Ultrahigh CMTI Isolated MOSFET Drivers

**Functional Diagrams**

- **IL610CMTI**
  - IN₁
  - OUT₁
  - $V_{cc}$

- **IL611CMTI**
  - IN₁
  - OUT₁
  - IN₂
  - OUT₂

**Features**

- 200 kV/µs guaranteed CMTI; 300 kV/µs with deglitch
- Extended 3 V to 6.6 V power supply range
- Switching frequencies up to 50 Mhz
- Flexible inputs with wide input voltage range
- Input current as low as 5 mA
- No input-side power supply needed
- No reverse input protection needed
- Failsafe output (high output for zero coil current)
- No carrier or clock for low EMI emissions and susceptibility
- Extremely high EMI and magnetic immunity
- 2.5 kV isolation
- 44000 year barrier life
- VDE V 0884-11 / IEC 60747-17 certified; UL 1577 recognized
- −40°C to 85°C temperature range
- Single and dual-channel configurations
- 8-pin MSOP and SOIC packages

**Applications**

- H-bridges
- Floating supply applications
- Noisy environments

**Description**

The IL600-Series isolators are passive input digital signal isolators with CMOS outputs. The IL6xxCMTI version is optimized for driving MOSFETs either directly or with an external gate driver.

Resistors set the input current, and five milliamps guarantees switching. The inputs can be configured as non-inverting or inverting.

CMTI-grade isolators are 100% tested to ensure each part has at least 200 kV/µs minimum Common-Mode Transient Immunity. Simple external deglitch circuitry can extend the CMTI to an extraordinary 350 kV/µs typical.

The parts also have an extended supply range of up to 6.6 volts for compatibility to directly drive a range of power MOSFETs or gate driver ICs.

The devices are manufactured with NVE’s patented* IsoLoop® spintronic Giant Magnetoresistive (GMR) technology for small size, high speed, and low power.

A unique ceramic/polymer composite barrier provides excellent isolation and virtually unlimited barrier life.

---

*U.S. Patent number 5,831,426; 6,300,617 and others.
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Temperature</td>
<td>$T_S$</td>
<td>$-55^{(1)}$</td>
<td></td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Ambient Operating Temperature</td>
<td>$T_A$</td>
<td>$-40^{(3)}$</td>
<td></td>
<td>85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>$V_{DD}$</td>
<td>$-0.5$</td>
<td></td>
<td>7</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>DC Input Current</td>
<td>$I_{IN}$</td>
<td>$-25$</td>
<td></td>
<td>25</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>AC Input Current (Single-Ended Input)</td>
<td>$I_{IN}$</td>
<td>$-35$</td>
<td></td>
<td>35</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>AC Input Current (Differential Input)</td>
<td>$I_{IN}$</td>
<td>$-75$</td>
<td></td>
<td>75</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td>$V_O$</td>
<td>$-0.5$</td>
<td></td>
<td>$V_{DD}+1.5$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Maximum Output Current</td>
<td>$I_O$</td>
<td>$-10$</td>
<td></td>
<td>10</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>ESD</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>kV</td>
<td>HBM</td>
</tr>
</tbody>
</table>

**Note 1:** Operating at absolute maximum ratings will not damage the device. Parametric performance is not guaranteed at absolute maximum ratings.

### Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Operating Temperature</td>
<td>$T_A$</td>
<td>60</td>
<td>85</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>$V_{DD}$</td>
<td>6</td>
<td>6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Signal Rise and Fall Times</td>
<td>$t_{IR}$, $t_{IF}$</td>
<td>1</td>
<td>1</td>
<td>μs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Mode Input Voltage</td>
<td>$V_{CM}$</td>
<td>1000</td>
<td></td>
<td>V$_{RMS}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Insulation Specifications

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creepage Distance (external)</td>
<td></td>
<td>3.01</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSOP8</td>
<td></td>
<td>4.03</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOIC8</td>
<td></td>
<td>4.03</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Barrier Thickness (internal)</td>
<td></td>
<td>0.012</td>
<td>0.013</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leakage Current</td>
<td>$R_{SO}$</td>
<td>0.2</td>
<td>$10^4$</td>
<td>μA</td>
<td>240 V$_{RMS}$, 60 Hz</td>
<td></td>
</tr>
<tr>
<td>Barrier Resistance</td>
<td>$C_{SO}$</td>
<td>3</td>
<td>6</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparative Tracking Index</td>
<td>$CTI$</td>
<td>≥175</td>
<td>V</td>
<td></td>
<td>Per IEC 60112</td>
<td></td>
</tr>
<tr>
<td>High Voltage Endurance (Maximum Barrier Voltage for Indefinite Life)</td>
<td></td>
<td>1000</td>
<td>$V_{RMS}$</td>
<td></td>
<td>At maximum operating temperature</td>
<td></td>
</tr>
<tr>
<td>Barrier Life</td>
<td></td>
<td>44000</td>
<td>Years</td>
<td>100°C, 1000 V$_{RMS}$, 60% CL activation energy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Thermal Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction–Ambient Thermal Resistance</td>
<td>$\theta_{JA}$</td>
<td>184</td>
<td>134</td>
<td>°C/W</td>
<td></td>
<td>Soldered to double-sided board; free air</td>
</tr>
<tr>
<td>Junction–Case (Top) Thermal Resistance</td>
<td>$\theta_{JT}$</td>
<td>15</td>
<td>10</td>
<td>°C/W</td>
<td></td>
<td>free air</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>$P_D$</td>
<td>500</td>
<td>675</td>
<td>mW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IL6xxCMTI Isolators

