

TABLE OF CONTENTS



Chapter 1: Getting Started

Introduction	1-2
The Purpose of this Manual	1-2
Supplemental Manuals	1-2
Technical Support	1-2
Conventions Used.....	1-3
Key Topics for Each Chapter.....	1-3
DL06 Micro PLC Overview.....	1-4
The DL06 PLC Features	1-4
DirectSOFT Programming for Windows™	1-4
Handheld Programmer	1-5
I/O Quick Selection Guide	1-5
Quick Start	1-6
Steps to Designing a Successful System	1-10
Questions and Answers about DL06 Micro PLCs.....	1-12

Chapter 2: Installation, Wiring, and Specifications

Safety Guidelines	2-2
Plan for Safety	2-2
Three Levels of Protection	2-3
Emergency Stops.....	2-3
Emergency Power Disconnect	2-4
Orderly System Shutdown.....	2-4
Class 1, Division 2 Approval	2-4
Orientation to DL06 Front Panel	2-5
Terminal Block Removal	2-6

Table of Contents

Mounting Guidelines.....	2-7
Unit Dimensions.....	2-7
Enclosures	2-7
Panel Layout & Clearances	2-8
Using Mounting Rails	2-9
Environmental Specifications	2-10
Agency Approvals.....	2-10
Marine Use.....	2-10
Wiring Guidelines.....	2-11
External Power Source.....	2-12
Planning the Wiring Routes	2-12
Fuse Protection for Input and Output Circuits	2-13
I/O Point Numbering	2-13
System Wiring Strategies	2-14
PLC Isolation Boundaries	2-14
Connecting Operator Interface Devices	2-15
Connecting Programming Devices	2-15
Sinking / Sourcing Concepts	2-16
I/O "Common" Terminal Concepts.....	2-17
Connecting DC I/O to "Solid State" Field Devices.....	2-18
Solid State Input Sensors.....	2-18
Solid State Output Loads.....	2-18
Relay Output Wiring Methods.....	2-20
Relay Outputs-Transient Suppression For Inductive Loads in a Control System.....	2-21
Prolonging Relay Contact Life	2-26
DC Input Wiring Methods.....	2-27
DC Output Wiring Methods.....	2-28
High-Speed I/O Wiring Methods	2-29
Wiring Diagrams and Specifications.....	2-30
D0-06AA I/O Wiring Diagram.....	2-30
D0-06AR I/O Wiring Diagram	2-32
D0-06DA I/O Wiring Diagram	2-34
D0-06DD1 I/O Wiring Diagram	2-36
D0-06DD2 I/O Wiring Diagram	2-38
D0-06DR I/O Wiring Diagram.....	2-40
D0-06DD1-D I/O Wiring Diagram.....	2-42

D0-06DD2-D I/O Wiring Diagram.....	2-44
D0-06DR-D I/O Wiring Diagram	2-46
Glossary of Specification Terms	2-48

Chapter 3: CPU Specifications and Operation

Overview 3-2

DL06 CPU Features	3-2
-------------------------	-----

CPU Specifications	3-3
---------------------------------	------------

CPU Hardware Setup	3-4
---------------------------------	------------

Communication Port Pinout Diagrams	3-4
--	-----

Connecting the Programming Devices.....	3-5
---	-----

CPU Setup Information	3-5
-----------------------------	-----

Status Indicators.....	3-6
------------------------	-----

Mode Switch Functions.....	3-6
----------------------------	-----

Changing Modes in the DL06 PLC	3-7
--------------------------------------	-----

Mode of Operation at Power-up	3-7
-------------------------------------	-----

Using Battery Backup	3-8
-----------------------------------	------------

Battery Backup	3-8
----------------------	-----

Auxiliary Functions	3-9
---------------------------	-----

Clearing an Existing Program	3-9
------------------------------------	-----

Initializing System Memory	3-9
----------------------------------	-----

Setting Retentive Memory Ranges.....	3-10
--------------------------------------	------

