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TIRIS Technology by Texas Instruments™

Low Frequency Transmitter Module

RI-MOD-048A

Reference Manual

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

TIRIS Low Frequency Transmitter Module RI-MOD-048A

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FCC / PTT Regulations

The TIRIS TX-MOD generates RF emissions at 134.2 kHz. The radiation of the fundamental and the harmonics will vary with the type of Antenna and other devices or functions connected to the TX-MOD.

Prior to operating the TX-MOD together with Antenna(s), power supply and a Control Module or other devices, the required FCC, PTT or relevant government agency approvals must be obtained.

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

Important note to Purchasers/Users of the TIRIS TX-MOD in the U.S.A.

The TIRIS TX-MOD product is considered by the Federal Communications Commission (FCC) to be a "subassembly". As such, no prior approval is required to import, sell or otherwise market the TX-MOD in the United States. In order to form a functioning radio frequency (RF) device, the TX-MOD must be connected to a suitable Antenna, power supply, and control circuitry. **A radio frequency device may not be operated unless authorised by the FCC nor may a radio frequency device be marketed (i.e. sold, leased, imported, or advertised for sale or lease) without the prior grant of an FCC equipment authorisation.**

FCC authorisation to operate an RF device may take one of two forms: first, the FCC may grant the user an experimental license; second, the FCC may issue an equipment authorisation permitting use of the RF device on an unlicensed basis. TI can assist the user in obtaining an experimental license that will cover a specific installation of the TX-MOD in a specific site or sites. Experimental authorisations are appropriate to cover operations during the development of an RF device. A grant of equipment authorisation (known as "certification") must be obtained from the FCC before RF devices are marketed or operated on a non development basis.

> DEVICES CONSTRUCTED FOR EVALUATION INCORPORATING THIS TX-MOD SHOULD BE OPERATED ONLY UNDER AN EXPERIMENTAL LICENSE ISSUED BY THE FCC AND MAY NOT BE MARKETED. BEFORE ANY DEVICE CONTAINING THIS TX-MOD IS MARKETED, AN EQUIPMENT AUTHORISATION FOR THE DEVICE MUST BE OBTAINED FROM THE FCC.

Prospective marketers of devices containing this TX-MOD are responsible for obtaining the necessary equipment authorisation. Upon request TI can provide assistance in obtaining FCC approval to market devices incorporating this TX-MOD.

WARNING

Care must be taken when handling the TX-MOD. High voltage across the Antenna terminals and some parts of the printed circuit board (PCB) could be harmful to your health. If the Antenna insulation is damaged the Antenna should not be connected to the TX-MOD.

CAUTION

This product might be subject to damage by electrostatic discharge (ESD), it should only be handled by ESD protected personnel at ESD secured workplaces.

The transmitter power output stage can only operate with a limited duty cycle. Please pay attention to this fact whilst performing the Antenna tuning procedure.

1. Introduction

1.1 General

This manual provides information about the TIRIS Low Frequency Transmitter Module (TX-MOD).

1.2 Product Description

The TX-MOD System is used together with an LF Tuning Circuit and an Antenna to initiate and write data to a TIRIS Low Frequency Transponder.

The Low Frequency Transmitter Module comprises a Carrier Board (RI-MOD-038A) onto which two Transmit Only RFMs (RI-RFM-028A) have been mounted.

1.3 About this Manual

This manual contains the following parts:

Section 1 Introduction: An introduction to this manual and general information about the Low Frequency Transmitter Module System.

Section 2 Product Description: A short description of all features and functional blocks of the Low Frequency Transmitter Module System. It also lists all the connector signals.

Section 3 Specifications: A list of all the electrical and mechanical parameters of the Low Frequency Transmitter Module System.

Section 4 Adjustments: A description of how to tune the RFMs to resonance with the Tuning Circuit and Antenna, and how to adjust the antenna charge-up field strength.

Certain conventions are used in order to display important information in this description, 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 system.

