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nRF24AP2

nRF24AP2-USB

Single-chip ANT^{TM} ultra-low power wireless network solution

Product Specification v1.0

Key Features

- Second generation single chip ANT solution
- Bridge from ANT networks and devices to computers, Macs, and the internet
- nRF24AP2- USB supports up to eight ANT (logic) channels – ideal for hubs
- World wide 2.4 GHz ISM band operation
- USB v2.0 interface
- Fully embedded, enhanced ANT protocol stack
- Built-in device search and pairing
- Built-in timing and power management
- Built-in interference handling
- Configurable channel period 5.2 ms - 2 s
- Broadcast, Acknowledged and Burst communication modes
- Burst data rate up to 20 kbps
- Simple to complex network topologies: Peer-to-peer, star, tree and practical mesh
- Supports public, private and managed networks
- Support for ANT+ device profile implementations enabling multivendor interoperability
- Fully interoperable with nRF24AP1, Dynastream ANT chipset / module based prod-ucts and other nRF24AP2 variants
- RoHS compliant 5x5 mm 32-pin QFN package
- Low cost external 16 MHz crystal

Applications

- Sports
- Wellness
- Home health monitoring
- Home/industrial automation
- Environmental sensor networks
- Active RFID
- Logistics/goods tracking
- Audience-response systems

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April 2010

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Datasheet status	
Objective product specification	This product specification contains target specifications for Nordic Semiconductor's product development.
Preliminary product specification	This product specification contains preliminary data; supplementary data may be published from Nordic Semiconductor ASA later.
Product specification	This product specification contains final product specifications. Nordic Semiconductor ASA reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

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RoHS statement

This product meets the requirements of Directive 2002/95/EC of the European Parliament and of the Council on the Restriction of Hazardous Substances (RoHS). Complete hazardous substance reports as well as material composition reports for all active Nordic products can be found on our web site www.nordicsemi.com.

Revision History

Date	Version	Description
April 2010	1.0	Product Specification

Contents

1 Introduction

The nRF24AP2 components belong to Nordic Semiconductor's low-cost, high-performance family of 2.4 GHz ISM Connectivity-on-Chip devices with the ANT protocol stack embedded. nRF24AP2 offers the market's most efficient, single chip, transceiver solution for Ultra Low Power (ULP) networks, through the integration of the extremely power efficient ANT protocol stack, the world leading Nordic Semiconductor 2.4 GHz RF technology as well as critical low-power oscillator and timing features.

This document covers the product nRF24AP2-USB, which is a single-chip implementation of an ANT USB bridge.

1.1 Prerequisites

In order to fully understand the product specification, a good knowledge of electronics and software engineering is necessary. Please also refer to the document *ANT Message Protocol and Usage* when reading this product specification. You can download the document from Nordic's web site www.nordicsemi.com or from www.thisisant.com.

1.2 Writing conventions

This product specification follows a set of typographic rules to ensure that the document is consistent and easy to read. The following writing conventions are used:

- Commands, bit state conditions, and register names are written in `Courier New`.
- Pin names and pin signal conditions are written in **`Courier New bold`**.
- Cross references are underlined and highlighted in blue.

2 Product overview

ANT is a demonstrably superior Wireless Sensor Network (WSN) RF protocol for almost all practical ultra-low power networking applications – from simple point-to-point links to complex networks. Embedded in nRF24AP2 devices, it is paired up with Nordic Semiconductor's market leading 2.4 GHz radio technology. The combination gives you a high performance-, ultra-low-power network connectivity to applications.

The nRF24AP2-USB, with its USB v2.0 compatible serial interface, is made specifically to act as a bridge between an ANT wireless network and backbone infrastructure. Backbone infrastructure can be advanced user interfaces, storage on a computer or other USB enabled equipment.

Figure 1. on page 7 shows a network in which a network node with nRF24AP2-USB embedded, communicates with up to eight ANT nodes. An example might be a computer collecting data from a hub (a watch) in a portable ANT sensor network containing several sensors (like heart rate-, speed and distance sensors). The 8-channel nRF24AP2-USB node can of course also set up ANT channels with other nodes (gym equipment, for instance). The information collected though nRF24AP2-USB can then be used either locally or shared with others over local networks or internet.

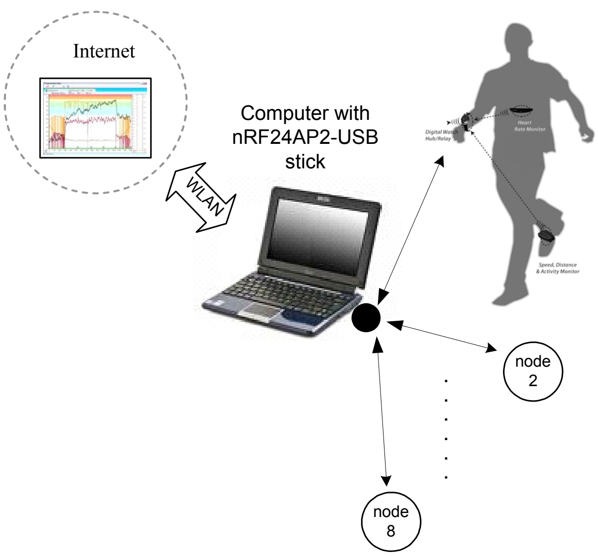


Figure 1. Simple setup with nRF24AP2-USB

See Figure 10. on page 19 for more complex ANT-network topologies.

