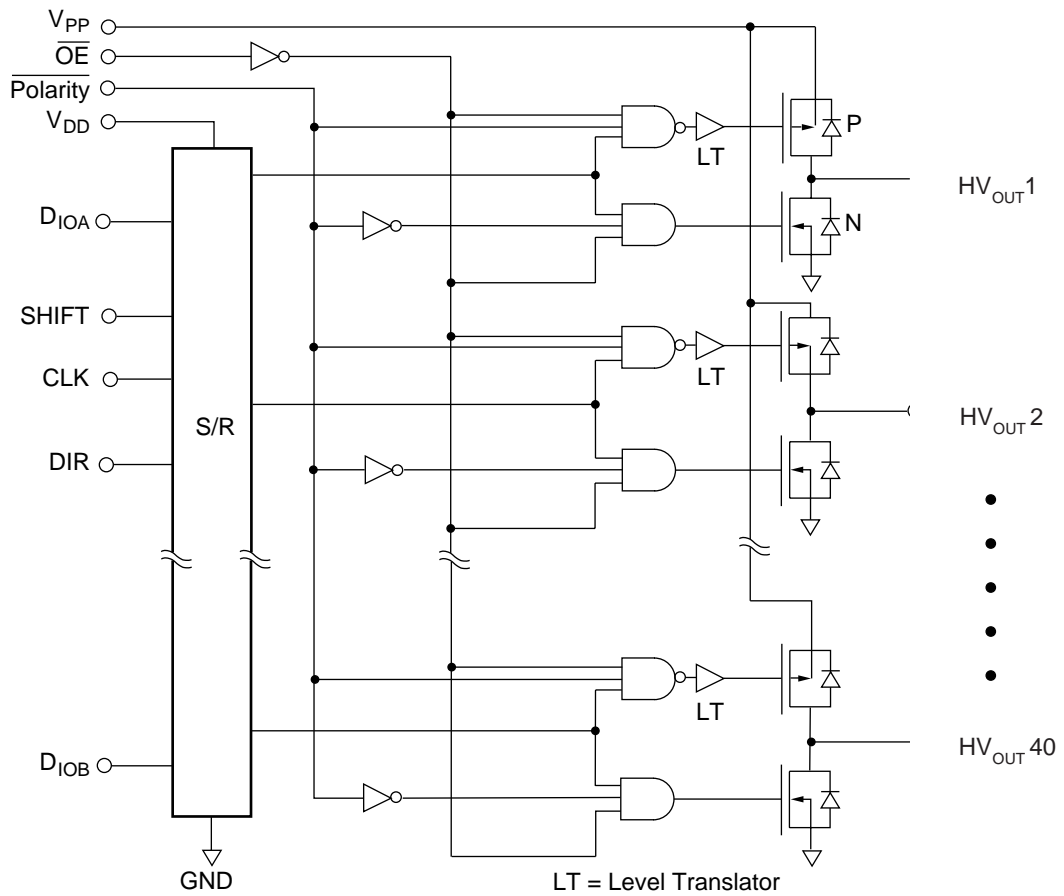
# Input and Output Equivalent Circuits



# Switching Waveforms



# Functional Block Diagram



## Function Table

I/O Relations	Inputs					HV Outputs
	CLK	DIR	S/R Data	$\overline{POL}$	$\overline{OE}$	
O/P HIGH	X	X	H	H	L	H
O/P OFF	X	X	L	X	L	HIGH-Z
O/P LOW	X	X	H	L	L	L
O/P OFF	X	X	X	X	H	All O/P HIGH-Z

**Notes:**

H = logic high level, L = logic low level, X = irrelevant

Data input ( $DR_{IO}$ ) loaded on the low-to-high transition of the clock.

