APPLICATION NOTE

Product Name	**S68F**
Version	**D**
Doc No	**902-12401(EN)**
Date	**2020/11/20**

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Document History

Date	Revised Contents	Revised By	Version
2019/12/12	Initial release	PW	A
2020/05/19	Add L1 Recommended Modify RF_Switch Control	PW	B
2020/06/17	Add Pi-circuit description & ESD protection	PW	C
2020/11/18	Update layout guide and RF Switch description, Add Digital Input/Output (DIO)	Kenny	D

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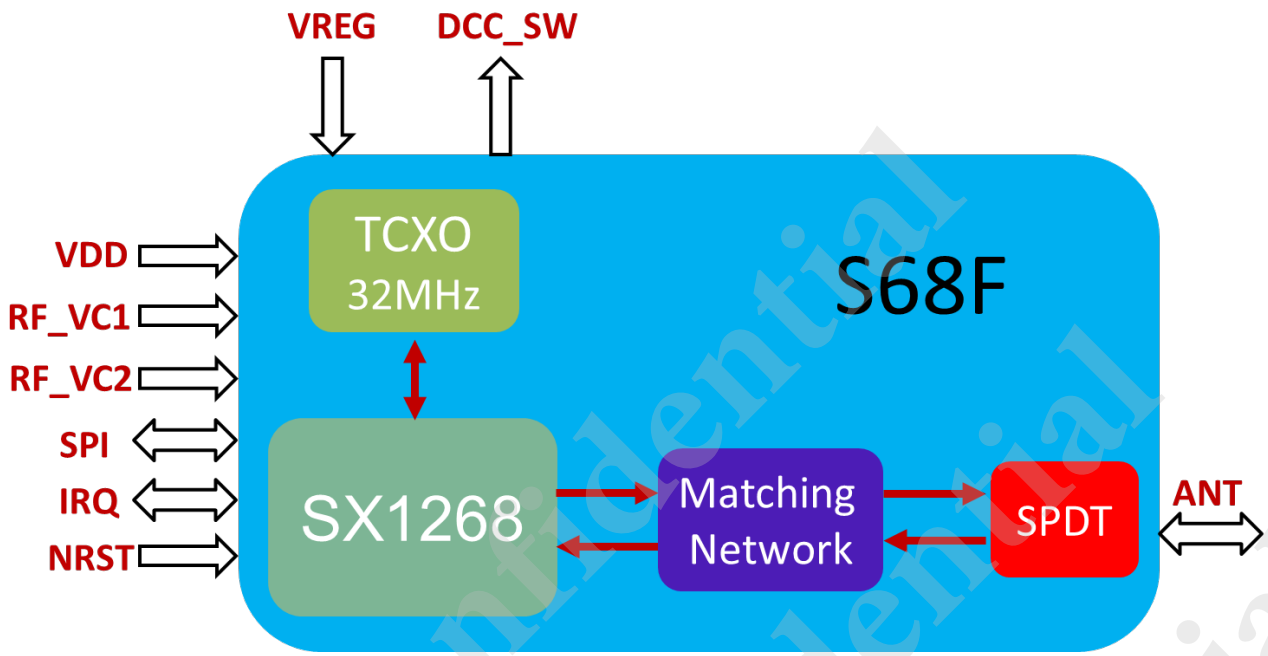
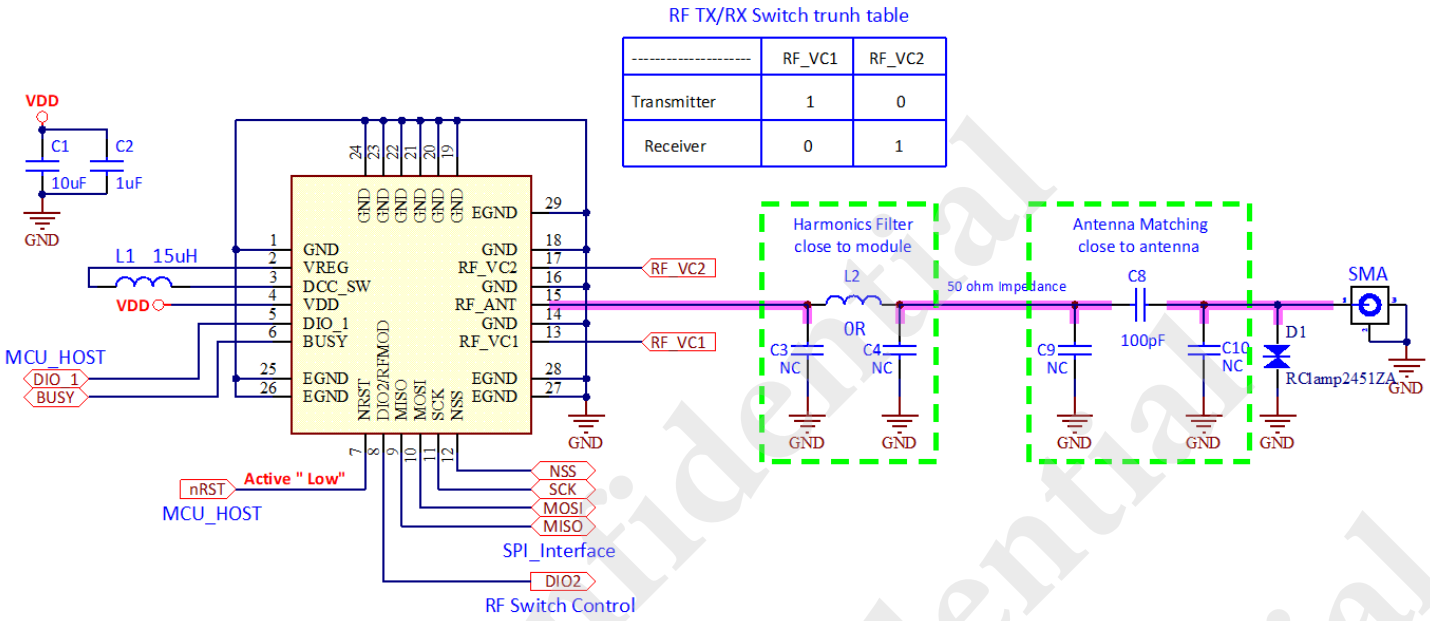
1 Block Diagram



