

PCB 76502 and PCB 76505

26.1 Introduction

The digital board contains a microcomputer based on the Motorola 6802 microprocessor. Input and output ports are memory-mapped. Input ports include 4 bits from the frequency and level bit generators, 10 bits (9 bits used) from front panel switches, 8 bits (4 bits in earlier versions) from internal DIL switches, and 8 bits from the MJS401D's microcomputer. Output ports include 24 bits for front panel LEDs, 8 bits for relays on the A1 and A2 boards, and 64 bits of isolated output for analogue switches on the A1 and A2 boards. 16 Kbytes of EPROM (1x27128) are present. The RAM consists of 128 bytes, internal to the 6802. The system clock is at 4 MHz, provided by the MJS401D.

The digital board also conditions the ± 23 V and ± 16 V supplies to the A1 and A2 boards. The digital board requires +8 V, which is provided from the power supply/speaker amplifier, and +9 V and +4 V, the isolated logic supplies, which are derived on the A2 board.

26.2 Circuit Description

26.2.1 +5 V Power Supply

IC31 regulates the incoming +8 V supply down to +5 V for the non-isolated logic ICs. L1 reduces spillback of HF signals, generated by the high speed clocked logic, along the power supply line.

26.2.2 ±23 V and ±16 V supplies

Power for the analogue sections of the MD404B is originally derived at approx. 50 V on the power supply and speaker amplifier PCB. This supply is isolated from test set ground.

TR3-TR5 and associated circuitry remove the ripple from this rail. R10, R12 and C2 derive a voltage of about 16/17ths of the incoming voltage, which C2 then smooths. TR4 and R13 pass a current to the base of TR5, the series-pass transistor, until the output voltage rises sufficiently for D6 to become forward biased. Emitter current is then removed from TR4 until equilibrium is reached.

Foldback current limiting is provided by R15, R14, R18, R45 and TR3. C34 ensures HF stability.

The ripple-free voltage of about 46 V is applied to R16 and R17, which derive an artificial centre-tap. IC20, TR8 and TR7 act as a compound voltage follower and hence reduce the impedance of the centre-tap.

IC25 and IC26 drop the ±23 V rails further, to ±16 V, for the small-signal analogue electronics. D3 and D4 protect IC25 and IC26 in case of sudden accidental short-circuiting of their input rails.

26.2.3 Microprocessor, EPROM, RAM, Clock

The microprocessor is a 6802 running at 1 MHz. The incoming clock is at 4 MHz, generated on the MJS401D's microcomputer card to ensure that there will be no beats between the two microcomputers. The incoming clock arrives as a near sine wave at PL1/10, and passes via R9 to IC14/3, a Schmitt inverter, which converts the waveform to a square wave suitable for IC12, the 6802. IC12 divides the clock frequency internally by four to generate the 1 MHz E clock at pin 37.

IC27/1, 2, 3 and IC14/13, 12 give the possibility of doubling the incoming clock frequency to 8 MHz if LK1 is removed. This would require a 68B02, and is not normally done.

The EPROM is a 27128 or 27128A. These devices are fully read-compatible. The socket will accept a 27256 by altering LK2. Again, this is not normally done. Decoding is done by IC20. The EPROM is enabled when A15, E, VMA and R (read) are all active, i.e. when a read operation is performed anywhere in the top half (\$8000 to \$FFFF) of the address space. A 27128 is addressed at \$C000 to \$FFFF, but also reflects at \$8000 to \$BFFF.

RAM is 128 bytes within the 6802, fully decoded at addresses 0000 to \$007F.

26.2.4 Switch Input Ports

IC18 and some bits of IC6 and IC7 are input ports for switches; IC18 for eight of the front panel push-buttons, and IC6 & 7 for the remaining two push-buttons and the DIL switches. The ports are decoded at addresses \$82 (IC8), \$81 (IC6) and \$80 (IC7). The ports are 74HC244s.

