

# ML7661

## 13.56MHz Wireless charging transmitter LSI

### ■ Overview

ML7661 is a 13.56MHz wireless power transmission LSI.

ML7661 can be combined with ML7660 to create a wireless power supply system that can supply up to 1W of power to the ML7660.

ML7661 has a communication command generation function for communicating with the ML7660, a variable power transmission control function for optimizing the power transmission, and wireless power transmission functions such as detection of foreign objects while the ML7660 is attached, detached, or powered, all in a 6mm square 40-pin WQFN package. It is the ideal LSI for wireless power supply of small devices.

The operating voltage is set at 5 V, allowing the device to be powered by a USB power supply such as a mobile battery.

In addition, it has a host interface (SPI (peripheral) / I<sup>2</sup>C (target)) function and a serial interface (SPI (controller) / I<sup>2</sup>C (target)) function.

The serial interface (SPI (controller) / I<sup>2</sup>C (controller) / UART) function enables configuration data update and various sensor controls from an external microcontroller.

### ■ Features

- Charging control
  - Built-in 13.56MHz power transmission control circuit
  - Transistor control output for power transmission
  - Abnormality detection function by software control and hardware control
- Communication control
  - Equipped with communication command generation function with ML7660.
  - Communication speed : 212kbps, 424kbps
  - Equipped with 2Kbyte Data Flash for storing user data.
- Host interface
  - Serial interface with 1-channel peripheral/target function (SPI and I<sup>2</sup>C selectable)
- Package
  - WQFN40pin (P-WQFN40-0606-0.50-63)
- 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 mouses and wireless keyboards
  - electric toothbrushes
  - beauty home appliances
  - personal health care devices
  - battery packs
  - rice cooker (for Batteryless)

## ■ Product name

Product name	Packages	Firmware type
ML7661-320GD	WQFN	Charge Control
ML7661-311GD	WQFN	Charge Control for Reference Design (REF66003)
ML7661-210GD	WQFN	Batteryless for Reference Design (REF67011)
ML7661-NN0GD	WQFN	Blank

