Programming KEELOQ® Devices with the PRO MATE® II Device Programmer

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break microchip’s code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, dsPIC, KEELOQ, MPLAB, PIC, PICmicro, PICSTART, PRO MATE and PowerSmart are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

FilterLab, microID, MXDEV, MXLAB, PICMASTER, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Accuron, Application Maestro, dsPICDEM, dsPICDEM.net, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, microPort, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, PICC, PICkit, PICDEM, PICDEM.net, PowerCal, PowerInfo, PowerMate, PowerTool, rfLAB, rfPIC, Select Mode, SmartSensor, SmartShunt, SmartTel and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

Serialized Quick Turn Programming (SQTP) is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

Printed on recycled paper.

NOTES:

Table of Contents

Chapter 3. KEELOQ Device Options (Cont.)

General Information

INTRODUCTION

This chapter contains general information that will be useful to know before using this document.

HIGHLIGHTS

This chapter contains the following topics:

- About this Guide
- Warranty Registration
- Recommended Reading
- Troubleshooting
- The Microchip Web Site
- Development Systems Customer Notification Service
- Customer Support

ABOUT THIS GUIDE

Document Layout

This document is intended as a supplement to the *PRO MATE® II User's Guide* (DS30082). This document describes how to use the PRO MATE II device programmer as a development tool to program KEELOQ® encoders and decoders. The manual layout is as follows:

- **Chapter 1: KEELOQ Programming Concepts** – Introduces key generation, the manufacturer's code and other concepts unique to KEELOQ devices.
- **Chapter 2: Programming KEELOQ Devices** – Describes how to program KEELOQ encoders and decoders. Includes step-by-step examples featuring simple applications.
- **Chapter 3: KEELOQ Device Options** – Describes the options available for each KEELOQ device.
- **Index** – Provides a cross-reference listing of terms, features and sections of this document.
- **Worldwide Sales and Service** – Lists Microchip sales and service locations and telephone numbers worldwide.

Conventions Used in this Guide

This manual uses the following documentation conventions:

TABLE 1: DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Code (Courier font):		
Plain characters	Sample code Filenames and paths	`#define START` `c:\autoexec.bat`
Square brackets [ ]	Optional arguments	`MPASMWIN [main.asm]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments An OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated instances of text	`list ["list_option..., "list_option"]`
0x*nnnn*	A hexadecimal number where *n* is a hexadecimal digit	`0xFFFF, 0x007A`
Italic characters	A variable argument; it can be either a type of data (in lower case characters) or a specific example (in upper-case characters).	`pic30-gcc` *`filename`*
Interface (Arial font):		
Underlined, italic text with right arrow	A menu selection from the menu bar	*File > Save*
Bold characters	A window or dialog button to click	**OK**, **Cancel**
Characters in angle brackets < >	A key on the keyboard	<Tab>, <Ctrl-C>
Documents (Arial font):		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*

Documentation Updates

All documentation becomes dated, and this document is no exception. Since Microchip language and other tools are constantly evolving to meet customer needs, some actual tool descriptions may differ from those in this document. Please refer to our web site to obtain the latest documentation available.

Documentation Numbering Conventions

Documents are numbered with a “DS” number. The number is located on the bottom of each page, in front of the page number. The numbering convention for the DS Number is DSXXXXXA, where:

XXXXX	=	The document number.
A	=	The revision level of the document.

WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in your Warranty Registration Card entitles you to receive new product updates. Interim software releases are available on the Microchip web site at www.microchip.com.

RECOMMENDED READING

This document describes how to use the PRO MATE II device programmer as a development tool to program firmware to KEELOQ encoders and decoders. For more information on using the PRO MATE II device programmer and general programming procedures, please refer to the *PRO MATE II User's Guide*. For the latest PRO MATE II device programmer information, please refer to the README file.

PRO MATE II User's Guide (DS30082)

This user's guide describes how to set up and use the PRO MATE II device programmer. General programming procedures and examples are provided for PICmicro® MCU, calibration memory and memory devices.

KEELOQ Evaluation Kit User's Guide (DS51044)

This user's guide describes how to use the KEELOQ evaluation kit. This kit enables the user to evaluate the KEELOQ code hopping technology quickly and easily without making a large financial investment.

README.PRO

For the latest information on the PRO MATE II device programmer, read the README.PRO file (ASCII text file) included with the PRO MATE II device programmer software. This README file contains updated information that may not be included in the *PRO MATE II User's Guide*.

MPLAB IDE User's Guide (DS51025)

Comprehensive guide that describes installation and features of Microchip's MPLAB Integrated Development Environment, as well as the editor and simulator functions.

Microchip Web Site

Our web site (http://www.microchip.com) contains a wealth of documentation. Individual data sheets, application notes, tutorials and user's guides are all available for easy download. All documentation is in Adobe® Acrobat® (pdf) format.

TROUBLESHOOTING

See the README files for information on common problems not addressed in this document.

THE MICROCHIP WEB SITE

Microchip provides online support on the Microchip World Wide Web (WWW) site. The web site is used by Microchip as a means to make files and information easily available to customers. To view the site, you must have access to the Internet and a web browser, such as, Netscape Navigator® or Microsoft® Internet Explorer.

The Microchip web site is available by using your favorite Internet browser to reach: http://www.microchip.com

The web site provides a variety of services. Users may download files for the latest development tools, data sheets, application notes, user's guides, articles and sample programs. A variety of information specific to the business of Microchip is also available, including listings of Microchip sales offices, distributors and factory representatives.

Technical Support

- Frequently Asked Questions (FAQ)
- Online Discussion Groups – conferences for products, development systems, technical information and more
- Microchip Consultant Program Member Listing
- Links to other useful web sites related to Microchip products

Engineer's Toolbox

- Design Tips
- Device Errata

Other Available Information

- Latest Microchip Press Releases
- Listing of seminars and events
- Job Postings

DEVELOPMENT SYSTEMS CUSTOMER NOTIFICATION SERVICE

Microchip started the customer notification service to help our customers keep current on Microchip products with the least amount of effort. Once you subscribe, you will receive e-mail notification whenever we change, update, revise or have errata related to your specified product family or development tool of interest.

Go to the Microchip web site at (http://www.microchip.com) and click on Customer Change Notification. Follow the instructions to register.

The Development Systems product group categories are:

- Compilers
- Emulators
- In-Circuit Debuggers
- MPLAB IDE
- Programmers

Here is a description of these categories:

Compilers – The latest information on Microchip C compilers and other language tools. These include the MPLAB® C17, MPLAB C18 and MPLAB C30 C compilers; MPASM™ and MPLAB ASM30 assemblers; MPLINK™ and MPLAB LINK30 object linkers; MPLIB™ and MPLAB LIB30 object librarians.

Emulators – The latest information on Microchip in-circuit emulators. This includes the MPLAB ICE 2000 and MPLAB ICE 4000.

In-Circuit Debuggers – The latest information on Microchip in-circuit debuggers. These include the MPLAB ICD and MPLAB ICD 2.

MPLAB IDE – The latest information on Microchip MPLAB® IDE, the Windows Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB SIM and MPLAB SIM30 simulators, MPLAB IDE Project Manager and general editing and debugging features.

Programmers – The latest information on Microchip device programmers. These include the PRO MATE® II device programmer and PICSTART® Plus development programmer.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Corporate Applications Engineer (CAE)
- Hotline

Customers should call their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. See the back cover for a list of sales offices and locations.

Corporate Applications Engineers (CAEs) may be contacted at (480) 792-7627.

In addition, there is a Systems Information and Upgrade Line. This line provides system users a list of the latest versions of all of Microchip's development systems software products. Plus, this line provides information on how customers can receive any currently available upgrade kits.

The Hotline Numbers are:

1-800-755-2345 for U.S. and most of Canada.

1-480-792-7302 for the rest of the world.

Chapter 1. KEELOQ Device Programming Concepts

1.1 INTRODUCTION

A KEELOQ device pair consists of an encoder and a decoder. In an automobile or garage door application, the encoder is in the remote, which transmits a rolling code ID and counter value. The decoder is in the vehicle or garage door and decodes the message sent by the encoder remote. It stores the ID numbers and counter values of the encoders it has “learned.” The decoder allows arm/disarm access only to learned remotes. KEELOQ encryption is accomplished by means of a complex equation and randomizer with a 32-bit result.

This chapter contains information on programming KEELOQ devices.

1.2 HIGHLIGHTS

This chapter contains the following topics:

- Key Generation
- Manufacturer’s Code

1.3 KEY GENERATION

The key generation options and process is described in detail in the Technical Brief, “Secure Learning RKE Systems Using KEELOQ Encoders” (DS40144). A summary follows.

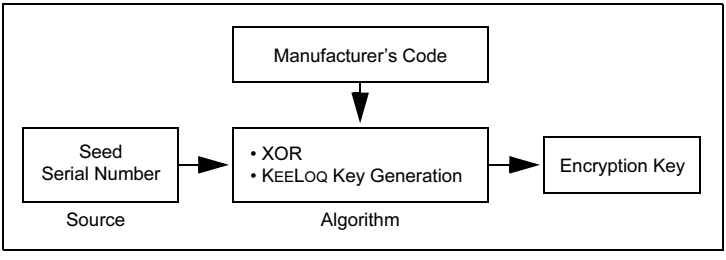
KEELOQ encoder transmissions have two parts. The unencrypted portion consists of the encoder’s serial number and other status bits such as button status. The second portion (HOP code) is encrypted and contains information such as the synchronization counter, counter overflow bits and discrimination values.

Every KEELOQ encoder has its own encryption key. Key generation has three parts. The first part, the manufacturer’s code, is input to the key generation algorithm. This second part is called the source of the key generation. This can either be the encoder’s serial number or the encoder’s Seed. The third part is the key generation algorithm.

The 64-bit manufacturer’s code customizes the key generation algorithm to a specific manufacturer. This means that two manufacturers using the same algorithm and the same source (e.g., the same serial number) will generate different key pairs so that the encoders produced by one manufacturer won’t be learnable on decoders produced by the other manufacturer. This prevents competitors from cloning the secure transmitters.

