LDR6022 USB Type-C PD Controller

REV1.4

Document History

REV1.0	New data sheet.	2016-03-09
REV1.1	Added linear voltage output mode.	2016-05-06
REV1.2	Added OTP function.	2016-10-15
REV1.3	Added constant current output mode	2016-11-08
REV1.4	Upgraded to USB PD3.0 Added PPS function	2017-01-31

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Contents

1.General Description

LDR6022 is a single port USB Type-C and USB Power Delivery 3.0 controller dedicates to smart power source and docking station applications. Besides standard USB PD power profiles, LDR6022 supports linear voltage regulation output mode (3.0V to 20V), constant current output mode (0.1A to 5.0A) , and constant power output mode. This feature is called AnyWatt™.

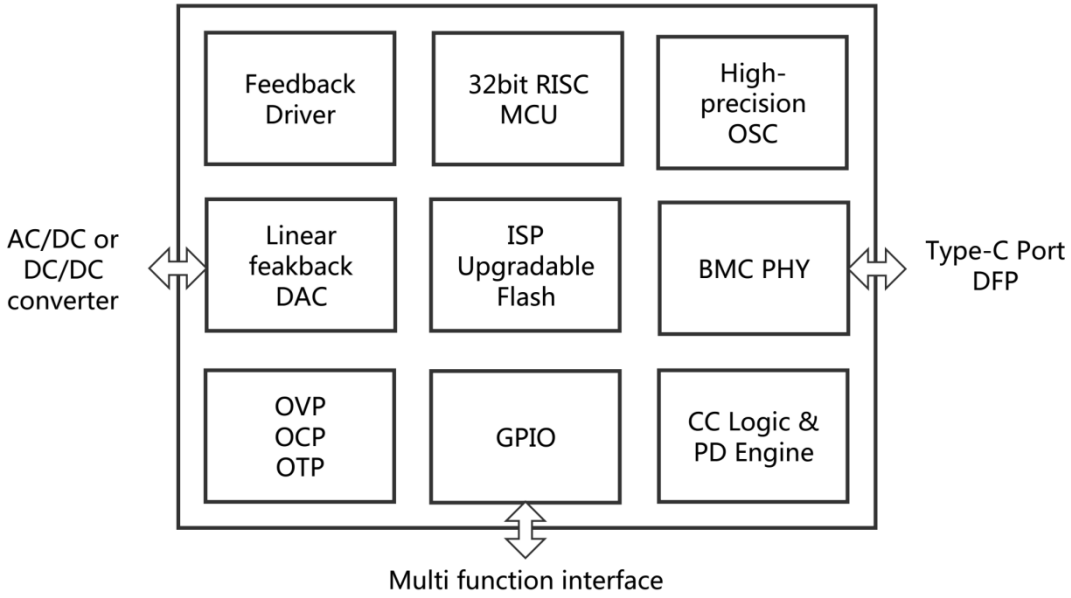

Figure 1. LDR6022 Block Diagram

1.1 Features

- USB Type-C Spec Rev1.2 compatible
- USB PD Spec Rev3.0 compatible
- Support OVP,OCP,OTP functions
- Support PPS 3V to 21V linear voltage output mode
- Support AnyWatt 3V to 20V linear voltage output mode
- Support firmware upgrade via Type-C port
- Support Data Swap to SRC/UFP Role

