

SIMATIC

FM 352-5 High-Speed Boolean Processor

User Manual

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Preface

Purpose of the Manual

This manual describes the purpose, features, and operating functions of the SIMATIC S7 FM 352-5 High-Speed Boolean Processor Modules (MLFB: 6ES7352-5AH00-0AE0) and (MLFB: 6ES7352-5AH10-0AE0). This manual also enables you to install, configure, program, and operate the FM 352-5 modules.

Contents of the Manual

This manual describes the FM 352-5 hardware and the software required to configure and program the modules. It consists of chapters containing instructions and reference chapters (technical specifications).

This manual deals with the following topics:

- Installing and wiring the FM 352-5 modules
- Configuring the FM 352-5 modules
- Assigning operating mode parameters to the FM 352-5 modules
- Programming the FM 352-5 modules
- Operating the modules
- Troubleshooting and diagnostics

Related Documentation

Consult the documentation for the SIMATIC S7-300 Programmable Controller system and the STEP 7 programming software for complete information on installing and programming the FM 352-5 High-Speed Boolean Processor Modules.

CD-ROM

The entire SIMATIC Manual Collection is also available on CD-ROM.

Configuring the Hardware

You configure the FM 352-5 module using the FM 352-5 Configuration software with the standard Hardware Configuration application of STEP 7. The hardware configuration dialogs for the FM 352-5 module allow you to set the following properties and parameters:

- Address assignments, where you can use the S7 system default assignments, or select your own addresses (with CPUs that support address selection).
- Programming parameters, where you specify the FB and DB numbers to be used to store the program, and where you select the operating mode.
- Operational parameters, such as interrupts, input filtering, module diagnostics, output diagnostics, encoder parameters, and others.

Programming the FM 352-5

You program the FM 352-5 module using the FM 352-5 Configuration software with the STEP 7 LAD/FBD editor (version 5.1, SP3 or greater). The FM 352-5 software provides a library of special instructions for the Program Elements catalog.

The library of function blocks (FBs) for the FM 352-5 includes timers, counters, shift registers, a binary scaler, and a clock pulse generator that are intended for use only with the FM 352-5 module. In addition, you will be able to select a subset of the standard STEP 7 bit-logic instructions, such as contacts and coils, as you create your program. The FM 352-5 instructions are described in Chapter 6.

You write your program in an Application FB. Using the FM 352-5 Configuration software and STEP 7, the program is compiled, then copied into a Micro Memory Card (MMC) for non-volatile storage. The MMC is installed in the slot on the front of the module. When the FM 352-5 module is powered up, the stored program is retrieved from the MMC and the module executes the program from that image.

Operating Characteristics

The FM 352-5 module executes its program independently of the master CPU. The inputs and outputs of the process controlled by the module are local and cannot be accessed directly by the master CPU. However, the user program of the CPU transfers control commands and configuration parameters to the FM 352-5 module over the I/O bus and evaluates the status information returned by the module.

The FM 352-5 module has the following operating characteristics:

- Recording and control of fast processes (for example, high-speed inspection & rejection systems, or control of high-speed machines in the packaging, food & beverage, tobacco, and personal care product industries).
- Data exchange with the CPU user program (when used in a coprocessor configuration). The S7 CPU has access to 16 bytes of input and 16 bytes of output data to permit transfer of control information, count values, counter preset values, and status information using a special Interface FB (Function Block) to coordinate the data exchange (see Figure 1-1).

1.2 Physical Features of the Module

Status Indicators

Figure 1-2 shows the status indicators on the faceplate of the FM 352-5 module.

