TEXAS INSTRUMENTS

Series 2000 Reader System

4-Channel TX/RX Multiplexer Module for Remote Antenna RFM RI-MOD-TX8A

Reference Guide

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TIRIS Technology by Texas Instruments™

Edition Three - July 2000

This is the third edition of this manual, it describes the following Series 2000 Module:

Series 2000 4-Channel TX/RX Multiplexer for RA-RFM RI-MOD-TX8A

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Read This First

About This Guide

This manual describes the TIRIS 4-Channel Transmit/Receive Multiplexer (TX/RX MUX) Module RI-MOD-TX8A. It describes the module itself, how to install it and how to use it.

Conventions

WARNING:

A WARNING IS USED WHERE CARE MUST BE TAKEN, OR A CERTAIN PROCEDURE MUST BE FOLLOWED IN ORDER TO PREVENT INJURY OR HARM TO YOUR HEALTH.

CAUTION:

This indicates information on conditions which must be met, or a procedure which must be followed, which if not heeded could cause permanent damage to the equipment or software.

Note:

Indicates conditions which must be met, or procedures which must be followed, to ensure proper functioning of the equipment or software.

Information:

Indicates information which makes usage of the equipment or software easier

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Document Overview

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CHAPTER 1

Product Description

This chapter will introduce you to the Multiplexer Module and the products with which it works. It also provides an overview of the function of the RA-RFM multiplexer.

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1.1 Introduction

1.1.1 General

This document provides information about the TIRIS 4-Channel Transmit/Receive Multiplexer (TX/RX MUX) Module RI-MOD-TX8A. It describes the module and how to install it.

The multiplexer module allows the use of up to 4 transmit/receive (TX/RX) antennas with one Remote Antenna Radio Frequency Module (RA-RFM) System.

1.1.2 Reference

This document should be used in conjunction with the High Performance Remote Antenna RFM (RI-RFM-008B) Reference Manual (Manual Number: 11-06-21-047).

1.2 Product Description

1.2.1 Description

The multiplexer is connected between an RA-RFM and the Tuning Board (TB). The active antenna (TX/RX channel) is selected by two digital input signals. All antennas can be disabled by removing one jumper.

The supply voltages and channel selection signals are connected via a 4-pin connector.

Connection to the RA-RFM and to the antennas is made via two screw block terminals.

The channel select input signals, connected to a data processing unit (for example: TIRIS Series 2000 Control Module, or a customer designed Control Unit), are Low Power Schottky TTL and HCMOS Logic compatible.

The Multiplexer includes circuitry to reduce crosstalk of transmit function.

There are four connectors on the multiplexer, they are:

- J1 which is used to connect the supply voltage and channel select signals
- J3 which is used to connect up to 4 antennas
- J4 the antenna resonator connector, which is used to connect the multiplexer board to the Antenna terminals of the RA-RFM
- J6 which can be used to connect the multiplexer ground to earth

The multiplexer can be mounted by means of four M3 mounting bolts on the underside of the module.

A layout of the multiplexer viewed from the top is shown in Figure 1. A block schematic of the multiplexer is shown in Figure 2. The multiplexer is described in the following section.

The multiplexer switches the selected Antenna to the RA-RFM. The multiplexer switches both the transmit and receive functions of the Antenna. Low resistance high voltage switches (MOSFETs) are used to switch the antenna connection because of the high voltage used during transmitting.

