1DESCRIPTION

The MT5715 is an SoC (System on Chip) for magnetic induction based wireless power receiver. It is fully compliant with the latest WPC Qi specification (Version 1.2.4)of BPP (Baseline Power Profile) and EPP (Extended Power Profile) and also supports various proprietary fast charging protocols used by major smart phone OEM's. It is capable of true fast wireless charging for up to 15W of delivered power with fully programmable output voltage (maximal 15V) and current. MT5715 has a very high overall AC to DC conversion efficiency (up to 97%), thanks to the optimized and adaptive full synchronous rectifier control, very small Rdson of power FET's, and extreme low bias current. With the exception of a few external passive components, this SoC integrates everything that is needed for a wireless power receiving function. It is composed of a generic embedded micro controller and its associated data and program memories, specialty digital and analog hardware co-processing units for wireless power, full synchronous rectifier and special output LDO, robust and reliable over voltage/current/temperature protection circuits, bi-directional communication unit and various GPIO's and serial interfaces. With the flexibility of SoC architecture and the unique implementation, the MT5715 is future proof in supporting WPC Qi specification's further updates and new proprietary protocols. It also supports "Power Sharing" mode where a wireless power receiver is configured into a wireless power transmitter by firmware control.

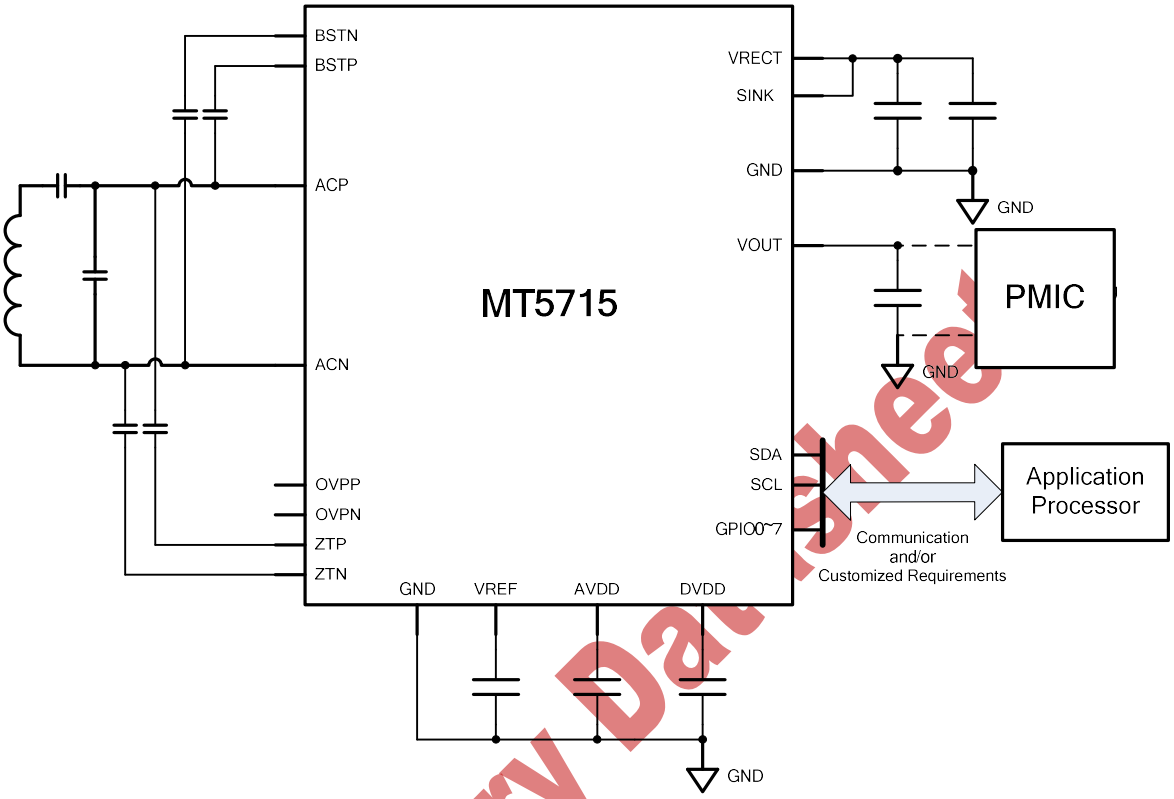
2 FEATURES

- Up to 15W power delivery
- Fully programmable output voltage and current
- WPC Qi Specification Version 1.2.4BPP and EPP compliant
- Up to 97% AC input to DC output efficiency
- Power sharing mode with both receiver and transmitter function
- Reliable and unique over voltage/current/temperature protection
- Specially designed output LDO with output clamping and fast response to line and load transient
- WPC compliant and proprietary communication protocolssupport with hardware ASK modulation and FSK demodulation
- Independent I2C slave and I2C master interface with additional GPIO's
- 2.46mm x 3.87mm (6x9 ball array) WLCSP and 6mm x6mmQFN48 packages

