15W Wireless Power Receiver

Description

The CV8035D is a highly-integrated Wireless power single-chip (SoC) , The device can be configured to receiver or transmitter modes, when the devices work in transmitter mode, The rectify bridge work as full/half

Bridge inverter, has a 16bits PWM generator, with dead-zone regulating. Embedded demodulator for Communication.When device work as receiver mode, The device receivers an AC power from a wireless transmitter, embedded a high efficiency synchronous full bridge rectifier converts to DC power, Embedded modulation and FSK demodulation circuits supports bi-direction communication,

A Microprocessor manages power receiver/transformer and communication, through a I2C port connect with mobile phones AP, Embedded 16K Bytes MTP memory to support on line debugging and OTA function, low power design to meet the energy star requirements.

The device includes over-temperature, over-current and over/under voltage protections. The CV8035D is available in 52-WLCSP package.

Features

- Compliance with WPC V1.2.4 BPP&EPP
- 16Kbytes Multiple-time programmable(MTP) no-volatile memory;
- Support private profile/protocol extension
- Support I2C 400KHZ standards interface and GPIOS
- Embedded 12bits high accuracy ADC
- Embedded +/- 2% accuracy OSC in full temperature rank
- Low standby and operating power consumption
- Voltage tolerance over 36V
- Receiver mode
  --- Delivers up to 18W
  --- High Efficiency synchronous rectifier with low Rds(on)
  ---Low dropout regulator with low Rds(on)
  ---High accuracy frequency detection for FSK communication
  ---Output Voltage up to 15V, with 0.2V regulation/step from 3.6V~15V
  ---Programmable current limit
  ---Programmable Clamping voltage and strength
- Package: 6x9 Ball array, 2.8x3.9mm, 52WLCSP with 0.4mm ball pitch

Wireless power system

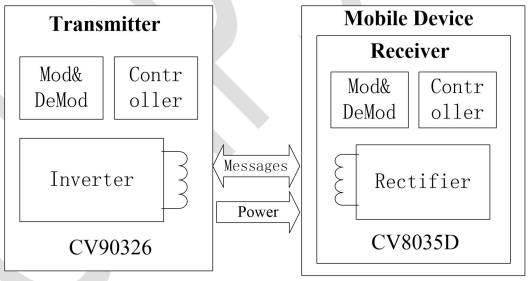


Figure 1

Typical Applications

- Wireless power RTx solution for portable devices
- Mobile phone
- Power bank
- E-cigarettes
- Tablets
- Accessories
- Stationary device power supply

1 System diagram

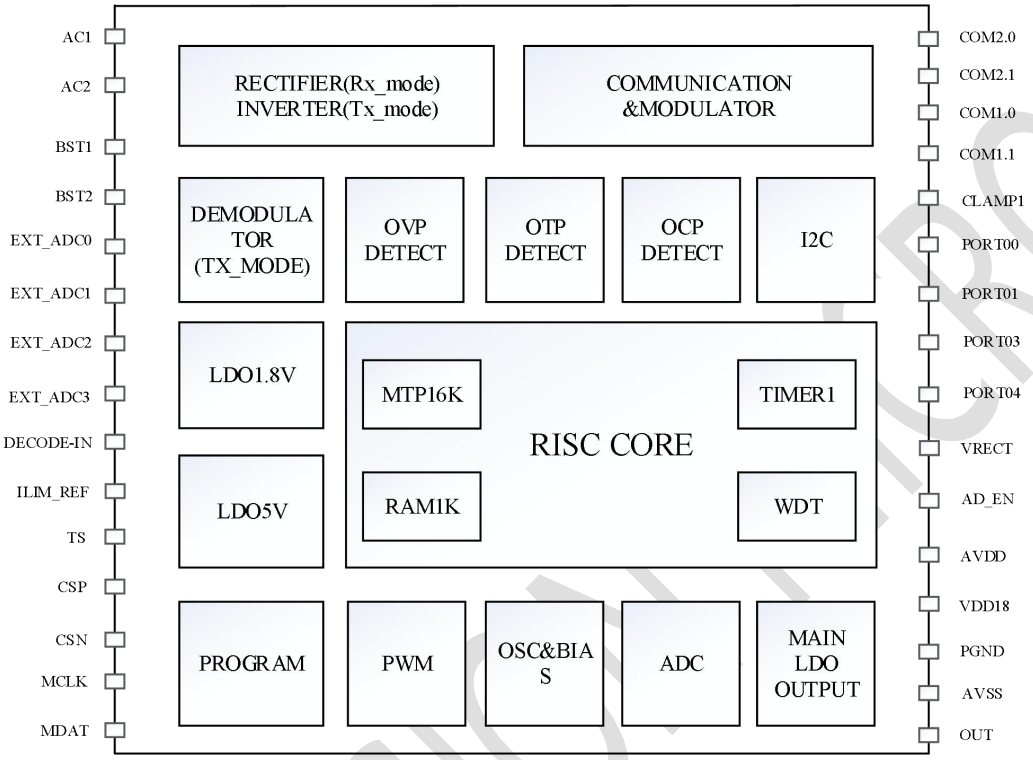


Figure 2

Wireless power system description

The CV8035D is a highly-integrated wireless power transmitter and receiver dual-function IC for mobile or stationary devices, The internal block diagram of CV8035D is shown in figure 2. The device can transmit up to 5W in WPC Transmitter mode and receiver up to 20W power, It also can support PMA mode (option).