Figure 1: Top View

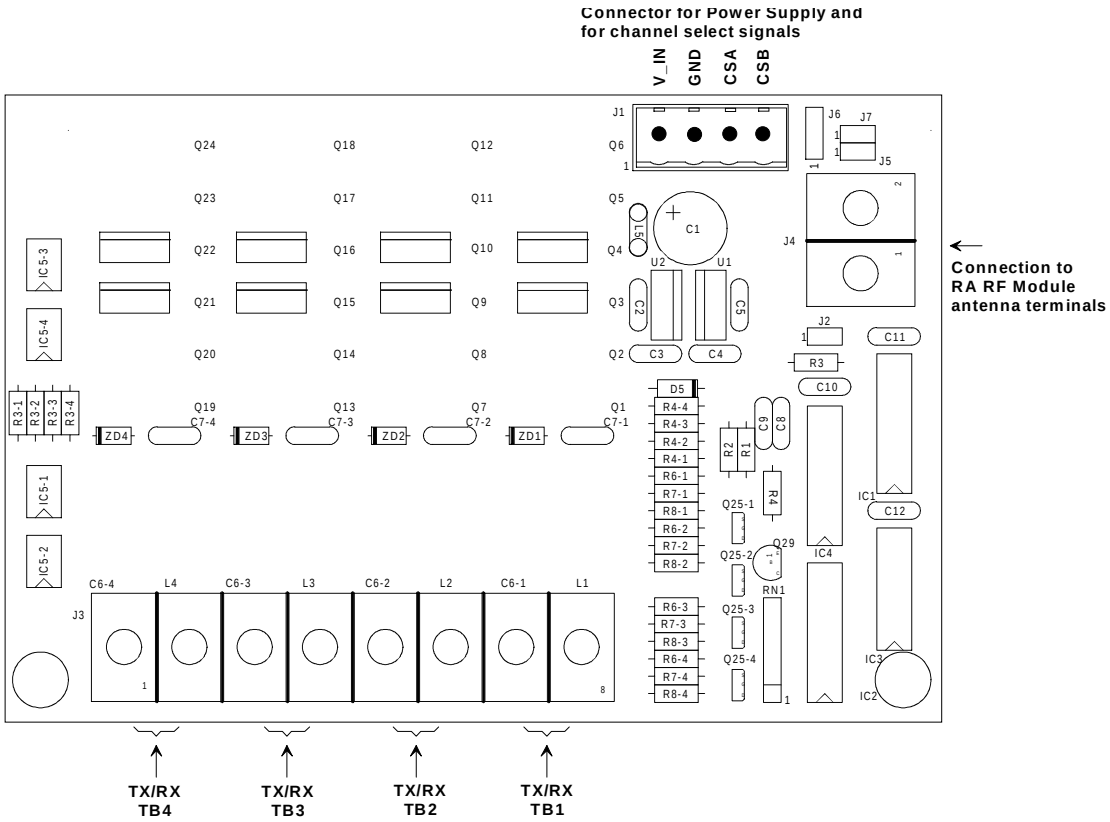
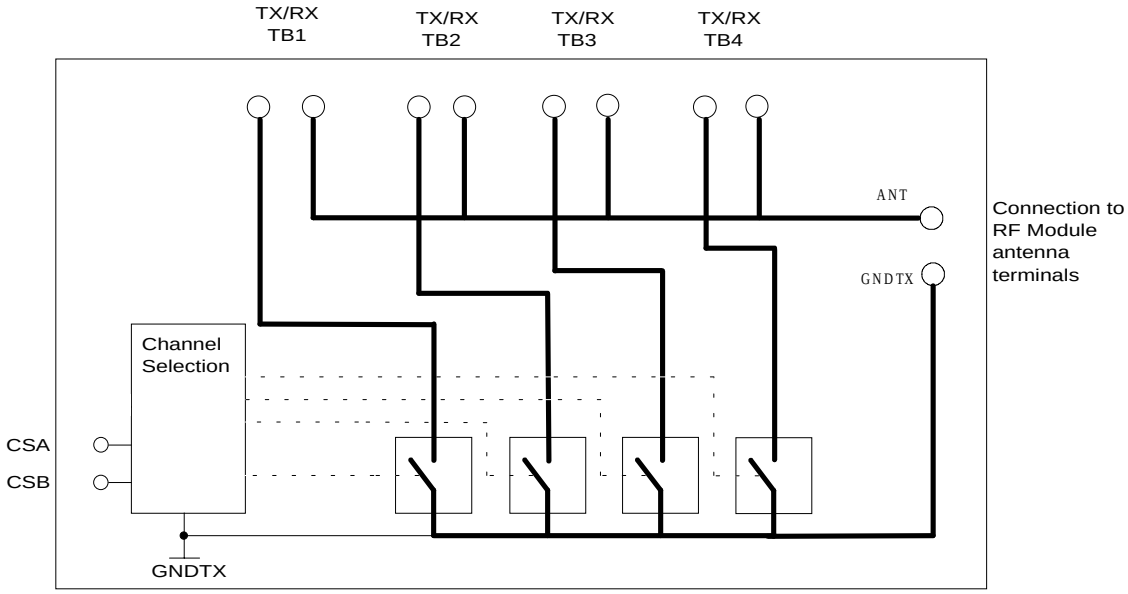