2.1 Features

Features of the nRF24AP2-USB include:

- Ultra low power 2.4 GHz transceiver
  - World wide 2.4 GHz ISM band operation
  - Based on nRF24L01+ transceiver
  - GFSK modulation
  - 1 Mbps on-air data rate
  - 1 MHz frequency resolution
  - 78 RF channels
  - -85 dBm sensitivity
  - Up to 0 dBm output power
- ANT protocol stack
  - Full implementation of the physical, data link, network- and transport OSI layers
  - Packet-based communication – 8 byte payload per packet
  - Optimized for ultra-low power operation
- ANT channels
  - Logic communication channel between ANT nodes
  - nRF24AP2USB support up to 8 channels–ideal for hubs
  - Built-in timing and power management
  - Built-in interference handling
  - Configurable channel period 5.2 ms - 2 s
  - Broadcast, acknowledged and burst communication modes
  - Burst data rate up to 20 kbps
- Device search and pairing
  - Wild-card searches
  - Proximity searches
  - Specific searches
  - Automatic link establishment if correct device is found
  - Automatic re-link attempt if link is lost
  - Configurable search timeout
- Network topologies
  - Point-to- point and star networks using independent ANT channels
  - Shared networks: Polled data collection (N:1) by using ANT shared channel option
  - Broadcast networks: Mass distribution of data (1:N)
- Network management / ANT+
  - Supports public and private (managed) networks
  - Support for ANT+ system implementations enabling multi-vendor interoperability
- ANT core stack enhancements
  - Background scanning channel
  - Continuous scanning mode
  - High density node support
  - Improved channel search
  - Channel ID management
  - Improved transmission power control on a per channel basis
  - Frequency agility
  - Proximity search
- Power Management
  - Fully controlled by ANT protocol stack
  - On-chip voltage regulator
  - USB supply operation
  - 4.0 to 5.25V supply range
- On-chip oscillators and clock inputs
  - 16 MHz crystal oscillator supporting low-cost crystals
- Host interface
  - USB v2.0 compatible
  - On-chip pull-up resistor on `D+`
  - Two control endpoints and two bulk endpoints
  - Suspend and resume power management functions
  - USB drivers and ANT command libraries supported by ANT

2.2 Block diagram

nRF24AP2 is composed of five main blocks as shown in Figure 2. The blocks indicate the interface, power management, the ANT protocol engine, on-chip oscillators and the RF transceiver.

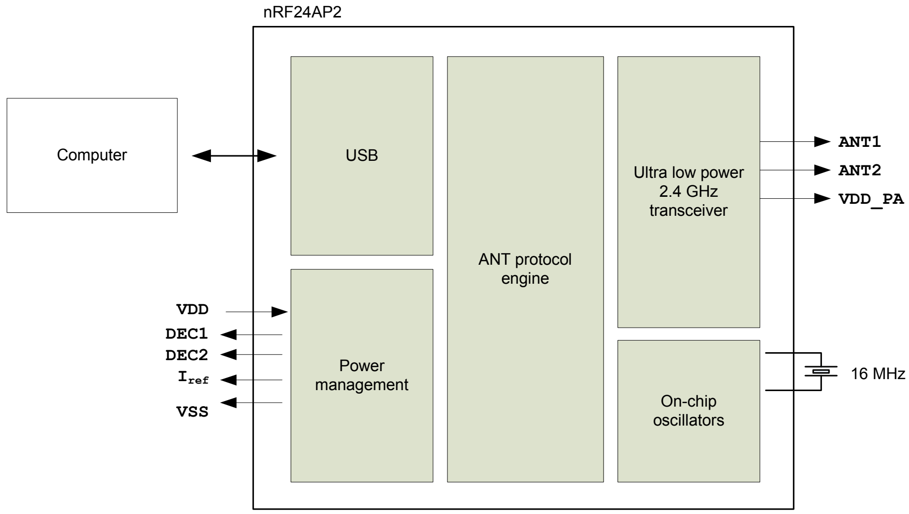


Figure 2. Block diagram of nRF24AP2 solution

To find more information about each block in the diagram, see Table 1.

Name	Reference
RF transceiver	Chapter 3 on page 12
ANT protocol engine	Chapter 4 on page 13
USB interfaces	Chapter 5 on page 21
On-chip oscillators	Chapter 6 on page 30
Power management	Chapter 8 on page 33

