

# VOLUME ONE: TABLE OF CONTENTS

---



Volume One: Table of Contents .....	i
Volume Two: Table of Contents .....	xi
<b>Chapter 1: Getting Started .....</b>	<b>1-1</b>
<b>Introduction .....</b>	<b>1-2</b>
The Purpose of this Manual .....	1-2
Where to Begin .....	1-2
Supplemental Manuals .....	1-2
Technical Support .....	1-2
<b>Conventions Used .....</b>	<b>1-3</b>
Key Topics for Each Chapter .....	1-3
<b>DL205 System Components .....</b>	<b>1-4</b>
CPUs .....	1-4
Bases .....	1-4
I/O Configuration .....	1-4
I/O Modules .....	1-4
DL205 System Diagrams .....	1-5
<b>Programming Methods .....</b>	<b>1-7</b>
<i>DirectSOFT</i> Programming for Windows .....	1-7
Handheld Programmer .....	1-7
<b><i>DirectLOGIC</i><sup>™</sup> Part Numbering System .....</b>	<b>1-8</b>
<b>Quick Start for PLC Validation and Programming .....</b>	<b>1-10</b>
<b>Steps to Designing a Successful System .....</b>	<b>1-13</b>
<b>Chapter 2: Installation, Wiring and Specifications .....</b>	<b>2-1</b>
<b>Safety Guidelines .....</b>	<b>2-2</b>

## Table of Contents

---

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
<b>Mounting Guidelines</b>	<b>.2-5</b>
Base Dimensions	.2-5
Panel Mounting and Layout	.2-6
Enclosures	.2-7
Environmental Specifications	.2-8
Power	.2-8
Marine Use	.2-9
Agency Approvals	.2-9
24 VDC Power Bases	.2-9
<b>Installing DL205 Bases</b>	<b>.2-10</b>
Choosing the Base Type	.2-10
Mounting the Base	.2-10
Using Mounting Rails	.2-11
<b>Installing Components in the Base</b>	<b>.2-12</b>
<b>Base Wiring Guidelines</b>	<b>.2-13</b>
Base Wiring	.2-13
<b>I/O Wiring Strategies</b>	<b>.2-14</b>
PLC Isolation Boundaries	.2-14
Powering I/O Circuits with the Auxiliary Supply	.2-15
Powering I/O Circuits Using Separate Supplies	.2-16
Sinking / Sourcing Concepts	.2-17
I/O “Common” Terminal Concepts	.2-18
Connecting DC I/O to “Solid State” Field Devices	.2-19
Solid State Input Sensors	.2-19
Solid State Output Loads	.2-19
Relay Output Guidelines	.2-21
Surge Suppression For Inductive Loads	.2-21
<b>I/O Modules Position, Wiring, and Specification</b>	<b>.2-25</b>
Slot Numbering	.2-25
Module Placement Restrictions	.2-25

Special Placement Considerations for Analog Modules	2-26
Discrete Input Module Status Indicators	2-26
Color Coding of I/O Modules	2-26
Wiring the Different Module Connectors	2-27
I/O Wiring Checklist	2-28
<b>D2-08ND3, DC Input</b>	<b>2-29</b>
<b>D2-16ND3-2, DC Input</b>	<b>2-29</b>
<b>D2-32ND3, DC Input</b>	<b>2-30</b>
<b>D2-32ND3-2, DC Input</b>	<b>2-31</b>
<b>D2-08NA-1, AC Input</b>	<b>2-32</b>
<b>D2-08NA-2, AC Input</b>	<b>2-33</b>
<b>D2-16NA, AC Input</b>	<b>2-34</b>
<b>F2-08SIM, Input Simulator</b>	<b>2-34</b>
<b>D2-04TD1, DC Output</b>	<b>2-35</b>
<b>D2-08TD1, DC Output</b>	<b>2-36</b>
<b>D2-08TD2, DC Output</b>	<b>2-36</b>
<b>D2-16TD1-2, DC Output</b>	<b>2-37</b>
<b>D2-16TD2-2, DC Output</b>	<b>2-37</b>
<b>F2-16TD1(2)P, DC Output With Fault Protection</b>	<b>2-38</b>
<b>F2-16TD1P, DC Output With Fault Protection</b>	<b>2-39</b>
<b>F2-16TD2P, DC Output with Fault Protection</b>	<b>2-40</b>
<b>D2-32TD1, DC Output</b>	<b>2-41</b>
<b>D2-32TD2, DC Output</b>	<b>2-41</b>
<b>F2-08TA, AC Output</b>	<b>2-42</b>
<b>D2-08TA, AC Output</b>	<b>2-42</b>
<b>D2-12TA, AC Output</b>	<b>2-43</b>
<b>D2-04TRS, Relay Output</b>	<b>2-44</b>
<b>D2-08TR, Relay Output</b>	<b>2-45</b>
<b>F2-08TR, Relay Output</b>	<b>2-46</b>
<b>F2-08TRS, Relay Output</b>	<b>2-47</b>