The algorithm and source are automatically selected when you select a decoder. If you select a device whose key generation source or algorithm can be changed (e.g., HCS512), you will be shown the options when you select the decoder.

FIGURE 1-1: KEELOQ KEY GENERATION



1.3.1 Key Generation Source and Algorithms

The key generation source and algorithms are selected when a decoder is selected. The source and algorithm selected for each decoder are listed in Table 1-1.

TABLE 1-1: KEELOQ DECODER KEY GENERATION METHODS

Decoder	Source		Algorithm	
	Serial Number	Seed	Decryption	XOR
SIMPLE*	No key generation. The simple decoder uses the manufacturer's code.			
NORMAL*	X		X	
SECURE*		X	X	X
HCS512	X	X	X	X
HCS515	X	X	X	

*The SIMPLE, NORMAL and SECURE decoders are software decoders. These decoders have been written as a "quick start" to a customer who would like to write a custom decoder. The source code for the decoders and application note describing each of the decoders is available by ordering the free KEELOQ CD (DS40038) from your local Microchip representative.

1.4 MANUFACTURER'S CODE

The manufacturer's code is arbitrarily chosen by a manufacturer for each product family. Knowledge of this code enables an attacker, competitor or partner to produce compatible encoders. This code is not stored in the encoder's memory, but is programmed into protected memory of the decoder.

Note: The manufacturer's code is very important to prevent cloning of transmitters and should be carefully guarded.

To ensure that the manufacturer's code remains secret, two trusted people (key custodians) should each be given unique 20-digit numbers. This prevents the entire manufacturer's code from being entrusted to a single person. The two custodian keys are exclusively ORed (XORed) to form the manufacturer's code.

The manufacturer's code is entered by two key custodians at the beginning of the programming session.

1.4.1 Entering the Manufacturer's Code

Each of two key custodians must enter their custodian key when you first start to program an HCS encoder. If entered correctly, the two custodian keys are used to generate the manufacturer's code. The first 16 digits entered by each custodian are used to generate the manufacturer's code. The last 4 digits are a checksum to prevent the custodian from entering an incorrect manufacturer's code as this directly influences the encryption keys generated. If the checksum entered does not match the key entered, the custodian will be prompted to re-enter the key.

The manufacturer's code can only be entered once during each session, when you first click **Program** in the PRO MATE® Device Programmer dialog. This prevents the manufacturer's code from being inadvertently changed during a programming session.

1.4.2 Changing the Manufacturer's Code

A manufacturer might want different manufacturer's codes for different product lines. In order to prevent the manufacturer's code being inadvertently changed during a programming session, you must exit MPLAB IDE and restart it. Once you start a new programming session, you can enter the new manufacturer's code in the PRO MATE Device Programmer dialog.

Chapter 2. Programming KEELOQ Devices

2.1 INTRODUCTION

This chapter contains step-by-step programming examples for KEELOQ encoders and decoders.

A KEELOQ device pair consists of an encoder and a decoder. In an automobile or garage door application, the encoder is in the remote, which transmits a rolling code ID and counter value. The decoder is in the vehicle or garage door and decodes the message sent by the encoder remote. It stores the ID numbers and counter values of the remotes it has “learned.” The decoder allows arm/disarm access only to learned remotes. KEELOQ encryption is accomplished by means of a complex equation and randomizer with a 32-bit result.

2.2 PROGRAMMING OVERVIEW

Programming a KEELOQ device pair involves programming the encoder and decoder.

Programming KEELOQ Encoders requires six steps:

- Enable the PRO MATE II device programmer
- Select the encoder
- Enter the manufacturer's code
- Select the decoder
- Select the encoder options
- Program the encoder

Programming of KEELOQ Decoders requires four steps:

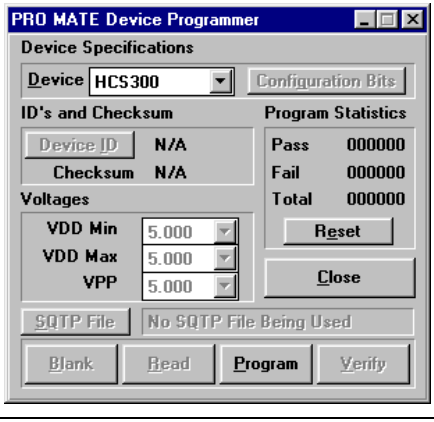
- Enable the PRO MATE II device programmer
- Select the decoder
- Select the decoder options
- Program the decoder

2.3 EXAMPLE: PROGRAMMING KEELOQ ENCODERS AND DECODERS

2.3.1 Programming the Encoder

1. Install an AC004001 socket module in the PRO MATE II device programmer. Make sure the AC004001 socket module does ***not*** contain a device. Power on the PRO MATE II. Place the HCS300 device in the socket module.
2. Enable the PRO MATE II programmer by clicking PRO MATE > Enable Programmer. For this example select the HCS300 device from the PRO MATE Device Programmer dialog box.

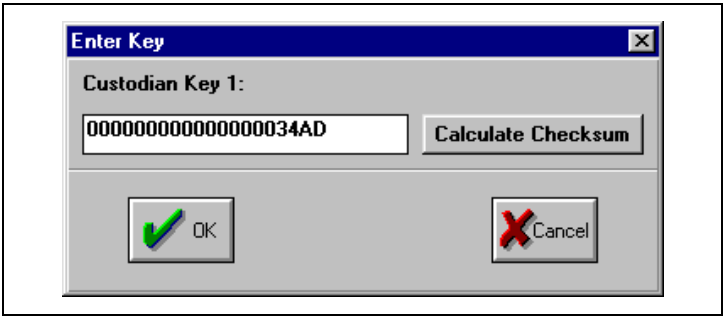
FIGURE 2-1: SELECTING THE ENCODER



3. Click **Program**. You will be prompted for two 20-bit custodian keys (Figure 2-3). Each of two key custodians must enter their custodian key. If entered correctly, the two custodian keys are used to generate the manufacturer's code as described in **Section 1.4 Manufacturer's Code**.
4. Initially each key custodian should be given a 16-digit key. The first time each key custodian enters their 16-digit key, they should click **Calculate Checksum** to generate a 4-digit checksum. This should be recorded by the key custodian in a secure location and each subsequent time the key needs to be entered, all 20 digits should be typed in. In the example shown, "0000000000000000" (16 zeros) is the key. The checksum calculated is "34AD" and the complete 20-digit custodian key is displayed.

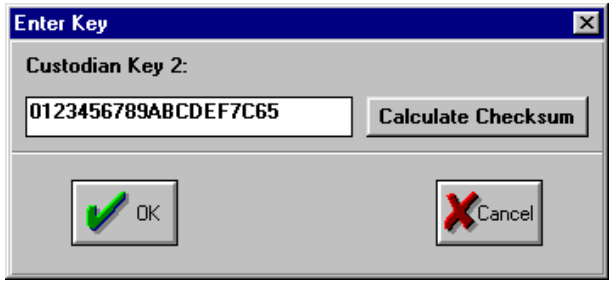
   By entering all 20 digits instead of entering 16 digits and clicking **Calculate Checksum** each time, the program can use the checksum to verify that the code has been entered correctly.

FIGURE 2-2: ENTER KEY DIALOG - CUSTODIAN KEY 1



5. When the prompt for custodian key 2 appears, the second key custodian must enter their key. In the example shown, “0123456789abcdef” is the 16-digit key and the checksum is “7C65”.

FIGURE 2-3: ENTER KEY DIALOG - CUSTODIAN KEY 2

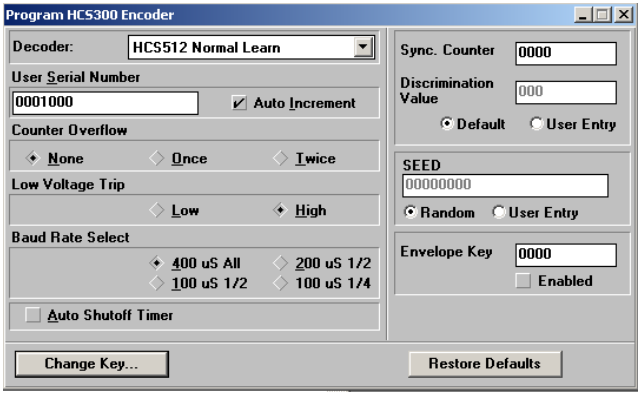


The checksum prevents an incorrect manufacturer’s code from being used to program the parts because the code directly influences the encryption keys generated. The manufacturer’s code is described in **Section 1.4 Manufacturer’s Code**.

The manufacturer’s code can only be entered once during each session. This prevents the manufacturer’s code from being inadvertently changed during a programming session.

The Program Security Device dialog for the encoder will be displayed (Figure 2-4).

FIGURE 2-4: PROGRAM HCS300 ENCODER DIALOG



6. Select the 400 µS All baud rate.
7. Select the HCS512 Normal Learn decoder.

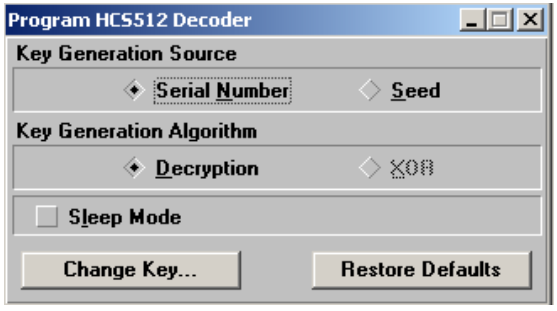
2.3.2 Programming the Decoder

1. In order to program the decoder, the socket modules must be changed. Select *PRO MATE > Disable Programmer*.
2. Turn the PRO MATE II device programmer off. Remove the HCS300 device from the socket module, then remove the AC004001 socket module and replace it with the AC164001 socket module. Tighten the screws evenly and avoid overtightening.
3. Make sure the AC164001 socket module does ***not*** contain a device. Power on the PRO MATE II device programmer.
4. Place the HCS512 in the socket module.
5. Enable the PROMATE II programmer by clicking *PRO MATE > Enable Programmer*. For this example select the HCS512 device from the PRO MATE Device Programmer dialog box.

