

# MRCU Error Handling

## Description and explanation of MRCU Errors

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### **Versions**

- V0.1 – 2011/04/05 created
- V1.0 – 2011/05/17 final version

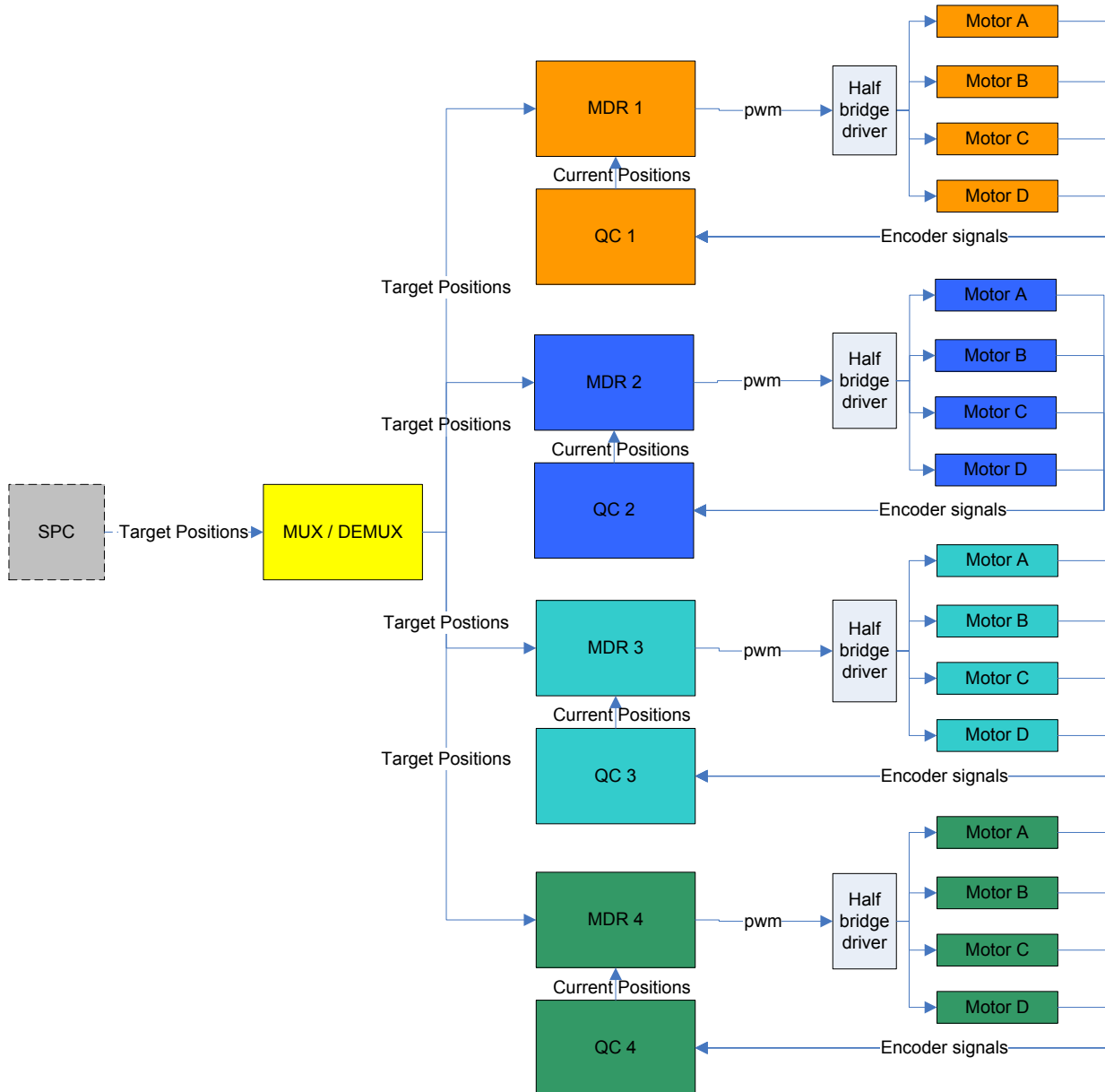


# 1. Abbreviations, acronyms and synonyms

Abbreviation	Description
MRCU	Motorized Rig Control Unit
MUX/DEMUX	The Mrcu Board's main controller which forwards the incoming motor positions (from SPC) to the 4 MDR controllers.
MDR	Motor Driver (motor control unit with 4 motors attached), part of a MRCU
QC	Quadrature counter (also referred to as Quadrature Encoder) The microcontroller which counts the steps of a motor's feedback signal.
MCU	Micro Controller Unit
pwm	Pulse width modulation. A pulse width modulated signal is applied from an MDR controller to its half bridge motor driver to actually drive the motor.
3fcc	3flex control center

