ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

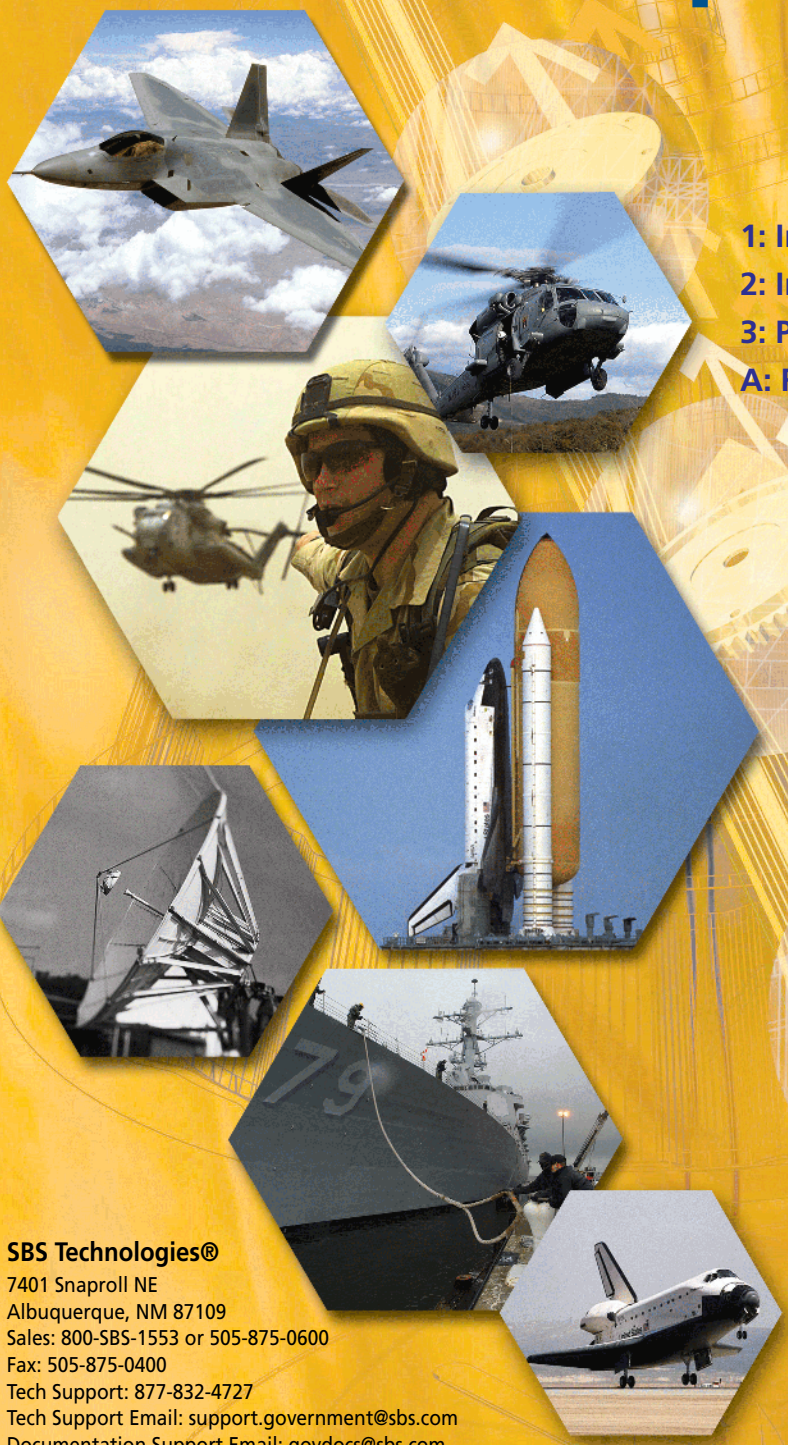
- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Abaco Systems / SBS 4430-VN* at our website: ***Click HERE***

4430-V & VN BPSK/QPSK VME Demodulator & Optional Modulator User's Manual



1: Introduction 1
2: Installation 11
3: Programming Information 21
A: Revisions 71

SBS Technologies®
7401 Snaproll NE
Albuquerque, NM 87109
Sales: 800-SBS-1553 or 505-875-0600
Fax: 505-875-0400
Tech Support: 877-832-4727
Tech Support Email: support.government@sbs.com
Documentation Support Email: govdocs@sbs.com
http://www.sbs.com
http://www.resource.sbs.com

Applies to models:
4430-V, 4430-VN

Doc PN: 501-449162-00

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

© 2005 SBS Technologies, Incorporated. All rights reserved.

4430-V & VN BPSK/QPSK VME Demodulator & Optional Modulator User's Manual

This document is the intellectual property of SBS Technologies, Inc. (SBS), and contains proprietary and confidential information. Use, disclosure, and reproduction is permitted only under the terms of an SBS software license agreement or explicit written permission of SBS. You are not authorized to use this document or its contents until you have read and agreed to the applicable software license agreement.

THIS DOCUMENT AND ITS CONTENTS ARE PROVIDED AS IS, WITH NO WARRANTIES OF ANY KIND, WHETHER EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF DESIGN, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR ARISING FROM ANY COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

All computer code and software contained in this document is licensed to be used only in connection with an SBS product. Even if this code or software is merged with any other code or software program, it remains subject to the terms and conditions of this license. If you copy, or merge, this code or software, you must reproduce and include all SBS copyright notices and any other proprietary rights notices.

In no event will SBS be liable for any lost revenue or profits or other special, indirect, incidental and consequential damage, even if SBS has been advised of the possibility of such damages, as a result of the usage of this document and the software that this document describes. The entire liability of SBS shall be limited to the amount paid by you for this document and its contents.

SBS shall have no liability with respect to the infringement of copyrights, trade secrets, or any patents by this document of any part thereof. Please see the applicable software license agreement for full disclaimer or warranties and limitations of liability.

RESTRICTED RIGHTS LEGEND

Use, duplication, reproduction, release, performance, display or disclosure by the Government is subject to restrictions set forth in subparagraph (b)(3) of the Rights in Technical Data and Computer Software clause at 48 CFR 252.227-7013.

SBS Technologies, Inc., 7401 Snaproll NE, Albuquerque, NM 87109

This manual, as well as the software described herein, is furnished under license and may only be used or copied in accordance with the terms of such license.

SBS Technologies and the SBS logo are trademarks of SBS Technologies, Inc. All other brand names and product names contained herein are trademarks, registered trademarks, or trade names of their respective holders.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1: Introduction

1.1 General

1.1.1 Description

The Model 4430-V and the 4430-VN VME cards are high-performance tunable BPSK/QPSK demodulator modules for the VMEbus. The demodulator features a tunable input carrier frequency range of 6kHz to 6 MHz. A tunable modulator is available for the Model 4430-V & VN for complete BPSK/QPSK system up-link and loop-back capabilities on a single module.

The demodulator is a Costas Loop implementation with input circuitry that features independently tunable high-pass and low-pass front-end filters (effectively offering a band-pass filter). This input circuitry also offers 40 dB of AGC, thus the demodulator can be connected directly to a receiver. The high level of programming (tuning) offered by the Model 4430-V/VN makes it ideal for SGLS and other multi-carrier applications.

All setup parameters for the Model 4430-V/VN such as carrier frequency, bit rate, loop bandwidth and input filtering are programmable via the VMEbus. Readback (status) of input signal presence and lock status are also available.

1.1.2 Description of the Specifications

- Standard Carrier Frequency 6 kHz to 6 MHz
- Supports Data Rates From 50 bps to 1.5 Mbps
- LBWs From .003 to 3% of Carrier Frequency
- Input Levels From -30dBm to +10dBm
- Optional On-Board BPSK/QPSK Modulator
- 1 db (Eb/No) Synchronization Threshold

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.2 Contents of *Getting Started with the 4430-V & VN*

This manual is intended to assist you in getting the 4430-V & VN up and running as quickly as possible. It addresses the following:

- Introduction (this Chapter)
- Installation
- Programming Information



Cross Reference: Appendix A gives a brief summary of technical revisions made to this manual.

1.3 Terminology

Table 1.3.1 defines some of the basic acronyms used throughout this manual.

Table 1.3.1: Basic Acronyms

Acronym	Definition
AGC	Automatic gain control
BER	Bit Error Rate
NCO	Numerically controlled oscillator
PCM	Pulse Code Modulation
PCI	Peripheral Component Interconnect
PLL	Phase locked loop
RSSI	Return Signal Strength Indicator
TTL	Transistor Logic
VCO	Voltage controlled oscillator
V p-p	Volts peak-to-peak

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.4 Conventions

The following conventions appear in this document. These conventions may differ from those used in other SBS publications. The subsections listed below describe each convention in more detail:

- Typographic Conventions
- Words Having Special Meaning
- Compound Keystrokes and Menu Selections
- Symbols

1.4.1 Typographic Conventions

Table 1.4.1 shows the typographic conventions used in this document.

Table 1.4.1: Typographic Conventions

Element	Use in Body Text	Use in Procedures
Italic	➢ Document, chapter, section, and topic titles and cross references. ➢ Emphasis.	➢ Filenames and directory paths.
Bold	➢ (Not used in body text.)	➢ Controls, dialogs, menus, and text or numeric fields that appear on the screen. ➢ Keys on your keyboard.
`Courier Roman`	➢ Code examples.	➢ Simulating the appearance of screens.
`Courier Bold`	➢ Library function calls and syntax. ➢ Emphasizing lines of code.	➢ Commands and other information that you type as given.
Angle brackets, e.g.,< >	➢ Enclosing variable information that you type (without the brackets) in place of a dummy variable.	➢ Enclosing variable information that you type (without the brackets) in place of a dummy variable.

The point size of the text varies depending on whether it is used in body text, code examples, notes, screens, or procedures.

1.4.2 Words Having Special Meaning

In procedures, the words “Enter” (or “enter”) and “Type” (or “type”) have special meanings that are indicated in Table 1.4.2.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 1.4.2: Words with Special Meaning

Word	Meaning
Enter	Key in the specified text or variable information and press the **Return** key.
Type	Key in the specified text. Do not press **Return**.

1.4.3 Compound Keystrokes and Menu Selections

Compound Keystrokes

Whenever a procedure instructs you to press multiple keys, a double angle bracket "»" separates the names of the keys. Table 1.4.3 shows an example.

Menu Selections

Whenever a procedure instructs you to select an item from a pull-down menu, a double angle bracket "»"separates the menu items. Table 1.4.3 shows an example.

Table 1.4.3: Examples of Notation for Compound Keystrokes and Menu Selections

Instruction	Meaning
Press **Ctrl** » **Alt** » **Delete**.	Press the **Ctrl**, **Alt**, and **Delete** keys simultaneously.
Select **File** » **Open**.	Select **Open** from the **File** menu.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.4.4 Symbols

The following symbols appear throughout this manual:



Warning: Paragraphs next to this symbol contain information critical to module operation or to your safety.



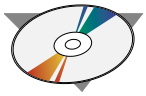
Note: Paragraphs next to this symbol contain information important to module operation.



Tip: Paragraphs next to this symbol contain useful tips.



Cross Reference: Paragraphs next to this symbol contain cross references to a related page in this manual, or to other SBS publications.



Software Cross Reference: Paragraphs next to this symbol contain cross references to software media included with this product.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.5 Block Diagrams