1.2 Applications

- AC adapters/Smart Charger
- Car chargers
- Power banks
- Docking Stations

1.3 Pin-outs

1.3.1. LDR6022 Pin-out Diagram

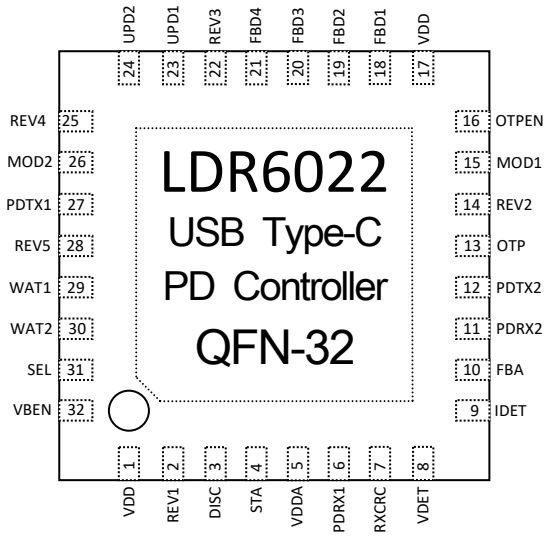

Figure 2. LDR6022 Pin-out

1.3.2. LDR6022 Pin-out Description

Pin No.	Name	Type	Description
1	VDD	P	Power Input Vcc=2.8V
2\14\22 25\28	REV	-	Reserved
3	DISC	O	VBUS Discharge
4	STA	I	Regulator output for filter capacitor
5	VDDA	P	Analog Power Input Vcc=2.8V
6	PDRX1	I	BMC receiver Channel 1
7	RXCRC	I	BMC CRC
8	VDET	I	VBUS Voltage Detect
9	IDET	P	VBUS Current Detect
10	FBA	O	Feedback Driver for Linear voltage
11	PDRX2	I	BMC receiver Channel 2
12	PDTX2	O	BMC Transmit Channel 2

13	OTP	I	ADC input pin for over temperature protection
15	MOD1	O	System clock output
16	OTPEN	O	Power of NTC resistor for OTP
17	VDD	P	Power Input Vcc=2.8V
18\19 20\21	FBD	IO	FBDX Feedback resistor pins for fixed output
23	UPD1	IO	Firmware upgrade interface A, connect to C1 port A8 pin
24	UPD2	IO	Firmware upgrade interface B, connect to C1 port B8 pin
25	PDEN	O	PD engine enable
26	MOD2	I	External clock input
27	PDTX1	O	BMC Transmit Channel 1
29	WAT1	I	Power setting options 1
30	WAT2	I	Power setting options 2
31	SEL	I	System Reference input, connect 100K to GND
32	VBEN	O	VBUS Enable
PAD	PAD	G	Ground

Type: P-Power; G-Ground; I-Input; O-Output; IO-Input/Output.

2. Functions

2.1. Fixed voltage output mode (Default)

In this mode LDR6022 can be configured by WATx pins and FBDx pins to provide normal USB PD Profiles, or user defined power profiles.

Table1 . WAT1 and WAT2 functions

WAT1	WAT2	Max Power (W)
0	0	24
1	0	30
0	1	45
1	1	60(default)

Table2. FBDx Functions

FBD1	FBD2	FBD3	FBD4	Power profiles
GND	GND	GND	GND	5V Only
FB Resistor	GND	GND	GND	5V/9V
FB Resistor	FB Resistor	GND	GND	5V/9V/12V
FB Resistor	FB Resistor	FB Resistor	GND	5V/9V/12V/15V
FB Resistor	FB Resistor	FB Resistor	FB Resistor	5V/9V/12V/15V/20V
FB Resistor	GND	FB Resistor	FB Resistor	5V/9V/15V/20V

