Table of contents

1 Introduction 16
1.1 Overview of the S7-1200 automation system 16
1.1.1 SIMATIC S7-1200 17
1.1.2 Overview of STEP 7 Basic 19
1.1.3 Two programming languages 21
1.1.4 Execution of the control program 22
1.1.5 Data management in the SIMATIC automation system 24
1.1.6 Operator control and monitoring with process images 25
1.2 Introduction to STEP 7 Basic for S7-1200 26
1.2.1 Installing STEP 7 26
1.2.2 Automation License Manager 26
1.2.3 Starting STEP 7 Basic 27
1.2.4 Portal view 27
1.2.5 Help information system 28
1.2.6 The windows of the project view 29
1.2.7 Adapting the user interface 31
1.3 Editing a SIMATIC project 32
1.3.1 Structured representation of project data 33
1.3.2 Project data and editors for a PLC station 34
1.3.3 Creating and editing a project 36
1.3.4 Creating and editing libraries 37

2 SIMATIC S7-1200 automation system 38
2.1 S7-1200 station components 38
2.2 S7-1200 CPU modules 39
2.2.1 Integrated I/O 39
2.2.2 PROFINET connection 41
2.2.3 Status LEDs 41
2.2.4 SIMATIC Memory Card 42
2.2.5 Signal board (SB) 42
2.3 Signal modules (SM) 42
2.3.1 Digital I/O modules 43
2.3.2 Analog I/O modules 43
2.3.3 Properties of the I/O connections 44
2.4 Communication modules (CM) 45
2.5 Other modules 46
2.5.1 Compact switch module (CSM) 46
2.5.2 Power module (PM) 46
2.5.3 SIM 1274 simulator 46
2.6 SIPLUS S7-1200 47

Bibliografische Informationen
http://d-nb.info/999729322

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

3 Device configuration ... 48
3.1 Introduction ... 48
3.2 Configuring a station ... 50
3.2.1 Adding a PLC station ... 50
3.2.2 Arranging modules ... 50
3.2.3 Adding an HMI station ... 50
3.3 Parameterization of modules ... 51
3.3.1 Addressing inputs and outputs ... 51
3.3.2 Parameterization of CPU properties ... 52
3.3.3 Parameterization of digital inputs ... 53
3.3.4 Parameterization of digital outputs ... 54
3.3.5 Parameterization of analog inputs ... 54
3.3.6 Parameterization of analog outputs ... 55
3.4 Configuring the network ... 56
3.4.1 MAC address, IP address and subnet mask ... 57
3.4.2 Setting the interface parameters ... 59
3.4.3 Networking stations ... 59
3.4.4 Configuring HMI connections ... 60

4 Execution of control program ... 62
4.1 Operating modes ... 62
4.1.1 STOP state ... 63
4.1.2 Retentive behavior ... 63
4.1.3 STARTUP mode ... 64
4.1.4 Startup program ... 65
4.1.5 RUN mode ... 66
4.2 Creation of control program ... 67
4.2.1 Program draft ... 67
4.2.2 Program execution ... 68
4.2.3 Nesting depth ... 70
4.3 Blocks ... 71
4.3.1 Block types ... 71
4.3.2 Block properties ... 73
4.3.3 Know-how protection ... 77
4.3.4 Block interface ... 78
4.3.5 Use of block parameters ... 80
4.3.6 Use of temporary local data ... 81
4.3.7 Use of static local data ... 83
4.3.8 Local instances ... 83
4.4 Calling blocks ... 84
4.4.1 Call functions ... 85
4.4.2 Supplying block parameters ... 85
4.4.3 “Passing on” of block parameters ... 88
4.5 Main program ... 88
4.5.1 Process image updating ... 89
4.5.2 Cycle time ... 90
4.5.3 Response time ... 91
4.5.4 Time ... 93

