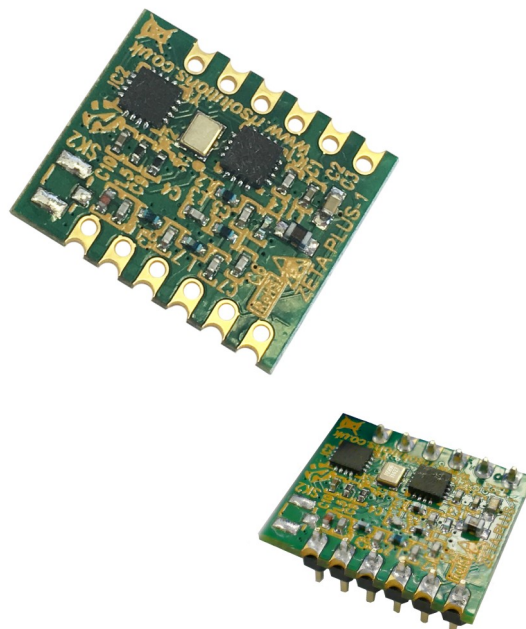


Miniature Smart RF Transceiver

Features

- Intelligent Wire replacement SMARTRADIO
- form factor: 16mm x 18mm
- 2Km range
- Transmit Power +13dBm
- High sensitivity -116dBm (@ 2.4kbps)
- Max data rate @ 500Kbps
- Simple UART and SPI interface
- Best in Class cost performance
- Available as 433/868/915MHz
- 1.8V – 3.6V Operating Voltage
- Low power consumption
 - 0.5nA Standby
 - 10mA Rx
 - 18mA Tx @ 10dBm
- 64 byte Buffer (FIFO)
- Integrated battery voltage sensor
- Based on Silicon Labs' Si4455 chipset
- No configuration necessary
- No external components
- Fast and effective Plug and Play RF Comms



Applications

- Home automation
- Sensor / mesh RF networks
- Telemetry
- Keyless entry
- Health monitors
- RF Data comms

Applications

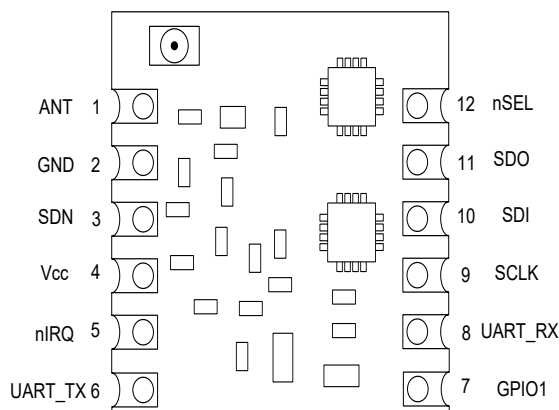
The ZETAPLUS Smart Module is a plug and play Radio Communications module with simple SPI and UART (LV RS232) interface.

With only a few connections to power, comms and antenna, the user can quickly start sending and receiving data. No other external components are required.

With a highly tuned on-board RF matching network ZETAPLUS outperforms other modules achieving range far in excess of its competitors for the given power output/power consumption.

Additional features, include a 64-byte TX/RX FIFOs, preamble detection, sync word detector, and CRC are all automatically handled, reducing current consumption and allow for the use of lower-cost system MCUs. The ZETAPLUS also gives access to the integrated auxiliary 11-bit ADC used for the internal battery voltage detector making low battery detect very simple to implement on your design.

Pin Description

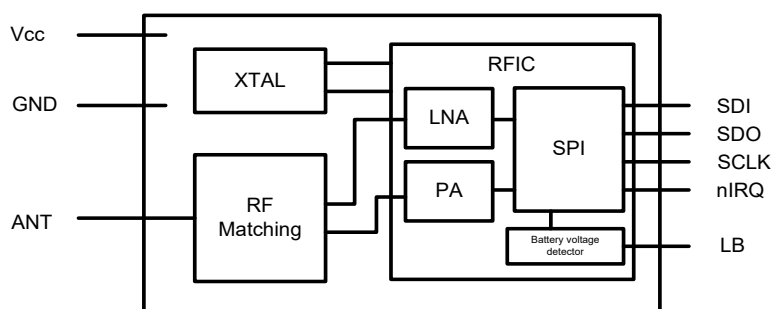


PIN	Definition	Type	Function
1	Antenna Pin	In/Out	Antenna pin connection. Keep short and match to 50ohms for best performance
2	GND	In	Ground connection
3	Shutdown	Active high	The shutdown state is the lowest current consumption state of the device and is entered by driving SDN high. In this state, all register contents are lost and there is no SPI access. Drive low to exit
4	Vcc	In	Power connection
5	Interrupt	Output	Active Low Interrupt Status Output – Read interrupt status for event details E.g. The FIFO on the ZETAPLUS module contains data
6	UART_TX	Out	RS232 Transmit pin
7	GPIO1	In / Out	General Purpose I/O can be configured by Si4455 to provide additional function
8	UART_RX	In	RS232 Receive Pin
9	Serial clock	In	SPI Clock In
10	Serial data In	In	SPI Data In
11	Serial data Out	Out	SPI Data Out
12	Serial interface select	In	SPI Device Select

