

# dSPIN Future in motion

L6470

*d*



# dSPIN: breakthrough in motor control



- ST is universally acknowledged as one of the leading semiconductor suppliers for motor control applications
- ST is a pioneer and leader in smart power monolithic and integrated solutions for motor driver applications



**dSPIN represents the breakthrough solution for stepper motors in terms of performance with fast & easy design**



# The 3 key benefits of dSPIN



## Voltage mode driving

- Outstanding position accuracy & smooth motion:**
- Resolution up to 128 microsteps/step
  - Very accurate sine-wave profile

## Digital core

- Fully digital motion management:**
- User-defined motion profiles easily programmable through SPI interface
  - No need of complex MCU routines

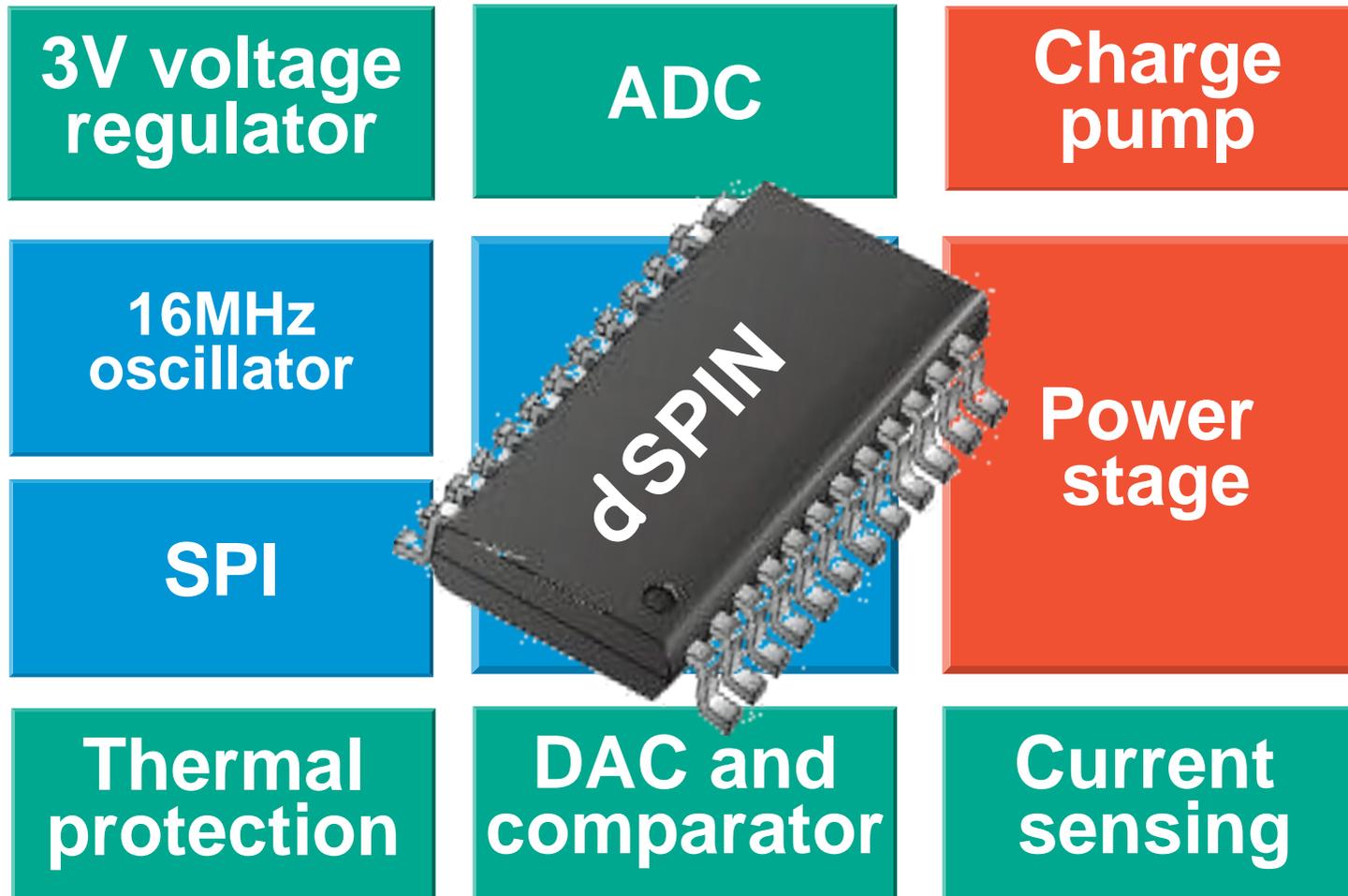
## Full set of protection features

- High level of robustness against system faults:**
- Thermal, low bus voltage, overcurrent, stall detection
  - Easy design, reduced external components