Using a Password	3-11
------------------------	------

CPU Operation	3-12
----------------------------	-------------

CPU Operating System.....	3-12
---------------------------	------

Program Mode.....	3-13
-------------------	------

Run Mode	3-13
----------------	------

Read Inputs	3-14
-------------------	------

Service Peripherals and Force I/O	3-14
---	------

CPU Bus Communication	3-15
-----------------------------	------

Update Clock, Special Relays and Special Registers.....	3-15
---	------

Solve Application Program	3-16
---------------------------------	------

Solve PID Loop Equations.....	3-16
-------------------------------	------

Write Outputs	3-16
---------------------	------

Table of Contents

Write Outputs to Specialty I/O	3-16
Diagnostics.....	3-17
I/O Response Time	3-17
Is Timing Important for Your Application?.....	3-17
Normal Minimum I/O Response.....	3-18
Normal Maximum I/O Response	3-18
Improving Response Time	3-19
CPU Scan Time Considerations	3-20
Reading Inputs	3-20
Writing Outputs	3-20
Service Peripherals.....	3-21
CPU Bus Communication	3-21
Update Clock/Calendar, Special Relays, Special Registers	3-21
Application Program Execution	3-22
PLC Numbering Systems.....	3-23
PLC Resources	3-23
V-Memory	3-24
Binary-Coded Decimal Numbers	3-24
Hexadecimal Numbers	3-24
Memory Map	3-25
Octal Numbering System	3-25
Discrete and Word Locations.....	3-25
V-memory Locations for Discrete Memory Areas	3-25
Input Points (X Data Type).....	3-26
Output Points (Y Data Type)	3-26
Control Relays (C Data Type)	3-26
Timers and Timer Status Bits (T Data Type).....	3-26
Timer Current Values (V Data Type)	3-27
Counters and Counter Status Bits (CT Data type).....	3-27
Counter Current Values (V Data Type)	3-27
Word Memory (V Data Type)	3-28
Stages (S Data type).....	3-28
Special Relays (SP Data Type).....	3-28
DL06 System V-memory	3-29
System Parameters and Default Data Locations (V Data Type)	3-29

DL06 Aliases	3-31
DL06 Memory Map.....	3-32
X Input/Y Output Bit Map	3-33
Stage Control/Status Bit Map	3-34
Control Relay Bit Map	3-36
Timer Status Bit Map.....	3-38
Counter Status Bit Map.....	3-38
GX and GY I/O Bit Map	3-39

Chapter 4: System Design and Configuration

DL06 System Design Strategies	4-2
I/O System Configurations	4-2
Networking Configurations	4-2
Module Placement.....	4-3
Slot Numbering.....	4-3
Automatic I/O Configuration.....	4-4
Manual I/O Configuration	4-4
Power Budgeting.....	4-5
Power supplied	4-5
Power required by base unit	4-5
Power required by option cards	4-5
Configuring the DL06's Comm Ports.....	4-7
DL06 Port Specifications.....	4-7
DL06 Port Pinouts	4-7
Choosing a Network Specification.....	4-8
RS-232 Network	4-8
RS-422 Network	4-8
RS-485 Network	4-8
Connecting to MODBUS and DirectNET Networks.....	4-9
MODBUS Port Configuration.....	4-9
DirectNET Port Configuration	4-10
Non-Sequence Protocol (ASCII In/Out and PRINT).....	4-11
Non-Sequence Port Configuration.....	4-11

Table of Contents

Network Slave Operation	4-12
MODBUS Function Codes Supported	4-12
Determining the MODBUS Address.....	4-12
If Your Host Software Requires the Data Type and Address	4-13
Example 1: V2100.....	4-14
Example 2: Y20	4-14
Example 3: T10 Current Value.....	4-14
Example 4: C54.....	4-14
If Your MODBUS Host Software Requires an Address ONLY	4-15
Example 1: V2100 584/984 Mode	4-16
Example 2: Y20 584/984 Mode	4-16
Example 3: T10 Current Value 484 Mode	4-17
Example 4: C54 584/984 Mode	4-17
Network Master Operation	4-17
Step 1: Identify Master Port # and Slave #.....	4-18
Step 2: Load Number of Bytes to Transfer.....	4-18
Step 3: Specify Master Memory Area.....	4-19
Step 4: Specify Slave Memory Area	4-20
Communications from a Ladder Program.....	4-21
Multiple Read and Write Interlocks.....	4-21
Network Master Operation (using MRX and MWX Instructions)	4-22
MODBUS Function Codes Supported	4-22
MODBUS Read from Network(MRX)	4-23
MRX Slave Memory Address.....	4-24
MRX Master Memory Addresses.....	4-24
MRX Number of Elements.....	4-24
MRX Exception Response Buffer	4-24
MODBUS Write to Network (MWX)	4-25
MWX Slave Memory Address	4-26
MWX Master Memory Addresses.....	4-26
MWX Number of Elements.....	4-26
MWX Exception Response Buffer.....	4-26
MRX/MWX Example in DirectSOFT	4-27
Multiple Read and Write Interlocks.....	4-27

