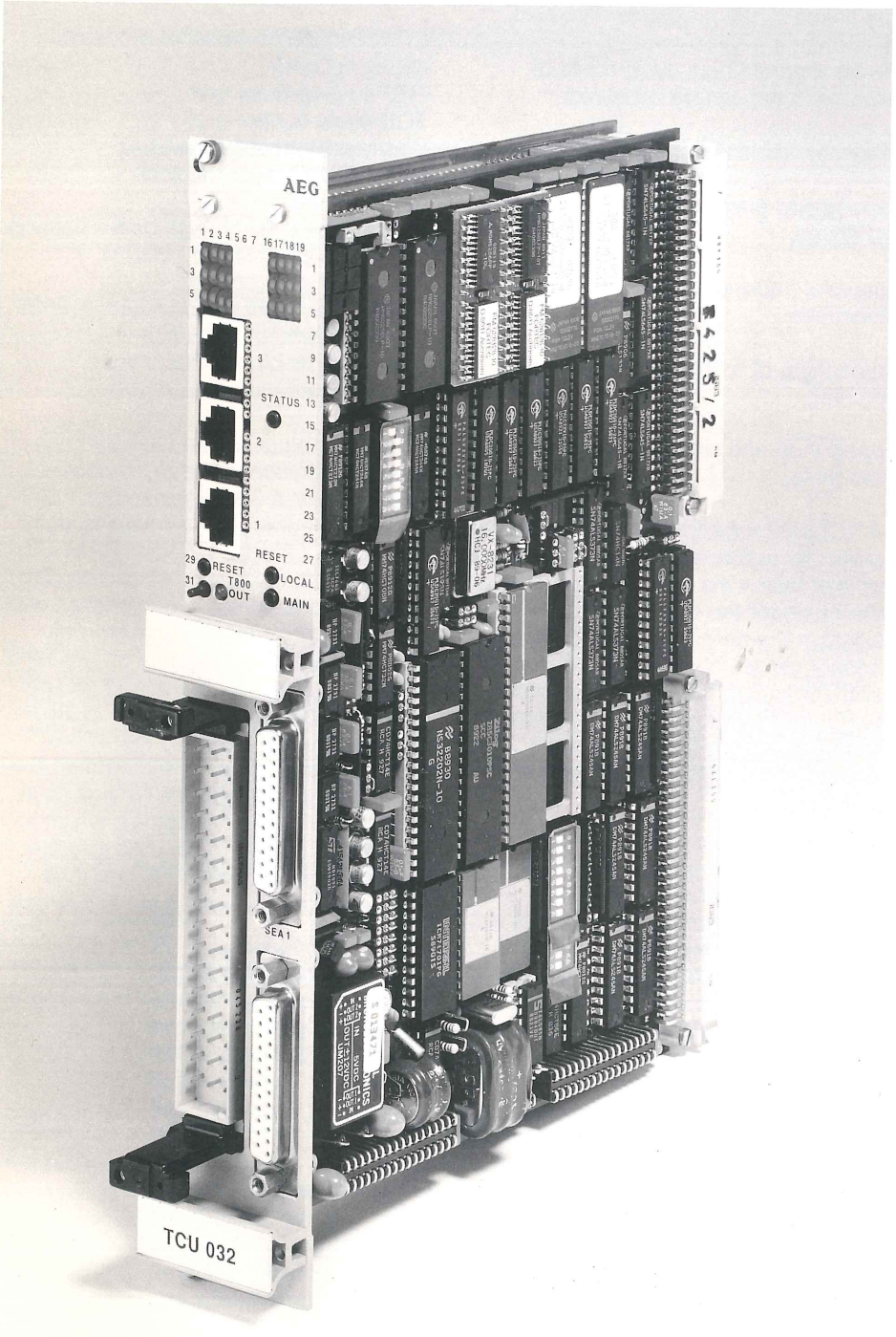
Processor assembly TCU 032

AEG



GeAmatics

Processor assembly TCU 032 for high-speed computing and control functions in the Modicon A800 system with Logidyn D

General

Components of the modular system Modicon A800 are used for plant automation in the area near the process in basic industries.

