Discrete Logic Analyser



MitchElectronics® 2020

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SCHEMATIC



SCHEMATIC

Schematic (Blocktised)



SCHEMATIC EXPLANATION

When it comes to debugging logic circuits, the logic analyser is arguably the most important piece of equipment. A logic probe, like the MitchElectornics Logic Probe Kit, can be used to probe a logic signal and see what it is doing in real-time but many times it is important to know how a logic signal is changing over time with respect to other logic signals. For example, imagine a counter circuit that has a clock and a counter IC with some control signals; how can all of the signals to the counter be probed at the same time while the clock is operating at 100kHz? The answer is the logic analyser!

A logic analyser not only records the logical state of a signal, it also records logic signals over time. This is really handy in situations where a signal is unpredictable, and since logic analysers typically have at least 8 channels, they are able to show how different signals relate to each other. Almost all analysers on the market have large memories that can store many hundreds of thousands of samples at very high frequencies while also being able to display this information on a graph. However, the Discrete Logic Analyser by MitchElectronics is truly one of a kind!

The MitchElectronics Discrete Logic Analyser, as the names suggests, is a logic analyser that is built entirely with glue logic and discrete components with not a single microcontroller or processor in sight! The analyser is very basic being only able to store 256 samples, 8 logic channels, and a slow samples speed in the kHz. However, this kit is a great demonstration of glue logic, is incredibly fun to operate, and interesting to see running with the many LEDs and controls. However, the use of glue logic also makes this design somewhat complex which is why it may be a good idea to refer to the blocktised schematic when learning how this circuit works!



SCHEMATIC EXPLANATION

The Discrete Logic Analyser, or the DLA, has two main modes of operation; view mode and run mode. In view mode, the step button, along with the up/down switch selector, will allow for viewing different memory locations and the logic data stored at that location. In run mode, the DLA will reset the counter to 0 and automatically start counting up while recording the data present on the input buffer. When the counter gets to 256 the system will automatically stop and reset the DLA into view mode.

At the heart of the DLA is an SRAM IC which is a memory IC that holds the logic data being recorded. The exact function as to how this works will not be covered here as it is somewhat complex but to summarise; the memory chip has address inputs which point to a memory location, data lines which can either have data going in or data going out, an output enable control line which enables data to be read from the memory IC, and a write enable control line that writes data to the memory location currently set by the address pins. The address lines of the memory IC are determined by the two 4516 counters (U2 and U6) which are configured as an 8-bit counter.

The current mode of the DLA is determined by the flip-flop U9B, and when the flip-flop is clear, then the DLA is in view mode. During view mode, pressing the step button will provide a clock pulse to the two 4516 counters which causes the pair to either increment or decrement (as a single 8-bit counter) depending on the switch position of SW1. The step button is able to clock the counter as its signal, controlled by U1C, is allowed to pass thanks to the VIEW signal being 1. The up/down switch is able to control if the counter increments or decrements thanks to its control gate, U1D, being enabled by the VIEW signal being 1. During view mode, the value of Q from the flip-flop U9B is 0 which is directly connected to the memory ICs OE input meaning that the memory IC will output data at the location designated by the address pins (which are connected to the 8-bit counter). The IC U7 will display the readings from the memory IC on the LEDs so that the current data can be easily seen.

When the START button is pressed the flip-flop that controls the current mode, U9B, is set and therefore Q = 1 and /Q = 0. This means that the OE input to the memory IC is now a logical 1, and therefore, the memory IC no longer output data. At the same time, the up/down switch is disabled, and both counters (U2 and U6) are forced to count up. The step button is disabled via the use of the AND gate U1C and the 555 astable clock is connected to the 8-bit counter via its AND gate U1B. Data from the outside world can only enter the DLA if the input buffer (U3) is enabled, and the enable signal for the buffer, which is an inverting type, is connected to VIEW. Since VIEW is equal to 0 in run mode, the input buffer is enabled, and data from the outside world is passed directly to the memory chip. In order for the memory chip to save data, it requires the WE pin to be strobed from 1 to a 0. Since the counter counts up upon a clock transition from a 0 to a 1, we want the data to save when the clock transitions from a 1 to a 0. We also only want the save strobe to occur when in run mode and never in step mode. Therefore, the 555 astable clock is first passed into a NOR gate U4A that prevents the system from writing when the START button is held down (has to be released for the system to start). Secondly, the clock signal is then fed into an inverter so that it can be controlled by the AND gate U1A. This AND gate prevents write signals from being sent when the DLA is in STEP mode. The output of the AND gate is connected to an inverter which makes the write strobe occur on the falling edge of the clock. When the 8-bit counter reaches 256, the TC output of U6 goes low which is fed into an inverter, and this causes the mode flip-flop, U9B, to reset and put the DLA into view mode.

The capacitor value of C13 can be changed to provide different clock speeds. Small values can be useful for reading fast logic signals but if a blinking lights project is desired, then use a 10uF as this demonstrates the counter incrementing very well.

