Electronics of the 1.5m fiber echelle front-end module

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1 Requirements

The Front-End Module (FEM) of the 1.5-m fiber echelle instrument is attached to the telescope and directs the stellar light into the fiber-optics cable. The cable brings the light to the spectrograph located in the coudé room. The FEM has to provide the following functions:

- Moving the comparison-light prism in and out. This is achieved by controlling the small servo motor inside the FEM.
- Powering the Th-Ar comparison lamp during comparison-spectra exposures. This hollow-cathode lamp needs a high voltage (∼200 V) and a current of 10 ma (max. current 20 ma). As the lamp lifetime is short (500 h at 10 ma), it must be powered only during the comparison exposures.
- Powering the quartz lamp for flat-field exposures. The lamp needs 5 V at 2 A (10 W power).
- Guiding with a small CCD TV camera WAT-902HS. It is powered by 12 V, max. current 180 mA. The video signal is brought to the control room by a coaxial cable.
- Adjusting the guider exposure. The camera has no remote exposure control, so the images of bright targets saturate badly. To avoid saturation, a remotely-controlled LED illuminates the unused part of the field, causing exposure decrease (the camera works with the automatic exposure ranging from 1/60 s to 1/100000 s, so-called "electronic iris"). The exposure range of the electronic iris corresponds to 8^m range in star magnitudes.
- Inserting the neutral-density filter in the guider path. This filter is provided to extend the guider dynamic range beyond the limits of the electronic iris, to observe the brightest stars. At present, the filter is activated manually, but a small servo motor can be installed in the future, if this filter proves to be essential.

All functions of the FEM must be controlled remotely from the control room.

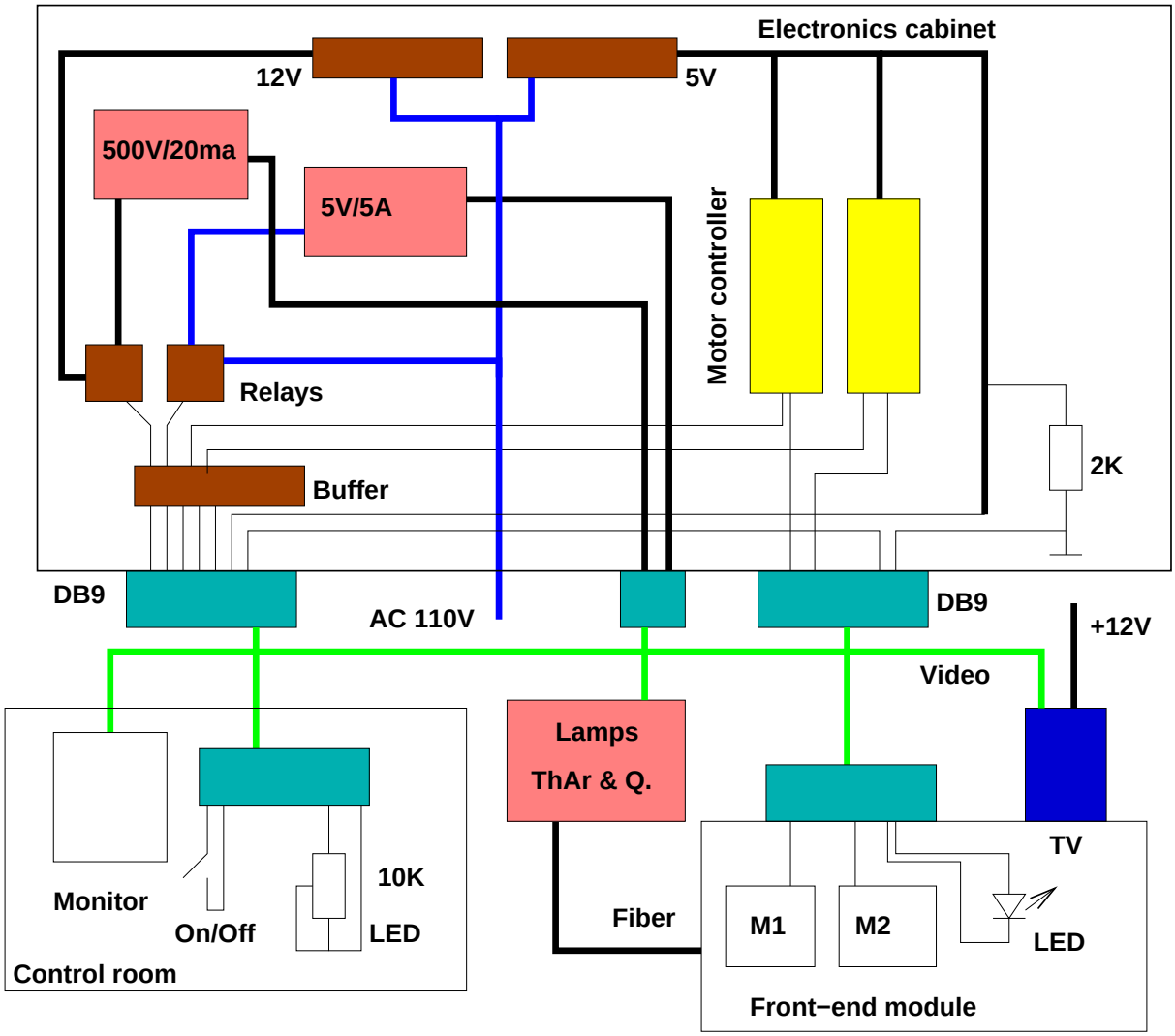

Figure 1: General diagram of the front-end electronics.

