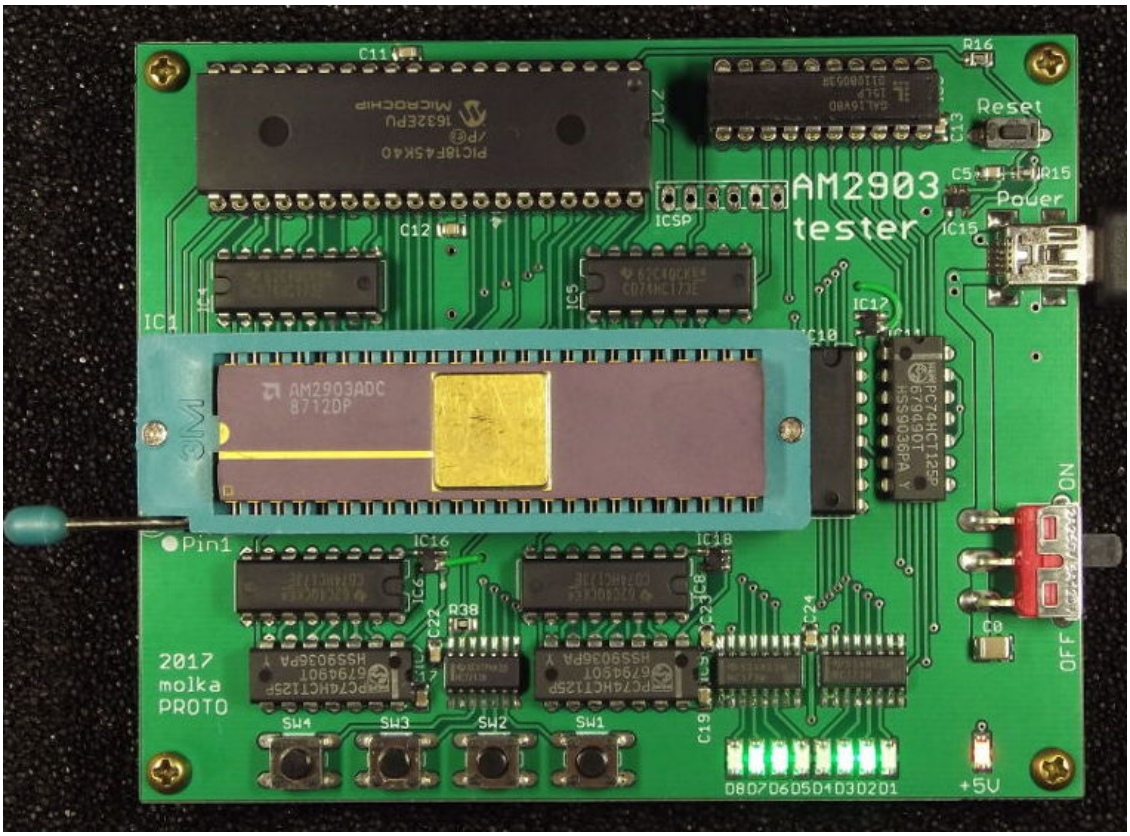
Am2903
4-Bit Slice Processor Tester



Am2903 /29203 BSP Test Board
User's Manual

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by molka

Overview

The Am2903 Test Board is intended to test the working condition of the AMD Am2903 and its many compatible BSP chips.
The Am2903 is a four-bit expandable bipolar microprocessor slice, of the Am2900 bit-slice family. The Am2903 performs all functions performed by the industry standard Am2901 and, in addition, provides a number of significant enhancements that are especially useful in arithmetic-oriented processors. In addition to its complete arithmetic and logic instruction set, the Am2903 provides a special set of instructions which facilitate the implementation of multiplication, division, normalization, and other previously time-consuming operations.. The 2903 also contains a 16x4 bit two-port RAM.