Decoding for these addresses is performed by IC9, IC28, IC14 and IC11. The logical expression for enabling of IC11 is:

/A4./A5./A6.A7./A15.E.VMA.Read

where / denotes negation. Decoding is incomplete (A3 and A8-A14 are not gated in) and so there are multiple reflections throughout the lower half of the 64 K address space. Address lines A0, A1 and A2 allow IC11 to address one of eight ports.

26.2.5 MJS401D Input Port

IC24, a 74HC374 octal D-type flip-flop with three-state outputs, is connected as an output port of the MJS401D in the same way as all its other output ports (see Microcomputer, Section 3, for more details). The D inputs come from the I/O bus, and the clock input comes from an output strobe line. IC19/11 is also clocked when a byte is received, and its /Q output goes low on the trailing edge of the strobe pulse to signal back that the latch is full. IC19/9, the Q output, goes high and causes a maskable interrupt.

The 6802 reads the byte from IC24 by reading from address \$85, which enables the three-state outputs of IC24 onto the data bus. Software later performs a read of address \$86 in order to reset IC19 and signal back to the MJS401D that the data latch is now free to be written to again. Data read from address \$86 is meaningless and is discarded.

26.2.6 Bit Generator Input Port

The main controls for frequency and level are bit generators which output two near-sine waves 90° apart, of levels approaching 0 V and +5 V, when rotated. The signals are squared up by sections of IC1, a Schmitt inverter, and fed into four D-type flip-flops, IC3 and IC4. For each bit generator, one flip-flop stores one detent anti-clockwise, and the other stores one detent clockwise.

IC3 and IC4 are connected in an inverted sense. Detents cause the Q output to go low, and cause a maskable interrupt via IC5 etc., and the /Q output to go high, which can be polled by a read of IC6.

When the interrupt has been acted upon, software causes the flip-flops to be reset by a read operation to address \$84 (frequency) or \$83 (level). Data read is meaningless and is discarded.

26.2.7 Interrupts

Non-maskable interrupts are not used. Maskable interrupts can be caused by rotation of the bit generators for frequency or level, and reception of a data byte from the MJS401D. The former cause an input of IC5 to go low, causing a high level on IC9/12, causing in turn a low level on IC9/13 and IC12/4 (IRQ)

via D5. The source is polled by a read of data bits 1 to 4 of input \$81.

Data bytes from the MJS401D cause IC9/11 to go high, IC9/13 to go low, and IRQ low via D5. The source is polled by a read of bit 0 of input \$81.

Interrupts can also be generated by pressing any front panel push-button if link LK3 is removed. Sufficient current is pulled through the pull-up resistor RN2, R35 or R36 to turn on TR1, which turns on TR2 and pulls IRQ low. This source cannot be polled. It is not normally used, and so LK3 is made.

26.2.8 LED and Relay Outputs

ICs 15, 16 and 17 are simple output ports for the front panel LEDs. IC8 is a simple output port for relays on the A1 and A2 boards. All are 74HC374 flip-flops. Decoding is carried out by IC9, IC28 and IC10. IC19 provides a shortened E pulse to IC10. The logical expression for enabling of IC10 is:

$$\neg A3.\neg A4.\neg A5.\neg A6.\neg A7.\neg A15.E'.VMA.Write$$

where / denotes negation, and E' is the modified E clock.

When A4, A5, A6, R/W and A15 are low, and E and VMA are high, IC9/10 goes high, removing the reset signal at IC19/1. IC19/3 is clocked at 4 times the E clock frequency, and /Q tied back to D. The result at IC19/5 (Q) is an active-high pulse, half the duration of the normal 500 ns E pulse, beginning after E begins and ending before E ends.

A0, A1 and A2 are fed to IC10 to allow one of eight decoding for addresses 0000 to 0007. These addresses are opposite RAM addresses internal to IC12, and so data written to any output port can be read back again.

