

# djr Discomp Disc Mastering Computer



## Operating and Service Manual

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## 1.0 General Description

The djr Discomp is a computer used to adjust the pitch and depth on Neumann VMS 66/70 disc mastering lathes. The Discomp also has utility functions related to disc cutting. The unit is housed in a 1U high standard rack mount enclosure. All connections are on the rear of the unit.

The unit operates on mains a.c. and is switchable for 115 volt or 230 volt 50/60 Hz operation.

It is microprocessor controlled, and synchronizes its functions with the Neumann system from a crystal oscillator. The unit digitizes the preview audio signals from the left and right channels, and stores a complete revolution of the left channel signal, along with various other manipulations of the audio data.

It outputs three control signals, L; Lateral (Pitch), V; Vertical (Depth), and LV; Increased Lateral due to Vertical. These outputs are fed to the cutting lathe. The unit receives status inputs from the lathe for turntable speed selection, base pitch, and run status.

When the lathe is stopped, the unit's menus can be accessed to change various parameters, and do calibration checks.

## 2.0 Menus and functions

The unit has eleven menus which allow for the setting up of the unit.

These menus are:

- Calibrate Gain
- Output 2.17 Hz
- Calibrate Output
- Calibrate Check
- Memory Check
- Polarity Check
- Powerup Options
- Display Options
- Load Defaults
- Save Settings

The sections below give more detail on these menus.

To move around the menus you use the rotary encoder and the six selector switches. The switches will illuminate to indicate that they can be used within a particular menu. In general the left two keys move left or right, and give choices. The rightmost red key is the 'OK' or Accept function. The green fifth key is the Escape or 'go back without saving' key. There is also a push key on the rotary encoder, that is not used.

Pressing the 'OK' key will save the parameter to internal ram memory, but the value is not permanently saved until you do a Save operation. The Save Settings operation stores the selected setup in EEPROM, which is retained on power down. To choose a menu, rotate the rotary encoder, and press the 'OK' key when the choice you want is displayed on the LCD.

The red 4 digit LED display shows run status, speed, or accumulated output levels for the three outputs, depending on the way it is set up.

## The Menus

### 2.1 Calibrate Gain

On selecting the Calibrate Gain menu, an internal low frequency oscillator is routed to the inputs. The level of this oscillator is set with an internal jumper to the peak operating level of the analog input section. This can be +24, +18, or +12. Units are shipped set to +18; for most users, this selection will be optimal.

There is a fourth position for a custom level, which requires the user to insert an appropriate resistor. The display will change to show the left and right input levels, as two numbers which can vary from 0 dB to -48 dB. The scale is 1 dB steps to -6dB, then 6 dB steps.

For standard calibration, adjust the P1 (left) and P2 (right) input trimmers to read -1, then increase slightly until the display just changes to 0. Pressing 'OK' will exit this menu. (New units ship with this step already performed.)

(For calibrations between the standard 6 dB steps you can set this level to different values. For example, to calibrate to a maximum of +14 dB, set the jumper to the 12 dB position, and adjust the levels to -2dB. Note that this procedure should not be used on the 24dB position, as the input buffers will clip at +24 dB.)

With the internal jumper set to +18 and trimmers P1 and P2 properly calibrated, 1K at +4 at the Left XLR input will produce -12 at TP-2; 1K at +4 at the Right XLR input will produce -12 at TP-3. The two trimmers can be adjusted precisely by routing +4 at 1K into the two XLR connectors and adjusting the trimmers for exactly -12 at the two test points.

### 2.2 Output 2.17 Hz

This menu outputs a 2.17 Hz square wave on the V output. The display will show '2.17 Hz level' and a number from 0 - 255. This level is EEPROM stored. Use the rotary encoder to change the level, 'OK' to store, 'Esc' to exit without storing. The default value is 128, corresponding to 7 volts peak level. Most setups will not require the use of this function.

