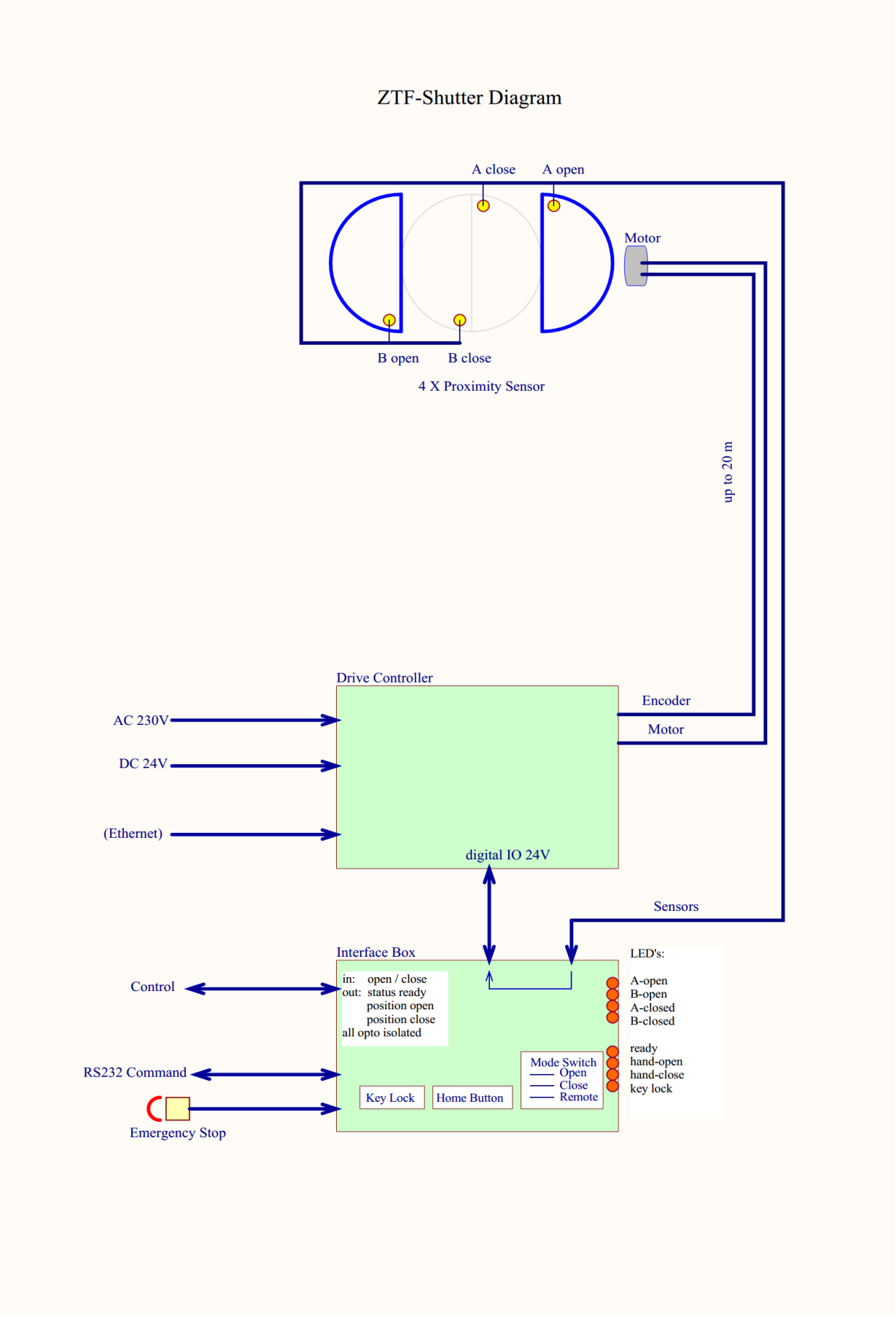
ZTF-Shutter motor control and safety issues

(Philipp Müller, Henning Poschmann 09.12.2015)

The ZTF shutter consists of three components (see sketch below):



1) The mechanical unit with two moving shutter blades on linear bearings driven by toothed belts and a servo motor with high resolution encoder and proximity sensors to confirm the successful movement of the blades.
2) The motor controller is a commercial programmable logic controller from the company Bosch-Rexroth. The controller is accessible over Ethernet with a special software from Bosch Rexroth. With this software the setup the controller is done. Programmable are the motor parameters and the parameters of shutter, encoder etc. Over this connection it is possible to download movement profiles into the controller and to monitor motor movements with a oscilloscope function.
3) The interface box for a manual control, remote control, status lines and security issues.

There are:
An input for an emergency shut off button
a switch with a key to enable / disable the motor controller,
a rotary switch to select the mode. Open, close and remote (from instrument control or camera).
A push button for Reset (Position calibration)
a RS232 command line (supported commands …tbd) ,
a Control port opto isolated input:
open/close
opto isolated output:
status : Ready
status: position closed
status: position open
+5V, 100mA(isol.) out for a external interface
LEDs to display the status of the proximity sensors
LEDs to display the status Ready, mode Open, mode Closed, key lock
Connection to the motor controller
Connection to the proximity sensors

Safety

Highest priority has the emergency switch

If this switch is activated all movements of the shutter motor (exposure, reset etc) are stopped and then the motor is switched off. The only way to restart the shutter is to clear the emergency error in the motor controller with the internal panel of the motor controller or to switch off and on the whole shutter.

On the second priority level is a switch with a key to enable / disable the motor controller. In the position disable the key can be removed (into the pocket of a technician) and no electrical movement of the motor can happen. You can open the cover of the shutter or the covers of the belts. You can move the shutter blades by hand and can make an inspection of the internal parts. If the key switch is turned back in the position “Enable” the blades will move back to the commanded position slowly (if they were moved) . Then the shutter is ready for the next operation.

On the third priority level is the “Mode” switch. This selects between a “hand” open and closed. The shutter opens or closes ignoring all remote commands. This is useful to check the basic operation of the shutter and to bring the blades to the position open/close before the disable key is activated. In the position “Remote” the interface box feeds the exposure signal from the “remote” connector to the motor controller. A pushbutton for Reset (Calibrate) is also integrated (not to see on the photo, covered by the keys). If this switch Is pressed all movement is stopped and the shutter starts the self calibration procedure. The same calibration starts with power on of the whole shutter electronics.

At calibration the shutter blades are moved to the center of the shutter (slow and reduced torque) until the blades touch each other. Then the blades move to the open position (slow and with reduced torque). Next the shutter moves to the close position. (No contact of the blades, gap 1mm tbd)

All movement is checked with the motor encoder and with proximity sensors next to the blades. With the information from the encoder it Is known if the movement was done correctly. An error detected by an encoder mismatch makes an emergency stop and can only be cleared by hand at the motor electronics. The proximity sensors detect if the blades really have reached the desired positions. (I.e. no ribbon is broken or blocked)

4 LEDs in the interface box show the status of the proximity sensors.
Blade A, B open and closed.
4 LEDs show the status :
Ready, Manual Mode Open, Manual Mode Close and Key lock.
The LEDs can be switched off.

IMPORTANT:

After power on or reset the shutter is ready for operation.

Now the blades move with high speed and much more torque.

Nobody should try to stop the blades by hand arm or finger.

Nobody should work next to the aperture to avoid any accident.

Only trained stuff should have access to the shutter.