Texas Instruments Registration and Identification System

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Dynamic Auto Tuning System

RI-MOD-DATA (discontinued)

Reference Manual

11-06-21-036 15 August 1996

Edition Notice: First Edition - August 1996

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

TIRIS Dynamic Auto Tuning System RI-MOD-DATA

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1. Introduction

1.1 General

This document provides information about the TIRIS Dynamic Auto Tuning System RI-MOD-DATA. This document describes the system and how to install it. The system comprises a Dynamic Auto Tuning Module and Power Radio Frequency Module.

1.2 Reference

This document should be used in conjunction with the Power-RFM Reference Manual:

Power Radio Frequency Module RI-RFM-007A
Reference Manual 11-06-29-026

1.3 Product Description

The Dynamic Auto Tuning (DAT) system is used to tune a TIRIS standard antenna (which is operated from a TIRIS RF Module) to resonance without any user interaction. The tuning is performed during the whole of the transmit burst cycle and therefore detuning even during the transmit burst is automatically compensated for (= dynamic tuning).

The DAT Module should be mounted on a corresponding Control Module (for example: TIRIS Series 2000 Control Module). The antenna is connected to the RF Module as usual. No extra control signals from the Control Module are needed, all necessary signals are derived from the RF Module.

Three LEDs are available to indicate the status of the resonance tuning, the LED signals are also available at a 4-pin male connector so that they can be sampled by a Control Module or used to connect additional external LEDs.

1.4 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.

1.5 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 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 Function

2.1 Description

All the signals that are required for the DAT are derived from the RF Module, they are accessed via the 6-pin ATI connector J2. The connection between the Control Module and the RF Module is directly connected through from the RFM's 16-pin connector J1.

Tuning of the RF Module's resonance circuit is achieved by changing its total capacitance.

There are seven connectors on the DAT Module, these are:

J1 This is a 6 line flat cable with a 6-pin plug connector which plugs onto the RF Module's ATI connector (J2).

J2 This is a 14 line flat cable with a 14-pin plug connector which plugs onto the RF Module's C-Tuning connector (J6).

J3 This is a 4-pin male connector, allowing access to the 3 indicator LED signals.

J4 This is a 6-pin male connector which is available for future options. The 'automatic' antenna inductance tuning range can be expanded by using an add-on module.

J5 This is a 16-pin connector (male pin header). This connector corresponds exactly to the RF Module's 16-pin interface connector (J1).

J6 This is a 16-pin connector (female plug). This connector corresponds exactly to the Control Module's 16-pin interface connector.

ANT_I These are the antenna terminal feed-through connections. They allow direct access
ANT_0 to the antenna terminals on the underside of the DAT Module. The antenna connections are fed directly through one-to-one.

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, the antenna should not be connected to the RF Module.

The DAT Module must be mounted underneath the RF Module by means of four M3 mounting bolts on the bottom side of the RF Module. The signals on the 16-pin interface connector are fed directly through.

A layout of the DAT Module viewed from the top is shown in figure 1. A block schematic is shown in figure 2.