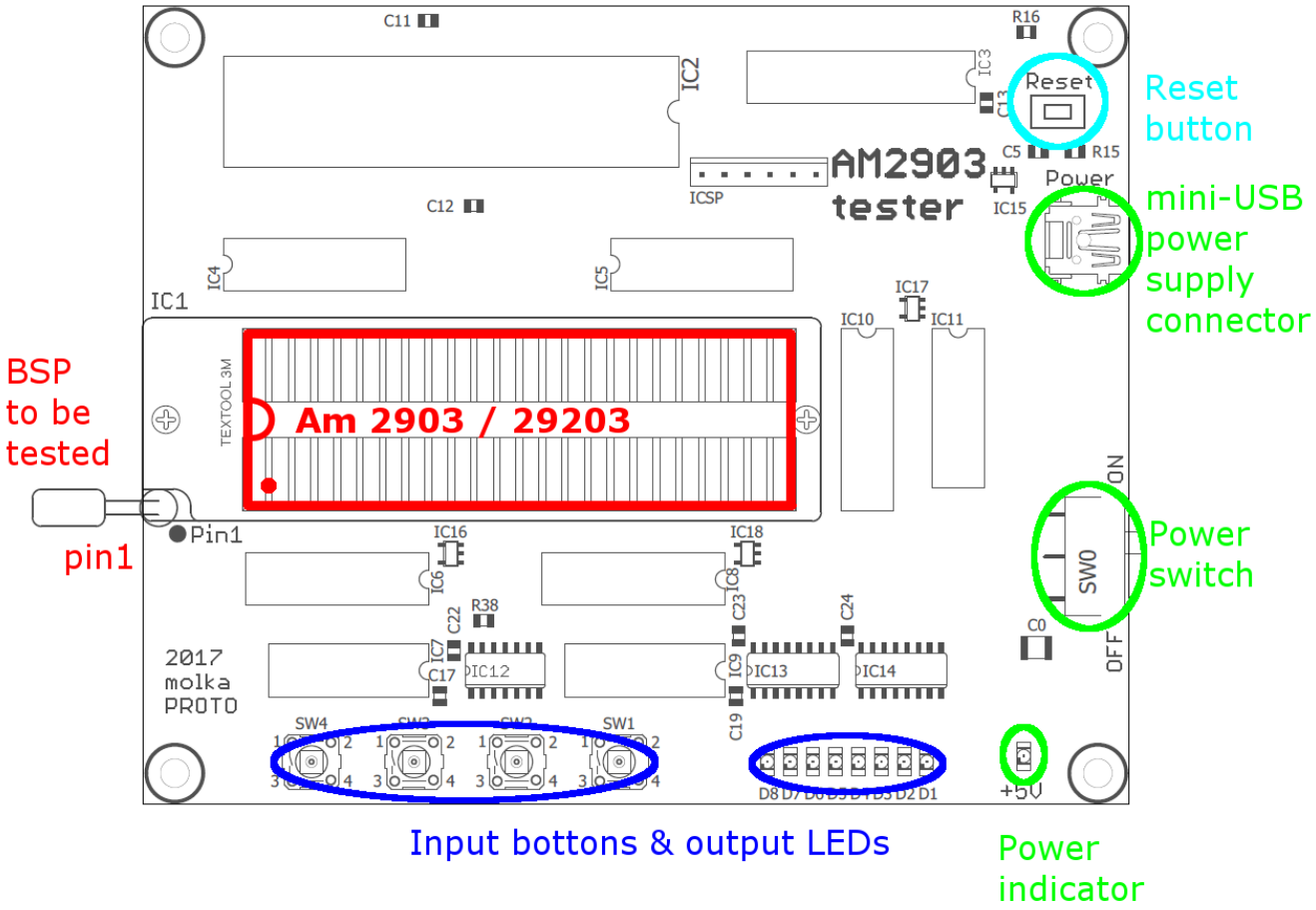
In a real application the Am2903 BSP elements execute micro instructions generated by a microprogram controller unit such as the AM2910, based on PROM stored microcode. In this test board a PIC MCU is used instead of a microcode PROM and microprogram controller.
The PIC MCU's test program provides register and function tests of AM2903 BSP and test routines with LED animations. It also supports 4 push buttons as inputs, and 8 LEDs as output devices.

