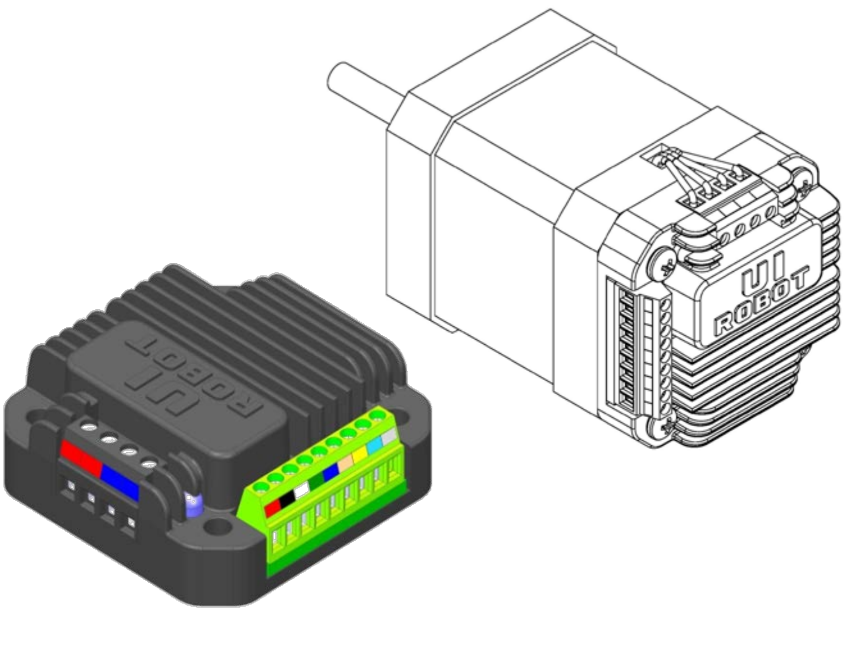
User Manual

UIM241XX Series

RS232 Instruction Control

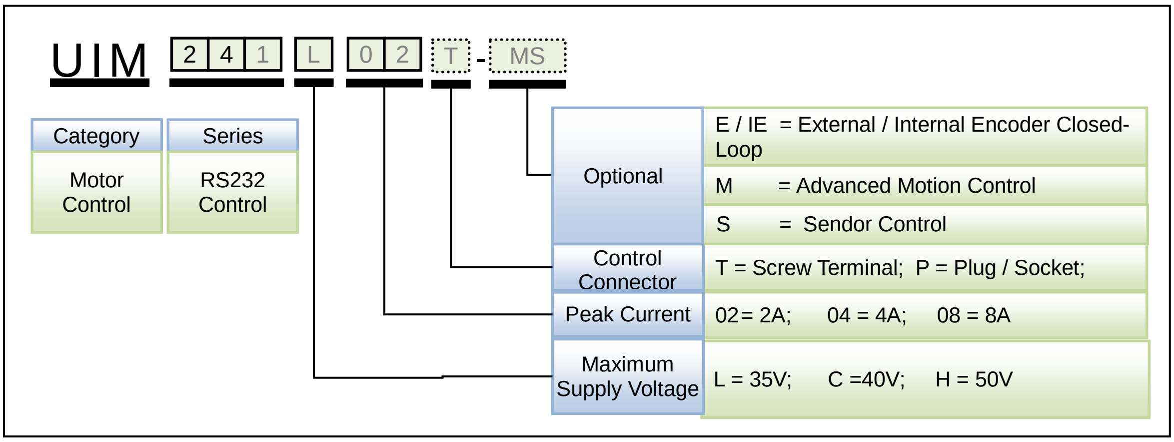
Miniature Integrated Stepper Motor Controller



[UIM241XX Ordering Information]

In order to serve you quicker and better, please provide the product number in following format.

UIM241XX PART NUMBERING SYSTEM



Note:

1） Peak current is decided by max. supply voltage (See in Table 0-1).

2） Default control connector is T (screw terminal), if not selected.

Table 0-1 Correspondence between Max. Supply Voltage and Peak Current

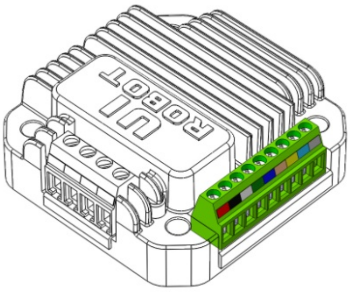
Voltage / Current	L（35V）	C（40V）	H（50V）
2A	√	√*	√*
4A	×	√	√*
8A	×	√	√*

*: Custom made, please contact with salesmans before purchase.

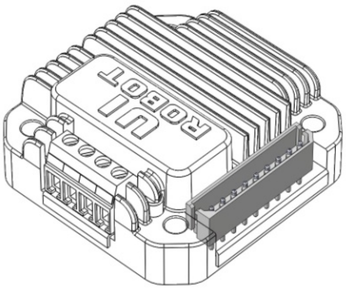
Examples：

UIM241L02P; UIM241C04T-MS; UIM241C08P-IE;

Examples of Control Connector options:



Screw Terminal



Rectangular Plug / Socket

UIM24102 / 04 / 08
RS232 Instruction Control
Miniature Integrated Stepper Motor Contrller

Miniature Integral Design

- Miniature size 42.3mm*42.3mm*16.5mm
- Fit onto motors seamlessly
- Die-cast aluminum enclosure, improving heat dissipation and durability

Motor Driving Characteristics

- Wide supply voltage range 12 ~ 40VDC
- Output current 2/4/8A, instruction adjustable
- Full to 16th micro-step resolution
- Dual full H-bridge with PWM constant current control
- Accurate micro-stepping and current control

Network Communication

- RS232 three-wire serial communication
- Max baud rate 57600 bps

Embedded DSP Microprocessor

- Firmware DSP, 64bits calculating precision
- Absolute position record / feedback, reset by instruction or sensor
- Quadrature encoder based closed-loop control
- Advanced motion control,linear and non-linear acceleration and deceleration, S-curve, PT/PVT displacement control
- 2 sensor input ports
- 8 programmable real-time event-based change notifications
- 13 programmable actions triggered by 6 sensor events
- Simple instructions
- Intelligent control, intuitive and fault-tolerating

GENERAL DESCRIPTION

UIM24102 / UIM24104 / UIM24108 are miniature stepper motor controllers with RS232 interface. UIM241 controllers can be mounted onto NEMA17/23/34/42 series stepper motor through adapting flanges. User device can command these controllers through RS232 protocol using ASCII coded instructions. Instructions are simple, intuitive and fault-tolerating. User is not required to have advanced knowledge on stepper motor driving.

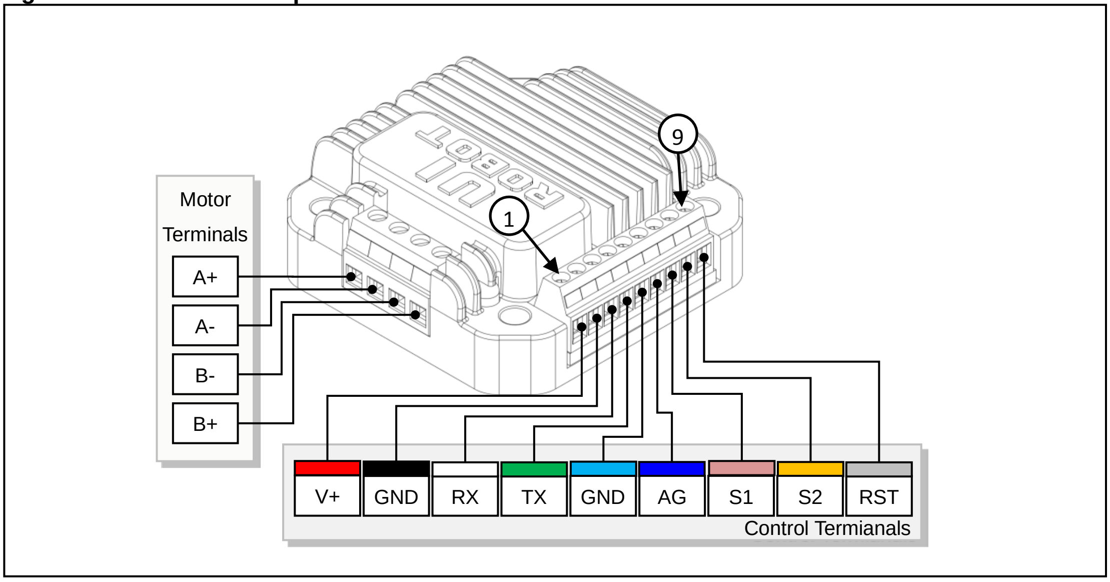
UIM241 can realize open-loop and encoder-based closed-loop control. UIM241's architecture includes communication system, basic motion control system, absolute position counter, quadrature encoder interface and real-time event-based change notification system. Furthermore, there are three optional modules can be installed per customer request: Advanced Motion Control Module (linear/non-linear acceleration/deceleration, S-curve PT/PVT displacement control), Encoder-based Closed-loop Control Module and Sensor Input Control Module.

Embedded 64-bit calculating precision DSP controller guarantees the real-time processing of the motion control and change notifications. Entire control process is finished within 1 millisecond.

Enclosure is made of die-cast aluminum to provide a rugged durable protection and improves the heat dissipation.

TERMINAL DESCRIPTION

Figure0-1: Terminal Description



Control Terminals

Terminal No.	Designator	Description
1	V+	Supply voltage, 12 - 40VDC
2	GND	Supply voltage ground
3	RX	To the RX pin on user device
4	TX	To the TX pin on user device
5	GND	To signal ground on user device
6	AG	Analog ground for sensors
7	S1	Sensor input port 1
8	S2	Sensor input port 2
9	RST	Reset R232 baud rate to 9600

Motor Terminals

Terminal No.	Description
A+ / A-	Connect to the stepper motor phase A
B+ / B-	Connect to the stepper motor phase B

WARNING: Incorrect connection of phase winds will permanently damage the controller!

Resistance between leads of different phases is usually > 100KΩ. Resistance between leads of the same phase is usually < 100Ω. It can simply measured by a multimeter.

WARNING: Except supply voltage port and motor terminal, voltage on port must be kept between -0.3~5.3V. Otherwise, the controller will be damaged.

TYPICAL APPLICATION

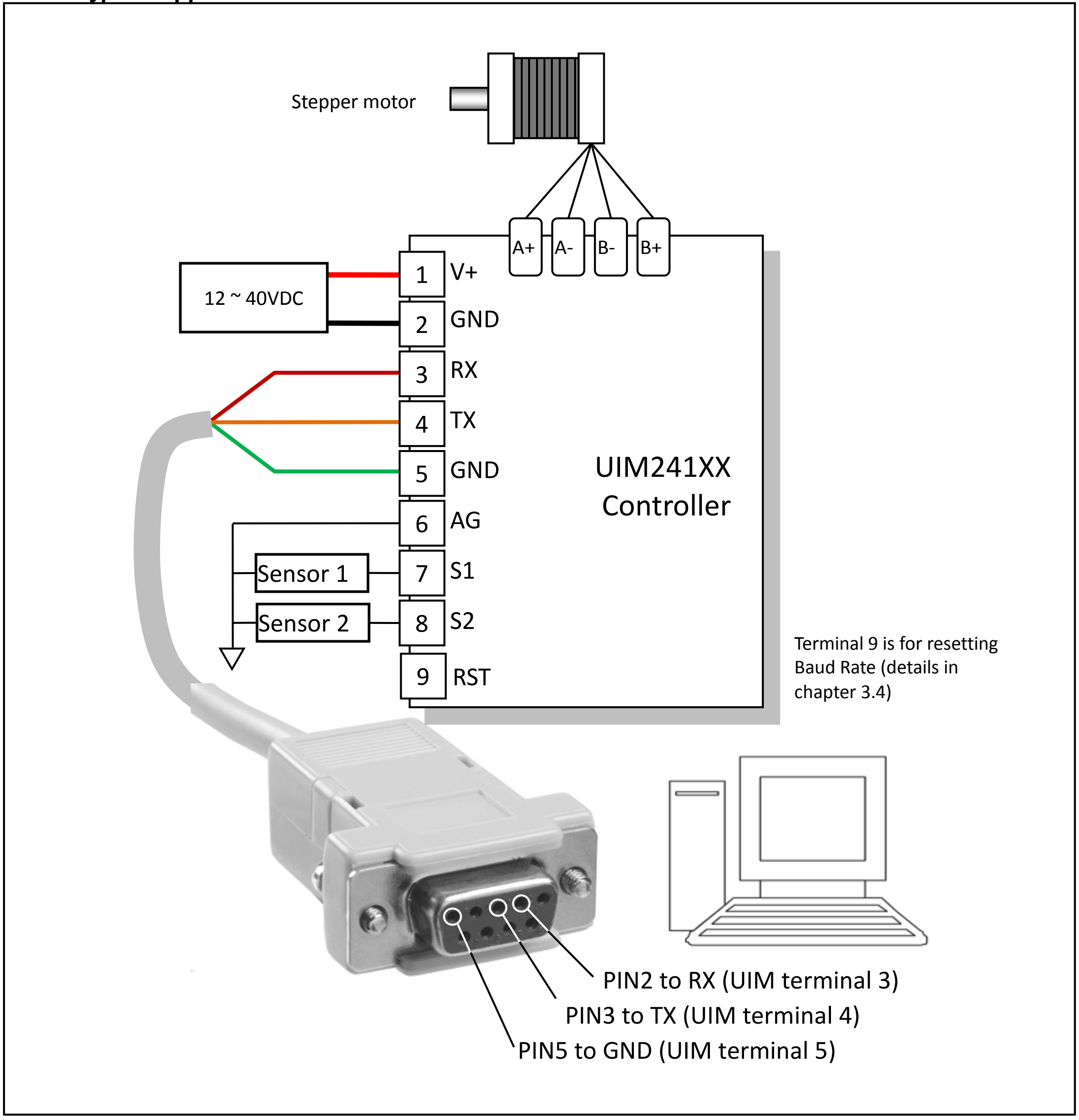
Wiring of UIM241 is simple.

UIM241xx controllers use 3-wire RS232 interface to communicate with user devices. Terminal 3 should be connected to the RX of user device; Terminal 4 should be connected to the TX of user device; Terminal 5 should be connected to the GND of user device. An example is provided in figure 0-2. User can use an existing RS232 cable or a converted cable.

If the sensor inputs are used, make sure the signal are wired to the terminal 7 and/or terminal 8, and the signal ground are wired to the terminal 6. Furthermore, please be aware:

- User is responsible for the power supply for sensors,
- Voltage on terminal 7 and 8 must be kept between -0.3V and 5.3V
- If using an external encoder, channel A should be connected to S1; channel B to S2; GND to AG

Figure 0-2: Typical Application



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INSTRUCTION SET SUMMARY

Network Communication

Instruction	Description	Feedback Header	Message ID	Page
BDRη;	Set RS232 communication baud rate	AA	BD	51

Model Check

Instruction	Description	Feedback Header	Message ID	Page
MDL;	Check the model of controller	CC	DE	68

Function Configuration

Instruction	Description	Feedback Header	Message ID	Page
ENAη;	Set enable time, boot time after η ms enable	AA	A0	56
ENAxFFFF;	Check enable time	AA	A0	57
ICFη;	Set initial configuration register	AA	DA	59
ICF;	Check initial configuration register	AA	DA	60
MCFη;	Set master configuration register	AA	B0	63
MCF;	Check master configuration register	AA	B0	64
SCFη;	Set sensor control configuration register η	AA	C0	78
SCF;	Check sensor control configuration register	AA	C0	79

General Check

Instruction	Description	Feedback Header	Message ID	Page
;	Check desired motor status	AA	-	48
FBK;	Check current motor status	CC	-	58
SFB;	Check sensor status	CC	C1	80

Motor Configuration

Instruction	Description	Feedback Header	Message ID	Page
ACRη;	Set auto-current reduction ratio η	AA	-	49
ACR;	Check auto-current reduction ratio	AA	BA	50
CURη;	Set output phase current η	AA	-	54
ENA;	Enable H-bridge circuit	AA	-	55
MCSη;	Set micro-stepping resolution	AA	-	65
OFF;	Disable H-bridge circuit	AA	-	73

Motion Control

Instruction	Description	Feedback Header	Message ID	Page
BLCη;	Set backlash compensation value η	AA	DE	52
BLC;	Check backlash compensation value	AA	DE	53
MACη;	Set acceleration rate η	AA	B1	61
MAC;	Check acceleration rate	AA	B1	62
MDEη;	Set deceleration rate η	AA	B2	66
MDE;	Check deceleration rate	AA	B2	67
MMDη	Set maximum cessation speed η	AA	B4	69
MMD;	Check maximum cessation speed	AA	B4	70
MMSη;	Set maximum starting speed η	AA	B3	71
MMS;	Check maximum starting speed	AA	B3	72
ORG;	Set zero/origin position	AA	B7	74
ORGη;	Reset the position to a given value η	AA	B7	75
POSη;	Set desired position η (open-loop control)	AA	B7	76
POS;	Check current position	CC	B0	77
SPDη;	Set the desired speed η	AA	B5	81
SPD;	Check current speed	CC	B2	82
STO;	Store motion control parameters	AA	D1	85
STOη;	Bind motion control parameters to sensor edge	AA	D1	86
STPη;	Set desired incremental displacement η	AA	B6	87
STP;	Check current incremental displacement	CC	B3	88

I/O Control

Instruction	Description	Feedback Header	Message ID	Page
STGη;	Set digital input sampling mode	AA	C9	83
STG;	Check digital input sampling mode	AA	C9	84

CHARACTERISTICS

Absolute Maximum Ratings

Supply voltage.. 10V to 40V
Voltage on S1/S2 with respect to GND..-0.3V to +5.3V
Maximum output current sunk by S1/S2..20 mA
Maximum output current sourced by S1/S2..20 mA
Voltage on RX with respect to GND.. -25V to +25V
Voltage on TX with respect to GND.. -13.2V to +13.2V
Ambient temperature under bias.. -20°C to +85°C
Storage temperature.. -50°C to +150°C

NOTE：Working under environment exceeding the above maximum value could result in permanent damage to controller. Working under conditions at the maximum value is not recommended as operation at maximum value for extended period may have negative effect on device reliability.

