

Analog & Power November 2011

Riccardo Tosoni(FAE STM)



STMicroelectronics Applications



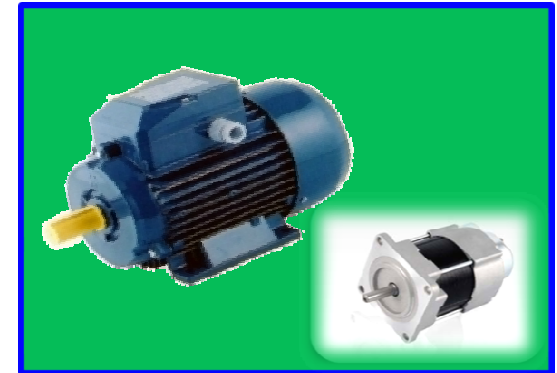
Solar



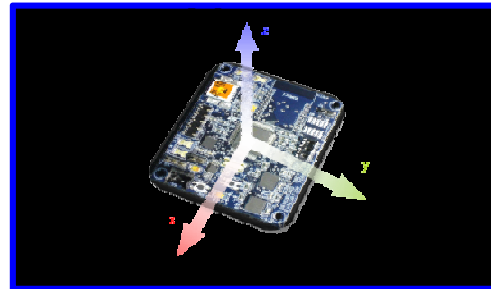
Pwr conversion



Motor control



Signal acq &



Industrial automation



Lighting



Automotive



High Voltage motor control

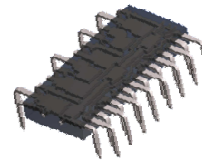
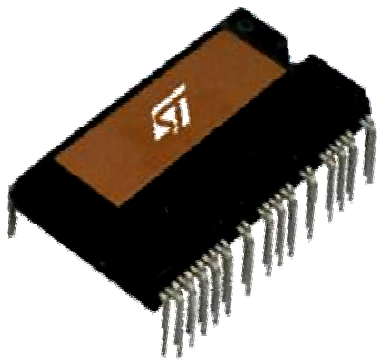


Industrial & Power Conversion Division
Off Line Power Supply Business Unit

SLLIMM™ family

Small Low Loss Intelligent Molded Module

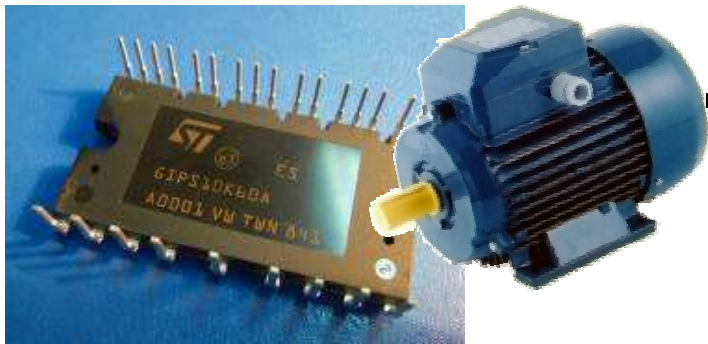
SLLIMM™ proposal for simple and compact solution for motor drive up to 2kW



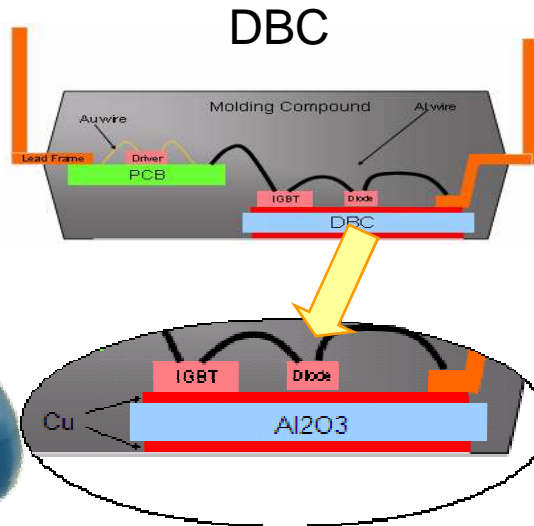
SLLIMM Package Technology (DBC vs. Ceramic)



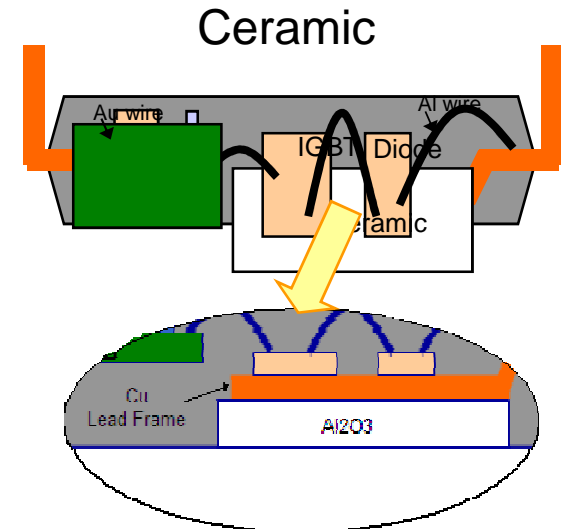
Highest Integration Level
Driving powerful BLDC
motors



6 IGBT &
3 Drivers inside
with thermal management
Integrated Op-Amp and
Comparator for sensing &
protection

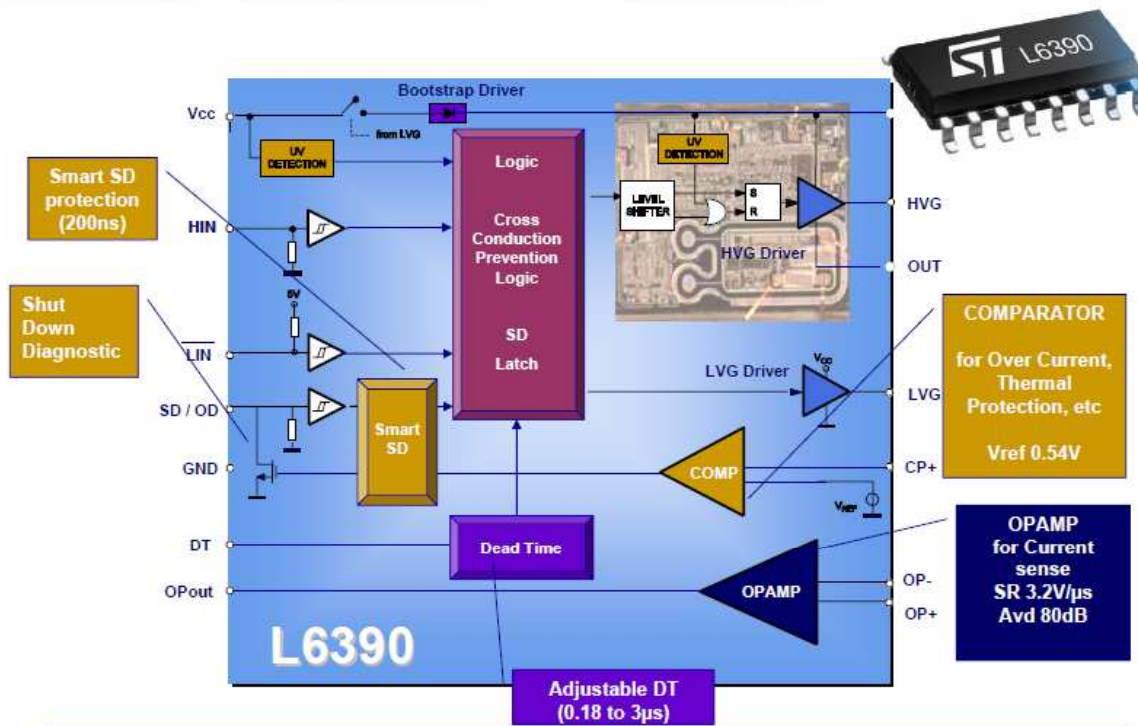


- DIP Molded Package
- PCB for drivers & SMD
- DBC (Direct Bond Copper) for power



- DIP Molded Package
- PCB for drivers & SMD
- Lead frame and exposed ceramic sink for power

SLLIMM Drivers



-50V BELOW-GROUND VOLTAGE SPIKE APPLICATIVE TEST

Figure 44. Example of below-ground voltage spike

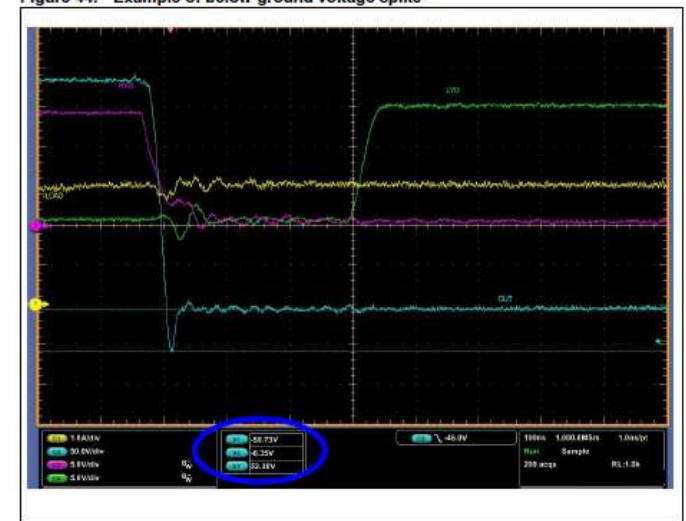


Table 3. Minimum V_{OUT} in DC condition providing safe and full operation of the high side section

	Example 1	Example 2	Example 3
VCC	12.5	15	17
V_{BOOT}	10.5	13	15
V_{OUT} (min)	-9.5	-7	-5
$V_{BOOT} - V_{OUT}$ (max)	20	20	20

SLLIMM Road Map



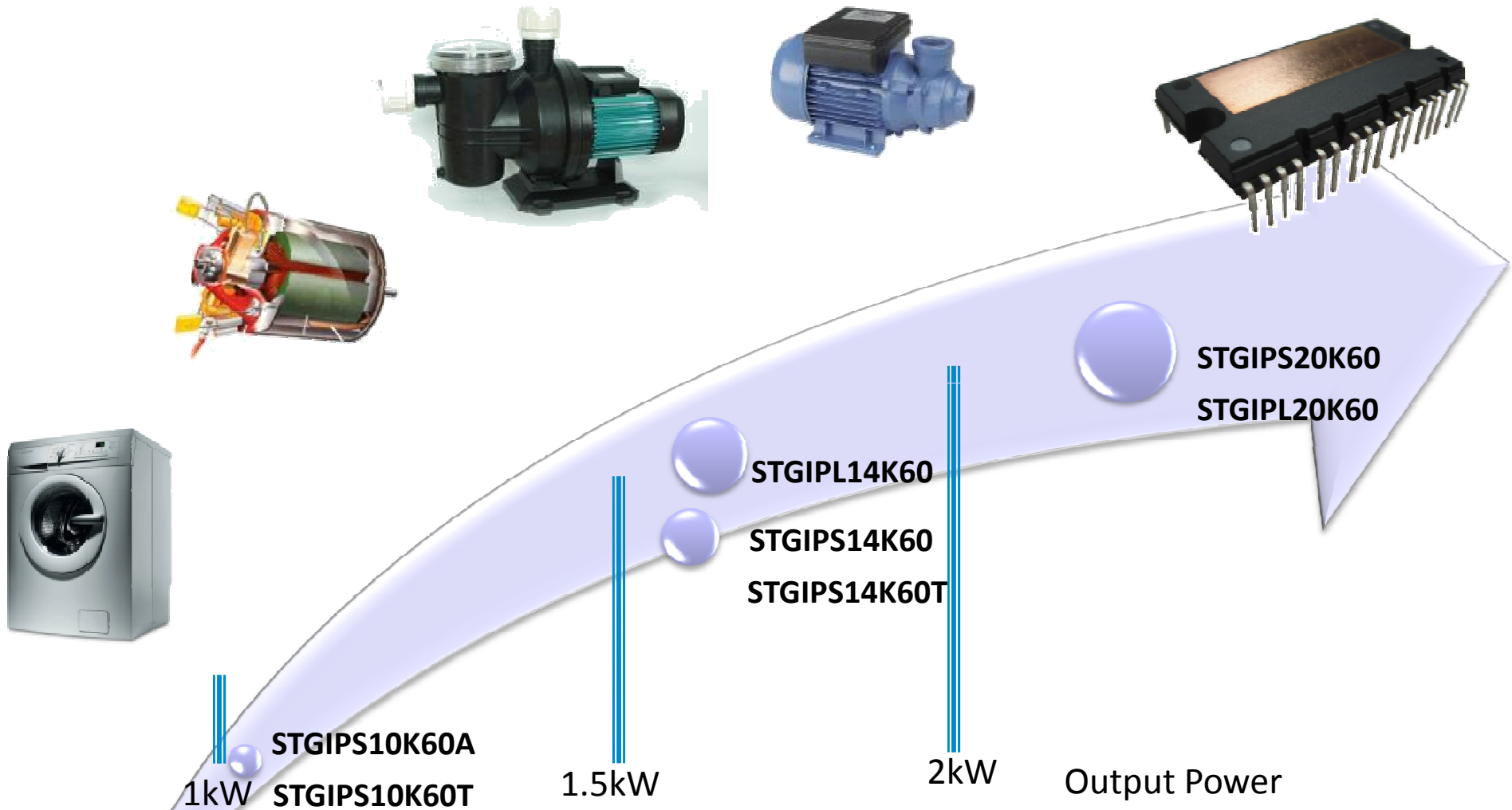
PART NUMBER	STGIPS10K60A	STGIPS10K60T	STGIPS14K60T	STGIPS14K60	STGIPL14K60	STGIPS20K60	STGIPL20K60
Pin Count	25	25	25	25	38	25	38
Pkg Size [mm]	44.4*22.0*5.4	44.4*22.0*5.4	44.4*22.0*5.4	44.4*22.0*5.4	49.6*24.5*5.4	44.4*22.0*5.4	49.6*24.5*5.4
DBC substrate	yes	yes	yes	yes	yes	yes	yes
Voltage [V]	600	600	600	600	600	600	600
Current @ Tc=25°C [A]	10	10	14	14	15	18	20
Rth (max) [°C/W]	3.8	3.8	3	3	2.8	2.4	2.2
NTC	yes	yes	yes	no	yes	no	yes
Integrated Bootstrap diode	yes	yes	yes	yes	yes	yes	yes
Smart shutdown function	no	no	no	yes	yes	yes	yes
SD function	no	yes	yes	yes	yes	yes	yes
Op-amps for Advanced current sensing	no	no	no	no	yes	no	yes
Comparator for fault protection	no	no	no	yes (1pin)	yes (3pin)	yes (1pin)	yes (3pin)

SLIMM Thermal Features



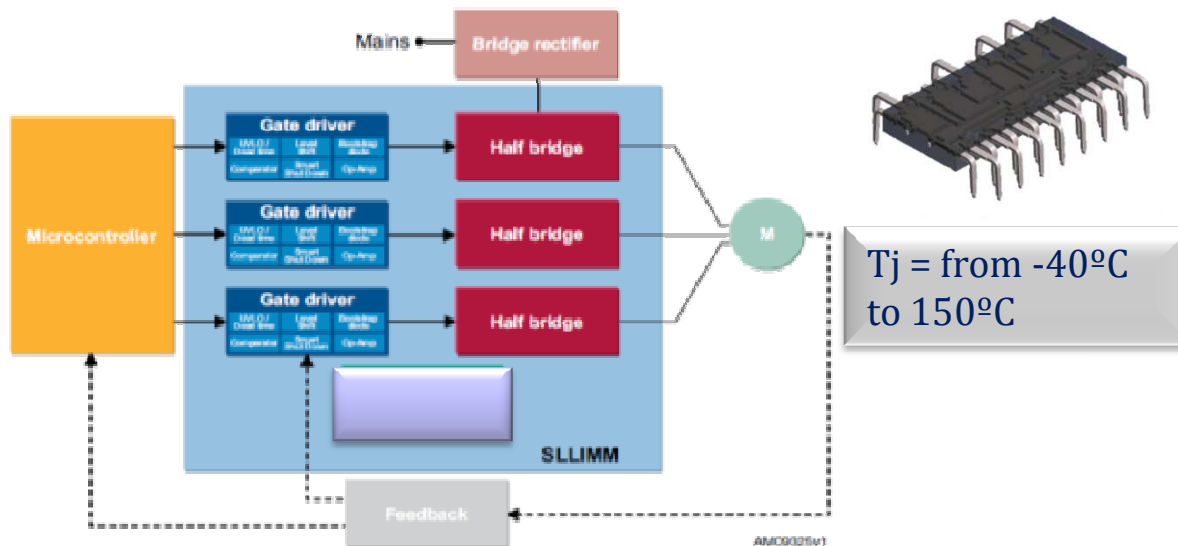
Part number	R_{TH} (°C/W)
STGIPS10K60A	3.8
STGIPS14K60	3
STGIPL14K60	2.8
STGIPS20K60	2.4
STGIPL20K60	2.2

SLLIMM Motor Control Power





NEWS !!! SLLIMM NANO Motor drive up to 100W



Tj = from -40°C to 150°C

- ### Benefits
- High quality and Reliability
 - Advanced protection function
 - Improved efficiency
 - Reduce EMI and noise
 - Reduce total system cost
 - Easy Layout

Main features and integrated functions

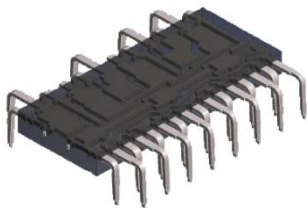
- 600 V, 3 A ratings
- 3-phase IGBT inverter bridge including:
 - 6 low-loss and short-circuit protected IGBTs
 - 6 low forward voltage drop and soft recovery freewheeling diodes
- Three control ICs for gate driving and protection including:
 - smart shutdown function
 - comparator for fault protection against overcurrent and short-circuit
 - op amp for advanced current sensing
 - three integrated bootstrap diodes
 - interlocking function
 - undervoltage lockout

Main Applications

- General purpose Low power motor drives
- Dish washers
- Compressor drives
- Refrigerators
- Pumps
- Air Con
- Fans

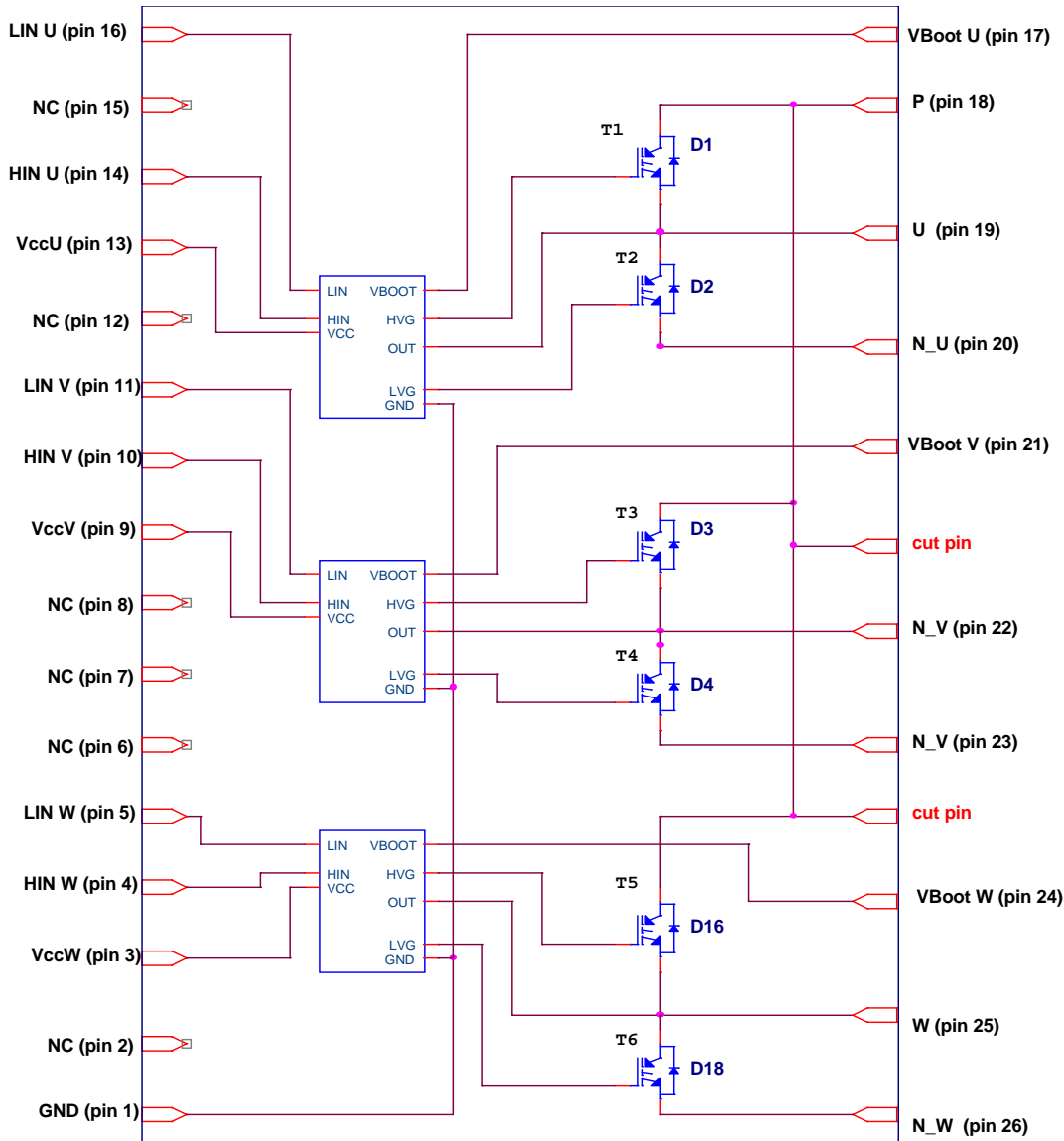
NEWS!!!!!!!!!! 2012
Samples available

SLLIMM NANO Features

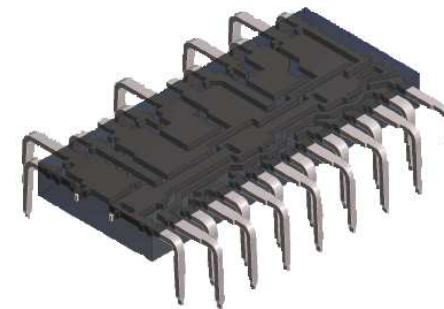


PART NUMBER	STGIPN3H60A	STGIPN3H60
Pin Count	26	26
Pkg Size [mm]	29,5x12.5X3.1	29,5x12.5X3.1
Voltage [V]	600	600
Current @ Tc=25°C [A]	3	3
R _{TH(J-A)} [°C/W]	50	50
Integrated bootstrap diode	✓	✓
Smart shutdown function	✗	✓
SD function	✗	✓
Op-amps for advanced current sensing	✗	✓
Comparator for fault protection	✗	✓
3.3/5V input interface compatibility	✓	✓
Interlocking function	✓	✓
Under Voltage Lock Out (on both Vcc and Vboot)	✓	✓

