

Chapter 1: Introduction

What is PL/1? 1

PL/1: Strengths and Advantages 2

Free-form 2

Machine Independence 2

Examples: 2

Macro Facility 2

Program Structure 3

Structured Programming Constructs 3

Data Types 4

Data Arrays, Structures, and Unions 4

Data Manipulation 4

Example: 4

Built-in Functions 5

Examples: 5

Storage Classes, Control, and Dynamic Storage Allocation 6

Condition Handling 7

Program Checkout 7

Input and Output 8

I/O Conditions 9

Language Features 10

Blocks 10

Keywords 10

Data 10

Defaults 11

Storage 12

I/O 12

Exceptions 12

Character Set 13

Character Types 13

Special Characters 14

Composite Symbols 15

Statement Elements 16

Identifiers 16

Programmer-defined Names 16

Blanks 17

Comments 17

Example: 17

Statements 18

Simple Statements 18

Example: 18

Compound Statements 19

Groups 19

Program Structure 20

Chapter 2: Creating Data Fields

Data Items 1

Variable 1

Constant 1

Data Types and Attributes 2

Numeric Data 2

Binary Fixed-point Data 3

Example: 3

Examples: 3

Decimal Fixed-point Data 3

Example: 3

Example: 4

Example: 4

Example: 4

Binary Floating-point Data 5

Example: 5

Examples: 5

String Data and Attributes 5

Example: 6

Example: 6

X (hex) Character Constant 6

Arithmetic Data Declaration 7

Fixed Decimal Declare 8

Fixed Binary Declare 8

Floating Point Declaration 9

Example: 9

Example: 9

Arithmetic Data Types in Review 10

Declaration of Strings 11

Examples: 11

Varying Length Strings 12

Initial Attribute 13

Examples: 13

String Data 14

Example: 14

Example: 14

Declaring Identifiers with the Bit Attribute 15

Example: 15

Initial Attribute 16

Example: 16

PICTURE Attribute 17

Picture Character 17

Numeric Character 17

Picture Characters 18

Examples: 19

Declare Statement Formats 20

Examples: 20

Chapter 3: Compiling and Link-editing on z/OS

Source, Object, and Load Modules 1

Source Libraries 2

INCLUDE Library versus Subroutine/Program 2

Compiling Programs on z/OS 3

Compiling with Cataloged Procedures 3

Object Deck 4

Object Decks and Load Module 4

Object Library 5

Load Module - Creation 6

Binder 7

Binder JCL 8

Example: 8

Chapter 4: Programming and Expressions

Expression - Definition and Purpose 1

Targets 2

Variables 2

Example: 2

Pseudovariables 2

Example: 2

Intermediate Results 2

Arithmetic Operations 3

Data Conversion in Arithmetic Operations 4

Bit Operations 5

Comparison Operations 6

Concatenation Operations 7

Priority of Operators 8

Example: 8

Chapter 5: Program Structure

Program Structure 1

Preprocessors 2

Code Reuse 3

Program Activation 4

Blocks 5

Procedures 6

Procedure Termination 7

Recursive Procedures 8

Subroutine 9

Functions 10

Basic I/O Program 11

Chapter 6: Program Statements

Assignment Statement 1

Assignment Statement - Operators 2

Compound Assignment Operators 2

Multiple Assignments 3

Example: 3

Date and Time Built-In Functions 4

Examples: 4

PL/1 Constants 5

Examples: 5

Rules for Identifiers 6

Assignment Statement 7

Operators 8

Hierarchy of Operations 8

Operator Priority 8

Prefix Operators 9

Assignment using Prefix Operators 9

Examples: 9

String Assignment 10

Bit Strings 10

Examples: 10

Character Strings 10

Examples: 10

String Operator 11

Concatenation - Character Strings 11

Examples: 11

Concatenation - Bit Strings 12

Logical - Bit String - Operators 13

Results of All Logical Operations 13

IF Statement 14

Simple IF Statement 14

Example: 14

Compound IF Statement 14

Example: 14

DO Group in IF Statement 14

Example: 14

IF Statement Structure 15

Examples: 15

NULL ELSE 15

Example: 15

Nested IF Statement 16

Example: 16

Example: 16

Example: 17

Example: 18

Combination of Operations 19

Non-Iterative DO Group 20

Non-Iterative DO Group within IF Statement 20

Example: 20

Iterative DO Group 21

Example: 21

DO Group-Form 1 22

| | |
|---|----|
| Example: | 22 |
