Texas Instruments Registration and Identification System

TIRIS Technology by Texas Instruments™

Multiplexer Module

RI-MOD-TX2A (discontinued)
RI-MOD-TX4A (discontinued)

Reference Manual

11-06-21-034 18 November 1996

Edition Notice: Second Edition - November 1996

This is the second edition of this manual, it describes the following equipment:

TIRIS 2-channel Transmit/Receive Multiplexer Module	RI-MOD-TX2A
TIRIS 4-channel Transmit/Receive Multiplexer Module	RI-MOD-TX4A

The text on page 13 about Jumper J5 has been changed to include the S25x0 Reader and a new figure (figure 6) showing how to connect the Multiplexer Module to the S25x0 has been included.

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1. Introduction

1.1 General

This document provides information about the TIRIS Transmit/Receive Multiplexer (MUX) Modules RI-MOD-TX2A and -TX4A. It describes the modules and how to install them.

1.2 Product Description

The 2 Channel Multiplexer Module allows the use of 2 transmit/receive (TX/RX) antennas with one RF Module and the 4 Channel Multiplexer Module allows the use of up to 4 transmit/receive (TX/RX) antennas with one RF Module.

The Multiplexer is connected between the RF Module and the TX/RX antennas. In this way up to 4 TX/RX antennas can be operated from one RF Module. The active antenna (TX/RX channel) is selected by two digital input signals.

1.3 Product Option Coding

For product and ordering numbers of RF Module, Antennas, Control Modules, combinations of these and Accessories, please contact your local TIRIS Application Center.

The Module RI-MOD-TX2A is the 2 channel Transmit/Receive Multiplexer
The Module RI-MOD-TX4A is the 4 channel Transmit/Receive Multiplexer

1.4 Conventions

Certain conventions are used in this document in order to display important information, these conventions are:

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 Module.

***Note**: Indicates conditions which must be met, or procedures which must be followed, to ensure proper functioning of the Module.*

HINT: Indicates information which makes usage of the Module easier.

2. Product Function

2.1 Description

The 2 Channel Multiplexer Module allows the use of 2 transmit/receive (TX/RX) antennas with one RF Module and the 4 Channel Multiplexer Module allows the use of up to 4 transmit/receive (TX/RX) antennas with one RF Module.

The Multiplexer is connected between an RF Module and the TX/RX antennas. All antennas can be disabled by removing one jumper.

The supply voltages and channel selection signals are connected via a 4-pin connector.
The connection to the RF Module 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 in total, these are:

J1 which is used to connect the supply voltage and channel select signals

J3 which is used to connect up to 4 TX/RX antennas

J4 the antenna resonator connector, which is used to connect the Multiplexer board to the antenna terminals of the RF Module

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 under-side of the module.

A layout of the Multiplexer viewed from the top is shown in figure 1 (the parts in dotted lines are not mounted for the Module RI-MOD-TX2A). A block schematic of the Multiplexer is shown in figure 2. The Multiplexer is described in the following section.