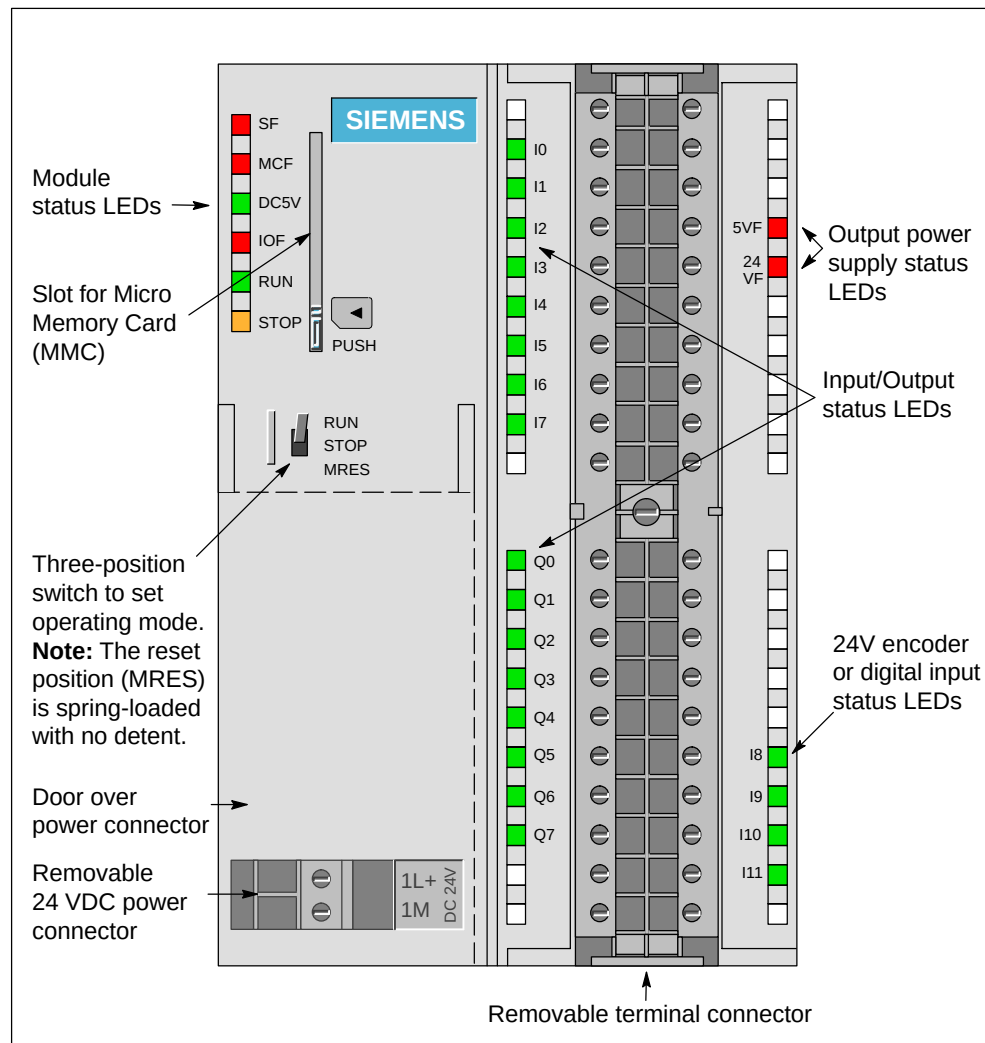


Figure 1-2 Main Features of the FM 352-5 Module

Other Physical Features

Other features found on the module, as shown in Figure 1-2, include the following:

- Three-position switch to set the operating mode of the module
- Slot for the Micro Memory Card (MMC), which stores the program in non-volatile memory
- Removable terminal connector for wiring inputs and outputs

Front Connector

The removable front connector allows the following connection options:

- 24 V digital inputs: 8 inputs, up to 12 inputs if the 24 V encoder is not connected
- 24 V digital outputs: 8 outputs
- Connections for 24 V user-supplied power
- Encoder signals: an incremental encoder (RS-422), an SSI absolute encoder, or a 24 V single-ended encoder
- 5 V and 24 V connections to supply power to the encoders

Wiring Diagram

A simplified wiring diagram is provided on the inside of the terminal connector door, as shown in Figure 4-1.

Labeling Strip

Enclosed with the module is a labeling strip for identifying the signals connected to the terminal connector. The labeling strip is inserted into the recessed space on the front of the connector door.