Chapter 5: Standard RLL Instructions

Introduction	5-2
Using Boolean Instructions	5-5
END Statement	5-5
Simple Rungs	5-5
Normally Closed Contact	5-6
Contacts in Series.....	5-6
Midline Outputs.....	5-6
Parallel Elements.....	5-7
Joining Series Branches in Parallel.....	5-7
Joining Parallel Branches in Series.....	5-7
Combination Networks	5-7
Comparative Boolean	5-8
Boolean Stack.....	5-8
Immediate Boolean	5-9
Boolean Instructions	5-10
Comparative Boolean	5-26
Immediate Instructions	5-32
Timer, Counter and Shift Register Instructions.....	5-39
Using Timers	5-39
Timer Example Using Discrete Status Bits	5-41
Timer Example Using Comparative Contacts	5-41
Accumulating Timer Example using Discrete Status Bits	5-43
Accumulator Timer Example Using Comparative Contacts	5-43
Using Counters.....	5-44
Counter Example Using Discrete Status Bits	5-46
Counter Example Using Comparative Contacts	5-46
Stage Counter Example Using Discrete Status Bits.....	5-48
Stage Counter Example Using Comparative Contacts	5-48
Up / Down Counter Example Using Discrete Status Bits.....	5-50
Up / Down Counter Example Using Comparative Contacts.....	5-50
Accumulator/Stack Load and Output Data Instructions	5-52
Using the Accumulator.....	5-52
Copying Data to the Accumulator.....	5-52

Table of Contents

Changing the Accumulator Data	5-53
Using the Accumulator Stack.....	5-54
Using Pointers	5-55
Logical Instructions (Accumulator)	5-69
Math Instructions	5-86
Transcendental Functions.....	5-118
Bit Operation Instructions.....	5-120
Number Conversion Instructions (Accumulator).....	5-127
Shuffle Digits Block Diagram	5-139
Table Instructions	5-141
Copy Data From a Data Label Area to V-memory.....	5-143
Clock/Calendar Instructions	5-171
CPU Control Instructions.....	5-173
Program Control Instructions	5-175
Interrupt Instructions	5-183
Message Instructions	5-186
Move Block Instruction (MOVBLK)	5-189
Copy Data From a Data Label Area to V-memory.....	5-189
Intelligent I/O Instructions.....	5-194
Read from Intelligent Module (RD).....	5-194
Write to Intelligent Module (WT)	5-195
Network Instructions	5-196
Direct Text Entry	5-200
Embedding date and/or time variables.....	5-201
Embedding V-memory data	5-201
Data Format Suffixes for Embedded V-memory Data.....	5-202
Text Entry from V-memory	5-203
MODBUS RTU Instructions	5-204
MRX Slave Address Ranges.....	5-205
MWX Slave Address Ranges.....	5-208
MWX Master Memory Address Ranges.....	5-208
MWX Number of Elements	5-208
MWX Exception Response Buffer.....	5-208

ASCII Instructions	5–210
Reading ASCII Input Strings.....	5–210
Writing ASCII Output Strings.....	5–210
Managing the ASCII Strings	5–211
Intelligent Box (IBox) Instructions.....	5–230

