Cc-Smart Technology Co., Ltd

User's Manual

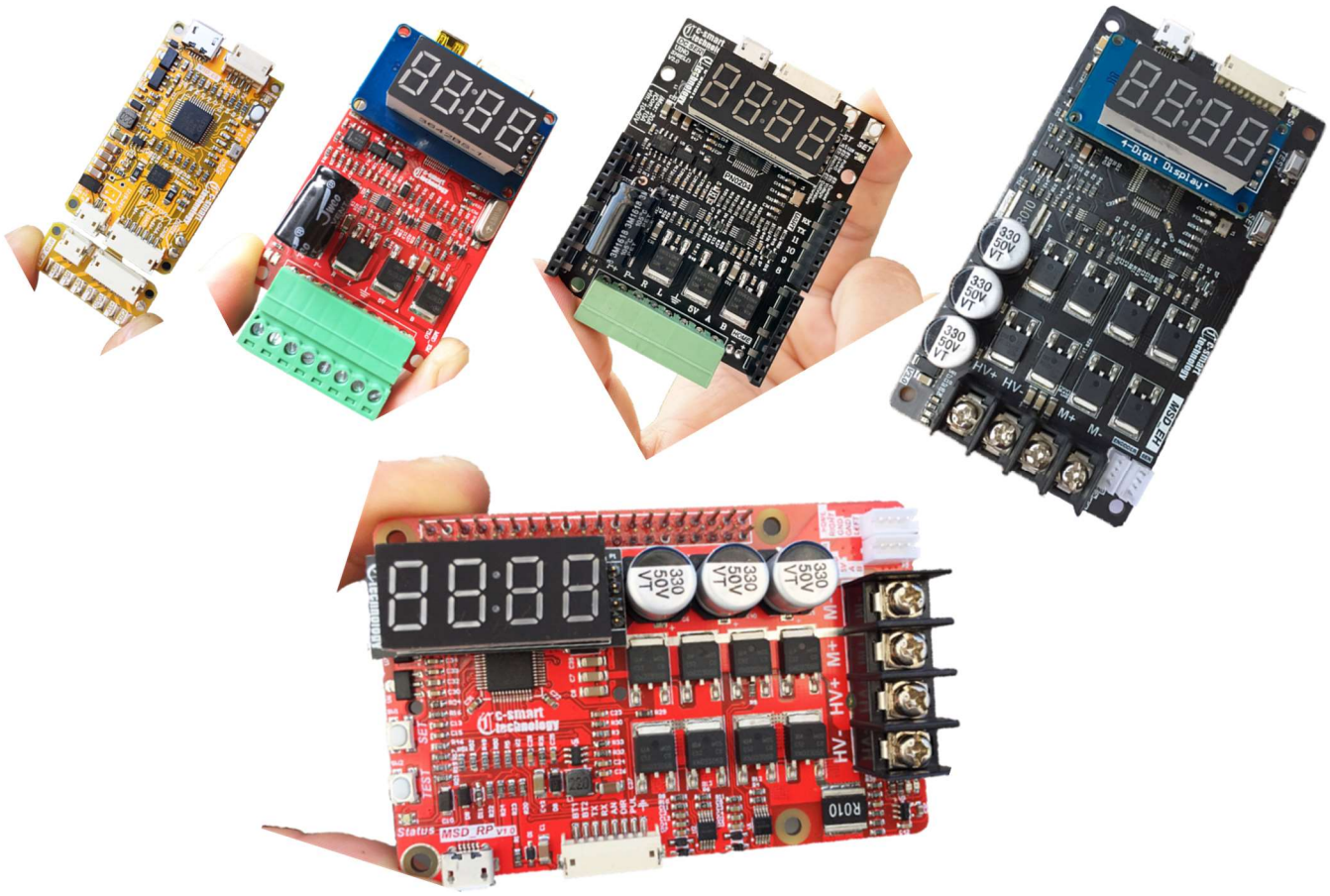
For

MSD_XX

Digital Multi Servo Driver

Revision 3.0

Attention: Please read this manual carefully before using the driver!



Cc-Smart Technology Co., Ltd

1419/125 Le Van Luong, Phuoc Kien Commune, Nha Be District, Ho Chi Minh City, Viet Nam.

Tel: +84983029530 Fax: No

URL: www.cc-smart.net E-mail: ccsmart.net@gmail.com

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1. Introuduction, Features and Applications

Introduction

The motion is very important and popular today. They appear in all most areas. Special the motor, that is a big part of this fill.

There are many Dc Servo Drivers in the market but they are very special (not open), more expensive, so big...

Our driver is very small, low cost, friendlier and open. The driver has an Auto Turning Tool which auto-detect motor information.

There are many communication methods Pulse/Dir, Uart Network, Virtual Com Port, Usb.

There is software that can configure, control, simulate, visual.

Features

- ✓ 7 Segment Indicator (not include MSD_E3).
- ✓ 10-28/40VDC, 0-10A/20A, 1-300/800W (depend on MSD_XX).
- ✓ Position, Velocity, Acceleration Control.
- ✓ Auto Turning Tool Support.
- ✓ Follow Over Protect, Encoder, Motor Fail Protect.
- ✓ Over Current, Over Temperature, Short Circuit Protected.
- ✓ Support USB Communicate with DcTurningPro Software.
- ✓ Support Virtual Com Port to communicate with users.
- ✓ Communication: Pulse/Dir, UART, USB, Analog (Velocity Mode).
- ✓ Close Loop Support: Smart PID, PID, PI, State Feedback.
- ✓ H-Bridge mode with over current, temperature...protect.

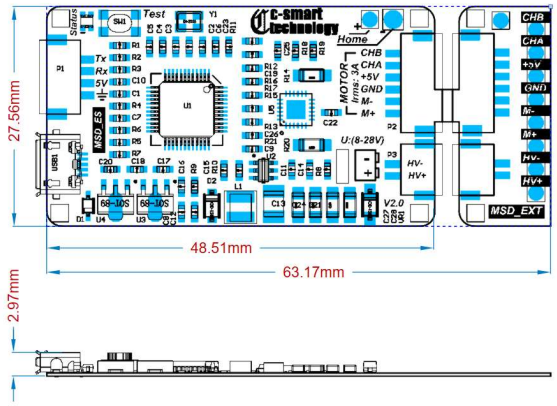
Applications

- ✓ Car, Toy…
- ✓ Robot…
- ✓ CNC…

2. Specification and Operating Enviroment

Mechaniccal Specification

MSD_E3:



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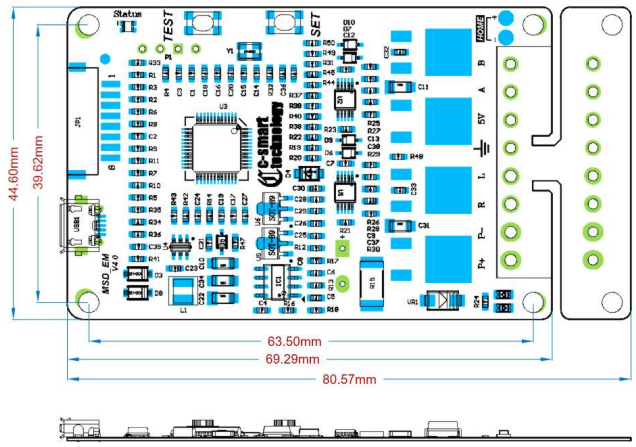

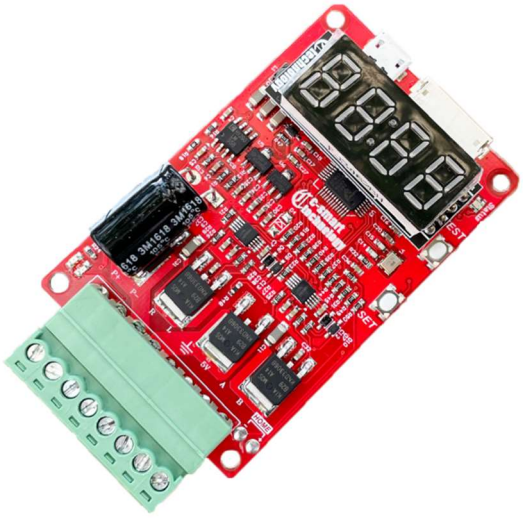

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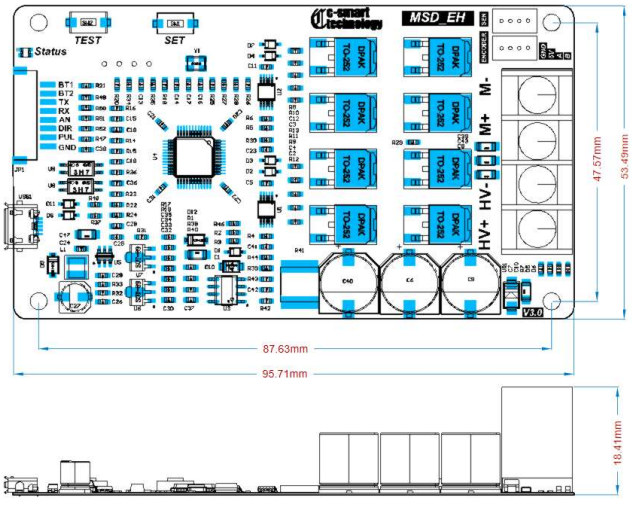