Micro Memory Card (MMC)

The Micro Memory Card stores the program files in non-volatile memory, and installs in the slot on the front of the FM 352-5 module. An MMC with 128 Kbytes, 512 Kbytes, or 2 Mbytes of memory is required for FM 352-5 operation.

The program files are downloaded from the MMC to the FPGA at power-up or after a memory reset.

1.3 System Configurations

Figure 1-3 shows some possible system configurations with the FM 352-5. The control program is developed in the STEP 7 environment with the FM 352-5 Configuration software. The FM 352-5 module can operate: ① in an S7 system, ② in a stand-alone configuration, or ③ in a distributed system (with an S7 or non-S7 master), using PROFIBUS communications.

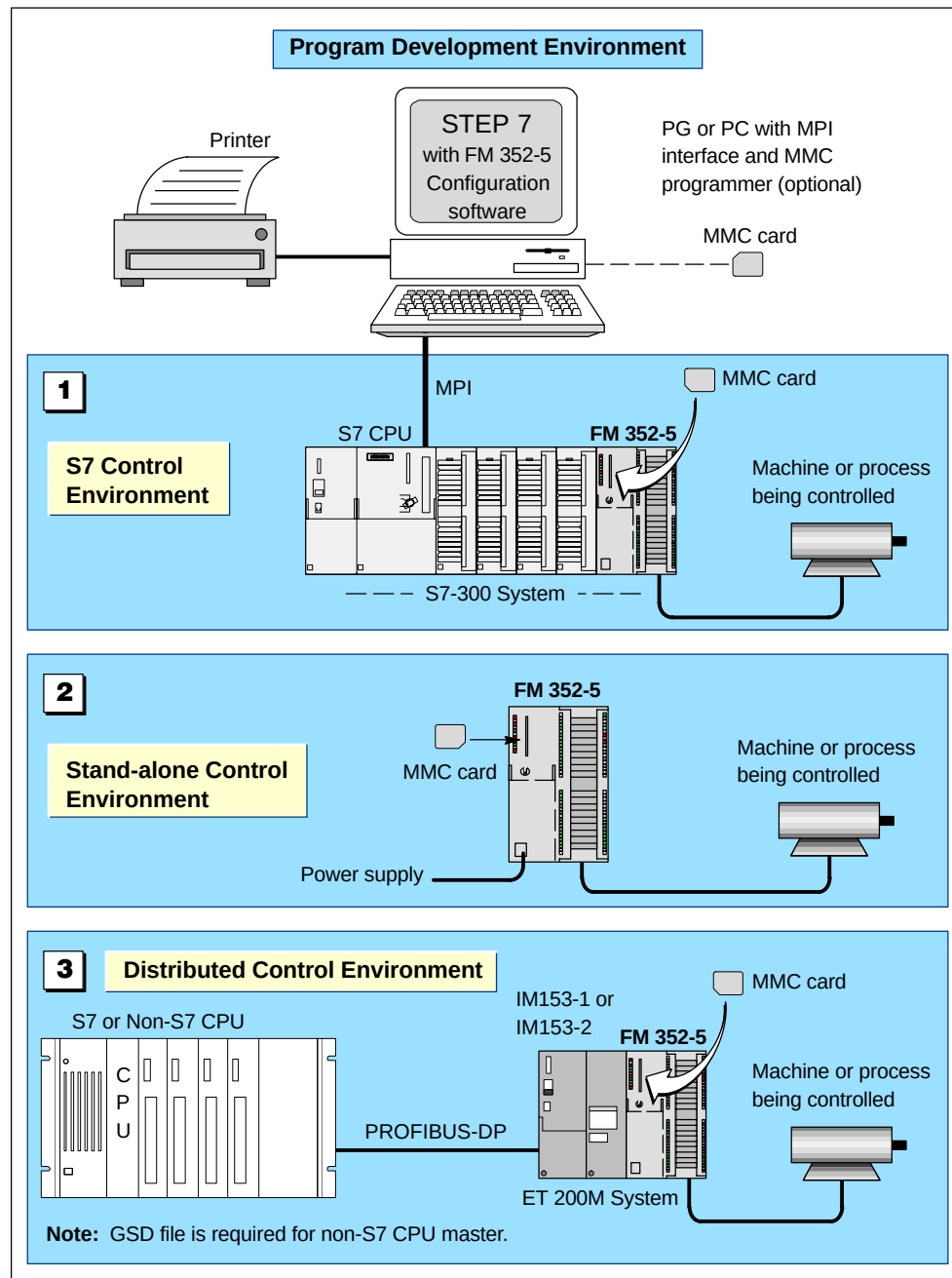


Figure 1-3 Examples of System Configurations

Specifications

A

Chapter Overview

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Emission of Radio Interference

Emitted interference of electromagnetic fields in accordance with EN 55011: Limit Value Class A, Group 1 (measured at a distance of 10 m).

Frequency	Emitted Interference
From 30 MHz to 230 MHz	< 40 dB (μV/m)Q
From 230 MHz to 1000 MHz	< 47 dB (μV/m)Q

Shipping and Storage Conditions

The FM 352-5 exceeds the requirements of IEC 1131, Part 2 as regards shipping and storage conditions.

A.3 Mechanical and Climatic Environmental Conditions

Climatic Environmental Conditions

The following climatic environmental conditions apply:
Requirements according to IEC 61131–2.

Environmental Conditions	Operating Ranges	Remarks
Temperature	from 0 °C to 60 °C	For horizontal installation