MATERIALS

Check that you have the following components

Component	Component Name	Quantity	Looks like
28 DIP Socket	U5	1	
20 DIP Socket	U3	1	
18 DIP Socket	U7, U8	2	
16 DIP Socket	U2, U6	2	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
14 DIP Socket	U1, U4, U9	3	
8 DIP Socket	IC1	1	
SRAM IC	U5	1	
74HC244	U3	1	
ULN2803	U7, U8	2	
4516	U2, U6	2	
4081	U1	1	
4001	U4	1	
4013	U9	1	
555 Timer	IC1	1	
2N3904	Q1, Q2, Q3	3	
7805	U10	1	

MATERIALS

Check that you have the following components

Component	Component Name	Quantity	Looks like
1KΩ Resistor	R1, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R24, R25, R26, R27, R28, R29, R30, R32, R33	22	
10KΩ Resistor	R2, R3, R4, R5, R6, R7, R8, R9, R10, R23, R31, R34, R35	13	
10KΩ Potentiometer	RV1	1	reger (
1nF Capacitor	C13	1	
100nF Capacitor	C1, C2, C3, C4, C5, C6, C7, C8, C9, C11, C12, C13, C14, C16, C17	15	
10uF Capacitor	C15	1	18001-73120 1716/0 2071
3mm Red LED	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16	16	
1N5817	D17, D18, D20	3	
Tactile Switch	SW2, SW4	2	*
Small Slide Switch	SW1, SW3	2	i
8-Pin Socket	J1	1	
PP3 Connector	J2	1	Ø 0
РСВ	-	1	

CONSTRUCTION

Download the electronics construction manual

To learn how to construct circuits on PCBs download the Electronics Construction Manual from MitchElectronics using the link below. This document shows you how to install all electronic components used in MitchElectronics kits. The list below shows the sections relevant to this kit so do not worry if you see component sections in the document that don't come with this kit!

www.mitchelectronics.co.uk/electronicsConstructionManual.pdf

Relevant sections in the electronics construction manual

Resistors

Capacitors

Transistors

Potentiometers

LEDs

Switches

ICs

Wires

RESISTOR AND CAPACITOR IDENTIFICATION

Colour	1 ST Band	2 ND Band	3 RD Band	Multiplier	Tolerance	
BLACK	0	0	0	1Ω		1ct Significant Di
BROWN	1	1	1	10Ω	±1%	
RED	2	2	2	100Ω	±2%	2nd Significant D
ORANGE	3	3	3	1kΩ		Multiplier
YELLOW	4	4	4	10kΩ		1 First Digit
GREEN	5	5	5	100kΩ	±0.50%	104 1 - First Digit
BLUE	6	6	6	1ΜΩ	±0.25%	0 - Second Digit
VIOLET	7	7	7	10ΜΩ	±0.10%	4 - 10000 Multipl
GREY	8	8	8		±0.05%	100nF Capacitor
WHITE	9	9	9			room capacitor
GOLD					±5%	
SILVER					±10%	· ·
				4 Band F	Resistor	1

IMPORTANT INFORMATION



TERMS AND CONDITIONS

MitchElectronics Mission

The main goal of MitchElectronics products is to provide safe electronics to makers and professionals alike while keeping the cost affordable. MitchElectronics kits are ideal for classrooms whereby students can learn about electronics using a hands-on approach which is not only highly effective at teaching students but also improves hand-eye co-ordination as well as grow interest in electronics. Since MitchElectronics kits are aimed at novices and those who are new to electronics they are designed to use low voltage power supplies such as 9V batteries which are inherently safe due to their limited voltage and current capabilities.

MitchElectronics Liability

MitchElectronics kits must be inspected and tested by a competent individual before use and must be constructed by those who are competent to do so. MitchElectronics is not liable for kits and products that are constructed incorrectly or to a poor standard whereby poor standard includes (but not limited to) poor solder connections, overheated components, and damaged components. MitchElectronics is not liable for harm, injury, or damage caused by the misuse of kits and/or products if

- Incorrectly constructed
- Powered by sources other than "portable batteries" or the specified power supply
- Kits used outside their operational range (such as voltage supply, temperature etc.)
- Used as a sub-system (i.e. connected to additional circuits and modules)
- Used in a non-educational environment
- Used in a commercial environment
- Used in any dangerous or potentially hazardous environment
- Purchased from an unauthorised third party

Portable batteries refers to low powered alkali batteries. Lithium-based batteries and those with large current capabilities (such as lead-acid batteries) are not considered portable or safe

The use of the kits or products in the above scenarios automatically voids any warrantee or guarantee of that kit or product.

Kits must be

- Inspected for damage before and after construction
- Inspected for missing parts
- Constructed correctly by a qualified individual
- Used in an appropriate manner (i.e. within operational ranges)
- Purchased from an authorised seller

Those who are not competent to construct, inspect, and test kits and products must be accompanied by a competent individual and that competent individual assumes all responsibility for harm or damages and MitchElectronics is not liable for any harm or damage.

Missing Parts

MitchElectronics is only liable for missing parts for kits that have been purchased within 28 days and that have been purchased directly from www.mitchelectronics.co.uk. MitchElectronics is not liable for any product sold by an unauthorised third party.