

YAMAHA
DS2416 Digital Mixing Card
Owner's Manual

First Draft: 30 March 1998

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Important Notices

- Do not place the DS2416 in an area subject to excessive heat, direct sunlight, excessive humidity, or dust.
- Keep the DS2416 inside its antistatic bag until you are ready to install it.
- To prevent handling damage, hold the DS2416 by the edges or bracket.
- If you accidentally touch the card edge connections, remove any fingerprints using a dry tissue.
- Do not place objects on top of the DS2416, and do not put it down in a place where other objects are likely to be placed on top of it.
- Before removing your computer's cover, turn it off and remove the power cord.
- To prevent static electricity damage, touch a grounded metal part of your computer, such as the power supply case, before handling the DS2416.

Packing List

- DS2416 Digital Mixing Card
- Driver and Setup Utility floppy disk
- Demo software CD-ROM
- 14-pin to 16-pin cable
- This manual

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Keep this manual for future reference!

Introduction

Thank you for purchasing the Yamaha DS2416 Digital Mixing Card. With 8-track simultaneous recording, 16-track simultaneous playback, 24-channel mixing, 4-band parametric EQ, effects, and dynamics, the DS2416 provides a complete digital recording studio inside a regular personal computer. Unlike other audio cards, the DS2416's five DSPs take the load off the computer's main processor leaving it free to concentrate on timing and other tasks while the DS2416 takes care of high-quality effects, EQ, and dynamics processing. In some cases, the DS2416's onboard processing powerhouse may allow audio software to record and playback a greater number of tracks.

For ease of installation and high data throughput, the DS2416 uses the industry-standard PCI (Peripheral Component Interconnect) bus. Sound cards such as the Yamaha SW1000XG can be connected digitally, or two DS2416 cards can be digitally cascaded for 48-channel mixing, each providing 2-channel analog inputs and outputs, with 20-bit 128-times oversampling A/D converters and 20-bit 8-times oversampling D/A converters, and stereo coaxial digital input and output. Inputs and outputs can be expanded using the optional AX44 Audio Expansion Unit, which offers four 1/4-inch analog inputs—two of which can be used with microphones—four 1/4-inch analog outputs and a stereo headphone jack. Two AX44s can be used with each DS2416 card for eight analog inputs and outputs.

Yamaha DSP Factory

The DS2416 Digital Mixing Card forms the heart of the Yamaha DSP Factory system, a range of products designed to bring professional digital multitrack recording and mixing to personal computers. Other DSP Factory products include the AX44 Audio Expansion Unit, and several analog and digital multi-channel input and output options are currently under development.

Check out the Yamaha DSP Factory Web site for the latest information <<http://www.yamaha.co.jp/product/proaudio/homeenglish/>>.

System Requirements

- IBM PC compatible PCI bus Windows 95 computer
- DS2416-compatible audio software

System Notes

The DS2416 can be used in any IBM PC-compatible PCI bus personal computer running Windows 95. Since the PCI bus standard relies on the Pentium processor, computers with earlier processors are not supported. The DS2416 requires a single 5 V PCI expansion bus slot, and cannot be used in 3.3 V PCI slots. It's compliant with PCI version 2.1, requires one IRQ (interrupt request), but no DMA (Direct Memory Access). Since it's a PCI card, IRQ settings are made automatically. PCI bus speeds other than 33 MHz are not supported.

Processor type, memory, and hard disk requirements are dependent on the controlling software, not the DS2416. The supplied device driver requires a few hundred kilobytes of disk space. Although the DS2416 supports 8-track simultaneous recording and 16-track simultaneous playback, actual performance will depend on the capabilities of your computer and audio software.

Compatible Software

Any software that supports Windows MME (Multimedia Extensions), including the Windows 95 Media Player accessory, can be used with the DS2416 for recording and playback. To use the mixing functions, however, requires software that supports the DS2416 mixer. The following software companies are supporting the DS2416.

