MPS BLDC Solution w/ High Efficiency & Accuracy
Controller and Position Sensor
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Leading BCD Process

Superior Performance:
- Monolithic
- Higher Operating Voltage
- Superior Power Density
- High CP Solution

Captive Fab

MPS

Foundry

The Future of Analog IC Technology®
Motor Application

- **Stepper**
- **Single-Phase**
- **3-Phase**

The Future of Analog IC Technology®
• Single Phase BLDC Solution
• 3-Phase BLDC & PMSM Solution
• MPS High Accuracy Position Sensor
• Robot Ball-Tossing Demo w/ MPS solution
Single Phase BLDC Solution

- **MPQ6610**: ½-H-Bridge Driver, Internal Current Sense 4.5 - 60V, 3A SOT23
- **MP6519**: H-Bridge Current Driver 2.5 – 35V 5A QFN
- **MP6528**: H-Bridge DC Motor Pre-Driver 5 – 60V QFN

- **MPQ6526**: 6x ½-H-Bridge Driver Serial Interface 8 – 40V 1A QFN AEC Q100
- **MPQ6523**: 3x ½-H-Bridge Driver Serial Interface 8 - 40V, 1A QFN AEC Q100
- **MPQ6524**: 4x ½-H-Bridge Driver Serial Interface 8 - 40V, 1A QFN AEC Q100

- **MP6516**: Dual ½-H-Bridge Driver 8 – 35V 2.8A TSSOP
- **MP6515**: H-Bridge DC Motor Driver 8 – 35V 2.8A TSSOP

- **MP6517**: H-Bridge Fan Driver 3 - 18V / 600mA SOT23-6
- **MP6513**: H-Bridge Motor Driver 2 - 22V / 1.2A TSSOP
- **MP6514**: Dual ½-H-Bridge Driver 2 - 22V / 1.2A QFN

- **Features**
  - Leading BCD Process
  - High Sensitivity Hall Sensor
  - Smart & Easy Use Control

**The Future of Analog IC Technology®**
Single Phase BLDC Solution

- Smart & Easy Use Digital Controller for Fan Driver

- 3V~18V range w/ OVP
- Soft Phase Transient BEMF & ZCS PLL
- Embedded Hall w/ ±1mT Sensitivity
- Speed Curve & Par. OTP Programmable
Single Phase BLDC Solution

1ps 1uF/0603 cap!
Up to 600mA@single-layer!

Straight Lead TSOT23-6

Rotor Magnet
Contents

- Single Phase BLDC Solution
- 3-Phase BLDC & PMSM Solution
- MPS High Accuracy Position Sensor
- Robot Ball-Tossing Demo w/ MPS solution
3-Phase BLDC Solution

160MHz clk, FOC control w/ 11-bit Sensor

High Eff. PS w/ Leading BCD Process

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3-Phase BLDC Solution

From System Controller

(VIN/3.3V/GND/EN/DIR/CLKIN/BRAKE/FG/FT)

3.3V LDO (optional)

MP6570
- FOC Control
- Speed/Position/Torque Mode
- Embedded Sensor
- QFN4x4mm

MP65xx
- MP6540: 60V/5A, 30mΩ/FET
- MP6541: 35V/8A, 13mΩ/FET
- MP6536: 26V/3A, 70mΩ/FET
- On-chip isense for MP6540/1
- QFN5x5mm

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3-Phase BLDC Solution

- **MP6570**: Parameters programmable with non-volatile memory

<table>
<thead>
<tr>
<th>Motor</th>
<th>Control</th>
<th>Protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>(L_d): d axis inductance</td>
<td>\textit{mode}: Position/Speed/Torque select</td>
<td>\textit{l_ocp}: current limit</td>
</tr>
<tr>
<td>(L_q): q axis inductance</td>
<td>(k_{p_i}, k_{i_i}): torque loop spec</td>
<td>(t_{\text{dec}}/t_{\text{lock}}): lock timer</td>
</tr>
<tr>
<td>(\psi_r): rotor flux</td>
<td>(k_{p_w}, k_{i_w}): speed/position loop spec</td>
<td>(t_{\text{dec}}): lock detection time</td>
</tr>
<tr>
<td>(p_0): stator pole-pair</td>
<td>\textit{period}: switching frequency</td>
<td>\textit{brk_{iq}}: brake current</td>
</tr>
<tr>
<td>(\text{spd}_{\text{min}}): min. speed</td>
<td>\textit{pos_step/spd_step}: ref slope</td>
<td>\textit{lin_{max}/Vin_{max}}: max. Vin/lin</td>
</tr>
<tr>
<td>\textit{speed_cmd}: speed ref</td>
<td>\textit{com_mod}: interface select</td>
<td>\textit{t_{retry}}: Fault retry timer</td>
</tr>
<tr>
<td>\textit{theta_cmd}: position ref</td>
<td>\textit{exang}: sensor source select</td>
<td>\textit{l_{max}}: max. torque current</td>
</tr>
<tr>
<td>\textit{Id_ref/iq_ref}: torque ref</td>
<td>\textit{ad_mod/ad_gain}: AD control</td>
<td>\textit{brk_mod}: brake mode</td>
</tr>
<tr>
<td>\textit{theta_bias}: initial position</td>
<td>\textit{bct/kalman/resolution}: sensor filter ctr.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{data_comp}: Accufilter 32 data set</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{pwm_mod}: PWM output mode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>\textit{sam_mod}: 1/2/3 phase current ctr.</td>
<td></td>
</tr>
</tbody>
</table>
3-Phase BLDC Solution