Chapter 6: Drum Instruction Programming

Introduction.....	6–2
Purpose	6–2
Drum Terminology.....	6–2
Drum Chart Representation.....	6–3
Output Sequences.....	6–3
Step Transitions.....	6–4
Drum Instruction Types.....	6–4
Timer-Only Transitions	6–4
Timer and Event Transitions	6–5
Event-Only Transitions.....	6–6
Counter Assignments	6–6
Last Step Completion.....	6–7
Overview of Drum Operation	6–8
Drum Instruction Block Diagram	6–8
Powerup State of Drum Registers	6–9
Drum Control Techniques	6–10
Drum Control Inputs	6–10
Self-Resetting Drum.....	6–11
Initializing Drum Outputs.....	6–11
Using Complex Event Step Transitions	6–11
Drum Instruction	6–12
Timed Drum with Discrete Outputs (DRUM).....	6–12
Event Drum (EDRUM)	6–14
Handheld Programmer Drum Mnemonics.....	6–16
Masked Event Drum with Discrete Outputs (MDRMD).....	6–19
Masked Event Drum with Word Output (MDRMW)	6–21

Table of Contents

Chapter 7: RLL^{PLUS} Stage Programming

Introduction to Stage Programming	7-2
Overcoming “Stage Fright”	7-2
Learning to Draw State Transition Diagrams.....	7-3
Introduction to Process States	7-3
The Need for State Diagrams	7-3
A 2-State Process	7-3
RLL Equivalent	7-4
Stage Equivalent.....	7-4
Let’s Compare	7-5
Initial Stages.....	7-5
What Stage Bits Do	7-6
Stage Instruction Characteristics.....	7-6
Using the Stage Jump Instruction for State Transitions	7-7
Stage Jump, Set, and Reset Instructions.....	7-7
Stage Program Example: Toggle On/Off Lamp Controller.....	7-8
A 4-State Process	7-8
Four Steps to Writing a Stage Program	7-9
1. Write a Word Description of the application.	7-9
2. Draw the Block Diagram.	7-9
3. Draw the State Transition Diagram.	7-9
4. Write the Stage Program.....	7-9
Stage Program Example: A Garage Door Opener.....	7-10
Garage Door Opener Example	7-10
Draw the Block Diagram	7-10
Draw the State Diagram.....	7-11
Add Safety Light Feature	7-12
Modify the Block Diagram and State Diagram	7-12
Using a Timer Inside a Stage	7-13
Add Emergency Stop Feature	7-14
Exclusive Transitions	7-14
Stage Program Design Considerations.....	7-15
Stage Program Organization	7-15
How Instructions Work Inside Stages.....	7-16

Using a Stage as a Supervisory Process.....	7-17
Stage Counter.....	7-17
Power Flow Transition Technique.....	7-18
Stage View in DirectSOFT.....	7-18
Parallel Processing Concepts.....	7-19
Parallel Processes	7-19
Converging Processes.....	7-19
Convergence Stages (CV).....	7-19
Convergence Jump (CVJMP).....	7-20
Convergence Stage Guidelines	7-20
RLL^{PLUS} (Stage) Instructions	7-21
Stage (SG).....	7-21
Initial Stage (ISG)	7-22
Jump (JMP).....	7-22
Not Jump (NJMP).....	7-22
Converge Stage (CV) and Converge Jump (CVJMP)	7-23
Block Call (BCALL).....	7-25
Block (BLK).....	7-25
Block End (BEND).....	7-25
Questions and Answers about Stage Programming	7-27

Chapter 8: PID Loop Operation

DL06 PID Control.....	8-2
DL06 PID Control Features	8-2
Introduction to PID Control.....	8-4
What is PID Control?	8-4
Introducing DL06 PID Control	8-6
Process Control Definitions.....	8-8
PID Loop Operation.....	8-9
Position Form of the PID Equation.....	8-9
Reset Windup Protection	8-10
Freeze Bias	8-11
Adjusting the Bias.....	8-11
Step Bias Proportional to Step Change in SP	8-12

