

DigiLock

iButton[®] Digital Key Access System
for Home Automation & Security Systems

March 1999

v1.02

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DigiLock Overview

The DigiLock is a very flexible and secure digital access system that uses Dallas Semiconductor iButtons® to identify people, usually to grant them access to a secure area (i.e. your home). iButtons have unique 64-bit serial numbers and are the size of a large watch battery. This unique 64-bit serial number is used to grant or deny access to someone. iButtons can be attached to key chains, wallets, watch bands, and even rings making it very easy to store and carry them with you. iButtons are accessed via a small probe contact the size of a dime. You simply press the iButton onto the probe and it is instantly read. A multi-color LED shows if access is granted or denied.

DigiLock's PIC processor has internal EEPROM, which can store up to seven unique iButton serial numbers allowing access to seven different people. Configuration is a snap. Power the DigiLock up in Configuration mode and press each iButton you want to authorize into the iButton probe. The serial number is stored in EEPROM so it is saved, even if the power is shut off. To ensure security and proper validation, the received IDs are validated using an 8-bit CRC code.

iButton probes can be located at all of your home's doors and are connected to the central DigiLock board via a 2 wire microLAN (1 data & 1 ground). No other power wire is needed. Standard Category 5 wire is recommended and multiple iButton probes can be connected to the microLAN, which can be up to 300 feet in length. If used, the Multi-color LED will use up one other twisted pair.

The DigiLock can be used in many different access scenarios. It can function as a stand-alone unit and power an electric door strike via an external relay. The DigiLock also can be interfaced to any Home Security or Home Automation System with digital inputs. The IDOK digital output is pulsed when any valid iButton code is read and matched to an ID learned during configuration. Seven other output lines are associated with a specific iButton and are pulsed when that specific ID is read, so you can tell who is requesting access or grant access to different areas based on the iButton code read. This allows your Home Automation system to respond differently to different members of your family beyond just granting them access. You can even track who came home and when.

Building the DigiLock

If you purchased a kit from CCC, check the contents to ensure you have all the necessary parts:

DigiLock Kit Contents

Qty	Description	Board Ref
1	DigiLock Circuit Board	NA
1	18-Pin DigiLock IC (16F84)	U1
1	7805 Voltage Regulator (Metal Tab on Top)	U2
1	4MHz Crystal (Silver & Oval Shaped)	X1
1	18-Pin IC Socket	NA
2	20pF Capacitors (look like green Resistors)	C1, C2
1	0.1μF Tantalum Capacitors (Blue Teardrop)	C4
1	100μF 35V Electrolytic Capacitor (Can Shaped)	C3
2	PN2222 NPN Transistors	Q1, Q2
3	10K ¼ watt Resistors (Brown-Black-Orange)	R1, R2, R3
1	4.7K ¼ watt Resistor (Yellow-Purple-Red)	R4
2	1K ¼ watt Resistors (Brown-Black-Red)	R5, R6
1	180Ω ¼ watt Resistor (Red-Red-Brown)	R7
1	2 lead Bi-Color LED	D1
1	3 lead Bi-Color LED w/ Resistor	NA
1	2x8 Square Pin Header	J1
3	2 Position Terminal Blocks	J2, J3, J4
1	2x3 Square Pin Header	J5
3	Shorting Jumpers	NA
1	Ribbon Cable with Connector	NA
1	iButton Panel Mount Probe	NA
1	iButton w/ Plastic Key Chain FOB	NA
1	LED Mounting Clip & Ring	NA

Deluxe kits have a pre-built wall plate with probe & LED instead of an individual probe and LED. The Deluxe kit also includes an extra iButton on a plastic key ring holder.

Construction Hints

- When building the circuit, mark off each connection on the schematic after it is soldered into place.
- Use ESD protection when handling the ICs! If you do not have a strap, touch something grounded before handling the chips.
- Use the included PCB mask diagram to place the components in the proper place. Ensure your PCB is properly oriented with the diagram. Note the Component and Solder Side notations. When all parts are in place, some holes will remain. These are vias to pass signals from one side to the other.
- Construct the circuit using the IC sockets, leaving the chips out. When you are done, check that +5V and GND appear on the proper pins in the IC sockets. Then remove power and install the chips.
- The LED outputs can handle 500mA each which is approximately 25 LED's.
- The digital output pins can only handle 20mA each. If you need more current, use a relay with a low coil current or a high current buffer/driver (to drive things like electric door strikes, etc.)