- Position Mode: ± 0.2° res., up to @31 rounds
- Speed Mode: 20-50000 rpm, ± 0.1% Accuracy
- Torque Mode: 10-bit res. current

160M clk, 12-bit PWM res. @20kHz
3-Phase BLDC Solution

**Energy Recycle Brake Mode**

- More energy recycle!
- Controlled by MP6570
- Brake un-controlled and slow!
- More energy lost on diode, winding resistance!
- Brake controlled and fast!

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3-Phase BLDC Solution

- High Efficiency Power Stage w/ Leading BCD Process

MP6537/8/9 family
3-phase pre-driver
7 – 100V, int. current sense
QFN/TSSOP

MP6540
3-phase power stage
30 mΩ rds(on) / FET
7 – 60V, 5A (DC)
QFN26-5x5

MP65xx
½-H power stage
17 mΩ rds(on) / FET
7 – 60V, 9A (DC)
QFN17-4x4

MP6530/2/
3-phase pre-driver
5-60V,
QFN/TSSOP

MP6534/5 family
3-phase pre-driver
5– 60V,
500mA Buck
QFN/TSSOP

MP6541
3-phase power stage
13 mΩ rds(on) / FET
7 – 35V, 8A (DC)
QFN26-5x5

MP65xx
½-H power stage
7.4 mΩ rds(on) / FET
7 – 35V, 10A (DC)
QFN17-4x4

MP6536
3-phase power stage
70 mΩ rds(on) / FET
5 – 26V, 8A (DC)
QFN40-5x5

MP65xx
3-phase power stage
4 mΩ rds(on) / FET
3 – 22V, 15A (DC)
QFN26-5x5

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3-Phase BLDC Solution

Accurate Current Sense w/ phase LSMOS

\[ I_{SO} = I_{LOAD} / 10,000 \]

\[ V_{SO} = V_{REF} + (I_{SO} \times R_{REF}) \]
\[ = V_{REF} + ((I_{LOAD} \times R_{REF}) / 10,000) \]

Robust OCP w/ Each MOS

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3-Phase BLDC Solution

½-H: 17 pads, 4mm x 4mm, 2.8 Watts @ 25°C

3-phase: 26 pads, 5mm x 5mm, 3.5 Watts @ 25°C

Mesh Connect™ (No Wire Bond)

- Advantages over standard packages:
  - Very low parasitic resistance
  - Very low inductance
  - Reduced thermal resistance
  - Small size
  - Low cost
• Single Phase BLDC Solution
• 3-Phase BLDC & PMSM Solution
• MPS High Accuracy Position Sensor
• Robot Ball-Tossing Demo w/ MPS solution
• What is MPS Magnetic Angel Sensor?

500kHz Data Refresh Rate!
11-bit Resolution

Angle information:
- U, V, W like Hall sensors
- A, B, Z like optical encoder
- SPI readout
MPS Position Sensor Solution

- Direct Sensing Rotor Position

- Side-shaft w/ Ring Magnet

- Side-shaft w/ Disc Magnet
MPS Position Sensor Solution

• What is the difference?
MPS Position Sensor Solution

• What is common in all competitors’ sensors?
  - Based on (X,Y) measurement and conversion to digital domain
  - Angle computed w/ complex arctan algorithm

• MPS Spinaxis Solution
  - No complex and time-consuming digital arctan algorithm
  - Measure the angle through a Phase Detection.
• Spin-axis Principle
• Spin-axis Principle
• Spin-axis Principle
• Single Phase BLDC Solution
• 3-Phase BLDC & PMSM Solution
• MPS High Accuracy Position Sensor
• Robot Ball-Tossing Demo w/ MPS solution
- Robot Arm Ball Tossing System w/ MPS Solution