



Intelligent Interactive Synthesizer Pinout and Functions (273LF, 197LF, 280LF packages)

This document describes the operating features and pin-out of the new generation of Synergy Microwave's "Intelligent Interactive Synthesizers" (I²S[®]). It is a generic document for the FSW and LFSW series of (I²S[®]) synthesizers in packages 273LF, 197LF and 280LF. These synthesizers are truly intelligent incorporating an internal controller that allows for optimal factory set performance and minimal software development by the user. Programming is easily done through four simple options that the user can adopt for fast in-circuit implementation.

What is the need for synthesizers having an integrated controller?

There are several good reasons to do so!

- The operational settings of the PLL chip have to be calculated for each frequency setting to be within the operational specifications. For example in wideband VCO's, the computation of the divider values has to guarantee that no chip internal frequency limits are exceeded.
- The settings of the charge pump current and other parameters, which finally define the phase noise and switching speed can be optimized easily with these intelligent features.
- Improves the speed of the system processor and makes the software easier to re-use.
- Operation can be made independent of the PLL IC used. The use of a controller allows change of the I²S[®] IC without any impact on the system software.
- Integrated error detection and signaling is possible without customer programming.
- Reduces design time for the user. A real plug and play solution!

Other benefits of the I²S[®] are:

- Intensive internal filtering of the supply voltages.
- Monitoring of internal voltages.
- Optimized layout to reduce impact of external ground loops.
- Standard programming interface for ALL models.
- No hardware programming for a specific PLL IC required.



Software Interface Pins

This section describes the software interface pins that are used to address the synthesizers. Some of the pins are not connected and can be used at a later time for software implementation of additional features. All I/O's are 5V CMOS, inputs with pull-up resistors. Their input characteristic has also been set to accommodate 3V CMOS input signals at slightly reduced noise immunity.

- ErrorFlag, special type output
This pin turns low after the Synthesizer has locked. (This is delayed to the Lock Detect output due to processing time!) If any internal error is detected this pin will go high. Internal errors are: Out of Lock, Vcc(Tune) Out of Range, Internal Voltage Regulator Out of Range, Invalid Frequency or Reference Command.
To use this feature the pin has to be tied to ground via a pull-down resistor. Recommended value is 120k Ω to 220k Ω . The Synthesizer will pull this output to +5V via a 20k Ω resistor in case of an error. For communication this pin acts as the return channel. Multiple I²S[®] error flags can be tied together.
- Latch Enable
LE for SPI port. (SS)
- Data In
Data for SPI port. (MOSI)
- Clock In
Clock for SPI port. (SCK)

Hardware Interface Pins

- Fref
Reference frequency input.
- Vcc(Digital)
+5V DC supply for the digital section of the Synthesizer. A 47uF tantalum bypass capacitor is highly recommended if the supply isn't clean to achieve the specified phase noise performance!
- Vcc(VCO)
Supply voltage for the VCO according to the datasheet. This has to be a clean, low noise supply. Decoupling close to the Synthesizer package is recommended.
- Vcc(Tune)
Supply voltage for the VCO tuning according to the datasheet or from the internal voltage converter. This has to be a clean, low noise supply. Decoupling close to the Synthesizer package is recommended.
- Vout(Converter) (For 197LF and 280LF packages only!)
Output of the internal voltage converter. Connect Vcc(Tune) and Vout(Converter)



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externally. No external loads allowed! A bypass capacitor of 10uF to 100uF/30V is recommended.

- Vcc (Converter) (For 197LF and 280LF package only!)
+5V supply voltage for the internal voltage converter.
- Vtune - Actual tuning voltage of the VCO. Please consult factory before using this voltage for tracking filters or other uses! Normally leave NC surrounded by ground.
- Vcc(Analog)
+5V analog supply for 280LF package only! This has to be a clean, low noise supply. Decoupling close to the Synthesizer package is recommended.
- LD
Lock Detect, a 3.3V CMOS output, which turns high after the Synthesizer locks.
- RFout
50Ω output of the Synthesizer.
- No Connection – leave these pins open (DO NOT CONNECT TO GROUND)

Note: External noise from the power supplies must be limited to no more than 30uV/Sqrt_Hz to achieve the specified phase noise performance.

