



System i  
Programming  
Process-Related APIs

*Version 6 Release 1*







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**Note**

Before using this information and the product it supports, read the information in "Notices," on page 83.

This edition applies to version 6, release 1, modification 0 of IBM i5/OS (product number 5761-SS1) and to all subsequent releases and modifications until otherwise indicated in new editions. This version does not run on all reduced instruction set computer (RISC) models nor does it run on CISC models.

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# Contents

## Process-Related APIs . . . . . 1

APIs . . . . .	2
getopt()—Get Flag Letters from Argument Vector . . . . .	2
Parameters . . . . .	2
Authorities . . . . .	3
Return Value . . . . .	3
Error Conditions . . . . .	3
Example . . . . .	3
getpgrp()—Get Process Group ID . . . . .	4
Parameters . . . . .	4
Authorities . . . . .	4
Return Value . . . . .	4
Error Conditions . . . . .	4
Usage Notes . . . . .	4
Related Information . . . . .	5
Example . . . . .	5
getpid()—Get Process ID . . . . .	5
Parameters . . . . .	5
Authorities . . . . .	5
Return Value . . . . .	5
Error Conditions . . . . .	5
Usage Notes . . . . .	5
Related Information . . . . .	5
Example . . . . .	6
getppid()—Get Process ID of Parent Process . . . . .	6
Parameters . . . . .	6
Authorities . . . . .	6
Return Value . . . . .	6
Error Conditions . . . . .	6
Related Information . . . . .	6
Example . . . . .	6
getrlimit()—Get resource limit . . . . .	7
Parameters . . . . .	7
Authorities and Locks . . . . .	7
Return Value . . . . .	7
Error Conditions . . . . .	7
Related Information . . . . .	8
Example . . . . .	8
pipe()—Create an Interprocess Channel . . . . .	8
Parameters . . . . .	9
Authorities . . . . .	9
Return Value . . . . .	9
Error Conditions . . . . .	9
Usage Notes . . . . .	9
Related Information . . . . .	10
Example . . . . .	10
QlgSpawn()—Spawn Process (using NLS-enabled path name) . . . . .	11
Parameters . . . . .	11
Usage Notes . . . . .	11
Related Information . . . . .	11
Example . . . . .	12
QlgSpawnp()—Spawn Process with Path (using NLS-enabled file name) . . . . .	17
Parameters . . . . .	17
Usage Notes . . . . .	17

Related Information . . . . .	18
Example . . . . .	18
Qp0wChkChld()—Check Status for Child Processes . . . . .	18
Parameters . . . . .	18
Authorities . . . . .	19
Return Value . . . . .	20
Usage Notes . . . . .	20
Related Information . . . . .	20
Qp0wChkPgrp()—Check Status for Process Group . . . . .	20
Parameters . . . . .	21
Authorities . . . . .	22
Return Value . . . . .	22
Usage Notes . . . . .	23
Related Information . . . . .	23
Qp0wChkPid()—Check Status for Process ID . . . . .	23
Parameters . . . . .	23
Authorities . . . . .	24
Return Value . . . . .	24
Usage Notes . . . . .	25
Related Information . . . . .	25
Qp0wGetJobID()—Get Qualified Job Name and ID for Process ID . . . . .	25
Parameters . . . . .	25
Authorities . . . . .	26
Return Value . . . . .	26
Related Information . . . . .	26
Qp0wGetPgrp()—Get Process Group ID . . . . .	27
Parameters . . . . .	27
Authorities . . . . .	27
Return Value . . . . .	27
Error Conditions . . . . .	27
Usage Notes . . . . .	27
Related Information . . . . .	27
Qp0wGetPid()—Get Process ID . . . . .	27
Parameters . . . . .	28
Authorities . . . . .	28
Return Value . . . . .	28
Error Conditions . . . . .	28
Usage Notes . . . . .	28
Related Information . . . . .	28
Qp0wGetPidNolnit()—Get Process ID without Initializing for Signals . . . . .	28
Parameters . . . . .	29
Authorities . . . . .	29
Return Value . . . . .	29
Error Conditions . . . . .	29
Usage Notes . . . . .	29
Related Information . . . . .	29
Qp0wGetPPid()—Get Process ID of Parent Process . . . . .	29
Parameters . . . . .	29
Authorities . . . . .	30
Return Value . . . . .	30
Error Conditions . . . . .	30
Usage Notes . . . . .	30
Related Information . . . . .	30

Qp0zPipe()—Create Interprocess Channel with Sockets . . . . .	30	Return Value . . . . .	51
Parameters . . . . .	30	Error Conditions. . . . .	52
Authorities . . . . .	30	Usage Notes . . . . .	54
Return Value . . . . .	31	Attributes Inherited. . . . .	59
Error Conditions. . . . .	31	Related Information . . . . .	60
Usage Notes . . . . .	31	Example . . . . .	60
Related Information . . . . .	31	ulimit()—Get and set process limits . . . . .	60
Qp0zSystem()—Run a CL Command . . . . .	32	Parameters . . . . .	61
Parameters . . . . .	32	Authorities and Locks . . . . .	61
Authorities . . . . .	32	Return Value . . . . .	61
Return Value . . . . .	32	Error Conditions. . . . .	61
Related Information . . . . .	32	Related Information . . . . .	62
Example . . . . .	32	Example . . . . .	62
Output. . . . .	33	wait()—Wait for Child Process to End . . . . .	62
setpgid()—Set Process Group ID for Job Control . . . . .	33	Parameters . . . . .	63
Parameters . . . . .	33	Authorities . . . . .	63
Authorities . . . . .	33	Return Value . . . . .	64
Return Value . . . . .	33	Error Conditions. . . . .	64
Error Conditions. . . . .	34	<b>Usage Notes</b> . . . . .	64
Usage Notes . . . . .	34	Related Information . . . . .	64
Related Information . . . . .	34	Example . . . . .	65
setrlimit()—Set resource limit . . . . .	34	waitpid()—Wait for Specific Child Process . . . . .	65
Parameters . . . . .	35	<b>Parameters</b> . . . . .	65
Authorities and Locks . . . . .	35	Authorities . . . . .	66
Return Value . . . . .	35	Return Value . . . . .	66
Error Conditions. . . . .	35	Error Conditions. . . . .	66
Related Information . . . . .	36	<b>Usage Notes</b> . . . . .	67
Example . . . . .	36	Related Information . . . . .	67
spawn()—Spawn Process . . . . .	37	Example . . . . .	68
Parameters . . . . .	37	Concepts . . . . .	68
Authorities . . . . .	39	About Shell Scripts . . . . .	68
Return Value . . . . .	39	Header Files for UNIX-Type Functions . . . . .	70
Error Conditions. . . . .	40	Errno Values for UNIX-Type Functions . . . . .	72
Usage Notes . . . . .	42	Code license and disclaimer information. . . . .	81
Attributes Inherited. . . . .	47		
Related Information . . . . .	48	<b>Appendix. Notices . . . . .</b>	<b>83</b>
Example . . . . .	48	Programming interface information . . . . .	84
spawnp()—Spawn Process with Path . . . . .	48	Trademarks . . . . .	85
Parameters . . . . .	49	Terms and conditions . . . . .	86
Authorities . . . . .	51		

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## Process-Related APIs

The process-related APIs perform process-related or other general operations. These APIs are C language functions that can be used in ILE C programs.

The process-related APIs are:

- “getopt()—Get Flag Letters from Argument Vector” on page 2 (Get flag letters from argument vector) returns the next flag letter in the argv list that matches a letter in optionstring.
- “getpgrp()—Get Process Group ID” on page 4 (Get process group ID) returns the process group ID of the calling process.
- “getpid()—Get Process ID” on page 5 (Get process ID) returns the process ID of the calling process.
- “getppid()—Get Process ID of Parent Process” on page 6 (Get process ID of parent process) returns the parent process ID of the calling process.
- “getrlimit()—Get resource limit” on page 7 (Get resource limit) returns the resource limit for the specified *resource*.
- “pipe()—Create an Interprocess Channel” on page 8 (Create interprocess channel) creates a data pipe and places two file descriptors, one each into the arguments *fdes[0]* and *fdes[1]*, that refer to the open file descriptions for the read and write ends of the pipe, respectively.
- “QlgSpawn()—Spawn Process (using NLS-enabled path name)” on page 11 (Spawn process (using NLS-enabled path name)) creates a child process that inherits specific attributes from the parent.
- “QlgSpawnp()—Spawn Process with Path (using NLS-enabled file name)” on page 17 (Spawn process with path (using NLS-enabled file name)) creates a child process that inherits specific attributes from the parent.
- “Qp0wChkChld()—Check Status for Child Processes” on page 18 (Check status for child processes) returns the status and process table entry information for the child processes of the specified process ID.
- “Qp0wChkPgrp()—Check Status for Process Group” on page 20 (Check status for process group) returns the status and process table entry information for the processes that are members of the process group identified by *pid* in the structure *QP0W\_PID\_Entry\_T*.
- “Qp0wChkPid()—Check Status for Process ID” on page 23 (Check status for process ID) returns the status and process table entry information for the process specified by the process ID *pid*.
- “Qp0wGetJobID()—Get Qualified Job Name and ID for Process ID” on page 25 (Get qualified job name and ID for process ID) returns the qualified job name and internal job identifier for the process whose process ID matches *pid*.
- “Qp0wGetPgrp()—Get Process Group ID” on page 27 (Get process group ID) returns the process group ID of the calling process.
- “Qp0wGetPid()—Get Process ID” on page 27 (Get process ID) returns the process ID of the calling process.
- “Qp0wGetPidNoInit()—Get Process ID without Initializing for Signals” on page 28 (Get process ID without initializing for signals) returns the process ID of the calling process without enabling the process to receive signals.
- “Qp0wGetPPid()—Get Process ID of Parent Process” on page 29 (Get process ID of parent process) returns the parent process ID of the calling process.
- “Qp0zPipe()—Create Interprocess Channel with Sockets” on page 30 (Create interprocess channel with sockets) creates a data pipe that can be used by two processes.
- “Qp0zSystem()—Run a CL Command” on page 32 (Run a CL command) spawns a new process, passes *CLcommand* to the CL command processor in the new process, and waits for the command to complete.

- “setpgid()—Set Process Group ID for Job Control” on page 33 (Set process group ID for job control) is used to either join an existing process group or create a new process group within the session of the calling process.
- “setrlimit()—Set resource limit” on page 34 (Set resource limit) sets the resource limit for the specified *resource*.
- “spawn()—Spawn Process” on page 37 (Spawn process) creates a child process that inherits specific attributes from the parent.
- “spawnp()—Spawn Process with Path” on page 48 (Spawn process with path) creates a child process that inherits specific attributes from the parent.
- “ulimit()—Get and set process limits” on page 60 (Get and set process limits) provides a way to get and set process resource limits.
- “wait()—Wait for Child Process to End” on page 62 (Wait for child process to end) suspends processing until a child process has ended.
- “waitpid()—Wait for Specific Child Process” on page 65 (Wait for specific child process) allows the calling thread to obtain status information for one of its child processes.

For additional information, see “About Shell Scripts” on page 68.

Top | UNIX-Type APIs | APIs by category

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## APIs

These are the APIs for this category.

---

### getopt()—Get Flag Letters from Argument Vector

Syntax

```
#include <unistd.h>

int getopt(int argc, char * const argv[],
           const char *optionstring);
```

Service Program Name: QP0ZCPA

Default Public Authority: \*USE

Threadsafe: No

The **getopt()** function returns the next flag letter in the *argv* list that matches a letter in *optionstring*. The *optarg* external variable is set to point to the start of the flag’s parameter on return from **getopt()**

**getopt()** places the *argv* index of the next argument to be processed in *optind*. The *optind* variable is external. It is initialized to 1 before the first call to **getopt()**.

**getopt()** can be used to help a program interpret command line flags that are passed to it.

### Parameters

*argc* (Input) The number of parameters passed by the function.

*argv* (Input) The list of parameters passed to the function.

*optionstring*

(Input) A string of flag letters. The string must contain the flag letters that the program using **getopt()** recognizes. If a letter is followed by a colon, the flag is expected to have an argument or group of arguments, which can be separated from it by blank spaces.

The special flag “—” (two hyphens) can be used to delimit the end of the options. When this flag is encountered, the “—” is skipped and EOF is returned. This flag is useful in delimiting arguments beginning with a hyphen that are not options.

## Authorities

None.

## Return Value

EOF `getopt()` processed all flags (that is, up to the first argument that is not a flag).  
'?' `getopt()` encountered a flag letter that was not included in *optionstring*. The variable *optopt* is set to the real option found in *argv* regardless of whether the flag is in *optionstring* or not. An error message is printed to *stderr*. The generation of error messages can be suppressed by setting *opterr* to 0.

## Error Conditions

The `getopt()` function does not return an error.

## Example

The following example processes the flags for a command that can take the mutually exclusive flags a and b, and the flags f and o, both of which require parameters.

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

```
#include <unistd.h>

int main( int argc, char *argv[] )
{
    int c;
    extern int optind;
    extern char *optarg;
    .
    .
    .
    while ((c = getopt(argc, argv, "abf:o:")) != EOF)
    {
        switch (c)
        {
            case 'a':
                if (bflg)
                    errflg++;
                else
                    aflg++;
                break;
            case 'b':
                if (aflg)
                    errflg++;
                else
                    bflg++;
                break;
            case 'f':
                ifile = optarg;
                break;
            case 'o':
                ofile = optarg;
                break;
            case '?':
                errflg++;
        } /* case */
    }
}
```

```

if (errflg)
{
    fprintf(stderr, "usage: . . . ");
    exit(2);
}
} /* while */
for ( ; optind < argc; optind++)
{
    if (access(argv[optind], R_OK))
    {
        .
        .
    }
} /* for */
} /* main */

```

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## getpgrp()—Get Process Group ID

Syntax

```

#include <sys/types.h>
#include <unistd.h>

```

```
pid_t getpgrp(void);
```

Service Program Name: QP0WSRV1  
 Default Public Authority: \*USE  
 Threadsafe: Yes

The `getpgrp()` function returns the process group ID of the calling process.

### Parameters

None.

### Authorities

None.

### Return Value

*pid\_t*      The value returned by `getpgrp()` is the process group ID of the calling process.

### Error Conditions

The `getpgrp()` function is always successful and does not return an error.

### Usage Notes

The `getpgrp()` function enables a process for signals if the process is not already enabled for signals. For details, see `Qp0sEnableSignals()`—Enable Process for Signals.

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<unistd.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “Qp0wGetPgrp()—Get Process Group ID” on page 27—Get Process Group ID

## Example

For an example of using this function, see the child program in Example: Using process-related APIs.

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## getpid()—Get Process ID

Syntax

```
#include <sys/types.h>
#include <unistd.h>
```

```
pid_t getpid(void);
```

Service Program Name: QP0WSRV1  
Default Public Authority: \*USE  
Threadsafe: Yes

The `getpid()` function returns the process ID of the calling process.

## Parameters

None.

## Authorities

None.

## Return Value

*pid\_t*      The value returned by `getpid()` is the process ID of the calling process.

## Error Conditions

The `getpid()` function is always successful and does not return an error.

## Usage Notes

The `getpid()` function enables a process for signals if the process is not already enabled for signals. For details, see `Qp0sEnableSignals()`—Enable Process for Signals.

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<unistd.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- `Qp0sDisableSignals()`—Disable Process for Signals
- `Qp0sEnableSignals()`—Enable Process for Signals
- “Qp0wGetPid()—Get Process ID” on page 27—Get Process ID

- “Qp0wGetPidNoInit()—Get Process ID without Initializing for Signals” on page 28—Get Process ID without Initializing for Signals

## Example

For an example of using this function, see the child program in Example: Using process-related APIs.

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## getppid()—Get Process ID of Parent Process

Syntax

```
#include <sys/types.h>
#include <unistd.h>
```

```
pid_t getppid(void);
```

Service Program Name: QP0WSRV1

Default Public Authority: \*USE

Threadsafe: Yes

The `getppid()` function returns the parent process ID of the calling process.

## Parameters

None.

## Authorities

None..

## Return Value

*pid\_t* The value returned by `getppid()` is the process ID of the parent process for the calling process. A process ID value of 1 indicates that there is no parent process associated with the calling process.

## Error Conditions

The `getppid()` function is always successful and does not return an error.

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<unistd.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “Qp0wGetPPid()—Get Process ID of Parent Process” on page 29—Get Process ID of Parent Process

## Example

For an example of using this function, see the child program in Example: Using process-related APIs.

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## getrlimit()—Get resource limit

Syntax

```
#include <sys/resource.h>
```

```
int getrlimit(int resource, struct rlimit *rlp);
```

Service Program Name: QP0WSRV1

Default Public Authority: \*USE

Threadsafe: Yes

The **getrlimit()** function returns the resource limit for the specified *resource*. A resource limit is a way for the operating system to enforce a limit on a variety of resources used by a process. A resource limit is represented by a *rlimit* structure. The *rlim\_cur* member specifies the current or soft limit and the *rlim\_max* member specifies the maximum or hard limit.

The **getrlimit()** function supports the following resources:

<i>RLIMIT_FSIZE</i> (0)	The maximum size of a file in bytes that can be created by a process.
<i>RLIMIT_NOFILE</i> (1)	The maximum number of file descriptors that can be opened by a process.
<i>RLIMIT_CORE</i> (2)	The maximum size of a core file in bytes that can be created by a process.
<i>RLIMIT_CPU</i> (3)	The maximum amount of CPU time in seconds that can be used by a process.
<i>RLIMIT_DATA</i> (4)	The maximum size of a process' data segment in bytes.
<i>RLIMIT_STACK</i> (5)	The maximum size of a process' stack in bytes.
<i>RLIMIT_AS</i> (6)	The maximum size of a process' total available storage in bytes.

The value of *RLIM\_INFINITY* is considered to be larger than any other limit value. If the value of the limit is *RLIM\_INFINITY*, then a limit is not enforced for that resource. The **getrlimit()** function always returns *RLIM\_INFINITY* for the following resources: *RLIMIT\_AS*, *RLIMIT\_CORE*, *RLIMIT\_CPU*, *RLIMIT\_DATA*, and *RLIMIT\_STACK*.

### Parameters

*resource*

(Input)

The resource to get the limits for.

*\*rlp* (Output)

Pointer to a *struct rlim\_t* where the values of the hard and soft limits are returned.

### Authorities and Locks

None.

### Return Value

0 **getrlimit()** was successful.

-1 **getrlimit()** was not successful. The *errno* variable is set to indicate the error.

### Error Conditions

If **getrlimit()** is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

[EFAULT]

The address used for an argument is not correct.

In attempting to use an argument in a call, the system detected an address that is not valid.

While attempting to access a parameter passed to this function, the system detected an address that is not valid.

[EINVAL]

An invalid parameter was found.

An invalid *resource* was specified.

