Application Report
SWRA382A–April 2013

TMS37157 Passive Low-Frequency Interface IC Performance With Neosid Antennas

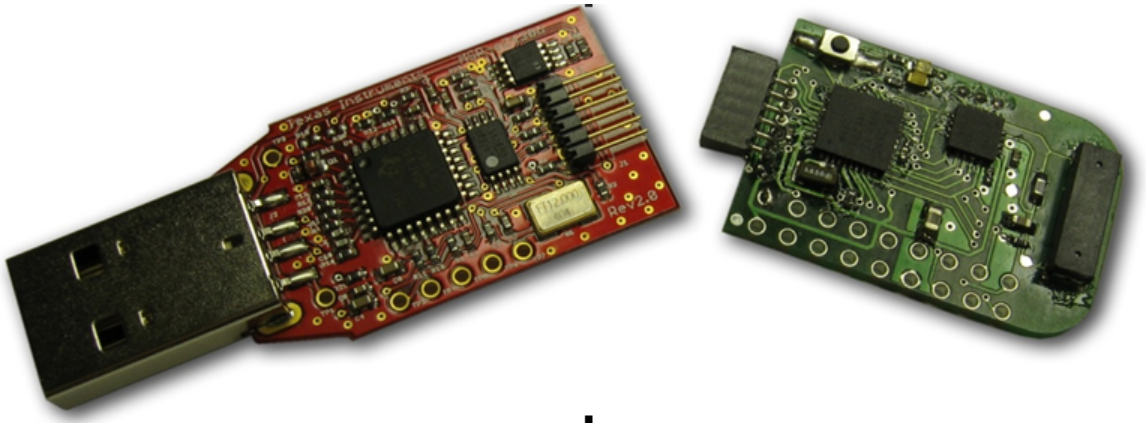
Kostas Aslanidis and Andre Frantzke

ABSTRACT

The Texas Instruments low-frequency transponder technology provides the possibility to use the TMS37157 (PaLFI) IC in combination with various antennas to meet application performance requirements.

For cost optimization purposes, off the shelf antennas can be used from various coil manufacturers.

This application report describes the performance measured with the antennas available from Neosid Pemetzrieder GmbH & Co. KG http://www.neosid.de/



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1 Introduction

The Texas Instruments low frequency half-duplex (HDX) transponder technology allows the possibility to improve the communication distance and performance between the transponder and reader.

This document provides information and measurement results based on different system RF power levels and antenna dimensions.

The type of antennas used for the tests, are off the shelf antennas from Neosid Pemetzrieder GmbH & Co. KG (http://www.neosid.de) and some additional form factors to show the performance difference and capabilities.

2 TMS37157 Dual Interface IC

2.1 IC Overview

The TMS37157 TI RFID transponder IC Passive Low-Frequency Interface (PaLFI) is designed to work in the low-frequency band (134.2 kHz) and uses the HDX RFID communication protocol.

The IC provides a dual communication interface:

- One interface is used for the communication over the RF interface
- One for the communication over the SPI interface

The IC fully operates as a passive RFID transponder without any need for external power supply. For additional functionality, the IC can be directly connected to a MSP430 microcontroller via the SPI interface. Depending on the system parameters and antennas used on the both reader and tag side, the PaLFI can supply external modules and components (e.g., uC, sensors, LED, etc.) with power derived from the magnetic field over various distances. This application report shows how to define the parameters to meet the system performance requirements.

Figure 1 shows a top level system overview and Figure 2 illustrates a block diagram of the IC.

