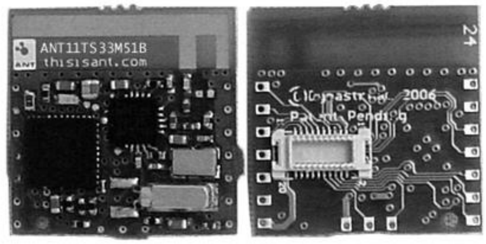
AT3 RF Transceiver Module



FEATURES

- 2.4GHz worldwide ISM band
- 20mm x 20mm drop-in module
- SensRcore™ development platform
- Ultra low power operation
- Simple sync/async serial interface
- Integrated F antenna
- Broadcast, acknowledged, or burst data transmissions
- ANT channel combined message rate up to 180Hz (8byte data payload)
- Minimum message rate per ANT channel 0.5Hz
- Burst transfer rate up to 20Kbps (true data throughput)
- 1 Mbps RF data rate
- Up to 1/4/8 ANT channels
- 125 selectable RF channels
- Up to 3 public, managed and/or private networks
- 2.0V to 3.6V supply voltage range
- -40°C to +85°C operating temperature
- FCC test ready
- RoHS compliant

FAMILY MEMBERS

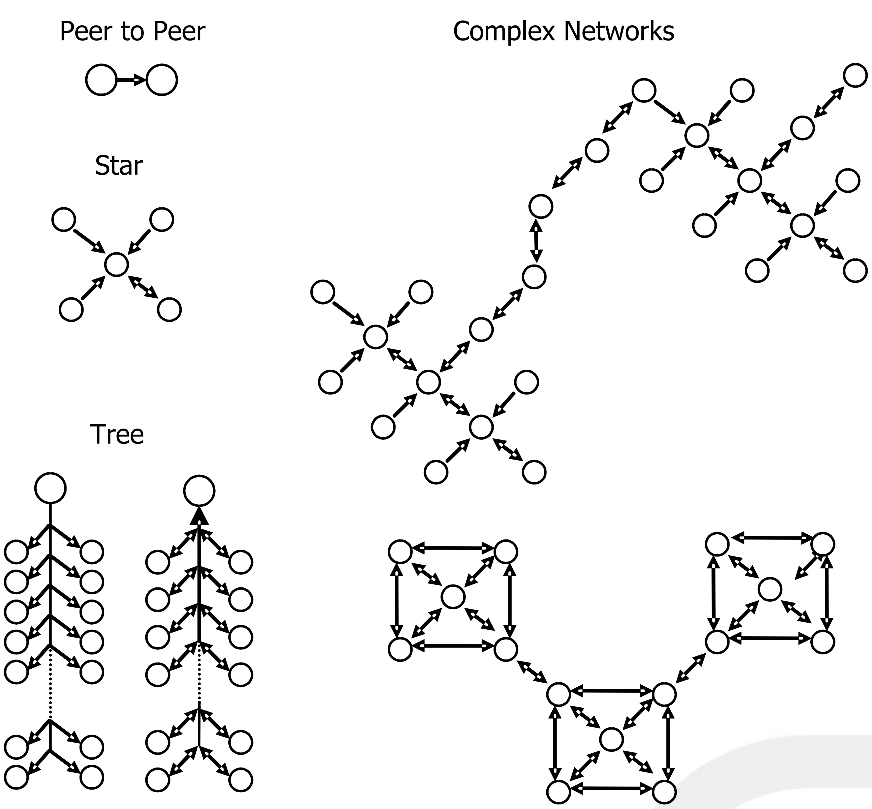
ANT11TS33M4IB / ANT11TS33M5IB
8 ANT channels, SensRcore™

ANT11TS53M4IB
4 ANT channels, SensRcore™

ANT11TS63M4IB
1 ANT channel, SensRcore™

ANT11TR13M4IB
8 ANT channels

ANT NETWORK CONFIGURATIONS



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Notices and Restricted Use Information

Restricted use of ANT RF Transceiver Modules.

The ANT RF Transceiver Module has not been certified for use by the FCC in accord with Part 15, or to other known standards of operation governing radio emissions. Distribution and sale of this RF Transceiver Module is intended solely as a component of an end-product(s) that is subject to FCC regulation, or other authorities governing radio emission. This RF Transceiver Module may not be resold by users for any purpose. Operation of the RF Transceiver Module in the development of future devices is deemed within the discretion of the user and the user shall have all responsibility for any compliance with any FCC regulation or other authority governing radio emission of such development or use. All products developed by the user must be approved by the FCC or other authority governing radio emission prior to marketing or sale of such products to consumers and user bears all responsibility for obtaining the authority's prior approval, or approval as needed from any other authority governing radio emission. If user has obtained the RF Transceiver Modules for any purpose not identified above, user should return the RF Transceiver Modules to Dynastream Innovations Inc. immediately. Dynastream makes no representation with respect to the adequacy of the RF Transceiver Modules in developing low-power wireless data communications applications or systems. The RF Transceiver Modules operate on shared radio channels. Any Products using ANT RF technology must be designed so that a loss of communications due to radio interference or otherwise will not endanger either people or property, and will not cause the loss of valuable data. Dynastream assumes no liability for the performance of products which are designed or created using the RF Transceiver Modules.

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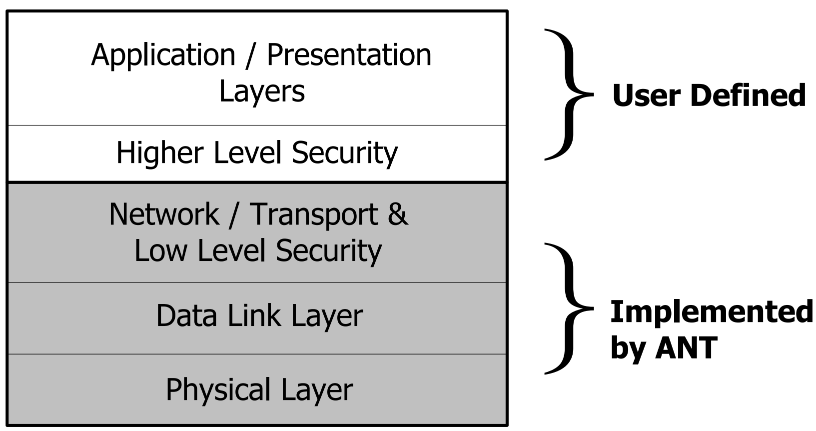
The information contained in this document is subject to change without notice and should not be construed as a commitment by Dynastream Innovations Inc. unless such commitment is expressly given in a covering document.