Electrical Characteristics（Ambient Temperature 25°C）

Supply Power Voltage	12V - 40VDC
Motor Output Current	Max 2A/4A/8A per phase (instruction adjustable)
Driving Mode	PWM constant current
Stepping Resolution	full-step, half-step, 1/4, 1/8 and 1/16 step

Communication (Ambient Temperature 25°C）

Protocol	RS232
Wiring method	3-wire: TX, RX, GND
Baud Rate	Max 57600 bps, instruction adjustable, Firmware reset to 9600

Environment Requirements

Cooling	Free air
Working environment	Avoid dust, oil mist and corrosive gases
Working temperature	-40 °C ～ 85°C
Humidity	<80%RH，no condensation, no frosting
Vibration	3G Max
Storage temperature	-50 °C ～ 150 °C

Size and Weight

Size	42.3mm x 42.3mm x 16.5mm
Weight	0.1 kg

CONTENTS

1.0 OVERVIEW

UIM241 miniature integrated stepper motor controllers communicate with user device using RS232 protocol. The user device controls UIM241 through ASCII coded instructions. Communication baud rate can be changed through instruction

UIM241 has a size of 42.3mm*42.3mm*16.5mm and is designed to mount onto NEMA17/23/34/42 stepper motors seamlessly. UIM24102 can provide 0.7-2A output current; UIM24104 can provide 1.5-4A output current; UIM24108 can provide 3-8A output current. Current value is adjustable within the range through instructions. Once set, the value is stored in EEPROM. UIM241XX controller also has the function of high speed current compensation to offset the effect of Back Electromotive Force (BEMF) of motor at high speed and therefore to facilitate motor’s high-speed performance. UIM241XX series of controllers work with 12 ~ 40VDC power supply.

UIM241XX can perform open-loop control. The control system comprises communication system, basic motion control system, absolute position counter, and real-time event-based change notification system. There are also two optional modules to be added on customer request: *Advanced Motion Module* (linear/non-linear acceleration/deceleration, S-curve PV/PVT displacement control)*, and Sensor Input control Module.*

The embedded 64-bit calculation precision DSP controller guarantees the real-time processing of the motion control and change notifications (similar to the interrupters of CPU). Entire control process is finished within 1 millisecond.

1.1 Basic Control System

UIM241 controller’s basic control system comprises communication system, basic motion control system, absolute position counter, and real-time event-based change notification system.

Communication System

UIM241 controller communicates with user device using RS232 protocol. User device controls the UIM241 controller through ASCII coded instructions. Communication baud rate can be changed through instruction.

Basic Motion Control

UIM241 has a build-in basic motion control system. User device can control the following basic motion parameters through instructions in real-time: direction, speed, angular displacement, phase current, micro-stepping, and enable/disable the H-bridge, etc. Speed input range is +/-65,000 pulses/sec, and displacement input range is +/-2,000,000,000 pulses.

Absolute Position Counter

UIM241 has a hardware pulse counter. The counter can be reset either by user instruction or automatically by the configurable sensor input event. Under most conditions, through the advanced motion control, this counter can provide the absolute position of the motor with enough accuracy. When the counter reaches zero position, there could be automatically generated message feedback to the user device, given the corresponding configuration through user instruction.

Furthermore, with the encoder-based closed-loop control module, the UIM241 can perform self closed-loop control.

Real-time Change Notification (RTCN)

Similar to CPU's interrupters, UIM241XX can automatically generate certain messages after predefined events and sends them to the user device. The time is less than 1 millisecond from the occurring of the event to the message being sent. Message transfer time depends on the baud rate of the RS232 setup. The transfer time will be less than 1 millisecond if the baud rate is set to 57600. UIM241XX's RTCN system supports 8 events: displacement control done absolution position reset; sensor 1/2 rising edge and falling edge; analog input beyond upper threshold, analog input lower than lower threshold, etc. All RTCNs can be enabled or disabled by instructions.

1.2 Advanced Motion Control Module

With advanced motion control module installed, UIM241XX controller can maintain linear and non-linear acceleration/deceleration, S-curve displacement control, PT/PVT control, auto direction control, etc. There are two ways to define acceleration/deceleration rate:

1.Value Mode: Input range: 1 ~ 65,000,000 PPS/Sec (pulse/sec2).

2.Period Mode: Input range: 1 ~60,000 milliseconds (time to fulfill the acceleration or deceleration).

The input range of the displacement control is +/- 2 billion pulses (steps). In advanced motion control mode, the actual direction is decided by module calculation. When displacement is in place, there will be a RTCN (Instruction configurable). Advanced motion control module can be disabled/enabled through user instruction.

1.3 Sensor Input Control Module

UIM241's Sensor Input Control Module supports 2 channels of sensor input. They can accept a TTL level input of 0~5V. There is 1 channel can be configured as analog input (Precision: 12bit; Sample frequency: 50K; mean of 16 calculation; Update frequency: 1000Hz). User can configure the desired automatic action triggered by sensor status change. There are 13 actions listed below that can be triggered by sensor event:

- Start and run forwardly at preset-speed and acceleration
- Start and run reversely at preset-speed and acceleration
- Change direction and run at preset-speed and acceleration
- Forword displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Reverse displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Direction-change displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Decelerate at preset deceleration until stop
- Emergency stop
- Reset position and encoder counter
- Reset position and encoder counter + Reverse displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Reset position and encoder counter + Decelerate at preset deceleration until stop
- Reset position and encoder counter + Emergency stop
- Off

1.4 Instructions and Interface

Instructions for UIM241XX are simple, intuitive and fault-tolerating.

For example, in order to command a speed of 1000 steps/sec, the following instructions are all valid: "SPD = 1000;", "SPD: 1000;", "SPD 1000;", "SPD1000;" or even "SPD %?&%* 1000;".

In case that a wrong instruction is entered, the controller will return an ACK of error message. Incorrect instructions will not be executed to prevent accidents.

UIROBOT provides free Microsoft Windows based VB / VC demo software and corresponding source code to facilitate the quick start of user device side programming.

2.0 INSTRUCTION AND FEEDBACK STRUCTURE

Once UIM241XX receives a message (instructions) from the user device, it will first ACK back (repeat) the received instruction, and then execute the instruction. UIM241XX will further send back a message to inform the user device of the completion of the instruction. Before a new instruction is received, UIM241XX will keep current working status (e.g. running, stop, etc.)

2.1 Instruction Structure

An instruction is a message sent from the user device to UIM241 to Comment certain operation. Instructions of UIM241 follow the rules listed below:

INS η; or **INSx η;** or **INS;**

Instruction symbol **INS** comprises three letters with no space between them, and is not case sensitive. If there is an x (INSx), then it means the value is hexadecimal. Value **η** comprises set of numbers. Some instructions have no value, such as "SPD;", "STP;" etc. Each instruction must end with semicolon (;). Instruction without semicolon will cause unpredictable results.

Feedback Message is the message sent to user device from UIM241 controller. The maximum length of feedback messages is 13 bytes.

Feedback messages from UIM241 follow the structure below:

[Header] [Controller ID] [Message ID] [Data] [Terminator]

There are 3 kinds of headers: AA、CC and EE.

Controller ID the identification number of current controller in a network (also known as Node ID). For UIM241, it is always 00..

Message ID denotes the property of the current message.

Data has a 7bits data structure. High is in front, and low is in the back. The 7bits data can be translated into 16bits data through the shifting operation. One 16bit data takes three 7bits data to represent.

Terminator denotes the end of a feedback message. UIM241 controller utilizes "FF" or "FE" as the terminator. If terminator is "FF", it means there is no follow-up message; If terminator is "FE", it means there has follow-up messages.

Note: there are two types of feedback that has NO message ID: ACK message and Motor Status feedback (controller's response to FBK instruction). Other messages could have NO data, such as some real-time change notification messages.

2.2 Macro Operator and Null Instruction

In practice, users will combine several instructions together and send them at once. Normally, the user device will receive an ACK message on every instruction sent, these message will cause pressure on CAN bus. Especially for those basic motion instructions like SPD, DIR, MCS, which have the same ACK, sending a set of ACK is unnecessary. For example:

CUR 20; MCS 16; SPD 5000; ENA;

The above instruction set will cause 4 ACK messages being transferred on the RS232 bus.

To facilitate the above situation, user can use the following method to send a set of instructions:

{Instruction 1; Instruction 2; …Instruction N; }; (N<10)

For example:

{CUR 20; MCS 16; SPD 5000; ENA; };

UIM241XX will only send back 1 ACK on receiving the above message.

In the above example, "{" and "}" is called **Macro Operator**. Instructions between a pair of macro operators will get no ACK message.

The semicolon at the end of the instruction set has no letter or number before it. That is called **Null Instruction**. The only purpose of a Null Instruction is to tell the UIM242XX to feedback all the inquired parameters of the basic motion control. (i.e. Enable/disable, Current, Micro-stepping, Auto current reduction, Direction, Speed, and Displacement) Actually, user can simply send the null instruction";" alone to check the status of the above parameters. If there is no null instruction ";" after the "}" in the above example, there will be no ACK message at all.

3.0 RS232 COMMUNICATION

UIM241xx controllers communicate and exchange information with user devices throughRS232 serial protocol. The RS232 configuration of user device, the hand-shaking methods and the instruction used to change the baud rate will be introduced in this Chapter, along with the method to reset the baud rate to factory default.

3.1 User Device RS232 Port Configuration

To communicate with UIM241XX, user device needs to have following RS232 port settings:

- 8 bits data
- 1 stop bit
- None Parity

3.2 Hand-Shaking

Any out-of-box UIM241 controller has a factory default baud rate 9600. User can use the 9600 baud rate to connect to a new UIM241 controller.

If the baud rate has been changed, the new baud rate will be stored in the controller's non-volatile memory (EEPROM). New baud rate will take effect after the controller is restarted.If user device knows the baud rate, it can start sending instructions without hand-shaking

Hand-shaking is more used as a method to check the existence and firmware version of the controller. Under following two situations the UIM241XX will issue a greeting message:

1. When UIM241XX is powered up.
2. When UIM241XX receives following ASCII message: ABC; A message started with AA, AB, AC at the user device implies a successful hand-shake.

A greeting Message from UIM241XX has the following structure:

Byte	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Value	AA	AB	AC	18	01	CUR	Module	Firmware Version			00	00	FF

Where,

AA AB AC denotes the greeting message

18 01 denotes the UIM241 controller.

[CUR] denotes the maximum motor current the controller can provide.

[Module] denotes the optional control modules the controller installed

[Firmware Version] denotes the firmware version. Data is in 7 bits format. Conversion from three 7bits message data to a 16bits integer is illustrated in figure 9-1.

3.3 Reset Baud Rate to Factory Default 9600

In case of forgotten the baud rate and cannot establish the connection, please take the following steps to reset the baud rate to factory default of 9600.

1. Reboot the controller.
2. In 10 seconds, short the terminal 9 (figure 0-1) to analog ground (terminal 6) for 2 times, with intervals around 1 second.
3. Each time, the LED on the controller will flash. If exceed 10 seconds, please restart from step 1.
4. If successful, the LED will turn off for one second and re-lit. That indicates the baud rate has been changed to 9600 and ready to use.
5. Use BDR instruction to change the baud rate to desired value.

3.4 Instruction List

The following table shows the instructions mentioned in this chapter, the detail of those instructions is descriped at the end of the document.

Instruction	**Description**	**Page**
BDRη;	Set the RS232 communication baud rate of UIM241XX controller to η	51
MDL;	Check the Model, installed optional modules and firmware version	55

4.0REAL-TIME CHANGE NOTIFICATION

UIM241 controllers support Real-time Change Notification (RTCN). Similar to interrupter of CPU, a RTCN is generated and sent when a user predefined event happens. The length of a RTCN is 4 bytes. The time from the occurrence of the event to the sending of the RTCN is less than 1 millisecond. The time is decided by baud rate. The transfer time is about 0.8ms (0.0008s) when the baud rate is 57600. Then, it takes only 1.5ms from an event happening to a RTCN being received.

4.1 RTCN Structure

The structure of an RTCN message is shown below:

CC [Controller ID] [Message ID] FF

The RTCN system is able to response to the following events:

Table4-1: Real-time change notification events

No.	Event	Message ID	Description
1	falling edge of S1	A0	Voltage on S1: High >>>Low
2	rising edge of S1	A1	Voltage on S1: Low >>>High
3	falling edge of S2	A2	Voltage on S2: High >>>Low
4	rising edge of S2	A3	Voltage on S2: Low >>>High
5	exceed upper limits	A1*	Analog input > user preset upper limit
6	below lower limit	A0**	Analog input < user preset lower limit
7	displacement control complete	A8	The desired position is reached
8	zero position	A9	Position counter reaches/passes zero

Note:

***** When S1 is configured as analog, A1 denotes event 9, otherwise A1 denotes event 2.

****** When S1 is configured as analog, A0 denotes event 10, otherwise A0 denotes event 1.

4.2 Enable/Disable RTCN

Every RTCN can be enabled or disabled through user instruction. Enable/disable the RTCN is achieved by the writing to the Master Configuration Register's ORGIE bit (MCFG<5>), STPIE bit (MCFG<4>), S2IE bit (MCFG<1>) and S1IE bit (MCFG<0>). Please refer to section 5.4 for details.

Please note, to realize the sensor event control, user needs to further configure the sensor control registers S12CON and ATCON. Please refer to Chapter 8.0 for details.

5.0 INITIAL AND HARDWARE/FIRMWARE CONFIGURATION

UIM241's hardware and firmware can be configured through user instructions. There are 4 configuration registers for UIM241: *Initial Configuration Register, Master Configuration Register, S12CON and Analog Threshold Register*. In this chapter, only the *Initial Configuration Register* and *Mater Configuration Register* are described. User can find details about the other registers in their corresponding chapters.

5.1 Initial Configuration Register (Firmware version: 1232 or higher)

Initial configuration register is used to decide the initial status of the controllers after power-on. Once configured, its value will be burned into the on-board EEPROM, and the controller will auto reboot. Initial configuration register is a 16bits register with following structure:

ICFG

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	X	X	X	X	X	X	X	X	X	X	X	X	Elock	PROG	CCW	ENA

Bit15-4 **Unimplemented. Read as 0.**

Bit3 **Elock, Lock when emergency events happen**

0 = After the sensor is emergency stop or power-off, the controller is unlock, and can execute instructions.
1 = After the sensor is emergency stop or power-off, the controller is lock, and receives no instruction. It needs to reboot the controller to unlock it.

Bit2 **Execute user program after power-on (Future function)**

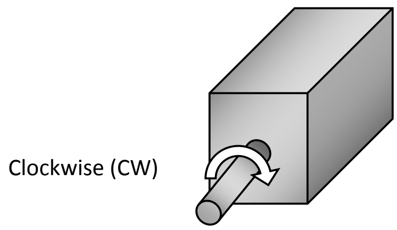
Bit1 **CCW, Adjust rotation direction (Figure 5-1)**

0 = Set CW is positive; when turn CW, displacement counter accumulate; otherwise, displacement counter decrease.
1 = Set anti-CW is positive; when turn anti-CW, displacement counter accumulate; otherwise, displacement counter decrease.

Bit0 **ENA, Auto-enable after powr-on**

0 = Disable the function (Auto-enable after power-on)
1 = Enable the function, auto-enable the controller after the pre-set time when power is on

Figure 5-1 Rotation Direction



5.2 Auto-enable

Once ICFG.ENA is set to 1, UIM241 will auto enable the H-Bridge of motor after the power is on for T ms, the interval time (T) can be set through instruction. For details of the instruction, please refer to Chapter 9.

5.3 User Program

User can program on UIM241. Once ICFG.PROG is set to 1, UIM241 will execute user program after the power is on. For details, please refer to “UIM Programming Manual”.

UIM241 still can execute user instructions when user program is running.

5.4 Master Configuration Register

Master Configuration Register is used to enable/disable the hardware/firmware functions.Once configured, it will be effective immediately and its value will be burned into the on-board EEPROM. The burning process will not affect any real-time process.Master Configuration Register is a 16bits register with the following structure:

MCFG

bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
value	ANE	CHS	QEI	X	QEM	CM	AM	DM	X	X	ORGIE	STPIE	X	X	S2IE	S1IE

Bit15 **ANE Enable / Disable Analog Input**
0 = Disable the analog input, all sensor are set to digital input
1 = Enable the analog input, Port S1 can be set to analog input

Bit14 **CHS Analog Input Channel**
0 = Analog input on port S1
1 = Analog input on port S3 (only for UIM242)
Note: This bit is always 0, for UIM241, means only S1 can be configured as Analog Input.

