User's Guide

Word Clock Module MKII

for the DIGI96® Series

Contents

1. Introduction

The WCM (Word Clock Module) adds a word clock input and output in professional quality to any card of the DIGI96* series. A low jitter optimized PLL circuit, an integrated clock generator, and a unique test mode extend the powerful capabilities of our digital audio cards, in a way many professional users have asked for.

2. Package Contents

Please ensure that all the following parts are included in the WCM's packaging box:

- Slot card WCM MKII
- 4 internal cables (3 core)
- 1 BNC T-adapter
- Quick Info guide
- RME Driver CD

Note: The WCM needs no drivers and no additional software installation!

3. System requirements

- One free slot in the PC's housing
- At least one, not more than three DIGI96 series cards*

4. Power supply

The WCM gets its power from the DIGI96 series via the supplied cables.

*DIGI96 and 96/8 revision 1.2 or lower have no connectors for the WCM (ST6 and ST7).

5. Brief Description and Characteristics

The Word Clock Module WCM is a small companion board to RME's DIGI96 series, and needs no slot on the motherboard. It adds a word clock input and output to these powerful digital interface cards. Both connectors are BNC jacks, so there's no hassle with adapters. The module includes an optimized low jitter PLL for reliable reconstruction of the audio clock signal, a low impedance output, and a complete word clock generator, usable as master clock or for test and check purposes.

The WCM is connected to the DIGIs using two supplied cables. After connection it is immediately ready to operate. The drivers of the DIGI96 series are already prepared for an operation with the WCM.

Thanks to several LEDs (power, test mode, LOCK) and the highly integrated concept of installation, first operation and usage are simple even for the unexperienced user.

6. Technical Specifications and Features

- Low Jitter Design: typical 2.5 ns (PLL / Test), < 1 ns (Masterclock)
- Input PLL ensures zero dropout, even at more than 40 ns jitter
- High sensitive input stage works from 1 Vpp input level
- Rejects DC offsets in the word clock net
- Overvoltage protected input stage
- Short protected output stage
- Frequency range PLL input: 27 kHz - 102 kHz
- Frequency range output: 27 kHz - 102 kHz
- Input BNC, high impedance (> 10 kOhm)
- Output BNC, low impedance (10 Ohm)
- Power supply: from DIGI96 series board, 12 V DC, 40 mA
- Standard slot, board dimensions 97 x 50 mm

7. Hardware Installation

Important: Switch off the computer and remove the power cable from the power supply before fitting the WCM.

1. Disconnect the power cord and all other cables from the computer.
2. Remove the computer's housing; further information on how to do this can be obtained from your computer´s instruction manual.
3. Neutralize the static build up by touching the computer's metal-chassis before unpacking the WCM from the protective bag.
4. Connect WCM and DIGI using the supplied 3-wire cables. Plug one end into the connector **ST 7** on the DIGI, the other end into **ST 7** on the WCM. Note: The cable's connectors will automatically plug in with the correct polarity.
5. Connect **ST 6** on the WCM with **ST 6** on the DIGI. In case several DIGIs are fitted, up to three can be connected to the module.
6. Insert WCM into a free slot, press and fasten the screw (if any). As the WCM needs no slot on the motherboard we recommend to use a free slot above the last PCI- or AGP slot.
7. Reinsert the DIGIs in their PCI slots and fasten the screws (if any).
8. Replace the computer's housing and tighten the screws (if any).
9. Reconnect the power cable and all other cables/connections.