# Monolithic digital microstepping driver



BCD 0.35  $\mu\text{m}$ , multi-power technology



# Driving multi-purpose bipolar stepper motors

**Factory automation, sewing machine**



**Stage lighting**



**Professional and label printers**



**ATM, POS, vending machines, gaming**



**Medical, security**



**Consumer, toys & robotics**



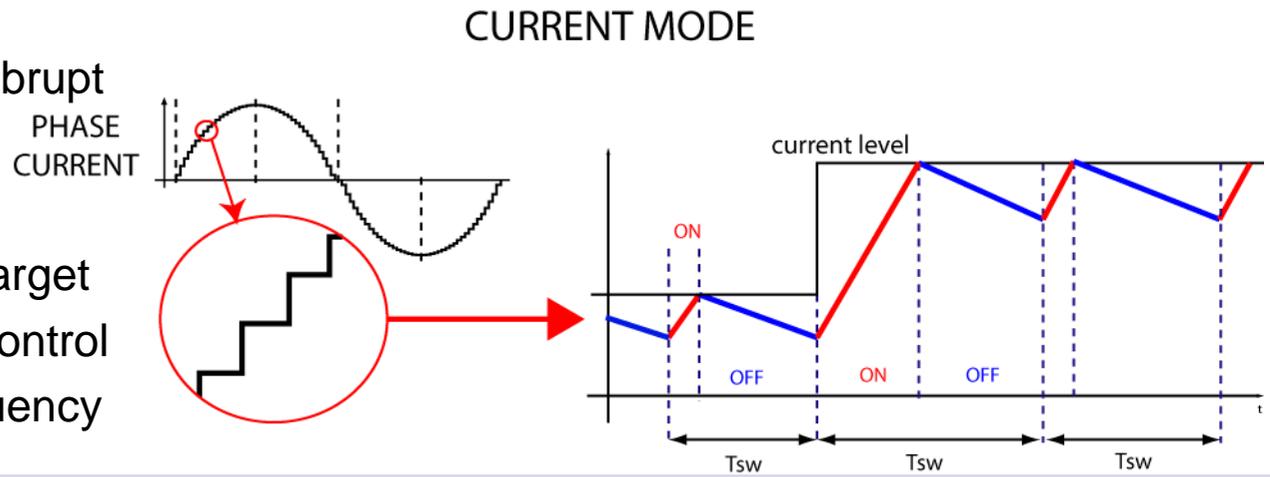
# Voltage driving versus current driving



## Without dSPIN

## Standard current mode driving

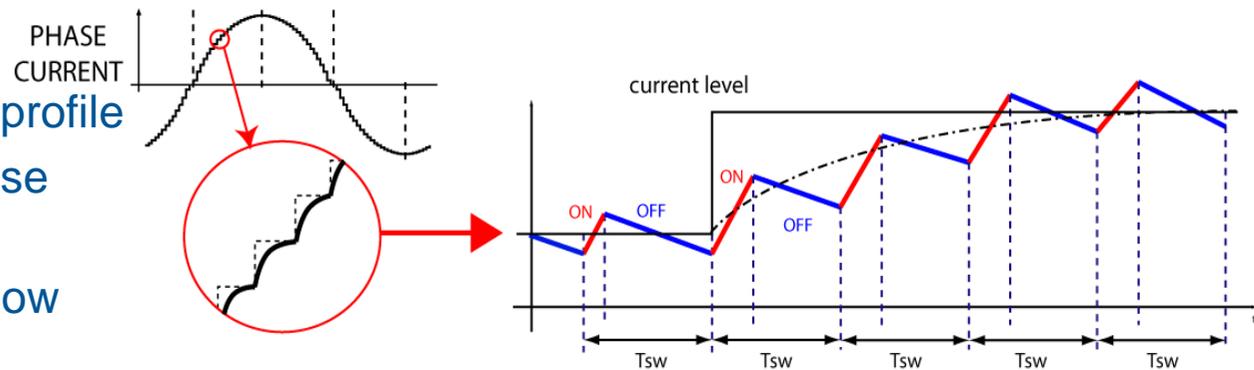
- Noisy and jerky motion
  - Mechanical vibrations from abrupt current changes
- Inaccurate positioning
  - Peak current different from target
- Torque ripple and EMI difficult to control
  - Non constant switching frequency