3 APPLICATIONS

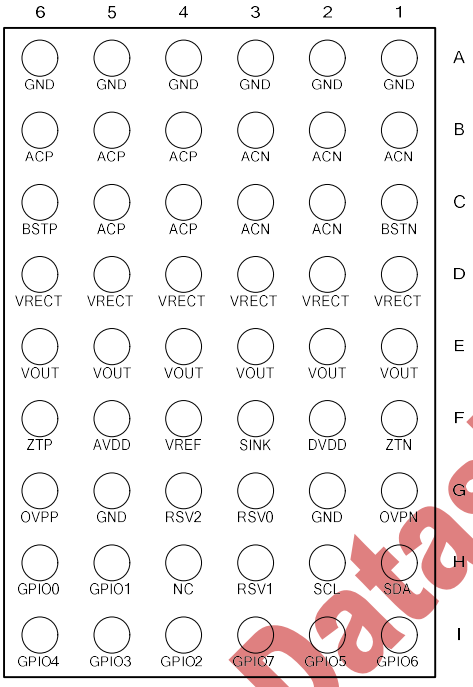
- Standard and fast wireless charging for smart phones with up to 15W power
- Wireless charging for wearable devices with high integration and samll formfactor
- TRx for phones or power banks where they can be wirelessly charged and wirelessly charge other devices
- Other wireless power applications

