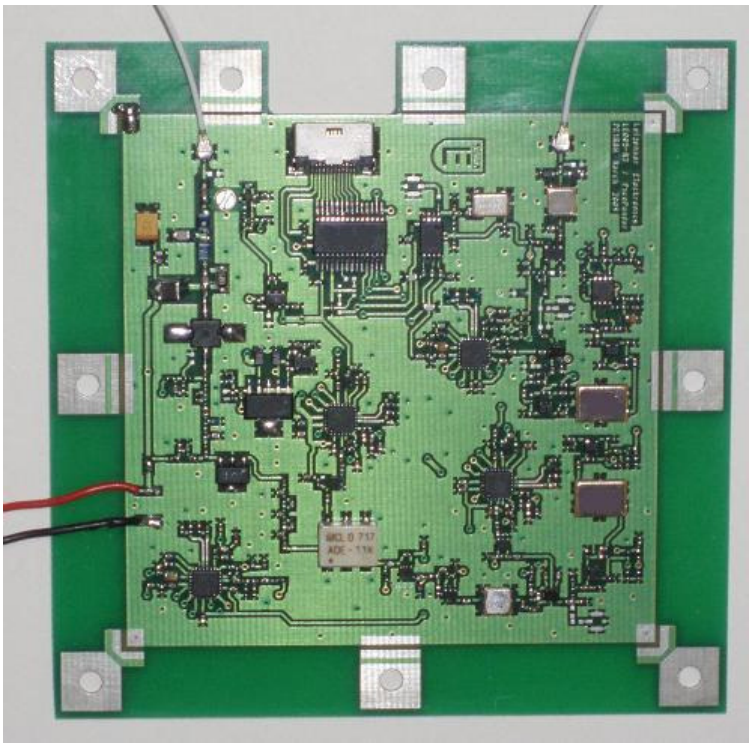
Features 特点

- **Linear Transponder (CW, AM, SSB, FM)**
  线性收发器 (CW, AM, SSB, FM)
- **Mode-UV (70cm receive, 2m transmit)**
  Mode-UV (70cm 接收, 2m 发射)
- **TXCO stable Uplink and downlink Frequencies**
  温度补偿晶体振荡器，上行和下行频率稳定
- **All frequencies software programmable**
  所有频率均可软件编程
- **23dBm PEP Typical Output Power**
  23dBm 的典型峰值输出功率
- **Linearity controlled by AGC loop**
  线性调节，自动增益控制环路
- **Onboard CW message beacon**
  集成无线电信标莫尔斯电码信息
- **Beacon (frequency and power) software programmable**
  无线电信标（频率和功率）软件编程
- **Small Size: 90mm × 90mm × 5mm**
  外型尺寸小: 90mm × 90mm × 5mm
- **Light weight: less than 30 grams**
  重量轻：低于 30 克
- **Supply Voltage Range: 3.6V to 4.0Vdc (Most cell-phone batteries can be used)**
  电源电压范围：直流 3.6 伏至 4.0 伏（普通手机电池即可供电使用）
- **Under voltage shut-off protection**
  低压开关断电保护
- **Onboard fuse in case of failure**
  板载保险丝（在失败的情况下）
- **Possibility to use external reference oscillator**
  可外部使用推荐振荡器
- **Tap available after 70cm pre-amp**
  70cm 输入放大器背后可连接
  → **For use with other onboard receiver**
  与其他接收器使用
- **Tap available in 1st IF path**
  第一中频可连接
  → **For external telemetry unit (rx and tx)**
  可使用外部遥测装置（接收器和发射器）



Description 描述

The LE005-R2 is an improved version of the LE005-R1, with lower distortion and more safety circuitry to ensure good functionality at a wide range of situations. The LE005-R2 is an ultra small sized Mode-UV linear transponder device, which can be used for radio amateur missions where small size and light weight is required. The transponder is made with PLL oscillators that are all locked to a temperature stabilized local oscillator, which secures no frequency drift during temperature cycles.
LE005-R2 型是 LE005-R1 型的改进，具有低失真和更多的安全电路特点，以确保在各种情况能良好运作。
LE005-R2 是一种超小型 Mode-UV 线性收发器，可用于业余无线电中要求体积小、重量轻的任务。该收发器带锁相环振荡器，且均锁定于本地温度稳定振荡器，保证在温度循环中频率不漂移。