Safety and Approvals

VDE V 0884-11 / IEC 60747-17 (Basic Isolation; VDE File Number 5016933-4880-0001)

- Isolation voltage ($V_{ISO}$): 2500 $V_{RMS}$
- Transient overvoltage ($V_{IOTM}$): 4000 $V_{PK}$
- Surge rating: 4000 $V_{PK}$
- Each part tested at 1590 $V_{PK}$ for 1 second, 5 pC partial discharge limit.
- Samples tested at 4000 $V_{PK}$ for 60 sec.; then 1358 $V_{PK}$ for 10 sec. with 5 pC partial discharge limit.

- Working Voltage ($V_{IORM}$; pollution degree 2):
  - MSOP8 (-1 part number suffix): 399 $V_{RMS}$
  - SOIC8 (-3 part number suffix): 1000 $V_{RMS}$

<table>
<thead>
<tr>
<th>Safety-Limiting Values</th>
<th>Symbol</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety rating ambient temperature</td>
<td>$T_S$</td>
<td>180</td>
<td>°C</td>
</tr>
<tr>
<td>Safety rating power (180 °C)</td>
<td>$P_S$</td>
<td>270</td>
<td>mW</td>
</tr>
<tr>
<td>Supply current safety rating (total of supplies)</td>
<td>$I_S$</td>
<td>54</td>
<td>mA</td>
</tr>
</tbody>
</table>

UL 1577 (Component Recognition Program File Number E207481)

- 2500 V rating.
- Each part tested at 3000 $V_{RMS}$ (4240 $V_{PK}$) for 1 second; each lot sample tested at 2500 $V_{RMS}$ (3530 $V_{PK}$) for 1 minute.

Soldering Profile

Per JEDEC J-STD-020C; MSL 1

Electrostatic Discharge Sensitivity

This product has been tested for electrostatic sensitivity to the limits stated in the specifications. However, NVE recommends that all integrated circuits be handled with appropriate care to avoid damage. Damage caused by inappropriate handling or storage could range from performance degradation to complete failure.
### Pin Connections

**IL610CMTI**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
</tr>
<tr>
<td>2</td>
<td>IN+</td>
</tr>
<tr>
<td>3</td>
<td>IN−</td>
</tr>
<tr>
<td>4</td>
<td>NC</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
</tr>
<tr>
<td>6</td>
<td>OUT</td>
</tr>
<tr>
<td>7</td>
<td>$V_{OE}$</td>
</tr>
<tr>
<td>8</td>
<td>$V_{DD}$</td>
</tr>
</tbody>
</table>

**IL611CMTI**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$IN_{1+}$</td>
</tr>
<tr>
<td>2</td>
<td>$IN_{1−}$</td>
</tr>
<tr>
<td>3</td>
<td>$IN_{2+}$</td>
</tr>
<tr>
<td>4</td>
<td>$IN_{2−}$</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
</tr>
<tr>
<td>6</td>
<td>OUT$_2$</td>
</tr>
<tr>
<td>7</td>
<td>OUT$_1$</td>
</tr>
<tr>
<td>8</td>
<td>$V_{DD}$</td>
</tr>
</tbody>
</table>

**Pin Connection Diagrams**

- **IL610CMTI**
- **IL611CMTI**
### Operating Specifications

#### Coil Specifications ($V_{DD} = 3 \text{ V} – 6.6 \text{ V}; T = −40°C – 85°C$ unless otherwise stated)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coil Input Resistance</td>
<td>$R_{COIL}$</td>
<td>47</td>
<td>85</td>
<td>112</td>
<td>Ω</td>
<td>$T = 25°C$</td>
</tr>
<tr>
<td>Coefficient</td>
<td>$TC R_{COIL}$</td>
<td>0.2</td>
<td>0.25</td>
<td>nH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil Resistance Temperature</td>
<td>$L_{COIL}$</td>
<td>9</td>
<td></td>
<td>nH</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1. Test circuit.**
## 5 V Specifications