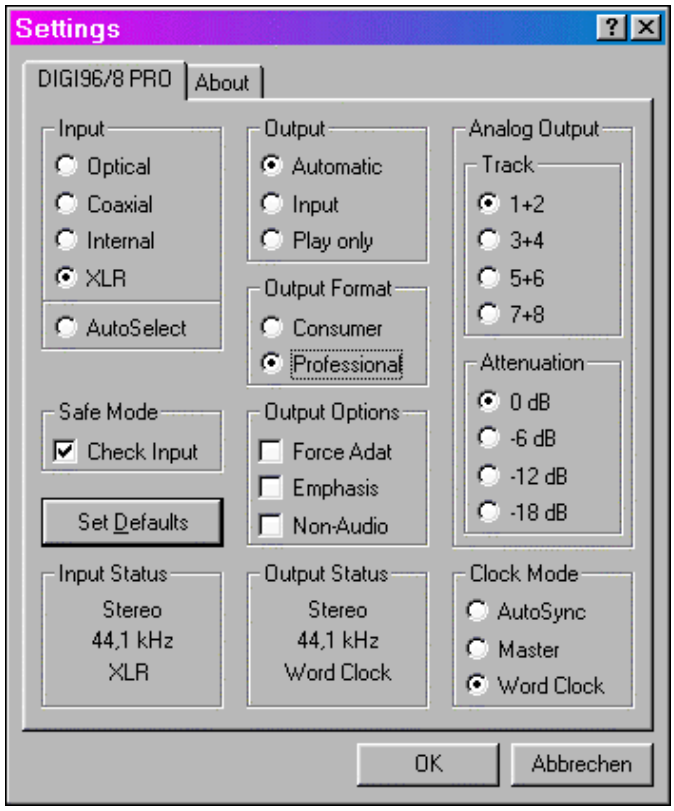
8. First Operation

After fitting the WCM (see 7. Hardware Installation) and switching on the computer, activate the push button switch 'Test Mode' located between the BNC jacks. Provided the module is correctly connected to the DIGI, the LED beside the switch must light up red. Additional the green 'Lock' LED must light up, indicating a valid and stable input signal.

When both LEDs do not light up, then the cables between DIGI and WCM are exchanged. Please switch off the computer immediately and check the cabling! *****

Exchanging the cables at **ST 6/ST 7** will not harm DIGI or WCM, but should be avoided.

After completed boot of computer and operating system, start the DIGI's Settings dialog and activate the mode 'Word Clock' in the field 'Clock Mode'. Under 'Output Status' the third line indicates the state of the output circuit (master or slave). It will change to 'Word Clock'. This display realizes the same functionality as the green 'Lock' LED besides the BNC input jack. Therefore you'll see directly on your screen when a valid word clock signal is received and used by the WCM.



Now again push the switch 'Test Mode', so that the red 'Test' and the green 'Lock' LED extinguish. The third line now shows 'Clock Master' or 'Clock Slave' instead of 'Word Clock'. As no word clock signal is present at the BNC jack (inactive 'Lock' LED), the card will switch back to its former operation (slave: sync to input signal, master: clock from quartz crystal).

While in word clock mode the displayed sample frequency in 'Output Status' is not the real sample frequency, but the channel status of the digital signal.

***** *Technical note: The LED VD7, located on the WCM board, indicates whether the WCM gets the needed 12V from the DIGI96 series board or not. This LED is not visible from the outside. It is placed before the 5 V voltage regulator, which supplies all of the electronics of the WCM.*

9. Setup and Operation

9.1 General

As soon as a valid word clock signal is present the green 'Lock' LED beside the input jack lights up. To switch from the DIGI's internal clock to the WCM's clock, activate the mode 'Word Clock' in the field 'Clock Mode' in the Settings dialog. Under 'Output Status' the third line indicates the state of the output circuit (master or slave). It will change to 'Word Clock'. This display realizes the same functionality as the green 'Lock' LED besides the BNC input jack. Therefore you'll see directly on your screen when a valid word clock signal is received and used by the WCM.

The word clock output is always active. It sends the current sample frequency of the DIGI96 series card as word clock signal. As long as the DIGI works in 'Master' mode (field 'Clock Mode'), the sent word clock has very low jitter (< 1 ns). In 'AutoSync' mode the amount of jitter depends on the quality of the signal received at the digital input.

The word clock signal received by the WCM can be distributed to other devices by using the WCM's word clock output. With this the usual T-adapter can be avoided, and the WCM operates as *Signal Refresher*. This application is especially useful as the WCM's outstanding input (1 Vpp instead of usual 3 Vpp sensitivity, DC filter, Signal Adaptation Circuit) guarantees a stable function even with very critical word clock signals.

