Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

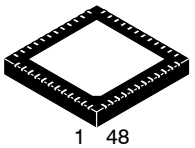
Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

AMIS-30422

Micro-Stepping Stepper Motor Bridge Controller

ON Semiconductor®

http://onsemi.com



QFN48
CASE 485AJ

MARKING DIAGRAM

A	= Assembly Location
WL	= Wafer Lot
YY	= Year
WW	= Work Week
G	= Pb−Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 44 of this data sheet.

Introduction

The AMIS−30422 is a micro-stepping stepper motor bridge controller for large current range bipolar applications. The chip interfaces via a SPI interface with an external controller in order to control two external power NMOS H−bridges. It has an on-chip voltage regulator, current sensing, self adapting PWM controller and pre-driver with smart slope control switching allowing the part to be EMC compliant with industrial and automotive applications. It uses a proprietary PWM algorithm for reliable current control.

The AMIS−30422 contains a current translation table and takes the next micro-step depending on the clock signal on the “NXT” input pin and the status of the “DIR” (direction) register or input pin. The chip provides a so-called “Speed and Load Angle” output. This allows the creation of stall detection algorithms and control loops based on load angle to adjust torque and speed.

The AMIS−30422 is implemented in a mature technology, enabling fast high voltage analog circuitry and multiple digital functionalities on the same chip. The chip is fully compatible with automotive voltage requirements.

The AMIS−30422 is easy to use and ideally suited for large current stepper motor applications in the automotive, industrial, medical and marine environment. With the on−chip voltage regulator it further reduces the BOM for mechatronic stepper applications.

Key Features

- Dual H−Bridge Pre−Drivers for 2−Phase Stepper Motors
- Programmable Current via SPI
- On−chip Current Translator
- SPI Interface
- Speed and Load Angle Output
- 9 Step Modes from Full Step up to 128 Micro−Steps
- Current−Sense via Two External Sense Resistors
- PWM Current Control with Automatic Selection of Fast and Slow Decay
- Low EMC PWM with Selectable Voltage Slopes
- Full Output Protection and Diagnosis
- Thermal Warning and Shutdown
- Compatible with 3.3 V Microcontrollers
- Integrated 3.3 V Regulator to Supply External Microcontroller
- Integrated Reset Function to Reset External Microcontroller
- Integrated Watchdog Function
- These Devices are Pb−Free and are RoHS Compliant

BLOCK DIAGRAM

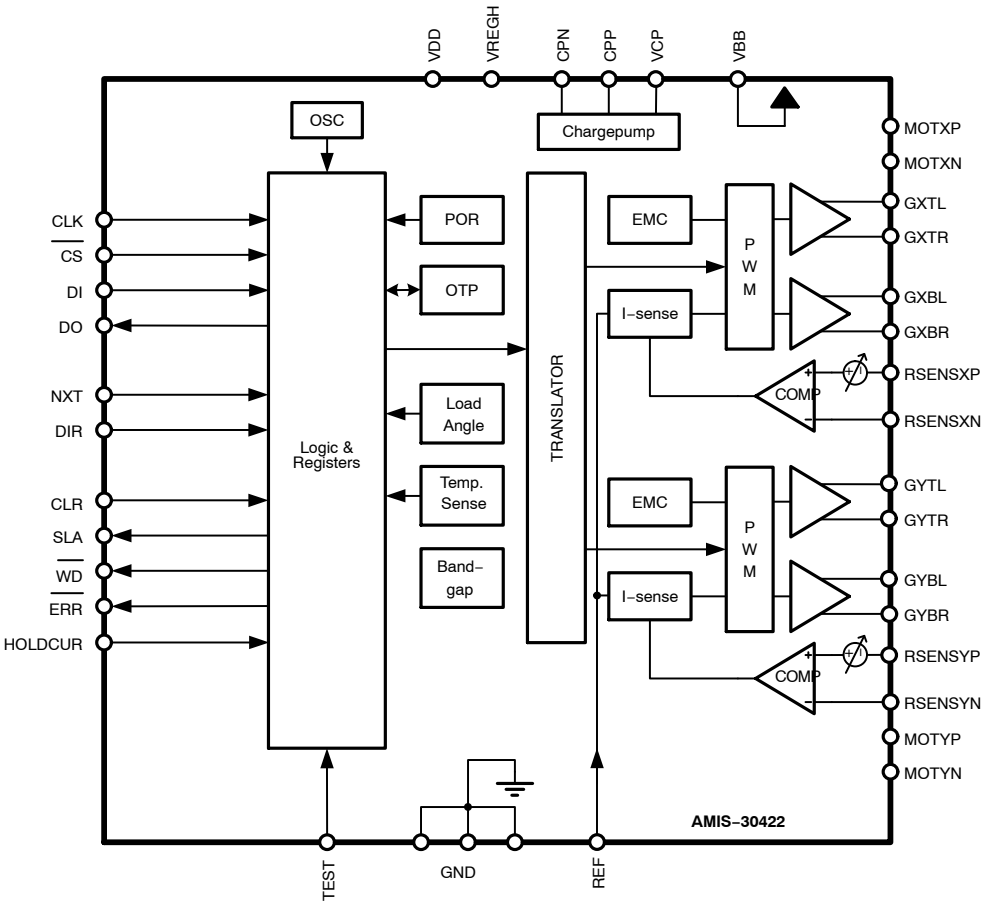


Figure 1. Block Diagram AMIS−30422

PIN OUT

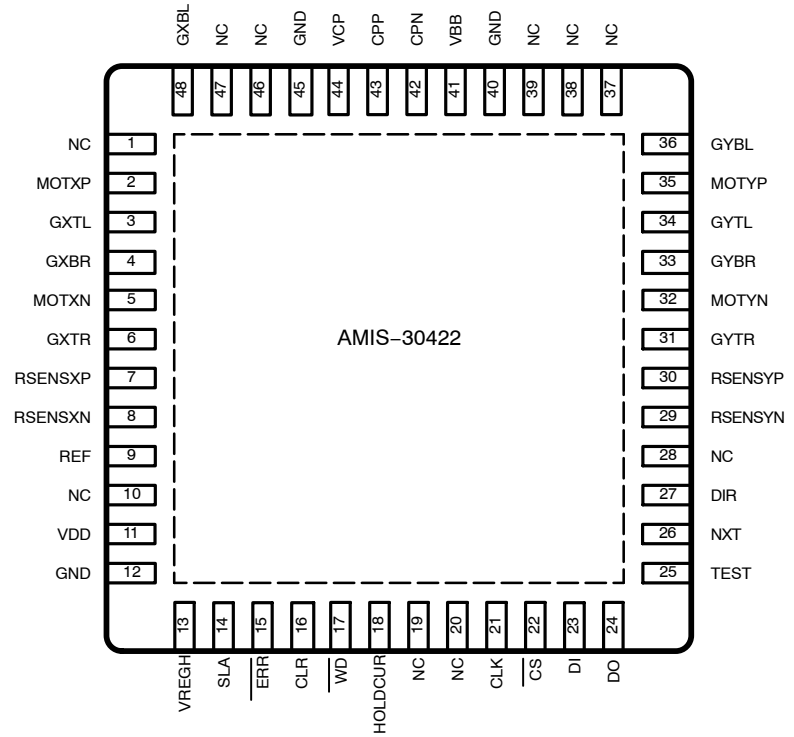


Figure 2. Pin Out AMIS−30422

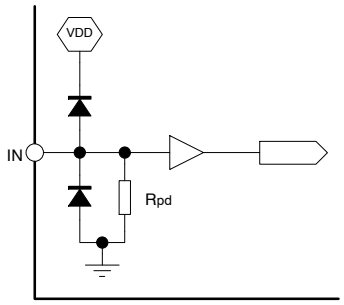
Table 1. PIN LIST AND DESCRIPTION

Name	Pin	Description	Type	Equivalent Schematic
MOTXP	2	Positive end of phase X−coil	Analog I/O	
GXTL	3	Gate of external NMOS FET of the X bridge top left side	Analog Output	
GXBR	4	Gate of external NMOS FET of the X bridge bottom right side	Analog Output	
MOTXN	5	Negative end of phase X−coil	Analog I/O	
GXTR	6	Gate of external NMOS FET of the X bridge top right side	Analog Output	
RSENSXP	7	Resistor sense of the X bridge positive pin	Analog Input	
RSENSXN	8	Resistor sense of the X bridge negative pin	Analog Input	
REF	9	Maximum Coil Current Setting	Analog Input	Type 7
VDD	11	Low voltage supply output (needs external decoupling capacitor)	Supply	Type 8
GND	12	Ground, heat sink	Supply	
VREGH	13	High voltage supply output	Analog output	
SLA	14	Speed and Load Angle output	Analog output	Type 6
ERRb	15	Error output	Digital Output	Type 2 or 4
CLR	16	Clear input	Digital Input	Type 5
WDb	17	Watchdog and Power On Reset output	Digital Output	Type 2 or 4
HOLDCUR	18	Hold Current Input	Digital Input	
CLK	21	SPI Clock input	Digital Input	Type 1
CSb	22	SPI Chip Select input	Digital Input	Type 3
DI	23	SPI Data input	Digital Input	Type 1
DO	24	SPI Data output	Digital Output	Type 4
TEST	25	Test input. To be tied to ground.	Digital Input	Type 1
NXT	26	Next Microstep input	Digital Input	Type 1
DIR	27	Direction input	Digital Input	Type 1
RSENSYN	29	Resistor sense of the Y bridge negative pin	Analog Input	
RSENSYP	30	Resistor sense of the Y bridge positive pin	Analog Input	
GYTR	31	Gate of external NMOS FET of the Y bridge top right side	Analog Output	
MOTYN	32	Negative end of phase Y−coil	Analog I/O	
GYBR	33	Gate of external NMOS FET of the Y bridge bottom right side	Analog Output	
GYTL	34	Gate of external NMOS FET of the Y bridge top left side	Analog Output	
MOTYP	35	Positive end of phase Y−coil	Analog I/O	
GYBL	36	Gate of external NMOS FET of the Y bridge bottom left side	Analog Output	
GND	40	Ground, heat sink	Supply	
VBB	41	High voltage supply input	Supply	Type 9
CPN	42	Negative connection of charge pump capacitor	Analog I/O	
CPP	43	Positive connection of charge pump capacitor	Analog I/O	
VCP	44	Charge Pump filter capacitor	Analog I/O	
GND	45	Ground, heat sink	Supply	
GXBL	48	Gate of external NMOS FET of the X bridge bottom left side	Analog Output	
NC	1, 10, 19, 20, 28, 37, 38, 39, 46, 47	Not connected or connect with ground		

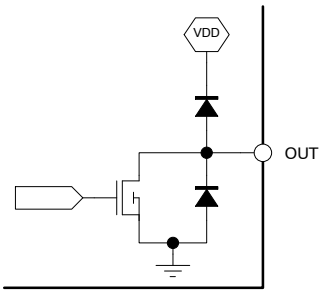
NOTE: Output type of WDb− and ERRb−pin is selectable through SPI.

EQUIVALENT SCHEMATICS

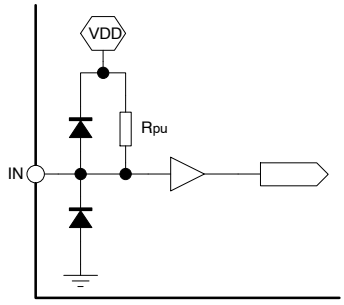
Following figure gives the equivalent schematics of the user relevant inputs and outputs. The diagrams are simplified representations of the circuits used.