## 2. MRCU introduction

The MRCU is the main circuit board of a rig. Underneath you can see the block diagram of a MRCU board.



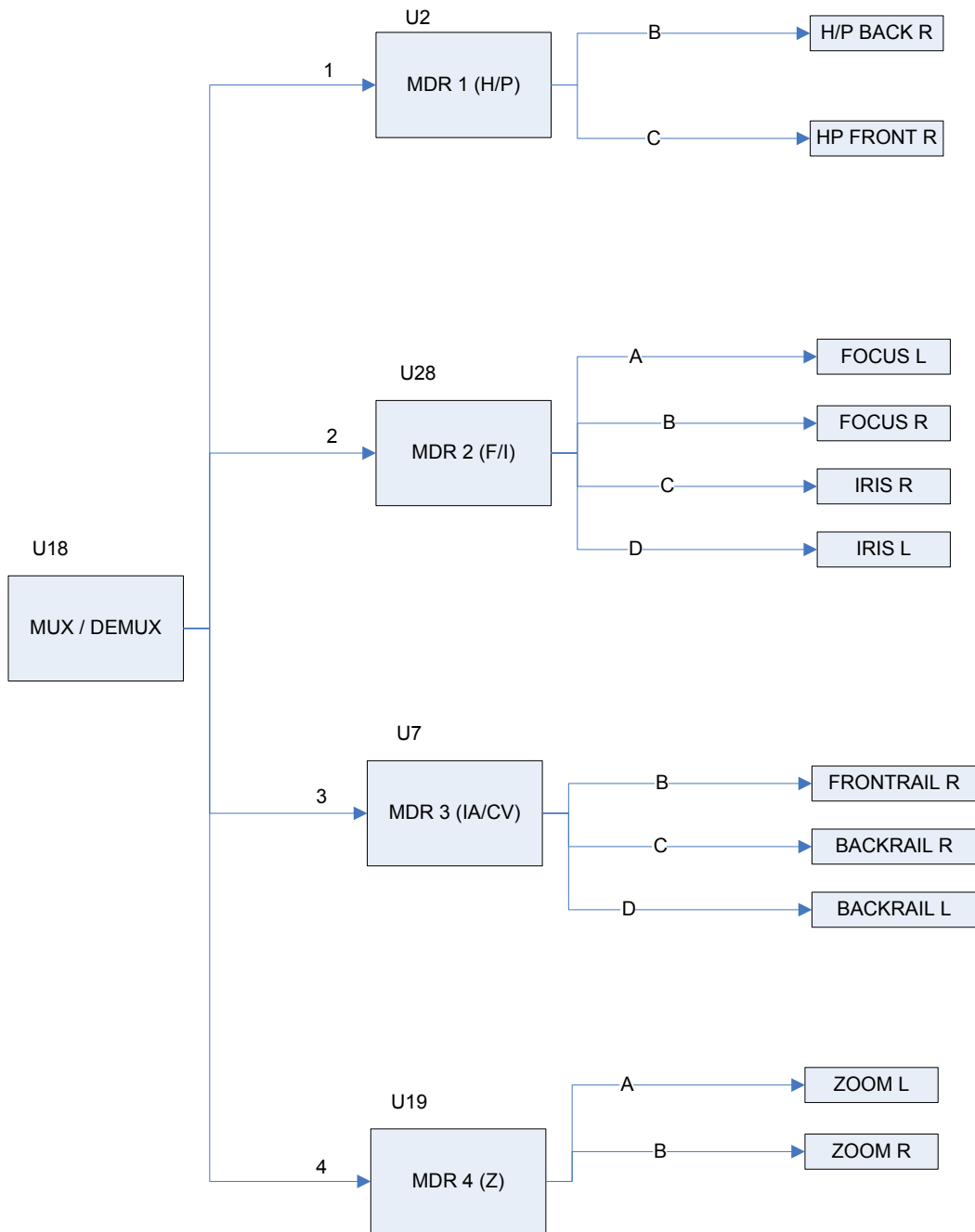
**Fig. 1 MRCU Block diagram**

The general jobs of the different MCUs are:

