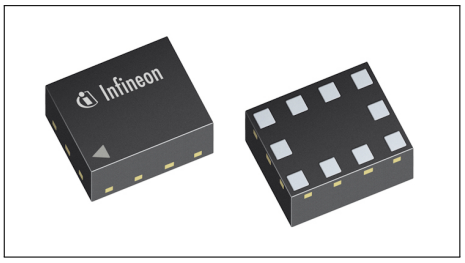
BGSA141MN10

Low Resistance Antenna Aperture Switch

Features

- Designed for high-linearity antenna aperture switching and RF tuning applications
- Multiple selectable switch configurations: SP4T/SP3T/SPDT/SPST
- Ultra low R_{ON} resistance of 1.0 Ω at each port in ON state
- Low C_{OFF} capacitance of 270 fF at each port in OFF state
- High max RF voltage OFF state handling
- Low harmonic generation
- MIPI RFFE control interface
- Hardware Pin swapping function to select 2 USID addresses
- Supply voltage range: 2.3 to 3.6 V
- No RF parameter change within supply voltage range
- Small form factor 1.1 mm x 1.5 mm
- RoHS and WEEE compliant package



1.1 x 1.5 mm^2

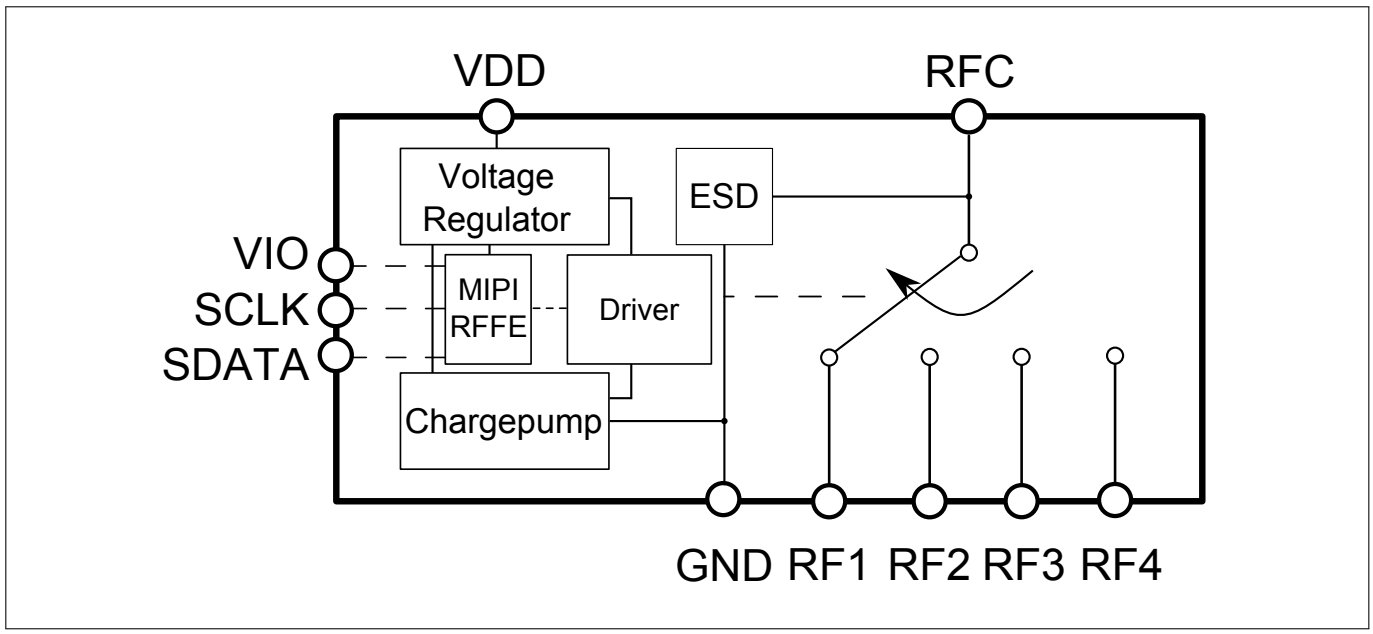
Application

- Impedance Tuning
- Antenna Tuning
- Inductance Tuning
- Tunable Filters

Product validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22

Block diagram



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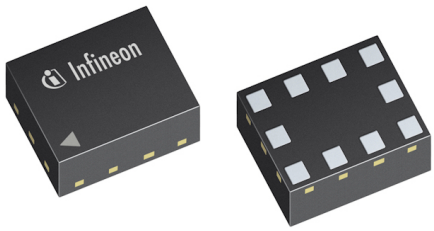
1 Features



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Description

The BGSA141MN10 is a versatile Single-Pole Quad Throw (SP4T) / Single Pole Triple Throw (SP3T) / Single Pole Double Throw (SPDT) and Single Pole Single Throw (SPST) RF antenna aperture switch optimized for low C_{off} as well as low R_{on} enabling applications up to 4.0 GHz. Including a RFFE digital control interface, this switch offers the possibility to adopt a SP4T, SP3T, SPDT along with SPST topology for a better flexibility in RF Front-End designs.

The BGSA141MN10 includes 4 ultra-low R_{on} ports making it ideal for antenna aperture switching and switchable capacitors of high values. This single supply chip integrates on-chip CMOS logic driven by a simple, single-pin CMOS or TTL compatible control input signal. Unlike GaAs technology, the 0.1 dB compression point exceeds the switch maximum input power level, resulting in linear performance at all signal levels and external DC blocking capacitors at the RF ports are only required if DC voltage is applied externally. Due to its very high RF voltage ruggedness, it is suited for switching any reactive devices such as inductors and capacitors in RF matching circuits without significant losses in quality factors.

BGSA141MN10 empower its users with a smart USID selection feature. Default USID is 0b1100 when data signal is routed to pin 5 and clock signal to pin 6. Default USID is 0b1101 when data signal is routed to pin 6 and clock signal to pin 5. This Infineon patented feature allows to drive 2 identical BGSA141MN10 parts with the same MIPI RFFE bus opening higher degree of flexibility and freedom in the PCB design.