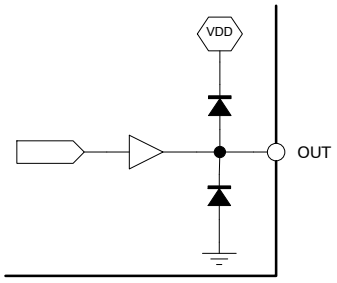
TYPE 1: CLK, DI, NXT, DIR, TEST Input



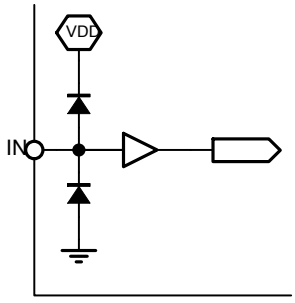
TYPE 2: WDb, ERRb Open Drain Output



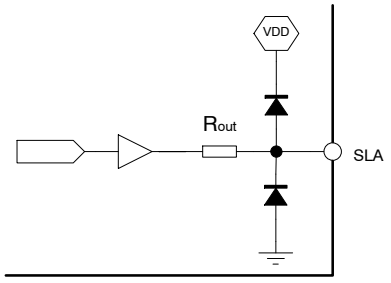
TYPE 3: CSb Input



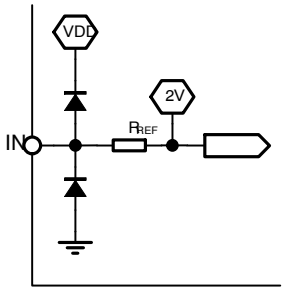
TYPE 4: DO, WDb, ERRb Push Pull Output



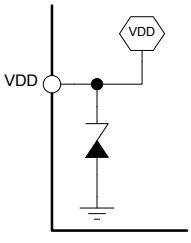
TYPE 5:



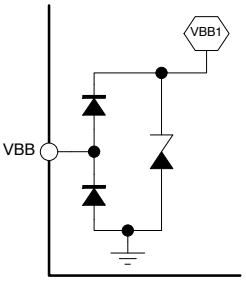
TYPE 6: SLA Analog Output



TYPE 7:



TYPE 8: VDD Power Supply



TYPE 9: VBB Power Supply

NOTE: Output type of WDb− and ERRb−pin is selectable through SPI, DO−pin is push−pull output with tristate

Figure 3. In− and Output Equivalent Diagrams

ELECTRICAL SPECIFICATION

Table 2. ABSOLUTE MAXIMUM RATINGS (Notes 1 and 2)

Symbol	Parameter	Min	Max	Unit
V_{BB}	Analog DC supply voltage (Note 3)	−0.3	+40	V
I_{load}	Logic supply external load current, Normal Mode	0	−10	mA
	Logic supply external load current, Sleep Mode	0	−1	mA
V_{RSENS}	Voltage on pins RSENSXP, RSENSXN, RSENSYP and RSENYN	−2.0	+2.0	V
V_{LVIO}	Voltage on digital I/O pins, REF−pin and SLA−pin	−0.3	3.6	V
			V_{DD} + 0.3	
I_{SLA}	Load current on SLA−pin	0	−40	μA
T_{ST}	Storage temperature	−55	+160	°C
T_J	Junction Temperature under bias (Note 4)	−50	+175	°C
V_{HBM}	Human Body Model electrostatic discharge immunity (Note 5)	−2	+2	kV
V_{HBM}	Human Body Model electrostatic discharge immunity, high voltage pins (Note 6)	−4	+4	kV
V_{MM}	Machine Model electrostatic discharge immunity (Note 7)	−150	+150	V
V_{CDM}	Charge Device Model electrostatic discharge immunity (Note 8)	−500	+500	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. If more than one value is mentioned, the most stringent applies.
2. Convention: currents flowing in the circuit are defined as positive.
3. +36 V < V_{BB} < +40 V limited to 1 day over lifetime
4. Circuit functionality not guaranteed.
5. According to JESD−A114
6. High Voltage Pins MOTxx, VBB, GND; According to JESD−A114
7. According to JESD−A114
8. According to STM5.3.1−1999

RECOMMEND OPERATION CONDITIONS

Operating ranges define the limits for functional operation and parametric characteristics of the device. Note that the functionality of the chip outside these operating ranges is not guaranteed. Operating outside the recommended operating ranges for extended periods of time may affect device reliability.

Table 3. OPERATING RANGES

Symbol	Parameter	Min	Max	Unit
V_{BB}	Analog DC supply	+6	+30	V
V_{DD}	Logic Supply Output Voltage (Normal Mode)	+3.0	+3.6	V
T_J	Junction temperature (Note 9)	−40	+125	°C

9. High junction temperature can result in reduced lifetime.

Table 4. DC PARAMETERS

The DC parameters are given for V_{BB} and temperature in their operating ranges unless otherwise specified.
Convention: currents flowing in the circuit are defined as positive.

Symbol	Pin(s)	Parameter	Remark/Test Conditions	Min	Typ	Max	Unit
SUPPLY & VOLTAGE REGULATOR							
V_{BB}	VBB	Nominal operating supply range		6		30	V
I_{BB}		Total internal current consumption	Unloaded outputs, internal consumption included, H−bridge disabled			20	mA
I_{SLEEP}		Sleep mode current consumption	Unloaded outputs, CSb = V_{DD}			150	μA
V_{DD}	VDD	Regulated Output Voltage	−10 mA ≤ I_{load} ≤ 0 mA	3.1	3.3	3.5	V
V_{DD_SLEEP}		Regulated Output Voltage in Sleep	−1 mA ≤ I_{load} ≤ 0 mA	2.1	2.95	3.63	V
I_{LOAD}		External load current				−10	mA
I_{DDLIM}		Current limitation	Pin shorted to ground	−20		−80	mA
I_{LOAD_PD}		Output current in sleep				−1	mA
V_{REGH}	VREGH	High voltage regulator	V_{BBLV} ≤ V_{BB} ≤ 30 V Based on Figure 9 H−bridge disabled 13.25 V ≤ V_{BBLV} ≤ 15.75 V	11.2	12.0	12.8	V
			6 V ≤ V_{BB} < V_{BBLV} Based on Figure 9 H−bridge disabled 13.25 V ≤ V_{BBLV} ≤ 15.75 V			V_{BB}	V
POWER ON RESET (POR)							
V_{DDH}	VDD	Internal POR comparator threshold	V_{DD} rising, see Figure 4	1.44	1.8	2.53	V
V_{DDL}		Internal POR comparator threshold	V_{DD} falling, see Figure 4	1.16	1.5	1.93	
V_{DDhys}		Internal POR comparator hysteresis			0.3		
UNDERVOLTAGE							
V_{BBUH}	VBB	V_{BB} undervoltage release level	V_{BB} rising, see Figure 5	5.5		6.5	V
V_{BBUL}		V_{BB} undervoltage trigger level	V_{BB} falling, see Figure 5	5.3		6.3	
V_{BBUhys}		V_{BB} undervoltage hysteresis			0.25		
PRE−DRIVER							
I_{ON}	GXTR, GXTL, GXBR, GXBL, GYTR, GYTL, GYBR, GYBL	Gate charge current	Selectable through SPI	−3		−33	mA
I_{OFF}		Gate discharge current	Selectable through SPI	3		33	mA
R_{SW}		Switch On−resistance	See also Figure 10		10	25	Ω

Table 4. DC PARAMETERS

The DC parameters are given for V_{BB} and temperature in their operating ranges unless otherwise specified.
Convention: currents flowing in the circuit are defined as positive.

Symbol	Pin(s)	Parameter	Remark/Test Conditions	Min	Typ	Max	Unit
PRE−DRIVER							
V_{SENS}	RSENSxx	PWM comparator toggle level	Selectable through SPI	1/40		1/5	V_{REF}
V_{SENS_Tol}		PWM comparator toggle level tolerance		−22		+22	%
REF INPUT							
V_{REF}	REF	REF input voltage		0		VDD	V
V_{REF_Range}		REF input voltage range		0.25		2	V
V_{REF_TOL}		Tolerance on maximum VREF_Range		−10		+10	%
I_{REF_LEAK}		REF input leakage	$V_{REF} \le 1.8$ V	−1		1	μA
R_{REF}		REF input impedance	See also Figure 3	10	20	30	kΩ
DIGITAL INPUTS							
V_{IL}	CLK, DI, CSb, NXT, DIR, CLR, HOLDCUR	Logic Low Threshold		0		0.3 x V_{DD}	V
V_{IH}		Logic High Threshold		0.7 x V_{DD}		V_{DD}	V
R_{pd}		Internal Pull Down Resistor	Csb and CLR excluded, See also Figure 3	250		1100	kΩ
R_{pu}	CSb	Internal Pull Up Resistor	See also Figure 3	250		1100	kΩ
DIGITAL OUTPUTS							
V_{OL}	DO, ERRb, WDb	Logic low output level	Output set to type 4 (see Figure 3)			0.5	V
V_{OH}		Logic high output level		V_{DD} − 0.5			
V_{OL_OPEN}		Logic Low level open drain	I_{OL} = 8 mA, Output set to type 2 (see Figure 3), DO excluded			0.5	
SPEED AND LOAD ANGLE OUTPUT							
V_{out}	SLA	Output Voltage Range		0.5		V_{DD} − 0.5	V
V_{off}		Output Offset SLA−pin	Selectable through SPI	0.6		1.2	V
V_{off_tol}		Tolerance on SLA output offset		−17		+17	%
G_{SLA}		Gain of SLA−pin = V_{BEMF} / V_{SLA}	Selectable through SPI	0.0625		1	
G_{SLA_tol}		Tolerance on SLA gain		−10		+10	%
R_{out}		Output Resistance SLA−pin	See also Figure 3			1	kΩ
I_{SLA_load}		Load current SLA−pin		0		−40	μA
THERMAL WARNING & SHUTDOWN							
T_1		Trigger level thermal range 1	See Figure 21	−5	15	35	°C
T_2		Trigger level thermal range 2	See Figure 21	55	70	85	°C
T_3		Trigger level thermal range 3	See Figure 21	138	150	162	°C
T_{TW}		Thermal Warning	See Figure 21	138	150	162	°C
T_{TSD}		Thermal shutdown	See Figure 21		T_{TW} + 20		°C
CHARGE PUMP							
V_{CP} − V_{BB}	VCP	Chargepump overdrive voltage	Based on Figure 9	3.5	V_{BB} − 2.5	15.75	V
V_{CPP} − V_{CPN}		Chargepump pumping voltage		3.5	V_{BB} − 2.5	15.75	V
C_{pump}		External pump capacitor	See also C_2 Figure 9		220		nF
C_{buffer}	CPP CPN	External buffer capacitor	See also C_3 Figure 9		220		nF

Table 4. DC PARAMETERS
The DC parameters are given for V_{BB} and temperature in their operating ranges unless otherwise specified.
Convention: currents flowing in the circuit are defined as positive.

