DCD-24
Word Clock Distributor

Owner's manual
Version 1.00
October 2018

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1. Introduction

Congratulations on purchasing the DCD-24 Word Clock Distributor. The DCD-24 is designed to distribute and generate extremely low-jitter Word Clock.

The DCD-24 can generate any standard rate, up to 192KHz, with any of the pull coefficients. It can also generate non standard rates using the VSO.

The DCD-24 can be used as a stand-alone master clock generator or genlocked to an external reference. As with the DCD-8, the generated frequency does not need to be a multiple of the reference frequency. For example, the DCD-24 can generate 44.1KHz referenced to a 96KHz source.

2. Installation

2.1. UNPACKING

When unpacking the DCD-24 the following items should be in the shipping carton:

- DCD-24 unit
- Universal Power Supply (12VDC @ 16w)
- IEC power cable
- Owner's Manual & Registration card

2.2. INSTALLING THE DCD-24

The DCD-24 is designed to be mounted in a standard 19" rack. It requires 1U in height. Ideally, it should be located near your AD/DA and in the same rack.

Usual precautions should be respected when wiring the DCD-24: use high quality cables with good shield to guarantee a good signal transmission. Keep your cables as short as possible.

Devices connected to the DCD-24's WC outputs need to be terminated. If no termination is provided on the device, use a BNC-T with a 75Ω termination. If multiple devices are connected to a single DCD-24 WC output, only the last device in the chain should be terminated. However, to preserve the integrity of the transmission line, it is recommended that you do not daisy-chain word clock outputs as it can significantly degrade signal quality.

3. I/O's Description and Cable Requirements

3.1 POWER

The DCD-24 requires 12VDC @ 18W. Acceptable range is 12VDC +/-15%.

The external supply provided with the DCD-24 accepts 100 to 240 VAC input at 50 - 60 Hz so it is suitable for use anywhere in the world.

Optionally, a second power supply can be connected to Power Input B for redundancy. To order a second power supply contact your dealer.

☛ Insert the 4 pin plug into the rear panel jack and secure by screwing the ring. Plug the supply into the wall using the standard IEC cable supplied.

3.2 ETHERNET

The Ethernet port is used to connect the DCD-24 via TCP/IP protocol to access the unit remotely and to upload firmware from any computer on the network.

Connector: RJ45 jack

☛ Use a standard Ethernet cat5 cable with RJ45 plugs.

3.3 UNIVERSAL REFERENCE INPUT & TERMINATION SWITCH

Input accepts WC, AES (AES-3id unbalanced), 10MHz and HD and SD video sync (see Appendix 1 for a list of supported video formats).

The switch enables 75Ω termination

Connector: BNC

☛ Use a standard 75Ω BNC cable.

3.4 WORD CLOCK OUTPUTS 1-24

24 BNC Connectors

When connecting the outputs keep in mind that 9-12 have a multiplier/divider.

☛ Use a standard 75Ω BNC Cable.

4. Quick Start

You should read this manual in its entirety to familiarize yourself with the DCD-24 features and its modes of operation. The following simple steps are only provided to get you started right away.

Connect the power supply provided with the DCD-24 to the Power A connector on the rear panel and plug the IEC cable into a wall outlet. Then tap the front panel power switch to turn on your unit (there will be a small delay, approximately 4-5 seconds, before the front panel actually turns on).

Out of the box, the DCD-24 is set to generate a 48KHz Word Clock, referenced to its internal crystal. This rate is fed to all WC outputs.

4.1. GENERATING A DIFFERENT RATE

To change the rate:

- Press the [SET UP] key (SET UP led lights up; INT led starts flashing)
- Press the [RIGHT] key once to move to the Rate menu (48K LED starts flashing)
- Press the [UP] or [DOWN] keys to select the desired rate
- Press the [SET UP] key again to exit SET UP (Set Up LED goes out)

Your change is reflected in the output rate LED column.