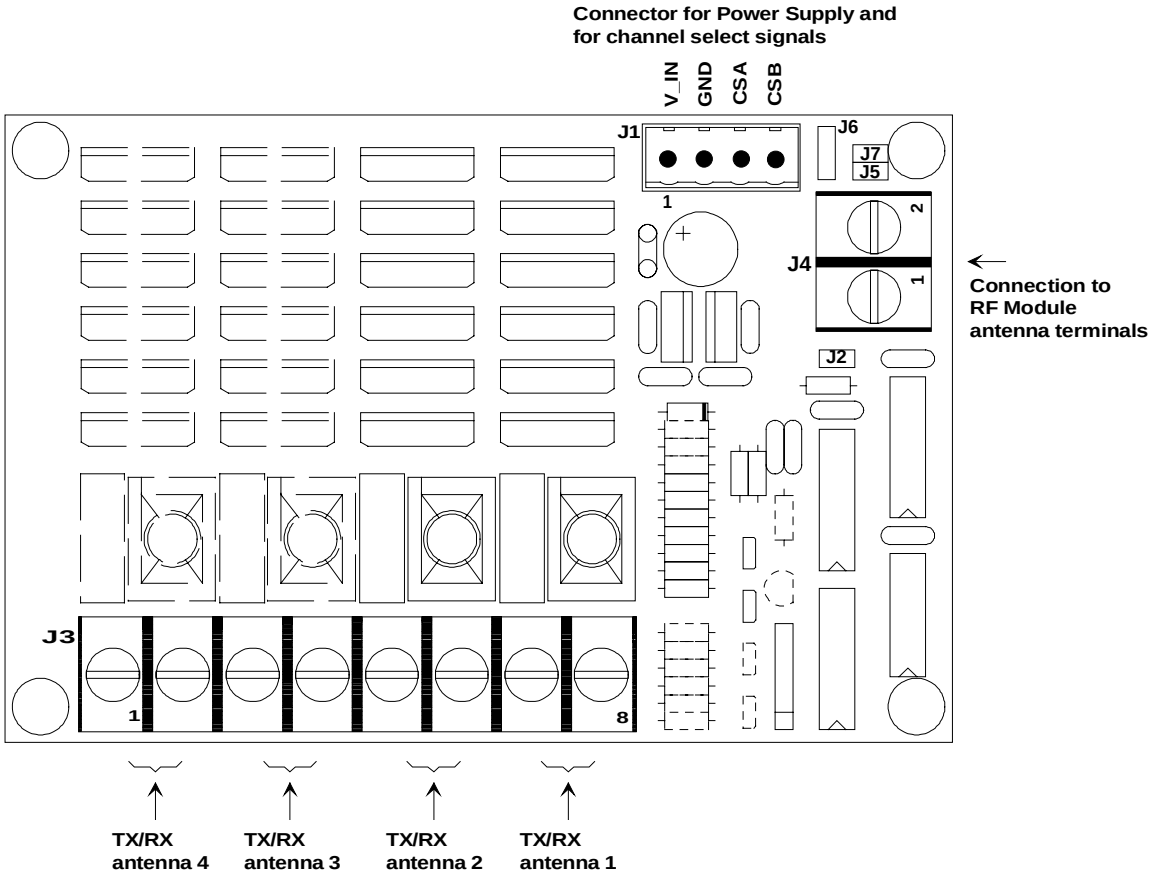

Figure 1: Top View

The Multiplexer switches the selected antenna to the RF Module. 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.

