DDL Demo Board

DDL Demo / 1-Bit Memory

Description

The DDL Demo Board implements an SR latch circuit using only four common diodes and two LEDs as active elements. The circuit can store a single bit of the user's choice.

An on-board power supply generates the required RF power from four AA batteries.

Features

- Digital logic using only diodes
- Unique circuit technology
- Self-contained executive desk toy
- Stores a single bit of memory

Electrical Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
V_{batt}	Battery supply voltage		2.0	4.8	6.5	V
I_{batt}	Battery current drain			50		mA
f_{supp}	RF power supply frequency			3.6		MHz
—	Data storage capacity			1		bit
—	Battery lifetime			48		hours

Notes:
1. Typical measurements with red LEDs at Vbatt = 5.0V
2. Battery lifetime based on 2000 mAH NiMH cells

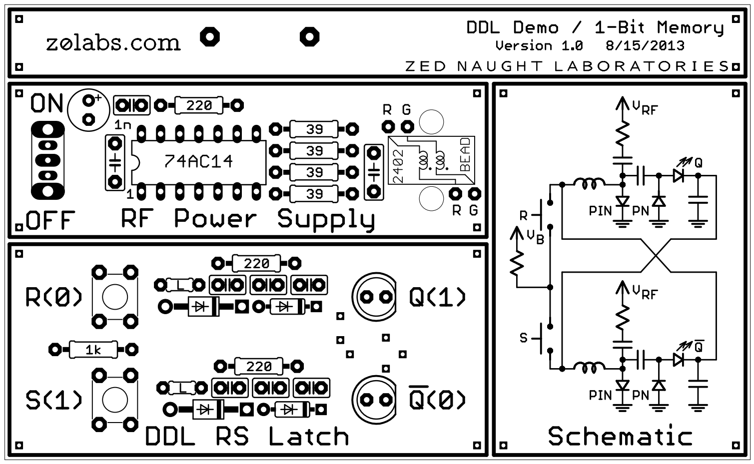

Figure 1: DDL Demo Board (1:1 scale on US letter size paper)

Operation

A diagram of the DDL Demo Board is shown in Figure 1. The user interface consists of a power switch, a pair of Set/Reset pushbutton switches, and two indicator LEDs.

Batteries

The DDL Demo Board requires (4) IEC-LR6 (AA size) batteries. The use of NiMH batteries is recommended, although NiCd, alkaline or lithium primary batteries may also be used.

Rechargeable batteries should be replaced before they are completely discharged to preserve battery health. The DDL Demo Board is capable of completely draining batteries, which may negatively impact the number of charge/discharge cycles possible with rechargeable types.

Power Switch

Use the power switch to turn the DDL Demo Board on or off. Note that the state of the board (storing a 0 or 1) is lost on power off. Upon power-up, the board may assume either one of the states, although most boards will show a bias toward one of the states due to slight differences in component values in the latch circuit.

Data Storage

Upon power up, the board will assume one of the states (0 or 1). To set a specific state, press one of the white buttons (Set or Reset). The circuit will continue to hold the desired state until the power is turned off.

RF Emissions

The DDL Demo Board may emit unintentional RF radiation between 3 and 4 MHz, and at harmonics thereof. In case this causes interference with any other electronic device, switch off the power to the DDL Demo Board.

DDL Background

DDL gates implement standard logic functions using silicon diodes as active elements. In order to enable arbitrary logic functions, DDL gates must provide absolute gains greater than unity and a logical inversion function, both of which are absent from previous diode-based logic. To achieve the required gain and inversion functions, PIN-type diodes are used to switch power from a radio-frequency (RF) supply, V_{RF}. The switched RF power is then rectified by a voltage doubler consisting of 1N4148 diodes and LEDs to produce a DC output signal. On the DDL Demo Board, common rectifier diodes (1N4007 typ.) are used as PIN diodes, achieving good performance at very low cost.