| DO Group-Form 2 | 23 |
| Example: | 23 |
| DO Group-Form 3 | 24 |
| Example: | 24 |
| DO Group-Form | 25 |
| Example: | 25 |
| Example: | 25 |
| Other Forms of Operative - DO Groups | 26 |
| LEAVE Statement | 27 |
| Nested DO Groups and Leave | 28 |
| Examples: | 28 |
| I/O Using DO WHILE and ENDFILE | 29 |
| Example: | 29 |
| Example: | 30 |
| Iterative DO - Forms | 31 |
| Example: | 31 |
| SELECT Statement | 32 |
| Example: | 32 |
| SELECT Statement - Type 1 and Type 2 | 33 |
| Example - Type 1 | 33 |
| Example - Type 2 | 33 |
| Examples: | 34 |
| Implementation of Pseudo-code SELECT FIRST ACTION FOR Construct | 35 |
| Pseudo-code | 35 |
| Example: | 35 |
| Coding | 35 |
| Example: | 35 |
| Implementation of Pseudo-code SELECT FIRST ACTION Construct | 36 |
| Pseudo-code | 36 |
| Example: | 36 |
| Coding | 36 |
| Example: | 36 |
| DO - UPTHRU - New Option | 37 |
| Example: | 37 |
| ITERATE Statement | 38 |
| Directives | 39 |
| %PAGE Directive | 39 |
| %PROCESS Directive | 39 |
| %SKIP Directive | 39 |
| %INCLUDE Directive | 40 |
| | |
| Chapter 7: Arrays | |
| Arrays: Purpose and Facilities | 1 |
| Bounds of Multi-dimensional Arrays | 2 |
| Attribute | 3 |
| Example: | 3 |
| Example: | 3 |
| Example: | 3 |
| Example: | 4 |
| Arrays: Referencing Elements | 5 |

| | |
|---|----|
| Examples: | 6 |
| Example: | 7 |
| Arrays: Initializing | 8 |
| Example: | 8 |
| Example: | 8 |
| Example: | 8 |
| Arrays: Iteration Factors | 9 |
| Example: | 9 |
| Example: | 9 |
| Example: | 10 |
| Example: | 10 |
| Array Variables: Assigning Values | 11 |
| Example: | 11 |
| Multidimensional Arrays: Order of Assignment and Output | 12 |
| Example: | 12 |
| Example: | 12 |
| Array Variables: GET and PUT Statements | 13 |
| Example: | 13 |
| Arrays: Passing as Arguments | 14 |
| Example: | 14 |
| Array Dimension Information: Built-In Functions | 15 |
| Example: | 15 |
| Array Initialization | 15 |
| Array Initialization with Unique Values | 16 |
| Examples: | 16 |
| Array Initialization - Iteration Factor | 16 |
| Example: | 16 |
| Repetition Factor - String Initialization | 17 |
| Example: | 17 |
| Example: | 17 |
| String Array Initialization | 17 |
| Example: | 17 |
| Array Operations | 18 |
| Example: | 18 |
| Arrays: Asterisk Subscript | 19 |
| Example: | 19 |
| Array Sizes: Defining | 20 |
| Example: | 20 |
| Bubble Sort | 20 |
| Example: | 20 |
| I/O Operations and Arrays | 21 |
| Example: | 21 |
| Built-In Array Functions | 22 |
| Array Assignments | 23 |
| Example: | 23 |
| ANY | 24 |
| Example: | 24 |

| | |
|---|----|
| Chapter 8: I/O: Input/Output | |
| Dataset | 1 |
| Record | 1 |
| Datasets: Sequential, Direct, and Partitioned | 2 |
| Sequential | 2 |
| Direct | 2 |
| Sequential | 2 |
| Storage Location of Datasets | 3 |
| DASD | 3 |
| DFSMS in Data Management | 4 |
| Access Methods | 5 |
| DASD Labels | 6 |
| Allocating a Dataset | 7 |
| Logical Records and Blocks | 8 |
| Dataset Record Formats | 9 |
| VSAM: Virtual Storage Access Method | 10 |
| Catalog | 11 |
| PL/1 I/O | 12 |
| I/O Definitions | 12 |
| I/O and Data Transmission | 12 |
| Stream Transmission | 13 |
| Record Transmission | 14 |
| Datasets | 15 |
| Dataset Organization | 16 |
| Consecutive | 16 |
| Indexed | 16 |
| Relative | 16 |
| Regional | 17 |
| Files | 18 |
| Alternative File Attributes | 18 |
| File Variable | 19 |
| RECORD and STREAM Attributes | 20 |
| INPUT, OUTPUT, and UPDATE Attributes | 20 |
| SEQUENTIAL and DIRECT Attributes | 21 |
| ENVIRONMENT Attribute | 21 |
| KEYED Attribute | 21 |
| Files: Opening and Closing Files | 22 |
| FLUSH Statement | 23 |
| SYSRINT and SYSIN | 24 |
| | |
| Chapter 9: Structures | |
| Structures | 1 |
| Structure Declarations and Attributes | 2 |
| Example: | 2 |
| Example: | 2 |
| Attributes for Structure Variables | 4 |
| Initializing Structures | 5 |
| Example: | 5 |
| Passing Structure Variables as Arguments | 6 |
| Example: | 6 |

