LONG RANGE SLOW SPEED TELEMETRY 2 TONE FSK

Application Note: 003

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Battery Life ~ 10 years = 87 000 hours

Using ~ 1/2 of the battery capacity for t he PIC

 15μ A continuous drain = $15 \times 10-6 \times 87000 = 1.3$ Ah

AA lithium ~ 2.3Ah leaves 1 Ah for transmissions

TX1 'ON' current - 10mA i.e. 100hrs TX time in 10 years

 $= \frac{100}{10 \times 365} = 0.274 \text{ hours per 24 hours}$ = 100 seconds 'ON' in 24 hours(864:1 duty cycle)

The Code

Assuming 3 transmissions every 24 hours _ 33 seconds TX Burst

First 3 seconds is preamble to allow lithium battery to stable.

Assuming 128 Bytes of data per transmission. (more than enough for energy profiting.)

= ~ 30 ms per bit

TX Protocol and Tones



OFF time must be randomized. suggest 8hours \pm 4hours to avoid synchronization with other units.

Tones

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Suggest logic '1' tone = 1024Hz (8 PIC \muC cycles)
logic '0' tone = 819.2Hz (10 PIC \muC cycles)
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choose an exact bit time of 240 PIC microcontroller cycles = 29.297 ms This is exactly 30 cycles for a logic '1' and 24 cycles for a logic 0.

THE DECODER



Calculations

Using 1 bit time = 2τ i.e. reaches 83% of value by and of one bit

 $\tau = \frac{29.297}{2} = 14.65 \text{ms} = 15 \text{ cycle of 1 or 12 cycle of 0}$

Hence, Q = $\tau\pi$ = 15 \times π = 47 for logic 1 (1024) BPF 12 $\times\pi$ = 37.7 for logic 0 (819.2) BPF

i.e. 3dB Band Width for each filter is $\frac{1024}{47} = \frac{819.2}{37.7} = 21.8$ Hz

Hence, decoder 'noise' BW = $2 \times 21.8 = 44$ Hz

Hence, noise reduction over RX1 AF output (5kHz) BW = 5000 = 20.5 dB

'CLASH' AVOIDANCE PROBABILITY CALCULATIONS

For 1 TX Duty cycle = 33sec ON in 8hrs

~1000:1 or 0.1% air usage.

For 2 TX's 'Clash' probability' = 1 in 333 or 0.3%



For N TX's Probability of loss of a burst

$$(N-1) \times 3 \times (Tx \text{ on time}) = (N-1) \times 0.3\%$$

Tx off time

Probability of not getting an update after n tries

$$= (N-1)^{n}$$
 where N = number of units RX can hear
333 n = Number of tries

e.g:



NOTES

Decoder filters must be temperature stable. Recommend either 4 op-amp state variable circuit. or switched capacitor filters. e.g: MF10 or similar from national semiconductors

The 2 decode channels must be gain balanced. (i.e: have the same gain)

Use op-amp - Zero offset rectifier circuits.

References:

- 1. Active filter cook book Don Lawcaster
- 2. Bi-FET manual Texas Instruments
- 3. The Art of Electronics Horowitz and Hill

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