Programming

The user can address the I²S[®] synthesizers in one of four different options to program the output frequency:

1. **Setting frequency allocation as a channel.** In this mode, an ASCII character code for the letter “C” in hexadecimal (43) indicates to the controller that mode frequency as a channel is selected. The information for the channel number follows in hexadecimal format having 32 bits with LSB sent first (total 40 bits sent). Based on the channel selected, the controller then calculates the frequency of the channel F_{CN} by the following equation:

$$F_{CN} = F_{C0} + (N * C_s), \text{ where:}$$

- F_{CN} - Frequency of the N_{th} channel
- F_{C0} - Specified starting frequency of the synthesizer
- C_s - Channel spacing
- N - N_{th} channel for synthesizer to tune

For example, channel 50 for the FSW150320-50 would be sent as follows:

 Data (Hex)
 43 32 00 00 00



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Similarly, the synthesizer can immediately be loaded for standby channel mode by sending ASCII character code for letter “c” in hexadecimal (63) and the data for the next wanted channel number. The programming format for this option is coded as “Little Endian” (MSB of the LSByte is sent first).

2. **Setting frequency by known N (division ratio).** In this mode, an ASCII character code for the letter “D” in hexadecimal (44) indicates to the controller that mode frequency by known N is selected. N is calculated by dividing the output frequency by the channel spacing (step size). The information for the N division ratio follows in hexadecimal format having 32 bits with LSB sent first (total 40 bits sent).

For example, an N ratio of 2700 would be loaded as:

Data (Hex)
44 8C 0A 00 00

Similarly, the synthesizer can immediately be loaded for standby mode by sending ASCII character code for letter “d” in hexadecimal (64) and the data for the next wanted known N. The programming format for this option is coded as “Little Endian” (MSB of the LSByte is sent first).

3. **Setting frequency directly (kHz).** In this mode, an ASCII character code for the letter “K” in hexadecimal (4B) indicates to the controller that mode frequency directly (kHz) is selected. The information is loaded in hexadecimal format (1 byte for the “K” command and 8 bytes for the frequency command (72 bits total). No real values allowed, the instruction must be in integer format (KHz).

For example, the frequency of 4,000,000 KHz (4 GHz) would be sent as:

Data ASCII(Hex) Hex
4B 30 30 33 44 30 39 30 30 or K003D0900

Similarly, the synthesizer can immediately be loaded for standby mode by sending ASCII character code for letter “k” in hexadecimal (6B) and the next wanted frequency (KHz).

4. **Setting frequency directly (MHz).** In this mode, an ASCII character code for the letter “M” in hexadecimal (4D) indicates to the controller that mode frequency directly (MHz) is selected. The information is loaded in hexadecimal format (1 byte for the “M” command and 8 bytes for the frequency command (72 bits total). No real values allowed, the instruction must be in integer format (MHz).

For example, the frequency of 4,000 MHz (4 GHz) would be sent as:



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Data ASCII(Hex) Hex
4D 30 30 30 30 30 46 41 30 or M00000FA0

Similarly, the synthesizer can immediately be loaded for standby mode by sending ASCII character code for letter “k” in hexadecimal (6D) and the next wanted frequency (MHz).

Reference Frequency – The factory set reference frequency is usually 10 MHz, in some models can be field re-programmed by the user for any reference frequency, typically in the range of 10 to 150 MHz, as long as the reference frequency is an integer multiple of the step size. Some models are factory set and cannot be field re-programmed, see specification sheet for specifics on field programmability. For synthesizer models that are not field re-programmable, contact factory for your specific reference frequency requirement.

For those models which the reference frequency can be field reprogrammable, the factory start-up reference frequency can be changed in two ways:

1. A volatile “R” command change, where the reference register settings are loaded every time with each command to over ride the factory setting. There is no limit to the number of register loads when using the “R” command setting.
2. A non-volatile command change where the factory setting is permanently changed in the EPROM by the user. In this case, there is a maximum limit to the number of times that the EPROM can be written (up to 100 times). This should be more than enough times to write to EPROM once the instruction is written by the user for the desired reference frequency there is usually no need to change again.