Product Name	Marking	Package
BGSA141MN10	M5	TSNP-10-3

2 Maximum Ratings

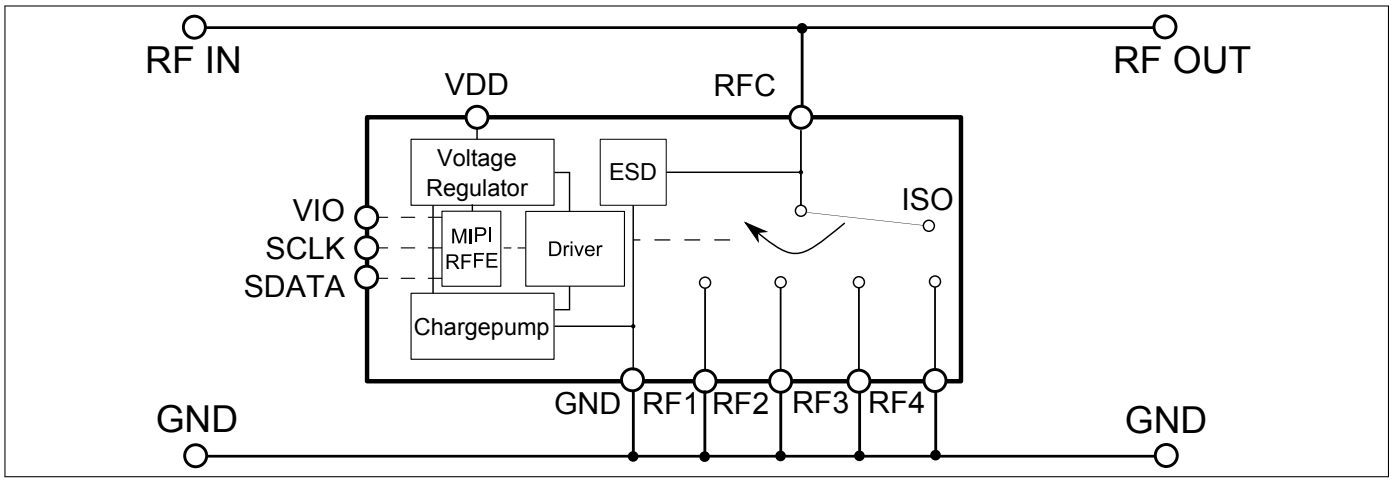

Figure 1: RF operating voltage measurement configuration

Table 1: Maximum Ratings, Table I at T_A = 25 °C, unless otherwise specified

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Frequency Range	f	0.1	–	–	GHz	[1]
Supply voltage [2]	V_{DD}	-0.5	–	6	V	only for infrequent and short duration time periods
Storage temperature range	T_{STG}	-55	–	150	°C	–
RF input power	P_{RF_max}	–	–	39	dBm	Pulsed RF input duty cycle of 25 % and 4620 μs in ON-state, measured per 3GPP TS 45.005
RF voltage	V_{RF_max}	–	–	44	V	Short term peaks (1μs in 0.1% duty cycle), exceeding typical linearity, Ron and Coff parameters, in Isolation mode, test condition schematic in Fig. 1
ESD capability, CDM [3]	$V_{ESD_{CDM}}$	-1	–	+1	kV	
ESD capability, HBM [4]	$V_{ESD_{HBM}}$	–	–	Class1B	-	
ESD capability, system level (RFc port) [5]	$V_{ESD_{ANT}}$	-8	–	+8	kV	RFC vs system GND, with 27 nH shunt inductor
Junction temperature	T_j	–	–	125	°C	–

[1] Switch has a lowpass response. For higher frequencies, losses have to be considered for their impact on thermal heating. The DC voltage at RF ports V_{RFDC} has to be 0V.
[2] Note: Consider potential ripple voltages on top of V_{DD}. Including RF ripple, V_{DD} must not exceed the maximum ratings: $V_{DD} = V_{DC} + V_{Ripple}$.
[3] Field-Induced Charged-Device Model JESD22-C101. Simulates charging/discharging events that occur in production equipment and processes. Potential for CDM ESD events occurs whenever there is metal-to-metal contact in manufacturing.
[4] Human Body Model ANSI/ESDA/JEDEC JS-001 (R = 1,5 kΩ, C = 100 pF).
[5] IEC 61000-4-2 (R = 330 Ω, C = 150 pF), contact discharge.

Maximum Ratings

Table 2: Maximum Ratings, Table II at T_A = 25 °C, unless otherwise specified

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Maximum DC-voltage on RF-Ports and RF-Ground	V_{RFDC}	0	–	0	V	No DC voltages allowed on RF-Ports
RFFE Supply Voltage	V_{IO}	-0.5	–	3.6	V	–
RFFE Control Voltage Levels	V_{SCLK}, V_{SDATA}	-0.7	–	V_{IO}+0.7 (max. 3.6)	V	–

Warning: Stresses above the max. values listed here may cause permanent damage to the device. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit. Exposure to conditions at or below absolute maximum rating but above the specified maximum operation conditions may affect device reliability and life time. Functionality of the device might not be given under these conditions.

3 DC Characteristics

Table 3: DC Characteristics at T_A = −40 °C to 85 °C

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply Voltage	V_{DD}	2.3	2.8	3.6	V	–
Supply Current	I_{DD}	–	80	150	µA	Normal Mode
		–	0.1	2	µA	Low Power or Default Mode
RFFE supply voltage	V_{IO}	1.65	1.8	1.95	V	–
RFFE input high voltage[1]	V_{IH}	0.7*V_{IO}	–	V_{IO}	V	–
RFFE input low voltage[1]	V_{IL}	0	–	0.3*V_{IO}	V	–
RFFE output high voltage[1]	V_{OH}	0.8*V_{IO}	–	V_{IO}	V	–
RFFE output low voltage[1]	V_{OL}	0	–	0.2*V_{IO}	V	–
RFFE control input capacitance	C_{Ctrl}	–	–	2	pF	–
RFFE supply current	I_{VIO}	–	15	25	µA	Idle State

[1]SCLK and SDATA

4 RF Small Signal Parameters

Table 4: Parametric specifications using SP4T configuration

Parameter	Symbol	Values			Unit	STATE / Notes
		Min.	Typ.	Max.		
Frequency range	f	0.1		4.0	GHz	
RF1, RF2, RF3 or RF4 to RFc ON resistance	$R_{ON_{SP4T}}$	–	1.0		Ω	V_{DD} = 2.3 – 3.6 V, T_A = −40 °C... + 85 °C, Z_0 = 50 Ω
RF1, RF2, RF3 or RF4 to RFc OFF capacitance	$C_{OFF_{SP4T}}$	–	270		fF	

Table 5: Parametric specifications using SP3T configuration

Parameter	Symbol	Values			Unit	STATE / Notes
		Min.	Typ.	Max.		
Frequency range	f	0.1		4.0	GHz	
RF1||RF2 or RF3||RF4 to RFc [1] ON resistance	$R_{ON_{SP3T(1)}}$	–	0.5		Ω	
RF1||RF2 or RF3||RF4 to RFc [1] OFF capacitance	$C_{OFF_{SP3T(1)}}$	–	540		fF	V_{DD} = 2.3 – 3.6 V, T_A = −40 °C... + 85 °C, Z_0 = 50 Ω
RF1, RF2, RF3 or RF4 to RFc ON resistance	$R_{ON_{SP3T(2)}}$	–	1.0		Ω	
RF1, RF2, RF3 or RF4 to RFc OFF capacitance	$C_{OFF_{SP3T(2)}}$	–	270		fF	

[1] RF1 and RF2 or RF3 and RF4 connected together on PCB

Table 6: Parametric specifications using SPDT configuration

Parameter	Symbol	Values			Unit	STATE / Notes
		Min.	Typ.	Max.		
Frequency range	f	0.1		4.0	GHz	
RF1||RF2 and RF3||RF4 to RFc [1] ON resistance	$R_{ON_{SPDT}}$	–	0.5		Ω	V_{DD} = 2.3 – 3.6 V, T_A = −40 °C... + 85 °C, Z_0 = 50 Ω
RF1||RF2 and RF3||RF4 to RFc [1] OFF capacitance	$C_{OFF_{SPDT}}$	–	540		fF	

[1] RF1 and RF2, RF3 and RF4 connected together on PCB

RF Small Signal Parameters

Table 7: Parametric specifications using SPST configuration

Parameter	Symbol	Values			Unit	STATE / Notes
		Min.	Typ.	Max.		
Frequency range	f	0.1		4.0	GHz	V_{DD} = 2.3 – 3.6 V, T_A = –40 °C... + 85 °C, Z_0 = 50 Ω
RF1||RF2||RF3||RF4 to RFc [1] ON resistance	$R_{ON_{SPST}}$	–	0.25		Ω	
RF1||RF2||RF3||RF4 to RFc [1] OFF capacitance	$C_{OFF_{SPST}}$	–	1.08		pF	