### 2.3 Calibrate Output

This menu allows all output channels to be swung between their maximum, halfscale, and minimum values. Rotating the rotary encoder selects the channel to alter, and the left/right keys select Max or Min output. These values are +14 volts, 7 volts, and 0 volts respectively. This mode is intended for testing and maintenance, and involves no calibration steps.

### 2.4 Calibrate Check

This menu does a check on the calibrate values, based on the fact that the audio channels should have identical gain. It uses the internal oscillator, and stores 1024 values from each channel, finds the maximum, and compares the two channels. It then displays the difference as a dB figure. Anything over -48 is acceptable. The display will wait for you to press a key. This value constantly updates, so you can fine tune the channel balance. This check should be performed during initial installation, and repeated any time that the internal levels are re-adjusted.

### 2.5 Memory Check

This menu does a check of the memory used to store disc revolution values. It writes hex AA and hex 55 to every memory location, and then indicates 'PASS' or 'FAIL'. The display then waits for a key press.

### 2.6 Polarity Check

This menu allows the input polarities to be checked. To run this check, use the calibration CD. There is a track with 100 Hz clipped sine wave. Apply this track to both inputs, and select the Polarity check menu item. The unit will show 'L: IN R : IN' if both inputs are in phase, or the 'IN' will change to 'OUT' on the respective channels if the signal is out of phase. If the unit displays 'L: --- R: ---' then the unit is not getting enough signal.

### 2.7 Power up Options

This menu allows the memory check and calibrate check to be run on power-up. Also the EEPROM can be checked for integrity. The left/right keys choose the check, the rotary encoder chooses 'OFF' or 'ON'. When these tests run on powerup, they will stop and wait for a key-press if they fail, but otherwise will run through. The default is OFF.

### 2.8 V Delay

(This menu item removed from current system version. The standard setting of 9/16 at 33 and 45 RPM is now permanently loaded.)

### 2.9 LV Delay

(This menu item removed from current system version. The standard settings of 1/16 at 33 and 45 RPM is now permanently loaded.)

### 2.10 Display Options

The unit can display two different functions in the LED display. It can display the speed setting, or the accumulated peak levels on the outputs. The accumulated peak levels is shown as a voltage from 0 to 14 volts. The three output levels are displayed when the rev counter changes, and in the sequence L, V, LV. The maximum levels are reset at the start of a run.

### 2.11 Load Defaults

This menu allows you to load the default settings. Select using the 'OK' key. The default unit settings will be loaded and the display top line will show 'Default'. The unit will power up loading the defaults.

### 2.12 Save Settings

This menu allows saving the user's settings. The top line of the display will show 'User' to indicate this. At powerup the unit will then load the user settings.

## 3.0 Installation

The unit should be installed in a clean, dry, well ventilated area. The main connections are the XLR audio inputs and the lathe connections, which are on a 24 pin male connector (Amphenol part number 57-30240). The wiring on the connector conforms with the wiring used by the Zumaudio ZMS-1 (Zuma) computer. (If your lathe was never set up for a Zuma system and has no remote cable, please refer to addendum instructions to modify your lathe and instal this cable.)

Pinout for the 24-pin Amphenol connector is as follows:

Pin 4 - Base pitch input (from lathe)

Pin 2 - 16 PRM status (this speed not supported)

Pin 11 - 22 RPM status (this speed not supported)

Pin 13 - 45 RPM status

Pin 15 - 33 RPM status

Pin 17 - Stop Status

Pin 18 - Start status

Pin 19 - LV output

Pin 20 - Ground (Common)

Pin 21 - V output

Pin 23 - LL output



The audio inputs should be wired with plus on pin 2, minus on pin 3, and ground on pin 1. Mains input is on a standard IEC input connector. Make sure that you set the correct input voltage with the selector switch on the rear panel.

The Disc Computer audio inputs should be .6 disc revolutions earlier than the inputs to the cutting amps. This preview time should be 1.08 seconds at 33.3 RPM and .8 seconds at 45 RPM.

