LSI/CSI

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LS7223

KEYPAD PROGRAMMABLE DIGITAL LOCK

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FEATURES:

- Stand alone lock logic
- 38416, 4-digit combinations
- 3 different user programmable codes
- Momentary and static lock control outputs
- Internal key debounce circuit
- Tamper detection output
- Status outputs
- Low current consumption
- +4V to +15V operation (V_{DD} - V_{SS})
- LS7223 (DIP); LS7223-S (SOIC) - See Figure 1

GENERAL DESCRIPTION:

The LS7223 is a programmable electronic lock implemented in a CMOS integrated circuit. The circuit contains all the necessary memory, decoder and control logic to make a programmable "keyless" lock system to control electro-mechanical locks. Input is provided by a matrix keypad whose maximum allowable size is 4 x 4.

The LS7223 can be programmed to recognize 3 different codes: one to toggle an output and generate a pulse (Primary), one to toggle an output (Secondary), and one to toggle an output and trigger an alarm (Duress). Programming is done via the keypad inputs. Any entry from the keypad (when not in the program mode) which does not match one of the 3 programmed codes causes the Tamper output to become active.

The low power CMOS design of the LS7223 enables it to be designed into battery backed-up and automotive type security systems.

DETAILED DESCRIPTION:

CODES - There are 3 different function codes which the LS7223 can store in memory. Each code consists of a 4 digit number which must be entered in exact sequence and before the keypad entry enable time expires. The 3 codes and their functions are explained below.

1. The Primary code, when entered from the keypad, causes the $\overline{\text{Lock}}$ 1 output to toggle and the Momentary output to momentarily go high. Whenever power is first applied to the LS7223, the circuit defaults to the Primary code corresponding to the keys X1Y1, X1Y2, X2Y2, X2Y1. The code can then be altered to any other 4 digit code by entering the Program mode and keying in the new code.

CONNECTION DIAGRAM - TOP VIEW

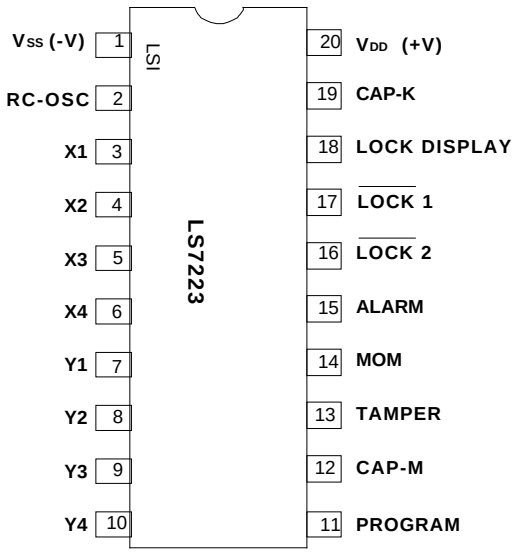


FIGURE 1

2. The Secondary code, when entered from the keypad, causes the $\overline{\text{Lock}}$ 2 output to toggle. The first 3 digits of the Secondary code must be identical to the first 3 digits of the Primary code; the 4th digit may or may not be identical for the two codes. When the two codes are the same in all 4 digits, the entry of the code will cause both the $\overline{\text{Lock}}$ 1 and the $\overline{\text{Lock}}$ 2 outputs to toggle. Whenever power is first applied to the LS7223, the circuit defaults to the Secondary code corresponding to the keys X1Y1, X1Y2, X2Y2, X1Y1. The code can then be altered by entering the Program mode.

3. The Duress code, when entered from the keypad, causes the $\overline{\text{Lock}}$ 1 output to toggle; at the same time the Alarm output will latch high to enable an external alarm. The first 3 digits of the Duress code must be identical to the first 3 digits of the Primary and Secondary codes; the 4th digit must be different to activate the Alarm output. Whenever power is first applied to the LS7223, the circuit defaults to the Duress code corresponding to the keys X1Y1, X1Y2, X2Y2, X1Y2. The code can then be altered the same way as the other two codes.

PROGRAM MODE

The current Primary/Secondary/Duress codes may be altered to any value by initializing the Program Mode. The steps involved for altering the codes are:

1. Enter the current Secondary code causing the $\overline{\text{Lock}}$ 2 output to toggle.

2. Before the keypad entry enable time expires, enter the key corresponding to matrix position X4Y1 two times. This will cause the Program Mode output to latch high, indicating that the circuit is now in the Program mode. The keypad entry enable timer is disabled during the Program mode.