[1] RF1, RF2, RF3, RF4 connected together on PCB

Table 8: RF electrical parameters

Parameter	Symbol	Values			Unit	STATE / Notes
		Min.	Typ.	Max.		
Insertion Loss: RF1 to RFc, RF2 to RFc, RF3 to RFc or RF4 to RFc (SP4T mode) [1,2]						
698 - 960 MHz	IL_{SP4T}	0.1	0.25	0.4	dB	V_{DD} = 2.3 – 3.6 V, Z_0 = 50 Ω, T_A = –40 °C... + 85 °C
1710 - 1980 MHz		0.35	0.55	0.7	dB	
1981 - 2169 MHz		0.45	0.65	1.0	dB	
2170 - 2690 MHz		0.5	0.80	1.2	dB	
Return Loss: RF1, RF2, RF3 or RF4 [1,2,3]						
698 - 960 MHz	RL_{SP4T}	16	21	–	dB	V_{DD} = 2.3 – 3.6 V, Z_0 = 50 Ω, T_A = –40 °C... + 85 °C
1710 - 2690 MHz		12	14	–	dB	
Isolation: RF1 to RFc, RF2 to RFc, RF3 to RFc or RF4 to RFc (SP4T mode) [1,2,3]						
698 - 960 MHz	ISO_{SP4T}	21	25	–	dB	V_{DD} = 2.3 – 3.6 V, Z_0 = 50 Ω, T_A = –40 °C... + 85 °C
1710 - 1980 MHz		15	18	–	dB	
1981 - 2169 MHz		14	17	–	dB	
2170 - 2690 MHz		13	16	–	dB	
Isolation: RFc to RFx (Isolation mode) [1,2,3]						
698 - 960 MHz	ISO_{ON}	17	20	–	dB	V_{DD} = 2.3 – 3.6 V, Z_0 = 50 Ω, T_A = –40 °C... + 85 °C
1710 - 1980 MHz		12	14	–	dB	
1981 - 2169 MHz		11	13	–	dB	
2170 - 2690 MHz		10	13	–	dB	
Switching Time						
MIPI to RF Time	t_{INT}	0.5	5	6	µs	50 % last SCLK falling edge to 90 % RF value settled, Fig. 2
Power Up Settling Time	t_{PUS}	–	10	25	µs	After power down mode, Fig. 3

[1] Valid for all RF power levels, no compression behavior
[2] On application board without any matching components

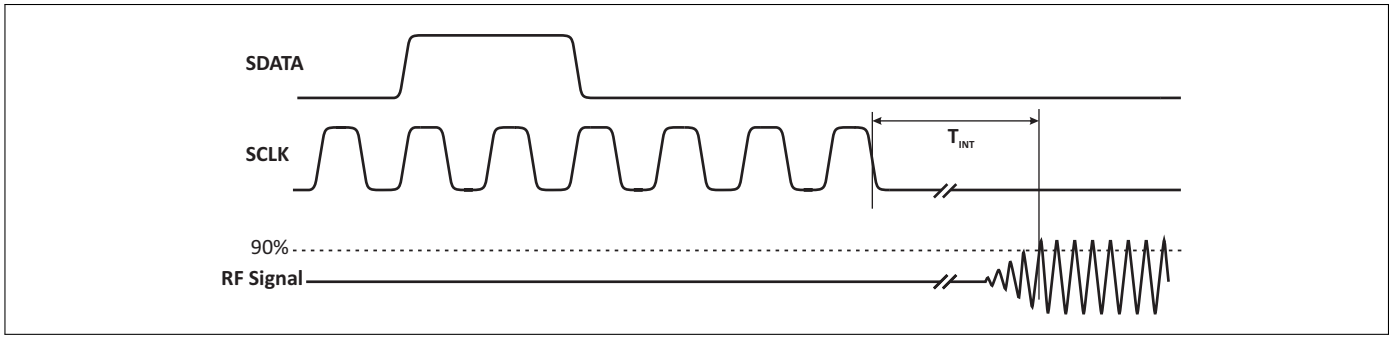

Figure 2: MIPI to RF Time

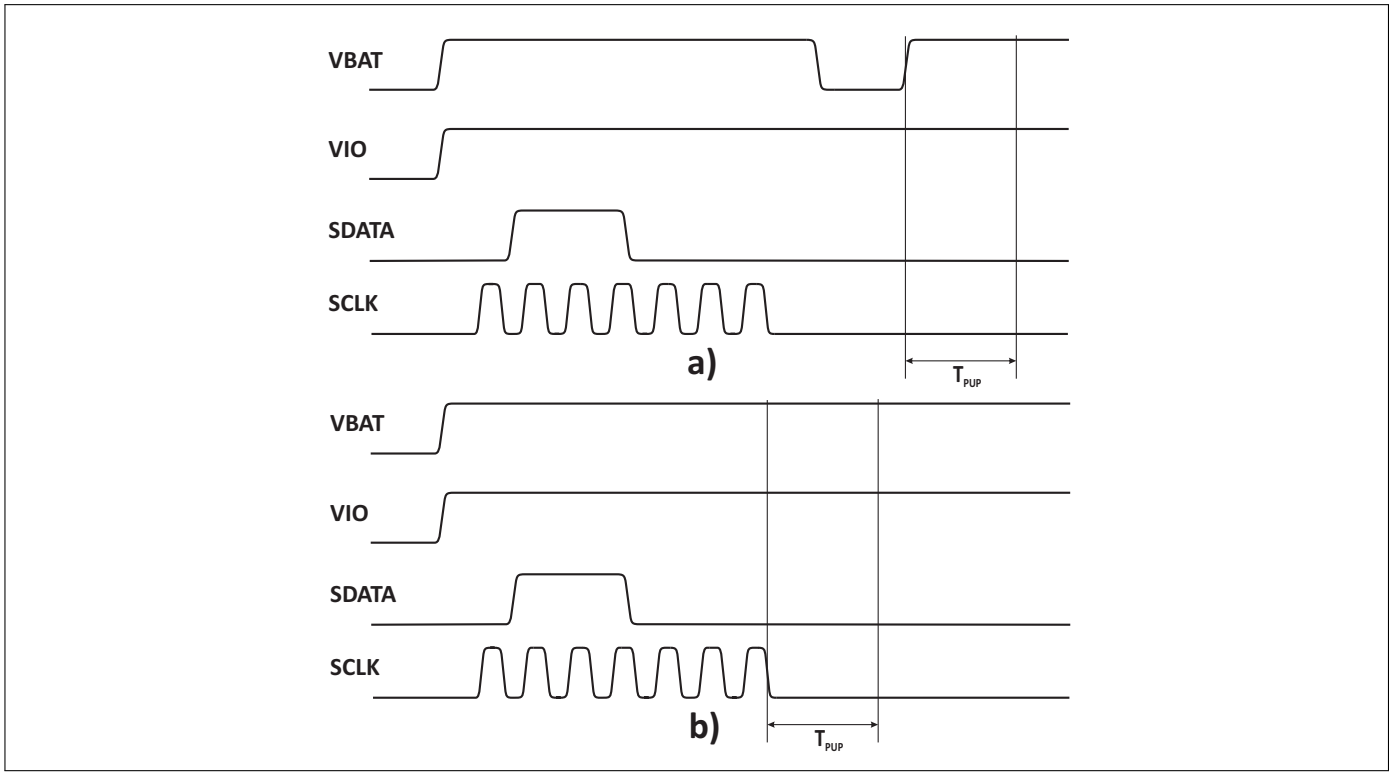

Figure 3: Power-Up Settling Time Definition

Power-Up Settling Time Definition: **a)** when the device is already in Active Mode. **b)** when changing from Low Power Mode to Active Mode.
After Power-Up of VIO the device is set to Low Power Mode. An additional MIPI instruction is necessary to set the switch to Active Mode. This case is covered by **b)**.

