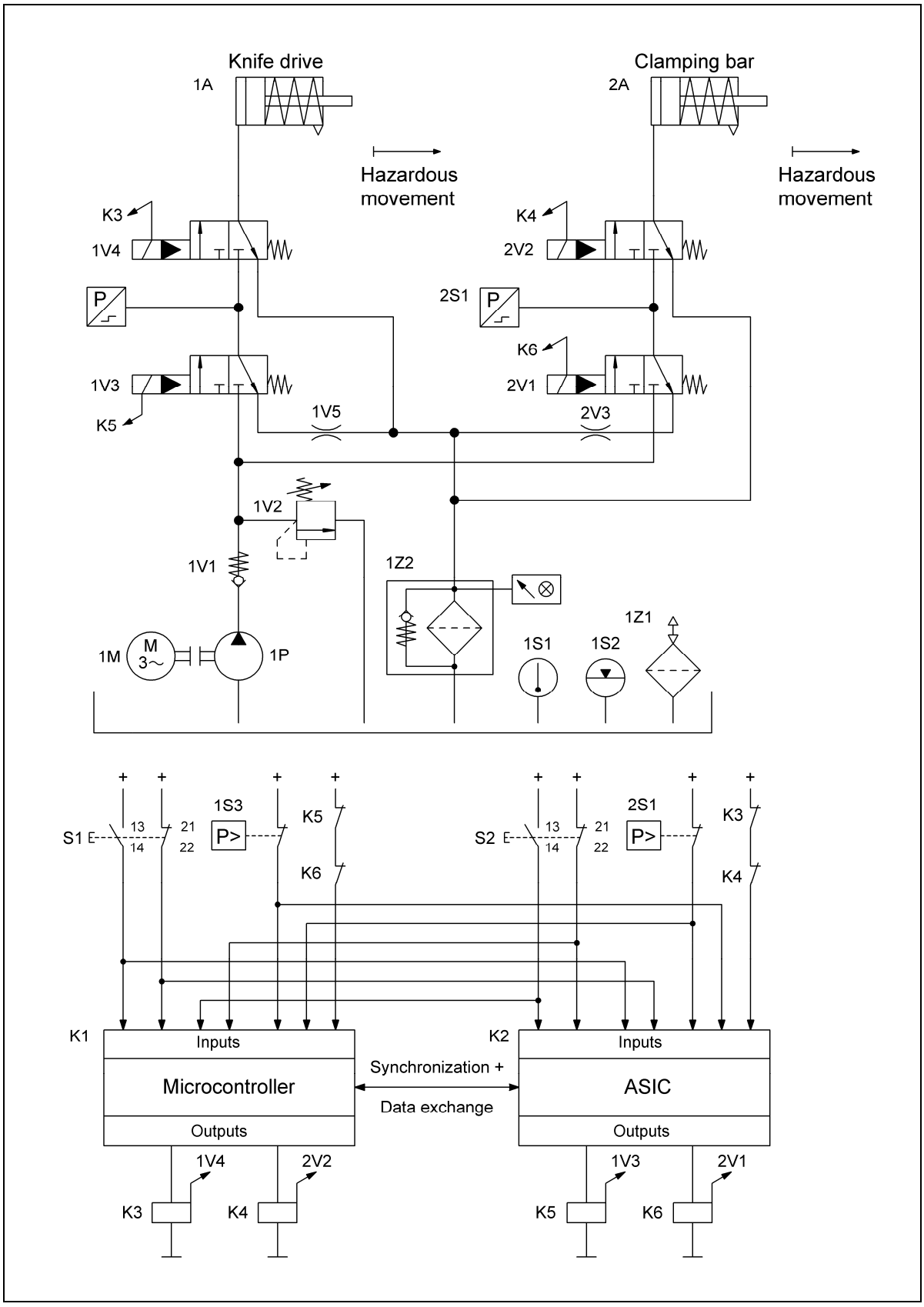
Figure 6.15:
Conceptual schematic diagram of the electronic drive of a hydraulic knife drive and a hydraulic clamping bar (essential components)



6.5.3 Functional description

A functional description explaining the circuit structure and signal paths is essential for an understanding of the circuit diagram. It is intended to permit identification of the functional process during execution of the safety function (which may take place in different channels) and the implemented test measures.

