CV90328B

WPC Qi Wireless Power Transmitter Datasheet

Description

The CV90328B is a system-on-chip device for magnetic induction wireless power transmitter application, supporting WPC specifications. The SoC is comprised of a MCU, Three half-bridge power stage drivers,12bits ADCs, high-speed PWM, a low offset Operational amplifiers , Demodulation unit, and 2000 times MTP memory.The device support I2C, Uart, SPI interface.The transmitter includes an industry-leading 32-bit ARM® Cortex®-M0 processor offering a high level of programmability while consuming extremely low standby power and meeting the ENERGY STAR® requirements. In addition, the microcontroller empowers the user to customize features such as LED patterns, buzzer, and FOD threshold settings.

The enhanced MCU and high-speed PWM can offer high High-precision power delivery, each analog part can be disable/enable, so chip consumes extremely low standby power and meet the Energy Star® requirements.

The transmitter includes input under-voltage, input over-voltage, output short circuit, and over-temperature protection.

The CV90328B is available in a Pb-free, 7x7 mm, 60pins-QFN package, and it is rated over the industrial temperature range of -40ºC to +85ºC

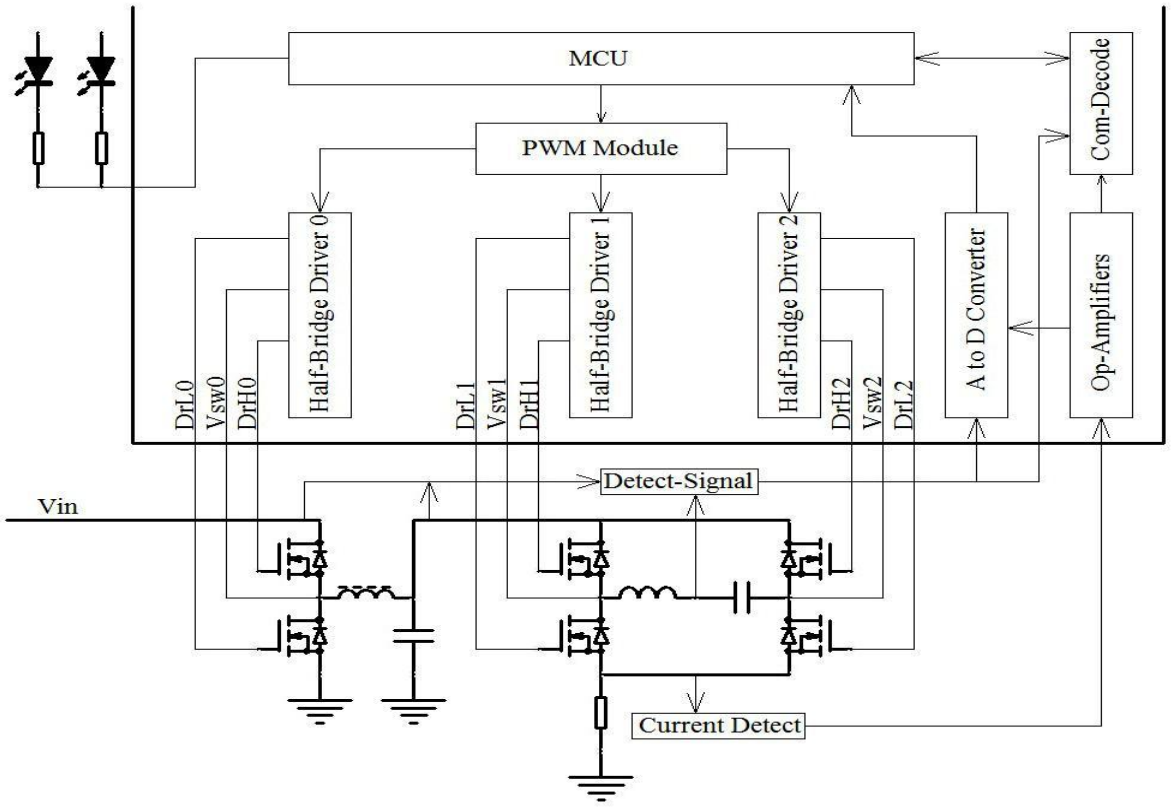
Figure 1. CV90328B Simplified application ciruit:

Features

- **Supply Voltage: 3.3V to 5.5V**
- **WPC-1.2.4 compatible (BPP & EPP)**
- **Supports over 15W high-speed charger Rx output power Support QC2.0，QC3.0 adapter**
- **Optimized for the best EMI performance**
- **Simultaneous voltage and current demodulation**
- **Embedded 8-bits enhanced 8051core, with 16kBytes NVRAM**
  - Buildded in simulation
  - module Built-in PLL Module
  - Embedded customized PWM module with 128MHz
  - Integrated gate drivers for external MOSFETs
- **Integrated 12bits 8-channel ADC**
  - Integrated low offset Op-Amplifiers with auto-calibration
  - 13 general I/O, with SPI, I2C and UART interface
  - Over-current and over-temperature protection -40ºC to +85ºC temperature range
- **Available in 7 x 7 mm, 60pins-QFN Package**

