

Automatic Binary Optimizer for z/OS  
2.1

*User's Guide*



**Note**

Before using this information and the product it supports, be sure to read the general information under [“Notices” on page 101](#).

**First edition (March 2021)**

This edition applies to Version 2.1 of IBM® Automatic Binary Optimizer for z/OS® (program number 5697-AB2), and IBM Automatic Binary Optimizer for z/OS Trial (program number 5697-TR2), and to all subsequent releases and modifications until otherwise indicated in new editions. Make sure you are using the correct edition for the level of the product.

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# Preface

## About this book

This book is for IBM COBOL compiler customers who use IBM Automatic Binary Optimizer for z/OS to improve the performance of their already compiled COBOL programs.

### Abbreviated terms

Certain terms are used in a shortened form in this information. Abbreviations for the terms used most frequently are listed alphabetically in the following table.

Term used	Long form
ABO	IBM Automatic Binary Optimizer for z/OS
CSECT	Control section
EBCDIC	Extended binary coded decimal interchange code
HFS	Hierarchical file system
JCL	Job control language
PDS	Partitioned data set
PDSE	Partitioned data set extended

Other terms, if not commonly understood, are spelled out the first time they appear.

### How to read syntax diagrams

Use the following description to read the syntax diagrams in this information:

- Read the syntax diagrams from left to right, from top to bottom, following the path of the line.

The >>--- symbol indicates the beginning of a syntax diagram.

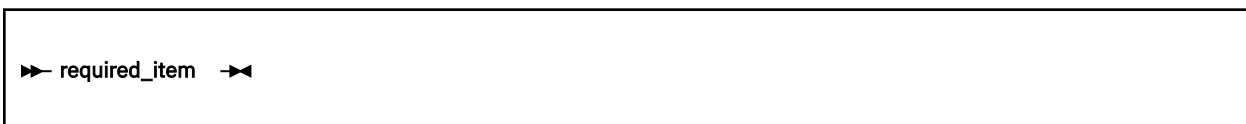
The ---> symbol indicates that the syntax diagram is continued on the next line.

The >--- symbol indicates that the syntax diagram is continued from the previous line.

The --->< symbol indicates the end of a syntax diagram.

Diagrams of syntactical units other than complete statements start with the >--- symbol and end with the ---> symbol.

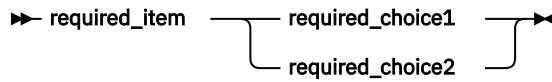
- Required items appear on the horizontal line (the main path).



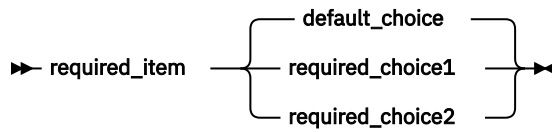
- Optional items appear below the main path.



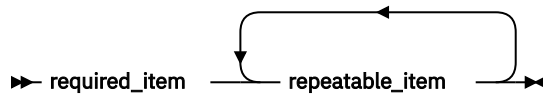
- If you can choose from two or more items, they appear vertically, in a stack. If you must choose one of the items, one item of the stack appears on the main path.



If one of the items is the default, it appears above the main path and the remaining choices are shown below:



- An arrow returning to the left, above the main line, indicates an item that can be repeated.



- Keywords appear in uppercase (for example, FROM). They must be spelled exactly as shown. Variables appear in all lowercase letters (for example, *column-name*). They represent user-supplied names or values.
- If punctuation marks, parentheses, arithmetic operators, or other such symbols are shown, you must enter them as part of the syntax.

## Summary of changes

This section lists the major changes that have been made to this document for IBM Automatic Binary Optimizer for z/OS Version 2 Release 1. The latest technical changes are highlighted in the HTML version, or marked by vertical bars (|) in the left margin in the PDF version.

### Version 2 Release 1 document refresh in March 2021

- PTF updates (UI74718, UI74719)
  - Introduces a new component, the SMF Analyzer, to the ABO Assistant tool. (See [Chapter 7, “Using the ABO Assistant,”](#) on page 55)
  - Adds support for the new z15 T02 machine. (See [“Target hardware levels”](#) on page 4)
- Other updates
  - Updates the Overview section to include information about additional features of ABO and the tools that come with ABO. (See [Chapter 1, “Overview,”](#) on page 1)

### Version 2 Release 1 document refresh in October 2020

- PTF updates (UI72097, UI72098)
  - Introduces a new tool, the ABO Assistant to automate all the individual steps required to efficiently optimize your COBOL application using ABO and to clearly report on the CPU time savings from using ABO. (See [Chapter 7, “Using the ABO Assistant,”](#) on page 55)
  - Introduces new syntax for the CSECT and member separator and negation. (See [“CSECT”](#) on page 21 and [“BOPT”](#) on page 16)



- Improves the ABO IVP by detecting if MACHMIG VEF is set. (See [“Verifying installation using the Installation Verification Program \(IVP\)”](#) on page 11)

## Version 2 Release 1 document refresh in March 2020

- PTF updates (UI68702, UI68703)
    - Improves the listing transform by displaying prolog information for each CSECT in the "Input Instructions" section. (See [“Listing transform contents”](#) on page 45)
    - Improves the Run Time Instrumentation report by:
      - Showing a "Summary report by language" subsection in the "Summary report" section.
      - Introducing the time stamps in the "RTI option" section and the "Summary report" section. These time stamps correspond with the profiling start and end times respectively.
- (See [Appendix D, “Run Time Instrumentation report,”](#) on page 95)

## Version 2 Release 1 document refresh in November 2019

- PTF updates (UI66467, UI66468)
  - Adds a new optimizer option, RTIBIND, to generate RTI Profiler enabled modules. (See [RTIBIND](#))
  - Adds the following messages: BOZ1426S, BOZ1495W, and BOZ1496W. (See [Messages](#))
- Other updates
  - Adds appendixes for the Run Time Instrumentation report, and the manual RTI rebinding instructions. (See [Run Time Instrumentation report](#) and [Manual RTI rebinding instructions](#))

## Version 2 Release 1

- Adds z/OS Version 2.4 to the list of supported operating systems, and removes z/OS Version 2.1. (See [Supported operating systems](#))
- Adds ARCH(13) for generating code that exploits the new IBM z15. (See [ARCH](#))
- Adds the following message: BOZ4124I. (See [Messages](#))
- Removes the following optimizer option: HANDLERS.

## How to send your comments

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Your feedback is important in helping us to provide accurate, high-quality information. If you have comments about this documentation, send your comments to the following address: [compinfo@cn.ibm.com](mailto:compinfo@cn.ibm.com).

Be sure to include the name of the document, the publication number, the version of the product, and, if applicable, the specific location (for example, the page number or section heading) of the text that you are commenting on.

When you send information to IBM, you grant IBM a nonexclusive right to use or distribute the information in any way that IBM believes appropriate without incurring any obligation to you.

## Accessibility features for Automatic Binary Optimizer for z/OS

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Accessibility features assist users who have a disability, such as restricted mobility or limited vision, to use information technology content successfully. The accessibility features in z/OS provide accessibility for Automatic Binary Optimizer for z/OS (ABO).

### Accessibility features

z/OS includes the following major accessibility features:

## How to send your comments

- Interfaces that are commonly used by screen readers and screen-magnifier software
- Keyboard-only navigation
- Ability to customize display attributes such as color, contrast, and font size

z/OS uses the latest W3C Standard, WAI-ARIA 1.0 (<http://www.w3.org/TR/wai-aria/>), to ensure compliance to US Section 508 (<http://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-section-508-standards/section-508-standards>) and Web Content Accessibility Guidelines (WCAG) 2.0 (<http://www.w3.org/TR/WCAG20/>). To take advantage of accessibility features, use the latest release of your screen reader in combination with the latest web browser that is supported by this product.

The ABO online product documentation in IBM Knowledge Center is enabled for accessibility. The accessibility features of IBM Knowledge Center are described at <http://www.ibm.com/support/knowledgecenter/en/about/releasesnotes.html>.

## Keyboard navigation

Users can access z/OS user interfaces by using TSO/E or ISPF.

Users can also access z/OS services by using IBM Developer for z/OS Enterprise Edition.

For information about accessing these interfaces, see the following publications:

- *z/OS TSO/E Primer* ([http://www.ibm.com/support/knowledgecenter/SSLTBW\\_2.2.0/com.ibm.zos.v2r2.ikjp100/toc.htm](http://www.ibm.com/support/knowledgecenter/SSLTBW_2.2.0/com.ibm.zos.v2r2.ikjp100/toc.htm))
- *z/OS TSO/E User's Guide* ([http://www.ibm.com/support/knowledgecenter/SSLTBW\\_2.2.0/com.ibm.zos.v2r2.ikjc200/toc.htm](http://www.ibm.com/support/knowledgecenter/SSLTBW_2.2.0/com.ibm.zos.v2r2.ikjc200/toc.htm))
- *z/OS ISPF User's Guide Volume I* ([http://www.ibm.com/support/knowledgecenter/SSLTBW\\_2.2.0/com.ibm.zos.v2r2.f54ug00/toc.htm](http://www.ibm.com/support/knowledgecenter/SSLTBW_2.2.0/com.ibm.zos.v2r2.f54ug00/toc.htm))
- IBM Developer for z/OS Knowledge Center ([http://www.ibm.com/support/knowledgecenter/SSQ2R2/rdz\\_welcome.html?lang=en](http://www.ibm.com/support/knowledgecenter/SSQ2R2/rdz_welcome.html?lang=en))

These guides describe how to use TSO/E and ISPF, including the use of keyboard shortcuts or function keys (PF keys). Each guide includes the default settings for the PF keys and explains how to modify their functions.

## Interface information

The ABO online product documentation is available in IBM Knowledge Center (<https://www.ibm.com/support/knowledgecenter/SSERQD>), which is viewable from a standard web browser.

PDF files have limited accessibility support. With PDF documentation, you can use optional font enlargement, high-contrast display settings, and can navigate by keyboard alone.

To enable your screen reader to accurately read syntax diagrams, source code examples, and text that contains period or comma PICTURE symbols, you must set the screen reader to speak all punctuation.

Assistive technology products work with the user interfaces that are found in z/OS. For specific guidance information, see the documentation for the assistive technology product that you use to access z/OS interfaces.

## Related accessibility information

In addition to standard IBM help desk and support websites, IBM has established a TTY telephone service for use by deaf or hard of hearing customers to access sales and support services:

TTY service  
800-IBM-3383 (800-426-3383)  
(within North America)

## **IBM and accessibility**

For more information about the commitment that IBM has to accessibility, see [IBM Accessibility \(www.ibm.com/able\)](http://www.ibm.com/able).



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# Chapter 1. Overview

IBM Automatic Binary Optimizer for z/OS (ABO) improves the performance of already compiled IBM COBOL programs. ABO does not require source code, source code migration, or performance options tuning. It uses modern optimization technology to target the latest IBM Z® Systems, including IBM z15™, to accelerate the performance of COBOL applications.

The main function of ABO is to optimize COBOL program modules to improve performance. ABO optimizes directly from the binary code inside the program modules, and this allows ABO to ensure the program logic remains exactly the same. In addition to optimization ABO has some other useful features:

- Use the ABO RTIBIND=Y to enable your COBOL program modules for performance profiling by the Run Time Instrumentation (RTI) Profiler included with ABO. Both the original and optimized program modules can be enabled for profiling. A detailed performance report is produced to help you identify performance bottlenecks.
- Use the ABO SCAN=Y option to obtain insight into your COBOL application inventory. Using this feature provides details on the makeup of your COBOL modules, including compiler versions, compilation dates and more.

ABO comes with the tools that complement ABO to improve the process of realizing performance gains of your COBOL applications.

- The ABO Assistant simplifies the ABO evaluation process, accelerates the deployment of ABO optimized modules, and allows you to easily see the performance improvements from using ABO. The ABO Assistant is a suite of tools to automate the identification and optimization of your top CPU consuming COBOL batch applications. The ABO Assistant enables you to drill down from high level SMF data all the way to obtain concrete performance evaluation results, and to help prepare your key optimized modules for deployment.
- The Run Time Instrumentation (RTI) Profiler allows you to profile COBOL applications to determine performance bottlenecks. It collects and reports on the execution time CPU performance characteristics of your batch z/OS applications.
- The SMF Analyzer simplifies the process of identifying the best applications to optimize with ABO. It analyzes your SMF data to filter, find, sort, and report on your top CPU consuming applications.

## Benefits

Using IBM Automatic Binary Optimizer for z/OS (ABO) to optimize your COBOL applications lowers your IBM Z System operating costs. The ABO-optimized modules behave the same as the original modules but consume fewer CPU resources and have shorter processing time.

Using ABO offers the quickest time to value. ABO 2.1 delivers the same performance benefit as the latest Enterprise COBOL V6 compiler. ABO directly optimizes already-compiled modules and testing cost is significantly reduced. Using the ABO Assistant, an evaluation is simplified, and deployment is accelerated.

Using ABO allows you to maximize the return on investment (ROI) of your new IBM Z Systems. IBM Z delivers performance with hardware features and advanced optimization technology. COBOL applications compiled by earlier COBOL compilers don't utilize new hardware instructions available on the latest IBM Z Systems. Optimizing these earlier COBOL applications with ABO provides delivers up to a 25-year jump forward in the evolution of hardware technology, with access to over 600 new hardware instructions that are already on the IBM z15, z14, z13s®, z13®, zEC12 and zBC12 systems. It is important to stay current with the latest Enterprise COBOL and ABO.

ABO and Enterprise COBOL are designed to work together. Use Enterprise COBOL to compile programs that are under active development; and ABO to optimize programs that are not frequently compiled.

## Using ABO and Enterprise COBOL together

IBM Automatic Binary Optimizer for z/OS and the latest IBM Enterprise COBOL compiler serve different but complementary purposes.

- ABO optimizes COBOL program modules compiled by earlier versions of the compiler and Enterprise COBOL compiles and optimizes COBOL source code.
- There is no performance trade-off when using ABO. In our performance testing, ABO 2.1 and Enterprise COBOL 6.3 deliver comparable performance.
- ABO offers a faster path to performance gains. Migrating to COBOL V6 can require multiple rounds of compile and test. Source code changes will be required if problems like invalid date are detected in existing applications.
- Use the latest Enterprise COBOL to compile new COBOL programs or to recompile COBOL programs requiring changes. Use ABO to optimize your COBOL programs that are not in your recompilation plan or if the program source code is not available.

You can choose which product to use according to [Table 1 on page 2](#).

Table 1. Comparing optimizer and compiler use cases		
Use case	IBM Automatic Binary Optimizer for z/OS	IBM Enterprise COBOL compilers
Significant performance improvements without requiring source, migration, or options tuning	√	
Built-in support on z/OS V2.2 and later for targeting multiple hardware levels	√	
Interoperability and legacy compatibility (e.g. PDS input/output, interoperate with OS/VS COBOL and VS COBOL II NORES)	√	
No need to downgrade ARCH setting to match disaster recovery machine	√	
New COBOL application development or to use new COBOL features		√
Maintenance on existing COBOL programs		√

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## Chapter 2. System requirements

### Supported operating systems

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IBM Automatic Binary Optimizer for z/OS can be run on the following operating systems:

- z/OS Version 2.4
- z/OS Version 2.3
- z/OS Version 2.2

For the operating system levels before z/OS 2.4, ABO requires some PTFs to be applied on the systems where Automatic Binary Optimizer for z/OS is installed and running. Other PTFs are required on systems where the ABO generated optimized modules will be running, even if ABO is not installed on these systems. APAR/PTF (OA47689/UA90982), which is available for z/OS 2.2 only, is required on systems where either ABO or the ABO generated modules are running.

These PTFs are required on systems where ABO is running:

- z/OS V2.3
  - OA55985/UA97356 (Binder)
- z/OS V2.2
  - OA47829/UA78084 (Binder)
  - OA50460/UA82866 (Binder)
  - OA47689/UA90982 (IEFOPZxx SYS1.PARMLIB support)
  - OA55985/UA97372 (Binder)

These PTFs are required on systems where ABO optimized modules are running:

- z/OS V2.4
  - PH15921/UI65058 (Language Environment)<sup>1</sup>
  - PH15921/UI65059 (Language Environment - Japanese)<sup>1</sup>
  - PH14705/UI64418 (Language Environment Automatic Binary Optimizer Runtime Engine)<sup>1</sup>
- z/OS V2.3
  - PI84561/UI49013 (Language Environment Automatic Binary Optimizer Runtime Engine)<sup>1</sup>
  - PH14705/UI64417 (Language Environment Automatic Binary Optimizer Runtime Engine)
- z/OS V2.2
  - PI51546/UI33445 (Language Environment)
  - PI51802/UI32944 (Language Environment CICS® system definition sample update)
  - OA47689/UA90982 (IEFOPZxx SYS1.PARMLIB support)
  - PH14705/UI64419 (Language Environment Automatic Binary Optimizer Runtime Engine)

If the same system is going to be used to both run ABO and run the ABO optimized modules then all the PTFs listed above per z/OS version must be installed on this system.

Optional programs that can be used with ABO:

- [Application Delivery Foundation for z/OS V3.2](#)
  - Developer for z/OS Enterprise Edition V14.2
  - Debug for z/OS V14.2
  - Fault Analyzer for z/OS V14.1.8

- Application Performance Analyzer for z/OS V14.2

It is highly recommended that the latest IBM Automatic Binary Optimizer or IBM Automatic Binary Optimizer Trial PTFs be installed. See the [fix list and new features page](#).

**Note:**

1. The PTF is included in the GA or GA PTF versions of z/OS 2.3 and z/OS 2.4 so is only required if running early release versions of these z/OS levels.

## Target hardware levels

IBM Automatic Binary Optimizer for z/OS can generate program modules for the latest IBM Z servers.

Automatic Binary Optimizer for z/OS uses the same hardware numbering scheme as the COBOL compilers. Table 2 on page 4 lists the hardware levels that are supported by IBM Automatic Binary Optimizer for z/OS Version 2.1. You can use the [ARCH option](#) to specify which hardware level you want the ABO produced modules to target.

Table 2. Supported hardware levels	
Hardware level	Description
10	<p>Generates code that uses instructions available on the 2827-xxxx (IBM zEnterprise® EC12) and 2828-xxxx (IBM zEnterprise BC12) models in z/Architecture® mode.</p> <p>Specifically, these level 10 machines and their follow-ons add instructions with support of the following facilities:</p> <ul style="list-style-type: none"> <li>• Execution-hint facility</li> <li>• Load-and-trap facility</li> <li>• Miscellaneous-instructions-extension facility</li> <li>• Transactional-execution facility</li> <li>• Enhanced decimal floating point facility that enables more efficient conversions between zoned decimal data items and decimal floating point data items. Instead of converting zoned decimal data items to packed-decimal data items to perform arithmetic operations, the compiler converts zoned decimal data items directly to decimal floating point data items, and then back again to zoned decimal data items after the computations are complete.</li> </ul>
11	<p>Generates code that uses instructions available on the 2964-xxxx (IBM z13®) and 2965-xxx (IBM z13s) models in z/Architecture mode.</p> <p>Specifically, these level 11 machines and their follow-ons add instructions with support of the following facilities:</p> <ul style="list-style-type: none"> <li>• Enhanced decimal floating point facility that enables more efficient conversions between packed-decimal data items and decimal floating point intermediate result data items</li> <li>• Vector extension facility for more efficient string processing from the COBOL statements or functions such as INSPECT and REVERSE</li> </ul>
12	<p>Generates code that uses instructions available on 3906-xxx (IBM z14) and 3907-xxx (IBM z14 ZR1) models in z/Architecture mode.</p> <p>Specifically, these level 12 machines and their follow-ons add instructions that support the vector packed-decimal facility, which accelerates packed-decimal computation by storing intermediate results in vector registers instead of in memory.</p>



Table 2. Supported hardware levels (continued)

Hardware level	Description
13	<p>Generates code that uses instructions available on 8561-xxx (IBM z15) and 8562-xxx (IBM z15 T02) models in z/Architecture mode.</p> <p>Specifically, these level 13 machines and their follow-ons add instructions supported by the following facilities:</p> <ul style="list-style-type: none"> <li>• Vector Packed-Decimal Enhancement Facility</li> <li>• Vector-Enhancements Facility 2</li> <li>• Miscellaneous Instruction-Extensions-Facility 3</li> <li>• Aligned Vector Load/Store Hints</li> </ul>
<p><b>Notes:</b></p> <ol style="list-style-type: none"> <li>1. ABO can run on any system supported by the z/OS level. For a complete list of IBM Z servers that support z/OS V2.2 and later, see <a href="#">z/OS Server Support</a>.</li> <li>2. When using ARCH=11 and higher, the SYS1.IPLPARM or SYS1.PARMLIB member LOADxx must not include MACHMIG VEF. This will disable the vector extension facility and cause an 0C7 data exception abend when executing vector instructions produced by ABO at ARCH=11 and higher.</li> </ol>	



## Chapter 3. COBOL module requirements

The input to the IBM Automatic Binary Optimizer for z/OS is your COBOL program modules. ABO verifies that the program modules provided are supported by ABO. ABO then scans the CSECTs within the program modules for those that are eligible for optimization. A CSECT is eligible for optimization by ABO if all of the following conditions apply:

- It was generated by an eligible IBM COBOL compiler.
- All the COBOL language features and options are supported.
- The optimization verification passes all succeed.

ABO optimizes all the eligible CSECTs in the program modules and produces new program modules containing the CSECTs that are successfully optimized.

### Supported program modules

IBM Automatic Binary Optimizer for z/OS optimizes program modules output from the binder and load modules output from the linkage editor. The program modules output from the binder can be either program objects or load modules. Load modules produced by the linkage editor must be acceptable input to the binder for ABO to optimize them.

ABO is able to optimize both fully bound or partially bound program modules. A partially bound module is one that has been bound with CALL=NO or NCAL option and are often contained in a link library. If the ALLOW=NOUNRESEXE option has been specified, ABO will not optimize partially bound program modules. See the [ALLOW option](#) for more details.

ABO does not support the following COBOL modules:

Table 3. COBOL modules that ABO does not support	
COBOL modules that ABO does not support	Messages issued
Modules that the binder will not process	BOZ4116I followed by BOZ1429U  For example, the binder will not process load modules that have ESD names with invalid characters. When ABO encounters a module with an invalid ESD name, ABO will produce a BOZ4116I message and the BOZ4116I message includes the text of binder message IEW2512E. The text of IEW2512E includes the name of the invalid ESD name.
Modules bound with EDIT=NO	BOZ1423S
Signed modules	BOZ1424S
Modules marked not executable	BOZ1422S

Table 3. COBOL modules that ABO does not support (continued)

COBOL modules that ABO does not support	Messages issued
Modules that include object files from a prelink step but the prelink step was not done properly	BOZ4116I followed by BOZ1419S  For example, prelinking may be improper if it was not performed on all object files. This improper prelink could result in load modules that the binder and ABO will not process. ABO would produce a BOZ4116I message followed by a BOZ1419S message if the binder would not process the module. Prelinking is also not proper if the module includes output from multiple prelink steps. In this case, the original module would normally not run properly and ABO would produce a module that would also not run properly.

ABO scans the CSECTs within the program modules for those that are eligible for optimization. A CSECT is eligible for optimization by ABO if it was generated by an eligible COBOL compiler and all COBOL features used in the original COBOL program are supported by ABO.

## Eligible compilers

IBM Automatic Binary Optimizer for z/OS, V2.1, can optimize CSECTs within program modules that were generated by the following COBOL compilers:

- Enterprise COBOL for z/OS V4
- Enterprise COBOL for z/OS V3
- COBOL for OS/390® & VM V2
- COBOL for MVS™ & VM V1.2
- COBOL/370 V1.1
- VS COBOL II V1.4.0 (LE enabled modules only)
- VS COBOL II V1.3.x (LE enabled modules only)

**Note:** COBOL modules that have been processed by CA-Optimizer cannot be optimized by ABO. For these types of modules it is recommended to use ABO to optimize the original module created by the COBOL compiler before it was processed by CA-Optimizer.

## COBOL language feature and compiler option support

### Supported COBOL language features and compiler options

The vast majority of COBOL language features are supported using IBM Automatic Binary Optimizer for z/OS.

Here is a list of key COBOL features that are supported in IBM Automatic Binary Optimizer for z/OS Version 2.1.

- ARITH(EXTEND | COMPAT)
- CICS
- CICS HANDLE ABEND
- CICS HANDLE AID
- CICS language translator generated SERVICE LABEL statements
- CMPR2
- DB2®

- DLL
- ENTRY
- IMS
- I/O and debugging declaratives
- NOOPTIMIZE, OPTIMIZE(STD | FULL)
- NUMPROC(NOPFD | PFD | MIG)
- Program segmentation<sup>1</sup>
- RECURSIVE
- RENT and NORENT
- SORT and MERGE
- SQL
- SSRANGE
- TEST<sup>2</sup>
- THREAD
- TRUNC(STD | BIN | OPT)
- User written SERVICE LABEL statements
- XML

## Unsupported COBOL language features and compiler options

IBM Automatic Binary Optimizer for z/OS Version 2.1 does not optimize program modules that use the following COBOL features:

- ACCEPT FROM SYSIPT used in the LABEL declarative
- CLASS
- DISPLAY UPON SYSLST used in the LABEL declarative
- DISPLAY UPON SYSPCH used in the LABEL declarative
- ENTER
- INVOKE
- Java-based object oriented (OO) syntax
- RERUN

## Handling ineligible CSECTs

Although IBM Automatic Binary Optimizer for z/OS (ABO) only optimizes CSECTs generated by the compilers listed in the [Eligible compilers](#) section, ABO will tolerate modules containing CSECTs from other COBOL compilers and languages.

ABO examines each CSECT before optimization begins. If any of the conditions in the following table applies, the CSECT is not eligible for optimization, a message is issued and the CSECT is skipped. If at least one eligible CSECT for optimization is found in a module, any ineligible CSECTs are copied over unchanged to the target module along with the optimized CSECTs.

- 
- <sup>1</sup> Most cases of Program Segmentation are supported. The remaining unsupported case is when the source for the CSECT processed by ABO contains independent segments, altered GO TO statements and GO TO DEPENDING ON statements. In this case, the message B0Z1455W: unsupported feature "Program Complexity 176" found is issued and the CSECT is skipped.
  - <sup>2</sup> Although programs compiled with TEST and any sub-option can be optimized by ABO, LE will not produce a formatted variable dump for the ABO generated module. LE will produce this message instead <prog> was not compiled with the SYM suboption of the TEST. A formatted variable dump cannot be produced.

<i>Table 4. Ineligible CSECTs and message issued</i>	
<b>Ineligible CSECT</b>	<b>Message issued</b>
The CSECT name does not match the CSECT filter expression specified. See <a href="#">CSECT</a> .	BOZ4113I
The CSECT is generated from a language other than COBOL. For example, it is from HLASM, C/C++, or PL/I.	No specific message issued <sup>3</sup>
The CSECT is not compiled by one of the eligible COBOL compilers.	BOZ1455W
The CSECT is compiled by one of the eligible COBOL compilers, but it contains one or more unsupported COBOL statements listed in <a href="#">Summary of unsupported COBOL features</a> .	BOZ1455W
The CSECT is too complex for ABO to safely optimize and generate correct functioning code.	BOZ1455W
The CSECT contains any unexpected data or code. This can include, but is not limited to, any missing, corrupted or other erroneous strings ABO relies on to properly understand the CSECT contents and perform correct optimizations.	BOZ1455W
The CSECT has previously been optimized by ABO.	BOZ1455W

---

<sup>3</sup> The optimizer option SCAN=Y can be used to determine the types of CSECTs present in a module.

---

## Chapter 4. Installing and verifying installation

### Installing IBM Automatic Binary Optimizer for z/OS

---

All information about installing IBM Automatic Binary Optimizer for z/OS is included in the Program Directory provided with the product.

It is highly recommended that the latest IBM Automatic Binary Optimizer for z/OS PTFs also be installed. See the [fix list and new features page](#) for a list of IBM Automatic Binary Optimizer for z/OS PTFs and APARs.

#### Related reference

[“IBM Automatic Binary Optimizer for z/OS publications” on page 103](#)

### Verifying installation using the Installation Verification Program (IVP)

---

After you complete the SMP/E installation of ABO, use the ABO Installation Verification Program (IVP), BOZJIVP, to verify that ABO is installed correctly and is functional.

#### Overview of BOZJIVP

The ABO Installation Verification Program (IVP), BOZJIVP, is located in the ABO sample library *HLQ.SBOZJCL*, where *HLQ* is the prefix used for the target libraries in your ABO SMP/E installation.

Run the IVP on any system on which you plan to use ABO and on any system where the optimized modules produced by ABO will be running.

**Note:** ABO can run on any hardware level supported by the minimum z/OS level but the ABO generated optimized modules can only run on zEC12, zBC12, z13, z13s, z14, z14 ZR1, z15, and z15 T02 systems. See [“Target hardware levels” on page 4](#) for more information. Keep these minimum hardware requirements in mind when you examine the IVP results.

#### Using BOZJIVP

To proceed with the IVP process on the selected system, edit BOZJIVP according to the included JCL description, and then submit it.

This job contains the following steps:

1. LKED - Link-edits the original COBOL program using as input the object BOZOBJ1 in the same sample library.

**Note:** The BOZOBJ1 program was compiled using Enterprise COBOL for z/OS V4R2 with the OPT(STD) option in effect. The program source example, BOZSRC1, is also available in the same library for your convenience.

2. GOBEFORE - Runs the original program.
3. VERIFY1 - Verifies z/OS version eligibility to run ABO.
4. OPTIMIZE - Optimizes the original program using ABO.
5. VERIFY2 - Verifies IBM z server type eligibility to run ABO optimized modules.
6. GOAFTER - Runs optimized version of the original COBOL program.
7. EXCEPT - Notifies about possible MACHMIG VEF specification in SYS1.IPLPARM(LOADxx). Runs if step GOAFTER condition code is S0C7 only.

**Note:** The LOADxx member may be located on some systems in SYS1.PARMLIB instead of SYS1.IPLPARM

8. POSTABND - Notifies about possible machine architecture level or LE PTF level conflict. Runs if step GOAFTER condition code is SOC1, SOC4 or SOC6 only.
9. REPORT - Reports IVP results.

## Results

You will receive a return code of 0 or 4 for each of the preceding steps when the IVP runs successfully. After the REPORT step completes, a report is available in the SYSTSRPT output file and in the JESMSG LG JOBLOG.

The following example shows a sample IVP report in the SYSTSRPT output file:

```
*** The original program start time is: 10:42:22.72
*** The original program end time is: 10:44:10.71

***                                ***
***      Optimization successful!    ***
***                                ***

*** The optimized program start time is: 10:44:11.41
*** The optimized program end time is: 10:44:15.63

***                                ***
*** The elapsed time is reduced by 103.77 sec    ***
***                                ***

***                                ***
***      Installation verification successful!    ***
***                                ***
```

The following example shows a sample JESMSG LG JOBLOG. Note that the Installation verification successful! message is present in both the JOBLOG and in the console.

