AN1248

PIC® MCU-Based KEELOQ® Receiver System Interfaced Via I²C™

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INTRODUCTION

A number of devices in the PIC® microcontroller family have a Synchronous Serial Port (SSP) or Master Synchronous Serial Port (MSSP) peripheral capable of implementing the I²C™ communication protocols. Using these peripherals, a PIC microcontroller device programmed as a KEELOQ® receiver/decoder can be interfaced into a larger system, such as a home security system, via the I²C protocol. This application note describes a simple system that uses a PIC16F690 as a KEELOQ receiver and decoder, and also uses I²C communication to send and receive status and command messages.

For more information on I²C protocol specification, please refer to the **Section "REFERENCES"**.

BACKGROUND

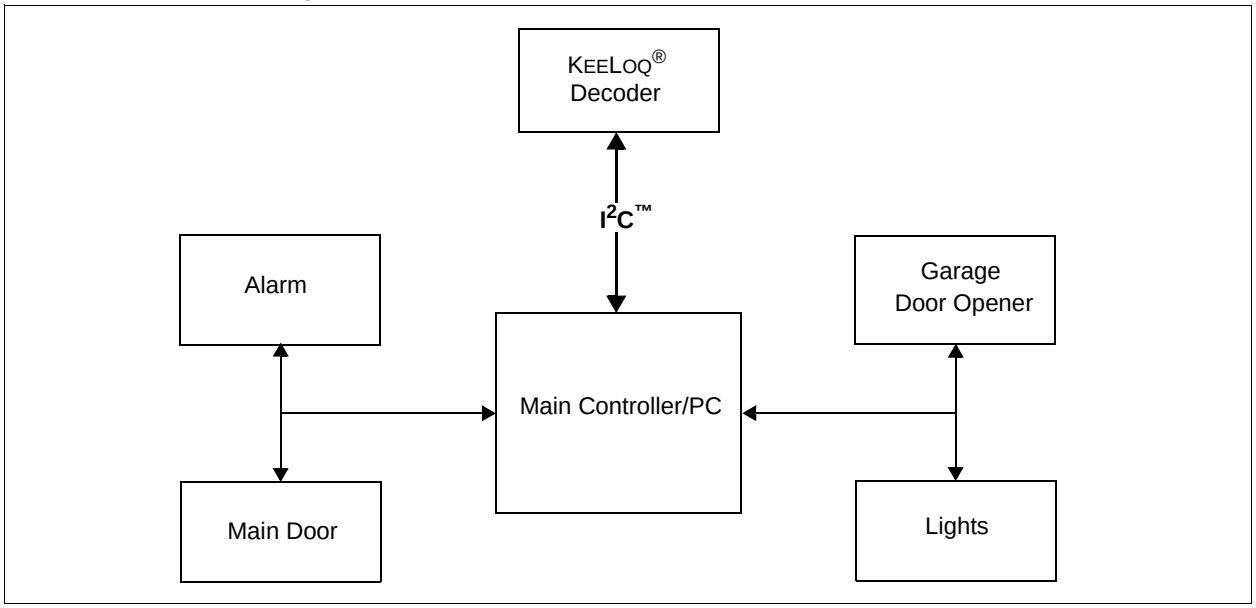
Traditionally, KEELOQ is viewed as a stand-alone system. An RF receptor PCB with a KEELOQ device is located in proximity of the device being secured (garage door, vehicle access, etc.). The KEELOQ decoder then waits for an incoming RF transmission, decodes the transmission and decides if it is valid. If valid, an appropriate output is activated. All housekeeping routines are entered through buttons in the decoder assembly: learn transmitters, erase transmitters command, etc.

Some systems, such as home security and automation, require the security of KEELOQ, but also need the KEELOQ decode module to be part of a larger automation system controlled by a main processor, such as the system shown in Figure 1. The KEELOQ module only decodes the signal, decides if it comes from a valid transmitter and sends the decoded function to the main processor. For example, in a home automation system, this main processor receives the function code from the KEELOQ receiver and decides what action to take; deactivate the main alarm, open the garage door, etc., and send the command to the appropriate module.

The main processor also instructs the KEELOQ module when to enter into Learn mode, when to erase a transmitters' information, or when to send a status message.

A practical solution is to implement the KEELOQ decoding algorithm in a microcontroller and perform all the housekeeping via I²C communication between the central processor and the KEELOQ microcontroller. The KEELOQ microcontroller will be operating in I²C Slave mode.

FIGURE 1: KEELOQ® DECODER AS A MODULE IN AN I²C™ BUS SYSTEM



IMPLEMENTATION

Figure 2 shows the implementation of an I²C interface with a KEELOQ decoder. For this application note, a PIC16F886 having an MSSP module is used. This implementation can also be implemented on a device with a SSP module, such as a PIC16F690.