### 5 V Electrical Specifications (V\(_{DD}\) = 4.5 V – 6.6 V; T = −40°C – 85°C unless otherwise stated)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiescent Supply Current</td>
<td>I(_{DD})</td>
<td>2</td>
<td>3</td>
<td>mA</td>
<td>V(<em>{DD}) = 5 V, I(</em>{IN}) = 0</td>
<td></td>
</tr>
<tr>
<td>Input Threshold</td>
<td>I(_{INH-DC})</td>
<td>0.5</td>
<td>3</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Threshold Hysteresis</td>
<td>I(<em>{INH} - I</em>{INL})</td>
<td>0.25</td>
<td>1</td>
<td>mA</td>
<td>V(_{DD}) = 5 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.25</td>
<td>0.5</td>
<td>mA</td>
<td>V(_{DD}) = 6 V</td>
<td></td>
</tr>
<tr>
<td>Failsafe Input Current(^{1})</td>
<td>I(_{FS-HIGH})</td>
<td>25</td>
<td>0.5</td>
<td>mA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I(_{FS-LOW})</td>
<td>25</td>
<td>mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Output Voltage</td>
<td>V(_{OH})</td>
<td>4.9</td>
<td>4.999</td>
<td>V</td>
<td>V(<em>{DD}) = 5 V, I(</em>{O}) = 20 μA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.0</td>
<td>4.8</td>
<td>V</td>
<td>V(<em>{DD}) = 5 V, I(</em>{O}) = 4 mA</td>
<td></td>
</tr>
<tr>
<td>Low Output Voltage</td>
<td>V(_{OL})</td>
<td>0.0007</td>
<td>0.1</td>
<td>V</td>
<td>V(<em>{DD}) = 5 V, I(</em>{O}) = 20 μA</td>
<td></td>
</tr>
<tr>
<td>Output Stage High-Side Drain-to-Source Resistance</td>
<td>R(_{DS-P})</td>
<td>40</td>
<td>38</td>
<td>Ω</td>
<td>V(_{DD}) = 5 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>28</td>
<td>Ω</td>
<td>V(_{DD}) = 6 V</td>
<td></td>
</tr>
<tr>
<td>Output Short-Circuit Current</td>
<td>I(_{SC})(^{1})</td>
<td>45</td>
<td>55</td>
<td>70</td>
<td>mA</td>
<td>V(_{DD}) = 5 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V(_{DD}) = 6 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 5 V Switching Specifications (V\(_{DD}\) = 4.5 V – 6.6 V; T = −40°C – 85°C unless otherwise stated)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Pulse Width(^{1})</td>
<td>PW</td>
<td>10</td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation Delay Input to Output (High-to-Low)</td>
<td>t(_{PHL})</td>
<td>8</td>
<td>15</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation Delay Input to Output (Low to High)</td>
<td>t(_{PLH})</td>
<td>8</td>
<td>15</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Propagation Delay Drift</td>
<td>t(_{PHL})</td>
<td>10</td>
<td>ps/C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse Width Distortion</td>
<td>I(<em>{PHL}-I</em>{PLH})(^{2})</td>
<td>3</td>
<td>5</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse Jitter</td>
<td>t(_{J})</td>
<td>100</td>
<td>ps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation Delay Skew(^{1})</td>
<td>t(_{PSK})</td>
<td>−2</td>
<td>2</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Rise Time (10–90%)</td>
<td>t(_{R})</td>
<td>2</td>
<td>4</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Fall Time (10–90%)</td>
<td>t(_{F})</td>
<td>2</td>
<td>4</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Pulse Width(^{1})</td>
<td>PW</td>
<td>75</td>
<td>ns</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation Delay Input to Output (High-to-Low)</td>
<td>t(_{PHL})</td>
<td>50</td>
<td>70</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation Delay Input to Output (Low to High)</td>
<td>t(_{PLH})</td>
<td>60</td>
<td>90</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse Width Distortion</td>
<td>I(<em>{PHL}-I</em>{PLH})(^{2})</td>
<td>30</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Rise Time (10–90%)</td>
<td>t(_{R})</td>
<td>130</td>
<td>160</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Fall Time (10–90%)</td>
<td>t(_{F})</td>
<td>110</td>
<td>140</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 5 V Common Mode Transient Immunity Specifications (V\(_{DD}\) = 4.5 V – 6.6 V; T = −40°C – 85°C unless otherwise stated)