Table 1. Block diagram cross references

2.3 Pin Assignments

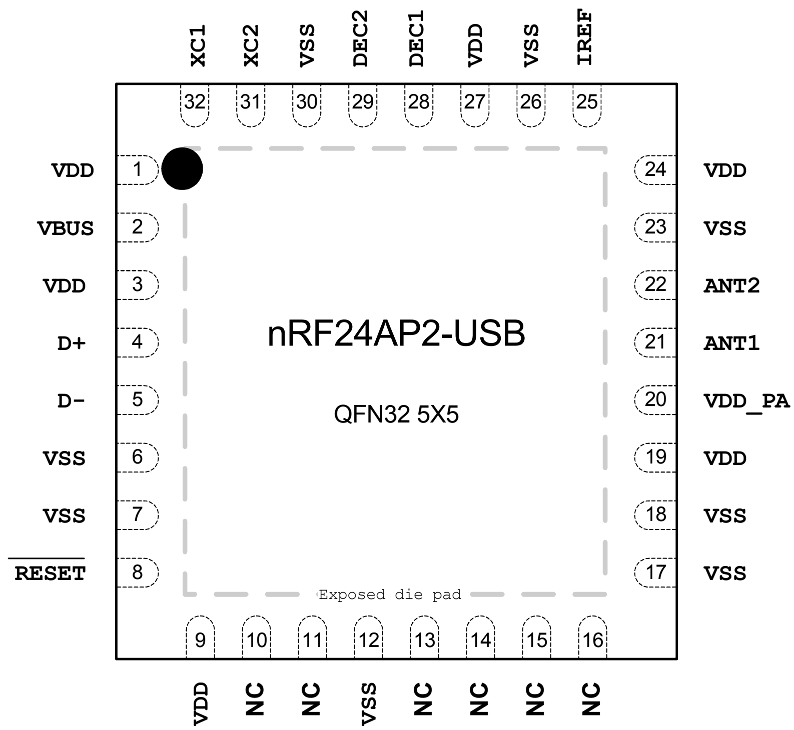


Figure 3. nRF24AP2-USB pin assignment (top view) for a QFN32 5x5 mm package

2.4 Pin Functions

Pin	Name	Type	Description
21, 22	**ANT1, ANT2**	RF	Differential antenna connection (TX and RX)
5, 4	**D-, D+**	Digital I/O	Differential USB connection
28, 29	**DEC1, DEC2**	Power	Power supply outputs for de-coupling purposes
25	**IREF**	Analog Input	Device reference current output. To be connected to reference resistor on PCB
10, 11, 13, 14, 15, 16	**NC**	NC	Not connected
8	**RESET**	Digital Input	Reset, active low. Connect to **VDD** if not used
2	**VBUS**	Power	USB power supply
1, 3, 9, 19, 24, 27	**VDD**	Power	Alternative power supply pins. The **VDD** pins must always be connected and de-coupled externally.
20	**VDD_PA**	Power Output	Power supply output (+1.8V) for on-chip RF Power amplifier
6, 7, 12, 17, 18, 23, 26, 30	**VSS**	Power	Ground (0V)
32, 31	**XC1, XC2**	Analog Input	Connection for 16 MHz crystal
	Exposed die pad	Power/heat relief	Not connected

Table 2. nRF24AP2-USB pin functions

2.4.1 Power supply pins

VBUS and **VSS** are the power supply and ground pins. The nRF24AP2-USB can operate from a single power supply.

The nRF24AP2-USB contains an on-chip regulator that produces +3.3V on the **VDD** pins, from the **VBUS** supply line (4.0 – 5.25V). Alternatively, the **VBUS** pin can be left open and the **VDD** pins may be fed from an external 3.3V supply. In this case, the on-chip 3.3V regulator is switched off.

2.4.2 Reset pin

The **RESET** pin provides an optional reset when the nRF24AP2-USB is placed in a system that has a master reset source, this pin is not needed for normal application. Pull **RESET** pin low for minimum 0.2 µs and return to high, this will reset the nRF24AP2-USB to the default state. Connect **RESET** pin to **VDD** if not used in the application.

3 RF transceiver

All transceiver operations are controlled solely by the ANT protocol stack. Configuration of the ANT protocol stack occurs through a serial interface by issuing ANT commands to nRF24AP2-USB.

3.1 Features

Features of the RF transceiver include:

- General
  - Worldwide 2.4 GHz ISM band operation
  - Common antenna interface in transmit and receive
  - GFSK modulation
  - 1 Mbps on air data rate
- Transmitter
  - Programmable output power: 0, -6, -12 or -18 dBm
- Receiver
  - Integrated channel filters
  - -85 dBm sensitivity
- RF Synthesizer
  - Fully integrated synthesizer
  - 1 MHz frequency programming resolution
  - 78 RF channels in the 2.4 GHz ISM band
  - Accepts low cost ± 50 ppm 16 MHz crystal
  - 1 MHz non-overlapping channel spacing

3.2 Block diagram

Figure 4. on page 12 shows a block diagram of the RF transceiver in nRF24AP2-USB.

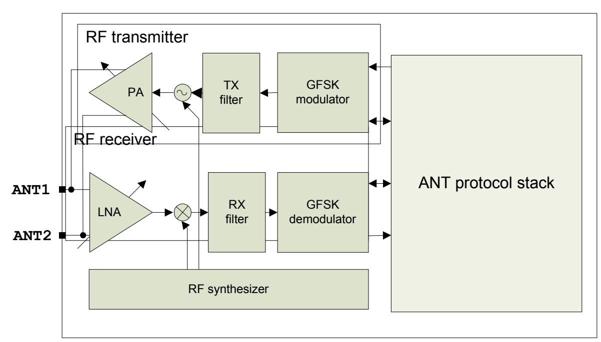


Figure 4. Internal circuitry of RF transceiver relative to ANT

4 ANT overview

The ANT protocol has been engineered for simplicity and efficiency. In operation, this results in ultra-low power consumption, maximized battery life, a minimal burden on system resources, simpler network designs and lower implementation costs.

4.1 Block diagram

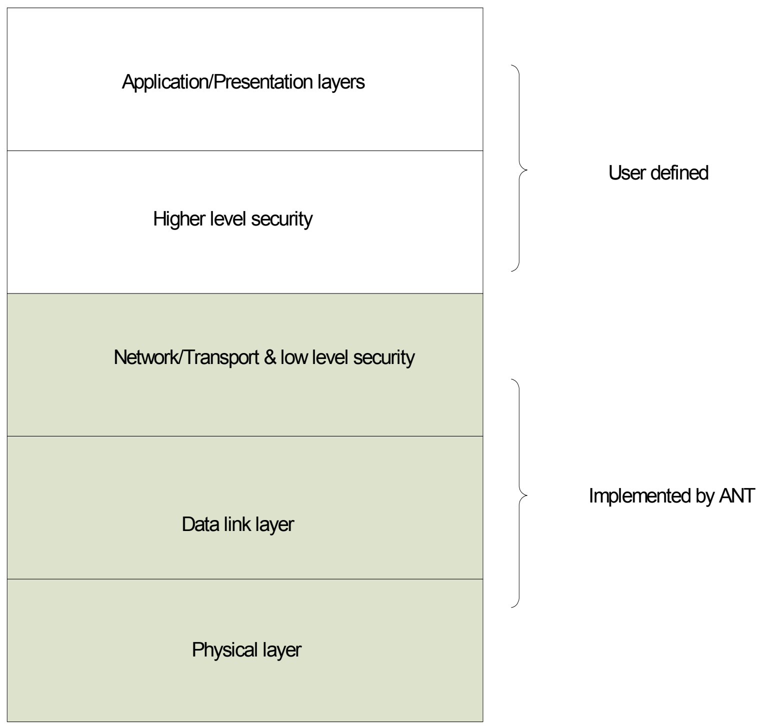


Figure 5. OSI layer model of ANT protocol stack

ANT provides carefree handling of the Physical, Data Link, Network, and Transport OSI layers. Please see Figure 5. on page 13. 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 easing the computational burden, by providing a simple yet effective wireless networking solution.

