With the English version following the Chinese version

型号	灵敏度 @PER 10%	读标签速度 @96 bit EPC)
SIM7600	-87dbm	>1000
SIM5600	-80dbm	>600
SIM3600	-73dbm	>300

描述

超小型 RFID 模块 SIMX600，是芯联创展技术团队基于 IMPINJ 新一代射频芯片 E710/E510/310 研发的高性价比超高频 RFID 读写模块。

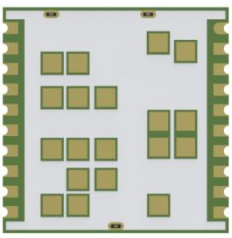
输出功率从 5dBm 到 27dBm 可设置，标签读取距离大于 5 米（取决于天线增益和标签尺寸），且具有卓越的多标签盘存性能。

SIMX600 模块功耗低、体积小、稳定可靠，采用先进的多标签识别算法，标签在移动或者静止状态下都能快速识别。

优越的抗干扰设计以及载波抵消功能，在各种环境下都能稳定工作。

多种配置模式，可广泛用于仓储，物流，产线，巡查等各种应用场合。

SIMX600 模块外形尺寸只有硬币大小，邮票半孔封装，仅 2.5 克重，便于嵌入移动便携式设备。



应用

- 手持终端
- 发卡器
- 打印机
- 一体机

特点

- ARMv7-M 架构 32bit Cortex-M4 CPU，集成 FPU、MPU，DSP，最高工作主频 200MHz ，512KByte 的 Flash
- 支持 UHF EPC Class1 Gen2/ISO 18000-6C
- 提供 Windows，Linux，Android SDK，以及基于 C，C#/.NET，JAVA 的 API
- 支持温度标签盘存，输出参数可包含标签返回信号的 RSSI，相位值
- 最大 27dBm 功率输出
- 优异的防冲突算法，高灵敏度，盘存标签最快速度大于 1000tag/s
- 多种盘存模式适应大多数应用
- 可设置 UART 串口通信波特率 9600bp～921600bps
- 两输入两输出 GPIO
- 北美频段满功率功耗 3 W
- 表面贴装（SMT），邮票半孔设计，重 2.5

克,尺寸 21mm x 21mm x 3.7mm

- 获得 SRRC,CE,FCC 等认证
- 符合 ROHS 要求

绝对最大额定值

参数	符号	最小值	典型值	最大值	单位
输入电压	VCC	-0.3		6	V
使能电压	Ven	-0.3		6	V
复位(NRST) GPI(IN1 IN2)输入低电压	Vil			0.6	V
复位(NRST) GPI(IN1 IN2)输入高电压	Vih	2.7			V
GPO(OUT1 OUT2)输出电流	Ioh			15	mA
模块输出电流	AVCC			20	mA
ESD 保护电压[1]	Vesd	-2		2	kV
天线口(ANT)驻波比[2]	VSWR			8	/
工作温度[3]	Tc	-30		75	℃
存储温度	Ts	-55		100	℃

ESD 注意事项

在搬运、包装和测试设备时必须遵守适当的预防措施。

1.天线端口测试条件 IEC61000-4-2 等级 1，接触放电；其他接口为 HBM 模型，接触放电。

2.防止功放芯片损坏的最大允许驻波比，为了保证性能，建议天线驻波比小于 1.5。

3.环境温度，温度最大限值与模块散热条件有关。

通用工作条件

参数	符号	最小值	典型值	最大值	单位
输入电压	VCC 非欧频	3.6		5.5	V
失能电压	VEN			0.4	V
使能电压		1.5			V
复位(NRST) GPI(IN1 IN2)输入低电压	VIL			0.3	V
复位(NRST) GPI(IN1 IN2)输入高电压	VIH	3			V
GPO(OUT1 OUT2)输出电流	IOH		10		mA
模块输出电流	AVCC		10		mA
天线口(ANT)驻波比[1]	VSWR			2.5	/
工作湿度(未冷凝)	RH	5		95	%
工作温度	TC	-20		55	℃
存储温度	TS	-40		85	℃

1.工作频率范围内,仅为推荐值。超过此值也能工作，不过读标签性能可能会下降。

通用电气参数

参数		条件	最小值	典型值	最大值	单位
频率	频率范围[1]		860		960	MHz
	频率步进值[2]			250/500		KHz
	频率误差	@25℃	-10		10	ppm
输出	输出功率		5		27	dBm
	功率步进			1		dB
	输出功率精度	5dBm~27dBm	-1		1	dB
	输出功率平坦度	5dBm~27dBm	-1		1	dB
	邻道泄露比*	第 1 邻道		-50		dB
		第 2 邻道		-65		dB
	20dB 占用带宽*	RF_MODE 7		125		KHz
		RF_MODE 11		225		KHz
	发射频谱模板*[3]	裕量	2			dB
	杂散发射（传导）[4]	二次谐波		-48		dBm
		三次谐波		-60		dBm
测量	标签 RSSI 测试精度	@-60dBm	-3		3	dB
	标签相位测试精度	@-60dBm	-5		5	degrees
	负载回波损耗测试精度	RL>18dB 接衰减器	-4		4	dB
UART	默认波特率	数据格式：8N1		115200		bps
	可设置波特率		9600		921600	bps
功耗	待机模式			0.81		W
	工作模式[5]	27dBm		3		W

1. 频率区域选择频段，不能同时支持多个频率区域。
2. 可通根据频率区域配置所需频率步进。
3. 参考《ETSI EN 302 208》 4.3.5 Transmitter spectrum masks,发射盘存信号。
4. 全频段条件下测试。
5. 接 50 欧负载，峰值功耗。

标注 * 表示测试时采用盘存模式 为 RF_MODE 7,频谱仪设置 MAXHOLD。

空口模式参数与性能

RF_MODE ID	Forward Link Modulation	Tari (us)	BLF (KHz)	Reverse Link Modulation	Receive Sensitivity Minimum[1] (dBm)			Read Rate[2] (tags/s)
					E710	E510	E310	
103	DSB-ASK	6.25	640	FM0	-64	N/A	N/A	>1000
11	PR-ASK	7.5	640	FM0	-64.1	N/A	N/A	>1000
120	DSB-ASK	6.25	640	Miller M=2	-69.5	-65	N/A	>600
1	PR-ASK	7.5	640	Miller M=2	-70.4	-65.4	N/A	>600
15	PR-ASK	7.5	640	Miller M=4	-76.2	-70.2	N/A	>450
345	PR-ASK	7.5	640	Miller M=4	-76.5	-70.8	-62	>300
12	PR-ASK	15	320	Miller M=2	-76.6	-71.4	-63	>300
3	PR-ASK	20	320	Miller M=2	-76.1	-71.4	-63	>300
5	PR-ASK	20	320	Miller M=4	-81.5	-75.5	-66.7	>200
7	PR-ASK	20	250	Miller M=4	-81.4	-76	-68	>150
13	PR-ASK	20	160	Miller M=8	-87.4	-80	-73.4	>70

1.测试仪器 CISC XPLORER 200，PER 10%,输出功率 27dBm，天线端口回波小于-20dB
2.测试天线增益 14dBi，4000 个标签
3.N/A 表示不支持此模式

从上表可以看出来，SIMX600 提供了多达 11 种配置方式，列出了衡量读写器模块最重要的两项指标：灵敏度和读多标签速度。灵敏度与多标签速度之间需要作出权衡，因为灵敏度更好的模式下读标签速率低。在读得更好与读得更多之间，需要根据应用需求选择合适的模式。另一项需要注意的是当多阅读器同时工作时，会存在干扰。更小的 TARI 虽然加快了与标签的通信连接，但会增加发射信道的带宽，更容易干扰其他读写器。更高的标签的反向散射链路频率(BLF)提高了标签反向传输信号的速度，标签返回信号会落在相邻信道内，当有其他读写器正好工作在这个信道内时，读写器很可能无法解调出标签的返回信号。

盘存模式参数

针对不同的应用场景， SIMX600 提供了多种工作模式。除了控温多标签盘存模式，其他都由读写器模块自动完成，不仅节省了主机与读写器模块的命令交互时间，优秀的处理算法也大大增强了产品的应用适配性。