The board consists of the following base components of an 4-bit microcomputer system:

- **48-pin ZIF Socket:** For one Am2903 BSP to be tested.
- **PIC MCU:** Microcode controller to generate micro instruction of test code.
- **8 LEDs:** Output devices.
- **4 Push Buttons:** Input devices.
- **4 bit data latches and bus drivers of each data and address ports.**

The board requires a single +5V power supply (400mA) provided through a mini-USB connector.
There is a power switch and power indicator LED in the lower-right corner of the test board.

Board layout and parts



- **Mini-USB 5V Power Supply Connector:** The board consumes around 400mA current so a computer USB connector or cell phone charger that can provide at least 500mA may be used as a power source.
- **Power Switch:** Power supply can be turned on and off by the sliding switch at the bottom right corner.
- **Red LED:** In the lower-right corner, indicates the 5V power level.
- **Reset Button:** The board contains a Power-Up reset circuit, but can be reset manually by pressing Reset button.
- **48-Pin ZIF Socket**: For the Am2903 BSP and expansions. Ensure proper orientation!!! The pin-1 is at lower-left corner, next to the release lever of the socket.
- **Eight Output LEDs:** Display simple animations/flashes to indicate that the BSP is working.
- **Four Push Buttons:** Used for testing inputs and changing animation sequences.

Usage

- Before changing the Am2903 BSP in the ZIF socket, make sure the power is off. The power indicator LED should be off!
- Place the BSP into the socket (socket lever should be in the **UP** position). Ensure proper orientation to prevent damage to the test board and BSP! Pin 1 must be at the lower-left corner, next to the release lever of the ZIF socket. Then lock the socket by moving the lever down into the lock position.
- Connect the power through the USB connector and switch the power switch to ON.
- The red power indicator LED should be illuminated.
- If the BSP is in working condition the 8 output LEDs should be flashing (1sec on/1sec off pattern).
- At this point the 2903 BSP can be considered WORKING. Congrats!

Base function test

- At start-up, or when the reset button is pressed, the base unit tests are executed, testing the Am2903s I/O functions, registers and standard instruction executions. Test program v1.0 does not execute the special instructions of the Am2903.
- When you press any of the four push buttons (SW1 – 4) the output LEDs copy the state of the buttons, duplicated in the low and high nibbles.
- Releasing the buttons causes one of the four different animation sequences to start, corresponding to the button released last.

Base function test failure

The base function test failure is indicated by rapid flashing of D1-4 and D5-8 alternately.
Press **SW1, SW2, SW3, or SW4** to display detailed error information on LED D1-8.
See **Table 1** for error codes of base function test failure.

Troubleshooting

- After connecting the power supply the power indicator LED remains off. Turn off the power immediately!

  This may be caused by:
  - The power supply is unable to provide enough current. Check that it can provide at least 400mA. (500-600mA recommended)
  - Thin, poor quality USB cable can also cause this problem.
  - There is short-circuit (fault) in the BSP.

- The 8 output LEDs do not start flashing.
  - Press the Reset button. If the output LEDs continue to remain off then the BSP may be faulty.
  - Check the BSP pins, if they are dirty or dusty clean them, and try testing again.
  - It may help to press firmly on the BSP while lowering the lock level to ensure it is properly seated in the socket.

Table 1. Error codes of base test:

o = LED is on, **-** = LED is off

Flag values:
N: *N* negative bit,
C: *Cn+4* carry bit,
O: *OVR* overflow bit,
Z: *Z* zero bit