5 RF large signal parameters

Table 9: RF large signal specifications

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
RF operating voltage	V_{RF_peak}	–	–	36	V	In isolation Mode. Test conditions schematic in Fig. 1
Harmonic Generation up to 12.75 GHz[1,2,3]						
All RF Ports Second Order Harmonics	P_{H2}	–	-105	–	dBc	25 dBm, f_0 = 786 MHz
All RF Ports Third Order Harmonics	P_{H3}	–	-115	–	dBc	25 dBm, f_0 = 786 MHz
All RF Ports Second Order Harmonics	P_{H2}	–	-93	–	dBc	33 dBm, f_0 = 824 MHz
All RF Ports Third Order Harmonics	P_{H3}	–	-94	–	dBc	33 dBm,f_0 = 824 MHz
All RF Ports Higher Order Harmonics	$P_{Hx,x>3}$	–	–	-105	dBc	25 dBm
Intermodulation Distortion IMD2 [1,2,3]						
IIP2, low	IIP2,l	–	110	–	dBm	IIP2 conditions, Tab. 10
IIP2, high	IIP2,h	–	120	–	dBm	
Intermodulation Distortion IMD3 [1,2,3]						
IIP3	IIP3	–	75	–	dBm	IIP3 conditions, Tab. 11
SV LTE Intermodulation [1,2,3]						
IIP3,SVLTE	IIP3,SV	–	75	–	dBm	SV-LTE conditions, Tab. 12

[1] Terminating Port Impedance: $Z_0 = 50\,\Omega$
[2] Supply Voltage: V_{DD} = 2.3 — 3.6 V
[3] On application board without any matching components

RF large signal parameters

Table 10: IIP2 conditions table

Band	In-Band Frequency [MHz]	Blocker Frequency 1 [MHz]	Blocker Power 1 [dBm]	Blocker Frequency 2 [MHz]	Blocker Power 2 [dBm]
Band 1 Low	2140	1950	20	190	-15
Band 1 High	2140	1950	20	4090	-15
Band 5 Low	881.5	836.5	20	45	-15
Band 5 High	881.5	836.5	20	1718	-15

Table 11: IIP3 conditions table

Band	In-Band Frequency [MHz]	Blocker Frequency 1 [MHz]	Blocker Power 1 [dBm]	Blocker Frequency 2 [MHz]	Blocker Power 2 [dBm]
Band 1	2140	1950	20	1760	-15
Band 5	881.5	836.5	20	791.5	-15

Table 12: SV-LTE conditions table

Band	In-Band Frequency [MHz]	Blocker Frequency 1 [MHz]	Blocker Power 1 [dBm]	Blocker Frequency 2 [MHz]	Blocker Power 2 [dBm]
Band 5	872	827	23	872	14
Band 13	747	786	23	747	14
Band 20	878	833	23	2544	14

6 MIPI RFFE Specification

All sequences are implemented according to the 'MIPI Alliance Specification for RF Front-End Control Interface' document version 1.10 - 26. July 2011.

Table 13: MIPI Features

Feature	Supported	Comment
Register write command sequence	Yes	
Register read command sequence	Yes	
Extended register write command sequence	No	Up to 4 Bytes
Extented register read command sequence	No	Up to 4 Bytes
Register 0 write command sequence	Yes	
Trigger function	Yes	Trigger assignment to each control register is supported
Programmable USID	Yes	3 register command sequence and extended register command sequence
Status Register	Yes	Register for debugging
Reset	Yes	By VIO, Power Mode and RFFE_STATUS
Group SID	Yes	
USID_Sel pin	Yes	External pin for changing USID: 1: Pin 5=SDATA and Pin 6=SCLK→ 1100, 2: Pin 5=SCLK and Pin 6=SDATA→ 1101
Full speed write	Yes	
Half speed read	Yes	
Full speed read	Yes	

Table 14: Startup Behavior

Feature	State	Comment
Power status	LOW POWER	The chip is in low power mode after startup
Trigger function	ENABLED	Trigger function is enabled after startup. Trigger function can be disabled via PM_TRIG register.

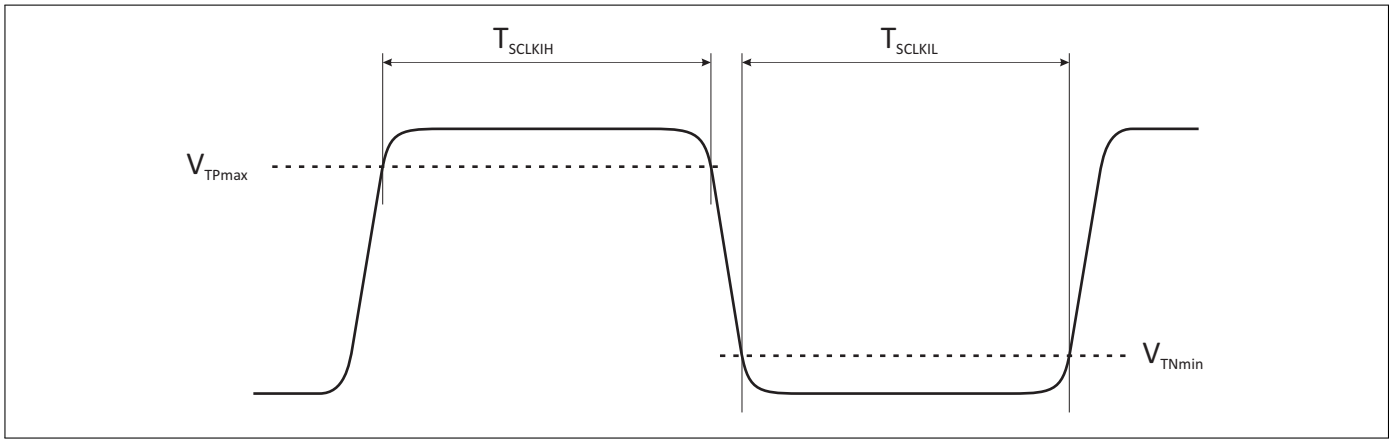

Figure 4: Received clock signal constraints

Table 15: MIPI RFFE Operating Timing

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
SCLK Frequency	FSCLK	0.032	–	26	MHz	Full speed
		0.032	–	13	MHz	Half speed
SCLK Period	TSCLK	0.038	–	32	µs	Full speed
		0.077	–	32	µs	Half speed
SCLK Low Period	TSCLKIL	11.25	–	–	ns	Full speed, see Fig. 4
		24	–	–	ns	Half speed, see Fig. 4
SCLK High Period	TSCLKIH	11.25	–	–	ns	Full speed, see Fig. 4
		24	–	–	ns	Half speed, see Fig. 4
SDATA Setup Time	TS	1	–	–	ns	Full speed, see Fig. 5
		2	–	–	ns	Half speed, see Fig. 5
SDATA Hold Time	TH	5	–	–	ns	Full speed, see Fig. 5
		5	–	–	ns	Half speed, see Fig. 5
SDATA Release Time	TSDATAZ	–	–	10	ns	Full speed, see Fig. 6
		–	–	18	ns	Half speed, see Fig. 6
Time for Data Output	TD	–	–	10.25	ns	Full speed, see Fig. 7
		–	–	22	ns	Half speed, see Fig. 7
SDATA Rise/Fall Time	TSDATAOTR	2.1	–	6.5	ns	Full speed, see Fig. 7
		2.1	–	10	ns	Half speed, see Fig. 7
VIO Rise Time	TVIO-R	10	–	450	µs	See Fig. 8
VIO Reset Time	TVIO-RST	10	–	–	µs	See Fig. 8
Reset Delay Time	TSIGOL	0.12	–	–	µs	See Fig. 8