The hardware interfaces of the plug-in cards are:

parallel microprocessor bus PMB for modular extension of analog and digital inputs and outputs,

multiprocessor bus VME to increase overall processor performance in up to 4 magazines with 8 processors each,

serial plant bus Modnet 1/D for linking to other A800 systems.

The mechanical design is based on the use of 19'' magazines. Design and programming is done by means of a PC which is also used for all diagnostic, display, parameterization and storing functions.

The processor assemblies form part of the open-loop and closed-loop drive control system Logidyn D. They can be programmed in the special language RELOG and/or via graphic input by means of LogiCAD. More than 80 software modules are available for this convenient form of designing open-loop and closed-loop control functions. Additional standard-language tasks and – through subprogram modules – even standard-language modules can be linked to the programs designed. Depending on the extent of the function to be programmed, cycle times of approx. 5 ms can be achieved.

Preferred fields of application are:

speed and position control for all kinds of drives,

material tracking and automatic stopping functions,

presetting of reference values (set-points),

open-loop and closed-loop control near the drive.

A TCU 032 assembly is used whenever particular functions require cycle times of less than 1 ms. The main processor works under the design surface Logidyn D whereas the additional processor carries out high-speed control and computing functions. A suitable telegram as well as special subprogram modules ensure the link with the design and diagnostic functions of Logidyn D.

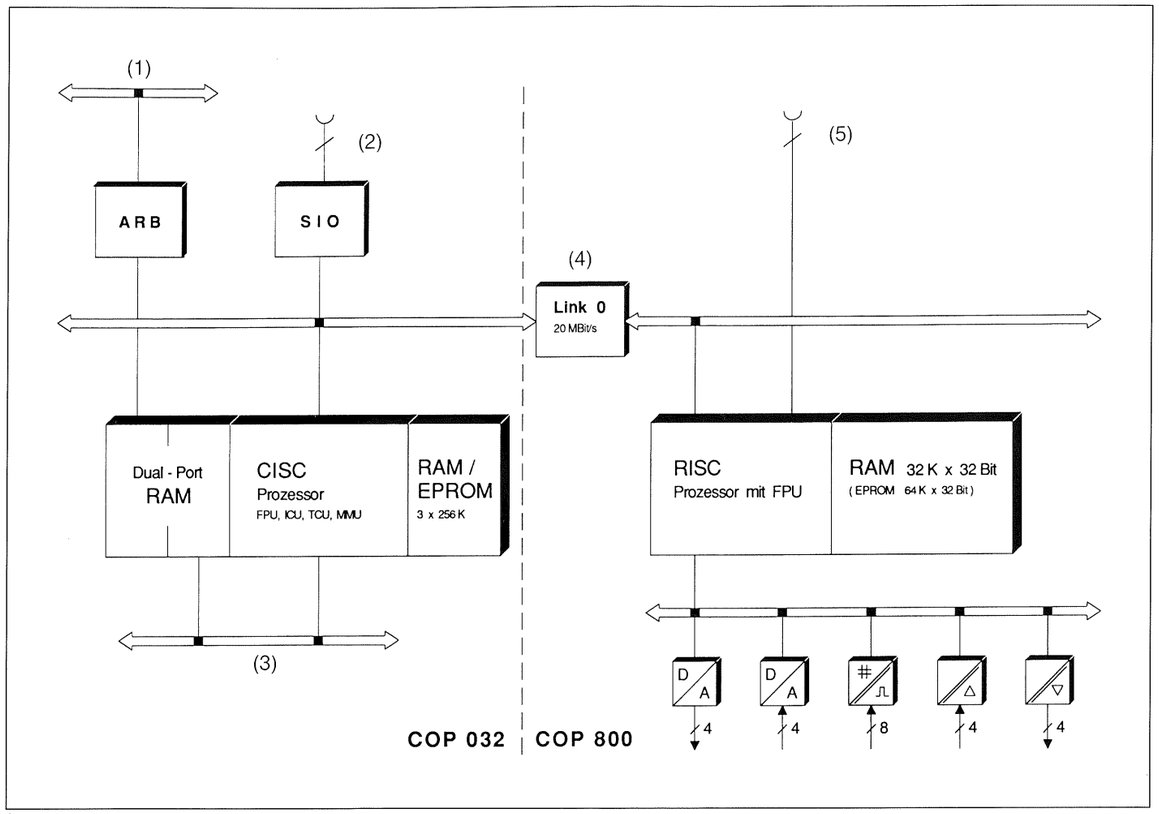
Features of the dynamic controller TCU 032