FIGURE 2-5: DEVICE PROGRAMMER DIALOG - HCS512

6. Click **Program** in the Device Programmer dialog to program the decoder.

FIGURE 2-6: HCS512 DECODING OPTIONS



After the device is programmed, “Success” will be displayed.

2.3.3 Testing the Programming

After programming the encoder and decoder, they can be tested by using the KEELOQ Evaluation Kit II (DM303006). Place the HCS512 decoder on the demonstration board and place the HCS300 encoder on the demonstration transmitter. For information on using the evaluation kit, see the *KEELOQ Evaluation Kit II User’s Guide* (DS41155).

NOTES:

Chapter 3. KEELOQ Device Options

3.1 INTRODUCTION

This chapter describes the programming options for each KEELOQ device that can be programmed using the PRO MATE II device programmer.

3.2 HIGHLIGHTS

Topics covered in this chapter:

- HCS101 Options
- HCS201 Options
- HCS300/301/320 Options
- HCS360 Options
- HCS361 Options
- HCS362/rfHCS362 Options
- HCS365 Options
- HCS370 Options
- HCS410 Options
- HCS412 Options
- HCS473 Options
- HCS512 Options
- HCS515 Options

3.3 HCS101 OPTIONS

The programming dialog for HCS101 devices is shown in Figure 3-1. Selectable options in this dialog are described in Table 3-1.

FIGURE 3-1: PROGRAM HCS101 ENCODER DIALOG

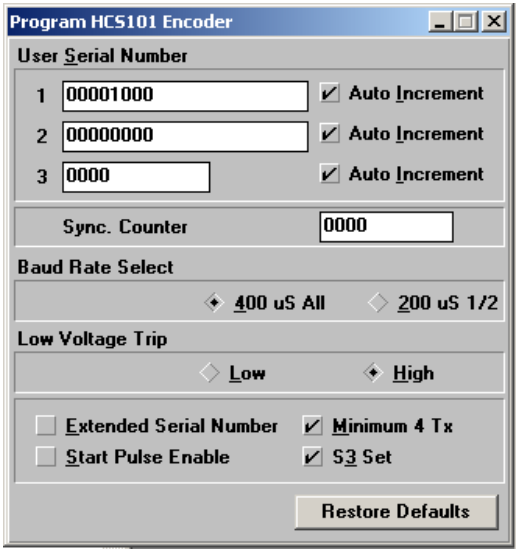


TABLE 3-1: SELECTABLE OPTIONS - HCS101

Option	Description
Serial Number 1	Enter a 32-bit HEX value (0 through FFFF FFFF). If the Extended Serial Number option is **not** selected, only the 28 LSb's will be transmitted.
Serial Number 2	Enter a 32-bit HEX value (0 through FFFF FFFF). Serial Number 2 is transmitted as the first 32 bits of the code word ONLY when S0, S1 and S2 are simultaneously activated. This is often used as an alternate access code to exercise some extra feature on a custom decoder.
Serial Number 3	Enter a 10-bit HEX value (0 through 3FF). Serial Number 3 is actually transmitted first, immediately after the preamble and the synchronization header. A simple decoder (like the one presented in AN740) could use this value alone to distinguish transmitters.
Auto Increment 1, 2, 3	This will cause the corresponding serial number field to increment every time an encoder is successfully programmed.
Baud Rate Select	TE value used during transmissions. Selecting a faster baud rate (200 µs) also selects alternate code word blanking; transmitting every other code word. Changing TE from 400 µs to 200 µs transmits the same number of code words per second but reduces the average energy radiated.
Low Voltage Trip	Selects the voltage at which the VLOW flag (bit) is set in a transmission. The low trip point is set to approximately 4.4V (recommended for 6V battery applications). There are two possible high trip points depending on the "S3 Set" configuration option. If 'S3 Set' is checked, the low voltage trip point is set to approximately 6.75V (recommended for 9V battery applications). If 'S3 Set' is unchecked, the low voltage trip point is set to approximately 9V (recommended for 12V battery applications).

TABLE 3-1: SELECTABLE OPTIONS - HCS101 (CONT.)

Option	Description
Sync. Counter	Enter a 16-bit HEX value (0 through FFFF). This is the initial value of the synchronization counter.
Extended Serial Number	If this option is enabled, the full 32 bits of the serial number are transmitted. The function code is then available only in the hopping portion of the code word. If disabled, the top nibble of the serial number is replaced with a second copy of the function code.
Start Pulse Enable	This option enables a start pulse output before the first code word transmission.
Minimum 4 Tx	If this option is enabled at least 4 complete code words will be transmitted even if the device is activated briefly. If disabled, a brief activation will transmit only one code word.
S3 Set	This option determines the S3 bit behavior in the transmitted function code. If enabled, S3 is transmitted as a '1' independent of the button inputs. Otherwise the S3 bit mirrors the S2 bit in the function code. This option also affects the Low Voltage Trip Point high value.

3.4 HCS200 OPTIONS

The programming dialog for HCS200 devices is shown in Figure 3-2. Selectable options in this dialog are described in Table 3-2.

FIGURE 3-2: PROGRAM HCS200 ENCODER DIALOG

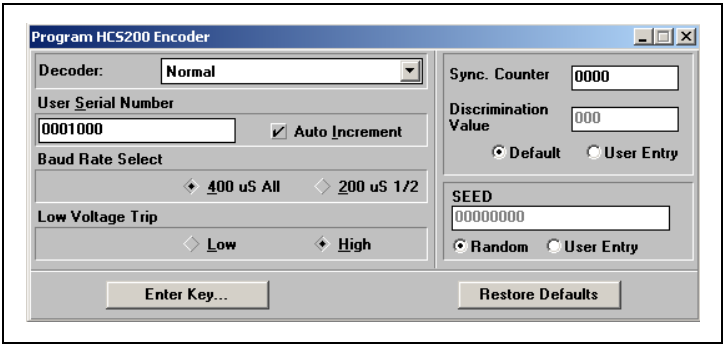


TABLE 3-2: SELECTABLE OPTIONS - HCS200

Option	Description
Serial Number	Enter the encoder's 32-bit (8 HEX digits) serial number. Select the Auto Increment check box if you want the serial number automatically incremented when an encoder is successfully programmed.
Baud Rate Select	Select the Basic Pulse Width (BPW): **400 µs All:** 400 µs, all code words transmitted **200 µs 1/2:** 200 µs, 1 in 2 code words transmitted
Low Voltage Trip	Select the point at which the VLOW bit in a transmission is set: **Low:** VLOW bit in transmission set at V_{DD} = 4V **High:** VLOW bit in transmission set at V_{DD} = 8V

3.5 HCS201 OPTIONS

The programming dialog for HCS201 devices is shown in Figure 3-3. Selectable options in this dialog are described in Table 3-3.

FIGURE 3-3: PROGRAM HCS201 ENCODER DIALOG

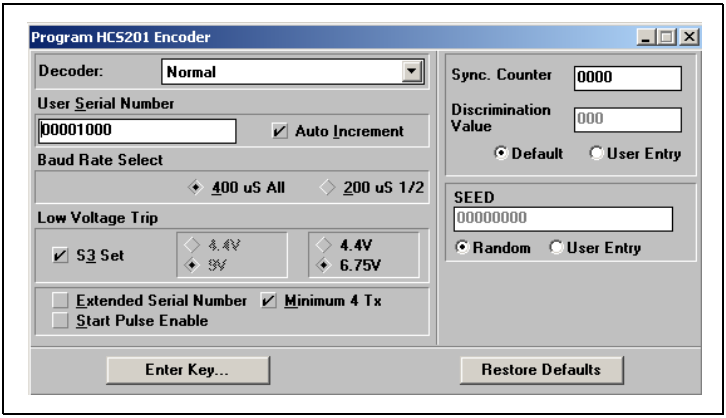


TABLE 3-3: SELECTABLE OPTIONS - HCS201

Option	Description
Serial Number	Enter the encoder's 32-bit (8 HEX digits) serial number. Select the Auto Increment check box if you want the serial number automatically incremented when an encoder is successfully programmed.
Baud Rate Select	Select the Basic Pulse Width (BPW): **400 μS All:** 400 μs, all code words transmitted **200 μS 1/2:** 200 μs, 1 in 2 code words transmitted
Low Voltage Trip	Select the point at which the VLOW bit in a transmission is set: **Low:** VLOW bit in transmission set at V_{DD} = 4V **High:** VLOW bit in transmission set at V_{DD} = 9V* * Where SSSET is selected, 6.8V
Extended Serial Number	If checked, the full 32-bit serial number is transmitted. If not checked, the most significant nibble of the serial number is replaced by the function code.
Start Pulse Enable	If checked, a Start pulse is transmitted before the first transmission.
Minimum 4 Tx	If checked, at least 4 complete code words are transmitted each time the encoder is activated, even if all buttons are released.
S3 Set	If checked, S3 is always transmitted as a '1'. If not checked, S3 in the transmitted function code mirrors the value of S2.

3.6 HCS300/301/320 OPTIONS

The programming dialog for HCS300/301/320 devices is shown in Figure 3-4. Selectable options in this dialog are described in Table 3-4.