Typical Applications

- Charging pads
- Accessories
- **Cradles Portable instruments**



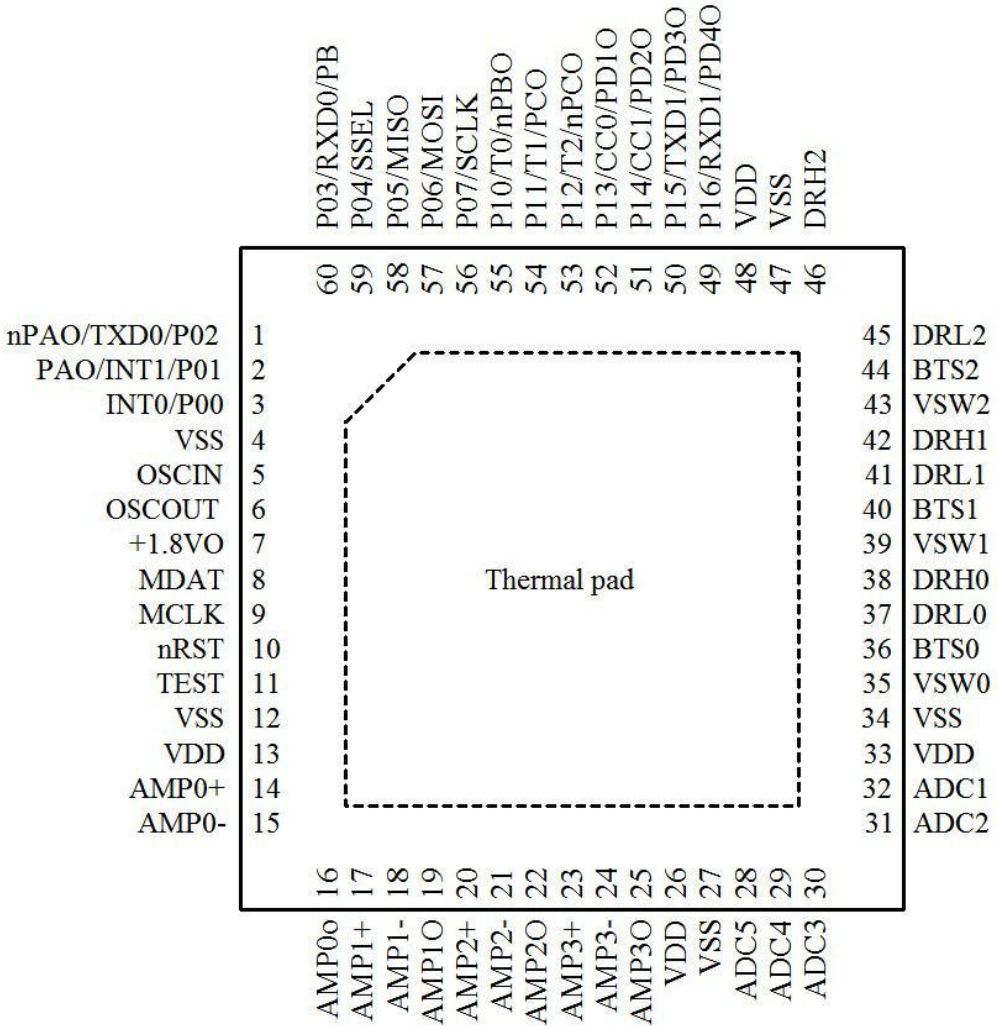
Contents

List of Figures

List of Tables

1. Pin Assignments

Figure 2. Pin Assignments for 7 7 mm, 60-QFN – Top View



2. Pin Descriptions

Table 1. Pin Descriptions

Pin No.	Name	I/O	Description
1	P02/TXD0/nPAO	I/O	General-purpose digital I/O pin Serial 0 transmit data PWM A inverted output
2	P01/INT1/PAO	I/O	General-purpose digital I/O pin External Interrupt 1 input PWM A Output
3	P00/INT0	I/O	General-purpose digital I/O pin External Interrupt 0 input
4	VSS		Ground
5	OSCIN	I	Input terminal of external crystal oscillator
6	OSCOUT	O	Output terminal of external crystal oscillator
7	+1.8VO		Internal +1.80V LDO Output terminal
8	MDAT	I/O	The data I/O during emulation and programming
9	MCLK	I	The data clock during emulation and programming
10	nRST	I	Reset input
11	TEST	I	Test mode select input terminal
12	VSS		Ground
13	VDD		Supply voltage
14	AMP0+	I	Op-amp 0 non-inverting input terminal
15	AMP0-	I	Op-amp 0 inverting input terminal
16	AMP0O	O	Op-amp 0 output terninal terminal
17	AMP1+	I	Op-amp 1 non-inverting input terminal
18	AMP1-	I	Op-amp 1 inverting input terminal
19	AMP1O	O	Op-amp 1 output terminal
20	AMP2+	I	Op-amp 2 non-inverting input terminal
21	AMP2-	I	Op-amp 2 inverting input terminal
22	AMP2O	O	Op-amp 2 output terminal
23	AMP3+	I	Op-amp 3 non-inverting input terminal
24	AMP3-	I	Op-amp 3 inverting input terminal
25	AMP3O	O	Op-amp 3 output terminal
26	VDD		Supply voltage
27	VSS		Ground
28	ADC5	I	ADC input channel 5
29	ADC4	I	ADC input channel 4
30	ADC3	I	ADC input channel 3
31	ADC2	I	ADC input channel 2
32	ADC1	I	ADC input channel 1
33	VDD		Supply voltage
34	VSS		Ground
35	VSW0		MOSFET Half-Bridge Driver 0 High-side source connection.
36	BTS0		MOSFET Half-Bridge Driver 0 High-side bootstrap supply
37	DRL0	O	MOSET Half-Bridge Driver 0 Low-Side output
38	DRH0	O	MOSET Half-Bridge Driver 0 High-Side output
39	VSW1		MOSFET Half-Bridge Driver 1 High-side source connection.
40	BTS1		MOSFET Half-Bridge Driver 1 High-side bootstrap supply
41	DRL1	O	MOSET Half-Bridge Driver 1 Low-Side output
42	DRH1	O	MOSET Half-Bridge Driver 1 High-Side output