Error description	SW4 D8 D7 D6 D5 D4 D3 D2 D1	SW3 D8 D7 D6 D5 D4 D3 D2 D1	SW2 D8 D7 D6 D5 D4 D3 D2 D1	SW1 D8 D7 D6 D5 D4 D3 D2 D1
No BSP or expansion detected	o o o o o o o o	- - - - - - - -	- - - - - - - -	- - - - - - - -
Register error r = register number in binary format	o o o o o o o o	Resulted value	Expected value	o - - - r r r r
Register Q error	o o o o o o o o	Resulted value	Expected value	o - - o - - - -
Output Y error	o o o o o o o o	Resulted value	Expected value	o o - - - - - -
Output data B error	o o o o o o o o	Resulted value	Expected value	o o - - - - o -
Flag bit error	o o o o o o o o	Resulted value N C O Z - - - -	Expected value N C O Z - - - -	o o - - - - - o
QIO bit error	o o o o o o o o	- - - - - - - -	- - - - - - - -	o o o - - - o -
SIO bit error	o o o o o o o o	- - - - - - - -	- - - - - - - -	o o o - - - - o

Am2901, MMI 6701 and SN74181 Test Expansion Tools

The expansion tools allow the Am2903 test-board to test the working state of Am2901 and MMI 6701/5701 BSPs and SN74181 type ALUs.

