Wireless World Digital Computer

A Construction project by Mike Tritt and Bob Jordan

Christchurch 1967

Introduction

Mike Tritt and Bob Jordan attained degrees in Electrical Engineering from the University of Canterbury, Christchurch, New Zealand in 1970. Although not a requirement of the curriculum, an interest in electronics and computing during their undergraduate years resulted in the design and construction of a digital computer, based on the articles published in "Wireless World" over the period August to December 1967.

The preface to the first of five articles in Wireless World magazine summarized the scope of the project;

> *"Low-cost desk-top binary machine for small scale calculations in schools as a teaching aid, designed by B Crank of 'Wireless world" staff. Numbers are fed in manually and results of calculations are read from indicator lamps. Instructions, entered in binary coded form by a set of switches, are interpreted and carried out automatically by the machine."*

This report has been prepared in 2004, some 34 years after the construction of the computer, which still exists, and sometimes still operates

Arithmetic unit re-design

After considerable analysis of the original design, and a fair amount on inquisitive questioning, plus a bit of stubborn 'we can do better', some significant changes in design were made:

The original design comprised a register, accumulator, and three stores. The adder/subtractor took inputs from the register and the accumulator, returning the result to the accumulator. The register was provided with 'loop-around' so the contents could be retained. A separate counter was 'compared' to one of the stores for purposes of multiplication and division.

Our design eliminated the register and the counter, and increased the stores from three to five. The accumulator was retained, and store five was designed to combine the functions of a counter *and* shift register, a complemented number could be moved to store5 (c.f. a preset) and then the store used as a counter, counting up to the 'all-ones' state.