Supporting 433 MHz ~ 510 MHz ISM-Bands

2 Application Circuit



Note : The L1 (15μH) consideration and recommended:

- DCR (max) = 2 ohms
- Idc (min) = 100 mA
- Freq (min) = 20 MHz

Reference	Manufacturer	Value (μH)	Idc max (mA)	Freq (MHz)	DCR (ohm)	Package (L x W x H in mm)
LPS3010-153	Coilcraft	15	370	43	0.95	2.95 x 2.95 x 0.9
MLZ2012N150L	TDK	15	90	40	0.47	2 x 1.25 x 1.25
MLZ2012M150W	TDK	15	120	40	0.95	2 x 1.25 x 1.25
VLS2010ET-150M	TDK	15	440	40	1.476	2 x 2 x 1
VLS2012ET-150M	TDK	15	440	40	1.062	2 x 2 x 1.2

3 Layout Guide

3.1 Power Trace Management

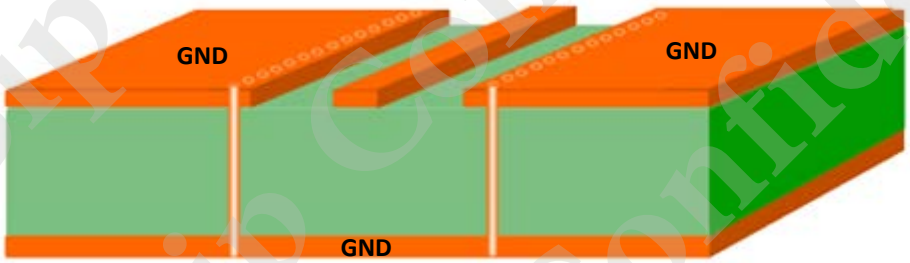
- Power traces should be directly connected with regulator outputs. And add 10uF bypass capacitors close to module on each power trace.
- Never let power trace cross the other one or high speed signal trace.