Table of Contents

Eliminating Proportional, Integral or Derivative Action	8-12
Velocity Form of the PID Equation.....	8-12
Bumpless Transfer	8-13
Loop Alarms	8-13
Loop Operating Modes	8-14
Special Loop Calculations.....	8-14
Ten Steps to Successful Process Control.....	8-16
PID Loop Setup.....	8-18
Some Things to Do and Know Before Starting	8-18
PID Error Flags.....	8-18
Establishing the Loop Table Size and Location	8-18
Loop Table Word Definitions.....	8-20
PID Mode Setting 1 Bit Descriptions (Addr + 00)	8-21
PID Mode Setting 2 Bit Descriptions (Addr + 01)	8-22
Mode/Alarm Monitoring Word (Addr + 06)	8-23
Ramp/Soak Table Flags (Addr + 33)	8-23
Ramp/Soak Table Location (Addr + 34).....	8-24
Ramp/Soak Table Programming Error Flags (Addr + 35).....	8-24
Configure the PID Loop.....	8-25
PID Loop Tuning.....	8-40
Open-Loop Test	8-40
Manual Tuning Procedure	8-41
Alternative Manual Tuning Procedures by Others	8-44
Tuning PID Controllers.....	8-44
Auto Tuning Procedure	8-45
Use DirectSOFT 5 Data View with PID View	8-49
Open a New Data View Window.....	8-49
Open PID View.....	8-50
Using the Special PID Features	8-53
How to Change Loop Modes	8-53
Operator Panel Control of PID Modes	8-54
PLC Modes Effect on Loop Modes.....	8-54
Loop Mode Override.....	8-54
PV Analog Filter.....	8-55
Creating an Analog Filter in Ladder Logic.....	8-56

Use the <i>DirectSOFT</i> Filter Intelligent Box Instructions	8-57
FilterB Example.....	8-57
Ramp/Soak Generator.....	8-58
Introduction	8-58
Ramp/Soak Table	8-59
Ramp/Soak Table Flags.....	8-61
Ramp/Soak Generator Enable	8-61
Ramp/Soak Controls.....	8-61
Ramp/Soak Profile Monitoring.....	8-62
Ramp/Soak Programming Errors.....	8-62
Testing Your Ramp/Soak Profile.....	8-62
 <i>DirectSOFT</i> Ramp/Soak Example	8-63
Setup the Profile in PID Setup	8-63
Program the Ramp/Soak Control in Relay Ladder.....	8-63
Test the Profile	8-64
Cascade Control.....	8-65
Introduction	8-65
Cascaded Loops in the DL06 CPU	8-66
Tuning Cascaded Loops	8-67
Time-Proportioning Control.....	8-68
On/Off Control Program Example	8-69
Feedforward Control	8-70
Feedforward Example.....	8-71
PID Example Program	8-72
Program Setup for the PID Loop	8-72
Troubleshooting Tips.....	8-75
Glossary of PID Loop Terminology	8-77
Bibliography	8-79
 Chapter 9: Maintenance and Troubleshooting	
 Hardware System Maintenance	9-2
Standard Maintenance	9-2
 Diagnostics.....	9-2

Table of Contents

Diagnostics.....	9-2
Fatal Errors	9-2
Non-fatal Errors.....	9-2
V-memory Error Code Locations.....	9-3
Special Relays (SP) Corresponding to Error Codes	9-3
DL06 Micro PLC Error Codes.....	9-4
Program Error Codes.....	9-5
CPU Indicators	9-6
PWR Indicator	9-6
RUN Indicator	9-7
CPU Indicator.....	9-7
Communications Problems	9-7
I/O Point Troubleshooting	9-8
Possible Causes	9-8
Some Quick Steps	9-8
Handheld Programmer Keystrokes Used to Test an Output Point	9-9
Noise Troubleshooting	9-10
Electrical Noise Problems.....	9-10
Reducing Electrical Noise.....	9-10
Machine Startup and Program Troubleshooting	9-11
Syntax Check	9-11
Special Instructions.....	9-12
Duplicate Reference Check.....	9-13
Run Time Edits	9-14
Run Time Edit Example	9-15
Forcing I/O Points	9-16
Regular Forcing with Direct Access.....	9-18
Bit Override Forcing	9-19
Bit Override Indicators.....	9-19
Reset the PLC to Factory Defaults.....	9-20