D2-12TR, Relay Output .....	2-48
D2-08CDR 4 pt., DC Input / 4pt., Relay Output .....	2-49
Glossary of Specification Terms .....	2-50
<b>Chapter 3: CPU Specifications and Operations .....</b>	<b>3-1</b>
<b>CPU Overview .....</b>	<b>3-2</b>
General CPU Features .....	3-2
DL230 CPU Features .....	3-2
DL240 CPU Features .....	3-2
DL250-1 CPU Features .....	3-3
DL260 CPU Features .....	3-3
<b>CPU General Specifications .....</b>	<b>3-4</b>
<b>CPU Base Electrical Specifications .....</b>	<b>3-5</b>
<b>CPU Hardware Setup .....</b>	<b>3-6</b>
Communication Port Pinout Diagrams .....	3-6
Port 1 Specifications .....	3-7
Port 2 Specifications .....	3-8
<b>Selecting the Program Storage Media .....</b>	<b>3-9</b>
Built-in EEPROM .....	3-9
EEPROM Sizes .....	3-9
EEPROM Operations .....	3-9
Installing the CPU .....	3-10
Connecting the Programming Devices .....	3-10
CPU Setup Information .....	3-11
Status Indicators .....	3-12
Mode Switch Functions .....	3-12
Changing Modes in the DL205 PLC .....	3-13
Mode of Operation at Power-up .....	3-13
<b>Using Battery Backup .....</b>	<b>3-14</b>
DL230 and DL240 .....	3-14
DL250-1 and DL260 .....	3-14
Battery Backup .....	3-14
Auxiliary Functions .....	3-15
Clearing an Existing Program .....	3-16
Initializing System Memory .....	3-16

Setting the Clock and Calendar	3-16
Setting the CPU Network Address	3-17
Setting Retentive Memory Ranges	3-17
Using a Password	3-18
Setting the Analog Potentiometer Ranges	3-19
<b>CPU Operation</b>	<b>3-21</b>
CPU Operating System	3-21
Program Mode Operation	3-22
Run Mode Operation	3-22
Read Inputs	3-23
Read Inputs from Specialty and Remote I/O	3-23
Service Peripherals and Force I/O	3-23
CPU Bus Communication	3-24
Update Clock, Special Relays and Special Registers	3-24
Solve Application Program	3-25
Solve PID Loop Equations	3-25
Write Outputs	3-25
Write Outputs to Specialty and Remote I/O	3-26
Diagnostics	3-26
<b>I/O Response Time</b>	<b>3-27</b>
Is Timing Important for Your Application?	3-27
Normal Minimum I/O Response	3-27
Normal Maximum I/O Response	3-27
Improving Response Time	3-28
<b>CPU Scan Time Considerations</b>	<b>3-29</b>
Initialization Process	3-30
Reading Inputs	3-30
Reading Inputs from Specialty I/O	3-31
Service Peripherals	3-31
CPU Bus Communication	3-32
Update Clock/Calendar, Special Relays, Special Registers	3-32
Writing Outputs	3-32
Writing Outputs to Specialty I/O	3-33
Diagnostics	3-33
Application Program Execution	3-34
<b>PLC Numbering Systems</b>	<b>3-35</b>