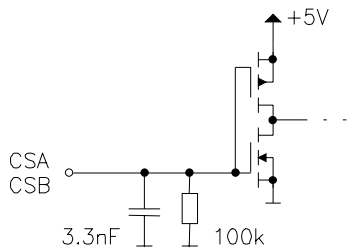
Figure 2: Block Diagram



All multiplexed antennas have one common terminal, which is the antenna terminal ANT. The other antenna terminals are connected to ground GNDTX via a switch.

The active TX/RX channel is selected by the two binary weighted channel select signals CSA and CSB, table 5 shows the binary configuration needed to select each channel. The configuration of the input signals CSA and CSB is shown in Figure 3.

Figure 3: Configuration for Input Signals CSA and CSB



WARNING:

CARE MUST BE TAKEN WHEN HANDLING THE RA-RFM. HIGH VOLTAGE ACROSS THE ANTENNA TERMINALS AND ALL ANTENNA RESONATOR PARTS COULD BE HARMFUL TO YOUR HEALTH. IF THE ANTENNA INSULATION IS DAMAGED IT SHOULD NOT BE CONNECTED TO THE RA-RFM.

CHAPTER 2

Connectors and Jumpers

This chapter describes the connectors and jumpers on the multiplexer.

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2.1 Connectors

Table 1 lists the pin functions for connector J1. The connector type is a 4-pin plug-in screw connector with 5.08 mm pin spacing.

Table 2 lists the pin functions for the antenna screw block terminal J4. The multiplexer is connected to the RA-RFM antenna terminals via connector J4.

Table 3 lists the pin functions for the antenna screw block terminal J3. The TX/RX antennas must be connected to the RA-RFM antenna terminals via the tuning boards to connector J3.

Table 4 lists the pin function for ground post J6.

Table 5 shows the logic switching of the active channel.

All connectors are accessible from the top.

Table 1: 1 Pin Functions

Pin#	Signal	Direction	Description
1	V_IN	IN	Supply voltage input
2	GND	IN	Ground
3	CSA	IN	Channel Select signal CSA (LSB)
4	CSB	IN	Channel Select signal CSB (MSB)

Table 2: J4 Pin Functions

Pin#	Signal	Direction	Description
1	ANT	IN/OUT	Antenna resonator signal. This pin must be connected to signal ANT_1 on the RA-RFM.
2	GNDTX	IN/OUT	Antenna ground. This pin must be connected to ANT_2 on the RA-RFM.

Table 3: J3 Pin Functions

Pin#	Signal	Direction	Description
1	A_OUT4	IN/OUT	Switched antenna signal (switched to ground GNDTX, when active). Connected to Tuning Board.
2	ANT	IN/OUT	Antenna resonator signal. Connected to Tuning Board.
3	A_OUT3	IN/OUT	Switched antenna signal (switched to ground GNDTX, when active). Connected to Tuning Board.
4	ANT	IN/OUT	Antenna resonator signal. Connected to Tuning Board.

