THEORY OF OPERATION FOR COMBINATION KEYLESS ENTRY E20503A

The Keyless Entry system consists of nine functional groups: keypad input, reset circuit, microcontroller, non-volatile memory, ambient light sensor, low battery detect, electro-luminescent driver, 315 MHz transmitter and power conditioning.

KEYPAD INPUT CIRCUITRY

Five SPST momentary switches SW1- SW5 are connect to ground on one side and input pins on the (U1) MSP430 microcontroller on the other. These pins are held a positive logic level, 1.8 to 3 volts by a 10K ohm resistor RN2 and RN1. When a switch is closed the input pin of the MSP430 is taken to ground giving a logic zero state. This transition is sensed by the MSP430 (U1), which will wake up from its normal sleep mode and read which switch was pressed.

RESET CIRCUIT

Two of the keys SW4 and SW5 are also connected to an OR gate U5, which operates as a negative logic AND gate. Closure of both these keys simultaneously pulls the output of U5 low, which causes C12 to start charging. This is seen as a low pulse at the U1 reset line. This low pulse resets the microcontroller U1 clearing any lockup conditions in the microcontroller. Upon reset the microcontroller will look at the state of SW4 and SW5 and if both are logic zero will send a lock command via the transmitter. This circuit provides fail-safe operation for the important LOCK command.

MICROCONTROLLER

The MSP430F1121 (U1) is the heart of the system. All inputs are sent to it and all outputs come from it. It normally is in a sleep state with all clocks stopped. Depression of any key will bring it into an active state for at least five seconds. A simultaneous closure of SW4 and SW5 will reset U1 and immediately send the lock command followed by transition into sleep mode. When active U1 uses X1 to generate a 2.00 MHz clock for internal operation. This in not active in sleep mode. When any of the supporting circuits require it, U1 will source 3 volts to the power inputs for the non-volatile memory, ambient light sensor, and low battery detect. This power switching reduces the quiescent current of the system. The pull-down resistor R1 keeps the TST input low as required for normal operation. Capacitor C1 and C4 provide decoupling at high switching frequencies to maintain a clean power source to U1.

NON-VOLATILE MEMORY

U3 a IIC bussed Electrically Erasable Programmable Read Only Memory (EEPROM) stores the rolling code counter, and the user programmable entry code. Two resistors in RN2 provide pull-ups to logic 1 for proper operation of the IIC bus. Both the clock line and the data are driven by U1 when rolling code writes and reads are done.

AMBIENT LIGHT SENSOR

Q1 a phototransistor and R2 form a high sensitivity light sensor. With no illumination, the output is held near ground. As the illumination increases the output signal increases toward 3 volts. This sensor output is connected to the analog comparator input on the microcontroller U1. If this level is greater than the internal reference level of the comparator, the comparator signals the microcontroller that the ambient light level is high. The Electro-luminescent panel is NOT energized for this condition.

LOW BATTERY DETECT

The internal analog comparator is setup using the internal diode as the reference. Power to the resistor R3 is applied by the microcontroller. The time required for the voltage on the capacitor C3 to reach the reference voltage of the internal diode is measured. This time is proportional to the battery voltage. A time lookup table equates time to battery voltage. If the battery voltage is below 1.8 volts and indication is given by a flashing the electro luminescent panel.

ELECTRO LUMINESCENT PANEL CIRCUIT

A 100 Hz 110v p-p AC signal is applied to the Electroluminesecnt (EL) panel connected at P1. One side is grounded is other is at 110 v p-p AC 100 Hz. This causes the EL panel to glow bluish-green when commanded by the microcontroller U1. EL panel drive is developed by U2 using an internal 50 KHz oscillator feeding inductor L1 in a flyback configuration. This develops a high DC voltage that is chopped by an internal oscillator running at 110 Hz. This frequency is determined by capacitor C10. Capacitor C16 prevents high frequency RF from entering U2. Capacitors C11 and C9 provide high and low frequency decoupling to provide a low impedance power source for U2.

315 MHz TRANSMITTER

Transistor Q2 forms a SAW controlled Colpitts oscillator. Resistors R6 and R7 determine Q2's bias point. C15 and L2 form a resonant collector load. While C13 decouples the power feed at high frequencies. Capacitors C7 and C5 form a divider that controls oscillator startup and also add to the resonant frequency of C15 and L2. SAW resonator X2 provides the high Q frequency control element that determines the oscillators frequency. Capacitor C8 prevents RF from reaching the microcontroller U1 by shunting RF energy to ground. C14 along with the printed circuit trace between C14 and the collector of Q2 form a 2nd harmonic trap that reduces the 2nd harmonic (630 MHz).

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