Bit13 **QEI Enable/Disable Quadrature Encoder Interface**
0 = Disable Quadrature Encoder Interface
1 = Enable Quadrature Encoder Interface

Bit12 **Unimplemented. Read as 0.**

Bit11 **QEM Enable/Disable Quadrature Encoder-based Closed-loop Control Module**
0 = Disable Quadrature Encoder-based Closed-loop Control Module
1 = Enable Quadrature Encoder-based Closed-loop Control Module

Bit10 **CM Advanced Motion Control Mode**
0 = Disable advanced motion control module, use basic control mode
1 = Enable advanced motion control module

Bit9 **AM Acceleration Mode**
0 = Value mode. Unit is pps/sec, or pulse/ (square second)
1 = Period mode. Unit is millisecond.

Bit8 **DM Deceleration Mode**
0 = Value mode. Unit is pps/sec, or pulse/ (square second)
1 = Period mode. Unit is millisecond.

Bit7 - 6 **Unimplemented. Read as 0.**

Bit5 **ORGIE Origin (Zero) Position RTCN**
0 = Disable the Origin (zero) position RTCN.

1 = Enable the Origin (zero) position RTCN. Once the value of pulsing counter or encoder counter is zero, a message will be send to user device automatically.

Bit4 **STPIE Displacement Control (STP/POS/QEC) Completion RTCN**
0 = Disable the displacement control completion RTCN.
1 = Enable the displacement control completion RTCN. Once the displacementinstruction has been executed, a message will be send to user device automatically.

Bit3 - 2 **Unimplemented. Read as 0.**

Bit1 **S2IE S2 Status Change RTCN**
0 = Disable sensor port 2 (S2) status change RTCN
1 = Enable S2 status change RTCN

Bit0 **S1IE S1 Status Change RTCN**
0 = Disable sensor port 1 (S1) status change RTCN
1 = Enable S1 status change RTCN

5.5 Instruction List

The following table shows the instructions mentioned in this chapter, the detail of those instructions is descriped at the end of the document.

Instruction	**Description**	**Page**
ICFη;	Set initial configuration register	59
ICF;	Check initial configuration register	60
MCFη;	Set master configuration register	63
MCF;	Check master configuration register	64

6.0BASIC CONTROL INSTRUCTIONS

UIM241 controllers support abundant motion control instructions. The instructions of UIm241 are valid for both basic motion control (without acceleration/deceleration or S-curve displacement control) and advanced motion control (if the module is installed and enabled). User can select either basic or advanced motion control by configuring the Master Configuration Registration (MCFG).

In this Chapter, introduction to UIM241XX motion control modes is provided.

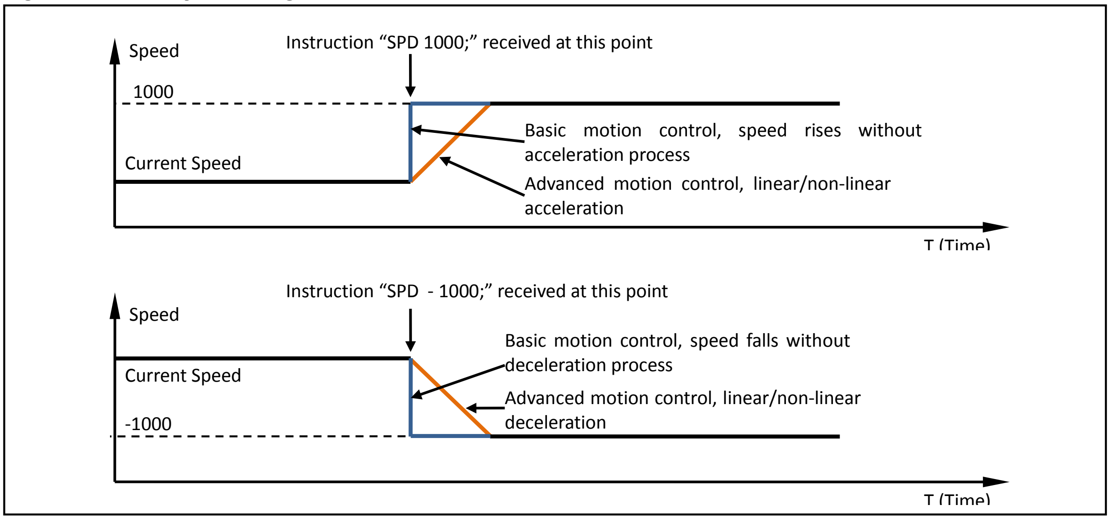
6.1 General Introduction of Motion Control Modes

There are three motion control modes for UIM241XX controller: Velocity Tracking (VT), Position Tracking (PT) and Position Velocity Tracking (PVT).

Velocity Tracking (VT)

In the Velocity Tracking (VT) mode, UIM241XX controller controls the motor speed to track desired speed.

Figure6-1 Velocity Tracking



Please note that: Sign (+/-) of the value of SPD instruction instructs the motion direction. For example: both the instruction “SPD=1000;” and “SPD=+1000;” make motor run forward at 1000pps. Meanwhile, the instruction “SPD= -1000;” can cause motor to run backward at 1000pps.

If Advanced Motion Control Module is installed, speed control can be achieved through linear or non-linear acceleration/deceleration. For details, please refer to Chapter 7.0 Advanced Motion Control. If Advanced Motion Control Module is not installed, once a SPD instruction is received, motor speed will be set to desired speed.

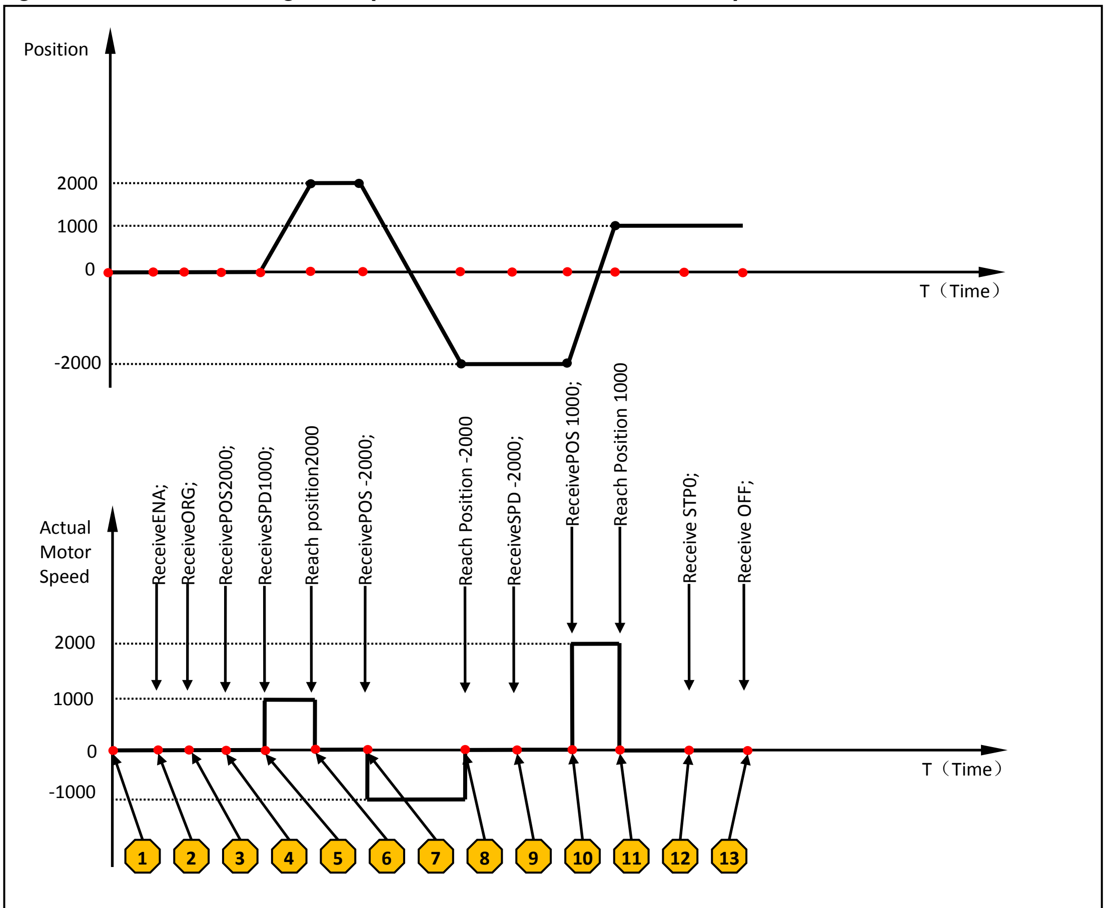
Position Tracking (PT)

In the Position Tracking (PT) mode, UIM241 controller will keep motor running at a speed close to the set value until it reaches the desired steps. After setting the desired speed, user can enter desired positions or incremental displacement continuously or discontinuously. UIM241 controller will make sure that the desired position is achieved when trying to approach the desired speed to the greatest extent.

As shown in Figure 6-2, UIM241 controller operates in PT mode automatically on receiving position instruction such as POS, STP until an instruction of “STP 0;” is given.（STP is a displacement control instruction. Logically “STP 0;” means no displacement. It is contradictory to send a displacement instruction of no displacement. Therefore, UIM241 will take this instruction as a request to shift from PT mode to VT mode.）

In PT mode, the actual speed, direction and desired displacement are related to deviation of actual displacement. When sign of desired speed and displacement deviation is different, the actual direction is decided by displacement deviation, while actual speed is set to absolute value of desired speed. Once deviation of desired and actual displacement is too small, and the acceleration is also too small, then it may cause the following situation: the motor has already reached the desired position, but it still has not reached the desired speed.

Figure6-2 Position Tracking Mode (without acceleration/deceleration)



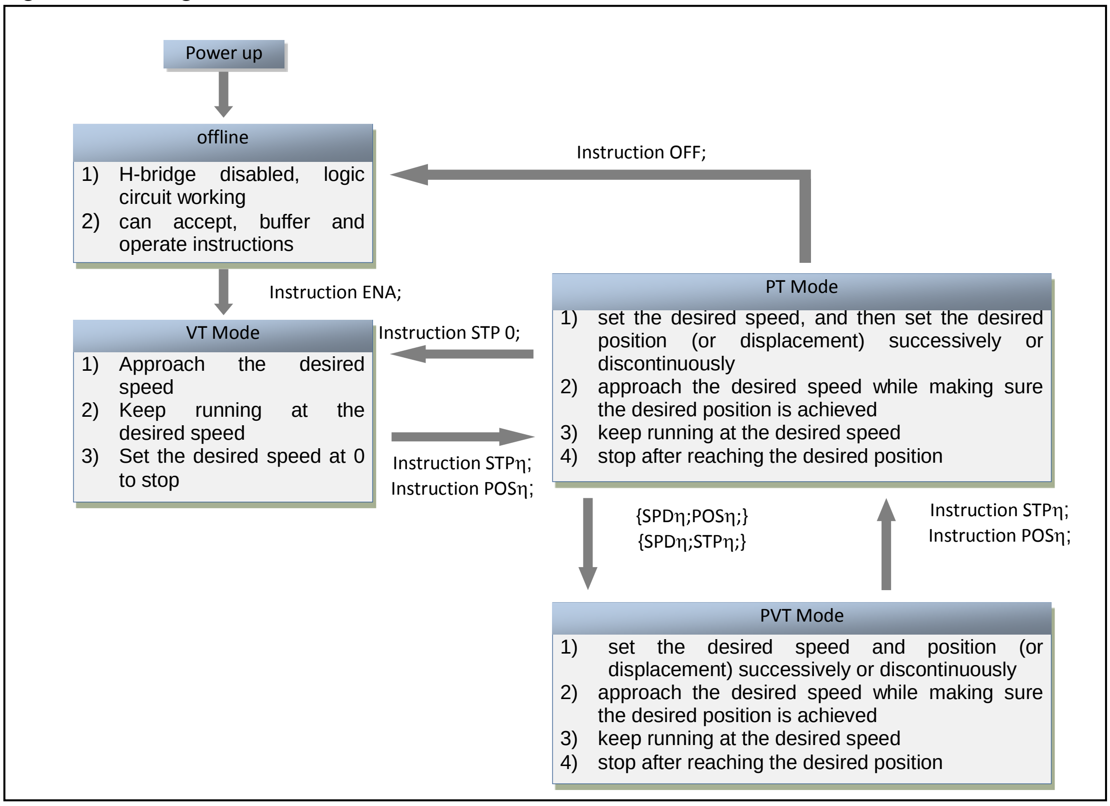
No.	Operation or Event	Control Mode	Desired Position	Current Position	Position Error	Desired Speed	Motor Direction	Motor Speed
1	Power up	VT	0	Stored position	- Stored position	0	1	0
2	ENA	VT	0	Stored position	- Stored position	0	1	0
3	ORG	VT	0	0	0	0	1	0
4	POS	PT	2000	0	2000	0	1	0
5	SPD	PT	2000	0	2000	1000	1	1000
6	Position reached	PT	2000	2000	0	1000	1	0
7	POS	PT	-2000	2000	-4000	1000	0	1000
8	Position reached	PT	-2000	-2000	0	1000	0	0
9	SPD	PT	-2000	-2000	0	-2000	0	0
10	POS	PT	1000	-2000	3000	-2000	1	2000
11	Position reached	PT	1000	1000	0	1000	1	0
12	PT mode off	VT	1000	1000	0	0	1	0
13	OFF	VT	0	1000	-1000	0	1	0

Position Velocity Tracking (PVT)

Position Velocity Tracking (PVT) mode is an extended mode of Position Tracking (PT) mode. In this mode, user can enter both desired position and desired speed.

UIM241XX controller will instruct motor to run at the desired speed until it reaches the desired position and then stop. User can enter, successively or discontinuously, both desired speed and desired position. Shifting between the three modes is displayed in the following chart:

Figure6-3 Shifting between Motion Control Modes



6.2 Basic Instruction Acknowledgment (ACK)

Upon receiving an instruction, the UIM241XX controller will immediately send back an Acknowledgment (ACK) message. There are only two ACK messages for all of them, as described below.

Error Message

If the received instruction is incorrect, UIM241 will issue an error message and the incorrect instruction will not be executed.

EE [Error Code] FF

Where, EE denotes an error message.

The error code is list below:

Error Code	65	66
Meaning	Syntax Error	Value Error

Basic ACK Message

When a valid instruction is received, the UIM241 will send back a basic ACK message. The basic ACK message contains all desired settings. Specifically, following information is included in the ACK message: STP, SPD, DIR, MCS, CUR, ENABLE/OFFLINE, and ACR. The basic ACK message is 13bytes long and has a structure as shown below:

Byte	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Value	AA	00	ASB	CUR	SPD2	SPD1	SPD0	STP4	STP3	STP2	STP1	STP0	FF

Where,

1. AA denotes a basic ACK message, is a kind of reply to instructions received.
2. ASM (Assembled byte) structure:

Bit	7	6	5	4	3	2	1	0
value	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1（0=full step，15=1/16 step)			

3. CUR (desired phase current) structure:

Bit	7	6	5	4	3	2	1	0
value	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

4. SPD2 – SPD0 denotes the desired motor speed. See figure 9-1 for how to convert to a signed 16bit integer.
5. STP4 – STP0 denotes the desired motor displacement. See figure 9-2 for how to convert to a signed 32bit integer.

6.3 Motor Status Feedback Message

Upon receiving the FBK instruction, the controller will send back the feedback message comprising the following up-to-date motor status: incremental displacement, speed, direction, micro-stepping resolution, and phase current, enabled/offline status and ACR status.

The feedback Message is 13 bytes long in the following format:

Byte	1	2	3	4	5	6	7	8	9	10	11	12	13
Value	CC	0	ASB	CUR	SPD2	SPD1	SPD0	STP4	STP3	STP2	STP1	STP0	FF

Where,

1. CC denotes a Motor Status Feedback Message. (i.e., the present value of motor status)
2. [ASB] (assembled) byte structure:

Bit	7	6	5	4	3	2	1	0
value	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1（0=full step，15=1/16 step)			

3. [CUR] (current phase current) structure

Bit	7	6	5	4	3	2	1	0
value	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

4. SPD2 – SPD0 denotes the current motor speed. See figure 9-1 for how to convert to a signed 16bit integer.
5. STP4 – STP0 denotes the current motor displacement. See figure 9-2 for how to convert to a signed 32bit integer.

For more details on above conversion, please refer to the source code of the provided demo software. These software and related source code are VC++/VB based and free.

6.4 Instruction List

The following table shows the instructions mentioned in this chapter, the detail of those instructions is descriped at the end of the document.