26.2.9 Isolated Outputs

Addresses \$0008 to \$000F write to isolated output ports, whose flip-flops (74HC374) are on the A1 and A2 boards. Isolation is needed to permit the output of the MD404B to float.

IC21 drives the bus isolation transformers, T4 and T5, with signals from the data bus. The enable pulse for IC21 is generated by IC9, IC28, IC14 and IC5. The logical expression for enable of IC21 is:

$$A3.\neg A4.\neg A5.\neg A6.\neg A7.\neg A15.E.Write$$

where / denotes negation.

IC23 passes the low three address lines when the above enable condition is valid. The fourth section of IC23 passes an active-low version of the E' signal, described in section 26.2.8 above. E' is 250 ns long and valid entirely within the E pulse time. E' is used to enable IC22, a 1-of-8 decoder, on the isolated side of the data bus, through isolating transformer T6. IC22 provides the strobe lines for the flip-flops on the A1 and A2 boards.

Being at the same addresses as RAM locations, data output to any of these ports can be read back by the microprocessor.

Note that the power for IC22 is derived on the A2 board, and therefore operation of IC22 cannot be observed unless either the A2 board is present, or an alternative power supply is provided.

26.2.10 Reset circuit

When the +5 V power supply rail is established, C26 is in the discharged state. IC14/11 therefore goes high, and IC14/10 low, holding the /RESET line IC12/40 active low.

C26 charges up through R33, and after about 700 ms passes through the threshold of IC14, causing IC14/10 to go high and remove the /RESET signal.

D25 ensures that C26 discharges rapidly when the +5 V rail is removed.

26.3. Removal/Replacement

26.3.1 Removal

Remove the MD404B and dismount the A1 and A2 boards and shield plate as described in section 25 of this manual.

26.3.2 Accessing the Bit Generators

Prise off the knob caps from the bit generators. Release the knobs with a collet driver. Remove the four screws holding the front panel assembly to the brackets, leaving the brackets attached to the digital board. Carefully unplug the ribbon cable connectors from the front of the digital board.

The bit generators should then come away from the front panel PCB as far as the ribbon cables will allow.

26.3.3 Replacing a Bit Generator

Note the connections to the bit generators. Desolder the connecting wires. Remove the four nuts. The potentiometer, bracket and fine control cable can then be slipped off. When the retaining nut is removed the bit generator can be extracted from the metal plate.

When the new bit generator is installed ensure the anti-rotation lug sits in the hole provided so that the shaft is upright. Slip the potentiometer and bracket back over the shaft and, using low strength thread locking compound, e.g. Bostik T22, tighten the four nuts. Ensure the shaft spins freely inside the potentiometer. If it doesn't then the nuts must be re-adjusted. If this continually occurs then the holes in the brackets may need to be filed out by a small amount.

Reconnect the bit generator.

26.3.4 Accessing the Front Panel LEDs and Switches

To release the front panel from the PCB the two pillars should be removed and the three retaining nuts undone. The two pillars between the bit generators are fixed to the PCB.

Switches and LEDs can now be removed by desoldering. To remove LEDs clip the leads off as near to the LED body as possible. Desolder the leads, removing them by pulling from the front of the PCB.

26.3.5 Push Button Replacement

Orient the switch ensuring that the flat is aligned with the PCB legend. Seat the new switch firmly against the PCB. Solder it into place, then examine it to ensure that it is still flush against the PCB.

26.3.6 LED Replacement

Orient the LED ensuring that the flat is aligned with the PCB legend. Insert the LED into clear holes in the PCB. **DO NOT SOLDER YET.**

Re-fit PCB to front panel and, using low strength thread locking compound,

e.g. Bostik T22, secure in place with the three retaining nuts.

Push LED through the front panel. Now solder the leads to hold it in place.

26.3.7 Refitting the Front Panel Assembly

Tighten up the three retaining nuts and replace the two pillars, with a small drop of low strength thread locking compound on the studs.