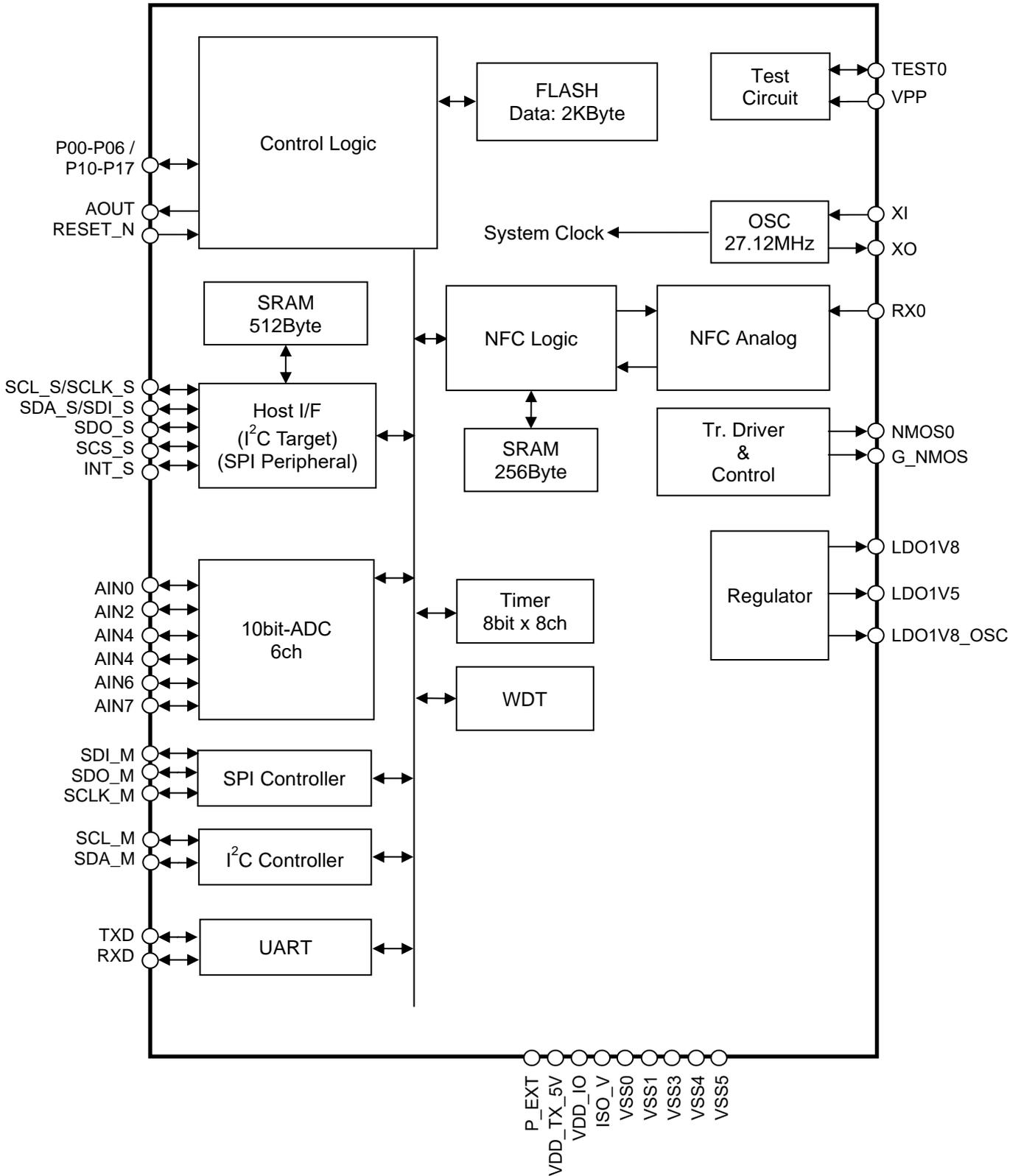
## ■ Related Documents

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

- ML7660 Data Sheet
- ML7660 / ML7661 Application Note

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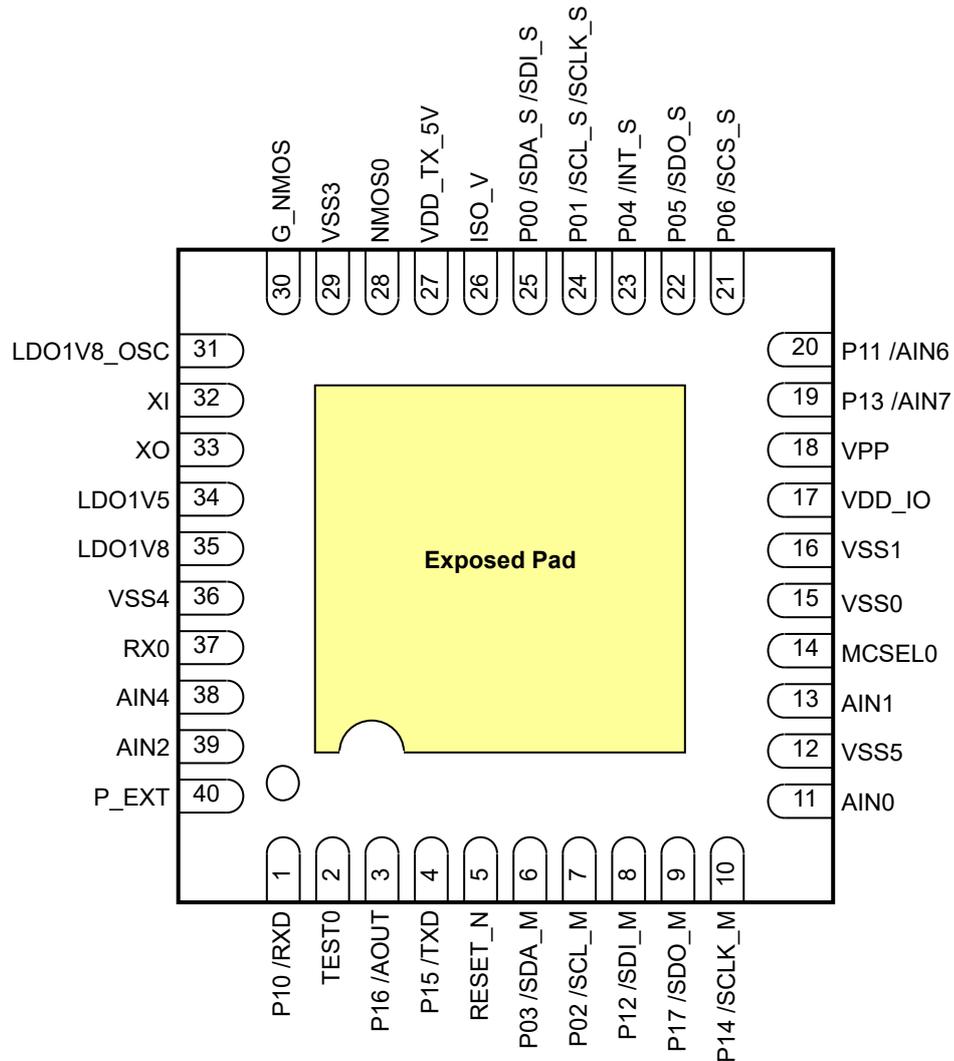
■ Block Diagram



## ■ Pin Assignment

40pin WQFN

TOP VIEW



**note :** The center square is the PAD on the back side of the package (exposed PAD).  
The exposed PAD should be connected to the GND of the board.

