YAMAHA

CONFIDENTIAL

IIR Filter Coefficient Calculation Tool
dd-1iirdgn
Manual

Version 1.05.00

Jun. 13, 2012

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List of Contents

1 General Description

The dd-1iirdgn is a command-line tool that calculates coefficients of the typical IIR filter, which can be used for creating coefficient data of YDA155/YDA156/YDA174/YSS951/YSS952 (DD-1/DD-1SP/DD-2SP/SPR-1/SPR-2) firmware. The result of the calculation is output in 2's complement fixed-point format (used by YDA155/YDA156/YDA174/YSS951/YSS952 (DD-1/DD-1SP/DD-2SP/SPR-1/SPR-2)). For details of the format, see the "YDA155/YDA156 Application Manual" or "YDA174 Application Manual" or "YSS951 Application Manual" or "YSS952 Application Manual".

- Supported filters:
  Filters up to 2nd-order: low pass, high pass, band pass, band eliminate, peak/dip, low shelving, or high shelving filter.
- Recommended Operating Environment:
  Windows XP SP3 32bit Japanese, English Versions
  Windows 7 32bit/64bit Japanese, English Versions

2 Install and Uninstall Methods

1) Install Method

Copy the "dd-1iirdgn.exe" into an appropriate folder.
Registry update, file association, etc. are not performed.

2) Uninstall Method

Delete "dd-1iirdgn.exe" file.

3 Usage

3.1 Command-line Syntax

prompt>dd-1iirdgn -t<type of filter> [-options]

-t<type of filter>	Specifies the type of a filter.	
	0: 1st-order through	1: 1st-order low pass
	2: 1st-order high pass	3: 1st-order low shelving
	4: 1st-order high shelving	
	10: 2nd-order through	11: 2nd-order low pass
	12: 2nd-order high pass	13: 2nd-order band pass
	14: 2nd-order band eliminate	15: 2nd-order peak/dip
	16: 2nd-order low shelving	17: 2nd-order high shelving

options:

-s<sampling frequency>	Specifies a sampling frequency in Hz (integer value). When this option is not specified, it is regarded as 48000[Hz].
-f<filter frequency>	Specifies a filter frequency in Hz (positive real number). The half of the frequency set in the above option -s, or lower frequency should be specified. When this option is not specified, it is regarded as 1000[Hz].
-q<Q>	Specifies quality factor Q (real number). With 1st-order filter, this option cannot be used. When this option is not specified, it is regarded as 0.7071(1/√2).
-g<gain>	Specifies a gain of peak/dip, high pass, low pass, or shelving filter in dB (real number). With the other filter than above, this option cannot be used. When this option is not specified, it is regarded as 0[dB].
-o<scale>	Specifies a scaling value in real number (1.0 or less). A filter coefficient multiplied by this value is output as a result of calculation. For fixed-point format for SDSP 24bit/47bit 2's complement output format, this option is not specified. When this option is not specified, it is regarded as 1.0.
-x<type of format>	Specifies an output format. 0: 16-bit 2’s complement fixed-point format for MDSP(2) 1: 28-bit 2’s complement fixed-point format for MDSP(2) 2: 24-bit 2’s complement fixed-point format for SDSP 3: 47-bit 2’s complement fixed-point format for SDSP When this option is not specified, it is regarded as 16-bit 2’s complement fixed-point format for MDSP(2).
-b	A 1st-order filter characteristic is realized by a 2nd-order filter. When specifying 1st-order low pass, 1st-order high pass, 1st-order shelving filter as the filter type, this option can be specified.
-c	Adds a comment to the result of calculation.
-h	Displays the usage.

［Notes］

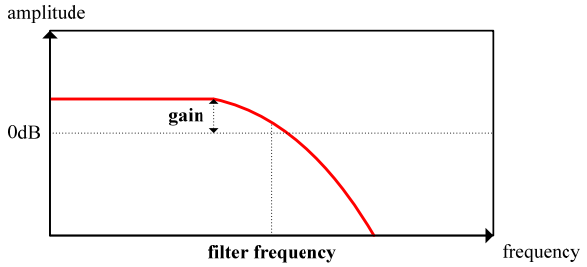
- < > indicates the content must be input. And, [ ] indicates the content can be omitted.
- In both -t0 (1st-order through) and -t10 (2nd-order through), a coefficient with “filter output = filter input” is calculated.
- In both -t0 (1st-order through) and -t10 (2nd-order through), -s, -f, -q, –g and –b options cannot be specified.
- For a comment to added to –c option, see “3.4 Execution Output”.
- The order to assign the arguments (-t and options) is arbitrary.
- When only “dd-1iirdgn” is input, its usage is displayed. (It corresponds to -h option.).