## With dSPIN

## Innovative voltage mode driving

- Resolution up to 128  $\mu$ steps/step
- Very accurate and smooth sine-wave profile
- Reduced resonances, mechanical noise and vibrations at low speed
- Reduced torque and speed ripple at low speeds



**Outstanding position resolution and smooth motion**

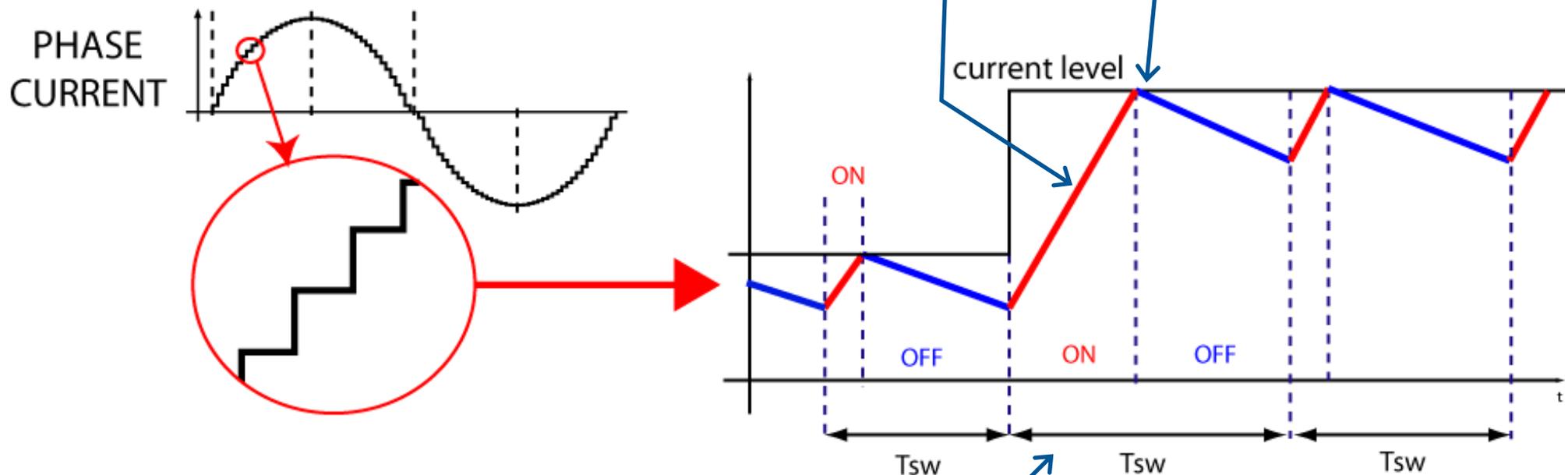
# Standard current mode – more details



**1.** Abrupt current changes cause high mechanical vibrations  
Current mode tries to follow even non-ideal steps (reference voltage quantization and sampling)  
**Noisy and jerky motion**

