MAX2769C- FCEN Configuration

User Guide

UG6379; Rev 0; 12/16

Scope

This document enables the user to configure the center frequency of the IF filter in the MAX2769C. It explains the register settings of FCEN, FCENX, FBW, and DRVCFG that are required for a specific application.

Introduction

The MAX2769C is a global navigation satellite system (GNSS) receiver covering GPS, GLONASS, Galileo, and BeiDou navigation satellite systems on a single chip. This single-conversion GNSS receiver is designed to provide high performance for industrial applications, and a wide range of consumer applications, including mobile handsets.

Filtering at IF is important as it limits the noise bandwidth and improves sensitivity while reducing interference. The MAX2769C's IF filtering is highly flexible. The Butterworth IF filter can be configured either as 3rd or 5th order, and bandpass or low pass as the application dictates. The center frequency is also programmable to match the selected IF. In bandpass mode, the (double-sided) 3dB bandwidths can be set to 2.5MHz, 4.2MHz or 9.66MHz. These bandwidths can also be used in low-pass mode. In low-pass mode, there is also the option of setting the double-sided filter bandwidth to 18MHz. Users can choose a design that optimizes performance for their application.

Understanding IF-Filter Center Frequency and Bandwidth

FCEN is the center frequency of the IF filter when it is configured in bandpass mode and is dependent on the configured bandwidth, which is configured with the FBW bits.

The FCEN setting is a 7-bit control word out of which 6 bits can be controlled through configuration register 1 and the 7th bit (FCENMSB) can be controlled through the TEST MODE 2 register LSB bit.

When calculating the center frequency of the IF filter, the FCEN bits set in the GUI need to be flipped, meaning the order of the bits is reversed. In other words, the most significant bit of the word before flipping is the least significant bit after flipping. This means the FCENMSB bit is actually the LSB for center-frequency setting when the bits are flipped. Because of this the FCENMSB bit only slightly changes the center frequency of the IF filter. This is clearly explained in the following pages of the document.

The IF filter center frequency calculation is dependent on the FBW setting.

If FBW = 00, which corresponds to 2.5 MHz BW, the center frequency of the IF filter can be calculated as below:

$$F_{CENTER} = \left(\frac{(128 - FCEN_{FLIPPED})}{2}\right) \times 0.195\text{MHz}$$

If FBW = 10, which corresponds to 4.2 MHz BW, the center frequency of the IF filter can be calculated as below:

$$F_{CENTER} = \left(\frac{(128 - FCEN_{FLIPPED})}{2}\right) \times 0.355\text{MHz}$$

Similarly, if FBW = 01, which corresponds to 9.66 MHz BW, the center frequency of the IF filter can be calculated as below:

$$F_{CENTER} = \left(\frac{(128 - FCEN_{FLIPPED})}{2}\right) \times 0.66\text{MHz}$$

where:

F_{CENTER} = Center frequency of the IF filter

$FCEN_{FLIPPED}$ = Flipped bits' decimal value

<u>Example:</u>

When FCEN is 001101 and FCENMSB is 0, the FCEN control word is 0001101.

When the FCEN bits are flipped, the control word becomes 1011000 or 88 decimal.

When FBW = 00, the center frequency of the filter can be calculated as below:

$$F_{CENTER} = \left(\frac{(128 - 88)}{2}\right) \times 0.195\text{MHz} = 20 \times 0.195\text{MHz} = 3.9\text{MHz}$$

When FBW = 10, the center frequency of the filter can be calculated as below:

$$F_{CENTER} = \left(\frac{(128-88)}{2}\right) \times 0.355\text{MHz} = 20 \times 0.355\text{MHz} = 7.1\text{MHz}$$

When FBW = 01, the center frequency of the filter can be calculated as below:

$$F_{CENTER} = \left(\frac{(128 - 88)}{2}\right) \times 0.66\text{MHz} = 20 \times 0.66\text{MHz} = 13.2\text{MHz}$$

Note: These equations give the approximate center frequency. The actual center frequency can be slightly different from the calculated value. The setting that gives the closest center frequency to the target value should be determined experimentally. The calculated value gives a good starting point.

