

**Danville Signal Processing, Inc.**

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**DSP-8200d**  
**Tone Suppression &  
Noise Reduction System**

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**Operating Manual**  
Version 3.0

# **Danville Signal Processing, Inc. DSP-8200d Tone Suppression & Noise Reduction System Operating Manual**

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# Digital Signal Processing

Digital Signal Processing (DSP) is a powerful and complex method of analyzing and modifying analog signals, such as speech. Speech signals have fairly well known and predictable characteristics; however, these characteristics are quite complex.

By converting the analog signal to a digital signal, a digital signal processor with a special program can analyze the characteristics of the analog signal. The digital signal processor can then modify the digital signal to enhance the desired characteristics and to remove undesirable characteristics such as noise or tones. The processed signal is converted back to an analog signal and sent on to a speaker or headphone.

## Overview

The DSP-8200d uses advanced digital signal processing technology to implement algorithms that perform four basic audio functions:

- Tone suppression
- Bandpass filtering
- Automatic Gain Control (AGC)
- Squelch (VOX)

There are four configurations of the above functions available in the DSP-8200d. They include:

- Automatic Tone Suppression
- Ground to Ground tone suppression (404 Hz, 1004 Hz, tones > 2700 Hz)
- Bandpass filtering
- Bypass (audio loopback)
  
- AGC & Squelch can be applied to each configuration except Bypass

## Automatic Tone Suppression

The Automatic Tone Suppression mode of the DSP-8200d removes heterodynes (tones) caused during multiple aircraft-to-aircraft and multiple aircraft-to-controller communications. It also attenuates unwanted signaling tones that may be inadvertently applied to normal monitoring channels. This tone suppression wipes out potential hearing-impairing test and interference tones in milliseconds.

The automatic tone suppression function of the DSP-8200d operates by examining a characteristic of the audio signal called correlation, and dynamically filters out undesired tones from the signal. The degree of correlation is relative. Tones are highly correlated as compared to speech signals. The DSP-8200d uses this difference to separate speech from tones. The DSP-

8200d can attenuate tones by as much as 50 dB depending on the specific characteristics of the incoming signal.

## **Ground to Ground Tone Suppression**

Ground-to-Ground circuits present a different challenge. In these circuits, certain signalling tones are acceptable (and required), therefore the automatic tone suppression algorithm will not work. It will suppress all the tones including the signaling tones.

The Ground to Ground Tone Suppression mode specifically notches certain frequencies that are the most common test tones while passing the signaling tones. This greatly reduces the chance of a “tone incidence” while using circuits where the automatic tone suppression algorithm can not be used.

The most common test tones are 404 Hz, 1004 Hz, 2713 Hz, 2800 Hz and 3200 Hz. These are the frequencies that the Ground-to-Ground mode is designed to suppress.

A brickwall bandpass filter is first created that is flat to 2600 Hz. This allows the highest signaling frequency (2600Hz) to be passed without attenuation. By 2700 Hz, signals are attenuated by 50dB. This is a very sharp filter made possible by the use of digital signal processing. After the bandpass filter, the 404 Hz and 1004 Hz tones could still be present.

The next filtering stage creates fixed notches at 404 Hz and 1004 Hz. These notches are very narrow and do not affect the speech or other signaling tones. High level test tones can also overload a circuit. This causes the test signal to look like a square wave. This means that we also have to consider the odd harmonics of the test tone. We therefore have additional notch filters at 1212 Hz (3rd harmonic of 404 Hz) and 2020 Hz (5th harmonic of 404 Hz). The harmonics of the other test frequencies are attenuated by the brickwall bandpass filter. For example, the 3rd harmonic of 1004 Hz is 3012 Hz which is in the stop band of the bandpass filter.

## **Bandpass Filtering**

The DSP-8200d provides high performance bandpass filtering from 300 to 3400 Hz. Since the DSP-8200d is intended for voice communication systems, signals outside of the voice band generally contribute to noise. This mode is very useful in conjunction with the Squelch function as a noise reduction system. The bandpass filter is also part of the Automatic Tone Suppression mode.

## **Automatic Gain Control**

The Automatic Gain Control (AGC) adjusts the signal to a constant level. AGC can be applied to all operating modes except Bypass.



## Control Module

The control module monitors each DSP module for proper operation. Through the use of a computer interface, the Control Module offers several key functions for monitoring and upgrading the DSP-8200d.

They include:

- Fault Detection
- Diagnostics
- DSP Module Configuration
- Reprogrammability

In the event of a DSP module failure, an audible alarm will alert the operator that a problem has occurred. To assist in identifying the failed module, the heartbeat indicator will blink at 4 times the normal rate. In addition, the BNC connector will go into fault position.