Pin No.	Name	I/O	Description
43	VSW2		MOSFET Half-Bridge Driver 2 High-side source connection.
44	BTS2		MOSFET Half-Bridge Driver 2 High-side bootstrap supply
45	DRL2	O	MOSFET Half-Bridge Driver 2 Low-Side output
46	DRH2	O	MOSFET Half-Bridge Driver 2 High-Side output
47	VSS		Ground
48	VDD		Supply voltage
49	P16/RXD1/PD4O	I/O	General-purpose digital I/O pin Serial 1 receive data PWM D Output 4
50	P15/TXD1/PD3O	I/O	General-purpose digital I/O pin Serial 1 transmit data PWM D Output 3
51	P14/CC1/PD2O	I/O	General-purpose digital I/O pin Timer2 capture/compare 1 input PWM D Output 2
52	P13/CC0/PD1O	I/O	General-purpose digital I/O pin Timer2 capture/compare 0 input PWM D Output 1
53	P12/T2/nPCO	I/O	General-purpose digital I/O pin Timer2 external input PWM C inverted output
54	P11/T1/PCO	I/O	General-purpose digital I/O pin Timer 1 external input PWM C output
55	P10/T0/nPBO	I/O	General-purpose digital I/O pin Timer 0 external input PWM B inverted output
56	P07/ SCLK	I/O	General-purpose digital I/O pin SPI clock
57	P06/MOSI	I/O	General-purpose digital I/O pin SPI Master Out, Slave In
58	P05/MISO	I/O	General-purpose digital I/O pin SPI Master In, Slave Out
59	P04/SSEL	I/O	General-purpose digital I/O pin SPI Slave Transmit Enable
60	P03/RXD0/PB	I/O	General-purpose digital I/O pin Serial 0 receive data

3. Absolute Maximum Ratings

The absolute maximum ratings are stress ratings only. Stresses greater than those listed in Table 2 and Table 3 can cause permanent damage to the CV90328B. Functional operation of the CV90328B at absolute maximum ratings is not implied. Exposure to absolute maximum rating conditions might affect device reliability.

Table 2. Absolute Maximum Ratings

Note: All voltages are referenced to ground.

Symbol/Pins	Parameter	Conditions	Minimum	Maximum	Units
VSW0,BTS0,DRL0,DRH0 VSW1,BTS1,DRL1,DRH1 VSW2,BTS2,DRL2,DRH2	Absolute Maximum Pin Voltage		-0.3	28	V
VDD,nRST,TEST, OSCIN,OSCOUT, P00 ~ P07, P10 ~ P16 MDAT,MCLK ADC1 ~ ADC5 AMP0+,AMP0-,AMP0o AMP1+,AMP1-,AMP1o AMP2+,AMP2-,AMP2o AMP3+,AMP3-,AMP3o	Absolute Maximum Pin Voltage		-0.3	6	V
GND	Absolute Maximum Pin Voltage		-0.3	0.3	V
+1.8VO	Absolute Maximum Pin Voltage		-0.3	2	V
HBM	ESD Rating – Human Body Model	All pins	-2000	2000	V
CDM	ESD Rating – Charged Device Model	All pins	-500	500	V
T_J	Maximum Junction Temperature	See Table 3 for important restrictions.		150	C
T_{STOR}	Storage Temperature		-55	150	C
T_{LEAD}	Lead Temperature (soldering, 10s)			300	C

4. Thermal Characteristics

Table 3. Thermal Characteristics

Symbol	Parameter	Value	Units
θ_{JA}	Thermal Resistance Junction to Ambient [a], [b], [c]	27.2	C/W
θ_{JC}	Thermal Resistance Junction to Case [a], [b], [c]	18.8	C/W
θ_{JB}	Thermal Resistance Junction to Board [a], [b], [c]	1.36	C/W

[a] The maximum power dissipation is $P_{D(MAX)} = (T_{J(MAX)} - T_{AMB}) / \theta_{JA}$ where $T_{J(MAX)}$ is 125°C. (See Table 4.) Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the device will enter thermalshutdown.

[b] This thermal rating was calculated on a JEDEC 51 standard 4-layer board with the dimensions 3" x 4.5" in still airconditions.