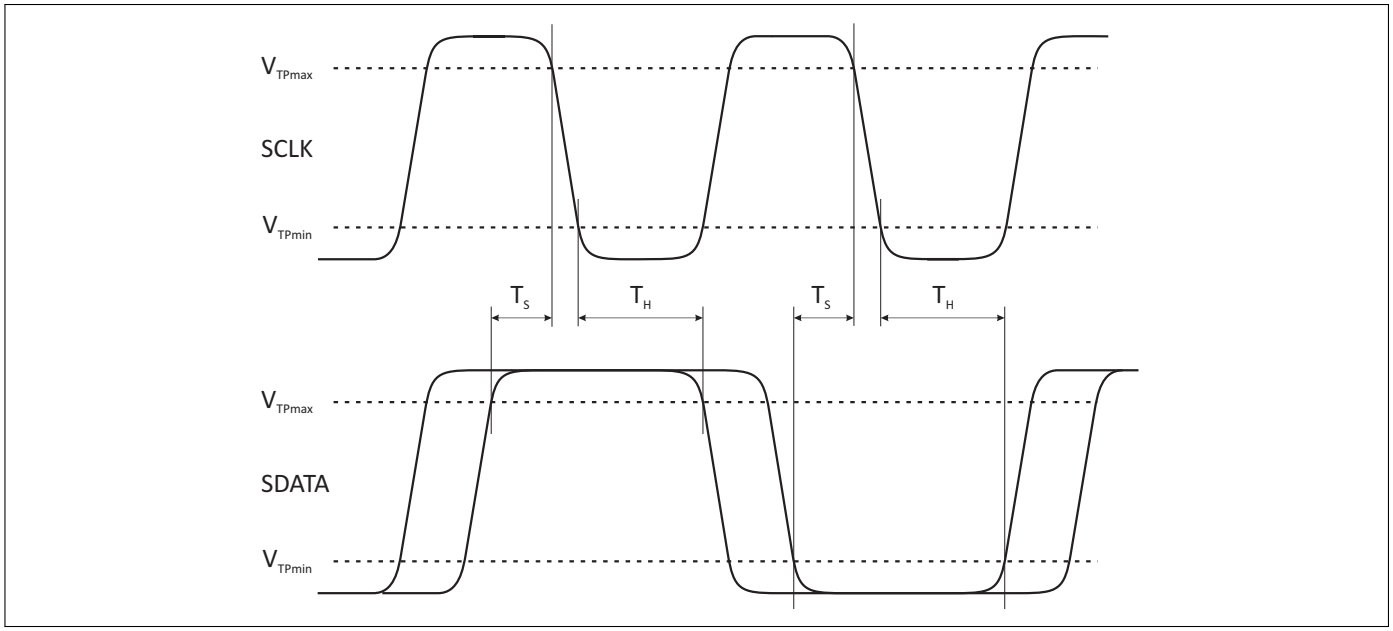

Figure 5: Bus active data receiver timing requirements

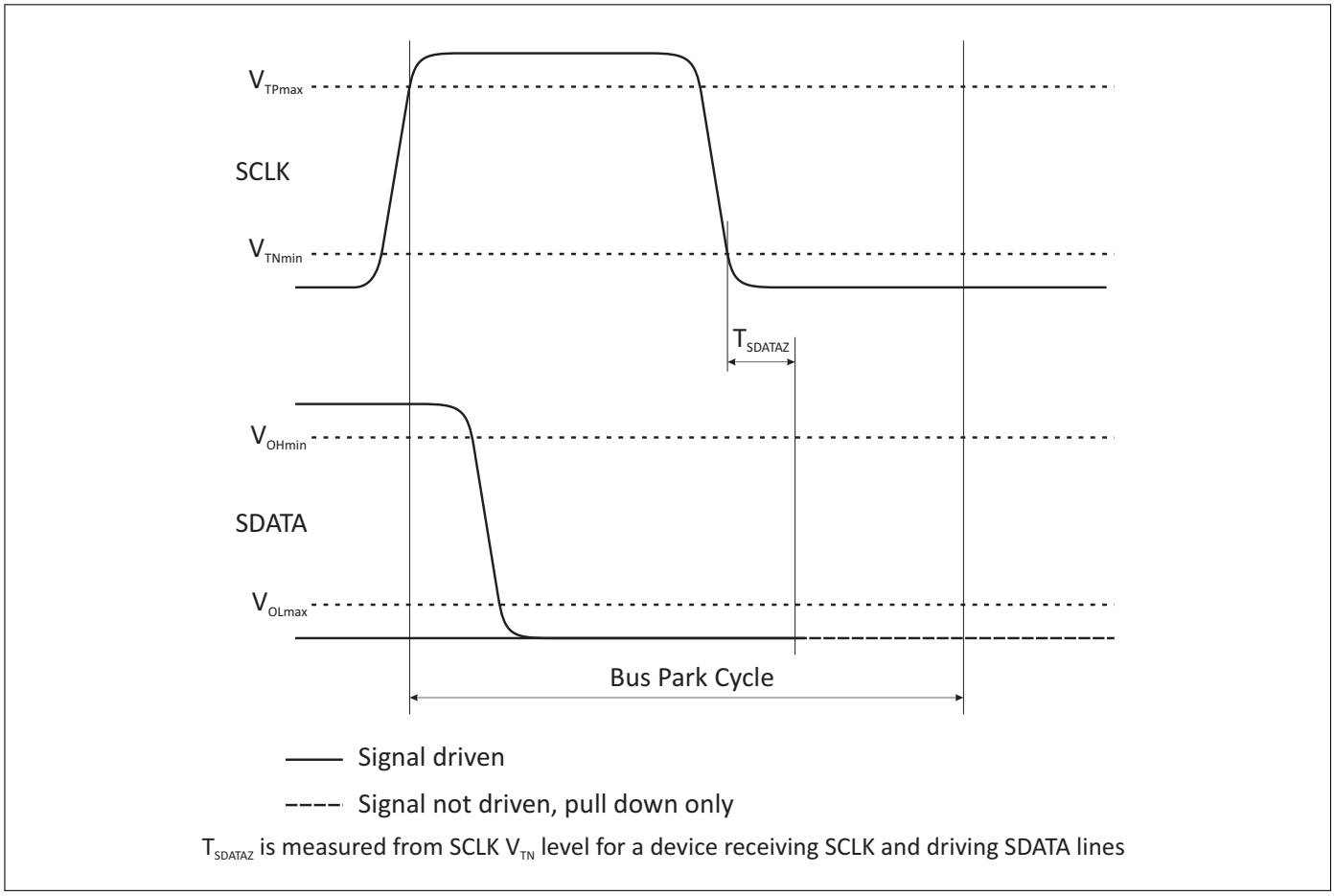

Figure 6: Bus park cycle timing

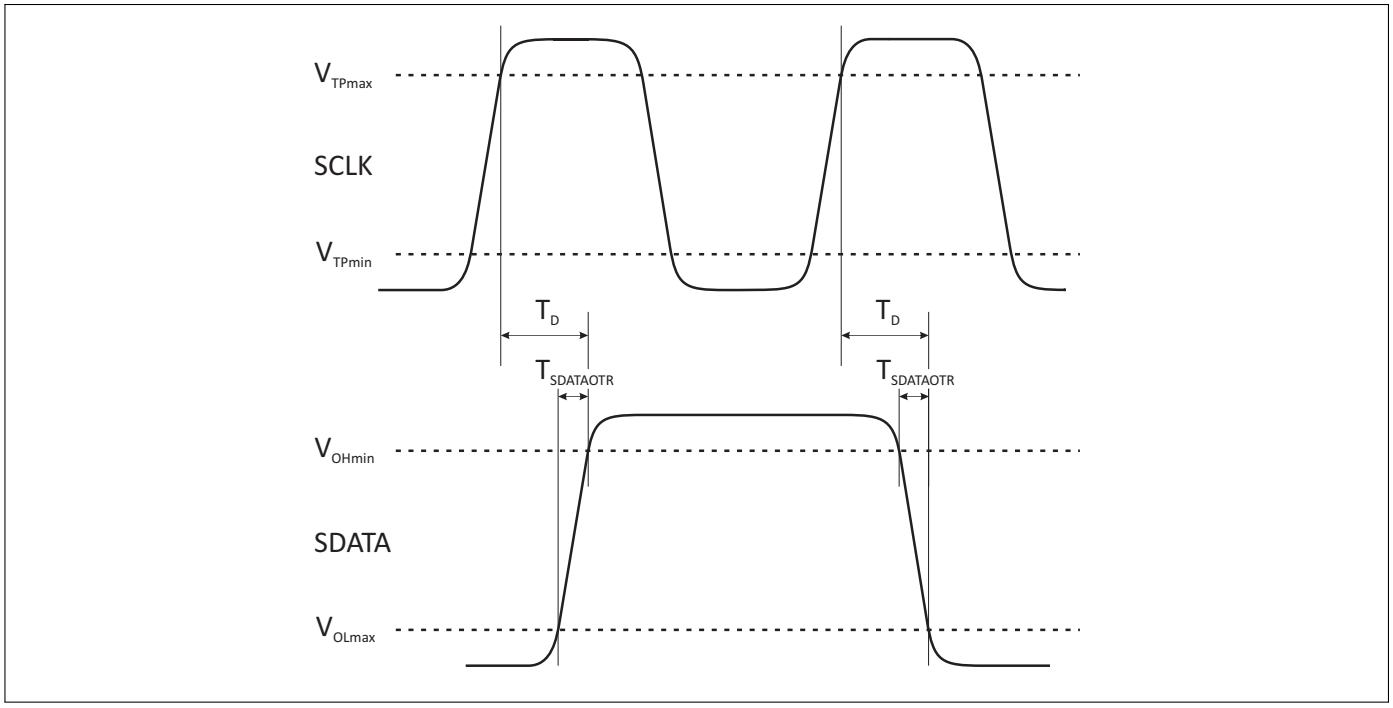

Figure 7: Bus active data transmission timing specification

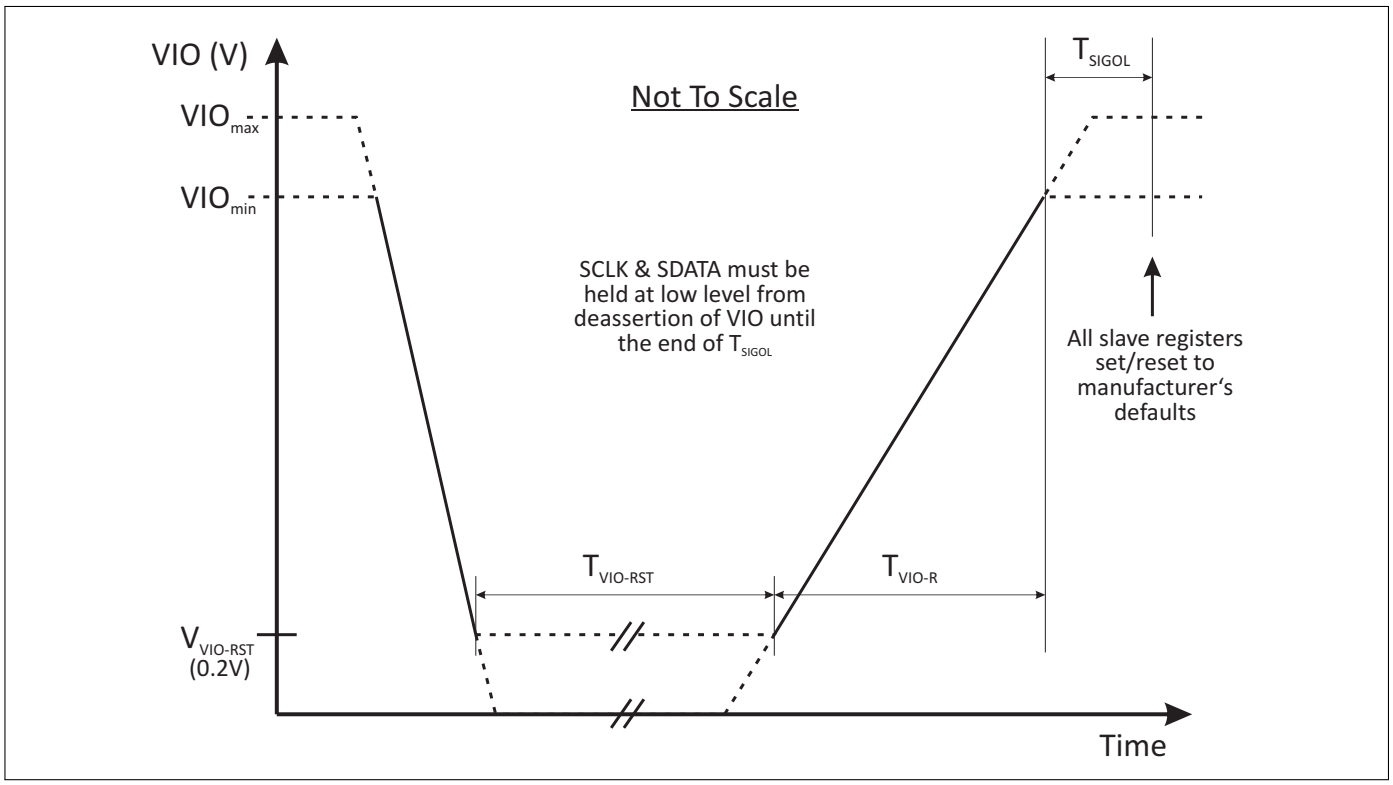

Figure 8: Requirements for VIO-initiated reset

Table 16: Register Mapping

Register Address	Register Name	Data Bits	Function	Description	Default	Broadcast_ID Support	Trigger Support	R/W
0x0000	REGISTER_0	7:0	MODE_CTRL	RF Switch Control	00000000	No	Yes	R/W
0x001D	PRODUCT_ID	7:0	PRODUCT_ID	This is a read-only register. However, during the programming of the USID a write command sequence is performed on this register, even though the write does not change its value.	00011100	No	No	R
0x001E	MANUFACTURER_ID	7:0	MANUFACTURER_ID [7:0]	This is a read-only register. However, during the programming of the USID, a write command sequence is performed on this register, even though the write does not change its value.	00011010	No	No	R
0x001C	PM_TRIG	7:6	PWR_MODE	00: Normal operation 01: Default settings (STARTUP) 10: Low power (LOW POWER) 11: Reserved	10	Yes	No	R/W
		5	TRIGGER_MASK_2	If this bit is set, trigger 2 is disabled. When all triggers disabled, if writing to a register that is associated to trigger 2, the data goes directly to the destination register.	0	No		
		4	TRIGGER_MASK_1	If this bit is set, trigger 1 is disabled. When all triggers disabled, if writing to a register that is associated to trigger 1, the data goes directly to the destination register.	0	No		