All the onboard PLL oscillators are controlled by an onboard microcontroller which is in system programmable by the user. This configuration makes the transponder suitable for use on all kinds of applications, from satellite usage, to a balloon payload, or for use as a terrestrial radio transponder on the top of a high mountain.
板上所有锁相环振荡器由微控制器控制，该控制器可由用户编程。这种配置令收发器适合各种场合的应用，其中包括卫星使用，气球载运，甚至可在高山上作为地面无线电收发器。

The device is working stable with a supply voltage between 3.6Vdc and 4.0Vdc, which makes it very suitable for 3.7V Li-ion or LiPo cell-phone batteries. The extra advantage for Li-Ion and LiPo is the high capacity and low mass, what makes it interested for balloon on satellite missions. In the LE005-R2 version a low voltage protection circuit has been integrated. This circuits switches off the transponder when the voltage supply gets less than 3.6Vdc, to avoid unstable behaviour. This is very useful with battery operation, in case the battery drops to a voltage lower than 3.6Vdc.
供应电压为直流电 3.6 伏~4.0 伏，该设备即能稳定工作，此设计非常适合于 3.7V 锂离子手机电池，充分利用了锂离子电池高容量和低重量的特点，在气球和卫星飞行任务中是一个极佳的选择。LE005-R2 型号电路已集成低电压保护，当电压供应低于直流 3.6 伏时，收发器自动断开，避免不稳定运转，即充分考虑使用锂电池时电压减弱至 3.6 伏及以下的状况。

The transponder has a bandwidth of ~30kHz with an extreme flat pass band response. The band pass is done by crystal filters which give a steep roll off at each side. To avoid overloading due too high upload signals the device has an Automatic Gain Control system integrated. The circuit will reduce the transponder gain when the final amplifier gets close to its maximum output level.
收发器带宽 30kHz，带通有极大的平曲线。带通经由晶体滤波器，两端频响跌落陡峭。设备集成自动增益控制系统从而避免因过高上传信号引起的超载：末级放大器的输出接近其最大输出电平时，该电路将减少收发器增益。

- Normal Operating Conditions 正常工作条件

Parameter 参数	**Symbol** 符号	**Condition** 条件	**Min** 最小值	**Typical** 典型值	**Max** 最大值	**Unit** 单位
Supply Voltage 电源电压	Vcc		3.5	3.7	4.0	Vdc
Low voltage switch off protection 低压开关断电保护			3.4	3.5		Vdc
Current 工作电流	Idc	Standby Mode 待机模式 Transmit High 高能量的传输		0.65 0.76		A A
Failure fuse 保险丝保护				1.50		A
Output power 输出功率 (CW 145.900MHz)	Pout	Supply = 3.7V 电源电压 = 3.7V Supply = 4.0V 电源电压= 4.0V		23.0 23.0		dBm dBm
Transponder gain (Single carrier) 收发器增益 (单载波)		Supply = 3.7V 电源电压 = 3.7V Centre of bandpass 带通中心		+118		dBGain
Frequency drift (Ref = +25dgrC) 频率漂移 参考温度= +25 摄氏度	Δf	Temp 温度= -20˚C Temp 温度= +25C Temp 温度= +85˚C		+250 0 +250		Hz Hz Hz
Operating temperature 工作温度	T	Vcc = 3.7Vdc	-20		+85	˚C
Input Frequency 输入频率范围	Fin		431.000		437.000	MHz
Output Frequency 输出频率范围	Fout		144.000		148.000	MHz

- Limiting Values (极限值)

Parameter 参数	**Symbol** 符号	**Value** 值	**Unit** 单位
Supply Voltage 电源电压	Vcc	5.0	V

- Beacon operation 无线电信标操作

Parameter 参数	Symbol 符号	Condition 条件	Min 最小值	Typical 典型值	Max 最大值	Unit 单位
Frequency** 频率**	Fbcn		144.000		148.000	MHz
Frequency step 频率阶跃				12.5		kHz
Beacon power 无线电信标功率	Pbcn	Vdc=3.7V Ftx=145.875MHz	10.8	14.2 / 17.2	20.1	dBm
** Beacon frequency should stay within 50kHz distance from the transponder centre frequency. ** 信标频率应保持在收发器中心频率 50kHz 上下范围内。						

