

PCB 77301

14.1 Introduction

The IEEE-488 interface card contains the following circuit functions:

- IEEE-488 interface, based on the TMS9914A IC set;
- address & terminator switch and buffer;
- isolated power supply;
- support logic for above.

The IEEE-488 lines are isolated from the rest of the MJS401D logic and signal system by transformers and opto-isolators in order not to create ground loops via the controller or other instruments in the system. This has necessitated some extra logic and an isolated power supply, as against a rudimentary system.

Early interfaces had the address & terminator switch on the interface card, accessible by removing the top cover of the MJS401D. Later models have the switch mounted on the back panel.

The syntax for control and measurement is extensive, and a separate operation manual is issued. A copy is in Part 3 of this manual.

14.2 Circuit description

Reference to the circuit diagram will show that there is no ohmic connection across the vertical dotted line near the middle. Take care not to confuse the two 0 V references!

14.2.1 Isolated Power Supply

IC15/1,2,3 forms a free-running oscillator at about 100 kHz. A sawtooth waveform is generated on C9. This is applied to the second half of IC15, along with a feedback signal derived from the isolated output voltage. IC15/5,6,7 thus functions as a pulse width modulator.

The output from IC15/7 is fed to the gate of TR2, whose drain current feeds the primary of T5, which is phased so as to function as a flyback converter, i.e. the energy is transferred to the output circuit when TR2 is turned off. C13, R14, D4 and D5 are snubber components to prevent damage to TR2 by energy stored in the primary leakage inductance of T5.

D6 and C14 rectify and store the energy transferred across the isolation barrier. D7, VR1 and IC16 feed back a signal related to the voltage appearing on C14. No current flows in the diode section of IC16 until nearly 5 V is established on C14, after which the current rises quite steeply with increasing voltage, until equilibrium is reached due to the action of the control system. VR1 adjusts the set point to 5 V.

TR1, R12 and R13 provide current limiting for TR2.

14.2.2 IEEE-488 Interface

IC11, IC12 and IC13 form the core of the bus interface. IC12 and IC13 are merely buffers to provide the drive capability for the heavily terminated IEEE-488 lines. Two sections of IC14 generate an active low power-on reset pulse to IC11.

A 4 MHz clock signal is received on PL1/24, buffered by IC5/8,12, and transferred across the isolation barrier in T2, a quad bus isolation transformer. D.C. restoration is effected by C6, D1 and D2, and the isolated clock signal is applied to IC11/8.

14.2.3 Interrupts

IC11 is entirely interrupt driven in this application. IC11 generates an active low signal at pin 9, which is transferred through IC8, and squared up again by IC1/9,8,3,4 to be presented to the microcomputer.

14.2.4 Bus buffering

IC6 (microcomputer side) and IC7 (IEEE-488 side) provide bus buffering, with enough drive for T3 and T4, the bus isolation transformers. These transformers can only transmit pulses of up to 500 ns duration at 5 V without saturating, so IC2 and the surrounding ICs reduce the duration of data bus transactions appropriately.

IC2 is clocked by the 4 MHz clock, and has an active high SELECT signal at its D input, pin 2. The SELECT signal is derived from ADDRESS.IORQ.NOT M1 (see

Microcomputer, section 3, for more complete information). The SELECT signal begins just after a rising clock edge, and ends just after a falling clock edge, similarly to the IORQ output of the Z80 CPU. IORQ is also applied to its active low clear input, pin 1. The result at IC2/5 is a version of the SELECT pulse which starts one clock cycle later, but ends at the same time, now being around 375 ns long. See Figure 14.2.1. This signal is used to enable the bus buffers IC6 and IC7, and the IEEE-488 interface, IC11.

The second section of IC2 delays the above signal by another clock cycle, but without the clear input. IC2 pins 8 and 9 generate pulses one clock cycle (250 ns) wide.

On Write cycles (i.e. CPU writes to IC11), the NOT WRITE ENABLE signal for IC11 is active from the time that the first section of IC2 is active but not the second section. These pulses are therefore 250 ns wide. The bus buffers remain enabled for a further 125 ns approximately after the termination of the NOT WRITE ENABLE pulse, to ensure adequate data hold time at IC11.