[c] Actual thermal resistance is affected by PCB size, solder joint quality, layer count, copper thickness, air flow, altitude, and other unlisted variables.

5. Recommended Operating Conditions

Table 4. Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Units
V_{IN}	Input Operating Range [a], [b]	4.25	5	21.0	V
V_{VDDIO}	Input Voltage Supply Range for GPIO A and B Banks	1.8		5.0	V
T_J	Operating Junction Temperature [c]	-40		+125	C
T_{AMB}	Ambient Operating Temperature [c]	-40		+85	C

[a] The input voltage operating range is dependent upon the type of transmitter power stage (full-bridge, half-bridge) and transmitting coil inductance. WPC specifications should be consulted for appropriate input voltage ranges by end product type.

[b] The minimum for this specification is the minimum IC operating specification. Full power transfer will not occur at this level.

[c] Important: Refer to Table 3 for important restrictions and notes.

6. Electrical Characteristics

Table 5. Electrical Characteristics

V_{IN} = 5V , TEST = 0V, L_P = 6.3μH or 10μH, C_P = 400nF, T_{AMB} =-40 C to +85 C. Typical values are at 25°C, unless otherwise noted. Refer to Figure 1 for the location of L_P and C_P.

Note: See important notes at the end of the table.

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
Input Supplies						
V_{IN}	Input Operating Range		3.3	5	5.5	V
I_{IN}	Operating Mode Input Current	Normal power transfer state		10		mA
Buck Converter [c], [d] (C_{OUT}=33μF; L=4.7μH)						
V_{OUT}	Buck Output Voltage	V_{IN}> 5.5V		5.1		V
I_{OUT}	Output Current			50		mA
N-Channel MOSFET Driver						
$t_{LS\_ON\_OFF}$	Low-Side Gate Driver Rise and Fall Times	Load capacitance C_L = 3nF; 10% to 90%, 90% to 10%		50	150	ns
$t_{HS\_ON\_OFF}$	High-Side Gate Driver Rise and Fall Times	C_L= 3nF; 10% to 90%, 90% to 10%		150	300	ns
Analog to Digital Converter						
N	Resolution			11		Bit
Channel	Number of Channels			8		
$V_{IN,FS}$	Full Scale Input Voltage			VDD		V
Operational Amplifiers						
V_{IO}	Input offset voltatge	Vcc = 5V			5	mV
I_{IO}	Input offset current	Vo = 1.4V			80	nA
CMMR	Common-mode rejection ratio	V_{IC} = 5V, 25°C		70		dB
SR	Slew rate at unity gain	R_L = 1MΩ, C_L = 30pF		0.5	5	V/μS
B_I	Unity-gain bandwidth	R_L = 1MΩ, C_L = 20pF		1.2		MHz
V_n	Equivalent input nose voltage	R_s = 100Ω, V_i = 0V, f = 1kHz		35		nV/√Hz
LDO18 (C_{OUT}=1μF)						
V_{OUT18}	Output Voltage			1.8		V
V_{OUT}/V_{OUT}	Output Voltage Accuracy			±5		%
I_{OUT18_MAX}	Maximum Output Load Current			10		mA
Thermal Shutdown						
T_{SD}	Thermal Shutdown	Threshold Rising		140		C
		Threshold Falling		120		C
Clock Oscillators						
$F_{RC\text{-}OSC}$	Internal RC-OSC Clock Frequency		12	20	24	MHz
$F_{CRYSTAL}$	External Crystal Clock Frequency		12	20	24	MHz
F_{SYSCLK}	OSC Clock Frequency		12	20	24	MHz
$F_{PLL\text{-}OUT}$	Phase Lock-Loop (PLL) Voltage Controlled Oscillator (VCO) Frequency [d]		12	96	192	MHz

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
General Purpose Inputs/Outputs (GPIO)						
V_{IH}	Input HIGH Voltage		0.7 VDD			V
V_{IL}	Input LOW Voltage				0.3 VDD	V
I_{LKG}	Leakage Current		-1.0		1.0	µA
V_{OH}	Output Logic HIGH	VDD = 5.0V, I_{OH} = 8mA	4.3			V
V_{OL}	Output Logic LOW	VDD = 5.0V, I_{IH} = 8mA			0.7	V

7. Theory of Operation

The CV90328B is a highly-integrated wireless power transmitter IC solution for mobile devices. It can transfer up to 15W of power in High-Speed- Charger Mode, such as QC2.0/QC3.0 mode or 5W (typical) in WPC mode from a wireless transmitter to an Rx receiver load (e.g., a battery charger) using near-field magnetic induction.

The CV90328B supports Tx configurations such as described in the WPC* v1.2.4 baseline power profile Tx specification. The CV90328B also sup- ports the Qualcomm® QC2.0/QC3.0 Quick Charge™ technology function using two GPIO pins when these GPIOs are connected to the D+/D- USB signals and the CV90328B is powered by a Quick Charge power adaptor.

7.1 Overview

The simplified block diagram of the CV90328B is shown in Figure 3 and contains the following functions:

Optimized and compliant support of WPC and High-Speed-Charger transmitter protocols. Supports WPC low power transmitter types with external MOSFET.

Embedded 8-bits enhanced 8051core, with 16kBytes NVRAM .

