DSP Third Party Interface

Version 1.8

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QSC Audio Products, Inc.

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Introduction

This document specifies an interface between a QSC DSP device and a Host. The Host may be any device that can send and receive RS-232. The QSC devices supported by this document are:

- DSP-3
- DSP-30
- DSP-4

This interface specification describes:

1. How to physically connect to the DSP device
2. How to read the status of a QSC amplifier through the DSP device, if the DSP device is connected to a QSC amplifier using the QSC Dataport
3. How to query the status of the DSP device
4. How to control basic features of the DSP device

Physical Connection Specification

The physical connection between the host and DSP device is specified as:

- RS-232
  - 38400 baud
  - 1 start bit, 8 data bits, 1 stop bit, no parity
  - DSP device is wired as a standard 9-pin D-sub connection
- Host and DSP device are connected with a straight-through (non-null modem) cable
  - Host is DTE (Data Terminal Equipment)
  - DSP device is DCE (Data Circuit-terminating Equipment).
- Data is transmitted least significant bit first

Data Types

Format	Binary Form	Decimal Value Range
S2.21	SII.FFFFF FFFFFFFF FFFFFFFF	-4 to 3.999999762
7.1	IIIIIII.F 00000000 00000000	0 to 127.5
C7	CIIIIIII	0 to 127

S = sign bit
I = integer bit; bit to the left of the decimal point
F = fractional bit; bit to the right of the decimal point
C = bit used to indicate clipping

S2.21 format assumes the binary form *sii.f…f*, where *s* is the sign bit, *ii* is a 2-bit 2's complement integer, and *f…f* is a 21-bit 2's complement fraction. This format is a linear value (no units). Note that since there are 21 significant bits after the decimal point in this format, the accuracy is limited to $\pm 2^{-22}$, or about ±2.4E-7.

To convert from decimal to S2.21:
1. If necessary, first convert from dB to linear using the conversion $10^{(g/20)}$
2. Limit the value to the Decimal Value Range shown in the table above
3. Multiply by 2^{21}
4. Round the result to the nearest integer

Example 1: Convert 3.14159265359 to S2.21 format.
Round($3.14159265359 \cdot 2^{21}$) = 6588397 or 6487EDh [a]

Example 2: Convert –15 dB to S2.21 format.
Round($10^{(-15/20)} \cdot 2^{21}$) = 372932 or 05B0C4h

To convert from S2.21 to decimal:
1. Multiply the value by 2^{-21}
2. If necessary, convert to dB using the conversion $20 \cdot \log_{10}(g)$

Example 1: Convert 6487EDh from S2.21 format to decimal.
6487EDh $\cdot 2^{-21} = 3.141593$

Example 2: Convert 05B0C4h from S2.21 format to decimal decibels.
$20 \cdot \log_{10}(05B0C4h \cdot 2^{-21}) = -15$ dB

[a] The "h" suffix refers to a hexadecimal number.

7.1 format assumes the binary form *iiiiiii.f*, where *iiiiiii* is a 7-bit integer and *f* is a 1-bit fraction. These 8-bits are left-justified and zero-filled to 24 bits. This format is a measure of attenuation in dB referenced to full scale.

To convert from decimal to 7.1 format:
1. Limit the value to the Decimal Value Range shown in the table above
2. Multiply by 2^{17}

Example: Convert 22.5 dB to 7.1 format.
$22.5 \bullet 2^{17} = 2949120$ or 2D0000h

To convert from 7.1 format to decimal, multiply the value by 2^{-17}.

Example: Convert 2D0000h to decimal.
$2D0000h \bullet 2^{-17} = 22.5$

C7 format assumes the binary form *ciiiiiii*, where:

c is the clip bit and is set if a clip has occurred since the last meter request

iiiiiii is a 7-bit integer and is a measure of attenuation in dB referenced to full scale; i.e., 127 = -127 dBfs (minimum) and 0 = -0 dBfs (maximum)

To convert from C7 format to decimal:
1. Read the clip bit
2. Mask the clip bit
3. Negate the remaining 7 bits

Example 1: Convert 4Ah from C7 format to decimal.
4Ah = 01001010b ‡
Masking the clip bit leaves 1001010b, or 74
Negating results in –74 dBfs

Example 2: Convert 93h from C7 format to decimal.
93h = 10010011b
Masking the clip bit leaves 0010011b, or 19
Negating results in –19 dBfs, clipping detected

‡ The "b" suffix refers to a binary number.