Hardware

The dynamic controller TCU 032 consists of two independent plug-in cards (see Fig. 1). The upper plug-in card is identical with COP 032, being the standard processor assembly of the Logidyn D system and comprising the following function blocks:

CPU NS 32C016 (internal processing depth: 32 bits)
FPU floating-point unit
TCU cycle control unit
ICU interrupt controller
MMU CMOS realtime clock
up to 256-KB EPROM
up to 256-KB RAM (with buffer battery)
up to 256-KB RAM or EPROM
TRI-PORT concept with
– VME bus (VME specification B1983)
– PMB interface (8/16-bit)
– internal 16-bit bus (local bus)
2 serial interfaces (SEA/V.24)

The lower plug-in card COP 800 contains, in addition to the I/O modules listed below, a 32-bit transputer T 800 with an integrated 64-bit floating point unit and a 1 K x 32-bit static RAM with a cycle time of approx. 40 µs (on chip). These two features, in conjunction with an internal command cycle time of 33 ns at a cycle frequency of 17.5 MHz and a RISC-similar command set, permit its single-chip application in areas in which in the past only signal processors were used. The integrated timer and interrupt capabilities as well as its four IN-MOS-DMA channels which are treated as serial 20-MB links are directly accessible via commands and thus make an own operating system largely obsolete!



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The plug-in card COP 800 can also be used independently, in which case it permits data exchange with other transputers via the links and thus the setting up of a parallel processor system which has been described by several authors (4) (5). The plug-in card COP 800 has an internal 32-bit data bus and an I/O bus with the following function blocks:

32 K x 32-bit	RAM
64 K x 32-bit	EPROM (option)
4 x 12-bit	digital/analog converter
4 x 12-bit	analog/digital converter with differential inputs, 100-V common-mode suppression, filter and track and hold module
4 x binary	24-V outputs, potential-isolated and short-circuit-proof
4 x binary	24-V inputs, potential-isolated, filtered and with indicating facility via LED
8 x 24-bit	(width) counters, potential-isolated, for passive and active incremental generators. The counters are combined in two groups and permit high-precision frequency or time measurement, depending on the respective mode.
3 x 10/20-	MB serial high-speed channels (links) for external connections via ISDN cables (RS 485)
1 x 20-	MB serial link connection, internally (C012 module) for COP 032 bus interface

error, watching, tot-mono, voltage monitoring.

1 Principles of operation of the dynamic controller TCU 032

1 Multiprocessor bus
2 2 x RS 232 96 kbit/s
3 I/O bus
4 Internal bus
5 3 x RS 485 20 Mbit/s Links 1 . . . 3

Software

Normal Logidyn D applications can be executed on the COP 032. An additional standard-language task is also integrated containing the telegram software for the other plug-in card. For time reasons, the telegram software is subject to interrupts and has a higher priority than the Logidyn D tasks which are thus processed with a minimum cycle time of 10 ms. This is where corresponding open-loop and closed-loop control functions can be processed within the multiprocessor and multi-tasking system Logidyn D.