ANT™ Overview

ANT™ is a practical wireless sensor network protocol running on 2.4 GHz ISM band. Designed for ultra low power, ease of use, efficiency and scalability, ANT easily handles peer-to-peer, star, tree and practical mesh topologies. ANT provides reliable data communications, flexible and adaptive network operation and cross-talk immunity. ANT's protocol stack is extremely compact, requiring minimal microcontroller resources and considerably reducing system costs.

ANT provides carefree handling of the Physical, Network, and Transport OSI layers. In addition, it incorporates key low-level security features that form the foundation for user-defined, sophisticated, network-security implementations. ANT ensures adequate user control while considerably lightening computational burden in providing a simple yet effective wireless networking solution.



ANT supports public, managed and private network architectures with 232 uniquely addressable devices possible, ensuring that each device can be uniquely identified from each other in the same network.

ANT is proven with an installed base of over two million nodes in ultra low power sensor network applications in sport, fitness, home and industrial automation. The ANT solutions are available in chips, chipsets and modules to suit a wide variety of application needs.

A complete description of the ANT message protocol is found in the ANT Message Protocol and Usage document. The serial interface details are provided in the Interfacing with ANT General Purpose Chipsets and Modules document.

1 AT3 Modules

The AT3 drop-in modules are intentionally engineered for ease of use, scalability and lowest power consumption. AT3 modules are based on the chipset combining MSP430f22x2/4, the ultra low power microcontroller (MCU) from Texas Instrument, and nRF24L01, the ultra low power radio chip from Nordic Semiconductor. Integrated with an F antenna, AT3 modules reduce the need for RF design expertise. SensRcore™, an easy-to-use design platform to build wireless sensors, is equipped in most of AT3 modules.

AT3 family of modules provides a comprehensive solution to the requirements of building a wireless sensor network consisting of nodes from simple sensors to complex hubs or control nodes. A common pin-out and 20 x 20mm footprint enables easy network development, upgrade, migration and maintenance.

Four standard AT3 modules are delivered on one common hardware platform:

Module	Description
ANT11TS33M4IB	8 ANT channels, SensRcore with 8 data channels, surface mountable, industrial temperature range
ANT11TS33M5IB	8 ANT channels, SensRcore with 8 data channels, Molex connector, industrial temperature range
ANT11TR13M4IB	8 ANT channels, surface mountable, industrial temperature range
ANT11TS53M4IB	4 ANT channels, SensRcore with 6 data channels, surface mountable, industrial temperature range
ANT11TS63M4IB	1 ANT channel, SensRcore with 4 data channels, surface mountable, industrial temperature range

The AT3 module has been pre-tested by a FCC registered lab to comply with the requirements for FCC CFR47 and other applicable standards for Intentional Radiators.

1.1 SensRcore™ Platform

SensRcore is a wireless sensor development platform that is equipped with most AT3 modules. When using sensRcore to develop a wireless sensor, both analog and digital sensors can be directly connected to the ANT MCU. The normally required firmware development is replaced by writing a simple SensRcore script. An application host MCU could be eliminated from the system design. The result is a reduced component cost, size, power and the shortened development cycle of the target sensor device.

When AT3 modules are operated in sensRcore mode, the channel configuration parameters are stored in non-volatile memory and are enabled upon power-up. When I/O pins are configured as digital inputs or outputs, the electrical requirements are the same as all other signaling pins. When I/O pins are configured as analog inputs, different signal ranges can be selected with different reference voltages. The reference voltages available are VCC, 2.5V, and 1.5V. Signals that exceed the specified reference level will be read by the A/D as a maximum value. Signal levels should not exceed VCC. Each AIOx pin can be used as an analog input or a digital I/O pin; each IOx pin can be used only as a digital I/O pin. I/O pins that are not being used in a specific SensRcore mode configuration should be left configured as digital inputs, which is the default setting.

ANT sensRcore scripts consist of ANT messages and commands. Please refer to "ANT Message Protocol and Usage" and "SensRcore Messaging and Usage". The script can be generated by using the software tool SensRware. There are 200 bytes available in the non volatile memory for SensRcore script.

1.2 Pin Assignment

The ANT11Txx3MxIB module contains a dual-chip ANT implementation. The ANT MCU contains the ANT protocol stack along with the ANT serial interface. The radio chip is Nordic Semiconductor's nRF24L01. The module may be connected to the user's host controller using the 17 pin-out assignment (surface mount) style or the 20-pin Molex header connection style provided below:

Surface Mount Pin	Molex Header Pin	Pin Name	Async Mode	Sync Mode	SensRcore Mode	Description
1	6	TIE_GND1	GND	GND	GND	Not used, must be tied to ground
2	10	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$	Active low reset pin
3	1	VCC	VCC	VCC	VCC	Power supply source
4	19	TIE_GND2	GND	GND	GND	Power supply ground
5	8	IO5	Tie to GND	Tie to GND	IO5	SensRcore mode -> digital input/output
6	17	$\overline{\text{SUSPEND}}$ / $\overline{\text{SRDY}}$ /AIO0	$\overline{\text{SUSPEND}}$	$\overline{\text{SRDY}}$	AIO0	ASync -> Suspend control Sync -> Serial port ready SensRcore -> Analog/Digital input / output
7	15	SLEEP/ $\overline{\text{MRDY}}$ /AIO1	SLEEP	$\overline{\text{MRDY}}$	AIO1	Async -> Sleep mode enable Sync -> Message ready indication SensRcore -> Analog/Digital input / output
8	13	IO7	Tie to GND	Tie to GND	IO7	SensRcore -> Digital input / output
9	11	PORTSEL	PORTSEL (Tie to GND)	PORTSEL (Tie to VCC)	Tie to VCC for custom Tie to GND for demo	Asynchronous or synchronous port select SensRcore -> Demo script or user scripts
10	7	BR2/SCLK/ DevSel2	BR2	SCLK	DevSel2	Async -> Baud rate selection Sync -> Clock output signal SensRcore -> Configuration selection
11	4	TXD0/SOUT/ IO6	TXD0	SOUT	IO6	Async -> Transmit data signal Sync -> Data output SensRcore -> Digital input / output
12	3	RXD0/SIN/AIO2	RXD0	SIN	AIO2	Async -> Receive data signal

