

SP4T Switch with MIPI for 5G FBRX

Features

- Broadband frequency range: 0.4 to 6.0 GHz
- Low insertion loss: 0.75dB typical @ 6GHz
- High isolation: 40dB typical @ 6GHz
- P0.1dB @ 30dBm
- MIPI RFFE V2.1 compatible Interface
- QFN 1.5mm X1.5mm X0.55mm-12L package

Applications

- Cellular 2G/3G/4G/5G RX
- Cellular modems, tablets and USB Devices
- Other RF front-end modules

General Description

The AW13524TQNR is a SP4T switch with low insertion loss and high isolation. It can be used for cellular 2G/3G/4G/5G, data cards and tablets.

The symmetrical design of internal ports makes it convenient for PCB routing and adjustment of receiving and transmitting signals. The band/mode switching is realized by the MIPI RFFE 2.1 Interface.

The AW13524TQNR is provided in a compact QFN 1.5mm X1.5mm X0.55mm-12L package.

Typical Application Circuit

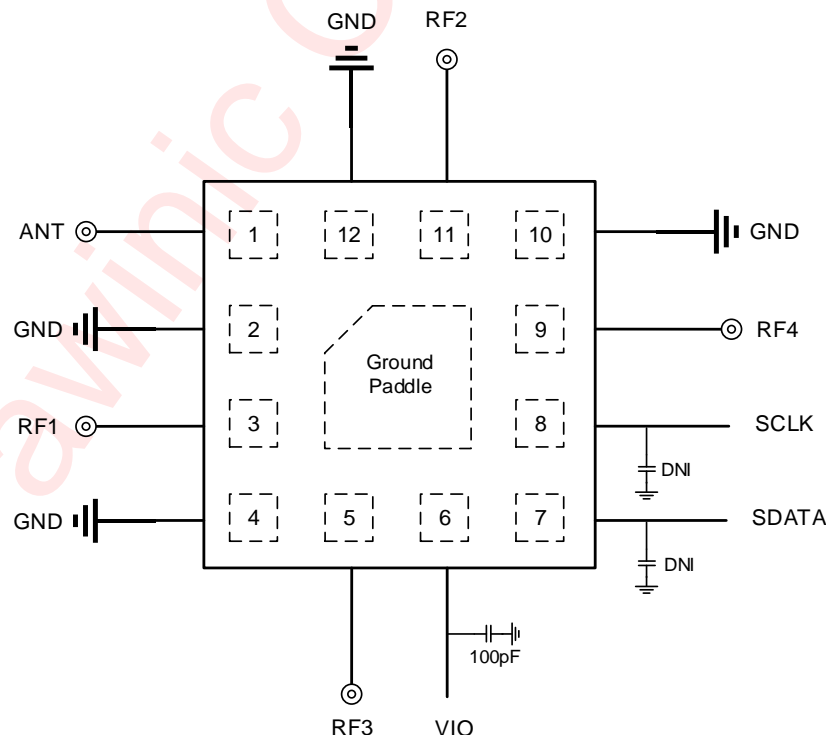


Figure 1 Typical Application Circuit

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Pin Configuration and Top Mark

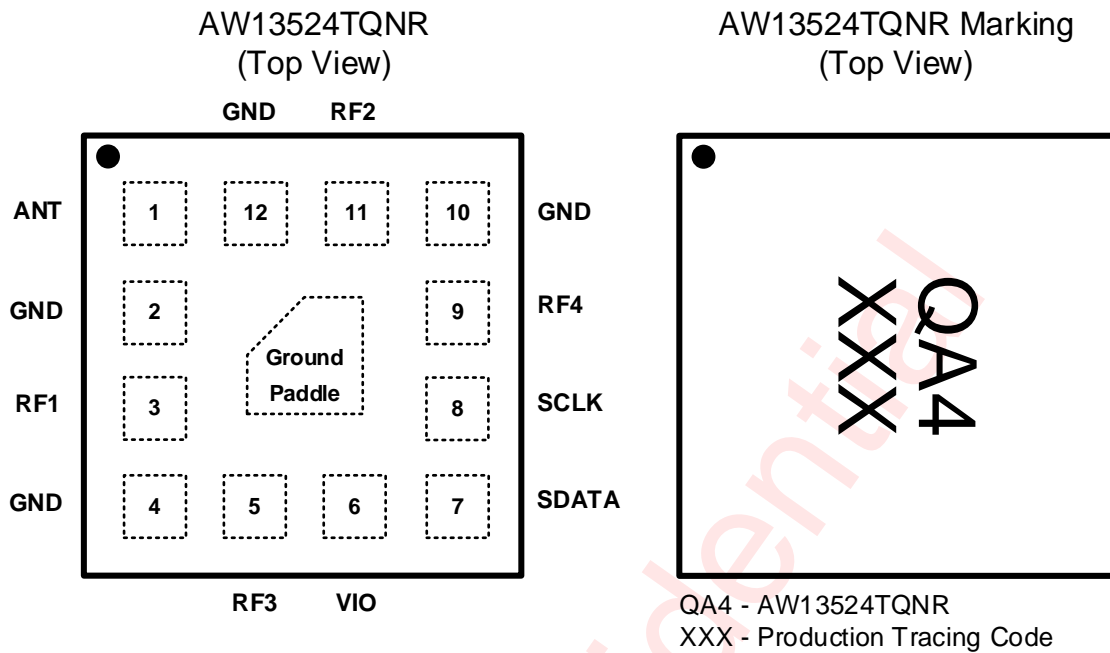


Figure 2 Pin Configuration and Top Mark

Pin Definition

No.	NAME	DESCRIPTION
1	ANT	Antenna Port
2	GND	Ground
3	RF1	RF1 Port
4	GND	Ground
5	RF3	RF3 Port
6	VIO	Voltage Supply
7	SDATA	RFFE Data Signal
8	SCLK	RFFE Clock Signal
9	RF4	RF4 Port
10	GND	Ground
11	RF2	RF2 Port
12	GND	Ground