Table 3: J3 Pin Functions

Pin#	Signal	Direction	Description
5	A_OUT2	IN/OUT	Switched antenna signal (switched to ground GNDTX, when active). Connected to Tuning Board.
6	ANT	IN/OUT	Antenna resonator signal. Connected to Tuning Board.
7	A_OUT1	IN/OUT	Switched antenna signal (switched to ground GNDTX, when active). Connected to Tuning Board.
8	ANT	IN/OUT	Antenna resonator signal. Connected to Tuning Board.

Table 4: J6 Pin Functions

Pin#	Signal	Direction	Description
1	GND	IN/OUT	Multiplexer Ground.

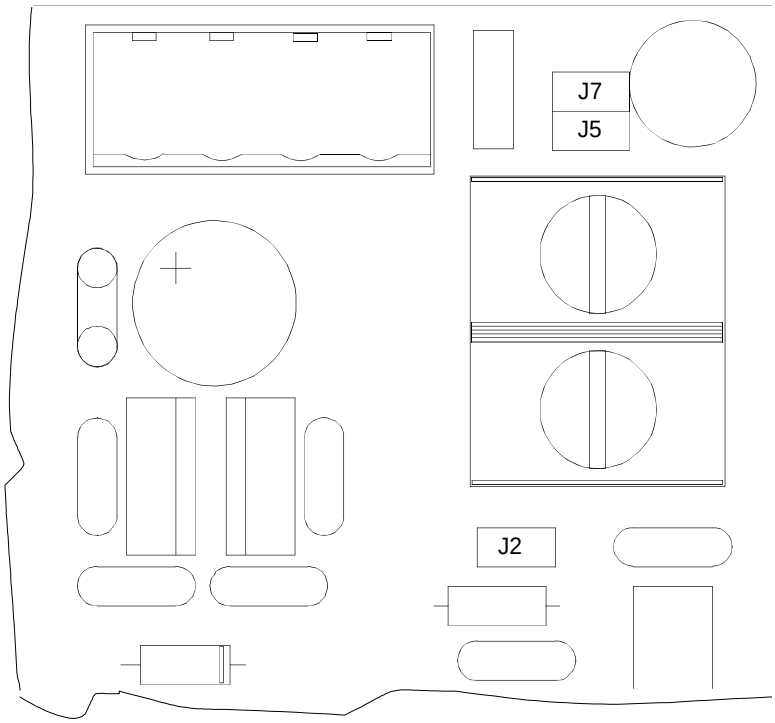
Table 5: TX/RX Channel Selection

Signal CSA	Signal CSB	Active TX/ RX antenna	at antennaat Connector
LOW	LOW	Channel 1	J3, pins 7 and 8
HIGH	LOW	Channel 2	J3, pins 5 and 6
LOW	HIGH	Channel 3	J3, pins 3 and 4
HIGH	HIGH	Channel 4	J3, pins 1 and 2

2.2 Jumpers

There are 3 jumpers on the Multiplexer, for location of the jumpers please refer to Figure 4. The jumpers are described in detail following:

Figure 4: Jumper Locations



2.2.1 Jumper J2

This jumper is used to enable all TX/RX channels. When this jumper is open, all TX/RX channels are disabled. When it is closed, all TX/RX channels are enabled.

Default: **closed**

2.2.2 Jumper J5

This jumper is used to connect the antenna terminal GNDTX (pin 2 of connector J4) to the Multiplexer ground GND.

Default: **open**

2.2.3 Jumper J7

This jumper is used to connect the Multiplexer mounting bolt to ground GND. The Multiplexer can be earthed via the mounting bolt if required.

Default: **open**

CHAPTER 3

Specifications

This chapter provides the specific details that you will need in order to use the TIRIS 4-Channel Transmit/Receive Multiplexer (TX/RX MUX) Module RI-MOD-TX8A correctly. It includes general data, electrical characteristics, timing characteristics and mechanical data.

