

***Integrated TIRIS™ RF Module
TMS3705A Introduction to Low
Frequency Reader***

Application Report

TIRIS Technology by
Texas Instruments™

October 1999

SCBA020

Integrated TIRIS™ RF Module TMS3705A Introduction to Low Frequency Reader

Application Report

TIRIS Technology by
Texas Instruments™

Literature Number: SCBA020
October 1999

Contents

Preface	5
1 Introduction	7
2 Key Features of the TMS3705A	9
3 Sequence Control	11
4 Circuit Description of the Sample RF Module	13
5 Regulatory Notices and Ordering	17

List of Figures

1-1	TIRIS Sample Setup Without PC	7
3-1	MCR Programming	11
4-1	Schematic Diagram for Sample RF Module	14
4-2	Sample Coil Former	15

List of Tables

4-1	Component List for Sample RF Module	14
4-2	Pin Assignment of the Connector J2 of the Sample RF Module	15

Read This First

Edition Two – October 1999

This is the second edition of the application note for the **Integrated TIRIS™ RF Module TMS3705A**.

Texas Instruments reserves the right to change its products or services or to discontinue any product or service at any time without notice. TI provides customer assistance in various technical areas, but does not have full access to data concerning the use and applications of customer's products.

Therefore, TI assumes no liability and is not responsible for customer applications or product or software design or performance relating to systems or applications incorporating TI products. In addition, TI assumes no liability and is not responsible for infringement of patents and/or any other intellectual or industrial property rights of third parties, which may result from assistance provided by TI.

TI products are not designed, intended, authorized or warranted to be suitable for life support applications or any other life critical applications which could involve potential risk of death, personal injury or severe property or environmental damage.

The TIRIS logo and the word TIRIS are registered trademarks of Texas Instruments Incorporated.

Copyright © 1998 Texas Instruments Incorporated. All rights reserved.

This document may be downloaded onto a computer, stored and duplicated as necessary to support the use of the related TI products. Any other type of duplication, circulation or storage on data carriers in any manner not authorized by TI represents a violation of the applicable Copyright laws and shall be prosecuted.

About TIRIS

TIRIS (Texas Instruments Registration and Identification Systems) manufactures Radio Frequency Identification Devices (RFID) and systems.

About This Application Note

The purpose of this note is to give an overview of the TMS3705A functionality. It does not cover all the details of the comprehensive data sheet.

Note: Please see the following data sheet for further reference:

TMS3705A TRANSPONDER BASE STATION IC, Rev. 1.0 – June 1999

Regulatory and safety notes that need to be followed are given in Chapter 5 – Regulatory Notices and Ordering.

Document Overview

This application note is composed of the following sections:

Chapter 1 Introduction

Gives a general description of the TIRIS system

Chapter 2 Key Features of the TMS3705A

Outlines the key features of the TMS3705A, a base station IC for TIRIS.

Chapter 3 Sequence Control

Provides general hints for initialization of the IC.

Chapter 4 Circuit Description of the Sample RF Module.

Describes a sample circuit using the TMS3705A.

Chapter 5 Regulatory Notices and Ordering

Information on regulatory notices and ordering procedures.

Introduction

A TIRIS setup consists of one or more Transponders and a Reader. The Reader described in this application note normally contains the Reader Antenna, the RF Module and the Control Module.

A TIRIS RF Module is the interface between the TIRIS transponder and the Control Module (data processing unit) of a TIRIS Transponder Reading/Writing System. It has the capability to charge up a TIRIS transponder, to write to and program a read/write or multipage one, to receive the transponder response signal and to demodulate it for further digital data processing.

The Control Module in this application example operates as interface for a PC which takes over the display and command input functions. In such a configuration the Control Module handles most data protocol items and the detailed fast timing functions. In other applications like automotive immobilizers the Control Module can be part of the Engine Management Unit.