9.2 Test Mode

Pushing the switch 'Test Mode' forces the WCM to generate its own quarz crystal controlled word clock, and to send it to all connected DIGIs. With this the internal generator provides two functions:

- Test Mode: The internal word clock signal replaces the external one at the BNC jack

The WCM includes a built in word clock generator for test purposes. It generates a square wave signal at 44.1 kHz or 48 kHz (S3 = ON), which is fed internally to the BNC input jack when the switch *Test Mode* is activated. The BNC jack is then out of function, an external signal at this jack will be disconnected automatically.

The test generator enables a complete test of the WCM and its correct function in combination with the DIGI96 series card, because the test signal runs through the same circuits and path as an externally fed signal.

So when connecting a BNC cable and activating the external word clock signal do not cause the green LED to light up, and the field Output Status does not show 'Word Clock', then a simple push on the test switch is enough to verify the function of the whole system, and to be sure the fault is on the external equipment's side.

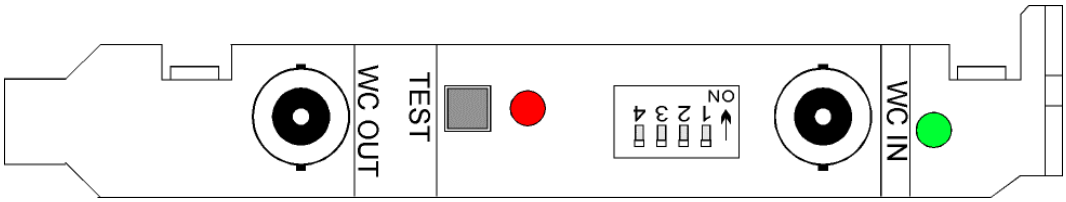
- Masterclock: The master clock allows to synchronize all connected DIGIs, and all devoices hooked up to the DIGIs.

The DIGI will send the input's word clock signal straight to its output when in 'Word Clock' mode. Therefore in test mode the WCM can be used as central word clock generator, generating the so called 'house clock'. Additional when using more than one card this mode offers a very convenient way of synchronizing all cards. Just make sure the clock mode 'Word Clock' is selected in all DIGI96 series Settings dialogs.

9.3 Erweiterte Modi – DIP-Schalter

Using 4 so called DIP switches allows you to activate several modes, making the WCM more flexible than ever before. Input and output can be set to single or double speed mode independently. An internal termination can also be activated. Therefore T-connector and BNC-terminator are no longer necessary. The internal clock generator can operate not only at 44.1 kHz, but also at 48 kHz. Thanks to the single/double mode of the input also 88.2 kHz and 96 kHz are provided internally

The switches can be set easily with a pen or small screw driver. Note that when installed in usual computers the switches are reversed. ON is the upper position then.



S1: Termination of the Word Clock Input

S1 = OFF: no termination. S1 = ON: terminated with 75 Ohms. A T-adapter and a 75 Ohm BNC terminator are no longer required.

S2: Doubling the Input Frequency

The DIGI96 series' word clock is always linear to the sample rate, whereas in the professional area the Double Speed mode (88.2 and 96 kHz) will sometimes be based on half word clock frequency (for example in Double Wire mode). With S2 = ON the WCM internally doubles the incoming word clock. So when feeding 44.1 kHz the DIGI96 connected to the WCM will operate at 88.2 kHz, 48 kHz will cause operation at 96 kHz.

S3: Test Mode 44.1 kHz / 48 kHz

In Test mode the WCM provides a quartz-based, internally generated word clock. S3 = OFF equals 44.1 kHz, S3 = ON 48 kHz. S2 allows to double these values to 88.2 and 96 kHz.

S4: Dividing the Output Frequency by 2

In Double Speed mode playback the DIGI96 series will provide 88.2 and 96 kHz at the word clock output. S4 = ON divides the outgoing word clock by 2, to 44.1 or 48 kHz respectively.

9.4 Multi-card Operation

The WCM supports Multi-card operation. Up to three cards of the DIGI96 series can be connected to and synchronized from the WCM.

Please note when using the word clock output and more than one card, that only one card can be master!