4TYPICALAPPLICATION CIRCUIT

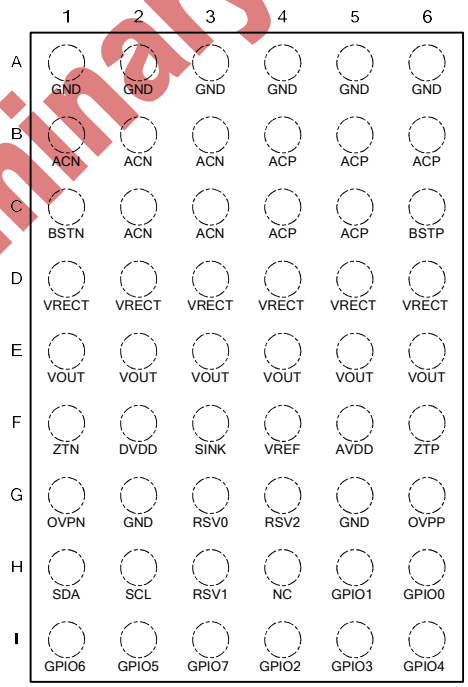


5 PINCONFIGURATIONS AND FUNCTIONS

5.1 WLCSP Ball Configurations

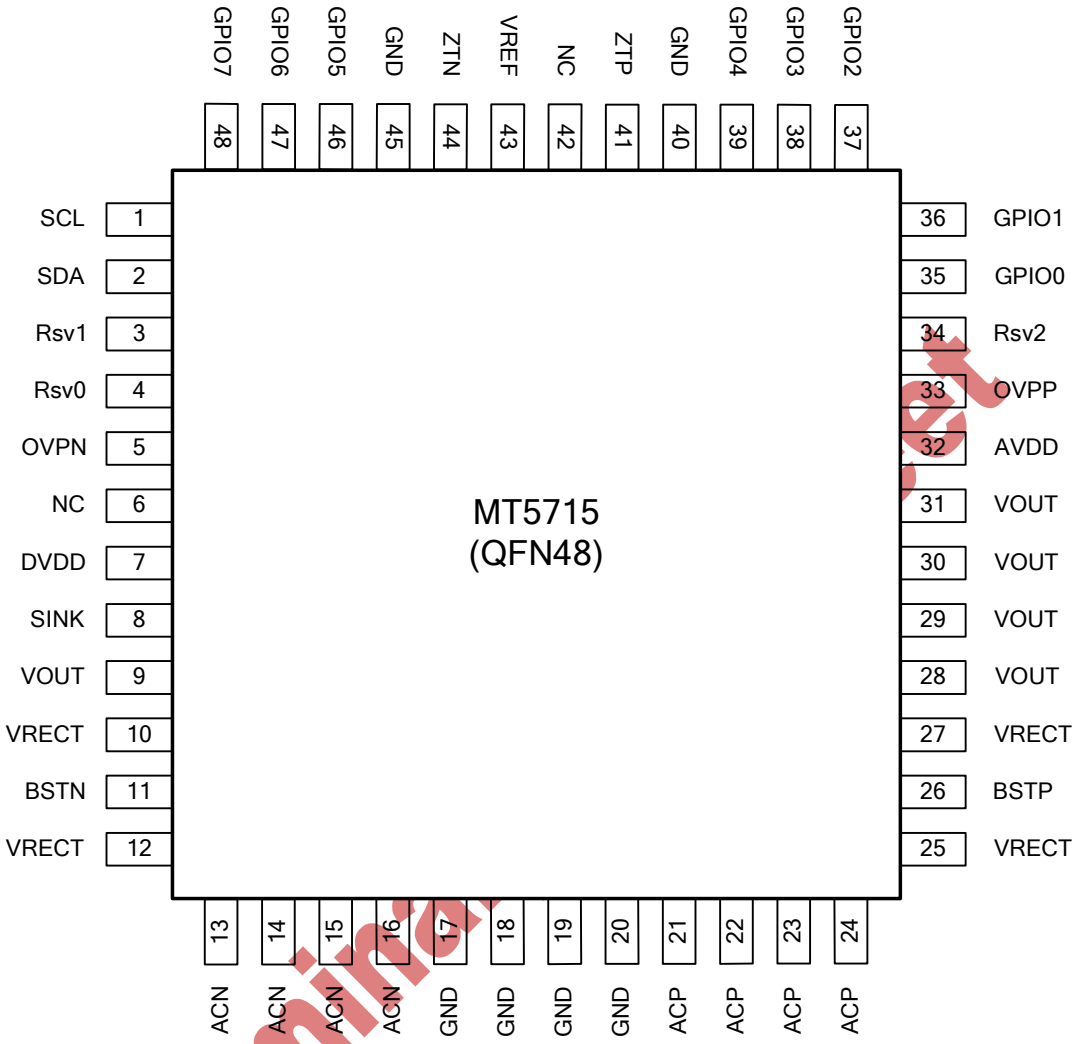


Bottom View (ball side)



Top View (marking side)

5.2 QFN Pin Configurations



5.3 Ball and Pin Functions

Pin Name	Ball No. (WLCSP)	Pin No. (QFN48)	Description
ACN	B1,B2,B3, C2,C3	13,14,15,16	AC input Pin.
ACP	B4,B5,B6, C4,C4	21,22,23,24	AC input Pin.
GND	A1,A2,A3 A4,A5,A6,G2,G5	17,18,19,20,	Power Ground.
		40	Ground for ASK and OVP FETs at ACP.
		45	Ground for ASK and OVP FETs at ACN.
VRECT	D1,D2,D3 D4,D5,D6	10,12,25,27	Output Pin of Synchronous Bridge Rectifier.
VOUT	E1,E2,E3 E4,E5,E6	9,28,29,30,31	Output of LDO.
SINK	F3	8	Providing sinking current.
BSTP	C6	26	Boost Capacitor for internal driver for synchronous bridge rectifier at ACP.
BSTN	C1	11	Boost Capacitor for internal driver for synchronous bridge rectifier at ACP.
OVPP	G6	33	OVP FET at ACP.
OVPN	G1	5	OVP FET at ACN.
ZTP	F6	41	ASK Modulation FET at ACP.
ZTN	F1	44	ASK Modulation FET at ACN.
AVDD	F5	32	Internal 5V Power Supply.
VREF	F4	43	Internal 1.2V Voltage Reference.
DVDD	F2	7	Internal 1.8V Power Supply.
Rsv0	G3	4	Soft-tie to Ground internally.
Rsv1	H3	3	
Rsv2	G4	34	
SCL	H2	1	I^2C Slave Port.
SDA	H1	2	
GPIO0	H6	35	General Purpose I/O, also can be configured as I^2C Master, Analog Input, PWM, etc.
GPIO1	H5	36	
GPIO2	I4	37	
GPIO3	I5	38	
GPIO4	I6	39	
GPIO5	I2	46	
GPIO6	I1	47	
GPIO7	I3	48	
NC	H4	6,42	No connection

5.4 I/O Pin Configurations

GPIO0~7	
GPIO0:	Power good. This is to indicate to AP that wireless power is ready.
GPIO1:	Interrupt. This is interrupt from wireless power to AP.
GPIO2:	I²C master SCL.
GPIO3:	I²C master SDA.
GPIO4:	General GPIO, ADC.
GPIO5:	General GPIO, ADC.
GPIO6:	General GPIO, ADC.
GPIO7:	General GPIO.
Note: GPIO0~7 can be re-configured up to customers requeset.	

