TB086

PIC12F635/PIC16F636/PIC16F639 Cryptographic Module General Overview

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INTRODUCTION

This application note describes the general use of the PIC12F635/PIC16F636/PIC16F639 Cryptographic module. Technical Brief TB076, "*Using the KEELOQ® Compatible Cryptographical Module*" (DS91076) and the corresponding KEELOQ® Encoder License Agreement are needed to use the Cryptographic module.

Obtaining TB076 requires the completion of a licensing agreement that must be obtained through the Microchip Technology Inc. web site (www.microchip.com) and approved by the Microchip Technology Inc. Legal Department. The agreement form is located under the KEELOQ® Authentication Products section of our web site (www.microchip.com/keeloq).

Technical Brief TB076 describes how to implement cryptography on these products using the hardware peripheral. The Cryptographic module is capable of handling KEELOQ® compatible encoding/decoding, as well as application specific encoding/decoding.

After receiving approval by the Microchip Technology Legal Department, customers will receive Application Note AN249, "*KEELOQ® Transmitter Shell Using the PIC12F6XX*" (DS00249) as well as the TB076 Technical Brief on a CD ROM. Additionally, the disk includes firmware implementations of the KEELOQ encryption algorithm for PIC12, PIC16 and PIC18 devices with minor modifications, the algorithms for the PIC12 and PIC16 devices can be adapted to the PIC10 series of PICmicro® microcontrollers.

Note:	If the PIC12F635/PIC16F636/PIC16F639 devices are designed into a system without using the KEELOQ Compatible Cryptographic module, then a licensing agreement is not required.

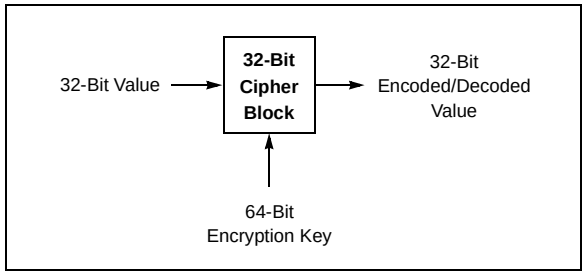
Additionally, firmware libraries for implementing decoding routines on PICmicro microcontrollers are also available by ordering the KEELOQ CD-ROM (DS40038). Please contact your local Microchip Technology sales office to order this CD-ROM.

CRYPTOGRAPHIC MODULE FEATURES

The PIC12F635/PIC16F636/PIC16F639 devices can be used as encoders or decoders based on the configuration settings of the peripheral. The cryptographic peripheral only does the actual data encryption and decryption. The peripheral requires that the following internal RAM locations are initialized before starting a KEELOQ compatible conversion:

1. Load a 64-bit encryption/decryption key into KEY<7:0>. This is completed in two 32-bit steps through the use of the CRCON and CRDAT<3:0> registers.
2. Load the Iteration Counter (ICR). This is also loaded through the CRCON and CRDAT0 register.
3. Load of the actual 32 bits of data using the CRCON and CRDAT<3:0> registers.

FIGURE 1: CRYPTOGRAPHIC MODULE



The conversion is then started by setting the GO/$\overline{\text{DONE}}$ bit in CRCON register and waiting for it to be cleared by the hardware. The peripheral can also generate an interrupt if enabled, which can also be used to poll for the end of the cryptographic process.

A main program in the C language will typically look like Example 1.

EXAMPLE 1:

```
void main(){
    .
    .
    .
Load_Encryption_Key()
Load_ICR()
Load_CSR()
//Start conversion by setting GO/DONE bit
//Wait for interrupt or GO/DONE to be cleared
     .
     .
     .
}
```

SUPPORTING FIRMWARE REQUIREMENTS

Encryption keys and serial numbers can be stored either in program memory or in data memory, which is up to the user to decide. The remaining code can be customized to implement KEELOQ compatible decoders and encoders as required by system specifications. This includes, but is not limited to:

- Keeping track of the 16-bit synchronization counter; storing the counter in EEPROM, adding EEPROM write error recovery schemes, and incrementing the counter before transmitting any new data.
- Reading and debouncing button inputs.
- Controlling actual transmission output. (Transmissions need to be firmware controlled on any of the available I/O pins.)
- Monitoring the battery voltage (i.e., using PLVD) and generating user feedback (i.e., LEDs, successful transmission or reception, etc.).
- Loading the pertinent information into the Code Shift Register (CSR), such as the function code, discrimination bits, and the synchronization counter data.

The data format and the communications protocol must also be customized by the end-user. Additionally, if end-users want to implement a solution similar to an existing KEELOQ device, such as any of the KEELOQ encoders, but with more features, they should reference the applicable KEELOQ device data sheet for information of what to store in EEPROM, how to transmit the actual data stream, how to setup the CSR registers, mapping how to sample and map of the input buttons and any outputs that exist.

As one can discern, the type of transmission can be implemented in any manner that is appropriate to system requirements such as Pulse Code Modulation (i.e., PWM, VPWM, PPM, Manchester, etc.). Validation and software testing are also left to customers, as is generating their own SQTP^{SM} data files. Microchip will handle all customer projects as either a standard QTP or SQTP (serialized) PICmicro microcontroller design with the same development tools and production support that are currently available.

CODE SPACE AND TIME RESOURCES

Since these PICmicro microcontrollers can implement the KEELOQ algorithm in a hardware module, the actual encoding and decoding process is typically 50 times faster than completing the algorithm in firmware with a processor running at the same speed (~500 µs vs. ~25 ms, with a 14-bit PICmicro microcontroller core running at 4 MHz).

In terms of resource space, the encryption/decryption routines typically utilize about 60 to 70 lines of code in a PICmicro microcontroller and about 14 RAM locations. All of these instructions and handling of volatile variables are now handled within the hardware peripheral after it is initialized, properly loaded and set into motion to complete the encryption/decryption process.

CONCLUSION

This document describes the general use of the Cryptographic module included on the PIC12F635/PIC16F636/PIC16F639. Additionally, a general description of the type of supporting firmware designers can expect to implement to effectively use the Cryptographic module was provided. An explanation of the necessity and process of obtaining a licensing agreement, the application note and technical brief relating to this module was included.

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

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- Microchip is willing to work with the customer who is concerned about the integrity of their code.
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