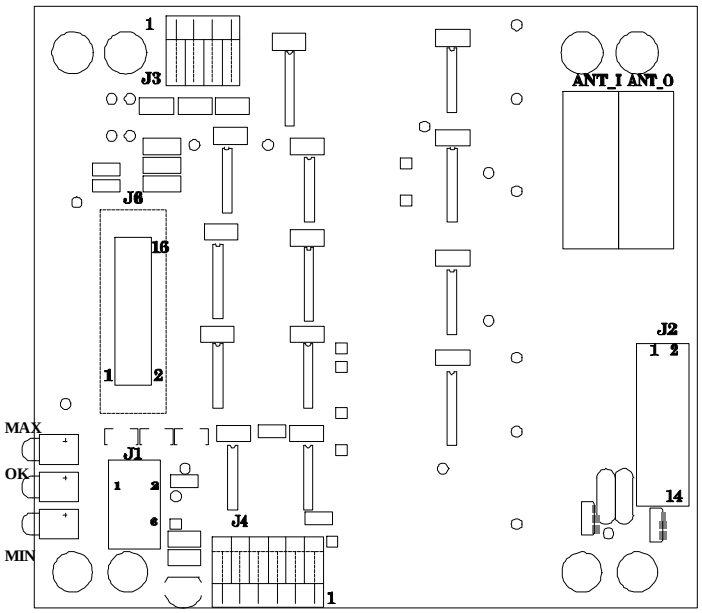

Figure 1: Top View

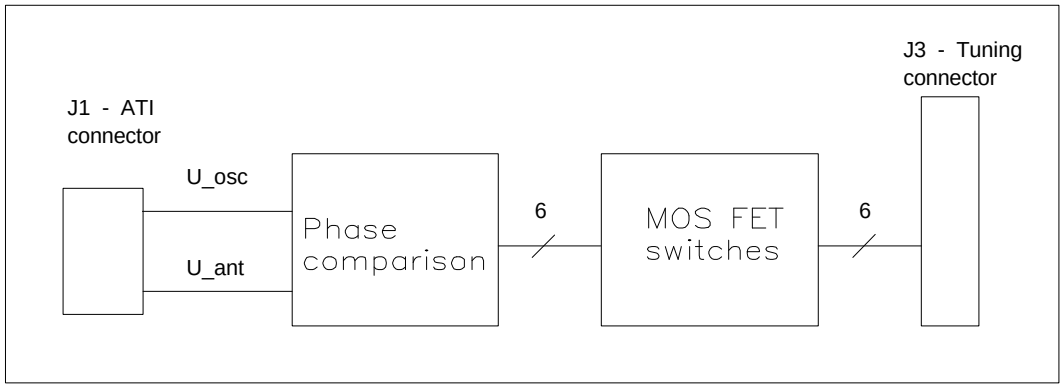

Figure 2: Block Diagram

To tune to resonance, the DAT Module does a phase comparison of the digital signals U_osc and U_ant from the RF Module's transmit oscillator and the antenna resonator. According to this phase correlation, the corresponding MOS FETs on the DAT Module are switched ON or OFF. In this way, the MOS FETs connect or disconnect the tuning capacitors on the RF Module and the antenna resonator is tuned.

When the phase correlation meets a certain condition, the status of the MOS FETs remains unchanged, until the phase correlation once again shows an untuned condition. In this way the tuning of the antenna can be done very quickly, one capacitive tuning step can be done within one period of the RF ringing. Thus the whole tuning range of the RF Module (64 binary steps) can be swept through within a maximum of 2 milliseconds.

The DAT Module is supplied from the RF Module, it needs two supplies:

- One is the regulated supply VSP from the RF Module for the LEDs.
- The other supply is the regulated +5V supply from the RF Module's on-board regulator.

Note: *Be careful to plug the connectors J2 and J3 in correctly. Do not offset the connectors by one or more pins, as they do not have a polarisation.*

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

2.2 DAT Connectors

Connector J1. This connector is the same as the 6-pin ATI connector on the RF Module and has exactly the same pin assignment. Please refer to the RF Module Reference Manual for details.

Connector J2. This connector is connected to the 14-pin tuning connector on the RF Module and has exactly the same pin assignment. Please refer to the RF Module Reference Manual for details.

Connector J3. This is a 4-pin male connector with 2.54 mm pin spacing (AMP Quick 828548-4). Its pin functions are listed in Table 1.

Connector J4. This connector is a 6-pin AMP-Quick connector (AMP Quick 828548-6). It is intended for future options of expanding the 'automatic' antenna inductance tuning range.

Connectors J5 and J6. These connector have the same pin assignment as the 16-pin interface connector on the RF Module. Please refer to the RF Module Reference Manual for details.

Table 1: J3 Pin Functions

Pin#	Signal	Direction	Description
1	V_LED	OUT	Roughly stabilized +5V supply voltage for LEDs
2	E_MIN	OUT	MIN signal indicating minimum possible tuning capacity
3	E_OK	OUT	OK signal indicating that antenna is tuned to resonance
4	E_MAX	OUT	MAX signal indicating maximum possible tuning capacity

3. Specifications

3.1 Absolute Maximum Ratings

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

Operating free-air temperature range	T_oper	DATA	-25 to +70	^{o}C
Storage temperature range	T_store	DATA	-40 to +85	^{o}C