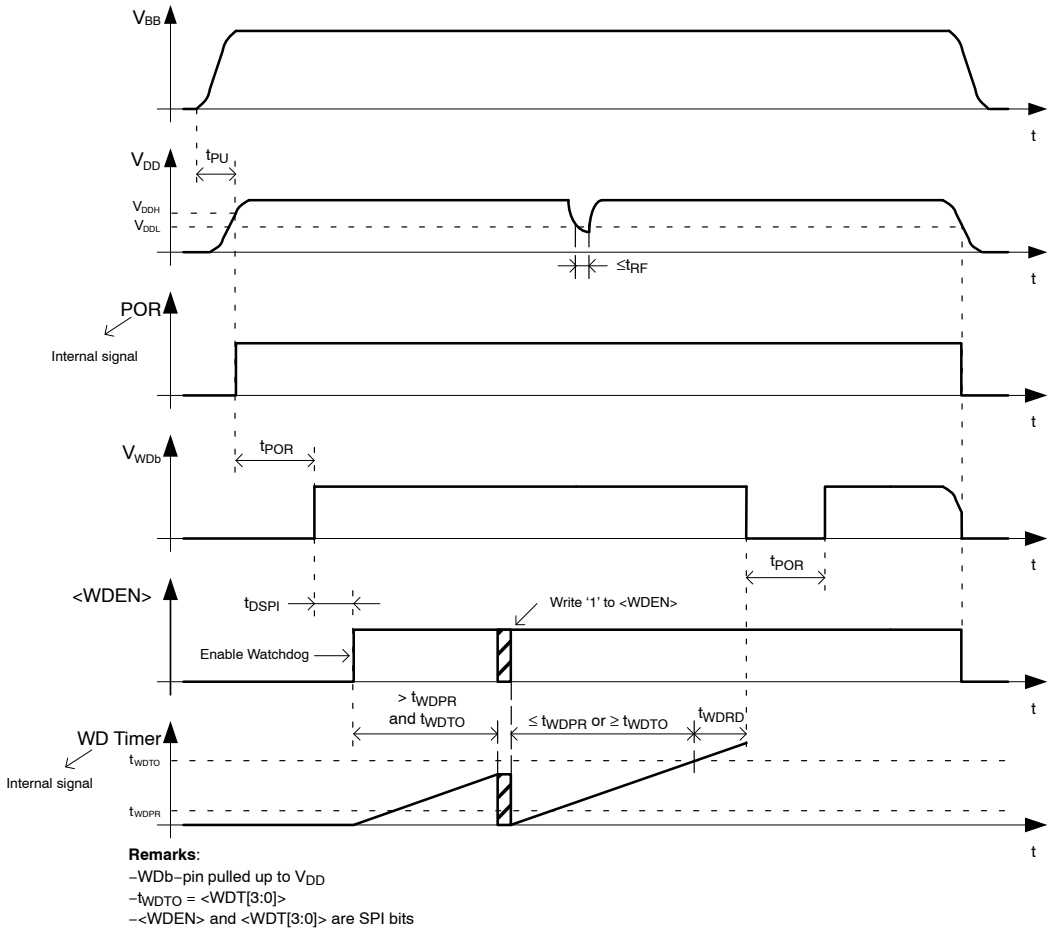
Symbol	Pin(s)	Parameter	Remark/Test Conditions	Min	Typ	Max	Unit
PACKAGE THERMAL RESISTANCE VALUE							
Rth_{ja}		Thermal Resistance Junction−to−Ambient	Simulated Conform JEDEC JESD−51, (2S2P)		30		K/W
			Simulated Conform JEDEC JESD−51, (1S0P)		60		K/W
Rth_{jp}		Thermal Resistance Junction−to−Exposed Pad			0.95		K/W

Table 5. AC PARAMETER The AC parameters are given for V_{BB} and temperature in their operating ranges unless otherwise specified.

Symbol	Pin(s)	Parameter	Remark/Test Conditions	Min	Typ	Max	Unit
INTERNAL OSCILLATOR							
f_{osc}		Frequency of internal oscillator		6.4	8	9.6	MHz
POWER−UP							
t_{PU}	POR	Power−up time	C_{VDD} = 200 nF, See Figure 4			60	μs
t_{POR}		Reset duration	See Figure 4	80	100	120	ms
t_{RF}		Reset filter time	See Figure 4	1		15	μs
t_{DSPI}		SPI Delay	See Figure 4			500	μs
PREDRIVER							
f_{PWM}		PWM frequency	Frequency depends only on internal oscillator	20	25	30	kHz
t_1		Bridge MOSFET switch on time t_1	Selectable through SPI. See Figure 11.	375		1250	ns
t_2		Bridge MOSFET switch on time t_2	Selectable through SPI. See Figure 11.	1250		4750	ns
t_{off}		Bridge MOSFET switch off time	Selectable through SPI. See Figure 11.	1250		4750	ns
t_{switch_tol}		Bridge MOSFET switch on/off tolerance		−20		+20	%
t_{open}		Open circuit time out	Selectable through SPI	0.32		163.84	ms
topen_acc		Open circuit time out accuracy		−20		+20	%
$t_{nocross}$		Non overlap time	Selectable through SPI	0		500	ns
$t_{nocross\_acc}$		Non overlap accuracy		−20		+20	%

Table 5. AC PARAMETER The AC parameters are given for V_{BB} and temperature in their operating ranges unless otherwise specified.

Symbol	Pin(s)	Parameter	Remark/Test Conditions	Min	Typ	Max	Unit
DIGITAL INPUTS							
t_{NXT_HI}		NXT Minimum, high pulse width	See Figure 6	625			ns
t_{NXT_LO}		NXT Minimum, low pulse width		625			ns
t_{DIR_SET}		NXT set up time, following change of DIR or <DIRCTRL>		1.28			μs
t_{DIR_HOLD}		NXT hold time, before change of DIR or <DIRCTRL>		1.28			μs
t_{SLP_SET}		<SLP> set up time		300			μs
t_{SLP_HOLD}		<SLP> hold time		1			μs
t_{MOTEN_SET}		<MOTEN> set up time		1			μs
t_{MOTEN_HOLD}		<MOTEN> hold time		1.28			μs
t_{MSP}		<MSP[7:0]> update delay				1.28	μs
CLEAR FUNCTION							
t_{CLR_SET}	CLR	Clear set up time	See Figure 7	40			μs
t_{CLR}		Clear duration time	See Figure 7	20		90	μs
DIGITAL OUTPUTS							
t_{H2L}	DO, WDb, ERRb	Output fall−time from V_{OH} to V_{OL}	Output type 2, capacitive load 400 pF and pull−up resistor of 1.5 kΩ			50	ns
WATCHDOG							
t_{WDPR}		Prohibited watchdog acknowledge time				2.5	ms
t_{WDTO}		Watchdog time out interval		32		512	ms
t_{WDTO_acc}		Watchdog time out accuracy		−20		+20	%
t_{WDRD}		Watchdog Reset Delay				500	ns
SERIAL PERIPHERAL INTERFACE (SPI)							
t_{CLK}	CLK	SPI Clock period	See Figure 8	1			μs
t_{CLK_HIGH}		SPI Clock high time		100			ns
t_{CLK_LOW}		SPI Clock low time		100			ns
t_{DI_SET}	DI	SPI Data Input set up time		50			ns
t_{DI_HOLD}		SPI Data Input hold time		50			ns
t_{CS_HIGH}	CSb	SPI Chip Select high time		2.5			μs
t_{CS_SET}		SPI Chip Select set up time		100			ns
t_{CS_HOLD}		SPI Chip Select hold time		100			ns
SPEED AND LOAD ANGLE OUTPUT							
t_{SLA_DELAY}	SLA	SLA output update delay	Not−transparent Mode See Figure 19			60	μs
t_{MinSLA}		Minimum zero crossing time	Selectable through SPI	40		360	μs
t_{MinSLA_Acc}		Minimum zero crossing accuracy		−20		+20	%
CHARGE PUMP							
f_{CP}	CPN CPP	Charge pump frequency		160	200	240	kHz
t_{CPU}	MOTxx	Start−up time of charge pump	Spec external components in Table 4		250		μs



Remarks:
−WDb−pin pulled up to V_{DD}
−t_{WDTO} = <WDT[3:0]>
−<WDEN> and <WDT[3:0]> are SPI bits

Figure 4. Power−On−Reset Timing Diagram

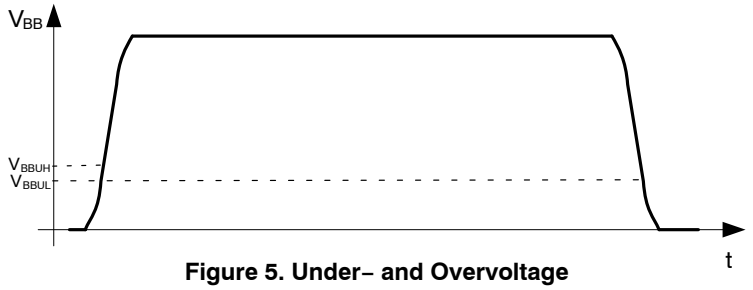
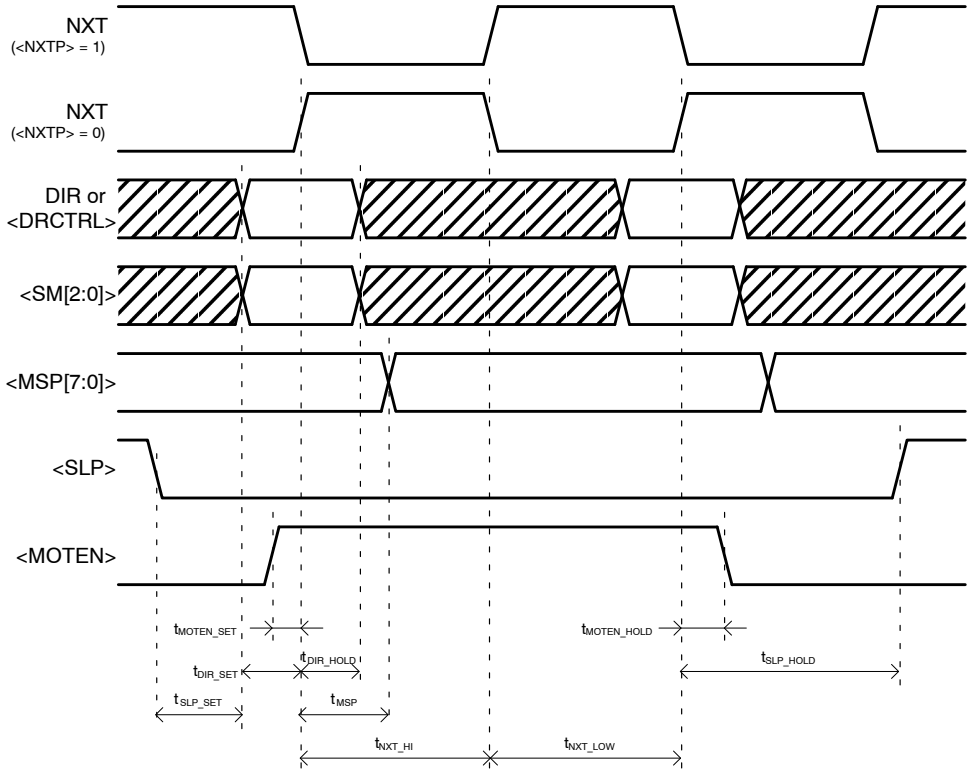
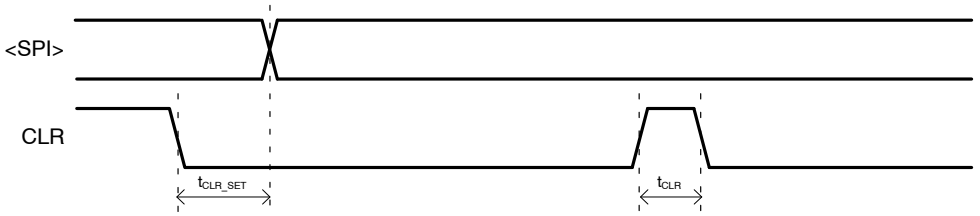


Figure 5. Under− and Overvoltage



Remarks:
−<DIRCTRL>, <SM[2:0]>, <MSP[7:0]>, <SLP>, <MOTEN> and <NXTP> are SPI bits
−Timing for SPI bits starts after CS is high
−T_{SLP_SET} only relates to the digital inputs pins DIR and NXT

