Product Development

CATTRON North America Inc.

LRM2 Radio Module – Host Interface Specification

Document p/n: 9S02-8969-A001 Rev.A

Revision History

Date	Revision	Description	Signature / Date	
2019-02-13	A	Initial draft	Prepared	Bo Gao
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89693 TRX module meets Part 90 of the FCC rules and regulations. Compliance with the labeling requirements, FCC notices is required. In order to comply with FCC Certification requirements, the Original Equipment Manufacturer (OEM) must fulfill the following requirements.

1. The system integrator must place an exterior label on the outside of the final product housing the 89693TRX Module. The figure below shows the contents that must be included in this label.
2. 89693 TRX modules may only be used with the antennas that have been tested and approved for use with the module.

Labeling Requirements

The OEM must make sure that FCC labeling requirements are met. This includes a clearly visible exterior label on the outside of the final product housing that displays the contents shown in below.

WARNING: The 89693 TRX modules have been tested by the FCC for use with other products without further certification (as per FCC Section 2.1091). Changes or modifications to this device not expressly approved by Cattron North America Inc. could void the user's authority to operate the equipment.

NOTICE: OEM's must verify the final product complies with unintentional radiators (FCC Section 15.107 and 15.109) before providing a declaration of conformity for their final product to Part 15 of the FCC Rules.

NOTICE: The 89693 TRX modules have been certified for mobile and fixed radio applications. If the module will be used for portable applications, the device must undergo SAR testing.

RF Exposure WARNING: This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTICE: The preceding statement must be included as a CAUTION statement in OEM product manuals in order to alert users of FCC RF Exposure compliance.

89693 TRX is designed for use in countless wireless applications requiring long range communications with low energy consumption. To ensure that the final product complies with the all of the regulatory requirements for the Modular Grant the following integration instructions should be followed. 89693 TRX is limited to OEM installation ONLY. The OEM integrator is responsible for ensuring that the end-user has no manual instructions to remove or install the module.

FCC Part 15.105(b) Warning Statement
NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: - Reorient or relocate the receiving antenna. - Increase the separation between the equipment and receiver. -Connect the equipment into an outlet on a circuit different from that to which the receiver is connected. -Consult the dealer or an experienced radio/TV technician for help.
IC RSS-GEN, Sec 7.1.2 Warning Statement- (Required for Transmitters)
ENGLISH: Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.
FRENCH: Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée quivalente (p.i.r.e.) ne dépassepas l'intensité nécessaire à l'établissement d'une communication satisfaisante.
IC RSS-GEN, Sec 7.1.2 Warning Statement- (Required for Transmitters w/ detachable antennas)
ENGLISH: This radio transmitter (identify the device by certification number, or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device. **Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi) and required impedance for each.**
FRENCH: Le présent émetteur radio (identifier le dispositif par son numéro de certification ou son numéro de modèle s'il fait partie du matériel de catégorie I) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.
IC RSS-102, Sec 2.6 Warning Statements
ENGLISH:

The applicant is responsible for providing proper instructions to the user of the radio device, and any usage restrictions, including limits of exposure durations. The user manual shall provide installation and operation instructions, as well as any special usage conditions, to ensure compliance with SAR and/or RF field strength limits. For instance, compliance distance shall be clearly stated in the user manual.
FRENCH: The user manual of devices intended for controlled use shall also include information relating to the operating characteristics of the device; the operating instructions to ensure compliance with SAR and/or RF field strength limits; information on the installation and operation of accessories to ensure compliance with SAR and/or RF field strength limits; and contact information where the user can obtain Canadian information on RF exposure and compliance. Other related information may also be included.

Only the following authorized antennas may be used with the equipment:

Only the antenna gain less than 4.15dBi may be used with the equipment.