10.42.22	JOB07227	HTRT01I						CPU (Total)
Elapsed								
10.42.22	JOB07227	HTRT02I	Jobname	Stepname	ProcStep	RC	I/O	hh:mm:ss.th
hh:mm:ss.th								
10.42.22	JOB07227	HTRT03I	BOZIVP	LKED		00	176	00.01
00.10								
10.44.10	JOB07227	HTRT03I	BOZIVP	GOBEFORE		00	192	01:47.49
01:48.14								
10.44.11	JOB07227	HTRT03I	BOZIVP	OPTIMIZE		00	13457	00.06
00.54								
10.44.15	JOB07227	HTRT03I	BOZIVP	GOAFTER		00	205	04.21
04.37								
10.44.15	JOB07227	++++	Installation verification successful!					
***								
10.44.15	JOB07227	HTRT03I	BOZIVP	REPORT		00	64	00.01
00.03								

If the VERIFY1 step fails, you will see the following message in both the JOBLOG and in the console:

```
z/OS version: xx.xx is not a supported z/OS version to run AB0.
```

If the VERIFY2 step fails, you will see the following message in both the JOBLOG and in the console:

```
IBM z server: type (name)
is not a supported hardware level to run AB0 optimized modules.
```



For example:

```
IBM z server: 2817 (zEnterprise 196)
is not a supported hardware level to run ABO optimized modules.
```

If the OPTIMIZE step fails, verify the messages in this step log file to see which system or Language Environment component is possibly missing. Fix the problem, and then run the BOZJIVP job again.

If the GOAFTER step fails, verify if step EXCEPT or POSTABND was executed. If the step EXCEPT was executed, you will see the following message in both the JOBLOG and in the console:

```
If MACHMIG VEF is specified in SYS1.IPLPARM(LOADxx), then it must be removed for ABO
optimization when ARCH >= 11.
```

Remove MACHMIG VEF specification from SYS1.IPLPARM(LOADxx), and then run the BOZJIVP job again.

If the step POSTABND was executed, you will see one of the following messages in both the JOBLOG and in the console:

```
IVP is incomplete. The ARCH level specified is 13 (z15), but the actual ARCH level is 12 (z14)
```

Correct ARCH specified and then run the BOZJIVP job again.

```
If any required LE PTFs is missing, then install it. Otherwise, contact IBM service to report
the problem
```

Verify which Language Environment PTF is possibly missing. If one or more of the "Language Environment Automatic Binary Optimizer Runtime Engine" PTFs listed in "Supported operating systems" on page 3 are not installed, an OC1 abend is likely to occur. If the "Language Environment Automatic Binary Optimizer Runtime Engine" PTF is installed but is not the latest PTF listed in the Program Directory, a U4038 abend will occur and one of the following messages will be displayed:

```
IGZ0153S Program BOZSRC1 was compiled with a level of the compiler that requires service to be
installed on Language Environment.
IGZ0355S Program BOZSRC1 was optimized with a level of the Automatic Binary Optimizer that
requires service to be installed on Language Environment.
```

"Language Environment Automatic Binary Optimizer Runtime Engine" PTFs on z/OS 2.2 and 2.3 will cause the first message to be issued, and PTFs on z/OS 2.4 will cause the second message to be issued.

If instead of an abend the GOAFTER step fails with a non-zero return code, the return code corresponds to a missing Language Environment PTF as follows:

Table 5. Return code and corresponding missing LE PTFs		
Return code	z/OS 2.2	z/OS 2.3
17	PI84563	PI84561

Install the required PTFs, and then run the BOZJIVP job again.

An OC1 abend will also occur if you attempt to run the ABO generated modules on a system that is not supported by ABO. See "Target hardware levels" on page 4 for the supported systems.



## Chapter 5. Optimizing modules

To use the Automatic Binary Optimizer for z/OS, write your JCL for the optimization process.

### Invoking ABO with the EXEC statement

Use the EXEC job control statement in your JCL to invoke ABO. The EXEC statement is as follows:

```
//OPT      EXEC PGM=B0Z0PT
```

### Required DD statements

The optimization process requires that you specify data sets for specific uses in the optimization process. You can define these data sets in DD statements with the required ddnames. The ddnames that are used by ABO and their characteristics are shown in [Table 6 on page 15](#).

### Specifying the optimizer directive BOPT or IEFOPZ

Use BOPT or IEFOPZ to direct ABO. You can include one or more of the BOPT or IEFOPZ directives in the SYSIN DD. For details, see [“BOPT” on page 16](#) and [“IEFOPZ” on page 18](#).

## Required DD statements

The table shows the ddnames that are used by the Automatic Binary Optimizer for z/OS.

Table 6. The ddnames used for binary optimization			
ddname	Type	Required	Description
STEPLIB	Input	Yes	Specifies the name of the data set containing ABO and the dependent Language Environment® runtime data sets.
SYSIN	Input	Yes	Specifies the location of the file that contains the optimizer directives BOPT and IEFOPZ and optimizer options. As a convenience, you can specify the in-stream file in the JCL using DD *.
OPTLOG	Output	Yes	Specifies that the optimization summary information (such as what is optimized and the location of the optimized binaries) is written to this DD. SCAN output is also written here.
SYSPRINT	Output	No, if the LIST option is specified Yes, if the LIST option is not specified	Specifies the default location for the listing transforms. See also <a href="#">“SYSPRINT DD and LIST option” on page 52</a> .

Table 6. The ddnames used for binary optimization (continued)

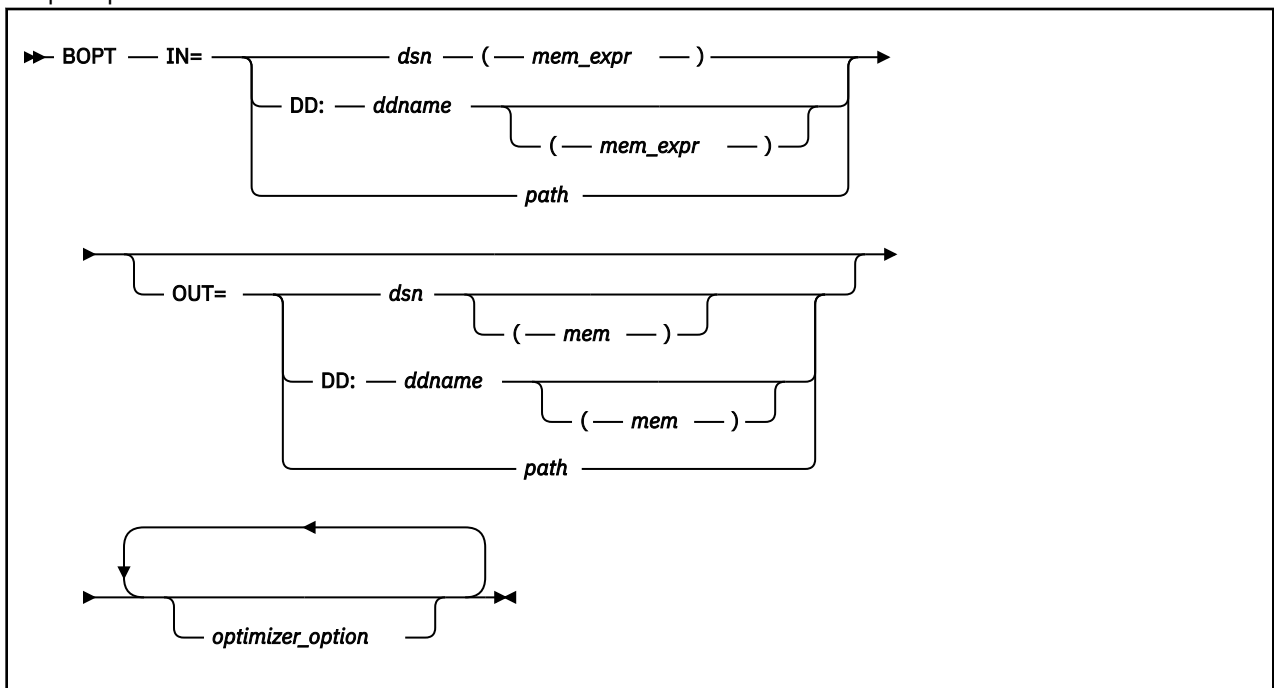
ddname	Type	Required	Description
OPTERR	Output	No	Specifies that the optimization diagnostic information is written to this DD in exceptional circumstances.
CEEDUMP	Output	No	Specifies that the optimization dump information is written to this DD in exceptional circumstances.
CEEOPTS	Input	No, if you want English messages. Yes, if you want Japanese messages.	Specifies the language to be used for messages. See also <a href="#">“Specifying the language to be used for ABO messages” on page 36.</a>

## Optimizer directives

Use BOPT or IEFOPZ to direct ABO.

### BOPT

You can use the BOPT optimizer directive to produce optimized modules based on explicit input and output specifiers.



#### IN

Specifies one input module that you want to optimize or multiple input modules when wildcards are given in the *mem\_expr* specifier.

## OUT

Specifies one output module, or a PDS(E) for one or more output modules when the *mem* specifier is omitted.

## DD:ddname

Specifies a ddname.

## dsn

Is a data set name that must include the high-level qualifier.

## mem

Is a data set member name.

## mem\_expr

Is a data set member name that might include an expression. Only the members whose name string match the expression will be processed. Matching is case insensitive.

A regular expression accepts the following symbols:

**\***

Matches any string.

**?**

Matches any character.

**:**

Can be used as a separator for multiple expressions. With multiple expressions any expression matching the string counts as a match. The symbol (!) can also be used as a separator but is deprecated as it is only interpreted correctly in a few EBCDIC code pages.

For example:

- To optimize only members PROGA and PROGB:

```
IN=DD:SYSBIN(PROGA:PROGB)
```

**<>**

Negates the entire expression that follows it. The symbol (!) can also be used for negation but is deprecated as it is only interpreted correctly in a few EBCDIC code pages.

For example:

- To skip a single member named MEMA:

```
IN=DD:SYSBIN(<>MEMA)
```

- To skip all members whose names begin with MEMB:

```
IN=DD:SYSBIN(<>MEMB*)
```

- To skip members named MEMA and MEMB:

```
IN=DD:SYSBIN(<>MEMA:MEMB)
```

## path

Is a full HFS path that starts with a slash (/), for example, /home/user1/a.out.opt.

## optimizer\_option

Is an optimizer option. For a list of optimizer options that you can specify, see [“Optimizer options” on page 19](#).

## Notes:

1. The OUT option on BOPT is optional when the SCAN optimizer option is set to Y.
2. When *mem\_expr* is specified on the IN option, all members that match *mem\_expr* are selected for optimization. Do not include a *mem* specifier on the OUT option when *mem\_expr* is specified.

3. When there is no *mem* specifier on the OUT option, the member names for OUT are determined to be those that match the *mem* or *mem\_expr* specifier on the IN option.
4. The IN specifier, the OUT specifier, and optimizer options can be in any order.
5. Due to different character encodings across EBCDIC code pages the deprecated symbols (!) for expression separation and (!) for expression negation will only work properly in the following code pages:
  - IBM-1047
  - IBM-37/1140
  - IBM-285/1146
  - IBM-924
6. The symbols (!) and (!) are deprecated and may be removed in the future.

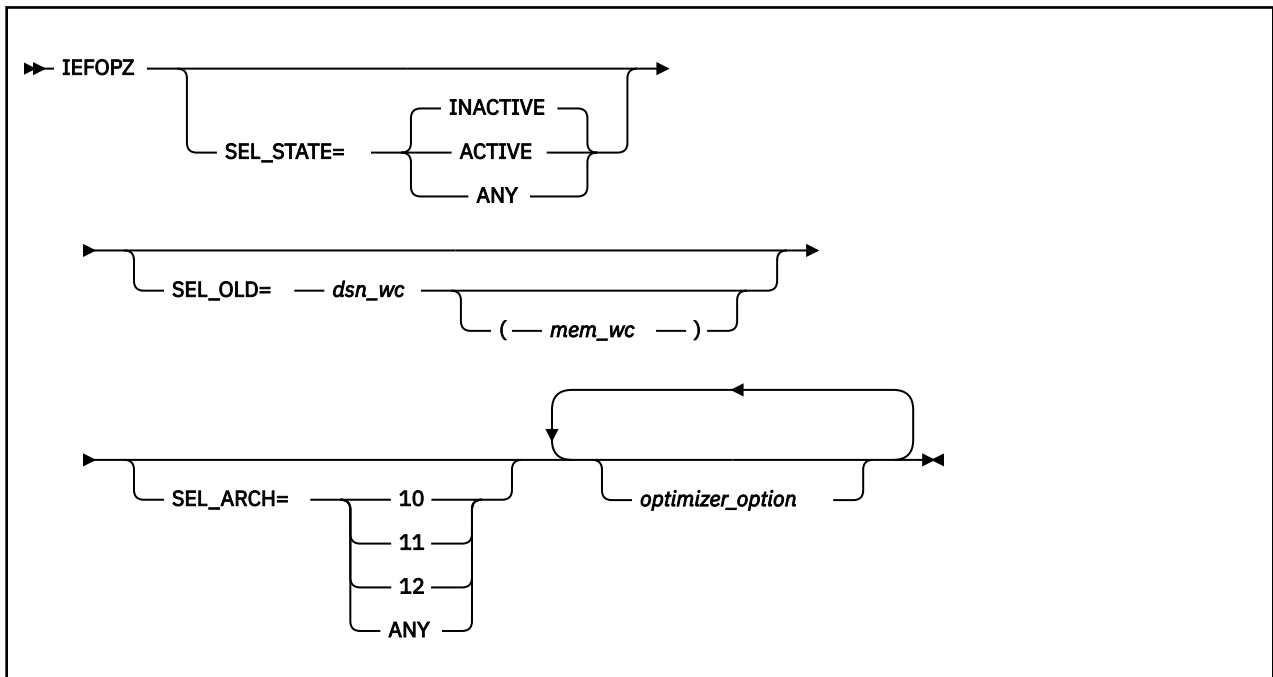
For examples of the BOPT directive see [“JCL examples”](#) on page 31. For sample scenarios of using the BOPT optimizer directive, see [“Scenario 1: Optimization process with static deployment”](#) on page 66 and [“Scenario 3: Optimization process using a hybrid approach”](#) on page 68.

## IEFOPZ

You can use the IEFOPZ optimizer directive to produce optimized modules based on the IEFOPZ configuration.

**Note:** IEFOPZ is only supported on z/OS V2.2 and later. On z/OS 2.2 the APAR/PTF OA47689/UA90982 must be applied.

For information about IEFOPZ configuration, see step 2 in [“Scenario 2: Optimization process with dynamic deployment”](#) on page 66.



### SEL\_STATE

Instructs the optimizer to optimize mappings that match the given state.

### ANY

Instructs the optimizer to optimize mappings marked as ACTIVE or INACTIVE.

### ACTIVE

Instructs the optimizer only to optimize mappings marked as ACTIVE.

### INACTIVE

Instructs the optimizer only to optimize mappings marked as INACTIVE.

**SEL\_OLD**

Restricts optimization to mappings with OLD data sets that match the given selector.

**dsn\_wc**

Is a data set name that might include wildcards using the asterisk (\*) symbol. For example, \*IN\*.LOAD.

**mem\_wc**

Is a data set member name that might include wildcards using the asterisk (\*) symbol. For example, M\*.

**SEL\_ARCH**

Instructs the optimizer to optimize mappings marked with the given architecture.

**10**

Instructs the optimizer only to optimize mappings marked as ARCH(10).

**11**

Instructs the optimizer only to optimize mappings marked as ARCH(11).

**12**

Instructs the optimizer only to optimize mappings marked as ARCH(12).

**ANY**

Instructs the optimizer to optimize mappings marked as ARCH(10), ARCH(11), or ARCH(12).

**optimizer\_option**

Is an optimizer option. For a list of optimizer options that you can specify, see [“Optimizer options” on page 19](#).

**Notes:**

1. Mapping refers to the association of OLD to NEW modules in the IEFOPZ configuration.
2. By default, all INACTIVE modules in OLD data sets of an IEFOPZ configuration are optimized at architecture levels as determined by NEW data sets and as determined by the IncludeMembers and ExcludeMembers configuration specifiers. The SEL\_OLD= and SEL\_ARCH= are selectors that can be used to restrict optimization or scanning to a subset of these modules.

The SEL\_STATE= is a selector that can be used to change optimization or scanning to ACTIVE modules or to modules of ANY state. While scanning of ACTIVE modules poses no risk, optimization of ACTIVE modules could cause problems for programs that use the ACTIVE modules. Care should be used with selectors SEL\_STATE=ACTIVE or SEL\_STATE=ANY and when optimization (as opposed to scanning) is performed.

3. The IN specifier, the OUT specifier, and optimizer options can be in any order.

For examples of the IEFOPZ directive see [“JCL examples” on page 31](#). For a sample scenario of using the IEFOPZ optimizer directive, see [“Scenario 2: Optimization process with dynamic deployment” on page 66](#).

## Optimizer options

---

An optimizer option is an Automatic Binary Optimizer for z/OS option that is applicable to both the BOPT and IEFOPZ optimizer directives.

Optimizer options can be placed at the start of the SYSIN file on one or more lines, or on the BOPT or IEFOPZ optimizer directives.

A global option is an optimizer option that is specified on a line that does not include a BOPT or IEFOPZ optimizer directive. The value of a global option is referred to as the global setting for the option.

When an optimizer option is specified on a particular line that has an optimizer directive, the value applies to that optimization optimizer directive only and reverts back to the global setting for subsequent statements.

[Table 7 on page 20](#) summarizes the optimizer options that apply to both BOPT and IEFOPZ.

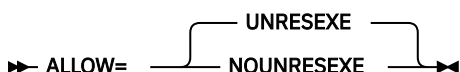
Table 7. Optimizer options

Option	Default	Description
<a href="#">“ALLOW” on page 20</a>	ALLOW=UNRESEXE	Controls the type of program modules that ABO will accept.
<a href="#">“ARCH” on page 21</a>	ARCH=10	Specifies the target hardware level.
<a href="#">“CSECT” on page 21</a>	If you do not specify the CSECT option, ABO will process all eligible CSECTs.	Allows the user to limit processing to one or more CSECTs.
<a href="#">“LIST” on page 24</a>	If you do not specify the LIST option, the listing transforms are placed in the location according to SYSPRINT DD.	Specifies the location of the generated listing transforms.
<a href="#">“LOG” on page 24</a>	If you do not specify the LOG option, ABO will not generate member-level log files.	Specifies the location of the member-level log files to be additionally generated.
<a href="#">“REPLACE” on page 25</a>	REPLACE=Y	Controls whether the output module is written or not.
<a href="#">“RTIBIND and the IBM Run Time Instrumentation Profiler” on page 26</a>	RTIBIND=N   NO	Controls whether to rebind with the RTI program modules.
<a href="#">“SCAN” on page 29</a>	SCAN=N	Controls whether to optimize or scan the program modules.
<b>Note:</b> The ARCH option can be specified at a global level and on the BOPT directive. It cannot be specified on the IEFOPZ directive. For IEFOPZ, use the SEL_ARCH option to select parts of an IEFOPZ configuration matching the SEL_ARCH value to optimize.		

## ALLOW

### Purpose

The ALLOW option controls the type of program modules that the Automatic Binary Optimizer for z/OS will accept.



### Default

ALLOW=UNRESEXE

### Usage

When ALLOW=UNRESEXE is specified, ABO accepts fully bound modules or partially bound modules. The only type of partially bound program modules accepted by the optimizer are those linked with the CALL=NO or NCAL binder option. If the input module is fully bound then the optimized output module will be fully bound. If the input module is partially bound then the optimized module will be partially bound.

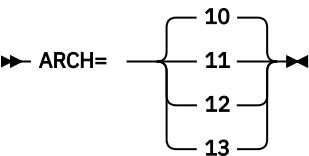
When ALLOW=NOUNRESEXE is specified, ABO only accepts fully bound program modules (program object or load module) and always produces a fully bound program module. If partially bound modules are processed when ALLOW=NOUNRESEXE is specified then message BOZ1494S is issued.



# ARCH

## Purpose

The ARCH option specifies the target hardware level.



## Default

ARCH=10

## Usage

Use the ARCH option to specify the hardware level that the optimized modules produced by ABO will target.

Optimized modules produced using a lower ARCH setting will run on a higher ARCH system. However optimized modules from a higher ARCH setting will not work on a lower ARCH system.

ARCH setting	Can only be run on IBM Z system
ARCH=10	zEC12, zBC12, z13, z13s, z14, z14 ZR1, z15, z15 T02
ARCH=11	z13, z13s, z14, z14 ZR1, z15, z15 T02
ARCH=12	z14, z14 ZR1, z15, z15 T02
ARCH=13	z15, z15 T02

If an invalid combination is attempted then the program is likely to terminate with the following runtime LE message:

```
CEE3201S The system detected an operation exception (System Completion Code=0C1)
```

For details of these ARCH levels, see [“Target hardware levels”](#) on page 4.

# CSECT

## Purpose

The CSECT option allows you to limit processing to zero or more CSECTs.

➤ CSECT= *expr* ➤

## Default

By default, if you do not specify the CSECT option, ABO processes all eligible CSECTs.

## Parameter

### *expr*

A regular expression for the CSECTs that you want to process. Only the CSECTs whose name string match the expression will be processed. Matching is case insensitive.

## Usage

A regular expression accepts the following symbols:

**\***

Matches any string.

**?**

Matches any character.

**:**

Can be used as a separator for multiple expressions. With multiple expressions any expression matching the string counts as a match. The symbol (|) can also be used as a separator but is deprecated as it is only interpreted correctly in a few EBCDIC code pages.

For example:

- To optimize only CSECTs PROGA and PROGB:

```
CSECT=PROGA:PROGB
```

**<>**

Negates the entire expression that follows it. The symbol (!) can also be used for negation but is deprecated as it is only interpreted correctly in a few EBCDIC code pages.

For example:

- To skip a single CSECT named PROGA:

```
CSECT=<>PROGA
```

- To skip all CSECTs whose names begin with PROGB:

```
CSECT=<>PROGB*
```

- To skip CSECTs named PROGA and PROGB:

```
CSECT=<>PROGA:PROGB
```

### Notes:

- Spaces and brackets are not allowed in a regular expression.
- An expression must match the entire string. A partial match does not count as a match. This means the expression M\*2 matches the string MA2 but not the string MA2A.
- Due to different character encodings across EBCDIC code pages the deprecated symbols (|) for expression separation and (!) for expression negation will only work properly in the following code pages:
  - IBM-1047
  - IBM-37/1140
  - IBM-285/1146
  - IBM-924
- The symbols (|) and (!) are deprecated and may be removed in the future.

### Example 1

In the following example, the CSECTs that do not match the wildcard filter are not processed.

JCL COMMAND

```
BOPT IN=DD:SYSBIN(*) OUT=DD:SYSBOUT CSECT=SUB*1*
```

OUTPUT (in OPTLOG)

```
10:46:04 Processing CSECT filter expression 'SUB*1*' on member CALLLITT
10:46:04 CSECT CALLLIT was excluded by filter - skip
10:46:04 Processing CSECT SUB01L00, in member CALLLITT
10:46:04 Optimizing CSECT SUB01L00 for zEC12
```

```

10:46:04      Succeeded in optimizing SUB01L00
10:46:04      Generating listing transform into DD:SYSPRINT
10:46:04      CSECT SUB02L00 was excluded by filter - skip
10:46:04      CSECT SUB03L00 was excluded by filter - skip
10:46:04      CSECT SUB04L00 was excluded by filter - skip
10:46:04      CSECT SUB05L00 was excluded by filter - skip
10:46:04      CSECT SUB06L00 was excluded by filter - skip
10:46:04      CSECT SUB07L00 was excluded by filter - skip
10:46:04      CSECT SUB08L00 was excluded by filter - skip
10:46:04      CSECT SUB09L00 was excluded by filter - skip
10:46:04      Processing CSECT SUB10L00, in member CALLLITT
10:46:04      Optimizing CSECT SUB10L00 for zEC12
10:46:04      Succeeded in optimizing SUB10L00
10:46:04      Generating listing transform into DD:SYSPRINT
10:46:04      Finished processing, processed 2 of 11 CSECTs in member CALLLITT

```

## Example 2

The following example shows how to specify multiple expressions for matching.

### JCL COMMAND

```
BOPT IN=DD:SYSBIN(*) OUT=DD:SYSBOUT CSECT=SUB01L00:SUB02L00
```

### OUTPUT

```

...
10:49:13      Processing CSECT filter expression 'SUB01L00:SUB02L00' on member CALLLITT
10:49:13      CSECT CALLLIT was excluded by filter - skip
10:49:13      Processing CSECT SUB01L00, in member CALLLITT
10:49:13      Optimizing CSECT SUB01L00 for zEC12
10:49:13      Succeeded in optimizing SUB01L00
10:49:13      Generating listing transform into DD:SYSPRINT
10:49:13      Processing CSECT SUB02L00, in member CALLLITT
10:49:13      Optimizing CSECT SUB02L00 for zEC12
10:49:13      Succeeded in optimizing SUB02L00
10:49:13      Generating listing transform into DD:SYSPRINT
10:49:13      CSECT SUB03L00 was excluded by filter - skip
10:49:13      CSECT SUB04L00 was excluded by filter - skip
10:49:13      CSECT SUB05L00 was excluded by filter - skip
10:49:13      CSECT SUB06L00 was excluded by filter - skip
10:49:13      CSECT SUB07L00 was excluded by filter - skip
10:49:13      CSECT SUB08L00 was excluded by filter - skip
10:49:13      CSECT SUB09L00 was excluded by filter - skip
10:49:13      CSECT SUB10L00 was excluded by filter - skip
10:49:13      Finished processing, processed 2 of 11 CSECTs in member CALLLITT

```

## Example 3

In the following example, MEM1 in dataset HLQ.IN.LOAD has two CSECTs named A1 and B1. To limit ABO processing to only A1, use a CSECT=A\* filter as follows:

### JCL COMMAND

```
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=HLQ.OUT.LOAD(MEM1) CSECT=A*
```

With this CSECT=A\* filter in place the OPTLOG looks like the following:

### OUTPUT

```

...
17:46:04      Processing CSECT filter expression 'A*' on member MEM1
17:46:04      Processing CSECT A1, in member MEM1
17:46:04      Optimizing CSECT A1 for zEC12
17:46:04      Succeeded in optimizing A1
17:46:04      Generating listing transform into DD:SYSPRINT
17:46:04      CSECT B1 was excluded by filter - skip
17:46:04      Finished processing, processed 1 of 2 CSECTs in member MEM1
...

```

Alternatively CSECT=A\* can be specified as a global option so it applies to all subsequent BOPT and IEFOPZ directives unless overridden by a particular directive:

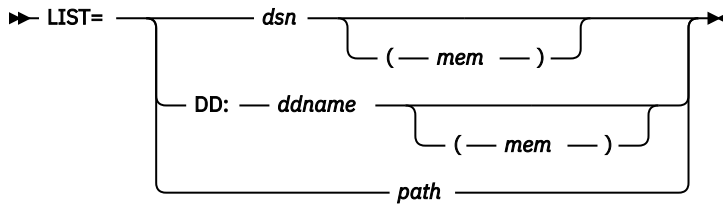
```
//SYSIN DD *
      CSECT=A*
      BOPT IN=HLQ.IN.LOAD(MEM1) OUT=HLQ.OUT.LOAD(MEM1A)
      BOPT IN=HLQ.IN.LOAD(MEM1) OUT=HLQ.OUT.LOAD(MEM1B) CSECT=B*
```

After processing, the member MEM1A will contain the optimized CSECT A1 and the original CSECT B1, and member MEM1B will contain the optimized CSECT B1 and the original CSECT A1.

## LIST

### Purpose

The LIST option specifies the location of the generated listing transforms.



### Default

By default, if you do not specify the LIST option, the listing transforms are placed in the location according to SYSPRINT DD.

### Parameters

#### *dsn*

Is a data set name that must include the high-level qualifier.

#### *mem*

Is a data set member name.

#### **DD:***ddname*

Specifies a ddname.

#### *path*

Is a full HFS path that starts with a slash (/), for example, /home/user1/a.list.

### Usage

The target of the LIST option can be one of the following items:

- A sequential data set or member of a PDSE (not PDS). The output of multiple CSECT optimizations are added to this single sequential data set.
- A PDS or PDSE. When a CSECT is optimized, the listing transform particular to that CSECT is placed in a member of the PDS or PDSE where the member name is based on the CSECT name (upper cased and truncated to 8 characters). The contents of the member, if any, are overwritten even if the former contents are produced by the optimizer in previous invocations.
- An HFS path. The output of multiple CSECT optimizations are added to this HFS file.

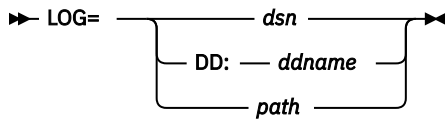
### Related information

[SYSPRINT DD.](#)

## LOG

### Purpose

The LOG option specifies the location of the member-level log files to be additionally generated.



## Default

By default, if you do not specify the LOG option, ABO will not generate member-level log files. Note that regardless of the LOG option the output from the entire ABO invocation will always be generated in the location according to OPTLOG DD.

## Parameters

### *dsn*

Is a data set name that must include the high-level qualifier.

### **DD:***ddname*

Specifies a ddname.

### *path*

Is a full HFS path that starts with a slash(/).

## Usage

The target of the LOG option can be one of the following items:

- A PDS or PDSE. When a member is optimized, the log output particular to that member is placed in a member of the PDS or PDSE where the member name is based on the optimized member name (upper-cased and truncated to 8 characters). The contents of the member, if any, are overwritten even if the former contents were produced by ABO in previous invocations.
- An HFS path pointing to a directory. When a member is optimized, the log output particular to that member is placed in a file in the specified HFS directory where the file name is based on the optimized member name appended with `.log`. The contents of the member, if any, are overwritten even if the former contents were produced by ABO in previous invocations.

## Notes:

1. The target of the LOG option must be either a PDS or PDSE with no member specified, or an HFS path that points to a directory. If the target of the LOG option is specified as a PDS or PDSE with a member specified, a sequential data set, or an HFS file, an error message will be issued.
2. The target data set of the LOG option should follow the recommended allocation parameters of the OPTLOG in [Table 12 on page 75](#).

### Example 1

```
BOPT IN=DD:SYSBIN(*) OUT=DD:SYSBOUT LOG=HLQ.LOG.OUT
```

### Example 2

```
BOPT IN=DD:SYSBIN(*) OUT=DD:SYSBOUT LOG=DD:LOG
```

### Example 3

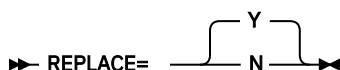
```
BOPT IN=DD:SYSBIN(*) OUT=DD:SYSBOUT LOG=/home/user1/logdir
```

For more information, see [“Log files” on page 43](#).

# REPLACE

## Purpose

Controls whether the output module is written or not.



## Default

REPLACE=Y

## Usage

When REPLACE=Y and SCAN=N, the optimized module is written to the output module regardless of whether the output module exists.

- If the output module does not exist, the output module will be created and written.
- If the output module already exists, its content will be overwritten.

However, if there are no eligible COBOL CSECTs present that can be optimized, nothing is written to the output module.

When REPLACE=N is specified, optimization or scanning of the input module is bypassed if the output module already exists; nothing is written to the output module.

