

ML7670

13.56MHz Wireless charging receiver LSI

■ Overview

ML7670 is a 13.56 MHz wireless power receiver LSI.

ML7670 realizes a wireless power transfer system by combining the wireless power transmitter LSI ML7671, and can output 250 mW to a charging device.

ML7670 is NFC Forum WLC* compliant. ML7670 can output power by combining with the NFC Forum WLC* compliant transmission device.

The ML7670 is equipped with a 10-bit SAR-ADC for measuring the power supply status and a wireless power supply control function in a 2.28 mm x 2.56 mm (equivalent to 2.42 mm square) WLCSP. This LSI is ideal for wireless power supply of small devices. In addition, since it is equipped with the NFC Forum Type 3 Tag function, it is possible to realize NFC functions such as Bluetooth® pairing by touch. Furthermore, ML7670 is equipped with a host interface (I²C Target) function, and it is possible to update configuration data from an external MCU.

*Note: NFC Forum WLC 2.0.

■ Features

- Charging control
 - Built-in LDO
 - LDO Output Voltage control function
 - Built-in Charging control circuit
 - Built-in setting of output voltage by shunt regulator
 - Voltage/Current supply ON/OFF function to external charging IC
 - 250mW receiving available
 - Abnormally detection function by software and hardware control
 - Abnormally notification function to the power transmitter
- Communication control
 - Communication speed: 212 kbps, 424 kbps
 - 2Kbyte data flash for storing user data
- Host interface
 - 1ch Serial interface (I²C Target)
- Package
 - WLCSP30pin (S-UFLGA30-2.28x2.56-0.40-W)
- Applications
 - NFC charging devices, e.g.
 - smart watches, fitness trackers and smart wristbands
 - smart rings
 - smart glasses
 - true wireless stereos and hearing aids
 - stylus pens, wireless mice and wireless keyboards
 - electric toothbrushes
 - beauty home appliances
 - personal health care devices
 - battery packs

●Product name

ML7670-61XHB (WLCSP Package)