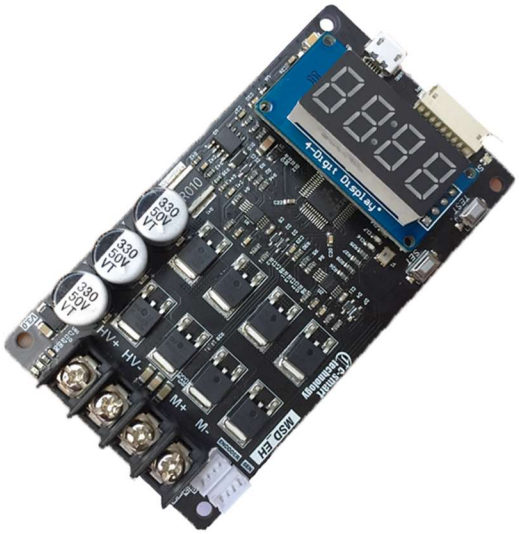

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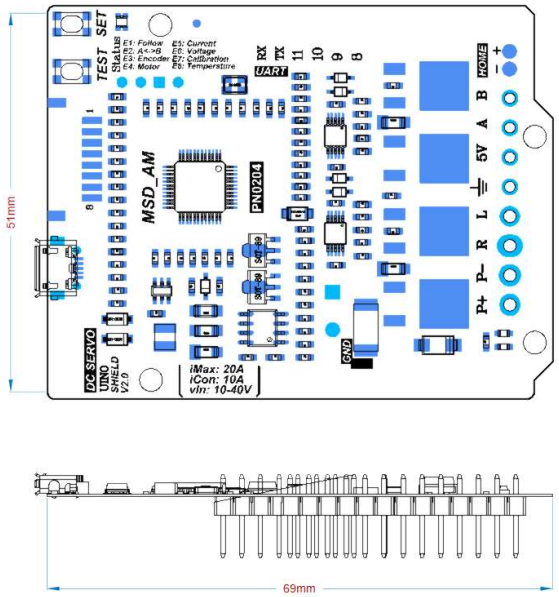
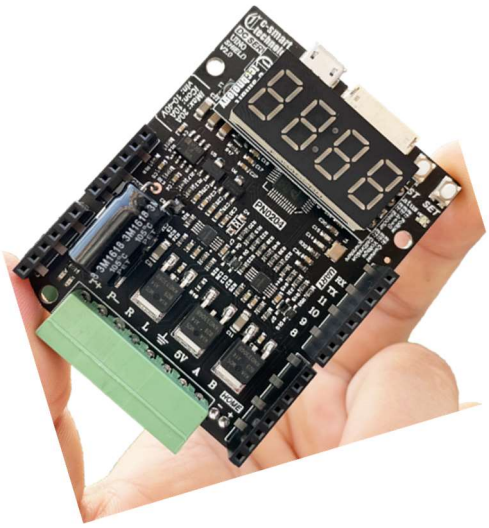
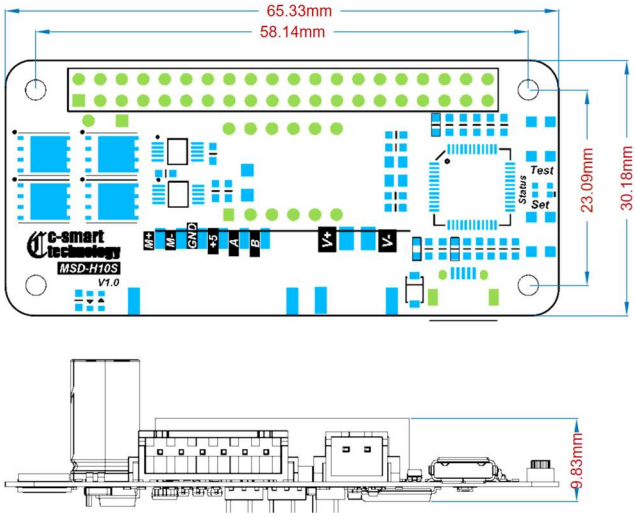
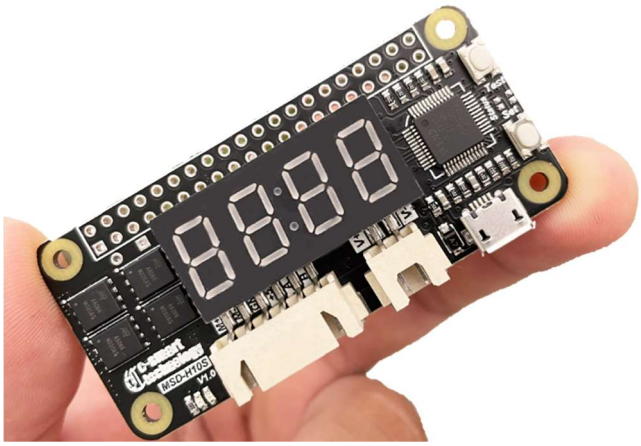




MSD_H10 (Raspberry Pi0):





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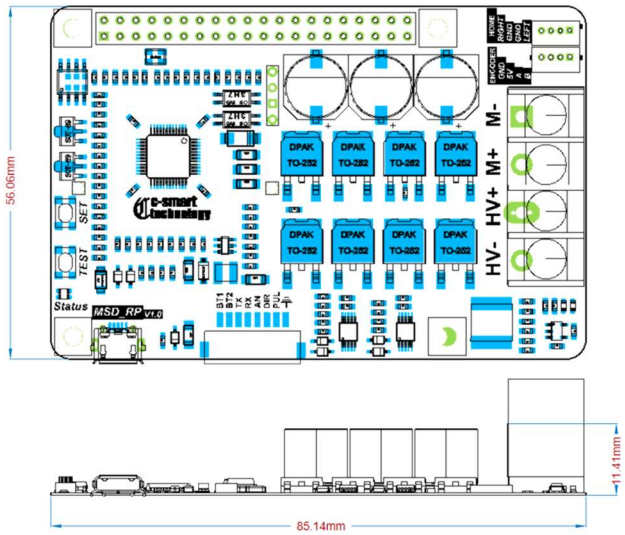
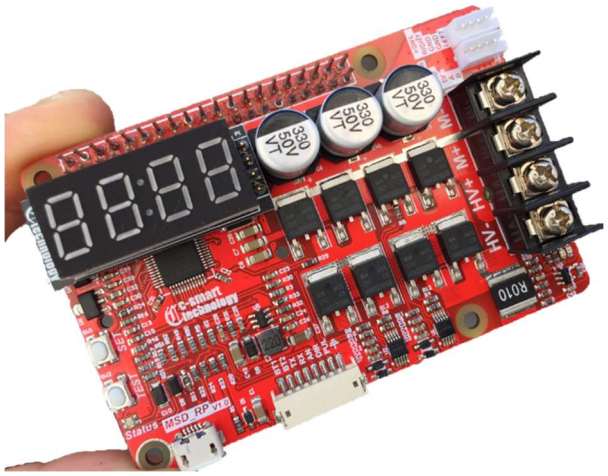




Electrical Specifications (Tj = 25°C /77°F)

Parameters	MSD_E3			
	Min.	Typical	Max.	Unit
Peak Output Current	0	-	4	A
Continuous Output Current(*)	0	-	3	A
Power Supply Voltage	+8	-	+30	VDC
V_{IOH} (Logic Input – High Level)	2	-	5	V
V_{IOL} (Logic Input – Low Level)	0	-	0.8	V
+5V Output Current	-	-	250	mA
Analog Pin (AN)	0	-	5	V