The I²C Slave mode portion of the application is implemented as shown in AN734, *"Using the PIC® Devices' SSP and MSSP Modules for Slave I²C™ Communication*".

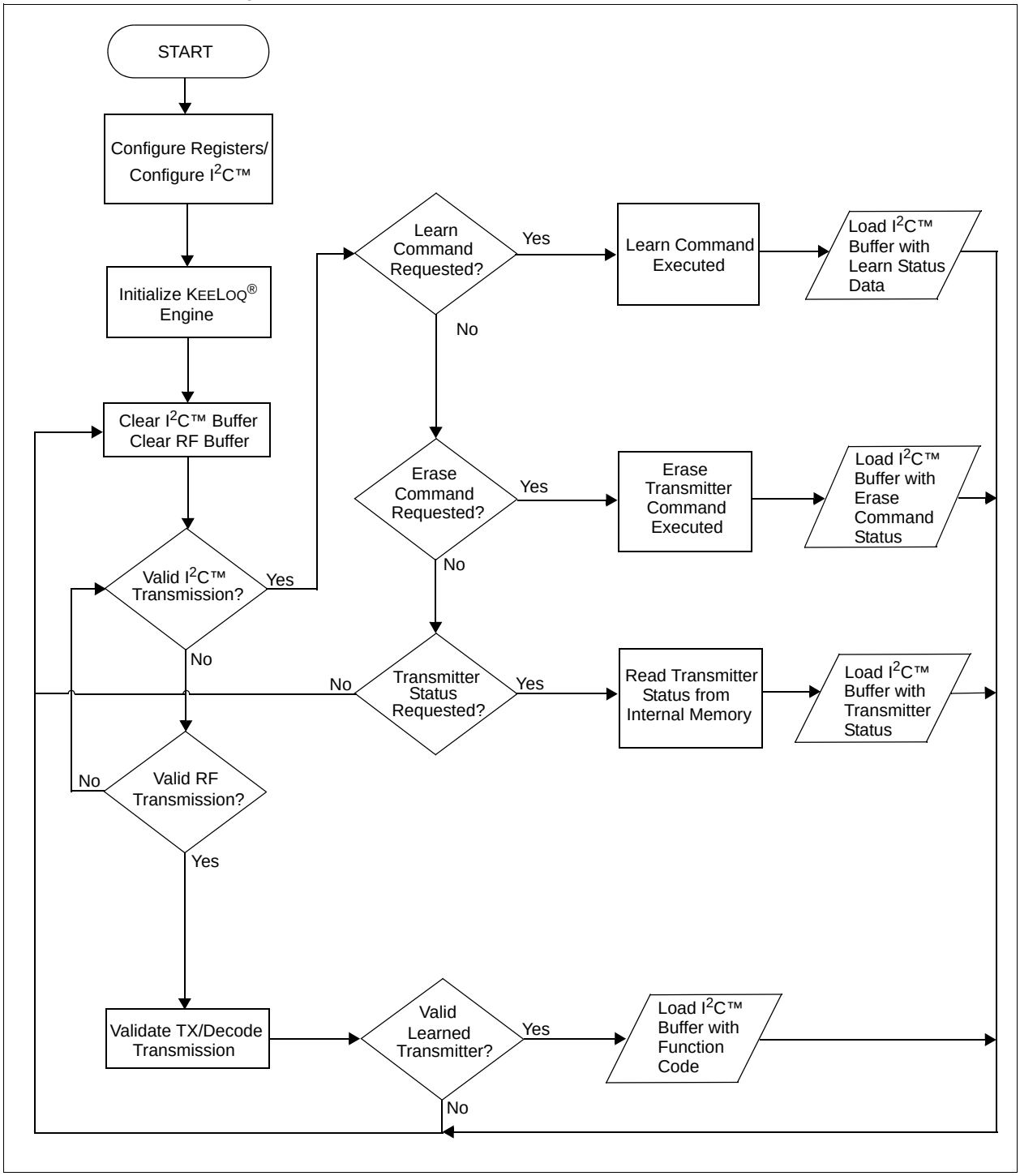
In I²C there are two types of events: write operation and read operation. When an SSP interrupt is detected, the SSP module will indicate what I²C event has occurred. An I²C write operation will let the receiver know what command will need to be executed. An I²C read operation requests the receiver to provide a current status.