FIGURE 3-4: PROGRAM HCS300/301/320 ENCODER DIALOG

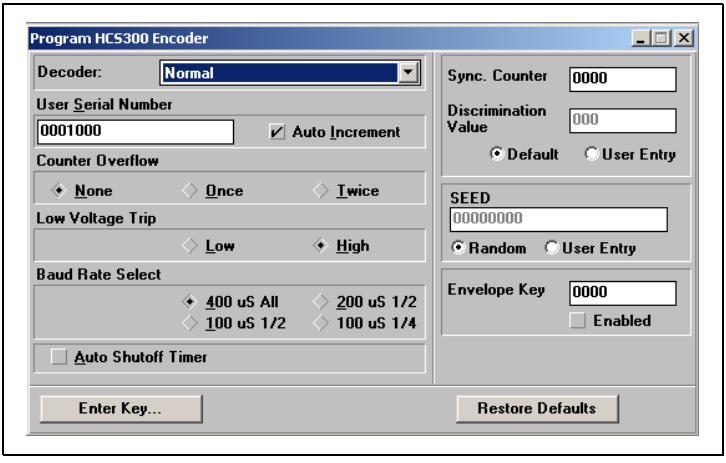


TABLE 3-4: SELECTABLE OPTIONS - HCS300/301/320

Option	Description
Serial Number	Enter the encoder's 32-bit (8 HEX digits) serial number. Select the Auto Increment check box if you want the serial number automatically incremented when an encoder is successfully programmed.
Counter Overflow	Select the overflow bit settings: **None:** None of the overflow bits are set. **Once:** One of the overflow bits are set. **Twice:** Both overflow bits are set.
Low Voltage Trip	Select the point at which the VLOW bit in a transmission is set: **Low:** VLOW bit in transmission set when VDD drops below 2V (HCS300) or 4V (HCS301/320). **High:** VLOW bit in transmission set when VDD drops below 4V (HCS300) or 8V (HCS301/320).
Baud Rate Select	Select the Basic Pulse Width (BPW): **400 μS All:** 400 μs, all code words transmitted **200 μS 1/2:** 200 μs, 1 in 2 code words transmitted **100 μS 1/2:** 100 μs, 1 in 2 code words transmitted **100 μS 1/4:** 100 μs, 1 in 4 code words transmitted
Auto Shutoff Timer	If checked, the encoder will automatically shut off after an amount of time, preventing the battery of a transmitter going flat if the transmitter is accidentally pressed in a pocket or handbag.

3.7 HCS360 OPTIONS

The programming dialog for HCS360 devices is shown in Figure 3-5. Selectable options in this dialog are described in Table 3-5.

FIGURE 3-5: PROGRAM HCS360 DIALOG

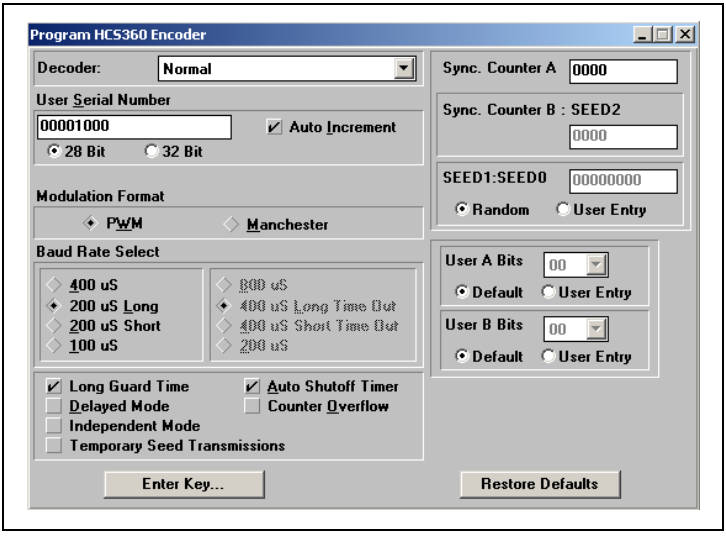


TABLE 3-5: SELECTABLE OPTIONS - HCS360

Option	Description
Decoder	This field selects the decoder device from the list of decoders currently defined in the same project, to associate (link) to this encoder.
Serial Number	Enter a 32-bit or 28-bit HEX value (0 through FFFF FFFF).
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Modulation Format	The HCS360 has 2 modulation formats: PWM and Manchester encoding. **NOTE:** Selecting Manchester format will render the encoder incompatible with standard KEELOQ decoders.
Baud Rate Select	TE value used during transmissions. Refer to the HCS360 datasheet to determine the effect of the FAST bits (in brackets) on the transmission delay and Auto shut-off time.
Temporary Seed Transmissions	This bit controls whether Seed transmissions will be disabled when the counter reaches 80 HEX (128). The user can preset the synchronization counter with any value between 0 and 80 HEX to disable Seed transmissions after fewer transmissions.
Seed	A 48-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 48-bit value (0 through FF FFFF). It will be transmitted in place of the hopping code portion and the 16 LSb's of the serial number when the Seed function code is activated. **NOTE**: The upper 16 MSb's of the Seed value are also used to store Counter B when in Independent mode. Therefore simultaneous use of both features is not possible.

TABLE 3-5: SELECTABLE OPTIONS - HCS360 (CONT.)

Option	Description
Independent Mode	This bit enables the second counter (B) operations for function codes with the S3 input activated. It also enables IR mode modulation (40 kHz) of the data output for transmissions activated with both S2 and S3. **NOTE:** If enabled, secure learn Seed transmissions are incompatible with standard KEELOQ decoders as the upper most significant 16 Seed bits contain counter B instead of a valid Seed value.
Auto Shutoff Timer (or Time-Out)	If enabled, the HCS360 will shut off after transmitting continuously for a predetermined time. This prevents a complete battery discharge if a button is accidentally stuck (in a pocket or purse). The time-out duration depends on the baud rate selection.
Counter Overflow	If set, the counter is extended to 128k unique transmissions. After the first 64k, the counter wraps from FFFF to 0000 and the Counter Overflow bit is **cleared**. After another 64k transmissions the counter will wrap back to 0000 and the overflow remains clear; effectively repeating the last 64k step sequence.
Long Guard Time	The long guard time can be used to lower the average power transmitted during a 100 μs period; to help meet FCC requirements.
Delayed Mode	This option enables the delayed transmission feature. A modified code word is transmitted if a button is pressed longer than a specified amount of time (determined by the baud rate selection). The modified code word inverts the lowest nibble of the discrimination bit field to flag the event. **NOTE:** This feature was introduced only for compatibility with previous Nanoteq NTQ105 encoder models. For new designs the user is recommended to refer to the Time Bits feature of the HCS362 encoder.

TABLE 3-5: SELECTABLE OPTIONS - HCS360 (CONT.)

Option	Description
Sync Counter A and B	Enter a 16-bit HEX value (0 through FFFF). They are the initial value of the synchronization counters.
User Bits	The user bits are a user-defined extension of the discrimination value. They are set by default to mirror bits 8 and 9 of the serial number. The bits can be crucial to distinguish between the two counters when independent mode is selected.

3.8 HCS361 OPTIONS

The programming dialog for HCS361 devices is shown in Figure 3-6. Selectable options in this dialog are described in Table 3-6.

FIGURE 3-6: PROGRAM HCS361 ENCODER DIALOG

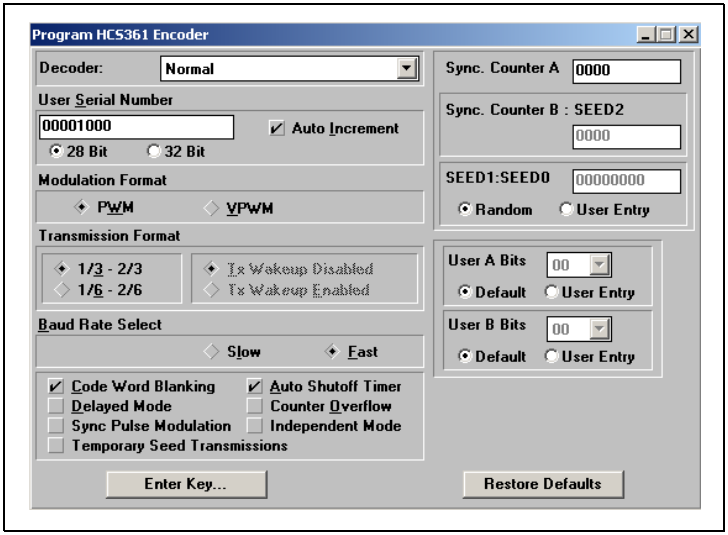


TABLE 3-6: SELECTABLE OPTIONS - HCS361

Option	Description
Decoder	This field selects the decoder device, from the list of decoders currently defined in the same project, to associate (link) to this encoder.
Serial Number	Enter a 32-bit or 28-bit HEX value (0 through FFFF FFFF).
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Modulation Format	The HCS361 has 2 modulation formats: PWM and VPWM. **NOTE:** Selecting VPWM format will render the encoder incompatible with standard KEELOQ decoders.
Baud Rate Select	TE value used during transmissions. Refer to the HCS361 data sheet to determine the effect of the FAST and TXWAK bits (in brackets) on the transmission delay and Auto shut-off time. When in PWM mode, changing baud rates also changes the transmitted bit shape (1/3-2/3 vs. 1/6-2/6). When in VPWM mode, changing baud rates also affects the Wake-Up Preamble generation. **NOTE:** Selecting PWM mode with a 1/6-2/6 bit shape makes the encoder incompatible with standard KEELOQ decoders.
Temporary Seed Transmissions	This bit controls whether Seed transmissions will be disabled when the counter reaches 80 HEX (128). The user can preset the synchronization counter with any value between 0 and 80 HEX to disable Seed transmissions after fewer transmissions.

TABLE 3-6: SELECTABLE OPTIONS - HCS361 (CONT.)

Option	Description
Seed	A 48-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 48-bit value (0 through FF FFFF). It will be transmitted in place of the hopping code portion and the 16 LSb's of the serial number when the Seed function code is activated. **NOTE**: The upper 16 MSb's of the Seed value are also used to store Counter B when Independent mode is selected. Therefore simultaneous use of both features is not possible.
Auto Shutoff Timer (or Time-Out)	If enabled, the HCS361 will shut off after transmitting continuously for a predetermined time. This prevents a complete battery discharge if a button is accidentally stuck (in a pocket or purse). The time-out duration depends on the baud rate selection.
Counter Overflow	If set, the counter is extended to 128k unique transmissions. After the first 64k, the counter wraps from FFFF to 0000 and the Counter Overflow bit is **cleared**. After another 64k transmissions the counter will wrap back to 0000 and the overflow remains clear; effectively repeating the last 64k step sequence.
Sync Pulse Modulation	If enabled, the transmission's preamble is made compatible with the other standard encoders. If disabled, an extra 10 TE long high pulse is inserted between the preamble and the standard synchronization header (provided for compatibility with previous Nanoteq products). **NOTE:** Synch Pulse Modulation should be enabled for any design desiring compatibility with standard KEELOQ decoders.

