



## 32-Channel High Voltage Amplifier Array

### Features

- ❑ 32 independent high voltage amplifiers
- ❑ Output voltage up to 250V
- ❑ 3V/ $\mu$ s output slew rate
- ❑ Fixed gain of 50V/V
- ❑ High value internal feedback resistors
- ❑ Very low operating current (typically 45 $\mu$ A per channel)
- ❑ Integrated silicon diode for temperature sensing

### Application

- ❑ MEMS (microelectromechanical systems) driver
- ❑ Piezoelectric transducer driver
- ❑ Optical crosspoint switches (using MEMS technology)

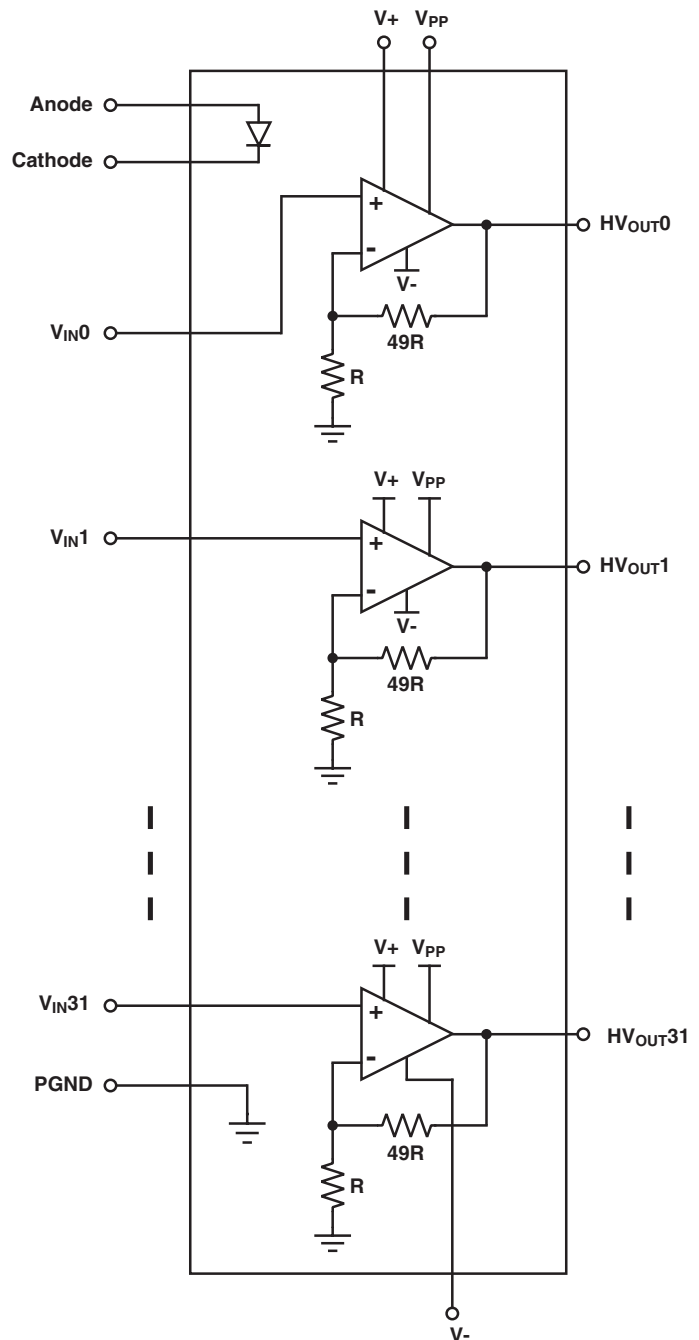
### General Description

The Supertex HV254 is a 32-channel high voltage amplifier array integrated circuit. It operates on a 275V high voltage supply and two low voltage supplies: +5.0V and -5.0V. Each channel has its own input and output. An integrated diode is included to help monitor die temperature.