| IL610CMTI (single channel) | | | | | | |
|-----------------------------|-----------------|------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 5 mA drive | | | | | | |
| 10 mA drive\(^{2}\) | \(|C_{M}|,|C_{M}|\) | 200\(^{±2}\) | 240 | kV/μs | I\(_{COIL}\) = 0/±5 mA |
| With external deglitching | | | | | | |
| | \(|C_{M}|,|C_{M}|\) | 300 | 350 | | I\(_{COIL}\) = 0/±10 mA |
| | | | | | 10 ns output deglitch |

| IL611CMTI (two channel) | | | | | | |
|-----------------------------|-----------------|------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 5 mA drive | | | | | | |
| 10 mA drive\(^{2}\) | \(|C_{M}|,|C_{M}|\) | 200\(^{±2}\) | 240 | kV/μs | I\(_{COIL}\) = 0/±5 mA |
| With external deglitching | | | | | | |
| | \(|C_{M}|,|C_{M}|\) | 300 | 350 | | I\(_{COIL}\) = 0/±10 mA |
| | | | | | 10 ns output deglitch |
### 3.3 V Specifications

#### 3.3 V Electrical Specifications \((V_{DD} = 3 \text{ V} - 3.6 \text{ V}; \ T = -40°C - 85°C \text{ unless otherwise stated})\)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiescent Supply Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(V_{DD} = 3.3 \text{ V}, I_{IN} = 0)</td>
</tr>
<tr>
<td>IL610</td>
<td>(I_{DD})</td>
<td>1.3</td>
<td>2</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>IL611</td>
<td>(I_{DD})</td>
<td>2.6</td>
<td>4</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Input Threshold</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Single-ended Unipolar</td>
</tr>
<tr>
<td>IL610CMTI (single channel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bipolar Differential</td>
</tr>
<tr>
<td>IL611CMTI (two channel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Threshold Hysteresis</td>
<td></td>
<td>0.25</td>
<td>3</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Failsafe Input Current (^{1})</td>
<td>(I_{FS:HIGH})</td>
<td>-25</td>
<td>0.3</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>High Output Voltage</td>
<td>(V_{OH})</td>
<td>3.2</td>
<td>2</td>
<td></td>
<td>V</td>
<td>(V_{DD} = 3.3 \text{ V}, I_{O} = -0.3 \text{ mA})</td>
</tr>
<tr>
<td>Low Output Voltage</td>
<td>(V_{OL})</td>
<td>0.005</td>
<td>0.1</td>
<td></td>
<td>V</td>
<td>(V_{DD} = 3.3 \text{ V}, I_{O} = 0.15 \text{ mA})</td>
</tr>
<tr>
<td>Output Stage High-Side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain-to-Source Resistance</td>
<td>(R_{DS-P})</td>
<td>55</td>
<td></td>
<td></td>
<td>(\Omega)</td>
<td></td>
</tr>
<tr>
<td>Output Stage Low-Side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain-to-Source Resistance</td>
<td>(R_{DS-N})</td>
<td>38</td>
<td></td>
<td></td>
<td>(\Omega)</td>
<td></td>
</tr>
<tr>
<td>Output Short-Circuit Current</td>
<td>(</td>
<td>I_{SC}</td>
<td>)</td>
<td>15</td>
<td>25</td>
<td>40</td>
</tr>
</tbody>
</table>

#### 3.3 V Switching Specifications \((V_{DD} = 3 \text{ V} - 3.6 \text{ V}; \ T = -40°C - 85°C \text{ unless otherwise stated})\)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>PW</th>
<th></th>
<th></th>
<th></th>
<th>ns</th>
<th>Digital Drive:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propagation Delay Input to Output</td>
<td>(t_{PHL})</td>
<td>12</td>
<td>18</td>
<td></td>
<td></td>
<td>Test Circuit 2; (R_{L} = 1 \text{ K(\Omega);})</td>
</tr>
<tr>
<td>(High to Low)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(C_{L} = 15 \text{ pF};) (t_{IR} = t_{IF} = 3 \text{ ns})</td>
</tr>
<tr>
<td>Propagation Delay Input to Output</td>
<td>(t_{PLH})</td>
<td>12</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Low to High)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Propagation Delay Drift (^{2})</td>
<td>(t_{PLH})</td>
<td>10</td>
<td>5</td>
<td></td>
<td>ps/°C</td>
<td></td>
</tr>
<tr>
<td>Pulse Width Distortion (^{2})</td>
<td>(PWD)</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation Delay Skew (^{3})</td>
<td>(t_{PSK})</td>
<td>-2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Rise Time (10–90%)</td>
<td>(t_{R})</td>
<td>3</td>
<td>5</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Output Fall Time (10–90%)</td>
<td>(t_{F})</td>
<td>3</td>
<td>5</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Minimum Pulse Width (^{1})</td>
<td>PW</td>
<td>100</td>
<td></td>
<td></td>
<td>ns</td>
<td>(\text{MOSFET drive:}) (R_{L} = 1 \text{ K(\Omega);})</td>
</tr>
<tr>
<td>Propagation Delay Input to Output</td>
<td>(t_{PHL})</td>
<td>75</td>
<td>100</td>
<td></td>
<td></td>
<td>Test Circuit 2; (C_{L} = 1000 \text{ pF};) (t_{IR} = t_{IF} = 3 \text{ ns})</td>
</tr>
<tr>
<td>(High-to-Low)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation Delay Input to Output</td>
<td>(t_{PLH})</td>
<td>90</td>
<td>130</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Low to High)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse Width Distortion (^{2})</td>
<td>(PWD)</td>
<td>45</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Rise Time (10–90%)</td>
<td>(t_{R})</td>
<td>200</td>
<td>240</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Fall Time (10–90%)</td>
<td>(t_{F})</td>
<td>165</td>
<td>200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3.3 V Common Mode Transient Immunity Specifications \((V_{DD} = 3 \text{ V} - 3.6 \text{ V}; \ T = -40°C - 85°C \text{ unless otherwise stated})\)

