APPENDIX: CHARACTERISTICS OF GENERATED UWB SIGNALS

The following sections describe details of UWB signal generation.

A.1 Signal Description

Each of the UWB signals used in these measurements was generated using a Time Domain Corporation PG-2000 pulser, triggered by either an AWG or custom-designed 2%-RRD trigger circuit.

Table A-1 lists parameters for each of the 17 UWB signals used for these measurements.

Table A-1. Characteristics of Generated UWB Signals

PRF (MHz)	Pulse Spacing Mode	Duty Cycle (%)	PRL[1] Spacing (kHz)	Spectral Line Placement [2] (MHz)	LSNB [3] (Hz)	LSS [4] (Hz)	Nearest SN to L1 [5] (MHz)
0.1	UPS	100	N/A	138.000506	N/A	N/A	N/A
0.1	UPS	100	N/A	137.999862	N/A	N/A	N/A
0.1	UPS	20	N/A	138.000506	500	50	N/A
0.1	UPS	20	N/A	137.999862	500	50	N/A
20	UPS	100	N/A	138.000506	N/A	N/A	N/A
20	UPS	100	N/A	137.999862	N/A	N/A	N/A
20	UPS	20	N/A	138.000506	500	50	N/A
20	UPS	20	N/A	137.999862	500	50	N/A
0.1	OOK	100	0.059	138.000506	N/A	N/A	N/A
0.1	OOK	100	0.059	137.999862	N/A	N/A	N/A
20	OOK	100	0.357	138.000506	N/A	N/A	N/A
20	OOK	100	0.357	137.999862	N/A	N/A	N/A
0.1	50%-ARD	100	0.098	N/A	N/A	N/A	119.1
0.1	50%-ARD	20	0.098	N/A	500	50	119.1
0.1	2%-RRD	100	0.25	N/A	N/A	N/A	95.0
20	2%-RRD	100	N/A	N/A	N/A	N/A	N/A

Con't Table A-1. Characteristics of Generated UWB Signals

PRF (MHz)	Pulse Spacing Mode	Duty Cycle (%)	PRL[1] Spacing (kHz)	Spectral Line Placement [2] (MHz)	LSNB [3] (Hz)	LSS [4] (Hz)	Nearest SN to L1 [5] (MHz)
20	2%-RRD	20	N/A	N/A	N/A	N/A	N/A

[1] Pattern Repetition Lines (PRL) refer to spectral lines generated due to a repetition of the pulse pattern. (See Section A.2 for a complete discussion.)

[2] Lines due to the pulse repetition period are spaced at intervals equal to the reciprocal of PRF, but for each UWB with these spectral lines, the PRF is adjusted slightly so that one of the lines occurs at 1575.570571 MHz.

[3] Line Spreading Null-to-null Bandwidth (LSNB) refers to the null spacing of the convolving sinc-squared function as a result of gating, where the null-to-null bandwidth is equal to 2 times the reciprocal of the gated-on time. (See Section 3.1.2 for a complete discussion.)

[4] Line Spread Spacing (LSS) refers to the spacing between lines of the convolving sinc-squared function as a result of gating, where the distance between lines is equal to the reciprocal of the gating period. (See Section 3.1.2 for a complete discussion.)

[5] Spectral Node (SN) refers to a spectral feature due to the placement of the position of pulses within discrete bins. (See Section A.2 for a complete discussion.)

A.2 Residual Spectral Effects due to Signal Generation

Because the pattern of pulse spacing, whether it be OOK or dithering, is stored in the memory of an AWG and because that memory has limits with regard to size, the same pattern has to be repeated at periodic intervals. This pattern repetition results in signal power being gathered up into spectral lines with a spacing equal to the reciprocal of the period of the pattern. For those UWB cases where we would expect real world signals to have no pattern repetition, the pattern is made as long as possible so that the spectral lines are spaced very close together, and therefore, have negligible impact on the receiver. For purposes of brevity, we call these spectral lines Pattern Repetition Lines (PRL).

