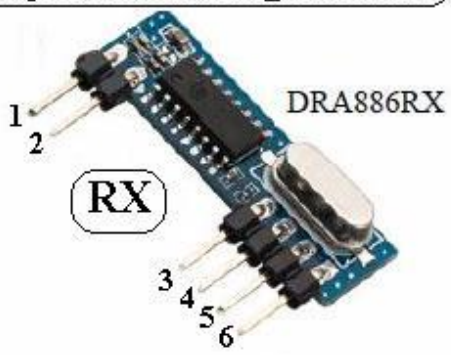
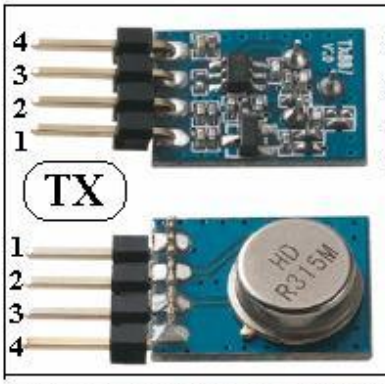
DORJI 433.92 MHz ASK TX/RX data modules - early 2012

* Cheap * Sensitive * Small * Powerful * Versatile supplies * Low drain * Snooze capable

Refer Dorji product details & data .pdfs => www.dorji.com/pro/Modules/ASK_module.html

The new DRA886RX 433 MHZ ASK receiver module is based on a highly integrated SYN470R superhet. RF IC, which allows extremely low external part count,high stability and strong anti-interference features. It features -107dBm sensitivity at 1200 bps, flexible supply (3.6-5.5V) and very low power (~µA level) microprocessor controlled snoozing.





Companion **DRA886/7TX** is higher power than normal (to legal 25 mW) and able to handle a flexible supply (1.8V - 5.5V)

1 = antenna
2 = data (to ~9.6kbps)
3= +ve supply
4= GND

1	GND	Ground (0V)
2	ANT	Antenna port (50 Ohm)
3	VCC	Power pin (3.6 - 5.5 V)
4	/CS	Enable pin; low effective
5	DATA	Data output
6	GND	Ground (0V)

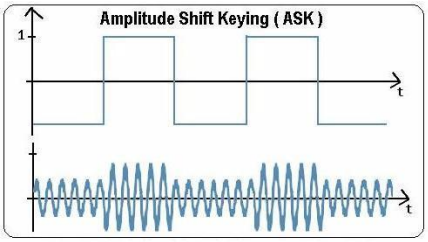
NOTE: Module pictures shown here correctly - data sheets were mirror imaged!

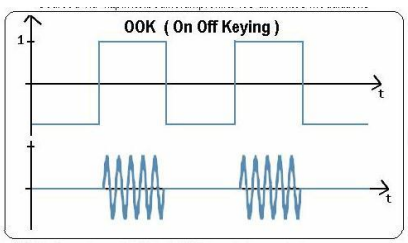
via => stan.swan@gmail.com 17th March 2012

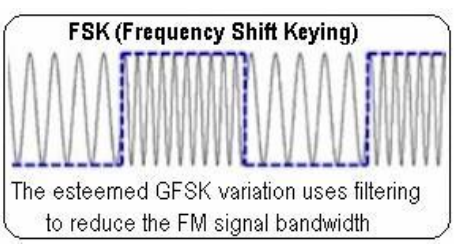
In spite of an increasing preference by many 433 MHz users for more sophisticated wireless data approaches, Chinese firm Dorji's new ASK (Amplitude Shift Keying) data modules look eye catching! Given Dorji's recent success with superb GFSK (Gaussian Frequency Shift Keyed) 433 MHz data transceivers, you'd think this beginners slot in the crowded 433 MHz ISM market would be hardly worth their while… Initial trials however show their ASK modules may have keen appeal for basic wireless needs –both with slow data (~2400 bps) and tones.

Compared with other entry level 433 MHz offerings these Dorjis are cheap (~US$10 a matched pair), compact, very easy to use, have a much more powerful -but nominally legal in most countries- transmitter (TX), significantly more sensitive receiver (RX), µA level snoozing & are supply voltage tolerant. Existing modules, such as Jaycar's long popular (but ~US$25 a pair) Keymark/SpiritOn offerings, have weak transmitters (~2mW) & "deaf" receivers (-104dBm) which annoyingly insist on a 5V supply.(The 5V need is particularly irksome for portable and battery use, as it often means extra cells and a LDO (low drop out) regulator have to be included in the receiver set up).

Data Modulation: ASK is essentially high-speed Morse code style OOK (On Off Keying), which does not totally cut the transmitted carrier to zero. Although prone to impulse interference on the increasingly noisy 433 MHz ISM band, simple ASK/OOK modules remain appealing for skinflint budgets & new users, especially since superior (but wider bandwidth & more complex) FSK (Frequency Shift Keyed) & narrow band GFSK modules are quite costly. GFSK transceiver devices (such as Dorji's popular DRF7020D13) may need daunting configuration too.