Configuration Procedure

FCEN is tested by configuring the analog outputs from MAX2769C (ADC Bypass mode) by setting bits DRVCFG to 1X in the Config 2 register. See the table below for available options.

DRVCFG (CONFIGURATION 2 REGISTER)	OUTPUT DRIVER CONFIGURATION
00	CMOS Logic
01	Reserved
1X	Analog Outputs (ADC Bypass Mode)

The FCENX setting is used to configure the filter for low-pass or bandpass mode. See the table below.

FCENX (CONFIGURATION 1 REGISTER)	FILTER MODE
0	Low Pass
1	Complex Bandpass

When FCENX is 1, Bandpass mode

When FCEN is 001101, if the FBW setting is 00 (2.5 MHz bandwidth), the center frequency of the IF filter is 3.9MHz. If the value of the LSB in the Test Mode 2 register (FCENMSB) is 1, the center frequency slightly changes by around 150kHz to 200kHz to the negative side. This means if the center frequency is 3.9MHz with the FCENMSB bit having a value of 0, setting the FCENMSB bit to 1 shifts the center frequency to 3.75MHz.

When FCEN is 001101, if the FBW setting is 10 (4.0 MHz bandwidth), the center frequency of the IF filter is 7.1MHz.

Similarly, when FCEN is 001101, if the FBW setting is 01 (9.66 MHz bandwidth), the center frequency of the IF filter is 13.2MHz.

Refer to the screenshots below for various configurations:

FCEN IS 001101	IF FILTER CENTER FREQUENCY (MHz)
FBW: 00 (2.5MHz)	3.9
FBW: 10 (4.2MHz)	7.1
FBW: 01 (9.66MHz)	13.2

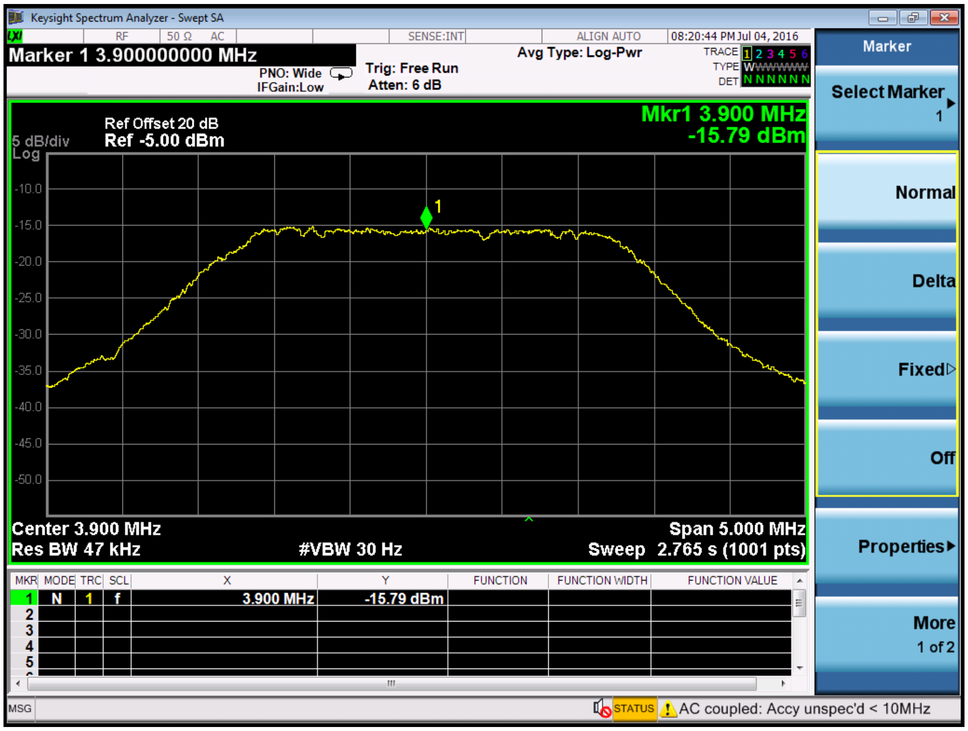

Figure 1. IF filter Center Frequency = 3.9MHz when FCEN is 001101, FBW is 00, and FCENMSB is 0 in Test Mode 2 register.