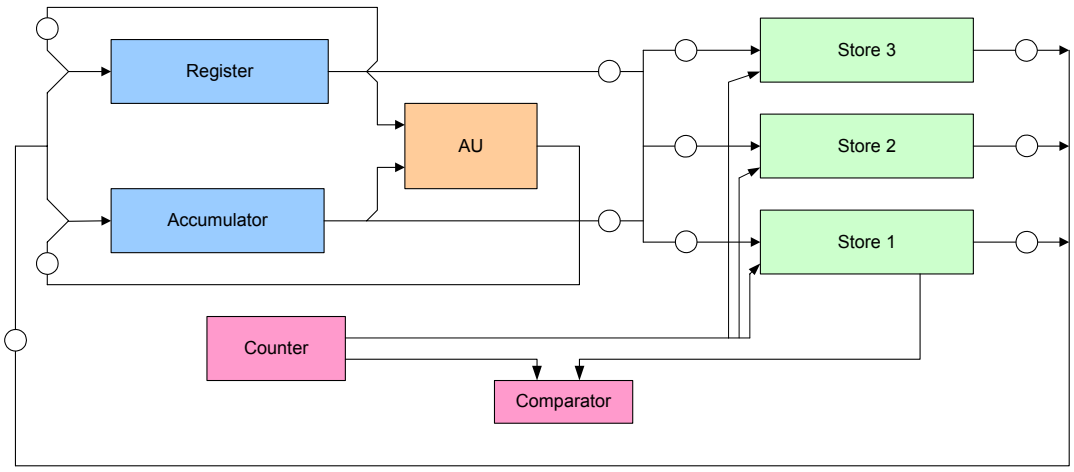


Fig 1: Original Logical diagram

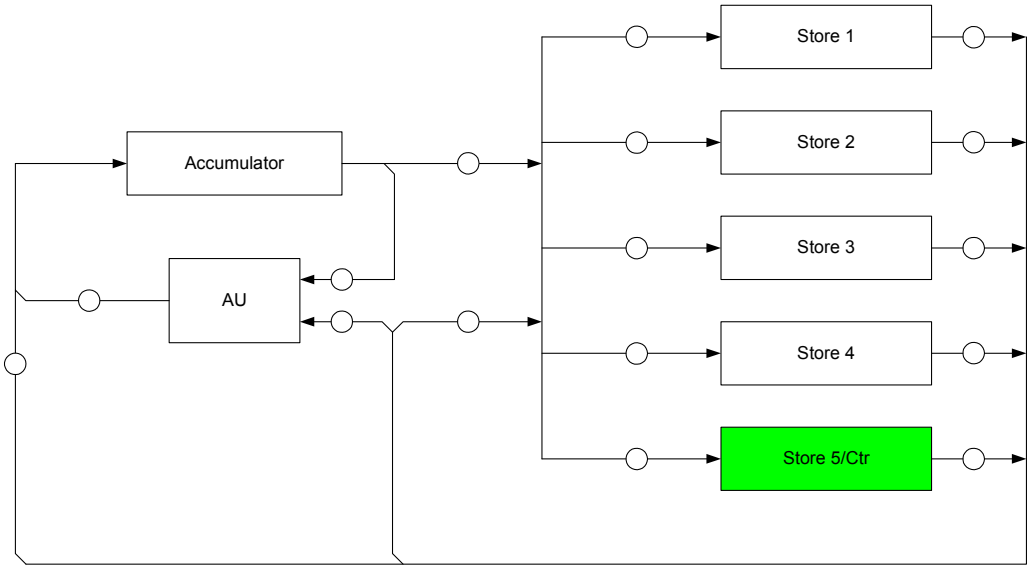


Fig 2: Revised Logical Diagram

Order Decoder

The order decoder was completely re-designed for the new logic, but also to minimize component count, by applying a large amount of complementary logic.

The command word used the first 4 bits (A~D) for the Order and the last 3 bits (F~H) for the store address (1 of 7). Bit 5 was never required.

The original design used bits AB for 'nature of order', CDE for AU address (ie Register, Accumulator or Counter), and FGH for store address.

Bits 1 2 3 4	Function
0 0 0 0	
0 0 0 1	Clear Accumulator
0 0 1 0	Clear Carry
0 0 1 1	
0 1 0 0	Acc to Store (non destructive)
0 1 0 1	Acc to Store (destructive)
0 1 1 0	Store to Acc (non destructive)
0 1 1 1	Store to Acc (destructive)
1 0 0 0	Add store (destructively)
1 0 0 1	Add store (non destructively)
1 0 1 0	Multiply by CSR (store 5)
1 0 1 1	
1 1 0 0	Subtract store (destructively)
1 1 0 1	Subtract store (non destructively)
1 1 1 0	Divide by store
1 1 1 1	Complement Accumulator

Bits 5 6 7	Function
0 0 0	
0 0 1	Store 1
0 1 0	Store 2
0 1 1	Store 3
1 0 0	Store 4
1 0 1	Store 5
1 1 0	
1 1 1	

Programme Board

The original designer contemplated an add on programme board which would store 64 words of data or commands. No further reference to this proposed add-on can be found.

A programme board was developed as part of our project, although, due to the passage of time, was never integrated with the computer. 125 steps of programme were available, and dual diode patching was used to the command (1 of 16) and the store address (1 of 7).