Chapter 10: LCD Display Panel

Introduction to the DL06 LCD Display Panel	10-2
Keypad	10-2

Snap-in installation	10-3
Display Priority	10-4
Menu Navigation	10-5
Confirm PLC Type, Firmware Revision Level, Memory Usage, Etc.	10-6
Examining Option Slot Contents	10-8
Menu 2, M2:SYSTEM CFG.	10-8
Monitoring and Changing Data Values.....	10-10
Menu 3, M3:MONITOR	10-10
Data Monitor	10-10
V-memory values.....	10-10
Pointer values.....	10-12
Bit Monitor	10-13
Bit status	10-13
Changing Date and Time	10-14
Menu 4, M4 : CALENDAR R/W.....	10-14
Setting Password and Locking	10-17
Menu 5, M5 : PASSWORD R/W.....	10-17
Reviewing Error History.....	10-20
Menu 6, M6 : ERR HISTORY	10-20
Toggle Light and Beeper, Test Keys	10-21
Menu 7, M7 : LCD TEST&SET	10-21
PLC Memory Information for the LCD Display Panel	10-22
Data Format Suffixes for Embedded V-memory Data.....	10-22
Reserved memory registers for the LCD Display Panel	10-23
V7742 bit definitions	10-24
Changing the Default Screen.....	10-25
Example program for setting the default screen message.....	10-25
DL06 LCD Display Panel Instruction (LCD).....	10-26
Source of message	10-26
ASCII Character Codes	10-27
Example program: alarm with embedded date/time stamp	10-28
Example program: alarm with embedded V-memory data	10-29
Example program: alarm text from V-memory with embedded V-memory data ..	10-30

Table of Contents

Appendix A: Auxiliary Functions

Introduction	A-2
Purpose of Auxiliary Functions.....	A-2
Accessing AUX Functions via DirectSOFT.....	A-3
Accessing AUX Functions via the Handheld Programmer.....	A-3
AUX 2* — RLL Operations.....	A-4
AUX 21 Check Program	A-4
AUX 22 Change Reference	A-4
AUX 23 Clear Ladder Range	A-4
AUX 24 Clear Ladders	A-4
AUX 3* — V-memory Operations.....	A-4
AUX 31 Clear V-memory	A-4
AUX 4* — I/O Configuration.....	A-5
AUX 41 Show I/O Configuration	A-5
AUX 5* — CPU Configuration	A-5
AUX 51 Modify Program Name.....	A-5
AUX 53 Display Scan Time	A-5
AUX 54 Initialize Scratchpad	A-5
AUX 55 Set Watchdog Timer	A-5
AUX 56 CPU Network Address	A-6
AUX 57 Set Retentive Ranges	A-6
AUX 58 Test Operations.....	A-6
AUX 59 Bit Override.....	A-7
AUX 5B Counter Interface Configuration.....	A-7
AUX 5D Select PLC Scan Mode	A-7
AUX 6* — Handheld Programmer Configuration	A-8
AUX 61 Show Revision Numbers.....	A-8
AUX 62 Beeper On/Off.....	A-8
AUX 65 Run Self Diagnostics	A-8
AUX 7* — EEPROM Operations.....	A-8
Transferable Memory Areas	A-8
AUX 71 CPU to HPP EEPROM.....	A-8
AUX 72 HPP EEPROM to CPU.....	A-9
AUX 73 Compare HPP EEPROM to CPU	A-9

AUX 74 HPP EEPROM Blank Check.....	A-9
AUX 75 Erase HPP EEPROM.....	A-9
AUX 76 Show EEPROM Type.....	A-9
AUX 8* — Password Operations	A-9
AUX 81 Modify Password	A-9
AUX 82 Unlock CPU	A-10
AUX 83 Lock CPU.....	A-10

Appendix B: DL06 Error codes

DL06 Error Codes.....	B-2
------------------------------	------------

Appendix C: Instruction Execution Times

Introduction	C-2
V-Memory Data Registers	C-2
V-Memory Bit Registers	C-2
How to Read the Tables	C-2
Instruction Execution Times	C-3
Boolean Instructions	C-3
Comparative Boolean Instructions	C-4
Immediate Instructions.....	C-11
Bit of Word Boolean Instructions	C-12
Timer, Counter and Shift Register.....	C-13
Accumulator Data Instructions	C-14
Logical Instructions.....	C-15
Math Instructions	C-16
Differential Instructions	C-19
Bit Instructions	C-19
Number Conversion Instructions	C-20
Table Instructions	C-20
CPU Control Instructions	C-22
Program Control Instructions	C-22
Interrupt Instructions.....	C-22
Network Instructions	C-22
Intelligent I/O Instructions.....	C-23
Message Instructions	C-23

