1. General description

The HEF4028B is a 4-bit BCD to decimal decoder, a 4-bit BCO to octal decoder with active LOW enable or an 8-output (Y0 to Y7) inverting demultiplexer. The outputs are fully buffered for best performance.

When used as a BCD to decimal decoder a 1-2-4-8 BCD code applied to inputs A0 to A3 causes the selected output to be HIGH. The other nine outputs will be LOW.

To use the HEF4028B as a BCO to octal decoder, input A3 is an active LOW enable pin and outputs Y8 and Y9 are not used. A 1-2-4 BCO code applied to inputs A0 to A2 causes the selected output (Y0 to Y7) to be HIGH. The other seven outputs will be LOW. When A3 is HIGH outputs (Y0 to Y7) will be forced LOW.

When used as an 8-output (Y0 to Y7) inverting demultiplexer A0 to A2 are used as address inputs and A3 is the data input. Outputs Y8 and Y9 are not used.

It operates over a recommended VDD power supply range of 3 V to 15 V referenced to VSS (usually ground). Unused inputs must be connected to VDD, VSS, or another input.

2. Features and benefits

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from −40 °C to +85 °C
- Complies with JEDEC standard JESD 13-B

3. Ordering information

Table 1. Ordering information
All types operate from −40 °C to +85 °C.

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEF4028BT</td>
<td>SO16</td>
<td>plastic small outline package; 16 leads; body width 3.9 mm</td>
<td>SOT109-1</td>
</tr>
</tbody>
</table>
4. Functional diagram

![Functional diagram](image1)

Fig 1. Functional diagram

![Logic diagram](image2)

Fig 2. Logic diagram
5. Pinning information

5.1 Pinning

![Pin configuration diagram]

Table 2. Pin description

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y0 to Y9</td>
<td>3, 14, 2, 15, 1, 6, 7, 4, 9, 5</td>
<td>output (active HIGH)</td>
</tr>
<tr>
<td>VSS</td>
<td>8</td>
<td>ground supply voltage</td>
</tr>
<tr>
<td>A0 to A3</td>
<td>10, 13, 12, 11</td>
<td>address input</td>
</tr>
<tr>
<td>VDD</td>
<td>16</td>
<td>supply voltage</td>
</tr>
</tbody>
</table>

6. Functional description

Table 3. Function table [1]

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>A2</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
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<td>L</td>
<td>H</td>
</tr>
<tr>
<td>L</td>
<td>H</td>
</tr>
</tbody>
</table>
### 7. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DD}$</td>
<td>supply voltage</td>
<td>$V_{i} &lt; -0.5 \text{ V} \text{ or } V_{i} &gt; V_{DD} + 0.5 \text{ V}$</td>
<td>$-0.5$</td>
<td>$+18$</td>
<td>V</td>
</tr>
<tr>
<td>$I_{IK}$</td>
<td>input clamping current</td>
<td>$V_{i} &lt; -0.5 \text{ V} \text{ or } V_{i} &gt; V_{DD} + 0.5 \text{ V}$</td>
<td>$-10$</td>
<td>$+10$</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{O}$</td>
<td>input voltage</td>
<td>$-0.5 \text{ V} \text{ or } V_{DD} + 0.5 \text{ V}$</td>
<td>$-10$</td>
<td>$+10$</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{OK}$</td>
<td>output clamping current</td>
<td>$V_{O} &lt; -0.5 \text{ V} \text{ or } V_{O} &gt; V_{DD} + 0.5 \text{ V}$</td>
<td>$-10$</td>
<td>$+10$</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{IO}$</td>
<td>input/output current</td>
<td>$-50$</td>
<td>$+50$</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>storage temperature</td>
<td>$-65 \text{ K} \text{ to } +150 \text{ K}$</td>
<td>$-65$</td>
<td>$+150$</td>
<td>°C</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{amb} = -40 \text{ °C} \text{ to } +85 \text{ °C}$</td>
<td>$500$</td>
<td></td>
<td>mW</td>
</tr>
<tr>
<td>$P$</td>
<td>power dissipation per output</td>
<td>SO16 package</td>
<td>$500$</td>
<td></td>
<td>mW</td>
</tr>
</tbody>
</table>

[1] For SO16 package: $P_{tot}$ derates linearly with 8 mW/K above 70 °C.