4.2. DISTRIBUTING AN EXTERNAL WORD CLOCK

To distribute and external Word Clock:

- Press the [SET UP] key (the SET UP led lights up; the selected rate led starts flashing)
- Press the [LEFT] navigation key to move to the Reference menu (INT led starts flashing)
- Press the [DOWN] navigation key once to select EXT

- Press the [RIGHT] navigation key once to go to the external reference menu
- Select WC
- Press the [RIGHT] key to move to the OUTPUT WC RATE
- Select FOLLOW INPUT
- Press the [SET UP] key again to exit SET UP (SET UP led goes out)

5. Front Panel Displays & LED's

5.1. 6 DIGIT DISPLAY

The 6 digit display has several functions:

- Generated frequency (output frequency in Hz)
- Reference frequency (input frequency in Hz)
- VSO amount (Cents)
- Output termination (values in Ohms)
- IP address
- Name, version & serial number

The functions of the display change depending on the mode of operation:

Normal Use:
- The generated frequency (output) is normally displayed.
- To view the input frequency (reference), press and hold the [VIEW] key.

SET UP Mode:
- In SET UP mode, the display remains unchanged, except while adjusting the VSO (VSO ADJUST) it indicates the amount of VSO in Cents.
- To view the output termination, press and hold the [VIEW] key. To view another output, use the [UP] or [DOWN] key while still holding the [VIEW] key.

The display has 2 other special functions:

IP Address:
To view the IP address, press and hold the [SET UP] key.
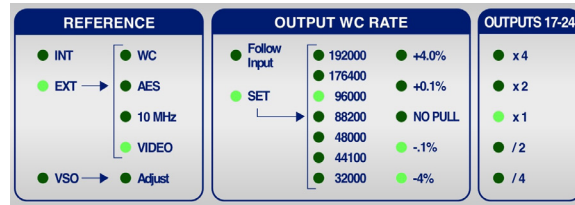
Start Up Banner:
When the unit is powered up, the display shows the following three banners, each lasting approx 2 sec:

    "DCD-24" –   name
    "1.00" –   version
    "1234" –   serial number

The banner can be cancelled by hitting any switch.

5.2. PARAMETERS LED'S

The 3 groups of LED's left of the display indicate parameters:

- REFERENCE

The first column of led's indicates the selected reference:
- Internal
- External
- VSO

If External has been selected, the second column of led's indicates which external, out of four choices:
- WC
- AES (AES-3id unbalanced)
- 10Mhz (GPS or Rubidium Clock)
- Video Sync (SD & HD).

If VSO has been selected, the second column has an ADJUST led indicating you are currently adjusting the amount of VSO.

- OUTPUT WC RATE

Two different options are available:
- FOLLOW INPUT
- SET

The first column of LED's indicates the option currently selected. FOLLOW INPUT is only available when the reference is WC or AES.

With SET selected, the next two columns indicate the rate selected and the pull coefficient(s). All standard rates are available and standard 'pull' coefficients. These coefficients can be combined to create +4.27% and -4.096%.

- OUTPUTS 17-24

Multipliers (and dividers) are available for outputs 17-24. This means that, if the output rate is set to 48K and x4 is selected, the frequency on outputs 17-24 will be 192K. Note that only the main frequency (48K in this case) will be shown on the display.

5.3. STATUS LED'S

The 3 groups of LED's right of the display indicate status:
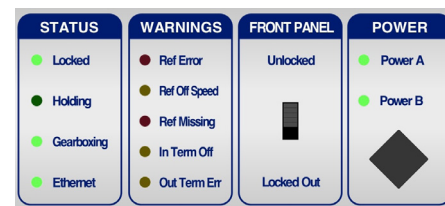
- STATUS

- Locked: The DCD-24 PLL has achieved lock
- Holding: The reference failed and the PLL is holding the last known frequency

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- Gearboxing: The generated frequency is different than the reference
  For example: GEN: 96K & REF: 44.1K or GEN: 48.048K & REF: 48K
- Ethernet: The DCD-24 is connected to a network via the Ethernet port.

- WARNINGS

- Ref Error: When an error occurs with the reference signal, this LED flashes. To clear, press any key.
- Ref Off Speed: The reference is detected to be off speed by more than 1.5%.
- Ref Missing: LED comes on when no valid signal is present at the Reference Input connector
- Termination: One of the outputs is improperly terminated. See 5.1 above for more information.