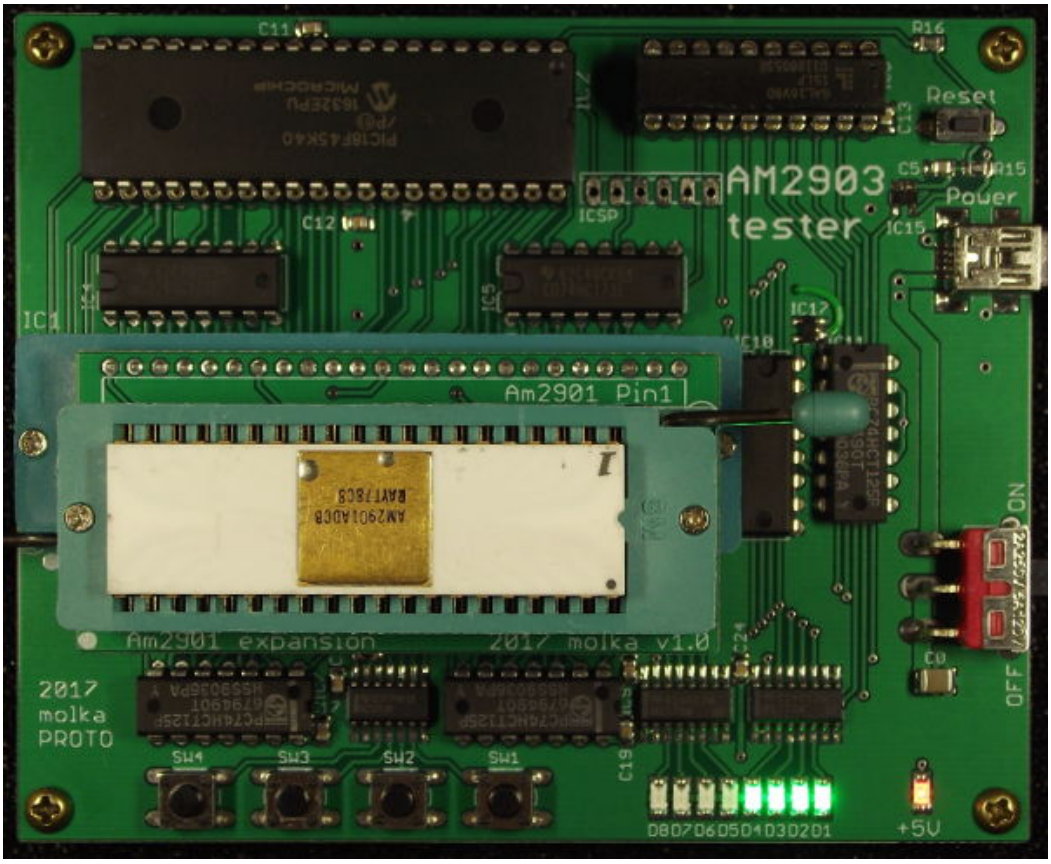
Expansion tool usage

- Turn off the power of the Am2903 test-board and unplug the power cord.
- Remove the last tested BSP and leave the release lever of the ZIF socket open.
- Insert the pins of the expansion tool carefully into the ZIF socket. Ensure proper orientation to prevent damage to the test board and BSP! The white dot in the corner of the expansion tool must match the white dot, indicating pin 1 of Am2903 ZIF socket, and then lock the ZIF socket of the test-board.
- Insert the BSP to be tested into the expansion tool's ZIF socket. Take care to ensure proper orientation! Pin 1 of BSP must be next to the release lever of the ZIF socket! Then lock the socket by moving the lever down into the lock position.
- Plug in the power supply and switch on the power of the test-board.
- The same behavior of test-board should be discerned as testing an Am2903 BSP inserted directly into the test-board.
- See the illustrations that show how the expansion boards should be inserted.

Removing the expansion tool

- Turn off the power of the test-board and unplug the power cord.
- Remove the tested BSP from the expansion tool’s ZIF socket.
- Unlock the release lever of the ZIF socket on test-board.
- Remove the expansion tool from the ZIF socket of test-board.

Picture 1. Am2901 expansion.

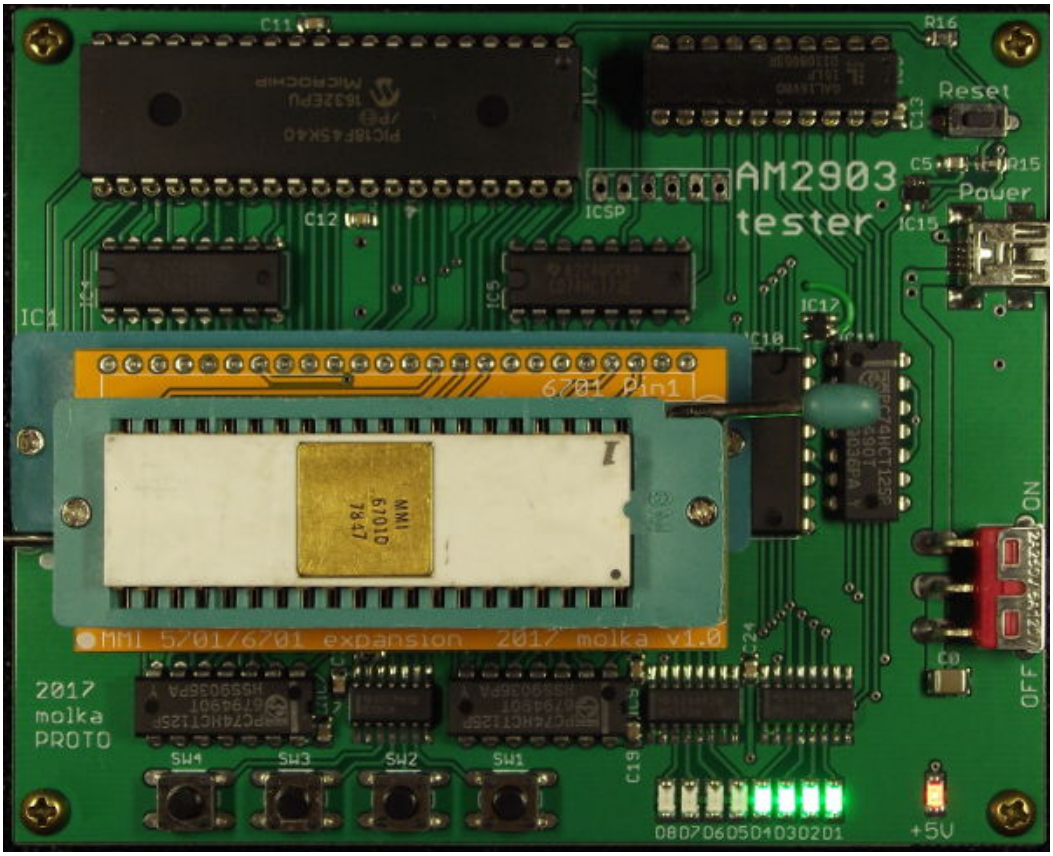


The Am2901 is a 4-bit bit-slice chip of the Am2900 bit-slice family. It was created in 1975 by Advanced Micro Devices.
It executes three arithmetic and five logical operations on two operands and left/right shift on one operand. The 2901 also contains a 16x4 bit two-port RAM.