## Related Information

- The `<sys/resource.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`setrlimit()`—Set resource limit” on page 34—Set resource limit
- “`ulimit()`—Get and set process limits” on page 60—Get and set process limits

## Example

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

```
#include <sys/resource.h>
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>

int main (int argc, char *argv[])
{
    struct rlimit limit;

    /* Set the file size resource limit. */
    limit.rlim_cur = 65535;
    limit.rlim_max = 65535;
    if (setrlimit(RLIMIT_FSIZE, &limit) != 0) {
        printf("setrlimit() failed with errno=%d\n", errno);
        exit(1);
    }

    /* Get the file size resource limit. */
    if (getrlimit(RLIMIT_FSIZE, &limit) != 0) {
        printf("getrlimit() failed with errno=%d\n", errno);
        exit(1);
    }

    printf("The soft limit is %llu\n", limit.rlim_cur);
    printf("The hard limit is %llu\n", limit.rlim_max);
    exit(0);
}
```

### Example Output:

```
The soft limit is 65535
The hard limit is 65535
```

API introduced: V5R2

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## pipe()—Create an Interprocess Channel

Syntax

```
#include <unistd.h>
```

```
int pipe(int fildes[2]);
```

Service Program Name: QP0LLIB1

Default Public Authority: \*USE

Threadsafe: Yes

The **pipe()** function creates a data pipe and places two file descriptors, one each into the arguments *fildes[0]* and *fildes[1]*, that refer to the open file descriptions for the read and write ends of the pipe, respectively. Their integer values will be the two lowest available at the time of the **pipe()** call. The `O_NONBLOCK` and `FD_CLOEXEC` flags will be clear on both descriptors. NOTE: these flags can, however, be set by the **fcntl()** function.

Data can be written to the file descriptor *fildes[1]* and read from file descriptor *fildes[0]*. A read on the file descriptor *fildes[0]* will access data written to the file descriptor *fildes[1]* on a first-in-first-out basis. File descriptor *fildes[0]* is open for reading only. File descriptor *fildes[1]* is open for writing only.

The **pipe()** function is often used with the **spawn()** function to allow the parent and child processes to send data to each other.

Upon successful completion, **pipe()** will update the access time, change time, and modification time of the pipe.

## Parameters

*fildes[2]*

(Output) An integer array of size 2 that will receive the pipe descriptors.

## Authorities

None.

## Return Value

0 **pipe()** was successful.

-1 **pipe()** was not successful. The *errno* variable is set to indicate the error.

## Error Conditions

If **pipe()** is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

Error condition	Additional information
[EFAULT (page 74)]	
[EMFILE (page 76)]	
[ENFILE (page 76)]	
[ENOMEM (page 76)]	
[EUNKNOWN (page 77)]	

## Usage Notes

1. If this function is called by a thread executing one of the scan-related exit programs (or any of its created threads), the descriptors that are returned are scan descriptors. See Integrated File System Scan on Open Exit Programs and Integrated File System Scan on Close Exit Programs for more information. If a process is spawned, these scan descriptors are not inherited by the spawned process

and therefore cannot be used in that spawned process. Therefore, in this case, the descriptors returned by `pipe()` function will only work within the same process.

## Related Information

- The `<unistd.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<fcntl.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- `fcntl()`—Perform File Control Command
- `fstat()`—Get File Information by Descriptor
- “`Qp0zPipe()`—Create Interprocess Channel with Sockets” on page 30—Create Interprocess Channel with Sockets
- `read()`—Read from Descriptor
- “`spawn()`—Spawn Process” on page 37—Spawn Process
- `write()`—Write to Descriptor

## Example

The following example creates a pipe, writes 10 bytes of data to the pipe, and then reads those 10 bytes of data from the pipe.

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

```
#include <stdio.h>
#include <unistd.h>
#include <string.h>

void main()
{
    int fildes[2];
    int rc;
    char writeData[10];
    char readData[10];
    int bytesWritten;
    int bytesRead;

    memset(writeData, 'A', 10);

    if (-1 == pipe(fildes))
    {
        perror("pipe error");
        return;
    }

    if (-1 == (bytesWritten = write(fildes[1],
                                   writeData,
                                   10)))
    {
        perror("write error");
    }
    else
    {
        printf("wrote %d bytes\n", bytesWritten);

        if (-1 == (bytesRead = read(fildes[0],
                                   readData,
                                   10)))
        {
            perror("read error");
        }
        else
        {
```

```

        printf("read %d bytes\n",bytesRead);
    }
}

close(filides[0]);
close(filides[1]);

return;
}

```

API introduced: V5R1

Top | UNIX-Type APIs | APIs by category

---

## QlgSpawn()—Spawn Process (using NLS-enabled path name)

### Syntax

```

#include <spawn.h>
#include <qlg.h>

pid_t QlgSpawn(const Qlg_Path_Name_T    *path,
               const int                 fd_count,
               const int                 fd_map[],
               const struct inheritance *inherit,
               char * const               argv[],
               char * const               envp[]);

```

Service Program Name: QP0ZSPWN

Default Public Authority: \*USE

Threadsafe: Conditional; see “Usage Notes.”

The **QlgSpawn()** function, like the **spawn()** function, creates a child process that inherits specific attributes from the parent. The difference is that for the *path* parameter, the **QlgSpawn()** function takes a pointer to a `Qlg_Path_Name_T` structure, while the **spawn()** function takes a pointer to a character string in the CCSID of the job.

Limited information about the *path* parameter is provided here. For more information about the *path* parameter and for a discussion of other parameters, authorities required, and return values, see “**spawn()—Spawn Process**” on page 37—Spawn Process.

## Parameters

**path** (Input) A pointer to a `Qlg_Path_Name_T` structure that contains a specific path name or a pointer to a specific path name of an executable file that will run in the new (child) process. For more information about the `Qlg_Path_Name_T` structure, see Path name format.

## Usage Notes

See “**spawn()—Spawn Process**” on page 37—Spawn Process for a complete discussion of usage information for **QlgSpawn()**. In addition, the following should be noted specifically for **QlgSpawn()**.

1. Shell scripts are supported; however, the interpreter path in the shell script itself cannot be a `Qlg_Path_Name_T` structure.

## Related Information

- The `<qlg.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “**spawn()—Spawn Process**” on page 37—Spawn Process

- “QlgSpawn()—Spawn Process with Path (using NLS-enabled file name)” on page 17—Spawn Process with Path (using NLS-enabled file name)

## Example

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

### Parent Program

The following ILE C for i5/OS<sup>®</sup> program can be created in any library. This parent program assumes the corresponding child program will be created with the name CHILD in the library QGPL. Call this parent program with no parameters to run the example.

```

/*****
/*****
/*
/* FUNCTION: This program acts as a parent to a child program. */
/*
/*
/* LANGUAGE: ILE C for i5/OS
/*
/*
/* APIs USED: QlgSpawn(), waitpid(),
/*           QlgCreat(), QlgUnlink(), QlgOpen()
/*
/*
/*****
/*****
#include <errno.h>
#include <fcntl.h>
#include <spawn.h>
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <sys/stat.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <unistd.h>
#include <qlg.h>
#include <Qp01stdi.h>

#define ARGV_NUM 6
#define ENVP_NUM 1
#define CHILD_PGM "QGPL/CHILD"
#define spwpath "/QSYS.LIB/QGPL.LIB/CHILD.PGM"
#define fpath "A_File"

typedef struct pnstruct
{
    Qlg_Path_Name_T qlg_struct;
    char pn[100]; /* This size must be >= the path */
                /* name length or this must be a */
                /* pointer to the path name. */
};

/* This is a parent program that will use QlgSpawn() to start a
/* child. A file is created that is written to, both by the parent
/* and the child. The end result of the file will look something
/* like the following:
/* Parent writes Child writes
/* -----
/* 1 argv[0] getppid() getpgrp() getpid()
/* The parent uses waitpid() to wait for the child to return and to
/* retrieve the resulting status of the child when it does return.
*/

int main(int argc, char *argv[])
{
    int rc; /* API return code */

```

```

int    fd, fd_read;          /* parent file descriptors */
char   fd_str[4];           /* file descriptor string */
const char US_const[3]= "US";
const char Language_const[4]="ENU";
const char Path_Name_Del_const[2]= "/";
struct pnstruct f_path_name; /* file pathname */
int    buf_int;             /* write(), read() buffer */
char   buf_pgm_name[22];    /* read() program name buffer */
struct pnstruct spw_path;   /* QlgSpawn() *path */
int    spw_fd_count = 0;    /* QlgSpawn() fd_count */
struct inheritance spw_inherit; /* QlgSpawn() *inherit */
char   *spw_argv[ARGV_NUM]; /* QlgSpawn() *argv[] */
char   *spw_envp[ENVP_NUM]; /* QlgSpawn() *envp[] */
int    seq_num;             /* sequence number */
char   seq_num_str[4];     /* sequence number string */
pid_t  pid;                 /* parent pid */
char   pid_str[11];        /* parent pid string */
pid_t  pgrp;                /* parent process group */
char   pgrp_str[11];       /* parent process group string */
pid_t  spw_child_pid;      /* QlgSpawn() child pid */
pid_t  wt_child_pid;       /* waitpid() child pid */
int    wt_stat_loc;        /* waitpid() *stat_loc */
int    wt_pid_opt = 0;     /* waitpid() option */

/* Get the pid and pgrp for the parent. */
pid = getpid();
pgrp = getpgrp();
/* Format the pid and pgrp value into null-terminated strings. */
sprintf(pid_str, "%d", pid);
sprintf(pgrp_str, "%d", pgrp);

/* Initialize Qlg_Path_Name_T parameters */
memset(&f_path_name,0x00,sizeof(struct pnstruct));
f_path_name.qlg_struct.CCSID = 37;
memcpy(f_path_name.qlg_struct.Country_ID,US_const,2);
memcpy(f_path_name.qlg_struct.Language_ID,Language_const,3);
f_path_name.qlg_struct.Path_Type = QLG_CHAR_SINGLE;
f_path_name.qlg_struct.Path_Length = sizeof(fpath)-1;
memcpy(f_path_name.qlg_struct.Path_Name_Delimiter,
       Path_Name_Del_const,1);
memcpy(f_path_name.pn,fpath,sizeof(fpath)-1);

/* Create a file and maintain the file descriptor. */
fd = QlgCreat((Qlg_Path_Name_T *)&f_path_name, S_IRWXU);
if (fd == -1)
{
    printf("FAILURE: QlgCreat() with errno = %d\n",errno);
    return -1;
}
/* Format the file descriptor into null-terminated string. */
sprintf(fd_str, "%d", fd);

/* Initialize Qlg_Path_Name_T parameters */
memset(&spw_path,0x00,sizeof(struct pnstruct));
spw_path.qlg_struct.CCSID = 37;
memcpy(spw_path.qlg_struct.Country_ID,US_const,2);
memcpy(spw_path.qlg_struct.Language_ID,Language_const,3);
spw_path.qlg_struct.Path_Type = QLG_CHAR_SINGLE;
spw_path.qlg_struct.Path_Length = sizeof(spwpath)-1;
memcpy(spw_path.qlg_struct.Path_Name_Delimiter,
       Path_Name_Del_const,1);
memcpy(spw_path.pn,spwpath,sizeof(spwpath)-1);

/* Write a '1' out to the file. */
seq_num = 1;
sprintf(seq_num_str, "%d", seq_num);
buf_int = seq_num;

```

```

write(fd, &buf_int, sizeof(int));

/* Set the QlgSpawn() child arguments for the child. */
/* NOTE: The child will always get argv[0] in the */
/* LIBRARY/PROGRAM notation, but the QlgSpawn() argv[0] */
/* (spw_argv[0] in this case) must be non-NULL in order */
/* to allow additional arguments. For this example, the */
/* CHILD_PGM was chosen. */
/* NOTE: The parent pid and the parent process group are */
/* passed to the child for demonstration purposes only. */
spw_argv[0] = CHILD_PGM;
spw_argv[1] = pid_str;
spw_argv[2] = pgrp_str;
spw_argv[3] = seq_num_str;
spw_argv[4] = fd_str;
spw_argv[5] = NULL;

/* This QlgSpawn() will use simple inheritance for file */
/* descriptors (fd_map[] value is NULL). */
memset(&spw_inherit,0x00,sizeof(spw_inherit));
spw_envp[0] = NULL;
spw_child_pid = QlgSpawn((Qlg_Path_Name_T *)&spw_path,
                        spw_fd_count, NULL, &spw_inherit, spw_argv, spw_envp);
if (spw_child_pid == -1)
{
    printf("FAILURE: QlgSpawn() with errno = %d\n",errno);
    close(fd);
    QlgUnlink((Qlg_Path_Name_T *)&f_path_name);
    return -1;
}

/* The parent no longer needs to use the file descriptor, so */
/* it can close it, now that it has issued QlgSpawn(). */
rc = close(fd);
if (rc != 0)
    printf("FAILURE: close(fd) with errno = %d\n",errno);

/* NOTE: The parent can continue processing while the child is */
/* also processing. In this example, though, the parent will */
/* simply wait until the child finishes processing. */
/* Issue waitpid() in order to wait for the child to return. */
wt_child_pid = waitpid(spw_child_pid,&wt_stat_loc,wt_pid_opt);
if (wt_child_pid == -1)
{
    printf("FAILURE: waitpid() with errno = %d\n",errno);
    close(fd);
    QlgUnlink((Qlg_Path_Name_T *)&f_path_name);
    return -1;
}

/* Check to ensure the child did not encounter an error */
/* condition. */
if (WIFEXITED(wt_stat_loc))
{
    if (WEXITSTATUS(wt_stat_loc) != 1)
        printf("FAILURE: waitpid() exit status = %d\n",
              WEXITSTATUS(wt_stat_loc));
}
else
    printf("FAILURE: unknown child status\n");

/* Open the file for read to verify what the child wrote. */
fd_read = QlgOpen((Qlg_Path_Name_T *)&f_path_name, O_RDONLY);
if (fd_read == -1)
{
    printf("FAILURE: open() for read with errno = %d\n",errno);
    QlgUnlink((Qlg_Path_Name_T *)&f_path_name);
}

```

```

        return -1;
    }

    /* Verify what child wrote. */
    rc = read(fd_read, &buf_int, sizeof(int));
    if ( (rc != sizeof(int)) || (buf_int != 1) )
        printf("FAILURE: read()\n");
    memset(buf_pgm_name,0x00,sizeof(buf_pgm_name));
    rc = read(fd_read, buf_pgm_name, strlen(CHILD_PGM));
    if ( (rc != strlen(CHILD_PGM)) ||
        (strcmp(buf_pgm_name,CHILD_PGM) != 0) )
        printf("FAILURE: read() child argv[0]\n");
    rc = read(fd_read, &buf_int, sizeof(int));
    if ( (rc != sizeof(int)) || (buf_int != pid) )
        printf("FAILURE: read() child getpid()\n");
    rc = read(fd_read, &buf_int, sizeof(int));
    if ( (rc != sizeof(int)) || (buf_int != pgrp) )
        printf("FAILURE: read() child getpgrp()\n");
    rc = read(fd_read, &buf_int, sizeof(int));
    if ( (rc != sizeof(int)) || (buf_int != spw_child_pid) ||
        (buf_int != wt_child_pid) )
        printf("FAILURE: read() child getpid()\n");

    /* Attempt one more read() to ensure there is no more data. */
    rc = read(fd_read, &buf_int, sizeof(int));
    if (rc != 0)
        printf("FAILURE: read() past end of data\n");

    /* The parent no longer needs to use the read() file descriptor, */
    /* so it can close it. */
    rc = close(fd_read);
    if (rc != 0)
        printf("FAILURE: close(fd_read) with errno = %d\n",errno);

    /* Clean up by performing unlink(). */
    rc = QlgUnlink((Qlg_Path_Name_T *)&f_path_name);
    if (rc != 0)
    {
        printf("FAILURE: QlgUnlink() with errno = %d\n",errno);
        return -1;
    }
    printf("completed successfully\n");
    return 0;
}

```

## Child Program

The following ILE C for i5/OS program must be created with the name CHILD in the library QGPL in order to be found by the parent program. This program is not to be called directly, as it is run through the use of QlgSpawn() in the parent program.

```

/*****
/*****
/*
/* FUNCTION: This program acts as a child to a parent program.
/*
/*
/* LANGUAGE: ILE C for i5/OS
/*
/*
/* APIs USED: getpid(), getpid(), getpgrp()
/*
/*
/*****
/*****
#include <stdlib.h>
#include <string.h>

```

```

#include <sys/types.h>
#include <unistd.h>

/* This is a child program that gets control from a parent program */
/* that issues QlgSpawn(). This particular child program expects */
/* the following 5 arguments (all are null-terminated strings): */
/* argv[0] - child program name */
/* argv[1] - parent pid (for demonstration only) */
/* argv[2] - parent process group (for demonstration only) */
/* argv[3] - sequence number */
/* argv[4] - parent file descriptor */
/* If the child program encounters an error, it returns with a */
/* value greater than 50. If the parent uses wait() or waitpid(), */
/* this return value can be interrogated using the WIFEXITED and */
/* WEXITSTATUS macros on the resulting wait() or waitpid() */
/* *stat_loc field. */

int main(int argc, char *argv[])
{
    pid_t p_pid;           /* parent pid argv[1] */
    pid_t p_pgrp;         /* parent process group argv[2] */
    int seq_num;          /* parent sequence num argv[3] */
    int fd;                /* parent file desc argv[4] */
    int rc;                /* API return code */
    pid_t pid;            /* getpid() - child pid */
    pid_t ppid;           /* getppid() - parent pid */
    pid_t pgrp;           /* getpgrp() - process group */

    /* Get the pid, ppid, and pgrp for the child. */
    pid = getpid();
    ppid = getppid();
    pgrp = getpgrp();

    /* Verify 5 parameters were passed to the child. */
    if (argc != 5)
        return 60;

    /* Since the parameters passed to the child using QlgSpawn() are */
    /* pointers to strings, convert the parent pid, parent process */
    /* group, sequence number, and the file descriptor from strings */
    /* to integers. */
    p_pid = atoi(argv[1]);
    p_pgrp = atoi(argv[2]);
    seq_num = atoi(argv[3]);
    fd = atoi(argv[4]);

    /* Verify the getpid() value of the parent is the same as the */
    /* getppid() value of the child. */
    if (p_pid != ppid)
        return 61;

    /* If the sequence number is 1, simple inheritance was used in */
    /* this case. First, verify the getpgrp() value of the parent */
    /* is the same as the getpgrp() value of the child. Next, the */
    /* child will use the file descriptor passed in to write the */
    /* child's values for argv[0], getppid(), getpgrp(), */
    /* and getpid(). Finally, the child returns, which will satisfy */
    /* the parent's wait() or waitpid(). */
    if (seq_num == 1)
    {
        if (p_pgrp != pgrp)
            return 70;
        rc = write(fd, argv[0], strlen(argv[0]));
        if (rc != strlen(argv[0]))
            return 71;
        rc = write(fd, &ppid, sizeof(pid_t));
        if (rc != sizeof(pid_t))

```

```

        return 72;
    rc = write(fd, &pgrp, sizeof(pid_t));
    if (rc != sizeof(pid_t))
        return 73;
    rc = write(fd, &pid, sizeof(pid_t));
    if (rc != sizeof(pid_t))
        return 74;
    return seq_num;
}

/* If the sequence number is an unexpected value, return */
/* indicating an error. */
else
    return 99;
}

```

API introduced: V5R1

Top | “Process-Related APIs,” on page 1 | APIs by category

---

## QlgSpawnp()—Spawn Process with Path (using NLS-enabled file name)

### Syntax

```

#include <spawn.h>
#include <qlg.h>

pid_t QlgSpawnp(const Qlg_Path_Name_T    *file,
                const int                 fd_count,
                const int                 fd_map[],
                const struct inheritance *inherit,
                char * const               argv[],
                char * const               envp[]);

```

Service Program Name: QP0ZSPWN

Default Public Authority: \*USE

Threadsafe: Conditional; see “Usage Notes.”

The **QlgSpawnp()** function, like the **spawnp()** function, creates a child process that inherits specific attributes from the parent. The difference is that for the *file* parameter, the **QlgSpawnp()** function takes a pointer to a `Qlg_Path_Name_T` structure, while the **spawnp()** function takes a pointer to a character string in the ccsid of the job.

