



# MagicQuartz

Software Documentation (2015-04-27)

[Blue parts refer to the free Arduino version.](#)

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# WARNING

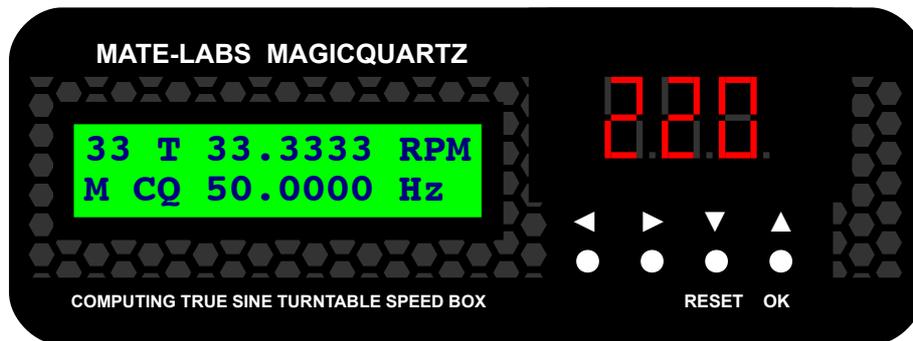
Much care was taken into account when MagicQuartz has been developed. However, please be aware of the following security considerations:

- **This unit operates with lethal high voltages.** Much caution and a considerable knowledge in electronics engineering are necessary in order to build and operate the unit. The inventor of this unit cannot be taken liable for any damage or harm that is caused by this unit.
- This unit is capable of producing voltages significantly higher (and lower) compared to standard mains voltage. Connecting devices (such as turntables) to this unit can damage these units.
- This unit operates with high frequency pulse width modulation (PWM) at 31.250 kHz, fed into a step-up transformer. Because of this being a rectangular signal, it also produces harmonics. Although the signal is low-pass-filtered, it may disturb radio and TV (and similar) reception and interfere with other electronic equipment. For example, the high frequency signal might be present in audio signals and may disrupt audio recordings or even damage audio speakers (tweeters), if the audio signal is amplified to high volume levels.
- For security reasons, never leave this unit unattended. Disconnect the power supply if the unit is not used.
- Keep the unit dry and out of the reach of children and animals.

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# 1. Introduction



Thank you for having purchased and/or built Mate-Labs MagicQuartz!

MagicQuartz is the world's most advanced turntable speed box. From now on, you will have precise control over you turntable's playback speed. You will probably be amazed about how many records you have played back at the wrong speed (i.e. too slow). In any case we believe that your listening experience will be as it has never been before.

*Note: Please be sure to have read the security warning at the beginning of this document, as MagicQuartz can be very dangerous to operate. We then highly recommend reading the rest of this document to get familiar with the MagicQuartz software.*

*We hope that you will enjoy MagicQuartz!*

## 2. Features

Although there are several turntable speed boxes available on the market, MagicQuartz is the most feature-laden and most precise one so far. And it's probably the cheapest one. Here's the full list of its features:

- Turntable speed control functions
  - Live quartz mode: MagicQuartz automatically corrects the supply frequency so that the turntable plays at the set speed
    - Configurable impact of the quartz algorithm (quartz latency)
    - Rejection of bad quartz measurements to improve performance and to stop regulation while the turntable's automatic start/stop functions are in operation
    - Algorithm efficiently deals with measurement errors
    - Clever and configurable averaging of measured speed
  - Change RPM or Hertz manually in precise 1/10.000 RPM/Hertz steps
  - Speed box function (instantaneously and electronically switch between 16, 33, 45 and 78 RPM)
  - Transpose playback in half tones
- True sine wave supply voltage generation

- Inaudible and power-efficient pulse width modulation (PWM) at 31.250 kHz
- High 9 bits resolution with 128 steps per full sine period
- Volts per frequency (U/f) inverter characteristic (configurable)
- 1/10.000 Hertz and RPM timer resolution (\*)
- Delivers 0-250 Volts and up to 20 Watts (\*)
- Super fast detection of motor status (on/off), followed by a correction of the supply voltage (latency is about 200 ms) (\*)
- Automatic optical sensor calibration that also guides the user when positioning the sensor on the turntable
- Uptime counter that also counts the on-time of the turntable (can be used to keep track of stylus wear) (\*)
- Microcontroller flash wear leveling (pessimistically estimated and calculated 100.000 hours of operation = 137 years of service life, if used 2 hours per day)
- Security and quality features:
  - Detection of internal power amplifier short-circuits (\*)
  - Detection and handling of amplifier overload (e.g. during a turntable failure) and amplifier overheating (\*)
  - Rejection of bad speed measurements (which can happen e.g. after a motor failure, broken belt or idler wheel)
  - Configurable limitation of live quartz' allowed frequency change (in percent)
  - Configurable automatic standby time
  - Circuit is fused (\*)

(\*) = Not in Arduino version.

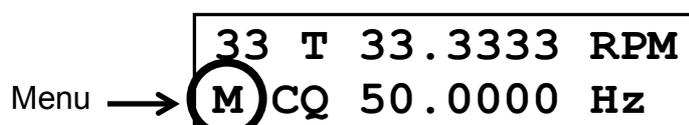
### 3. Quick start

Please follow this chapter closely as the procedure described here is necessary before operating the MagicQuartz unit. Not sticking to these instructions may damage your turntable. If you have started with a DIY kit, make sure that the unit is correctly built and everything has been double-checked.

**Disconnect the turntable.** Connect MagicQuartz to its 24V power adaptor and switch it on.

#### 3.1. Setting the default supply frequency

With the left and right buttons, move the cursor below the **m** character in the lower left corner (it should be already there):



Then press the OK button. This opens the configuration menu (also see chapter "Configuration Menu"):

```
Select Function:
Exit Menu
```

The first parameter that needs to be changed (or at least verified) is the default power supply frequency of your turntable (50 or 60 Hertz). Press the right button until you reach the menu option to set the default frequency setting:

```
Select Function:
Set DefaultHertz
```

Then press the OK button. The next screen allows you to change the value:

```
Set DefaultHertz
0050.0000 OK
```

Use the left and right buttons to move the cursor below the digit to be changed and use the up and down buttons to increase or decrease the digit. If your turntable is a 60 Hertz unit, change the setting to 0060.000. To accept this value, move the cursor below `OK` and press the OK button. *Note: If you change the value from 50 to 60 Hertz, MagicQuartz automatically adjusts the voltage to 110V.* You are then taken back to the configuration menu.

## 3.2. Calibrating the turntable's motor

*Arduino: This section cannot be applied to the free Arduino version, because it has no power-monitoring features. Please refer to the Arduino-specific documentation on how to set up the supply voltage!*

The next step is the motor calibration. This ensures that the turntable is powered with the correct supply voltage (e.g. 110 or 220 Volts). MagicQuartz features a guided setup that helps calibrating the voltages.

If your MagicQuartz unit does not feature a built-in AC voltmeter, connect a true RMS multimeter to the power line (e.g. next to the filter capacitor) and set this to the AC range. *Note: Be careful – you're dealing with lethal voltages! It is a good idea to first shut down MagicQuartz and then to connect the multimeter. In this case you can open the menu again as described above.*

Select the corresponding menu entry:

**Select Function:  
Calibrate Motor**

Then press the OK button.

MagicQuartz will now guide you through the power calibration procedure and request to turn the turntable on and off, stop the platter, and to set the two motor voltages (for the motor being switched “off” and “on”). These are based on the factor values **VoltageMtOff** and **VoltageMtOn**. It is a good idea to first change the lower digits to avoid unexpected big changes in the output voltage. Increase or decrease the **VoltageMtOff** and **VoltageMtOn** values so that the generated voltage (i.e. the multimeter or voltmeter readout) matches your turntable’s rated voltage.

*Note: The calibration routine automatically determines the values **BootRunThrs**, **MotorSwThrs**, **OvlProtThrs** and **AmpFailThrs** and requests the user to set **VoltageMtOff** and **VoltageMtOn** as described above. All values can also be set manually in the configuration menu by selecting the corresponding menu entry.*

To exit the configuration menu, press the left button until you reach the **Exit Menu** entry, then press the OK button.

### 3.3. Testing and correcting the motor calibration

*Arduino: This section cannot be applied to the free Arduino version, because it has no power-monitoring features. Please refer to the Arduino-specific documentation on how to set up the supply voltage!*

#### Testing the motor status detection and supply voltage

Back on the main screen, switch the turntable motor on and off. The motor status indicator in the lower right corner should show a flash symbol whenever the motor is switched on. The supply voltage should always stays at the rated voltage (e.g. 220V). Small fluctuations after a switch are normal because MagicQuartz needs a very short time to adapt to the load change (about 200 ms).