Tx mode

In Tx mode, The power will input through Vout pin, The processor will control Rectify full bridge to work as inverter bridge, A high resolution PWM to control the inverter bridge work as half/full bridge modes, and dead-zone setting, A high resolution Voltage modulation decoding to get Rx's instruction through DEMOD filter shown in Figure 3, Based on the received packet, the CV8035D will adjust the operating frequency to match the transmitted power level to reliable wireless power transfer, A high resolution PWM controller ensure system in higher efficiency。

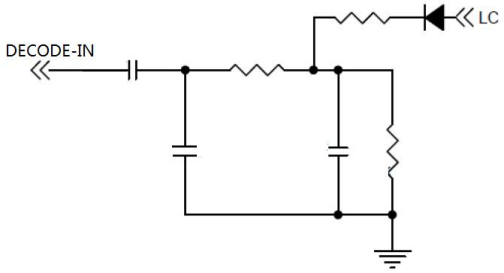


Figure 3

Power Control

The voltage across the Vrect and the current through the rectifier are periodically sampled and digitized by the ADC. The digital equivalent of voltage and current is provided to internal control logic that determines if the operating point needs to be changed based on the load conditions on the Vrect. If the load is heavy enough to cause the voltage at Vrect to be below the target value, the power transmitter is instructed to reduce its frequency, near resonance. If the voltage at Vrect is above its target, the power transmitter is instructed to increase its frequency. To maximize efficiency, the voltage of the Vrect is programmed to decrease as the LDO load current increases.

Power Transfer

When a mobile device containing the CV8035D is placed on the WPC "QI" charging pad, the CV8035D responds to the transmitter's "Ping" signal, completing the "Identification and Configuration". Once the "Identification and Configuration" phase is completed and successfully negotiated and calibrated, the transmitter will initiate the power transfer mode. The CV8035D control circuit measures the Vrect voltage and sends a control error packet to the power transmitter, adjusting the Vrect voltage to achieve optimum efficiency of the LDO. At the same time, the rectifier bridge power data packet is sent to the power transmitter as the basis of the transmitter foreign object detection (FOD) to ensure safe and effective power transmission.

Synchronous Rectifier

The CV8035D 's built-in synchronous rectifier bridge can effectively improve the rectification efficiency. When the load is higher than 200mA, the rectifier bridge operates in a synchronous full-bridge rectification manner. When the load is less than 200 mA, the rectifier bridge operates in a semi-synchronous full-bridge rectification mode. During the power-on phase, when the Vrect voltage is lower than the uvlo threshold, the rectifier bridge is fully bridge rectified by the NMOS body diode. The BST capacitor is used to provide a switching drive voltage for the NMOS of the upper bridge.

Advanced Foreign Object Detection（FOD)

When the metal is placed in an alternating magnetic field, the electromagnetic eddy current heats the metal. For example, coins, keys, paper clips, etc. The degree of heating depends on the amplitude and frequency of the coupled magnetic field, as well as the resistivity, size and shape of the object. In wireless energy transmission systems, this heat is energy loss, reducing energy transfer efficiency. If proper measures are not taken, metal objects are continuously heated and high temperatures are generated, which may cause other dangerous situations.

In addition, there may be other metals in the final product design of the WPC power transmitter and receiver (these metals are neither part of the power transmitter nor part of the power receiver, but will be from the coupled AC magnetic field during power transmission). Absorbing energy, causing power loss, such as lithium-ion batteries, metal ICs, etc., so FOD detection also needs to compensate for the power loss caused by these metals.

The CV8035D uses advanced FOD technology to detect foreign objects placed on or near the launch pad. The FOD settings can be optimized through an I2C interface or programming to match the power transfer characteristics of each particular WPC system, including power losses for TX and RX coils, batteries, shields, and housing materials from no load to full load. These values are based on a comparison of the received power to the reference power curve so that any foreign matter can be detected when the received power is different than the expected system power.

Over Voltage Protection

If the input voltage increases above 15V, the control loop disables the LDO, sends a control error packet to the power transmitter to attempt to restore the rectifier voltage to a safe operating voltage level, and uses high voltage open drain (Clamp1) to control the OVP FET to the input voltage. Clamping allows Vrect to stabilize. The clamp is released when the Vrect voltage is below the VOVP hysteresis calibration level. Cannot be used directly with Vrect.