Limited information about the *file* parameter is provided here. For more information about the *file* parameter and for a discussion of other parameters, authorities required, and return values, see “**spawnp()—Spawn Process with Path**” on page 48.

## Parameters

**file** (Input) A pointer to a `Qlg_Path_Name_T` structure that contains a file name or a pointer to a file name that is used with the search path to find an executable file that will run in the new (child) process. For more information on the `Qlg_Path_Name_T` structure, see Path name format.

## Usage Notes

See “**spawnp()—Spawn Process with Path**” on page 48—Spawn Process with Path for a complete discussion of usage information for **QlgSpawnp()**. In addition, the following should be noted specifically for **QlgSpawnp()**.

1. The PATH environment variable is used; however, the PATH environment variable cannot be a `Qlg_Path_Name_T` structure.

2. Shell scripts are supported; however, the interpreter path in the shell script itself cannot be a `Qlg_Path_Name_T` structure.

## Related Information

- The `<qlg.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`spawnp()`—Spawn Process with Path” on page 48—Spawn Process with Path
- “`QlgSpawn()`—Spawn Process (using NLS-enabled path name)” on page 11—Spawn Process (using NLS-enabled path name)

**Note:** All of the related information for `spawnp()` applies to `QlgSpawn()`.

## Example

For an example of using this function, see the example in the “`QlgSpawn()`—Spawn Process (using NLS-enabled path name)” on page 11—Spawn Process (using NLS-enabled path name) API.

API introduced: V5R1

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## Qp0wChkChld()—Check Status for Child Processes

Syntax

```
#include <qp0wpid.h>
```

```
int Qp0wChkChld(QP0W_PID_Entries_T *chldinfo);
```

Service Program Name: QP0WPID

Default Public Authority: \*USE

Threadsafe: Yes

The `Qp0wChkChld()` function returns the status and process table entry information for the child processes of the specified process ID.

## Parameters

*\*chldinfo*

(I/O) A pointer to the `QP0W_PID_Entry_T` structure. This structure contains the process table entry information for the children processes identified by *pid*.

The structure `QP0W_PID_Entry_T` is defined in the `<qp0wpid.h>` header file as follows:

```
typedef struct QP0W_PID_Entries_T {
    int     entries_prov;
    int     entries_could;
    int     entries_return;
    pid_t   pid;
    QP0W_PID_Data_T entry[1];
} QP0W_PID_Entries_T;
```

The members of the `QP0W_PID_Entry_T` structure are as follows:

*int entries\_prov;* (Input) The number of entries of type `QP0W_PID_Data_T` for which that the caller has allocated storage to contain the status and process table entry information.

<i>int entries_could;</i>	(Output) The number of entries of type <code>QP0W_PID_Data_T</code> that could be returned. If the <code>entries_could</code> value exceeds the <code>entries_prov</code> value, the <code>Qp0wChkChld()</code> function should be called again with sufficient storage to contain the number of entries returned in <code>entries_could</code> ( <code>entries_prov</code> must be greater than or equal to <code>entries_could</code> ).
<i>int entries_return;</i>	(Output) The number of entries of type <code>QP0W_PID_Data_T</code> that were returned. If the <code>entries_return</code> value is less than the <code>entries_prov</code> value, the content of the excess number of entries provided is unchanged by <code>Qp0wChkChld()</code> .
<i>pid_t pid;</i>	(Input) The process ID of the process for which information about its child processes is to be returned.
<i>QP0W_PID_Data_T entry[1];</i>	(Output) The process table information for child processes. There is one <code>QP0W_PID_Data_T</code> structure entry for each child process, limited by the value of <code>entries_prov</code> .

The structure `QP0W_PID_Data_T` is defined in the `<qp0wpid.h>` header file as follows:

```
typedef struct QP0W_PID_Data_T {
    pid_t      pid;
    pid_t      ppid;
    pid_t      pgrp;
    int        status;
    unsigned int exit_status;
} QP0W_PID_Data_T;
```

The members of the `QP0W_PID_Data_T` structure are as follows:

<i>pid_t pid;</i>	The process ID of the process.
<i>pid_t ppid;</i>	The process ID of the parent process. If <code>ppid</code> has a value of binary 1, there is no parent process associated with the process.
<i>pid_t pgrp;</i>	The process group ID of the process.
<i>int status;</i>	A collection of flag bits that describe the current state of the process. The following flag bits can be set in <code>status</code> :
	<code>QP0W_PID_TERMINATED</code> The process has ended.
	<code>QP0W_PID_StopPED</code> The process has been stopped by a signal.
	<code>QP0W_PID_CHILDWAIT</code> The process is waiting for a child process to be ended or stopped by a signal.
	<code>QP0W_PID_SIGNALStop</code> The process has requested that the <code>SIGCHLD</code> signal be generated for the process when one of its child processes has been stopped by a signal.
<i>unsigned int exit_status;</i>	Exit status of the process. This member only has meaning if the <code>status</code> has been set to <code>QP0W_PID_TERMINATED</code> . See the <code>wait()</code> function for a description of the exit status for a process.

## Authorities

The process calling `Qp0wChkChld()` must have the appropriate authority to the process being examined. A process is allowed to examine the process table information for a process if at least one of the following conditions is true:

- The process is calling `Qp0wChkChld()` for its own process.
- The process has `*JOBCTL` special authority defined in the process user profile or in a current adopted user profile.
- The process is the parent of the process (the process being examined has a parent process ID equal to the process ID of the process calling `Qp0wChkChld()`).

- The real or effective user ID of the process matches the real or effective user ID of the process calling `Qp0wChkChld()`.

## Return Value

- `0` `Qp0wChkChld()` was successful.
- value* `Qp0wChkChld()` was not successful. The value returned indicates one of the following errors. Under some conditions, *value* could indicate an error other than those listed here.
- [EINVAL]*  
The value specified for the argument is not correct.
- A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.
- An argument value is not valid, out of range, or NULL.
- [EPERM]*  
Operation not permitted.
- You must have appropriate privileges or be the owner of the object or other resource to do the requested operation.
- [ESRCH]*  
No item could be found that matches the specified value.

## Usage Notes

The `Qp0wChkChld()` function provides an i5/OS<sup>®</sup>-specific way to obtain the process table information for the child processes of the specified process.

## Related Information

- The `<qp0wpid.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<signal.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getpgrp()`—Get Process Group ID” on page 4—Get Process Group ID
- “`getpid()`—Get Process ID” on page 5—Get Process ID
- “`getppid()`—Get Process ID of Parent Process” on page 6—Get Process ID of Parent Process
- “`Qp0wGetPgrp()`—Get Process Group ID” on page 27—Get Process Group ID
- “`Qp0wGetPid()`—Get Process ID” on page 27—Get Process ID
- “`Qp0wGetPPid()`—Get Process ID of Parent Process” on page 29—Get Process ID of Parent Process
- “`wait()`—Wait for Child Process to End” on page 62—Wait for Child Process to End

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## Qp0wChkPgrp()—Check Status for Process Group

Syntax

```
#include <qp0wpid.h>
```

```
int Qp0wChkPgrp(QP0W_PID_Entries_T *mbrinfo);
```

Service Program Name: QP0WPID

Default Public Authority: \*USE

Threadsafe: Yes

The `Qp0wChkPgrp()` function returns the status and process table entry information for the processes that are members of the process group identified by `pid` in the structure `QP0W_PID_Entry_T`.

## Parameters

### *\*mbrinfo*

(I/O) A pointer to the `QP0W_PID_Entry_T` structure. This structure contains the process table entry information for the processes that are members of the process group identified by `pid`.

The structure `QP0W_PID_Entry_T` is defined in the `<qp0wpid.h>` header file as follows:

```
typedef struct QP0W_PID_Entries_T {
    int         entries_prov;
    int         entries_could;
    int         entries_return;
    pid_t       pid;
    QP0W_PID_Data_T entry[1];
} QP0W_PID_Entries_T;
```

The members of the `QP0W_PID_Entry_T` structure are as follows:

<code>int entries_prov;</code>	(Input) The number of entries of type <code>QP0W_PID_Data_T</code> for which the caller has allocated storage to contain the status and process table entry information.
<code>int entries_could;</code>	(Output) The number of entries of type <code>QP0W_PID_Data_T</code> that could be returned. If the <code>entries_could</code> value exceeds the <code>entries_prov</code> value, the <code>Qp0wChkPgrp()</code> function should be called again with sufficient storage to contain the number of entries returned in <code>entries_could</code> ( <code>entries_prov</code> must be greater than or equal to <code>entries_could</code> ).
<code>int entries_return;</code>	(Output) The number of entries of type <code>QP0W_PID_Data_T</code> that were returned. If the <code>entries_return</code> value is less than the <code>entries_prov</code> value, the content of the excess number of entries provided is unchanged by <code>Qp0wChkPgrp()</code> .
<code>pid_t pid;</code>	(Input) The process group ID of the group of processes for which the process information is to be returned.
<code>QP0W_PID_Data_T entry[1];</code>	(Output) The process table information for the process group members. There is one <code>QP0W_PID_Data_T</code> structure entry for each process group member, limited by the value of <code>entries_prov</code> .

The structure `QP0W_PID_Data_T` is defined in the `<qp0wpid.h>` file as follows:

```
typedef struct QP0W_PID_Data_T {
    pid_t       pid;
    pid_t       ppid;
    pid_t       pgrp;
    int         status;
    unsigned int exit_status;
} QP0W_PID_Data_T;
```

The members of the `QP0W_PID_Data_T` structure are as follows:

<code>pid_t pid;</code>	The process ID of the process.
<code>pid_t ppid;</code>	The process ID of the parent process. If <code>ppid</code> has a value of binary 1, there is no parent process associated with the process.
<code>pid_t pgrp;</code>	The process group ID of the process.

*int status;* A collection of flag bits that describe the current state of the process. The following flag bits can be set in `status`:

`QPOW_PID_TERMINATED`  
The process has ended.

`QPOW_PID_StopPED`  
The process was stopped by a signal.

`QPOW_PID_CHILDWAIT`  
The process is waiting for a child process to be ended or stopped by a signal.

`QPOW_PID_SIGNALStop`  
The process has requested that the SIGCHLD signal be generated for the process when one of its child processes is stopped by a signal.

*unsigned int exit\_status;* Exit status of the process. This member only has meaning if the `status` is set to `QPOW_PID_TERMINATED`. See the `wait()` function for a description of the exit status for a process.

## Authorities

The process calling `Qp0wChkPgrp()` must have the appropriate authority to the processes being examined. A process is allowed to examine the process table information for a process if at least one of the following conditions is true:

- The process is calling `Qp0wChkPgrp()` for its own process.
- The process has \*JOBCTL special authority defined in the process user profile or in a current adopted user profile.
- The process is the parent of the process (the process being examined has a parent process ID equal to the process ID of the process calling `Qp0wChkPgrp()`).
- The real or effective user ID of the process matches the real or effective user ID of the process calling `Qp0wChkPgrp()`.

## Return Value

`0`  
*value* `Qp0wChkPgrp()` was successful.  
`Qp0wChkPgrp()` was not successful. The value returned indicates one of the following errors. Under some conditions, *value* could indicate an error other than those listed here.

### [EINVAL]

The value specified for the argument is not correct.

A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.

An argument value is not valid, out of range, or NULL.

### [EPERM]

Operation not permitted.

You must have appropriate privileges or be the owner of the object or other resource to do the requested operation.

### [ESRCH]

No item could be found that matches the specified value.

## Usage Notes

The `Qp0wChkPgrp()` function provides an i5/OS®-specific way to obtain the process table information for the members of a process group.

## Related Information

- The `<qp0wpid.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<signal.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getpgrp()`—Get Process Group ID” on page 4—Get Process Group ID
- “`getpid()`—Get Process ID” on page 5—Get Process ID
- “`getppid()`—Get Process ID of Parent Process” on page 6—Get Process ID of Parent Process
- “`Qp0wGetPgrp()`—Get Process Group ID” on page 27—Get Process Group ID
- “`Qp0wGetPid()`—Get Process ID” on page 27—Get Process ID
- “`Qp0wGetPPid()`—Get Process ID of Parent Process” on page 29—Get Process ID of Parent Process
- “`wait()`—Wait for Child Process to End” on page 62—Wait for Child Process to End

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## Qp0wChkPid()—Check Status for Process ID

### Syntax

```
#include <sys/types.h>
#include <qp0wpid.h>

int Qp0wChkPid(pid_t pid,
               QP0W_PID_Data_T *pidinfo);
```

Service Program Name: QP0WPID  
Default Public Authority: \*USE  
Threadsafe: Yes

The `Qp0wChkPid()` function returns the status and process table entry information for the process specified by the process ID *pid*.

## Parameters

*pid* (Input) The process ID of the process whose process table information is to be returned. When *pid* has a value of binary 0, the process table information for the current process is returned.

### *\*pidinfo*

(Output) A pointer to the `QP0W_PID_Data_T` structure. The process table entry information for the process identified by *pid* is stored in the location pointed to by the *pidinfo* parameter.

The structure `QP0W_PID_Data_T` is defined in `<qp0wpid.h>` header file as follows:

```
typedef struct QP0W_PID_Data_T {
    pid_t      pid;
    pid_t      ppid;
    pid_t      pgrp;
    int        status;
    unsigned int exit_status;
} QP0W_PID_Data_T;
```

The members of the `QP0W_PID_Data_T` structure are as follows:

<i>pid_t pid;</i>	The process ID of the process.
<i>pid_t ppid;</i>	The process ID of the parent process. If <i>ppid</i> has a value of binary 1, there is no parent process associated with the process.
<i>pid_t pgrp;</i>	The process group ID of the process.
<i>int status;</i>	A collection of flag bits that describe the current state of the process. The following flag bits can be set in <i>status</i> : <ul style="list-style-type: none"> <li><i>QP0W_PID_TERMINATED</i> The process has ended.</li> <li><i>QP0W_PID_StopPED</i> The process has been stopped by a signal.</li> <li><i>QP0W_PID_CHILDWAIT</i> The process is waiting for a child process to be ended or stopped by a signal.</li> <li><i>QP0W_PID_SIGNALStop</i> The process has requested that the SIGCHLD signal be generated for the process when one of it's child processes has been stopped by a signal.</li> </ul>
<i>unsigned int exit_status;</i>	Exit status of the process. This member only has meaning if the <i>status</i> has been set to <i>QP0W_PID_TERMINATED</i> . See the <b>wait()</b> function for a description of the exit status for a process.

## Authorities

The process calling **Qp0wChkPid()** must have the appropriate authority to the process being examined. A process is allowed to examine the process table information for a process if at least one of the following conditions is true:

- The process is calling **Qp0wChkPid()** for its own process.
- The process has \*JOBCTL special authority defined in the process user profile or in a current adopted user profile.
- The process is the parent of the process (the process being examined has a parent process ID equal to the process ID of the process calling **Qp0wChkPid()**).
- The real or effective user ID of the process matches the real or effective user ID of the process calling **Qp0wChkPid()**.

## Return Value

<i>0</i>	<b>Qp0wChkPid()</b> was successful.
<i>value</i>	<b>Qp0wChkPid()</b> was not successful. The value returned indicates one of the following errors. Under some conditions, <i>value</i> could indicate an error other than those listed here.
	<i>[EINVAL]</i> The value specified for the argument is not correct.  A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.  An argument value is not valid, out of range, or NULL.
	<i>[EPERM]</i> Operation not permitted.  You must have appropriate privileges or be the owner of the object or other resource to do the requested operation.
	<i>[ESRCH]</i> No item could be found that matches the specified value.

## Usage Notes

The `Qp0wChkPid()` function provides an i5/OS<sup>®</sup>-specific way to obtain the process table information for the specified process.

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<qp0wpid.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<signal.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getpgrp()`—Get Process Group ID” on page 4—Get Process Group ID
- “`getpid()`—Get Process ID” on page 5—Get Process ID
- “`getppid()`—Get Process ID of Parent Process” on page 6—Get Process ID of Parent Process
- “`Qp0wGetPgrp()`—Get Process Group ID” on page 27—Get Process Group ID
- “`Qp0wGetPid()`—Get Process ID” on page 27—Get Process ID
- “`Qp0wGetPPid()`—Get Process ID of Parent Process” on page 29—Get Process ID of Parent Process
- “`wait()`—Wait for Child Process to End” on page 62—Wait for Child Process to End

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## Qp0wGetJobID()—Get Qualified Job Name and ID for Process ID

Syntax

```
#include <qp0wpid.h>
```

```
int Qp0wGetJobID(pid_t pid, QP0W_Job_ID_T *jobinfo);
```

Service Program Name: QP0WPID

Default Public Authority: \*USE

Threadsafe: Yes

The `Qp0wGetJobID()` function returns the qualified job name and internal job identifier for the process whose process ID matches *pid*.

## Parameters

*pid* (Input) The process ID of the process whose job number is to be returned. When *pid* has a value of zero, the process ID of the calling process is used.

*\*jobinfo*

(Output) A pointer to the `qp0w_job_id_t` structure. This structure contains the qualified i5/OS<sup>®</sup> job name and internal job identifier for the process identified by *pid*.

The structure `qp0w_job_id_t` is defined in the `<qp0wpid.h>` header file as follows:

```
typedef struct QP0W_Job_ID_T {
    char    jobname[10];
    char    username[10];
    char    jobnumber[6];
    char    jobid[16];
} QP0W_Job_ID_T;
```

The members of the `qp0w_job_id_t` structure are as follows:

*char jobname[10]* The name of the job as identified to the system. For an interactive job, the system assigns the job the name of the work station where the job started. For a batch job, you specify the name in the command when you submit the job.

*char username[10]* The user name under which the job runs. The user name is the same as the user profile name and can come from several different sources, depending on the type of job.

*char jobnumber[6]* The system-generated job number.

*char jobid[16]* The internal job identifier. This value is sent to other APIs to speed the process of locating the job on the system. The identifier is not valid following an initial program load (IPL). If you attempt to use it after an IPL, an exception occurs.

## Authorities

The process calling **Qp0wGetJobID()** must have the appropriate authority to the process whose job number is to be returned. A process is allowed to access the job number for a process if at least one of the following conditions is true:

- The process is calling **Qp0wGetJobID()** for its own process.
- The process has \*JOBCTL special authority defined in the process user profile or in a current adopted user profile.
- The process is the parent of the process (the process being examined has a parent process ID equal to the process ID of the process calling **Qp0wGetJobID()**).
- The real or effective user ID of the process matches the real or effective user ID of the process calling **Qp0wGetJobID()**.

## Return Value

*0* **Qp0wGetJobID()** was successful.

*value* **Qp0wGetJobID()** was not successful. The value returned indicates one of the following errors. Under some conditions, *value* could indicate an error other than those listed here.

*[EINVAL]*  
The value specified for the argument is not correct.

A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.

An argument value is not valid, out of range, or NULL.

*[EPERM]*  
Operation not permitted.

You must have appropriate privileges or be the owner of the object or other resource to do the requested operation.

*[ESRCH]*  
No item could be found that matches the specified value.

## Related Information

- The <qp0wpid.h> file (see “Header Files for UNIX-Type Functions” on page 70)
- “getpid()—Get Process ID” on page 5—Get Process ID
- “Qp0wGetPid()—Get Process ID” on page 27—Get Process ID

API introduced: V3R6

Top | UNIX-Type APIs | APIs by category

---

## Qp0wGetPgrp()—Get Process Group ID

Syntax

```
#include <sys/types.h>
#include <qp0wpid.h>
```

```
pid_t Qp0wGetPgrp(void);
```

Service Program Name: QP0WSRV1  
Default Public Authority: \*USE  
Threadsafe: Yes

The `Qp0wGetPgrp()` function returns the process group ID of the calling process.