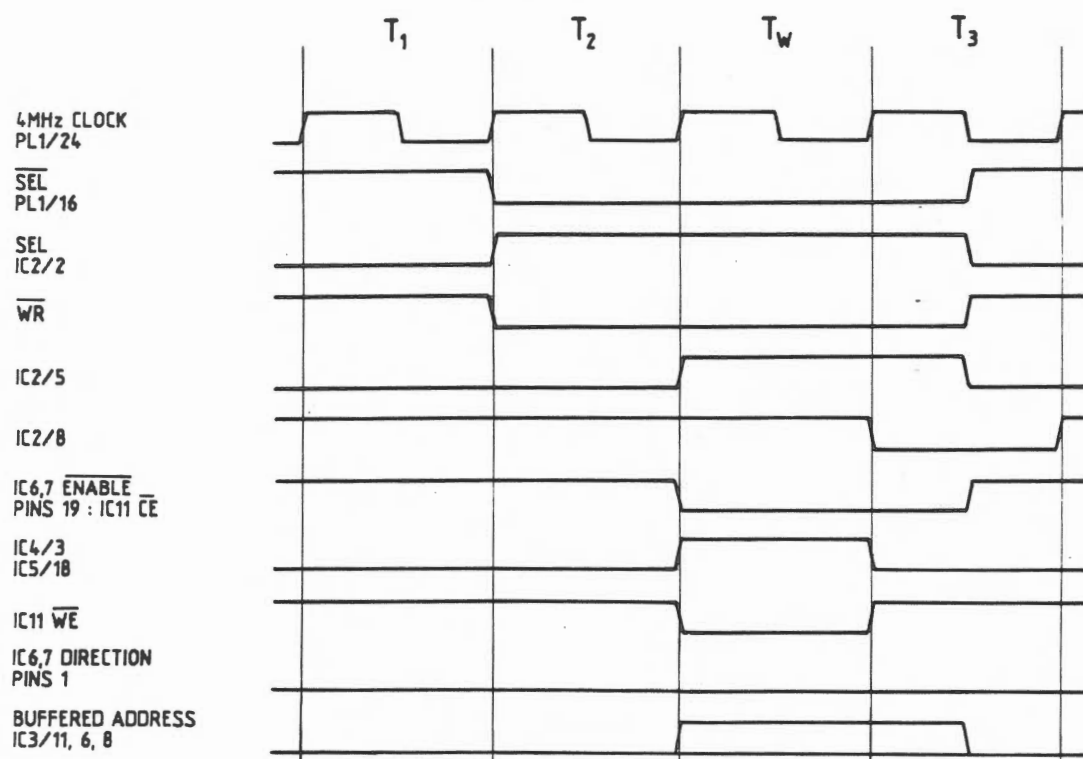


Figure 14.2.1 Write Cycle Timing Diagram

On Read cycles (i.e. CPU reads from IC11), the DBIN (Data Bus IN) signal for IC11 is timed similarly to the data bus buffer enable signal. Data is sampled by the CPU on the falling edge of the clock during its T_3 state (see Figure 14.2.2). Adequate data hold time for the CPU (0 ns required after the trailing edge of RD) is ensured by propagation delays through IC7, IC6, and the microcomputer's IC26.