Table 2. Error codes of base test with inserted Am2901 expansion:
o = LED is on, - = LED is off
Flag values: **S**: *F3* sign bit, **C**: *Cn+4* carry bit, **O**: *OVR* overflow bit, **Z**: *F=0* zero bit

Error description	SW4 D8 D7 D6 D5 D4 D3 D2 D1	SW3 D8 D7 D6 D5 D4 D3 D2 D1	SW2 D8 D7 D6 D5 D4 D3 D2 D1	SW1 D8 D7 D6 D5 D4 D3 D2 D1
No BSP detected	- - - - - - o o	- - - - - - - -	- - - - - - - -	- - - - - - - -
Register error r = register number in binary format	- - - - - - o o	Resulted value	Expected value	o - - - r r r r
Register Q error	- - - - - - o o	Resulted value	Expected value	o - - o - - - -
Output Y error	- - - - - - o o	Resulted value	Expected value	o o - - - - - -
Flag bit error	- - - - - - o o	Resulted value S C O Z - - - -	Expected value S C O Z - - - -	o o - - - - - o
QIO bit error	- - - - - - o o	- - - - - - - -	- - - - - - - -	o o o - - - o -
SIO bit error	- - - - - - o o	- - - - - - - -	- - - - - - - -	o o o - - - - o

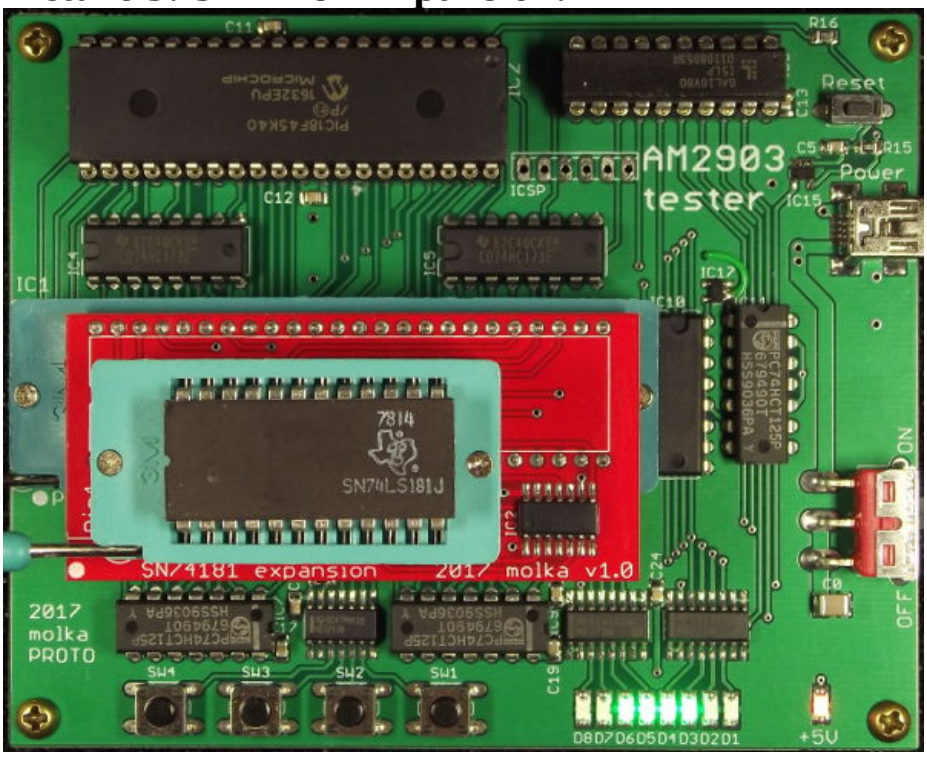
Picture 2. MMI 5701/6701 expansion.