4.2 Functional description

A brief overview of the ANT concept is presented here for convenience. A complete description of the ANT protocol is found in the document *ANT Message Protocol and Usage* available at www.nordicsemi.com or www.thisisant.com.

4.2.1 ANT nodes

All ANT networks are built up of nodes. See the ANT node represented in Figure 6. on page 14. A node can be anything from a simple sensor to a complex, collection unit like a watch or computer. Common to all nodes is that they contain an ANT engine (nRF24AP2) handling all connectivity to other nodes and a host processor handling the application features. nRF24AP2 interfaces to the host processor through a serial interface, and all configuration and control are performed using a simple command library.

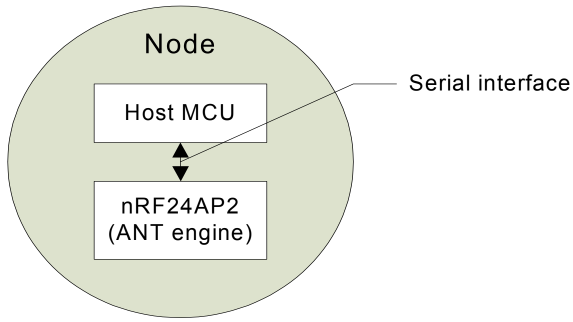


Figure 6. The ANT node

4.2.2 ANT channels

nRF24AP2 can establish one or up to eight logic channels, called ANT channels, to other ANT nodes. The number of ANT channels available depends on the nRF24AP2 variant being used.

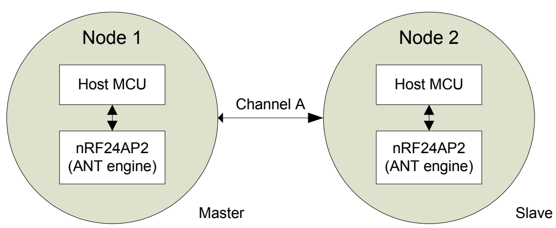


Figure 7. ANT nodes and the channel between them

The simplest ANT channel is called an independent channel and consists of two nodes, one acting as master, the other as slave for this channel. For each ANT channel opened, nRF24AP2 will set up and manage a synchronous wireless link, exchanging data packets with other ANT nodes at preset time intervals called channel periods. See Figure 8. on page 15. The master controls the timing of a channel, that is to say, it will always initiate communication between the nodes. The slave locks on to the timing set by the master, receives the transmissions from the master and can then (if configured so) send acknowledge and/or data (if any) back to the master.

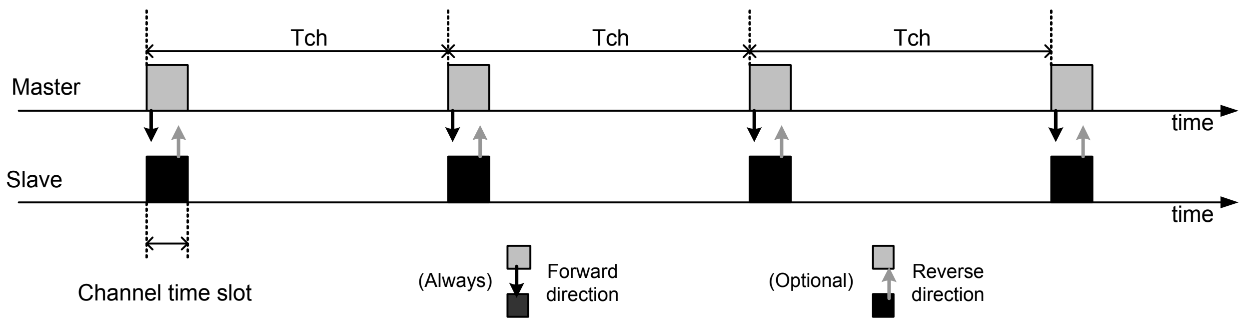


Figure 8. Channel communication showing forward and reverse directions. Not to scale

At each time slot an ANT channel can transfer user data (8 bytes) both ways as simple broadcasts, broadcast with acknowledgement from the receiver, or transfer data as bursts (this will extend the time slot used) to accommodate transfer of larger blocks of user data. The total available payload bandwidth (20 kbps) in an ANT node is shared between active ANT channels through a Time Division Multiple Access (TDMA) scheme. If a channel time slot comes up, but there is no new data from the master, the master will still send the last packet to keep the timing of the channel and enable the slave to send data back if needed.

Each ANT channel available in the nRF24AP2 can for example be configured as a simple unidirectional (broadcast), or bi-directional independent channel; or as a more complex, shared channel where a master interfaces to multiple slaves (1:N topologies). Please see the *ANT Message Protocol and Usage* document for further details on shared ANT channels.

4.2.3 ANT channel configuration

Unique to ANT is that the setup of each ANT channel is independent from all the other ANT channels in the network, including other channels in the same node. This means that one ANT node can act as master on one ANT channel while being a slave to another. Since there is no overall 'network master' present in ANT networks, ANT allows you to configure and run each ANT channel solely based on the needs of the nodes on that channel. Search- and pairing algorithms in ANT let you easily set up and shut down ANT channels in an ad-hoc fashion. This gives you ultimate flexibility in adjusting ANT channel parameters like data rate and latency versus power consumption. Moreover, you only make the network as complex as it needs to be at any given time. In order for two ANT nodes to set up an ANT channel, they must share a common channel configuration and channel ID. The necessary configuration parameters are summarized in Table 3. on page 16.