TABLE 3-6: SELECTABLE OPTIONS - HCS361 (CONT.)

Option	Description
Delayed Mode	This option enables the delayed transmission feature. A modified code word is transmitted if a button is pressed longer than a specified amount of time (determined by the baud rate selection). The modified code word inverts the lowest nibble of the discrimination bit field to flag the event. **NOTE:** This feature was introduced only for compatibility with previous Nanoteq NTQ105 encoder models. For new designs the user is recommended to refer to the Time Bits feature of the HCS362 encoder.
Code Word Blanking	Enables a long guard time. The long guard time can be used to lower the average power transmitted during a 100 μs period; to help meet FCC requirements.
Sync Counter A and B	Enter a 16-bit HEX value (0 through FFFF). They are the initial values of the synchronization counters.
Independent Mode	This bit enables the second counter (B) operations for function codes with the S3 input activated. It also enables IR mode modulation (40 kHz) of the data output for transmissions activated with both S2 and S3. **NOTE:** If enabled, secure learn Seed transmissions are incompatible with standard KEELOQ decoders as the upper most significant 16 Seed bits contain counter B instead of a valid Seed value.
User Bits	The user bits are a user-defined extension of the discrimination value. They are set by default to mirror bits 8 and 9 of the serial number. The bits can be crucial to distinguish between the two counters when independent mode is selected.

3.9 HCS362/rfHCS362 OPTIONS

The programming dialog for HCS362/rfHCS362 devices is shown in Figure 3-7. Selectable options in this dialog are described in Table 3-7.

FIGURE 3-7: PROGRAMMING HCS362/rfHCS362 ENCODER DIALOG

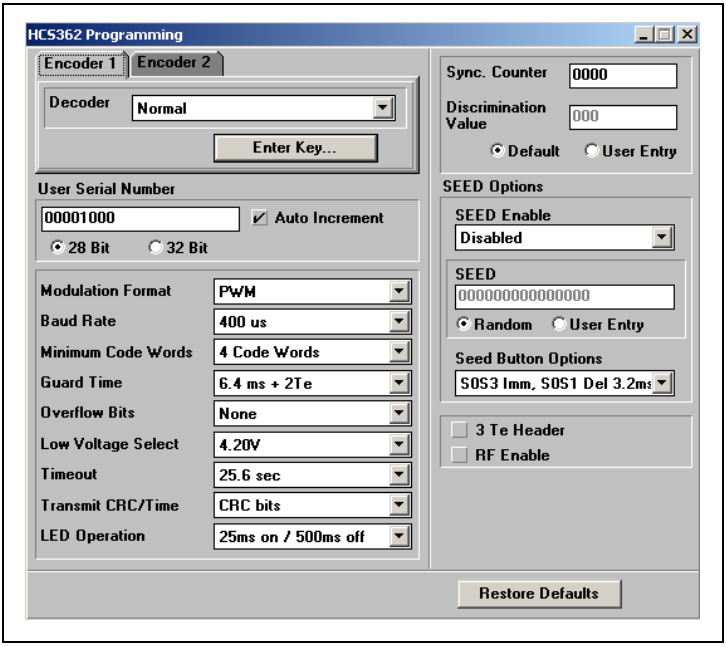


TABLE 3-7: SELECTABLE OPTIONS - HCS362/rfHCS362

Option	Description
Decoders	The HCS362 can use two encryption keys derived from a different Manufacturer Key for dual encoder operation. A Manufacturer's Key can be entered for both decoders.
Serial Number	Enter a 32-bit or 28-bit HEX value (0 through FFFF FFFF).
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Modulation Format	The HCS362 has 2 modulation formats: PWM and Manchester. **NOTE:** Selecting Manchester format will render the encoder incompatible with standard KEELOQ decoders.
Baud Rate	TE value used during transmissions. **NOTE:** Selecting an 800 μs baud rate makes the encoder incompatible with standard KEELOQ decoders.
Low Voltage Select	Selects the voltage at which the VLOW flag (bit) is set in a transmission. There are 8 possible values to select from. Four around the 2.15V value (for single 3V lithium battery applications) and four around the 4.2V (for double lithium cell, 6V applications).
Auto Shutoff Timer (or Time Out)	If enabled, the HCS362 will shut off after transmitting continuously for a predetermined time. This prevents a complete battery discharge if a button is accidentally stuck (in a pocket or purse).
Overflow Bits	The Counter Overflow option allows the user to extend the counter to up to 192k unique transmissions. Each time the counter wraps from FFFF to 0000 one of the overflow bits is cleared. These bits are never reset.
Minimum Code Words Transmitted	Used to select the minimum number of code words transmitted when the device is activated briefly (just longer than the minimum button de-bouncing time).

TABLE 3-7: SELECTABLE OPTIONS - HCS362/rfHCS362 (CONT.)

Option	Description
Guard Time	The long guard time can be used to lower the average power transmitted during a 100 μs period; to help meet FCC requirements.
CRC/Time Bits	The user can select the desired functionality of these two status bits. Selecting CRC will enable a two bit Cyclic Redundancy Check code used by the decoder to verify the integrity of a code word. Selecting Time bits will send different bit patterns at different points in time when pressing and holding a button. This permits multiple functions obtained from the same function code (button input).
LED Operation	Two different LED flashing rates are available which correspond to different low battery indication modes.
Sync Counter	Enter a 16-bit HEX value (0 through FFFF). This is the initial value of the synchronization counter.
Discrimination Value	The user can opt for the default setting equal to the 10 LSb's of the serial number or enter an arbitrary 10-bit value (0 through 3FF). **NOTE:** The latter will render the encoder incompatible with standard KEELOQ decoders.
SEED Enable Options	The user can select between four modes of operation: No Seed – disables the Seed transmission feature Limited Seed – disables Seed transmission when the synchronization counter reaches 80 HEX (128) Permanent Seed – Seed transmissions are permanently enabled Immediate Seed Only – Disables the Delayed Seed transmission function codes
SEED Button Options	This field determines what function code will produce an immediate or delayed Seed transmission.

TABLE 3-7: SELECTABLE OPTIONS - HCS362/rfHCS362 (CONT.)

Option	Description
SEED	The Seed is a 60-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 60-bit value. It will be transmitted in place of the hopping code and fixed code portions of the code word when the predetermined Seed function code (button) is activated.
3 x TE Header	This option allows the user to shorten the synchronization header to 3 x TE. **NOTE:** Selecting a short header length makes the encoder incompatible with standard KEELOQ decoders.
RF Enable	If enabled, this option will produce a high output on the S3 pin to use as an Enable signal for ASK PLL transmitter circuits. The S3 pin will still be available as a button input, but its de-bouncing and repeat timing functionality will be affected; its use cannot be recommended for frequent function codes use. (Refer to TB042 for schematics and various recommendations).

3.10 HCS365 OPTIONS

The programming dialog for HCS365 devices is shown in Figure 3-8. Selectable options in this dialog are described in Table 3-8.

FIGURE 3-8: PROGRAMMING HCS365 ENCODER DIALOG

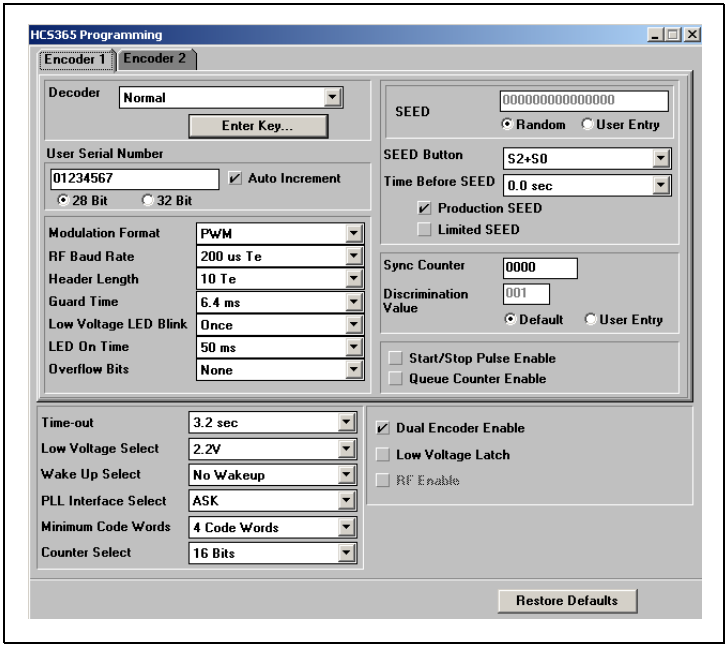


TABLE 3-8: SELECTABLE OPTIONS - HCS365

Option	Description
Decoder	The HCS365 can use two encryption keys derived from a different Manufacturer Key for dual encoder operation. A Manufacturer's Key can be entered for both decoders
Serial Number	Enter a 32-bit or 28-bit HEX value (0 through FFFF FFFF).
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Modulation Format	The HCS365 has 4 modulation formats: PWM, Manchester, VPWM and PPM. **NOTE:** Selecting any format other than PWM will render the encoder incompatible with standard KEELOQ decoders.
RF Baud Rate	TE value used during transmissions. **NOTE:** Selecting an 800 μs baud rate makes the encoder incompatible with standard KEELOQ decoders.
Overflow Bits	The Counter Overflow option allows the user to extend the counter to up to 192k unique transmissions. Each time the counter wraps from FFFF to 0000 one of the overflow bits is cleared. These bits are never reset.
Header Length	This option allows the user to shorten the synchronization header to 4 x TE. **NOTE:** Selecting a header length <10 x TE makes the encoder incompatible with standard KEELOQ decoders.
Guard Time	Extending the guard time can be used to lower the average power transmitted during a 100 μs period; to help meet FCC requirements.
Low Voltage LED Blink	If set to Once, the transmitter's LED blinks only once if a low battery condition is detected.
LED On Time	Allows selection of the LED blink timing.

TABLE 3-8: SELECTABLE OPTIONS - HCS365 (CONT.)