### 3.1 Operating Instructions

The unit does not require any specific operation, as it receives all of its control signals from the lathe. You must make sure that the lathe speed signals are correct. Failure to provide correct speed signals will cause an error reading on the display. The unit gets run status from the lathe, and timing from its internal crystal. When the unit is in run mode, the 4 yellow buttons will flash in sequence at the revolution rate of the lathe. If you don't see this sequential flashing, a synchronization fault is indicated. Audio input to the unit should be at a nominal line level of +4 dBm, though there is provision for different levels.

It is very important that the audio input section of the unit does not clip while running. Because the inverse RIAA curve in the unit adds a large amount of low frequency boost, the gain structure of the analog section has been designed very conservatively. There are a set of jumpers internally to set the maximum operating level. The unit comes set and adjusted for +18 dBm peak. If input clipping occurs, the LCD will flash 'Clip!' in the bottom right corner.

Note that in the event of EEPROM failure, the unit will stop, and display 'EEPROM FAILURE Loading Defaults'. The unit will continue to work. If this occurs, you can try two things. First, try resetting the contents of the EEPROM. To do this, hold the 'OK' and 'Esc' keys and turn the power on. The unit will display 'Reloading EEPROM'. If after this the unit operates OK, then continue. If the unit still fails, try replacing U19, the EEPROM IC and reloading it.

The unit will run with default settings if the EEPROM is faulty.

### 3.2 Lathe Setup.

1. Calibrate the lathe playback levels with a reference disk, and calibrate lathe drive and monitor levels. Be sure that all preview and program outputs are set to +4 (1.23VAC).
2. Be sure the preview time difference between the Disc Computer inputs and the lathe inputs is 1.08 seconds at 33 RPM and 800 ms at 45 RPM.
3. Check that the unit shows correct speeds with the lathe running at 33 and 45 RPM.
4. Check that the unit is getting lathe run status. With lathe stopped, the Discomp display should read S7OP. With the lathe running, the Disc Computer should show the run speed and the four yellow buttons should flash in sequence at the rotation rate of the turntable.
5. Perform the steps in section 2.1; "Calibrate Gain".
6. Perform the steps in section 2.6; "Polarity Check".
7. Adjust the LL, LV, and V controls on the programmer to approx. 90% full clockwise. (For maximum system headroom at least one of these controls should be close to 90% after adjustments are completed.)
8. Put the lathe in Start mode and let it stabilize for at least 10 minutes. After the lathe has stabilized, turn the base pitch control on the lathe fully CCW (finest pitch). Adjust trimmer P8 (recessed inside the Neumann Programmer Plug) so that the LPI meter reads 450–600 LPI.
9. Adjust the depth control (next to the depth meter) for a reading of 30 ma. (Make sure the tilt-able face of the cutter suspension is flush with the stationary front of the cutter suspension. Use the height adjustment just to the right of the suspension to make it flush.)
10. Adjust base pitch for 400 LPI, then adjust the knurled nut at the BACK of the cutter suspension for a 2 mil wide groove. Then readjust pitch to 500 LPI and confirm that there is no land, and the grooves just touch. (Steps 11 and 13 are performed at non-standard 500 LPI pitch because "zero land" conditions can be seen most easily when inspecting grooves.)
11. With base pitch still set at 500 LPI, play track 4 (200 Hz. Pulses, in phase). Adjust the LL control so that the modulated groove peaks are just touching the two adjacent grooves.
12. Play track 3 of the test disc (200 Hz. anti-phase) and adjust the V control on so that the narrowest part of the modulated groove is no less than 2 mils.
13. Play track 5 (200 Hz. Pulses, anti-phase). Adjust LV on the Neumann Programmer so that the peaks are just touching the two adjacent grooves.
14. When finished, it may be necessary to readjust the P8 control inside the Neumann Programmer for 450–600 LPI (per user preference) with Pitch control full CCW. You may also need to adjust P3 in Disc Computer (Base Pitch gain) for desired base pitch range. Be aware P3 and P8 will interact.