### Parameters

None.

### Authorities

None.

### Return Value

*pid\_t*        The value returned by `Qp0wGetPgrp()` is the process group ID of the calling process.

### Error Conditions

The `Qp0wGetPgrp()` function is always successful and does not return an error.

### Usage Notes

1. The `Qp0wGetPgrp()` function provides an i5/OS<sup>®</sup>-specific way to obtain the process group ID of the calling process. It performs the same function as `getpgrp()`.
2. `Qp0wGetPgrp()` enables a process for signals if the process is not already enabled for signals. For details, see `Qp0sEnableSignals()—Enable Process for Signals`.

### Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getpgrp()—Get Process Group ID`” on page 4—Get Process Group ID
- `Qp0sDisableSignals()—Disable Process for Signals`
- `Qp0sEnableSignals()—Enable Process for Signals`

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## Qp0wGetPid()—Get Process ID

Syntax

```
#include <sys/types.h>
#include <qp0wpid.h>
```

```
pid_t Qp0wGetPid(void);
```

Service Program Name: QP0WSRV1  
Default Public Authority: \*USE  
Threadsafe: Yes

The `Qp0wGetPid()` function returns the process ID of the calling process.

## Parameters

None.

## Authorities

None.

## Return Value

`pid_t` The value returned by `Qp0wGetPid()` is the process ID of the calling process.

## Error Conditions

The `Qp0wGetPid()` function is always successful and does not return an error.

## Usage Notes

1. The `Qp0wGetPid()` function provides an i5/OS<sup>®</sup>-specific way to obtain the process ID of the calling process. It performs the same function as `getpid()`.
2. `Qp0wGetPid()` enables a process for signals if the process is not already enabled for signals. For details, see (see `Qp0sEnableSignals()`—Enable Process for Signals).

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<qp0wpid.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getpid()`—Get Process ID” on page 5—Get Process ID
- `Qp0sDisableSignals()`—Disable Process for Signals
- `Qp0sEnableSignals()`—Enable Process for Signals
- “`Qp0wGetPidNoInit()`—Get Process ID without Initializing for Signals”—Get Process ID without Initializing for Signals

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## Qp0wGetPidNoInit()—Get Process ID without Initializing for Signals

Syntax

```
#include <sys/types.h>  
#include <qp0wpid.h>
```

```
pid_t Qp0wGetPidNoInit(void);
```

Service Program Name: QP0WSRV1  
Default Public Authority: \*USE  
Threadsafe: Yes

The `Qp0wGetPidNoInit()` function returns the process ID of the calling process without enabling the process to receive signals.

## Parameters

None.

## Authorities

None.

## Return Value

*pid\_t* The value returned by `Qp0wGetPidNoInit()` is the process ID of the calling process.

## Error Conditions

The `Qp0wGetPidNoInit()` function is always successful and does not return an error.

## Usage Notes

The `Qp0wGetPidNoInit()` function provides an i5/OS<sup>®</sup>-specific way to obtain the process ID of the calling process. It performs the same function as the `getpid()` function without enabling the process to receive signals.

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<qp0wpid.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getpid()`—Get Process ID” on page 5—Get Process ID
- “`Qp0wGetPid()`—Get Process ID” on page 27—Get Process ID
- `Qp0sDisableSignals()`—Disable Process for Signals
- `Qp0sEnableSignals()`—Enable Process for Signals

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## Qp0wGetPPid()—Get Process ID of Parent Process

Syntax

```
#include <sys/types.h>
#include <qp0wpid.h>
```

```
pid_t Qp0wGetPPid(void);
```

Service Program Name: QP0WSRV1

Default Public Authority: \*USE

Threadsafe: Yes

The `Qp0wGetPPid()` function returns the parent process ID of the calling process.

## Parameters

None.

## Authorities

None.

## Return Value

*pid\_t* The value returned by **Qp0wGetPPid()** is the process ID of the parent process for the calling process. A process ID value of 1 indicates that there is no parent process associated with the calling process.

## Error Conditions

The **Qp0wGetPPid()** function is always successful and does not return an error.

## Usage Notes

The **Qp0wGetPPid()** function provides an i5/OS®-specific way to obtain the parent process ID of the calling process. It performs the same function as **getppid()**.

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<qp0wppid.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “getppid()—Get Process ID of Parent Process” on page 6—Get Process ID of Parent Process

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

---

## Qp0zPipe()—Create Interprocess Channel with Sockets

Syntax

```
#include <spawn.h>
```

```
int Qp0zPipe(int fildes[2]);
```

Service Program Name: QP0ZSPWN

Default Public Authority: \*USE

Threadsafe: Yes

The **Qp0zPipe()** function creates a data pipe that can be used by two processes. One end of the pipe is represented by the file descriptor returned in *fildes*[0]. The other end of the pipe is represented by the file descriptor returned in *fildes*[1]. Data that is written to one end of the pipe can be read from the other end of the pipe in a first-in-first-out basis. Both ends of the pipe are open for reading and writing.

The **Qp0zPipe()** function is often used with the **spawn()** function to allow the parent and child processes to send data to each other.

## Parameters

*fildes*[2]

(Input) An integer array of size 2 that will contain the pipe descriptors.

## Authorities

None.

## Return Value

- 0 `Qp0zPipe()` was successful.
- 1 `Qp0zPipe()` was not successful. The *errno* variable is set to indicate the error.

## Error Conditions

If `Qp0zPipe()` is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

Error condition	Additional information
[EFAULT (page 74)]	
[EINVAL (page 73)]	
[EIO (page 73)]	
[EMFILE (page 76)]	
[ENFILE (page 76)]	
[ENOBUFFS (page 75)]	
[EOPNOTSUPP (page 75)]	
[EUNKNOWN (page 77)]	

## Usage Notes

The i5/OS<sup>®</sup> implementation of the `Qp0zPipe()` function is based on sockets rather than pipes and, therefore, uses socket descriptors. There are several differences:

1. After calling the `fstat()` function using one of the file descriptors returned on a `Qp0zPipe()` call, when the `st_mode` from the `stat` structure is passed to the `S_ISFIFO()` macro, the return value indicates FALSE. When the `st_mode` from the `stat` structure is passed to `S_ISSOCK()`, the return value indicates TRUE.
2. The file descriptors returned on a `Qp0zPipe()` call can be used with the `send()`, `recv()`, `sendto()`, `recvfrom()`, `sendmsg()`, and `recvmsg()` functions.
3. If this function is called by a thread executing one of the scan-related exit programs (or any of its created threads), the descriptors that are returned are scan descriptors. See Integrated File System Scan on Open Exit Programs and Integrated File System Scan on Close Exit Programs for more information. If a process is spawned, these scan descriptors are not inherited by the spawned process and therefore cannot be used in that spawned process. Therefore, in this case, the descriptors returned by `Qp0zPipe()` function will only work within the same process.

If you want to use the traditional implementation of pipes, in which the descriptors returned are pipe descriptors instead of socket descriptors, use the `pipe()` function.

## Related Information

- The `<spawn.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- `fstat()`—Get File Information by Descriptor
- “`pipe()`—Create an Interprocess Channel” on page 8—Create an Interprocess Channel
- “`spawn()`—Spawn Process” on page 37—Spawn Process
- `socketpair()`—Create a Pair of Sockets
- `stat()`—Get File Information

API introduced: V4R1

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## Qp0zSystem()—Run a CL Command

Syntax

```
#include <qp0z1170.h>
```

```
int Qp0zSystem( const char *CLcommand );
```

Service Program Name: QP0ZTRML

Default Public Authority: \*USE

Threadsafe: Yes

The **Qp0zSystem()** function spawns a new process, passes *CLcommand* to the CL command processor in the new process, and waits for the command to complete. The command runs in a batch job so it does not have access to a terminal.

This function is similar to the **system()** function provided by ILE C, but allows a program to safely run a CL command from a multithreaded process. Note that if *CLcommand* fails, the global variable `_EXCP_MSGID` is not set with the exception message id.

### Parameters

*\*CLcommand*

(Input) Pointer to null-terminated CL command string.

### Authorities

The user calling **Qp0zSystem()** must have \*USE authority to the specified CL command.

### Return Value

0      The specified CL command was successful.  
1      The specified CL command was not successful.  
-1     **Qp0zSystem()** was not successful.

### Related Information

- The `<qp0z1170.h>` file (see “Header Files for UNIX-Type Functions” on page 70)

### Example

The following example shows how to use the **Qp0zSystem()** function to create a library.

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

```
#include <stdio.h>
#include <qp0z1170.h>

int main(int argc, char *argv[])
{
    if (Qp0zSystem("CRTLIB LIB(XYZ)") != 0)
        printf("Error creating library XYZ.\n");
    else
        printf("Library XYZ created.\n");

    return(0);
}
```

## Output:

Library XYZ created

API introduced: V4R2

Top | UNIX-Type APIs | APIs by category

---

## setpgid()—Set Process Group ID for Job Control

Syntax

```
#include <sys/types.h>
#include <unistd.h>
```

```
int setpgid(pid_t pid, pid_t pgid);
```

Service Program Name: QP0WSRV1

Default Public Authority: \*USE

Threadsafe: Yes

The **setpgid()** function is used to either join an existing process group or create a new process group within the session of the calling process.

See the “Usage Notes” on page 34 for considerations in using **setpgid()**.

### Parameters

**pid** (Input) The process ID of the process whose process group ID is to be changed. When *pid* has a value of zero, the process group ID of the calling process is changed.

**pgid** (Input) The process group ID to be assigned to the process whose process ID matches *pid*. The value of *pgid* must be within the range of zero through the maximum signed integer. When *pgid/em>* has a value of zero, the process group ID is set to the process ID of the process indicated by *pid*.

### Authorities

The process calling **setpgid()** must have the appropriate authority to the process being changed. A process is allowed to access the process group ID for a process if at least one of the following conditions is true:

- The process is calling **setpgid()** for its own process.
- The process has \*JOBCTL special authority defined in the process user profile or in a current adopted user profile.
- The process is the parent of the process (the process being examined has a parent process ID equal to the process ID of the process calling **setpgid()**).
- The real or effective user ID of the process matches the real or effective user ID of the process calling **setpgid()**.

### Return Value

0 **setpgid()** was successful.

-1 **setpgid()** was not successful. The *errno* variable is set to indicate the error.

## Error Conditions

If `setpgid()` is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than that listed here.

### [EINVAL]

The value specified for the argument is not correct.

A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.

An argument value is not valid, out of range, or NULL.

### [EPERM]

Operation not permitted.

You must have appropriate privileges or be the owner of the object or other resource to do the requested operation.

### [ESRCH]

No item could be found that matches the specified value.

## Usage Notes

1. i5/OS<sup>®</sup> does not support sessions. Until session support is available on i5/OS, the restriction that the process group must be within the session of the calling process will not be enforced.
2. The `setpgid()` function fails if a nonzero process group ID is specified and that process group does not exist. If this occurs, the return value is set to -1 and *errno* is set to [EPERM].

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<unistd.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getpgrp()`—Get Process Group ID” on page 4—Get Process Group ID
- “`Qp0wGetPgrp()`—Get Process Group ID” on page 27—Get Process Group ID

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## setrlimit()—Set resource limit

Syntax

```
#include <sys/resource.h>
```

```
int setrlimit(int resource, const struct rlimit *r1p);
```

Service Program Name: QP0WSRV1

Default Public Authority: \*USE

Threadsafe: Yes

The `setrlimit()` function sets the resource limit for the specified *resource*. A resource limit is a way for the operating system to enforce a limit on a variety of resources used by a process. A resource limit is represented by a `rlimit` structure. The `rlim_cur` member specifies the current or soft limit and the `rlim_max` member specifies the maximum or hard limit.

A soft limit can be changed to any value that is less than or equal to the hard limit. The hard limit can be changed to any value that is greater than or equal to the soft limit. Only a process with appropriate authorities can increase a hard limit.

The **setrlimit()** function supports the following resources:

*RLIMIT\_FSIZE*    The maximum size of a file in bytes that can be created by a process.  
(0)

The **setrlimit()** function does not support setting the following resources: *RLIMIT\_AS*, *RLIMIT\_CORE*, *RLIMIT\_CPU*, *RLIMIT\_DATA*, *RLIMIT\_NOFILE*, and *RLIMIT\_STACK*. The **setrlimit()** function returns -1 and sets *errno* to *ENOTSUP* when called with one of these resources.

The value of *RLIM\_INFINITY* is considered to be larger than any other limit value. If the value of the limit is set to *RLIM\_INFINITY*, then a limit is not enforced for that resource. If the value of the limit is set to *RLIM\_SAVED\_MAX*, the new limit is the corresponding saved hard limit. If the value of the limit is *RLIM\_SAVED\_CUR*, the new limit is the corresponding saved soft limit.

## Parameters

*resource*

(Input)

The resource to set the limits for.

*\*rlp*    (Input)

Pointer to a struct *rlim\_t* that contains the new values for the hard and soft limits.

## Authorities and Locks

The current user profile must have *\*JOBCTL* special authority to increase the hard limit.

## Return Value

0        **setrlimit()** was successful.

-1        **setrlimit()** was not successful. The *errno* variable is set to indicate the error.

## Error Conditions

If **setrlimit()** is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

[EFAULT]

The address used for an argument is not correct.

In attempting to use an argument in a call, the system detected an address that is not valid.

While attempting to access a parameter passed to this function, the system detected an address that is not valid.

[EINVAL]

An invalid parameter was found.

An invalid *resource* was specified.

The new soft limit is greater the new hard limit.

The new hard limit is lower than the new soft limit.

## [EPERM]

Permission denied.

An attempt was made to increase the hard limit and the current user profile does not have \*JOBCTL special authority.

## [ENOTSUP]

Operation not supported.

The operation, though supported in general, is not supported for the requested *resource*.

## Related Information

- The `<sys/resource.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “`getrlimit()`—Get resource limit” on page 7—Get resource limit
- “`ulimit()`—Get and set process limits” on page 60—Get and set process limits

## Example

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

```
#include <sys/resource.h>
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>

int main (int argc, char *argv[])
{
    struct rlimit limit;

    /* Set the file size resource limit. */
    limit.rlim_cur = 65535;
    limit.rlim_max = 65535;
    if (setrlimit(RLIMIT_FSIZE, &limit) != 0) {
        printf("setrlimit() failed with errno=%d\n", errno);
        exit(1);
    }

    /* Get the file size resource limit. */
    if (getrlimit(RLIMIT_FSIZE, &limit) != 0) {
        printf("getrlimit() failed with errno=%d\n", errno);
        exit(1);
    }

    printf("The soft limit is %llu\n", limit.rlim_cur);
    printf("The hard limit is %llu\n", limit.rlim_max);
    exit(0);
}
```

### Example Output:

```
The soft limit is 65535
The hard limit is 65535
```

Introduced: V5R2

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## spawn()—Spawn Process

Syntax

```
#include <spawn.h>
```

```
pid_t spawn( const char      *path,  
             const int      fd_count,  
             const int      fd_map[],  
             const struct inheritance *inherit,  
             char * const   argv[],  
             char * const   envp[]);
```

Service Program Name: QP0ZSPWN

Default Public Authority: \*USE

Threadsafe: Conditional; see “Usage Notes” on page 42.

The **spawn()** function creates a child process that inherits specific attributes from the parent. The attributes inherited by the child process are file descriptors, the signal mask, the signal action vector, and environment variables, among others.

### Parameters

**path** (Input) Specific path to an executable file that will run in the new (child) process. The path name is expected to be in the CCSID of the job.

See “QlgSpawn()—Spawn Process (using NLS-enabled path name)” on page 11 for a description and an example of supplying the *path* in any CCSID.

**fd\_count**

(Input) The number of file descriptors the child process can inherit. It can have a value from zero to the value returned from a call to **sysconf(SC\_OPEN\_MAX)**.

**fd\_map[]**

(Input) An array that maps the parent process file descriptor numbers to the child process file descriptor numbers. If this value is **NULL**, it indicates simple inheritance. **Simple inheritance** means that the child process inherits all eligible open file descriptors of the parent process. In addition, the file descriptor number in the child process is the same as the file descriptor number in the parent process. Refer to “Attributes Inherited” on page 47 for details of file descriptor inheritance.

**inherit** (Input) A pointer to an area of type **struct inheritance**. If the pointer is **NULL**, an error occurs. The inheritance structure contains control information to indicate attributes the child process should inherit from the parent. The following is an example of the inheritance structure, as defined in the **<spawn.h>** header file:

```
struct inheritance {  
    flagset_t  flags;  
    int        pgroup;  
    sigset_t   sigmask;  
    sigset_t   sigdefault;  
};
```

The **flags** field specifies the manner in which the child process should be created. Only the constants defined in **<spawn.h>** are allowed; otherwise, **spawn()** returns -1 with **errno** set to **EINVAL**. The allowed constants follow:

<i>SPAWN_SETPGROUP</i>	If this flag is set ON, <b>spawn()</b> sets the process group ID of the child process to the value in <i>pgroup</i> . In this case, the process group field, <i>pgroup</i> , must be valid. If it is not valid, an error occurs. If this flag is set OFF, the <i>pgroup</i> field is checked to determine what the process group ID of the child process is set to. If the <i>pgroup</i> field is set to the constant <i>SPAWN_NEWPGROUP</i> , the child process group ID is set to the child process ID. If the <i>pgroup</i> field is not set to <i>SPAWN_NEWPGROUP</i> and the <i>flags</i> field is not set to <i>SPAWN_SETPGROUP</i> , the process group ID of the child process is set to the process group ID of the parent process. If the <i>pgroup</i> field is set to <i>SPAWN_NEWPGROUP</i> and the <i>flags</i> field is set to <i>SPAWN_SETPGROUP</i> , an error occurs.
<i>SPAWN_SETSIGMASK</i>	If this flag is set ON, <b>spawn()</b> sets the signal blocking mask of the child process to the value in <i>sigmask</i> . In this case, the signal blocking mask must be valid. If it is not valid, an error occurs. If this flag is set OFF, <b>spawn()</b> sets the signal blocking mask of the child process to the signal blocking mask of the calling thread.
<i>SPAWN_SETSIGDEF</i>	If this flag is set ON, <b>spawn()</b> sets the child process' signals identified in <i>sigdefault</i> to the default actions. The <i>sigdefault</i> must be valid. If it is not valid, an error occurs. If this flag is set OFF, <b>spawn()</b> sets the child process' signal actions to those of the parent process. Any signals of the parent process that have a catcher specified are set to default in the child process. The child process' signal actions inherit the parent process' ignore and default signal actions.
<i>SPAWN_SETTHREAD_NP</i>	If this flag is set ON, <b>spawn()</b> will create the child process as multithread capable. The child process will be allowed to create threads. If this flag is set OFF, the child process will not be allowed to create threads.
<i>SPAWN_SETPJ_NP</i>	If this flag is set ON, <b>spawn()</b> attempts to use available i5/OS® prestart jobs. The prestart job entries that may be used follow: <ul style="list-style-type: none"> <li>• QSYS/QP0ZSPWP, if the flag <i>SPAWN_SETTHREAD_NP</i> is set OFF.</li> <li>• QSYS/QP0ZSPWT, if the flag <i>SPAWN_SETTHREAD_NP</i> is set ON.</li> </ul> <p>The i5/OS prestart jobs must have been started using either QSYS/QP0ZSPWP or QSYS/QP0ZSPWT as the program that identifies a prestart job entry for the i5/OS subsystem that the parent process is running under. If a prestart job entry is not defined, the child process will run as a batch immediate job under the same subsystem as the parent process.</p> <p>If this flag (<i>SPAWN_SETPJ_NP</i>) is set OFF, the child process will run as a batch immediate job under the same subsystem as the parent process.</p> <p><b>Note:</b>In order to more closely emulate POSIX semantics, <b>spawn()</b> will ignore the Maximum number of uses (MAXUSE) value specified for the prestart job entry. The prestart job will only be used once, behaving as if MAXUSE(1) was specified.</p>
<i>SPAWN_SETCOMPMSG_NP</i>	If this flag is set ON, <b>spawn()</b> causes the child process to send a completion message to the user's message queue when the child process ends. If this flag is set OFF, no completion message is sent to the user's message queue when the child process ends. If both the <i>SPAWN_SETCOMPMSG_NP</i> and <i>SPAWN_SETPJ_NP</i> flags are set ON, an error occurs.
<i>SPAWN_SETJOBNAMEPARENT_NP</i>	If this flag is set ON, <b>spawn()</b> sets the child's i5/OS simple job name to that of the parent's. If this flag is set OFF, <b>spawn()</b> sets the child's i5/OS simple job name based on the <i>path</i> parameter.
<i>SPAWN_SETJOBNAMEARGV_NP</i>	If this flag is set ON, <b>spawn()</b> sets the child's i5/OS simple job name based on the name found in <i>argv[0]</i> of the <i>argv[]</i> parameter. If this flag is set OFF, <b>spawn()</b> sets the child's i5/OS simple job name based on the <i>path</i> parameter.

