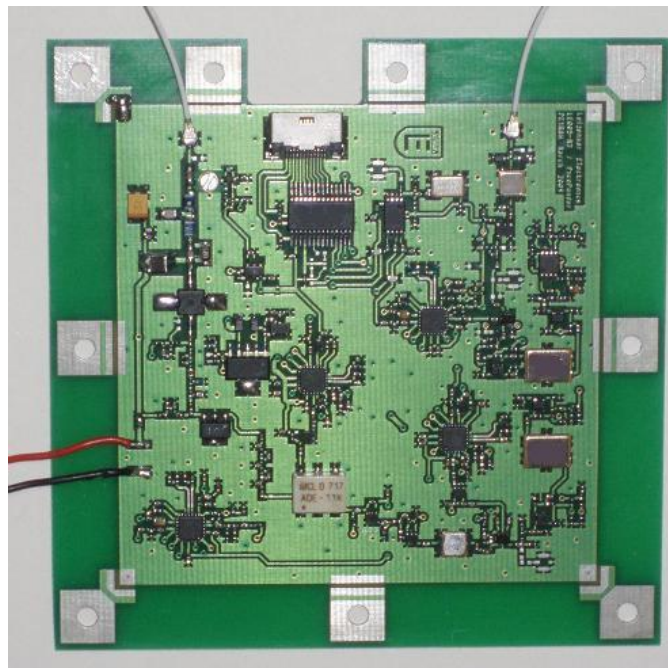


- **Linear Transponder (CW, AM, SSB, FM)**
- **Mode-UV (70cm receive, 2m transmit)**
- **TXCO stable Uplink and downlink Frequencies**
- **All frequencies software programmable**
- **23dBm PEP Typical Output Power**
- **Linearity controlled by AGC loop**
- **Onboard CW message beacon**
- **Beacon frequency and power software programmable**
- **Small Size: 90mm x 90mm x 5mm**
- **Light weight: less than 30 grams**
- **Supply Voltage Range: 3.6V to 4.0Vdc**
- **Under voltage shut-off protection**
- **Onboard fuse in case of failure**
- **Possibility to use external reference oscillator**
- **Tap available after 70cm pre-amp**  
→ For use with other onboard receiver
- **Tap available in 1<sup>st</sup> IF path**  
→ For external telemetry unit (rx and tx)



### Introduction

The LE005-R2 is an improved version of the LE005-R1, with better 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, that 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.

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 use, to a balloon payload, or for use as a terrestrial radio transponder on the top of a high mountain.

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 circuit switches of 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.

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.

- Normal Operating Conditions

Parameter	Symbol	Condition	Min	Typical	Max	Unit
Supply Voltage	Vcc		3.5	3.7	4.0	Vdc
Low voltage switch off protection			3.4	3.5		Vdc
Current	Idc	Standby Mode Transmit High		0.65 0.76		A A
Failure fuse				1.50		A
Output power (CW 145.900MHz)	Pout	Supply = 3.7V Supply = 4.0V		23.0 23.0		dBm dBm
Transponder gain (Single carrier)		Supply = 3.7V Center of bandpass		+118		dBGain
Frequency drift (Ref = +25°C)	$\Delta f$	Temp = -20°C Temp = +25°C Temp = +85°C		+250 0 +250		Hz Hz Hz
Input Frequency	Fin		431.000		437.000	MHz
Output Frequency	Fout		144.000		148.000	MHz

- Absolute maximum Conditions

Parameter	Symbol	Value	Unit
Supply Voltage	Vcc	5.0	V

- Beacon operation

Parameter	Symbol	Condition	Min	Typical	Max	Unit
Frequency**	Fbcn		144.000		148.000	MHz
Frequency step				12.5		kHz
Beacon power	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 center frequency.