						Sync -> Data input SensRcore -> Analog/Digital input / output
13	5	BR1/SFLOW/ DevSel1	BR1	SFLOW	DevSel1	Async -> Baud rate selection Sync -> Bit or byte flow control select SensRcore -> Configuration selection
14	9	BR3/DevSel3	BR3	Tie to GND	DevSel3	Async -> Baud rate selection Sync -> Tie low SensRcore -> Configuration selection
15	14	AIO3	Tie to GND	Tie to GND	AIO3	SensRcore -> Analog/Digital input / output
16	12	AIO4	Tie to GND	Tie to GND	AIO4	SensRcore -> Analog/Digital input / output
17	2	RTS/SEN/IOSEL	RTS	SEN	IOSEL (Tie to GND)	Async -> Request to send Sync -> Serial enable signal SensRcore -> IOSEL tie low
	16, 18, 20	NC	NC	NC	NC	No connection

1.3 Asynchronous Baud Rate

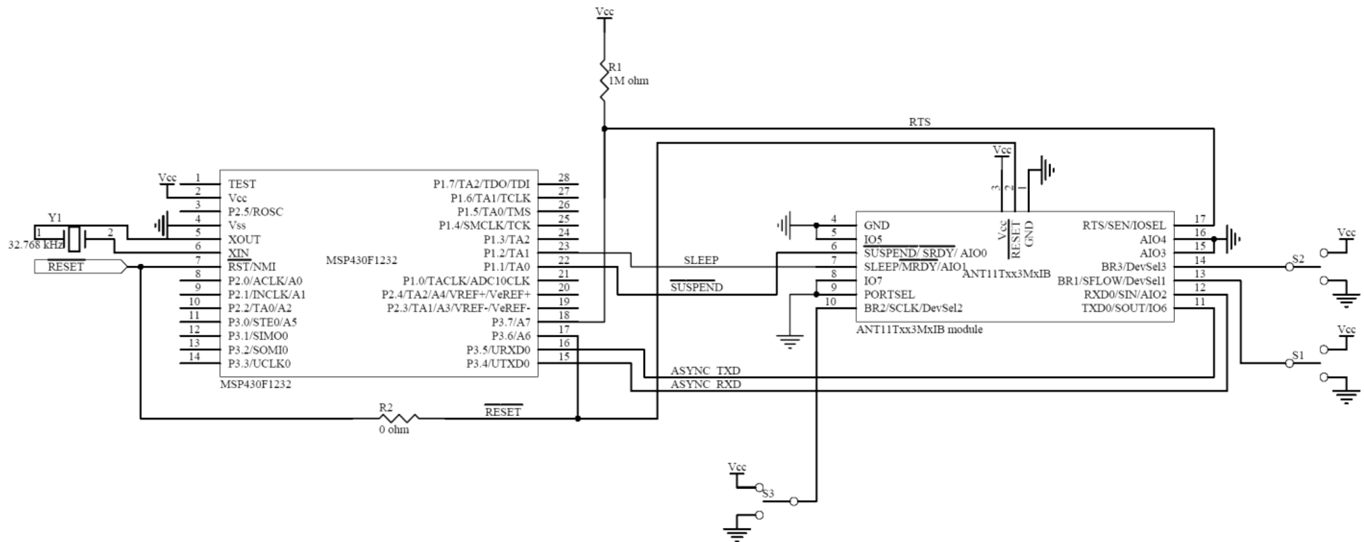
The baud rate of the asynchronous communication is controlled by the speed select signals BR1, BR2 and BR3. The table below shows the relationship between the states of the speed **select signals and the** corresponding baud rates.

BR3	BR2	BR1	Baud Rate
0	0	0	4800
0	1	0	19200
0	0	1	38400
0	1	1	50000
1	0	0	1200
1	1	0	2400
1	0	1	9600
1	1	1	57600

2 Sample Designs

Samples 3.1, 3.2, and 3.3 show the proper electrical connectivity of an ANT11TxxxMxIB module to an application's host microcontroller. The three reference designs use the 17 pin-out assignment connection style.

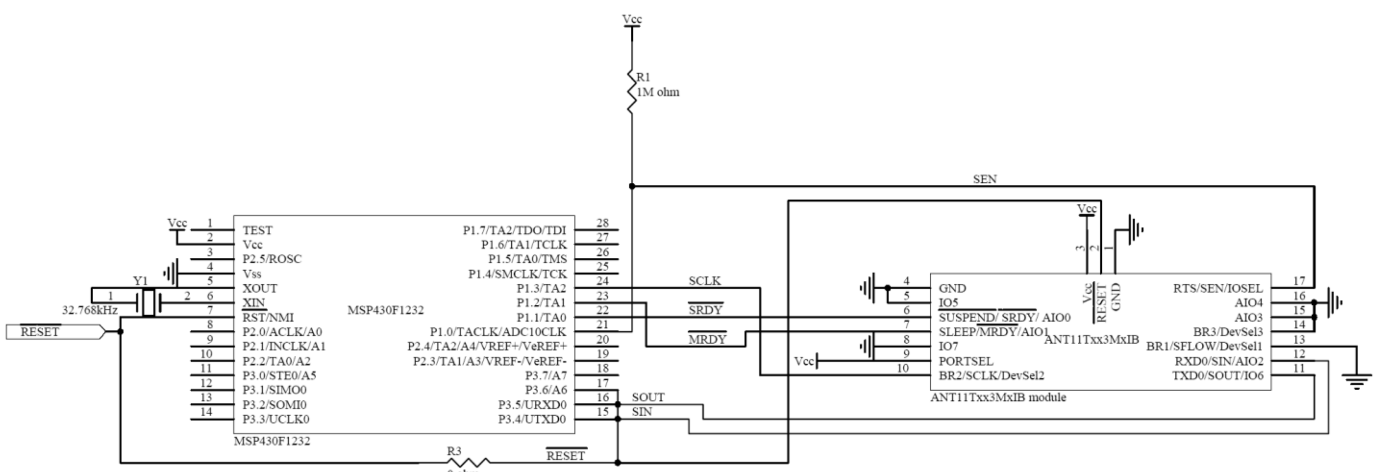
2.1 Async Mode



Notes:

