Intelligent Power Switches

Ester Spitale
IPS: Concept

- Monolithic Fully Protected Power Stage and Control
- Designed for Harsh Environment (-40°C .. +150°C )
- Capability to drive any kind of Load
- Exhaustive Diagnostics
IPS vs. Relay: Benefits

- Compactness: Space Saving
- No Contacts: No Wear-out!
- Protections and Diagnostics: On Chip!

Very High Reliability!
Competitive Prices!
IPS Targeted Market Segments

- Factory Automation
  - Programmable Logic Controller
  - Programmable Automation Controller
  - Distributed I/O modules
  - Process Instrumentation

- Textile Industry
  - Sewing machines

- Building Automation
  - Alarms / Security systems

- Agricultural Systems & Vehicles
  - Hydraulics/pneumatics control (due to 24V supply system)

- Green Energy Applications
  - Windmills (auxiliary functions)

- Motor Drives
  - AC Variable Speed Drives
    - Additional I/Os for sensors / actuators
Current IPS Portfolio

Single Channel
- TDE1737DP
- TDE1747
- TDE1787
- TDE1798
- TDE1897RFPT
- TDE1898
- TDE3247
- L6370
- L6375
- L6377
- VN540
- VN751
- TDE1707BFP
- TDE1708DFT

Dual Channel
- L6360 *)
- VNI2140J
*) 2 drivers + 2 receivers

Quad Channel
- L6374
- L6376
- VN330 (-32)
- VN340 (-33)
- VNI4140K
- VNI4140K-32
- VNQ860

Octal Channel
- VN808
- VN808-32
- VN808CM
- VN808CM-32

VNI4140K & VNI4140K-32 are recommended products for all new designs instead of the VN330 / VN340!
# Products / Technology Overview

<table>
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<th>Technology</th>
<th>Product examples</th>
<th>Characteristics</th>
<th>Application target</th>
</tr>
</thead>
</table>
| Multipower BCD | L6370, L6375, L6376, L6377 | • High level of diagnostics  
                      • Non-dissipative overload protection                                      | • PLC  
                      • Distributed I/Os                                                          |
| VIPower        | VN751, VNI2140J, VNI4140K, VN808 | • Low $R_{DSON}$ vs. silicon size  
                      • Great thermal performance                                                   |                                  |
| Multipower BCD | L6360                | • Combination of 2 drivers and 2 receivers (type 1)  
                      • Non-dissipative overload protection  
                      • High Speed operation  
                      • Configurable features                                                       | • PLC  
                      • Distributed I/Os  
                      • General purpose transceiver  
                      • IO-Link Master                                                             |
L6370, Single Channel IPS

Key features

• Supply Voltage 9.5V to 50V
• Output current 2.5A
• $R_{\text{DS(ON)}}$ typical 70mΩ
• Non-dissipative short circuit protection
• On state open-load detection (1 to 6mA)
• Short to $V_{\text{CC}}$ detection
• Under-Voltage detection
• Adjustable ON time at short circuit or overload conditions
• Programmable Current limiter
• 2-bit Diagnostics
• On chip Status LED driver
• QFN 7x7 mm and Power-SO20 packages
L6370Q: High Power with Less Space

**MINIATURIZATION / GOOD THERMAL PERFORMANCE**

**L6370D**

**PowerSO-20**

Footprint: 16 x 14.5 = 232mm²

**L6370Q**

QFN 7x7x1 – 48L
max. 50°C/W

- Space savings

Footprint: 7 x 7 = 49mm²

- 79% Footprint Area
L6370Q Evalboard

- Order Code: STEVAL-IFP020V1

- Application Immunity verified
  - IEC61000-4-2, ESD, Contact / Air, both higher than ±25kV
  - IEC61000-4-4, Burst, > ±4kV, performance criteria A
  - IEC61000-4-5, Surge, 42Ω/0.5μF, > ±3kV, common / differential modes
VNI2140J – Dual HSD (80mΩ)