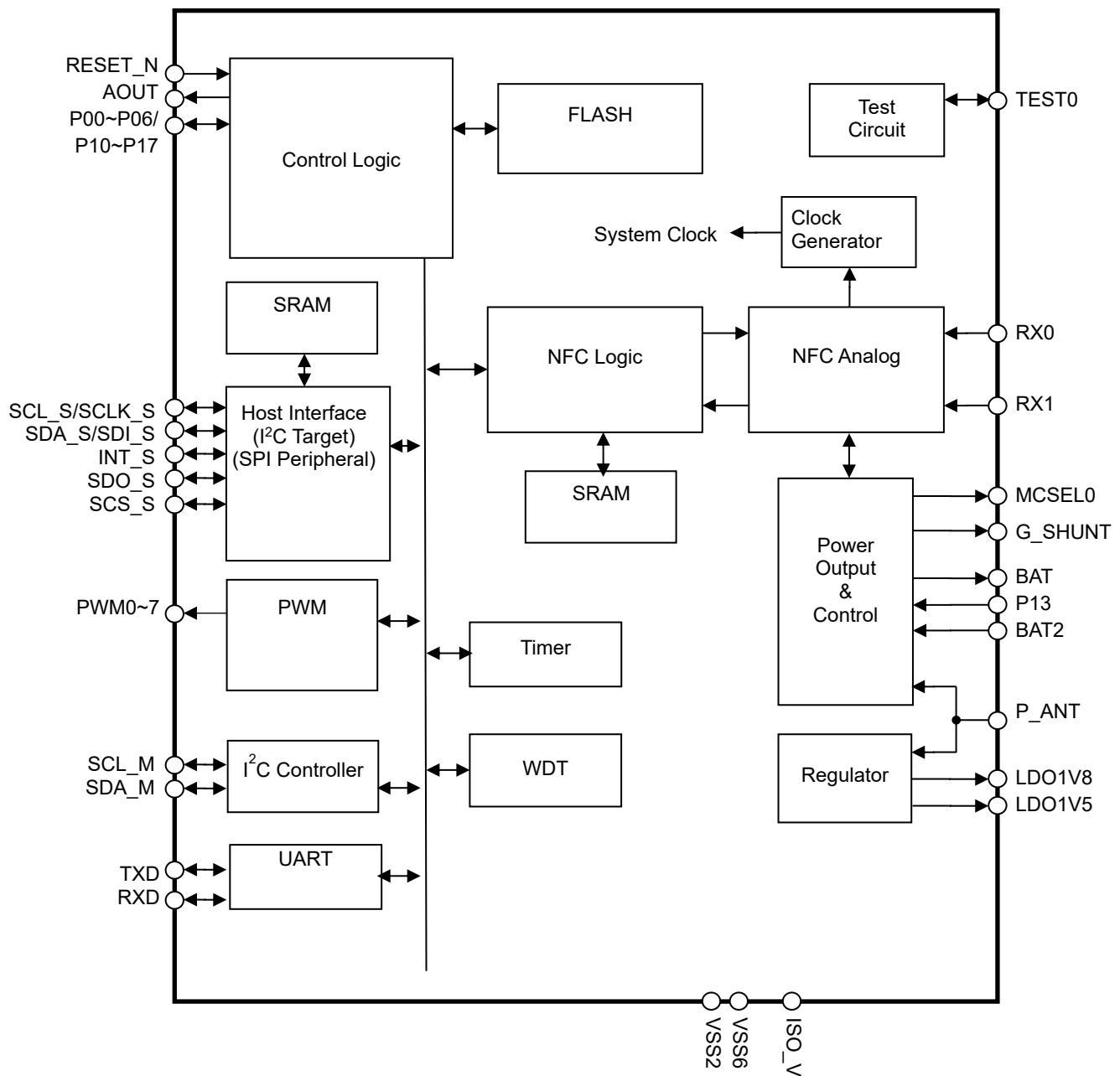
■Related Documents

In addition to this document, the following documents should also be read together as necessary.

- ML7671 Data Sheet
- ML7670 / ML7671Application Note

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■Block Diagram



■ Pin Assignment

WLCSP 30pin

BOTTOM VIEW

P13 / AIN7	VSS6	MCSEL0	AIN1	P14 / PWM5	6
P06 / SCS_S/ PWM3	P11 / AIN6	P02 / SCL_M/ PWM0	P17 / PWM7	P12	5
P04 / INT_S	P05 / SDO_S/ PWM2	P15 / TXD/ PWM6	RESET_N	P03 / SDA_M/ PWM1	4
P00 / SDI_S SDA_S /	P01 / SCL_S / SCLK_S	TEST0	P_EXT/ P_ANT	P16 / AOUT/ PWM6	3
LDO1V5	ISO_V	RX1	VSS2	P10 / RXD/ PWM4	2
LDO1V8	RX0	BAT2	G_SHUNT	BAT	1
E	D	C	B	A	

■ PIN list

PIN No	Pin name (Function name) ¹	1 st function	2 nd function	3 rd function
A1	BAT	Charging voltage output	-	-
A2	P10/RXD/PWM4	General purpose port	UART data input	PWM4 output
A3	P16/AOUT/PWM6	General purpose port	Analog monitor output	-
A4	P03/SDA_M/PWM1	General purpose port	I ² C Controller data I/O	PWM1 output
A5	P12	General purpose port	-	-
A6	P14/PWM5	General purpose port	PWM5 output	-
B1	G_SHUNT	Shunt transistor control signal	-	-
B2	VSS2	GND	-	-
B3	P_EXT/P_ANT	Rectifier input	-	-
B4	RESET_N	Reset pin	Debugger pin	-
B5	P17/PWM7	General purpose port	PWM7 output	-
B6	AIN1	General purpose analog input 1	-	-
C1	BAT2	Battery voltage detection	-	-
C2	RX1	Magnetic field (negative side) / Data reception	-	-
C3	TEST0	Debugger pin	-	-
C4	P15/TXD/PWM6	General purpose port	UART data output	PWM6 output
C5	P02/SCL_M/PWM0	General purpose port	I ² C Controller clock output	PWM0 output
C6	MCSEL0	Matching capacitor selection signal	-	-
D1	RX0	Magnetic field (positive side) / Data reception	-	-
D2	ISO_V	Logic I/O power supply (for host communication)	-	-
D3	P01/SCL_S/SCLK_S	General purpose port	HostIF (I ² C Target) clock input	HostIF (SPI Peripheral) clock input
D4	P05/SDO_S/PWM2	General purpose port	HostIF (SPI Peripheral) data output	PWM2 output
D5	P11/AIN6	General purpose port	General purpose analog input 6	-
D6	VSS6	GND	-	-
E1	LDO1V8	1.8V power output for ADC	-	-
E2	LDO1V5	1.5V core power output	-	-
E3	P00/SDI_S/SDA_S	General purpose port	HostIF (I ² C Target) data I/O	HostIF (SPI Peripheral) data input
E4	P04/INT_S	General purpose port	HostIF INT output	-
E5	P06/SCS_S/PWM3	General purpose port	HostIF (SPI Peripheral) chip select signal	PWM3 output
E6	P13/AIN7 (BAT_CHG)	General purpose port	General purpose analog input 7	-

¹ Function name assigned by firmware.