| | |
|--|----|
| TYPE Attribute | 7 |
| Example: | 7 |
| Example: | 8 |
| Example: | 8 |
| Example: | 9 |
| Example: | 10 |
| LIKE Attribute | 11 |
| Example: | 11 |
| Example: | 12 |
| Example: | 12 |
| Example: | 12 |
| Example: | 12 |
| Structure-Qualified References | 13 |
| Example: | 13 |
| Arrays of Structures | 15 |
| Example: | 15 |
| Example: | 15 |
| Example: | 15 |
| Arrays of Structures that Contain Arrays | 16 |
| Example: | 16 |
| Example: | 16 |
| | |
| Chapter 10: Record I/O | |
| Record I/O: Purpose and Features | 1 |
| Varying Length Strings | 2 |
| Data Transmission Statements | 3 |
| READ FILE Statement | 3 |
| WRITE FILE Statement | 3 |
| REWRITE FILE Statement | 4 |
| LOCATE FILE Statement | 4 |
| DELETE FILE Statement | 5 |
| Options | 6 |
| FROM Option | 6 |
| INTO Option | 6 |
| Processing Modes | 7 |
| Move Mode | 7 |
| Example: | 7 |
| Locate Mode | 8 |
| Example: | 8 |
| Record I/O Examples | 9 |
| Example 1 | 9 |
| Example 2 | 10 |
| Example 3 | 11 |
| Example 4 | 12 |
| Example 5 | 13 |

Chapter 11: Stream I/O

Stream I/O Types 1
 Stream I/O 2
 File Description Attributes and Access Modes for Stream Files 2
 Processing and Positioning of Stream Files 4
 Output Stream 5
 Data Transmissions - Types 6
 Example 6
 Example 6
 Declaring Stream Files 7
 Examples 7
 OPEN Statement 8
 Examples 8
 CLOSE Statement 9
 Example 9
 Stream I/O Statements 10
 Stream Input 10
 Stream Output 10
 List Directed I/O 11
 Example 11
 Data Directed I/O 12
 Example 12
 Edit Directed Data Specification 13
 Input by the GET Statement 14
 COPY Option 15
 Example 15
 GET EDIT Statement 16
 Example 16
 Example 16
 Example 16
 Example 16
 GET LIST Statement 17
 GET SKIP Statement 18
 Example 18
 Example 18
 Output by the PUT Statement 19
 Options 20
 PAGE 20
 LINE (expression) 20
 SKIP ((expression)) 20
 STRING(reference) 20
 PUT - Derivative Forms 21
 PUT EDIT Statement 21
 PUT LINE Statement 21
 PUT LIST Statement 21
 PUT PAGE Statement 22
 Example 22
 PUT SKIP 22
 FORMAT Statement 23
 Format Items 24
 Format Items - Guidelines 25
 A Format Item 26

Input with GET EDIT 26
 Output with PUT EDIT 26
 COLUMN Format Item 27
 Example 27
 F Format Item 28
 LINE Format Item 30
 P Format Item 31
 PAGE Format Item 32
 R Format Item 32
 SKIP Format Item 33
 TAB Format Item 33
 X Format Item 34
 Format Specifications 35
 Example 35
 Example 35
 Example 35
 Example 36
 Format-Specification List 37
 Rules for Use 37
 Successive GET and PUT Statements 38
 Stream I/O Examples 1 39
 Stream I/O Example 2 39
 Stream I/O Example 3 40
 Stream I/O Example 4 40
 Stream I/O Example 5 41
 Stream I/O Example 6 41
 Stream I/O Example 7 42

Chapter 12: Storage Allocation

Based Variables 1
 Example 1
 Data Types Used with Based Variables 2
 Allocation in Areas 3
 IN and SET Options 4
 Referring to Based Variables 5
 Example 5
 Valid Pointer Values - Obtaining 6
 Dynamic Storage Allocation 7
 ALLOCATE Statement 7
 Example 7
 Example 9
 SET Option of the READ Statement 9
 Example 9
 READ Statement with a Based Variable 11
 ADDR Built-in Function 12
 Example 12
 Controlled Variables 13
 Controlled Attribute 13
 Example 14
 ALLOCATION Built-in Function 15