Application Layer Specification

Requests are always initiated by the Host and responded to by the DSP device. The entire request/response sequence should be completed within 100 milliseconds, unless otherwise noted. If the DSP device does not respond in the specified amount of time, a fault may have occurred. *

DSP Response Description

All responses from the DSP will have a single byte prefix that contains the information about the length of the response and the clip/protect status of the amplifier to which it is connected. If the DSP is not connected to an amplifier using the QSC Dataport, the clip/protect information will be invalid.

The first four bits of this prefix byte is the length of the response minus 1. For example, if the response is 3 bytes long, then the first four bits of the response will be a 2. The length-1 will be denoted as *L*, and the clip/protect status bits will be denoted as *S*.

Prefix Byte							
L				S			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Length-1				Channel B Protect	Channel B Clip	Channel A Protect	Channel A Clip

The last four bits (S) of the prefix byte are the clip/protect status of the amplifier which is connected through the Dataport connection. These bit definitions are as follows:

Channel A/B Protect is set to 1 if the respective amplifier channel has had output protection enabled at any time between the current and previous responses. This bit is cleared after the response is sent to the Host.

Channel A/B Clip is set to 1 if the respective amplifier channel has clipped at any time between the current and previous responses. This bit is cleared after the response is sent to the Host.

* See the Failure Recovery section at the end of this document for details on recovering from a fault condition.

Get DSP ID Command

Get DSP ID Request requests the ID and firmware revision of the DSP device.

Byte 1	Byte 2	Byte 3
02h[a]	02h	02h

Get DSP ID Response implies that the DSP device is properly running and ready.

Prefix Byte	Manufacturer ID Byte	Model ID Byte	Major Revision Byte	Middle Revision Byte	Minor Revision Byte
5Sh	00-FFh	00-FFh	00-FFh	00-FFh	00-FFh

Manufacturer ID	Manufacturer
00h	(undefined)
01h	QSC Audio Products, Inc.

Model ID	Model
00h	(undefined)
01h	DSP-3
02h	FIR DSP-3
03h	DSP-30
04h	DSP-4

Example: Get DSP ID

Request—

```
02 02 02h
```

Response—

```
50 01 01 04 03 02h
```

- No amplifier clip or protect
- QSC Audio DSP-3 detected, firmware version 4.3.2

[a] The “h” suffix refers to a hexadecimal number.

Get Meters Command

Get Meters Request requests the meters from the DSP device. The meters must be defined in the active configuration; otherwise, the Meter Bytes of the response will be erroneous.

Byte 1	Byte 2	Byte 3
21h	01h	00-02h (see below)

Get Meters Response is a 6-byte response if Byte 3 is 0.

Prefix Byte	Command Byte	Meter 1 Byte	Meter 2 Byte	Output Meter 1 Byte	Output Meter 2 Byte
5Sh	01h	C7 †	C7	C7	C7

Get Meters Response is a 9-byte response if Byte 3 is 1. ‡

Prefix Byte	Command Byte	Meter 1 Byte	Meter 2 Byte	Meter 3 Byte	Meter 4 Byte	Meter 5 Byte	Output Meter 1 Byte	Output Meter 2 Byte
8Sh	01h	C7 †	C7	C7	C7	C7	C7	C7

Get Meters Response is a 12-byte response if Byte 3 is 2. ‡

Prefix Byte	Command Byte	Meter 1 Byte	Meter 2 Byte	Meter 3 Byte	Meter 4 Byte	Meter 5 Byte	Meter 6 Byte	Meter 7 Byte	Meter 8 Byte	Output Meter 1 Byte	Output Meter 2 Byte
BSh	01h	C7 †	C7	C7	C7	C7	C7	C7	C7	C7	C7

Example: Get Four Meters

Request—

```
21 01 00h
```

Response—

```
50 01 0F 12 15 8Ch
```

- No amplifier clip or protect
- Meter 1 = -15 dBfs, Meter 2 = -18 dBfs, Meter 3 = -21 dBfs
- Meter 4 = -12 dBfs, clipping detected

† See the Data Types section for an explanation of the C7 format.
‡ This response is only valid for DSP firmware version 3.x.x and above.