- POWER

When the DCD-24 is on, the Power A and Power B LED's indicate that power is present at the corresponding connector. When the DCD-24 is turned off, these LED's stay off, even with power present at the connector.

Only one power supply is required to operate the DCD-24. The second input is provided for redundancy. If two supplies are connected to the DCD-24 and one fails, the corresponding LED flashes until the faulty supply is replaced.

When using a single power supply, either input can be used.

5.4. FRONT PANEL LOCK OUT SWITCH

When the front panel lockout switch is on, all switches except the [VIEW] switch are inactive (i.e. you can still check the input rate).

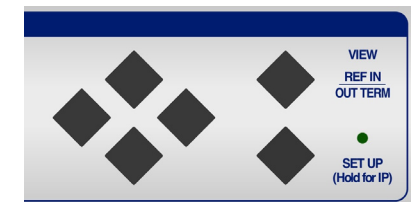Note: *To reset a Ref Error, you must first 'unlock' the front panel.*

6. Navigation Keys

6.1. SET UP KEY

The Set Up mode is used to change parameters. To enter the Set Up mode, press the [SET UP] key.

While in Set Up mode, the SET UP LED is on.

To exit the Set Up mode, simply press the [SET UP] key again.

6.2. UP, DOWN, LEFT, RIGHT KEYS

These keys are directly left of the [VIEW] and [SET UP] keys. They are not labeled as such because their function is fairly obvious.

While in Set Up mode, the [UP] and [DOWN] keys are used to change the value of the selected menu, while the [LEFT] and [RIGHT] keys are used to move to a different menu.

6.3. VIEW KEY

The [VIEW] key is used to momentarily change the function of the display.

- Reference:

During normal operation, press this key to display the reference.

If the reference is WC, AES or 10MHz, the display indicates the frequency;
If the reference is INT, the display indicates "INT";
if the reference is VSO, the display indicates the VSO amount in cents;
if the reference is Video, the display alternates between the format and the frequency of the video ref, for example 1080p and 59.94 Hz (video formats recognized by the DCD-24 are listed in Appendix 15.1 at the end of this manual).

- Output Termination:

In SET UP mode, press the [VIEW] key to display the output termination measurements. The 2 digits on the left indicate the selected output while the 3 digits on the right indicate the measured termination in ohms. If nothing is connected to the selected output (open), 3 dashes appear in the 3 right digits.

While holding the [VIEW] key, press the [UP] or [DOWN] key to change output.

7. Menu Navigation

Menus in the DCD-24 are represented by groups of LED's. There are 3 of them, located on the left of the display:

- REFERENCE
- OUTPUT WC RATE
- OUTPUT 17-24.

When you enter the SET UP mode, all the leds of the selected menu are on solid and all the other parameter leds shut off for about 3/4 sec (this is done so that you can clearly see which menu is currently selected). In the selected menu, the current value led is flashing.

To change value, use the [UP] or [DOWN] key. Note that changes take effect immediately.

To move to another menu, press the [LEFT] or [RIGHT] key. When pressing the [LEFT] or [RIGHT] key, the cursor will move to the next available menu, which may not be the adjacent menu. For example, when INT is selected as a reference, pressing the [RIGHT] key will make the cursor 'jump' 2 columns to the RATE column, skipping the EXTERNAL REFERENCE menu (we are on INTERNAL) and the OUTPUT RATE MODE (FOLLOW INPUT is not available with internal reference).

8. Menus Description

8.1. REFERENCE

Choices for Reference are INTERNAL, EXTERNAL and VSO.

- INTERNAL indicates that the DCD-24 is operating as a master generator on its internal crystal;

- EXTERNAL can be one of the following:
  - Word Clock
  - AES (AES3id)
  - 10 MHz (GPS or Rubidium clock)
  - Video Sync (HD or SD - NTSC & PAL).
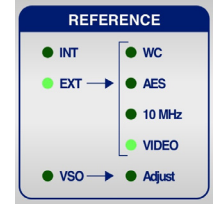
The external reference is connected to the rear panel universal input connector (BNC). By selecting an input type, it is assumed that it corresponds to the actual input signal

- VSO is selected for varispeed operations.

