1 Features

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results:
  - Device Temperature Grade 3: -40°C to 85°C Ambient Operating Temperature Range
  - Device HBM ESD Classification Level 2
  - Device CDM ESD Classification Level C6
- $(V_S = 1.8 \text{ V}, \ T_A = 25^\circ \text{C}, \text{ Typical Values Unless Specified})$.
- Single or Dual Supplies
- Open Drain Output
- Ultra Low Supply Current 9 µA Per Channel
- Low Input Bias Current 10 nA
- Low Input Offset Current 200 pA
- Low Ensured $V_{OS}$ 4 mV
- Propagation Delay 880 ns (20-mV Overdrive)
- Input Common Mode Voltage Range 0.1 V Beyond Rails

2 Applications

- Wearable Devices
- Mobile Phones and Tablets
- Battery-Powered Electronics
- General Purpose Low Voltage Applications

3 Description

The LMV7275-Q1 is a single rail-to-rail input low power comparator, characterized at supply voltages of 1.8 V, 2.7 V, and 5 V. It consumes as little as 9-µA supply current per channel while achieving a 800-ns propagation delay.

The LMV7275-Q1 is available in a SC-70 package. With these tiny packages, the PCB area can be significantly reduced. They are ideal for low voltage, low power, and space-critical designs.

The LMV7275-Q1 features an open-drain output stage that allows for wired-OR configurations. The open-drain output also offers the advantage of allowing the output to be pulled to any voltage up to 5.5 V, regardless of the supply voltage of the LMV7275-Q1, which is useful for level-shifting applications.

The LMV7275-Q1 is built with Texas Instruments' advance submicron silicon-gate BiCMOS process. It has bipolar inputs for improved noise performance, and CMOS outputs for lowest negative output swing.

### Device Information(1)

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>PACKAGE</th>
<th>BODY SIZE (NOM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMV7275-Q1</td>
<td>SC70 (5)</td>
<td>1.25 mm × 2.00 mm</td>
</tr>
</tbody>
</table>

(1) For all available packages, see the orderable addendum at the end of the data sheet.
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4 Revision History

<table>
<thead>
<tr>
<th>DATE</th>
<th>REVISION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 2015</td>
<td>*</td>
<td>Initial release.</td>
</tr>
</tbody>
</table>
5 Pin Configuration and Functions

![DGK Package 5-Pin SC70 Top View](image)

**Pin Functions**

<table>
<thead>
<tr>
<th>PIN</th>
<th>I/O</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN+</td>
<td>1</td>
<td>Non-Inverting Input</td>
</tr>
<tr>
<td>V-</td>
<td>2</td>
<td>Negative Supply Voltage</td>
</tr>
<tr>
<td>IN-</td>
<td>3</td>
<td>Inverting Input</td>
</tr>
<tr>
<td>OUT</td>
<td>4</td>
<td>Output</td>
</tr>
<tr>
<td>V+</td>
<td>5</td>
<td>Positive Supply Voltage</td>
</tr>
</tbody>
</table>

6 Specifications

6.1 Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>NAME</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V\text{IN} Differential</td>
<td>±Supply Voltage</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Supply Voltage (V\text{+} - V\text{-})</td>
<td>6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Voltage at Input/Output pins</td>
<td>(V\text{-}) - 0.1 (V\text{+}) + 0.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Junction Temperature(2)</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature, T\text{stg}</td>
<td>−65, 150</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) The maximum power dissipation is a function of T\text{J(MAX)}, R\text{θJA}, and T\text{A}. The maximum allowable power dissipation at any ambient temperature is P\text{D} = (T\text{J(MAX)} - T\text{A})/R\text{θJA}. All numbers apply for packages soldered directly into a PCB.

6.2 ESD Ratings LMV7275-Q1

<table>
<thead>
<tr>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>V\text{ESD} Electrostatic discharge</td>
<td>±2000 V</td>
</tr>
<tr>
<td>Human-body model (HBM), per AEC Q100-002(1)</td>
<td>±2000 V</td>
</tr>
<tr>
<td>Charged-device model (CDM), per AEC Q100-011</td>
<td>±1000 V</td>
</tr>
</tbody>
</table>

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions

<table>
<thead>
<tr>
<th>NAME</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>1.8</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Temperature(1)</td>
<td>−40</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>

(1) The maximum power dissipation is a function of T\text{J(MAX)}, R\text{θJA}, and T\text{A}. The maximum allowable power dissipation at any ambient temperature is P\text{D} = (T\text{J(MAX)} - T\text{A})/R\text{θJA}. All numbers apply for packages soldered directly into a PCB.
### 6.4 Thermal Information

<table>
<thead>
<tr>
<th>THERMAL METRIC(1)</th>
<th>LMV7275-Q1</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{JA}}$</td>
<td>DGK (SC70)</td>
<td>273.8°C/W</td>
</tr>
<tr>
<td>$R_{\text{JC(top)}}$</td>
<td>106.1°C/W</td>
<td></td>
</tr>
<tr>
<td>$R_{\text{JB}}$</td>
<td>54.9°C/W</td>
<td></td>
</tr>
<tr>
<td>$\psi_{\text{JT}}$</td>
<td>3.6°C/W</td>
<td></td>
</tr>
<tr>
<td>$\psi_{\text{JB}}$</td>
<td>54.1°C/W</td>
<td></td>
</tr>
</tbody>
</table>

(1) For more information about traditional and new thermal metrics, see the Semiconductor and IC Package Thermal Metrics application report, SPRA953.