- Module RXD and TXD connected directly to hardware USART of microcontroller.
- The illustrated switches on the baud rate selection pins (BR1, BR2, and BR3) are for ease of use only. The Baud rate selection pins may be connected directly to the logic level of interest.
- R2 allows optional control of the module RESET signal by a microcontroller I/O pin.

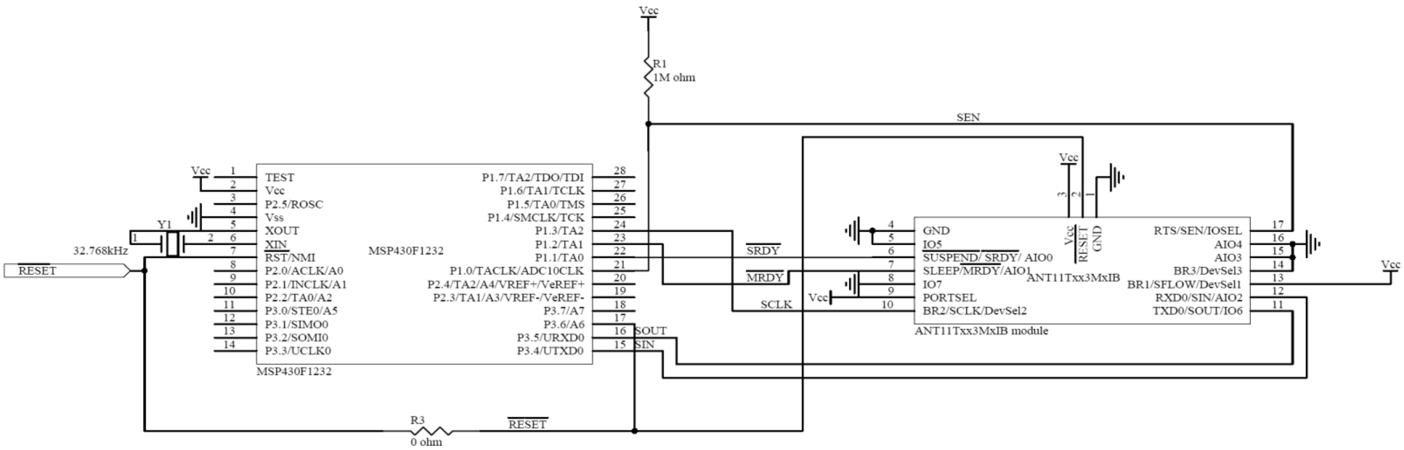
2.2 Byte Sync Mode



Notes:

- Module SOUT and SIN connected directly to hardware USART of microcontroller.
- SCLK and SEN need to be on interrupt-capable I/O pins on the microcontroller.
- R3 allows optional control of the module RESET signal by a microcontroller I/O pin.

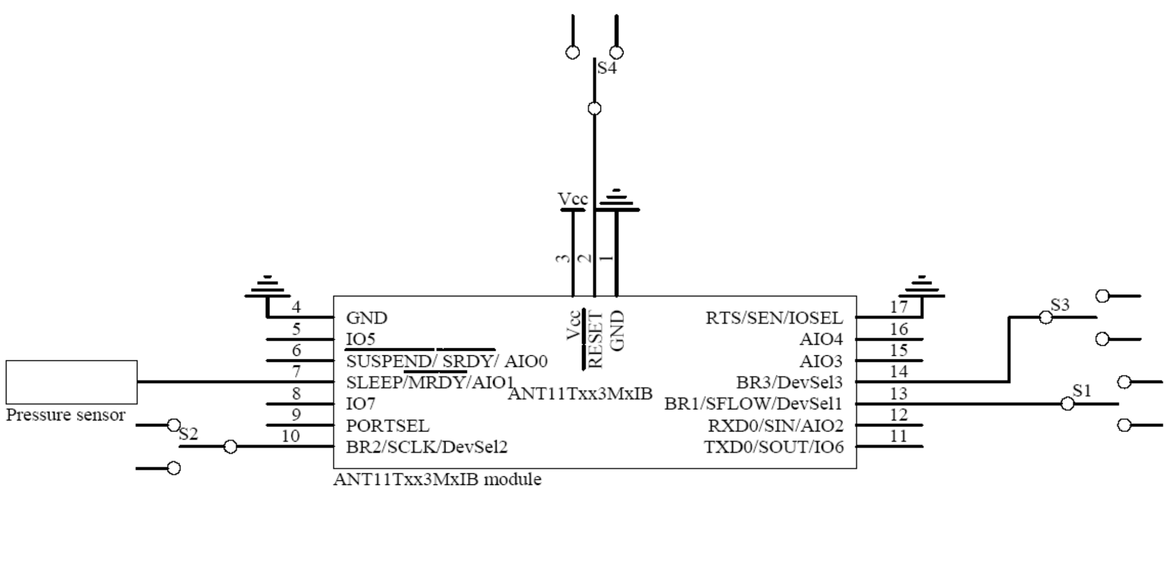
2.3 Bit Sync Mode



Notes:

- All interface signals are connected directly to I/O pins on the microcontroller.
- SCLK and SEN need to be on interrupt-capable I/O pins on the microcontroller.
- R3 allows optional control of the module RESET signal by a microcontroller I/O pin.

2.4 SensRcore™ Mode (pressure sensor configuration)



3 Electrical Specifications

Absolute Maximum Ratings	
Voltage applied at VCC to VSS	-0.3V to +3.6V
Input voltage at any pin	-0.3V to VCC +0.3V
Diode current at any pin	±2mA
Operating temperature	-40°C to +85°C
Storage temperature	-40°C to +85°C

Note: Stress exceeding one or more of the absolute maximum ratings may cause permanent damage to the chipsets.