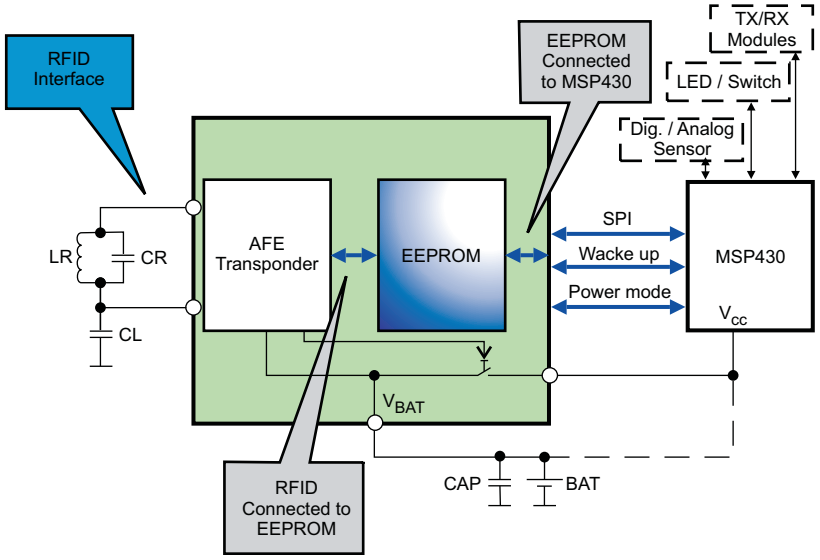


Figure 1. TMS37157 System Concept

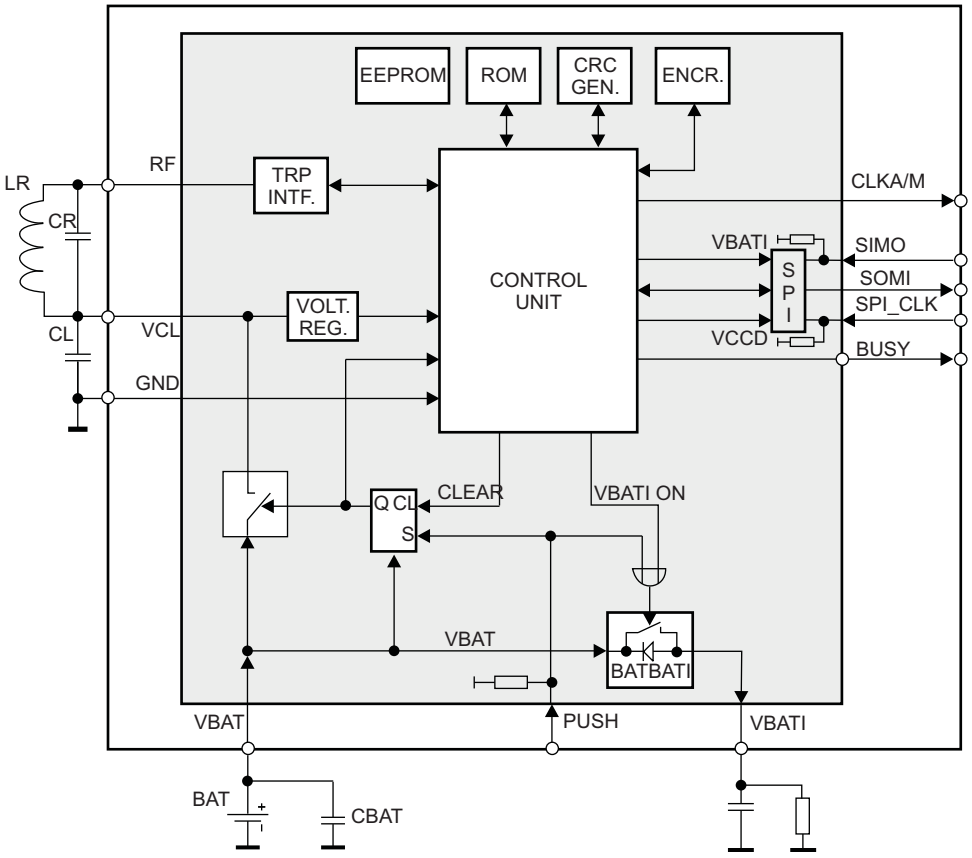


Figure 2. TMS37157 System Block diagram

2.2 Applications

- Medical
  - Configuration of hearing aids, implants
  - Batteryless operation of implants and sensors
- Wireless, battery-less sensor interface
  - Wireless operation of sensors attached to containers, and other objects
- Configuration interface (PLC, CD/DVD Player)
  - End of production line configuration of electronic devices; configuration of already packaged goods in the warehouse
- Stand alone LF RFID transponder with memory
  - Works as stand alone device without microcontroller
- Metering
  - PaLFI in, e.g., E-meters works without battery: Counter values can be read even if battery is empty, or remains switched off
- Semi-active transponder
- Wireless charging
- Wireless activation and deactivation (wake-up) of remote devices

2.3 TMS37157 System Description

A typical RFID system consists basically of two main components:

- Reader
- Transponder

The proper definition and design of the transponder and reader system parameters will provide the best possible system performance.

The TMS37157 operates as a typical RFID system, but offers additional functionality that can be executed using the MSP430 microcontroller connected directly to the PaLFI via the SPI interface. A typical application with an active UHF transceiver can be seen in Figure 3.

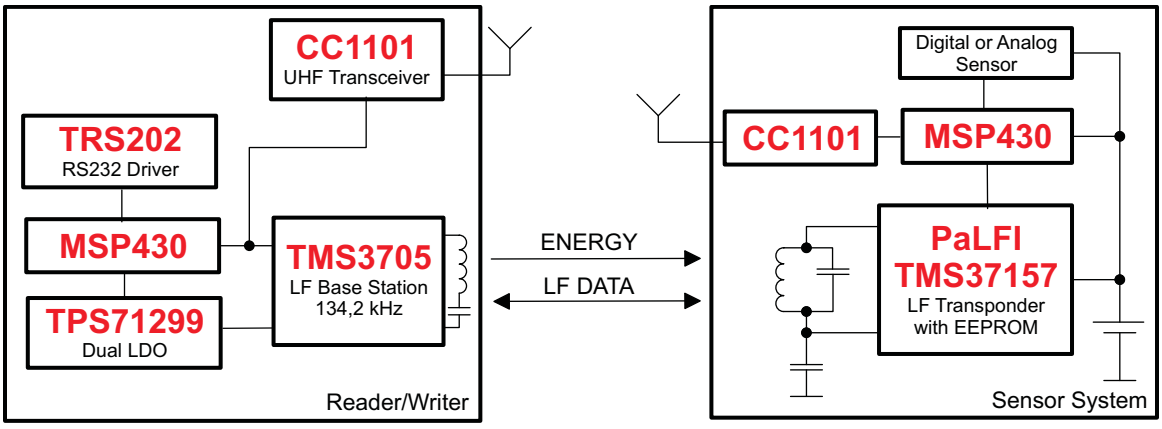


Figure 3. TMS37157 Application Example

2.4 TMS37157 Product Collaterals and Support

http://www.ti.com/tool/ez430-tms37157

- Data Sheet and Manual
- Application Reports
- Example source code in C for all transponder functions

- SPI library for using the TMS37157 with an MSP430
- Reader/writer base station source code in C
- GUI
- Recommended application circuit
- Antenna design support

Further information can be found at:

- http://www.ti.com/product/tms37157
- http://www.ti.com/product/tms3705
- http://focus.ti.com/wireless/docs/wirelessoverview.tsp?familyId=2003&sectionId=646&tabId=2735
- http://www.ti.com/product/msp430f2274
- *80mA, 10V, 3.2µA Quiescent Current Low-Dropout Linear Regulator in SC70 or SON 2x2 Data Sheet* (SBVS116)
- http://www.ti.com/product/ri-rfm-007b
- http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=rfid&sectionId=475&tabId=2104&familyId=1354&paramCriteria=no

3 Test Setup

3.1 Test Setup

A simple test set-up can be used to measure the system performance (voltage and current) over distance.

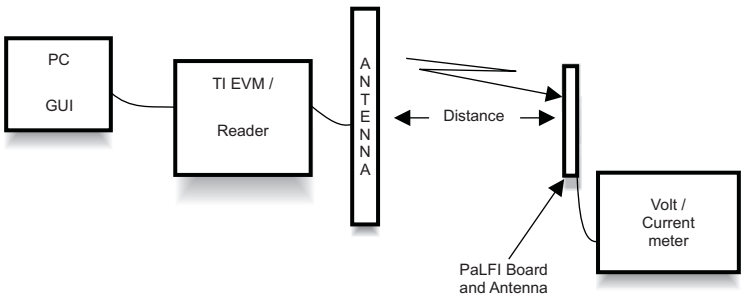


Figure 4. Performance Test Set-Up

3.2 Voltage Regulator

For applications where a current up to 4 mA is required, the internal regulator can be used as described in the product documents.

For applications where a higher current is required, an external voltage regulator is recommended. As an example, the TPS71433 can be used. For more information, see the *80mA, 10V, 3.2µA Quiescent Current Low-Dropout Linear Regulator in SC70 or SON 2x2 Data Sheet* (SBVS116).