		3	TRIGGER_MASK_0	If this bit is set, trigger 0 is disabled. When all triggers disabled, if writing to a register that is associated to trigger 0, the data goes directly to the destination register.	0	No		
		2	TRIGGER_2	A write of a one to this bit loads trigger 2's registers.	0	Yes		
		1	TRIGGER_1	A write of a one to this bit loads trigger 1's registers.	0	Yes		
		0	TRIGGER_0	A write of a one to this bit loads trigger 0's registers.	0	Yes		
0x001F	MAN_USID	7:6	SPARE	These are read-only bits that are reserved and yield a value of 0b00 at readback.	00	No	No	R/W
		5:4	MANUFACTURER_ID [9:8]	These bits are read-only. However, during the programming of the USID, a write command sequence is performed on this register even though the write does not change its value.	01			
		3:0	USID	Programmable USID. Performing a write to this register using the described programming sequences will program the USID in devices supporting this feature. These bits store the USID of the device.	See Tab. 13			
0x001A	RFFE_STATUS	7	SOFTWARE RESET	0: Normal operation 1: Software reset	0	No	No	R/W
		6	COMMAND_FRAME_ PARITY_ERR	Command sequence received with parity error - discard command.	0	No	No	R
		5	COMMAND_LENGTH_ERR	Command length error	0			
		4	ADDRESS_FRAME_ PARITY_ERR	Address frame parity error = 1	0			
		3	DATA_FRAME_ PARITY_ERR	Data frame with parity error	0			
		2	READ_UNUSED_REG	Read command to an invalid address	0			
		1	WRITE_UNUSED_REG	Write command to an invalid address	0			
		0	BID_GID_ERR	Read command with a BROADCAST_ID or GROUP_SID	0			
0x001B	GROUP_SID	7:4	RESERVED		0000	No	No	R/W
		3:0	GROUP_SID	Group slave ID	0000			

