RPG/3000

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Accessing and controlling a file that is open only to you is a relatively simple matter. However, when the file is being accessed by several users simultaneously, each user must be aware of how access is controlled for this shared file.

Simultaneous Access of Files

When a program issues a request to open a file, that request is regarded as an individual accessor of the file and a unique file pointer, set of buffers, and other file control information is established for that access path. Even when the same program issues several different open calls for the same file, each call is treated as a separate accessor. Under the normal security provisions of MPE, when an accessor opens a file not presently in use, the access restrictions that apply to this file for subsequent accessors depend upon the access mode requested by this initial accessor.

File sharing restrictions may be specified using file equations.

The file sharing restriction options are:

;EXC	Exclusive Access	After file is opened, PROHIBITS concurrent access in ANY mode through another open request, whether issued by this or another program until this program issues a close or terminates.
;SEMI	Semi-Exclusive Access	After file is opened, PROHIBITS concurrent write access through another open request, whether issued by this or another program, until this program issues a close or terminates. PERMITS concurrent read access.
;SHR	Sharable Access	After file is opened, PERMITS concurrent access to file in any mode through another open request issued by this or another program, in this or any other session or job.

Exclusive Access

```
:FILE A;EXC
```

In all cases, when the first accessor to a file opens it with Exclusive Access, all other attempts to open the file will fail.

This option is useful when you wish to update a file, and wish to prevent other users or programs from reading or writing to the file while you are using it. Thus, no other users can read information that is about to be changed, nor can they alter that information.

Semi-Exclusive Access

```
:FILE A;SEMI
```

This option allows other accessors to read the file but PREVENTS them from altering it.

Share Access

```
:FILE A;SHR
```

This option allows other accessors to use the file. Each accessor transfers its input/output to and from the file via its own unique buffers, using its own set of file control information and its own record pointer. Effectively, each accessor retrieves its own copy of that portion of the file presently in its buffer.

File sharing by two or more processes may be hazardous. When a file is being shared by two or more processes and is being written to by one or more of them, care must be taken to ensure that the processes are properly interlocked. The necessary interlocking is provided by properly locking and unlocking the file.

Locking and unlocking in the MPE system allows you to perform your own conditional or unconditional locking and unlocking on Image, KSAM, and MPE files. When an unconditional lock is executed on a file which cannot be locked immediately, the calling program suspends until the file can be locked. A conditional lock will take place only if the file is not currently locked. If the file is locked, control returns immediately to the calling program, and the lock fails.

One example of unconditional locking occurs when a file is shared between a writing process and a reading process, with the writing process adding records to the file. Locking is executed prior to writing each record. Unlocking is then executed when the writing process is finished. By contrast, the reading process locks the file prior to reading each record, and unlocks the file after reading is finished. If the writing process should execute while the reader is in the middle of a read, the writer's call to lock the file will be suspended until the reader signals that it is finished by unlocking the file.

Locking within RPG

In order for locking and unlocking to be allowed for a shared file in RPG you must enable the appropriate locking facility. For KSAM and MPE files, you enable the MPE dynamic locking facility by specifying a KLOCK or KNOLOCK continuation record for the file. For Image files, you enable Image locking by specifying one of the locking modes (B,S,1,9,R, or L) on the KIMAGE continuation record for the file.

KSAM and MPE

You can only lock KSAM and MPE files on the file level (i.e., the entire file must be locked; indivdual records cannot be locked). Both automatic and manual locking options are available.

Automatic Locking

When the KLOCK option is specified, RPG opens the file with the dynamic locking facility enabled for shared access and automatically locks and unlocks the file whenever a record is read or written.

Manual Locking

When the KNOLOCK option is specified, RPG opens the file with the dynamic locking facility enabled, but does not do any automatic locking or unlocking of the file. If you want to lock and unlock the file, you will need to do so manually by using the LOCK and UNLCK operations in the Calculation Specifications.

If one user opens a file with the dynamic locking facility enabled then all other concurrent users must also open the file with dynamic locking enabled, whether or not they are going to be locking and unlocking the file.

There are 3 ways that concurrent users can enable the dynamic locking facility:

1) Through use of a KLOCK continuation record in RPG program.

2) Through use of a KNOLOCK continuation record in RPG program.

3) Through use of the LOCK option on a file equation.

RPG does automatic locking and unlocking of KSAM, MPE, and Image files in the following way:

An input file is locked before it is read and unlocked after it is read.

An output file is locked before it is written and unlocked after it is written.