3. Enter a 6-digit number from the keypad. The Program Mode output will latch low, indicating that the new codes have successfully been programmed. Of the 6 digits, the first 4 constitute the Primary code; the first 3 and the 5th constitute the Secondary code and the first 3 and the 6th constitute the Duress code. If an error is introduced or it is desired to change the codes before the 6th digit is typed, enter the key X4Y3. This will reset the internal memory pointer of the LS7223 and a new 6-digit number can be entered.

KEYPAD INTERFACE

The four X inputs and four Y outputs are designed for keypad interface (see Fig. 2). Since the X inputs have internal pull-ups, the maximum matrix size of 4 by 4 does not have to be utilized.

During normal operation, the LS7223 will scan the matrix looking for a switch closure. Once a closure has been detected, the internal key debounce logic determines if a "valid" key has been pressed or that if noise is just present. Only one valid input will be generated with any key closure. The use of internal key debouncing and Schmitt triggers on the inputs provides the LS7223 with very high noise immunity.

TAMPER

When a valid key has been detected by the LS7223, the entry is compared against the appropriate reference in the internal memory. If the requirements of digit value and code sequential position are not fulfilled, the Tamper output will momentarily go high; this indicates that an illegal code entry was attempted. The keypad entry enable timer and memory pointer will both be reset so that entry of the code can be attempted again.

TABLE 1. PIN DESCRIPTIONS

PIN	FUNCTION	DESCRIPTION
1	Vss	Supply voltage negative.
2	RC-OSC	Determines the LS7223's internal clock frequency, which is used for keypad scanning and debounce. A resistor (to V_{DD}) and a capacitor (to Vss) connected to this input sets the frequency. With a 1.5MΩ resistor and a 100pF capacitor, the internal frequency is typically 10kHz and the internal anti-bounce is typically 25ms.
3, 4, 5, 6 7, 8, 9, 10	X1, X2, X3, X4 Y1, Y2, Y3, Y4	The four X inputs and four Y outputs are designed to interface to a keypad matrix whose maximum allowable size is 4 by 4.
11	PROGRAM MODE	This output goes high when the program mode is initiated. It resets to a low state after the 6-digit Primary/Secondary/Duress combination code has been programmed.
12	CAP-M	A capacitor connected between this input and Vss controls the duration of the Momentary and Tamper outputs.
13	TAMPER	Whenever a key is entered that is not a valid code element, this output goes high for a period determined by the capacitor on the CAP-M input.
14	MOMEMTARY	This output generates an active high output every time the Primary code is entered. The duration of this output is determined by the capacitor on the CAP-M input.
15	ALARM	When the Duress code is entered, this output latches high to enable an external alarm. The Alarm output resets to a low state when the Primary code is entered again. This output powers-up to a low state.
16	$\overline{\text{LOCK}}$ 2	Whenever the Secondary code is entered, this output toggles. The output powers-up into a low state.
17	$\overline{\text{LOCK}}$1	When ever the Primary code or the Duress code is entered, this output toggles. The output powers-up into a low state.
18	LOCK DISPLAY	Functionally, this output is identical to the $\overline{\text{Lock}}$ 1 output, with the exception that its polarity is reversed with respect to the $\overline{\text{Lock}}$ 1 output. This output is intended for driving a display lamp to indicate the lock status.
19	CAP-K	A capacitor connected between this input and Vss sets the time limit for entering a 4 digit code from the keypad. (6 digits when initiating the Program Mode.)
20	V_{DD}	Supply voltage positive.

Quiescent supply current: (100pF capacitor to Vss and 1.5MΩ resistor to V_{DD}, connected to the RC-OSC input)

SYMBOL	V_{DD}	MAX	UNIT
I_{DD}	5V	15	µA
I_{DD}	9V	25	µA
I_{DD}	12V	30	µA

MAXIMUM RATINGS: (Voltages references to Vss)

RATING	SYMBOL	VALUE	UNIT
DC supply voltage	V_{DD}	+4 to +18	V
Operating temperature range	T_A	-25 to +70	°C
Storage temperature	T_{STG}	-65 to +150	°C

DC Electrical Characteristics:

(V_{SS} = 0V, V_{DD} = +4V to +15V, 25°C ≤ T_A ≤ +70°C unless otherwise specified)

PARAMETER	CONDITIONS	V_{DD}	MIN	TYP	MAX	UNIT
Output source current	Logic 1 Output	5V	1.50	2.50	-	mA
Momentary, Alarm, Lock 1,	$V_{OUT} \geq V_{DD}$ - 2V	12V	5.60	8.25	-	mA
Lock 2, Program Mode Outputs		15V	7.25	10.7	-	mA
Output Sink Current	Logic 0 Output	5V	0.40	0.60	-	mA
Momentary, Alarm, Lock 1,	$V_{OUT} \leq$ Vss + 0.4V	12V	1.20	1.70	-	mA
Lock 2, Program Mode Outputs		15V	1.50	2.25	-	mA
Output Source Current	Logic 1 Output	5V	0.25	0.40	-	mA
Tamper Output	$V_{OUT} \geq V_{DD}$ - 2V	12V	0.90	1.30	-	mA
		15V	1.10	1.70	-	mA
Output Sink Current	Logic 0 Output	5V	0.06	0.10	-	mA
Tamper Output	$V_{OUT} \leq$ Vss + 0.4V	12V	0.20	0.29	-	mA
		15V	0.25	0.37	-	mA
Input Level Detection	V_{IH} = Logic 1	5V	3.5	-	V_{DD}	V
All Inputs		12V	8.0	-	V_{DD}	V
		15V	10.0	-	V_{DD}	V
	V_{IL} = Logic 0	5V	Vss	-	1.6	V
		12V	Vss	-	4.0	V
		15V	Vss	-	5.0	V

FIGURE 3.

KEYPAD ENTRY TIME vs. CAPACITOR ON CAP-K INPUT

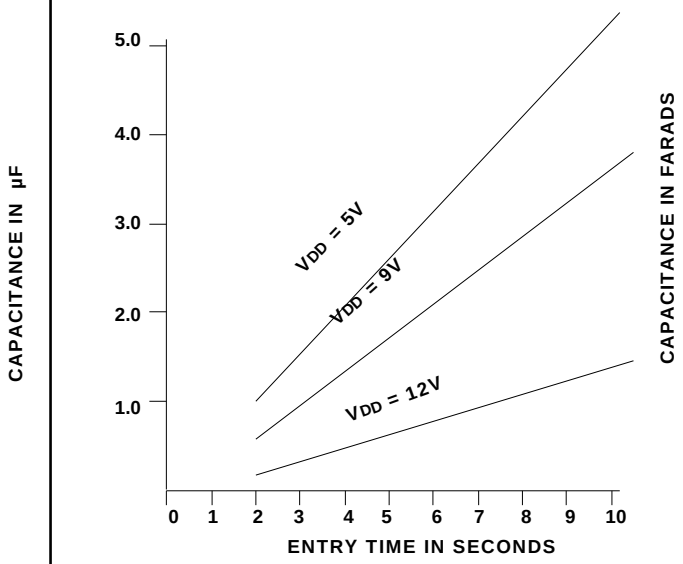
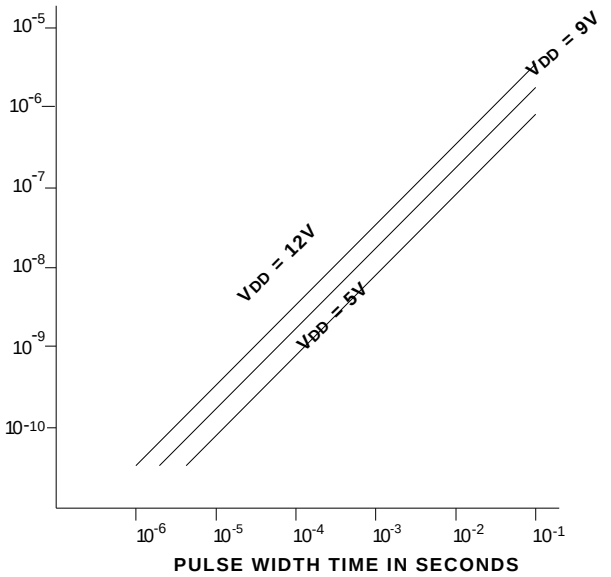


FIGURE 4.