Table 17: Switch MIPI Control Combinations (truth table)

		REGISTER_0 – Switch control register							
State	**Mode**	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
0	Isolation mode (open)	0	0	0	0	0	0	0	0
1	RF1	0	0	0	0	0	0	0	1
2	RF2	0	0	0	0	0	0	1	0
3	RF3	0	0	0	0	0	1	0	0
4	RF4	0	0	0	0	1	0	0	0
5	RF1||RF2	0	0	0	0	0	0	1	1
6	RF1||RF3	0	0	0	0	0	1	0	1
7	RF1||RF4	0	0	0	0	1	0	0	1
8	RF2||RF3	0	0	0	0	0	1	1	0
9	RF2||RF4	0	0	0	0	1	0	1	0
10	RF3||RF4	0	0	0	0	1	1	0	0
11	RF1||RF2||RF3	0	0	0	0	0	1	1	1
12	RF1||RF2||RF4	0	0	0	0	1	0	1	1
13	RF1||RF3||RF4	0	0	0	0	1	1	0	1
14	RF2||RF3||RF4	0	0	0	0	1	1	1	0
15	RF1||RF2||RF3||RF4	0	0	0	0	1	1	1	1
16	RFC short to GND	x	1	x	x	x	x	x	x

7 Application Information

Pin Configuration and Function

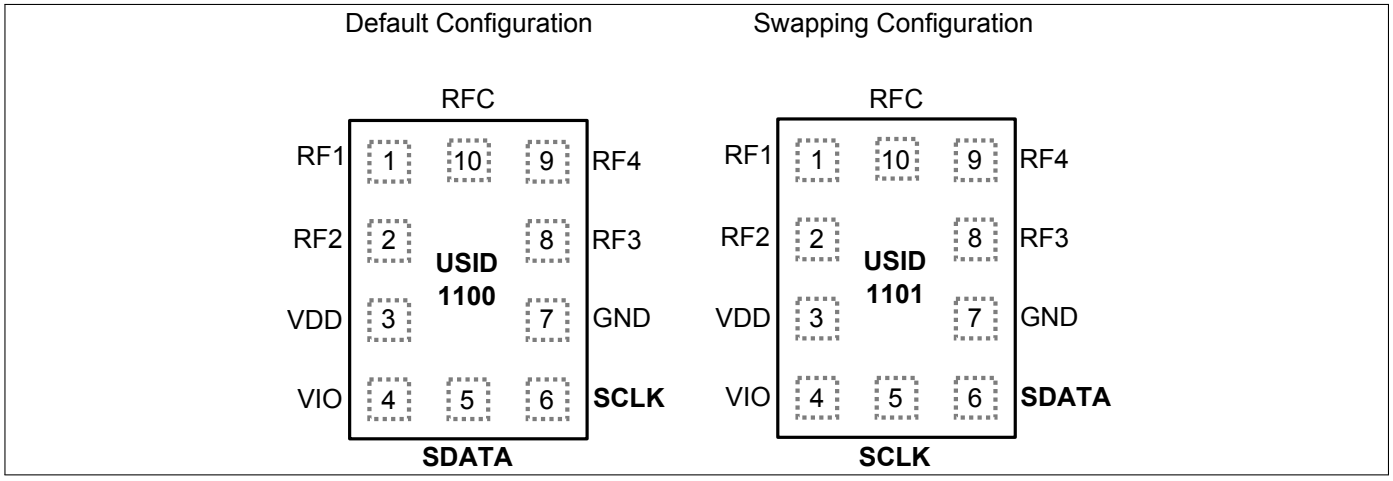

Figure 9: BGSA141MN10 Pin Configuration - USID 1100 and USID 1101 (top view)

Table 18: Pin Definition and Function USID 1100

Pin No.	Name	Function
1	RF1	RF1 port
2	RF2	RF2 port
3	VDD	Power Supply
4	VIO	RFFE Power Supply
5	SDATA	MIPI RFFE DATA
6	SCLK	MIPI RFFE CLOCK
7	GND	Ground
8	RF3	RF3 port
9	RF4	RF port
10	RFC	Common RF port

Table 19: Pin Definition and Function - USID 1101

Pin No.	Name	Function
1	RF1	RF1 port
2	RF2	RF2 port
3	VDD	Power Supply
4	VIO	RFFE Power Supply
5	SCLK	MIPI RFFE CLOCK
6	SDATA	MIPI RFFE DATA
7	GND	Ground
8	RF3	RF3 port
9	RF4	RF port
10	RFC	Common RF port

8 Package Information

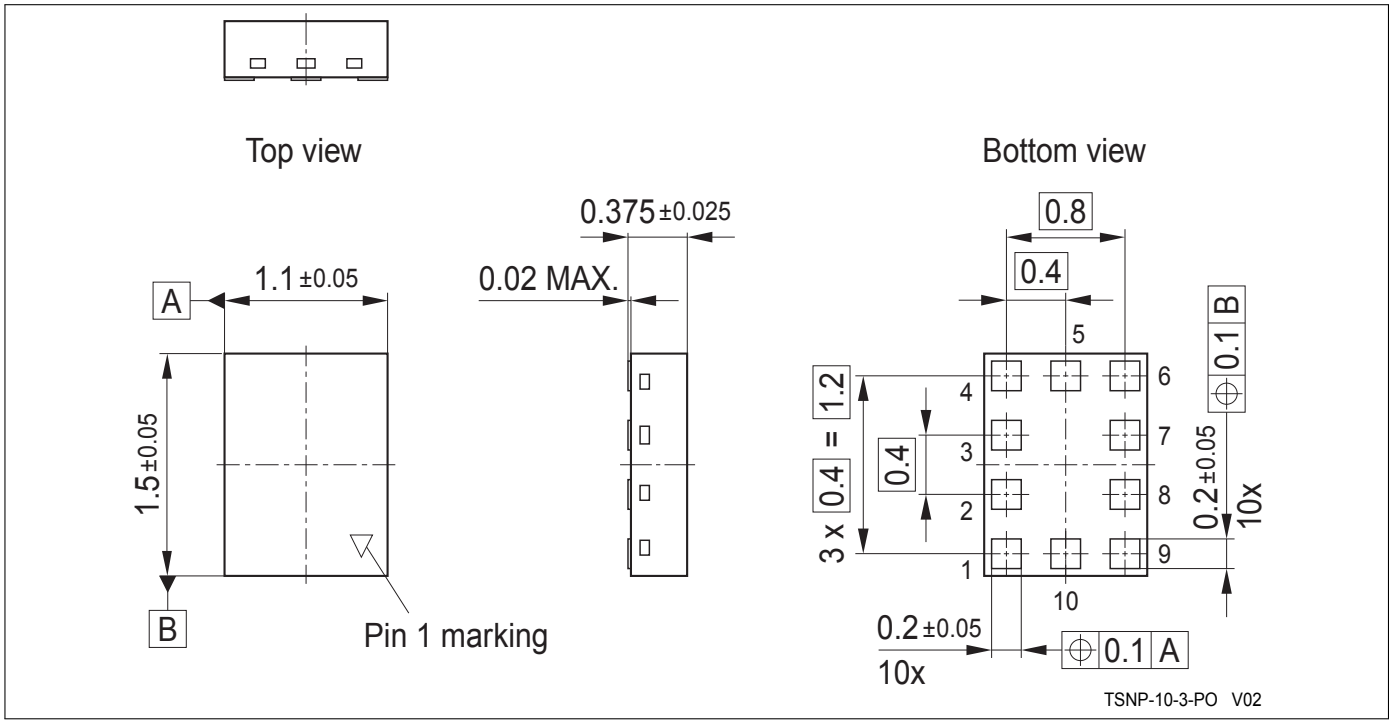

Figure 10: TSNP-10-3 Package Outline (top, side and bottom views)