For this implementation the write operation will consider the following commands:

EXAMPLE 1: COMMANDS

Value	Command
01	Learn Transmitter
02	Erase All Transmitters
03	Confirm Transmitter Learned

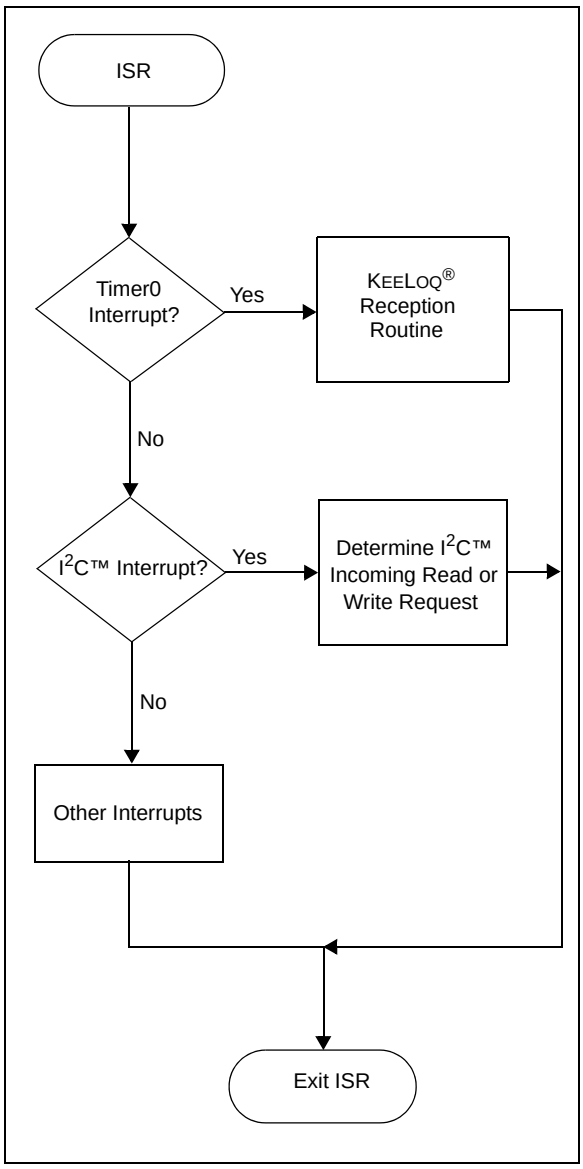
FIGURE 2: KEELOQ® DECODER WITH I²C INTERFACE



KEELOQ decoding is implemented as shown in AN672, *"PIC® MCU Mid-range MCU Code Hopping Decoder"*.

The KEELOQ receiving routine is interrupt driven based on Timer0. With the I²C communications this give us two sources of interrupts: SSP for I²C communication, and TMR0 for KEELOQ reception. The interrupt routine flow diagram is shown in Figure 3.

FIGURE 3: INTERRUPT ROUTINE FLOW DIAGRAM



In this application, the main processor (it could be a PC or another microcontroller), will be operating in I^2C Master mode and sends commands as detailed in Example 2.

The write request consists of three bytes: module address, task byte and a third byte for additional information, as needed.

EXAMPLE 2: WRITE REQUEST

```
Byte 1   Keeloq Module Address
Byte 2   Command Byte
Byte 3   Additional Info
```

The command byte indicates to the KEELOQ module what task to perform.

The KEELOQ decoder microcontroller can receive a variety of commands via I^2C, such as: Learn a Transmitter, Erase All Transmitters, Decoder Status, etc.

A read request is used to retrieve status data from the KEELOQ module. Status data includes the reception of a valid transmitter signal. The data sent from the KEELOQ module is in the following format:

EXAMPLE 3: SENT DATA FORMAT

```
Byte 1     Master Controller Address
Byte 2     Command Performed
Byte 3     Transmitter Information
```

ADVANTAGES

The main advantage of this type of system is that the KEELOQ receiver can be designed as a “plug-in” module to the overall system, releasing the processor to do other housekeeping tasks. The system is secure since all the encryption and decryption is done inside the microcontroller.

CONCLUSION

A decoding KEELOQ based controller, that is part of a larger system, can be interfaced to other microcontroller units via I^2C. This adds flexibility to system designs because the decoder commands can be managed through a separate microcontroller without compromising security. Only decoded data and commands travel through the I^2C bus.

REFERENCES

AN734, *“Using the PIC® Devices’ SSP and MSSP Modules for Slave I2C™ Communication*”

AN672, *“PIC® MCU Mid-range MCU Code Hopping Decoder”*

The I2C™ Bus Specification, Philips Semiconductor, Version 2.1, 2000,

http://www.nxp.com/I2C

ADDITIONAL INFORMATION

Microchip's Secure Data Products are covered by some or all of the following:

Code hopping encoder patents issued in European countries and U.S.A.

Secure learning patents issued in European countries, U.S.A. and R.S.A.

REVISION HISTORY

Revision B (June 2011)

- Added new section **Additional Information**
- Minor formatting and text changes were incorporated throughout the document

NOTES:

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