Latch Design

A schematic diagram of the latch circuit implemented on the DDL Demo Board is shown in Figure 2. Two diode-based inverters are cross-coupled to form an RS latch. In operation, an RF power supply of nominally 5V amplitude at 3.6MHz is used as V_{RF}. Assuming the latch is in the set state, D1 has negligible DC current flowing through it, so it assumes a high impedance at the RF power supply frequency. This allows RF power from the supply to flow through R2 and C1 to the voltage doubler formed by C2, D2, D3, and C3. The resulting DC output current flows through L2 and D4, causing D4 to assume a low impedance, shunting RF current away from the lower voltage doubler consisting of C5, D5, D6, and C6. Since little current is allowed to flow in the lower doubler, a low DC bias is maintained on D1, completing the feedback loop.

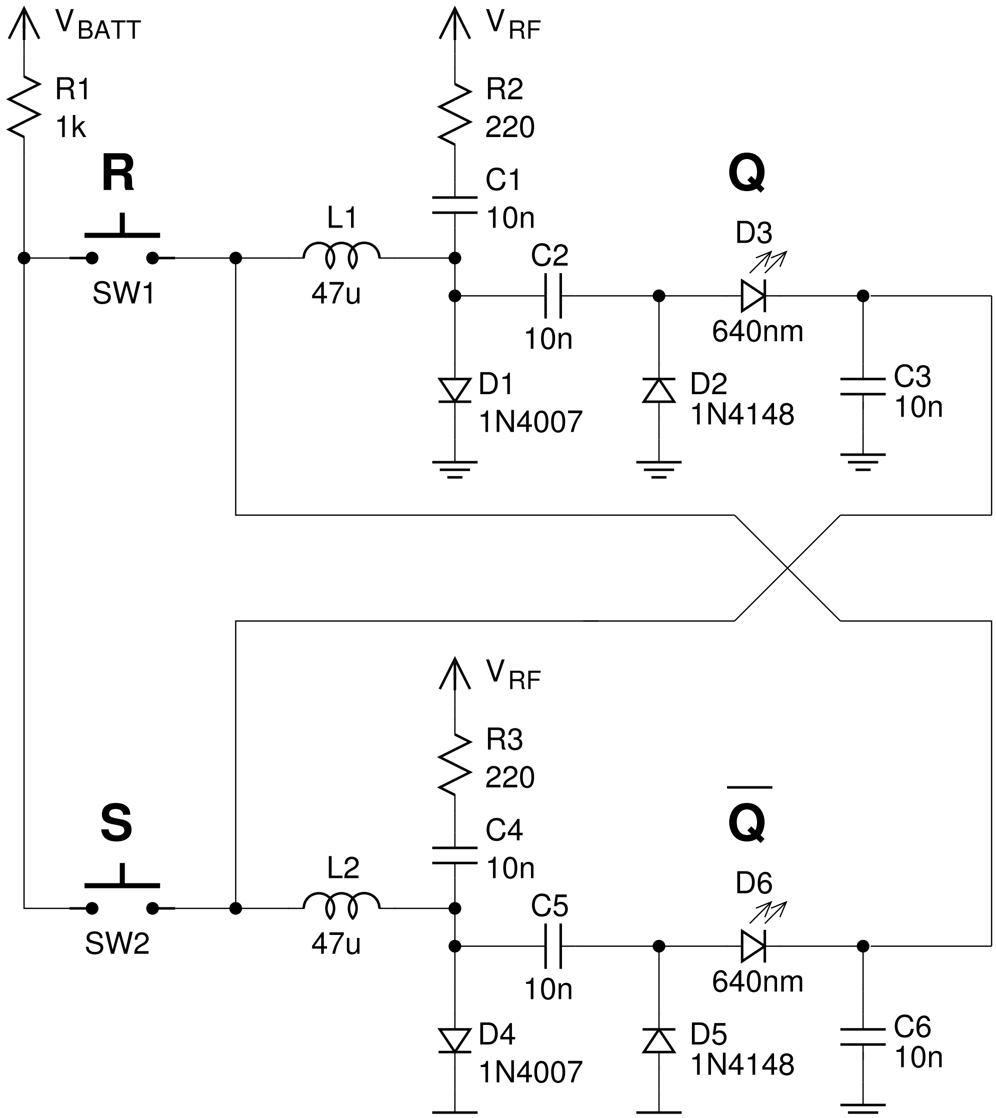

Figure 2: DDL Demo Board Latch Schematic

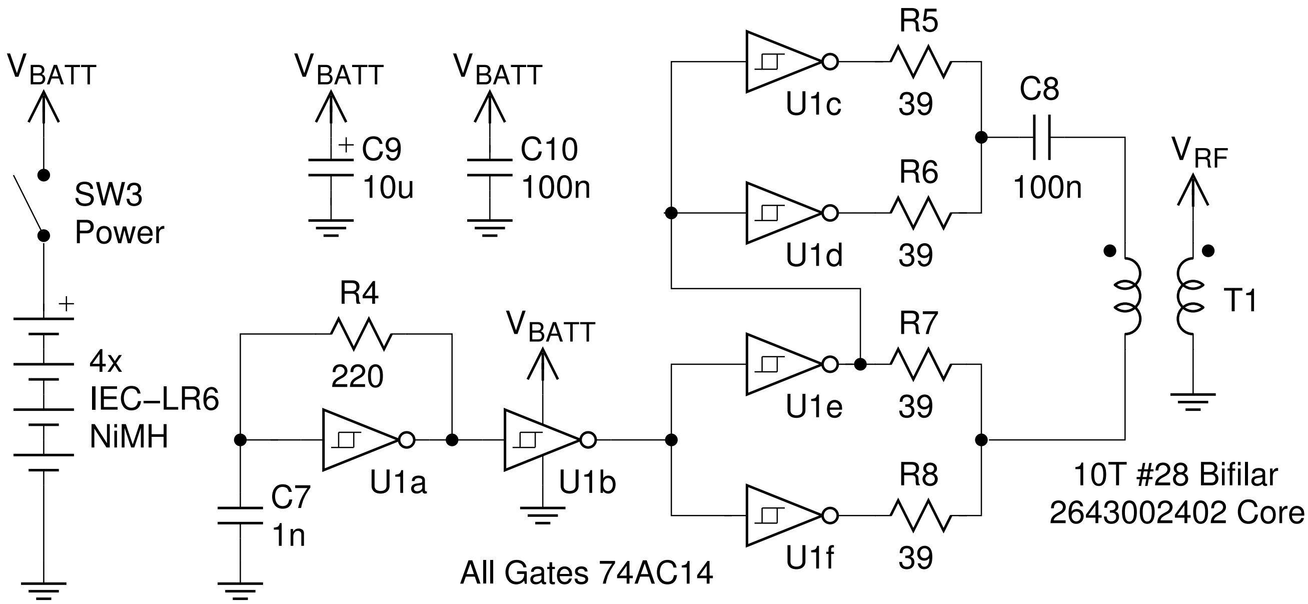

Figure 3: DDL Demo Board Power Supply Schematic

The result is a stable state with the Q LED illuminated.

With the latch in the reset state, the roles of the upper and lower inverters are reversed, with D1 shunting RF current to ground, and D4 allowing current to flow through the lower voltage doubler.

When pressed, push-button switches SW1 and SW2 cause the latch to assume either the RESET or SET state, respectively, buy forcing either D1 or D4 into a low RF impedance state. When the switch input is removed, the latch retains its current state.

RF Power Supply

The DDL latch on the DDL Demo Board requires an RF power supply for operation. The simple supply shown in Figure 3 is implemented on the board. In operation, R4, C7, and U1a, a Schmitt-trigger inverter, form an RC relaxation oscillator with a nominal frequency around 3.6 MHz. The resulting signal is buffered through U1b to drive a push-pull output stage consisting of U1c-U1f. Output resistors R5-R8 establish an output impedance of 50Ω for the output stage, which is AC-coupled to output transformer T1. T1 acts as a balun transformer converting the balanced output of the push-pull stage to unbalanced RF power for the latch circuit.