## ■ Pin list

Table 1 Pin list

PIN No.	Pin name (Function name) <sup>1</sup>	1 <sup>st</sup> function	2 <sup>nd</sup> function	3 <sup>rd</sup> function
1	P10/RXD (I <sup>2</sup> C ADDRESS)	General purpose port	UART data input	-
2	TEST0	Debug port	-	-
3	P16/AOUT (SHUTDOWN)	General purpose port	Analog monitor output	-
4	P15/TXD	General purpose port	UART data output	-
5	RESET_N	Reset pin	Debug port	-
6	P03/SDA_M (WAKEUP)	General purpose port	I <sup>2</sup> C Controller data I/O	-
7	P02/SCL_M	General purpose port	I <sup>2</sup> C Controller clock output	-
8	P12/SDI_M (POWER)	General purpose port	SPI Controller data input	-
9	P17/SDO_M (ERROR)	General purpose port	SPI Controller data output	-
10	P14/SCLK_M (CHARGE)	General purpose port	SPI Controller clock output	-
11	AIN0	General-purpose port 0 (for AD input)	-	-
12	VSS5	GND	-	-
13	AIN1	General-purpose port 1 (for current measurement)	-	-
14	MCSEL0	Capacitor selection signal (for impedance matching)	-	-
15	VSS0	GND	-	-
16	VSS1	GND	-	-
17	VDD_IO	Power supply (for logic IO)	-	-
18	VPP	Test pin	-	-
19	P13/AIN7	General purpose port	General-purpose port 7 for AD input	-
20	P11/AIN6 (INTERFACE)	General purpose port	General-purpose port 6 for AD input	-
21	P06/SCS_S (SCS_S)	General purpose port	SPI Peripheral chip select input	-
22	P05/SDO_S (SDO_S)	General purpose port	SPI Peripheral data output	-
23	P04/INT_S (INT_S)	General purpose port	Host IF INT output	-
24	P01/SCL_S/SCLK_S (SCL_S / SCLK_S)	General purpose port	I <sup>2</sup> C Target clock input	SPI Peripheral clock input
25	P00/SDA_S/SDI_S (SDA_S / SDI_S)	General purpose port	I <sup>2</sup> C Target data I/O	SPI Peripheral data input
26	ISO_V	Power supply for logic IO (for Host IF) <sup>2</sup>	-	-
27	VDD_TX_5V	Power source for driving	-	-
28	NMOS0	Nch transistor driver (for power feed)	-	-
29	VSS3	GND	-	-
30	G_NMOS	Nch transistor bias output (for power feed)	-	-
31	LDO1V8_OSC	1.8V power supply output for 27.12MHz oscillator circuit	-	-
32	XI	27.12MHz oscillation terminal	-	-
33	XO	27.12MHz oscillation terminal	-	-
34	LDO1V5	Internal power supply (1.5V)	-	-
35	LDO1V8	Internal power supply (1.8V)	-	-
36	VSS4	GND	-	-

<sup>1</sup> Function name assigned by firmware.<sup>2</sup> ISO\_V should be connected to VDD\_IO on the board.

PIN No.	Pin name (Function name) <sup>1</sup>	1 <sup>st</sup> function	2 <sup>nd</sup> function	3 <sup>rd</sup> function
37	RX0	RF data receiving terminal	-	-
38	AIN4	General-purpose input port 4 for high frequency current measurement	-	-
39	AIN2	General-purpose input port 2 for measuring transmission current	-	-
40	P_EXT	External power supply (5V)	-	-

## ■ Pin Description

Notation Definition: Pin state in reset

Index	Notation	Description
In reset	L	"L" level output
	H	"H" level output
	PU	Pull-Up
	PD	Pull-Down
	Z	Floating state

Notation Definition: input/output direction

index	Notation	Description
I/O	I	Input pin
	O	Output pin
	I/O	Bi-directional pin

## ● Power, GND, and reference voltage pins

PIN No.	Pin name	I/O	Pin description
12	VSS5	-	GND
15	VSS0	-	GND
16	VSS1	-	GND
17	VDD_IO	-	Power supply (for Logic IO)
18	VPP	I	Power supply (for Test)
26	ISO_V	-	Power supply (for Host Interface control)
27	VDD_TX_5V	-	Power supply (for magnetic field generation transistor)
29	VSS3	-	GND
31	LDO1V8_OSC	-	Power supply for crystal oscillator (1.8V)
34	LDO1V5	-	Power supply for internal use (1.5V)
35	LDO1V8	-	Power supply for internal use (1.8V)
36	VSS4	-	GND
40	P_EXT	-	Power supply (5V)

## ● Analog signal pin

PIN No.	Pin name	In reset	I/O	Pin description
28	NMOS0	Z	O	Pin that generates a 13.56 MHz sine wave to generate a magnetic field in a later stage Nch MOSFET.
30	G_NMOS	PD	O	Pin for adjusting the gain of the Nch MOSFET in the subsequent stage. G_NMOS makes modulation degree changeable.
37	RX0	-	I	Pins Connected to LSI internal circuits that demodulate communications.

## ● Clock pin

PIN No.	Pin name	I/O	Pin description
32	XI	I	Pins to generate clock by connecting to 27.12MHz crystal oscillator
33	XO	O	

● General purpose port pin (P\_EXT system)

PIN No.	Pin name	in reset	I/O	Pin Description
38	AIN4	Z	I	Pins connected to the internal circuitry of the LSI that demodulates the notification. <sup>13</sup>
39	AIN2	Z	I	Pins that can measure the current flowing through the antenna with AD.

● General purpose port terminal (ISO\_V system)<sup>14</sup>

PIN No.	Pin name	in reset	I/O	Pin Description
6	P03/SDA_M	Z	I/O	General purpose port I <sup>2</sup> C Controller data I/O
7	P02/SCL_M	Z	I/O	General purpose port I <sup>2</sup> C Controller Clock output
8	P12/SDI_M	Z	I/O	General purpose port SPI Controller Data input
9	P17/SDO_M	Z	I/O	General purpose port SPI Controller Data output
10	P14/SCLK_M	Z	I/O	General purpose port SPI Controller Clock output
20	P11/AIN6	Z	I/O	General purpose port General-purpose port 6 (for AD input)
21	P06/SCS_S	Z	I/O	General purpose port SPI Peripheral Chip Select input
22	P05/SDO_S	Z	I/O	General purpose port SPI Peripheral Data output
23	P04/INT_S	Z	I/O	General purpose port Host IF INT output
24	P01/SCL_S/SCLK_S	Z	I/O	General purpose port I <sup>2</sup> C Target Clock input SPI Peripheral Clock input
25	P00/SDA_S/SDI_S	Z	I/O	General purpose port I <sup>2</sup> C Target Data I/O SPI Peripheral Data input

● General-purpose port pins (VDD\_IO system)

PIN No.	Pin name	In reset	I/O	Active Level	Pin Description
1	P10/RXD	PU	I/O	-	General purpose port UART data input
2	TEST0	Z	I/O	L	Debug port
3	P16/AOUT	Z	I/O	-	General purpose port Analog Monitor Outputs
4	P15/TXD	Z	I/O	-	General purpose port UART data output
5	RESET_N	PU	I	L	Reset Input Pin L : System reset mode H : Program operation mode
11	AIN0	Z	I	-	General-purpose port 0 (for AD input)
13	AIN1	Z	I	-	General-purpose port 1 (for AD input)
14	MCSEL0	PU	O	-	Selection signal for impedance matching capacitor
19	P13/AIN7	Z	I/O	-	General purpose port General-purpose port 7 (for AD input)

<sup>13</sup> A communication that originates from the power receiver as defined in the NFC standard.

