PLEIADES SET BOARDS

Revision 20.05.05
PLEIADES SET

The boards in this set are made to simplify mounting since they already contain many elements that you do not need to install:

- connector simple handbox,
- connector for autoguiding camera,
- buttons to set the tracking speed in autonomous mode,
- connector for Bluetooth module.

All you need to add are cables to connect the motors, an ON-OFF button, a power plug and a fuse.

For the rest, just drill the holes in the right places in a case large enough to hold the cards.

This set allows you to have up to 4 controllers connected to the Arduino.

This set includes boards for controlling DC motors with encoder and bipolar and unipolar stepper motors.
PLEIADES SET BOARDS

External control box (front view)

- 12 volt DC power input, Center positive, 2.5-5.5mm jack
- ON-OFF switch
- Tracking setting in autonomous mode
- DB9 R.A. and decl. cables
- Autoguiding camera socket
- Bluetooth status indicator: flashes if not paired; on if paired.
- USB-Bluetooth switch
- Simple handbox socket
External control box (interior view)
PLEIADES SET BOARDS

Connections between the boards and boards location

R.A. controller
TAYGETA-3, MAIA-3 or MEROPE-3 board

Decl. controller
TAYGETA-3, MAIA-3 or MEROPE-3 board

ARDUINO

12 V power connector

Simple handbox modular socket

Bluetooth module

USB

ELECTRA-3 board

ALCYONE-3 board

Adapters

Autoguiding camera modular socket

Connectors

SKYPIKIT

Arduino chip

Power driver

Modular socket

12 V power connector

Modular socket
Boards for DC motors with encoder

MEROPA-3 with TB6612 driver for up to 1.2 A for most small telescope motors.

MAIA-3 with TB67H303HG driver for up to 4 A for more powerful motors (Pittman, Maxon ...).

Boards for stepper motors

TAYGETA-3 with A4988 driver for bipolar stepper motors.

TAYGETA-3 with TB67S142NG driver for unipolar stepper motors.
PLEIADES SET BOARDS

ALCYONE-3: Arduino shield and power supplies

ELECTRA-3: Motherboard to power and insert the motor control boards
ALCYONE-3 BOARD

ARDUINO SHIELD AND POWER SUPPLIES
PRESENTATION OF THE BOARD

This board is first of all an ARDUINO shield, that is to say that you can directly connect the ARDUINO UNO board to it.

The ALCYONE-3 board receives the main 12 volt power supply and contains a 9 volt voltage regulator to power the ARDUINO UNO.

On the back side, this board contains a connector for inserting a BLUETOOTH module and an RJ12 connector for connecting the simple handbox.

You can also install two SPDT switches (SW6 and SW7) there to adjust different functions. SW7 is used to determine whether the telescope is controlled by USB or by BLUETOOTH.

The ALCYONE-3 board contains two 10-position connectors (2X5) for interconnecting power supplies and I2C signals to ELECTRA-3 boards.

Finally, it contains LEDs and a connection to a push button to adjust the tracking speed in autonomous mode.
Electronic diagram of the ALCYONE-3 board
Install two bridges, between the pins: 1-2 and 6-7 of U1

Items marked with an X are not installed because they are not used.
Voltage supply to the ALCYONE-3 board

ALCYONE-3 BOARD

The PS1 screw connector receives 12 volt DC power.

The 9 volt regulator LM7809 supplies the 9 volt voltage to the ARDUINO.

External power circuit recommended
The 12 volts power can come from a battery, a regulated power supply with sufficient amperage, a car 12 volts plug, or a 12 volts DC wall adapter.

A 4 to 8 amp fuse is used as required.

Respect the direction of the connections:
GND to GND
12 V to 12 V.
The ARDUINO connects upside down on the ALCYONE-3 card.

The ARDUINO is powered with 9 volts by its Vin pin.

Never use the ARDUINO power jack connector.

The ARDUINO contains the program (sketch) which allows communication with the computer via USB or with a tablet via Bluetooth.

The ARDUINO also communicates with the motor controllers by I2C link (pins A4-SDA and A5-SCL).
The ALCYONE-3 board contains two 10-position connectors P1 and P2 (2X5) to interconnect the power supplies and I2C signals (SDA and SCL) to the ELECTRA-3 boards using flat cables or wires. See examples of applications.
On its back, the ALCYONE-3 board contains a connector for the simple handbox, a Bluetooth module and the USB-BT switch.