The input voltage can be from a DAC with a voltage range of 0V to the low voltage supply, V+. The output of the HV254FG will swing from 7V to 250V. It cannot swing to ground. With the internal gain set at 50V/V, a minimum input signal of 140mV will still maintain linearity. Input voltages below 140mV can be applied without damage to the device. The amplifier, however, will be saturated. Typical output load is equivalent to a 125Mohm resistor in parallel with a 100pF capacitor. The outputs have a guaranteed slew rate of at least 3V/ $\mu$ s. The internal closed loop gain is set at a nominal value of 34.0dB (50V/V).

The HV254 is designed to operate with minimal power consumption while maintaining a guaranteed slew rate of 3V/ $\mu$ s. High value resistors are used for the gain setting to minimize current on the feedback path.

### Block Diagram



## Ordering Information

| Device | Maximum Output Voltage | Package Options |        |
|--------|------------------------|-----------------|--------|
|        |                        | 100 Lead MQFP   | Die    |
| HV254  | 250V                   | HV254FG         | HV254X |

## Absolute Maximum Ratings\*

|                                     |                |
|-------------------------------------|----------------|
| $V_{PP}$ , High voltage supply      | 275V           |
| $V_+$ , Low voltage positive supply | 7.0V           |
| $V_-$ , Low voltage negative supply | -7.0V          |
| $HV_{OUT}$ , Output voltage         | 0V to 275V     |
| $V_{IN}$ , Analog input signal      | 0V to 5.0V     |
| Storage temperature range           | -65°C to 150°C |
| Maximum junction temperature        | 150°C          |

\*Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. Continuous operation of the device at the absolute rating level may affect device reliability. All voltages are referenced to device ground.

## Electrical Characteristics (Over operating conditions unless otherwise noted.)

| Symbol | Parameter | Min | Typ | Max | Units | Conditions |
|--------|-----------|-----|-----|-----|-------|------------|
|--------|-----------|-----|-----|-----|-------|------------|

### Operating Conditions

|          |                              |       |      |       |     |                                                                     |
|----------|------------------------------|-------|------|-------|-----|---------------------------------------------------------------------|
| $V_{PP}$ | High voltage positive supply | 50    |      | 275   | V   |                                                                     |
| $V_+$    | Low voltage positive supply  | 4.75  | 5.0  | 5.25  | V   |                                                                     |
| $V_-$    | Low voltage negative supply  | -4.75 | -5.0 | -5.25 | V   |                                                                     |
| $I_{PP}$ | $V_{PP}$ supply current      | 1.0   |      | 2.5   | mA  | $V_{PP}=275V$ , All inputs set at 140mV. Typically 45μA per channel |
| $I_+$    | $V_+$ supply current         |       |      | 1.0   | mA  | $V_+ = 5.25V$                                                       |
| $I_-$    | $V_{NN}$ supply current      |       |      | -3.0  | mA  | $V_- = -5.25V$                                                      |
| $T_A$    | Ambient temperature range    | -10   |      | 70    | ° C |                                                                     |
| $T_J$    | Junction temperature range   | -10   |      | 125   | ° C |                                                                     |

### High Voltage Amplifier Output

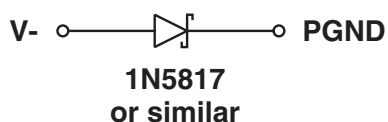
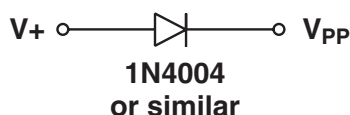
|            |                                   |      |      |       |      |                                       |
|------------|-----------------------------------|------|------|-------|------|---------------------------------------|
| $HV_{OUT}$ | $HV_{OUT}$ voltage swing          | 7.0  |      | 250   | V    | $V_{PP} = 275V$ , Load=125MΩ//100pF   |
| $V_{IN}$   | Input Voltage Range               | 0.14 |      | $V_+$ | V    |                                       |
| $HV_{OS}$  | $HV_{OUT}$ DC offset              |      | ±1.5 | ±1.52 | V    | $V_{PP} = 275V$ . 30mV input offset   |
| SR         | $HV_{OUT}$ slew rate              | 3.0  |      |       | V/μs | $V_{PP} = 275V$ , Load = 125MΩ//100pF |
| $R_{FB}$   | Feedback impedance                | 8    | 12   |       | MΩ   |                                       |
| $A_V$      | Closed loop gain                  | 47.5 | 50.0 | 52.5  | V/V  |                                       |
| BW         | $HV_{OUT}$ -3dB channel bandwidth | 5.0  |      |       | KHz  | $V_{PP} = 275V$                       |
| $C_{LOAD}$ | $HV_{OUT}$ capacitive load        | 0    |      | 100   | pF   |                                       |
|            | Stability (max drift)             |      |      | 500   | mV   | Measured at $HV_{OUT}$                |