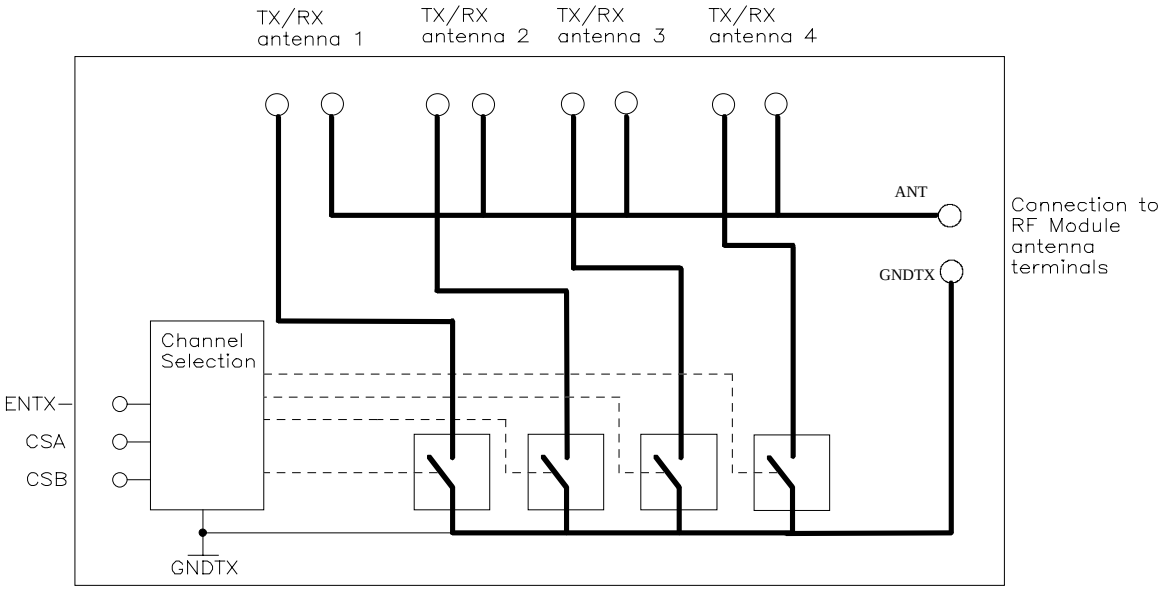

Figure 2: Block Diagram

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 characteristics of the TX/RX antennas are shown in figure 3.

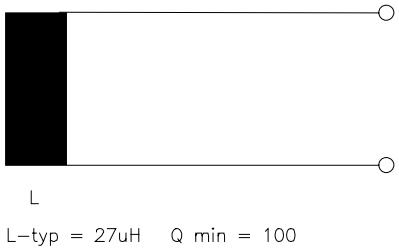

Figure 3: Configuration of TIRIS Standard TX/RX Antennas

For more details refer to Section 4 “Installation and Use of the 4 Channel Multiplexer”.

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 and the Enable signal (ENTX-) is shown in figure 4.

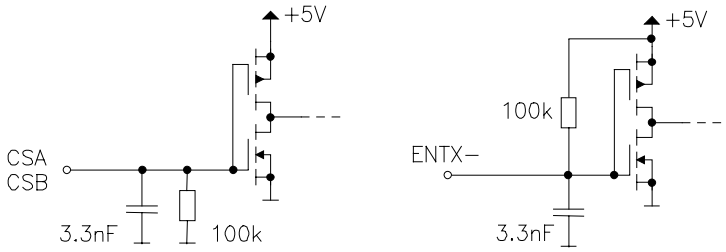

Figure 4: Configuration for Input Signals CSA, CSB and Enable

The Multiplexer has built-in voltage regulators to supply the logic part and the MOS FET drivers with 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 (i.e. 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.***

Figure 5 shows how the Multiplexer should be connected to the Power RFM and how the TX/RX antennas should be connected. Figure 6 shows how the Multiplexer should be connected to the S25x0 Reader, how the TX/RX antennas and how the power should be connected.