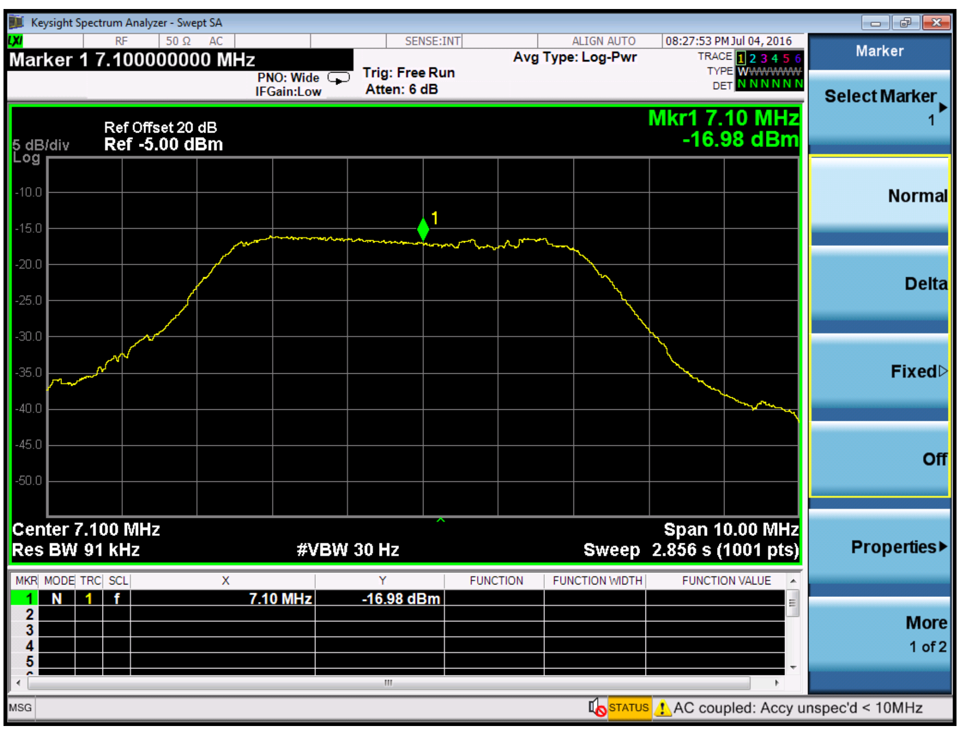

Figure 2. IF filter Center Frequency = 7.1MHz when FCEN is 001101, FBW is 10, and FCENMSB is 0 in Test Mode 2 register.

Figure 3. IF filter Center Frequency = 13.2MHz when FCEN is 001101, FBW is 01, and FCENMSB is 0 in Test Mode 2 register.

When FCENX is 0, Low-Pass Mode

In low-pass mode, the filter responses are centered on DC. For low-pass filters, it is traditional to refer to the single-sided bandwidth, in which case the filter bandwidths are simply divided by two. When FBW is 11, the filter bandwidth is the maximum possible (9MHz single-sided). The 9MHz filter setting can be used in low-pass mode only.

Note: The below screenshots are without carrier and are meant to show the IF-filter frequency response by shaping of the noise. Ignore the DC signal from the Spectrum Analyzer.