Rsv0~2			Chip Mode
Rsv2	Rsv1	Rsv0	
Low	Low	Low	Normal operation mode for RX function. Firmware is from internal OTP.
Low	Low	High	Debug mode. Firmware is downloaded from external host through I2C slave interface and start executing under the command from external host. Also, the OTP can be programmed only in this mode.
Low	High	Low	Host mode. Firmware is downloaded from external E²PROM through I2C master and then run automatically (size and I2C speed can be configured in OTP).

6 SPECIFICATIONS

6.1 Absolute Maximum Ratings

ACN, ACP, OVPP, OVPN, ZTP, ZTN	-0.3V to 24V
BSTP, BSTN	-0.3V to ACP+6V, ACN+6V
VRECT, SINK	-0.3V to 24V
VOUT	-0.3V to 24V
AVDD, VREF	-0.3V to 6V
SDA, SCL	-0.3V to 6V
GPIO0~7	-0.3V to 6V
DVDD	-0.3V to 2V
Storage Temperature	-55°C to 150°C
Maximum Soldering Temperature(Reflow, Pb-Free)	260°C

6.2 ESD Ratings

Test Model	Pins	Ratings
HBM	All pins except BSTP, BSTN	2KV
	BSTP and BSTN	1KV
Latch-up	All pins	250mA

6.3Recommended Operating Conditions

Operating Temperature(Environment)	-40°C ~85°C
Operating Current (Iout)	0 ~ 1.2A
Operating Voltage (Vrect)	3.5V ~ 20V

6.4Thermal Information(Package Thermal Data)

Junction to ambient($R_{\theta JA}$)	36°C/W (QFN)
Junction to ambient ($R_{\theta JA}$)	50°C/W (WLCSP)
Junction to Case ($R_{\theta JC}$)	TBD°C/W (QFN)
Junction to Case ($R_{\theta JC}$)	TBD°C/W (WLCSP)

6.5 Electrical Characteristics

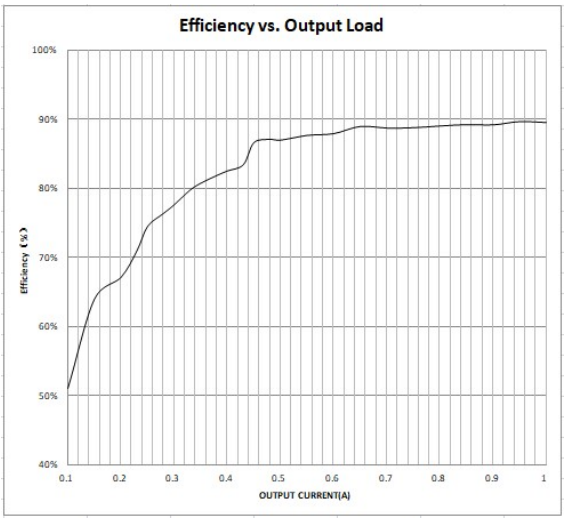
(Test conditions: V_{RECT}=12V, T_A=25°C unless otherwise stated.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Start-up (VDD pin)						
UVLO	Under Voltage Lockout	VRECT Rising from 0V		2.95		V
U_{VLO_HYS}	Under Voltage Lockout Hysteresis	VRECT falling		200		mV
Supply Current						
I_q	Quiescent Current		4.5	6	7.5	mA
Bridge Rectifier						
Rds(on)	Rds(on) of 4 MOSFETs			50		mΩ
LDO						
VOUT	Output Voltage		4.9	5	5.1	V
LSB_VOUT	Least Significant Bit when programming output voltage	Normal ouput		50		mV
		Special output		100		mV
Programming _Range		Normal output		3~15		V
		Special output		3~20		V
ILimit	Output Current Limit			0.025 ~1.5		A
LSB_ILimit	Least Significant Bit when programming output current			25		mA
ADC						
N	Resolution			10		Bit
f_{Sample}	Sampling Rate			100		kS/s
Channel	Number of Channels			8		
Auxiliary						
AVDD	AVDD Output Voltage		4.7	5	5.3	V
DVDD	DVDD Output Voltage		1.7	1.8	1.9	V
VREF	Reference Voltage		1.198	1.2	1.202	V
f_{OSC}	Oscillator Frequency			60		MHz

6.6 Typical Operating Characteristics

The following performance characteristics were taken using MT5603 15W wireless power transmitter at T_A=25℃ unless otherwise noted.