3.2 Ground Management

- Please ensure: (1).GND polygon regions used for module are as complete as possible and (2).well established GND via holes, in order to keep good heat dissipation and RF performance.
- The reference ground planes of RF trace need to add via holes and we recommend the distance between each adding ones less than 1/8λ.

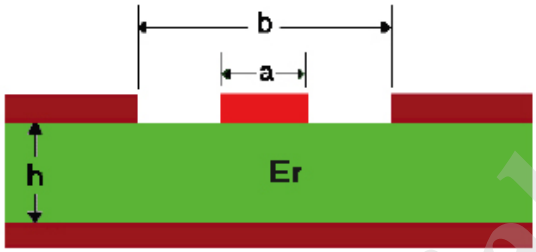
3.3 RF Trace Management

- CPWG model is recommended for RF trace calculation, which has better EMC and RF capability. And please discuss with PCB manufacturer to evaluate and keep RF trace in 50 ohm.

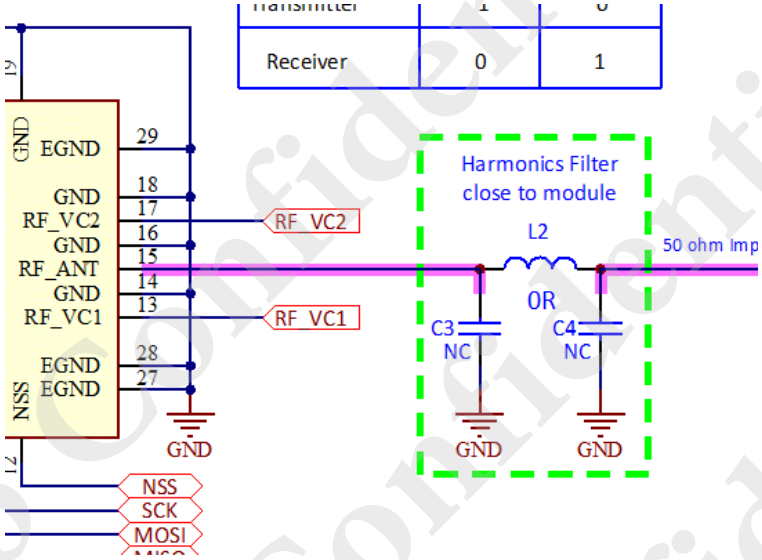


- Do not use right angles in the RF trace, it is better to use 45° bend or radius to change direction.

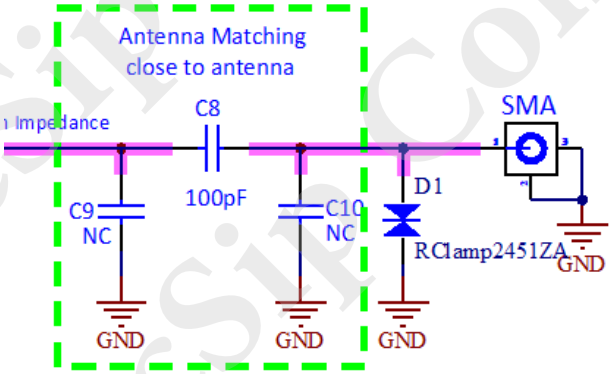
- The values of a and b will affect each other, it is best to control it not to be too wide from the width and gap of the output pad of the module.



- Suggest customer deploy LC low-pass filter close to module to suppress 3rd harmonics.

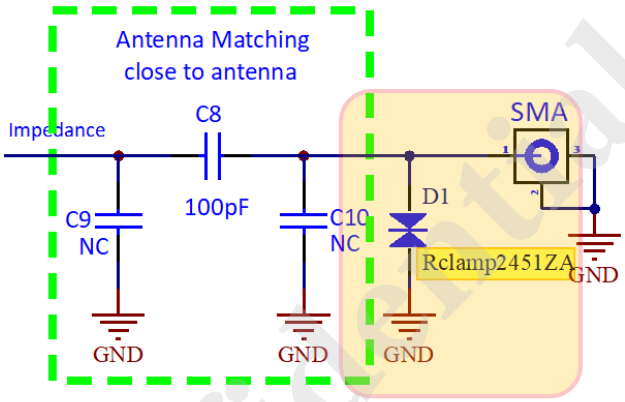


- Suggest customer deploy Pi-matching circuits close to antenna.