In one of these Logidyn D tasks, the linking to the computing and control processor is ensured by special subprogram modules. Reference values (setpoints) and actual values, parameters, control and monitoring bits for the additional processor are passed on to the convenient open-loop and closed-loop control, diagnostic and parameterization system Logidyn D (Logiview, Logirec) through this feature.

The transputer program is preferrably written in the standard language "C".

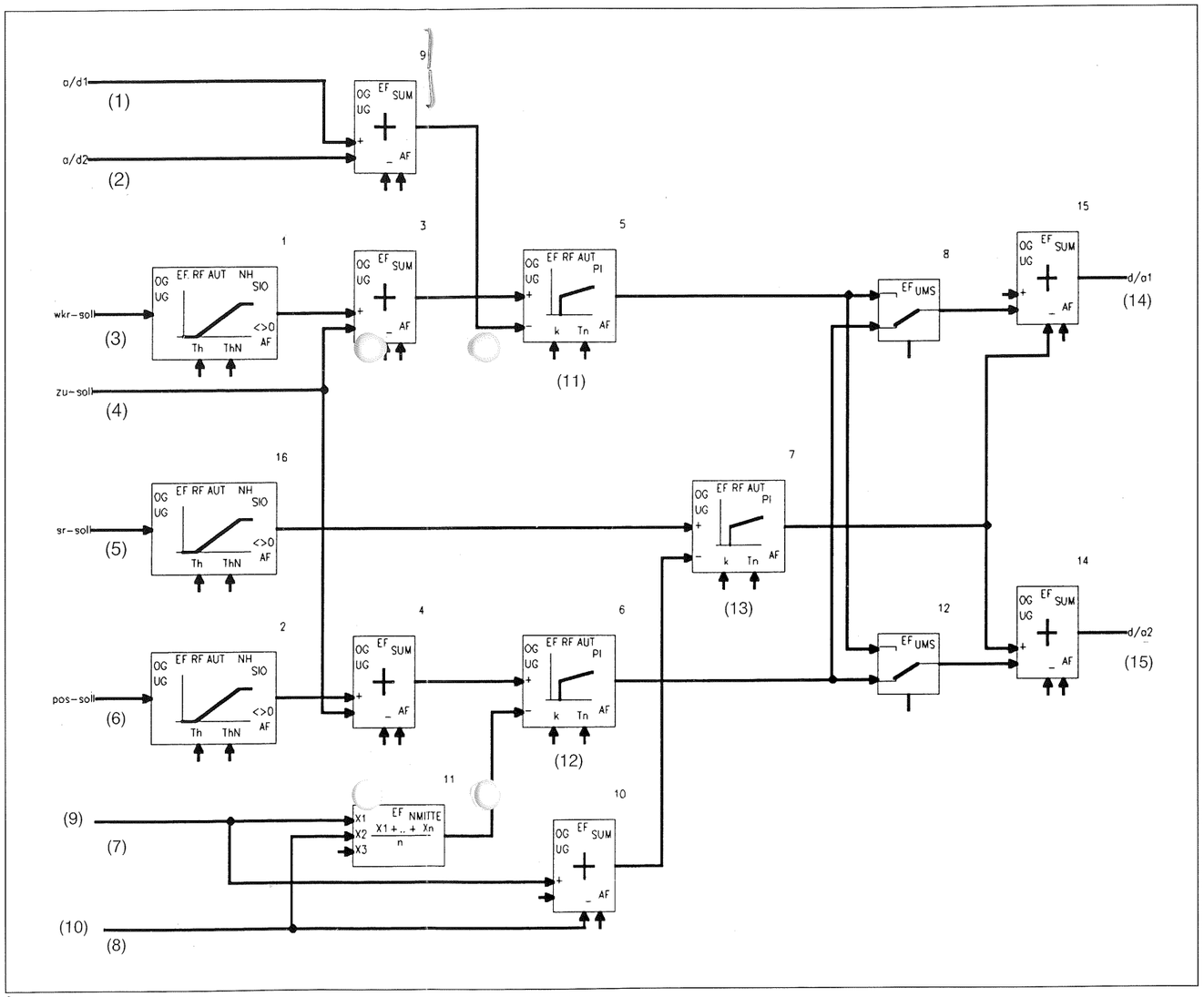
It also contains a telegram function, a monitoring function as well as open-loop and closed-loop control functions, depending on the particular applications.