PLC Resources	3–35
V–Memory	3–36
Binary-Coded Decimal Numbers	3–36
Hexadecimal Numbers	3–36
<b>Memory Map</b>	<b>3–37</b>
Octal Numbering System	3–37
Discrete and Word Locations	3–37
V–Memory Locations for Discrete Memory Areas	3–37
Input Points (X Data Type)	3–38
Output Points (Y Data Type)	3–38
Control Relays (C Data Type)	3–38
Timers and Timer Status Bits (T Data type)	3–38
Timer Current Values (V Data Type)	3–39
Counters and Counter Status Bits (CT Data type)	3–39
Counter Current Values (V Data Type)	3–39
Word Memory (V Data Type)	3–39
Stages (S Data type)	3–40
Special Relays (SP Data Type)	3–40
Remote I/O Points (GX Data Type)	3–40
<b>DL230 System V-memory</b>	<b>3–41</b>
<b>DL240 System V-memory</b>	<b>3–43</b>
<b>DL250–1 System V-memory (DL250 also)</b>	<b>3–46</b>
<b>DL260 System V-memory</b>	<b>3–49</b>
<b>DL205 Aliases</b>	<b>3–52</b>
<b>DL230 Memory Map</b>	<b>3–53</b>
<b>DL240 Memory Map</b>	<b>3–54</b>
<b>DL250–1 Memory Map (DL250 also)</b>	<b>3–55</b>
<b>DL260 Memory Map</b>	<b>3–56</b>
<b>X Input/Y Output Bit Map</b>	<b>3–57</b>
<b>Control Relay Bit Map</b>	<b>3–59</b>
<b>Stage Control/Status Bit Map</b>	<b>3–63</b>
<b>Timer and Counter Status Bit Maps</b>	<b>3–65</b>
<b>Remote I/O Bit Map</b>	<b>3–66</b>

<b>Chapter 4: System Design and Configuration</b> .....	<b>4-1</b>
<b>DL205 System Design Strategies</b> .....	<b>4-2</b>
I/O System Configurations .....	4-2
Networking Configurations .....	4-2
<b>Module Placement</b> .....	<b>4-3</b>
Slot Numbering .....	4-3
Module Placement Restrictions .....	4-3
Automatic I/O Configuration .....	4-4
Manual I/O Configuration .....	4-4
Removing a Manual Configuration .....	4-5
Power-On I/O Configuration Check .....	4-5
I/O Points Required for Each Module .....	4-6
<b>Calculating the Power Budget</b> .....	<b>4-7</b>
Managing your Power Resource .....	4-7
CPU Power Specifications .....	4-7
Module Power Requirements .....	4-7
Power Budget Calculation Example .....	4-9
Power Budget Calculation Worksheet .....	4-10
<b>Local Expansion I/O</b> .....	<b>4-11</b>
D2-CM Local Expansion Module .....	4-11
D2-EM Local Expansion Module .....	4-12
D2-EXCBL-1 Local Expansion Cable .....	4-12
DL260 Local Expansion System .....	4-13
DL250-1 Local Expansion System .....	4-14
Expansion Base Output Hold Option .....	4-15
Enabling I/O Configuration Check using <i>DirectSOFT</i> .....	4-16
<b>Expanding DL205 I/O</b> .....	<b>4-17</b>
I/O Expansion Overview .....	4-17
Ethernet Remote Master, H2-ERM(-F) .....	4-17
Ethernet Remote Master Hardware Configuration .....	4-18
Installing the ERM Module .....	4-19
Ethernet Base Controller, H2-EBC(100)(-F) .....	4-22
Install the EBC Module .....	4-23
Set the Module ID .....	4-23
Insert the EBC Module .....	4-23
Network Cabling .....	4-24