VSO is adjusted in cents (semitone/100). The range goes from +200 to -200 (+ to - 2 whole tones), which translates to +12,2562% to -10,9101%.

To adjust the VSO amount, press the [RIGHT] key to move to the ADJUST menu. Then use the [UP] or [DOWN] keys, reading the adjusted amount in cents on the display.

8.2. OUTPUT WC RATE

Two modes are available for output rate: FOLLOW INPUT and SET.

- Follow Input:

In FOLLOW INPUT mode, the input rate (the rate of the reference) is simply transferred to the output. In this mode, no other adjustment is required. This mode can be used when distributing a word clock. Note that even in this mode, the clock is always regenerated.
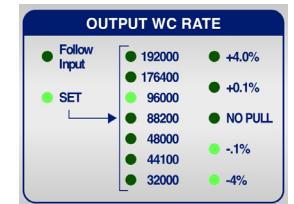
FOLLOW INPUT is only available if the reference is Word Clock or AES.

- Set:

In SET mode, you must select a specific rate.

Select SET, then press the [RIGHT] key once and select one of the standard rates, from 32KHz to 192Khz, with the [UP] or [DOWN] key.

If required, you can also apply a 'pull' coefficient, up or down, or a combination of coefficients. Press the [RIGHT] key once and select the right coefficient. The resulting frequency is indicated in the main display.

NOTE: when you change the rate, if a pull coefficient was previously set, it is removed ('NO PULL').

8.3. OUTPUTS 17-24

Multipliers and dividers are available for outputs 17-24. Simply select the one needed for your application. When x1 is selected, the selected frequency is unaffected.
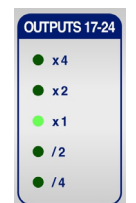
9. Non-Volatile Storage

The DCD-24 has non-volatile memory holding all the DCD-24 settings such as rate and reference selection. This memory is continuously updated so that, when the unit is turned on, it is in the same condition as it was when powered down.

NOTE: You should wait approximately 10 seconds after a change was entered before powering down, to allow for the flash memory to be updated

10. Lock Status

The lock status of the DCD-24 is indicated in the STATUS led section:

- LOCKED   Good and locked
- HOLDING   Holding last known frequency after lock failure
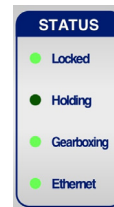
The DCD-24 always tries to lock to its input. Once the rate has been established, if the reference is off speed by more than 10%, it starts slewing. Note that with video, the 10% rule applies to the horizontal frequency and not the frame rate.

While slewing, the LOCKED led is flashing. Once lock has been established, the DCD-24 may need to adjust the phase. During the phase locking adjustment, the LOCKED led flashes rapidly.

11. Defining the reference rate

The DCD-24 always measures the input reference and determines it's rate.

OFF SPEED: When the reference is detected to be off speed by more than 1.5%, the DCD-24 alerts the user by illuminating the REF OFF SPEED led in the WARNING section. The generated frequency will track the reference and be off by the same percentage.

12. Source Reference Failure

In the event of failure of the external reference, the DCD-24 holds the last known frequency and displays "HOLDING" as a lock status.

If a signal is still present at the main reference input, the DCD-24 automatically attempts to lock to it again. If it succeeds, it goes through the normal 'Locked' sequence; if not, it continues holding and attempts to Lock to the main reference again.

If no signal is present at the main reference input, the DCD-24 will remain in 'HOLDING' mode indefinitely.

13. Ethernet

The Ethernet port is used to connect the DCD-24 to a network via standard TCP/IP protocol. It enables the user to access the DCD-24 remotely, and to upload firmware from any computer on the network.

The first thing needed is to set its IP address properly using the front panel keys.

13.1. ETHERNET IP SETTINGS

The IP address setup mode is entered when you hold down the [SETUP] key. What you then view on the display are portions of a long string of characters made up of the following (default values shown):

- DHCP Y/N
- IP 192.168. 0.120
- M 255.255.255. 0
- GA 192.168. 0. 1

where "M" indicates the mask and "GA" the gateway address.