- Microcontroller Programming Conditions 微控制器编程条件

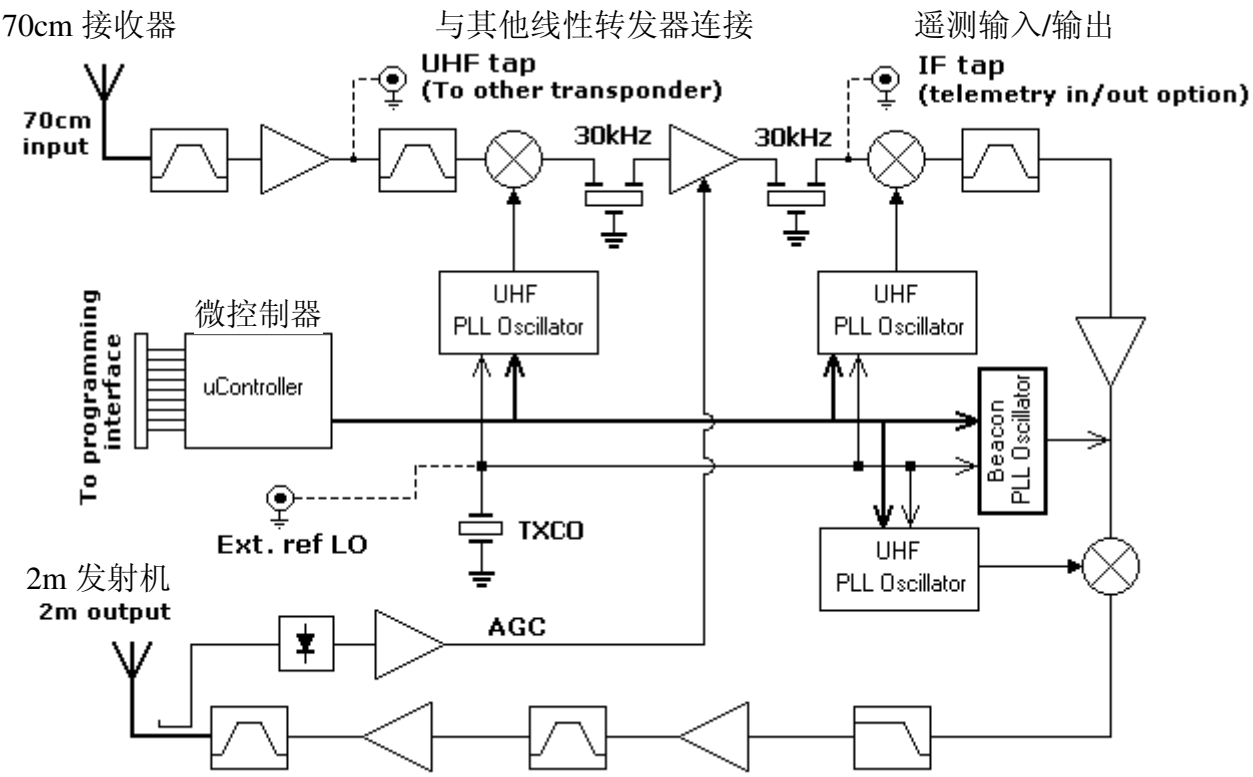
Parameter 参数	Symbol 符号	Condition 条件	Min 最小值	Typical 典型值	Max 最大值	Unit 单位
Supply Voltage 电源电压	Vcc		3.7		4.0	Vdc
RF input 射频输入		Terminated with 50Ω 终止，50Ω 电阻				
RF output 射频输出		Terminated with 50Ω 终止，50Ω 电阻				

EMC Notice 电磁兼容须知

When the LE005-R2 transponder is mount in close proximity to other electronics circuit boards care should be taken with regards to Electro Magnetic Compatibility (EMC). Especially boards which generate high-speed digital signals and/or high RF powers may cause EMI to the LE005-R2 transponder and degrade its linear functionality. Proper grounding and/or RF shielding might be needed in case of EMC problems.
当 LE005-R2 收发器附近安装有其他电子设备电路板时，应注意电磁兼容（EMC）问题。尤其是能产生高速数字信号和/或高射频电磁干扰的电路板，它们可能会对 LE005-R2 收发器造成电磁干扰，从而降低其线性功能。遇到电磁兼容问题时，须进行正确的接地和/或射频屏蔽。