Over Temperature、 Over Current Protection

Both the over temperature protection threshold and the over current protection threshold of the CV8035D can be programmed. When the output current of the CV8035D exceeds the over current protection threshold or the detected temperature exceeds the over temperature protection threshold, the CV8035D turns off the LDO output and sends a charge end packet to the power transmitter to terminate the power transfer.

Status Output

GPIO2-4 can be selected to indicate the current working status. For example, charging is completed, charging is abnormal, and the like.

LDO

The CV8035D has three LDOs built in, a high-power LDO, programmable select outputs of 3.6V--15V, VDD5V LDO and VPP18 LDO (VDD5V and VPP18 are both used to power the internal low-voltage operating modules). A filter capacitor is required on each LDO pin.

WPC Mode Communication

Modulation method

According to the WPC specification, in the wireless medium power transmission system, the duplex communication method is adopted: the communication sent by the receiver to the transmitter - the amplitude shift keying (ASK) and the communication sent by the transmitter to the receiver - frequency shift keying (FSK) .

The communication signal sent by the receiver to the transmitter is controlled by the baud rate of 2kpbs to control the external capacitor connected to the internal switch and AC1/AC2 to be grounded or suspended to adjust the load on the receiving inductor coil for modulation. This causes the output impedance of the transmitter to change, and this communication signal is ultimately reflected in the resonant amplitude of the transmitting coil. The transmitter acquires communication data by detecting changes in voltage or current on the transmitting coil.

The communication signal sent by the transmitter to the receiver is modulated by changing the frequency of the AC power signal of the transmitter. The receiver detects a frequency change and acquires communication data. A handshake protocol is established with the transmitter through this communication data.

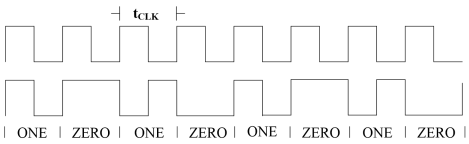
Data Format

According to the WPC specification, the CV8035D communicates with the power transmitter or receiver in the form of data packets. The format of the data packet is as follows:

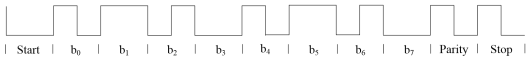
Preamble	Header	Message	Checksum

Encoding

According to the WPC specification, the CV8035D uses a 2 kHz clock frequency to modulate data bits onto the power signal using a two-phase differential encoding. Logic one uses two narrow transforms for encoding, while logic zero uses two wide transforms for encoding, as follows:

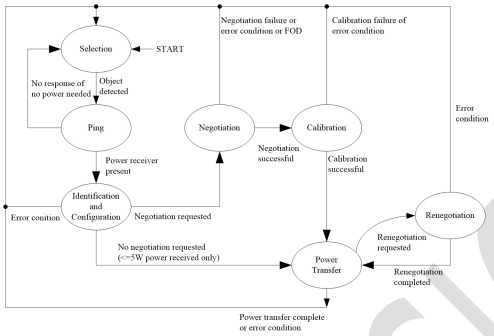


Each byte in the communication packet includes 11 bits in the asynchronous serial format as follows:



System Feedback Control

The CV8035D is fully compatible with WPC (latest specification) and has all the necessary circuitry to communicate with the transmitter or receiver via a WPC communication packet.
The communication process between the transmitter and the receiver is as follows:



ThcCV8035D goes through five phases：
Selection，Ping，Identification & Configuration，Negotiation，Calibration & Power Transfer

Selection

At this stage, the CV8035D receives or transmits wireless power and enters the ping phase. When the Vrect voltage is higher than UVLO, the CV8035D is ready to communicate with the transmitter or enter the power ping mode.

Ping

At this stage, the CV8035D sends a signal strength packet as the first communication packet to instruct the sender to keep the power signal on (or the CV8035D detects the signal strength packet). After transmitting/receiving the signal strength packet, the CV8035D enters the identification and configuration phase. Conversely, if a transport end packet is sent, it will remain in the ping phase.
At this stage, the following two messages are sent/expected:

- Signal strength packet
- End of power packet

Identification & Configuration

At this stage, the following two messages are sent/expected:

- Identification packet
- Configuration packet

NEGOTIATION

The receiver negotiates with the transmitter to adjust the transmitter. In this process, the receiver sends a negotiation request to the transmitter, and the transmitter can agree or reject the negotiation request.

CALIBRATION

At this stage, the receiver provides the received power to the transmitter.