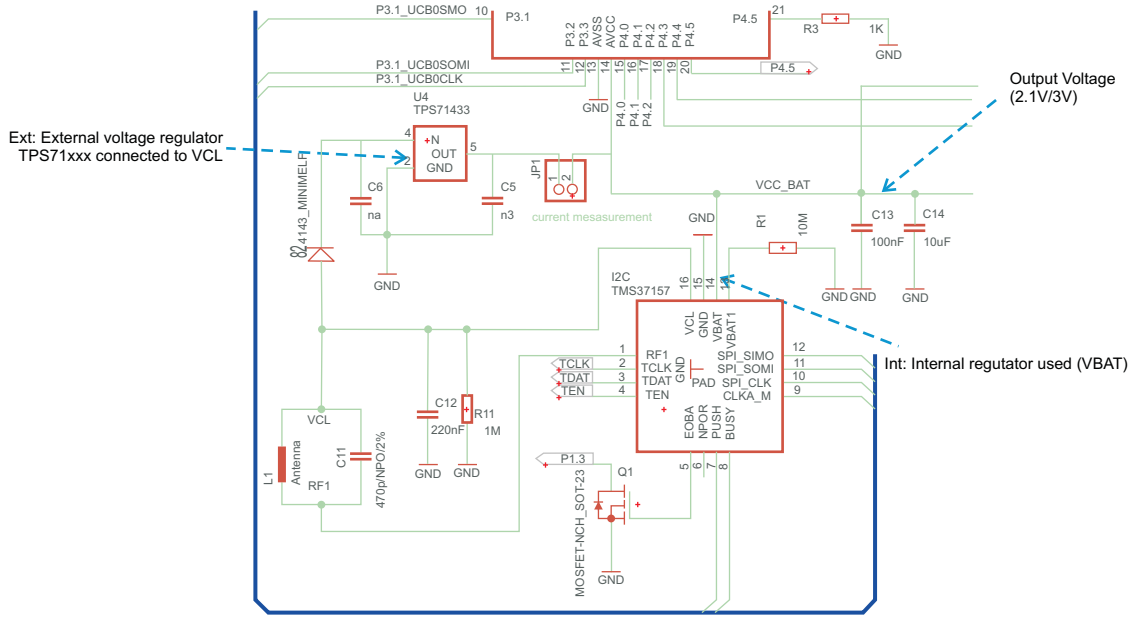


Figure 5. TMS37157 Internal and External Voltage Regulator

3.3 Measurement Set-Up

A variable resistor is used to simulate the load on the output.

At a certain distance between the reader and the PaLFI board, the resistor value at the output is changed until the desired voltage has been reached. At that position and resistor setting, the current through the resistor can be recorded. The same circuit and test procedure can be used to measure the induced voltage and current in both cases using an external or the internal voltage regulator.

This measurement has to be repeated for different distances and antenna/power combination.

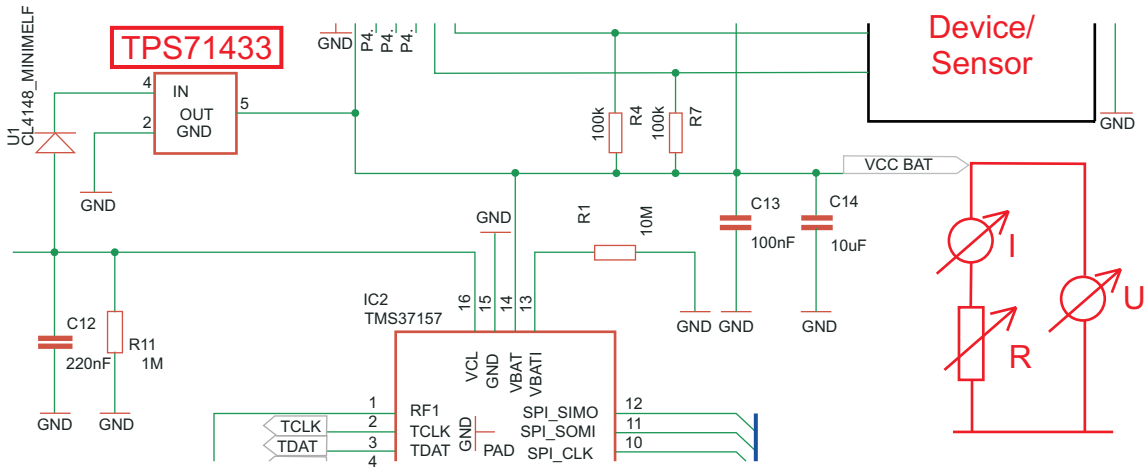


Figure 6. Voltage and Current Test Arrangement

3.4 eZ430 TMS37157 5 V Power Supply Over USB

The reader module is supplied only with 5 V from the USB. The detailed description can be found in the device-specific user's guide.

Figure 7. eZ430-TMS37157 EVM Reader

3.5 eZ430 TMS37157 12 V External Power Supply

The Reader module is connected to the PC via USB, but is supplied with 5 V-12 V from an external power source. In this case, remove the 0-Ω resistors from the R34 position and solder the same resistor on position R35.

The detailed description can be found in the device-specific user's guide.

3.6 eZ430 TMS37157 High Power Reader Module (RI-RFM-007B)

This option describes an easy way to get fast access to a high power reader. The TI RI-RFM-007B high power module can be used in combination with the PaLFI EVM reader. In that case the PaLFI EVM reader module will be used as the controller to control the RF power module. Small modifications on the EVM HW and a FW update will be needed. For modifications of the EVM module, see Section A.4.

You can choose the reader antenna dimensions to be used. TI does offer a portfolio on reader antennas for high power readers, but you can design your own antenna, too.

Neosid does have experience on antenna design and will support the design activities.

For volume production, the RI-RFM-007B can be used with any other control module supporting the PaLFI functionality.

Figure 8. RI-RFM-007B RF Power Module

4 Neosid

Neosid is a company specialized in antenna production and design. The company has many years of experience on RFID antenna design and already offers standard antennas for the PaLFI device.

Neosid provides design support forPaLFI antennas and also offers low-volume samples for test purposes.

4.1 Neosid Antenna Specification

The specification and data sheets of the antennas used for the measurements and additional form factors can be found in the ANNEX 1 Neosid Antenna Specification or at: http://www.neosid.de/produkte/induktivitaeten/transponderspulen/.

4.2 Neosid Antenna Test Execution

Several tests have been executed to generate a performance overview of the Neosid antennas used in combination with the PaLFI device.

- Communication distance over functionality (detection and data communication range)
- Induced Current and Voltage over distance

4.2.1 Neosid Antenna Functional Performance

Table 1 provides an overview of the measured communication distance of the Neosid standard PaLFI antennas using the EVM reader. To increase the performance, the Reader is set to an operating voltage of 5 V and 12 V. The tested system functionality is: Read Single Block, Write Configuration and Flash LED as described in the *eZ430-TMS37157 Development Tool User's Guide* (SLAU281).

Table 1. Neosid Antenna Functional Performance

NEOSID Part #		**Reader**	
Read Range [mm]		**eZ430-TMS37157 at 5V USB supply**	**eZ430-TMS37157 at 12V External supply**
00 6172 44	Read Page	65	98
	Configuration	53	85
	Flash LED	42	74
88 840 62	Read Page	115	170
	Configuration	94	140
	Flash LED	75	120
88 840 65	Read Page	45	68
	Configuration	42	64
	Flash LED	39	61
88 8040 61	Read Page	49	69
	Configuration	47	67
	Flash LED	42	62
88 8040 71	Read Page	61	87
	Configuration	53	71
	Flash LED	35	61
88 8040 72	Read Page	85	112
	Configuration	67	92
	Flash LED	55	86
88 8040 66	Read Page	50	92
	Configuration	42	75
	Flash LED	38	58
	Read Page		
	Configuration		
	Flash LED		

4.2.2 Neosid Antenna Functional Performance Summary

Figure 9 gives an overview of the communication (operating) distance using the PaLFI IC with the Neosid 00 6172 44 antenna and different reader RF power and antenna geometry.