A relay switch closure output (BNC connector) is provided which will indicate if power has been lost to the DSP-8200d as well as an individual module failure. This output may be configured (via shorting jumper) as either normally open or normally closed.

Operators can connect the DSP-8200d to a standard terminal program using a RS-232 or USB cable. One such common terminal program that is included in all Windows Operating Systems since Windows 95 is HyperTerminal. Danville's dspterm™ 8200 terminal program may also be used to monitor system status. This program is discussed in a subsequent section of this manual.

To access the Control Module, hook up the terminal program and press the 'Esc' key. To access a list of commands available, press the '?' key. While many of the commands are specific to programming and updating, two commands will be useful for system status and diagnostic purposes. They include:

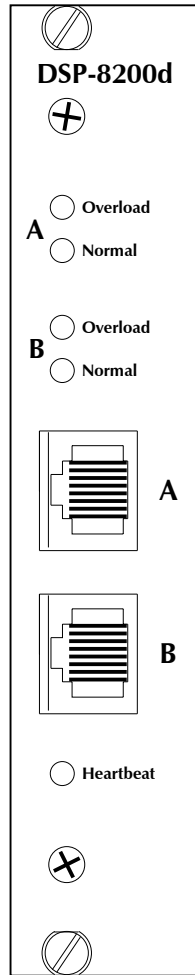
- 'A' Command - reports jumper settings of each individual module
- 'S' Command - reports overall system settings, including Power Supply voltages

Please contact the factory for assistance in any other updating or reprogramming needs.

## DSP Modules

Each DSP module has signal processing for two audio channels. Overload and Normal Level indicators are provided for each channel. A Heartbeat Status LED flashes at a one-second interval to show proper operation. The input and output audio interface are balanced 600 ohm lines with audio transformers. A watchdog timer monitors circuit operation and will reset each the module in the event of program failure. To insure that audio is never interrupted, each audio channel is passively relay bypassed when the unit is unpowered.

# DSP-8200d DSP Module

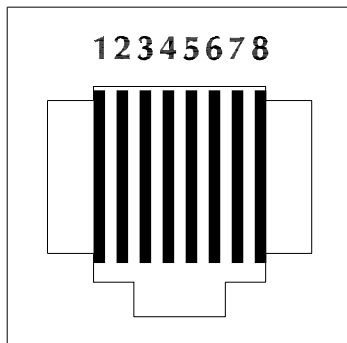


(Actual Size)

## Power Supply Modules

Each card cage has two power supply modules for redundant operation. Each power supply module is fully capable of supplying all of the necessary power to operate all the modules. If one of the power supply modules fail, the card cage will continue to operate.

# Cable Connections & DSP Configuration



## RJ-45 Connector

Audio In - Pin 1 & 2 (600 Ohm Balanced)  
Audio Out - Pin 3 & 6 (600 Ohm Balanced)  
Ground - Pin 8  
Reserved - Pins 4,5,7 (leave open)

Note: These connections are the same as Ethernet 10BaseT; off-the-shelf Cat 5 cables may be used.

## DSP Module Configuration

Each DSP Module can be configured for a variety of operating modes. There are two main methods for configuring a DSP module, Soft Configuration & Hard Configuration.

Soft Configuration is the preferred configuration method. Parameters are set via a terminal program called dspterm™ 8200. This program is available from Danville. If you do not have a copy, send a request to [support@danvillesignal.com](mailto:support@danvillesignal.com) and we will email you the program.

Soft Configuration allows you to configure each channel of the DSP Module independently. Input and output levels, AGC & Squelch functions may be selected as well as the operating mode of each channel.

Soft Configuration is selected by removing any jumpers in positions 1,2 & 3 of JH1; position 4 is ignored. In most cases, jumpers are also removed from positions 5,6,7 & 8. If a special attenuator has been added to the DSP Module for high level audio circuits, then jumpers are placed in positions 5 or 6 according to the table that follows on the next page. Most DSP-8200d DSP modules do not have these special attenuators. They have only been added via specific customer request. The latest DSP-8200d modules have attenuator jumpers JH2 (Ch A) and CH3 (Ch B). If these jumpers are available then if JH2 is jumpered, JH1-6 should be jumpered. Likewise, if JH3 is jumpered, then JH1-5 should be jumpered.

If the jumpers have been set appropriately, the module is ready for software configuration via dspterm™ 8200. Details on this program are discussed in the dspterm™ 8200 section of this manual.

Hard Configuration is less flexible and included largely for backwards compatibility with earlier versions of the DSP-8200d. If the firmware version is before 3.0, then Soft Configuration is not available. Contact [support@danvillesignal.com](mailto:support@danvillesignal.com) for firmware update information.