Parameter	Comment
Channel configuration	
Channel period	Time interval between data exchanges on this channel (5.2 ms - 2 s)
RF frequencies	Which of the 78 available RF frequencies is used by this channel
Channel type	Bi-directional slave, bi-directional master, shared bi-directional slave, Slave Receive only
Network type	Decides if this ANT channel is going to be generally accessible (public) to all ANT nodes, or if it shall limit its connectivity to devices belonging to a managed or private network
Channel ID	
Transmission type	1 byte – Identifying characteristics of the transmission, can for instance contain codes on how payload is to be interpreted
Device type	1 byte - ID to identify the device type of the channel master (Ex: heartrate belt, temperature sensor etc.)
Device number	2 byte - Unique ID for this channel

Table 3. ANT channel ID

The channel configuration parameters are static system parameters that must match in the master and slave, and the channel ID is included in all transmissions identifying the two nodes for each other. For in-depth details on each parameter please refer to *ANT Message Protocol and Usage*.

Network

In addition to setting the content of the channel ID, which is the primary ID of an ANT node, ANT nodes can limit their connectivity to a selection of other ANT nodes by defining a network for each ANT channel. The limited access to certain networks is managed through unique network keys

The defined ANT networks are:

1. **Public networks:** These are open ANT networks with no limitation on connectivity. All ANT nodes sharing the same channel configuration (by design or by accident) will be able to connect. This is the default setting in nRF24AP2.
2. **Managed networks:** These are ANT networks managed by special interest groups or alliances. An example is the ANT+ alliance for sport and wellness products. To join the ANT+ alliance, please visit www.thisisant.com. By joining the ANT+ alliance and complying with the ANT+ device profiles set by the alliance, you achieve two goals:
   - Limited connectivity: Only other ANT+ compliant devices can connect on this channel.
   - Interoperability: Your node can connect to ANT+ compliant products from other vendors.
3. **Private networks:** Your own protected networks, and no other devices, will be able to connect to your ANT nodes unless you share the network key with someone outside the network. Please note that this requires purchase of a unique network key from ANT, see www.thisisant.com.

Since the network parameter can be chosen independently for each ANT channel, one ANT node can have up to eight ANT channels, operating on different networks at the same time.

Note: The network parameter has no impact on the network topologies you can build. It is merely a tool to protect your ANT network and prevent accidental or deliberate access from other ANT nodes.

Channel ID, search and pairing

The primary parameters which two ANT nodes use to identify each other make up the **channel ID**. Once an ANT channel is established, the **channel ID parameters** must of course match; but they don't have to be known by both nodes (pre-configured) to be able to establish an ANT channel.

When an nRF24AP2 configured as a master (set in channel type) opens an ANT channel, it will broadcast its entire **channel ID**. Hence you must configure all three **channel ID parameters** before opening an ANT channel as a master.

On the other hand, in a slave you can configure nRF24AP2 to search for and connect with both known and unknown masters. To connect with a known master you must configure the **Transmission type**, **Device type** and **Device number** in nRF24AP2 before opening the ANT channel.

You can also configure the nRF24AP2 to conduct wild-card searches on one or more of the three parameters in the **channel ID** to enable it to pair up with unknown masters. You can for instance set only the **Device type** of the masters you want to link up with, and set wild cards on the **Transmission type** and **Device number**. If a new master with a matching **Device type** is found, the slave device will connect and store the unknown parts of the **channel ID**. The new parts of the **channel ID** can then be stored in the host MCU to enable specific searches for this master later.

4.2.4 Proximity search

When using the basic search and pairing algorithm a slave will automatically identify and connect to the first master it finds matching the search criteria. In areas where you either have a high density of similar master nodes or high density of independent ANT networks, there is always the chance that multiple masters are found within the coverage area. This presents the risk that it is not the master you want to connect to that is found first. The proximity search feature in ANT designates 'bins' of proximity from 1 (closest) to 10 (furthest) as shown in Figure 9. on page 17.

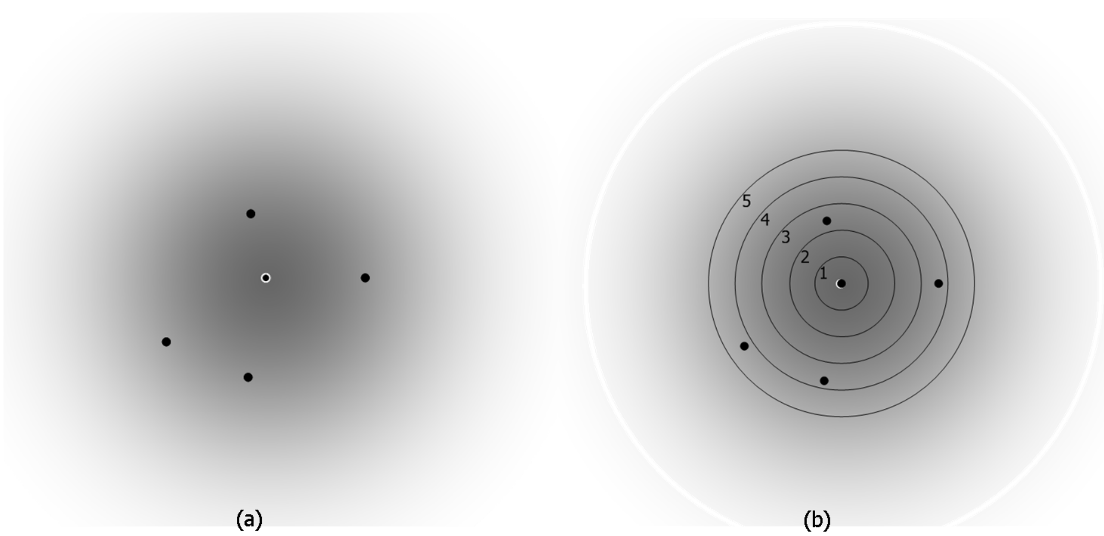


Figure 9. Standard search (a), Proximity search (b), showing bins 1-5 (of maximum 10)

This 'binning' enables you to further control your search, for example by only accepting the master that is closest (only accepting masters that fall in bin 1-2). This makes it easy for a user to pair up network nodes and prevent accidental connection to nodes possibly belonging to another network close by.