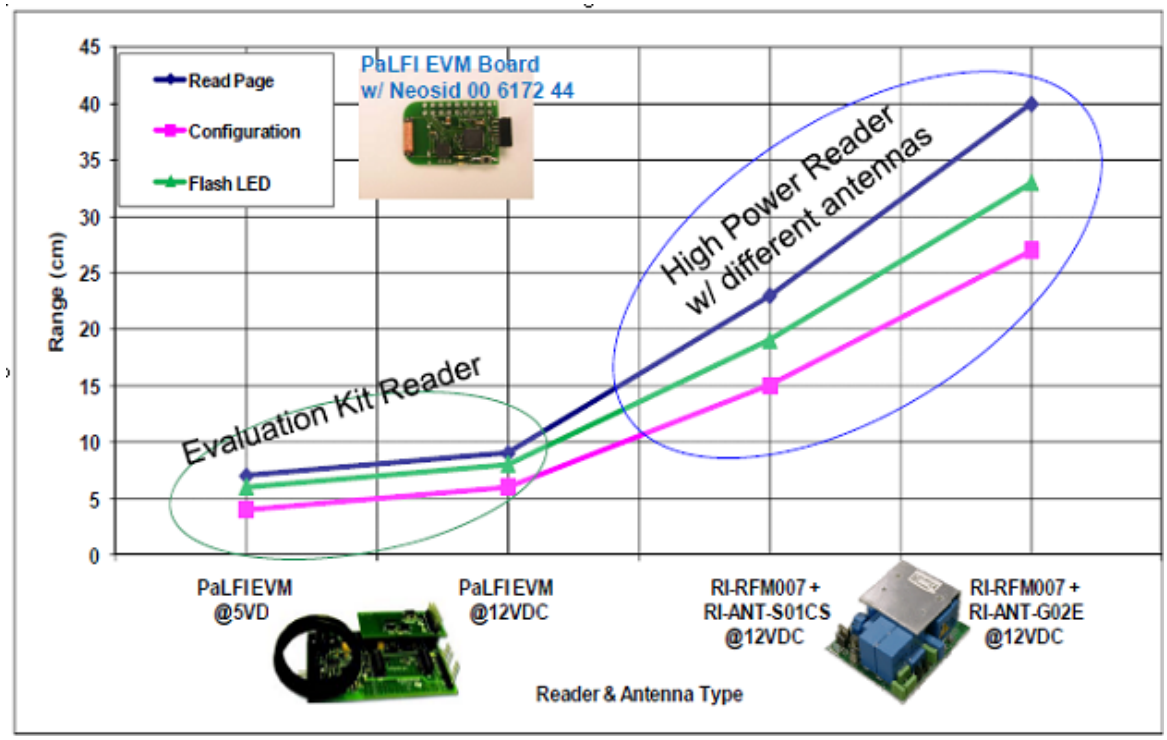


Figure 9. Neosid Antenna Functional Performance Summary

4.2.3 Neosid Antenna Induced Voltage/Current Performance

Figure 10 illustrates how to read the diagrams.

