Motor Control

Power & Analog program

European Multi System Market Competence Center
- Motors overview
- Standard chip solution
  - Controllers
  - Integrated power stages
- Power spin
- ST Gate drivers
  - High voltage gate drivers L638x
  - TD35x Family: Advanced IGBT/Mosfet Driver for 1200V Applications
- Evaluation boards
# Types of motors

<table>
<thead>
<tr>
<th>WITH BRUSHES</th>
<th>BRUSHLESS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNIVERSAL</strong></td>
<td><strong>ELECTRONICALLY COMMUTATED</strong></td>
</tr>
<tr>
<td>Standard MCU – ACS/Triac Control</td>
<td>BLDC + SR Synchronous</td>
</tr>
<tr>
<td>Dedicated MCU – 3 phase Inverter Control</td>
<td>1 &amp; 3 phase induction Asynchronous</td>
</tr>
</tbody>
</table>
# Main motors and driving methods

<table>
<thead>
<tr>
<th>Motor Type &amp; Suitable MCU</th>
<th>Supply</th>
<th>Speed controlled by</th>
<th>Typical Power Controller</th>
<th>Main Advantage</th>
<th>Main Weakness</th>
<th>Typical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal (single phase)</td>
<td></td>
<td></td>
<td>Triac (phase angle)</td>
<td>Easy speed control, high torque at start-up</td>
<td>Lower life time, noisy sparks, poor efficiency</td>
<td>Washing-machine in Europe, vaccum-cleaner, power tools, food processor</td>
</tr>
<tr>
<td>AC or DC</td>
<td>RMS Voltage</td>
<td></td>
<td>IGBT + Free Wheeling Diode (PWM)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST72F32x &amp; ST7FLite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Induction (single phase)</td>
<td>AC</td>
<td>Freq.</td>
<td>Triac (on/off)</td>
<td>Robust, silent, efficient</td>
<td>Fixed speed</td>
<td>Fridge compressor, aircon compressor, washing-machine in A/P &amp; US</td>
</tr>
<tr>
<td>ST72F32x &amp; ST7FLite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Induction (3 phases)</td>
<td>AC</td>
<td>Freq.</td>
<td>Inverter (electronic control)</td>
<td>Robust, silent, efficient, variable speed</td>
<td>Cost until volume effect appears</td>
<td>Aircon compressor and fans, industrial control, washing-machine, UPS, pumps</td>
</tr>
<tr>
<td>ST7FMC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>High-end industrial control (vector ctrl)</td>
</tr>
<tr>
<td>STR91x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>STM32x</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>PM BLDC &amp; Switched</td>
<td>AC</td>
<td>Phase commutation speed</td>
<td>Inverter (electronic control)</td>
<td>Silent, very efficient, variable speed</td>
<td>Cost until volume effect appears</td>
<td>Automotive, fridge, compressor, aircon compressor, vaccum-cleaner, fans, pumps (sensorless)</td>
</tr>
<tr>
<td>Reluctance (3 phases)</td>
<td>DC</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ST7FMC</td>
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<tr>
<td>STR91x</td>
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<tr>
<td>STM32x</td>
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<td></td>
</tr>
<tr>
<td>PMAC (2&amp;3 phases)</td>
<td>AC</td>
<td>Freq.</td>
<td>Inverter (electronic control)</td>
<td>Silent, very efficient, variable speed</td>
<td>Cost until volume effect appears</td>
<td>Pumps (sensorless)</td>
</tr>
<tr>
<td>STR91x</td>
<td></td>
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<tr>
<td>STM32x</td>
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</tr>
</tbody>
</table>
Motor control: flexible platform

Discrete Solution
- Single Gate Driver: **TD3xx Family**
- + MOS / IGBTs
  - High Voltage Gate Drivers: L638x Family
  - L639x Family

Monolithic Solution
- controlSPIN
- + Mosfets
  - L62xx
  - L293/298
  - L6201/2/3

Factories: Smart Factory, Home Automation
- Office Automation: Printers, LBP
- Industrial: Vending Machine, Money dispenser, POS
- Toys, Consumer Applications, Medical

Climate Control, Fans, White goods
Vacuum cleaner, food processor
Pumps, Industrial Applications
Motor control product matrix

