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Alternating 1,0 Test Modes in the CDM-625 Advanced Satellite Modem

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Overview

This paper describes the Alternating 1,0 test mode of the CDM-625 Satellite Modem, and explains its uses and applicability, with particular reference to QPSK and OQPSK operation. This information supersedes and supplements information that may be contained in earlier versions of the CDM-625 Installation and Operation Manual.

Background

There has been confusion amongst a small number customers concerning the Alternating 1,0 Test Mode, and in certain cases, this has resulted in the incorrect conclusion that the CDM-625 design is incorrect. This paper attempts to explain the two different modes, and show why the behavior is not only correct, but essential in the manufacturing process of the CDM-625.

Modulator impairments, and their measurement

There are two principle figures of merit for an I/Q modulator of the type used in the CDM-625 modem (and other modems in the Comtech product line). These are

a) Carrier suppression
b) Single sideband (SSB) suppression

With digitally modulated waveforms, it is highly desirable to suppress the carrier component as far as possible. The carrier component conveys no information, and, in extreme cases, can reduce, by a small amount, the power in the information-bearing sidebands, reducing system performance.

The most common cause of poorly suppressed carrier is unwanted DC offsets in the modulator. This is mitigated by adding small correcting offsets during the manufacturing process, whereby a calibration routine is performed at a number of RF frequencies to produce optimum performance. However, under normal operating conditions (random data feeding the modulator) it becomes impossible to see (and hence measure) the level of the suppressed carrier. It becomes necessary, therefore, to provide a test mode that will permit the observation and measurement of the suppressed carrier component.

This is illustrated in Figure 1. For this test, a ‘standard’ QPSK configuration is used, and the I and Q channels are fed with an identical data stream, comprising an alternating 1,0,1,0 data stream at the symbol rate. The resulting spectrum is shown alongside the modulator block diagram. As can be seen, there are two sidebands, spaced above and below the suppressed carrier. The frequency spacing of the sidebands corresponds to +/- Rs/2, where Rs is the symbol rate.

However, carrier suppression alone is not adequate for ensuring modulator performance. If the balance between the power in the I and Q channels is not closely matched, or if the phase accuracy of the 90 degree hybrid (shown in the modulator block diagrams) is poor, the overall system performance will be degraded.