(2) The maximum power dissipation is a function of $T_{\text{J(MAX)}}$, $R_{\text{JA}}$, and $T_{\text{A}}$. The maximum allowable power dissipation at any ambient temperature is $P_{\text{D}} = (T_{\text{J(MAX)}} - T_{\text{A}})/R_{\text{JA}}$. All numbers apply for packages soldered directly into a PCB.

### 6.5 1.8-V Electrical Characteristics

Unless otherwise specified, all limits ensured for $T_{\text{J}} = 25°C$, $V^+ = 1.8$ V, $V^- = 0$ V.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITION</th>
<th>MIN(1)</th>
<th>TYP(2)</th>
<th>MAX(1)</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{OS}}$</td>
<td>Input Offset Voltage</td>
<td>0.3</td>
<td>4</td>
<td>6</td>
<td>mV</td>
</tr>
<tr>
<td>$V_{\text{CM}}$</td>
<td>Input Offset Temperature Drift</td>
<td>0.9</td>
<td>20</td>
<td></td>
<td>μV/°C</td>
</tr>
<tr>
<td>$I_{\text{B}}$</td>
<td>Input Bias Current</td>
<td>10</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{\text{OS}}$</td>
<td>Input Offset Current</td>
<td>200</td>
<td></td>
<td></td>
<td>pA</td>
</tr>
<tr>
<td>$I_{\text{S}}$</td>
<td>Supply Current</td>
<td>9</td>
<td>12</td>
<td>14</td>
<td>μA</td>
</tr>
<tr>
<td>$I_{\text{SC}}$</td>
<td>Output Short Circuit Current</td>
<td>4</td>
<td>6</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$V_{\text{OL}}$</td>
<td>Output Voltage Low</td>
<td>-0.5</td>
<td>52</td>
<td>100</td>
<td>mV</td>
</tr>
<tr>
<td>$V_{\text{CM}}$</td>
<td>Input Common-Mode Voltage Range</td>
<td>-0.1</td>
<td>1.9</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>CMRR</td>
<td>Common-Mode Rejection Ratio</td>
<td>0 &lt; $V_{\text{CM}}$ &lt; 1.8 V</td>
<td>46</td>
<td>78</td>
<td>dB</td>
</tr>
<tr>
<td>PSRR</td>
<td>Power Supply Rejection Ratio</td>
<td>$V^+ = 1.8$ V to $5$ V</td>
<td>55</td>
<td>80</td>
<td>dB</td>
</tr>
<tr>
<td>$I_{\text{LEAKAGE}}$</td>
<td>Output Leakage Current</td>
<td>2</td>
<td></td>
<td></td>
<td>pA</td>
</tr>
</tbody>
</table>

(1) All limits are ensured by testing or statistical analysis.

(2) Typical values represent the most likely parametric norm.

(3) Offset Voltage average drift determined by dividing the change in $V_{\text{OS}}$ at temperature extremes into the total temperature change.

### 6.6 1.8-V AC Electrical Characteristics

Unless otherwise specified, all limits ensured for $T_{\text{J}} = 25°C$, $V^+ = 1.8$ V, $V^- = 0$ V, $V_{\text{CM}} = 0.5$ V, $V_{\text{O}} = V^+/2$ and $R_{\text{L}} > 1$ MΩ to $V^-$.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITION</th>
<th>MIN(1)</th>
<th>TYP(2)</th>
<th>MAX(1)</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{\text{PHL}}$</td>
<td>Propagation Delay (High to Low)</td>
<td>Input Overdrive = 20 mV Load = 50 pF/5 kΩ</td>
<td>880</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input Overdrive = 50 mV Load = 50 pF/5 kΩ</td>
<td>570</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{\text{PLH}}$</td>
<td>Propagation Delay (Low to High)</td>
<td>Input Overdrive = 20 mV Load = 50 pF/5 kΩ</td>
<td>1100</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input Overdrive = 50 mV Load = 50 pF/5 kΩ</td>
<td>800</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) All limits are ensured by testing or statistical analysis.