Functional Block Diagram

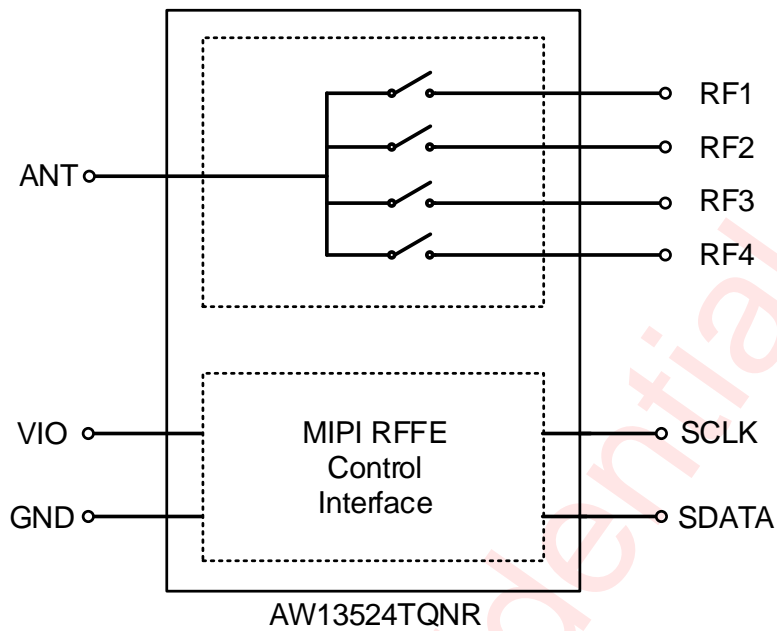


Figure 3 Functional Block Diagram

Ordering Information

Part Number	Temperature	Package	Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW13524TQNR	-40°C~90°C	QFN 1.5mm X1.5 mm X0.55 mm-12L	QA4	MSL1	ROHS+HF	4500 units/ Tape and Reel

Absolute Maximum Ratings (NOTE1)

PARAMETERS	RANGE
Supply Voltage Range V_{IO}	-0.3V to +2.5 V
RRFFE Bus Voltage (SDATA, SCLK)	-0.3V to +2.5 V
Max input power(RF1/RF2/RF3/RF4/ANT)	30dBm
Maximum Junction temperature T_{JMAX}	125 °C
Operating Free-air Temperature Range	-40°C to 90°C
Storage Temperature T_{STG}	-65°C to 150°C
ESD <small>(NOTE 2)</small>	
HBM	±1000V
CDM	±1000V

NOTE1: Conditions out of those ranges listed in "absolute maximum ratings" may cause permanent damages to the device. In spite of the limits above, functional operation conditions of the device should within the ranges listed in "recommended operating conditions". Exposure to absolute-maximum-rated conditions for prolonged periods may affect device reliability.

NOTE2: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: ESDA-JEDEC JS-001-2017. CDM test method is ESDA/JEDEC JS-002-2018.

Electrical Characteristics

$V_{IO}=1.8V$, $SCLK/SDATA=0$ or $1.8V$, $P_{IN}=0dBm$, $Temp=+25^{\circ}C$, $Z_0=50\Omega$. (unless otherwise noted)

PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT
DC Specifications					
V_{IO}	Supply Voltage	1.62	1.8	1.98	V
I_{IO}	Supply Current	Active Mode	45		μA
		Low Power Mode	2.1		μA
V_{CTL_H}	SDATA,SCLK Control Voltage High	Must not exceed V_{IO} voltage	$0.8*V_{IO}$	V_{IO}	V
V_{CTL_L}	SDATA,SCLK Control Voltage Low	Must not exceed V_{IO} voltage	0	$0.2*V_{IO}$	V
T_{ON}	Turn-On Time	From end of RFFE Sequence to 90% of final RF amplitude	4		μs
T_{SW}	Switching Speed One RF port to another	From end of RFFE Sequence to 90% of final RF amplitude	330	500	ns
RF Specifications					
IL	Insertion loss(ANT pin to RF1/RF2/RF3/RF4)	0.4-1.0G	0.50	0.56	dB
		1.0-2.2G	0.54	0.61	dB
		2.2-2.7G	0.55	0.64	dB
		2.7-3.8G	0.59	0.71	dB
		3.8G-5.0G	0.63	0.76	dB
		5.0G-6.0G	0.72	0.87	dB
ISO	Isolation (ANT pin to RF1/RF2/RF3/RF4)	0.4-1.0G	52	59	dB
		1.0-2.2G	46	55	dB
		2.2-2.7G	45	52	dB
		2.7-3.8G	43	49	dB
		3.8G-5.0G	41	46	dB
		5.0G-6.0G	40	45	dB
ISO	Isolation (RFx to RFy)	0.4-1.0G	52	60	dB
		1.0-2.2G	46	54	dB
		2.2-2.7G	45	52	dB
		2.7-3.8G	43	48	dB
		3.8G-5.0G	38	45	dB
		5.0G-6.0G	35	44	dB
RL	Input return loss (ANT pin to RF1/RF2/RF3/RF4)	0.4-1.0G	20	25	dB
		1.0-2.2G	19	24	dB
		2.2-2.7G	18	23	dB
		2.7-3.8G	17	22	dB
		3.8G-5.0G	16	21	dB
		5.0G-6.0G	15	18	dB
$P_{0.1dB}$	0.1dB Compression Point (ANT pin to RF1/RF2/RF3/RF4)	0.4-6.0G	30		dBm