**2.** Peak current is controlled; average current value is different from target  
**Inaccurate positioning**

## CURRENT MODE



**3.** Non-constant switching frequency  
Torque ripple and EMI are difficult to control

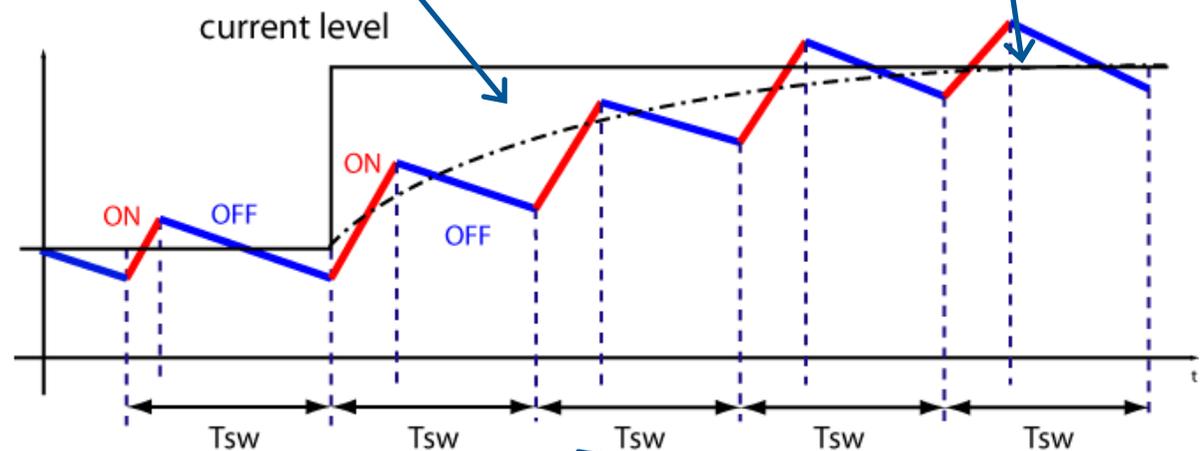
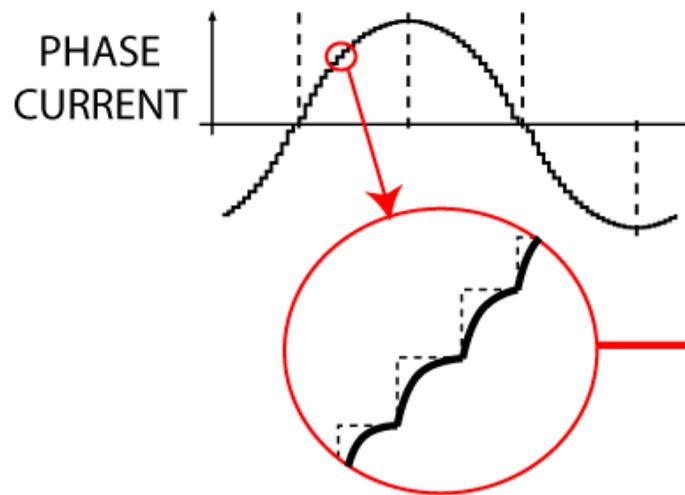
# dSPIN innovative control – more details



Smooth current transient reduces mechanical vibrations  
**Motor movement is soft and silent**

Average current is controlled  
**Accurate positioning**

VOLTAGE MODE



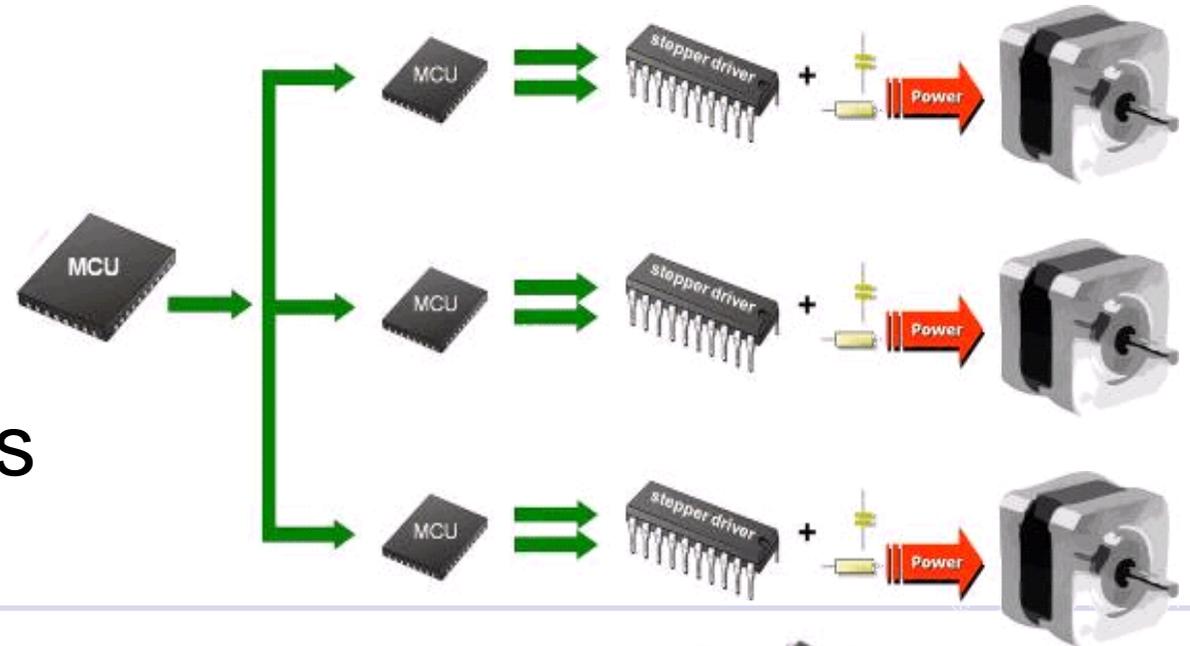
Constant switching frequency  
**Torque ripple and EMI are controlled**