3.2 Return Value

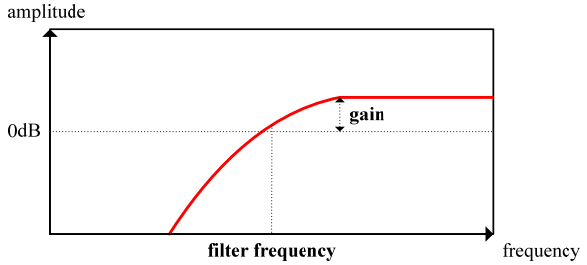
When it successfully terminated, 0 is returned. Otherwise, 1 is returned.

3.3 Filter Type

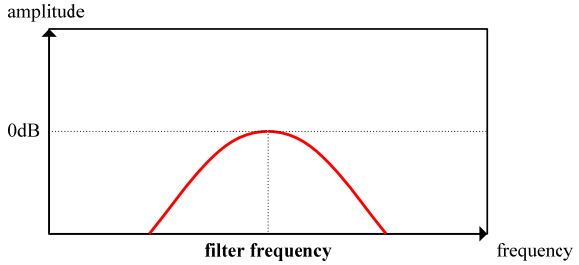
3.3.1 low pass



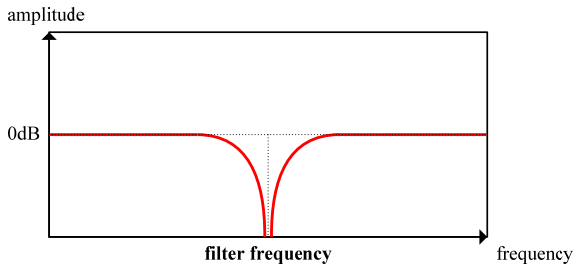
3.3.2 high pass



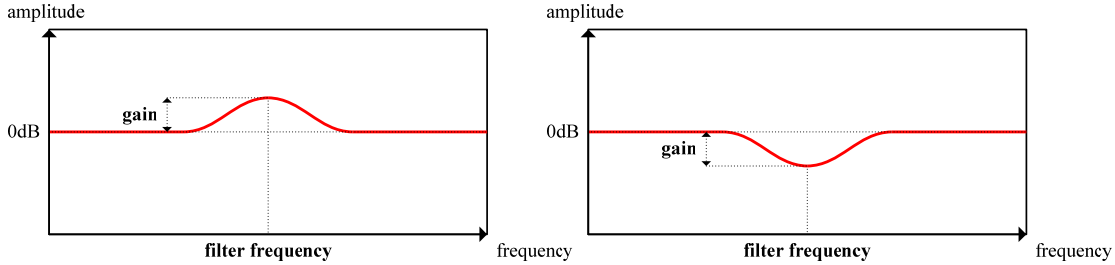
3.3.3 band pass



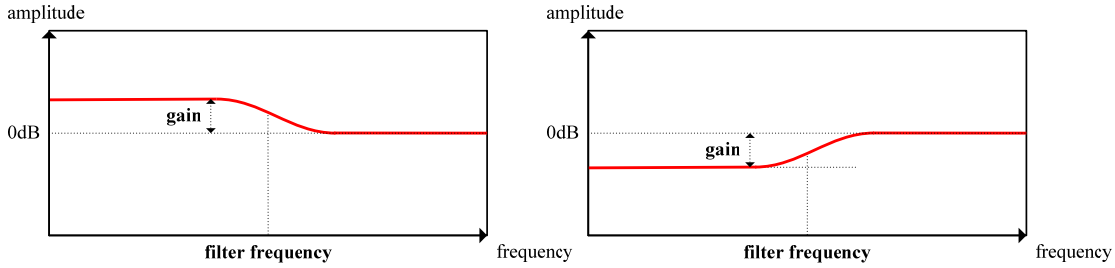
3.3.4 band eliminate



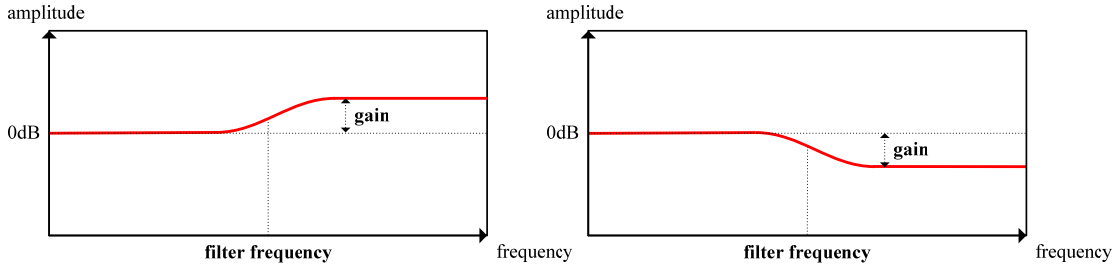
3.3.5 peak/dip



3.3.6 low shelving



3.3.7 high shelving

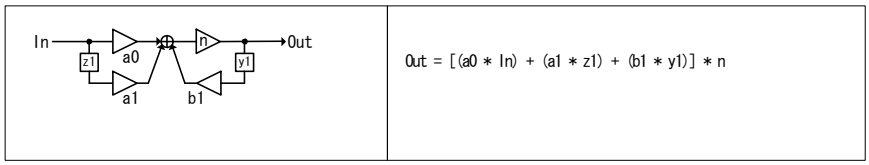


3.4 Execution Output

3.4.1 1st-order Filter

3.4.1-1 Data Output in 16-bit 2's Complement Fixed-point Format for MDSP(2)

Coefficients of a0, a1, and b1 are output in 16-bit 2's complement fixed-point format for MDSP(2), one line by one line in this order. When a value other than 1.0 is specified as a scaling value (scale) by -o option, the above coefficient multiplied by the scaling value is output as a result. In this case, scaling (× 1/scale) should be performed again by gain "n" shown in the flow.
When -c option is specified, filter coefficients in real number format, relevant arguments, and error messages are added as comments.