- C-Mexx
- Cakewalk
- Canam Computers
- Emagic
- IQS (Innovative Quality Software)
- Musicator
- SEK'D
- Sonic Foundry
- Steinberg

Features

General

- PCI bus card (compliant with version 2.1)
- Support for Windows 95 MME (Multimedia Extensions)
- Plug and Play installation
- Supported by the major audio software companies
- 5 onboard DSPs take the load of the computer's main processor
- 2 analog inputs with 20-bit 128-times oversampling A/D converters
- 2 analog outputs with 20-bit 8-times oversampling D/A converters
- Stereo coaxial digital input and output (16-, 20-, or 24-bit)
- Optional multi-channel analog and digital input and output options

Mixer

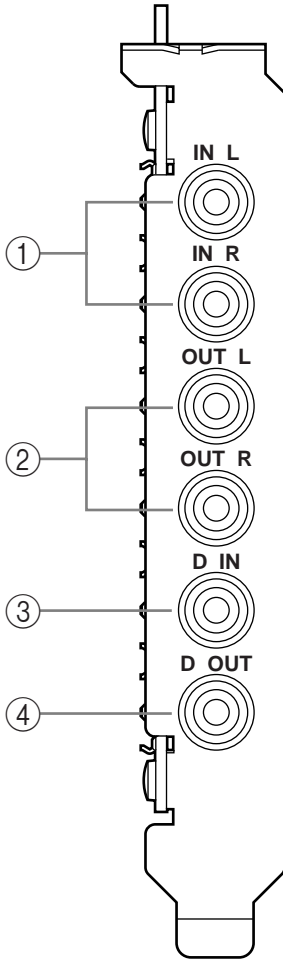
- 24 input channels, 8 bus outs, 6 aux sends (two feeding the onboard effects processors), and a stereo output
- 4-band parametric EQ on all inputs channels and the stereo output
- Dynamics processors on all inputs channels and the stereo output
- Two onboard effects processors with Yamaha ProR3/REV500 quality
- Input channels 21–24 function as effects returns for the onboard effects
- Input delay on input channels 1–20
- Comprehensive signal level metering
- Digital cascading of two DS2416 cards for 48-channel mixing
- 32-bit digital audio processing

Recorder

- 8-track simultaneous recording
- 16-track simultaneous playback
- Up to 32-bit recording and playback (software dependent)
- Sample-accurate synchronization between tracks
- Recorder digitally hard-wired to the mixer
- External synchronization via controlling software

Connections

Rear



① **IN L, IN R**

Analog IN L and IN R inputs feature phono jacks with a nominal input level of -10 dBV. Analog to digital conversion features 20-bit 128-times oversampling techniques.

② **OUT L, OUT R**

Analog OUT L and OUT R outputs feature phono jacks with a nominal output level of -10 dBV. Digital to analog conversion features 20-bit 8-times oversampling.