■ Pin Description

Notation Definition: Pin state in reset

Index	Notation	Description
In reset	L(O)	"L" level output
	H(O)	"H" level output
	L(A)	Analog "L" level output
	H(A)	Analog "H" level output
	PU	Pull-Up
	PD	Pull-Down
	Z	Floating state

Notation Definition: input/output direction

Index	Notation	Description
I/O	IA	Analog input pin
	OA	Analog output pin
	I	Digital input pin
	I/O	Bi-directional pin
	I _{DA} /O	Bi-directional pin, Input are digital and analog shared
	I/O _{DA}	Bi-directional pin, Output are digital and analog shared
	O	Digital output pin

● Power, GND, Reference Voltage Pins

PIN No.	Pin name	In reset	I/O	Supply power	Active Level	Description
D6	VSS6	-	-	-	-	Ground
B2	VSS2					
E2	LDO1V5	H(A)	OA	-	-	This pin is for connecting decoupling capacitor of internal LDO (Core 1.5V)
E1	LDO1V8	H(A)	OA	-	-	This pin is for connecting decoupling capacitor of internal LDO (ADC 1.8V)
B3	P_EXT/P_ANT	-	-	-	-	Input pin of the output of a rectifier circuit and logic IO voltage supply pin.
D2	ISO_V	-	-	-	-	Logic IO voltage supply pin(1.8V to 5.5V) (For host communication)
C1	BAT2	-	IA	-	-	Battery voltage monitor pin
A1	BAT	-	-	-	-	Charging LDO output

● Analog Signal Pins

PIN No.	Pin name	In reset	I/O	Supply power	Active Level	Description
D1	RX0	-	IA	-	-	NFC RF input pin
C2	RX1	-	IA	-	-	NFC RF input pin

● General purpose port terminal (ISO_V system)

PIN No.	Pin name	In reset	I/O	Active Level	Description
E3	P00/ SDI_S/ SDA_S	Z	I/O	-	General purpose port I ² C Target data input/output pin HostIF (SPI Peripheral) data input
D3	P01/ SCL_S/ SCLK_S	Z	I/O	-	General purpose port I ² C Target clock input pin HostIF (SPI Peripheral) clock input
C5	P02/ SCL_M/ PWM0	Z	I/O	-	General purpose port I ² C Controller clock output PWM0 output
A4	P03/ SDA_M/ PWM1	Z	I/O	-	General purpose port I ² C Controller data I/O PWM1 output
E4	P04/ INT_S	Z	I/O	L	General purpose port Interrupt output pin (for Host)
D4	P05/ SDO_S/ PWM2	Z	I/O	-	General purpose port HostIF (SPI Peripheral) data output PWM2 output
E5	P06/ SCS_S/ PWM3	Z	I/O	-	General purpose port HostIF (SPI Peripheral) chip select signal PWM3 output
D5	P11/ AIN6 (RFDET)	Z	I _{DA} /O	-	General purpose port General purpose analog input 6
A5	P12 (POWER)	Z	I/O	-	General purpose port
A6	P14/ PWM5 (CHARGE)	Z	I/O	-	General purpose port PWM5 output
A3	P16/ AOUT/ PWM6	Z	I/O	-	General purpose port Analog monitor output PWM6 output
B5	P17/PWM7 (ERROR)	Z	I/O	-	General purpose port

● General purpose port terminal (P_ANT system)

PIN No.	Pin name	In reset	I/O	Active Level	Description
B4	RESET_N	PU	I	L	Reset input pin Normally, use this terminal OPEN.
B6	AIN1	Z	I/O	-	General purpose analog input 1
A2	P10/ RXD/ PWM4	Z	I/O	-	General purpose port UART data input PWM4 output
E6	P13/AIN7 (BAT_CHG)	Z	I _{DA} /O	Selectable	General purpose port General purpose analog input 7
C4	P15/TXD/PWM6 (DEBUG)	Z	I/O	-	General purpose port UART data output PWM6 output
C6	MCSEL0	PU	O	Selectable	Matching circuit configuration signal output pin
B1	G_SHUNT	PU	O	-	This pin executes shunt control when the external shunt circuit mode is enabled.
C3	TEST0	Z	I/O	L	Input/Output pin for debugger This pin is used for firmware update.