*SPAWN\_SETLOGJOBMSGABN\_NP*

If this flag is set ON, the child process does not log the job started (CPF1124) message and will only log the job ended (CPF1164) message when the job ends abnormally (job ending code 30 or greater). This applies to the job log as well as the system history log (QHST). If this flag is set OFF, the child process logs the job started (CPF1124) and the job ended (CPF1164) messages.

*SPAWN\_SETLOGJOBMSGNONE\_NP*

If this flag is set ON, the child process does not log the job started (CPF1124) and the job ended (CPF1164) messages to either the job log or to the system history log (QHST). If this flag is set OFF, the child process logs the job started (CPF1124) and the job ended (CPF1164) messages.

*SPAWN\_SETAFFINITYID\_NP*

If this flag is set ON, **spawn()** sets the resources affinity identifier of the child process to the 4-byte integer value, treated as an unsigned int, that immediately follows the inheritance structure in memory. A value of 0 indicates i5/OS selects the resources affinity identifier. The caller must ensure the value immediately follows the inheritance structure. For example:

```
struct extended_inheritance {
    struct inheritance inherit;
    unsigned int affinityID;
};
struct extended_inheritance extended_inherit;
```

If this flag is set OFF, i5/OS selects the resources affinity identifier of the child process.

*SPAWN\_SETTHREADRUNPTY\_NP*

If this flag is set ON, **spawn()** sets the run priority of the child process to the current thread's run priority. If this flag is set OFF, **spawn()** sets the run priority of the child process to the current process' run priority.

*argv[]* (Input) An array of pointers to strings that contain the argument list for the executable file. The last element in the array must be the NULL pointer. If this parameter is NULL, an error occurs.

*envp[]* (Input) An array of pointers to strings that contain the environment variable lists for the executable file. The last element in the array must be the NULL pointer. If this parameter is NULL, an error occurs.

## Authorities

### Authorization Required for spawn()

Object Referred to	Authority Required	errno
Each directory in the path name preceding the executable file that will run in the new process	*X	EACCES
Executable file that will run in the new process	*X	EACCES
If executable file that will run in the new process is a shell script	*RX	EACCES

## Return Value

*value* **spawn()** was successful. The value returned is the process ID of the child process.  
-1 **spawn()** was not successful. The *errno* variable is set to indicate the error.

## Error Conditions

If `spawn()` is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

### [E2BIG]

Argument list too long.

### [EACCES]

Permission denied.

An attempt was made to access an object in a way forbidden by its object access permissions.

The thread does not have access to the specified file, directory, component, or path.

If you are accessing a remote file through the Network File System, update operations to file permissions at the server are not reflected at the client until updates to data that is stored locally by the Network File System take place. (Several options on the Add Mounted File System (ADDMFS) command determine the time between refresh operations of local data.) Access to a remote file may also fail due to different mappings of user IDs (UID) or group IDs (GID) on the local and remote systems.

### [EAPAR]

Possible APAR condition or hardware failure.

### [EBADFUNC]

Function parameter in the signal function is not set.

A given file descriptor or directory pointer is not valid for this operation. The specified descriptor is incorrect, or does not refer to an open file.

### [EBADNAME]

The object name specified is not correct.

### [ECANCEL]

Operation canceled.

### [ECONVERT]

Conversion error.

One or more characters could not be converted from the source CCSID to the target CCSID.

The specified path name is not in the CCSID of the job.

### [EFAULT]

The address used for an argument is not correct.

In attempting to use an argument in a call, the system detected an address that is not valid.

While attempting to access a parameter passed to this function, the system detected an address that is not valid.

### [EINVAL]

The value specified for the argument is not correct.

A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.

An argument value is not valid, out of range, or NULL.

The `flags` field in the `inherit` parameter contains an invalid value.

*[EIO]*

Input/output error.

A physical I/O error occurred.

A referenced object may be damaged.

*[ELOOP]*

A loop exists in the symbolic links.

This error is issued if the number of symbolic links encountered is more than `POSIX_SYMLINK_MAX` (defined in the `limits.h` header file). Symbolic links are encountered during resolution of the directory or path name.

*[ENAMETOOLONG]*

A path name is too long.

A path name is longer than `PATH_MAX` characters or some component of the name is longer than `NAME_MAX` characters while `_POSIX_NO_TRUNC` is in effect. For symbolic links, the length of the name string substituted for a symbolic link exceeds `PATH_MAX`. The `PATH_MAX` and `NAME_MAX` values can be determined using the `pathconf()` function.

*[ENFILE]*

Too many open files in the system.

A system limit has been reached for the number of files that are allowed to be concurrently open in the system.

The entire system has too many other file descriptors already open.

*[ENOENT]*

No such path or directory.

The directory or a component of the path name specified does not exist.

A named file or directory does not exist or is an empty string.

*[ENOMEM]*

Storage allocation request failed.

A function needed to allocate storage, but no storage is available.

There is not enough memory to perform the requested function.

*[ENOTDIR]*

Not a directory.

A component of the specified path name existed, but it was not a directory when a directory was expected.

Some component of the path name is not a directory, or is an empty string.

*[ENOTSUP]*

Function is not allowed in a job that is running with multiple threads.

*[ENOTSUP]*

Operation not supported.

The operation, though supported in general, is not supported for the requested object or the requested arguments.

*[ETERM]*

Operation terminated.

[ENOSYSRSC]

System resources not available to complete request.

The child process failed to start. The maximum active jobs in a subsystem may have been reached. CHGSBSD and CHGJOBQE CL commands can be used to change the maximum active jobs.

[EUNKNOWN]

Unknown system state.

The operation failed because of an unknown system state. See any messages in the job log and correct any errors that are indicated, then retry the operation.

## Usage Notes

1. **spawn()** is threadsafe, except this function will fail and errno ENOTSAFE will be set if it is called in any of the following ways:
  - From a multithreaded process and path refers to a shell script that does not exist in a threadsafe file system.
2. There are performance considerations when using **spawn()** and **spawnp()** concurrently among threads in the same process. **spawn()** and **spawnp()** serialize against other **spawn()** and **spawnp()** calls from other threads in the same process.
3. The child process is enabled for signals. A side effect of this function is that the parent process is also enabled for signals if it was not enabled for signals before this function was called.
4. If this function is called from a program running in user state and it specifies a system-domain program as the executable program for the child process, an exception occurs. In this case, **spawn()** returns the process ID of the child process. On a subsequent call to **wait()** or **waitpid()**, the status information returned indicates that an exception occurred in the child process.
5. The program that will be run in the child process must be either a program object in the QSYS.LIB file system or an independent ASP QSYS.LIB file system (\*PGM object) or a shell script (see “About Shell Scripts” on page 68). The syntax of the name of the file to run must be the proper syntax for the file system in which the file resides. For example, if the program MYPROG resides in the QSYS.LIB file system and in library MYLIB, the specification for **spawn()** would be the following:  

```
/QSYS.LIB/MYLIB.LIB/MYPROG.PGM
```

See “QlgSpawn()—Spawn Process (using NLS-enabled path name)” on page 11 for an example specifying the program using the Qlg\_Path\_Name\_T structure. The Qlg\_Path\_Name\_T structure is supported by **QlgSpawn()** and allows the program name to be specified in any CCSID.  
**Note:** For more information about path syntaxes for the different file systems, see the Integrated file system information in the Files and file systems topic.
6. Spawned child processes are batch jobs or prestart jobs. As such, they do not have the ability to do 5250-type interactive I/O.
7. Spawned child processes that are i5/OS prestart jobs are similar to batch jobs. Due to the nature of prestart jobs, only the following i5/OS-specific attributes are explicitly inherited in a child process when you use prestart jobs:
  - Library list
  - Language identifier
  - Country or region identifier
  - Coded character set identifier
  - Default coded character set identifier

- Locale (as specified in the user profile)

The child process has the same user profile as the calling thread. However, the i5/OS job attributes come from the job description specified for the prestart job entry, and the run attributes come from the class that is associated with the i5/OS subsystem used for the prestart job entry.

**Notes:**

- The prestart job entry QP0ZSPWP is used with prestart jobs that will not be creating threads. The prestart job entry QP0ZSPWT is used with prestart jobs that will allow multiple threads. Both types of prestart jobs may be used in the same subsystem. The prestart job entry must be defined for the subsystem that the **spawn()** parent process runs under in order for it to be used.
- The following example defines a prestart job entry (QP0ZSPWP) for use by **spawn()** under the subsystem QINTER. The **spawn()** API must have the SPAWN\_SETPJ\_NP flag set (but not SPAWN\_SETTHREAD\_NP) in order to use these prestart jobs:

```
ADDPJE SBS(D(QSYS/QINTER) PGM(QSYS/QP0ZSPWP)
      INLJOBS(20) THRESHOLD(5) ADLJOBS(5)
      JOBD(QGPL/QDFTJOB) MAXUSE(1)
      CLS(QGPL/QINTER)
```

- The following example defines a prestart job entry (QP0ZSPWT) that will create prestart jobs that are multithread capable for use by **spawn()** under the subsystem QINTER. The **spawn()** API must have both SPAWN\_SETPJ\_NP and SPAWN\_SETTHREAD\_NP flags set in order to use these prestart jobs. Also, the JOBD parameter must be a job description that allows multiple threads as follows:

```
ADDPJE SBS(D(QSYS/QINTER) PGM(QSYS/QP0ZSPWT)
      INLJOBS(20) THRESHOLD(5) ADLJOBS(5)
      JOBD(QSYS/QAMTJOB) MAXUSE(1)
      CLS(QGPL/QINTER)
```

Refer to the Work Management topic for complete details on prestart jobs.

- Shell scripts are allowed for the child process. If a shell script is specified, the appropriate shell interpreter program is called. The shell script must be a text file and must contain the following format on the first line of the file:

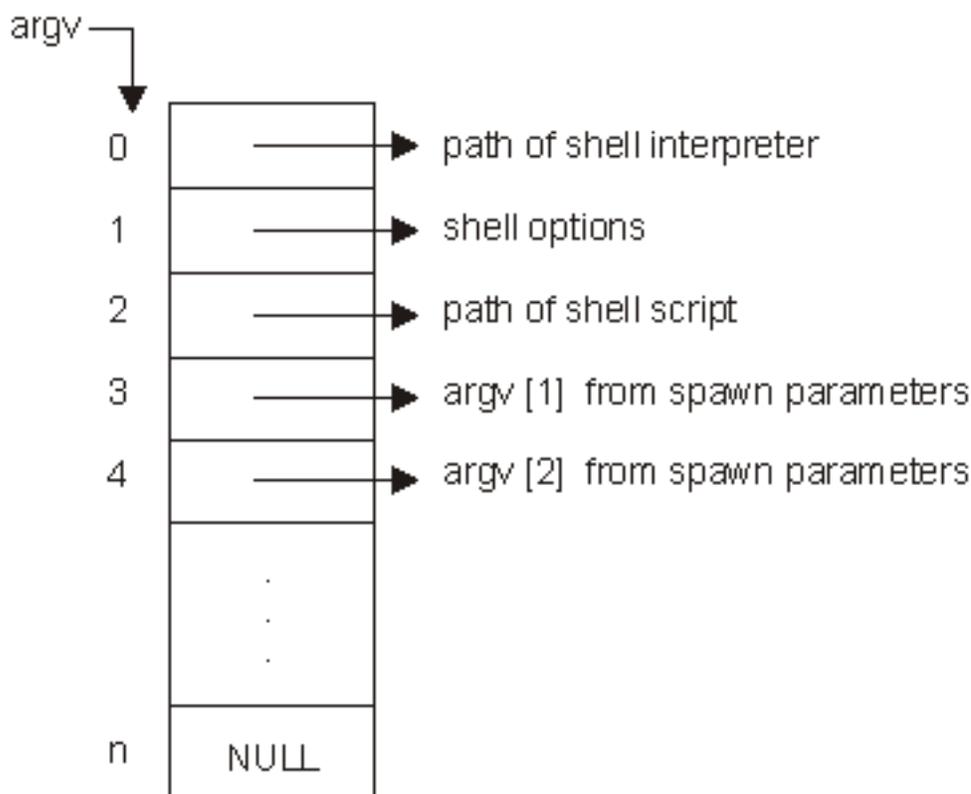
```
#!/interpreter_path <options>
```

where `interpreter_path` is the path to the shell interpreter program.

If the calling process is multithreaded, `path` (the first parameter to **spawn()**) must reference a threadsafe file system.

**spawn()** calls the shell interpreter, passing in the shell options and the arguments passed in as a parameter to **spawn()**. The argument list passed into the shell interpreter will look like Arguments to Shell Interpreter (page 44).

## Arguments to Shell Interpreter



See “About Shell Scripts” on page 68 for an example using `spawn()` and shell scripts.

9. Only programs that expect arguments as null-terminated character strings can be spawned. The program that is run in the child process is called at its initial entry point. The arguments explicitly passed to the program start with element `argv[1]` of the `argv[]` parameter that was specified during the call to `spawn()`. The program language type determines how the arguments passed are seen by that program. For example, if the program language type is ILE C or ILE C++, the linkage can be described as:

```
int main(int argc, char *argv[])
{
}
```

where the following are true:

- `argc` is the number of arguments in `argv[]`.
- `argv[]` is an array of arguments represented as null-terminated character strings.
- The last entry in the array is NULL.
- The first element in the array, `argv[0]`, is automatically set to the name of the program. Any value specified for `argv[0]` during the call to `spawn()` will be overwritten.
- The remaining `argv[]` elements, if any, will correspond directly to the `argv[]` elements specified during the call to `spawn()`.

The maximum number of arguments that can be specified is dependent on the following:

- The maximum number of parameters allowed for the program that is run in the child process, as seen by the DSPPGM CL command. Some programs allow up to 65 535 parameters, while others may only allow up to 255 parameters. The value of `SPAWN_MAX_NUM_ARGS` is 255, in order to maintain compatibility with programs that only allow up to 255 parameters. If the maximum number is exceeded, `spawn()` returns -1 with `errno` set to `E2BIG`.

- The total size required for containing the arguments, which includes the array of pointers to strings, and the total size of all the strings. The total size is limited to approximately 16 500 000 bytes. If the total size is exceeded, **spawn()** returns -1 with `errno` set to `ENOMEM`.
10. The child process does not inherit any of the environment variables of the parent process. That is, the default environment variable environment is empty. If the child process is to inherit all the parent process' environment variables, the extern variable `environ` can be used as the value for `envp[]` when **spawn()** is called. If a specific set of environment variables is required in the child process, the user must build the `envp[]` array with the "name=value" strings. In the child process, **spawn()** does the equivalent of a **putenv()** on each element of the `envp[]` array. Then the extern variable `environ` will be set and available to the child process' program.

**Note:** If the user of **spawn()** specifies the extern variable `environ` as the `envp[]` parameter, the user must successfully call one of the following APIs before calling **spawn()**:

- `getenv()`
- `putenv()`
- `Qp0zGetEnv()`
- `Qp0zInitEnv()`
- `Qp0zPutEnv()`

The extern variable `environ` is not initialized until one of these APIs is called in the current activation group. If `environ` is used in a call to **spawn()** without first calling one of these APIs, **spawn()** returns an error.

11. i5/OS handles `stdin`, `stdout`, and `stderr` differently than most UNIX<sup>®</sup> systems. On most UNIX systems, `stdin`, `stdout`, and `stderr` have file descriptors 0, 1, and 2 reserved and allocated for them. On i5/OS, this is not the case. There are two ramifications of this difference:
- a. File descriptor 0, 1, and 2 are allocated to the first three files that have descriptors allocated to them. If an application writes to file descriptor 1 assuming it is `stdout`, the result will not be as expected.
  - b. Any API that assumes `stdin`, `stdout`, and `stderr` are file descriptors 0, 1, and 2 will not behave as expected.

Users and applications can enable descriptor-based standard I/O for child processes by setting environment variable `QIBM_USE_DESCRIPTOR_STDIO` to the value Y in the child process. This can be accomplished on the call to **spawn()** by either of the following:

- a. Specifying the extern variable `environ` as the `envp[]` parameter. This assumes that the `QIBM_USE_DESCRIPTOR_STDIO` environment variable exists in the calling process. The environment variable can be set by using one of the following:
  - API `putenv("QIBM_USE_DESCRIPTOR_STDIO=Y");`
  - Command `ADDENVVAR ENVVAR(QIBM_USE_DESCRIPTOR_STDIO) VALUE(Y)`
  - Command `CHGENVVAR ENVVAR(QIBM_USE_DESCRIPTOR_STDIO) VALUE(Y)`
- b. Explicitly include "QIBM\_USE\_DESCRIPTOR\_STDIO=Y" in the user-defined `envp[]` array with the "name=value" strings.

If you enable descriptor-based standard I/O for child processes, file descriptors 0, 1, and 2 are automatically used for `stdin`, `stdout`, and `stderr`, respectively. However, **spawn()** must be called using a `fd_map` that has file descriptors 0, 1, and 2 properly allocated. See "About Shell Scripts" on page 68 for an example that enables descriptor-based standard I/O for a child process. Refer to the

WebSphere<sup>®</sup> Development Studio: ILE C/C++ Programmer's Guide  for complete details on this support.

12. Spawn users have a facility to aid in debugging child processes. To help the user start a debug session (when **spawn()** is the mechanism used to start the process), the user sets the environment variable `QIBM_CHILD_JOB_SNDINQMSG`.

If the environment variable is assigned a numerical value, it indicates the number of descendent levels that will be enabled for debugging. This support can be used to debug applications that create children, grandchildren, great-grandchildren, and so forth. When the environment variable has a value of 1, it enables debugging of all subsequent child processes. A value of 2 enables debugging of all subsequent child processes and grandchild processes.

When the environment variable has a value less than or equal to 0, or any non-numerical value, debugging will not occur.