4.2.5 Continuous scanning mode

Continuous scanning mode allows for fully asynchronous communication between an ANT node using continuous scanning mode, and any other ANT node using a standard master channel. This has two main advantages over only using standard ANT channels. The first is that the latency to initiate communication with the scanning node is reduced to zero and every message sent by a master channel in proximity will be received by the scanning device. Secondly, the requirement to maintain communication for the purpose of synchronization while in proximity is removed. This means that it is possible for nodes to come and go very quickly or to turn off for long periods of time in between communication events. This saves power on the transmitting node.

The disadvantage of continuous scanning mode is that it consumes much more power than standard ANT channels. Therefore, continuous scanning mode will typically be used only on devices that are plugged in and not mobile such as a computer (USB dongle). Another disadvantage is that a node in scanning mode can no longer be configured to have discoverable master channels because scanning mode disables standard ANT channel functionality. It is worth noting that two ANT nodes in scanning mode cannot communicate with one another because neither will be able to spontaneously generate communication.

Standard ANT channels are recommended over scanning channels, even in dynamic systems where devices are coming and going. This is because scanning channels are not recommended for a mobile network, which is the primary use case for ANT. Scanning channels will typically be used in statically located networks where the scanning channel node is plugged in and not mobile.

4.2.6 ANT network topologies

By combining ANT channels with different features depending on local needs, you can build anything from very simple peer-to-peer links and star networks to complex networks as shown in Figure 10. on page 19.

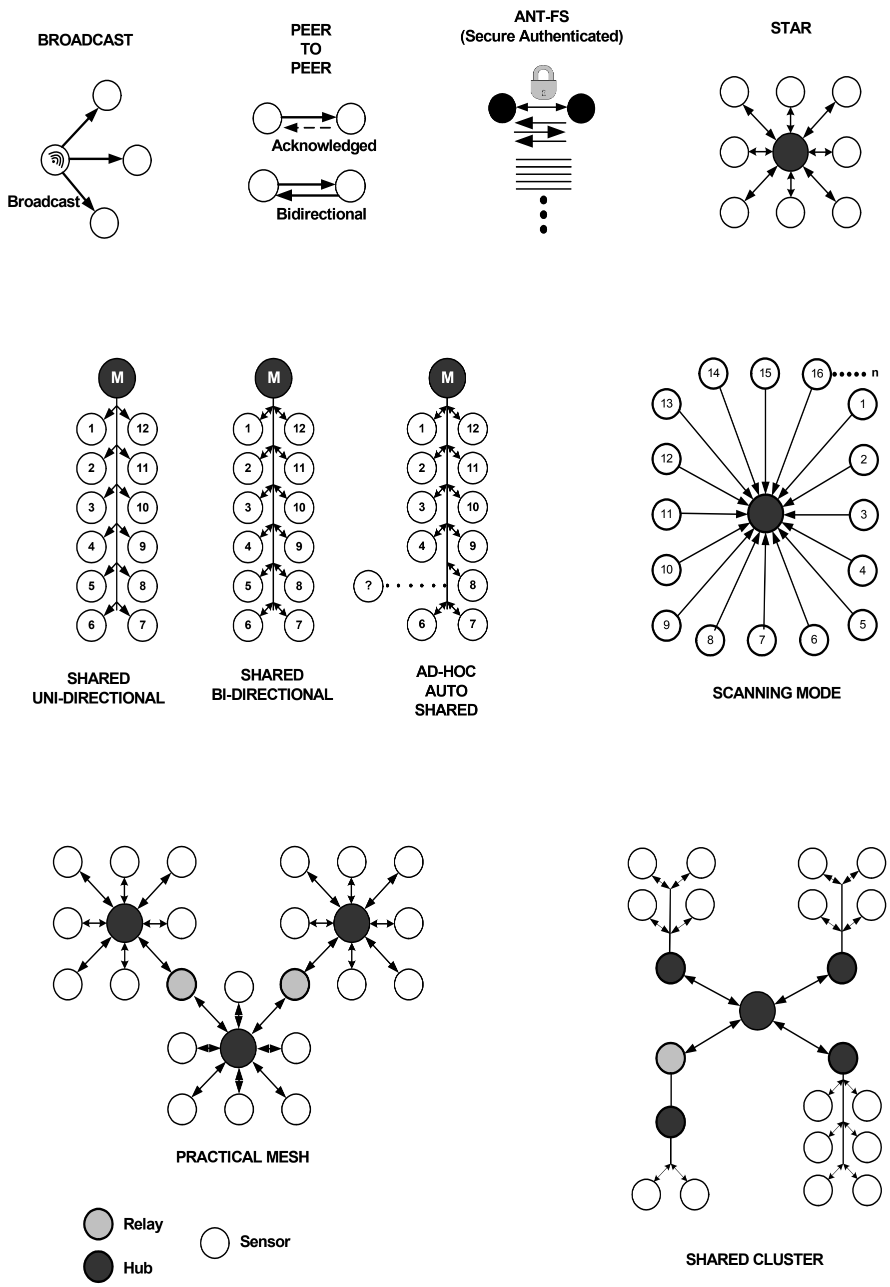


Figure 10. Network topology examples supported by ANT

4.2.7 ANT message protocol

The host microcontroller handles all the configuration and control of the various ANT node and channel parameters in nRF24AP2 over a simple serial interface, by using the command library. See the document *ANT Message Protocol and Usage* for further details on the command library.

