9922-R
Operation manual

Chapter 1 Introduction

Prodigit develops 9922-R Quick Charger Controller, it provides Quick Charger, Pump Express and USB PD quick charging device simulation test.

9922-R can simulate fast charge control signal of mobile phones, tablet and notebook devices for a variety of fast charging technology to provide rapid testing and verification of the charger.

9922-R's banana plug can be directly connected with the binding post of electronic load, using the electronic load to simulate the load of the quick charger.

For the connection with the U.U.T, the 9922-R provides a Micro USB and a USB Type C hardware interface. Product front/rear panel and Micro USB / Type C pin definitions are shown below.

The output of the quick charger is equipped with the connector USB Type A or Type C, and through a specific cable (such as USB Type A - Micro USB, USB Type A - USB Type C, USB Type C - USB Type C, etc.) which can connect to 9922-R Quick Charger Controller's Micro USB or USB Type C input.
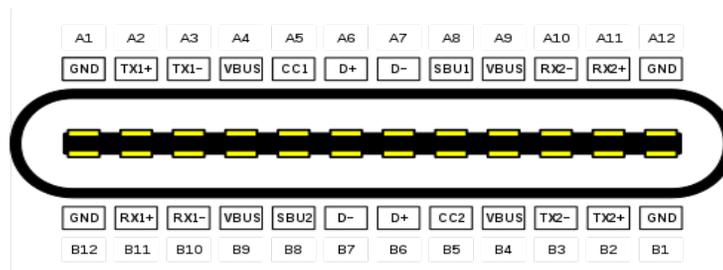

Front panel   Rear panel
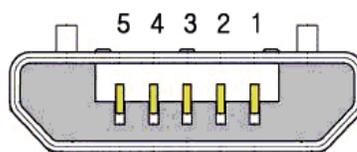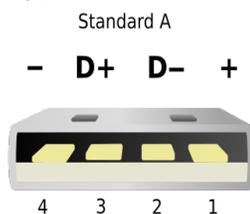
USB Type-C pin definition

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
GND	TX1+	TX1-	VBUS	CC1	D+	D-	SBU1	VBUS	RX2-	RX2+	GND

GND	RX1+	RX1-	VBUS	SBU2	D-	D+	CC2	VBUS	TX2-	TX2+	GND
B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1

Type C pin definition

USB Type A and Micro USB pin definition

Pin	Name	Description
1	VCC	+5V
2	D-	Data-
3	D+	Data+
4	NC	
5	GND	Ground

Micro USB pin definition

1-1 Equipment connection and operation
Please turn on the power of the electronic load, then insert the 9922-R banana plugs into the Binding posts of electronic load, which includes Load +/- and Vsense +/-. The 9922-R plugs terminal group is designed to be fully compatible with the Load and Vsense terminal Connectors of 3310F/G series of electronic load, besides the attached accessories in the Connector adapter cable which is suitable for operation when 9922-R can not be directly Inserted into the electronic load input connector.

Provide 5V power input which can be supplied by the Micro USB or D-SUB connector for 9922-R circuit operation. The connector of power input connector is located on the rear panel of the 9922-R. When using Micro USB for 9922-R power supply, by any V = 5V, I $\geq$ 0.15A power supply or adapter through the output cable with Micro-USB connector to connect to the rear panel's Micro USB input of 9922-R.

When using D-SUB for 9922-R power supply, the 3302F/G mainframe needs to be purchased Option with "9922-R Power Supply", and then connect the 3302F/G rear panel's D-SUB Connector to the rear panel's D-SUB input of 9922-R, and the 9922-R will be powered by 3302F/G.

The U.U.T output is connected to the Micro USB or USB Type C connector of the 9922-R.
After the connection is complete, start the test

1-2 Panel operation

- MODE Key
  Press the MODE key, you can select one of fast charge control technology QC 2.0 -> QC 3.0 -> PE + -> PE + 2.0 -> PD, it is required to select the same quick charge control Technology within 9922-R to comply fast charging charger (U.U.T.) to perform control.

- UP Key
  Increase the programmed voltage value. For the QC3.0 and PE + 2.0 mode, the function of UP key can be short press, press and hold respectively; press and hold the UP key for 2 Sec. can quickly increase the voltage value, please see the key operation list below.

- DOWN Key
  Decrease the programmed voltage value. For the QC3.0 and PE + 2.0 mode, the function of DOWN key can be short press, press and hold respectively; press and hold the DOWN key For 2 sec. can quickly lower the voltage value, please see the key operation list below.

- UP+DOWN Key
  Due to PE + and PE + 2.0 control technology will automatically return to default +5 V if there Is no loading, so to avoid the user to program the output voltage and then can not Immediately press the Load ON button of electronic load to start loading test, causing the Test PE + or PE + 2.0 fast charger automatically return to + 5V, 9922-R designed a parameter For the user to adjust the programming hold time of 0 ~ 5.0 seconds (PE + and PE + 2.0 Use only); 9922-R within this
  Time will continue to sink 0.3A current to avoid the PE+ or PE+2.0 charger goes to the Default +5 V. User press the Load ON button of electronic load and sink current $\geq$0.3A Within the programming hold time, then the charger can adjust its output voltage according To the UP/DOWN key setting.