## Diode

| Symbol | Parameter                     | Min | Typ   | Max | Units   | Conditions                        |
|--------|-------------------------------|-----|-------|-----|---------|-----------------------------------|
| PIV    | Peak inverse voltage          |     |       | 5.0 | V       | cathode to anode                  |
| $V_F$  | Forward diode drop            |     |       | 0.8 | V       | $I_f=100\mu A$ , anode to cathode |
| $I_F$  | Forward diode current         |     |       | 100 | $\mu A$ | anode to cathode                  |
| $T_C$  | $V_F$ Temperature coefficient |     | -2.20 |     | mV/°C   | anode to cathode                  |

## Power Up/Down Sequence

The device can be damaged due to improper power up / down sequence. To prevent damage, please follow the acceptable power up /down sequences and add two external diodes as shown in the diagram below. The first diode is a high voltage diode across  $V_{pp}$  and  $V_+$  where the anode of the diode is connected to  $V_+$  and the cathode of the diode is connected to  $V_{pp}$ . Any low current high voltage diode such as a 1N4004 will be adequate. The second diode is a schottky diode across  $V_-$  and DGnd where the anode of the schottky diode is connected to  $V_-$  and the cathode is connected to DGnd. Any low current schottky diode such as a 1N5817 will be adequate.



### Acceptable Power Up Sequences

- |             |          |             |                   |
|-------------|----------|-------------|-------------------|
| 1) $V_{pp}$ | 2) $V_-$ | 3) $V_+$    | 4) Inputs & Anode |
| or          |          |             |                   |
| 1) $V_-$    | 2) $V_+$ | 3) $V_{pp}$ | 4) Inputs & Anode |

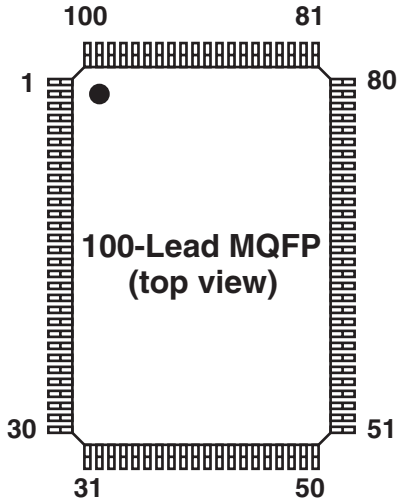
### Acceptable Power Down Sequences

- |                   |             |          |             |
|-------------------|-------------|----------|-------------|
| 1) Inputs & Anode | 2) $V_+$    | 3) $V_-$ | 4) $V_{pp}$ |
| or                |             |          |             |
| 1) Inputs & Anode | 2) $V_{pp}$ | 3) $V_+$ | 4) $V_-$    |

## Pin Description

|                             |                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------|
| $V_{pp}$                    | High voltage positive supply.                                                            |
| $V_+$                       | Analog low voltage positive supply                                                       |
| $V_-$                       | Analog low voltage negative supply                                                       |
| PGND                        | Device ground                                                                            |
| Anode                       | Anode side of a low voltage silicon diode that can be used to monitor die temperature.   |
| Cathode                     | Cathode side of a low voltage silicon diode that can be used to monitor die temperature. |
| $V_{IN0}$ to $V_{IN31}$     | Amplifier inputs                                                                         |
| $HV_{OUT0}$ to $HV_{OUT31}$ | Amplifier outputs                                                                        |