Note: *Free-air temperature: air temperature immediately surrounding the System. If the system 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 System. 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
I_V_LED	Output current of internal +5 V regulator to drive LEDs (connector J3 pin 1)			10	mA
I_sink	Maximum current which the driver transistors for the indicator signals Min, OK and Max can sink (signals at connector J3)			15	mA

3.3 Electrical Characteristics

Symbol	Parameter	min.	typ.	max.	Unit
VoL	Low level output voltage (= active state) of indicator signals Min, OK and Max * no current load			0.8	V
VoH	High level output voltage (= inactive state) of indicator signals Min, OK and Max * no current load	2.4			V
R_Cha_ ATC1/2	Additional resistance added by MOSFET switches for tuning capacitors: ATC1 and ATC2			1.8	Ohm
R_Cha_ ATC3/4	Additional resistance added by MOSFET switches for tuning capacitors: ATC3 ATC4			1.0	Ohm
R_Cha_ ATC5	Additional resistance added by MOSFET switches for tuning capacitors: ATC5			0.55	Ohm
R_Cha_ ATC6	Additional resistance added by MOSFET switches for tuning capacitors: ATC6			0.28	Ohm

3.4 Timing Characteristics

Symbol	Parameter	min.	typ.	max	Unit
t_TA	Time required to tune antenna to resonance (max value corresponds to tuning from minimum to maximum tuning capacitor value)	7.5	1000	2000	µs
t_ramp	Ring-in time for antenna resonance voltage, after which the signals Min, OK and Max are valid	1	2	5	ms
Delta_phi	Width of phase window, within which the antenna tuning is regarded as tuned	- 4		+ 4	degree

3.5 Mechanical Data

Table 2: Mechanical Data

Parameter	Typical	Unit
Height (including RFM)	55.0 +/- 1.5	mm
Weight of DAT System	340	Grams

The outline dimensions in figure 3 have a tolerance of ± 1.0 mm, the remaining dimensions have a tolerance of ± 0.35 mm.