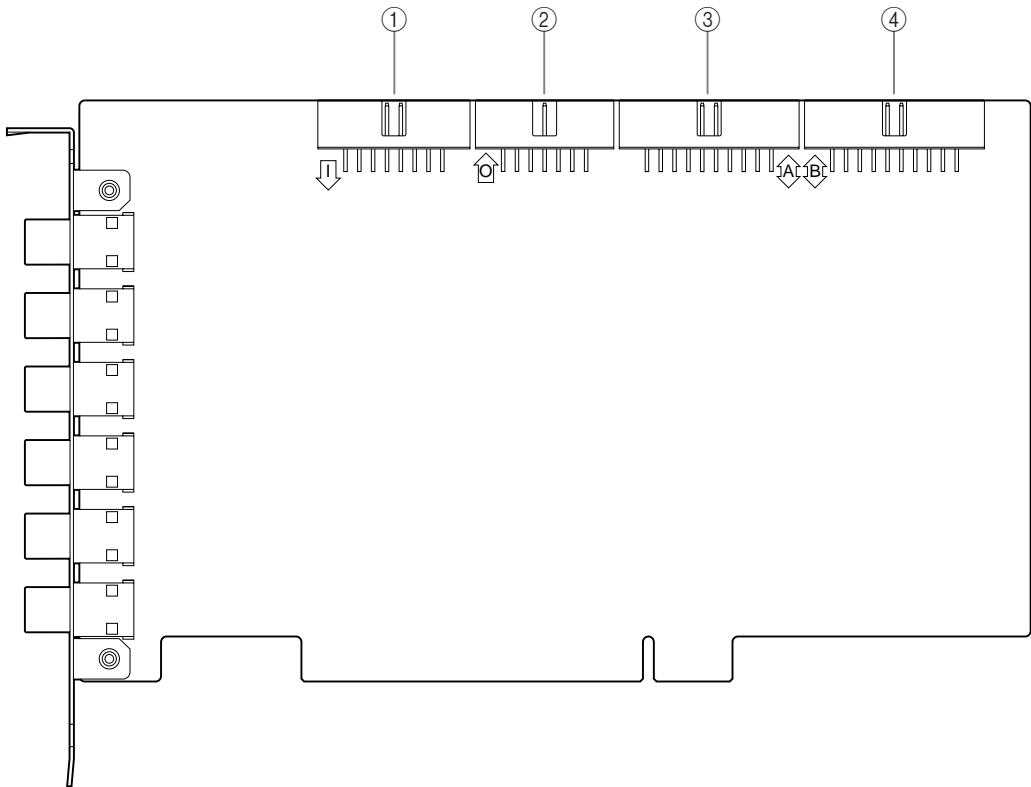
③ **D IN**

This two-channel coaxial-type phono connection accepts Consumer format digital audio with a 24-bit maximum wordlength.

④ **D OUT**

This two-channel coaxial-type phono connection outputs Consumer format digital audio with a 24-bit maximum wordlength.

Internal



① I connector

When two DS2416 cards are installed, this connector is connected to the “O” connector on the other card using the supplied 14-pin to 16-pin cable. Sound cards such as the Yamaha SW1000XG can be connected directly to this connector, with its output signals appearing at the DS2416 mixer’s sub inputs.

② O connector

When two DS2416 cards are installed, this connector is connected to the “I” connector on the other card using the supplied 14-pin to 16-pin cable.

③ A connector

This connector connects to the first optional AX44 Audio Expansion Unit.

④ B connector

This connector connects to the second optional AX44 Audio Expansion Unit.

Installing the DS2416

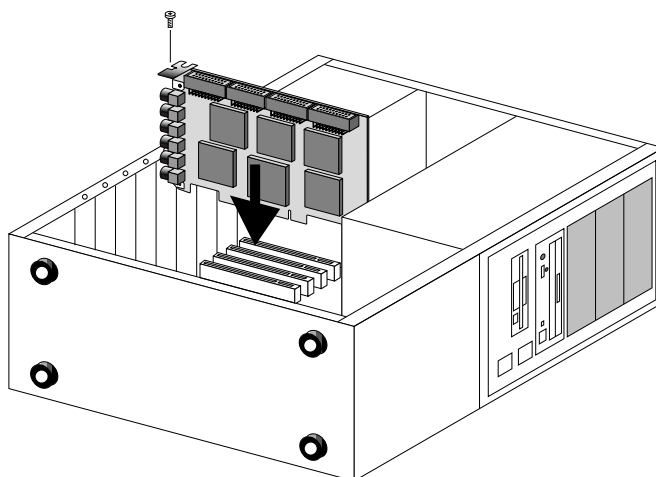
The DS2416 installs into a PCI expansion slot and requires no special jumper settings or interrupt settings.

See your computer's manual for full details on installing PCI cards.

- 1 Turn off the computer and disconnect the power cord.
- 2 Remove the computer's cover.
- 3 Choose an empty PCI slot for the DS2416, and remove the screw from its expansion-slot cover.

To prevent static electricity from damaging the DS2416, touch a grounded metal part of your computer, such as the power supply case, before handling it.

- 4 Carefully align and insert the DS2416 into the PCI slot.
- 5 Secure the DS2416 using the screw removed previously.



Important: The DS2416 is grounded via the expansion-card fixing screw, so be sure to tighten it securely.

- 6 Replace the computer's cover.
- 7 Turn on your computer.
- 8 When the New Hardware Found dialog box appears, select "Driver from disk provided by hardware manufacturer", and then click OK.
- 9 When the Install From Disk dialog box appears, insert the driver floppy disk into the floppy disk drive, and then click OK.

The driver software is installed, and the Windows 95 desktop appears as normal.

Configuring the DS2416

The included setup utility is used to assign DS2416 inputs and outputs and select the wordclock source. Note that some audio software may use its own input and output assignments and ignore settings made using this utility.