## Pin Configuration

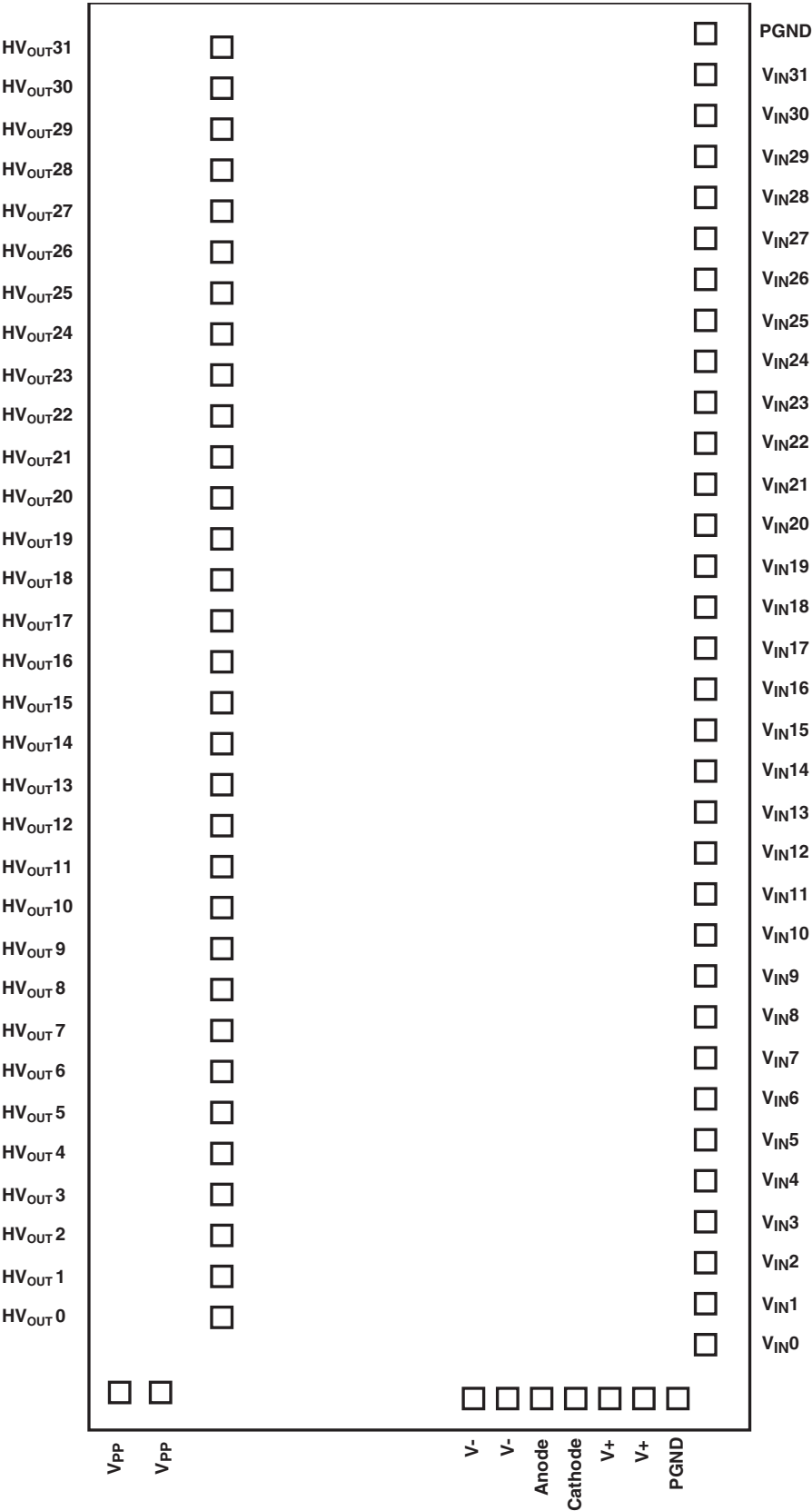


## Pin Configuration

| Pin # | Function             | Pin # | Function            | Pin # | Function           | Pin # | Function             |
|-------|----------------------|-------|---------------------|-------|--------------------|-------|----------------------|
| 1     | HV <sub>OUT</sub> 29 | 26    | HV <sub>OUT</sub> 4 | 51    | V <sub>IN</sub> 2  | 76    | V <sub>IN</sub> 27   |
| 2     | HV <sub>OUT</sub> 28 | 27    | HV <sub>OUT</sub> 3 | 52    | V <sub>IN</sub> 3  | 77    | V <sub>IN</sub> 28   |
| 3     | HV <sub>OUT</sub> 27 | 28    | HV <sub>OUT</sub> 2 | 53    | V <sub>IN</sub> 4  | 78    | V <sub>IN</sub> 29   |
| 4     | HV <sub>OUT</sub> 26 | 29    | HV <sub>OUT</sub> 1 | 54    | V <sub>IN</sub> 5  | 79    | V <sub>IN</sub> 30   |
| 5     | HV <sub>OUT</sub> 25 | 30    | HV <sub>OUT</sub> 0 | 55    | V <sub>IN</sub> 6  | 80    | V <sub>IN</sub> 31   |
| 6     | HV <sub>OUT</sub> 24 | 31    | NC                  | 56    | V <sub>IN</sub> 7  | 81    | PGND                 |
| 7     | HV <sub>OUT</sub> 23 | 32    | NC                  | 57    | V <sub>IN</sub> 8  | 82    | NC                   |
| 8     | HV <sub>OUT</sub> 22 | 33    | NC                  | 58    | V <sub>IN</sub> 9  | 83    | NC                   |
| 9     | HV <sub>OUT</sub> 21 | 34    | NC                  | 59    | V <sub>IN</sub> 10 | 84    | NC                   |
| 10    | HV <sub>OUT</sub> 20 | 35    | NC                  | 60    | V <sub>IN</sub> 11 | 85    | NC                   |
| 11    | HV <sub>OUT</sub> 19 | 36    | V <sub>PP</sub>     | 61    | V <sub>IN</sub> 12 | 86    | NC                   |