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3.1 Recommended Operating Conditions

These specifications are based on a free-air temperature of 25 ºC.

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Note:

Free-air temperature: air temperature immediately surrounding the Multiplexer module. If the module is incorporated into a housing, it must be guaranteed by proper design or cooling that the internal temperature does not exceed the absolute maximum ratings.

Symbol	Parameter	min.	typ.	max.	Unit
V_V_IN	Supply voltage Multiplexer Module	10.0	12.0	24.0	V DC
I_V_IN	Supply current for Multiplexer Module		60	120	mA
V_ANT	Antenna Resonance Voltage			350	Vpeak
T_oper	Operating Temperature	-25	25	+70	ºC
T_store	Storage Temperature	-40	-	+85	ºC

3.2 Electrical Characteristics

Symbol	Parameter	min.	typ.	max.	Unit
R_Cha	Additional antenna resonator resistance per channel			4.0	Ohm
V_U1	Internal stabilized logic supply voltage	4.5	5.0	5.5	V
V_U2	Internal stabilized driver supply voltage	10.8	12.0	13.2	V
ViL	Low level input voltage of signals CSA, CSB and Enable signal	0		0.8	V
ViH	High level input voltage of signals CSA, CSB and Enable signal (J2)	2.4		5.0	V
Fan-In	Low Power Schottky compatible fan-in of signals CSA, CSB and Enable signal (Iin = -400 µA)			1	-

3.3 Timing Characteristics

Symbol	Parameter	min.	typ.	max.	Unit
f_TX	Transmit frequency	134.18	134.20	134.22	kHz
t_ri t_fi	Rise and fall time of input signals CSA, CSB and Enable signal			1 1	µs µs
t_short	Maximum short circuit time of antenna terminals			10	s

CAUTION:

Shorting the antenna terminals during operation may cause permanent damage to the RA-RFM.

3.4 Mechanical data

The mechanical size and weight is given in Table 6. Further mechanical details are provided in Figure 5. All of the measurements given in Figure 5 have a tolerance of ± 0.25 mm.