(2) Typical values represent the most likely parametric norm.
6.7 2.7-V Electrical Characteristics

Unless otherwise specified, all limits ensured for $T_J = 25°C$, $V^+ = 2.7\, V$, $V^- = 0\, V$.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN$^{(1)}$</th>
<th>TYP$^{(2)}$</th>
<th>MAX$^{(1)}$</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OS}$</td>
<td>Input Offset Voltage</td>
<td>0.3</td>
<td>4</td>
<td>6</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td>At the temperature extremes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$TC, V_{OS}$</td>
<td>Input Offset Temperature Drift</td>
<td>20</td>
<td></td>
<td></td>
<td>$\mu V/°C$</td>
</tr>
<tr>
<td></td>
<td>$V_{CM} = 1.35, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_B$</td>
<td>Input Bias Current</td>
<td>10</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{OS}$</td>
<td>Input Offset Current</td>
<td>200</td>
<td></td>
<td></td>
<td>pA</td>
</tr>
<tr>
<td>$I_S$</td>
<td>Supply Current</td>
<td>9</td>
<td>13</td>
<td></td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td>At the temperature extremes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SC}$</td>
<td>Output Short Circuit Current</td>
<td>10</td>
<td>15</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>Sinking, $V_O = 1.35, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Output Voltage Low</td>
<td>$I_O = -0.5, mA$</td>
<td>50</td>
<td>70</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td>$I_O = -2, mA$</td>
<td>155</td>
<td>220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{CM}$</td>
<td>Input Common Voltage Range</td>
<td>-0.1</td>
<td>2.8</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>CMRR</td>
<td>Common-Mode Rejection Ratio</td>
<td>46</td>
<td>78</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>PSRR</td>
<td>Power Supply Rejection Ratio</td>
<td>55</td>
<td>80</td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$I_{LEAKAGE}$</td>
<td>Output Leakage Current</td>
<td>2</td>
<td></td>
<td></td>
<td>pA</td>
</tr>
<tr>
<td></td>
<td>$V_O = 2.7, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) All limits are ensured by testing or statistical analysis.
(2) Typical values represent the most likely parametric norm.
(3) Offset Voltage average drift determined by dividing the change in $V_{OS}$ at temperature extremes into the total temperature change.

6.8 2.7-V AC Electrical Characteristics

Unless otherwise specified, all limits ensured for $T_J = 25°C$, $V^+ = 2.7\, V$, $V^- = 0\, V$, $V_{CM} = 0.5\, V$, $V_O = V^+/2$ and $R_L > 1\, M\Omega$ to $V^-$. 

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITION</th>
<th>MIN$^{(1)}$</th>
<th>TYP$^{(2)}$</th>
<th>MAX$^{(1)}$</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{PHL}$</td>
<td>Propagation Delay (High to Low)</td>
<td>1200</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Input Overdrive = 20 mV Load = 50 pF//5 kΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{PLH}$</td>
<td>Propagation Delay (Low to High)</td>
<td>810</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Input Overdrive = 50 mV Load = 50 pF//5 kΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input Overdrive = 20 mV Load = 50 pF//5 kΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input Overdrive = 50 mV Load = 50 pF//5 kΩ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) All limits are ensured by testing or statistical analysis.
(2) Typical values represent the most likely parametric norm.

6.9 5-V Electrical Characteristics

Unless otherwise specified, all limits ensured for $T_J = 25°C$, $V^+ = 5\, V$, $V^- = 0\, V$.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN$^{(1)}$</th>
<th>TYP$^{(2)}$</th>
<th>MAX$^{(1)}$</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OS}$</td>
<td>Input Offset Voltage</td>
<td>0.3</td>
<td>4</td>
<td>6</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td>At the temperature extremes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$TC, V_{OS}$</td>
<td>Input Offset Temperature Drift</td>
<td>20</td>
<td></td>
<td></td>
<td>$\mu V/°C$</td>
</tr>
<tr>
<td></td>
<td>$V_{CM} = 2.5, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_B$</td>
<td>Input Bias Current</td>
<td>10</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td>$I_{OS}$</td>
<td>Input Offset Current</td>
<td>200</td>
<td></td>
<td></td>
<td>pA</td>
</tr>
<tr>
<td>$I_S$</td>
<td>Supply Current</td>
<td>10</td>
<td>14</td>
<td></td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td>At the temperature extremes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SC}$</td>
<td>Output Short Circuit Current</td>
<td>18</td>
<td>34</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>Sinking, $V_O = 2.5, V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Output Voltage Low</td>
<td>$I_O = -0.5, mA$</td>
<td>27</td>
<td>70</td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td>$I_O = -4.0, mA$</td>
<td>225</td>
<td>315</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) All limits are ensured by testing or statistical analysis.
(2) Typical values represent the most likely parametric norm.
(3) Offset Voltage average drift determined by dividing the change in $V_{OS}$ at temperature extremes into the total temperature change.
5-V Electrical Characteristics (continued)

Unless otherwise specified, all limits ensured for $T_J = 25^\circ C$, $V^+ = 5 \, V$, $V^- = 0 \, V$.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>MIN$^{(1)}$</th>
<th>TYP$^{(2)}$</th>
<th>MAX$^{(1)}$</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{CM}$</td>
<td>Input Common Voltage Range</td>
<td>$-0.1$</td>
<td>$5.1$</td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td>CMRR</td>
<td>Common-Mode Rejection Ratio</td>
<td>$46$</td>
<td>$78$</td>
<td>$dB$</td>
<td></td>
</tr>
<tr>
<td>PSRR</td>
<td>Power Supply Rejection Ratio</td>
<td>$55$</td>
<td>$80$</td>
<td>$dB$</td>
<td></td>
</tr>
<tr>
<td>$I_{LEAKAGE}$</td>
<td>Output Leakage Current</td>
<td>$2$</td>
<td>$pA$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.10 5-V AC Electrical Characteristics