Note: most users will have a 33 RPM 12" Neumann programmr and a 45 RPM 7" Neumann programmer. To preserve maximum DC headroom between the Disc Computer and lathe, at least one of the 3 trimmers (LL, V, LV) on one of the two programmers should be close to its maximum setting. This insures minimum attenuation in the programmers and maximum voltage output to the lathe servo system. If you find that none of the trimmers are set beyond 80, you will achieve more headroom by lowering the P1 and P2 input trimmers in the Disc Computer by approx. 1-3 db, and then re-doing the above calibration procedure, so that all of the programmer trimmers end up at higher values.

The Baba O'Reilly track on the test CD can be used to check space usage. Cut this track at standard level, 400 LPI base pitch, 2 mil wide groove, with no crossover or compression. Confirm that grooves are not overcutting or getting too shallow. Slight readjustments of LL, LV or V may be needed. If there is any overcutting, notice if it is happening on predominately lateral or vertical grooves. That will tell you whether LL or LV needs to be increased. After confirming that that the lathe is cutting properly, measure the amount of disc space used. At 33 RPM the track should occupy approx. .94" of disc space.

This completes lathe setup.

**Please note: as all experienced mastering engineers are aware, real world disc cutting situations will sometimes demand preview level or programmer over-rides, etc. Base pitch, groove depth, limiting, filtering, low frequency cross-over, and the engineer's personal cutting preferences are also factors. The above procedure is only a baseline starting point; the engineer will need to use his or her own judgement, along with close visual inspection of cut discs, to determine the optimum settings for each master that is cut.**

## 4.0 Circuit Description

### 4.1 Input Stage

The signal from the input connectors is connected to U2, U4 which are balanced line receivers. These receivers are padded on their inputs so that the maximum input signal can be +24 dBm. Note that at the input connector, the phase is reversed on the right channel.

From there the signal passes to U3, a CMOS switch. This switch allows selection of the oscillator signal for calibrations. From here the signals pass through two identical chains for left and right. Left uses P1,U6/1,U7/1,U7/2. Right uses P2,U6/2,U8/1,U8/2. This discussion will cover the left channel, the right channel is identical. First the signal passes through a pot P1, which is adjusted to set calibration level. The signal passes through U6/1, a buffer. Next there is an equalization network around U7/1. The signal then passes to U7/2. At this stage it is also level shifted by 2.5 volts, and sent to U26, the Analog to Digital converter.

### 4.2 Oscillator

U17/2,U17/3 forms an oscillator which is gated on by U15 pin 17. The signal from this oscillator is a 60Hz square wave. This is low pass filtered and buffered by U5/1, and passes to a set of jumpers which allows setting of the oscillator calibration level. This signal is switched to the inputs by U3 when required, U3 being controlled by U29 pin.

### 4.3 Pitch Input

This input is padded and applied to U9/1. It then passes to P3, so that the calibration level can be set. It is then buffered by U9/2, and sent to the Analog to Digital converter.

### 4.4 Analog to Digital Converter

U26 is a 12 bit multiplexed Analog to Digital converter. It is used in 12 bit and 8 bit modes depending on the function being carried out. 3 channels are digitized, L, R, and Base Pitch.

### 4.5 Input Switches And Rotary Encoder

SW3 to SW8 are illuminated pushbuttons which feed an octal latch U13, and are read by the microprocessor. SW2 is an optical rotary encoder. The two quadrature channels from this, feed to the microprocessor through inverters U17/5 and U17/6 to port pins PA1 and PA2. The microprocessor does all the direction and counting in software. There is a push switch on this encoder which is read as part of U13.

### 4.6 Input Status Signals

Input status signals are applied to octal latch U14 through a voltage divider to convert the 12 volt lathe levels to 5 volts.

### 4.7 Analog Outputs

The D/A converter U27 is an 8 bit converter, which outputs three signals to output buffers. All the buffers are identical. The buffers convert the 0–5 volt converter outputs to 0–14 volts. They have transistor output stages to produce extra drive capability. Components used include U10, U11, and Q2 – Q7.

