JetDrive™ III User's Guide

The JetDrive™ III Controller (previously named MicroJet™ III Controller for revisions A-C) consists of a waveform generator and an amplifier to provide pulses for operating piezo-driven fluid dispensers. It is designed to match the ranges of operating parameters required by the MicroJet™ fluid dispensers of MicroFab Technologies, Inc.

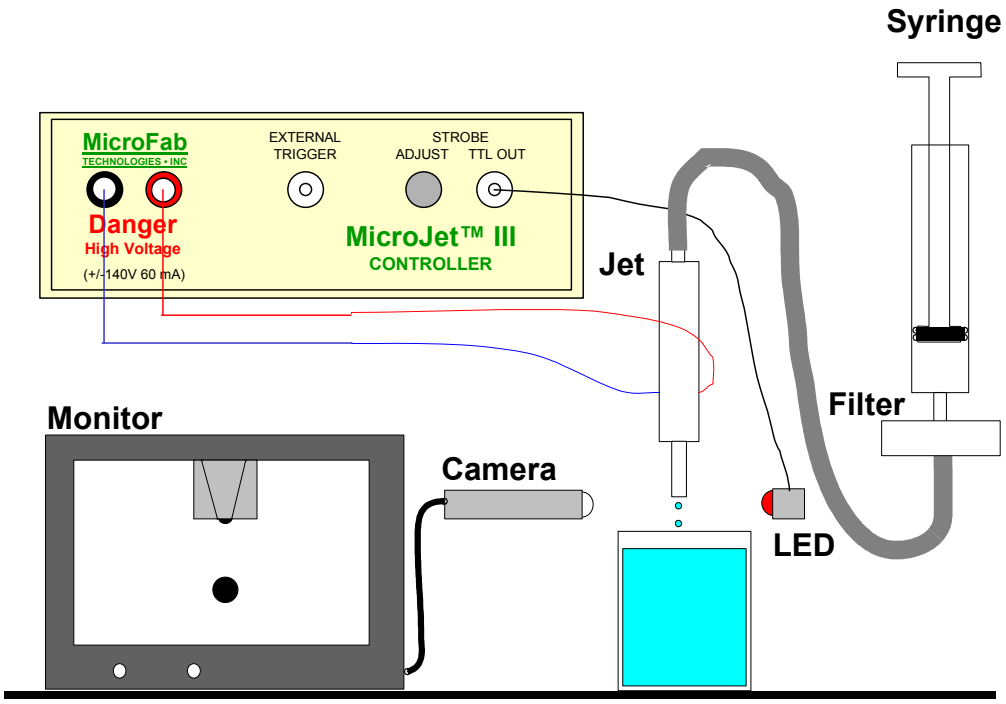
Safety Notice:

Revisions (A-C) of the controller (MicroJet™ III) will show +140 V on the output at turn-on of power. It is therefore recommended safe practice to have the controller turned on only when it is to be used. Starting the control program (MFJETDRV or MFJET32 provided with the controller, or any other written following the "JetDrive™ III Command Set" document), will reset the output voltage to zero. ***Reappearance of wall power after an outage with the controller switched on is like turning on the controller, so the output will go to +140 V. Any control program must start from the beginning again then.***
Revision D of the controller (JetDrive™ III) will show a transient +140 V at power-up and reset to 0 V as its firmware starts up automatically.

Setup

A simple test setup is shown in the figure below. The JetDrive™ III Controller is operated from a computer through a regular serial connection which plugs into the back of the controller (DTE to DCE; 9600 baud, 8 bits, no parity, 1 stop bit). It uses 110 V wall power, connected to the back. A power switch is located there also. A test program (MS-DOS based MFJETDRV.EXE, or 32-bit for Windows 95, 98, ME, NT 4 and 2000 MFJET32.EXE) for stand-alone operation is included with the controller.