Figure 6. Digital Input Timing Diagram



Remarks:
<SPI> is any SPI data

Figure 7. CLR−pin Timing Diagram

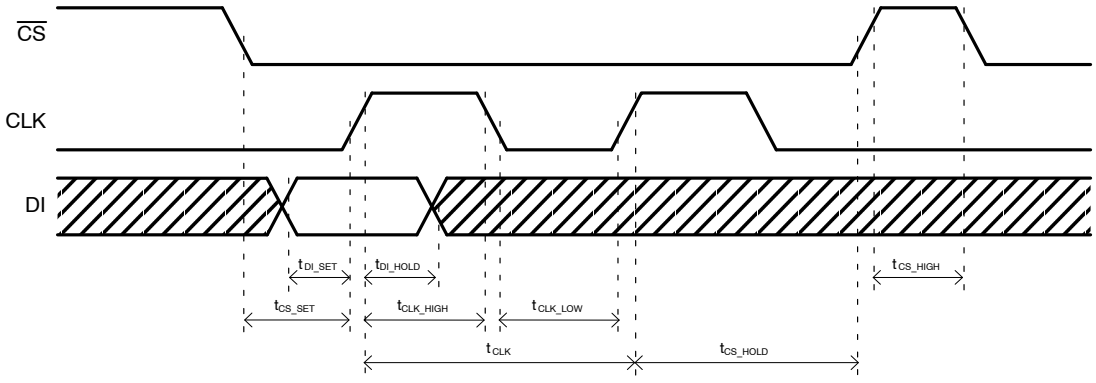


Figure 8. SPI Bus Timing Diagram

TYPICAL APPLICATION SCHEMATIC

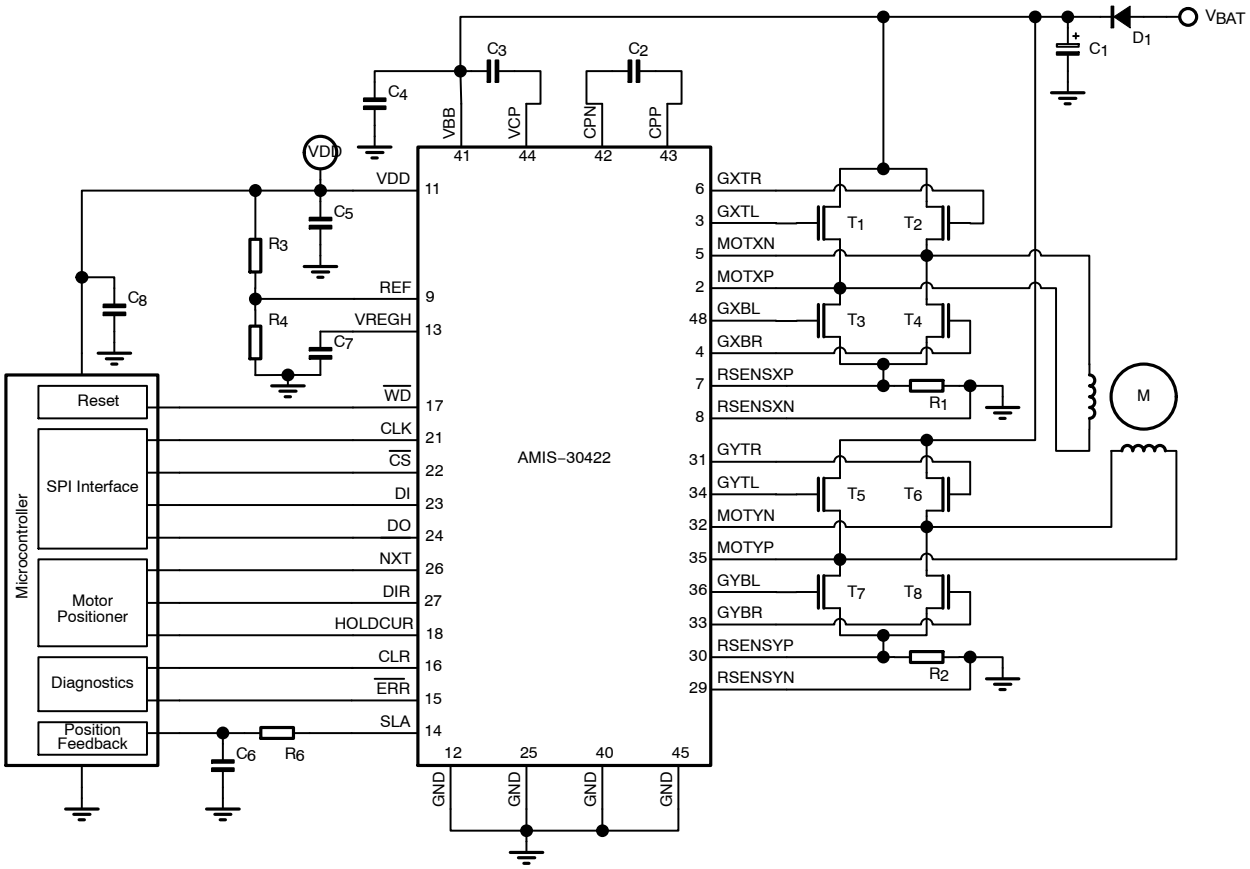


Figure 9. Typical Application Schematic AMIS−30422

Table 6. EXTERNAL COMPONENTS LIST AND DESCRIPTION

Component	Function	Typ Value	Tolerance	Unit
C_1	V_{BB} buffer capacitor (Note 10)	100	±20%	μF
C_2	Charge−pump pumping capacitor	220	± 20%	nF
C_3	Charge−pump buffer capacitor	220	±20%	nF
C_4	V_{BB} decoupling capacitor (Note 11)	100	±20%	nF
C_5, C_8	V_{DD} buffer capacitor	100	±20 %	nF
C_6	Low pass filter SLA	1	±20%	nF
C_7	VREGH buffer capacitor	4.7	±20%	uF
R_1, R_2	Sense Resistors	>25	±1%	mΩ
R_3, R_4	Coil Current Peak Setting	Depending on desired voltage on REF−pin		
R_6	Low pass filter SLA	5.6	±1%	kΩ
D_1	Optional reverse protection diode	MBRD1045		
T_1 … T_8	H−Bridge N−MOSFET	NTD4815N or NTD4813N or NTD40N03R or NTD5807N		

10. ESR < 1 Ω.
11. ESR < 50 mΩ.

FUNCTIONAL DESCRIPTION

H−Bridge Pre−Drivers

The H−bridge pre−drivers for external N−type MOSFETs are controlled by means of current sources for slope regulation (Figure 10). The current source value can be set through SPI (see p41 and further). During the MOSFET switch−on and switch−off phase this current source will be applied for a certain time (respectively t_{on} and t_{off} where t_{on} is divided in t_1 and t_2). After this time (t_{on} or t_{off}) the gate of the MOSFET is pulled high or low by means of a switch (SW_{on} or SW_{off}). The timings can also be set through SPI (see p41 and further).

To prevent short circuits, an additional time $t_{nocross}$ can be added between switching off one MOSFET and switching on the other MOSFET of a half H−bridge (SPI bits <NO_CROSS[1:0]>).

More information on the current sources and timings can be found in Table 5. A detailed description of the SPI settings for the H−bridge pre−drivers can be found at p35 and further.

Figure 11 gives a detailed view on the different stages during switching of the MOSFET.

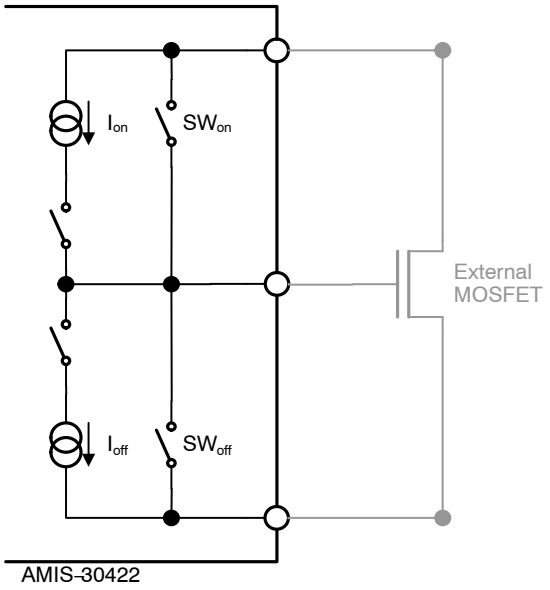


Figure 10. Pre−driver Topology

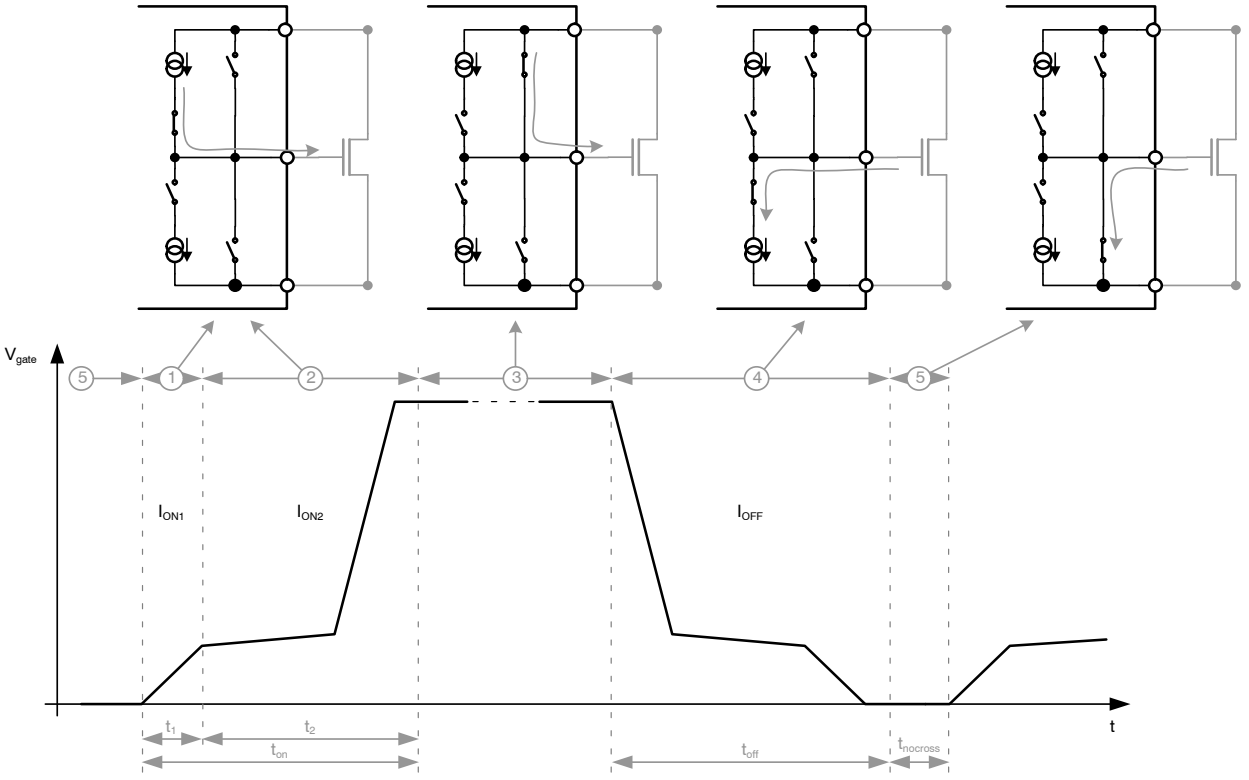


Figure 11. Detailed View on MOSFET Switching

PWM Current Control

A PWM comparator compares continuously the actual winding current (measured over the external sense resistor) with the requested current and feeds back the information to a digital regulation loop. This loop then generates a PWM signal, which turns on/off the current sources (I_{on}, I_{off}) and switches (SW_{on}, SW_{off}). The switching points of the PWM duty−cycle are synchronized to the on−chip PWM clock. The frequency of the PWM controller is fixed and will not vary with changes in the supply voltage. Also variations in motor−speed or load−conditions of the motor have no effect. There are no external components required to adjust the PWM frequency.