3.4 ESD Protection

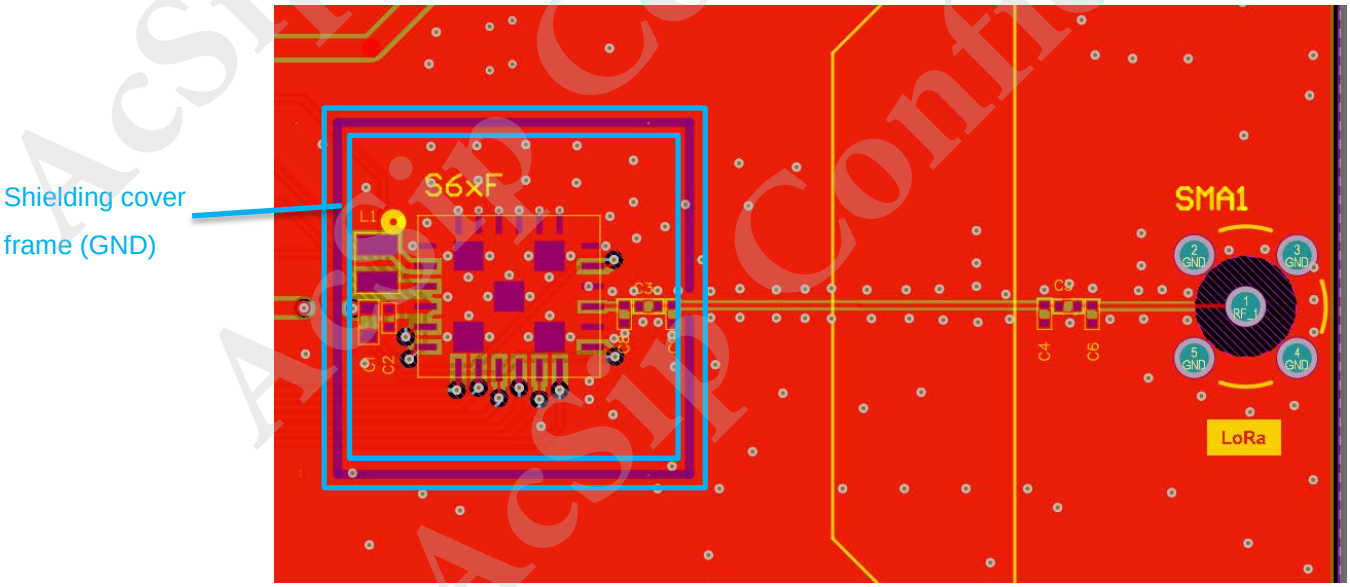
If used in a harsh ESD environment, the following example is reference design for ESD Protection, the recommended part is: Semtech@Rclamp2451ZA (1-Line, 24 V)



3.5 Shielding Cover

Due to FCC strict harmonic emission limits, it is recommended to retain the shield cover.

If necessary shielding cover can be used to shield the harmonic radiations of the PCB; in that case, the shield cover should cover all module components.