### 4.8 Output Displays

U31 is an 2 line 16 character LCD display. This is controlled by the microprocessor via the data bus and U22, U17/4. U18 is a LED driver which drives four 7 segment leds and the lamps in the pushbuttons. It is controlled by the microprocessor via the SPI bus.

### 4.9 Microprocessor And Support ICs.

The microprocessor U20 is a 68HC11 with internal EEPROM. Associated with this IC are the support ICs. U21 is a reset generator which resets the microprocessor.

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U23 is an octal latch which latches the low byte of the address bus from the microprocessor.

U24 is an 8 K EPROM which provides program storage.

U25 is an 8K ram which provides memory storage.

U22 and U16 provide decoding to address the peripherals.

U15 is an octal latch which controls the oscillator and input cmos switch, and provides programmable test points and the buzzer.

U19 is a serial EEPROM which stores settings.

### 4.10 Power Supply

T1 is a transformer with switchable primaries to allow 115 or 230 volt operation.

This feeds a diode bridge to generate  $\pm 26$  volts. U28,U29, U30 are regulators providing +18, - 15 and +5 volt rails.

### 4.11 General Notes On Construction

The unit has been constructed to last for many years and remain stable. Electrolytic capacitors have only been used in the power supply section. All other capacitors are mylar, polypropylene, ceramic, or tantalum types which should last indefinitely. The power supply has a lot of rail-margin on the unregulated side, so life of the power supply electrolytics should be long. All parts operate at relatively low temperatures for long life.

None of the opamp circuits require trimming, and stability of the filters is effectively checked by running the calibration test. If you replace an IC it would pay to check calibration, but in fact it should be possible to change any of the ICs with no change in performance.

All parts are off the shelf types, which should be available for some time. Offsets on the various opamps should be less than 30 mV.

## 5.0 Theory of operation

The unit accepts line level inputs of left and right preview signals. These signals are passed through a filter which rolls off high frequencies so as to simulate the amplitude of the cut signal. The signals are then digitised and passed to the microprocessor. The unit computes the peak signal of the left from the previous revolution and the current right peak, and uses this to generate the Lateral signal. This is then delayed to output effectively as the signal enters the cutting head. The out of phase signal L-R is generated and used to determine the Vertical output. this is applied again after a delay. This signal is also averaged and applied to the LV output.

The unit uses the speed settings from the lathe to calculate the required timings. In addition the number of samples per revolution will be set. The unit digitises the input audio at 2100 samples/second, and then makes a control output at 8 times per revolution. The sample rate can be observed at TP8, and should be a square wave of uneven duration. The high time represents the time the unit is spending in the timer IRQ loop.



## Lathe Modifications

If your lathe has been modified for use with a Zuma computer, your Disc Computer simply plugs into the same cable, and no other mods need be done. If your lathe was never modified for a Zuma, please perform these steps to enable operation with the Disc Computer.

Note: when performing these mods, the user can either either hard wire the Disc Computer interface cable to the rear of the lathe, or add a panel with a female 24-pin Amphenol connector to the rear of the lathe. Either way is fine. If no connector panel is fitted to the rear of the lathe (the simpler option), a female dummy plug should be built to allow use of the original Neumann analog computer, in case the Disc Computer needs to be serviced. If a connector panel is installed, the dummy plug can be male and used at the back of the lathe, or female and used at the Disc Computer end of the interface cable. If no connector panel is installed at the lathe, the dummy plug must be female, for use at the Disc Computer end of the interface cable.

These instructions below assume that no connector panel will be installed at the rear of the lathe. If you wish to install a connector panel, observe the same wiring and pinout as explained below, with the two additional connectors added to the wiring scheme.

### **A. Depth Control Box modification.**

To allow more frequent and rapid groove depth changes, the time constant capacitor in the depth control circuit must be changed. Remove 4 screws from the front of the Depth Control panel, pull the panel out, and unplug the Tuchel connector. Unplug the small PC board and replace C1 with a 1uf 50 VDC tantalum capacitor, taking care to observe correct polarity. Re-install the PC board and Depth Control panel.