Instruction	**Description**	**Page**
ACRη;	Set auto-current attenuation ratio η	49
ACR;	Check auto-current attenuation ratio	50
CURη;	Set output phase current η	54
ENA;	Enable H-bridge circuit	55
ENAη;	Set enable time, boot after η ms enable	56
ENAxFFFF;	Check enable time	57
FBK;	Check current motor status	58
MCSη;	Set micro-stepping resolution	65
OFF;	Disable H-bridge circuit	73
ORG;	Set zero/origin position	74
ORGη;	Reset the position to a given value η	75
POSη;	Set desired position η (open-loop control)	76
POS;	Check current position	77
SPDη;	Set the desired speed η	81
SPD;	Check current speed	82
STPη;	Set desired incremental displacement η	87
STP;	Check current incremental displacement	88

7.0ADVANCED MOTION CONTROL

UIM241XX has an optional Advanced Motion Control Module (sold separately) to perform linear/non-linear acceleration/deceleration and S-curve displacement and position control. User can specify corresponding motion control parameters through instructions. Instructions for the advanced motion control includes all the basic motion instructions and 6 additional instructions.

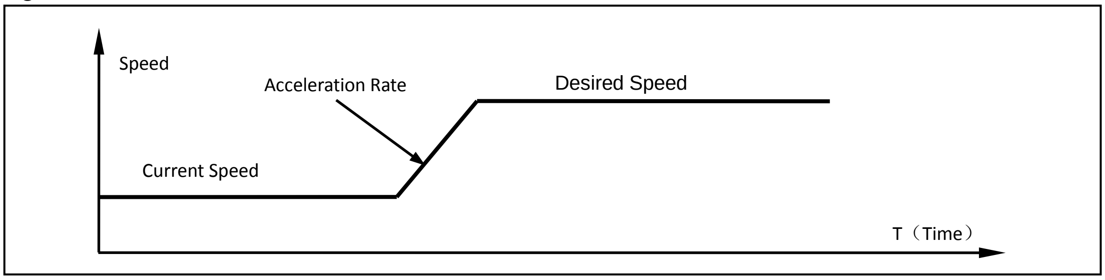
Values of these instructions will be stored in the EEPROM, the burning process will not affect any real-time process.Once the parameters are set, the controller will perform the advanced motion control automatically. At any time, user can use instructions (e.g., FBK, POS, SPD, etc.) to get the current status of the motor.

In this chapter, the Advanced Motion Control processes are introduced。

7.1 Linear Acceleration

Linear acceleration is defined as acceleration at constant rate. The relationship between the speed and time is shown in figure 7-1. After the acceleration rate and desired speed is set(MAC and SPD), UIM241 controller will perform the acceleration process automatically.

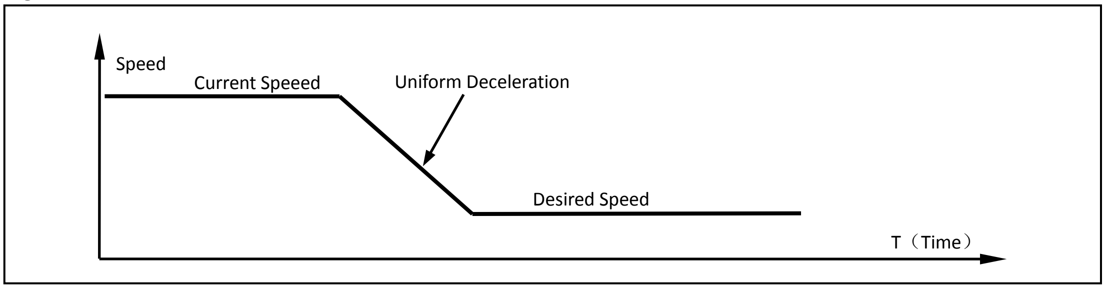
Figure7-1: Linear Acceleration Control



7.2 Linear Deceleration

Linear deceleration is defined as deceleration at constant rate. The relationship between the speed and time is shown in figure 7-2. After the deceleration rate and desired speed is set(MDE and SPD), UIM241 controller will perform the deceleration process automatically.

Figure7-2: Linear Deceleration Control

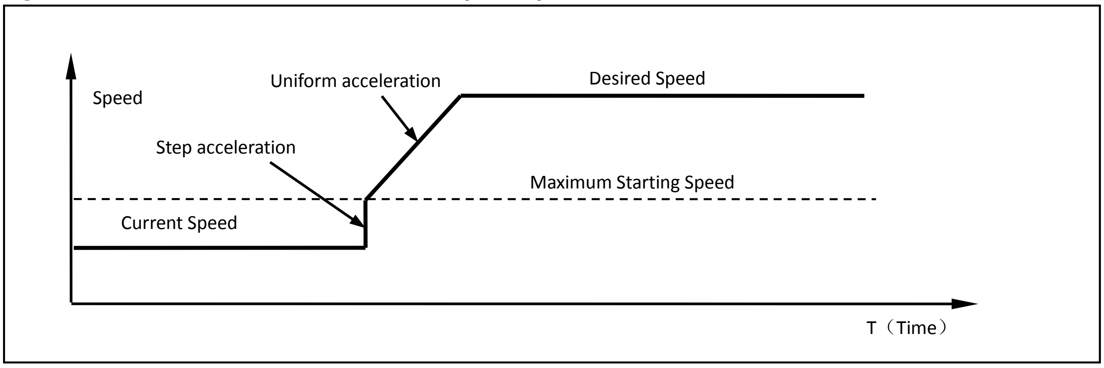


7.3 Nonlinear Acceleration

To minimize the response time and to avoid resonance point, user can use UIM241XX's non-linear acceleration function. Experiments show that through non-linear acceleration, UIM241XX can make NEMA17/23 4000RPM (quad step) in 0.25 seconds. UIM241XX controller has the following non-linear acceleration functions.

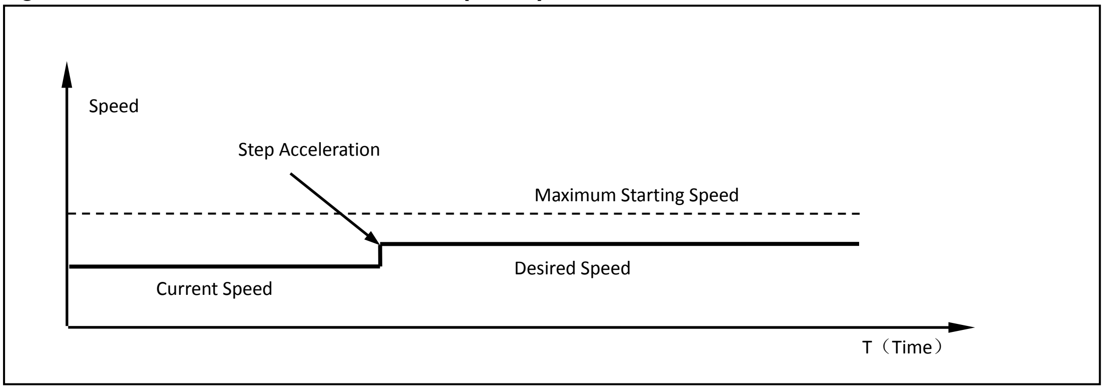
If the desired speed is higher than a certain value (i.e. the Maximum Starting Speed, defined by instruction), and current motor speed is lower than the Max. Starting Speed, then the motor speed will first step up to the Max Starting Speed and then linearly accelerated according to the acceleration rate.

Figure7-3: Nonlinear Acceleration Control (case 1)



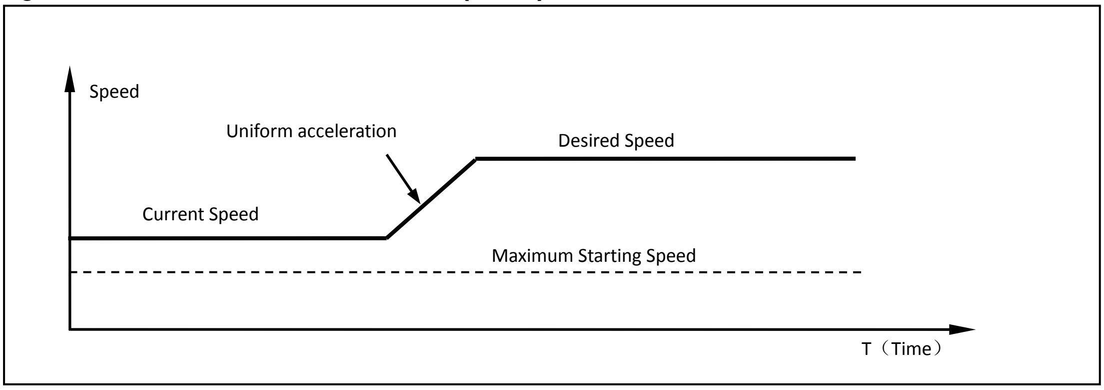
If the desired speed is less than the Max Starting Speed, then the motor speed will step up to the desired speed immediately.

Figure7-4: Nonlinear Acceleration Control (case 2)



If the current speed is higher than the Max Starting Speed, the UIM241 will use the linear Acceleration Control Algorithm to control the speed.

Figure7-5: Nonlinear Acceleration Control (case 3)

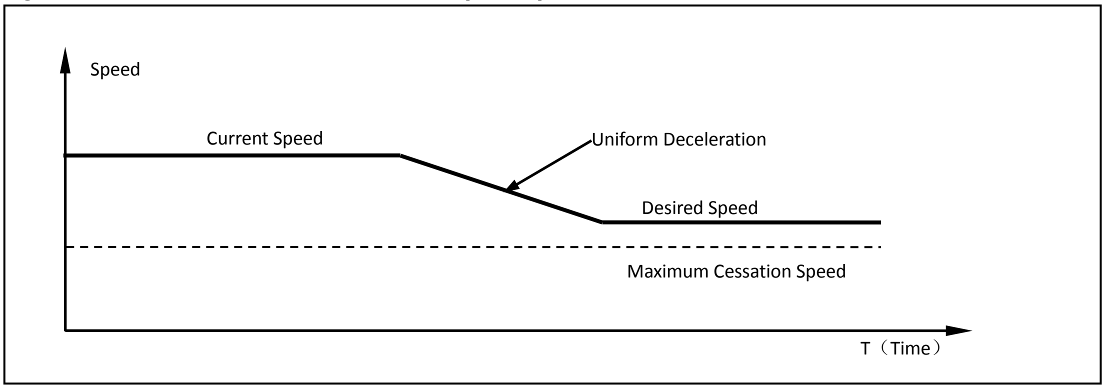


7.4 Nonlinear Deceleration

Similar to the nonlinear acceleration control, there are three cases and corresponding control algorithms as listed below.

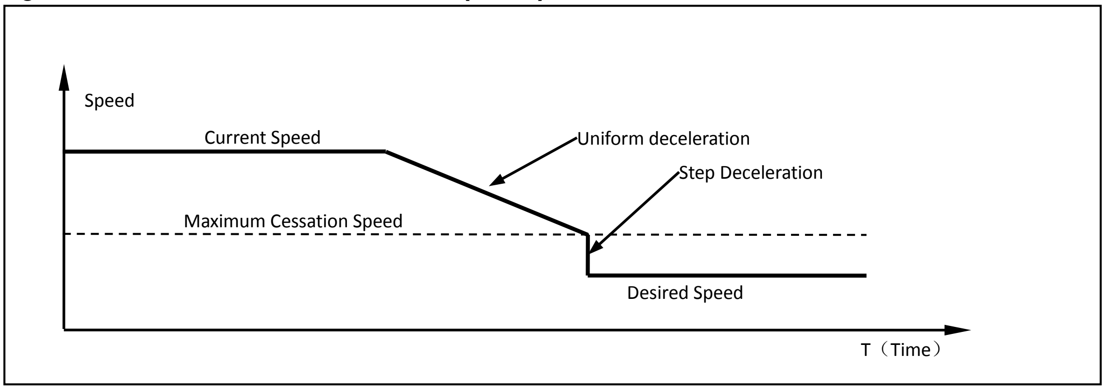
If the desired speed is higher than a certain user preset value (i.e. the Maximum Cessation Speed), UIM241XX will use the Uniform Deceleration Control algorithm.

Figure7-6: Nonlinear Deceleration Control (case 1)



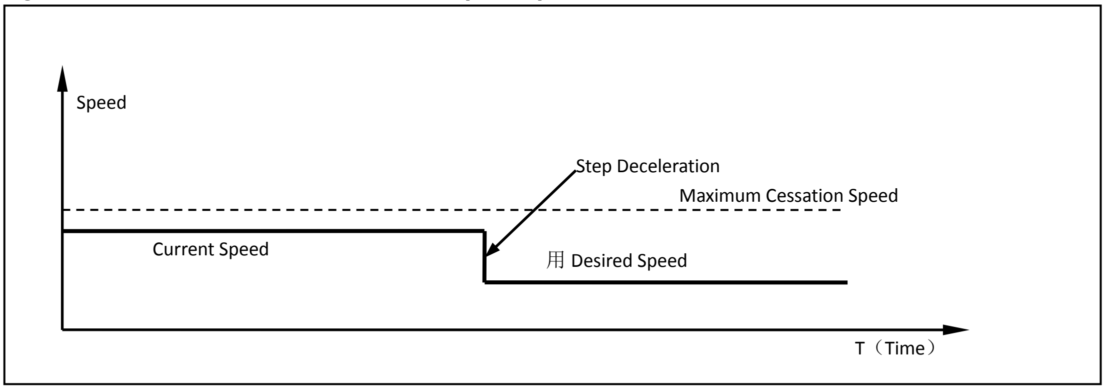
If desired speed is lower than the Max Cessation Speed and current motor speed is higher than the Max. Cessation Speed, the Uniform Deceleration Control will be first applied and followed by a step deceleration to the desired speed.

Figure7-7: Nonlinear Deceleration Control (case 2)



If the desired speed is lower than the Max Cessation Speed and current motor speed is lower than Max. Cessation Speed, then the speed will be adjusted to the desired speed through step deceleration.

Figure7-8: Nonlinear Deceleration Control (case 3)

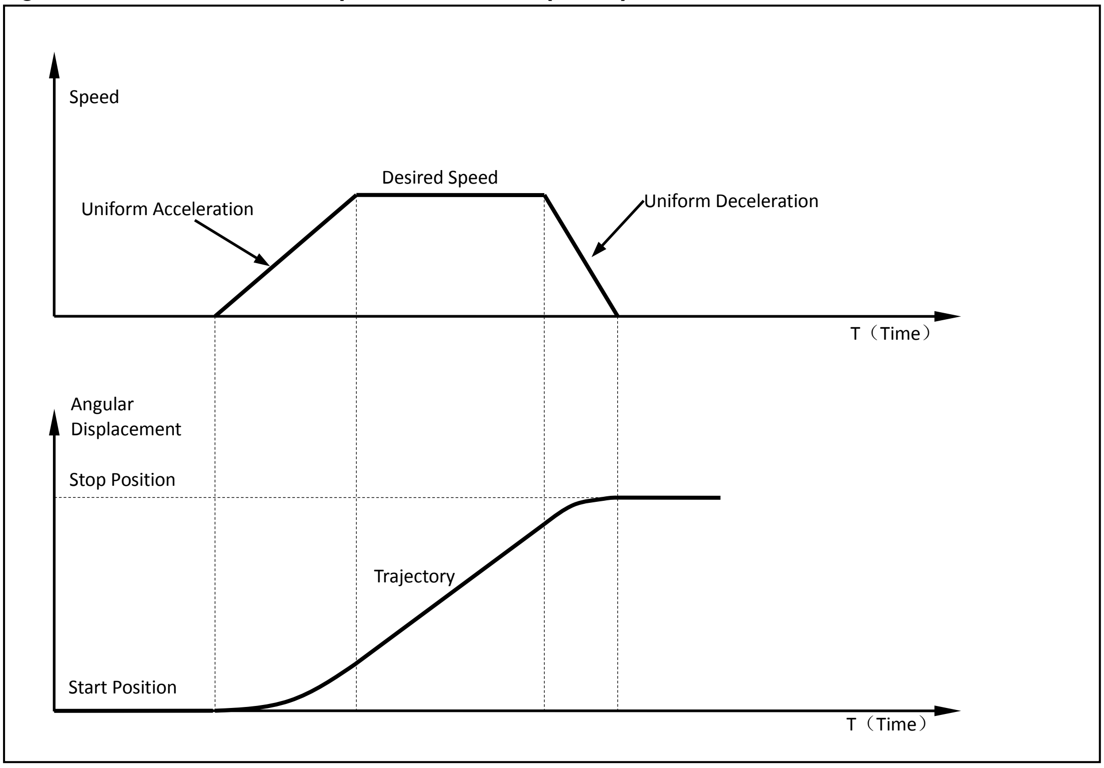


Note: Setting the Maximum Starting Speed or the Maximum Cessation Speed to 0(zero) will force the controller use Linear Acceleration / Deceleration Control Algorithm.