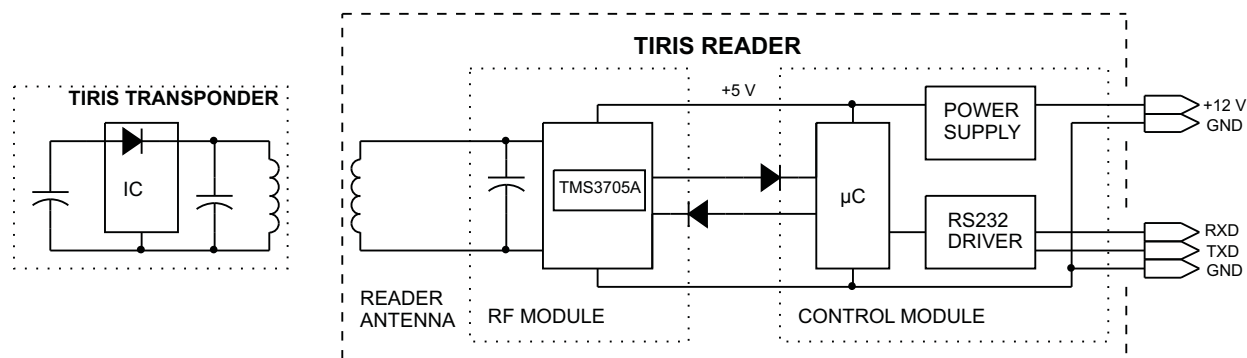


Figure 1-1. TIRIS Sample Setup Without PC

Key Features of the TMS3705A

PLL FOR THE SYSTEM CLOCK

An integrated PLL system generates the 16 MHz system clock which determines the different internal timings. Using the lower 2 or 4 MHz oscillator as reference for the PLL system minimizes the emissions of electromagnetic interference.

CERAMIC RESONATOR FOR REFERENCE OSCILLATOR

The digital FSK demodulator of the TMS3705A can vary the discriminator level for its high respectively its low frequency. Therefore the use of a ceramic resonator becomes possible instead of the more expensive crystal.

FULL BRIDGE DRIVER STAGE

The IC TMS3705A is manufactured in a CMOS process and contains all elements needed to build a TIRIS RF Module. This includes two push pull stages forming a full bridge to drive the antenna circuit directly. Their drive capability (I_{OC_min}) covers low range applications such as automotive immobilizer or contactless identification. In case of a short circuit producing a higher current than I_{OC_max} the over current protection circuit disables the driver stages for a duration t_{doc} .

FULLY INTEGRATED BANDPASS AMPLIFIER

To amplify the low antenna signal to logic level the IC contains a pre-amplifier, two band pass amplifiers and a sensitive Schmitt Trigger stage. While the gain of the pre-amplifier can be adjusted with two external resistors, the following band pass stages are fully integrated.

MULTIFUNCTIONAL TWO WIRE INTERFACE

All communication between the RF Module and the Control Module is done with only two signal lines. While one line carries the demodulated data from the transponder, the other line is used to control and to modulate the transmitter and to set the IC into the different modes by sending the mode byte in front of a transmitter activation.

Sequence Control

INITIALIZATION

For proper Mode Control Write, it is essential to know if the TMS3705A is in IDLE or SLEEP State.

Independent of the SLEEP or IDLE state of the IC, the timing in Figure 2 can be used. The timing is given for a Read Only transponder, but the wake sequence can also be used for other transponder types.

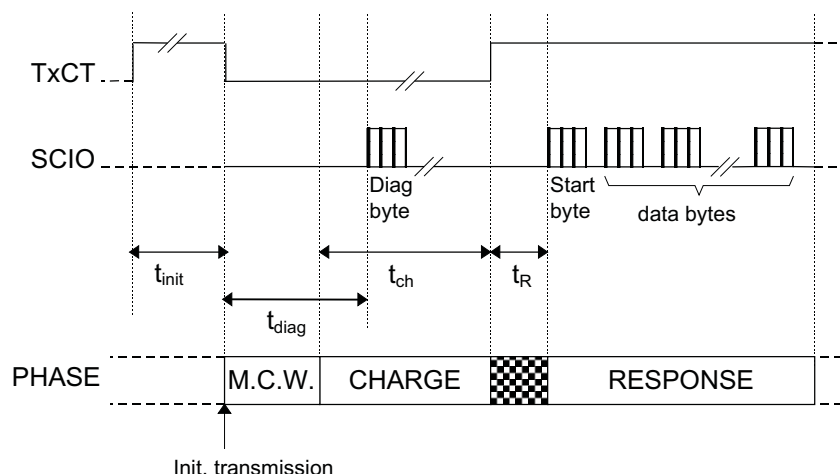


Figure 3-1. MCR Programming

The wake pulse (low) must be shorter than t_{mcr} ($t_{wake} \ll t_{mcr}$; $t_{wake} = \text{typ } 50\mu\text{s}$) to avoid that the wake pulse is interpreted as a start of transmission.

After the wake pulse, the TXCT signal must be high for at least the maximum time of the minimum initialization time $t_{init \text{ min}}$.

The proposed timing assures that an IC in Sleep Mode will switch to IDLE state. In case the IC was already in IDLE state, the wake pulse will not have an effect and it will remain in IDLE state.

Circuit Description of the Sample RF Module

For the following discussion please refer to figure 3 with the schematic of a sample RF module.

THE OSCILLATOR SYSTEM

The reference oscillator for the internal PLL system clock uses a 3 pin ceramic resonator. Those resonators are available with build-in load capacitors so that the capacitors C4 and C5 can be omitted. If crystals are used, C4 and C5 are needed and their value depend very much on the crystal itself. The PLL system allows the use of two different reference frequencies, either 4.0 MHz or 2.0 MHz. For a 4 MHz resonator the F_SEL input must be put to VDD level or to GND if a 2 MHz resonator is used. If one of these two frequencies are already available in the system and it has logic level then this signal with logic level can be fed directly into the OSC1 input.