Ordering information

Part Number	Description
ZETAPLUS-433-S0	FM transceiver module, 433MHz (marked Red Dot) SMT
ZETAPLUS-433-D	FM transceiver module, 433MHz (marked Red Dot) DIP
ZETAPLUS-868-S0	FM transceiver module, 868MHz (marked Blue Dot) SMT
ZETAPLUS-868-D	FM transceiver module, 868MHz (marked Blue Dot) DIP
ZETAPLUS-915-S0	FM transceiver module 915MHz (marked Yellow Dot) SMT
ZETAPLUS-915-D	FM transceiver module 915MHz (marked Yellow Dot) DIP

Block Diagram



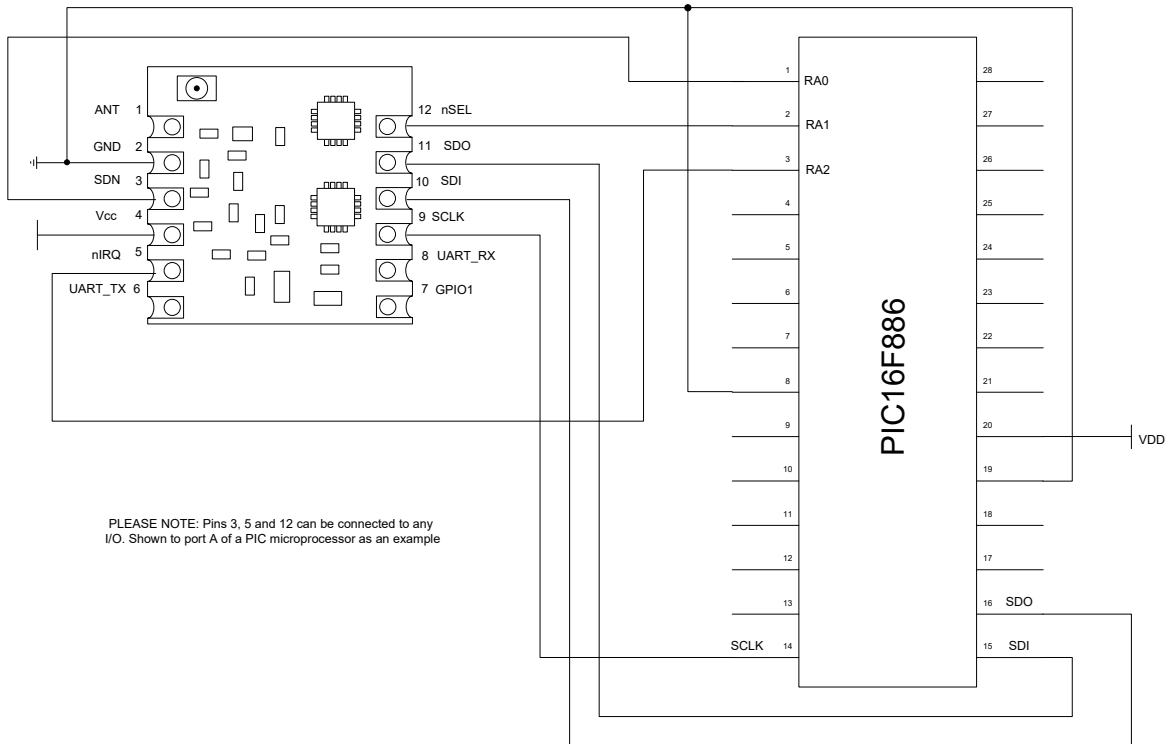
Application notes

Communication with ZETAPLUS module can be via SPI interface or UART (LVTTTL). For transmission using SPI load the correct decimal byte values into the SPI TX register. When a byte is received using SPI the nIRQ line will be pulled low, this shows that data will be ready to be read from the SPI register.

Using the UART (LVTTTL) load the correct decimal byte values into the UART TX register, this will be sent to the ZETAPLUS via it's RX pin. When data is received by a ZETAPLUS the module will output the data through the TX pin of the module to the RX pin of the controlling device (microprocessor) where this can be read.

SPI Command Set and Interface

Application schematic- ZETAPLUS and PIC16F886



Mode selection:

Command for MODE select: ATM 1-3			
Command	Name	Description	
1	RX	The command enters RX mode using whichever settings were last configured using the #R command below.	
2	Ready	Ready is a low power wake state which can be used for fast entry to RX or switching between TX and RX. Time to RX or TX from READY <1ms	
3	Sleep	Low power sleep mode with register retention.	

Command A T M 1
 Decimal byte value 65 84 77 1

Example: Place the codec in receive mode

Note: alternative possible example of mode select for some terminal programs: ATM#001.

Receive mode:

Command for RECEIVER select: ATR CHANNEL, PACKET LENGTH		
Command	Name	Description
0-15	CHANNEL	Set in 250KHz increments starting at (FREQ dependent): At 433MHz: 0=433.92 At 868MHz: 0=869.50 At 915MHz: 0=915
1-65	PACKET LENGTH	Length of data packet to be sent in 8 bit bytes

Example: Enter receiver mode on channel 2 with a packet length of 10 (8 bit) bytes.

Command A T R 2 10

Decimal byte value 65 84 82 2 10

Transmit mode

Command for Transmit Mode: ATS CHANNEL, PACKET LENGTH, DATA		
Command	Name	Description
0-15	Channel	Set in 250KHz increments starting at (FREQ dependent): At 433MHz: 0=433.92 At 868MHz: 0=869.50 At 915MHz: 0=915
1-64	Packet length	The length of the data packet to follow. In 8 bit bytes.
	Data	Your data to be transmitted.