■Unused pin processing

Pin name	Pin processing
TEST0	Pull-Up
P00~P06, P10~P17 RESET_N AIN1 MCSEL0 G_SHUNT	Open

■Electrical Characteristics

●Absolute Maximum Ratings

Item	Symbol	Condition	Rating	Unit
Power voltage	ISO_V	Ta=25°C	-0.3 to +6.5	V
	P_ANT	Ta=25°C	-0.3 to +6.5	V
	BAT2	Ta=25°C	-0.3 to +6.5	V
Core power voltage	LDO1V5	Ta=25°C	-0.3 to +2.0	V
Analog power voltage	LDO1V8	Ta=25°C	-0.3 to +6.5	V
Input voltage	VDIN	Ta=25°C	-0.3 to V _{DD} +0.3	V
		Ta=25°C, RX0/RX1	12	V
Input current	I _i	Ta=25°C	-10 to +10	mA
	I _{P_ANT}	Ta=25°C	100	mA
Output voltage	V _{DO}	Ta=25°C	-0.3 to V _{DD} +0.3	V
Digital output current	I _{DO}	Ta=25°C	-12 to +20	mA
Power dissipation (CSP)	PD	Ta=25°C	0.5	W
Storage temperature	T _{stg}	-	-55 to +150	°C

V_{DD}: V_{DD} indicates Power supply voltage (P_ANT or ISO_V) for each pins.
Refer to Supply power in "■Pin Description" table.

●Recommended Operating Conditions

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating voltage	ISO_V	-	1.8	-	5.5	V
	P_ANT	Communication	2.0	5.0	5.5	V
		Charging	-	-	5.5	V
Operating temperature	T _a	Communication	-40	+25	+85	°C
		Charging	-40	+25	+50	°C

●Flash Memory Operating Conditions

(P_ANT=2.7 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Item	Symbol	Condition	Range	Unit
Rewrite count	C _{EPD}	Data Flash	10,000	Times

●RF Characteristics

(P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Input Level	V _{RX1}	RX0/RX1	2.0	-	5.9	V
Input data amplitude	V _{RX2}	RX0/RX1	50	-	-	mV
Communication speed	F _{RX}	RX0/RX1	-	212	-	kbps
			-	424	-	kbps

●Notification Characteristics

(P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
P_ANT limiter	V _{PANT1}	Normal	-	-	5.5	V
	V _{PANT2}	In case of abnormality notice	-	3.0	-	V

●Power supply Characteristics

(P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +50°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
BAT pin output voltage	V _{BAT}	No Load	-	5	-	V
	V _{BAT_LD}	55mA load	V _{BAT} -0.5	-	-	V

●AD Characteristics

(P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Resolution	AD _{res}	-	-	10	-	bit
Zero-Scale Error	ZSE	-	-6	-	+6	LSB
Full-Scale Error	FSE	-	-6	-	+6	LSB

● AC Characteristics (I²C Bus Interface)