*in fixed voltage output mode FBA pin is ignored

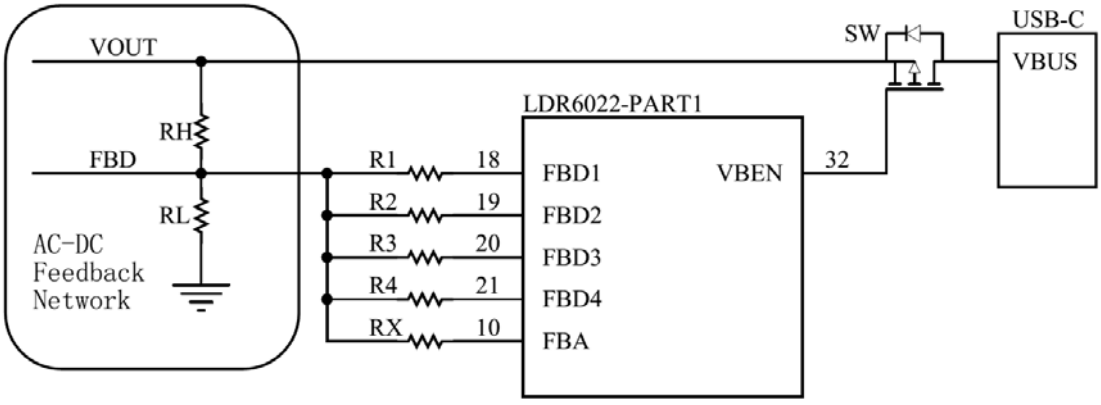

Figure 3. FBDx Functions

The output voltage is set using a resistive voltage divider from the output voltage to FBD. The voltage divider divides the output voltage down by the ratio:

$$V_{FBD} = V_{OUT} \times \frac{R_L}{R_H + R_L}$$

In most case of AC-DC application, the VFBD is determine by TL431, A typical value for the voltage divider RH is 12.7KΩ, and RL is 12.1KΩ.

Thus, to change the output voltage, the FB Resistor (R1/R2/R3/R4) will be set by the following formula:

$$R = \frac{R_H \times R_L \times V_{FBD}}{R_L \times V_{OUT} - R_L \times V_{FBD} - R_H \times V_{FBD}}$$

2.2 PPS Output Mode

LDR6022 is able to send Programmable Power Supply APDO to SNK. The data structure of the APDO is described in the Table 6-13 of USB PD3.0 Spec V1.1.

Table 3 Data Structure of Programmable Power Supply APDO

Bit(s)	Description
B31...30	11b – Augmented Power Data Object (APDO)
B29...28	00b – Programmable Power Supply 01b...11b - ***Reserved, Shall Not*** be used
B27...25	***Reserved – Shall*** be set to zero
B24...17	Maximum Voltage in 100mV increments
B16	***Reserved – Shall*** be set to zero
B15...8	Minimum Voltage in 100mV increments
B7	***Reserved – Shall*** be set to zero
B6...0	Maximum Current in 50mA increments

If the connected SNK request an APDO that can be satisfied, LDR6022 will enter PPS output mode and reply accept. In this mode LDR6022 is able to provide 3V to 21V fixed voltage output step by 20mV according to the RDO of the SNK.

Table 4 Programmable Request Data Object

Bits	Description
B31	***Reserved – Shall*** be set to zero
B30...28	Object position (000b is ***Reserved*** and ***Shall Not*** be used)
B27	***Reserved – Shall*** be set to zero
B26	Capability Mismatch
B25	USB Communications Capable
B24	No USB Suspend
B23	Unchunked Extended Messages Supported
B22...20	***Reserved - Shall*** be set to zero.
B19...9	Output Voltage in 20mV units
B8...7	***Reserved - Shall*** be set to zero.
B6...0	Operating Current 50mA units

2.2 Linear fixed voltage output mode

In this mode LDR6022 is able to provide 3V to 20V fixed voltage output step by 50mV according to the sink capability messages provided by the SNK. By sending request messages with capability mismatch bit, SNK is able to change the output voltage dynamically, but the maximum power is limited by the WATX configure according to Table-1 and the maximum output voltage is limited by the FBDX configure according to Table-2. If there is not e-marker cable detected the maximum current will be limited to 3A.

In order to enter this mode, the capability mismatch field bit of the request message that sent by the sink shall be set to 1'b. After evaluating this special request, LDR6022 will finish the current power negotiation process with accept/ps_ready or reject. After that, LDR6022 will send a get sink capability message to make sure how to match the SNK's request. If the SNK answer with a fixed type sink capability message, LDR6022 will enter the linear fixed voltage output mode. And create a new source capability message according to the sink capability message and the maximum power.

