en/Redundant

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1 Redundancy at the MikroKopter

In some countries, only copters with redundant design are allowed (e.g. Austria).
Our electronics allow the redundant design of a MikroKopter.

Redundancy means, that important components have to be replaced in case of a fault and the MK should not crash if there is a failure of a (single) component (eg, motor, receiver, Flight Control, etc.).

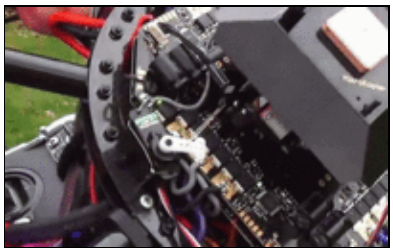
To increase safety, the master- and slave- FlightCtrl V3 are connected to each other via CAN bus. This is used to monitor all functions and detect faults quickly in the event of a fault.

Should the master flight control fail, the control is transferred to the slave unit and the copter can be safely flown back.

With this concept the Austro Control gave a the MikroKopter the highest approval "D" !

2 Demo-Video

- Here, the redundant system is described in a video:



3 What is needed:

3.1 Hardware

For a redundant configuration is required:

- 1x BL-Ctrl board "Redundant"
  - Shoplink -> Quadro V3 - Combi
  - Shoplink -> Hexa XL V3 - Combi
  - Shoplink -> Okto XL V3 - Combi
  - Shoplink -> Doppel Quadro V3 - Cool
- 2x FlightCtrl V3 (Master + Slave)
  - Shoplink -> Flight-Ctrl V3.0
- 1x GPS-System with compass
  - Shoplink -> MK GNSS V4 + compass (Redundant)
- 1x Cable set "Redundanz"
  - Shoplink -> Cable set Redundant for 2 FlightCtrl
- 2x Lipo Decoupler
  - Shoplink -> Lipo Decoupler

    or
  - Shoplink -> Lipo Decoupler XT60

INFO: With the FlightCtrl V3.0 and the redundant MK GPS you have also a redundancy with the navigation system

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3.2 Software

If you use the redundant system you need on your master- and Slave-FlightCtrl a special software.
Here you can download the latest software including the matching KopterTool.

Latest Software + MikroKopter Tool **(ZIP Archive)** Please use a MKUSB for a update !!!	

For a software update connect the MKUSB wit the right FlightCtrl.

- The software "REDUNDANT_MASTER" is imported into the Master-FlightCtrl:
  - Flight-Ctrl_MEGA1284p_V2_xxx_REDUNDANT_MASTER.hex
  - Navi-Ctrl_STR9_V2_xxx.hex

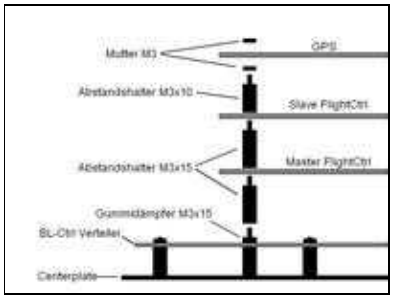
- the software "REDUNDANT_Slave" is imported into the Slave-FlightCtrl:
    - Flight-Ctrl_MEGA1284p_V2_xxx_REDUNDANT_SLAVE.hex
    - Navi-Ctrl_STR9_V2_xxx.hex

- Information for **installing the software** can be found here: **Link**

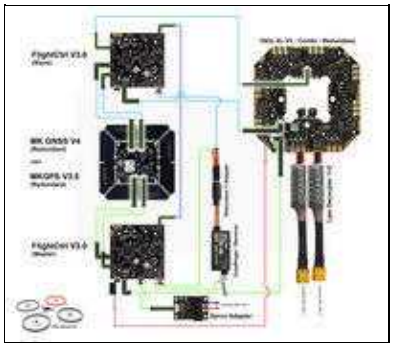
4 The assembling

Here is pictorially described the assembly of the individual components.