Wordclocks

Unlike analog audio equipment, digital audio equipment must be synchronized when digital audio is transferred from one device to another, otherwise, the digital audio might not be read correctly and audible noise, glitches, or clicks may occur. Synchronization is achieved using what's called a *wordclock*, which is a clock signal for synchronizing all the digital audio words in an audio system. Note that wordclocks are not the same as SMPTE or MIDI timecode, which are used to synchronize audio recorders, MIDI sequencers, and so on. Wordclock synchronization refers to the synchronization of the digital audio processing circuits inside each digital audio device.

In a typical digital audio system, one device acts as the wordclock master and the other devices act as wordclock slaves, synchronizing to the wordclock master. If the DS2416 is the only digital audio device in your system, no special wordclock settings are required, as the DS2416 synchronizes to its own internal wordclock. Add a DAT recorder or digital multitrack recorder, however, and you must decide which device to use as wordclock master and which devices to use as slaves. Even when you've done this and configured your system, it may sometimes be necessary to change the wordclock settings, such as when recording from a DAT or CD player.

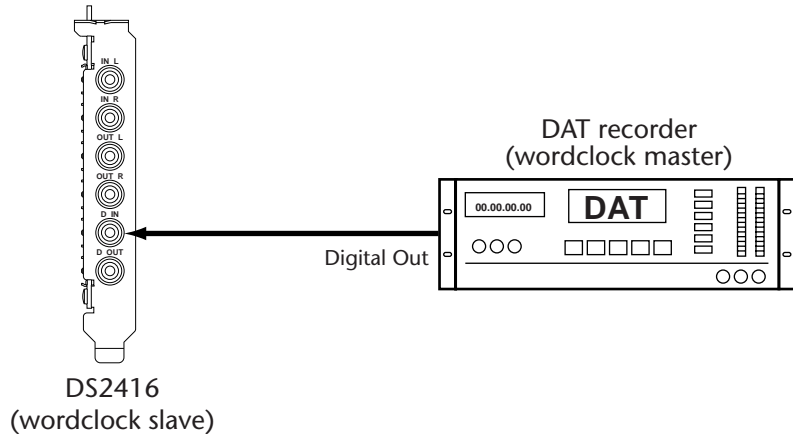
Wordclocks run at the same frequency as the sampling rate. The DS2416 generates its own wordclock at 44.1 kHz (the industry-standard sampling rate for music CDs) or 48 kHz and can be used as wordclock master. Alternatively, it can be used as a wordclock slave synchronized to an external wordclock of between 30.08 kHz and 50.88 kHz (32 kHz -6% , 48 kHz $+6\%$). Converting the sampling rate of digital audio is a complicated process, so it's best to use the 44.1 kHz sampling rate, especially if your work is destined for CD distribution.

Wordclock signals can be distributed via dedicated cables or derived from standard digital audio connections, such as the D IN connection on the DS2416. With Coaxial digital audio connections, a wordclock signal is transmitted even when no audio signal is present.

In a system where all devices share a common wordclock, it's important that all devices be turned on even when they're not being used. Turn on the wordclock master first, and then the slaves. When shutting down the system, turn off the slaves first, and then the master. Before commencing with a recording session, make sure that all wordclock slaves are synchronized to the master. Some devices have front panel indicators to show when they are wordclock synchronized. Refer to the instructions for each device.

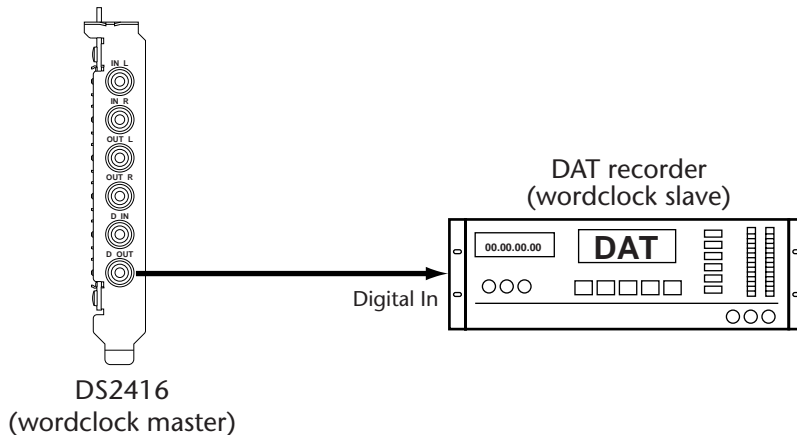
Recording Digitally to the DS2416

In this example, a DAT deck is connected to the DS2416 D IN connector for digital recording. The DS2416 works as wordclock slave and the DAT works as wordclock master.