e.g.:

```
C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x0
0207
0207
3BF2

C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x0 -c
0207              // a0=+0.0316772461 "-t1 -s48000 -f500 -g0.00 -o0.5000 -x0"
0207              // a1=+0.0316772461
3BF2              // b1=+0.9366455078

C:\>dd-1iirdgn -t1 -s48000 -f500 -g40.0  -o0.5 -x0 -c
????              // a0=+3.1698608398 "-t1 -s48000 -f500 -g40.00 -o0.5000 -x0" [Error] Overflowed.
????              // a1=+3.1698608398 [Error] Overflowed.
3BE8              // b1=+0.9360351563
[Error]
```

[Note]

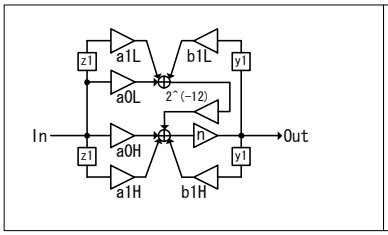
- The data that cannot be output is displayed as "????".

3.4.1-2 Data Output in 28-bit 2's Complement Fixed-point Format for MDSP(2)

Coefficients of a0H, a0L, a1H, a1L, b1H, and b1L are output in 28-bit 2's complement fixed-point format for MDSP(2), one line by one line in this order.

When a value other than 1.0 is specified as a scaling value (scale) by -o option, the above coefficient multiplied by the scaling value is output as a result. In this case, scaling (× 1/scale) should be performed again by gain "n" shown in the flow.