# Digital core



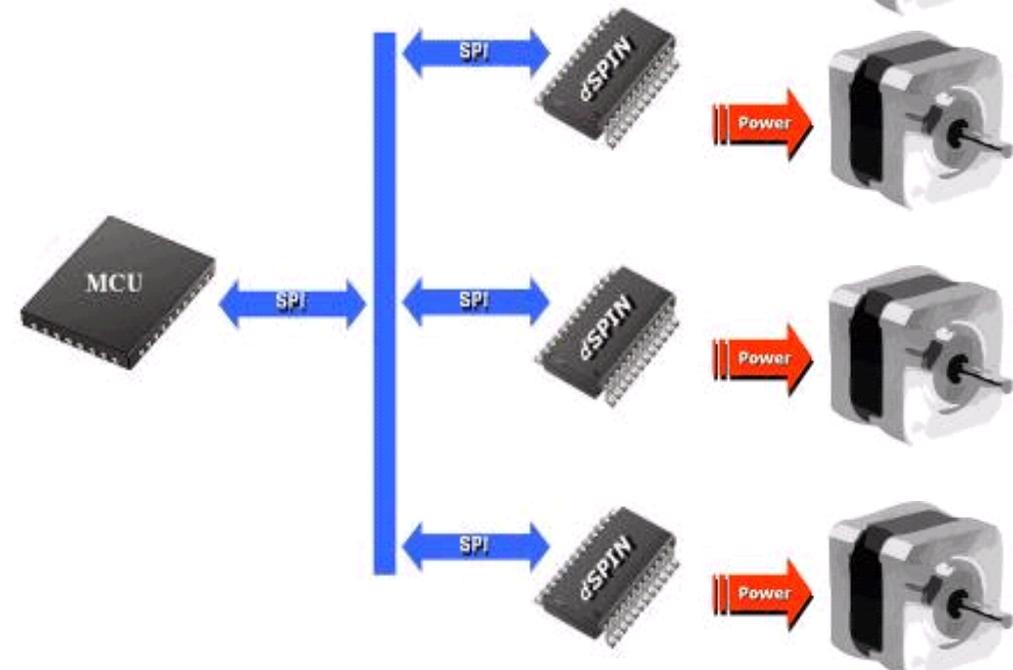
## Without dSPIN

- Speed and position profiles required complex MCU routines



## With dSPIN

- dSPIN does the tricky part, following simple high-level SPI commands



**Fully digital motion management with simple commands**

# Integration