[LEFT] and [RIGHT] keys navigate through the strings 3 digits at a time (approximately), so all of the possible views of the above would be:

- DHCP N (or Y)
- I P 192. ↔ 192.168. ↔ 168. 0. ↔ 0.120
- M 255. ↔ 255.255. ↔ 255.255. ↔ 255. 0
- GA 192. ↔ 192.168. ↔ 168. 0. ↔ 0. 1

The [UP] and [DOWN] keys always control the right-most digit, which is normally flashing.

In DHCP mode ("DHCP Y"), the addresses are not adjustable, but serve to display the values assigned by the DHCP address server.

13.2. MAIN HTML PAGE

Once your IP settings are entered properly, use any browser (Firefox, Explorer …) and enter the IP address of your DCD-24 to display the main HTML page.

Header

The header of the HTML page includes the Serial Number, the IP Address and the Firmware. This information comes from the unit and cannot be edited here.

Also included is the Device Name. To change it, click on the name area and a text box will open up. Type in a new name (up to 32 characters) an hit Enter. Or hit Esc to get out without any change.

In the upper right corner is the UPDATE FIRMWARE button. Clicking this takes you to a separate specialized page. See chapter 14.

Front Panel Replica

The main section of the HTML page is a functional replica of the front panel.

The front panel switches and web page buttons operate in parallel, although web page clicks are inhibited while any front panel key is being pressed.

Menus are accessed by clicking on the [SET UP] button. In SET UP mode, a yellow LED bar is added under the active set up column.
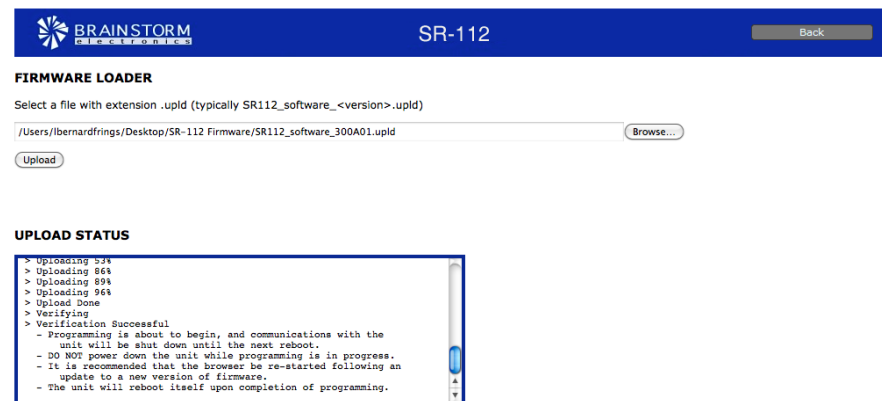
Unlike the front panel switch, the [VIEW] button is click-on, click-off.

The page is refreshed every second, plus immediately after any button on the page is clicked.

14. Firmware Updates

14.1. FIRMWARE UPDATE PAGE

Clicking on the UPDATE FIRMWARE button of the main HTML page takes you to another page, strictly dedicated to uploading new firmware.

To update your firmware, click on the BROWSE button and select the firmware file on your hard disk (.upld). Then click UPLOAD. The normal programming sequence will follow.

Messages in the Upload Status box at the bottom of the page keep you informed of the progress, including error messages.

14.2. COMPLETE VS SOFTWARE

When downloading firmware updates from the Brainstorm website, 2 types of image files are available: 'complete' and 'software'.

The DCD-24 FLASH memory is divided in several sections, for the parameters settings, the application software, the Loader software and the FPGA image. The diagram

below shows the difference between 'complete' and 'software' updates.
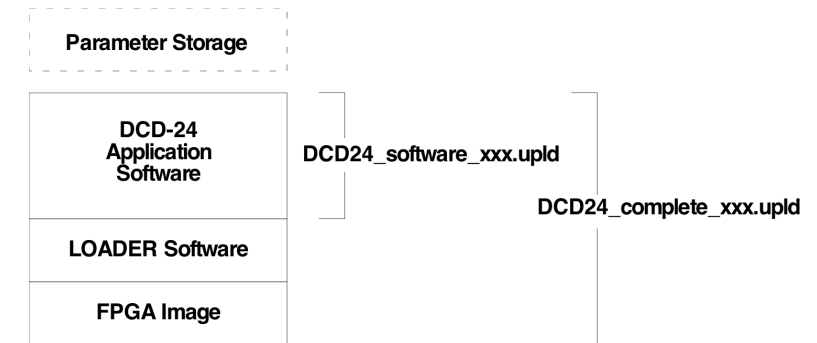
The major software rev number will change whenever the FPGA or LOADER changes. This means that:
- updates between any 1.xx version can be "software" only,
- updates from, for example, 1.xx to 2.xx must be a "complete" update.