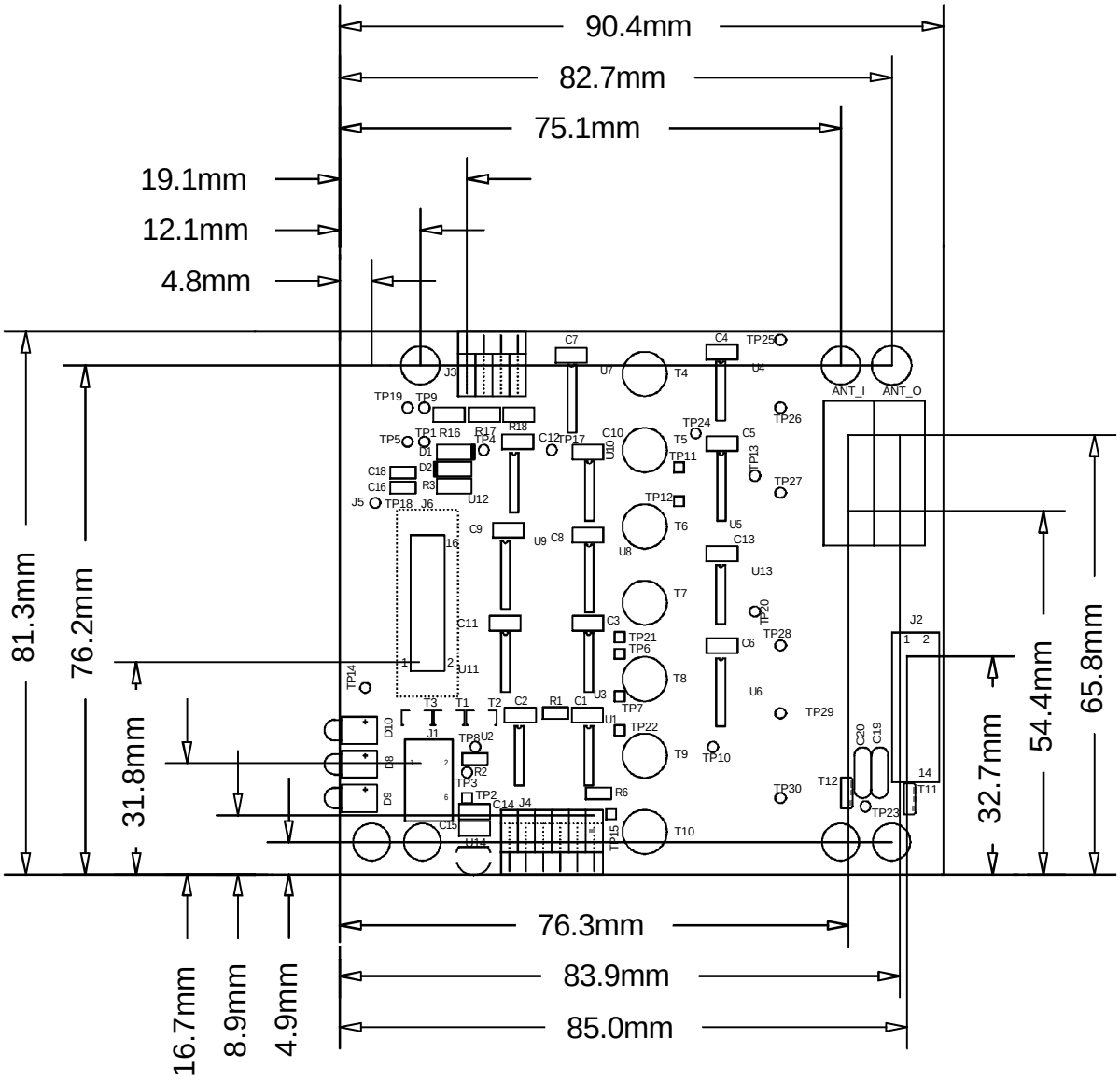

Figure 3: Mechanical data

4. Installation and use of the DAT System

4.1 Power Supply

The DAT System is completely supplied from the RF Module. Therefore all supply connections are to the RFM.

4.2 Antenna Resonance Tuning

For proper operation of the transmitter and receiver function, the antenna has to be tuned to the resonance frequency f_TX. This is done automatically in a fast and easy way using the DAT System.

The DAT System uses a phase comparison to verify that the antenna is tuned to resonance. When this phase comparison result shows that the antenna is outside a certain phase window (refer to Section 3 “Specifications” for details), the tuning of the antenna is started again. In this way, the antenna tuning is performed dynamically, because the antenna is tuned to resonance during the transmit burst.

Tuning is very fast. The longest time needed to tune the antenna to resonance is when all tuning capacitors have to be switched from minimum to maximum value (or vice-versa). In order to do this, all 64 steps of the tuning capacitors have to be switched. Nevertheless this is done in a maximum time of 2000 µs. The tuning of the antenna is done in a really transparent way; no further control signals from a Control Unit are necessary.

The DAT has three indicator LEDs on board (see figure 1 for location of LEDs). These LEDs are:

- Red LED indicating that the lower limit of the tuning range is reached ==> Min LED
- Green LED indicating that the antenna is tuned to resonance ==> OK LED
- Red LED indicating that the upper limit of the tuning range is reached ==> Max LED

Min, OK and Max are printed on the PCB close to these LEDs.

These three signals are also accessible at the connector J3, so that additional external LEDs could be driven. In addition these signals at the connector J3 could also be connected to an I/O port of a Control Module so that the Control Module could sample fault conditions of the DAT System.

Note: *The indicator signals Min, OK and Max are not valid during the build-up time of the antenna resonator voltage. Please refer to Section 3 “Specifications” for parameter 't_ramp’.*

Figure 4 shows how the DAT Module is mounted onto the RF Module. As you can see, the RF Module is mounted on the DAT Module in such a way that the 16-pin connectors are offset. This allows the signals of the 16-pin connector to be fed through. In addition, this offset offers the advantage that the RF Module together with the DAT Module can be mounted on a TIRIS S2000 CTL Module without increasing the surface area of the CTL Module (the DAT Module has the same surface area as the CTL Module).

Figure 4 also shows where connectors J1 and J2 must be plugged in. It is also possible to connect the antenna terminals through so that they can be accessed on the underside of the DAT Module.

