M-Sequence Signal Parameters

The parameters of the maximal length m-sequence beacon ranging signal are:

source level SL	=	81 W (190 dB re 1 μPa at 1 m)
center frequency f_o	=	75 Hz
bandwidth	=	37.5 Hz
digit	=	2 cycles = 26.6667 ms
sequence order N	=	10
sequence length L	=	1023 digits = 2^N–1
sequence period	=	27.2800 s
sequence law	=	3471 octal
sequence initialization	=	0000000001
binary modulation angle δ	=	$\tan^{-1}(\sqrt{L}) = 88.209215°$
sequences sent	=	44 for nominal 20-minute transmission = 1200.32 s.

The pseudo-random sequence of 0s and 1s that make the m-sequence can be generated using a simple generating function available in many signal-processing toolboxes.

If a 1 in the m-sequence is equivalent to $s = +1$ and a 0 to $s = –1$, then the signal sent is:

$$\cos (2\pi f_0 t + s(i(t))\theta),$$

where $i(t)$ is the digit value (0 or 1) of the m-sequence at time t. If s changes sign, the phase angle changes between $+\theta$ or $-\theta$.

A transmission starts ramping up in power 5 minutes plus one period (300 s + 27.2800 s = 327.2800 s) before the hour (UTC) at a level of 0.26 W (165 dB re 1 μPa at 1 m) and increases step-wise in level by an amount 6 dB every minute until the desired output level SL is reached. With SL = 190 dB, the first 5 steps are 6 dB, and the last step is 1 dB.

The marktime of each transmission, defined as the start of the 44 sequences, will be exactly on the UTC hour. GNSS/GPS quality precise timing must be used. The ramp will start 327.2800 s before the marktime. Marktimes will be 0000, 0400, 0800, 1200, 1600, 2000 UTC. There will be 6 transmissions on the transmission day. Transmission days will occur every 4th day.

The result is a 2 percent duty cycle:

6 transmissions per day x 20 minutes = 120 minutes per transmission day
Duty cycle = 120 minutes / (1440 minutes / day) / 4 days = 0.02 = 2 percent.

The transmission schedule started March 18 2023.