The Monolithic Memories Incorporated 5701/6701 bit slice processor family was introduced in 1974. The 5701/6701 family consisted from two members: 6701 is a bit-slice processor operating in commercial temperature range, and 5701 is a BSP operating in military temperature range.
This 4-bit Bipolar LSI Processor Slice on a single chip replaces 25 TTL MSI packages and includes 16 x 4-bit directly addressable, two-port general purpose accumulators and a separate Q-register, useful as a Scratchpad or Accumulator expansion. The BSP has 36 instructions including Arithmetic, Logic and Shifting capability.

The error codes of MMI5701/6701 test are similar to Am2901 error codes in **Table 2** with the following exceptions:
- LED's state when pressing SW4 are "- - - - o - - o",
- The flag bits are:
  - **S**: *F all high* bit
  - **C**: *Cn+4* carry bit
  - **O**: *OVR* overflow bit
  - **Z**: *F all low* bit

Picture 3: SN74181 Expansion.



The 74181 is a bit slice arithmetic logic unit (ALU), implemented as a 7400 series TTL integrated circuit. The first complete ALU on a single chip, it was used as the arithmetic/logic core in the CPUs of many historically significant minicomputers and other devices. It is a standard 7400 series medium-scale integration (MSI) TTL integrated circuit, containing the equivalent of 75 logic gates and most commonly packaged as a 24-pin DIP. The 4-bit wide ALU can perform all the traditional ADD/SUB and decrement operations with or without carry, as well as AND, NAND, OR, NOR, XOR and shift.
The 74181 performs these operations on two four-bit operands generating a four-bit result with carry in 22 nanoseconds (45 MHz).

The ‘181 was made in military spec (54181) as well as several other TTL varieties such as Schottky (74S181), Low Power Schottky (74LS181) Fast (74F181) and High speed CMOS (HC and HCT). The Expansion supports all these versions.

Table 3. Error codes of base test with inserted SN74181 expansion:
o = LED is on, - = LED is off

Error description	SW4 D8 D7 D6 D5 D4 D3 D2 D1	SW3 D8 D7 D6 D5 D4 D3 D2 D1	SW2 D8 D7 D6 D5 D4 D3 D2 D1	SW1 D8 D7 D6 D5 D4 D3 D2 D1
No ALU detected	- - - - o o - -	- - - - - - - -	- - - - - - - -	- - - - - - - -
Instruction error n = test operation number in binary format	- - - - o o - -	Resulted value	Expected value	o - - n n n n n

Tested BSPs:

Manufacturer	Variant

Am2903:

AMD	AM2903DC, AM2903ADC, AM2903DMB, AM29203DC
IDT	IDT39C03ACB
Electronika (Russian)	KM1804BC2

Am2901:

AMD	AM2901ADC, AM2901BDC, AM2901CDC AM2901APC AM2901BPC, AM2901CPC, AM2901DC, AM2901PC, AM2901BDCTB
National Semiconductor	IDM2901A DC, IDM2901AJC, IDM2901A-1JC IDM2901A-1 NC
NEC	B2901AD
WSI	5901CP (CMOS)
CCCP	KM1804 BC1, KP1804 BC1

MMI 5701/6701:

Monolithic Memories Incorporated	MMI6701D

SN74181:

Texas Instruments	SN74**LS**181J, SN74**LS**181N, SN54**LS**181J
AMD	SN54S181J
Fairchild	F74181PC, F74**F**181SDC (Skinny DIP)
Motorola	MC74**LS**181N
National Semiconductor	74**F**181PC
RCA	CD74**HC**181E, CD74**HCT**181E
SGS	T74**LS**181N
Signetics	74181N, N74**LS**181N, 74**S**181N, JM38510/07801BJA
Tungsram (Hungary)	74181PC

Thanks to CPUShack for review and advises!

Feel free to write an e-mail to me at molnar.kalman@freemail.hu or send a PM to molka at CPU-World forum if you have any question.