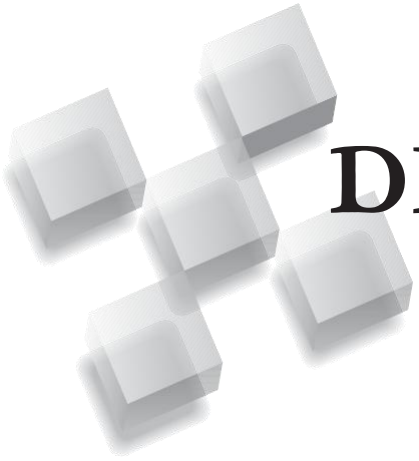

DBMaker

DCI User's Guide

CASEMaker®

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1 Introduction

This manual is intended for software developers who want to combine the reliability of COBOL programs with the flexibility and efficiency of a relational database management system (RDBMS). The manual gives systematic instructions on using the DBMaker COBOL Interface (DCI), a program designed to allow for efficient management and integration of data with COBOL using DBMaker's database engine.

DCI provides a communication channel between COBOL programs and DBMaker. DBMaker COBOL Interface (DCI) allows COBOL programs to efficiently access information stored in the DBMaker relational database. COBOL programs usually store data in standard B-TREE files. Information stored in B-TREE files are traditionally accessed through standard COBOL I/O statements like READ, WRITE and REWRITE.

COBOL programs can also access data stored in the DBMaker RDBMS. Traditionally, COBOL programmers use a technique called embedded SQL to embed SQL statements with COBOL source code. Before compiling the source code, a special pre-compiler translates SQL statements into "calls" to the database engine. These calls execute to access the DBMaker RDBMS during runtime.

Though this technique is a good solution for storing information on a database using COBOL programs, it has some drawbacks. First, it implies COBOL programmers have a good knowledge of the SQL language. Second, a program written in this way is not portable — it cannot work both with B-TREE files

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and the DBMaker RDBMS. Furthermore, SQL syntax often varies among databases. This makes COBOL programs embedded with SQL statements for a specific DBMaker RDBMS unable to work with another database. Finally, embedded SQL is difficult to implement with existing programs. In fact, embedded SQL requires significant application re-engineering, including substantial additions to the working storage, data storage, and reworking of each I/O statement's logic.

There is an alternative to embedded SQL. Some suppliers have developed seamless COBOL to database interfaces. These interfaces translate COBOL I/O commands, on the fly, into SQL statements. In this way, COBOL programmers need not be familiar with SQL and COBOL programs can remain portable. However, this solution does present a performance problem.

In fact, SQL has a different purpose than COBOL I/O statements. SQL is intended to be a set-based, ad hoc query language that can find almost any combination of data from a general specification. In contrast, COBOL B-TREE or other data structure calls use well-defined traversal keys or navigation logic or both for direct data access. Therefore, forcing transaction rich, performance sensitive COBOL applications to operate exclusively via SQL-based I/O is often an inappropriate method.

CASEMaker's COBOL interface product, DCI, does not use SQL in this way. DCI provides direct access and traversal to data storage in a manner similar to COBOL's own access to users replaceable COBOL file systems. DCI provides seamless interfaces between COBOL programs and DBMaker file systems. Information exchange between the application and the database are invisible to end users. In cases when full SQL-based file and data storage access is required, like desktop decision support systems (DSS), data warehousing and 4GL applications, DBMaker provides these features along with the reliability and robustness of an RDBMS.

CASEMaker's database and DCI products combine the power of 4GLs and navigational data structures with the ad hoc flexibility of SQL-based database access and reporting while delivering tremendous performance.

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1.1 Additional Resources

DBMaker provides a complete set of DBMS manuals including this one. For more information on a particular subject, consult one of the manuals listed below:

- For an introduction to DBMaker's capabilities and functions, refer to the *DBMaker Tutorial.*
- For more information on designing, administering, and maintaining a DBMaker database, refer to the *Database Administrator's Guide.*
- For more information on DBMaker management, refer to the *JServer Manager User's Guide.*
- For more information on DBMaker configurations, refer to the *JConfiguration Tool Reference.*
- For more information on DBMaker functions, refer to the *JDBA Tool User's Guide.*
- For more information on the dmSQL interface tool, refer to the *dmSQL User's Guide.*
- For more information on the SQL language used in dmSQL, refer to the *SQL Command and Function Reference.*
- For more information on the ESQL/C programming, refer to the *ESQL/C User's Guide.*
- For more information on the native ODBC API and JDBC API, refer to the *ODBC Programmer's Guide and JDBC Programmer's Guide.*
- For more information on error and warning messages, refer to the *Error and Message Reference.*

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1.2 Technical Support

CASEMaker provides thirty days of complimentary email and phone support during the evaluation period. When software is registered, an additional thirty days of support is included, extending the total software support period to sixty days. However, CASEMaker continues providing email support free of charge for reported bugs after the complimentary support or registered support has expired.

For most products, support is available beyond sixty days and may be purchased for twenty percent of the retail price of the product. Please contact sales@casemaker.com for details and pricing.

CASEMaker support contact information, by post mail, phone, or email, for your area is at: www.casemaker.com/support. We recommend searching the most current FAQ database before contacting CASEMaker support staff.

Please have the following information available when phoning support for a troubleshooting enquiry or include this information in your correspondence:

- Product name and version number
- Registration number
- Registered customer name and address
- Supplier/distributor where product was purchased
- Platform and computer system configuration
- Specific action(s) performed before error(s) occurred
- Error message and number, if any
- Any additional helpful information

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1.3 Document Conventions

This manual uses a standard set of typographical conventions for clarity and ease of use. The NOTE, Procedure, Example, and Command Line conventions also have a second setting used with indentation.

CONVENTION	DESCRIPTION
Italics	Italics indicate placeholders for information that must be supplied, such as user and table names. The word in italics should not be typed, but is replaced by the actual name. Italics also introduce new words, and are occasionally used for emphasis in text.
Boldface	Boldface indicates filenames, database names, table names, column names, user names, and other database schema objects. It is also used to emphasize menu commands in procedural steps.
KEYWORDS	All keywords used by the SQL language appear in uppercase when used in normal paragraph text.
SMALL CAPS	Small capital letters indicate keys on the keyboard. A plus sign (+) between two key names indicates to hold down the first key while pressing the second. A comma (,) between two key names indicates to release the first key before pressing the second key.
NOTE	Contains important information.
➲ Procedure	Indicates that procedural steps or sequential items will follow. Many tasks are described using this format to provide a logical sequence of steps for the user to follow .
➲ Example	Examples are given to clarify descriptions, and commonly include text, as it will appear on the screen. Other forms of this convention include Prototype and Syntax.
`CommandLine`	Indicates text, as it should appear on a text-delimited screen. This format is commonly used to show input and output for dmSQL commands or the content in the dmconfig.ini file.

Figure 1-1 Document Conventions Table

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2 DCI Basics

This chapter provides essential DCI environment set up and configuration information for DBMaker. Also included is information about using the demonstration program to show you the basic functions of DCI.

The following topics are covered in this chapter:

- Software and hardware requirements
- Step-by-step setup for UNIX and Windows platforms
- Options for configuring DCI for DBMaker
- DCI demonstration program instructions

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2.1 DCI Overview

Although traditional COBOL file systems and databases both contain data, they differ significantly. Databases are generally more robust and reliable than traditional file systems. Furthermore, they act as efficient systems for data recovery from software or hardware crashes. In addition, to ensure data integrity, DBMaker RDBMS provides support for referential actions and domain, column and table constraints.

File System and Databases

There are parallels between database data storage and COBOL indexed files. The following table shows each system's data structures and how they correspond.

COBOL Indexed File System Object	Database Object
Directory	Database
File	Table
Record	Row
Field	Column

Figure 2-1 COBOL and Database Object Structures

Indexed file operations are performed on records in COBOL and operations are performed on columns in a database. Logically, a COBOL indexed file represents a database table. Each record in a COBOL file represents a table row in a database and each field represents a table column. Data can have multiple definition types in COBOL while table columns in a database must associate with a particular data type such as integer, character, or date.

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➲ Example

A COBOL record is defined using the following format:

```
terms-record.
        03      terms-code      PIC 999.
        03      terms-rate      PIC s9v999.
        03      terms-days      PIC 9(2).
        03      terms-descript  PIC x(15).
```

The COBOL record in the above example has the following representation in a database. Notice how each row is an instance of the COBOL 01 level record terms-record.

TERMS_CODE	TERMS_RATE	TERMS_DAYS	TERMS_DESCRIPT
234	1.500	10	net 10
235	1.750	10	net 10
245	2.000	30	net 30
255	1.500	15	net 15
236	2.125	10	net 10
237	2.500	10	net 10
256	2.000	15	net 15

Figure 2-2 COBOL Records Converted to Database Rows

Accessing Data

ACUCOBOL-GT's generic file handler interfaces with DCI and the Vision file system. Vision is the standard indexed file system supplied with ACUCOBOL-GT. See ACUCOBOL-GT's manual for more detail about Vision files.

DCI, in combination with data dictionaries, bridges data access in a COBOL-based application program interface (API) and DBMaker's database management system. Users may access data through the API. Furthermore, ad

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hoc data queries can use either of DBMaker's SQL interfaces: dmSQL or JDBA Tool. The ACUCOBOL-GT compiler creates data dictionaries which are discussed in Chapter 3, *Data Dictionaries*.

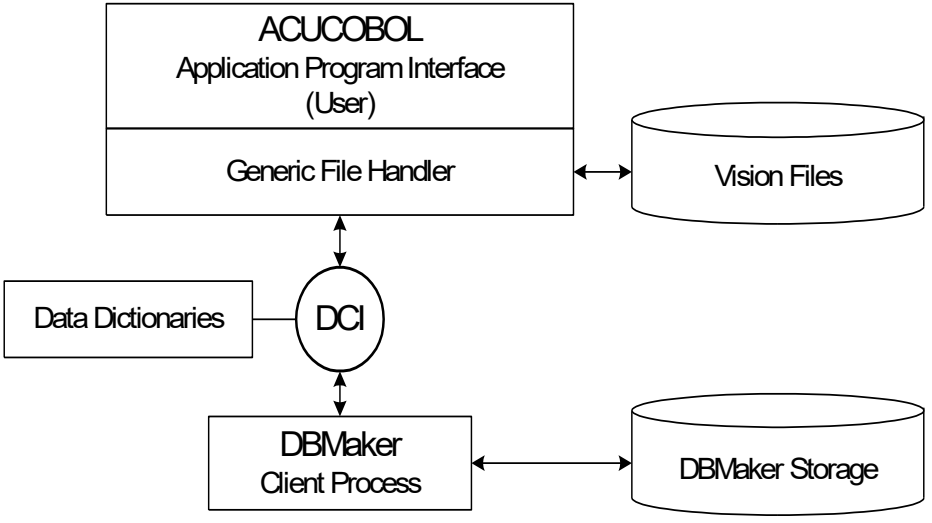

Figure 2-3 Data Flowchart

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2.2 System Requirements

DCI for DBMaker is an add-on module that must be linked with the ACUCOBOL-GT runtime system. For this reason, a C compiler is required to install the DCI product. To interface the ACUCOBOL-GT Version 4.3 or later compiler and runtime is required. The README.TXT file located in the DCI directory lists files that ship with the product.

DCI supports the following platforms:

- Windows 32bit and x86_64bit (Windows 2008/7/8/2012/10)
- Linux 32bit (glibc 2.3) and x86_64bit (glibc 2.7)
- Windows 32bit and x86_64bit (Windows 2000/XP/2003/Vista)

DCI requires the following software:

- DBMaker version 5.2 or greater
- ACUCOBOL-GT runtime version 4.3 or greater
- C compiler for the local machine (e.g., Visual C++™ Version 6.0 for a Windows platform)

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2.3 Setup Instructions

Install and configure the most recent version of DBMaker before configuring DCI. Refer to the Quick Start sheet included with the DBMaker CD for installation instructions.

Windows Setup

The DCI files must be copied from the source directory in the DCI zip file (\DCI\OS\) to a target directory before proceeding to setup DCI. The DCI libraries include dmdcic.lib, dmacu51.lib for ACUCOBOL-GT 5.1 and previous versions, dmacu52.lib for ACUCOBOL-GT 5.2 and versions before 8.0, dmacu80.lib for ACUCOBOL-GT 8.0, and dmacu90.lib for ACUCOBOL-GT 9.0.

➲ DCI Setup

1. Install @DM_PRODUCT_NAME@. The latest @DM_PRODUCT_NAME@ must be installed and configured prior to configuring DCI.
2. Copy the DCI library dmdcic.lib and the DCI library for ACUCOBOL-GT from the @DM_PRODUCT_NAME@ DCI zip file into the ACUCOBOL-GT installation directory.

```
copy DCI\WIN32\dmdcic.lib c:\acucobol\acugt\lib
```

   a) For ACUCOBOL-GT 5.1 or previous versions:

```
copy DCI\WIN32\dmacu51.lib c:\acucobol\acugt\lib
```

   b) For ACUCOBOL-GT 5.2 or versions before 8.0:

```
copy DCI\WIN32\dmacu52.lib c:\acucobol\acugt\lib
```

   c) For ACUCOBOL-GT 8.0:

```
copy DCI\WIN32\dmacu80.lib c:\acucobol\acugt\lib
```

   d) For ACUCOBOL-GT 9.0:

```
copy DCI\WIN32\dmacu90.lib c:\acucobol\acugt\lib
```

3. Edit the ACUCOBOL-GT runtime configuration file filetbl.c. It should be in the same directory as the ACUCOBOL-GT libraries, for example: *c:\acucobol\acugt\lib*.

   a) The original filetbl.c contains the entry:

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```
#ifndef USE_VISION
#define USE_VISION  1
#endif
```

Add a new entry:

```
#ifndef USE_DCI
#define USE_DCI     1
#endif
```

b) The original filetbl.c contains the entry:

```
extern DISPATCH_TBL v4_dispatch, ci_dispatch, bt_dispatch;
```

Add a new entry:

```
#if USE_DCI
extern DISPATCH_TBL DBM_dispatch;
#endif  /* USE_DCI */
```

c) The original filetbl.c contains the entry:

```
TABLE_ENTRY file_table[] = {
#if USE_VISION
{ &v4_dispatch,   "VISIO" },
#endif  /* USE_VISION */
```

Add a new entry:

```
#if USE_DCI
{ &DBM_dispatch,  "DCI" },
#endif  /* USE_DCI */
```

4. Edit the ACUCOBOL-GT runtime configuration file sub85.c. It is in the same directory as the ACUCOBOL-GT libraries.

The original sub85.c contains the entry:

```
struct  PROCTABLE WNEAR LIBTABLE[] = {
{ "SYSTEM",     call_system },
```

Add a new entry as follows:

```
extern int  DCI_GETENV();
extern int  DCI_SETENV();
extern int  DCI_DISCONNECT();
extern int  DCI_GET_TABLE_NAME();
extern int  DCI_SET_TABLE_CACHE();
extern int  DCI_BLOB_ERROR();
extern int  DCI_BLOB_PUT();
```

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```
extern int  DCI_BLOB_GET();
extern int  DCI_GET_TABLE_SERIAL_VALUE();
extern int  DCI_FREE_XFD();
struct  PROCTABLE WNEAR LIBTABLE[] = {
{ "SYSTEM",          call_system },
{ "DCI_SETENV",      DCI_SETENV },
{ "DCI_GETENV",      DCI_GETENV },
{ "DCI_DISCONNECT", DCI_DISCONNECT },
{ "DCI_GET_TABLE_NAME", DCI_GET_TABLE_NAME },
{ "DCI_SET_TABLE_CACHE", DCI_SET_TABLE_CACHE },
{ "DCI_BLOB_ERROR", DCI_BLOB_ERROR },
{ "DCI_BLOB_PUT", DCI_BLOB_PUT },
{ "DCI_BLOB_GET", DCI_BLOB_GET },
{ "DCI_GET_TABLE_SERIAL_VALUE", DCI_GET_TABLE_SERIAL_VALUE },
{ "DCI_FREE_XFD", DCI_FREE_XFD },
{ NULL,              NULL }
};
```

5. Edit the ACUCOBOL-GT runtime configuration file direct.c. It is in the same directory as the ACUCOBOL-GT libraries.

   The original direct.c contains the entry:

```
struct  EXTRNTABLE EXTDATA[] = {
{ NULL,          NULL }
};
```

   Add a new entry:

```
extern char *dci_where_constraint;
struct  EXTRNTABLE EXTDATA[] = {
{ "DCI-WHERE-CONSTRAINT",    (char *) &dci_where_constraint },
{ NULL,          NULL }
};
```

6. If you are using a version of ACUCOBOL-GT prior to 6.0, open wrun32.mak and search for LIBS. The wrun32.mak file should be in the same directory as the ACUCOBOL-GT libraries, for example: *c:\acucobol\acugt\lib*.

   a) If using ACUCOBOL-GT 5.1 or previous versions, add the files: dmacu51.lib, dmdcic.lib and dmapi52.lib. Build the project to obtain a new wrun32.exe and wrun32.dll file:

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```
nmake.exe -f wrun32.mak wrun32.exe.
```

b) If using ACUCOBOL-GT 5.2 or later version, add the files: dmacu52.lib, dmdcic.lib and dmapi52.lib. Build the project to obtain a new wrun32.exe and wrun32.dll file:

```
nmake.exe -f wrun32.mak wrun32.exe.
```

7. If you are using ACUCOBOL-GT 6.0 or 6.1, open the VS6.0 project named wrun32.dsw located in the lib directory of the ACUCOBOL-GT installation. Add the files dmacu52.lib, dmdcic.lib and dmapi52.lib to the project. Build the project to obtain a new wrun32.dll file.

8. If you are using ACUCOBOL-GT 6.2 or 7.0, open the VS2003 project named wrundll.vcproj located in the lib directory of the ACUCOBOL-GT installation. Add the files dmacu52.lib, dmdcic.lib and dmapi52.lib to the project. In the property, select MFC's common DLL. Build the project to obtain a new wrun32.dll file.

9. If you are using ACUCOBOL-GT 8.0, edit the VS2005 project named wrundll.vcproj located in the lib directory of the ACUCOBOL-GT installation.

   a) Change UseOfMFC from "0" to "2" (i.e., Use MFC in a shared DLL)

   b) Add dmacu80.lib dmdcic.lib dmapi52.lib to AdditionalDependencies, for example:

```
AdditionalDependencies="rpcrt4.lib wcvt32.lib wfsi32.lib
wrunlib.lib dmacu80.lib dmdcic.lib dmapi52.lib"
```

   c) Use VS2005 to build the project to obtain a new wrun32.dll file.

   NOTE *To build the runtime with 64-bit ACUCOBOL-GT 8.0, you must install VS2005 x64 components.*

   NOTE *You cannot build the runtime with VS2005 express edition because it does not have the MFC library.*

   NOTE We recommend using the -Fx3 or -Fx4 compiler options to generate an XFD file with the same format as previous ACUCOBOL-GT versions because ACUCOBOL-GT 8.0 compiler does not support some XFD syntax like the "$XFD COMMENT directive" in XML format. However, to use the new XML format add DCI_XML_XFD 1 to the DCI configuration file.

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10. If you are using ACUCOBOL-GT 9.0, edit the VS2008 project named wrundll.vcproj located in the lib directory of the ACUCOBOL-GT installation.
    a) Change UseOfMFC from "0" to "2". (i.e., Use MFC in a shared DLL)
    b) Add dmacu90.lib dmdcic.lib dmapi52.lib to AdditionalDependencies, for example:

```
AdditionalDependencies="mpr.lib rpcrt4.lib wcvt32.lib
wfsi32.lib wrunlib.lib dmacu90.lib dmdcic.lib dmapi52.lib"
```

    c) Use VS2008 to build the project to obtain a new wrun32.dll file.

    NOTE *To build the runtime with 64-bit ACUCOBOL-GT 9.0, you must install VS2008 x64 components.*

    NOTE *You cannot build the runtime with the VS2008 express edition because it does not have the MFC library.*

    NOTE *We recommend using the -Fx3 or -Fx4 compiler options to generate an XFD file with the same format as previous ACUCOBOL-GT versions because ACUCOBOL-GT 9.0 compiler does not support some XFD syntax like the "$XFD COMMENT directive" in XML format. However, to use the new XML format add DCI_XML_XFD 1 to the DCI configuration file.*

11. Copy the new wrun32.exe and wrun32.dll files to a directory mentioned in your execution path (or just wrun32.dll if using ACUCOBOL-GT 6.2 and above), for example:

```
copy wrun32.exe c:\acucobol\acugt\bin
copy wrun32.dll c:\acucobol\acugt\bin
```

12. Set the PATH system variable for @DM_PRODUCT_NAME@ installed\bin directory, for example:

```
set PATH=c:\@DM_PRODUCT_NAME@\5.2\bin:%PATH%
```

    You can also copy the c:\@DM_PRODUCT_NAME@\5.2\bin\dmapi52.dll to where the wrun32.exe and wrun32.dll files are located. Please update the dmapi52.dll to that directory if you have installed the new @DM_PRODUCT_NAME@ patch.

13. Verify the link by entering:

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```
wrun32 -vv
```

This returns the version information for all products linked with your runtime system. Make sure it shows the version of the @DM_PRODUCT_NAME@ interface.

