

MASTER CLOCK

PRECIZNOST PMC-1

USER MANUAL

VERSION 1.2

Version	Changes
1.2	1. Corrected wording in list of commands. 2. Added device characteristics. 3. Added recommended peripherals.
1.1	1. Added this changes table. 2. Table column headers centered.
1.0	Published initial version of this document.

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1 Device Overview

1.1 Main Block (the Master Clock)

The main block has a lithium battery that helps keep the internal time and device settings and has a life of over 10 years. When this battery is depleted, the device will continue to function, however, if all power sources fail, all settings will be reset to their default values. The status of the block (depleted battery) is checked with the 'RTC' command described below.

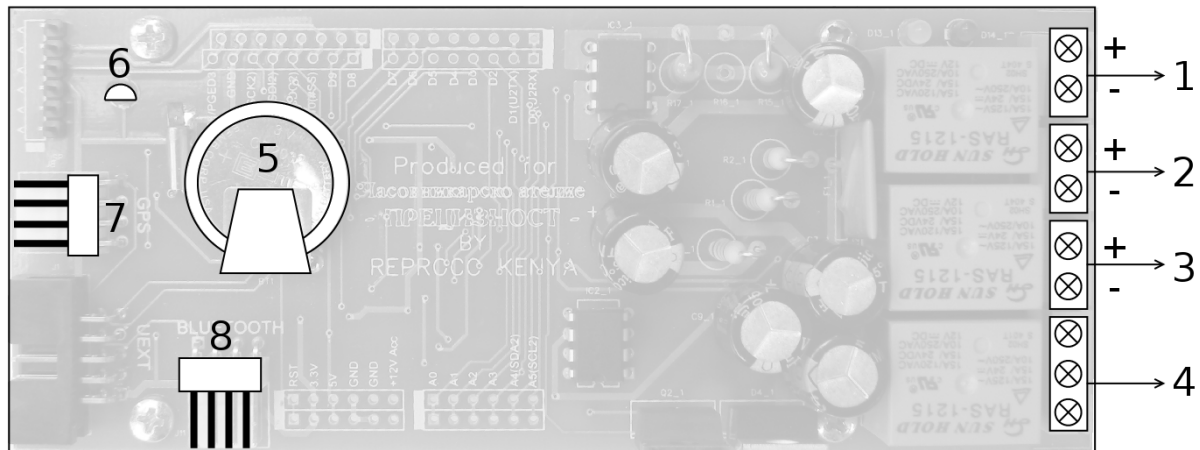


Figure 1: Generalized schematic of the master clock's PCB. 1. Power supply 24V input; 2. Lead-acid battery output; 3. Mechanical clock control pulse output; 4. Relay; 5. Lithium battery; 6. Status LED; 7. GPS socket; 8. Bluetooth socket.

1.2 Power Supply Unit and Lead-Acid Battery Charger

The Power Supply Unit or PSU serves as a source of power for the master clock and as a lead-acid battery charger. A lead-acid battery can be attached to the main PCB that can keep the system running for a limited amount of time if the power goes down. The lead-acid battery is charged with a fixed voltage of 14.2V and maximum current of 500mA. The PSU's output voltage is between 16V and 30V.

1.3 Amplifying Block

The main PCB contains an amplifying block. It outputs 24V for the control of a slave clock mechanism with a 24V coil. The amplifying block is controlled from the system and is turned on only when a control signal is given and is explicitly configured for a 24V mechanism. The block can provide up to 2A of output current, which allows for powering up to 10 clocks with 200mA of nominal current. **WARNING:** The amplifying block can only work if a lead-acid battery/supply block is provided. Without that lead-acid battery the system cannot provide the necessary energy for the amplifying block.

1.4 GPS Block

The GPS block connects to the main block via the designated socket. If the GPS module is available, the date and time are configured automatically when enough satellites are visible.

The device is fully operational without a GPS module, but then it relies only on its internal clock.

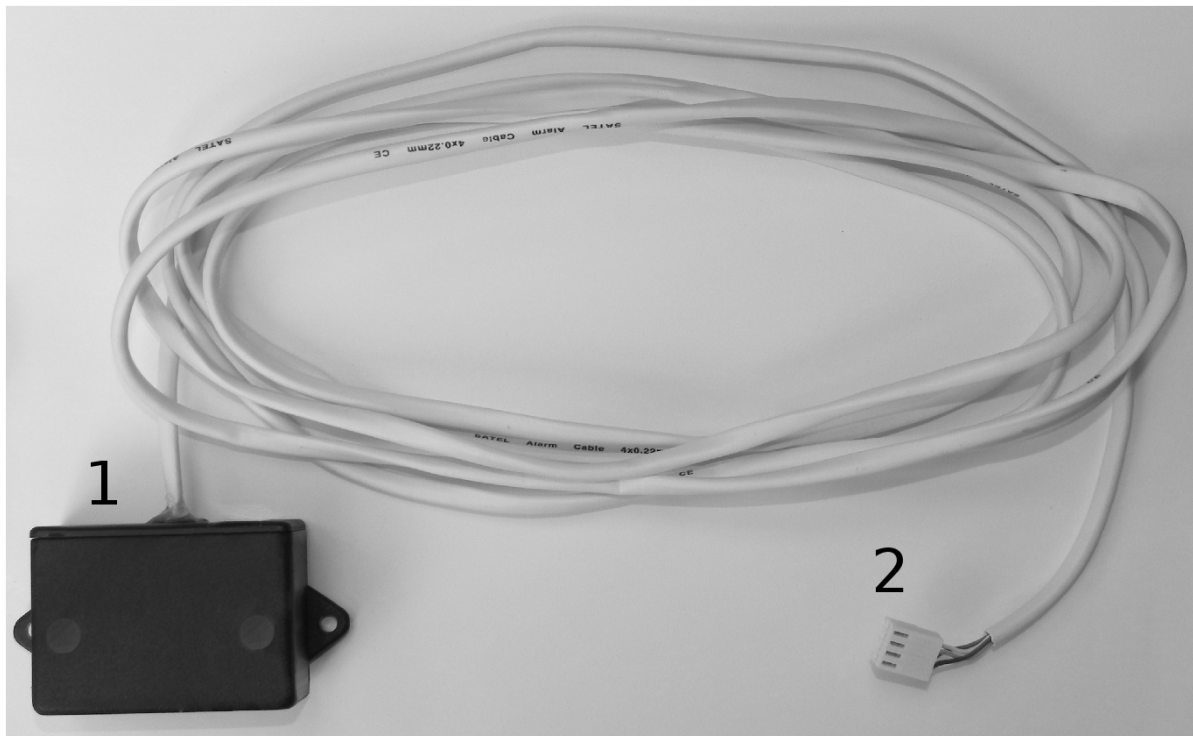


Figure 2: Disconnected GPS module.
1. GPS element; 2. Master clock connector.

1.5 Bluetooth module

The Bluetooth module is used for setting inspection and configuration. It is not needed for the normal operation of the device, so it can be connected only when the master clock is being configured. The module can be replaced by a 3.3V serial cable with settings '115200,n,8,1'.

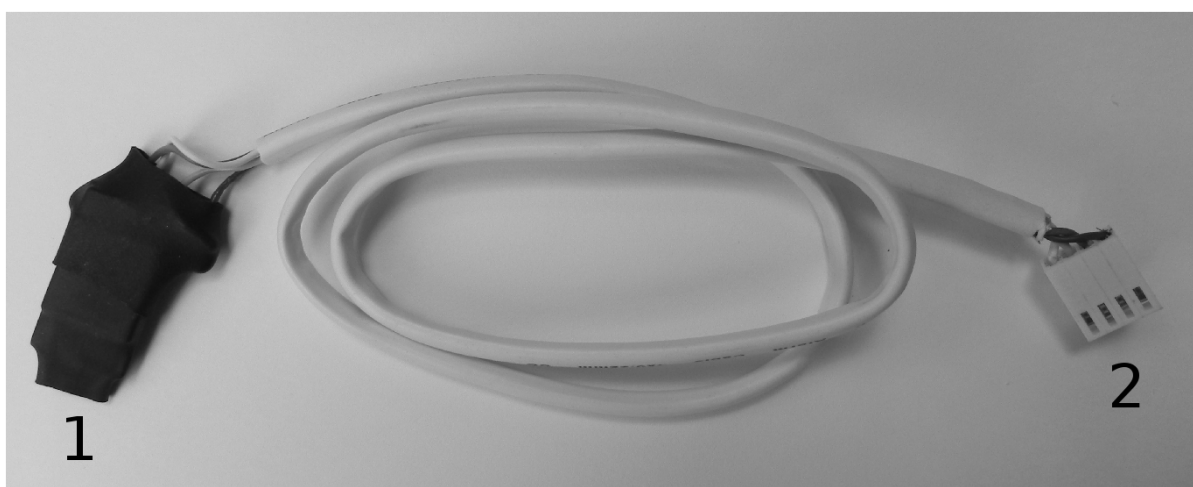


Figure 3: Disconnected Bluetooth module.
1. Bluetooth element; 2. Master clock connector.

2 Directions for Use

2.1 General Description

The master clock connects to a control terminal via Bluetooth. The PIN code is '1234' by default. Terminal programs that can be used for access include Hyperterminal and Teraterm for Windows, and TerminalBT jmj and RN Bluetooth for Android devices. After connecting to the master clock, it can accept commands. The first command issued must always be 'HELLO' (commands are case-insensitive). That unlocks the rest of the commands. If the device is left idle for two minutes, it locks again and an initial 'HELLO' is required.

After all settings have been configured and power has been provided, the master clock first synchronizes the arrows of the slave clock with its internal time. During this synch-up, the master clock decides whether to start turning the arrows with the intention to set them to the correct time, or to wait for time to catch up with the arrows. After the first power on if a GPS module is available, the master clock synchronizes its own internal clock with satellite time on the first given signal and then three times a day afterwards (every 8 hours). Local time offset from GMT (which is received from satellite) is done with a command (the offset for Bulgaria is +2). Daylight savings mode is enabled with the 'SDST' command, described below.

2.2 Charge and Discharge of the Lead-Acid Battery

The battery is continuously charged under a constant 14.2V. When the power supply is cut off, the system continues working on battery power. When the battery is discharged to 11.4V, the system enters a low-power mode – it turns off all internal components apart from the CPU, which also enters a low-power mode. **WARNING:** After entering low-power mode, a Bluetooth link cannot be established until the system enters normal operation mode again. Normal operation mode is entered after the power supply is restored and the battery has reached 13.6V output voltage, which means that some time is required after power has been restored for the system to enter its normal operation mode.

2.3 Control Commands

All commands are case-insensitive. All commands are locked until an initial 'HELLO' command is sent. After two minutes of idle time the system locks out all commands again until another 'HELLO' is sent.

2.4 Initial Configuration

1. Disconnect all components from each other and from the master clock. This includes disconnecting the master clock from the slave clock;
2. Connect the master clock to the battery;
3. Connect the 24V power supply;
4. Connect to the master clock via Bluetooth (from a phone, laptop, PC);
5. Issue the command 'HELLO' and begin the configuration:

- (a) Check if the slave clock movement is allowed with the command 'RUN' and disable it with the command 'SRUN';
 - (b) Check the configured output voltage for the slave clocks with 'POWER' and correct it with 'SPOWER';
 - (c) Check the pulse period with 'PULSE' and correct it with 'SPULSE';
 - (d) Check the pause period with 'PAUSE' and correct it with 'SPAUSE';
 - (e) Check the time zone with the 'GMT' and correct it with 'SGMT';
 - (f) Check the daylight savings setting with 'DST' and correct it with 'SDST';
 - (g) Datetime and GPS configuration:
 - i. If a GPS module is missing, set the date and time manually;
 - ii. If there is a GPS module plugged in and turned on place it somewhere with a view of the sky and wait – the usual automatic synchronization takes up to 2-3 minutes. Check if the synchronization is complete by issuing 'GPS'. If the clock is synched from GPS before the 'DST' and 'GMT' settings have been set correctly, the time will be wrong. You can check the current time with 'TIME' and if such a scenario has occurred, you can force another synchronization with 'SGPS'.
 - (h) Move the slave clock's hands as close to the current time (if possible) as possible and tell the master clock their location with 'SHAND';
 - (i) Connect the slave clock to the master clock;
 - (j) Allow slave control pulse output with 'SRUN'.
6. Wait until the slave clock starts showing the correct time. If the slave clock is one minute off, this means that the polarity of the control pulse needs to be inverted with 'SINVERT'. Correct the master clock's knowledge of where the slave clock's arrows are with 'SHAND'.

3 List of Commands

Name	Description
HELLO	Always the first command, needed to unlock the system.
DST	This means that the time is autocorrected for daylight savings.
SDST	Enable/Disable daylight savings time change.
TIME	Reports the internal clock value. If there is a 'DST' after the time, this means that an hour has been added for daylight savings.
STIME	Set the master clock's internal clock.
GMT	Reports the configured time zone. It is important this is correctly set when GPS is used, since it is used to calculate the time from the satellites.
SGMT	Configures the timezone.
GPS	Check if internal time is synchronized via GPS.
SGPS [‡]	Enable/Disable the master clock to synchronize via GPS.
DATE	Reports the internal clock's date.
SDATE	Configures the internal clock's date.
HAND	Reports where the master clock knows the mechanical clock's arrows are located.
SHAND	Tells the master clock the position of the arrows of the mechanical clock.
PULSE	Reports the length of the control pulse, output to the mechanical clock.
SPULSE	Sets the length of the control pulse, output to the mechanical clock.
PAUSE	The minimal time between two control pulses to the mechanical clock. This make sense when the mechanical clock has drifted more than a minute from the master clock's time and needs to be corrected with many consecutive pulses.
SPAUSE	Sets the minimal time between two control pulses to the mechanical clock.
INVERT	Reports the polarity of the pulse to the mechanical clock.
SINVERT	Configures the polarity of the pulse to the mechanical clock.
POWER	Reports the voltage supplied to the mechanical clock.
SPOWER	Configures the voltage supplied to the mechanical clock.
RUN	Reports if the control pulse output is enabled. If it is not enabled, the control pulse that moves the arrows on the mechanical clock is not supplied. IMPORTANT: It is recommended this setting to be set to 'ON' at the end of the master clock's configuration procedure – after the settings 'HAND', 'POWER', 'PULSE', 'PAUSE', etc., are configured and conform to the requirements of the mechanical clock.
SRUN	Enable/Disable the control pulse.
RTC	Reports the time of the internal clock, powered by a battery. If it reports 'no RTC', the battery is depleted or the device is faulty.
STAT	Reports when the power supply has last been down or the lead-acid battery has been depleted and charged again.
ACC	Reports the current voltage of the lead-acid battery.

CHARGE	Reports if the block that charges the lead-acid battery is switched on. With the next command the block can be enabled or disabled. During discharge, when the lead-acid battery voltage drops under 11.3V, the system enters a low-power mode and the block is enabled automatically. If the lead-acid battery is fully charged and the next command is issued, then the system will begin operation only on lead-acid battery power. When that battery is depleted, the system will automatically enable the charger. After that operation you can check how long the lead-acid battery lasts with 'STAT'.
SCHARGE	Enable/Disable the block that charges the lead-acid battery.
RESET	FOR INTERNAL USE – resets the processor.
HALT	FOR INTERNAL USE – halts the processor. Used to check if the built-in recovery system works.
TST24	FOR INTERNAL USE – turns the 24V converter and output relay so that the converter can be tested.

‡ This command only makes sense when a GPS module is attached.

4 Device Characteristics

4.1 Physical Dimensions

Element	Width	Length	Height
Main PCB	56mm	140mm	30mm
Main PCB Case	90mm	180mm	48mm

4.2 Electrical Characteristics

Power Provided By	Consumption	Conditions
24V PSU	55mA	Fully charged lead-acid battery.
24V PSU	650mA	Lead-acid battery recharging.
Lead-Acid Battery	50mA	Device is in active mode.
Lead-Acid Battery	15mA	Power-conserving (sleep) mode.
Lead-Acid Battery	120mA	24V relay and control pulse to slave clocks (but no slave clocks attached) turned ON.

5 Recommended Peripherals

Power Supply	18-30V	
Lead-Acid Battery	12V	3.5-7.5Ah

6 Dictionary

Master clock – refers to the main PCB or the whole device itself. The main PCB has an internal clock that keeps precise time and a lithium battery that holds that time and the device's settings.

Internal clock – the reference clock of the master clock.

Mechanical clock – the clocks that the master clock controls via electric pulses to move the arrows.

Slave clock – see Mechanical clock.

Lead-acid battery – an optional rechargeable battery that can keep the system functioning, including controlling the mechanical clock for a limited time.

Power supply block – provides power to the main PCB and charges the attachable lead-acid battery.

Control pulse – master-clock generated electrical pulse that moves the arrows of the mechanical clock.

Control signal – see control pulse.

GPS module – an optional module that allows the device to synchronize time via GPS satellites.

Bluetooth module – an optional module that allows the device settings to be viewed and configured.