<sup>14</sup> When controlled by an MCU or other device, the voltage should be the same as the interface voltage of the MCU.

■Unused pin processing

Pin name	Pin processing
TEST0	Pull-Up
P00~P06, P10~P17 RESET_N AIN0 AIN1 MCSEL0 AIN4 AIN2	Open

## ■Electrical Characteristics

### ●Absolute Maximum Ratings

Index		Symbol	Rated value	Unit
Supply voltage	Power supply for logic IO	VDD_IO	-0.3~+6.5	V
	Power supply for logic IO (for Host IF)	ISO_V		
	Regulator input voltage	P_EXT	-0.3~+6.5	V
	Power supply voltage for power transmission	VDD_TX_5V	-0.3~+6.5	V
	Internal power supply / Crystal oscillation voltage	LDO1V5	-0.3~+2.0	V
	Internal power supply	LDO1V8	-0.3~+6.5	V
	27.12MHz oscillator	LSO1V8_OSC	-0.3~+6.5	V
Input voltage		V <sub>DIN_IO</sub>	-0.3~VDD_IO+0.3	V
		V <sub>DINmax</sub>	-0.3~+6.5	V
Input current		I <sub>i</sub>	-10~+10	mA
Output voltage		V <sub>DO</sub>	-0.3~VDD_IO+0.3	V
Digital output current		I <sub>DO</sub>	-12~+20	mA
Allowable Loss		PD	1	W
Storage Temperature		T <sub>stg</sub>	-55~+150	°C

### ●Recommended Operating Conditions

Index	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage range	VDD_IO	-	1.8	-	5.5	V
	ISO_V	Connect with VDD_IO on the board	1.8	-	5.5	V
	P_EXT	-	4.5	5.0	5.5	V
	VDD_TX_5V	-	4.5	5.0	5.5	V
Operating temperature	T <sub>a</sub>	-	-40	+25	+85	°C
Crystal oscillator frequency	f <sub>XTL</sub>	-	Typ. -0.05%	27.12	Typ. +0.05%	MHz

### ●Flash Memory Operating Conditions

(VDD\_IO=2.7 to 5.5V, P\_EXT=2.7 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Index	Symbol	Condition	Range	Unit
Rewrite count	C <sub>EPD</sub>	Data Flash	10,000	times

### ●Power Transmission Characteristics

(VDD\_IO=1.8 to 5.5V, VDD\_TX\_5V=4.5 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Index	Symbol	Condition	Min.	Typ.	Max.	Unit
nmos0 output frequency	F <sub>TX</sub>	-	-	13.56	-	MHz

● AC Characteristics (I<sup>2</sup>C Bus Interface)

- Standard Mode 100 kHz

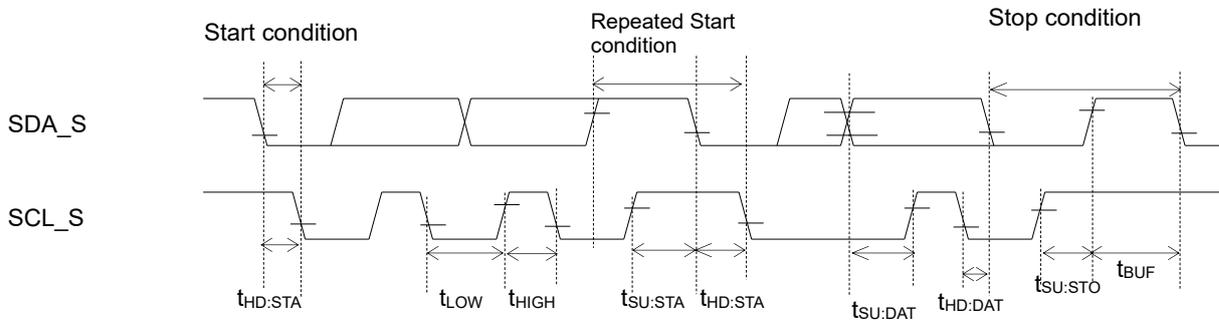
(VDD<sub>IO</sub>=1.8 to 5.5V, P<sub>EXT</sub>=4.5 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Index		Symbol	Condition	Min.	Typ.	Max.	Unit
SCL_S	Clock frequency	f <sub>SCL</sub>	-	-	-	100	kHz
	Hold time (start/repeated start condition)	t <sub>HD:STA</sub>	-	4.0	-	-	μs
	"L" level time	t <sub>LOW</sub>	-	4.7	-	-	μs
	"H" level time	t <sub>HIGH</sub>	-	4.0	-	-	μs
	Setup time (repeated start condition)	t <sub>SU:STA</sub>	-	4.7	-	-	μs
SDA_S	Hold time	t <sub>HD:DAT</sub>	-	0	-	-	μs
	Setup time	t <sub>SU:DAT</sub>	-	0.25	-	-	μs
	Setup time (Stop condition)	t <sub>SU:STO</sub>	-	4.0	-	-	μs
Bus free time		t <sub>BUF</sub>	-	4.7	-	-	μs