UNIX Setup

The DCI files must be copied from the source directory on the DCI zip file (\DCI\OS\) to a target directory before proceeding to setup DCI. The DCI libraries include libdmdcic.a, libdmacu51.a for ACUCOBOL-GT 5.1 and previous versions, libdmacu52.a for ACUCOBOL-GT 5.2 and versions before 8.0, dmacu80.lib for ACUCOBOL-GT 8.0, and dmacu90.lib for ACUCOBOL-GT 9.0.

1. Copy the DCI library libdmdcic.a and the DCI library for ACUCOBOL-GT to the ACUCOBOL-GT installed directories.

   For example, to get DCI libraries for Linux:

   ```
   cp dci/Linux2.x86/libdmdcic.a /usr/acucobol/lib
   cp dci/Linux2.x86/libdmapic.a /usr/acucobol/lib
   ```

   For linking DCI libraries with ACUCOBOL-GT 5.1 or previous versions:

   ```
   cp dci/Linux2.x86/libdmacu51.a /usr/acucobol/lib
   ```

   For linking DCI libraries with ACUCOBOL-GT 5.2 or versions before 8.0:

   ```
   cp dci/Linux2.x86/libdmacu52.a /usr/acucobol/lib
   ```

   For linking DCI libraries with ACUCOBOL-GT 8.0:

   ```
   cp dci/Linux2.x86/libdmacu80.a /usr/acucobol/lib
   ```

   For linking DCI libraries with ACUCOBOL-GT 9.0:

   ```
   cp dci/Linux2.x86/libdmacu90.a /usr/acucobol/lib
   ```

2. Edit the ACUCOBOL runtime configuration file filetbl.c. found in the same directory as the ACUCOBOL-GT libraries.

   a) The original filetbl.c contains the entry:

   ```
   #ifndef USE_VISION
   #define USE_VISION  1
   #endif
   ```

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Add a new entry:

```
#ifndef USE_DCI
#define USE_DCI     1
#endif
```

b) The original filetbl.c contains the entry:

```
extern DISPATCH_TBL v4_dispatch, ci_dispatch, bt_dispatch;
```

Add a new entry:

```
#if USE_DCI
extern DISPATCH_TBL DBM_dispatch;
#endif  /* USE_DCI */
```

c) The original filetbl.c contains the entry:

```
TABLE_ENTRY file_table[] = {
#if USE_VISION
{ &v4_dispatch,   "VISIO" },
#endif  /* USE_VISION */
```

Add a new entry:

```
#if USE_DCI
{ &DBM_dispatch,  "DCI" },
#endif  /* USE_DCI */
```

3. Edit the ACUCOBOL-GT runtime configuration file sub85.c. It is in the same directory as the ACUCOBOL-GT libraries.

The original sub85.c contains the entry:

```
struct  PROCTABLE WNEAR LIBTABLE[] = {
{ "SYSTEM",     call_system },
```

Add a new entry:

```
extern int  DCI_GETENV();
extern int  DCI_SETENV();
extern int  DCI_DISCONNECT();
extern int  DCI_GET_TABLE_NAME();
extern int  DCI_SET_TABLE_CACHE();
extern int  DCI_BLOB_ERROR();
extern int  DCI_BLOB_PUT();
extern int  DCI_BLOB_GET();
extern int  DCI_GET_TABLE_SERIAL_VALUE();
extern int  DCI_FREE_XFD();
```


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```
struct  PROCTABLE WNEAR LIBTABLE[] = {
{ "SYSTEM",         call_system },
{ "DCI_SETENV",     DCI_SETENV },
{ "DCI_GETENV",     DCI_GETENV },
{ "DCI_DISCONNECT", DCI_DISCONNECT },
{ "DCI_GET_TABLE_NAME", DCI_GET_TABLE_NAME },
{ "DCI_SET_TABLE_CACHE", DCI_SET_TABLE_CACHE },
{ "DCI_BLOB_ERROR", DCI_BLOB_ERROR },
{ "DCI_BLOB_PUT", DCI_BLOB_PUT },
{ "DCI_BLOB_GET", DCI_BLOB_GET },
{ "DCI_GET_TABLE_SERIAL_VALUE", DCI_GET_TABLE_SERIAL_VALUE },
{ "DCI_FREE_XFD", DCI_FREE_XFD },
{ NULL,             NULL }
};
```

4. Edit the ACUCOBOL-GT runtime configuration file direct.c. It is in the same directory as the ACUCOBOL-GT libraries.

   The original direct.c contains the entry:

```
struct  EXTRNTABLE EXTDATA[] = {
{ NULL,         NULL }
};
```

   Add a new entry:

```
extern char *dci_where_constraint;
struct  EXTRNTABLE EXTDATA[] = {
{ "DCI-WHERE-CONSTRAINT",   (char *) &dci_where_constraint },
{ NULL,         NULL }
};
```

5. Open the Makefile file located in \usr\acucobol\lib. If you need to link it with your own C routines, add them to a SUBS= line in the Makefile of your C routine. See Appendix C of the ACUCOBOL-GT compiler documentation for details on linking C subroutines.

6. Add /APP_HOME/lib/libdmdcic.a and /APP_HOME/lib/libdmapic.a to the line FSI_LIBS=, where /APP_HOME is the directory containing the @DM_PRODUCT_NAME@ installation. If @DM_PRODUCT_NAME@ has been installed in the directory /APP_HOME then the Makefile will contain the following string(s):

   For ACUCOBOL-GT 5.1 and previous versions:

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```
FSI_LIBS=libdmacu51.a libdmdcic.a libdmapic.a
```

For ACUCOBOL-GT 5.2:

```
FSI_LIBS=libdmacu52.a libdmdcic.a libdmapic.a
```

For ACUCOBOL-GT 6.0 and 7.0:

```
FSI_LIBS=libdmacu60.a libdmdcic.a libdmapic.a
```

For ACUCOBOL-GT 8.0:

```
FSI_LIBS=libdmacu80.a libdmdcic.a libdmapic.a
```

For ACUCOBOL-GT 9.0:

```
FSI_LIBS=libdmacu90.a libdmdcic.a libdmapic.a
```

7. Ensure you are in the directory containing the ACUCOBOL-GT runtime system. At the prompt enter:

```
make -f Makefile
```

This compiles sub.c and filetbl.c, and then links the runtime system. If the make fails because of an out-of-date symbol table, execute the following:

```
ranlib *.a
```

Then re-execute the make. If the make fails for any other reason, please call ACUCORP Technical Support.

8. Verify the link with the following command:

```
./runcbl -vv
```

This returns version information for all products linked to your runtime system. Ensure it shows the version of DCI for @DM_PRODUCT_NAME@.

NOTE *You may also link your own C routines with the runtime system.*

9. Copy the new runcbl file to a directory in your execution path. Everyone who will be using the runtime system must have execute permission for this file. The remaining files can be left were they were installed.

10. We recommend using the -Fx3 or -Fx4 compiler options to generate an XFD file with the same format as previous ACUCOBOL-GT versions because the ACUCOBOL-GT 8.0 and 9.0 compilers do not support some XFD syntax like the "$XFD COMMENT directive" in XML format. However, to use the new XML format add DCI_XML_XFD 1 to the DCI configuration file.

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Shared Libraries

When re-linking and executing the ACUCOBOL-GT runtime, an error message similar to these may result:

- Could not load library, no such file or directory
- Can't open shared library . . .

That could mean the operating system is unable to locate some needed shared libraries. This can happen even if the shared libraries exist in the current directory.

Some versions require setting an environment variable, which points to shared libraries on the system. For example, an IBM RS/6000 running AIX 4.1, the environment variable LIBPATH must indicate the directory where shared libraries reside. For HP/UX, the environment variable is SHLIB_PATH. For UNIX SVR4, the environment variable is LD_LIBRARY_PATH. Please consult your UNIX documentation for specific details.

Alternatively, linking the shared libraries to the runtime with a static link resolves this error. Please refer to the documentation for your C development system to find the correct flag for your environment.

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2.4 Basic Configuration

DCI requires parameters in two configuration files. The first is **cblconfig**, the ACUCOBOL runtime configuration file. The second is the DCI_CONFIG file that is located in a directory determined by an environment variable (see *Configuration File Variables* for details). The DCI_CONFIG file sets parameters for DCI that determine how data appears in the database and defines certain DBA functions allowing database access. The following configuration variables must be set before using DCI.

- DCI_DATABASE
- DCI_LOGIN
- DCI_PASSWD
- DCI_XFDPATH

➲ Example

Here is a basic DCI_CONFIG file.

```
DCI LOGIN SYSADM
DCI PASSWD
DCI DATABASE DBMaker Test
DCI_XFDPATH /usr/dbmaker/dictionaries
```

DCI_DATABASE

DCI_DATABASE specifies the database that will transact with DCI. This database must exist. Use DBMaker setup to establish it. Please note, database names are case-sensitive by default, and must be less than or equal to 128 characters. Please refer to *Chapter 6, DCI_DATABASE* for more information

➲ Syntax

The following entry must be included in the configuration file. In this example, we show DBMaker_Test as the database to be used with DCI.

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```
DCI-DATABASE DBMaker_Test
```

DCI_LOGIN

Provide your COBOL application with a user name to ensure it has permission to access objects in the database. The configuration variable DCI_LOGIN sets the username for all COBOL applications that use DCI. Initially set to SYSADM to ensure full access to databases, this variable is easily changed to another user name as described in *Chapter 6, DCI_LOGIN*.

➲ Syntax

The DCI configuration file must include the following entry for DCI to connect with databases via the SYSADM username:

```
DCI_LOGIN SYSADM
```

DCI_PASSWD

Once a username has been specified via the DCI_LOGIN variable, a database account is associated with it. Please note, by default DBMaker sets no password for SYSADM. Your database administrator will know if the account information (LOGIN, PASSWD) is correct. See *Chapter 6,* DCI_PASSWD for more information.

➲ Syntax

The configuration file should appear as follows when the database account is set to SYSADM.

```
DCI_PASSWD
```

DCI_XFDPATH

DCI_XFDPATH specifies the directory where data dictionaries are stored. The default value is the current directory.

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- Syntax 1

  If data dictionaries are stored in */usr/dbmaker/dictionaries*, include this entry in the configuration file:

  ```
  DCI_XFDPATH /usrdbmaker/dictionaries
  ```

- Syntax 2

  When specifying more than one path, separate by spaces. For example:

  ```
  DCI_XFDPATH /usr/dbmaker/dictionaries /usr/dbmaker/dictionaries1
  ```

- Syntax 3

  Use double-quotes in a WIN-32 environment when including embedded spaces. For example:

  ```
  DCI_XFDPATH c:\tmp\xfdlist "c:\my folder with space\xfdlist"
  ```


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2.5 Runsql Utility

DCI's runsql.acu program provides access to some standard SQL commands. It can be called from a COBOL program or executed from the command line. The SQL command is limited to 32,767 characters. It may be a variable or a quoted command string in the CALL statement.

Runsql.acu may issue most all SQL commands but those for data retrieval. For example, statements that return data, such as SELECT, are unsupported. This category of statement returns an error when passed to runsql.acu.

The global variable return-code is 0 when a command has completed successfully. If a command is unsuccessful, the global variable return-code contains an error code.

➲ Syntax 1

Creating a DBMaker view.

```
runcbl runsql.acu
```

➲ Example 1

Pausing a program before accepting SQL commands.

```
create table TEST (col1 char(10), col2 char(10))
create view TESTW as select * from TEST
```

➲ Syntax 2

Calling runsql.acu from a COBOL program.

```
call "runsql.acu" using sql-command
```

➲ Example 2

```
Call "runsql" using "create view TESTW as select * from TEST".
```

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2.6 Invalid Data

Some data is valid for COBOL applications but invalid for DBMaker RDBMS databases. Data types not accepted by RDBMS are listed here along with solutions that DCI implements to solve this problem.

COBOL VALUE	WHERE IT IS CONSIDERED ILLEGAL
LOW-VALUES	In USAGE DISPLAY NUMBERS and text fields
HIGH-VALUES	In USAGE DISPLAY NUMBERS, COMP-2 numbers and COMP-3 numbers
SPACES	In USAGE DISPLAY NUMBERS and COMP-2 numbers
Zero	In DATE fields

Figure 2-4 Illegal COBOL Data

Check the internal storage format of other numeric types to determine which Figure 2-4 category it applies to. BINARY numbers and values in BINARY text fields are always legal.

Certain data types must be converted before DBMaker will accept them. DCI converts these values as follows:

- Illegal LOW-VALUES: stored as the lowest possible value, 0 or –99999, or DCI_MIN_DATE default value
- Illegal HIGH-VALUES: stored as the highest possible value, 99999, or DCI_MAX_DATE default value
- Illegal SPACES: stored as zero (or DCI_MIN_DATE, in the case of a date field)
- Illegal DATE values: stored as DCI_INV_DATE default value
- Illegal TIME: stored as DCI_INV_DATE default value

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Null fields sent to DCI from a database convert to COBOL in the following ways:

- Numbers (including dates) convert to zero
- Text (including binary text) converts to spaces

If you want to change these conversion rules, except for the key fields, you can use DCI_NULL_ON_ILLEGAL_DATE that convert to NULL illegal COBOL data.

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2.7 Sample Application

A sample application program is included with the DCI files and demonstrates mapping application data to a DBMaker database. This section teaches:

- Setting up the application
- Compiling source code to create application object code
- Application data input
- Data access using dmSQL and JDBA Tool
- How source code conforms to the generated table's schema

Setting up the Application

Located in the DCI directory, the application consists of these files INVD.CBL, INVD.FD, INVD.SL, TOTEM.DEF, CBLCONFIG, INVD.XFD, DCI.CFG, and the object file INVD.ACU. The application may be run directly from the INVD.ACU object code file as shown in the following paragraph. Applications may also be compiled from the source code, INVD.CBL, also demonstrated below.

NOTE *ACUCOBOL 4.3 or greater is needed to compile the sample application*

➲ Running the Application

1. Setup a database in DBMaker to accept data from DCI. For example, we created a database called DCI using JServer Manager with all default settings. Specifically, SYSADM is the default login name and no password was set. For information on creating and setting up a database, refer to the *Database Administrator's Reference* or the *JServer Manager User's Guide*.
2. Located in the DCI directory, use a text editor to open the DCI.CFG file. Set the configuration variables to appropriate values. Refer to *Section 2.4, Basic Configuration* for details. .

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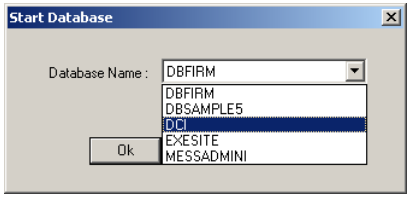
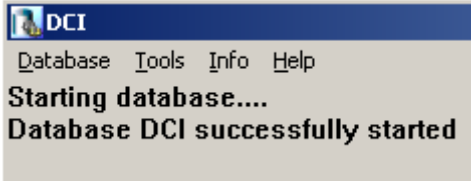
➲ Example

```
DCI_DATABASE     DCI
DCI_LOGIN        SYSTEM
DCI_PASSWD
//DCI_LOGFILE
DCI_STORAGE_CONVENTION Dca
//DCI_XFDPATH C:\DCI
```

3. Run the DBMaker Server program:dmserver.exe. When prompted, select the database designated by the DCI.CFG file.



4. The database starts normally and the following window appears. If any problems or error messages occur, refer to the *Error Message Reference* or the *Database Administrator's Guide*.



5. From the command prompt go to the ..*DCI* directory.
6. Define DCI_CONFIG by entering the following at the command prompt.

➲ Syntax 6a

```
..\DCI\>SET DCI_CONFIG=C:\..\DCI\DCI.CFG
```

7. Run the COBOL program INVD.ACU using WRUN32.

➲ Syntax 7a

From the same directory, enter the following command:

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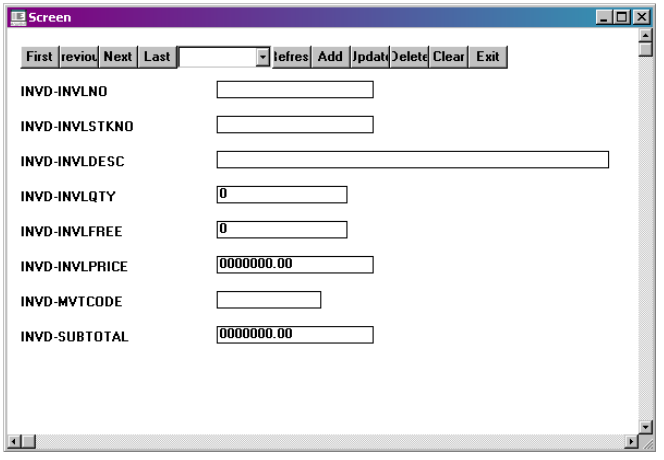
```
..\DCI\>WRUN32 -C CBLCONFIG INVD.ACU
```

8. The file CBLCONFIG contains the command line DEFAULT-HOST DCI and is used to set the default file system. For more information refer to *Chapter 5*, *Compiler and Runtime Options*.
9. The INVD.ACU COBOL application window opens as shown below, allowing data entry.



NOTE *For instructions on adding records, refer to Adding Records below*

➲ Compiling the sample application from the source code:

1. Follow *Running the Application* steps 1 through 6 shown above.
2. Copy these definition files: acucobol.def, acugui.def, crtvars.def, fonts.def, showmsg.def,
   from ..*Acucorp**Acucbl500**AcuGT**sample*\def to the DCI directory.
   NOTE *ACUCOBOL 4.3 users should copy the definition files from \Acucbl43\AcuGT\sample*
3. At the command prompt go to the DCI directory.

   ➲ Syntax 3a
   Enter the following line:

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```
..\DCI\>ccbl32 -Fx INVD.CBL
```

4. The file will be compiled and will create a new object code file INVD.ACU and data dictionary file INVD.XFD. To run the object file follow steps 6 and 7 in *To run the application*, above.