### 8. Recommended operating conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DD}$</td>
<td>supply voltage</td>
<td>$3$</td>
<td>$-1$</td>
<td>$15$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{i}$</td>
<td>input voltage</td>
<td>$0$</td>
<td>$-V_{DD}$</td>
<td>$V_{DD}$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>ambient temperature</td>
<td>in free air</td>
<td>$-40$</td>
<td>$-+85$</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$\Delta V/\Delta t$</td>
<td>input transition rise and fall rate</td>
<td>$V_{DD} = 5 \text{ V}$</td>
<td>$-6.25$</td>
<td>$\text{ ms/V}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 10 \text{ V}$</td>
<td>$-0.5$</td>
<td>$\text{ ms/V}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 15 \text{ V}$</td>
<td>$-0.08$</td>
<td>$\text{ ms/V}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. Static characteristics

Table 6. Static characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>VDD</th>
<th>T\text{amb} = \text{-}40 ^\circ \text{C}</th>
<th>T\text{amb} = 25 ^\circ \text{C}</th>
<th>T\text{amb} = 85 ^\circ \text{C}</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>V\text{IH}</td>
<td>HIGH-level input voltage</td>
<td></td>
<td>5 V</td>
<td>3.5</td>
<td>3.5</td>
<td>3.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>11.0</td>
<td>11.0</td>
<td>11.0</td>
<td>V</td>
</tr>
<tr>
<td>V\text{IL}</td>
<td>LOW-level input voltage</td>
<td></td>
<td>5 V</td>
<td>-</td>
<td>1.5</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>-</td>
<td>3.0</td>
<td>3.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>-</td>
<td>4.0</td>
<td>4.0</td>
<td>V</td>
</tr>
<tr>
<td>V\text{OH}</td>
<td>HIGH-level output voltage</td>
<td></td>
<td>5 V</td>
<td>4.95</td>
<td>4.95</td>
<td>4.95</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>9.95</td>
<td>9.95</td>
<td>9.95</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>14.95</td>
<td>14.95</td>
<td>14.95</td>
<td>V</td>
</tr>
<tr>
<td>V\text{OL}</td>
<td>LOW-level output voltage</td>
<td></td>
<td>5 V</td>
<td>-</td>
<td>0.05</td>
<td>0.05</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>-</td>
<td>0.05</td>
<td>0.05</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>-</td>
<td>0.05</td>
<td>0.05</td>
<td>V</td>
</tr>
<tr>
<td>I\text{OH}</td>
<td>HIGH-level output current</td>
<td></td>
<td>V\text{O} = 2.5 V</td>
<td>5 V</td>
<td>-</td>
<td>-1.7</td>
<td>-1.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V\text{O} = 4.6 V</td>
<td>5 V</td>
<td>-</td>
<td>-0.52</td>
<td>-0.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V\text{O} = 9.5 V</td>
<td>10 V</td>
<td>-</td>
<td>-1.3</td>
<td>-1.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V\text{O} = 13.5 V</td>
<td>15 V</td>
<td>-</td>
<td>-3.6</td>
<td>-3.0</td>
</tr>
<tr>
<td>I\text{OL}</td>
<td>LOW-level output current</td>
<td></td>
<td>V\text{O} = 0.4 V</td>
<td>5 V</td>
<td>0.52</td>
<td>0.44</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V\text{O} = 0.5 V</td>
<td>10 V</td>
<td>1.3</td>
<td>1.1</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V\text{O} = 1.5 V</td>
<td>15 V</td>
<td>3.6</td>
<td>3.0</td>
<td>mA</td>
</tr>
<tr>
<td>I\text{i}</td>
<td>input leakage current</td>
<td>15 V</td>
<td>-</td>
<td>±0.3</td>
<td>±0.3</td>
<td>±1.0</td>
<td>mA</td>
</tr>
<tr>
<td>I\text{DD}</td>
<td>supply current</td>
<td></td>
<td>V\text{O} = 0 A</td>
<td>5 V</td>
<td>20</td>
<td>20</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>40</td>
<td>40</td>
<td>300</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>80</td>
<td>80</td>
<td>600</td>
<td>µA</td>
</tr>
<tr>
<td>C\text{i}</td>
<td>input capacitance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7.5</td>
<td>-</td>
<td>pF</td>
</tr>
</tbody>
</table>

10. Dynamic characteristics

Table 7. Dynamic characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>VDD</th>
<th>Extrapolation formula</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>t\text{PHL}</td>
<td>HIGH to LOW propagation delay</td>
<td>An to Yn; see Figure 4</td>
<td>5 V</td>
<td>73 ns + (0.55 ns/pF)C\text{L}</td>
<td>-</td>
<td>100</td>
<td>200</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>29 ns + (0.23 ns/pF)C\text{L}</td>
<td>-</td>
<td>40</td>
<td>80</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>22 ns + (0.16 ns/pF)C\text{L}</td>
<td>-</td>
<td>30</td>
<td>60</td>
<td>ns</td>
</tr>
<tr>
<td>t\text{PLH}</td>
<td>LOW to HIGH propagation delay</td>
<td>An to Yn; see Figure 4</td>
<td>5 V</td>
<td>63 ns + (0.55 ns/pF)C\text{L}</td>
<td>-</td>
<td>90</td>
<td>180</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>29 ns + (0.23 ns/pF)C\text{L}</td>
<td>-</td>
<td>40</td>
<td>80</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>22 ns + (0.16 ns/pF)C\text{L}</td>
<td>-</td>
<td>30</td>
<td>60</td>
<td>ns</td>
</tr>
</tbody>
</table>
Table 7. Dynamic characteristics ...continued