Also because of the limitations of memory size and sample rates of the AWG, the location of pulses (within the context of dithering) has to be confined to a limited number of discrete time bins. This is illustrated in Figure A-1 for the case of 50% clock-referenced dithering, in which the pulse position can be assigned to any of 19 possible discrete positions within the first 50% of the interval between reference clock periods (t is the size of the bins, in units of time). As opposed to a continuum of possible pulse positions, this discrete binning results in some additional spectral features worth noting. Figure A-2 demonstrates what we

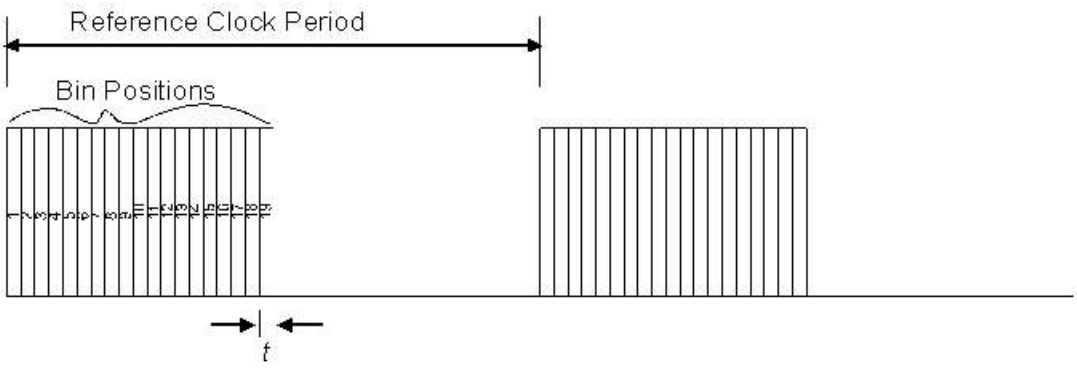

Figure A-1. Discrete binning of pulse position for clock referenced dithering.

have described as a spectral node (SN), in which there is a depression in the spectral noise and the emergence of spectral lines. The spacing of these spectral nodes is directly related to the bin size *t*, where the distance between spectral nodes is 1/*t*. This phenomenon is described in greater detail in Appendix D (Theoretical Analysis of UWB Signals Using Binary Pulse-modulation and Fixed Time-base Dither) of [3]. For these measurements, efforts were specifically made to place these spectral nodes in a location other than the 138-MHz band.

The custom built 2%-RRD circuit is analog, and therefore signals generated using this circuit do not have PRLs or SNs characteristic of signals generated digitally with an AWG.

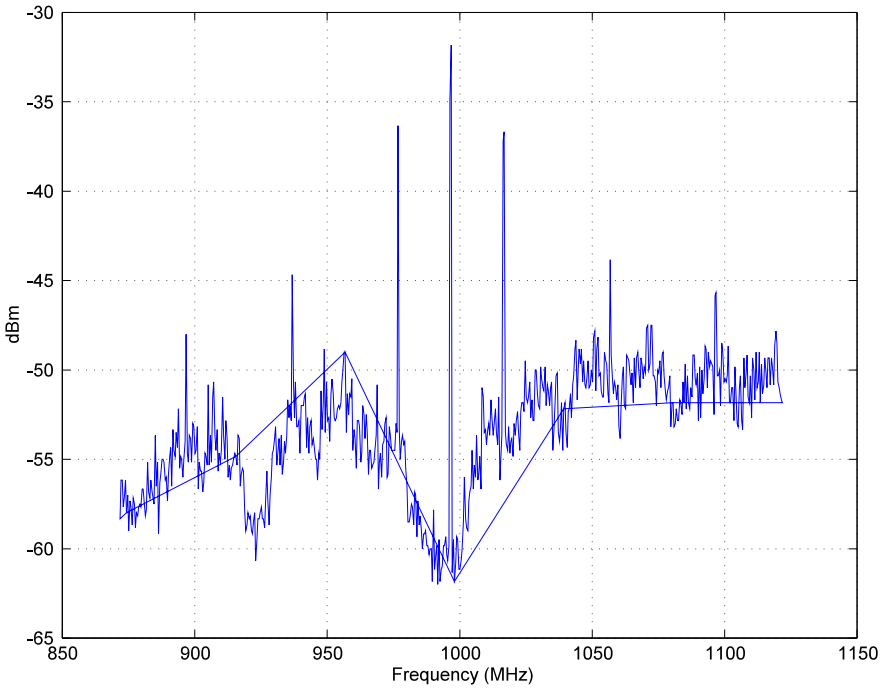

Figure A.3. Spectral lines due to discrete binning of pulse position.