| 12    | HV <sub>OUT</sub> 18 | 37    | V <sub>PP</sub>     | 62    | V <sub>IN</sub> 13 | 87    | NC                   |
| 13    | HV <sub>OUT</sub> 17 | 38    | NC                  | 63    | V <sub>IN</sub> 14 | 88    | NC                   |
| 14    | HV <sub>OUT</sub> 16 | 39*   | I <sub>bias</sub>   | 64    | V <sub>IN</sub> 15 | 89    | NC                   |
| 15    | HV <sub>OUT</sub> 15 | 40    | NC                  | 65    | V <sub>IN</sub> 16 | 90    | NC                   |
| 16    | HV <sub>OUT</sub> 14 | 41    | V-                  | 66    | V <sub>IN</sub> 17 | 91    | NC                   |
| 17    | HV <sub>OUT</sub> 13 | 42    | V-                  | 67    | V <sub>IN</sub> 18 | 92    | NC                   |
| 18    | HV <sub>OUT</sub> 12 | 43    | Anode               | 68    | V <sub>IN</sub> 19 | 93    | NC                   |
| 19    | HV <sub>OUT</sub> 11 | 44    | Cathode             | 69    | V <sub>IN</sub> 20 | 94    | NC                   |
| 20    | HV <sub>OUT</sub> 10 | 45    | V+                  | 70    | V <sub>IN</sub> 21 | 95    | NC                   |
| 21    | HV <sub>OUT</sub> 9  | 46    | V+                  | 71    | V <sub>IN</sub> 22 | 96    | NC                   |
| 22    | HV <sub>OUT</sub> 8  | 47    | NC                  | 72    | V <sub>IN</sub> 23 | 97    | NC                   |
| 23    | HV <sub>OUT</sub> 7  | 48    | PGND                | 73    | V <sub>IN</sub> 24 | 98    | NC                   |
| 24    | HV <sub>OUT</sub> 6  | 49    | V <sub>IN</sub> 0   | 74    | V <sub>IN</sub> 25 | 99    | HV <sub>OUT</sub> 31 |
| 25    | HV <sub>OUT</sub> 5  | 50    | V <sub>IN</sub> 1   | 75    | V <sub>IN</sub> 26 | 100   | HV <sub>OUT</sub> 30 |