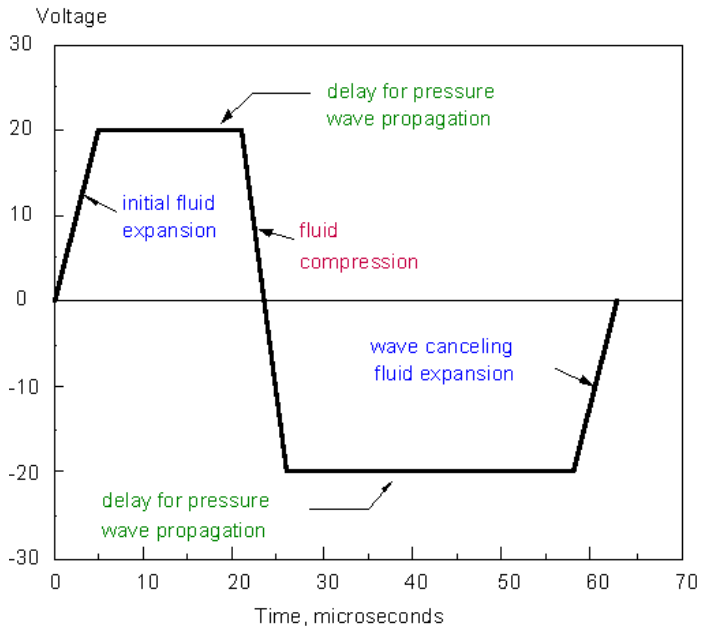
On units of Rev. A-C, the voltage pulse is issued on the red binding post, including a possible DC offset, and the black binding post is kept at 0 V. On units of Rev. D and later, a 3-pin DIN style connector is used, with the active pins marked as "+" (corresponding to the red binding post) and "-" (black post, 0 V); the third pin is connected to chassis ground. The external trigger input (if desired) and the strobe signal output operate with TTL type signals (5 V positive, BNC connectors). The timing of the rising edge of the strobe output signal can be shifted relative to start of the main voltage pulse both through program control and through the adjustment knob on the front panel of the controller.



For observing droplets in flight, a strobed LED (order of 10 µs long pulses), a black-and-white CCD camera and a monitor are the basic recommended equipment. The strobe output of the JetDrive™ III Controller is strictly meant to provide a timing/trigger signal and will have to be fed into a driving circuit (not shown above) for the strobe light.

Principles of Operation

The MicroJet™ dispensers operate with piecewise linear unipolar or bipolar pulses as sketched in the following figure. The JetDrive™ III Controller allows to use pulses,



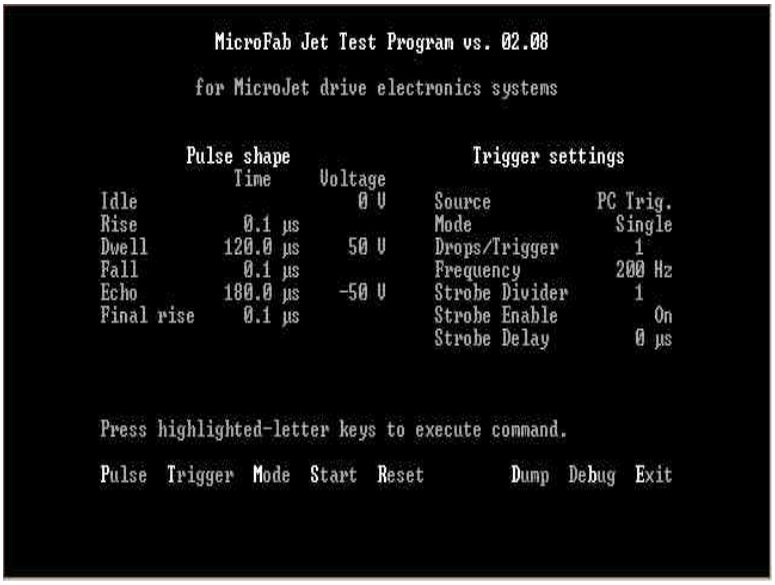
including possibly a DC offset, within the voltage range from –140 V to 140 V. Most applications will actually require the pulse amplitudes at less than 40 V, in some cases even as low as 10 V. The controller allows all three voltage levels (DC, positive pulse part, negative pulse part) to be adjusted in steps of 1 V, and all rise, dwell, and fall times in steps of 1 µs. The rise and fall times in most cases are around 3-5 µs, and the dwell times (durations of the positive and negative voltage pulse plateaus) are normally in the range 15-50 µs. The revisions A-C of the controller support time values up to 300 µs for rise and fall times, and 800 µs for the dwell times. Revision D allows a total pulse length (sum of all 5 terms plus 1 µs) of 4095 µs, and a longest single piece of 3276 µs.