- Fast Mode 400 kHz

(VDD<sub>IO/ISO\_V</sub>=1.8 to 5.5V, P<sub>EXT</sub>=4.5 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Index		symbol	Condition	Min.	Typ.	Max.	Unit
SCL_S	Clock frequency	f <sub>SCL</sub>	-	-	-	400	kHz
	Hold time (start/repeated start condition)	t <sub>HD:STA</sub>	-	0.6	-	-	μs
	"L" level time	t <sub>LOW</sub>	-	1.3	-	-	μs
	"H" level time	t <sub>HIGH</sub>	-	0.6	-	-	μs
	Setup time (repeated start condition)	t <sub>SU:STA</sub>	-	0.6	-	-	μs
SDA_S	Hold time	t <sub>HD:DAT</sub>	-	0	-	-	μs
	Setup time	t <sub>SU:DAT</sub>	-	0.1	-	-	μs
	Setup time (Stop condition)	t <sub>SU:STO</sub>	-	0.6	-	-	μs
Bus free time		t <sub>BUF</sub>	-	1.3	-	-	μs

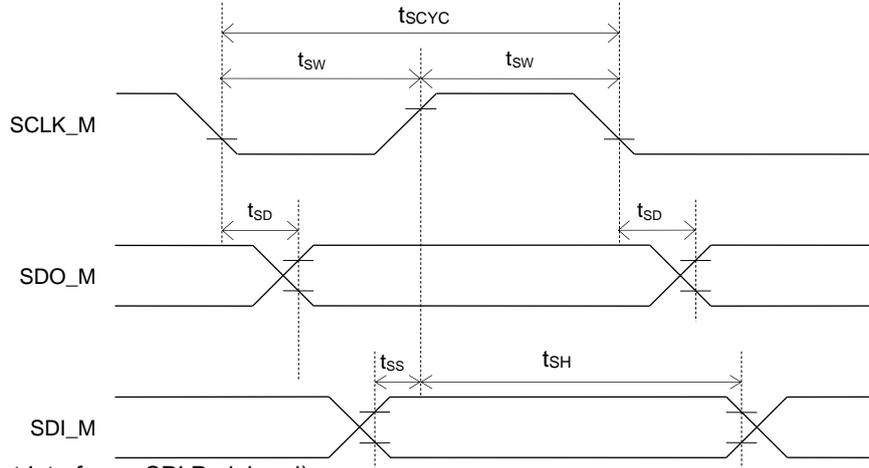


**Note** : If powering off this LSI, it disables communications of other devices on the I<sup>2</sup>C bus

●AC Characteristics (Host Interface : SPI Controller)

(VDD\_IO/ISO\_V=1.8 to 5.5V, P\_EXT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

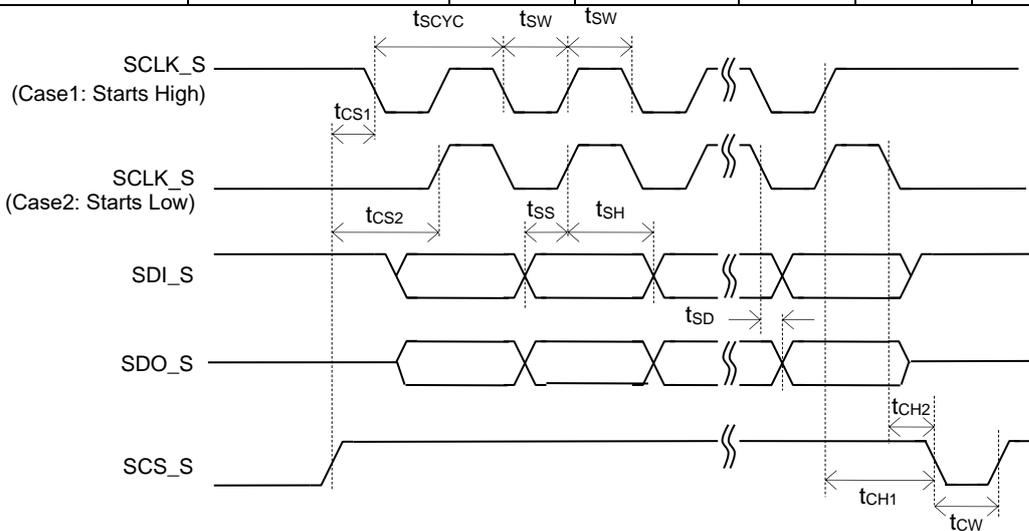
Index	Symbol	Condition	Min.	Typ.	Max.	Unit	
SCLK_M	Output cycle	t <sub>SCYC</sub>	-	250	SCLK <sup>15</sup>	-	ns
	Output pulse width	t <sub>SW</sub>	-	t <sub>SCYC</sub> × 0.4	t <sub>SCYC</sub> × 0.5	t <sub>SCYC</sub> × 0.6	ns
SDO_M	Output delay time	t <sub>SD</sub>	-	-	100	ns	
SDI_M	Input setup time	t <sub>SS</sub>	-	100	-	-	ns
	Input hold time	t <sub>SH</sub>	-	60	-	-	ns



●AC Characteristics (Host Interface : SPI Peripheral)