### **B. Interface cable and lathe preparation.**

1. Cut the interface cable to length, allowing ample service loop on both ends. On the lathe end, strip the cable jacket back approx. 48" (120cm).
2. Separate the interface cable wires into 3 groups: the 5 wires that will connect to AS303, the 6 wires that will connect to SV309, and the 4 wires that will connect to ZT3010. Cut the AS303 and SV309 groups to approx. 24" (60cm).

3. Unplug the lathe's AC power cord to completely remove power. Remove the pitch motor housing and set it aside.
4. At the left rear of the lathe, remove Tuchel connector panels SV309 and AS303.
5. Dress the interface cable into the rear of the lathe. Bring the ZT3010 group of wires up into the upper part of the rear cabinet and into the Pitch Motor area, to the Tuchel connector at left front. Bring the SV309 and AS303 groups to the area of those connectors and bring them out through the openings. Using small cable ties, neatly join each group to the existing wires bundles to go to those connectors.

**C.ZT3010 connector modifications.** The next four steps connect the speed select signals to the Disc Computer. (No wires are disconnected in these steps.)

1. Add the wire from Amphenol plug pin 5 to ZT3010 pin 5a (16 rpm lamp).
2. Add the wire from Amphenol plug pin 11 to ZT3010 pin 5b (22 rpm lamp).
3. Add the wire from Amphenol plug pin 15 to ZT3010 pin 6a (33 rpm lamp).
4. Add the wire from Amphenol plug pin 13 to ZT3010 pin 6b (45 rpm lamp).
5. Install 10k  $\frac{1}{4}$  watt resistors in parallel with the following lamps in the meter housing: Stop, Start, 16, 22, 33, 45. This mod assures that in the event of lamp failure, correct voltages are still sent to the Disc Computer.
6. Reinstall the Pitch Motor housing.

**D.SV309 panel connector modifications.** These steps interrupt the LL, LV, and V signals between the Neumann computer and the programmer plug socket, and in their place connect new wires from the Disc Computer Amphenol connector.

1. Remove the wire from pin 5a (LL feed from Neumann computer) and connect it to pin 4a (formerly unused). Connect the wire from Amphenol plug pin 10 (LL feed from Neumann computer) to pin 4a. Connect the wire from Amphenol plug pin 23 (LL feed from Interface cable) to pin 5a.
2. Remove the wire from pin 6a (LV feed from Neumann computer) and connect it to pin 8a (formerly unused). Connect the wire from Amphenol plug pin 12n(LV feed from Neumann computer) to pin 8a. Connect the wire from Amphenol plug pin 19 (LV feed from interface cable) to pin 6a.

3. Remove the wire from pin 7a (V feed from Neumann computer) and connect it to pin 8b (formerly unused). Connect the wire from Amphenol plug pin 14 (V feed from Neumann computer) to pin 8b. Connect the wire from Amphenol plug pin 21 (V feed from interface cable) to pin 7a.

**E. AS303 panel connector modifications.** These steps interrupt the Base Pitch signal to the Neumann computer and in its place connect a new wire from the Disc Computer Amphenol connector. They also connect ground and the Start and Stop signals to the Disc Computer.

1. Remove the wire from pin 5a (Base Pitch from lathe) and move it to pin 9c. Connect the wire from Amphenol plug pin 4 (Base Pitch from lathe) to pin 9c. Connect the wire from Amphenol plug pin 24 (Base Pitch to lathe) to pin 5a.
2. Add the wire from Amphenol plug pin 20 (Ground) to pin 0a.
3. Add the wire from Amphenol plug pin 17 (Stop) to pin 4b.
4. Add the wire from Amphenol plug pin 18 (Start) to pin 1b.

**F. Programmer Plug modifications.**

1. Using a short piece of wire, jumper across R11 in the 33 rpm Programmer, to short it. This mod allows the servo motor to turn faster with the Base Pitch control fully clockwise.
2. Cut or de-solder one leg of R9 in the 45 rpm Programmer, to open it. This mod allows the servo motor to turn slower with the Base Pitch control fully counter-clockwise.