Supports high speed serial flash (SPI interface) for system development, application development, and troubleshooting. Dithered pulse-width modulation (PWM) controller for high resolution voltage modulation.

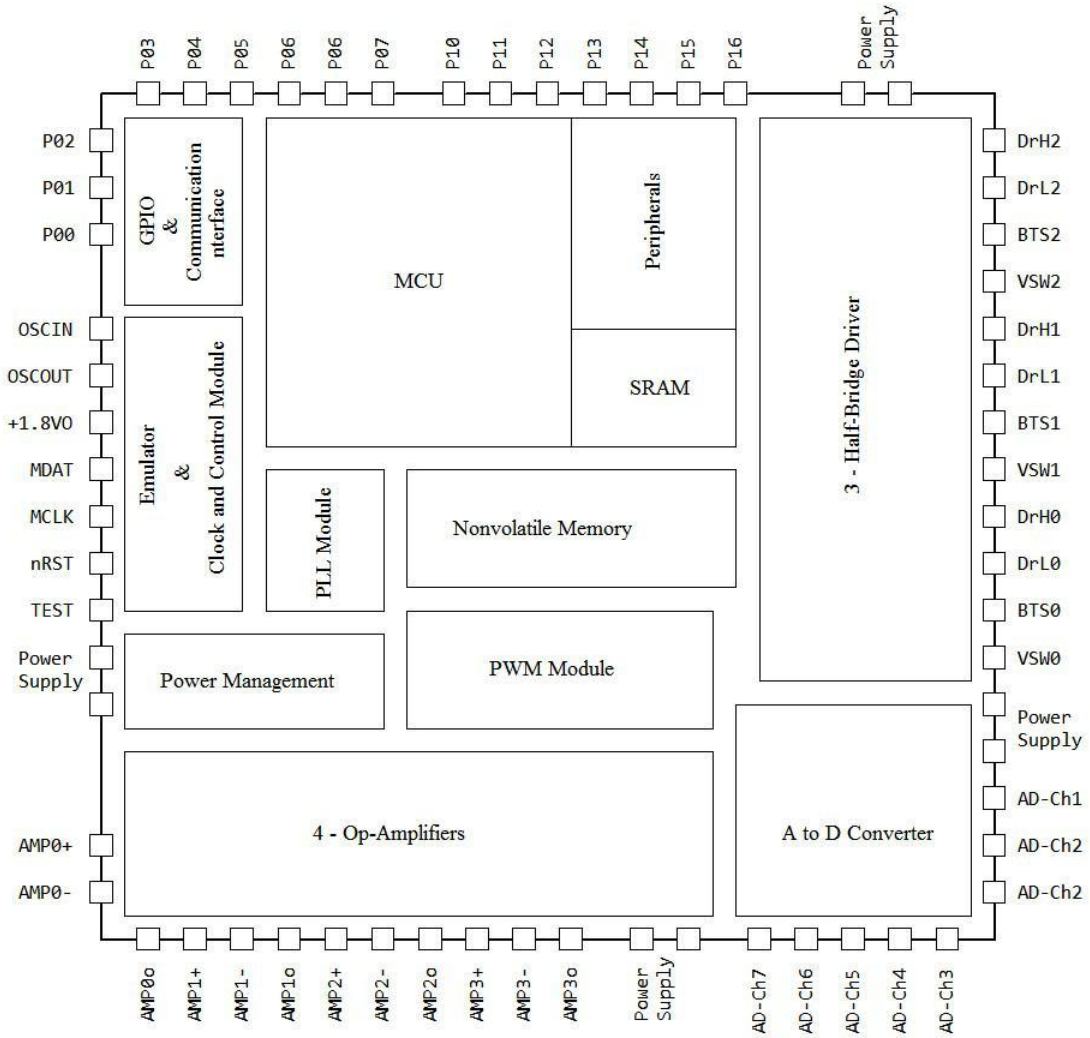
Multiple enhanced demodulation schemes using fewer external components for robust communication. Built-in SPI and URAT interface to communicate with external devices.

Built-in PLL and clock synthesizer for PWM generation and back channel communication. Supports variable logic I/O voltages with dedicated VDD pin.

Built-in general purpose 11-bit, 100ksps ADC for temperature, voltage, current measurement, and signal processing. Two banks of GPIOs with a dedicated power supply.

7.2 Functional Block Diagram

Figure 3. CV90328B Block Diagram



7.3 Overview of GPIO Usage

On the CV90328B transmitter IC, there are two banks of GPIOs, P0[7:0] and P1[6:0], which can be configured for various functions. Some of the GPIOs Multifunctional multiplexing as described in Table 1.

7.4 ADC Considerations

AD-Ch[5:1] can be connected internally to the successive-approximation 11-bit ADC via a multiplexed input. AD-Ch0 and AD-Ch6 is not lead out, AD-Ch7 is connected to the 1.200 valtage reference source inside the chip.

7.5 User Indicators

The CV90328B supports a variety of options for notifying end-users of the charging status by configuring the GPIO port:

A piezo-electric buzzer that is supported using GPIO and built-in Timer, which buzzes when the power transfer link is established

LED visual indicators connected to the LED to notify users of

various events Defined other status indicators by end-users.