应用场景	工作模式	描述
少量标签 远距离盘存	普通模式	推荐 RF_MODE 13，session0，读时长根据上报周期自定义，多天线建议读时长为使用天线数量 n*200ms 及以上，读间隔最低可以设置成 0ms
	快速模式	推荐 RF_MODE 13，session1，Target A-B
少量标签 多次数盘存	快速模式	推荐 RF_MODE 103（E710）、RF_MODE 120（E510）、RF_MODE 12（E310），session1，Target A-B，静态 Q 值（2^Q≥标签数量）甚至可以定单个频点读取
多标签盘存	EX10 快速模式	RF_MODE 自动调整,推荐采用高波特率（模块默认 115200bps，根据通讯接口上限最大可以配置 921600bps），读取标签速度快
多标签读全	快速模式	推荐 RF_MODE 7/13，session1，条件允许下使用全频段 860-960MHz
控温多标签盘存	E7 控温模式	RF_MODE 自动调整,当新增标签小于指定个数时，自动调整工作占空比，当新增标签超过指定个数时，恢复全速模式
多标签高读速率盘存	快速模式	RF_MODE 103（E710）、RF_MODE 120（E510）、RF_MODE 12（E310），session2/3，Target A，静态 Q 值（2^Q ≥标签数量）

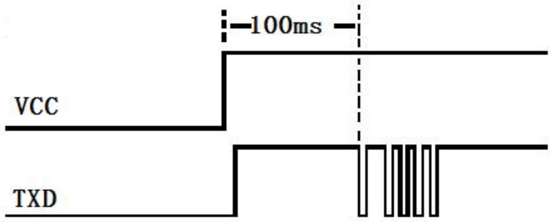
引脚配置及功能

引脚	定义	描述
1	VCC	供电电压，3.6V~5V 输入
2	GND	地
3	EN	使能模块供电，高电平输入或者悬空使能供电
4	OUT2	GPO，推挽输出
5	IN1	GPI,内部已接上拉电阻
6	IN2	GPI，内部已接上拉电阻
7	RXD	模块 UART 输入，3.3V 电平
8	TXD	模块 UART 输出，3.3V 电平
9	NRST	模块复位，低电平使模块复位，不用时可悬空
10	OUT1	GPO，推挽输出
11	GND	地
12	AVCC	3.3V 输出，建议驱动电流不大于 20mA
13	SWCLK	SWD 烧录接口，时钟线，悬空
14	SWDIO	SWD 烧录接口，数据传输线，悬空
15	NC	悬空
16	NC	悬空
17	GND	地
18	GND	地
19	ANT	接天线
20	GND	地

应用说明

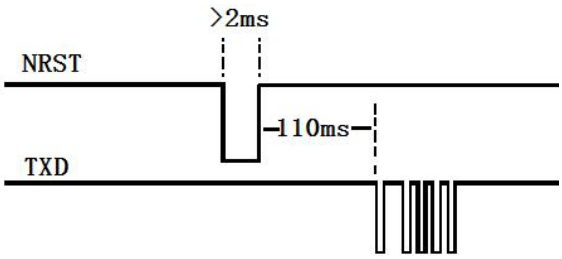
● 上电启动与 IO 接口

模块上电后，需要花费 100ms 进行初始化，在这段时间内不要拉低复位引脚，读写器模块也不会响应接收到的命令。



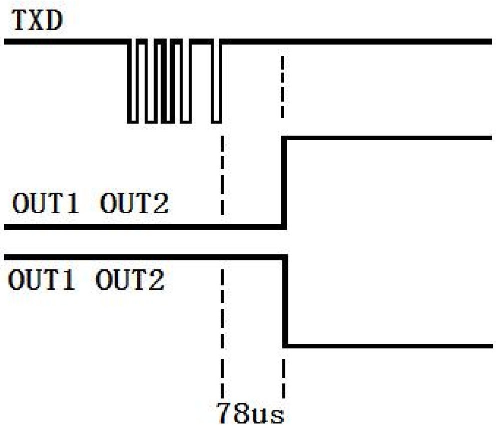
上电启动时间

NRST 上电复位解除时间小于 3ms，模块上电后，NRST 电平拉低会使内部模块的 MCU 重新启动。模块内 NRST 已接 100K 上拉电阻。如果模块已上电，触发复位的低电平保持时间需大于 2ms。当复位发生时，等待复位时间需大于 110ms。

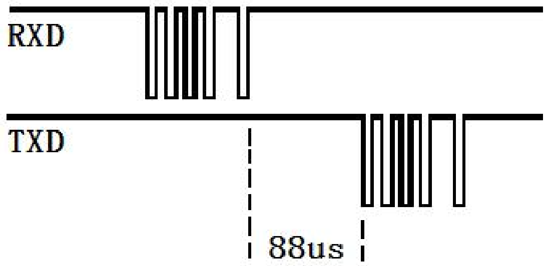


复位等待时间

OUT1，OUT2 设置命令动作时间大于 78us（不含命令时间）。IN1，IN2 设置命令动作时间大于 88us（不含命令时间）。



OUT1，OUT2 动作时间



IN1，IN2 动作时间

EN 高电平使能上电，内部已经上拉 100K 电阻。

输入电源

VCC端口建议使用一个22～100uF的钽电容,如果尺寸限制,也可以改为小尺寸的陶瓷电容，并且至少并联一个 0.1uF 与一个 100pF 陶瓷电容。模块工作时的最大电流将近 0.6A（当天线端口失配）。在盘存标签时，会快速开启和关闭发射信号，导致模块输入端电源也随着产生电压波动。大容量电容可以减小纹波幅度，除了滤除低频信号的干扰，却也引起瞬间电流过大，根据供电电路的驱动能力，选择合适容量退耦电容。0.1uF 和 100pF 电容用于滤除高频段的电源纹波，因为高频段的干扰信号，特别是工作频段内的干扰信号进入到模块会使模块的读标签性能下降，此外陶瓷电容的加入也能防止模块工作时产生的高频信号通过电源通路，干扰到其他电路系统。

由于模块工作电流大，连接模块 VCC 端口的走线要足够粗，否则连接线两端会产生过大的压差，当模块输入端电压低于 3.3V，将使模块无法正常工作；过细的连接线也更容易辐射出干扰信号。

如果输入的电源电压比较低，或者电源电压非稳定的(比如用电池给模块供电)，建议先采用升/降压电路将电压钳位到一个固定电压（比如 5V），这样能保证模块性能的一致性。如果升压/降压电路是 DC-DC 转换电路，优先选择开关频率超过 1.5MHz 的电源转换芯片，相比开关频率低的电源芯片可能转换效率低一点点（一般 5%以内），但避免对标签返回的微弱信号产生干扰。

● 通讯串口

读写器模块采用 3.3V UART 串口进行数据通信，数据格式配置为 1 位起始位，8 位数据，1 位停止位，无校验位（8N1）。

串口进行通信时，串口通信信号产生的频率与杂散和标签返回的 BLF 信号接近，有可能会通过传导与辐射的方式进入到模块射频芯片的接收端。由于标签散射回模块的信号很弱，当这样的干扰发生时，会使模块的接收性能急剧下降。

如果串口的 PCB 走线较长，可将走线布在 PCB 的内层或者布在放置天线相反的 PCB 层上，同时预留用于串联的匹配电阻和到地的并联电容，这可以用于减小串口信号的振铃；当需要采用板间连接线连接时，连接线最好贴地布线。

串口的波特率需要满足模块上传标签数据的传输速率要求，盘存较多标签时，推荐波特率如下表所示：

RF_MODE ID	Forward Link Modulation	BLF(KHz)	Reverse Link Modulation	Baud Rate Select
103	DSB-ASK	640	FM0	921600
11	PR-ASK	640	FM0	921600
120	DSB-ASK	640	Miller M=2	>460800
1	PR-ASK	640	Miller M=2	>460800
345	PR-ASK	640	Miller M=4	>230400
15	PR-ASK	640	Miller M=4	>230400
12	PR-ASK	320	Miller M=2	>230400
3	PR-ASK	320	Miller M=2	>230400
5	PR-ASK	320	Miller M=4	>115200
7	PR-ASK	250	Miller M=4	>57600
13	PR-ASK	160	Miller M=8	>57600

● 天线端口

当模块与天线不匹配时，从天线反射回读写器模块的功率过大，这会使接收灵敏度恶化，特别是使用 E710 芯片的模块灵敏度影响程度更大。举例说明，采用 RF_MODE 7 进行测试，满功率工作，与匹配较好的情况相比，在驻波比为 2.0(回波损耗约-9.5dB)时，使用 E710 芯片的模块灵敏度恶化约 4dB～5dB，使用 E510 芯片的模块恶化约 1dB～2dB，使用 E310 芯片的模块恶化程度在 1dB 以内。因此，当使用 E710 芯片的模块应用在需要快速读取大量标签的应用场合时，如果天线驻波较大，会极大地增加读全标签的时间；对于距离近标签少的应用环境，选择使用 E510 或者 E310 的模块更加合适。