With the higher frequency tolerance of the ceramic resonator the 16 MHz system clock gets also more variation and with this the transmission rate of the SCIO data output changes in asynchronous mode. If this variation cannot be tolerated by the Control Module, the data output stage can be switched into synchronous mode.

ANTENNA CIRCUIT

The antenna circuit is mainly formed by the resonance capacitor C1 and the antenna coil which is connected to the connector J1. The antenna circuit is driven by the push-pull output stages at the terminals ANT1 and ANT2 which can be seen as fast digital switches. These produce harmonic interference. To minimize this interference each driver stage is fed to the antenna circuit via a low pass RC filter (R3/C3; R4/C2). These filters are helpful especially if the antenna coil and the RF Module are not combined. In such a case the line to the antenna coil could operate as antenna for the high frequency interference.

Because of the resistors R3 and R4 are in line with the antenna circuit, they reduce the quality factor of the resonance circuit so that the unloaded quality factor of the coil must be higher to achieve the same reading performance. Using additional resistors in line with antenna coil winded with copper wire can stabilize the quality factor of the antenna circuit versus temperature.

PRE-AMPLIFIER

During receive phase both outputs ANT1 and ANT2 are switched to GND. The built-in pre-amplifier operates as internal biased operational amplifier. The resistors ratio R2/R1 determines the gain factor which should not be greater than 5. If the gain is higher than 5 the amplifier output can run into its upper limiting area due to the internal DC biasing.

INTERFACE CIRCUIT TO THE CONTROL MODULE

The control input TXCTL of the RF Module activates the transmitter if it is low level. To prevent transmitting continuously if the line to the controller is accidentally interrupted the resistor R7 pulls up the signal to high level. This TXCTL control line transfers the modulation signal and the Mode Control Byte. To improve its electromagnetic susceptibility a low pass RC filter R6/C6 is introduced to this line.

The RX data output SCIO of the IC is protected against a short circuit to GND by the serial resistor R5.

In case of a very noisy environment and long signal lines between the RF Module and the Control Module additional circuitry might be needed to avoid damaging the IC terminals by overvoltage or mal functions by corrupted data.