When -c option is specified, filter coefficients in real number format, relevant arguments, and error messages are added as comments.




```
Out = [((a0H * In) + (a1H * z1) + (b1H * y1)) +
       ((a0L * In) + (a1L * z1) + (b1L * y1)) * 2^(-12)] * n
```

e.g.:

```
C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x1
0207
05AD
0207
05AD
3BF1
04A6

C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x1 -c
0207            // a0=+0.0316988960 "-t1 -s48000 -f500 -g0.00 -o0.5000 -x1"
05AD
0207            // a1=+0.0316988960
05AD
3BF1             // b1=+0.9366022080
04A6

C:\>dd-1iirdgn -t1 -s48000 -f500 -g40.0 -o0.5 -x1 -c
????            // a0=+3.1698896004 "-t1 -s48000 -f500 -g40.00 -o0.5000 -x1" [Error] Overflowed.
????
????            // a1=+3.1698896004 [Error] Overflowed.
????
3BF1             // b1=+0.9366022080
04A6
[Error]
```

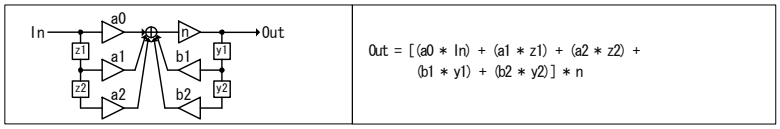
[Note]

- The data that cannot be output is displayed as "????".

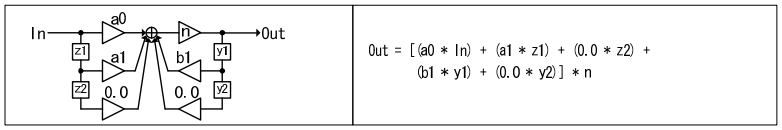
3.4.2 2nd-order Filter

3.4.2-1 Data Output in 16-bit 2's Complement Fixed-point Format for MDSP(2)

Coefficients for the 2nd-order filters (single precision) of MDSP(2) is output.
Generally (When -b option is not specified), coefficients of a0, a1, a2, b1, and b2 are output in the specified format, one line by one line in this order.



When -b option is specified, coefficients that a 1st-order filter characteristic is realized is output. coefficients of a0, a1, zero, b1, and zero are output in the specified format, one line by one line in this order.



When a value other than 1.0 is specified as a scaling value (scale) by -o option, the above coefficient multiplied by the scaling value is output as a result. In this case, scaling (× 1/scale) should be performed again by gain "n" shown in the flow.
When -c option is specified, filter coefficients in real number format, relevant arguments, and warning messages are added as comments.

e.g.: Generally (When -b option is not specified)

```
C:\>dd-1iirdgn -t15 -s48000 -f5000 -g-3.0 -o0.5 -x0
38EF
C0D9
16AB
3F27
F066

C:\>dd-1iirdgn -t15 -s48000 -f5000 -g-3.0 -o0.5 -x0 -c
38EF            // a0=+0.8895874023 "-t15 -s48000 -f5000 -q0.7071 -g-3.00 -o0.5000 -x0"
C0D9            // a1=-0.9867553711
16AB            // a2=+0.3541870117
3F27            // b1=+0.9867553711
F066            // b2=-0.2437744141

C:\>dd-1iirdgn -t15 -s48000 -f5000 -g20.0 -o0.5 -x0 -c
????            // a0=+3.7083129883 "-t15 -s48000 -f5000 -q0.7071 -g20.00 -o0.5000 -x0" [Error] Overflowed.
B902            // a1=-1.1092529297
????            // a2=-2.3101806641 [Error] Overflowed.
46FE            // b1=+1.1092529297
E685            // b2=-0.3981323242
[Error]
```

e.g.: When -b option is specified

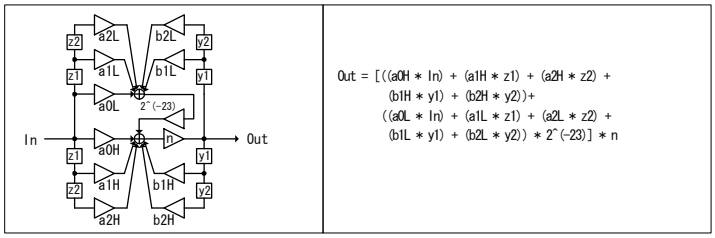
```
C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x0 -b
0207
0207
0000
3BF2
0000

C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x0 -b -c
0207       // a0=+0.0316772461 "-t1 -s48000 -f500 -g0.00 -o0.5000 -x0 -b"
0207       // a1=+0.0316772461
0000
3BF2       // b1=+0.9366455078
0000

C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -g40.0 -x0 -b -c
????       // a0=+3.1698608398 "-t1 -s48000 -f500 -g40.00 -o0.5000 -x0 -b" [Error] Overflowed.
????       // a1=+3.1698608398 [Error] Overflowed.
0000
3BE8       // b1=+0.9360351563
0000
[Error]
```