- Frequency and Beacon Programming Conditions

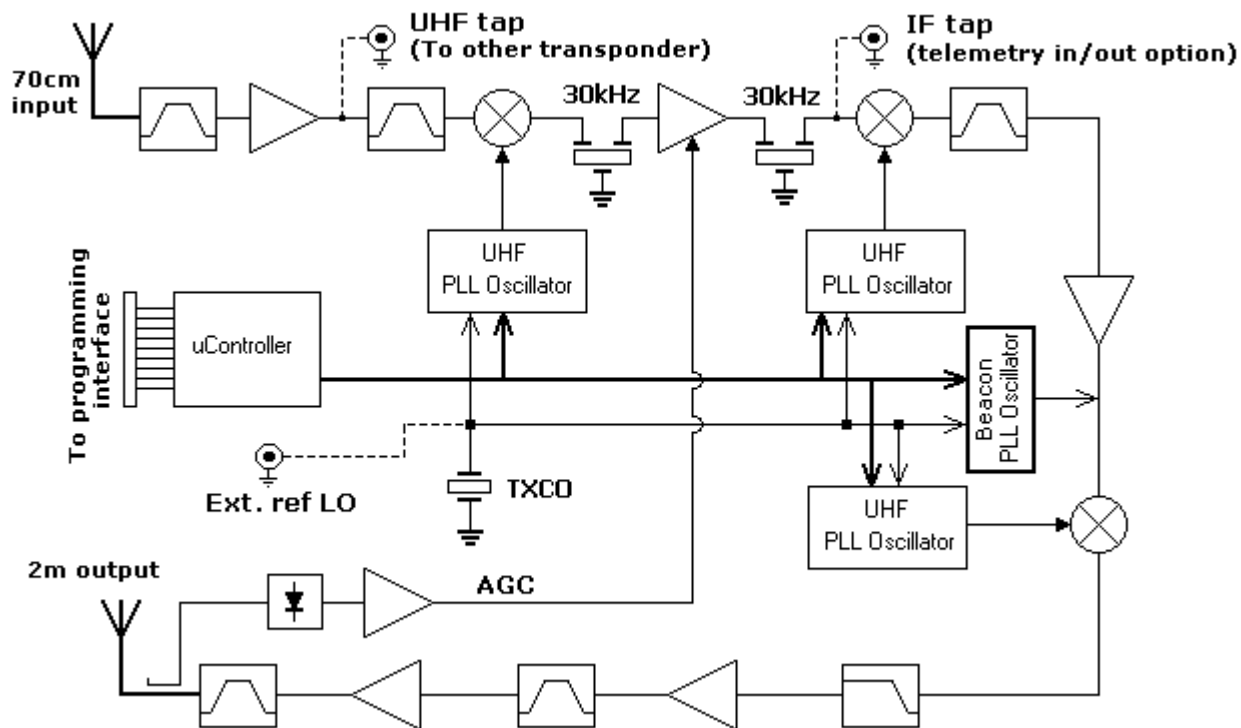
Parameter	Symbol	Condition	Min	Typical	Max	Unit
Supply Voltage	Vcc		3.7		4.0	Vdc
RF input		Terminated with 50Ω				
RF output		Terminated with 50Ω				