In this mode, if the cc connection is reset or a hard reset message is sent, LDR6022 will return to the default fixed voltage output mode. (2.1)

In this mode, if the sink sends a variable type sink capability messages LDR6022 will change to the constant current output mode. (2.3)

The detail communication process is shown as Figure 4 and Figure 5

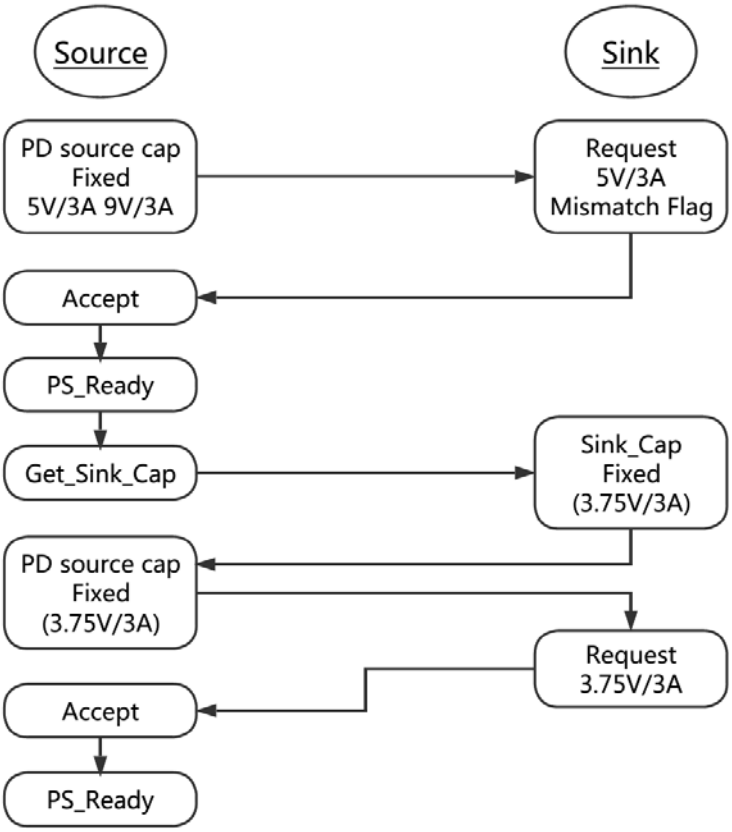

Figure 4. Linear fixed voltage output mode

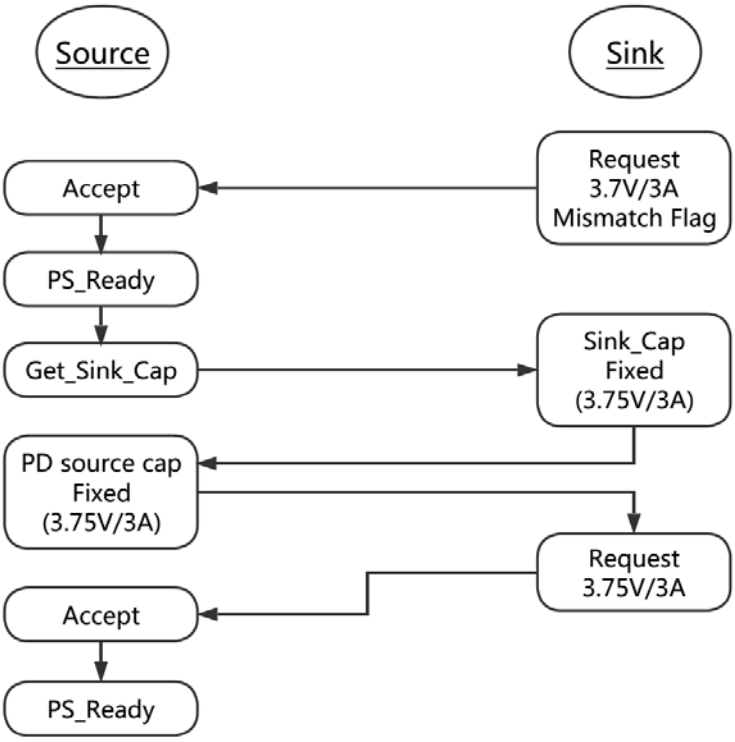

Figure 5. Sink request to increase 50mV voltage

2.3. Const Current output mode

In this mode LDR6022 is able to provide 0.1A to 5A constant current output step by 100mA according to the variable type sink capability messages provided by the SNK. By sending request messages with capability mismatch bit, SNK is able to change the output current dynamically. LDR6022 will automatically control the output voltage between the maximum voltage which is defined by Bit20 to Bit29 of the variable type PDO and the minimum voltage which is defined by Bit10 to Bit19 of the variable type PDO. If fail to achieve the specified current output between the maximum and minimum voltage, LDR6022 will output the maximum voltage in case the current is less than the specified current or minimum voltage on the other hand. Anyway, the maximum power is limited by the WATX configure according to Table-1 and the maximum output voltage is limited by the FBDX configure according to Table-2. If there is not e-marker cable detected, the maximum current will be limited to 3A.