由于模块内的功放芯片与天线之间并未使用 RF 隔离器或者 RF 环形器进行隔离，当功放芯片与天线不匹配时，功放芯片输出的线性度与转换效率会发生变化。前者会使发射性能发生变化，比如功率输出减小，辐射杂散与频谱模板不符合当地无线电法规要求等等；后者则会使模块的功耗增加，增加了工作温度，从而使使用寿命减小。当功放芯片工作在不稳定区域时产生自激，这种情况下功放芯片则容易损坏。虽然 SIMX600 采用了对失配容忍度很高的功放芯片，并且在最差的情况下(模块天线端开路，VSWR=+∞)进行了长时间的测试(超过一周)也未发生损坏，但是并不能覆盖所有的匹配情况。如果有测试条件，在产品整体测试时可检查其与接 50 欧负载相比的功耗情况，功耗增加量不要超过 0.75W(具体视模块的散热情况而定，当散热良好时，限制条件可以放宽，此处仅作为模块使用时失配程度的直观判断，并不一定准确)；为保证模块的盘存性能，并能长期稳定工作，建议将天线安装在应用环境中后，检测一下连接天线后的驻波比，天线驻波比尽量小于 2.0(回波损耗-9.5dB)。如果输出功率较低，可以降低驻波比的要求。

● 静电保护

SIMX600 的 ESD 测试只能达到±2KV，如果需要满足更高的要求，就要增加 ESD 保护电路。

当过强的静电进入到天线端口，会损坏功放芯片与读写器芯片。有一种情况是，模块还能工作，但性能已经发生了改变。从天线端口静电测试情况来看，大多数表现在标签的接收灵敏度变差约 7dB，也有可能情况更加严重，所以产品整体测试时需要关注这一项的性能是否发生了变化。简单的测试方法是与一个工作正常的产品作对比，比如定频读取同一个标签（先确保 RSSI 值不小于-60），对比两者的 RSSI 值，一般 RSSI 的变化应小于±3dB。

参考电路中给出了一种 ESD 保护电路(天线端口采用电感电容组成的高通滤波电路)，在模块未上电的情况下测试，天线端口在±8KV 未发生损坏，但电路会增加约 0.3dB 左右的插入损耗，模块与天线或者负载的匹配也发生了改变。另一种 ESD 保护的方法，是直接增加低寄生电容的双向 ESD 保护二极管，相比于上面的方法，插入损耗会更低，匹配的改变程度也更小，不过要注意，ESD 保护二极管的使用，有可能使发射的射频波形产生失真，从频谱仪上可以观测到高次谐波分量有增加（一般 2、3 次谐波增加得更多）。为了满足当地无线电法规要求，请选择合适的 ESD 保护二极管。

在实际应用中，如果所使用天线的辐射面与地能充分连接，也能对天线端口起到部分的 ESD 保护作用。

● 屏蔽说明

SIMX600 使用金属屏蔽盖作电磁屏蔽，如前面描述的，邮票孔封装的模块需要通过一段微带线与不同的天线或者负载相连接，这会减弱金属屏蔽盖的作用，并且由于匹配发生了变化，功放芯片输出的射频参数也会跟着变化，这都有可能使产品的辐射杂散指标超过要求门限值。

当产品的辐射要求比较严格时，建议在 SIMX600 模块周边额外再增加一层屏蔽，这会减小辐射杂散超标的风险。

● 散热说明

SIMX600 尺寸较小，很难通过模块本身将工作时产生的热量发散出去，所以模块提供了尽量多的散热焊盘（见封装信息）。

SIMX600 贴在底板上时，底板需要考虑散热，保证模块的工作温度不要过高。当标签不多，或者不需要实时盘存时，可以根据模块温度调节模块的工作间隔。如果觉得这个方法占用了盘存标签的时间，可以使用模块提供的控温多标签盘存模式。

在 SIMX600 模块中，功放芯片是主要的发热芯片，所以主要考虑它的温度要求，可通过下面的公式大概计算功放芯片结温：

输出功率 Pout；模块整体功耗 Pmod； EX10 芯片功耗与 CPU 等外围电路功耗为 Pext；

功放的耗散功率：

$$\mathbf{Pdiss = Pmod - Pout - Pext}$$

在这里假设功放热阻系数：

$$\mathbf{Rth\_PA = 30℃/W}$$

模块系数热阻：Rth_BOARD（与底板和散热设计有关,更好的散热，热阻会降低）

模块上的功放芯片热阻系数:

$$\mathbf{Rth = Rth\_PA + Rth\_BOARD}$$

PA 结温(Junction Temperature@55℃ ambient)

$$\mathbf{TJ = 55℃ + Pdiss\ x\ Rth < 135℃}$$

135℃的 PA 结温限值小于功放芯片所允许的最大结温 150℃，这是为了保证模块工作稳定，降低了温度限值。

从上面的公式可知，如果要使模块可正常工作的最大环境温度增加，需要减小模块的热阻系数 Rth_BOARD。

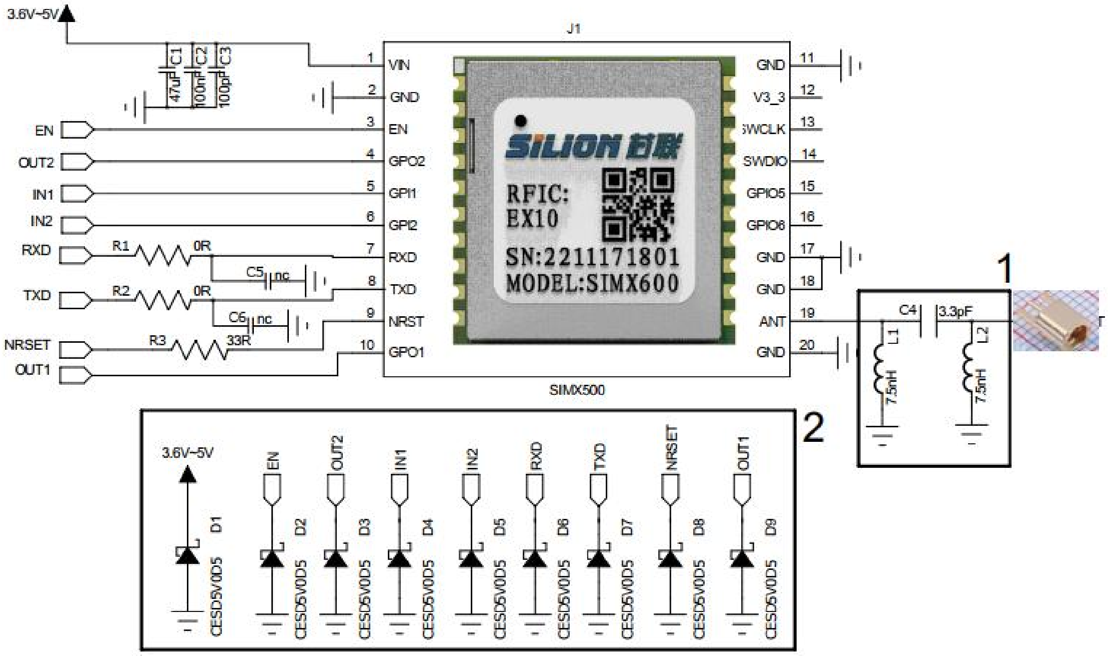
有时不能准确获得 Rth_BOARD 的值，因为它和产品（使用了 SIMX600 模块）的散热方式有关。为此，可以通过测试的方式大概估计 Rth_BOARD 的值。为了进一步说明，做了下面的测试。

将 SIM7600 模块贴在一块长 29mm，宽 29mm，厚 1.0mm，板材为 FR4 的底板上，SIM7600 底部涂满导热硅脂(Kafuter K-5211H)，测量环境温度 Tambient=28℃，Pout =31.6mW(15dBm)，Pmod=1.65W, Pext=1W,测量得到功放芯片表面温度 81℃，读写器芯片 E710 表面温度 70℃，模块其他区域最大温度 67℃，底板温度 70℃。假设功放芯片结温与芯片表面温度差 10℃(这个数值有可能更小)，计算得到（仅用于大概评估，非精确结果，实际是输出功率越高，计算结果越准确）：

$$\mathbf{Rth\_BOARD = (81℃ + 10℃ - 28℃) / (1.65W - 1W - 0.0316W) - 30℃/W = 71.8\ ℃/W}$$