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

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

2. Product Description

2.1 LF Transmitter Module

2.1.1 General

The Low Frequency Transmitter Module contains all the functions of a TIRIS transmit unit that are needed to initialize a TIRIS transponder. The Low Frequency Transmitter Module also sends the necessary programming and addressing signals to TIRIS Read/Write and Multipage transponders.

The RFMs contain all the analog functions of a TIRIS LF transmitting unit.

The Carrier Board contains:

internal voltage stabilisation for the RFMs
an oscillator for the RFMs
logic circuitry to determine RFM selection
RFM power output level adjustment
RFM tuning facilities

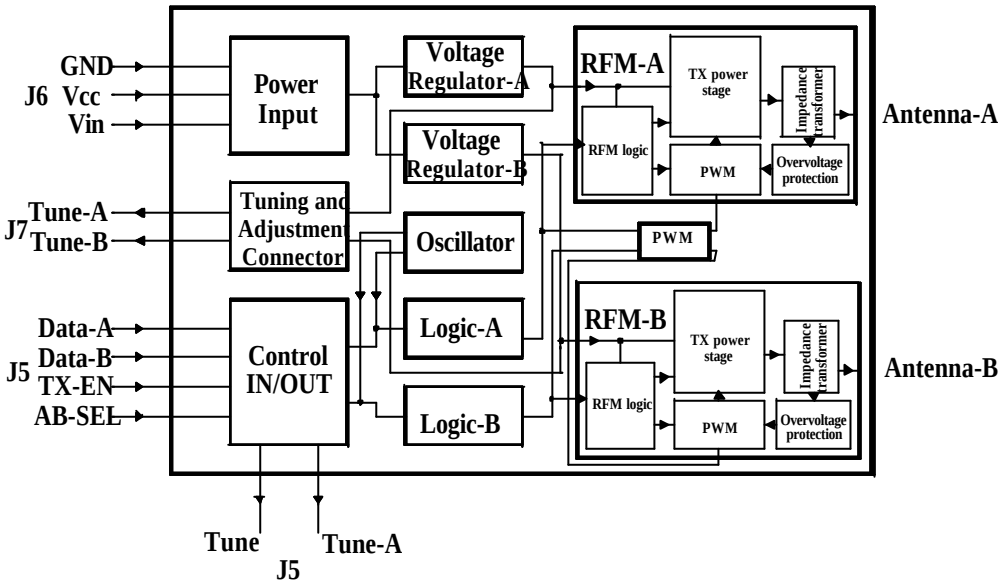

Figure 1: System Schematic Diagram

There are five connectors available for external connection on the Low Frequency Transmitter Module, one on each of the RFMs and three on the Carrier Board. These connectors are:

Transmit Only RFMs: A 3-pin antenna connector (ANT) to connect the RFM via a symmetrically shielded antenna cable (Twin-Ax) to the Tuning Circuit.

Carrier Board:

J5 Interface connector with four input and two output lines to communicate with an external control device.

J6 Power connector for Vcc = 5 V and Vin = 17.5 to 38 V dc and GND (refer to figure 3).

J7 Voltmeter connection to tune the RFMs according to the field strength requirements.

The TX-MOD can be mounted by means of the four pan head screws no. 4-40 mounting bolts underneath the Carrier Board.

WARNING

Care must be taken when handling the TX-MOD System. HIGH VOLTAGE across the antenna terminals and all antenna resonator parts could be harmful to your health.