Multi-tasking is handled by the transputer by starting parallel functions on two different priority levels which can be linked to a hardware timer interrupt in order to achieve their temporal synchronization.

A PC (AT) is necessary as development environment. This is where the corresponding software including libraries is installed:

Compiler	CCT	Cesys
Assembler	ASST	"
Linker	LINKT	"
Optimizer	OPTIM	"
Formatter	TCUPACK	AEG

The linked program is code-optimized and provided with a boot loader. By means of an additional 8-bit PC board (for data transfer only) it is possible to directly load and debug the program with a special loading and terminal program via an ISDN cable and one of the link connections. In a manner similar to the executable Logidyn D programs without this additional board, the debugged program is loaded via the serial interface of the COP 032 into a dedicated, battery-backed RAM area of the COP 032. A task of the COP 032, which will only be processed after a reset, first loads the boot code into the transputer via the internal link connection. The boot code contains all information necessary for further loading and starting in the transputer. The TCU 032 is ready for operation on completion of automatic tests and after having been enabled by the mutual processor monitoring feature.



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2 Control structure for hydraulic screwdown (graph: LogiCAD)

1 Actual rolling force, "A" side
2 Actual rolling force, "B" side
3 Rolling force setpoint
4 Additional setpoint
5 Slanted position
6 Position setpoint
7 Actual position, "A" side
8 Actual position, "B" side
9 Counter 1
10 Counter 2
11 Rolling force controller
12 Position controller
13 Synchro controller
14 Servo valve, "A" side
15 Servo valve, "B" side

Applications

TCU 032 for open-loop and closed-loop control of a hydraulic screwdown

In modern rolling mills, the roll gap is adjusted by means of a hydraulic screwdown. The quality of the product largely depends on the program cycle time and the resulting polling time of the closed-loop control system. Polling times in the order of 5 ms were achieved with assemblies of the currently known type. Due to the development of the transputer card TCU 032, it is possible to reduce the required 1-ms polling time to values of less than 500 µs. This extremely short polling time is achieved by implementing the complex open-loop control functions of the hydraulic screwdown system on the COP 032, whereas the closed-loop control functions are run on the high-speed transputer card COP 800. Communication between the open-loop and closed-loop control system proceeds via the serial links permitting the exchange of data in a manner similar to DMA. Data exchange and processing of the control algorithm thus take place in quasi-parallel form.