2PCA-7839-A001, 50Ohm, Gain:-0dBi

2PCA-8339-X301, 50Ohm, Gain:-5.0dBi

PRT-0000430 (EXD-450-BN), 50Ohm, Gain:-0dBi

2PCA-8430-X001, 50Ohm, Gain: 2.0dBi

PRT-0001715, 50Ohm, Gain:3.61dBi

½ wave Omni antenna (SUB-4302), 4.15dBi

1. Introduction

1.1 Purpose

A new family of RF module, the LRM2 family, is being developed by Cattron North America Inc. This family is employing Silicon Labs EFR32FG13 Flex Gecko SoC(System On Chip),which is including a high performance Radio transceiver and a high performance Micro-Controller Unit.

1.2 Scope

This document describes the host interface signal definitions, timings, operation mode, available functionalities, and provide details about its integration to Unity products. This document does not cover RF specifications or power supply specifications.

1.3 Applicability

Applies to LRM2 family members, P/N 2PCA-8969-xxxx

1.4 Definitions, Acronyms

1.4.1 Definitions

1.4.2 Acronyms

LRM	Radio Module
MCU	Machine Control Unit
SoC	System-On-Chip
OCU	Operator Control Unit

1.5 References

[1] "Schematic Drawing for LRM2", Cattron P/N 9D02-8969-A001

[2] "Unity RF Telegrams Format", Cattron P/N 9S01-7640-A101

[3] "LRM2 Radio Module – Configuration Registers Specifications", Cattron P/N 9S02-8969-A002

2. Features Summary

The LRM2 is designed to replace LRM(2PCA-7954-xxxx) with less cost and improved performance. Its host interface is compatible with previous LRM(2PCA-7954-xxxx) series.

- Direct electrical compatibility to LRM(2PCA-7954-xxxx) interface
- On-board wireless SoC– The interface is controlled by an on-board Silicon Labs EFR32FG13 SoC. The EFR32FG13 Flex Gecko SoC includes both a high-performance radio transceiver and a high performance, low power Micro-Controller.
- Minimum buffers/Minimum Delay – LRM2 firmware is implemented to provide a "almost transparent" operation; transmission and reception delays are kept to a minimum
- Support for different Modulation modes– The LRM2 family is designed to support multiple different RF Modulations (2FSK and 4FSK), which is transparent to Host firmware.

These different aspects are covered in the rest of this document.

3. Host Interface Definition

3.1 Pins Assignment

Description	IO	Signal	Pin Number		Signal	IO	Description
			49	50	GND		*Ground*
			47	48	RX_BB	O	*RX Baseband signal*
			45	46			
			43	44			
			41	42			
			39	40			
			37	38			
			35	36			
			33	34			
			31	32			
Data transfer Handshaking Signal	O	!READY	29	30			
3.3V DC supply	I	3V3	27	28			
Receive data	O	RXD	25	26	TXD	I	*Transmit Data*
RX Enable	I	!RX_EN	23	24	!TX_EN	I	*Tx Enable*
Serial port Configuration mode	I	!CONFIG	21	22	GND		*Ground*
			19	20	DCLK	O	*Data Clock*
			17	18			
			15	16			
			13	14			
			11	12			
			9	10			
Reset	I	!RESET	7	8			
CPU flash mode	I	!PGM	5	6			
Ground		GND-PA	3	4	GND-PA		*Ground*
Voltage Supply, RF power amplifier	I	VPA	1	2	VPA	I	*Voltage Supply, RF power amplifier*