Conditions: VCC = +2.0V, VSS = 0V, TA = - 40°C to +85°C

Symbol	Parameter (condition)	Notes	Min	Typ	Max	Units
	Operating conditions					
VCC	Supply voltage		2.0	3.0	3.6	V
TEMP	Operating temperature		-40	25	+85	ºC
	Digital input pin					
VIH	HIGH level input voltage		1.9		VCC	V
VIL	LOW level input voltage		VSS			V
	Digital output pin					
VOH	HIGH level output voltage (IOH=-0.5mA)		VCC - 0.25		VCC	V
VOL	LOW level output voltage (IOL=0.5mA)		VSS		0.25	V
	Analog input pin					
VAnalog	Input voltage range	4)	VSS		VCC	V
FSample	Sample rate	5)	0.002		500	Sample/s
	Counter input pin					
FCounter	Input frequency				1000	Hz
	Synchronous serial timing					
SCLK freq.	Synchronous clock frequency (byte mode)		285	300	315	kHz

Symbol	Parameter (condition)	Notes	Min	Typ	Max	Units
tReadValid	Data is valid on read before low-to-high transition on the clock (byte mode)		0.5			µs
tWriteValid	Data must be valid on write within this time after a high-to-low transition on the clock (byte mode)				2	µs
tSRDY_MinLow	Minimum $\overline{\text{SRDY}}$ low time		2.5			µs
tReset	Synchronous reset. $\overline{\text{SRDY}}$ falling edge to $\overline{\text{MRDY}}$ falling edge		250			µs
	General RF conditions					
fOP	Operating frequency	1)	2400		2524	MHz
FChannel	Channel spacing			1		MHz
Δf	Frequency deviation			±156		kHz
	Current consumption					
IIdle	No active channels – no communications			1.1		µA
ISuspend	Asynchronous suspend activated			1.1		µA
IBase	Base active current			2.6		µA
Isample	Average current/analog sample			0.5		µA
ISC_RF	Average current/ ANT message in sensRcore mode			13		µA
IMsg_Rx_ByteSync	Average current / Rx message in byte sync mode			10.5		µA
IMsg_Rx_BitSync	Average current / Rx message in bit sync mode			13.1		µA
IMsg_Rx_57600	Average current / Rx message in async mode at 57600 baud			9.1		µA
IMsg_Rx_19200	Average current / Rx message in async mode at 19200 baud			10.4		µA
IMsg_Rx_4800	Average RF current / Rx message in async mode at 4800 baud			8.5		µA
IMsg_Tx_ByteSync	Average current / Tx-only message in byte sync mode			6.4		µA
IMsg_Tx_BitSync	Average current / Tx-only message in bit sync mode			10.8		µA
IMsg_Tx_57600	Average current / Tx-only message in async mode at 57600 baud			5.7		µA

Symbol	Parameter (condition)	Notes	Min	Typ	Max	Units
IMsg_Tx_19200	Average current / Tx-only message in async mode at 19200 baud			7.5		μA
IMsg_Tx_4800	Average current / Tx-only message in async mode at 4800 baud			4.4		μA
IMsg_TR_ByteSync	Average current / Tx message in byte sync mode			14.1		μA
IMsg_TR_BitSync	Average current / Tx message in bit sync mode			18.4		μA
IMsg_TR_57600	Average current / Tx message in async mode at 57600 baud			13.5		μA
IMsg_TR_19200	Average current / Tx message in async mode at 19200 baud			15.0		μA
IMsg_TR_4800	Average current / Tx message in async mode at 4800 baud			11.7		μA
IMsg_Ack_ByteSync	Average current / Acknowledged message in byte sync mode			19.6		μA
IMsg_Ack_BitSync	Average current / Acknowledged message in bit sync mode			23.4		μA
IMsg_Ack_57600	Average current / Acknowledged message in async mode at 57600 baud			18.7		μA
IMsg_Ack_19200	Average current / Acknowledged message in async mode at 19200 baud			19.9		μA
IMsg_Ack_4800	Average current / Acknowledged message in async mode at 4800 baud			17.2		μA
IPeak	Peak Current consumption			19		mA
IPeakTx	Peak Current – Tx-only @ 0dBm			13		mA
IAve	Broadcast Tx-only @ 0.5Hz in byte sync mode			5.8		μA
IAve	Broadcast Tx-only @ 2Hz in byte sync mode			15.4		μA
IAve	Broadcast Rx @ 0.5Hz in byte sync mode			7.8		μA
IAve	Acknowledged @ 0.5Hz in byte sync mode			12.4		μA
IAve	Burst continuous @ 14Kbps in byte sync mode			2.24		mA
IAve	Burst continuous @ 20Kbps in byte sync mode			3.21		mA
IAve	Burst continuous @ 10Kbps in bit sync mode			3.22		mA

Symbol	Parameter (condition)	Notes	Min	Typ	Max	Units
IAve	Burst continuous @ 14Kbps in async mode at 57600 baud			2.37		mA
IAve	Burst continuous @ 20Kbps in async mode at 57600 baud			3.31		mA
	Transmitter operation					
PRF	Maximum output power	2)		0	4	dBm
ΔP	Output power variation	3)			±4	dBm
PBW	20dB bandwidth for modulated carrier				1000	kHz
PRF2	2nd adjacent channel transmit power 2MHz				-20	dBm
PRF3	3rd adjacent channel transmit power 3MHz				-40	dBm
IVCC	Supply peak current @ 0dBm output power			11.3		mA
IVCC	Supply peak current @ -20dBm output power			7		mA
	Receiver operation					
IVCC	Supply peak current receive mode			12		mA
RXSENS	Sensitivity at 0.1%BER (@1000kbps)			-85		dBm
C/ICO	C/I co-channel			9		dB
C/I1ST	1st adjacent channel selectivity C/I 1MHz			8		dB
C/I2ND	2nd adjacent channel selectivity C/I 2MHz			-22		dB
C/I3RD	3rd adjacent channel selectivity C/I 3MHz			-30		dB

1) Usable band is determined by local regulations.
2) Maximum output power with 0dBm output power setting.
3) Variation from 2402MHz to 2479MHz.
4) Voltages exceeding the reference can be used but provide no information.
5) Max refers to total number of samples available to be distributed over the number of A/D sources currently active.