In order to enter this mode, the capability mismatch field bit of the request message which sends by a sink shall be set to 1'b, and the capability messages of source or sink must be the variable supply type.

The communication process shows as Figure 6.

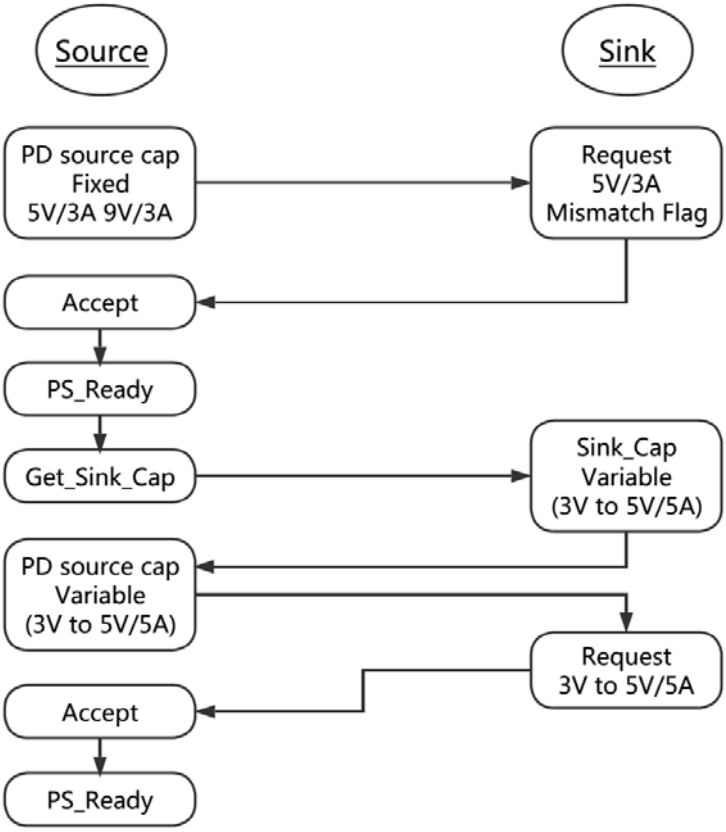

Figure 6. Const Current output mode

2.4. Const power output mode

In this mode LDR6022 is able to provide 500mW to 100W constant power output step by 250mW according to the battery type sink capability messages provided by the SNK. By sending request messages with capability mismatch bit, SNK is able to change the output power dynamically. LDR6022 will automatically control the output voltage between the maximum voltage which is defined by Bit20 to Bit29 of the battery type PDO and the minimum voltage which is defined by Bit10 to Bit19 of the battery type PDO. If fail to achieve the specified power output between the maximum and minimum voltage, LDR6022 will output the maximum voltage in case the power is less than the specified power or minimum voltage on the other hand. Anyway, the maximum power is limited by the WATX configure according to Table-1 and the maximum output voltage is limited by the FBDX configure according to Table-2. If there is not E-Marked cable detected, the maximum current will be limited to 3A.

In order to enter this mode, the capability mismatch field bit of the request message which sends by a sink shall be set to 1'b, and the capability messages of source or sink must be the battery supply type.