The falling edge of the positive pulse excursion effectively determines the release time of the drop from the MicroJet™ dispenser. Additional drops ("satellites") or, more commonly, prevention of the same, can be controlled by varying the pulse shape parameters, foremost the pulse amplitude and to some extent the dwell times. Unipolar pulses are sufficient in many cases and can be accomplished by setting the voltage level of the negative excursion equal to the DC offset of the whole pulse shape.

Two operating modes are distinguished: "Single" mode, where a trigger generates a finite number of droplets (1-999), and "Continuous" where droplets are produced continuously until an explicit stop command is given. Triggers can come from one of two sources: internally generated following a corresponding command received from the host computer, and externally through a TTL signal through the corresponding connector on the front panel. The leading edge of the TTL signal then defines the timing of the trigger.

Using the Control Program MFJET32.EXE

MFJET32.EXE is a 32-bit console program and works under Windows 95, 98, ME, NT 4 and 2000. Upon request, a 16-bit DOS version MFJETDRV.EXE is available; apart from



the different name, everything else explained below applies to both program versions. To install, simply copy it to the desired location; no further setup is needed. Add "COM2" as an argument on the command line if the controller is used on the COM2 port rather than COM1. The 32-bit version can handle COM ports up to COM9. The program produces a log file MFJETDRV.LOG recording all commands sent and their responses. This may be helpful in determining problems, reproducing sequences of commands, and as a reference for creating customized control programs.

When starting the program, first a few messages appear at the bottom of the screen, then the full display as shown above follows. The highlighted letters in the row of commands near the bottom of the screen indicate the keys to press in order to execute the corresponding command. The input is ***not*** case-sensitive. The commands are used as follows:

Command	*Effect*
Pulse	Enter the "Pulse Shape" section on the screen to allow adjustment of the pulse shape parameters. Editing of parameters occurs by overtyping, and movement from one parameter to the next by use of the "Tab" key. Only forward tabbing is supported. The "Delete" and "Backspace" keys are not available, so typos have to be corrected by tabbing through all entries and overtyping the whole entry again. At every entry, a hint on what can be entered, and possibly an error message if warranted, is displayed.
Trigger	Enter the "Trigger Settings" section on the screen to allow adjustment of triggering parameters. Editing follows the same pattern as described for the "Pulse" command; the non-numeric entries are toggled by pressing the space bar.
Mode	Toggle the trigger mode in the trigger settings between "Single" and "Continuous". This is a short-cut to avoid having to use the "Trigger" command, tab to the mode entry and toggle the mode then.
Start	Generate a trigger for pulse output. If the trigger mode is "Continuous", the command displayed changes to "Stop" which then is available to stop dispensing in continuous mode.
Reset	Reset the controller settings to start-up values.
Dump	This command is not during regular operation. All operating parameters are retrieved from the controller and compared to the current settings in the program. A flag word is displayed in hexadecimal format indicating differences to expected values.
Debug	This command currently has no effect.
Exit	Terminate the program.

If the controller is turned off (intentionally or through a power outage), the control program (MFJET32 or custom written) must be terminated and started again after power-on of the controller.

Protecting the Jetting Device

With the sign convention for voltage (positive to the red wire, return side to the blue wire on MicroJet devices), positive voltage levels are "opposing" the polarization of the PZT material, which imparts the pulses onto the fluid to form droplets. Continued high positive voltages can lead to partial or complete depolarization, destroying the ability to dispense droplets. At room temperature, this is usually not much of a problem, while operation at elevated temperature makes this a real risk. Units of revisions A-C will, upon turn-on, show an output level of +140 V DC, until the firmware program of the controller gets started by the host program (MFJET32 or a user-written program). Rev. D units have their firmware start automatically upon power-up and show only a very short transient of +140 V before resetting to 0 V DC output level. After setting a DC level and issuing at least one pulse, the new DC level will be maintained until it is changed. Therefore, depolarization can be "accomplished" with any version of the jet controller.

Miscellaneous

For writing custom control programs, refer to the document "JetDrive™ III Command Set". Excerpts from the MFJET32 source code showing the serial communications and command building implemented in straight C++ with the MS Windows 32-bit API are available upon request.

In case of problems with the controller, contact (preferably via e-mail):

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