Because of this the WCM has three connectors named **ST 6**, but only one labelled **ST 7**. The DIGI connected to **ST 7** will be the master for the whole word clock system. The other cards inside the computer won't get a synchronous clock and have to be synchronized to the master. This is easy to accomplish in several ways.

Example 1: All DIGIs digital inputs are connected to other devices synced to the word clock net.

Activate the corresponding input of each card in its Settings dialog, and activate the mode AutoSync for all cards except the master card, which stays in 'Word Clock' mode.

Example 2: Only the outputs of the DIGIs are connected to other devices.

Connect the internal Sync-Out of the master card to the Sync-In (CD-ROM) of the second card, activate its internal input and AutoSync mode. Next connect the third card in the same way, from the second's card Sync-Out to the third's card Sync-In. Configure this card like the second one. The necessary 2-wire cables are the ones supplied with the DIGI cards. Another possibility is to use the WCM's comfortable test mode.

Example 3: All DIGIs are correctly connected to the Word Clock Module.

As already described the WCM can also be used as Masterclock. Activate the Test Mode by pushing the test switch, so that the red LED lights up. Next activate the mode 'Word Clock' in all card's Settings dialogs. Now all cards should show 'Word Clock' in the third line of 'Output Status'.

10. Word Clock

10.1 Technical Background

In the analog domain one can connect any device to another device, a synchronization is not necessary. Digital audio is different. It uses a clock, the sample frequency. The signal can only be processed and transmitted when all participating devices share the same clock. If not, the signal will suffer from wrong samples, distortion, crackle sounds and drop outs.

AES/EBU, SPDIF and ADAT are self-clocking, an additional word clock connection in principle isn't necessary. But when using more than one device simultaneously problems are likely to happen. For example any self-clocking will not work in a loop cabling, when there is no 'master' (main clock) inside the loop. Additionally the clock of all participating devices has to be synchronous. This is often impossible with devices limited to playback, for example CD players, as these have no SPDIF input, thus can't use the self clocking technique as clock reference.

In a digital studio synchronisation is maintained by connecting all devices to a central sync source. For example the mixing desk works as master and sends a reference signal, the word clock, to all other devices. Of course this will only work as long as all other devices are equipped with a word clock or sync input, thus being able to work as slave (some professional CD players indeed have a word clock input). Then all devices get the same clock and will work in every possible combination with each other.

But word clock is not only the 'great problem solver', it also has some disadvantages. The word clock is based on a fraction of the really needed clock. For example SPDIF: 44.1 kHz word clock (a simple square wave signal) has to be multiplied by 256 inside the device using a special PLL (to about 11.2 MHz). This signal then replaces the one from the quartz crystal. Big disadvantage: because of the high multiplication factor the reconstructed clock will have great deviations called jitter. The jitter of a word clock is typically 15 times higher as when using a quartz based clock. We even know a Synchronizer which generates word clock signals digitally (!) with more than 30 ns jitter, and - when used as house clock for the whole studio - lowers the reliability and audio quality of all attached devices.

The end of these problems should have been the so called Superclock, which uses 256 times the word clock frequency. This equals the internal quartz frequency, so no PLL for multiplying is needed and the clock can be used directly. But reality was different, the Superclock proved to be much more critical than word clock. A square wave signal of 11 MHz distributed to several devices - this simply means to fight with high frequency technology. Reflections, cable quality, capacitive loads - at 44.1 kHz these factors may be ignored, at 11 MHz they are the end of the clock network. Additionally it was found that a PLL not only generates jitter, but also also rejects disturbances. The slow PLL works like a filter for induced and modulated frequencies above several kHz. As the Superclock is used without any filtering such a kind of jitter and noise suppression is missing. No wonder Superclock did not become a conmmonly accepted standard.

More information on these subjects can be found in the HTML document 'sync96.htm', located in the directory **\rmeaudio.web\english\techinfo** on the RME Driver CD, or on our web site.

10.2 Cabling and Termination

Word clock signals are usually distributed in the form of a network, split with BNC T-adapters and terminated with resistors. We recommend using off-the-shelf BNC cables to connect all devices, as this type of cable is used for most computer networks. You will find all the necessary components (T-adapters, terminators, cables) in most electronics and/or computer stores.