Class	Type	Commands in ANT command library	Reply	From
Config. messages	Unassign Channel	ANT_UnassignChannel()	Yes	Host
	Assign Channel	ANT_AssignChannel()	Yes	Host
	Channel ID	ANT_SetChannelId()	Yes	Host
	Channel Period	ANT_SetChannelPeriod()	Yes	Host
	Search Timeout	ANT_SetChannelSearchTimeout()	Yes	Host
	Channel RF Frequency	ANT_SetChannelRFFreq()	Yes	Host
	Set Network	ANT_SetNetworkKey()	Yes	Host
	Transmit Power	ANT_SetTransmitPower()	Yes	Host
	ID List Add	ANT_AddChannelID()	Yes	Host
	ID List Config	ANT_ConfigList()	Yes	Host
	Channel Transmit Power	ANT_SetChannelTxPower()	Yes	Host
	Low Priority Search Timeout	ANT_SetLowPriorityChannelSearchTimeout()	Yes	Host
	Enable Ext RX Mesgs	ANT_RxExtMesgsEnable()	Yes	Host
	Frequency Agility	ANT_ConfigFrequencyAgility()	Yes	Host
	Proximity Search	ANT_SetProximitySearch()	Yes	Host
Notifications	Startup Message	→ ResponseFunc(-, 0x6F)	-	ANT
Control Messages	SystemReset	ANT_ResetSystem()	No	Host
	Open Channel	ANT_OpenChannel()	Yes	Host
	Close Channel	ANT_CloseChannel()	Yes	Host
	Open Rx Scan Mode	ANT_OpenRxScanMode(	Yes	Host
	Request Message	ANT_RequestMessage()	Yes	Host
Data Messages	Broadcast Data	ANT_SendBroadcastData() → ChannelEventFunc(Chan,EV)	No	Host/ ANT
	Acknowledge Data	ANT_SendAcknowledgedData() → ChannelEventFunc(Chan, EV)	No	Host/ ANT
	Burst Transfer Data	ANT_SendBurstTransferPacket() → ChannelEventFunc(Chan, EV)	No	Host/ ANT
Channel Event Messages	Channel Response/ Event	→ ChannelEventFunc(Chan, MessageCode) or → ResponseFunc(Chan, MsgID)	-	ANT
Requested Response Messages	Channel Status	→ ResponseFunc(Chan, 0x52)	-	ANT
	Channel ID	→ ResponseFunc(Chan, 0x51)	-	ANT
	ANT Version	→ ResponseFunc(Chan, 0x51)	-	ANT
	Capabilities	→ ResponseFunc(-, 0x3E)	-	ANT
Test Mode	CW Init	ANT InitCWTestMode()	Yes	Host
	CW Test	ANT SetCWTestMode()	Yes	Host
Ext Data messages	Extended Broadcast Data	ANT SendExtBroadcastData()[a] → ChannelEventFunc(Chan, EV)	No	Host
	Extended Ack. Data	ANT SendExtAcknowledgedData()[a] → ChannelEventFunc(Chan, EV)	No	Host
	Extended Burst Data	ANT SendExtBurstTransferPacket()[a] → ChannelEventFunc(Chan, EV)	No	Host

a. nRF24AP2 does not send these ChannelEventFunctions() to the host. nRF24AP2 will send extended messages by appending the additional bytes to standard broadcast, acknowledged and burst data.

Table 4. ANT message summary supported by nRF24AP2

5 Host interface

The nRF24AP2-USB has a USB v2.0 compliant host interface. This enables direct connection from the nRF24AP2-USB to a computer or hubs in other USB enabled equipment. Together with the command libraries and USB drivers available from ANT the nRF24AP2-USB enables ANT connectivity for applications in computers and other advanced hosts.

5.1 Features

USB serial interface of nRF24AP2-USB:

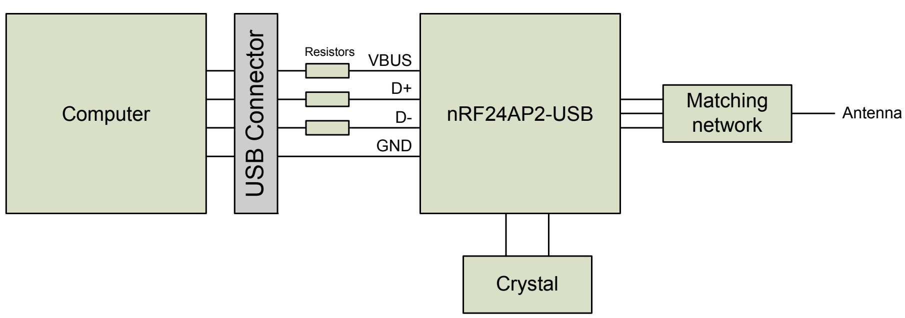
- Serial interface engine:
  - USB v2.0 compliant
  - On-chip pull-up resistor on **D+**
- Two control endpoints and two bulk endpoints
- Suspend and resume power management functions
- USB drivers and ANT command libraries supported by ANT

The following USB features are necessary to declare when your product undergoes USB compliance testing:

- Full speed peripheral
- Microcontroller with USB drivers on same chip
- Bus powered
- No remote wakeup

5.2 Block diagram

Figure 11. shows a USB block with external signals **VBUS, D+, D-, GND**, on-chip pull up resistor on **D+** on one side and connection to the RF transceiver on the other.



Note: The serial resistors on VBUS, D+ and D- are for ESD protection and USB v2.0 compliance

Figure 11. USB block connected to ANT engine

5.3 Functional description

When the nRF24AP2-USB is plugged into a USB the first thing that needs to take place is for the nRF24AP2-USB to identify itself for the USB hub. This process is called enumeration and is handled automatically by the nRF24AP2-USB. Once the device is enumerated, applications on the host can access the nRF24AP2-USB using ANT command libraries.

This section outlines the enumeration process, user configurable USB parameters, and message exchanges that take place on the nRF24AP2-USB host interface.

5.3.1 Physical USB connection

The physical connection between nRF24AP2-USB and the host must follow the USB standard v2.0 (for instance, use USB approved connectors) in order for your nRF24AP2-USB based application to go through USB compliance testing.

5.3.2 USB enumeration

The USB enumeration process is handled by the nRF24AP2-USB. During the enumeration the host reads out the USB descriptors and strings to determine which device has been connected to the bus. After the host has received the parameters it will then assign the device an address and allowing it to transfer data on the bus.