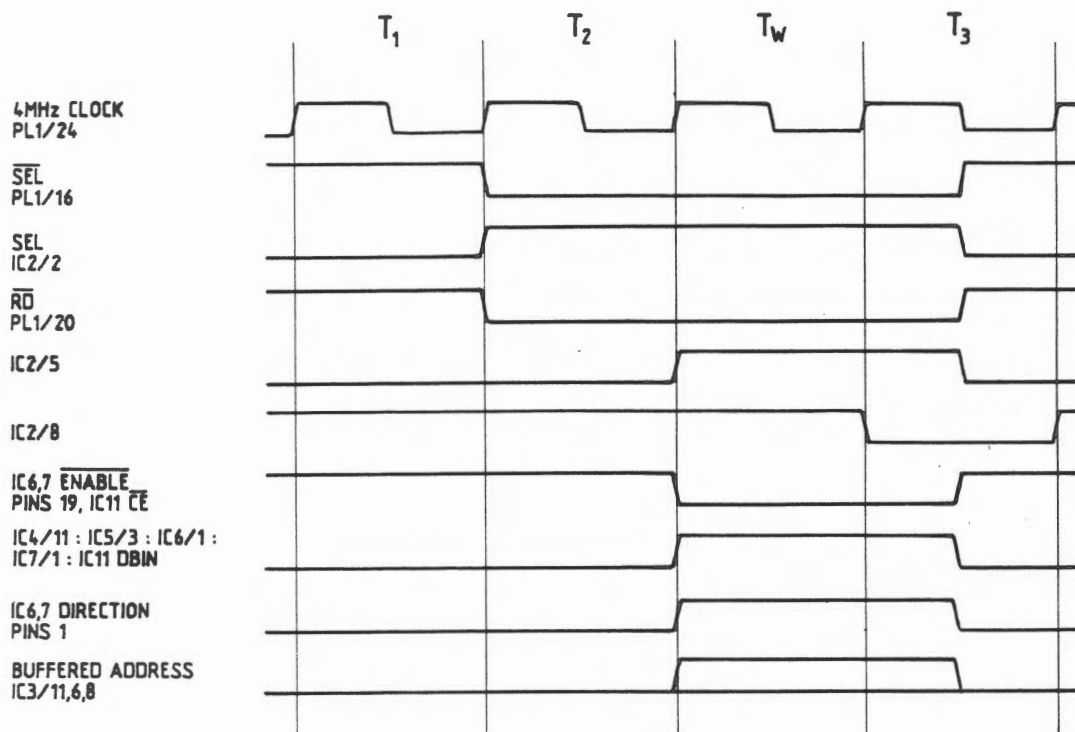


Figure 14.2.2 Read Cycle Timing Diagram

One of eight register locations in IC11 is selected by RS0, RS1 and RS2, which are fed from isolated versions of address lines A0-A2 from the CPU, enabled by IC2/5.

14.2.5 Address & Terminator Switch

Though eight read register locations are decoded, IC11 only has six, and does not respond to the remaining two, its data bus remaining in the high impedance state. It is therefore possible to put another input port at one of these unused locations. IC9 is such a port, and is enabled by IC10, which receives a three bit address, plus chip enable and data bus in signals. The inputs of IC9 are eight DIL switches, pulled up to logic 1 by RN2 if the switches are open. The logic state of the switches is inverted in software.