POWER TRANSFER

- At this stage, the CV8035D controls power transfer through the following control packets:
- Control error packet
- Rectified power packet
- End power transfer packet

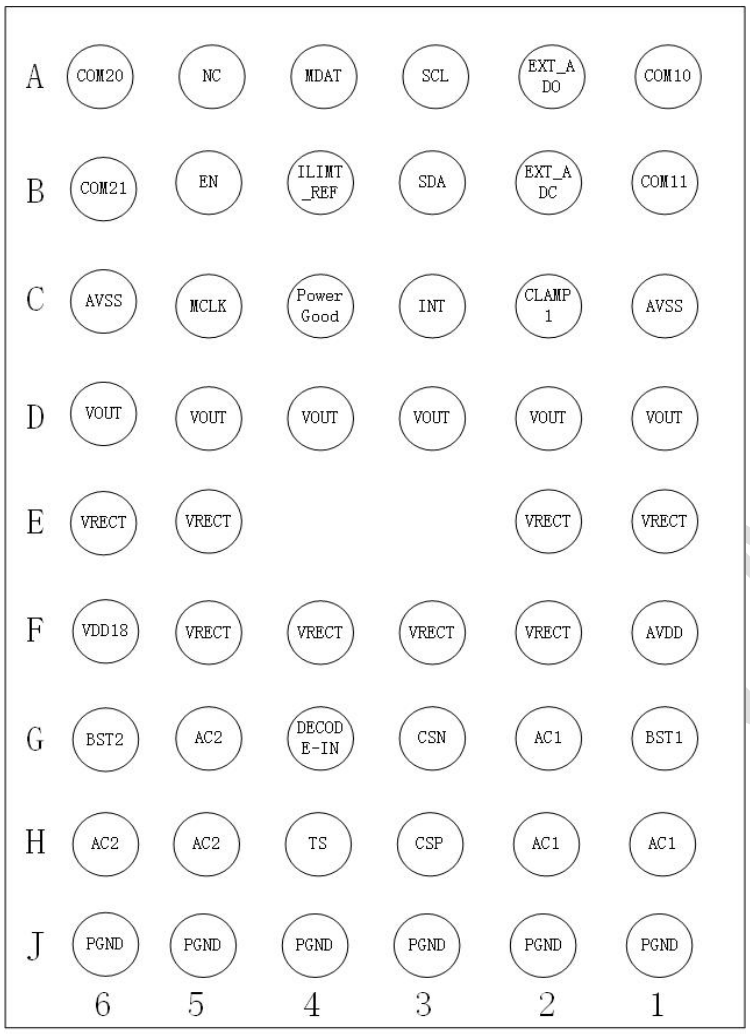
RE-NEGOTIATION

At this stage, the receiver can communicate with the transmitter to adjust if needed. This phase can be terminated early without changing the transmit power.

END OF POWER

When the load on the receiver ends the power request (eg, charging is completed), the CV8035D turns off the LDO output, and continuously transmits the transmission end packet to the transmitter until the transmitter ends the power transmission, or the receiver's Vrect voltage is lower than the UVLO threshold.

2 I/O Interface description



Ball View

CV8035D Pin Definition：

Ball NO	Pin Name	I/O	Description
A1	COM10	O	Communication modulation signal output
A2	EXT_AD0	A	External AD0 pin
A3	SCL	I/O	I2C clock pin. Open-drain output. Connect a 5.1kΩ resistor to VDD18 pin.
A4	MDAT	I/O	Program data
A5	NC		NC
A6	COM20	O	Communication modulation signal output

Ball NO	Pin Name	I/O	Description
B1	COM11	O	Communication modulation signal output
B2	EXT_ADC	A	External ADC 2 pin
B3	SDA	I/O	I2C Data pin. Open-drain output. Connect a 5.1kΩ resistor to VDD18 pin.
B4	ILIMT_REF	I	Programmable over-current limit pin. Connect this pin to the center tap of a resistor divider to set the current limit. For more information about the current limit function, see section 5.1
B5	/EN	I	Active-LOW enable pin. Pulling this pin to logic HIGH forces the device into Shut Down Mode.When connected to logic LOW, the device is enabled. Do not leave this pin floating.
B6	COM21	O	Communication modulation signal output
C1	AVSS	A	Analog GND
C2	CLAMP1(HOVD)	O	Open drain output for over voltage protection, Which will be triggered, once the Vrect over setting voltage. Connect a resistor from this pin to the Vrect pin, for more detail information about over voltage setting, see section5.2
C3	/INT	O	Interrupt flag output pin, It is an open-drain output for fault interrupt. It will be pulled to LOW if any of fault exists: an Over-Voltage is detected， an over-current is detected, the die temperature exceeds 130° C,or an external T-sensor exceeds setting condition is detected, connect to VDD18 through a 10Kohm resistor，
C4	Power Good	I	GPIO， charging status indication.
C5	MCLK	I	Program CLK, connect a 10Kohm resistor to VDD18 pin.
C6	AVSS	A	Analog GND
D1	VOUT	A	Output voltage to load