## DSP Module Jumper Configuration (JH1) – Mode

Mode	Jumper			
	4	3	2	1
SOFT CONFIGURATION (PARAMETERS SET VIA SOFTWARE)	Off/On	Off	Off	Off
<b>HARD CONFIGURATIONS:</b>				
Automatic Tone Suppression – Squelch On	Off	Off	On	On
Automatic Tone Suppression – Squelch Off	On	Off	On	On
Ground/Ground Tone Suppression – Squelch On	Off	On	Off	On
Ground/Ground Tone Suppression – Squelch Off	On	On	Off	On
Bandpass – Squelch On	Off	Off	On	Off
Bandpass – Squelch Off	On	Off	On	Off
Bypass (Audio Loopback)	Off/On	On	On	On
<b>RESERVED CONFIGURATIONS (FUTURE - DO NOT USE !)</b>				
Reserved	Off/On	Off	Off	On
Reserved	Off/On	On	Off	Off
Reserved	Off/On	Off	Off	On
Reserved	Off/On	Off	Off	On
* Factory Default is Soft Configuration				
* Soft Configuration default is Automatic Tone Suppression with Squelch On, AGC Off				

### WARNING:

**DO NOT USE TONE SUPPRESSION FOR GUARD FREQUENCIES 121.5 MHz AND 243.0 MHz. YOU MUST USE BANDPASS MODE ONLY FOR THESE FREQUENCIES.**

## DSP Module Jumper Configuration (JH1) – Level Settings

Level Settings	Jumper			
	8	7	6	5
Soft Configuration (parameters set via software)				
Normal Levels	Off	Off	Off	Off
Attenuator in Ch B	Off	Off	Off	On
Attenuator in Ch A	Off	Off	On	Off
Attenuator in Ch A & Ch B	Off	Off	On	On
Hard Configurations: (Nominal Input & Output Level)				
-2.0 dBm	Off	On	Off	Off
-3.5 dBm	Off	On	Off	On
-5.0 dBm	Off	On	On	Off
-6.5 dBm	Off	On	On	On
-8.0 dBm	On	Off	Off	Off
-9.5 dBm	On	Off	Off	On
-11.0 dBm	On	Off	On	Off
-12.5 dBm	On	Off	On	On
-14.0 dBm	On	On	Off	Off
-15.5 dBm	On	On	Off	On
-17.0 dBm	On	On	On	Off
-18.5 dBm	On	On	On	On
* Factory Default is Soft Configuration				
* Soft Configuration default is -8 dBm Input & Output level for both channels				

The nominal input level adjustment is used to optimize the performance of the signal processing algorithms and to maximize signal to noise without overload. Input/output gain is constant for all settings. The squelch threshold is approximately 24dB below the nominal input level.

When the DSP-8200d is properly configured, the yellow (normal) led will be on and the red (overload) led will flash occasionally.

## Control Module Jumper Configuration

A 3-pin header (JH1) configures the relay switch closure. This header is located near the front panel just behind the BNC connector.

If a system failure occurs, the switch closure is open when the shorting jumper is in the NC position.

If a system failure occurs, the switch closure is closed when the shorting jumper is in the NO position.

The factory default position is NC (closed during normal operation and open during a failure).

## Control Module Cables

The Control Module may be connected to a computer using either a RS-232 connection or a USB connection.

A standard DB9F to DB9M cable with no twists is used for the RS-232 connection.

A standard USB cable with a B connector on the Control Module side is used for a USB connection. Consult the factory for USB device drivers.

## Terminal Configuration

Port Settings should be set as listed:

Bits per second:	38400
Data bits:	8
Parity:	None
Stop bits:	1
Flow control:	None

# dspterm™ 8200

Danville's dspterm™ 8200 terminal program is used to configure each DSP-8200d DSP module. You can also use dspterm™ 8200 to monitor system status of the DSP-8200d card cage.

There are three basic modules of dspterm™ 8200:

- Connection
- Interface
- Monitor

These modules are opened or created from either the File Menu or the Toolbar.

## **Connection Module:**

Connection is used to configure the COM port of the computer. In most cases, the COM port will be set to COM1. The remaining parameters are fixed since the DSP-8200d must be configured as shown for proper operation.

## **Interface Module:**

The Interface module is used to configure individual DSP-8200d modules. To read the current configuration of a module, select the desired card slot and press "Read". To change the current configuration, modify the desired parameters and press "Write". The module will reset automatically after a "Write" has been executed.

## **Monitor Module:**

The Monitor module allows commands to be sent to the control module. Transmitted characters are entered in the "Transmit" window. The Monitor window will show the responses from the Control Module. Communication to the Control Module is initiated by sending an <ESC> character. To see a list of available commands press "?" followed by an <ENTER>. The most useful commands are "A" – Individual Module Status and "S" – Display System Status.

# Troubleshooting & Checkout

## DSP Modules

The DSP-8200d signal processing modules require no adjustments or calibration. All signal processing functions are performed within the DSP processor.