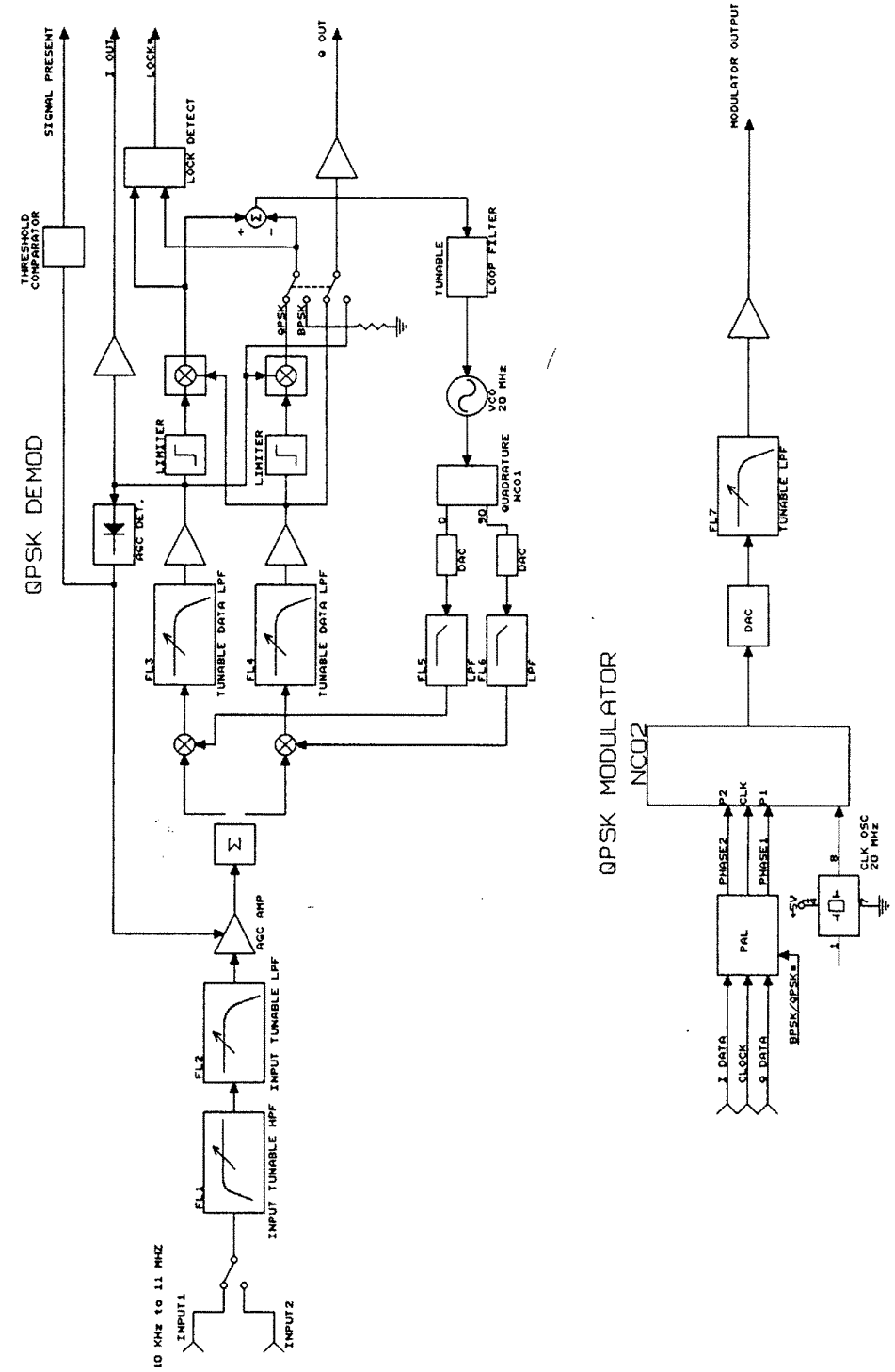


Figure 1.5.1: 4430-V/VN Block Diagram

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

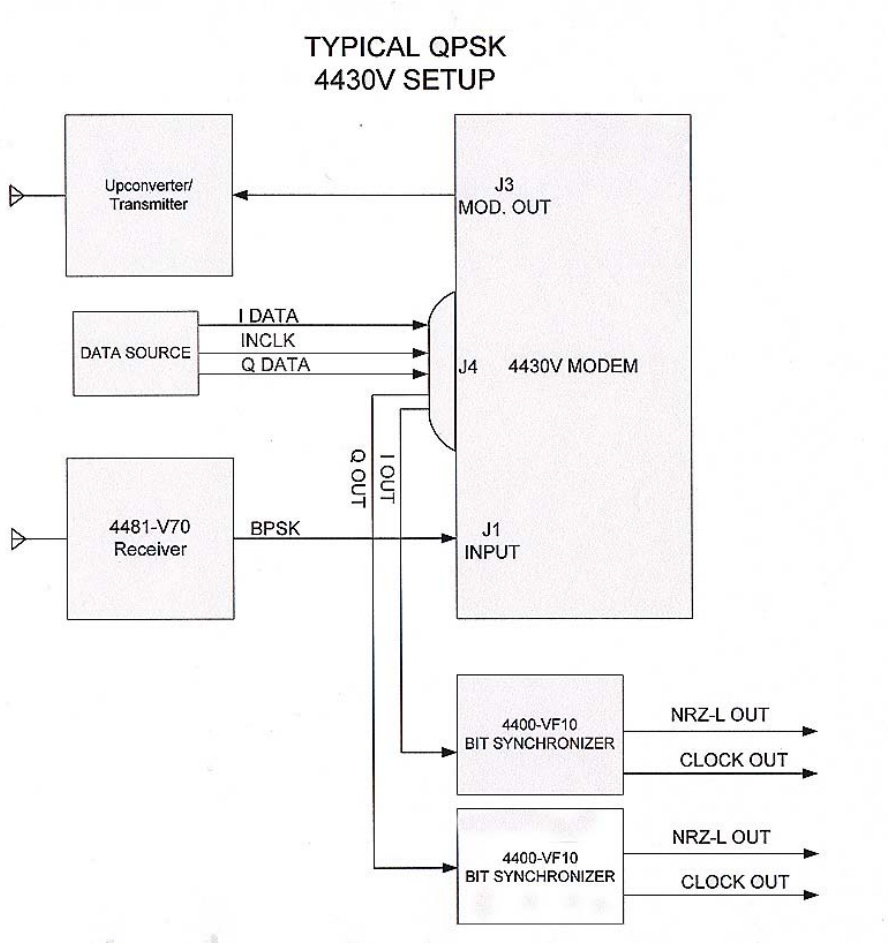


Figure 1.5.2: 4430-V/VN QPSK Setup Diagram

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

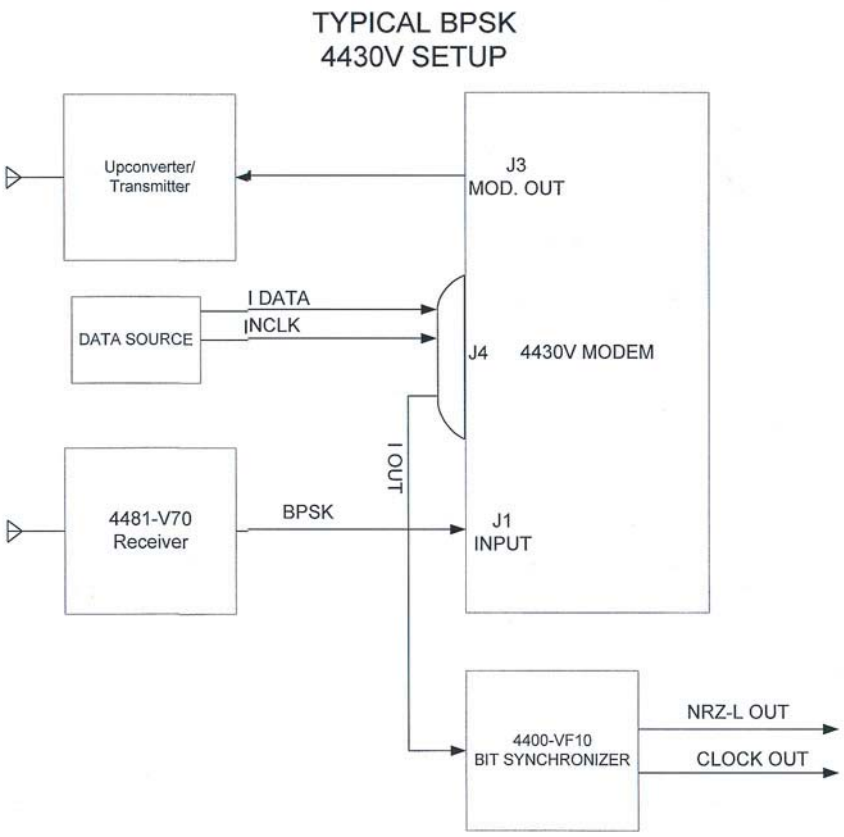


Figure 1.5.3: BPSK Setup Diagram

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.6 Specifications

1.6.1 Electrical Specifications

Table 1.6.1: Electrical Specifications

Specification	Description
	Demodulator
Carrier Frequency	6 kHz to 6 MHz Tunable. Independently tunable front end high pass and low pass filters.
Data Rates	To 1.5Mbps.
Loop Bandwidth	4430-V = 0.05% to 3% of Carrier Frequency. 4430-VN = 0.003% to 0.05%.
Tracking Range	Minimum 3 times loop bandwidth. Typical is 5 to 10 times.
Input Level	-30 dBm to + 10 dBm into 75 ohms. Other ranges and impedances are optional.
Implementation Loss	< 1 dB
Carrier to Bit Rate Ratio:	4 to 1 up to 10k to 1.
Sync Threshold	4430-V - To 5 dB Eb/N0 (Loop BW dependent). 4430-VN - Lower.
	Modulator
Carrier Frequency	6 kHz to 6 MHz Tunable.
Carrier Stability	+100 ppm 0˚ to 70˚C.
Output Level	0 dBm into 75 ohms.
Output Bandwidth	Tunable 4 pole Low pass filter.
Carrier Suppression	30 dB Minimum.
Input modulation rate	to 1.5 Mbps.
Min. CLK Pulse Width	150 nsec
Modulation input level	TTL compatible or RS422.



Note: Unless noted, specifications apply to both the 4430-V and the 4430-VN modules.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.6.2 System Interface Specifications

Table 1.6.2: System Interface Specifications

Specification	Description
Interface Type	VME(C.1) A24 D08 Slave for setup status.
Programmable Functions	Demod center frequency Modulator center frequency Data filter frequency Input LPF frequency Input HPF frequency Loop filter parameters Q/BPSK mode Input Select Modulator LPF frequency Phase states
Soft Readback	Lock status Signal presence

1.6.3 Mechanical Specifications

Table 1.6.3: Mechanical Specifications

Specification	Description
Board Size	Single 6U x 160 Eurocard
Front Panel Indicators	Signal present & Lock status

1.6.4 Environmental Specifications

Table 1.6.4: Environmental Specifications

Specification	Operating	Non-Operating
Temperature	10˚C to 50˚C.	-25˚C to +70˚C.
Humidity	0 to 90% non-condensing	Packing must prevent contact with moisture and contaminants.



Warning: This is an electronic product that is sensitive to electrostatic discharge. Take normal precautions in handling the card to prevent damage.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2: Installation

2.1 Introduction

Chapter 2 provides installation instructions for both the Model 4430-V and Model 4430-VN.

If you ordered the 4430-V/VN directly from SBS for your specific application, hardware identification is straightforward. If, however, you "inherited" the board from within your own company, proper identification of the hardware as well as proper application of the board may be more difficult.

Before installing this board, please perform Section 3.3 Programming Interview on page 23. Section 3.3.1 User Setup on page 23 provides an opportunity to enter critical setup parameters. Section 3.3.2 Setup Analysis on page 24 enables you to evaluate your setup criteria to ensure that it falls within the operational capabilities of the 4430-V or 4430-VN.

Use this chapter to help you locate serial numbers, to familiarize yourself with the layout of the board, and to set up the hardware.

2.2 Product Identification

2.2.1 Model Number

The model number is located on a tab on the handle of the front panel. See Figure 2.2.1 on page 12, Figure 2.2.2 on page 13, and Figure 2.2.3 on page 14.

2.2.2 Serial Number

See Figure 2.2.1 on page 12, Figure 2.2.2 on page 13, and Figure 2.2.3 on page 14 for serial number location. Serial number location depends on revision and board options.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2.2.3 Firmware Numbers

Firmware identification numbers are printed on labels attached to their respective programmable parts. See Figure 2.2.1 on page 12, Figure 2.2.2 on page 13, and Figure 2.2.3 on page 14.

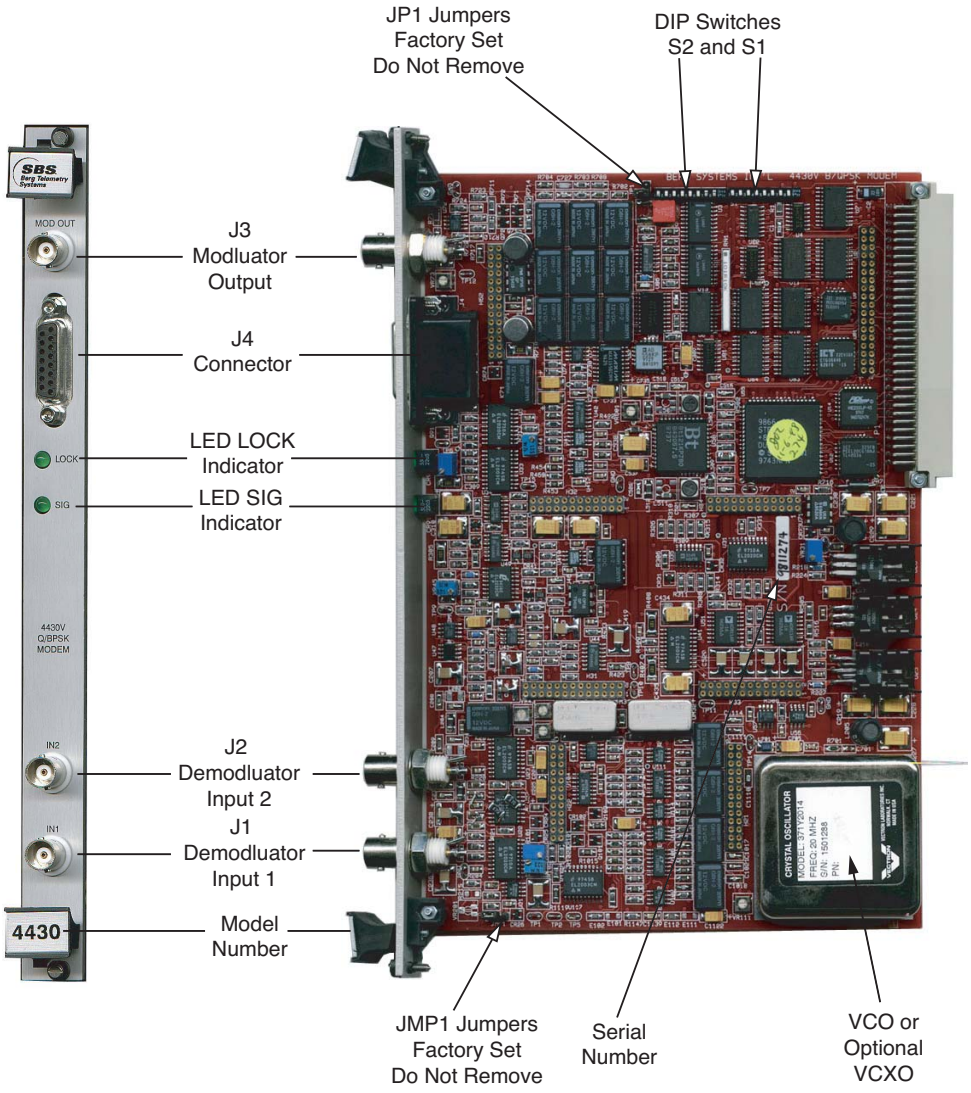


Figure 2.2.1: 4430-V & VN, Rev A - C, Front Panel and Board without Modules

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

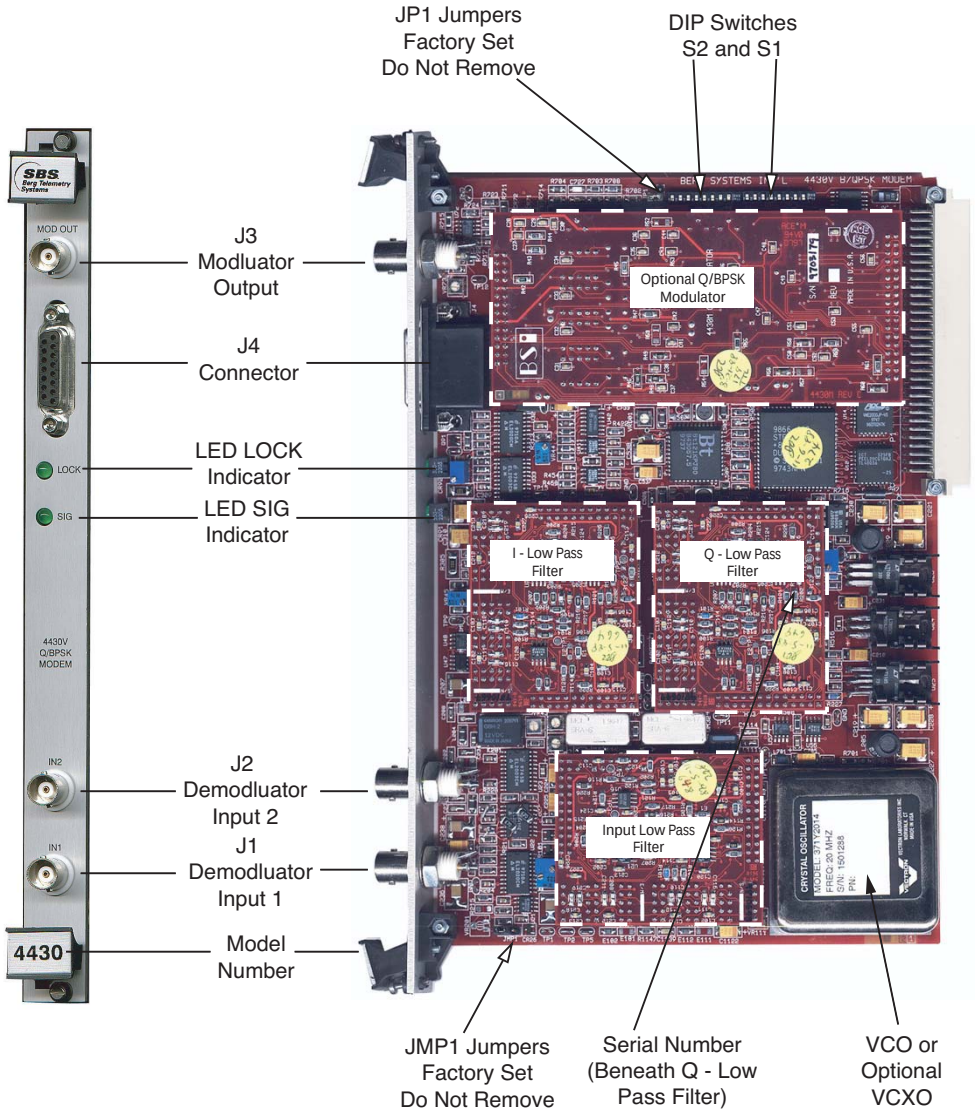


Figure 2.2.2: 4430-V & -VN, Rev A - C, Front Panel and Board with Modules

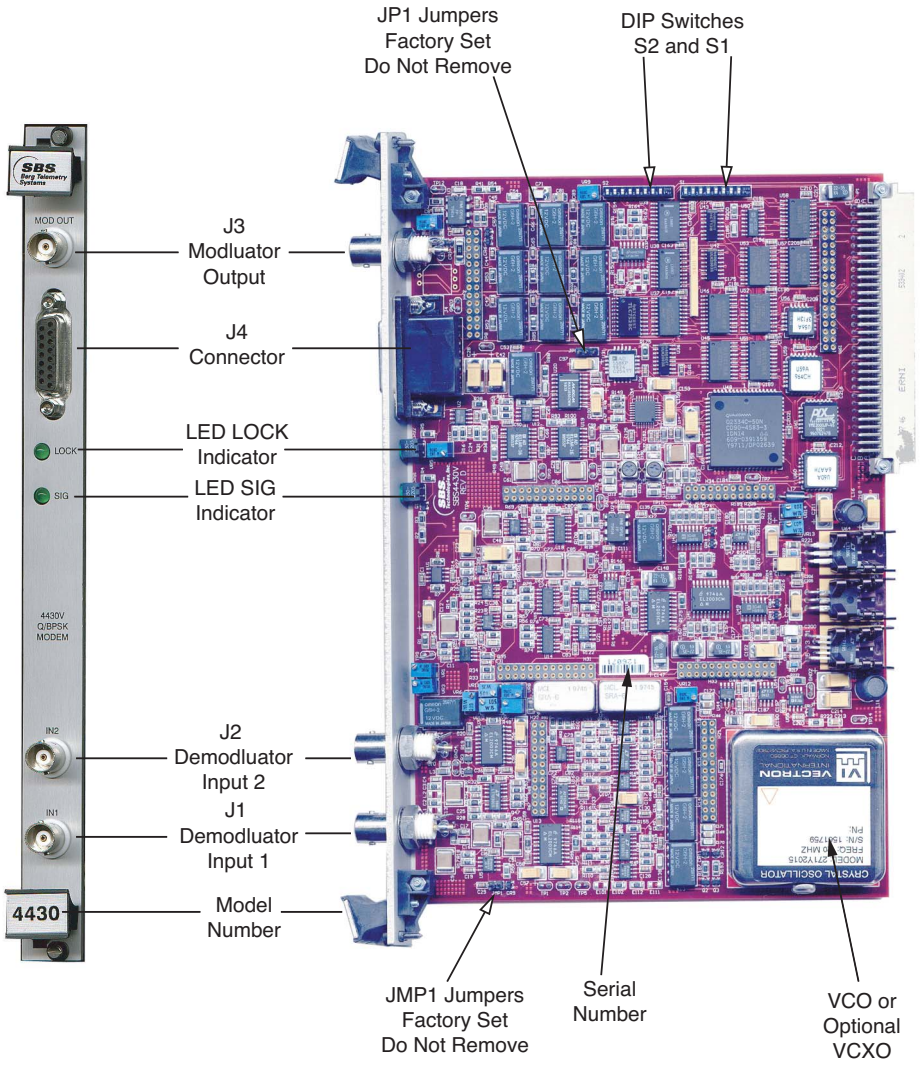


Figure 2.2.3: 4430-V & -VN, Rev D, Front Panel and Board without Modules

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2.3 Hardware Setup

2.3.1 Hardware Revisions

The nomenclature and positioning of hardware on Revision D is slightly different than on Revisions A, B and C, but does not effect setup.

- Rev A, B and C, without modules is shown in Figure 2.2.1.
- Rev A, B and C, with modules, is shown in Figure 2.2.2.
- Rev D, without modules, is shown in Figure 2.2.3.

DIP switches S1 and S2 are unchanged, as are the VCO, the connectors and the LEDs.

The J1 is now the JP1, and the JP1 is now the JMP1, but they both serve the same functions and are still both factory set. Do not remove the shunts.

2.3.2 Addressing the Board

The 4430-V/VN occupies 128 bytes of VME Standard Address Space. The device address is selected by setting DIP switches S1 and S2. Ones in the address are noted by turning the corresponding switch section off. The switches are equated to the address bits as shown in Table 2.3.1 below.

Table 2.3.1: Address Switch Settings

Switch	Address Bit	Switch	Address Bit
S1-1	A08	S2-1	A16
S1-2	A09	S2-2	A17
S1-3	A10	S2-3	A18
S1-4	A11	S2-4	A19
S1-5	A12	S2-5	A20
S1-6	A13	S2-6	A21
S1-7	A14	S2-7	A22
S1-8	A15	S2-8	A23

The 4430-V/VN is a D08 VMEbus slave, which means it only uses the 8 low-order VME Data lines at odd addresses.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2.4 Configuration Information

2.4.1 Setting Interrupts

The 4430-V/VN has no interrupts.

2.4.2 Jumpers

The 4430-V/VN has jumpers - J1 and JP1. These are identified in Figure 2.2.1 on page 12. These jumpers are set at the factory and should not be changed.