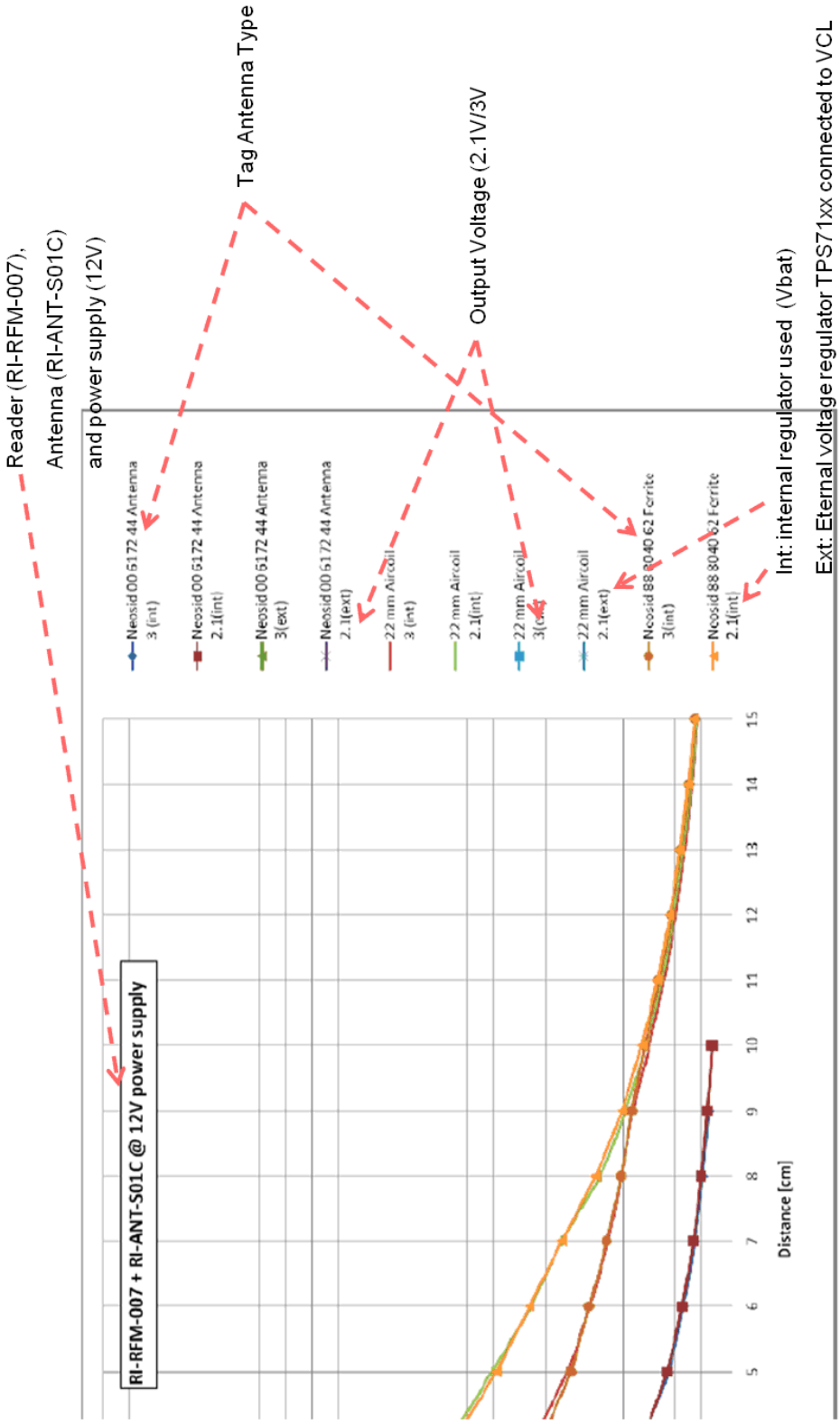


Figure 10. Neosid Antenna Induced Voltage/Current Performance

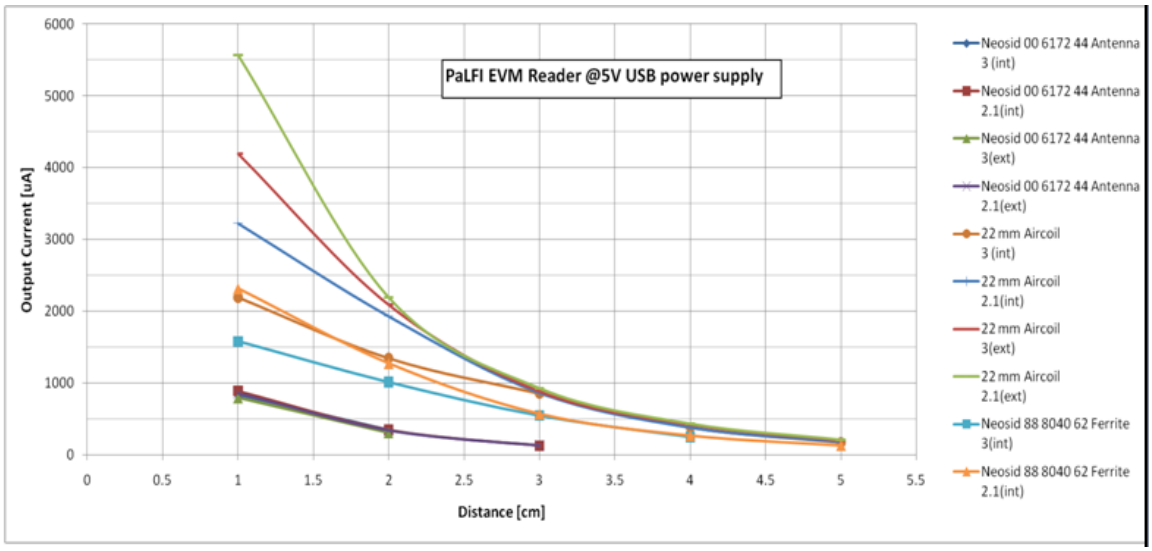


Figure 11. PaLFI EVM Reader at 5 V USB Power Supply

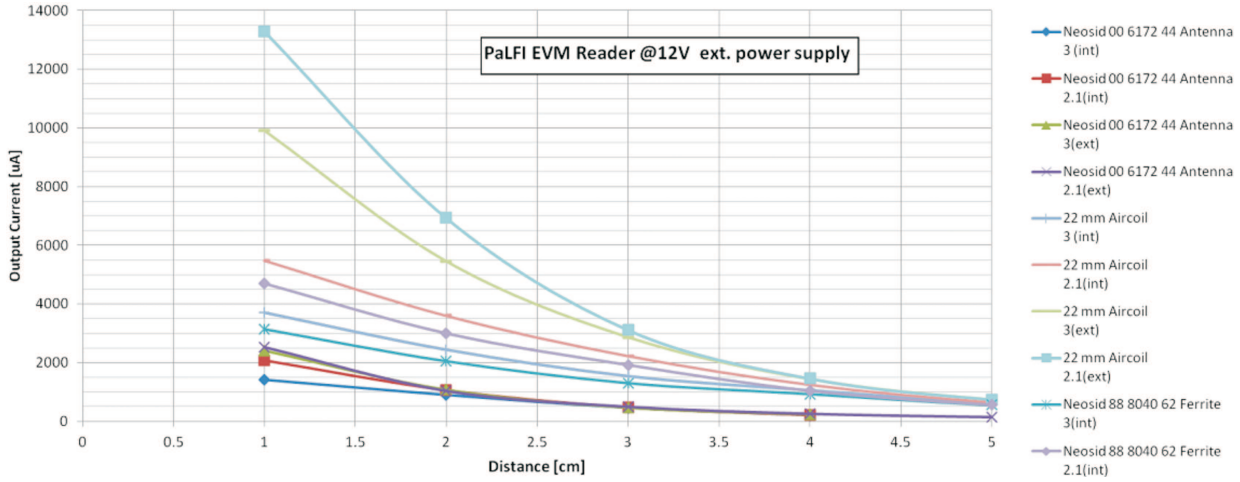


Figure 12. PaLFI EVM Reader at 12 V ext. Power Supply

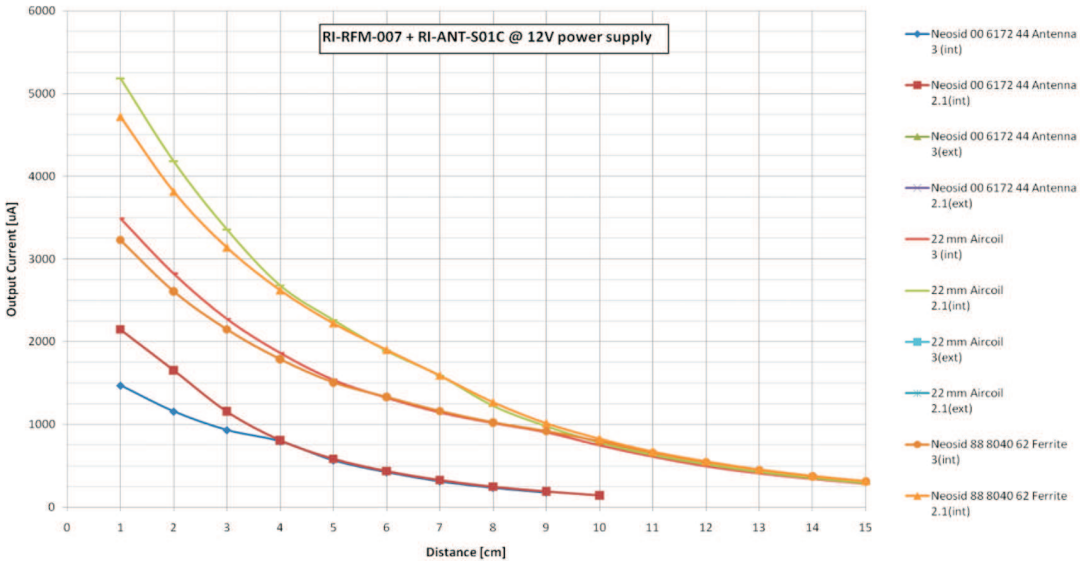


Figure 13. RI-RFM-007 + RI-ANT-S01C at 12 V Power Supply

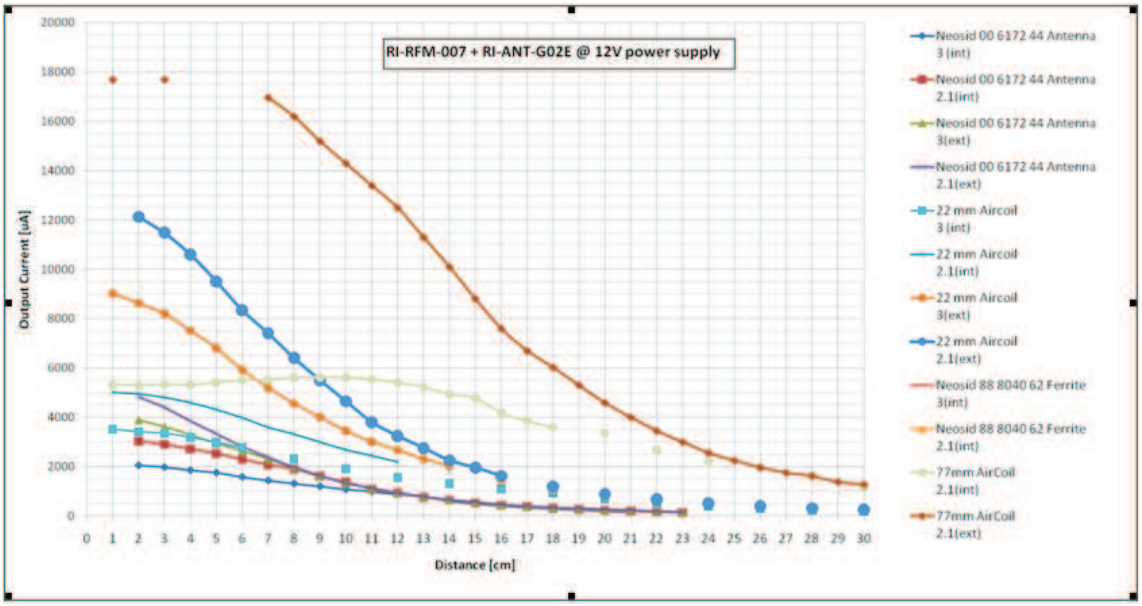


Figure 14. RI-RFM-007 + RI-ANT-G02E at 12 V Power Supply

5 Contacts and References

- http://www.neosid.de/
- http://www.ti.com/product/tms37157
- *80mA, 10V, 3.2µA Quiescent Current Low-Dropout Linear Regulator in SC70 or SON 2x2 Data Sheet* (SBVS116)
- *eZ430-TMS37157 Development Tool User's Guide* (SLAU281)
- http://www.ti.com/rfid/
- http://www.neosid.de/produkte/induktivitaeten/transponderspulen/

Appendix A ANNEX

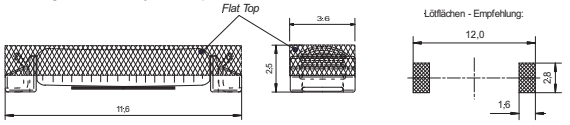
A.1 Neosid Antenna Specification

Rx/Tx-Antennas

Series Ms 32ka [10µH-39 mH]

L [mH]	Q ≥	$f_{L,Q}$ [kHz]	f_{res} ≥ [MHz]	R_{DC} ≤ [Ω]	I_{max} [mA]	S [mV/A/m]	Art. Nr.:
2.66	55	125/134	0,6	26	50	35	00 6172 44