Unless otherwise specified, all limits ensured for $T_J = 25^\circ C$, $V^+ = 5.0 \, V$, $V^- = 0 \, V$, $V_{CM} = 0.5 \, V$, $V_O = V^+/2$ and $R_L > 1 \, M\Omega$ to $V^-$.  

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITION</th>
<th>MIN$^{(1)}$</th>
<th>TYP$^{(2)}$</th>
<th>MAX$^{(1)}$</th>
<th>UNIT</th>
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<tbody>
<tr>
<td>$t_{PHL}$</td>
<td>Propagation Delay (High to Low)</td>
<td>Input Overdrive = 20 mV Load = 50 pF//5 kΩ</td>
<td>$2100$</td>
<td>ns</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Input Overdrive = 50 mV Load = 50 pF//5 kΩ</td>
<td>$1380$</td>
<td>ns</td>
<td></td>
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<tr>
<td>$t_{PLH}$</td>
<td>Propagation Delay (Low to High)</td>
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<td>$1800$</td>
<td>ns</td>
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<td></td>
<td></td>
<td>Input Overdrive = 50 mV Load = 50 pF//5 kΩ</td>
<td>$1100$</td>
<td>ns</td>
<td></td>
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</table>

$^{(1)}$ All limits are ensured by testing or statistical analysis.
$^{(2)}$ Typical values represent the most likely parametric norm.
6.11 Typical Characteristics

\( T_A = 25^\circ C \), Unless otherwise specified.

**Figure 1.** \( V_{OS} \) vs. \( V_{CM} \)

**Figure 2.** \( V_{OS} \) vs. \( V_{CM} \)

**Figure 3.** \( V_{OS} \) vs. \( V_{CM} \)

**Figure 4.** Short Circuit vs. Supply Voltage

**Figure 5.** Supply Current vs. Supply Voltage

**Figure 6.** Output Negative Swing vs. \( V_{SUPPLY} \)
Typical Characteristics (continued)

\( T_A = 25^\circ C, \text{ Unless otherwise specified.} \)

![Figure 7. Output Negative Swing vs. \( I_{\text{SINK}} \)](image)

![Figure 8. Output Negative Swing vs. \( I_{\text{SINK}} \)](image)

![Figure 9. Output Negative Swing vs. \( I_{\text{SINK}} \)](image)

![Figure 10. Propagation Delay (\( t_{\text{PLH}} \))](image)

![Figure 11. Propagation Delay (\( t_{\text{PHL}} \))](image)

![Figure 12. Propagation Delay (\( t_{\text{PHL}} \))](image)
Typical Characteristics (continued)

\( T_A = 25^\circ C, \) Unless otherwise specified.

**Figure 13. Propagation Delay \( (t_{PHL}) \)**

**Figure 14. Propagation Delay \( (t_{PLH}) \)**

**Figure 15. Propagation Delay \( (t_{PHL}) \)**

**Figure 16. \( t_{PHL} \) vs. Overdrive**

**Figure 17. \( t_{PLH} \) vs. Overdrive**
7 Detailed Description

7.1 Overview

A comparator is often used to convert an analog signal to a digital signal. As shown in Figure 18, the comparator compares an input voltage (V\textsubscript{IN}) to a reference voltage (V\textsubscript{REF}). If V\textsubscript{IN} is less than V\textsubscript{REF}, the output transistor turns on and pulls the output to V-, and thus the output (V\textsubscript{O}) goes low.

However, if V\textsubscript{IN} is greater than V\textsubscript{REF}, the output transistor turns off and the voltage (V\textsubscript{O}) is pulled high by the external pull-up resistor.

![Figure 18. Basic Comparator](image)

7.2 Functional Block Diagram

7.3 Feature Description

7.3.1 Rail-to-Rail Input Stage

The LMV7275-Q1 has an input common mode voltage range (V\textsubscript{CM}) of -0.1V below the V\textsuperscript{-} to 0.1 V above V\textsuperscript{+}. This is achieved by using paralleled PNP and NPN differential input pairs. When the V\textsubscript{CM} is near V\textsuperscript{+}, the NPN pair is on and the PNP pair is off. When the V\textsubscript{CM} is near V\textsuperscript{-}, the NPN pair is off and the PNP pair is on. The crossover point between the NPN and PNP input stages is around 950mV from V\textsuperscript{*}. Because each input stage has its own offset voltage (V\textsubscript{OS}), the V\textsubscript{OS} of the comparator becomes a function of the V\textsubscript{CM}. See curves for V\textsubscript{OS} vs. V\textsubscript{CM} in the Typical Characteristics section. In application design, it is recommended to keep the V\textsubscript{CM} away from the crossover point to avoid problems. The wide input voltage range makes LMV7275-Q1 ideal in power supply monitoring circuits, where the comparators are used to sense signals close to ground and power supplies.
Feature Description (continued)

7.3.2 Output Stage

The LMV7275-Q1 has an open-drain output that requires a pull-up resistor to a positive supply voltage for the output to operate properly. When the internal output transistor is off, the output voltage will be pulled up to the external positive voltage \( V_{2+} \) by the external pull-up resistor. This allows the output to be OR'ed with other open-drain outputs on the same bus.