Command A T S 2 13 DATA

Decimal byte value 65 84 83 2 13 Your 13 bytes

Sync bytes / addressing

Configure module sync bytes: Command: ATA SYNC1, SYNC2, SYNC3, SYNC4		
Command	Name	Description
1-4	SYNC1-4	Sent sync bytes 1-4. The sync bytes appear directly after the pre-amble in data packet and can be used as a form of addressing to discriminate between required and spurious data. Set these bytes and the module will then only pass on data which contains the correct sync bytes configuration. Set all to AA if not required. NOTE: Reverse order bytes: ie 2D = D4, D4 = 2B

Example: Set the sync bytes to 12 34 56 78

Command A T A 12 34 56 78

Decimal byte value 65 84 65 12 34 56 78

RF Baud Rate

Configure the RF baud rate: Command: ATB 1-6
 Note SDN must be toggled high/low for setting to take affect and can take up to 15ms to complete.

Command	Name	Description
1-6	Baud rate	GFSK RF baud rates in kbps 1=4.8 kbps 2=9.6 kbps 3=38.4 kbps 4=128.0 kbps 5=256.0 kbps 6=500.0 kbps

Example: Set the RF baud rate to 500kbps GFSK:

Command	A	T	B	6
Decimal byte value	65	84	66	6

RF Output Power

Configure the RF power output: Command: ATP 1-127

Command	Name	Description
1-127	Power output	Power output in increments from 1-127

Example: Set the power outputs to 32:

Command	A	T	P	15
ASCII	65	84	80	32

NOTE

"SI4455 o/p power as defined in the datasheet:-

The PA circuitry in the chip contains an output device whose size may be adjusted by enabling/disabling different numbers of device fingers. Selection of a higher value results in an increase in TX output power.

The relationship between output power and the number of enabled device fingers is not necessarily linear, and is dependent upon the PA mode of operation (e.g., Class-E or Switched Current), the duty cycle of the drive signal to the output circuit, the VDD supply voltage, and the output match. As a result, there is no simple formula to relate the setting of the PA_PWR_LVL property to an absolute value of output power in dBm.

The adjustment resolution of the TX output power is very fine (step size < 0.1 dB) when operating near the maximum power setting, but becomes coarser as the output power level is reduced."

Ping-Pong (Walk test)

The ZETA-PLUS has a built in walk test mode that allows users to range test the product via simple commands. By setting both transmitter and receiver into this mode, the transmitter will send a packet to the receiver (ping) and the receiver will output #RZYXWVUTSRQ (this is just #R and then the first 10 letters of the alphabet in reverse) to show that the ping command has been received. The receiver will then send a packet back to the transmitter (pong), this will be output by the transmitter by #T and then the RSSI (Received Signal Strength Indication) value. If no reply packet is received back from the receiver with 200ms the RSSI value will be 0.

TRANSMITTER

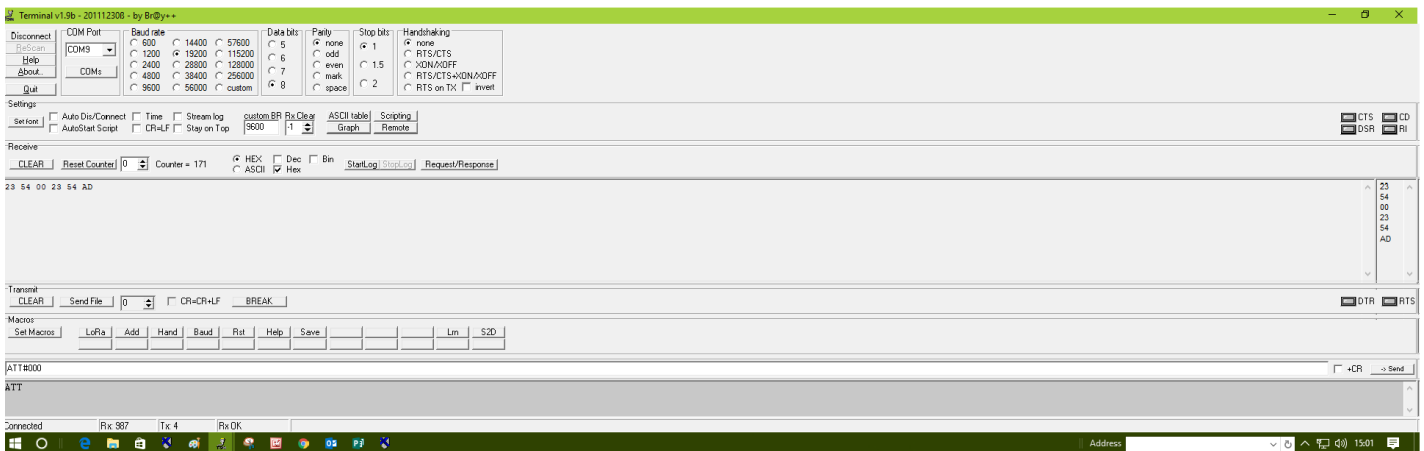
The below command will place the ZETAPLUS into ping-pong mode as a transmitter. The transmitter will output every 200ms the RSSI value of a valid packet through its UART RX pin.

ATT#000



Channel number (byte value)

The below screen shots shows a terminal window and the received data on the RX pin. The image shows the data



packet that is output when a successful ping-pong takes place on the transmitter.