| IL610CMTI (single channel)              | \(|CM_{IL}|,|CM_{IL}|\) | 125  | \(|CM_{IL}|,|CM_{IL}|\) | kV/\(\mu\text{s}\) | \(I_{COIL} = 0/ +5 \text{ mA}\) |
|                                         | With external degliching| 300  |                               |                     | 10 ns output deglich |
| IL611CMTI (two channel)                 | \(|CM_{IL}|,|CM_{IL}|\) | 110  | \(|CM_{IL}|,|CM_{IL}|\) | kV/\(\mu\text{s}\) | \(I_{COIL} = 0/ +5 \text{ mA}\) |
|                                         | With external degliching| 300  |                               |                     | 10 ns output deglich |

Notes:
1. Failsafe Operation is defined as the guaranteed output state which will be achieved if the DC input current falls between the input levels specified.
2. Note if Failsafe to Logic Low is required, the DC current supplied to the coil must be at least 8 mA using 3.3 V supplies versus 5 mA for 4.5 V or higher supplies.
3. Minimum Pulse Width is the shortest pulse width at which the specified PWD is guaranteed.
4. PWD is defined as \(t_{PHL} - t_{PLH}\).
5. \(t_{PSK}\) is equal to the magnitude of the worst case difference in \(t_{PHL}\) and/or \(t_{PLH}\) that will be seen between units at 25°C.
6. 100% tested.
Typical Performance Graphs

**Figure 2.** Typical CMTI vs. drive current ($V_{DD} = 5$ V).

**Figure 3.** Typical high output voltage vs. load.

**Figure 4.** Typical low output voltage vs. load.
**Figure 5.** Typical input threshold current hysteresis.

**Figure 6.** Typical output rise time vs. load capacitance
Applications Information

Overview
Figure 7 shows a block diagram of the IL61xCMTI. The coil, GMR, and support integrated circuitry are integrated on a single chip:

GMR Wheatstone Bridge
The heart of the Isolator is a Wheatstone bridge constructed of GMR resistor elements. The current in the coil driven from the input side of the isolator creates a magnetic field that switches the GMR in the bridge. Thus the signal is transmitted by magnetic field.

Schmitt Trigger and Output Stage
The change in the bridge is detected by a Schmitt trigger comparator. This drives a push-pull MOSFET output stage.

Input Coil
IL600-Series Isolators are current mode devices. Changes in current flow into the input coil result in logic state changes at the output. Input-stage hysteresis improves noise immunity. Output logic high is the zero input current state:

Coil Polarity
The device switches to low if current flows from (In−) to (In+). Note that the designations “In−” and “In+” refer to logic levels, not current flow. Positive values of current mean current flow into the In− input.
Input Resistor Selection

Resistors set the coil input current:

![Figure 8. Input resistors.](image)

There is no limit to input voltages because there are no semiconductor input structures.

The resistors can be divided between the two inputs. The two resistors can be the same if necessary, although because of some inherent structural asymmetry, an $R_{IN-}$ resistor approximately 50% larger than $R_{IN+}$ is optimal for CMTI.

The worst-case drive current is calculated from the worst-case input voltage divided by the total series resistance plus the worst-case coil resistance. Note that coil resistance increases with temperature. Driver output impedance should also be considered if it is significant.