2.4.3 Dip Switches

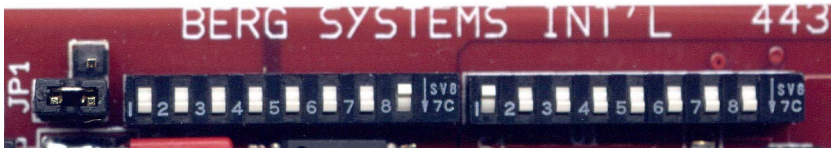
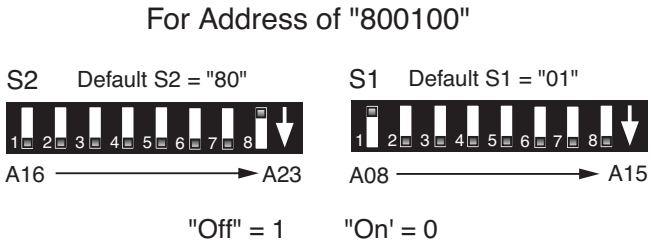


Figure 2.4.1: DIP Switches S2 & S1

2.4.4 Factory Default Table



Note: The arrow adjacent to the DIP switches points to the "On" position.

Figure 2.4.2: DIP Switches - Sample Settings

2.4.5 LEDs

There are two LEDs on the front panel. See Figure 2.2.1 through Figure 2.2.3 for their locations.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- LED Lock Indicator - When this LED is illuminated, it indicates that the demodulator is locked to the signal.
- LED Sig Indicator - When this LED is illuminated, it indicates that there is a signal detected on selected input.

2.4.6 Optional Modules

The 4430-V/VN has one optional module, an on-board modulator. (See Table 2.4.1 for ordering information.)

Table 2.4.1: Combination Table

Board	Description	VCXO	Modulator	Part #
4430-V	Standard 4430-V	No	No	4430-V-0000
4430-VM	Standard 4430-V	No	Yes	4430-V-0001
4430-VN	4430-V with VCXO	Yes	No	4430-V-0010
4430-VNM	4430V with VCXO & optional modulator	Yes	Yes	4430-V-0011

2.5 Connector Assignments

All non-bus I/O connections for the 4430-VE are on the front panel. Three BNC connectors are provided for signal inputs and the modulator output:

- J1-Demodulator Input 1
- J2-Demodulator Input 2
- J3-Modulator output
- J4-Miscellaneous I/O connections

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2.6 J4 Pin-outs

Connector J4 provides miscellaneous signal inputs and outputs. The pin-out is shown in Table 2.6.1, "J4 Pinouts," on page 18. Where pairs of signal names have trailing + and – signs, these represent the pair connections of an RS-422 signal. When TTL signals are used, the input is brought to the (+) signal and the corresponding (-) signal pin is left open.

Table 2.6.1: J4 Pinouts

Description	Pin	Signal
Demodulator In Lock	1	LOCK*
Signal Within Demodulator's Range	2	SIGNAL*
I Data Output	3	I OUT
Modulator Q Data Input	4 5 6	Q DATA– Q DATA+ Ground
Modulator 0˚ Input Clock	7 8 9	INCLK– INCLK+ Ground
Q Data Output (I Output in BPSK)	10 11	Q OUT Ground
Indicates the deviation of the loop	12	Loop Tuning**
Modulator I Data Input	13 14 15	I DATA– I DATA+ Ground

*Indicates a TTL status signal that is active when low.
**This output can be used to drive an external loop stress meter. The output is a current in the range +50mA.

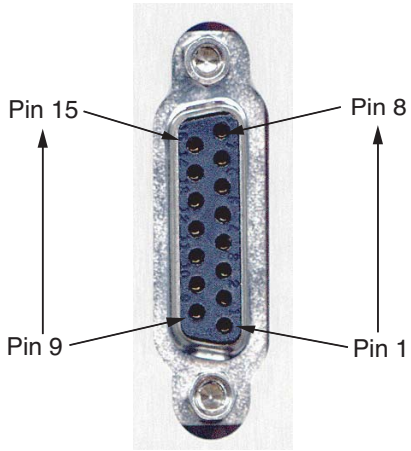


Figure 2.6.1: J4 Pinouts

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

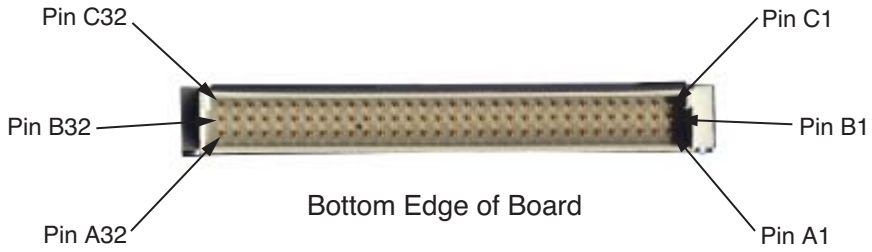


Figure 2.6.2: P1 Pinout Interface to VMEbus

Table 2.6.2: P1 Pinouts

Pin #	A	B	C
1	D00	BBSY*	D08
2	D01	BCLR*	D09
3	D02	ACFAIL*	D10
4	D03	BG0IN*	D11
5	D04	BG0OUT*	D12
6	D05	BG1IN*	D13
7	D06	BG1OUT*	D14
8	D07	BG2IN*	D15
9	GND	BG2OUT*	GND
10	SYSCLK	BG3IN*	SYSFAIL*
11	GND	BG3OUT*	BERR*
12	DS1*	BR0*	SYSRESET*
13	DS0*	BR1*	LWORD*
14	WRITE*	BR2*	AM5
15	GND	BR3*	A23
16	DTACK*	AM0	A22
17	GND	AM1	A21
18	AS*	AM2	A20
19	GND	AM3	A19
20	IACK*	GND	A18
21	IACKIN*	SERCLK	A17
22	IACKOUT*	SERDAT	A16
23	AM4	GND	A15
24	A07	IRQ7*	A14
25	A06	IRQ6*	A13
26	A05	IRQ5*	A12
27	A04	IRQ4*	A11
28	A03	IRQ3*	A10
29	A02	IRQ2*	A09
30	A01	IRQ1*	A08
31	-12VDC	+5VSTDBY	+12VDC
32	+5VDC	+5VDC	+5VDC

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2.7 Mating Component Information

2.7.1 Cable Information

Cable connections are custom-designed for each application. You may purchase connectors to produce your own cables, or order them from a supplier.

2.7.2 Cable Connector

Figure 2.7.1 shows the 4430-V/VN 15-pin cable connector.

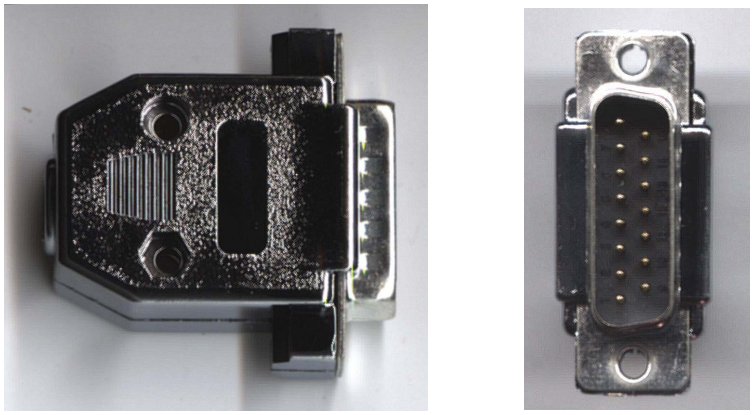


Figure 2.7.1: 4430-V/VN 15-Pin Cable Connector

2.7.3 Source for Mating Cables and Connectors

There are a number of manufacturers for the 4430-V/VN connectors. For your convenience, we are providing the name of one vendor. This listing is provided strictly for your convenience.

Table 2.7.1: 4430-VE Connectors

Part	Description	Vendor	Number	URL
J1, J2 & J3 Jack	BNC Amp Female Jack	AMP	227726-3	www.amp.com
J1, J2 & J3 Mating Connector	BNC Amp Mating Connector	AMP	2-329083-1	www.amp.com
J4 Board Jack	DA 15S 15-pin Female Jack	AMP	747837-4	www.amp.com
J4 Mating Connector	DA 15A 15-pin Male Connector	AMP	205206-2	www.amp.com
J4 Mating Connector Contacts	15 contacts required for 205206-2	AMP	66570-3	www.amp.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3: Programming Information

3.1 Host Interface

The host programming interface of the 4430-V/VN maps to 128 bytes of VME address space. An array of 35 8-bit registers are located at the bottom of the address space. Writing to or reading from addresses that are not listed in the register map in Table 3.2.1, “Register Map-4430-V/VN Demodulator & Optional Modulator,” on page 22 may result in erratic or unexpected operations of the board.

Only the least-significant-bits (LSBs) of the VMEbus address are utilized, therefore all of the physical bus addresses for the registers are odd. Title references within this chapter refer to register addresses and list the associated physical bus address in parenthesis for reference.

The following formula describes the association between the physical bus addresses and register addresses. To convert from a given register address to a physical bus address, the board’s base address must be determined as described in Section 2.3.2 Addressing the Board on page 15. The base address is then evaluated given the following formula to find the associated physical bus address:

Physical Bus Address = Base Address + (2 x Register Address) + 1

As an example, if the base address of the board is set to 800000h, register 0Ah would be mapped as follows:

Physical Base Address = 800000h + (2 x 0Ah) + 1
Physical Base Address = 800015h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.2 Register Map

Table 3.2.1 shows a numerical listing of interface registers for the 4430-V/VN demodulator and optional modulator.

Table 3.2.1: Register Map-4430-V/VN Demodulator & Optional Modulator

Physical Bus Address Offset	Register Address Offset	Functional Description	Data Access	R/W	Ref. Section
01h	00h	Demodulator Carrier Frequency NCO - Register 1 (Bits 7-0)	D08	WO	3.5.5
03h	01h	Demodulator Carrier Frequency NCO - Register 2 (Bits 15-8)	D08	WO	3.5.5
05h	02h	Demodulator Carrier Frequency NCO - Register 3 (Bits 23-16)	D08	WO	3.5.5
07h	03h	Demodulator Carrier Frequency NCO - Register 4 (Bits 31-24)	D08	WO	3.5.5
11h	08h	Demodulator Carrier Frequency NCO - Synchronous Mode Control	D08	WO	3.5.1
15h	0Ah	Demodulator Carrier Frequency NCO - Asynchronous Mode Control	D08	WO	3.5.3
19h	0Ch	Demodulator Carrier Frequency NCO - Phase Accumulator Reset	D08	WO	3.5.7
21h	10h	Demodulator Quadrature NCO - Register 1 (Bits 7-0)	D08	WO	3.5.6
23h	11h	Demodulator Quadrature NCO - Register 2 (Bits 15-8)	D08	WO	3.5.6
25h	12h	Demodulator Quadrature NCO - Register 3 (Bits 23-16)	D08	WO	3.5.6
27h	13h	Demodulator Quadrature NCO - Register 4 (Bits 31-24)	D08	WO	3.5.6
31h	18h	Demodulator Quadrature NCO - Synchronous Mode Control	D08	WO	3.5.2
35h	1Ah	Demodulator Quadrature NCO - Asynchronous Mode Control	D08	WO	3.5.4
39h	1Ch	Demodulator Quadrature NCO - Phase Accumulator Reset	D08	WO	3.5.8
41h	20h	Modulator Carrier Frequency NCO - Register 1 (Bits 7-0)	D08	WO	3.5.12
43h	21h	Modulator Carrier Frequency NCO - Register 2 (Bits 15-8)	D08	WO	3.5.12
45h	22h	Modulator Carrier Frequency NCO - Register 3 (Bits 23-16)	D08	WO	3.5.12
47h	23h	Modulator Carrier Frequency NCO - Register 4 (Bits 31-24)	D08	WO	3.5.12
51h	28h	Modulator Carrier Frequency NCO - Synchronous Mode Control	D08	WO	3.5.10
55h	2Ah	Modulator Carrier Frequency NCO - Asynchronous Mode Control	D08	WO	3.5.11
59h	2Ch	Modulator Carrier Frequency NCO - Phase Accumulator Reset	D08	WO	3.5.13
61h	30h	Data Filter Tuning Register	D08	WO	3.5.14
63h	31h	Input Low Pass Filter Tuning Register	D08	WO	3.5.15
65h	32h	Demodulator General Status Register	D08	RO	3.5.26
67h	33h	Loop Filter Bandwidth Resistor Register	D08	W	3.5.18
67h	33h	Demodulator Loop Stress Status Register	D08	R	3.5.25
69h	34h	Loop Filter Damping Resistor Register	D08	WO	3.5.19
6Bh	35h	Loop Filter Gain Register	D08	WO	3.5.20
71h	38h	Loop Capacitor / Input Select Register	D08	WO	3.5.17
73h	39h	Input High Pass Filter Tuning Register	D08	WO	3.5.21
75h	3Ah	Modulator Low Pass Filter Tuning Register	D08	WO	3.5.22
77h	3Bh	Modulator Control/Demodulator High Pass Filter Register	D08	WO	3.5.23
79h	3Ch	Data Filter Capacitor Select/Input Low Pass Filter Select/QPSK Select	D08	WO	3.5.16
7Bh	3Dh	NCO Strobe Register	D08	WO	3.5.9
7Dh	3Eh	Demodulator Offset Nulling Loop Tuning	D08	WO	3.5.24

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.3 Programming Interview

Before installing this board, please perform this "Programming Interview." The "User Setup" in Section 3.3.1 provides an opportunity to enter critical setup parameters. Section 3.3.2 enables you to evaluate your setup criteria to ensure that it falls within the operational capabilities of the 4430-VE. If not, you should contact your SBS Technologies representative to determine which module will best serve your needs.

3.3.1 User Setup

Prior to programming the 4430-V/VN registers, certain setup parameters must be provided by the user. The following section outlines the setup parameters and associated boundaries that must be provided based on user requirements.

1. What is the anticipated demodulator input carrier frequency?

   (Range: 6 KHz - 6 MHz) — *Demod* f_c =

2. What is the input PCM code provided to the demodulator?

   (Options: NRZ or BIΦ) — *Demod PCM* =

3. What is the anticipated input data rate provided to the demodulator?

   (Range: 250bps - 1.5Mbps) — *Demod DR* =

4. Which input source and type will the demodulator be using?

   (Options: Ch. 1 or Ch. 2) — *Demod Source* =
   (Options: QPSK or BPSK) — *Demod Input* =

5. What is the minimum anticipated signal-to-noise ratio (Eb/No) of the signal being provided to the demodulator? (This should be a result of link margin analysis performed by the user.)

   (Range: values greater than -4dB) — E_b/N_o =

6. What demodulator carrier signal tracking range is desired to obtain and stay locked, given the effects of drift and doppler shift?

   (Range for 4430-V: 27Hz to 390kHz)
   (Range for 4430-VN: 0.75Hz to 9kHz) — *Tracking Range* =

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7. If the demodulator contains the optional modulator daughter board (refer to Chapter 2 for configuration details), is the modulator being utilized?

(Options: Yes or No) | *Modulator Select* =

Note: If the response to question 7 is "No," skip interview questions 8 through 12.

8. What modulation format is desired?

(Options: BPSK or QPSK) | *Mod Format* =

9. If the modulation format desired is QPSK, are the I and Q signals being modulated via separate or combined inputs?

(Options: Separate or Combined) | *Mod QPSK Input* =

10. What is the desired modulator output carrier frequency?

(Range: 6 KHz - 6 MHz) | *Mod* f_c =

11. What is the intended PCM code of the modulator?

(Options: NRZ or BIΦ) | *Mod PCM* =

12. What is the desired data rate for the modulator?

(Range: 250bps - 1.5Mbps) | *Mod DR* =

3.3.2 Setup Analysis

Prior to advancing to programming the registers, an evaluation of the setup criteria needs to be performed. This analysis will help to ensure that the setup being requested falls within the operational capabilities of the 4430-V/VN.

If the analysis results are outside of the specified ranges, setup parameters need to be altered to ensure proper operation of the board.

3.3.3 Evaluation of the Carrier Frequency Versus Data Rate

When setting up the demodulator or modulator sections of the 4430-V/VN, the data rate needs to be less than that of the carrier frequency. As a rule of thumb the data rate needs to 25% or less of the carrier frequency.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Therefore, perform the following calculations and determine if the results fall within the stated range:

1. Calculate the demodulator data rate to carrier frequency ratio.

   (Ratio: <0.25) | *Demod Ratio* =

2. Calculate the modulator data rate to carrier frequency ratio.

   (Ratio: <0.25) | *Mod Ratio* =

3.3.4 Calculation of the Symbol Rate

The symbol rate is dependent upon the PCM format selected. Calculate the symbol rate as shown below:

1. Symbol Rate = Demod DR x PCM Factor

   If variable Demod PCM = BIΦ then PCM Factor = 2
   If variable Demod PCM = NRZ then PCM Factor = 1

   Symbol Rate =

3.3.5 Evaluation of the Demodulator E_b/N_o Setup

The E_b/N_o setup parameter directly effects the loop bandwidth selection which in turn effects the ability of the demodulator to obtain lock and remain locked.

To determine the loop bandwidth (LBW) first refer to Table 3.3.1. Select the LPSR based on the E_b/N_o selected in Section 3.3.1. Multiply this value by the Symbol Rate determined in Section 3.3.4.

1. Loop Bandwidth (LBW) = LPSR x Symbol Rate

   (Range 4430-V: 9Hz to 130kHz)
   (Range 4430-VN: 0.25Hz to 3kHz)

   LBW =

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 3.3.1: E_b/N_O versus LPSR Selection Table

E_b/N_0	LPSR	E_b/N_0	LPSR
-4	0.00003	6	0.007
-3	0.00005	7	0.015
-2	0.0008	8	0.02
-1	0.00014	9	0.035
0	0.00024	10	0.06
1	0.0003	11	0.1
2	0.0006	12	0.15
3	0.001	13	0.2
4	0.002	14	0.3
5	0.004	-	-

Calculate the percentage loop bandwidth by dividing the loop bandwidth value by the demodulator carrier frequency as shown below.