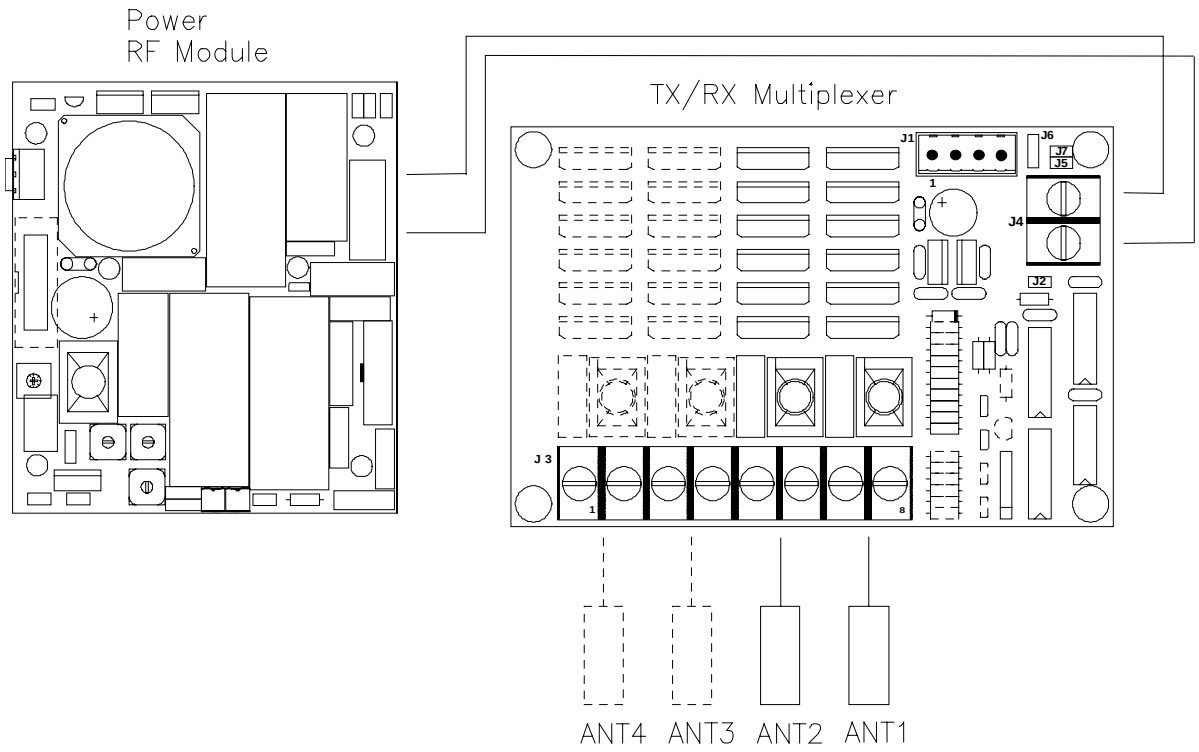

Figure 5: Connection of Multiplexer to RF Module

Note: *The lines ANT and GNDTX, which connect the Multiplexer board to the RF Module 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 the RF Module. 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. We recommend using the TIRIS Add-on Module 'Dynamic Auto Tuning', which allows each antenna to be individually and automatically tuned to resonance.

HINT: If you do not have the Dynamic Auto Tuning Module in your system we strongly recommended that you use the TIRIS Antenna Tuning Indicator (ATI), for simple monitoring of antenna resonance tuning.

Notes: *If you are not using the TIRIS Add-on Module 'Dynamic Auto Tuning' remember that the antennas are not individually tuned to resonance when used together with the Multiplexer. So either tune the RF Module to the best resonance condition for all the antennas being used, or include a 'Dynamic Auto Tuning' Module in your system.*

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. Basically the receive performance at a switched off TX/RX antenna is reduced by about 50% compared to an enabled TX/RX antenna.

CAUTION: The RF Module must not be operated in continuous transmit mode.

WARNING

Care must be taken when handling the RF Module. 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 RF Module.