14.3 PROGRAMMING SEQUENCE

There are 3 steps in the normal programming sequence: Upload, Verify and Program.

• Step 1: the file is uploaded. A message indicates 'UPL' followed by a percentage complete value.

• Step 2: the file is checked, indicated by a 'TEST' message, then 'PASSED'.

• Step 3: the file is programmed into the DCD-24 flash memory. A message indicates 'PRG' followed by a percentage complete value.

Note: During the 3rd step (programming), Ethernet is internally disconnected.

Reboot

• At the conclusion of a Flash programming sequence following the upload of a 'complete' image file, the display slow flashes "REBOOT" to indicate that a reboot is required. Turn power off then back on.

• After uploading a 'software' image file, the DCD-24 automatically reboots.

14.4 PROGRAMMING ERRORS

A. Upload Error

An error during the upload step should always be recoverable since the programming hasn't started yet. Simply start the Upload again.

B. Programming Error

If an error occurs during the programming step, the consequences will depend on the type of update:

- SOFTWARE UPDATE: The Application Software is probably corrupted but the Loader is intact and can be used to restore the DCD-24 (see 14.5).

- COMPLETE UPDATE: A Programming error during a 'complete' update is most likely not recoverable via Ethernet and your DCD-24 will need to be returned to the factory for a full restore of its flash memory.

IMPORTANT:

IF A PROGRAMMING ERROR OCCURED DURING A 'COMPLETE' UPDATE AND THE UNIT IS STILL ON, TRY RUNNING THE PROGRAMMING SEQUENCE AGAIN AS DESCRIBED IN 14.2, WITHOUT CYCLING POWER.

IF POWER IS TURNED OFF, THE UNIT WILL MOST LIKELY NEED TO BE RETURNED TO THE FACTORY.

14.5 LOADER

The Loader is a fall-back web page that allows you to restore your DCD-24 in case of programming failure. This page is located in a different area of the Flash Memory (see LOADER SOFTWARE on the Flash Memory map above, 14.2).

To enter the LOADER mode:

Hold down the [DOWN] and [SETUP] keys while powering up and until "DCD-24" appears on the display (you don't have to hold down the power key itself – a single hit is sufficient).

The unit will next display "Loader" instead of the usual software version number.

From Loader mode the IP addresses and DHCP mode can be adjusted in the usual way. Then, simply point your browser to the IP address of your DCD-24.

The LOADER page is similar to the regular Upload page described above, without active status updates.
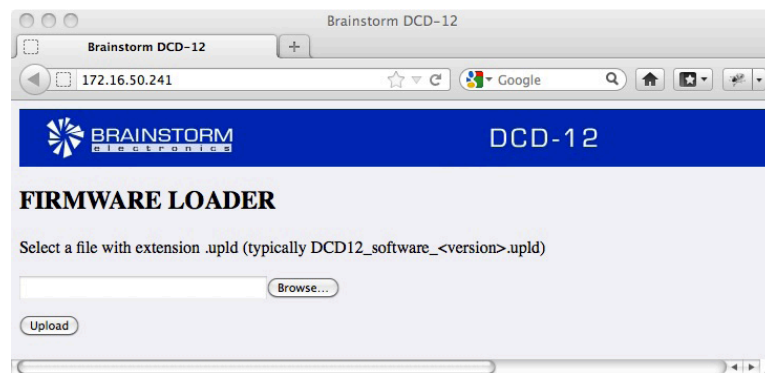
To restore your unit, use the BROWSE button to locate the firmware file on your hard disk (.upld) and click UPLOAD. The normal programming sequence described in 14.3 will follow. Either "software" or "complete" files can be uploaded this way.