It also contains LEDs and a connection to a push button to set the tracking speed in autonomous mode. The ARDUINO program controls the operation of the TRACK button. We press the button until the LEDs indicate the desired state:

- All LEDs off = tracking OFF
- LED 1 on = sidereal tracking
- LED 2 on = solar tracking
- LED 3 on = lunar tracking

When control is via USB or Bluetooth, manual control becomes inactive. You will then see the tracking status on the computer or tablet screen.
The ALCYONE-3 board contains a 6-pin RJ12 connector to connect the simple handbox which is used to move the telescope and the focuser in autonomous mode.

Respect the color sequence of the wires of the RJ12 cable when mounting the handbox:

<table>
<thead>
<tr>
<th>Pin number</th>
<th>Wire color</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>white</td>
<td>VHP (5V)</td>
</tr>
<tr>
<td>2</td>
<td>black</td>
<td>GND</td>
</tr>
<tr>
<td>3</td>
<td>red</td>
<td>R. A.</td>
</tr>
<tr>
<td>4</td>
<td>green</td>
<td>Decl.</td>
</tr>
<tr>
<td>5</td>
<td>yellow</td>
<td>Focus</td>
</tr>
<tr>
<td>6</td>
<td>blue</td>
<td>Speed</td>
</tr>
</tbody>
</table>
Photos of the two types of simple handboxes (with and without focuser control)
ALCYONE-3 BOARD

Electronic diagram of the simple handbox without focuser control
ALCYONE-3 BOARD

Electronic diagram of the simple handbox with focuser control
ELECTRA-3 BOARD

MOTHERBOARD FOR THE CONTROLLERS
PRESENTATION OF THE BOARD

The ELECTRA-3 board is a motherboard whose main purpose is to insert one or two motor control boards (MEROPE, MAIA or TAYGETA) into it. It contains the female adapters to insert these boards.

The board contains the 5 volt and 3.3 volt regulators to power the motor control boards.

It also contains a 6-pin RJ12 connector for connecting an autoguiding camera.

Finally, it contains two connectors so that it can be connected to an ALCYONE-3 board using a 10-conductor flat cable or some wires. One or two ELECTRA-3 boards can be connected to an ALCYONE-3 board.
Items marked with an X are not installed because they are not used.
Connectors for controller A (right ascension or other) (TAYGETA-3, MAIA-3 or MEROPE-3 board)

Connectors for controller B (declination or other) (TAYGETA-3, MAIA-3 or MEROPE-3 board)
The autoguiding cameras are supplied with a modular 6-wire RJ12 cable, according to the ST-4 standard. The wires have colors in a specific order. Be careful to respect the order of the connections.

<table>
<thead>
<tr>
<th>Wire #</th>
<th>Color</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>white</td>
<td>NC (not connected)</td>
</tr>
<tr>
<td>2</td>
<td>black</td>
<td>GND (Ground)</td>
</tr>
<tr>
<td>3</td>
<td>red</td>
<td>RA+ (R.A. correction towards East)</td>
</tr>
<tr>
<td>4</td>
<td>green</td>
<td>DE+ (DECL. correction towards North)</td>
</tr>
<tr>
<td>5</td>
<td>yellow</td>
<td>DE- (DECL. Correction towards South)</td>
</tr>
<tr>
<td>6</td>
<td>blue</td>
<td>RA- (R.A. correction towards West)</td>
</tr>
</tbody>
</table>
ELECTRA-3 BOARD

Case where only one ELECTRA board is connected to an ALCYONE board with a 10-conductor flat cable. The ELECTRA board contains two controller boards, a controller for right ascension and one for declination.

The flat cable is used to supply power (12V and GND) to the ELECTRA-3 boards. It also transmits I2C signals (SDA and SCL).

Case where two ELECTRA boards are connected to an ALCYONE board with two 10 conductors flat cables. The second ELECTRA board contains a controller for a motorized focuser.

Electra-2 and Alcyone-2 boards shown here on these photos
TAYGETA-3 BOARD

STEPPER MOTOR CONTROLLER
UNIPOLAR WITH TB67S142NG DRIVER
OR BIPOLAR WITH A4988 DRIVER
PRESENTATION OF THE BOARD

The TAYGETA-3 board contains the circuits necessary to control a stepper motor.