You can use REPLACE=N to bypass optimization for already optimized modules. For example, if after binary optimization, you add new members to the original data sets and you want to optimize only the new members, you can use a member wildcard with REPLACE=N as follows:

```
BOPT IN=HLQ.IN.LOAD(*) OUT=HLQ.OUT.LOAD REPLACE=N
```

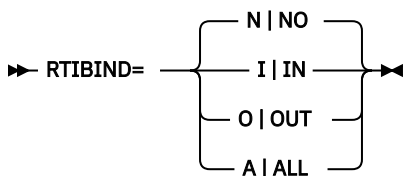
In some cases, the optimizer prematurely terminates because of exceeded time or other abnormal conditions. To solve the problem, you can incrementally build the optimized modules in a sequence of jobs without spending time repeating optimizations done in an earlier job. Or you can use REPLACE=N in these cases.

## RTIBIND and the IBM Run Time Instrumentation Profiler

The IBM Run Time Instrumentation (RTI) Profiler is a performance analysis tool to collect and report on the execution time CPU performance characteristics of your batch z/OS applications.

The RTIBIND option controls whether to rebind your modules with the RTI program modules to enable the RTI performance profiling reports to be generated when the program runs.

All the Language Environment (LE) CSECTs in your application can be bound with the RTI program modules to enable profiling in order to get a complete picture of overall CPU performance. This includes programs compiled by the IBM COBOL, C/C++ and PL/I compilers as well as COBOL programs optimized by ABO. The time spent in any LE library routines is also collected and reported.



## Default

RTIBIND=N | NO

## Usage

When RTIBIND=N | NO is specified, ABO optimizes any eligible CSECTs as usual, and does not rebind any of the input program modules with the RTI program modules.

When RTIBIND=I | IN is specified, ABO does not perform any optimizations, but only rebinds all the input program modules with the RTI program modules (that is, rebind the modules specified by the BOPT IN= directive).

When RTIBIND=O | OUT is specified, ABO optimizes any eligible CSECTs as usual, and rebinds any input program modules that have at least one eligible CSECT optimized with the RTI program modules (that is, rebind the modules optimized and placed in the location specified by the BOPT OUT= directive).

When RTIBIND=A | ALL is specified, ABO optimizes any eligible CSECTs as usual, and rebinds these optimized modules plus any input modules that are not optimized, with the RTI program modules (that is, rebind the union of all the modules specified by BOPT IN= and OUT= directives).

### New SYSLIB requirement for the JCL used to invoke ABO

When specifying RTIBIND=I | O | A, the JCL used to invoke ABO requires an additional DD name, SYSLIB, to be present (see Appendix A, “JCL sample,” on page 75)

```
//SYSLIB DD DSN=hlqboz.BOZ210.SBOZMOD1,DISP=SHR <- ABO install location
//      DD DSN=hlqcee.SCEELKED,DISP=SHR
//      DD DSN=hlqcee.SCEELKEX,DISP=SHR
```

If the SYSLIB DD is not specified when required, the severe message BOZ1426S is issued:

```
BOZ1426S Link library "SYSLIB" not specified or does not specify a PDS(E).
```

### Capturing profiling results during program execution

Before using the RTI Profiler enabled modules, you must allocate a PDS or PDSE dataset in order to hold the profiling results. The RTI Profiler generated report is stored into a member of this dataset. In the following JCL examples, this dataset is named hlq.SYSPROFD.

The following table shows the recommended allocation parameters for hlq.SYSPROFD.

Table 8. Recommended allocation parameters	
Data sets	Recommended allocation parameters
hlq.SYSPROFD (as a PDS)	Space units : CYLINDER Primary quantity : 10 Secondary quantity : 10 Directory blocks : 10 Record format : FB Record length : 80 Block size : 27920 Data set name type PDS
hlq.SYSPROFD (as a PDSE)	Space units : CYLINDER Primary quantity: 10 Secondary quantity : 10 Directory blocks : 10 Record format : FB Record length : 80 Block size : 27920 Data set name type LIBRARY

In addition, when running the application containing the RTI rebound modules there are two modifications required to your run step JCL in order to collect the profile.

In your existing JCL for executing your program:

- Add the ABO install location, for example hlqboz.BOZ210.SBOZMOD1, to the existing STEPLIB
- Add the DDNAME SYSPROFD as the location to receive the profiling results

Below is a JCL example for this step:

```
//GO EXEC PGM=pgmname
//STEPLIB DD DSN=hlq.OUT.LOAD.RTI,DISP=SHR <- the RTI rebound modules from ABO
//      DD DSN=hlqboz.BOZ210.SBOZMOD1,DISP=SHR <- add ABO install location
//SYSPROFD DD DSN=hlq.SYSPROFD(pgmname),DISP=SHR <- add SYSPROFD DD
```

When program execution completes, the profiling results are contained in hlq.SYSPROFD(pgmname).

If SYSPROFD is not added in the execution step, the message RIDATA: OPENING SYSPROFD FAILED is generated to the job log. Also, the abend code ABEND=S000 U1130 REASON=00000000 is produced.

### **Understanding the RTI Profiler Results**

The output of the RTI Profiler is a text file containing details per compiled or optimized module and CSECT where the program is spending its time while running. There is a high-level summary provided as well as a breakdown of timing samples down to the offsets within each CSECT. For more detailed information, see [Run Time Instrumentation report](#).

In conjunction with the corresponding compiler or ABO listing files for the programs being profiled, the RTI Profiler output can help determine specific parts of your program, down to the machine instruction, where there may be opportunities for improving application CPU performance.

An IBM support or development representative may also request the RTIBIND option be used and an RTI Profile be collected, and its output sent to IBM along with other artifacts (e.g. listing files) from the original compilation or optimization of your programs to aid in performance investigations.

### **RTI Profiler hardware and software prerequisites**

The supported z/OS versions for using the RTI Profiler are:

- z/OS Version 2.4
- z/OS Version 2.3
- z/OS Version 2.2

The supported IBM Z systems for using the RTI Profiler enabled modules are zEC12 and later: zEC12, zBC12, z13, z13s, z14, z14 ZR1, z15, and z15 T02.

### **RTI Profiler capabilities and restrictions**

The RTI Profiler is best suited for in-depth CPU profiling of LE enabled batch applications but does not provide other system-level performance metrics such as wait times, I/O performance or DASD usage.

The RTI Profiler can be used on all LE enabled batch applications including IMS batch and batch programs that interact with Db2®. Running non-LE programs that have been rebound with the RTI program modules is not supported and the result is unpredictable.

The RTI Profiler does not work for CICS® applications and is not supported for any application that is part of a non-batch IMS environment.

The RTI Profiler will not work if your z/OS operating system is running on z/VM®. If run on z/VM guest, the message RISTART: AUTH REQUEST FAILED is output to the job log.

The RTI Profiler does not provide CSECT level details for modules in LPA or that are managed by LLA. Profiling sample information will only be reported at the module level for these cases.

If you require more complete and full featured application profiling, we recommend using a profiling tool such as [Application Performance Analyzer for z/OS in ADFz](#).

### **Notes:**

1. SCAN=Y takes precedence over the RTIBIND option settings. Specifying SCAN=Y disables rebinding with the RTI program modules and optimization of any eligible CSECTs regardless of the RTIBIND option.
2. When processing a module originally linked with the AMODE 24 or RMODE 24 option and then processed by ABO with the RTIBIND=I | O | A option, the warning message BOZ1490W is expected. The BOZ1490W message reflects an AMODE/RMODE conflict due to rebinding with the AMODE 31 RTI modules. The message has no impact on the original module execution. The program will still run correctly in the original AMODE 24 or RMODE 24 mode.
3. The RTIBIND option is the most convenient way to enable modules for RTI profiling. However, if you require more low-level control of the rebinding process, see [Appendix E, “Manual RTI rebinding instructions,”](#) on page 99.



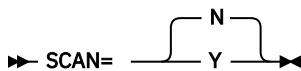
4. If the program to be profiled was compiled using VS COBOL II or an ABO optimized VS COBOL II compiled program, an extra step might be needed to rebind the module to replace the bootstrap routine IGZEBST with the current version from LE. If you do not see any profiling output at the SYSPROFD location after using RTIBIND and attempting to profile VS COBOL II or an ABO optimized VS COBOL II compiled program, follow the steps below to replace the IGZEBST routine before using RTIBIND (or before following the manual rebinding steps) to enable the module for RTI profiling.

```
//LKED EXEC PGM=IEWL,PARM='options' <- original link options
//SYSLIB DD DSN=hlqcee.SCEELKED,DISP=SHR
// DD DSN=hlqcee.SCEELKEX,DISP=SHR
//LOAD DD DISP=SHR,DSN=&LOAD <- original module that will be linked with new IGZEBST
//SYSLMOD DD DISP=SHR,DSN=&SYSLMOD(pgmname) <- output module location
//SYSPRINT DD SYSOUT=*
//SYSLIN DD *
  INCLUDE SYSLIB(IGZEBST) <- new bootstrap to include from CEE
  INCLUDE LOAD(pgmname) <- original member from LOAD to link new parts into
  REPLACE -IMMED,IGZEBST <- bootstrap member to replace
  ENTRY pgmname
  NAME pgmname(R)
/*
```

## SCAN

### Purpose

The SCAN option instructs ABO whether to optimize or to scan the program modules



### Default

SCAN=N

### Usage

When SCAN=N is in effect, ABO performs optimization on the input program modules.

When SCAN=Y is in effect, ABO scans the input program modules instead of performing optimization. No output modules are produced.

The REPLACE=N option can affect whether scanning is performed:

- If REPLACE=N is specified on the BOPT directive and the output module on the OUT option already exists, scanning of the module on the IN option is bypassed.
- If REPLACE=N is specified on the IEFOPZ directive, scanning of the member of the OLD data set is bypassed if the member of the NEW data set already exists.

If you exclude the OUT option on the BOPT directive, scanning is always performed regardless of the value of the REPLACE option.

In the scanning mode, the optimizer checks the input and output program modules, and lists the CSECTs in the modules. Scanning output is written to the OPTLOG DD.

You can use SCAN=Y to test the SYSIN setup or to see what modules are present and their contents. If the program is ineligible for optimization due to the original compiler used, this is also indicated in the scanning output.

For more information, see [“The log file for scanning”](#) on page 44.

## Comments

A comment is specified by starting with the (#) character.

When using the (#) character, the following rules apply:

- If the first non-blank character on a line of the SYSIN file is the (#) character, the rest of the line is ignored.
- If ABO sees a (#) character, which is preceded by a blank, on an input line of SYSIN file, the rest of the line is ignored.

#### Example 1

```
#BOPT IN=DD:SYSBIN OUT=SYSBOUT
#BOPT IN=SYSBIN OUT=SYSBOUT
```

In example 1, both of the BOPT directives are commented out. On the first line, the # character is in column 1 and the rest of the line is ignored. On the second line, the first non-blank character is the # character and the rest of the line is ignored.

#### Example 2

```
# Optimizing all members of library
# Note: we don't compile a member optimized earlier and found in the OUT dataset
BOPT IN=SYSBIN(*) OUT=SYSBOUT REPLACE=N
```

Example 2 shows adding two full lines of informational comments to the SYSIN file.

#### Example 3

```
BOPT IN=SYSBIN(*) OUT=SYSBOUT #
```

In example 3, the # character at the end of a line is ignored.

#### Example 4

```
BOPT IN=SYSBIN(*) OUT=SYSBOUT #optimizing library files
```

Example 4 shows adding a comment after a directive.

## Line continuation

Line continuation in a SYSIN file is specified by the (+) or (-) continuation character, which indicates the next line should be read as if it were a part of the previous line. Line continuation is not required but can be used to break up long lines to simplify editing or to ease consumption by other tooling that may have line length restrictions.

The (+) or (-) continuation character must be the last non-blank and non-comment character on a line. When using the continuation characters, the following rules apply:

- The (-) character can only be used to continue a line following complete options, directives, or specifiers. Line continuation begins at column 1 on the next line. The (-) character must be preceded by one or more blanks.
- The (+) character can be used to continue a line following complete options, directives, or specifiers, or in the middle of options, directives, or specifiers. Line continuation begins with the first non-blank character on the next line. When continuing complete options, directives, or specifiers, the (+) character must be preceded by one or more blanks.
- Blanks that precede the line continuation character will be included in the concatenated line.
- The comment character (#) takes precedence over the line continuation character. If a line continuation character is part of a comment, it will be ignored as part of that comment and not continue the comment.

An error message might be issued if the continuation character is in an unexpected position.

These examples show the JCL using the BOPT optimizer directive. The examples are not full examples. They are intended to reflect what the user should specify in the SYSIN file. For basic JCL configuration, see [Appendix A, “JCL sample,” on page 75](#).

#### Example 1

```
//SYSIN DD *
ARCH=11 -
ALLOW=UNRESEXE
```

```
BOPT IN=HLQ.LOAD.APPXYZ1.Orig(*) -
OUT=HLQ.LOAD.APPXYZ1.ABO
```

This example is interpreted by ABO as the following:

```
//SYSIN DD *
ARCH=11 ALLOW=UNRESEXE
BOPT IN=HLQ.LOAD.APPXYZ1.Orig(*) OUT=HLQ.LOAD.APPXYZ1.ABO
```

Note that blanks preceding the continuation character are included in the concatenated string in all cases.

### Example 2

```
//SYSIN DD *
                                AR+
                                CH=12 +
                                ALLOW=UNRESEXE

BOPT IN=HLQ.LOAD.APPXYZ1.Orig+
IG(*) -
OUT=HLQ.LOAD.APPXYZ1.ABO
```

This example shows how the (+) character allows continuing wherever desired on the next line (at the first non-blank) instead of only at column 1, and how the (+) character can be used to continue an option, directive, or specifier that is not complete. This example is interpreted by ABO as the following:

```
//SYSIN DD *
ARCH=12 ALLOW=UNRESEXE
BOPT IN=HLQ.LOAD.APPXYZ1.Orig(*) OUT=HLQ.LOAD.APPXYZ1.ABO
```

### Example 3

```
//SYSOPTF DD *
# some comment +
                                ARCH=12 + #other comment -
                                ALLOW=UNRESEXE
BOPT IN=HLQ.LOAD.APPXYZ1.Orig(*) OUT=HLQ.LOAD.APPXYZ1.ABO
```

(1)  
(2)  
(3)  
(4)

This example is processed by ABO as the following:

```
//SYSOPTF DD *
ARCH=12 ALLOW=UNRESEXE
BOPT IN=HLQ.LOAD.APPXYZ1.Orig(*) OUT=HLQ.LOAD.APPXYZ1.ABO
```

The (+) character on line 1 and the (-) character on line 2 are ignored because they are part of comments. The (+) character on line 2 is treated as line continuation character because it is the last non-comment and non-blank character on the line.

## JCL examples

You can use the job control language (JCL) statements that are shown in these examples to process compiled COBOL modules with the Automatic Binary Optimizer for z/OS.

### Specifying optimization with BOPT

These examples show the JCL using the BOPT optimizer directive.

The examples in this section are not full examples. They are intended to reflect what the user should specify in the SYSIN file. For basic JCL configuration, see [Appendix A, “JCL sample,” on page 75](#).

#### Example 1. Specifying I/O modules using data set names

In this example, input and output modules are determined by the BOPT line. Input and output data set names are given precisely rather than specified in ddnames.

```
//SYSIN DD *
```

```
ARCH=12
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=HLQ.OUT.LOAD(MEM1)
```

### Example 2. Specifying I/O modules using ddnames

In this example, input and output modules are specified using ddnames.

```
...
//SYSBIN DD DSN=HLQ.IN.LOAD,DISP=SHR
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
ARCH=12
BOPT IN=DD:SYSBIN(MEM1) OUT=DD:SYSBOUT(MEM1)
```

### Example 3. Specifying I/O modules using HFS paths

In this example, the input and output modules are specified using HFS paths. You must use fully qualified HFS paths that start with a slash (/).

```
...
//SYSIN DD *
ARCH=12
BOPT IN=/home/user1/a.out OUT=/home/user1/a.out.opt
```

### Example 4. Specifying an input module and omitting the output member specifier

In this example, an input module is specified and the output member specifier is omitted. The member name in the output PDS(E) for the optimized module will be the same name as the specified member of the input PDS(E).

```
...
//SYSBIN DD DSN=HLQ.IN.LOAD,DISP=SHR
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
ARCH=10
BOPT IN=DD:SYSBIN(MEM1) OUT=DD:SYSBOUT
```

### Example 5. Specifying multiple input modules using an expression

In this example, multiple input modules are specified using an expression. The member name in the output PDS(E) for an optimized module will be the same name as the corresponding member of the input PDS(E).

To include modules with names that start with MEM:

```
...
//SYSBIN DD DSN=HLQ.IN.LOAD,DISP=SHR
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
ARCH=10
BOPT IN=DD:SYSBIN(MEM*) OUT=DD:SYSBOUT
```

To exclude a single module named MEMA:

```
...
//SYSBIN DD DSN=HLQ.IN.LOAD,DISP=SHR
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
ARCH=10
BOPT IN=DD:SYSBIN(<>MEMA) OUT=DD:SYSBOUT
```

To exclude all members whose names begin with MEMB:

```
...
//SYSBIN DD DSN=HLQ.IN.LOAD,DISP=SHR
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
```

```

ARCH=10
BOPT IN=DD:SYSBIN(<>MEMB*) OUT=DD:SYSBOUT

```

To exclude members named SUB1 and SUB2:

```

...
//SYSBIN DD DSN=HLQ.IN.LOAD,DISP=SHR
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
ARCH=10
BOPT IN=DD:SYSBIN(<>SUB1:SUB2) OUT=DD:SYSBOUT

```

### Example 6. Specifying multiple input modules by using multiple BOPT optimizer directives

In this example, multiple input modules are specified using multiple BOPT optimizer directives:

```

...
//SYSIN DD *
ARCH=10
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=HLQ.OUT.LOAD(MEM1)
BOPT IN=HLQ.IN.LOAD(MEM5) OUT=HLQ.OUT.LOAD(MEM5)

```

### Example 7. Bypassing optimizations or scans with the REPLACE option

In this example, the REPLACE option is used. REPLACE=N bypasses optimization or scanning if the associated output modules already exist. In this example, the optimizer performs optimization in the first and third BOPT directives. The optimizer bypasses optimization in the second BOPT directive and scanning in the last BOPT directive REPLACE=N is specified, and the output modules were created in the first and third BOPT directives.

```

...
//SYSIN DD *
ARCH=10
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=HLQ.OUT.LOAD(MEM1) REPLACE=Y
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=HLQ.OUT.LOAD(MEM1) REPLACE=N
BOPT IN=HLQ.IN.LOAD(*) OUT=HLQ.OUT.LOAD REPLACE=Y
BOPT IN=HLQ.IN.LOAD(*) OUT=HLQ.OUT.LOAD SCAN=Y REPLACE=N

```

### Example 8. Specifying global and local optimizer options

In the example, global and local options are used. ARCH=11 and REPLACE=N apply to the first BOPT directive; ARCH=10 and REPLACE=Y apply to the second BOPT directive.

```

...
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
ARCH=10 REPLACE=N
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=DD:SYSBOUT(MEM1) ARCH=11
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=DD:SYSBOUT(MEM1) REPLACE=Y

```

### Example 9. Switching to scan mode by using global SCAN

The following example changes the mode from optimizing input modules to scanning input modules using the global option SCAN. In this scan mode, output modules are not written. The OUT option is processed, for example for correct syntax, but otherwise ignored. For details about the SCAN option, see [“SCAN” on page 29](#).

The optimizer reverts back to the optimization mode for the second BOPT directive.

```

...
//SYSBOUT DD DSN=HLQ.OUT.LOAD,DISP=SHR
//SYSIN DD *
ARCH=11 SCAN=Y
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=DD:SYSBOUT(MEM1)
BOPT IN=HLQ.IN.LOAD(MEM1) OUT=DD:SYSBOUT(MEM1) SCAN=N

```

### Example 10. Specifying ALLOW options

This example shows a global setting of ALLOW=NOUNRESEXE being specified with a local override for the second BOPT directive.

The first (MEM1) and third (MEM3) BOPT directives are done using ALLOW=NOUNRESEXE meaning that only fully bound program modules will be accepted. If a partially bound program module is encountered then the BOZ1494S message will be issued.

The second (MEM2) BOPT directive is done using ALLOW=UNRESEXE so both fully and partially bound program modules are accepted as input.

```
...  
//SYSBOUT DD DSN=HLQ. OUT. LOAD, DISP=SHR  
//SYSIN DD *  
  ARCH=11 ALLOW=NOUNRESEXE  
  BOPT IN=HLQ. IN. LOAD (MEM1) OUT=DD:SYSBOUT (MEM1)  
  BOPT IN=HLQ. IN. LOAD (MEM2) OUT=DD:SYSBOUT (MEM2) ALLOW=UNRESEXE  
  BOPT IN=HLQ. IN. LOAD (MEM3) OUT=DD:SYSBOUT (MEM3)
```

## Specifying optimization with IEFOPZ

These examples show the JCL using the IEFOPZ optimizer directive.

The examples in this section are not full examples. They are intended to reflect what the user should specify in the SYSIN file. For basic JCL configuration, see [Appendix A, “JCL sample,” on page 75](#).

### Example 1. Single ARCH configuration

This example shows the minimal JCL for running ABO with the IEFOPZ directive.

You can use this JCL when your IEFOPZ configuration includes only one ARCH level.

```
...  
//SYSIN DD *  
  IEFOPZ
```

### Example 2. Multiple ARCH configuration

If your IEFOPZ configuration includes more than one ARCH level, specify separate IEFOPZ directives lines to avoid listing file name collisions.

```
...  
//SYSIN DD *  
  IEFOPZ SEL_ARCH=11 LIST=HLQ. OUT1. ARCH11. LIST  
  IEFOPZ SEL_ARCH=12 LIST=HLQ. OUT1. ARCH12. LIST
```

### Example 3. Restricting optimization using the SEL\_STATE and SEL\_ARCH selectors

The following example produces optimized modules for those OLDNEW mappings that are marked as INACTIVE. As with example 2, if mappings have more than one ARCH level, the LIST option is used to avoid listing file name collisions.

```
...  
//SYSIN DD *  
  IEFOPZ SEL_STATE=INACTIVE SEL_ARCH=10 LIST=HLQ. OUT. ARCH10. LIST  
  IEFOPZ SEL_STATE=INACTIVE SEL_ARCH=11 LIST=HLQ. OUT. ARCH11. LIST
```

### Example 4. Restricting optimization using the SEL\_OLD selector

The following example produces optimized modules for members of OLD data sets that match given patterns.

In the first line, optimized modules will be produced for all members of HLQ.IN.LOAD.

In the second line, optimized modules will be produced for data set members that match M\* in OLD data sets matching HLQ.IN.\*. REPLACE=N is specified on the second line to avoid re-optimizing modules from the first line.

```
//SYSIN DD *  
IEFOPZ SEL_OLD=HLQ.IN.LOAD  
IEFOPZ SEL_OLD=HLQ.IN*.*(M*) REPLACE=N
```

## Recommended settings for the z/OS JCL REGION and JCL MEMLIMIT parameters

---

### ABO optimization techniques

To generate high performing optimized modules, beyond those possible from Enterprise COBOL V4 and earlier, ABO performs advanced analysis and uses code optimization techniques that require substantial machine resources.

In addition, since ABO is easily invoked on many compiled programs at once, the overall resources can be high due to the amount of processing requested. An entire data set, potentially composed of many modules, where each module can itself contain many compiled programs (CSECTs), can be optimized in bulk using ABO. Therefore, the total resources required by ABO for optimizing hundreds or thousands of compiled programs at once will be higher compared to a compilation process that is operating on a single source file at a time.

The time and memory required to optimize a module is based on the following factors:

- The number of CSECTs in the module.
- The complexity of each CSECT. Complexity is impacted by both the size of the compiled PROCEDURE DIVISION statements and also by the size of the input program's DATA DIVISION.

### Setting the z/OS JCL REGION and JCL MEMLIMIT parameters appropriately

As shown in the [Appendix A, “JCL sample,”](#) on [page 75](#), the JCL REGION parameter should be set to 0M to allow ABO the memory it requires to operate.

ABO will use storage above the 2 GB BAR to optimize large CSECTs. This means that the z/OS MEMLIMIT parameter should be set to a high enough value in order to allow ABO processing to complete successfully.

The recommended REGION setting of 0M will set MEMLIMIT to NOLIMIT. However, this NOLIMIT value may have been overridden to a lower value by a MEMLIMIT setting on JOB or EXEC statements or by the exit routine IEFUSI. The amount of storage required by ABO will depend on the number and size of CSECTs being optimized.

If MEMLIMIT=NOLIMIT has been overridden to a lower value and this MEMLIMIT setting is not high enough, you may get one of these ABO messages:

```
BOZ1145U Insufficient memory in the compiler to continue compilation.  
BOZ1428U Insufficient memory encountered during binder API "&1": return code=&2  
         reason code=&3. Terminating optimizer.  
BOZ1449U Unhandled out of memory exception
```

A MEMLIMIT setting of 10GB or more may be required for optimizing very large CSECTs, or a high number of smaller CSECTs. If any of the ABO BOZ1145U, BOZ1428U or BOZ1449U messages are encountered then increase the MEMLIMIT setting to a higher value.

For more information on JCL REGION and JCL MEMLIMIT parameters, see the [z/OS MVS Initialization and Tuning Reference](#) and the [z/OS MVS Initialization and Tuning Guide](#).

## Specifying the language to be used for ABO messages

The CEEOPTS DD is used to specify the language for ABO produced messages.

By default, messages are in English. To specify that you want Japanese messages, add the following code to your JCL:

```
//CEEOPTS DD *  
                NATLANG(JPN)  
/*
```

## Invoking ABO from TSO, REXX and assembler code

This section describes how to invoke ABO from TSO, REXX and the assembler.

### Optimizing under TSO

Under TSO, you can use TSO commands, command lists (CLISTs), REXX execs, or ISPF to optimize COBOL programs using traditional MVS data sets. You can use TSO commands or REXX execs to optimize programs using z/OS UNIX files.

With each method, you need to allocate the data sets and request the optimization following these steps:

1. Use the ALLOCATE command to allocate data sets. You can allocate data sets in any order. However, you must allocate all needed data sets before you start to optimize.
2. Provide the optimizer parameters within your SYSIN data set.
3. Use the CALL command at the READY prompt to request optimization:  
CALL 'hlqboz.SBOZMOD1(BOZOPT)'

You can specify the ALLOCATE and CALL commands on the TSO command line, or, if you are not using z/OS UNIX files, you can include them in a CLIST.

You can allocate z/OS UNIX files for all the optimizer data sets if they are not PDS or PDSE libraries. For example, if ABO parameters are stored in the UNIX file /u/myu/abo.parms, then the ALLOCATE statements have the following form:

```
Allocate File(SYSIN) Path('/u/myu/abo.parms') Pathopts(ORDONLY) Filedata(TEXT)
```

### ALLOCATE and CALL for optimizing under TSO

The following example shows how to specify the ALLOCATE and CALL commands when you are optimizing under TSO. Notice that all the files can be either new or existing ones, except the input files SYSIN and SYSBIN that must exist before optimization starts.

```
[READY]  
FREE F(SYSPRINT SYSIN OPTLOG OPTERR CEEDUMP SYSBIN  
SYSBOUT)  
[READY]  
ALLOC F(SYSPRINT) DA(ABO.LISTING) SPACE(10,10) CYL NEW CATALOG RECFM(V B) LRECL(512)  
BLKSIZE(27998) DSORG(PS)  
[READY]  
ALLOC FI(OPTLOG) DA(ABO.OPTLOG) SPACE(10,10) CYL NEW CATALOG RECFM(V B) LRECL(512)  
BLKSIZE(27998) DSORG(PS)  
[READY]  
ALLOC FI(OPTERR) DA(ABO.OPTERR) SPACE(10,10) CYL NEW CATALOG RECFM(V B) LRECL(512)  
BLKSIZE(27998) DSORG(PS)  
[READY]  
ALLOC FI(CEEDUMP) DA(ABO.CEEDUMP) SPACE(50,10) CYL NEW CATALOG RECFM(F B) LRECL(133)  
BLKSIZE(27930) DSORG(PS)  
[READY]  
ALLOC FI(SYSIN) DA(ABO.SYSIN) SHR /* supply ABO parameters within SYSIN file  
*/  
[READY]  
ALLOC FI(SYSBIN) DA(IN.LOAD) SHR /* supply COBOL load library to be optimized */  
[READY]
```



```

ALLOC FI(SYSBOUT) DA(OUT.LOAD) SHR          /* supply load library for optimized load modules */
[READY]
CALL 'hlqboz.SBOZMOD1(BOZOPT)'
[READY]
FREE F(SYSPRINT SYSIN OPTLOG OPTERR CEEDUMP SYSBIN SYSBOUT)

```

## CLIST for optimizing under TSO

The following example shows a CLIST for optimizing under TSO:

```

PROC 1 HLQBOZ
FREE F(SYSPRINT SYSIN OPTLOG OPTERR CEEDUMP SYSBIN
SYSBOUT)
ALLOC FI(SYSPRINT) DA(ABO.LISTING) SHR
ALLOC FI(SYSIN) UNIT(SYSDA) SPACE(1,0) TRACKS NEW +
RECFM(F B) LRECL(80) BLKSIZE(800) DSORG(PS)
OPENFILE SYSIN OUTPUT
SET SYSIN = &STR(BOPT IN=DD:SYSBIN(MEMBER) OUT=DD:SYSBOUT(MEMBER))
PUTFILE SYSIN
CLOSEFILE SYSIN
ALLOC FI(OPTLOG) DA(ABO.OPTLOG) SHR
ALLOC FI(OPTERR) DA(ABO.OPTERR) SHR
ALLOC FI(CEEDUMP) DA(ABO.CEEDUMP) SHR
ALLOC FI(SYSBIN) DA(IN.LOAD) SHR
ALLOC FI(SYSBOUT) DA(OUT.LOAD) SHR
CALL '&HLQBOZ..SBOZMOD1(BOZOPT)'
FREE F(SYSIN SYSPRINT OPTLOG OPTERR CEEDUMP SYSBIN SYSBOUT)

```

## REXX for optimizing under TSO

The following example shows a REXX for optimizing under TSO:

```

/*=====>> REXX <<=====*/
Parse Arg hlqboz .
IF HLQBOZ = '' THEN DO
SAY 'HLQBOZ ARGUMENT MISSING'
EXIT
END
ADDRESS TSO
msgstat = MSG("OFF")
"FREE FILE (SYSIN SYSPRINT)"
"ALLOC FI(SYSPRINT) DA(ABO.LISTING) SHR"
"ALLOC FI(OPTLOG) DA(ABO.OPTLOG) SHR"
"ALLOC FI(OPTERR) DA(ABO.OPTERR) SHR"
"ALLOC FI(CEEDUMP) DA(ABO.CEEDUMP) SHR"
"ALLOC FI(SYSBIN) DA(IN.LOAD) SHR"
"ALLOC FI(SYSBOUT) DA(OUT.LOAD) SHR"
"ALLOC FI(SYSIN) NEW CYL SPACE(1,1) RECFM(F B)",
" LRECL(80) BLKSIZE(800) DSORG(PS)"
line.1 = 'ARCH=11'
line.2 = 'BOPT IN=DD:SYSBIN(MEMBER) OUT=DD:SYSBOUT(MEMBER)'
"EXECIO 2 DISKW SYSIN (STEM line. FINIS"
"CALL 'hlqboz'.SBOZMOD1(BOZOPT)"
"FREE FI(OPTLOG OPTERR CEEDUMP SYSPRINT SYSBIN SYSBOUT SYSIN)"
msgstat = MSG("ON")

```

## REXX for optimizing under TSO batch, directing OPTLOG and SYSPRINT output to the library members.

Sometimes you may need to optimize every member of the entire load library or even more than one load library without having to type multiple BOPT statements.