15. Appendix

15.1 VIDEO INPUT FORMATS

The following table lists all the video formats recognized by the DCD-24 as reference:

525i/29.97 NTSC	1080i/25	1080p/23.976
625i/25 PAL	1080i/25 295M	1080p/24
	1080i/29.97	1080p/25
	1080i/30	1080p/29.97
	1080sF/23.976	1080p/30
	1080sF/24	1080p/50
720p/50	1080sF/25	1080p/50 295M
720p/59.94	1080sF/29.97	1080p/59.94
720p/60	1080sF/30	1080p/60

Not supported are the low frame rate 720p formats.

15.2. PULLED RATES

Here is a list of the standard and pulled rates generated by the DCD-24.

-4.096%	(25 to 23.976 f/s)	42,294	84,587	169,175
-4.0%	(25 to 24 f/s)	42,336	84,672	169,344
-0.1%	(30 to 29.97 f/s)	44,056	88,112	176,224
BASE RATE		44,100	88,200	176,400
+0.1%	(29.97 to 30 f/s)	44,144	88,288	176,576
+4.166%	(24 to 25 f/s)	45,938	91,875	183,750
+4.2709%	(23.976 to 25 f/s)	45,983	91,967	183,934
-4.096%	(25 to 23.976 f/s)	46,034	92,068	184,136
-4.0%	(25 to 24 f/s)	46,080	92,160	184,320
-0.1%	(30 to 29.97 f/s)	47,952	95,904	191,808
BASE RATE		48,000	96,000	192,000
+0.1%	(29.97 to 30 f/s)	48,048	96,096	192,192
+4.166%	(24 to 25 f/s)	50,000	100,000	200,000
+4.2709%	(23.976 to 25 f/s)	50,050	100,100	200,200

15.3. MULTIPLIER/DIVIDER RATES

Through WC outputs 9-12, the DCD-24 can apply a multiplier or a divider to the selected base frequency. Here is a list of the available rates. An 'X' indicates this choice is not available.

	FSx2	FSx4	FS/2	FS/4
192.0 KHz	X	X	96.0KHz	48.0KHz
176.4 KHz	X	X	88.2KHz	44.1KHz
96.0 KHz	192.0KHz	X	48.0KHz	X
88.2 KHz	176.4KHz	X	44.1KHz	X
48.0 KHz	96.0KHz	192.0KHz	X	X
44.1 KHz	88.2KHz	176.4KHz	X	X
32.0 KHz	64.0KHz	128.0KHz	X	X

15.4. WORD CLOCK PHASE ALIGNMENT TO VIDEO

Whenever mathematically possible, the DCD-24 will achieve accurate alignment between the vertical sync of the incoming video and the rising edge of the output wordclock. Accuracy is per the original AES requirement of 5% of the sample clock period. This phase adjustment begins immediately after intial lock has been achieved. Please allow up to 30 seconds for this state to be realized.

The table below indicates when alignment will occur between the input video "reference point" (vertical sync) and the output wordclock rising edge.

		Video Input Types and Rates				
			PAL	Slow PAL 24	NTSC	Slow PAL 23.976
		HD 30 HD 60	HD 25 HD 50	HD 24	HD 29.97 HD 59.94	HD 23.976
		30.000	25.000	24.000	29.970	23.976
DCD-24 WC Output Rates	32000.000		Y			
	42293.706					
	42336.000					
	44055.944				Y	
	44100.000	Y	Y			
	44144.100					
	45937.500					
	45983.438					
	46033.966					
	46080.000					
	47952.048				Y	Y
	48000.000	Y	Y	Y		Y
	48048.000					
	50000.000					
	50050.000					

NOTES: All outputs are rate locked at all times.

15.5. FACTORY DEFAULT SETTINGS

The following are the factory default settings.

REFERENCE	WC
OUTPUT RATE	48KHz
OUTPUTS 9-12	X1
DHCP	No
IP ADDRESS	192.168.0.120
SUBNET MASK	255.255.255.0
GATEWAY	192.168.0.1

DCD-24

Word Clock
Distributor

Operation Manual

Software version 1.00

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