Timing Requirements

1. Once V_{IO} is powered down to 0 V, wait at least 10 μs to reapply power to V_{IO} .

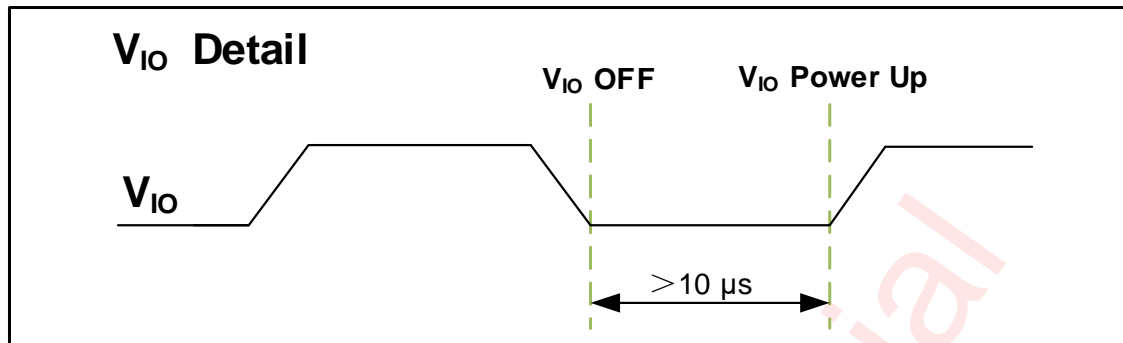


Figure 4 Digital Supply Detail

2. Before applying RF power, V_{IO} must be turned on for at least 20 μs .

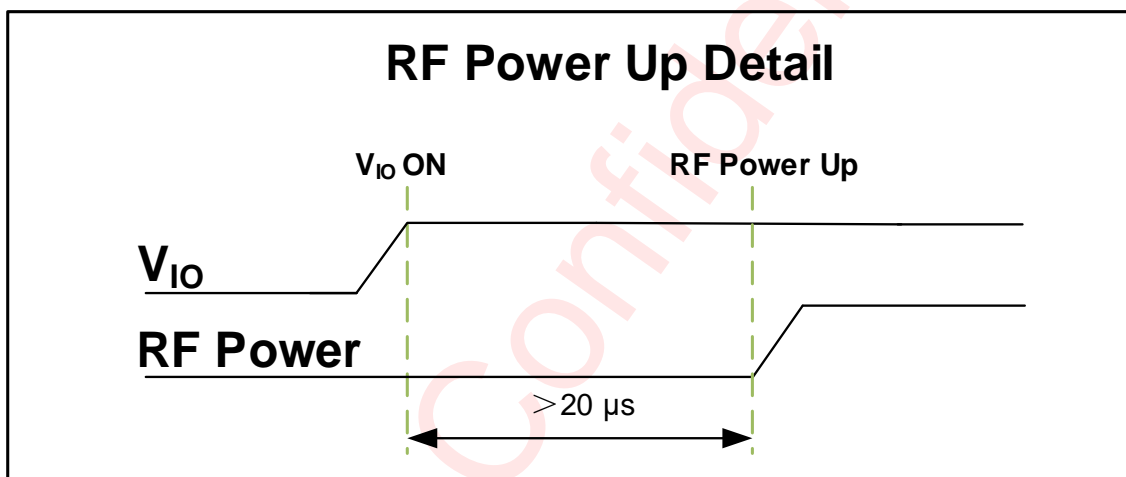


Figure 5 RF Power-Up Detail

3. Before sending SDATA/SCLK, V_{IO} must be applied for at least 800 ns to ensure correct data transmission. And after the RFFE bus is idle, wait at least 20 μs to apply the RF signal.

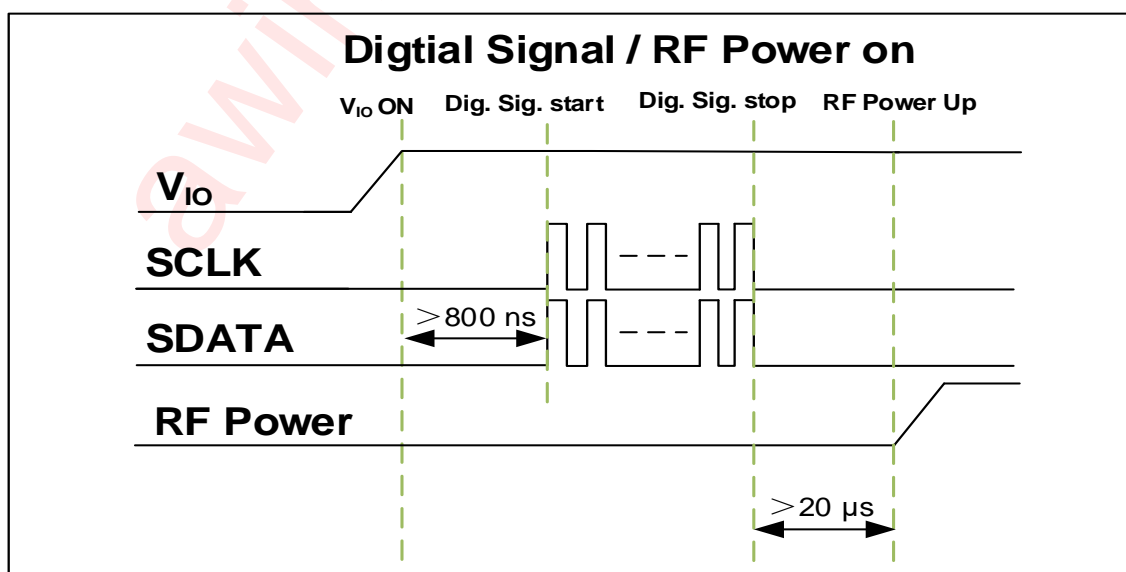


Figure 6 Digital Signal / RF Power-On Detail

4. There shall be no RFFE bus operations during RF Signal active to protect the device. So RF input signal shall be applied T_{UP} after RFFE bus operations being finished and be removed T_{DOWN} before RFFE bus operations being started.