  Press UP and DOWN two keys simultaneously for two seconds, then the 9922-R enters the setting mode of programmable Hold Time.
  Press UP or DOWN button to increase or decrease the programming hold time setting in the

range of 0 ~ 5 seconds, resolution 0.1S
Press and hold: UP or DOWN button for two seconds to increase or decrease the programming hold time in the range of 0 ~ 5 seconds, resolution 1.0S
Press the START Key to store the programmable hold time setting into the RAM of 9922-R, then to quit from the hold time setting mode.

- START Key
  Short press: Execute the output voltage programming setting according to the UP/DOWN key.
  Press and hold for 2 seconds: Execute programming, store the selected fast charge mode and the programming hold time of the PE mode into EEPROM of 9922-R. The LED flashes three times to acknowledgement the store operation, these settings are automatically restored at the next power ON of the 9922-R, so that the user does not need to set the mode and programming hold time of 9922-R again.

  Key operation list

Key / QC technology		QC 2.0	QC 3.0	PE+	PE+ 2.0	USB PD 2.0
MODE		Select fast charge mode				
UP	Press	5V => 9V => 12V => 20V	0.2V step increment	5V => 7V => 9V => 12V	0.5V step increment	1 ~ 7
	Press and hold		5V => 9V => 12V => 20V		5V => 9V => 12V => 20V	
DOWN	Press	5V <= 9V <= 12V <= 20V	0.2V step decrement	5V <= 7V <= 9V <= 12V	0.5V step decrement	7 ~ 1
	Press and hold		5V <= 9V <= 12V <= 20V		5V <= 9V <= 12V <= 20V	
UP+DOWN	Press	NA	NA	Enter the programmable Hold time mode (for PE+ / PE+ 2.0 only)		NA
	Press and hold					
START	Press	Execute the UP/DOWN setting operation				
	Press and hold	Store the fast charge mode and programmable Hold time (PE+ / PE+ 2.0 only) into the EEROM of 9922				

Chapter 2 Quick Charger 2.0 and 3.0

In response to handheld devices, mobile phones, tablet's battery capacity increased, the use of 5V / 1A, 5W standard charger lead to charging time is too long, In addition to QC 1.0 5V / 2A, 10W charger than the 5W standard charger which can reduce the charging time of 50% of the solution, the Quick Charge 2.0 is a solution that Qualcomm can provide for quick charging for mobile devices, while mobile devices and chargers meet Quick Charge 2.0 protocol, the charger accepts the instructions of the mobile device to increase the charger power output to achieve fast charging of the mobile device battery.

Specifically, Quick Charge 2.0 provides 5V, 9V, 12V, 20V, maximum 18W four voltage level charging, the symbol is lightning plus a circle with Class A and Class B, as shown below, which Class A supports three voltage level (5 / 9 / 12V), Class B supports four voltages (5 / 9 / 12 / 20V).


- The principle of QC 2.0
  The charger is to detect the voltage of D + and D - on USB to control the output voltage of the charger, as shown in the following table

| D+	D-	Output
0.6V	0.6V	12V
3.3V	0.6V	9V
3.3V	3.3V	20V
0.6V	GND	5V(default)