Parameters	MSD_E10			
	Min.	Typical	Max.	Unit
Peak Output Current	0	-	30	A
Continuous Output Current(*)	0	-	10	A
Power Supply Voltage	+8	-	+38	VDC
V_{IOH} (Logic Input – High Level)	2	-	5	V
V_{IOL} (Logic Input – Low Level)	0	-	0.8	V
+5V Output Current	-	-	250	mA
Analog Pin (AN)	0	-	5	V

Parameters	MSD_E20			
	Min.	Typical	Max.	Unit
Peak Output Current	0	-	50	A
Continuous Output Current(*)	0	-	20	A
Power Supply Voltage	+8	-	+40	VDC
V_{IOH} (Logic Input – High Level)	2	-	5	V
V_{IOL} (Logic Input – Low Level)	0	-	0.8	V
+5V Output Current	-	-	250	mA
Analog Pin (AN)	0	-	5	V

Parameters	MSD_A10			
	Min.	Typical	Max.	Unit
Peak Output Current	0	-	30	A
Continuous Output Current(*)	0	-	10	A
Power Supply Voltage	+8	-	+40	VDC
V_{IOH} (Logic Input – High Level)	2	-	5	V
V_{IOL} (Logic Input – Low Level)	0	-	0.8	V
+5V Output Current	-	-	250	mA
Analog Pin (AN)	0	-	5	V

Parameters	MSD_H10			
	Min.	Typical	Max.	Unit
Peak Output Current	0	-	30	A
Continuous Output Current(*)	0	-	10	A
Power Supply Voltage	+8	-	+32	VDC
V_{IOH} (Logic Input – High Level)	2	-	5	V
V_{IOL} (Logic Input – Low Level)	0	-	0.8	V
+5V Output Current	-	-	250	mA
Analog Pin (AN)	0	-	5	V

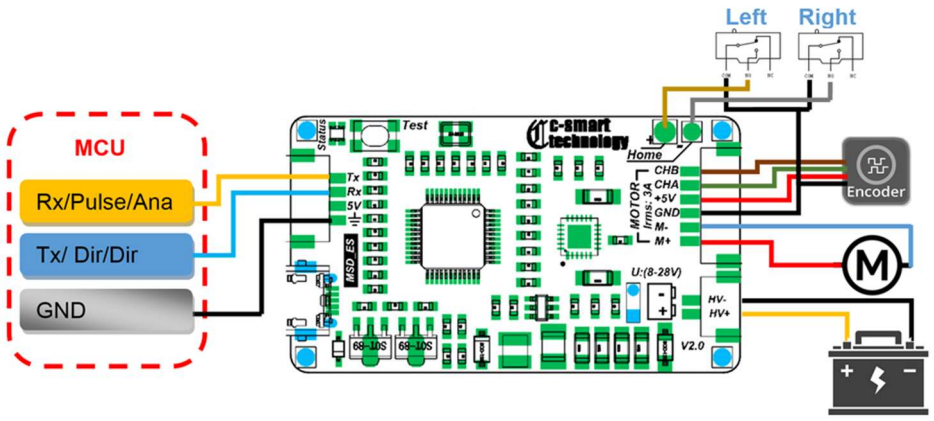
Parameters	MSD_H20			
	Min.	Typical	Max.	Unit
Peak Output Current	0	-	50	A
Continuous Output Current(*)	0	-	20	A
Power Supply Voltage	+8	-	+40	VDC
V_{IOH} (Logic Input – High Level)	2	-	5	V
V_{IOL} (Logic Input – Low Level)	0	-	0.8	V
+5V Output Current	-	-	250	mA
Analog Pin (AN)	0	-	5	V

Operating Environment and Parameters

Cooling	Natural cooling or forced cooling	
Operating Environment	Environment	Avoid dust, oil fog and corrosive gases
	Ambient Temperature	0℃—50℃ (32℉— 122℉)
	Humidity	40%RH— 90%RH
	Vibration	5.9 m/s2 Max
Storage Temperature	-20℃ — 65℃ (-4℉ — 149℉)	
Weight	Approx. 50 grams	

3. Connections Overview:

MSD_E3:



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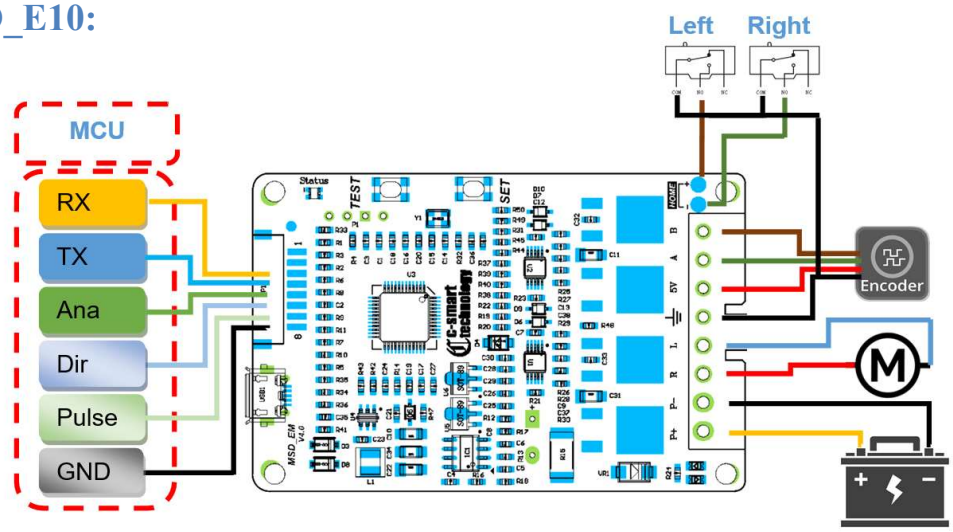

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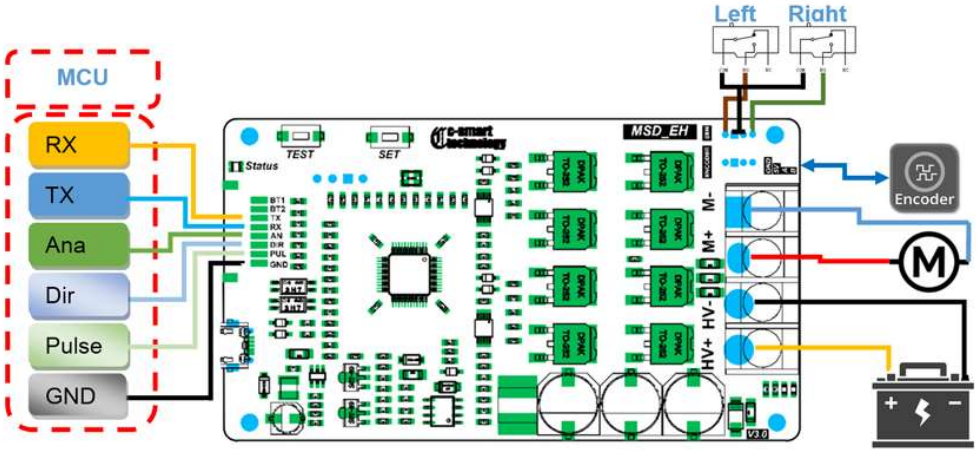

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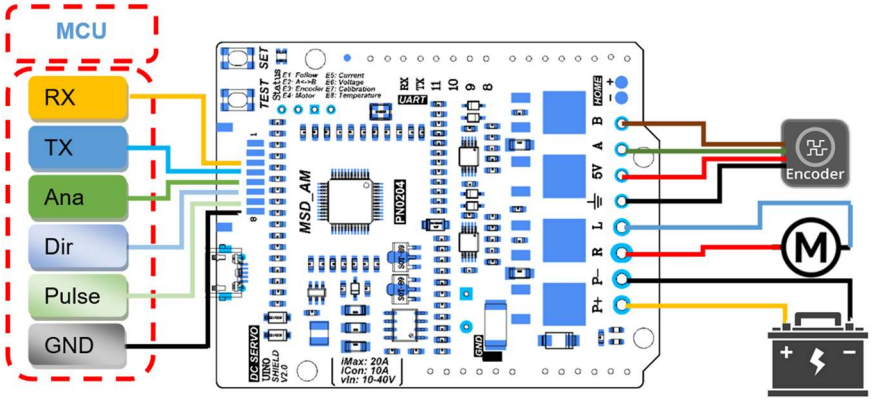