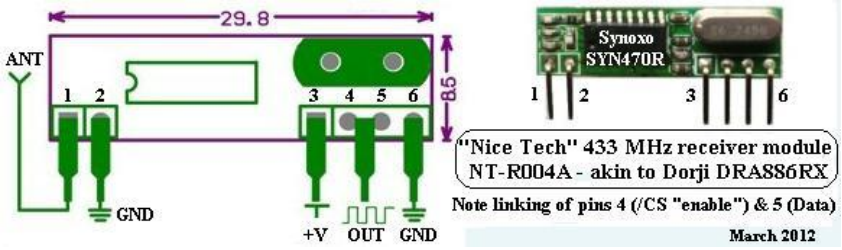
A tight 5V supply normally requires extra circuitry or more batteries (or both), so the Dorji's supply flexibility (plus handy RX snooze feature & low drain) may particularly appeal - a trio of AA cells may be good for near shelf life on the receiver when suitably (PICAXE?) micro controlled. Users after more punch than other 433 MHz simplex (one way) ASK offerings may be especially taken with the "powerful" (~25mW!) transmitter. This further suits non data lost model beacons or fox hunt applications as it's signal can be readily modulated. All up (as every 6dB system gain doubles range), perhaps an order of magnitude range boost over regular 433 MHz cheapies may result. Slow data rate (~2400 bps) telemetry links of perhaps a km could thus be feasible over open terrain. The nature of the wireless application and local RF conditions (especially interference) naturally influences this.

Minor issues: **A** glaring data sheet blunder has been noted. It transpires that Dorji's web site & .pdf images for these new modules are –gasp- shown mirror imaged! Hopefully this lateral inversion will soon be corrected They're shown flipped correctly in my feature summary!

Part Name: DRA887TX
Category: ASK transmitter module
Features: Frequency Range: 433MHz
10/17dBm output power
Tx current: 24mA
Temperature: -20~+70C
Supply voltage: 1.5~5.5V

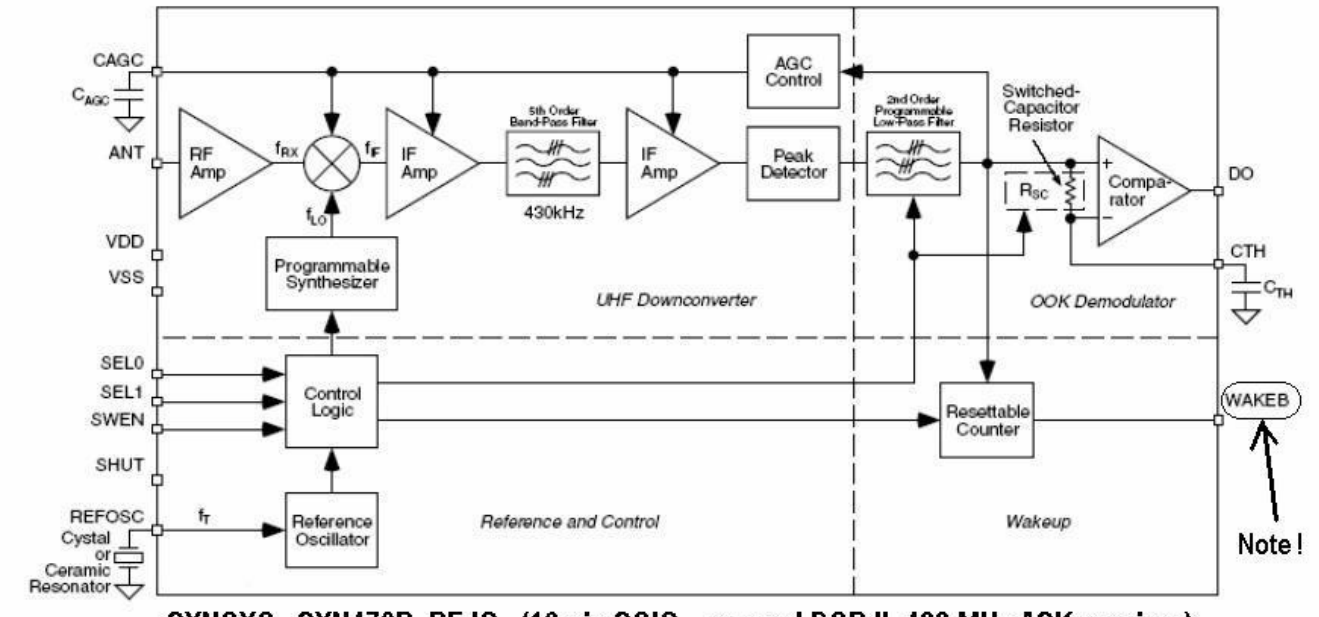
Part Name: DRA886RX
Category: ASK receiver module
Features: Frequency Range: 433MHz
-107dBm sensitivity
Rx current: 4mA
Temperature: -20~+70C
Supply voltage: 3.6~5.5V

Somewhat annoyingly the receiver module's 1/10th inch (2.54mm) pin spacing seems slightly too wide- it's ANT. & GND pins can only just be breadboard persuaded! The transmitter pins are however OK.