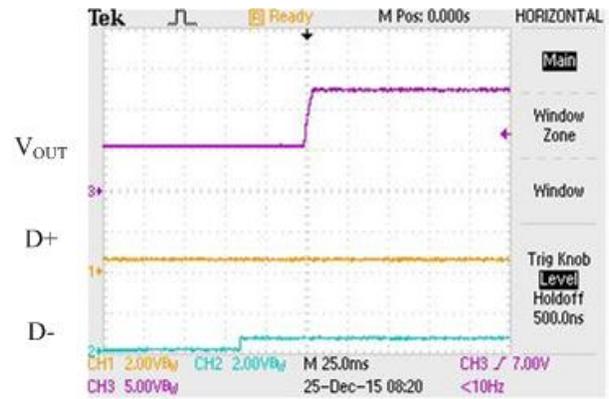QC 2.0 Class A Adapter

QC 2.0 control table

- The 9922-R Quick Charger Controller can simulate the various voltage combinations of D +, D- for QC 2.0 testing to verify the output voltage of the test charger, and to simulate the connection and remove the connection to the charger to verify that the charger can be immediately Automatically stop the high voltage output down to 5V, to ensure that the function is normal to meet the Quick Charge 2.0 specification
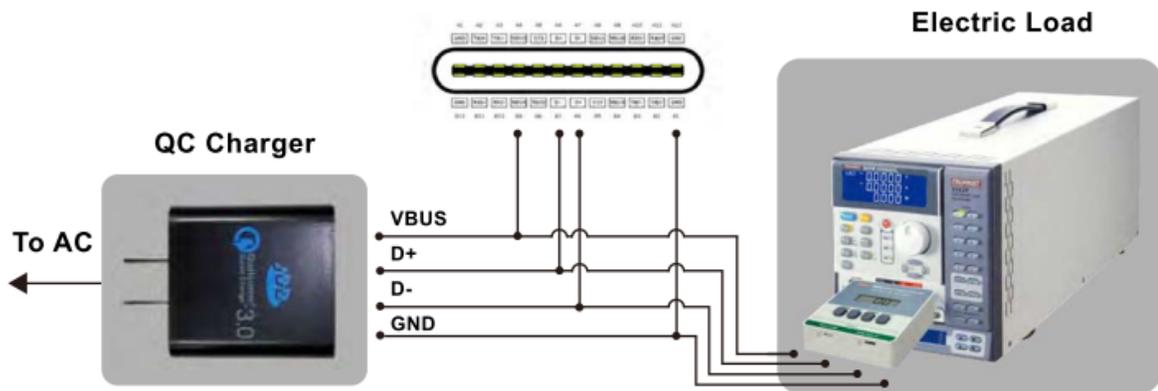
QC Charger Application Connect Diagram
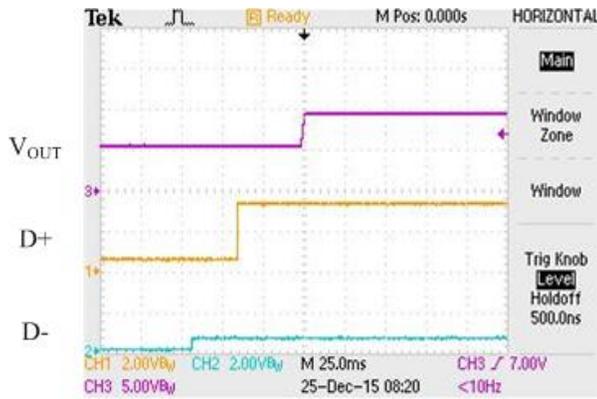
QC 2.0 Transition 5V to 9V   QC 2.0 Transition 5V to 12V

At present there are many manufacturers' products to support Quick Charge devices, such as HTC, SONY, MOTOROLA, Google, Samsung, Asus and so on.

Because Quick Charge 2.0 has a significant performance of reduction in charging time, it is very convenient for consumer users, and it is expected that the future will become more common, and of course the charger should also be upgraded from the current standard 5V / 1A 5W to 15W or 18W in order to be able to quickly charge.

In addition to Quick Charge 2.0, Qualcomm also introduced the next generation of Quick Charge 3.0 fast charging technology, using the best voltage precision algorithm (Intelligent Negotiation for Optimum Voltage, INOV) can further reduce the power loss up to 45%, Quick Charge 3.0 to 0.2V increase reduction, from 3.6V to 20V voltage to get the most appropriate voltage for mobile phone so as to achieve improved efficiency and improve the heat problem.

●   Operating instructions of 9922-R in QC 2.0
    1. Select mode
       Press the MODE button to switch to QC2.0, then QC2.0 LED lights.
    2. Set the output voltage
       Press UP, DOWN button to increase or decrease the voltage setting 5.0 ~ 20.0V.

         5.0 ⟺ 9.0 ⟺ 12.0 ⟺ 20.0

    3. Start
       Press the START button to start changing the output voltage value.
●   The principle of QC 3.0
Charger is to detect the D + and D on the USB voltage and pulse to control the charger output voltage, as shown in the table below

D+	D-	Output	Note	
0.6V	0.6V	12V	Class A	
3.3V	0.6V	9V	Class B	
0.6V	3.3V	Continuous Mode	Class A/B with ±0.2V step size	
3.3V	3.3V	20V	Class B	
0.6V	GND	5V	Default mode	QC 3.0 Class A Adapter