1. % Loop Bandwidth (%LBW) = LBW/Demod fc

(Range 4430-V: 0.0005 to 0.03)
(Range 4430-VN: 0.00003 to 0.0005)

%LBW =

If the value is outside the ranges specified, the VCO or VCXO on the board will not be capable of supporting the loop bandwidth selected. Therefore, an evaluation should be made based on the following criteria:

1. If the %LBW is greater than the range supported by the board, the %LBW value should be defaulted at the highest value for the particular board and the LBW should be reassessed via the following formula:

   LBW = %LBW x Demod fc

2. If the %LBW is less than the range supported by the board, the %LBW value should be defaulted at the lowest value for the particular board and the LBW should be reassessed via the following formula:

   LBW = %LBW x Demod fc

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



Note: In both cases described above, the user should be notified that the selected Eb/No is not directly supported. In the case that the %LBW value is outside the given range on the low side, the user should be notified that the demodulator can not support the signal to noise ratio selected. In the case that the %LBW value is on the high side of the range, the user should be alerted that the loop bandwidth has been adjusted for appropriate demodulator operation.

3.3.6 Evaluation of the Demodulator Tracking Range

The tracking range of the demodulator is another factor to consider in the setup. This tracking range takes into account variations for Doppler shift and drift of the carrier. The tracking range will be at least three times the loop bandwidth (LBW).

1. Tracking Range ≥ LBW x 3

(Range 4430-V: 27Hz to 390kHz)
(Range 4430-VN: 0.75Hz to 9kHz)

Tracking Range =

3.3.7 Calculation of the Demodulator NCO Frequency

To calculate the demodulator NCO frequency, the demodulator carrier frequency must be multiplied by a constant K. The following equation applies.

1. f_{NCO} = Demod fc x K = Demod fc x 214.74837

f_{NCO} =

3.3.8 Calculation of the Data Filter Cutoff Frequency

To calculate the data filter cutoff frequency, the demodulator data rate must be multiplied by a constant based on the demodulator PCM format selected in Section 3.3.1. The following equation applies.

1. f_D = Demod DR x PCM Factor2

If variable Demod PCM = BIΦ, then PCM Factor2 = 3
If variable Demod PCM = NRZ, then PCM Factor2 = 1.5

f_D =

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.3.9 Calculation of the Input Low Pass Filter Frequency

To calculate the demodulator input low pass filter frequency, the demodulator carrier frequency must be added to the symbol rate multiplied by two. The following equation applies.

1. f_L = Demod fc + (2 x Symbol Rate)

f_L =

3.3.10 Setup Precautions

Certain values and selections within Section 3.3 and Section 3.4 are interrelated. Settings that are likely to provide intermittent or unstable operation of the device should be avoided. Likewise, since there are several analog sections of the board design, some of the ranges provided in the previous sections have bell shaped operational characteristics. This does not point out deficiencies in the design but rather the nature of analog designs and part tolerances.

➢ NCO Setup Sequence

There are two critical aspects of setting up either the dual demodulator NCO or the modulator NCO: the sequence of setup steps, and repeating the setup steps.

The registers must be setup in the sequence shown in Section 3.5. This sets all NCO registers in a programming state.

All NCO registers setup sequences should be executed twice. The NCOs used in the hardware design of the 4430 require that they be written to twice to ensure proper setup. This is a response to an anomaly from the NCO manufacturer.

➢ Data Filter Settings

Another concern is to make certain that the data filters are not set to a frequency that is too close to the loop bandwidth (LBW) setting. In the case that the settings are to close to the LBW, the loop filter will be impacted and the demodulator may not lock up correctly. The data filter cutoff (f_D) should be at least 20 times the LBW setting.

➢ Loop Bandwidth Setting

When selecting the loop bandwidth, selecting a value at the bottom of the LBW range, increases the likelihood of inconsistent demodulator lock. Selection of a reasonable loop bandwidth setting is critical for consistent operation. Unless the

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

input signal is likely to experience a noisy environment, selection of more moderate Eb/No settings will allow for a wider loop bandwidth setting and more consistent operation.

➢ Eliminating loop stress during demodulator setup

Loop stress can have an affect the demodulator's tuning process. If the input to the demodulator is different than the source being applied to the input, it is best to remove stress from the input loop by switching to an unused input and then returning to the original input.

If both inputs are being used, prior to tuning the loop, set the demodulator low pass filter step in register 3Ch to the lowest setting (111b). Set the input low pass filter (register 31h) value to all zeros. This action filters all inputs during loop tuning acquisition.

3.4 Critical Register Programming Sequences

The 4430-V/VN has a few critical register programming sequences. These registers should be programmed in a sequential fashion for proper operation of the board.

To initialize the board, the critical sequence of registers should be programmed as shown in the steps below. Registers that are not included below are not consider sequence critical.

1. Demodulator Carrier Frequency NCO - Synchronous Mode Control
2. Demodulator Carrier Frequency NCO - Asynchronous Mode Control
3. Demodulator Carrier Frequency NCO - Register 1 (Bits 7-0)
   Demodulator Carrier Frequency NCO - Register 2 (Bits 15-8)
   Demodulator Carrier Frequency NCO - Register 3 (Bits 23-16)
   Demodulator Carrier Frequency NCO - Register 4 (Bits 31-24)
4. Demodulator Quadrature NCO - Register 1 (Bits 7-0)
   Demodulator Quadrature NCO - Register 2 (Bits 15-8)
   Demodulator Quadrature NCO - Register 3 (Bits 23-16)
   Demodulator Quadrature NCO - Register 4 (Bits 31-24)
5. Demodulator Carrier Frequency NCO - Phase Accumulator Reset
   Demodulator Quadrature NCO - Phase Accumulator Reset
6. NCO Strobe/Modulator Control Register (Low Clock Strobe)
7. NCO Strobe/Modulator Control Register (High Clock Strobe)
8. Demodulator Carrier Frequency NCO - Phase Accumulator Reset

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Demodulator Quadrature NCO - Phase Accumulator Reset

9. Repeat Step 1 through Step 8.

10. Modulator Carrier Frequency NCO - Synchronous Mode Control

11. Modulator Carrier Frequency NCO - Asynchronous Mode Control

12. Modulator Carrier Frequency NCO - Register 1 (Bits 7-0)
    Modulator Carrier Frequency NCO - Register 2 (Bits 15-8)
    Modulator Carrier Frequency NCO - Register 3 (Bits 23-16)
    Modulator Carrier Frequency NCO - Register 4 (Bits 31-24)

13. Modulator Carrier Frequency NCO - Phase Accumulator Reset

14. NCO Strobe/Modulator Control Register (Low Clock Strobe)

15. NCO Strobe/Modulator Control Register (High Clock Strobe)

16. Modulator Carrier Frequency NCO - Phase Accumulator Reset

17. Repeat Step 10 through Step 16.



Note: If the optional modulator is not present or is not being utilized, Steps 10 through 17 above are not required. The inadvertent or incorrect programming of the modulator registers will not affect the operation of the demodulator.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5 Register Programming

The following subsections contain information on programming the 4430-V/VN registers. Example calculations are included at the bottom of each register definition page.

The example calculations within this report are based on the following 4430 example setup:

- Board Type = 4430-VN
- Demod fc = 8000 Hz
- Demod PCM = NRZ
- Demod DR = 1000 bps
- Demod Source = Ch. 1
- Demod Input = BPSK
- Eb/No = 8dB
- Tracking Range = 8Hz
- Modulator Select = YES
- Mod Format = QPSK
- Mod QPSK Input = Separate
- Mod fc = 8000 Hz
- Mod PCM = NRZ
- Mod DR = 1000

This setup assumes a demodulator with optional modulator setup.



Note: All of the register definition pages that follow refer to the register offset address with the physical offset address in parenthesis.

3.5.1 Register 08h (11h), Demod Carrier Freq NCO - Synchronous Mode Control

This register provides synchronous mode control of the demodulator Carrier Frequency NCO. Figure 3.5.1 illustrates the breakout of register bit assignments.

Prior to programming the NCO, the synchronous mode must be enabled.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

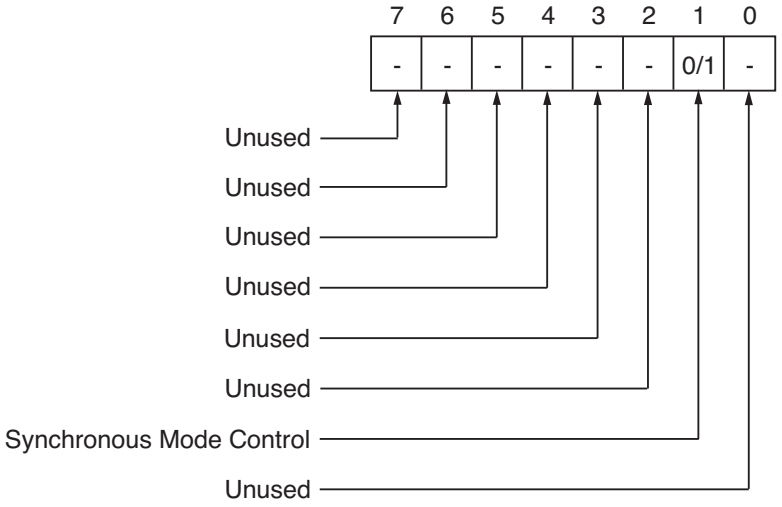


Figure 3.5.1: Register 08h Bit Assignments

Table 3.5.1: Carrier Frequency NCO Synchronous Mode Control Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06	Unused	Set to zero for proper operation
05	Unused	Set to zero for proper operation
04	Unused	Set to zero for proper operation
03	Unused	Set to zero for proper operation
02	Unused	Set to zero for proper operation
01	Sync Mode Control	0 - Synchronous Mode Control Disabled 1 - Synchronous Mode Enabled
00	Unused	Set to zero for proper operation

Programming Example

1. For the programming example given, a 02h would be programmed in this register.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.2 Register 18h (31h), Quadrature NCO - Synchronous Mode Control

This register provides synchronous mode control of the demodulator Quadrature NCO. Figure 3.5.2 illustrates the breakout of register bit assignments.

Prior to programming the NCO, the synchronous mode must be enabled.

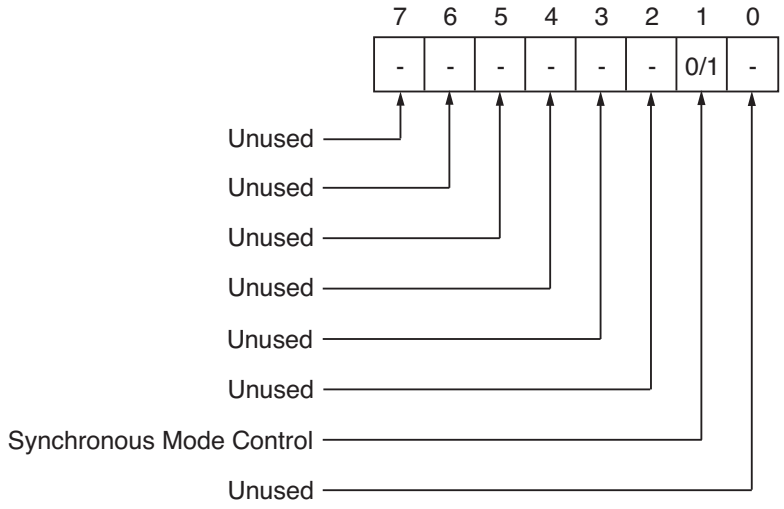


Figure 3.5.2: Register 18h Bit Assignments

Table 3.5.2: Quadrature NCO Synchronous Mode Control Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06	Unused	Set to zero for proper operation
05	Unused	Set to zero for proper operation
04	Unused	Set to zero for proper operation
03	Unused	Set to zero for proper operation
02	Unused	Set to zero for proper operation
01	Sync Mode Control	0- Synchronous Mode Control Disabled 1- Synchronous Mode Enabled
00	Unused	Set to zero for proper operation

Programming Example

1. For the programming example given, a 02h would be programmed in this register.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.3 Register 0Ah (15h), Demod Carrier Freq NCO - Asynchronous Mode Control

This register provides asynchronous mode control of the demodulator Carrier Frequency NCO. Figure 3.5.3 illustrates the breakout of register bit assignments.

Prior to programming the NCO, the asynchronous mode must be enabled.

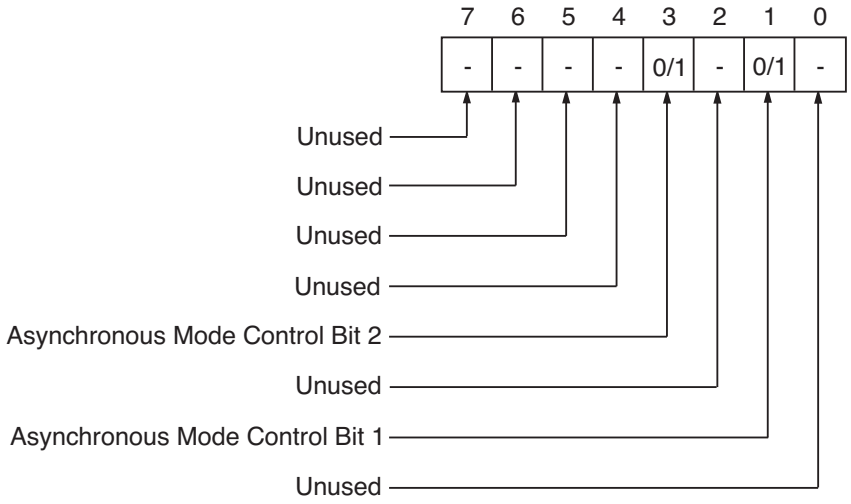


Figure 3.5.3: Register 0Ah Bit Assignments

Table 3.5.3: Carrier Frequency NCO Asynchronous Mode Control Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06	Unused	Set to zero for proper operation
05	Unused	Set to zero for proper operation
04	Unused	Set to zero for proper operation
03	Async Mode Bit 2	0- Async mode disabled 1- Async mode enabled
02	Unused	Set to zero for proper operation
01	Async Mode Bit 1	0- Async mode disabled 1- Async mode enabled
00	Unused	Set to zero for proper operation

Programming Example

1. For the programming example given, a 0Ah would be programmed in this register.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.4 Register 1Ah (35h), Demod Quadrature NCO - Asynchronous Mode Control

This register provides asynchronous mode control of the demodulator quadrature NCO. Figure 3.5.4 illustrates the breakout of register bit assignments.

Prior to programming the NCO, the asynchronous mode must be enabled.

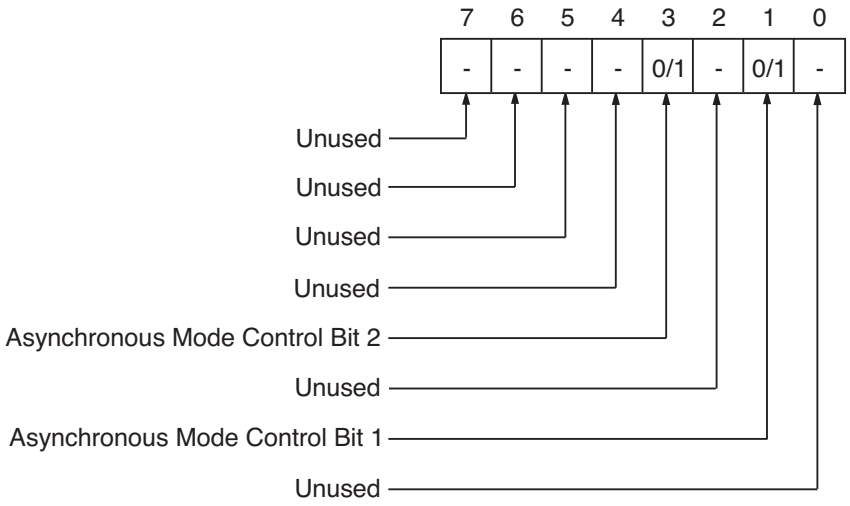


Figure 3.5.4: Register 1Ah Bit Assignments

Table 3.5.4: Quadrature NCO Asynchronous Mode Control Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06	Unused	Set to zero for proper operation
05	Unused	Set to zero for proper operation
04	Unused	Set to zero for proper operation
03	Async Mode Bit 2	0- Async mode disabled 1- Async mode enabled
02	Unused	Set to zero for proper operation
01	Async Mode Bit 1	0- Async mode disabled 1- Async mode enabled
00	Unused	Set to zero for proper operation

Programming Example

1. For the programming example given, a 0Ah would be programmed in this register.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.5 Register 00h, 01h, 02h, 03h (01h, 03h, 05h, 07h), Demod Carrier Freq NCO

This group of registers provides the programming interface to the demodulator carrier frequency NCO. The registers are to be programmed in a group as a single 32-bit integer value. The value programmed into the registers are based on the following equation:

Register Value = Demod f_c x 214.74837

Results are rounded to the nearest integer and then cleaved into four separate bytes as shown in Figure 3.5.5.