An update file is locked before a record is read, and unlocked either after it is updated or before the next lock and read. That is, if an update file has been locked and read, but not updated, RPG unlocks the file when the program next attempts to lock and read from it.

```
INPUT FILE:  LOCK-->READ------------>UNLOCK->-------->LOCK...
OUTPUT FILE: LOCK----------->WRITE--->UNLOCK->-------->LOCK...
UPDATE FILE: LOCK-->READ---->UPDATE-->UNLOCK->-------->LOCK...
      or     LOCK-->READ--------------------->-UNLOCK->LOCK...
```

igure 1

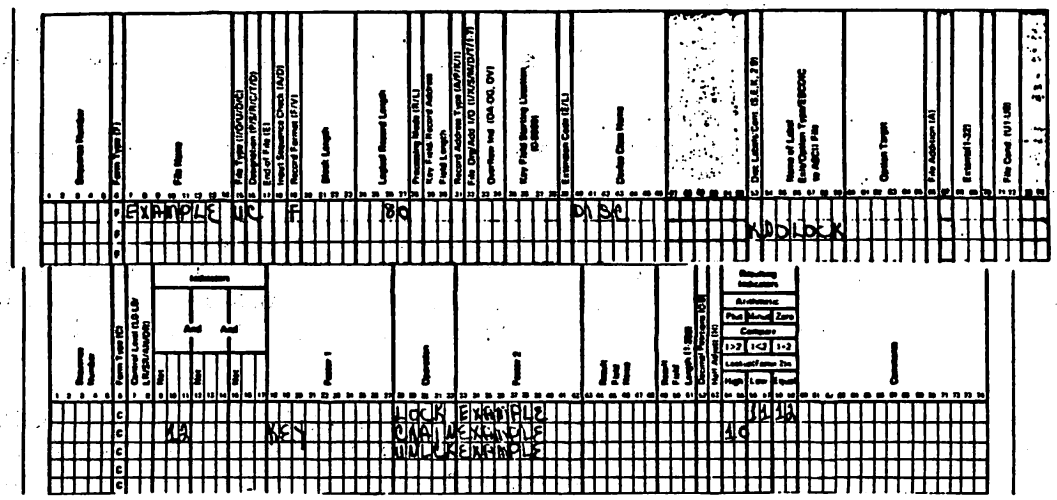
NOTE - If a user uses the LOCK option on a file equation, and does not also include a KLOCK or KNOLOCK continuation record, RPG will not perform automatic locking and will not recognize any LOCK and UNLCK operations found in the Calculation Specifications. Therefore, this combination (LOCK on file equation, without KLOCK or KNOLOCK in program) serves only to open the file with the dynamic locking facility enabled to allow concurrent access to a shared file.

The following figure shows how multiple programs can access a file concurrently.

Program 1 is doing updates.
Program 2 is writing.
Program 3 is reading.