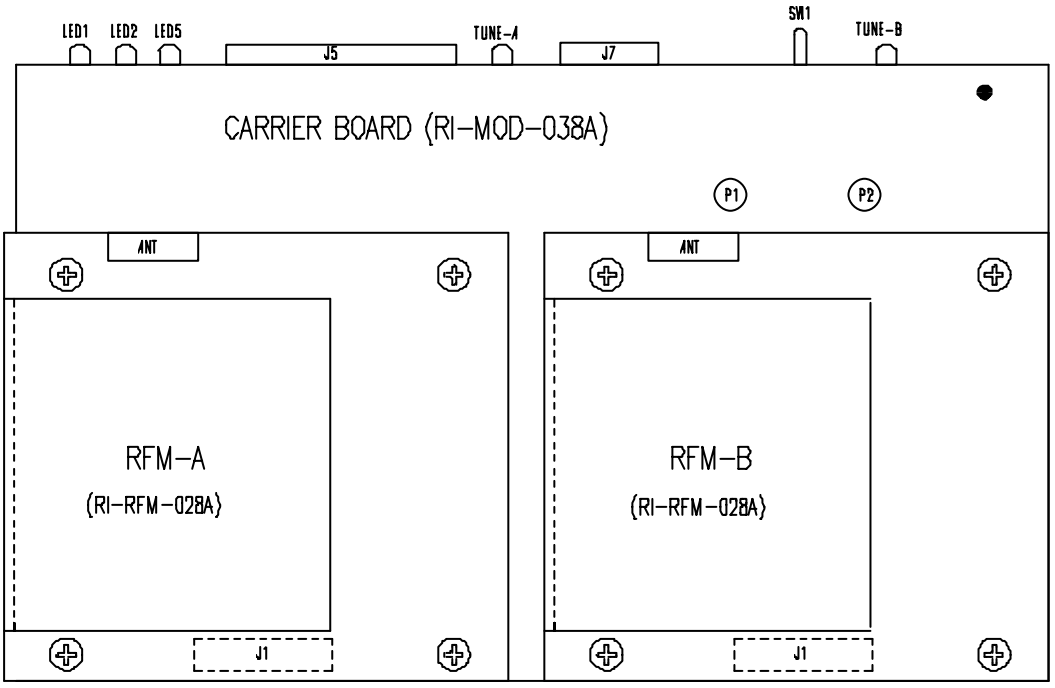

Figure 2: Top View

2.1.2 LEDs

There are 5 LEDs present on the Carrier Board, they indicate the following:

LED 1 green indicates logic supply voltage

LED 2 yellow indicates supply of RFM-A
LED 5 yellow indicates supply of RFM-B

TUNE-A (LED 3) red ON = RFM-A to be tuned
TUNE-B (LED 4) red ON = RFM-B to be tuned

2.1.3 Connectors

2.1.3.1 Connectors and Signal I/O Configurations

The bottom view of the TX-MOD is shown in figure 3. The RFMs are connected to the Carrier Board via 16-pin module connectors J1 (as can be seen in figure 2 there are two J1s - one for each RFM). Each J1 connector carries the supply voltage lines, the data, and the control lines for its own RFM. The pin functions of these connectors is listed in table 1.