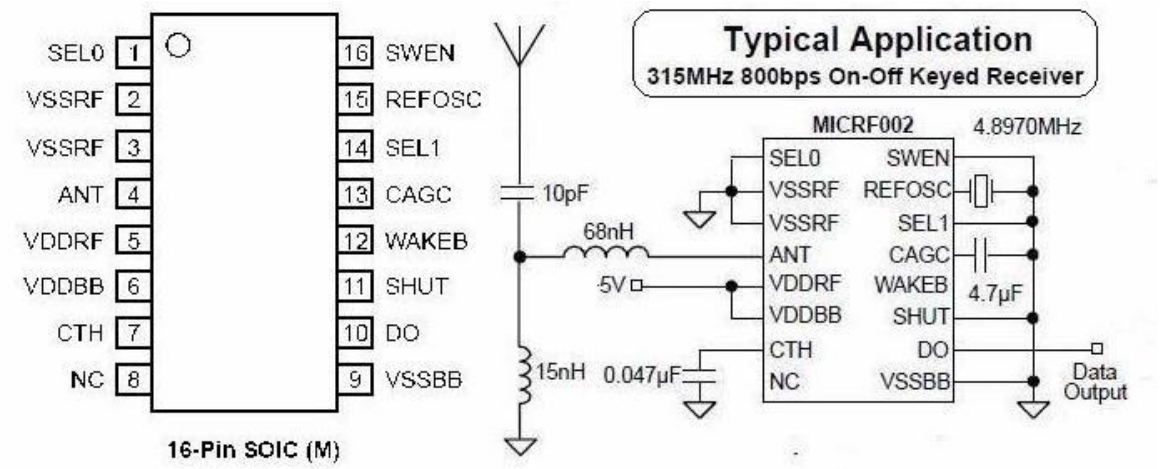
"Nice Tech"'s RX look-alike module uses seemingly almost the same circuitry. However it's ANT & GND look swapped, with pins 4 & 5 linked. Given the hi-tech manufacturing power - house of China's Shenzhen region, there are no doubt diverse "badge engineered" equivalents-Gaily TX-1A?

Radio Frequency IC (RF IC) "engine": Much of the receiver modules performance & simplicity arises from Synoxo's Chinese sourced **SYN470R** 16 pin RF IC, which seems identical to Micrel's "QwikRadio" MICRF002



SYNOXO SYN470R RF IC (16 pin SOIC - as used DORJI 433 MHz ASK receiver)

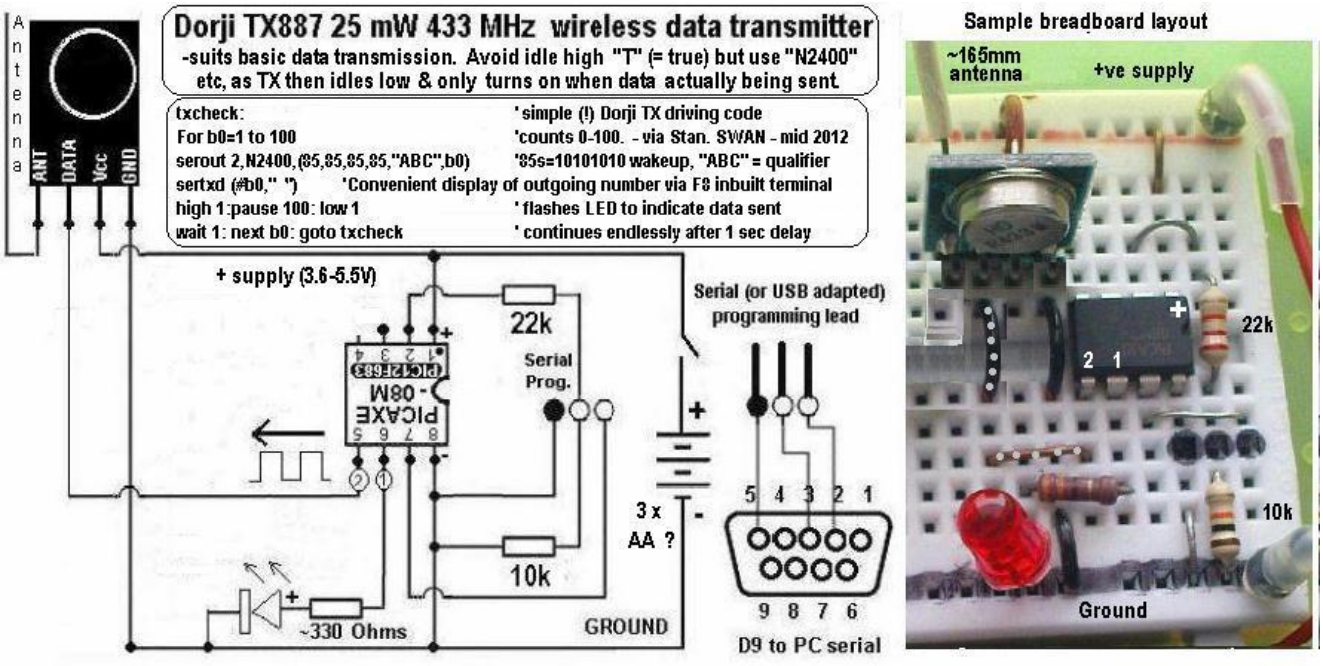
These radio frequency small outline ICs (SOIC) are refined externally to a near laughable “RF in-data out” level. Both apparently have Wake On Radio (WOR) features (pin 12). However this is not brought out to the Dorji RX module control pins, & may anyway only be available when the SYN470R/MICRF002 is powered up and drawing a few mA. Keen eyed & steady hand readers may find it worth exploring the relevant IC pins & data sheets! **The undocumented RSSI (signal strength) feature on the Synoxo pin 13 has been particularly interesting !**