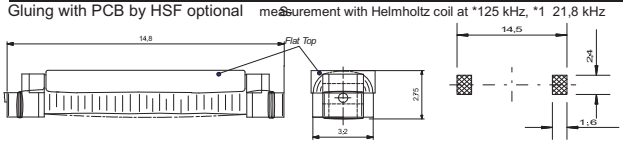
Gluing with PCB by HSF optional S-measurement with Helmholtz coil at *125 kHz, *1 21,8 kHz

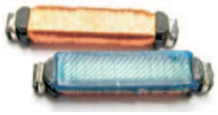


Series Ms 32c [10µH-39mH]

L [mH]	Q ≥	$f_{L,Q}$ [kHz]	f_{res} ≥ [MHz]	R_{DC} ≤ [Ω]	I_{max} [mA]	S* [mV/A/m]	Art. Nr.:
2.66	-	125	0,5	20	30		88 8040 61

Gluing with PCB by HSF optional measurement with Helmholtz coil at *125 kHz, *1 21,8 kHz

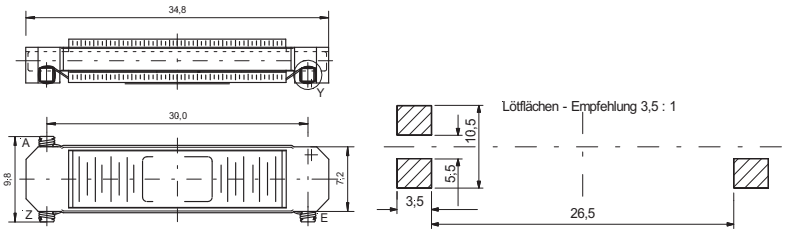




Series Ms 62

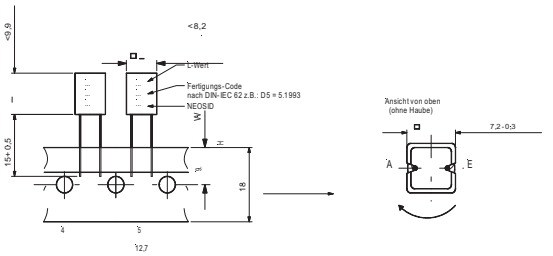
L [mH]	Q ≥	$f_{L,Q}$ [kHz]	f_{res} ≥ [MHz]	R_{DC} ≤ [Ω]	I_{max} [mA]	S [mV/A/m]	Art. Nr.:
2.66	60	125/134	0,5	3	200	-	88 8040 62

Gluing with PCB by HSF optional S-measurement with Helmholtz coil at *125 kHz, *1 21,8 kHz



Series Sd 8

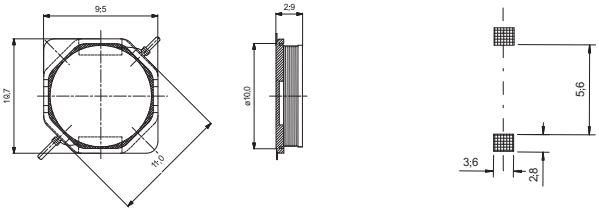
L [mH]	Q ≥	$f_{L,Q}$ [kHz]	f_{res} ≥ [MHz]	R_{DC} ≤ [Ω]	I_{max} [mA]	S* [mV/A/m]	Art. Nr.:
2.66	120	125	0.7	12	150	-	88 8040 72



Series SM-W903 [1µH-65mH]

L [mH]	Q ≥	$f_{L,Q}$ [kHz]	f_{res} ≥ [MHz]	R_{DC} ≤ [Ω]	I_{max} [mA]	S* [mV/A/m]	Art. Nr.:
2.66	70	125/134	1,0	16	60	-	88 8040 66