	from 0 °C to 40 °C	For all other installation positions
Temperature variation	10 K/h	
Relative humidity	From 15% to maximum 95%	Without condensation
Air pressure	From 1080 hPa to 795 hPa	Corresponds to an altitude of -1000 m to 2000 m

Testing Mechanical Environmental Conditions

The following table provides information on the type and extent of tests of mechanical environmental conditions. Requirements according to IEC 61131–2.

Test for ...	Test Standard
Oscillations	Oscillation test to IEC 60068-2-6, Test Fc
Shock	Shock test to IEC 60068-2-27, Test Ea

A.4 Information on Insulation Testing, Safety Class, Degree of Protection, and Rated Voltage

Test Voltages

Insulation strength is demonstrated in the routine test with the following test voltage in accordance with IEC 1131, Part 2:

Circuits with Rated Voltage E_{eff} to Other Circuits or Ground	Test Voltage
$0 \text{ V} < E_{\text{eff}} \leq 50 \text{ V}$	500 VDC

Pollution Severity/Overvoltage Category

- Pollution severity 2 in accordance with IEC 60664 (IEC 1131)
- Overvoltage category in accordance with IEC 60664
 - for $E_{\text{rated}} = 24 \text{ VDC}$: II

Safety Class

Safety class I in accordance with IEC 536 (VDE 0106, Part 1)

IP 20 Degree of Protection

IP 20 protection in accordance with IEC 529, which means:

- Protection against contact with standard test probes
- Protection against foreign bodies with a diameter greater than 12.5 mm
- No special protection against water

Rated Voltage for Operation

The FM 352-5 works with the rated voltage and corresponding tolerances specified in the following table.