## Output Sequence Operation Table

DIR	Shift	Data Reset In	Data Reset Out	HV <sub>OUT</sub> # Sequence	Direction*	Option (See pin-out on P. 12-158)
L	L	$DR_{IOB}$	$DR_{IOA}^1$	40 → 1	↶	A
H	L	$DR_{IOA}$	$DR_{IOB}^2$	1 → 40	↷	A
L	H	$DR_{IOB}$	$DR_{IOA}^1$	20 → 1 → 40 → 21	↶↷	B
H	H	$DR_{IOA}$	$DR_{IOB}^2$	21 → 40 → 1 → 20	↷↶	B

\* Reference to package outline or chip layout drawing.

1.  $DR_{IOA}$  is  $DR_{IOB}$  delayed by 40 clock pulses.

2.  $DR_{IOB}$  is  $DR_{IOA}$  delayed by 40 clock pulses.

# Pin Configurations

## HV72

### Option A:

Pin	Function	Pin	Function
1	HV <sub>OUT</sub> 1/40	33	N/C
2	HV <sub>OUT</sub> 2/39	34	DR <sub>IOB</sub>
3	HV <sub>OUT</sub> 3/38	35	$\overline{OE}$
4	HV <sub>OUT</sub> 4/37	36	NC
5	HV <sub>OUT</sub> 5/36	37	$\overline{POL}$
6	HV <sub>OUT</sub> 6/35	38	N/C
7	HV <sub>OUT</sub> 7/34	39	V <sub>DD</sub>
8	HV <sub>OUT</sub> 8/33	40	N/C
9	HV <sub>OUT</sub> 9/32	41	GND (Logic)
10	HV <sub>OUT</sub> 10/31	42	GND (Power)
11	HV <sub>OUT</sub> 11/30	43	N/C
12	HV <sub>OUT</sub> 12/29	44	V <sub>PP</sub>
13	HV <sub>OUT</sub> 13/28	45	HV <sub>OUT</sub> 21/20
14	HV <sub>OUT</sub> 14/27	46	HV <sub>OUT</sub> 22/19
15	HV <sub>OUT</sub> 15/26	47	HV <sub>OUT</sub> 23/18
16	HV <sub>OUT</sub> 16/25	48	HV <sub>OUT</sub> 24/17
17	HV <sub>OUT</sub> 17/24	49	HV <sub>OUT</sub> 25/16
18	HV <sub>OUT</sub> 18/23	50	HV <sub>OUT</sub> 26/15
19	HV <sub>OUT</sub> 19/22	51	HV <sub>OUT</sub> 27/14
20	HV <sub>OUT</sub> 20/21	52	HV <sub>OUT</sub> 28/13
21	V <sub>PP</sub>	53	HV <sub>OUT</sub> 29/12
22	N/C	54	HV <sub>OUT</sub> 30/11
23	GND (Power)	55	HV <sub>OUT</sub> 31/10
24	GND (Logic)	56	HV <sub>OUT</sub> 32/9
25	DIR	57	HV <sub>OUT</sub> 33/8
26	V <sub>DD</sub>	58	HV <sub>OUT</sub> 34/7
27	CLK	59	HV <sub>OUT</sub> 35/6
28	N/C	60	HV <sub>OUT</sub> 36/5
29	SHIFT	61	HV <sub>OUT</sub> 37/4
30	N/C	62	HV <sub>OUT</sub> 38/3
31	DR <sub>IOA</sub>	63	HV <sub>OUT</sub> 39/2
32	N/C	64	HV <sub>OUT</sub> 40/1

#### Note:

Pin designation for DIR H/L, SHIFT = L.

Example: For DIR = H, pin 1 is HV<sub>OUT</sub>1.

For DIR = L, pin 1 is HV<sub>OUT</sub>40.

Pins 65–80 are NC (ceramic only).