Key features

- Supply Voltage 9V to 45V
- Output current per channel 1A
- $R_{DSON} = 80m\Omega$ (typ. @25°C)
- Narrow current limitation spread 1A ÷ 2A
- Low quiescent supply current 300µA (All OFF), 1.9mA (All ON)
- Low thermal resistance
- Short circuit protection
- Junction over-temperature protections (each channel)
- Additional case over-temperature protection (common for all chan.)
- Non-simultaneous channel restart to minimize supply current peak & EMI
- Open load in off-state and short to VCC detection
- Two open-drain diagnostic outputs
- Conform to IEC 61131-2

Redesigned product with outstanding immunity available in full production!
VNI2140J Evalboard

- New Order Code: STEVAL-IFP010V3

- Application Immunity verified
  - IEC61000-4-2, ESD, Contact / Air, both higher than ±25kV
  - IEC61000-4-4, Burst, > ±4kV, performance criteria A
  - IEC61000-4-5, Surge, 42Ω/0.5μF, > ±2kV, common / differential modes
VNI4140K / -32 Quad HSD (80 mΩ)

Key features

- Supply Voltage 10.5V to 41V
- Output current per channel 0.7A / 1A (-32)
- $R_{\text{DS\_ON}} = 80\,\text{mΩ}$ (max. @25°C)
- Narrow current limitation spread 0.7A + 1.7A / 1A + 2.6A (-32)
- Low quiescent supply current 250µA (All OFF), 2.4mA (All ON)
- Low thermal resistance
- Four independent diagnostic outputs
- Short circuit protection
- Junction over-temperature protections (each channel)
- Additional case over-temperature protection (common for all chan.)
- Non-simultaneous channel restart to minimize supply current peak & EMI
- Conform to IEC61131-2

Redesigned product with outstanding immunity available in full production!

$R_{\text{th\,(J-C)}}$ 2°C/W (max.)

$R_{\text{th\,(J-A)}}$ 30°C/W simply reachable with passive cooling
VNI4140K (-32) Short Circuit Operation

DIAG pin
- Provides only the over-temperature indication
- The short circuit itself is not indicated
VNI4140K (-32): No Simultaneous Restart

- If case temperature is exceeded, all channels are shut down.
- When the chip is cooled down, channels operation is restarted.
- Channels are activated one after the other one, not in the same time.

- Lower inrush current
- Better EMI
VNI4140K (-32) Evalboards

- **Order Codes**
  - STEVAL-IFP006V1 for VNI4140K / 0.7A per channel
  - STEVAL-IFP019V1 for VNI4140K-32 / 1A per channel

- **Application Immunity verified**
  - IEC61000-4-2, ESD, Contact / Air, both higher than ±25kV
  - IEC61000-4-4, Burst, > ±4kV, performance criteria A
  - IEC61000-4-5, Surge, 42Ω/0.5μF, > ±2kV, common / differential modes
VN808 (CM, -32) Octal HSD (150 mΩ)

Key features

- Supply Voltage 10.5V to 45V
- Output current per channel 0.7A / 1A (-32)
- \( R_{DSON} = 150\text{mΩ} \) (typ. @25°C)
- Narrow current limitation spread 0.7A ÷ 1.7A / 1A ÷ 1.7A (-32)
- \( V_{CC}/2 \) or CMOS (VN808CM) input threshold
- Low thermal resistance
- Status LED driver (3mA)
- Common diagnostic output
- Short circuit protection
- Junction over-temperature protections (each channel)
- Additional case over-temperature protection (common for all chan.)
- Conform to IEC61131-2
VN808 (CM) Evalboards

- **Order Codes**
  - STEVAL-IFP002V1 for VN808 / 0.7A per channel, \( V_{CC}/2 \) threshold
  - STEVAL-IFP001V1 for VN808CM / 0.7A per channel, CMOS threshold