Rated Voltage	Tolerance Range
24 VDC	20.4 VDC to 28.8 VDC

A.5 Technical Specifications

Dimensions and Weight		Power dissipation of the module	6.5 W typical
Dimensions W x H x D	80 x 125 x 130 mm	Data for Selecting a Sensor	
Weight	Approx. 434 g (with 1L connector, without I/O connector or MMC)	Input voltage	
Data for Specific Modules		- Rated value - For signal "1" - For signal "0"	24 VDC 11 V to 30 V –30 V to 5 V
Number of inputs	12 (24 VDC) 3 (RS-422)	Input current	
Number of outputs	8	- At signal "1" - At signal "0"	3.8 mA typical ≤1.5 mA
Voltage, Currents, Potentials		Input frequency	200 kHz max.
Power rated voltage of the electronics (1L+, 2L+, 3L+)	24 VDC, Class 2 power supply	Hardware input delay	3 μs max.
- Reverse polarity protection - Power failure bypass	Yes 5 ms	Parameterizable input delay times	None, 5 μs, 10 μs, 15 μs, 20 μs, 50 μs, 1.6 ms
Isolation		Minimum pulse width for program response ¹	1 μs, 5 μs, 10 μs, 15 μs, 20 μs, 50 μs, 1.6 ms
- Between the field side I/O card (2L) and the encoder card (3L) - Between the field side I/O card (2L) and logic - Between Aux supply (1L) and logic - Between Aux supply (1L) and field side of encoder or I/O card (2L or 3L) - Potential differences between M terminals and central ground	75 VDC, 60 VAC 75 VDC, 60 VAC 75 VDC, 60 VAC 75 VDC, 60 VAC 75 VDC, 60 VAC	Cable length, sensors	100 meters unshielded, 600 meters shielded. Shielded cable is recommended when less than 1.6 ms filtering is selected.
Insulation tested with	500 VDC	Minimum pulse width (max. SW counter frequency)	1 μs (200 kHz)
Current consumption		Connection of two-wire BEROs	Possible
- From input voltage 1L+ @20.4 – 28.8 V - From input voltage 2L+ @20.4 – 28.8 V - From input voltage 3L+ with 5.2 V or 24 V encoder - From input voltage 3L+ @20.4 – 28.8 V - From backplane bus	150 mA max. 200 mA max. 600 mA max., with encoder supply fully loaded 200 mA max., with no encoder supply load 100 mA typical	Permitted bias current	Off (idle): 1.5 mA max. On: 3.2 mA min.

Note¹ The input delay filter is a noise (pulse) filter. It may not reject a continuous wave of 1/delay.

Data for Selecting an Actuator (5AH00: M switching output)	
Output voltage	
• At signal "1"	max. (M +0.5 V)
Output current	
• At signal "1"	
Rated value	0.5 A
Permitted range	5 mA to 0.6 A
• At signal "0"	
(leakage current)	max. 1.0 mA
Total current of the outputs	max. 4 A
Output delay, (for resistive load)	
• At "1" to "0"	max. 3.2 μ s typ. 1.7 μ s
• At "0" to "1"	max. 2 μ s typ. 1.0 μ s
Output dv/dt, (for resistive load)	
• At "1" to "0"	max. 15 V/ μ s typ. >50 V/ μ s
• At "0" to "1"	max. 12 V/ μ s typ. >39 V/ μ s
Lamp load	max. 5 W
Connecting two outputs in parallel	
• For redundant triggering of a load	Possible
• To increase performance	Possible max. 1 A (resistive only)
Triggering a digital input	Not possible
Switch rate	
• For resistive load	max. 20 kHz at 0.5 A max. 50 kHz at 0.5 A
• For inductive load ¹	Refer to Section A.8
• For lamp load	max. 10 Hz
Limit (internal) of the inductive circuit interruption voltage	max. M (+55 V) typ. M (+45 V)
Short-circuit protection for the output ²	electronic
• Threshold on	typ. 1.7 A to 3.5 A
Cable length	
• Unshielded	100 m
• Shielded	600 m

Note¹: Not protected by Inductive kickback >55 mJ

Note²: Outputs not protected from contravoltage if the current is not limited to < 3 A.