The output pull-up resistor may be connected to any voltage level between \( V_- \) and \( V_+ \) for level shifting applications.

7.4 Device Functional Modes

7.4.1 Capacitive and Resistive Loads

The propagation delay on the rising edge of the LMV7275-Q1 depends on the load resistance and capacitance values.

7.4.2 Noise

Most comparators have rather low gain. This allows the output to alternate between high and low when the input signal changes slowly. The result is the output may oscillate between high and low when the differential input is near zero and triggers on noise. The high gain of this comparator eliminates this problem. Less than 1 \( \mu \)V of change on the input will drive the output from one rail to the other rail. If the input signal is noisy, the output cannot ignore the noise unless some hysteresis is provided by positive feedback. (See Hysteresis.)

7.4.3 Hysteresis

It is a standard procedure to use hysteresis (positive feedback) around a comparator to prevent oscillation due to the comparator triggering its own noise on slowly ramping signals. The following sections will describe various ways to apply hysteresis.

7.4.3.1 Non-inverting Comparator With Hysteresis

Non-inverting comparator with hysteresis requires a two resistor network, and a voltage reference \( (V_{\text{ref}}) \) at the inverting input. When \( V_{\text{in}} \) is low, the output is also low. For the output to switch from low to high, \( V_{\text{in}} \) must rise up to \( V_{\text{in1}} \) where \( V_{\text{in1}} \) is calculated by:

\[
V_{\text{in1}} = \frac{V_{\text{ref}}(R_1 + R_2)}{R_2} \tag{1}
\]

When \( V_{\text{in}} \) is high, the output is also high. To make the comparator switch back to its low state, \( V_{\text{in}} \) must equal \( V_{\text{ref}} \) before \( V_A \) will again equal \( V_{\text{ref}} \). \( V_{\text{in}} \) can be calculated by:

\[
V_{\text{in2}} = \frac{V_{\text{ref}}(R_1 + R_2) - V_{\text{cc}}R_1}{R_2} \tag{2}
\]

The hysteresis of this circuit is the difference between \( V_{\text{in1}} \) and \( V_{\text{in2}} \).
Device Functional Modes (continued)

\[ \Delta V_{in} = V_{CC} R_1 / R_2 \]

\[ V_{CC} = +5V \]

\[ V_{REF} = +2.5V \]

\[ V_{IN} \]

\[ R_1 \text{ 330 k}\Omega \]

\[ V_A \text{ 1 M}\Omega \]

\[ R_{LOAD} \text{ 100 K}\Omega \]

\[ R_{PULL-UP} \text{ 3 K}\Omega \]

\[ V_{IN} \]

\[ V_{IN2} \]

\[ V_{IN1} \]

\[ 1.675 \]

\[ 3.325 \]

\[ 0V \]

\[ 5V \]

\[ V_O \]

\[ V_{O HIGH} \]

\[ V_{O LOW} \]

\[ V_{CC} \]

\[ V_{IN} \]

\[ V_{IN2} \]

\[ V_A = V_{REF} \]

\[ R_1 \]

\[ R_2 \]

\[ V_A = V_{REF} \]

\[ R_1 \]

\[ R_2 \]

Figure 20. Non-Inverting Comparator With Hysteresis

7.4.3.2 Inverting Comparator With Hysteresis

The inverting comparator with hysteresis requires a three resistor network that are referenced to the supply voltage \( V_{CC} \) of the comparator. When \( V_{in} \) at the inverting input is less than \( V_a \), the voltage at the non-inverting node of the comparator \( (V_{in} < V_a) \), the output voltage is high (for simplicity assume \( V_O \) switches as high as \( V_{CC} \)). The three network resistors can be represented as \( R_1//R_3 \) in series with \( R_2 \). The lower input trip voltage \( V_{a1} \) is defined as:

\[ V_{a1} = \frac{V_{CC} R_2}{(R_1//R_3) + R_2} \]

When \( V_{in} \) is greater than \( V_a \) \( (V_{in} > V_a) \), the output voltage is low very close to ground. In this case the three network resistors can be presented as \( R_2//R_3 \) in series with \( R_1 \). The upper trip voltage \( V_{a2} \) is defined as:
Device Functional Modes (continued)

\[ V_{a2} = \frac{V_{CC}(R_2 \parallel R_3)}{R_1 + (R_2 \parallel R_3)} \]  

The total hysteresis provided by the network is defined as:

\[ \Delta V_a = V_{a1} - V_{a2} \]  

(5)

To assure that the comparator will always switch fully to \( V_{CC} \) and not be pulled down by the load the resistors values should be chosen as follow:

\[ R_{\text{PULL-UP}} \ll R_{\text{LOAD}} \]  

and \( R_1 > R_{\text{PULL-UP}} \).

\[ \Delta V_a = V_{a1} - V_{a2} \]  

(6)

\[ R_{\text{PULL-UP}} \ll R_{\text{LOAD}} \]  

and \( R_1 > R_{\text{PULL-UP}} \).