2 Implementation

Figure 1 shows the implementation of the FEM electronics. All major components are located in the electronics cabinet attached to the telescope. The source module with lamps ("light box") may be mechanically connected with the cabinet, thus forming a common module.

The electronics cabinet is connected with the control room by the existing 9-way cable with male DB9 connectors. All binary (In/Out) control signals are TTL levels or simple switches. The only exception is the LED current control done by a potentiometer. Tentative pin assignment of the DB9 control connector is: 1 - ThAr, 2 - Quartz, 3 - Motor-1 (prism), 4 - Motor-2 (density), 5,6 - LED, 7,8 - spare, 9 - common (ground). In the future, the FEM will be controlled by a computer using some standard module like DGH. This will permit to automate the observing process by writing IRAF

scripts to control lamps and motors in the required order.

The FEM is connected to the cabinet by means of a short (2m?) cable with female DB9 connectors. The pin assignment is: 1 - common, 2 - control Motor-1, 3 - +5V, 4, - control Motor-2, 5,6 - LED, 7 - +12V to TV camera, 8,9 - spare. This cable is bundled with the optical fiber (length 5 m) connecting FEM with the lamps. In addition, the video signal from the TV camera is brought to the control room through the BNC patch-panel connectors at the telescope (line RF1).

The control signals (active when low or shortened to the ground) are fed through the 8-line digital buffer with open-collector output (type TBD). The buffer activates the relays which power the spectral lamps. It also provides the TTL signals to the two motor controllers defining the In/Out motor positions. The motor controllers are described separately.

The LED is powered by 5V through a regulated 10K resistor on the control panel. The LED is shortened to the ground by an additional internal 2K resistor, so it gives no light when the 10K resistor is set to maximum. An option of controling LED by some voltage (regulated power supply with DAC) is to be considered.

The electronics cabinet contains three internal power supplies: one +12 V and two +5 V. They are powered by the 110 V AC line (connection at the telescope). Table 1 lists the components of the electronics cabinet.

Table 1: List of components

Element	Parameters	Model, Vendor
Th-Ar lamp HV supply	12V input, 500V/20ma output	F05, www.emcohighvoltage.com
Quartz power supply	110V AC inp., 5V/5A output	Kepco HDK
Relays	4-32 V ∼10ma inp., 48-660V AC out	GN84137120
12V power supply	12V 2A	TBD
5V power supply	5V 0.6A Regulated	Condor

Questions: It will be good to feed the 12V for the TV camera from the electronics-cabinet 12V line through the same cable. Is it possible? Is it also possible to have the 5V supply permanently active and to switch the quartz lamp with a relay? In the present scheme, there are two 5V supplies, one for the quartz (activated by the relay) and another for the motor control and LED. What component is best suited for the input buffer?

3 Motor controller

The servo motor is powered by a voltage from 5V to 6V. Its position is determined by the width of the control pulses (positive) which must range from 1 ms to 3 ms for the full-range rotation (±40°). The frequency of the pulses is between 40 and 50 Hz, its stability is not critical.

A simple circuit for generating the control pulses is shown in Fig. 2. It is based on the NE556 double timer. The length of the pulses is determined by the capacitor charging current, i.e. by the resistor which connects it to +5 V. The 56K resistor gives the shortest pulses ("In" position). It is doubled by closing the transistor, adding another (adjustable?) resistor in series. The transistor is controlled by the In/Out TTL level (or by an open-collector buffer). The second half of NE6556

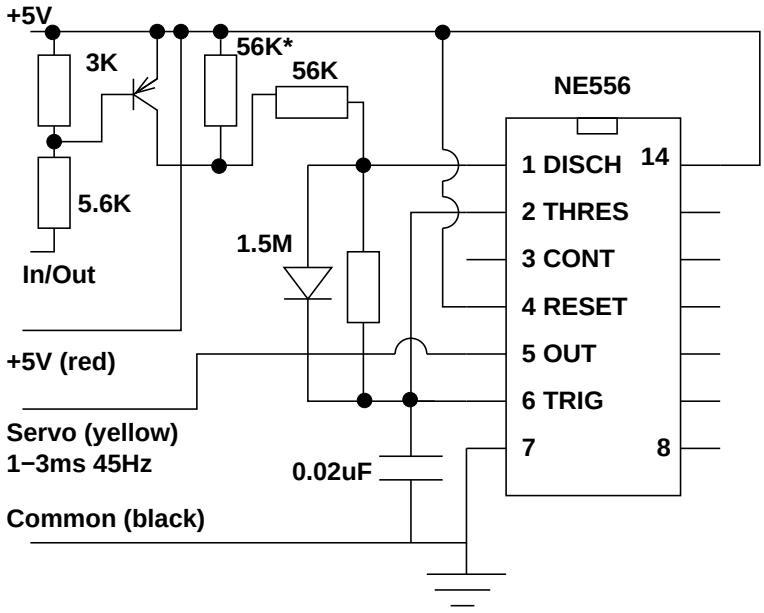

Figure 2: Schematics of the motor controller

provides the control of the 2-nd servo motor for moving the density filter, if necessary.