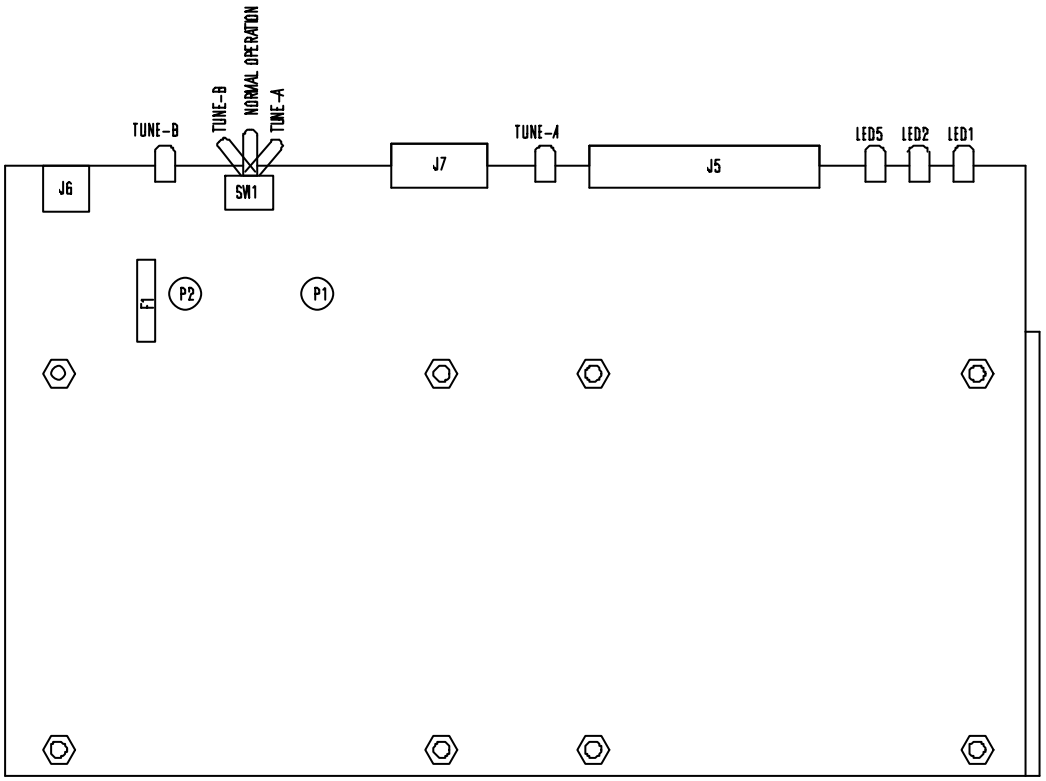

Figure 3: Bottom View

There are four external connectors, their pin functions are described in tables 2 to 5, the pin functions of the connectors between the Carrier Board and the RFMs are described in table 1:

Table 1 lists the pin functions for the Carrier Board to RFM Connectors

Table 2 lists the pin functions of the Interface Connector (J5) to external control units

Table 3 lists the pin functions for the Power Connector (J6)

Table 4 lists the pin functions for the Tuning/Adjustment Connector (J7)

Table 1: J1 Pin Functions

Pin#	Signal	Direction	Description
1	GND	IN	Logic ground
2	TXCT-	IN	Transmitter control input for activation of transmitter (active low, internal pull-up resistor)
3	VSP	IN	Supply voltage for transmitter power stage
4	NC	-	Not connected
5	NC	-	Not connected
6	NC	-	Not connected
7	GNDP	IN	Transmitter power stage ground
8	NC		Not connected
9	GNDP	IN	Transmitter power stage ground
10	NC	-	Not connected
11	VSP	IN	Supply voltage for transmitter power stage
12	NC	-	Not connected
13	VSP	IN	Supply voltage for transmitter power stage
14	NC	-	Not connected
15	VCC	IN/OUT	Internal regulated logic supply voltage output / externally regulated logic supply voltage input
16	CPS	IN	Carrier Phase Synchronization oscillator signal input

Table 2: J5 - Interface Connector Pin Functions (EIA Standard RS422-A)

Pin#	Signal	Direction	Description
1	DATA-A+	IN	RFM-A select, non-inverted input
2	GND		Ground
3	DATA-A-	IN	RFM-A select, inverted input
4	GND		Ground
5	DATA-B+	IN	RFM-B select, non-inverted input
6	GND		Ground
7	DATA-B-	IN	RFM-B select, inverted input
8	GND		Ground
9	TX-EN+	IN	TX-EN control, transmit enable for RFM-A &-B
10	GND		Ground
11	TX-EN-	IN	TX-EN control, transmit enable for RFM-A &-B
12	GND		Ground
13	AB-SEL+	IN	AB-SEL control, toggle power output level between RFM-A & -B
14	GND		Ground
15	AB-SEL-	IN	AB-SEL control, toggle power output level between RFM-A & -B
16	GND		Ground
17	TUNE+	OUT	Signal output tune mode indicator
18	GND		Ground
19	TUNE-	OUT	Signal output tune mode indicator
20	GND		Ground
21	TUNE-A+	OUT	Signal output to show activated RFM
22	GND		Ground
23	TUNE-A-	OUT	Signal output to show activated RFM
24	GND	IN	Ground
25	NC	-	Not connected
26	GND		Ground