The below image shows the values output by the transmitter during the walk test when no packet is received back from the receiver.



RECEIVER

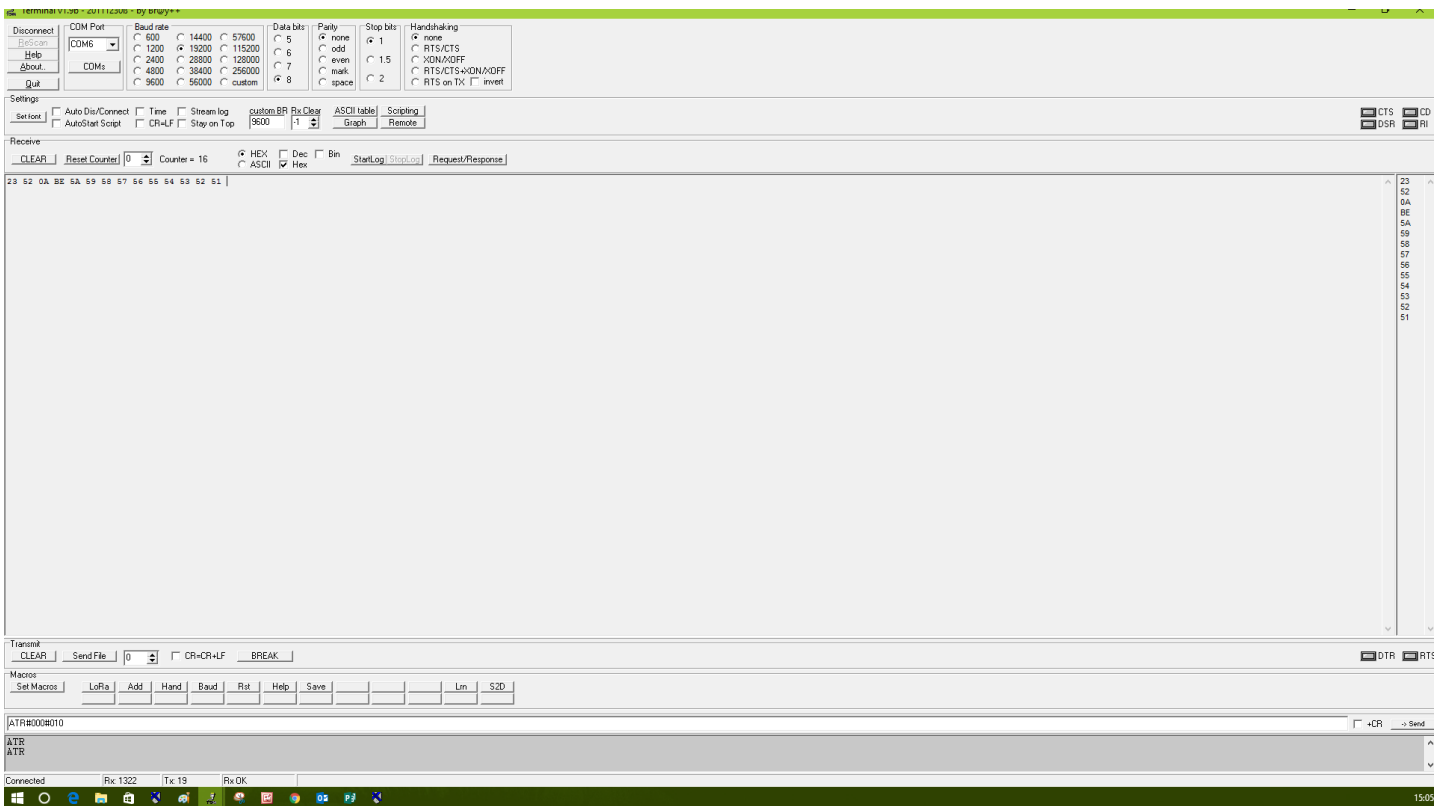
To configure the ZETAPLUS into receiver mode for the ping-pong walk test, the following string needs to be input on the TX pin.

ATR#000#010

Channel number (byte value)

10 byte payload (this is the only byte value that will enter the device into ping-pong)

The image below shows a terminal window with a successful packet received, here you can see the HEX values for #RZYXWVUTSRQ (This being the TEN BYTES and the #R showing receiver).



Communication with the ZETAPLUS via SPI interface.

Maximum SPI data rate: 1.4Mhz

Data is sent over the SPI bus on the ZETAPLUS codec in standard SPI format using the correct command set. A 50ms timeout exists to avoid lock-up if not all requested data bytes are sent - in this scenario the packet would be aborted and no data sent.