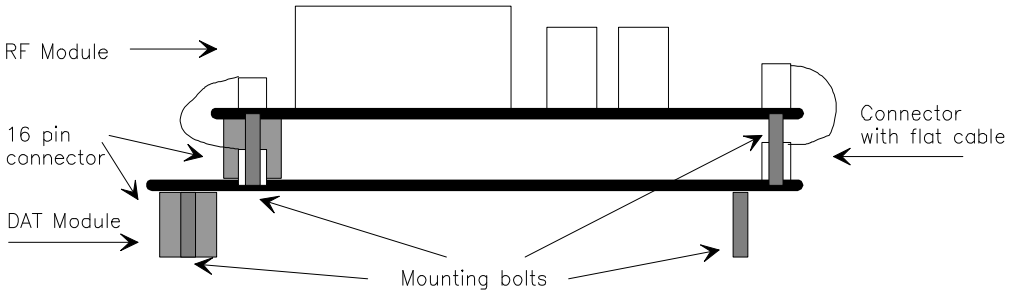

Figure 4: Side view of DAT System mounted on RF Module

The antenna tuning inductance range is still determined by the RF Module. It is not changed by the DAT System. Please refer to the RF Module Reference Manual for antenna tuning inductance ranges.

Note: *If you use the methods for increasing the antenna tuning inductance range, as described in the RF Module Reference Manual, it could result in a reduction of the standard antenna inductance tuning range.*

4.3 RXSS- Tuning

To synchronize the wireless RF burst of several Readers, the RXSS threshold level of the RF Module must be adjusted correctly (as described in the RF Module Reference Manual).

It is recommended to use the TIRIS accessory 'Antenna Tuning Indicator' (ATI) for this purpose.

As the ATI connector of the RF Module is already used by the DAT System, there are two options for tuning the RXSS- threshold level:

- Watching the EMI LED on the TIRIS Control Module

or

- Disconnecting the 6-pin connector of the DAT System. Connect the ATI to adjust the RXSS- threshold level, and then plug the 6-pin DAT connector in again afterwards.

For instructions on how to tune the RXSS- threshold level, please refer to the RF Module Reference Manual.

4.4 Connection of external LEDs

It is possible to connect additional external LEDs (Min, OK and Max LEDs) via connector J3. Pins 2 to 4 have a 470 Ohm series resistor on board for driving the LEDs. Pin 1 supplies regulated +5V.

Figure 5 shows how these LEDs need to be connected.

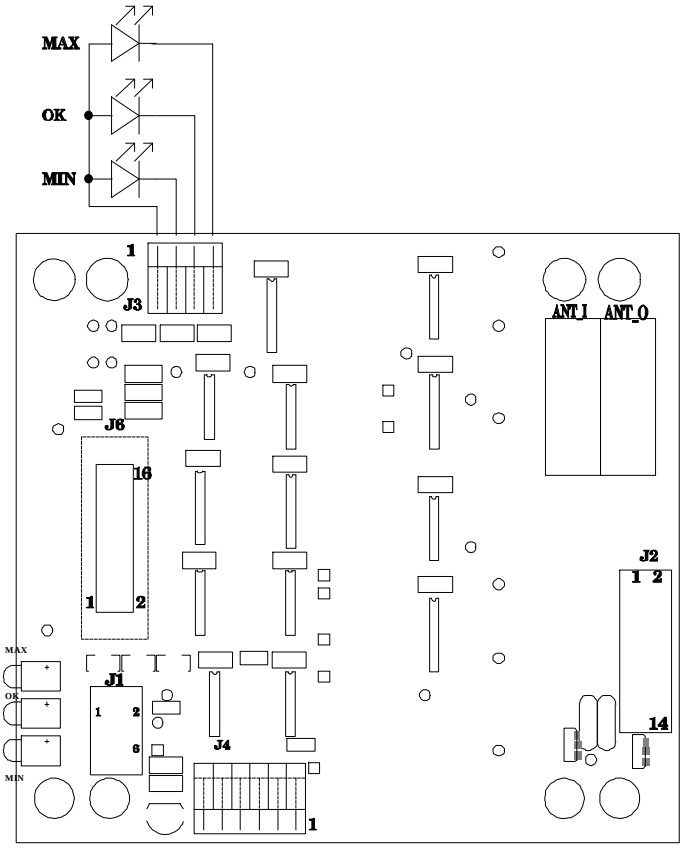

Figure 5: Connection of external LEDs