4.5.5 Stopping the program execution 96
4.6 Interrupt processing 96
4.6.1 Introduction to interrupt processing 96
4.6.2 Time-delay interrupts 99
4.6.3 Cyclic interrupts 102
4.6.4 Process interrupts 104
4.6.5 Delay and enable interrupts 107
4.7 Error handling 108
4.7.1 Causes of errors and responses 108
4.7.2 Local error handling 108
4.7.3 Error display with the ENO output 110
4.7.4 Diagnostics interrupt OB 82 112
4.7.5 Time error OB 80 112

5 LAD/FBD program editor 114
5.1 Introduction 114
5.2 PLC tag table 115
5.2.1 Defining PLC tags 115
5.2.2 Constants table 117
5.3 Programming a code block 118
5.3.1 Creating a new code block 118
5.3.2 Working area of program editor for code blocks 119
5.3.3 Specifying code block properties 121
5.3.4 Programming a block interface 121
5.3.5 Edit code block, network handling 123
5.3.6 Edit code block, enter program 123
5.4 Programming a data block 128
5.4.1 Creating a new data block 128
5.4.2 Working area of program editor for data blocks 129
5.4.3 Defining properties for data blocks 129
5.4.4 Declaring data tags 130
5.4.5 Entering data tags in global data blocks 130
5.5 Compiling blocks 131
5.5.1 Starting the compilation 132
5.5.2 Eliminating errors following compilation 133
5.6 Program information 134
5.6.1 Cross-reference list 134
5.6.2 Assignment list 136
5.6.3 Call structure 137
5.6.4 Dependency structure 138
5.6.5 Consistency check 139
5.6.6 CPU resources 139
5.7 Language setting 140

6 Ladder logic LAD 142
6.1 Introduction 142
6.1.1 Programming with LAD in general 142
6.1.2 Program elements of ladder logic 144

6.2 Programming with contacts 145
6.2.1 NO and NC contacts 145
6.2.2 Consideration of sensor type in ladder logic 147
6.2.3 Series connection of contacts 147
6.2.4 Parallel connection of contacts 147
6.2.5 Mixed series and parallel connections 149
6.2.6 T branch, open parallel branch in the ladder logic 150
6.2.7 Negating result of logic operation in the ladder logic 151
6.2.8 Edge evaluation of a binary tag in ladder logic 152
6.2.9 OK contact 153
6.2.10 Comparison contacts 154
6.3 Programming with coils 155
6.3.1 Simple and negated coils 155
6.3.2 Set and reset coil 156
6.3.3 Retentive response due to latching 157
6.3.4 Edge evaluation with pulse output in the ladder logic 158
6.3.5 Multiple setting and resetting (filling of bit field) in the ladder logic . 159
6.4 Programming with Q boxes in the ladder logic 159
6.4.1 Arrangement of Q boxes in the ladder logic 159
6.4.2 Memory boxes in the ladder logic 160
6.4.3 Edge evaluation of current flow 162
6.4.4 Example of binary scaler in the ladder logic 163
6.4.5 IEC timer functions in the ladder logic 164
6.4.6 IEC counter functions in the ladder logic 165
6.5 Programming with EN/ENO boxes in the ladder logic 167
6.5.1 Positioning of EN/ENO boxes in the ladder logic 168
6.5.2 Transfer functions in the ladder logic 169
6.5.3 Arithmetic functions for numerical values in the ladder logic 170
6.5.4 Arithmetic functions for time values in the ladder logic 171
6.5.5 Math functions in the ladder logic 171
6.5.6 Conversion functions in the ladder logic 172
6.5.7 Shift functions in the ladder logic 173
6.5.8 Logic functions in the ladder logic 174
6.5.9 Functions for strings in the ladder logic 175
6.6 Functions for program flow control (LAD) 176
6.6.1 Jump functions in the ladder logic 176
6.6.2 Block end function in the ladder logic 176
6.6.3 Block call functions in the ladder logic 177

7 Function block diagram FBD 178
7.1 Introduction 178
7.1.1 Programming with function block diagram in general 178
7.1.2 Program elements of the function block diagram 180
7.2 Programming of binary logic operations (FBD) 181
7.2.1 Scanning for signal states “1” and “0” 182
7.2.2 Taking account of the sensor type in the function block diagram 183
7.2.3 AND function 185
7.2.4 OR function 185