SLIMM NANO STGIPN3H60A Basic Features

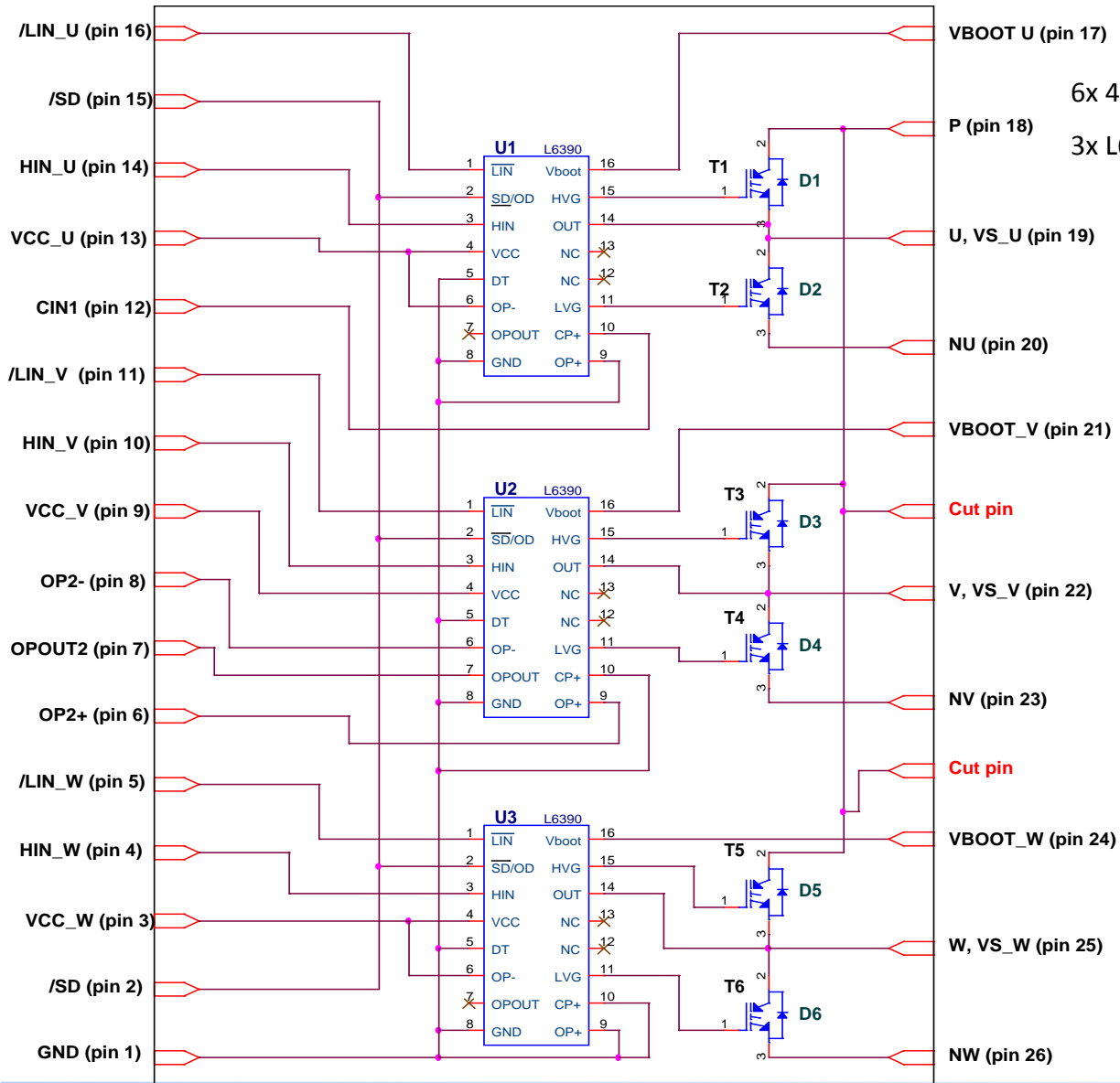


- 6x 4A/600V IGBTs with ultra-soft fast recovery diode.
- 3x L6388 (High voltage gate driver)
 - ✓ Dead time and interlocking function
 - ✓ Internal bootstrap diode
 - ✓ 3.3V, 5V and 15V CMOS/TTL compatible inputs



29,5x12.5X3.1

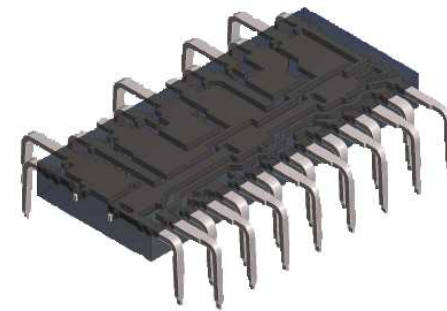
SLIMM NANO STGIPN3H60 Full Features



6x 4A/600V IGBTs with ultra-soft fast recovery diode.

3x L6390 (High voltage gate driver)

- ✓ L6388 features plus:
- ✓ Shutdown pin and Smart shutdown
- ✓ Comparator for fault detection
- ✓ OpAmp for advanced current sensing



29,5x12.5X3.1

Low power motor control board featuring SLLIMM™ NANO STGIPN3H60 and MCU STM32F100C6T6

Industrial & Multi-Market Competence Center
& Power Transistor Division

STEVAL-IHM036V1 evaluation board



I&MMCC & PTD
Daniel Kohout
November 14, 2011



Target Applications

- General purpose 3-phase inverter for 3-phase permanent magnet synchronous motors with vector field oriented control for output power up to 100W.
 - Inverter for high efficiency circulating water pump for heating systems in single-family houses
 - High efficiency drain pump for home appliance white goods, like dishwashers and washers
 - High efficiency and reliable solution for small power transfer pumps for waste sludge – sewerage plants in single-family houses, waste piping
 - High efficiency transfer pumps for outlet condensation water
 - High efficiency exactor hoods and blowers for gas furnace application
 - Compressor drives for fridges

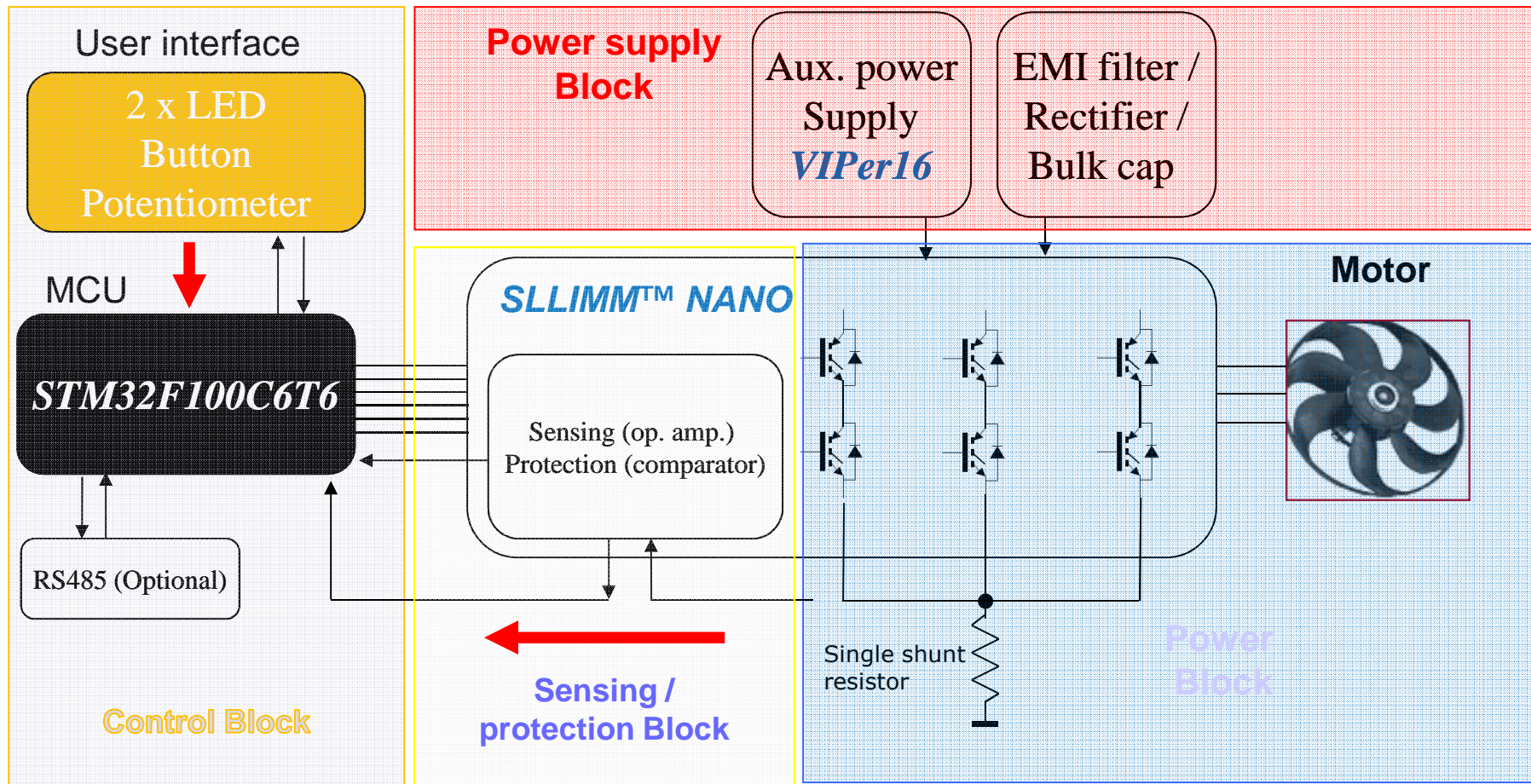




Marketing positioning

- **STEVAL-IHM036V1 evaluation board:**
 - The goal of the **STEVAL-IHM036V1 demonstration board** is to present an design consisting in a **3-phase inverter bridge** based on 600V, 3A small loss intelligent molded module STGIPN3H60 and STM32F100C6T6 MCU.
 - The SLLIMMTM NANO itself consist of short-circuit rugged IGBT's and wide range of auxiliary functions like under voltage lockout and smart shut-down.
 - The system has been **designed** to **for a field oriented control (FOC)**.

System Architecture





Main Features

- **STEVAL-IHM036V1 main features:**
 - Using IGBT **SLLIMM™ NANO STGIPN3H60** in NDIP-26L molded package
 - **Maximum output power** for applied motor **up to 100 W**
 - Single phase power supply: 195VAC to 265VAC, or direct DC line up to +400VDC
 - Input in-rush current limiter controlled by NTC resistor
 - **Based on** STMicroelectronics's ARM™ Cortex-M3 core-based **STM32F100C6T6** microcontroller
 - Single shunt resistor current sensing method
 - Possibility to modify the board by adding RS-485 bus
 - EN55014 (CISPR 14), IEC 61000-4-5 and IEC61000-4-4 compliant
 - Compact and safe design

ST components used in the application

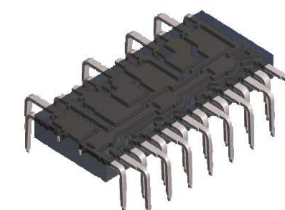


- STEVAL-IHM036V1 bill of material includes:
 - 1 x IGBT SLLIMM™ NANO **STGIPN3H60**
 - 1 x MCU **STM32F100C6T6** microcontroller
 - 1 x PWM SMPS smart driver **VIPer16LD**
 - 1 x Linear regulator L78L33CV
 - 2 x High efficiency power rectifier STTH1L06U
 - 2 x Small signal schottky diode BAT48JFILM
 - 1 x Bus driver ST485EB (N.A.)

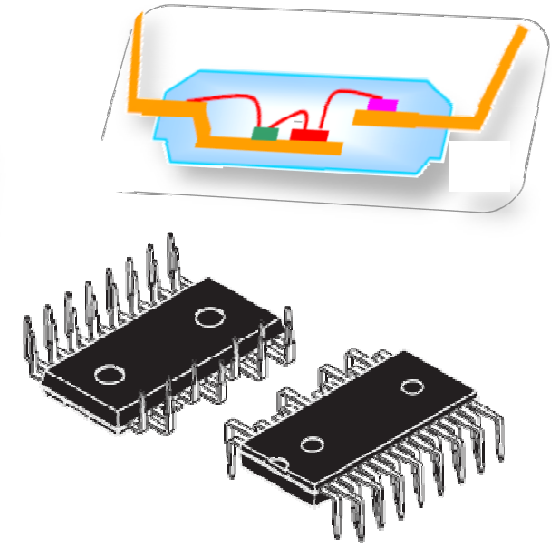
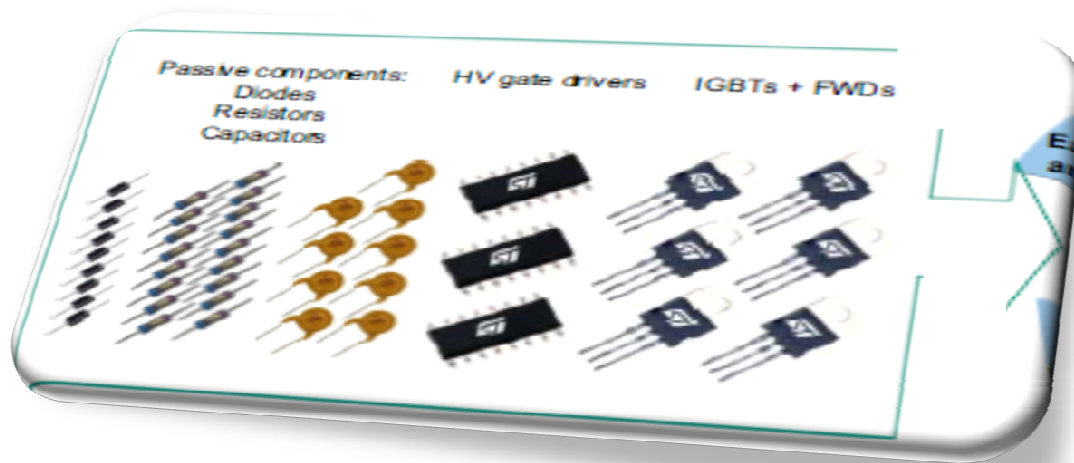


Why STGIPN3H60 SLLIMM™ NANO

- Why STGIPN3H60:
 - 600 V, 3A 3-phase IGBT inverter bridge including control ICs for gate driving and freewheeling diodes
 - Internal bootstrap diode
 - Interlocking function
 - Optimized for low electromagnetic interference
 - $V_{CE_{SAT}}$ negative temperature coefficient
 - Short-circuit rugged IGBT
 - Under-voltage lockout
 - Fully isolated package
 - Smart shut down function
 - Op-amps for advanced current sensing
 - Comparators for fault protection against over temperature and over current
- A good alternative to promote:
 - STGIPN3H60 A - The same IGBT's, no extra feature available (Op.Amp., comparator)



SLLIMM™-nano for low power motor control up 100W



Main features:

- 600 V 3-phase IGBT inverter bridge including control ICs for gate driving and ultra - soft fast recovery freewheeling diodes
- Dead time and interlocking function
- Internal bootstrap diode
- 3.3V, 5V and 15V CMOS/TTL compatible inputs
- Smart shutdown function
- Integrated comparator for fault protection against over current and short-circuit
- Integrated Op-amp for advanced current sensing

Benefits:

- Improved design time,
- Reduced manufacturing efforts,
- Increased reliability and quality level.
- Maximized efficiency, reduced EMI and noise
- Higher level of protection and lower propagation delay time.
- Small form factor (PCB space reduction)

Why VIPer16L

- Why VIPer16L:
 - 800 V avalanche rugged power section
 - Relative simple design
 - Operating frequency 60kHz
 - Hysteretic thermal shutdown
 - Limiting current with adjustable set point

- A good alternative to promote:
 - VIPer06 - When less power is required
 - VIPer26 - When higher power is required (> 200 mA)

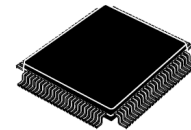




Why STM32F100C6T6

- Why STM32F100C6T6 :
 - Low & medium-density value line, advanced ARM-based 32-bit MCU
 - LQFP48 7 × 7 mm package
 - Core: ARM 32-bit Cortex™-M3 CPU
 - 2.0 to 3.6 V application supply and I/Os
 - 32 Kbytes of Flash memory
 - Temperature range from -40 to 85°C

- A good alternative to promote:
 - STM32F100x8 or STM32F100xB, if larger Flash memory is requested



LQFP100 14 × 14 mm
LQFP64 10 × 10 mm
LQFP48 7 × 7 mm



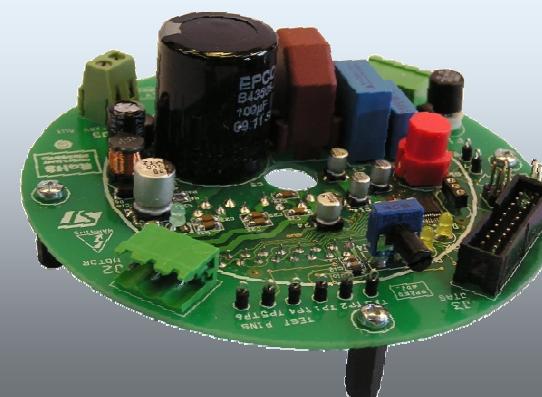
For Sales and Marketing



STEVAL-IHM036V1

Low power motor control board STEVAL-IHM036V1 featuring SLLIMM™
STGIPN3H60 and MCU STM32F100C6T6

Targeted to dishwasher, washer and dryer drain pumps, fridge compressors, extractor hood fans and heating recirculation pumps
Single phase connection – input supply voltage from 195VAC to 265VAC
Possibility to use single supply or dual supply mode
For dual supply mode DC supply input from 18VDC to 400VDC
Complete motor control platform for output power up to 100W
Compliance with EN55014, IEC 61000-4-5 and IEC 61000-4-4
Over-temperature and over-current hardware protection
Possibility to modify the board with RS-485 interface
Single shunt current reading configuration



 **EVALUATION BOARD**
www.st.com/evalboards



Ordering code: **STEVAL-IHM036V1**

User Manual: **UM1483**

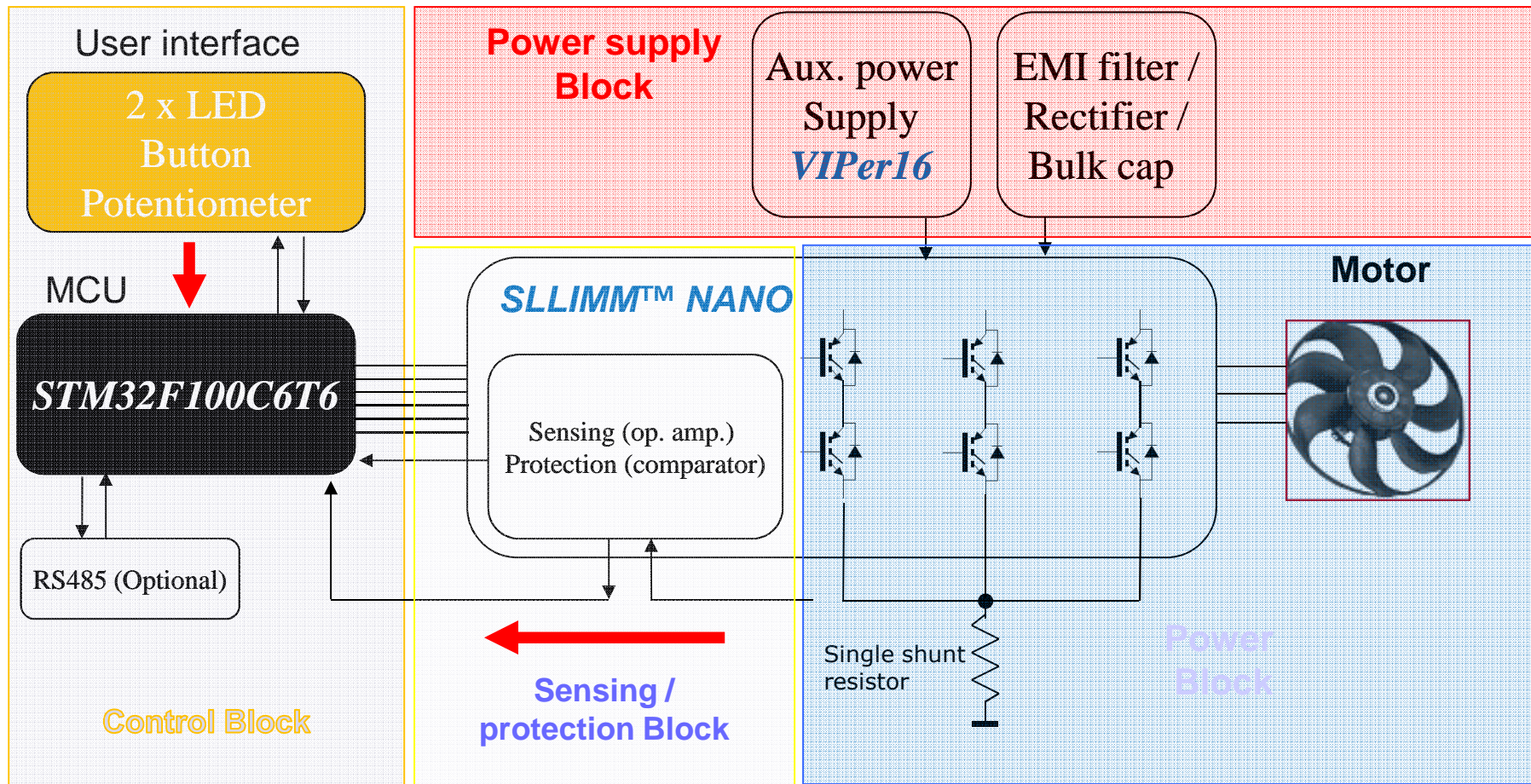
On Stock by end of **Q4/2011** (prototypes available now)