7.6 Receiver Type Detection (WPC or High-Speed-Charger Modes)

The CV90328B supports receivers that are WPC or High-Speed-Charger Mode compliant. The detection of the operating mode of the receiver type is accomplished by sending WPC-compliant ping operations and then connecting to the WPC receiver. Then normal 5W operation will commence or the Rx will request the Tx to change to High-Speed-Charger Mode. A series of back-channel communication handshakes will take place and then GPIO (connected to the USB port D- pin and connected to the USB port D+ pin) will be used to detect High-Speed-Charger adaptors and communicate with the adaptor for voltage changes. The CV90328B can connect to a WPC receiver and either continue using standard WPC 5W power or engage in High-Speed-Charger protocols depending on the state of the D- and D+ pins due to the USB power adaptor currently in use.

7.7 Over-Voltage and Over-Current Protection

The CV90328B integrates over-voltage protection (OVP) and over-current protection (OCP) shutdown protection including programmable thresholds. These thresholds are designed to protect the full-bridge and wireless receiver units from exposure to voltages and/or currents that could potentially cause damage or unexpected behavior from the system. For WPC A11 +5 VIN applications, the default OVP level is 6.5V, and this is only monitored during initial power startup. The default OCP level is 2.0A, and this is continuously monitored. The voltage is detected at the VIN pin, and the current is sensed across the R_{SENSE} resistor. If the OCP threshold is exceeded during operation, the CV90328B will cease power transmission and will only resume normal operation after the receiver is removed and replaced on the charging pad or the Tx power is cycled. If an OVP event occurs during startup, the power must be cycled and remain below the OVP threshold during startup for normal operation to occur.

7.8 Thermal Protection

The CV90328B integrates thermal overload shutdown circuitry to prevent damage resulting from excessive thermal stress that could be encountered under fault conditions. This circuitry will shut down or reset the device if the die temperature exceeds the thermal shutdown specification (see Table 5).

To allow the maximum possible load current and to prevent thermal overload, it is important to ensure that the heat generated by the CV90328B solution is dissipated into the PCB. All the available pins must be soldered to the PCB. GND pins (especially the E-PAD) and the external bridge FETs should be soldered to the PCB ground or power planes to improve thermal performance with multiple vias connected to all layers of the PCB. For the QFN package, the exposed paddle (Thermal Pad) must be soldered to the PCB with multiple vias evenly distributed under the package and exiting the bottom side of the PCB. This improves heat flow away from the package and minimizes package thermal gradients.

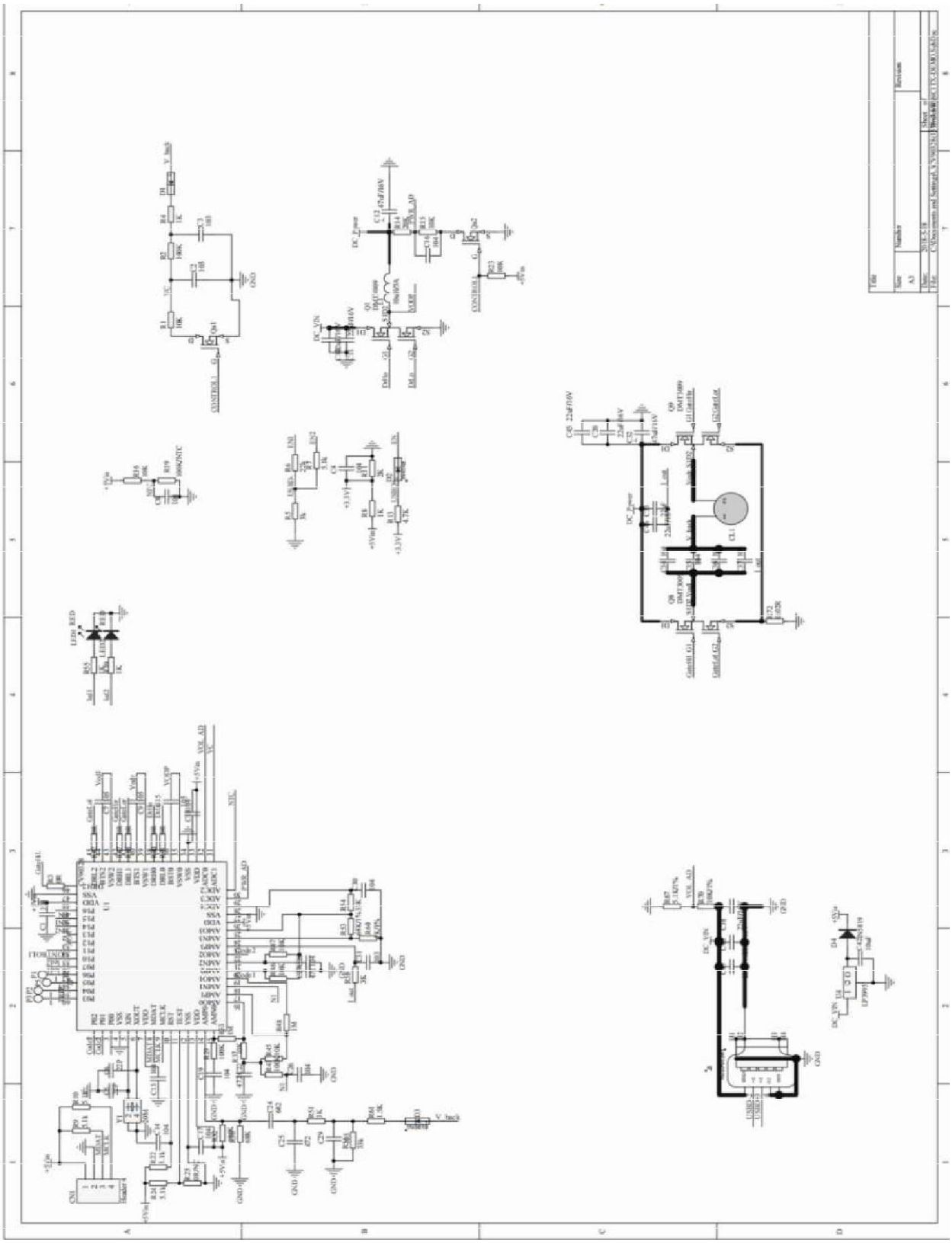
8. Description of the Wireless Power Charging System