[Note]

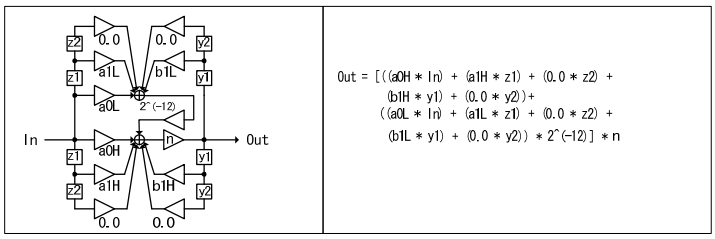
- The data that cannot be output is displayed as “????” .

3.4.2-2 Data Output in 28-bit 2's Complement Fixed-point Format for MDSP(2)

Coefficients for the 2nd-order filters (double precision) of MDSP(2) is output.
Generally (When -b option is not specified), coefficients of a0H, a0L, a1H, a1L, a2H, a2L, b1H, b1L, b2H, and b2L are output in 28-bit 2's complement fixed-point format for MDSP(2), one line by one line in this order.



When -b option is specified, coefficients that a 1st-order filter characteristic is realized is output. coefficients of a0H, a0L, a1H, a1L, zero, zero, b1H、b1L, zero, zero are output in the specified format, one line by one line in this order.



When a value other than 1.0 is specified as a scaling value (scale) by -o option, the above coefficient multiplied by the scaling value is output as a result. In this case, scaling (× 1/scale) should be performed again by gain "n" shown in the flow.
When -c option is specified, filter coefficients in real number format, relevant arguments, and warning messages are added as comments.

e.g.: Generally (When -b option is not specified)

```
C:\>dd-1iirdgn -t15 -s48000 -f5000 -g-3.0 -o0.5 -x1
38EE
0AA9
C0D9
05C5
16AA
0EFD
3F26
0A3B
F066
065A

C:\>dd-1iirdgn -t15 -s48000 -f5000 -g-3.0 -o0.5 -x1 -c
38EE            // a0=+0.8895670256 "-t15 -s48000 -f5000 -q0.7071 -g-3.00 -o0.5000 -x1"
0AA9
C0D9             // a1=-0.9867333578
05C5
16AA             // a2=+0.3541831519
0EFD
3F26            // b1=+0.9867333578
0A3B
F066            // b2=-0.2437501775
065A
```

```
C:\>dd-1iirdgn -t15 -s48000 -f5000 -g20.0 -o0.5 -x1 -c
????            // a0=+3.7083146774 "-t15 -s48000 -f5000 -q0.7071 -g20.00 -o0.5000 -x1" [Error] Overflowed.
????
B902            // a1=-1.1092287926
0654
????            // a2=-2.3101623834 [Error] Overflowed.
????
46FD            // b1=+1.1092287926
09AC
E684             // b2=-0.3981522939
0AC4
[Error]
```

e.g.: When -b option is specified

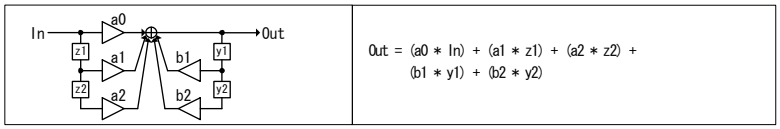
```
C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x1 -b
0207
05AD
0207
05AD
0000
0000
3BF1
04A6
0000
0000

C:\>dd-1iirdgn -t1 -s48000 -f500 -o0.5 -x1 -b -c
0207      // a0=+0.0316988960 "-t1 -s48000 -f500 -g0.00 -o0.5000 -x1 -b"
05AD
0207      // a1=+0.0316988960
05AD
0000
0000
3BF1      // b1=+0.9366022080
04A6
0000
0000

C:\>dd-1iirdgn -t1 -s48000 -f500 -g40.0 -o0.5 -x1 -b -c
????      // a0=+3.1698896004 "-t1 -s48000 -f500 -g40.00 -o0.5000 -x1 -b" [Error] Overflowed.
????
????      // a1=+3.1698896004 [Error] Overflowed.
????
0000
0000
3BF1      // b1=+0.9366022080
04A6
0000
0000
[Error]
```