Pin Description — Micrel QwikRadio MICRF002 (& also Synoxo SYN470R)

Pin Num SOIC-16	Pin Name	Pin Name
1	SEL0	Bandwidth Selection Bit 0 (Digital Input): Used in conjunction with SEL1 to set the desired demodulator filter bandwidth. See Table 1. Internally pulled-up to VDDRF.
2, 3	VSSRF	RF Power Supply: Ground return to the RF section power supply.
4	ANT	Antenna (Analog Input): For optimal performance the ANT pin should be impedance matched to the antenna. See "Applications Information" for information on input impedance and matching techniques.
5	VDDRF	RF Power Supply: Positive supply input for the RF section of the IC.
6	VDDBB	Base-Band Power Supply: Positive supply input for the baseband section (digital section) of the IC.
7	CTH	Data Slicing Threshold Capacitor (Analog I/O): Capacitor connected to this pin extracts the dc average value from the demodulated waveform which becomes the reference for the internal data slicing comparator.
8	NC	Not internally connected
9	VSSBB	Base-Band Power Supply: Ground return to the baseband section power supply.
10	DO	Data Output (Digital Output)
11	SHUT	Shutdown (Digital Input): Shutdown-mode logic-level control input. Pull low to enable the receiver. Internally pulled-up to VDDRF.
12	WAKEB	Wakeup (Digital Output): Active-low output that indicates detection of an incoming RF signal.
13	CAGC	Automatic Gain Control (Analog I/O): Connect an external capacitor to set the attack/decay rate of the on-chip automatic gain control.
14	SEL1	Bandwidth Selection Bit 1 (Digital Input): Used in conjunction with SEL0 to set the desired demodulator filter bandwidth. See Table 1. Internally pulled-up to VDDRF.
15	REFOSC	Reference Oscillator: Timing reference, sets the RF receive frequency.
16	SWEN	Sweep-Mode Enable (Digital Input): Sweep- or Fixed-mode operation control input. SWEN high= sweep mode; SWEN low = conventional superheterodyne receiver. Internally pulled-up to VDDRF.

Simple TX testing: Putting the modules to work (under PICAXE-08M2 control), gave very pleasing results using this simple 08M2 driven set up- pleasingly the TX stays totally off unless data is being sent. Classic PICAXE "SERIN/SEROUT" commands were used to suit the many users who'd have the popular 08M2s on hand, as the more elegant "RFIN/RFOUT" commands need 14M2, 20M2, 28X2 & 40X2 PICAXEs. Refer later pictures for a matching receiver layout using Dorji's DRA886 – this has been further explored in an Instructable (Resource 7)