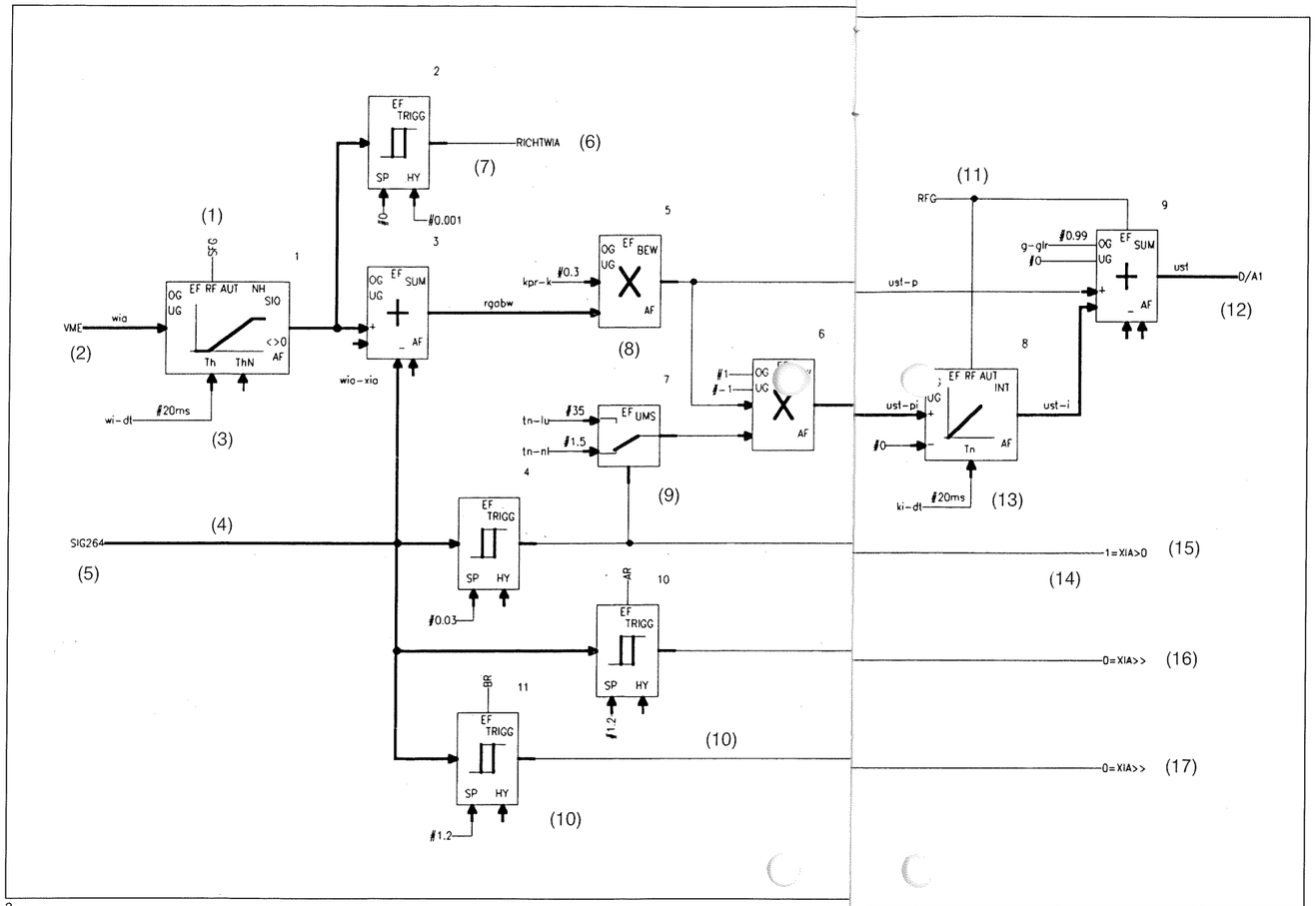
Fig. 2 shows the structure of such a control system. The screwdown is adjusted on the basis of preset rolling force values or on the basis of target position values. The COP 032 sends the setpoints via link 0 to the closed-loop control program on the COP 800. The actual values are read in via the counters "actual position values" and A/D converters (actual rolling force values) of the COP 800. The adjustment commands for the servo valves of the hydraulic screwdown are read out via D/A converters. A synchro controller forms part of the program in order to ensure synchronous operation of the two roll sides which can be adjusted independently. From the synchro controller, the adjustment command is passed on to the D/A converters. The design of hardware and software permits, for example, the implementation of 4 separate position control systems with one TCU 032.

TCU 032 for open-loop and closed-loop control of a DC machine

The main drives of rolling mills are equipped with DC or AC motors. Thyristors in anti-parallel three-phase bridge connection serve as power controlling elements. Precise speed control, associated technological control functions, calculations of characteristics, closed-loop control as well as monitoring functions are implemented in the Logidyn D system. The transputer handles the monitoring functions near the static converter as well as armature and field current control functions:

Within the framework of the monitoring function, both the digital input signals (converter fuse trip ...) and internally detected limit-value violations (XIA>>, run-time monitoring ...) are stored and linked to the control signals of the superior system. They directly cause a quick, orderly controller and pulse lockout as well as an acknowledgment message to be sent to the Logirec diagnostic system.