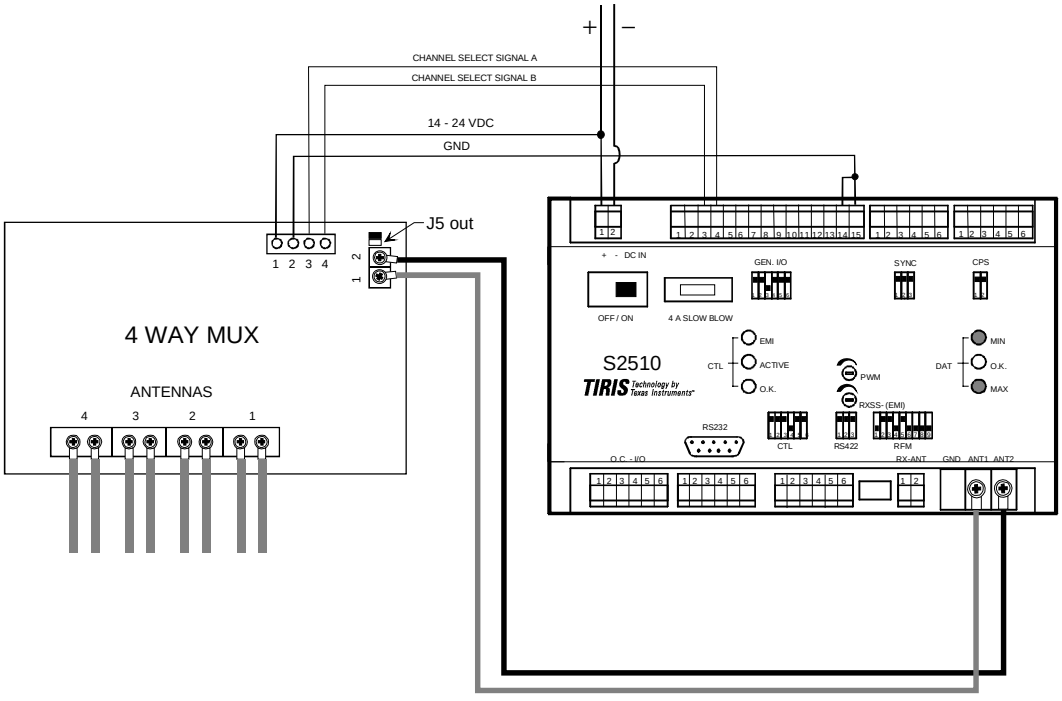

Figure 6: Connection of Multiplexer to S25x0 Reader

2.2 Multiplexer Connectors and Jumpers

2.2.1 Connectors

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

Tables 2 lists the pin functions for the antenna screw block terminal J4. The Multiplexer is connected to the 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 RFM antenna terminals via 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: J1 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 of the S2000 RFM, or ANT1 if you are using the Power RFM.
2	GNDTX	IN/OUT	Antenna ground. This pin must be connected to ground GNDA of the S2000 RFM, or ANT2 if you are using the Power 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 TX/RX antennas.
2	ANT	IN/OUT	Antenna resonator signal. Connected to TX/RX antennas.
3	A_OUT3	IN/OUT	Switched antenna signal (switched to ground GNDTX, when active). Connected to TX/RX antennas.
4	ANT	IN/OUT	Antenna resonator signal. Connected to TX/RX antennas.
5	A_OUT2	IN/OUT	Switched antenna signal (switched to ground GNDTX, when active). Connected to TX/RX antennas.
6	ANT	IN/OUT	Antenna resonator signal. Connected to TX/RX antennas.
7	A_OUT1	IN/OUT	Switched antenna signal (switched to ground GNDTX, when active). Connected to TX/RX antennas.
8	ANT	IN/OUT	Antenna resonator signal. Connected to TX/RX antennas.

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 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

2.2.2 Jumpers

There are 3 jumpers on the Multiplexer, for location of the jumpers please refer to figure 7. The jumpers are described in detail following:

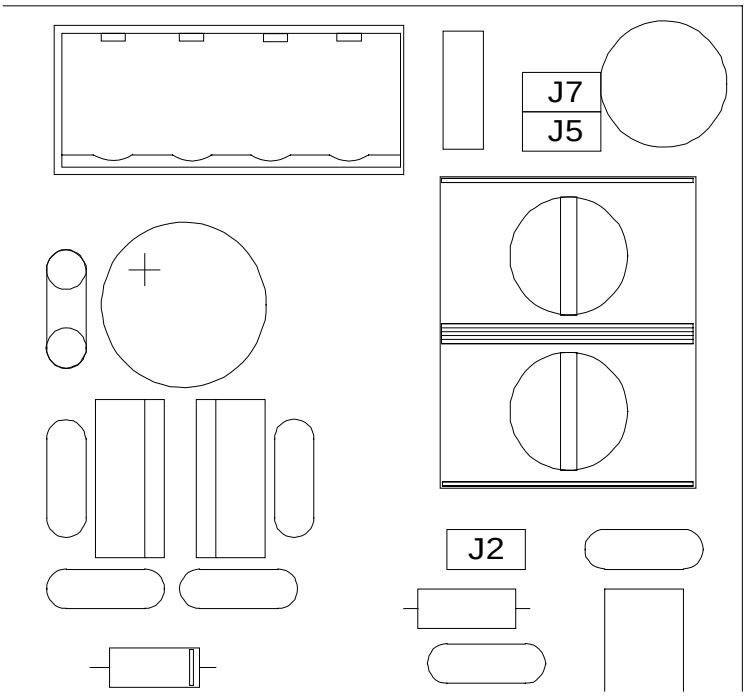

Figure 7: Jumper Locations

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: J2 closed

J5

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

When using the Multiplexer together with the S2000 RFM, this jumper has to be closed. When using the Multiplexer together with the Power RFM or the S25x0 Reader, this jumper must be opened.

Default: J5 open

J7

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

Default: J7 open

3. Specifications

3.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

Supply voltage	V_IN	+26	V
Antenna resonance voltage	V_ANT	250	Vpeak
Operating free-air temperature range	T_oper	-25 to +70	^{o}C
Storage temperature range	T_store	-40 to +85	^{o}C

Notes: *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.*

CAUTION: Exceeding absolute maximum ratings may lead to permanent damage to the Module. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

The RF Module must not be operated in continuous transmit mode.

3.2 Recommended Operating Conditions

at a free-air temperature of 25 ^{o}C

Symbol	Parameter	min.	typ.	max.	Unit
V_V_IN	TX/RX Mux Module supply voltage	10.0	12.0	24.0	V DC
I_V_IN	Supply current for Multiplexer Module		60	120	mA
V_ANT	Antenna resonance voltage			230	Vpeak

3.3 Electrical Characteristics

Symbol	Parameter	min.	typ.	max.	Unit
R_Cha	Additional antenna resonator resistance per channel			0.2	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	-

3.4 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: The parameter t_short is determined by the RF Module circuitry and refers to static short circuit of the antenna terminals. Shorting the antenna terminals during operation may cause permanent damage to the RF Module.

3.5 Mechanical data

The mechanical size and weight is given in Table 6. Further mechanical details are provided in figure 8. All of the measurements given in figure 8 have a tolerance of ± 0.25 m.