STMicroelectronics

The STEVAL-IHM036V1 evaluation board

Technical Part

System Architecture

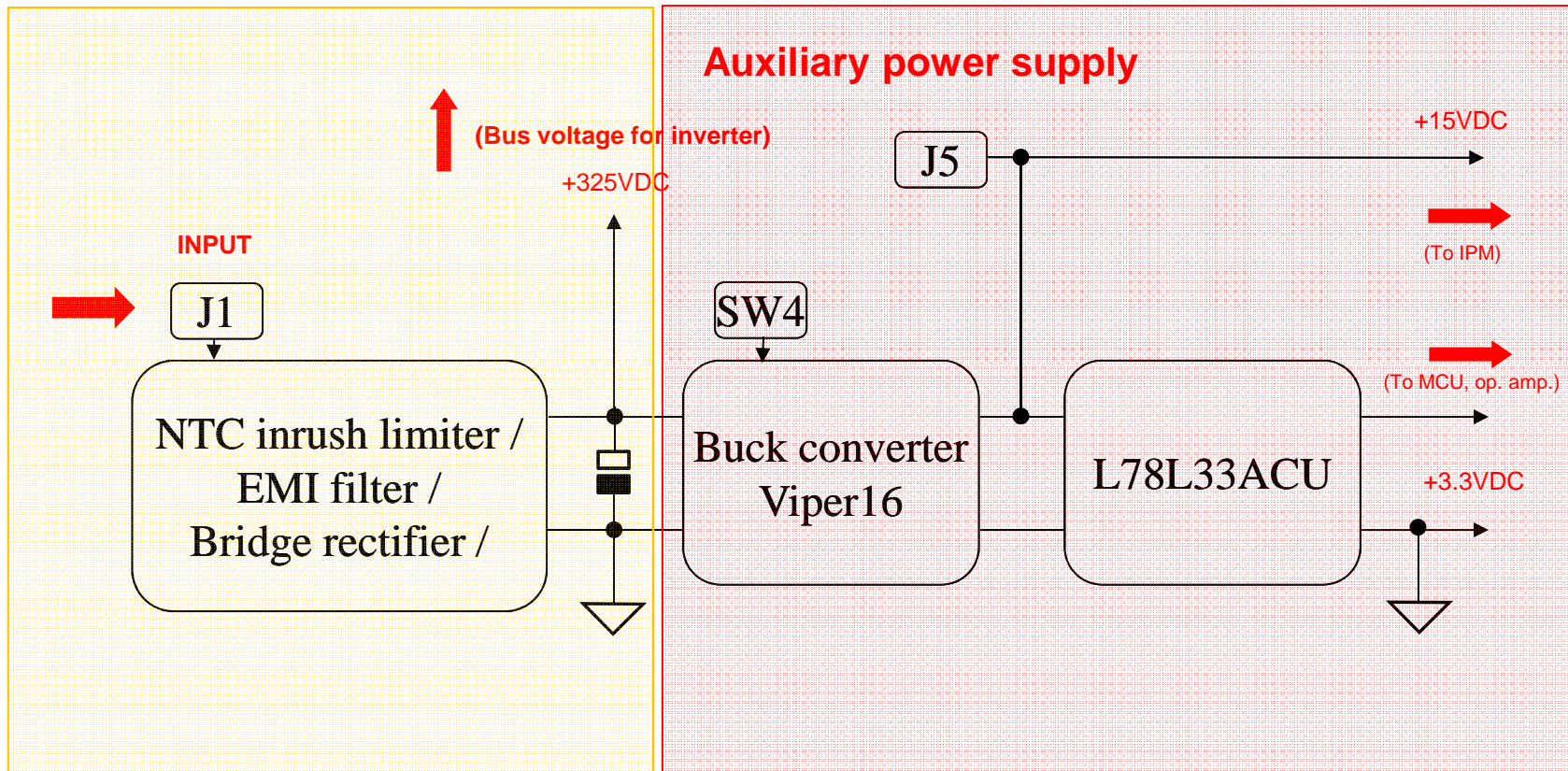


System Architecture



- **Control block:**
 - Accept user commands, motor drive configuration parameters
 - provide appropriate digital signals to perform the proper motor driving strategy
 - Could be updated with driver ST485EB for RS485 BUS
- **Power block:**
 - performs a power conversion from DC bus in to the motor
 - three-phase inverter topology
 - based on SLLIMM™ STGIPN3H60
- **Sensing / protection:**
 - Single shunt topology
 - PMSM with using of FOC itself is conceived for sinusoidal shaped back-EMF
 - Fully using advantage of the SLLIMM™
- **Power supply block:**
 - Single phase connecting - supply voltage 195VAC to 265VAC or direct DC line up to +400VDC

System Architecture - Supply Block

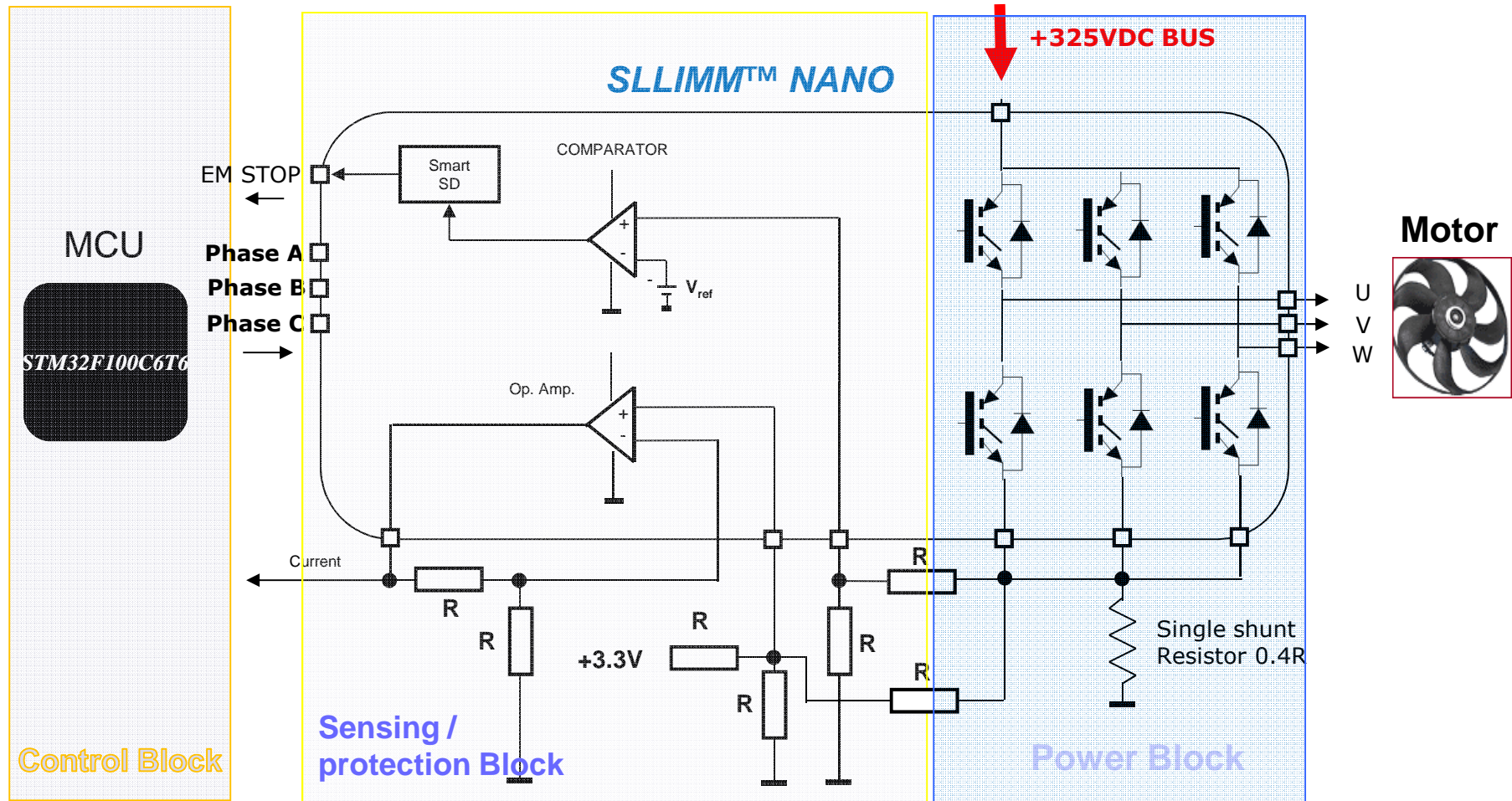




System Architecture - Supply Block

- Includes rectifier bridge
- In-rush current limiter – NTC resistor
- Complete EMI filter based on CM choke, X2 and Y2 capacitors
- EN55014, IEC61000-4-4 and IEC61000 4-5 compliant
- Auxiliary power supply based on Viper16L in buck converter topology
- Working frequency: 60 kHz
- Single phase power supply: 195VAC to 265VAC or direct DC line up to +400VDC

System Architecture - Power / Sensing Block

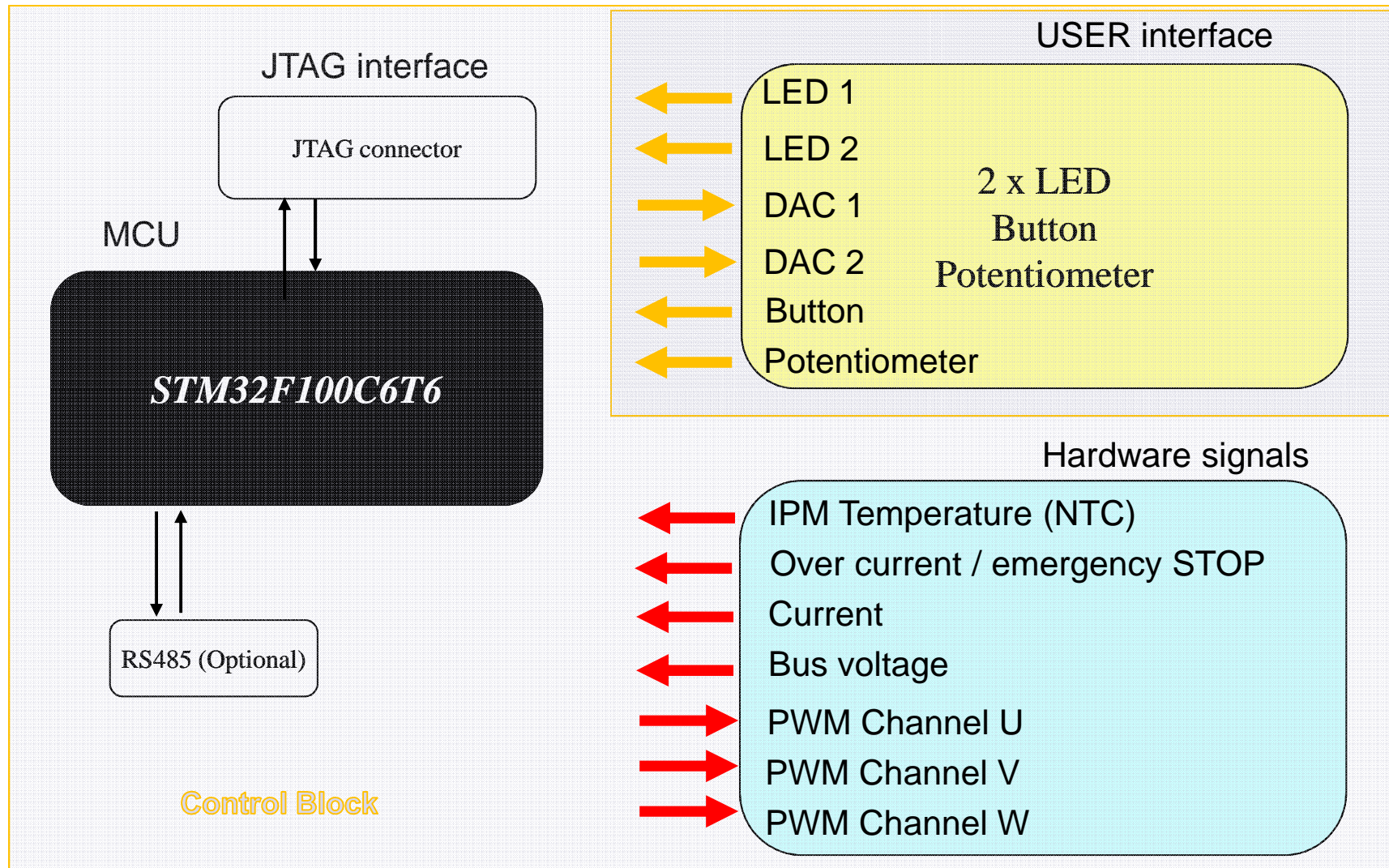


System Architecture - Power / Sensing Block



- Based on SLLIMM™ STGIPN3H60
- Designed for current up to 3A
- Integrated drivers dice L6390
- FOC with single shunt current reading for vector control method
- Fully using integrated features of the SLLIMM™ :
 - Using integrated comparator for over-current protection
 - Direct connection to shut down function of the IPM
 - Advanced current sensing with integrated Op-Amp
 - Adjustable gain of operational amplifier with external resistor network

System Architecture – Control block





System Architecture – Control block

- Based on STM32F100C6T6
- Generated PWM signals for SLLIMM™
- User interface: LED, buttons, potentiometer, DAC
- JTAG interface
- Possibility to modify the board by adding RS485 serial interface
- Sensing various signal with ADC channels
- External 8 MHz crystal
- +3.3V supply voltage

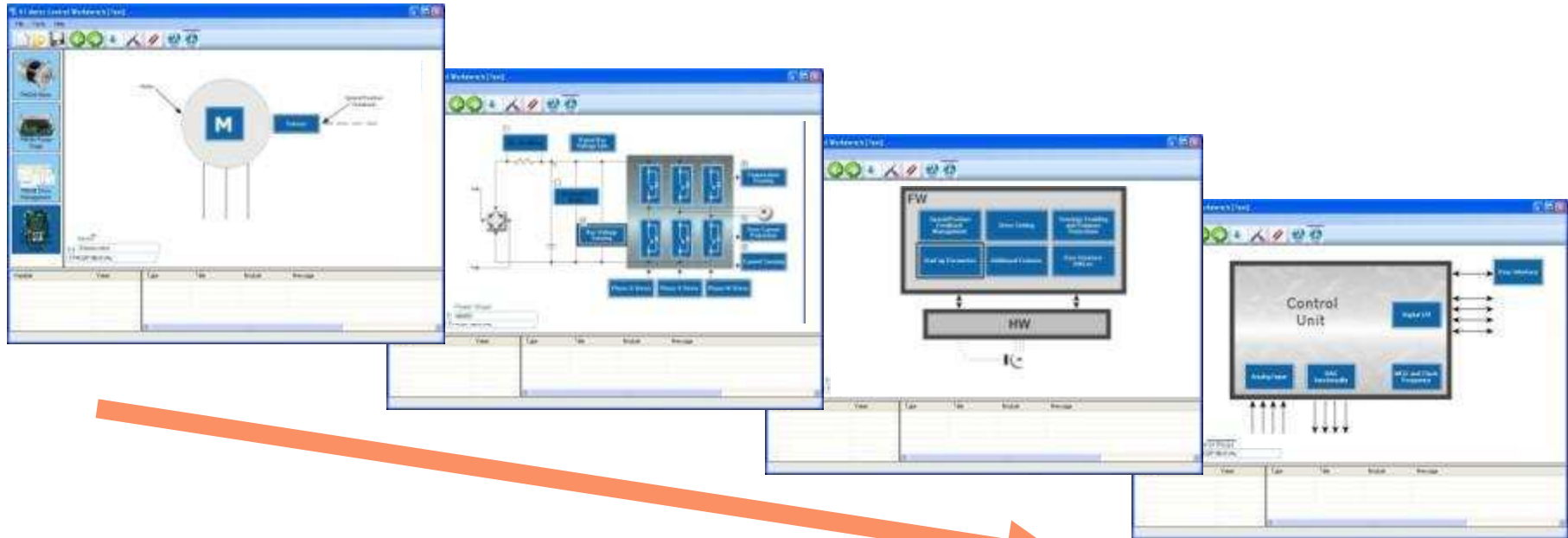


Control block – PMSM FOC library v3.0

- The STM32 PMSM FOC Library v3.0 is a:
 - Motor Control Software Development Kit
 - To be used with STM32F103xx or STM32F100xx
 - For 3-phase Permanent Magnet Synchronous Motors
- Library main features:
 - Single/Dual simultaneous vector control (FOC)
 - Sensor / Sensorless
 - Energy efficient, quiet, motor drive
 - Outstanding dynamic performances, speed range
 - Full customization through GUI
 - Wide range of hardware support, system configurations, addressing applications from Home Appliances to Factory Automation



Control block - ST Motor Control Workbench (STMCWB)



ST Motor Control Workbench, in this version, is a PC code generator tool that reduces the designer effort and time in the firmware development for all the ST Motor control FW library (starting from STM32 PMSM FOC FW library 3.0). The user through a graphical user interface (GUI) generate the parameter header files which configures the library according the application needs.



Tools – Software part

■ Download:

- STM32 FOC PMSM SDK v 3.0 firmware library zip file
 - http://www.st.com/internet/com/SOFTWARE_RESOURCES/SW_COMPONENT/FIRMWARE/stm32_pmsm_foc_motorcontrol_fwlib.zip
- ST MC Workbench v 1.0.2 zip file
 - http://www.st.com/internet/com/SOFTWARE_RESOURCES/TOOL/CONFIGURATION_UTILITY/motorcontrol_workbench.zip

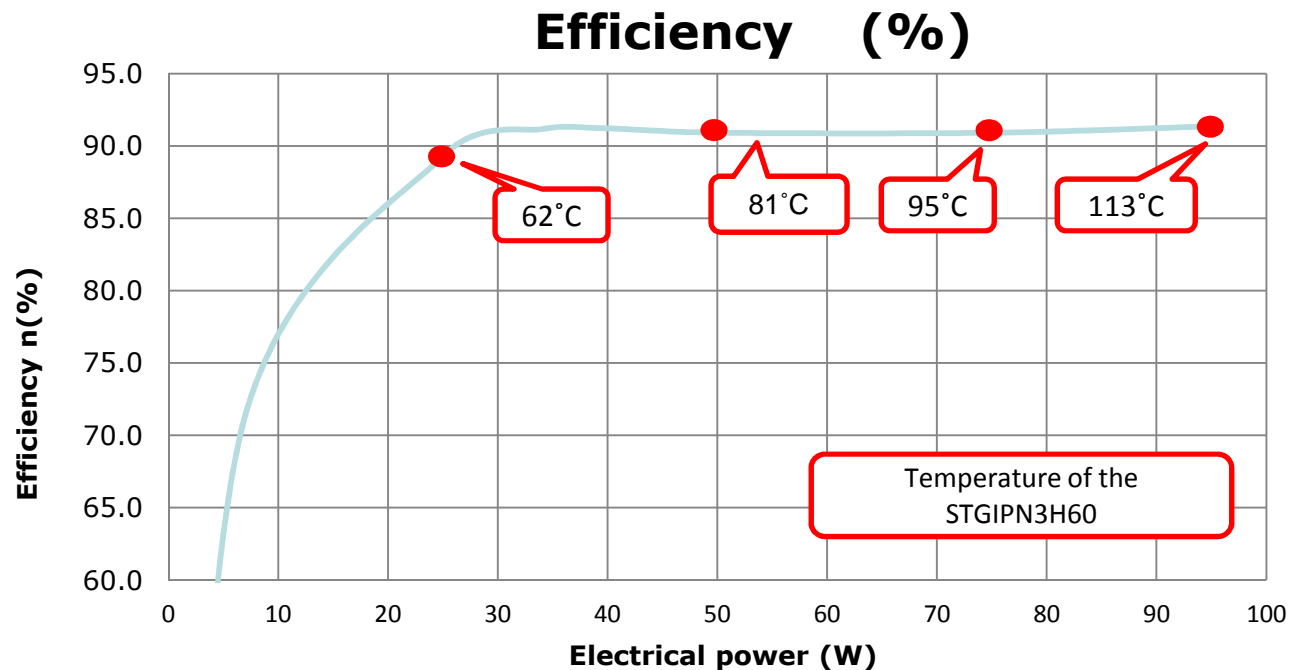
■ Consult:

- TN0516 “Overview of the STM32F103xx/STM32F100xx PMSM single/dual FOC SDK V3.0”
 - http://www.st.com/internet/com/TECHNICAL_RESOURCES/TECHNICAL_LITERATURE/TECHNICAL_NOTE/DM00026481.pdf
- UM1052 “STM32F103 or STM32F100 PMSM single/dual FOC SDK V 3.0”
 - http://www.st.com/internet/com/TECHNICAL_RESOURCES/TECHNICAL_LITERATURE/USER_MANUAL/CD00298474.pdf
- UM1053 “Advanced development Guide for STM32F103 or STM32F100 PMSM single/dual FOC library”
 - http://www.st.com/internet/com/TECHNICAL_RESOURCES/TECHNICAL_LITERATURE/USER_MANUAL/CD00298482.pdf

STEVAL-IHM036V1 parameters - efficiency



- Efficiency measurement:
 - Overall efficiency of the whole demonstration board is above 90% (test conditions- 230VAC, PWM 16kHz, T_{amb} 25°C)
 - Consumption with no motor commutation (STNBY) ~0.6W





STGIPN3H60 vs. Main Competitor FOC @ 16kHz

- SINUSOIDAL FOC CONTROL – SINGLE SHUNT – 3200 RPM (160Hz) – 16kHz – [STGIPN3H60](#)

Ta	Electrical Pout	25W	50W (*)	75W (*)	95(*)
25°C		61°C	80°C	96°C	120°C
50°C		87°C	109°C	123°C @ 65W	-
75°C		116°C	122°C @ 35W	-	-

(*) or the maximum power according to a case temperature of 125°C

- SINUSOIDAL FOC CONTROL – SINGLE SHUNT – 3200 RPM (160Hz) – 16kHz – [Main Competitor](#)

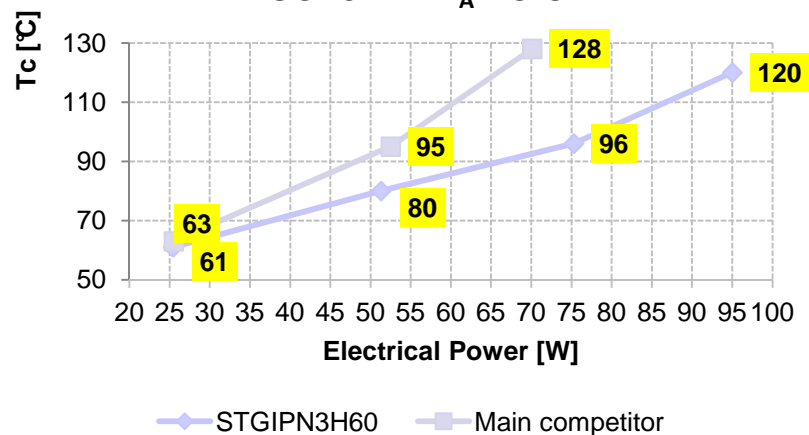
Ta	Electrical Pout	25W	50W (*)	75W (*)
25°C		63°C	95°C	133°C @ 70W
50°C		93°C	126°C @ 47W	-
75°C		119°C	128°C @ 30W	-