Step by Step Construction

- 1) Orient your circuit board so "Component Side" is on the right. CCC DigiLock should be on the top and the I/O labels should be on the bottom. See the diagram on the next page (available in hardcopy versions only). If you are unsure of the placement of a part, place the board under the diagram below and see which holes line up.
- 2) Install Resistors R1-R7. Also, install C1 & C2, which look like green resistors. Resistors and Caps C1 & C2 have no polarity and can be installed either way.
- 3) Install the 18-pin IC socket, being careful not to bridge any pins together when soldering. Ensure the dimple on the edge faces to the RIGHT. Be careful not to bridge pins together with solder as well as the traces which run near each pin.
- 4) Install the 4MHz Crystal (X1). Can be oriented either way.
- 5) Install capacitors C3 & C4 according to the diagram. POLARITY IS IMPORTANT! The positive lead of each cap should go into the square pad.
- 6) Install Q1 & Q2, making sure they align as shown in the diagram below. The flat face must face the flat line in the diagram towards the Component Side label. Try to solder these parts quickly, as excessive heat can damage them. Clipping an alligator clip to the lead being soldered will act as a heatsink.
- 7) Install the D1 LED and ensure the flat edge is oriented towards the lower left corner of the board as shown in the diagram below.
- 8) Install the 7805 voltage regulator (U2) so that the back of the device with the metal tab faces to the right. The 7805 imprint should face to the left.
- 9) Install the 2x3 header as J5. Install the 2x8 J1 header connector, making sure you don't bridge any pins together while soldering. Orient them either way. **Note**, if you are using the DigiLock in standalone mode and only need the IDOK output, don't install J1 and simply solder wires to the IDOK and GND pin pads and connect them to your external door strike driver circuit.
- 10) Install the Terminal Blocks as indicated for J2, J3, & J4. So the wire inlets face down.
- 11) Without installing the chip, apply +12V and use a voltmeter to check that +5V appears at the proper pins for U1 (See Schematic). The microLAN data output should also be at +5V. **ENSURE PROPER VOLTAGE POLARITY OR THE DIGI-LOCK WILL BE RUINED!**
- 12) Disconnect the power and install the DigiLock IC ensuring Pin 1 (indicated by a small dimple) is towards the top of the board. Your DigiLock is ready to be configured.

(Included in hardcopy versions only)

1X Circuit Board Mask

(Included in hardcopy versions only)

2X Circuit Board Mask

DigiLock Configuration

In order to train your DigiLock, you must connect an iButton probe to the microLAN terminal block. The gray wire is Data and the black wire is Ground. Apply power to your DigiLock and the LED should flash green, then red, and then turn off as it waits for an iButton to read. However, you must train the DigiLock with your iButtons first.

The DigiLock is very simple to configure. Take a shorting block and place it on the leftmost 2 pins on J5, which will enable configuration mode. Now reset the DigiLock by placing a shorting jumper on the rightmost 2 pins and then removing it, which resets the DigiLock processor. The LED should flash Green, then Red, then it will stay Red, indicating it is in train/config mode. Take each iButton you wish to grant access to and touch it to the probe. The LED will turn Green, indicating the ID was read and stored. If the LED blinks Red, this means that there was an error reading the iButton or the iButton's ID is already stored in EEPROM. If you know you have not stored the iButton you have, and the LED blinks Red, wait until the LED stops flashing and try again.

You can store between 1 and 7 iButton IDs in the DigiLock's internal EEPROM memory. After you store a 7th ID, the Green LED will flash continuously, indicating that the ID storage is full. Remember the order you store your iButtons. During normal operation, the first button you stored will pulse output #1 when read, the second will pulse output #2, and so on.

Once you have stored your iButton IDs, remove the configuration jumper (leftmost jumper on J5) and reset the DigiLock. The LED will flash both colors and go out. Your DigiLock is now waiting to read iButtons. Place an iButton, whose ID you have already stored, onto the iButton probe. The LED should turn Green for approx. 10 seconds. If you have an iButton you did not store, touch it to the probe and the LED should turn Red for 10 seconds. If the LED flashes Red, an error occurred reading the iButton's ID. Remove it from the probe and when the LED stops flashing, touch the iButton to the probe again.

The DigiLock outputs can be configured to stay high 1 or 10 seconds after a valid ID match. For 10 seconds, remove the middle jumper on J5, for 1 second, install the middle jumper on J5. If you interface to another digital system, like your Home Automation system, 1 second pulses are probably best. If you use the DigiLock in a standalone fashion to, say, drive an electric door strike, 10 second pulses are probably better.

Since iButton IDs are stored sequentially, if you add an iButton to your DigiLock, you must reread every iButton you had previously stored, not just the new one.

DigiLock Operation

iButtons make ideal access devices since each iButton has a unique 64-bit serial number, which cannot be changed. The 64-bit serial number is made up of an 8-bit family code, 48-bit unique ID number, and an 8-bit CRC value. This means there are 2.8×10^{14} possible IDs. The DigiLock uses a microcontroller with built-in EEPROM memory to read, store, and validate the serial numbers in iButtons.

The iButton LAN is unique because it does not require a separate power wire. Power for the iButton is carried on the data line. This allows iButtons to be connected via just one data wire and one ground wire. However, this 1-wire LAN makes sending data somewhat involved. The DigiLock processor handles this protocol with ease.

Communications are initiated with an iButton by sending a RESET pulse over the LAN. When no iButton is present on the 1-wire LAN, the DigiLock constantly sends RESET pulses until an iButton is inserted into the probe. When an iButton is inserted into any probe, it is reset and sends a presence pulse back to the DigiLock. The DigiLock then sends a 'Read ROM' command to the iButton and the iButton returns the 64-bit serial number. The DigiLock then takes the 64-bit serial number and calculates a CRC value to check the data integrity. This ensures the received ID is the true ID for an iButton. If the CRC check fails, the DigiLock tries to read the iButton two more times. If the check still fails, the DigiLock signals a read failure by flashing the Red LED. CRC check failures are usually due to bad contact between the iButton and probe during a read. The DigiLock's redundant read routine significantly improves the likelihood that an iButton is read the first time that it is inserted into a probe.

The configuration of the DigiLock is very straightforward. When the DigiLock is brought up in configuration mode, it waits for an iButton to be inserted into a probe (The LED stays Red). When a valid ID is read, the DigiLock stores the ID in EEPROM, signals a valid ID storage for 5 seconds with the Green LED, and then waits for another iButton to be inserted. If you insert an iButton more than once during configuration, the DigiLock senses this and signals a read error with a flashing Red LED since the ID has already been stored. If you leave an iButton inserted for more than 5 seconds, the DigiLock will read it again and indicate a duplicate ID with the flashing Red LED. If you store 7 iButton IDs, the DigiLock will indicate the EEPROM is full by flashing the Green LED. After the first iButton ID is read in configuration mode, any previous IDs in EEPROM are erased.

During normal operation, the DigiLock waits for an iButton to be inserted into any probe. When an ID is read, it is checked for data integrity with the CRC value and then if it is deemed valid, it is compared against all IDs stored in EEPROM. If it doesn't match, the LED turns Red for 10 seconds. During this 10 seconds, the 1-wire LAN is deactivated and no other IDs can be sent/read. This ensures that a hacker cannot blast IDs to the DigiLock trying to pick it by blasting iButton serial numbers into the data line. To sequence through all IDs with this 10 second delay would require **89 million years!**

If a valid ID is read and matched, the IDOK output is brought high for 1 or 10 seconds, depending on the pulse width configuration jumper. During this time, the ID# output associated with this ID is also brought high, indicating which specific iButton was matched. So if the 3rd iButton stored were read, the ID3 output would be brought high along with IDOK.

By storing the valid IDs in EEPROM memory, the DigiLock will not lose the stored IDs if power is lost.

The 1 and 10 second pulse widths were chosen to allow the DigiLock to be used in a variety of setups. If you interface your DigiLock to the digital inputs of your Home Automation or Security system, the 1-second pulse width is probably best. If your system requires some type of interrupt pulse to read the digital inputs, connect the IDOK output to the interrupt input. The 10-second pulse width is intended for users who install their DigiLock in stand-alone mode. This usually involves using the IDOK output to drive an electric door strike (via an external relay). After you press your iButton onto the probe, you have 10 seconds to open the door which is usually more than enough time, even if you have to open a screen door.

DigiLock Installation Info

Installing the DigiLock Board

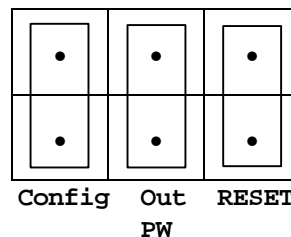
If you plan to use the DigiLock as a standalone device, locate it near the door and near the 24VAC power source for the electric door strike. DO NOT install the board outside in an enclosure since it would be possible to short the circuit to trip the strike. If all a hacker can get to is the probe, there is NOTHING they can do to trip the strike. At worst, they would just blow the microcontroller input. It is best to install the DigiLock in its own box inside your house. Radio Shack has plenty to choose from. If you plan to connect your DigiLock to your Home Automation or Security System, locate it near their main controllers. Chances are you can steal some 12V power from the main system and you might even be able to mount the tiny DigiLock in the same enclosure as your main system. Mount the DigiLock board to a flat, clean surface where it will be protected. If a 12VDC power source is not available, use the optional DigiLock power adapter (DL-PA), which will need to be plugged into an electric outlet. However, the power cube and DigiLock board can be up to 50 feet apart if you use good 18AWG wire to carry the 12VDC. **ENSURE PROPER VOLTAGE POLARITY OR THE DIGI-LOCK WILL BE RUINED!**

Below are the pinouts of the configuration and output headers. Use care when connecting the outputs as touching them against high voltages will ruin your DigiLock processor. **WARNING! The DigiLock outputs can only drive 20mA each! This is enough to drive one LED, but anything else, like most relay coils, will require an external transistor. See the diagrams later in this manual for sample connection circuits.**

ID Output Header Pin Diagram

Pin 2	Pin 4	Pin 6	Pin 8	Pin 10	Pin 12	Pin 14	Pin 16
GND	GND	GND	GND	GND	GND	GND	GND
Pin 1	Pin 3	Pin 5	Pin 7	Pin 9	Pin 11	Pin 13	Pin 15
IDOK	ID1	ID2	ID3	ID4	ID5	ID6	ID7

Configuration Header Diagram



Installing an iButton Probe and Multi-Color LED

- 1) The iButton probe has two wires. The black wire is ground (GND) and the gray wire is DATA. Connect these using high quality twisted pair wire (Cat 3 or 5) to the GND/DATA terminal block on the DigiLock. iButton probes mount in 3/8" holes. Simply slide the plastic washer and black retaining ring over the back of the probe to secure it to the surface of your enclosure.

NOTE: Probes can be daisy-chained in parallel or wired in star configuration. You should generally limit your cable length to 300 feet or less. No termination is necessary.

- 2) If you want to install the Bi-Color LED with the probe, drill a 1/4" hole for mounting. Install the pronged ring from the front and push the LED in from the back until the LED flange snaps into the inner grove of the prongs. Now slide the plain ring over the prongs on the back and push it flush with the back of the mounting surface. Your LED is now secure.

The center lead with the resistor soldered to it should be connected to ground (GND). You can use the same GND as you used for the iButton probe. The lead next to the flat edge on the LED flange with the square bends in it is Red and should be connected to the R LED terminal on the DigiLock board. The other lead with the 45-degree angle bend in it is Green and should be connected to the G LED terminal.

LED's can be wired in parallel. No more than 20 LED's should be connected to one DigiLock board.

- 3) Any wiring done in an outdoor installation should be in a water-resistant enclosure. However, the LED itself and the probe can get wet without damage.

Installing pre-built iButton Probe & LED wall plates

- 1) Creative Control Concepts sells pre-built iButton probe wall plates with LED's. These outdoor wall plates fit any standard single gang electrical box and come with a seal to ensure weather resistance. The wall plate also has a terminal strip on the back for easy connection to your iButton LAN and LED lines.
- 2) Run appropriate cable to the electrical box where you will install the probe. **NO 120V wires can be present in a probe electrical box!** Use the terminal strip to connect the Ground (GND), Data, and LED Red/Green wires to the wall plate. Connect the other ends of your cable to the DigiLock board.
- 3) Install the wall plate using the supplied foam gasket. Do not overtighten the screws as it can bend the wall plate. If used indoors, the gasket is not required.

Additional iButton probes, LED's and pre-built wallplates can be purchased from Creative Control Concepts. We also have numerous accessories for carrying your iButtons like leather key chains, wallets, and watchband mounted holders.

Go to <http://www.cc-concepts.com/> for more information.

DigiLock Implementation Ideas

The flexibility of the DigiLock's outputs allows you to use it in a variety of setups. Below are a few ideas along with possible connection diagrams. Keep in mind that the DigiLock digital outputs can only drive 20mA each. This is fine for most digital inputs or for driving an LED. Most relay coils require more than 20mA at 5V and thus require a transistor to drive the relay coil.

Stand Alone Electric Door Strike Control

The DigiLock works well as a stand alone door lock controller. All that is required is a transistor, resistor, diode, relay, and electric door strike or deadbolt. Most of the electronics can be found at Radio Shack and the door strikes can be found in most home automation catalogs. Below is a circuit diagram for connecting a door strike:

(Included in hardcopy versions only)

Note that there are two types of door strikes: Fail Safe and Fail Secure. Fail Safe versions will unlock if power is lost. Fail Secure versions will stay locked if power is lost. It is often recommended to use Fail Secure Door Strikes and Fail Safe Electric Deadbolts since a doorknob can still open a door with a Fail Secure door strike in an emergency. Connect the appropriate relay output to your strike depending on its type.

While the electric door strike is the most common stand alone use for the DigiLock, it is by no means the only one. The DigiLock can be used for cars as well. Buy a third party starter disconnect and use a DigiLock to disable it! You can put it in a watertight enclosure and wire it to your jet-ski start switch.

Home Automation Ideas

The DigiLock can be interfaced to any Home Automation system with digital inputs. The IDOK output will tell your system when any valid iButton has been read. However, if your system can make IF THEN type decisions, the DigiLock's individual ID output can make your access system much more powerful.

For example, you can have the system execute different macros based on who unlocked the door (indicated by the ID output that was pulsed). Turn on the favorite radio station of the person unlocking the door if they are the first home. If you use an output on your Home Automation system to fire an electric door strike based on the inputs from the DigiLock, you can disable certain iButtons based on things like time of day. Thus you could give your cleaning person an iButton and only recognize it during daytime hours on the days they normally come. Or teach your teenager a lesson and disable their iButton if they don't get home on time ☺ Seriously, you can have your system log the time they arrived so you'll know when they got home without staying up waiting for them!

The DigiLock is not limited just to door locks. If you have a workshop with lots of power tools and you have kids, control the power to your shop via an iButton and power relay. Or have your HA system control an AC relay controlling your TV's power and give each child an iButton. Now you can control when they watch TV and if your controller can handle it, control how long they watch.

As you can see, the applications are only limited by your imagination and the capabilities of your Home Automation controller.

Need Help?

If you get stuck trying to get your DigiLock to work, drop us a line at support@cc-concepts.com and we will do our best to help you get your DigiLock working.

Check out our web site at <http://www.cc-concepts.com/> for updates, bug reports, or to purchase many DigiLock accessories from Creative Control Concepts.