of digital core



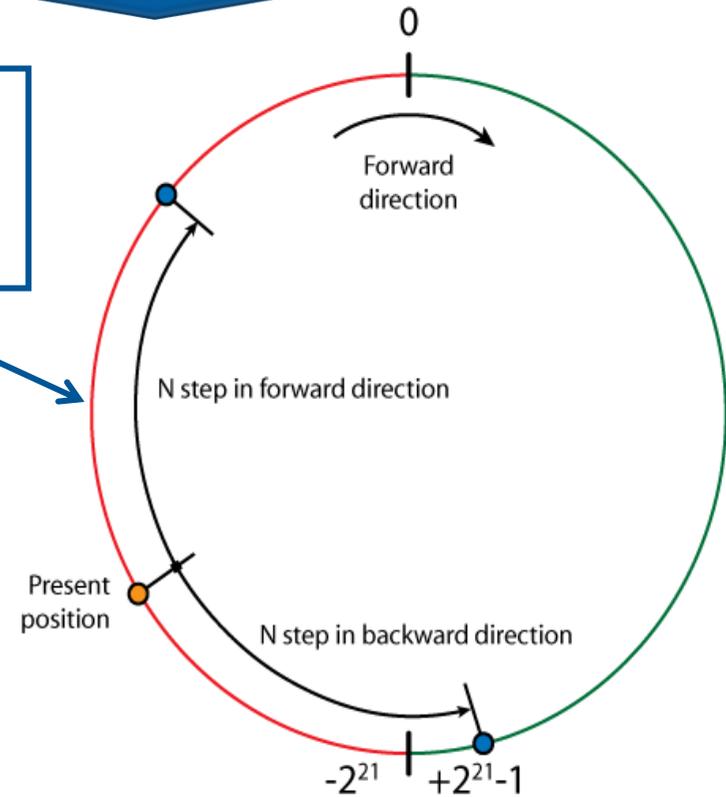
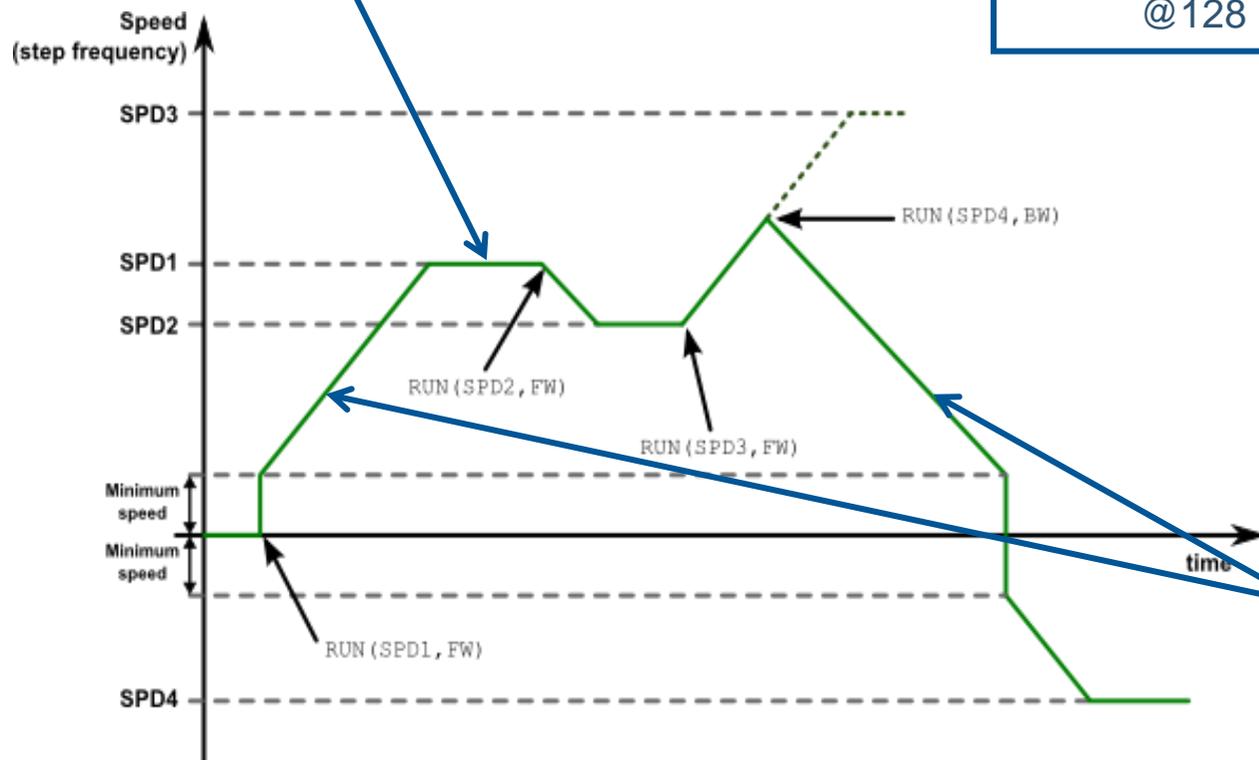
**dSPIN** manages the full motion profile

Target speed, acceleration, deceleration

Absolute/ relative positioning

Maximum speed  
from 15.25 to 15610 step/s  
(15.25 step/s resolution)