● Standard Mode 100kHz

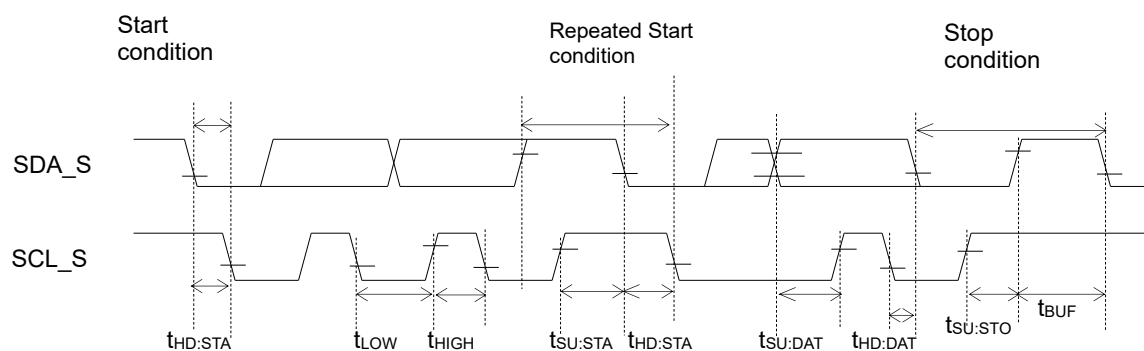
(ISO_V=1.8 to 5.5V, P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
SCL_S	Clock frequency	f _{SCL}	-	-	100	kHz
	Hold time (start/repeated start condition)	t _{HD:STA}	4.0	-	-	μs
	"L" level time	t _{LOW}	4.7	-	-	μs
	"H" level time	t _{HIGH}	4.0	-	-	μs
	setup time (repeated start condition)	t _{SU:STA}	4.7	-	-	μs
SDA_S	hold time	t _{HD:DAT}	0	-	-	μs
	setup time	t _{SU:DAT}	0.25	-	-	μs
	setup time (P:Stop condition)	t _{SU:STO}	4.0	-	-	μs
Bus free time		t _{BUF}	4.7	-	-	μs

● Fast Mode 400kHz

(ISO_V=1.8 to 5.5V, P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
SCL_S	Clock frequency	f _{SCL}	-	-	400	kHz
	hold time (start/repeated start condition)	t _{HD:STA}	0.6	-	-	μs
	"L" level time	t _{LOW}	1.3	-	-	μs
	"H" level time	t _{HIGH}	0.6	-	-	μs
	setup time (repeated start condition)	t _{SU:STA}	0.6	-	-	μs
SDA_S	hold time	t _{HD:DAT}	0	-	-	μs
	setup time	t _{SU:DAT}	0.1	-	-	μs
	setup time (P:Stop condition)	t _{SU:STO}	0.6	-	-	μs
Bus free time		t _{BUF}	1.3	-	-	μs



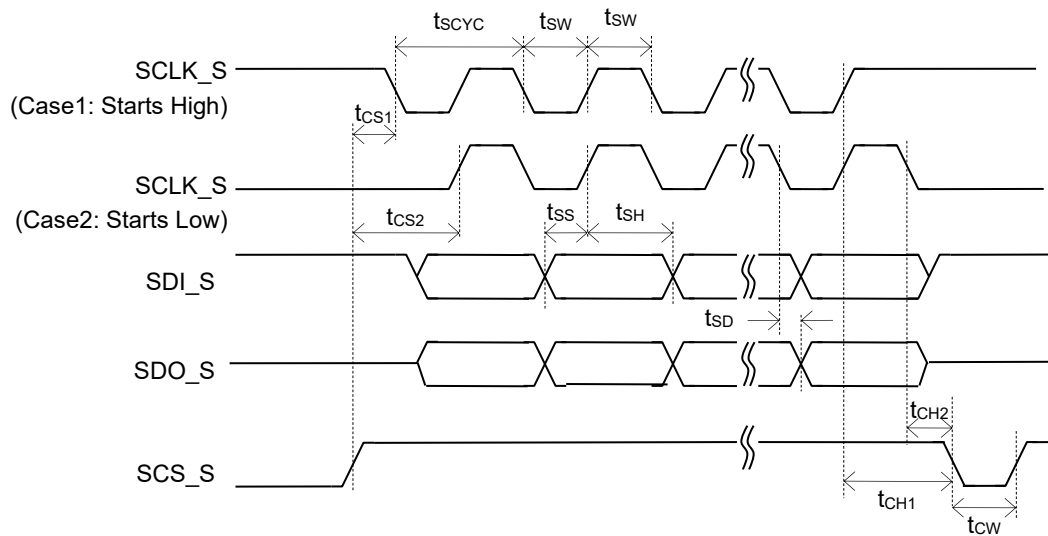
If powering off ISO_V of this LSI, it disables communications of other devices on the I²C bus.

Even when there is no receiving power from the P_ANT pin, the SDA_S/SCL_S pin will maintain the Hi-Z state when there is a power input on the ISO_V pin of this LSI.