The following example shows a TSO batch job used to run ABOMEMBS REXX located in the data set referenced by the SYSEXEC DD name. ABOMEMBS goes through the SYSBIN data sets concatenation and individually optimizes every data set member found in that concatenation.

```

//OPTMEMBS EXEC PGM=IKJEFT01,PARM='ABOMEMBS',
REGION=0M
//STEPLIB DD DISP=SHR,DSN= hlqboz.SBOZMOD1
//SYSEXEC DD DISP=SHR,DSN=hlq.CLIST /* supply ABOMEMBS REXX member within SYSEXEC
library */
//SYSTSPRT DD SYSOUT=*,DCB=(LRECL=132,RECFM=FBA,BLKSIZE=1320)
//SYSTSIN DD DUMMY

```

```

//OPTERR DD SYSOUT=*
//CEEDUMP DD SYSOUT=*
//SYSBIN DD DISP=SHR,DSN=hlq.INLOAD1 /* supply one or more COBOL load libraries to be
optimized */
// DD DISP=SHR,DSN=hlq.INLOAD2
// DD DISP=SHR,DSN=hlq.INLOAD3
//SYSBOUT DD DISP=SHR,DSN=hlq.OUTLOAD
//OPTLOG DD DISP=(,CATLG),DSN=hlq.OPTLOG,UNIT=3390, /* supply new or existing PDS/PDSE or
SEQ file */
// SPACE=(CYL,(5,5,20)),DSNTYPE=LIBRARY,
// DCB=(RECFM=VB,LRECL=512,BLKSIZE=0)
//SYSPRINT DD DISP=(,CATLG),DSN=hlq.SYSPRINT,UNIT=3390, /* supply new or existing PDS/PDSE or
SEQ file */
// SPACE=(CYL,(5,5,20)),DSNTYPE=LIBRARY,
// DCB=(RECFM=VB,LRECL=512,BLKSIZE=0)
//SYSIN DD *
ARCH=11
SCAN=N
# optionally put BOPTs below this line for specific library members optimization
BOPT IN=hlq.INLOAD7(A*) OUT=hlq.OUTLOAD LOG=hlq.OPTLOG LIST=hlq.SYSPRINT
/*

```

For every member found in the above SYSBIN DD concatenation, ABOMEMBS invokes ABO with SYSIN, OPTLOG, SYSBIN and SYSPRINT files individually allocated for that member.

For example, for member MEM1 located in the hlq.INLOAD1 data set, it will allocate the SYSBIN file hlq.INLOAD1, reallocate the OPTLOG file hlq.OPTLOG(MEM1) and the SYSPRINT file hlq.SYSPRINT(MEM1), if the OPTLOG and SYSPRINT files allocated in the above JCL are PDS or PDSE data sets. Otherwise, it will keep using JCL allocation of these files.

To construct the SYSIN file for MEM1, it will use all the ABO parameters listed in the above JCL SYSIN file down to the first BOPT statement, and then append it with internally generated BOPT statement. Here is an example of the SYSIN file for MEM1:

```

=====
ARCH=11
SCAN=N
BOPT IN=DD:SYSBIN(MEM1) OUT=DD:SYSBOUT(MEM1)
=====

```

After all the individual SYSIN, OPTLOG, SYSPRINT and SYSBIN files are allocated, ABO is invoked to optimize MEM1.

ABOMEMBS exec repeats this process for every member in the SYSBIN concatenation. If the BOPT statement is present in the above JCL SYSIN file, after all the members in the SYSBIN concatenation are optimized, ABOMEMBS reallocates the OPTLOG and SYSPRINT files to SYSOUT, reallocates the SYSIN file containing all the same statement as the original JCL SYSIN file, and invokes ABO one more time to proceed with the parameters explicitly specified in the SYSIN file.

This approach can be useful to optimize all the library members just by including it into the SYSBIN concatenation, without having to specify any additional BOPT explicitly, and optionally, including an additional BOPT statement when you need to optimize some members of the library only. The JCL cards in the above JCL can be in any order.

ABOMEMBS generates the following SYSTSPRT output:

```

===== Processing hlq.INLOAD1 data set =====
Member ADD10 processed, rc=4
Member CALLEE processed, rc=0
Member CALLEE1 processed, rc=0
...
===== Processing hlq.INLOAD2 data set =====
Member COBPGM processed, rc=0
Member DJSIEV85 processed, rc=0
Member IAMASM processed, rc=4
...
===== Processing hlq.INLOAD3 data set =====
Member TEMPNAM6 processed, rc=12
Member TEMPNAM7 processed, rc=0
Member TEMPNAM8 processed, rc=0
...
===== Processing SYSIN statements =====
ARCH=11

```

```

SCAN=N
BOPT IN=h1q.INLOAD7(A*) OUT=h1q.OUTLOAD LOG=h1q.OPTLOG LIST=h1q.SYSPRINT
=====
READY
END

```

The following is an example of the ABOMEMBS REXX source code:

```

BROWSE      h1q.CLIST(ABOMEMBS)
Command ==>
***** Top of Data
/*=====>> REXX <<=====*/
  Parse Arg

  X = LISTDSI(STEPLIB FILE)
  If x > 0 Then Do
    Say 'Check STEPLIB allocation' ; Exit
  End
  optimizer = "''||SYSDSNAME||'(BOZOPT)''|'"
  flaglog = 0 /* assume OPTLOG is sequential */
  X = LISTDSI(OPTLOG FILE)
  IF x = 0 & SYSDSORG = 'PO' Then Do
    optlogds = SYSDSNAME ; flaglog = 1
  End
  flaglist = 0 /* assume SYSPRINT is sequential */
  X = LISTDSI(SYSPRINT FILE)
  IF x = 0 & SYSDSORG = 'PO' Then Do
    sysprtds = SYSDSNAME ; flaglist = 1
  End
  "EXECIO * DISKR SYSIN (STEM line. FINIS" /* read in SYSIN parameters into
line. array */
  n = line.0 + 1 /* assume no explicit BOPT specified. n is per-member BOPT
line number */
  Do l = 1 To
line.0
    PARSE UPPER VALUE line.l WITH
line.l
    If POS('BOPT ',line.l) > 0 Then
  Do
    n = l ; flagbopt = 1 ; leave /* leave when first BOPT found
*/
  End
  linea.l = line.l /* copy all lines before first BOPT into linea. array
*/
  End
  X = LISTDSI(SYSBIN
FILE)
  If x > 0 Then
  Do
    Say 'Check SYSBIN allocation' ;
  Exit
  End
  x =
outtrap(concatl.)
  lista
status
  x =
outtrap(off)
/* i2 is a line with last dsn in SYSBIN concatenation
*/
  i2 = concatl.0 - 1 /* assume that SYSBIN concatenation is a last in JCL
*/
  Do i = 1 To
concatl.0
    If substr(concatl.i,3,6) = 'SYSBIN' Then
  Do

```

```

        i1 = i - 1 ; leave      /* i1 line with first dsn in concatenation
*/
End

End
k = i + 2
If k < concat1.0 Then Do
    Do i = k To concat1.0 by 2
        If substr(concat1.i,3,1) <> ' ' Then Do
            i2 = i - 3 ; leave /* i2 line with last dsn in concatenation */
        End
    End
End
Else i2 = i1          /* when SYSBIN DD with a single data set is a last JCL card
*/

msgstat = MSG("OFF")

Do i = i1 To i2 by 2 /* loop trough SYSBIN concatenation */
    sysbinds = strip(concat1.i)
    Say '===== Processing 'sysbinds' data set ====='
    x=outtrap('row.')
        Address TSO "LISTDS '"sysbinds'" members"
    x=outtrap('off')
    If row.0 < 6 Then Do
        Say 'Check SYSBIN file' ; Exit
    End
    DO J = 7 TO row.0 /* loop trough member list */
        PARSE VALUE row.J WITH memn alias
        "FREE FI(SYSIN)"
        "ALLOC FI(SYSIN) NEW CYL SPACE(1,1) RECFM(F B)",
        " LRECL(80) BLKSIZE(800) DSORG(PS)"
        linea.n = 'BOPT IN=DD:SYSBIN('||memn||') ',
        'OUT=DD:SYSBOUT('||memn||')'
        "EXECIO * DISKW SYSIN (STEM linea. FINIS"
        If flaglog = 1 Then Do
            "FREE FI(OPTLOG)"
            optlogm = "||optlogds||('||memn||')||"
            "ALLOC FI(OPTLOG) DA("optlogm") SHR"
        End
        If flaglist = 1 Then Do
            "FREE FI(SYSPRINT)"
            sysprtm = "||sysprtds||('||memn||')||"
            "ALLOC FI(SYSPRINT) DA("sysprtm") SHR"
        End
        "FREE FI(SYSBIN)"
        "ALLOC FI(SYSBIN) DA('"sysbinds"') SHR"
        "CALL "optimizer /* optimize member */
        Say 'Member 'memn' processed, rc='rc
    END /* end of member list loop */
End /* end of concatenation list loop */
If flagbopt = 1 Then Do
    "FREE FI(SYSIN)"
    "ALLOC FI(SYSIN) NEW CYL SPACE(1,1) RECFM(F B)",
    " LRECL(80) BLKSIZE(800) DSORG(PS)"
    "EXECIO * DISKW SYSIN (STEM line. FINIS"
    "FREE FI(OPTLOG)"
    "ALLOC FI(OPTLOG) SYSOUT"
    "FREE FI(SYSPRINT)"
    "ALLOC FI(SYSPRINT) SYSOUT"
    "CALL "optimizer /* optimize with BOPTs provided in SYSIN */
    Say '===== Processing SYSIN statements ====='
    Do i = 1 To line.0
        Say line.i
    End
    Say '===== '
End
msgstat = MSG("ON")
EXIT

```

## Starting the optimizer from an assembler program

You can invoke ABO programmatically from within an HLASM program.

Before you start to optimize, complete these steps:

1. Allocate all the needed data sets, either by using dynamic allocation within your assembler program or specifying the DD cards in the job JCL used for your assembler program invocation. The following DD names must be allocated: SYSPRINT, SYSBIN, SYSBOUT, SYSIN, OPTLOG, OPTERR, CEEDUMP.
2. Provide the ABO parameters within your SYSIN data set.

You can start ABO from within an assembler program by using the LINKX or ATTACHX macro because those two are 64 bit mode compatible and ABO is running in AMODE 64.

The following is an example of the LINKX macro in list form:

```
symbol {LINKX} EP=BOZOPT,AMODE64OK=YES,PLIST8=YES,SF=L
```

The following is an example of the LINKX macro in execute form:

```
LINKX EP=BOZOPT,AMODE64OK=YES,PARAM=(addr),PLIST8=YES,      *  
      MF=(E,#LINKX),SF=(E,#LINK2)
```

where # is used as a prefix symbol.

### EP

Specifies the symbolic name of ABO.

### PARAM

Specifies the address parameters list to be passed from the assembler program to ABO. In the example, *addr* can be any value because it's ignored by BOZOPT program which directly reads parameters supplied in the SYSIN file.

### PLIST8=YES

Defines the size of the parameter list entries for a parameter list to be built by LINKX based on the PARAM keyword, as an 8-bytes-per-entry parameter list.

### AMODE64OK=YES

Indicates that the system is to accept an attempt to link to an AMODE 64 target routine from an AMODE 24 or AMODE 31 routine.

### SF=L

Specifies the list form of the LINKX macro.

When ABO completes processing, it puts a return code in register 15.

## Assembler program starting the optimizer

The following example shows the ABO invocation from an assembler program:

```
//JOB CARD JOB  
//*  
//ASM HCL PROC MAC='SYS1.MACLIB',MAC1='SYS1.MODGEN',U=3390,  
//          MAC2='SYS1.MACLIB'  
//*-----***  
//*          A S M H C L      H-ASSEMBLER          ***  
//*          IBM-PROCEDURE: COMPILE + LINK          ***  
//*-----***  
//ASM      EXEC PGM=ASMA90,PARM=OBJECT,REGION=0M  
//SYSLIB    DD DSN=&MAC,DISP=SHR  
//          DD DSN=&MAC1,DISP=SHR  
//          DD DSN=&MAC2,DISP=SHR  
//SYSUT1    DD DSN=&&SYSUT1,UNIT=&U,SPACE=(TRK,(60,45))  
//SYSPRINT  DD SYSOUT=*,DCB=BLKSIZE=1089  
//SYSPUNCH  DD DUMMY  
//SYSLIN    DD DSN=&&OBJSET,UNIT=&U,SPACE=(80,(2000,500)),  
//          DISP=(MOD,PASS)  
//LKED      EXEC PGM=HEWLH096,  
//          PARM='XREF,LET,LIST,AC=0,FILL=NONE',
```

```

//          COND=(8,LT,ASM)
//SYSLIN DD DSN=&&OBJSET,DISP=(OLD,DELETE)
//          DD DDNAME=SYSIN
//SYSLMOD DD DSN=h1q.CALLABO.LOAD,DISP=SHR
//SYSUT1 DD DSN=&&SYSUT1,UNIT=(&U,SEP=(SYSLIN,SYSLMOD)),
//          SPACE=(1024,(50,20))
//SYSPRINT DD SYSOUT=*
//          PEND
//
//*
//          EXEC ASMHCL
//ASM.SYSIN DD
*
          YREGS
CALLABO CSECT
CALLABO AMODE 31
CALLABO RMODE ANY
          STM R14,R12,12(R13)
          USING CALLABO,R12
          LR R12,R15          LOAD BASE REGISTER
          LA R9,SAVE          POINT TO CURRENT SAVEAREA
          ST R9,8(,R13)        A(CURRENT_SA) IN OLD_SA
          ST R13,4(,R9)        A(OLD_SA) IN CURRENT_SA
          LR R13,R9            R13=A(CURRENT_SAVEAREA)
*-----*
          LLGTR R12,R12          allow 64-bit
addressability
          BAL R14,LINKOPT        invoke BOZOPT
*-----*
DONE DS 0H
      L R13,4(,R13)
      ST R15,16(,R13)
      LM R14,R12,12(R13)
      BR R14
*-----*
LINKOPT DS 0H
it XR R15,R15          nullify parm addr, BOZOPT ignores
          LLGTR R15,R15
          SAM64
          LINKX EP=BOZOPT,AMODE640K=YES,PARAM=((R15)),PLIST8=YES, *
              MF=(E,#LINKX),SF=(E,#LINK2)
          SAM31
          B DONE
*-----*
          DS 0F
SAVE DC XL72'00'
#LINKX LINKX EP=BOZOPT,AMODE640K=YES,PLIST8=YES,SF=L
#LINK2 LINKX EP=BOZOPT,AMODE640K=YES,PLIST8=YES,SF=L
          LTORG
          END
//LKED.SYSIN DD *
          PAGE CALLABO
          NAME CALLABO(R)
//

```

The following is a sample JCL to run the CALLABO program:

```

//OPT EXEC PGM=CALLABO,REGION=0M
//STEPLIB DD DSN=h1qboz.SBOZMOD1,DISP=SHR
//          DD DSN=h1q.CALLABO.LOAD,DISP=SHR
//OPTLOG DD SYSOUT=*
//OPTERR DD SYSOUT=*
//CEEDUMP DD SYSOUT=*
//SYSPRINT DD SYSOUT=*
//SYSBIN DD DSN=h1q.IN.LOAD,DISP=SHR
//SYSBOUT DD DSN=h1q.OUT.LOAD,DISP=SHR
//SYSIN DD *
# supply ABO directives down this line
BOPT IN=DD:SYSBIN(*) OUT=DD:SYSBOUT

```

---

# Chapter 6. Understanding output from the optimization process

## Log files

---

IBM Automatic Binary Optimizer for z/OS generates a log file that helps you identify and resolve problems.

You can diagnose problems at optimize time by inspecting the log file that is generated unconditionally by ABO into the OPTLOG DD (see [Table 6 on page 15](#)). The log file contains diagnostic information about optimization and scanning.

To generate additional member-level log files, use the [LOG option](#).

### The log file for optimization

When optimization is performed on a module (SCAN=N optimizer option is in effect), the log file includes the following information:

- File name information of the input module being processed
- Names of the CSECTs being optimized
- File name information of the listing transform for each optimized CSECT
- File name information of the output optimized module
- A time stamp for each line of the OPTLOG and a header for the date
- Other diagnostic information including error messages

#### Example 1:

The following log file shows COBOL CSECTs from members MEMA and MEMB of data set *HLQ.IN1.LOAD* are being optimized. Module MEMA has two COBOL CSECTs named SUB1 and SUB2 that are optimized. Module MEMB has one COBOL CSECT named PROGB that is optimized. Listing transforms are all placed in the default SYSPRINT DD. Optimized modules are written to the *HLQ.OUT1.LOAD* data set.

```
5697-AB2 IBM Automatic Binary Optimizer for z/OS 2.1.0

===== Sept 24 2019 =====
10:53:16 Optimizer build level: tr_v21_binopt_20190730_1658_t54Rw7MMEem46oTHworqTQ
(Jul 30 2019 20:05:19)
10:53:16 Processing HLQ.IN1.LOAD, member MEMA
10:53:16   Processing CSECT SUB1, in member MEMA
10:53:16     Optimizing CSECT SUB1 for zEC12
10:53:16     Succeeded in optimizing SUB1
10:53:16     Generating listing transform into DD:SYSPRINT
10:53:16   Processing CSECT SUB2, in member MEMA
10:53:16     Optimizing CSECT SUB2 for zEC12
10:53:16     Succeeded in optimizing SUB2
10:53:16     Generating listing transform into DD:SYSPRINT
10:53:16   Finished processing, processed 2 of 2 CSECTs in member MEMA
10:53:16   Save HLQ.OUT1.LOAD (MEMA) succeeded
10:53:16 Processing HLQ.IN1.LOAD, member MEMB
10:53:16   Processing CSECT PROGB, in member MEMB
10:53:16     Optimizing CSECT PROGB for zEC12
10:53:16     Succeeded in optimizing PROGB
10:53:16     Generating listing transform into DD:SYSPRINT
10:53:16   Finished processing, processed 1 of 1 CSECTs in member MEMB
10:53:16   Save HLQ.OUT1.LOAD (MEMB) succeeded
10:53:16 Exiting with return code: 0
```

## Example 2:

The following log files show the output for the member-level log files produced by the same *HLQ.IN1.LOAD* as the previous example with *LOG=HLQ.LOG. OUT* specified.

The contents of *HLQ.LOG.OUT(MEMA)*:

```
5697-AB2 IBM Automatic Binary Optimizer for z/OS 2.1.0
===== Sept 24 2019 =====
10:53:16 Optimizer build level: tr_v21_binopt_20190730_1658_t54Rw7MMEem46oTHworqTQ (Jul 30 2019 20:05:19)
10:53:16 Processing HLQ.IN1.LOAD, member MEMA
10:53:16   Processing CSECT SUB1, in member MEMA
10:53:16     Optimizing CSECT SUB1 for zEC12
10:53:16     Succeeded in optimizing SUB1
10:53:16     Generating listing transform into DD:SYSPRINT
10:53:16   Processing CSECT SUB2, in member MEMA
10:53:16     Optimizing CSECT SUB2 for zEC12
10:53:16     Succeeded in optimizing SUB2
10:53:16     Generating listing transform into DD:SYSPRINT
10:53:16   Finished processing, processed 2 of 2 CSECTs in member MEMA
10:53:16   Save HLQ.OUT1.LOAD (MEMA) succeeded
10:53:16 Exiting with return code: 0
```

The contents of *HLQ.LOG.OUT(MEMB)*:

```
5697-AB2 IBM Automatic Binary Optimizer for z/OS 2.1.0
===== Sept 24 2019 =====
10:53:16 Optimizer build level: tr_v21_binopt_20190730_1658_t54Rw7MMEem46oTHworqTQ (Jul 30 2019 20:05:19)
10:53:16 Processing HLQ.IN1.LOAD, member MEMB
10:53:16   Processing CSECT PROGB, in member MEMB
10:53:16     Optimizing CSECT PROGB for zEC12
10:53:16     Succeeded in optimizing PROGB
10:53:16     Generating listing transform into DD:SYSPRINT
10:53:16   Finished processing, processed 1 of 1 CSECTs in member MEMB
10:53:16   Save HLQ.OUT1.LOAD (MEMB) succeeded
10:53:16 Exiting with return code: 0
```

## The log file for scanning

When scanning is performed (SCAN=Y optimizer option is in effect), the log file shows:

- File name information of the input module being scanned
- Names of the CSECT of the module being scanned
- Other diagnostic messages

### Example:

The following log file shows modules MEMA and MEMB of data set *HLQ.MEM1.LOAD* are being scanned. Scanning output shows each of the CSECTs in the modules. The COBOL compiler version used for the compilation and the "Signature information bytes" extracted from the CSECT are displayed for the COBOL CSECTs SUB, SUB2 and PROGB. "Signature information bytes" are documented in the *COBOL Programming Guide* and provide information about the compiled program.

```
5697-AB2 IBM Automatic Binary Optimizer for z/OS 2.1.0
===== Sept 24 2019 =====
10:58:23 Optimizer build level: tr_v21_binopt_20190730_1658_t54Rw7MMEem46oTHworqTQ (Jul 30 2019 20:05:19)
10:58:23 Processing HLQ.IN1.LOAD, member MEMA
      Language ID Records:
          id 5688187 v21 m00 2015281 resident EDCOEXTS
          id 5655S7100 v42 m00 2015281 resident SUB
          Enterprise COBOL V4: start=0x10, length=4.19 (kBytes)
              Signature information bytes:
                  a0487d4c 20000000 00880100 00000040
                  08000000 000000 00008004 1400
          id 5655S7100 v42 m00 2015281 resident SUB2
          Enterprise COBOL V4: start=0x10d8, length=4.20 (kBytes)
              Signature information bytes:
```



```

a0487d4c 20000000 00880100 00000040
08000000 000000 00008004 1400
id 569623400 v01 m06 2013071 resident CEESG005
id 569623400 v01 m06 2013072 resident CEEBETBL
id 569623400 v01 m06 2013072 resident CEESTART
10:58:23 Processing HLQ.IN1.LOAD, member MEMB
Language ID Records:
id 5688187 v21 m00 2015281 resident EDCOEXTS
id 5655S7100 v42 m00 2015281 resident PROGB
Enterprise COBOL V4: start=0x10, length=8.19 (kBytes)
Signature information bytes:
a0487d4c 20000000 00880100 00000040
08000000 000000 00008004 1400
id 569623400 v01 m06 2013072 resident CEESTART
10:58:23 Exiting with return code: 0

```

## Listing transform

The listing transform describes the changes made by the Automatic Binary Optimizer for z/OS to your already compiled program module. It shows how the instructions in the input binary map to the optimized instructions. A listing transform is produced for every CSECT that is optimized. The listing transform is intended to complement the compiler listing generated when the input binary was originally compiled from source. While the listing transform does not depend on the compiler listing, using the two together will allow you to better understand how IBM Automatic Binary Optimizer for z/OS transformed your binary.

A listing transform is generated unconditionally for every optimized CSECT; no special options or flags need to be specified. By default, listing transforms are generated into the SYSPRINT DD.

The listing transform is also used by [“Application Delivery Foundation for z/OS” on page 73](#).

## Listing transform contents

The listing transform is provided to help in diagnosing problems encountered during the execution of the optimized program. The listing transform is primarily intended for use by debugging tools such as IBM Debug for z/OS.

A listing transform contains the following information:

- A summary of the optimization options
- The optimized instructions interspersed with the input instructions
- A literal pool containing any new literals created by ABO
- A PPA4 section containing information about the optimized CSECT
- An automatic map, also known as a dynamic storage area (DSA) map, of any new stack symbols that were created by ABO
- An input instructions section containing the complete list of instructions and compiler options for the CSECT being optimized

## Summary of optimization parameters

This section contains the name of the architecture level for which the program is optimized, and the date and time stamp of both the input binary, along with the compiler used to produce it. The date and time stamp of the output binary is also shown.

Example:

```

Invocation Parameters:
Architecture Level: zEC12

Input IDRL Record: 5655S7100 v42 m00 2013122

```

```
Name: Enterprise COBOL V4
Version: 42
Mod Level: 00
Compiled Date (YYYYDDDD): 2013122
```

```
Output IDRL Record: 5697-AB2 v21 m00 2019256
Name: IBM Automatic Binary Optimizer for z/OS
Version: 21
Mod Level: 00
Optimized Date (YYYYDDDD): 2019256
```

## Optimized instructions

This section makes up the majority of the data in the listings transform. It is similar to the object code section of the listings generated by various IBM COBOL compilers, such as IBM Enterprise COBOL V5 and V6. Each CSECT that was optimized begins with the PROC psuedo opcode and the name of the CSECT as its operand.

Example:

(1)	(2)	(3)	(4)	(5)
000258		000000	PROC	PROGA
000258	183F	000000	LR	R3,R15
00025A	5800 3008	000000	L	R0, 8(,R3)
00025E	1E01	000000	ALR	R0,R1
000260	5500 C00C	000000	CL	R0, 12(,R12)
000264	0DF0	000000	BASR	R15,R0
000266	47D0 F00C	000000	BC	R13, 12(,R15)
00026A	58F0 C300	000000	L	R15, 768(,R12)
00026E	0DEF	000000	BASR	R14,R15
000270	181F	000000	LR	R1,R15
000272	50D0 1004	000000	ST	R13, 4(,R1)
000276	5000 104C	000000	ST	R0, 76(,R1)
00027A	D203 1000 3058	000000	MVC	0(4,R1), 88(R3)
000280	D703 1084 1084	000000	XC	132(4,R1), 132(R1)
000286	5090 105C	000000	ST	R9, 92(,R1)
00028A	18D1	000000	LR	R13,R1
00028C	41A0 D120	000000	LA	R10, 288(,R13)

The preceding example shows the optimized instructions produced for a CSECT named PROGA. The five sections of an optimized instruction are described as follows:

1. The hexadecimal offset in the CSECT of the optimized instruction
2. The hexadecimal representation of the instruction bytes
3. The hexadecimal CSECT offset of the "source" instructions for which these optimized instructions were generated
4. Instruction opcode
5. Instruction operands

Interspersed with the optimized instructions are the "source" instructions for which the optimized instructions are generated. Lines that begin in column 5 are the optimized instructions, and the lines that begin in column 1 are the "source" instructions. In the following example, the first two lines, starting at column 1, are the PACK and OI source instructions at hex offsets 00042C and 000432 respectively. The third line, starting in column 5, is the ABO generated instruction 'CDZT'. Notice that the "source" hex offset of the CDZT is 00042c, which shows that it was generated for the PACK instruction in the input module.

Example:

00042C	PACK	272(4,13),0(7,8)		
000432	OI	276(13),15		
	0004C4	ED07 4000 00AA	00042C	CDZT FP0,_WSA[0x12c] 0(8,R4),0x0
000436	PACK	280(4,13),8(7,8)		
00043C	OI	284(13),15		
	0004CA	ED07 4008 10AA	000436	CDZT FP1,_WSA[0x12c] 8(8,R4),0x0
000440	AP	272(4,13),280(4,13)		
000446	UNPK	16(7,8),272(4,13)		
	0004D0	B3D2 1000	000440	ADTR FP0,FP0,FP1

```

00044C OI 23(8),240
000450 L 2,248(0,,13)
0004D4 ED07 4010 00A8 00044C CZDT FP0, 16(8,R4),0x0

```

## The literal pool

ABO places any new literals it creates at the end of the code section. These sections are named *Constant Data Snippets* in the listing transform. There may be zero or more Constant Data Snippets in the listing and their contents are very similar to the literal pool that is created by the original compiler. The original literal pool remains intact and continues to be used, just as in the input binary.

Example:

(1)	(2)	(3)	(4)
		L0032:	# Constant Data Snippet
000550	4040 4040 4040 4040	DC	X'4040404040404040'
000558	4040 4040 4040 4040	DC	X'4040404040404040'
000560	4040 4040 4040 4040	DC	X'4040404040404040'
000568	4040 4040 4040 0000	DC	X'4040404040400000'
000570	8000 0000 0000 0000	DC	X'8000000000000000'
000578	0000 0000 0000 0000	DC	X'0000000000000000'
000580	0000 0001 0000 0000	DC	X'0000000100000000'
000588	C9C7 E9E2 D9E3 C3C4	DC	X'C9C7E9E2D9E3C3C4'
000590	E2E8 E2D6 E4E3 4040	DC	X'E2E8E2D6E4E34040'
000598	0E00 0000 0000 0000	DC	X'0E00000000000000'

A description of the four sections of data is as follows:

1. The hexadecimal offset from the start of the CSECT to these bytes in the literal pool
2. The hexadecimal representation of the bytes in the literal pool
3. The label denoting the start of the literal pool
4. Assembler syntax of these bytes

## Additional DSA and TGT Bytes Allocated section

This section displays in hexadecimal number of bytes any additional DSA or TGT bytes allocated by the optimizer

Example:

```

DSA WILL BE ALLOCATED FOR AN ADDITIONAL 000001A8 BYTES
TGT WILL BE ALLOCATED FOR AN ADDITIONAL 00000000 BYTES

```

## The PPA4 section

The PPA4 section contains information about the optimization of the program module. For example, it contains the time and date of optimization, the length of the code section and other information.

Example:

(1)	(2)	(3)	(4)
	PPA4: Entry Point Constants		
046668	00000000	=X'00000000'	Flags 1
04666C	00000300	=X'00000300'	Flags 2
046670	F2F0F1F6	=C'2019'	Compiled Year
046674	F0F8F2F1	=C'0913'	Compiled Date MMDD
046678	F1F2F3F0F2F3	=C'123023'	Compiled Time HHMMSS
04667E	F0F1F0F2F0F0	=C'010200'	Compiler Version
046684	0004706A	=F'290922'	Code Length
046688	0B020000	=X'0B020000'	Options
04668C	00000028	=X'00000028'	A(PPA4-ListName)
	PPA4 End		

A description of the four sections of PPA4 follows:

1. The offset in hexadecimal in the CSECT of PPA4 section entry
2. The hexadecimal representation of the bytes in the PPA4 section
3. Assembler syntax of the bytes in the PPA4
4. Description of the data in the PPA4

## The automatic map

The automatic map contains the offsets and sizes (in hexadecimal) of symbols that are created by ABO. These offsets are relative to a base established at the end of the original DSA. The automatic map does not show automatics in the original program or temporaries created by the original compiler. ABO will establish a general purpose register (GPR) to contain the start offset of the "new" DSA. All newly created automatics will be referenced with this new register as the base.