Adding Records

Once the application has been started (see *To run the application* above) it is a simple matter to add records to the application, and subsequently, to the database. The field INVD-INVLNO is a key field, so a unique value is required for a record to be a valid entry. All other fields may be left blank. When you have finished entering values into the field, click the **Add** button. The values entered into the fields will now be saved in the DBMaker database specified by the DCI.CFG variable, DCI-DATABASE.

➲ Example

The file descriptor for the application looks like this:

```
FD INVD
        LABEL RECORDS ARE STANDARD
        01      INVD-R
                05      INVD-INVLNO             PIC X(10).
                05      INVD-INVLSSTKNO         PIC X(10).
                05      INVD-INVLDESC           PIC X(30).
                05      INVD-INVLQTY            PIC 9(8).
                05      INVD-INVLFREE           PIC 9(8).
                05      INVD-INVLPRICE          PIC 9(7)V99.
                05      INVD-MVTCODE            PIC X(6).
                05      INVD-SUBTOTAL           PIC 9(7)V99.
```

Once a record has been added, you may browse through the entries by selecting the **First**, **Previous**, **Next**, or **Last** buttons on the **Screen** window. An individual record may be selected from the drop-down menu at the top of the **Screen** window that displays all the key field values. The section *Accessing Data* describes how to browse data using DBMaker SQL based tools.

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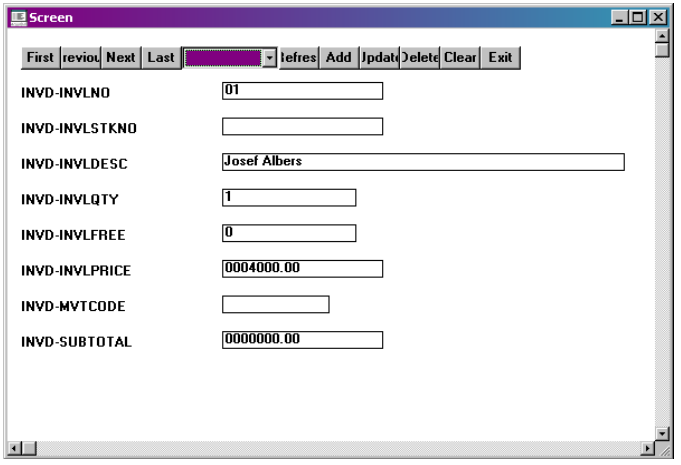

Figure 2-5 INVD-INVLNO Key Field Sample Entry

Accessing Data

To browse and manipulate records created within the sample application is straightforward. First, we recommend that you familiarize yourself with one of the DBMaker tools: dmSQL, DBA Tool, or JDBA Tool. For information on the use of these tools, refer to the *Database Administrator's Guide*, or the *JDBA Tool User's Guide*. The following example shows how data can be accessed using JDBA Tool.

The INVD application must first be shut down, because it places a lock on the table that has been created within the database. Connect to the database with JDBA. You will be able to see the table by expanding the Tables node within the database tree as shown below.

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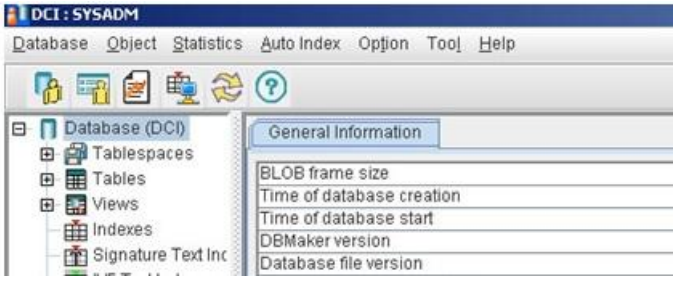

Figure 2-6 INVD Application Tables Tree Node

Double clicking on the **SYSADM.invd** table allows you to view the table's schema. All of the columns and their properties can be viewed here.

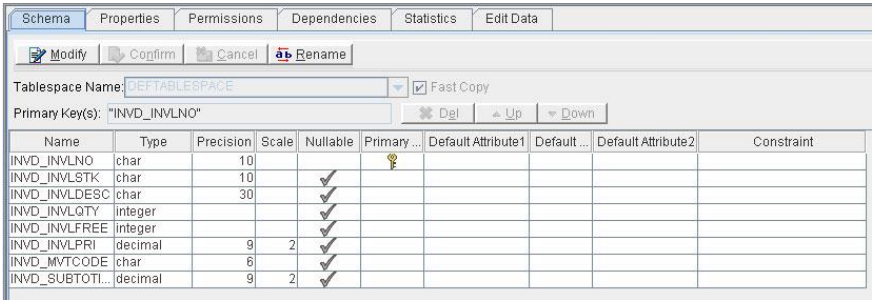

Figure 2-7 SYSADM.invd Table Schema

Selecting the **Edit Data** tab allows you to view the values of each field.

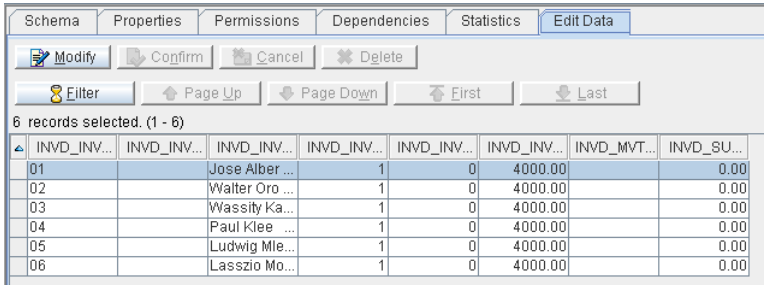

Figure 2-8 SYSADM.invd Edit Data Tab Field Values

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3 Data Dictionaries

Data Dictionaries describe how extended file descriptor (.XFD) files are created and accessed. DCI avoids using SQL function calls embedded in COBOL code by using a special feature of ACUCOBOL-GT. When a COBOL application is compiled using the "–Fx" option data dictionaries are generated. These are known as "extended file descriptors"" (XFD files), which are based on COBOL file descriptors. DCI uses the data dictionaries to map data between the fields of a COBOL application and the columns of a DBMaker table. Every DBMaker table used by DCI has at least one corresponding data dictionary file associated with it.

NOTE *Refer to Chapter 5.3 of the ACUCOBOL-GT User's Guide for more detailed information and rules concerning the creation of XFDs.*

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3.1 Assigning Table Names

Database tables correspond to file descriptors in the FILE CONTROL section of the COBOL application. The database tables must have unique names under 128 bytes in length (128 ASCII characters).

It is possible for a DBMaker table to have more columns than a COBOL program's corresponding file descriptor. It is also possible to have different column orders than the COBOL program's corresponding file descriptor.

The number of columns in the database table and the number of fields in the COBOL program that is accessing the table are not required to match. The DBMaker table can have more columns than the COBOL program references; however, the COBOL program may not have more fields than the DBMaker table. Ensure that any extra columns are set correctly when adding new rows to a table.

ACUCOBOL generates XFD file names by default from the FILE CONTROL section. If the SELECT statement for the file has a variable ASSIGN *name* (ASSIGN TO *filename*), then specify a starting name for the XFD file using a FILE directive (refer to $XFD FILE Directive in chapter 4). If the SELECT statement for the file has a constant ASSIGN *name* (such as ASSIGN TO "EMPLOYEE"), then the constant is used to generate the XFD file name. If the ASSIGN phrase refers to a device and is generic (such as ASSIGN TO "DISK"), then the compiler uses the SELECT name to generate the XFD file name.

File names and usernames are case-insensitive. All file descriptors containing uppercase characters will be converted to lowercase. Users must be aware of this if using a case sensitive operating system.

➲ Example 1

If the FILE CONTROL section contains the following line of text:

```
SELECT FILENAME ASSIGN TO "Customer"
```


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➲ Example 2

DCI, based on dictionary information read in "customer.xfd", will make a DBMaker table called "*username*.customer". The ACUCOBOL-GT compiler always creates a file name in lowercase. The "username" default is determined by the DCI_LOGIN value in the DCI_CONFIG file, or can be changed with the DCI_USER_PATH configuration variable.

```
SELECT FILENAME ASSIGN TO "CUSTOMER"
```

➲ Example 3

If the file has a file extension, DCI replaces "." characters with "_". DCI will open a DBMaker table named "username.customer_dat".

```
SELECT FILENAME ASSIGN TO "customer.dat"
```

➲ Example 4

DCI_MAPPING can be used to make the dictionary customer.xfd available. Since DCI uses the base name to look for the XFD dictionary, in this case it looks for an XFD file named "customer_dat.xfd". The following setting is based on an XFD file named "customer.xfd".

```
DCI_MAPPING customer*=customer
```

COBOL applications may use the same base file name in different directories. For example a COBOL application opens a file named "customer" in different directories such as "*/usr/file/customer*" and "*/usr1/file/customer*". To make the file names unique we would include directory paths in the file names. A way to do this is to change the DCI_CONFIG variable DCI_USEDIR_LEVEL to "2". DCI will then open a table as follows:

COBOL	RDBMS	XFD FILENAME
/usr/file/customer	usrfilecustomer	usrfilecustomer.xfd
/usr1/file/customer	usr1filecustomer	usr1filecustomer.xfd

Figure 3-1 Sample DCI_USEDIR_LEVEL to "2" Table

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NOTE *Please remember there is a limit to the maximum length of DBMaker table names and that DCI_MAPPING must be used to map .XFD file dictionary definitions.*

COBOL CODE	RESULTING FILE NAME	RESULTING TABLE NAME
ASSIGN TO "usr/hr/employees.dat"	employees_dat.xfd	employees_dat
SELECT DATAFILE, ASSIGN TO DISK	datafile.xfd	datafile
ASSIGN TO "-D SYS$LIB:EMP"	emp.xfd	emp
ASSIGN TO FILENAME	(user specified)	(user specified)

Figure 3-2 Example Table Names Formed From Different COBOL Statements

➲ Example

Table names are, in turn, generated from the XFD file name. Another way to specify the table name is to use the $XFD FILE directive.

```
*(( XFD FILE = PURCHASE-FILE2 ))
FD PURCHASE-FILE.
01 PURCHASE-RECORD.
05 DATE-PURCHASED.
   10 YYYY            PIC 9(04).
   10 MM              PIC 9(02).
   10 DD              PIC 9(02).
05 PAY-METHOD         PIC X(05).
```

The final name is formed as follows:

- The compiler converts extensions and includes them with the starting name by replacing the "." with an underscore "_".
- It constructs a universal base name from the file name and directory information as specified by the DCI_CONFIG variable DCI_USEDIR_LEVEL.

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It reduces the base name to 32 characters and converts it to lowercase depending of DCI_CASE value.

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3.2 Mapping Columns and Records

The table that is created is based on the largest record in the COBOL file. It contains all of the fields from that record and any key fields. Key fields are specified in the FILE CONTROL section using the KEY IS phrase. Key fields correspond to primary keys in the database table and are discussed in detail in the next section. Note that DCI will create column names for the database that are case-sensitive, unlike table names.

➲ Example 1

The following illustrates how data is transferred.

```
ENVIRONMENT DIVISION.
 INPUT-OUTPUT SECTION.
 FILE-CONTROL.
      SELECT HR-FILE
             ORGANIZATION   IS INDEXED
             RECORD KEY     IS EMP-ID
             ACCESS MODE    IS DYNAMIC.
 DATA DIVISION.
 FILE SECTION.
 FD  HR-FILE
     LABEL RECORDS ARE STANDARD.
 01  EMPLOYEE-RECORD.
     05 EMP-ID              PIC 9(06).
     05 EMP-NAME            PIC X(17).
     05 EMP-PHONE           PIC X(10).
 WORKING-STORAGE SECTION.
 01  HR-NUMBER-FIELD        PIC 9(05).
 PROCEDURE DIVISION.
 PROGRAM-BEGIN.
     OPEN I-O HR-FILE.
     PERFORM GET-NEW-EMPLOYEE-ID.
     PERFORM ADD-RECORDS UNTIL EMP-ID = ZEROS.
     CLOSE HR-FLE.
PROGRAM-DONE.
     STOP RUN.
```


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```
GET-NEW-EMPLOYEE-ID.
     PERFORM INIT-EMPLOYEE-RECORD.
     PERFORM ENTER-EMPLOYEE-ID.
 INIT-EMPLOYEE-ID.
      MOVE SPACES TO EMPLOYEE-RECORD.
      MOVE ZEROS  TO EMP-ID.
 ENTER-EMPLOYEE-ID.
      DISPLAY "ENTER EMPLOYEE ID NUMBER (1-99999),"
      DISPLAY "ENTER 0 TO STOP ENTRY".
      ACCEPT   HR-NUMBER-FIELD.
      MOVE     HR-NUMBER-FIELD TO EMP-ID.
 ADD-RECORDS.
      ACCEPT  EMP-NAME.
      ACCEPT  EMP-PHONE.
      WRITE   EMPLOYEE-RECORD.
      PERFORM GET-NEW-EMPLOYE-NUMBER.
```

➲ Example 2

The preceding program normally would write all fields sequentially to file. The output would appear as follows:

```
ENTER EMPLOYEE ID NUMBER (1-99999), ENTER 0 TO STOP ENTRY
51100
LAVERNE HENDERSON
2221212999
ENTER EMPLOYEE ID NUMBER (1-99999), ENTER 0 TO STOP ENTRY
52231
MATTHEW LEWIS
2225551212
ENTER EMPLOYEE ID NUMBER (1-99999), ENTER 0 TO STOP ENTRY
```

In a traditional COBOL file system, records will be stored sequentially. Every time a write command is executed, the data is sent to the file. When DCI is used, the data dictionary will create a map for the data to be stored in the database. In this case, the record (EMPLOYEE-RECORD) is the only record in the file.

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➲ Example 3

The database will create a distinct column for each field in the file descriptor. The table name will be HR-FILE in accordance with the SELECT statement in the FILE-CONTROL section. The database records in the example would therefore have the following structure:

EMP_ID (INT(6))	EMP_NAME (CHAR(17))	EMP_PHONE (DEC(10))
51100	LAVERNE HENDERSON	2221212999
52231	MATTHEW LEWIS	2225551212

Figure 3-3 Table EMPLOYEE-RECORD

In this table, the column EMP-ID is the primary key as defined by the KEY IS statement of the input-output section. The data dictionary creates a "mapping" that allows it to retrieve records and place them in the correct fields. A COBOL application that stores information in this way can take advantage of the backup and recovery features of the database, as well as take advantage of the capabilities of SQL.

Identical Field Names

In COBOL, fields with identical names are distinguished by qualifying them with a group item. DBMaker does not allow duplicate column names on a table. If fields have the same name, DCI will not generate columns for those fields.

Adding a NAME directive that associates an alternate name with one or both of the conflicting fields is a method for handling this situation. Please refer to $XFD NAME Directive in Chapter 4 for additional details.

➲ Example

In the following example, you would reference PERSONNEL and PAYROLL in your program:

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```
FD HR-FILE
        LABEL RECORDS ARE STANDARD.
01      EMPLOYEE-RECORD.
        03      PERSONNEL.
                05      EMP-ID          PIC 9(6).
                05      EMP-NAME        PIC X(17).
                05      EMP PHONE       PIC 9(10).
        03      PAYROLL.
                05      EMP-ID          PIC 9(6).
                05      EMP-NAME        PIC X(17).
                05      EMP PHONE       PIC 9(10).
```

Long Field Names

DBMaker supports table names up to 128 characters. DCI truncates field names longer than 128 characters. In the case of the OCCURS clause, described below, the truncation is to the original name, not the appended index numbers. The final name, however, including the index number, is limited to the 32 characters. For example, if the field name is Employee-statistics-01 it truncates to Employee_statis_01. It is important to ensure that field names are unique and meaningful within the first 18 characters.

NAME can be used to rename a field with a long name, but within the COBOL application you must continue using the original name. The NAME directive affects only the corresponding column name in the database.

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3.3 Using Multiple Record Formats

The example in the previous section showed how fields are used to create a database table. However, the example only shows the case of an application with one record.

A multiple record format is stored differently from a single record format. COBOL programs with multiple records map all records from the "master" (largest) record in the file and any key fields in the file. Smaller records map to the database table by the XFD file but do not appear as discrete, defined columns in the table; they occupy new records in the existing columns of the database.

➲ Example 1

Take the previous example but modify the file descriptor to include several records.

```
DATA DIVISION
FILE SECTION
FD HR-FILE
  LABEL RECORDS ARE STANDARD.
01 EMPLOYEE-RECORD.
   05 EMP-ID          PIC 9(6).
   05 EMP-NAME        PIC X(17).
   05 EMP PHONE       PIC 9(10).
01 PAYROLL-RECORD.
   05 EMP-SALARY      PIC 9(10).
   05 DD              PIC 9(2).
   05 MM              PIC 9(2).
   05 YY              PIC 9(2).
```

In this case, the data dictionary is created from the largest file. The record EMPLOYEE-RECORD contains 33 characters, while the record PAYROLL-RECORD contains only 16. In this case, records are sequentially entered into the database. The record EMPLOYEE-RECORD is used to create the schema for the table column size and data type.

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EMP_ID (INT(6))	EMP_NAME (CHAR(17))	EMP_PHONE (DEC(10))

Figure 3-4 Preceding Example Table

Fields from the following record are written into the columns according to the character positions of the fields. The result is that no discrete columns exist for the smaller records. The data can be retrieved from the database by the COBOL application because the XFD file contains a map for the fields, but there are no columns in the table representing those fields.

In the previous example, when adding the first record to the database, there is a correlation between the columns and the COBOL fields. When adding the second record, there is no such correlation. The data occupies its corresponding character position according to the field. So the first five characters of EMP_SALARY occupy the EMP_ID column, the last five characters of EMP_SALARY occupy the EMP_NAME column. The fields DD and MM and YY are also located within the EMP_NAME column.

➲ Example 2

The following example illustrates this. Given the following input to the COBOL application:

```
ENTER EMPLOYEE ID NUMBER (1-99999), ENTER 0 TO STOP ENTRY
51100
LAVERNE HENDERSON
2221212999
5000000000
01
04
00
```

The fields have been merged and split according to the character positions of the fields relative to the table's schema. Furthermore, the data type of the column EMP_NAME is CHAR. Because DCI has access to the data dictionary, all fields will be mapped back to the COBOL application in the correct positions.

This is a very important fact, by default, the fields of the largest record are used to create the schema of the table, therefore table schema must be

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carefully considered when creating file descriptors. To take advantage of the flexibility of SQL, data types are consistent between fields for different records that will occupy the same character positions. If a PIC X field is written to a DECIMAL type database column, the database will return an error to the application.

- Example 3

  A SQL select on the first record of all columns in EMP_NAME would display the following:

```
51100, LAVERNE HENDERSON, 2221212999
```

- Example 4

  A SQL select on the second record of all columns in EMP_NAME would display the following:

```
500000, 0000010400
```


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3.4 Using XFD File Defaults

In many cases, directives can override the default behavior of DCI. Please refer to XFD Directives for more information.

The compiler uses special methods to deal with the following COBOL elements:

- REDEFINES Clause
- KEY IS phrase
- FILLER data items
- OCCURS Clauses

REDEFINES Clause

A REDEFINES clause creates multiple definitions for the same field. DBMaker supports a single data definition per column. Therefore, a redefined field occupies the same position in the table as the original field. By default, the data dictionary uses the field definition of the subordinate field to define the column data type.

Multiple record definitions are essentially redefines of the entire record area. Please refer to the previous section for details on multiple record definitions.

Group items are not included in the data dictionary's definition of the resultant table's schema. Instead, the individual fields within the group item are used to generate the schema. Grouped fields may be combined using the USE GROUP directive.