## EMC Notice

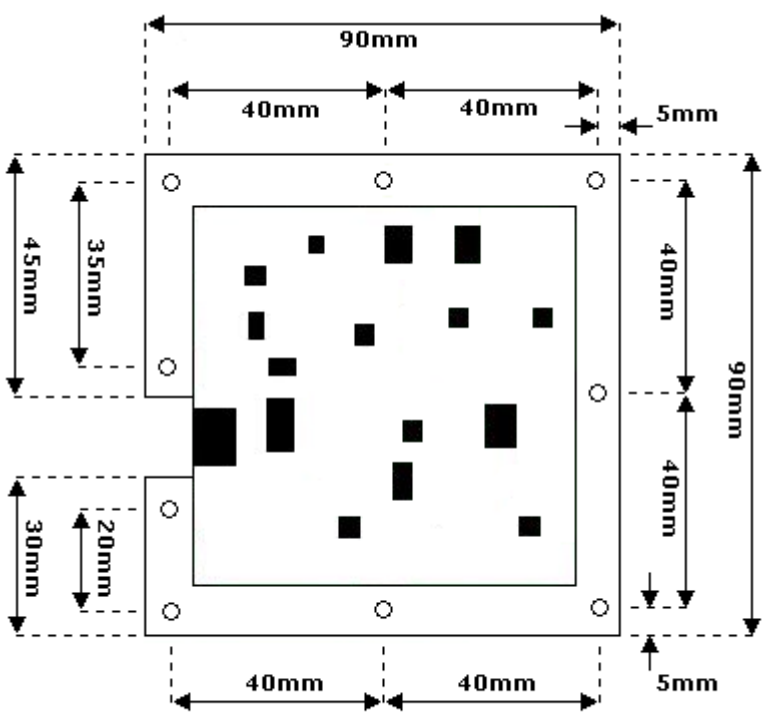
When the LE005-R2 transponder is mount in close proximity to other electronics circuit boards care should be taken with regards to Electro Magnetic Compatibility (EMC). Especially boards which generate high-speed digital signals and/or high RF powers may cause EMI to the LE005-R2 transponder and degrade its linear functionality. Proper grounding and/or RF shielding might be needed in case of EMC problems.

For technical assistance see "Contact information".

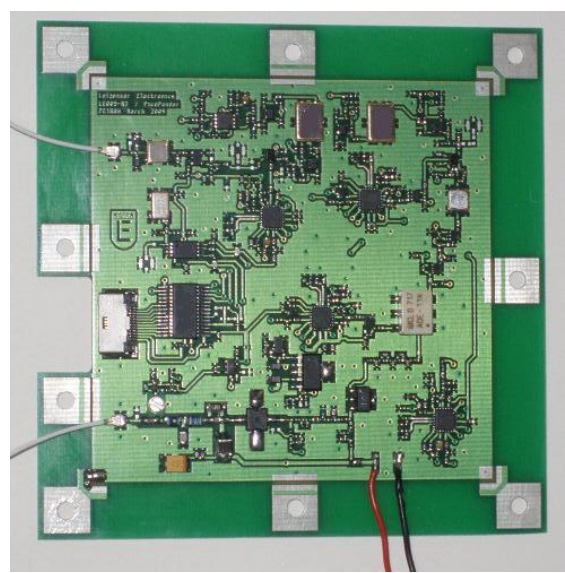
### Circuit Block Diagram



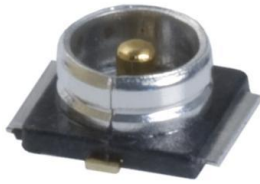
Mechanical Data



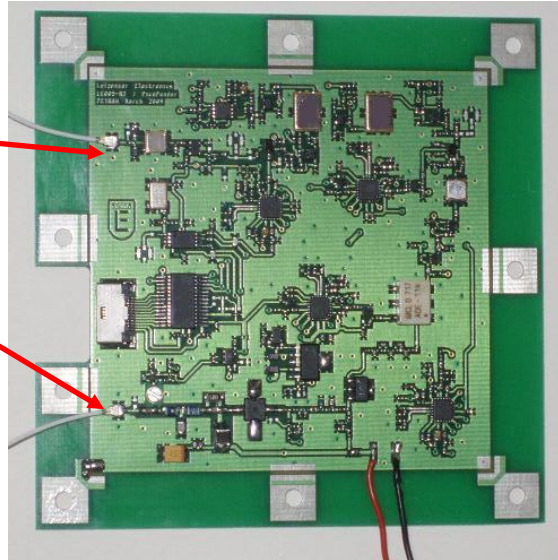
All mounting holes are  $\varnothing$ 3mm