- **MUX/DEMUX:** receives position data from outside and forwards the positions to their target MDRs
- **MDR:** receives position data from MUX/DEMUX and calculates a pwm value out of the received target position and the current position of the motor. This MCU also implements the boot routine of the attached motors.
- **QC:** The job of this MCU is to generate the current position data of its attached motors out of the encoder signal feedback. It also saves the position of a motor's reference switch if it was detected during driving. These reference switches occur on 3D and HP axis and are used for high accuracy and reproducibility of positioning during the boot process.

## 1.1 TS 2 and TS4 MRCU Board

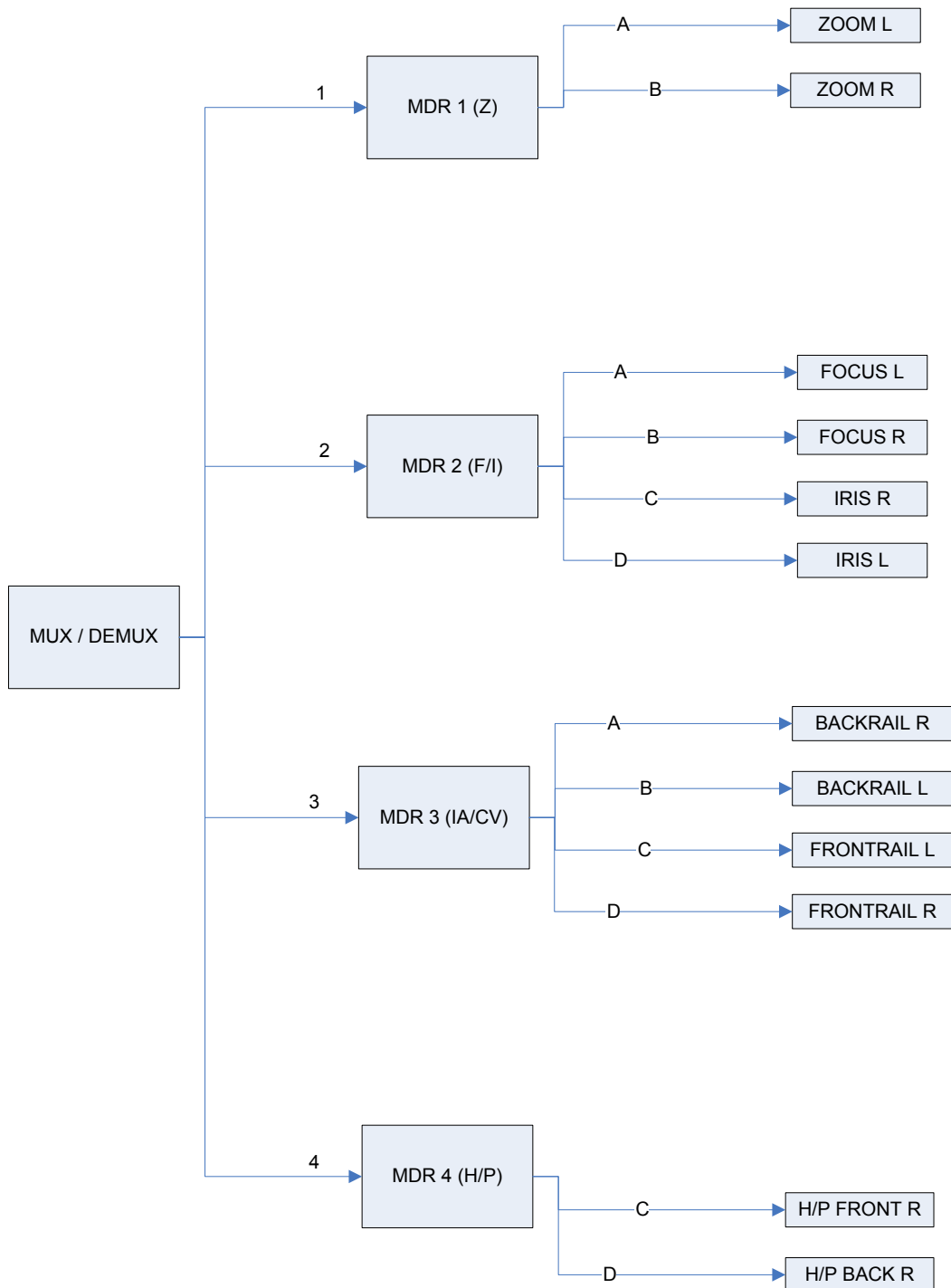
The Block diagram in Fig. 2 shows the assignment of the different MDRs and motors of TS2 and TS4 MRCUs.