Table 3: J6 - Power Connector Pin Functions

Pin#	Signal	Description
1	Vin	Transmitter supply voltage
2	Vcc	Logic supply voltage
3	GND	Ground

Table 4: J7 - Tuning/Adjustment Connector Pin Functions

Pin#	Signal	Direction	Description
1	V_RFMA+	OUT	Tuning measurement point for RFM-A (Tune-A)
2	V_RFMA-	OUT	Tuning measurement point for RFM-A(Tune-A)
3	V_RFMB+	OUT	Tuning measurement point for RFM-B(Tune-B)

4	V_RFMB-	OUT	Tuning measurement point for RFM-B(Tune-B)
5	NC	-	Not connected
6	NC	-	Not connected

2.2 Transmit Only RFM

2.2.1 Connectors

Table 5 lists the pin functions for the antenna terminal connectors (ANT) on both RFMs

Table 5: Antenna Connector Pin Functions

Pin#	Signal	Direction	Description
1	GNDA	OUT	Ground for cable shield
2	ANT_1	OUT	Symmetrical Antenna output 1
3	ANT_2	OUT	Symmetrical Antenna output 2

2.2.2 Transmitter

The logic is supplied with a regulated VCC = 5 V from the Carrier Board.

The RFM's transmitter power stage is supplied by the Carrier Board supply lines VSP and GNDP. Because of the high current for the transmitter power stage, these supply lines are separated from the logic supply lines and have two pins per line.

CAUTION: The TX-MOD must not be operated in continuous transmit mode, when operated at full Power Output.

The pulse width modulated oscillator signal is fed to the transmitter power stage. The transmitter power stage amplifies the oscillator signal and feeds this amplified signal to the antenna circuit, to generate the charge-up field.

The antenna circuit is described in Section 2.2.3 “RF Output Circuit”.

2.2.3 RF Output Circuit

A block diagram of the antenna output circuit can be seen in figure 4.

The RFM together with the Tuning Circuit (which is connected via a symmetric shielded antenna cable (Twin-Ax)), generates the magnetic charge-up field.

The antenna circuit comprises inductance and capacitance resonating at the transmit frequency f_TX of 134.2 kHz. The resonator inductance consists of the antenna coil and an adjustable series coil.