(VDD\_IO/ISO\_V=1.8 to 5.5V, P\_EXT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Index	Symbol	Condition	Min.	Typ.	Max.	Unit	
SCLK_S	Input cycle	t <sub>SCYC</sub>	-	500	-	-	ns
	Input pulse width	t <sub>SW</sub>	-	200	-	-	ns
SCS_S <sup>16</sup>	Setup time	t <sub>CS1</sub>	-	80	-	-	ns
		t <sub>CS2</sub>	-	80	-	-	ns
	Hold time	t <sub>CH1</sub>	-	80	-	-	ns
		t <sub>CH2</sub>	-	80	-	-	ns
Input pulse width	t <sub>CW</sub>	-	80	-	-	ns	
SDO_S	Output delay time	t <sub>SD</sub>	-	-	240	ns	
SDI_S	Input setup time	t <sub>SS</sub>	-	80	-	-	ns
	Input hold time	t <sub>SH</sub>	-	80	-	-	ns



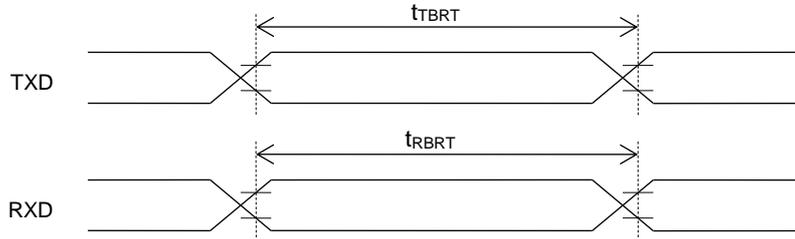
<sup>15</sup> SCLK is configurable via register. See the ML7660/ML7661 Application Note for details.

<sup>16</sup> SCS\_S polarity (active-high or active-low) is switchable. See the ML7660/ML7661 Application Note for details.

●AC Characteristics (UART)

(VDD IO/ISO V=1.8 to 5.5V, P\_EXT=2.0 to 5.5V, VSS=0V, Ta=-40 to +85°C)

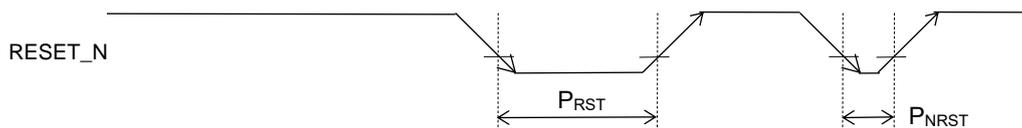
Index	Symbol	Condition	Min.	Typ.	Max.	Unit
Tx Baud Rate	$t_{TBRT}$	-	-	-	115.2	kbps
Rx Baud Rate	$t_{RBRT}$	-	-	-	115.2	kbps



●AC Characteristics (Reset)

(VDD IO=1.8 to 5.5V, P\_EXT=4.5 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	$P_{NRST}$	-	-	-	0.3	$\mu s$



## ●IO Characteristics

(Unless otherwise specified, VDD\_IO=1.8 to 5.5V, P\_EXT=4.5 to 5.5V, VSS=0V, Ta=-40 to +85°C)

Index	Symbol	Condition	Min.	Typ. <sup>17</sup>	Max.	Unit
Output voltage 1	VOH1	IOH=-1.0mA	VDD_IO -0.5	-	-	V
	VOL1	IOL=+0.5mA	-	-	0.4	V
Output voltage 2 (LED mode selected)	VOL2	2.7V ≤ VDD_IO ≤ 5.5V IOL=+5.0mA	-	-	0.6	V
		IOL=+2.0mA	-	-	0.4	V
Output voltage 3 (I <sup>2</sup> C mode selected)	VOL3	IOL3= +3mA (I <sup>2</sup> C Spec. ) (VDD_IO ≥ 2V)	-	-	0.4	V
Output voltage 4 (I <sup>2</sup> C mode selected)	VOL4	IOL4= +2mA (I <sup>2</sup> C Spec.) (VDD_IO < 2V)	-	-	VDD_IO ×0.2	V
Output leakage 1	IOOH1	VOH=VDD_IO (at high impedance)	-	-	1	μA
	IOOL1	VOL=VSS (at high impedance)	-1	-	-	μA
Input current 1 (RESET_N)	IIH1	VIH1=VDD_IO	-	-	1	μA
	IIL1	VIL1=VSS	-900	-300	-20	μA
Input current 2 (TEST0)	IIH2	VIH2=VDD_IO	-	-	1	μA
	IIL2	VIL2=VSS	-200	-15	-1	μA
Input current 3	IIH3	VIH3=VDD_IO (when pull down)	1	15	200	μA
	IIL3	VIL3=VSS (when pull down)	-200	-15	-1	μA
	IIH3Z	VIH3=VDD_IO (at high impedance)	-	-	1	μA
	IIL3Z	VIL3=VSS (at high impedance)	-1	-	-	μA
Input voltage1	VIH1	-	0.75× VDD_IO	-	VDD_IO	V
	VIL1	-	0	-	0.3× VDD_IO	V
Input pin capacitance	CIN	f=10kHz Vrms=50mV Ta=25°C	-	10	-	pF

## ●Current Consumption

(VDD\_IO=1.8 to 5.5V, P\_EXT=4.5 to 5.5V, VSS=0V, Ta=-40 to +85°C)