D2	VOUT		
D3	VOUT		
D4	VOUT		
D5	VOUT		
D6	VOUT		
E1	VRECT	A	Output voltage of the synchronous rectifier bridge. Connect three 10μF capacitors from this pinto GND
E2	VRECT	A	
E5	VRECT	A	
E6	VRECT	A	
F1	AVDD	A	Internal 5V regulator output voltage
F2	VRECT	A	Output voltage of the synchronous rectifier bridge. Connect three 10μF capacitors from this pinto GND
F3	VRECT	A	
F4	VRECT	A	
F5	VRECT	A	
F6	VDD18	A	Internal 1.8V regulator output voltage. Connect a 1μF capacitor from this pin to ground.
G1	BST1	A	Boost capacitor for driving the high-side switch of the internal rectifier
G2	AC1	A	AC input power. Connect to the resonant capacitor
G3	CSN	I	Floating, Had been contact in internal.
G4	DECODE-IN	I	Voltage decoding input on TX_mode
G5	AC2	A	AC input power. Connect to the Rx coil
G6	BST2	A	Boost capacitor for driving the high-side switch of the internal rectifier. Connect a 15nFcapacitor from the AC2 pin to BST2
H1	AC1	A	AC input power. Connect to the resonant capacitor
H2	AC1		
H3	CSP	I	Floating, Had been contact in internal.
H4	TS	A	Temperature monitoring, externally connected to the thermistor ADC pin, see

			section 5.3
H5	AC2	A	AC input power. Connect to the resonant capacitor
H6	AC2		
J1	PGND	P	GND
J2	PGND		
J3	PGND		
J4	PGND		
J5	PGND		
J6	PGND		

3 Electrical specification

Symbol	Description	Conditions	Min	Typ	Max	Units
Input Supplies & UVLO (Tx Mode)						
V_{IN_OUT}	V_{OUT} Input Operating Voltage Range		4.5	5	12	V
VIN_UVLO	Under-Voltage Lockout	VIN Rising		2.8		V
		VIN Failing		200		mV
I_{SHD}	Shutdown Current	V_{EN} = V_{IN}		500		uA
Input Current Sense (Tx Mode)						
V_{SEN_OFST}	Amplifier Output Offset voltage	Measured at amplifier output node; V_{ISH} =V_{ISL}		0.6		V
$ISEN_{ACC\_TYP}$	Measured Current sense accuracy	V_{R_ISNS} =10mV		±2		%
Analog to Digital Converter						
N	Resolution			12		Bit
f_{sample}	Sampling Rate			67.5		kSa/s
Channel	Number of channels			12		
$V_{IN,FS}$	Full scale Input voltage			5		V
Thermal Shutdown						
TSD	Thermal shutdown	Threshold Rising		140		℃
		Threshold Falling		120		℃
Clocks						

F_{LSOSC}	System clock			16.2		Mhz
General Purpose Inputs/Outputs						
V_{IH}	Input threshold high		1.35			V
V_{IL}	Input threshold low				0.5	V
I_{LKG}	Input Leakage Current	0V and 1.8V	-1		1	uA
V_{OH}	Output logic high	I_{OH} = 4mA, 12mA total	1.44			V
V_{OL}	Output logic low	I_{OL} = 12mA			0.36	V
SCL, SDA (I_2C Interface)						
f_{SCL}	Clock Frequency				400	khz
$t_{HD,STA}$	Hold Time (Repeated) for START Condition		0.6			us
$t_{HD:DAT}$	Data Hold Time		0			ns
t_{LOW}	Clock Low Period		1.3			us
t_{HIGH}	Clock High Period		0.6			us
$t_{SU:STA}$	Set-up Time for Repeated START Condition		0.6			us
t_{BUF}	Bus Free Time Between STOP and START Condition		1.3			us
C_B	Capacitive Load for Each Bus Line			150		pF
C_I	SCL, SDA Input Capacitance			5		pF
V_{IL}	Input Threshold Low				0.7	V
V_{IH}	Input Threshold High		1.4			V
I_{LKG}	Input Leakage Current	V = 0V and 5V	-1		1	uA
V_{OL}	Output Logic Low	I_{OL} = 12mA			0.36	V

