Design and control of Static Converters

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Design and Control of Static Converters

Power Converter as interface

DSP /Microprocessor as a Core

Applications

Motor Control

Distributed Generation

Grid Interface
Index

- Static Converters
- DSP core of application: From Hardware to software
- Inner current loop: power electronics building block.
- One topology, many applications:
  - DCM (Digital Motor Control).
  - Active Front-End.
    - Active compensator of Reactive energy
    - Active filter
    - Hybrid filters
  - Back-to-Back
    - UPS
    - Renewable power generators
    - Sag Generator.
- More over: CAN, CANOpen, IEC 1131.
Design and Control of Static Converters
DSP core of application: From Hardware to software
Inner Current loop: Power Electronics Building Block

- Torque
- Active/Reactive Power
- Voltage

Diagram showing the connections and blocks involved in the current loop, including:
- Iq*
- Ernq
- Id*
- Ernd
- PID
- Rotation
- Vq*
- Vd*
- Rotation^-1
- SVPWM
- LC Filter
- Rotor PLL
- Synchronism
- DSP
- Utility
Inner Current loop: Power Electronics Building Block
Digital Motor Control
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Mechanical Angle ($\epsilon$) -> Resolver -> Amplifier

Lowpass Filter + Amplifier

PWM

Delay $\gamma$

DAC 10bit

FIR Filter + Decimation

PLL

Angle

Speed

$\sin(\omega_{\text{exc}} t - \gamma)\sin(\epsilon)$

$\sin(\omega_{\text{exc}} t - \gamma)\cos(\epsilon)$

$\frac{1}{2}\sin(\epsilon) - \frac{1}{2}\cos(2\omega_{\text{exc}} t - \gamma)\sin(\epsilon)$

$\frac{1}{2}\cos(\epsilon) + \frac{1}{2}\cos(2\omega_{\text{exc}} t - \gamma)\cos(\epsilon)$

$\frac{1}{2}\sin(\epsilon)$

$\frac{1}{2}\cos(\epsilon)$
• Angle and speed determination
• Resolution increase
• Delay correction

\[
\begin{align*}
\sin(\varepsilon) &= y_Q \\
\cos(\varepsilon) &= y_D
\end{align*}
\]
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CNC

PID

PID

Division

Rotation⁻¹

SVPWM

Park

Oversampling + PLL

1/ν Poles

1/ν Poles

Motor

Resolver

ν

ν

Sin

Cos

Exc

DSP
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Grid Interface
\[ \begin{bmatrix} v_r \\ v_s \\ v_t \end{bmatrix} = \sum_{k=1}^{\infty} \begin{bmatrix} V_+^k \\ \cos\left(w^k - \frac{2\pi}{3^k}\right) \\ \cos\left(w^k + \frac{2\pi}{3^k}\right) \end{bmatrix} \begin{bmatrix} \cos\left(w^k \cdot t + \varphi^k\right) \\ \cos\left(w^k \cdot t + 2\pi/3^k + \varphi^k\right) \\ \cos\left(w^k \cdot t - 2\pi/3^k + \varphi^k\right) \end{bmatrix} + V_-^k \]
\[ I_r = \sqrt{2} I_{eff} \cos(\omega t - \theta) \]
\[ I_s = \sqrt{2} I_{eff} \cos(\omega t - \frac{2\pi}{3} - \theta) \]
\[ I_t = \sqrt{2} I_{eff} \cos(\omega t + \frac{2\pi}{3} - \theta) \]
\[ I_d = I_{\text{eff}} \cdot \cos(\theta) \]
\[ I_q = I_{\text{eff}} \cdot \sin(\theta) \]
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[Diagram of a control system involving components such as PID, Reactive Regulator, Park, Rotation, SVPWM, SRF-PLL, and Vbus, with signals like Vbus, Ia, Ib, Iq, and error terms such as ErrV, ErrId, ErrIq.]
Back-to-Back
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### Harmonics and Their Rotation after a 60° Rotation

<table>
<thead>
<tr>
<th>Harmonics</th>
<th>Rotation after Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_1^+$</td>
<td>DC</td>
</tr>
<tr>
<td>$V_1^-$</td>
<td>$-2 \omega$</td>
</tr>
<tr>
<td>$V_5^+$</td>
<td>$-6 \omega$</td>
</tr>
<tr>
<td>$V_7^+$</td>
<td>$6 \omega$</td>
</tr>
<tr>
<td>$V_{11}^+$</td>
<td>$-12 \omega$</td>
</tr>
<tr>
<td>$V_{13}^+$</td>
<td>$12 \omega$</td>
</tr>
</tbody>
</table>
All Pass Filter
Remote generator (Off shore facility)

Removable power part: 500 kW

On shore installation
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