Example:

(1)	(2)	(3)
	*****	A U T O M A T I C M A P *****
OFFSET (HEX)	LENGTH (HEX)	NAME
0	4	_GPR0
4	4	_GPR1
8	4	_GPR2
C	4	_GPR3
10	4	_GPR4
14	4	_GPR5
18	4	_GPR6
1C	4	_GPR7
20	4	_GPR8
24	4	_GPR9
28	4	_GPR10
2C	4	_GPR11
30	4	_GPR12
34	4	_GPR13

A description of the three sections of the automatic map follows:

1. Hexadecimal offset of the stack symbol, relative to the start of the new stack
2. Hexadecimal length of the symbol in bytes
3. Name of the symbol

## Input instructions

This section contains the complete list of instructions from the input module. There is one section for each CSECT that was optimized. These input instructions are the same as those already shown in the [Optimized instructions](#) section. In that section, the input instructions are shown interspersed with the corresponding optimized instructions, and as such are not a complete and ordered list. Each CSECT has its own prolog section and is displayed after "Compiler Options in Effect" finishes. This prolog section is displayed for CSECTs compiled by compiler releases from COBOL/370 1.1 to Enterprise COBOL V4R2. CSECTs compiled by VS COBOL II 1.3 and 1.4 do not display the prolog section.

The input instructions section begins with the COBOL compiler version used for the compilation and the "Signature information bytes" extracted from the CSECT. "Signature information bytes" are documented in the *COBOL Programming Guide* and provide information about the compiled program. These information bytes are decoded and the corresponding compiler options that were in effect are printed. Note that the decoded compiler options may not exactly match in content and formatting those displayed in the original compiler listing. This is because ABO decodes the options only according to the signature information bytes present in the input CSECT instead of the full original source and options specified during the original compilation process.

In the following example, the COBOL CSECT named PROGA was optimized.

```

(1)      (2)      (3)

          * * * * *   I N P U T   I N S T R U C T I O N S   * * * * *

id 5655S7100 v42 m00 2020072 resident PROGA
Enterprise COBOL V4: start=0x0, length=1.39 (kBytes)
Signature information bytes:
a4487d4c 20000000 00080000 00000000
08000000 00000000 00808014 00
Compiler Options in effect:
ADV
ARITH(COMPAT)
NOAWO
NOBLOCK0
Compilation unit is a program.
NOCICS
CODEPAGE(1140)
NOCURRENCY
Default DDNAME for OUTDD will be used
DATA(31)
NODATEPROC
DBCS
NODECK
NODLL
NODUMP
DYNAM
NOEXPORTALL
NOFASTSRT
INTDATE(ANSI)
NOLIB
LIST
NOMAP
NOMDECK
NONAME
NONUM
NUMCLS(PRIM)
NUMPROC(NOPFD)
OBJ
NOOFFSET
NOOPTIMIZE
PGMNAME(LONGUPPER)
QUOTE
RENT
RMODE(ANY)
SEQUENCE
SIZE(MAX)
SOURCE
NOSQL
SQLCCSID
NOSSRANGE
TERM
NOTEST
NOTHREAD
TRUNC(STD)
NOVBREF
NOWORD
XMLPARSE(XMLSS)
XREF
YEARWINDOW(1900)
ZWB

          * * * * *   P R O L O G U E   I N F O   * * * * *

000000      47F0F028      BYPASS CONSTANTS. BRANCH TO @STM
000004      00          ZERO NAME LENGTH FOR DUMPS
000005      C3C5C5      CEE EYE CATCHER
000008      00000110     STACK FRAME SIZE
00000C      00000014     OFFSET TO PPA1 FROM PRIMARY ENTRY
000010      47F0F001     RESERVED

CSECT: PROGA      PPA1
000014      98          OFFSET TO LENGTH OF PROGRAM NAME FROM PPA1
000015      CE          CEL SIGNATURE
000016      AC          CEL FLAGS
000017      00          MEMBER FLAGS FOR COBOL
000018      000000B6     ADDRESS OF PPA2
00001C      00000000     OFFSET TO THE BDI
000020      00000000     ADDRESS OF ENTRY POINT DESCRIPTORS

```

000024	0000	RESERVED
000026	00	DSA FPR 8-15 SAVE AREA OFFSET/16
000027	00	DSA FPR 8-15 SAVE AREA BIT MASK
000028	90ECD00C	STM STARTS HERE: SAVE CALLER'S REGISTERS
00002C	4110F038	GET ADDRESS OF PARMLIST INTO R1
000030	98EFF04C	LOAD ADDRESSES FROM @BRVAL
000034	07FF	DO ANY NECESSARY INITIALIZATION
000036	0000	AVAILABLE HALF-WORD
000038	00000000	1) PRIMARY ENTRY POINT ADDRESS
00003C	00000000	2) AVAILABLE
000040	000003A0	3) DAB ADDRESS
000044	000000AE	4) ENTRY POINT NAME ADDRESS
000048	00000000	5) CURRENT ENTRY POINT ADDRESS
00004C	00000262	6) PROCEDURE CODE ADDRESS
000050	000018C0	7) INITIALIZATION ROUTINE
000054	000000CA	8) ADDRESS OF PARM LIST FOR CEEINT
000058	00104001	DSA WORD 0 CONSTANT
00005C	00000008	AVAILABLE WORD
000060	D7D9D6C7	AVAILABLE WORD
000064	C1404040	AVAILABLE WORD
000068	F2F0F2F0	YEAR OF COMPILATION
00006C	F0F3F1F2	MONTH/DAY OF COMPILATION
000070	F1F3F3F8	HOURS/MINUTES OF COMPILATION
000074	F2F1	SECONDS FOR COMPILATION DATE
000076	F0F4F0F2F0F0	VERSION/RELEASE/MOD LEVEL OF PROD
00007C	0474	UNSIGNED BINARY CODE PAGE CCSID VALUE
00007E	0000	AVAILABLE HALF-WORD
000080	1400	INFO. BYTES 28-29
000082	076C	SIGNED BINARY YEARWINDOW OPTION VALUE
000084	A4487D4C2000	INFO. BYTES 1-6
00008A	000000080000	INFO. BYTES 7-12
000090	000000000800	INFO. BYTES 13-18
000096	0000000000	INFO. BYTES 19-23
00009B	00	COBOL SIGNATURE LEVEL
00009C	00000003	# DATA DIVISION STATEMENTS
0000A0	00000002	# PROCEDURE DIVISION STATEMENTS
0000A4	000080	INFO. BYTES 24-26
0000A7	80	INFO. BYTE 27
0000A8	40404040	USER LEVEL INFO (LVLINFO)
0000AC	0005	LENGTH OF PROGRAM NAME
0000AE	D7D9D6C7C1404040	PROGRAM NAME

CSECT: PROGA		PPA2	
0000B6	05		CEL MEMBER IDENTIFIER
0000B7	00		CEL MEMBER SUB-IDENTIFIER
0000B8	00		CEL MEMBER DEFINED BYTE
0000B9	01		CONTROL LEVEL OF PROLOG
0000BA	00001810		VCON FOR LOAD MODULE
0000BE	00000000		OFFSET TO THE CDI
0000C2	FFFFFFB2		OFFSET TO TIMESTAMP/VERSION INFO
0000C6	00000000		ADDRESS OF CU PRIMARY ENTRY POINT
0000CA	00000038		PARM LIST FOR CEEINT: POINTER TO PRIMARY ENTRY PT ADDR
0000CE	00000008		OFFSET TO PARAMETERS FOR CEEINT
0000D2	00000006		PARAMETERS FOR CEEINT 1) NUMBER OF ENTRIES IN PARM LIST
0000D6	00000038		2) POINTER TO PRIMARY ENTRY PT ADDR
0000DA	00001810		3) ADDRESS OF CEESTART
0000DE	000017E8		4) ADDRESS OF CEEBETBL
0000E2	00000005		5) CEL MEMBER IDENTIFIER
0000E6	00000000		6) FOR CEL MEMBER USE
0000EA	00000000		AVAILABLE WORD
0000EE	00000000		AVAILABLE WORD
0000F2	00000000		AVAILABLE WORD
0000F6	00000000		AVAILABLE WORD
0000FA	0000		AVAILABLE HALF-WORD

CSECT: PROGA		PGT SECTION						
0000FC	(LIT+0)	00000001	40404040	40404040	40404040	40404040	40404040	40404040
40404040	....							
00011C	(LIT+32)	40400000	2A05D7C0	2A05D890	2A05D8E4			
2A05D8FA						....P{...Q...QU..Q.		

CSECT: PROGA		CGT SECTION									
000130	(LIT+0)	FFFFFFFC	00001000	00000001	00000000	899540D7	D9D6C7C1	E2E8E2D6			
E4E34040	.....in										
000150	(LIT+32)	C9C7E9E2	D9E3C3C4	00000000	0000012C	00000001	00000130	00000001			
00000000	IGZSRCD.....										
000170	(LIT+64)	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	
00000000	.....										

```

000190 (LIT+96) 80000000 40000000 00000000 00000000 F0F0F0F9 F7F9F1F6 F4F0F3F6
F0400000 |....|.....0009791640360 ..|
0001B0 (LIT+128) 00000000 00000000 00000000 00400000 000025C0 0001C000 05080000
24001B01 |.....|.....|.....|.....|
0001D0 (LIT+160) 40000008 08000024 0018FF40 00000000 40C00001 40000508 00002400
1B02C000 |.....|.....|.....|.....|
0001F0 (LIT+244) 05080000
24001B00 |.....|

```

\* \* \* \* \* E N D O F P R O L O G U E I N F O \* \* \* \* \*

```

0001F8 5820 9128 L 2,296(0,,9)
0001FC D201 2008 A00C MVC 8(2,2),12(10)
000202 D201 2010 A00C MVC 16(2,2),12(10)
000208 D207 2018 A028 MVC 24(8,2),40(10)
00020E D203 2020 A014 MVC 32(4,2),20(10)
000214 D203 2028 A014 MVC 40(4,2),20(10)
00021A D203 2030 A014 MVC 48(4,2),20(10)
000220 D207 2038 A020 MVC 56(8,2),32(10)
000226 D203 2040 A014 MVC 64(4,2),20(10)
00022C 920E 2048 MVI 72(2),14
000230 920F 2050 MVI 80(2),15
000234 D203 2058 A014 MVC 88(4,2),20(10)
00023A D203 2080 A014 MVC 128(4,2),20(10)
000240 D21D 2060 C004 MVC 96(30,2),4(12)
000246 5830 D0F0 L 3,240(0,,13)
00024A 07F3 BCR -1,3
00024C 5820 912C L 2,300(0,,9)
000250 D208 2010 A078 MVC 16(9,2),120(10)
000256 D203 2020 A081 MVC 32(4,2),129(10)
00025C 5830 D0F4 L 3,244(0,,13)
000260 07F3 BCR -1,3
000262 183F LR 3,15
000264 4100 1110 LA 0,272(0,,1)
000268 5500 C00C CL 0,12(0,,12)
00026C 0DF0 BASR 15,0
00026E 47D0 F00C BC 13,12(0,15)
000272 58F0 C300 L 15,768(0,,12)
000276 0DEF BASR 14,15
000278 181F LR 1,15
00027A 50D0 1004 ST 13,4(0,,1)
00027E 5000 104C ST 0,76(0,,1)
000282 D203 1000 3058 MVC 0(4,1),88(3)
000288 D703 1084 1084 XC 132(4,1),132(1)
00028E 5090 105C ST 9,92(0,,1)
000292 18D1 LR 13,1
000294 58C0 90E8 L 12,232(0,,9)
000298 1812 LR 1,2
00029A 50D0 D058 ST 13,88(0,,13)
00029E 58A0 C024 L 10,36(0,,12)
0002A2 D203 D088 A010 MVC 136(4,13),16(10)
0002A8 BF2F 9144 ICM 2,15,324(9)
0002AC 58B0 C028 L 11,40(0,,12)
0002B0 4780 B0CA BC 8,202(0,11)
0002B4 5830 905C L 3,92(0,,9)
0002B8 58F0 30F4 L 15,244(0,,3)
0002BC 4110 A0B3 LA 1,179(0,,10)
0002C0 0DEF BASR 14,15
0002C2 5A20 C000 A 2,0(0,,12)
0002C6 5020 9144 ST 2,324(0,,9)
0002CA 9140 9134 TM 308(9),64
0002CE 4710 B0F2 BC 1,242(0,11)
0002D2 D203 D0F8 D0F4 MVC 248(4,13),244(13)
0002D8 4120 B0EC LA 2,236(0,,11)
0002DC 5020 D0F4 ST 2,244(0,,13)
0002E0 47F0 B054 BC 15,84(0,11)
0002E4 D203 D0F4 D0F8 MVC 244(4,13),248(13)
0002EA 9140 9134 TM 308(9),64
0002EE 58B0 C028 L 11,40(0,,12)
0002F2 4710 B116 BC 1,278(0,11)
0002F6 D203 D0FC D0F0 MVC 252(4,13),240(13)
0002FC 4120 B110 LA 2,272(0,,11)
000300 5020 D0F0 ST 2,240(0,,13)
000304 47F0 B000 BC 15,0(0,11)
000308 D203 D0F0 D0FC MVC 240(4,13),252(13)
00030E 9140 9057 TM 87(9),64
000312 58B0 C028 L 11,40(0,,12)
000316 4710 B136 BC 1,310(0,11)
00031A 9120 9054 TM 84(9),32
00031E 47E0 B12E BC 14,302(0,11)
000322 9620 D084 OI 132(13),32

```

000326	9640	9057	OI	87(9),64
00032A	47F0	B136	BC	15,310(0,11)
00032E	9640	9134	OI	308(9),64
000332	9601	D084	OI	132(13),1
000336	5820	905C	L	2,92(0,,9)
00033A	58F0	202C	L	15,44(0,,2)
00033E	4110	A0A7	LA	1,167(0,,10)
000342	0DEF		BASR	14,15
000344	47F0	B162	BC	15,354(0,11)
000348	9120	D084	TM	132(13),32
00034C	47E0	B162	BC	14,354(0,11)
000350	58F0	20F4	L	15,244(0,,2)
000354	4110	A095	LA	1,149(0,,10)
000358	0DEF		BASR	14,15
00035A	5830	9144	L	3,324(0,,9)
00035E	5B30	C000	S	3,0(0,,12)
000362	5030	9144	ST	3,324(0,,9)
000366	9128	9054	TM	84(9),40
00036A	4770	B18C	BC	7,396(0,11)
00036E	5830	9128	L	3,296(0,,9)
000372	48F0	3008	LH	15,8(0,,3)
000376	58D0	D004	L	13,4(0,,13)
00037A	58E0	D00C	L	14,12(0,,13)
00037E	980C	D014	LM	0,12,20(13)
000382	07FE		BCR	-1,14
000384	D20B	D100 A06C	MVC	256(12,13),108(10)
00038A	5840	9128	L	4,296(0,,9)
00038E	4830	4008	LH	3,8(0,,4)
000392	5030	D10C	ST	3,268(0,,13)

\* \* \* \* \* E N D O F I N P U T I N S T R U C T I O N S \* \* \* \* \*

A description of the three sections of the input instructions section follows:

1. The hexadecimal offset in the input CSECT of the original instruction
2. Instruction mnemonic
3. Instruction operands

## SYSPRINT DD and LIST option

Use the SYSPRINT DD or LIST options to specify the locations of the generated listing transforms.

The target of SYSPRINT or LIST can be one of the following items:

- A sequential data set or member of a PDSE (not PDS). The output of multiple CSECT optimizations are added to this sequential data set in optimization order.
- A PDS or PDSE. When a CSECT is optimized, the listing transform particular to that CSECT is placed in a member of the PDS or PDSE where the member name is based on the CSECT name (upper cased and truncated to 8 characters). The contents of the member, if any, are overwritten even if the former contents are produced by ABO in previous invocations.
- An HFS path. The output of multiple CSECT optimizations are added to this HFS file.

The LIST option takes precedence over the SYSPRINT DD. If you specify the LIST option, it will override the SYSPRINT DD. When the LIST option is specified, you can omit the SYSPRINT DDname.

### Note:

The ABO listing contains detailed transformation information and can therefore become very large. Specifying SYSPRINT DD target as SYSOUT might cause the JES2 spools to reach a system specified line limit. When the spool line limit is reached, the JES2 passes control to an installation exit routine but the ABO job may or may not be terminated. Although the spool line limit can be increased using the JOBPARM L option, the maximum L setting of 999999 might still not be large enough for the ABO listing.

To avoid this problem, it is recommended that SYSPRINT specify a PDS, PDSE or HFS location as documented in this section.



## Example

The following JCL example uses a PDSE in the SYSPRINT DD so that listing transforms are written to the members of the PDSE.

```
//SYSIN DD *  
  BOPT IN=HLQ.IN.LOAD(MOD*) OUT=HLQ.OUT.LOAD  
  ...  
//SYSPRINT DD DSN=HLQ.LIST.PDSE,DISP=SHR
```

In this example, the input program modules are specified as *HLQ.IN.LOAD(MOD\*)*, which means, optimize all eligible members in *HLQ.IN.LOAD* with names beginning with "MOD".

There are two members in the input data set, MOD1 and MOD2. Within these two program modules, are various CSECTs:

Table 9. Input modules and their containing CSECTs	
<b>HLQ.IN.LOAD</b>	<b>CSECTs</b>
MOD1	PROG1A
	PROG1B
	PROG1C
MOD2	PROG2A
	PROG2B

ABO will optimize each of these CSECTs, one at a time, and produce two outputs for each CSECT:

1. The optimized CSECT
2. The listing transform for the CSECT

The optimized CSECT has the same name as the input CSECT, and the optimized CSECT will be placed in a program module that has the same member name as the input program module. However, the new program modules will be placed into a new PDSE called '*HLQ.OUT.LOAD*'

Table 10. Output 1: Optimized modules and their CSECTs	
<b>HLQ.OUT.LOAD</b>	<b>CSECTs</b>
MOD1	PROG1A
	PROG1B
	PROG1C
MOD2	PROG2A
	PROG2B

The listings, generated for each of the optimized CSECT, are placed into the PDSE '*HLQ.LIST.PDSE*', as separate members. Each such PDSE member will have the same name as the input CSECT name. The results is that *HLQ.LIST.PDSE* will have 5 members, PROG1A, PROG1B, PROG1C, PROG2A and PROG2B.

Table 11. Output 2: Listing transforms	
<b>HLQ.LIST.PDSE</b>	
PROG1A	
PROG1B	
PROG1C	
PROG2A	

<i>Table 11. Output 2: Listing transforms (continued)</i>
<b>HLQ.LIST.PDSE</b>
PROG2B

---

## Chapter 7. Using the ABO Assistant

### Overview of the ABO Assistant

The IBM Automatic Binary Optimizer (ABO) Assistant is a suite of tools to automate the main parts of finding and optimizing your top CPU consuming COBOL batch applications.

Starting from your provided SMF data, the SMF Analyzer component of the ABO Assistant will produce a prioritized report on the jobs and programs that consume the most CPU across all the jobs running on your system. Optionally, the JCL locations to run these programs will also be displayed.

For programs known to contain COBOL, these JCL locations can then be used as input to the second component of the ABO Assistant called the Program Analyzer and Optimizer. This component will automate all the individual steps required to efficiently optimize the top CPU consuming individual COBOL batch applications using ABO and to clearly report the CPU time savings from using ABO.

After inputting the JCL used to run each COBOL batch application, one at a time, to the Program Analyzer and Optimizer, it automatically does the following:

- Rebinds the original program to enable an [RTI Profile](#) to be collected
- Runs the rebound original program to report the CPU time taken by the program and to collect the RTI profile
- Optimizes the top CPU consuming COBOL CSECTs as found in the RTI profile with ABO
- Runs the ABO optimized program
- Reports the CPU time of the optimized program, proportion of time spent in COBOL, and the percentage of the CPU reduction from using ABO

The JCL for the next top CPU consuming COBOL batch application can then be passed to the Program Analyzer and Optimizer component of the ABO Assistant to repeat the above process.

**Note:** Each target COBOL application must be re-runnable sequentially without cleanup or other steps needed that are not already present in the original JCL. As the application will be run twice, it is highly recommended that the Program Analyzer and Optimizer component of the ABO Assistant only be used on a test or development system. For more information on this and other restrictions, see [“Limitations and requirements on Program Analyzer and Optimizer”](#) on page 60.

---

## Components of the ABO Assistant

In addition to the beta version of ABO itself, the ABO Assistant beta is comprised of two components:

- [SMF Analyzer](#)
- [Program Analyzer and Optimizer](#)

### ABO Assistant – SMF Analyzer

The SMF Analyzer component of the ABO Assistant consists of 3 files:

- BOZSMFJ - Sample JCL for invoking the ABO Assistant’s SMF Analyzer programs. There are 4 input parameters that must be specified in this JCL:
  - SMFDUMP - Data set name of SMF DUMP to analyze containing SMF 30(4) records
  - ABO - Data set name of the ABO installation location (location of the BOZSMF program)
  - EXE - Data set name where the BOZSMFR REXX program is located
  - THRSHOLD - Minimum CPU time required for program to be included in the report
- BOZSMF - Program that is invoked by the sample job BOZSMFJ described above

- BOZSMFR - REXX program that is invoked by the sample job BOZSMFJ described above

**Note:** The SMFDUMP data must consist of SMF Type 30 subtype 4 records for the time interval you wish to analyze. See [“SMF DUMP generation” on page 62](#) for information on how to generate this SMF dump.

After setting the 4 input parameters in BOZSMFJ and submitting the JCL, the SMF Analyzer will produce a report at userid.BOZSMF.OUTPUT detailing the top CPU consuming programs, sorted high to low based on the CPU time.

Optionally, a list of data set locations where your COBOL run JCL files are located can be specified and the SMF Analyzer tool will produce an additional report at userid.BOZSMF.OUTPUT.JCLLIST to also show the specific JCL location for each program found in the SMF data.

These JCL files can be used as input to the second component of the ABO Assistant, described next, to automatically optimize and produce a performance report on the CPU time savings from using ABO.

## **ABO Assistant – Program Analyzer and Optimizer**

The Program Analyzer and Optimizer component of the ABO Assistant consists of 2 files:

- BOZPAJ - Sample JCL for invoking the ABO Assistant REXX program BOZPA. There are 6 input parameters that must be specified in this JCL:
  - JCLNAME - Name of the sequential file or PDS(E) member that contains the JCL to run the original COBOL program
  - PGMNAME - Name of the original COBOL program
  - ABO - Data set name of the ABO installation location
  - EXE - Data set name where the BOZPA REXX program is located
  - OPTLOAD - New or existing data set name where the optimized modules will be stored or TEMP to indicate a temporary data set should be used. TEMP is the default.
  - DYNSCAN - Y | N. A setting of Y will cause the modules that make up the application to be scanned for compilation details and no performance report will be produced. A setting of N is the default and will cause the performance report to be generated.
- BOZPA - REXX program that is invoked by the sample job BOZPAJ described above.

After setting the 6 input parameters in BOZPAJ and submitting the JCL, the Program Analyzer and Optimizer actions will depend on the DYNSCAN setting.

When DYNSCAN=N is in effect (the default setting), a performance report is produced at userid.BOZPA.OUTPUT.pgmname. This report shows the time spent in the COBOL application and LE as well as the actual performance improvements from using ABO."

When DYNSCAN=Y is in effect, a report containing compilation details for all programs that dynamically make up the application is produced in the job #2 OPTLOG. This report contains the module and CSECT names, compilation dates, COBOL compiler versions or translator ID records and more for every module that contributes to the applications CPU time.

The report contents are the same as those described in [“The log file for scanning” on page 44](#), except instead of statically scanning modules as with the ABO option SCAN=Y, the DYNSCAN=Y report provides the more targeted information of only those modules/programs actually used by the application.

The report produced by DYNSCAN=Y allows deep insight into the dynamic make up of your COBOL applications.

### **Notes:**

1. When DYNSCAN=Y is in effect, no ABO optimization is performed, and no performance report is produced at userid.BOZPA.OUTPUT.pgmname. The OPTLOAD parameter is also ignored in this case.
2. ABO is automatically and transparently used by the Program Analyzer and Optimizer, so no user action is required to directly invoke ABO.

## How to use the ABO Assistant

This section contains instructions on how to use the two components of the ABO Assistant.

### How to use the SMF Analyzer

Four parameters must be set before submitting BOZSMFJ to run the SMF Analyzer tool:

```
// SET SMFDUMP=hlq.SMF30.DUMP      <- SMF TYPE 30 subtype 4 dump location
// SET ABO=hlq.abo.loadlib         <- Program BOZSMF location
// SET EXE=hlq.bozpa.location      <- REXX program BOZSMFR location
// SET THRESHOLD=0                 <- Minimum CPU Time threshold value
```

Optionally, an additional report can be produced to display the JCL locations to run each program found in the SMF data. To enable this function, provide a list of existing JCL library locations at the PGMHOME in-stream JCLLIST DD file at the bottom of BOZSMFJ:

```
//PGMHOME EXEC PGM=IKJEFT01,REGION=0M,PARM='BOZSMFR 2'
//JCLLIST DD *
example.jcl.library1    <- Put your COBOL related JCL library here
example.jcl.library2    <- Put your COBOL related JCL library here
example.jcl.library3    <- Put your COBOL related JCL library here
```

When BOZSMFJ is submitted with these settings, the following actions take place:

The ABO Assistant REXX program **BOZSMFR** in **hlq.bozpa.location** and program BOZSMF in **hlq.abo.loadlib** will analyze your SMF data in **hlq.SMF30.DUMP** and produce a report at **userid.BOZSMF.OUTPUT** detailing the top CPU consuming programs, sorted high to low based on the CPU time.

If the JCLLIST function is enabled, then the provided JCL data set locations in the final BOZSMFJ step PGMHOME is used to find the JCL locations to run each program. These JCL file locations are displayed next to the sorted CPU data in an additional report at **userid.BOZSMF.OUTPUT.JCLLIST**.

If the JCLLIST function is not enabled or not successful, either by leaving the example data set locations unchanged or specifying an empty JCLLIST in-stream file, or if one or more data sets specified cannot be found, then the PGMHOME step completes with a return code of 4 and the additional report is not generated.

In most cases, only the final reports at BOZSMF.OUTPUT or BOZSMF.OUTPUT.JCLLIST will be required, but two earlier intermediate reports are also generated:

- **userid.BOZSMF.UTTEMP1** - All the performance related fields for all the programs from the SMF30 records
- **userid.BOZSMF.UTTEMP2** - All the performance related fields for non-excluded programs from the SMF30 records. The excluded programs are the records generated by STC/TSU and those in the default exclusion list. BOZSMFJ contains this default exclusion list.

See also [“Example report from the SMF Analyzer”](#) on page 58 for the example reports.

### How to use the Program Analyzer and Optimizer

Six parameters must be set before submitting BOZPAJ to run the Program Analyzer and Optimizer component of the ABO Assistant:

```
// SET JCLNAME=hlq.JCL.LIB(COBJCL)  <- original COBOL program JCL location
// SET PGMNAME=COBPGM              <- COBOL program name
// SET ABO=hlq.abo.loadlib         <- ABO install location
// SET EXE=hlq.bozpa.location      <- REXX program BOZPA location
```

```
// SET OPTLOAD=TEMP          <- put data set name or TEMP
// SET DYNSCAN=N             <- for dynamic scan set to Y
```

The JCLNAME parameter can be obtained from the SMF Analyzer final report that can provide the JCL locations for the top CPU consuming programs.

When BOZPAJ is submitted with these settings, including DYNSCAN=N, the following actions take place:

The ABO Assistant REXX program **BOZPA** in **hlq.bozpa.location** will automatically profile the program **COBPGM** in the original application JCL at **hlq.JCL.LIB(COBYCL)** and then optimize the ABO eligible COBOL CSECTs using the ABO at **hlq.abo.loadlib**. The original and ABO optimized versions of the program will each be run and the performance improvement from using ABO, along with other performance data, will be generated in the ABO Assistant report. See [“Example report from the Program Analyzer and Optimizer”](#) on page 59.

The ABO Assistant report is available at userid.BOZPA.OUTPUT.pgmname file. For example, if the TSO ID of the user who submitted BOZPAJ is *USER* and PGMNAME=COBPGM, then the ABO Assistant report is available at *USER.BOZPA.OUTPUT.COBYCL* file.

The OPTLOAD parameter specifies where the optimized modules will be stored. If left at the default value of TEMP, then the ABO Assistant will use a dynamically allocated temporary data set for the optimized modules. This temporary data set will be removed after the performance report is produced. If the OPTLOAD parameter specifies an existing data set name then the optimized modules will be stored at this location. If the OPTLOAD parameter specifies the name of a data set that does not exist, then this data set will be dynamically allocated at hlq.OPTLOAD to contain the optimized modules. Specifying an existing or new data set name for OPTLOAD allows you to retain the optimized modules after the Program Analyzer and Optimizer completes to be used for further evaluation or deployment.

If DYNSCAN=Y is in effect, then a report detailing compilation information for the modules that dynamically make up the application is produced in the job #2 OPTLOG file. In this case no performance report is generated to userid.BOZPA.OUTPUT.pgmname and the OPTLOAD parameter is also ignored.

If there is a problem with the setting of a BOZPAJ parameter, an error message will be produced in the SYSTSPRT file. See [BOZPAJ Parameter Error Messages](#) for a list of possible messages.

**Note:** Each target COBOL application must be re-runnable sequentially without cleanup or other steps needed that are not already present in the original JCL. For more information on this and other restrictions see [“Limitations and requirements on Program Analyzer and Optimizer”](#) on page 60.

## Example reports

This section contains example reports produced by the two components of the ABO Assistant.

### Example report from the SMF Analyzer

Below are example reports from the SMF Analyzer.

These reports provide a sorted list, from high to low CPU time, of the application jobs and programs for the time range of SMF data that was collected.

This report enables you to quickly identify, at a high level, the applications consuming the most CPU time on your system. These applications would be the best candidates for ABO optimization.

Due to limitations in the SMF data, only the main or driver program name is listed in this report so the second component of the ABO Assistant, the Program Analyzer and Optimizer, should be used to identify and optimize all the programs that make up each application.

The following is an example report of userid.BOZSMF.OUTPUT:

```
IBM Automatic Binary Optimizer for z/OS Assistant
SMF Analyzer, 28 Jan 2021 12:35:13
System: ZTFP      z/OS 2.3
Range: JAN 21, 2021 01:00:01 - JAN 21, 2021 09:00:02
=====
```

```

Top CPU consuming programs
* Listed by job step location
* Sorted high to low by CPU Time

JobName  ProgName StepName CPU sssss.hh
G00960D  ATMCFO00 DMS      8433.67
G73745C  IKJEFT01 BATCHTSO    7791.43
G77121F  TUYS200B SB330      6781.52
G52682H  IKJEFT01 SB332      3384.34
...
G46530T  PK8141SQ SB501       62.98
G21044N  UT8080HG SB423       61.33
Total CPU:                83145.23

```

The following is an example report of userid.B0ZSMF.OUTPUT.JCLLIST:

```

IBM Automatic Binary Optimizer for z/OS Assistant
SMF Analyzer, 28 Jan 2021 12:35:13
System: ZTFP      z/OS 2.3
Range: JAN 21, 2021 01:00:01 - JAN 21, 2021 09:00:02
=====
Top CPU consuming programs
* Listed by job step location
* Sorted high to low by CPU Time

JobName  ProgName StepName CPU sssss.hh Location
G00960D  ATMCFO00 DMS      8433.67 hlq1.PROD.LOAD1.JCL(TYDFD1)
G73745C  IKJEFT01 BATCHTSO    7791.43 hlq1.PROD.LOAD2.JCL(GSDFD2)
G77121F  TUYS200B SB330      6781.52 hlq2.TEST.LOAD.JCL(RDTR5)
G52682H  IKJEFT01 SB332      3384.34 hlq2.TEST.LOAD.JCL(RDTR6)
...
G46530T  PK8141SQ SB501       62.98 hlq1.PROD.LOAD1.JCL(UBBJ4)
G21044N  UT8080HG SB423       61.33 NOT FOUND
Total CPU:                83145.23

```

In these examples, program ATMCFO00 is identified as the top CPU consuming program. The JCL to run this application (hlq1.PROD.LOAD1.JCL(TYDFD1)) is then the input for the example Program Analyzer and Optimizer report shown next to determine the actual CPU reduction from ABO.