\* For internal testing only. Leave floating.  
NC=No Connect.

Pad Configuration (Not Drawn to Scale)



Die Size=4800 $\mu$ m X 11180 $\mu$ m (including scribes)

Center of the die is 0,0.

Coordinates for the four corners of the chip (not including scribe):

| X ( $\mu$ m) | Y ( $\mu$ m) |
|--------------|--------------|
| -2402        | 5492         |
| -2402        | -5492        |
| 2335         | 5492         |
| 2335         | -5492        |

**Notes:**

- 1) The two PGND pads are not electrically connected.
- 2) The two  $V_{PP}$  pads,  $V+$  pads, and  $V-$  pads are electrically connected.
- 3) Backside potential is  $V_{PP}$ . Leave floating or connect to  $V_{PP}$ .
- 4) Anode and Cathode are connected to the P and N terminals (respectively) of a silicon diode which can be used to measure temperature.

## Pad Description

|                             |                                                                        |
|-----------------------------|------------------------------------------------------------------------|
| $V_{PP}$                    | High voltage positive supply. Two $V_{PP}$ pads.                       |
| $V+$                        | Low voltage positive supply. Two $V+$ pads.                            |
| $V-$                        | Low voltage negative supply. Two $V-$ pads.                            |
| $V_{IN0}$ to $V_{IN31}$     | Amplifier inputs.                                                      |
| $HV_{OUT0}$ to $HV_{OUT31}$ | Amplifier outputs.                                                     |
| PGND                        | Power ground. Two PGND pads. Need to be externally connected together. |
| Anode                       | Anode side of diode.                                                   |
| Cathode                     | Cathode side of diode.                                                 |