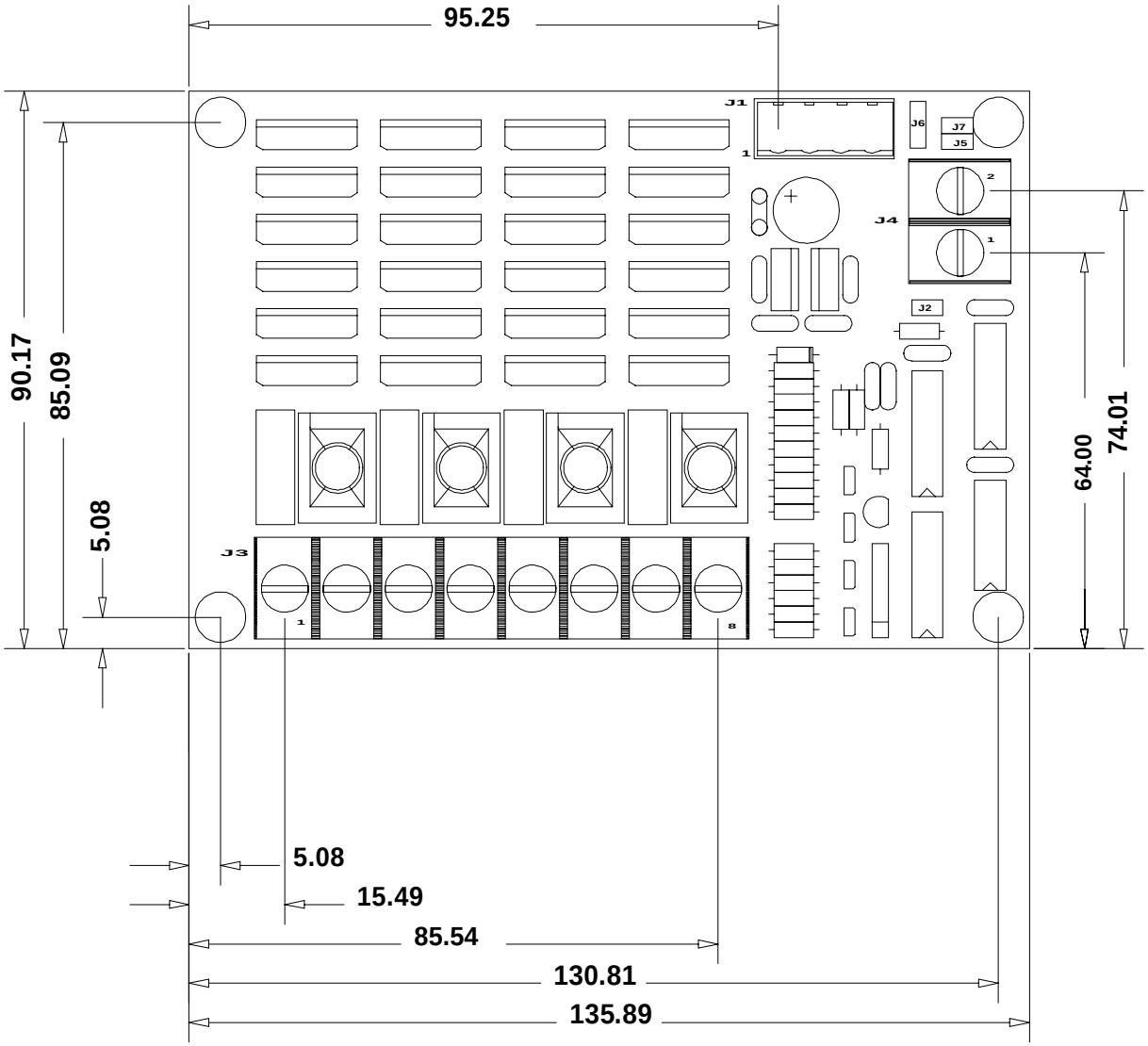

Figure 8: Module Layout and Dimensions

Table 6: Size and Weight

Parameter	typical	Unit
Length	135.89 ± 1.0	mm
Width	90.17 ± 1.0	mm
Height(including mounting bolts)	36.0 ± 2.0	mm
Weight of complete Multiplexer RI-MOD-TX4A RI-MOD-TX2A	 260 190	 Grams Grams

4. Installation and Use of the 4 Channel Multiplexer Module

4.1 Power Supply

4.1.1 Supply Requirements

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 RF Module'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 RF Module Operating Manual.

In order to guarantee full RF Module performance, the power supplies should fulfill the specifications for ripple voltage given in Table 7.

Table 7: Power Supply Ripple Specifications

Supply type	**Maximum allowed Ripple Voltage**	**Allowed Ripple Frequency**
Unregulated VCL supply	30 mVrms	0 to 100 kHz maximum (sinusoidal)

4.2 Antenna Requirements

The transmit antenna for the RF Module (which is used to charge up the transponder) is a coil (see figure 3), 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 8. The quality factor of the antenna is decreased when the Multiplexer is used, a maximum resistance of 200 mOhms is added per channel, which reduces the quality factor of TIRIS Standard antennas to about 55 (the original quality factor is approximately 100).

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 RF Module Operating Manual.

To ensure that the antenna can be tuned to resonance with the connected RF Module, the antenna inductance can only vary within the limits given in table 8.

Table 8: 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	26.0	27.0	27.9	µH
Q_ANT	Recommended quality factor of antenna coil for proper operation	100			-
A_ANT_ TX/RX	Quality factor of TIRIS Standard Antennas, when used together with the Multiplexer		55		-

4.3 Connecting Cable

We recommend that the cable between the 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.

4.4 Antenna Resonance Tuning

In order to achieve the high charge-up field strength, the antenna resonator frequency must be tuned to the transmitter frequency f_TX (tuning to resonance).