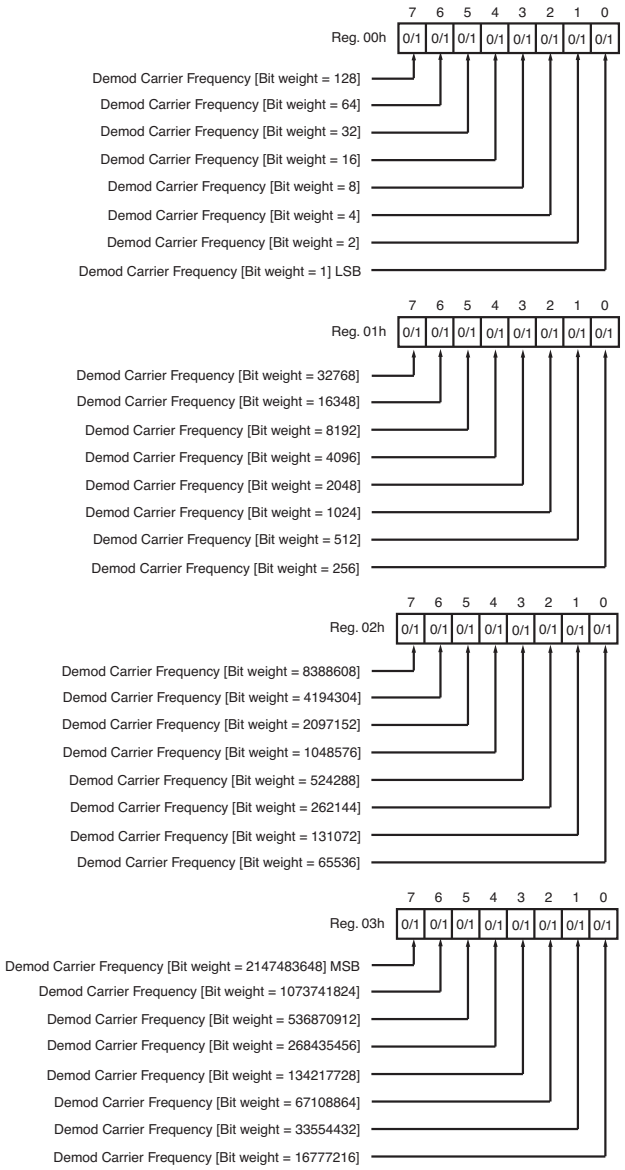


Figure 3.5.5: Bit Assignments, Demodulator Carrier Frequency NCO Registers

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 3.5.5: Demodulator Carrier Frequency NCO Group Register Definition

Bit No.	Bit Name(s)	Functional Description
31-24	Demod Carrier Frequency	Most significant carrier frequency word (See Figure 3.5.5 for register assignments)
25-16	Demod Carrier Frequency	Carrier frequency word 3 (See Figure 3.5.5 for register assignments)
15-8	Demod Carrier Frequency	Carrier frequency word 2 (See Figure 3.5.5 for register assignments)
7-0	Demod Carrier Frequency	Least significant carrier frequency word (See Figure 3.5.5 for register assignments)

Programming Example

1. For the programming example given, the following equation must be evaluated:

   Register Value = Demod f_C x 214.74837
   Register Value = 8000 x 214.74837 = 1717986.96

2. Rounding results as shown below:

   Register Value = 1717987

3. By successively dividing the above value by the bit weight values shown in Figure 3.5.5, the appropriate hexadecimal equivalent can be obtained:

   Register Value = 001A36E3h

4. Cleave the results into the four respective registers and write as shown:

   Register 03h= 00h
   Register 02h= 1Ah
   Register 01h= 36h
   Register 00h= E3h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.6 Register 10h, 11h, 12h, 13h (21h, 23h, 25h, 27h), Demod Quadrature NCO

This group of registers provides the programming interface to the demodulator quadrature NCO. The registers are to be programmed in a group as a single 32-bit integer value and should be programmed with the same values as the demodulator carrier frequency NCO registers.

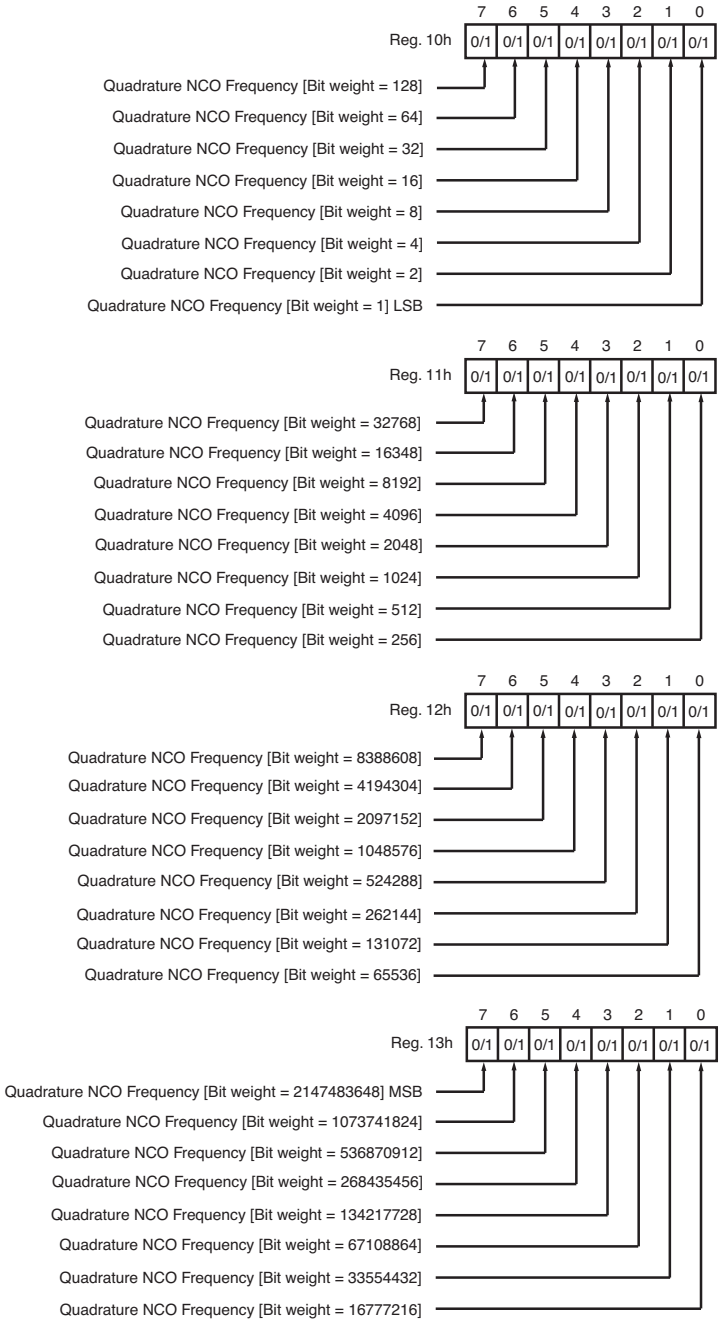


Figure 3.5.6: Bit Assignments for the Demodulator Quadrature NCO Registers

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The value programmed into the registers are based on the following equation:

Register Value = Demod f_c x 214.74837

Results are rounded to the nearest integer and then cleaved into four separate bytes as shown in Figure 3.5.6.

Table 3.5.6: Demodulator Quadrature NCO Group Register Definition

Bit No.	Bit Name(s)	Functional Description
31-24	Quadrature NCO Frequency	Most significant quadrature NCO frequency word (See Figure 3.5.6 for register assignments)
25-16	Quadrature NCO Frequency	Quadrature NCO frequency word 3 (See Figure 3.5.6 for register assignments)
15-8	Quadrature NCO `Frequency`	Quadrature NCO frequency word 2 (See Figure 3.5.6 for register assignments)
7-0	Quadrature NCO Frequency	Least significant quadrature NCO frequency word (See Figure 3.5.6 for register assignments)

Programming Example

1. For the programming example given, the following equation must be evaluated:

   Register Value = Demod f_c x 214.74837
   Register Value = 8000 x 214.74837 = 1717986.96

2. Rounding results as shown below:

   Register Value = 1717987

3. By successively dividing the above value by the bit weight values shown in figure above, the appropriate hexadecimal equivalent can be obtained:

   Register Value = 001A36E3h

4. Cleave the results into the four respective registers and write as shown:

   Register 13h = 00h
   Register 12h = 1Ah
   Register 11h = 36h
   Register 10h = E3h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.7 Register 0Ch (19h), Demod Carrier Freq NCO - Phase Accumulator Reset

This register resets the phase accumulator for the demodulator carrier frequency NCO. Figure 3.5.7 illustrates the breakout of register bit assignments.

This register should be written in accordance with the sequence outlined in Section 3.5.

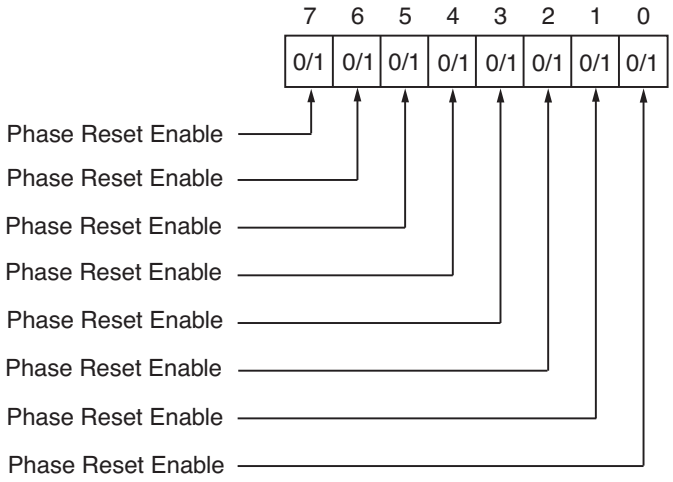


Figure 3.5.7: Register 0Ch Bit Assignments

Table 3.5.7: Carrier Frequency NCO Phase Accumulator Reset Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Phase Reset	Set all bits to zero for reset.

Programming Example

1. For the programming example given, a 00h would be programmed in this register.

   This register must be rewritten after the NCO strobe process is complete. (See Section 3.5.9).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.8 Register 1Ch (39h), Demod Quadrature NCO - Phase Accumulator Reset

This register resets the phase accumulator for the demodulator quadrature NCO. Figure 3.5.8 illustrates the breakout of register bit assignments.

This register should be written in accordance with the sequence outlined in Section 3.5.

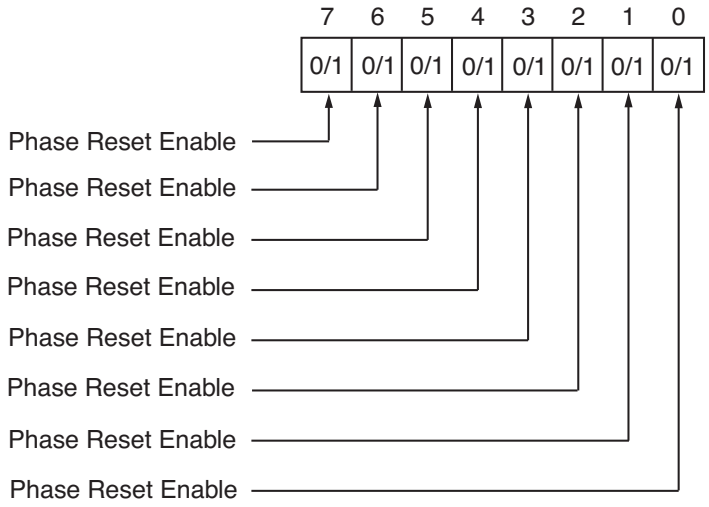


Figure 3.5.8: Register 1Ch Bit Assignments

Table 3.5.8: Quadrature NCO Phase Accumulator Reset Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Phase Reset	Set all bits to zero for reset.

Programming Example

1. For the programming example given, a 00h would be programmed in this register.

   This register must be rewritten after the NCO strobe process is complete. (See Section 3.5.9).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.9 Register 3Dh (7Bh), NCO Strobe

This register is used to load or "strobe" the demodulator and modulator NCO register settings. Figure 3.5.9 illustrates the breakout of register bit assignments.

Once the NCO registers have been written and the phase accumulators have been reset, the appropriate NCO strobes must be set to one then subsequently written as zeros to complete the NCO load. The load is rising edge triggered.

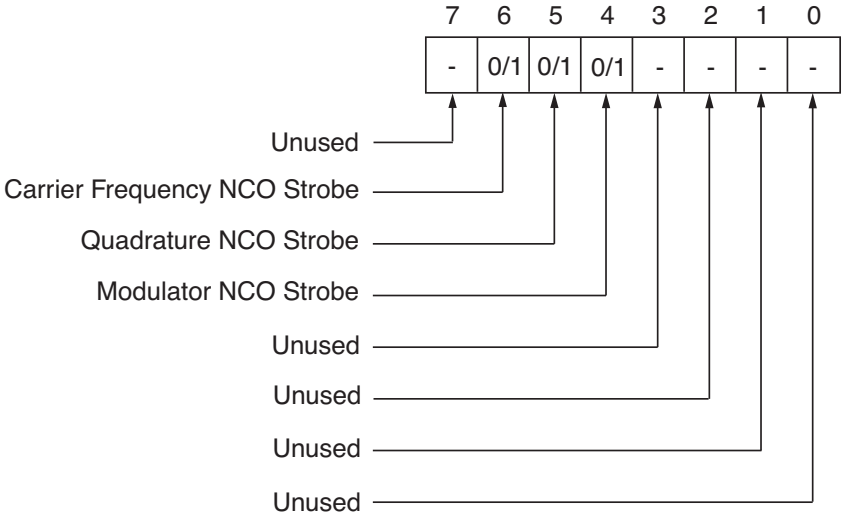


Figure 3.5.9: Register 3Dh Bit Assignments

Table 3.5.9: NCO Strobe Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06	Demod NCO	0 - Strobe low 1 - Strobe high
05	Quad NCO	0- Strobe low 1- Strobe high
04	Mod NCO	0- Strobe low 1- Strobe high
00-03	Not used.	

Programming Example

For the programming example given, the following sequence would be programmed in this register:

1. Strobing the NCO clock low: Register 3Dh= 00010000b =10h
2. Strobing the NCO clock high: Register 3Dh= 01110000b =70h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

For strobing the modulator NCO settings, there is a similar two step process:

1. Strobing the NCO clock low: Register 3Dh= 01100000b =60h
2. Strobing the NCO clock high: Register 3Dh= 01110000b =70h

This register should only be strobed in accordance with the sequence outlined in Section 3.5.

3.5.10 Register 28h (51h), Modulator Carrier Freq NCO - Synchronous Mode Control

This register provides synchronous mode control of the modulator Carrier Frequency NCO. The Figure 3.5.10 illustrates the breakout of register bit assignments.

Prior to programming the NCO, the synchronous mode must be enabled.

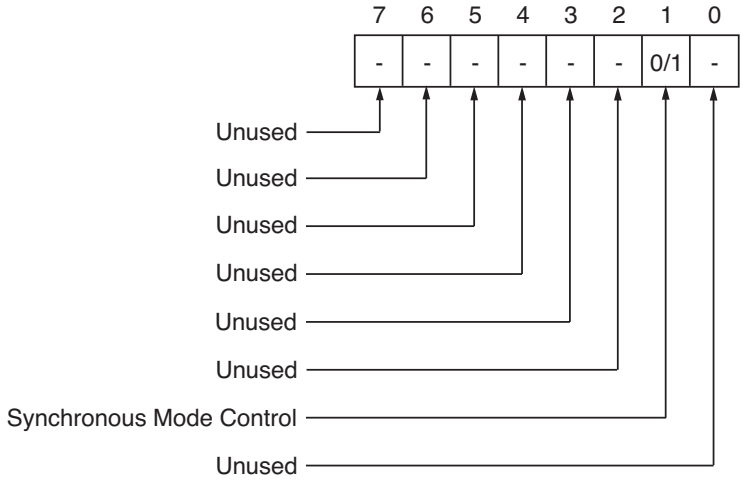


Figure 3.5.10: Register 28h Bit Assignments

Table 3.5.10: Modulator NCO Synchronous Mode Control Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06	Unused	Set to zero for proper operation
05	Unused	Set to zero for proper operation
04	Unused	Set to zero for proper operation
03	Unused	Set to zero for proper operation
02	Unused	Set to zero for proper operation
01	Sync Mode Control	0 - Synchronous Mode Control Disabled 1 - Synchronous Mode Enabled
00	Unused	Set to zero for proper operation

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Programming Example

1. For the programming example given, a 02h would be programmed in this register.

3.5.11 Register 2Ah (55h), Mod Carrier Freq NCO - Asynchronous Mode Control

This register provides asynchronous mode control of the modulator Carrier Frequency NCO. Figure 3.5.11 illustrates the breakout of register bit assignments.

Prior to programming the NCO, the asynchronous mode must be enabled.

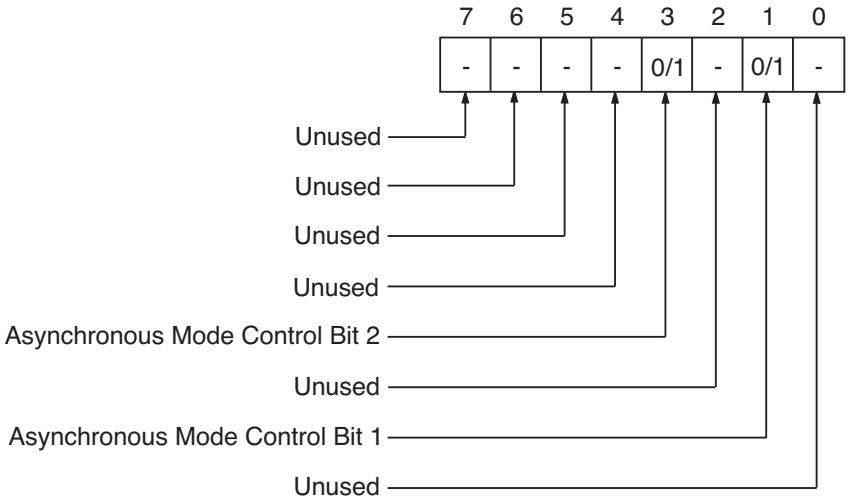


Figure 3.5.11: Register 2Ah Bit Assignments

Table 3.5.11: Modulator NCO Asynchronous Mode Control Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Reserved	Set to zero for proper operation
06	Reserved	Set to zero for proper operation
05	Reserved	Set to zero for proper operation
04	Reserved	Set to zero for proper operation
03	Async Mode Bit 2	0- Async mode disabled 1- Async mode enabled
02	Reserved	Set to zero for proper operation
01	Async Mode Bit 1	0- Async mode disabled 1- Async mode enabled
00	Reserved	Set to zero for proper operation

Programming Example

1. For the programming example given, a 0Ah would be programmed in this register.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.12 Register 20h, 21h, 22h, 23h (41h, 43h, 45h, 47h), Mod Carrier Freq NCO

This group of registers provides the programming interface to the modulator carrier frequency NCO. The registers are to be programmed in a group as a single 32-bit integer value. The value programmed into the registers are based on the following equation:

Register Value = Mod fc **x** 214.74837

Results are rounded to the nearest integer and then cleaved into four separate bytes as shown in Figure 3.5.12.