## Pad Coordinates

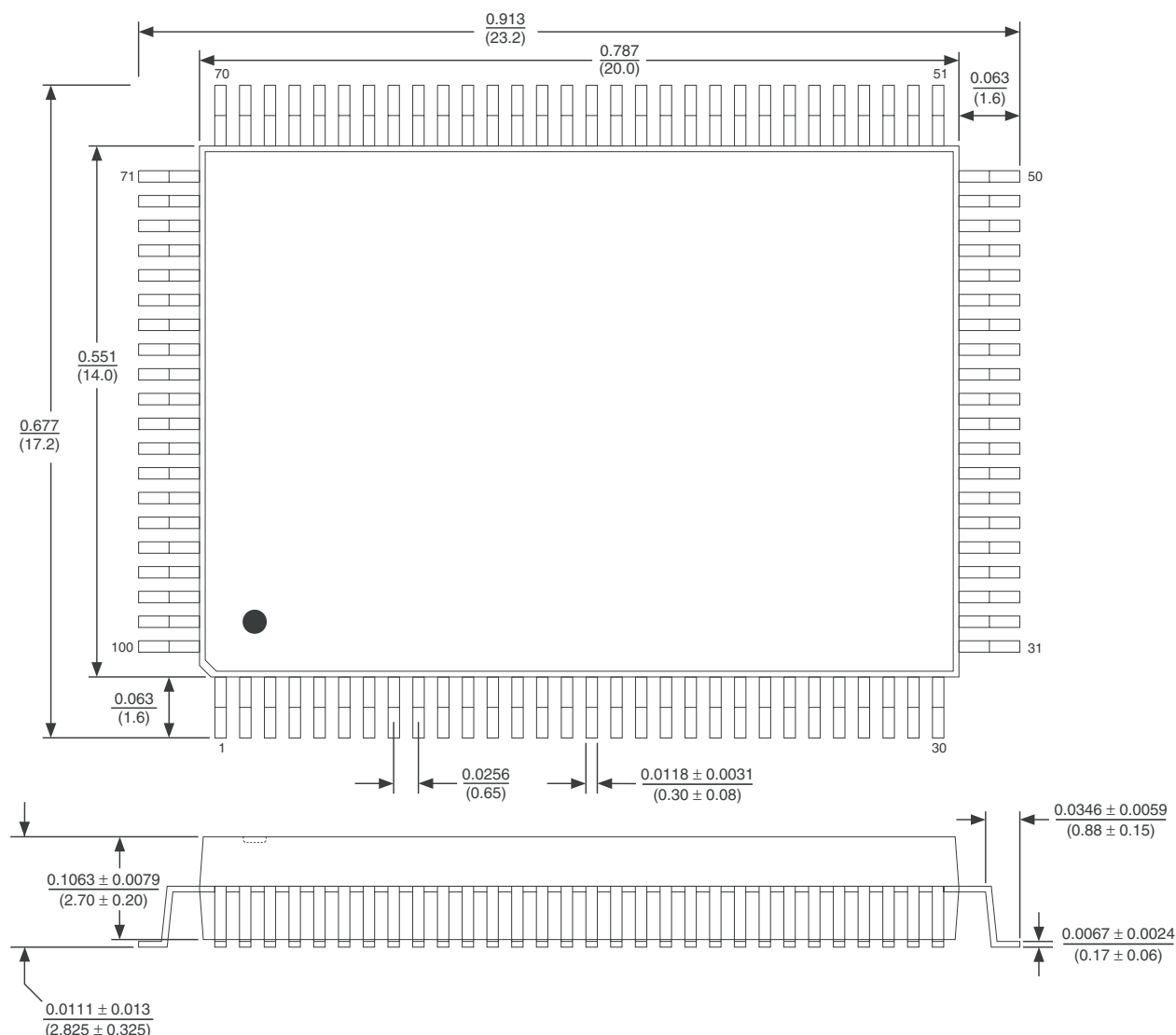
| Pad Name            | X ( $\mu$ m) | Y ( $\mu$ m) |
|---------------------|--------------|--------------|
| HV <sub>OUT31</sub> | -1447.5      | 5244         |
| HV <sub>OUT30</sub> | -1447.5      | 4926.5       |
| HV <sub>OUT29</sub> | -1447.5      | 4609         |
| HV <sub>OUT28</sub> | -1447.5      | 4291.5       |
| HV <sub>OUT27</sub> | -1447.5      | 3974         |
| HV <sub>OUT26</sub> | -1447.5      | 3656.5       |
| HV <sub>OUT25</sub> | -1447.5      | 3339         |
| HV <sub>OUT24</sub> | -1447.5      | 3021.5       |
| HV <sub>OUT23</sub> | -1447.5      | 2704         |
| HV <sub>OUT22</sub> | -1447.5      | 2386.5       |
| HV <sub>OUT21</sub> | -1447.5      | 2069         |
| HV <sub>OUT20</sub> | -1447.5      | 1751.5       |
| HV <sub>OUT19</sub> | -1447.5      | 1434         |
| HV <sub>OUT18</sub> | -1447.5      | 1116.5       |
| HV <sub>OUT17</sub> | -1447.5      | 799          |
| HV <sub>OUT16</sub> | -1447.5      | 481.5        |
| HV <sub>OUT15</sub> | -1447.5      | 164          |
| HV <sub>OUT14</sub> | -1447.5      | -153.5       |
| HV <sub>OUT13</sub> | -1447.5      | -471         |
| HV <sub>OUT12</sub> | -1447.5      | -788.5       |
| HV <sub>OUT11</sub> | -1447.5      | -1106        |
| HV <sub>OUT10</sub> | -1447.5      | -1423.5      |
| HV <sub>OUT9</sub>  | -1447.5      | -1741        |
| HV <sub>OUT8</sub>  | -1447.5      | -2058.5      |
| HV <sub>OUT7</sub>  | -1447.5      | -2376        |