7.5 S-curve Displacement Control

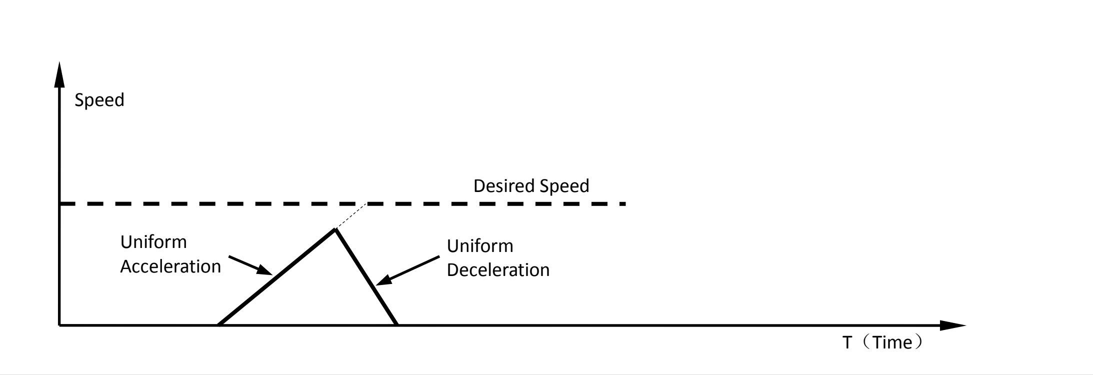
S-curve displacement control essentially is the displacement control under the linear acceleration and deceleration speed control. The name is originated from the shape of the motion trajectory. The original S-curve displacement control is the acceleration-coast-deceleration speed control. In the entire trajectory, there is no knee point, which makes the motion very smooth without impact or vibration. The control process is shown in figure 7-9.

Figure7-9: S-curve Relative Displacement Control (case 1)



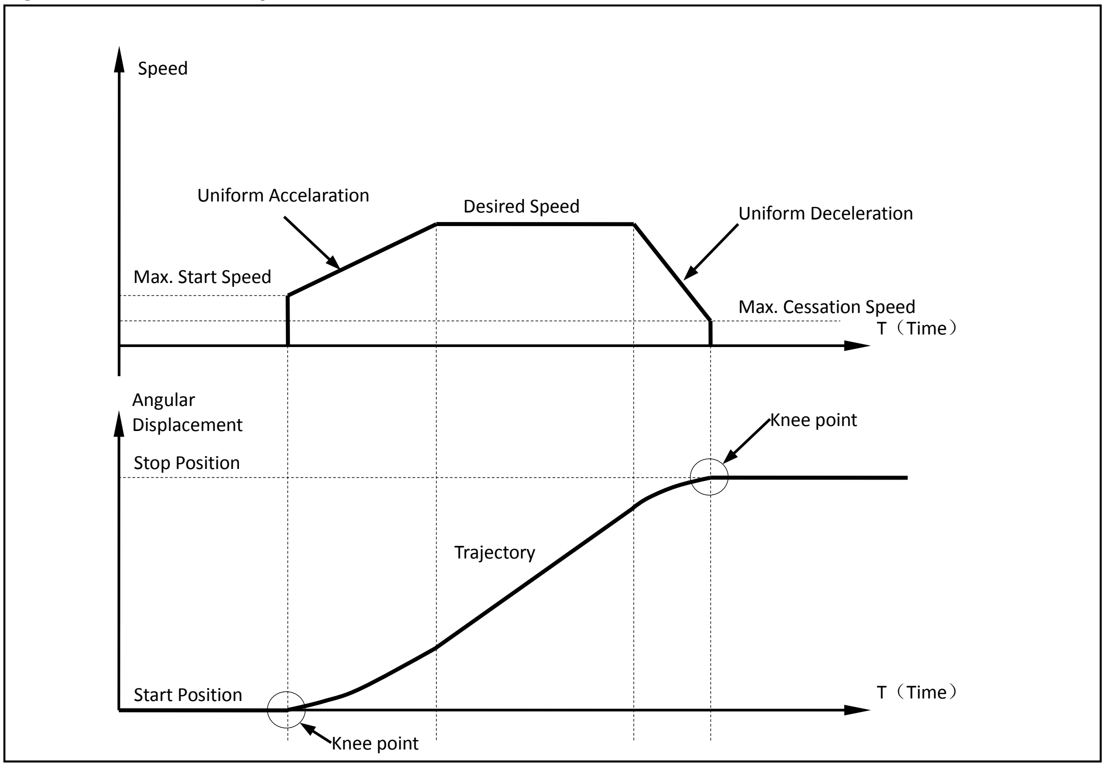
In the control process, UIM241XX's advance motion control module will continuously calculate the deceleration happening point (time) and then perform the deceleration to guarantee that when desired displacement is reached, the speed is right zero. The entire calculation time is around 20 micro-seconds with 64bit accuracy. In practice, when the desired displacement is small and the desired speed is high, deceleration starts before the desired speed is achieved to ensure that the speed decelerate to right zero when desired displacement is completed. The process is shown in figure 7-10.

Figure7-10: S-curve Relative Displacement Control (case 2)



All the acceleration/deceleration methods may be applied in the S-curve displacement control, including linear acceleration/deceleration and non-linear acceleration/deceleration which is not described in the above figures though. Please note that for the non-linear acceleration/deceleration, as there are knee points in its trajectory, is not suitable for applications requiring motion smoothness. In this case, user can set the maximum start speed and maximum cessation speed at zero to disable non-linear acceleration/deceleration. This process is shown is figure 7-11.

Figure7-11: S-curve Displacement Control



7.6 Direction Control and Position Counter

When the user enables the advanced motion control module, the actual motor direction is controlled by the module. This is because if the user input commands a motion direction different from the current motion direction, the desired direction cannot be executed immediately.

UIM241 has two types of position counters: absolute position counter and displacement counter.

Absolute position counter is for recording the absolute position of motor. The actual angular displacement is also relative to micro stepping. The value recorded in absolute position counter will be stored automatically on Power Failure situation and can only be cleared on user instruction or preset sensor event. The counter will increase or decrease according to ICFG.CWW and the actual direction of motor. Absolute position counter value can be read through POS instruction.

Displacement counter is mainly used for displacement control. The former information is cleared when it receives a new displacement instruction. It can also be used to record the displacement since last time it was cleared.

7.7 Backlash Compensation

Backlash is a ubiquitous matter for mechanical system (e.g.: screw nut transmission or gear rack transmission). For example, there is a gap between screw and nut, once the rotation direction is change, in certain angle, though the screw is turing, the nut will not drive the table moving until the gap is eliminate, this gap is known as backlash, which is reflected in the rotation angle of screw. Quantitatively, if the screw rotates clockwise to drive the nut moving 5mm forward, then, rotates anticlockwise for the same cycles, the nut will moving backword 4.99mm, the difference between the two value is the backlash.

Because of backlash, once reverse motion starts, the accumulative error will increase until the backlash is compensate, then the accumulative error tends to be steady. The influence caused by backlash is considerable in a reciprocating motion.

UIM241 controllers provide the function of backlash compensation to reduce the influence on mechanical transmission accuracy.

To compensate backlash, user needs to set a reference backlash first, then once there is a backlash, user can compensate it by sending instruction BLC. Since this instruction compensate backlash automatically when motion direction changes, and the direction before can not get automatically, then it will be thought as no backlash exsiting at the initial moment. Therefore, user must ensure that there is no backlash before sending instruction BLC.

The units of backlash compensation value is pulse, the range is 0 ~ 65536 (recommended value <5000), the default value is 0.

7.8 Advanced Motion Control Instructions

There are 6 additional instructions added as listed below.

1) Enable / disable MCFG: MCF; User can clear the CM bit of Master Configuration Register (MCFG<CM>=0) to disable the module or set the CM bit (MCFG<CM>=1) to enable the module.

2) Set acceleration: MAC; There are two ways to set the acceleration rate:(Figure7-12):

   Value mode If the AM bit of the Master Configuration Register is clear to zero (MCFG<AM>=0), then the value of the instruction will be interpreted as the value of the acceleration rate. The range of the input value is 1 ~ 65,000,000 and unit is pulse/sec/sec or pulse / square-second.

   Period mode If the AM bit of Master Configuration Register is set to one (MCFG<AM>=1), then the value of the instruction will be interpreted as the period of the acceleration, or in other words, the time used for motor to accelerate to the desired speed from current speed. The range of the input value is 1 ~ 60,000 milliseconds, i.e., 0.001~ 60 seconds.

3) Set deceleration: MDE; Similar to mACC, the deceleration also has two ways to set as listed below.

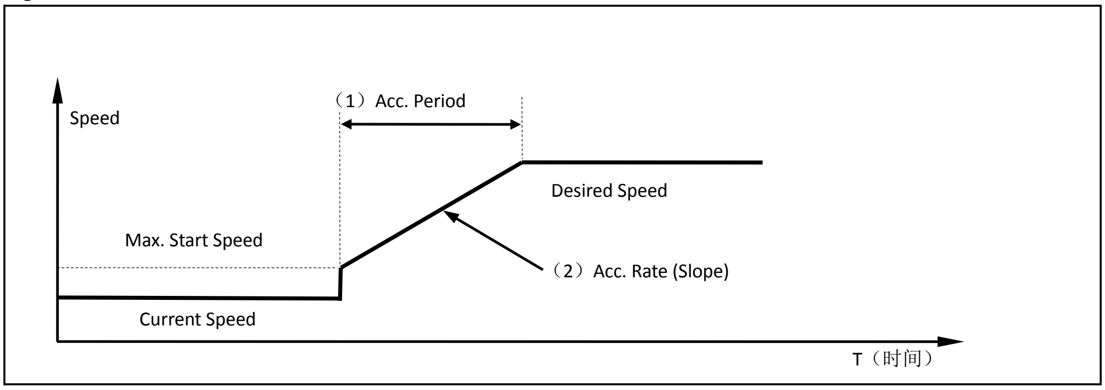
Value mode If the DM bit of the Master Configuration Register is clear to zero (MCFG<DM>=0), then the value of the instruction will be interpreted as the value of the deceleration rate. The range of the input value is 1 ~ 65,000,000 and unit is pulse/sec/sec or pulse / square-second.

Period mode If the DM bit of Master Configuration Register is set to one (MCFG<DM>=1), then the value of the instruction will be interpreted as the period of the acceleration, or in other words, the time used for motor to decelerate to the desired speed from current speed. The range of the input value is 1 ~ 60,000 milliseconds, i.e., 0.001~ 60 seconds.

4) Set maximum starting speed: MMS
5) Set maximum cessation speed MMD
6) Set backlash compensation value: BLC

Max starting speed and max cessation speed has been described in front section. The unit of MMS and MMD are pps.

Figure7-12: Two modes to Set the of Acceleration Rate



7.9 Enable/disable Advanced Motion Control Module (MCFG)

Advanced Motion Control Module can be enabled or disabled by setting the CM bit of MCFG (MCFG<10>). Setting the CM bit (MCFG<CM>=1) will enable the module and clearing the CM bit (MCFG<CM>=0) will disable the advanced motion control module. (For details of setting, please refer to Section 5.1 Master Configuration Register.) Meanwhile, the AM and DM bit of MCFG also defines the input methods of acceleration/deceleration.

7.10 Instruction List

The following table shows the instructions mentioned in this chapter, the detail of those instructions is descriped at the end of the document.

Instruction	Description	Page
BLCη;	Set backlash compensation value η	52
BLC;	Check backlash compensation value	53
MACη;	Set acceleration rate η	61
MAC;	Check acceleration rate	62
MDEη;	Set deceleration rate η	66
MDE;	Check deceleration rate	67

MMDη;	Set maximum cessation speed η	69
MMD;	Check maximum cessation speed	70
MMSη;	Set maximum starting speed η	71
MMS;	Check maximum starting speed	72

8.0SENSOR INPUT CONTROL

UIM241XX Motion Controller has an optional (sold separately) Sensor Control Module which supports two sensor input ports: S1, S2. Port S2 can be configured for digital input (0-5V). Port S1 can be configured for either digital input or analog input.

Besides digital input condition circuit, UIM241XX has a 12 bits ADC (analog/digital converter) and a 5V reference voltage. If the input voltage is 0~5V, the feedback value will be 0~4095. The ADC sample rate is 50K Hz. The analog feedback value is a mathematic average of 16 samples, and the update rate is 1000 Hz. Regardless of whether it's digital or analog, the input voltage cannot exceed -0.3V ~ 5.3V, otherwise permanent damage can be done.

Besides measuring the voltage input and providing the reads to the user device when inquired, the sensor control module is able to carry out a certain control action when a sensor event happens. Actions and sensor events can be defined by instructions. With the Sensor Control Module, UIM241 can perform motion controls without the user device.

There are 6 sensor events that can be configured, as listed below:

Table8-1: Sensor Events

No.	Sensor Events	Description
1	S1 Falling Edge	S1 Voltage Level Change, High >>>Low
2	S1 Rising Edge	S1 Voltage Level Change, Low >>>High
3	S2 Falling Edge	S2 Voltage Level Change, High >>>Low
4	S2 Rising Edge	S2 Voltage Level Change, Low >>>High
5	Exceeding the Upper Limit	Analog input voltage is higher than user defined upper limit
6	Exceeding the Lower Limit	Analog input voltage is lower than user defined lower limit

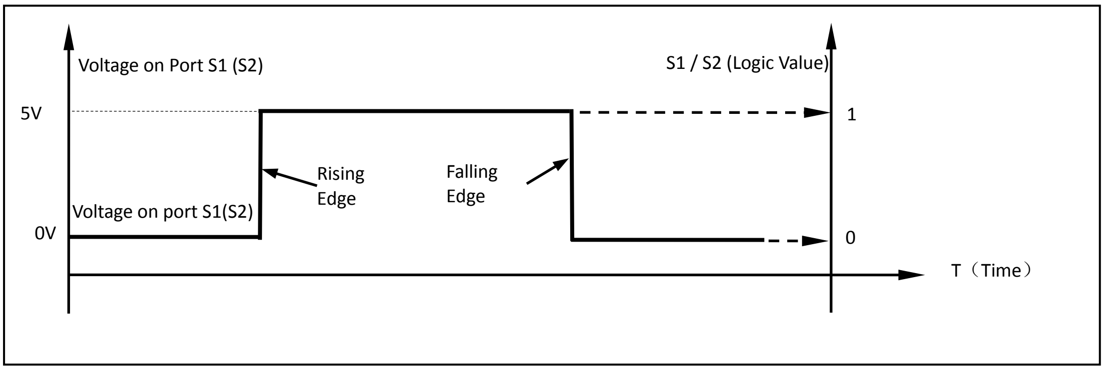
There are 13 actions that can be furthermore bound to sensor events:

- Start and run forwardly at preset-speed and acceleration
- Start and run reversely at preset-speed and acceleration
- Change direction and run at preset-speed and acceleration
- Forword displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Reverse displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Direction-change displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Decelerate at preset deceleration until stop
- Emergency stop
- Reset position and encoder counter
- Reset position and encoder counter + Reverse displacement control follow the preset motion parameters (speed, displacement, acceleration)
- Reset position and encoder counter + Decelerate at preset deceleration until stop
- Reset position and encoder counter + Emergency stop
- Off

8.1 Rising and Falling Edge

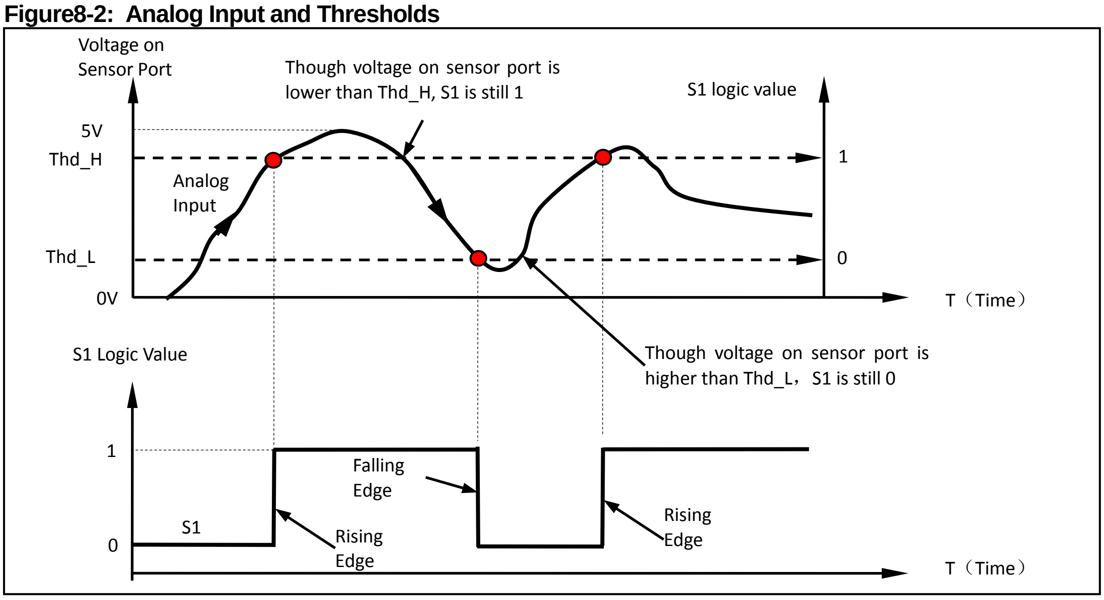
When port S1 and S2 is configured for digital input, if the sensor module detects a voltage change on S1(S2) from 0V to 5V, an Sx rising-edge event will be created, meanwhile S1(S2) is assigned a logic value 1 (i.e. S1=1). If the sensor module detects a change on S1(S2) from 5V to 0V, an S1(S2) falling-edge event will be created, meanwhile S1(S2)=0.