Figure1. Efficiency vs. Output load: VOUT=15V Figure2. Efficiency vs. Output load: VOUT=12V



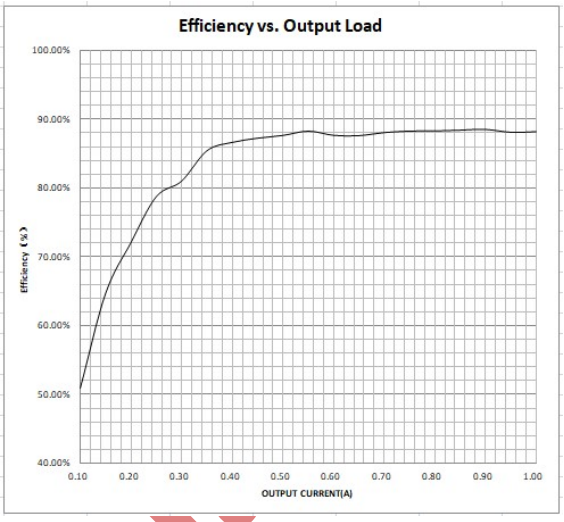
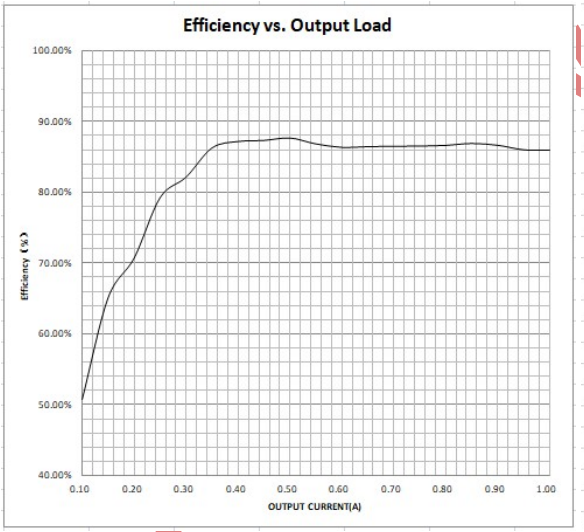
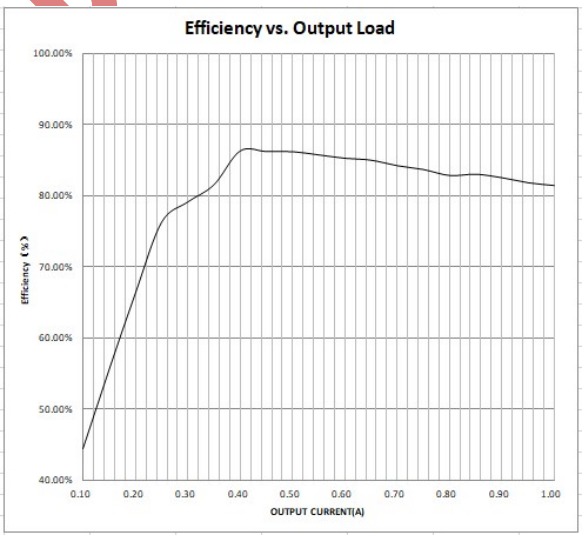


Figure3. Efficiency vs. Output load: VOUT=9V Figure4. Efficiency vs. Output load: VOUT=5V