<table>
<thead>
<tr>
<th>Controller</th>
<th>Gate Driver</th>
<th>Power Stage</th>
<th>Driver</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L6205</td>
<td>L6208</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L6206</td>
<td>L6206</td>
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<tr>
<td></td>
<td></td>
<td>L6207</td>
<td>L6207</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L6226</td>
<td>L6226</td>
</tr>
<tr>
<td>Dual H-Bridges</td>
<td>Bipolar Integrated Power Stage</td>
<td>TD310</td>
<td>L6203</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L6227</td>
<td>L6227</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>powerSPIN</td>
</tr>
<tr>
<td>3ph Bridges</td>
<td>TD310</td>
<td>L6234</td>
<td>L6235</td>
</tr>
<tr>
<td>H-Bridges</td>
<td>L296</td>
<td>L6234</td>
<td>L6229</td>
</tr>
<tr>
<td>Half Bridges</td>
<td>L297</td>
<td>L6201</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>L6229</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>L6506</td>
<td>L6201</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L297</td>
<td>L6202</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>L6201</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>L297</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L293</td>
<td>L6235</td>
<td></td>
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<tr>
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<tr>
<td></td>
<td></td>
<td>L6235</td>
<td></td>
</tr>
</tbody>
</table>
L297 – Bipolar Stepper Motor Controller

**L297 Main Features**

- Supply Voltage from 4.75 to 7V
- Typ. Quiescent Supply Current 50mA
- Constant Frequency PWM Control
- Sync. Function
- Phase Sequence Generator
  - Half Step Mode
  - Full Step Mode
- Reset Input & Home Output
- Enable Input
- Direction Setting

**Packages**

- DIP20 (L297)
- SO20 (L297D)
L6506 Main Features

- Supply Voltage from 4.5 to 7V
- Max. Quiescent Supply Current 25mA
- Constant Frequency PWM Current Control
- Sync. Function

Packages

- DIP18 (L6506)
- SO20 (L6506D)
L293D/L293DD Main Features

- Supply Voltage up to 36V
- Output Peak Current 1.2A (0.6A DC)
- $V_{cesat} = 1.8V_{max} @0.6A$
- Operating Frequency up to 5KHz
- Thermal Shut Down
- TTL Compatible Inputs
- Internal Clamp Diodes

Packages

- SO20 (L293DD)
- PowerDIP20 (L293D)
- QFN 5x5x1 – 32 L
L2293Q Main Features

- Supply Voltage rating 2.8V - 36V
- Output Peak Current 1.2A (0.6A DC)
- Vcesat = 1.8Vmax @0.6A
- Operating Frequency up to 50KHz
- Thermal Shut Down
- TTL Compatible Inputs
- Internal Clamp Diodes

Packages
- QFN 5x5x1 – 32 L

NEW !!!
L298 – Bipolar Dual Full Bridge

**L298 Main Features**

- Supply Voltage up to 46V
- Output Peak Current 3A (2A DC)
- $V_{cesat} = 3.7V_{max} @2A/25^\circ C$
- Cross Conduction Protection
- Thermal Shut Down
- TTL Compatible Inputs

**Packages**

- MultiWatt15 Vert. (L298N)
- MultiWatt15 Horiz. (L298HN)
- PowerSO20 (L298P)
L6201/L6202/L6203 DMOS Full Bridge

Key Features
• Up to 46 V supply
• 5A Peak current
• $R_{DSON} \ 0.3\, \Omega$
• Cross conduction protection
• Thermal shutdown
• Internal charge pump

2x L6201/02/03 are needed to drive a Bipolar Stepper motor
Power SPIN

- Operating Supply Voltage from 8 to 52V
- PowerMOS output stage:
  - $R_{ds(on)} = 0.3\Omega$ or $0.73\Omega$
  - *Intrinsic Fast Free Wheeling Diodes* L622X: 2.8Apk and 1.4Arms
- Two product classes covering different current ratings:
  - L620X and L6235: 5.6Apk and 2.8Arms
  - L622X: 2.8Apk and 1.4 A rms
  - *Paralleled Operation doubles peak and rms ratings!*
- Extensive Protection Schemes
  - Non-Dissipative High Side Current Sensing for *Over Current Protection*
  - Cross Conduction Protection
  - *Thermal Protection*
  - Under Voltage Lock Out
- CMOS/TTL Inputs
- Operating Frequency up to 100KHz

*a motor driver platform ready for mass customization*
Power SPIN family portrait

**Dual H-Bridge**
- Basic Power Stage
  - Fixed Over Current
  - Smallest Package
  - For Dual DC or Stepper
- Stepper Motor Driver
  - Single Chip
  - For bipolar Stepper