显然底板的散热能力不够导致 Rth_BOARD 过高，需要使用更好的散热方式。

● 参考电路



1. 增加了 ESD 保护能力，会引入额外的插入损耗，天线端口匹配也发生改变。如果 ESD 满足要求，尽量不增加此电路。

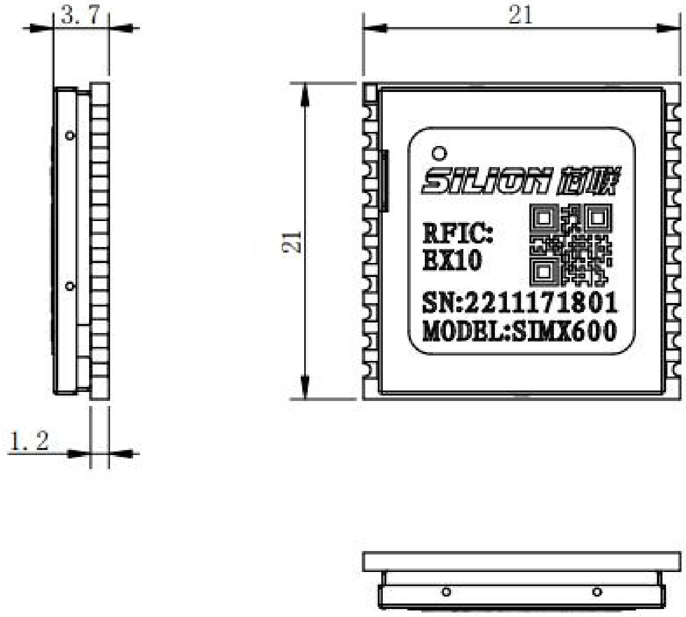
2. 根据实际需要选择合适的 ESD 保护二极管。如果 SIMX600 通信及电源接口不与产品外部接头相连接，ESD 保护二极管一般可以省略。

● 标记说明

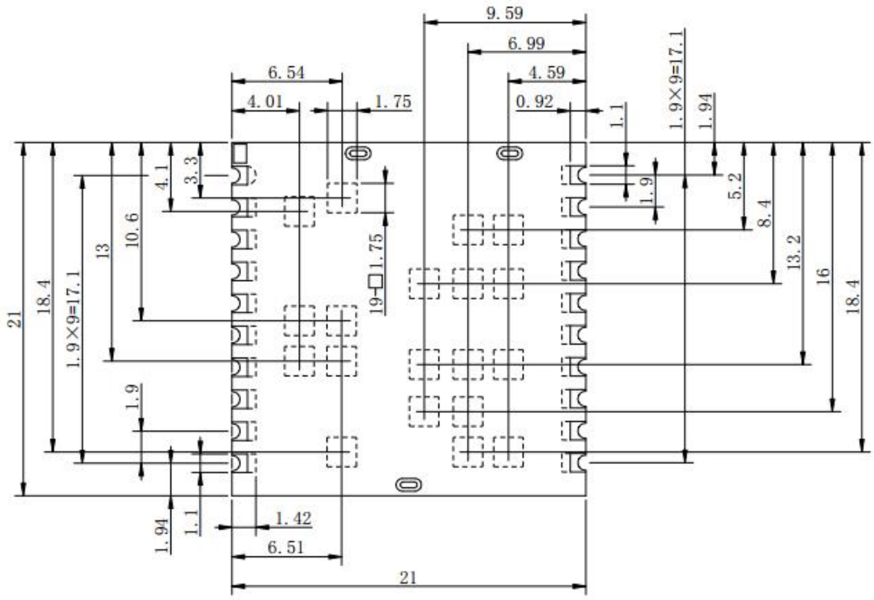
尺寸与封装信息

● 封装尺寸

21mm x 21mm x 3.7mm（长 x 宽 x 高），重 2.5g



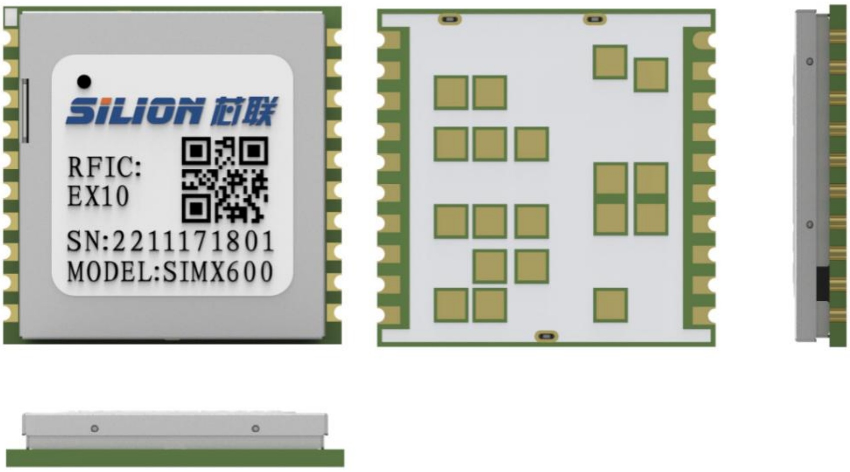
● PCB 焊盘



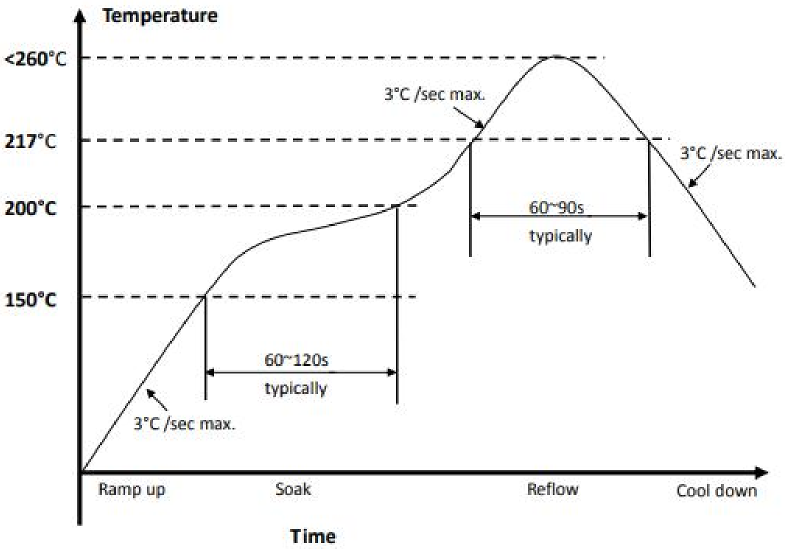
圆形焊盘内孔是射频走线过孔，模块所贴底板这个位置不铺铜，底板的下一层要铺地。

建议使用提供的模块封装，减小电路设计的时间。

- 外观示意图



SMT 回流焊信息



贴片回流焊推荐使用上图的温度控制

1. 参照 IPC/JEDEC 标准。
2. 峰值温度： <260℃。
3. 回流焊循环次数：最大 2 次。
4. 在回流焊过程中加入氮气（N2）以实现 2000ppm 或更低的氧气浓度要求。
5. 烘烤温度要求为 125℃±5℃，烘烤时间要求：

   A. 对于在三个月以上六个月以内烘烤时间为 4H。

   B. 对于在六个月以上烘烤时间为 24H。

版本信息

版本	日期	修订内容
V1.0	2023/7/6	首版编辑
V1.1	2023/11/16	增加应用场景参数配置
……		

联系方式

如果您有产品需求或者在产品使用中有任何疑问，请随时与我们联系，我们将竭诚为您服务。

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Overview

The small size UHF RFID module SIMx600 with high-performance, designed by SILION R&D team. It based on IMPINJ New Generation RF chip E710/E510/E310.

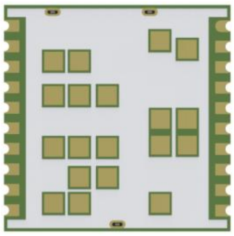
Output power can be set from 5dBm to 27dBm. Tag reading distance is more than 5m (depending on antenna gain and tag size), And has excellent multi-label inventory performance.

SIMX600 module has low power consumption, small size, stable and reliable, and adopts advanced multi-tag recognition algorithm. Tags can be quickly identified whether they are moving or stationary.

Superior anti-interference design and carrier cancellation function ensure stable operation in various environments.

Various configuration modes can be widely used in various applications such as warehousing, logistics, production lines, and inspections.

The SIMX600 module is only the size of a coin, comes in a half-hole postage stamp package, and weighs only 2.5g, making it easy to embed in mobile and portable devices.