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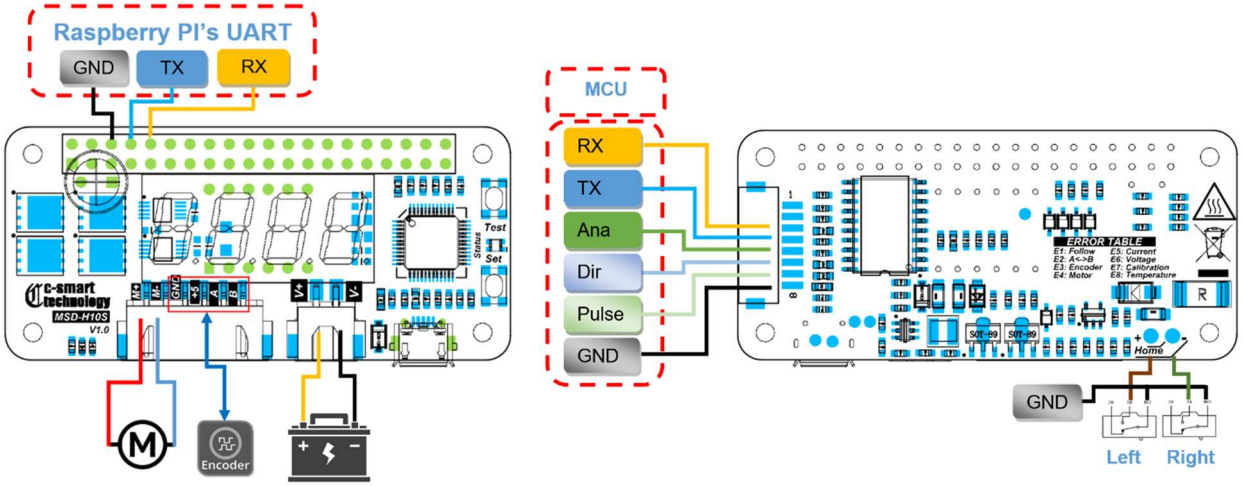
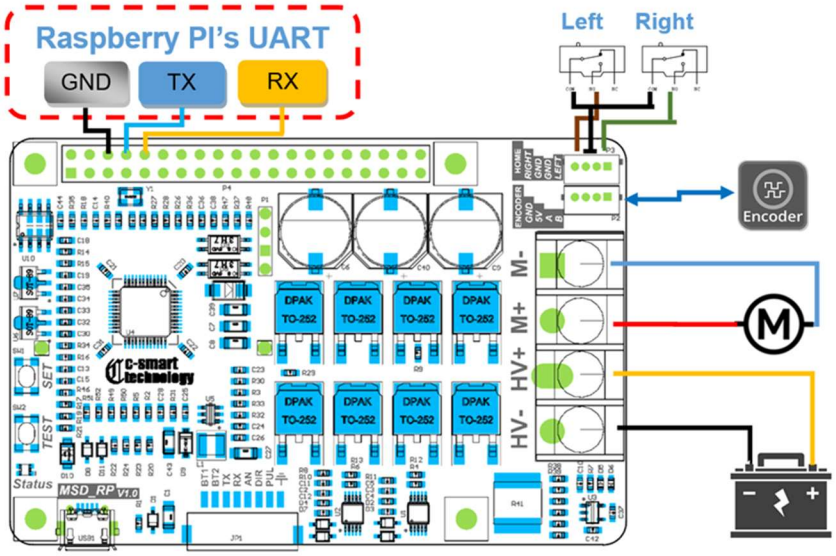
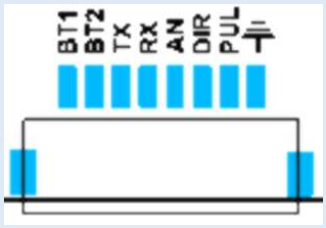


(Top) (Bottom)

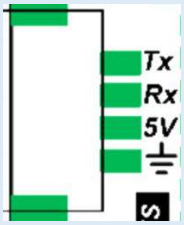
MSD_H20:



General information

Driver Control Signal (Not For MSD_E3)				
No	Name	Description	I/O	8 Pins Header In Driver
1	BT1 Test*	Short Touch to GND to Test Function	I	
2	BT2 Set*	Short Touch to GND to Set Function	I	
3	TX	UART TX Pin	O	
4	RX	UART RX Pin	I	
5	Analog(**)	Range [0-3V3]	I	
6	Dir	Direction of Motor	I	
7	Pul	Pulse in put (Active Edge Negative)	I	
8	GND	Ground	O	

(*) BT1, BT2 are two Pins Witch are connected Button Test and Button Set. So they will work as Button Test and Button Set.
(**) The maximum effect value is 3V3.

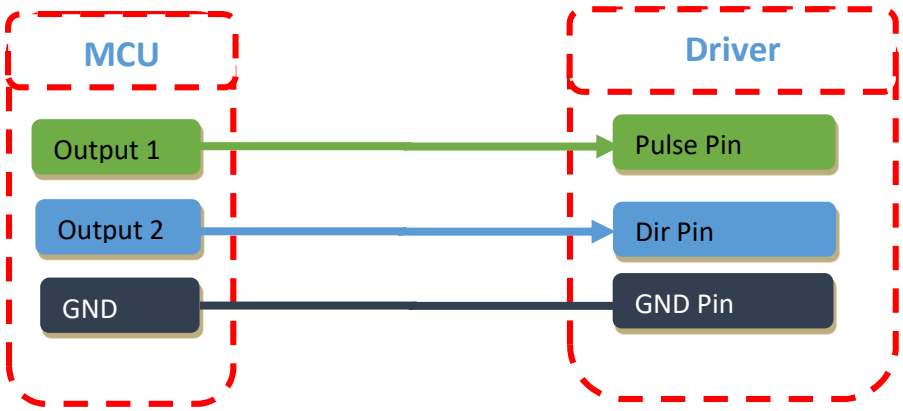
Driver Control Signal For MSD_E3				
No	Name	Description	I/O	4 Pins Header In Driver
1	TX/Pul/Ana	✓ TX in UART Mode ✓ Pulse In Pulse/Dir Mode ✓ Analog in Analog Mode	I/O	
2	RX/Dir	✓ RX in UART Mode ✓ Dir in Pulse/Dir Mode or Analog Mode	I	
3	5V	+5V, 200mA Power Supply Out-Put	O	
4	GND	Ground	O	

Encoder Connection			
No	Name	Description	I/O
1	GND	Ground	O
2	VCC	+5V, 200mA Power Supply Out-Put	O
3	A/CHA	Encoder Signal Chanel A	I
4	B/CHB	Encoder Signal Chanel B	I

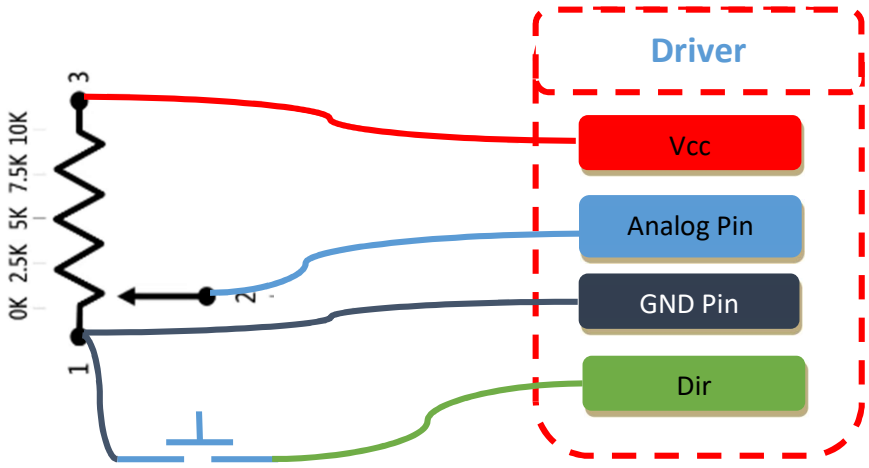
Home Sensor Detect			
No	Name	Description	I/O
1	RIGHT/+	Detect Right Touch (Active ==0)	I
2	LEFT/-	Detect Left Touch (Active ==0)	I

Main POWER and MOTOR Connection			
No	Name	Description	I/O
1	V-/P-/HV-	Ground of power supply	I
2	V+/P+/HV+	10->32/40V power supply	I
3	M-/L	Motor negative connection	O
4	M+/R	Motor positive connection	O