3.1 Current Calculation Examples

1.Master channel with Broadcast data at 4Hz with a bit synchronous serial interface.

Iave = (IMsg_Tx_BitSync * Message_Rate) + IBase

= (18.4 µA/message * 4 messages) + 2.6µA

= 76.2 µA

2.Receive channel with Acknowledged data at 2Hz with an asynchronous serial interface at 57 600 baud.

Iave = (IMsg_Ack_57600 * Message_Rate) + IBase

= (18.7µA/message * 2 messages) + 2.6µA

= 40.0µA

3.Transmit channel with Acknowledged data at 2Hz with an asynchronous serial interface at 57 600 baud.

Iave = (IMsg_Ack_57600 * Message_Rate) + IBase

= (18.7 µA/message * 2 messages) + 2.6µA

= 40.0µA

4.SensRcore device using an ANT message rate of 4Hz and sampling an A/D input at 16 Hz.

Iave = (ISC_RF * Message_Rate) + (ISample * Sample_Rate) + IBase

= (13µA/message * 4 messages) + (0.5µA/sample * 16 samples) + 2.6µA

= 62.6µA

3.2 A/D Specifications

These are taken from the TI MSP430x22x4 datasheet:

10-bit ADC, power supply and input range conditions (see Note 1)

PARAMETER		TEST CONDITIONS	T_A	VCC	MIN	TYP	MAX	UNIT
V_{CC}	Analog supply voltage range	V_{SS} = 0 V			2.2		3.6	V
V_{Ax}	Analog input voltage range (see Note 2)	All Ax terminals. Analog inputs selected in ADC10AE register.			0		V_{CC}	V
I_{ADC10}	ADC10 supply current (see Note 3)	$f_{ADC10CLK}$ = 5.0 MHz ADC10ON = 1, REFON = 0 ADC10SHT0 = 1, ADC10SHT1 = 0, ADC10DIV = 0	I: -40–85°C T: -40–105°C	2.2 V		0.52	1.05	mA
				3 V		0.6	1.2	

NOTES:
1. The leakage current is defined in the leakage current table with Px.x/Ax parameter.
2. The analog input voltage range must be within the selected reference voltage range V_{R+} to V_{R-} for valid conversion results.
3. The internal reference supply current is not included in current consumption parameter I_{ADC10}.
4. The internal reference current is supplied via terminal V_{CC}. Consumption is independent of the ADC10ON control bit, unless a conversion is active. The REFON bit enables the built-in reference to settle before starting an A/D conversion.

10-bit ADC, built-in voltage reference

PARAMETER		TEST CONDITIONS	VCC	MIN	TYP	MAX	UNIT
$V_{CC,REF+}$	Positive built-in reference analog supply voltage range	$I_{VREF+} \le$ 1mA, REF2_5V=0		2.2			V
		$I_{VREF+} \le$ 0.5mA, REF2_5V=1		2.8			
		$I_{VREF+} \le$ 1mA, REF2_5V=1		2.9			
V_{REF+}	Positive built-in reference voltage	$I_{VREF+} \le I_{VREF+}max$, REF2_5V=0	2.2 V/3 V	1.41	1.5	1.59	V
		$I_{VREF+} \le I_{VREF+}max$, REF2_5V=1	3 V	2.35	2.5	2.65	V

10-bit ADC, linearity parameters

PARAMETER		TEST CONDITIONS	VCC	MIN	TYP	MAX	UNIT
E_I	Integral linearity error		2.2 V/3 V			±1	LSB
E_D	Differential linearity error		2.2 V/3 V			±1	LSB
E_O	Offset error	Source impedance R_S < 100 Ω,	2.2 V/3 V			±1	LSB
E_G	Gain error	SREFx = 010; un-buffered external reference; V_{eREF+} = 1.5V	2.2 V		±1.1	±2	LSB
		SREFx = 010; un-buffered external reference; V_{eREF+} = 2.5V	3 V		±1.1	±2	LSB
		SREFx = 011; buffered external reference (see Note 1); V_{eREF+} = 1.5V	2.2 V		±1.1	±4	LSB
		SREFx = 011; buffered external reference (see Note 1); V_{eREF+} = 2.5V	3 V		±1.1	±3	LSB
E_T	Total unadjusted error	SREFx = 010; un-buffered external reference; V_{eREF+} = 1.5V	2.2 V		±2	±5	LSB
		SREFx = 010; un-buffered external reference; V_{eREF+} = 2.5V	3 V		±2	±5	LSB
		SREFx = 011; buffered external reference (see Note 1); V_{eREF+} = 1.5V	2.2 V		±2	±7	LSB
		SREFx = 011; buffered external reference (see Note 1); V_{eREF+} = 2.5V	3 V		±2	±6	LSB

NOTES: 1. The reference buffer's offset adds to the gain and total unadjusted error.