Figure8-1: Rising and Falling Edge of a Digital Sensor Input



8.2 Analog Input and Thresholds

Figure8-2: Analog Input and Thresholds



Sensor input port S1 can be configured for analog input by instruction. To do that, user needs to first enable the analog input function by set the ANE bit of the master configuration register (i.e., MCFG<ANE> =1). Then, user needs to select the analog input port by clear the CHS bit of the master configuration register (i.e., make MCFG<CHS> =0). Once configured, the analog voltage on port S1 can be obtained by instruction SFB.

In order to use the sensor events, user may need to further setup the input upper and lower thresholds (i.e., AH / AL in figure 8-2). If the sensor module detects the analog input voltage is changing from lower than AH to high than AH, an S1 rising-edge event will be created, meanwhile S1 is assigned a logic value 1 (i.e. S1=1). If the sensor module detects a change on S1 from higher than AL to lower than AL, an S1 falling-edge event will be created, meanwhile S1=0. Otherwise, S1 is kept unchanged.

8.3 Digital Input Sampling Mode

Digital input of UIM241 has three sampling mode:

1） Continuous sampling

2） Intermittent sampling

3） Single sampling

Continuous Sampling

In continuous sampling mode, UIM241 controllers detect level fluctuation at port S1/S2 uninterruptrdly. Once a fluctuation happens, controllers will call corresponding program, execute pre-set actions, and (or) send a message to user device.

If user sets the sampling interval to 0 by using instruction STG, the controllers will work in continuous sampling mode.

Intermittent Sampling

In intermittent sampling mode, user needs to set sampling interval T (1~60000ms) at first.

Once a fluctuation is detected at one port, UIM241 controllers will not detect the level fluctuation at this port until (T+1) ms later.

When working in this mode, it is available for prevention and treatment of disturb and shake eliminating of digital input.

If user sets the sampling interval to T (1 ~ 60000) by using instruction STG, the controllers will work in intermittent sampling mode, and sampling interval is T.

Single Sampling

In single sampling mode, once a fluctuation is detected at one port, UIM241 controllers will not detect the level fluctuation at this port until user configures the corresponding control bit of S12CON again.

If user sets the sampling interval to T (> 60000) by using instruction STG, the controllers will work in single sampling mode.

8.4 Sensor Event, Action and Binding

UIM241XXs support 6 sensor events as listed in section 8.0. There are 13 actions that can be bound to those 6 sensor events. Binding means assigning a sensor action to a sensor event. The binding between events and actions are realized through the configuration of the Sensor Control Register S12CON. An action-code is needed when configuring sensor registers.

- Start and run forwardly at preset-speed and acceleration (code: 10)
- Start and run reversely at preset-speed and acceleration (code: 2)
- Change direction and run at preset-speed and acceleration (code: 14)
- Forword displacement control follow the preset motion parameters (speed, displacement, acceleration) (code: 13)
- Reverse displacement control follow the preset motion parameters (speed, displacement, acceleration) (code: 5)
- Direction-change displacement control follow the preset motion parameters (speed, displacement, acceleration) (code: 9)
- Decelerate at preset deceleration until stop (code: 3)
- Emergency stop (code: 4)
- Reset position and encoder counter (code: 6)

- Reset position and encoder counter + Reverse displacement control follow the preset motion parameters (speed, displacement, acceleration) (code: 7)
- Reset position and encoder counter + Decelerate at preset deceleration until stop (code: 11)
- Reset position and encoder counter + Emergency stop (code: 12)
- Off (code: 15)

8.5 Introduction to Sensor Input Control Instructions

There are only 5 instructions related to the sensor input control.

1. MCF (Master Configuration Register)

   The ANE bit (MCFG<15>) and CHS bit (MCFG<14>) of the master configuration register define the digital/analog input of the sensor port. The S1IE bit (MCFG<0>) and S2IE bit (MCFG<1>) enable/disable the sensor real-time change notification (RTCN). See section 5.4 for details.

2. SCF (Sensor Configuration Register)

   SCF is used to configure following sensor input control registers: S12CON, ATCONH 和 ATCONL。

3. STG (Sensor Trigger Configuration)

   STG is used to configure sensor trigger mode, UIM241 has three trigger modes: *Single Trigger, Continouns Trigger* and *N ms Intermittent Trigger*.

4. STO (Sensor Parameter Store into EEPROM)

   STO is used for storing parameters such as S12CON, ATCONH, ATCONL, SPD, and STP into EEPROM so that Sensor Input Control Module can perform the control when user device is absent.

5. SFB (Sensor Status Feedback)

   At any time and under any scenario, using the instruction SFB can always read back the logic value of S1 and S2 as well as the analog measurement (given MCFG<ANE>=1, MCFG<CHS> =0).

8.6 Sensor Input Control Register S12CON

S12CON（Sensor 1/2 Control）defines the binding relationship between S1 and S2 sensor events and actions, as well as the activation of corresponding RTCNs. It is a 16bits register inside the controller, and can be configured using the instruction SCF. When writing to it user needs to affix a 4bits suffix-code to point to this register. For details of SCF, please refer to chapter 11.

The suffix-code for S12CON is 0000 (binary). S12CON structure is as follows:

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Defination	S2RACT				S2FACT				S1RACT				S1FACT			

Bit 15-12 **S2RACT<3:0>** S2 Rising-edge Action

Bit 11-8 **S2FACT<3:0>** S2 Falling-edge Action

Bit 7-4 **S1RACT<3:0>** S1 Rising-edge Action

Bit 3-0 **S1FACT<3:0>** S1 Falling-edge Action

The binding relationship between S1 and S2 sensor events and actions is as follow:

ACT Code（binary）	Action	RTCN or Not
0000	N/A	No RTCN (Ignore MCFG<S2IE><S1IE>)
0001	N/A	Depends on MCFG<S2IE><S1IE>
0010	Start and Run Reversely	Depends on MCFG<S2IE><S1IE>
0011	Decelerate until Stop	Depends on MCFG<S2IE><S1IE>
0100	Emergency Stop	Depends on MCFG<S2IE><S1IE>
0101	Reverse Displacement Control	Depends on MCFG<S2IE><S1IE>
0110	Reset position	Depends on MCFG<S2IE><S1IE>
0111	Reset position + Dispalcement Control	Depends on MCFG<S2IE><S1IE>
1001	Direction-change displacement control	Depends on MCFG<S2IE><S1IE>
1010	Start and Run Forwardly	Depends on MCFG<S2IE><S1IE>
1011	Reset position + Decelerate until Stop	Depends on MCFG<S2IE><S1IE>
1100	Reset position + Emergency Stop	Depends on MCFG<S2IE><S1IE>
1101	Forward Displacement Control	Depends on MCFG<S2IE><S1IE>
1110	Change direction and run	Depends on MCFG<S2IE><S1IE>
1111	OFF	Depends on MCFG<S2IE><S1IE>

8.7 Analog Threshold Control Register ATCONH & ATCONL

ATCONH（Analog Threshold Control High）and ATCONL define the upper and lower limit of the analog threshold. Both registers are 16bits registers in the controller memory space, configured through SCF instructions. However, when configuring, user needs to affix a 4bits suffix-code to point to a specific register. The suffix-code for ATCONL is 0010 (binary), the suffix-code for ATCONH is 0011 (binary).

ATCONH structure is as follows:

Bit	*15*	*14*	*13*	*12*	*11*	*10*	*9*	*8*	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Defination	Reserved				AH <11:0>											

Bit 15-12 Unimplemented, read as 0.

Bit 11-0 **AH<11:0>** Upper limit of analog threshold.

ATCONL structure is as follows:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Defination	Reserved				AL <11:0>											

位 15-12 Unimplemented, read as 0.

位 11-0 **AL<11:0>** Lower limit of analog threshold.

Note: ATCONH / ATCONL input range is 0 ~ 4095, with 0 corresponding to 0V and 4095 corresponding to 5V. (4095 is the maximum of a 12bits data).

8.8 Instruction List

The following table shows the instructions mentioned in this chapter, the detail of those instructions is descriped at the end of the document.

Instruction	Description	Page
SCFη;	Set sensor control configuration register η	78
SCF;	Check sensor control configuration register	79
SFB;	Check sensor status	80
STGη;	Set digital input sampling mode	83
STG;	Check digital input sampling mode	84
STO;	Store motion control parameters	85
STOη;	Bind motion control parameters to sensor edge	86

8.9 Example of S12CON Configuration

When configuring S12CON, user needs to first fill every bit of the S12CON according to the information provided in previous sections, and then affixes the suffix code 0000 (binary). An example is provided below.

System Description

A reciprocating mobile platform has one ON/OFF stroke limit sensor at each end. When the mobile table hit the sensor, a 0V presents.

Requirements:

1. As soon as one sensor S2 is hit, the stepper motor starts to run reversely until the table hits the other sensor S1.
2. As soon as S1 is hit, the stepper motor starts to run positively, until the table hits S2.

Realization:

1. First stop the motor by sending: **OFF;**
2. We are not interested in the rising edge of S2, so set S2RACT<3:0> = 0000
3. It is required Start and Run Reversely on S2 failing edge, so, set S2FACT<3:0> =0010
4. Same as 2, set S1RACT<3:0> = 0000
5. It is required Start and Run Forwardly on S1 failing edge, so, set S1FACT<3:0> =1010
6. Fill the S12CON with above bits, get: S12CON = 0000 0010 0000 1010 (binary)
7. Affix the suffix-code 0000 to S12CON, get:

   SCFG = 0000 0010 0000 1010 0000 (binary)=0x20A0 (hex)=8352 (decimal)
8. Send instruction:**SCFx 20A0;** or **SCF 8352;**
9. Set up desired speed, by sending instruction: **SPD 5000;**
10. Burn parameters into EEPROM, by sending: **STO;**
11. Press any one of the limit sensors, the mobile platform will work.
12. Disconnect the user device, and restart the UIM241 controller, the system will automatically run.

13. If enable auto-feedback, once the motor touches limit switch, user device will receive a feedback message of falling-edge on port S1/S2.

8.10 Example of ATCONH, ATCONL Configuration

Similar to S12CON configuration, user needs to first fill every bit of the ATCONH (ATCONL) according to the information provided in previous sections, and then affixes the suffix code 0011 (0010). An example is provided below.

System Description

A reciprocating mobile platform has one linear potentiometer attached to the mobile table. Within the stroke range, the potentiometer outputs 0.6V ~4V.

Requirements:

1. As soon as the sensor output is less than 0.6V, the stepper motor starts to run forward until the potentiometer outputs arrives 4V.
2. As soon as the sensor output is higher than 4V, the stepper motor starts to run backward until the potentiometer outputs reaches 0.6V.

Realization:

1. First stop the motor by sending:**OFF;**
2. Set MCFG<ANE>=1, MCFG<CHS> =0, MCFG<S1IE> =1, get:

   MCFG = 1000 0000 0000 0001 (binary) = 0x8001 (hex) = 32769 (decimal)
3. Send instruction: **MCF x8001;** or **MCF 32769;**
4. It is required Start and Run Forwardly on S1 falling edge (when analog input < 0.6V), therefore, S1FACT<3:0> =1010
5. It is required Start and Run Reversely on S1 rising edge (when analog input >4V), therefore, S1RACT<3:0> =0010
6. Fill the S12CON with above bits, get: S12CON = 0000 0000 0010 1010 (binary)
7. Add suffix-code 0000 (for S12CON), get:

   SCFG = 0000 0000 0010 1010 0000 (binary)= 0x2A0 (hex)= 672 (decimal)
8. Send instruction: **SCF x2A0;** or **SCF 672;**
9. Calculate the upper limit:(4V/5V)*4095 = 3276 = 0000 1100 1100 1100（binary）
10. Add suffix-code 0011 (for ATCONH), get:

    SCFG= 0000 1100 1100 1100 0011 (binary)= 0xCCC3 (hex)= 52419 (decimal)
11. Send instruction **SCF xCCC3;** or **SCF 52419;**
12. Calculate the lower limit:（0.6V/5V）*4095 = 491 (value is rounded)= 0000 0001 1110 1011 (binary)
13. Add suffix-code 0010 (for ATCONL), get:

    SCFG= 0000 0001 1110 1011 0010 (binary)= 0x1EB2 (hex)= 7858 (decimal)
14. Send instruction: **SCF x1EB2;** or **SCF 7858;**
15. Set desired speed, by sending instruction: **SPD 5000;**
16. Burn parameters into EEPROM, by sending: **STO;**
17. Send instruction: **ENA;**
18. The system starts to work continuously.
19. Disconnect the user device, and restart the UIM241 controller, the system will automatically run.

9.0 INSTRUCTION

This chapter describes the detail of the instructions mentioned in this document.

9.1 Instruction Structure

An instruction is a message sent from the user device to motion controller to command certain operatio. Instructions of UIM241 follow the rules listed below:

1. Length of an instruction (including the ending semicolon ";") should be within 20 characters
2. Coded with standard 7 bits ASCII code (1-127). Expended ASCII code is NOT accepted.
3. Instruction structure is as follow:

INS η ;

or **INSx η ;**

or **INS ;**

Where,

INS	**Instruction Symbol**	Comprises three letters with no space between them, and is not case sensitive. If there is an x (INSx), then it means the value is hexadecimal. Please note, if η is hexadecimal, then the data must have an even number of digits, such as 00, 01, 0A. A data has an odd number of digits will cause erroes, for example, 001, 10A are illegal input.
η	**Value**	Comprises set of numbers, with no other characters between them. Some instruction have no value, such as "SPD;" "STP;" etc.
;	**Terminator**	Each instruction must end with semicolon (;) Note: Instruction without terminator will cause unpredictable results.

9.2 Feedback Message Structure

Feedback Message is the message sent to user device from motion controller. The length of feedback message is not regular, maximum length is 13 bytes.

Structure of feedback message from UIM241XX is as follow:

[Header] [Controller ID] [Message ID] [Data] [Terminator]

Header

The start of a feedback message

There are 3 kinds of headers:

- AA represents the ACK message, which is a repeat of the received instruction.
- CC represents the status feedback, which is a description of current working status.
- EE represents the error message.

Controller ID

The identification number of current controller in a network (also known as Node ID)

For UIM 241, Node ID is always 00.

Message ID

The property of the current message

For example, CC 00 A0 FF, where A0 denotes that there is a low level on sensor 1. For details, please refer to following sections.

Data

Has a 7bits data structure. High is in front, and low is in the back.

In figure 9-1 and 9-2, examples are shown on how to convert a set of 7bits data into 16bit data and 32bit data.

Obviously, one 16bit data takes three 7bit data to represent, and one 32bit data takes five 7bit data.

Terminator

The end of a feedback message. UIM motion controller utilizes “FF” or “FE” as the terminator. If terminator is “FF”, it means there is no follow-up message; if terminator is “FE”, it means there has follow-up messages.

Note: there are two types of feedback that has NO message ID: ACK message and Motor Status feedback (controller’s response to FBK instruction). Other messages could have NO data, such as some real-time change notification messages.