(*) or the maximum power according to a case temperature of 125°C

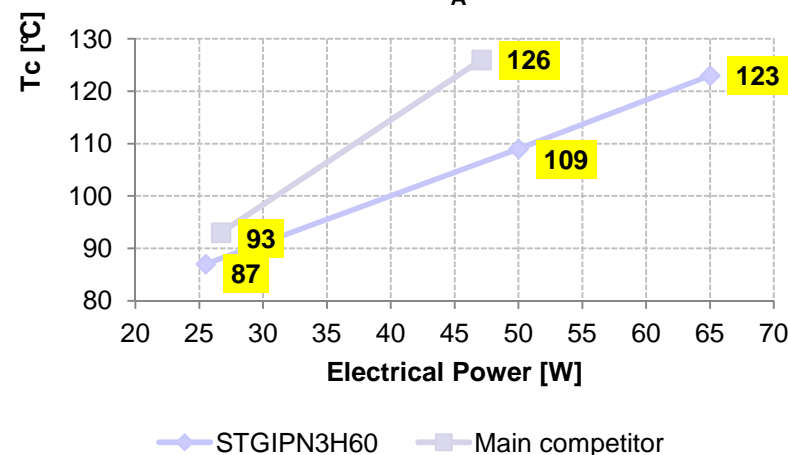


STGIPN3H60 vs. Main Competitor FOC @ 16kHz

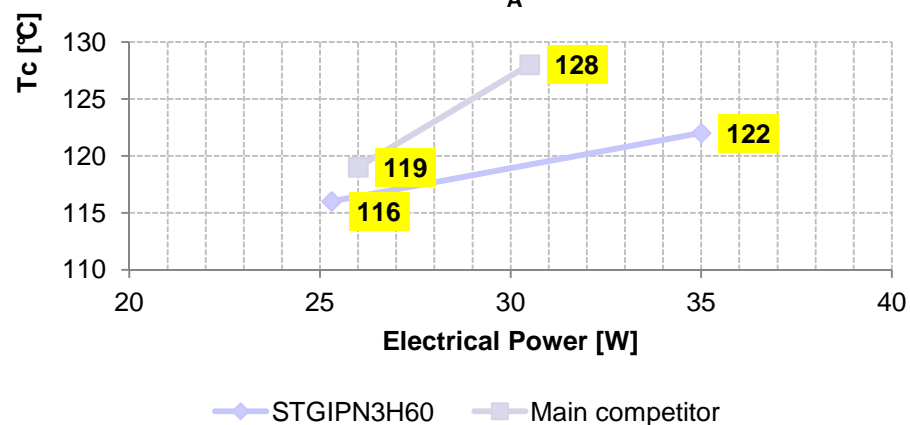
FOC 16kHz - $T_A=25^\circ\text{C}$



FOC 16kHz - $T_A = 50^\circ\text{C}$



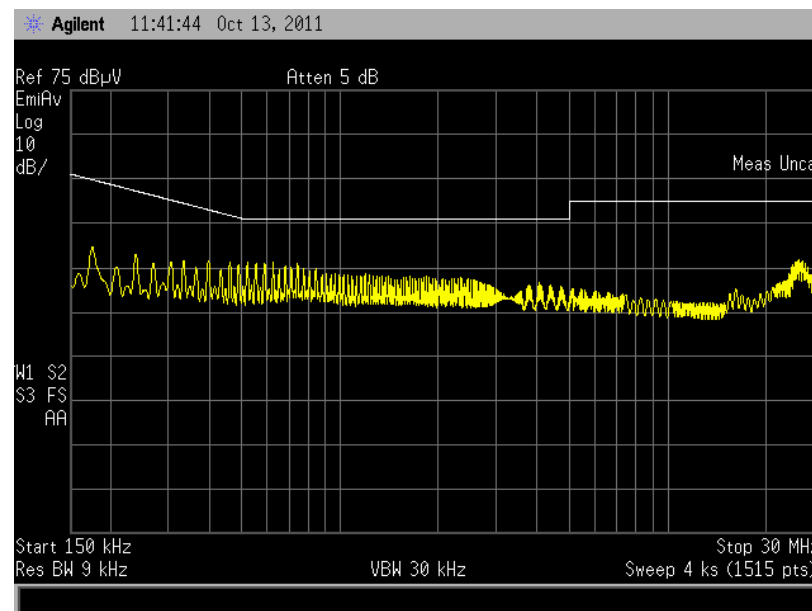
FOC 16kHz - $T_A = 75^\circ\text{C}$





STEVAL-IHM036V1 parameters – compliance with EN55014 (CISPR14-1)

- The STEVAL-IHM036V1 evaluation board was tested to be compliant with conducted radio disturbances according to CISPR14 specification, for frequency range from 150kHz to 30MHz
 - Frequency range 150kHz – 30MHz
 - Detector average; detector quasi peak
 - Measured on power supply lines (AC line: L and N)



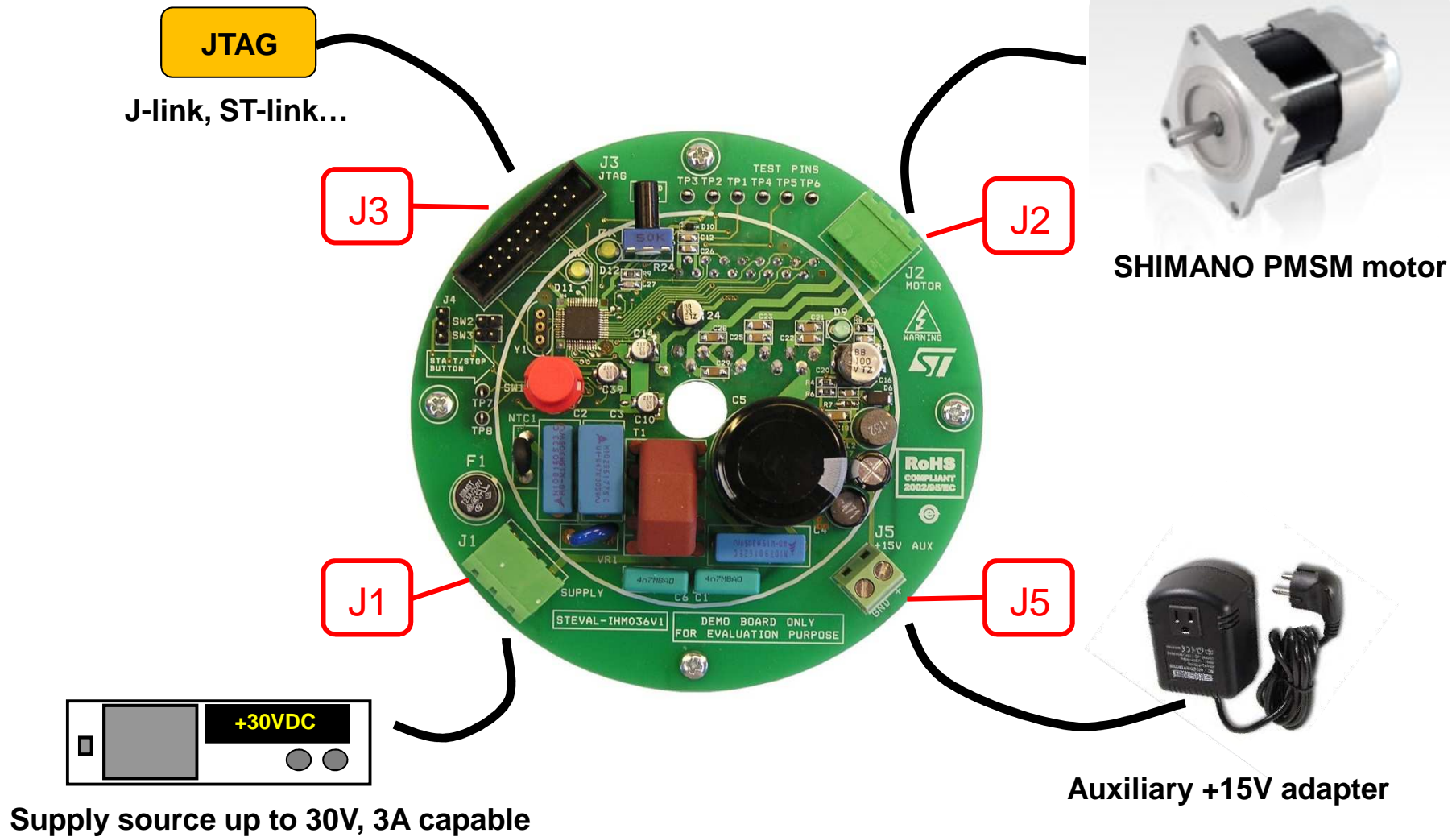


STEVAL-IHM036V1 parameters – compliance with IEC61000-4-4 and IEC61000-4-5

- The board was tested to be compliant with **IEC61000-4-4 burst immunity**:
 - Burst duration 15ms +/- 20% at 5kHz
 - Burst period 300ms +/- 20%
 - Polarity positive/negative
 - Applied to power supply lines (AC line: L and N)
 - Passed 2kV with criteria A (no damage, no influence)

- The board was tested to be compliant with **IEC61000-4-5 surge immunity**:
 - Polarity positive/negative
 - Duration time 10 events; repetition time 30s
 - Phase angle 0°, 90°, 180°, 270° for each test condition
 - Common mode – applied among to AC line and PE earth
 - Differential mode – applied to AC line (L and N)
 - Passed 2kV line to line and 2kV line to earth

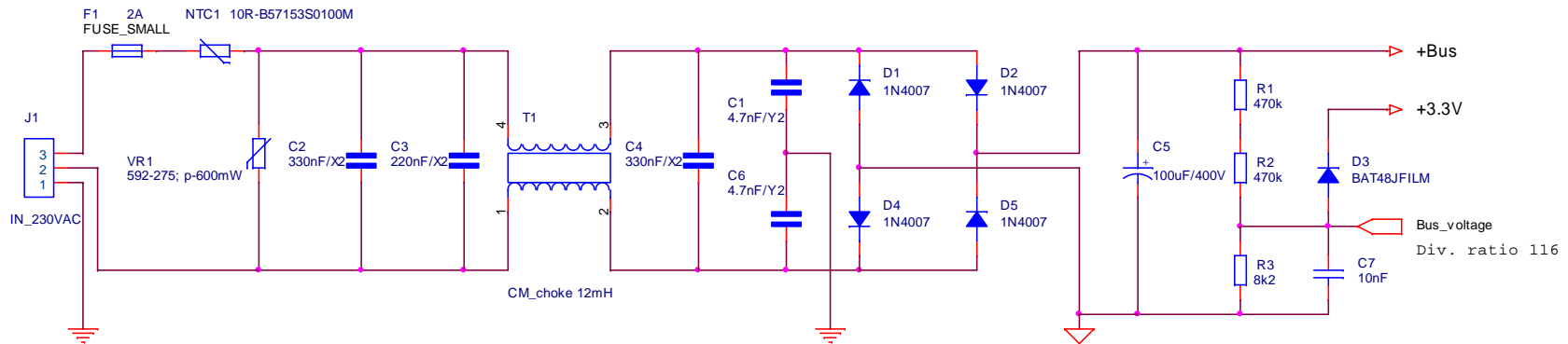
How to connect STEVAL-IHM036V1



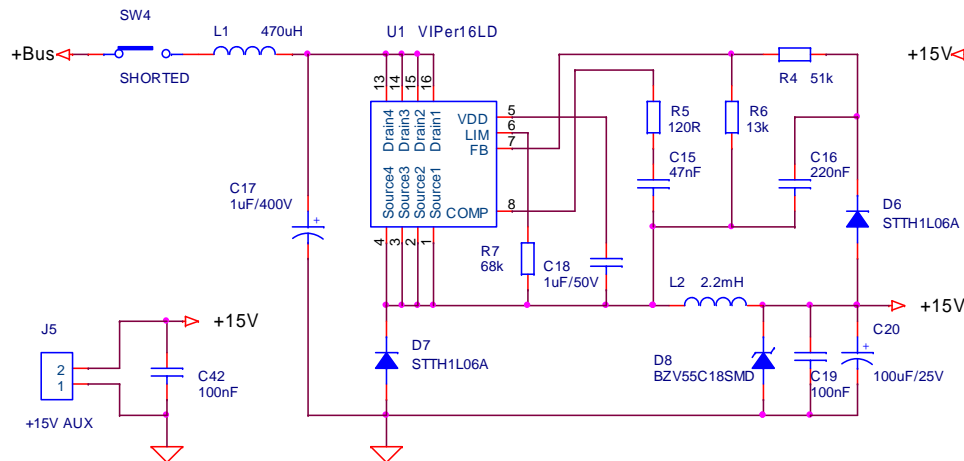
Schematic /1



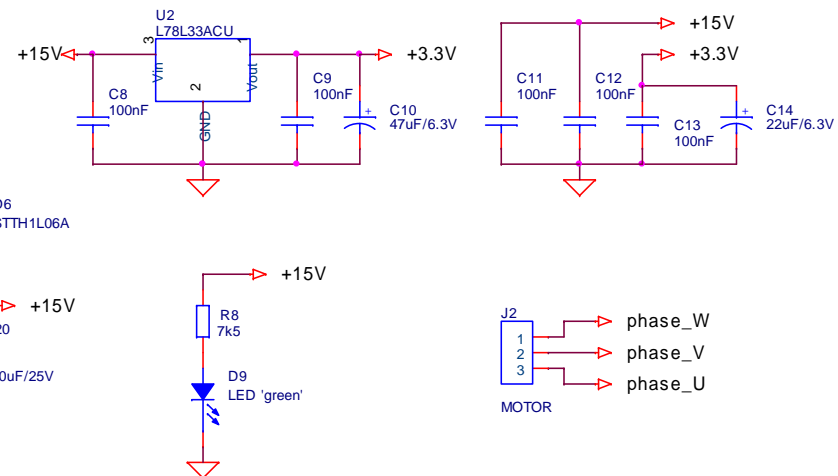
INPUT PART WITH RECTIFIER



BUCK CONVERTER



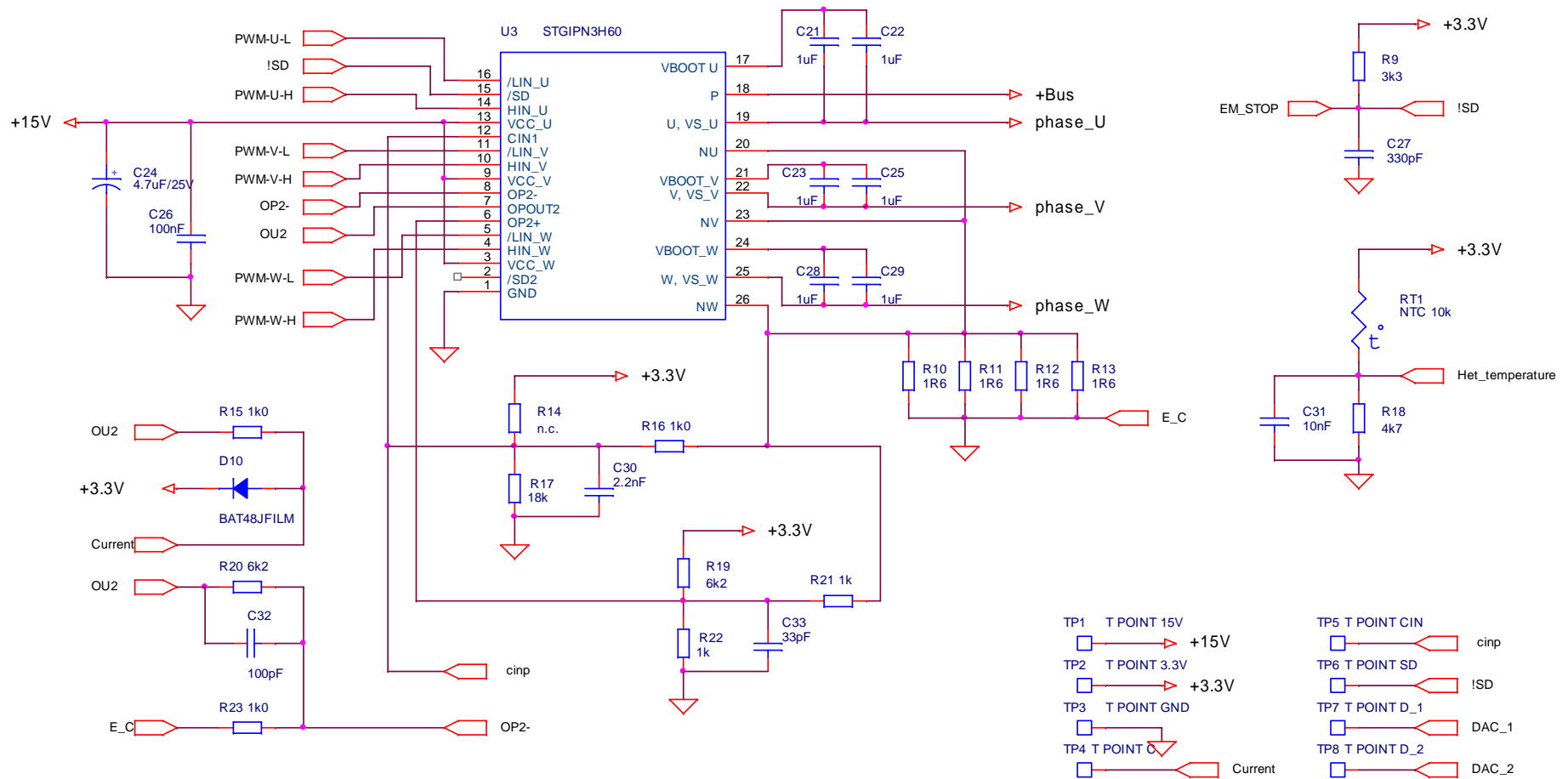
+3.3V LINEAR



Schematic /2



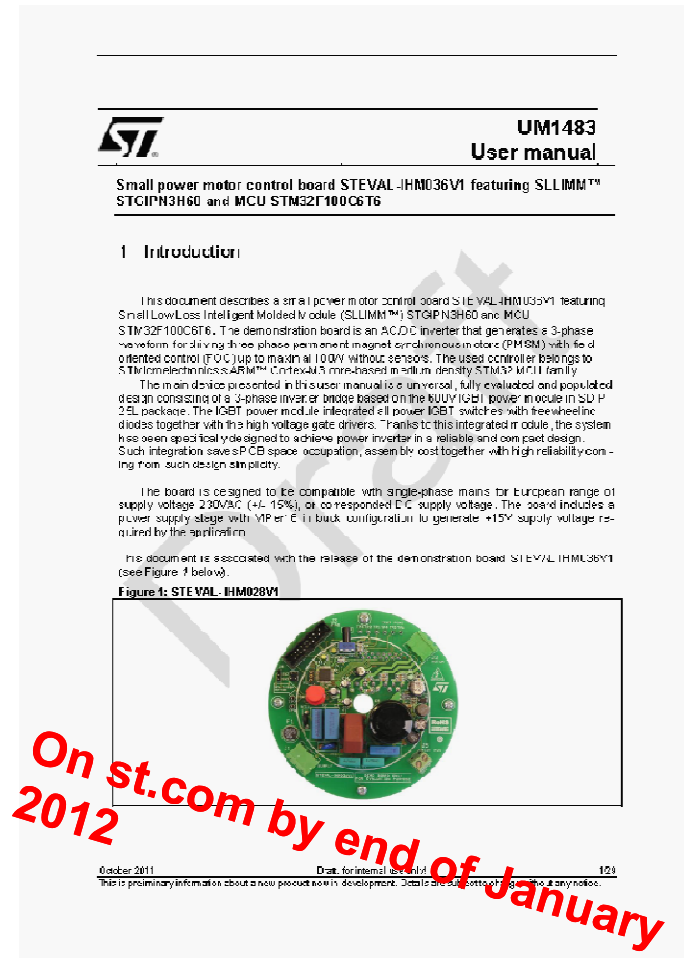
POWER INVERTER PART



Tools



- **Datasheets of available components:**
 - STGIPN3H60 IPM
http://www.st.com/internet/com/TECHNICAL_RESOURCES/TECHNICAL_LITERATURE/DATASHEET/DM00032611.pdf
 - VIPer16
http://www.st.com/internet/com/TECHNICAL_RESOURCES/TECHNICAL_LITERATURE/DATASHEET/CD00218828.pdf
 - STM32F100C6T6
http://www.st.com/internet/com/TECHNICAL_RESOURCES/TECHNICAL_LITERATURE/DATASHEET/CD00251732.pdf
- **User manual UM:1483**
Low power motor control board STEVAL-IHM036V1 featuring SLLIMM™ STGIPN3H60 and MCU STM32F100C6T6



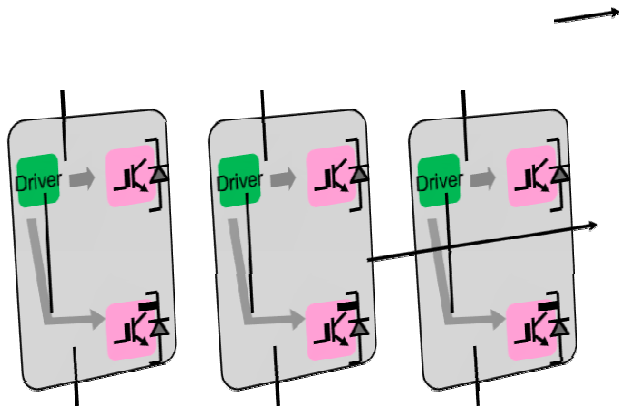
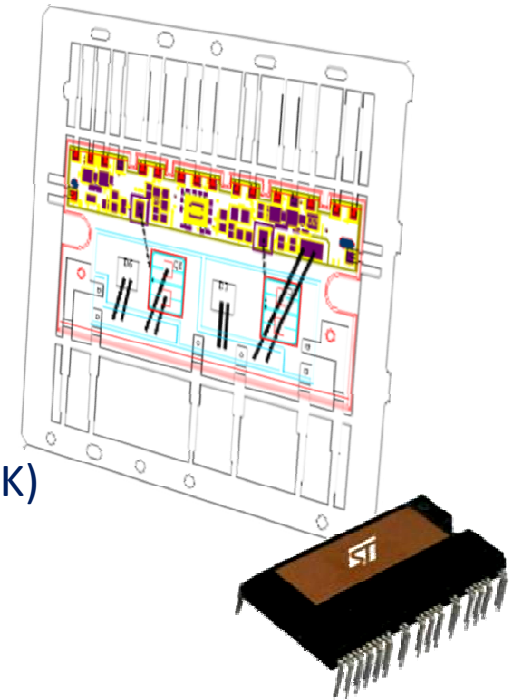
NEWS!!! SLIMM SINGLE LEG Modular half bridge



NEWS!!!!!!!!!! 2012
Samples available

1. It includes several innovative features:

- Modular and expandable solution
- Better Thermal behavior than a six-pack solution
- Improved board layout
- Several “smart” functions embedded
- Silicon options offered for both PFC (W) and Motor Control (K)



M

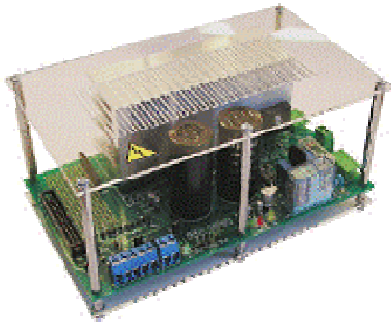
PN	$BV_{CES} @ 25^{\circ}C$	$I_c @ 25^{\circ}C$	Features	NTC	Package
STGIPS35K60L1	600 V	35 A	L6390 based	Y	SDIP 22L
STGIPS40W60L1	600 V	40 A	L6390 based	Y	SDIP 22L

SLIMM SINGLE LEG Features



L6390 Driver available features	35A 600V	
Pkg Size [mm]	49.6*24.5*5.4	Integrated bootstrap diodes mean: component cost saving easy layout
DBC substrate	yes	
Voltage [V]	600	Thanks to Smart Shutdown function, ST HV gate driver can turn off the IPM in a faster (T:200ns) and safer way during abnormal state (Over Current or Over Temperature)
Current @ Tc=25°C [A]	35	
Rth (max) [°C/W]	1.25	
Embedded Thermal Resistor (NTC)	Yes	SD function available for an efficient connection with micro-controller
Integrated Bootstrap diode	Yes	
Smart shutdown function	Yes	Integrated interlocking function can avoid any malfunctioning coming from overlapped input signals
SD function	Yes	
Op-amps for Advanced current sensing	Yes (3 pins)	
Comparator for fault protection	Yes	
3.3/5V input interface compatibility	Yes	
Interlocking Function	Yes	
Under Voltage lockout (on Vcc and Vboot)	yes	