For the volatile change of the reference (setting sent with each frequency command), an ASCII character code for the letter “R” in hexadecimal (52) indicates to the controller that reference frequency is being temporarily changed. The information for the division ratio follows in hexadecimal format having 32 bits with LSB sent first - 1 byte for the “R” command and 4 bytes for the division ratio (40 bits total). The information is loaded in hexadecimal format.

For example, with a reference frequency of 10 MHz and a step size of 500 KHz, (division ratio of 20) the data would be sent as:



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Data (Hex)
52 14 00 00 00

The programming format for this option is coded as “Little Endian” (MSB of the LSByte is sent first).

For the non-volatile change of the factory setting, the letter “r” in hexadecimal (72) is sent instead, indicating to the controller that the EPROM will be written to with a new non-volatile user setting. The information for the division ratio similarly follows in hexadecimal format. In this case, the four bytes of the division ratio are repeated bits with LSB sent first – 1 byte for “r” command and 4 bytes repeated (72 bits total) and followed by a power cycle (off/on). For example, a reference frequency of 10 MHz and step size of 500 kHz (division ratio of 20) the data would be sent as:

Data (Hex)
72 14 00 00 00 14 00 00 00

The programming format for this option is coded as “Little Endian” (MSB of the LSByte is sent first).

Swap Active/Standby frequencies – When an ASCII character code for the letter “S” in hexadecimal (53) is sent, it indicates to the controller that swap frequency command requests swapping the active and the standby frequency register settings. The information follows in hexadecimal format having 8 bits with LSB sent first - 1 byte for the “S” command.

Data (Hex)
53

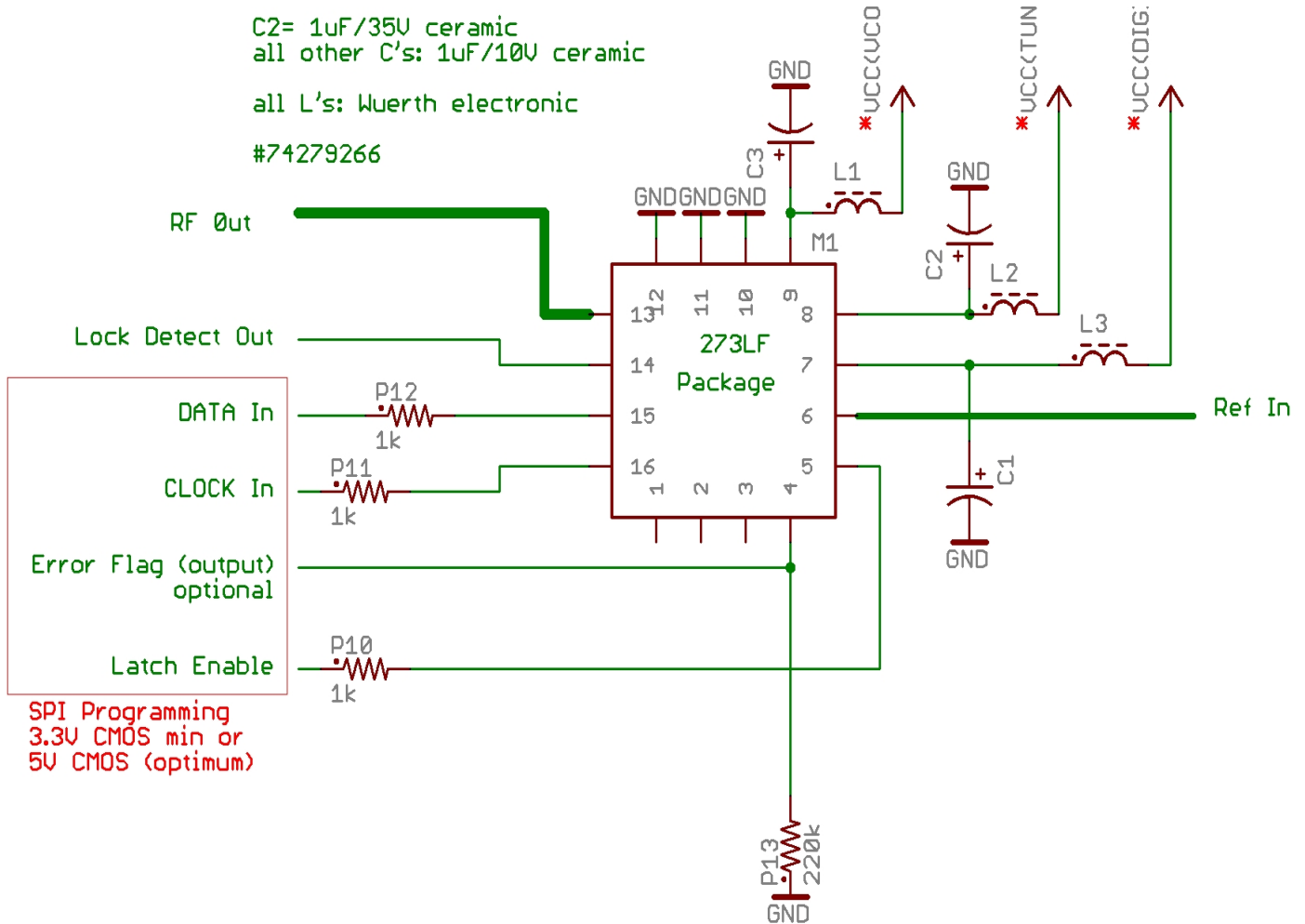
Maximum SPI programming speed is recommended not to exceed 200kb/sec in present designs.