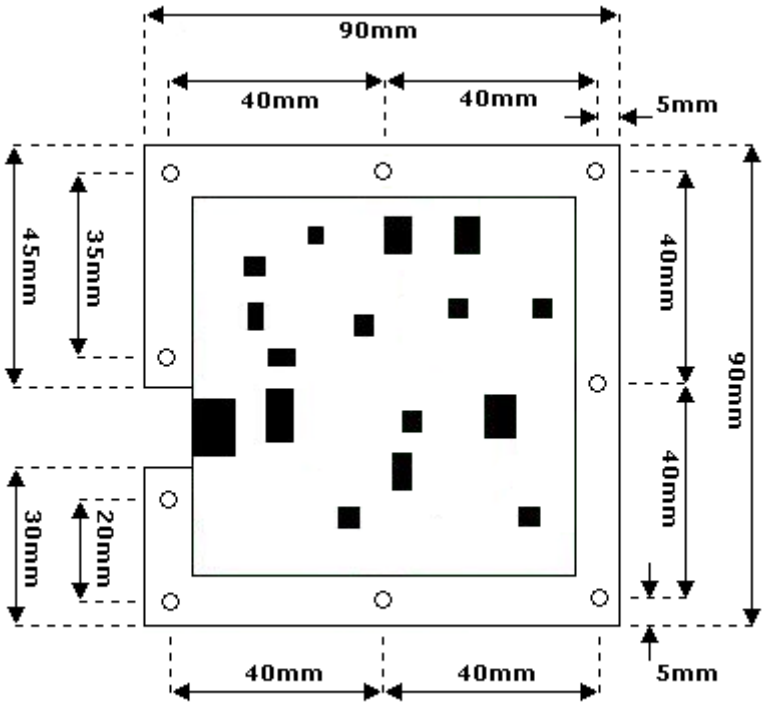
For technical assistance see “Contact information” on page 11.
需要技术援助，请参阅“联络资料”第 11 页。

Electrical Block Diagram 方框图



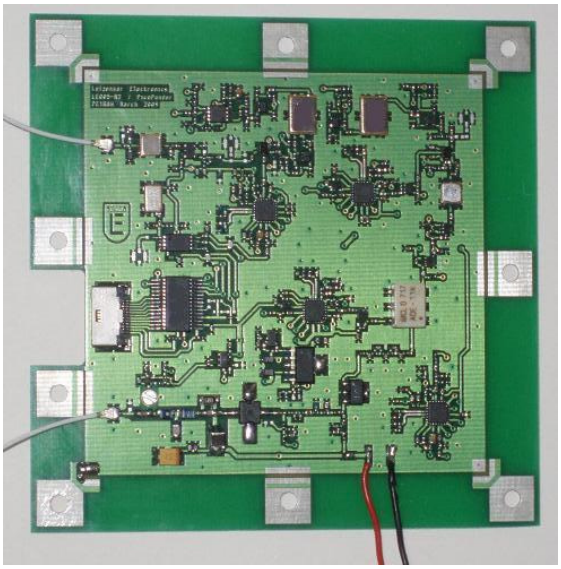
TXCO = 温度补偿晶体振荡器
AGC = 自动增益控制
Beacon = 无线电信标