**3ph Bridge**
- Brushless Motor Driver
  - Hall sensors decoding logic
  - PWM Current Control
  - Tacho output

**Power Stage with PWM**
- Twin Current Control
- For Dual DC or Stepper

**Enhanced Power Stage**
- Settable Over Current Diagnostic Output
- For Dual DC or Stepper
# Power Spin selection table

<table>
<thead>
<tr>
<th>Function</th>
<th>P/N</th>
<th>Description</th>
<th>Packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three phase brushless motor driver</td>
<td>L6229</td>
<td>Hall sensor decoding logic, PWM current loop, diagnostic output, fixed overcurrent detection</td>
<td>PowerSO36 SO24 - DIP24</td>
</tr>
<tr>
<td>Bipolar Stepper Motor Driver</td>
<td>L6228</td>
<td>Stepping sequence generation logic, twin PWM current loop, diagnostic output, fixed overcurrent detection</td>
<td>PowerSO36 SO24 - DIP24 QFN32</td>
</tr>
<tr>
<td>Dual H Bridge with twin PWM control</td>
<td>L6227</td>
<td>Twin PWM current loop, diagnostic output, fixed overcurrent detection</td>
<td>PowerSO36 SO24 - DIP24 QFN32</td>
</tr>
<tr>
<td>Dual H Bridge with adjustable overcurrent detection</td>
<td>L6226</td>
<td>Diagnostic output, adjustable overcurrent detection</td>
<td>PowerSO36 SO24 - DIP24 QFN32</td>
</tr>
<tr>
<td>Dual H Bridge with fixed overcurrent detection</td>
<td>L6225</td>
<td>Fixed overcurrent detection</td>
<td>PowerSO20 SO20 - DIP20</td>
</tr>
</tbody>
</table>

**Common Features:**

- BCDIIIs, 1um, 60 V Mixed signal power technology
- Operating Supply Voltage from 8 to 52V
- PowerMOS output stage:
  - typical $R_{ds(on)} = 0.3\Omega$ or $0.73\Omega$ @ $T_j = 25\, ^\circ C$
  - Intrinsic Fast Free Wheeling Diodes
Main Features:

- Operative Voltage: 7V - 52V
- Output Peak Current 5.6A / 2.8A*
- Operating Frequency up to 100KHz
- Cross conduction protection
- Fixed (5.6A/2.8A*) Over Current trip point
- Thermal Shut down
- Aimed at dual DC / Bipolar Stepper
Fully protected dual H-bridge: L6205/25
Main Features:
- Supply Voltage rating 7V - 52V
- Output Peak Current 5.6A (2.8A)*
- $R_{dson} = 0.3\ \Omega \ (0.73\ \Omega) \ast \text{typ}$
- Operating Frequency up to 100KHz
- Cross conduction protection
- Settable Over Current Threshold
- Thermal Shut down

Application
- Dual or quad DC Motors
- Bipolar Stepper Motors
- High Current DC Motor

...with an external OCD setting, here's L6206 and L6226

New **L6226Q** !!!
Typical application with L6206/26

- Drives:
  - Dual DC
  - Bipolar Stepper
  - High Current DC
...then add a twin PWM control to get L6207 and L6227*

Main Features
- Supply Voltage rating 7V - 52V
- Output Peak Current 5.6A (2.8A)*
- \( R_{ds} = 0.3\Omega \) (0.73\( \Omega \))* typ
- Operating Frequency up to 100KHz
- Twin integrated PWM for chopping regulation
- Cross conduction protection
- Thermal Shut down

New **L6227Q**!!!
...twin PWM control: L6207 and L6227
L6208 & L6228* — DMOS stepper motor driver!!!

**L6228Q Main Features**

- Supply Voltage rating 7V - 52V
- Output Peak Current 5.6A (2.8A)*
- Rdson = 0.3Ω (0.73Ω)* typ
- Operating Frequency up to 100KHz
- Internal PWM current control
- Cross conduction protection
- Thermal Shut down
- Non dissipative Over Current protection
- Translator integrated
- Digital setting of decay mode

**Packages**

- SO24, DIP24, powerSO36
- QFN 5x5x1 – 32 L

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Twin integrated PWM current controller
Integrated Translator
Digital decay mode setting

New **L6228Q***
Stepper Motor Driver Complete Solution: L6208/L6228
Current Ratings vs Package and configuration

Assumptions

- $T_j = 125^\circ C$
- $V_s = 24V$
- Synchronous Rectification
- SO $P_{d\max} = 1W$
- DIP $P_{d\max} = 2W$
- PowerSO $P_{d\max} = 3.5W$
**L622xQ: more (power) with less (space)**

**MINIATURIZATION / THERMAL PERFORMANCES**

- **L622xD**
  - SO24
  - Footprint: 10.3 mm x 15.4mm

- **L622xQ**
  - **QFN 5x5x1 – 32L**
  - + 50% Thermal Performance
  - - 85% Footprint Area
### VFQFP-N PACKAGE THERMAL COMPARISON