[Note]

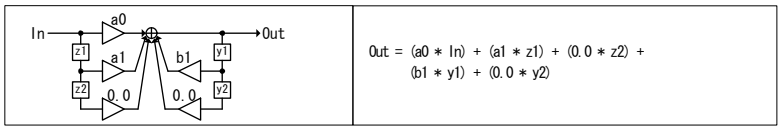
- The data that cannot be output is displayed as “????”.

3.4.2-3 Data Output in 24-bit 2's Complement Fixed-point Format for SDSP

Coefficients for the single precision filters of SDSP 10-band PEQ is output.
Generally (When -b option is not specified), coefficients of a0, a1, a2, b1,and b2 are output in 24-bit 2's complement fixed-point format for SDSP, one line by one line in this order.



When -b option is specified, coefficients that a 1st-order filter characteristic is realized is output. coefficients of a0, a1, zero, b1, and zero are output in 24-bit 2's complement fixed-point format for SDSP, one line by one line in this order.



When -c option is specified, filter coefficients in real number format, relevant arguments, and error messages are added as comments.

e.g.: Generally (When -b option is not specified)

```
C:\>dd-1iirdgn -t15 -s48000 -f100 -g-2.0 -q2.5 –x2
1FFA77
C03738
1FCFB7
3FC8C8
E035D2

C:\>dd-1iirdgn -t15 -s48000 -f100 -g-2.0 -q2.5 –x2 -c
1FFA77                  // a0=+0.9993243809 "-t15 -s48000 -f100 -q2.5000 -g-2.00 –x2
C03738                  // a1=-1.9932593410
1FCFB7                  // a2=+0.9941057421
3FC8C8                  // b1=+1.9932593410
E035D2                  // b2=-0.9934301230

C:\>dd-1iirdgn -t15 -s48000 -f300 -g50.0 -q1.4 –x2 –c
??????                  // a0=+5.3588064563 "-t15 -s48000 -f300 -q1.4000 -g50.00 –x2" [Error] Overflowed.
C0EF02                  // a1=-1.9708244282
93A21C                  // a2=-3.3864614215
3F10FE                  // b1=+1.9708244282
E0E28D                  // b2=-0.9723450348
[Error]
```

e.g.: When -b option is specified

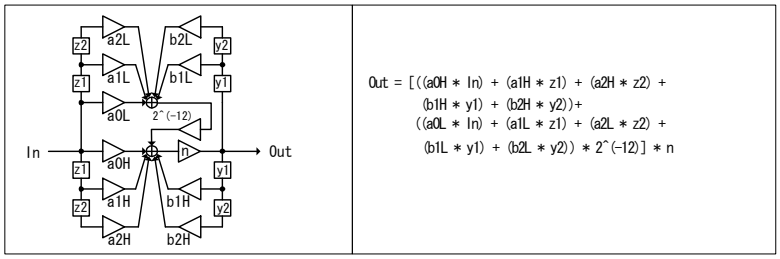
```
c:\>dd-1iirdgn -t1 -s48000 -f500 –x2 -b
0103AD
0103AD
000000
1DF8A5
000000

c:\>dd-1iirdgn -t1 -s48000 -f500 –x2 –b -c
0103AD          // a0=+0.0316988960 "-t1 -s48000 -f500 –g0.00 -x2 -b"
0103AD          // a1=+0.0316988960
000000
1DF8A5          // b1=+0.9366022080
000000
```

[Note]

- The data that cannot be output is displayed as “????” .