INTERFACE CIRCUIT TO THE CONTROL MODULE

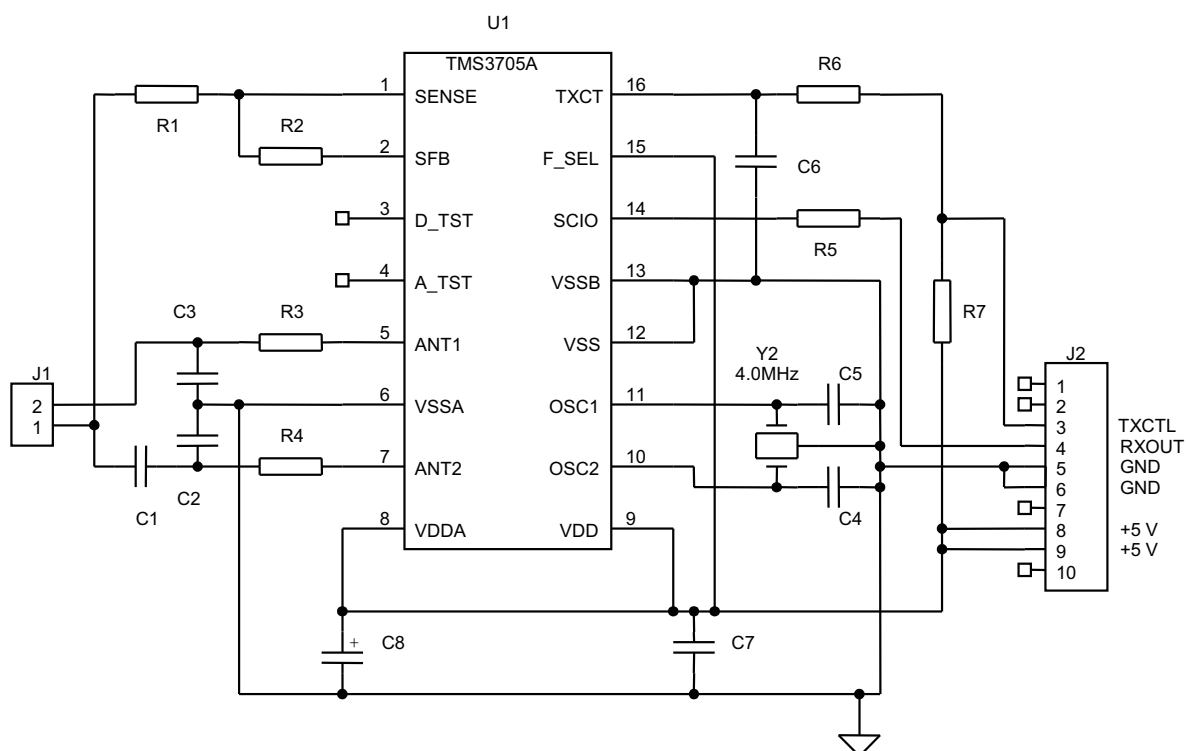


Figure 4-1. Schematic Diagram for Sample RF Module

Table 4-1. Component List for Sample RF Module

Pos.	Ref.	Description	Shape	Value
1	U1	TIRIS ASIC	SO16	TMS3705AD
2	Y1	Ceramic Resonator	3pin	4.0 MHz
3	C1	Ceramic Capacitor	1210	3.3nF, 50V, 2% matching with Antenna coil
4	C2	Ceramic Capacitor	0603	220 pF, 50V
5	C3	Ceramic Capacitor	0603	220 pF, 50V
6	C4	Ceramic Capacitor	0603	(10 pF) see description
7	C5	Ceramic Capacitor	0603	(10 pF) see description
8	C6	Ceramic Capacitor	0603	1 nF, 50V
9	C7	Ceramic Capacitor	1206	0.1 uF, 50V
10	C8	Tantalum Capacitor	D	22 uF, 16V
11	R1	Resistor	0603	47 kOhm
12	R2	Resistor	0603	150 kOhm
13	R3	Resistor	1206	4.7 Ohm
14	R4	Resistor	1206	4.7 Ohm
15	R5	Resistor	0603	220 Ohm
16	R6	Resistor	0603	1 kOhm
17	R7	Resistor	0603	10 kOhm
18	J1	Connector	R= 2.54 mm	2 pin female
19	J2	Connector	R= 2.54 mm	10 pin male

Table 4-2. Pin Assignment of the Connector J2 of the Sample RF Module

Pin No.	Pin Function
1	not used
2	not used
3	TXCTL–
4	RXOUT
5	GND
6	GND
7	not used
8	+5 V
9	+5 V
10	reserved for +12 V

ANTENNA COIL

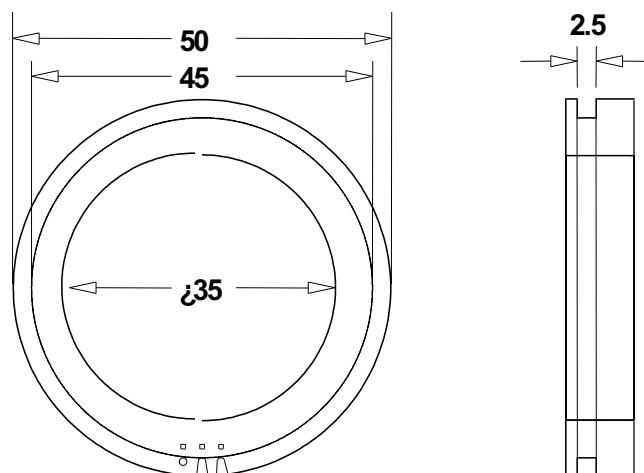
Figure 4 shows the Coil Former of the Sample Antenna.

Antenna Inductance = ~440 μ H

Coil = 66 turns,

Wire = enameled copper wire

Wire diameter = 0.18 mm diameter



all dimensions in mm

Figure 4-2. Sample Coil Former

The antenna is designed for a free air application. A parallel resistor of 15kOhm should be connected to the antenna to reduce the quality factor. If the antenna is mounted on a keylock, the antenna parameters have to be redefined.

Regulatory Notices and Ordering

REGULATORY NOTICES

A TIRIS RF Module generates RF emissions at 127 to 142 kHz. The radiation of the fundamental and the harmonics will vary with the type of antenna and other devices or functions connected to the RF module.

Prior to operating a TIRIS RF Module with antenna(s), power supply and a control module or other devices, the required FCC or PTT approvals must be obtained.

Sale, lease or operation in other countries may be subject to prior approval by the government or other organizations.

This reader can only be operated and/or marketed if the relevant FCC, PTT or other government agency has issued an equipment authorization for a complete system.

For marketing functional systems within the European Community, a Declaration of Conformity to European EMC laws is required.

ORDERING

For ordering please contact your nearest TIRIS Sales and Application Center.

Application Centers are located in Europe, North and South America, the Far East and Australia to provide direct engineering support.

For more information, please contact your nearest TIRIS Sales and Application Center. The contact addresses can be found on our home page: <http://www.tiris.com>

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
Low Power Wireless	www.ti.com/lpw	Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2006, Texas Instruments Incorporated