Set/Get Register Commands

The Set/Get Register Commands are used to read write registers that control input/output level and sensitivity settings. The state of the external contact closure can also be read.

Index	Register
00h	Input Gain A
01h	Input Gain B
F8h	Analog Input Sensitivity
F9h	Analog Output Gain
FAh	Output Attenuation A
FBh	Output Attenuation B
FCh	Contact Closure (read-only)

- **Input Gain A and Input Gain B Registers** are S2.21 numbers that specify the input gain. †

- **Analog Input Sensitivity** is a 24-bit register that controls the input sensitivity before the A/D converters. Note: an "X" in the table means "don't care".

Sensitivity	Analog Input Sensitivity (binary)
1.5 Vrms	xxxxxxxxxxxxxxxxxxxx01xx
4 Vrms	xxxxxxxxxxxxxxxxxxxx00xx
9 Vrms	xxxxxxxxxxxxxxxxxxxx11xx
18 Vrms	xxxxxxxxxxxxxxxxxxxx10xx

- **Analog Output Gain** is a 24-bit register that controls the output gain after the D/A converters. The 6 Vrms/4 Vrms levels apply to the "daisy chain" outputs and not the Dataport outputs, while the Mute setting applies to both.

Level	Analog Output Gain (binary)
6 Vrms	xxxxxxxxxxxxxxxxxx0xxxx0
4 Vrms	xxxxxxxxxxxxxxxxxx0xxxx1
Mute	xxxxxxxxxxxxxxxxxx1xxxxx

- **Output Attenuation A and B** are 7.1 registers that specify the output attenuation in dB. †

- **Contact Closure** is a 24-bit read-only register that returns the state of the external contact closure. A value of zero means the switch is open; a non-zero value means the switch is closed.

† See the Data Types section for an explanation of the S2.21 and 7.1 formats.

Set Register Request writes Data to the register specified by the Index byte.

Prefix Byte	Command Byte	Index Byte	24-bit data, MSB first
51h	02h	00-01h,F8-FCh	000000h – FFFFFFh

Set Register Response announces the successful completion of the Set Data Register Request. The data is echoed for verification.

Prefix Byte	Command Byte	Index Byte	24-bit data, MSB first
5Sh	02h	00-01h,F8-FCh	000000h – FFFFFFh

Example 1: Set Input Gain A to –6 dB

Request—

```
51 02 00 10 09 BAh
```

- Write to register 00h (Input Gain A)
- Data value = Round($10^{(-6/20)} \cdot 2^{21}$) = 1051066 or 1009BAh

Response—

```
5A 02 00 10 09 BAh
```

- Both amplifier channels are in protection

Example 2: Set Output Attenuation A to –12 dB

Request—

```
51 02 FA 18 00 00h
```

- Write to register FAh (Output Attenuation A)
- Data value = $12 \cdot 2^{17}$ = 1572864 or 180000h

Response—

```
50 02 FA 18 00 00h
```

- No amplifier clip or protect

Get Register Request requests the data in the register specified by the Index byte.

Prefix Byte	Command Byte	Index Byte
21h	03h	00-01h,F8-FCh

Get Register Response returns the data in the register specified by the Index byte.

Prefix Byte	Command Byte	Index Byte	24-bit data, MSB first
5Sh	03	00-01h,F8-FCh	000000h – FFFFFFh

Example: Get State of Contact Closure

Request—

```
21 03 FCh
```

- Read from register FCh (Contact Closure)

Response—

```
50 03 FC 00 00 00h
```

- No amplifier clip or protect
- Contact Closure is open

Example: Muting and Unmuting the DSP

To Mute:

Get Output Attenuation A—

```
21 03 FAh
```

Response—

```
50 03 FA aa 00 00h
```

- "aa" is the 7.1 formatted attenuation value

Get Output Attenuation B—

```
21 03 FBh
```

Response—

```
50 03 FB bb 00 00h
```

- "bb" is the 7.1 formatted attenuation value

Set Output Attenuation A to mute—

```
51 02 FA FF 00 00h
```

Response—

```
50 02 FA FF 00 00h
```

Set Output Attenuation B to mute—

```
51 02 FB FF 00 00h
```

Response—

```
50 02 FB FF 00 00h
```

To Unmute:

Set Output Attenuation A to "aa"—

```
51 02 FA aa 00 00h
```

- "aa" is the 7.1 formatted attenuation value that was received

Response—

```
50 02 FA aa 00 00h
```

Set Output Attenuation B to "bb"—

```
51 02 FA bb 00 00h
```

- "bb" is the 7.1 formatted attenuation value that was received

Response—

```
50 02 FA bb 00 00h
```

Save Preset Command

Save Preset Request saves the active configuration to the specified preset in non-volatile memory and saves the preset number as the power-on default.

Transport Byte	Command Byte	Preset Byte
21h	06h	01-08h

Save Preset Response announces the success of the Save Preset Request. It will take between 250 milliseconds and 1.2 seconds to receive this response.

Transport Byte	Command Byte	Preset Byte
2Sh	06h	Preset

Example: Save Active Configuration to Preset #4

Request—

```
21 06 04h
```

Response—

```
20 06 04h
```

Restore Preset Command

Restore Preset Request restores a preset from non-volatile memory.

Transport Byte	Command Byte	Preset Byte
21h	07h	01-08h

Restore Preset Response announces the success of the Restore Preset Request.

Transport Byte	Command Byte	Preset Byte
2Sh	07h	Preset

Example: Restore Preset #2 to Active Configuration

Request—

```
21 07 02h
```

Response—

```
20 07 02h
```

Set Power-Up Preset Command

This Command is only valid for firmware versions less than 5.x.x.

Set Power-Up Preset Request specifies which preset will be active upon next power-up.

Transport	Command	Preset
21h	08h	01-08h

Set Power-Up Preset Response announces the success of the Set Power-Up Preset Request.

Transport	Command	Preset
2Sh	08h	Preset

Example: Make preset #2 the power-up preset

Request—

```
21 08 02h
```

Response—

```
20 08 02h
```

G*et Power-Up Preset Command*

This Command is only valid for firmware versions less than 5.x.x.

Get Power-Up Preset Request requests the power-up preset stored in non-volatile memory.

Transport	Command	Don't Care
21h	09h	00-FFh

Get Power-Up Preset Response returns the power-up preset stored in non-volatile memory.

Transport	Command	Preset
2Sh	09h	Preset

Example: Request the power-up preset

Request—

```
21 09 00h
```

Response—

```
20 09 02h
```

The power-up preset is #2

Get Status Command

This command is only valid for firmware version 5.1.0 and greater.

Get Status Request requests the switched preset numbers and status from non-volatile memory.

Transport Byte	Command Byte	Don't Care Byte
21h	0Fh	00-FFh

Get Status Response returns the switched preset numbers and status from non-volatile memory. If preset switching is disabled, the Enable bit will be 0; if enabled, 1.

Transport Byte	Command Byte	Unused 7-bits	Enable Switch Bit	Active Preset Byte	Open Preset Byte	Closed Preset Byte
5Sh	0Fh	xxxxxxxb	0-1b	01-08h	01-08h	01-08h

Example: Get the Active and Switched Preset Numbers

Request—

```
21 0F 00h
```

Response—

```
50 0F 01 03 03 04h
```

- Preset switching is enabled
- Preset #3 is the Active Preset
- Preset #3 is the Preset when the switch is open
- Preset #4 is the Preset when the switch is closed

Failure Recovery

If the DSP device fails to respond after repeated requests, the following attempts may be made to restore communications:

Communications Reset-- Send the one-byte message 02h to the DSP and wait a minimum of 500 msec. This action will reset the internal communications of the DSP and will not interrupt audio processing.

Firmware Reset should only be used after all other attempts to restore communications have failed. This action will interrupt audio processing for about one second. This forced reset may be accomplished by the following command sequence:

91 0A 55 0F F0 3C C3 5A A5 00 00 02 00 00 00 0A F0 80 FF 00 28h