Pulse/Dir Mode Connection:



ANALOG/DIR Mode Connection:



4. Setting the Driver by Button (MSD_E3 don't support)

Implement:

*Note: In First Menu (Indicate =0000): Long Pressing the Set Button until 7-Segment blinking to go to configuration Mode (Indicate = **C0:XX**) -> Short press the Set Button to switch to Parameter Code **Or** Long Pressing to go to change Parameter Value Mode (the ":" will blinking) -> Short Press or Long Press to change the Parameter value.*

7 Step Setting Processing:

1. *Connect motor -> Encoder -> power up the driver **(Make sure correct power supply direction).***
2. *Setting Encoder (by **C0 and C1**)*
3. *Switch The Control Mode to Turning Mode to turning the Motor by **C4 = 0***
4. *Turning the motor by press the Test Button (The driver will identify the Motor properties in this step. **Note: the motor will run about 3 second to detect the system**). If Turning success the driver will indicate **F0:XX**, if Failed the driver will indicate a error message code.*
5. *Choosing Control **Mode** by C4: C4=2 (**Position**) or C4=1 (**Velocity**)*
6. *Choosing Control **Method** by C5: C5=0 **Pulse/Dir**, C5=1 **Uart-Network**,...*

If C5=0 (Pulse/Dir): Please also configuration the C2 (Electronic Gear) in your case.

If C5=1 (Uart-Network): Please also configuration the C6 (Address of driver in Network) and C7 (UART Baud Rate)

7. *Saving (by pressing the Test Button) -> Reset (by press the both the Test and Set Button same time).*

Video demo:

https://youtu.be/eCQlDmrCkeY

List Parameter Code:

C0: Encoder Line C0 (Encoder Line of Motor = C0*100 + C1)
C1: Encoder Line C1 (Ex: Encoder 321 Pulse/Round <=> C0 =3; C1 = 21)
C2: Electronic Gear =C2*100 (Number of external pulses per one revolution.)
C3: Current limit (A)
C4: Control Modes (C4=0: Turning; C4=1: Velocity Control; C4=2: Position Control; C4=4: Hbridge or Open Loop)
C5: Control Methods (C5=0: Pulse/Dir; C5=1: Uart-Network; C5=3: potentiometer/Analog; C5=5: Usb to Com)
C6: Address of the driver in Uart-Network
C7: UART Baud Rate. (C7=0: 115220; C7=1: 57600; C7= 2: 19200).
F0: Number of rounds to run when the test button is pressed for the position

control.
F1: Velocity setting for the test button. For example, F1:01 means 10 rads/second.
F2: Acceleration setting for the test button. For example, F2:01 means 100 rads/second^2.
F3: Follow Error Value (rad) (difference between estimate position vs current position)
F4: Protection Flag (F4=0: Disable Protection feature; F4=1: Enable protection feature)
F8: Counter Pass (F8 increase one value when every pass)
F9: Save settings. (F9=1: Saving & Reset; F9=2: Reset; F9=3: Factory Reset & Reset)

5. Setting the Driver by DcTunerPro App:

Introduction

This manual will provide an overview of connection and basic setup instructions for the digital servo driver using the **DCTunerPro** software. The basic setup of a digital driver is designed to be analogous to the setup and tuning of an analog amplifier. These instructions will walk you through the following steps necessary to start up your driver and motor. This document is intended for setting up the driver with the **DCTunerPro**.

Software Installation

The DCTunerPro is windows based setup software for tuning Cc-Smart's digital drivers.
It can run in windows systems, including Windows XP/Window7, Window10. And the selected PC should have 1 USB port at least for communicating with the driver.
Double click "DCTunerPro_V2.0.exe" to begin installing the DCTunerPro. See Figure 6-1 to 6-4

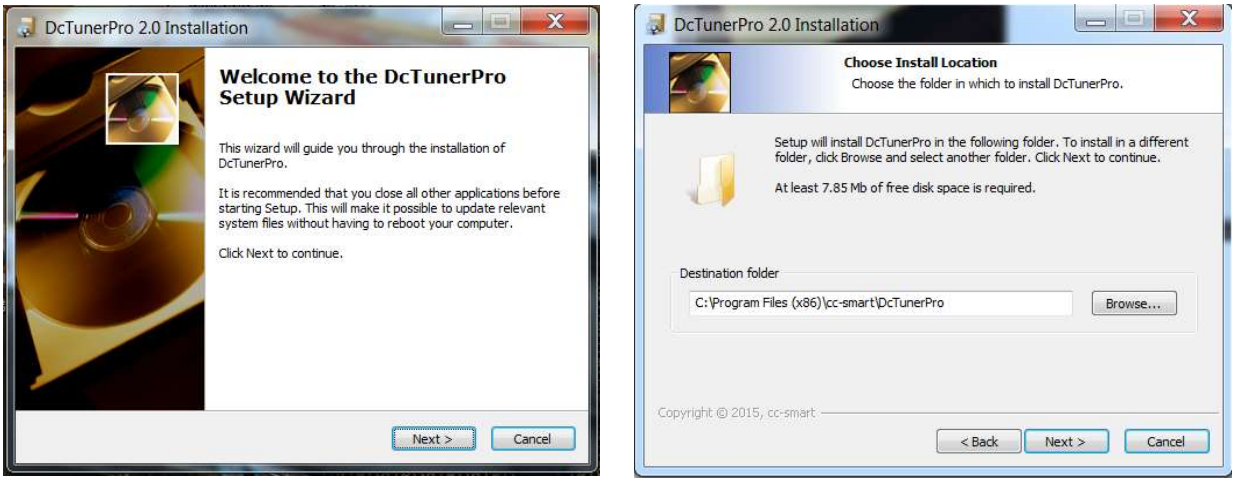


Figure 6-1/2

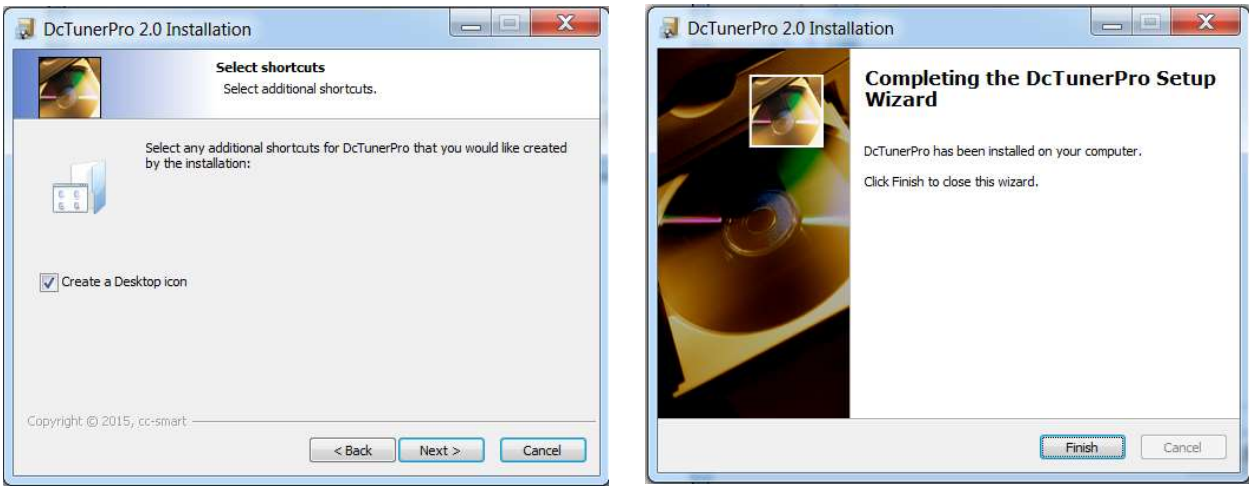
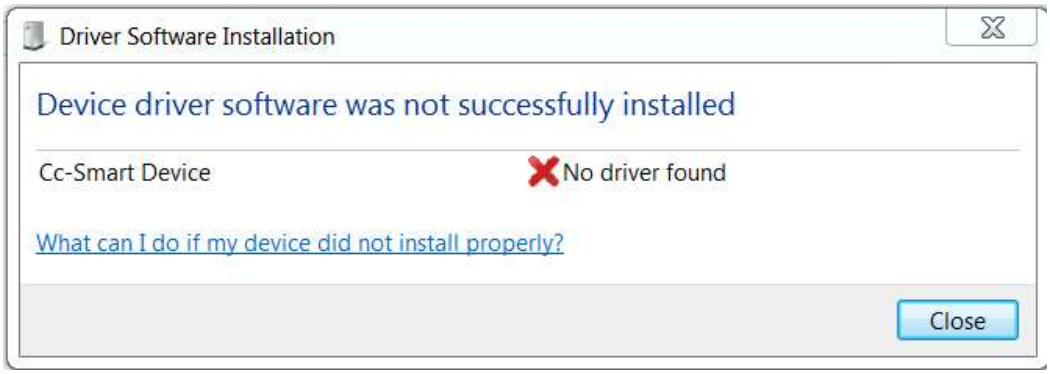