For EMC reasons it's possible to add jitter to the PWM by means of the <PWMJ> bit.

Step Translator and Step Mode

The step translator provides the control of the motor by means of the stepmode SPI bits <SM[3:0]>, the enable SPI bit <MOTEN>, the direction SPI bit <DIRCTRL> and input pins DIR and NXT. It is translating consecutive steps in corresponding currents in both motor coils for a given step mode. One out of 9 possible stepping modes can be selected through SPI bits <SM[3:0]>.

After power−up or clear (CLR−pin) the coil current translator is set to position 0. For all stepping modes except full step this means that the coil current is maximum in the Y−coil and zero in the X−coil (see Table 7). If NXT pulses are applied when the DIR−pin is pulled low, SPI bit <DIRCTRL> is zero and SPI bit <MOTEN> is one, the coil current translator will step through Table 7 from top till bottom. If DIR−pin is pulled high or SPI bit <DIRCTRL> is set to '1', the coil current translator will step in opposite direction through the table.

Figures 12 up to 15 gives another view on the different stepping modes. The Y−coil current is plotted on the Y−axes, the X−coil current on the X−axes.

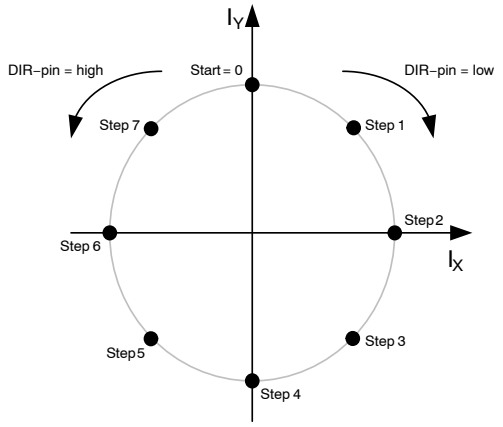


Figure 12. Half−step

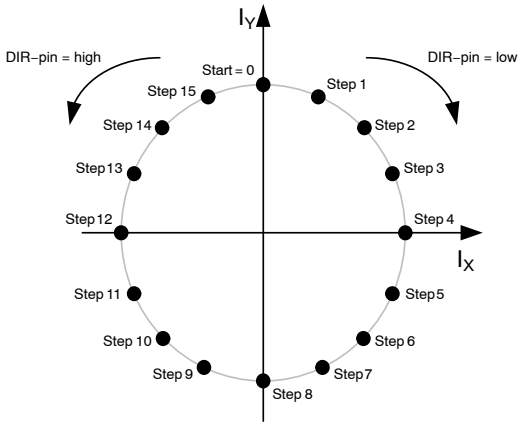


Figure 13. 1/4 Microstepping

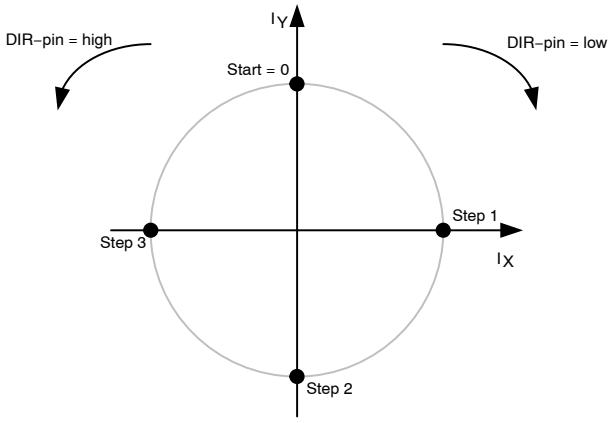


Figure 14. Full−Step 1/2 Rotated

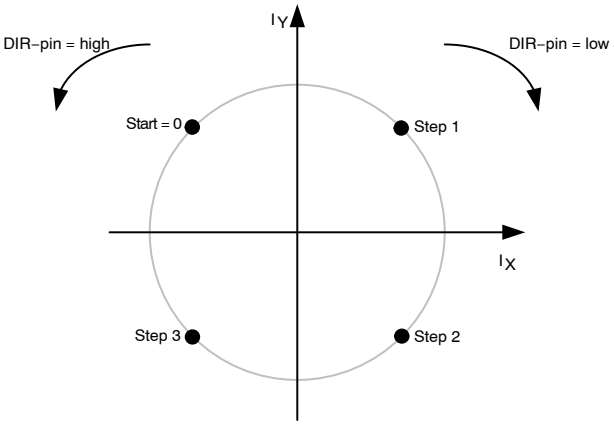


Figure 15. Full−step

Remark:

- Positive coil current flows from MOTXP to MOTXN and MOTYP to MOTYN.
- In above figures SPI bit <DIRCTRL> is set to '0'. When set to '1', rotation will be reversed.

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
0	0	0	0	0	0	0	–	0	0	100
1	–	–	–	–	–	–	–	–	1	100
2	1	–	–	–	–	–	–	–	2	100
3	–	–	–	–	–	–	–	–	4	100
4	2	1	–	–	–	–	–	–	5	100
5	–	–	–	–	–	–	–	–	6	100
6	3	–	–	–	–	–	–	–	7	100
7	–	–	–	–	–	–	–	–	9	100
8	4	2	1	–	–	–	–	–	10	100
9	–	–	–	–	–	–	–	–	11	99
10	5	–	–	–	–	–	–	–	12	99
11	–	–	–	–	–	–	–	–	13	99
12	6	3	–	–	–	–	–	–	15	99
13	–	–	–	–	–	–	–	–	16	99
14	7	–	–	–	–	–	–	–	17	99
15	–	–	–	–	–	–	–	–	18	98
16	8	4	2	1	–	–	–	–	20	98
17	–	–	–	–	–	–	–	–	21	98
18	9	–	–	–	–	–	–	–	22	98
19	–	–	–	–	–	–	–	–	23	97
20	10	5	–	–	–	–	–	–	24	97
21	–	–	–	–	–	–	–	–	25	97
22	11	–	–	–	–	–	–	–	27	96
23	–	–	–	–	–	–	–	–	28	96
24	12	6	3	–	–	–	–	–	29	96
25	–	–	–	–	–	–	–	–	30	95
26	13	–	–	–	–	–	–	–	31	95
27	–	–	–	–	–	–	–	–	33	95
28	14	7	–	–	–	–	–	–	34	94
29	–	–	–	–	–	–	–	–	35	94
30	15	–	–	–	–	–	–	–	36	93
31	–	–	–	–	–	–	–	–	37	93
32	16	8	4	2	1	–	–	–	38	92
33	–	–	–	–	–	–	–	–	39	92
34	17	–	–	–	–	–	–	–	41	91
35	–	–	–	–	–	–	–	–	42	91
36	18	9	–	–	–	–	–	–	43	90
37	–	–	–	–	–	–	–	–	44	90
38	19	–	–	–	–	–	–	–	45	89
39	–	–	–	–	–	–	–	–	46	89
40	20	10	5	–	–	–	–	–	47	88
41	–	–	–	–	–	–	–	–	48	88
42	21	–	–	–	–	–	–	–	49	87
43	–	–	–	–	–	–	–	–	50	86
44	22	11	–	–	–	–	–	–	51	86
45	–	–	–	–	–	–	–	–	52	85
46	23	–	–	–	–	–	–	–	53	84
47	–	–	–	–	–	–	–	–	55	84
48	24	12	6	3	–	–	–	–	56	83
49	–	–	–	–	–	–	–	–	57	82
50	25	–	–	–	–	–	–	–	58	82
51	–	–	–	–	–	–	–	–	59	81
52	26	13	–	–	–	–	–	–	60	80
53	–	–	–	–	–	–	–	–	61	80
54	27	–	–	–	–	–	–	–	62	79
55	–	–	–	–	–	–	–	–	62	78
56	28	14	7	–	–	–	–	–	63	77
57	–	–	–	–	–	–	–	–	64	77
58	29	–	–	–	–	–	–	–	65	76
59	–	–	–	–	–	–	–	–	66	75
60	30	15	–	–	–	–	–	–	67	74
61	–	–	–	–	–	–	–	–	68	73
62	31	–	–	–	–	–	–	–	69	72
63	–	–	–	–	–	–	–	–	70	72
64	32	16	8	4	2	1	1	–	71	71

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
65	–	–	–	–	–	–	–	–	72	70
66	33	–	–	–	–	–	–	–	72	69
67	–	–	–	–	–	–	–	–	73	68
68	34	17	–	–	–	–	–	–	74	67
69	–	–	–	–	–	–	–	–	75	66
70	35	–	–	–	–	–	–	–	76	65
71	–	–	–	–	–	–	–	–	77	64
72	36	18	9	–	–	–	–	–	77	63
73	–	–	–	–	–	–	–	–	78	62
74	37	–	–	–	–	–	–	–	79	62
75	–	–	–	–	–	–	–	–	80	61
76	38	19	–	–	–	–	–	–	80	60
77	–	–	–	–	–	–	–	–	81	59
78	39	–	–	–	–	–	–	–	82	58
79	–	–	–	–	–	–	–	–	82	57
80	40	20	10	5	–	–	–	–	83	56
81	–	–	–	–	–	–	–	–	84	55
82	41	–	–	–	–	–	–	–	84	53
83	–	–	–	–	–	–	–	–	85	52
84	42	21	–	–	–	–	–	–	86	51
85	–	–	–	–	–	–	–	–	86	50
86	43	–	–	–	–	–	–	–	87	49
87	–	–	–	–	–	–	–	–	88	48
88	44	22	11	–	–	–	–	–	88	47
89	–	–	–	–	–	–	–	–	89	46
90	45	–	–	–	–	–	–	–	89	45
91	–	–	–	–	–	–	–	–	90	44
92	46	23	–	–	–	–	–	–	90	43
93	–	–	–	–	–	–	–	–	91	42
94	47	–	–	–	–	–	–	–	91	41
95	–	–	–	–	–	–	–	–	92	39
96	48	24	12	6	3	–	–	–	92	38
97	–	–	–	–	–	–	–	–	93	37
98	49	–	–	–	–	–	–	–	93	36
99	–	–	–	–	–	–	–	–	94	35
100	50	25	–	–	–	–	–	–	94	34
101	–	–	–	–	–	–	–	–	95	33
102	51	–	–	–	–	–	–	–	95	31
103	–	–	–	–	–	–	–	–	95	30
104	52	26	13	–	–	–	–	–	96	29
105	–	–	–	–	–	–	–	–	96	28
106	53	–	–	–	–	–	–	–	96	27
107	–	–	–	–	–	–	–	–	97	25
108	54	27	–	–	–	–	–	–	97	24
109	–	–	–	–	–	–	–	–	97	23
110	55	–	–	–	–	–	–	–	98	22
111	–	–	–	–	–	–	–	–	98	21
112	56	28	14	7	–	–	–	–	98	20
113	–	–	–	–	–	–	–	–	98	18
114	57	–	–	–	–	–	–	–	99	17
115	–	–	–	–	–	–	–	–	99	16
116	58	29	–	–	–	–	–	–	99	15
117	–	–	–	–	–	–	–	–	99	13
118	59	–	–	–	–	–	–	–	99	12
119	–	–	–	–	–	–	–	–	99	11
120	60	30	15	–	–	–	–	–	100	10
121	–	–	–	–	–	–	–	–	100	9
122	61	–	–	–	–	–	–	–	100	7
123	–	–	–	–	–	–	–	–	100	6
124	62	31	–	–	–	–	–	–	100	5
125	–	–	–	–	–	–	–	–	100	4
126	63	–	–	–	–	–	–	–	100	2
127	–	–	–	–	–	–	–	–	100	1
128	64	32	16	8	4	2	–	1	100	0
129	–	–	–	–	–	–	–	–	100	−1