Here are the steps a user would take to debug an application by using `spawn()`:

Assume the user wants to debug child processes in an application called CHILDAPP found in library MYAPPLIB.

- Set the QIBM\_CHILD\_JOB\_SNDINQMSG environment variable to 1.

The environment variable can be set by using one of the following:

- `API putenv("QIBM_CHILD_JOB_SNDINQMSG=1");`
- `Command ADDENVVAR ENVVAR(QIBM_CHILD_JOB_SNDINQMSG) VALUE(1)`
- `Command CHGENVVAR ENVVAR(QIBM_CHILD_JOB_SNDINQMSG) VALUE(1)`

- Call or run the application that specifies `/QSYS.LIB/MYAPPLIB.LIB/CHILDAPP.PGM` as the path on the `spawn()` invocation. CHILDAPP will start running, send a CPAA980 \*INQUIRY message to the user's message queue, and then will block, waiting for a reply to the message. Issue a Work with Active Jobs (WRKACTJOB) command and find the CHILDAPP in a MSGW job status. Option 7 (Display message) performed against this job will display the CPAA980 \*INQUIRY message that was sent. As part of this message, the Qualified Job Name will be displayed in the proper format to pass to the Start Service Job (STRSRVJOB) command (for example, 145778/RANDYR/CHILDAPP).

**Note:** Alternatively, a Display Messages (DSPMSG) command can be issued for the user, and the output searched for the specific CPAA980 \*INQUIRY message.

**Note:** If the job's inquiry message reply specifies using the default message reply, the child process will not block since the default reply for the CPAA980 \*INQUIRY message is G.

- Issue a Start Service Job against the child process: `STRSRVJOB JOB(145778/RANDYR/CHILDAPP)`.
- Issue a Start Debug Command: `STRDBG PGM(MYAPPLIB/CHILDAPP)`.
- Set whatever breakpoints are needed in CHILDAPP. When ready to continue, find the CPAA980 message and reply with G. This will unblock CHILDAPP, which allows it to run until a breakpoint is reached, at which time CHILDAPP will again stop.

**Note:** If you reply with C to the CPAA980 message, the child process is ended before the child process' program ever receives control. In this case, on a subsequent call to `wait()` or `waitpid()`, the status information returned indicates `WIFEXCEPTION()`, which evaluates to a nonzero value, and `WEXCEPTNUMBER()` will evaluate to 0.

- The application is now stopped at a breakpoint and debugging can proceed.

13. By default, the child's i5/OS simple job name is derived directly from the *path* parameter. If *path* is a symbolic link to another object, the i5/OS simple job name is derived from the symbolic link itself. For example, if *path* was set to `/QSYS.LIB/MYLIB.LIB/CHILD.PGM`, the child's i5/OS simple job name would be CHILD. If `/usr/bin/daughter` was a symbolic link to `/QSYS.LIB/MYLIB.LIB/CHILD.PGM` and *path* was set to `/usr/bin/daughter`, the child's i5/OS simple job name would be DAUGHTER.

If `SPAWN_SETJOBNAMEPARENT_NP` is set in *inherit.flags*, the child's i5/OS simple job name would be the same as the parent's i5/OS simple job name.

If `SPAWN_SETJOBNAMEARGV_NP` is set in *inherit.flags*, the null-terminated character string represented by `argv[0]` of the *argv[]* parameter will be used to derive the child's i5/OS simple job name. The name can be up to 10 characters, must be uppercase, and must contain only those characters allowed for an i5/OS job name. However, a period (.) is not considered a valid character. For example, if *path* was set to `/QSYS.LIB/MYLIB.LIB/CHILD.PGM`,

SPAWN\_SETJOBNAMEARGV\_NP was set ON, and argv[0] was set to SON, the child's i5/OS simple job name would be SON. If the first character of the name is invalid, the *path* will be used. If any of the remaining characters of the name are invalid, the valid characters up to that point will be used.

14. The *\_NP* used at the end of certain flag names, that can be specified for the *flags* field of the *inherit* parameter, indicate the flag is a non-standard, i5/OS-platform-specific extension to the inheritance structure. Applications that wish to avoid using platform-specific extensions should not use these flags.
15. The child process has an associated process ID, which uses system resources. Those resources will remain in use, even after the child process has ended. In order to ensure those resources are reclaimed, the parent process should either successfully call **wait()** or **waitpid()**, or the parent process should end.

## Attributes Inherited

The child process inherits the following POSIX attributes from the parent:

1. File descriptor table (mapped according to *fd\_map*).

**Note:** The following file descriptor table information does **not** apply to any of the scan descriptors which are created by the thread executing one of the scan-related exit programs (or any of its created threads). See Integrated File System Scan on Open Exit Programs and Integrated File System Scan on Close Exit Programs for more information.

- If *fd\_map* is NULL, all file descriptors are inherited without being reordered.

**Note:** File descriptors that have the FD\_CLOEXEC file descriptor flag set are not inherited. File descriptors that are created as a result of the **opendir()** API (to implement open directory streams) are not inherited.

- If *fd\_map* is not NULL, it is a mapping from the file descriptor table of the parent process to the file descriptor table of the child process. *fd\_count* specifies the number of file descriptors the child process will inherit. Except for those file descriptors designated by SPAWN\_FDCLOSED, file descriptor *i* in the child process is specified by *fd\_map[i]*. For example, *fd\_map[5]= 7* sets the child process' file descriptor 5 to the parent process' file descriptor 7. File descriptors *fd\_count* through OPEN\_MAX are closed in the child process, as are any file descriptors designated by SPAWN\_FDCLOSED.

**Note:** File descriptors that are specified in the *fd\_map* array are inherited even if they have the FD\_CLOEXEC file descriptor flag set. After inheritance, the FD\_CLOEXEC flag in the child process' file descriptor is cleared.

- For files descriptors that remain open, no attributes are changed.
- If a file descriptor refers to an open instance in a file system that does not support file descriptors in two different processes pointing to the same open instance of a file, the file descriptor is closed in the child process.

Only open files managed by the Root, QOpenSys, or user-defined file systems support inheritance of their file descriptors. All other file systems will have their file descriptors closed in the child process.

2. Process group ID

- If *inherit.flags* is set to SPAWN\_SETPGROUP, the child process group ID is set to the value in *inherit.pgroup*.

**Note:** i5/OS does not support the ability to set the process group ID for the child process to a user-specified group ID. This is a deviation from the POSIX standard.

- If *inherit.pgroup* is set to SPAWN\_NEWPGROUP, the child process is put in a new process group with a process group ID equal to the process ID.
- If *inherit.pgroup* is not set to SPAWN\_NEWPGROUP, the child process inherits the process group of the parent process.

If the process group that the child process is attempting to join has received the SIGKILL signal, the child process is ended.

3. Real user ID of the calling thread.
4. Real group ID of the calling thread.
5. Supplementary group IDs (group profile list) of the calling thread.
6. Current working directory of the parent process.
7. Root directory of the parent process.
8. File mode creation mask of the parent process.
9. Signal mask of the calling thread, except if the SPAWN\_SETSIGMASK flag is set in *inherit.flags*. Then the child process will initially have the signal mask specified in *inherit.mask*.
10. Signal action vector, as determined by the following:
  - If the SPAWN\_SETSIGDEF flag is set in *inherit.flags*, the signal specified in *inherit.sigdefault* is set to the default actions in the child process. Signals set to the default action in the parent process are set to the default action in the child process.
  - Signals set to be caught in the parent process are set to the default action in the child process.
  - Signals set to be ignored in the parent process are set to ignore in the child process, unless set to default by the above rules.
11. Priority of the parent process.  
**Note:** i5/OS prestart jobs do not inherit priority.
12. Scheduling policy (the i5/OS scheduling policy) of the parent process.
13. i5/OS-specific attributes of the parent, such as job attributes, run attributes, library list, and user profile.  
**Note:** i5/OS prestart jobs inherit a subset of i5/OS-specific attributes.
14. Resource limits of the parent process.

## Related Information

- The `<spawn.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “QlgSpawn()—Spawn Process (using NLS-enabled path name)” on page 11—Spawn Process (using NLS-enabled path name)
- “spawnp()—Spawn Process with Path”—Spawn Process with Path
- `sysconf()`—Get System Configuration Variables
- “wait()—Wait for Child Process to End” on page 62—Wait for Child Process to End
- “waitpid()—Wait for Specific Child Process” on page 65—Wait for Specific Child Process

## Example

For an example of using this function, see Example: Using process-related APIs in the Examples: APIs and exit programs topic.

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## spawnp()—Spawn Process with Path

Syntax

```
#include <spawn.h>
```

```
pid_t spawnp(const char *file,
```

```

const int          fd_count,
const int          fd_map[],
const struct inheritance *inherit,
char * const      argv[],
char * const      envp[]);

```

Service Program Name: QP0ZSPWN  
 Default Public Authority: \*USE  
 Threadsafe: Conditional; see “Usage Notes” on page 54.

The **spawnp()** function creates a child process that inherits specific attributes from the parent. The attributes inherited by the child process are file descriptors, the signal mask, the signal action vector, and environment variables, among others. **spawnp()** takes the *file* parameter and searches the environment variable PATH. The *file* parameter is concatenated to each path defined in the PATH environment variable. It uses the first occurrence of the *file* parameter that is found with a mode of execute.

If the PATH environment variable does not contain a value, an error occurs. If the *file* parameter contains a "/" character, the value of *file* is used as a path and a search of the PATH or library list is not performed. Specifying a *file* parameter containing a "/" is the same as calling **spawn()**.

To search the library list, a special value for the PATH environment variable is used. The string %LIBL% can be the entire PATH value or a component of the PATH value. When the string %LIBL% is encountered, the library list is searched. For example, the following path searches the directory /usr/bin first, searches the library list next, and then searches the /tobrien/bin directory for the file:

```
PATH=/usr/bin:%LIBL%:/tobrien/bin
```

## Parameters

**file** (Input) A file name used with the search path to find an executable file that will run in the new (child) process. The file name is expected to be in the CCSID of the job.

See “QlgSpawnp()—Spawn Process with Path (using NLS-enabled file name)” on page 17 for a description and an example of supplying the *file* in any CCSID.

**fd\_count** (Input) The number of file descriptors the child process can inherit. It can have a value from zero to the value returned from a call to **sysconf(SC\_OPEN\_MAX)**.

**fd\_map[]** (Input) An array that maps the parent process file descriptor numbers to the child process file descriptor numbers. If this value is NULL, it indicates simple inheritance. **Simple inheritance** means that the child process inherits all eligible open file descriptors of the parent process. In addition, the file descriptor number in the child process is the same as the file descriptor number in the parent process. Refer to “Attributes Inherited” on page 59 for details of file descriptor inheritance.

**inherit** (Input) A pointer to an area of type struct inheritance. If the pointer is NULL, an error occurs. The inheritance structure contains control information to indicate attributes the child process should inherit from the parent. The following is an example of the inheritance structure, as defined in the <spawn.h> header file:

```

struct inheritance {
    flagset_t  flags;
    int        pgroup;
    sigset_t   sigmask;
    sigset_t   sigdefault;
};

```

The flags field specifies the manner in which the child process should be created. Only the constants defined in <spawn.h> are allowed; otherwise, **spawnp()** returns -1 with errno set to EINVAL. The allowed constants follow:

<i>SPAWN_SETPGROUP</i>	If this flag is set ON, <b>spawnp()</b> sets the process group ID of the child process to the value in <i>pgroup</i> . In this case, the process group field, <i>pgroup</i> , must be valid. If it is not valid, an error occurs. If this flag is set OFF, the <i>pgroup</i> field is checked to determine what the process group ID of the child process is set to. If the <i>pgroup</i> field is set to the constant <i>SPAWN_NEWPGROUP</i> , the child process group ID is set to the child process ID. If the <i>pgroup</i> field is not set to <i>SPAWN_NEWPGROUP</i> and the <i>flags</i> field is not set to <i>SPAWN_SETPGROUP</i> , the process group ID of the child process is set to the process group ID of the parent process. If the <i>pgroup</i> field is set to <i>SPAWN_NEWPGROUP</i> and the <i>flags</i> field is set to <i>SPAWN_SETPGROUP</i> , an error occurs.
<i>SPAWN_SETSIGMASK</i>	If this flag is set ON, <b>spawnp()</b> sets the signal blocking mask of the child process to the value in <i>sigmask</i> . In this case, the signal blocking mask must be valid. If it is not valid, an error occurs. If this flag is set OFF, <b>spawnp()</b> sets the signal blocking mask of the child process to the signal blocking mask of the calling thread.
<i>SPAWN_SETSIGDEF</i>	If this flag is set ON, <b>spawnp()</b> sets the child process' signals identified in <i>sigdefault</i> to the default actions. The <i>sigdefault</i> must be valid. If it is not valid, an error occurs. If this flag is set OFF, <b>spawnp()</b> sets the child process' signal actions to those of the parent process. Any signals of the parent process that have a catcher specified are set to default in the child process. The child process' signal actions inherit the parent process' ignore and default signal actions.
<i>SPAWN_SETTHREAD_NP</i>	If this flag is set ON, <b>spawnp()</b> will create the child process as multithread capable. The child process will be allowed to create threads. If this flag is set OFF, the child process will not be allowed to create threads.
<i>SPAWN_SETPJ_NP</i>	If this flag is set ON, <b>spawnp()</b> attempts to use available i5/OS® prestart jobs. The prestart job entries that may be used follow: <ul style="list-style-type: none"> <li>• QSYS/QP0ZSPWP, if the flag <i>SPAWN_SETTHREAD_NP</i> is set OFF.</li> <li>• QSYS/QP0ZSPWT, if the flag <i>SPAWN_SETTHREAD_NP</i> is set ON.</li> </ul> <p>The i5/OS prestart jobs must have been started using either <i>QSYS/QP0ZSPWP</i> or <i>QSYS/QP0ZSPWT</i> as the program that identifies a prestart job entry for the i5/OS subsystem that the parent process is running under. If a prestart job entry is not defined, the child process will run as a batch immediate job under the same subsystem as the parent process.</p> <p>If this flag (<i>SPAWN_SETPJ_NP</i>) is set OFF, the child process will run as a batch immediate job under the same subsystem as the parent process.</p> <p><b>Note:</b>In order to more closely emulate POSIX semantics, <b>spawnp()</b> will ignore the Maximum number of uses (<i>MAXUSE</i>) value specified for the prestart job entry. The prestart job will only be used once, behaving as if <i>MAXUSE(1)</i> was specified.</p>
<i>SPAWN_SETCOMPMSG_NP</i>	If this flag is set ON, <b>spawnp()</b> causes the child process to send a completion message to the user's message queue when the child process ends. If this flag is set OFF, no completion message is sent to the user's message queue when the child process ends. If both the <i>SPAWN_SETCOMPMSG_NP</i> and <i>SPAWN_SETPJ_NP</i> flags are set ON, an error occurs.
<i>SPAWN_SETJOBNAMEPARENT_NP</i>	If this flag is set ON, <b>spawnp()</b> sets the child's i5/OS simple job name to that of the parent's. If this flag is set OFF, <b>spawnp()</b> sets the child's i5/OS simple job name based on the <i>file</i> parameter.
<i>SPAWN_SETJOBNAMEARGV_NP</i>	If this flag is set ON, <b>spawnp()</b> sets the child's i5/OS simple job name based on the name found in <i>argv[0]</i> of the <i>argv[]</i> parameter. If this flag is set OFF, <b>spawnp()</b> sets the child's i5/OS simple job name based on the <i>file</i> parameter.

*SPAWN\_SETLOGJOBMSGABN\_NP*

If this flag is set ON, the child process does not log the job started (CPF1124) message and will only log the job ended (CPF1164) message when the job ends abnormally (job ending code 30 or greater). This applies to the job log as well as the system history log (QHST). If this flag is set OFF, the child process logs the job started (CPF1124) and the job ended (CPF1164) messages.

*SPAWN\_SETLOGJOBMSGNONE\_NP*

If this flag is set ON, the child process does not log the job started (CPF1124) and the job ended (CPF1164) messages to either the job log or to the system history log (QHST). If this flag is set OFF, the child process logs the job started (CPF1124) and the job ended (CPF1164) messages.

*SPAWN\_SETAFFINITYID\_NP*

If this flag is set ON, **spawnp()** sets the resources affinity identifier of the child process to the 4-byte integer value, treated as an unsigned int, that immediately follows the inheritance structure in memory. A value of 0 indicates i5/OS selects the resources affinity identifier. The caller must ensure the value immediately follows the inheritance structure. For example:

```
struct extended_inheritance {
    struct inheritance inherit;
    unsigned int affinityID;
};
struct extended_inheritance extended_inherit;
```

If this flag is set OFF, i5/OS selects the resources affinity identifier of the child process.

*SPAWN\_SETTHREADRUNPTY\_NP*

If this flag is set ON, **spawnp()** sets the run priority of the child process to the current thread's run priority. If this flag is set OFF, **spawnp()** sets the run priority of the child process to the current process' run priority.

*argv[]* (Input) An array of pointers to strings that contain the argument list for the executable file. The last element in the array must be the NULL pointer. If this parameter is NULL, an error occurs.

*envp[]* (Input) An array of pointers to strings that contain the environment variable lists for the executable file. The last element in the array must be the NULL pointer. If this parameter is NULL, an error occurs.

## Authorities

### Authorization Required for spawnp()

Object Referred to	Authority Required	errno
Each directory in the path name preceding the executable file that will run in the new process	*X	EACCES
Executable file that will run in the new process	*X	EACCES
If executable file that will run in the new process is a shell script	*RX	EACCES

## Return Value

*value* **spawnp()** was successful. The value returned is the process ID of the child process.  
-1 **spawnp()** was not successful. The *errno* variable is set to indicate the error.

## Error Conditions

If `spawnp()` is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

### [E2BIG]

Argument list too long.

### [EACCES]

Permission denied.

An attempt was made to access an object in a way forbidden by its object access permissions.

The thread does not have access to the specified file, directory, component, or path.

If you are accessing a remote file through the Network File System, update operations to file permissions at the server are not reflected at the client until updates to data that is stored locally by the Network File System take place. (Several options on the Add Mounted File System (ADDMFS) command determine the time between refresh operations of local data.) Access to a remote file may also fail due to different mappings of user IDs (UID) or group IDs (GID) on the local and remote systems.

### [EAPAR]

Possible APAR condition or hardware failure.

### [EBADFUNC]

Function parameter in the signal function is not set.

A given file descriptor or directory pointer is not valid for this operation. The specified descriptor is incorrect, or does not refer to an open file.

### [EBADNAME]

The object name specified is not correct.

### [ECANCEL]

Operation canceled.

### [ECONVERT]

Conversion error.

One or more characters could not be converted from the source CCSID to the target CCSID.

The specified path name is not in the CCSID of the job.

### [EFAULT]

The address used for an argument is not correct.

In attempting to use an argument in a call, the system detected an address that is not valid.

While attempting to access a parameter passed to this function, the system detected an address that is not valid.

### [EINVAL]

The value specified for the argument is not correct.

A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.

An argument value is not valid, out of range, or NULL.

The flags field in the inherit parameter contains an invalid value.

*[EIO]*

Input/output error.

A physical I/O error occurred.

A referenced object may be damaged.

*[ELOOP]*

A loop exists in the symbolic links.

This error is issued if the number of symbolic links encountered is more than `POSIX_SYMLLOOP` (defined in the `limits.h` header file). Symbolic links are encountered during resolution of the directory or path name.

*[ENAMETOOLONG]*

A path name is too long.