By default all I²S[®] are set to a reference frequency of 10 MHz unless otherwise noted in the datasheet. If the reference frequency in an application is different the first data string sent to the Synthesizer has to be the R command! On turn on, the Synthesizer defaults to the lowest specified frequency (channel 0). Standby frequency defaults to maximum frequency unless otherwise specified in the datasheet.

Table I shows some examples of the different programming options and figure 1 shows a typical timing diagram. The number of bits in the diagram below applies to the example for MHz or kHz commands, but the timing applies for all test commands described in the above text.

Suggested Connection Diagrams:

FSW Series



* NOTE:

Common Voltage Supplies can be Connected together and Filtered as indicated in the diagram.

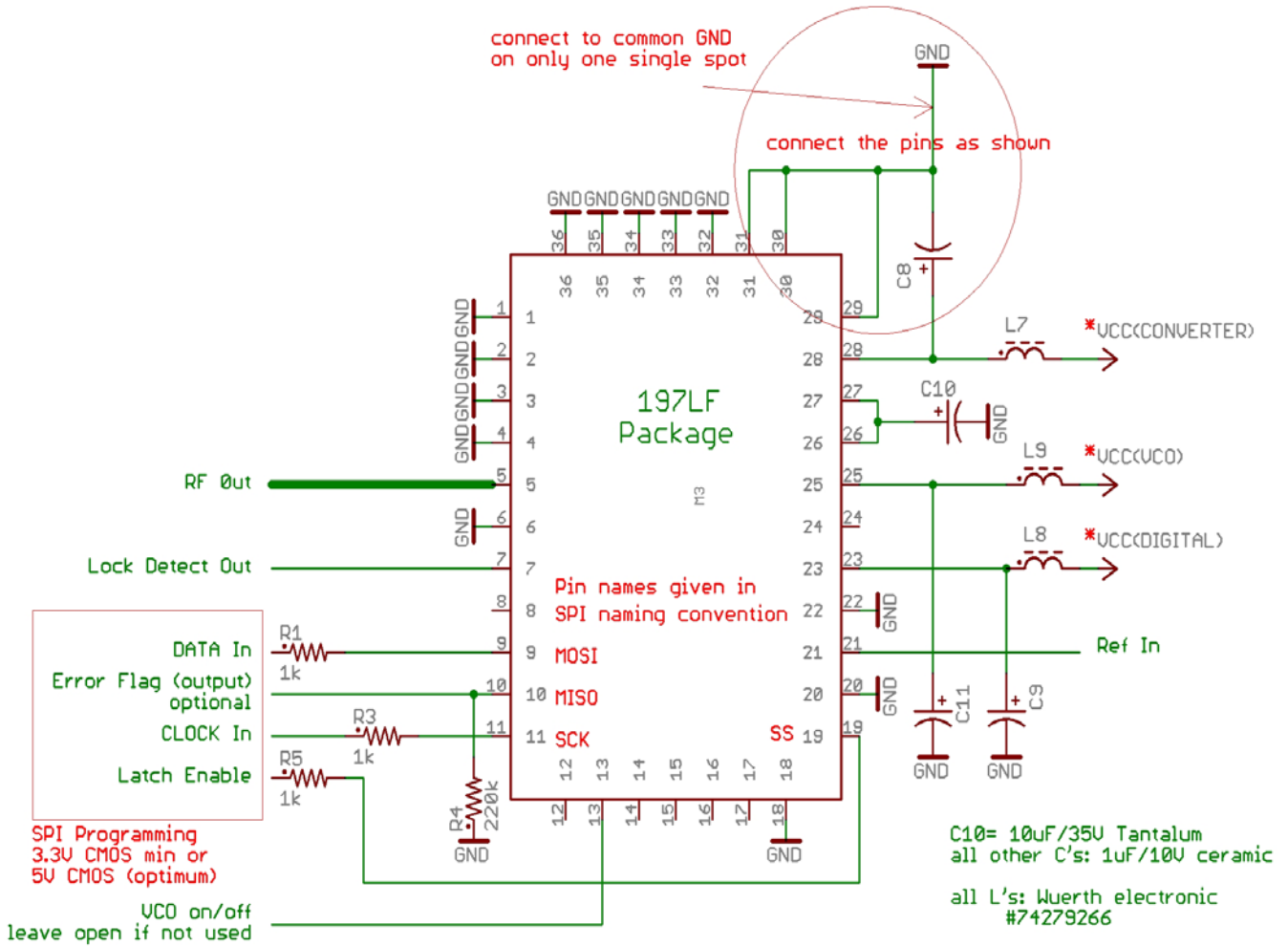
Please Check the Specific Product Specification Sheet for the Supply Voltages.