- If the motor status indicator in the lower right corner does not change as you switch the unit on and off, you can try to manually decrease the value **MotorSwThrs** in the configuration menu.
- If the motor status indicator flips or behaves erratically, you can try to manually increase the value **MotorSwThrs**.
- If the motor status indicator flash symbol disappears immediately after the motor has been switched on, MagicQuartz probably interprets a dropping inrush current peak (see “Theory of operation”) as a “motor switch off”. Try to increase the value **MotorSwTime** to prolong the inrush current compensation time.

- If the voltage readings are not correct, you can correct them by adjusting the **VoltageMtOff** and **VoltageMtOn** parameters. Please note that the voltage readings are only stable for the nominal frequency as set with the **DefaultHertz** value. For higher frequencies, the voltage can be slightly higher and decreases dramatically for lower frequencies due to the U/f characteristic (see “Theory of operation”).

### Testing the motor status detection upon start-up

Turn off MagicQuartz, then turn on the motor. With the motor still being switched on, turn on MagicQuartz. Upon startup, it should display a message that the motor is turned on and display a flash symbol in the lower right corner of the main screen. Repeat the procedure with the motor being switched off; it should then detected that the motor is switched off with no flash symbol appearing in the lower right corner of the main screen.

- If MagicQuartz falsely detects that your motor is switched off during start-up, you can try to decrease the **BootRunThrs** value.
- If MagicQuartz falsely detects that your motor is switched on during start-up, you can try to increase the **BootRunThrs** value.

### Testing the overload protection

Connect a lamp with an incandescent light bulb (rated 28W or higher, do not use LED or CFL lamps) to MagicQuartz and turn it on. MagicQuartz should then display an overload warning. If not, execute the function **Calibrate Motor** and/or **Calib OvlProtThrs**. If this does not help, lower the value **OvlProtThrs** manually.

### Verifying sine wave purity

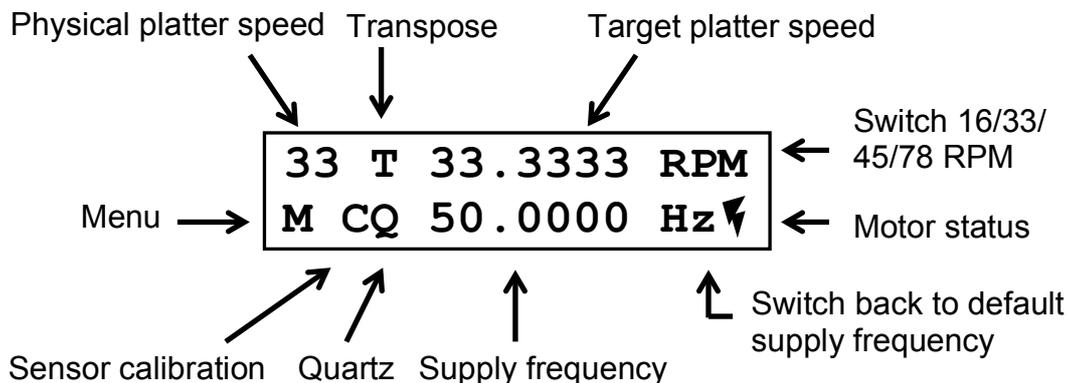
If you have access to an oscilloscope, you can verify that the generated voltage follows a clean, true sine wave. *Note: Be careful – you’re dealing with lethal voltages!*

- If you experience distortions when using lower supply frequencies, you can try to adjust **VoltageDrop** value as described in the chapter “Theory of operation”. Please note that if your unit is equipped with a built-in voltmeter, small brake-ins at the peaks of the sine wave are normal; they have no impact on the overall performance of MagicQuartz.
- If you experience distortions at the turntable’s nominal supply frequency and voltage, MagicQuartz is probably not suited to correctly drive your turntable (i.e. the load of the turntable exceeds MagicQuartz driving capabilities). In this case, you can try to lower the **VoltageMtOff** and **VoltageMtOn** values, while accepting that the turntable’s motor runs at a lower-than-nominal voltage.

## 4. Functions and menu walk-through

### 4.1. Main screen

The main screen allows you to change various speed settings for your turntable and acts as the entry point to all other functions (e.g. the live quartz mode). It is cursor-controlled: Use the left and right buttons to move the cursor below the digits representing values (e.g. 33.333 or 50.000) or characters representing menus or functions (e.g. **M**, which enters the setup menu). Then use the up and down buttons to change the values or to enter the menu or function.



- **Physical platter speed:** Set this to match the physical speed setting of your turntable. "Physical" means the belt or idler wheel setting on your turntable: if the turntable is set to play at 45 RPM, set this to parameter 45. Use the up and down buttons to switch between 16, 33, 45 and 78 RPM.
- **Transpose:** Use the up and down buttons to transpose the playback in half tones.
- **Target platter speed:** Move the cursor below the desired digit, then use the up and down buttons to increase or decrease the RPM. The unit automatically calculates the corresponding supply frequency.
- **Switch 16/45/45/78 RPM:** Move the cursor below **RPM** and use the up and down buttons to switch between the standard RPM settings. This directly changes the target platter speed and the supply frequency is changed accordingly.
- **Motor status:** This shows if the turntable's motor is running, or not. A flash symbol is displayed if it's running. Otherwise nothing is shown. [The Arduino version cannot detect the motor status. It displays an \*\*R\*\* because it is assuming that the motor is running.](#)
- **Switch back to default supply frequency:** Move the cursor below **Hz** and use the up or down button to switch back to the default supply frequency (typically 50 or 60 Hertz). Note: This deletes the current (static) quartz calibration (if applicable).
- **Supply frequency:** Move the cursor below the desired digit. Then use the up and down buttons to increase or decrease the supply frequency (in Hertz). The unit automatically calculates the corresponding target platter speed.
- **Quartz:** Enter live quartz mode (see chapter "Live Quartz Mode").

- **Sensor calibration:** Enter sensor calibration mode (see chapter "Sensor Calibration Mode").
- **Menu:** Enter setup menu (see chapter "Setup Menu").

### Example: Changing the RPM or supply frequency (Hertz)

Move the cursor with the left and right buttons below one of the digits (e.g. those of 33.333 or 50.000) and use the up and down buttons to increase or decrease the value. If you change the RPM setting, the unit will automatically calculate the corresponding supply frequency and vice versa. The playback speed of your turntable changes accordingly.

### Example: speed box function

The MagicQuartz unit can be used as a simple speed box. This means that you can change the playback speed of your record without changing the physical speed setting on the turntable. This is handy if your turntable does not feature a mechanical speed switch. For example, some decks require you to move the motor belt to a different roller below the platter or on the motor, e.g. to switch between 33 and 45 RPM. With the speed box function, you can do this electronically.

Even more, you can have your turntable playing back records at speeds, which are not supported by your turntable! For example, you can play back 78 records on turntables, which do not feature a 78 RPM speed selection.

The general approach is:

1. Change the **physical platter speed** setting in the upper left corner to match the setting of your turntable.
2. Switch the speed of your turntable by making use of the **switch 16/45/45/78 RPM** function. Move the cursor below **RPM** in the upper right corner and use the up and down buttons to switch between the standard RPM settings.

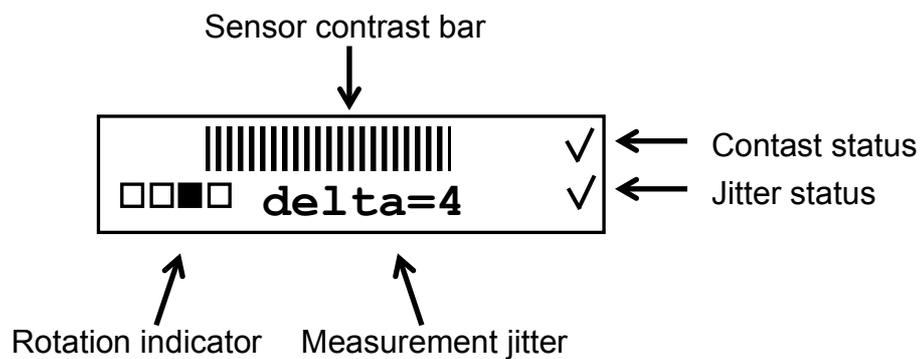
Notes:

- *Making use of the speed box function dramatically changes the supply frequency. For example, switching to 78 RPM with a physical setting of 33 RPM changes the supply frequency to 117 Hertz (for a default mains frequency unit with 50 Hertz). It is possible that this damages the turntable's motor. Please refer to the appendix if your turntable model is considered to be safely usable with this function!*
- *It is recommend to set the physical platter speed (on your turntable and in MagicQuartz) to the speed next to the desired setting. For example, if you want to play back a 78 RPM record, set both values to 45 RPM. This decreases the frequency discrepancy between the motor's optimal frequency (typically 50 or 60 Hertz) and the frequency, which is required to maintain the target speed.*
- *The supply frequency is a calculated value only. Use the live quartz function afterwards to precisely calibrate the supply frequency.*

- You can also use this function to shift the noise spectrum (rumble and motor hum) to a different frequency. For example, if you set your turntable to a physical speed of 78 RPM and then tell MagicQuartz it to play it back at 33 RPM, it changes the supply frequency to 21.3675 Hertz (for 50 Hertz units). This lets the turntable motor spin considerably slower and shifts the rumble and motor hum to a lower frequency. If you digitize vinyl records, you can then use a low-pass filter to remove this lower frequency noise without affecting the playback quality of the actual sound signal.