Option	Description
Discrimination Value	The user can opt for the default setting equal to the 10 LSb's of the serial number or enter an arbitrary 10-bit value (0 through 3FF). **NOTE:** The latter will render the encoder incompatible with standard KEELOQ decoders.
Sync Counter	Enter a 16-bit HEX value (0 through FFFF). This is the initial value of the synchronization counter.
SEED	A 60-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 60-bit value. It will be transmitted in place of the hopping and fixed code portions of the code word when the appropriate Seed function code (button) is activated.
Production SEED	Enables the transmission of MTX hopping code words followed by MTX Seed code words every time the Seed button combination is activated. This simplifies and accelerates learning in a production environment. **NOTE:** This functionality is automatically disabled once the synchronization counter reaches 80 HEX (128).
Limited SEED	If enabled, disables the Seed transmission when the Synchronization counter reaches 80 HEX (128).
Time before SEED (or Seed Delay)	Determines if and when a delayed Seed transmission will be activated by the Seed Button function code.
SEED Button	This field determines what function code will produce an immediate or delayed Seed transmission.
Start/Stop Pulse Enable	If enabled, this option adds a start bit (1) to the code word after the synchronization header and a stop bit (1) after the last status bit (end of the code word).
Queue Counter Enable	Activates the Queue status bits functionality. This allows an application to distinguish between single, double, triple and quadruple button presses.

TABLE 3-8: SELECTABLE OPTIONS - HCS365 (CONT.)

Option	Description
Low Voltage Select	Selects the voltage at which the VLOW flag (bit) is set in a transmission. There are 2 possible values to select from. The 2.2V value (for single 3V lithium battery applications) and the 3.2V (for 5V applications).
Auto Shutoff Timer (or Time Out)	If enabled, the HCS365 will shut off after transmitting continuously for a predetermined time. This prevents a complete battery discharge if a button is accidentally stuck (in a pocket or purse).
Minimum Code Words	Selects the minimum number of code words transmitted when the device is activated briefly (just longer than the minimum button de-bouncing time).
Counter Select	Selects the Synchronization Counter size to be the standard 16-bit or extended to 20-bit. **NOTE:** Selecting a 20-bit counter makes the encoder incompatible with standard KEELOQ decoders.
Low Voltage Latch	If enabled, low battery indication is latched on the first occurrence and remains so until the battery is changed, i.e., power cycled.
Wake-Up Select	Selects the length and duty cycle of an optional extra Wake-Up preamble, transmitted before the first code word.
PLL Interface Select	Determines the activation sequence of the RF Enable output and Data output. It is used to configure standard PLL integrated circuits for ASK or FSK mode. (Refer to TB042 for schematics and various recommendations).
Dual Encoder Enable	Makes the S3 pin act as a shift input to select between (sub) encoder #1 and #2 activation.
RF Enable	If enabled, this option will produce a high output on the S3 pin to use as an Enable signal for ASK PLL transmitter circuits. The S3 pin will still be available as a button input, but its de-bouncing and repeat timing functionality will be affected; its use cannot be recommended for frequent function codes use.

3.11 HCS370 OPTIONS

The programming dialog for HCS370 devices is shown in Figure 3-9 Selectable options in this dialog are described in Table 3-9.

FIGURE 3-9: PROGRAMMING HCS370 ENCODER DIALOG

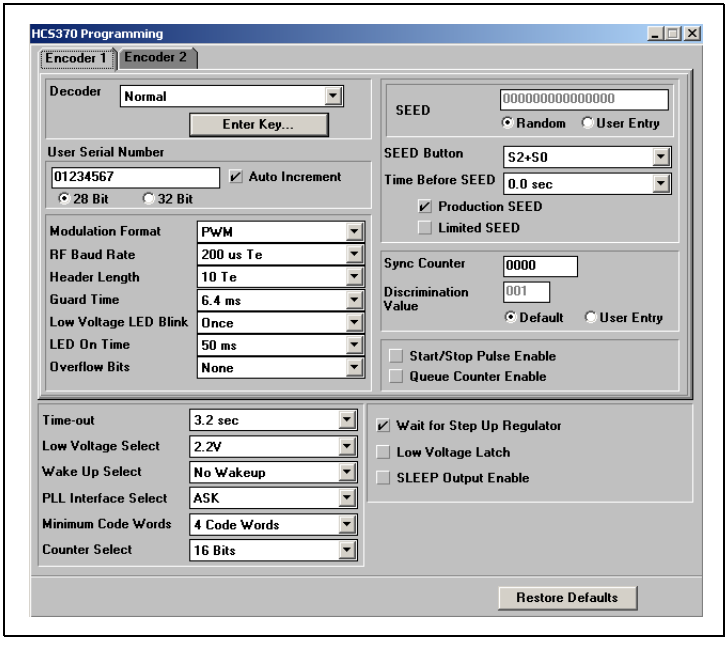


TABLE 3-9: SELECTABLE OPTIONS - HCS370

Option	Description
Decoder	The HCS370 can use two encryption keys derived from a different Manufacturer Key for dual encoder operation. A Manufacturer's Key can be entered for both decoders.
Serial Number	Enter a 32-bit or 28-bit HEX value (0 through FFFF FFFF).
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Modulation Format	The HCS370 has 4 modulation formats: PWM, Manchester, VPWM and PPM. **NOTE:** Selecting any format other than PWM, will render the encoder incompatible with standard KEELOQ decoders.
RF Baud Rate	TE value used during transmissions. **NOTE:** Selecting an 800 µs baud rate makes the encoder incompatible with standard KEELOQ decoders.
Overflow Bits	The Counter Overflow option allows the user to extend the counter to up to 192k unique transmissions. Each time the counter wraps from FFFF to 0000 one of the overflow bits is cleared. These bits are never reset.
Header Length	This option allows the user to shorten the synchronization header to 4 x TE. **NOTE:** Selecting a header length <10 x TE makes the encoder incompatible with standard KEELOQ decoders.
Guard Time	Extending the guard time can be used to lower the average power transmitted during a 100 µs period; to help meet FCC requirements.
Low Voltage LED Blink	If set to Once, the transmitter's LED blinks only once if a low battery condition is detected.
LED On Time	Allows selection of the LED blink timing.

TABLE 3-9: SELECTABLE OPTIONS - HCS370 (CONT.)

Option	Description
Discrimination Value	The user can opt for the default setting equal to the 10 LSb's of the serial number or enter an arbitrary 10-bit value (0 through 3FF). **NOTE:** The latter will render the encoder incompatible with standard KEELOQ decoders.
Sync. Counter	Enter a 16-bit HEX value (0 through FFFF). This is the initial value of the synchronization counter.
SEED	A 60-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 60-bit value. It will be transmitted in place of the hopping and fixed code portions of the code word when the appropriate Seed function code (button) is activated.
Production SEED	Enables the transmission of MTX hopping code words followed by MTX Seed code words every time the Seed button combination is activated. This simplifies and accelerates learning in a production environment. **NOTE:** This functionality is automatically disabled once the synchronization counter reaches 80 HEX (128).
Limited SEED	If enabled, disables the Seed transmission when the Synchronization counter reaches 80 HEX (128).
Time before SEED (or Seed Delay)	Determines if and when a delayed Seed transmission will be activated by the Seed Button function code.
SEED Button	This field determines what function code will produce an immediate or delayed Seed transmission.
Start/Stop Pulse Enable	If enabled, this option adds a Start bit '1' to the code word after the synchronization header and a Stop bit '1' after the last status bit (end of the code word).

TABLE 3-9: SELECTABLE OPTIONS - HCS370 (CONT.)

Option	Description
Queue Counter Enable	Activates the Queue status bits functionality. This allows an application to distinguish between single, double, triple and quadruple button presses.
Low Voltage Select	Selects the voltage at which the VLOW flag (bit) is set in a transmission. There are 2 possible values to select from. The 2.2V value (for single 3V lithium battery applications) and the 3.2V (for 5V applications).
Auto Shutoff Timer (or Time Out)	If enabled, the HCS370 will shut off after transmitting continuously for a predetermined time. This prevents a complete battery discharge if a button is accidentally stuck (in a pocket or purse).
Minimum Code Words	Selects the minimum number of code words transmitted when the device is activated briefly (just longer than the minimum button de-bouncing time).
Counter Select	Selects the Synchronization Counter size to be the standard 16-bit or extended to 20-bit. **NOTE:** Selecting a 20-bit counter makes the encoder incompatible with standard KEELOQ decoders.
Low Voltage Latch	If enabled, Low battery indication is latched on the first occurrence and remains so until the battery is changed, i.e., power cycled.
Wake-Up Select	Selects the length and duty cycle of an optional extra Wake-Up preamble, transmitted before the first code word.
PLL Interface Select	Determines the activation sequence of the RF Enable output and the Data output. It is used to configure standard PLL integrated circuits for ASK or FSK mode.

TABLE 3-9: SELECTABLE OPTIONS - HCS370 (CONT.)

Option	Description
Wait for Step-up Regulator	When enabled, the encoder will wait for the Step-up circuit to stabilize and the VIN voltage to rise above the minimum threshold before starting a transmission.
Sleep Output Enable	Makes the S5 pin act as Sleep output.

3.12 HCS410 OPTIONS

The programming dialog for HCS410 devices is shown in Figure 3-10. Selectable options in this dialog are described in Table 3-10.