LS7223 PULSE WIDTH ON MOMENTARY AND TAMPER OUTPUTS vs. CAPACITOR ON CAP-M INPUT



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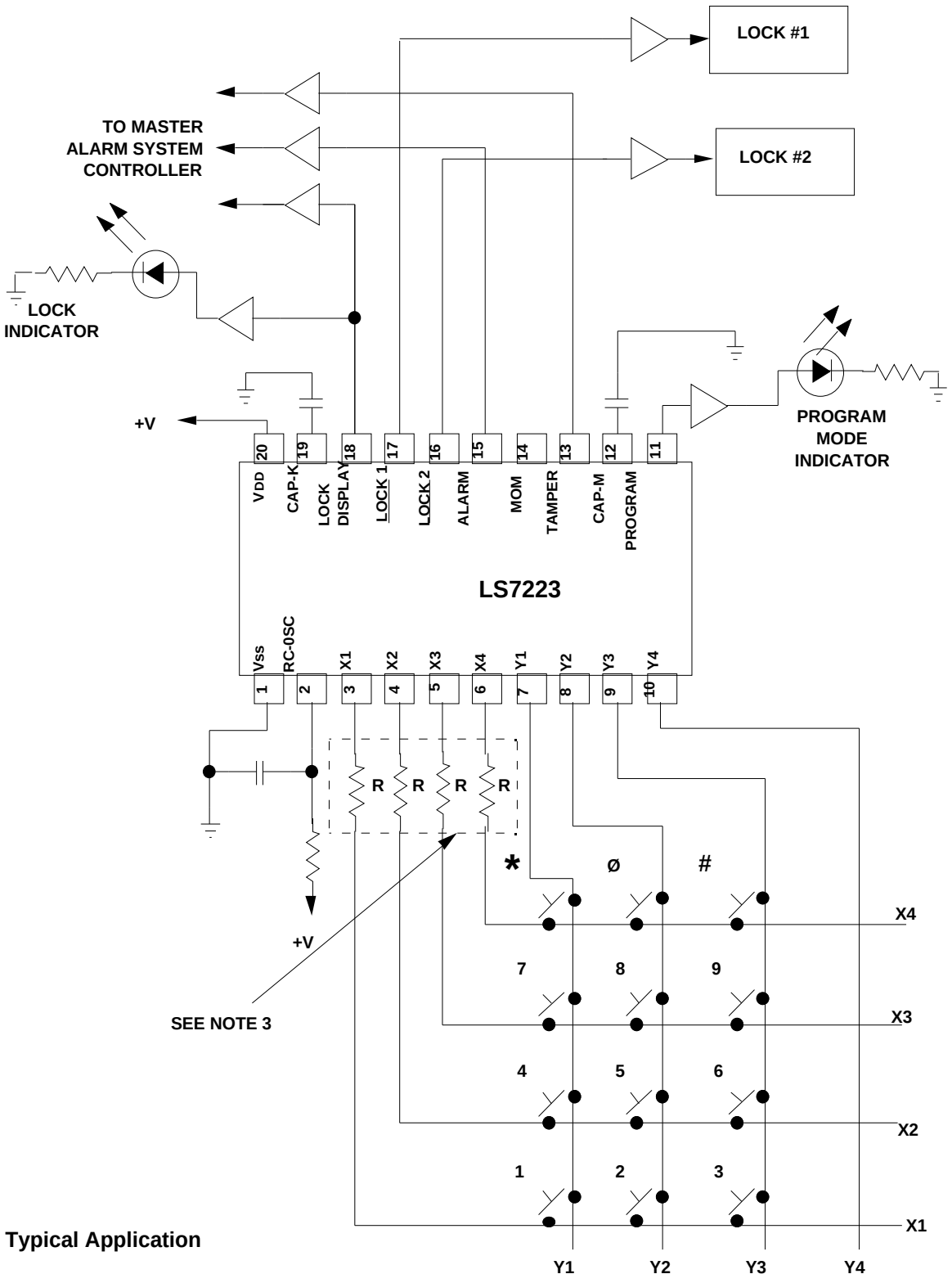

FIGURE 2. Typical Application

NOTES:

1. Keypad is typical 4 x 3 matrix type. Switch resistance should be ≤ 1kΩ.

2. Configuration shown is typical. The outputs of the LS7223 are functionally designed to provide either status or display information.

3. Resistors may be added in series with X inputs to provide protection against ESD from the keypad. R = 10kΩ, 1/4 W