Figure 5: Module Layout and Dimensions

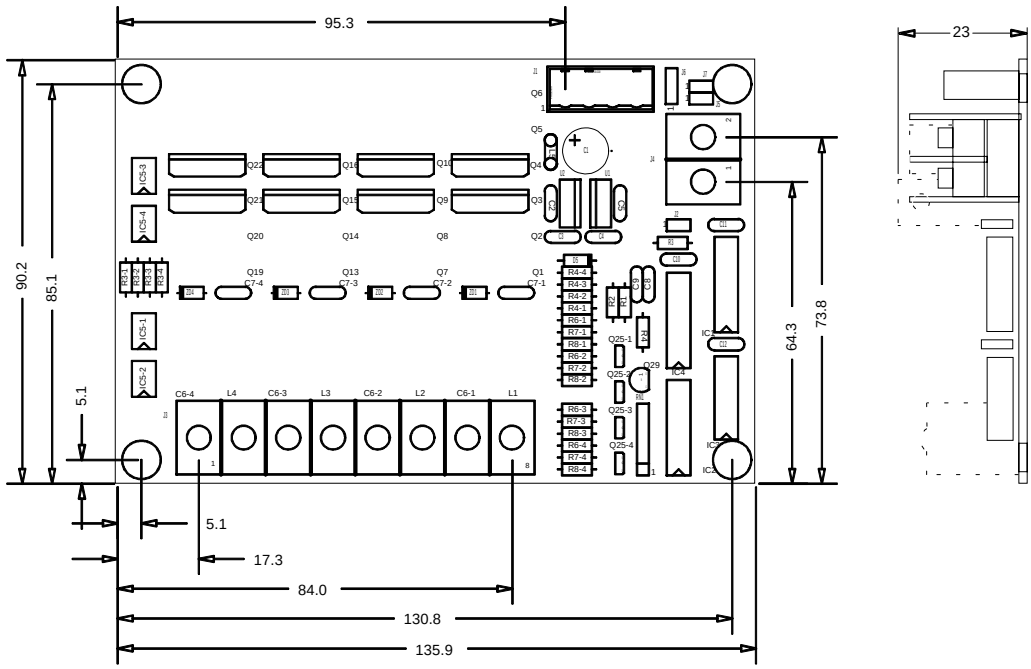

Table 6: Size and Weight

Parameter	typical	Unit
Height (including mounting bolts)	31.0 ± 2.0	mm
Weight of complete Multiplexer	120	Grams

CHAPTER 4

Installation & Use

This chapter provides the specific details that you will need in order to install the TI-RIS 4-Channel Transmit/Receive Multiplexer correctly. It includes a detailed description of the power supply requirements, the antenna characteristics, the connecting cable and how to tune the antenna to resonance.

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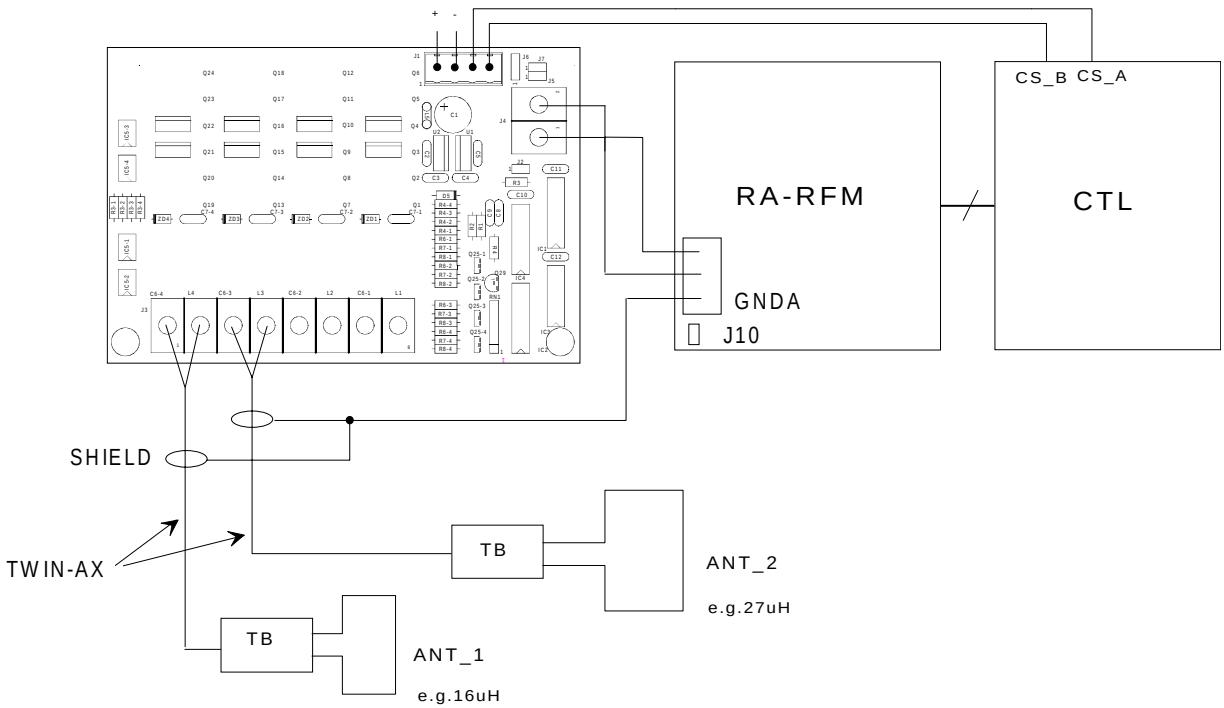
4.1 Connecting Multiplexer to Remote Antenna RFM

Figure 6 shows how the multiplexer should be connected to the RA-RFM and how the TX/RX antennas should be connected. If you wish to connect the antenna connecting cable shields to ground at the reader end, the cable shields can be connected together and then connected to pin 1 of the RA-RFM antenna connector. In order to connect pin 1 of the antenna connector to ground (GNDA), jumper J10 on the RA-RFM must be closed.