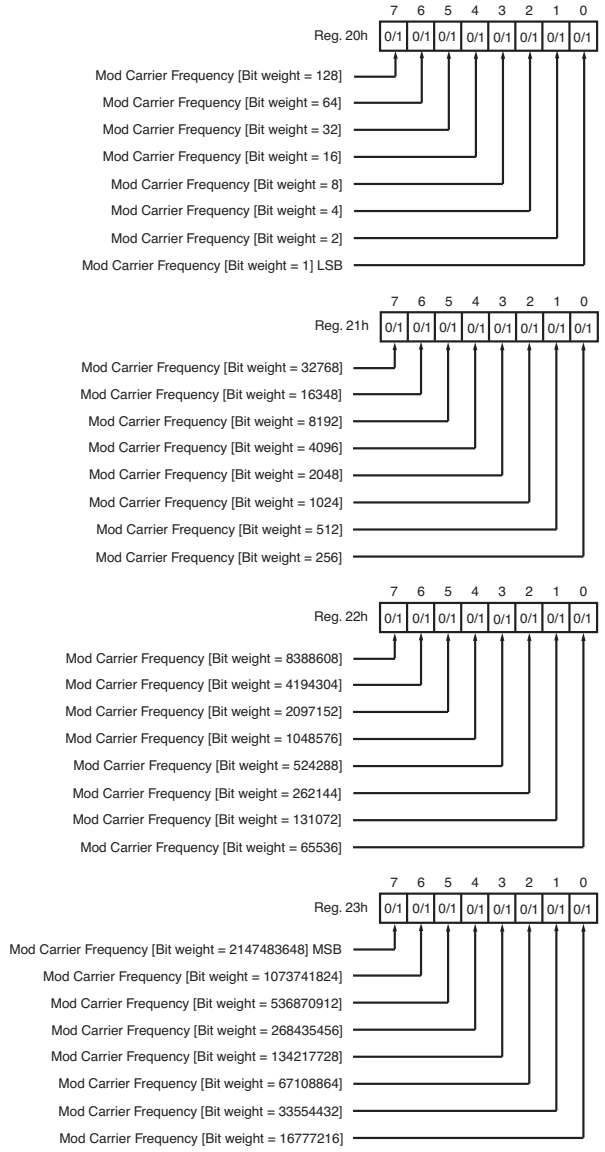


Figure 3.5.12: Bit Assignments for the Modulator Carrier Frequency NCO Registers

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 3.5.12: Modulator Carrier Frequency NCO Group Register Definition

Bit No.	Bit Name(s)	Functional Description
31-24	Mod Carrier Frequency	Most significant carrier frequency word (See Figure 3.5.12 for register assignments)
25-16	Mod Carrier Frequency	Carrier frequency word 3 (See Figure 3.5.12 for register assignments)
15-8	Mod Carrier Frequency	Carrier frequency word 2 (See Figure 3.5.12 for register assignments)
7-0	Mod Carrier Frequency	Least significant carrier frequency word (See Figure 3.5.12 for register assignments)

Programming Example

1. For the programming example given, the following equation must be evaluated:

   Register Value = Mod fc x 214.74837
   Register Value = 8000 x 214.74837 = 1717986.96

2. Rounding results as shown below:

   Register Value = 1717987

3. By successively dividing the above value by the bit weight values shown in figure above, the appropriate hexadecimal equivalent can be obtained:

   Register Value = 001A36E3h

4. Cleave the results into the four respective registers and write as shown:

   Register 23h= 00h
   Register 22h= 1Ah
   Register 21h= 36h
   Register 20h= E3h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.13 Register 2Ch (59h), Mod Carrier Freq NCO - Phase Accumulator Reset

This register resets the phase accumulator for the modulator carrier frequency NCO. Figure 3.5.13 illustrates the breakout of register bit assignments.

This register should be written in accordance with the sequence outlined in Section 3.5.

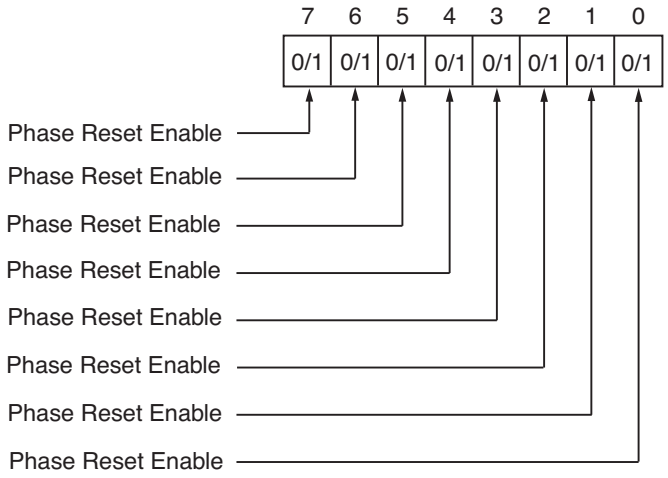


Figure 3.5.13: Register 2Ch Bit Assignments

Table 3.5.13: Mod Carrier Frequency NCO Phase Accumulator Reset Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Phase Reset	Set all bits to zero for reset.

Programming Example

1. For the programming example given, a 00h would be programmed in this register.

   This register must be rewritten after the NCO strobe process is complete. (See register 3Dh).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.14 Register 30h (61h), Data Filter Tuning

This register tunes the frequency of the two demodulator low pass filters.

This register tunes the frequency of the two demodulator low pass filters. Normally, the data filter cutoff frequency is set to 1.5 x Bit Rate for NRZ codes and 3 x Bit Rate for BIΦ codes plus any frequency offset. The data filter bandwidth should be at least 20 times the loop bandwidth or else the loop dynamics will be affected. The data filter bandwidth must be less than 25% of the carrier frequency. This sets the minimum Bit Rate to carrier ratio of 1/4.

The value of the filter cutoff frequency (f_D) must be determined according to the equation in Section 3.3.8 Calculation of the Data Filter Cutoff Frequency on page 27. An example is shown below.

There are four different ranges that can be selected for the data filters. Using the cutoff frequency calculated, match the table entry below and select the appropriate coefficients for K_0, K_1, and K_2.

Table 3.5.14: Data Filter Tuning Ranges

Range of f_D	Step	K_0	K_1	K_2
225KHz ≤ f_D <= 8MHz	000b	4.28×10^{-19}	-9.45×10^{-12}	8.1×10^{-5}
20KHZ ≤ f_D < 225KHz	001b	0	1.25×10^{-10}	9.66×10^{-4}
2KHz ≤ f_D < 20KHz	011b	0	2.26×10^{-8}	9.3×10^{-3}
150Hz ≤ f_D < 2KHz	111b	0	6.53×10^{-7}	9×10^{-2}

Given the value of the cutoff frequency f_D along with the coefficients values from the table above, evaluate the following equation:

$$\text{Data Filter Value} = (K_0 \times f_D^3) + (K_1 \times f_D^2) + (K_2 \times f_D)$$

Round to the result to the nearest integer. Since the register is only 8 bits, limit the value to the range [0 - 255]. Convert this value to a hexadecimal value and write the value to Register 30h.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

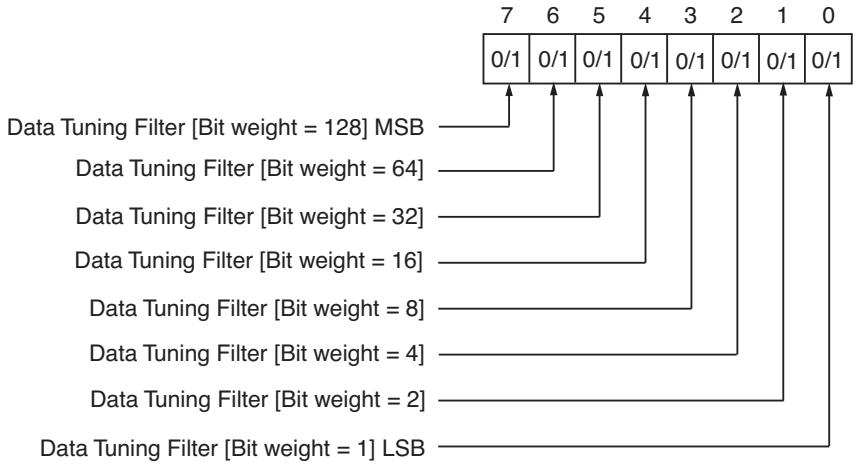


Figure 3.5.14: Register 30h Bit Assignments

Table 3.5.15: Data Filter Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Data Filter	(Set bits according to the formula results. See above.)

Programming Example

For the programming example given, the following steps apply:

1. Calculating f_D:

   f_D = Demod DR x PCM Factor2
   f_D = 1000 x 1.5 = 1500 Hz

2. Using the value for f_D, select the K_0, K_1, and K_2 from the table:

   $K_0 = 0$; $K_1 = 6.53 \times 10^{-7}$; $K_2 = 9 \times 10^{-2}$

3. Using the value for the coefficients, evaluate the formula:

   Data Filter Value = $(K_0 \times f_D^3) + (K_1 \times f_D^2) + (K_2 \times f_D)$
   Data Filter Value = 0 + 1.469 + 135
   Data Filter Value = 136.47

4. Round the value:

   Data Filter Value = 136

5. Convert the value to a hexadecimal number and write the value to register 30h:

   Data Filter Value = 136 = 88h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.15 Register 31h (63h), Input Low Pass Filter

This register is used in conjunction with the input high pass filter to form a tunable bandpass filter.

The value of the low pass filter frequency (f_L) must be determined according to the equation in Section 3.3.9 Calculation of the Input Low Pass Filter Frequency on page 28. An example is shown below.

There are four different ranges that can be selected for the low pass filters. Using the low pass filter frequency calculated, match the table entry below and select the appropriate coefficients for K_0, K_1, and K_2.

Table 3.5.16: Low Pass Filter Tuning Ranges

Range of f_L	Step	K_0	K_1	K_2
225KHz ≤ f_L ≤ 8MHz	000b	4.28×10^{-19}	-9.45×10^{-12}	8.1×10^{-5}
20KHZ ≤ f_L < 225KHz	001b	0	1.25×10^{-10}	9.66×10^{-4}
2KHz ≤ f_L < 20KHz	011b	0	2.26×10^{-8}	9.3×10^{-3}
150Hz ≤ f_L < 2KHz	111b	0	6.53×10^{-7}	9×10^{-2}

Given the value of the low pass filter frequency f_L along with the coefficients values from the table above, evaluate the following equation:

$$\text{Low Pass Filter Value} = (K_0 \times f_L^3) + (K_1 \times f_L^2) + (K_2 \times f_L)$$

Round to the result to the nearest integer. Since the register is only 8 bits, limit the value to the range [0 - 255]. Convert this value to a hexadecimal value and write the value to Register 31h.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

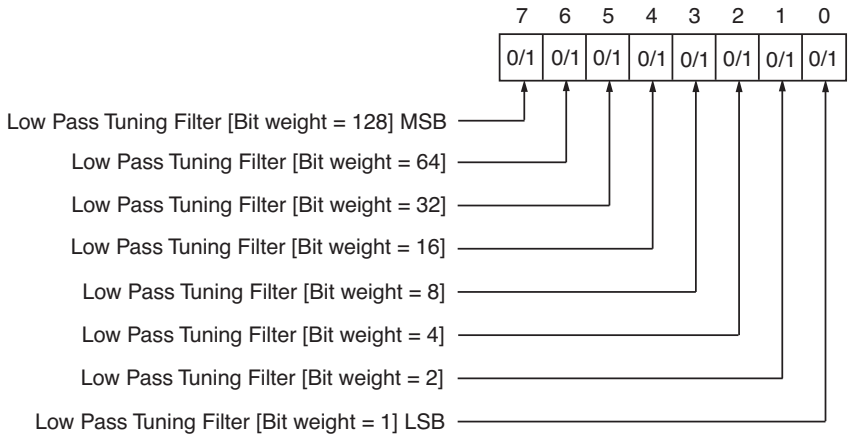


Figure 3.5.15: Register 31h Bit Assignments

Table 3.5.17: Low Pass Filter Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Low Pass Filter	(Set bits according to the formula results. See above.)

Programming Example

For the programming example given, the following steps apply:

1. Calculating f_L:

   f_L = Demod f_c + (2 x Symbol Rate)
   f_L = 8000 + (2 x 1000) = 10000 Hz

2. Using the value for f_L, select the K_0, K_1, and K_2 from the table:

   $K_0 = 0$; $K_1 = 2.26 \times 10^{-8}$; $K_2 = 9.3 \times 10^{-3}$

3. Using the value for the coefficients, evaluate the formula:

   Low Pass Filter Value = $(K_0 \times f_L^3) + (K_1 \times f_L^2) + (K_2 \times f_L)$
   Low Pass Filter Value = 0 + 2.26 + 93
   Low Pass Filter Value = 95.26

4. Round the value:

   Low Pass Filter Value = 95

5. Convert the value to a hexadecimal number and write the value to register 31h:

   Low Pass Filter Value = 95 = 5Fh

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.16 Register 3Ch (79h), Data Filter Cap Select/Input Pass Filter Select/QPSK Select

This register selects the range for the input low pass filter and the data filter. It also is used to select the QPSK input format for the modulator. Figure 3.5.16 illustrates the breakout of register bit assignments.

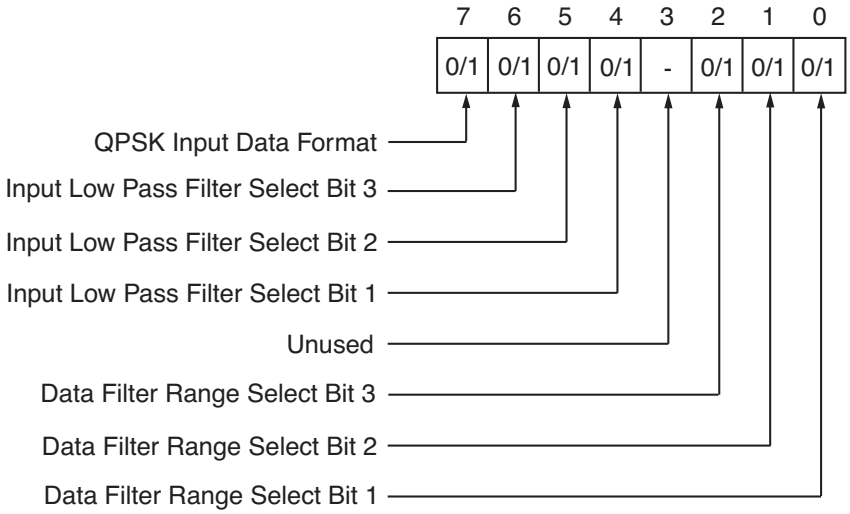


Figure 3.5.16: Register 3Ch Bit Assignments

Table 3.5.18: Data Filter Capacitor Select/Input Pass Filter Select/QPSK Select Register Definition

Bit No.	Bit Name(s)	Functional Description
*07	QPSK Data Input	0 - I and Q signals via parallel inputs to the modulator 1 - I and Q signals via a serial input to the modulator
06-04	Low Pass Filter Select	000 = Range Step 0 001 = Range Step 1 011 = Range Step 3 111 = Range Step 7
03	Unused	Set to zero for proper operation
02-00	Data Filter Select	000 = Range Step 0 001 = Range Step 1 011 = Range Step 3 111 = Range Step 7

* Bit 7 must be set to the parallel mode for the modulator to work correctly when in BPSK mode.

This register is partially programmed based on results of the input low pass filter selection processes previously outlined in Section 3.5.15 Register 31h (63h), Input Low Pass Filter on page 50.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Programming Example

For the programming example given, the step values can be determined by looking back at Section 3.3 Programming Interview on page 23.

1. First, recover the values from the previous sections:

   f_L = 10000
   f_D = 1500

2. From the tables shown below, pick the step value and apply it to the register bits for the low pass step select and data filter select in Section 3.5.14 Register 30h (61h), Data Filter Tuning on page 48 and Section 3.5.15 Register 31h (63h), Input Low Pass Filter on page 50. The step values are determined as follows:

Table 3.5.19: Low Pass Filter Step Ranges

Range of f_L	Step
225KHz ≤ f_L < 8MHz	000b
20KHZ ≤ f_L < 225KHz	001b
2KHz ≤ f_L < 20KHz	011b
150Hz ≤ f_L < 2KHz	111b

Table 3.5.20: Data Filter Step Ranges

Range of f_D	Step
225KHz ≤ f_D < 8MHz	000b
20KHZ ≤ f_D < 225KHz	001b
2KHz ≤ f_D < 20KHz	011b
150Hz ≤ f_D < 2KHz	111b

   f_L Step = 011b
   f_D Step = 111b

3. Based on the modulator format given in the example, select the QPSK data input format:

   Mod Format = QPSK
   Mod QPSK Input = Separate
   Therefore, the QPSK Data Input bit is set to “0”

4. Combining all inputs, the following should be written to register 3Ch:

   Register 3Ch = 00110111b = 37h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.17 Register 38h (71h), Loop Capacitor/Input Select

This register selects the demodulator input mode and source as well as the capacitor used in the loop filter. Figure 3.5.17 illustrates the breakout of register bit assignments.