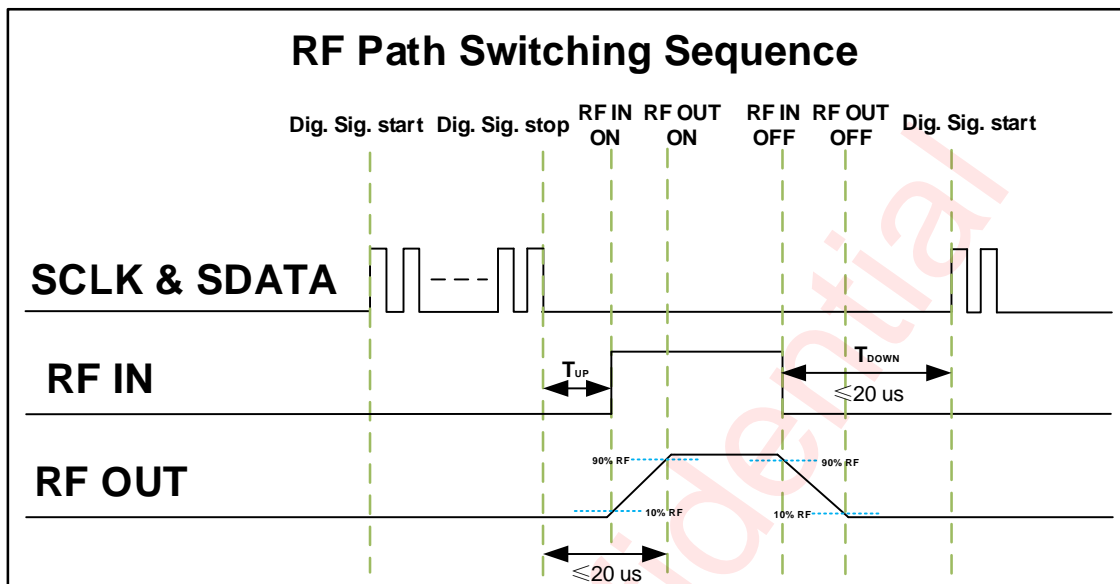


Figure 7 RF Path Switching Sequence

5. If "Lower Power Mode" is used, there must be a 10 μ s delay before exiting "Lower Power Mode".

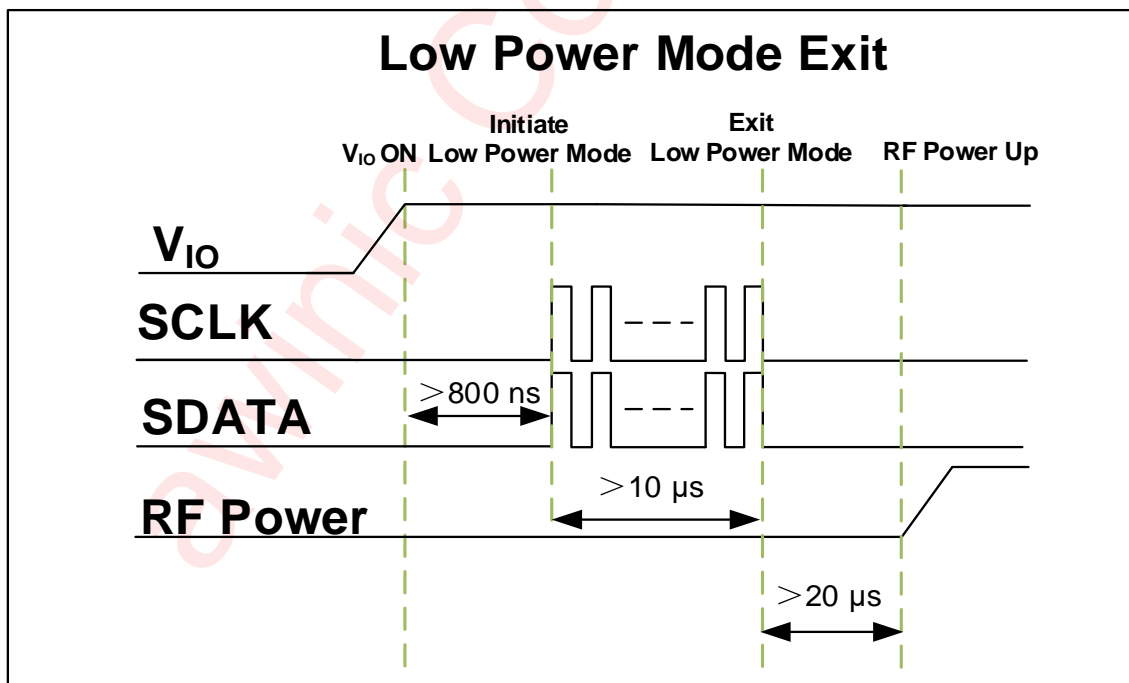


Figure 8 Lower Power Mode Exit Timing

MIPI RFFE Specification

The MIPI RFFE interface is working in systems following the MIPI Alliance Specification for RF Front-End Control Interface version 2.1.

TABLE1: MIPI FEATURES

Feature	Supported	Comment
MIPI RFFE 2.1 standard	Yes	
Register 0 write command sequence	Yes	
Register read and write command sequence	Yes	
Extended register read and write command sequence	Yes	
Masked write command sequence	Yes	Indicated as MW in below register mapping tables
Support for standard frequency range operations for SCLK	Yes	Up to 26 MHz for read and write
Support for extended frequency range operations for SCLK	Yes	Up to 52 MHz for write
Half speed read	Yes	
Full speed read/Full speed write	Yes	
Longer Reach RFFE Bus Length Feature	Yes	
Programmable driver strength	Yes	
Programmable Group SID	Yes	
Programmable USID	Yes	Support for three registers write and extended write sequences
Trigger functionality	Yes	
Extended Triggers and Trigger Masks	Yes	
Broadcast / GSID write to PM TRIG register	Yes	
Reset	Yes	Via VIO, PM TRIG or software register
Status / error sum register	Yes	
Extended product ID register	Yes	
Revision ID register	Yes	
Group SID register	Yes	
USID select pin	No	