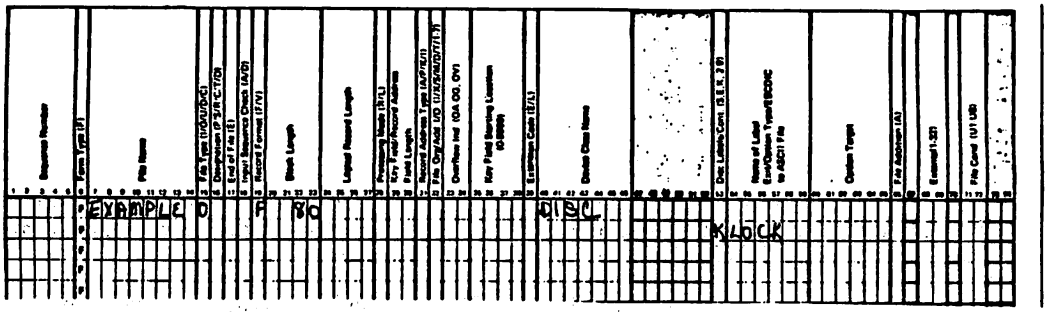
PROGRAM 1

:FILE EXAMPLE;SHR



PROGRAM 2

:FILE EXAMPLE;SHR



PROGRAM 3

:FILE EXAMPLE;LOCK

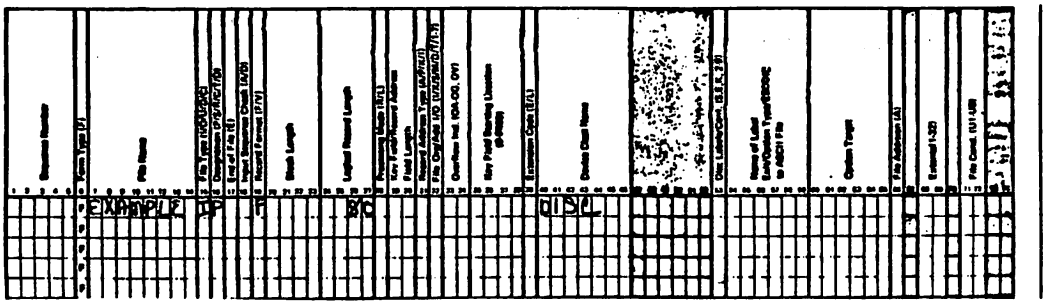


Figure 2

LOCK/UNLCK Summary for KSAM and MPE files

Type of Lock	Factor 1	Operation	Factor 2	Result Fld
KSAM file	blank	LOCK/UNLCK	filename	blank
MPE file	blank	LOCK/UNLCK	filename	blank

Figure 3

KDSNAME continuation records are used to link several access paths to a single physical file. Only the first File Description of such a DSNAME group will be used to determine whether or not the file is to be opened with dynamic locking enabled. To enable dynamic locking for a DSNAME file, then, you must specify a KLOCK or KNOLOCK continuation record for the first File Description of the DSNAME group, or include a ;LOCK option on the file equation for the first file in the group.

IMAGE

To lock Image files you specify one of the locking modes (B,S,1, 9,R, or L) on the KIMAGE continuation record. Image files can be locked at the data base, data set, or data record (item) level. You have the option of doing automatic or manual locking.

Automatic Locking

MODE B - The data base is locked for the duration of program execution.

MODE S - A specified data set is locked for the duration of program execution.

MODE 1 - The data base is locked and unlocked whenever a record is accessed from that data base.

MODE 9 - A data set is locked and unlocked whenever a record is accessed from that data set.

MODE R - A specified record is locked and unlocked whenever it is accessed.

NOTE - All of the above locking modes do UNCONDITIONAL AUTOMATIC locking.

Locking modes B and S cause a data base or data set to be locked at program initialization and remain locked for the duration of program execution. Modes 1,9, and R cause the data base, data set, or record to be locked and/or unlocked whenever a record is read, written or updated.

See FIGURE NLTXT-1 to determine how RPG automatically locks and unlocks files.

Manual Locking

MODE L - Allows the user to do manual locking and unlocking (conditional or unconditional) via the LOCK and UNLCK operations in the Calculation Specifications.

To manually lock and unlock a data base, data set, or data record you specify LOCK or UNLCK in the Operation Field, the filename in Factor 2, and Resulting Indicators. For data base locking, the data base name goes in the Result Field, and a value between 1 and 256 must be specified in the Result Field Length (1

is recommended). The entry in the Result Field Length is neccessary because the Result Field is interpreted by RPG as a field rather than a literal enclosed in quotes. Therefore, in addition to providing the data base name for the LOCK and UNLCK operator, the Result Field Name and Length define an actual RPG field. This field will appear on the compiler listing Symbol Map and Cross Reference. For data record locking a key value goes into Factor 1.

LOCK/UNLCK Summary for Image files

Type of Lock	Factor 1	Operation	Factor 2	Result Fld	Result Fld. Lth
IMAGE Data Base	blank	LOCK/UNLCK	filename	data base	1 - 256
IMAGE Data Set	blank	LOCK/UNLCK	filename	blank	blank
IMAGE Record	key value	LOCK/UNLCK	filename	blank	blank

Figure 4

If you are manually locking and unlocking KSAM, MPE, or Image files, Resulting Indicators which both define the type of locking to be done (conditional vs. unconditional) and return status information for the operation must be specified. The High indicator is optional, but one of either the Low or Equal indicators is required. The presence of the High indicator declares conditional locking whereas, its absence declares unconditional locking.