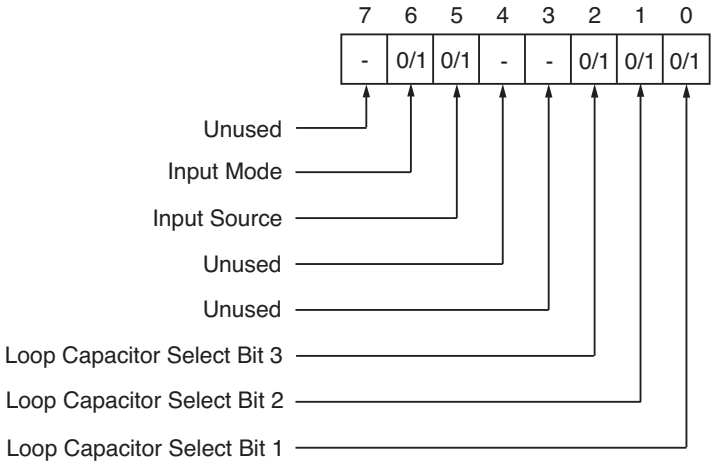


Figure 3.5.17: Register 38h Bit Assignments

Table 3.5.21: Loop Capacitor Input Source/Mode Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06	Input Mode	0 - QPSK Mode 1 - BPSK Mode
05	Input Source	0 - Input 1 1 - Input 2
04	Unused	Set to zero for proper operation
03	Unused	Set to zero for proper operation
02-00	Loop Capacitor Select	(See table and calculations to follow)

To program this register, follow the procedure below.

1. First, to select the appropriate loop capacitor value, the value for Eb/No must be known. This was determined in Section 3.3 on page 23.

2. This value is then used to select a LPSR value from Table 3.5.22, "Eb/N0 vs. Maximum LPSR," on page 55.

3. The LPSR value is then used in calculating the loop bandwidth value from the formula in Section 3.3.2 Setup Analysis on page 24.

   Loop Bandwidth (LBW) = LPSR x Symbol Rate

4. The square root of the demodulator carrier frequency (Demod f_c) is then

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

determined.

Table 3.5.22: E_b/N_0 vs. Maximum LPSR

E_b/N_0	LPSR	E_b/N_0	LPSR
-4	0.00003	6	0.007
-3	0.00005	7	0.015
-2	0.0008	8	0.02
-1	0.00014	9	0.035
0	0.00024	10	0.06
1	0.0003	11	0.1
2	0.0006	12	0.15
3	0.001	13	0.2
4	0.002	14	0.3
5	0.004	-	-

5. The loop bandwidth value is then divided by the square root of the demodulator frequency.

6. The results are compared to the values from Table 3.5.23, "Loop Capacitor Selection," on page 55. The loop bandwidth capacitor select bits are then determined.



Note: The table has different selections for the 4430-VN model versus the 4430-V model.

Table 3.5.23: Loop Capacitor Selection

Range for 4430-V LBW/Demod f_c	Range for 4430-VN LBW/Demod f_c	4430-V Cap (C)	4430-VN Cap (C)	Reg. 38h Bits 2-0
Range: (15 to 50)	Range: (.05 to 3)	1.5×10^{-10}	2.2×10^{-9}	000b
Range: (3 to15)	Range: (0.1 to 0.5)	6.8×10^{-9}	3.9×10^{-8}	001b
Range: (0.5 to 3)	Range: (0.015 to 0.1)	2.2×10^{-7}	6.8×10^{-7}	011b
Range: (0.03 to 0.5)	Range: (1.5×10^{-3} to 0.015)	1.1×10^{-5}	5.0×10^{-5}	100b

7. Select the input source and mode for the demodulator.

8. Arrange the bits per Table 3.5.21, "Loop Capacitor Input Source/Mode Register Definition," on page 54 and write the value to the register.

Programming Example

Following the steps listed above:

1. From Section 3.5 Register Programming on page 31 the user value for Eb/No was selected as 8dB.

2. A LPSR value is selected from Table 3.5.22, "Eb/N0 vs. Maximum LPSR," on page 55.

   LPSR = 0.02

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. This value is then used to calculate loop bandwidth per the following equation:

   Loop Bandwidth (LBW) = LPSR x Symbol Rate
   Loop Bandwidth (LBW) = 0.02 x 1000 = 20h



Note: The LBW and %LBW values should be evaluated per the criteria outlined in Section 3.3.5 Evaluation of the Demodulator Eb/No Setup on page 25 for the model of 4430 device installed.

The Loop Bandwidth (LBW) of 20Hz results in a %LBW as follows:

%Loop Bandwidth (%LBW) = LBW/Demod f_c
%Loop Bandwidth (%LBW) = 20/8000 = 0.0025

Since the range for a 4430-VN %LBW is between the values of (0.00003 to 0.0005), the LBW value can not be supported by the VCXO. Therefore, the %LBW number will be defaulted at the highest value of 0.0005. The new LBW value will then be calculated as follows:

LBW = %LBW x Demod f_c
LBW = 0.0005 x 8000 = 4Hz

4. The square root of the carrier frequency is determined:

   Demod f_c^{-2} = 8000^{-2} = 89.44

5. The loop bandwidth value is then divided by the square root of the carrier frequency:

   LBW/Demod f_c^{-2} = $4/8000^{-2}$ = 4/89.44 = 0.04

6. This value is then compared to range values from Table 3.5.23, "Loop Capacitor Selection," on page 55 to determine the loop capacitor value select bits and the loop capacitor value:

   Given that the board is a 4430-VN, the value of 0.224 falls in the range of 0.015 to 0.1 and the corresponding capacitor select bits are 011b. The corresponding capacitor value (C) is 6.8×10^{-7}.

7. Determine the input and mode selection from the user input defined in Section 3.5 Register Programming on page 31:

   Demod Input = BPSK
   Demod Source = Ch. 1

   This means that bit 5 is a one and bit 6 of register 38h is set to zero.

8. Arranging the bit selections:

   Register 38h = 01000011b = 43h

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.18 Register 33h (67h), Loop Filter Bandwidth Resistor

This register is programmed based on the results of the loop bandwidth value and the results of the loop capacitor selected in Section 3.5.17 Register 38h (71h), Loop Capacitor/Input Select on page 54.

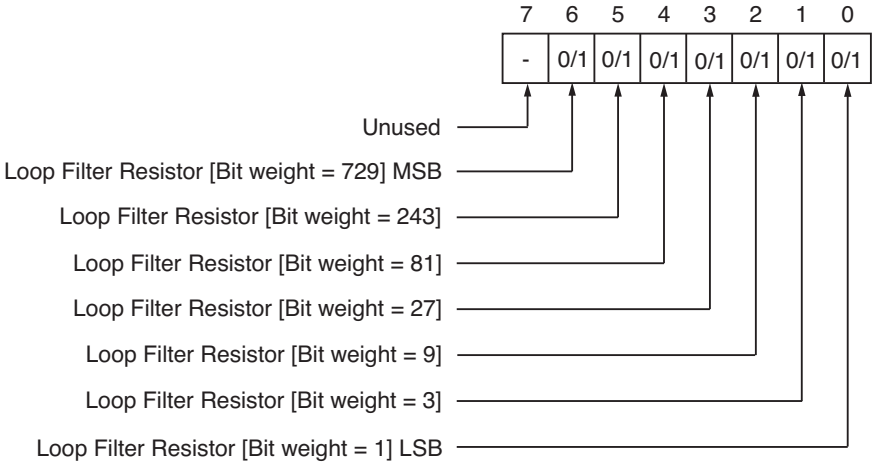


Figure 3.5.18: Register 33h Bit Assignments

Table 3.5.24: Loop Filter Resistor Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Unused	Set to zero for proper operation
06-00	Loop Filter Resistor	(Set according to the formulas to follow)

The following formulas and steps are used to calculate the Loop Resistor value:

1. Calculate the value for R_{in}:

   (For the 4430-V) $R_{in} = ((5 \times 10^{-3}) \times (\text{Demod } f_C))/(LBW^2 \times C)$

   (For the 4430-VN) $R_{in} = ((2.55 \times 10^{-5}) \times (\text{Demod } f_C))/(LBW^2 \times C)$

Where LBW is the loop bandwidth, Demod f_C is the demodulator carrier frequency and C is the loop capacitor value selected in Section 3.5.17 Register 38h (71h), Loop Capacitor/Input Select on page 54.

2. Calculate the value for R_3 and round to the nearest whole number.

   $R_3 = 1 \times 10^6/R_{in}$

3. Using Figure 3.5.18 Register 33h Bit Assignments on page 57 determine the bit or bit combinations that most closely approximate the value calculated for R_3 above.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. Write the value to the register.

Programming Example

For the programming example given, the following steps apply:

1. Calculating the value for R_{in}:

   For the 4430-VN
   $R_{in} = ((2.55 \times 10^{-5}) \times (\text{Demod } f_C))/(LBW^2 \times C)$
   $R_{in} = ((2.55 \times 10^{-5}) \times (8000))/(4^2 \times 6.8 \times 10^{-7})$
   $R_{in} = 18750$

2. Calculating the value for R3 and rounding:

   $R_3 = 1 \times 10^6/R_{in}$
   $R_3 = 1 \times 10^6/18750 = 53.4 = 53$

3. Using Figure 3.5.18 Register 33h Bit Assignments on page 57 the bit values are determined as follows:

   a. 53 - 27 = 26 (Bit 3 is set to a "1")
   b. 26 - 9 = 17 (Bit 2 is set to a "1")
   c. 17 - 3 = 14 (Bit 1 is set to a "1")
   d. 14 - 1 = 13 (Bit 0 is set to a "1")
   e. 81 - 53 = 28
   f. Since the results of Step d. are less than that of Step e., the addition of the bit weights of bits 0 through 4 are a closer approximation to the value of R_3 than the value of 81.

4. Set bits 0 through 6 according to Step 3 results and write the following value to register 33h:

   Register 33h = 00001111b = 0Fh

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.19 Register 34h (69h), Loop Filter Damping Resistor

This register is programmed based on the results of the loop bandwidth value and the results of the loop capacitor selected in Section 3.5.17 Register 38h (71h), Loop Capacitor/Input Select on page 54.

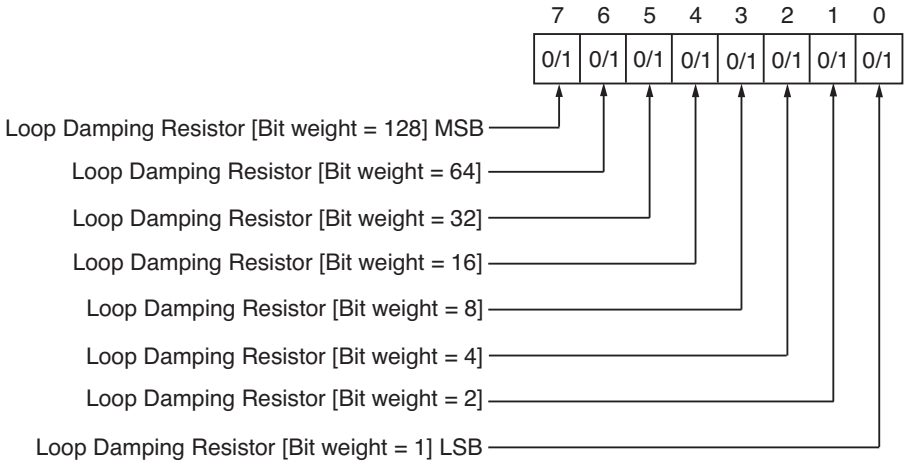


Figure 3.5.19: Register 34h Bit Assignments

Table 3.5.25: Loop Damping Resistor Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Loop Damping Resistor	(Set according to the formulas that follow)

The following formulas and steps are used to calculate the Loop Damping Resistor Register value:

1. Calculate the value for R_d:

   R_d = (1/(pi x C x LBW)) ohms

Where LBW is the loop bandwidth and C is the loop capacitor value selected in Section 3.5.17 Register 38h (71h), Loop Capacitor/Input Select on page 54.

Allowable range of values:
4430-V, Rd is 215 - 37500.
4430-VN, Rd is 1500 -1 x 10^6.

2. Calculate the register value given the following equation:

   (For the 4430-VN) Register value = (104.5 x 10^3) x $Rd^{-0.835}$
   (For the 4430-V) Register value = (1.49 x 10^5) x $Rd^{-1.21}$

3. Round the results of Step 2.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. If the results of Step 3 are greater than 255, write an FFh to register 34h. If the results are less than 255, convert the number to a hexadecimal number and write it to the register.

Programming Example

For the programming example given, the following steps apply:

1. Calculating the value for R_d:

   R_d = (1/(pi x C x LBW)) ohms
   R_d = (1/(pi x 6.8 x 10^{-7} x 4)) ohms = 117025.7

2. Calculating the register value for the 4430-VN given the following equation:

   Register value = (104.5 x 10^3) x $Rd^{-0.835}$
   Register value = (104.5 x 10^3) x $(117025)^{-0.835}$ = 6.12

3. Round the results of Step 2:

   Register value = 6

4. Converting the number to a hexadecimal number:

   Register 34h value = 06h

3.5.20 Register 35h (6Bh), Loop Gain

This register is programmed based on the results of the loop bandwidth and the demodulator carrier frequency. The loop bandwidth was determined in Section 3.3.5 Evaluation of the Demodulator Eb/No Setup on page 25. The demodulator carrier frequency is determined by the user in Section 3.3.

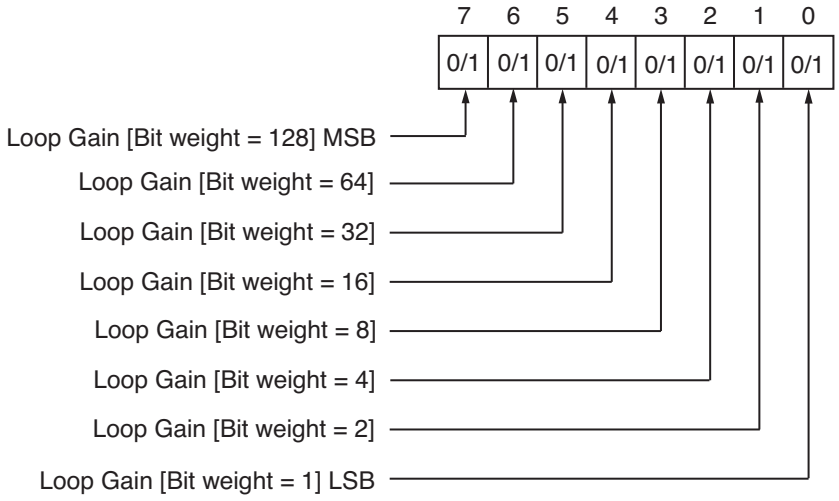


Figure 3.5.20: Register 35h Bit Assignments

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Table 3.5.26: Loop Gain Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Loop Gain	(Set according to the formulas that follow)

The following formulas and steps are used to calculate the loop gain register value:

1. Calculate the value for Loop Gain (LG):

   For the 4430-V LG = (LBW/Demod f_C) x 12750
   For the 4430-VN LG = (LBW/Demod f_C) x (5.1×10^5)

Where LBW is the loop bandwidth selected in Section 3.5.17 Register 38h (71h), Loop Capacitor/Input Select on page 54 and Demod fc is the demodulator carrier frequency input by the user in Section 3.3.

2. Round the results of Step 1.

3. If the results of Step 1 are less than 40, write a 28h to register 35h. If the results are greater than 40, convert the number to a hexadecimal number and write it to the register. If the value is larger than 255, write a FFh to register 35h.

Programming Example

For the programming example given, the following steps apply:

1. Calculating the value for LG for the 4430-VN:

   LG = (LBW/Demod f_C) x (5.1×10^5)
   LG = (4/8000) x (5.1×10^5) = 255

2. Rounding the results of Step 1 results in LG = 255.

   A value of FFh is written to register 35h.

3.5.21 Register 39h (73h), Input High Pass Filter Tuning

This register selects the demodulator input high pass filter setting. Figure 3.5.21 illustrates the breakout of register bit assignments.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

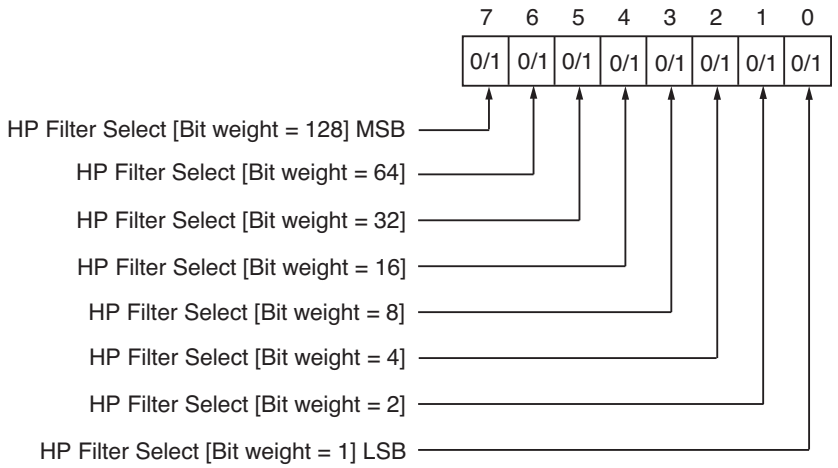


Figure 3.5.21: Register 39h Bit Assignments

Table 3.5.27: High Pass Filter Tuning Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	High Pass Filter Tuning	(See steps below)

To program this register, follow the procedure below.