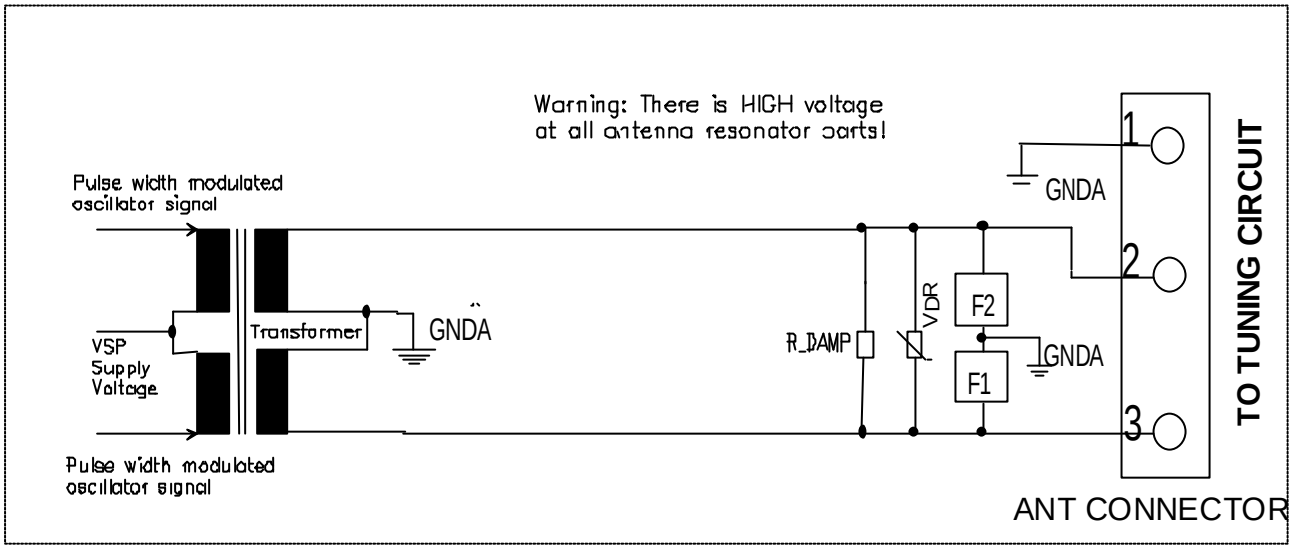

Figure 4: RF Output Circuit Block Diagram

In order to get high resonance voltage and thus high charge-up field strength, the antenna circuit has to be tuned to resonance by means of the Tuning Circuit at the antenna location.

The RFM transformer's secondary winding is split into two windings. These windings are wound in such a way that Common Mode Noise that is coupled to both antenna cables is canceled out.

WARNING

Care must be taken when handling the TX-MOD System. HIGH VOLTAGE across the antenna terminals and all antenna resonator parts could be harmful to your health.

2.2.4 RF Overvoltage Protection

The Antenna resonance voltage is internally limited in order not to damage the TX-MOD System if no load (Antenna) is connected. The RF output voltage on the ANT connectors is limited to 700 Vpp.

2.2.5 RF Overcurrent and Temperature Protection

The RFMs on the TX-MOD have a temperature compensation circuit built into them which will switch off the transmitter power stage if an over-current situation causes the temperature to exceed the allowed limits. After recovery (when the temperature drops again) the RFM reverts to normal operation. If this happens it is an indication that the TX-MOD is not being operated within the allowed specifications.

2.2.6 Pulse Width Modulation

The transmitter power stage is internally connected to the supply lines GNDP and VSP via a com-mon mode choke coil, in order to reduce Electromagnetic Interference (EMI) on the supply lines.

The transmit frequency (134.2 kHz) from the oscillator is fed to the Pulse Width Modulator (PWM). By means of a potentiometer (P1/P2 on the Carrier Board) connected to the TX-RFM, the PWM sets the pulse width ratio between 20% and 37%. For an example of two different oscillator signal pulse widths see figure 5. Decreasing the 134.2 kHz frequency pulse width ratio decreases the generated transmit (charge-up) field strength.

Thus it is possible to adjust the generated field strength by selecting different pulse width ratios.

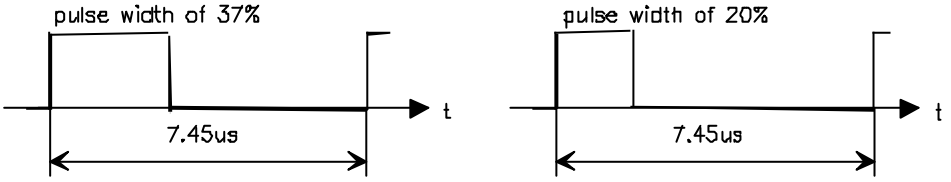

Figure 5: Pulse Width Examples

Note: *The pulse width setting for adjusting the field strength is done on the TX-MOD for each RFM individually.*

3. Specifications

3.1 Characteristics

CAUTION: Exceeding the electrical characteristics may lead to permanent damage to the TX-MOD system. Exposure to maximum rated conditions for extended periods may affect device reliability.

The TX-MOD must not be operated in continuous transmit mode, when operated at full power output.