Recording Digitally to DAT

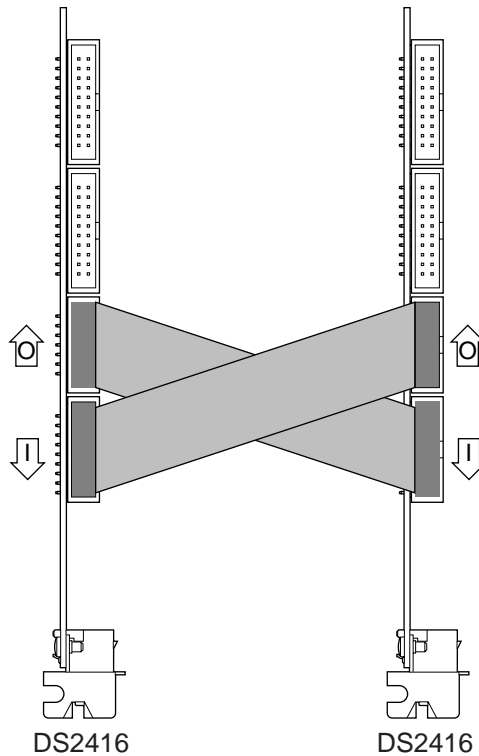
In this example, the D OUT connector on the DS2416 is connected to the digital input of a DAT recorder for digital mixdown recording. The DS2416 works as wordclock master and the DAT works as wordclock slave. When the digital input on the DAT recorder is selected as the recording source, the DAT should automatically synchronize to the wordclock signal coming from the DS2416. On some DAT recorders, the wordclock source may have to be set separately. Refer to the instructions supplied with your DAT recorder.



Digitally Cascading DS2416 Cards

Using the digital “I” and “O” connectors, two DS2416 cards can be digitally cascaded for common busing and 48-channel mixing.

- 1 Install the second DS2416 into a PCI slot adjacent to the first DS2416, as explained previously.
- 2 Using the supplied 14-pin to 16-pin cables, connect the “I” connector on the second DS2416 to the “O” connector on the first DS2416, and the “O” connector on the second DS2416 to the “I” connector on the first DS2416, as shown below.

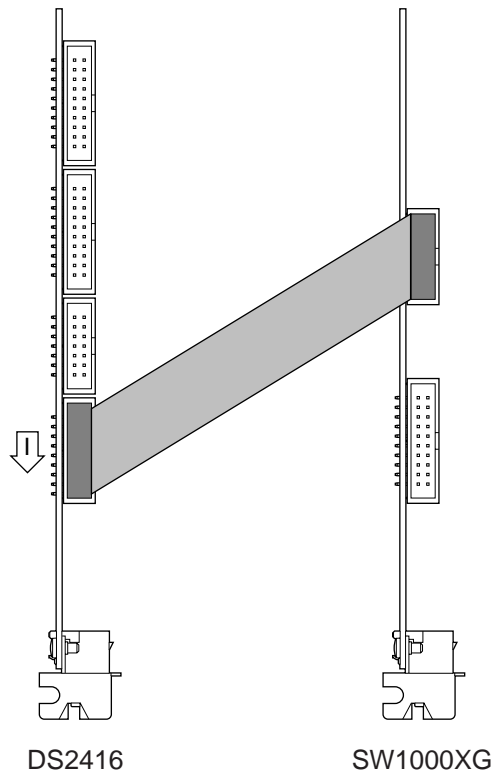


- 3 Replace the computer's cover.
- 4 Use the included setup utility to configure each card.

Connecting an SW1000XG Sound Card

The Yamaha SW1000XG PCI Sound Card features an XG tone generator, onboard effects, MIDI interface, and analog inputs, and by connecting it to the “I” connector on a DS2416, its outputs can be digitally connected to the DS2416 mixer via its sub inputs. Note that you cannot use an SW1000XG card with two digitally cascaded DS2416 cards.

- 1 Install the DS2416 and SW1000XG cards in your computer.
- 2 Using the supplied 14-pin to 16-pin cables, connect the “I” connector on the DS2416 to the “??” connector on the SW1000XG, as shown below.