SLIMM Motor Control Evaluation Board



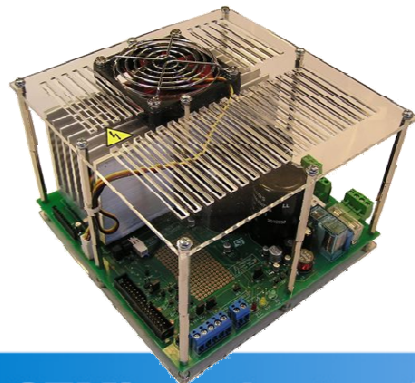
STEVAL-IHM025V1

- 1 x IGBT IPM STGIPL14K60
- 1 x PWM SMPS smart driver VIPer16LD
- 1 x IGBT power switch STGP10NC60KD



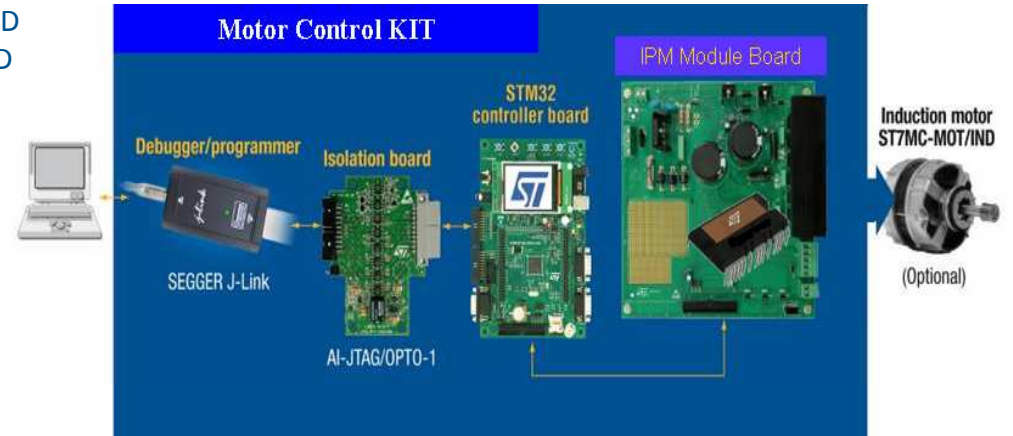
STEVAL-IHM027V1

- 1 x IGBT IPM STGIPS10K60A
- 1 x buck converter based on Viper16
- 1 x IGBT power switch STGP10NC60KD



STEVAL-IHM028V1

- 1 x IGBT IPM STGIPS20K60
- 1 x PWM SMPS smart driver VIPer26LD
- 1 x IGBT power switch STGW35NB60SD



- Three-phase power stage with shunt-based current reading
- Complete source files software libraries for 3-PH Induction and PMSM motors provided

1KW Power Inverter STGIPL14K60



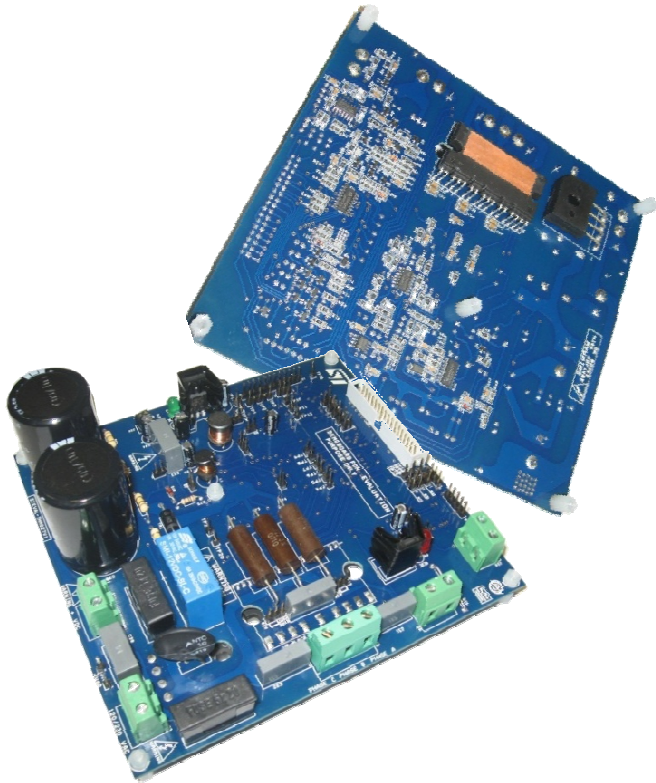
- Single phase connecting - supply voltage from 125VDC to 400VDC
- Possibility to use PMAC motors, 3-phase asynchronous motors, bi-phase AC motors or BLDC motors
- Input in-rush limiter with by-passing relay
- Brake switch with over-voltage comparator
- Hall sensor or encoder input feature, tachometer input feature
- Over-temperature and over-current hardware protection
- Compact and safety design

- 1 x IGBT IPM **STGIPL14K60**
- 1 x PWM SMPS smart driver **VIPer16LD**
- 1 x IGBT power switch **STGP10NC60KD**

Ordering code: STEVAL-IHM025V1

Evaluation boards available at: <http://www.st.com/evalboards>

1KW Power Inverter STGIPS10K60A



- Single phase connecting - supply voltage from 125VDC to 350VDC
- Motor control connector for interface with STM3210B-EVAL board
- Possibility to use induction motor or PMSM motors up to 1000 W
- Regenerative brake control feature
- Input inrush limitation with bypassing relay
- Hall\Encoder inputs
- Possibility to connect BEMF daughter board for sensor-less six-step control of BLDC motors
- Tachometer input
- Compact and safety design

- 1 x IGBT IPM **STGIPS10K60A**
- 1 x buck converter based on **Viper16**

Ordering code: STEVAL-IHM027V1

Evaluation boards available at: <http://www.st.com/evalboards>

2 KW Power Inverter STGIPS20K60



- HV supply mode -voltage 90VAC to 285VAC or direct DC line 125VDC to 400VDC
- Input voltage range extended to +400V to be compliant with PFC
- Input inrush limiter with bypassing relay
- Brake feature with over-voltage comparator
- Single or three shunt resistors current sensing method
- Hall sensor or encoder input feature
- Tachometer input feature
- Over-temperature and over-current hardware protection
- Active fan with automatic over-temperature switching
- Relative compact and safety design

- 1 x IGBT IPM **STGIPS20K60**
- 1 x PWM SMPS smart driver **VIPer26LD**
- 1 x IGBT power switch **STGW35NB60SD**

Ordering code: STEVAL-IHM028V1

Evaluation boards available at: <http://www.st.com/evalboards>

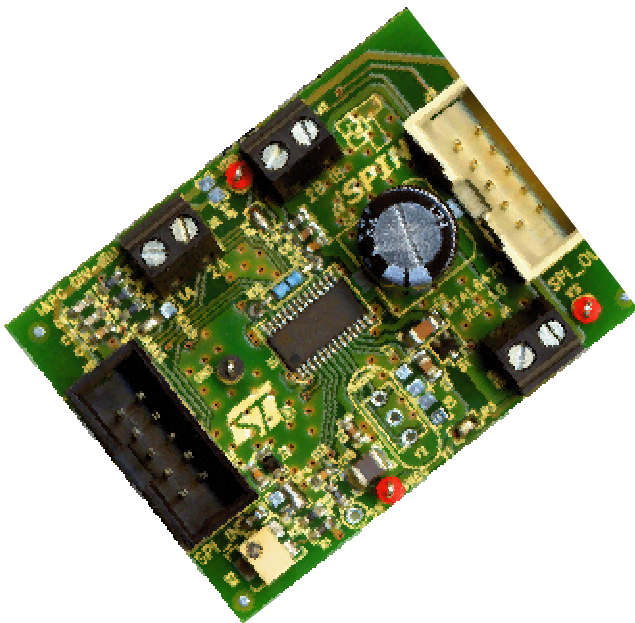
Stepper motor control L6470 DSPIN & L6480 CSPIN



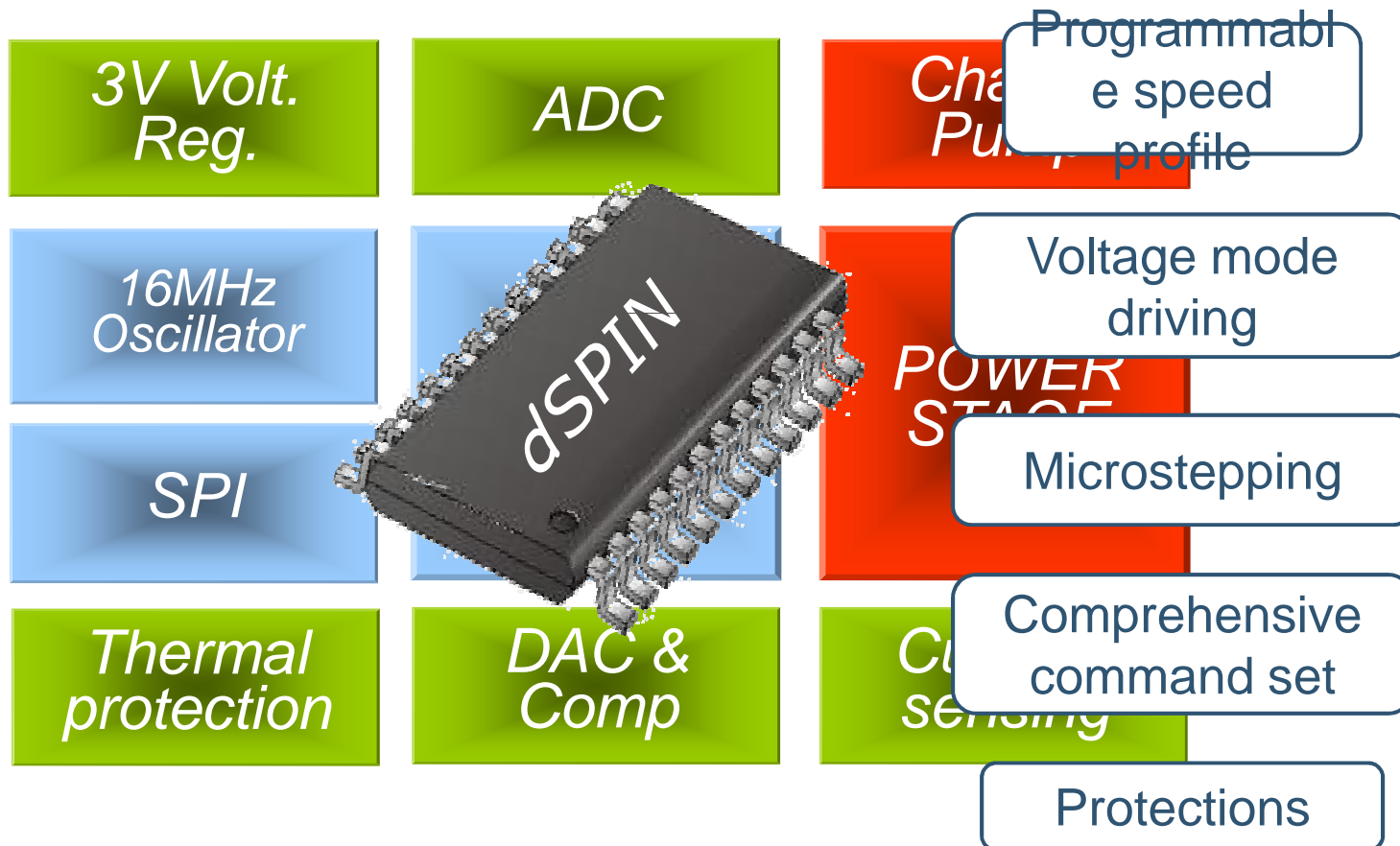
Industrial & Power Conversion Division
Off Line Power Supply Business Unit

DSPIN & CSPIN

The new *State of the Art* in μ stepping Drivers



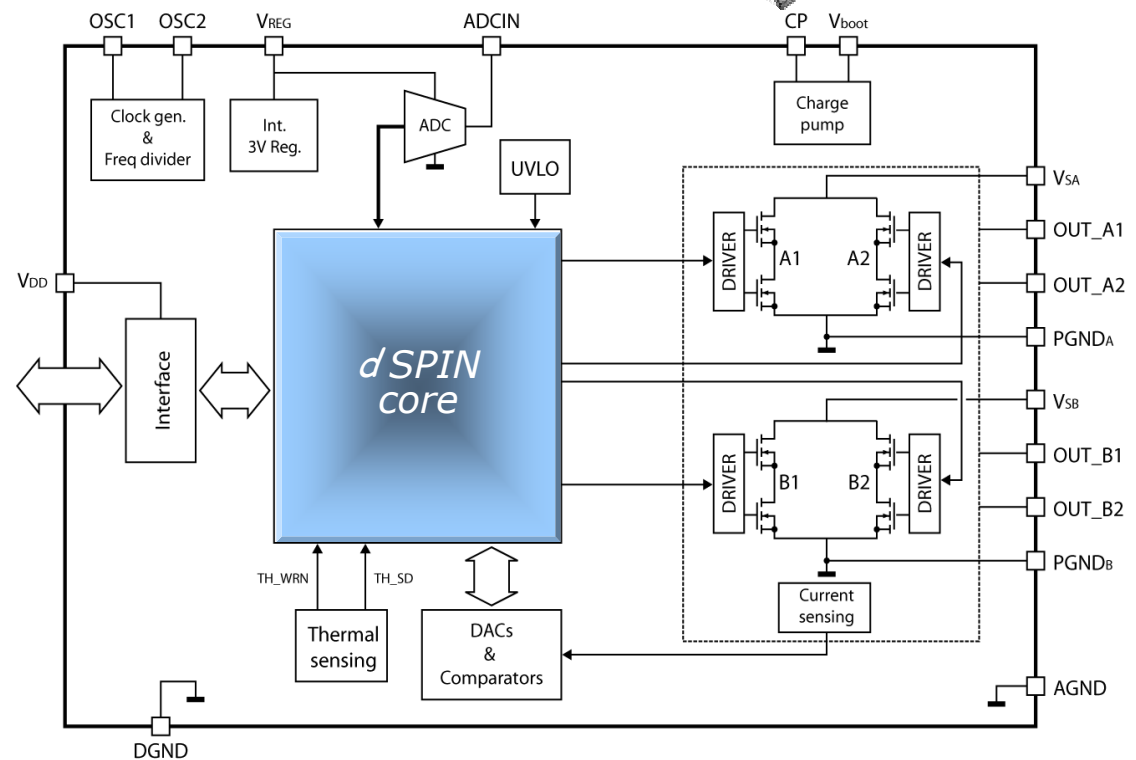
L6470 DSPIN Functional Block



L6470 DSPIN Features



- ▶ Supply voltage 8V – 45V
- ▶ 3Arms (7A peak)
- ▶ $R_{DS,ON} = 0.37 \text{ ohm (high side)} + 0.18 \text{ ohm (low side)}$
- ▶ Integrated Current Sensing (no external shunt)
- ▶ Up to 128 microsteps
- ▶ Voltage mode operation
- ▶ Sensorless Stall Detection
- ▶ Programmable speed profile
- ▶ Programmable positioning
- ▶ 8bit 5Mhz SPI interface (Daisy Chain compatible)
- ▶ Integrated 16MHz oscillator
- ▶ Integrated 5bit ADC
- ▶ Integrated 3V voltage regulator
- ▶ Over Current, Over Temperature and Under Voltage protections
- ▶ QFN and HTSSOP package



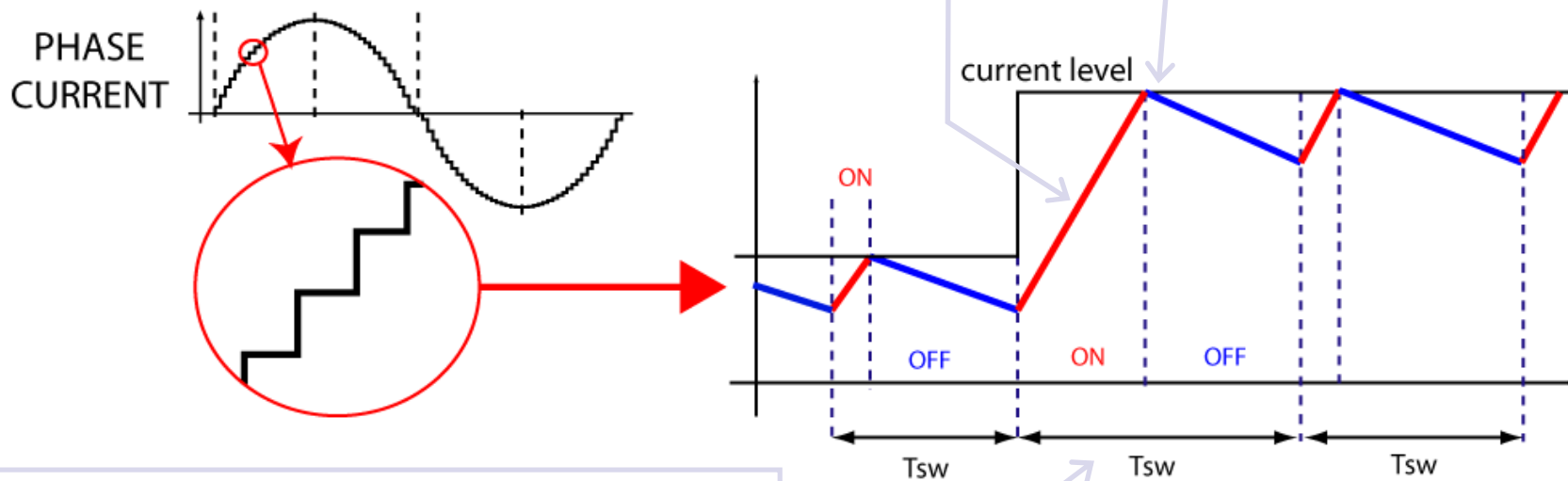
L6470 DSPIN Voltage mode vs Current Mode



1. Abrupt current changes cause strong mechanical vibrations.
Current mode tries to follow even non idealities (reference voltage quantization and sampling)
Noisy and jerky motion.

2. Peak current is controlled. Average current value is different from target one.
Inaccurate positioning

CURRENT MODE



3. Non constant switching freq.
Torque ripple and EMI are difficult to control.

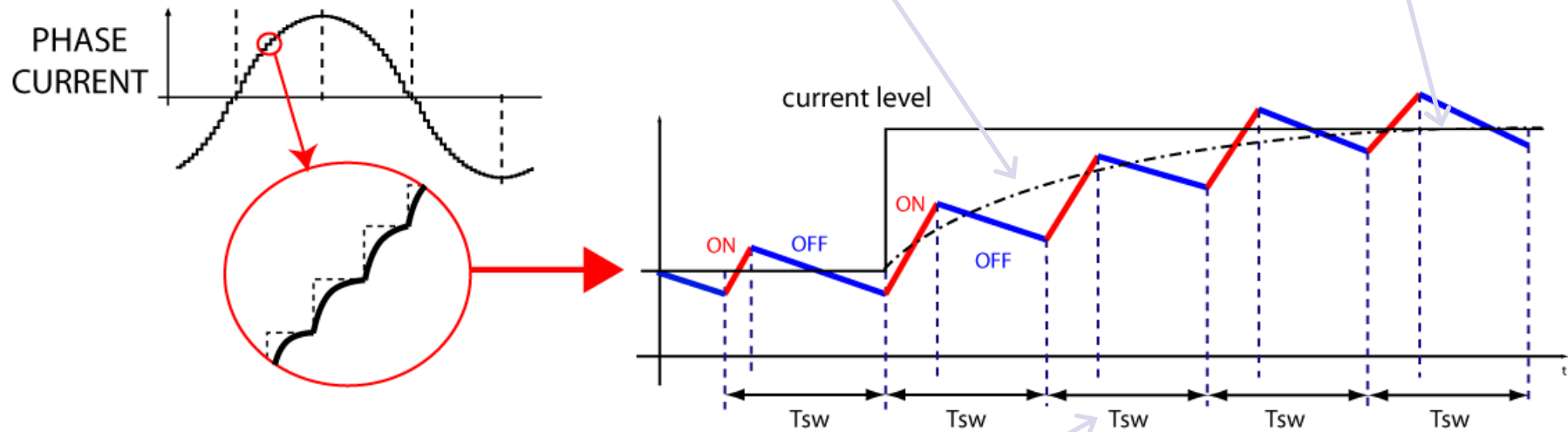
L6470 DSPIN Voltage mode vs Current Mode



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

Average current is controlled. Accurate positioning.

VOLTAGE MODE



Constant switching freq. Torque ripple and EMI are under control.



