

Provisional GNSS synchronised on off keying protocol 'OOK48'

Transmit

Messages are sent one character at a time at a rate of one character per second.

The start of each 1 second timeslot is defined by the GNSS derived 1PPS signal.

Each 1 Second timeslot is divided into 9 equal periods of 1/9th second each.

The first 8 periods are used to send the 4 from 8 coded version of the character.

The 8 bits of the 4 from 8 value are sent MSB first. A one is sent as Key Down. A Zero is sent as Key Up.

The 9th period is sent with Key Up and does not form part of the character. It is to allow the receiver time to decode and display the character. The 9th period can also be shortened or lengthened as needed by the receiver to maintain sync with the 1PPS signal.

Ascii characters from 32 (space) to 95 (_) are mapped to the 70 available 4 from 8 values.

Lower case letters are mapped to their upper case equivalent.

A CR character is used to define the end of the message.

The last 5 of the 4 from 8 values are currently unused but could be used for additional control characters if needed.

Messages are repeated for as long as the transmission lasts. There is no gap between repeats.

Message length is not defined but each message ends with a CR character. This would allow a short message like a report to be repeated rapidly many times. Typical longer lengths would be about 15 to 30 characters taking 15 or 30 seconds to send.

Receive

My experimental system does the following...

Reception of each character starts on the GNS derived 1PPS signal. The ADC DMA sampling is started by this signal.

1024 ADC Samples are repeatedly taken using DMA at a sample rate of 9216 samples per second. Each capture therefore takes 1/9th of a second or one bit period.

As each capture becomes available the following is done

Apply Hanning window.

FFT transform.

Calculate the 512 Bin Magnitudes. Each bin is 9 Hz wide.

Use some of these bins to display the Spectrum and Waterfall.

Save all the FFT bins that fall within the tone search window for this capture to a large array.

Tone centre frequency is 800Hz and the available search widths are +_50 Hz, +-100Hz, +_250Hz, +-500Hz and the full 300 -2200 Hz Spectrum. Wider search widths require less precise tuning but increase the risk if the tone being incorrectly detected.

After 8 captures attempt to decode the received character.

There are two slightly different decode modes, selectable from the configuration page. Normal decode gives slightly better sensitivity but relies on the received tone frequency being stable and remaining in the same FFT bin for the whole character. Alternate decode allows a less stable received tone to drift between bins during the character. This can be useful for the higher microwave bands where stability can be difficult to achieve.

Normal Decode.

Search the saved FFT bins and find the bin that contains the tone.

Currently this is done by looking for the bin with the largest Max to Min range. This seems to work however there may be better ways to do this. Using the same bin for all 8 timeslots save the 8 magnitudes for the next step.

Alt Decode.

Search the saved FFT bins and find the bin with the highest magnitude. Repeat this search for each of the 8 of the timeslots. Save these 8 magnitudes for the next step.

Normal and Alt Decode.

Examine the 8 captured magnitudes and find the highest 4 magnitudes. Set these bits to one and set the remaining bits to 0. This will always form a valid 4 from 8 value although this value may be in error. Look up the ASCII character and display this.

An additional experimental 2 seconds per character mode is also being tried. In this mode the transmitter repeats each character with the first character being sent at the start of every Even GPS second.

The receiver now sums the two received characters before decoding. This give a slight improvement in low signal sensitivity.

Timing Adjustment.

To allow for modern radios that use DSP processing the Tx start of character can be advanced from the 1PPS signal to compensate for any delay between Key down and the start of the RF output. Likewise the ADC start time during Rx can be retarded to allow for any audio processing delays. These settings are made using the config menu.

These settings may need to be adjusted to ensure the 'Over the air' signal is exactly synchronised to the GPS 1PPS signal.

4 from 8 value to ASCII mapping is shown in the next table.

4 From 8	Ascii	Char	4 From 8	Ascii	Char
15	13	CR	135	66	B
23	32	Space	139	67	C
27	33	!	141	68	D
29	34	“	142	69	E
30	35	#	147	70	F
39	36	\$	149	71	G
43	37	%	150	72	H
45	38	&	153	73	I
46	39	‘	154	74	J
51	40	(156	75	K
53	41)	163	76	L
54	42	*	165	77	M
57	43	+	166	78	N
58	44	,	169	79	O
60	45	-	170	80	P
71	46	.	172	81	Q
75	47	/	177	82	R
77	48	0	178	83	S
78	49	1	180	84	T
83	50	2	184	85	U
85	51	3	195	86	V
86	52	4	197	87	W
89	53	5	198	88	X
90	54	6	201	89	Y
92	55	7	202	90	Z
99	56	8	204	91	[
101	57	9	209	92	\
102	58	:	210	93]
105	59	;	212	94	^
106	60	<	216	95	_
108	61	=	225	Spare	~
113	62	>	226	Spare	~
114	63	?	228	Spare	~
116	64	@	232	Spare	~
120	65	A	240	Spare	~