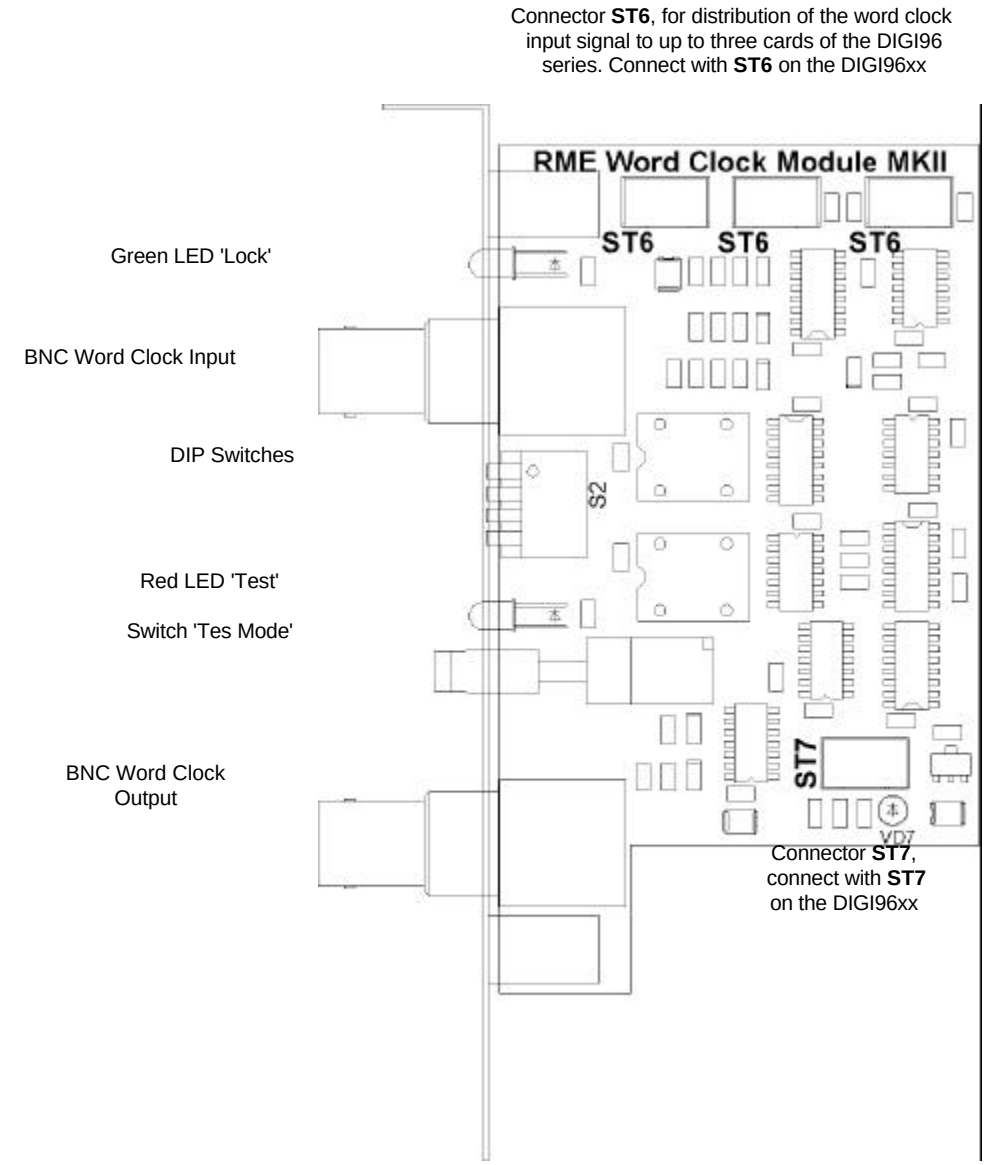
The ideal word clock signal should be a 5 Volt square wave having the same frequency as the sample rate. This signal will generate harmonics up to more than 500 kHz. To avoid voltage loss and reflections, both the cable itself and the terminating resistor should have an impedance of 75 Ohm. If the voltage is too low, synchronization will fail. High frequency reflection effects can cause both jitter and sync failure.