KEY IS Phrase

The KEY IS phrase in the input-output section of a COBOL program defines a field or group of fields as a unique index for all records. The data dictionary

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maps fields included in the KEY IS phrase to primary keys in the database. If the field named in the KEY IS phrase is a group item, the subordinate fields of the group item become the primary key columns of the table. Use the USE GROUP directive to collect all subordinate fields into one field. Please see $XFD USE GROUP Directive in Chapter 4 for more details.

FILLER Data Items

FILLER data items are placeholders in a COBOL file descriptor. They do not have unique names and cannot be uniquely referenced. The data dictionary maps all other named fields as if the fillers existed in terms of character position, but does not create a distinct field for the FILLER data item.

If a FILLER must be included in the table schema it can be combined with other fields using the USE GROUP directive (see $XFD USE GROUP Directive in Chapter 4) or the $XFD NAME directive (see in Chapter 4).

OCCURS Clauses

The OCCURS clause allows a field to be defined as many times as necessary. DCI must assign a unique name for each database column, but multiple fields defined with an OCCURS clause will all have identical names. To avoid this problem, a sequential index number is appended to the field specified in the OCCURS clause.

- Example 1

  The following file descriptor part...

```
   03 EMPLOYEE-RECORD OCCURS 20 TIMES.
       05 CUST-ID                        PIC 9(5).
```

- Example 2

  Generates the following column names for the database:

```
EMP_ID_1
EMP_ID_2
.
```


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```
.
.
EMP_ID_5
EMP_ID_6
.
.
.
EMP_ID_19
EMP_ID_20
```

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3.5 Mapping Multiple Files

It is possible at runtime to use a single XFD file for multiple files with different names. If the record definitions are identical then it is unnecessary to create a separate XFD for each file.

The runtime configuration variable DCI_MAPPING determines file mapping to an XFD.

Suppose a COBOL application has a SELECT with a variable ASSIGN name, such as EMPLOYEE-RECORD. This variable assumes different values (such as EMP0001 and EMP0002) during program execution. To provide a base name for the XFD, use the FILE directive (see ((XFD DATE, USE GROUP)).

➲ Example

If "EMP" is the base, then the compiler generates an XFD named "Emp.xfd". The asterisk ("*") in the following example is a wildcard character that replaces any number of characters in the file name. The file extension ".xfd" is not included in the map. This statement would cause the XFD "emp.xfd" to be used for all files with names that begin with "EMP". Add the following entry in the runtime configuration file to ensure that all employee files, each having a unique but related name, use the same XFD:

```
DCI_MAPPING EMP* = EMP
```

The DCI_MAPPING variable is read during the open file stage. The "*" and "?" wildcards can be used within the pattern as follows:

* matches any number of characters

? matches a single occurrence of any character

EMP????? matches EMP00001 and EMPLOYEE, but does not match EMP001 or EMP0001

EMP* matches all of the above

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EMP*1 matches EMP001, EMP0001, and EMP00001, but does nor match EMPLOYEE.

*OYEE matches EMPLOYEE
does not match EMP0001 or EMP00001

➲ Syntax

Where <*pattern*> consists of any valid filename characters and may include "*" or "?". The DCI_MAPPING variable has the following syntax:

```
DCI_MAPPING [<pattern> = base-xfd-name],
```

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3.6 Mapping to Multiple Databases

It is possible to reference tables in different databases with DCI_DB_MAP by specifying different files or COBOL file-prefix links to the DBMS.

➲ Example

To reference table **idx1** in the databases DBNAME (as default), DBCED, and DBMULTI, add the following settings in the DCI_CONFIG configuration file.

```
DCI_DB_MAP      /usr/CED=DBCED
DCI_DB_MAP      /usr/MULTI=DBMULTI
```

To create the **idx1** table in these databases by specifying different files:

```
...
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.

           SELECT IDX-1-FILE
           ASSIGN TO DISK "/usr/CED/IDX1"
           ORGANIZATION IS INDEXED
           ACCESS IS DYNAMIC
           RECORD KEY IS IDX-1-KEY.

           SELECT IDX-2-FILE
           ASSIGN TO DISK "/usr/MULTI/IDX1"
           ORGANIZATION IS INDEXED
           ACCESS IS DYNAMIC
           RECORD KEY IS IDX-2-KEY.

           SELECT IDX-3-FILE
           ASSIGN TO DISK "IDX1"
           ORGANIZATION IS INDEXED
           ACCESS IS DYNAMIC
           RECORD KEY IS IDX-3-KEY.

      DATA DIVISION.
       FILE SECTION.
```


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```
FD  IDX-1-FILE.
01  IDX-1-RECORD.
    03  IDX-1-KEY                      PIC X(10).
    03  IDX-1-ALT-KEY.
        05  IDX-1-ALT-KEY-A            PIC X(30).
        05  IDX-1-ALT-KEY-B            PIC X(10).
    03  IDX-1-BODY                     PIC X(50).

FD  IDX-2-FILE.
01  IDX-2-RECORD.
    03  IDX-2-KEY                      PIC X(10).
    03  IDX-2-ALT-KEY.
        05  IDX-2-ALT-KEY-A            PIC X(30).
        05  IDX-2-ALT-KEY-B            PIC X(10).
    03  IDX-2-BODY                     PIC X(50).

FD  IDX-3-FILE.
01  IDX-3-RECORD.
    03  IDX-3-KEY                      PIC X(10).
    03  IDX-3-ALT-KEY.
        05  IDX-3-ALT-KEY-A            PIC X(30).
        05  IDX-3-ALT-KEY-B            PIC X(10).
    03  IDX-3-BODY                     PIC X(50).
WORKING-STORAGE SECTION.


PROCEDURE DIVISION.
LEVEL-1 SECTION.
MAIN-LOGIC.
    set environment "default-host" to "dci"

*   make IDX1 table on DBCED

    OPEN OUTPUT IDX-1-FILE
    MOVE "IDX IN DBCED" TO IDX-1-BODY
    MOVE "A" TO IDX-1-KEY
    WRITE IDX-1-RECORD
    MOVE "B" TO IDX-1-KEY
    WRITE IDX-1-RECORD
```

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```
           MOVE "C" TO IDX-1-KEY
           WRITE IDX-1-RECORD
           CLOSE IDX-1-FILE

      *    make IDX1 table on DBMULTI
           OPEN INPUT IDX-1-FILE
           OPEN OUTPUT IDX-2-FILE
           PERFORM UNTIL 1 = 2
             READ IDX-1-FILE NEXT AT END EXIT PERFORM END-READ
             MOVE IDX-1-RECORD TO IDX-2-RECORD
             MOVE "IDX IN DBMULTI" TO IDX-2-BODY
             WRITE IDX-2-RECORD
           END-PERFORM
           CLOSE IDX-1-FILE IDX-2-FILE

      *    make IDX1 table on DBNAME
           OPEN INPUT IDX-1-FILE
           OPEN OUTPUT IDX-3-FILE
           PERFORM UNTIL 1 = 2
             READ IDX-1-FILE NEXT AT END EXIT PERFORM END-READ
             MOVE IDX-1-RECORD TO IDX-3-RECORD
             MOVE "IDX IN DBNAME" TO IDX-3-BODY
             WRITE IDX-3-RECORD
           END-PERFORM

           CLOSE IDX-1-FILE IDX-3-FILE
```

To read table **idx-1** in these databases by file-prefix:

```
...
      INPUT-OUTPUT SECTION.
       FILE-CONTROL.

           SELECT IDX-1-FILE
           ASSIGN TO DISK "IDX1"
           ORGANIZATION IS INDEXED
           ACCESS IS DYNAMIC
           RECORD KEY IS IDX-1-KEY.
```


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```
DATA DIVISION.
FILE SECTION.
FD  IDX-1-FILE.
01  IDX-1-RECORD.
    03  IDX-1-KEY                      PIC X(10).
    03  IDX-1-ALT-KEY.
        05  IDX-1-ALT-KEY-A            PIC X(30).
        05  IDX-1-ALT-KEY-B            PIC X(10).
    03  IDX-1-BODY                     PIC X(50).

WORKING-STORAGE SECTION.

PROCEDURE DIVISION.
LEVEL-1 SECTION.
MAIN-LOGIC.
    set environment "default-host" to "dci"

    set environment "file-prefix" to "/usr/MULTI:/usr/CED".
    OPEN INPUT IDX-1-FILE
    READ IDX-1-FILE NEXT
    DISPLAY IDX-1-BODY
    ACCEPT OMITTED
    CLOSE IDX-1-FILE

    set environment "file-prefix" to "/usr/CED:/usr/MULTI".
    OPEN INPUT IDX-1-FILE
    READ IDX-1-FILE NEXT
    DISPLAY IDX-1-BODY
    ACCEPT OMITTED
    CLOSE IDX-1-FILE

    set environment "file-prefix" to ".:/usr/CED:/usr/MULTI".
    OPEN INPUT IDX-1-FILE
    READ IDX-1-FILE NEXT
    DISPLAY IDX-1-BODY
    ACCEPT OMITTED
    CLOSE IDX-1-FILE
```

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3.7 Using Triggers

COBOL Triggers are a very useful and powerful feature of DCI. COBOL triggers can automatically execute predefined COBOL programs in response to specific I/O events, regardless of which user or application program generated them. COBOL triggers can:

- Implement business rules
- Create an audit trail for COBOL activities
- Derive additional values from existing data
- Replicate data across multiple files
- Perform security authorization procedures
- Control data integrity
- Define unconventional integrity constraints

The following XFD directives to define a COBOL trigger specifying the COBOL program name to be called when an I/O event occurs.

➲ Syntax

```
$XFD DCI COMMENT COBTRIGGER "cobolpgmname"
```

➲ Example 1

The "cobolpgmname" is case-sensitive and looks in the CODE-PREFIX directory or current running directory. The I/O events may be READ (any), WRITE, REWRITE, DELETE, and OPEN. The COBOL trigger performs BEFORE and AFTER I/O events except for OPEN that performs BEFORE I/O events.

```
$xfd dci comment cobtrigger "cobtrig"
```

➲ Example 2

The "cobolpgmname" must following the LINKAGE SECTION rule:

```
LINKAGE SECTION.
```


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```
01    op-code  PIC x.
88    read-after     value "R".
88    read-before    value "r".
88    write-after    value "W".
88    write-before   value "w".
88    rewrite-after  value "U".
88    rewrite-before value "u".
88    delete-after   value "D".
88    delete-before  value "d".
88    open-before    value "O".

01    record-image   PIC x(32767).

01    rc-error       PIC 99.
```

➲ Example 3

Op-code is valued from DCI based on I/O events. The *record-image* contains the COBOL record value before/after the I/O events. The rc-error could be used to force the COBOL I/O events error using the following values:

```
88  F-IN-ERROR                  VALUES 1 THRU 99.
88  E-SYS-ERR                   VALUE 1.
88  E-PARAM-ERR                 VALUE 2.
88  E-TOO-MANY-FILES            VALUE 3.
88  E-MODE-CLASH                VALUE 4.
88  E-REC-LOCKED                VALUE 5.
88  E-BROKEN                    VALUE 6.
88  E-DUPLICATE                 VALUE 7.
88  E-NOT-FOUND                 VALUE 8.
88  E-UNDEF-RECORD              VALUE 9.
88  E-DISK-FULL                 VALUE 10.
88  E-FILE-LOCKED               VALUE 11.
88  E-REC-CHANGED               VALUE 12.
88  E-MISMATCH                  VALUE 13.
88  E-NO-MEMORY                 VALUE 14.
88  E-MISSING-FILE              VALUE 15.
88  E-PERMISSION                VALUE 16.
88  E-NO-SUPPORT                VALUE 17.
```

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```
88  E-NO-LOCKS                      VALUE 18.
88  E-INTERFACE                     VALUE 19.
```


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3.8 Using Views

DCI allows the use of DBMaker views instead of a table. In this case, DCI users must manually create a view and be aware of the following limitations:

- Open a view and do all DML operations when the view is a single table view and the projection column on the original table is without an expression, aggregate or UDF.
- For other kinds of views, open the view as an OPEN INPUT and perform a READ operation only.

➲ Example 1

This example illustrates creating and opening a view. It assumes there are 2 tables, named **t2** and **t3** created in this way:

```
create table t2 ( c1 char(30), c2 int);
create table t3(c1 int);
```

Additionally, these tables contain some data.

```
identification division.

       file-control.
         select miofile assign to ws-nomefile
              organization indexed
              access mode dynamic
              record key rec
              .
       data division.
       file section.
      $XFD FILE=miofile
       fd miofile.
       01 rec.
          03 c1 pic x(30).
          03 c2 pic 9(9).

       working-storage section.
```

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```
       01 ws-nomefile pic x(30).
       01 sql-command pic x(1000).
       procedure division.
       main.
            set environment "default_host" to "dci"
            display "Enter the name of the view to create:" no
            accept ws-nomefile

            inspect ws-nomefile replacing trailing spaces
                    by low-value

            string "create view " delimited by size
                   ws-nomefile delimited by low-value
                 " as (select c1, c2 from t2 where c2 in (select max(c1)
      -            " from t3));" delimited by size
                   x"00" delimited by size
              into sql-command

            display sql-command
            accept omitted

            call "i$io" using 15, "dci", sql-command
            if return-code not = 0
               display "Errore : " return-code
               accept omitted
               stop run
            end-if

            string "commit;" delimited by size
                   x"00" delimited by size
               into sql-command
            call "i$io" using 15, "dci", sql-command
            if return-code not = 0
               display "Errore : " return-code
               accept omitted
               stop run
            end-if
            open input  miofile
            perform until 1=2
```


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```
           read miofile next
             at end exit perform
           end-read
           display rec
         end-perform
         close miofile

         exit program
```

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3.9 Using Synonyms

DCI allows the use of DBMaker synonyms instead of a table or view. Users can create the synonym on a table, view or remote database's table or view. If the synonym for the view is not a single table view, the user can only OPEN INPUT with that synonym.

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3.10 Open Tables in Remote Databases

Users can access the remote database's table or view by adding a special token "@" in the COBOL SELECT statement. For example:

```
SELECT tb1 ASSIGN TO RANDOM, "lnk1@tb1"
```

To use a different user name and password, set **DD_DDBMD**=1 in the **dmconfig.ini** and create a remote database link.

➲ Example

Connecting to database **dci_db1** and accessing a table in database **dci_db2**.

1. Set **DD_DDBMD**=1 in **dmconfig.ini**.
2. Create the table in dci_db2

   NOTE *Use dmSQL tool to create the tables in the dci_db2 database.*
3. Use a COBOL program to connect to dci_db1 and then open the table in dci_db2.

```
dmconfig.ini
[DCI_DB1]
DB_SVADR = 127.0.0.1
DB_PTNUM = 22999
DD_DDBMD = 1

[DCI_DB2]
DB_SVADR = 127.0.0.1
DB_PTNUM = 23000
DD_DDBMD = 1

Use dmSQL tool to create the table
connect to DCI_DB2 SYSADM;
create table tb1 (c1 int not null, c2 int, c3 char(10), primary key c1);
```

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```
commit;
disconnect;

COBOL program
identification division.
program-id.RemoteTable.
date-written.
remarks.
environment division.
input-output section.
file-control.
      SELECT tb1 ASSIGN TO RANDOM, "dci_db2@tb1"
             ORGANIZATION IS INDEXED
             ACCESS IS DYNAMIC
             FILE STATUS IS I-O-STATUS
             RECORD KEY  IS C1.

data division.
file section.
FD  tb1.
01  tb1-record.
        03 C1             PIC 9(8) COMP-5.
        03 C2             PIC 9(8) COMP-5.
        03 C3             PIC X(10).
working-storage section.
77   I-O-STATUS pic xx.
procedure division.
main.
      set environment "default_host" to "dci"
      call "DCI_SETENV" using "DCI_DATABASE" "DCI_DB1"
      call "DCI_SETENV" using "DCI_LOGIN" "SYSADM"

      open i-o tb1
      move 100 TO C1.
      move 200 TO C2.
      move "AAAAAAAAAA" TO C3.
      write tb1-record.
      initialize tb1-record.
      read tb1 next.
```


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```
        display C1, C2, " ", C3.
    close tb1.
    accept omitted.
    stop run.
```

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3.11 Using DCI_WHERE_CONSTRAINT

DCI_WHERE_CONSTRAINT specifies an additional WHERE condition for a succeeding START operation. To be compatible with Acu4gl, DCI also supports the 4gl_where_constraint.

➲ Example

The following example queries city names that start with **A**:

```
WORKING-STORAGE SECTION.
01  dci_where_constraint pic x(4095) is external.
...

PROCEDURE DIVISION.
...

* to pecify dci_where_constraint
move low-values to dci_where_constraint
  open i-o idx-1-file
  move "city_name = 'a%'" to dci_where_constraint
  inspect dci_where_constraint replacing trailing spaces by low-values.

  move spaces to idx-1-key
  start idx-1-file key is not less idx-1-key
  ...
```


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4 XFD Directives

Directives are comments placed in COBOL file descriptors that alter how the database table is built. Directives change the way data is defined in the database and they assign names to database fields. Directives can also assign names to .XFD files, assign data to binary large object (BLOB) fields, and add comments.

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4.1 Using Directive Syntax

Each directive occupies the entire line located immediately before the related line of COBOL code. All directives have the prefix $XFD; a $ symbol in the 7th column followed immediately by XFD.

➲ Syntax 1

The following command provides a unique database name for an undefined COBOL variable. Locate the directive directly above the line it affects; in this case the second instance of the COBOL defined variable *qty*.

```
. . .
    03 QTY        PIC 9(03).
 01 CAP.
$XFD NAME=CAPQTY
    03 QTY        PIC 9(03).
```

➲ Syntax 2

Directives may also be specified using this ANSI-compliant syntax:

```
*(( XFD NAME=CAPQTY ))
```

➲ Syntax 3

More than one directive may be combined together. Directives may share the same line when preceded by the prefix $XFD and separated by a space or comma.

```
$XFD NAME=CAPQTY, ALPHA
```

➲ Syntax 4

Alternatively, the following can be used.

```
*(( XFD NAME=CAPQTY, ALPHA))
```


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4.2 Using XFD Directives

Directives are used when a COBOL file descriptor is mapped to a database field. The $XFD prefix tells the compiler the proceeding command will be used during generation of the data dictionary.

$XFD ALPHA Directive

To store non-numeric data like, LOW-VALUES or special codes, in numeric keys, this directive allows a data item that has been defined as numeric in the COBOL program to be treated as alphanumeric text (CHAR (n) n 1-max column length) in the database.

➲ Syntax 1

```
$XFD ALPHA
```

➲ Syntax 2

```
*(( XFD ALPHA ))
```

Moving a non-numeric value like "A234" to the key without using the $XFD ALPHA directive would be rejected by the database.

➲ Example 1

Assume the KEY IS code-key has been specified and we have the following record definition. CODE-NUM is a numeric value and since group items are disregarded in the database, it is the key field,.

```
01 EMPLOYEE-RECORD.
    05 EMP-KEY.
       10 EMP-NUM          PIC 9(5).
```

➲ Example 2

Using the $XFD ALPHA directive changes a non-numeric value like "A234" saves the record from rejection by the database, since "A234" is an alphanumeric value and CODE-NUM is a numeric value.

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```
01 EMPLOYEE-RECORD.
    05 EMP-KEY.
$XFD ALPHA
       10 EMP-NUM           PIC 9(5)
```

➲ Example 3

Now, the following operation can be used without worrying about any rejection.

```
MOVE "C0531" TO CODE-KEY.
WRITE CODE-RECORD.
```

$XFD BINARY Directive

To allow for data in a field to be alphanumeric data of any type, for example, LOW-VALUES, use the BINARY directive. With LOW-VALUES, for example, COBOL allows both LOW and HIGH-VALUES in a numeric field but DBMaker does not.

BINARY directives transform the COBOL fields into DBMaker BINARY data types.

➲ Syntax 1

```
$XFD BINARY
```

➲ Syntax 2

```
*(( XFD BINARY ))
```

➲ Example

This allows moving of LOW-VALUES to CODE-NUM.