●AC Characteristics (Host Interface : SPI Peripheral)

(ISO_V=1.8 to 5.5V, P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

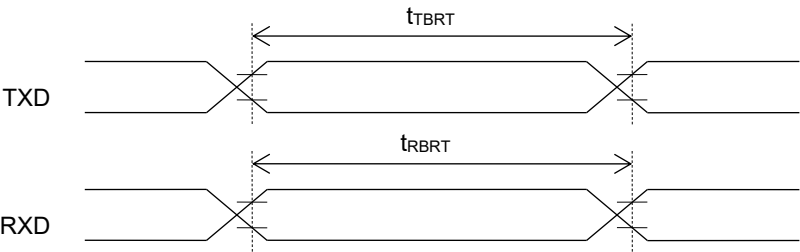
Index	Symbol	Condition	Min.	Typ.	Max.	Unit
SCLK_S	Input cycle	t_{SCYC}	500	-	-	ns
	Input pulse width	t_{SW}	200	-	-	ns
SCS_S	Setup time	t_{CS1}	80	-	-	ns
		t_{CS2}	80	-	-	ns
	Hold time	t_{CH1}	80	-	-	ns
		t_{CH2}	80	-	-	ns
	Input pulse width	t_{CW}	80	-	-	ns
SDO_S	Output delay time	t_{SD}	-	-	240	ns
SDI_S	Input setup time	t_{SS}	80	-	-	ns
	Input hold time	t_{SH}	80	-	-	ns



●AC Characteristics (UART)

(ISO_V=1.8 to 5.5V, P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

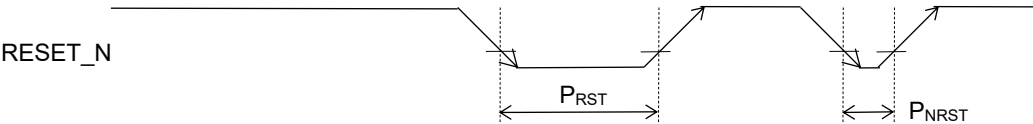
Index	Symbol	Condition	Min.	Typ.	Max.	Unit
Tx Baud Rate	tTBRT	-	-	-	115.2	kbps
Rx Baud Rate	tRBRT	-	-	-	115.2	kbps



●AC Characteristics (Reset)

(P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Index	Symbol	Condition	Min.	Typ.	Max.	Unit
Reset Pulse Width	P_RST	-	2	-	-	ms
Non-reset Pulse Width	P_N_RST	-	-	-	0.3	μ s



●IO Characteristics

(Unless otherwise specified, P_ANT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Output voltage 1	VOH1	IOH=-1.0mA	$V_{DD}-0.5$	-	-	V
	VOL1	IOL=+0.5mA	-	-	0.4	V
Output voltage 2 (LED mode selected)	VOL2	$2.7V \leq V_{DD} \leq 5.5V$ IOL=+5.0mA	-	-	0.6	V
		IOL=+2.0mA	-	-	0.4	V
Output voltage 3 (I ² C mode selected)	VOL3	IOL3= +3mA (I ² C spec) (P_ANT ≥ 2V、ISO_V ≥ 2V)	-	-	0.4	V
Output voltage 4 (I ² C mode selected)	VOL4	IOL4= +2mA (I ² C spec) (P_ANT < 2V、ISO_V < 2V)	-	-	$V_{DD} \times 0.2$	V
Output leakage 1	IOOH1	VOH= V_{DD} (at high impedance)	-	-	1	μA
	IOOL1	VOL=VSS (at high impedance)	-1	-	-	μA
Input current 1 (RESET_N)	IIH1	VIH1= V_{DD}	-	-	1	μA
	IIL1	VIL1=VSS	-900	-300	-20	μA
Input current 2 (TEST0)	IIH2	VIH2= V_{DD}	-	-	1	μA
	IIL2	VIL2=VSS	-200	-15	-1	μA
Input current 3	IIH3	VIH3= V_{DD} (when pull-down)	1	15	200	μA
	IIL3	VIL3=VSS (when pull-down)	-200	-15	-1	μA
	IIH3Z	VIH3= V_{DD} (at high impedance)	-	-	1	μA
	IIL3Z	VIL3=VSS (at high impedance)	-1	-	-	μA
Input voltage 1	VIH1	-	$0.75 \times V_{DD}$	-	V_{DD}	V
	VIL1	-	0	-	$0.3 \times V_{DD}$	V
Input pin capacitance	CIN	f=10kHz Vrms=50mV Ta=25°C	-	10	-	pF
Leak current	IISOV	Voltage supply to the ISO_V terminal, no magnetic field input	-	100	-	nA