Applications

● Handheld PDA	● Card reader
● Printers	● Integrated reader

Model	sensitivity @PER 10%	Inventory speed @96 bit EPC)
SIM7600	-87dbm	>1000
SIM5600	-80dbm	>600
SIM3600	-73dbm	>300

Features

- ARMv7-M architecture 32bit Cortex-M4 CPU, integrated FPU, MPU, DSP, the highest work main frequency is 200MHz, 512KByte Flash
- Support UHF EPC Class1 Gen2/ISO 18000-6C
- Provide Windows， Linux and Android SDK, and API based on C, C#/.NET, JAVA
- Support inventory of temperature tags, the output parameters include the RSSI and phase value of the tag return signal
- Maximum 27dBm power output
- Excellent anti-collision algorithm and high sensitivity. The fastest speed of inventory tags is

greater than 1000tag/s

- Multiple inventory modes suitable for most applications.
- The UART serial communication baud rate can be set from 9600bp to 921600bps
- 2 inputs 2 outputs GPIO
- The full power consumption of the North American frequency band is 3W
- Surface mount (SMT), stamp half-hole design, weight 2.5g, size 21mm x 21mm x 3.7mm
- Obtained SRRC, CE, FCC and other certifications
- Comply with ROHS requirements

Absolute Max Ratings Value

Parameter	Sign	Mini	Typical	Max	Unit
Input voltage	VCC	-0.3		6	V
Enable voltage	Ven	-0.3		6	V
Reset (NRST) GPI (IN1 IN2) input low voltage	Vil			0.6	V
Reset (NRST) GPI (IN1 IN2) input high voltage	Vih	2.7			V
GPO (OUT1 OUT2) output current	Ioh			15	mA
Module output current	AVCC			20	mA
ESD protection voltage[1]	Vesd	-2		2	kV
Antenna port (ANT) standing wave ratio[2]	VSWR			8	/
Operating temperature[3]	Tc	-30		75	℃
Storage temperature	Ts	-55		100	℃

ESD Precautions

Proper precautions must be followed when transporting, packaging and testing the equipment.

1. Antenna port test conditions IEC61000-4-2 level 1, contact discharge; other interfaces are HBM model, contact discharge.
2. The maximum allowable standing wave ratio to prevent damage to the power amplifier chip. To ensure performance, it is recommended that the antenna standing wave ratio be less than 2.0.
3. Ambient temperature. The max temperature limit is related to the module heat dissipation conditions.

General Operating Conditions

Parameter	Sign	Mini	Typical	Max	Unit
Input voltage	VCC non-EU	3.6		5.5	V
Disabling voltage	VEN			0.4	V
Disabling voltage		1.5			V
Enable voltage	VIL			0.3	V
Reset (NRST) GPI (IN1 IN2) input low voltage	VIH	3			V
Reset (NRST) GPI (IN1 IN2) input high voltage	IOH		10		mA
GPO (OUT1 OUT2) output current	AVCC		10		mA
Module output current	VSWR			2.5	/
Antenna port (ANT) standing wave ratio1	RH	5		95	%
Operating humidity (non-condensing)	TC	-20		55	℃
Operating temperature	TS	-40		85	℃

1. Within the operating frequency range, these are only recommended values. It will work above this value, but tag reading performance may be degraded.

General Electrical Parameters

Parameters		Condition	Mini	Typical	Max	Unit
Frequency	Range[1]		860		960	MHz
	Step value[2]			250/500		KHz
	Deviation	@25℃	-10		10	ppm
Output	Output power		5		27	dBm
	Power step			1		dB
	Output power accuracy	5dBm~27dBm	-1		1	dB
	Output power flatness	5dBm~27dBm	-1		1	dB
	Adjacent channel leakage ratio*	1st adjacent channel		-50		dB
		2nd adjacent channel		-65		dB
	20dB occupied bandwidth*	RF_MODE 7		125		KHz
		RF_MODE 11		225		KHz
	Emission spectrum template*[3]	margin	2			dB
	Spurious Emissions (Conducted)[4]	2nd harmonic		-48		dBm
		3rd harmonic		-60		dBm
Measure	Module temperature accuracy	@-60dBm	-3		3	dB
	Tag RSSI test accuracy	@-60dBm	-5		5	degrees
	Tag PHASE test accuracy	RL>18dB Connect the attenuator	-4		4	dB
UART	Load return loss test accuracy	data format：8N1		115200		bps
	Default baud rate		9600		921600	bps
Consumption	Configurable baud rate			0.81		W
	Normal standby mode[5]	27dBm		3		W

1. Select the frequency band by frequency area and cannot support multiple frequency areas at the

same time.
2. The required frequency step can be configured according to the frequency area.
3. Refer to "ETSI EN 302 208" 4.3.5 Transmitter spectrum masks, transmitting inventory signals.
4. Tested under full frequency band conditions.
5. Connect 50 Ω load, peak power consumption.
Marked * indicates that the inventory mode is used during testing. For RF_MODE 7, the spectrum analyzer is set to MAXHOLD.

Air Interface Mode Parameters and Performance

RF_MODE ID	Forward Link Modulation	Tari (us)	BLF (KHz)	Reverse Link Modulation	Receive Sensitivity Minimum[1](dBm)			Read Rate[2](tags/s)
					E710	E510	E310	
103	DSB-ASK	6.25	640	FM0	-64	N/A	N/A	>1000
11	PR-ASK	7.5	640	FM0	-64.1	N/A	N/A	>1000
120	DSB-ASK	6.25	640	Miller M=2	-69.5	-65	N/A	>600
1	PR-ASK	7.5	640	Miller M=2	-70.4	-65.4	N/A	>600
15	PR-ASK	7.5	640	Miller M=4	-76.2	-70.2	N/A	>450
345	PR-ASK	7.5	640	Miller M=4	-76.5	-70.8	-62	>300
12	PR-ASK	15	320	Miller M=2	-76.6	-71.4	-63	>300
3	PR-ASK	20	320	Miller M=2	-76.1	-71.4	-63	>300
5	PR-ASK	20	320	Miller M=4	-81.5	-75.5	-66.7	>200
7	PR-ASK	20	250	Miller M=4	-81.4	-76	-68	>150
13	PR-ASK	20	160	Miller M=8	-87.4	-80	-73.4	>70

1. Test instrument CISC XPLORER 200， PER 90%, output power 27dBm, antenna port echo less than -20dB.
2. Test antenna gain 14dBi, 4000 tags.
3.N/A indicate this mode is not supported.

From the above table, SIMX600 provides up to 11 configuration methods, listing the two most important indicators for measuring the reader module: sensitivity and multi-tag reading speed. There is a trade-off between sensitivity and multi-tag speed. When the sensitivity is better, the reading speed rate of tags is lower. Between reading better and reading more, need to choose the appropriate mode based on customer application needs. Another thing to note is that when multiple readers work at the same time, there will be interference. Although a smaller TARI speeds up the communication connection with the tag, it will increase the bandwidth of the emission channel, which is easier to interfere with other readers. Higher BLF of the tag will increase the speed of the tag's reverse transmission signal. The tag return signal will fall in the adjacent channel. When other readers happen to be working in this channel, the reader is likely to be unable to demodulate the return signal of the label.

Inventory Mode Parameters

For different application scenarios, SIMX600 provides multiple working modes. Except for the temperature-controlled multi-tag inventory mode, everything else is automatically completed by the reader module. This not only saves the command interaction time between the host and the reader module, but the excellent processing algorithm also greatly enhances the application adaptability of the product.

Application	Operating Mode	Description
Few tags, remote inventory	Normal mode	Recommend RF_MODE 13, session0, the reading time can be customized according to the reporting cycle. For multi-antenna products, it is recommended that the read time be set to the number of antennas used n*200ms or more. The read interval can be set to 0ms at the lowest.
	Fast mode	Recommend RF_MODE 13， session0, Target A
Few tags multi-times inventory	Fast mode	Recommended RF_MODE 11/103 (E710), RF_MODE 1/120 (E510), RF_MODE 12/345 (E310), session1, Target A-B, static Q value (2^Q≥number of tags) and even single frequency reading can be set

Multi-tag inventory	EX10 fast mode	RF_MODE, session and other Gen2 parameter devices are dynamically adjusted, and the tag reading speed is fast. Configuring related parameters in this mode does not take effect. It is recommended to use this mode for multi-tag testing.
Read all multi-tags	Fast mode	Recommended RF_MODE 7/13, session1, use the full frequency band 860-960MHz if conditions permit.
Temperature control/low power consumption Multi-label inventory	E7 temperature control mode	RF_MODE automatically adjusts. When the number of new tags is less than the specified number, the working duty cycle is automatically adjusted. When the number of new tags exceeds the specified number, the full-speed mode is restored. This mode is recommended for long-term battery life testing/low power consumption testing.
High read rate multi-tags inventory	Fast mode	RF_MODE 11/103（E710）、RF_MODE 1/120（E510）、RF_MODE 12/345（E310），session2/3，Target A，Static Q value (2^Q≥number of tags)

※If the above mode is supported by the motherboard and communication interface, it is better to increase the baud rate to 921600bps (the default baud rate is 115200bps).