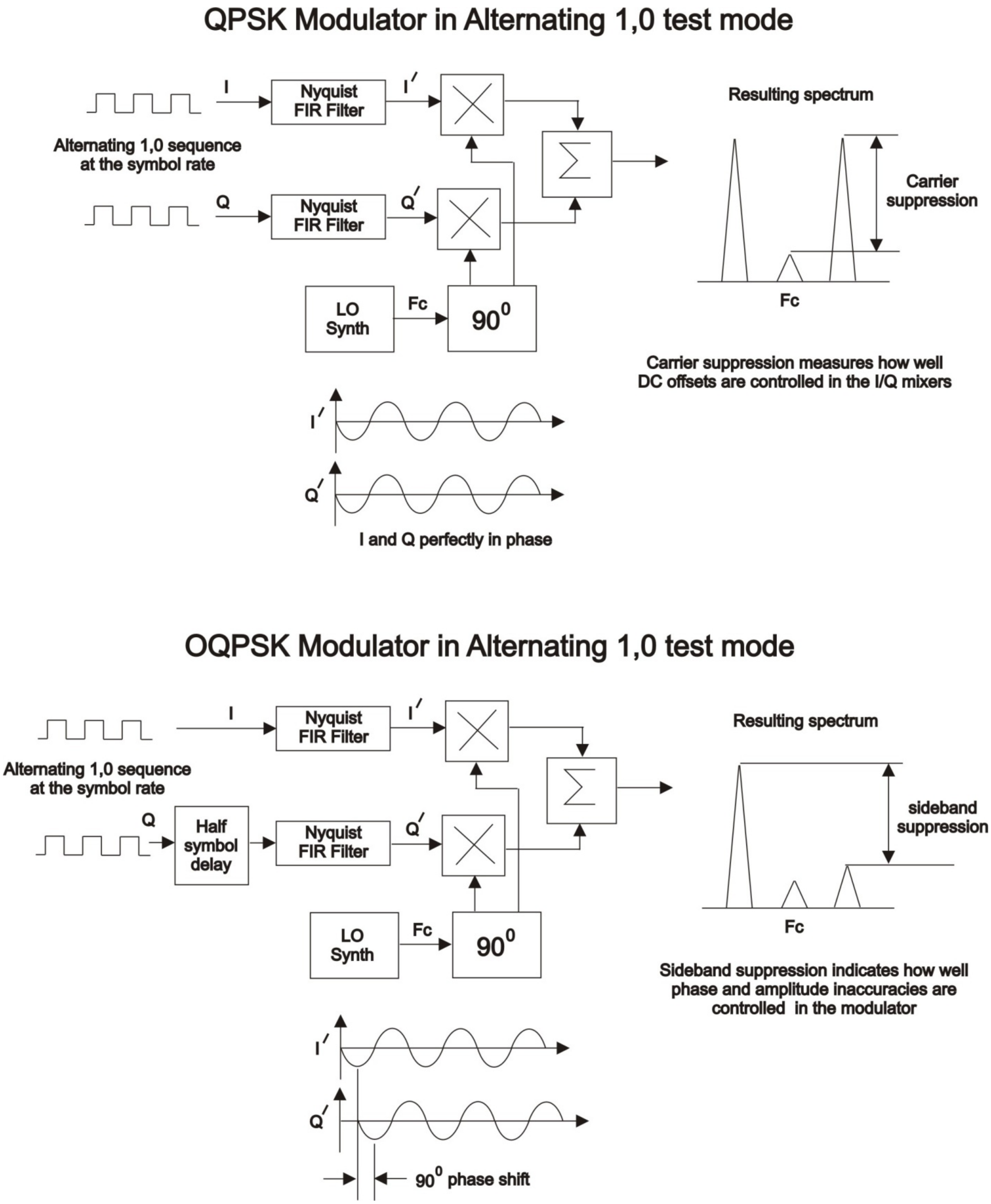

Figure 1 – QPSK and OQPSK Modulators in Alt 1,0 Test Mode

Fortunately, there is a very simple test that be performed that will show the effects of poor amplitude balance and phase inaccuracy. It is referred to as the ***single-sideband (SSB) suppression test***. It is almost identical to the carrier suppression test, but this time an OQPSK modulator configuration is used. This is identical to the QPSK design, but in the Q channel, a delay is added of exactly one-half of the symbol period. See Figure 1.

Now, when I and Q are fed with an alternating 1,0,1,0 data stream at the symbol rate, there is a resulting 90 degree phase shift between the baseband signals I' and Q'. This has the effect of suppressing one or other of the sidebands. (Whether the phase of Q' leads or lags I' will determine if it is the upper or lower sideband that gets suppressed.) The amount by which the sideband is suppressed is a ***direct measure of the phase and amplitude accuracy of the modulator***, and as such is a vitally important method during the manufacturing process of guaranteeing modulator performance. In addition to the carrier suppression test, the SSB test can be of great utility to a user in the field as a troubleshooting aid when modulator performance needs to verified.

As an example, taking the Intelsat IESS-308 specification, a maximum amplitude imbalance of +/- 0.2dB, and a maximum phase inaccuracy of +/- 2 degrees is permitted. This, in turn, corresponds to an SSB suppression ratio of -33 dB.

For these reasons, the operation of the Alternating 1,0 test mode is very deliberately different between QPSK and OQPSK. It needs to be emphasized that this is essential for our manufacturing process and field validation.

Note: This represents an enhancement in functionality, and not all legacy products support this. There has been some confusion concerning this feature – a customer may incorrectly expect the spectrum to be identical in both QPSK and OQPSK. This is emphatically not the case.

Selection of the Alternating 1,0 Test Mode

The Alternating 1,0 mode is accessed from the front panel through the **Test** menu, or alternatively through the serial remote control port, or via Ethernet (http or SNMP).

Once the Alternating 1,0 mode has been selected if the modulation type is QPSK, the carrier suppression may be observed. If OQPSK is selected, the SSB suppression may be observed.

Caution: selecting the Alternating 1,0 Test Mode with a higher-order modulation scheme will result in unpredictable results. The user is cautioned to use only QPSK (for carrier suppression testing) and OQPSK (or single sideband testing).