QC 3.0 control table

The difference of QC 3.0 and QC 2.0 is increasing the voltage fine-tuning function, D + PULSE gets Vout voltage increase 0.2V, D-PULSE gets Vout voltage reduce 0.2V, the test results as shown below, 16 of D + PULSE gets Vout voltage increase 3.2V, 16 of D-PULSE gets Vout voltage reduce 3.2V.
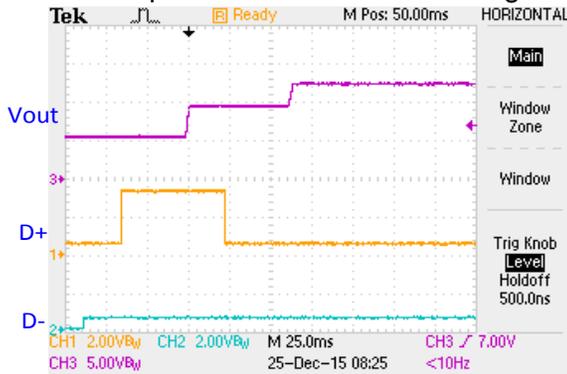
Continuous Mode Ramp Up and Down
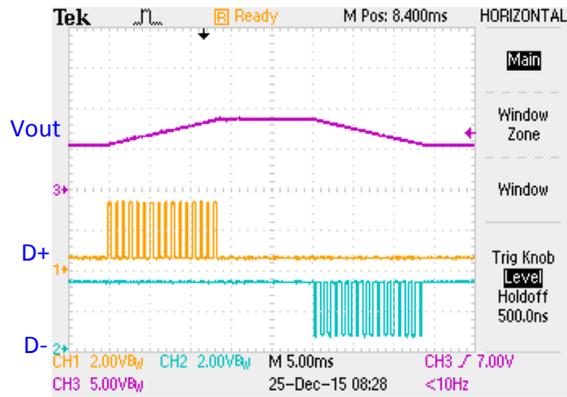
CH1: D+
CH2: D-
CH3: Vout(adapter voltage output)
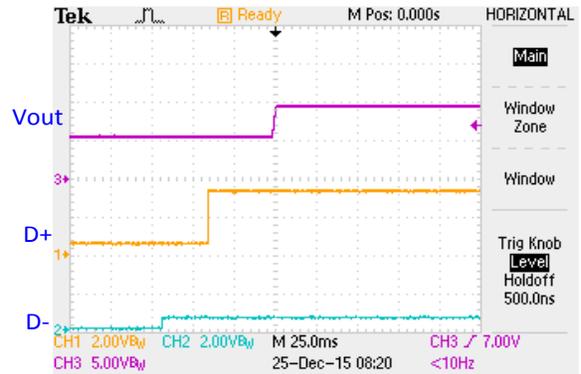
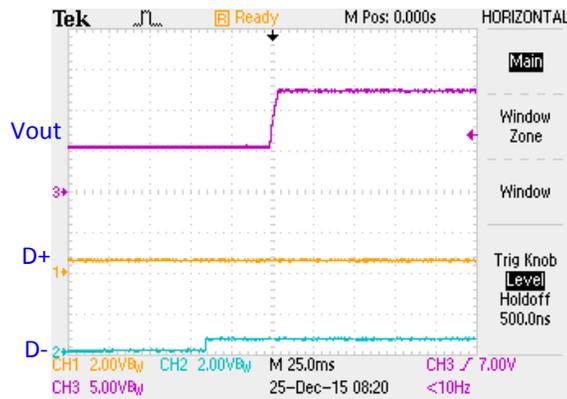Quick Charge 3.0 Ramp Up 3.2V and Ramp Down 3.2V

- The 9922-R Quick Charger Controller which is capable of simulating D +, D- pulse control to control 0.2V increments and decrements to verify and test the output voltage of the charger to ensure compliance with the Quick Charge 3.0 specification. As shown below.
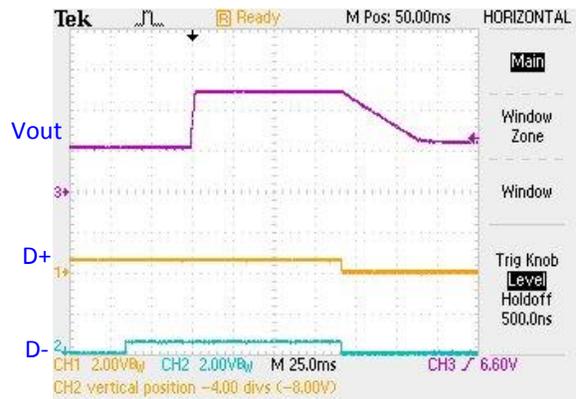

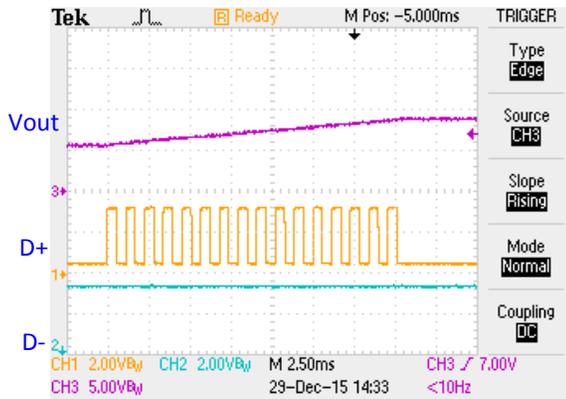**Transition from 5.0 V to 9.0 V to 12V**
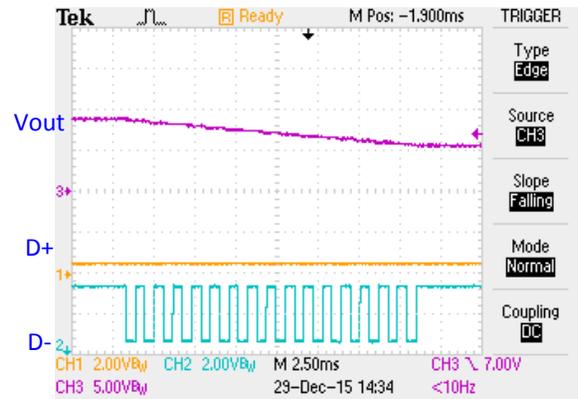