```
01 EMPLOYEE-RECORD.
    05 EMP-KEY.
       10 EMP-TYPE      PIC X.
$(( XFD BINARY ))
       10 EMP-NUM       PIC 9(05).
       10 EMP-SUFFIX    PIC X(03).
```


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$XFD COMMENT DCI BIGINT Directive

The XFD COMMENT DCI BIGINT directive is to specify data type is BIGINT.

➲ Example

```
01 RECORD-A.
         02 A.
            03 A1 PIC 9(19).
            $XFD COMMENT DCI BIGINT
            03 a2 pic 9(19).
```

The column types for columns A1 and A2 are as following :

```
A1  DECIMAL(19, 0)
A2  BIGINT
```

$XFD COMMENT DCI SERIAL n Directive

This directive defines a serial data field and an optional starting number "n". Trigger DBMaker to generate a serial number by inserting a record and supplying a 0 value for the serial field. DBMaker will not generate a serial number when inserting a new row but supplying an integer value instead of a 0 value. If the supplied integer value is greater than the last serial number generated, DBMaker resets the sequence of generated serial numbers to start with the supplied integer value.

➲ Syntax 1

```
$XFD COMMENT DCI SERIAL 1000
```

➲ Syntax 2

```
*(( XFD COMMENT DCI SERIAL 1000 ))
```

➲ Example 1

```
01 EMPLOYEE-RECORD.
    05 EMP-KEY.
       10 EMP-TYPE      PIC X.
$(( XFD COMMENT DCI SERIAL 250 ))
       10 EMP-COUNT     PIC 9(05).
```

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➲ Example 2

To reference data type BIGSERIAL in FD, we support for PIC 9(18) or 9(19).

```
01  testeserial-REG.
    02 TESTESERIAL-CHAVE.
      $XFD COMMENT DCI SERIAL 1
          03 ID-S          PIC  9(18).
          03 EMPRESA       PIC  9(04).
    02  DESCRICAO          PIC  X(60).
```

Open output testeserial will create table as following :

```
create table SYSADM.BIGSERIALTB (
 ID_S  BIGSERIAL(1),
 EMPRESA  SMALLINT not null  ,
 DESCRICAO  CHAR(60) default null )
 in DEFTABLESPACE  lock mode row  fillfactor 100  nocache ;
alter table SYSADM.BIGSERIALTB primary key ( ID_S, MPRESA) in DEFTABLESPACE;
```

$XFD COMMENT DCI COBTRIGGER Directive

This directive defines a COBOL program to be triggered by I/O events like READ, WRITE, REWRITE, or DELETE. The COBOL program is automatic called before and after I/O events.

➲ Syntax 1

```
$XFD COMMENT DCI COBTRIGGER "cblprogramname"
```

➲ Syntax 2

```
*(( XFD COMMENT DCI COBTRIGGER "cblprogramname"))
```

$XFD COMMENT Directive

This directive identifies comments in an XFD file. In this way, information can be embedded in an XFD file so that other applications can access the data dictionary. Embedded information in the form of a comment using this directive does not interfere with processing by DCI interfaces. Each comment will be recognizable in the XFD file as having the "#"symbol in column 1.

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➲ Syntax 1

```
$XFD COMMENT text
```

➲ Syntax 2

```
*(( XFD COMMENT text ))
```

$XFD DATE Directive

DATE type data is a special data format supported by DBMaker that is not supported by COBOL. To take advantage of the properties of this data type, convert fields from numeric type data. The DATE directive's purpose is storage of dates in fields in the database. This directive differentiates dates from other numbers, so that they enjoy the properties associated with dates in the RDBMS.

➲ Syntax 1

```
$(( XFD DATE=date-format-string ))
```

➲ Syntax 2

```
*((XFD DATE= ))
```

If no date-format-string is specified, then six-digit (or six-character) fields are retrieved as YYMMDD from the database. Eight-digit fields are retrieved as

YYYYMMDD.

The *date-format-string* is a description of the desired date format, composed of characters.

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CHARACTER	DESCRIPTION
M	Month (01-12)
Y	Year (2 or 4 digit)
D	Day of month (01-31)
J	Julian day (00000000-99999999)
E	Day of year (001-366)
H	Hour (00-23)
N	Minute (00-59)
S	Second (00-59)
T	Hundredths of a second

Figure 4-1 date-format-string Characters

Each character in a date format string is a placeholder representing the type of information stored at that location. The characters also determine how many digits will be used for each type of data.

For example, although you would typically represent the month with two digits, if you specify MMM as part of your date format, the resulting date will use three digits for the month, with a left-zero filling the value. If the month is given as M, the resulting date will use a single digit, and will truncate on the left.

JULIAN DATES

The definition of Julian dates varies, so the DATE directive allows for a flexible representation of Julian dates. Many sources define a Julian day as the day of the year, with January 1st being 001, January 2nd being 002, etc. To use this definition, use FEE (day of year) in the date formats.

Other references define a Julian day as the number of days since a specific base date. This definition is represented in the DATE directive by the letter J. For example, a six-digit date field would be preceded with the directive $XFD

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DATE=JJJJJJ. The default base date for this form of Julian date is *01/01/0001AD*.

You may define your own base date for Julian date calculations by setting the configuration variable DCI_JULIAN_BASE_DATE.

DCI considers dates in the following range to be valid:

01/01/0001 to 12/31/9999

If a COBOL program attempts to write a record containing a date that DCI knows is invalid, DCI inserts a date value that depends on the setting specified by the DCI_INV_DATE, DCI_MIN_DATE and DCI_MAX_DATE configuration variables into the date field and writes the record.

If a COBOL program attempts to insert into a record from a table with a NULL date field, zeroes are inserted into that field in the COBOL record.

If a date field has two-digit years, then years 0 through 19 are inserted as 2000 through 2019, and years 20 through 99 are inserted as 1920 through 1999. You can change this behavior by changing the value of the variable DCI_DATE_CUTOFF. Also, refer to the configuration variables DCI_MAX_DATE and DCI_MIN_DATE for information regarding invalid dates when the date is in a key.

NOTE *If a field is used as part of a key, the field cannot be a NULL value.*

USING GROUP ITEMS

You may place the DATE directive in front of a group item, so long as you also use the USE GROUP directive.

➲ Example 1

```
$XFD DATE
    05 DATE-PURCHASED      PIC 9(08).
    05 PAY-METHOD          PIC X(05).
```

The date-purchased column will have eight digits and will be type DATE in the database, with a format of YYYYMMDD.

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➲ Example 2

```
$(( XFD DATE, USE GROUP ))
    05 DATE-PURCHASED.
       10 YYYY             PIC 9(04).
       10 MM               PIC 9(02).
       10 DD               PIC 9(02).
    05 PAY-METHOD          PIC X(05).
```

$XFD DCI SPLIT

The DCI SPLIT directive is used to define one or more table splitting points starting where the DCI interface makes a new DBMS table.

➲ Example 1

A COBOL FD structure using DCI SPLIT directive.

In this example three DBMaker tables named INVOICE, INVOICE_A, and INVOICE_B are created with fields between the split points.

```
FILE SECTION.
FD  INVOICE.
        01 INV-RECORD-TOP.
        03 INV-KEY.
        05 INV-TYPE         PIC X.
        05 INV-NUMBER       PIC 9(5).
        05 INV-ID           PIC 999.
        03 INV-CUSTOMER     PIC X(30).
$XFD DCI SPLIT
        03 INV-KEY-D.
        05 INV-TYPE-D       PIC X.
        05 INV-NUMBER-D     PIC 9(5).
        05 INV-ID-B         PIC 999.
$XFD DCI SPLIT
     03 INV-ARTICLES        PIC X(30).
     03 INV-QTA             PIC 9(5).
     03 INV-PRICE           PIC 9(17).
```


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$XFD FILE Directive

The FILE directive names the data dictionary with the file extension .XFD. This directive is required when creating a different .XFD name from that specified in the SELECT COBOL statement. Another case that requires this kind of directive is when the COBOL file name is not specific.

- Syntax 1

```
$XFD FILE=filename
```

- Syntax 2

```
*(( XFD FILE=filename ))
```

- Example

In this case, the ACUCOBOL-GT compiler makes an XFD file name called CUSTOMER.xfd.

```
ENVIRONMENT DIVISION.
 FILE-CONTROL.
 SELECT FILENAME ASSIGN TO VARIABLE-OF-WORKING.
 . . .
 DATA DIVISION.
 FILE SECTION.
$XFD FILE=CUSTOMER
 FD FILENAME
 . . .
```

$XFD HIDDEN Directive

This directive allows a field to be marked as hidden. This will avoid the need to convert a field into a database field. The field will be ignored by the external interfaces that read the XFD file.

- Syntax 1

```
$XFD HIDDEN
```

- Syntax 2

```
*(( XFD HIDDEN ))
```

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- Example

```
$XFD HIDDEN
 05 USELESS        PIC X(32).
```

$XFD NAME Directive

The NAME directive assigns a DBMaker RDBMS column name to the field defined on the next line. In DBMaker, all column names are unique and must be less than 128 characters. This directive can be used to avoid problems created by columns with incompatible or duplicate names.

- Syntax 1

```
$XFD NAME=columnname
```

- Syntax 2

```
*(( XFD NAME=columnname ))
```

- Example

In DBMaker RDBMS, the COBOL field cus-cod will map to a RDBMS field named customercode.

```
$XFD NAME=customercode
    05 cus-cod        PIC 9(05).
```

$XFD NUMERIC Directive

The NUMERIC directive causes the subsequent field to be treated as an unsigned integer if it is declared as alphanumeric.

- Syntax 1

```
$XFD NUMERIC
```

- Syntax 2

```
*(( XFD NUMERIC ))
```

- Example

The field customer-code will be stored as INTEGER type data in the DBMaker table.

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```
$xfd numeric
        03      customer-code            PIC x(7).
```

$XFD USE GROUP Directive

The USE GROUP directive assigns a group of items to a single column in the DBMaker table. The default data type for the resultant dataset in the database column is alphanumeric (CHAR (n), where n = 1- max column length). The directive may be combined with other directives if the data is stored as a different type (BINARY, DATE, NUMERIC). Combining fields into groups improves processing speed on the database, so effort is made to determine which fields can be combined.

➲ Syntax 1

```
$XFD USE GROUP
```

➲ Syntax 2

```
*(( XFD USE GROUP ))
```

➲ Example 1

By adding the USE GROUP directive, the data is stored as a single numeric field where the column name is *code-key*.

```
01 CODE-RECORD.
$XFD USE GROUP
    05 CODE-KEY.
       10 AREA-CODE-NUM    PIC 9(03).
       10 CODE-NUM         PIC 9(07).
```

➲ Example 2

The USE GROUP directive can be combined with other directives. The fields are mapped into a single DATE type data column in the database.

```
$(( XFD DATE, USE GROUP ))
    05 DATE-PURCHASED.
       10 YYYY             PIC 9(04).
       10 MM               PIC 9(02).
       10 DD               PIC 9(02).
```

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$XFD VAR-LENGTH Directive

VAR-LENGTH directives force DBMaker to use a BLOB field to save COBOL fields. This is useful if the COBOL field is over or near the maximum allowable column size for regular data types. Please refer to *Chapter 8, COBOL Conversions*.

Since BLOB fields cannot be used in any key field and are slower to retrieve then normal data type fields such as CHAR, we suggest you use this directive only when needed.

- Syntax 1

```
$XFD USE VAR-LENGTH
```

- Syntax 2

```
*(( XFD USE VAR-LENGTH ))
```

- Example

```
$XFD USE VAR-LENGTH
    05 LARGE-FIELD    PIC X(10000).
```

$XFD WHEN Directive for File Names

The WHEN directive is used to build certain columns in DBMaker that wouldn't normally be built by default. By specifying a WHEN directive in the code, the field (and subordinate fields in the case of a group item) immediately following this directive will appear as an explicit column, or columns, in the database tables.

The database stores and retrieves all fields regardless of whether they are explicit or not. Furthermore, key fields and fields from the largest record automatically become explicit columns in the database table. The WHEN directive is only used to guarantee that additional fields will become explicit columns when you want to include multiple record definitions or REDEFINES in a database table.

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One condition for how the columns are to be used is specified in the WHEN directive. Additional fields you want to become explicit columns in a database table must not be FILLER or occupy the same area as key fields.

- Syntax 1

  Equal to

```
$XFD WHEN field = value
```

- Syntax 2

  Less than or equal to)

```
$XFD WHEN field <= value
```

- Syntax 3

  Less than

```
$XFD WHEN field < value
```

- Syntax 4

  Greater than or equal to

```
$XFD WHEN field >= value
```

- Syntax 5

  Greater than

```
$XFD WHEN field > value
```

- Syntax 6

  Not equal to

```
$XFD WHEN field != value
```

- Syntax 7

  OTHER can only be used with the symbol "=". In this case, the field or fields after OTHER must be used only if the WHEN condition or conditions listed at the same level are not met. OTHER can be used before one record definition, and, within each record definition, once at each level. It is necessary to use a WHEN directive with OTHER in the eventuality that the data in a field doesn't

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meet the explicit conditions specified in the other WHEN directives. Otherwise, the results will be undefined.

```
$XFD WHEN field = OTHER
```

➲ Syntax 8

Value is an explicit data value used in quotes, and field is a previously defined COBOL field.

```
*(( XFD WHEN field(operator)value ))
```

➲ Example

Explicit data values in quotes ("") are permitted.

```
     05 AR-CODE-TYPE        PIC X.
$XFD WHEN AR-CODE-TYPE="S"
     05 SHIP-CODE-RECORD    PIC X(04).
$XFD WHEN AR-CODE-TYPE="B"
     05 BACKORDER-CODE-RECORD REDEFINES SHIP-CODE-RECORD.
$XFD WHEN AR-CODE-TYPE=OTHER
     05 OBSOLETE-CODE-RECORD REFEFINES SHIP-CODE-RECORD.
```

TABLENAME OPTION

The WHEN directive has the TABLENAME option to change the table name according to the value of the WHEN directive during runtime.

When using the TABLENAME option in a WHEN statement, be aware of the DCI_DEFAULT_RULES and filename_RULES DCI configuration variables.

➲ Example 1

A COBOL FD structure using the "When" directive with two table names.

```
FILE SECTION.
$XFD FILE=INV
 FD  INVOICE.
$XFD WHEN INV-TYPE = "A" TABLENAME=INV-TOP
 01  INV-RECORD-TOP.
     03 INV-KEY.
        05 INV-TYPE         PIC X.
        05 INV-NUMBER       PIC 9(5).
        05 INV-ID           PIC 999.
```


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```
     03 INV-CUSTOMER        PIC X(30).
$XFD WHEN INV-TYPE = "B" TABLENAME=INV-DETAILS
 01  INV-RECORD-DETAILS.
     03 INV-KEY-D.
        05 INV-TYPE-D       PIC X.
        05 INV-NUMBER-D     PIC 9(5).
        05 INV-ID-B         PIC 999.
     03 INV-ARTICLES        PIC X(30).
     03 INV-QTA             PIC 9(5).
     03 INV-PRICE           PIC 9(17).
```

➲ Example 2

The DCI interface makes two tables named "**inv-top**" and "**inv-details**" based on the value of the inv-type fields in example 1. DCI checks the value of the inv-type field to know where to fill the record.

```
*MAKE TOP ROW
   MOVE "A" TO INV-TYPE
   MOVE 1 TO INV-NUMBER
   MOVE 0 TO INV-ID
   MOVE "acme company" TO INV-CUSTOMER
   WRITE INV-RECORD-TOP
*MAKE DETAIL ROWS
   MOVE "B" TO INV TYPE
   MOVE 1 TO INV-NUMBER
   MOVE 0 TO INV-ID
   MOVE "floppy disk" TO INV-ARTICLES
   MOVE 10 TO INV-QTA
   MOVE 123 TO INV-PRICE
   WRITE INV-RECORD-DETAILS
```

Running the preceding code, DCI fills the "**TOP-ROW**" record in the "**INV-TOP**" table and "**DETAIL-ROW**" in the "**INV-DETAILS**" table. When DCI reads the above record, it can use sequential reading, or use the key to access filled records. If you plan to use sequential reading through record types, you must set DCI_DEFAULT_RULES = POST or = COBOL. Alternately, if you plan to use sequential reading inside record types you must set DCI_DEFAULT_RULES=BEFORE or = DBMS.

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There are advantages and disadvantages to using this rule. To have a 100% COBOL ANSI reading behavior, you should use the "**POST**" or "**COBOL**" method, but this method can degrade performance (more records are read and all involved tables are open at the same time).

If you use the "**BEFORE**" or "**DBMS**" method, the involved table is opened when the $WHEN condition matches at the read record level.

➲ Example 3

In other words, if you use the previous records, and code the following statements

```
     OPEN INPUT INVOICE.
*  to see the customer invoice
     READ INVOICE NEXT.
     DISPLAY "Customer: " INV-CUSTOMER
     DISPLAY "Invoice number: " INV-NUMBER
*  to see the invoice details
     READ INVOICE NEXT.
     DISPLAY INV-ARTICLES.
```

If the method is "**POST**" or "**COBOL**", the "**open input**" opens both tables and "**read next**", reads thru different tables.

➲ Example 4

The matched table is opened at the "**start**" statement level.

If the method is "**BEFORE**" or "**DBMS**" the code is changed as follows.

```
       open input invoice.
*     to see the customer invoice
       move "A" to  inv-type
       move 1   to  inv-number
       move 0   to  inv-id
       start invoice key is = inv-key.
       read invoice next
       display "Customer  " inv-customer
display "Invoice number "inv-number
*     to see the  invoice details
       move "B" to  inv-type
```


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```
        move 1   to  inv-number
        move 0   to  inv-id
start invoice key is = inv-key.
        read invoice next
        display inv-articles
```

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5 Compiler and Runtime Options

This section describes configuration settings for ACUCOBOL-GT used to specify what file system to use.

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5.1 Using ACUCOBOL-GT Default File System

Existing files opened with a COBOL application are associated with their respective file systems as defined in the ACUCOBOL-GT configuration file. When new files are created by a COBOL application, you need to specify what file system to use. The ACUCOBOL-GT configuration file needs to be set so that new files use the file system of choice.

The DEFAULT-HOST setting tells ACUCOBOL which file system to use if no other system is specified for a new file. If no value has been given to this variable, ACUCOBOL will use the Vision file system as default. The filename-HOST setting allows you to set a file system for a specific file. The name of the file should replace *filename* in the setting.

The following variables in the ACUCOBOL-GT configuration file allow the file system of choice to be used.

- Syntax 1

```
DEFAULT-HOST (*)
```

- Syntax 2

```
filename-HOST (*)
```


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5.2 Using DCI Default File System

In order to take advantage of DBMaker's reliability and features such as replication, backup and integrity constraints, we suggest using the DEFAULT-HOST DCI to avoid use of the ACUCOBOL-GT Vision file system. If no file system is specified, the Vision file system will be used by default.

➲ Syntax 1

In this case, all new files will be DBMaker files, unless the new files have been designated to a different file system.

```
DEFAULT-HOST DCI
```

➲ Syntax 2

In order to establish that all new files, unless otherwise specified, will be Vision files, use the following.

```
DEFAULT-HOST VISION
```

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5.3 Using Multiple File Systems

Filename-HOST is used to associate new files to a particular file system. It differs from the DEFAULT-HOST variable in that it associates single data files to a file system. In this way, files that use a different file system than the default file system can be used.