**Fig. 2 TS2 and TS4 MRCU Board Block diagram**

## 1.2 TS5 MRCU Board

The Block diagram in Fig. 3 shows the assignment of the different MDRs and motors of a TS5 MRCU.

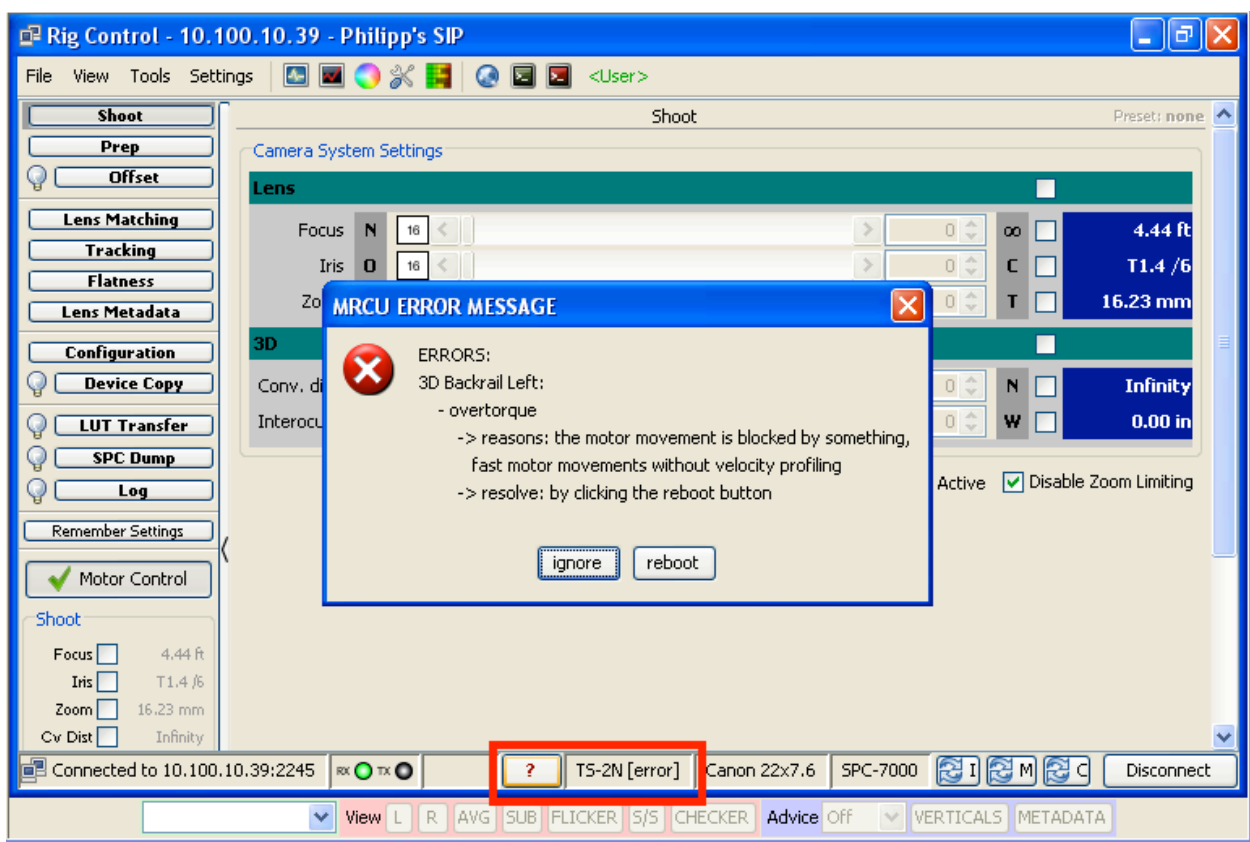


**Fig. 3 TS5 MRCU Board Block diagram**

### 3. Detecting errors

There are 3 ways of detecting MRCU errors:

1. On the rig itself: There are two LEDs on the rig which show the rig's current status condition. For decoding of the blink codes please refer to Chapter 4 "MRCU LED Blink codes".
2. On the attached SPC(s): The display of the SPC shows the current status of the rig. If an error or warning occurs the rig status will change from "running" to "error" or "warning". Tapping on the status field will bring up a dialog showing you the current error or warning and its location. You will then have the option to reboot only the single erroneous MDR.
3. In 3flex Control Center: If you have opened a Rig Control Panel and are connected to a SPC you will see the Rig's status like shown in Fig. 4. If an error occurs a red question mark will be shown on the left side of the status text that now shows "error". Clicking on the question mark will bring up a panel which shows you which errors or warnings occurred and what to do to solve them.



**Fig. 4 resolving rig errors in 3fcc**

## 4. MRCU LED Blink codes

RED freq	GREEN freq	Meaning
OFF	ON	Idle, connected to SPC
OFF	1 s	Booting
OFF	250 ms	Positioning
ON	ON	Idle, not connected to SPC
500 ms	500 ms	These states are signaling the initialization stages of the MRCU Board. If the LEDs are constantly showing this state after switching the MRCU board on it is an indication that at least a part of the board communication can be broken.
1 s	1 s	
2 s	2 s	
One 100ms Pulse every sec.	ON	Motor error occurred (see detailed information in the next chapter): <ul style="list-style-type: none"> <li>• Over torque</li> <li>• Invalid position from QC</li> <li>• Invalid reference switch position</li> <li>• Steps lost</li> <li>• Total travel is too small</li> <li>• Invalid pwm state</li> </ul>
Two 100ms Pulses every sec.	ON	MDR error occurred (see detailed information in the next chapter): <ul style="list-style-type: none"> <li>• Problem with QC communication</li> <li>• Temperature of a motor driver is too high</li> <li>• Timeout during boot</li> </ul>
Three 100ms Pulses every sec.	ON	MUX/DEMUX error occurred (see detailed information in the next chapter): <ul style="list-style-type: none"> <li>• Problem with MDR communication</li> <li>• The physical difference of input positions of a motor pair (e.g. HP front - back) is too large</li> </ul>
Pulsed in a ratio from above or alternating between the ratios	OFF	Critical error (more than one error at the same time) error type is defined by the pulse ratio(s)



## 5. Errors and Warnings Explanations

### 1.3 Errors

- **Overtorque**
  - This is a safety mechanism for powering down a motor if it for example is blocked by something. Every motor in the rig has a certain torque limit which is fixed for the 3D and Height/Pitch axis but variable for the FIZ motors to enable the use of different lenses. If you're seeing this error on a FIZ motor first verify that the correct lens settings are applied in the 3flexControlCenter (3flexControlCenter -> RigControl -> Configuration -> Lens -> Lens Motor Settings). If you're not sure which setting to apply you can also run the Auto Config tool which automatically will adjust the driving parameters including the torque limits for every FIZ motor. Also make sure that the motor movement is not blocked by anything.
  
- **bad actual position**
  - This error indicates that an invalid position was received from the motor feedback. A microcontroller inside the MRCU board samples the positions of a motor every 500µs. These sampled positions run through a sanity check. If the difference between the currently sampled position and the last sampled position is out of a valid range this error will be shown.
  
- **small total travel**
  - During the boot procedure of a rig the total travel (total physical movement distance) of every motor is measured. If the travel is detected as too small this is an indication for the fact that a motor did not detect the real mechanical end stops but for example was blocked by something before. This error can also occur if the lens motor settings don't match the actually used lenses (for example if you use minizoom lens settings but actually have prime lenses mounted).
  