3.6 RF Switch Control

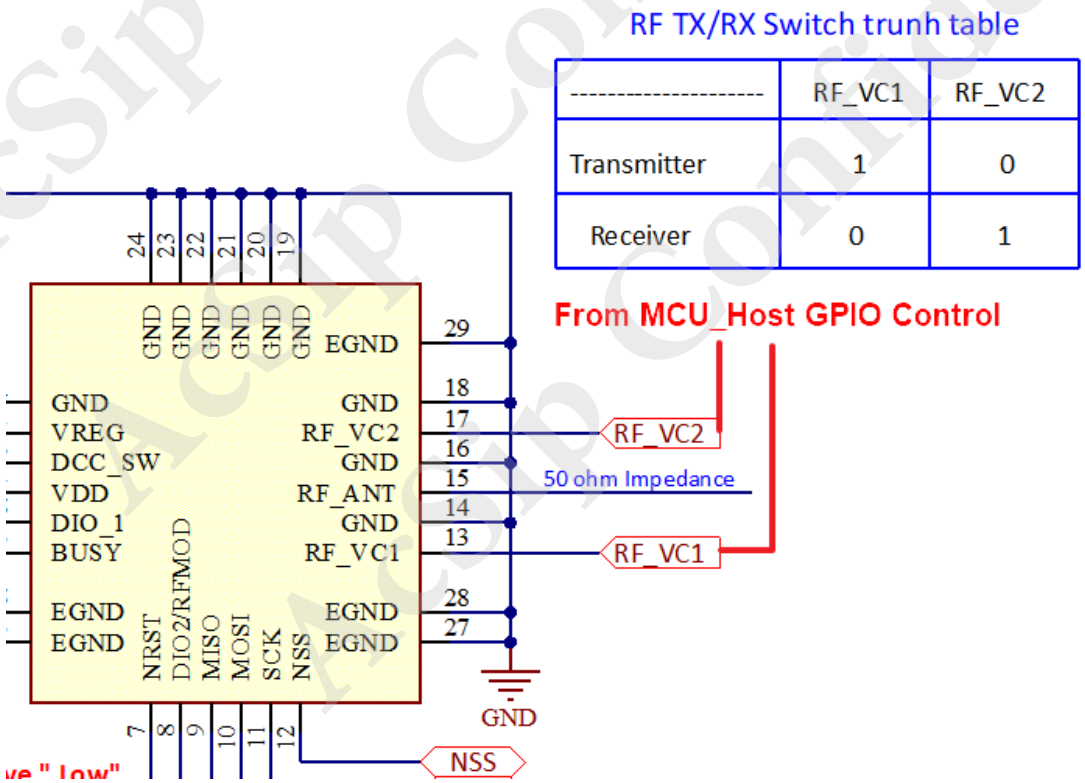
Please refer to truth table for control mode

RF TX/RX Switch Truth table		
	RF_VC1	RF_VC2
Transmitter	H	L
Receiver	L	H

Recommended Operating Range:

Parameter	Symbol	Min.	Typ.	Max.	Unit
Control Voltage (Low)	RF_VC1, RF_VC2	0		0.3	V
Control Voltage (High)	RF_VC1, RF_VC2	1.8	3.3	3.6	V