Example 15
 ADDR Built-in Function 16
 Example 16
 Dynamically Allocated Variables 17
 ALLOCATE Statement 17
 Examples 18
 Example 18
 FREE Statement 19
 Example 20
 Example 20
 DEFINED Attribute 21
 Example 21
 Example 21
 POSITION Attribute 23
 Example 23
 Overlay Defined Variable 23

Chapter 13: Conditions

Conditions and SIGNAL Statement 1
 Condition Prefixes 2
 Example 2
 Conditions 2
 Condition Status 3
 Computational Conditions 3
 Input/Output 3
 Program CheckOut 3
 Miscellaneous 4
 Condition Scope 5
 ON Statement 6
 Dynamically Descendent ON-units 7
 REVERT Statement 8
 SIGNAL Statement 9
 ANYCONDITION Condition 10
 Example 10
 CONDITION Condition 11
 Example 11
 CONVERSION Condition 12
 ENDFILE Condition 13
 ENDPAGE Condition 14
 ERROR Condition 15
 FINISH Condition 16
 KEY Condition 17
 RECORD Condition 18
 SIZE Condition 19
 STRINGRANGE Condition 20
 SUBSCRIPTRANGE Condition 21
 UNDEFINEDFILE Condition 22
 Exceptional Conditions 23
 Examples 23
 ON-units 24

Commonly Used ON-units 24
 Begin Blocks within ON-units 25
 Example 25
 ON ENDPAGE 26
 Error Condition 27
 Example 27
 Signal Statement 28
 Example 28
 Enable/Disabled Conditions 29
 Permanently Enabled Conditions 29
 Automatically Enabled Conditions 30
 Automatically Disabled Conditions 30
 Condition Prefixes 31
 Condition Handling Built-in Functions 32
 Example 32
 Example 33
 Error Correction Using ONCHAR 34
 Example 34
 Verifying for Numeric 35
 Example 35

Chapter 14: Built-in Functions

BUILTIN Attribute 1
 Example 1
 Invoking Built-in Functions and Subroutines 2
 Aggregate Arguments 3
 Arithmetic Built-in Functions 8
 Array-handling Built-in Functions 9
 Buffer-management Built-in Functions 10
 Condition-handling Built-in Functions 11
 Date/time Built-in Functions 12
 Input/output Built-in Functions 13
 Miscellaneous Built-in Functions 14
 Pseudovariables 15
 Storage Control Built-in Functions 16
 String-handling Built-in Functions 18
 Built-in Subroutines 20
 Built-in Function 21
 Example 21
 String Handling Functions 22
 Key of Arguments 22
 String Built-in Function 23
 Example 23
 Example 23
 Example 25
 Examples 26
 TRANSLATE(source, replacement characters, comparison characters) 27
 Example 27
 Example 27
 Built-in Function 28

| | |
|--|----|
| Examples..... | 28 |
| Arithmetic Built-in Functions..... | 29 |
| Examples..... | 30 |
| Miscellaneous Functions..... | 31 |
| Example: | 31 |
| Stream Function..... | 33 |
| Built-in Subroutines..... | 34 |
| PLIDUMP | 34 |
| PLIRETC | 35 |
| Example: | 35 |
| PL/1 Program Structure | 36 |
| Blocks..... | 36 |
| Begin Blocks..... | 36 |
| Flow of Control | 37 |
| Invoking a Function Procedure | 38 |
| The Returns Attribute in Functions | 39 |
| Example: | 39 |
| Calling a Procedure with Arguments in Dynamic Storage..... | 40 |
| Example: | 40 |
| Calling a Procedure with Arguments in Static Storage..... | 41 |
| Example: | 41 |
| Returning Results to a Calling Program..... | 42 |
| Example: | 42 |
| Dummy Arguments | 43 |
| Example: | 43 |
| PL/1 Sort Feature | 44 |
| Sort Datasets | 46 |
| Sort Optional Arguments..... | 46 |
| Sort Program..... | 47 |
| Example: | 47 |
| Example: | 48 |
| Example: | 49 |

Chapter 15: Programming Guidelines

| | |
|--|----|
| Compiler Options - Selecting | 1 |
| GET/PUT DATA | 2 |
| Example: | 2 |
| GOTO Statements | 3 |
| String Assignments | 4 |
| Loop Control Variables..... | 5 |
| REDUCIBLE..... | 6 |
| DEFINED and UNION..... | 7 |
| Named Constants and Static Variables | 9 |
| Avoiding Calls to Library Routines | 10 |