7.2.5 Exclusive OR function ... 186
7.2.6 Mixed binary logic operations ... 187
7.2.7 T branch in the function block diagram ... 187
7.2.8 Negate result of logic operation in the function block diagram ... 188
7.2.9 Edge evaluation of binary tags in the function block diagram ... 189
7.2.10 Validity checking of floating-point numbers in the function block diagram ... 189
7.2.11 Comparison functions in the function block diagram ... 190
7.3 Programming with standard boxes (FBD) ... 191
7.3.1 Assignment and negated assignment ... 192
7.3.2 Set and reset boxes ... 193
7.3.3 Edge evaluation with pulse output in the function block diagram ... 193
7.3.4 Multiple setting and resetting (filling of bit field) in the function block diagram ... 194
7.4 Programming with Q boxes (FBD) ... 195
7.4.1 Arrangement of Q boxes in the function block diagram ... 195
7.4.2 Memory boxes in the function block diagram ... 197
7.4.3 Edge evaluation of logic operation result in the function block diagram ... 197
7.4.4 Example of binary scaler in the function block diagram ... 198
7.4.5 IEC timer functions in the function block diagram ... 199
7.4.6 IEC counter functions in the function block diagram ... 199
7.5 Programming with EN/ENO boxes (FBD) ... 202
7.5.1 Positioning of EN/ENO boxes in the function block diagram ... 203
7.5.2 Transfer functions in the function block diagram ... 204
7.5.3 Arithmetic functions for numerical values in the function block diagram ... 205
7.5.4 Arithmetic functions with time values in the function block diagram ... 206
7.5.5 Math functions in the function block diagram ... 206
7.5.6 Conversion functions in the function block diagram ... 207
7.5.7 Shift functions in the function block diagram ... 208
7.5.8 Logic functions in the function block diagram ... 209
7.5.9 Functions for strings in the function block diagram ... 210
7.6 Functions for program flow control (FBD) ... 211
7.6.1 Jump functions in the function block diagram ... 211
7.6.2 Block end function in the function block diagram ... 212
7.6.3 Block call functions in the function block diagram ... 212

8 Tags and data types ... 214
8.1 Operands and tags ... 214
8.1.1 Introduction, overview ... 214
8.1.2 Operand areas ... 215
8.1.3 Addressing ... 219
8.2 Elementary data types ... 221
8.2.1 Bit-serial data types BOOL, BYTE, WORD and DWORD ... 222
8.2.2 BCD-coded numbers BCD16 and BCD32 ... 222
8.2.3 Unsigned fixed-point data types USINT, UINT and UDINT ... 223
8.2.4 Fixed-point data types with sign SINT, INT and DINT ... 223

8.2.5 Floating-point data types REAL and LREAL 224
8.2.6 Data type CHAR 226
8.2.7 Data type TIME 226
8.3 Compound data types 227
8.3.1 Data type DTL 227
8.3.2 Data type STRING 228
8.3.3 Data type ARRAY 229
8.3.4 Data type STRUCT 231
8.3.5 Data type ErrorStruct 232
8.4 Parameter types 232
8.4.1 Parameter type VARIANT 232
8.4.2 Parameter type VOID 234
8.5 System data types 234
8.6 Hardware data types 235

9 Language-independent function description 236
9.1 Basic functions 236
9.1.1 Binary logic operations 236
9.1.2 Memory functions 240
9.1.3 Edge evaluation 244
9.1.4 Time functions 249
9.1.5 Counter functions 254
9.2 Digital functions 258
9.2.1 Transfer functions 258
9.2.2 Comparison functions 264
9.2.3 Arithmetic functions for numerical values 266
9.2.4 Arithmetic functions for time values 269
9.2.5 Mathematical functions 270
9.2.6 Conversion functions (Conversion of data type) 274
9.2.7 Shift functions 284
9.2.8 Logic functions 286
9.2.9 Processing of strings (Data type STRING) 291
9.3 Program flow control 296
9.3.1 Overview 296
9.3.2 Jump functions 296
9.3.3 Block end function 297
9.3.4 Calling of code blocks 298
9.3.5 EN/ENO mechanism 300