- 3 Replace the computer's cover.
- 4 Use the included setup utility to assign the DS2416's mixer inputs to connector “I” (sub inputs).

DS2416 Q&A (Questions & Answers)

Q What's a DSP?

A A DSP, or Digital Signal Processor is a processor optimized for real-time digital data processing. The DS2416 features the same DSP as the Yamaha 02R and 03D digital mixing consoles.

Q At what wordlength is digital audio processed?

A The EQ features a 44-bit data path, 32-bit coefficient, and 54-bit accumulator. All other mixer sections feature a 32-bit data path, 24-bit coefficient, and 42-bit accumulator.

Q Does the DS2416 have any onboard memory?

A Yes, 3 megabytes, which is used for input, and effects delays.

Q What is the available recording time?

A This is dependent on the software and selected wordlength

Q How do I synchronize the DS2416 to MIDI Clock, MTC, or SMPTE timecode?

A The DS2416 receives timing information from the controlling software, so if the software supports external timecode, so does the DS2416.

Q Can DS2416 mixer functions be controlled via MIDI?

A If the controlling software supports this, yes.

Q How good are the onboard effects processors?

A As good as those used in the Yamaha ProR3 and REV500 effects processors.

Q Can the DS2416 be used simultaneously with a Sound Blaster or Korg 1212 I/O card?

A Yes.

Troubleshooting

Trouble	Advice
The DS2416 does not work?	Make sure that the computer is turned on.
	Make sure that the DS2416 is inserted in the PCI bus slot correctly.
	Make sure that the DS2416 input and outputs are correctly assigned using the controlling software.
	In older computers, some PCI slots may not function as the bus master, and the DS2416 will not work in such slots. See your computer's manual for more details.
	Some PCI cards may conflict with the DS2416. Try removing cards, or swapping slots with the DS2416.

Specifications

General

Sampling rate	Internal	44.1 kHz, 48 kHz
	Internal vari-pitch	30.08 to 50.88 kHz
	External	30.08 to 50.88 kHz
Signal delay (fs = 48 kHz)	A/D	620 μ s typical
	D/A	310 μ s typical
Total harmonic distortion ¹ (fs = 48 kHz, +6 dB, analog input to output)		Less than 0.02% (20 Hz–20 kHz)
Frequency response (analog input to output)		20 Hz–20 kHz, -3, +1 dB
Dynamic range ² (fs = 48 kHz)	D/A	Typically 94 dB
	A/D + D/A	Typically 93 dB
Residual output noise ² (D/A input = digital 0)		Typically -88 dBV
Input	IN L, IN R	20-bit 128-times oversampling A/D
	D IN	Consumer format (Coaxial)
Output	OUT L, OUT R	20-bit 8-times oversampling D/A
	D OUT	Consumer format (Coaxial)
Effects (HQ. Pitch type for Effect 2 only)	Effect 1	39 types
	Effect 2	40 types
Power supply		+5 V (1.5 A max) +12 V (150 mA max)
Maximum power consumption		9.3 W
Temperature	Operating	+10°C to +40°C
	Storage	-20°C to +55°C
Dimensions (H x L x D)		125.92 x 187.95 x 21.59 mm (4.95 x 7.4 x 0.85 inch) PCI Raw Variable Height Short Card (5 V, 32-bit)
Weight		170 g (6 oz)
Supplied accessories	Driver and Setup Utility floppy disk	
	Demo software CD-ROM	
	14-pin to 16-pin 80 mm cable x1	