4 Application

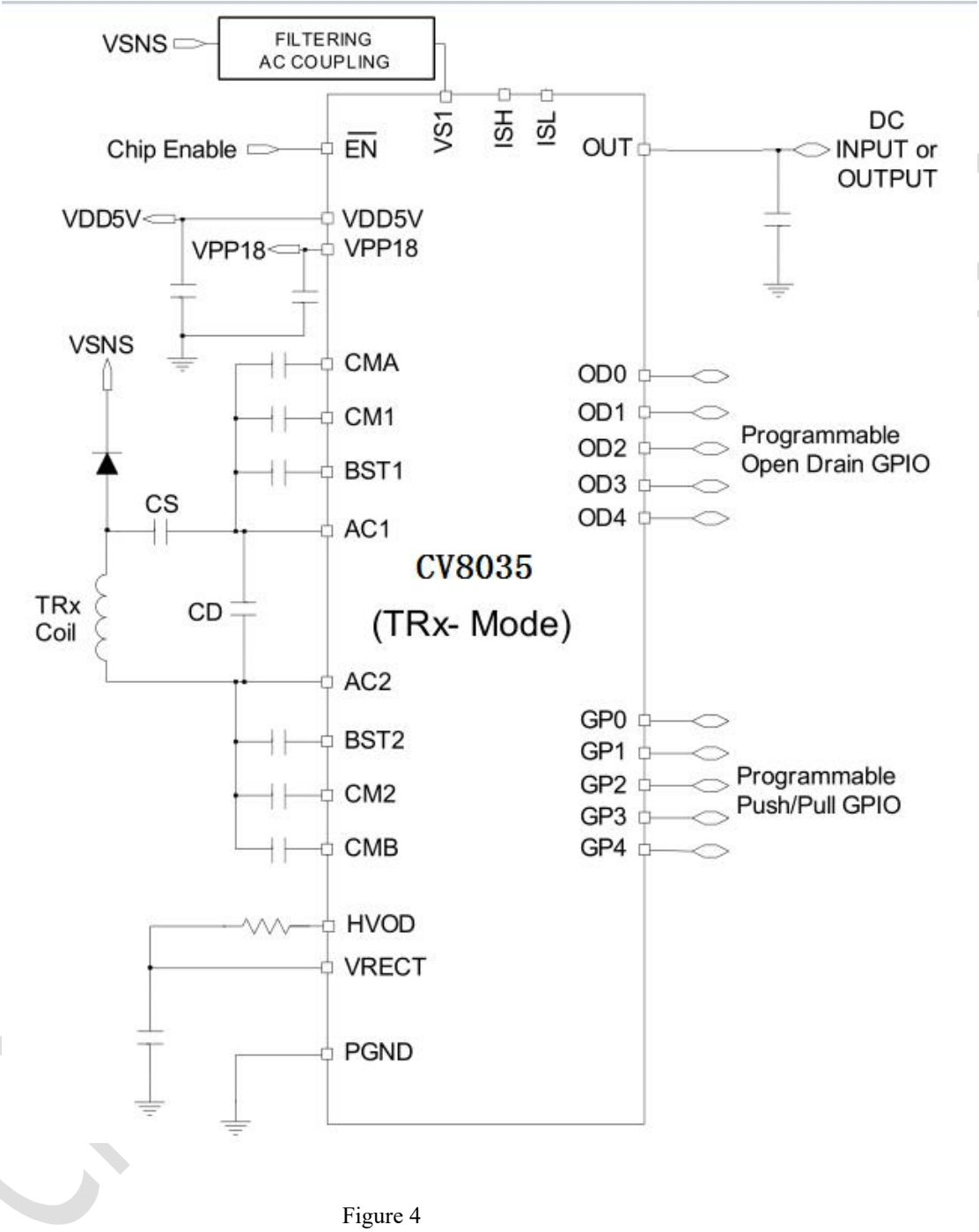
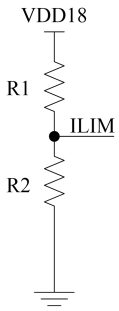


Figure 4

5 Setting and Configuration

5.1 Over-Current limit –ILIM setting

The device has a programmable current limit function for protecting the device in the event of an over-current or short-circuit fault condition.When the output current exceeds the programmed threshold, the device will shut-down. The current limit should be set to 130% of the target maximum output current. To set the over current though a resistor divider.



The calculation formula as following:

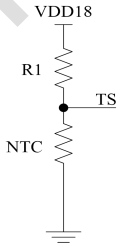
The current limit I(mA) = 1.8*R2/(R1+R2)*500mA/0.33；

5.2 Clamp1 (HOVD) pin

The CV8035D ha embedded a programmable DC clamping to protect the device in the event of high voltage transients, which is a programmable current source, the dissipation capability are 40mA, 80mA, 120mA.

5.3 External Temperature sensing –TS

has a temperature sensor input, TS, which can be used to monitor an external temperature by using a thermistor.