In order to accomplish this, substitute the configuration file "DEFAULT" value, with the name of a file, without using directory names, or file extensions. DEFAULT-HOST and filename-HOST can be used together.

➲ Example

In this case, file 1 and 2 will use DBMaker, while the other files will use the vision file system.

```
DEFAULT-HOST VISION
file1-HOST DCI
file2-HOST DCI
```


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5.4 Using the Environment Variable

In order to allow the file system to be setup during execution of a program, specify the following in the COBOL code. The (*) is only used for the ACUCOBOL runtime. Also, be aware that specification of a file system is usually done in the runtime configuration file and NOT changed in the COBOL program.

NOTE *Refer to the ACUCOBOL-GT, User's Manual (chapter 2.1 and 2.2) for detailed instructions on how to use the ACUCOBOL-GT compiler and runtime.*

- Syntax 1

```
SET ENVIRONMENT "filename-HOST" TO filesystem (*)
```

- Syntax 2

```
SET ENVIRONMENT "DEFAULT-HOST" TO filesystem (*)
```

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6 Configuration File Variables

This section lists the acceptable ranges of data for DCI, as well as tables specifying how COBOL data types are mapped to DBMaker data types. Configuration file variables are used to modify the standard behavior of DCI and are stored in a file called DCI_CONFIG.

In addition to DCI_CONFIG file, this section also lists DCI keywords in DBMaker, these keywords have to be set in dmconfig.ini to take effort.

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6.1 Setting DCI_CONFIG Variables

It is possible to give a configuration file a different address by setting a value to an environment variable called DCI_CONFIG. The value assignable to this environment variable can be either a full pathname or simply the directory where the configuration file resides. In this case, DCI will look for a file called DCI_CONFIG stored in the directory specified in the environmental variable. If the file specified in the configuration variable doesn't exist, DCI doesn't display an error and assumes that no configuration variables have been assigned. This variable is set in the COBOL runtime configuration file.

- Syntax 1

  In UNIX, DCI will look for the file DCI_CONFIG. This environment variable is used to establish the path and name of the DCI configuration file. Working with the Bourne shell, the following command can be used.

```
DCI_CONFIG=/usr/marc/config;export DCI_CONFIG
```

- Syntax 2

  In DOS, DCI reads the configuration file called DCI_CONFIG in the directory *c:\etc\test*.

```
set DCI_CONFIG=c:\etc\test
```

- Syntax 3

  In UNIX, DCI utilizes the file called "DCI" in the directory */home/test*.

```
DCI_CONFIG=/home/test/dci; export DCI_CONFIG
```

<*filename*>_RULES

Default management for a multi-definition file. The actual file name replaces <*filename*>.

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➲ Example

All of the files will use the POST rule except for the CLIENT file when the following commands are used.

```
DCI_DEFAULT_RULES         POST
CLIENT_RULES              BEFORE
```

DCI_AUTO_CREATE_FOR_INVALID_TABLE

DCI_AUTO_CREATE_FOR_INVALID_TABLE is used to create table when any table open fail with multiple table case.

The default value is ***off*** (***0***).

➲ Example

User can set DCI_AUTO_CREATE_FOR_INVALID_TABLE 1 in DCI_CONFIG when any table opened in the following case fail.

```
$xfd when rt = 1, tablename = tableA
  01 record-definition1.
  …
$xfd when rt = 2, tablename = tableB
  01 record-definition2.
  …
$xfd when rt = 3, tablename = tableC
  01 record-definition3.
  …
```

DCI_AUTOMATIC_SCHEMA_ADJUST

This variable directs DCI to alter the table schema definition when the XFD differs from the table schema. This variable is incompatible with the split tables (those with a number of columns > 2000, and those who's record size is greater than 32 KB -exclude the BLOB field).
The possible values of this variable are:

0 Default, does nothing

1 Add the new fields to the table, and drop the ones who are not in the XFD

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2 Add the new fields to the table, but do not drop the ones who are not in the XFD

DCI_CASE

File names in COBOL are case insensitive but table names are case sensitive. The DCI_CASE configuration variable determines how file names are translated into table names. Setting it to *lower* translates file names into table names with all lowercase characters. Setting it to *upper* translates file names into table names with all uppercase characters. Setting it to *ignore* means no file names are translated into table names with all lowercase or uppercase characters. The default setting for DCI_CASE is *lower*. If your file names are DBCS words, set DCI_CASE to *ignore*.

- Example

```
DCI_CASE IGNORE
```

DCI_COLUMNS_MAPPING

DCI_COLUMNS_MAPPING keyword is used to specified only the necessary columns need to be returned for reading record. It may speed up read performance if user do not need all the columns to be returned. This keyword must be set before OPEN table and can only be used for OPEN INPUT table. User should also make sure all necessary column including key column is specified in the columns list or the result will be wrong.

- Syntax

```
DCI_COLUMNS_MAPPING table1=col1,col2,…coln
```

- Example

When user open INPUT with the following table and specified DCI_COLUMNS_MAPPING, only the specified columns will be returned when START/READ/NEXT/PREVIOUS.

It will retrieve 3 columns of table.

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```
call "DCI_SETENV" using "DCI_COLUMNS_MAPPING"
" EMPTABLE = EMPID,EMP-NAME,EMP-PHONE "
```

DCI_COMMIT_COUNT

The DCI_COMMIT_COUNT configuration variable indicates the conditions under which a COMMIT WORK operation is issued. There are two possible values, 0 and <*n*>.

DCI_COMMIT_COUNT = 0

No automatic commit is done (default value).

DCI_COMMIT_COUNT = <*N*>

Under this condition DCI waits until the number of WRITE, REWRITE, AND DELETE operations are equal to the value <*n*> before issuing a COMMIT WORK statement. This rule applies only when opening the file in "output" or "exclusive" mode.

DCI_CONNECTION_ID

DCI_CONNECTION_ID is used to get runtime connection ID.

➲ Example:

```
77 SID pic x(20).
...

     CALL "DCI_GETENV" using "DCI_CONNECTION_ID", SID
     DISPLAY "CONNECTION_ID: " SID
```

DCI_CREATE_ALTERNATE_KEY

DCI_CREATE_ALTERNATE_KEY can be used when migrating table from vision files and do not want to create alternate key (when setting DCI_CREATE_ALTERNATE_KEY 0) to speed up migrating progress. Therefore, it will build only primary key. The default value is 1.

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➲ Example

1. Migrate without alternate key.

   Setting DCI_CONFIG before migration.

```
DCI_CREATE_ALTERNATE_KEY 0
;DCI_AUTOMATIC_SCHEMA_ADJUST 1
```

2. Check index created or not

```
shell> runcbl dcimigrate.acu PERF PERF --noverify
```

3. Run COBOL program after migration.

   Turn on DCI_AUTOMATIC_SCHEMA_ADJUST after migration.

```
;DCI_CREATE_ALTERNATE_KEY 0
DCI_AUTOMATIC_SCHEMA_ADJUST 1
shell> runcbl -c dciconf prog_testTurn on DCI_AUTOMATIC_SCHEMA_ADJUST after
migrating.
```

Please don't set DCI_AUTOMATIC_SCHEMA_ADJUST when migrating. Otherwise, "alternate key" will be created.

DCI_CREATE_TABLE_NOCACHE

DCI_CREATE_TABLE_NOCACHE is used to disable adding NOCACHE keyword when create a table. The default value is on.

Syntax

```
DCI_CREATE_TABLE_NOCACHE tbname_pat=off (default is on, only set off can turn
off this option)
```

➲ Example 1

User can set NOCACHE for table name start with EMP or TBL.

```
DCI_CREATE_TABLE_NOCACHE   emp*=off tbl*=off
```

➲ Example 2

User can set NOCACHE for every table.

```
DCI_CREATE_TABLE_NOCACHE   *=off
```


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DCI_DATABASE

DCI_DATABASE is used to specify the name of the database established during the setup of DBMaker.

➲ Example 1

The following entry has to be included in the configuration file if the database used is named DBMaker_Test.

```
DCI_DATABASE DBMaker_Test
```

➲ Example 2

Sometimes, the database name is not known in advance, and for this reason it is necessary to set it dynamically during runtime. In cases like this, it is possible to write special code in the COBOL program similar to the one listed below. The following code has to be executed before the first OPEN statement has been executed.

```
CALL "DCI_SETENV" USING "DCI_DATABASE" , "DBMaker_Test"
```

➲ Example 3

You can use DCI_DATABASE to connect to more than one database and dynamically switch between databases to access a table on a different database.

```
* connect to DBNAME to access idx-1-file
CALL "DCI_SETENV" USING "DCI_DATABASE" "DBNAME"
...
open output idx-1-file
...
* connect to DCIDB to access idx-2-file CALL "DCI_SETENV" USING "DCI_DATABASE"
"DCIDB"
...
open output idx-2-file

* to switch dynamically to DBNAME connection
CALL "DCI_SETENV" USING "DCI_DATABASE" "DBNAME"
close idx-1-file
...
```

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DCI_DATE_CUTOFF

This variable uses a two-digit value and establishes the two-digit years that will be interpreted by the program as being in the 20th Century and the two-digit years that will be interpreted by the program as being in the 21st Century.

The default value for the DCI_DATE_CUTOFF is ***20***. In this case, 2000 will be added to the two-digit years that are smaller than "20" (or whatever value you give to this variable), and will therefore make them part of the 21st Century. 1900 will be added to the two-digit years that are larger than "20" (or whatever value you give to this variable), making them part of the 20th Century. A COBOL date like 99/10/10 will be translated into 1999/10/10. A COBOL date like 00/02/12 will be translated into 2000/02/12.

DCI_DB_MAP

This variable is used to map files in different directories as tables of different databases. Refer to Mapping to Multiple Databases for more info. DCI_DEFAULT_TABLESPACEThis variable is used to set the default tablespace where new tables are to be stored. The tablespace specified must already exist in the database. If no tablespace is specified by this variable, then new tables will be created in the default user tablespace.

DCI_DEFAULT_CACHE Variables

By default, DCI pre-reads data into the client data buffer to reduce client/server network traffic. The default maximum pre-read buffer is the smaller of 8kb ÷ (record size) or 5 records.

It is possible that user's application will read a small table and only read a few records which are less than 8kb ÷ (record size). For example, for a table with an average record size of 20 bytes and a total of 1,000 records, DBMaker will be able to read about 400 records (8kb ÷ 20) but the user's application may only read 4 or 5 records then call the START statement again. In this case, set

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the following variable to reduce the cache size and improve performance. Consider the application and data's behavior carefully when using these variables or it may increase network traffic and cause reductions in performance.

The following are the three DCI_CACHE variables to set in the DCI_CONFIG file:

- DCI_DEFAULT_CACHE_START – sets the first read records to cache for START or READ. The default is the maximum of 8kb ÷ (record size) or 5 records.
- DCI_DEFAULT_CACHE_NEXT – sets the next read records after the first cached record for START or READ have been read or discarded. The default is the maximum of 8kb ÷ (record size) or 5 records.
- DCI_DEFAULT_CACHE_PREV – sets the read records for caching the previous records after the first cache record for START or READ have been read or discarded.

The default is DCI_DEFAULT_CACHE_NEXT/2.

Setting these variables in the DCI_CONFIG will affect all the tables in the user's application.

➲ Example

```
DCI_DEFAULT_CACHE_START        10
DCI_DEFAULT_CACHE_NEXT         10
DCI_DEFAULT_CACHE_PREV         5
```

DCI_DEFAULT_USER

DCI_DEFAULT_USER is used when user want to specify different default user

for OPEN OUTPUT/I-O/INPUT when create table. The default user is DCI_LOGIN if user did not specify DCI_DEFAULT_USER.

➲ Example

If user want to open DB_USER2's table and login user is DB_USER1, user can

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set DCI_CONFIG as follows:

```
call "DCI_SETENV" using "DCI_LOGIN" "DB_USER1"
call "DCI_SETENV" using "DCI_DEFAULT_USER" "DB_USER2"
```

DCI_DUPLICATE_CONNECTION

DCI_DUPLICATE_CONNECTION is used to acquire a lock when opening the same table and locking the same record two times in the same COBOL application by opening the same table using the same COBOL process but with a different database connection.

Set DCI_DUPLICATE_CONNECTION 1 in DCI_CONFIG, when a table is opened in the default connection and open the same table again, it will open another connection for this table. So the table will be opened in different connection, and "commit" does not affect each other, but it is also possible to cause a locked state because of the two connections.

The default value is ***off*** (***0***).

➲ Example

To allow a COBOL application to acquire a lock on a table using different database connections:

```
DCI_DUPLICATION_CONNECTION 1
```

The following application will open table TB1 and tableTB3, then open TB1 again and write TB1.

```
       IDENTIFICATION DIVISION.
       PROGRAM-ID. dupdci.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SPECIAL-NAMES.
              DECIMAL-POINT IS COMMA.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
       SELECT ARQDCI
           ASSIGN TO "TB1"
           ORGANIZATION IS INDEXED
           ACCESS MODE IS DYNAMIC
```


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```
        LOCK MODE IS AUTOMATIC
        RECORD KEY IS DCI-CODIGO
        ALTERNATE RECORD KEY IS DCI-DESCRICAO WITH DUPLICATES
        FILE STATUS IS STAT-ARQDCI.

    SELECT ARQDCI2
        ASSIGN TO "TB1"
        ORGANIZATION IS INDEXED
        ACCESS MODE IS DYNAMIC
        LOCK MODE IS AUTOMATIC
        RECORD KEY IS DCI2-CODIGO
        ALTERNATE RECORD KEY IS DCI2-DESCRICAO WITH DUPLICATES
        FILE STATUS IS STAT-ARQDCI2.

    SELECT ARQDCI3
        ASSIGN       TO "TB3"
        ORGANIZATION IS INDEXED
        ACCESS MODE IS DYNAMIC
        LOCK MODE    IS AUTOMATIC
        RECORD KEY   IS DCI3-CODIGO
        ALTERNATE RECORD KEY IS DCI3-DESCRICAO WITH DUPLICATES
        FILE STATUS IS STAT-ARQDCI3.

    DATA DIVISION.
    FILE SECTION.

    FD ARQDCI.
    01 REG-ARQDCI.
       02 DCI-CODIGO       PIC  99.
       02 DCI-DESCRICAO    PIC  X(30).

    FD ARQDCI2.
    01 REG-ARQDCI2.
       02 DCI2-CODIGO       PIC  99.
       02 DCI2-DESCRICAO    PIC  X(30).
    FD ARQDCI3.
    01 REG-ARQDCI3.
       02 DCI3-CODIGO       PIC  99.
       02 DCI3-DESCRICAO    PIC  X(30).
```

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```
WORKING-STORAGE SECTION.

01 STAT-ARQDCI         PIC X(02).
   88 valid-arqdci     value is "00" thru "09".

01 STAT-ARQDCI2         PIC X(02).
   88 valid-arqdci2     value is "00" thru "09".

01 STAT-ARQDCI3         PIC X(02).
   88 valid-arqdci3     value is "00" thru "09".

01 W-OP      PIC 9.
77 w7 pic x(20).

PROCEDURE DIVISION.
INICIO.
    OPEN OUTPUT ARQDCI
    CLOSE ARQDCI.
    OPEN I-O ARQDCI.

    OPEN OUTPUT ARQDCI3
    CLOSE ARQDCI3.
    OPEN I-O ARQDCI3.

    DISPLAY "OPEN TB1 and TB3 at 1 conn: CHECK SYSUSER AT dmSQL"
    ACCEPT W-OP

    OPEN INPUT ARQDCI2.

    DISPLAY "OPEN TB1 again at 2nd conn: CHECK SYSUSER AT dmSQL"
    ACCEPT W-OP

    INITIALIZE REG-ARQDCI
    MOVE 1 TO DCI-CODIGO
    MOVE 'aaaaa' TO DCI-DESCRICAO.
    WRITE REG-ARQDCI.

    DISPLAY "WRITE TB1 at 1st conn: CHECK SYSUSER AT dmSQL"
```


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```
          ACCEPT W-OP

          CLOSE ARQDCI
          CLOSE ARQDCI2
          CLOSE ARQDCI3
          EXIT PROGRAM
          STOP RUN.
```

Users can check the commands executed by duplicate connections by selecting system table SYSUSER. The following shows the result from SYSUSER in different steps from the example above.

1. After table TB1 and TB3 are opened first time:

```
dmSQL> select CONNECTION ID, CAST(USER NAME as char(20)) as USER NAME,
CAST(SQL CMD as char(50)) AS SQL CMD FROM SYSUSER;

================================================================================
       18424 SYSADM               [EXIT]  DCI OPEN TB3 (client: 18421)
       18393 SYSADM               [EXEC]  select CONNECTION_ID, CAST(USER_NAME
```

2. After table TB1 is opened second time:

```
================================================================================
       18430 SYSADM (DCITB_18424) [EXIT]  DCI OPEN TB1 (client: 18421)
       18424 SYSADM               [EXIT]  DCI OPEN TB3 (client: 18421)
       18393 SYSADM               [EXEC]  select CONNECTION_ID, CAST(USER_NAME
```

3. After table TB1 is written:

```
================================================================================
       18430 SYSADM (DCITB_18424) [EXIT]  DCI OPEN TB1 (client: 18421)
       18424 SYSADM               [EXIT]  DCI WRITE TB1 (client: 18421)
       18393 SYSADM               [EXEC]  select CONNECTION_ID, CAST(USER_NAME
```

DCI_GET_EDGE_DATES

DCI_SET_EDGE_DATE is used to specify the value to be displayed if a user enters a low/high value in the DATE field. When a user inputs low/high value for a DATE field in a COBOL program, for example, by entering 00010101/99991231, the date will be displayed using COBOL's low/high value 00000000/99999999. When this variable is used, the low/high value of the DATE field will be displayed using the database's low/high value

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00010101/99991231. This rule is also applied when the DATE field is a part of a key. The default value is off.

➲ Syntax

The following line must be added in the dci.cfg file:

```
DCI_GET_EDGE_DATES 1
```

DCI_GRANT_ON_OUTPUT

This new option allows you to specify the permission on the table during table creation (OPEN OUTPUT).

➲ Example

```
DCI_GRANT_ON_OUTPUT user1=SELECT
DCI_GRANT_ON_OUTPUT user2=SELECT,INSERT,UPDATE
```

After open output, user1 will be able to select from the table, user2 will be able to select and modify data.

DCI_IGNORE_MAX_BUFFER_LENGTH

This variable is used to ignore the setting of DCI_MAX_BUFFER_LENGTH value. It will not split the table when the record length > 32k. The default is off.

DCI_INCLUDE

This variable permits the inclusion an additional DCI_CONFIG file. It works as the COBOL COPY statement, and allows you to define more complex configurations.

➲ Example

```
DCI_INCLUDE /etc/generic_dci_config
```


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DCI_INV_DATE

This variable is used to establish an invalid date (like 2000/02/31) in order to avoid problems that can occur when an incorrect date format has been written to the database. The default for this variable is 99991230 (December 30th, 9999).

DCI_LOGFILE

This variable specifies the pathname of the DCI log file used to write all of the I/O operations executed by the interface. The *dci_trace.log* log file, stored in the */tmp* directory is used for debugging purposes. The use of a log file slows down the performance of DCI. For this reason it is recommended not add this variable in the configuration file unless deemed absolutely necessary.

➲ Example

A sample log file entry in the Config.ini file:

```
DCI_LOGFILE /tmp/dci_trace.log
```

DCI_LOGIN

The variable DCI_LOGIN allows specification of a username for connecting to the database system. It has no default value. Therefore, if no username is specified, no login will be used.

The username specified by the DCI_LOGIN variable should have RESOURCE authority or higher with the database. Additionally, the user should have permission with existing data tables. New users may be created using the JDBA Tool or dmSQL.