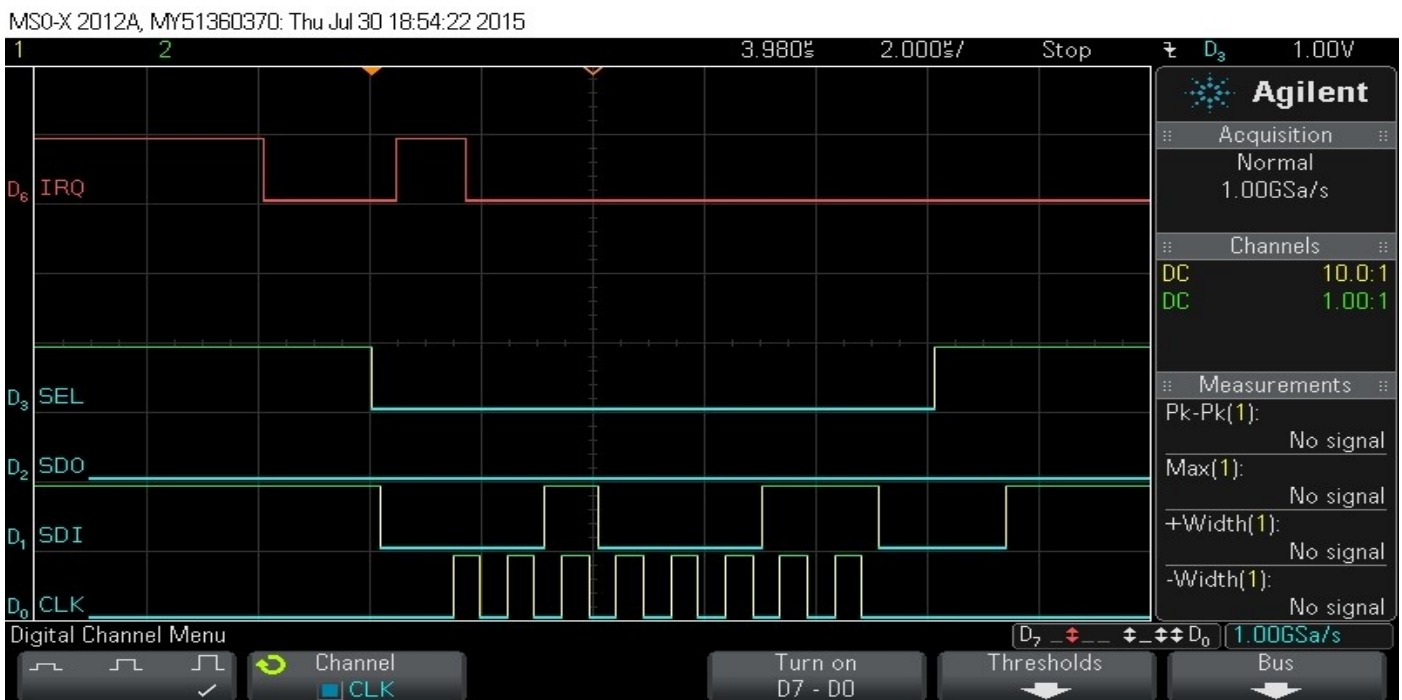
When in receive mode and an RF packet is received the U_IRQ pin will go low indicating SPI data is ready to be read.

The following two pages show example timing diagrams for the SPI bus communication.

Selecting preferred communication method.

Only one communication method can be used at a time and priority is set by the last access method.

For example if you enable receive mode via SPI it will revert to SPI communication from there on unless you access the device via UART it will then revert to UART communication only from then on.



Above is the first byte of SPI data following U_IRQ going low after an RF packet has been received.

Sequence:-

1. IRQ goes low indicating a packet has been received.
2. Read byte over SPI bus.
3. If IRQ remains low then more data is still available to read. Goto 2.

The first two bytes read should be #R followed by the packet length & RSSI value then the packet data.

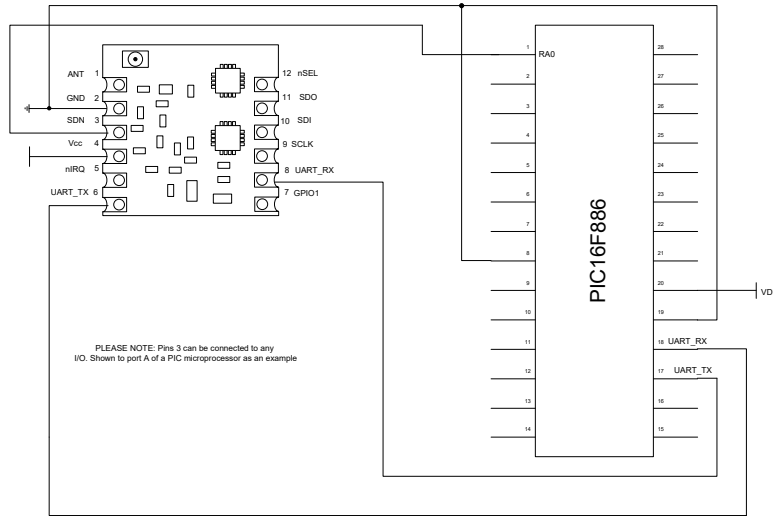
MSO-X 2012A, MY51360370: Thu Jul 30 18:55:05 2015



Above is the complete SPI & IRQ Timing diagram for #R<RSSI> <Packet > plus 12 byte data packet

UART Application

Application schematic- ZETAPLUS and PIC16F886



UART command set

UART configuration:

Baud rate: 19200, Data bits: 8, Parity: none, Stop bits: 1

Note all UART I/O are at Low level and must not exceed 5V.

UART in

Data is sent to the RX pin on the ZETAPLUS in standard UART format using the correct command set. A 50ms timeout exists to avoid lock-up if not all requested data bytes are sent - in this scenario the packet would be aborted and no data sent.

UART out

Data is output from the TX pin on the ZETAPLUS.

When in receive mode and an RF packet is received the data packet is automatically sent over the UART.