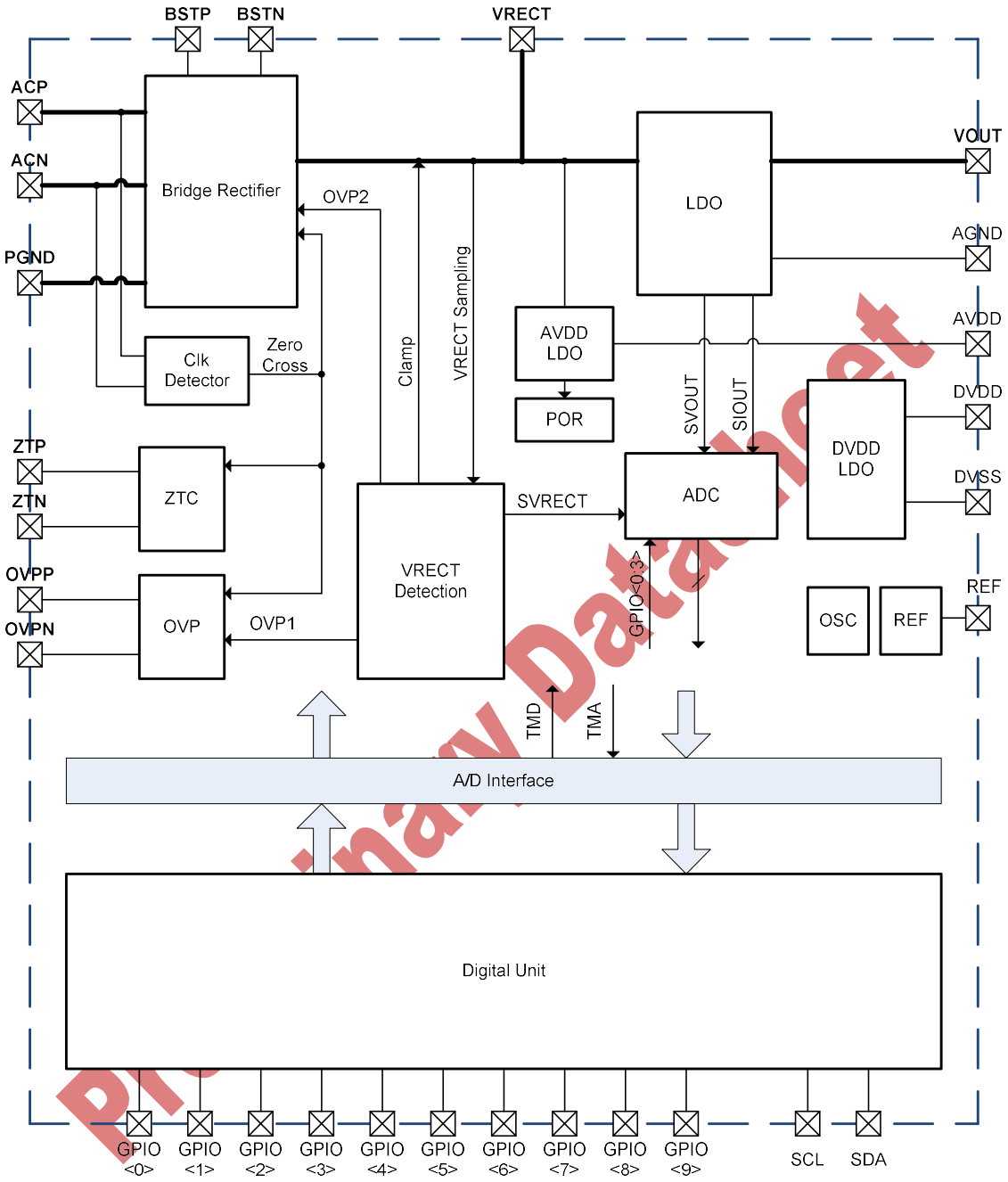


7 DETAILED DESCRIPTIONS

7.1 Overview

MT5715 is an SoC (System on Chip) for wireless power receiver. It only needs several passive components like power receiving coils, resonant tank capacitors, decoupling capacitors and pull up/down resistors to build a complete wireless power receiver system. When coupled with a wireless power transmitter, this system can provide all the functions for wireless power transfer, including power receiving and rectification, output regulation, communication for power control and data exchange, and abnormal condition (FOD, over voltage, current, temperature, etc.) protection. MT5715 is by default programmed to be fully compliant with the latest WPC Qi Specification Version 1.2.4 with support of both BPP (Baseline Power Profile) and EPP (Extended Power Profile). It can also be programmed to be compliant with major smart phone vendors' proprietary fast wireless charging protocols.

7.2 Functional Block Diagram



7.3 Theory of Operation

MT5715 is composed of several major functional blocks which together achieve the wireless power receiving function.

Bridge Rectifier, which is also called Full Synchronous Rectifier. This block converts the received AC power from the resonant tank to DC power with the help of the capacitors connected on its output.

LDO, which is also called Main LDO or Output LDO. This block functions as a load switch (connecting and disconnecting the external load), output voltage and current regulation and output clamping when fast load/line transient happens.

AVDD and DVDD LDO and POR. These blocks provide the necessary regulated power supplies from rectifier output for the operation of the chip.

ZTC and CLK Detector. These blocks are for the bi-directional communication for power control and data exchange.

OVP and Vrect Detection. These blocks are for the rectifier output voltage detection and over voltage protection when Vrect is too high.

OSC and REF. These blocks provide the timing reference and voltage reference for the whole chip.
ADC. This block is one of the key blocks that convert various measured analog variables (voltages, currents, temperature, external analog inputs, etc.) to digital domain such that the embedded micro controller can use the information for follow up actions.

Digital Unit. This block contains all the digital circuits, which include embedded micro controller, volatile and non volatile memories, I2C interface, peripherals, DMA (Direct Memory Access), internal buses, and other digital functional blocks. This block is the brain of the whole chip which dynamically configures chip for different functions in different state, communicate with the outside world (power transmitter and receiver side external host), and perform necessary data processing for proper operation (like FOD calculation, target Vrect and Vout calculation, etc.)