The calculation formula as following:

Vts=1.8*NTC/（R1+NTC）；

6 Application circuit

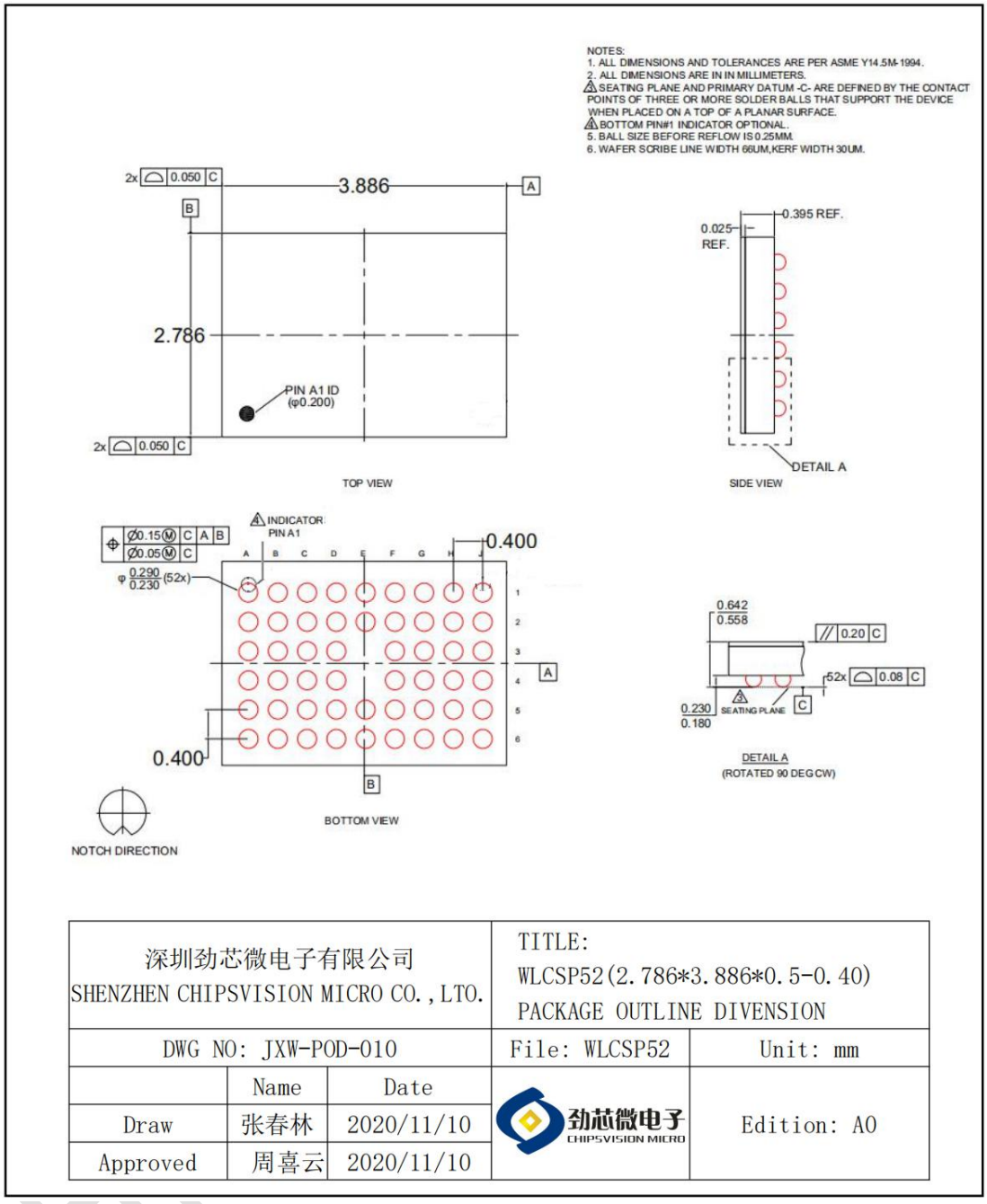
The circuit reference design is on page 17 of this document.