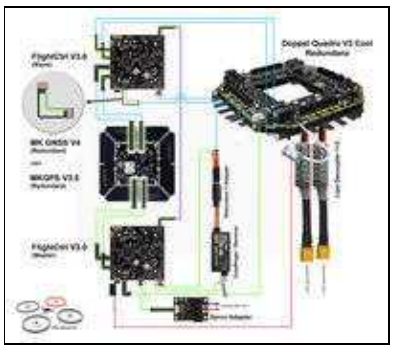
4.1 MK-Tower



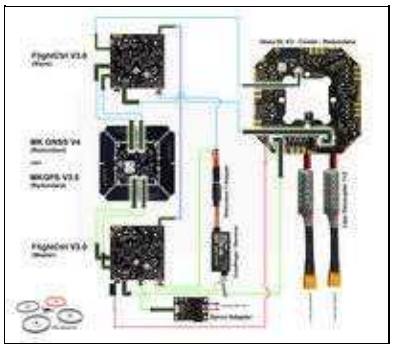
4.2 Okto XL V3 - Combi



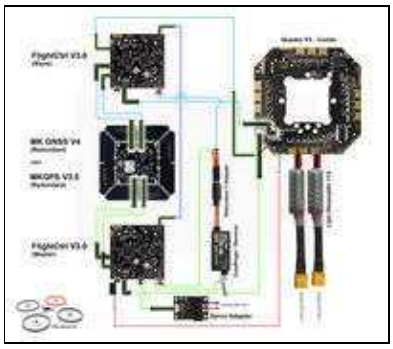
4.3 Doppel Quadro V3 - Cool



4.4 Hexa XL V3 - Combi



4.5 Quadro V3 - Combi



5 Settings

To ensure that the operation is maintained in the event of a fault, the master and slave FlightCtrl must be set the same!

Master-FlightCtrl

- To setup the Master-FlightCtrl connect the MKUSB (or a wireless connection) with the Master-FlightCtrl.
  The settings for the mixer and the channels can be made as usual. It is recommended to copy the settings to all 5 settings (Parameterset).

Slave-FlightCtrl

- To setup the Slave-FlightCtrl connect the MKUSB (or a wireless connection) with the Slave-FlightCtrl.
  Copy now the settings of your Master-FlightCtrl into the Slave-FlightCtrl. Here it is also recommended to copy the settings to all 5 settings (Parameterset). In short:

    - ♦ The mixer setting in your Master- and Slave-FlightCtrl must be the same
    - ♦ The channel settings in your Master- and Slave-FlightCtrl must be the same

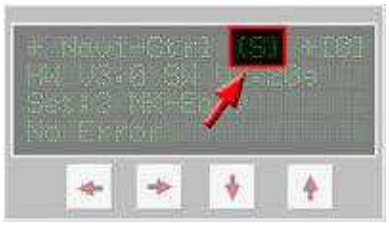
  The redundant FC listens to the same stick positions and, just like the main FC, goes into the states "Calibrate", "Start", "Stop"

INFO:
If all settings / connections are right, you see in your **Telemetry a "R"** after you start the motors.

6 Function test

6.1 Slave-FlightCtrl

- If the Slave-FlightCtrl is connected with the KopterTool, in the virtual display you see an "S" for Slave.

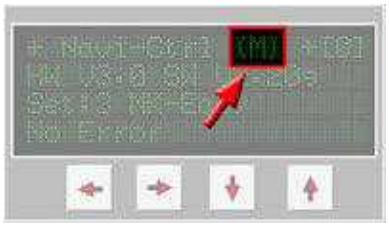


- The green LED on your Slave-FlightCtrl is flashing fast
- If you disconnect the Master-FlightCtrl (disconnect the Molex connector):

  - ♦ The green LED on your Slave-FlightCtrl is flashing fast PLUS the red LED is ON
  - ♦ On your BL-Ctrl the green LED is still ON, the red LED is still OFF

6.2 Master-FlightCtrl

- If the Master-FlightCtrl is connected with the KopterTool, in the virtual display you see an "M" for Master.



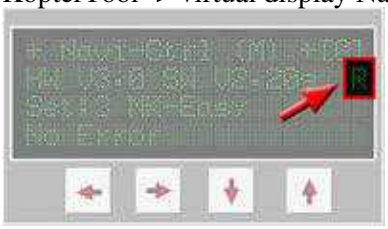
6.3 Redundancy

- After starting the motors via the transmitter, in the telemetry you see an **"R"**
  -> this means that the redundancy is active