The following table summarizes typical input resistor values:

<table>
<thead>
<tr>
<th>$V_{COIL}$</th>
<th>5 mA min. drive current</th>
<th>10 mA typical drive current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R_{IN-}$</td>
<td>$R_{IN+}$</td>
</tr>
<tr>
<td>3.3 V</td>
<td>300 Ω</td>
<td>200 Ω</td>
</tr>
<tr>
<td>5 V</td>
<td>500 Ω</td>
<td>330 Ω</td>
</tr>
</tbody>
</table>

Table 1. Typical input resistor values.

The values for 5 mA drive are designed to provide a minimum of 5 mA drive current so the isolator is guaranteed to switch. The values for 10 mA drive are designed to provide 10 mA typical drive current to maximize CMTI.

The worst-case logic low threshold current is 8 mA, which is for single-ended operation with a 3 V supply. With differential drive the logic low threshold current is 5 mA for the range of supplies.

Maximum Coil Current

Absolute Maximum unipolar coil current is 25 mA, while bipolar mode allows up to ±75 mA. The difference in specifications is due to the risk of electromigration of coil metals under constant current flow. Long-term unipolar DC current flow above 25 mA can cause erosion of the coil metal. In differential mode, erosion takes place in both directions as each current cycle reverses and has no net effect up to the absolute maximum current.

An advantage over optocouplers and other high-speed couplers in differential mode is that no reverse bias protection for the input structure is required for a differential signal.
Drive Configurations
IL600-Series Isolators can be configured in inverting (Figure 9) non-inverting (Figure 10) or bipolar (Figure 11) configurations.

This configuration is similar to standard logic. The output is high when the coil current is less than 0.5 mA, and low when the current is more than 5 mA.

When a logic high is applied to the input, the current through the coil is zero. When the input is a logic low (0 V), at least 5 mA flows through the coil from the In− side to the In+ side.

The differential coil current is negative for a high output and positive for a low output. Bipolar drive increases the absolute maximum coil current, minimizes the required input current with a 3.3-volt supply, and maximizes immunity to external magnetic fields. No reverse bias protection for the input structure is required for a bipolar signal.
Maximizing CMTI

10 mA coil current
CMTI increases with coil current, up to approximately 10 mA. More than 10 mA does not significantly improve CMTI.

Output Deglitching
Deglitching significantly increases CMTI. Some MOSFET drivers have built-in deglitching, or a simple deglitch circuit is shown in Figure 12.

Power Supply Decoupling
A 0.1 µF ceramic capacitor is recommended to decouple the output-side power supply (\(V_{DD2}\)). The capacitor should be as close as possible to the \(V_{DD}\) pin.

Maintaining Creepage
Standard pad libraries often extend under the package, compromising creepage and clearance. Similarly, ground planes, if used, should be spaced to avoid compromising clearance. Package drawings and recommended pad layouts are included in this datasheet.

Electromagnetic Compatibility and Magnetic Field Immunity
IL600-Series isolators are ideal for harsh industrial environments with low emitted fields and very high external magnetic field immunity. Because IL600-Series Isolators are completely static, they have the lowest emitted noise of any non-optical isolators.

Internal shielding and inherent common-mode field immunity
IsoLoop Isolators operate by imposing a magnetic field on a GMR sensor, which translates the change in field into a change in logic state. A magnetic shield and a Wheatstone Bridge configuration provide superb immunity to external magnetic fields.

Inherent AC magnetic field immunity
Unlike inductive or capacitive which transmit and detect high-frequency carriers, IsoLoop Isolators do not rely on AC signals, and are inherently insensitive to AC magnetic fields. It is harder to disrupt an isolated AC signal with an external magnetic field than a DC signal. This enhances the IL6xxCMTI magnetic immunity in switch-mode power control applications. Immunity to external magnetic fields can be enhanced by (1) optimal orientation of the device with respect to the field direction and (2) the use of bipolar inputs.

1. Orientation of the device with respect to the field direction
An applied field in the “H1” direction is the worst case for magnetic immunity. In this case the external field is in the same direction as the applied internal field. In one direction it will tend to help switching; in the other it will hinder switching. This can cause unpredictable operation.
An applied field in direction “H2” has considerably less effect and results in higher magnetic immunity.

2. Bipolar input
Regardless of orientation, a bipolar input improves magnetic immunity. This is because the logic high state is driven by an applied field instead of zero field, as is the case with single-ended operation. The higher the coil current, the higher the internal field, and the higher the immunity to external fields.