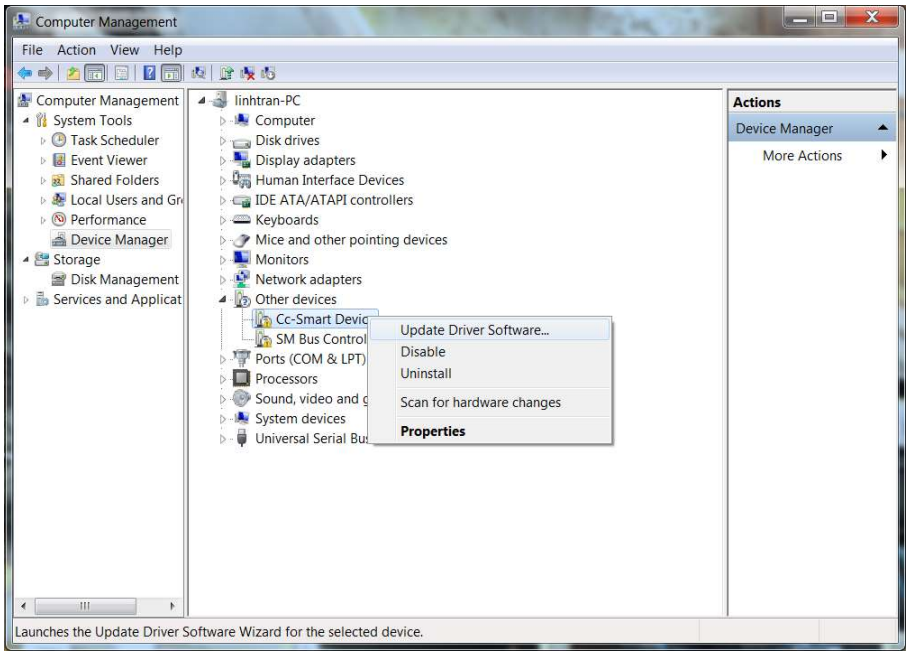
Figure 6-3/4

Install Usb Driver:

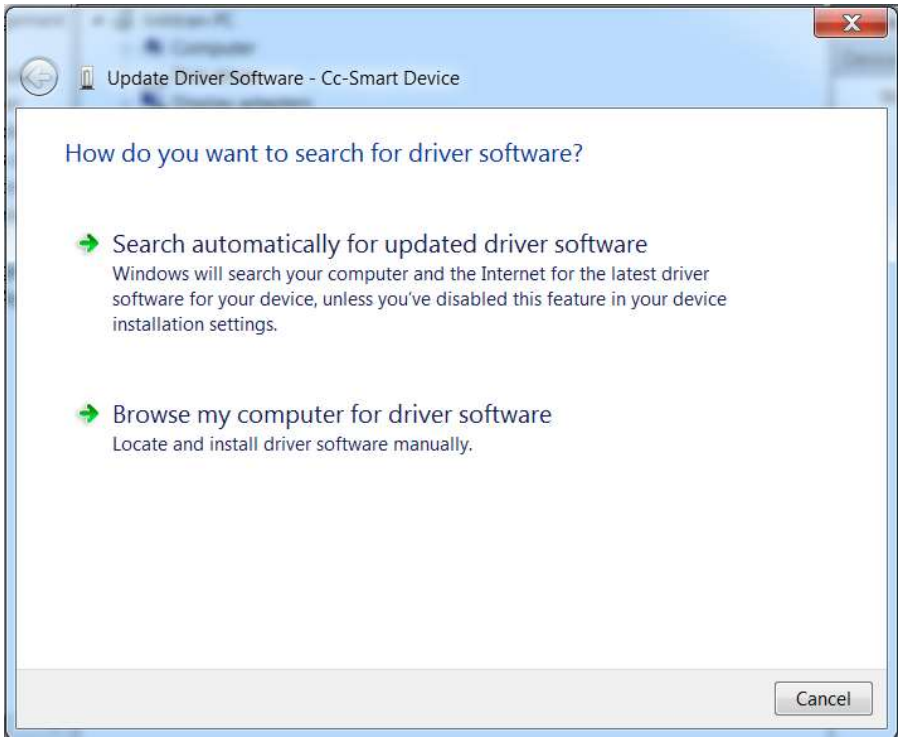
The widow will show a below dialog When you plug USB cable and turn on the driver power in the first time.



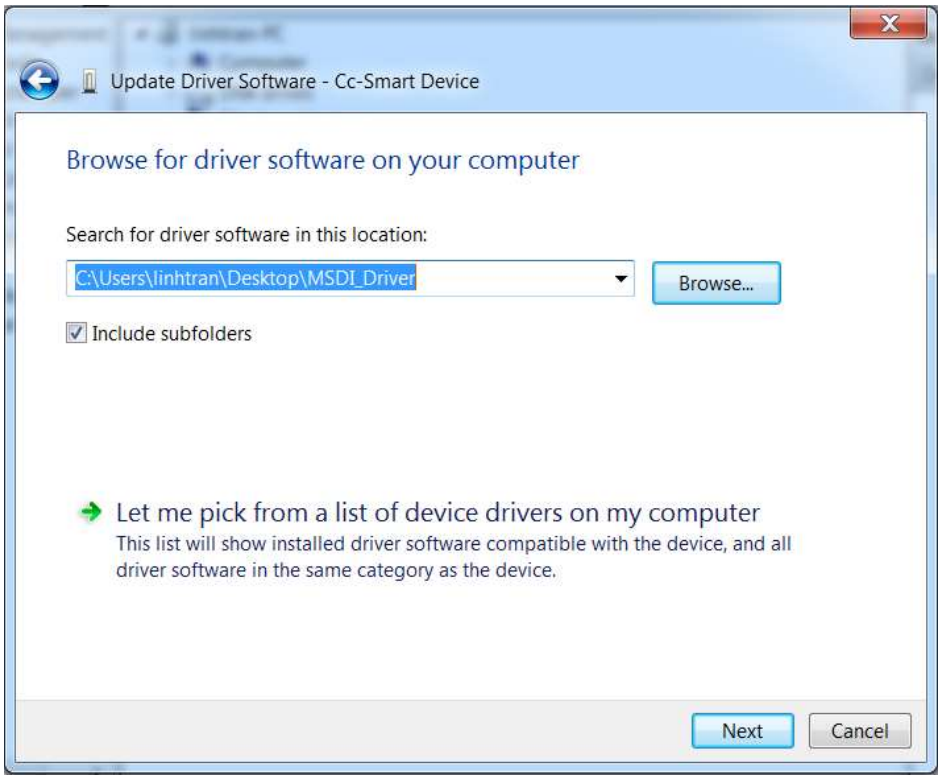
Right click "My Computer-> Manage -> Device manage"



Right click “Cc-Smart Device -> Update Driver Software”