3.3 Reflow Guideline

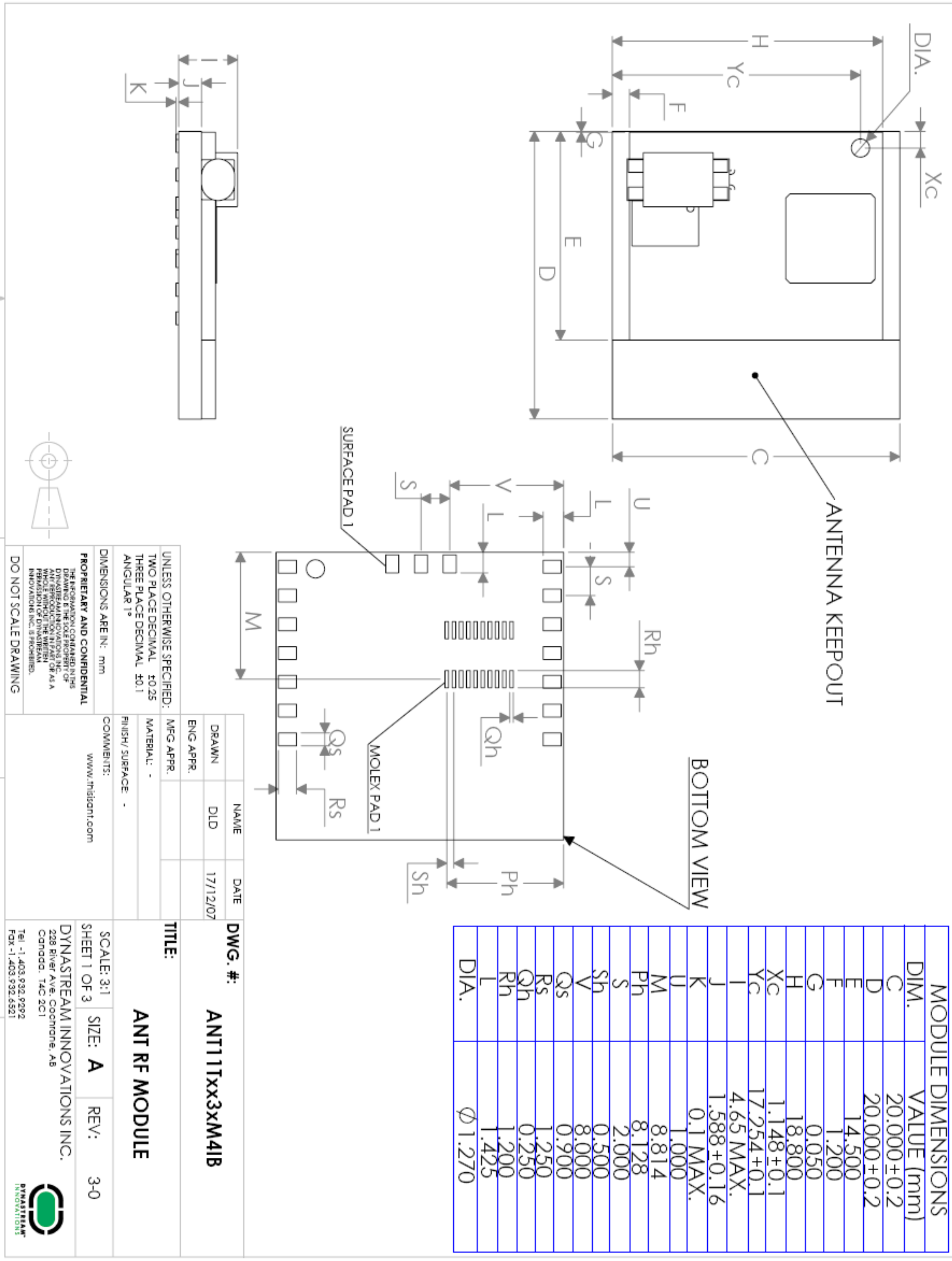
Follow the guideline below if ANT11TxxM4IB modules go through reflow oven.

Peak solder joint/pad temperatures exceeding 240ºC are not recommended.

If possible, pre-heat the assembly within the oven profile for ~30 seconds at ~150 ºC.

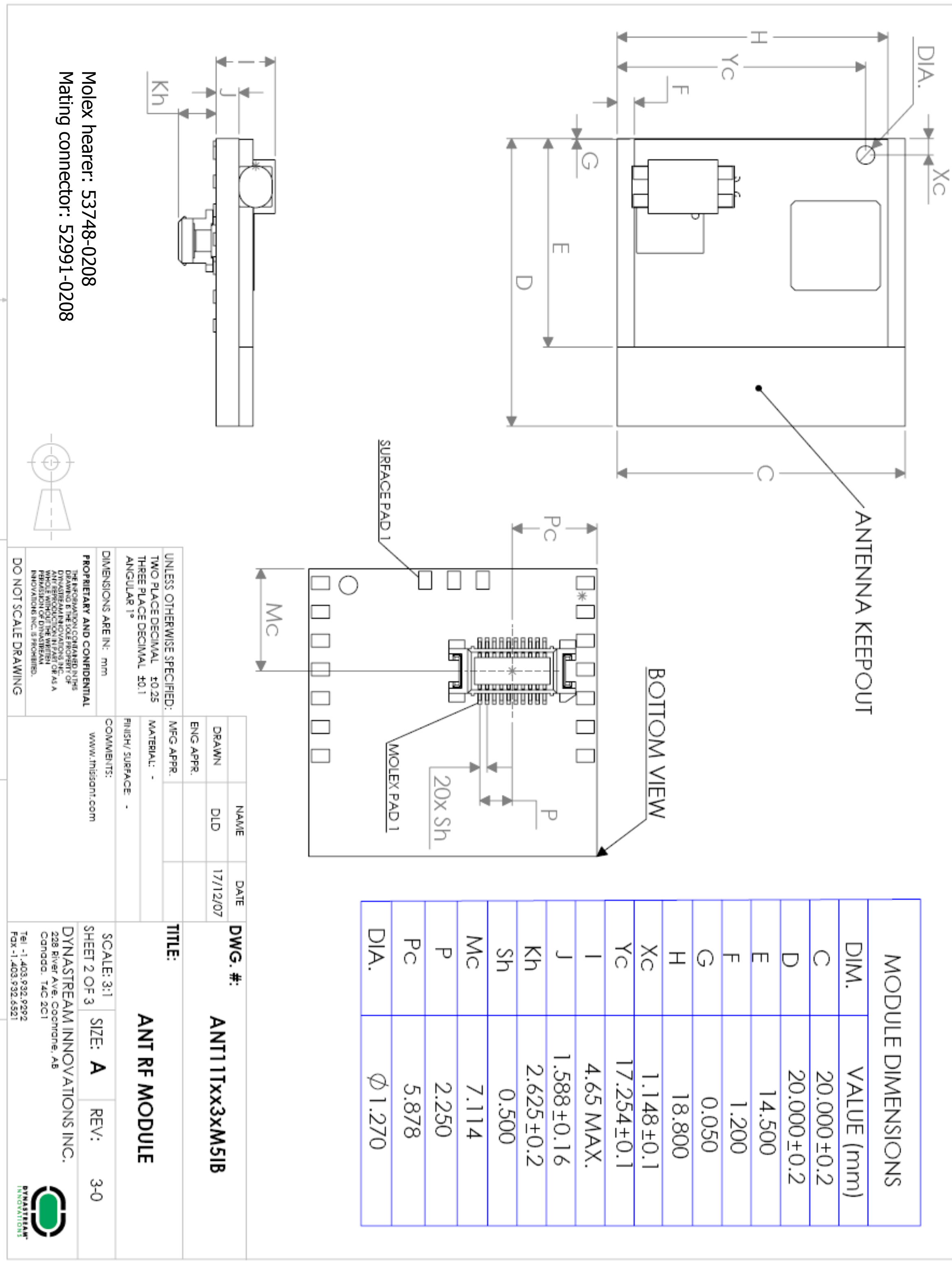
Follow the solder paste manufacturer's recommendations, especially regarding temperature ramp rate and the time above liquidus.