We can connect two models of power drivers on this board: either the A4988 power driver if we want to control a bipolar stepper motor, or the TB67S142NG power driver if we want to control a unipolar stepper motor.

This board is connected to the ELECTRA-3 board using its connectors located on the back side.
Electronic diagram of the TAYGETA-3 board
Install two bridges, between the pins: 1-2 and 6-7 of U2

Items marked with an X are not installed because they are not used
TAYGETA-3 BOARD

- Connector to an encoder (optional)
- Connector to stepper motor driver
- Connector to motor coils
- Connector for ICSP, index and sensor
- I2C booster not used with new versions

Front side of the TAYGETA-3 board
CONNECTORS FOR INSERTION IN THE ELECTRA-3 BOARD
A bipolar stepper motor contains two coils, coil 1 and coil 2. We recognize a bipolar motor because it has four wires.

You can use a multimeter on the ohm scale to find which terminals are the ends of each coil. If your multimeter indicates a measurable resistance (usually between 5 and 100 ohms), you are connected to the ends of a coil. Take the opportunity to note the value of the resistance of each coil. This will be useful for adjusting the current limit of the A4988 driver (see next page).
With the A4988 module, a higher voltage than the nominal motor voltage can be used, since this circuit can actively limit the current in the coils. This allows the motor to run much faster than if only the nominal voltage were used.

The maximum current that can pass through each motor coil is equal to the nominal motor voltage indicated by the manufacturer divided by the resistance of the coil which you can measure with a multimeter:

\[ I_{\text{max}} = \frac{V_{\text{nominal}}}{R_{\text{coil}}} \]

For example, if you measure 60 ohms across each coil of a 6-volt stepper motor, the maximum current allowed will be 6 volts / 60 ohms, or 0.1 amps or 100 mA.

The maximum current is adjusted with a small current limit potentiometer located on the A4988 module.

To know the adjusted current limit, you must use a multimeter on the 200 millivolt scale, and measure a voltage \( V_{\text{ref}} \) proportional to this current using the following formula:

\[ V_{\text{ref}} = 8 \times R_{\text{cs}} \times I_{\text{max}} \]

where \( I_{\text{max}} \) is the maximum wanted current and \( R_{\text{cs}} \) a resistance whose value is 0.1 ohm for the A4988 modules distributed with the boards.

For example, for a wanted current of 100 mA, we obtain

\[ V_{\text{ref}} = 8 \times 0.1 \text{ ohm} \times 100 \text{ mA} = 80 \text{ mV} \]

If the motor is noisy with the current limit obtained, you can make tests by slightly reducing this limit.
The A4988 power driver can be configured to operate with different micro-steps per step values.

The board is delivered with the configuration to have 16 micro-steps per step, which is recommended, with bridges already installed in positions MS1, MS2 and MS3.

If you want to modify this configuration, you can do so by removing some bridges according to the positions given in the table.

Check the results using the SKYPIKIT MOTOR TESTER TUNER app.

<table>
<thead>
<tr>
<th>MS1</th>
<th>MS2</th>
<th>MS3</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Full Step</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Half Step</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 micro-steps / step</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 micro-steps / step</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16 micro-steps / step</td>
</tr>
</tbody>
</table>

The table shows the positions where bridges must be installed for each configuration.
A unipolar stepper motor contains four coils. The COM1 and COM2 terminations of the coils are connected together inside the motor, so that 5 wires exit from the motor.

Connect the COM wire to the VMOT terminal of the PS3 connector.
With the TB67S142NG module, a higher voltage than the nominal motor voltage can be used, since this circuit can actively limit the current in the coils. This allows the motor to run much faster than if only the nominal voltage were used.

The maximum current that can pass through each motor coil is equal to the nominal motor voltage indicated by the manufacturer divided by the resistance of the coil which you can measure with a multimeter:

$$I_{\text{max}} = \frac{V_{\text{nominal}}}{R_{\text{coil}}}$$

For example, if you measure 60 ohms across each coil of a 12-volt stepper motor, the maximum current allowed will be 12 volts / 60 ohms, or 0.2 amps or 200 mA.

The maximum current is adjusted with a small current limit potentiometer located on the TB67S142NG module.