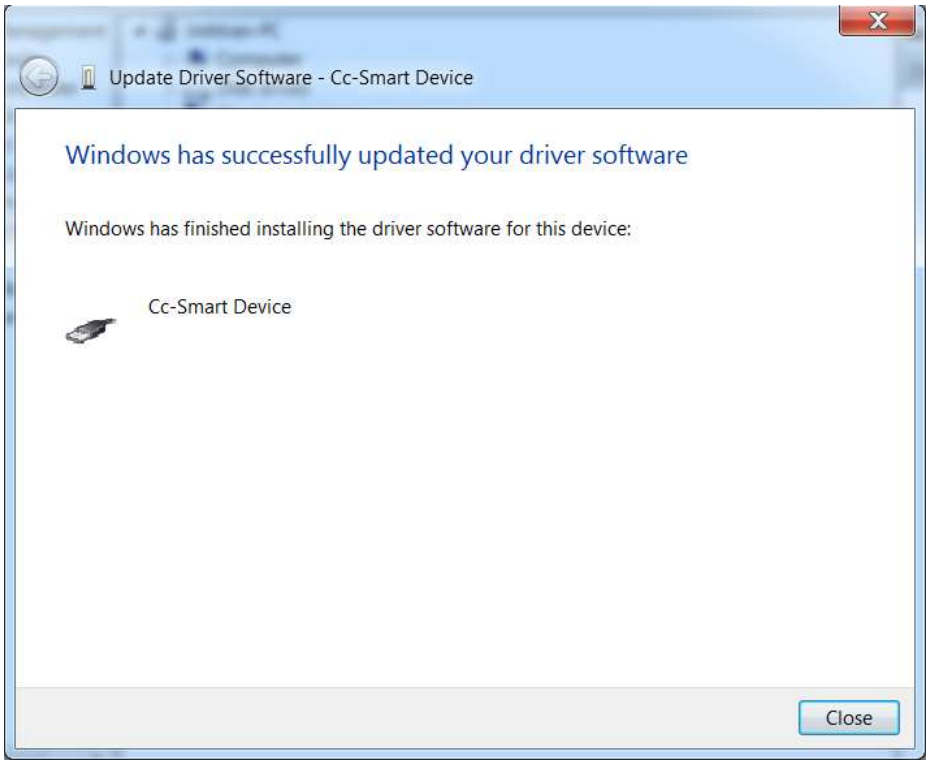


Choose “Browse my computer for driver software”



Choose Browse button to driver folder -> choose Next

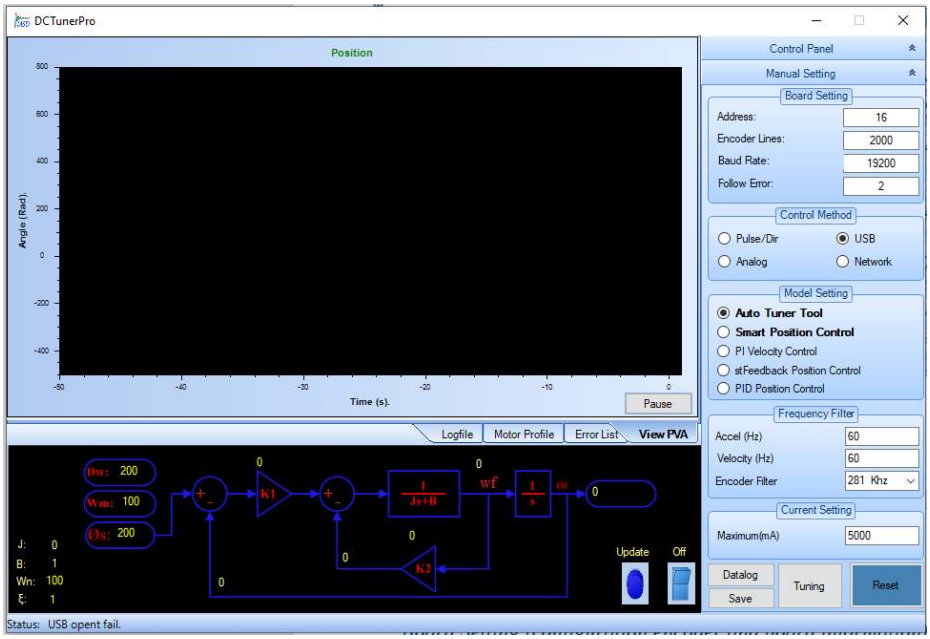
Choose "Install this driver software anyway"



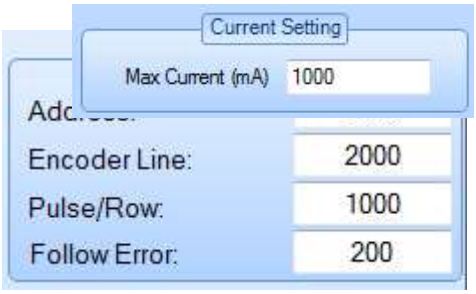
Note: with the Window version >7, when installing the driver, we will see this message **"The third-party INF does not contain digital signature information".** You can go to our product information web to find a video show how to fix or you can search in the internet to know how to fix it.

Software Introduction

DCTurnerPro Main Window



Board Setting (configuration encoder and board information)



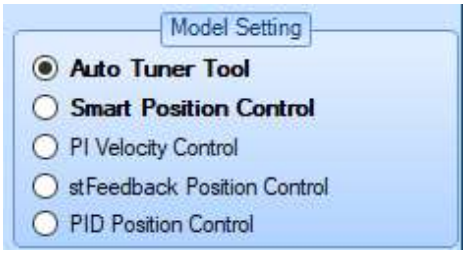
Address: Address of the driver in the Uart-Network (Network)
Encoder Line: The resolution of encoder (number pulses encoder per one circle).
Pulse/Row (Baud Rate): Same electronic gear ratio. This value configures how many external pulses correspond to ONE rotation round of motor. For example, if the value is 300 means the motor needs 300 pulses (from the external source) to rotate exactly one round.
Follow Error: Follow Error Value (rad) (difference between estimate position vs current position)

Control method

Pulse/Dir: This method the driver is controlled by external signal "Pulse-Direction".
USB: The driver is controlled by software via USB
Analog: The analog signal input is command for driver. It is only used with Velocity mode.
Network: Control multi driver by UART

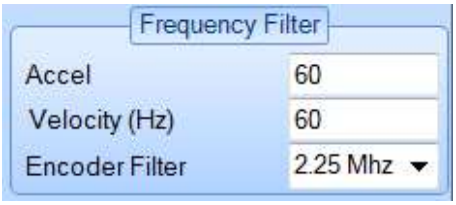
Selecting Model Control

Auto Tuner Tool: This tool is used to auto finding a system information.
stFeedback Position Control: The motor is used a position mode and controlled by state feed-back loop.
PID Position Control: The motor is used a position mode and controlled PID loop.
PI Velocity Control: The motor is used a velocity mode and controlled by PI loop**.**
Smart Position Control: This is our advanced close loop to control the motor (recommend).



Filter:

Accel: A frequency of low pass filter for accelerator. This value is usually about 50-60 (Hz)
Velocity: A frequency of low pass filter for velocity loop. This value is usually about 50-60 (Hz)
Encoder Filter: A frequency hardware filter. The Hardware filter Encoder is calculated as below formula:



$$F\_filter = Encoder\ Line*4*60*V\_max+ 1000$$

With:

F_filter: filter frequency.
Encoder_Line: the number of encoder pulse per round.
V_max: the maxium velocity of motor.

Current Setting:

Configure maximum current for controlling motor. This function protects overload or short circuit. The Driver automatically cuts off output current in 50ms.

In these cases, the user has to reset system to continue operating.

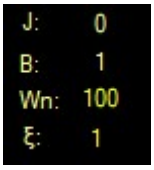
Automatically identify motor specification:

Principles:

The system will run as 80% power in first 4s then inverse rotation in next 4s. While this process is running, the *Auto Tuning* tool collects the response data of system, then analyzed and calculated *J* and *B* parameter of motor.

Operation:

-Step 1: Set Encoder Line value of your motor
-Step 2: Choose "Save button" to save Encoder information
-Step 3: Choose "Turning button" to start Turning. The driver will start the motor in some seconds to detect the J and B of motor property, result of J and B should be stable and positive in some Turning time.



-Step 4: Choose mode **"Smart Position Control"** in **Model Setting** to switch to control mode

-Step 5: Turn on the loop by putting the button like this (red color). you change the Model Control, this button will automatic changing please check again this button when you want to start the motor.

Note: When the state, so

-Step 6: Testing result by type Dw (Acceleration rad/s^2), Wm (Velocity rad/s), Phi_s (Position rad) witch you want the motor go to.

-Step 7: Click the button Update, the driver will control the motor run to (Phi_s) Position set. Try to change the position in step 6 and try again, if the motor has good respond go to next step

-Step 8: Choose the Control Method Pulse/Dir or Uart (Network) witch you want how to communicate with the driver. If the Control Method is Uart, please also set Baud rate and Address.

-Step 9: Click "Save Button" to save all config.

-Step 10: Click "Reset Button" to start the driver again, If all are correct, the driver will hold the motor. You can connect your controller to send the command (Uart command or Pulse/Dir command) to make the motor moving.

6. UART Command Feature:

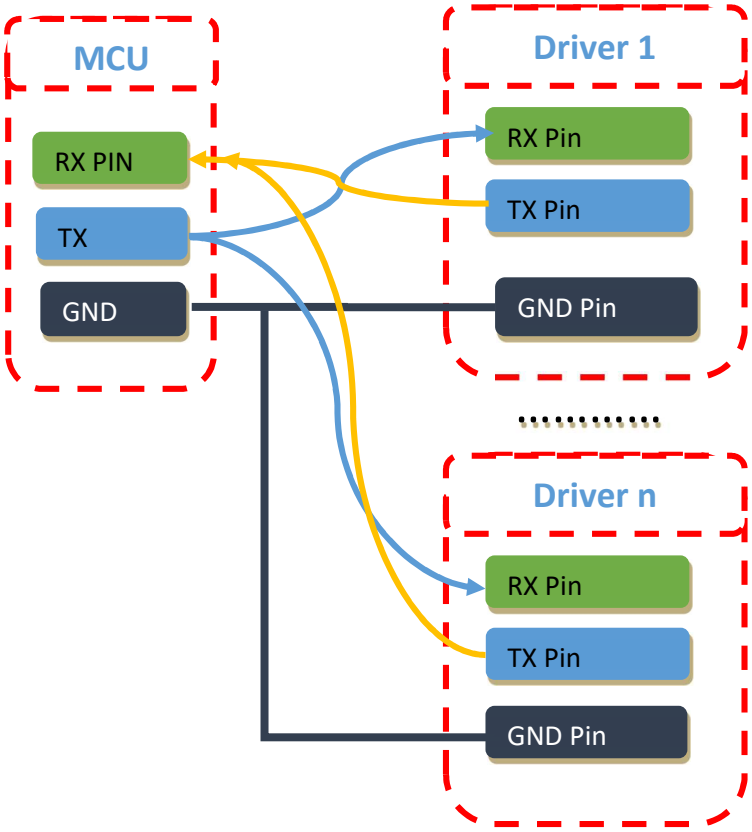
Discription:

This driver support **ASCII UART** command line. User can use UART interface to communicate with the driver by ASCII. So they can work well with MCU, Arduino, Raspberry... by the UART interface.

Any MSD_XX is **addressed in the manufacture (the user can reconfigure by the button or by the DcTurnerPro App) and work as Slave Mode in the UART Network**. A MCU can work as Mater mode and communicate to many slave (Msd_xx Driver)

UART Parameter

Baud Rate 1 (C7=0): 115200
Baud Rate 2 (C7=1): 57600
Baud Rate 3 (C7=2): 19200
Word Length: 8 Bit
Stop Bits: 1
Parity: None



Configuration by the Button:

Use button to config

C5=1; C6=1; C7=2 -> Reset

UART Command:

Host Send Format:

N0 ? \n : Help

Nx $xxx= Parameter_Value \n : Parameter Setting Group;

$001=20; Address of the Driver is: 20

$002=200; Encoder Line (Encoder resolution per Round)

$003=400; The main Motor Saft will run 1/400 circle per One Pulse from External Pin (Pul/Dir).

$004=4; Model Close Loop Type (0: Turning, 1: None, 2: PID Position, 3: PI Velocity (recommend), 4: Smart Position (recommend), 5: None, 6: H-Bridge mode (Working as H-Bridge))

$005=0; Communicate Methode (0: PULSE/DIR, 1: UART Network, 2: None, 3: Analog (Just for velocity Mode))

$006=2000mA; Current Limit
$007=12; Follow Error (rad(Position Model) or rad/s(Velocity Model)): The Maximum different between Estimate Value vs Real Value is 12
$008=1; Motor Protection Active (0: Disable, 1: Enable)
$009=115200; Uart Baud rate
$010=2; Delta Position Expect When press the TEST Button (Circle)
$011=60; Velocity Expect When press the TEST Button (Round/s)
$012=500; Acceleration Expect When press the TEST Button (Round/s2)

$020=4870; Kp_P=4870
$021=0; Ki_P=0
$022=69; Kd_P=69
$023=33; Kp_V=33
$024=1144; Ki_V=1144
$025=0; Kd_V=0
$026=0; Kp_I=0
$027=0; Ki_I=0
$028=0; Kd_I=0

$101=0; MCU(0: Running, 1: Saving & Reset; 2: Reset; 3: Factory Reset & Reset;)

Nx [p/P value] [v value] [a value] \n: Moving motor Nx with p/P,v,a parametter
Nx: x Adress Of Driver (0: Broadcast ; 1->99: Unicast)
p: Absolute Position Value (Option)
P: Relative Position Value (Option)
v: Velocity Value(Option)
a: Acceleration Value (Option)
Example: (The Driver 1 go to 100rad with Velocity 50rad/s and Acceleration 600rad/s^2): **N1 p100 v50 a600**

Nx [d value] \n: d= Duty Cycle in H-Bridge Mode ($004 = 6); (Value Range: -900 to 900)

***Note**: "-": Direct =0 ; "1": Direct = 1 ;*

Nx O [Kx] [T] [Mx] [Dx] [S] [L] [U] [r] [R101] [Gx] [C] \n; (O: Operation Group Command)
[ ] : Option
Kx : Ack command respond (K1: Enable (default at start up MCU); K0: Disable
T: Turning The Motor
Mx: Control Method = M4 (M3: PI Velocity, M4: Smart Position, M5: None, M6: H-Bridge mode (Working as H-Bridge))
Dx: Communicate Method = D0 (D0: PULSE/DIR, D1: UART Network, D2: None, D3: Analog (Just for velocity Mode))

S: Saving All Parameter
L: Lock/Pause/Stoop the Motor immediately
U: Unlock Motor
r: Reset the Current Position to 0
R101: Reset the driver
C: Clear error list
G: Get moving information (G1: One Time; G3: Until Receive a New Data With Frequency Respond 5Hz; G255: One time with Random Delay)

7. Protection & Indication Feature:

Protection:

Under/Over Voltage (vBus):

The motor driver output will be shut down when the power input voltage drops below the lower limit. This is to make sure the MOSFETs have sufficient voltage to fully turn on and do not overheat. ERR LED will blink during under voltage shutdown.

Temperature Protection:

The maximum current limiting threshold is determined by the board temperature. The higher the board temperature, the lower the current limiting threshold. This way, the driver is able to deliver its full potential depending on the actual condition without damaging the MOSFETs.

Overcurrent Protection with Active Current Limiting

When the motor is trying to draw more current than what the motor driver can supply, the PWM to the motor will be chopped off and the motor current will be maintained at maximum current limit. This prevents the motor driver from damage when the motor stalls or an oversized motor is hooked up. OC LED will turn on when current limiting is in action.

8. Recommendation:

Wire Gauge

The smaller wire diameter (lower gauge), the higher impedance. Higher impedance wire will broadcast more noise than lower impedance wire. Therefore, when selecting the wire gauge, it is preferable to select lower gauge (i.e. larger diameter) wire. This recommendation becomes more critical as the cable length increases. Use the following table to select the appropriate wire size to use in your application.

Current (A)	Minimum wire size (AWG)
10	#20
15	#18
20	#16

System Grounding

Good grounding practices help reduce the majority of noise present in a system. All

common grounds within an isolated system should be tied to PE (protective earth) through a 'SINGLE' low resistance point. Avoiding repetitive links to PE creating ground loops, which are a frequent source of noise. Central point grounding should also be applied to cable shielding; shields should be open on one end and grounded on the other. Close attention should also be given to chassis wires. For example, motors are typically supplied with a chassis wire. If this chassis wire is connected to PE, but the motor chassis itself is attached to the machine frame, which is also connected to PE, a ground loop will be created. Wires used for grounding should be of a heavy gauge and as short as possible. Unused wiring should also be grounded when safe to do so since wires left floating can act as large antennas, which contribute to EMI.

Power Supply Connection

NEVER connect power and ground in the wrong direction, because it will damage the driver. The distance between the DC power supply of the drive and the drive itself should be as short as possible since the cable between the two is a source of noise. When the power supply lines are longer than 50 cm, a **1000μF/100V** electrolytic capacitor should be connected between the terminal "GND" and the terminal "+VDC". This capacitor stabilizes the voltage supplied to the drive as well as filters noise on the power supply line. Please note that the polarity can't be reversed.

It is recommended to have multiple drivers to share one power supply to reduce cost if the supply has enough capacity. To avoid cross interference, **DO NOT** daisy-chain the power supply input pins of the drivers. Instead, please connect them to power supply separately.