Fig. 3 shows the general structure of the armature current controller which is implemented as a pulsating-current adaptive PI controller with upstream rate-of-rise limiter. The controller can thus be adjusted to the different behaviour of pulsating and continuous current. An automatic change-over unit to enable the pulses of the respective static-converter bridge is subordinated



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3 Control structure of adaptive armature current control (graph: LogiCAD)

1 Enable signal from change-over logic
2 Armature current setpoint
+ = working direction/
– = braking direction
3 Current rate-of-rise limiter
4 XIA amount
5 Actual armature current value
6 to change-over logic
7 Direction monitoring
1 = working direction (AR)
0 = braking direction (BR)
8 P gain
9 Time constant change-over
10 Overcurrent monitoring
11 Controller enable signal from change-over logic
12 Control voltage
1 = rectifier end position
0 = inverter end position
13 Time constant
14 Zero current monitoring
15 to change-over logic
16 Working direction
17 Braking direction

to the controller. The controller outputs for the pulses are passed on to a frequency-adaptive trigger unit via two D/A converters.

The field current controller is based on a similar design; it can, however, be processed at a lower priority due to the high time constant of the field.

The parameters for commissioning are adjusted via the uniform operator surface Logiview. All relevant quantities can be displayed on this level. Realtime analysis is possible by means of the D/A converters which are still available and an oscilloscope. Simultaneous output to these channels of two relevant quantities between the modules shown (Fig. 3) is possible.

The program run time for the armature current control is less than 300 µs, the monitoring functions and the field current control being processed every 900 µs. Due to the short processing time, this block can be considered as an analog controller with all advantages offered by modern digital controllers.

Parallel computer concepts with TCU 032

Parallel processing is an important aspect for the design of the transputer technology. The corresponding hardware support was implemented in the T 800 chip. The three link connections which are accessible through ISDN connnectors at the front panel can be used for data communication purposes between transputers. These 20-MBaud two-wire connections transmit any information in two directions in serial form and constitute independent DMA channels through which data is transmitted to and from the RAM in a CPU-independent manner. These processes can take place simultaneously and independently in all links. In this way, even the most complex functions can be attributed to any number of transputers each of which being connected to at least one other transputer through a separate link channel.

Such a concept is currently being designed for a cycloconverter-fed drive. Integration into Logidyn D is achieved by means of a TCU 032, another three COP 800 plug-in cards being connected via links. This approach permits a meaningful distribution of functions (three times current control, excitation current control, calculations within the machine model).

Control concepts for DC double-motor drives include a speed control with two subordinated armature current control systems. For these purposes, the TCU 032 is supplemented by an additional plug-in card COP 800 on which the second current control loop and the compensating control functions are implemented.

Explanations:

Modicon A800: basic unit in the form of a multiprocessor-based programmable logic control system for the basic industries to perform the following functions: control, technological control, process technology, arithmetic/logic operations, data acquisition, fault-value acquisition (32-bit processors).

Logidyn D: freely programmable control system with multiprocessor capability for high-speed and dynamic information processing in drive and power supply applications (32-bit processors, partly identical with A800).

RELOG: special language for open-loop and closed-loop control applications (realtime capable).

DOLOG: special language for open-loop control and closed-loop process control applications.

LogiCAD: CAD tool as a software package for documentation and preparation of RELOG programs, executable on A800, Logidyn D.

MMT..: realtime operating system (micro-multi-tasking) for A800, Logidyn D.

RDT..: realtime testing/debugging system for A800, Logidyn D.

RELOG V: module management.

BS-RELOG: operator system for the special language RELOG.

BSDOL: operator system for the special language DOLOG.

Logview: display parameterization system for RELOG.

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