A path name is longer than `PATH_MAX` characters or some component of the name is longer than `NAME_MAX` characters while `_POSIX_NO_TRUNC` is in effect. For symbolic links, the length of the name string substituted for a symbolic link exceeds `PATH_MAX`. The `PATH_MAX` and `NAME_MAX` values can be determined using the `pathconf()` function.

*[ENFILE]*

Too many open files in the system.

A system limit has been reached for the number of files that are allowed to be concurrently open in the system.

The entire system has too many other file descriptors already open.

*[ENOENT]*

No such path or directory.

The directory or a component of the path name specified does not exist.

A named file or directory does not exist or is an empty string.

*[ENOMEM]*

Storage allocation request failed.

A function needed to allocate storage, but no storage is available.

There is not enough memory to perform the requested function.

*[ENOTDIR]*

Not a directory.

A component of the specified path name existed, but it was not a directory when a directory was expected.

Some component of the path name is not a directory, or is an empty string.

*[ENOTSAFE]*

Function is not allowed in a job that is running with multiple threads.

*[ENOTSUP]*

Operation not supported.

The operation, though supported in general, is not supported for the requested object or the requested arguments.

*[ETERM]*

Operation terminated.

[ENOSYSRSC]

System resources not available to complete request.

The child process failed to start. The maximum active jobs in a subsystem may have been reached. CHGSBSD and CHGJOBQE CL commands can be used to change the maximum active jobs.

[EUNKNOWN]

Unknown system state.

The operation failed because of an unknown system state. See any messages in the job log and correct any errors that are indicated, then retry the operation.

## Usage Notes

1. **spawnp()** is threadsafe, except this function will fail and errno ENOTSAFE will be set if it is called in any of the following ways:
  - From a multithreaded process and file refers to a shell script that does not exist in a threadsafe file system.
  - From a multithreaded process with a current working directory that is not in a threadsafe file system, and the PATH environment variable causes **spawnp()** to check the current working directory.
2. There are performance considerations when using **spawn()** and **spawnp()** concurrently among threads in the same process. **spawn()** and **spawnp()** serialize against other **spawn()** and **spawnp()** calls from other threads in the same process.
3. The child process is enabled for signals. A side effect of this function is that the parent process is also enabled for signals if it was not enabled for signals before this function was called.
4. If this function is called from a program running in user state and it specifies a system-domain program as the executable program for the child process, an exception occurs. In this case, **spawnp()** returns the process ID of the child process. On a subsequent call to **wait()** or **waitpid()**, the status information returned indicates that an exception occurred in the child process.
5. The program that will be run in the child process must be either a program object in the QSYS.LIB file system or an independent ASP QSYS.LIB file system (\*PGM object) or a shell script (see “About Shell Scripts” on page 68). The syntax of the name of the file to run must be the proper syntax for the file system in which the file resides. For example, if the program MYPROG resides in the QSYS.LIB file system and in library MYLIB, the specification for **spawnp()** would be the following:  
MYPROG.PGM  
See “QlgSpawn()—Spawn Process (using NLS-enabled path name)” on page 11 for an example specifying the program using the Qlg\_Path\_Name\_T structure. The Qlg\_Path\_Name\_T structure is supported by **QlgSpawn()** and allows the program name to be specified in any CCSID.  
**Note:** For more information about path syntaxes for the different file systems, see the Integrated file system information in the Files and file systems topic.
6. Spawned child processes are batch jobs or prestart jobs. As such, they do not have the ability to do 5250-type interactive I/O.
7. Spawned child processes that are i5/OS prestart jobs are similar to batch jobs. Due to the nature of prestart jobs, only the following i5/OS-specific attributes are explicitly inherited in a child process when you use prestart jobs:
  - Library list
  - Language identifier

- Country or region identifier
- Coded character set identifier
- Default coded character set identifier
- Locale (as specified in the user profile)

The child process has the same user profile as the calling thread. However, the i5/OS job attributes come from the job description specified for the prestart job entry, and the run attributes come from the class that is associated with the i5/OS subsystem used for the prestart job entry.

**Notes:**

- The prestart job entry QP0ZSPWP is used with prestart jobs that will not be creating threads. The prestart job entry QP0ZSPWT is used with prestart jobs that will allow multiple threads. Both types of prestart jobs may be used in the same subsystem. The prestart job entry must be defined for the subsystem that the **spawnp()** parent process runs under in order for it to be used.
- The following example defines a prestart job entry (QP0ZSPWP) for use by **spawnp()** under the subsystem QINTER. The **spawnp()** API must have the SPAWN\_SETPJ\_NP flag set (but not SPAWN\_SETTHREAD\_NP) in order to use these prestart jobs:

```
ADDPJE SBS(D(QSYS/QINTER) PGM(QSYS/QP0ZSPWP)
        INLJOBS(20) THRESHOLD(5) ADLJOBS(5)
        JOB(D(QGPL/QDFTJOB) MAXUSE(1)
        CLS(QGPL/QINTER)
```

- The following example defines a prestart job entry (QP0ZSPWT) that will create prestart jobs that are multithread capable for use by **spawnp()** under the subsystem QINTER. The **spawnp()** API must have both SPAWN\_SETPJ\_NP and SPAWN\_SETTHREAD\_NP flags set in order to use these prestart jobs. Also, the JOB(D parameter must be a job description that allows multiple threads as follows:

```
ADDPJE SBS(D(QSYS/QINTER) PGM(QSYS/QP0ZSPWT)
        INLJOBS(20) THRESHOLD(5) ADLJOBS(5)
        JOB(D(QSYS/QAMTJOB) MAXUSE(1)
        CLS(QGPL/QINTER)
```

Refer to the Work Management topic for complete details on prestart jobs.

- Shell scripts are allowed for the child process. If a shell script is specified, the appropriate shell interpreter program is called. The shell script must be a text file and must contain the following format on the first line of the file:

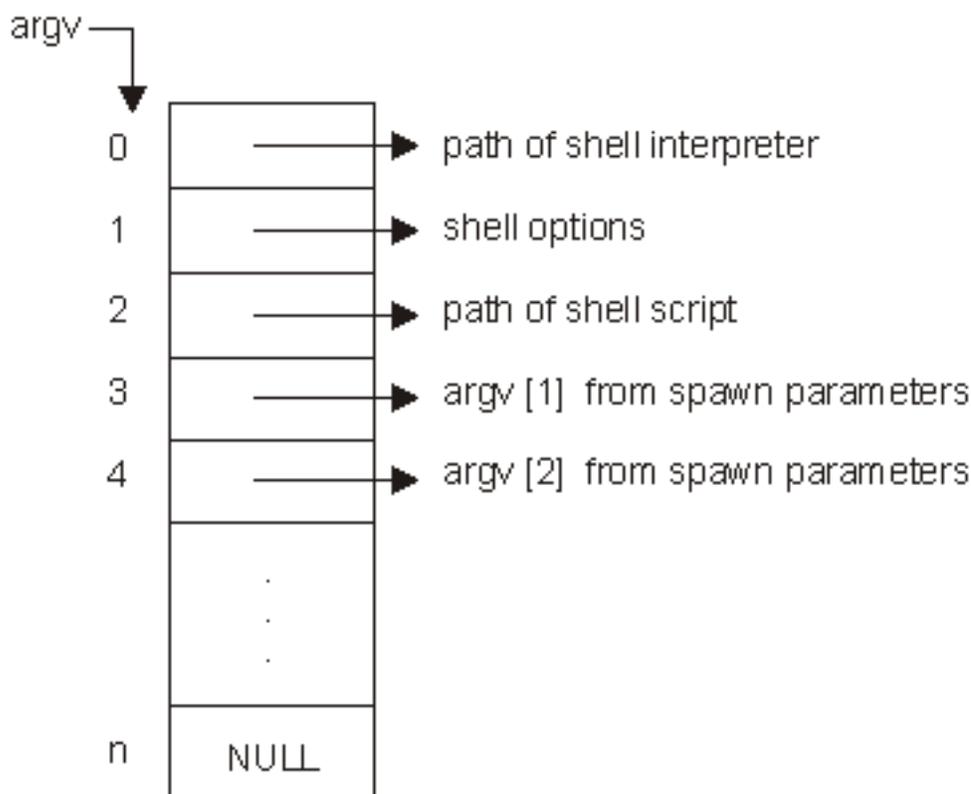
```
#!/interpreter_path <options>
```

where `interpreter_path` is the path to the shell interpreter program.

If the calling process is multithreaded, `file` (the first parameter to **spawnp()**) must reference a threadsafe file system.

**spawnp()** calls the shell interpreter, passing in the shell options and the arguments passed in as a parameter to **spawnp()**. The argument list passed into the shell interpreter will look like Arguments to Shell Interpreter (page 56).

## Arguments to Shell Interpreter



See “About Shell Scripts” on page 68 for an example using `spawn()` and shell scripts.

9. Only programs that expect arguments as null-terminated character strings can be spawned. The program that is run in the child process is called at its initial entry point. The arguments explicitly passed to the program start with element `argv[1]` of the `argv[]` parameter that was specified during the call to `spawnp()`. The program language type determines how the arguments passed are seen by that program. For example, if the program language type is ILE C or ILE C++, the linkage can be described as:

```
int main(int argc, char *argv[])
{
}
```

where the following are true:

- `argc` is the number of arguments in `argv[]`.
- `argv[]` is an array of arguments represented as null-terminated character strings.
- The last entry in the array is NULL.
- The first element in the array, `argv[0]`, is automatically set to the name of the program. Any value specified for `argv[0]` during the call to `spawnp()` will be overwritten.
- The remaining `argv[]` elements, if any, will correspond directly to the `argv[]` elements specified during the call to `spawnp()`.

The maximum number of arguments that can be specified is dependent on the following:

- The maximum number of parameters allowed for the program that is run in the child process, as seen by the DSPPGM CL command. Some programs allow up to 65 535 parameters, while others may only allow up to 255 parameters. The value of `SPAWN_MAX_NUM_ARGS` is 255, in order to maintain compatibility with programs that only allow up to 255 parameters. If the maximum number is exceeded, `spawnp()` returns -1 with `errno` set to `E2BIG`.

- The total size required for containing the arguments, which includes the array of pointers to strings, and the total size of all the strings. The total size is limited to approximately 16 500 000 bytes. If the total size is exceeded, **spawnp()** returns -1 with `errno` set to `ENOMEM`.
10. The child process does not inherit any of the environment variables of the parent process. That is, the default environment variable environment is empty. If the child process is to inherit all the parent process' environment variables, the extern variable `environ` can be used as the value for `envp[]` when **spawnp()** is called. If a specific set of environment variables is required in the child process, the user must build the `envp[]` array with the "name=value" strings. In the child process, **spawnp()** does the equivalent of a **putenv()** on each element of the `envp[]` array. Then the extern variable `environ` will be set and available to the child process' program.

**Note:** If the user of **spawnp()** specifies the extern variable `environ` as the `envp[]` parameter, the user must successfully call one of the following APIs before calling **spawnp()**:

- `getenv()`
- `putenv()`
- `Qp0zGetEnv()`
- `Qp0zInitEnv()`
- `Qp0zPutEnv()`

The extern variable `environ` is not initialized until one of these APIs is called in the current activation group. If `environ` is used in a call to **spawnp()** without first calling one of these APIs, **spawnp()** returns an error.

11. i5/OS handles `stdin`, `stdout`, and `stderr` differently than most UNIX<sup>®</sup> systems. On most UNIX systems, `stdin`, `stdout`, and `stderr` have file descriptors 0, 1, and 2 reserved and allocated for them. On i5/OS, this is not the case. There are two ramifications of this difference:
- a. File descriptor 0, 1, and 2 are allocated to the first three files that have descriptors allocated to them. If an application writes to file descriptor 1 assuming it is `stdout`, the result will not be as expected.
  - b. Any API that assumes `stdin`, `stdout`, and `stderr` are file descriptors 0, 1, and 2 will not behave as expected.

Users and applications can enable descriptor-based standard I/O for child processes by setting environment variable `QIBM_USE_DESCRIPTOR_STDIO` to the value Y in the child process. This can be accomplished on the call to **spawnp()** by either of the following:

- a. Specifying the extern variable `environ` as the `envp[]` parameter. This assumes that the `QIBM_USE_DESCRIPTOR_STDIO` environment variable exists in the calling process. The environment variable can be set by using one of the following:
  - API `putenv("QIBM_USE_DESCRIPTOR_STDIO=Y");`
  - Command `ADDENVVAR ENVVAR(QIBM_USE_DESCRIPTOR_STDIO) VALUE(Y)`
  - Command `CHGENVVAR ENVVAR(QIBM_USE_DESCRIPTOR_STDIO) VALUE(Y)`
- b. Explicitly include "QIBM\_USE\_DESCRIPTOR\_STDIO=Y" in the user-defined `envp[]` array with the "name=value" strings.

If you enable descriptor-based standard I/O for child processes, file descriptors 0, 1, and 2 are automatically used for `stdin`, `stdout`, and `stderr`, respectively. However, **spawnp()** must be called using a `fd_map` that has file descriptors 0, 1, and 2 properly allocated. See "About Shell Scripts" on page 68 for an example that enables descriptor-based standard I/O for a child process. Refer to

WebSphere<sup>®</sup> Development Studio: ILE C/C++ Programmer's Guide  for complete details on this support.

12. Spawn users have a facility to aid in debugging child processes. To help the user start a debug session (when **spawnp()** is the mechanism used to start the process), the user sets the environment variable `QIBM_CHILD_JOB_SNDINQMSG`.

If the environment variable is assigned a numerical value, it indicates the number of descendent levels that will be enabled for debugging. This support can be used to debug applications that create children, grandchildren, great-grandchildren, and so forth. When the environment variable has a value of 1, it enables debugging of all subsequent child processes. A value of 2 enables debugging of all subsequent child processes and grandchild processes.

When the environment variable has a value less than or equal to 0, or any non-numerical value, debugging will not occur.

Here are the steps a user would take to debug an application by using **spawnp(0)**:

Assume the user wants to debug child processes in an application called CHILDAPP found in library MYAPPLIB.

- Set the QIBM\_CHILD\_JOB\_SNDINQMSG environment variable to 1.

The environment variable can be set by using one of the following:

- API `putenv("QIBM_CHILD_JOB_SNDINQMSG=1");`
- Command `ADDENVVAR ENVVAR(QIBM_CHILD_JOB_SNDINQMSG) VALUE(1)`
- Command `CHGENVVAR ENVVAR(QIBM_CHILD_JOB_SNDINQMSG) VALUE(1)`

- Call or run the application that specifies CHILDAPP.PGM as the *file* on the **spawnp(0)** invocation. CHILDAPP will start running, send a CPAA980 \*INQUIRY message to the user's message queue, and then will block, waiting for a reply to the message. Issue a Work with Active Jobs (WRKACTJOB) command and find the CHILDAPP in a MSGW job status. Option 7 (Display message) performed against this job will display the CPAA980 \*INQUIRY message that was sent. As part of this message, the Qualified Job Name will be displayed in the proper format to pass to the Start Service Job (STRSRVJOB) command (for example, 145778/RANDYR/CHILDAPP).

**Note:** Alternatively, a Display Messages (DSPMSG) command can be issued for the user, and the output searched for the specific CPAA980 \*INQUIRY message.

**Note:** If the job's inquiry message reply specifies using the default message reply, the child process will not block since the default reply for the CPAA980 \*INQUIRY message is G.

- Issue a Start Service Job against the child process: `STRSRVJOB JOB(145778/RANDYR/CHILDAPP)`.
- Issue a Start Debug Command: `STRDBG PGM(MYAPPLIB/CHILDAPP)`.
- Set whatever breakpoints are needed in CHILDAPP. When ready to continue, find the CPAA980 message and reply with G. This will unblock CHILDAPP, which allows it to run until a breakpoint is reached, at which time CHILDAPP will again stop.

**Note:** If you reply with C to the CPAA980 message, the child process is ended before the child process' program ever receives control. In this case, on a subsequent call to **wait(0)** or **waitpid(0)**, the status information returned indicates `WIFEXCEPTION()`, which evaluates to a nonzero value, and `WEXCEPTNUMBER()` will evaluate to 0.
- The application is now stopped at a breakpoint and debugging can proceed.

13. By default, the child's i5/OS simple job name is derived directly from the *file* parameter. If *file* is a symbolic link to another object, the i5/OS simple job name is derived from the symbolic link itself. For example, if *file* was set to CHILD.PGM, the child's i5/OS simple job name would be CHILD. If `/usr/bin/daughter` was a symbolic link to `/QSYS.LIB/MYLIB.LIB/CHILD.PGM` and *file* was set to daughter, the child's i5/OS simple job name would be DAUGHTER.

If `SPAWN_SETJOBNAMEPARENT_NP` is set in *inherit.flags*, the child's i5/OS simple job name would be the same as the parent's i5/OS simple job name.

If `SPAWN_SETJOBNAMEARGV_NP` is set in *inherit.flags*, the null-terminated character string represented by `argv[0]` of the *argv[]* parameter will be used to derive the child's i5/OS simple job name. The name can be up to 10 characters, must be uppercase, and must contain only those characters allowed for an i5/OS job name. However, a period (.) is not considered a valid character. For example, if *file* was set to CHILD.PGM, `SPAWN_SETJOBNAMEARGV_NP` was set ON, and

`argv[0]` was set to `SON`, the child's `i5/OS` simple job name would be `SON`. If the first character of the name is invalid, the *file* will be used. If any of the remaining characters of the name are invalid, the valid characters up to that point will be used.

14. The `_NP` used at the end of certain flag names, that can be specified for the *flags* field of the *inherit* parameter, indicate the flag is a non-standard, `i5/OS`-platform-specific extension to the inheritance structure. Applications that wish to avoid using platform-specific extensions should not use these flags.
15. The child process has an associated process ID, which uses system resources. Those resources will remain in use, even after the child process has ended. In order to ensure those resources are reclaimed, the parent process should either successfully call `wait()` or `waitpid()`, or the parent process should end.

## Attributes Inherited

The child process inherits the following POSIX attributes from the parent:

1. File descriptor table (mapped according to *fd\_map*).

**Note:** The following file descriptor table information does **not** apply to any of the scan descriptors which are created by the thread executing one of the scan-related exit programs (or any of its created threads). See Integrated File System Scan on Open Exit Programs and Integrated File System Scan on Close Exit Programs for more information.

- If *fd\_map* is `NULL`, all file descriptors are inherited without being reordered.

**Note:** File descriptors that have the `FD_CLOEXEC` file descriptor flag set are not inherited. File descriptors that are created as a result of the `opendir()` API (to implement open directory streams) are not inherited.

- If *fd\_map* is not `NULL`, it is a mapping from the file descriptor table of the parent process to the file descriptor table of the child process. *fd\_count* specifies the number of file descriptors the child process will inherit. Except for those file descriptors designated by `SPAWN_FDCLOSED`, file descriptor *i* in the child process is specified by *fd\_map[i]*. For example, *fd\_map[5]= 7* sets the child process' file descriptor 5 to the parent process' file descriptor 7. File descriptors *fd\_count* through `OPEN_MAX` are closed in the child process, as are any file descriptors designated by `SPAWN_FDCLOSED`.

**Note:** File descriptors that are specified in the *fd\_map* array are inherited even if they have the `FD_CLOEXEC` file descriptor flag set. After inheritance, the `FD_CLOEXEC` flag in the child process' file descriptor is cleared.