Table 3.1 – Host Interface pins assignment

3.2 Signals Description

Pin Nb	Signal Name	I/O	Description	Category
1, 2	VPA	Input	Voltage Supply, RF power amplifier. This supply is needed when an optional piggy-back power amplifier board is used. Specifications (voltage, current) depend on piggy-back board used.	Power supply
3, 4	GND-PA		GND, RF power amplifier. This ground is connected internally to the module ground. It does not need to be connected when the module is used without PA	Power supply
22, 50	GND		System ground	Power supply
27	3V3	Input	3.3 V power supply voltage input (Vcc)	Power supply
5	!PGM	Input	Used to download on-board CPU firmware. Connect this signal to GND at power-up to force the CPU to enter firmware programming mode. Otherwise, connect to Vcc or leave unconnected	Module control
7	!RESET	Input	Main reset (active low). When reset is asserted, the content of the internal registers is lost.	Module control
29	!READY	Output	Handshaking signal for transmit or receive data on the host interface.	Data Transmission
23	!RX_EN	Input	Receive Enable (active low). Used to place the RF module in received mode *Note: when !TX_EN and !RX_EN are asserted simultaneously, the module is placed in STANDBY mode (low power consumption, internal registers conservation)	Data Transmission
24	!TX_EN	Input	Transmit Enable (active low). Used to activate telegram transmit process	Data Transmission
25	RXD	Output	Receive Data.	Data Transmission
26	TXD	Input	Transmit Data	Data Transmission
20	DCLK	Output	Data Clock. Active when serial port is configured in Synchronous Mode	Data Transmission
21	!CONFIG	Input	Used to configure the Data transmission signals RXD and TXD for module configuration. Asserting can be done in IDLE state only. Active low	Configuration interface
48	RX_BB	Output	Analog demodulated RX signal	Data Transmission

Table 3.2 - Host Interface signals description

4. Functional Description

4.1 Concepts Overview

4.1.1 Block Diagram

The figure below shows a high-level block diagram of the LRM2.

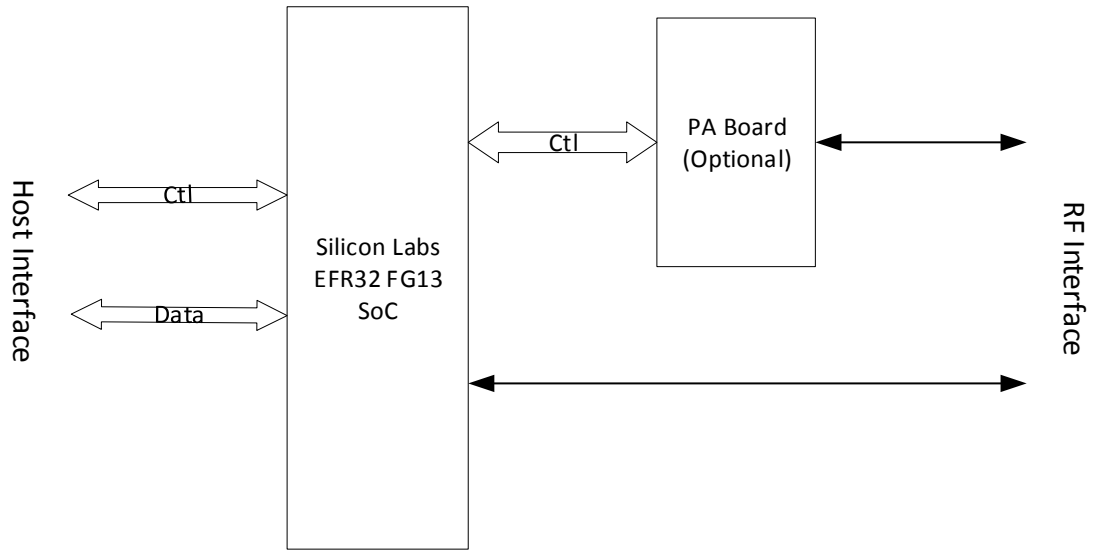

Figure 4.1 – LRM2 high-level block diagram

The Silicon Labs ERF32FG13 SoC is located between the host interface and the RF interface, providing decoupling between host and RF interface. The EFR32FG13 SoC has sufficient buffer space for one telegram.

As shown later, telegram processing is defined to minimize delays, so to provide a "transparent-like" behavior.

4.1.2 Data Communication Model & Definitions

The communication model defines some of the terminology used in the rest of this document.