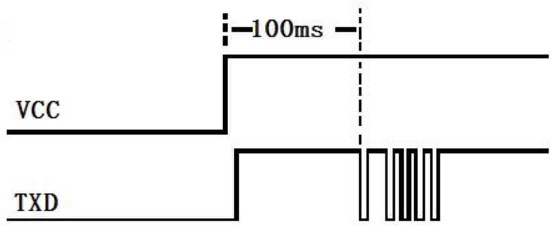
Pin configuration and

function

PIN No.	Define	Description
1	VCC	Power supply voltage, 3.6V~5V input
2	GND	GND
3	EN	Enable module power supply, high level input or floating to enable power supply
4	OUT2	GPO, push-pull output
5	IN1	GPI, internal pull-up resistor is connected
6	IN2	GPI, internal pull-up resistor is connected
7	RXD	Module UART input, 3.3V level
8	TXD	Module UART output, 3.3V level
9	NRST	Module reset, low level resets the module, it can be hang in the air when not in use
10	OUT1	GPO, push-pull output, 3.3V level
11	GND	GND
12	AVCC	3.0V output, it is recommended that the driving current is no more than 20mA
13	SWCLK	SWD programming interface, clock line, unconnected (hang in the air)
14	SWDIO	SWD programming interface, data transmission line, unconnected (hang in the air)
15	NC	unconnected
16	NC	unconnected
17	GND	GND
18	GND	GND
19	ANT	Antenna connection
20	GND	GND

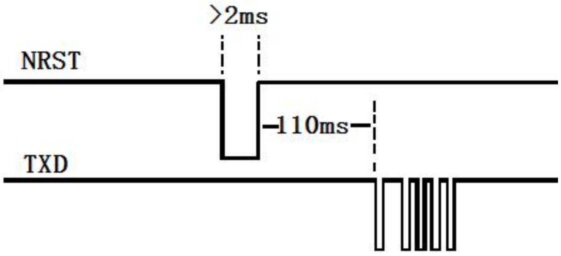
- **Application Description**

- **Power-on Boot and IO Interface**
- After the module is powered on, it takes 100ms to initialize. Do not pull the reset pin low during this time, and the reader module will not respond to the received commands.



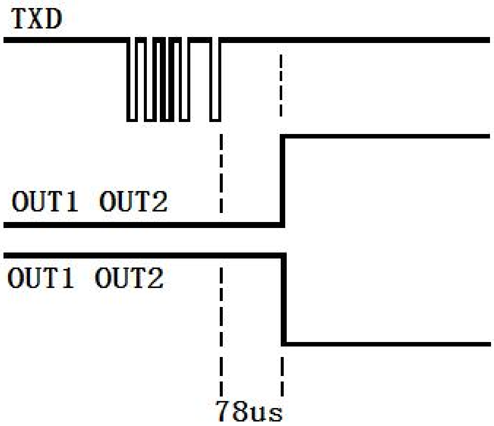
Power-on boot time

The NRST power-on reset release time is less than 3ms. After the module is powered on, pulling the NRST level low will cause the MCU of the internal module to restart. The NRST in the module has been connected to a 100K pull-up resistor. If the module is powered on, the low-level holding time that triggers the reset needs to be greater than 2ms. When reset occurs, the actual waiting time for reset needs to be greater than 110ms.

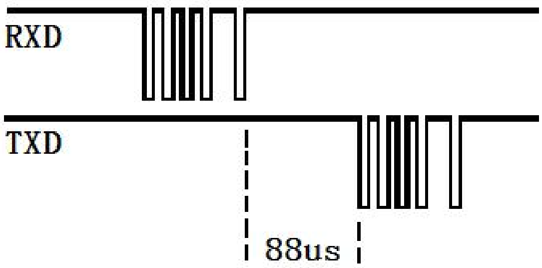


Reset waiting time

The response time is measured by the time difference between sending the GPIO command and the response. The command action time set by OUT1 and OUT2 is greater than 78us (not including command time). IN1, IN2 set command action time is greater than 88us (not including command time).



OUT1，OUT2 action time



IN1，IN2 action time

EN high level enables power-on, and the internal 100K resistor has been pulled up.

- **输入电源**

It is recommended to use a 22-100uF tantalum capacitor for the VCC port. If the size is limited, it can be changed to a small-sized ceramic capacitor, and at least a 0.1uF and a 100pF ceramic capacitor are connected in parallel. The maximum current when the module is working is nearly 0.6A (when the antenna port is mismatched). When taking inventory of tags, the transmit signal will be turned on and off quickly, causing voltage fluctuations in the power supply at the input end of the module. Large-capacity capacitors can reduce the ripple amplitude. In addition to filtering out the interference of low-frequency signals, they also cause excessive instantaneous current. According to the driving capability of the power supply circuit, select a decoupling capacitor with a suitable capacity. 0.1uF and 100pF capacitors are used to filter out high-frequency power supply ripples, because high-frequency interference signals, especially interference signals in the working frequency band, entering the module will degrade the module's tag reading performance. In addition, the addition of ceramic capacitors can also Prevent high-frequency signals generated when the module is working from passing through the power path and interfering with other circuit systems.

Due to the large operating current of the module, the wiring connecting the VCC port of the module must be thick enough, otherwise there will be an excessive voltage difference at both ends of the connecting line. When the voltage at the input terminal of the module is lower than 3.3V, the module cannot work normally; too thin connecting wires are more likely to radiate interference signals.

If the input power supply voltage is relatively low, or the power supply voltage is unstable (such as using a battery to power the module), it is recommended to first use a boost/step-down circuit to clamp the voltage to a fixed voltage (such as 5V), so as to ensure module performance consistency. If the boost/ step-down circuit is a DC-DC conversion circuit, give priority to a power conversion chip with a switching frequency exceeding 1.5MHz; compared with a power chip with a lower switching frequency, the conversion efficiency may be a little lower (generally within 5%), but avoid the weak signal interference returned by the tag.

- **Communication Serial Port**
- The reader module adapts a 3.3V UART serial port for data communication. The data format is configured as 1 bit start, 8 bits data, 1 bit stop, and no check bit (8N1).

When the serial port communicates, the frequency of the serial port communication signal is close to the spurious and BLF signal returned by the tag, and may enter the receiving end of the module RF chip through conduction and radiation. Since the signal that the tag scatters back to the module is very weak, when such interference occurs, the module's reception performance will drop sharply.

If the PCB trace of the serial port is long, the trace can be laid on the inner layer of the PCB or on the PCB layer opposite to the antenna, and a matching resistor for series connection and a parallel capacitor to ground can be reserved. This can be used Reduce the ringing of the serial port signal; when it is necessary to use an inter-board connection cable, it is best to lay the connection cable close to the ground.

The baud rate of the serial port needs to meet the transmission rate requirements of the module for uploading tag data. When inventorying a large number of tags, the recommended baud rate is as shown in the following table:

RF_MODE ID	Forward Link Modulation	BLF(KHz)	Reverse Link Modulation	Baud Rate Select
103	DSB-ASK	640	FM0	921600
11	PR-ASK	640	FM0	921600
120	DSB-ASK	640	Miller M=2	>460800
1	PR-ASK	640	Miller M=2	>460800
345	PR-ASK	640	Miller M=4	>230400
15	PR-ASK	640	Miller M=4	>230400
12	PR-ASK	320	Miller M=2	>230400
3	PR-ASK	320	Miller M=2	>230400

5	PR-ASK	320	Miller M=4	>115200
7	PR-ASK	250	Miller M=4	>57600
13	PR-ASK	160	Miller M=8	>57600

- **Antenna Ports**

When the module and the antenna do not match, the power reflected from the antenna back to the reader module is too large, which will worsen the receiving sensitivity. In particular, the sensitivity of the module using the E710 chip will have a greater impact. For example, using RF_MODE 7 for testing and working at full power, compared with the situation with good matching, when the standing wave ratio is 2.0 (return loss is about -9.5dB), the sensitivity of the module using the E710 chip deteriorates by about 4dB to 5dB. , the module using the E510 chip deteriorates by about 1dB to 2dB, and the module using the E310 chip deteriorates within 1dB. Therefore, when a module using the E710 chip is used in an application that requires fast reading of a large number of tags, if the antenna standing wave is large, it will greatly increase the time to read all tags; for applications with close distances and few tags, choose to use E510 Or the E310 module is more suitable.