## Example report from the Program Analyzer and Optimizer

Below is an example report from the Program Analyzer and Optimizer.

The report indicates the original CPU time when running the application, the CPU time after automatically optimizing the top CPU consuming CSECTs with ABO, and finally the actual CPU reduction from using ABO on this application.

```

=====
IBM Automatic Binary Optimizer for z/OS Assistant
Program Analyzer and Optimizer, 26 Feb 2021 14:06:04

Program: ATMCFO00
z/OS version: 02 . 03
LPAR name: SYSZEF1
IBM Z system: z14 (3906-7F4)

===== ORIGINAL RUN DETAILS =====

Original CPU Time for ATMCFO00: 8.90 seconds

CPU consuming COBOL CSECTs:

Module    CSECT      Product              Status    %TOTAL    DSNAME
-----
ATMSTAC0  ATMSTAC0  Enterprise COBOL V4    *         35.95%    USER.ATM06.COBV42.OPTFULL.LOAD
ATMSTCU0  ATMSTCU0  Enterprise COBOL V4    *         15.44%    USER.ATM06.COBV42.OPTFULL.LOAD
IGZCPAC   IGZCXDI   COBOL LE              -         14.56%    SYS2.CEEZ240.SCEERUN
          IGZCFCC   COBOL LE              -          5.37%
          IGZCONVX  COBOL LE              -          5.10%
          IGZCONV   COBOL LE              -          2.05%
ATMCF000  ATMCF000  Enterprise COBOL V4    *          1.52%    USER.ATM06.COBV42.OPTFULL.LOAD
ATMM0000  ATMM0000  Enterprise COBOL V4    -          1.42%    USER.ATM06.COBV42.OPTFULL.LOAD
ATMVITF0  ATMVITF0  Enterprise COBOL V5    -          0.37%    USER.ATM06.COBV42.OPTFULL.LOAD
ATMSTBR0  ATMSTBR0  Enterprise COBOL V4    *          0.31%    USER.ATM06.COBV42.OPTFULL.LOAD
ATMURND0  ATMURND0  Enterprise COBOL V6    -          0.07%    USER.ATM06.COBV42.OPTFULL.LOAD
ATMCFEE0  ATMCFEE0  Enterprise COBOL V4    *          0.05%    USER.ATM06.COBV42.OPTFULL.LOAD

```

```

      ATMOFEE0 Enterprise COBOL V4      *      0.03%
      ATMRTALG Enterprise COBOL V4      *      0.00%
      ATMRTCLG ATMRTCLG Enterprise COBOL V4      *      0.00%      USER.ATM06.COBV42.OPTFULL.LOAD

Program ATMCFO00 spends 82.24% of time in COBOL application & LE

===== OPTIMIZED RUN DETAILS =====

Set ARCH=12 for z14

* Optimize 8 COBOL CSECTs from 6 modules using ABO, store the modules in
USER.BOPPA.TEST.OPTLOAD

ABO optimized CPU Time for ATMCFO00: 03.84 seconds

===== RESULTS =====

CPU time reduction using ABO: 56.85%

=====

```

**Note:** The character in column 4 (following the language or product name) indicates the CSECT's eligibility for optimization by ABO:

- An asterisk `\*` indicates the CSECT is eligible for ABO optimization
- A space ` ` indicates the CSECT is not eligible for ABO optimization, because for example, it is part of Language Environment (LE), or is from a language not supported by ABO (e.g. PL/I) or that it is compiled by a version of the COBOL compiler not currently eligible for ABO optimization (e.g. Enterprise COBOL V5 or V6)
- A dash `-` indicates the CSECT has already been optimized by ABO so is not eligible to be optimized again. Optimization by ABO can only happen from original CSECT.

## BOZPAJ parameter error messages

Any errors in the BOZPAJ parameters will cause a BOZPAJ job failure with return code 8 and the **SYSTSPRT** file will have one of the following messages:

```

*** Error: no JOB card provided in jclname
*** Error: no EXEC card provided in jclname
*** Error: invalid data set jclname
*** Error: data set jclname could not be found
*** Error: data set ABO could not be found
*** Error: invalid OPTLOAD optload
*** Error: invalid DYNSCAN dynscan
*** Error: allocating data set optload

```

## Limitations and requirements on Program Analyzer and Optimizer

The Program Analyzer and Optimizer component of the ABO Assistant beta has some limitations and requirements on the types and format of JCL it can process and the application environments where it can operate.

Unless otherwise indicated, all the error messages are placed in the SYSTSPRT file from job #2.

1. The ABO Assistant can be used on LE enabled batch applications. The ABO Assistant does not work for CICS or IMS applications. The ABO Assistant will not work if your z/OS operating system is running on z/VM.
2. The target COBOL application must be re-runnable sequentially without cleanup or other steps needed that are not already present in the original JCL. This is required as two runs of the application (original and ABO optimized) are required to form the performance comparison. The errors generated in case of some resource missing or a skipped cleanup step will vary depending on the missing action during the second run of the application.

User response:

Modify the original JCL so all required cleanup or other steps are included to enable a sequential rerun of the application



3. The COBOL program specified by the `pgmname` variable, as well as, any other COBOL program implicitly called must be in the STEPLIB data set concatenation for it to be available for ABO optimization.

If a module is not found in the STEPLIB, but still found in the LINKLIST or any other system library, then the ABO Assistant will continue, but the corresponding module will not be optimized, and will be marked as 'not found in STEPLIB' in the ABO Assistant report.

If the module is not found at all then ABEND 806 will be generated.

User response:

Add the missing data set(s) containing all modules required for the application to the STEPLIB concatenation

4. As the ABO Assistant uses ABO it has the same system and hardware requirements as ABO does. If the system used for any of generated jobs #1 or #2 is not supported, the BOZPAJ job will fail with return code 8 and one of the following error messages will be generated.

Messages:

z/OS version: `xx.xx` is not a supported z/OS version to run ABO.

IBM z server: `(xxxx)` is not a supported hardware level to run ABO optimized modules.

User Response:

Ensure the system being used for the ABO Assistant meets the minimum requirements for ABO.

**Note:** The ABO Assistant automatically detects the IBM Z system where it is being run and sets the ARCH level for ABO optimization to match the IBM Z system.

5. The target COBOL program name provided in the original JCL with 'PGM=' parameter cannot be a variable. For example, the following are not allowed:

```
//STEP1 EXEC PGM=&pgm
```

or

```
PGM=%pgm
```

If variable name is used in the 'PGM=' field, or there is no step with the specified COBOL program name `pgmname` found in the original JCL, the BOZPAJ job fails with return code 8 and an error message is generated.

This error can occur if your JCL contains external JCL procedures as expansion is not supported. To work around this the JCL procedures can be copied into the JCL.

Message:

```
*** Error: no step with PGM=pgmname located in jclname
```

User response:

Correct the JCL so a variable is not used for the program name. If your JCL contains external JCL procedures, then copy the JCL procedures into your JCL.

6. If the original job JCL has system affinity or routing directives, such as CLASS, SYSAFF, ROUTE, SCHENV, these may cause the job to be routed for execution on a system that satisfies the requirements.

Depending on routing directives there may be a different system selected each time. This may cause the automatically generated jobs #1 and #2 to be run on different systems

In case the IBM mainframe level of the jobs #1 and #2 runs are not the same, then the job #2 completion code will be 4 and a warning message will be generated at the end of the ABO Assistant report.

Message:

\*\*\* Warning: the system ARCH level for POC JOB # 1 and # 2 is nn nn respectively

The evaluation results may not be accurate.

User response:

Adjust the original JCL routing directives to ensure the same single system selection for each job

7. The TSO user invoking the ABO Assistant must be authorized to use the TSO SUBMIT command. If not, then the tool's use of this command will fail, and the BOZPAJ job will fail with return code 8 and an error message generated.

Message:

\*\*\* Error: TSO SUBMIT command failure

User response:

Obtain TSO user authorization for using TSO SUBMIT

8. The STEPLIB JCL card must be present in the target step (step with EXEC PGM=pgmname) of the original JCL. If no STEPLIB card is found, then the BOZPAJ job fails with return code 8 and an error message is generated.

Message:

\*\*\* Error: no STEPLIB provided for stepname step in jclname

User response:

Add the required STEPLIB card to the JCL

## Additional usage notes

The following are some additional usage notes:

- You can use the SDSF SJ command in front of jobs #1 and #2 to see and possibly reuse the JCL internally generated for those jobs by the ABO Assistant.
- The complete RTI profiles generated by jobs #1 and #2 for your original and ABO optimized COBOL programs can be found in the following locations for program pgmname:
  - Original RTI Profile: userid.SYSPROFD.ORIG(pgmname)
  - ABO optimized RTI profile: userid.SYSPROFD.OPTIM(pgmname)

## SMF DUMP generation

The SMF dump used as the input to the SMF Analyzer component of the ABO Assistant can be produced by either the IFASMFDP or IFASMF DL program depending on your system installation and your system programmer recommendations.

Sample 1:

```
//IFASMFDP JOB    accounting information
//STEP     EXEC   PGM=IFASMFDP
//INDD1    DD     DSN=SYS1.MANB,DISP=SHR
//OUTDD1   DD     DSN=&SYSUID..SMFDUMP,DISP=(,CATLG,DELETE),UNIT=SYSDA,
//          SPACE=(CYL,(10,10),RLSE),DCB=(LRECL=32760,RECFM=VBS,BLKSIZE=0)
//SYSPRINT DD     SYSOUT=*
//SYSIN    DD     *
              INDD(INDD1,OPTIONS(DUMP))
              OUTDD(OUTDD1,TYPE(30(4)))
              DATE(2020151,2020151)
              START(1200)
              END(1600)
/*
```

The above job produces &SYSUID..SMFDUMP that contains the SMF 30 subtype 4 records collected by system in the data set SYS1.MANB on day 151 of year 2020, from 12:00 to 16:00.

**Note:** Consult your system programmer to determine the correct data set name for the INDD1 statement.

Sample 2:

```
//IFASMF DL  JOB   accounting information
//STEP      EXEC   PGM=IFASMF DL
//OUTDD1    DD     DSN=&SYSUID..SMFDUMP,DISP=(,CATLG,DELETE),UNIT=SYSDA,
//           SPACE=(CYL,(10,10),RLSE),DCB=(LRECL=32760,RECFM=VBS,BLKSIZE=0)
//SYSPRINT  DD     SYSOUT=*
//SYSIN     DD     *
              LSNAME (IFASMF.SMFT030.SYSA,OPTIONS(DUMP))
              OUTDD (OUTDD1,TYPE(30(4)))
              DATE (2020151,2020151)
              START (1200)
              END (1600)
/*
```

The above job produces &SYSUID..SMFDUMP that contains the SMF 30 subtype 4 records collected by system in the log stream IFASMF.SMFT030.SYSA on day 151 of year 2020 from 12:00 to 16:00.

**Note:** Consult your system programmer to determine the right log stream name for the LSNAME statement. In the above sample, the appropriate log stream name on LPAR SYSA is IFASMF.SMFT030.SYSA.



---

## Chapter 8. Managing optimization and optimized module deployment process

### Taking an iterative and staged approach when using ABO

An iterative and staged approach to using ABO is a recommended approach to balance the cost of the optimization process to the benefits from running the optimized programs generated by ABO.

For example, first optimize the modules containing the top x% contributors to CPU time. Measure the impact (for example, the reduction in CPU time) using these ABO generated modules, and then repeat for the next top x% CPU contributors until your performance goals are met.

Included with ABO is the [Chapter 7, “Using the ABO Assistant,” on page 55](#). The ABO Assistant automates all the individual steps required to efficiently optimize your COBOL batch application using ABO and to clearly report on the CPU time savings from using ABO. The ABO Assistant can be used when evaluating ABO to determine potential CPU savings and also to prioritize deployment of applications and determine the top CPU consuming modules and CSECTs.

There are also stand-alone performance measurement and reporting tools that can be used, such as [IBM Application Performance Analyzer \(APA\) for z/OS](#), to help determine the top CPU contributors. Alternatively, the [RTI Profiler](#) that comes with ABO can be used for COBOL batch applications to help determine which modules and CSECTs are most frequently executed when the application is running.

### Characteristics of programs that benefit most from ABO

Some compiled programs will benefit more from ABO than others. Knowing some key characteristics of these programs can also help in staging use of ABO on your compiled COBOL programs.

ABO can only improve performance of the original compiler generated code and some select Language Environment (LE) routines, but ABO does not have the means to improve performance when time is spent in other subsystems such as CICS, Db2, and IMS.

Key characteristics of programs that might benefit more from optimization with ABO are:

- A significant portion of the application’s execution time is spent in the COBOL code instead of in other subsystems such as CICS, Db2, and IMS.
- The COBOL code is performing a significant amount of computations. For example, a program where the COBOL code itself is doing the actual, real work, and is not simply acting as a "driver" program for other programs or subsystems.
  - At the source level, some statements most likely to benefit include, but are not limited to: COMPUTE, IF, MOVE, ADD, SUBTRACT, MULTIPLY, DIVIDE, and REMAINDER.
  - In addition, some select Language Environment (LE) routines can also be optimized by ABO. These routines perform a variety of conversion, move, and arithmetic operations and include IGZCSH2, IGZCFPC, IGZCONV, IGZCVMO, IGZCXPR, IGZCXMU, and IGZCXDI. ABO optimizes these routines by more efficiently performing the work of these routines directly in the optimized code or by calling a more efficient LE routine.

**Note:** Looking at the COBOL source alone does not take into account where the time in the application is actually spent, so this should be done in combination with a performance report from an analysis tool such as APA.

- Most COBOL modules within the application are eligible for optimization by ABO. This means that the modules were compiled with an eligible COBOL compiler and contain language features that are supported by ABO.

## Optimization and deployment usage scenarios

This section contains three typical usage scenarios for IBM Automatic Binary Optimizer for z/OS. These scenarios describe possible approaches to using the IBM Automatic Binary Optimizer for z/OS to improve the performance of already compiled IBM COBOL programs. Each scenario provides step-by-step instructions to enable you to optimize your compiled IBM COBOL programs.

### Scenario 1: Optimization process with static deployment

In this usage scenario, specify input modules to the optimizer in your JCL using BOPT directives, and for deployment, update all existing JCL that identifies data sets containing the original modules.

#### Procedure

To perform the optimization with static deployment, complete the following steps:

1. Create new data sets. For example, the following data sets are created for this scenario where *HLQ* is the high-level qualifier that you define.
  - *HLQ.OUT.LOAD.Z14*. This data set will be populated with optimized binaries targeting the z14 machine.
  - *HLQ.OUT.LOAD.Z15*. This data set will be populated with optimized binaries targeting the z15 machine.
2. Run ABO to populate the new data sets. To run the optimizer, create new JCL. In the in-stream line that starts with SYSIN, use the BOPT optimizer directive. Select your compiled COBOL programs to optimize with the IN option. For example, the following JCL instructs the optimizer to optimize all the members with names beginning with M from *HLQ.IN.LOAD*. The optimized binaries targeting z14 and z15 are placed in *HLQ.OUT.LOAD.Z14* and *HLQ.OUT.LOAD.Z15* respectively.

```
...  
//SYSIN DD *  
BOPT IN=HLQ.IN.LOAD(M*) OUT=HLQ.OUT.LOAD.Z14 LIST=HLQ.OUT.LIST.Z14 ARCH=12  
BOPT IN=HLQ.IN.LOAD(M*) OUT=HLQ.OUT.LOAD.Z15 LIST=HLQ.OUT.LIST.Z15 ARCH=13
```

The example is intended to reflect what the user should specify in the SYSIN file. For basic JCL configuration, see [Appendix A, “JCL sample,”](#) on page 75. For more sample JCL that you can use in the static deployment scenario, see [“Specifying optimization with BOPT”](#) on page 31.

3. To run the optimized programs, modify the JCL that is used to run the original programs. That JCL identifies data sets that contain the original modules. In the STEPLIB setting, you must place the data sets of the optimized modules ahead of the data sets of the original modules for each targeted architecture. The following snippets show the modified parts in JCL that points to the optimized and original program binaries.

Here's the modified part in the JCL that is used to run the original program on z14:

```
//STEPLIB DD DSN=HLQ.OUT.LOAD.Z14,DISP=SHR  
// DD DSN=HLQ.IN.LOAD,DISP=SHR  
...
```

Here's the modified part in the JCL that is used to run the original program on z15:

```
//STEPLIB DD DSN=HLQ.OUT.LOAD.Z15,DISP=SHR  
// DD DSN=HLQ.IN.LOAD,DISP=SHR  
...
```

### Scenario 2: Optimization process with dynamic deployment

In this usage scenario, map input to output modules in IEFOPZxx SYS1.PARMLIB's members and then use the IEFOPZ optimizer directive to specify optimization of input to output modules. After the binary

optimization completes, run the optimized programs with no changes to the existing JCL that was used to run the original programs.

## About this task

IEFOPZxx contains statements that define the data set optimization configuration which provide a list of pairings of an old COBOL library and the intended new libraries (one for each desired architecture level) and specifies which members are to be processed (optimized). For more information, see *z/OS MVS Initialization and Tuning Reference*.

## Procedure

To perform the binary optimization with dynamic deployment, complete the following steps:

1. Create new data sets. For example, the following data sets are created for this scenario where *HLQ* is the high-level qualifier that you define.
  - *HLQ.OUT.LOAD.Z14*. This data set will be populated with optimized binaries targeting the z14 machine.
  - *HLQ.OUT.LOAD.Z15*. This data set will be populated with optimized binaries targeting the z15 machine.
2. Define the IEFOPZ configuration.
  - a. Create an IEFOPZxx member.
  - b. For each old data set that contains the compiled module that you want to optimize, define an OLD/NEW pair in the IEFOPZxx member. Mark the OLD/NEW pair as INACTIVE so that the system does not do any OLDNEW processing unexpectedly. See the following example:

```
MAXARCH(13)
CHECKALL
OWNER(IBM) MINARCH(12)
OLDNEW(
  OWNER(IBM)
  OLD (DSN(HLQ.IN.LOAD))
  NEW (DSN(HLQ.OUT.LOAD.Z14)  ARCH(12))
  NEW (DSN(HLQ.OUT.LOAD.Z15)  ARCH(13))
  INCLUDEMEMBERS(M*) //Identifies to process all members beginning with M
  INACTIVE
)
```

**Note:** The OLD/NEW pairs can be defined in one or multiple IEFOPZxx members.

3. To activate the IEFOPZ configuration, use the following z/OS MVS System command:

```
SET IEFOPZ=( $x_1, \dots, x_n$ )
```

where  $x_1, \dots, x_n$  are the suffixes xx for the IEFOPZxx members. If in the previous step, you only create one member, the command is as follows:

```
SET IEFOPZ= $x_1$ 
```

**Note:** The SET command modification stays through the current IPL session only. Therefore, it is usually used for the new configuration quick test, or to override some permanent definitions during the current IPL session. For permanent configuration definitions, see step 5.

4. Run IBM Automatic Binary Optimizer for z/OS to populate the new data sets.

To run the optimizer, write JCL as follows. In the in-stream data that starts with SYSIN, use the IEFOPZ directive.

```
..SYSIN DD *
IEFOPZ SEL_ARCH=12 LIST=HLQ.BOZOPT.ARCH12.LIST
IEFOPZ SEL_ARCH=13 LIST=HLQ.BOZOPT.ARCH13.LIST
```

The example is intended to reflect what the user should specify in the SYSIN file. For basic JCL configuration, see Appendix A, “JCL sample,” on page 75. For more sample JCL that you can use in the dynamic deployment scenario, see “Specifying optimization with IEFOPZ” on page 34.

5. Update your IEASYSxx SYS1.PARMLIB member with the IEFOPZ system parameter so that subsequent IPLs will properly activate the desired IEFOPZ configuration. For example, to have the IEFOPZ configuration specified in member IEFOPZ99 automatically activated with each subsequent IPL, put the IEFOPZ=99 statement into your IEASYSxx member. However, the SET command described in step 3, if issued for example as follows: SET IEFOPZ=99, will activate the desired IEFOPZ99 member for the current IPL session only.
6. Redefine the OLD/NEW pairs as ACTIVE. If you want OLD/NEW processing to be done for any DDNAMEs other than JOBLIB and STEPLIB, define those within an IEFOPZxx parmlib member using the DDNAME statement. Then activate that updated IEFOPZ configuration.
7. Run the optimized programs by using the existing JCL that was used to run the original programs.

#### Related reference

[“Related publications” on page 103](#)

## Scenario 3: Optimization process using a hybrid approach

In the hybrid approach, specify the input binaries to optimize explicitly in your JCL as what you do in Scenario 1, but combine with dynamic deployment demonstrated in Scenario 2. With dynamic deployment, run the optimized modules without changing the existing JCL.

### Procedure

To perform the binary optimization using a hybrid approach, complete the following steps:

1. Create new data sets. For example, the following data sets are created for this scenario where *HLQ* is the high-level qualifier that you define.
  - *HLQ.OUT.LOAD.Z14*. This data set will be populated with optimized binaries targeting the z14 machine.
  - *HLQ.OUT.LOAD.Z15*. This data set will be populated with optimized binaries targeting the z15 machine.
2. Run IBM Automatic Binary Optimizer for z/OS to populate the new data sets.

To run the optimizer, create new JCL. In the in-stream data that starts with SYSIN, use the BOPT optimizer directive to select compiled COBOL modules to optimize. For example, the following JCL instructs the optimizer to optimize all the members that begin with the letter M from *HLQ.IN.LOAD*. The optimized binaries targeting z14 and z15 are placed in *HLQ.OUT.LOAD.Z14* and *HLQ.OUT.LOAD.Z15* respectively.

```
//SYSIN      DD *
BOPT IN=HLQ.IN.LOAD(M*) OUT=HLQ.OUT.LOAD.Z14  ARCH=12
BOPT IN=HLQ.IN.LOAD(M*) OUT=HLQ.OUT.LOAD.Z15  ARCH=13
```

The example is intended to reflect what the user should specify in the SYSIN file. For basic JCL configuration, see Appendix A, “JCL sample,” on page 75. For more sample JCL that you can use in the hybrid scenario, see “Specifying optimization with BOPT” on page 31.

3. Define the IEFOPZ configuration.
  - a. Create an IEFOPZxx member.
  - b. For each old data set that contains the compiled module that you want to optimize, define an OLD/NEW pair in the IEFOPZxx member. Mark the OLD/NEW pair as ACTIVE. See the following example.

```
OLDNEW (
  OLD( DSNAME (HLQ.IN.LOAD) )
  NEW( DSNAME (HLQ.OUT.LOAD.Z14) ARCH(12) )
  NEW( DSNAME (HLQ.OUT.LOAD.Z15) ARCH(13) )
```



```
INCLUDEMEMBERS(M*) //Identifies to process all members beginning with M  
ACTIVE )
```

**Note:** The OLD/NEW pairs can be defined in one or multiple IEFOPZxx members.

- c. If you want OLDNEW processing to be done for any DDNAMEs other than JOBLIB and STEPLIB, define those within an IEFOPZxx parmlib member using the DDNAME statement. Then activate that updated IEFOPZ configuration by using the following command:

```
SET IEFOPZ=( $x_1, \dots, x_n$ )
```

where  $x_1, \dots, x_n$  are the suffixes xx for the IEFOPZxx members. If in the preceding step, you create only a single member, the command is as follows:

```
SET IEFOPZ= $x_1$ 
```

4. Run the optimized programs by using the existing JCL that was used to run the original programs.

#### **Related reference**

[“Related publications” on page 103](#)

## Testing information

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The optimized modules that ABO produces will run faster but will have the same behavior, except from some isolated [error message and abend code differences](#), as the original COBOL modules. ABO is able to do this because it processes the binary code within the COBOL module so it is able to ensure the low level logic of the program remains the same. This means that users of ABO do not have to perform full functional verification testing of the ABO optimized modules. Some limited testing is recommended to ensure basic functioning of the applications using the ABO optimized modules prior to deploying ABO optimized modules into a production environment.

Performance testing is best done in a controlled environment with the same input data used with the original application and with the application containing ABO optimized modules. Using a machine or LPAR that has as few as possible other applications running for performance testing will allow for stable and reproducible performance results. Comparing the CPU time between the original application and optimized application is the best way to see performance gains.



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# Chapter 9. Resolving problems with optimization and optimized module deployment

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## Resolving problems that occur during optimization time

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The return code that ABO passes to z/OS is an indicator of whether a problem was encountered during optimization. A return code value of zero means that optimization was successful and no problems were encountered. A return code value other than zero, indicates something unexpected occurred or a problem was encountered. For more information on return codes, see [Appendix B, “Return codes,” on page 77](#).

ABO produces output files that can be used to diagnose problems.

The following files can be helpful in diagnosing problems encountered during the optimization of COBOL programs:

- The [log file](#) gives a summary of what has been optimized or scanned, and error messages if applicable. See [Messages](#) for more information. The log file is the first place you should examine if problems are detected during the optimization process.
- The file specified by the [OPTERR DD](#) are written to in exceptional circumstances. If the OPTERR DD is not specified, those messages are written to the JOBLOG.
- The file specified by the [CEEDUMP DD](#) are written to in circumstances such as a program exception when running ABO. The CEEDUMP file is produced by Language Environment (LE) and includes information such as a traceback of procedures that were executing at the time of the abend.
- The JOBLOG includes additional diagnostic messages that complement error messages that were written elsewhere or the JOBLOG can be a default location for errors encountered in exceptional circumstances.

---

## Resolving problems encountered during execution

---

### Common execution error solutions

ABO optimized modules might fail with a U4038 abend if the "Language Environment Automatic Binary Optimizer Runtime Engine" PTF installed is not the latest PTF available. In this case, the module will output one of the following messages:

```
IGZ0153S Program B0ZSRC1 was compiled with a level of the compiler that requires service to be
installed on Language Environment.
IGZ0355S Program B0ZSRC1 was optimized with a level of the Automatic Binary Optimizer that
requires service to be installed on Language Environment.
```

PTFs on z/OS 2.2 and 2.3 will cause the first message to be issued, and PTFs on z/OS 2.4 will cause the second message to be issued. To resolve this problem, the latest "Language Environment Automatic Binary Optimizer Runtime Engine" PTF listed in the Program Directory should be installed. The latest information about the ABO PTFs can also be found on the [fix list and new features page](#).

An 0C1 abend occurs if you attempt to run the ABO generated modules on a system that is not supported by ABO. See [“Target hardware levels” on page 4](#) for the supported systems.

### Execution error diagnosis

The problem determination tools provided by IBM in the [Application Delivery Foundation for z/OS](#) can be used to determine the source of execution time problems in applications that contain ABO optimized modules. If the problem determination tools are not available, the listing transform produced by ABO can help diagnose the execution time problems.

If diagnoses determine that an ABO optimized module causes the execution time problem, revert to the original COBOL module and contact IBM service to report the problem. To learn about the information that needs to be collected to report an ABO problem to IBM, see [ABO Mustgather page](#).

## Changes in COBOL module size after optimization

---

The size of an optimized module is typically larger than the original module due to the types of optimizations ABO does to improve performance.

Here are some common reasons for the module size increase:

- Use of higher ARCH instructions that are usually 6 bytes versus 4 or 2 bytes in length for many lower ARCH instructions. For example:
  - Using Decimal Floating Point (DFP) for packed/zoned decimal arithmetic to improve performance
  - Replacing "base locator" pointers in the original module with more efficient but larger long displacement instructions
  - Using more than one move immediate instruction instead of one in memory move
- A number of optimizations in ABO generate more code but shorter path length and better performance. For example:
  - More efficient handling of numeric edited variables
  - Unrolling long move and compare operations instead of using shorter but much slower instructions
  - Conditionally correcting decimal precision for binary data
- The inlining of the behavior of various runtime library routines results in more code in the optimized module but much faster performance in many cases.

So for these and similar reasons the optimized modules produced by ABO are often larger than the original modules and require more on disk storage. However, the amount of memory used by the optimized program itself when running is the same as that used by the original module. A slightly higher EXCP count will sometimes be observed when running the optimized program but this is only due to the few extra I/O operations required to load the larger module.

Note that an optimized module will keep its size unchanged if the optimized code happens to be smaller than the original code.

## Error message and abend code differences

---

The optimized modules generated by ABO are in almost every case functionally equivalent to the corresponding original modules. However, in some rare cases an ABO generated module will produce different Language Environment (LE) runtime messages or different CICS abend codes than the original module.

This can happen when division on large data items and other complex operations are inlined or optimized in the generated code by ABO for more efficient processing, instead of being handled by an LE library routine or inefficient machine instructions.

In a non-CICS application, an ABO generated module:

- may produce a fixed-point divide exception (CEE3209S) message in places where the original module produced a decimal-divide exception (CEE3211S) or IGZ0061S message.
- may produce a decimal-divide exception (CEE3211S) in places where the original module produced a IGZ0061S message

For reference the full LE runtime message text for these differing exceptions is given below.

```
CEE3211S The system detected a decimal-divide exception (System Completion Code=0CB).  
IGZ0061S Division by zero occurred in program 'program-name' at displacement 'displacement'.  
CEE3209S The system detected a fixed-point divide exception (System Completion Code=0C9).
```

For a CICS application the abend code returned by "CICS ASSIGN ABCODE" can change from '1061' from the original module to 'ASRA' from the ABO generated module.

## Application Delivery Foundation for z/OS

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You can use Application Delivery Foundation for z/OS (ADFz) on ABO generated modules.

Find out more about Application Delivery Foundation for z/OS at <https://www.ibm.com/ca-en/marketplace/app-delivery-foundation-on-zsystems>.

The following Application Delivery Foundation for z/OS family of problem determination tools can be used on ABO generated COBOL modules:

- Developer for z/OS Enterprise Edition, which includes the IBM Debug for z/OS
- Fault Analyzer for z/OS (FA)
- Application Performance Analyzer for z/OS (APA)

In order to use these tools more effectively, you need to produce a LANGX side file for each optimized program. DT, FA, and APA exploit the side file to provide a better tool experience. For example, source-level debugging is provided with Debug for z/OS when a LANGX side file is provided. Without the side file, source-level debugging is not possible.

### Creating a LANGX side file

IPVLANGO is a new tool provided with IBM Problem Determination Tools Common Component for z/OS V1.7, which is shared by the Application Delivery Foundation for z/OS tools. IPVLANGO combines the SYSDEBUG data set or compiler listing or the LANGX side file of the original compiled program along with the ABO listing transform to produce a new LANGX side file appropriate for the ABO generated module. Use the new LANGX file when you use DT, FA, or APA on the ABO generated module.