LFSW Series

make the GND connection according to drawing

connect to common GND on only one single spot

connect the pins as shown

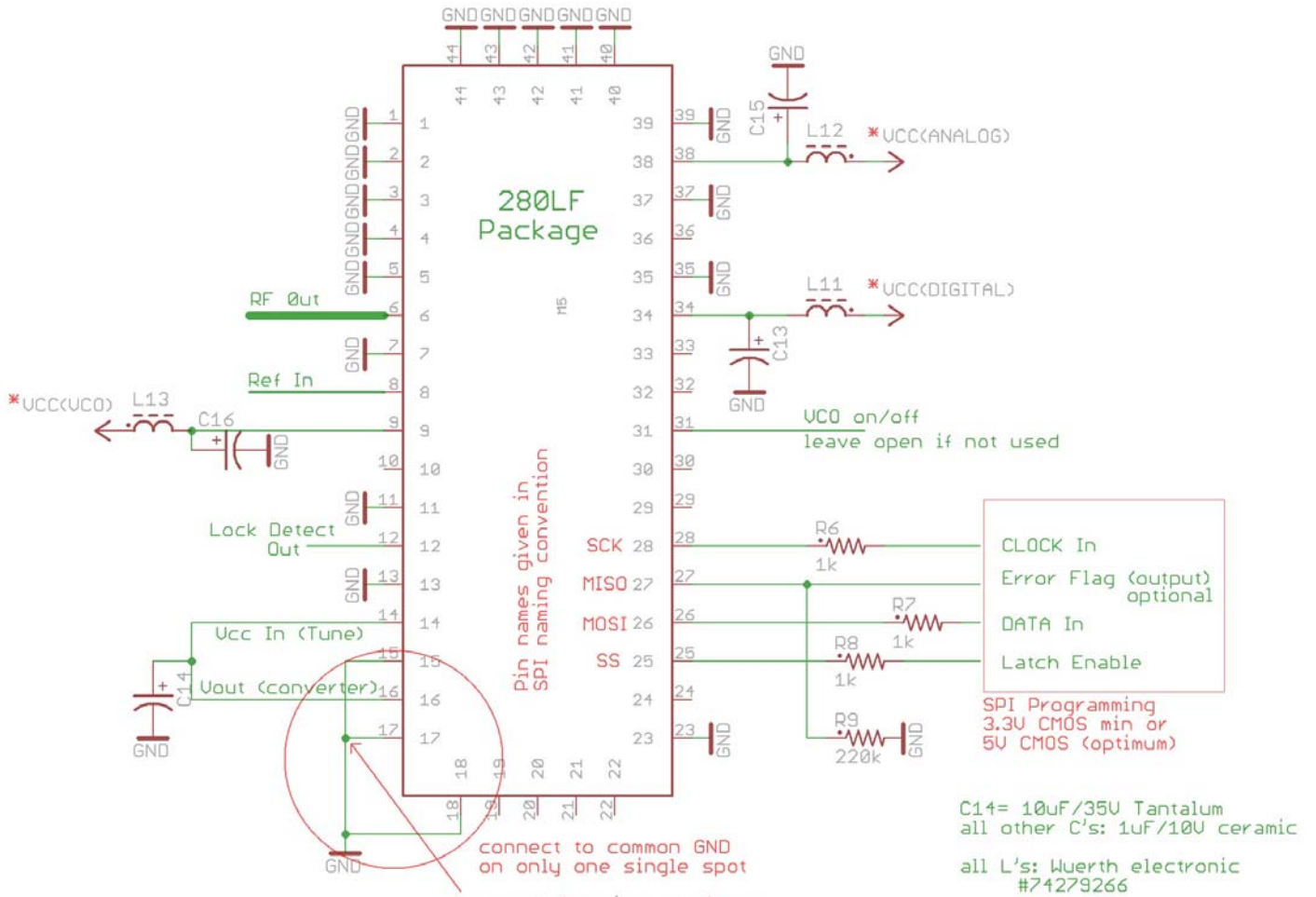


* NOTE:

Common Voltage Supplies can be Connected together and Filtered as indicated in the diagram.

Please Check the Specific Product Specification Sheet for the Supply Voltages.

LFSW35105-xx



* NOTE:

Common Voltage Supplies can be Connected together and Filtered as indicated in the diagram.

Please Check the Specific Product Specification Sheet for the Supply Voltages.



Table I

Interface Commands

Command Character	Command Description	Parameter	Byte Position										
			1	2	3	4	5	6	7	8	9		
C	Set Active Frequency as Channel	Unsigned Long Integer, LSByte first	0x43	B	B	B	B						
c	Set Standby Frequency as Channel	Unsigned Long Integer, LSByte first	0x63	B	B	B	B						
D	Set Active Division Ratio	Unsigned Long Integer, LSByte first	0x44	B	B	B	B						
d	Set Standby Division Ratio	Unsigned Long Integer, LSByte first	0x64	B	B	B	B						
K	Set Active Frequency in kHz	Hexadecimal characters	0x4B	H	H	H	H	H	H	H	H	H	H
k	Set Standby Frequency in kHz	Hexadecimal characters	0x6B	H	H	H	H	H	H	H	H	H	H
M	Set Active Frequency in MHz	Hexadecimal characters	0x4D	H	H	H	H	H	H	H	H	H	H
m	Set Standby Frequency in MHz	Hexadecimal characters	0x6D	H	H	H	H	H	H	H	H	H	H
R	Reference Frequency In Multiples Of Channel Spacing	Unsigned Long Integer, LSByte first	0x52	B	B	B	B						
r	Changes factory set reference frequency to new start-up setting	Unsigned Long Integer, LSByte first	0x72	B	B	B	B	B	B	B	B	B	B
S	Swap Active / Standby Frequencies	No parameter	0x53										

All SPI communication uses most significant bit first

“B” – Binary value with least significant byte first.