Integrated 22-bit register  
For up to 32768 full steps  
@ 128  $\mu$ step

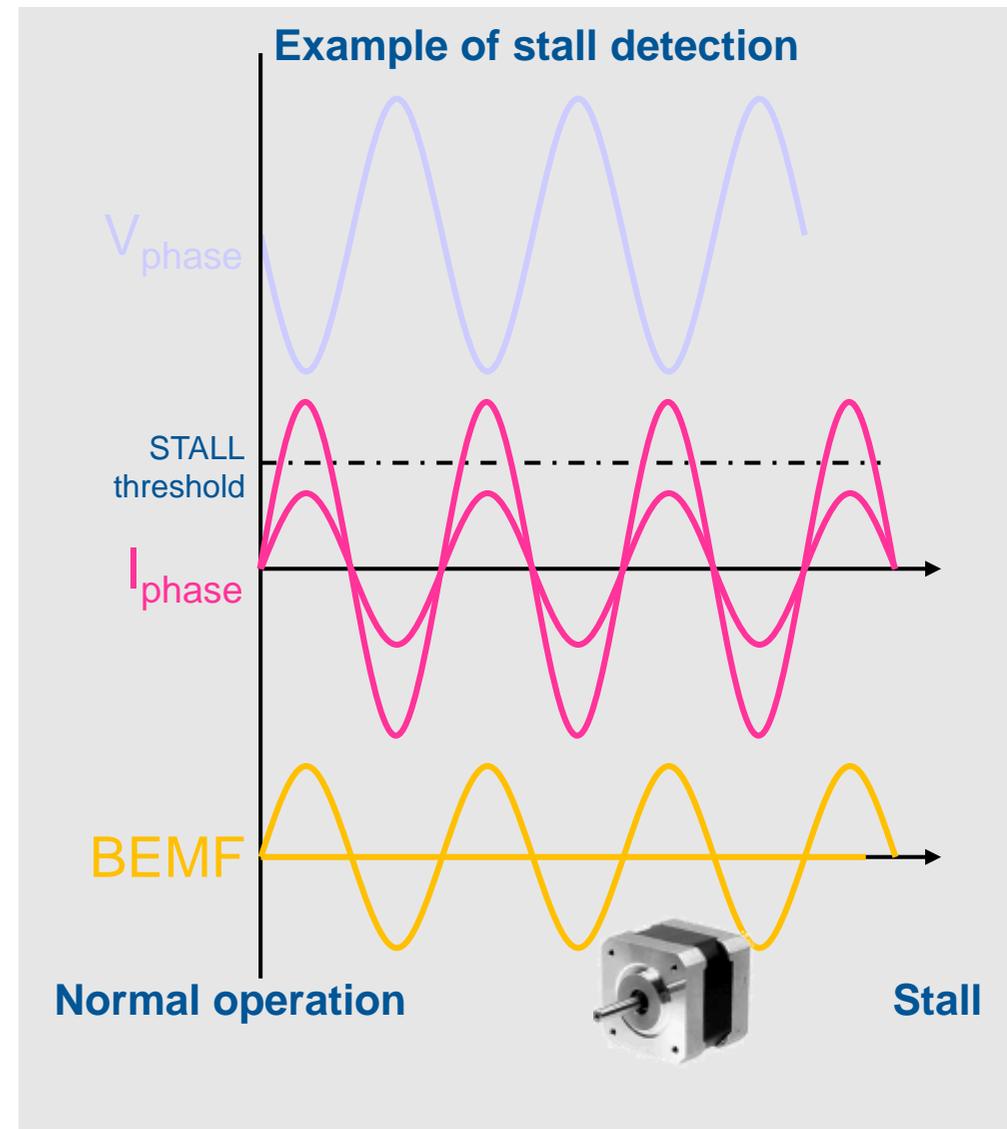


Acceleration and deceleration  
from 14.55 to 59590 step/s<sup>2</sup>  
(14.55 step/s<sup>2</sup> resolution)

# Advanced set of protection features



- Programmable non dissipative overcurrent protection
- Internal sensing of high- and low-side power
- Two levels of over-temperature protection
- Under voltage protection
- Stall detection



High level of robustness against system faults



# Fully-digital control through SPI



Name	Address	Description
ABS_POS	01	Current Position
EL_POS	02	Electrical Position
MARK	03	Mark Position
SPEED	04	Current Speed
ACC	05	Acceleration
DEC	06	Deceleration
MAX_SPEED	07	Maximum speed
MIN_SPEED	08	Minimum speed and low speed optimization
FS_SPD	15	Full step speed
KVAL_HOLD	09	Holding Kval
KVAL_RUN	0A	Constant speed Kval
KVAL_ACC	0B	Acceleration starting Kval
KVAL_DEC	0C	Deceleration starting Kval
INT_SPD	0D	BEMF comp. curve intersect speed
ST_SLP	0E	BEMF comp. curve starting slope
FN_SLP_ACC	0F	BEMF comp. curve final slope (acceleration)
FN_SLP_DEC	10	BEMF comp. curve final slope (deceleration)
K_THERM	11	Thermal compensation factor
ADC_OUT	12	ADC output
OCD_TH	13	OCD threshold
STALL_TH	14	STALL threshold
STEP_MODE	16	Step mode and sync signal setup
ALARM_EN	17	Alarms enables
CONFIG	18	IC configuration
STATUS	19	Status