<table>
<thead>
<tr>
<th>PACKAGE TYPE (pitch : 0.5mm)</th>
<th>Theta J-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFQFPN 32 (5x5)</td>
<td>27.3°C/W</td>
</tr>
<tr>
<td>powerDIP24</td>
<td>36°C/W</td>
</tr>
<tr>
<td>SO24</td>
<td>60°C/W</td>
</tr>
<tr>
<td>powerSO36</td>
<td>18°C/W</td>
</tr>
</tbody>
</table>
L6234 Main Features

- Supply Voltage from 7 to 52V
- Output Peak Current 5A (2.8A DC)
- PowerMOS Typical \( R_{DS(ON)} = 0.3 \Omega @ T_J = 25^\circ C \)
- Operating Frequency up to 50KHz
- Cross Conduction Protection
- Thermal Shut Down
- CMOS/TTL Inputs
- Intrinsic Fast Free Wheeling Diodes
- Internal Logic Supply

Applications:

- BLDC 3 phases sensorless
Complete BLDC Motor Driver Solutions: Fully Protected L6235 and L6229 Driver

- Integrated hall sensor decoding logic
  - 60 or 120 degrees
- Integrated PWM current control
- Diagnostic Output
- Simple Interface to host
- Tacho Output for Speed control

Applications:
- BLDC 3 phases with hall sensors
• L6235/L6229 common main features
  – Internal PWM current Control
  – Thermal Protection
  – Overcurrent Protection
  – Power On Reset Circuit
  – Translator integrated
  – Slow Decay
  – Simple Interface to Host
L6235/29: current rating vs. package options

Assumptions

•  $T_j = 125^\circ C$
•  $V_s = 24V$
•  Switching Frequency $F_s = 20Ky$z
•  SO $P_{d_{\text{max}}} = 1.3 \text{ W}$
•  DIP $P_{d_{\text{max}}} = 1.9 \text{ W}$
•  PowerSO $P_{d_{\text{max}}} = 3.6 \text{ W}$
PractiSPIN: PowerSpin demotools architecture

A comprehensive set of tools:
- a set of Demo Boards (EVAL620X, x = 5, 6, 7, 8 and EVAL6235)
- an ST7 Based Demo-to-PC interface board
- a Windows based User Interface

Enabling user to:
- establish plug-and-play connection to the motor for a rapid product evaluation
- first cut thermal analysis
- Motors overview
- Standard chip solution
  - Controllers
  - Integrated power stages
- Power spin
- **ST Gate drivers**
  - High voltage gate drivers L638x
  - TD35x Family: Advanced IGBT/Mosfet Driver for 1200V Applications
- Evaluation boards
Monolithic and Discrete Approach

Voltage [V]

1200
600
75
52

Current [A]

3
15

Discrete Solution
Single Gate Driver: **TD3xx Family**
+ MOS / IGBTs

High Voltage Gate Drivers:
**L638xE and L639x Family**

Monolithic Solution

L62xx
L293/298
L6201/2/3

Factory automation, Home Automation
Office Automation: Printers, LBP
Industrial: Vending Machine, Money dispenser, POS
Toys, Consumer Applications, Medical

Climate Control, Fans
White goods
Vacuum cleaner, food processor
Pumps
Industrial Applications

TD3xx Family
High Voltage Gate Drivers Family

Current Generation

- L6384E
  - Hi/Low Side & SD Input Uncommitted Comp SO/DIP14

- L6385E
  - Hi & Low Side Input Shoot Through Protection
  - 3.3V Input Logic

- L6387E
  - Hi & Low Side Input Shoot Through Protection

- L6388E
  - Single Input Adjustable Dead Time

- L6386E

smartDRIVE

- Half Bridge
- Optimized Driving Current
- 3.3V Input Logic
- Additional Features
  - OpAmp
  - Comparator
  - Bootstrap Diode
  - Smart SD
KEY FEATURES

- 1 Logic input → 2 Outputs
- Input in phase with HVG, out of phase with LVG
- Adjustable Dead-Time / Shut Down input
- Inputs compatible to Vcc
- Vcc Under-voltage lock out (Turn-On@12V, Turn-Off@10V)
- Internal clamp on Vcc at 15.6V (typ)
The L6384 SD/DT pin has a double function:

1. dead time setting from 0.4 to 3.1 µs (resistor);
2. Shut down functionality (SD/DT below 0.5V Typ.);

The Shut Down propagation delay is 280ns max.;
KEY FEATURES

• 2 Logic input → 2 Outputs
• Logic Inputs in phase with the Outputs
• Under-voltage Lock-out on lower and Upper driving section
• Supply Voltage up to 17 V (Typ.)
• **KEY FEATURES**
• 2 Logic input → 2 Outputs
• Logic Inputs in phase with the Outputs
• Cross-conduction prevention logic