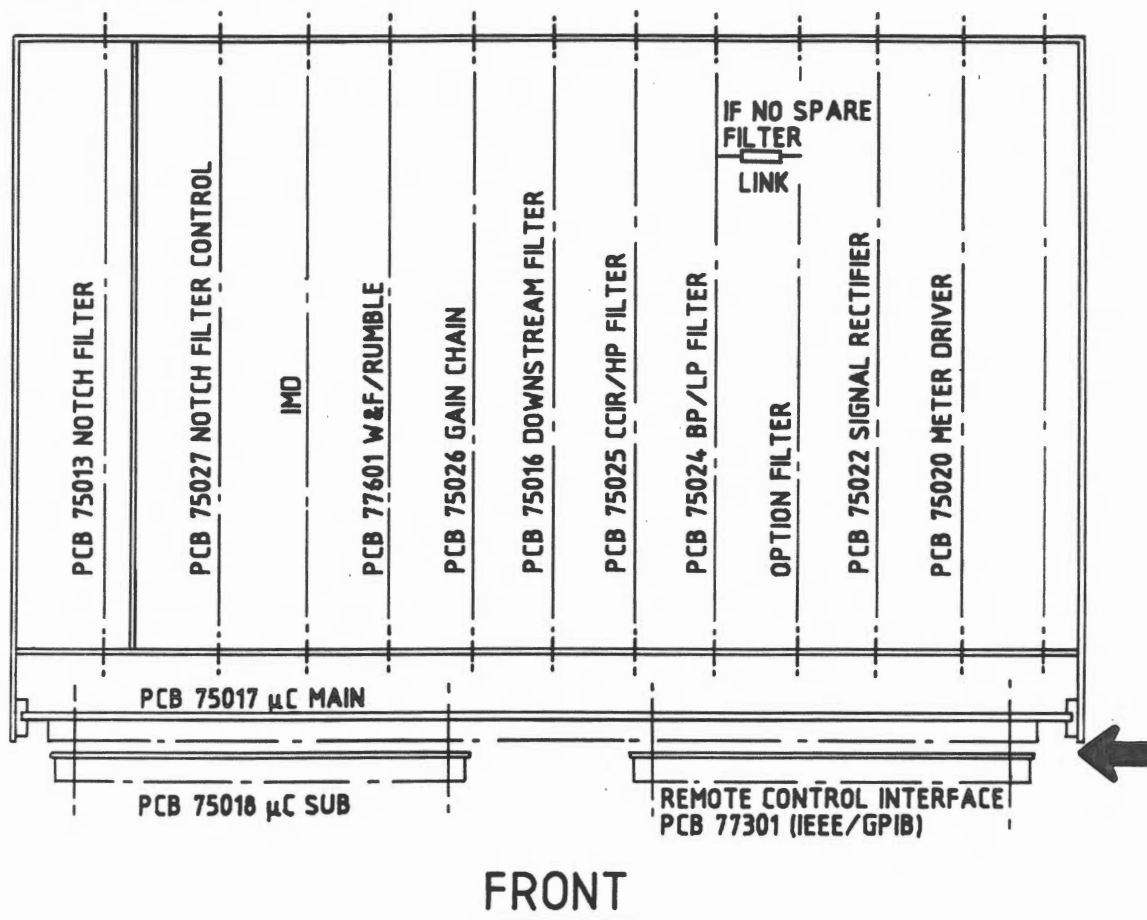
14.3 Removal/Replacement

14.3.1 Removal

Turn off the MJS401D and remove the mains lead.

Remove the four screws retaining the instrument's top cover. Remove the top cover by pulling straight up.

The IEEE-488 PCB is mounted on the microcomputer main board, which is located across the front of the main card frame.



MJS401D PCB Location Guide

Unplug the ribbon cable connecting the microcomputer to the front panel. Fold the cable forward over the front of the case.

To remove, pull up on the corners. It will probably be necessary to ease it slowly one side at a time due to the large number of contacts. A ribbon cable runs from the right side of the IEEE-488 interface card to the rear of the case. Unplug this cable to ease the extraction. Later models of the MJS401D with the address & terminator switch on the back panel have a second cable to a DIL socket on the interface PCB. Remove the DIL plug CAREFULLY ensuring that pins are not bent at all, since they fatigue and break easily. It is

recommended that the now exposed DIL plug is protected either by being plugged into a spare DIL socket, or by being pushed into some expanded polystyrene.

Unplug the interface PCB from CONN 3 on the microcomputer main board. Remove the four screws and shakeproof washers **ON THE REAR OF THE MICROCOMPUTER MAIN BOARD** to remove the interface PCB. The four pillars should remain with the interface PCB.

14.3.2 Replacement

Using a drop of low strength thread locking compound (Bostik T22 or similar) on each screw, replace the four screws holding the interface PCB to the microcomputer, with a shakeproof washer under the head of each screw.

Otherwise, replacement is the reverse of removal. The interface PCB plugs into CONN 3 (the **LOWER** of the two headers). The cable to the 24-way IEEE-488 connector plugs into the right side of the interface PCB. The address & terminator switch cable (if present) plugs into the DIL socket at the top of the interface PCB, with the cable exiting from the bottom of the DIL plug.

Slide the microcomputer PCB down carefully in its guides. Before pressing down, check that the connectors in the centre of the microcomputer are properly aligned with the pins on the motherboard. Failure to do this may result in bending or breaking the connector pins. Also ensure that the front panel wiring does not interfere.

Push the PCBs fully down - they should snap into place.

Plug the ribbon cable from the front panel into CONN 2, the **UPPER** header of the main microcomputer PCB.

14.4 Fault Finding

Use the Microcomputer Extender Assembly.

First check the isolated power supply.

14.4.1 Isolated power supply

Check that there is 5 V between the "+5 V" and "0 V" test points under PL1.

Check that there is 5 V between test points "+5 V FLOATING" and "0 V FLOATING".

If not, check that the ± 18 V test points have about ± 18 V on them, relative to the 0 V test point under PL1.

Check that IC15/1 has a square wave at about 100 kHz, between 0 V and -18 V.

If the isolated 5 V supply is low, IC15/5 should be near 0 V, and IC15/7 should be at 0 V most of the time. If the isolated 5 V is high, IC15/5 should be near -18 V, and IC15/7 should be at -18 V most of the time. Either way, IC15/5 should be switching between 0 V and -18 V quite cleanly, not hovering at intermediate voltages.

The drain of TR2 should be as in Figure 14.4.1. Do NOT attempt to run with any of the snubber components C13, R14, D4 or D5 missing or incorrectly substituted, as damage to TR2 will probably result.

Note also that IC15 is a dual comparator, which switches much faster than an op-amp. Do not attempt to substitute an op-amp, as TR2 would almost certainly burn out.