NOTE *For more detailed information on creating new users, refer to the JDBA Tool User's Guide or the Database Administrator's Guide.*

➲ Example

A sample username entry, JOHNDOE, made in the Config.cfg file:

```
DCI_LOGIN JOHNDOE
```

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DCI_JULIAN_BASE_DATE

This variable, used with the DATE directive, sets the base date for Julian date calculations. It utilizes the format YYYYMMDD. The default value for this variable is January 1st, 1 AD.

One usage of this variable could be a COBOL program that uses dates from 1850 onwards. These dates can be stored in a database by setting the DATE directive to $XFD DATE = JJJJJJ (the date field must have the same number of characters) and setting the DCI configuration variable DCI_JULIAN_BASE_DATE to 18500101.

DCI_LOGTRACE

This variable sets different levels for the trace log.

- 0: no trace
- 1: connect trace
- 2: record i/o trace
- 3: full trace
- 4: internal debug trace

DCI_MAPPING

This variable is used to associate particular filenames with a specific XFD in the DCI system. In this way, one XFD can be used in conjunction with multiple files. A "***pattern***" can be made up of any valid filename characters. It may include the wildcard "*" symbol, which stands for any number of characters, or the question mark "?", which stands for a single occurrence of any one character and can be used multiple times.

➲ Syntax

```
DCI_MAPPING [pattern = base-xfd-name]  ...
```


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➲ Example 1

The pattern "CUST*1" and base-XFD-name "CUSTOMER" will cause filenames such as "CUST01", "CUST001", "CUST0001" and "CUST00001" to be associated with the XFD "customer.XFD".

```
DCI_MAPPING CUST*1=CUSTOMER ORD*=ORDER "ord cli*=ordcli"
```

➲ Example 2

The pattern "CUST????" and base-XFD-name "CUST" will cause filenames such as "CUSTOMER" and "CUST0001" to be associated with the XFD "cust.XFD".

```
DCI_MAPPING  CUST????=CUST
```

DCI_MAX_ATTRS_PER_TABLE

A DBMaker table may have up to 2000 columns. A COBOL file with more than 2000 fields will not be able to map all fields to columns in the table. DCI provides the DCI_MAX_ATTRS_PER_TABLE configuration variable to define the number of fields at which the table will split into two or more distinct tables. The resulting tables must have unique names, so DCI appends the table name with an underscore (_) character followed by letters in consecutive order (A, B, C, …).

➲ Example 1

A COBOL file has 300 fields, and the following statement:

```
SELECT FILENAME ASSIGN TO "customer"
```

➲ Syntax

The following line must be added in the **dci.cfg** file:

```
DCI_MAX_ATTRS_PER_TABLE = 100.
```

➲ Example 2

Three tables will be created with the following names:

```
customer_a
customer_b
customer_c
```

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DCI_MAX_BUFFER_LENGTH

DCI_MAX_BUFFER_LENGTH is used to split a COBOL data record into multiple database tables, similar to the function performed by DCI_MAX_ATTRS_PER_TABLE. However, the cutoff value used to determine where a table will be split is determined by buffer length. The default value is ***32640***.

➲ Example 1

A COBOL record size contains 9000 bytes of data, and the following statement:

```
SELECT FILENAME ASSIGN TO "customer"
```

➲ Syntax:

The following line must be added in the dci.**cfg** file:

```
DCI_MAX_BUFFER_LENGTH 3000
```

➲ Example 2

Three tables will be created with the following names:

```
customer_a
customer_b
customer_c
```

DCI_MAX_DATE

This variable is used to establish a high-value date in order to avoid problems in cases where invalid dates have been incorrectly written to the database. The default for this variable is ***99991231*** (December 31st, 9999).

DCI_MIN_DATE

This variable is used to establish a low-value, 0 or space date in order to avoid problems that can occur when invalid dates have been incorrectly written to the database. The default for this variable is ***00010101*** (January 1st, 1AD).

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DCI_NULL_DATE

When DCI writes a date field with this value it will write NULL, and when DCI reads a date with a NULL value, it will return DCI_NULL_DATE to a COBOL program.

DCI_NULL_ON_ILLEGAL_DATE

DCI_NULL_ON_ILLEGAL_DATE determines how COBOL data that is considered illegal by the database will be converted before it is stored. The value 1 causes all illegal data (except key fields) to be converted to null before it is stored. The value 0 (default value) causes the following conversions to occur:

- Illegal LOW-VALUES: stored as the lowest possible value (0 or - 99999...) or DCI_MIN_DATE default value.
- Illegal HIGH-VALUES: stored as the highest possible value (99999...) or DCI_MAX_DATE default value.
- Illegal SPACES: stored as zero (or DCI_MIN_DATE, in the case of a date field).
- Illegal DATE values: stored as DCI_INV_DATE default value.
- Illegal TIME: stored as DCI_INV_DATE default value.
- Illegal data in key fields is always converted, regardless of the value of this configuration variable.

DCI_NULL_ON_MIN_DATE

With this variable set to 1 the following action occurs. When a COBOL program writes a value of 0 to a DATE field, the value is stored in the database as NULL. Likewise, when a NULL value is read from the database the COBOL FD will be 0.

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DCI_NULL_ON_ZERO_NUMBER

DCI_NULL_ON_ZERO_NUMBER is used to specify whether to insert NULL value into database for numeric type and its value is zero.

The default value is ***off*** (***0***).

➲ Example

When move 0 to col1, the col1's value should be set to NULL when WRITE record.

In DCI_CONFIG sets as following:

```
DCI_NULL_ON_ZERO_NUMBER 1
```

COBOL program

```
05 col1 pic 9(5) value zeros.
   move 0 to col1
   WRITE table_record
```

DCI_NULL_ON_SPACE_CHAR

DCI_NULL_ON_SPACE_CHAR is used to specify whether to insert NULL value

into database for CHAR type and its value is space.

➲ Example

When move space to col1, the col1's value should be set to NULL when WRITE record.

In DCI_CONFIG sets as following:

```
DCI_NULL_ON_SPACE_CHAR 1
```

COBOL program

```
05 col1 pic 9(5) value zeros.
move spaces to col1
WRITE table_record
```


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DCI_PASSWD

Once a username has been specified via the DCI_LOGIN variable, a database account is associated with it. A password needs to be designated to this database account. This can be done using the variable DCI_PASSWD.

➲ Example 1

If the password you want to designate to the database account is SUPERVISOR, the following must be specified in the configuration file:

```
DCI_PASSWD SUPERVISOR
```

➲ Example 2

A password can also be accepted from a user upon execution of the program. This allows for greater reliability. To do this, the DCI_PASSWD variable must be set according to the response:

```
ACCEPT RESPONSE NO-ECHO.
CALL "DCI_SETENV" USING  "DCI_PASSWD" , RESPONSE.
```

In this case, however, you should furnish a native API to call in order to read and write environment variables,

➲ Syntax 1

This statement can be used in the COBOL program to write or update the environment variable.

```
 CALL "DCI_SETENV" USING "environment variable", value.
```

➲ Syntax 2

This statement can be used in the COBOL program to read the environment variable.

```
 CALL "DCI_GETENV" USING "environment variable", value.
```

DCI_RESET_CHARTOBLOB_LENGTH

DCI_RESET_CHARTOBLOB_LENGTH is used to specify the max length to be declared as CHAR type.

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The default value is ***off*** (***0***).

When setting DCI_RESET_CHARTOBLOB_LENGTH to a positive integer,

any field specified with PIC X(N) and N >= DCI_RESET_CHARTOBLOB_LENGTH, its column type will be long varbinary(N).

➲ Example

In DCI_CONFIG sets as following:

```
DCI_RESET_CHARTOBLOB_LENGTH 10000
```

COBOL program

```
FD file1.
 01 file1-record.
    03 col-key pic 9(3).
    03 col-data pic x(10).
    03 col-blob pic x(10000).
```

With OPEN OUTPUT DCI creates a table as follows:

TABLE FILE1 (COL_KEY NUMERIC(3), COL_DATA CHAR(10), COL_BLOB BLOB)

DCI_STORAGE_CONVENTION

This variable sets the COBOL storage convention. There are four value types currently supported by DBMaker.

DCI

Selects the IBM storage convention. It is compatible with IBM COBOL, as well as with several other COBOL versions including RM/COBOL-85. It is also compatible with the X/Open COBOL standard.

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DCM

Selects the Micro Focus storage convention. It is compatible with Micro Focus COBOL when the Micro Focus "ASCII" sign-storage option is used (this is the Micro Focus default).

DCN

Causes a different numeric format to be used. The format is the same as the one used when the "-DCI" option is used, except that positive COMP-3 items use "x0B" as the positive sign value instead of "x0C". This option is compatible with NCR COBOL.

DCA

Selects the ACUCOBOL-GT storage convention. It is the default setting. This convention is also compatible with data produced by RM/COBOL (not RM/COBOL-85) and previous versions of ACUCOBOL-GT.

DCI_TABLE_CACHE

This function is to support DCI_TABLE_CACHE tablename=start,next,prev for specify cache with different table. This keyword DCI_TABLE_CACHE, can refer to DCI_MAPPING feature.

- Syntax:

```
DCI_TABLE_CACHE tabname=start,next,prev
```

- Example

In DCI_CONFIG set as following. Checking config's link list before START or READ, if accorded with table name or pattern, then call DBM_SET_TABLE_CACHE.

```
DCI_TABLE_CACHE tab*=10,10,5
DCI_TABLE_CACHE employee=20,20,10
```

It is not only one setting, so cannot support DCI_SETENV or DCI_GETENV.

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DCI_TABLE_FILLFACTOR

DCI_TABLE_FILLFACTOR specified the fillfactor for creating table.

➲ Example

To specify fillfactor 90 for table emp_tab1 and emp_tab2. Add the following line in DCI_CONFIG file.

```
DCI_TABLE_FILLFACTOR  emp_tab*=90
```

DCI_TABLESPACE

This allows you to define in which tablespace to create a table. It also works with wildcards. It is important only when a table is first created. Once the table exists, DCI does not monitor the value of this variable.

➲ Example 1

You want to create the customer table in tablespace tbs1:

```
DCI_TABLESPACE customer=tbs1
```

➲ Example 2

You want to create all tables that begin with cust in tablespace tbs1.

```
DCI_TABLESPACE cust*=tbs1
```

DCI_TABLESPACE_IDX

Use this keyword to specify the index tablespace when creating an index. If the user does not specify this keyword, the default tablespace for creating the index will be the same as the table's tablespace.

➲ Syntax

```
DCI_TABLESPACE_IDX table_pat=tablespace_name
```

➲ Example

```
DCI_TABLESPACE_IDX tab*=TS1
```


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DCI_USER_TABLESPACE

DCI_USER_TABLESPACE is used to specify tablespace for create table for user/schema.

➲ Syntax

```
DCI_USER_TABLESPACE USER_NAME=TABLESPACE_NAME"
```

➲ Example

We try to map all tables from USER1 to Tablespace TS1 and all tables that start with CUST* to TS2.

```
DCI_USER_TABLESPACE USER1=TS1
DCI_TABLESPACE CUST*=TS2
```

About the priority for creating table in tablespace is listed as followings:

- Check if DCI_TABLESPACE specified for table_name=tablespace_name, if matched, then create table in specified tablespace.
- Check if DCI_USER_TABLESPACE specified for user_name=tablespace_name, if matched, then create table in specified tablespace.
- Check if DCI_DEFAULT_TABLESPACE specified and create table in specified tablespace.

DCI_USEDIR_LEVEL

If this variable is set > 0, use the directory in addition to the name of the table.

➲ Example 1

The following line is equal to: */usr/test/01/clients 01clients*

```
DCI_USEDIR_LEVEL 1
```

➲ Example 2

The following line is equal to: */usr/test/01/clients test01clients*

```
DCI_USEDIR_LEVEL 2
```

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➲ Example 3

The following line is equal to: */usr/test/01/clients usrtest01clients*

```
DCI_USEDIR_LEVEL 3
```

DCI_USER_PATH

When DCI looks for a file or files, the variable DCI_USER_PATH allows for specification of a username, or names. The user argument can be a period (.) with regard to the files, or the name of a user on the system.

➲ Syntax

```
DCI_USER_PATH user1 [user2] [user3] .
```

The type of OPEN statement issued for a file will determine the results of this setting.

OPEN STATEMENT	DCI_USER_PATH	DCI SEARCH SEQUENCE	RESULT
OPEN INPUT or OPEN I/O	Yes	1-list of users in USER_PATH 2-the current user	The first valid file will be opened.
OPEN INPUT or OPEN I/O	No	The user associated with DCI_LOGIN.	The first file with a valid user/file-name will be opened.
OPEN OUTPUT	Yes or no	Doesn't search for a user.	A new table will be made for the name associated with DCI_LOGIN.

Figure 6-1 Types of OPEN Statements

DCI_XFD_INFO_OFF

This feature is used to turn off DBM_SET_XFD_INFO(). This option was implemented to speed OPEN of large numbers of fields, tables.
We have supported to set XFD_INFO_OFF dynamic.

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➲ Example

```
CALL "DCI_SETENV" USING "DCI_XFD_INFO_OFF" "1"
```

DCI_XFDPATH

DCI_XFDPATH is used to specify the name of the directory where data dictionaries are stored. The default value is the current directory.

➲ Example 1

Include the following entry in the configuration file in order to store data dictionaries in the directory */usr/dbmaker/dictionaries*.

```
DCI_XFDPATH /usr/dbmaker/dictionaries
```

➲ Example 2

If it is necessary to specify more than one path, different directories have to be separated by spaces.

```
DCI_XFDPATH /usr/dbmaker/dictionaries /usr/dbmaker/dictionaries1
```

➲ Example 3

In a WIN-32 environment, "embedded spaces" can be specified using double-quotes.

```
DCI_XFDPATH c:\tmp\xfdlist "c:\my folder with space\xfdlist"
```

DCI_XML_XFD

This variable is set to 1 to indicate the DCI runtime need to use the ACUCOBOL XML format XFD file. The default is 0 for users are using old xfd format which is made by previous ACUCOBOL compiler or when ACUCOBOL users compile their COBOL program with –Fx3 option.

Because ACUCOBOL-GT compiler does not support some XFD syntax like the "$XFD COMMENT directive" syntax in the XML format, it is not recommended for users to use the XML format if they want to use the related syntax in their COBOL

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➲ Example 1

The following syntax listed in Chapter 4.2 is not supported.

```
$XFD COMMENT  DCI SERIAL  n directive
$XFD COMMENT DCI COBTRIGGER Directive
$XFD COMMENT Directive
$XFD COMMENT DCI SPLIT
```

DCI_VARCHAR

With this variable set to 1 the following action occurs: When a COBOL program creates a new table (trough OPEN OUTPUT verb) all fields that were created as CHAR will become VARCHAR.

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6.2 DCI keywords in dmconfig.ini

This chapter will introduce keywords about DCI which can be set in dmconfig.ini.

DCI_CHKDEC=<value>

This keyword specifies whether to check decimal's precision and scale mismatch problem. This keyword can ignore error 9D,5515 in different DCI and DBMaker version. Set to 1 means to check decimal's precision and scale mismatch problem; set to 0 means not to check decimal's precision and scale mismatch problem and ignore Error 9D,5515 when XFD's decimal's precision and scale is different from table's column definition and the following write/read get wrong decimal.

default value: 1

valid range: 0, 1

where to use: **server side**

DCI_TRACE=<value>

This keyword is set in the DM_COMMON_OPTION section and specifies whether the DBMaker DCI log is turned on or off. Setting this value to 1 will turn on the DCI log; setting it to 0 will turn it off. When the DCI log is on, the called DCIfunction, input parameters, output parameters, and returned code or error information will be logged to the file defined by DCI_PATH.

default value: 0

valid range: 0, 1

where to use: **server side**

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DCI_PATH=<string>

This keyword can only be set in the DM_COMMON_OPTION section and specifies the file path name of the output DCI log file.

default value: c:\dmdci.log (for Windows), ./dmdci.log (for UNIX)

valid range: string with length < 256

where to use: **server side**

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7 DCI Functions

This section lists the DCI functions that could be called in the COBOL program. To enable these functions, the user must add these functions in the sub85.c and rebuild the DCI runtime.

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7.1 Calling DCI functions

Add this to your COBOL program to call these DCI functions:

```
CALL "dci_function_name" USING variable [, variable, ...]
```

DCI_SETENV

This function writes or updates the environment variable.

- Syntax

```
CALL "DCI_SETENV" USING "environment variable", value
```

- Example

```
call "DCI_SETENV" using  "DCI_DATABASE" , "DBNAME"
```

DCI_GETENV

This function reads the environment variable.

- Syntax

```
CALL "DCI_GETENV" USING "environment variable", variable
```

- Example

```
CALL "DCI_GETENV" USING "DCI_DATABASE", ws_dci_database
```

DCI_DISCONNECT

This function disconnects a database connection.

- Example 1

If there is only one connection in the COBOL program, use the following code to disconnect from the database.

```
CALL "DCI_DISCONNECT".
```


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➲ Example 2

If there is more than one connection the COBOL program, use the following code to disconnect a specific database.

```
CALL "DCI_DISCONNECT" USING "DBNAME"
```

DCI_GET_TABLE_NAME

This function gets the table name of the passed COBOL name (It's not always so immediate to know the effective table name, because there can be some manipulation in these cases: XFD WHEN ... TABLENAME.).

```
CALL "DCI_GET_TABLE_NAME" USING ws-filename, ws-dci-file-name
```

DCI_SET_TABLE_CACHE

This function dynamically changes the cache for tables set these variables before START or READ statements.

➲ Example

```
…
WORKING-STORAGE SECTION.
       01 CACHE-START PIC 9(5) VALUE 10.
       01 CACHE-NEXT  PIC 9(5) VALUE 20.
       01 CACHE-PREV  PIC 9(5) VALUE 30.
…
PROCEDURE DIVISION.
      OPEN INPUT IDX-1-FILE
           MOVE SPACES TO IDX-1-KEY
           CALL "DCI_SET_TABLE_CACHE" USING CACHE-START
                                            CACHE-NEXT
                                            CACHE-PREV
           START IDX-1-FILE KEY IS NOT LESS IDX-1-KEY.
           PERFORM VARYING IND FROM 1 BY 1 UNTIL IND = 10000
              READ IDX-1-FILE NEXT AT END EXIT PERFORM END-READ
              DISPLAY IND AT 0101
           END-PERFORM
           CLOSE IDX-1-FILE
```

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DCI_BLOB_ERROR

This function gets the error after calling DCI_BLOB_GET or DCI_BLOB_PUT.