10 Online operation, diagnostics and debugging 302
10.1 Connecting a programming device to the PLC station 303
10.1.1 IP addresses of the programming device 303
10.1.2 Connecting the programming device to the PLC station 305
10.1.3 Assigning an IP address to the CPU module 306
10.1.4 Switching on the online mode 306
10.2 Transferring project data 307
10.2.1 Downloading project data for the first time 307
10.2.2 Delta downloading of project data 309

10.2.3 Error message following downloading 310
10.2.4 Working with the memory card 310
10.2.5 Processing blocks offline/online 313
10.2.6 Comparing blocks offline/online 314
10.2.7 Editing online project without offline project 316
10.2.8 Uploading project data from the CPU 317
10.3 Hardware diagnostics 319
10.3.1 Status displays on the modules 319
10.3.2 Diagnostics information 320
10.3.3 Diagnostics buffer 320
10.3.4 Diagnostics functions 322
10.3.5 Online tools 322
10.3.6 Further diagnostics information via the programming device 323
10.4 Debugging of control program 324
10.4.1 Monitoring with the PLC tag table 324
10.4.2 Introduction to testing with program status 324
10.4.3 Program status for code blocks 325
10.4.4 Debugging data operands with program status 327
10.4.5 Debugging with watch tables 328
10.4.6 Monitoring tags using watch tables 330
10.4.7 Modifying tags using watch tables 331
10.4.8 Forcing tags using watch tables 332
10.4.9 Enabling peripheral outputs and “Modify now” 334

11 Communication 336
11.1 Overview 336
11.1.1 Introduction to communication with Ethernet 336
11.1.2 Configuring communication with STEP 7 Basic 337
11.2 Open user communication 338
11.2.1 Introduction to open user communication 338
11.2.2 Configuring open user communication 340
11.2.3 Communication functions for open user communication 342
11.3 Point-to-point communication 345
11.3.1 Introduction to point-to-point communication 345
11.3.2 Configuring the CM 1241 communication module 345
11.3.3 Point-to-point communication functions 347

12 Visualization 350
12.1 Introduction to visualization 350
12.1.1 Overview of Basic Panels 351
12.1.2 Creating a project with an HMI station 352
12.1.3 Cross-references for HMI objects 355
12.2 Creating HMI tags and area pointers 356
12.2.1 Introduction to HMI tags 356
12.2.2 Creating an HMI tag 357
12.2.3 Creating an area pointer 357
12.3 Configuring process screens 360
12.3.1 Introduction to configuring process screens 360

12.3.2 Working window for process screens 360
12.3.3 Working with screen levels 361
12.3.4 Working with templates 362
12.3.5 Working with function keys 362
12.3.6 Creating a new screen 364
12.3.7 Configuring a screen change 364
12.3.8 Working with objects in process screens 365
12.3.9 Changing screen objects during runtime 366
12.3.10 Basic objects for screen configuration 367
12.4 HMI functions 367
12.4.1 Input and display of process values 367
12.4.2 Working with alarms 371
12.4.3 Working with recipes 378
12.4.4 Working with the user administration 382
12.5 Completing HMI configuration 385
12.5.1 Compiling the HMI configuration (Consistency test) 385
12.5.2 Simulation of HMI configuration 386
12.5.3 Downloading configuration to the HMI station 387
12.5.4 Maintenance of the HMI station 389

13 Appendix 392
13.1 Integral and technological functions 392
13.1.1 High-speed counter (HSC) 392
13.1.2 Pulse generator 398
13.1.3 Technology object Axis 401
13.1.4 Technological object PID controller 404
13.2 Global libraries 406
13.2.1 USS drive protocol 406
13.2.2 MODBUS global library 408

Index 410