1. Bandwidth filter ± 0.1 dB (20 Hz–20 kHz), -60 dB (more than 24.1 kHz)

2. Bandwidth filter as above plus Weighting Filter (IEC60651 A curve, Tolerance: Type 0)

Input Channels

De-emphasis (CH19, CH20)		Automatically applied as needed
DC Cut		Automatically applied as needed
ATT		-96 dB to +12 dB (109 steps)
Phase		Normal/reverse
4-band EQ (12 EQ types per band)	Frequency	20 Hz–20 kHz (120 steps, 12 points/octave)
	Gain	-18 dB to +18 dB (73 steps, 0.5 dB/step)
	Q	0.1–10.0 (41 steps)
Dynamics (6 types)	Threshold	-54 dB to 0 dB (55 steps, 1.0 dB/step)
	Attack	0–120 ms (121 steps, 1 ms/step)
	Gain	0 dB–18 dB (37 steps, 0.5 dB/step)
	Release	5 ms–42.3 s, fs = 48.0 kHz (160 steps) 6 ms–46.0 s, fs = 44.1 kHz (160 steps)
	Ratio	1.0 to infinity (16 steps)
	Knee	Hard, 1, 2, 3, 4, 5 (6 steps)
	Range	-70 to 0 dB (71 steps, 1.0 dB/step)
	Hold	0.02 ms–42.3 s, fs = 48.0 kHz (216 steps) 0.02 ms–2.13 s, fs = 44.1 kHz (216 steps)
	Decay	5 ms–42.3 s, fs = 48.0 kHz (160 steps) 6 ms–46.0 s, fs = 44.1 kHz (160 steps)
	Width	1–90 (90 steps, 1.0 dB/step)
Reduction meter		-18 dB to 0 dB (12 steps)
Delay (CH1–CH20)		0–2,600 samples (2,601 steps) On/Off
On/Off		
Fader		-Infinity, -90 dB to +10 dB (128 steps)
Pan		33 steps
Channel meter		-72 dB to 0 dB (32 steps)
		Pre/Post/Signal
		Peak Hold
		Decay Fast/Slow
Bus send	Level	-Infinity, -120 dB to 0 dB (128 steps)
	Pre/Post	(Pre pan/post pan)
	On/Off	
Aux send	Level	-Infinity, -120 dB to 0 dB (128 steps)
	Pre/Post	(Pre fader/post fader)
	On/Off	

Bus Outs 1–8

Bus master fader	–Infinity, –120 dB to 0 dB (128 steps)
On/Off	
Bus meter	–72 dB to 0 dB (32 steps)
	Pre/Post
	Peak Hold
	Decay Fast/Slow

Aux Sends 1–6

Aux master fader	–Infinity, –120 dB to 0 dB (128 steps)
On/Off	
Aux meter	–72 dB to 0 dB (32 steps)
	Pre/Post
	Peak Hold
	Decay Fast/Slow

Stereo Output

ATT	–96 dB to +12 dB (109 steps)	
4-band EQ (12 EQ types per band)	Frequency	20 Hz–20 kHz (120 steps, 12 points/octave)
	Gain	–18 dB to +18 dB (73 steps, 0.5 dB/step)
	Q	0.1–10.0 (41 steps)
Stereo master fader	–Infinity, –120 dB to 0 dB (128 steps)	
Dynamics (6 types)	Threshold	–54 dB to 0 dB (55 steps, 1.0 dB/step)
	Attack	0–120 ms (121 steps, 1 ms/step)
	Gain	0 dB–18 dB (37 steps, 0.5 dB/step)
	Release	5 ms–42.3 s, fs = 48.0 kHz (160 steps)
		6 ms–46.0 s, fs = 44.1 kHz (160 steps)
	Ratio	1.0 to infinity (16 steps)
	Knee	Hard, 1, 2, 3, 4, 5 (6 steps)
	Range	–70 to 0 dB (71 steps, 1.0 dB/step)
	Hold	0.02 ms–42.3 s, fs = 48.0 kHz (216 steps)
0.02 ms–2.13 s, fs = 44.1 kHz (216 steps)		
Decay	5 ms–42.3 s, fs = 48.0 kHz (160 steps)	
	6 ms–46.0 s, fs = 44.1 kHz (160 steps)	
Width	1–90 (90 steps, 1.0 dB/step)	
Reduction meter	–18 dB to 0 dB (12 steps)	
Balance	33 steps	