4 Mechanical Drawings



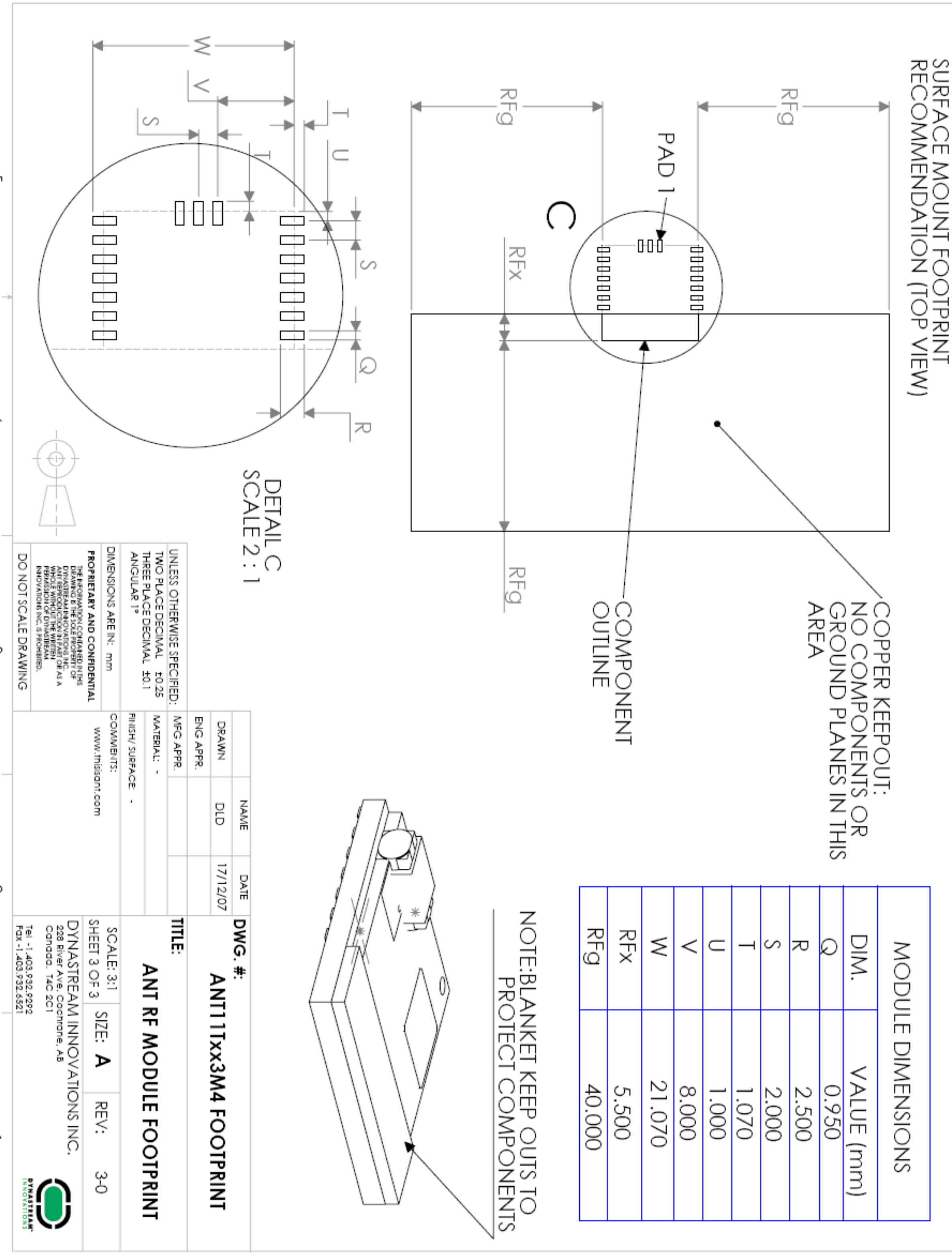
MODULE DIMENSIONS

DIM.	VALUE (mm)
C	20.000±0.2
D	20.000+0.2
E	14.500
F	1.200
G	0.050
H	18.800
Xc	1.148±0.1
Yc	17.254+0.1
I	4.65 MAX.
J	1.588+0.16
K	0.1 MAX.
U	1.000
M	8.814
Ph	8.128
S	2.000
Sh	0.500
V	8.000
Qs	0.900
Rs	1.250
Qh	0.250
Rh	1.200
L	1.425
DIA.	Ø1.270



MODULE DIMENSIONS

DIM.	VALUE (mm)
C	20.000±0.2
D	20.000±0.2
E	14.500
F	1.200
G	0.050
H	18.800
Xc	1.148±0.1
Yc	17.254±0.1
I	4.65 MAX.
J	1.588±0.16
Kh	2.625±0.2
Sh	0.500
Mc	7.114
P	2.250
Pc	5.878
DIA.	Ø1.270



MODULE DIMENSIONS

DIM.	VALUE (mm)
Q	0.950
R	2.500
S	2.000
T	1.070
U	1.000
V	8.000
W	21.070
RFx	5.500
RFg	40.000

4.1 Connection Diagram