A wireless power charging system has a base station with one or more transmitters that make power available via DC-to DC voltage conversion and DC-to-AC inverter(s) and transmit the power over a strongly-coupled inductor pair to a receiver in a mobile device. A WPC* transmitter could be a free-positioning or magnetically-guided type. A free-positioning type of transmitter has a coil that gives limited spatial freedom to the end-user to align the receiver to the transmitter.

The amount of power transferred to the mobile device is controlled by the receiver. The receiver sends communication packets to the transmitter to increase power, decrease power, or maintain the power level. The communication is purely digital, and communication 1's and 0's ride on top of the power link that exists between the two coils.

A feature of wireless charging system is the fact that when they are not charging a mobile device, the transmitter is in a very-low-power sleep mode. The transmitter remains in this low-power mode and periodically pings until the transmitter detects the presence of a receiver; only after a valid receiver is detected does the transmitter enter the negotiation phase of operation and commence with power transfer.

9. Application Schematics



10. Component Selection

Table 6 gives the bill of materials for the CV90328B QFN60 DEMO PCB V1.0 with High-Speed Charging.

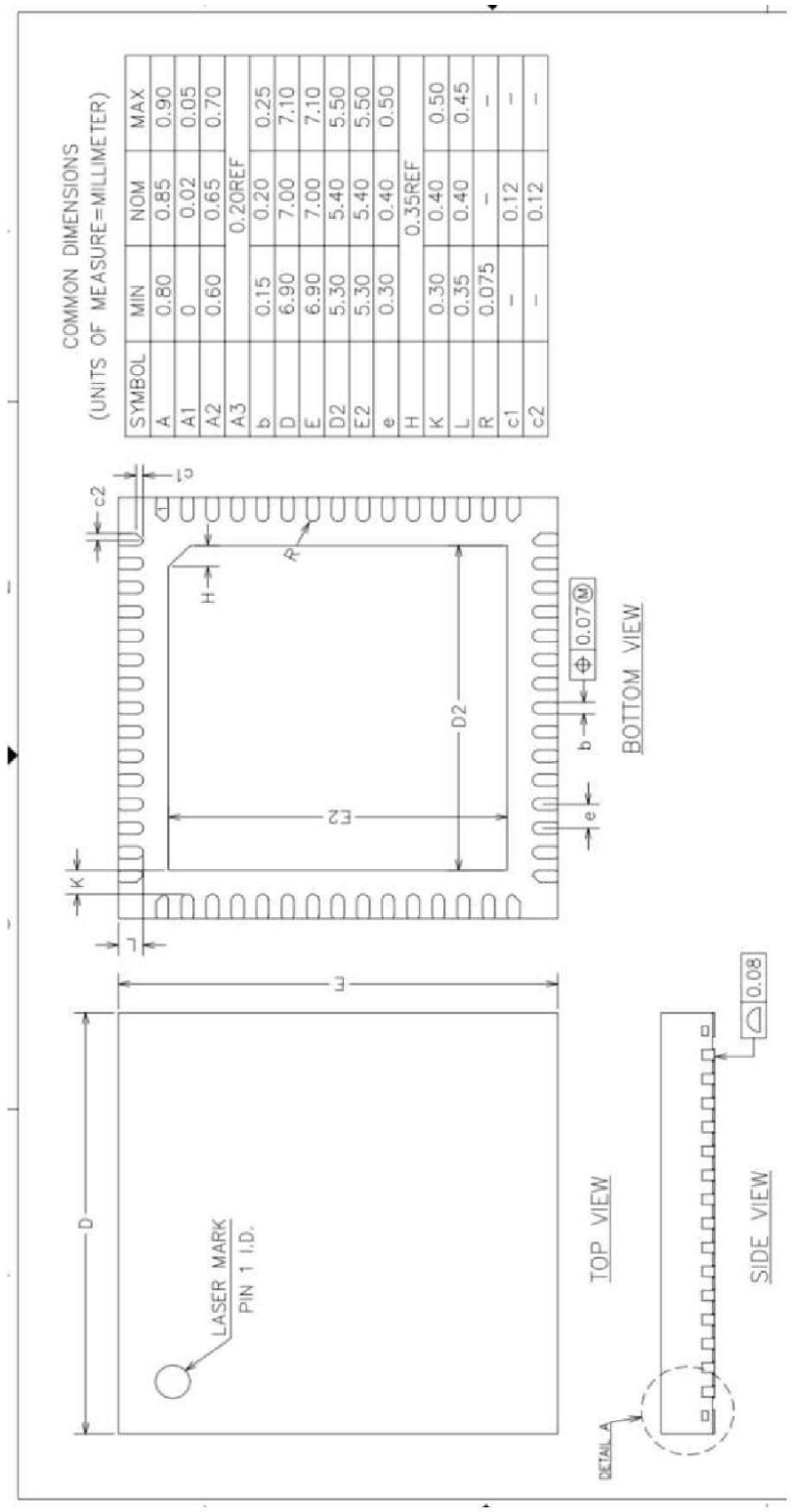
Table 6. CV90328B A11/High-Speed-Charger Mode Reference Design Component List