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
130	65	–	–	–	–	–	–	–	100	−2
131	–	–	–	–	–	–	–	–	100	−4
132	66	33	–	–	–	–	–	–	100	−5
133	–	–	–	–	–	–	–	–	100	−6
134	67	–	–	–	–	–	–	–	100	−7
135	–	–	–	–	–	–	–	–	100	−9
136	68	34	17	–	–	–	–	–	100	−10
137	–	–	–	–	–	–	–	–	99	−11
138	69	–	–	–	–	–	–	–	99	−12
139	–	–	–	–	–	–	–	–	99	−13
140	70	35	–	–	–	–	–	–	99	−15
141	–	–	–	–	–	–	–	–	99	−16
142	71	–	–	–	–	–	–	–	99	−17
143	–	–	–	–	–	–	–	–	98	−18
144	72	36	18	9	–	–	–	–	98	−20
145	–	–	–	–	–	–	–	–	98	−21
146	73	–	–	–	–	–	–	–	98	−22
147	–	–	–	–	–	–	–	–	97	−23
148	74	37	–	–	–	–	–	–	97	−24
149	–	–	–	–	–	–	–	–	97	−25
150	75	–	–	–	–	–	–	–	96	−27
151	–	–	–	–	–	–	–	–	96	−28
152	76	38	19	–	–	–	–	–	96	−29
153	–	–	–	–	–	–	–	–	95	−30
154	77	–	–	–	–	–	–	–	95	−31
155	–	–	–	–	–	–	–	–	95	−33
156	78	39	–	–	–	–	–	–	94	−34
157	–	–	–	–	–	–	–	–	94	−35
158	79	–	–	–	–	–	–	–	93	−36
159	–	–	–	–	–	–	–	–	93	−37
160	80	40	20	10	5	–	–	–	92	−38
161	–	–	–	–	–	–	–	–	92	−39
162	81	–	–	–	–	–	–	–	91	−41
163	–	–	–	–	–	–	–	–	91	−42
164	82	41	–	–	–	–	–	–	90	−43
165	–	–	–	–	–	–	–	–	90	−44
166	83	–	–	–	–	–	–	–	89	−45
167	–	–	–	–	–	–	–	–	89	−46
168	84	42	21	–	–	–	–	–	88	−47
169	–	–	–	–	–	–	–	–	88	−48
170	85	–	–	–	–	–	–	–	87	−49
171	–	–	–	–	–	–	–	–	86	−50
172	86	43	–	–	–	–	–	–	86	−51
173	–	–	–	–	–	–	–	–	85	−52
174	87	–	–	–	–	–	–	–	84	−53
175	–	–	–	–	–	–	–	–	84	−55
176	88	44	22	11	–	–	–	–	83	−56
177	–	–	–	–	–	–	–	–	82	−57
178	89	–	–	–	–	–	–	–	82	−58
179	–	–	–	–	–	–	–	–	81	−59
180	90	45	–	–	–	–	–	–	80	−60
181	–	–	–	–	–	–	–	–	80	−61
182	91	–	–	–	–	–	–	–	79	−62
183	–	–	–	–	–	–	–	–	78	−62
184	92	46	23	–	–	–	–	–	77	−63
185	–	–	–	–	–	–	–	–	77	−64
186	93	–	–	–	–	–	–	–	76	−65
187	–	–	–	–	–	–	–	–	75	−66
188	94	47	–	–	–	–	–	–	74	−67
189	–	–	–	–	–	–	–	–	73	−68
190	95	–	–	–	–	–	–	–	72	−69
191	–	–	–	–	–	–	–	–	72	−70
192	96	48	24	12	6	3	2	–	71	−71
193	–	–	–	–	–	–	–	–	70	−72
194	97	–	–	–	–	–	–	–	69	−72

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
195	–	–	–	–	–	–	–	–	68	−73
196	98	49	–	–	–	–	–	–	67	−74
197	–	–	–	–	–	–	–	–	66	−75
198	99	–	–	–	–	–	–	–	65	−76
199	–	–	–	–	–	–	–	–	64	−77
200	100	50	25	–	–	–	–	–	63	−77
201	–	–	–	–	–	–	–	–	62	−78
202	101	–	–	–	–	–	–	–	62	−79
203	–	–	–	–	–	–	–	–	61	−80
204	102	51	–	–	–	–	–	–	60	−80
205	–	–	–	–	–	–	–	–	59	−81
206	103	–	–	–	–	–	–	–	58	−82
207	–	–	–	–	–	–	–	–	57	−82
208	104	52	26	13	–	–	–	–	56	−83
209	–	–	–	–	–	–	–	–	55	−84
210	105	–	–	–	–	–	–	–	53	−84
211	–	–	–	–	–	–	–	–	52	−85
212	106	53	–	–	–	–	–	–	51	−86
213	–	–	–	–	–	–	–	–	50	−86
214	107	–	–	–	–	–	–	–	49	−87
215	–	–	–	–	–	–	–	–	48	−88
216	108	54	27	–	–	–	–	–	47	−88
217	–	–	–	–	–	–	–	–	46	−89
218	109	–	–	–	–	–	–	–	45	−89
219	–	–	–	–	–	–	–	–	44	−90
220	110	55	–	–	–	–	–	–	43	−90
221	–	–	–	–	–	–	–	–	42	−91
222	111	–	–	–	–	–	–	–	41	−91
223	–	–	–	–	–	–	–	–	39	−92
224	112	56	28	14	7	–	–	–	38	−92
225	–	–	–	–	–	–	–	–	37	−93
226	113	–	–	–	–	–	–	–	36	−93
227	–	–	–	–	–	–	–	–	35	−94
228	114	57	–	–	–	–	–	–	34	−94
229	–	–	–	–	–	–	–	–	33	−95
230	115	–	–	–	–	–	–	–	31	−95
231	–	–	–	–	–	–	–	–	30	−95
232	116	58	29	–	–	–	–	–	29	−96
233	–	–	–	–	–	–	–	–	28	−96
234	117	–	–	–	–	–	–	–	27	−96
235	–	–	–	–	–	–	–	–	25	−97
236	118	59	–	–	–	–	–	–	24	−97
237	–	–	–	–	–	–	–	–	23	−97
238	119	–	–	–	–	–	–	–	22	−98
239	–	–	–	–	–	–	–	–	21	−98
240	120	60	30	15	–	–	–	–	20	−98
241	–	–	–	–	–	–	–	–	18	−98
242	121	–	–	–	–	–	–	–	17	−99
243	–	–	–	–	–	–	–	–	16	−99
244	122	61	–	–	–	–	–	–	15	−99
245	–	–	–	–	–	–	–	–	13	−99
246	123	–	–	–	–	–	–	–	12	−99
247	–	–	–	–	–	–	–	–	11	−99
248	124	62	31	–	–	–	–	–	10	−100
249	–	–	–	–	–	–	–	–	9	−100
250	125	–	–	–	–	–	–	–	7	−100
251	–	–	–	–	–	–	–	–	6	−100
252	126	63	–	–	–	–	–	–	5	−100
253	–	–	–	–	–	–	–	–	4	−100
254	127	–	–	–	–	–	–	–	2	−100
255	–	–	–	–	–	–	–	–	1	−100
256	128	64	32	16	8	4	–	2	0	−100
257	–	–	–	–	–	–	–	–	−1	−100
258	129	–	–	–	–	–	–	–	−2	−100
259	–	–	–	–	–	–	–	–	−4	−100

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
260	130	65	–	–	–	–	–	–	−5	−100
261	–	–	–	–	–	–	–	–	−6	−100
262	131	–	–	–	–	–	–	–	−7	−100
263	–	–	–	–	–	–	–	–	−9	−100
264	132	66	33	–	–	–	–	–	−10	−100
265	–	–	–	–	–	–	–	–	−11	−99
266	133	–	–	–	–	–	–	–	−12	−99
267	–	–	–	–	–	–	–	–	−13	−99
268	134	67	–	–	–	–	–	–	−15	−99
269	–	–	–	–	–	–	–	–	−16	−99
270	135	–	–	–	–	–	–	–	−17	−99
271	–	–	–	–	–	–	–	–	−18	−98
272	136	68	34	17	–	–	–	–	−20	−98
273	–	–	–	–	–	–	–	–	−21	−98
274	137	–	–	–	–	–	–	–	−22	−98
275	–	–	–	–	–	–	–	–	−23	−97
276	138	69	–	–	–	–	–	–	−24	−97
277	–	–	–	–	–	–	–	–	−25	−97
278	139	–	–	–	–	–	–	–	−27	−96
279	–	–	–	–	–	–	–	–	−28	−96
280	140	70	35	–	–	–	–	–	−29	−96
281	–	–	–	–	–	–	–	–	−30	−95
282	141	–	–	–	–	–	–	–	−31	−95
283	–	–	–	–	–	–	–	–	−33	−95
284	142	71	–	–	–	–	–	–	−34	−94
285	–	–	–	–	–	–	–	–	−35	−94
286	143	–	–	–	–	–	–	–	−36	−93
287	–	–	–	–	–	–	–	–	−37	−93
288	144	72	36	18	9	–	–	–	−38	−92
289	–	–	–	–	–	–	–	–	−39	−92
290	145	–	–	–	–	–	–	–	−41	−91
291	–	–	–	–	–	–	–	–	−42	−91
292	146	73	–	–	–	–	–	–	−43	−90
293	–	–	–	–	–	–	–	–	−44	−90
294	147	–	–	–	–	–	–	–	−45	−89
295	–	–	–	–	–	–	–	–	−46	−89
296	148	74	37	–	–	–	–	–	−47	−88
297	–	–	–	–	–	–	–	–	−48	−88
298	149	–	–	–	–	–	–	–	−49	−87
299	–	–	–	–	–	–	–	–	−50	−86
300	150	75	–	–	–	–	–	–	−51	−86
301	–	–	–	–	–	–	–	–	−52	−85
302	151	–	–	–	–	–	–	–	−53	−84
303	–	–	–	–	–	–	–	–	−55	−84
304	152	76	38	19	–	–	–	–	−56	−83
305	–	–	–	–	–	–	–	–	−57	−82
306	153	–	–	–	–	–	–	–	−58	−82
307	–	–	–	–	–	–	–	–	−59	−81
308	154	77	–	–	–	–	–	–	−60	−80
309	–	–	–	–	–	–	–	–	−61	−80
310	155	–	–	–	–	–	–	–	−62	−79
311	–	–	–	–	–	–	–	–	−62	−78
312	156	78	39	–	–	–	–	–	−63	−77
313	–	–	–	–	–	–	–	–	−64	−77
314	157	–	–	–	–	–	–	–	−65	−76
315	–	–	–	–	–	–	–	–	−66	−75
316	158	79	–	–	–	–	–	–	−67	−74
317	–	–	–	–	–	–	–	–	−68	−73
318	159	–	–	–	–	–	–	–	−69	−72
319	–	–	–	–	–	–	–	–	−70	−72
320	160	80	40	20	10	5	3	–	−71	−71
321	–	–	–	–	–	–	–	–	−72	−70
322	161	–	–	–	–	–	–	–	−72	−69
323	–	–	–	–	–	–	–	–	−73	−68
324	162	81	–	–	–	–	–	–	−74	−67