- **Application Immunity verified**
  - IEC61000-4-2, ESD, Contact / Air, both higher than \( \pm 15kV \)
  - IEC61000-4-4, Burst, > \( \pm 4kV \), performance criteria A
  - IEC61000-4-5, Surge, \( 42\Omega/0.5\mu F \), > \( \pm 2kV \), common / differential modes
<table>
<thead>
<tr>
<th>Product</th>
<th>Characteristics</th>
<th>Application target</th>
<th>System Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNI8200XP</td>
<td>• 8 channels&lt;br&gt;• Selectable SPI/Parallel interface&lt;br&gt;• <strong>Daisy-chain</strong> operation support</td>
<td>• Wide range use&lt;br&gt;• High channel count Output modules</td>
<td>• Minimized amount of isolators thanks to SPI bus&lt;br&gt;• Only 4 isolators necessary</td>
</tr>
<tr>
<td>ISO8200B</td>
<td>• 8 channels&lt;br&gt;• Parallel interface&lt;br&gt;• Direct / Synchronous operation&lt;br&gt;• <strong>Galvanic isolation included</strong></td>
<td>• Wide range use&lt;br&gt;• 8/16 bit Digital Output modules</td>
<td>• No external isolators&lt;br&gt;• High reliability</td>
</tr>
</tbody>
</table>
**Key features**

- Maximum supply voltage: 45V
- 8 Channel with Inductive Clamping (VCC - 45V)
- $0.11 \Omega$ typ /$0.2 \Omega$ max @125°C
- Output Current: 0.7A per channel
- Serial/parallel selectable interface
- Short Circuit protection and thermal protection with pre-warning detection
- 8 bit and 16 bit 5MHz SPI Interface for IC command, control and diagnostic, daisy-chain
- Junction over-temperature protections (each channel)
- Additional case over-temperature protection (common for all chan.)
- Low supply current
- Loss of GND protection
- Power Good diagnostic
- Under-voltage protection
- VCC clamp
- Common fault open drain output
- Integrated 3.3V/5V 100mA DC/DC converter
- Programmable Watchdog
- 4x2 Led Matrix integrated driver (outputs status)
- IEC 61131-2 compliant

**System Benefits**

- Reduced component count
- Reduced amount (&cost) of isolators
- Reduced power losses
- Safe Operation
- Less amount of controller I/Os
ISO8200B Octal HSD (110mΩ)

Key features

- Galvanic Isolation according to EN 60664-1
  Transient Overvoltage max. 3500V_{PEAK}
- 8 Channel with Inductive Clamping (VCC - 45V)
- Maximum supply voltage: 45V
- 0.1Ω typ. / 0.2Ω max. @125°C
- Output Current: 0.7A per channel
- Parallel interface with Output Disable pin
- Direct Control Mode, Synchronous Control Mode
- Embedded Watchdog and Vcc fault systems
- Short Circuit protection and thermal protection
- Channel independent over-temp detection and protection
- Drives all type of loads (resistive, capacitive, inductive)
- Loss of GND protection
- Under voltage protection
- VCC clamping
- Low supply current
- Common fault open drain output
- IEC 61131-2 compliant

System Benefits

- Reduced component count
- Reduce System Level Losses
- Safe Operation
Main reason to create IO-Link standard was to enable process data, configuration and diagnostics information exchange between sensors / actuators and control system.

It is a simple point – to – point communication topology, one Master communicates to one Slave (called Device in the IO-Link conventions).

IO-Link uses the same infrastructure like conventional sensors / actuators.

Systems are „backward compatible“ means that IO-Link Master works also with non IO-Link Device and vice-versa.

IO-Link can be used for Digital as well as Analog Sensors and Actuators.
L6360 General Purpose Transceiver / IO-Link compliant Physical Layer