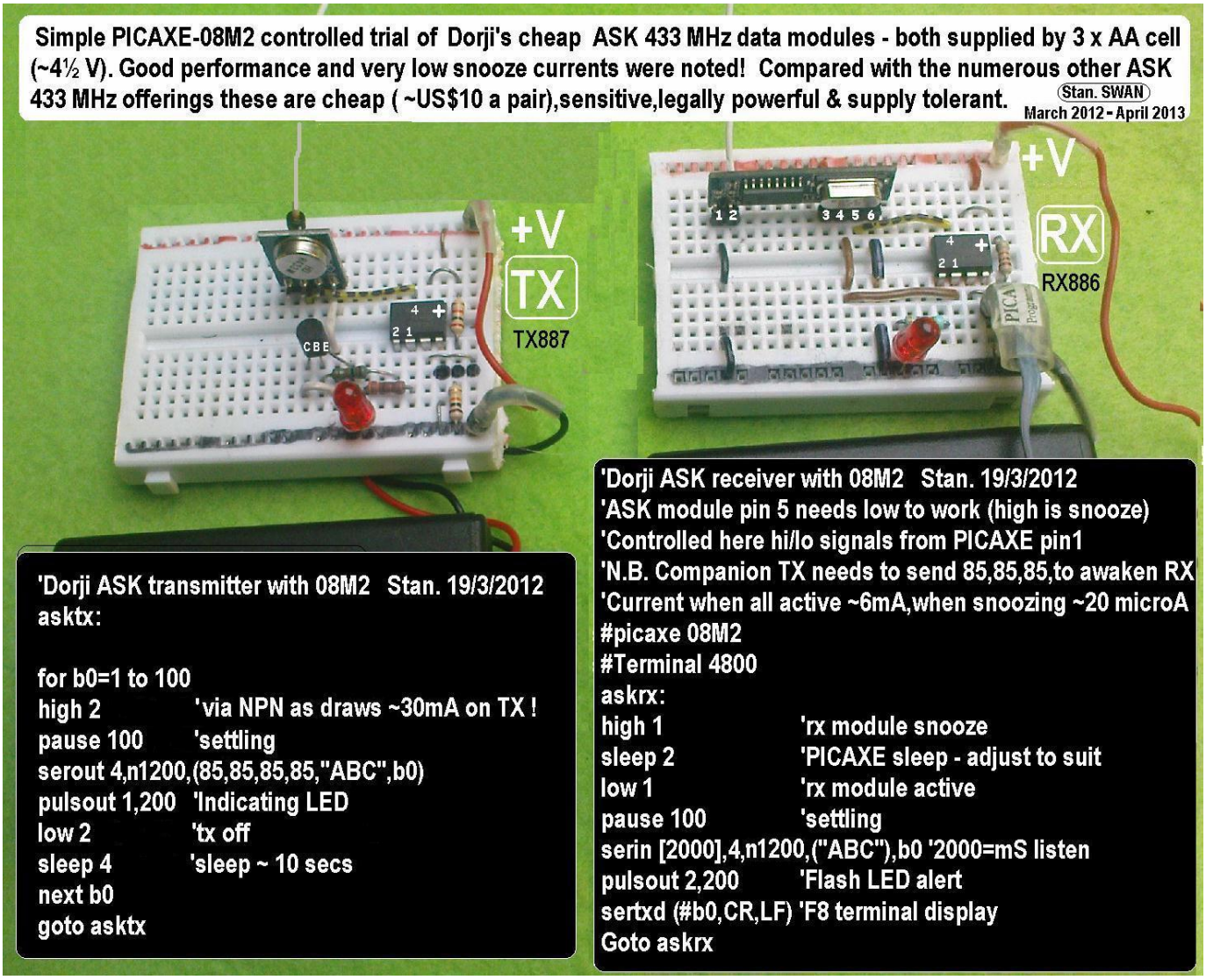


As wired above, the beefy **DRA887TX** draws ~30mA on ~4.5V, which just exceeds a PICAXE pin 25mA source current. No ill effects have been noted (perhaps thanks to the OOK data), but lower supply voltages, NiMH or weary batteries better suit direct PICAXE sourcing, as the TX current draw would be also reduced below 25mA.
The coded example just endlessly counts to 100 - the appeal of this relates to lost or corrupted data reception being readily spotted on a PICAXE Editor's attached (F8) reception terminal screen. All manner of code tweaking & refining, plus hardware juggling, can naturally be done -this trial was intended as a "heads up" !

IMPORTANT: Avoid a "t2400"serial protocol for data directly sourced from the PICAXE, as wasteful current drain occurs, even when the data signal is absent! This relates to the "idle high" nature of the t2400 (t = true) setting, & is overcome by coding instead as n2400 (n = inverted) for both the TX & RX. The "n" setting idles low, so with no data output there will be no transmitter current drain.

At the data level a particularly crucial need is to use the likes of several 85,85,85,85 (01010101 = ASCII "U" of course) preceding the outgoing serial data to ensure the receiver is suitably responsive. PICAXE fans know this is a classic "wakeup" need for similar 433 MHz modules, & it was found essential here as well. The "ABC" qualifier can be anything, but must have a matching qualifier at the receiver of course!

Extension: As a PICAXE-08M directly drives the Dorji TX quite OK with no ill effects, a precautionary transistor buffer may be hence redundant, although switching could be via a small NPN and ~4.7k -10k base resistor from the PICAXE pin2. Such power on control may be an over-kill however, as most simple TX modules (including the Dorji) draw current only when transmitting, & hence need no such software control. TX are effectively open circuit when idle, & a check of a bare Dorji TX module confirmed µA level drain with no data input. Here's however an extended setup, along with the matching receiver layout. Note the slower 1200bps data rate (which enhances range). No great effort to match the RX/TX alert spells was made, as no data was lost during this trial,but TX SLEEP and RX module snoozing (& serial wait) times may require adjusting for more demanding needs. **Note - the handy new 08M2 "serin [2000]" timeout feature will probably be defeated here by RX circuit noise…**