Firmware Version

Use this command to check which firmware version of the ZETAPLUS-PLUS you are using.		
Command	Name	Description
N/A	Firmware Version	Example reply: # v 1 . 0 0 EXAMPLE 35 86 31 46 30 30

Example: Check firmware version

Command	A	T	V
Decimal byte value	65	84	86

Retrieve Configuration and Settings

Use this command to check the current settings of the device		
Command	Name	Description
N/A	Configuration and settings	Example reply: #? FOLLOWED BY 8 BYTE AS BELOW OPERATING MODE (MODE:- 1= RX 2=READY) RF BAUD RATE (1- 19 AS PER DS) RF POWER OP (1- 127) SYNC BYTE 1 SYNC BYTE 2 SYNC BYTE 3 SYNC BYTE 4 CHANNEL NUMBER (0 -15 AS PER DS) EXAMPLE 35 63 1 1 127 45 210 0 0 0

Example: Retrieve settings

Command	A	T	?
Decimal byte value	65	84	63

RSSI

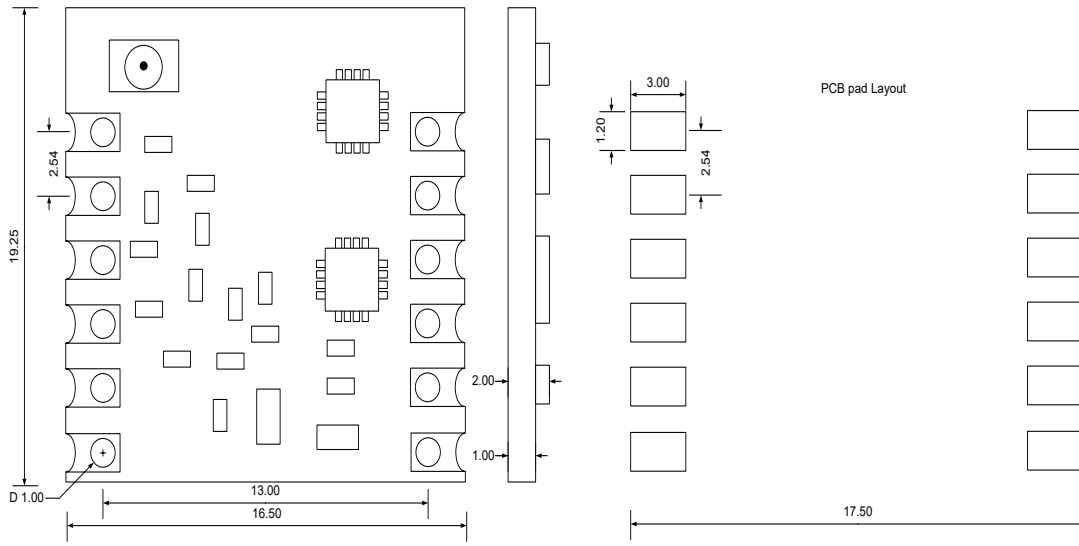
Use this command to retrieve the RSSI value		
Command	Name	Description
N/A	RSSI	Example reply: #Q FOLLOWED BY ONE BYTE RSSI VALUE (0-255) EXAMPLE 35 81 56

Example: Retrieve settings

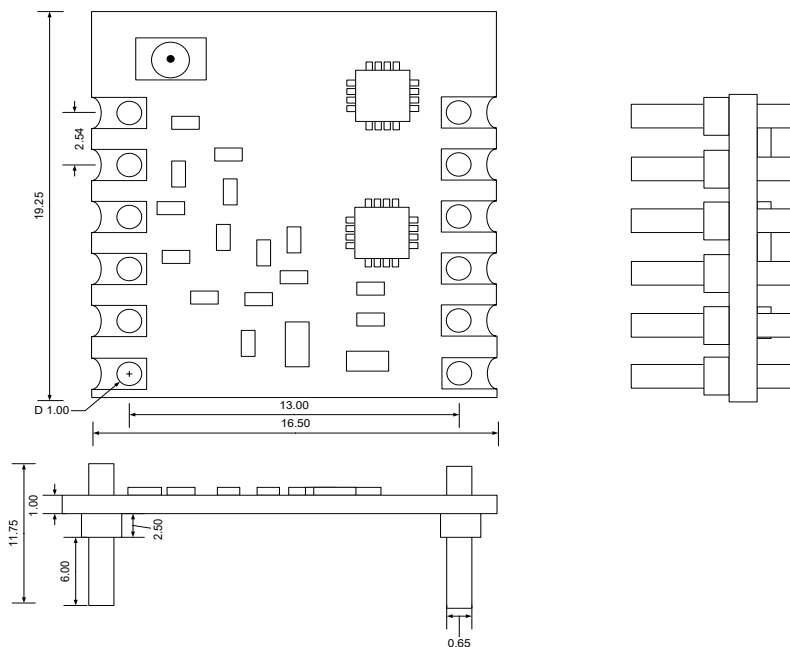
Command	A	T	Q
Decimal byte value	65	84	81

Mechanical dimensions

Surface Mount Package



P-DIP Package



Electrical Specifications

Recommended operating conditions

Parameter	Symbol	Test condition	Min	Typ.	Max	Unit
Ambient Temperature	T_A		-40	25	85	°C
Supply Voltage	V_{DD}		1.8		3.6	V
I/O Drive Voltage	V_{GPIO}		1.8		3.6	V