Encoder Section		Cable length, HTL incremental encoders, Siemens type 6FX2001-4		25 m shielded, max. at 50 kHz 50 m shielded, max. at 25 kHz
Input frequency		Cable length, RS-422 (5V) incremental encoders Siemens type 6FX201-2, 5V supply		32 m shielded, max. at 500 kHz
• RS422 input	1 MHz max.	Cable length, RS-422 (5V) incremental encoders Siemens type 6FX201-2, 24V supply		100 m shielded, max. at 500 kHz
• 24 VDC input	200 kHz max.	Cable length, RS-422 SSI absolute encoders Siemens type 6FX201-5, 24V supply		320 m shielded, max. at 125 kHz 160 m shielded, max. at 250 kHz 60 m shielded, max. at 500 kHz 20 m shielded, max. at 1 MHz
Encoder signal interpretation	Pulse & direction, x1, x2, x4	Frame Time of the Encoders		
Reset source	None, HW, SW, HW and SW, HW or SW	Encoder Frame Times	<u>13-bit</u>	<u>25-bit</u>
Reset value source	Constant 0, Min/Max value, Load value	• 125 kHz	108 µs	204 µs
Reset signal type	Edge, Level	• 250 kHz	54 µs	102 µs
Load value source	Constant, Module application	• 500 kHz	27 µs	51 µs
Hold source	None, HW, SW, HW and SW, HW or SW	• 1 MHz	14 µs	26 µs
Load value	User entry or module application	Sensor Power Supply Outputs		
Count range minimum	User entry	5.2 V output power for sensors and encoders ¹		
Count range maximum	User entry	• Supply output		
Main count direction	Count up, Count down	• Output current		
Hardware hold source	Inputs 0 through 14	• Protection		
Hardware reset source	Inputs 0 through 14	• Diagnostic		
Counting modes	Continuous, single, periodic	24 V output power for sensors and encoders ¹		
Count range, 16-bit	–32768 to 32767	• Supply output		
Count range, 32-bit	–2147483648 to 2147483647	• Output current		
Encoder signals		• Protection		
• 5 V (RS-422)	A, $\bar{A}$, B, $\bar{B}$, and N, $\bar{N}$	• Diagnostic		
• 24 V (HTL)	A, B, and N			
SSI Encoder				
• SSI signals	D, $\bar{D}$, CK, and $\bar{CK}$			
• Frame length	25 bits or 13 bits, Gray code			
• Resolution	16,777,216 max.			
• Delay times (Monoflop)	16, 32, 48, or 64 µs			
• Shift register length	13 bits or 25 bits			
• Clock rate	125 kHz, 250 kHz, 500 kHz, or 1 MHz			
• Data shift direction	Left or right			
• Data shift length	0 to 12 bits			
• SSI modes	Master, Listen (up to two stations)			

Note¹ Only one of the output power supplies for encoders can be used at a time, not both together.

Status, Interrupts, Diagnostics		High-Speed Boolean Processor Operation	
Interrupts	Yes	Execution time	1 μ s
- Hardware interrupts 1L missing¹ 2L missing¹ 3L missing¹ - Encoder overload¹ - Encoder broken wire¹ - SSI frame error¹ - Output overload^{1, 2} - MMC fault - Process interrupts	Parameters can be assigned Diagnostics data record Diagnostics data record Diagnostics data record Diagnostics data record Diagnostics data record Diagnostics data record Diagnostics data record Diagnostics data record Yes, 8 process alarms Note: Process Alarms; “Alarm–N is set on the PROFIBUS after a 24 V input sets Intr [x]” 63 μs typ. 200 μs max. Maximum sustained process alarm rate (without process alarm lost) 400 Hz (2.5 ms)	PLC update cycle time	$\approx$ 2.6 ms (5 ms max.)
		Program and hardware response time	2 to 6 μ s, input to output
Diagnostic functions		Note¹ Diagnostic indications for these conditions are available only when enabled in the Parameters tab of the FM 352-5 Properties dialog. Note² Output overload diagnostics may not be reported if the output pulse width is less than 2 ms (5AH00), or 20 μs (5AH10). Note³ MCF LED status is only updated when the MMC is removed or when the module is commanded to Read or Write the MMC.	
	Yes		
- Group error display - MMC error ³ - Monitoring of the power supply voltage of the electronics	SF, red LED MCF, red LED DC5V, green LED		
- I/O fault status - Run mode - Stop mode - Power supply fault (encoder) - Input status - Output status	IOF, red LED RUN, green LED STOP, yellow LED 5VF, red LED 24VF, red LED Green LED (I 0 to I11) Green LED (Q 0 to Q 7)		

A.6 Functional Block Diagram

Figure A-1 shows a functional block representation of the essential hardware components of the FM 352-5 module.