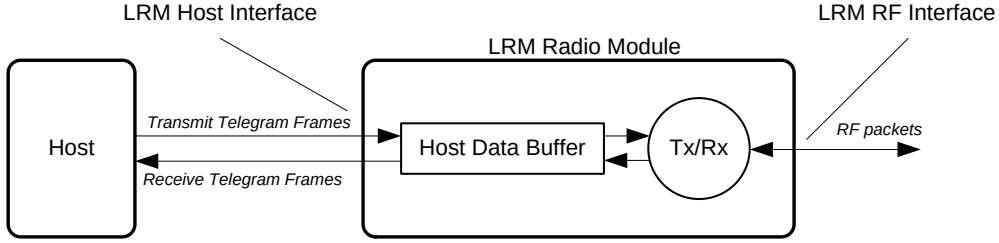

Figure 4.2 - Data communication model

- The LRM2 Radio Module is used to communicate telegrams between **hosts**. In Unity context, hosts are OCU and MCU CPU boards. The LRM2 has two interfaces: a **Host Interface** and a **RF Interface**.

- Transmit and Received Telegrams are relayed through the LRM2 **Host Data Buffer**. This buffer is capable to hold only one telegram at a time. The purpose of this buffer is to relax host timings requirements, and to allow decoupling between Host Interface and RF Interface data rates.
- Telegrams sent/received on the Host Interface and RF interface are encapsulated into **frames** to improve synchronization.
- The LRM2 does not perform any processing on the telegrams content; it controls only the frames overhead.

4.2 System States

The LRM2 supports five operational states

State	Control Signals				Functions permitted				Remarks
	!RESET	***!TX_EN***	***!RX_EN***	***!CONFIG***	***Transmit Telegram***	***Receive Telegram***	***Write Config Registers***	***Read Registers***	
RESET	0	X	X	X					Config registers are reset
IDLE	1	1	1	1					Transceiver is disabled
CONFIG	1	1	1	0			√	√	Config register values are retained
TX	1	0	1	***1***	√				
RX	1	1	0	1		√			

Table 4.1 – LRM2 States Definition

All possible transitions are allowed. The internal configuration registers can be written in CONFIG state only. Attempt to write registers in any other state result in no action / no response.

4.3 Telegram Transmission

Transmit frames have two fields:

- Telegram length (number of bytes). The length is used by the CPU to control the transmission process.
- Telegram (maximum 254 bytes). The content of the telegram is defined by the application. For Unity application, this is the Unity Telegram beginning with the Scrambling byte, the TID and terminated with the 16bits CRC, as defined in ref [2].

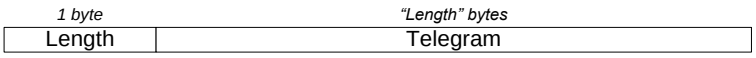

Figure 4.3 - Transmit Telegram frame format

4.4 Telegram Reception

Each RF packet received by the LRM2 is sent to the host interface, followed by its RSSI. Also, in order to ensure receive telegram frame synchronization (i.e. unambiguous detection of the start of the frame), the frame is encapsulated according to SLIP framing. SLIP framing is very simple to decode. It is described in section **Error! Reference source not found.**.

Receive frame fields are:

- SOF (Start-of-Frame character). This is part of SLIP encapsulation.
- Length of the Telegram field (number of bytes), not counting RSSI fields and any additional control characters introduced for SLIP encapsulation.
- Telegram (maximum 254 bytes). The content of the telegram is defined by the application.
- RSSI: Received signal strength for this frame. RSSI is an 8 bits integer value, expressed in dBm. Range;-128 to +127 dBm.

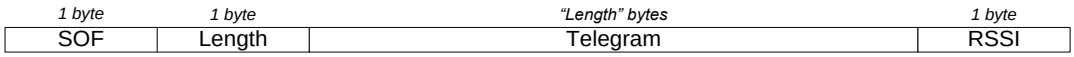

Figure 4.4 - Receive Telegram frame format

5. LRM2 Configuration Concept

All LRM2 configuration and status parameters are accessible through addressable registers.

- All parameters can be read and written only in CONFIG mode.