S-measurement with Helmholtz coil at *125 kHz, *1 21,8 kHz



A.2 Air Coil Antenna Specification

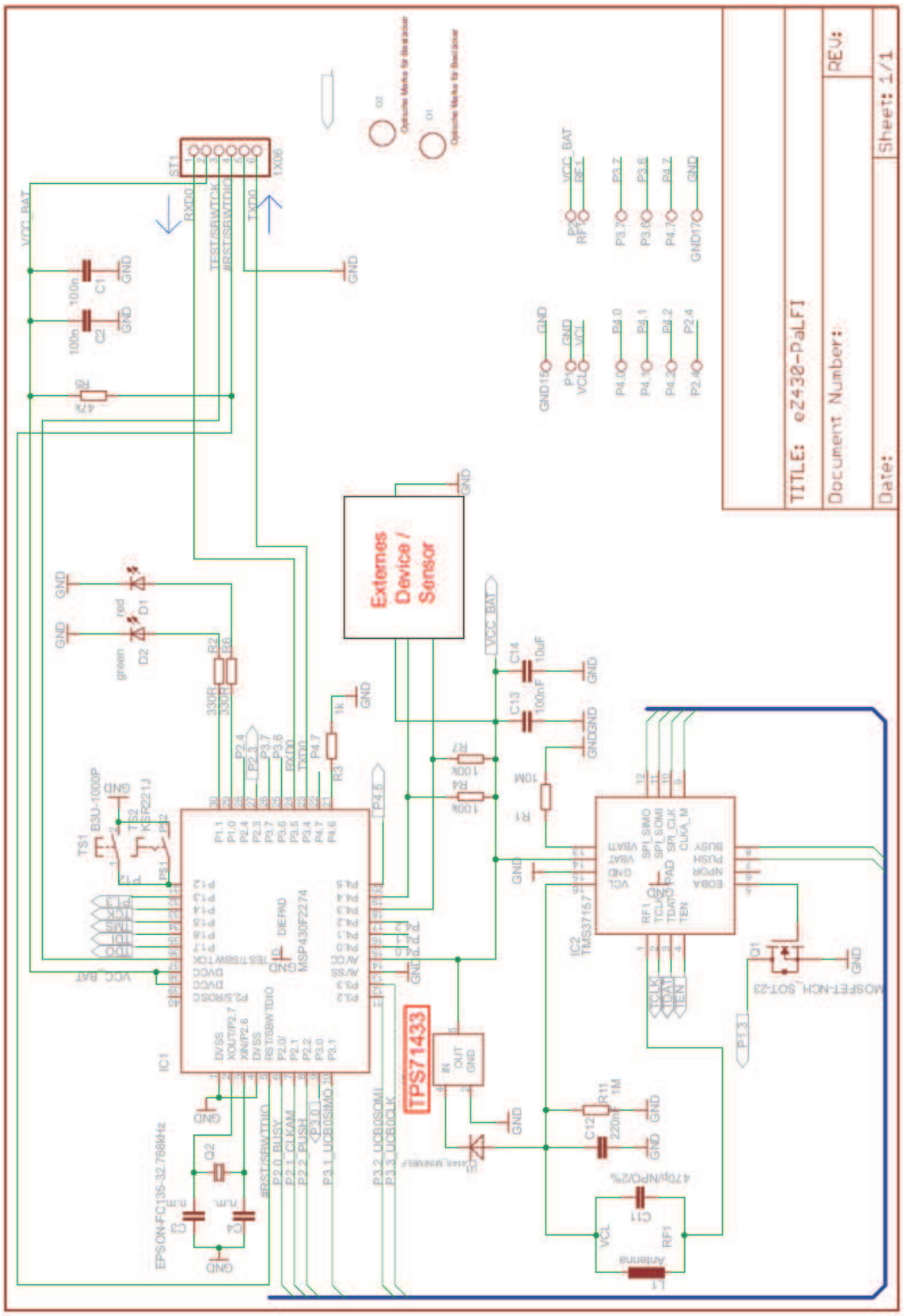
Table 2. Air coil 22mm

	Min	Nom	Max	Comment
DI [mm]		14.3		
DO [mm]		22		
Q	60			
Inductance [mH]		2.66		at 134.2kHz
Wire ø [mm]		0.1		

Table 3. Air coil 77mm

	Min	Nom	Max	Comment
DI [mm]		55		
DO [mm]		77		
Q	60			
Inductance [mH]		2.66		at 134.2kHz
Wire ø [mm]		0.1		