1. Determine the filter range by evaluating the following:

   Filter Range (f_h) = Demod f_c - (2 x Symbol Rate)

2. Using the results of Step 1, select the coefficients K_0, K_1, K_2, and K_3 from the table below.

Table 3.5.28: Input High Pass Filter Tuning Ranges

Input High Pass Filter Range	Step	K_0	K_1	K_2	K_3
500 kHZ ≤ f_h ≤ 5MHz	00b	0	-7.1×10^{-13}	6.12×10^{-5}	-25.26
55kHZ ≤ f_h < 500kHz	01b	-8.99×10^{-16}	8.4×10^{-10}	2.91×10^{-4}	-15.27
5kHz ≤ f_h < 55kHz	11b	-1.01×10^{-12}	7.17×10^{-8}	3.9×10^{-3}	-16

3. Using the coefficients selected in Step 2, evaluate the following equation:

   HP Filter = $(K_0 \times f_h^3) + (K_1 \times f_h^2) + (K_2 \times f_h) + K_3$

4. Round the value from Step 3 and limit it to the range of 0 to 255.

5. Convert the number to a hexadecimal value and write the value to register 39h.

Programming Example For the programming example given, the following steps apply:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1. Determine the filter range by evaluating the following:

   Filter Range (f_h) = Demod f_c - (2 x Symbol Rate)
   Filter Range (f_h) = 8000 - (2 x 1000) = 6000Hz

2. Using the results of Step 1, select the coefficients K_0, K_1, K_2, and K_3 from Table 3.5.28:

   $K_0 = -1.01 \times 10^{-12}$
   $K_1 = 7.17 \times 10^{-8}$
   $K_2 = 3.9 \times 10^{-3}$
   $K_3 = -16$

3. Using the coefficients selected in Step 2, evaluate the following equation:

   HP Filter = $(K_0 \times f_h^3) + (K_1 \times f_h^2) + (K_2 \times f_h) + K_3$
   HP Filter = (-.22) + (2.58) + (23.4) -16 = 9.76

4. Rounding the value from step results in HP Filter = 10. This value is within the range of 0-255 so no limiting is required.

5. Converting the number to a hexadecimal value results in a 0Ah which is written to register 39h.

3.5.22 Register 3Ah (75h), Modulator Low Pass Filter Tuning

This register selects the modulator low pass filter setting. Figure 3.5.22 illustrates the breakout of register bit assignments.

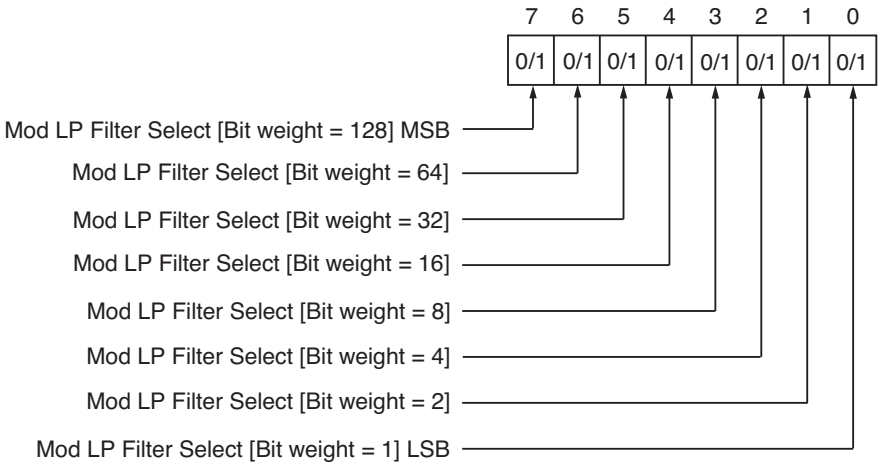


Figure 3.5.22: Register 3Ah Bit Assignments

Table 3.5.29: Modulator Low Pass Filter Tuning Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Mod Low Pass Filter Tuning	(See steps below)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To program this register, follow the procedure below.

1. Determine the filter range by evaluating the following:

   Mod LP Filter Range (f_{LM}) = Mod f_c + (2 x Symbol Rate)

2. Using the results of Step 1, select the coefficients K_0, K_1, K_2, and K_3 from the table below:

Table 3.5.30: Modulator Low Pass Filter Turning Ranges

Modulator LP Filter Range	Step	K_0	K_1	K_2	K_3
175 kHZ ≤ f_{LM} ≤ 7.5MHz	00b	1.51×10^{-18}	-2.57×10^{-11}	1.37×10^{-4}	-10.65
17kHZ ≤ f_{LM} < 175kHz	01b	0	-2.65×10^{-12}	1.34×10^{-8}	-12.56
4kHz ≤ f_{LM} < 17kHz	11b	0	-1.89×10^{-8}	1.48×10^{-2}	-20

3. Using the coefficients selected in Step 2, evaluate the following equation:

   Mod LP Filter = $(K_0 \times f_{LM}^3) + (K_1 \times f_{LM}^2) + (K_2 \times f_{LM}) + K_3$

4. Round the value from Step 3 and limit it to the range of 0 to 255.

5. Convert the number to a hexadecimal value and write the value to register 3Ah.

Programming Example

For the programming example given, the following steps apply:

1. Determine the filter range by evaluating the following:

   Mod LP Filter Range (f_{LM}) = Mod f_c + (2 x Symbol Rate)
   Mod LP Filter Range (f_{LM}) = 8000 + (2 x 1000) = 10000Hz

2. Using the results of Step 1, select the coefficients K_0, K_1, K_2, and K_3 from Table 3.5.30:

   K_0 = 0
   $K_1 = -1.89 \times 10^{-8}$
   $K_2 = 1.48 \times 10^{-2}$
   K_3 = -20

3. Using the coefficients selected in Step 2, evaluate the following equation:

   Mod LP Filter = $(K_0 \times f_{LM}^3) + (K_1 \times f_{LM}^2) + (K_2 \times f_{LM}) + K_3$
   Mod LP Filter = (0) + (-1.89) + (148) - 20 = 126.11

4. Rounding the value from Step 3 and limiting it to the range of 0 to 255:

   Mod LP Filter = 126

5. Converting the number to a hexadecimal value results in a value of 7Eh being written to register 3Ah.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.23 Register 3Bh (77h), Modulator Control/Demodulator High Pass Filter

This register selects the modulator phase increment, the input high pass filter step value, the modulator carrier on/off select, and the modulator low pass filter step value. Figure 3.5.23 illustrates the breakout of register bit assignments.

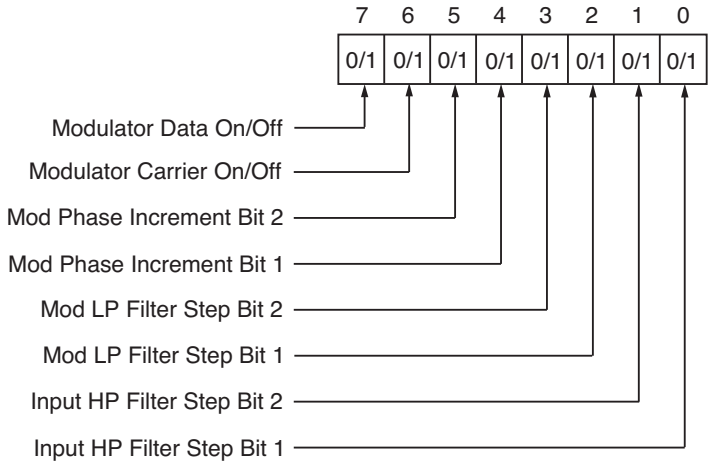


Figure 3.5.23: Register 3Bh Bit Assignments

Table 3.5.31: Modulator/Demodulator Control Register Definition

Bit No.	Bit Name(s)	Functional Description
07	Modulator Data	0 - Modulator Data On 1 - Modulator Data Off
06	Modulator Carrier	0 - Modulator Carrier On1 - Modulator Carrier Off
05-04	Mod Phase Increment	00 - Phase Shifted 0 Degrees 01 - Phase Shifted 90 Degrees (Only valid for QPSK formats) 10 - Phase Shifted 180 Degrees 11 - Phase Shifted 270 Degrees (Only valid for QPSK formats)
03-02	Mod LP Filter Step	See below for definitions
01-00	Input HP Filter Step	See below for definitions

The programming of this register requires the user input as to the functional state of the optional modulator as well as the results of Section 3.3 Programming Interview on page 23 and Section 3.4 Critical Register Programming Sequences on page 29.

The following steps apply:

1. Determine whether the optional modulator is in an active state or inactive state based on the user inputs as defined in Section 3.3 on page 23.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. The modulator phase increment is used for ambiguity resolution. All PSK demodulators have inherent ambiguity concerning the relationship of the locked signal versus the internal oscillator phase. A demodulator can lock to any of four phase in QPSK mode and either of two phases in BPSK mode. In QPSK mode, the incorrect phase may result in inverted data or may result in the I and Q signals being swapped. In BPSK mode, the incorrect phase relation could result in inverted data.

   To deal with these ambiguities, the 4430 Modulator has two bits (bits 4 and 5) within register 3Bh which allow the user to alter this phase relationship to allow demodulators to correctly lock.

   The definition of these bits is shown in Table 3.5.31, "Modulator/Demodulator Control Register Definition," on page 65. The user should only select 0 and 180 degree settings in the BPSK mode. Users may want to experiment with different settings if they are using the on-board modulator when attempting to get a demodulator correctly locked.

   The user should start with these values in a 00b state and then adjust the values as needed.

3. To set the modulator low pass filter bits, refer to Section 3.5.22 on page 63. Taking the low pass filter value, select the proper range within Table 3.5.30. The step bits in the selected range are the bits for programming bits 2 and 3 of the register.

4. The user has the ability to turn on and off the modulator carrier and the modulator data. Bit 6 and 7 of the register provide this user input. For normal operation, set both bits to "ON".

5. The demodulator input high pass filter step setting is based on the results of Section 3.5.21 on page 61.

   Taking the value of f_h select the step value from Table 3.5.27, "High Pass Filter Tuning Register Definition," on page 62.

Programming Example

Following the steps listed above:

1. From Section 3.3 on page 23 the user has selected the modulator as being operational. Therefor bits 6 and 7 are set to the default state:

   Bit 7 = 0
   Bit 6 = 0

2. Since the phase increment bits are a user option, these bits should be placed in the default state:

   Bit 5 = 0
   Bit 4 = 0

3. From Section 3.5.22 on page 63 the step value is determined:

   Since the Mod LP Filter Range = 10000Hz. Table 3.5.30, "Modulator Low Pass Filter Turning Ranges," on page 64 indicates that the step value is 3.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Bit 3 = 1
Bit 2 = 1

4. Determine the value of f_h as shown in Section 3.5.21 Register 39h (73h), Input High Pass Filter Tuning on page 61 and then select the step value:

   f_h = 6000 Hz

   Selecting the step value from Table 3.5.28 on page 62: step = 11b

5. Writing the bits to register 3Bh

   Register 3Bh = 00001111b = 0Fh

3.5.24 Register 3Eh (7Dh), Demodulator Offset Nulling Loop

This register, in conjunction with the Loop Stress Status register 33h, forms a demodulator tracking loop. Figure 3.5.24 illustrates the breakout of register bit assignments.

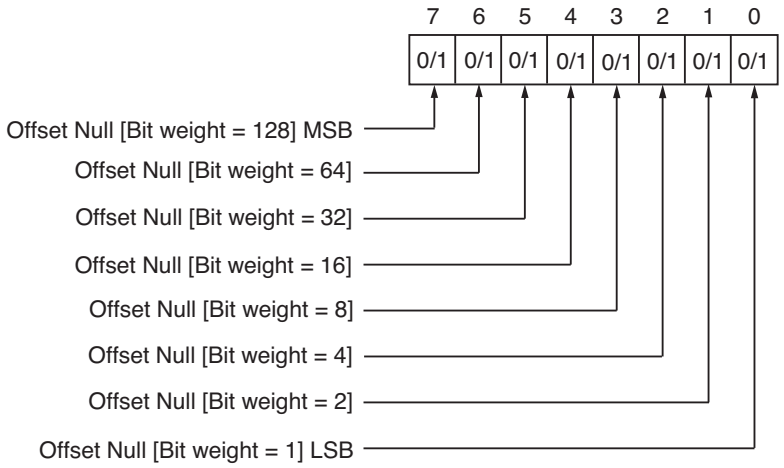


Figure 3.5.24: Register 3Eh Bit Assignments

Table 3.5.32: Demodulator Offset Null Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Demod Offset Null	See definitions to follow

Loop stress data is read from status register 33h and the loop is centered with register 3Eh. When the 4430-V is first tuned to a new carrier frequency, status register 33h should be read and register 3Eh should be used to center the loop. Due to the wide tuning range, the offset nulling loop should always be used to null out the changing mixer offset.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Initially, set register 3Eh to 128. Read back the value in register 33h. It should read 128 + 12. If the number is too high, you should step register 3Eh down one increment at a time while reading back register 33h. Likewise, if the value is to low, you should decrement the value in register 3Eh while reading the value in register 33h. A delay of greater than (1/(2 x p x loop bandwidth)) should be allowed between each step to allow the loop to settle. If it is not desired to use a programmed delay between the read and write functions, bit 2 of register 32h can be polled to determine if the loop stress value conversion is complete.

If register 3Eh is stepped to the maximum value of 255 or minimum of 0 and is still not within the tolerance, then set the register 80h.

Programming Example

Following the steps described above:

1. Set the register in the default state:

   Register 3Eh = 80h

2. Delay while waiting for the loop to settle:

   Settling Delay = 1/(2 x p x loop bandwidth)
   Settling Delay = (1/125.7) = 0.00795 seconds = 7.95 milliseconds

3. Read the status in register 33h:

   Assume register 33h = 8Fh

4. Evaluate the results to determine if the value is within the range 128 ± 12.

   Assuming register 33h = 8Fh = 143.
   Since this value is greater than 128 + 12, register 3Eh will require decrementing

5. Increment or decrement the value written to register 3Eh as necessary:

   Register 3Eh = 7Fh

6. Repeat Step 2 through Step 5 until the value in register 33h is within the 128_{10} ($\pm 12_{10}$) desired value or until the value written to register 3Eh is equal to 00h or FFh.

7. If the value written to register 3Eh is equal to 00h or FFh write 80h to the register.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.25 Register 33h (67h), Demodulator Loop Stress Status

This register, in conjunction with the demodulator offset nulling register 3Eh, forms a demodulator tracking loop. The following figure illustrates the breakout of register bit assignments.

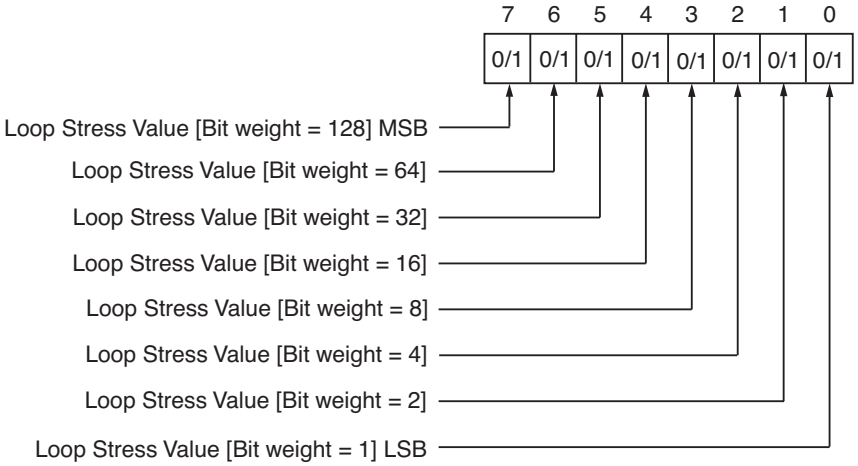


Figure 3.5.25: Register 33h Bit Assignments

Table 3.5.33: Demodulator Loop Stress Status Register Definition

Bit No.	Bit Name(s)	Functional Description
07-00	Loop Stress	See definitions to follow

Loop stress data is read from register 33h in response to offset null loop tuning values written to register 3Eh. The register contents will become stable according the following delay formula:

Settling Delay = 1/(2 x p x LBW)

Since this is a read function, no programing example is provided.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5.26 Register 32h (65h), Demodulator General Status

This register provides status on the operational state of the demodulator. The following figure illustrates the breakout of register bit assignments.

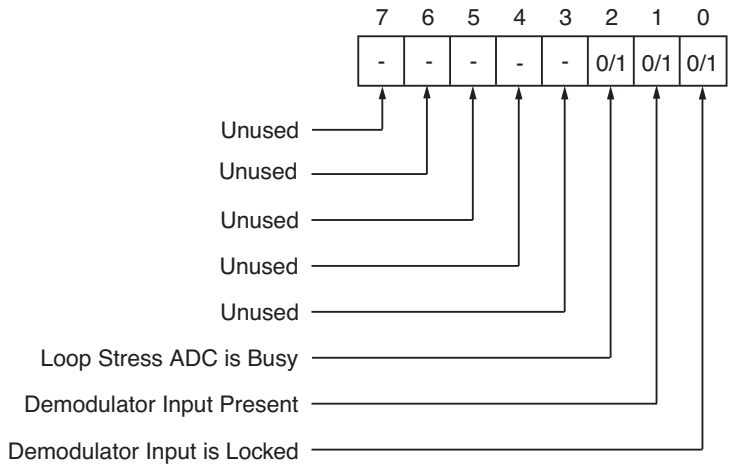


Figure 3.5.26: Register 32h Bit Assignments

Table 3.5.34: Demodulator General Status Register Definition

Bit No.	Bit Name(s)	Functional Description
07-03	Unused	Set to zero during proper operation
02	Loop Stress ADC	0 - ADC Busy 1 - Loop Stress value is converted
01	Demod Input Present	0 - Demod input is within range for the AGC circuitry 1 - Demod input is not within range for the AGC circuitry
00	Demod Lock	0 - Demodulator is locked to the input signal 1 - Demodulator is not locked to the input signal

Loop Stress ADC status can be used to determine when a loop stress value is available during loop null tuning in place of a delay loop.

The demodulator signal present and signal lock bits indicate when the demodulator first detects a signal and then locks to that signal respectively.

Since this is a read function, no programing example is provided.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

A: Revisions

The table in this appendix gives a brief summary of any technical revisions made to this manual. When reading this manual online, you can jump to the first citation of a revision by clicking the links in blue.



Note: Only technical revisions appear in the table. Most even numbered pages contain a date stamp in the footer. If the footer date is more recent then the latest revision date given in the table, then the newest revision of this manual contains only *non-technical* revisions.

Revision Number	Revision Date	Description
2	8 Jun 2005	Added this revision appendix. This revision also incorporates all previous revisions.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP