KIT 53. CODEPAD/ALARM USING 68HC705P9

This project started out to use the K1 micro-controller (as used in some of our other Kits) for a codepad - entering a four digit code would operate a relay. The most common use of such a codepad is to open a security door using a door relay (also called a door strike.) Then we looked at other codepads on the market. We tried to incorporate all their good features into our software to produce the best codepad possible. (And at the same time learn what not to do from some of the very poor features we came across.) The project outgrew the K1 and we ended up using a Motorola 68HC705P9.

We found some codepads which already used a micro-controller (uC) did not use it to its full advantage. Other codepads were so complicated to program that you almost needed a PhD in electronics! We have put together a combined codepad & independent burglar alarm into a hopefully easy to understand package. It has all the normal features of a modern codepad (EEPROM storage, programmable alarm times, master & user access codes, panic, tamper alarm etc.) But we have added other features such as an independent burglar alarm with its own relay, a second relay on board with its own user access code and direct triggering of the main door relay (used for the door strike) in software if required. We have tried to use the power & capability of the P9 uC to make all features logical & easy to use. The 3x4 matrix keypad is located remote from the main board. The software code fully commented is supplied on 3 1/2" floppy disk so you can learn how to program these uC's for yourself.
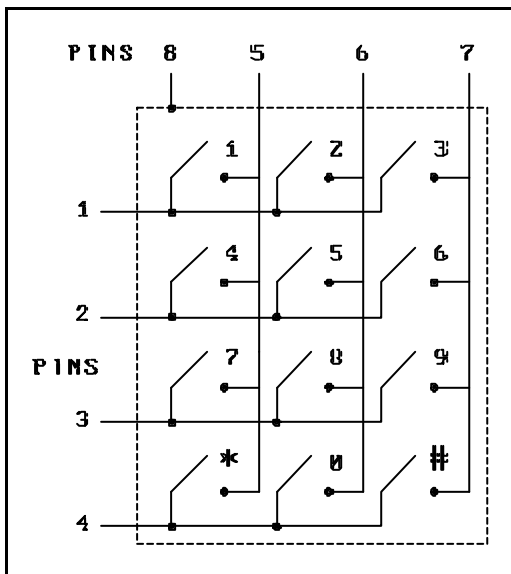

Figure 1. Keypad Connections

Features
3 relay outputs:
- door strike relay (with green LED indicator)
- auxiliary relay (with yellow LED indicator)
- alarm relay (flashing red LED)

3 programmable User Access Codes (UAC):
- UAC1 operates door strike relay only
- UAC2 operates auxiliary relay only
- UAC3 operates both door & auxiliary relays

Programmable Master Access Code. If you forget the Master Access Code, you can enter programming mode and make another one if you have access to the PCB.

EEPROM for data retention and security.

Momentary or latch output for either door strike or auxiliary relay.

Programmable access time from 1 to 9 seconds. Normally Open (NO) and Normally Closed (NC) alarm inputs which operate an alarm relay. Alarm inputs are turned off after entering a valid User Access Code 1. (Why? Because the alarm may be connected to a device - reed switch on the door, PIR - inside the room you are just about to enter.) Alarm inputs are re-enabled when you leave the room by entering '*' followed by a valid user access code.

Alarm inputs may be completely disabled.

Programmable alarm time from 0001 to 9999 seconds (0000 disables alarms). Alarm turned off by entering a valid user access code. Visual indication that alarm was set off.

Keypad Tampering. The alarm is triggered after 4 invalid access codes are entered consecutively over any length of time. The invalid count is cleared by entering a valid access code.

Panic Alarm. The alarm is triggered by pressing '*' and '#' keys together. This feature can be disabled.

Hardware test point to check software operation.

Construction
First check the tracks on the top and bottom layers of the PCB under a strong light. Look for any defects in the track work. Next check the components against the listing on the next page. The 68HC705P9P, or (P9CP) comes preprogrammed. However, we have supplied a copy of the source code with full comments on the floppy disk so you can learn how to program these uC's.

It is generally good practice to insert & solder all the lowest height components first. Note the orientation for the electrolytic capacitors, the ICs, the piezo buzzer and the LED's. Bend the legs of the 7805 using needle-nosed pliers. Do not just solder it into place then push it over; you may break the case where the legs enter it. Screw down the body using the nut & bolt provided.

Follow the overlay as you place the components and check them against the reference designator in the Components list. Note that the terminal blocks slide-fit together.

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Keypad. Although most commercial codepads place the keypad & the main PCB together as a single unit we felt the kit was more versatile by allowing them to be separate. For example, to have the codepad unit outside a door but the expensive PCB board to be on the other side of the wall. We have supplied some flat rainbow cable with the kit. It is up to the user to attach the keypad to the code pad to suit their own application. The GND pad of the keypad, KP1 on the PCB goes to pin 8 of the keypad unit. Then all the wires connect in turn to pin 1 on the keypad unit which goes to the top pad of KP1 in the box marked on the overlay by a box.

Looking at the back of the keypad, pin 1 is on the right and pin 8 is on the left.

The internal matrix arrangement of the keypad can be seen on the previous page. A '1' for example is indicated to the microcontroller by shorting together of pins 1 & 5.

PCB I/O. At the top of the PCB is terminal block X1. A 12V unregulated supply is satisfactory but a regulated supply would be preferred. Note that the voltage output for the door strike at X2 will draw well over 1A when operating (typically 1.4A) so the power supply must be able to deliver this. A 1A supply is not enough. X2 supplies 12V when a correct UAC1 or UAC3 is entered. X3 outputs the auxilliary relay triggered by UAC2. The Common, NO & NC terminals are available. UAC2 allows you to use the codepad to operate another device from it

X4 makes available the Common, NC & NO outputs from the alarm relay.

X5 accepts NC & NO external alarm loops. Eg, the NC loop could go to a tamper switch; if someone forces open the container & the switch opens then the alarm is triggered. Or it could go to a reed switch that the door strike opens. If not used put a wire connection between GND & NC (otherwise the alarm will go off continuously.)

Closing the terminals of X6 triggers the door strike. In other codepads this is usually done in the power supply to the door relay itself. But it is easier & neater to incorporate the function into software.

Software Test Point. Test point TP1 has been provided on the PCB to test that the software is working. The software generates a continuous 250 Hz square wave at pin 24 of the P9. You can use a CRO or frequency meter to test for the presence of this signal.

First Time Start. First, did you put a wire connection between the GND & NC terminals of the terminal block X5, Alarm Inputs? This is the NC burglar alarm input. If there is no connection between NC and GND then the alarm will be triggered continuously.

Second, there are no preprogrammed defaults. When you power-up for the first time hold down the Lost Code button - the zippy switch - in the centre of the PCB. This will take you straight into program mode. This is indicated by the rapidly flashing red & green LEDs. Press 0 (the yellow LED will go on) to set the Master Access Code of 4 digits. The yellow LED will go out when you have entered 4 digits & the red & green LEDs will keep flashing. You have 30 seconds to continue with programming. Press 1 to set the user access code 1; the yellow LED come on then goes off after 4 digits are entered. Then press 2 to set user access code 2. (After 30 seconds of inactivity the program jumps out of program mode back to normal mode.)

If you press an option then decide you do not want to go on then press #. Pressing # a second time will take you out of program mode. Now play with it. When you have a good idea of what is going on go into program mode again & set the other program options:

- − 3. Set User Access Code 3 (4 digits)
- − 4. Set Door Strike relay ON time from 1 to 9 seconds (0= latch mode). (1 digit)
- − 5. Set Auxiliary relay ON time from 1 to 9 seconds (0 = latch mode). (1 digit)
- − 6. Set alarm ON time from 0001 to 9999 seconds (0000 = disable). (4 digits). See below for how this option also affects the red LED L1.
- − 7. Enable/disable panic alarm (0 = disable, 1 = enable). (1 digit)
- − 8. Enable/disable user access code (1, 2 or 3) followed by 0 (disable) or 1 (enable). (2 digits.)

All these entered options are now remembered by the 93LC46. Even when the power is turned off they will be loaded automatically into the P9 upon power-up.

Operation Guide
Overview. We have tried to make this Codepad & Burglar Alarm as simple & logical to use as possible. We have tried to include different options.

The Codepad has two modes of operation - **NORMAL** mode and **PROGRAM** mode. Normal mode is the day to day running mode of the codepad. Program mode is used to set or alter the various options available.

NORMAL mode. The red LED L1 can be on or off. If Option 6 is set to '0000' then the alarm inputs are peranently disabled & the red LED is off. If Option 6 is set between '0001' to '9999' seconds then the alarm inputs are enabled & the L1 LED is continuously on. See "Alarm Conditions" for further information. Let us assume for the following discussion that the Alarm Option is on & the red LED L1 is on.

Entering User Access Code 1 operates the door strike relay and turns on the green LED. The red LED starts to flash. The door strike relay remains operated for the user-

programmed entry time (1 - 9 seconds). If the door strike relay is set up for latch mode operation (0 seconds), it will remain on until UAC 1 is entered again. After the relay entry time the green LED goes but the red LED L1 keeps flashing. For the reason see 3 paragraphs below.

The door strike relay may also be operated via the External Strike Control input. (For example, a guard on the inside of the door sees you, recognises you as allowed to enter and presses a button to open the door for you to save you entering the UAC.)

Entering User Access Code 2 operates the auxiliary relay and turns on the yellow LED. It remains operated for a user-programmed time (1 - 9 seconds). This may be a different time to that programmed for the door strike relay. Latch mode is also available if 0 seconds is set. Note that this Auxilliary Relay is only rated at 1A and must not be used to directly control a second door strike relay.

Entering User Access Code 3 operates both the door strike and auxiliary relays. Both the green and yellow LEDs will turn on for their respectivelyprogrammed entry times.

Flashing Red LED. Entering a valid user access code automatically disables the alarm inputs. The red LED L1 starts to flash, indicating that the alarm inputs have been temporarily disabled. Why do this? Because the alarm may be connected to a device - reed switch on the door, PIR - inside the room you are just about to enter. When you leave the room or you want to re-enable the alarm inputs enter '*' followed by a valid user access code. This reactivation of the alarm input - by putting * in front of a valid UAC will not activate a relay. It will just stop the LED flashing as the alarm input is re-enabled. All UAC's still work and operate the relays. (If you want to completely disable the alarm inputs and at the same time stop the LED flashing enter '0000' for Option 6.)

Each UAC may be disabled (see Program Mode).

Once started, each digit of an access code must be entered within 5 seconds of the previous one. If not, any entered digits are "thrown away" and the sequence automatically re-started. If you make a mistake while entering the access code, press ' * ' or ' # ' to start again.

Alarm Conditions. The alarm relay may be triggered in threeways:

- Burglar alarm input (provided it is enabled)
- Entering 4 successive invalid access codes
- Panic alarm (provided it is enabled)

If any of the above conditions are met, the alarm relay will operate and remain operated for the programmed alarm time (0001 - 9999 seconds). The alarm LED L4 will also start flashing, giving visual indication that an alarm has been triggered. This LED L4 will continue to flash even after the

alarm time has elapsed. (This is to let you know that the alarm has been triggered.)

The alarm (and flashing LED) may be turned off by entering any valid User Access Code either with or without a * before it.

If both L1 & L4 are flashing then the one entry of a UAC preceeded by a '*' will turn of both of them.

The burglar alarm can be either the closing of a normally open loop, or the opening of a normally closed loop. It operates independently of the Codepad. It could be the input to a tamper switch if the PCB is mounted inside a box. The burglar alarm inputs may be permanently disabled by setting the alarm ON time to "0000" (programming option 6). This turns the red LED off completely. Keyboard tamper and panic alarms (if enabled) are not affected except that the alarm ON time
is now automatically set to 10 minutes.

Alarm conditions are continually monitored, even if the codepad is in Program mode. To turn off the alarm while in Program mode, first exit Program mode then enter a valid user access code.

The panic alarm feature can be disabled if not required (Program Mode Option 7).

PROGRAM Mode. Program mode can be accessed at any time by entering the Master Access Code. The codepad will beep 4 times and the red and green LEDs will flash.

When using the codepad for the first time or if you forget the Master Access Code, hold down the Lost Code button when you turn on the power. This will take you directly into Program mode. There are no pre-programmed default codes or conditions in the codepad. When first used, all access codes and time settings must be entered by the user.

The flashing LEDs indicate that the codepad is waiting for a valid programming option to be entered. The codepad will automatically exit Program mode after 30 seconds if a valid programming option is not entered at this point. The codepad will beep 4 times and normal mode re-entered.

Program mode may be exited by pressing ' # '.

There are 9 valid programming options, 0 - 8:
- 0. Set Master Access Code (4 digits)
- 1. Set User Access Code 1 (4 digits)
- 2. Set User Access Code 2 (4 digits)
- 3. Set User Access Code 3 (4 digits)
- 4. Set Door Strike relay ON time from 1 to 9 seconds (0 = latch mode). (1 digit)
- 5. Set Auxiliary relay ON time from 1 to 9 seconds (0 = latch mode). (1 digit)

- 6. Set alarm ON time from 0001 to 9999 seconds (0000 = disable). (4 digits)
- 7. Enable/disable panic alarm (0 = disable, 1 = enable). (1 digit)
- 8. Enable/disable user access code (1, 2 or 3) followed by 0 (disable) or 1 (enable). (2 digits.)

Once a programming option has been entered, the yellow LED will turn on. This indicates that the codepad is waiting for new programming data to be entered.

Data entry must commence within 5 seconds of the programming option being selected. Where more than 1 digit of data is required (e.g. access codes), each digit must be entered within 5 seconds of the previous one. If not, the codepad will automatically exit the programming option selected. Pressing '#' will abort the option selected without any change taking place. In either case, a long beep will sound to indicate the "error" condition.

Four beeps will sound when the correct data is entered and the codepad will return to Program mode entry (flashing red/green LEDs and yellow LED off). There is no "enter" key.

Options 0,1,2,3 and 6 require 4 digits, options 4, 5 and 7 require 1 digit and option 8 requires 2 digits.

External Control Input. This normally open input allows a pushbutton switch or remote control device to be connected to the codepad. Shorting the two input pins together operates the door strike relay for the programmed ON time. This input is disabled when the codepad is in program mode.

Access Code Priorities. The Master Access Code has priority over all the User Access Codes. This means that any User Access Code that is the same as the Master Access Code will be ignored. The User Access Codes also have a priority order, 1-2-3. Setting 2 or more User Access Codes the same will cause the lower priority code to be ignored.

Some Technical Information. The MC68HC705P9P (or P9CP) is a member of the HC05 family of 8-bit microcontrollers from Motorola. The P9 contains 2112 bytes of one-time programmable ROM, and 128 bytes of user RAM. There are 20 bi-directional I/O port pins and one input-only port pin. There is a 4 channel, 8 bit ADC. Single 3.3V - 5.0V supply. The P suffix means that it is a One Time Programmable device. There is no window in it to allow the program to be erased. See the MC68HC705P9 Data Book from Motorola for full information or download it from their website.

93LC46/93C46. This IC can be a trap. There are 8 bit & 16 bit versions & not all manufacturers support both versions. Some manufacturers pull a pin high or low to switch between versions. Others like Microchip use different parts completely. We now use the Microchip 93LC46A (8 bit) NOT the B (16 bit.)
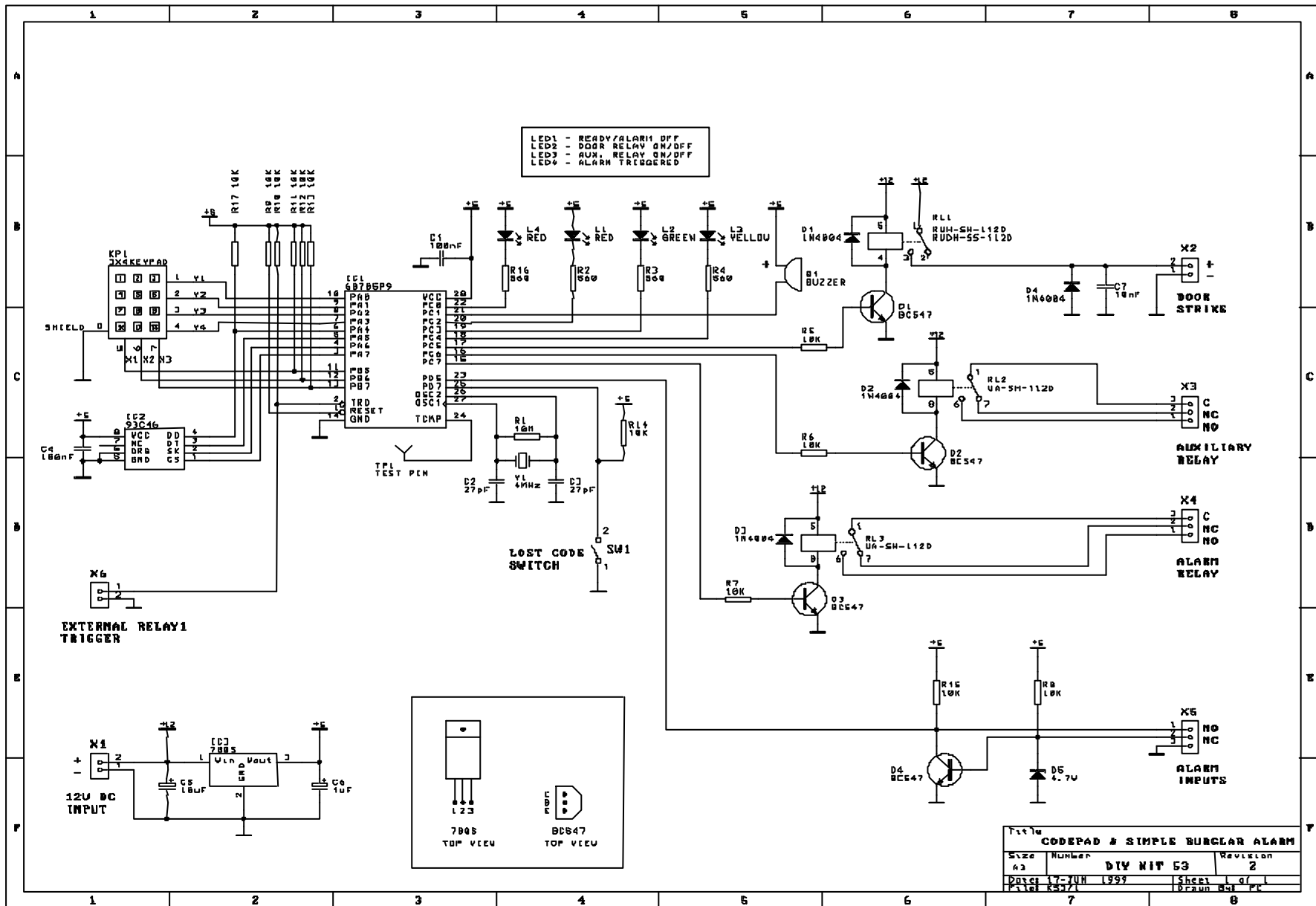
COMPONENTS		
Resistors 1/4W, 5%:		
10K	R5 to R15, R17	12
560R	R2 R3 R4 R16	4
10M	R1	1
Capacitors:		
10nF mono cap	C7	1
100nF mono caps	C1 C4	2
10uF mini elcap	C5	1
1uF mini elcap	C6	1
27pF ceramic	C2 C3	2
Regulator 7805		1
EEPROM 93LC46A	IC2	1
Programmed 68HC705P9CP		1
BC547	Q1 Q2 Q3 Q4	4
Piezo Buzzer	B1	1
Zippy tact switch	SW1	1
1N4004 diode	D1 D2 D3 D4	4
4.7V zener diode	D5	1
12V Relay RWH-SH-112D / RUDH-SS-112D		1
Mini 12V relay UA-SH-112D		2
4.000 mHz crystal (49U/S)	Y1	1
3mm green LED	L2	1
3mm red LED	L1 L4	2
3mm yellow LED	L3	1
3x4 key X-Y Codepad		1
2 pole terminal block		3
3 pole terminal block		3
Nut & bolt for 7805		1 set
K53 PCB		1
8 pin IC socket		1
28 pin IC socket		1
Rainbow ribbon cable, 8 strand		12"
Floppy disk		1
Documentation		

For questions email the kit designer Frank Crivelli at

frank@ozitronics.com

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KIT 53. CODEPAD/ALARM USING 68HC705P9

LED1 - READY/ALARM OFF
LED2 - DOOR RELAY ON/OFF
LED3 - AUX. RELAY ON/OFF
LED4 - ALARM TRIGGERED

Title	CODEPAD & SIMPLE BURGLAR ALARM		
Size A3	Number DIY KIT 53		Revision 2
Date: 17-JUN 1999		Sheet 1 of 1	
File: KS3/1		Drawn By: PC	