TABLE2: Start-up Behavior

Feature	State	Comment
Power status	Low power mode	Low power mode after start-up
Trigger function	Enable	Enable after start-up. Programmable via register

MIPI Read and Write Timing

Register 0 write:

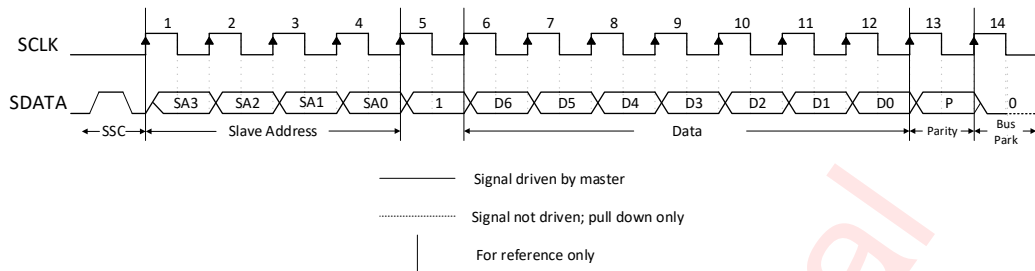


Figure 9 Register 0 write command sequence

Register write:

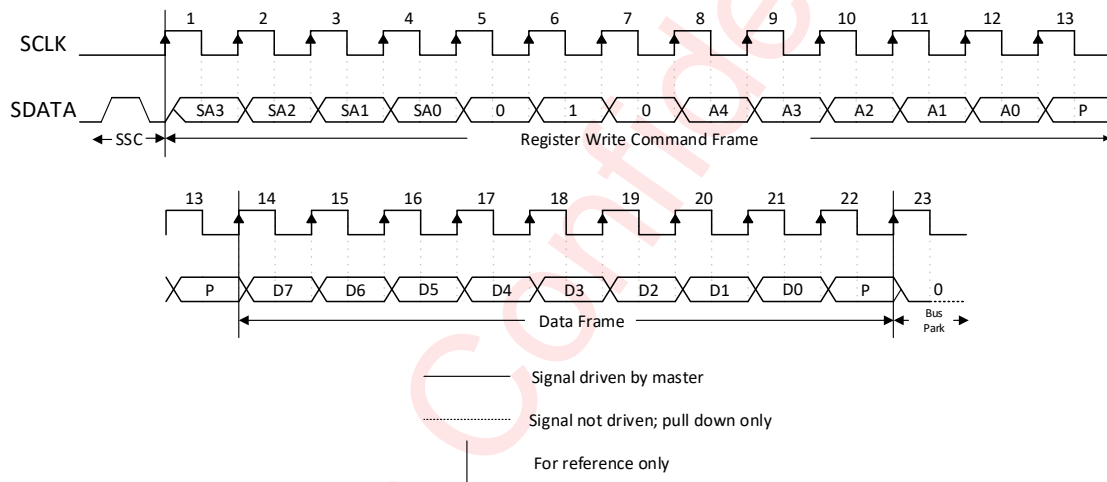


Figure 10 Register write command sequence

Register read:

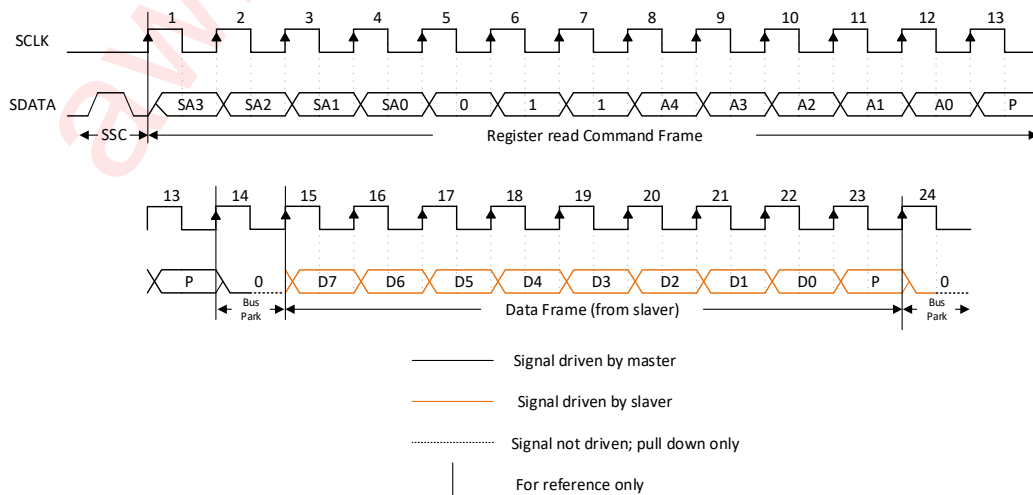


Figure 11 Register read command sequence

Extended Register write:

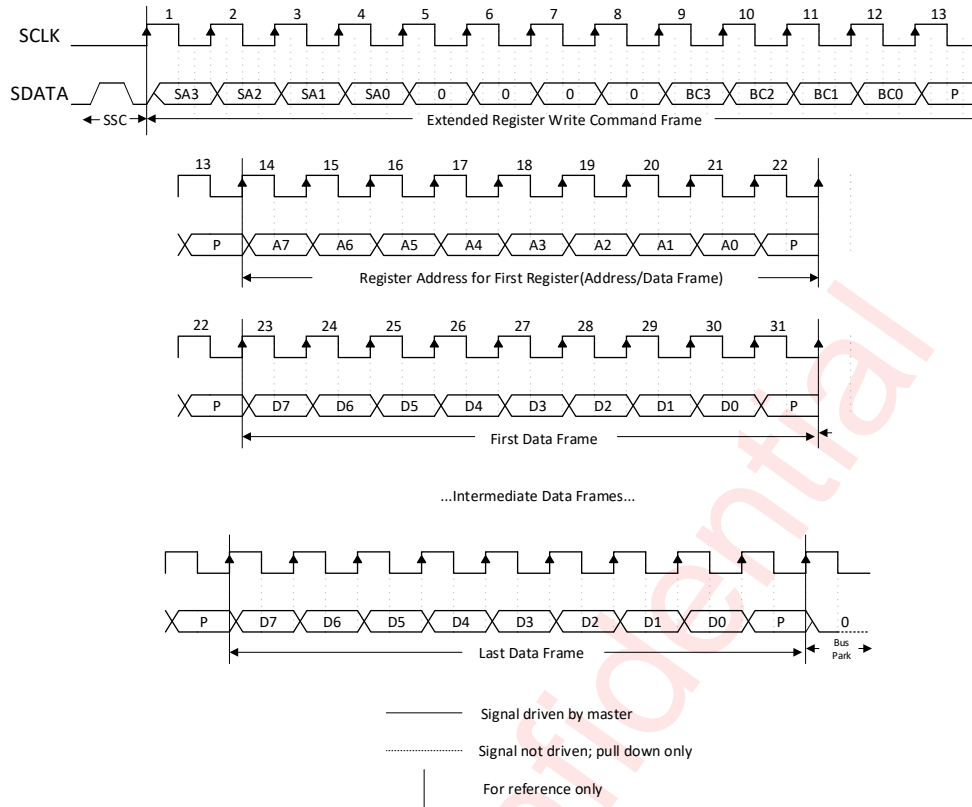


Figure 12 Extended Register write command sequence

Extended Register read:

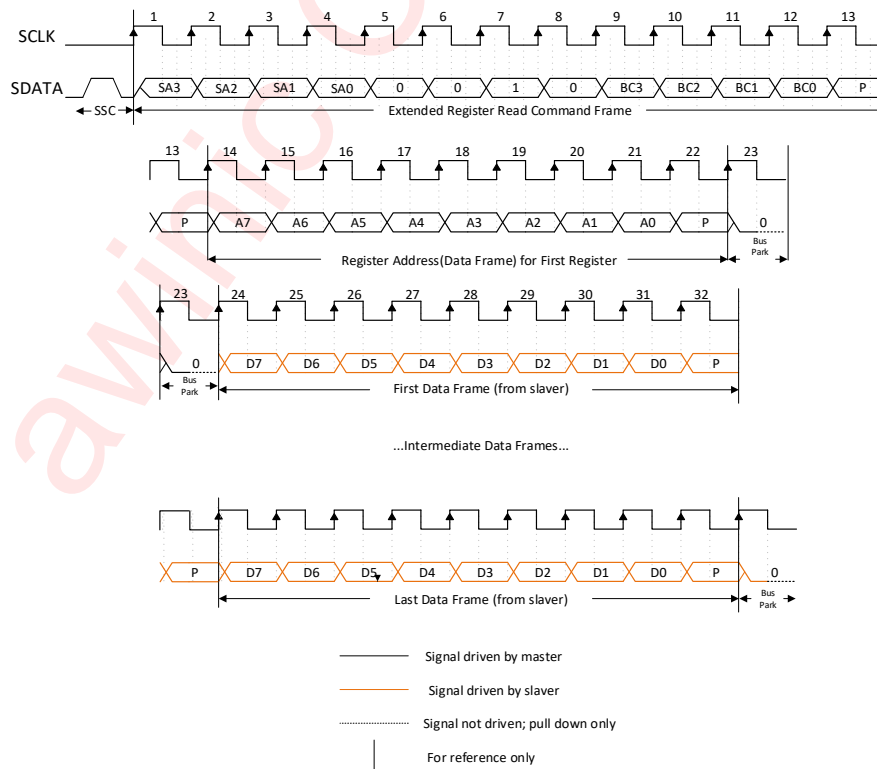


Figure 13 Extended Register read command sequence

Masked write:

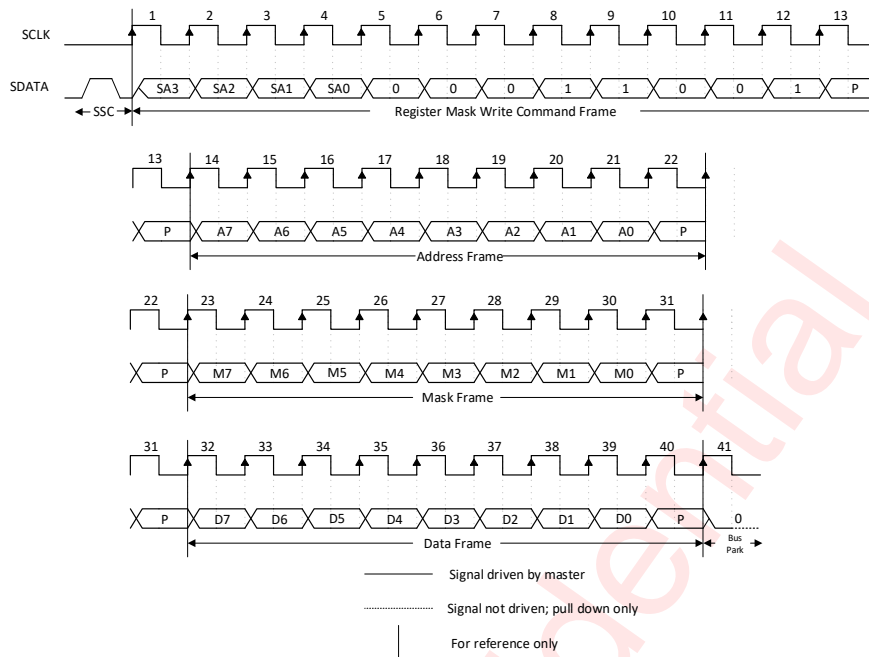


Figure 14 Masked Write Command Sequence

Register Configuration

Register Detailed Description

REGISTER_0 : Mode Control Register(Address 0000h)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:0	MODE_CTRL	xxx1: RF1 on xx1x: RF2 on x1xx: RF3 on 1xxx: RF4 on Other: Isolation	RW MW	No	Yes 0-10	0x00