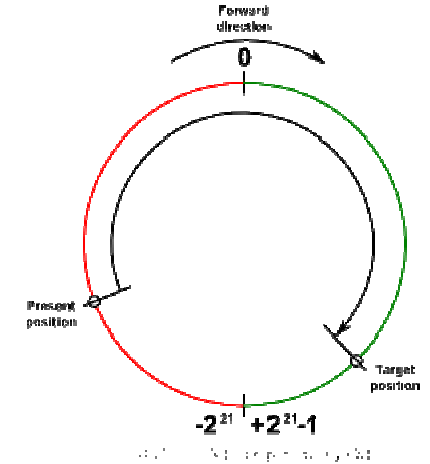
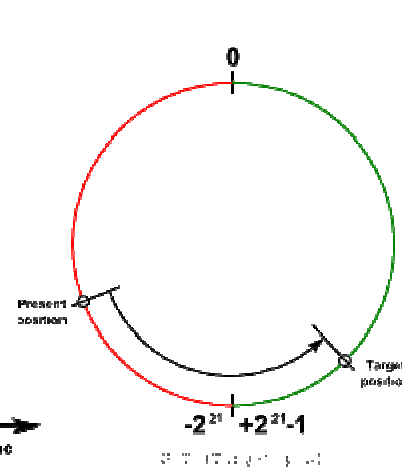
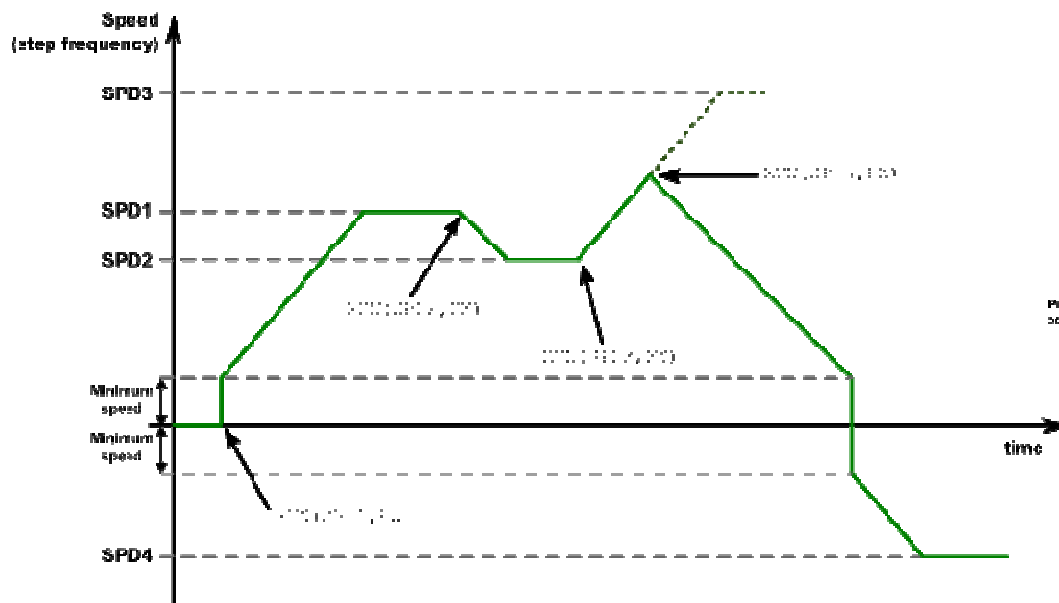
L6470 DSPIN Advantages: Integration

Intelligence integration

Speed and position profiles required complex μ controller routines

and *SPIN* does the whole tricky job, listening to simple high level SPI

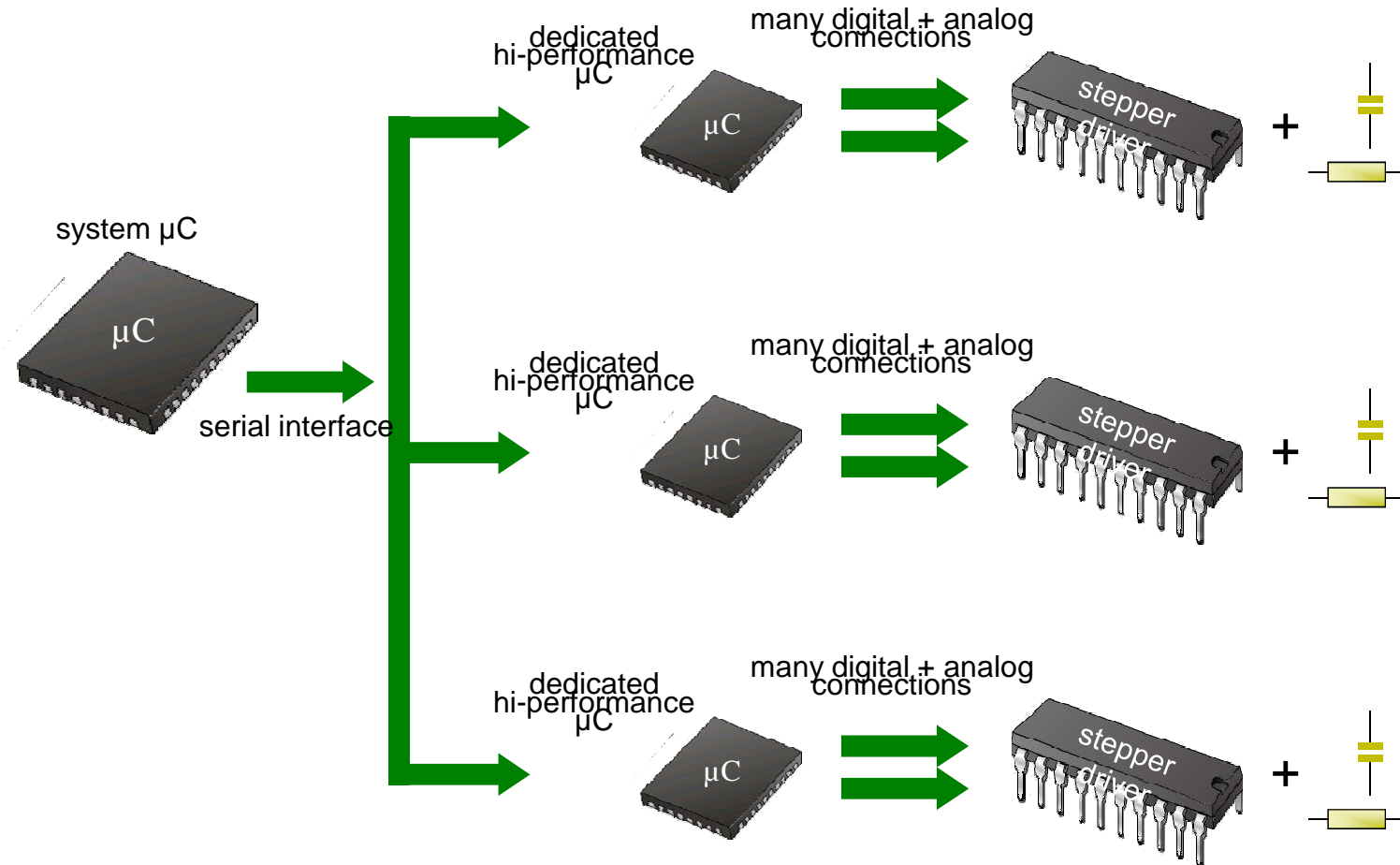
commands



L6470 DSPIN Intelligence Integration



before dSPIN...



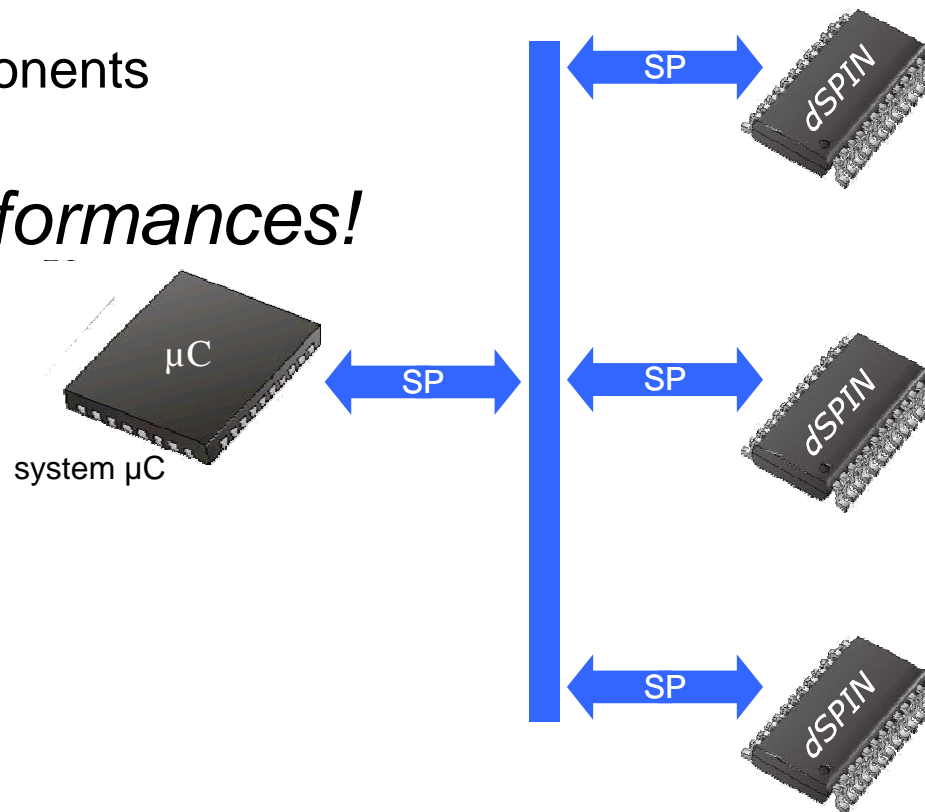
L6470 DSPIN Intelligence Integration



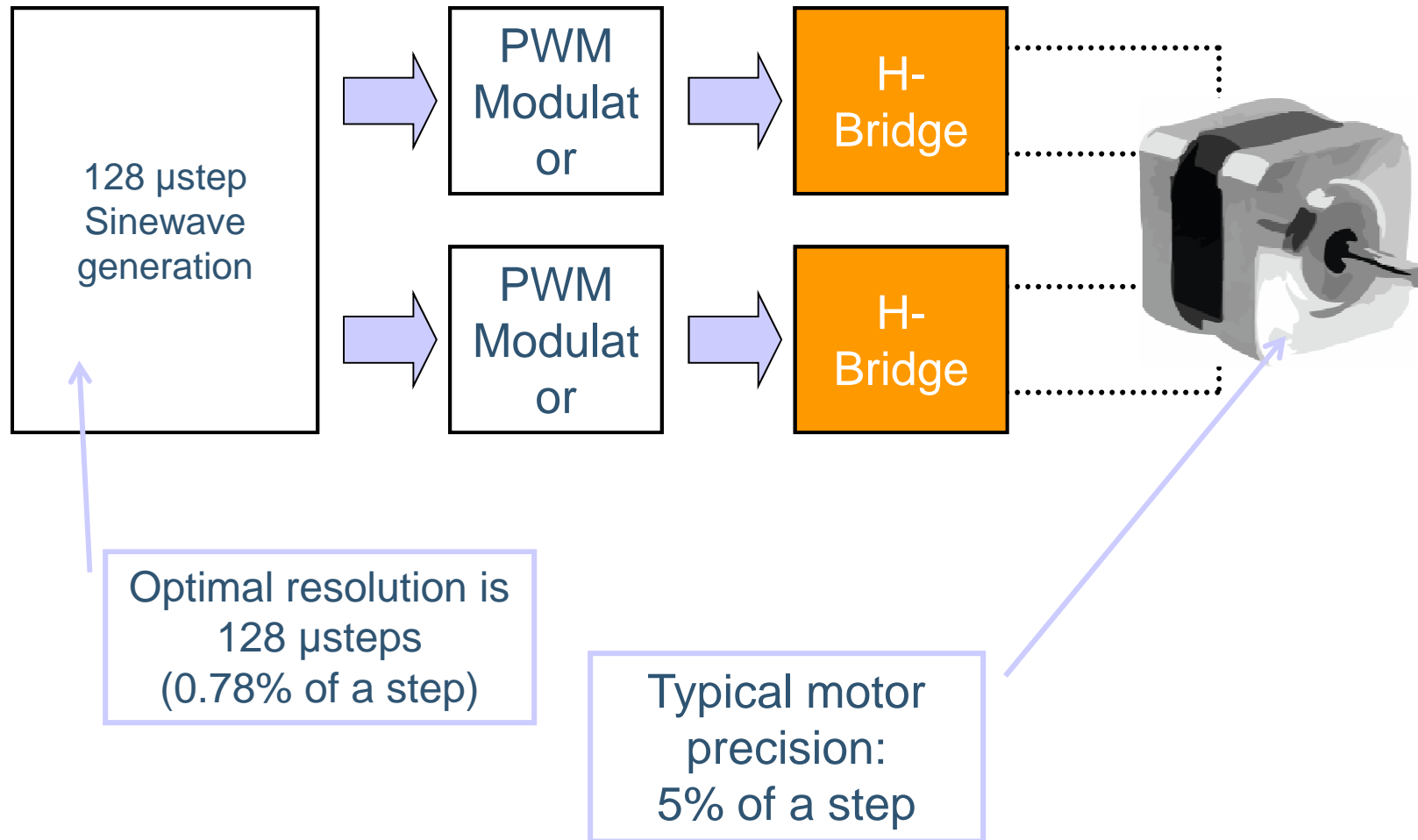
...after dSPIN !

- ▶ System is heavily simplified
- ▶ No more dedicated μC to perform speed profile and positioning calculations
- ▶ A lot less passive components

and... *far better performances!*



L6470 DSPIN Technical Details



Voltage mode drawbacks and solutions



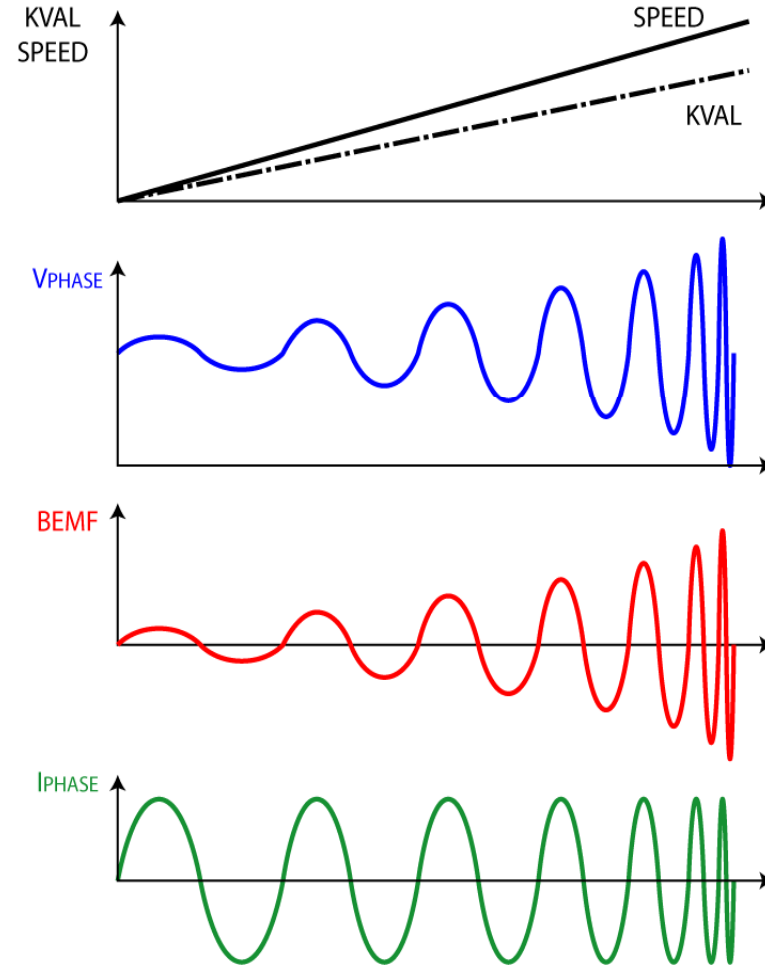
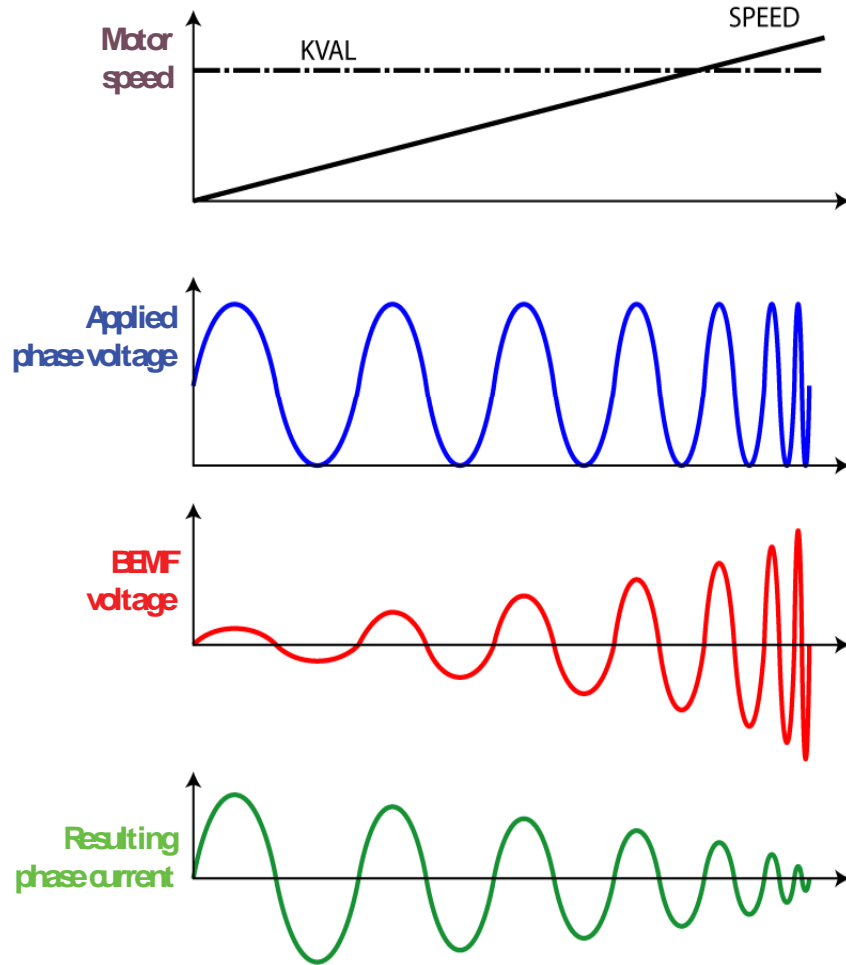
- ✘** *Back-Electro Motive Force heavily influences voltage to current relation*
- ✔** Effective and flexible BEMF compensation system
- ✘** Windings applied voltages are perturbed by supply voltage fluctuations
- ✔** Supply voltage compensation through integrated 5bit ADC
- ✘** Phase resistances vary with temperature
- ✔** Phase resistance compensation register