<table>
<thead>
<tr>
<th>Method</th>
<th>Approximate Immunity</th>
<th>Immunity Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field applied in H1 direction</td>
<td>±20 Gauss</td>
<td>A DC current of 16 A flowing in a conductor 1 cm from the device could cause disturbance.</td>
</tr>
<tr>
<td>Field applied in H2 direction</td>
<td>±70 Gauss</td>
<td>A DC current of 56 A flowing in a conductor 1 cm from the device could cause disturbance.</td>
</tr>
<tr>
<td>Field applied in any direction but with a bipolar input</td>
<td>±250 Gauss</td>
<td>A DC current of 200 A flowing in a conductor 1 cm from the device could cause disturbance.</td>
</tr>
</tbody>
</table>
Deglitching provides a minimum of 300 kV/μs transient immunity. In this circuit, the RC delay filters out pulses less than approximately 10 ns, and an inexpensive Schmitt-trigger provides a digital output.

The isolators can drive general-purpose gate drivers for applications requiring high speed or high gate capacitance MOSFETs. A Renesas ICL7667 dual high-speed monolithic driver is used in the circuit above to drive the primary of an isolated DC-DC convertor transformer. The resistor values shown are typical for a 3.3-volt supply.
The isolators can be used in conjunction with a half-bridge driver to create an isolated driver for motors or power-drive circuits. The HIP2104 IC provides fast drive of high gate-capacitance MOSFETs and powers the bridge side of the isolator. The resistor values shown are typical for a 3.3 volt input.

Figure 14. Isolated half-bridge motor drive.
Four channels of isolation in three IL6xxCMTI isolators allow referencing the high-side gate signals to the floating MOSFET source pins, plus they level-shift low-voltage controller inputs to six volts to drive MOSFET gates. These isolators have low-impedance outputs to directly drive MOSFETs, so separate MOSFET drivers are not required.

The ILDC11 ultraminiature DC-DC convertor isolates and floats the high-side gate power, and commodity regulators boost the output to the six volts needed to drive the MOSFET gates.

The isolator inputs on each side of the H-bridge are connected in series, which ensures two MOSFETs on the same side cannot be ON at the same time.
Figure 16. Bipolar driver.

A simple ±10 mA bipolar differential coil driver using an inexpensive dual Schmitt trigger. Bipolar drive increases the absolute maximum coil current, minimizes the required input current with a 3.3-volt supply, and maximizes immunity to external magnetic fields.
Package Drawings

8-pin MSOP (-1 suffix)

Dimensions in inches (mm); scale = approx. 5X

8-pin SOIC Package (-3 suffix)

Dimensions in inches (mm); scale = approx. 5X

NOTE: Pin spacing is a BASIC dimension; tolerances do not accumulate.
## Recommended Pad Layouts

### 8-pin MSOP Pad Layout

Dimensions in inches (mm); scale = approx. 5X

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 PLCS</td>
<td>0.120</td>
</tr>
<tr>
<td></td>
<td>(3.05)</td>
</tr>
<tr>
<td>30 mil</td>
<td>0.025</td>
</tr>
<tr>
<td></td>
<td>(0.65)</td>
</tr>
<tr>
<td>2 mil</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>(0.43)</td>
</tr>
<tr>
<td>2 mil</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>(5.77)</td>
</tr>
</tbody>
</table>

### 8-pin SOIC Pad Layout

Dimensions in inches (mm); scale = approx. 5X

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 PLCS</td>
<td>0.160</td>
</tr>
<tr>
<td></td>
<td>(4.05)</td>
</tr>
<tr>
<td>6 mil</td>
<td>0.050</td>
</tr>
<tr>
<td></td>
<td>(1.27)</td>
</tr>
<tr>
<td>2 mil</td>
<td>0.020</td>
</tr>
<tr>
<td></td>
<td>(0.51)</td>
</tr>
<tr>
<td>30 mil</td>
<td>0.275</td>
</tr>
<tr>
<td></td>
<td>(6.99)</td>
</tr>
</tbody>
</table>
Ordering Information and Valid Part Numbers

IL 6xx  CMTI - 1  E  TR13

- **Bulk Packaging**
  - Blank = Tube
  - TR7 = 7” Tape and Reel
  - TR13 = 13” Tape and Reel