Mechanical Data 外型尺寸

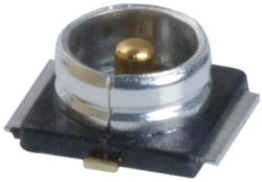


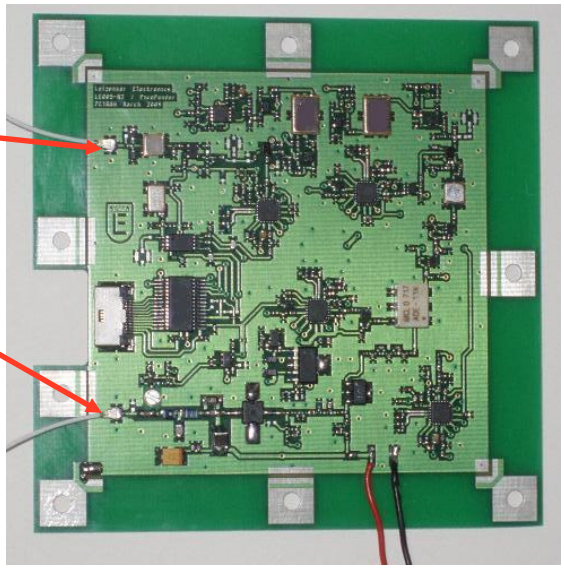
All mounting holes are ⌀3mm

所有安装孔直径均为 3 毫米



RF Connectors 射频连接器



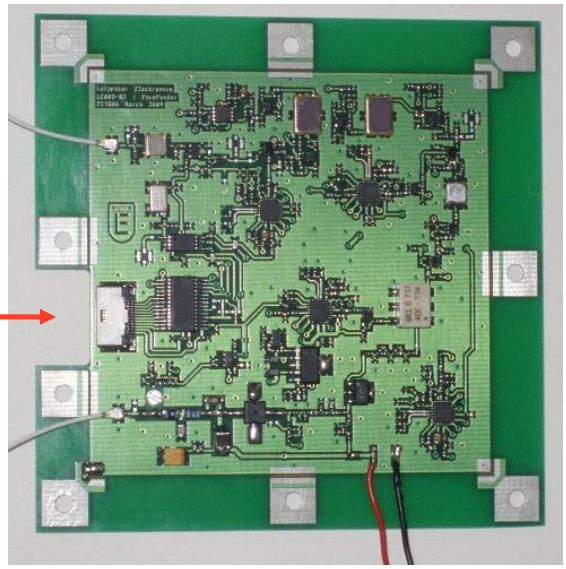


Type 类型 : W.FL-R-SMT
Manufacturer 制造商: Hirose Electric Co Ltd

Examples of cable parts that can be used with the LE005-R2:
示例，可与 LE005-R2 组合使用的电缆零件:

Manufacterer	Type No	Length (mm)	Distributer	Order No
Hirose Electric Co Ltd	W.FL-2LP-04N1-A-(100)	100	Digi-Key	H9168-ND
Hirose Electric Co Ltd	W.FL-2LP-04N1-A-(200)	200	Digi-Key	H11585-ND
Hirose Electric Co Ltd	W.FL-2LP-04N1-A-(500)	500	Digi-Key	H9170-ND
Hirose Electric Co Ltd	W.FL-2LP-04N1-A-(1000)	1000	Digi-Key	H9169-ND
Hirose Electric Co Ltd	W.FL-2LP-04N2-A-(100)	100	Farnell	1325918
Hirose Electric Co Ltd	W.FL-2LP-04N2-A-(500)	500	Farnell	1325919

uController Connector
微控制器连接器



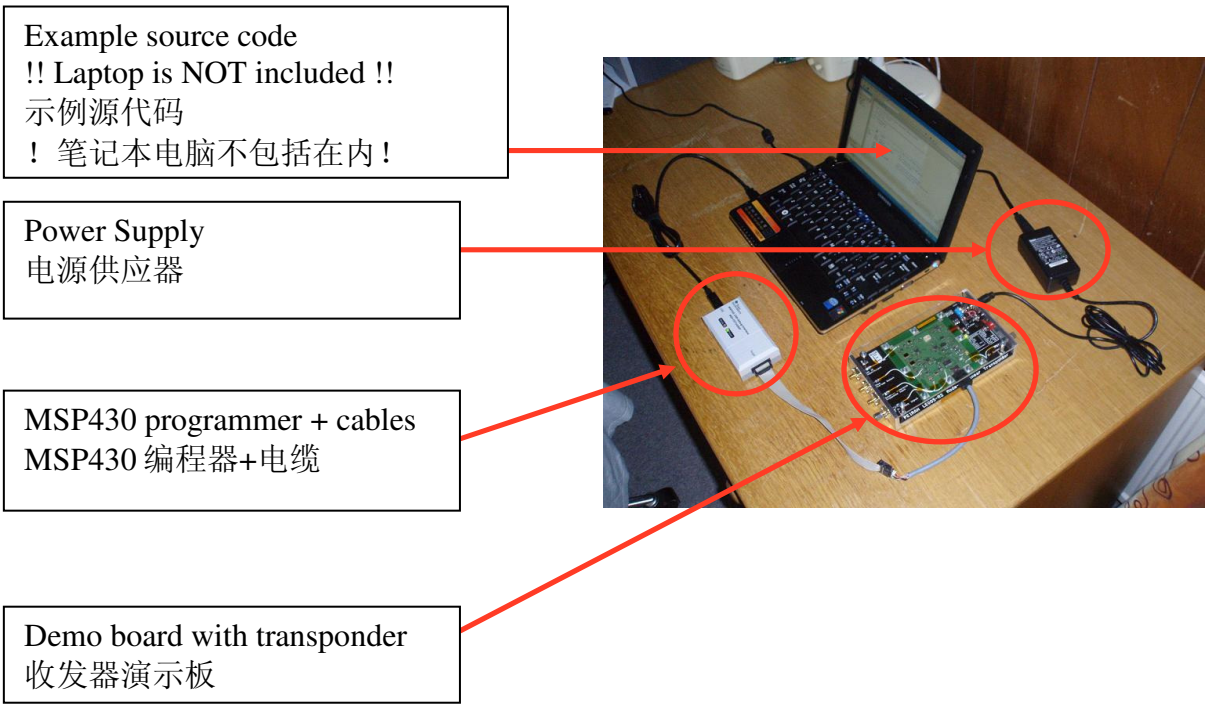
Type 类型: LX60-12P
Manufacturer 制造商: Hirose Electric Co Ltd