Figure 9-1: Conversion from three 7bits message data to a 16bits data

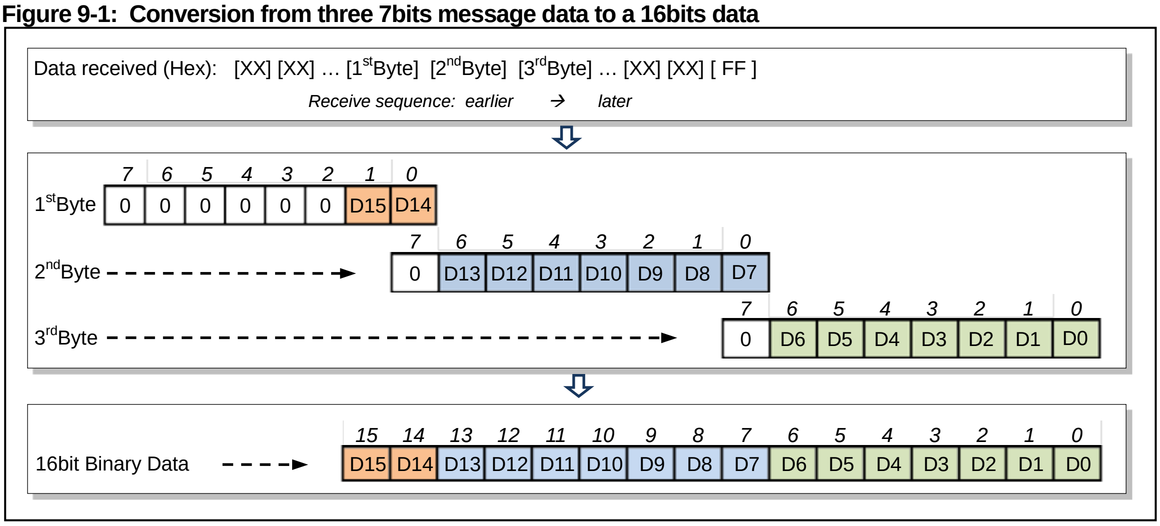
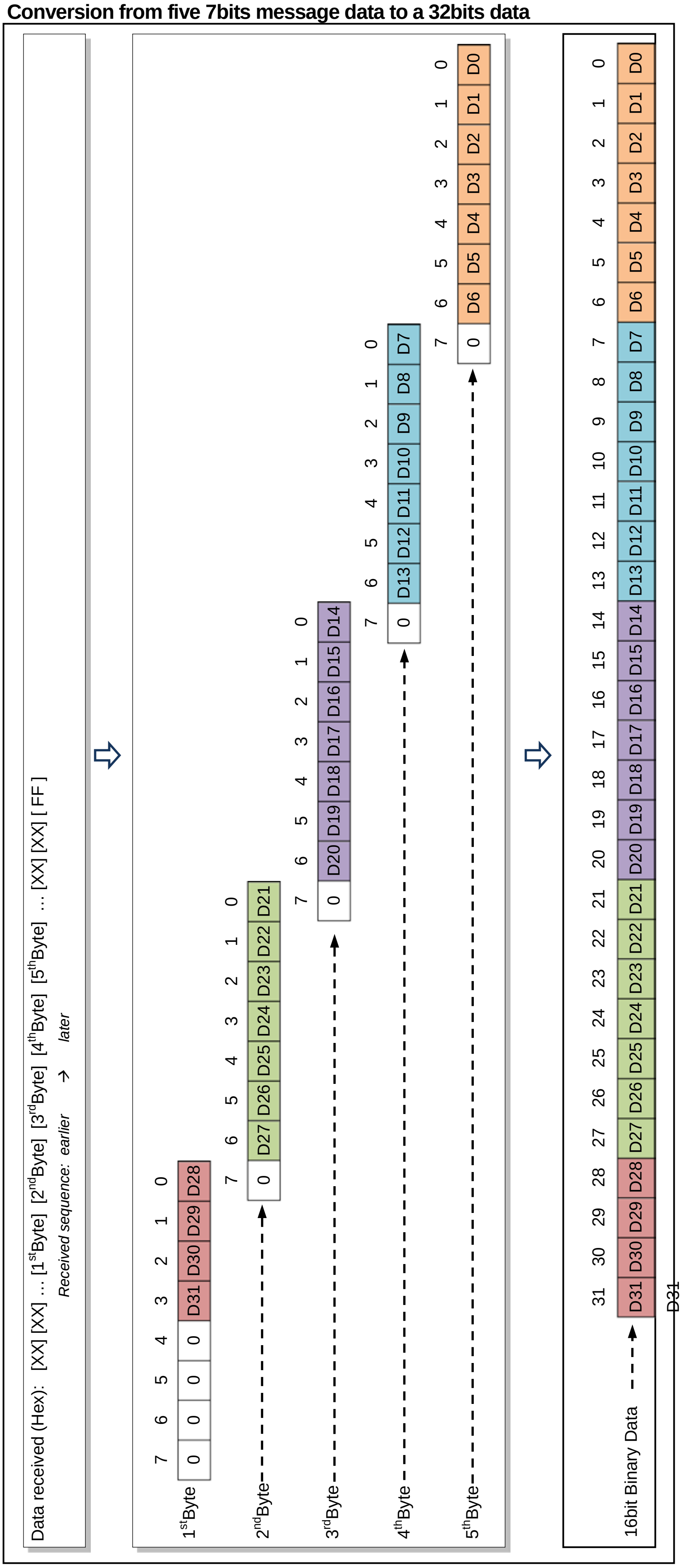


Figure 9-2: Conversion from five 7bits message data to a 32bits data



9.3 Instruction Description

This section describes the detail of the instructions mentioned in this document. (In the alphabetic order)

1. ; Check desired motor status

Format: ;

Description: Check desired motor status

ACK: AA 00 [ASB] [CUR] [V0] [V1] [V2] [P0] [P1] [P2] [P3] [P4] FF

Comment:
[ASB] >> Received data 0
[CUR] >> Received data 1
[V0] ~ [P4] >> Received data 2 ~ 9

[ASB] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1(0 = full step，15 = 1/16 step)			

[CUR] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

[V0] ~ [V2] is the converted value for desired speed (16 bits) (Figure 9-1)

[P0] ~ [P4] is the converted value for desired displacement (32 bits) (Figure 9-2)

2. ACRη Set auto-current reduction ratio

Format: ACRη;

Description: set auto-current reduction ratio η

η = 0,1,⋯,99.

η = 0, disable auto-current reduction. Standby-CUR = working current.

η = 1, in standeby mode, current reduces to 50%. Standby-CUR = working current / 2.

η = 2,3,⋯,99, in standeby mode, current reduces to 2,3,⋯,99%. Standby-CUR = working current * η / 100.

ACK: η = 0 or η = 1, ACK is the same as ACK of “6. ENA”

η = 2,3,⋯,99, ACK is as follow:

AA 00 BA [A0] FF

Comment: BA >> Message ID of instruction ACRη;

[A0] >> Received data 0，A0 = η

Note: ACR is short for Automatic Current Reduce.

When ACR is enabled, the current will be reduced after motor stop, which means a decrease of holding torque. Value of this instruction will be stored in EEPROM.

η = 2,3,⋯,99 require controller Firmware version being 1232 or higher.

3. ACR Check auto-current reduction ratio

Format: ACR;

Description: Check auto-current reduction ratio

ACK: AA 00 BA [A0] FF

Comment: Refer to ACK comment of instruction ACRη;

Note: Require controller Firmware version being 1232 or higher.

4. BDRη Set RS232 Baud Rate

Format: BDRη;

Description: Set RS232 Baud Rate

η = 9600, 19200, 38400, 56000, 100000, 115200, 250000;

Other value of baud rate is also available, but it must be integral multiple of 100.

ACK: AA [Reserved] BD FF

Comment:

[Reserved] >> Factory use;

BD >> Message ID of instruction BDR.

Note: The new baud rate will be stored in the controller's non-volatile memory (EEPROM). New baud rate will take effect after the controller is restarted.

5. BLCη Backlash compensation

Format: BLCη;

Description: Set value of backlash compensation in reciprocating motion

η = 0,1,⋯,65535 (Unsigned integer)

Units: pps (open-loop)

ACK: AA 00 DE [B0] [B1] [B2] FF

Comment:

DE >> Message ID of instruction BLCη;

[B0] ~ [B2] >> Received data 0 ~ 2

[B0] ~ [B2] is the converted value for the value of backlash compensation (16 bits) (Figure 9-1)

6. BLC Check backlash compensation

Format: BLC;

Description: Check the value of backlash compensation in reciprocating motion

ACK: AA 00 DE [B0] [B1] [B2] FF

Comment: Refer to ACK comment of instruction BLCη;

7. CURη Motor Current Adjusting

Format: CURη;

Description: Set the output phase current to η.

η = 0,1,⋯,80 (unsigned integer)

0…80 represent 0…8.0 amps.

ACK: AA 00 [ASB] [CUR] [V0] [V1] [V2] [P0] [P1] [P2] [P3] [P4] FF

Comment:

[ASB] >> Received data 0

[CUR] >> Received data 1

[V0] ~ [P4] >> Received data 2 ~ 9

[ASB] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1(0 = full step，15 = 1/16 step)			

[CUR] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

[V0] ~ [V2] is the converted value for desired speed (16 bits) (Figure 9-1)

[P0] ~ [P4] is the converted value for desired displacement (32 bits) (Figure 9-2)

Note: Value of this instruction will be stored in EEPROM.

If the received current value is not one of the above integers, an Error ACK will be sent to the user device through RS232. Incorrect instructions will be discarded without being executed.

8. ENA H-Bridge Enable

Format: ENA;

Description: Enable the stepper motor driver (i.e. H-bridge driving circuit).

ACK: AA 00 [ASB] [CUR] [V0] [V1] [V2] [P0] [P1] [P2] [P3] [P4] FF

Comment:
[ASB] >> Received data 0
[CUR] >> Received data 1
[V0] ~ [P4] >> Received data 2 ~ 9

[ASB] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1(0 = full step，15 = 1/16 step)			

[CUR] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

[V0] ~ [V2] is the converted value for desired speed (16 bits) (Figure 9-1)

[P0] ~ [P4] is the converted value for desired displacement (32 bits) (Figure 9-2)

Note: Only after the H-bridge enabled, can the controller drive the motor.

9. ENAη Set enable time

Format: ENAη;

Description: Set auto-enable time register ENAtimer.

Controller auto-enable the H-bridge circuit afer power is on for η ms.

η = 1,2,⋯,60000;

ACK: AA 00 A0 [E0] [E1] [E2] FF

Comment:

A0	>>	Message ID of instruction ENAη;
[E0] ~ [E2]	>>	Received data 0 ~ 2

[E0] ~ [E2] is the converted value for auto-ENA time (16 bits) (Figure 9-1), units: ms.

Note: This instruction sets ENAtimer only, can not enable controller.

In order to enable controller after pre-set time, user needs to configure initial configuration register by using instruction ICF after ENAtimer is set.

Require controller Firmware version being 1232 or higher.

10. ENAxFFFF Check enable time

Format: ENAxFFFF;

Description: Check auto-enable time

ACK: AA 00 A0 [E0] [E1] [E2] FF

Comment: Refer to ACK comment of instruction ENAη;.

Note: This instruction checks ENAtimer only, can not enable controller.
Require controller Firmware version being 1232 or higher.

11. FBK Motor Status Feedback Inquiry

Format: FBK;

Description: Check the current motor status

ACK: AA 00 [ASB] [CUR] [V0] [V1] [V2] [P0] [P1] [P2] [P3] [P4] FF

Comment:

[ASB] >> Received data 0

[CUR] >> Received data 1

[V0] ~ [P4] >> Received data 2 ~ 9

Structure of [ASB] is as follow:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Defination	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1（0 = full step,15 = 1/16 step)			

Structure of [CUR] is as follow:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Defination	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

[V0] ~ [V2] is the converted value for the current motor speed. (16 bits) (Figure 9-1)

[P0] ~ [P4] is the converted value for the current motor displacement. (32 bits) (Figure 9-2)

Note: User can get current motor status by using this instruction at any time.

Please note: current status is different from desired status.

12. ICFxη Initial Configuration Register Instruction

Format: ICFxη;

Description: Configure the initial configuration register (InitCFG)

Parameter η has two bytes, structure is as follow:

Byte	*0*	*1*
Defination	D0	D1

Where,

[D1 D0] compose a hexadecimal 16bit data. D1 is high, D0 is low.

Example:

Initial Configuration = 0x1234;

Then send instruction: ICFx 34 12;

ACK: AA 00 DA [C0] [C1] [C2] FF

Comment:

DA >> Message ID of instruction ICFxη;

[C0] ~ [C2] >> Received data 0 ~ 2

[C0] ~ [C2] is the converted value for the value of initial configuration register (16 bits) (Figure 9-1)

Note: Require controller Firmware version being 1232 or higher.

13. ICF Check Initial Configuration Register

Format: ICF;

Description: Check initial configuration register

ACK: AA 00 DA [C0] [C1] [C2] FF

Comment: Refer to ACK comment of ICFxη;

Note: Require controller Firmware version being 1232 or higher.

14. MACη Set Acceleration Rate

Format: MACη;

Description: Set the acceleration rate to η.

η = 1、2 … 65,000,000; (Pre-requiring MCFG<AM> = 0, value mode)

η = 1、2 … 60,000; (Pre-requiring MCFG<AM> = 1, period mode)

ACK: AA 00 B1 [FG] [A0] [A1] [A2] [A3] [A4] FF

Comment:

B1 >> The message ID of MACη;

[FG] >> Equal to the AM bit of the MCFG

Denote the input mode (value / period):

FG =1, unit: ms;

FG =0, unit: pps/s;

[A0] ~ [A4] >> Received data 0 ~ 4

[A0] ~ [A4] is the converted value for the value of the acceleration rate (32 bits) (Figure 9-2).

15. MAC Check Current Acceleration Rate

Format: MAC;

Description: Check current acceleration rate

ACK: AA 00 B1 [FG] [A0] [A1] [A2] [A3] [A4] FF

Comment: Refer to ACK comment of MACη;.

16. MCFη / MCFxη Master Configuration Register Instruction

Format: MCFη; or MCFxη;

Description: Setup Master Configuration Register

1）If η is decimal,

Use format: MCFη;

Where, η = 0,1,…65535 (16 bits unsigned integer)

2）If η is hexadecimal,

Use format MCFxη;

Where, η has 2 bytes, and the structure is as follow:

Byte	*0*	*1*
Defination	D0	D1

Where,

[D1 D0] compose a hexadecimal 16bit data, D1 is high, D0 is low.

For example:

Master Configuration = 0x1234;

Then send instruction MCFx 34 12;

Each Byte must have an even number of digits or letters.

ACK: AA 00 B0 [C0] [C1] [C2] FF

Comment:

B0 >> The Message ID of MCFη;

[C0] ~ [C2] >> Received data 0 ~ 2

[C0] ~ [C2] is the converted value for the value of master configuration register. (16 bits) (Figure 9-1)

Note: If η using decimal, first convert the 16 bits binary number to a decimal based number.

Example:

Instruction : MCF34611; or MCFx8733;

ACK: AA 05 B0 02 0E 33 FF

Comment: Convert 02 0E 33 to 16 bits (2Bytes) data, get:

0x8733 (34611 decimal).Here assume, Controller ID=5.

17. MCF Check Master Configuration Register

Format: MCF;

Description: Check the value of the Master Configuration Register

ACK: AA 00 B0 [C0] [C1] [C2] FF

Comment: Refer to ACK comment of MCFη;

18. MCSη Setup Micro Stepping

Format: MCSη;

Description: Set micro-stepping resolution.

η = 1,2,4,8,16 (unsigned integer);

η = 1, 2, 4, 8, 16 represents the full, half, quarter, eighth and sixteenth step resolution, respectively.

ACK: AA 00 [ASB] [CUR] [V0] [V1] [V2] [P0] [P1] [P2] [P3] [P4] FF

Comment:

[ASB] >> Received data 0

[CUR] >> Received data 1

[V0] ~ [P4] >> Received data 2 ~ 9

[ASB] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1(0 = full step，15 = 1/16 step)			

[CUR] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

[V0] ~ [V2] is the converted value for desired speed (16 bits) (Figure 9-1)

[P0] ~ [P4] is the converted value for desired displacement (32 bits) (Figure 9-2)

Note: Real-time update micro-stepping. MCS is short forMicrostepping.

Once received, the MCS value will be stored in the controller’s EEPROM.

19. MDEη Set Deceleration Rate

Format: MDEη;

Description: Set the deceleration rate to η.

η = 1、2 … 65,000,000;(Pre-requiring MCFG<DM> = 0, value mode)

η = 1、2 … 60,000; (Pre-requiring MCFG<DM> = 1, period mode)

ACK: AA 00 B2 [FG] [D0] [D1] [D2] [D3] [D4] FF

Comment:

B2 >> The message ID of MDEη;

[FG] >> Equal to the DM bit of the MCFG 的 DM

Denote the input mode (value / period):

FG =1, unit: ms;

FG =0, unit: pps/s;

[D0] ~ [D4] >> Received data 0 ~ 4

[D0] ~ [D4] is the converted value for the value of the deceleration rate (32 bits) (Figure 9-2).

20. MDE Check Current Deceleration Rate

Format: MDE;

Description: Check current deceleration rate

ACK: AA 00 B2 [FG] [D0] [D1] [D2] [D3] [D4] FF

Comment: Refer to ACK comment of MDEη;.

21. MDL Check Controller Model

Format: MDL;

Description: Check the Model, installed optional modules and firmware version of current controller.

ACK: CC 00 DE 18 02 [CUR] [asb] [V0] [V1] [V2] FF

Note: [ ] denotes one byte, the data is hexadecimal.

Comment:

DE	>>	Message ID of instruction MDL;
[CUR]	>>	The Max phase current. e.g., “20” means 2.0 A.
[asb]	>>	The installed optional modules and sensor ports.
[V0] ~ [V2]	>>	Received data 0 ~ 2

[V0] ~ [V2] is the converted value for the firmware version (12 bits) (Figure 9-1).

Structure of [asb] is as follow:

Bit	*7*	*6*	*5*	*4*	*3 2 1 0*
Defination	0	Int. QE	Closed-loop	Adv. Motion	No. of sensor port

For example, if bit 4 is 1, the Advanced Motion Control module is installed.

22. MMDη Set Maximum Cessation Speed

Format: MMDη;

Description: Set the maximum cessation speed at η.

η = 1、2 … 65,000,000; (unsigned integer)

ACK: AA 00 B4 [M0] [M1] [M2] FF

COMMENT:

B4 >> The message ID of MMDη;

[M0] ~ [M2] >> Received data 0 ~ 2

[M0] ~ [M2] is the converted value for the value of maximum cessation speed. (16 bits) (Figure 9-1).

Unit: pps (pulse/second)

23. MMD Check current Maximum Cessation Speed

Format: MMD;

Description: Check the maximum cessation speed

ACK: AA 00 B4 [M0] [M1] [M2] FF

Comment: Refer to ACK comment of MMDη;.

24. MMSη Set Maximum Starting Speed

Format: MMSη;

Description: Set the maximum starting speed at η.

η = 1、2 … 65,000,000; (unsigned integer)

ACK: AA 00 B3 [M0] [M1] [M2] FF

Comment:

B3 >> The message ID of MMSη;

[M0] ~ [M2] >> Received data 0 ~ 2

[M0] ~ [M2] is the converted value for the value of maximum starting speed. (16 bits) (Figure 9-1).