A typical enumeration process consists of the following steps:

1. The host detects a new device on the bus via the pull up resistor on **D+**.
2. The host issues a reset to place the nRF24AP2-USB to the default state. This will enable the device to respond to the default address zero requests.
3. The host requests the Device Descriptor on address 0.
4. The host issues another bus reset.
5. The host issues a set address command, placing the nRF24AP2-USB in an addressed state.
6. The host requests the Device Descriptor again.
7. The host requests the Configuration, Interface and Endpoint Descriptors.
8. The host requests the String Descriptors.

After the enumeration process the nRF24AP2-USB can transfer ANT messages on the bus. A complete summary of ANT messages supported are listed in Table 4. on page 20.

5.3.3 USB descriptors

The nRF24AP2-USB has a set of USB descriptors which describe to the host information about manufacturer, product, USB version, the number of endpoints and their types.

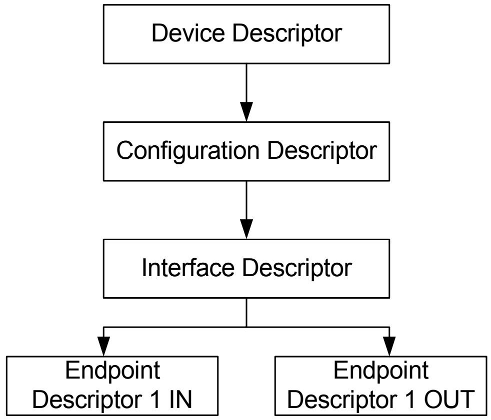


Figure 12. Organization of USB descriptors

The device descriptor contains basic information about the device such as the supported USB version, maximum packet size, vendor and product IDs.

Field	Notes	Value	Description
bLength		0x12	18
bDescriptorType		0x01	DEVICE
bcdUSB		0x0200	2.0
bDeviceClass		0x00	Class defined at interface level
bDeviceSubClass		0x00	Subclass defined at interface level
bDeviceProtocol		0x00	None
bMaxPacketSize0		0x20	32
idVendor	a	0x0FCF	Dynastream Innovations, Inc.
idProduct	a	0x1008	0x1008
bcdDevice		0x0100	1.0
iManufacturer		0x01	1
iProduct		0x02	2
iSerialNumber		0x03	3
bNumConfigurations		0x01	1

a. These fields can be customized with your own value

Table 5. Device descriptors

The configuration descriptor specifies how the device is powered, the maximum power consumption, and the number of interfaces used.

Field	Notes	Value	Description
bLength		0x09	Valid
bDescriptorType		0x02	CONFIGURATION
wTotalLength		0x0020	32 bytes
bNumInterface		0x01	1
bConfigurationValue		0x01	1
iConfiguration		0x02	2
bmAttributes. Reserved		0x00	Zero
bmAttributes. RemoteWakeup		0x0	Not supported
bmAttributes. SelfPowered		0x0	No, Bus powered
bmAttributes. Reserved7		0x1	One
bMaxPower		0x32	100 mA

Table 6. Configuration descriptor

The interface descriptor contains information about the number of endpoints and their class.

Field	Notes	Value	Description
bLength		0x09	Valid
bDescriptorType		0x04	INTERFACE
bInterfaceNumber		0x00	0
bAlternateSetting		0x00	0
bNumEndpoints		0x02	2
bInterfaceClass		0xFF	Vendor-specific
bInterfaceSubClass		0x00	Vendor-specific
bInterfaceProtocol		0x00	None
iInterface		0x02	2

Table 7. Interface descriptor

Endpoint descriptors contain information about the transfer type, interval and the packet size. The host will use the information to decide on the requirements for the bus. The nRF24AP2-USB uses two endpoints for communication with the host, one configured as IN and the other as OUT.

Field	**Notes**	**Value**	**Description**
bLength		0x07	Valid
bDescriptorType		0x05	ENDPOINT
bEndpointAddress		0x81	1 IN
bmAttributes. TransferType		0x2	Bulk
bmAttributes. Reserved		0x00	Zero
wMaxPacketSize		0x0040	64 bytes
bInterval		0x01	Ignored for full speed, Bulk endpoints

Table 8. Endpoint descriptor 1 IN

Field	**Notes**	**Value**	**Description**
bLength		0x07	Valid
bDescriptorType		0x05	ENDPOINT
bEndpointAddress		0x01	1 OUT
bmAttributes. TransferType		0x2	Bulk
bmAttributes. Reserved		0x00	Zero
wMaxPacketSize		0x0040	64 bytes
bInterval		0x01	Ignored for full speed, Bulk endpoints

Table 9. Endpoint descriptor 1 OUT

5.3.4 String descriptors

String descriptors provide information about the manufacturer, product and serial number for the nRF24AP2-USB. These strings can be modified, see section 5.3.5 on page 25.

String Index 0 returns a list of supported languages.

Field	Notes	Value	Description
bLength		0x04	4
bDescriptorType		0x03	STRING
wLANGID[0]		0x0409	English (US)

Table 10. String index 0 (language identifier)

Field	Notes	Value	Description
bLength		0x30	48
bDescriptorType		0x03	STRING
bString	a	“Dynastream Innovations”	

a. This field can be customized with your own manufacturer string

Table 11. String index 1 (manufacturer string)

Field	Notes	Value	Description
bLength		0x1E	30
bDescriptorType		0x03	STRING
bString	a	"ANT USBStick2"	

a. This field can be customized with your own product string

Table 12. String index 2 (product string)

Field	Notes	Value	Description
bLength		0x2A	42
bDescriptorType		0x03	STRING
bString	a	“123”	

a. This field can be customized with your own serial number

Table 13. String index 3 (serial number string)

5.3.5 Customize descriptors

The nRF24AP2-USB is programmed with default VID/PID values which allow it to function with the drivers and libraries provided by ANT. However, it is possible to customize the nRF24AP2-USB. You can customize the following values and string descriptors:

- Vendor ID (VID)
- Product ID (PID)
- Manufacturer string
- Product string
- Serial number