<table>
<thead>
<tr>
<th>INPUT</th>
<th>HIN</th>
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<td>LIN</td>
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<tr>
<td>OUTPUT</td>
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<td>1</td>
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<tr>
<td></td>
<td>LVG</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

• Supply voltage up to 17 V (typ.)
• Vcc Under-voltage lock-out (Turn-On@6V, Turn-Off@5.5V)
KEY FEATURES

- **2 Logic input → 2 Outputs**
- Logic Inputs in phase with the Outputs
- Shut-Down input
- Built-in comparator
- Signal and Power Ground
- Under-voltage Lock-out on
- Lower and Upper driving section
- Supply voltage up to 17 V (typ.)
The L6386 has a **fast Shut Down logic input** (propagation delay **150ns** max.)

This pin can be used in a double way:

1. Together with the DIAG pin
2. With an external uC/DSP/Logic…

**DIAG PIN: Built-in comparator timing**

**Overcurrent protection using the SD/DIAG pin**

**DIAG pin (pin 5) current capability:**
DIAG pin is “open collector” and the pull down capability is up to **2.5mA**. (Suggested values for the Pull up Resistor are 5kΩ-10kΩ)
KEY FEATURES

• 2 Logic input → 2 Outputs
• 3.3V Compatible Inputs
• Cross-conduction prevention logic
• Logic Inputs in phase with the Outputs
• Under-voltage Lock-out on lower and Upper driving section
• Supply Voltage up to 17 V (Typ.)
## L638XE Short Form

<table>
<thead>
<tr>
<th></th>
<th>L6384E</th>
<th>L6385E</th>
<th>L6386E</th>
<th>L6387E</th>
<th>L6388E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asymm. H.B</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td><strong>Symm. H.B</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td><strong>Shut Down</strong></td>
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<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td><strong>Built in Comp.</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>UVLO on Vcc</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Turn-On: 12V Turn-Off: 10V</td>
<td>Turn-On: 9.6V Turn-Off: 8.3V</td>
<td>Turn-On: 12V Turn-Off: 10V</td>
<td>Turn-On: 6V Turn-Off: 5.5V</td>
<td>Turn-On: 9.6V Turn-Off: 8.3V</td>
</tr>
<tr>
<td><strong>UVLO On Vboot</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td></td>
<td>Turn-On: 9.5V Turn-Off: 8.2V</td>
<td>Turn-On: 11.9V Turn-Off: 9.9V</td>
<td>No</td>
<td>Turn-On: 9.5V Turn-Off: 8.2V</td>
<td></td>
</tr>
</tbody>
</table>
smartDRIVE: HV gate driver evolution

L638xE Evolution

ALL BASED on ST BCD OFF LINE Technology

Q1 06  Q2 06  Q3 06  Q4 06  Q1 07  Q2 07  Q3 07  Q4 07

Full Featured
14/16 Lead SO / DIP Packages

Multiple Driver

New Full Feature Driver

Multiple H Bridge & 3-Phase

Engineering Samples

Production Start up

Specification ready

Family Definition
L639x: the smartDRIVE

- Power MOSFETs
- IGBT

**Power Supply**
- Interface

**Control**
- Digital Control

**smartDRIVE**
- High Voltage GATE DRIVER
- Protections
- Full Features
- Feedback

**Power Stage**
- Power MOSFETs
- IGBT
smartDRIVE L639x
A Flexible Platform for Mass Customization

Wide Block Diagrams Spectrum in the Library

- UVLO on HS
  3 different Thresholds
- Dead Time
  Fixed or Adjustable
- Shut Down
  Fast Shut Down Block
- UVLO on LS
  3 different Thresholds

High Side Driver
Current Capability: 290/430 Sink/Source

Low Side Driver
Current Capability: 290/430 Sink/Source

Interlocking
for Cross Conduction Prevention

OPAMP
12MHz  3.8V/µs
offset < 6mV

Comparator
> 10 V/µs

Bootstrap Diode
smartDRIVE Platform Features

KEY FEATURES
• Current capability - 290mA source / 430mA sink
• Integrated bootstrap diode
• TTL/CMOS/ 3.3V, 5V, 15V inputs with hysteresis and pull-down
• UVLO on Both Low- and High-Side
• SO14/DIP14, SO16/Dip16
• Operational Amplifier for advanced current sensing
• Comparator (for protections)

ST ADVANTAGE
• Designed to optimize vector Motor Drive Systems
• Internal bootstrap diode eliminating the external high voltage diode
• Better Performance at high switching frequencies (thanks to BCD ST process)
• Unique level of integration: external component reduction
• Simplify board layout, reduction of board dimension
L639x family portrait