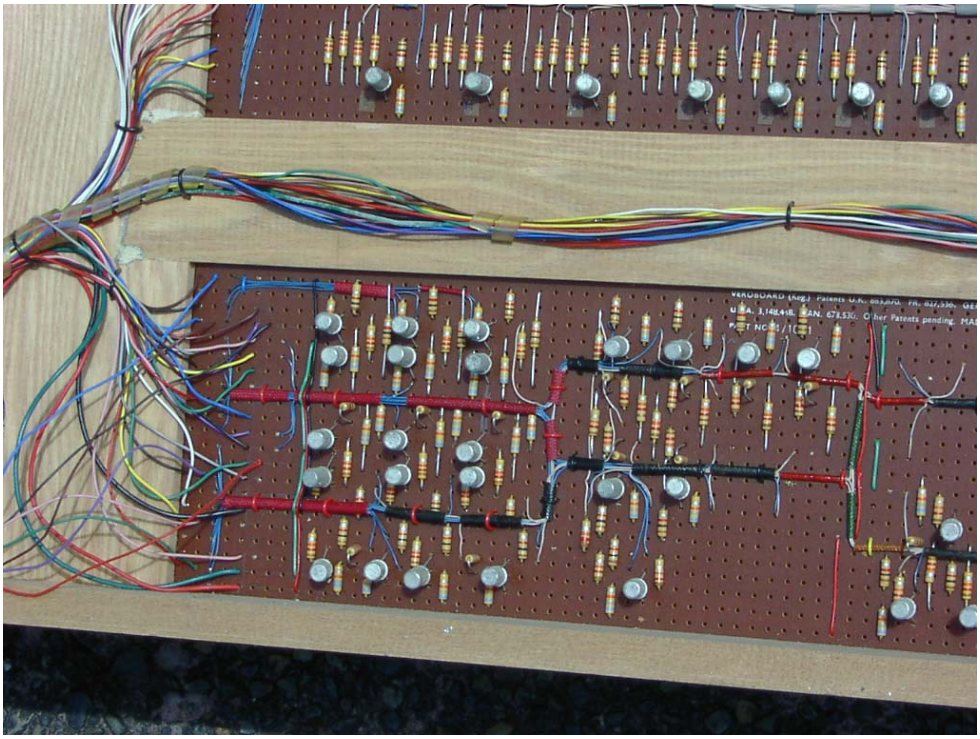
The programme counter was based on the use of three cascaded 'five-stables', a unique design using five transistors and having five stable states.

Construction

Board Design

Little detail was provided in the magazine regarding the physical aspects of construction, apart from the front panel layout. Veroboard was popular at the time and was an obvious choice for layouts.

Considerable time was spent optimizing the layout in X and Y directions, minimizing the amount of board required, yet not cramping the layout. All interconnections between boards were made using pads at the two ends, and use was made of very fine wire (including some post office 4lb/mile single strand PVC insulated) which could be grouped and held in place using 'spaghetti' held under the resistors and capacitors.



Components

Most components were sourced from England (firms such as Bi-Pre-Pak) and paid for via five shilling postal orders. In those days (in New Zealand) it was only possible to purchase one 5/0 order per person per post office per day, so when time came to make a purchase, a planned trip around 10 or so post office branches, by the two of us, was made, sometimes more than once.

Records show the component count for the main computer comprised 424 transistors, 203 diodes, 1348 resistors and 233 capacitors. The programme unit included another 375 transistors, 104 diodes, 1020 resistors and 40 capacitors, bring the total semiconductor count to around 800 transistors.

The following is a summary of the component count.

Component	**Total Cost**
Power supply components	$19.77
Hook-up wire (7/40)	$13.82
Transistors (799)	$30.14
Diodes (307)	$9.21
Resistors (2368)	$42.40
Veroboard (13)	$24.64
Other components	$60.49
TOTAL	NZ$200.47

Physical construction

A friend's father (a Joiner) provided a custom designed timber cabinet, which comprised six frames, each capable of holding two veroboards.. The frames are hinged at the left and cable holes at this end allowed the cabinet to be opened up, like the spokes of a wheel, allowing full access to both sides of a board for servicing. The front frame contains only the aluminium front panel mounting the switches and indicator lights All interconnecting cabling is permanently attached, apart from a plug/socket connector for the external power supply

Documentation

The following documentation is available in PDF format

Original Wireless World Articles

- Chapter 1 – 818 KB
- Chapter 2 – 1066 KB
- Chapter 3 – 659 KB
- Chapter 4 – 1162 KB
- Chapter 5 – 924 KB

Tritt/Jordan Project

- This Document
- Block Diagram – (3 pages) – 117 KB
- Board Layouts – (23 pages) – 1066 KB
- Design Stuff – (17 pages) – 2034 KB
- Line Signal diagrams – (4 pages) – 272 KB

Other reference documentation

- Scientific American Article (Sept 1966) – 1109 KB

Please contact Mike at miketritt@clear.net.nz