The communication process shows as Figure 6.

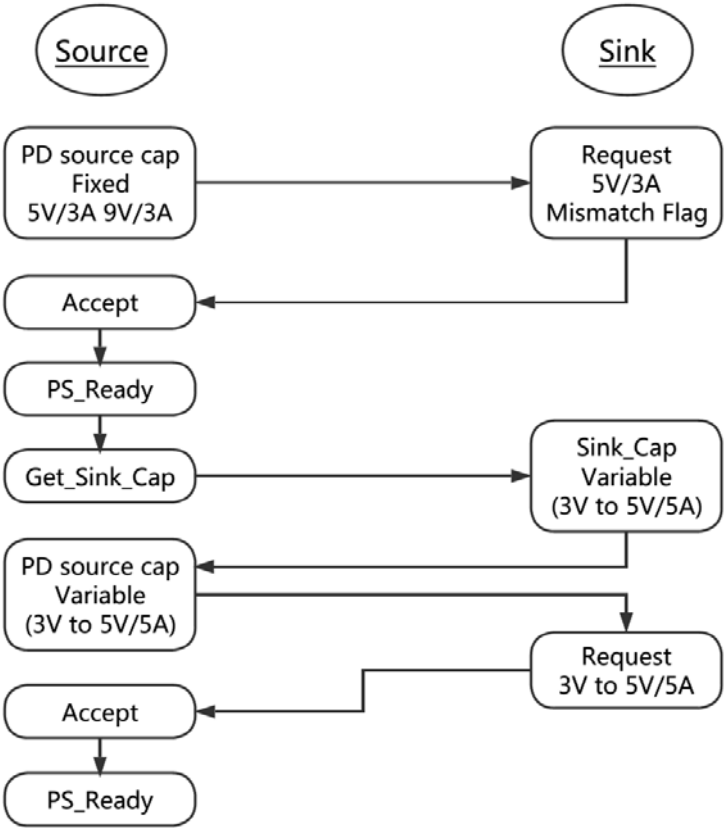

Figure 6. Const Current output mode

2.5 Data Swap to SRC/UFP mode

After the first power negotiation, LDR6022 will try to send a data swap message and turn to SRC/UFP role. No matter in which power output mode, LDR6022 will accept data swap request message.

2.6 OVP/OCP/OTP

The VDET/IDET/OTP pins are the ADC input pins for the three functions. The tolerance limit of LDR6022's OVP and OCP is 20%. The OTP limit point depends on the NTC resistor and the reference resistor. LDR6022 will disable the VBEN to turn off the VBUS output when the voltage of pin OTP is lower than 0.105V.

For example R_{REF}=10K, R_{NTC}=10K, when temperature is 120℃ , R'_{NTC}=0.3894K, the pin OTP should detect a ADC value:

$$V_{OTP} = V_{DD} \times \frac{R'_{NTC}}{R'_{NTC} + R_{REF}} = 2.8 \times \frac{0.3894}{0.3894 + 10} = 0.105V$$

In this case the limited temperature is 120℃. To change this point just changes the R_{REF}.

3. Electrical Characteristics

3.1 Maximum Ratings

Parameter	Description	Min/Max	Unit
VCC	Power supply	-0.3/3.6	V
V_I	Voltage input	-0.3/3.6	V
V_0	Voltage output	-0.3/3.6	V
T_{stg}	Storage temperature	-65/150	℃

3.2 ESD Characteristics

Parameter	Description	Range	Unit
V_{ESD}	Human body model ESD	±2000	V
	Machine model ESD	±1000	V

3.3 Operating Ranges

Parameter	Description	Min/Max	Unit
VCC	Power supply	2.77/2.83	V
Ta	Storage temperature	-40/85	℃

*VCC is also the reference voltage for output

4. Application Solution

NOTE: Information in the following applications sections is not part of the LDR component specification, and LDR does not warrant its accuracy or completeness. LDR's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

4.1. PD Adapter Module

5. Package Dimension