FIGURE 3-10: PROGRAM HCS410 ENCODER DIALOG

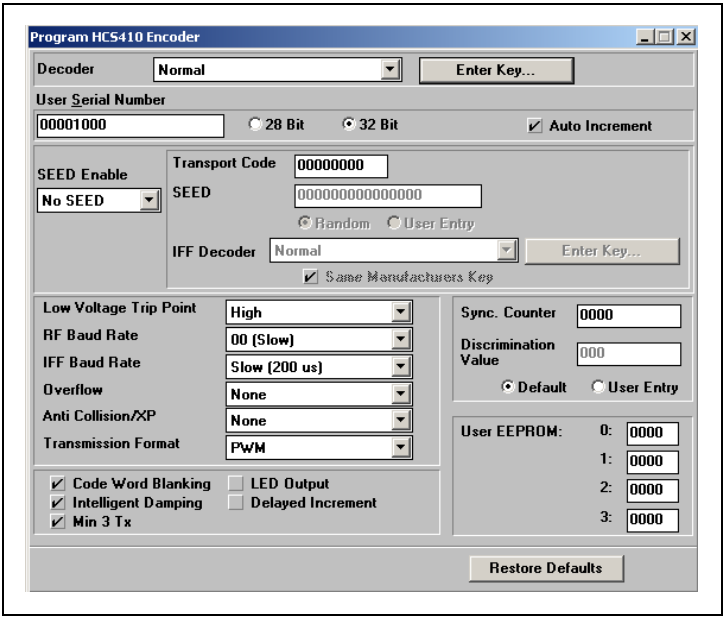


TABLE 3-10: SELECTABLE OPTIONS - HCS410

Option	Description
Decoder	This field selects the decoder device from the list of decoders.
Transponder Reader	The HCS410 can use a second encryption key (derived from a different manufacturer code) for IFF authentication.
Serial Number	Enter a 32-bit or 28-bit HEX value (0 through FFFF FFFF).
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Transmission Format	The HCS410 offers 2 modulation formats: PWM and Manchester. **NOTE:** Selecting Manchester format will render the encoder incompatible with standard KEELOQ decoders.
RF Baud Rate	TE value used during RF encoder transmissions. The indicated code-blanking ratio applies only if the Code Word Blanking option is enabled. **NOTE:** Selecting an 800 μs baud rate makes the encoder incompatible with standard KEELOQ decoders.
Low Voltage Trip Point	Selects the voltage at which the VLOW flag (bit) is set in a transmission. There are 2 possible values to select from. The 2.2V value (for single 3V lithium battery applications) and the 4.2V (for 6V applications).
IFF Baud Rate	TE value used during LF transponder communication.
Overflow	The Counter Overflow option allows the user to extend the counter to up to 192k unique transmissions. Each time the counter wraps from FFFF to 0000 one of the overflow bits is cleared. These bits are never reset.

TABLE 3-10: SELECTABLE OPTIONS - HCS410 (CONT.)

Option	Description
Minimum Code Words	Selects the minimum number of code words transmitted when the device is activated briefly (just longer than the minimum button de-bouncing time).
User EEPROM	Four 16-bit memory locations are available to read and write user data via LF transponder commands.
Anticollision/XP RF	This field configures the device for normal mode, Anti-collision mode, RF Echo mode or Proximity Activation mode.
Discrimination Value	The user can opt for the default setting equal to the 10 LSb's of the serial number or enter an arbitrary 10-bit value (0 through 3FF). **NOTE:** The latter will render the encoder incompatible with standard KEELOQ decoders.
Sync Counter	Enter a 16-bit HEX value (0 through FFFF). This is the initial value of the synchronization counter.
SEED Mode	The user can select between four modes of operation: No Seed – disables the whole Seed transmission feature. Limited Seed – disables Seed transmission when the synchronization counter reaches 80 HEX (128). Unlimited Seed – Seed transmissions are not limited by the counter value. Key2– Disables the Seed transmission and enables the second key to be used for IFF authentication.
SEED	A 60-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 60-bit value. It will be transmitted in place of the hopping and fixed code portions of the code word when the appropriate Seed function code (button) is activated. **NOTE:** The Seed location is shared with the second encryption key and the Transport Code field. Therefore Two Key operation cannot use Secure Learn algorithms since it would require the use of the Seed value.

TABLE 3-10: SELECTABLE OPTIONS - HCS410 (CONT.)

Option	Description
Transport Code	A 32-bit code used to protect the device from accidental re-programming during LF communication. It is defined as the 32 LSb's of the SEED/Key memory location. **NOTE:** Enabling the second key and generating the key with any method beyond Simple Learn makes tracking the transport code arduous.
LED Output	Makes the S2 pin the active LED output pin. The S2 pin can still be used as an input, but low battery indication is not available when pressing a button connected to it.
Delayed Increment	When enabled, produces an automatic 12 step increment to the synchronization counter a fixed time after the last button press.
Code Word Blanking	Selects transmit of every other or every fourth code word; reducing the number of code words transmitted per second and therefore the average energy radiated. This option can be used to lower the average power transmitted during a 100 μs period; to help meet FCC requirements. The blanking ratio depends on the selected Baud rate.
Intelligent Damping	If enabled, an automatic damping of the resonant circuit oscillation (coil antenna and capacitor) occurs to allow faster communication with high Q LF antennas.

3.13 HCS412 OPTIONS

The programming dialog for HCS412 devices is shown in Figure 3-11. Selectable options in this dialog are described in Table 3-11.

FIGURE 3-11: PROGRAM HCS412 ENCODER DIALOG

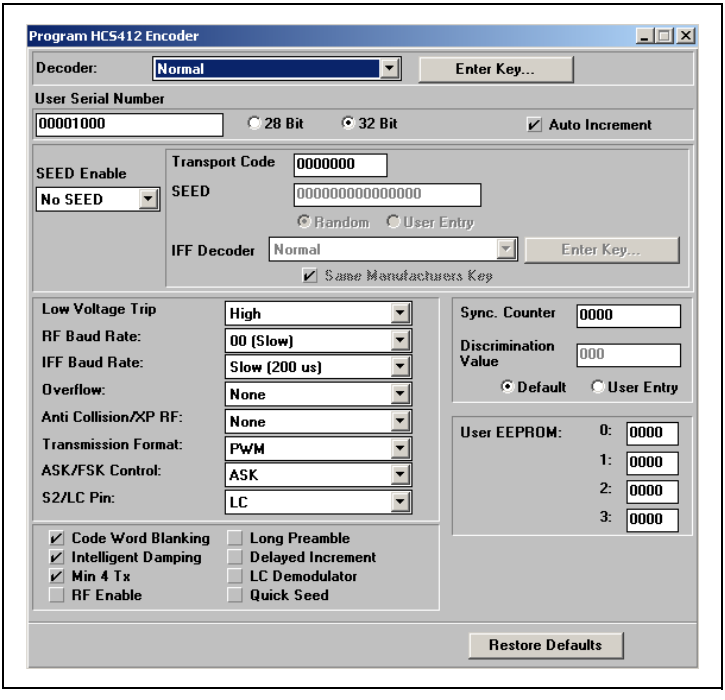


TABLE 3-11: SELECTABLE OPTIONS - HCS412

Option	Description
Decoder	This field selects the decoder device from the list of decoders.
Transponder Reader	The HCS412 can use a second encryption key (derived from a different manufacturer code) for IFF authentication. Linking the device to a transponder reader defines the manufacturer code and key generation method used to produce the second key.
Serial Number	Enter a 32-bit or 28-bit HEX value (0 through FFFF FFFF).
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Transmission Format	The HCS412 offers 2 modulation formats: PWM and Manchester. **NOTE:** Selecting Manchester format will render the encoder incompatible with standard KEELOQ decoders.
RF Baud Rate	TE value used during RF encoder transmissions. The indicated code-blanking ratio applies only if the Code Word Blanking option is enabled. **NOTE:** Selecting an 800 μs baud rate makes the encoder incompatible with standard KEELOQ decoders.
Low Voltage Trip	Selects the voltage at which the VLOW flag (bit) is set in a transmission. There are 2 possible values to select from. The 2.2V value (for single 3V lithium battery applications) and the 4.2V (for 6V applications).
IFF Baud Rate	TE value used during LF transponder communication.
Overflow	The Counter Overflow option allows the user to extend the counter to up to 192k unique transmissions. Each time the counter wraps from FFFF to 0000 one of the overflow bits is cleared. These bits are never reset.

TABLE 3-11: SELECTABLE OPTIONS - HCS412 (CONT.)

Option	Description
Minimum Code Words	Selects the minimum number of code words transmitted when the device is activated briefly (just longer than the minimum button de-bouncing time).
User EEPROM	Four 16-bit memory locations are available to read and write user data via LF transponder commands.
Anticollision/XP RF	This field configures the device for normal mode, Anticollision mode, RF Echo mode or Proximity Activation mode.
Discrimination Value	The user can opt for the default setting equal to the 10 LSb's of the serial number or enter an arbitrary 10-bit value (0 through 3FF). **NOTE:** The latter will render the encoder incompatible with standard KEELOQ decoders.
Sync Counter	Enter a 16-bit HEX value (0 through FFFF). This is the initial value of the synchronization counter.
SEED Mode	The user can select between four modes of operation: No Seed – disables the whole Seed transmission feature. Limited Seed – disables Seed transmission when the synchronization counter reaches 80 HEX (128). Unlimited Seed – Seed transmissions are not limited by the counter value. Key2– Disables the Seed transmission and enables the second key to be used for IFF authentication.

TABLE 3-11: SELECTABLE OPTIONS - HCS412 (CONT.)

Option	Description
SEED	A 60-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 60-bit value. It will be transmitted in place of the hopping and fixed code portions of the code word when the appropriate Seed function code (button) is activated. **NOTE:** The Seed location is shared with the second encryption key and the Transport Code field. Therefore Two Key operation cannot use Secure Learn algorithms since it would require the use of the Seed value.
Transport Code	A 32-bit code used to protect the device from accidental re-programming during LF communication. It is defined as the 32 LSb's of the SEED/Key memory location. **NOTE:** Enabling the second key and generating the key with any method beyond Simple Learn makes tracking the transport code arduous.
Quick Seed	This option enables a whole set of features among which a special short delay Seed mode.
S2 Input	Selects the S2 pin functionality between Transponder Coil input and Encoder S2 button input (or RF Enable output).
LC Demodulator	Forces the device to operate as a simple transponder demodulator. If enabled, the Data pin will output a logic level value respective of the presence or absence of signal on the LC input pins.
RF Enable	If enabled, this option will produce a high output on the S2 pin to use as an Enable signal for ASK or FSK PLL transmitter circuits. The S2 pin will still be available as a button input (unless configured as Transponder Coil input), but its de-bouncing and repeat timing functionality will be affected; its use cannot be recommended for frequent function codes use.

TABLE 3-11: SELECTABLE OPTIONS - HCS412 (CONT.)