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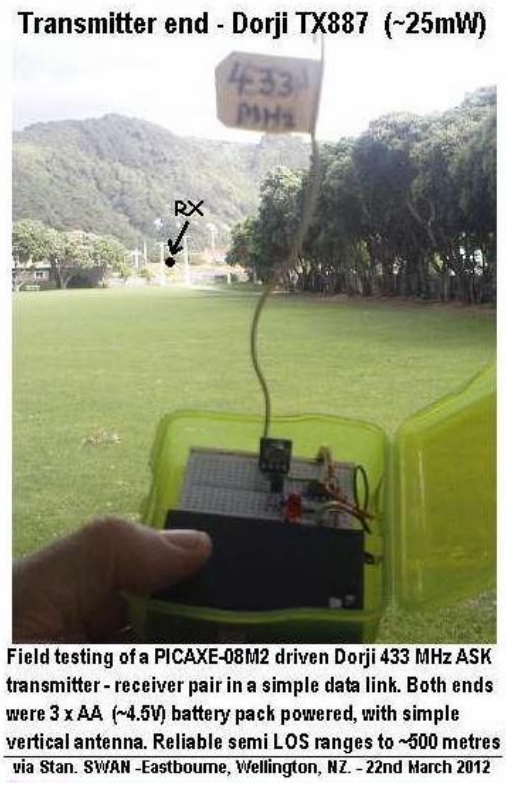
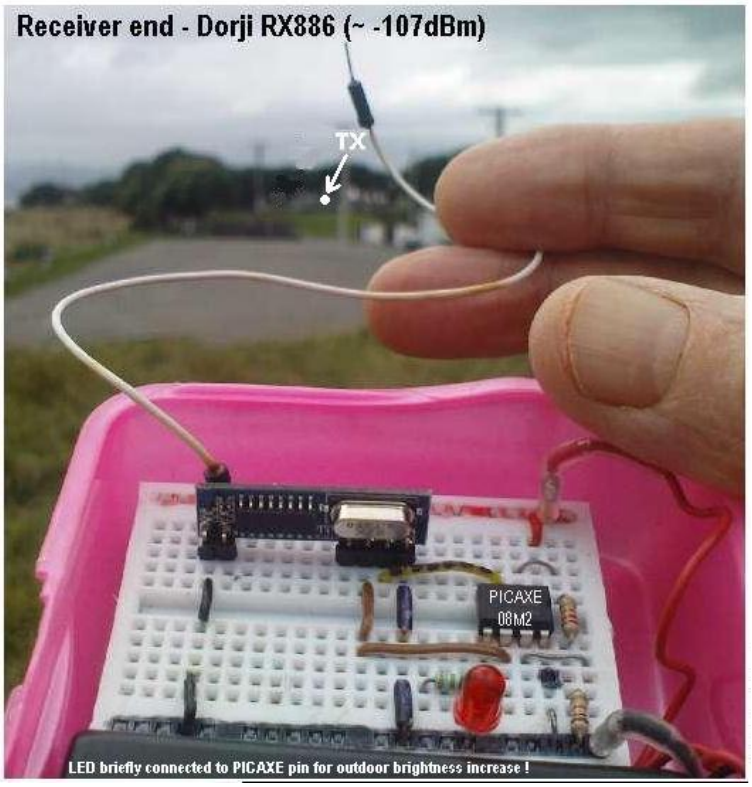
Results: Range comparison trials were conducted during heavy rain showers, with attendant frustration & likely signal attenuation. Transmitters used 3 x (fresh) AA, with all antenna approximating a ¼ wave (~165mm) whip at both TX & RX ends. Indoor TX & roving outdoor RX units were all ~waist high above ground, with signals travelling thru' timber buildings & urban vegetation obstructions (+ stray reflections from garage doors & vehicles). All modules were ASK & 1200bps was used. Rough verifications of viable range under such conditions were –

Keymark/SpiritOn (Ex.Jaycar-**TX** *ZW3100* & **RX** *ZW3102*) -totalling Aust $21.90)	**~ 30 metres**
Dorji (Ex. Wiltronics - **TX** (RF-DRA887TX) & **RX** (RF-DRA-886RX)-totalling Aust $8.35)	**~150 metres**

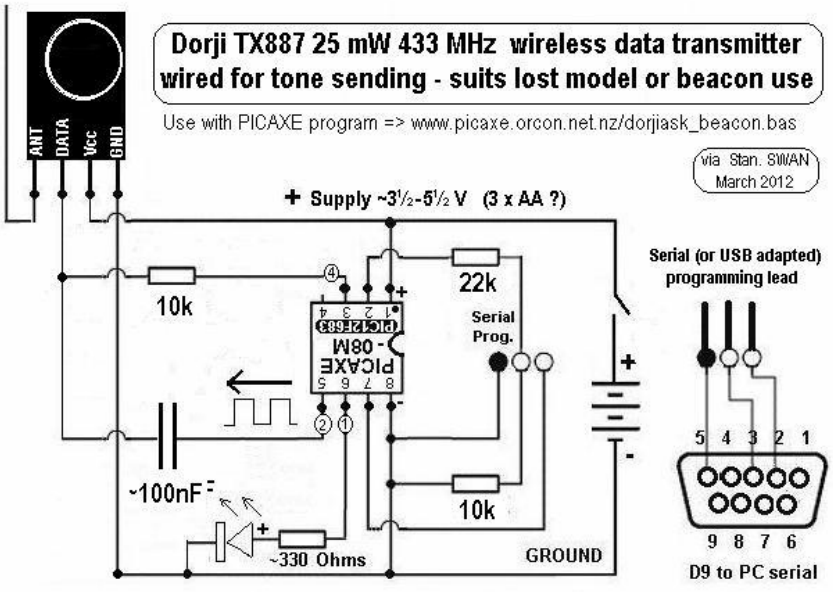
These results are consistent with Dorji's quoted superior RX (by ~3 dB) & more powerful TX (by ~10dB), giving a system gain of some 13dB. As each 6dB gain doubles range, then approx a good 2x2 = 4-5 times the range would be expected. Hence the verified 150 metres/30 metres (=5), a close confirmation of the Dorji's enhanced performance. A subsequent fine weather trial (pictured below) gave reliable data links to a good 500 metres semi LOS, verifying range boosting. Credit for this seems largely due to the more powerful 25 mW transmitter (TX),as ASK TX typically offer just ~2mW power. A simple "cotanga" (coat hanger wire !) style 6dB gain Yagi beam at the receiver could extend range to 1km. Note: Directive gain antenna at the transmitter may boost EIRP (Effective Isotropic Radiated Power) too high & be illegal, although gain antenna are quite OK at the receiver. This has been explored in depth at => www.instructables.com/id/433-MHz-tape-measure-antenna-suits-UHF-transmitte/