Operating free-air temperature range	T_oper	-20 to +70 ^{o}C
Storage temperature range	T_store	-40 to +85 ^{o}C

Note: *Free-air temperature: air temperature immediately surrounding the TX-MOD. 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 maximum ratings.*

Symbol	**Parameter**	**min.**	**typ.**	**max.**	**Unit**
Vcc	Logic Supply Voltage	4.75	5.0	5.25	V dc
Vin	Supply voltage	17.5	24.0	38.0	V dc
I_Vin	Current consumption		1.5	2.5	A
I_Vcc	Current consumption of logic supply	50	120	240	mA
V_ANT	Antenna resonance voltage		250	350	Vpeak
f_TX	Transmitter output frequency	134.18	134.20	134.22	kHz

3.2 Relative Humidity

≤ 97% non-condensing, IEC 68-2-30, Test Db, 21 cycles

3.3 Mechanical data

The mechanical data is given in the table below.

Parameter	typical	Unit
Height of complete TX-MOD (excluding mounting bolts)	2185 + 80 - 40	mil
Weight of TX-MOD	435	gram

The mechanical dimensions given in figure 6 are in mil with a tolerance of +/- 30 mil (unless otherwise noted).

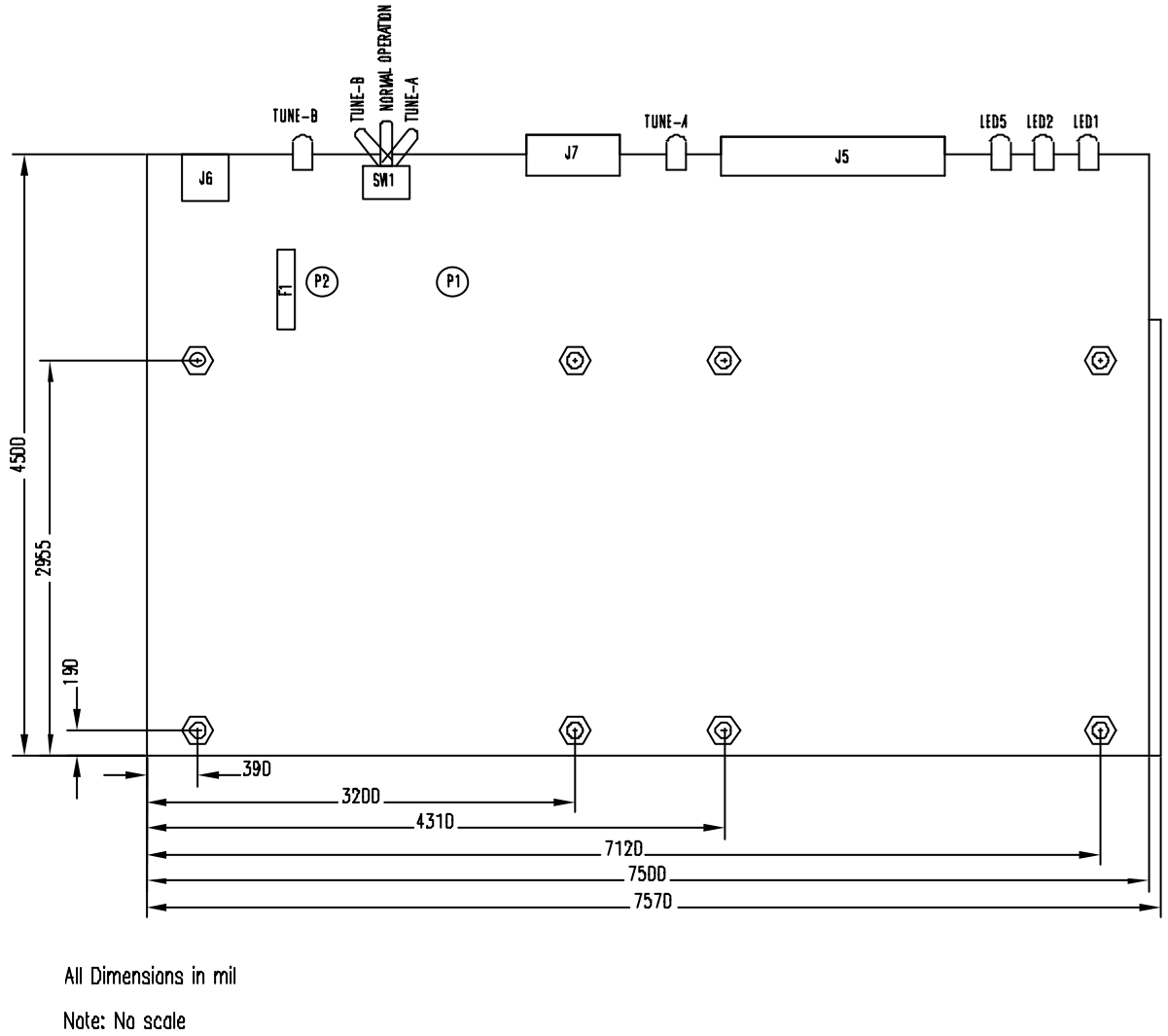

Figure 6: Mechanical Dimensions

4. Adjustments

4.1 Adjustment of Oscillator Signal Pulse Width

The TX-MOD has a built-in feature to set the pulse width of the transmitter signal which is generated by the RFM. This enables the generated field strength to be reduced from 37% down to about 20%.

For this purpose there are pulse width setting potentiometers on the TX-MOD PCB (P1/P2, refer to figure 2 for location). Reducing the resistance value of the potentiometer decreases the pulse width and thus also the field strength.

Table 6 provides an overview of oscillator signal pulse width and corresponding size of field strength reduction, when different oscillator signal pulse widths are selected by the potentiometer.

Table 6: Oscillator Signal Pulse Width Versus Potentiometer Position