# Appendix A. JCL sample

The following JCL sample is included in the IBM Automatic Binary Optimizer for z/OS installation package.

```
//BOZJCLE JOB <job parameters>
//*****
//* Job Name: BOZJCLE *
// *
// * Licensed Materials - Property of IBM *
// * 5697-AB2, 5655-EC6 *
// * Copyright IBM Corp. 2015, 2019 *
// * This file is part of product 5655-EC6, 5655-TY6, 5697-V61 *
// * 5697-AB2, 5697-TR2 *
// *
// * US government users restricted rights *
// * use, duplication or disclosure restricted *
// * by GSA ADP schedule contract with IBM Corp. *
// *
//*****
//* Description: This JCL will optimize a COBOL program using *
// * IBM Automatic Binary Optimizer for z/OS *
// * V02.01.00 *
//*****
// SET BOZJOBID = 'unique-identifier'
// *
//OPT EXEC PGM=BOZOPT,REGION=0M
//STEPLIB DD DSN=hlqboz.BOZ210.SBOZMOD1,DISP=SHR
//SYSLIB DD DSN=hlqboz.BOZ210.SBOZMOD1,DISP=SHR
// DD DSN=hlqcee.SCEELKED,DISP=SHR
// DD DSN=hlqcee.SCEELKEX,DISP=SHR
//OPTLOG DD DSN=hlq.BOZOUT.OPTLOG(&BOZJOBID),DISP=SHR
//OPTERR DD DSN=hlq.BOZOUT.OPTERR(&BOZJOBID),DISP=SHR
//CEEDUMP DD DSN=hlq.BOZOUT.CEEDUMP(&BOZJOBID),DISP=SHR
//SYSPRINT DD DSN=hlq.BOZOUT.LISTING,DISP=SHR
//SYSBIN DD DSN=input-load-library,DISP=SHR
//SYSBOUT DD DSN=output-load-library,DISP=SHR
//SYSIN DD *
ARCH=arch-number
BOPT IN=DD:SYSBIN(member-name) OUT=DD:SYSBOUT(member-name)
```

**Note:**

The SYSLIB DD in the above JCL might be required if the external call resolution is required only.

In the JCL example, hlqboz.BOZ210.SBOZMOD1 is the installation location chosen for the optimizer.

This example requires the following data sets to be allocated beforehand:

- hlq.BOZOUT.OPTLOG
- hlq.BOZOUT.OPTERR
- hlq.BOZOUT.LISTING
- hlq.BOZOUT.CEEDUMP

You can allocate these data sets with the recommended parameters in the following table:

Table 12. Recommended allocation parameters	
Data sets	Recommended allocation parameters
hlq.BOZOUT.OPTLOG hlq.BOZOUT.OPTERR hlq.BOZOUT.LISTING	Space units: CYLS Primary quantity: 50 Secondary quantity: 50 Directory blocks: 10 Record format: VB <sup>1</sup> Record length: 512 Block size: 27998 Data set name type: Library

Table 12. Recommended allocation parameters (continued)

Data sets	Recommended allocation parameters
hlq.BEZOUT.CEEDUMP	Space units: CYLS Primary quantity: 10 Secondary quantity: 10 Directory blocks: 10 Record format: FB Record length: 133 Block size: 27930 Data set name type: Library
<b>Notes:</b>  1. hlq.BEZOUT.OPTLOG and hlq.BEZOUT.OPTERR <b>must</b> have a record format of VB to be opened successfully. For hlq.BEZOUT.LISTING a record format of FB is also allowed, though information will be truncated from the listing if the record length is too short. A record length of at least 133 is recommended to ensure no truncation occurs.	

&BEZJOBID is a unique identifier for this job chosen by the user. It is used as the member name in each of the hlq.BEZOUT.OPTLOG, hlq.BEZOUT.OPTERR, and hlq.BEZOUT.CEEDUMP data sets. &BEZJOBID must be a valid member name.

This JCL sample shows a definition of the SYSIN DD for optimizing a single module. For more examples, see “JCL examples” on page 31 and “Optimization and deployment usage scenarios ” on page 66. For descriptions of the ddnames used in the example, see [“Required DD statements” on page 15.](#)



---

## Appendix B. Return codes

IBM Automatic Binary Optimizer for z/OS emits messages to provide information, provide possible warnings, or to report errors. Each message has a "Message return code" that is documented in [Appendix C, "Messages," on page 79](#). On termination, ABO passes a return code value to z/OS that is the maximum of the "Message return code" values of all the messages that were emitted. If no messages were emitted, then a return code of 0 is returned to z/OS.

Table 13. IBM Automatic Binary Optimizer for z/OS return codes	
Return code (decimal)	Description
0	Successful completion of all processing. One or more informational messages may have been emitted.
4	Successful completion but an unusual condition was detected. One or more warning messages have been emitted.
12	<p>An error was detected during the processing of a BOPT or IEFOPZ directive or global option. One or more messages have been emitted.</p> <ul style="list-style-type: none"><li>• If the error occurs during syntax processing of a line of input, the rest of the line is rejected and ABO proceeds to process the next line of input.</li><li>• If the error occurs while processing a BOPT or IEFOPZ directive, ABO proceeds to process the next applicable module of the BOPT or IEFOPZ directive. If there are no further input modules to process for the BOPT or IEFOPZ directive, processing of the directive is terminated and ABO proceeds to the next line of input to process the next directive or terminates if there are no more lines of input.</li></ul>
16	An unrecoverable error was detected. One or more messages are emitted and ABO immediately terminates processing.



---

## Appendix C. Messages

The messages described in this section are written to the OPTLOG DD. In some exceptional cases, it may not be possible to write to the OPTLOG DD in which case the message is written to the OPTERR DD otherwise to the JOBLOG. Each message, listed below, has a "Message return code" that is used to determine the return code returned to z/OS as described in [Appendix B, "Return codes,"](#) on page 77.

Each ABO message in this section has the form BOZnnnnX where BOZ indicates that the message is an ABO message, nnnn is the message number, X is the severity indicator.

Severity indicators can be any of the following: I, W, E, S, or U.

- I**  
Informational message (RC=0)
- W**  
Warning message (RC=4)
- E**  
Error message (RC=8)
- S**  
Severe error message (RC=12)
- U**  
Unrecoverable error message (RC=16)

---

### **BOZ1003U      Program caught signal &1, exiting with return code 16.**

#### **Explanation:**

The optimizer was unable to continue because an unexpected condition was encountered during processing.

#### **System action:**

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

#### **User response:**

Unexpected problems could happen due to an earlier problem. Correct any problems reported in the log file and retry the optimization process. If the problem persists, consult IBM service for assistance.

#### **Message return code**

16

---

### **BOZ1031S      An error occurred while attempting to open "&1".**

#### **Explanation:**

The optimizer was unable to open the file specified by &1.

#### **System action:**

If the open failure was associated with one of the required optimizer DDs, such as the SYSIN DD, the optimizer immediately terminates with a return code of 16. Otherwise, if the file is specified on a line in the SYSIN input file (in a global option or BOPT or IEFOPZ

directive), processing of the line is terminated and the optimizer proceeds to process the next line of the SYSIN input file.

#### **User response:**

Ensure that the file name is correct, and that the file has been allocated and with an appropriate record format and with an appropriate record length.

#### **Message return code**

16 when attempting to open a mandatory DD, otherwise 12.

---

### **BOZ1145U      Insufficient memory in the compiler to continue compilation.**

#### **Explanation**

The optimizer was unable to continue due to memory being low.

#### **System action:**

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

#### **User response:**

Consider using the JCL MEMLIMIT or JCL REGION parameters to increase the memory used by the optimizer. For more information, see the [z/OS MVS Initialization and Tuning Reference](#) and the [z/OS MVS Initialization and Tuning Guide](#).

#### **Message return code**

**BOZ1400S      Directive is missing "&1" specifier.****Explanation**

The optimizer encountered a BOPT or IEFOPZ directive that requires an &1 specifier, but the specifier was missing.

**System action:**

The optimizer discards the directive and proceeds to process the next line in the SYSIN input file.

**User response:**

Correct the directive by adding an appropriate &1 specifier.

**Message return code**

12

**BOZ1401S      "&1" directive must be specified at start of line.****Explanation**

An option preceded the &1 directive on a line of the SYSIN input file, or the line is missing the &1 directive.

**System action:**

The optimizer discards the directive and proceeds to process the next line in the SYSIN input file.

**User response:**

Fix the line by specifying &1 directive at the start of the line.

**Message return code**

12

**BOZ1402S      Invalid specifier in "&1".****Explanation**

The &1 option of BOPT or IEFOPZ directive contained an invalid specifier. For example, "H" is an invalid specifier in the option: "SCAN=H".

**System action:**

The optimizer discards the directive with the invalid specifier and proceeds to process the next line in the SYSIN input file.

**User response:**

Change the specifier in the option to one that is valid.

**Message return code**

12

**BOZ1403S      Invalid option "&1".****Explanation**

While processing the SYSIN input file, &1 was encountered such that &1 is not an optimizer directive and &1 is not a valid option.

**System action:**

The optimizer discards the line with the invalid option and proceeds to process the next line in the SYSIN file.

**User response:**

Correct the line of SYSIN by using a properly spelled directive or option.

**Message return code**

12

**BOZ1404S      "&1" can only be specified on "&2" directive.****Explanation**

The &1 option was specified on a directive but it was not the &2 directive. For example, SEL\_ARCH cannot be specified on the BOPT directive as SEL\_ARCH is only applicable to the IEFOPZ directive.

**System action:**

The optimizer discards the line with the invalid option and proceeds to process the next line in the SYSIN file.

**User response:**

Fix the line with &1, by specifying a proper option or proper directive.

**Message return code**

12

**BOZ1405S      "&1" not allowed on "&2" directive.****Explanation**

The &2 directive contained an option, &1, that is not applicable to the &2 directive. For example, the "IN" option is not applicable and cannot be specified on the IEFOPZ directive.

**System action:**

The optimizer discards the line with the invalid option and proceeds to process the next line in the SYSIN file.

**User response:**

Fix the line by specifying a proper option that applies to the &2 directive.

**Message return code**

12

**BOZ1406S      Wildcards not supported in member specifier of "&1".**

## Explanation

A line of SYSIN was encountered with an "IN" option with a member specifier (&1) that included wildcards, and an "OUT" option that included a dataset member specifier. When wildcards are used in an "IN" option, the "OUT" option must not include a member specifier.

### System action:

The optimizer discards the line with the invalid option and proceeds to process the next line in the SYSIN file.

### User response:

Change the "IN" option to not specify wildcards or remove the member specifier from the "OUT" option.

### Message return code

12

---

<b>BOZ1407S</b>	<b>Output specifier "&amp;1" invalid when using wildcards on input.</b>
-----------------	---

---

## Explanation

The optimizer detected a BOPT directive with a wildcard specifier on the "IN" option and the "OUT" option specified a USS path of &1. When member wildcards are used on the "IN" option, the "OUT" option must specify a dataset and not a USS path.

### System action:

The optimizer discards the BOPT option with the invalid "OUT" option and proceeds to process the next line in the SYSIN file.

### User response:

Change the "IN" option to not specify wildcards or change the "OUT" option to specify a dataset.

### Message return code

12

---

<b>BOZ1408S</b>	<b>Module specifier "&amp;1" is an existing directory.</b>
-----------------	--

---

## Explanation

The optimizer detected an HFS directory, &1, specified as the module location on the "IN" or "OUT" option of the BOPT directive. In HFS, a module is an ordinary file and not a directory.

### System action:

The optimizer discards the directive and proceeds to process the next line in the SYSIN file.

### User response:

Change the path specifier on the "IN" or "OUT" option to be an ordinary file and not a directory.

### Message return code

12

---

<b>BOZ1409S</b>	<b>Output specifier "&amp;1" is not an existing PDS(E).</b>
-----------------	---

---

## Explanation

The optimizer encountered either:

- &1 as a NEW dataset from an IEFOPZ configuration
- &1 as a DD name or dataset name on a file specifier in the SYSIN file where the file specifier included a member name
- &1 as a dataset specifier for the LOG option

but, the dataset associated with &1 did not exist or the dataset was a sequential dataset and not a PDS(E).

### System action:

In the IEFOPZ case, the optimizer ignores the NEW dataset and continues on processing the IEFOPZ configuration. Otherwise, the optimizer discards the directive and proceeds to process the next line in the SYSIN file.

### User response:

Change the dataset location to an existing PDS(E) or allocate the PDS(E) prior to running the optimizer.

### Message return code

12

---

<b>BOZ1410I</b>	<b>Output module "&amp;1" cannot be replaced as REPLACE=N is in effect.</b>
-----------------	---

---

## Explanation

When the REPLACE=Y option is specified, the optimizer issues this informational message when it detects that the output module (&1) of the same name already exists.

### System action:

The optimizer bypasses optimizing the input module and proceeds to process the next module or next directive.

### User response:

No action is required by the user.

### Message return code

0

---

<b>BOZ1411S</b>	<b>Error getting member list from dataset specifier "&amp;1".</b>
-----------------	---

---

## Explanation

The optimizer was processing either:

- a BOPT directive where a PDS(E) (&1) was specified on the "IN" option (that included member wildcards) and the PDS(E) had no members
- a IEFOPZ directive, and an OLD dataset (&1) in the IEFOPZ configuration was found to have no members

#### System action:

In the case of a BOPT directive, the optimizer discards the directive and proceeds to process the next line of the SYSIN file. In the case of the IEFOPZ directive, the optimizer ignores the OLD dataset and proceeds to process the rest of the IEFOPZ configuration.

#### User response:

Check that the proper dataset was specified on the BOPT directive or that the proper dataset was specified in the IEFOPZ configuration.

#### Message return code

12

---

<b>BOZ1412S</b>	<b>IEFOPZ is not available on this system.</b>
-----------------	--

---

#### Explanation

The optimizer was processing an IEFOPZ directive on a z/OS system that did not have the IEFOPZ feature

#### System action:

The optimizer discards the IEFOPZ directive and proceeds to process the next line in the SYSIN file.

#### User response:

The IEFOPZ facility is only available on z/OS V2R2 and above. If the optimizer is run on a z/OS system prior to V2R2, change SYSIN to not specify the IEFOPZ directive. If the optimizer is run on z/OS V2R2 or higher, have your system programmer install the appropriate PTFs required for the IEFOPZ feature.

#### Message return code

12

---

<b>BOZ1413S</b>	<b>Problem with IEFOPZQ system service (return code="&amp;1", reason code="&amp;2"): &amp;3.</b>
-----------------	--

---

#### Explanation

The optimizer encountered a problem reading an IEFOPZ configuration while processing an IEFOPZ directive. &1 specifies the error return code and &2 specifies the error reason code of the IEFOPZQ system service that is used to read the configuration. &3 gives a short description of the reason code.

#### System action:

The optimizer discards the IEFOPZ directive and proceeds to process the next line in the SYSIN file.

#### User response:

Provide this error message to your system programmer to see if the error is valid. If there are no issues with IEFOPZ usage, consult IBM service providing this optimizer message and any other IEFOPZ configuration information.

#### Message return code

12

---

<b>BOZ1414S</b>	<b>Input specifier "&amp;1" is not an existing PDS(E).</b>
-----------------	--

---

#### Explanation

The optimizer encountered either:

- &1 as an OLD dataset from an IEFOPZ configuration
- &1 as a DD name or dataset name on a file specifier in the SYSIN file where the file specifier included a member name

but, the dataset associated with &1 did not exist or the dataset was a sequential dataset and not a PDS(E).

#### System action:

In the IEFOPZ case, the optimizer ignores the OLD dataset and continues on processing the IEFOPZ configuration. Otherwise, the optimizer discards the directive and proceeds to process the next line in the SYSIN file.

#### User response:

Change the dataset name to an existing PDS(E) or allocate the PDS(E).

#### Message return code

12

---

<b>BOZ1415S</b>	<b>No DD definition is supplied for "&amp;1".</b>
-----------------	---

---

#### Explanation

The optimizer could not find a DD definition for a mandatory optimizer DD (&1), or no DD definition was specified for a DD (&1) used in the SYSIN file.

#### System action:

If the DD is for a mandatory DD of the optimizer, the optimizer immediately terminates with a return code of 16. Otherwise, the optimizer discards the line of the SYSIN file that included the DD definition and processes the next line of SYSIN.

#### User response:

Provide a DD definition for the DD in error.

#### Message return code

16, if &1 is a mandatory DD, otherwise 12

---

**BOZ1416S      A member name is not specified  
for PDS(E) specifier "&1".**

---

**Explanation**

The optimizer encountered an "IN" or "OUT" option that specified a PDS(E) (&1) and requires a member name, but no member was included on the option.

**System action:**

The optimizer discards the directive with the invalid "IN" or "OUT" option and proceeds to process the next line in the SYSIN file.

**User response:**

Change the "IN" or "OUT" option to include a dataset member.

**Message return code**

12

---

**BOZ1417S      File "&1" does not exist.**

---

**Explanation**

Input file &1 could not be located. Two common reasons this can happen are:

1. A member of an existing input module PDS(E) does not exist
2. An invalid HFS path was specified

**System action:**

The optimizer ignores processing the directive (or input module) that used the invalid file specification and proceeds to process the next input module or next directive

**User response:**

Correct the problem by specifying an existing dataset member or correct the path specification to point to an existing HFS file.

**Message return code**

12

---

**BOZ1418S      Invalid file specification "&1".**

---

**Explanation**

The specification of the file &1 is incorrect. Examples of incorrect specifications include:

1. A member name is specified twice:
  - once, in the definition of a DD
  - second, in an optimizer option or directive that included the DD definition
2. A HFS path is specified, but a directory in the path is non-existent or the path is not accessible.

3. The length of a DD name or dataset name is too long.

**System action:**

The optimizer ignores processing the directive (or input module) that used the invalid file specification and proceeds to process the next input module or next directive

**User response:**

Specify a proper format for the file specification (&1).

**Message return code**

12

---

**BOZ1419S      Output of load module(s) to "&1"  
is not supported when input has  
program object format.**

---

**Explanation**

An input module has a newer program object format but the optimized module (&1) is targeted to the older load module format. This happens when the input module is a member of a PDSE or a file in a HFS path, but the optimized module is targeted to a member of a PDS or is targeted to a sequential dataset.

**System action:**

The optimizer terminates processing the input module and proceeds to process the next input module or next directive.

**User response:**

Correct the output location (&1) of the optimized module to be a member of a PDSE or to a HFS path.

**Message return code**

12

---

**BOZ1420S      Path "&1" must be absolute and  
begin with a "/".**

---

**Explanation**

The specification (&1) of an input or output file is to an HFS file, but a full path specification is not provided for &1. A full or absolute file specification must begin with a "/" character. This error can happen, for example, when the optimizer processes an HFS specification of an input module, output module or listing transform.

**System action:**

The optimizer bypasses optimizing a module when an invalid path is specified and proceeds to process the next input module or next directive.

**User response:**

Correct the specification of the path (&1) to be absolute.

**Message return code**

---

**BOZ1421S      Binder API "&1" failed: return code=&2 reason code=&3.**

---

### Explanation

While processing a module using a binder API (&1), the binder API returned with an unexpected return code (&2) and reason code (&3).

#### System action:

In most cases, the optimizer discontinues processing the input module and proceeds to process the next input module or next directive. In some cases (for example, return code=4, reason code = 0x83000526), the binder is able to recover from the problem (in this case unexpected input) and the optimization of the input module proceeds.

### User response

Examine binder documentation for information on the reason code. The reason code information can help determine the cause of the problem. For example, the reason code may indicate that the input file for optimization is not a proper load module or program object file. In this case, correct the JCL or SYSIN file to specify a proper input module. For information about binder API return codes and reason codes, see [z/OS MVS Program Management: Advanced Facilities](#).

This message is normally preceded by a BOZ4116 binder message that might provide additional information that helps in your response.

#### Message return code

12 when the optimizer discontinues processing, otherwise 4.

---

**BOZ1422S      Module cannot be processed as it is not marked executable.**

---

### Explanation

The optimizer encountered an input module that was not marked executable. The optimizer requires the module to be marked executable in order for the optimization process to succeed.

#### System action:

The optimizer discontinues processing the input module and proceeds to process the next input module or next directive.

#### User response:

If this problem is expected for the module, then either ignore the message or change the optimizer directives to exclude the module. Otherwise, if the problem is unexpected, correct the bind steps that produced the

input module so that the module resulting from the bind is marked executable.

#### Message return code

12

---

**BOZ1423S      Module cannot be processed as it was linked EDIT=NO or otherwise cannot be reprocessed.**

---

### Explanation

The optimizer encountered an input module that cannot be edited. The most common case where this can happen is when the bind step used to produce the module included the EDIT=NO binder option. Modules that cannot be edited are missing important information required by the optimizer.

#### System action:

The optimizer discontinues processing the input module and proceeds to process the next input module or next directive.

#### User response:

If this problem is expected for the module, then either ignore the message or change the optimizer directives to exclude the module. Otherwise, if the problem is unexpected, remove the EDIT=NO option from the bind steps that produced the input module.

#### Message return code

12

---

**BOZ1424S      Module cannot be appropriately processed as program is SIGNEd.**

---

### Explanation

The optimizer encountered an input module that is marked SIGNEd.

#### System action:

The optimizer does not supported SIGNEd modules and discontinues processing the input module and proceeds to process the next input module or next directive.

#### User response:

If this problem is expected for the module, then either ignore the message or change the optimizer directives to exclude the module. Otherwise, if the problem is unexpected, correct the bind steps used to produce the module so that the module is not marked SIGNEd.

#### Message return code

12

---

**BOZ1426S      Link library "SYSLIB" not specified or does not specify a PDS(E).**

---



## Explanation

The DD name card allocating link library SYSLIB is missing or doesn't specify a PDS(E) data set in the optimizer job step JCL.

### System action:

The optimizer terminates optimizing the input module and proceeds to process the next module.

### User response:

Specify SYSLIB correctly in your optimizer job step JCL. See [New SYSLIB requirement for the JCL used to invoke ABO](#) for more information.

### Message return code

12

---

<b>BOZ1428U</b>	<b>Insufficient memory encountered during binder API "&amp;1": return code=&amp;2 reason code=&amp;3. Terminating optimizer.</b>
-----------------	--

---

## Explanation

While processing a module using a binder API (&1), the binder was unable to proceed due to memory being low. The binder produces the return code (&2) and reason code (&3) indicating the memory problem.

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

### User response

Consider using the JCL MEMLIMIT or JCL REGION parameters to increase the memory used during the optimization process. For more information, see the [z/OS MVS Initialization and Tuning Reference](#) and the [z/OS MVS Initialization and Tuning Guide](#).

This message is normally preceded by a BOZ4116 binder message that might provide additional information that helps in your response.

### Message return code

16

---

<b>BOZ1429U</b>	<b>"&amp;1" I/O error encountered during binder API "&amp;2": return code=&amp;3 reason code=&amp;4. Terminating optimizer.</b>
-----------------	---

---

## Explanation

While processing a module using a binder API (&2), the binder detected an I/O error of type &1. The binder API provided the return code (&3) and reason code (&4).

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

### User response

The type (&1) of I/O problem and the reason code (&4) can help direct the steps of how to diagnose and fix the problem. See binder documentation for an explanation of the reason code. Now, an example is a "WRITE" (&1) error of the optimized module because the output PDS(E) or file system is full. The binder API information (&2) or reason code (&4) can help confirm, or lead to, the cause of the "WRITE" problem. Note that increasing the size of the PDS(E) (or file system) could fix the "WRITE" problem. For information about binder API return codes and reason codes, see [z/OS MVS Program Management: Advanced Facilities](#).

This message is normally preceded by a BOZ4116 binder message that might provide additional information that helps in your response.

### Message return code

16

---

<b>BOZ1430U</b>	<b>Unrecoverable "&amp;1" error encountered during binder API "&amp;2": return code=&amp;3 reason code=&amp;4. Terminating optimizer.</b>
-----------------	---

---

## Explanation

While processing a module using a binder API (&2), the binder detected an error of type &1. The binder API provided the return code (&3) and reason code (&4).

### System action:

The binder immediately terminates with a return code of 16.

### User response

The type (&1) of problem and the reason code (&4) can help direct the steps of how to diagnose and fix the problem. If you are unable to diagnose the problem, consult IBM service for assistance. For information about binder API return codes and reason codes, see [z/OS MVS Program Management: Advanced Facilities](#).

This message is normally preceded by a BOZ4116 binder message that might provide additional information that helps in your response.

### Message return code

16

---

**BOZ1431S**      **Input module with unsupported feature (&1) encountered during binder API "&2": return code=&3 reason code=&4. Module bypassed.**

---

## Explanation

While processing a module using a binder API (&2), the binder detected that the module cannot be optimized due to the module contained a feature &1 that is not supported. The binder API provided the return code (&3) and reason code (&4).

One example of an unsupported feature is when the input is an object module (as opposed to the input being a load module or program object). Another example of this problem, is when the input module is not fully bound and contains "UNRESOLVED" references.

## System action:

## User response

Since the input module cannot be supported, the choices are:

- ignore the message
- change optimizer input to avoid optimizing the module
- fix the problem. For example, in the case of a module with "UNRESOLVED" references, change the build steps used to produce the module so that the module is fully bound

For information about binder API return codes and reason codes, see [z/OS MVS Program Management: Advanced Facilities](#).

This message is normally proceeded by a BOZ4116 binder message that might provide additional information that helps in your response.

## Message return code

12

---

**BOZ1432S**      **Output module size exceeded module format limitations and cannot be saved.**

---

## Explanation

The optimizer attempted to write the optimized module but ran into output format restrictions. A load module, saved into a PDS member (or sequential dataset), has the most restrictive format. Far less common is encountering a format limitation with a program objects (written to PDSE or HFS path).

## System action:

The optimizer terminates optimizing the input module and proceeds to process the next module or next directive.

## User response:

If the output module is to be saved into a PDS member or sequential dataset, consider changing the output location to be a member of a PDSE. Otherwise, consider splitting the program into multiple modules.

## Message return code

12

---

**BOZ1436S**      **Invalid ARCH specification : &1**

---

## Explanation

An invalid or unsupported architecture specification (&1) was detected in one of the following cases:

1. In an ARCH option or SEL\_ARCH option when processing the SYSIN file
2. When processing a NEW dataset in an IEFOPZ configuration

## System action:

If the invalid specification was detected on a line of the SYSIN file, the optimizer discards the line with the invalid option and proceeds to process the next line in the SYSIN file. If the invalid specification was detected processing a NEW dataset of an IEFOPZ configuration, the optimizer ignores the NEW dataset and proceeds to process the remainder of the IEFOPZ configuration

## User response:

Correct the SYSIN file or IEFOPZ configuration by specifying an ARCH level supported by the optimizer.

## Message return code

12

---

**BOZ1437S**      **No BOPT or IEFOPZ directive found**

---

## Explanation

The optimizer can neither find a BOPT nor an IEFOPZ directive.

## System action:

The optimizer terminates execution and returns to the operating system with a return code of 12.

## User response:

Check that your JCL includes at least one BOPT or IEFOPZ directive.

## Message return code

12

---

**BOZ1438U**      **dynfree dyn failed: rc=&1 for DD &2**

---

## Explanation

The optimizer detected an error attempting to free an internal input DD name (&2) that the optimizer was using as part of the optimization process.

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

### User response:

This problem could have been caused by an earlier problem. Correct any problems reported in the log file and retry the optimization process. If the problem persists, consult IBM service for assistance.

### Message return code

16

---

<b>BOZ1439U</b>	<b>dynfree saveDyn failed: rc=&amp;1 for DD &amp;2</b>
-----------------	--

---

## Explanation

The optimizer detected an error (the dynfree service returned &1) attempting to free an internal output DD name (&2) that the optimizer was using as part of the optimization process.

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

### User response:

This problem could have been caused by an earlier problem. Correct any problems reported in the log file and retry the optimization process. If the problem persists, consult IBM service for assistance.

### Message return code

16

---

<b>BOZ1446U</b>	<b>An I/O error occurred while writing &amp;1</b>
-----------------	---

---

## Explanation

The optimizer detected an I/O error when writing to &1, where &1 could be either 'the Listing transform' or 'the Log file'.

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

### User response:

Check whether the PDS(E) or file systems is full and allocate a larger file for the PDS(E) or increase the size of the file system. Also check whether the dataset was

allocated with a proper record format and record length.

### Message return code

16

---

<b>BOZ1447U</b>	<b>An Unexpected I/O error occurred</b>
-----------------	---

---

## Explanation

The optimizer detected an I/O error during execution.

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

### User response:

Check the definitions of the output files (you should be able to exclude the output modules) to ensure a proper record length and record format is used and check whether the files are full.

### Message return code

16

---

<b>BOZ1449U</b>	<b>Unhandled out of memory exception</b>
-----------------	--

---

## Explanation

The optimizer was unable to continue due to memory being low.

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

### User response:

Consider using the JCL MEMLIMIT or JCL REGION parameters to increase the memory used by the optimizer. For more information, see [the z/OS MVS Initialization and Tuning Reference](#) and the [z/OS MVS Initialization and Tuning Guide](#).

### Message return code

16

---

<b>BOZ1450U</b>	<b>Assertion failure, check logs for traceback</b>
-----------------	--

---

## Explanation

The optimizer was unable to continue as an unexpected condition was encountered during processing.

### System action:

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

**User response:**

Unexpected problems could happen due to an earlier problem. Correct any problems reported in the log file and retry the optimization process. If the problem persists, consult IBM service for assistance.

**Message return code**

16

---

<b>BOZ1451S</b>	<b>dynalloc(): failed for DSN &amp;1 with DD &amp;2, errcode &amp;3, info code &amp;4</b>
-----------------	---

---

**Explanation**

The optimizer encountered an error allocating an internal DD (&2) for dataset (&1). &3 is the error code returned by the MVS dynamic allocation functions. &4 is the information code returned by the MVS dynamic allocation functions.

**System action:**

The optimizer terminates optimizing the input module and proceeds to process the next module or next directive.

**User response:**

Check that the dataset (&2) exists and is accessible and check that your JCL does NOT include a definition for the same DD (&2). Also, unexpected problems could happen due to an earlier problem. Correct any problems reported in the log file and retry the optimization process. If the problem persists, consult IBM service for assistance.

**Message return code**

12

---

<b>BOZ1452S</b>	<b>dynalloc(): failed for path &amp;1 with DD &amp;2, errcode &amp;3, info code &amp;4</b>
-----------------	--

---

**Explanation**

&3 is the error code returned by the MVS dynamic allocation functions. &4 is the information code returned by the MVS dynamic allocation functions.

**System action:**

The optimizer terminates optimizing the input module and proceeds to process the next module or next directive.

**User response:**

Check that the path is accessible and can be written to and check that your JCL does NOT include a definition for the same DD (&2). Also, unexpected problems could happen due to an earlier problem. Correct any problems reported in the log file and retry the

optimization process. If the problem persists, consult IBM service for assistance.

**Message return code**

12

---

<b>BOZ1453U</b>	<b>dynalloc(): failed for DUMMY DD &amp;1 errcode &amp;2, info code &amp;3</b>
-----------------	--

---

**Explanation**

The optimizer encountered an error allocating a mandatory DUMMY DD (&1) that is required for the optimization process. &2 is the error code returned by the MVS dynamic allocation functions. &3 is the information code returned by the MVS dynamic allocation functions.