Unit: pps (pluse/second).

25. MMS Check current Maximum Starting Speed

Format: MMS;

Description: Check the maximum starting speed

ACK: AA 00 B3 [M0] [M1] [M2] FF

Comment: Refer to ACK comment of MMSη;

26. OFF H- Bridge Disable

Format: OFF;

Description: Disable the stepper motor driver (i.e. H-bridge driving circuit).

ACK: AA 00 [ASB] [CUR] [V0] [V1] [V2] [P0] [P1] [P2] [P3] [P4] FF

Comment:

[ASB] >> Received data 0

[CUR] >> Received data 1

[V0] ~ [P4] >> Received data 2 ~ 9

[ASB] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	ACR	ENA / OFF	DIR	MCS – 1(0 = full step，15 = 1/16 step)			

[CUR] structure:

Bit	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
Value	N/A(=0)	Phase Current (e.g. 27 = 2.7 Amp)						

[V0] ~ [V2] is the converted value for desired speed (16 bits) (Figure 9-1)

[P0] ~ [P4] is the converted value for desired displacement (32 bits) (Figure 9-2)

Note: Turns off the dual H-bridge motor driving circuit.

Once controller is OFF, most devices of controller (including MOSFET) are turn off, the motor is free, and the logical circuit can work.

27. ORG Reset Position Counter

Format: ORG;

Description: Reset the position/encoder counter to zero (0), is equivalent to instruction ORG=0;

ACK: AA 00 B7 [P0] [P1] [P2] [P3] [P4] FF

Comment: Please refer to “29. POS;”.

28. ORGη Reset Position Counter

Format: ORGη;

Description: Reset the position/encoder counter to a given value η.

η = - 2147483647 ~ + 2147483647 (signed integer)

η = 0, reset the position/encoder counter to zero (0)

η ≠ 0, reset the position/encoder counter to a given value η

ACK: AA 00 B7 [P0] [P1] [P2] [P3] [P4] FF

Comment: Please refer to “29. POS;”.

29. POSη Position Control

Format: POSη;

Description: Set desired position (for open-loop control)

η = - 2147483647 ~ + 2147483647 (signed integer)

ACK: AA 00 B7 [P0] [P1] [P2] [P3] [P4] FF

Comment:

B7	>> The message ID of desired position
[P0] ~ [P4]	>> Received data 0 ~ 4

[P0] ~ [P4] is the converted value for the desired absolute position (32 bits) (Figure10-2)

Note: Position is essentially recorded from counts of the pulse counter.

The position counter records the total pulses sent to motor. When the direction is positive, the counter increases by 1; when the direction is negative, the counter decreases by 1. When ICFG.CW = 0, consider clockwise as forword direction; when ICFG.CW = 1, consider anticlockwise as forword direction.

The absolute position counter only resets (back to zero) in two situations:

User issues the instruction ORG

User pre-configured sensor ORG event takes place.

User needs pay attention to the two notes list below:

Power Failure Protection: Should a Power Failure situation happen, the value of the pulse counter will be pushed into EEPROM and restored when reboot next time. However, passive movement after power off cannot be recorded.

The actual motor position is also relative to the micro-stepping resolution.

30. POS Check Current Position

Format: POS;

Description: Check the value of current Firmware absolute pulse counter, i.e. current absolute position of the motor.

ACK: CC 00 B0 [P0] [P1] [P2] [P3] [P4] FF

Comment:

B0 >> The message ID of current position

[P0] ~ [P4] >> Received data 0 ~ 4

[P0] ~ [P4] is the converted value for the desired absolute position (32 bits) (Figure 9-2)

This position is relative to origin / zero position of couter.

31. SCFη / SCFxη Set Sensor Configuration

Format: SCFη; or SCFxη;

Description: Configure S12CON、ATCONH and ATCONL.

1） When η is decimal:

Instruction type is SCFη;

Where, η = 0,1 … 1048575 (24 bits unsigned integer)

2） When η is hexadecimal:

Instruction is SCFxη;

Where η has 3 bytes, the structure is as follow:

Byte	*0*	*1*	*2*
Defination	D0	D1	IDX

Where,

[D1 D0] compose a hexadecimal 16bit data, D1 is high, D0 is low.

IDX = 0,1,2,3 denotes configuration of S12CON, ATCONH and ATCONL separately.

Example:

Set S12CON as 0x1234;

Then send instruction SCFx 34 12 00; (00 is suffix)

Each Byte must have an even number of digits or letters.

ACK: AA 00 C0 [S0] [S1] [S2] [AL0] [AL1] [AH0] [AH1] FF

Comment:

C0	>>	The message ID of SCFη;
[S0] ~ [S2]	>>	Received data 0 ~ 2
[AL0] ~ [AL1]	>>	Received data 3 ~ 4
[AH0] ~ [AH1]	>>	Received data 5 ~ 6

[S0] ~ [S2] is the converted value for [S12CON] (16 bits) (Figure 9-1),

[AL0] [AL1] is the converted value for lower limit of analog threshold ATCONL (12 bits) (Figure 9-1)

[AH0] [AH1] is the converted value for upper limit of analog threshold ATCONH (12 bits) (Figure 9-1)

Note: The suffix-code for S12CON is 00 (hexadecimal)

The suffix-code for ATCONH is 02 (hexadecimal)

The suffix-code for ATCONL is 03 (hexadecimal)

32. SCF Check the value of Sensor Configuration

Format: SCF;

Description: Check the current value of S12CON\ATCONH and ATCONL

ACK: AA 00 C0 [S0] [S1] [S2] [AL0] [AL1] [AH0] [AH1] FF

Comment: Refer to ACK comment of SCFη;

33. SFB Check Sensor Data

Format: SFB;

Description: Check sensor readings and status

ACK: CC 00 C1 [D1] [D2] [AN0] [AN1] FF

Comment:

C1	>>	The message ID of SFB;
[D1] ~ [D2]	>>	Received data 1 ~ 2
[AN0] ~ [AN1]	>>	Received data 3 ~ 4

[D1] ~ [D2] represent the logic level of S1, S2 respectively (0/1).

[AN0] [AN1] is the converted value for analog input (12 bits). (Figure 9-1)

AN1 and AN0 are 0 if no analog input port is configured.

Note: This instruction can be used for sensor data inquiry at any time and under any condition.

34. SPDη Speed Adjusting

Format: SPDη;

Description: Set the desired speed to η.

η = - 65535…-1, 0, 1 … + 65535; (signed integer)

ACK: AA 00 B5 [V0] [V1] [V2] FF

Comment:

B5 >> The message ID for desired speed

[V0] ~ [V2] >> Received data 0 ~ 2

[V0] ~ [V2] is the converted value for the value of desired speed. (16 bits) (Figure 9-1)

Unit: Pluse/ Second,PPS or Hz.

The sign of speed decides direction. If no "+" or "-" specified before "x", it is taken as "+".

Note: Once H-bridge is enabled, motor starts running on receiving the instruction SPDη (η≠0) until another instruction "SPD0;" is given.

Example: For a 1.8° stepper motor, if the SPD =100;

User sent: SPD100;

If MCS=1, motor speed = 1.8 * 100 = 180°/sec = 30 rpm

If MCS=16, motr speed = 1.8 * 100 / 16 = 11.25°/sec = 1.875 rpm

35. SPD Check Current Speed

Format: SPD;

Description: Check current speed

ACK: CC 00 B2 [V0] [V1] [V2] FF

Comment:

B2 >> The message ID of current speed

[V0] ~ [V2] >> Received data 0 ~ 2

[V0] ~ [V2] is the converted value for the value of desired speed. (16 bits) (Figure 9-1)

Unit: Pluse/ Second,PPS or Hz.

The sign of speed decides direction. If no “+” or “-” specified before “x”, it is taken as “+”.

36. STGxη Set Digital Input Sampling Mode

Format: STGxη;

Description: Set sampling mode of digital input: continnous, intermittent and single sampling.

Structure of η:

Byte	*0*	*1*	*2*
Defination	D0	D1	IDX

Where,

[D1 D0] compose a hexadecimal 16bit data, D1 is high, D0 is low.

IDX = 00,01 (hexadecimal) denotes configurating sensor 1,2;

[D1 D0] = 0000,0001,0002,⋯,EA60 denotes that the sensor will not be triggered until 0,1,2,⋯,60000ms after last sampling. This can eliminate the shake of sensor signal.

[D1 D0] > EA60, denotes signle sampling, once triggered, the S12CON must be configurated again.

ACK: AA 00 C9 [S0] [S1] [S2] [S3] [S4] [S5] FF

Comment:

C9 >> Message ID of instruction STGxη;

[S0] ~ [S5] >> Received data 0 ~ 5

[S0] ~ [S2] is the converted value for sampling mode of sensor 1 (16 bits) (Figure 9-1)

[S3] ~ [S5] is the converted value for sampling mode of sensor 2 (16 bits)

Example: Requirements:

1） Sensor 1;

2） Intermittent mode, interval is 200ms.

Then:

1） IDX = 00 (hexadecimal)

2） [D1 D0] = 200 (decimal) = 00C8 (hexadecimal),

So, D0 = C8, D1=00; (hexadecimal)

3） Then send instruction STGx C8 00 00;

37. STG Check Digital Input Sampling Mode

Format: STG;

Description: Check digital input sampling mode of S1, S2

ACK: AA 00 C9 [S0] [S1] [S2] [S3] [S4] [S5] FF

Comment: Refer to ACK comment of instruction STGxη;

38. STO EEPROM Store

Format: STO;

Description: Banding motion parameters to motions (Triggered by sensor edge or controllered by instruction)

Motion parameters include:

1） Acceleration

2） Deceleration

3） Max. starting speed

4） Max. cessation speed

For sensor, there also has:

5） Speed

6） Displacement

ACK: AA 00 D1 FF

Comment: D1 >> The message ID of STO;

Note: This instruction will affect real time performance.

It takes around 20 ms for the instruction to be executed. It is recommended that sending this instruction when the motor is idle, and wait 20ms before sending other instructions.

39. STOη Parameter Banding

Format: STOη;

Description: Banding motion parameters to motions (Triggered by sensor edge or controllered by instruction)

η = 0,1,⋯,5

η = 0, >> Montion controlled by instrcution

η = 1, >> Only for close-loop

η = 2, >> Motion triggered by rising edge of S1

η = 3, >> Motion triggered by falling edge of S1

η = 4, >> Motion triggered by rising edge of S2

η = 5, >> Motion triggered by falling edge of S2

ACK: AA 00 D1 FF

Comment: D1 >> Message ID of instruction STO;

Note: Require controller Firmware version being 1232 or higher.

This instruction will affect real time performance. It takes around 15 ms for the instruction to be executed. It is recommended that sending this instruction when the motor is idle, and wait 20ms before sending other instructions. Before set parameters, disable the controller first.

Default setting for STO0: 300/300/0/0/0/0, it can be configurated by instruction.

Parameters for each edge can be different. Not all parameters are needed; the non-value parameter will be assigned as the value of parameters for STO0

Example: Disable the controller: OFF;

Set 1st group of parameters: SPDη; STPη; MACη; MDEη; MMSη; MMDη;

Banding it to rising edge of S1: STO2;

……

Set 4th group of parameters: SPDη; STPη; MACη; MDEη; MMSη; MMDη;

Banding it to falling edge of S2: STO5;

40. STPη Displacement Control

Format: STPη;

Description: Set the desired incremental displacement, i.e. the displacement relative to current position

η = - 2,000,000,000…-1, 0, 1 … + 2,000,000,000; (signed integer)

ACK: AA 00 B6 [P0] [P1] [P2] [P3] [P4] FF

Comment:

B6 >> The message ID of STPη;

[P0] ~ [P4] >> Received data 0 ~ 4

[P0] ~ [P4] is the converted value for the desired motor displacement (32 bits) (Figure 9-2)

Note: Displacement is essentially defined as counts of the pulse or encoder counter.

Actual pulse sended to motor is controlled by displacement counter. The actual motor displacement is also relative to the micro-stepping resolution or encoder resolution.

If an STP0; instruction is received before the former STP instruction is completed, UIM241 will execute the current instruction and stop motor. The former STP instruction is regarded as being completed. Meanwhile, system will shift from PT mode to VT mode.

If an STP instruction is received while the motor is already running, the former steps will not be counted in the displacement of current STP instruction.

Example: For a 1.8° stepper motor, if STP = 200 pulse;

User sent: STP200;

If MCS=1, motor rotation angle = 1.8 * 200 = 360°

If MCS=16, motor rotation angle = 1.8 * 200 / 16 = 22.5°

41. STP Check Displacement

Format: STP;

Description: Check current incremental displacement.

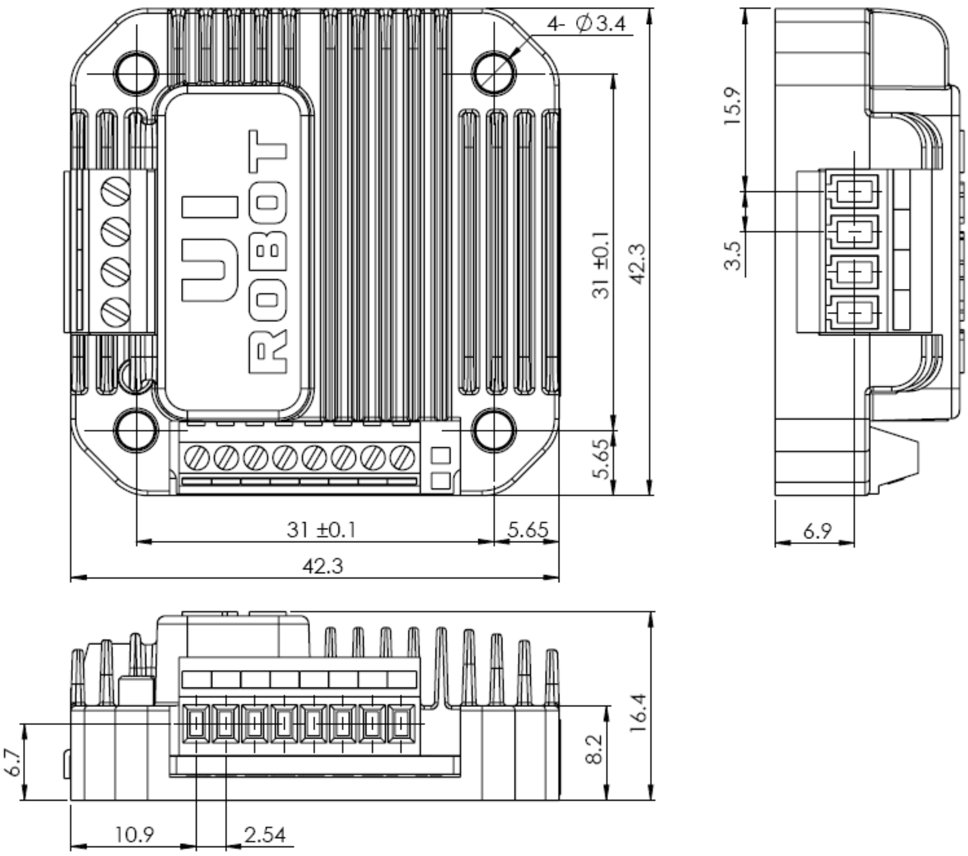
ACK: CC 00 B3 [P0] [P1] [P2] [P3] [P4] FF

Comment:

B3	>> The message ID of current incremental displacement
[P0] ~ [P4]	>> Received data 0 ~ 4

[P0] ~ [P4] is the converted value for the current incremental displacement (32 bits) (Figure 9-2)

APPENDIX A DIMENSIONS

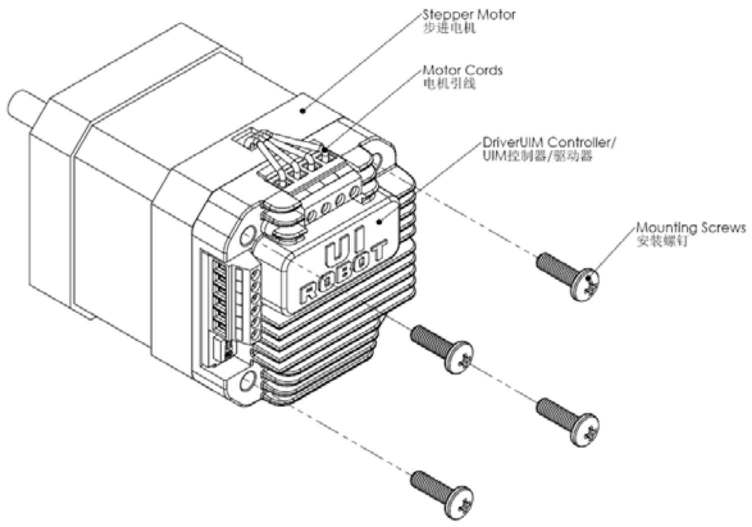


Units: mm

APPENDIX B INSTALLATION INSTRUCTION

NEMA 17 (do not need flange)

1. Fix the UIM controller on motor with screw (2 or 4)
2. Connect the motor pin to motor terminal of UIM controller



NEMA 23/34/42 (need flange)

1. Fix flange on motor
2. Fix the UIM controller on flange with screw
3. Connect the motor pin to motor terminal of UIM controller