- **Invalid pwm state**
  - This error will occur if the maximum pwm value is applied to a motor but the sampled motor positions don't change. The reason of this error is preventing a motor from driving out of control if a motor's feedback signal is broken.
  
- **quadrature encoder communication**
  - This error indicates communication problems between a MDR and a QC controller.
  
- **over temperature**
  - The temperature of a MDR's half bridge motor driver is too high.
  
- **boot timeout**
  - If the boot procedure of a rig has not finished after approximately 30 seconds it will be cancelled and a boot timeout error will occur.
  
- **motor driver communication**
  - This error indicates communication problems between the MRCU board's main controller (MUX/DEMUX) and one of the MDRs.

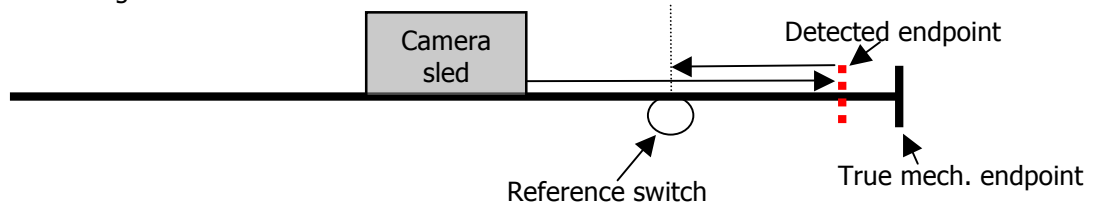


## 1.4 Warnings

- **bad reference switch position**

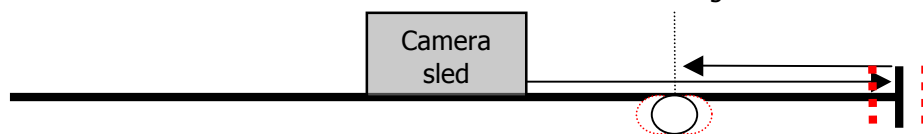
- Every Height/Pitch and 3D motor has a so called reference switch. This is a magnetic sensor used to position the motors as accurate and repeatable as possible during the boot up procedure. The position of the reference switch is constantly stored in the rig. If this position is detected out of a valid range during boot up a "bad reference switch position" warning is generated. There are 3 main reasons why this can happen:

1. The mechanical endpoint did actually occur on the wrong position. A simple reboot of the rig should solve this.



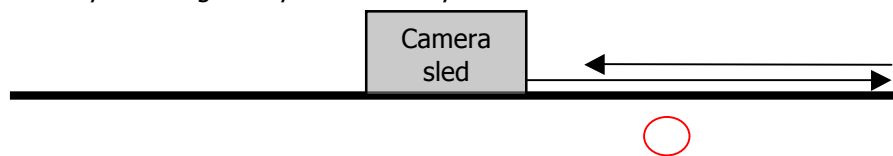
**Fig. 5 Wrong detection of reference switch**

2. Due to mechanical and/or temperature changes the reference switch was detected at a slightly different position. In this case the warning might not go away with a simple reboot. You will have to reset the system's stored reference position by clicking the "reset" button in 3flex control center's MRCU error dialog.



**Fig. 6 Wrong detection of reference switch due to temperature/mechanical changes**

3. The reference switch is misaligned. In this case the affected motor will only use the position of the mechanical endpoint during boot up. The rig is still totally working but the applied tracking LUT might suffer in its repeatability after several reboots and you will always see the "bad reference switch position" warning. The reference switch can only be realigned by trained 3ality staff.



**Fig. 7 Sensor Misalignment**

- **encoder steps were lost**

- This warning is most commonly related to one of the hedén FIZ motors and is caused by high motor velocity. The accuracy of your applied lens LUTs may suffer because of that. Furthermore it is possible that the motor drives a lens ring out of its system position range to the mechanical endstops if you constantly ignore this warning. It is highly recommended to perform a reboot by the next time possible.

- **maximum difference between front and back motor positions exceeded**

- This warning will occur if the incoming positions would for example bring the Height/Pitch axis to an amount of pitch which is larger than physically possible.