DC characteristics

Parameter	Symbol	Test condition	Min	Typ.	Max	Unit
Supply voltage range	V_{DD}		1.8	3.3	3.6	V
Power saving modes	$I_{Shutdown}$	RC oscillator, main digital regulator, and low power digital regulator OFF.	–	30	–	nA
	$I_{Standby}$	Register values maintained.	–	50	–	nA
	I_{Ready}	Crystal oscillator and main digital regulator ON, all other blocks OFF.	–	2	–	mA
	ISPI Active	SPI active state		1.35		mA
TUNE mode current	I_{Tune_RX}	RX tune	–	6.5	–	mA
	I_{Tune_TX}	TX tune	–	6.9	–	mA
RX mode current	I_{RX}		–	10	–	mA
TX mode current	I_{TX}	+10 dBm output power, 868 MHz	–	18	–	mA
		+13 dBm output power, 868 MHz	–	30	–	mA

Synthesiser AC electrical characteristics

Parameter	Symbol	Test condition	Min	Typ	Max	Unit
Synthesizer frequency Range	F_{SYN}		860	–	869	MHz
Synthesizer frequency Resolution	$F_{RES-868}$	850–870 MHz	–	114.4	–	Hz

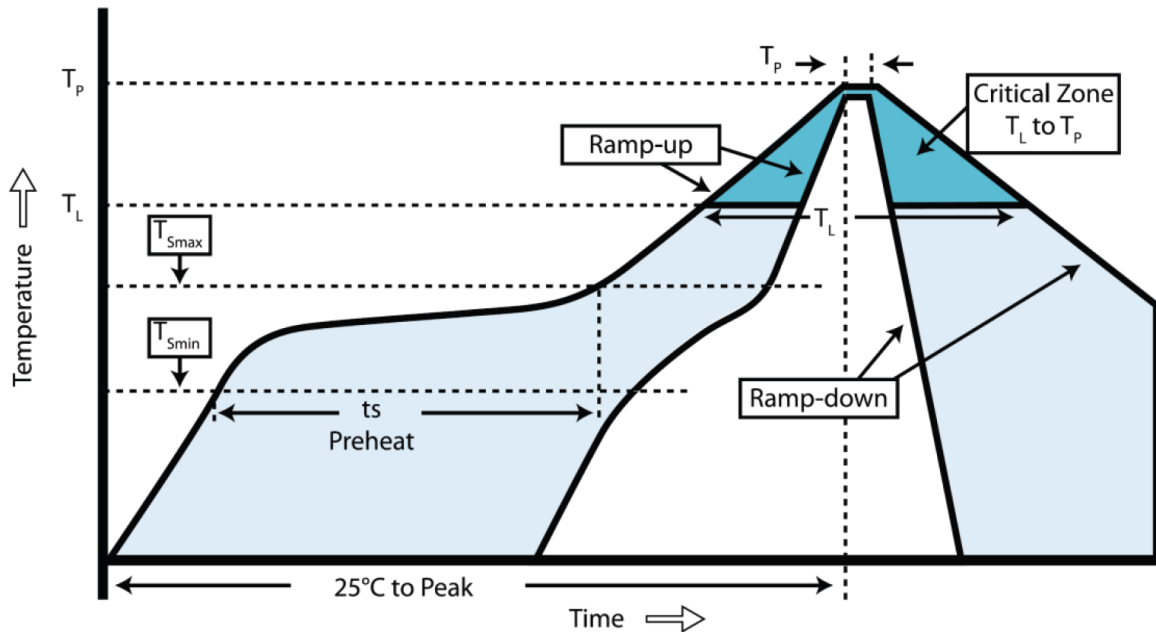
Transmitter AC electrical characteristics

Parameter	Symbol	Test condition	Min	Typ	Max	Unit
TX frequency range	F_{TX}		850	–	870	MHz
(G)FSK data rate	DR_{FSK}		1.0	–	500	kbps
OOK data rate	DR_{OOK}		0.5	–	120	kbps
Modulation deviation range	Df_{960}	850–870 MHz	–	–	500	kHz
Modulation deviation resolution	$FRES_{960}$	850-870 MHz	–	114.4	–	Hz
Output power range	P_{TX}		–40	–	+13	dBm
TX RF output steps	DP	Using switched current match within 6 dB of max power	–	0.1	–	dB
TX RF output level variation vs. temperature	DP_{RF_TEMP}	–40 to +85 °C	–	1	–	dB
TX RF output level Variation vs. frequency	DP_{RF_FREQ}	Measured across 850-870 MHz	–	0.5	–	dB
Transmit modulation filtering	B*T	Gaussian filtering bandwidth time product	–	0.5	–	
Spurious emissions	P_{OB-TX1}	$P_{OUT} = +13$ dBm, Frequencies < 1 GHz	–	–54	–	dBm
	P_{OB-TX2}	1–12.75 GHz, excluding harmonics	–	–42	–	dBm
Harmonics	P_{2HARM}	Using reference design TX matching network and filter with max output power. Harmonics reduce linearly with output power.	–	–42	–	dBm
	P_{3HARM}		–	–42	–	dBm