Value	Hex	Default
0 Step	0	0
16.02%	29	29
16.02%	29	29
16.02%	29	29
246.048 Step/s	408	408
0.03815 % s/Step	19	19
0.06256 % s/Step	29	29
0.06256 % s/Step	29	29
1	0	0
0	0	0
3.375 A	8	8
2.03125 A	40	40
Step mode: 1/128 step, Sync signal: Disabled	7	7
Overcurrent, Thermal shutdown, Thermal warning, Under voltage lock out, Stall detection (Bridge A), Stall detection (Bridge B), Switch turn-on event, Wrong or not performable command	FF	FF
Int. osc @16MHz (2MHz output), SW input: HardStop interrupt, Motor supply voltage compensation: Disabled, Overcurrent shutdown: Enabled, Output slew-rate: Medium, fPWM = fosc x 1 / 1024	2E88	2E88
Device BUSY, SW status: Open, Motor status: Stopped in Counterclockwise direction, Undervoltage, Thermal warning, Thermal shutdown, Overcurrent, Step-loss on bridge A, Step-loss on bridge B	0	0

Absolute-position register can be set

Speed profile parameters

Torque control parameters

BEMF compensation

Phase resistance drift compensation

ADC conversion result

Overcurrent threshold

Stall detection threshold

Device configuration and status

Motor electrical position (current microstep) can be set

# L6470 - Benefits summary



## Voltage mode driving

- **128  $\mu$ steps/ step** is the best motion **resolution** ever reached in monolithic stepper motor drivers
- **Smoothness** of motion is like never before
- All with a **single chip**, avoiding more expensive and space consuming discrete solutions

## Digital core

- Fully **digital motion control** allows the user to set a variety of features: target speed, acceleration/ deceleration, absolute and relative position, just to name a few
- **SPI interface** allows user to easily insert desired parameters with **no need for external microcontroller**

## Full set of protections

- A full set of **protection functions** confers **robustness** to the system and helps to further reduce the number of external components, the cost and complexity

**Outstanding performance with fast & easy design**

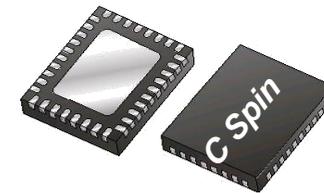
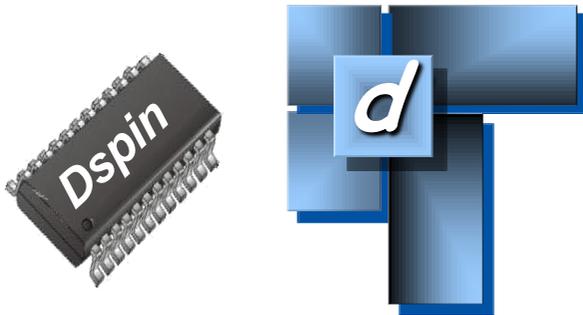
# Motor control ICs



**Performance & Integration**

*Motor control system-on-chip*

*Advanced control driving*



**C-SPIN digital controller + driver**

conceived to enable a wide variety of implementations



# Making your designs easier



## Packages



HTSSOP28 package (H type) – mass production

PowerSO36 (PD Type) – samples already available

## Support



Full design support: evaluation board, software, USB and IBU interface boards, application notes, available at:

[www.st.com/dspin](http://www.st.com/dspin)

# Tools and documentation



- **Sales codes**
  - L6470H - HTSSOP28 - Tray
  - L6470HTR - HTSSOP28 - Tape & Reel
  - L6470PD - PowerSO36 (Samples available now)
- **L6470 Documentation:**
  - [L6470 webpage](#)
  - [Datasheet](#)
  - [Application Note \(AN3103\)](#)
- **Software:** [L6470 Evaluation tool software](#)
- **Evaluation boards**
  - [EVAL6470H](#)
  - [EVAL6470PD](#)
- **Control boards**
  - [STEVAL-PCC009V2](#) (and -V1)
- **dSPIN firmware library**
  - Available at <http://www.st.com/dspin>