Table of Contents

RLL ^{PLUS} Instructions.....	C-23
Drum Instructions	C-23
Clock/Calendar Instructions.....	C-24
MODBUS Instructions.....	C-24
ASCII Instructions	C-24

Appendix D: Special Relays

DL06 PLC Special Relays.....	D-2
Startup and Real-Time Relays	D-2
CPU Status Relays.....	D-2
System Monitoring.....	D-3
Accumulator Status	D-3
HSIO Input Status.....	D-4
HSIO Pulse Output Relay	D-4
Communication Monitoring Relay.....	D-4
Option Slot Communication Monitoring Relay.....	D-4
Option Slot Special Relay	D-4
Counter 1 Mode 10 Equal Relays	D-5
Counter 2 Mode 10 Equal Relays	D-6

Appendix E: High-speed Input and Pulse Output Features

Introduction	E-2
Built-in Motion Control Solution	E-2
Availability of HSIO Features.....	E-2
Dedicated High- Speed I/O Circuit.....	E-3
Wiring Diagrams for Each HSIO Mode	E-3
Choosing the HSIO Operating Mode.....	E-4
Understanding the Six Modes	E-4
Default Mode.....	E-5
Configuring the HSIO Mode	E-6
Configuring Inputs X0 – X3.....	E-6
Mode 10: High-Speed Counter	E-7
Purpose	E-7
Functional Block Diagram.....	E-7
Wiring Diagram.....	E-8
Interfacing to Counter Inputs	E-8

Setup for Mode 10.....	E-9
Presets and Special Relays	E-9
Absolute and Incremental Presets.....	E-10
Preset Data Starting Location	E-11
Using Fewer than 24 Presets	E-11
Equal Relay Numbers	E-12
Calculating Your Preset Values.....	E-13
X Input Configuration	E-14
Writing Your Control Program.....	E-15
Program Example 1: Counter Without Presets	E-16
Program Example 2: Counter With Presets	E-18
Program Example 3: Counter With Preload	E-21
Troubleshooting Guide for Mode 10	E-23
Symptom: The counter does not count.....	E-23
Symptom: The counter counts but the presets do not function.	E-23
Symptom: The counter counts up but will not reset.	E-23
Mode 20: Up/Down Counter	E-24
Purpose	E-24
Functional Block Diagram.....	E-24
Quadrature Encoder Signals	E-25
Wiring Diagram.....	E-25
Interfacing to Encoder Outputs	E-26
Setup for Mode 20	E-27
Presets and Special Relays	E-27
X Input Configuration	E-28
Mode 20 Up/Down Counter	E-28
Writing Your Control Program.....	E-29
Program Example 1: Quadrature Counting with an Interrupt.....	E-30
Program Example 2: Up/Down Counting with Standard Inputs	E-32
Program Example 3: Quadrature Counting	E-34
Troubleshooting Guide for Mode 20	E-37
Symptom: The counter does not count.....	E-37
Symptom: The counter counts in the wrong direction.....	E-37
Symptom: The counter counts up and down but will not reset.....	E-37

Table of Contents

Mode 30: Pulse Output	E-38
Purpose	E-38
Functional Block Diagram.....	E-39
Wiring Diagram.....	E-40
Interfacing to Drive Inputs.....	E-40
Motion Profile Specifications	E-41
Physical I/O Configuration.....	E-41
Logical I/O Functions	E-41
Setup for Mode 30.....	E-42
Profile/Velocity Select Register.....	E-43
Profile Parameter Table.....	E-43
Automatic Trapezoidal Profile.....	E-43
Step Trapezoidal Profile.....	E-44
Velocity Control	E-44
Step Trapezoidal Profile.....	E-44
Choosing the Profile Type	E-45
Automatic Trapezoidal Profile Defined.....	E-45
Step Trapezoidal Profiles Defined	E-46
Velocity Control Defined	E-46
Automatic Trapezoidal Profile Operation	E-47
Program Example 1: Automatic Trapezoidal Profile without External Interrupt	E-48
Preload Position Value	E-49
Program Example 2: Automatic Trapezoidal Profile with External Interrupt	E-50
Program Example 3: Automatic Trapezoidal Profile with Home Search.....	E-53
Step Trapezoidal Profile Operation	E-58
Program Example 4: Step Trapezoidal Profile	E-59
Velocity Profile Operation.....	E-62
Program Example 5: Velocity Profile	E-63
Automatic Trapezoidal Profile Error Codes.....	E-65
Troubleshooting Guide for Mode 30	E-65
Symptom: The stepper motor does not rotate.	E-65
Symptom: The motor turns in the wrong direction.....	E-66
Mode 40: High-Speed Interrupts	E-67
Purpose	E-67
Functional Block Diagram.....	E-67
Setup for Mode 40.....	E-68

