



FOCUS ENHANCEMENTS

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TT-6001 DS-OFDM Waveform Generator

# Theory of Operations

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## Theory of Operations

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## Scope

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**F**ocus Enhancements' proprietary modulation and signaling approach is based on a Direct Sequence Spread Spectrum (DS-SS) technique. This approach covers the frequency band from 3.2 to 7.3 GHz with an ensemble of codes instead of a single code per data rate as in other DS-SS solutions already certified. The purpose of this paper is to explain our DS-SS technology as implemented in our Waveform Generator.

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The Waveform Generator radio will be placed into a test mode in which all of the normal radio off times, either inter-packet or intra-packet, are removed eliminating all gating on the transmitter.

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# Description

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Focus Enhancement's proprietary DS-SS approach is based on chirp spreading sequences of ternary  $\{+1, 0, -1\}$  codes. The ternary chips are complex valued and contain both In-Phase and Quadrature sequences which are output at 5.28 GChips/sec each. This complex pair is then low passed with brick-wall filters to a bandwidth of +/- 2 GHz and then modulated to a 5.28 MHz center frequency. The resulting pass band spectrum covers 3.2 to 7.3 GHz. The symbols will support constellations up to 8 PSK. An example is shown following:

I Value	1	0	-1	-1	0	1	1	0	-1	-1	1	1
Q Value	1	1	1	0	-1	-1	-1	1	1	0	-1	-1

Table 1 - Complex 12 Chip Symbol

The symbols vary in length according to their purpose. For example, the shortest symbol is 8 complex chips long and is used for synchronization and the longest symbol is 48 chips long and used to transmit data at the lowest data rate. The table below summarizes the properties and use of each symbol.

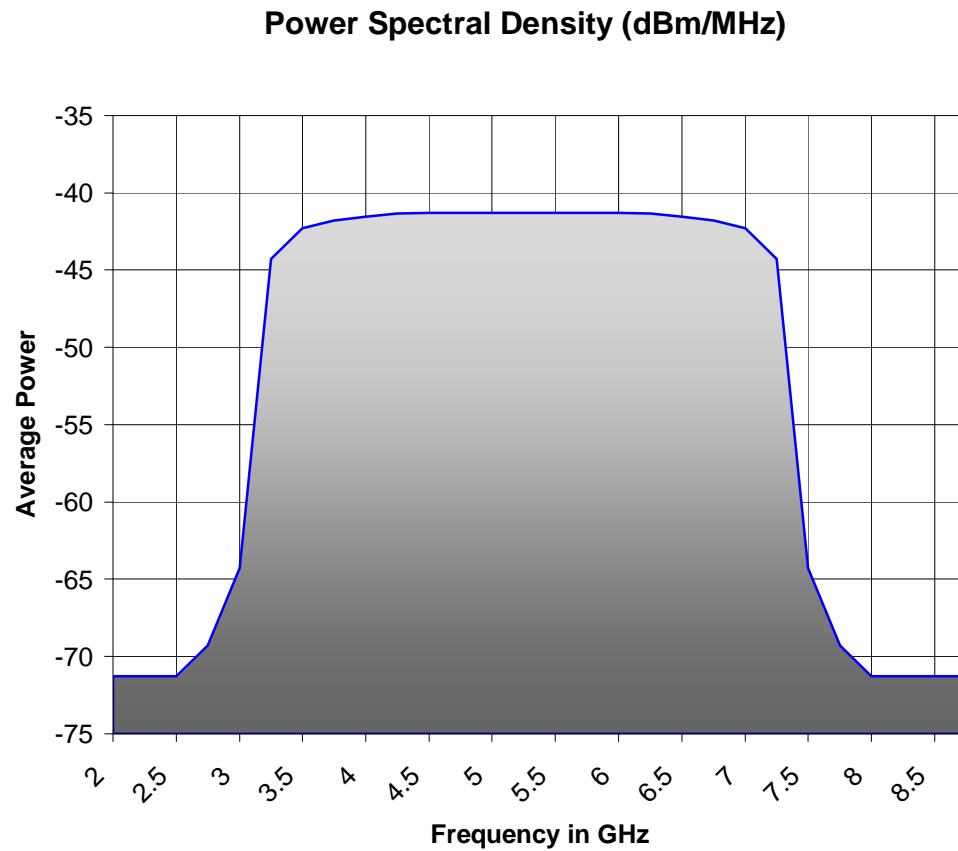
Symbol Use	Chips per Symbol	Symbol Rate (MSym/sec)	Symbol Modulation
Synchronization	8	660	BPSK
Data 440 to 880 Mb/sec	12	440	8 PSK
Data 220 to 330 Mb/sec	24	220	8 PSK
Data 37 to 110 Mb/sec	48	110	8 PSK

Table 2 - Symbol Properties and Use

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The Synchronization Symbol is a single simple code which has autocorrelation properties that make it best for measuring time of arrival of the packet.

The data symbols have multiple orthogonal codes per Long Code set. This allows the receiver to combine the energy associated with one symbol while ignoring the other symbols and their delayed multi-path energy are arriving at the receiver. This tried and true Long Code (or Random Code) sequence approach is used in most CDMA cell phone systems used today.



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