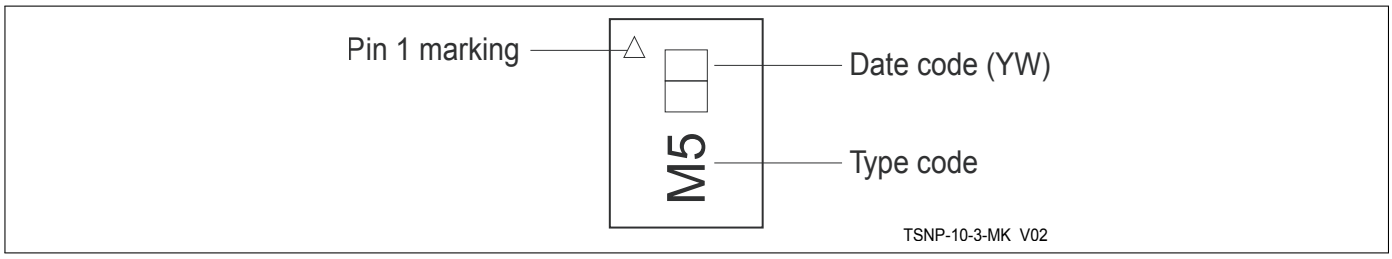

Figure 11: Marking Specification (top view): Date code digits Y and W defined in Table 20/21

Table 20: Year date code marking - digit "Y"

Year	"Y"	Year	"Y"	Year	"Y"
2000	0	2010	0	2020	0
2001	1	2011	1	2021	1
2002	2	2012	2	2022	2
2003	3	2013	3	2023	3
2004	4	2014	4	2024	4
2005	5	2015	5	2025	5
2006	6	2016	6	2026	6
2007	7	2017	7	2027	7
2008	8	2018	8	2028	8
2009	9	2019	9	2029	9

Table 21: Week date code marking - digit "W"

Week	"W"	Week	"W"	Week	"W"	Week	"W"	Week	"W"
1	A	12	N	23	4	34	h	45	v
2	B	13	P	24	5	35	j	46	x
3	C	14	Q	25	6	36	k	47	y
4	D	15	R	26	7	37	l	48	z
5	E	16	S	27	a	38	n	49	8
6	F	17	T	28	b	39	p	50	9
7	G	18	U	29	c	40	q	51	2
8	H	19	V	30	d	41	r	52	3
9	J	20	W	31	e	42	s		
10	K	21	Y	32	f	43	t		
11	L	22	Z	33	g	44	u		

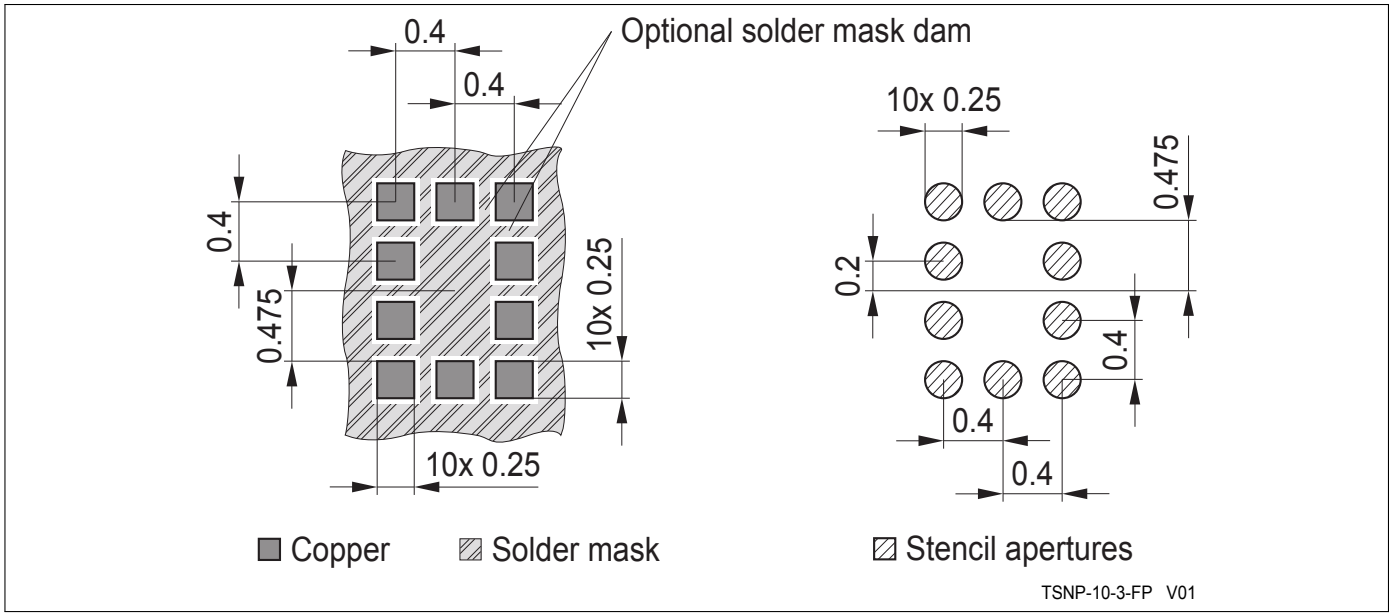

Figure 12: Footprint Recommendation

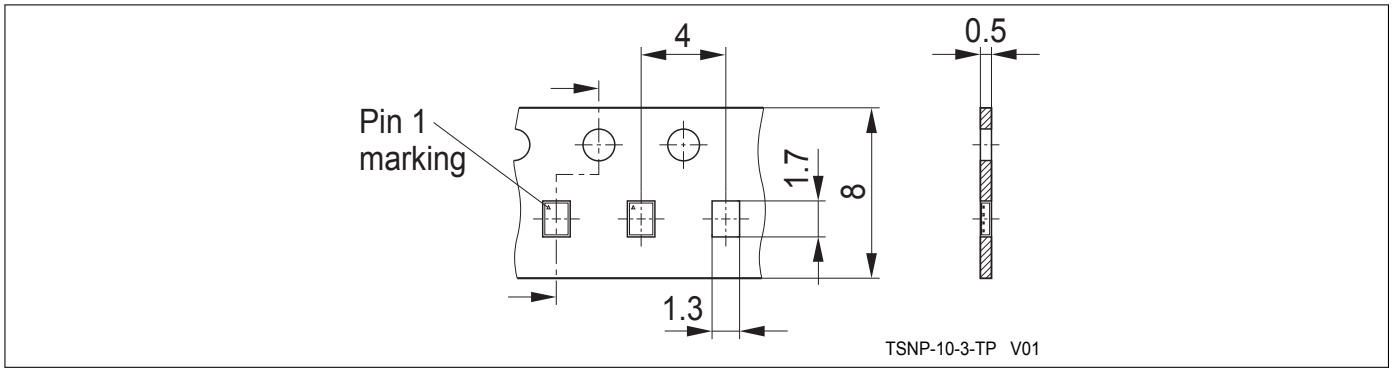

Figure 13: TSNP-10-3 Carrier Tape

Revision History	
Page or Item	**Subjects (major changes since previous revision)**
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