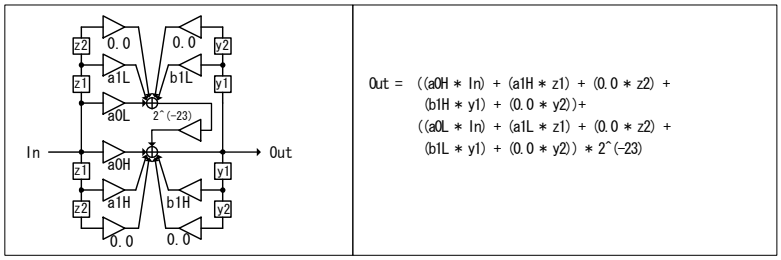
3.4.2-4 Data Output in 47-bit 2's Complement Fixed-point Format for SDSP

Coefficients for the double precision filters of SDSP 10-band PEQ is output.
Generally (When -b option is not specified), coefficients of a0H, a1H, a2H, b1H, b2H, a0L, a1L, a2L, b1L, and b2L are output in 47-bit 2's complement fixed-point format for SDSP, one line by one line in this order.



Out = [((a0H * In) + (a1H * z1) + (a2H * z2) +
(b1H * y1) + (b2H * y2))+
((a0L * In) + (a1L * z1) + (a2L * z2) +
(b1L * y1) + (b2L * y2)) * 2^(-12)] * n

When -b option is specified, coefficients of a0H, a1H, zero, b1H, zero, a0L, a1L, zero, b1L and zero are output in 47-bit 2's complement fixed-point format for 10-band PEQ of SDSP, one line by one line in this order.



Out = ((a0H * In) + (a1H * z1) + (0.0 * z2) +
(b1H * y1) + (0.0 * y2))+
((a0L * In) + (a1L * z1) + (0.0 * z2) +
(b1L * y1) + (0.0 * y2)) * 2^(-23)

When -c option is specified, filter coefficients in real number format, relevant arguments, and warning messages are added as comments.

e.g.: Generally (When -b option is not specified)

```
C:\>dd-1iirdgn -t15 -s48000 -f100 -g-2.0 -q2.5 –x3
1FFA77
C03738
1FCFB6
3FC8C7
E035D2
0FE0C5
17E0E2
6C2FA8
681F1E
03EF93

C:\>dd-1iirdgn -t15 -s48000 -f100 -g-2.0 -q2.5 –x3 -c
1FFA77                  // a0=+0.9993243809 "-t15 -s48000 -f100 -q2.5000 -g-2.00 –x3"
C03738                  // a1=-1.9932593410
1FCFB6                  // a2=+0.9941057421
3FC8C7                  // b1=+1.9932593410
E035D2                  // b2=-0.9934301230
0FE0C5
17E0E2
6C2FA8
681F1E
03EF93
```

```
C:\>dd-1iirdgn -t15 -s48000 -f300 -g50.0 -q1.4 –x3 –c
??????                    // a0=+5.3588064563 “-t15 -s48000 -f300 -q1.4000 -g50.00 –x3” [Error] Overflowed.
C0EF01                    // a1=-1.9708244282
93A21B                    // a2=-3.3864614215
3F10FE                    // b1=+1.9708244282
E0E28C                    // b2=-0.9723450348
??????
4DEA85
5416E9
32157B
553497
[Error]
```

e.g.: When -b option is specified

```
c:\>dd-1iirdgn -t1 -s48000 -f500 –x3 -b
0103AD
0103AD
000000
1DF8A5
000000
339A80
339A80
000000
18CAFF
000000

c:\>dd-1iirdgn -t1 -s48000 -f500 –x3 –b -c
0103AD          // a0=+0.0316988960 "-t1 -s48000 -f500 –g0.00 –x3 -b"
0103AD          // a1=+0.0316988960
000000
1DF8A5          // b1=+0.9366022080
000000
339A80
339A80
000000
18CAFF
000000
```

[Note]

- The data that cannot be output is displayed as “??????”.

4 Error Message

1) Possible messages when converting a filter coefficient into 2's complement fixed-point format:

Message	Description
[Error] Overflowed.	Output data exceeded the maximum value that can be converted.

2) Other Messages

Message	Description
xxx : Illegal option parameter.	A numeric expression of argument is wrong. Or, a filter frequency is too large.
xxx : Wrong syntax.	Argument is not specified correctly.
xxx : No such option.	Argument outside the range was specified.