  - ♦ Graupner HOTT -> MK-Telemetrie

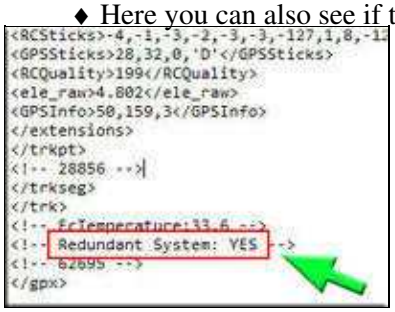
  - ♦ Jeti -> Jeti-Box

- ♦ KopterTool -> virtual display NaviCtrl



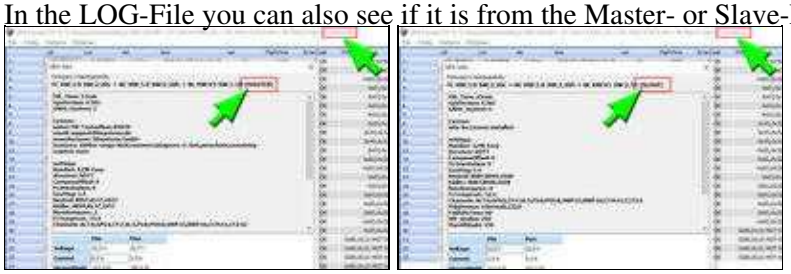
6.4 Logfile

- During flight the copter record a LOG file with all telemetry data.
  - ♦ Here you can also see if the redundancy was active:



((since V2.20) at the end of the LOG - open with Text-Editor)

- In the LOG-File you can also see if it is from the Master- or Slave-FlightCtrl:



(since V2.20)

7 Fault simulation

- Two errors with redundancy can be simulated:
    - ♦ I2C error => Bus-failure of the Master-FlightCtrl
    - ♦ Motor failure

If an motor fails, only the OktoCopter (8 engines) can compensate for this safely.
A HexaCopter (6 engines) can become unstable, a QuadroCopter (4 engines) crashes.

7.1 I2C error

- To simulate this, a free channel on the transmitter is needed which is placed on a switch. This channel is set in the settings to the *user parameter 7* (see Picture):

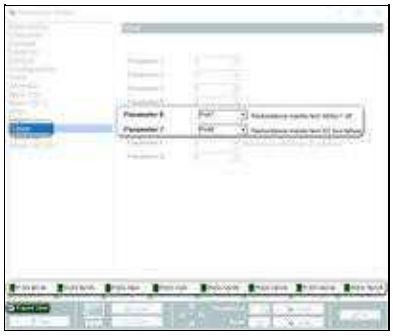
- Function:
    - ♦ Switch OFF => Normal operation
        - ◊ All functions are controllable as usual - no error message
    - ♦ Switch ON => The I2C-Bus of your Master-FlightCtrl is deactivated
        - ◊ The complete control is transferred to the Slave-FlightCtrl
        - ◊ A beep will sound at the Master-FlightCtrl
        - ◊ In the telemetry you can see the error message "37:Redundancy test"
        - ◊ The copter can be controlled as usual

- Condition: The function is only activated if there is redundancy ('R' in the display).

- 
  For this test place your MikroKopter (with running motors) on the ground. Now "Switch OFF -> deactivate the I2C-Bus.

A beep will sound at the Master-FlightCtrl but the Motors will still run.
Lifting off and flying with the redundant FC is possible.
If this is OK, the test can also be carried out in flight.


For normal operation, change the *user parameter 7* back to "0" !!!



7.2 Motorausfall

- To simulate this, a free channel on the transmitter is needed which is placed on a switch.
  This channel is set in the settings to the *user parameter 6* (see Picture):

- Function:
  - ♦ Switch OFF => Normal operation
    - ◊ All functions are controllable as usual - no error message
  - ♦ Switch ON => Motor Nr.1 is deactivated
    - ◊ The complete control is transferred to the Slave-FlightCtrl
    - ◊ In the telemetry you can see the error message "37:Redundancy test"
    - ◊ The copter can be controlled as usual

-  Condition: The function is only activated if there is redundancy ('R' in the display).
  If the I2C error was previously simulated, the motor failure will NOT be executed!

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  For this test place your MikroKopter (with running motors) on the ground. Now "Switch OFF -> deactivate the Motor.
  Motor Nr. 1 is off, all other motors will still run.
  Lifting off and flying with the redundant FC is possible.
  If this is OK, the test can also be carried out in flight.

For normal operation, change the *user parameter 6* back to "0" !!!

If an motor fails, only the OktoCopter (8 engines) can compensate for this safely.

A HexaCopter (6 engines) can become unstable, a QuadroCopter (4 engines) crashes.

8 Anlage F Austro Control

If you want to allow your MikroKopter with redundancy in Austria, we have deposited information for this purpose:

- Anlage F