- Since no RF isolator or RF circulator is used for isolation between the power amplifier chip and the antenna in the module, when the power amplifier chip and the antenna do not match, the linearity and conversion efficiency of the power amplifier chip output will change. The former will cause changes in transmission performance, such as reduced power output, radiation spuriousness and spectrum templates that do not meet local radio regulations, etc.; the latter will increase the power consumption of the module and increase the operating temperature, thus reducing the service life. Small. When the power amplifier chip works in an unstable region, self-excitation occurs. In this case, the power amplifier chip is easily damaged. Although SIMX600 uses a power amplifier chip that has a high tolerance for mismatch, and has been tested for a long time (more than a week) in the worst case (module antenna end open circuit, VSWR=+∞) without damage, it does not cause any damage. Not all matching situations can be covered. If there are test conditions, during the overall test of the product, you can check its power consumption compared with the 50 Ω load. The increase in power consumption should not exceed 0.75W (depending on the heat dissipation of the module. When the heat dissipation is good, the restriction It can be relaxed, this is only used as an intuitive judgment of the degree of mismatch when the module is used, and is not necessarily accurate); in order to ensure the module's inventory performance and long-term stable operation, it is recommended to test the connected antenna after installing the antenna in the application environment. The standing wave ratio of the antenna should be less than 1.5 as much as possible (return loss -14dB). If the output power is lower, the standing wave ratio requirement can be reduced.

- **Electrostatic protection (ESD)**

The ESD test of SIMX600 can only reach ±2KV. If higher requirements need to be met, an ESD protection circuit must be added.

When excessive static electricity enters the antenna port, it will damage the power amplifier chip and reader chip. There is a situation where the module still works, but the performance has changed. Judging from the static electricity test of the antenna port, most of the manifestations are that the receiving sensitivity of the tag has deteriorated by about 7dB, and the situation may be more serious. Therefore, when testing the overall product, you need to pay attention to whether the performance of this item has changed. A simple test method is to compare it with a product that works normally, such as reading the same tag at a fixed frequency (first make sure the RSSI value is not less than -60), and compare the RSSI values of the two. Generally, the change in RSSI should be less than ±3dB.The reference circuit provides an ESD protection circuit (the antenna port uses a high-pass filter circuit composed of inductors and capacitors). When the module is not powered on, the antenna port is not damaged at ±8KV, but the circuit will increase by about 0.3dB. About the insertion loss, the matching between the module and the antenna or load has also changed. Another method of ESD protection is to directly add bidirectional ESD protection diodes with low parasitic capacitance. Compared with the above method, the insertion loss will be lower and the degree of matching change will be smaller. However, attention should be paid to the use of ESD protection diodes. it is possible to distort the transmitted radio frequency waveform, and an increase in high-order harmonic components can be observed from the spectrum analyzer (generally the 2nd and 3rd harmonics increase more). To meet local radio regulatory requirements, select appropriate ESD protection diodes.

In practical applications, if the radiation surface of the antenna used can be fully connected to the ground, it can also provide partial ESD protection for the antenna port.

Shielding instructions

SIMX600 uses a metal shielding cover for electromagnetic shielding. As described earlier, the stamp hole package module needs to be connected to different antennas or loads through a microstrip line, which will weaken the effect of the metal shielding cover, and due to changes in matching, The RF parameters output by the power amplifier chip will also change accordingly, which may cause the product's radiation spurious indicators to exceed the required threshold.

When the product's radiation requirements are strict, it is recommended to add an additional layer of shielding around the SIMX600 module, which will reduce the risk of radiation spurious exceeding the standard.

Heat dissipation instructions

SIMX600 is small in size and it is difficult to dissipate the heat generated during operation through the module itself, so the module provides as many heat dissipation pads as possible (see packaging information). It should be noted that in order to protect the module, when the module’s detection temperature reaches 90 ℃, the reader/writer module will automatically stop inventorying tags. When it is necessary to inventory tags again, the inventory command must be resent.

When the SIMX600 is attached to the base plate, the base plate needs to consider heat dissipation to ensure that the operating temperature of the module is not too high. When there are not many tags, or real-time inventory is not required, the working interval of the module can be adjusted according to the module temperature. If you feel that this method takes up time for inventorying tags, you can use the temperature-controlled multi-tag inventory mode provided by the module.

In the SIMX600 module, the power amplifier chip is the main heating chip, so its temperature requirements are mainly considered. The junction temperature of the power amplifier chip can be roughly calculated through the following formula:

Amplifier power dissipation:

$$\mathbf{Pdiss = Pmod - Pout - Pext}$$

Power amplifier thermal resistance coefficient：

$$\mathbf{Rth\_PA = 30℃/W}$$

Module coefficient thermal resistance: Rth_BOARD (related to the base plate and heat dissipation design, better heat dissipation, the thermal resistance will be reduced)

Thermal resistance coefficient of the power amplifier chip on the module:

$$\mathbf{Rth = Rth\_PA + Rth\_BOARD}$$

PA junction temperature (Junction Temperature@55℃ ambient)

$$\mathbf{TJ = 55℃ + Pdiss\ x\ Rth\ <\ 135℃}$$

The PA junction temperature limit of 135°C is lower than the maximum junction temperature of 155°C allowed by the power amplifier chip. This is to ensure the stable operation of the module and reduce the temperature limit.

From the above formula, we can know that if you want to increase the maximum ambient temperature at which the module can work normally, you need to reduce the thermal resistance coefficient Rth_BOARD of the module.

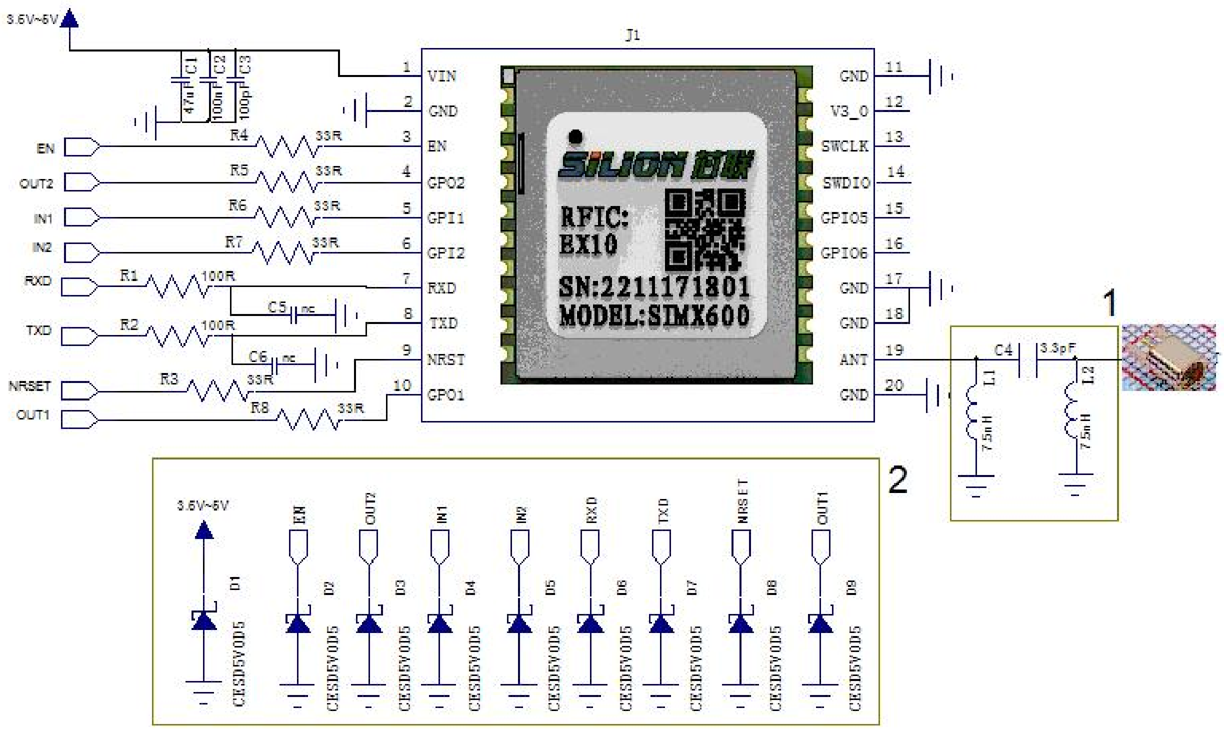
Sometimes the value of Rth_BOARD cannot be obtained accurately because it is related to the heat dissipation method of the product (using the SIMX600 module). For this reason, the value of Rth_BOARD can be roughly estimated through testing. For further explanation, the following test was done.