Option	Description
ASK/FSK Control	Determines the activation sequence of the RF Enable output and the Data output. It is used to configure standard PLL integrated circuits for ASK or FSK mode. (Refer to TB042 for schematics and various recommendations)
Delayed Increment	When enabled, produces an automatic 12 step increment to the synchronization counter a fixed time after the last button press.
Code Word Blanking	Selects transmit of every other or every fourth code word; reducing the number of code words transmitted per second and therefore the average energy radiated. This option can be used to lower the average power transmitted during a 100 μs period; to help meet FCC requirements. The blanking ratio depends on the selected baud rate.
Intelligent Damping	If enabled, an automatic damping of the resonant circuit oscillation (coil antenna and capacitor) occurs to allow faster communication with high Q LF antennas.
Long Preamble	Enables an optional extra Wake-Up preamble transmitted before the first code word.

3.14 HCS473 OPTIONS

The programming dialog for HCS473 devices is shown in Figure 3-12. Selectable Encoder options in this dialog are described in Table 3-12. Selectable Transponder options in this dialog are described in Table 3-13.

FIGURE 3-12: PROGRAMMING HCS473 DIALOG

TABLE 3-12: ENCODER OPTIONS HCS473

Option	Description
Decoder	This field selects the decoder device from the list of decoders.
Serial Number	Enter a 32-bit HEX value (0 through FFFF FFFF). If the Extended Serial Number option is **not** selected, only the 28 LSb's will be transmitted.
Auto Increment	This will cause the serial number field to increment if an encoder is programmed successfully.
Modulation Format	The HCS473 offers 2 modulation formats: PWM and Manchester. **NOTE:** Selecting Manchester format will render the encoder incompatible with standard KEELOQ decoders.
RF Baud Rate	TE value used during RF transmissions. **NOTE:** Selecting an 800 μs baud rate makes the encoder incompatible with standard KEELOQ decoders.
Low Voltage Select	Selects the voltage at which the VLOW flag (bit) is set in a transmission. There are 2 possible values to select from. The 2.2V value (for single 3V lithium battery applications) and the 3.2V (for 5V applications).
Minimum Code Words	Selects the minimum number of code words transmitted when the device is activated briefly (just longer than the minimum button de-bouncing time).
Preamble	The user can select the length and duty cycle of the preamble.
Header Width	This option allows the user to shorten the synchronization header to 4 x TE. **NOTE:** Selecting a header length <10 x TE makes the encoder incompatible with standard KEELOQ decoders.
Guard Time	This option can extend the guard time between code words to lower the average power transmitted during a 100 μs period; to help meet FCC requirements.

TABLE 3-12: ENCODER OPTIONS HCS473 (CONT.)

Option	Description
Time-Out	If enabled, the HCS473 will shut off after transmitting continuously for a predetermined time. This prevents a complete battery discharge if a button is accidentally stuck (in a pocket or purse).
PLL Select	Determines the activation sequence of the RF Enable output and Data output. It is used to configure standard PLL integrated circuits for ASK or FSK mode.
Sync. Counter	Enter a 16-bit HEX value (0 through FFFF). This is the initial value of the synchronization counter. Selecting the "20 Bit" check box extends the counter length. **NOTE:** Selecting a 20-bit counter makes the encoder incompatible with standard KEELOQ decoders.
Queue Counter	Activates the Queue status bits functionality. This allows an application to distinguish between single, double, triple and quadruple button presses.
S3/RF Enable	If enabled, this option will produce a high output on the S3 pin to use as an Enable signal for PLL transmitter circuits. The S3 pin will still be available as a button input, but its de-bouncing and repeat timing functionality will be affected; its use cannot be recommended for frequent function codes use.
Discrimination Bits	The user can opt for the default setting equal to the 10 LSb's of the serial number or enter an arbitrary 10-bit value (0 through 3FF). **NOTE:** The latter will render the encoder incompatible with standard KEELOQ decoders.
SEED	A 60-bit value that can be either random (recommended for Secure Learn methods) or an arbitrary 60-bit value. It will be transmitted in place of the hopping and fixed code portions of the code word when the appropriate Seed function code (button) is activated.

TABLE 3-12: ENCODER OPTIONS HCS473 (CONT.)

Option	Description
SEED Production Mode	Enables the transmission of MTX hopping code words followed by MTX Seed code words every time the Seed button combination is activated. This simplifies and accelerates learning in a production environment. **NOTE:** This functionality is automatically disabled once the synchronization counter reaches 80 HEX (128).
Limited SEED	If enabled, disables Seed transmissions when the synchronization counter reaches 80 HEX (128).
SEED Button	This field determines what function code will produce an immediate or delayed Seed transmission.
Time before SEED	Determines if a delayed Seed transmission will be activated by the Seed Button function code and the delay requested.
Overflow Bits	The Counter Overflow option allows the user to extend the counter to up to 192k unique transmissions. Each time the counter wraps from FFFF to 0000 one of the overflow bits is cleared. These bits are never reset.

TABLE 3-13: TRANSPONDER OPTIONS HCS473

Option	Description
Transponder Reader	The HCS473 uses a second encryption key (derived from a different manufacturer code) for IFF authentication.
LF Baud Rate	Selects the LF TE value used for transponder communication
Short Preamble	The RF response preamble, through the data pin, is normally configured with the encoder options. However, if a shorter response time is required for Transponder mode the preamble can be reduced to eight RF TE (4 high pulses) with the Short Preamble option. **NOTE:** This only affects the responses as a result of transponder commands and does not change normal code hopping transmissions.
Anti-Collision	Enables the anti-collision protocol. When enabled, the HCS473 must first be successfully addressed with the select encoder command before it will respond to the other commands.
Intelligent Damping	The Intelligent damping option enables a high resistive shorting of the LC pins when the HCS473 is expecting the LC signal to go low. This provides quicker decay times when the field is removed from high Q antennae. Quicker decay times translate to higher potential baud rates.
LF Response	The device replies to a transponder command through the LF channel.
RF Response	The device replies to a transponder command through the RF channel. **NOTE:** Both responses can be enabled at the same time; the RF response will occur first.

TABLE 3-13: TRANSPONDER OPTIONS HCS473 (CONT.)

Option	Description
Proximity Activation	If enabled, the device goes through a normal power-up sequence when a wake pulse is detected. After the acknowledge is returned, the HCS473 waits 10 ms to receive any transponder commands. If no commands are received, the code hopping transmission is generated and the minimum code words (set with MTX option) are transmitted.
Transport Code	Before writing the serial number or Vehicle ID's, a 32-bit transport code (password) must be accepted to gain write access to these memory areas.
User Memory	Four 16-bit memory locations are available to read and write user data via LF transponder commands.
Vehicle ID	Unique 12-bit values used during the anti-collision protocol to identify a vehicle.
Token ID	Unique 4-bit values used during the anti-collision protocol to identify a token linked with a specific vehicle.

3.15 HCS512 OPTIONS

The programming dialog for HCS512 devices is shown in Figure 3-13. Selectable options in this dialog are described in Table 3-14.

FIGURE 3-13: PROGRAM HCS512 DECODER DIALOG

TABLE 3-14: SELECTABLE OPTIONS - HCS512

Option	Description
Key Generation Source	Select the key generation source: **Serial Number:** Normal learn mode **Seed:** Secure learn mode
Key Generation Algorithm	Select the algorithm used to generate encoder keys. Either algorithm uses the manufacturer's code and the key generation source when an encoder is learned. The XOR algorithm can only be used if the Seed is used as the key generation source.
Sleep Mode	If checked, Sleep mode is enabled. Sleep mode can be used to reduce current consumption when there is no activity on its RF and learn input pins. During sleep the clock stops, significantly reducing operating current.

3.16 HCS515 OPTIONS

The programming dialog for HCS515 devices is shown in Figure 3-14. Selectable Decoder options in this dialog are described in Table 3-15.

FIGURE 3-14: PROGRAM HCS515 DECODER DIALOG

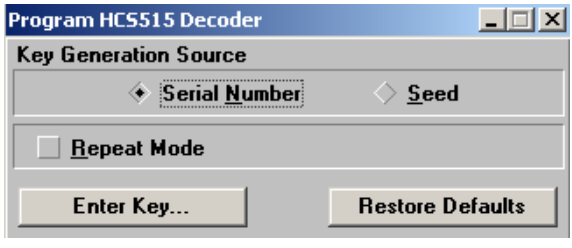


TABLE 3-15: SELECTABLE DECODER OPTIONS - HCS515

Option	Description
Key Generation Source	Select the key generation source: **Serial Number:** Normal learn mode **Seed:** Secure learn mode
Repeat	If enabled, the decoder will repeat the valid transmission indication as long as the encoder transmits. Otherwise the valid indication is given only once for each encoder button press.

NOTES:

NOTES:

Worldwide Sales and Service

AMERICAS

Corporate Office
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
480-792-7627
Web Address:
www.microchip.com

Atlanta
Tel: 770-640-0034
Fax: 770-640-0307

Boston
Tel: 978-692-3848
Fax: 978-692-3821

Chicago
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Tel: 949-263-1888
Fax: 949-263-1338

Phoenix
Tel: 480-792-7966
Fax: 480-792-4338

San Jose
Tel: 408-436-7950
Fax: 408-436-7955

Toronto
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Australia
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-85282100
Fax: 86-10-85282104

China - Chengdu
Tel: 86-28-86766200
Fax: 86-28-86766599

China - Fuzhou
Tel: 86-591-7503506
Fax: 86-591-7503521

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Qingdao
Tel: 86-532-5027355
Fax: 86-532-5027205

China - Shanghai
Tel: 86-21-6275-5700
Fax: 86-21-6275-5060

China - Shenzhen
Tel: 86-755-82901380
Fax: 86-755-82951393

India
Tel: 91-80-2290061
Fax: 91-80-2290062

Japan
Tel: 81-45-471-6166
Fax: 81-45-471-6122

Korea
Tel: 82-2-554-7200
Fax: 82-2-558-5934

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan
Tel: 886-2-2717-7175
Fax: 886-2-2545-0139

EUROPE

Austria
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark
Tel: 45-4420-9895
Fax: 45-4420-9910

France
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands
Tel: 31-416-690399
Fax: 31-416-690340

United Kingdom
Tel: 44-118-921-5869
Fax: 44-118-921-5820

10/3/03