Transition from 5.0 V to 9.0 V

Transition from 5.0 V to 12 V

USB Cable Unplug Discharge

Continuous Mode Ramp Up   **Continuous Mode Ramp Down**

● Operating instructions of 9922-R in QC 3.0
1. Select mode
   Press the MODE button to switch to QC3.0, then QC3.0 LED lights
2. Set the output voltage
   Short press: press UP, DOWN button to increase or decrease the voltage setting, resolution 0.2V

   Press 2 seconds: Press UP, DOWN button to increase or decrease the voltage setting 3.6 ~ 20.0V

3. Start
   Press the START button to start changing the output voltage values.

Chapter 3 Pump Express Plus & Pump Express Plus 2.0
Pump Express is the quick charge product of MediaTek, it has been extended to version 3.0, basically it is used of high voltage and high current to provide fast charge.
It has been used by SONY, Lenovo and other brands. The features of Pump Express are allowing the charger according to the current to determine the initial voltage required for charging. The pulse current command from the PMIC in the handset is sent to the charger via USB Vbus. The charger adjusts the output voltage according to this instruction.

MediaTek currently has two fast charge specifications：
（1） Pump Express Plus provides output power for fast DC chargers less than 15W (5V) similar to QC2.0, controlled output Fixed voltage: 5V, 7V, 9V, 12V, mainstream Output power: 5V / 1A & 5V / 1.5A.
（2） Pump Express Plus 2.0 for the charger to provide the output power is greater than 15W, the difference is the output voltage can be controlled, similar to QC3.0 but based on 0.5V be increase or decrease, from 5V to 20V voltage to get the most appropriate voltage for mobile phone so as to achieve improved efficiency and improve the heat problem.

● The principle of Pump Express
Use the command (sink different current) control Adapter output different voltage, as shown in Figure 2 & 3, current Ilow <0.13A, Ihigh> 0.3A, PE shall sink current at least 0.3A immediately in the conversion voltage, otherwise the voltage will automatically jump back 5V. As shown below...
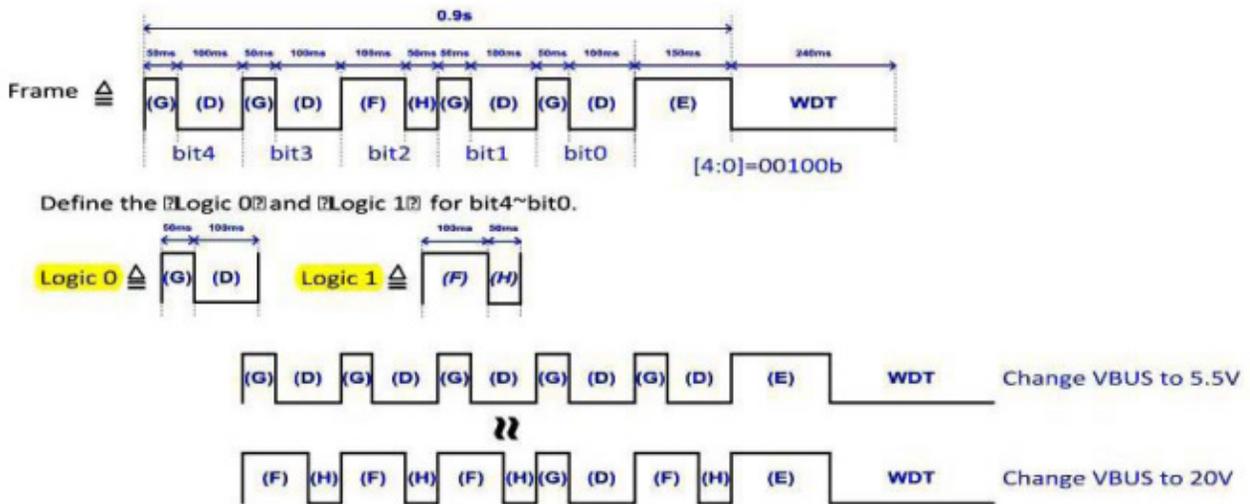
PE+ 2.0 Timing Diagram

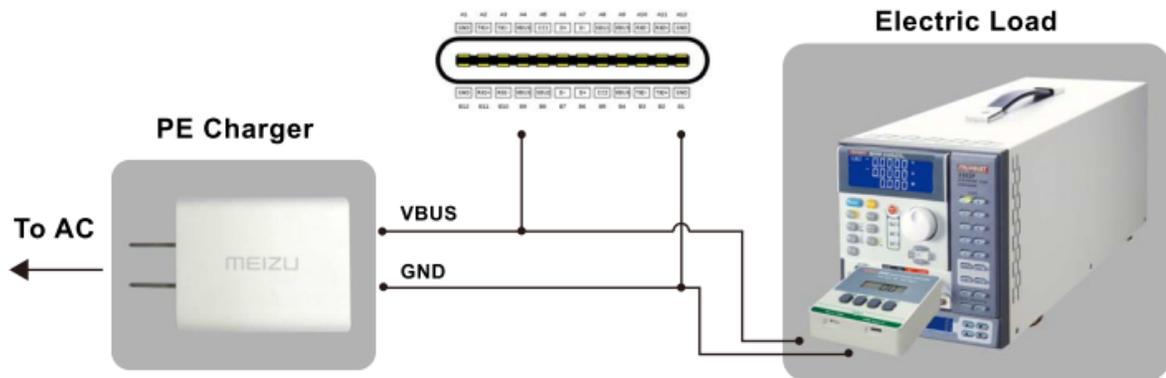PE 1.0 Adapter   PE+ 2.0 Adapter

● The 9922-R Quick Charger Controller, which is capable of simulating commands and loads a different current, current Ilow <0.13A and Ihigh> 0.3A to verify and test the output voltage of the charger to ensure compliance with PE specifications. As shown below...

PE Charger Application Connect Diagram

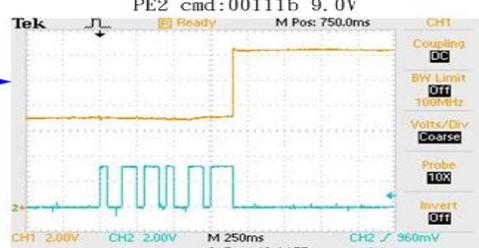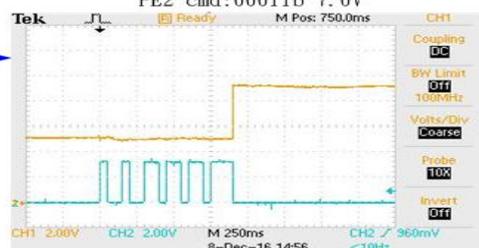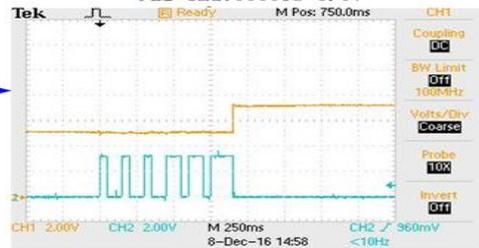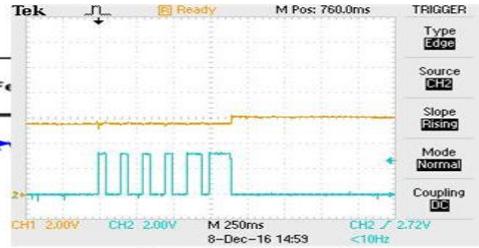| Digital Code bit5~bit0 [4:0]	Absolute Voltage	Unit	F
00000B	5.5	V	
00001B	6	V	Change Output
00010B	6.5	V	
00011B	7	V	
00100B	7.5	V	
00101B	8	V	
00110B	8.5	V	
00111B	9	V	
01000B	9.5	V	
01001B	10	V	
01010B	10.5	V	
01011B	11	V	
01100B	11.5	V	
01101B	12	V	
01110B	12.5	V	
01111B	13	V	
10000B	13.5	V	
10001B	14	V	
10010B	14.5	V	
10011B	15	V	
10100B	15.5	V	
10101B	16	V	
10110B	16.5	V	
10111B	17	V	
11000B	17.5	V	
11001B	18	V	
11010B	18.5	V	
11011B	19	V	
11100B	19.5	V	
11101B	20	V	

PE+ 2.0 COMMAND

PE2 cmd:00001b 6.0V

PE2 cmd:00011b 7.0V

PE2 cmd:00111b 9.0V

PE2 cmd:01101b 12.0V

PE2 current & cmd
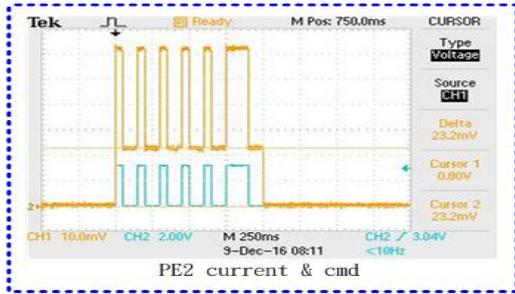
● The operating instructions of 9922-R in PE+
  1. Select mode
     Press the MODE button to switch to PE +, then the LED of PE + lights up
  2. Set the output voltage
     Press UP, DOWN button to increase or decrease the voltage setting 5.0V / 7.0V / 9.0V / 12.0V

     5.0 ⇔ 7.0 ⇔ 9.0 ⇔ 12.0

  3. Start
     Press the START button to start changing the output voltage values.

● The operating instructions of 9922-R in PE+ 2.0
  1. Select mode
     Press the MODE button to switch to PE + 2.0, then the LED of PE + 2.0 lights up
  2. Set the output voltage
     Short Press: Press UP, DOWN button to increase or decrease the voltage setting 0.5V

     5.0 ↔ 5.5 ↔ 6.0 ↔ ••• ↔ 20.0

     Press 2 seconds: press UP, DOWN button to increase or decrease the voltage setting 5.0V / 9.0V / 12.0V / 20.0V

     5.0 ↔ 9.0 ↔ 12.0 ↔ 20.0

  3. Start
   Press the START button to start changing the output voltage values.

Chapter 4 USB Type-C support USB Power Delivery
In order to have more popular for the USB application on different devices the power supply, and reduce the power cord configuration, including mobile phones and laptop charger, the new USB Power Delivery came into being. USB-IF recently has announced the power transfer specification called USB Power Delivery (PD), which aims to deliver power through up to 20V 5A 100 watts, up to seven voltage output combinations, so that a variety of devices can be a single USB cable to meet the power supply needs, and the advantages of shorten charging time, better optimize the convenience of mobile applications.
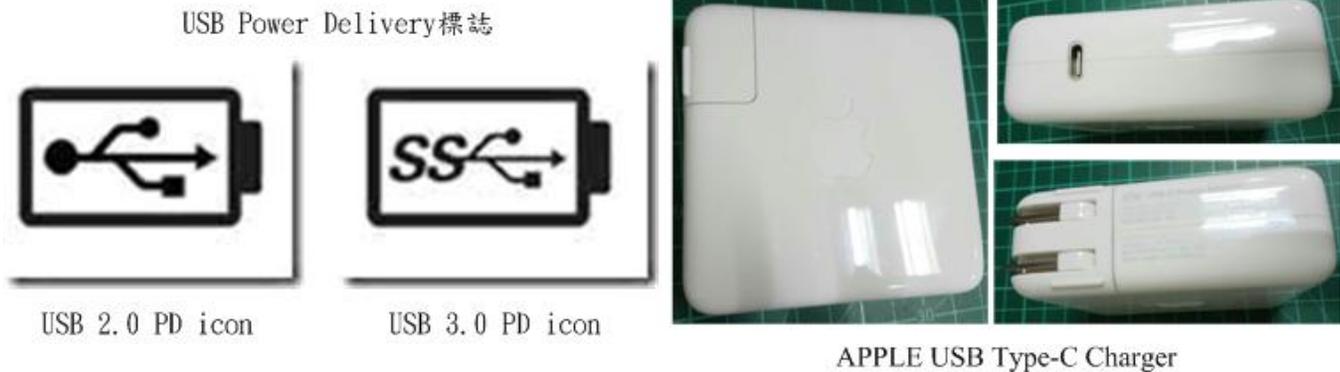

- The principle of Power Delivery
  USB PD communication is the protocol layer of the message is modulated into FSK signal of 24MHZ and coupled to VBUS or from the VBUS to get FSK signal so as to achieve the mobile phone and charger communication process.
  An example based on mobile phones and chargers which are supported to USB PD to explain the following:

  ➢ PHY of USB OTG monitor VBUS voltage, if there is VBUS 5V voltage exists and detects the OTG ID pin is 1K pull-down resistor (not OTG Host mode, the ID resistance of OTG Host mode is less than 1K), it means that the cable is supported USB PD.
  ➢ USB OTG to do the normal BCS V1.2 standard charger and start the USB PD device policy manager, the policy manager to monitor the VBUS DC level if it is coupled with the FSK signal, and the decoding message gets Capabilities Source message, according to USB PD Specification Resolution this message concludes all voltage and current list combinations supported by the USB PD Charger.

> ➢ The phone selects a voltage and current pair from the Capabilities Source message according to the user's configuration and adds the voltage and current pairs to the payload of the Request message, and then the policy manager couples the FSK signal to the VBUS DC level.
> ➢ The charger decodes the FSK signal and issues an Accept message to the handset while adjusting the Power supply's DC voltage and current output.
> ➢ The phone receives an Accept message to adjust the charging voltage and current of the Charger IC.
> ➢ The phone can send a Request message dynamically during charging to request the charger to change the output voltage and current to achieve a fast charging process.

● Prodigit's 9922-R Quick Charger Controller, including the PD-controlled chip which can simulate the device to verify and test the USB PD testing process, and you can use all the simple operations to complete all the tedious tests to ensure compliance with the PD specification. As shown below...
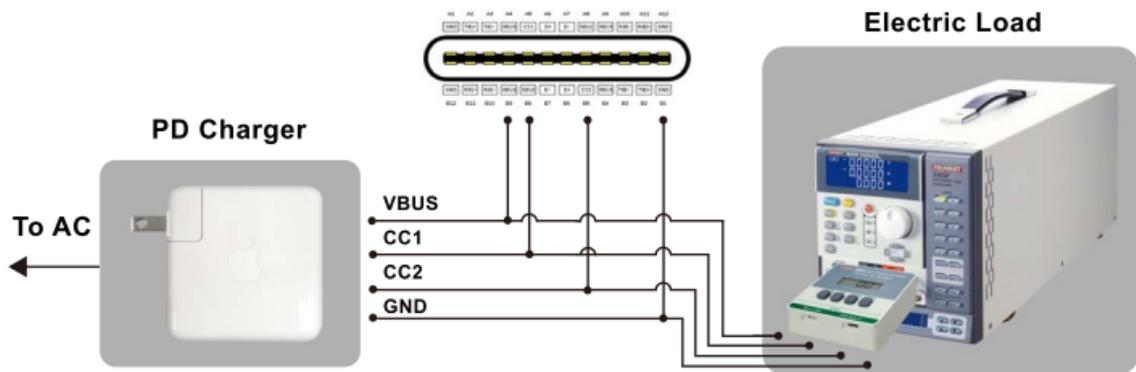
PD Charger Application Connect Diagram

PD 5V to 9V   PD 5V to 20V
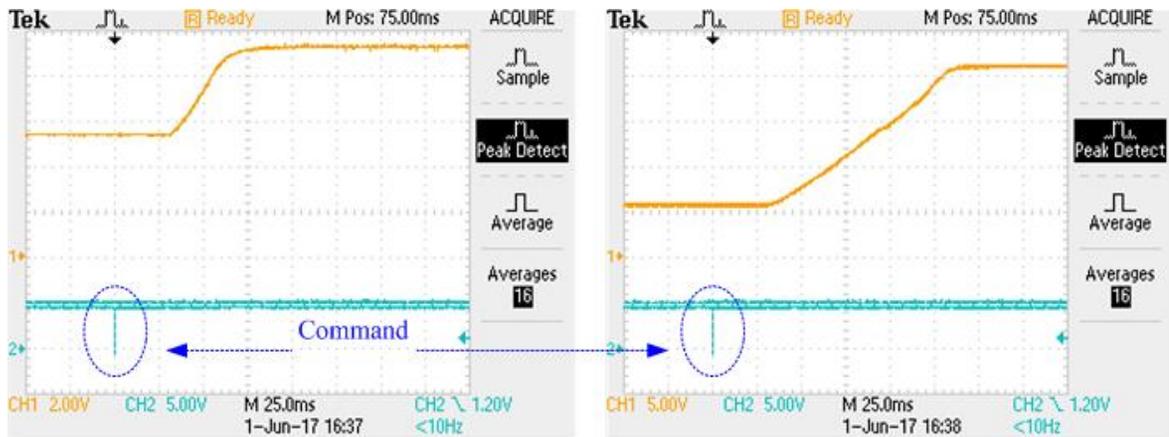
● The operating instructions of 9922-R in USB PD
  1. Select mode
     Press the MODE button to switch to the PD, then PD LED lights up
  2. Set the output voltage
     Press the UP and DOWN buttons to select the voltage output from 1 to 7 groups

  3. Start
     Press the START button to start changing the output voltage
  Note: Take USB PD as an example, the output voltage is only three groups, one group is 5V, the second group is 9V, the third group is 20V.

Chapter 5 Communication Interface programming command

The following RS232 commands are same as commands. The RS232 protocol in 9922-R is listing below:

Baud-rate	: 115200bps
Parity	: None
Data bit	: 8 bits
Stop bit	: 1 bit
Handshaking	：Hardware (RTS/CTS).

Byte 1	Byte 2	Byte 3	Byte 4	Description
0x01				reading the model name
0x02				Reading mode
0x03				Reading Voltage
0x04				Enter fast charge mode and return D, D-state (QC mode use)
0x80	Address	DataH	DataL	Write word data (used in PD mode)
0x81	Address			Read word data (used in PD mode)
0x82	Address	Data Length	Data 1 ~ N	Write block data (used in PD mode)
0x83	Address			Reading block data (PD mode use)
0x84	0x10 ~ 0x70			Control 1~7 sets of output voltage (PD mode use)
0x85	0x00			Set QC 2.0 mode
	0x01			Set QC 3.0 mode
	0x02			Set PE+ mode
	0x03			Set PE+2.0 mode
	0x04			Set PD mode
0x86	30 ~ 200 (3.0V ~ 20.0V)			Control QC/PE output voltage
0x87	0x00 ~ 0xFF			Increase voltage (QC3.0 continuous mode or PE+2.0)
0x88	0x00 ~ 0xFF			Reduce voltage (QC3.0 continuous mode or PE+2.0)
0x89	0 ~ 50 (0.0~5.0S)			Timer, preset value 1.0 second (used in PE+ mode)
0x8B	0x00			Leave continuous mode (QC mode use)
	0x01			Enter continuous mode (QC mode use)

Return command:
Byte 1: Command Byte.
Bit7: S/D Bit, 0 = System state return, 1 = Data return.
Bit 6~0：Return Item

Byte1	Byte2	Byte3	Description
0x01	0x99	0x22	Return model name
0x02	Data1		Return mode
0x03	Data1		Return voltage
0x04	Data1		Return status, 0: D+, D- short circuit, 1: D+, D- open circuit
0x06			The command is correct
0x15			The Command error
0x81	Data 1	Data 2	Return word data command error
0x83	Data1 ~ N		Return block data

Communication Command Sequence (QC 3.0)

1. 0x85 0x01	Set QC 3.0 mode
2. 0x04	Enter fast charge mode
3. 0x 86 0x5A	Control output voltages is 9.0V
4. 0x8B 0x01	Enter continuous mode, adjust voltage
5. 0x 86 0x5E	Control output voltages is 9.4V
6. 0x8B 0x00	Leave continuous mode, the voltage returns to 5V