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
325	–	–	–	–	–	–	–	–	−75	−66
326	163	–	–	–	–	–	–	–	−76	−65
327	–	–	–	–	–	–	–	–	−77	−64
328	164	82	41	–	–	–	–	–	−77	−63
329	–	–	–	–	–	–	–	–	−78	−62
330	165	–	–	–	–	–	–	–	−79	−62
331	–	–	–	–	–	–	–	–	−80	−61
332	166	83	–	–	–	–	–	–	−80	−60
333	–	–	–	–	–	–	–	–	−81	−59
334	167	–	–	–	–	–	–	–	−82	−58
335	–	–	–	–	–	–	–	–	−82	−57
336	168	84	42	21	–	–	–	–	−83	−56
337	–	–	–	–	–	–	–	–	−84	−55
338	169	–	–	–	–	–	–	–	−84	−53
339	–	–	–	–	–	–	–	–	−85	−52
340	170	85	–	–	–	–	–	–	−86	−51
341	–	–	–	–	–	–	–	–	−86	−50
342	171	–	–	–	–	–	–	–	−87	−49
343	–	–	–	–	–	–	–	–	−88	−48
344	172	86	43	–	–	–	–	–	−88	−47
345	–	–	–	–	–	–	–	–	−89	−46
346	173	–	–	–	–	–	–	–	−89	−45
347	–	–	–	–	–	–	–	–	−90	−44
348	174	87	–	–	–	–	–	–	−90	−43
349	–	–	–	–	–	–	–	–	−91	−42
350	175	–	–	–	–	–	–	–	−91	−41
351	–	–	–	–	–	–	–	–	−92	−39
352	176	88	44	22	11	–	–	–	−92	−38
353	–	–	–	–	–	–	–	–	−93	−37
354	177	–	–	–	–	–	–	–	−93	−36
355	–	–	–	–	–	–	–	–	−94	−35
356	178	89	–	–	–	–	–	–	−94	−34
357	–	–	–	–	–	–	–	–	−95	−33
358	179	–	–	–	–	–	–	–	−95	−31
359	–	–	–	–	–	–	–	–	−95	−30
360	180	90	45	–	–	–	–	–	−96	−29
361	–	–	–	–	–	–	–	–	−96	−28
362	181	–	–	–	–	–	–	–	−96	−27
363	–	–	–	–	–	–	–	–	−97	−25
364	182	91	–	–	–	–	–	–	−97	−24
365	–	–	–	–	–	–	–	–	−97	−23
366	183	–	–	–	–	–	–	–	−98	−22
367	–	–	–	–	–	–	–	–	−98	−21
368	184	92	46	23	–	–	–	–	−98	−20
369	–	–	–	–	–	–	–	–	−98	−18
370	185	–	–	–	–	–	–	–	−99	−17
371	–	–	–	–	–	–	–	–	−99	−16
372	186	93	–	–	–	–	–	–	−99	−15
373	–	–	–	–	–	–	–	–	−99	−13
374	187	–	–	–	–	–	–	–	−99	−12
375	–	–	–	–	–	–	–	–	−99	−11
376	188	94	47	–	–	–	–	–	−100	−10
377	–	–	–	–	–	–	–	–	−100	−9
378	189	–	–	–	–	–	–	–	−100	−7
379	–	–	–	–	–	–	–	–	−100	−6
380	190	95	–	–	–	–	–	–	−100	−5
381	–	–	–	–	–	–	–	–	−100	−4
382	191	–	–	–	–	–	–	–	−100	−2
383	–	–	–	–	–	–	–	–	−100	−1
384	192	96	48	24	12	6	–	3	−100	0
385	–	–	–	–	–	–	–	–	−100	1
386	193	–	–	–	–	–	–	–	−100	2
387	–	–	–	–	–	–	–	–	−100	4
388	194	97	–	–	–	–	–	–	−100	5
389	–	–	–	–	–	–	–	–	−100	6

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
390	195	–	–	–	–	–	–	–	−100	7
391	–	–	–	–	–	–	–	–	−100	9
392	196	98	49	–	–	–	–	–	−100	10
393	–	–	–	–	–	–	–	–	−99	11
394	197	–	–	–	–	–	–	–	−99	12
395	–	–	–	–	–	–	–	–	−99	13
396	198	99	–	–	–	–	–	–	−99	15
397	–	–	–	–	–	–	–	–	−99	16
398	199	–	–	–	–	–	–	–	−99	17
399	–	–	–	–	–	–	–	–	−98	18
400	200	100	50	25	–	–	–	–	−98	20
401	–	–	–	–	–	–	–	–	−98	21
402	201	–	–	–	–	–	–	–	−98	22
403	–	–	–	–	–	–	–	–	−97	23
404	202	101	–	–	–	–	–	–	−97	24
405	–	–	–	–	–	–	–	–	−97	25
406	203	–	–	–	–	–	–	–	−96	27
407	–	–	–	–	–	–	–	–	−96	28
408	204	102	51	–	–	–	–	–	−96	29
409	–	–	–	–	–	–	–	–	−95	30
410	205	–	–	–	–	–	–	–	−95	31
411	–	–	–	–	–	–	–	–	−95	33
412	206	103	–	–	–	–	–	–	−94	34
413	–	–	–	–	–	–	–	–	−94	35
414	207	–	–	–	–	–	–	–	−93	36
415	–	–	–	–	–	–	–	–	−93	37
416	208	104	52	26	13	–	–	–	−92	38
417	–	–	–	–	–	–	–	–	−92	39
418	209	–	–	–	–	–	–	–	−91	41
419	–	–	–	–	–	–	–	–	−91	42
420	210	105	–	–	–	–	–	–	−90	43
421	–	–	–	–	–	–	–	–	−90	44
422	211	–	–	–	–	–	–	–	−89	45
423	–	–	–	–	–	–	–	–	−89	46
424	212	106	53	–	–	–	–	–	−88	47
425	–	–	–	–	–	–	–	–	−88	48
426	213	–	–	–	–	–	–	–	−87	49
427	–	–	–	–	–	–	–	–	−86	50
428	214	107	–	–	–	–	–	–	−86	51
429	–	–	–	–	–	–	–	–	−85	52
430	215	–	–	–	–	–	–	–	−84	53
431	–	–	–	–	–	–	–	–	−84	55
432	216	108	54	27	–	–	–	–	−83	56
433	–	–	–	–	–	–	–	–	−82	57
434	217	–	–	–	–	–	–	–	−82	58
435	–	–	–	–	–	–	–	–	−81	59
436	218	109	–	–	–	–	–	–	−80	60
437	–	–	–	–	–	–	–	–	−80	61
438	219	–	–	–	–	–	–	–	−79	62
439	–	–	–	–	–	–	–	–	−78	62
440	220	110	55	–	–	–	–	–	−77	63
441	–	–	–	–	–	–	–	–	−77	64
442	221	–	–	–	–	–	–	–	−76	65
443	–	–	–	–	–	–	–	–	−75	66
444	222	111	–	–	–	–	–	–	−74	67
445	–	–	–	–	–	–	–	–	−73	68
446	223	–	–	–	–	–	–	–	−72	69
447	–	–	–	–	–	–	–	–	−72	70
448	224	112	56	28	14	7	0	–	−71	71
449	–	–	–	–	–	–	–	–	−70	72
450	225	–	–	–	–	–	–	–	−69	72
451	–	–	–	–	–	–	–	–	−68	73
452	226	113	–	–	–	–	–	–	−67	74
453	–	–	–	–	–	–	–	–	−66	75
454	227	–	–	–	–	–	–	–	−65	76

Table 7. CIRCULAR TRANSLATOR TABLE

Stepmode(< SM[3:0]>)									% of Imax	
0000	0001	0010	0011	0100	0101	0110	0111	1111		
1/128	1/64	1/32	1/16	1/8	1/4	1/2	Full Step	Full Step + 1/2 rotation	Coil X	Coil Y
455	–	–	–	–	–	–	–	–	−64	77
456	228	114	57	–	–	–	–	–	−63	77
457	–	–	–	–	–	–	–	–	−62	78
458	229	–	–	–	–	–	–	–	−62	79
459	–	–	–	–	–	–	–	–	−61	80
460	230	115	–	–	–	–	–	–	−60	80
461	–	–	–	–	–	–	–	–	−59	81
462	231	–	–	–	–	–	–	–	−58	82
463	–	–	–	–	–	–	–	–	−57	82
464	232	116	58	29	–	–	–	–	−56	83
465	–	–	–	–	–	–	–	–	−55	84
466	233	–	–	–	–	–	–	–	−53	84
467	–	–	–	–	–	–	–	–	−52	85
468	234	117	–	–	–	–	–	–	−51	86
469	–	–	–	–	–	–	–	–	−50	86
470	235	–	–	–	–	–	–	–	−49	87
471	–	–	–	–	–	–	–	–	−48	88
472	236	118	59	–	–	–	–	–	−47	88
473	–	–	–	–	–	–	–	–	−46	89
474	237	–	–	–	–	–	–	–	−45	89
475	–	–	–	–	–	–	–	–	−44	90
476	238	119	–	–	–	–	–	–	−43	90
477	–	–	–	–	–	–	–	–	−42	91
478	239	–	–	–	–	–	–	–	−41	91
479	–	–	–	–	–	–	–	–	−39	92
480	240	120	60	30	15	–	–	–	−38	92
481	–	–	–	–	–	–	–	–	−37	93
482	241	–	–	–	–	–	–	–	−36	93
483	–	–	–	–	–	–	–	–	−35	94
484	242	121	–	–	–	–	–	–	−34	94
485	–	–	–	–	–	–	–	–	−33	95
486	243	–	–	–	–	–	–	–	−31	95
487	–	–	–	–	–	–	–	–	−30	95
488	244	122	61	–	–	–	–	–	−29	96
489	–	–	–	–	–	–	–	–	−28	96
490	245	–	–	–	–	–	–	–	−27	96
491	–	–	–	–	–	–	–	–	−25	97
492	246	123	–	–	–	–	–	–	−24	97
493	–	–	–	–	–	–	–	–	−23	97
494	247	–	–	–	–	–	–	–	−22	98
495	–	–	–	–	–	–	–	–	−21	98
496	248	124	62	31	–	–	–	–	−20	98
497	–	–	–	–	–	–	–	–	−18	98
498	249	–	–	–	–	–	–	–	−17	99
499	–	–	–	–	–	–	–	–	−16	99
500	250	125	–	–	–	–	–	–	−15	99
501	–	–	–	–	–	–	–	–	−13	99
502	251	–	–	–	–	–	–	–	−12	99
503	–	–	–	–	–	–	–	–	−11	99
504	252	126	63	–	–	–	–	–	−10	100
505	–	–	–	–	–	–	–	–	−9	100
506	253	–	–	–	–	–	–	–	−7	100
507	–	–	–	–	–	–	–	–	−6	100
508	254	127	–	–	–	–	–	–	−5	100
509	–	–	–	–	–	–	–	–	−4	100
510	255	–	–	–	–	–	–	–	−2	100
511	–	–	–	–	–	–	–	–	−1	100

Remarks:

- Positive coil current conducts from MOTXP to MOTXN or MOTYP to MOTYN.

Direction

The direction of rotation can be changed by means of the DIR−pin and the SPI bit <DIRCTRL>. See also Figure 12 up to Figure 15. Setup and hold times need to be respected when changing direction (see Figure 6).

NXT Input

Every rising or falling edge on the NXT−pin (selectable through SPI bit <NXTP>) will move the coil current one step up or down (dependant on the DIR−pin and <DIRCTRL> bit) in the translator table (see Table 7). The motor current will be updated at the next PWM cycle.

Enable

The enable SPI bit <MOTEN> is used to enable the PWM regulator and drive coil current through the stepper motor coils. When '1' the motor driver is enabled and coil current will be conducted. If '0' (zero), the H−bridge drivers are disabled.

When the motor driver is enabled, the NXT− and DIR−pin as also the <DIRCTRL> SPI bit can be used to control the movement of the stepper motor. It's not allowed to apply pulses on the NXT−pin when the motor driver is disabled.

Certain errors (see Error Output p28) will automatically disable the motor driver (<MOTEN> = 0). The errors first need to be cleared before one is able to enable the motor driver again.