(7)

(8)

Figure 21. Inverting Comparator With Hysteresis
Device Functional Modes (continued)

7.4.4 Zero Crossing Detector

In a zero crossing detector circuit, the inverting input is connected to ground and the Non-Inverting input is connected to a 100 mV<sub>PP</sub> AC signal. As the signal at the Non-Inverting input crosses 0 V, the output of the comparator changes state.

R<sub>PROT</sub> is an optional input protection resistor to limit the current should the input voltage exceed the supply rails. R<sub>PROT</sub> should be a minimum of 1 kΩ per volt of expected over-voltage and limit the current to less than ±1mA under worst case fault conditions.

7.4.4.1 Zero Crossing Detector With Hysteresis

To improve switching times and centering the input threshold to ground a small amount of positive feedback is added to the circuit. Voltage divider R<sub>4</sub> and R<sub>5</sub> establishes a reference voltage, V<sub>1</sub>, at the positive input. By making the series resistance, R<sub>1</sub> plus R<sub>2</sub> equal to R<sub>5</sub>, the switching condition, V<sub>1</sub> = V<sub>2</sub>, will be satisfied when V<sub>IN</sub> = 0.
Device Functional Modes (continued)

The positive feedback resistor, \( R_6 \), is made very large (with respect to \( R_5 \parallel R_6 = 2000 \, R_5 \)). The resultant hysteresis established by this network is very small (\( \Delta V_1 < 10 \, \text{mV} \)) but it is sufficient to insure rapid output voltage transitions.

Diode \( D_1 \) is used to insure that the inverting input terminal of the comparator never goes below approximately \(-100 \, \text{mV}\). As the input terminal goes negative, \( D_1 \) will forward bias, clamping the node between \( R_1 \) and \( R_2 \) to approximately \(-300 \, \text{mV}\). This sets up a voltage divider with \( R_2 \) and \( R_3 \) preventing \( V_2 \) from going below ground. The maximum negative input overdrive is limited by the current handling ability of \( D_1 \).

### 7.4.5 Threshold Detector

![Threshold Detector Diagram](image)

Instead of tying the inverting input to 0 V, the inverting input can be tied to a reference voltage. As the input on the Non-Inverting input passes the \( V_{\text{REF}} \) threshold, the output of the comparator changes state. It is important to use a stable reference voltage to ensure a consistent switching point.

### 7.4.6 Universal Logic Level Shifter

![Logic Level Shifter Diagram](image)

The output of LMV7275-Q1 is an unconnected drain of an NMOS device, which can be pulled up, through a resistor, to any desired output level below the comparators power supply voltage (\( V_B \leq V_C \)). Hence, the following simple circuit works as a universal logic level shifter, pulling up the signal to the desired level.
Device Functional Modes (continued)

For example, $V_A$ could be the 5-V analog supply voltage, where $V_B$ could be the 3.3-V supply of the processor. The output will now be compatible with the 3.3-V logic.

7.4.7 OR'ING the Output

Open-drain outputs may be tied together, pulled up to $V_D$ by a common resistor to provide an output OR'ing function. If any of the comparator outputs goes low, the output $V_O$ goes low.
8 Application and Implementation

NOTE
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI’s customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information
The LMV7275-Q1 is a single-supply comparator with 880 ns of propagation delay and only 12 µA of supply current.

8.2 Typical Applications
8.2.1 Square Wave Oscillator

8.2.1.1 Design Requirements
A typical application for a comparator is as a square wave oscillator. Figure 27 generates a square wave whose period is set by the RC time constant of the capacitor C1 and resistor R4. The maximum frequency is limited by the large signal propagation delay of the comparator, and by the capacitive loading at the output, which limits the output slew rate.

8.2.1.2 Detailed Design Procedure
To analyze the circuit, consider it when the output is high. That implies that the inverted input (VC) is lower than the Non-Inverting input (VA).