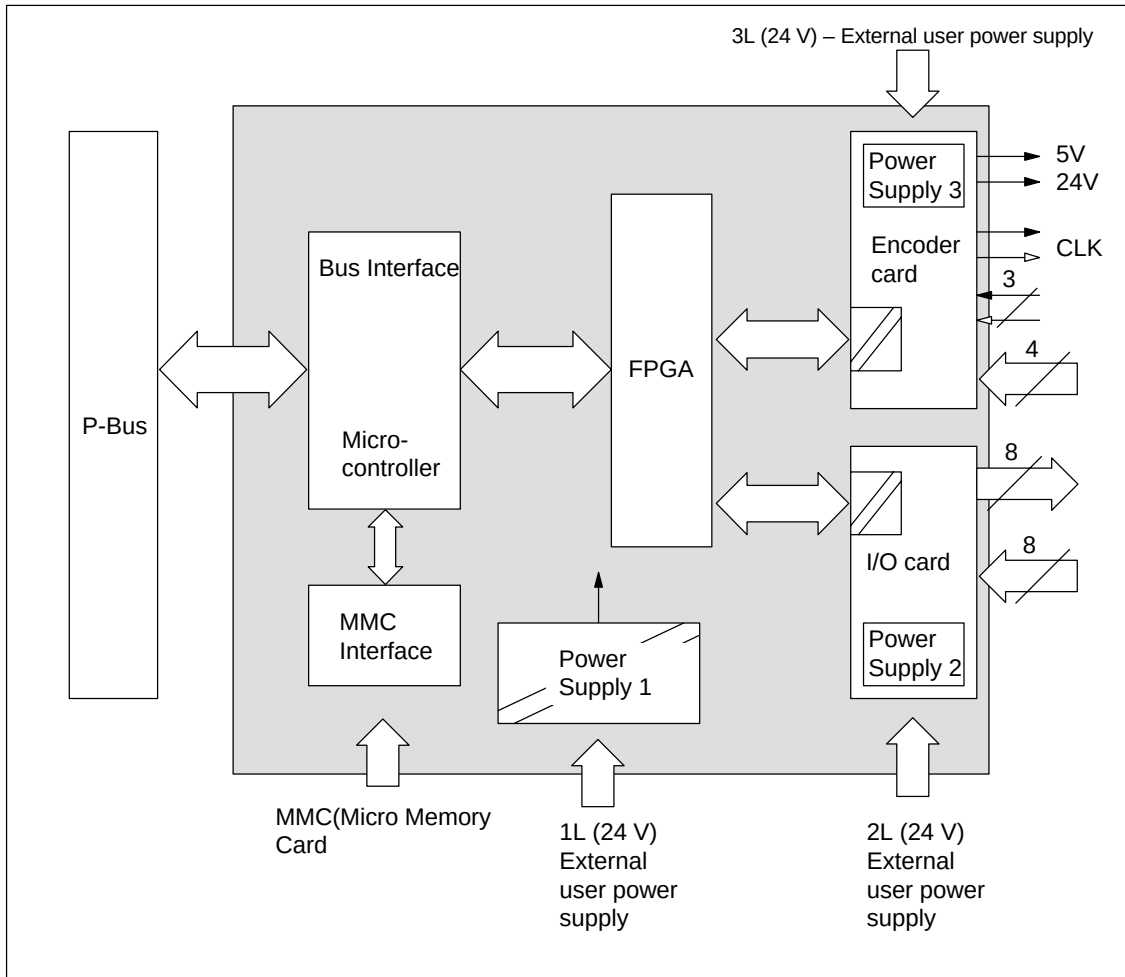


Figure A-1 Functional Block Diagram of the FM 352-5 Module