L6470 DSPIN BEMF Compensation



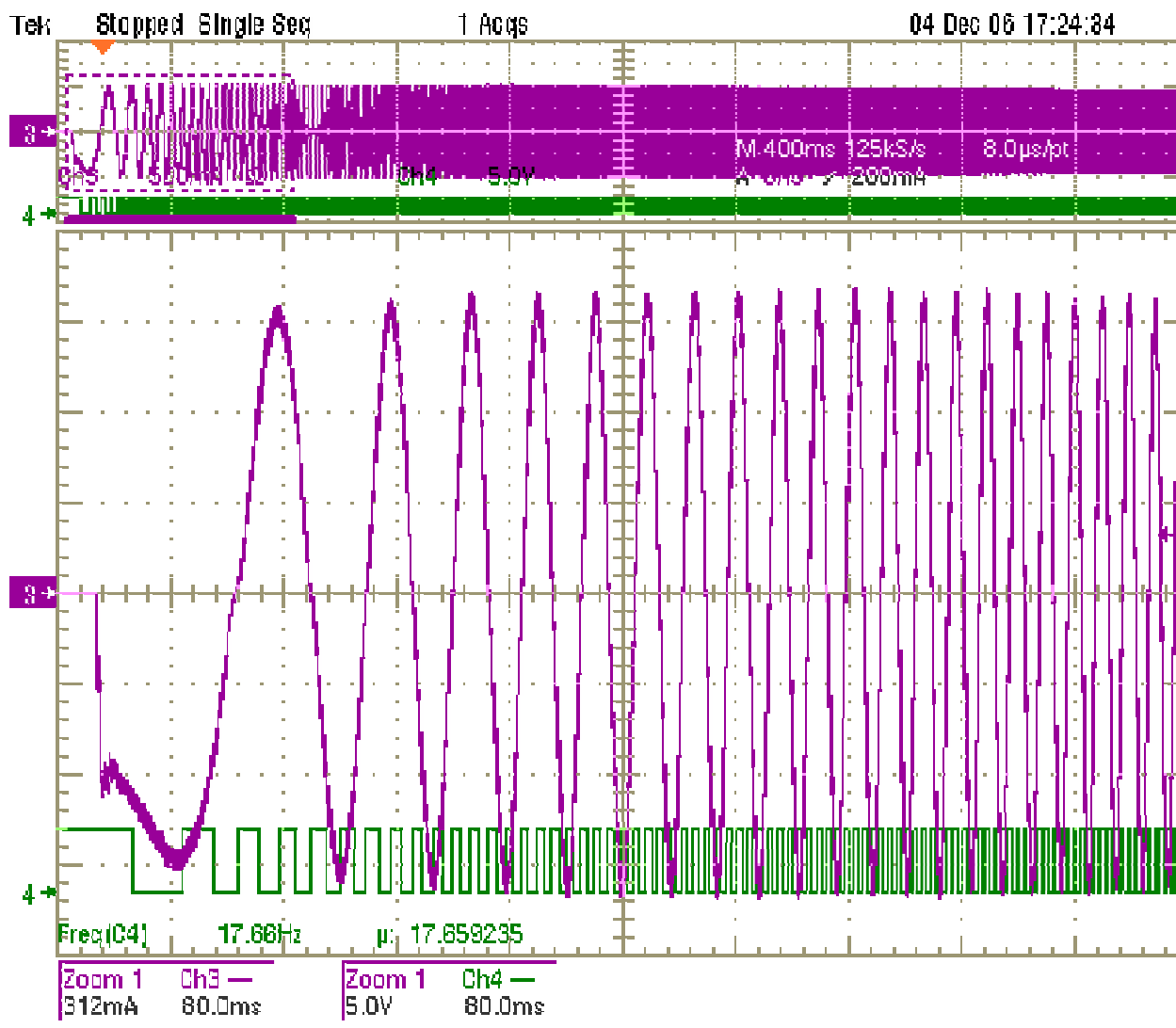
Without BEMF compensation

With BEMF compensation

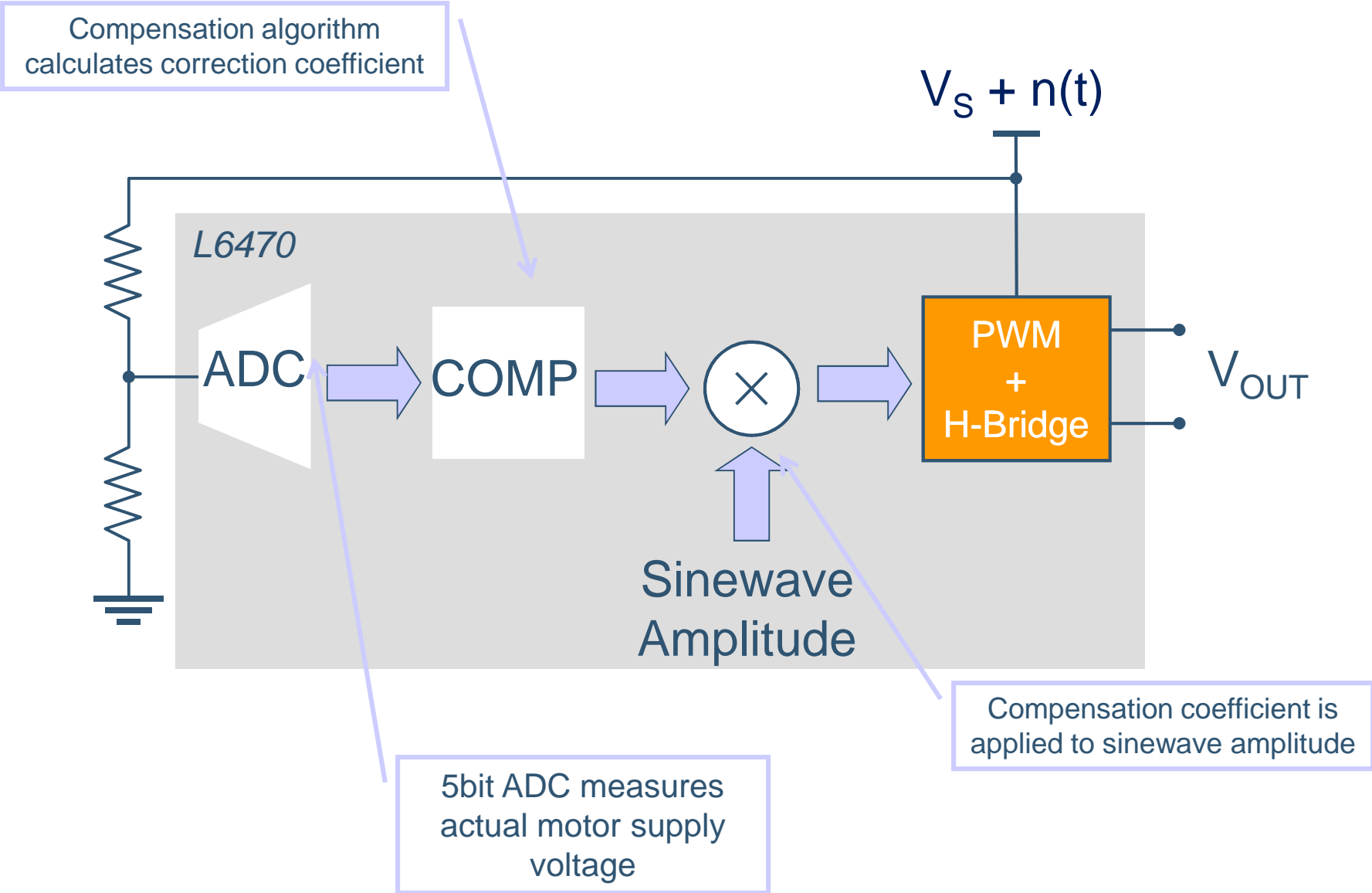




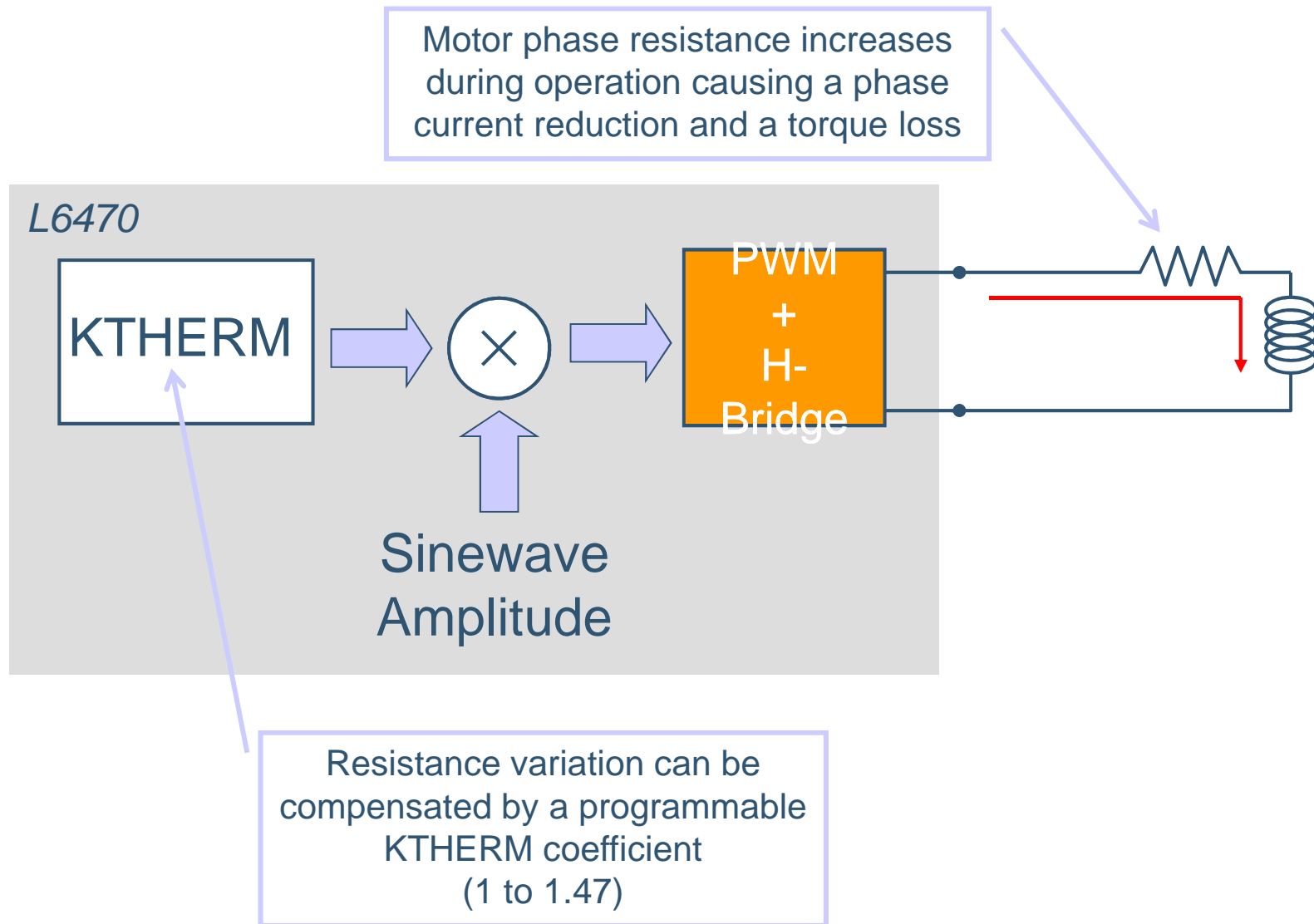
L6470 DSPIN Current with BEMF compensation



L6470 DSPIN Supply voltage compensation



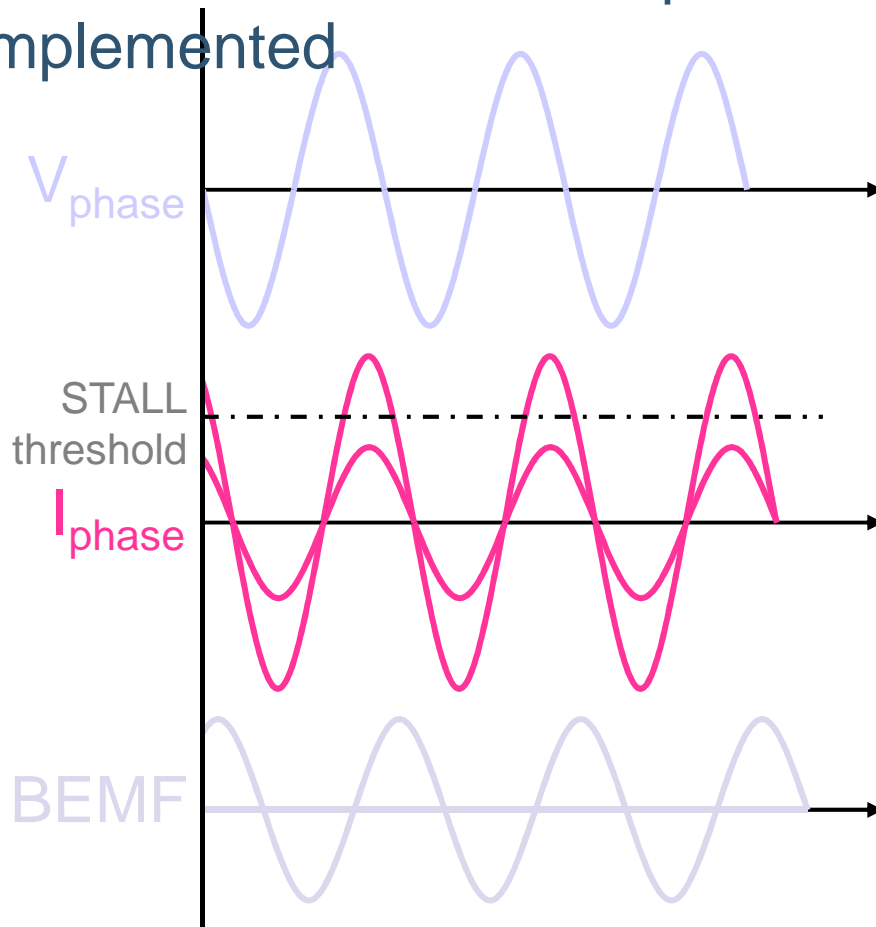
L6470 DSPIN Phase resistance variation compensation



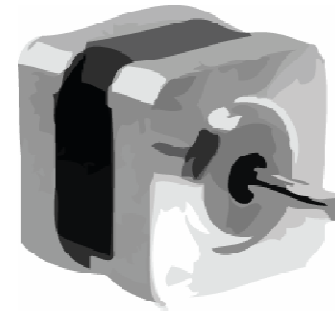
L6470 DSPIN Stall Detection



Using integrated current sensing and the adjustable STALL current threshold a cheap and easy stall detection can be implemented



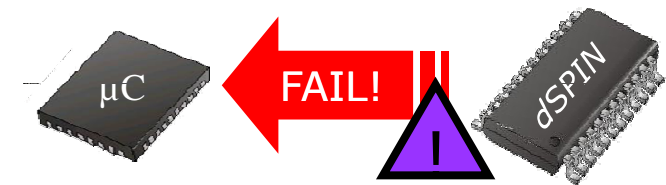
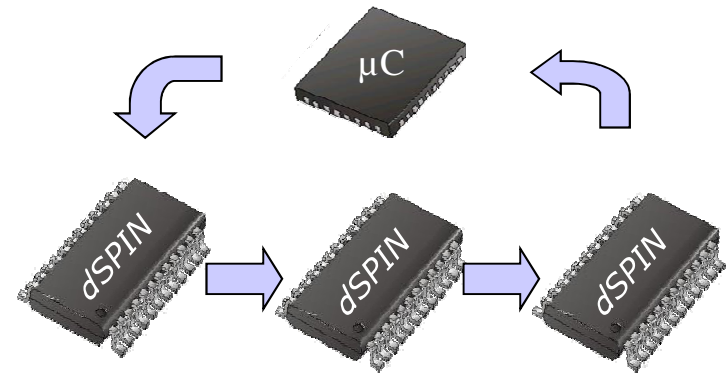
STALL!
BEMF is null and
current is suddenly
increased



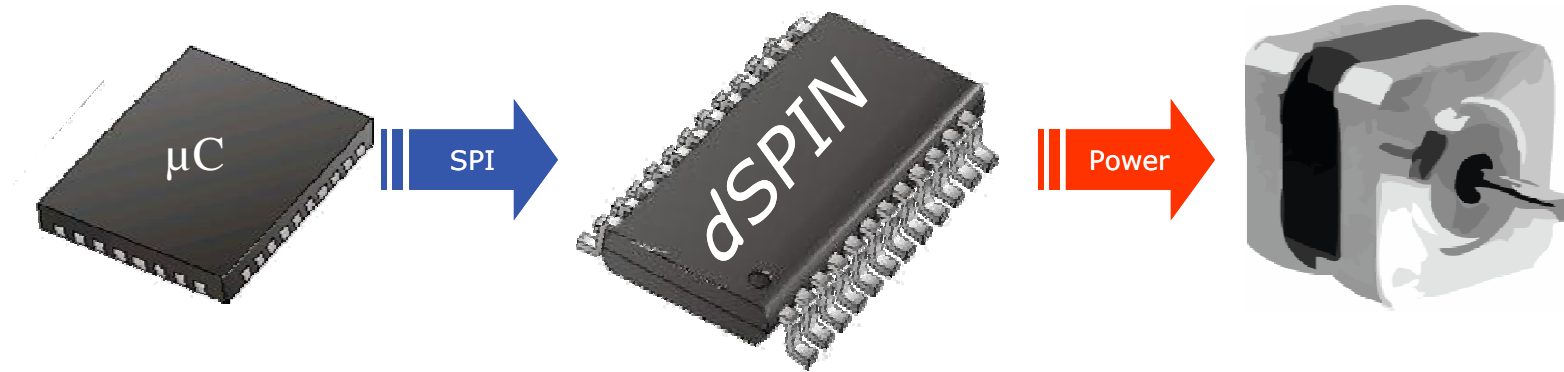
L6470 DSPIN a complete digital interface



- ▶ The fast SPI interface with *daisy-chain* capability allows a single MCU to manage multiple devices
- ✓ Programmable alarm *FLAG* open drain output for interrupt-based FW
In daisy-chain configuration, *FLAG* pins of different devices can be or-wired to save host controller GPIOs
- ✓ *BUSY* open drain output allows the MCU to know when the last command has been performed
In daisy-chain configuration, *BUSY* pins of different devices can be or-wired to save host controller GPIOs



L6470 DSPIN Positioning & Speed profile



µC sends dSPIN high level commands...

Free-run → run at constant speed

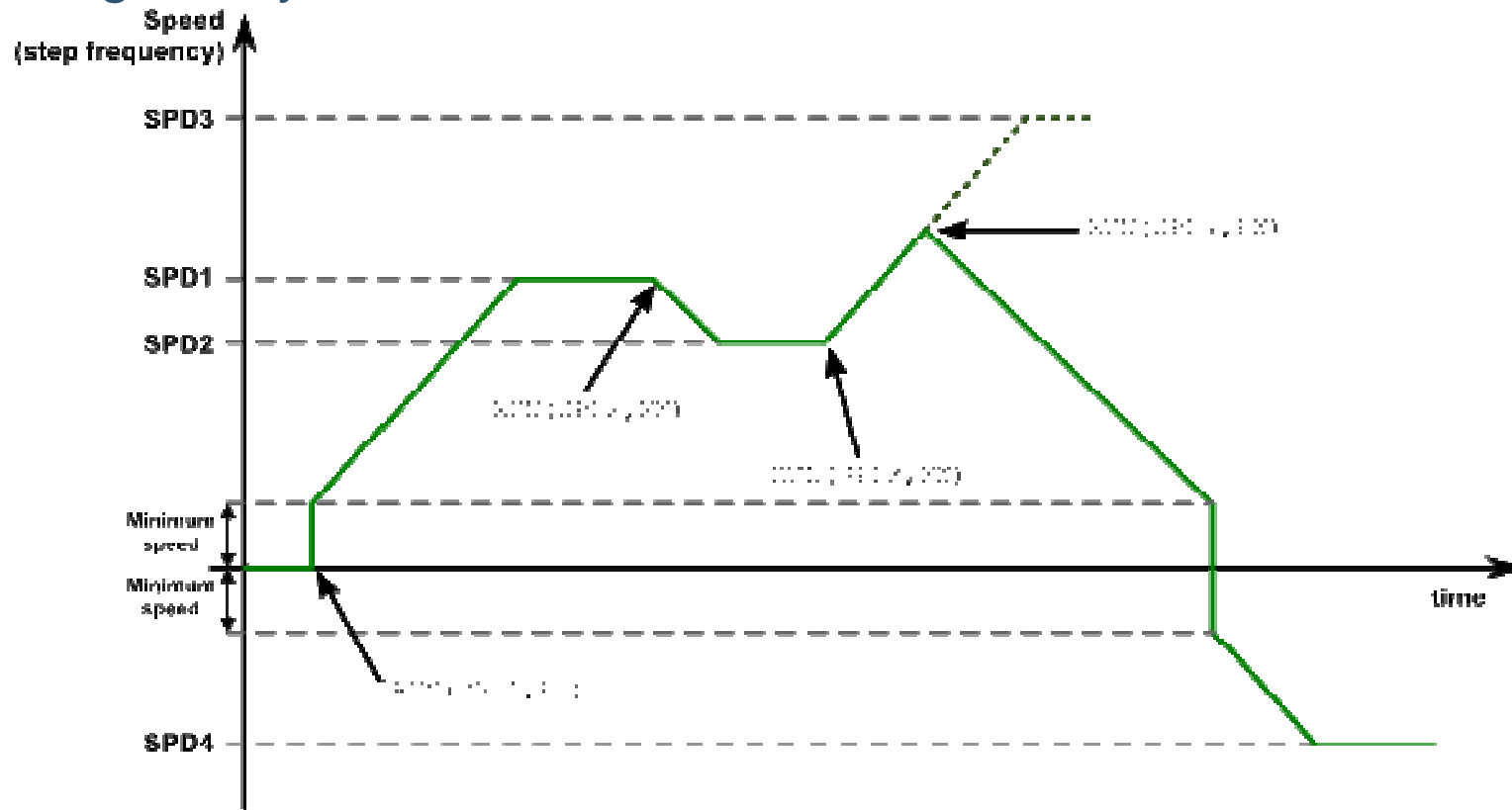
Positioning → reach the desired position

... and dSPIN does the tricky job!

L6470 DSPIN Costant speed command



Run(SPD, DIR) command drives the motor to reach the target speed SPD in the selected direction. Target speed and direction can be changed anytime

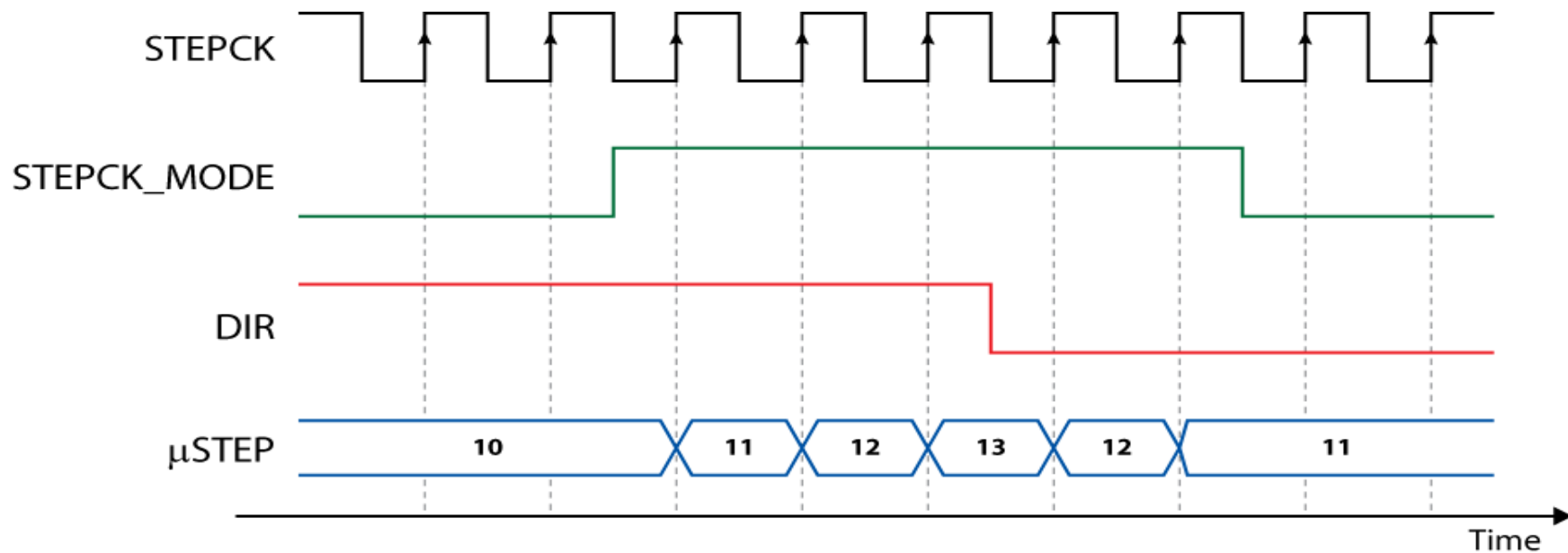


L6470 DSPIN Step Clock Mode



Very slow motion can be achieved enabling step-clock mode through the StepClock(DIR) command

When L6470 is in step-clock mode, internal μ step logic is clocked through the external STCK pin instead of internal motion engine

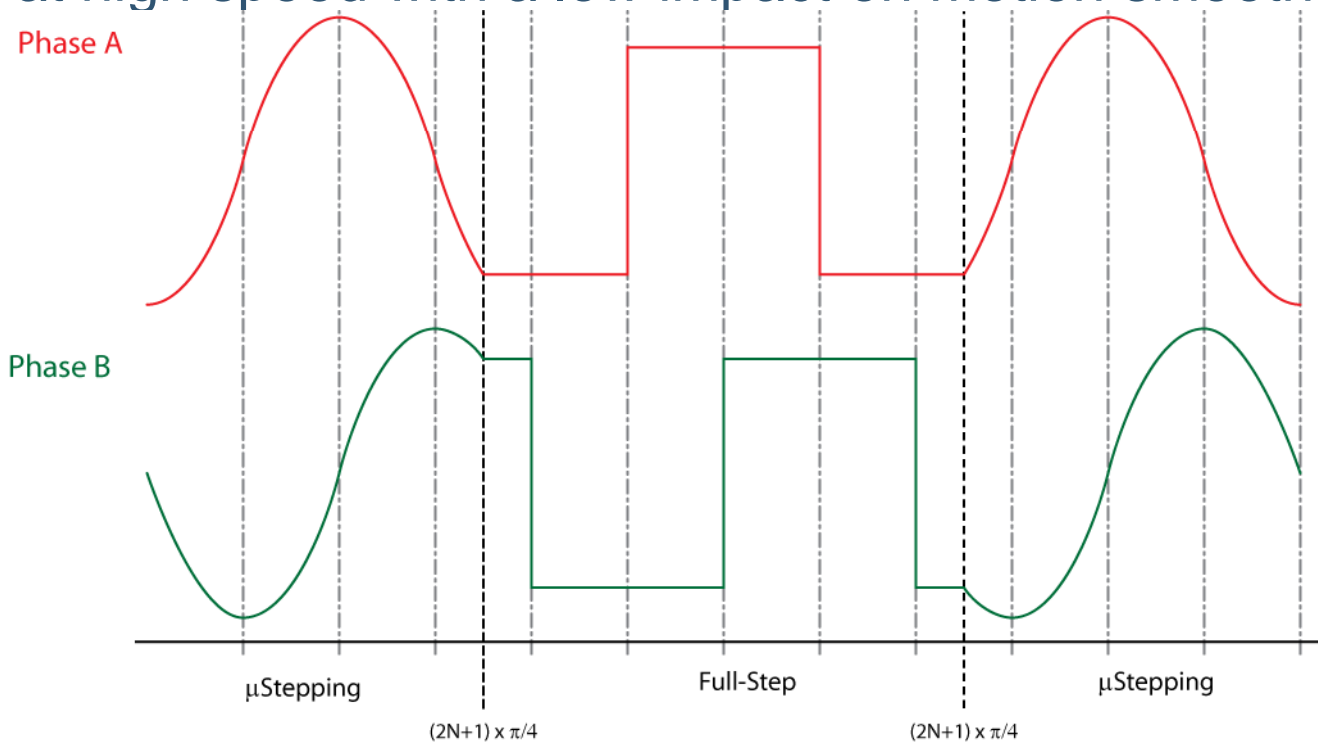


L6470 DSPIN Automatic Microstepping Full Step



Control system automatically switches from microstep to full- step mode when the speed is greater than a programmable threshold

Switching from microstep to full-step allows increasing the torque at high speed with a low impact on motion smoothness

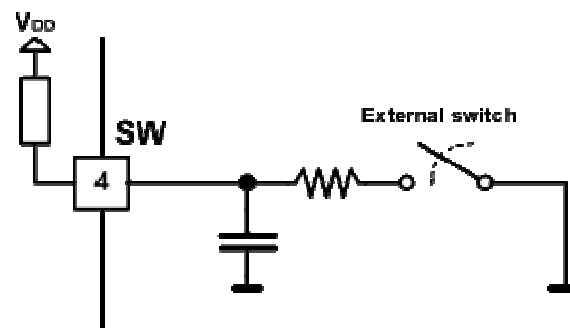


L6470 DSPIN External Switch Management



Device can manage an external switch to:

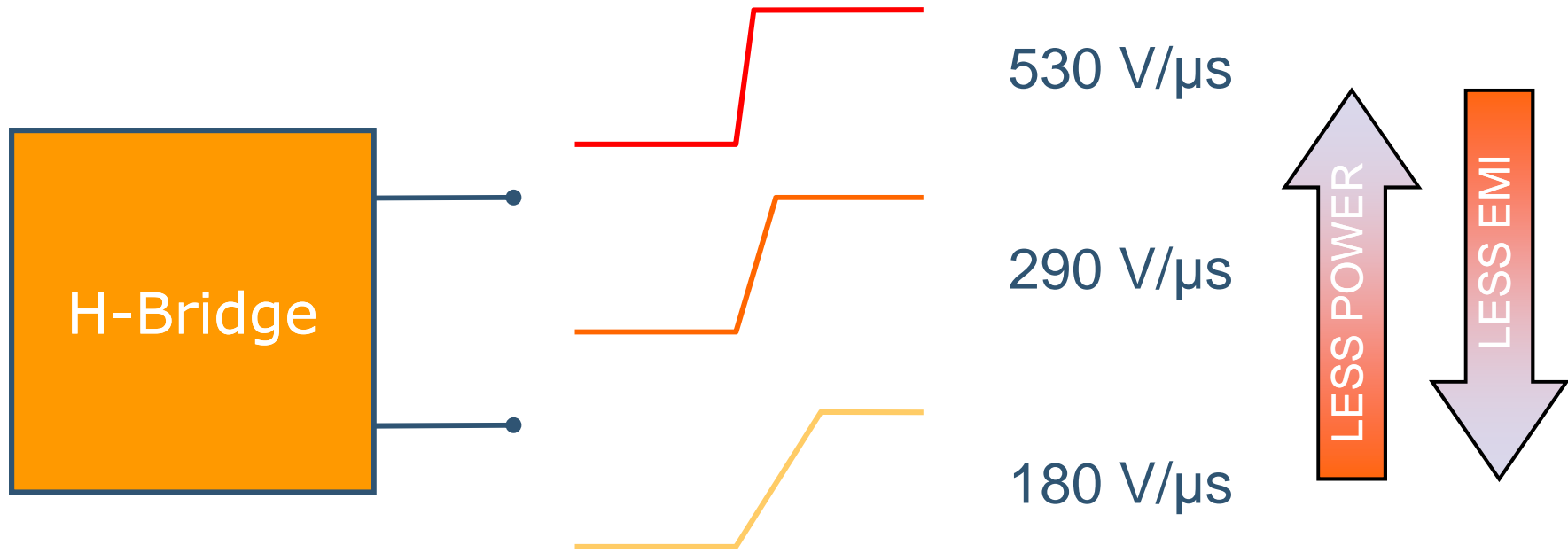
- immediately stop the motor
- init home position through GoUntil command



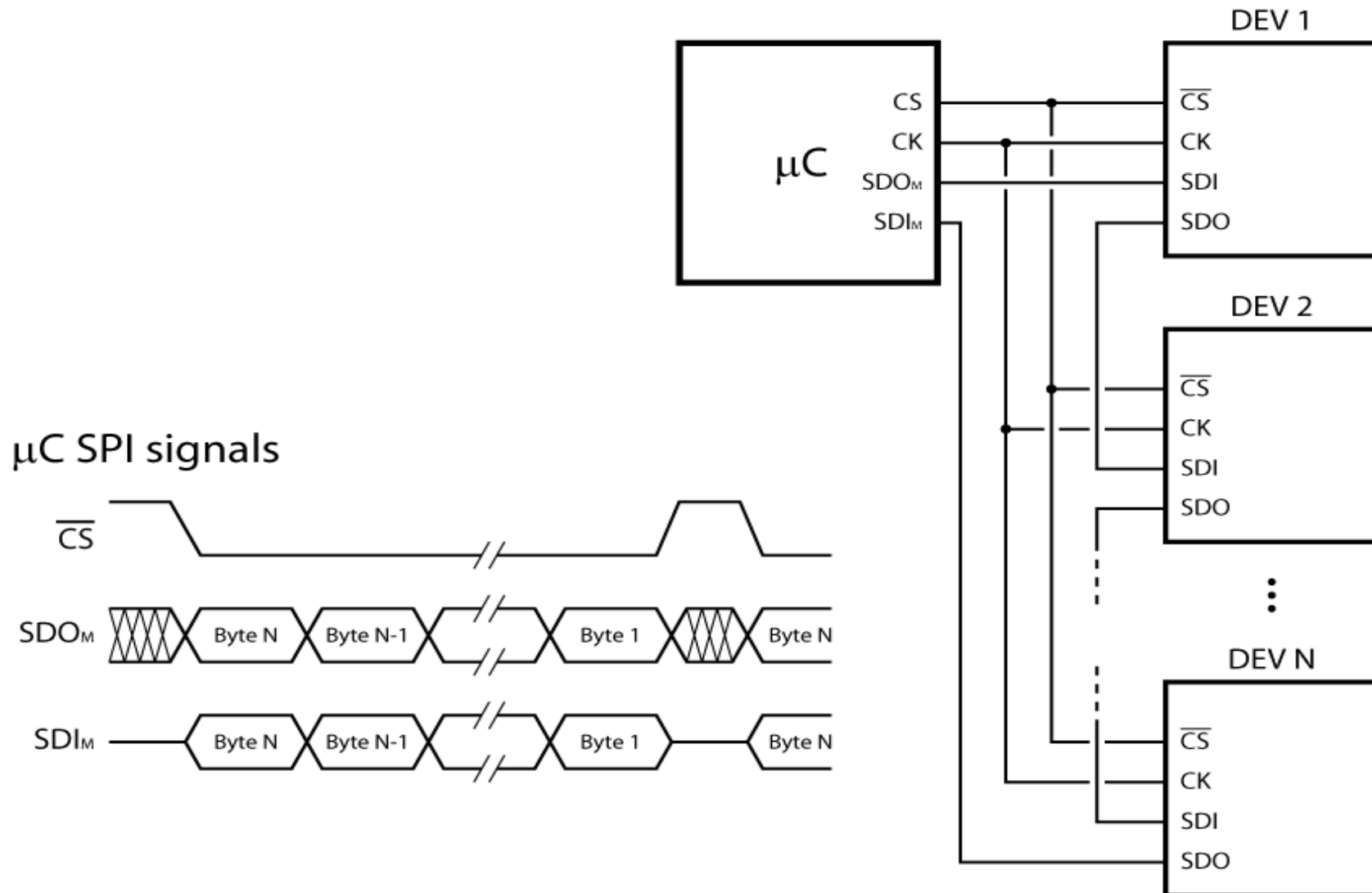
GoUntil command moves the motor with a selected constant speed and stops the motor when the switch is closed; at that time one of the following actions can be taken:

- absolute position register is reset to zero
- current absolute position is stored into MARK register

L6470 DSPIN Programmable Output Slew Rate



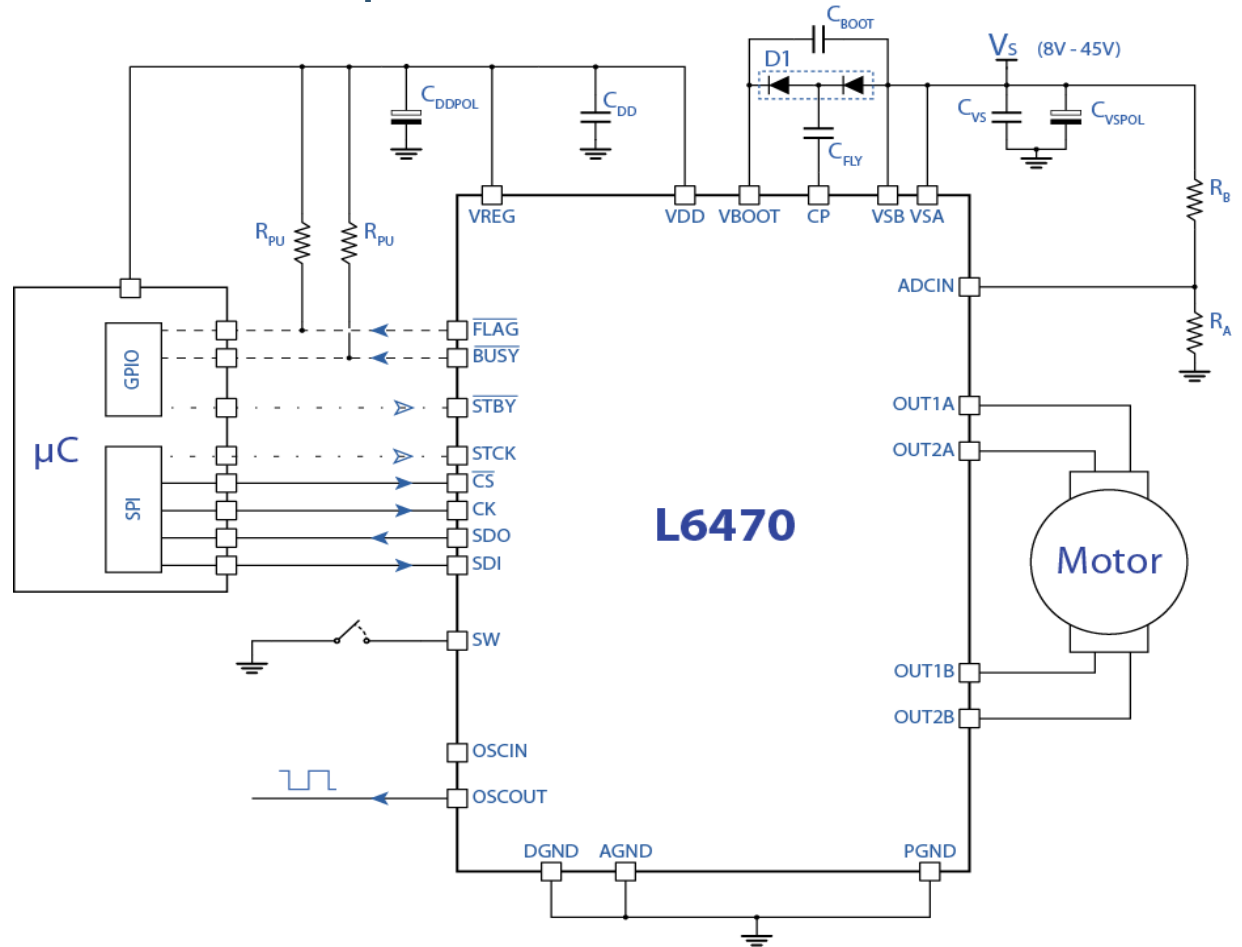
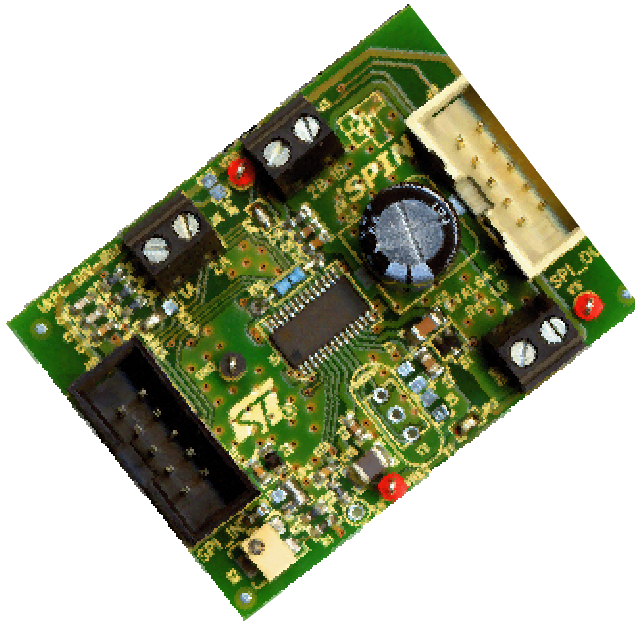
L6470 DSPIN Daisy Chaining



L6470 DSPIN Typical Application



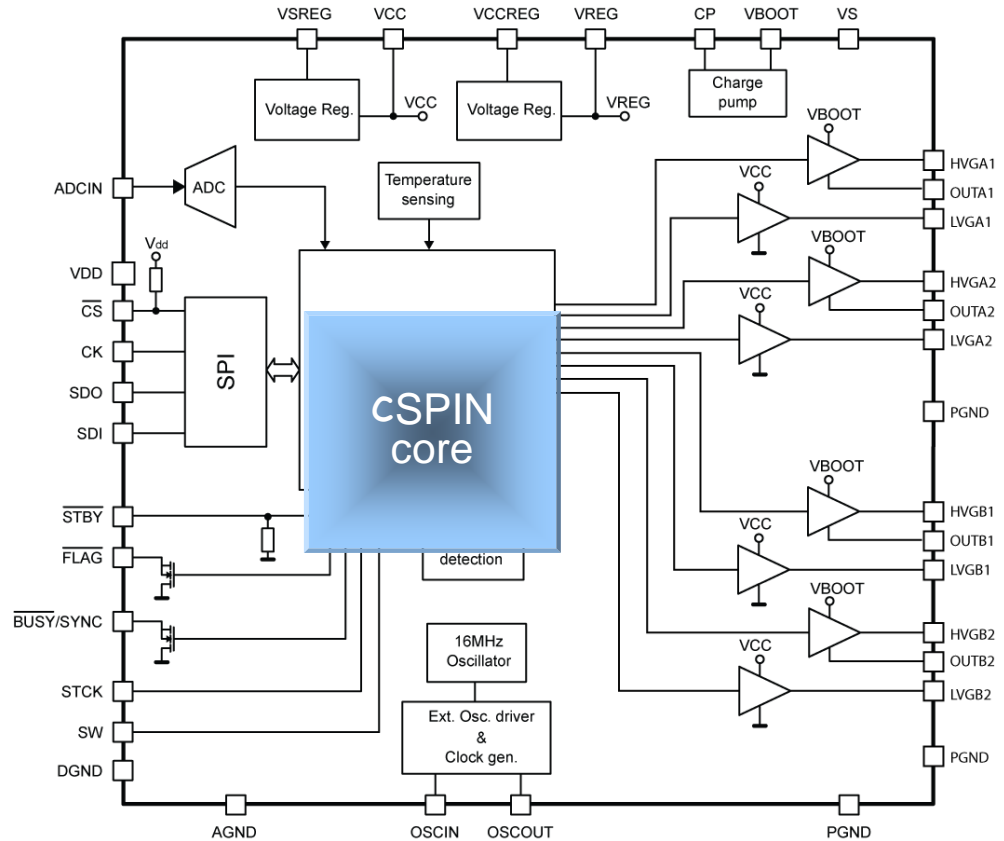
- ✓ Minimal component count
- ✓ μC : only 4 SPI signals + 2÷4 optional GPIOs



NEWS L6480 CSPIN Features



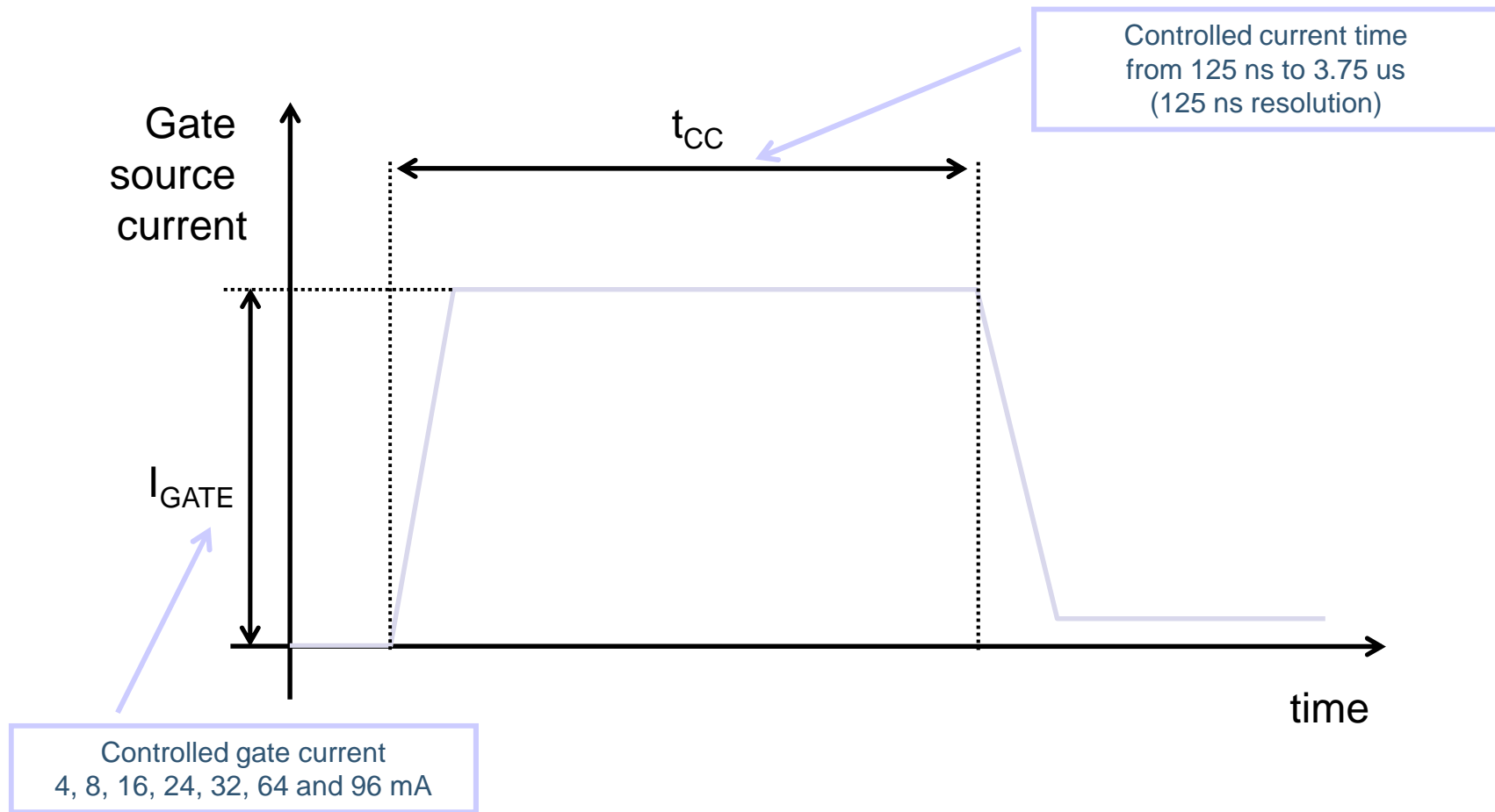
- ▶ Supply voltage 7.5V – 85V
- ▶ Dual full-bridge gate drivers
- ▶ Fully programmable gate driving
- ▶ Embedded miller clamp
- ▶ Up to 128 microsteps
- ▶ Voltage mode operation
- ▶ Sensorless Stall Detection
- ▶ Programmable speed profile
- ▶ Programmable positioning
- ▶ 8bit 5Mhz SPI interface (Daisy Chain compatible)
- ▶ Integrated 16MHz oscillator
- ▶ Integrated 5bit ADC
- ▶ Integrated 3.3V voltage regulator
- ▶ Integrated 15V/7.5V voltage regulator
- ▶ Full set of protection
 - Over Current
 - Over Temperature
 - Under Voltage protections



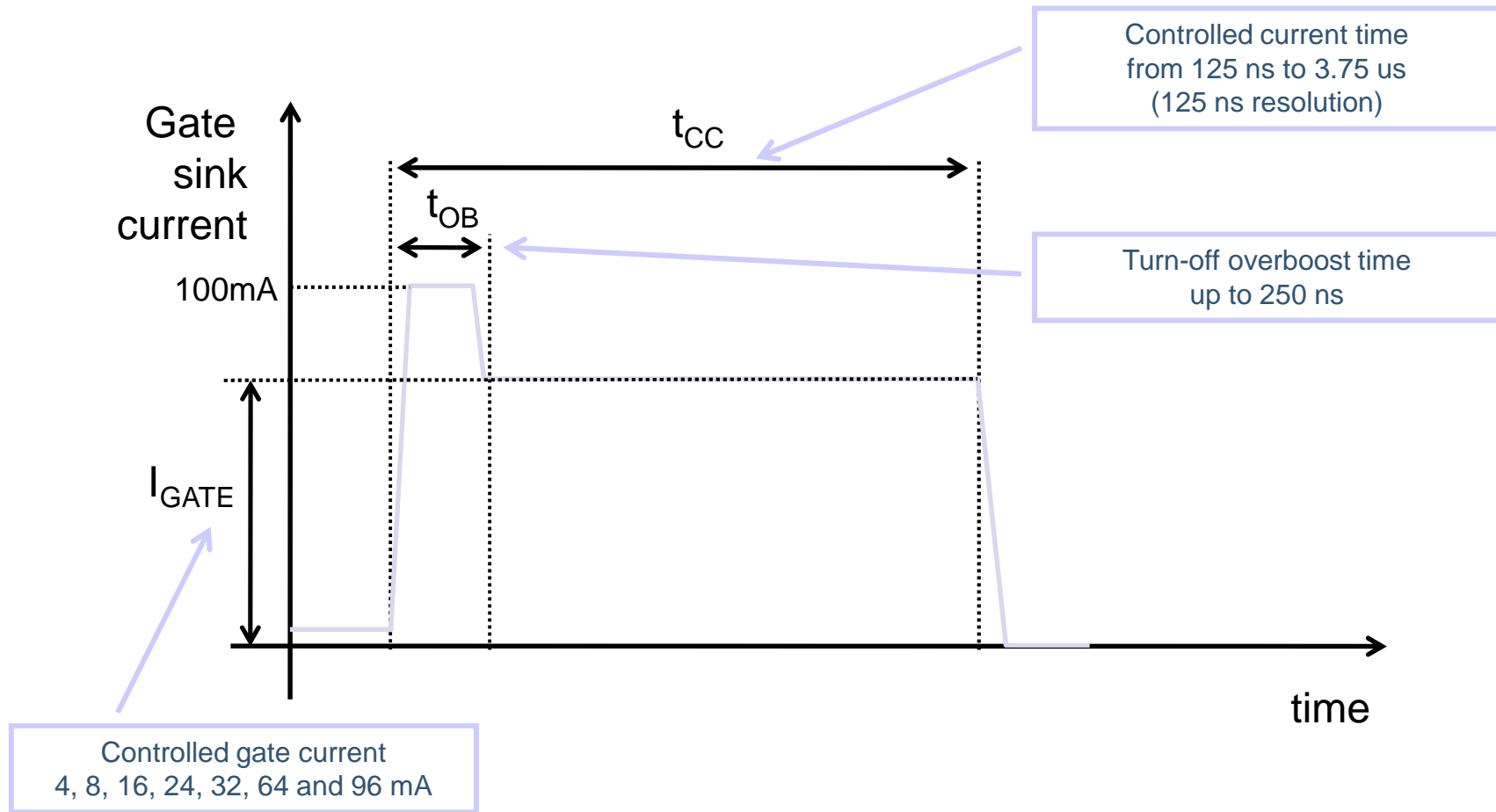
ES available
SOP H1 2012



L6480 CSPIN Programmable Gate Driver Turn ON



L6480 CSPIN Programmable Gate Driver Turn Off



L6480 CSPIN Eval Board



Try the new cSPIN with our demonstration board!