Figure 27. Square Wave Oscillator Application

Figure 28. Squarewave Oscillator Timing Thresholds
Typical Applications (continued)

This causes the \( C_1 \) to get charged through \( R_4 \) and the voltage \( V_C \) increases till it is equal to the Non-Inverting input. The value of \( V_A \) at this point is

\[
V_{A1} = \frac{V_{CC} \cdot R_2}{R_2 + R_1 || R_3}
\]

(9)

If \( R_1 = R_2 = R_3 \), then \( V_{A1} = 2V_{CC}/3 \)

At this point the comparator switches pulling down the output to the negative rail. The value of \( V_A \) at this point is

\[
V_{A2} = \frac{V_{CC} (R_2 || R_3)}{R_1 + (R_2 || R_3)}
\]

(10)

If \( R_1 = R_2 = R_3 \), then \( V_{A2} = V_{CC}/3 \)

The capacitor \( C_1 \) now discharges through \( R_4 \), and the voltage \( V_C \) decreases till it is equal to \( V_{A2} \), at which point the comparator switches again, bringing it back to the initial stage. The time period is equal to twice the time it takes to discharge \( C_1 \) from \( 2V_{CC}/3 \) to \( V_{CC}/3 \), which is given by \( R_4 \cdot C_1 \cdot \ln 2 \). Hence the formula for the frequency is:

\[
F = \frac{1}{2 \cdot R_4 \cdot C_1 \cdot \ln 2}
\]

8.2.1.3 Application Curve

Figure 29 shows the simulated results of an oscillator using the following values:

1. \( R_1 = R_2 = R_3 = R_4 = 100 \, k\Omega \)
2. \( C_1 = 750 \, pF \), \( C_L = 20 \, pF \)
3. \( V_+ = 5 \, V \), \( V_- = GND \)
4. \( C_{STRAY} \) (not shown) from \( Va \) to \( GND = 10 \, pF \)

Figure 29. Square Wave Oscillator Output Waveforms
Typical Applications (continued)

8.2.2 Positive Peak Detector

The positive peak detector is basically the comparator operated as a unity gain follower with a large holding capacitor from the output to ground. A transistor is added to the output to provide a low impedance current source. The upper output swing is limited by the emitter-base forward voltage. This allows capture of the most positive input signal between 0 V and (V+) - 0.7V.

When the output of the comparator goes high, current is passed through the transistor to charge up the capacitor. The only discharge path will be the 1-MΩ resistor shunting C1 and any load that is connected to the output. The decay time can be altered simply by changing the 1-MΩ resistor.

8.2.3 Negative Peak Detector

The Negative Peak Detector circuit will store the peak negative voltage below ground (0 V to V-). For the negative detector, the output transistor acts as a low-impedance current sink.

When \( V_{IN} \) is more negative than \( V_{OUT} \), the output transistor will conduct and pull the output to \(-V_{CC}\) charging C1. Charging stops when C1 reaches the same level as \( V_{IN} \). Because there is no pull-up resistor, the only discharge path will be the 1-MΩ resistor and any load impedance applied. Therefore, the decay time is set by varying the 1-MΩ resistor. Be sure to observe the polarity of C1!
Typical Applications (continued)

Figure 32. Negative Peak Detector for Positive Supply

An alternate positive supply version is shown in Figure 32 that will capture the lowest applied $V_{IN}$ value between $V+$ and ground ($V+$ to 0V).

The output of either version should be buffered by a high-impedance follower stage to prevent loading of the RC circuit.

8.2.4 Window Detector

Figure 33. Window Detector

A window detector monitors the input signal to determine if it falls between two voltage levels. Both outputs are true (high) when $V_{REF1} < V_{IN} < V_{REF2}$.
Typical Applications (continued)

![Figure 34. Window Detector Output Signal](image)

The comparator outputs A and B are high only when $V_{\text{REF1}} < V_{\text{IN}} < V_{\text{REF2}}$, or *within the window*, where these are defined as:

\[
V_{\text{REF1}} = \frac{R_3}{R_1 + R_2 + R_3} \times V^+ \tag{11}
\]

\[
V_{\text{REF2}} = \left(\frac{R_2 + R_3}{R_1 + R_2 + R_3}\right) \times V^+ \tag{12}
\]

To determine if the input signal falls outside of the two voltage levels, both inputs on each comparators can be reversed to invert the logic.

The outputs should be tied together and use a shared pull-up resistor for a common logic output. If individual limit outputs are needed, then each output will require it's own pull-up resistor.

Other names for window detectors are: threshold detector, level detector, and amplitude trigger or detector.
9 Power Supply Recommendations

To minimize supply noise, power supplies should be decoupled by a 0.01-μF ceramic capacitor in parallel with a 10-μF capacitor.

Due to the nanosecond edges on the output transition, peak supply currents will be drawn during the time the output is transitioning. Peak current depends on the capacitive loading on the output. The output transition can cause transients on poorly bypassed power supplies. These transients can cause a poorly bypassed power supply to ring due to trace inductance and low self-resonance frequency of high ESR bypass capacitors.

Treat the LMV7275-Q1 as a high-speed device. Keep the ground paths short and place small (low-ESR ceramic) bypass capacitors directly between the V+ and V– pins.

Output capacitive loading and output toggle rate will cause the average supply current to rise over the quiescent current.