## 4.2. Sensor calibration mode

MagicQuartz automatically calibrates the sensor read-out of the optical motion sensor next to the turntable's platter. In most cases, this works perfectly fine out of the box. However, a properly set-up optical sensor can improve the performance of MagicQuartz. For this - and in the unlikely case of problems - the sensor calibration menu assists the user in precisely positioning the optical sensor next to the turntable's platter.



**Sensor contrast bar and contrast status:** The graphical bar on top indicates the current sensor image contrast. Try to increase the sensor contrast as much as possible (the graphical bar on top then becomes longer). A higher contrast allows MagicQuartz to better detect the signal edge of the bypassing paper sticker on your turntable's platter. You can influence the contrast by moving it closer or further off to the spinning platter. It takes some time until the bar image changes, depending on the current RPM setting. *Note: It is normal that the bar's ends sometimes can jump by three vertical lines on each side.*

If the contrast is considered to be good enough, a check mark will be displayed on the right side next to the bar, as shown above (contrast status). [The Arduino version displays an asterisk \(\\*\) if the contrast is good.](#) However, it is still possible to improve the overall performance of MagicQuartz by increasing the contrast even further. If otherwise a user or setup error is detected, MagicQuartz automatically displays recommendations:

	+	The sensor is too close to the turntable's platter. Increase the distance between the sensor and the turntable's platter to improve the contrast.
---	---	---

	-	The sensor is either not connected or too far off to the turntable's platter. Connect the sensor or decrease the distance between the sensor and the turntable's platter to improve the contrast.
	C	Low contrast. Check if you have attached a paper sticker to the turntable's platter and that the platter is rotating. If everything is set-up properly but still does not work, it might help to use a sticker with a different color (e.g. black instead of white). Generally speaking, the sticker should have a different shade compared to the turntable's platter.

**Rotation indicator:** The rotation indicator is used to visualize whether MagicQuartz is able to correctly detect the bypassing paper sticker on the platter or not. With each rotation, the rotation indicator progresses to the next rectangle. If the detection is erroneous it skips, often at irregular time intervals. As a consequence, it will display jumpy, sometimes high delta values (see below).

Highly reflective turntable platters can cause such a “jumpy” rotation indicator. In conjunction with an unevenly machined surface of the platter, a moving reflection can trigger false edges in the signal. This can be circumvented by slightly tilting the motion sensor next to the platter, therefore avoiding the sensor picking up its own reflection.

**Advanced:** *Understanding and optimizing the measurement jitter / delta value*

The measurement jitter value, as indicated by the delta value, is the deviation in 10th milliseconds between two measurement intervals. For example, if the platter is spinning at exactly 33.3333 RPM, it takes 1,800 milliseconds (or 18,000 10th milliseconds) for one full rotation. However, due to measurement errors (signal noise, ambient light flicker, etc.), MagicQuartz typically measures some fluctuation, e.g. 18,002, 17,998, 18,000, 18,001, 17,997 and so on. For the first two measurements, the delta value would be 4 (the difference between 18,002 and 17,998).

To improve the overall performance of MagicQuartz, it is desired to keep this measurement jitter as low as possible. The ideal value would be zero, which is typically never achieved in the long run. Lower values (below 20) are, however, acceptable, because MagicQuartz's live quartz algorithm is capable of efficiently dealing with this type of measurement error.

If an acceptable jitter value is measured over some time, MagicQuartz displays a check mark right to the delta value. However, if the jitter is too bad (e.g., > 20), it displays a cross next to the delta value.

You can try to improve (i.e. lower) the measurement jitter by changing the position of the optical motion sensor. A high contrast does not necessarily correlate with a low jitter. Moving the sensor closer to the platter (and thereby reducing the contrast in some cases) may reduce the jitter. Also, avoiding fluorescent or changing ambient light could help.

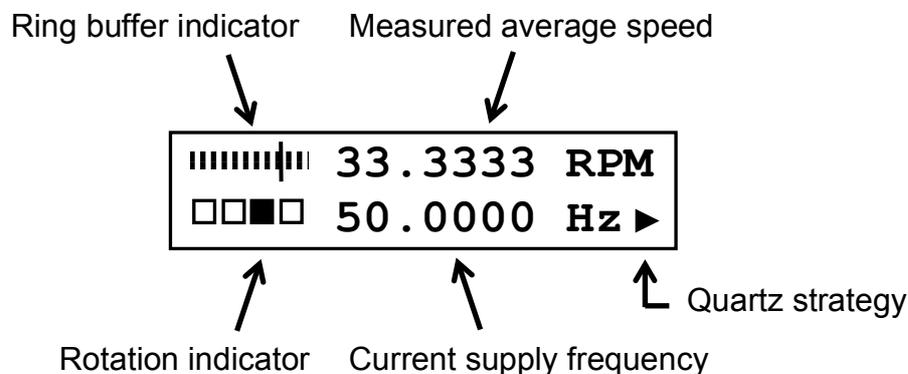
MagicQuartz features a software low-pass filter for the optical motion sensor. You can use the up and down buttons in the sensor calibration mode to change the strength of the low-pass filter. A higher value means more filtering. It reduces the

signal noise but also reduces the edge quality of the bypassing sticker. You can play around with this value in order to (slightly) improve the jitter.

### 4.3. Live quartz mode

MagicQuartz features a live quartz mode in which the software constantly monitors and corrects the platter rotation speed. The speed is adjusted by calculating and changing the supply frequency.

To start live quartz mode, select the **Q** in the lower left corner of the main menu. MagicQuartz automatically calibrates the sensor and then enters the live quartz mode. To exit live quartz mode, press the OK button again. The following figure shows the live quartz mode screen:



The **rotation indicator** has the same functionality as described in *Sensor Calibration Mode*. It should progress to the next rectangle at each rotation and never skip.

MagicQuartz displays the **measured average speed** of the turntable's platter on top and the computed **current supply frequency** on the bottom of the screen.

#### **Advanced:** Understanding the speed and frequency values in live quartz mode

The **measured average speed** is calculated based on an *unweighted moving average* of the previous speed measurements (one per rotation). To calculate this speed, MagicQuartz uses a ring buffer to store the speed measurements. Once this buffer is completely filled, the oldest values are overwritten again. The **ring buffer indicator** on the upper left of the screen displays the fill level and the current writing position. The size of the buffer is determined by the parameter **BufferSize**, which can be changed in the configuration menu. Depending on the setting of the parameter, the **measured average speed** display reacts more promptly (small values for **BufferSize**) or less promptly (higher values for **BufferSize**) to speed changes. The buffer is also automatically cleared when MagicQuartz believes that this is appropriate (see parameter **BufferClear**). To clear the ring buffer at any time, press the RE-SET button.

MagicQuartz computes the **current supply frequency** based on a *special weighted moving average* algorithm while considering each measurement's quality. This *live quartz algorithm* therefore can efficiently deal with measurement errors. It operates totally independent from the "simple" average speed computation as described above. Hence, the measured average speed cannot be understood as an indicator to assess the performance of the live quartz algorithm.

To assess the live quartz algorithm's performance, the current **quartz strategy** and status is shown with a symbol in the lower right corner:

▶		MagicQuartz is considering the current platter speed on par with the target platter speed. Everything is fine - the turntable is running with quartz precision.
▲	)	MagicQuartz is considering the current platter speed a bit too low and is up-regulating the supply frequency. Everything is fine - the turntable is still running with quartz precision.
▼	(	MagicQuartz is considering the current platter speed a bit too high and is down-regulating the supply frequency. Everything is fine - the turntable is still running with quartz precision.
▲▲	>	MagicQuartz is considering the current platter speed as too low and is constantly up-regulating the supply frequency. If this does not disappear, please consider reducing the value <b>QrtzLatency</b> (see below).
▼▼	<	MagicQuartz is considering the current platter speed as too high and is constantly down-regulating the supply frequency. If this does not disappear, please consider reducing the value <b>QrtzLatency</b> (see below).
	W	MagicQuartz has paused the quartz regulation. This for example happens after MagicQuartz has rejected bad measurements (see below) or waits for an accelerating turntable platter. For details, see parameter <b>WaitOnBad</b> and <b>WaitOnStart</b> .
✘	D	MagicQuartz has detected and dropped a bad measurement. (For details, see parameter <b>BadDelta</b> .)
■	S	The quartz regulation is turned off ( <b>QrtzLatency</b> = 0).
LIM	LIM	The limit of the quartz regulation range has been reached and MagicQuartz has stopped regulating the supply frequency for security reasons. Please refer to the description of the parameter <b>QuartzRange</b> for more information.

The live quartz algorithm can be tuned by changing the **quartz latency** (parameter **QrtzLatency**). This can either be set in the configuration menu or by pressing the left and right buttons while being in live quartz mode.

When **QrtzLatency** is set to "0", quartz regulation is deactivated. "1" sets the quartz regulation to full impact where MagicQuartz can quickly react to speed changes. The drawback is that this causes larger supply frequency changes, which should be avoided (because these could be audible).

Setting `QrtzLatency` to higher values reduces the strength of the quartz regulation. As shown in the **quartz strategy** table above for the two double arrow symbols, the quartz algorithm however may fail for too high values. In this case MagicQuartz will fail to keep up with speed changes or speed drifts. It then constantly shows double up or down arrows. If this happens, reduce `QrtzLatency`.

It is recommended to keep `QrtzLatency` as high as possible to avoid larger supply frequency changes, but low enough to let the quartz algorithm properly keep up with speed changes. The default value is "3". Values higher than "6" are typically not recommended.

## 4.4. Configuration Menu

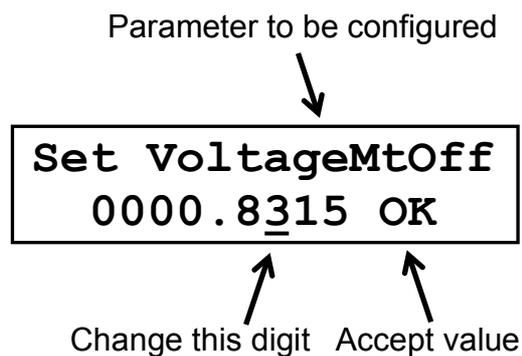
The configuration menu allows you to set up MagicQuartz. It allows you to execute different functions and to set parameter values.

### General Use

Use the left and right buttons to switch between the menu entries. Press the OK button to activate a function.

The first menu entries (which do not start with `set . . .`) execute various functions. Please refer to the corresponding sections below for details.

The `set . . .` functions (see illustration below) allow you to change numeric parameters. Use the left and right buttons to select a digit. You can then increase or decrease the value by pressing the up and down buttons. To exit the screen, move the cursor below `OK` and press the up button.



### Summary of all functions

The table below lists all menu entries along with a short description. Where necessary, more details are given in the other sections.

*Note: The given value ranges below describe the absolute minimum and maximum values that can be entered and stored, but should not suggest that it actually makes sense using them. Please refer to the corresponding sections below for details!*

Function default (range)	Description
<b>Exit Menu</b>	Exits the menu and returns to the main screen.
<b>Show Power Info</b>	Displays useful information about the motor's current draw. It can be used to determine various motor-related values. See dedicated chapter.
<b>Show Sensor Info</b>	Displays useful information about the optical sensor readout. See dedicated chapter.
<b>Show Statistics</b>	Displays the total uptime (without standby time), the time the turntable's platter was running, the time until it performs a memory shift (flash wear leveling) again and the flash memory write operations since start-up.
<b>Calibrate Motor</b>	Starts a guided procedure that automatically determines <b>VoltageMtOff</b> , <b>VoltageMtOn</b> , <b>BootRunThrs</b> , <b>MotorSwThrs</b> , <b>OvlProtThrs</b> and <b>AmpFailThrs</b> .
<b>Calib OvlProtThrs</b>	Better calibrates <b>OvlProtThrs</b> , because it detects the maximum possible value. You need to connect a light bulb (about 28W) to MagicQuartz and switch it on for a very short time. <i>Note: This can blow the fuse of your MagicQuartz unit, so it is a good idea to short-circuit the fuse while executing this function.</i> See dedicated chapter for details.
<b>Reset Settings</b>	Resets all settings, but leaves the flash wear leveling intact.
<b>Run Full Format</b>	Resets all settings, factory reset. Also resets the wear leveling.
<b>Shift Memory</b>	Manually triggers a flash memory shift by one byte (wear leveling).
<b>Set DefaultHertz</b> 50 (40-70)	Sets the default (nominal) supply frequency. It should match the mains frequency your turntable was built for (50 or 60 Hertz). <i>Warning: Changing the frequency from 50 to 60 Hertz (or vice versa) automatically adjusts VoltageMtOff and VoltageMtOn!</i>
<b>Set VoltageMtOff</b> 0.8403	Sets a factor that controls the supply voltage when the motor is off. See dedicated chapter below.
<b>Set VoltageMtOn</b> 0.8971	Sets a factor that controls the supply voltage when the motor is on. See dedicated chapter below.
<b>Set VoltageDrop</b> 1.1000	Sets a factor that controls the supply voltage drop depending on the supply frequency (U/f characteristic).
<b>Set BootRunThrs</b> 310 (0-1023)	Sets the motor's current draw above which the motor is considered to be switched on upon boot (system start). With a value of 0 MagicQuartz assumes that the motor is already switched on.
<b>Set OvlProtThrs</b> 600 (0-1023)	Sets the motor's current draw at which the amplifier is supposed to be over-loaded during normal operation.
<b>Set AmpFailThrs</b> 40 (0-1023)	Sets the current draw upon boot (with no supply voltage activated yet) at which the power amplifier is supposed to be defective. Such a current draw typically occurs if the amplifier has developed an internal short-circuit.
<b>Set MotorSwThrs</b>	Sets the current draw delta that is used to determine the

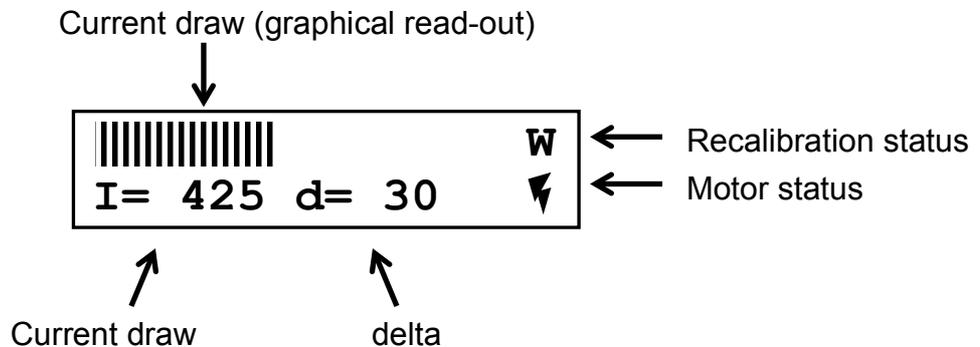
75 (0-1023)	on and off states of the motor. A value of 0 disables the switching state detection and MagicQuartz assumes that the motor is always switched on.
<b>Set MotorSwTime</b> 5 (0-1023)	Sets the delay that is used to compensate the inrush current measurement, when switching the motor on. The value is in 200 ms, i.e. a value of 5 means 1 second.
<b>Set SensLowPass</b> 50 (0-255)	Sets a value that determines the strength of the low pass filter for the optical sensor. Higher values mean more filtering.
<b>Set QuickCalib</b> 0 (0-1)	If set to 1, MagicQuartz performs a quicker calibration when entering live quartz mode. It then does not check for low enough delta values.
<b>Set MaxOKDelta</b> 20 (0-255)	Sets the maximum delta (measurement jitter) that is accepted by the automatic sensor calibration before entering live quartz mode when <code>QuickCalib</code> is set to 0.
<b>Set BufferSize</b> 40 (0-40)	Sets the size of the speed buffer, which is used in live quartz mode to compute the average real-time speed of the turntable's platter. It is recommended to use a multiple of two.
<b>Set BufferClear</b> 8 (0-255)	Sets the number of platter rotations after which the speed buffer is cleared when the turntable is steadily increasing or decreasing its speed.
<b>Set QrtzLatency</b> 3 (0-255)	Sets the latency of the quartz regulation in live quartz mode. 0 means "quartz off", 1 "quartz at full intensity". The quartz intensity regulation decreases with higher values.
<b>Set QuartzRange</b> 10 (0-100)	Sets the percentage of the maximum allowed supply frequency change during live quartz mode.
<b>Set WaitOnStart</b> 3 (0-255)	Sets the number of rotations MagicQuartz waits in live quartz mode at start or after the motor has been switched off and on again.
<b>Set WaitOnBad</b> 3 (0-255)	Sets the number of rotations MagicQuartz waits in live quartz mode after it has detected a "bad" measurement (see <code>BadDelta</code> to adjust the threshold). <i>Note: Do not set this to zero. If you do, you must set <code>WaitOnStart</code> to a value that is high enough to compensate an accelerating platter, e.g. 3.</i>
<b>Set BadDelta</b> 50 (0-255)	Sets the delta (measurement jitter) value above which the measurements are being considered as "bad" in live quartz mode. Zero disables the reject function. <i>Note: Do not set this to zero. If you do, you must set <code>WaitOnStart</code> to a value that is high enough to compensate an accelerating platter, e.g. 3.</i>
<b>Set StandByMins</b> 40 (0-255)	Sets the standby timer in minutes. If this time has passed, MagicQuartz will switch into standby mode. The timer is reset whenever a key is pressed, the motor is switched on or off and when platter motion is detected in live quartz mode. Zero disables the standby function.
<b>Set TotalHours</b> (0-9999)	Sets the hours of the total uptime. This can be used to restore the time counter after a unit reset. <i>Note: It is not possible to change minutes or seconds.</i>

<b>Set PlayHours</b> (0-9999)	Sets the hours of the time in which the turntable's motor was supposed to be running. This can be used to restore the time counter after a unit reset. <i>Note: It is not possible to change minutes or seconds.</i>
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### "Show Power Info"

This function displays the internal measurement of the **current draw**, which is displayed in the lower left corner, I.

*Note: The range is from 0 (no current is drawn) to 1023 (the maximum value that can be measured by MagicQuartz), but the operational amplifier circuit limits it to about 700, which means you will never measure values above 700, even if the current draw is higher. The value is different on each unit because of the components' tolerances.*



Switching the motor on and off should display different current draw values, and the **motor status** indicator should change accordingly (if not, you may need to calibrate your motor or change **MotorSwThrs**). As in the main menu, a flash symbol is shown in the lower right corner when MagicQuartz believes that the motor is switched on.

The function also displays the measured **delta** value, d. This value can be set to zero by pressing the RESET button (button 3).

When switching the motor on or off, the **recalibration status** displays a **w** ("wait") for the duration set in **MotorSwTime**, and then a **c** ("calibrate"). While a **w** is displayed, MagicQuartz does not re-measure its internal current draw reference until the **c** is shown; however, it still reacts to switches. This is necessary because the **w** period is used to ignore motor start inrush current peaks.

For more information on how to understand these values, please refer to "Theory of operation".

### "Show Sensor Info"

This function displays the measurement value of the optical sensor. The range is from 0 (bright) to 1023 (dark).



Please note that the MagicQuartz firmware has been optimized to keep the number of memory writes as low as possible. In combination with the flash wear leveling, a total of 100.000 hours of operation can be estimated. This corresponds to 137 years of service life if used 2 hours per day.

### **“Calibrate Motor”**

Please refer to section *Calibrating the turntable's motor* in *Quick Start*.

### **“Calib OvlProtThrs”**

This function calibrates `OvlProtThrs` (overload protection threshold).

<pre>Turn on load... OvlProtThrs=520</pre>
--

Although this is also done in the *Calibrate Motor* function (see above), this function is better. It detects the absolute maximum value that can be measured, whereas *Calibrate Motor* just picks a value that is slightly above the maximum load of the turntable's motor.

As this procedure can blow the fuse of your MagicQuartz unit, it is a good idea to short-circuit the fuse while executing this function. Then connect a light bulb (about 28W, no CFL or LED lamp) to MagicQuartz and switch it on for a very short time, then immediately switch it off again. The value shown in the second line should increase to about 720 (note that this can vary depending on the tolerances of the hardware components). Press OK to exit this function again.

### **“Reset Settings” and “Run Full Format”**

These functions can be used to reset the settings of MagicQuartz. The function “Reset Settings” restores the standard settings but leaves the flash wear leveling intact. The “Run Full Format” function also resets the wear leveling. More information about the flash wear leveling can be found above under “Show Statistics”.

### **“Shift Memory”**

Normally, MagicQuartz shifts the whole configuration flash memory every 24 hours to distribute the memory writes across the whole memory area. The function „Shift Memory“ triggers this manually and resets the timer back to 24 hours. More information about the flash wear leveling can be found above under “Show Statistics”.

### **“Set DefaultHertz”**

This parameter sets the default (nominal) supply frequency. It should match the frequency your turntable was built for (typically 50 or 60 Hertz).

Switching between 50 and 60 Hertz automatically adjusts `VoltageMtOff` and `VoltageMtOn`. Switching from 50 to 60 Hertz applies a factor of 0.5 to both of these values, while switching from 60 to 50 Hertz applies a factor of 2. This is supposed to automatically change the supply voltage from 220 to 110 Volts or vice versa.

### **“Set VoltageMtOff” and “Set VoltageMtOn”**

These values change the generated output voltages, for the motor being switched “off” and “on”. When changing one of these voltages, make sure to have your motor in the respective switched state (i.e. “on” if you change `VoltageMtOn`). It is a good idea to first change the lower digits to avoid unexpected big changes in the output voltage. Increasing the value increases the voltage.

Setting the value to 1 produces the highest output voltage possible with the sine wave not being disturbed. For values above 1 the generated sine wave is chopped off at its peaks and humming from the transformer might be audible. For higher settings, the generated waveform changes to a rectangular wave. It is therefore recommended to keep the values below or at 1.

If you cannot reach a sufficient output voltage even at the setting of 1, MagicQuartz might not be suitable to power your turntable model. However, many turntables run just fine below nominal voltage. For example, a Dual 1219 (rated at 220 Volts) runs OK on 180 Volts. Below 160 volts the motor’s rotor however starts to slip.

**Arduino:** The Arduino version is not capable of generating 220 Volts when the motor shield is powered with 18 Volts. Depending on the transformer being used, it is generating around 180 Volts. It is not recommended to power the Arduino motor shield with more than 18 Volts as this might be damaging it.

### **“Set VoltageDrop”**

This sets the factor for the Volts per Hertz (U/f) characteristic, which is explained in more detail in the section “Theory of operation” below.

### **“Set BootRunThrs”, “Set OvIProtThrs” and “Set AmpFailThrs”**

These values control the power monitoring features of MagicQuartz. Please refer to the section “Theory of operation” for an explanation.

### **“Set MotorSwThrs” and “Set MotorSwTime”**

These values control the motor status detection (i.e. if the motor has been switched on or off). Please refer to the section “Theory of operation” below for an explanation.

### **“Set SensLowPass”**

This value sets the strength of the low pass filter for the optical sensor signal. Higher values mean more filtering. Please refer to the section “Theory of operation, Optical sensor” below for an explanation.

### **“Set QuickCalib”**

If this is set to 1, MagicQuartz performs a quicker calibration when entering live quartz mode. It then does not check for low enough delta values.

### **“Set MaxOKDelta”**

Sets the maximum delta (measurement jitter) that is accepted by the automatic sensor calibration before entering live quartz mode when `QuickCalib` is set to 0.

### **“Set BufferSize” and “Set BufferClear”**

These two values determine the behavior of the current speed display in live quartz mode.

`BufferSize` determines the size of the speed ring buffer, which is used in live quartz mode to compute the average real-time speed of the turntable’s platter. It is recommended to use a multiple of two. Depending on the setting of this parameter, the measured average speed value in live quartz mode reacts more promptly (small values for `BufferSize`) or less promptly (higher values for `BufferSize`) to speed changes. Please note that changing this value has no impact on the quartz algorithm, as the supply frequency is calculated independently from average speed value.

`BufferClear` sets the number of platter rotations after which the speed buffer is automatically cleared when the turntable is steadily increasing or decreasing its speed. This approach gives you more timely speed-readings if there were big speed changes (which should, in fact, not happen).

### **“Set QrtzLatency”**

This is the main parameter to control the performance of the live quartz algorithm. Please refer to section "Live quartz mode" for an explanation on how to use this value.

### **“Set QuartzRange”, “Set WaitOnStart”, “Set WaitOnBad” and “Set BadDelta”**

These are advanced parameters to control the performance of the live quartz algorithm. They are used to actually disable the quartz regulation in certain moments. Please refer to the table above for explanations.

## “Set StandByMins”

Sets the time after which MagicQuartz goes into stand-by mode.

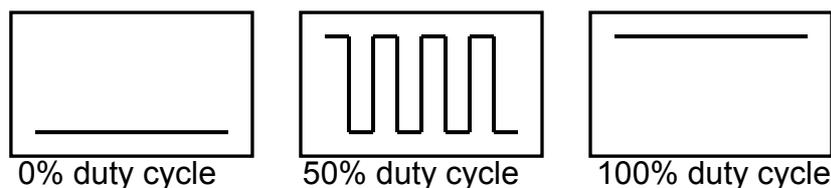
## “Set TotalHours” and “Set PlayHours”

These functions can be used to reset usage timers after a unit reset.

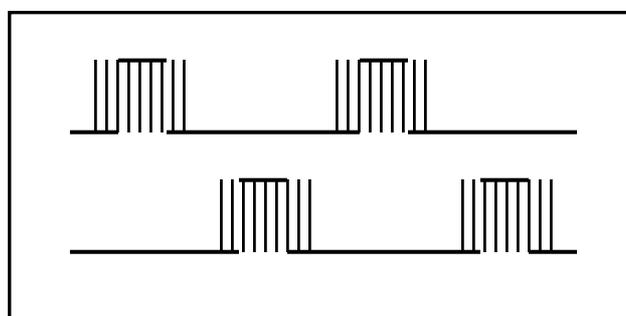
# 5. Theory of operation

## 5.1. Supply voltage and frequency generation

MagicQuartz acts as a high-efficiency, digital switching voltage transformer. To produce the ultra-pure sine wave supply voltage, it makes use of high-frequency pulse width modulation (PWM). This is a common, very power-efficient technique to produce analogue-like signals with digital systems. It works by switching a digital signal on and off very quickly. The analogue signal level corresponds to the percentage of the on time in the digital signal (the duty cycle), as shown in the following figure:



Note that arbitrary values between 0% (always off) and 100% (always on) are possible and necessary to reconstruct a sine wave. Because the switching frequency (which is always fixed) theoretically audible in the audio signal of the turntable, a switching frequency of 31.250 kHz has been chosen, which is inaudible to humans. MagicQuartz produces two such signals, which correspond to the two halves of a sine wave. The two signals can be observed with a two-channel oscilloscope and look like this (simplified, the dashed areas actually consist of increasing and decreasing duty cycles):



These signals are then being amplified and fed into a step-up transformer to produce the high supply voltage. Before exiting the unit, this voltage is low-pass filtered to produce the pure sine wave. To adjust the voltage of the output voltage, MagicQuartz simply alters the duty cycle of the two halves. At full voltage, a high dynamic resolu-

tion of 8 bits per half-wave (totaling in 9 bits for the full sine wave) with 128 discrete values per sine period ( $2\pi$ ) is achieved.

The supply frequency is determined by the speed, at which MagicQuartz steps through these 128 discrete values. By doing this, MagicQuartz is able to reproduce all 128 values at any speed, resulting in a non-distorted, pure sine wave signal. Because the timing capabilities of the whole circuit are limited by the clock signal of the microprocessor and the time that is needed to reproduce the full sine wave, a specially developed technology (we call it "GCD Time Interleaving Algorithm") is employed to achieve the high temporal resolution that allows frequency changes by 1/10.000 Hertz.

## 5.2. Security features and motor status detection

Much care has been taken during the development of MagicQuartz to ensure safe operation. The unit constantly monitors the current draw of the power amplifier to detect the motor status and to assure that the power amplifier is working as expected. The following explanations are illustrated in the figure below.

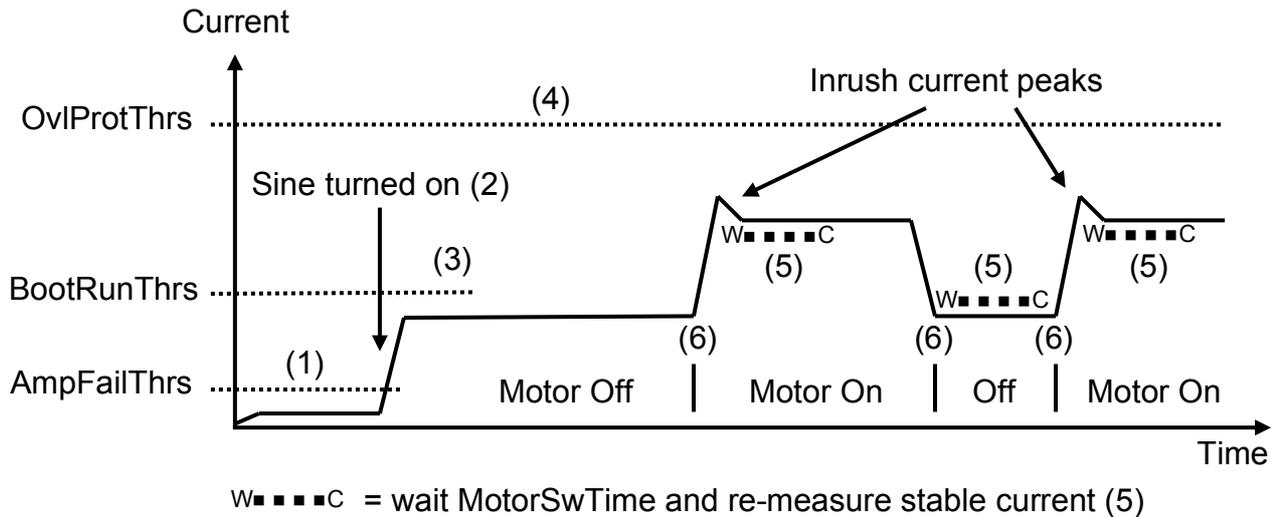
- After switching on MagicQuartz, the current-draw of the motor is checked before activating the sine wave generation. In this phase, the current draw of the amplifier should be nearly zero. If the current draw is higher than the **AmpFailThrs** (Amplifier Failure Threshold) value (1), it displays the warning "**Amplifier fail? Turn off!**". The user should switch off the unit immediately. In the figure below, the reading is below **AmpFailThrs**, so everything is OK.
- MagicQuartz then switches on the sine wave generation (2). If the current draw is higher than the **BootRunThrs** (Boot Run Threshold) value, it assumes that the motor is already turned on (3). In the figure below this limit is not reached, so the motor is assumed to be off.
- From now on, MagicQuartz continuously monitors the current draw of the amplifier to check if it is overloaded and if the motor was switched on or off.
- If the current draw exceeds the value in **Ov1ProtThrs** (Overload Protection Threshold), it displays an overload warning (4). In the figure below this never happens, so everything is OK.
- If the current draw exceeds the rating of the fuse, the fuse will blow.

The automatic detection of the motor status works as follows:

- After MagicQuartz has started up or whenever it has detected a motor switch (from on to off or vice versa), it waits the time as specified in **MotorSwTime** (Motor Switch Time) to ignore a possible inrush current (for a short time, the motor draws more current when switched on) and then re-measures the stable current draw. In the illustration below, this waiting period is indicated with the "w----" and the re-measurement with the "c" (5). *Note: The value in **MotorSwTime** is in 200 ms, i.e. a value of 5 means 1 second.*
- MagicQuartz now continues to monitor the current draw. If it detects a difference to the stable current (see above) as specified with the value **Mo-**

`torSwThrs` (Motor Switch Threshold) it assumes that the motor has been switched on (for positive deltas) or off (for negative deltas) (6).

- MagicQuartz also detects motor switches while waiting the `MotorSwTime` time. However, it should be avoided to switch the motor on or off at the end of this time period, when the stable current is re-measured, as this leads to the detection of a bad motor status. Therefore, it is a good idea to set the `MotorSwTime` to a higher value.



Please note that the function “Show Power Info” in the configuration menu can be used to demonstrate this behavior. In this function, the current drawn is shown with the  $I$  value. The inrush current compensation behavior is shown with the **recalibration status**, which displays a **w** (“wait”) while waiting `MotorSwTime`, and a **c** (“calibrate”) when re-measuring the stable current draw.

### 5.3. Output voltage generation

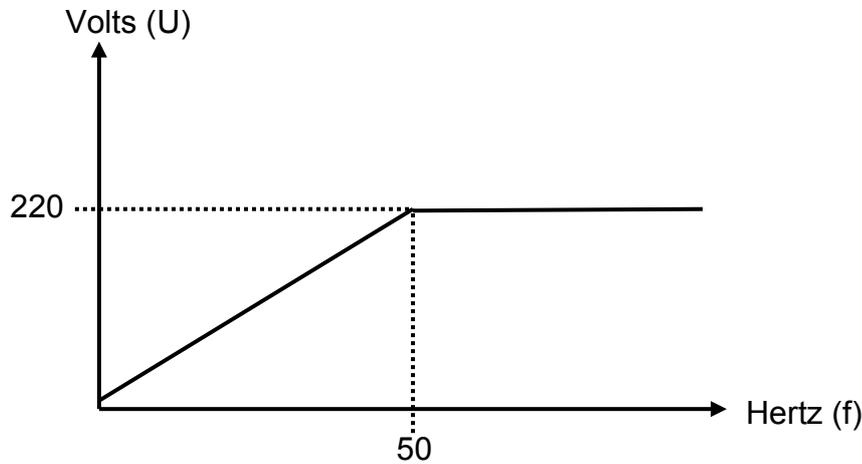
Depending on the detected motor status (on or off) the factors `VoltageMtOn` or `VoltageMtOff` are applied to the amplitude of the generated sine wave in order to adjust the supply voltage. Both values should be set to output exactly the operation voltage of the turntable (220 or 110 Volts) at the nominal supply frequency (as set in `DefaultHertz`).

MagicQuartz applies the Volts per Hertz (U/f) characteristic, because the AC motor requires that the voltage magnitude of the inverter's output to the motor be adjusted to match the required load torque in a linear U/f relationship. This means that MagicQuartz reduces the amplitude of the sine wave for Hertz values below the nominal supply frequency (as set in `DefaultHertz`). This factor that is applied to the sine wave's amplitude is determined by the `VoltageDrop` value. A higher `VoltageDrop` value corresponds to a higher voltage drop for lower frequencies (as illustrated in the next figure). The factor controls the output voltages as follows:

$$\text{VoltageMtOn} = (\text{currentHertz} / \text{DefaultHertz}) * \text{VoltageDrop}$$

$$\text{VoltageMtoOff} = (\text{currentHertz} / \text{DefaultHertz}) * \text{VoltageDrop}$$

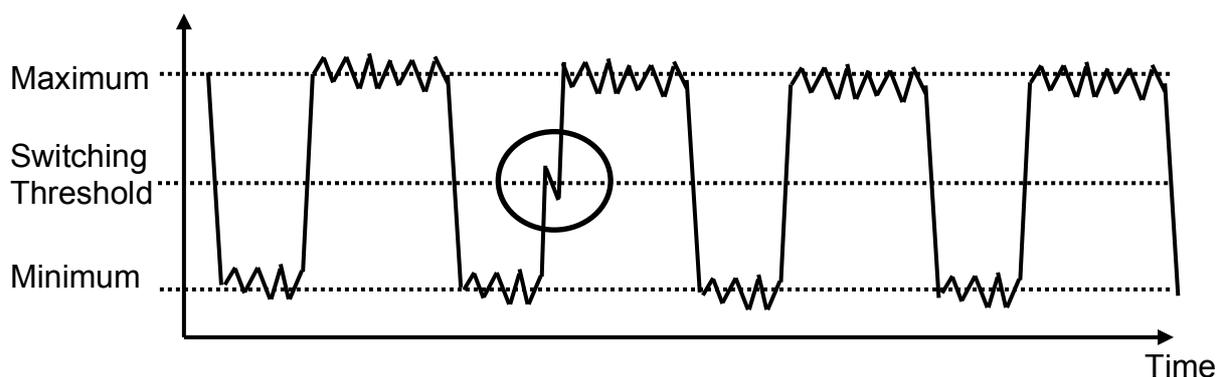
where “currentHertz” is the supply frequency currently being generated. This expression shows that there is no voltage drop for a `VoltageDrop` set to 1. In this case the U/f characteristic is, so to say, disabled.



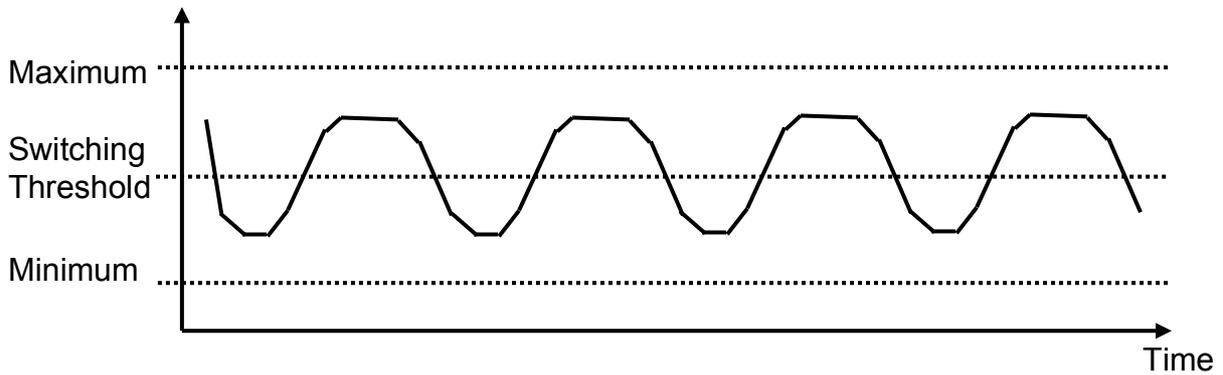
If you experience a distorted sine wave (which can be measured with an oscilloscope – but be careful when measuring high voltages!) or a buzzing/humming noise (as a result of the distorted sine wave that is caused in the transformer), it is a good idea to increase the `VoltageDrop` value.

## 5.4. Optical sensor

The optical sensor signal is used to determine the speed of the turntable’s platter. The original optical sensor signal is typically overlaid with a noise signal, which can cause falsely detected edges, as shown in the following figure (circle):



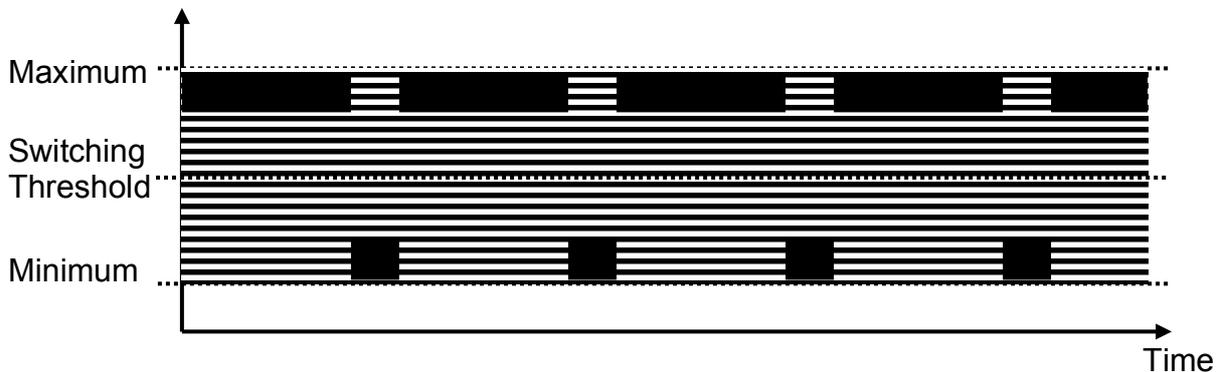
By applying a low pass filter, this noise can be removed. The higher the strength of low pass filter, the more noise is removed. However, the filter also smoothens the overall signal, turning it from a rectangular-like signal (as shown above) into a more sine-like signal (as shown below). This also reduces the quality of the edges and reduces the precision of the edge detection.



In MagicQuartz, such a low-pass filter can be configured by changing the parameter **SensLowPass**, where higher values mean more filtering.

The graphical display in the function "Show Sensor Info" can be used to evaluate how well the optical signal is suited to be processed by MagicQuartz. In the illustration below, the graphical screen display is "rotated" by 90° and plotted against time.

For an optimal signal, the current sensor value (black boxes) flips between maximum and minimum. The bypassing sticker causes the short "low" periods (in this example at the minimum value, because the sticker is brighter than the turntable's platter). MagicQuartz is interpreting flips across the half of the detected range (dashed area), i.e.  $(\text{Maximum} + \text{Minimum}) / 2$  as detected edges (switch threshold).



Please note that for real-world signals, the current value typically does not always flip between minimum and maximum due to the noise added to the signal (see above). This is perfectly fine as long as the "high" and "low" periods are well above and below the switching threshold.

However, if e.g. the maximum value (which in our above example is the rim of the platter and not the sticker) is not stable and goes below the switching threshold, MagicQuartz will fail to detect a "sharp" edge in the optical signal. It will detect an edge before the sticker reaches the optical sensor. This can happen if the rim of the turntable's platter does not have a constant brightness, as it can happen e.g. on polished platters.

## 6. Solving issues

This section covers issues that you may encounter, along with solutions. If you come across other problems, please contact us!

### Problems during or directly after system boot (after switching it on):

Problem / Message	Cause and solutions
<p>Error message:</p> <p><b>Amplifier fail?</b> <b>Turn off! = XXX</b></p>	<p>The power amplifier or its connected circuitry is drawing more current (<b>xxx</b>) than allowed by the parameter <b>AmpFailThrs</b> while being in idle mode (i.e. no wave form is generated).</p> <ul style="list-style-type: none"> <li>• Immediately turn off MagicQuartz to avoid possible further damage to the unit.</li> </ul> <p>There could be a soldering issue on the PCB. Bridges between the PCB's traces or soldering points may cause a high current load.</p> <ul style="list-style-type: none"> <li>• Check the soldering around the power amplifier, the shunt resistor and the OP amp.</li> </ul> <p>This may also be due to a short circuit in the amplifier.</p> <ul style="list-style-type: none"> <li>• If the shown <b>xxx</b> value is rather high, e.g. &gt; 50, replace the amplifier.</li> <li>• If the shown <b>xxx</b> value is rather low, e.g. &lt; 50, turn MagicQuartz on again while keeping the right button (button 2) pressed. This disables the power monitoring and allows you to increase the value <b>AmpFailThrs</b>. Set this to a value slightly higher than <b>xxx</b> and restart MagicQuartz.</li> </ul>
<p>MagicQuartz fails to detect that the motor has been switched on before the MagicQuartz unit itself has been switched on.</p>	<p>The parameter <b>BootRunThrs</b> is not properly set.</p> <ul style="list-style-type: none"> <li>• Repeat the steps in "Calibrating the turntable's motor" <b>OR</b></li> <li>• Lower the value in <b>BootRunThrs</b>. <b>OR</b></li> <li>• Use the function <b>Show Power Info</b> to determine the threshold parameter <b>BootRunThrs</b>, above which the motor is supposed to be running. You can manually calculate <b>BootRunThrs</b> with <math>(I_{\text{MotorOn}} + I_{\text{MotorOff}}) / 2</math>.</li> </ul> <p>The motor's current draw is too low to allow MagicQuartz to properly detect its status.</p>