## Table of Contents

---

10BaseFL Network Cabling	4-25
Maximum Cable Length	4-25
Add a Serial Remote I/O Master/Slave Module	4-26
Configuring the CPU's Remote I/O Channel	4-27
Configure Remote I/O Slaves	4-29
Configuring the Remote I/O Table	4-29
Remote I/O Setup Program	4-30
Remote I/O Test Program	4-31
<b>Network Connections to Modbus and <i>DirectNet</i></b>	<b>4-32</b>
Configuring Port 2 For <i>DirectNet</i>	4-32
Configuring Port 2 For Modbus RTU	4-32
Modbus Port Configuration	4-33
<i>DirectNET</i> Port Configuration	4-34
<b>Network Slave Operation</b>	<b>4-35</b>
Modbus Function Codes Supported	4-35
Determining the Modbus Address	4-35
If Your Host Software Requires the Data Type and Address	4-35
If Your Modbus Host Software Requires an Address ONLY	4-38
Example 1: V2100 584/984 Mode	4-40
Example 2: Y20 584/984 Mode	4-40
Example 3: T10 Current Value 484 Mode	4-40
Example 4: C54 584/984 Mode	4-40
Determining the <i>DirectNET</i> Address	4-40
Network Master Operation	4-41
Communications from a Ladder Program	4-44
Multiple Read and Write Interlocks	4-44
<b>Network Modbus RTU Master Operation (DL260 only)</b>	<b>4-45</b>
Modbus Function Codes Supported	4-45
Modbus Port Configuration	4-46
RS-485 Network (Modbus only)	4-47
RS-232 Network	4-47
Modbus Read from Network (MRX)	4-48
MRX Slave Memory Address	4-49
MRX Master Memory Addresses	4-49
MRX Number of Elements	4-49
MRX Exception Response Buffer	4-49
Modbus Write to Network (MWX)	4-50

MWX Slave Memory Address	4-51
MWX Master Memory Addresses	4-51
MWX Number of Elements	4-51
MWX Exception Response Buffer	4-51
MRX/MWX Example in <i>DirectSOFT</i>	4-52
Multiple Read and Write Interlocks	4-52
<b>Non-Sequence Protocol (ASCII In/Out and PRINT)</b>	<b>4-54</b>
Configure the DL260 Port 2 for Non-Sequence	4-54
RS-485 Network	4-55
RS-232 Network	4-55
Configure the DL250-1 Port 2 for Non-Sequence	4-56
RS-422 Network	4-57
RS-232 Network	4-57
<b>Chapter 5: RLL and Intelligent Box (IBOX) Instructions</b>	<b>5-1</b>
<b>Introduction</b>	<b>5-2</b>
<b>Using Boolean Instructions</b>	<b>5-5</b>
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
<b>Boolean Instructions</b>	<b>5-10</b>
<b>Comparative Boolean</b>	<b>5-27</b>
<b>Immediate Instructions</b>	<b>5-33</b>
<b>Timer, Counter and Shift Register Instructions</b>	<b>5-41</b>
Using Timers	5-41
Timer Example Using Discrete Status Bits	5-43

## Table of Contents

---

Timer Example Using Comparative Contacts	5-43
Accumulating Timer (TMRA)	5-44
Accumulating Timer Example using Discrete Status Bits	5-45
Accumulator Timer Example Using Comparative Contacts	5-45
Counter Example Using Discrete Status Bits	5-47
Counter Example Using Comparative Contacts	5-47
Stage Counter Example Using Discrete Status Bits	5-49
Stage Counter Example Using Comparative Contacts	5-49
Up/Down Counter Example Using Discrete Status Bits	5-51
Up/Down Counter Example Using Comparative Contacts	5-51
<b>Accumulator/Stack Load and Output Data Instructions</b>	<b>5-53</b>
<b>Logical Instructions (Accumulator)</b>	<b>5-71</b>
<b>Math Instructions</b>	<b>5-88</b>
<b>Transcendental Functions (DL260 only)</b>	<b>5-121</b>
<b>Bit Operation Instructions</b>	<b>5-123</b>
<b>Number Conversion Instructions (Accumulator)</b>	<b>5-130</b>
<b>Table Instructions</b>	<b>5-144</b>
<b>Clock/Calendar Instructions</b>	<b>5-175</b>
<b>CPU Control Instructions</b>	<b>5-177</b>
<b>Program Control Instructions</b>	<b>5-179</b>
<b>Interrupt Instructions</b>	<b>5-187</b>
<b>Intelligent I/O Instructions</b>	<b>5-191</b>
<b>Network Instructions</b>	<b>5-193</b>
<b>Message Instructions</b>	<b>5-197</b>
<b>Modbus RTU Instructions (DL260)</b>	<b>5-205</b>
Modbus Read from Network (MRX)	5-205
Modbus Write to Network (MWX)	5-208
<b>ASCII Instructions (DL260)</b>	<b>5-211</b>
<b>Intelligent Box (IBox) Instructions (DL250-1/DL260)</b>	<b>5-230</b>