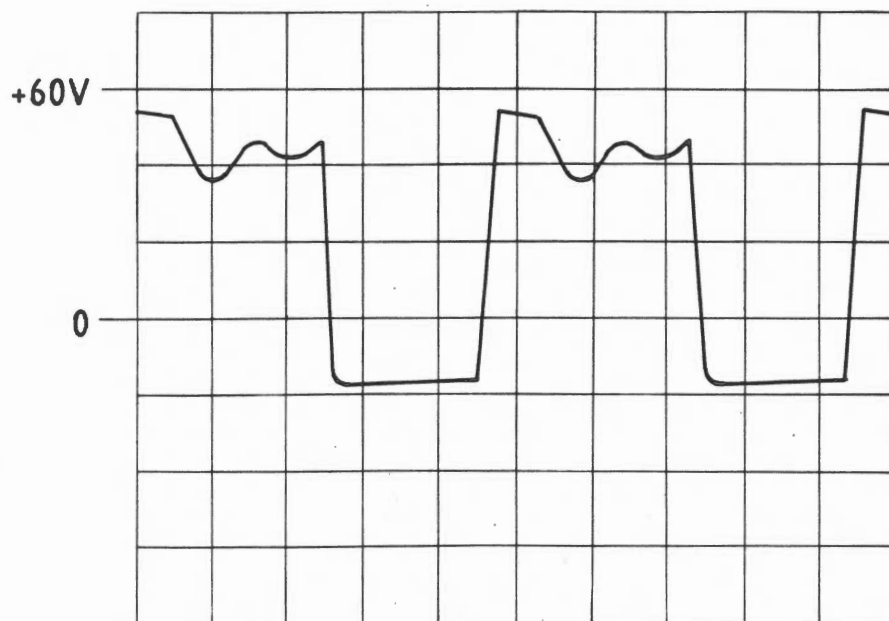


Figure 14.4.1 TR2 Drain Waveform

14.4.2 IEEE-488 interface

IC12 and IC13, being connected to the outside world, are most likely to suffer damage. It is most unlikely, however, that anything would propagate through to IC11 to damage it.

Ensure that a RESET pulse is generated on IC11/19, and is removed cleanly ~100 ms after power-up.

If IC11/9 (NOT INTERRUPT) is low, this low state should be propagated through IC8 and IC1, and pull the NOT INT line of the Z80 CPU low on the microcomputer PCB.

The data bus lines between IC7 and IC11 should normally be high, pulled up by RN1. If any is normally low, check the state of IC7/19 (should be high), then try removing IC9 (the interface won't work in this state, but it may help to isolate a fault) or replacing IC7. Remember that the interface is entirely interrupt driven; this means that, if there is no NOT INT signal from IC11, there will be no transactions with the entire interface.

Bus transformers, if they fail, are most likely to go open circuit. Check for resistance of the winding. In an emergency, bridge across the transformer, but note the following:

(i) You **MUST** bridge the isolated 0 V to the non-isolated 0 V first. The interface will no longer be isolated, of course.

(ii) All sections of T2, T3 and T4, and two sections of T1, are connected as non-inverting. T1 pins 3/4/13/14, however, is connected as inverting, and so the remaining section of IC1 would have to be used to invert the signal.

Three different systems of numbering data busses are used on the circuit diagram. The I/O bus is numbered 0 (least significant) to 7 (most significant). This system seems to be the most common in industry. Texas Instruments, however, use the opposite system, so the data bus of IC11 is numbered 7 (least significant) to 0 (most significant). The third system is used in IEEE-488, which is 1 (least significant) to 8 (most significant). This is visible on the IEEE-488 bus side of IC11, and on IC12. (We didn't invent these systems, we merely reproduce what is in the data books and standards.) Most importantly, though, the busses follow in the same order on the circuit diagram; least significant is at the top, following through in order to most significant at the bottom.

14.5 Calibration

The only calibration adjustment is for the isolated 5 V supply.

Use the Microcomputer Extender Assembly.