Resistive value of potentiometer	Oscillator signal pulse width [%]	Field strength reduction [dB]
100 kΩ	37	-3
11 kΩ	25	-6
0	20	-7

4.2 Adjustment Procedure

1. Select RFM-A for tuning by switching SW1 (see figure 6) into Tune-A position.

2. Activate RFM-A by applying a positive differential voltage at TX-EN.

3. Adjust the Tuning Module at the antenna for maximum field strength (monitor output at connector J7).

4. Adjust the “active” potentiometer (P1 or P2, depending on AB_SEL) to bring the field strength to the required level (monitor output at connector J7).

5. Switch SW1 to Tune-B and repeat steps 2 to 4 for the other RFM.

6. Return SW1 to the middle position.

Appendix A: Abbreviations

AM	Amplitude Modulation
AQL	Acceptable Quality Level
ASK	Amplitude Shift Keying
BCC	Block Check Character
Cmd	Command
CRC	Cyclic Redundancy Check
DBCC	Data BCC
EM	Electro-Magnetic
EMI	Electro-Magnetic Interference
ESD	Electro Static Discharge
FBCC	Frame BCC
FCC	Federal Communications Commission
FM	Frequency Modulation
FM/FSK	Frequency Modulation/Frequency Shift Keying
FSK	Frequency Shift Keying
IC	Integrated Circuit
LED	Light Emitting Diode
LF	Low Frequency
LSB	Least Significant Bit
LSByte	Least Significant Byte
MPT	Multipage Transponder
MSB	Most Significant Bit
MSByte	Most Significant Byte
NRZ	Non Return to Zero
PB I	Power Burst one
PB II	Power Burst two
PCB	Printed Circuit Board
PTT	Post & Telecommunications Telegraph
PWM	Pulse Width Modulation
RF	Radio Frequency
RF-ID	Radio Frequency Identification
RFM	Radio Frequency Module
RO	Read Only Transponder
R/W	Read/Write Transponder
SCI	Serial Communications Interface
SAMPT	Selective Addressable Multipage Transponder
S/W	Software
TIRIS	Texas Instruments Registration and Identification System
TX-MOD	Transmitter Module