7.4 Device Function Modes

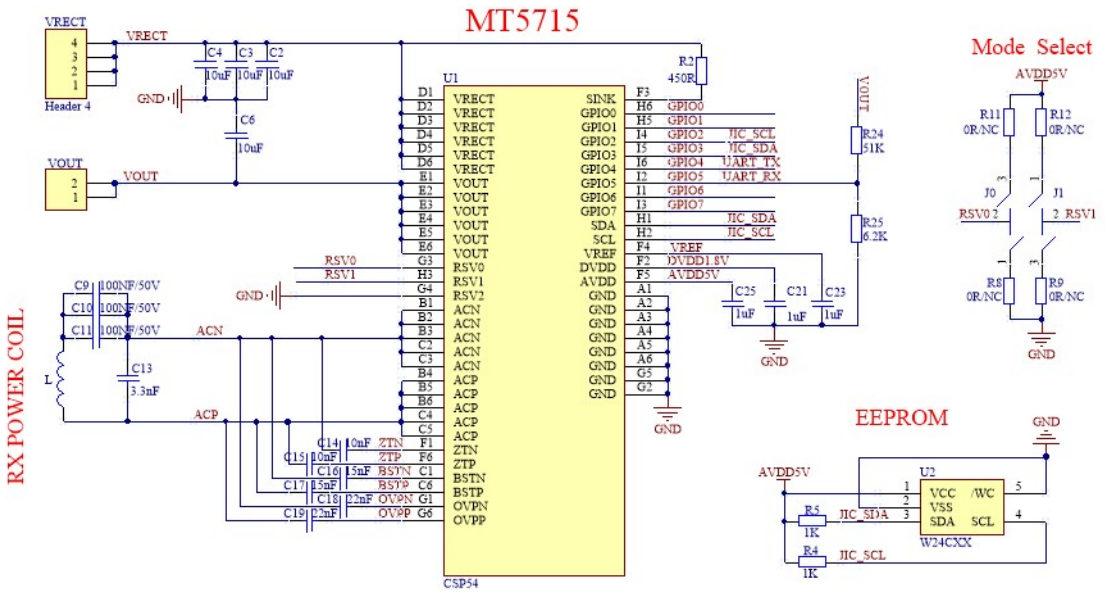
MT5715 can be programmed to operate in different modes. The switching among these modes can be made automatically based on the types of the transmitter or the instruction from the transmitter the receiver is coupled with. The operation modes can also be programmed by an external host (e.g., an Application Processor in a smart phone) via I2C interface. Here are some of these modes:

- WPC BPP only receiver mode
- WPC BPP and EPP receiver mode
- WPC BPP and proprietary receiver mode

- WPC BPP, EPP and proprietary receiver mode
- WPC proprietary only receiver mode
- WPC BPP transmitter mode
- Proprietary transmitter mode