10 Layout

10.1 Layout Guidelines

10.1.1 Circuit Techniques for Avoiding Oscillations in Comparator Applications

Feedback to almost any pin of a comparator can result in oscillation. In addition, when the input signal is a slow voltage ramp or sine wave, the comparator may also burst into oscillation near the crossing point. To avoid oscillation or instability, PCB layout should be engineered thoughtfully. Several precautions are recommended:

1. Power supply bypassing is critical, and will improve stability and response time. Resistance and inductance from power supply wires and board traces increase power supply line impedance. When supply current changes, the power supply line will move due to its impedance. Large enough supply line shift will cause the comparator to malfunction. To avoid problems, a small bypass capacitor, such as 0.1-μF ceramic, should be placed immediately adjacent to the supply pins. An additional 6.8 μF or greater tantalum capacitor should be placed at the point where the power supply for the comparator is introduced onto the board. These capacitors act as an energy reservoir and keep the supply impedance low. In a dual-supply application, a 0.1-μF capacitor is recommended to be placed across V+ and V– pins.

2. Keep all leads short to reduce stray capacitance and lead inductance. It will also minimize any unwanted coupling from any high-level signals (such as the output). The comparators can easily oscillate if the output lead is inadvertently allowed to capacitively couple to the inputs through stray capacitance. This shows up only during the output voltage transition intervals as the comparator changes states. Try to avoid a long loop which could act as an inductor (coil).

3. It is a good practice to use an unbroken ground plane on a printed-circuit-board to provide all components with a low inductive ground connection. Make sure ground paths are low-impedance where heavier currents are flowing to avoid ground level shift. Preferably there should be a ground plane under the component.

4. The output trace should be routed away from inputs. The ground plane should extend between the output and inputs to act as a guard. This can be achieved by running a topside ground plane between the output and inputs. A typical PCB layout is shown in Figure 35.

5. When the signal source is applied through a resistive network to one input of the comparator, it is usually advantageous to connect the other input with a resistor with the same value, for both DC and AC consideration. Input traces should be laid out symmetrically if possible.
10.2 Layout Example

Figure 35. Typical PCB Layout
11 Device and Documentation Support

11.1 Device Support

11.1.1 Development Support
For developmental support, see the following:
• LMV7275 PSPICE Model, SNOM555
• TINA-TI SPICE-Based Analog Simulation Program, http://www.ti.com/tool/tina-ti

11.2 Documentation Support

11.2.1 Related Documentation
For related documentation, see the following:
• AN-74 A Quad of Independently Functioning Comparators, SNOA654

11.3 Community Resources
The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community TI's Engineer-to-Engineer (E2E) Community. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support TI's Design Support Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.4 Trademarks
E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.5 Electrostatic Discharge Caution
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.6 Glossary
SLYZ022 — TI Glossary.
This glossary lists and explains terms, acronyms, and definitions.

12 Mechanical, Packaging, and Orderable Information
The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.
# Packaging Information

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<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>PIns</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/Ball Finish (6)</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
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<td>DCK</td>
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<td>-40 to 85</td>
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(1) The marketing status values are defined as follows:
- **ACTIVE**: Product device recommended for new designs.
- **LIFEBUY**: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
- **NRND**: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
- **PREVIEW**: Device has been announced but is not in production. Samples may or may not be available.
- ** OBSOLETE**: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check [http://www.ti.com/productcontent](http://www.ti.com/productcontent) for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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Addendum-Page 1
OTHER QUALIFIED VERSIONS OF LMV7275-Q1:

- Catalog: LMV7275

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
# TAPE AND REEL INFORMATION

## TAPE DIMENSIONS

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<th>Dimension designed to accommodate the component width</th>
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<td>B0</td>
<td>Dimension designed to accommodate the component length</td>
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<td>K0</td>
<td>Dimension designed to accommodate the component thickness</td>
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<td>W</td>
<td>Overall width of the carrier tape</td>
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<tr>
<td>P1</td>
<td>Pitch between successive cavity centers</td>
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## REEL DIMENSIONS

*All dimensions are nominal*

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<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Reel Diameter (mm)</th>
<th>Reel Width W1 (mm)</th>
<th>A0 (mm)</th>
<th>B0 (mm)</th>
<th>K0 (mm)</th>
<th>P1 (mm)</th>
<th>W (mm)</th>
<th>Pin 1 Quadrant</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMV7275IDCKRQ1</td>
<td>SC70</td>
<td>DCK</td>
<td>5</td>
<td>3000</td>
<td>178.0</td>
<td>8.4</td>
<td>2.25</td>
<td>2.45</td>
<td>1.2</td>
<td>4.0</td>
<td>8.0</td>
<td>Q3</td>
</tr>
</tbody>
</table>
**TAPE AND REEL BOX DIMENSIONS**

<table>
<thead>
<tr>
<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMV7275IDCKRQ1</td>
<td>SC70</td>
<td>DCK</td>
<td>5</td>
<td>3000</td>
<td>210.0</td>
<td>185.0</td>
<td>35.0</td>
</tr>
</tbody>
</table>

*All dimensions are nominal*
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO-203 variation AA.
NOTES:

A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC-7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.
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