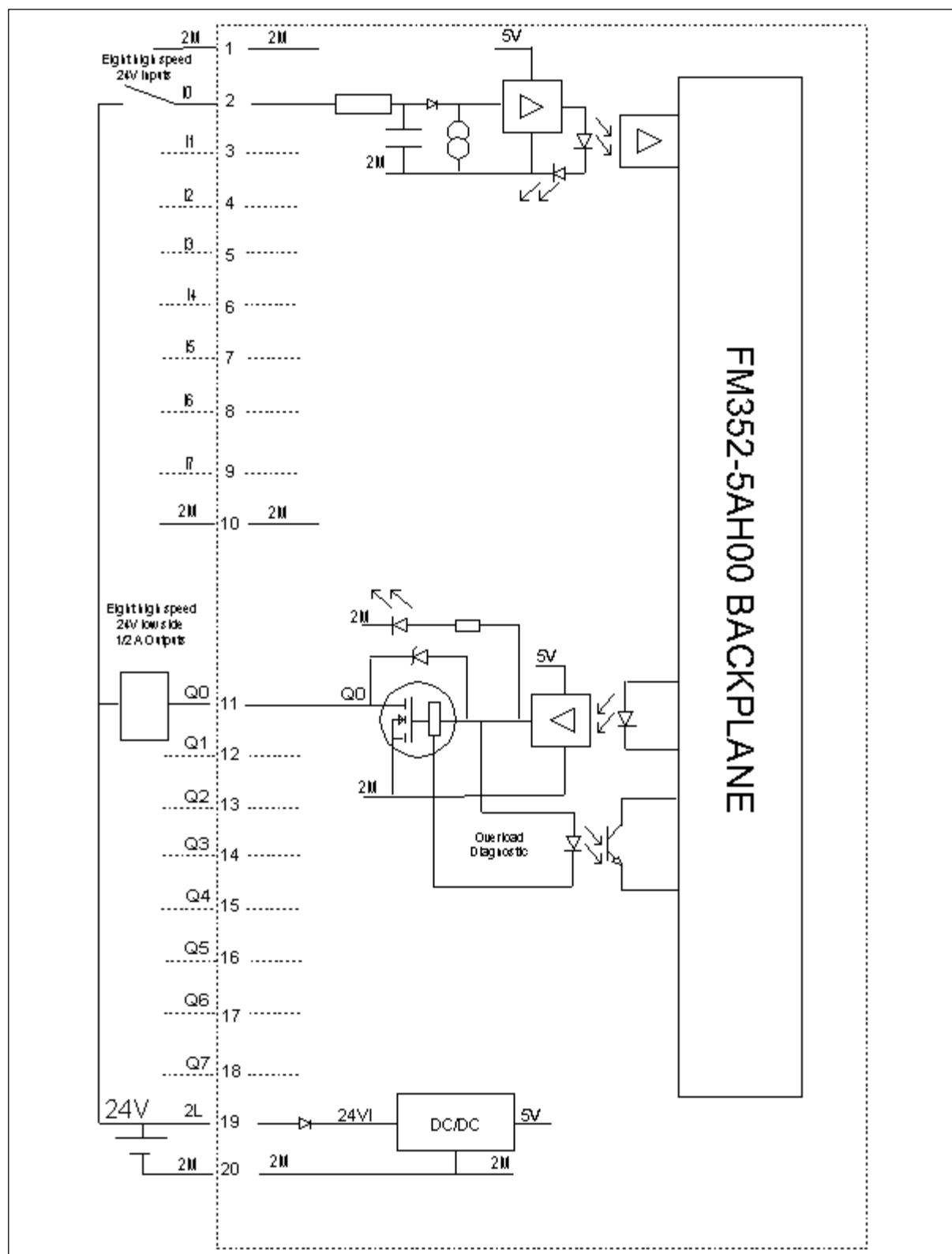


Figure A-3 Function Block Diagram of the FM 352-5AH00-0AE0 I/O Card