## RF Connectors



**Type:** W.FL-R-SMT  
**Manufacturer:** Hirose Electric Co Ltd



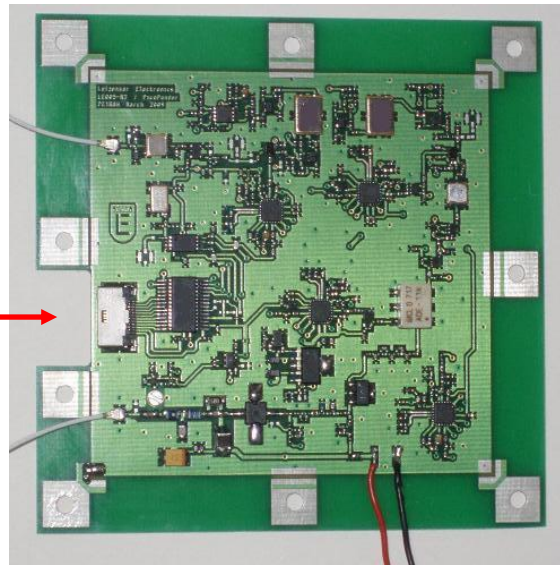
### Examples of cable parts that can be used with the LE005-R2:

Manufacturer	Type No	Length (mm)	Distributor	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

**Type:** LX60-12P  
**Manufacturer:** Hirose Electric Co Ltd

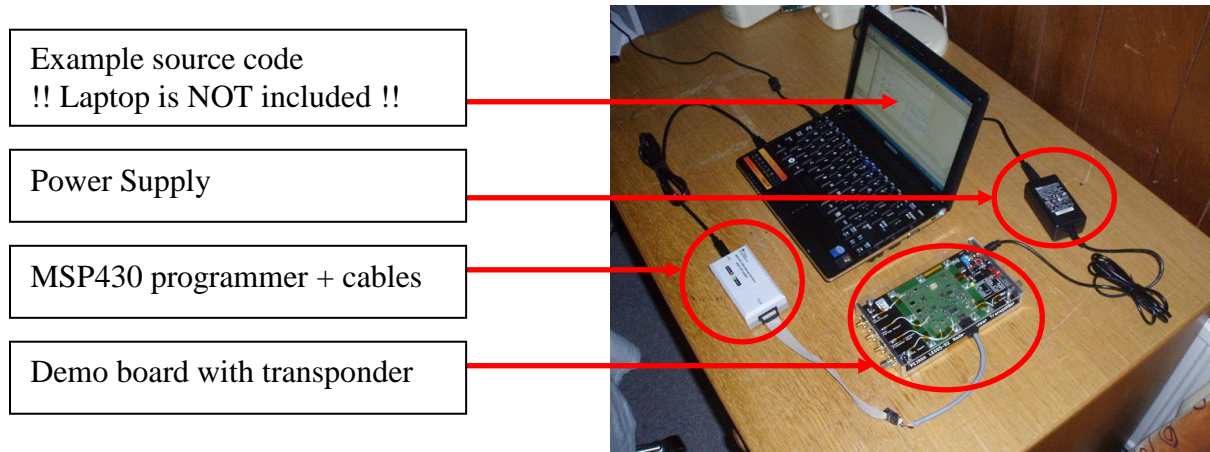
**Cable part to be used:**  
**Type:** LX40-12P  
**Manufacturer:** Hirose Electric Co Ltd  
**Digi-Key order no:** H11399-ND  
**Farnell order no :** 1425713



## Demo platform

The LE005-R2 transponder has been designed to fit in a CubeSat structure of 10cm x 10cm x 10cm. To achieve this small size the RF connectors had to be of SMT types. The disadvantage is that the user can not easy test the transponder without having good SMT solder 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.