7 Package info

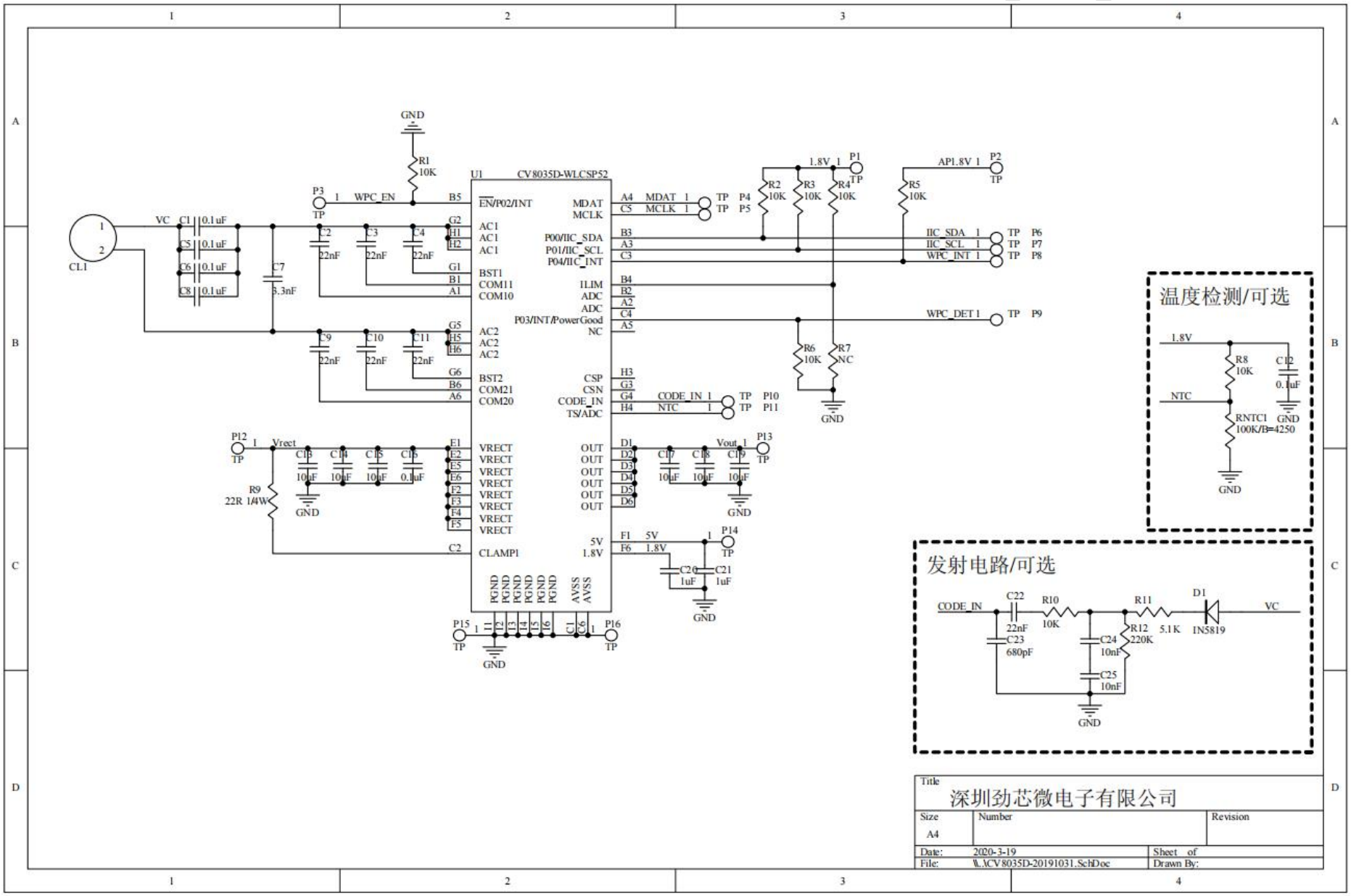
The package outline drawings is on page 16 of this document.

8 Ordering Information

Orderable Part Number	Description and Package	MSL Rating	Shipping Packaging	Ambient Temperature
CV8035D	CV8035D Wireless Power Receiver for 15W , 2.8x3.9 mm WLCSP-52	MSL1	Tape and reel	0°C to +85°C



深圳劲芯微电子有限公司 SHENZHEN CHIPSVISION MICRO CO.,LTO.			TITLE: WLCSP52(2.786*3.886*0.5-0.40) PACKAGE OUTLINE DIVENSION	
DWG NO: JXW-POD-010			File: WLCSP52	Unit: mm
	Name	Date	劲芯微电子 CHIPSVISION MICRO	Edition: A0
Draw	张春林	2020/11/10		
Approved	周喜云	2020/11/10		


U1 CV8035D-WLCSP52
EN/P02/INT
MDAT
MCLK
P00/IIC_SDA
P01/IIC_SCL
P04/IIC_INT
1LIM
ADC
ADC
P03/INT/PowerGood
NC
CSP
CSN
CODE_IN
TS/ADC
VRECT
CLAMP1
OUT
5V
1.8V
PGND
AVSS
BST1
COM11
COM10
BST2
COM21
COM20
AC1
AC2
WPC_EN
MDAT_1
MCLK_1
IIC_SDA_1
IIC_SCL_1
WPC_INT_1
WPC_DET 1
CODE_IN_1
NTC_1
Vrect
Vout_1
1.8V_1
AP1.8V 1
温度检测/可选
RNTC1 100K/B=4250
发射电路/可选
CODE_IN
IN5819
VC
GND
Title
深圳劲芯微电子有限公司
Size A4
Number
Revision
Date: 2020-3-19
Sheet of
File: \\..\CV8035D-20191031.SchDoc
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