The definition of the configuration registers is given in reference [3]. This section addresses the basic description of all these three methods.

5.1 Console Interface

The serial interface configuration port is enabled by asserting !CONFIG signal; the serial interface is automatically reconfigured in asynchronous mode, running at 38400bps, 8N1. All ASCII strings received are interpreted as configuration commands. This mode is particularly useful for stand-alone testing, when the unit can be controlled from a PC or by an operator/tester using a terminal emulation program.

5.1.1 "Write" command

wrCmd register value , where:

wrCmd = write command. "**w"** or "**wr"** can be used and are equivalent
register = register identification. Can use the register name or register address
value = value to be written, in decimal or hexadecimal format. Hexadecimal values are preceded by '0x'

Examples:

wr txf 915000000 :Write 915000000 to register txf (Tx frequency)
wr 0x80 18 :Write 18 to register address 0x80
wr txf 915000000 0x80 18 :Concatenate the two writes above in a single instruction

Here is the command to set the transmit output power level in range 0dBm to 20dBm

wr txp 20 :the radio transmit power is 20+/-1.0dBm (maximum)
wr txp 10 : the radio transmit power is 10+/-1.0dBm (mid power level)
wr txp 0 : the radio transmit power is 0+/-1.0dBm (minimum)

5.1.2 "Read" command

rdCmd reg where:

rdCmd= read command. **r** or **rd** can be used and are equivalent
reg = register identification. Can use the register name or register address

Examples:

rd txf : Reads register txf (Tx frequency)
rd 0x80 : Reads register address 0x80
rd txf 0x80 : Reads registers txf and 0x80 in a single instruction

5.1.3 "Help" command

helpCmd where:

helpCmd= help command. **h**, **help** or **?** can be used and are equivalent.

The LRM2 responds with the list off all available configuration registers.

5.2 Stand-Alone Test Mode

The LRM2 can be operated in stand-alone mode for production/service tests. In this case, only a 3.3VDC supply is needed, and a RS232/TTL transceiver (like Cattron FLASHBOX) to connect to a PC serial port.

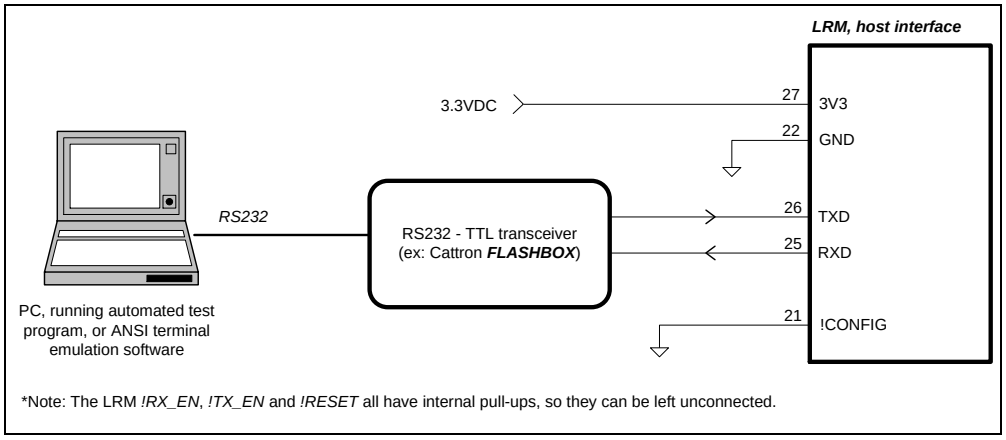

Figure 5.1 - LRM2 connection for stand-alone operation

The LRM2 will support several built-in test modes to ease testing from a PC. For example

a. Transmission Tests

- Generation of different type of carrier: unmodulated (CW), or modulated with "101010.." or pseudo-random sequence
- Automatic generation of test RF frames with predefined content

b. Reception Tests

- Measure PER (packet error rate) when receiving the predefined test RF frames
- Measure RF input level