The tone suppression and noise reduction modes of the DSP-8200d do not easily lend themselves to traditional measurement techniques. These algorithms have been designed for human speech and interfering noise or tones. As such, these algorithms modify themselves dynamically with changing speech or noise conditions.

The easiest method to verify correct operation of a DSP-8200d module is to reconfigure the mode to bandpass. Since all signal processing functions are performed exclusively by mathematical calculation, a DSP-8200d module that passes this test will also operate correctly in the other operating modes.

### **WARNING:**

**THIS PROCEDURE SHOULD NEVER BE PERFORMED IN AN  
OPERATING COMMUNICATION CHANNEL!**

**IT IS INTENDED FOR OUT-OF-CIRCUIT TESTING ONLY.**

**TEST TONES WILL PASS THROUGH THE DSP  
MODULE IN THIS TEST!!**

### **Test Procedure – DSP Module**

1. Remove the DSP module from the card cage and reconfigure the mode to bandpass.
2. Reinstall the DSP module in an off-line, unpowered DSP-8200d card cage.
3. Apply a signal to the input of each DSP channel. The signal should be passively bypassed by a mechanical relay and therefore identical at the output of each channel. If this test fails, it is an indication of a bad relay on the DSP module or a connector/cabling problem.

4. Apply power to the DSP-8200d card cage. The normal and overload LEDs will flash alternately during the power up stage and the heartbeat will begin the pulse at a one-second rate. The DSP card cage control module alarm will go off.
5. Apply a 1000 Hz sine wave to each input and adjust the level so that the yellow (normal) led is on and the red (overload) led is off. The output will be slightly higher than the input when loaded into 600 ohms.
6. Vary the input frequency from 100 Hz to 5000 Hz. The signal will attenuate outside of a 300-3400 Hz bandwidth. If it does not, it indicates that the signal is being bypassed by the relay. An open transistor or defective relay could cause this symptom.
7. If the DSP module passes these tests, reconfigure the mode to the desired operating configuration.

## Power Supply Modules

Each power supply module consists of an unregulated linear supply and a low noise 5.3 volt switching regulator. Diode rectifiers on the back plane of the card cage isolate each power supply module from the other.

## Test Procedure – Power Supply

1. Remove the power supply module from the card cage.
2. Apply power via the IEC power connector. Remember 110 Volt or 230 Volt AC is present on the circuit traces.
3. Verify that the green led is lit. If the led is off, check the 1 Amp fuse.
4. Typical output voltages (unloaded).

Row	(pins a,b,c of DIN connector)	
7,8	GND	
10	+5.3 Vdc	(Digital)
11	+15 Vdc	(Analog)
12	-15 Vdc	(Analog)

# Product Warranty

Danville Signal Processing, Inc. products carry the following warranty:

Danville Signal Processing products are warranted against defects in materials and workmanship. If Danville Signal Processing receives notice of such defects during the warranty period, Danville Signal Processing shall, at its option, either repair or replace hardware products which prove to be defective.

Danville Signal Processing software and firmware products which are designated by Danville Signal Processing for use with our hardware products are warranted not to fail to execute their programming instructions due to defects in materials and workmanship. If Danville Signal Processing receives notice of such defects during the warranty period, Danville Signal Processing shall, at its option, either repair or replace software media or firmware which do not execute their programming instructions due to such defects. Danville Signal Processing does not warrant that operation of the software, firmware, or hardware shall be uninterrupted or error free.

The warranty period for each product is one year from date of installation.

## **Limitation of Warranty:**

The forgoing warranty shall not apply to defects resulting from:

- Improper or inadequate maintenance by the Buyer;
- Buyer-supplied software or interfacing;
- Unauthorized modification or misuse;
- Operation outside the environmental specification of the product;
- Improper site preparation and maintenance.

## **Exclusive Remedies:**

The remedies provided herein are the Buyer's sole and exclusive remedies. In no event shall Danville Signal Processing, Inc. be liable for direct, indirect, special, incidental or consequential damages (including loss of profits) whether based on contract, tort, or any other legal theory.

# Appendix A

## Typical FAA Installation:



The DSP-8200d is useful in many FAA applications. Each module can be configured for tone suppression or broadband noise reduction.

Tone suppression prevents loud signaling tones from reaching air traffic controllers and eliminates or reduces naturally occurring heterodynes between air traffic control and multiple airplanes.

Noise reduction is useful in applications where channel signal to noise is poor and may be used to enhance intelligibility and reduce listener fatigue.

The DSP-8200d is installed prior to controller switching equipment in the receive audio chain and does not require any FAA equipment modification.

Application sites may include FAA Control Centers, Automatic Flight Service Stations, TRACONs, Control Towers, and Flight Service Stations.