Setup and hold times need to be respected (see Figure 6).

Microstep Position

To be able to track the position in the current translator table (Table 7), the microstep position SPI byte can be used (<MSP[8:0]>). This byte gives the position within the current translator table in units of 1/128 microsteps. This means that when working in 1/4th microstepping the read out microstep positions will be 0, 32, 64, ...

The microstep position can be used to track/verify the real position of the stepper motor.

Keep in mind that <MSP[8:0]> will only be update 1 μs after the NXT pulse was applied.

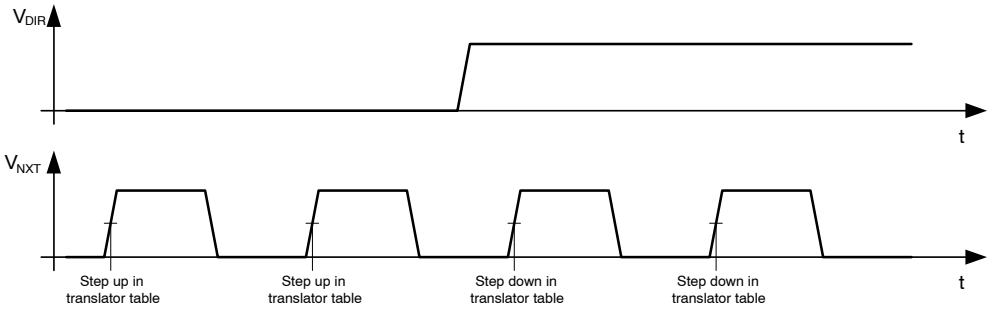
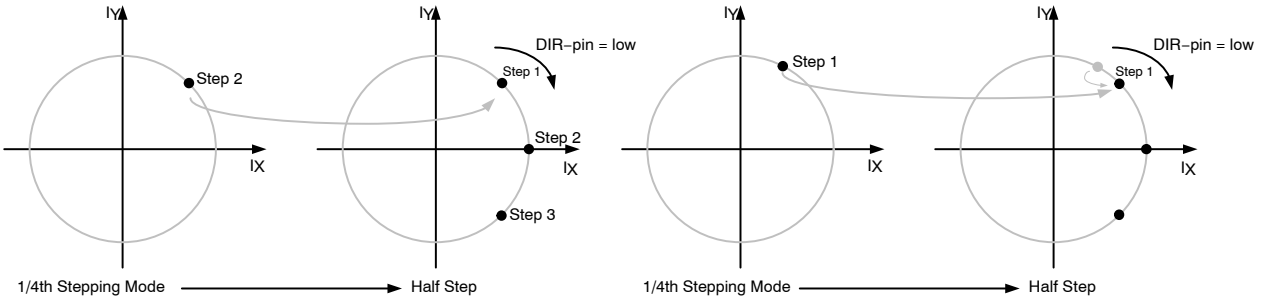


Figure 16. Translator Table Update

Microstep

<SM[3:0]> is used to set the microstep stepping mode. Changing to another microstep stepping mode can be done but the setup and hold timings need to be respected (see Figure 6). Changing to another stepping mode can be done in any (microstep) position. When changing to a lower stepping mode this could lead to a change in coil current (= movement of rotor) even if no NXT pulses are applied. This will only be the case if the microstep position is not shared between the old and new stepping mode (see also Table 7 and Figure 17). This is done to avoid unwanted phase shifts in the coil current.



Step 2 of 1/4th stepping mode is equal to Step 1 of half step stepping mode (see Table 7). No change of coil current during change of stepping mode.

Step 1 of 1/4th stepping mode is NOT shared with a step in half step stepping mode (see Table 7). Change of coil current will occur during change of stepping mode (to avoid a coil current phase shift).

Figure 17. NXT−Step Mode Synchronization

Programmable Peak−Current

The amplitude of the current waveform in the motor coils (I_{max}) can be programmed through SPI bits <CUR[2:0]>. The coil current can be calculated as next:

$$I_{max} = \text{<CUR[2:0]>} / R_{SENSE}$$

R_{SENSE} is resistor R_1 and R_2 as given in Figure 9, <CUR[2:0]> is dependant on the REF−pin voltage. This makes it possible to set the coil current by means of SPI commands or by adjusting the REF−pin voltage. See also page 35.

A change in the coil current (<CUR[2:0]>) will be updated at the next PWM cycle.

Hold Current Setting

A second coil current value can be programmed which is called the Hold Current (<HOLD_CUR[2:0]>). By enabling this functionality (<EN_HOLD> = 1), AMIS−30422 will automatically change the coil current to the programmed Hold Current value when no NXT pulse is detected for a time longer than the specified <HOLD_TIME[1:0]>. From the moment a NXT pulse is detected, AMIS−30422 will automatically set the coil current back to <CUR[2:0]>. This functionality makes it easy to add Run and Hold Current capability to your application.

The HOLDCUR−pin can be used if one wants to select Run or Hold Current manually. To use this pin, <EN_HOLD> must be set to 0 (zero). When pulling the HOLDCUR−pin high, the coil current will be defined by the <HOLD_CUR[2:0]> value. When pulled low, the coil current will be defined by the <CUR[2:0]> value. When <EN_HOLD> is set to 0 (zero) <HOLD_TIME[1:0]> will have no meaning. Switching between the two coil current values can be done at any time (= independent of the NXT frequency). By this the HOLDCUR−pin can also be used to switch between two coil current values in an easy way (even when the motor is rotating).

The Hold Current (<HOLD_CUR[2:0]>) is calculated in the same way as the Run Current (<CUR[2:0]>).

Clear

Logic 0 on the CLR−pin allows normal operation of the chip. To clear the complete digital inside AMIS−30422, the CLR−pin needs to be pulled to logic 1 for a minimum time of t_{CLR} (Table 5). Clearing the motor driver can not be done during Sleep Mode. During a clear the charge pump remains active. The voltage regulator remains functional during and after the clear action and the WDb−pin is not activated.

After a clear, NXT pulses can be applied after t_{CLR_SET} (see Figure 7).

Speed and Load Angle Output

The SLA−pin provides an output voltage that indicates the level of the BEMF (Back Electro Magnetic Force) voltage of the motor. This BEMF voltage is sampled during every so−called ”coil current zero crossing”. Per coil, two zero−current positions exist per electrical period, yielding in a total of four zero−current observation points per electrical period.

Because of the relatively high recirculation currents in the coil during current decay, the coil voltage V_{COIL} shows a transient behavior. This transient behavior (which is not the BEMF) can be made visible or invisible on the SLA−pin by means of SPI bit <SLAT>. When set to transparent (<SLAT> = ‘1’), the coil voltage is sampled every PWM cycle and updated on the SLA−pin (see Figure 18). When set to not−transparent (<SLAT> = ‘0’), only the last sample (taken right before leaving the “coil current zero crossing”) will be copied to the SLA−pin (see Figure 19).

When working in not−transparent mode (<SLAT> = ‘0’) keep in mind that there is a delay between applying the NXT pulse (to leave the “coil current zero crossing”) and the updated voltage on the SLA−pin (see t_{SLA_DELAY} in Figure 19 and Table 5).

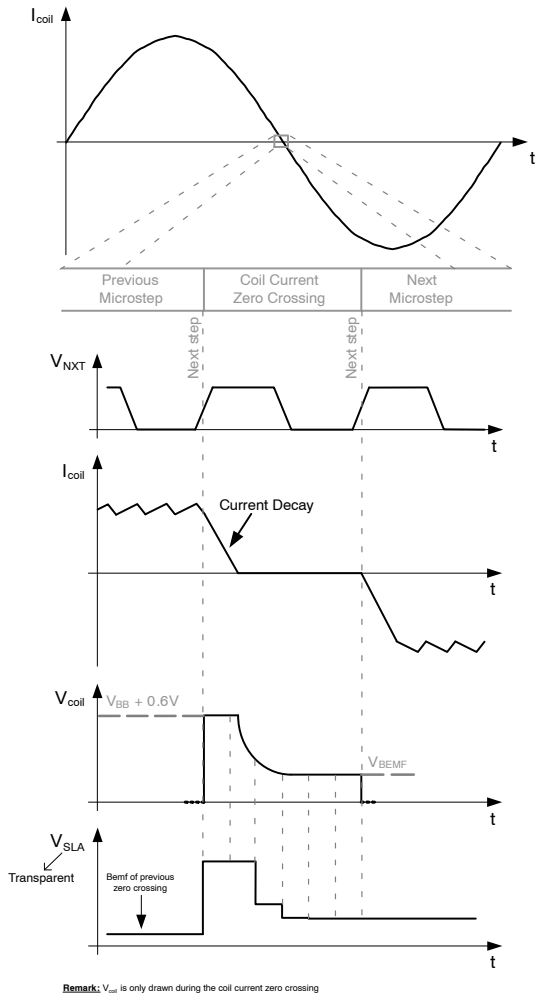


Figure 18. Principle of BEMF Measurement in Transparent Mode

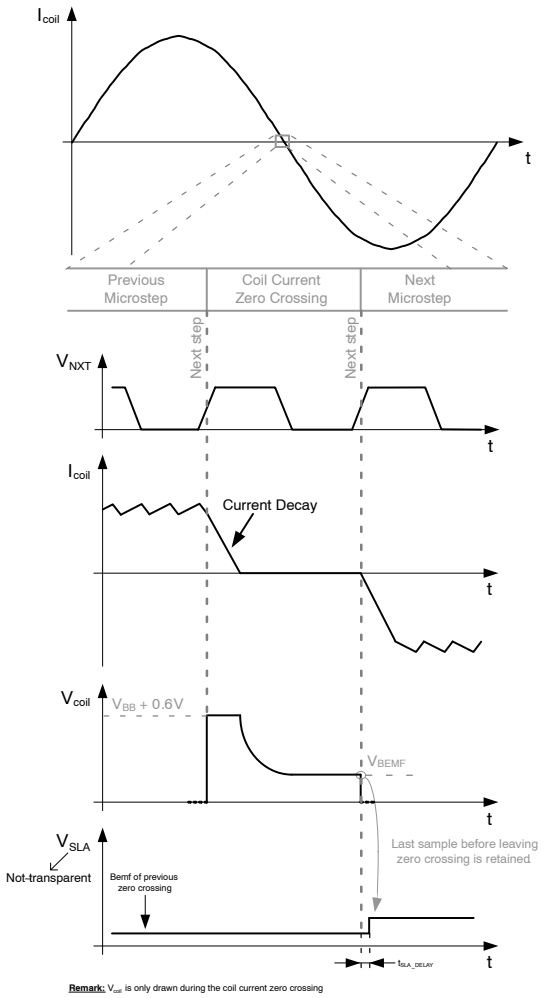


Figure 19. Principle of BEMF Measurement in Not−Transparent Mode

The relationship between the voltage measured on the SLA−pin and the coil voltage is:

V_{SLA} = 0.6 + (0.6 x <SLA_OFFS>) + (V_{coil} x <SLAG>)

SPI bit <SLA_OFFS> can be used to add an additional offset of 0.6 V. Five different SLA gain values can be set by means of SPI bits <SLAG[2:0]>.

AMIS−30422 has the ability to stretch the “coil current zero crossing”. If NXT pulses are applied too fast it’s possible that the “coil current zero crossing” is too short making it impossible to measure the real BEMF (see Figure 20). By using SPI bits <MIN_SLA_TIME[1:0]> one can stretch the “coil current zero crossing” without changing the speed of the motor (see Figure 20). AMIS−30422 will ignore but keep track of the NXT pulses applied during the “stretched coil current zero crossing” and compensate the ignored pulses when leaving the “coil current zero crossing”.

More information on using the SLA−pin can be found in application note AND8399. Although this application note refers to AMIS−305xx, it is also valid for AMIS−30422.