Interrupts and the Ladder Program	E-68
External Interrupt Timing Parameters	E-69
Timed Interrupt Parameters.....	E-69
X Input/Timed INT Configuration	E-69
Program Example 1: External Interrupt	E-70
Program Example 2: Timed Interrupt	E-71
Mode 50: Pulse Catch Input.....	E-72
Purpose	E-72
Functional Block Diagram.....	E-72
Pulse Catch Timing Parameters	E-72
Setup for Mode 50.....	E-73
X Input Configuration	E-74
Program Example 1: Pulse Catch	E-75
Mode 60: Discrete Inputs with Filter	E-76
Purpose	E-76
Functional Block Diagram.....	E-76
Input Filter Timing Parameters	E-76
Setup for Mode 60.....	E-77
X Input Configuration	E-77
Program Example: Filtered Inputs	E-78
Appendix F: PLC Memory	
DL06 PLC Memory.....	F-2
Non-volatile V-memory in the DL06.....	F-3
Appendix G: ASCII Table	
ASCII Conversion Table	G-2
Appendix H: Product Weights	
Product Weight Table	H-2
Appendix I: Numbering Systems	
Introduction.....	I-2
Binary Numbering System	I-2

Table of Contents

Hexadecimal Numbering System	I-3
Octal Numbering System	I-4
Binary Coded Decimal (BCD) Numbering System	I-5
Real (Floating Point) Numbering System	I-5
BCD/Binary/Decimal/Hex/Octal -What is the Difference?.....	I-6
Data Type Mismatch.....	I-7
Signed vs. Unsigned Integers.....	I-8
AutomationDirect.com Products and Data Types	I-9
<i>DirectLOGIC</i> PLCs.....	I-9
C-more/C-more Micro-Graphic Panels.....	I-9

Appendix J: European Union Directives (CE)

European Union (EU) Directives	J-2
Member Countries	J-2
Applicable Directives	J-2
Compliance.....	J-2
General Safety	J-3
Special Installation Manual	J-4
Other Sources of Information	J-4
Basic EMC Installation Guidelines	J-5
Enclosures	J-5
Electrostatic Discharge (ESD).....	J-5
AC Mains Filters	J-6
Suppression and Fusing.....	J-6
Internal Enclosure Grounding.....	J-6
Equipotential Grounding	J-7
Communications and Shielded Cables	J-7
Analog and RS232 Cables	J-8
Multidrop Cables.....	J-8
Shielded Cables within Enclosures	J-8
Analog Modules and RF Interference	J-9
Network Isolation	J-9
DC Powered Versions	J-9
Items Specific to the DL06	J-10

Appendix K: Introduction to Serial Communications

Introduction to Serial Communications	K-2
Wiring Standards.....	K-2
Communications Protocols.....	K-3
DL06 Port Specifications.....	K-5
DL06 Port Pinouts	K-5
Port Setup Using <i>DirectSOFT</i> 5 or Ladder Logic Instructions.....	K-6
Port 2 Setup for RLL Using K-Sequence, <i>DirectNET</i> or MODBUS RTU	K-7
K-Sequence Communications.....	K-10
<i>DirectNET</i> Communications	K-10
Step 1: Identify Master Port # and Slave #.....	K-10
Step 2: Load Number of Bytes to Transfer.....	K-10
Step 3: Specify Master Memory Area.....	K-11
Step 4: Specify Slave Memory Area	K-12
Communications from a Ladder Program.....	K-13
Multiple Read and Write Interlocks.....	K-13
MODBUS RTU Communications.....	K-14
ASCII Communications.....	K-14