Cable part to be used 使用电缆:
Type 类型: LX40-12P
Manufacturer 制造商: Hirose Electric Co Ltd
Digi-Key order No.订单号: H11399-ND
Farnell order No.订单号: 1425713

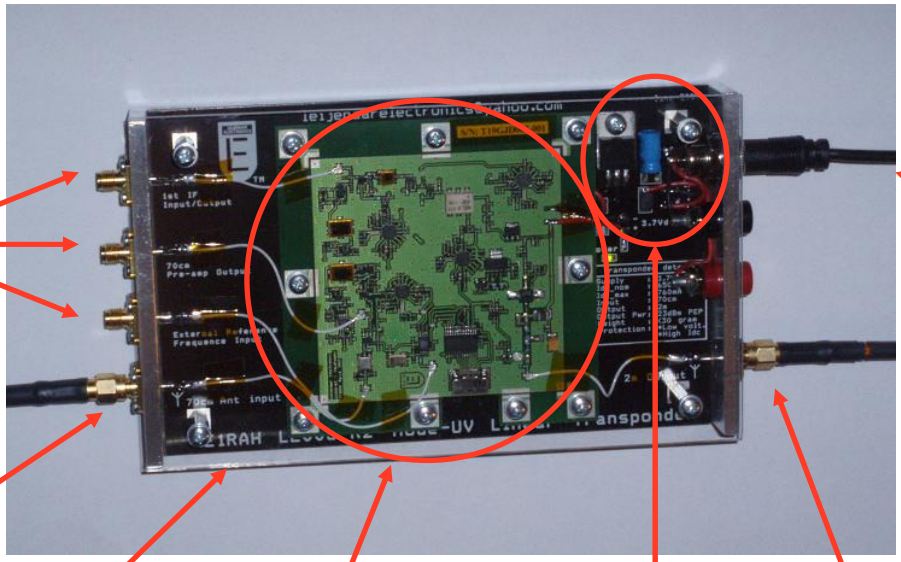
Demonstration and test platform 演示和测试平台

The LE005-R2 transponder has been designed to fit in a CubeSat structure of 10cm × 10cm × 10cm. To achieve this small size the RF connectors have to be the SMT types. The disadvantage is that the user can not easy test the transponder without having good SMT soldering skills. Besides the solder skills the user also needs to have a stable 3.7Vdc voltage supply. And for programming the microcontroller, a programmer and source code is also needed.
LE005-R2 收发器的设计基于 10cm×10cm×10cm CubeSat 结构。要实现如此小的尺寸结构要求，射频连接器必须为 SMT 类型，其缺点是用户须有良好 SMT 焊接技巧，否则测试收发器有困难。除焊接技巧外，用户同时需要具备稳定的 3.7 伏直流电供应；对微控制器编程时，还需要编程器和源代码。

To overcome any start-up problems that mentioned above, a demo platform has been developed which consist of a demo board with transponder, power supply, programmer (via USB), and example source code; all these will be sold as a package in the LE005-R2 transponder product at your convenience. This demo platform has been chosen to be the reference to determine the final datasheet.
为了克服上述启动问题，演示平台已经研制成功作为示范，同时为了方便客户使用，演示平台各部分（不包括笔记本电脑）已包括在 LE005-R2 收发器产品中。该演示平台包括收发器演示板，电源供应器，编程器（USB 接口），以及源代码示例。以该演示平台作为参考，以确定最终的数据。



The Demo board with transponder 收发器演示板



Optional taps with SMA connectors. (not standard)
可供 SMA 连接器的 tap 接口。（非标准版）

70cm RF input SMA connector
70cm 射频输入 SMA 连接器

5V…12Vdc

Transparent plexiglas for protection
透明有机玻璃(保护用)

LE005-R2 Transponder Mount on 6mm spacers.
LE005-R2 线性收发器安装在 6mm 的隔板上

3.7V voltage regulator
3.7V 电压调节器

2m RF output SMA connector
2m 射频输出 SMA 连接器

** All datasheet test values and measurements have been determined under the condition of this demo board design.
** 所有测试数据、测量数值均由决定于此演示板当时的工作状况。

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