The SIM7600 module is attached to a base plate with a length of 29mm, a width of 29mm, and a thickness of 1.0mm. The board is made of FR4. The bottom of the SIM7600 is covered with thermal conductive silicone grease (Kafuter K-5211H). The measured ambient temperature is Tambient=28 ℃ , Pout =31.6mW (15dBm), Pmod=1.65W, Pext=1W, the measured surface temperature of the power amplifier chip is 81℃, the surface temperature of the reader chip E710 is 70 ℃ , the maximum temperature of other areas of the module is 67 ℃ , and the base plate temperature is 70℃. Assuming that the difference between the junction temperature of the power amplifier chip and the surface temperature of the chip is 10°C (this value may be smaller), the calculation is (only for approximate evaluation, non-exact results, the actual higher the output power, the more accurate the calculation result):

$$\mathbf{Rth\_BOARD = (81℃ + 10℃ - 28℃) / (1.65W - 1W - 0.0316W) - 30℃/W = 71.8\ ℃/W}$$

Obviously, the heat dissipation capacity of the base plate is insufficient, causing Rth_BOARD to be too high, and a better heat dissipation method needs to be used.

Reference circuit



1. Adding ESD protection capability will introduce additional insertion loss, and the antenna port matching will also change. If ESD meets the requirements, try not to add this circuit.

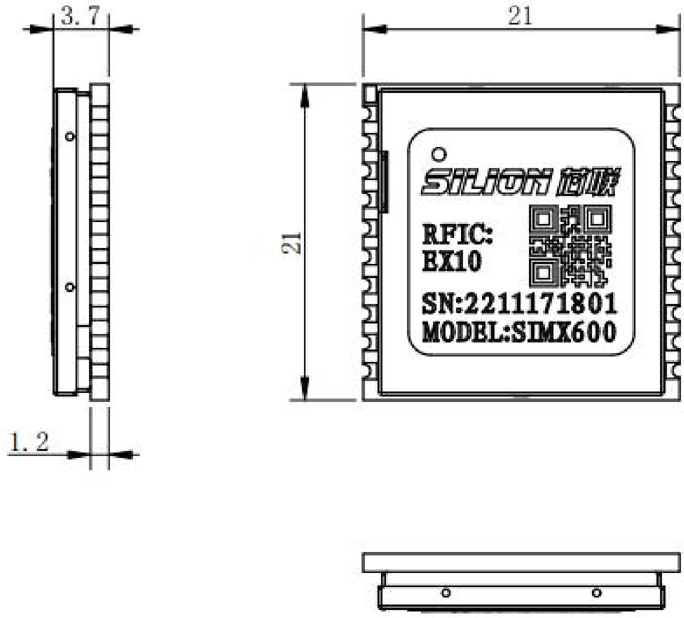
2. Select the appropriate ESD protection diode according to actual needs. If the SIMX600 communication and power interface are not connected to the product's external connector, the ESD protection diode can generally be omitted.

3. In order to work at a lower power supply voltage, the power supply voltage of the microcontroller is 3V. It is recommended to reserve a series resistor on the interface.

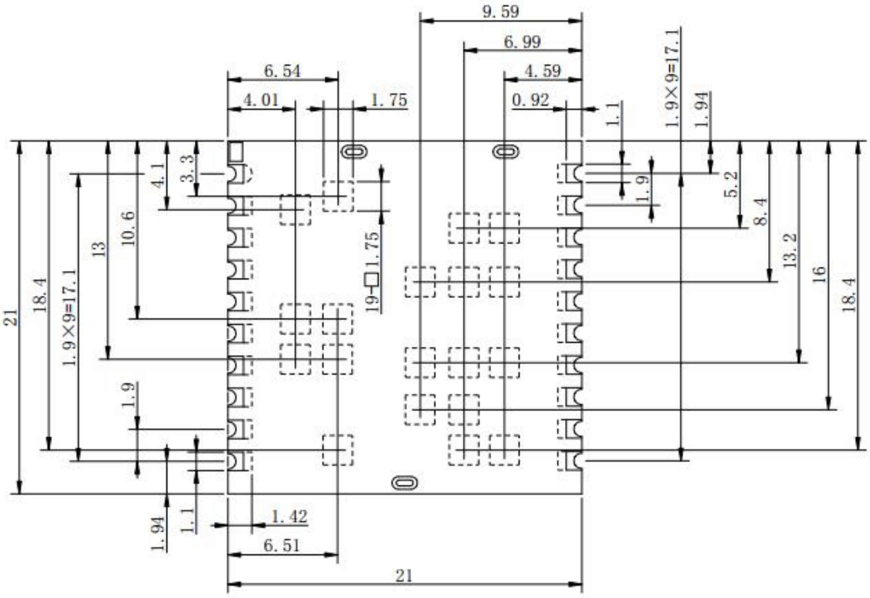
- **Marking instructions**

- **Dimensions and packaging information**
- **Dimensions**

21mm x 21mm x 3.7mm（L x W x H），W: 2.5g

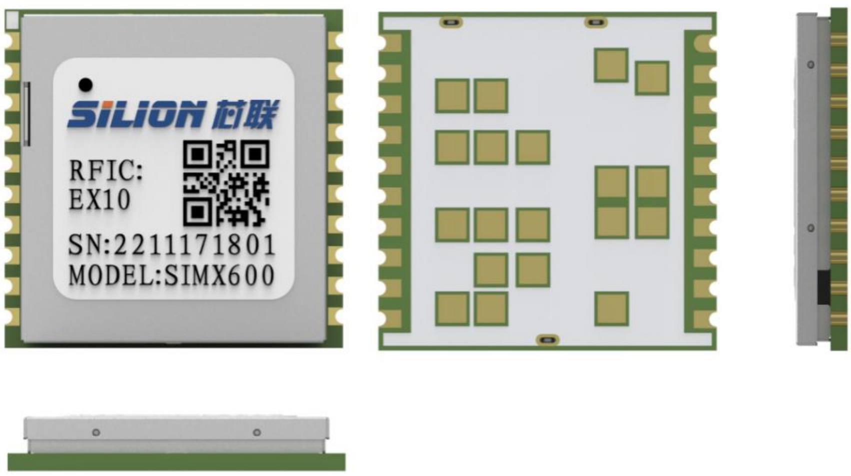


- **PCB Pad**

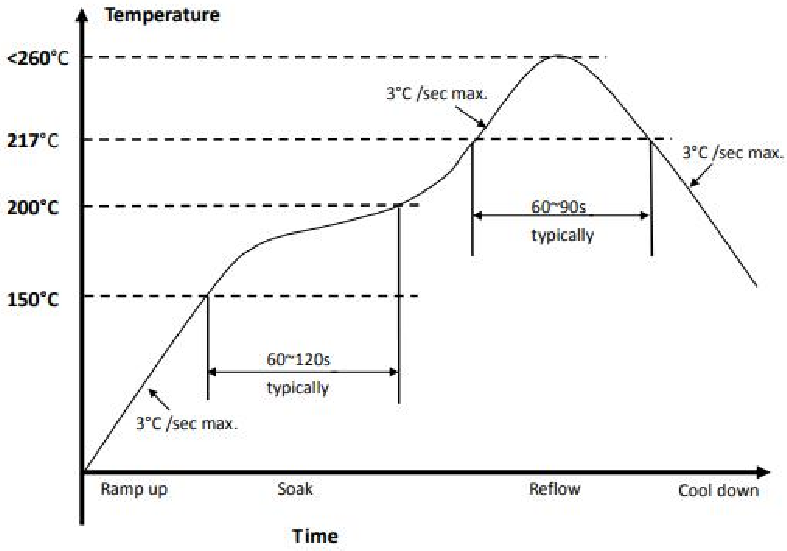


The inner hole of the circular pad is the RF wiring via hole. The base plate where the module is attached is not covered with copper. The next layer of the base plate must be paved with ground. It is recommended to use the provided module package to reduce circuit design time.

Appearance



SMT reflow soldering information



It is recommended to use the temperature control shown in the figure above for patch reflow soldering

1. Refer to IPC/JEDEC standards.

2. Peak temperature: <260℃.

3. Number of reflow soldering cycles: maximum 2 times.

4. Add nitrogen (N2) during the reflow soldering process to achieve the oxygen concentration requirement of 2000ppm or less.

5. The baking temperature requirement is 125℃±5℃, and the baking time requirement is:

A. For more than three months and less than six months, the baking time is 4H.

B. For more than six months, the baking time is 24H.

Version Information

Version	Date	Modify content
V1.0	2023/7/6	First edition
V1.1	2023/11/16	Add application scenario parameter configuration
V1.2	2023/12/5	Modify reference circuit
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If you have any product requirements or any questions about using our products, please feel free to contact us at any time. We are here to serve you wholeheartedly.

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