| Pad Name           | X ( $\mu$ m) | Y ( $\mu$ m) |
|--------------------|--------------|--------------|
| HV <sub>OUT6</sub> | -1447.5      | -2693.5      |
| HV <sub>OUT5</sub> | -1447.5      | -3011        |
| HV <sub>OUT4</sub> | -1447.5      | -3328.5      |
| HV <sub>OUT3</sub> | -1447.5      | -3646        |
| HV <sub>OUT2</sub> | -1447.5      | -3963.5      |
| HV <sub>OUT1</sub> | -1447.5      | -4281        |
| HV <sub>OUT0</sub> | -1447.5      | -4598.5      |
| $V_{PP}$           | -2057        | -4985        |
| $V_{PP}$           | -1897        | -4985        |
| $V-$               | 1030.5       | -5018        |
| $V-$               | 1190.5       | -5018        |
| Anode              | 1350.5       | -5018        |
| Cathode            | 1550.5       | -5018        |
| $V+$               | 1710.5       | -5018        |
| $V+$               | 1870.5       | -5018        |
| Pgnd               | 2034.5       | -5018        |
| $V_{IN0}$          | 2156.5       | -4725        |
| $V_{IN1}$          | 2156.5       | -4411        |
| $V_{IN2}$          | 2156.5       | -4097        |
| $V_{IN3}$          | 2156.5       | -3783        |
| $V_{IN4}$          | 2156.5       | -3469        |
| $V_{IN5}$          | 2156.5       | -3155        |
| $V_{IN6}$          | 2156.5       | -2841        |
| $V_{IN7}$          | 2156.5       | -2527        |
| $V_{IN8}$          | 2156.5       | -2213        |

| Pad Name   | X ( $\mu$ m) | Y ( $\mu$ m) |
|------------|--------------|--------------|
| $V_{IN9}$  | 2156.5       | -1899        |
| $V_{IN10}$ | 2156.5       | -1585        |
| $V_{IN11}$ | 2156.5       | -1271        |
| $V_{IN12}$ | 2156.5       | -957         |
| $V_{IN13}$ | 2156.5       | -643         |
| $V_{IN14}$ | 2156.5       | -329         |
| $V_{IN15}$ | 2156.5       | -15          |
| $V_{IN16}$ | 2156.5       | 299          |
| $V_{IN17}$ | 2156.5       | 613          |
| $V_{IN18}$ | 2156.5       | 927          |
| $V_{IN19}$ | 2156.5       | 1241         |
| $V_{IN20}$ | 2156.5       | 1555         |
| $V_{IN21}$ | 2156.5       | 1869         |
| $V_{IN22}$ | 2156.5       | 2183         |
| $V_{IN23}$ | 2156.5       | 2497         |
| $V_{IN24}$ | 2156.5       | 2811         |
| $V_{IN25}$ | 2156.5       | 3125         |
| $V_{IN26}$ | 2156.5       | 3439         |
| $V_{IN27}$ | 2156.5       | 3753         |
| $V_{IN28}$ | 2156.5       | 4067         |
| $V_{IN29}$ | 2156.5       | 4381         |
| $V_{IN30}$ | 2156.5       | 4695         |
| $V_{IN31}$ | 2156.5       | 5009         |
| Pgnd       | 2156.5       | 5315.5       |
|            |              |              |

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## 100-LEAD MQFP PACKAGE OUTLINE (FG)



**Note:** Circle (e.g. Ⓑ) indicates JEDEC Reference.

Measurement Legend =  $\frac{\text{Dimensions in Inches}}{(\text{Dimensions in Millimeters})}$