To know the adjusted current limit, you must use a multimeter on the 2000 millivolt scale, and measure a voltage $V_{\text{ref}}$ proportional to this current using the following formula:

$$V_{\text{ref}} = 1.33 \times I_{\text{max}}$$

where $I_{\text{max}}$ is the maximum wanted current.

For example, for a wanted current of 100 mA, we obtain $V_{\text{ref}} = 1.33 \, \text{mV} / \, \text{mA} \times 100 \, \text{mA} = 133 \, \text{mV}$.

If the motor is noisy with the current limit obtained, you can make tests by slightly reducing this limit.
The TB67S142NG power driver can be configured to operate with different micro-step values in steps.

The board is delivered with the configuration to have 4 micro-steps per step, which is recommended, with bridges already installed in positions MS1 and MS2. The MS3 bridge is not used.

If you want to modify this configuration, you can do so by removing some bridges according to the positions given in the table.

Check the results using the SKYPIKIT MOTOR TESTER TUNER app.

### Table: MS1 and MS2 Configurations

<table>
<thead>
<tr>
<th>MS1</th>
<th>MS2</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OFF (motor free)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full Step</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Half Step</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 micro-steps / step</td>
</tr>
</tbody>
</table>

The table shows the positions where bridges must be installed for each configuration.
The stepper motors are controlled in open loop and do not need a quadrature encoder to know their position.

The Skypikit only counts the micro-step pulses it sends to the power driver to know where the stepping motor is positioned.

Normally, a quadrature encoder is not used with stepper motors and the encoder connector is not used.

However, nothing prevents you from using a quadrature encoder for another use. The Skypikit is then able to count the steps of an encoder at the same time as controlling an open-loop stepper motor.

Please note: the encoder must operate on a 5-volt supply.
Connection to limit switches

LIMIT+
Towards the North or East

LIMIT-
Towards the South or West

Example shown with normally open limit switches.
MEROPE-3 BOARD

CONTROLLER FOR DC MOTOR WITH ENCODER
USING THE TB6612 DRIVER
PRESENTATION OF THE BOARD

The MEROPE-3 board contains the circuits necessary to control a DC motor with encoder.

This board uses a Polulu TB6612 power driver that can supply a maximum of 1.2 amps to the motor.

This board is connected to the ELECTRA-3 motherboard using its connectors located on the rear face.
MEROPE-3 BOARD

Connector to the encoder of the DC Motor
Connector to limit switches
TB6612 driver for the DC Motor
Connector to the coils of the DC Motor
Connector for ICSP, Index and Sensor

Front side of the MEROPE-3 board
Electronic diagram of the MEROPE-3 board
Items marked with an X are not installed because they are not used

Install two bridges, between the pins: 1-2 and 6-7 of U2
The DC motor is closed loop controlled and needs a quadrature encoder so the Skypikit can know its position and speed.
Warning: the encoder of the chosen motor must work with a 5 volt supply.

See the description of the TAYGETA-3 board for the connections to limit switches and for the connectors on the back side.
MAIA-3 BOARD

CONTROLLER FOR DC MOTOR WITH ENCODER
USING THE TB67H303HG DRIVER
PRESENTATION OF THE BOARD

The MAIA-3 board contains the circuits necessary to control a DC motor with encoder.

This board uses a Toshiba TB67H303HG power driver that can supply up to 4 amps of current to the motor.

This board is connected to the ELECTRA-3 motherboard using its connectors located on the back side.
MAIA-3 BOARD

CONNECTOR TO THE ENCODER OF THE DC MOTOR

CONNECTOR TO LIMIT SWITCHES

CONNECTOR TO THE COILS OF THE DC MOTOR

TB67H303HG DRIVER FOR DC MOTOR

SKYPIKIT

CONNECTOR FOR ICSP, INDEX AND SENSOR

Front side of the MAIA-3 board
Electronic diagram of the MAIA-3 board
Install two bridges, between the pins: 1-2 and 6-7 of U2

Items marked with an X are not installed because they are not used.
The DC motor is closed loop controlled and needs a quadrature encoder so the Skypikit can know its position and speed.

Warning: the encoder of the chosen motor must work with a 5 volt supply.

See the description of the TAYGETA-3 board for the connections to limit switches and for the connectors on the back side.
END