Key features

- Supply Voltage from 18V to 32.5V
- Programmable C/Q output stage: high-side, low-side or push-pull
- Low $R_{DSON}$ 1.2Ω LS / 2Ω HS max.
- 500mA L+ protected high-side driver, $R_{DSON}$ < 2Ω max.
- Supports COM1, COM2 & COM3 modes (4.8/38.4/230.4kbps)
- Additional IEC61131-2 type-1 input (I/Q)
- Short circuit and over-current outputs protection through current limitation and programmable cut-off current / time delays
- 3.3V/5V 50mA linear regulator
- 5-6mA / 2-3mA current sink on C/Qi
- Fast mode I2C for IC control, configuration and diagnostic
- Dual indication LEDs sequence generator and driver
- 5V and 3.3V compatible I/Os
- Over-voltage protection (> 36V)
- Over-temperature protection
- ESD protection
- Miniaturized: QFN 3.5x5x1mm 26L package

QFN 3.5x5x1mm 26L
L6360 Evalboard

Control Board
STEVAL-PCC009V2

USB Interface to PC
GUI Application available

L6360 EvalBoard
STEVAL-IFP016V2

Order Codes
- L6360 Evalboard: STEVAL-IFP016V2
- Control board: STEVAL-PCC009V2 or STEVAL-PCC009V1

Application Immunity verified
- IEC61000-4-2, ESD, Contact / Air, both higher than ±8kV
- IEC61000-4-4, Burst, > ±4kV, performance criteria A* (= internal registers stable)
- IEC61000-4-5, Surge, 4Ω/0.5µF, > ±2.5kV CM / > ±1kV DM (common / differential modes)
# Current IPS Portfolio – Single Channel

<table>
<thead>
<tr>
<th>Part</th>
<th>( V_{CC} )</th>
<th>( R_{PSON} ) [( \Omega )]</th>
<th>( I_{OUT} ) [A]</th>
<th>Technology</th>
<th>Package</th>
<th>Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDE1737DP</td>
<td>8÷50</td>
<td>-</td>
<td>0.5</td>
<td>Bipolar</td>
<td>DIP-8</td>
<td>1 (Low Side)</td>
</tr>
<tr>
<td>TDE1747</td>
<td>10÷50</td>
<td>-</td>
<td>0.5</td>
<td>Bipolar</td>
<td>SO-14</td>
<td>1</td>
</tr>
<tr>
<td>TDE1787</td>
<td>6÷50 (60)</td>
<td>-</td>
<td>0.3</td>
<td>Bipolar</td>
<td>DIP-8</td>
<td>1</td>
</tr>
<tr>
<td>TDE1798</td>
<td>6÷50</td>
<td>-</td>
<td>0.5</td>
<td>Bipolar</td>
<td>DIP-8</td>
<td>1</td>
</tr>
<tr>
<td>TDE1897RFPT</td>
<td>18÷35</td>
<td>0.4</td>
<td>0.5</td>
<td>MultiBCD</td>
<td>DIP-8</td>
<td>1</td>
</tr>
<tr>
<td>TDE1898</td>
<td>18÷35</td>
<td>0.4</td>
<td>0.5</td>
<td>MultiBCD</td>
<td>DIP-8 / SO-20</td>
<td>1</td>
</tr>
<tr>
<td>TDE3247</td>
<td>10÷36</td>
<td>-</td>
<td>0.25</td>
<td>Bipolar</td>
<td>SO-14</td>
<td>1</td>
</tr>
<tr>
<td>L6370</td>
<td>9.5÷50</td>
<td>0.1</td>
<td>2.5</td>
<td>MultiBCD</td>
<td>PowerSO-20 / QFN-48L</td>
<td>1</td>
</tr>
<tr>
<td>L6375</td>
<td>8÷40</td>
<td>0.4</td>
<td>0.5</td>
<td>MultiBCD</td>
<td>SO-20/SO-8</td>
<td>1</td>
</tr>
<tr>
<td>L6377</td>
<td>8÷40</td>
<td>0.4</td>
<td>0.5</td>
<td>MultiBCD</td>
<td>SO-14</td>
<td>1</td>
</tr>
<tr>
<td>VN540</td>
<td>10÷45</td>
<td>0.05</td>
<td>2.8</td>
<td>VIPower</td>
<td>PENTAWATT / PowerSO-10</td>
<td>1</td>
</tr>
<tr>
<td>VN751</td>
<td>5.5÷45</td>
<td>0.06</td>
<td>2.5</td>
<td>VIPower</td>
<td>PPAK / SO-8</td>
<td>1</td>
</tr>
<tr>
<td>TDE1707BFP</td>
<td>6÷48</td>
<td>-</td>
<td>0.5</td>
<td>Bipolar</td>
<td>SO-8</td>
<td>1 (Hi &amp; Low)</td>
</tr>
<tr>
<td>TDE1708DFT</td>
<td>6÷48</td>
<td>-</td>
<td>0.3</td>
<td>Bipolar</td>
<td><strong>DFN 8L</strong></td>
<td>1 (Hi &amp; Low)</td>
</tr>
</tbody>
</table>
## Current IPS Portfolio – Multi Channel