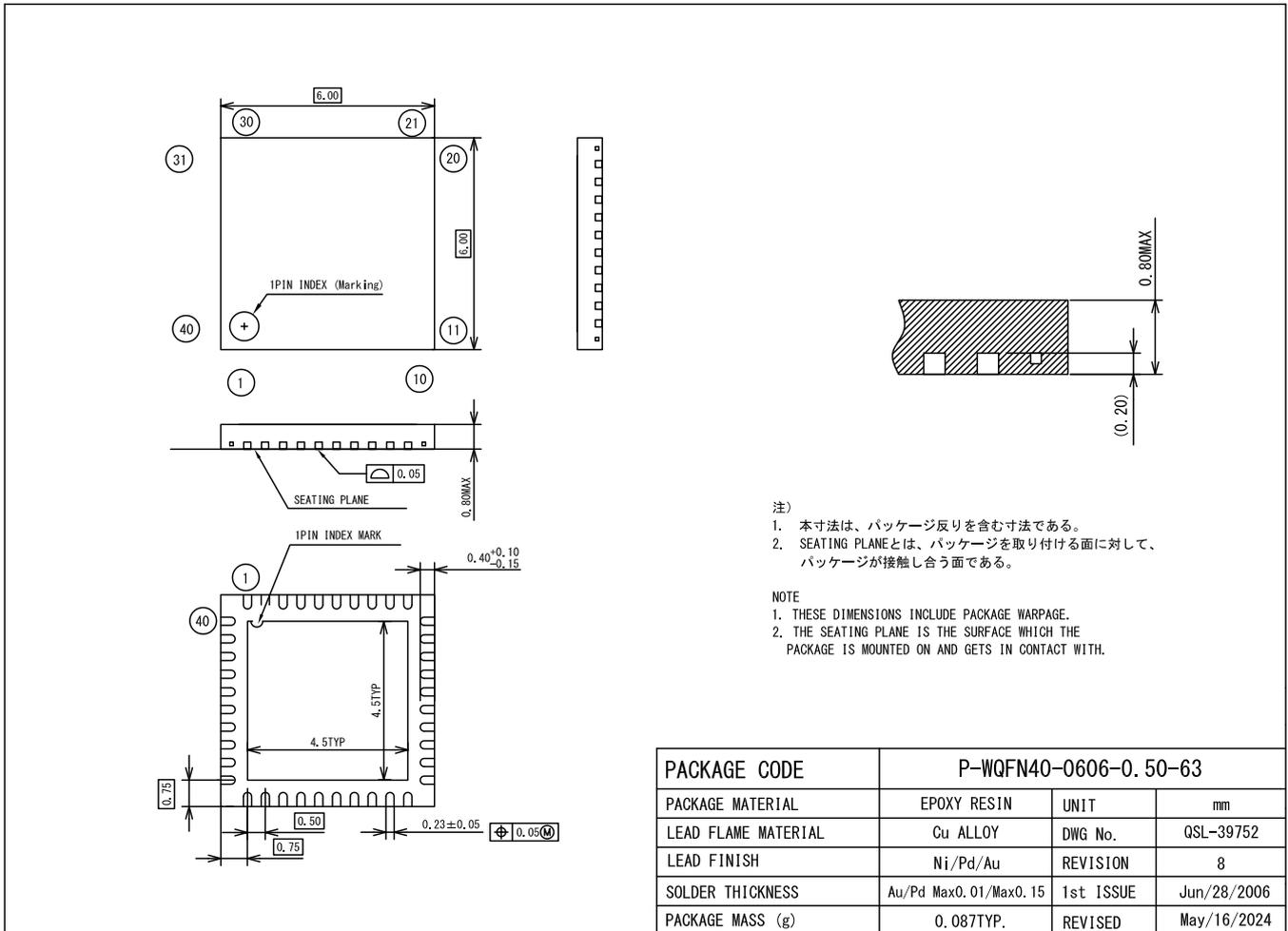
Index	Symbol	Condition	Min.	Typ.	Max.	Unit
Current Consumption	IDD1	HALT-H High speed clock stops	-	7	23.6	μA
	IDD2	HALT	-	1.3	2.0	mA
	IDD3	CPU 6.78MHz operation Peripherals stop	-	2.2	3.0	mA
	IDD4	CPU 6.78MHz operation During communication <sup>18</sup>	-	15	-	mA
	IDD5	CPU 6.78MHz operation During power transmission <sup>18</sup>	-	20	-	mA

<sup>17</sup> Typical values are listed for Ta=25°C and VDD\_IO=3.0V.

<sup>18</sup> Current consumption depends on the antenna design. The smaller the load resistance, the higher the current consumption. External transistor current is not included.