8 APPLICATIONS AND IMPLEMENTIONS

8.1 Reference schematic

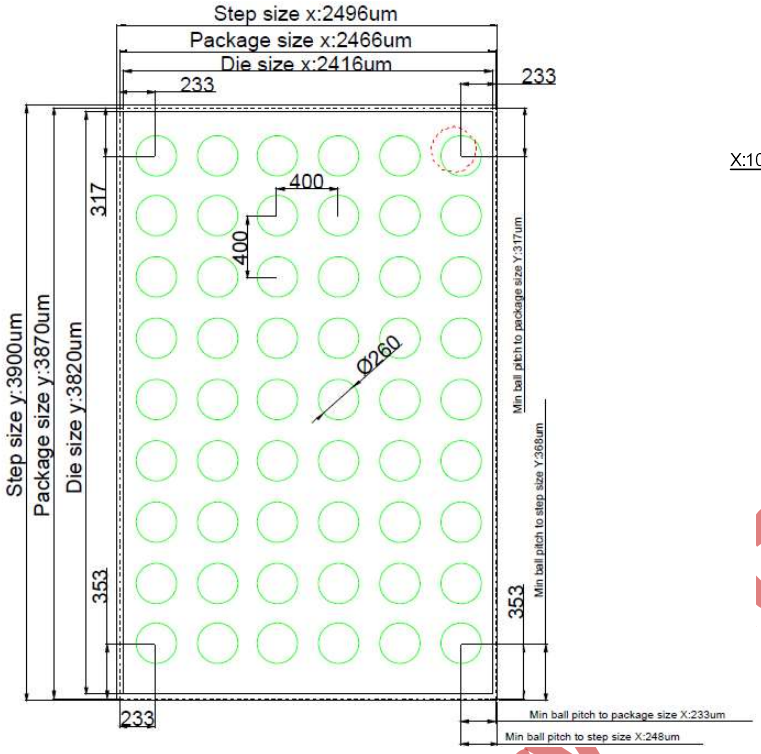


8.2 BOM

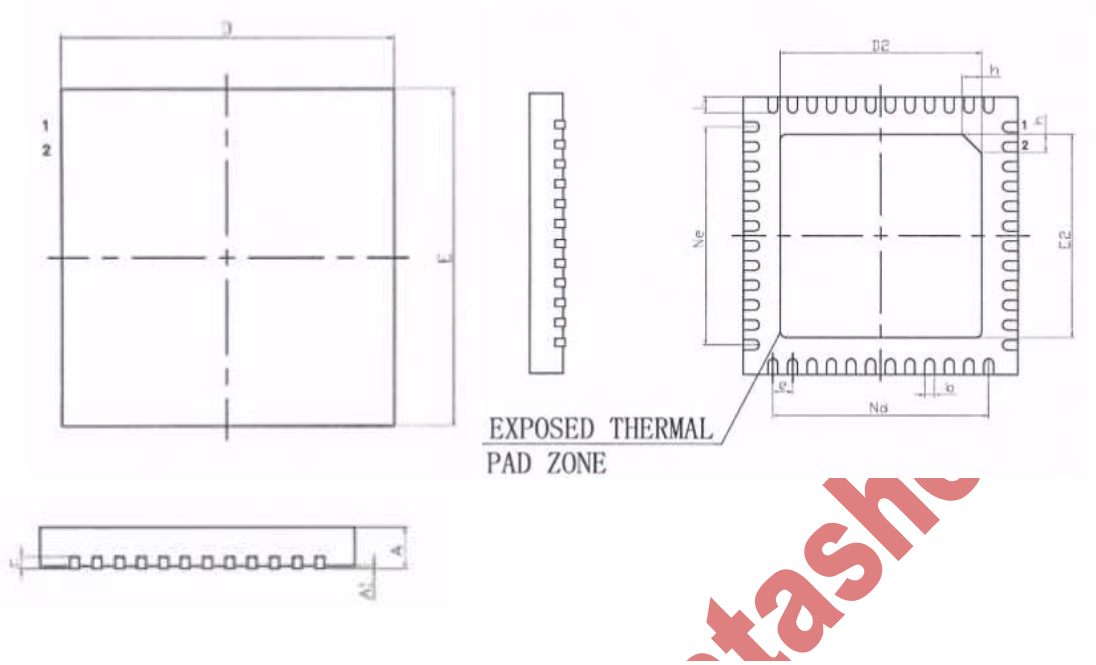
#	Reference	Value	Description	Footpri	Quantity
1	R1,R2	450R	RES SMD 450R 5% 1/2W	0805	2
2	R3,R4	1K	RES SMD 1K 5% 1/10W	0402	2
3	C18, C19	150nF	CAP CER 0.15UF 50V X7R 0402	0402	2
4	C7, C8, C9, C10	100NF/50V	CAP CER 0.1UF 50V X5R 0402	0402	4
5	C20, C22, C24	100NF	CAP CER 0.1UF 10V X7R 0402	0402	3
6	C14, C15	22nF	CAP CER 0.022UF 50V X7R 0402	0402	2
7	C16, C17	15nF	CAP CER 0.015UF 50V X7R 0402	0402	2
8	C1, C2, C3, C4, C5, C6	10uF	CAP CER 10UF 25V X5R 0603	0603	6
9	C11	3.3nF	CAP CER 10UF 50V X5R 0402	0402	1
10	C21, C23, C25	1uF	CAP CER 1UF 10V X5R 0402	0402	3
11	COIL_N, COIL_P	8uH	RX Coil		1
12	U2	NP	AT24C64	SO8NB	1
13	U1	MT5715	Wireless power receiver	CSP54	1
				Notes	30

9 DETAILED PACKAGING INFORMATIONS

9.1 WLCSP Package Outline and Dimensions



9.2 QFN48Package Outline and Dimensions



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.15	0.20	0.25
c	0.18	0.20	0.23
D	5.90	6.00	6.10
D2	4.10	4.20	4.30
e	0.40BSC		
Ne	4.40BSC		
Nd	4.40BSC		
E	5.90	6.00	6.102.7
E2	4.10	4.20	4.30
L	0.35	0.40	0.45
b1	0.69		0.79
h	0.30	0.35	0.40

For detail product information and sample requests, please contact:

Maxic Technology Corporation (Beijing Office)
1006，Crown Plaza Office Tower, No106, ZhiChun Road, Hai Dian District, Beijing, China, 100086
Tel: 86-10-62662828
Fax: 86-10-62662951

Maxic Technology Coporation (Shenzhen office)
25BC, FortunePlaza, Futian District, Shenzhen 518040
Tel: 86-0755-83021778
Fax: 86-0755-83021336

Maxic Technology Corporation(Hong Kong office)
Rm D1, 7th floor, JianAnCommercialBuilding,
No. 49-51, Suhong Str., Sheung Wan, Hong Kong

Web: www.maxictech.com
E-mail: sales@maxictech.com, info@maxictech.com