Figure 6: Connection of Multiplexer to RA-RFM



Note:

The lines ANT and GNDTX, which connect the Multiplexer board to the RA-RFM must be connected as shown. They must not be swapped, otherwise the Multiplexer will not work.

The antennas must (as usual) be tuned to resonance together with RA-RFM system and the Tuning Board. As the Multiplexer does not include the feature to tune the antennas individually to resonance, the tuning has to be done in such a way that the optimum reading performance is achieved for each antenna.

Note:

Enabling a TX/RX channel enables both the transmit and receive function. However disabling a TX/RX channel only disables the Transmit function (charge-up of a transponder). The transmit function of a disabled channel is never completely switched off, as there is still some coupling of the antenna resonance voltage from the active channel to the disabled channels via the parasitic capacitance of the MOSFET switch. This means that a transponder could still be charged-up at a distance of a few centimetres from a disabled TX/RX antenna.

The receive function at a switched off antenna is never completely switched off, because there is still reasonable coupling via the parasitic capacitance of the MOSFET switch. As the TIRIS receiver is very sensitive, the small voltage which is coupled via this capacitance, can still be enough to receive a transponder signal.

4.2 Power Supply

The multiplexer has built-in voltage regulators to supply the logic part and the MOS FET drivers with a regulated voltage. The input supply voltage must be connected to the pins V_IN and GND of connector J1. The input voltage needs to be stabilized (dc), but not regulated and can be between 10 and 24 V.

Note:

The multiplexer must not be supplied by Switched Mode Power Supplies (SMPS). This is because most SMPS operate at frequencies around 50 kHz. The harmonics of the generated field can interfere with the TIRIS receiver. Therefore only use linear power supplies, or SMPS with a fundamental operating frequency of 200 kHz or higher.

Noise from power supplies or noise on the interface lines can interfere with the RA-RFM's receiver. Therefore, if the application requires it, it may be necessary to place additional filters in series to the supply and interface lines. For more details refer to RA-RFM Reference Manual (see section 1.1.2).

4.3 Antenna Requirements

The transmit antenna for the RF Module (which is used to charge up the transponder) is a coil, this coil is part of the antenna resonant circuit of the RF Module.

In order to achieve the high voltages at the antenna resonant circuit and thus high field strength at the antenna for charge-up (transmit) function, the antenna coil must have a high quality factor. The recommended quality factor for proper operation is listed in Table 7.

Table 7: Antenna Characteristics

Parameter	Conditions	Min.	typ.	max.	Unit
L_ANT	Antenna inductance range, within which the antenna can be tuned to resonance using the tuning coil on the RF Module	8	27	80	µH
Q_ANT	Recommended quality factor of antenna coil for proper operation		100		

4.4 Connecting Cable

We recommend that the cable between the RA-RFM and the Multiplexer is low resistive (for example: RF Litz wire 120 x 0.1 mm, or loudspeaker cable with at least the same cross-sectional area) with a maximum length of 30 cm. If the connecting cable is longer than 20 cm it will affect the quality factor and inductance.

For the connection between the Multiplexer and the Antenna Tuning Board we recommend a symmetrically shielded Cable (Twin-Ax) with a maximum length of 100meter (Characteristic Impedance 100 to 105 Ohm, Capacitance 50.9 pF/meter, Diameter 8.4 mm).

4.5 Antenna Resonance Tuning

For proper operation of the transmitter and receive function, the antenna has to be tuned to the resonance frequency f_TX. For a detailed description of the antenna resonance tuning procedure, see the RA-RFM Reference Manual (see section 1.1.2)