<table>
<thead>
<tr>
<th>Part</th>
<th>$V_{CC}$</th>
<th>$R_{DSON}$ [Ω]</th>
<th>$I_{OUT}$ [A]</th>
<th>Technology</th>
<th>Package</th>
<th>Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>L6360</td>
<td>18÷36</td>
<td>1.2 / 2</td>
<td>0.5</td>
<td>MultiBCD</td>
<td>VFQFPN-26L</td>
<td>2 (+ receivers)</td>
</tr>
<tr>
<td>VNI2140</td>
<td>9÷45</td>
<td>0.08</td>
<td>1</td>
<td>VIPower</td>
<td>PowerSSO-12</td>
<td>2</td>
</tr>
<tr>
<td>L6374</td>
<td>10.8÷40</td>
<td>4</td>
<td>0.1</td>
<td>MultiBCD</td>
<td>SO-20</td>
<td>4</td>
</tr>
<tr>
<td>L6376</td>
<td>9.5÷40</td>
<td>0.64</td>
<td>0.5</td>
<td>MultiBCD</td>
<td>PowerSO-20</td>
<td>4</td>
</tr>
<tr>
<td>VN330</td>
<td>10÷45</td>
<td>0.2</td>
<td>0.7 / 1</td>
<td>VIPower</td>
<td>PowerSO-10</td>
<td>4</td>
</tr>
<tr>
<td>VN340</td>
<td>10÷45</td>
<td>0.2</td>
<td>0.7 / 1</td>
<td>VIPower</td>
<td>PowerSO-10</td>
<td>4</td>
</tr>
<tr>
<td>VNI4140</td>
<td>10.5÷41</td>
<td>0.08</td>
<td>0.7 / 1</td>
<td>VIPower</td>
<td>PowerSSO-24</td>
<td>4</td>
</tr>
<tr>
<td>VNQ860</td>
<td>5.5÷41</td>
<td>0.27</td>
<td>0.25</td>
<td>VIPower</td>
<td>SO-20/PowerSO-10</td>
<td>4</td>
</tr>
<tr>
<td>VN808</td>
<td>10.5÷45</td>
<td>0.15 / 0.16</td>
<td>0.7 / 1</td>
<td>VIPower</td>
<td>PowerSO-36</td>
<td>8</td>
</tr>
</tbody>
</table>

## IPS in Development

<table>
<thead>
<tr>
<th>Part</th>
<th>$R_{DSON}$ [Ω]</th>
<th>Package</th>
<th>Datasheet</th>
<th>Eng. samples</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNI8200XP</td>
<td>0.110</td>
<td>PowerSSO-36</td>
<td>Available</td>
<td>Available</td>
<td>Octal HSD with SPI / Parallel interface, DC/DC, LED driver…</td>
</tr>
<tr>
<td>ISO8200B</td>
<td>0.110</td>
<td>PowerSO-36</td>
<td>Available</td>
<td>Available</td>
<td>Octal HSD with galvanic isolation, parallel interface</td>
</tr>
<tr>
<td>L6362</td>
<td>2</td>
<td>DFN-10L 3x3 mm</td>
<td>Available</td>
<td>Q3/2013</td>
<td>General purpose transceiver / IO-Link Device physical layer</td>
</tr>
</tbody>
</table>
Thank you for attention!