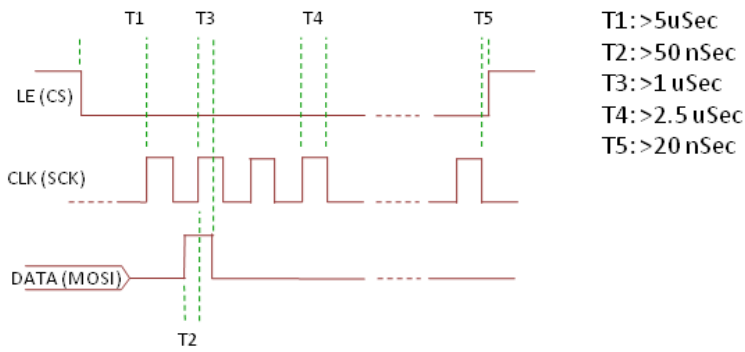
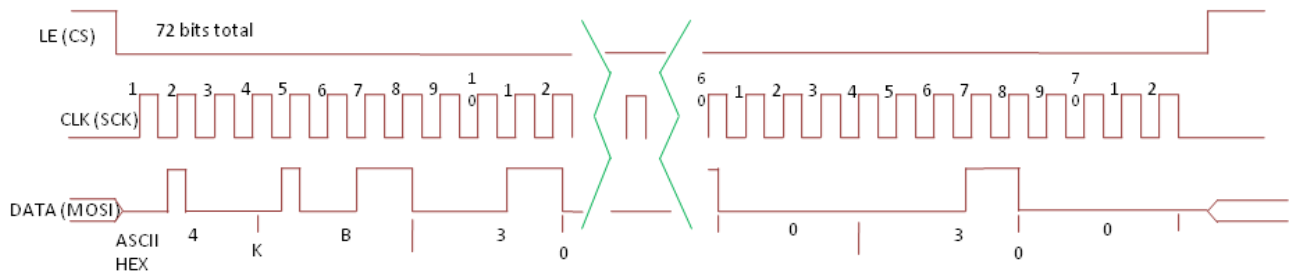
“H” – ASCII value of a hexadecimal character (uppercase) most significant character first.

“C” – ASCII value of option parameter.

Examples:

“D” Command: Set Active N using Division Ratio of 2700 → 44 8C 0A 00 00 (2700 = 0x00000A8C)
 “F” Command: Set Active N using Preset Frequency #1 → 46 01
 “k” Command: Set Standby N using Frequency of 1100000kHz → 6B 30 30 31 30 43 38 45 30 or “k0010C8E0”
 “K” Command: Set Active N using Frequency of 4000000kHz → 4B 30 30 33 44 30 39 30 30 or “K003D0900”
 “M” Command: Set Active N using Frequency of 4000MHz → 4D 30 30 30 30 30 46 41 30 or “M00000FA0”

TIMING DIAGRAM





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Rev. "B" In-circuit programming section: Changed series resistor value statement for error flag, clock, data, reset to 1k ohms from 10k ohms. Added suggested connection diagrams.

Rev. "C" Changed timing diagram.

Rev. "D" Added information to re-program the factory reference frequency setting by sending a non-volatile "r" command.

Rev. "E" Reference in bullet 5 on page 1 referencing in-circuit firmware upgradeability and page 3 were removed. Reference Frequency paragraph on Page 5 was corrected to include reference for field re-programmability of the reference frequency on some models. Revised connection diagrams to remove optional for in circuit programming reference and removed reference to the reset pin to avoid possible unintended re-programming of the factory settings in the field. Contact is now labeled in spec sheet NC without reference. Reset is for internal use only.

Rev. "F" Changed timing diagram to indicate T1 as >5 uSec instead of 10 clock cycles.

Rev. "G" Pin 10 is now NC therefore L10, C12 and Vcc(Converter) label was removed. Also labeled pin 16 and pin 14 since they had no labels in the schematic.