14.5.1 Isolated 5 V Supply

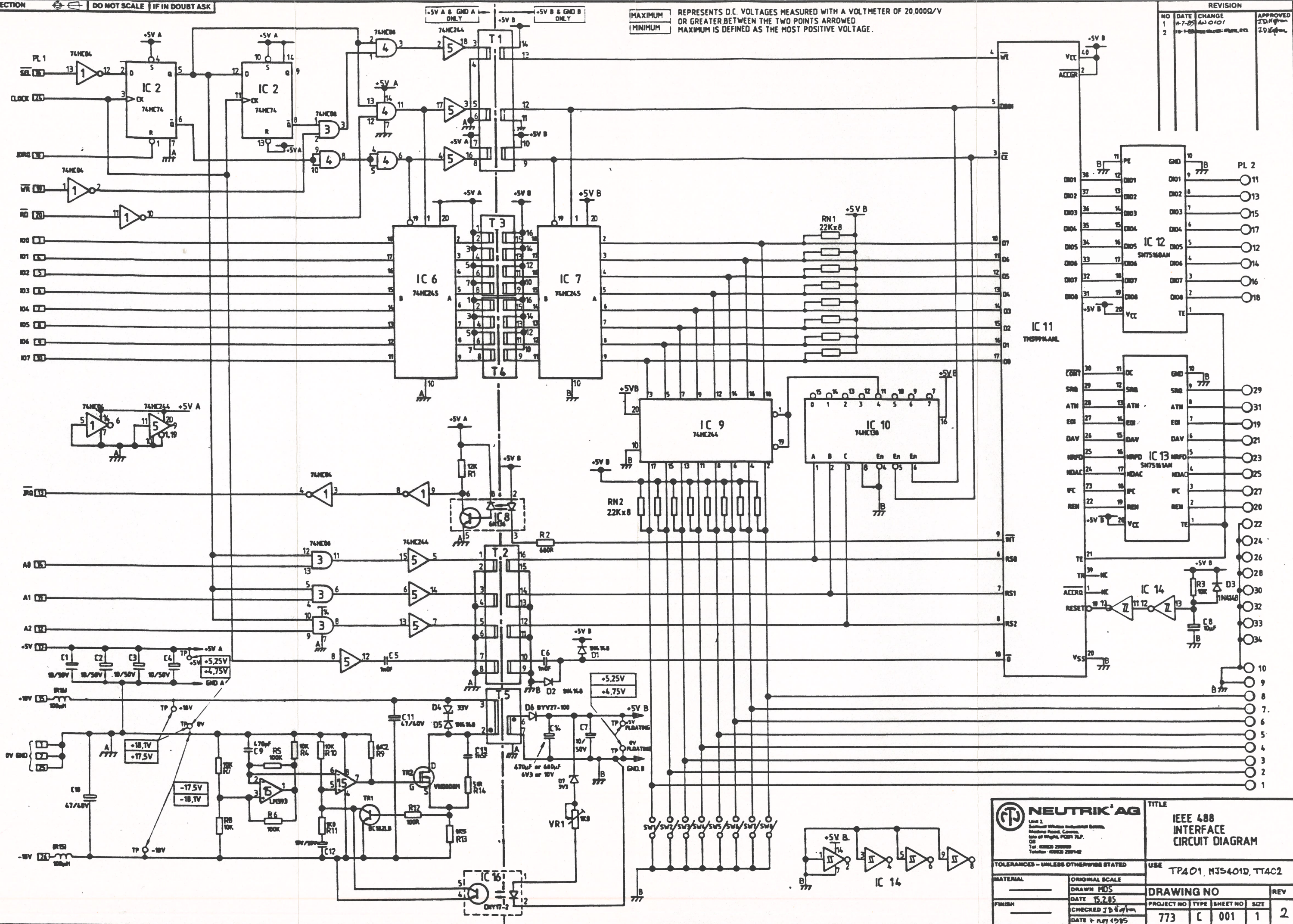
All ICs must be present and working correctly first, because the output voltage depends to a small extent on load. The adjustment should be done after the MJS401D has reached normal operating temperature (e.g. after being on for an hour), since there is also a small variation with temperature.

Measure the voltage between the "+5 V FLOATING" and "0 V FLOATING" test points. Adjust VR1 for exactly 5 V.

MAXIMUM
MINIMUM

REPRESENTS D.C. VOLTAGES MEASURED WITH A VOLTMETER OF 20,000Ω/V
OR GREATER BETWEEN THE TWO POINTS ARROWED
MAXIMUM IS DEFINED AS THE MOST POSITIVE VOLTAGE.

REVISION			
NO	DATE	CHANGE	APPROVED
1	11-7-85	AW 0101	J.D.H.
2	10-1-86	AW 0102	J.D.H.





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TITLE
IEEE 488
INTERFACE
CIRCUIT DIAGRAM

TOLERANCES - UNLESS OTHERWISE STATED		USE	
MATERIAL	ORIGINAL SCALE	TP401, H35401D, TT4C2	
FINISH	DRAWN HOS	DRAWING NO	REV
	DATE 15.2.85	PROJECT NO	773
	CHECKED J.D.H.	TYPE	C
	DATE 7 JUL 1985	SHEET NO	001
		SIZE	1
			2