Field testing of a PICAXE-08M2 driven Dorji 433 MHz ASK transmitter - receiver pair in a simple data link. Both ends were 3 x AA (~4.5V) battery pack powered, with simple vertical antenna. Reliable semi LOS ranges to ~500 metres via Stan. SWAN -Eastbourne, Wellington, NZ. - 22nd March 2012



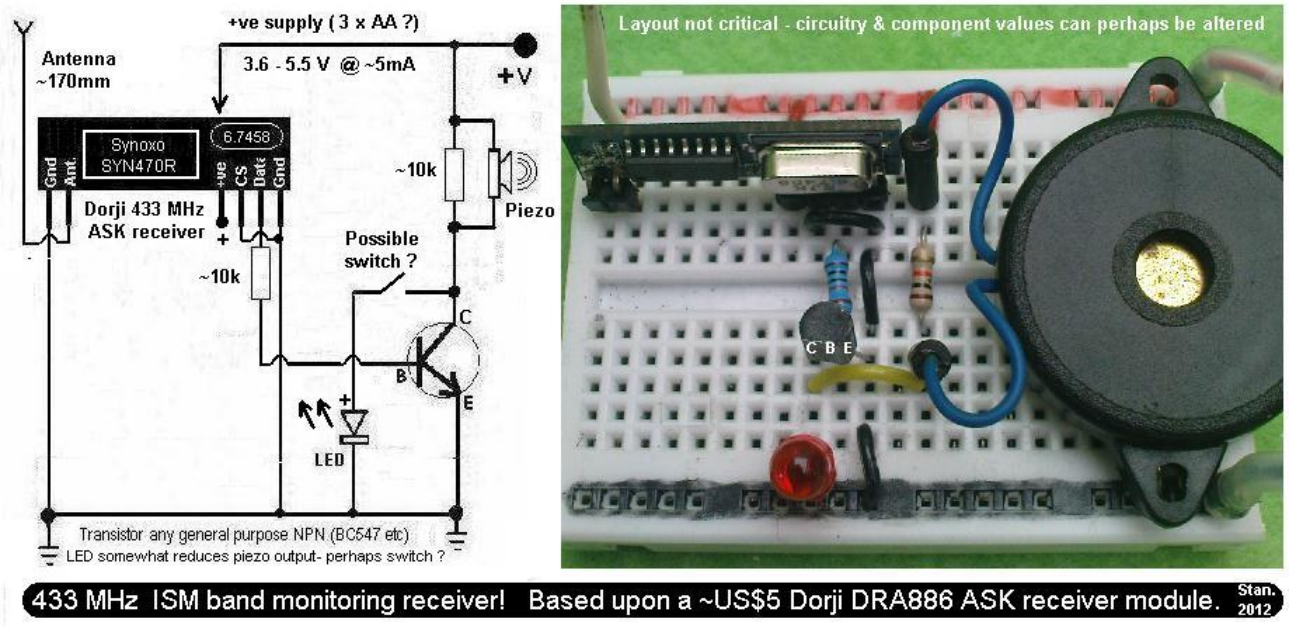
Audio tone transmitter: Many 433 MHz ASK transmitters are also capable of handy non-data modulation. When used in conjunction with a UHF scanner and directive antenna, this may particularly suit tone senders (perhaps DTMF or Hellschreiber), alarms, status alerts, "fox hunts", lost model/pet finders, beacons or even antenna design & signal coverage. The weak output of many ASK transmitters usually mean ranges maximise at ~half km line of sight, but these more powerful Dorji could raise this to perhaps several km. Even with masking vegetation or buildings, signals could still valuably reach hundreds of metres. Although any classic tone generation technique could be used (discrete RC oscillator, 555 timer etc),a cheap (~US$3) PICAXE micro allows very easy generation of assorted tones, plus encoding into messages (Morse etc) & also valuable system "sleep" control to maximise battery life. Note: Dorji's TX modules may differ slightly in frequency from a nominal 433.920 MHz, with samples found transmitting between 433.940 & 434.050 MHz. Although of little concern with broad band ASK receivers, this deviation may be an issue for a UHF scanner etc, as receiver fine tuning may be needed.



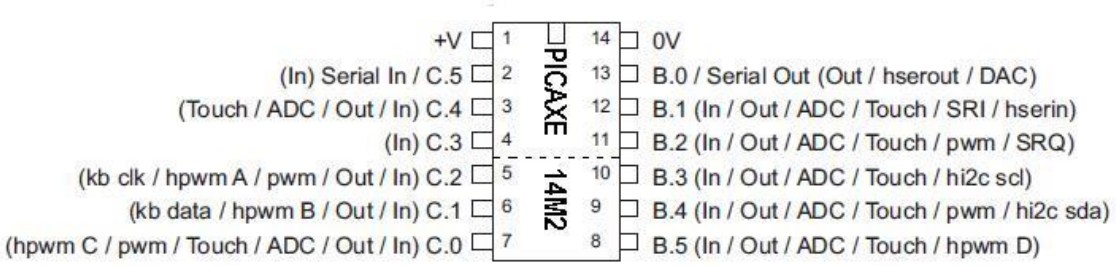
Tone signals from an outdoor rooftop mounted Dorji 25mW TX were still reliably detected by an old (but sensitive) Kenwood TH-28A ham set (NBFM) at an over water monitoring spot ~5km away. At sea level "around the bays" signals were often lost due to terrain obstructions, but reception was strong to ~2km at headlands, even with buildings and vegetation giving only semi LOS (line of site) coverage. Both TX and RX had simple non directional antenna. Being AM, ASK tone signals may not be of "orchestral quality" on typical FM only UHF receivers!