Reconnect the ribbon cable connectors. Insert the bit generators through the front panel. Replace the four screws through the brackets into the four pillars, with a small drop of low strength thread locking compound on each.

Replace the knobs on the bit generators, being careful not to let the fine control interfere with the normal control.

26.3.8 Replacing the Digital Board

Solder the ground plane back in place, pushing it hard against the digital board in all places. Add the shield plate to the digital board. The sockets on the shield plate fix onto either pins of PL5, PL6 and PL7 on the digital board.

26.3.9 EPROM Replacement

From time to time, software upgrades are released. These are in EPROM. The EPROM contains calibration information for the specific A1 and A2 boards which form a set with this digital board. Therefore the EPROMs and all PC boards are serial numbered. When fitting replacement software, check that the serial numbers of A1 board, A2 board, digital board and EPROM all match. If they don't, the oscillator will work, but will be out of calibration, and will probably have a high residual harmonic distortion.

For the same reason, when diagnosing faults, by all means exchange boards in order to find the fault, but be sure to put the boards back as a serial-numbered set afterwards!

To replace an EPROM, follow the removal and disassembly instructions in section 25 until the shield plate is removed from the digital board. Then, noting which way up the existing EPROM is, carefully remove it. An IC extraction tool is ideal; failing that, careful use of a screwdriver from both ends of the EPROM in turn will prise the EPROM out. Make sure that the pins of the EPROM are not bent. Send the old EPROM back to your agent or dealer.

Check that the pins of the new EPROM are parallel and not bent. Some EPROMs are supplied with the pins angled outwards to aid retention into a PCB. If this is the case, bend them parallel by folding against a flat surface. Push down hard, or the pins will bend halfway down, and have a large chance of folding under when they are inserted into the socket. They should bend at the existing near-right-angle bend.

Insert the pins into the socket, taking care that pin 1 goes into the correct hole. With the front panel to your right and the 64-way connector to your left, pin 1 should be at top left. The small "nick" in the EPROM package should be uppermost.

Push the EPROM in fully. Check that all 28 pins are in, and not folded under or out.

Replace the shield plate and analogue boards, strictly following the instructions in section 25. Failure to do so may result in the oscillator's not fitting into the compartment in the MJS401D.

26.4 Fault Finding

26.4.1 Bit Generator Faults

If the bit generators appear to work intermittently, or not at all, check the levels emerging from the two outputs of each when rotated. The signals should be nearly sinusoidal, and should reach levels below +1 V and above +4 V. R1-R4 may be changed if necessary. Reduce the value to bring the levels more positive, increase them to make less positive. Usual values are 1k Ω to 2k Ω .

If the signals are absent, check the +5 V and 0 V connections to the bit generators, and the signal connections back to the board. The ribbon cables can become trapped, and then shorted or broken.

Spinning the bit generators rapidly should produce active-low pulses a few microseconds long at one of the inputs to IC5, pins 1, 2, 4 or 5, according to which bit generator and which direction.

26.4.2 Power Supply Faults

Identify which supply line is at fault. The +5 V line regulated by IC31 (7805) supplies the non-isolated logic on the digital board, and powers the relays on the analogue boards.

The ± 23 V lines are regulated in total by TR3, TR4 and TR5, and the centre-tap provided by IC20, TR7 and TR8. Therefore, if there is about 46 V between the two rails, but they are widely different, suspect the centring arrangement. The ± 23 V rails feed the main output stages on the A2 board directly, and also feed the regulators IC25 and IC26 which regulate the ± 16 V rails.

The ± 16 V rails feed all the small-signal electronics on the A1 and A2 boards.

The +9 V and +4 V rails which feed IC22 are derived on the A2 board; therefore IC22 will not work unless an A2 board or a substitute power supply is available.

26.5 Calibration

There are no calibration adjustments to be made to the digital board.

Calibration data for the EPROM can only reasonably be captured and calculated by an automatic test programme. This is only possible at the factory at this time. For recalibration of your oscillator, contact your local agent.