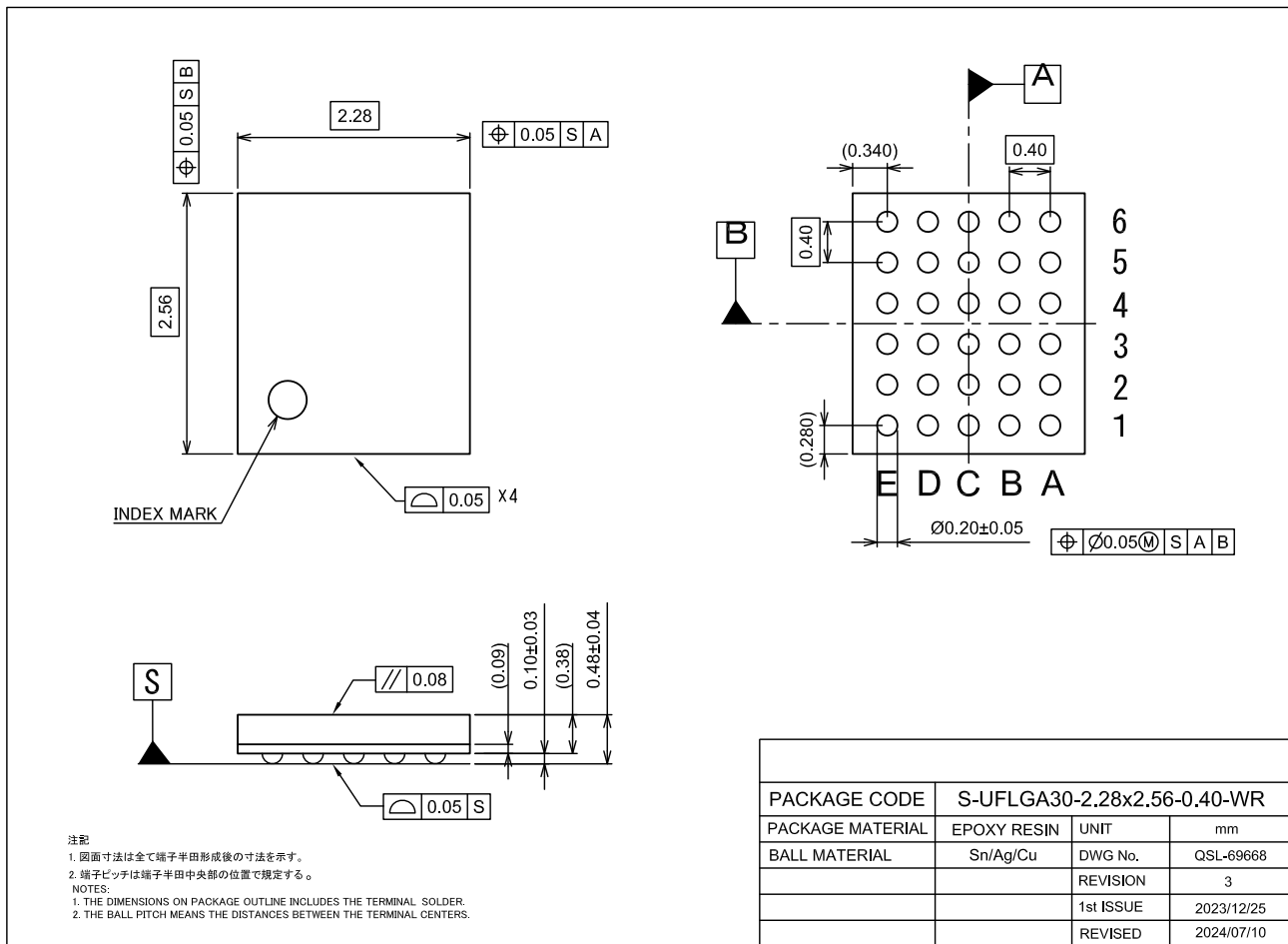
V_{DD}: V_{DD} indicates Power supply voltage (P_ANT or ISO_V) for each pins.

Refer to Supply power in “■Pin Description” table.