	<ul style="list-style-type: none"> <li>This is not a good solution, but rather a work-around: Set the value in <code>BootRunThrs</code> to 0. MagicQuartz now believes that the motor is always switched on. Note that this may cause changes in the output voltage because MagicQuartz cannot adapt to these.</li> </ul>
<p>MagicQuartz displays strange values on the main screen.</p> <p><b>OR</b></p> <p>MagicQuartz behaves erratic.</p>	<p>The internal flash memory has been corrupted (this should never happen).</p> <ul style="list-style-type: none"> <li>Turn off MagicQuartz.</li> <li>With the RESET button (button 3) kept pressed, turn it on again. This will reset MagicQuartz to its default values.</li> <li>You will now need to go through the setup procedure as described in "Quick start".</li> </ul>

**Problems during normal operation:**

<b>Problem / Message</b>	<b>Cause and solutions</b>
<p>Error message:</p> <p><b>L6203 overheated</b> <b>Retry?</b></p>	<p>The power amplifier switched itself off, typically because it was running hot.</p> <ul style="list-style-type: none"> <li>Wait 2 minutes, then press any key to retry.</li> <li>Try to better cool the amplifier.</li> </ul> <p>If this message appears directly after the start, the power amplifier could be defective or not properly soldered to the PCB. Also check the soldering of the shunt resistor and the OP amp.</p>
<p>Error message:</p> <p><b>Overload = XXX</b> <b>Retry?</b></p>	<p>The turntable is drawing more current than allowed by the parameter <code>Ov1ProtThrs</code>:</p> <ul style="list-style-type: none"> <li>Press any key to retry.</li> <li>If the problem persists, repeat the steps in "Calibrating the turntable's motor"</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>Use the function <code>Calib Ov1ProtThrs</code>.</li> </ul> <p>The turntable is drawing more current than MagicQuartz can deliver:</p> <ul style="list-style-type: none"> <li>Increase <code>Ov1ProtThrs</code> to a value that can never be reached/measured (e.g. 1023, which is the absolute maximum). This disables the software overload protection feature. Use with caution!</li> </ul>

<p>Message</p> <p><b>Please wait ...</b></p> <p>does not disappear</p>	<ul style="list-style-type: none"> <li>Restart the unit.</li> </ul>
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**Problems related to the detection of the motor switching status:**

<b>Problem / Message</b>	<b>Cause and solutions</b>
<p>Error message:</p> <p><b>Motor is off!</b></p> <p><b>Abort?</b></p>	<p>MagicQuartz believes that the turntable's motor is switched off. It therefore does not enter the sensor calibration or live quartz mode.</p> <ul style="list-style-type: none"> <li>If it is switched off, switch it on.</li> <li>Switch if off, then switch it on again.</li> </ul> <p>If this does not work, your current supply frequency or RPM setting might be low to allow MagicQuartz to properly detect the motor status (in this case, the current draw is too low to allow detecting the switching status).</p> <ul style="list-style-type: none"> <li>Press any key to abort. Reset MagicQuartz to the default speed, then try again.</li> <li>Switch the motor off, then switch it on again.</li> </ul> <p>If this does not work, also try the solutions from the following three problems:</p>
<p>MagicQuartz fails to detect the motor switching status. When switching the motor on, there is no flash symbol in the lower right corner of the main screen.</p>	<p>The parameter <b>MotorSwThrs</b> is not properly set.</p> <ul style="list-style-type: none"> <li>Repeat the steps in "Calibrating the turntable's motor"</li> <li><b>OR</b></li> <li>Use the function <b>Show Power Info</b> to determine the parameter <b>MotorSwThrs</b>. To manually calculate <b>MotorSwThrs</b>, you can use a fraction of the difference <math>I_{\text{MotorOn}} - I_{\text{MotorOff}}</math>, e.g. <math>(I_{\text{MotorOn}} - I_{\text{MotorOff}}) / 2</math>. Using a smaller fraction (e.g. by dividing the difference by 3) can help if MagicQuartz does not properly detect switches. However, the calculated value must not be lower or equal to the delta value that is shown in the <b>Show Power Info</b> function (illustrated as "30" in the corresponding section), because in this case MagicQuartz would detect random switches in the signal noise.</li> </ul> <p>The motor's current draw is too low to allow MagicQuartz to properly detect its status.</p>

	<ul style="list-style-type: none"> <li>This is not a good solution, but rather a work-around: Set the parameter <b>MotorSwThrs</b> to 0 so that MagicQuartz believes that the motor is always switched on. Note that this may cause changes in the output voltage because MagicQuartz cannot adapt to these.</li> </ul>
The motor switching status detection is not stable. The flash symbol in the lower right corner of the main screen "flickers".	<p>The parameter <b>MotorSwThrs</b> is too low.</p> <ul style="list-style-type: none"> <li>Increase the parameter <b>MotorSwThrs</b>.</li> </ul>
The motor switching status detection is not stable. After switching the motor on, the flash symbol in the main screen appears and disappears immediately thereafter.	<p>MagicQuartz falsely interprets the drops of inrush current peaks as "switch offs". The parameter <b>MotorSwTime</b> is too low.</p> <ul style="list-style-type: none"> <li>Increase the parameter <b>MotorSwTime</b>.</li> <li>Use the function <b>Show Power Info</b> to determine the value <b>MotorSwTime</b>: Immediately after switching the motor on, the current peaks for a very short time and then normalizes to a stable current. Depending on your turntable, this can be seen in the graphical read-out of function <b>Show Power Info</b>. The recalibration status should display <b>w</b> until the peak is fully gone. If it displays a <b>c</b> during the current spike, you should increase the <b>MotorSwTime</b> value. This increases the time between the <b>w</b> and the <b>c</b>. <i>Note: Please refer to section "Theory of operation, Security features and motor status detection" for a better understanding of this.</i></li> </ul>

#### Problems related to the optical sensor:

Problem / Message	Cause and solutions
When entering live quartz mode, MagicQuartz never leaves the sensor calibration screen.	<p>This is because the sensor contrast and the jitter are not good enough for MagicQuartz to continue. Two checkmarks should appear on the right side if both are OK.</p> <p>Please refer to section "Sensor calibration mode" on how to adjust the contrast. Also refer to the next problem and solution for fixing jitter issues.</p>
In the sensor calibration screen, the jitter is nev-	The jitter is too high to be accepted by MagicQuartz.

<p>er considered to be good enough.</p>	<ul style="list-style-type: none"> <li>• Try to improve the jitter by changing the position of the optical sensor.</li> <li>• Read and understand the advanced information box "Understanding and optimizing the measurement jitter / delta value" in section "Sensor calibration mode".</li> <li>• Increase the value in parameter <b>MaxOKDelta</b>.</li> <li>• If nothing else helps, set <b>QuickCalib</b> to 1. Depending on how "bad" your jitter is, prepare yourself for unexpected behavior in live quartz mode.</li> </ul>
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**Problems in live quartz mode:**

<b>Problem / Message</b>	<b>Cause and solutions</b>
<p>MagicQuartz constantly drops bad measurements, pauses the quartz regulation and never (or rarely) displays the "play" symbol.</p>	<p>This is because the sensor contrast and the jitter of the optical sensor are not good enough.</p> <ul style="list-style-type: none"> <li>• Make sure that your turntable is in excellent mechanical condition.</li> <li>• Increase the parameter value <b>BadDelta</b>.</li> </ul>
<p>MagicQuartz constantly displays up or down arrows and never (or rarely) displays the "play" symbol.</p>	<p>The quartz algorithm cannot keep up with the speed changes because the value in <b>QrtzLatency</b> is too high.</p> <ul style="list-style-type: none"> <li>• Reduce <b>QrtzLatency</b> to a value <math>\geq 1</math> by pressing the left and right buttons in live quartz mode. Note: It is not possible to set <b>QrtzLatency</b> to less than 1 (0 turns the quartz regulation off).</li> <li>• If you still experience problems, make sure that your turntable is in excellent mechanical condition.</li> </ul>

## 7. Turntable compatibility chart

The table below shows successfully tested settings for various models of turntables. Please note that you should tweak the settings for your turntable for best performance. No two turntables are the same, even if they are the same model.

*Note: This table is a work in progress!*

Turntable	VoltageMtoOff	VoltageMtoOn	VoltageDrop	BootRunThrs	OvlProthrs	MotorSwThrs	MotorSwTime	SensLowPass	MaxOKDelta	QrtzLatency	WaitOnStart	WaitOnBad	BadDelta
Default	0.8403	0.8971	1.1	310	600	75	5	50	20	3	3	3	50
Dual 1219	0.8403	0.8971	1.1	310	600	75	5	50	20	3	3	3	50
Dual 1019													
Dual 1009													
Dual 1226													
Dual 1210													
PE 2020													
PE 2015													
Micro Seiki MR-311													
Telefunken Mister Hit													
Elac Miracord													