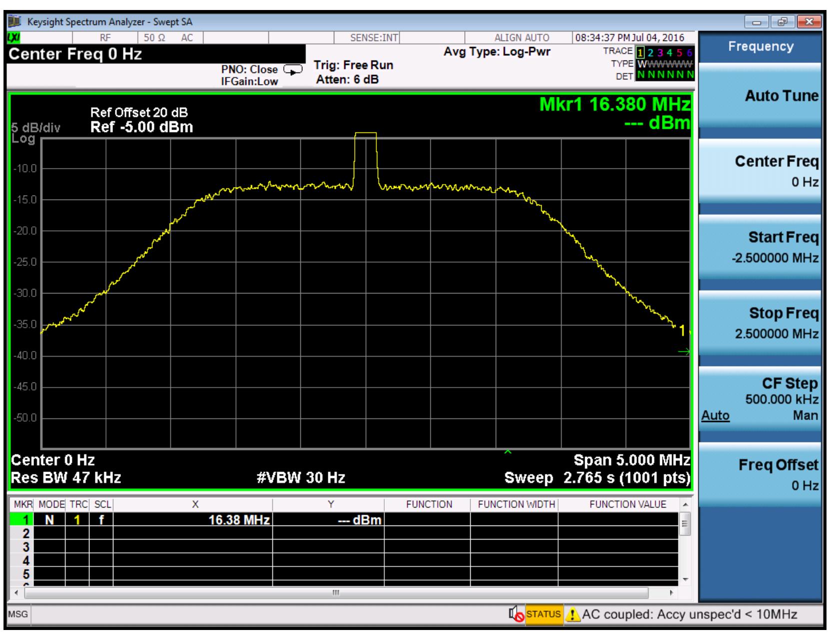

Figure 4. FBW is 00 (1.25MHz).

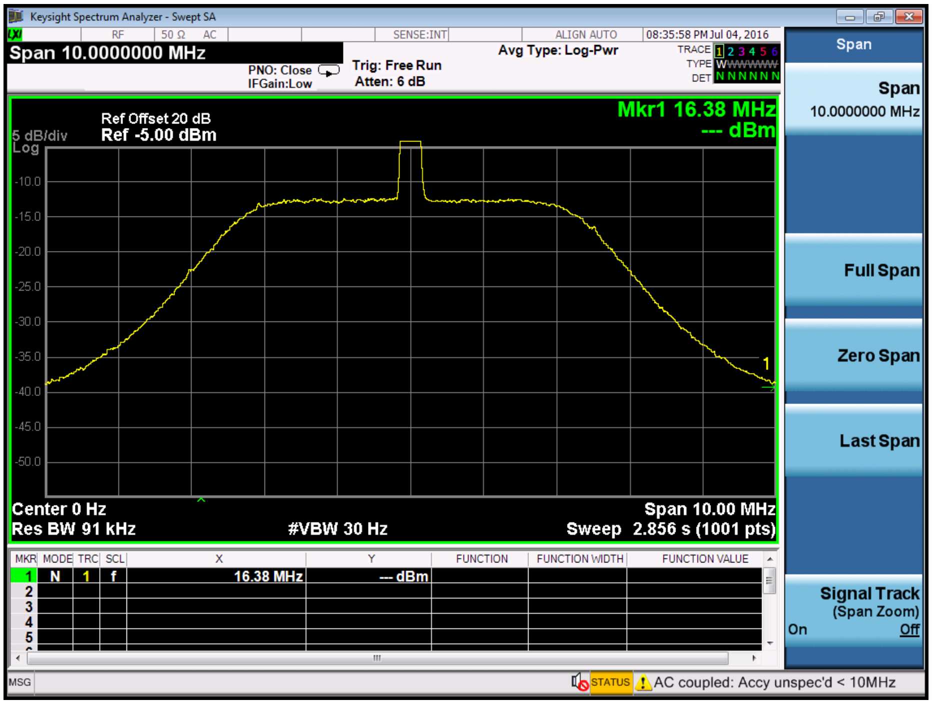

Figure 5. FBW is 10 (2.1MHz).