Full Feature
- Single Input Comparator
- Dedicated Pin for SD
- Adjustable DT
- Dedicated Pin for OCD
- Slow Decay Input

Dual Feature
- Dual Input OPAMP
- Dedicated Pin for SD
- Adjustable DT
- One input out of phase

Coming soon!

smartDRIVE
L6390: Full Feature Half Bridge Driver

Smart SD protection (200ns)

Shut Down Diagnostic

COMPARATOR
Vref 500mV; >10V/μs
Open drain 3mA @ 0.5V
for Over Current, Thermal Protection, etc

OPAMP for Current sense
GBWP 8Mhz; SR = 3.8V/μs
GB 85dB

Adjustable DT (0.18 to 3μs)
Motor Drive: Field Oriented Vector Control

Power Supply (Flyback o Buck)

15V

AC Line (230V rms)

300V

15V

Gate Driver

15V

Gate Driver

15V

Gate Driver

ADC

CURRENT SENSING
3x OP-AMP in SO14
Signal conditioning (filtering, shifting) before A/D conversion

PROTECTIONS
3x COMPARATOR
For fast overcurrent protection
### Full Features Half Bridge Driver

<table>
<thead>
<tr>
<th>Feature</th>
<th>L6390</th>
<th>L6393</th>
<th>L6392</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Capability (source/sink)</td>
<td>[mA]</td>
<td>290/430</td>
<td>290/430</td>
</tr>
<tr>
<td>Internal Bootstrap Diode</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Input phasing</td>
<td>Out of phase</td>
<td>One input / slow decay input</td>
<td>Out of phase</td>
</tr>
<tr>
<td>Input Logic threshold Levels</td>
<td>[V]</td>
<td>3.3, 5 or 15 V</td>
<td>3.3, 5 or 15 V</td>
</tr>
<tr>
<td>UVLO Vcc</td>
<td>[V]</td>
<td>12 – 10.5</td>
<td>12 – 10.5</td>
</tr>
<tr>
<td>UVLO Vboot</td>
<td>[V]</td>
<td>11.5 – 10</td>
<td>9.1 – 8.1</td>
</tr>
<tr>
<td>Dead Time</td>
<td>Adjustable (0.18 to 3µs)</td>
<td>Adjustable (0.18 to 3µs)</td>
<td>Adjustable (0.18 to 3µs)</td>
</tr>
<tr>
<td>Interlocking</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Comparator</td>
<td>Y</td>
<td>Y (Uncommitted)</td>
<td>N</td>
</tr>
<tr>
<td>OPAMP</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Package</td>
<td>SO16 / DIP16</td>
<td>SO14 / DIP14</td>
<td>SO14 / DIP14</td>
</tr>
</tbody>
</table>
Advanced IGBT / Mosfet Driver for 1200V Applications - TD35x Family -
**600V Applications:**
- Use High Voltage Gate Drivers
- Don’t need advanced functions nor galvanic insulation
- Appliance/Industrial applications

**1200V Applications:**
- Use separate HS & LS Drivers
- Higher power applications need more advanced control functions
- Galvanic insulation mandatory for High Side, also often needed for Low Side
- Industrial only applications

TD35x as part of ST Motor Control Solutions
TD350 is a flexible solution for high performance designs with advanced control and protection features.

TD351/352 are cost effective solutions with minimum external component count, although providing the most valuable features.
TD350 – Single IGBT/MOSFET Driver

**Features:**
- 0.75A/1.2A min current capability
- Active Miller clamp
- Separate sink & source outputs for easy gate drive
- Desaturation protection (programmable blanking time)
- Optional 2-steps turn-off sequence
- Input compatible with pulse transformer or optocoupler
- Negative gate drive capability
- Fault status output
- UVLO Protection
- SO14 package

**Applications:**
- 1200V 3-phase inverter
- Industrial motor control
- UPS systems
Medium IGBT/Mosfet drive with single supply and active Miller clamp

Large IGBT/Mosfet drive with negative gate drive and external buffers

- STS01DTP06
- STS05DTP03
<table>
<thead>
<tr>
<th>Feature</th>
<th>Part</th>
<th>TD350</th>
<th>TD351</th>
<th>TD352</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak current +/- (min.)</td>
<td></td>
<td>+0.75A / -1.2A</td>
<td>+0.75A / -1.0A</td>
<td></td>
</tr>
<tr>
<td>Active Miller clamp</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Negative gate drive ability</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>2-level turn-off control</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Desaturation protection</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Fault output</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Separate sink/src outputs</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Input - pulse transf. - optocoupler</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Package</td>
<td></td>
<td>SO14</td>
<td>SO8</td>
<td></td>
</tr>
</tbody>
</table>
Available demo-boards where ST HV drivers are used:

- Motor Control

www.st.com/evalboards
BLDC & AC Motor Control Control Board

Features:

- Quick to set up, to install and easy to run
- Easy to configure thanks to dedicated Graphic User Interface (RDK-GUI)
- Firmware libraries available for easy customization (RDK-Libraries)
- Design is re-usable (the ORCAD source files are available for free)
- Several kinds of applications with six-step commutation or 6-signal PWM (sine-wave modulated) outputs, including: 3 Phase AC Induction motor control, 3 Phase BLDC/AC PM motor control (6-step sensorless), 3 Phase BLAC PM motor control (sinusoidal driven, with Hall sensors)
- Optimized layout to provide very low level of interference between the Power and the Signal noise
- Modular approach with three different power board module (300W, 1kW, 3kW)

Control board for power stage
MCU: ST7FMC – Driver: L6386D

In stock
300W BLDC & AC Motor Control Power Driver Board

Features

■ Quick to set up, to install and easy to run
■ Inverter stage IGBT short circuit rugged based
■ Design is re-usable (the ORCAD source files are available for free)
■ Several kinds of applications with six-step commutation or 6-signal PWM (sine wave modulated) outputs, including: 3 Phase AC Induction motor control, 3 Phase BLDC/AC PM motor control (6-step sensorless), 3 Phase BLAC PM motor control (sinusoidal driven, with Hall sensors)
■ Optimized layout to provide very low level of interference between the Power and the Signal noise
■ Modular approach with three different power board module (300W, 1kW, 3kW)
1kW BLDC & AC Motor Control Power Driver Board

Features:

- Quick to set up, to install and easy to run
- Inverter stage IGBT short circuit rugged based
- Design is re-usable (the ORCAD source files are available for free)
- Several kinds of applications with six-step commutation or 6-signal PWM (sine-wave modulated) outputs, including: 3 Phase AC Induction motor control, 3 Phase BLDC/AC PM motor control (6-step sensorless), 3 Phase BLAC PM motor control (sinusoidal driven, with Hall sensors)
- Optimized layout to provide very low level of interference between the Power and the Signal noise
- Modular approach with three different power board module (300W, 1kW, 3kW)
3kW BLDC & AC Motor Control Power Board

Features:

- Reusable design (the ORCAD source files are available free of charge)
- Supports several applications with six-step commutation or 6-signal PWM (sine-wave modulated) outputs including: 3-phase AC induction motor control, 3-phase BLDC/AC PM motor control (6-step sensorless) and 3-phase BLAC PM motor control (sinusoidal driven, with hall sensors)
- Optimized layout providing a very low level of interference between power and signal noise Inverter stage based on short-circuit rugged IGBTs
Motor Control

1kW BLDC & AC Motor Control Power board with SEMITOP®2

Features:

- Quick to set up, to install and easy to run
- Inverter stage IGBT short circuit rugged based
- Design is re-usable (the ORCAD source files are available for free)
- Several kinds of applications with six-step commutation or 6-signal PWM (sine-wave modulated) outputs, including: 3 Phase AC Induction motor control, 3 Phase BLDC/AC PM motor control (6-step sensorless), 3 Phase BLAC PM motor control (sinusoidal driven, with Hall sensors)
- Optimized layout to provide very low level of interference between the Power and the Signal noise
- Designed with ST SEMITOP® 600V / 10A module (STG3P2M10N60B)
3kW BLDC & AC Motor Control Power Board with SEMITOP®3

Features:

■ Quick to set up, to install and easy to run
■ Inverter stage IGBT short circuit rugged based
■ Design is re-usable (the ORCAD source files are available for free)
■ Several kinds of applications with six-step commutation or 6-signal PWM (sine-wave modulated) outputs, including: 3 Phase AC Induction motor control, 3 Phase BLDC/AC PM motor control (6-step sensorless), 3 Phase BLAC PM motor control (sinusoidal driven, with Hall sensors)
■ Optimized layout to provide very low level of interference between the Power and the Signal noise
■ Designed with ST SEMITOP® 600V / 25A module (STG3P3M25N60)
IGBT power module kit controlled by ST7FMC

Features:

- 5 V power supply connector
- 34-pin dedicated motor-control connector
- Serial communication interface connector
- Programming and debug support via 10-pin ICC connector
- Onboard 2-Kbit (256 byte) serial memory
- 4 potentiometers for runtime settings
- Start / stop button
- Reset button
- Debug pins available
IGBT power module kit – SEMITOP®2 power board

Features:

- 34-pin dedicated motor-control connector
- 5-pin Hall sensor/encoder input
- Tachometer sensor input
- Support for 5 V or 3.3 V microcontroller
- Three configurations for current detection:
  - 1 shunt resistor
  - 3 shunt resistors or
  - 3 external ICSs (insulated current sensor)
- Current amplification network BEMF detecting network
- Hardware current protection
- Hardware thermal protection (on board temperature sensor)
- Resistive brake network

Driver: L6386D
Low-voltage motor control demo kit based on ST7FMC2S4T6 and STS8DNH3LL

Features:

- Voltage range from 5 V to 48 V Current up to 25 A
- Power MOSFET STS8DNH3LL (dual device) 8 A 30 V included Compatible with power MOSFET in SO-8 and DPAK
- 10 V auxiliary power supply connector Serial communication interface connector Programming and debug support via 10-pin ICC connector
- Onboard 2-Kbit (256 byte) serial memory
- Four potentiometers for runtime settings
- Start/stop button Reset button
- Debug pins available

Driver: L6387D
100W 3-phase inverter for BLDC sensor less motor control

Features:

- Minimum input voltage 125VDC or 90VAC
- Wide input voltage range Maximum power up to 100 W
- 4.4 A, 520 V power MOSFET included Compatible with power MOSFETs in IPAK packages
- 15 V auxiliary power supply connector
- Programming and debugging support via 10-pin ICC connector
- Three potentiometers for runtime settings
- Start/stop button
- Reset button

Driver: L6386D
Complete inverter for low power 3-phase asynchronous motors demonstration board

Features:

- Voltage Input range 115 VAC to 230 VAC 50/60 Hz
- Total output power 50 W
- High efficiency
- Switching PWM frequency 12 - 22 kHz
- Compliant with EN61000-6-3 and EN61000-6-2
- Possibility to use two motor types:
  - 2-phase motor two sinusoidal voltage waves restored with a phase displacement of 90° between them
  - 3-phase motor three sinusoidal voltages with phase displacement of 120° among them

Driver: L6388D
100W 3-phase inverter based on L6390D and STD5NK52ZD for speed FOC of 3-phase PMSM Motor drive

Features:

- 50 Hz or 60 Hz Input voltage wide range (110 VAC and 230 VAC)
- Maximum power-up to 100 W at 230 VAC input voltage
- Power MOSFET STD5NK52ZD-1 (4.4 A 520 V) Compatible with other power MOSFET’s in IPAK packages
- +15 V auxiliary power supply connector
- Connector for interface with STM3210B-EVAL board
- Target applications:
  - Refrigerators compressors
  - Dishwasher pumps

Driver: L6390D
1 kW 3-phase motor control evaluation board featuring L6390 drivers and STGP10NC60KD IGBT

Features:
■ Minimum input voltage 125VDC or 90VAC
■ Maximum input voltage 375VDC or 270VAC
■ Voltage range for low voltage motor control application from 18VDC to 35VDC
■ Possibility to use auxiliary +15V supply voltage
■ Maximum output power for motor up to 1000W
■ Regenerative brake control feature
■ Input inrush limitation with bypassing relay
■ +15V auxiliary power supply based on buck converter with VIPer16
■ Fully populated board conception with testing points and safety isolated plastic cover
■ Motor control connector for interface with STM3210B-EVAL board and further ST motor control dedicated kits
■ Tacho input
■ Hall/encoder inputs
■ Possibility to connect BEMF daughter board
STM3210B-MCKIT and STR750-MCKIT
3-phase motor control power stage

Motor Control

Features:

- Voltage Input range 115 VAC to 230 VAC
- An input power stage with voltage rectification and auxiliary power supply,
- A 7A three-phase inverter based on IGBT and level shifter,
- A motor connector for linking with the control board,
- A connector for motors with Hall/encoder and tachometer input.
- The MB459B motor control evaluation board can be supplied in two ways:
  - From a single power supply for motors requiring a voltage greater than 18 V
  - From a dual power supply for motors requiring a voltage less than 18 V
TD350 Advanced IGBT Driver

Motor Control

TD350 Advanced IGBT/MOSFET Driver

Features:

- 0.75A min gate drive
- Negative gate drive ability
- Input compatible with pulse transformer or optocoupler
- Separate sink and source outputs for easy gate drive
- Two steps turn-off with adjustable level and delay
- Miller clamp feature
- Desaturation protection
- Fault status output
- UVLO protection
- 2kV ESD protection
L6393 Full-Bridge board

- **Available L6393 full-bridge board:**
  - For DC motors and Single-phase BLDC (e.g. FAN)
  - Up to **5A** on output phase
  - All **SMD** components, **no heat-sink**
  - Highly compact and **optimized layout**

**reference design**

TOP LAYER

BOTTOM LAYER

4.5 cm

4.3 cm