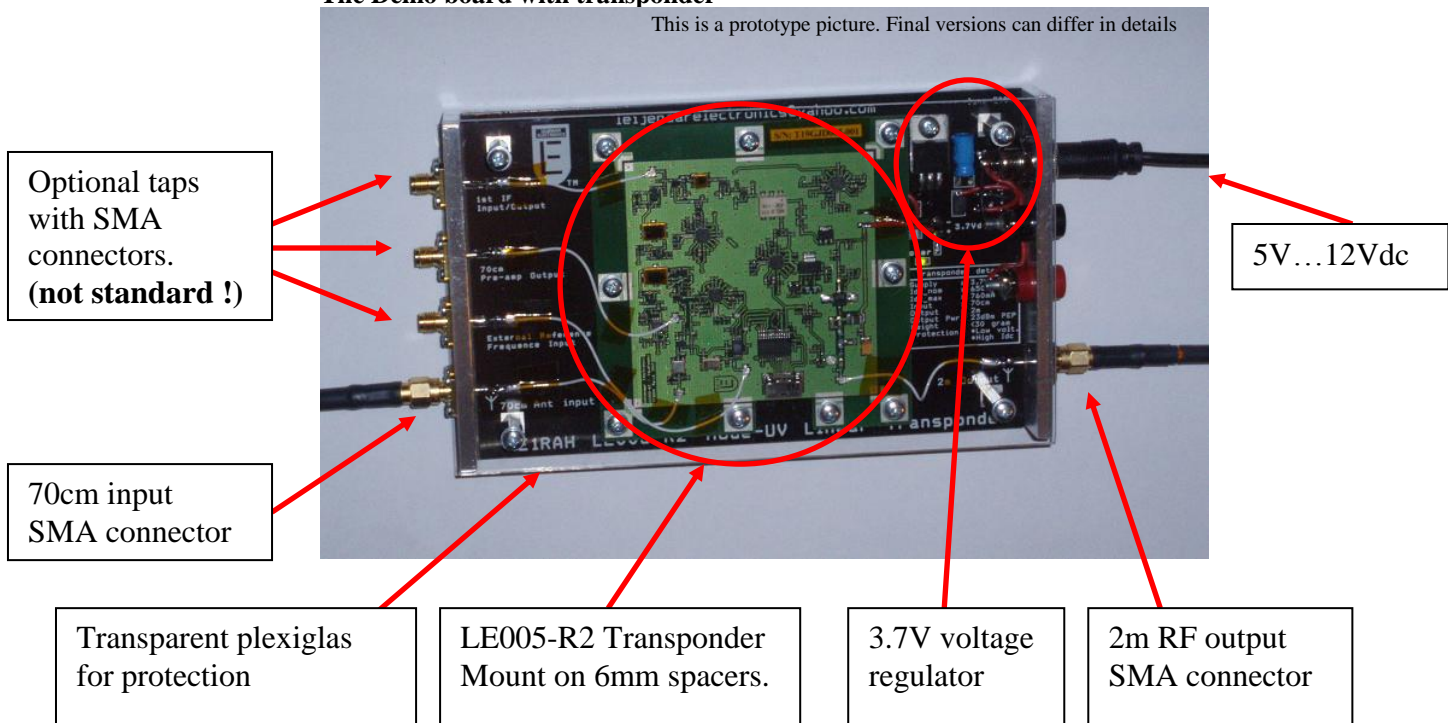
To overcome any start-up problems a demo platform has been developed which consist of a demo board with transponder, power supply, programmer (via USB), and example source code. This demo platform has been chosen to be the reference to determine the final datasheet.



- Example source code  
!! Laptop is NOT included !!
- Power Supply
- MSP430 programmer + cables
- Demo board with transponder

### The Demo board with transponder

This is a prototype picture. Final versions can differ in details



Optional taps with SMA connectors.  
**(not standard !)**

5V...12Vdc

70cm input SMA connector

Transparent plexiglas for protection

LE005-R2 Transponder Mount on 6mm spacers.

3.7V voltage regulator

2m RF output SMA connector

\*\* All datasheet test values and measurements have been determined under the condition of this demo board design.

## **Disclaimer**

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## **Contact information**

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