Conditional and Unconditional Locking on Image Files

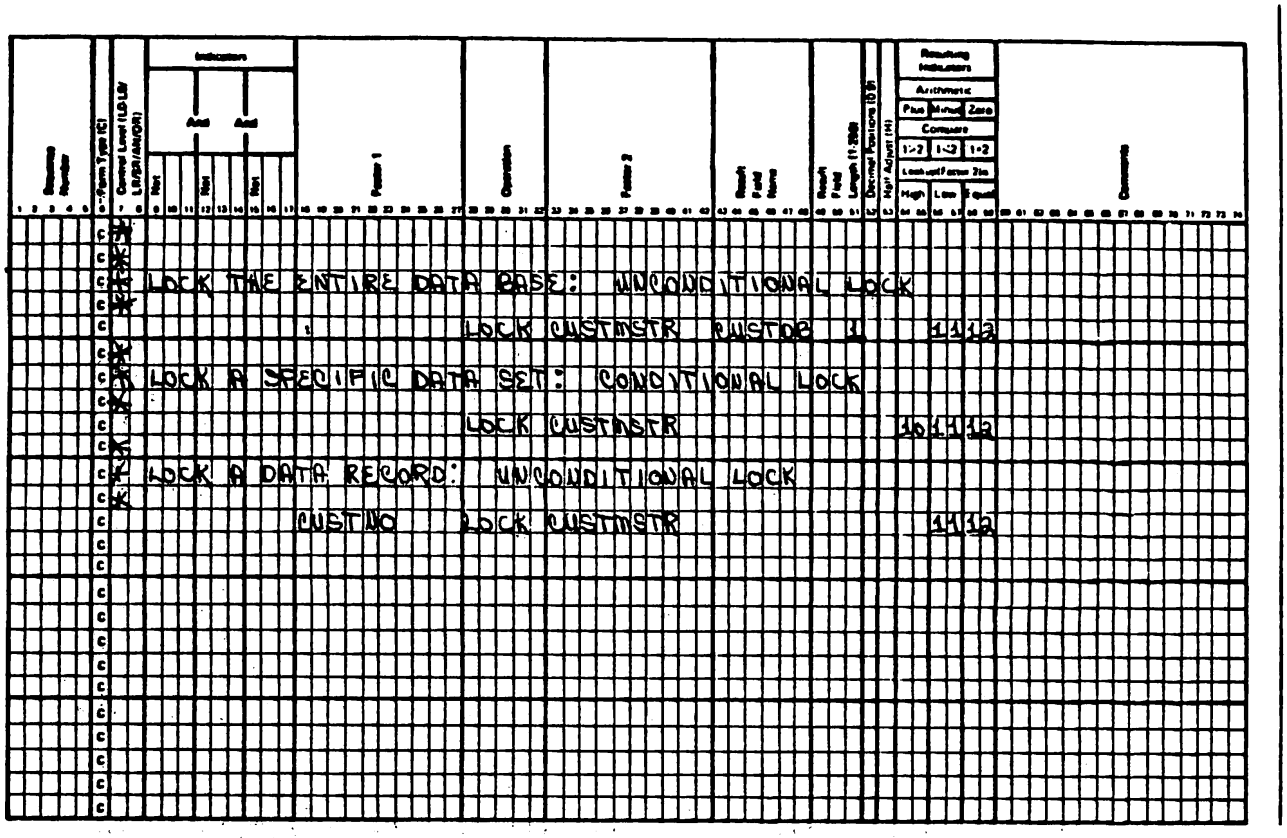


Figure 5

RPG Enhancements

Some of the recent enhancements to RPG include Forms Downloading on 2624B terminals, and Buffer Integrity Checking. Forms Downloading is enabled via a KFORMDL continuation record. You are able to download 1 to 255 forms. Buffer checking is an enhancement that allows you to ensure data integrity for KSAM and MPE files. Other enhancements to RPG are being done to make RPG/3000 more Sys/34 compatible.

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LOCK/UNLCK Resulting Indicators

	IMAGE				KSAM and MPE	
Resulting Indicator Set ON	LOCK			UNLCK	LOCK	UNLCK
	Data Base	Data Set	Record			
High (Conditional Locking only)	Status=20 →Data base locked or contains locks	Status= 20→Data base locked or contains locks 22→Data set locked by another process 23→Entries locked within set	Status= 20→Data base locked or contains locks 22→Data set locked by another process 23→Entries locked within set 24→Item conflicts with current locks 25→Entries already locked	Status > 0 →Exceptional error	Condition Code > →Locked by another process	Condition Code > →Not already locked
Low	Status < 0 →File System or memory manager failure	Status=-125 →Second lock without CAP=MR	Status=-125 →Second lock without CAP=MR	Status < 0 →File system or memory manager failure	Condition Code < →Not opened with dynamic locking facility enabled or need MR capability	Condition Code < →Not opened with dynamic locking facility enabled or need MR capability
Equal	Status=0 →Request granted	Status=0 →Request granted	Status=0 →Request granted	Status=0 →Request granted	Condition Code= →Request granted	Condition Code= →Request granted
None	Status=any value other than above	Status=any value other than above	Status=any value other than above	Can never happen – will always have one Resulting Indicator ON	Can never happen – will always have one Resulting Indicator ON	Can never happen – will always have one Resulting Indicator ON

Figure 6