Stereo meter	-72 dB to 0 dB (32 steps)
	Pre/Post
	Peak Hold
	Decay Fast/Slow

Input Patchbay

Input	Selectable Source
CH1	PCI PB1, IO-B2-1
CH2	PCI PB2, IO-B2-2
CH3	PCI PB3, IO-B2-3
CH4	PCI PB4, IO-B2-4
CH5	PCI PB5, IO-B2-5
CH6	PCI PB6, IO-B2-6
CH7	PCI PB7, IO-B2-7
CH8	PCI PB8, IO-B2-8
CH9	PCI PB9, IO-B1-1, SUB IN1, IO-A2-1
CH10	PCI PB10, IO-B1-2, SUB IN2, IO-A2-2
CH11	PCI PB11, IO-B1-3, SUB IN3, IO-A2-3
CH12	PCI PB12, IO-B1-4, SUB IN4, IO-A2-4
CH13	PCI PB13, IO-A1-1, SUB IN5, IO-A2-5
CH14	PCI PB14, IO-A1-2, SUB IN6, IO-A2-6
CH15	PCI PB15, IO-A1-3, SUB IN7, IO-A2-7
CH16	PCI PB16, IO-A1-4, SUB IN8, IO-A2-8
CH17	IN L, IO-A1-1, SUB IN1, IO-A2-1
CH18	IN R, IO-A1-2, SUB IN2, IO-A2-2
CH19	DIN L, IO-A1-3, SUB IN3, IO-A2-3
CH20	DIN R, IO-A1-4, SUB IN4, IO-A2-4
CH21	Effect1 L, SUB IN5, IO-A2-5
CH22	Effect1 R, SUB IN6, IO-A2-6
CH23	Effect2 L, SUB IN7, IO-A2-7
CH24	Effect2 R, SUB IN8, IO-A2-8

PCI PB: DS2416 playback
 IO-A1: 4-input/4-output device connected to IO-A
 IO-A2: 8-input/8-output device connected to IO-A
 IO-B1: 4-input/4-output device connected to IO-B
 IO-B2: 8-input/8-output device connected to IO-B

Output Patchbay

Source	Destination
1: BUS 1, 2	1: REC 1, 2
2: BUS 3, 4	2: REC 3, 4
3: BUS 5, 6	3: REC 5, 6
4: BUS 7, 8	4: REC 7, 8
5: AUX 1, 2	5: IO-A1-1, 2 (IO-A2-1, 2)
6: AUX 3, 4	6: IO-A1-3, 4 (IO-A2-3, 4)
7: AUX 5, 6	7: IO-B1-1, 2 (IO-B2-1, 2)
8: STL, STR	8: IO-B1-3, 4 (IO-B2-3, 4)
	9: AOUTL, AOUTR
	10: DOUTL, DOUTR
	11: IO-A2-5, 6
	12: IO-A2-7, 8
	13: IO-B2-5, 6
	14: IO-B2-7, 8

IO-A1: 4-input/4-output device connected to IO-A

IO-A2: 8-input/8-output device connected to IO-A

IO-B1: 4-input/4-output device connected to IO-B

IO-B2: 8-input/8-output device connected to IO-B

Analog Inputs

Connection	Actual load impedance	For use with nominal	Input level		Connector
			Nominal	Max. before clip	
IN L, IN R ¹	10k Ω	600 Ω lines	-10 dBV ² (316 mV)	+6 dBV (1.995 V)	Phono jack (unbalanced)

1. Inputs feature linear 20-bit 128-times oversampling A/D converters.

2. Where dBV represents a specific voltage, 0 dBV is referenced to 1 V rms.

Analog Outputs

Connection	Actual source impedance	For use with nominal	Output level		Connector
			Nominal	Max. before clip	
OUT L, OUT R ¹	600 Ω	10k Ω lines	-10 dBV ² (316 mV)	+6 dBV (1.995 V)	Phono jack (unbalanced)

1. Outputs feature linear 20-bit 8-times oversampling D/A converters.

2. Where dBV represents a specific voltage, 0 dBV is referenced to 1 V rms.

Digital I/O

Connection	I/O	Format	Level	Connector
D IN	I	IEC60958 Consumer	0.5 V _{pp} , 75 Ω	Phono jack (unbalanced)
D OUT	O	IEC60958 Consumer	0.5 V _{pp} , 75 Ω	Phono jack (unbalanced)
IO-A, IO-B	I/O	4CH or 8CH digital audio inputs 4CH or 8CH digital audio outputs 32-bit max/channel Format depends on counterpart	5 V CMOS	20-pin connector
SERIAL IN	I	8CH or 16CH digital audio inputs 32-bit max/channel Format depends on counterpart	5 V CMOS	16-pin connector
SERIAL OUT	O	8CH or 16CH digital audio outputs 32-bit max/channel Format depends on counterpart	5 V CMOS	14-pin connector

Dimensions