RFFE_STATUS : RFFE Status Register(Address 001Ah)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7	UDR_RST	Reset all configurable non-RFFE reserved register to default values 0: normal operation 1: software reset	W	No	No	0
6	CMD_FR_P_ERR	Command Frame received with a parity error	RW	No	No	0
5	CMD_LEN_ERR	Command Sequence received with an incorrect length	RW	No	No	0
4	ADDR_FR_P_ERR	Address Frame received with a parity error	RW	No	No	0
3	DATA_FR_P_ERR	Data Frame received with a parity error	RW	No	No	0
2	RD_INVLD_ADDR	Read Command Sequence received with an invalid address	RW	No	No	0
1	WR_INVLD_ADDR	Write Command Sequence received with an invalid address	RW	No	No	0
0	BID_GID_ERR	Read Command Sequence received with a BSID or GSID	RW	No	No	0

GSID0_1 : Group ID 0-1 Register(Address 001Bh)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:4	GSID0	Group Slave ID0	RW	No	No	0000
3:0	GSID1	Group Slave ID1	RW	No	No	0000

PM_TRIG : Pwr_mode and Trig Register(Address 001Ch)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7	PWR_MODE[1]	0: normal operation 1: low power	RW MW	Yes	No	1

6	PWR_MODE[0]	0: active 1: start up – Reset all register to default	RW MW	Yes	No	0
5:3	TRIGGER_MASK	Setting bit TRIGGER[n] loads TRIGGER[n]'s associated register	RW MW	No	No	000
2:0	TRIGGER	Setting bit TRIGGER[n] loads TRIGGER[n]'s associated register	RW MW	Yes	No	000

PRODUCT_ID : Product ID Register(Address 001Dh)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:0	PROD_ID	Lower eight bits of Product ID	R	No	No	0x0A

MANUFACTURER_ID : Manufacture ID Register(Address 001Eh)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:0	MFG_ID	Lower eight bits of Manufacturer ID	R	No	No	0x49

MAN_USID : User ID Register(Address 001Fh)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:4	MFG_ID	Upper four bits of Manufacturer ID	R	No	No	0000
3:0	USID	Unique Slave ID	RW	No	No	1000

EXT_PRODUCT_ID : Extend Product ID Register(Address 0020h)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:0	PROD_ID	Upper eight bits of Product ID	R	No	No	0x00

REVISION_ID : Revision ID Register(Address 0021h)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:0	REV_ID	Revision ID	R	No	No	0x01

GSID2_3 : Group ID 2-3 Register(Address 0022h)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:4	GSID2	Group Slave ID2	R/W	No	No	0000
3:0	GSID3	Group Slave ID3	R/W	No	No	0000

UDR_RST : UDR Reset Register(Address 0023h)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7	UDR_RST	Reset all configurable non-RFFE reserved register to default values 0: normal 1: software reset	R/W	Yes	No	0
6:0	RESERVED	Reserved	R/W	No	No	0x00

ERR_SUM : Error Command Status Register(Address 0024h)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7	SPARE	Reserved for future use	R/W	No	No	0
6	COM_FR_P_ERR	Command Frame received with a parity error	R/W	No	No	0
5	COM_LEN_ERR	Command Sequence received with an incorrect length	R/W	No	No	0
4	ADDR_FR_P_ERR	Address Frame received with a parity error	R/W	No	No	0
3	DATA_FR_P_ERR	Data Frame received with a parity error	R/W	No	No	0
2	RD_INVLD_ADDR	Read Command Sequence received with an invalid address	R/W	No	No	0
1	WR_INVLD_ADDR	Write Command Sequence received with an invalid address	R/W	No	No	0
0	BID_GID_ERR	Read Command Sequence received with a BSID or GSID	R/W	No	No	0

BUS_LD : SDATA Driver Strength Register(Address 002Bh)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:1	reserved	reserved	R/W	No	No	0x00
0	BUS_LD	SDATA drive strength 0: 50pf 1: 80pf	R/W	No	No	0