Receiver AC electrical characteristics

Parameter	Symbol	Test condition	Min	Typ.	Max.	Unit
RX frequency range	F_{RX}		850	—	870	MHz
RX sensitivity	P_{RX-2}	(BER < 0.1%) (2.4 kbps, GFSK, BT = 0.5, DF = ±30 kHz, 114 kHz Rx BW)	—	-116	—	dBm
	P_{RX-40}	(BER < 0.1%) (40 kbps, GFSK, BT = 0.5, DF = ±25 kHz, 114 kHz Rx BW)	—	-108	—	dBm
	P_{RX-128}	(BER < 0.1%) (128 kbps, GFSK, BT = 0.5, DF = ±70 kHz, 305 kHz Rx BW)	—	-103	—	dBm
	P_{RX-00K}	(BER < 0.1%, 1 kbps, 185 kHz Rx BW, OOK, PN15 data)	—	-113	—	dBm
		(BER < 0.1%, 40 kbps, 185 kHz Rx BW, OOK, PN15 data)	—	-102	—	dBm
RX channel bandwidth	BW		40	—	850	kHz
BER variation vs power Level ₂	P_{RX-RES}	Up to +5 dBm Input Level	—	0	0.1	ppm
RSSI resolution	RES_{RSSI}		—	±0.5	—	dB
±1-Ch offset selectivity	C/I_{1-CH}	Desired Ref Signal 3 dB above sensitivity, BER < 0.1%. Interferer is CW and desired modulated with 1.2 kbps, DF = 5.2 kHz, GFSK with BT = 0.5, RX BW = 58 kHz channel spacing = 100 kHz	—	-56	—	dB
±2-Ch offset selectivity	C/I_{2-CH}		—	-59	—	dB
Blocking 200 kHz–1 MHz	$200K_{BLOCK}$	Desired ref signal 3 dB above sensitivity, BER < 0.1%. Interferer is CW and desired modulated with 1.2 kbps DF = 5.2 kHz GFSK with BT = 0.5, RX BW = 58 kHz	—	-58	—	dB
Blocking 1 MHz offset	$1M_{BLOCK}$		—	-61	—	dB
Blocking 8 MHz offset	$8M_{BLOCK}$		—	-79	—	dB
Image rejection	Im_{REJ}	Rejection at the image frequency IF = 468 kHz	—	-35	—	dB
Spurious emissions	P_{OB-RX1}	Measured at RX pins	—	-54	—	dBm

ZETAPLUS module re-flow guide



ZETAPLUS MODULE is a 2 layer PCB, re-flow is based on IPC/JEDEC JSTD020C July 2004

Profile feature	Value (lead free)
Ramp up rate	3°C /s
Pre-heat temperature - Temperature Min (T_{smin}) - Temperature Max (T_{smax}) - Pre-heat time	150°C 200°C 60-100s
Peak temperature (T_p)	240°C
Time at T_p	10-20sec
Ramp down rate	6°C/s
Time from 25°C to peak	8 mins max.

ZETAPLUS Smart RF Transceiver

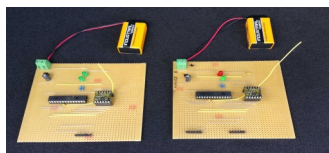


Range Test

Two Transceiver boards were built using simple prototyping board and a host PIC microcontroller . One board was programmed as a transmitter to send a beacon signal at 1 second interval. The other board was programmed as receiver which acknowledged the received signal back to the transmitter thus creating a ping-pong test set.

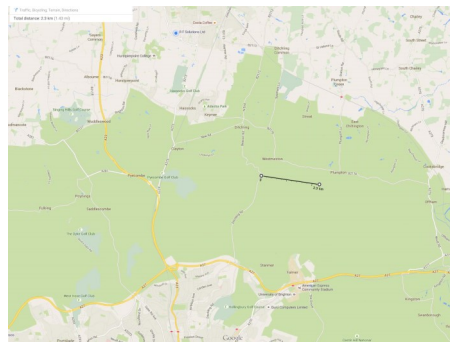
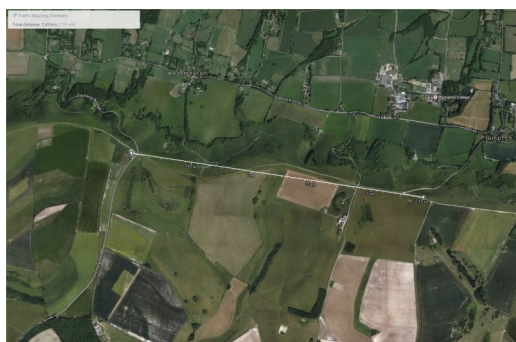
A simple piece of wire was used as antenna for both boards

Prototyping board and wire as antenna is not ideal, but many real applications are often a compromise!



Our Range Testing was conducted from Ditchling Beacon providing an open Line of Sight Test.

1. The Transmitter was placed Receiver was mounted on the back of a pick up truck and the receiver was carried by hand ~5ft from the ground .
2. As the receiver travelled away from the transmitter Line of sight was occasionally lost when we went in the shadow of a hill, at this time the RF signal was intermittent, A Reliable signal in Line of sight was observed to 2.4K range, thereafter we couldn't go any further as the pathway stopped.. At this range in L.O.S the signal was 100% reliable.



Test conditions

- $T_A = +18\text{ }^\circ\text{C}$
- $V_{DD} = +3.3\text{ Vdc}$
- Dry, Broken Sunshine, Relative Humidity 45%

Result:

The test achieve a maximum range of 2.4km after this point the terrain dropped away and a line of sight was completely lost, it is possible that the module may have achieved a longer range.



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ROHS Directive 2002/95/EC

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