Typ. : Standard is at Ta=25°C, P_ANT=3.0V

■ Package Dimensions

WLCSP30pin

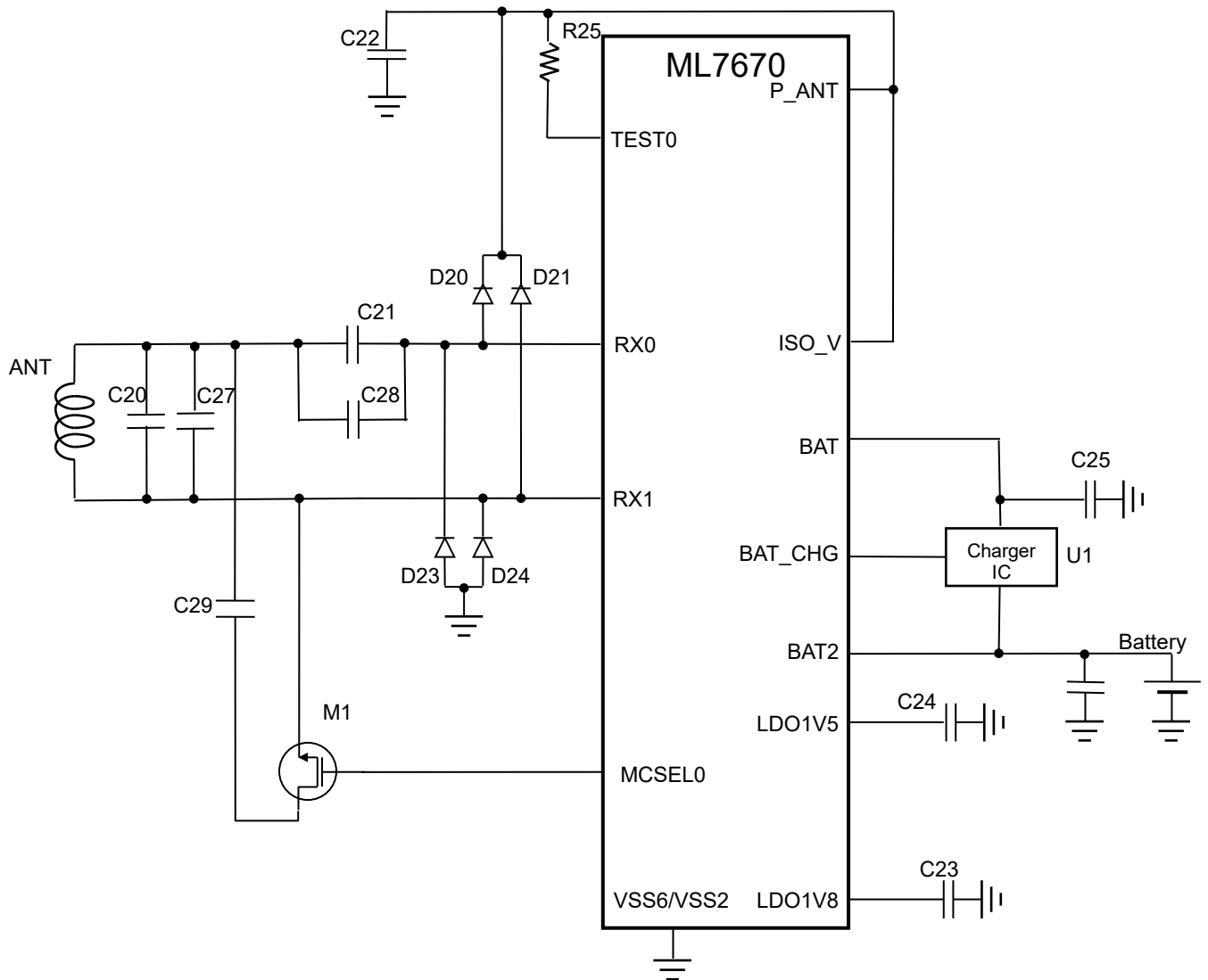


Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact a ROHM sales office for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

■ Application Circuit Example

Please refer to the ML7670 / ML7671 Application Note for details.



■Revision History

Document No.	Issue Date	Page		Change Contents
		Previous Edition	Current Edition	
FEDL7670-01	2023.6.9	-	-	First edition
FEDL7670-02	2023.7.7	6	6	Modify VDD description
		9	9	Modify VDD description
		11	11	Add VSS6/VSS2 connection.
FEDL7670-03	2024.3.28	-	1	Add product name and applications description
		13	13	Modified Notes
FEDL7670-04	2025.12.4	-	1	Revise the product name
FEDL7670-05	2026.1.30	all	all	Revise datasheet layout Added: AC Characteristics (Peripheral) Added: AC Characteristics (UART) Added: AC Characteristics (Reset)

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