Note: It's been feasible to persuade the Dorji receiver module into broadband "poor man's scanner" 433 MHz general duty. Although cheap & convenient, sensitivity will however be inferior to a proper UHF receiver. Refer full details at the authors Instructable (Resource 7)

The companion 886RX receiver, tweaked for general 433 MHz monitoring duties, has shown itself a handy aid for confirming transmissions or checking local interference. A LED can be used in noisy conditions or at night. Given the simplicity & low cost this should now be considered as a near essential 433 MHz device to have on hand !



Data coding extension: UK PICAXE maker "Rev. Ed" (Revolution Education) now offers some 20 variants of their popular micro-controllers, & although essentially just a stretched 08M2, their 14M2 features enhanced **RFIN** & **RFOUT** commands. These simplify wireless data handling, & also may be particularly useful for more demanding work,as data then becomes robustly Manchester encoded. (This coding concept arose in 1948 during Manchester University's early "computer" development). RFIN/RFOUT data has to be organised into exactly 8 byte chunks however – at the receiver it's **rfin C.4,b0,b1,b2,b3,b4,b5,b6,b7** (Refer PICAXE manuals for details.)



Power limitation issues: After years of struggling on 433 MHz with just a few trivial mW, the increased Dorji TX power is extremely welcome! It's apparent however that even a portable 3 x AA supply may mean the DRA887TX (quoted as 17dBm = 50mW at 5 V) runs above the legal 13dBm (25mW) limit permitted in most countries. Fresh alkaline AAs may have voltages ~1.6V (thus 3 x 1.6 = 4.8V), making use of this TX a potential "out of the box" illegality. Running off 3 x NiMH cells may suit (3 x 1.2 = 3.6V), but be marginal a TX supply. To avoid regulator use, a dropping Si diode in the TX supply line could perhaps be fitted. The NPN switching on the TX supply (as shown) drops just the TX voltage by ~0.7V of course, ensuring regulations are at least nominally respected.

This 25 mW transmitter restriction could be a particularly important regulatory issue, as overpowered 433 MHz TX modules may be become banned imports. Although mere 10s of mW may well be involved, radio regulations need respecting to prevent such recent incidents as NZ's illegal VHF band "dog collars".

Conclusion: As mentioned initially, experienced 433 MHz users may not now be bothered with ASK modules, as enhanced GFSK transceiver types are considered far superior. However the significant configuration, & higher costs (~US$60 a pair with SMA antenna) of these may daunt. For those new to wireless data work, or for simplex needs, the ease of use & LOW PRICE (under US$10 a matched TX/RX pair) of the ASK offerings may appeal. They're likely to carve out a "down under" niche (via Australian PICAXE distributor Wiltronics), as the likes of traditional Keymark/SpiritOn 433 MHz modules cost well over twice as much, are RX "supply picky", offer a less sensitive receiver, and (most tellingly) have only very low TX power. ***Dorji's cheap ASK offerings look winners!***

Resources:

1. Dorji (Shenzhen-China) => www.dorji.com
2. Wiltronics (Australia) => www.wiltronics.com.au (New Australian PICAXE distrib. Sept 2012)
3. Rev. Ed's PICAXE resource (UK) => www.picaxe.com
4. Author's PICAXE resource site (NZ) => www.picaxe.orcon.net.nz/
5. PICAXE "Lost model " beacon (NZ) => www.instructables.com/id/433-MHz-UHF-lost-model-radio-beacon/
6. PICAXE SMT Hellschreiber (NZ) => www.picaxe.orcon.net.nz/hellsmt.htm
7. Dorji's tweaked ASK RX=> www.instructables.com/id/433-MHz-tape-measure-antenna-suits-UHF-transmitte/

Extension: The new breed of cheap (~US$2.50) AA sized LiFePO4 (Lithium Iron Phosphate = "LFE") rechargeable cells may suit Dorji ASK transmitters. As such cells have a 3.2V output, a single LFE AA could suffice, leaving more room in a case for circuitry. Check my recent review => www.picaxe.orcon.net.nz/LFE.htm

Disclaimer: I have no financial involvement with Dorji or their agents, and although open to product samples (!), my reviews of wireless modules (especially 433 MHz) are usually posted as a "heads up" for the wider (PICAXE focused) community. Somewhat predictably - given my lengthy educational background – my slant is towards products that are reliable, battery friendly, cost effective & easily configured. Feedback welcomed- "copy-left" !

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Initial versions 13th April & 10th Oct. 2012, with significant updates (simpler TX, RX monitor etc) 7th April 2013