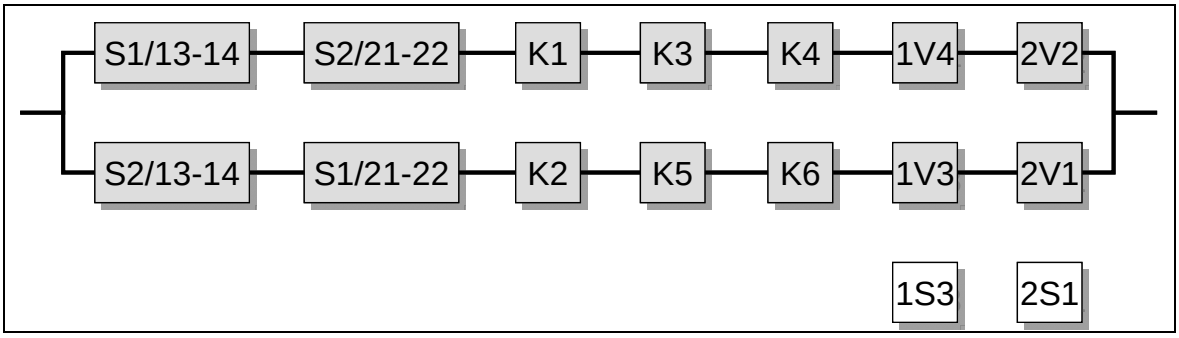
Functional description:

- Operation of the actuators S1 and S2 of the two-hand control initiates the hazardous movements (processing cycle) of the clamping bar and the knife. Should either of the actuators of the two-hand control be released during this cycle or a signal change occur in the peripheral system of the machine which is not expected by the control system, the cycle is halted and the machine assumes the safe state.
- Pressing the actuators S1 and S2 causes the rising edges of the signals to be fed to the two processing channels K1 (microcontroller) and K2 (ASIC). Provided these signals satisfy the requirements for simultaneity in accordance with the relevant standard, EN 574, the two processing channels set the outputs (contactor relays K3 to K6) for a valid cut request.
- The two processing channels act synchronously and also mutually evaluate internal intermediate states of the cyclical signal processing operations. Deviations from defined intermediate states cause the machine to be halted. One processing channel is formed by a microcontroller (K1), the other by an ASIC (K2). K1 and K2 perform background self-tests during operation.
- Faults in the actuators S1/S2 and in contactor relays K3 to K6 (with mechanically linked readback contacts) are detected by cross-checking in the processing channels.
- Failure of the valves 1V3/1V4 and 2V1/2V2 is detected by means of the pressure switches 1S3 and 2S1.
- Failure of the valves or sticking open of 1V4 or 2V2 is detected by a strong reduction in the return speed of the hydraulic cylinders. This situation can also be detected by the control system by suitable evaluation of the pressure signals (duration of pressure drop).
- Failure of the valves or sticking open of 1V3 or 2V1 is detected directly by monitoring of the signal change of the pressure switches 1S3 and 2S1: in the event of valve sticking, a pressure would be signalled although no pressure should be present.
- All machine states are monitored by both processing channels. The cyclical nature of the cut cycle causes all system states to be cycled through, and faults can thus be detected.

6.5.4 Safety-related block diagram

The description of the circuit arrangement in conjunction with the circuit diagram and if appropriate other descriptive documents (comprehensive specification) enables a control category to be determined and the actual circuit to be mapped to an abstracted safety-related block diagram (Figure 6.16). This example soon shows that the safety function is executed in two-channel mode. Category 3 or 4 may therefore be considered. The high-quality test measures, by which combinations of faults can also be controlled, suggest Category 4. Actual verification is obtained in Chapter 7, as is checking of the quantitative requirements for the $MTTF_d$, DC_{avg} and CCF (see below). The explanations provided in Sections 6.2.8 and 6.2.9 are helpful for implementation in the safety-related block diagram. A proven procedure is to trace the signal path, beginning at the actuator side, by asking: “How is the hazardous movement driven/prevented?”, and then to follow the logic through to the sensors. Note in this example that actuators S1 and S2 are not mutually redundant, even though they may initially appear so, since each button independently protects one of the user's hands. Rather, the redundancy begins within each button by the use of electrical make/break contact combinations. Each control channel monitors both hands/actuators by evaluation of at least one electrical switching contact in each actuator. The safety-related block diagram therefore contains a make contact, e.g. S1/13-14, and a break contact, e.g. S2/21-22, in each channel. The safety-related block diagram differs substantially in this respect from the functional circuit diagram.

Figure 6.16:
Safety-related block diagram of the SRP/CS for the selected safety function SF2 on the paper-cutting guillotine



Under certain circumstances, implementation of the safety function in practice may result in restrictions or recommendations for the application. For example, the effectiveness of fault detection by the work process is by definition closely related to the application.

Remark

- Application for example on paper-cutting guillotines (EN 1010-3)