Item	Quantity	Reference	Part Number	PCB Footprint	Description
1	12	C1, C4, C8, C13, C14, C16,C17, C18, C19, C26, C28, C30	104	0402	X7R/25V/10%
2	4	C2, C3, C29, C31	103	0402	X7R/25V/10%
3	2	C5, C6	22P	0402	X7R/25V/10%
4	3	C7, C9, C15	105	0402	X7R/25V/10%
5	8	C10, C11, C20, C38, C45, C46, C47, C48	22uF/16V	1206_min	X7R/25V/10%
6	2	C12, C32	47uF/16V	1206_min	X7R/25V/10%
7	3	C22, C25, C27	472	0402	X7R/25V/10%
8	1	C24	682	0402	X7R/25V/10%
9	1	C33	22uF	1206_min	10%/25V/X7R
10	4	C34, C35, C36, C37	104	1206_min	10%/50V/NPO
11	1	C42	10uF	0603C	X7R/25V/10%
12	1	CL1	Coil	SIP2-3	A11 Coil
13	2	D1, D3	1N5819	SOD-323	diodes
14	1	D2	1N4148	SOD-323	Schottky Diode
15	1	D4	IN5819	SOD-323	
16	1	J3	UAF95-05254	MicroUSB	MicroUSB
17	1	L1	10uH/5A	L6*6	5A-Inductor
18	1	LED1	3010LED	3010LED	3010-red and blue
19	4	P1, P2, P3, P5	TP	TP	
20	3	Q1, Q8, Q9	DMT3009	DFN3*3_TDM3412	
21	2	Qa1, Qa2	AO3402_NM	AO3402_SOT23	
22	8	R1, R15, R16, R23, R37, R45, R46, R47	10K	0402	5%/1/10W
23	4	R2, R29, R32, R43	100K	0402	5%/1/10W
24	6	R3, R12, R17, R18, R20, R21	0R	0402	5%/1/10W
25	4	R4, R8, R55, R59	1K	0402	5%/1/10W
26	3	R5, R51, R58	3k	0402	5%/1/10W
27	1	R6	22k	0402	5%/1/10W
28	5	R7, R9, R10, R22, R24	5.1k	0402	5%/1/10W
29	1	R11	2K	0402	5%/1/10W
30	1	R13	4.7K	0402	5%/1/10W
31	1	R14	20K	0402	5%/1/10W
32	1	R19	100K/NTC	0402	B=3950
33	1	R25	0R/NC	0402	5%/1/10W
34	2	R33, R48	1M	0402	5%/1/10W
35	1	R36	68K	0402	5%/1/10W
36	1	R53	68K/1%	0402	1%/1/10W
37	2	R54, R56	33K	0402	5%/1/10W
38	1	R60	1K/1%	0402	1%/1/10W
39	1	R61	1.5K	0402	5%/1/10W
40	1	R67	5.1K/1%	0402	1%/1/10W
41	1	R70	10K/1%	0402	1%/1/10W

Item	Quantity	Reference	Part Number	PCB Footprint	Description
42	1	R72	0.02R	1206_min	5%/1/10W
43	1	U1	CV90328B	QFN60	
44	1	U4	LP3995	SOT-89	
45	1	Y1	20M	OSC5x2	Crytal
∑	108				

11. Package Drawings

Figure 5. Package Outline Drawing



12. Special Notes: QFN-60 Package Assembly

Note 1: Unopened dry packaged parts have a one-year shelf life.

Note 2: The HIC indicator card for newly-opened dry packaged parts should be checked. If there is any moisture content, the parts must be baked for a minimum of 8 hours at 125°C within 24 hours prior to the assembly reflow process.

13. Ordering Information

Note: In the orderable part number below, the * refers to a field that is a custom value specific to each customer, which is provided by Chipsvision Sales

Orderable Part Number	Description and Package	MSL Rating	Shipping Packaging	Temperature
CV90328B-0*NDGI	WPC and High-Speed Charger, 7 7 0.53 mm QFN60	1	Tray/Reel	-40°C to +85°C

14. Revision History

Revision Date	Description of Change
May 10, 2018	Initial release.