➲ Example

```
     working-storage section.
      77   BLOB-ERROR-ERRNO pic S9(4) COMP-5.
      77   BLOB-ERROR-INT-ERRNO pic S9(4) COMP-5.

 PROCEDURE DIVISION.
CALL "DCI_BLOB_ERROR" USING BLOB-ERROR-ERRNO
                            BLOB-ERROR-INT-ERRNO
       DISPLAY "BLOB-ERROR-ERRNO=" BLOB-ERROR-ERRNO.
       DISPLAY "BLOB-ERROR-INT-ERRNO=" BLOB-ERROR-INT-ERRNO.
```

DCI_BLOB_GET

This function enables users to more effectively use BLOB data in a COBOL program. By using the DCI_BLOB_GET command you can quickly and efficiently access BLOB data using COBOL. When using the DCI_BLOB_GET command you must follow the rules listed below:

- The user's table must have a BLOB (long varchar/long varbinary) data type
- Users cannot set the field with BLOB type in the COBOL FD
- Users can only use the DCI_BLOB_GET command after the READ, READ NEXT or READ PREVIOUS command

➲ Example

A user creates a table by:

```
CREATE TABLE BLOBTB (
         SB_CODCLI  char(8),
         SB_PROG    SERIAL,
         IL_BLOB    LONG VARBINARY,
         PRIMARY KEY ("sb_codcli")) LOCK MODE ROW NOCACHE;
```


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The following gives a practical application of the use of the DCI_BLOB_GET in the COBOL program.

```
       identification division.
       program-id. blobtb.
       date-written.
       remarks.
       environment division.
       input-output section.
       file-control.
           SELECT BLOBTB ASSIGN TO RANDOM, "BLOBTB"
                       ORGANIZATION IS INDEXED
                       ACCESS IS DYNAMIC
                       FILE STATUS IS I-O-STATUS
                       RECORD KEY  IS SB-CODCLI.
      *================================================================*
       data division.
       file section.
       FD  BLOBTB.
       01  SB-RECORD.
       03  SB-CODCLI         PIC X(8).
       03  SB-PROG           PIC S9(9) COMP-5.
      *================================================================*
       working-storage section.
       77   I-O-STATUS pic xx.
       77   BLOB-ERROR-ERRNO pic S9(4) COMP-5.
       77   BLOB-ERROR-INT-ERRNO pic S9(4) COMP-5.

procedure division.
main.
              open i-o blobtb
              initialize sb-record.
              READ blobtb next.
              CALL "DCI_BLOB_GET" USING "il_blob" "laecopy.bmp" 1.
              CALL "DCI_BLOB_ERROR" USIG BLOB-ERROR-ERRNO
                                         BLOB-ERROR-INT-ERRNO
              DISPLAY "BLOB-ERROR-ERRNO=" BLOB-ERROR-ERRNO.
              DISPLAY "BLOB-ERROR-INT-ERRNO=" BLOB-ERROR-INT-ERRNO.
              DISPLAY "SB-CODCLI=" SB-CODCLI.
              DISPLAY "SB-PROG=" SB-PROG.
```

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```
            close blobtb.
            ACCEPT OMITTED.
            stop run.
```

DCI_BLOB_PUT

This function enables users to more effectively use BLOB data in a COBOL program. Using the DCI_BLOB_PUT command you can insert data into a BLOB. When using the DCI_BLOB_PUT command you must follow the rules listed below:

- The user's table must have a BLOB (long varchar/long varbinary) data type.
- Users cannot set the field with BLOB type in the COBOL FD.
- Users can only call the DCI_BLOB_PUT command before a WRITE or REWRITE command.
- If users do not call DCI_BLOB_PUT before a WRITE statement, the default value will be inserted in the blob column.
- If users do not call DCI_BLOB_PUT before REWRITE statement, the blob column will not be updated.

➲ Example

The following gives a practical application of the use of the DCI_BLOB_PUT in the COBOL program.

First the user creates a table:

```
CREATE TABLE BLOBTB (
         SB_CODCLI  char(8),
         SB_PROG    SERIAL,
         IL_BLOB    LONG VARBINARY,
         PRIMARY KEY ("sb_codcli")) LOCK MODE ROW NOCACHE;
```

Once the table is created the user continues with the following.

```
identification division.
       program-id. blobtb.
```


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```
       date-written.
       remarks.
       environment division.
       input-output section.
       file-control.
           SELECT BLOBTB ASSIGN TO RANDOM, "BLOBTB"
                       ORGANIZATION IS INDEXED
                       ACCESS IS DYNAMIC
                       FILE STATUS IS I-O-STATUS
                       RECORD KEY  IS SB-CODCLI.
      *================================================================*
       data division.
       file section.
       FD  BLOBTB.
       01  SB-RECORD.
           03  SB-CODCLI         PIC X(8).
           03  SB-PROG           PIC S9(9) COMP-5.
      *================================================================*
       working-storage section.
       77   I-O-STATUS pic xx.
       77   BLOB-ERROR-ERRNO pic S9(4) COMP-5.
77   BLOB-ERROR-INT-ERRNO pic S9(4) COMP-5.

procedure division.
main.
             open i-o blobtb
             move "AAAAAAAA" TO SB-CODCLI.
             move 0 TO SB-PROG.
             CALL "DCI_BLOB_PUT" USING "il_blob" "laetitia.bmp".
             WRITE SB-RECORD.
             close blobtb.
             ACCEPT OMITTED.
             stop run.
```

DCI_GET_TABLE_SERIAL_VALUE

This function gets the serial value after a WRITE statement.

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➲ Example

```
FD  SERIALTB.
    01  SB-RECORD.
    03  SB-CODCLI         PIC X(8).
$XFD COMMENT dci serial
    03  SB-PROG           PIC S9(9) COMP-5.
working-storage section.
77   I-O-STATUS pic xx.
77   SERIAL-NUM pic S9(9) COMP-5.

procedure division.
main.
      open i-o serialtb
      move "AAAAAAAA" TO SB-CODCLI.
      move 0 TO SB-PROG.
      WRITE SB-RECORD.
      CALL "DCI_GET_TABLE_SERIAL_VALUE" USING SERIAL-NUM.
      DISPLAY "SERIAL-NUM=" SERIAL-NUM.
```

DCI_FREE_XFD

This function is used to purge the XFD image DCI keeps in cache. This can be useful to reload a XFD that changed after a table has already been opened by this connection.

```
CALL "DCI_FREE_XFD"
```

DCI_UNLOAD_CONFIG

This function is used to unload the current configuration. Then you can create a new configuration by calling DCI_SETENV. Very useful in ThinClient environment.

```
CALL "DCI_UNLOAD_CONFIG"
```


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8 COBOL Conversions

Transactions are enforced in DCI during conversions. All I/O operations are done using transactions. DCI sets AUTOCOMMIT off and manages DBMaker transactions to make record changes for users available. DCI fully supports COBOL transaction statements like START TRANSACTION, COMMIT/ROLLBACK TRANSACTION.

DCI doesn't support record encryption, record compression, or the alternate collating sequence. If these options are included in code, they will be disregarded. DCI also doesn't support the "P" PICture edit function in the XFD data definition and all file names are converted to lowercase.

DBMaker Database Settings	Range Limit
Indexed key size.	4000
Number of columns per key.	32
Length for a CHAR field.	32640
Simultaneous RDBMS connections.	4800
Character for column names.	128
Database tables simultaneously open by a single process.	256

Figure 8-1 DBMaker Database Settings Range Limits table

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8.1 Using Special Directives

DBMaker can use the same sort or retrieval sequence as the Vision file system, but it requires that a BINARY directive be placed before each key field containing signed numeric data. High and low values can create complications in key fields.

The DBMaker OID, VARCHAR(size), and FILE data types are not currently supported with special directives.

DBMAKER DATA TYPE	DIRECTIVE
DATE	Using XFD DATE
TIME	Using XFD DATE
TIMESTAMP	Using XFD DATE
LONGVARCHAR	Using XFD VAR-LENGH
LONGVARBINARY	Using XFD VAR-LENGH*
BINARY	Using XFD BINARY
SERIAL	Using XFD COMMENT DCI SERIAL

Figure 8-2 DBMaker Data Types Supported using Special Directives

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8.2 Mapping COBOL Data Types

DCI establishes what it considers to be the best match for COBOL data types in the creation of all columns in a DBMaker database table. Any data the COBOL date type can contain can also be contained in the database column. The XFD directives that have been specified will be checked first.

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COBOL	DBMAKER		COBOL	DBMAKER
9(1-4)	SMALLINT		9(5-9) comp-4	INTEGER
9(5-9)	INTEGER		9(10-18) comp-4	DECIMAL(10-18)
9(10-18)	DECIMAL(10-18)		9(1-4) comp-5	SMALLINT
s9(1-4)	SMALLINT		9(5-10) comp-5	DECIMAL(10)
s9(5-9)	INTEGER		s9(1-4) comp-5	SMALLINT
s9(10-18	DECIMAL(10-18)		s9(5-10) comp-5	DECIMAL(10)
9(n) comp-1 n (1-17)	INTEGER		9(1-4) comp-6	SMALLINT
s9(n) comp-1 n (1-17)	INTEGER		9(5-9) comp-6	INTEGER
9(1-4) comp-2	SMALLINT		9(10-18) comp-6	DECIMAL(10-18)
9(5-9) comp-2	INTEGER		s9(1-4) comp-6	SMALLINT
9(10-18) comp-2	DECIMAL(10-18)		s9(5-9) comp-6	INTEGER
s9(1-4) comp-2	SMALLINT		s9(10-18) comp-6	DECIMAL(10-18)
s9(5-9) comp-2	INTEGER		signed-short	SMALLINT
s9(10-18) comp-2	DECIMAL(10-18)		unsigned-short	SMALLINT
9(1-4) comp-3	SMALLINT		signed-int	CHAR(10)
9(5-9) comp-3	INTEGER		unsigned-int	CHAR(10)
9(10-18) comp-3	DECIMAL(10-18)		signed-long	CHAR(18)
s9(1-4) comp-3	SMALLINT		unsigned-long	CHAR(18)
s9(5-9) comp-3	INTEGER		float	FLOAT
s9(10-18) comp-3	DECIMAL(10-18)		Double	DOUBLE
9(1-4) comp-4	SMALLINT		PIC x(n)	CHAR(n) n 1-max column length

Figure 8-3 COBOL to DBMaker Data Type Conversion Chart

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8.3 Mapping DBMaker Data Types

DCI reads data from the database by doing a COBOL-like MOVE from the native data types to the COBOL data types (most of which have a CHAR representation so you can display them by using dmSQL).

It is not necessary to worry about exactly matching the database data types to COBOL data types. PIC X(nn) can be used for each column with regards to database types having a CHAR representation. PIC 9(9) is a closer COBOL match for databases that have INTEGER types. The more you know about a database type, the more flexible you can be in finding a matching COBOL type. For example, if a column in a DBMaker database only contains values between zero and 99 (0-99), PIC 99 would be a sufficient COBOL date match.

Choosing COMP-types can be left to the discretion of the programmer since it has little effect on the COBOL data used. BINARY data types will usually be re-written without change, because they are foreign to COBOL. However, a closer analysis of BINARY columns might allow you to find a different solution. The DECIMAL, NUMERIC, DATE and TIMESTAMP types have no exact COBOL matches. They are returned from the database in character form, so the best COBOL data type equivalent would be USAGE DISPLAY.
The following table illustrates the best matches for database data types and COBOL data types:

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DBMAKER	COBOL		DBMAKER	COBOL
SMALLINT	9(1-4)		INTEGER	9(5-9) comp-4
INTEGER	9(5-9)		DECIMAL(10-18)	9(10-18) comp-4
DECIMAL(10-18)	9(10-18)		SMALLINT	9(1-4) comp-5
SMALLINT	s9(1-4)		DECIMAL(10)	9(5-10) comp-5
INTEGER	s9(5-9)		SMALLINT	s9(1-4) comp-5
DECIMAL(10-18)	s9(10-18		DECIMAL(10)	s9(5-10) comp-5
INTEGER	9(n) comp-1 n (1-17)		SMALLINT	9(1-4) comp-6
INTEGER	s9(n) comp-1 n (1-17)		INTEGER	9(5-9) comp-6
SMALLINT	9(1-4) comp-2		DECIMAL(10-18)	9(10-18) comp-6
INTEGER	9(5-9) comp-2		SMALLINT	s9(1-4) comp-6
DECIMAL(10-18)	9(10-18) comp-2		INTEGER	s9(5-9) comp-6
SMALLINT	s9(1-4) comp-2		DECIMAL(10-18)	s9(10-18) comp-6
INTEGER	s9(5-9) comp-2		SMALLINT	signed-short
DECIMAL(10-18)	s9(10-18) comp-2		SMALLINT	unsigned-short
SMALLINT	9(1-4) comp-3		CHAR(10)	signed-int
INTEGER	9(5-9) comp-3		CHAR(10)	unsigned-int
DECIMAL(10-18)	9(10-18) comp-3		CHAR(18)	signed-long
SMALLINT	s9(1-4) comp-3		CHAR(18)	unsigned-long
INTEGER	s9(5-9) comp-3		FLOAT	float
DECIMAL(10-18)	s9(10-18) comp-3		DOUBLE	Double
SMALLINT	9(1-4) comp-4		CHAR(n) n 1-max column length	PIC x(n)

Figure 8-4 DBMaker to COBOL Data Type Conversion Chart

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8.4 Troubleshooting Runtime Errors

Runtime errors have the format "9D, xx", where "9D" indicates a file system error (reported in the FILE STATUS variable) and "xx" indicates a secondary error code.

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ERROR	DEFINITION	INTERPRETATION	SOLUTION
9D,01	There is a read error on the dictionary file.	An error occurred while reading the XFD file. The XFD file is corrupt.	Recompile with -Fx to re-create the dictionary file.
9D,02	There is a corrupt dictionary file. The dictionary file cannot be read.	The dictionary file for a COBOL file is corrupt.	Recompile with -Fx to re-create the dictionary file.
9D,03	A dictionary file (.xfd) has not been found.	The dictionary file for a COBOL file cannot be found.	Specify a correct directory in the DCI_XFDPATH configuration file variable (it may be necessary to recompile using –Fx).
9D,04	There are too many fields in the key.	There are more than16 fields in a key.	Check key definitions, re-structure illegal key, recompile with –Fx.
9D,12	There is an unexpected error on a DBMaker library function.	A DBMaker library function returned an unexpected error.	
9D,13	The size of the "xxx" variable is illegal.	An elementary data item in an FD is larger than 255 bytes.	
9D,13	The type of data for the "xxx" variable is illegal.	There is no DBMaker type that matches the data type used.	
9D,14	There is more than one table with the same name.	More than one table had the same name when they were listed.	

Figure 8-5 DCI Secondary Errors Chart

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8.5 Troubleshooting Native SQL Errors

Some native SQL errors may be generated by a database while using DCI for DBMaker. The exact error number and wording may vary from database to database.

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NUMBER	DEFINITION	INTERPRETATION	SOLUTION
9D, 6523,6018	Invalid column name or reserved word.	A column was named using a word that has been reserved for the database.	Compare a file trace of CREATE TABLE to the list of database reserved words. Apply the NAME directive to the FD field of an invalid column and recompile to create a new XFD file.
9D, 1310	Journal full, command rolled back to internal savepoint		Add "start transaction/commit/rollback" code in the COBOL program. Or set DCI_COMMIT_COUNT in the DCI configuration file.
9D, 5503	invalid key name	The table does not have the index	Create the index with correct index name and columns
9D, 5504	Cannot use host variable		Users cannot use host variable in the runsql.acu
9D, 5508	do not have INSERT/UPDATE/DELETE privilege	Users cannot open I-O for table that they does not have the insert/delete/update privilege	OPEN INPUT with that table
9D, 5512	cannot issue select query		Users cannot issue select statement in the runsql.acu
9D,5513	client-server version mismatch when dci connect	User's DCI runtime is newer than the dmserver	User should upgrade their dmserver before running new DCI runtime
9D, 5514	invalid column number	COBOL FD column number > table column number	Users need to check the FD column number and table column number
9D, 5515	invalid XFD column name or data type and length does not	COBOL FD column name or column type does not match with table definition	Compare the FD and table definition. Fix this problem by either change the COBOL FD or alter table.

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	match		
9D, 5518	DCI blob data is null	When users get blob from a column and the data is null	
9D, 5519	DCI blob file does not exist		Users should ensure the blob file has existed.

Figure 8-6 Native SQL Errors Char

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8.6 Converting Vision Files

DCI provides a sample program to convert COBOL files into RDBMS tables. Before using the DCI_MIGRATE program, a Vision file to be converted and an XFD data dictionary for the Vision file are required. The ACUCOBOL runtime system 4.3 or higher linked to DCI must be installed and a DCI_MIGRATE object program must be ready.

Using DCI_Migrate

This is a general-purpose program that converts any COBOL vision file into a DBMaker table. To run correctly the minimum DCI configuration settings must be defined to work with DBMaker (DCI_LOGIN, DCI_DATABASE, DCI_PASSWD etc) and match the .XFD file name with *dbm_table_name* or use DCI_MAPPING to specify the name and location.

The program DCI_MIGRATE reads vision files and writes DBMaker tuples through DCI. In addition, after migration, it checks if all records are correct by reading vision records and comparing them by reading DBMaker rows.

The DCI_MIGRATE program will report the following:

- Total record read successful
- Total record write successful
- Total record read unsuccessful
- Total record write unsuccessful
- Total record compared successful
- Total record compared unsuccessful

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DCI_MIGRATE OPTIONS	RESULT
--help	Displays the online help.
--nowait	Doesn't wait for user confirmation during interactive mode.
--noverify	Skips the verify process.
--nomigrate	Skips the migrate process.
--visdbm	Converts vision files to DBMaker tables (default).
--dbmvis	Converts DBMaker tables to vision files.

Figure 8-7 DCI_MMIGRATE Options Result table

➲ Syntax 1

The *vision_file_name* is the name of the Vision file to be converted and *dbm_table_name* is the name of the DBMaker table.

```
runcbl DCI_MIGRATE vision_file_name dbm_table_name [options]
```

➲ Syntax 2

Setting the environment variable named DCI_MIGRATE to "yes" can turn off the report. The report will then append a file named "dbm_table_name.log".

```
DCI_MIGRATE = yes
```

➲ Syntax 3

The record can be dumped for an unsuccessful operation by adding, "dump" to the DCI_MIGRATE setting (Spaces will be considered separators. Log file names with embedded spaces are not permitted).

```
DCI_MIGRATE = yes dump
```

➲ Syntax 4

Setting the environment variable named DCIMIGRATE_COMMIT_COUNT can change the commit count from 100 to specified number.

```
DCIMIGRATE_COMMIT_COUNT = 200
```

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Glossary

API

Application Programming Interface: The API is an interface between an application and an operating system.

Binary Large Object (BLOB)

A large block of data stored in the database that is not stored as distinct records in a table. A BLOB cannot be accessed through the database in the same way as ordinary records. The database can only access the name and location of a BLOB; typically, another application is used to read the data.

Buffer

A buffer is an internal memory space (zone) where data is temporarily stored during input or output operations.

Client

A computer that can access and manipulate data that is stored on a central server computer.

Column

A set of data in a database table defined as multiple records consisting of the same data type.

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Data dictionaries

Also known as extended file descriptors; they serve as maps (links) between database schema and the file descriptors in a COBOL application.

Directive

An optional comment placed in the COBOL code that sets the proceeding field or fields to a data type other than the default DCI setting.

Field

Part of a COBOL file descriptor roughly corresponding to a database column. It is a discrete data item contained in a COBOL record.

File Descriptor

A file descriptor is an integer that identifies a file that is operated on by a process. Operations that read, write, or close a file use the file descriptor as an input parameter.

Indexed file

File containing a list of keys that uniquely identify all records.

Key

A unique value used to identify a record in a database. (See ***Primary Key*** for more details).

Primary key

A primary key consists of a column of unique (or key) values, which can be used to identify individual records contained in a table.

Query

In DBMaker, SQL commands used to execute data query requests made by a user to obtain specific information.

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Record

In COBOL, a group of related fields defined in the Data Division. In DBMaker, a record is also referred to as a row, and defines a set of related data items in table columns.

Relational Database

A relational database is a database system where internal database tables on different databases may be related to one another by the use of keys or unique indexes.

Schema

A database table's structure as defined by its columns. Data type, size, number of columns, keys, and constraints all define a table's schema.

Server

A server is a central computer that stores and handles network configuration files, which also can consist of a database management system to store data (database) and distribute data to clients via a network connection.

SQL

Structured Query Language is the language DBMaker and other ODBC compliant programs use to access and manipulate data.

Table

A logical storage unit in a database that consists of columns and rows used to store records.

XFD file

An acronym for extended file descriptor or data dictionary. It also forms the file extension for the data dictionary.

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