## HV72

### Option B:

Pin	Function	Pin	Function
1	HV <sub>OUT</sub> 20/21	33	N/C
2	HV <sub>OUT</sub> 19/22	34	DR <sub>IOB</sub>
3	HV <sub>OUT</sub> 18/23	35	$\overline{OE}$
4	HV <sub>OUT</sub> 17/24	36	N/C
5	HV <sub>OUT</sub> 16/25	37	$\overline{POL}$
6	HV <sub>OUT</sub> 15/26	38	N/C
7	HV <sub>OUT</sub> 14/27	39	V <sub>DD</sub>
8	HV <sub>OUT</sub> 13/28	40	N/C
9	HV <sub>OUT</sub> 12/29	41	GND (Logic)
10	HV <sub>OUT</sub> 11/30	42	GND (Power)
11	HV <sub>OUT</sub> 10/31	43	N/C
12	HV <sub>OUT</sub> 9/32	44	V <sub>PP</sub>
13	HV <sub>OUT</sub> 8/33	45	HV <sub>OUT</sub> 40/1
14	HV <sub>OUT</sub> 7/34	46	HV <sub>OUT</sub> 39/2
15	HV <sub>OUT</sub> 6/35	47	HV <sub>OUT</sub> 38/3
16	HV <sub>OUT</sub> 5/36	48	HV <sub>OUT</sub> 37/4
17	HV <sub>OUT</sub> 4/37	49	HV <sub>OUT</sub> 36/5
18	HV <sub>OUT</sub> 3/38	50	HV <sub>OUT</sub> 35/6
19	HV <sub>OUT</sub> 2/39	51	HV <sub>OUT</sub> 34/7
20	HV <sub>OUT</sub> 1/40	52	HV <sub>OUT</sub> 33/8
21	V <sub>PP</sub>	53	HV <sub>OUT</sub> 32/9
22	N/C	54	HV <sub>OUT</sub> 31/10
23	GND (Power)	55	HV <sub>OUT</sub> 30/11
24	GND (Logic)	56	HV <sub>OUT</sub> 29/12
25	DIR	57	HV <sub>OUT</sub> 28/13
26	V <sub>DD</sub>	58	HV <sub>OUT</sub> 27/14
27	CLK	59	HV <sub>OUT</sub> 26/15
28	N/C	60	HV <sub>OUT</sub> 25/16
29	SHIFT	61	HV <sub>OUT</sub> 24/17
30	N/C	62	HV <sub>OUT</sub> 23/18
31	DR <sub>IOA</sub>	63	HV <sub>OUT</sub> 22/19
32	N/C	64	HV <sub>OUT</sub> 21/20

#### Note:

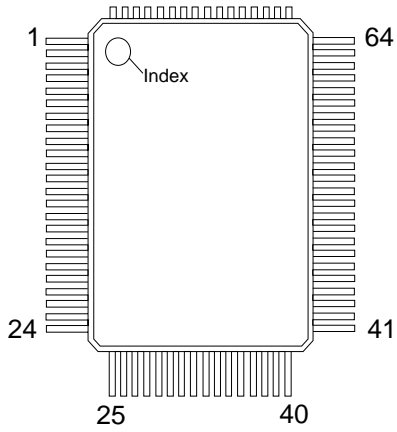
Pin designation for DIR L/H, SHIFT = H.

Example: For DIR = L, pin 1 is HV<sub>OUT</sub>20.

For DIR = H, pin 1 is HV<sub>OUT</sub>21.

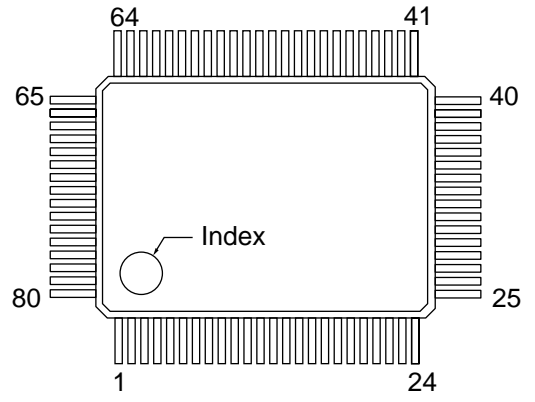
Pins 65–80 are NC (ceramic only).

# Package Outline



top view

3-sided Plastic 64-pin Gullwing Package



top view

80-pin Ceramic Gullwing Package