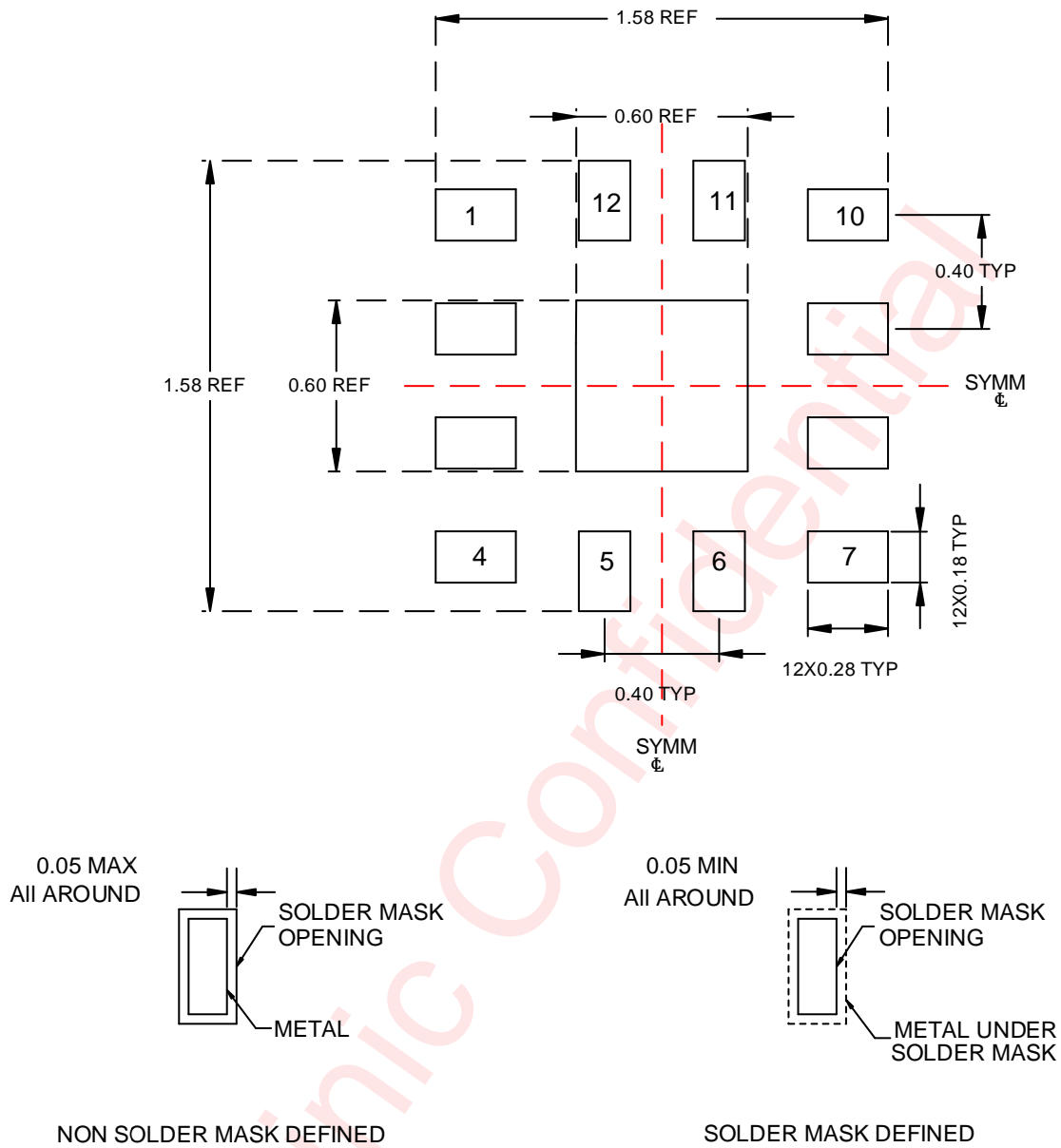
EXT_TRIG_MASK : Extend Trig Mask Register(Address 002Dh)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:0	EXT_TRIG_MASK	Setting bit EXT_TRIG_MASK[n] disables EXT_TRIG[n]	RW MW	No	No	0xff

EXT_TRIG : Extend Trig Register(Address 002Eh)

Bit	Symbol	Description	R/W	B/G	Trig	Default
7:0	EXT_TRIG	Setting bit EXT_TRIG[n] loads EXT_TRIG[n]'s associated register	R/W MW	Yes	No	0x00

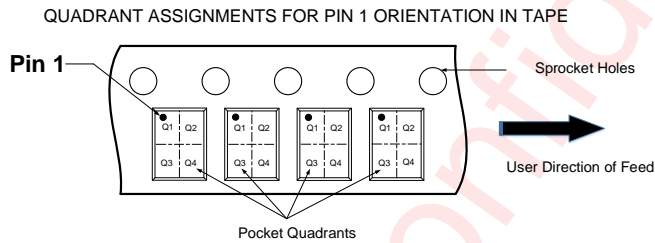
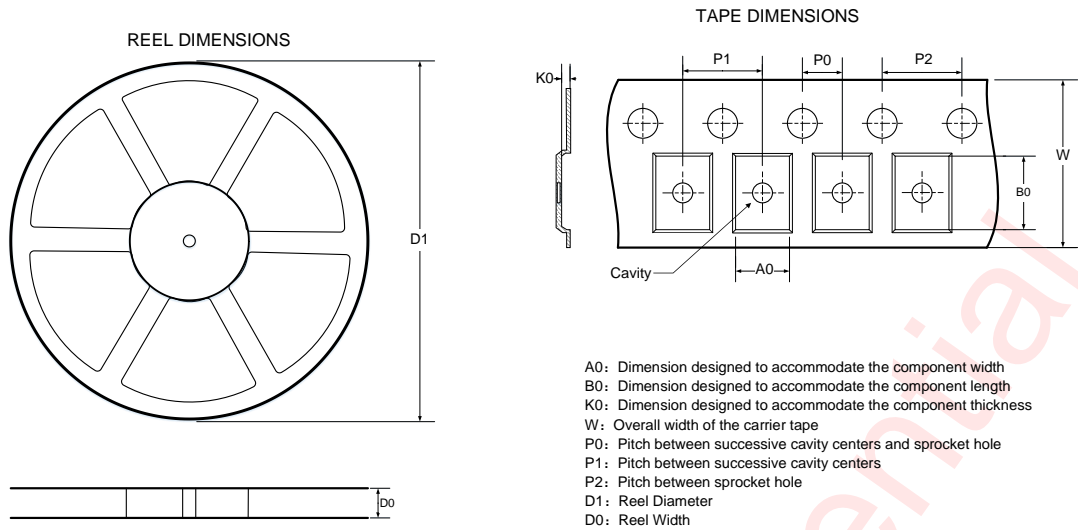
Land Pattern Data



Unit: mm

Figure 16 Land Pattern Data

Tape and Reel Information



DIMENSIONS AND PIN1 ORIENTATION

D1 (mm)	D0 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
178	8.4	1.7	1.7	0.76	2	4	4	8	Q1

All dimensions are nominal

Figure 17 Tape and Reel

Revision History

Version	Date	Change Record
V1.0	Dec. 2021	Officially Released
V1.1	Nov. 2022	1. In the Pin Configuration and Top Mark section, change AW134524TQNR to AW13524TQNR. 2. In the Features section, change WBQFN to QFN. 3. In the General Description section, change WBQFN to QFN. 4. In AMR section, storage temperature T_{STG} changed from -55°C to -65°C .
V1.2	Jun. 2023	1. Update AMR 2. Update Revision ID Register.

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