- **Package**
  - E = RoHS Compliant

- **Package Type**
  - -1 = MSOP8
  - -3 = SOIC8

- **Grade**
  - Blank = Standard
  - CMTI = Ultrahigh Transient Immunity

- **Base Part Number**
  - 610 = Single Channel
  - 611 = Dual Channel

- **Product Family**
  - IL = Isolators

**Available Parts:**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Channels</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL610CMTI-1E</td>
<td>1</td>
<td>MSOP8</td>
</tr>
<tr>
<td>IL610CMTI-3E</td>
<td>1</td>
<td>SOIC8</td>
</tr>
<tr>
<td>IL611CMTI-1E</td>
<td>2</td>
<td>MSOP8</td>
</tr>
</tbody>
</table>
## Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISB-DS-001-IL6xxCMTI-RevD</td>
<td>• More detailed Figure 15 (isolated H-bridge driver).</td>
</tr>
<tr>
<td>Sept. 2020</td>
<td></td>
</tr>
<tr>
<td>ISB-DS-001-IL6xxCMTI-RevC</td>
<td>• Dropped IL6xxCMTI-3 part type.</td>
</tr>
<tr>
<td>March 2020</td>
<td></td>
</tr>
<tr>
<td>ISB-DS-001-IL6xxCMTI-RevB</td>
<td>• Increased SOIC Working Voltage to 1000 V_{RMS} (p. 3).</td>
</tr>
<tr>
<td>February 2020</td>
<td>• Added drain-source resistance and more detailed output voltage specs.</td>
</tr>
<tr>
<td></td>
<td>• Separated 3.3 V and 5 V CMTI specification tables and separated one- and two-channel models.</td>
</tr>
<tr>
<td></td>
<td>• Added detailed block diagram.</td>
</tr>
<tr>
<td></td>
<td>• Dropped boost capacitor recommendation because it degrades CMTI.</td>
</tr>
<tr>
<td></td>
<td>• Added several performance graphs.</td>
</tr>
<tr>
<td></td>
<td>• Recommended two coil resistors and imbalanced resistors.</td>
</tr>
<tr>
<td></td>
<td>• VDE and UL approval.</td>
</tr>
<tr>
<td>ISB-DS-001-IL6xxCMTI-RevA</td>
<td>• Added thermal characteristics (p. 2).</td>
</tr>
<tr>
<td>November 22, 2019</td>
<td>• Increased supply voltage range from 6 V to 6.6 V.</td>
</tr>
<tr>
<td></td>
<td>• Additional application circuits.</td>
</tr>
<tr>
<td></td>
<td>• Initial release.</td>
</tr>
<tr>
<td>ISB-DS-001-IL6xxCMTI-PRELIM2</td>
<td>• Updated CMTI specs.</td>
</tr>
<tr>
<td>November 1, 2019</td>
<td>• Additional application circuits.</td>
</tr>
<tr>
<td>ISB-DS-001-IL6xxCMTI-PRELIM</td>
<td>• Preliminary release.</td>
</tr>
<tr>
<td>September 2019</td>
<td></td>
</tr>
</tbody>
</table>
Datasheet Limitations
The information and data provided in datasheets shall define the specification of the product as agreed between NVE and its customer, unless NVE and customer have explicitly agreed otherwise in writing. All specifications are based on NVE test protocols. In no event however, shall an agreement be valid in which the NVE product is deemed to offer functions and qualities beyond those described in the datasheet.

Limited Warranty and Liability
Information in this document is believed to be accurate and reliable. However, NVE does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information.

In no event shall NVE be liable for any indirect, incidental, punitive, special or consequential damages (including, without limitation, lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Right to Make Changes
NVE reserves the right to make changes to information published in this document including, without limitation, specifications and product descriptions at any time and without notice. This document supersedes and replaces all information supplied prior to its publication.

Use in Life-Critical or Safety-Critical Applications
Unless NVE and a customer explicitly agree otherwise in writing, NVE products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical devices or equipment. NVE accepts no liability for inclusion or use of NVE products in such applications and such inclusion or use is at the customer’s own risk. Should the customer use NVE products for such application whether authorized by NVE or not, the customer shall indemnify and hold NVE harmless against all claims and damages.

Applications
Applications described in this datasheet are illustrative only. NVE makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NVE products, and NVE accepts no liability for any assistance with applications or customer product design. It is customer’s sole responsibility to determine whether the NVE product is suitable and fit for the customer’s applications and products planned, as well as for the planned application and use of customer’s third party customers. Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NVE does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer’s applications or products, or the application or use by customer’s third party customers. The customer is responsible for all necessary testing for the customer’s applications and products using NVE products in order to avoid a default of the applications and the products or of the application or use by customer’s third party customers. NVE accepts no liability in this respect.

Limiting Values
Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and operation of the device at these or any other conditions above those given in the recommended operating conditions of the datasheet is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and Conditions of Sale
In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NVE hereby expressly objects to applying the customer’s general terms and conditions with regard to the purchase of NVE products by customer.

No Offer to Sell or License
Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export Control
This document as well as the items described herein may be subject to export control regulations. Export might require a prior authorization from national authorities.

Automotive Qualified Products
Unless the datasheet expressly states that a specific NVE product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NVE accepts no liability for inclusion or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NVE’s warranty of the product for such automotive applications, use and specifications, and (b) whenever customer uses the product for automotive applications beyond NVE’s specifications such use shall be solely at customer’s own risk, and (c) customer fully indemnifies NVE for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NVE’s standard warranty and NVE’s product specifications.