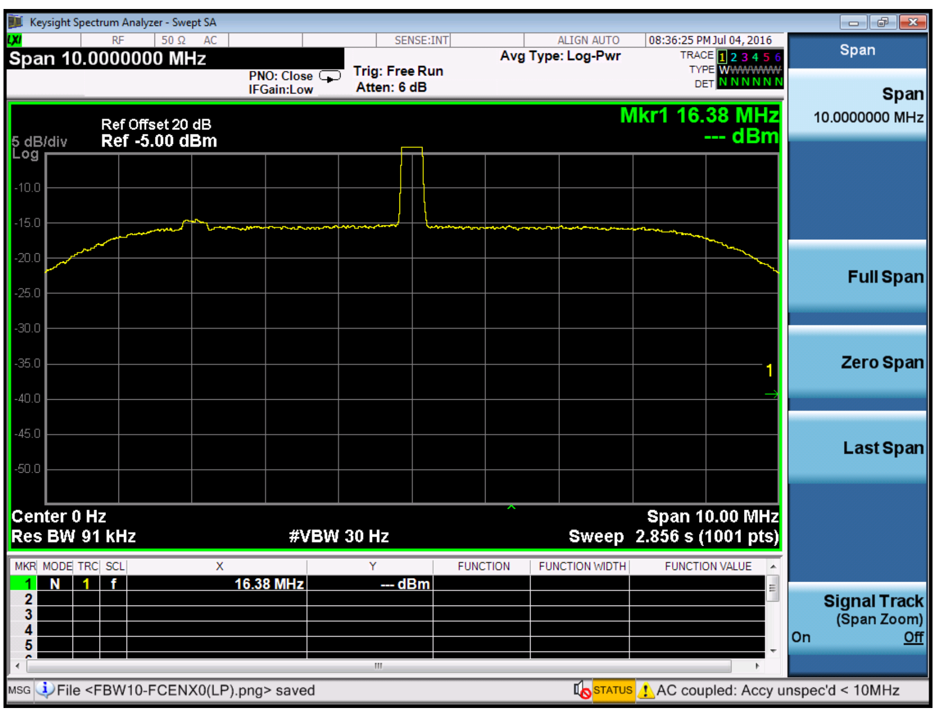

Figure 6. FBW is 01 (4.83MHz).

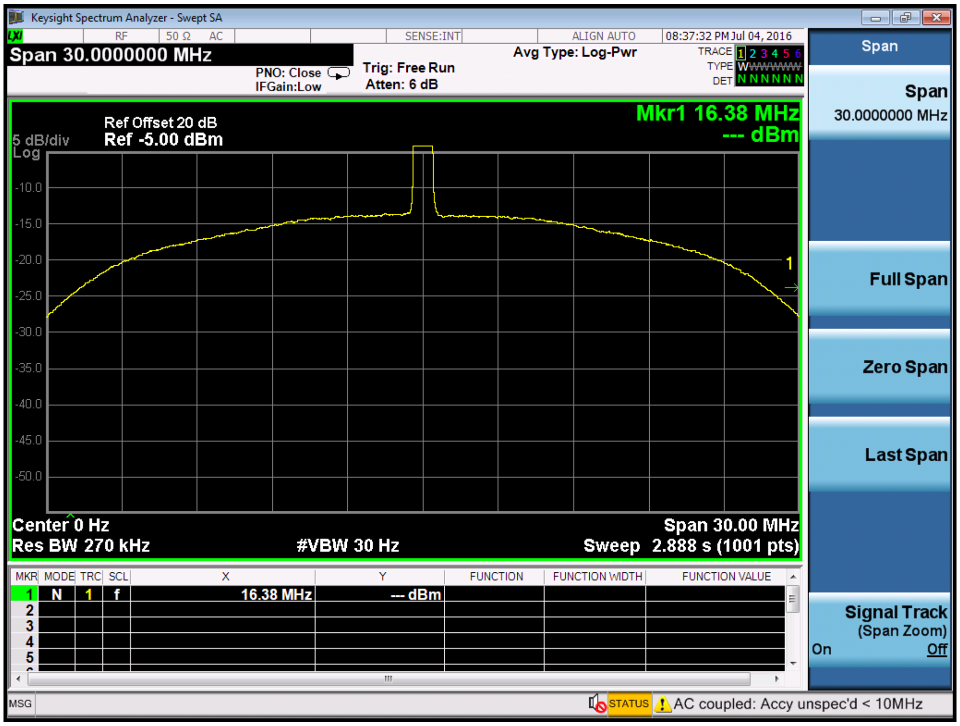

Figure 7. FBW is 11 (9MHz, preferred in Zero-IF mode).