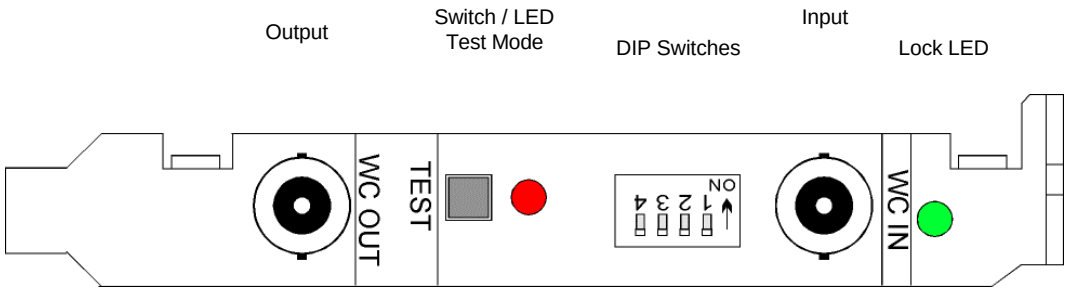
In practice, the situation has improved in recent years. The relatively low frequency of word clock signals is not a problem for modern electronic circuits. Because of the higher voltage, big word clock networks are often more stable and reliable if cables are not terminated at all. Also, 75 Ohm cable is almost impossible to find these days. 50 Ohm cable is standard - this will also work as long as the termination resistors are 75 Ohm.

The input of the WCM is a high impedance type to offer highest flexibility for the user. In case a termination according to the standard is necessary (because the WCM is the last device in a chain of several devices), set S1 to ON. This activates an internal 75 Ohm termination resistor.

In case the WCM resides within a chain of devices receiving word clock, plug a T-adapter into the WCM's BNC input jack, and the cable supplying the word clock signal to one end of the adapter (as above), but connect the free end to the next device in the chain via a further BNC cable. The last device in the chain should be terminated using another T-adapter and a terminator plug as described in the previous paragraph. Some devices (like the WCM MKII) have switchable 75 Ohm resistors, which saves both T-adapter and terminator.

11. Controls and Connectors





12. TECH INFO

RME provides more and very detailed information regarding all RME products on the Tech Info pages in the web (http://www.rme-audio.com/techinfo/index.htm), and on the RME Driver CD in the directory **\rmeaudio.web\techinfo**. These documents provide very detailed and interesting technical background information.

13. Warranty

Each individual WCM undergoes comprehensive quality control and a complete test in a PC environment at RME before shipping.

The usage of high grade components allows us to offer a full two year warranty. We accept a copy of the sales receipt as valid warranty legitimation.

RME's replacement service within this period is handled by the retailer. If you suspect that your card is faulty, please contact your local retailer. The warranty does not cover damage caused by improper installation or maltreatment - replacement or repair in such cases can only be carried out at the owner's expense.

RME does not accept claims for damages of any kind, especially consequential damage. Liability is limited to the value of the WCM. The general terms of business drawn up by Synthax Audio AG apply at all times.

14. Appendix

RME news, driver updates and further product information are available on our website:
http://www.rme-audio.com

If you prefer to read the information off-line, you can load a complete copy of the RME website from the RME Driver CD (in the **\rmeaudio.web** directory) into your browser.

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CE

This device has been tested and found to comply with the limits of the European Council Directive on the approximation of the laws of the member states relating to electromagnetic compatibility (EMVG) according to EN 55022 class B and EN50082-1.

FCC Compliance Statement

Certified to comply with the limits for a Class B computing device according to subpart J or part 15 of FCC rules. See instructions if interference to radio reception is suspected.

FCC Warning

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This device complies with part 15 of FCC rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference
2. This device must accept any interference received, including interference that may cause undesired operation.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the seperation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help.

In order for an installation of this product to maintain compliance with the limits for a Class B device, shielded cables must be used for the connection of any devices external to this product.