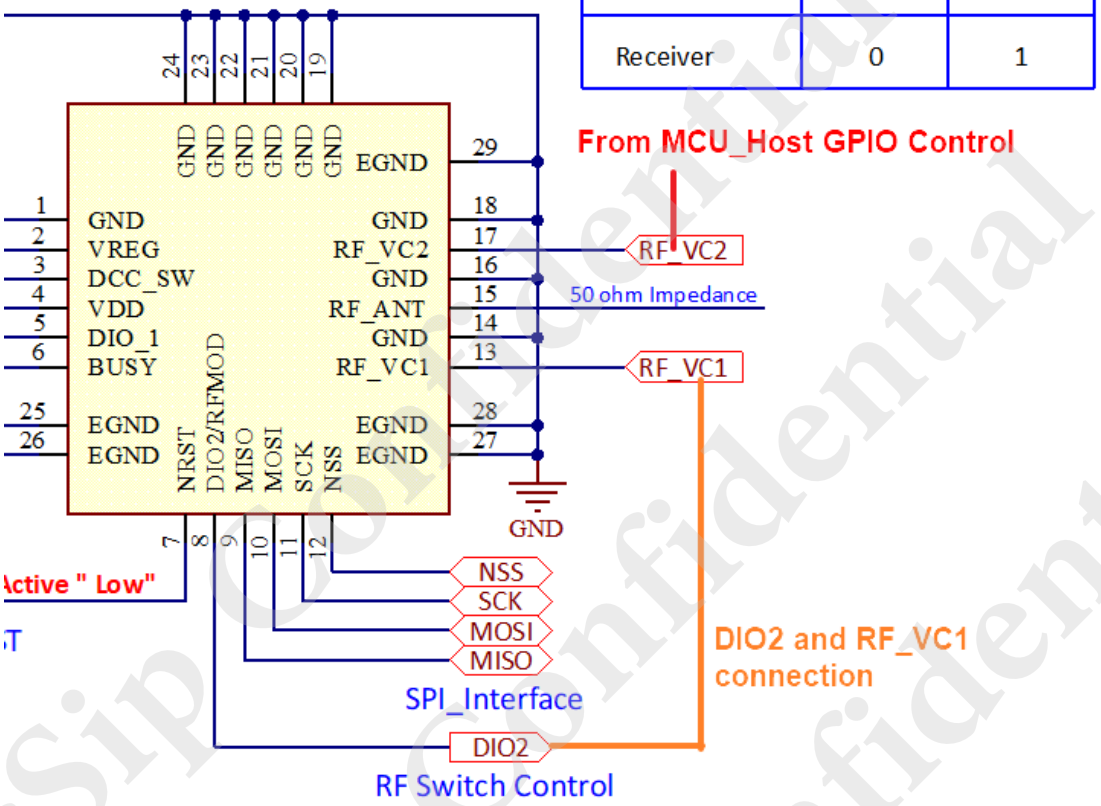
Mode A : Use MCU_Host GPIO to control RF_VC1 & RF_VC2 pins



Mode B: RF_VC1 pin is directly connected to DIO2 pin for control, while RF_VC2 is connected to MCU_HOST for GPIO control (note)

RF TX/RX Switch trunh table

----------	RF_VC1	RF_VC2
Transmitter	1	0
Receiver	0	1



Note:

The standard driver of Semtech GitHub works under single switch mode, which means that RF_VC2 will be in an uncontrolled state, so firmware developers need to modify driver to set RF_VC2 in an appropriate control state.

4 Digital Input/Output (DIO)

The module is interfaced through the 4 control lines which are composed of the BUSY pin and 3 DIOs pins that can be configured as interrupt, debug or to control the radio immediate peripherals (TCXO or RF Switch).

4.1 BUSY Control Line

The BUSY control line is used to indicate the status of the internal state machine. When the BUSY line is held low, it indicates that the internal state machine is in idle mode and that the radio is ready to accept a command from the host controller.

The BUSY control line is set back to zero once the module has reached a stable mode and it is ready for a new command.

For detailed function description of the BUSY pin, please refer to the Semtech DS_SX1268 datasheet.

4.2 IRQ Control Line

DIO1 is the generic IRQ line, any interrupt can be mapped to DIO1.

For detailed description of IRQ pin interrupt status, please refer to the Semtech DS_SX1268 datasheet.

4.3 RF Switch Control functions

DIO2 can be configured to drive an RF switch through the use of the command *SetDio2AsRfSwitchCtrl(...)*. In this mode, DIO2 will be at a logical 1 during Tx and at a logical 0 in any other mode.

- **SetDIO2AsRfSwitchCtrl**

  This command is used to configure DIO2 so that it can be used to control an RF switch.

Byte	0	1
Data from host	Opcode = 0x9D	enable

4.4 TCXO Control functions

DIO3 can be used to automatically control a TCXO through the command SetDio3AsTCXOCtrl(...). In this case, the device will automatically power cycle the TCXO when needed.

- **SetDIO3AsTCXOCtrl**

  This command is used to configure the module as an embedded TCXO reference voltage controlled by DIO3.

Byte	0	1	2-4
Data from host	Opcode = 0x97	tcxoVoltage	delay(23:0)

The tcxoVoltage byte definition is given in as follows:

tcxoVoltage	Description
0x06	DIO3 outputs 3.0 V to supply the TCXO

5 Other Information

- Do not put any signal trace or power trace on system PCB top layer under S68F module.
- Discuss with AcSiP engineer after schematic and layout finished.