■ Package Dimensions

WQFN 40pin

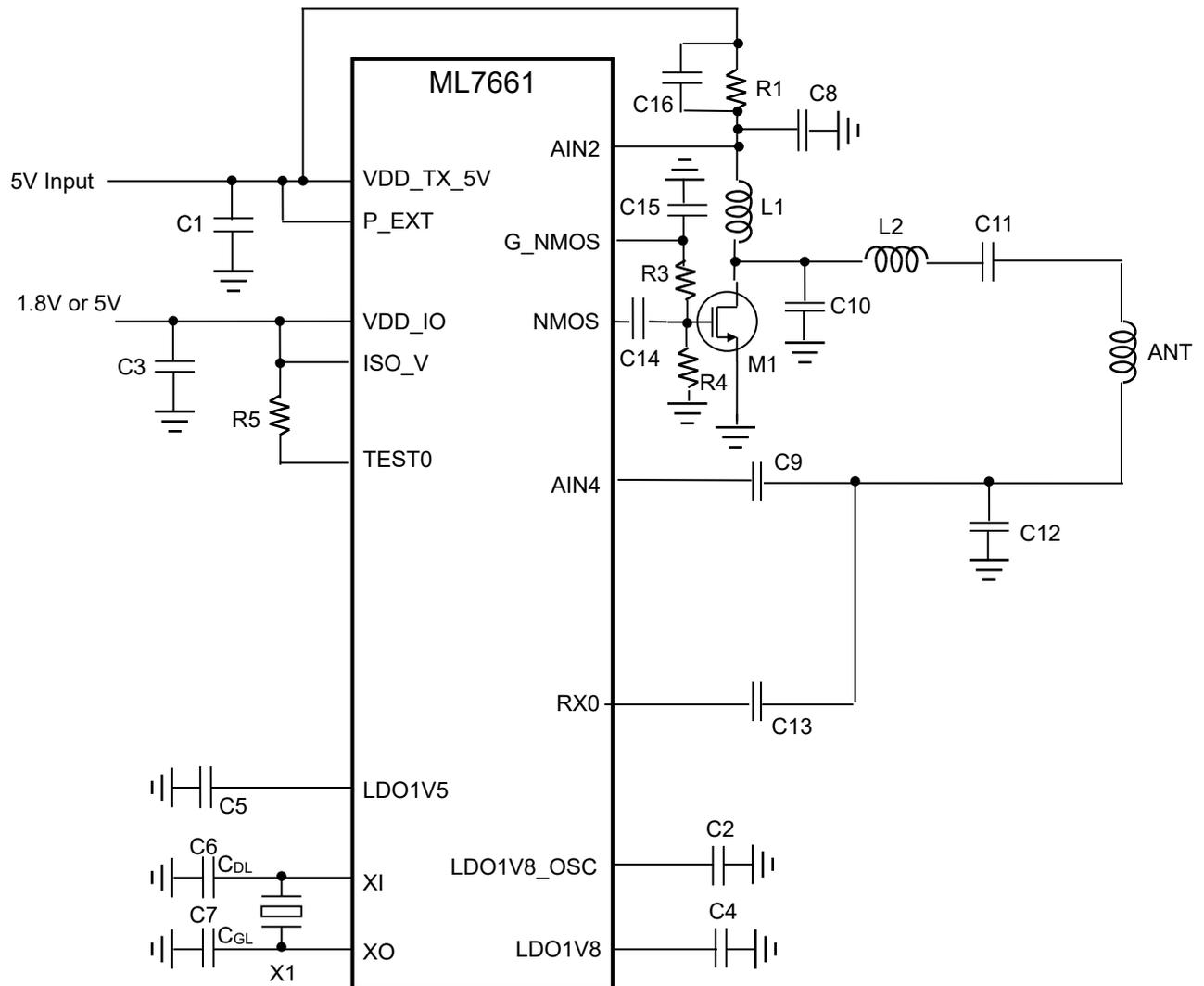


Notes for Mounting the Surface Mount Type Package

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 ML7660 / ML7661 Application Note for details.



## ■Revision History

Document No.	Issue Date	Page		Change contents
		Previous Edition	Current Edition	
FEDL7661-01	2021.10.5	-	-	First edition
FEDL7661-02	2022.12.28	P.1-14	P.1-14	Correction of errors.
		P.9	P.9	Correction of Flash operating temperature upper / lower limit, and oscillator frequency range.
		P.16	P.16	Added optional notation to C12, R2, M3.
FEDL7661-03	2023.3.10	P.1-14	P.1-12	Removed description of serial interface, and general port.
		P.16	P.14	Removed C12, R2, M3.
FEDL7661-04	2023.6.7	P.1-14	P.1-12	Correction of errors.
		P.1-2	P.1	Modified features.
		P.4-6	P.3-5	Modified pin names and descriptions.
		P.14	P.12	Added R5.
FEDL7661-05	2023.12.15	P.1	P.1	Added product name and applications.
FEDL7661-06	2024.1.10	P.14	P.14	Modified notes.
FEDL7661-07	2024.1.26	P.1	P.1	Added product name.
FEDL7661-08	-	-	-	Blank
FEDL7661-09	2025.2.14	P.1-15	P.1-15	<p>Full review and company name change</p> <p>Modified: ■ Overview Correction of errors</p> <p>Modified: ■ Features Additional product name revision</p> <p>Added: ■ Related Documents</p> <p>Added: ● Product name Latest code number added.</p> <p>Modified: ■ Block diagram Modified terminal names.</p> <p>Added: ■ Pin assignment Changed from function name to pin name Correction of error (MCSELO)</p> <p>Added: ■ Pin list</p> <p>Modified: ■ Pin description General-purpose port classification updated ■ Pin Description updated ● General-purpose port pins (ISO_V) ● General-purpose port pins (VDD_IO)</p> <p>Added: ■ Electrical Characteristics AC Characteristics of SPI Controller</p> <p>Modified: ■ Package Dimensions Company name deleted.</p> <p>Modified: ■ Modified "Caution"</p> <p>Modified: ■ Application circuit example modified (L3 deleted, C12 added)</p>
FEDL7661-10	2025.8.18	P.2	P.2	Modified: ● Product Name Revision of product lineup
		P.12	P.12	Added: t <sub>scyc</sub> MIN. value Added: SCS_S polarity is register-selectable.
FEDL7661-11	2026.1.30	P.13	P.13	Added: AC Characteristics (UART) Added: AC Characteristics (Reset)
		P.15	P.15	Delete: Note for the package with exposed die pad

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