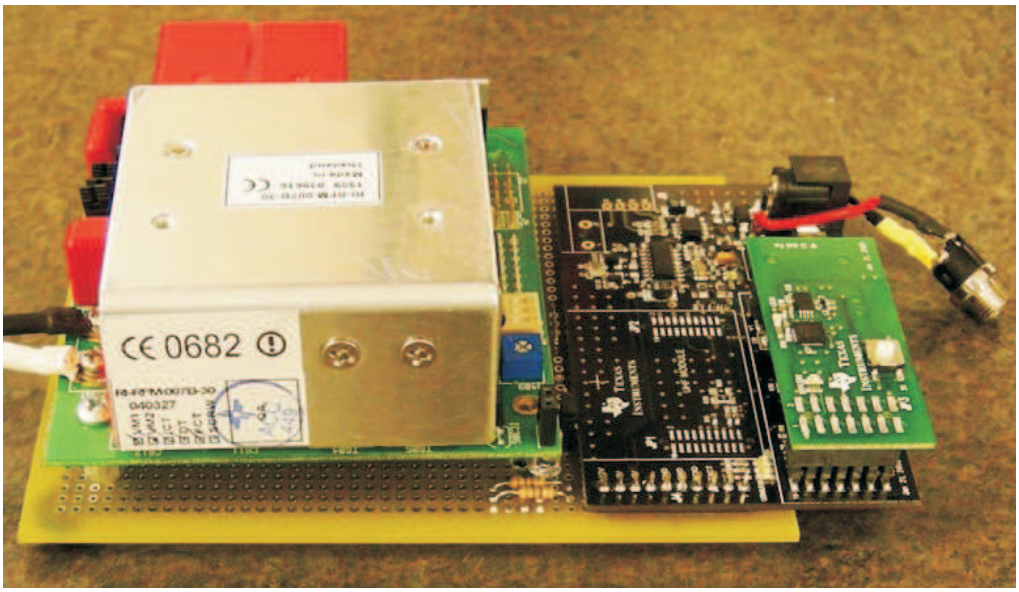
A.3 PaLFI Reference Circuit / Design



A.4 PaLFI EVM Power Module HW Modifications

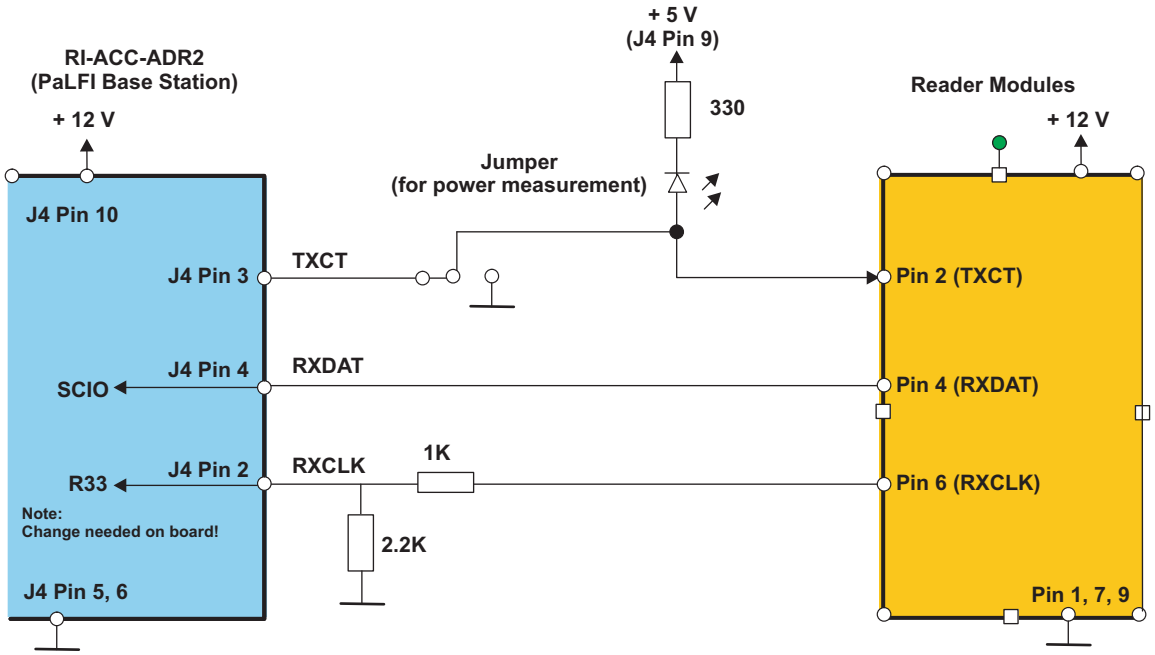
A.4.1 Reader Modules

- RI-RFM-008B: http://focus.ti.com/docs/prod/folders/print/ri-rfm-008b.html
- RI-RFM-007B: http://focus.ti.com/docs/prod/folders/print/ri-rfm-007b.html
- Reader Antenna: http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=rfid&sectionId=475&tabId=2104&familyId=1354amp;paramCriteria=no

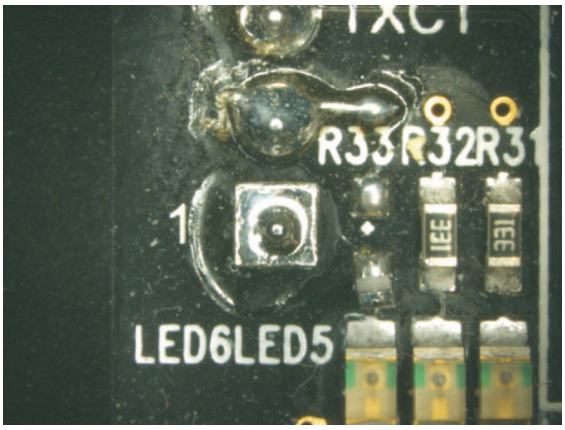


A.4.2 Parts Needed

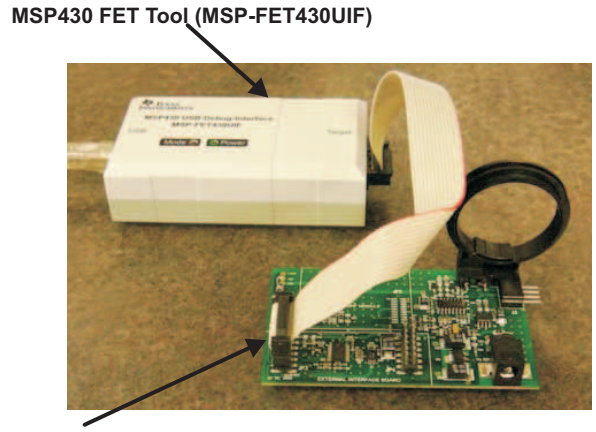
- RI-ACC-ADR2 Board (found in ez430-TMS37157 kit)
- RI-RFM-007B Module (available through distribution)
  see the *Series 2000 Reader System High Performance Reader Frequency Module RI-RFM-007B Reference Guide* (SCBU022)
- RI-ANT-x0xx Antenna (available through distribution)
  see the *Antenna Reference Guide* (SCBU025)
- Recommended Components
  - 330 Ω resistor (for current limiting TXCT activity LED)
  - 1kΩ resistor
  - 2.2kΩ resistor
  - One LED (your choice of color and size, for TXCT activity indication)
  - Board Headers for mounting RFM (0.100CTR Double Row Style)
  - Four 4x40 Standoffs (for mounting RFM to circuit board)
- Small Circuit Board
  - 15” x 10” or greater size (similar to picture at end of presentation)

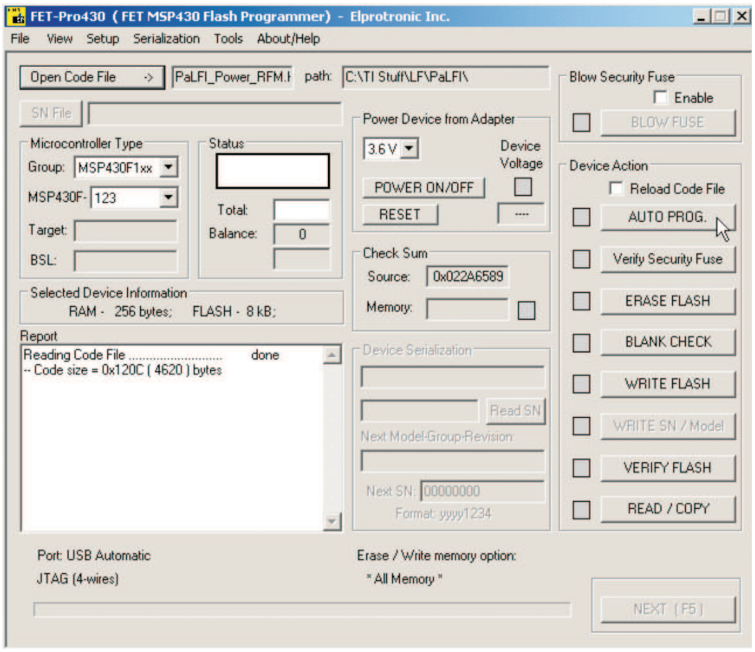


- Implement change on RI-ACC-ADR2 board - remove R33 and connect J4 pin2 with via



- Use modified Firmware that can handle the RXCLK / RXDAT signals
  - Firmware file for RI-ACC-ADR2 Reader use copy paste to save this file: `PaLFI_Power_RFM.hex`





A.4.3 Product Information

- http://focus.ti.com/docs/prod/folders/print/tms37157.html?DCMP=Palfi&HQS=Other+BA+palfib

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In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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