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>$V_{DD}$</th>
<th>Extrapolation formula</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_i$</td>
<td>transition time</td>
<td>see Figure</td>
<td>5 V</td>
<td>10 ns + (1.00 ns/pF)$C_L$</td>
<td>-</td>
<td>60</td>
<td>120</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 V</td>
<td>9 ns + (0.42 ns/pF)$C_L$</td>
<td>-</td>
<td>30</td>
<td>60</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15 V</td>
<td>6 ns + (0.28 ns/pF)$C_L$</td>
<td>-</td>
<td>20</td>
<td>40</td>
<td>ns</td>
</tr>
</tbody>
</table>

[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown ($C_L$ in pF).

Table 8. Dynamic power dissipation $P_D$

$P_D$ can be calculated from the formulas shown. $V_{SS} = 0$ V; $t_r = t_f \leq 20$ ns; $T_{amb} = 25$ ºC.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>$V_{DD}$</th>
<th>Typical formula for $P_D$ (µW) where:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_D$</td>
<td>dynamic power</td>
<td>5 V</td>
<td>$P_D = 350 \times f_i + \sum (f_o \times C_L) \times V_{DD}^2$</td>
<td>$f_i =$ input frequency in MHz; $f_o =$ output frequency in MHz; $C_L =$ output load capacitance in pF; $V_{DD} =$ supply voltage in V; $\sum (f_o \times C_L) =$ sum of the outputs.</td>
</tr>
<tr>
<td></td>
<td>dissipation</td>
<td>10 V</td>
<td>$P_D = 2200 \times f_i + \sum (f_o \times C_L) \times V_{DD}^2$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15 V</td>
<td>$P_D = 7350 \times f_i + \sum (f_o \times C_L) \times V_{DD}^2$</td>
<td></td>
</tr>
</tbody>
</table>

11. Waveforms

Output shown going high when address input goes low, see Table 3.

Measurement points are given in Table 9.

Logic levels: $V_{OL}$ and $V_{OH}$ are typical output voltage levels that occur with the output load.

Fig 4. Input rise and fall times, propagation delays and output transition times

Table 9. Measurement points

<table>
<thead>
<tr>
<th>Supply voltage</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DD}$</td>
<td>$V_M$</td>
<td>$V_M$</td>
</tr>
<tr>
<td>5 V to 15 V</td>
<td>0.5$V_{DD}$</td>
<td>0.5$V_{DD}$</td>
</tr>
</tbody>
</table>
a. Input waveforms

b. Test circuit

Test data is given in Table 10.
Definitions for test circuit:
DUT = Device Under Test;
CL = load capacitance including jig and probe capacitance;
RT = termination resistance should be equal to the output impedance Zo of the pulse generator.

**Fig 5. Test circuit for measuring switching times**

<table>
<thead>
<tr>
<th>Table 10. Test data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply voltage</strong></td>
</tr>
<tr>
<td>VDD</td>
</tr>
<tr>
<td>5 V to 15 V</td>
</tr>
</tbody>
</table>
12. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

---

Fig 6. Package outline SOT109-1 (SO16)
13. Abbreviations

Table 11. Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCD</td>
<td>Binary Coded Decimal</td>
</tr>
<tr>
<td>BCO</td>
<td>Binary Coded Octal</td>
</tr>
</tbody>
</table>

14. Revision history

Table 12. Revision history

<table>
<thead>
<tr>
<th>Document ID</th>
<th>Release date</th>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEF4028B v.9</td>
<td>20160323</td>
<td>Product data sheet</td>
<td>-</td>
<td>HEF4028B v.8</td>
</tr>
<tr>
<td>Modifications:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type number HEF4028BP (SOT38-4) removed.</td>
<td></td>
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<td></td>
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<tr>
<td>HEF4028B v.8</td>
<td>20111117</td>
<td>Product data sheet</td>
<td>-</td>
<td>HEF4028B v.7</td>
</tr>
<tr>
<td>Modifications:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legal pages updated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in “General description” and “Features and benefits”.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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15.1 Data sheet status

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<td>Production</td>
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[1] Please consult the most recently issued document before initiating or completing a design.  
[2] The term ‘short data sheet’ is explained in section “Definitions”.  
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nexperia.com.

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For more information, please visit: http://www.nexperia.com

For sales office addresses, please send an email to: salesaddresses@nexperia.com
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