**System action:**

The optimizer immediately terminates execution and returns to the operating system with a return code of 16.

**User response:**

Check that your JCL does NOT include a definition for the same DD (&1). Also, unexpected problems could happen due to an earlier problem. Correct any problems reported in the log file and retry the optimization process. If the problem persists, consult IBM service for assistance.

**Message return code**

16

---

<b>BOZ1455W</b>	<b>Unsupported feature "&amp;1" found</b>
-----------------	---

---

**Explanation**

This message is issued in one of the following situations:

1. When ABO encounters a COBOL CSECT (i.e. compiled COBOL program) built by a compiler not eligible for use with ABO or the CSECT contains a COBOL language feature not supported by ABO.
2. When ABO encounters a CSECT that is too complex to safely optimize.

In the first situation, ABO detected a feature "&1" that it does not support in the CSECT being processed. See [COBOL module requirements](#) for the compilers eligible for use with ABO and the COBOL language features not supported by ABO.

In the second situation, ABO has determined that the CSECT is too complex to be safely optimized so it has been skipped. ABO will only optimize a CSECT if it can ensure the optimized program will execute with the same logic as the original compiled program. In cases where the CSECT is so complex that ABO cannot guarantee this, ABO stops the optimization process

and skips this CSECT. Any other eligible CSECTs in the module will still be processed.

Note that this message is issued for informational purposes only and does not indicate a functional issue with ABO.

**System action:**  
ABO bypasses optimization of the CSECT and proceeds to process the next CSECT.

**User response:**  
If you see message BOZ1455 issued for a particular unsupported feature while optimizing a large number of your modules, you may [open an RFE](#) to indicate that the lack of this feature is inhibiting your ability to use ABO effectively.

**Message return code**  
4

---

<b>BOZ1456S</b>	<b>"&amp;1" cannot be both optimizer input and optimizer output.</b>
-----------------	--

---

**Explanation**  
The optimizer does not allow a dataset or file to be used as input to the optimizer as well as output from the optimizer. For example, an optimized module cannot be written to a PDS(E) if that PDS(E) is also a source of input modules. This message is emitted when &1 is used as both a location of input to the optimizer and a location of output from the optimizer.

**System action:**  
The optimizer terminates optimizing the input module and proceeds to process the next module.

**User response:**  
Correct your JCL or SYSIN file such that the output datasets are separate from input datasets.

**Message return code**  
12

---

<b>BOZ1457S</b>	<b>Invalid filter expression "&amp;1".</b>
-----------------	--

---

**Explanation**  
The optimizer cannot process the *mem\_expr* parameter of BOPT optimizer directive or the *expr* parameter of the CSECT optimizer option. The expression contains invalid syntax or wildcards and cannot be processed as written.

**System action:**  
The optimizer terminates optimizing the current directive and proceeds to process the next directive.

**User response:**

Correct the expression. See the description of the *mem\_expr* parameter of “BOPT” on [page 16](#) and the *expr* parameter of the [CSECT optimizer option](#).

**Message return code**  
12

---

<b>BOZ1490W</b>	<b>Warning: AMODE/RMODE conflicts encountered during binder API "&amp;1": return code=&amp;2 reason code=&amp;3. Operation performed and processing continues.</b>
-----------------	--

---

**Explanation**  
During the optimization process, the binder detected a conflict with the AMODE and RMODE settings. This problem was detected by the binder API (&1) for which the binder issued a return code (&2) and reason code (&3). You can use binder reason code documentation along with the reason code (&3) to determine the precise nature of the conflict. Normally, the conflict is already present in the input module and not introduced by the optimization process.

**System action:**  
The binder issues this BOZ1490 warning message and continues with the optimization of the input module.

**User response:**  
The warning message may be an indicator of a problem with the input module being optimized. Fixing the problem may require fixing the build steps used to produce the input module. For information about binder API return codes and reason codes, see [z/OS MVS Program Management: Advanced Facilities](#).

**Message return code**  
4

---

<b>BOZ1491W</b>	<b>Warning: problems encountered adding aliases to directory during binder API "&amp;1": return code=&amp;2 reason code=&amp;3. Module saved and processing continues.</b>
-----------------	--

---

**Explanation**  
During the optimization process, the binder detected an issue adding aliases to a directory. This problem was detected by the binder API (&1) for which the binder issued a return code (&2) and reason code (&3). An alias cannot be added to a PDS(E) directory when the binder finds that there is a member of the PDS(E) directory with the same name as the name of the alias.

**System action:**  
The binder issues this BOZ1491 warning message and continues with the optimization of the input module.

## User response

To resolve this problem, it is important to understand why there is an existing member in the output PDS(E) with the same name as the name of the alias. For example:

- Do not specify an alias name on the member specifier of IN option of a BOPT directive. If an alias name was specified, delete this BOPT directive and delete the member from the target dataset.
- An incorrect member specifier on the OUT option of a BOPT directive could cause a conflict with the name of an alias. Ensure that the OUT option of a BOPT directive has the same member specifier as the member specifier supplied of the IN option.
- Merging aliases from more than one input datasets could cause conflicts with aliases and member names of the two datasets. It is recommended that a different output dataset be used for each input dataset. For information about binder API return codes and reason codes, see *z/OS MVS Program Management: Advanced Facilities*.

## Message return code

4

<b>BOZ1492W</b>	<b>Warning: input module "&amp;1" with exported symbols is saved to different named module "&amp;2".</b>
-----------------	--

## Explanation

The optimizer detected an input module (&1) in a PDS(E) that included exported symbols and the optimized module was being written to a differently named member (&2) in an output PDS(E).

### System action:

The binder issues this BOZ1492 warning message and continues with the optimization of the input module.

### User response:

To fix the problem, change your JCL or SYSIN file such that the member name of the optimized module is the same as the member name of the input module. Failing to do so could result in runtime problems with locating the optimized module because of the change in the member name.

## Message return code

4

<b>BOZ1493S</b>	<b>Concatenated DD "&amp;1" encountered and not is allowed for "&amp;2".</b>
-----------------	--

## Explanation

The optimizer detected an input or output DD definition (&1) that was the concatenation of two or more datasets. &2 provides the context in which the DDs were used. For example, &2 may indicate that the DD was used as an input module location, or as an output module location, or as an output listing transform location.

### System action:

The optimizer bypasses directives that include concatenated DD definitions and the optimizer proceeds to process the next directive.

### User response:

Fix your JCL to not include a concatenated DD definition for input modules, output modules and for listing transforms.

## Message return code

12

<b>BOZ1494S</b>	<b>Module not processed as it is not fully bound.</b>
-----------------	---

## Explanation

During the optimization process, a module was encountered in input that is not fully bound and the ALLOW=NOUNRESEX option was specified. The optimizer will not process the module that is not fully bound unless the ALLOW=UNRESEX option is specified.

### System action:

The optimizer terminates optimizing the input module and proceeds to process the next module or next directive.

### User response:

If the intent is to optimize partially bound modules, remove the ALLOW=NOUNRESEX option. If the intent is to only optimize fully bound modules, ignore the error, or correct your JCL or SYSIN file to only process fully bound modules.

## Message return code

12

<b>BOZ1495W</b>	<b>Rebind of dependent DLL "&amp;1" with RTI bypassed.</b>
-----------------	--

### Explanation:

The optimizer emits this warning message when the RTIBIND=IN | OUT | ALL option was specified for the dependent DLL module &1 it's processing.

### System action:

The optimizer bypasses rebinding the dependent DLL module &1 and continues to process the next module if it's present. It has no impact on the profiling of the



main DLL module. As long as the main DLL is successfully rebound with the RTI Profiler modules then profiling information of the main and the dependent DLL modules will be collected.

**User response:**

No action is required by the user. In case the RTI Profiler enabled dependent DLL module is required for some other purpose, you can use the [Manual RTI rebinding instructions](#).

**Message return code**

4

---

**BOZ1496W      Rebind of dependent DLL "&1" ("&2") with RTI bypassed.**

**Explanation:**

The optimizer issues this warning message when the RTIBIND=IN | OUT | ALL option was specified for the dependent DLL module &1(&2) it's processing.

**System action:**

The optimizer bypasses rebinding the dependent DLL module &1(&2) and continues to process the next module if it's present. It has no impact on the profiling of the main DLL module. As long as the main DLL is successfully rebound with the RTI Profiler modules then profiling information of the main and the dependent DLL modules will be collected.

**User response:**

No action is required by the user. In case the RTI Profiler enabled dependent DLL module is required for some other purpose, you can use the [Manual RTI rebinding instructions](#).

**Message return code**

4

---

**BOZ4089I      IEFOPZ: did not get ARCH=&1 match for dataset: '&2' which has ARCH=&3.**

**Explanation**

While processing an IEFOPZ optimizer directive, the optimizer emits this informational message whenever a NEW dataset (&2) is found in an IEFOPZ configuration that has an ARCH specification (&3) that does not match the SEL\_ARCH selector (&1) that was specified on the IEFOPZ optimizer directive.

**System action:**

The optimizer bypasses the NEW dataset and processes the next NEW dataset in the configuration.

**User response:**

No action is required by the user.

**Message return code**

0

---

**BOZ4091I      IEFOPZ: did not get STATE=&1 match for dataset: '&2' which has STATE=&3.**

**Explanation**

While processing an IEFOPZ optimizer directive, the optimizer emits this informational message whenever a NEW dataset (&2) is found in an IEFOPZ configuration that has a STATE specification (&3) that does not match the SEL\_STATE selector (&1) that was specified on the IEFOPZ optimizer directive.

**System action:**

The optimizer bypasses the NEW dataset and processes the next NEW dataset in the configuration.

**User response:**

No action is required by the user.

**Message return code**

0

---

**BOZ4092I      IEFOPZ: did not get DSN='&1' match for dataset '&2'.**

**Explanation**

While processing an IEFOPZ optimizer directive, the optimizer emits this informational message whenever an OLD dataset (&2) is found in an IEFOPZ configuration that does not match the SEL\_OLD selector value (&1) that was specified on the IEFOPZ optimizer directive.

**System action:**

The optimizer bypasses the OLD dataset and processes the next OLD dataset in the configuration.

**User response:**

No action is required by the user.

**Message return code**

0

---

**BOZ4097I      No members in dataset '&1' to process**

**Explanation**

This message is emitted when there are no members in the dataset to process.

**System action:**

The optimizer continues processing the next dataset.

**User response:**

No action is required by the user.

**Message return code**

---

**BOZ4101W**      **No applicable COBOL code section found, return code 4**

---

### Explanation

This message is emitted in the following cases:

1. When the optimizer encounters a load module but does not optimize any CSECTs within the load module (note: the message is not printed if the REPLACE=Y option is specified and an optimized module already exists)
2. After a BOPT directive that has member wildcards in the "IN" option, but no modules in the "IN" dataset were optimized
3. After an OLD dataset is processed and no modules in an OLD dataset were optimized
4. After an IEFOPZ directive is processed but no modules were optimized

#### System action:

The optimizer continues processing the next module of input.

#### User response:

No action is required by the user.

#### Message return code

4

---

**BOZ4107I**      **INFO: IDRL record not added to CSECT &1 as load module format does not support three IDRLs. Processing continues.**

---

### Explanation

The optimizer issues this informational message when an IDRL record (for the binary optimizer itself) could not be added to an optimized CSECT in a load module because that CSECT already has 2 IDRL records. Note: a maximum of 2 IDRLs per CSECT is a restriction of load modules in PDS (but is not a restriction for program objects in PDSE).

#### System action:

The optimizer continues its processing of the output load module.

#### User response:

No action is required by the user.

#### Message return code

0

---

**BOZ4109I**      **INFO: Adding a third IDRL to load module CSECT "&1".**

---

### Explanation

While processing a CSECT (&1) in a load module, the optimizer emits this informational message when the optimizer adds its language record as the third IDRL of the CSECT (&1). Note that an update to the binder is required so that the binder can properly add a third IDRL to a CSECT. If the binder update is not installed on your system, the optimizer will emit a subsequent warning message when attempting to save the optimized load module.

#### System action:

If the optimizer emits a warning message when saving the module, the language record may not have been added to the CSECT and the optimizer continues processing of the CSECT. Otherwise, processing of the CSECT was successfully performed.

#### User response:

If the optimizer emits a warning message when saving the module, you should contact your system programmer to install the binder update and perform the optimization process again. Otherwise, no action is required by the user. The required binder update for this message is under APAR OA50460. See ["Supported operating systems" on page 3](#) for more information.

#### Message return code

0

---

**BOZ4110I**      **INFO: performing a second bind to handle private section "&1" in class "&2" referring to ENTRY "&3" at offset &4.**

---

### Explanation

The optimizer emits this message when processing a CSECT that had a COBOL ENTRY statement (&3) and there was a reference to the ENTRY (&3) from a private section (&1) from within a class (&2, which is normally C\_WSA) at an offset (&4). Note that an update to the binder is required so that the second bind works successfully. Without the binder update, the optimized program could experience problems.

#### System action:

If the binder update is available, processing completes successfully. But, if the binder update is not available, the second bind may appear to complete successfully, but, runtime errors may happen.

#### User response:

If the binder update is installed on your system, no action is required. Otherwise, have your system programmer install the binder update and perform the optimization process again. The required binder update for this message is under APAR OA50460. See



[“Supported operating systems”](#) on page 3 for more information.

#### Message return code

0

---

<b>BOZ4111I</b>	<b>INFO: performing update to private section "&amp;1" in class "&amp;2" referring to ENTRY "&amp;3" at offset &amp;4.</b>
-----------------	--

---

#### Explanation

The optimizer emits this message when processing a CSECT that had a COBOL ENTRY statement (&3) and there was a reference to the ENTRY (&3) from a private section (&1) from within a class (&2) at an offset (&4). Note that an update to the binder is required so that the second bind works successfully. Without the binder update, the optimized program will emit an error message when processing the reference.

#### System action:

If the binder update is not available, the optimizer emits an error processing the reference. Otherwise, the binder processes the reference successfully.

#### User response:

If the optimizer emitted an error processing the reference, have your system programmer install the binder update and perform the optimization process again. Otherwise, no action is required. The required binder update for this message is under APAR OA50460. See [“Supported operating systems”](#) on page 3 for more information.

#### Message return code

0

---

<b>BOZ4113I</b>	<b>CSECT &amp;1 was excluded by filter - skip</b>
-----------------	---

---

#### Explanation

This message is emitted when a CSECT is excluded by the optimizer due to the expression in the CSECT optimizer option.

#### System action:

The optimizer continues processing the next CSECT.

#### User response:

No action is required by the user.

#### Message return code

0

---

<b>BOZ4114I</b>	<b>INFO: processing module that is not fully bound with ALLOW=UNRESEXE option in effect.</b>
-----------------	--

---

#### Explanation

When the ALLOW=UNRESEXE option is specified, the optimizer issues this informational message when it encounters a module in input that is not fully bound.

This message is not issued if the module is fully bound.

This message can be used to determine which partially bound modules were processed by the optimizer.

#### System action:

If the binder update is not available, the optimizer emits an error processing the reference. Otherwise, the binder processes the reference successfully.

#### User response:

The optimizer processes the partially bound module and outputs an optimized partially bound module.

#### Message return code

0

---

<b>BOZ4116I</b>	<b>Binder message "&amp;1"</b>
-----------------	--------------------------------

---

#### Explanation

The optimizer uses binder services and a service might fail which prevents a module from being optimized. In response to a binder service that fails, ABO produces a message such as BOZ1429 and terminates processing in some manner. The BOZ1429 message might lack detailed information as to why the binder service failed. For example, the BOZ1429 message indicates that the binder found some problem with the input module but BOZ1429 does not include the precise input problem that the binder found. To provide more information about binder services that fail, the optimizer captures severe binder messages and includes the text of a binder message within &1 of the BOZ4116 informational message. This means that, when a binder service fails, ABO normally emits two messages:

1. The BOZ4116 message with &1 holding the text of a severe binder message. The BOZ4116 message is followed by
2. A summary message such as BOZ1429, indicating the general nature of binder failure.

#### System action:

See the "System action" section of the summary message to determine the actions of the optimizer.

#### User response:

See the "User response" section of the summary message to determine what to do. The BOZ4116 message might provide information that helps guide your response.

#### Message return code

0

---

**BOZ4117I**      **Member "&1" was excluded by filter - skip**

---

### Explanation

This message is emitted when a module is excluded by the optimizer due to the expression in the IN option of the BOPT directive.

#### System action:

The optimizer continues processing the next module.

#### User response:

No action is required by the user.

#### Message return code

0

---

**BOZ4119S**      **Continuation indicated on SYSIN line &1. Unable to read SYSIN line &2.**

---

### Explanation

Continuation was indicated on line &1 of SYSIN with the last non-blank character of line &1 being a continuation char (either '+' or '-'). While reading SYSIN, the optimizer was unable to read line &2.

#### System action:

The optimizer discards the line.

#### User response:

Either remove the continuation character at the end of line &1 of SYSIN, or add a new line &2 to the SYSIN that will continue line &1.

#### Message return code

12

---

**BOZ4120S**      **Cannot have more than one IN= or OUT= specifier.**

---

### Explanation

This message is emitted when more than one IN or OUT specifier is detected in a BOPT directive.

#### System action:

The optimizer continues processing the next BOPT directive.

#### User response:

Remove IN or OUT specifiers from the BOPT directive until there is no more than one of each per directive.

#### Message return code

12

---

**BOZ4121S**      **Invalid log specification. '&1' is not a directory.**

---

### Explanation

Only directories are valid specifiers for the LOG option. &1 is not a directory.

#### System action:

The LOG option is ignored.

#### User response:

Correct the LOG specification to a supported format, see the [LOG option](#) for supported specifications.

#### Message return code

12

---

**BOZ4124I**      **The HANDLERS option is now deprecated and no longer necessary; the previously default HANDLERS=Y behaviour now always applies.**

---

### Explanation

The optimizer option HANDLERS is now deprecated and is no longer supported nor required.

#### System action:

Regardless of the HANDLERS option specified, the optimizer will always behave as if the previously default and conservative HANDLERS=Y option is in effect.

#### User response:

No action is required by the user.

#### Message return code

0

## Appendix D. Run Time Instrumentation report

**Note:** The RTI profiler output format is subject to change at any time and with no prior notice. Therefore, do not rely on the specific layout or content of the output as described below in building any post-processing tooling that uses the RTI profiler output.

The output of the RTI Profiler is a text file split into the following sections:

1. [RTI options section](#)
2. [Module info section](#)
3. [Summary report section](#)
4. [Sampling tables section](#)
5. [Report Totals section](#)

### RTI options section

The RTI options section displays the default RTI configuration. These options are fixed and cannot be changed. For example:

```
*****
* RTI options                                     2020/03/02 14:23:04 *
*****
SCALING-FACTOR=0000500000
ANALYSIS-MODE=1, PDF-MODE=0, VERBOSE=0
BUF-SIZE=0000001024, #BUFS=0000000004, TIMER-INTERVAL=0000000050
*****
```

### Module info section

Detailed module information is displayed next. This information includes the module name (specified by MJNAME), address, and length and other information on the content of the module. For example:

```
*****
* Module Info                                     *
*****
QUERYING MODULE INFO: ADDR=X'26EA5154'
CSVQUERY: RC=00, VALID=X'573C0800'
MJNAME=COBMOD
EPTKN=X'000003B703E8003B'
EPA=X'26EA4C48'
EXTENT=X'0001', ADDR=X'26EA4C48', LEN=X'000013B8'
ATTR1=X'08'
ATTR2=X'10'
ATTR3=X'C0'
XATTR1=X'00'
PID=PGMF
DIAG=X'7F6E4F48'
MJNAME=COBMOD , EPADDR=X'26EA4C48'
EXTENT=X'0001', ADDR=X'26EA4C48', LEN=X'000013B8'
OPENING BINDER INTERFACE
CLASS=B_TEXT , SEG=X'0001', LOAD=X'0', OFF=X'00000000', LEN=X'000013B8'
CLASS=B_MAP , SEG=X'0001', LOAD=X'2', OFF=X'00000000', LEN=X'00000000'
...
SEG=X'0001' => EXTENT=X'0001'
```

The module info section is followed by a list all the CSECTs and the release and version information for the translator(s) that produced the CSECT. The translator is typically a compiler, optimizer or assembler product. For example:

```
*****
* List of CSECTs processed for module COBMOD      *
*****
```

```

COBMAIN: Enterprise COBOL V4          , VER=42, MOD=00, PID=5655S7100
          TYPE=B_TEXT                  , OFF=X'00000000', LEN=X'00000988'
          ADDR=X'26EB6A30'-X'26EB73B7'
COBMAIN: Automatic Binary Optimizer, VER=13, MOD=00, PID=5697-AB1
SUB1: Enterprise COBOL V4          , VER=42, MOD=00, PID=5655S7100
          TYPE=B_TEXT                  , OFF=X'00000670', LEN=X'00000C26'
          ADDR=X'26900670'-X'26901295'
CEESTART: HIGH-LEVEL ASSEMBLER      , VER=01, MOD=06, PID=569623400
          TYPE=B_TEXT                  , OFF=X'00001F00', LEN=X'000000B0'
          ADDR=X'26901F00'-X'26901FAF'
...

```

Each entry in the CSECT list represents CSECT details in the format:

```
Module name: Translator name, Major and minor version, mod level, PID
```

There are also additional data provided, such as CSECT offset (OFF) in the module, length (LEN) of the CSECT, and the loaded address (ADDR) of the CSECT.

Note that some CSECTs may have been translated by more than one product, in which case an additional entry appears one for each translator used. In this example, there are two entries for the CSECT COBMAIN – one for Enterprise COBOL V4 and another for ABO. This indicates that COBMAIN is the ABO optimized version of a program originally compiled by Enterprise COBOL V4.

If no translator name is available then a dash sign (-) is displayed in the translator name field, but the PID of the translator product is always displayed.

## Summary report section

A high-level summary report section is displayed next, which includes a summary report by language subsection and a summary report by module subsection. This section is useful for obtaining an overall view of CPU performance without having to drill down into the detailed profiling information per CSECT.

For example:

```

*****
* Summary report                                     2020/03/02 14:23:18 *
*****
#TOTAL SAMPLES=0000000000012450, #MAPPED SAMPLES=0000000000011946
*****
* Summary report by language                         *
*****
Language      | Number Of Samples | % TOTAL
COBOL         | 32724             | ( 100.00% )
  Application | 12                | (   0.03% )
  LE          | 32712             | (  99.96% )
PLI           | 0                 | (   0.00% )
C/C++        | 0                 | (   0.00% )
Java         | 0                 | (   0.00% )
*****
* Summary report by module                           *
*****
MODULE=COBMOD, EXTENT=X'0001', #SAMPLES=0000000000011946, ( 93.55% )
CSECT Name    | Number Of Samples | % of COBMOD | % TOTAL
COBMAIN       | 10234              | ( 85.67% )  | ( 82.20% )
SUB1          | 1203               | ( 10.07% )  | (  9.66% )
SUB2          | 507                | (  4.24% )  | (  4.07% )
RICHK         | 2                  | (  0.02% )  | (  0.02% )
MODULE=IGZCPAC, EXTENT=X'0001', #SAMPLES=000000000000430, (  3.45% )
CSECT Name    | Number Of Samples | % of IGZCPAC
IGZCXDI       | 267                | ( 62.09% )
IGZCXMU       | 163                | ( 37.91% )
MODULE=MODC, EXTENT=X'0001', #SAMPLES=000000000000074, (  0.59% )
*****

```

All numeric values in the profiling report are displayed in either decimal or hexadecimal. All hexadecimal values in the profiling output are indicated by wrapping the number in the X' ` notation. If the value is not wrapped in the X' ` notation, then it is in a decimal representation. All the samples values in the profiling report are in decimal.

A larger number of samples attributed to a particular module or CSECT means a higher relative amount of CPU time is spent in these parts of the application when it ran.

The percentage values provided per module (for example, 93.55% for MODULE=COBMOD) are the total number of samples found for this module out of the overall TOTAL SAMPLES.

The percentage values provided per CSECT (for example, 62.09% for CSECT IGZCXDI) are the number of samples found for this CSECT out of the overall SAMPLES found for only the particular module where this CSECT is contained (MODULE=IGZCPAC in this case).

Note that it is normal and expected to see CSECT names starting with the RI prefix (such as RICHK in this example) in the profiling report. These RI\* CSECTs are part of the RTI program modules bound into the modules using RTIBIND and they are used to manage the profiling and report collection. The samples attributed to these RI\* CSECTs will be very low as the profiling overhead using the RTI profiler is negligible.

## Sampling tables section

This next section provides a detailed per CSECT breakdown that shows the samples attributed to the CSECT offsets.

A samples count is shown for an offset if at least one sample was attributed to this offset. The offsets are sorted in increasing order and match those found in the compiler or optimizer listing file.

For example:

```
*****
* Sampling tables
*****
MODULE=IGZCPAC , EXTENT=X'0001', #SAMPLES=0000000000000430
CSECT=IGZCXDI, #SAMPLES=0000000000000267
TABLE=X'26D970B0'
SIZE=X'00000048', ALIGN=X'00000002', #ENTRIES=0000000082
Offset      | Number Of Samples |
X'00000000' |                   25 |
X'00000028' |                   10 |
X'0000002C' |                    3 |
X'0000002E' |                    12 |
X'00000032' |                   38 |
X'00000040' |                    8 |
X'00000048' |                   32 |
...
MODULE=COBMOD , EXTENT=X'0001', #SAMPLES=0000000000011946
CSECT=COBMAIN, #SAMPLES=0000000000010234
TABLE=X'26EB51A0'
SIZE=X'00000077', ALIGN=X'00000002', #ENTRIES=0000000006
Offset      | Number Of Samples |
X'0000004E' |                    1 |
X'0000004E' |                    1 |
X'0000004F' |                    2 |
X'00000050' |                   121 |
X'00000050' |                   411 |
X'00000051' |                   234 |
X'00000051' |                    34 |
...
```

## Report totals section

At the bottom of the RTI report, the sum totals for the internal state used to store and process the RTI data are displayed.

This portion of the output does not normally need to be examined and is used for IBM diagnostic purposes only. For example:

```
List=0000004192 bytes, ListEntry=0000032053 bytes
SamplingTable=0001101276 bytes, SamplingEntry=0000028080 bytes
#ListEntries=0000000517, #SamplingEntries=0000001404
RIBuffers=0004194304 bytes
```



## Appendix E. Manual RTI rebinding instructions

It is recommended to use the [RTIBIND](#) option in order to enable modules for RTI Profiling. However, if more low-level control of the rebinding process is required then the manual steps below can be used instead.

The RTI Profiler consists of the two members BOZBXITA and BOZRIDT included in the same dataset where ABO was installed.

- BOZBXITA: links CEEBXITA and the related profiling routines to the main program of the application. This step enables the starting and stopping of the profiling as well as the monitoring and managing of the buffers for the RTI Profiler during the program execution.
- BOZRIDT: processes the RTI Profiler buffer data and generates the text file report.

To use the RTI Profiler, follow these steps:

1. In the link-edit step, rebind your existing program to include BOZBXITA
2. In the execution step, specify the location of the dataset that will hold the profiling results

In the steps and JCL examples below, hlqboz.BOZ210.SBOZMOD1 is the installation location chosen for ABO.

### Step 1. Rebind your existing program to include BOZBXITA

The first step is to rebind your existing program to include BOZBXITA so the RTI Profiler is enabled when running your program.

To perform this rebind, modify the link-edit step of the program containing the main entry point to your application:

- Add hlqboz.BOZ210.SBOZMOD1 to the link-edit step as SYSLIB
- Include BOZBXITA as additional input to link-edit step

Below is a JCL example for this step:

```
//LKED EXEC PGM=IEWL,PARM='options' <- original link options
//SYSLIB DD DISP=SHR,DSN=hlqboz.BOZ210.SBOZMOD1 <-- add hlqcee.BOZ210.SBOZMOD1 as SYSLIB
//      DD DSN=hlqcee.SCEELKED,DISP=SHR
//      DD DSN=hlqcee.SCEELKEX,DISP=SHR
//LOAD DD DISP=SHR,DSN=&LOAD
//SYSLMOD DD DISP=SHR,DSN=&SYSLMOD(pgmname)
//SYSPRINT DD SYSOUT=*
//SYSLIN DD *
INCLUDE LOAD(pgmname)
INCLUDE SYSLIB(BOZBXITA) <-- add INCLUDE for BOZBXITA
ENTRY pgmname
NAME pgmname(R)
```

For step 1, the same set of the link options as the original module must be used when rebinding for RTI Profiler usage. To verify the same set of the link options were used, you can use AMBLIST on the original and rebound modules. The most likely mismatch for COBOL programs is inadvertently changing AMODE from 24 to 31 when rebinding. Below is a JCL example that shows how to set the link options for AMODE=24.

```
//LKED EXEC PGM=IEWL,PARM='LIST,MAP,AMODE=24'
```

### Step 2. Specify the location of the dataset that will hold the profiling results

See [Capturing profiling results during program Execution](#).





## Notices

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## List of resources

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### IBM Automatic Binary Optimizer for z/OS publications

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You can find the latest and most complete information about the IBM Automatic Optimizer for z/OS APARs and PTFs on the [fix list and new features page](#).

You can find the following publications in the [IBM Automatic Binary Optimizer for z/OS library](#):

- *User's Guide*, SC27-9587-00
- *Program Directory*, GI13-4513-04

### Related publications

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#### **z/OS publications**

You can find the following publications in the [z/OS Internet Library](#).

- *Initialization and Tuning Reference*, SA23-1380, contains information about the parmlib member IEFOPZxx.
- *Program Management: Advanced Facilities*, SA23-1392, contains information on binder API return codes and reason codes.
- *System Management Facilities (SMF)*, SA38-0667, contains information about the SMF record 90 subtype 38, which captures the IEFOPZ configuration.
- *System Messages, Volume 8*, SA38-0675, contains information about the messages.

#### **Enterprise COBOL for z/OS publications**

You can find the following publications in the [Enterprise COBOL for z/OS library](#).

- *Customization Guide*, SC27-8712, contains information that helps you plan for and customize Enterprise COBOL under z/OS.
- *Language Reference*, SC27-8713, contains information about COBOL language and references needed to write a program for an IBM COBOL compiler.
- *Programming Guide*, SC27-8714, contains information and examples that help you write, compile, and debug programs and classes.
- *Migration Guide*, GC27-8715, contains information that helps you move to the latest version of IBM Enterprise COBOL.
- *Performance Tuning Guide*, SC27-9202, identifies key performance benefits and tuning considerations when using IBM Enterprise COBOL for z/OS.
- *Messages and Codes*, SC27-4648, helps you understand compiler and preprocessor messages.

#### **Application Delivery Foundation for z/OS publications**

You can find the following publication in the [IBM Knowledge Center](#).

- *IBM Application Performance Analyzer for z/OS User's Guide*, SC27-8403, contains information that helps identify system constraints and improve application performance.
- *IBM Developer for z/OS documentation* (online version only), contains information about the Integrated Development Environment (IDE), designed to increase developer productivity.
- *IBM Fault Analyzer for z/OS User's Guide and Reference*, SC19-4116, contains information about analyzing and fixing application and system failures.







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