- For files descriptors that remain open, no attributes are changed.
- If a file descriptor refers to an open instance in a file system that does not support file descriptors in two different processes pointing to the same open instance of a file, the file descriptor is closed in the child process.

Only open files managed by the `Root`, `QOpenSys`, or user-defined file systems support inheritance of their file descriptors. All other file systems will have their file descriptors closed in the child process.

2. Process group ID

- If *inherit.flags* is set to `SPAWN_SETPGROUP`, the child process group ID is set to the value in *inherit.pgroup*.

**Note:** `i5/OS` does not support the ability to set the process group ID for the child process to a user-specified group ID. This is a deviation from the POSIX standard.

- If *inherit.pgroup* is set to `SPAWN_NEWPGROUP`, the child process is put in a new process group with a process group ID equal to the process ID.
- If *inherit.pgroup* is not set to `SPAWN_NEWPGROUP`, the child process inherits the process group of the parent process.

If the process group that the child process is attempting to join has received the SIGKILL signal, the child process is ended.

3. Real user ID of the calling thread.
4. Real group ID of the calling thread.
5. Supplementary group IDs (group profile list) of the calling thread.
6. Current working directory of the parent process.
7. Root directory of the parent process.
8. File mode creation mask of the parent process.
9. Signal mask of the calling thread, except if the SPAWN\_SETSIGMASK flag is set in *inherit.flags*. Then the child process will initially have the signal mask specified in *inherit.mask*.
10. Signal action vector, as determined by the following:
  - If the SPAWN\_SETSIGDEF flag is set in *inherit.flags*, the signal specified in *inherit.sigdefault* is set to the default actions in the child process. Signals set to the default action in the parent process are set to the default action in the child process.
  - Signals set to be caught in the parent process are set to the default action in the child process.
  - Signals set to be ignored in the parent process are set to ignore in the child process, unless set to default by the above rules.
11. Priority of the parent process.  
**Note:** i5/OS prestart jobs do not inherit priority.
12. Scheduling policy (the i5/OS scheduling policy) of the parent process.
13. i5/OS-specific attributes of the parent, such as job attributes, run attributes, library list, and user profile.  
**Note:** i5/OS prestart jobs inherit a subset of i5/OS-specific attributes.
14. Resource limits of the parent process.

## Related Information

- The `<spawn.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “QlgSpawnp()—Spawn Process with Path (using NLS-enabled file name)” on page 17—Spawn Process with Path (using NLS-enabled file name)
- “spawn()—Spawn Process” on page 37—Spawn Process
- sysconf()—Get System Configuration Variables
- “wait()—Wait for Child Process to End” on page 62—Wait for Child Process to End
- “waitpid()—Wait for Specific Child Process” on page 65—Wait for Specific Child Process

## Example

For an example of using this function, see Example: Using process-related APIs in the Examples: APIs and exit programs topic.

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## ulimit()—Get and set process limits

Syntax

```
#include <ulimit.h>
```

```
long int ulimit(int cmd, ...);
```

Service Program Name: QP0WSRV1  
Default Public Authority: \*USE  
Threadsafe: Yes

The **ulimit()** function provides a way to get and set process resource limits. A resource limit is a way for the operating system to enforce a limit on a variety of resources used by a process. A resource limit has a current or soft limit and a maximum or hard limit.

The **ulimit()** function is provided for compatibility with older applications. The “getrlimit()—Get resource limit” on page 7 and “setrlimit()—Set resource limit” on page 34 functions should be used for working with resource limits.

A soft limit can be changed to any value that is less than or equal to the hard limit. The hard limit can be changed to any value that is greater than or equal to the soft limit. Only a process with appropriate authorities can increase a hard limit.

The **ulimit()** function supports the following *cmd* values:

*UL\_GETFSIZE* (0) Return the current or soft limit for the file size resource limit. The returned limit is in 512-byte blocks. The return value is the integer part of the file size resource limit divided by 512.  
*UL\_SETFSIZE* (1) Set the current or soft limit and the maximum or hard limit for the file size resource limit. The second argument is taken as a long int that represents the limit in 512-byte blocks. The specified value is multiplied by 512 to set the resource limit. If the result overflows an *rlim\_t*, **ulimit()** returns -1 and sets *errno* to EINVAL. The new file size resource limit is returned.

## Parameters

*cmd* (Input)

The command to be performed.

... (Input)

When the *cmd* is *UL\_SETFSIZE*, a long int that represents the limit in 512-byte blocks.

## Authorities and Locks

The current user profile must have \*JOBCTL special authority to increase the hard limit.

## Return Value

**value** **ulimit()** was successful. The value is the requested limit.

-1 **ulimit()** was not successful. The *errno* variable is set to indicate the error.

## Error Conditions

If **ulimit()** is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

[EINVAL]

An invalid parameter was found.

An invalid *cmd* was specified.

[EPERM]

Permission denied.

An attempt was made to increase the hard limit and the current user profile does not have \*JOBCTL special authority.

## Related Information

- The <ulimit.h> file (see “Header Files for UNIX-Type Functions” on page 70)
- “getrlimit()—Get resource limit” on page 7—Get resource limit
- “setrlimit()—Set resource limit” on page 34—Set resource limit

## Example

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

```
#include <ulimit.h>
#include <stdio.h>
#include <stdlib.h>
#include <errno.h>

int main (int argc, char *argv[])
{
    long int value;
    long int limit;

    /* Set the file size resource limit. */
    limit = 65535;
    errno = 0;
    value = ulimit(UL_SETFSIZE, limit);
    if ((value == -1) && (errno != 0)) {
        printf("ulimit() failed with errno=%d\n", errno);
        exit(1);
    }
    printf("The limit is set to %ld\n", value);

    /* Get the file size resource limit. */
    value = ulimit(UL_GETFSIZE);
    if ((value == -1) && (errno != 0)) {
        printf("ulimit() failed with errno=%d\n", errno);
        exit(1);
    }
    printf("The limit is %ld\n", value);

    exit(0);
}
```

### Example Output:

```
The limit is set to 65535
The limit is 65535
```

Introduced: V5R2

Top | UNIX-Type APIs | APIs by category

---

## wait()—Wait for Child Process to End

Syntax

```
#include <sys/types.h>
#include <sys/wait.h>

pid_t wait(int *stat_loc);
```

Service Program Name: QP0ZSPWN  
 Default Public Authority: \*USE  
 Threadsafe: Yes

The **wait()** function suspends processing until a child process has ended. The calling thread will suspend processing until status information is available for a child process that ended. A suspended **wait()** function call can be interrupted by the delivery of a signal whose action is either to run a signal-catching function or to terminate the process. When **wait()** is successful, status information about how the child process ended (for example, whether the process ended *\*stat\_loc*).

## Parameters

### *stat\_loc*

(Input) Pointer to an area where status information about how the child process ended is to be placed.

*\*stat\_loc* argument is interpreted using macros defined in the `<sys/wait.h>` header file. The macros use an argument *stat\_val*, which is the integer value *\*stat\_loc*. When **wait()** returns with a valid process ID (pid), the macros analyze the status referenced by the *\*stat\_loc* argument. The macros are as follows:

<i>WIFEXITED(stat_val)</i>	Evaluates to a nonzero value if the status was returned for a child process that ended normally.
<i>WEXITSTATUS(stat_val)</i>	If the value of the <i>WIFEXITED(stat_val)</i> is nonzero, evaluates to the low-order 8 bits of the status argument that the child process passed to <b>exit()</b> , or to the value the child process returned from <b>main()</b> .
<i>WIFSIGNALED(stat_val)</i>	Evaluates to a nonzero value if the status was returned for a child process that ended because of the receipt of a terminating signal that was not caught by the process.
<i>WTERMSIG(stat_val)</i>	If the value of <i>WIFSIGNALED(stat_val)</i> is nonzero, evaluates to the number of the signal that caused the child process to end.
<i>WIFStopPED(stat_val)</i>	Evaluates to a nonzero value if the status was returned for a child process that is currently stopped.
<i>WStopSIG(stat_val)</i>	If the value of the <i>WIFStopPED(stat_val)</i> is nonzero, evaluates to the number of the signal that caused the child process to stop.
<i>WIFEXCEPTION(stat_val)</i>	Evaluates to a nonzero value if the status was returned for a child process that ended because of an error condition.
	<b>Note:</b> The <i>WIFEXCEPTION</i> macro is unique to the i5/OS <sup>®</sup> implementation. See “Usage Notes” on page 64.
<i>WEXCEPTNUMBER(stat_val)</i>	If the value of the <i>WIFEXCEPTION(stat_val)</i> is nonzero, this macro evaluates to the last i5/OS exception number related to the child process.

**Note:** The *WEXCEPTNUMBER* macro is unique to the i5/OS implementation. See “Usage Notes” on page 64.

## Authorities

None.

## Return Value

- value*        **wait()** was successful. The value returned indicates the process ID of the child process whose status information *\*stat\_loc*.
- 1            **wait()** was not successful. The *errno* value is set to indicate the error.

## Error Conditions

If **wait()** is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

### [ECHILD]

Calling process has no remaining child processes on which wait operation can be performed.

### [EFAULT]

The address used for an argument is not correct.

In attempting to use an argument in a call, the system detected an address that is not valid.

While attempting to access a parameter passed to this function, the system detected an address that is not valid.

### [EINTR]

Interrupted function call.

### [EUNKNOWN]

Unknown system state.

The operation failed because of an unknown system state. See any messages in the job log and correct any errors that are indicated, then retry the operation.

## Usage Notes

1. The WIFEXCEPTION macro is unique to the i5/OS implementation. This macro can be used to determine whether the child process has ended because of an exception. When WIFEXCEPTION returns a nonzero value, the value returned by the WEXCEPTNUMBER macro corresponds to the last i5/OS exception number related to the child process.
2. When a child process ends because of an exception, the ILE C run-time library catches and handles the original exception. The value returned by WEXCEPTNUMBER indicates that the exception was CEE9901. This is a common exception ID. If you want to determine the original exception that ended the child process, look at the job log for the child process.
3. If the child process is ended by any of the following:
  - ENDJOB OPTION(\*IMMED)
  - ENDJOB OPTION(\*CNTRLD) and delay time was reached
  - Debugging a child process (environment variable QIBM\_CHILD\_JOB\_SNDINQMSG is used) and the resulting CPAA980 \*INQUIRY message is replied to using C,  
then the parent's **wait()** *stat\_loc* value indicates that:
    - WIFEXCEPTION(*stat\_val*) evaluates to a nonzero value
    - WEXCEPTNUMBER(*stat\_val*) evaluates to zero.

## Related Information

- The <sys/types.h> file (see "Header Files for UNIX-Type Functions" on page 70)
- The <sys/wait.h> file (see "Header Files for UNIX-Type Functions" on page 70)

- “spawn()—Spawn Process” on page 37—Spawn Process
- “spawnp()—Spawn Process with Path” on page 48—Spawn Process with Path
- “waitpid()—Wait for Specific Child Process”—Wait for Specific Child Process
- Signal Concepts

## Example

For an example of using this function, see Example: Using process-related APIs.

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## waitpid()—Wait for Specific Child Process

Syntax

```
#include <sys/types.h>
#include <sys/wait.h>
```

```
pid_t waitpid(pid_t pid, int *stat_loc, int options);
```

Service Program Name: QP0ZSPWN

Default Public Authority: \*USE

Threadsafe: Yes

The **waitpid()** function allows the calling thread to obtain status information for one of its child processes. The calling thread suspends processing until status information is available for the specified child process, if the *options* argument is 0. A suspended **waitpid()** function call can be interrupted by the delivery of a signal whose action is either to run a signal-catching function or to terminate the process. When **waitpid()** is successful, status information about how the child process ended (for example, whether the process ended normally) is stored in the location specified by *stat\_loc*.

The **waitpid()** function behaves the same as **wait()** if the *pid* argument is (pid\_t)-1 and the *options* argument is 0.

## Parameters

**pid** (Input) A process ID or a process group ID to identify the child process or processes on which **waitpid()** should operate.

**stat\_loc** (Input) Pointer to an area where status information about how the child process ended is to be placed.

**options** (Input) An integer field containing flags that define how **waitpid()** should operate.

The *pid* argument specifies a set of child processes for which status is requested. The **waitpid()** function only returns the status of a child process from the following set:

- If *pid* is equal to (pid\_t)-1, status is requested for any child process. In this respect, **waitpid()** is then equivalent to **wait()**.
- If *pid* is greater than (pid\_t)0, it specifies the process ID of a single child process for which status is requested.
- If *pid* is (pid\_t)0, status is requested for any child process whose process group ID is equal to that of the calling thread.

- If *pid* is less than (*pid\_t*)-1, status is requested for any child process whose process group ID is equal to the absolute value of *pid*.

The status referenced by the *stat\_loc* argument is interpreted using macros defined in the `<sys/wait.h>` header file. The macros use an argument *stat\_val*, which is the integer value pointed to by *stat\_loc*. When `waitpid()` returns with a valid process ID (*pid*), the macros analyze the status referenced by the *stat\_loc* argument. The macros are as follows:

<code>WIFEXITED(stat_val)</code>	Evaluates to a nonzero value if the status was returned for a child process that ended normally.
<code>WEXITSTATUS(stat_val)</code>	If the value of the <code>WIFEXITED(stat_val)</code> is nonzero, evaluates to the low-order 8 bits of the status argument that the child process passed to <code>exit()</code> , or to the value the child process returned from <code>main()</code> .
<code>WIFSIGNALED(stat_val)</code>	Evaluates to a nonzero value if the status was returned for a child process that ended because of the receipt of a terminating signal that was not caught by the process.
<code>WTERMSIG(stat_val)</code>	If the value of <code>WIFSIGNALED(stat_val)</code> is nonzero, evaluates to the number of the signal that caused the child process to end.
<code>WIFStopPED(stat_val)</code>	Evaluates to a nonzero value if the status was returned for a child process that is currently stopped.
<code>WStopSIG(stat_val)</code>	If the value of the <code>WIFStopPED(stat_val)</code> is nonzero, evaluates to the number of the signal that caused the child process to stop.
<code>WIFEXCEPTION(stat_val)</code>	Evaluates to a nonzero value if the status was returned for a child process that ended because of an error condition.
	<b>Note:</b> The <code>WIFEXCEPTION</code> macro is unique to the i5/OS <sup>®</sup> implementation. See “Usage Notes” on page 67.
<code>WEXCEPTNUMBER(stat_val)</code>	If the value of the <code>WIFEXCEPTION(stat_val)</code> is nonzero, this macro evaluates to the last i5/OS exception number related to the child process.
	<b>Note:</b> The <code>WEXCEPTNUMBER</code> macro is unique to the i5/OS implementation. See “Usage Notes” on page 67.

The *options* argument can be set to either 0 or `WNOHANG`. `WNOHANG` indicates that the `waitpid()` function should not suspend processing of the calling thread if status is not immediately available for one of the child processes specified by *pid*. If `WNOHANG` is specified and no child process is immediately available, `waitpid()` returns 0.

## Authorities

None.

## Return Value

<i>value</i>	<code>waitpid()</code> was successful. The value returned indicates the process ID of the child process whose status information was recorded in the storage pointed to by <i>stat_loc</i> .
0	<code>WNOHANG</code> was specified on the <i>options</i> parameter, but no child process was immediately available.
-1	<code>waitpid()</code> was not successful. The <i>errno</i> value is set to indicate the error.

## Error Conditions

If `waitpid()` is not successful, *errno* usually indicates one of the following errors. Under some conditions, *errno* could indicate an error other than those listed here.

[ECHILD]

Calling process has no remaining child processes on which wait operation can be performed.

[EINVAL]

The value specified for the argument is not correct.

A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.

An argument value is not valid, out of range, or NULL.

#### [EFAULT]

The address used for an argument is not correct.

In attempting to use an argument in a call, the system detected an address that is not valid.

While attempting to access a parameter passed to this function, the system detected an address that is not valid.

#### [EINTR]

Interrupted function call.

#### [EOPNOTSUPP]

Operation not supported.

The operation, though supported in general, is not supported for the requested object or the requested arguments.

#### [EUNKNOWN]

Unknown system state.

The operation failed because of an unknown system state. See any messages in the job log and correct any errors that are indicated, then retry the operation.

## Usage Notes

1. The WIFEXCEPTION macro is unique to the i5/OS implementation. This macro can be used to determine whether the child process has ended because of an exception. When WIFEXCEPTION returns a nonzero value, the value returned by the WEXCEPTNUMBER macro corresponds to the last i5/OS exception number related to the child process.
2. When a child process ends because of an exception, the ILE C run-time library catches and handles the original exception. The value returned by WEXCEPTNUMBER indicates that the exception was **CEE9901**. This is a common exception ID. If you want to determine the original exception that ended the child process, look at the job log for the child process.
3. If the child process is ended by any of the following:
  - ENDJOB OPTION(\*IMMED),
  - ENDJOB OPTION(\*CNTRLD) and delay time was reached, or
  - Debugging a child process (environment variable QIBM\_CHILD\_JOB\_SNDINQMSG is used) and the resulting CPAA980 \*INQUIRY message is replied to using C,then the parent's `wait()` `stat_loc` value indicates that:
  - WIFEXCEPTION(`stat_val`) evaluates to a nonzero value, and
  - WEXCEPTNUMBER(`stat_val`) evaluates to zero.

## Related Information

- The `<sys/types.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- The `<sys/wait.h>` file (see “Header Files for UNIX-Type Functions” on page 70)
- “spawn()—Spawn Process” on page 37—Spawn Process
- “spawnp()—Spawn Process with Path” on page 48—Spawn Process with Path
- “wait()—Wait for Child Process to End” on page 62—Wait for Child Process to End
- Signal Concepts

## Example

For an example of using this function, see Example: Using process-related APIs.

API introduced: V3R6

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## Concepts

These are the concepts for this category.

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## About Shell Scripts

A **shell** (or shell interpreter) is a command interpreter. The shell interprets text strings and performs some function for each string. As part of interpreting the string, the shell may do variable or wildcard replacement or change the string in some way. Typically, the shell itself performs functions specified by internal commands and spawns a child process to perform processing on the external commands. Depending on the command, the shell then does one of the following:

- Waits for the child process to complete
- Continues processing with the next command

A **shell script** is a text file whose format defines the following:

- A shell interpreter (path and program)
- Options or arguments to pass to the shell
- Text to be interpreted as a series of commands to the shell

The format of a shell script, starting on line one and column one, is as follows:

```
#!/interpreter_path <options>
text to be interpreted
text to be interpreted
.
.
.
```

where

`interpreter_path` is the shell interpreter.

`options` are the options to pass to the shell interpreter.

The **spawn()** and **spawnp()** functions support shell scripts. i5/OS<sup>®</sup> currently provides the Qshell Interpreter. The Qshell Interpreter is a standard command interpreter for i5/OS based on the POSIX 1003.2 standard and X/Open CAE Specification for Shell and Utilities.

## Examples

The following example uses **spawn()** to run a shell script written for the Qshell Interpreter:

**Note:** By using the code examples, you agree to the terms of the “Code license and disclaimer information” on page 81.

```
#include <stdio.h>
#include <spawn.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/wait.h>
```

```

int main(int argc, char *argv[])
{
    int fd_map[3], stdoutFds[2];
    char *xmp_argv[4], *xmp_envp[3];
    struct inheritance xmp_inherit = {0};
    char buffer[20];
    pid_t child_pid, wait_rv;
    int wait_stat_loc, rc;

    xmp_argv[0] = "/home/myuserid/myscript";
    xmp_argv[1] = "Hello";
    xmp_argv[2] = "world!";
    xmp_argv[3] = NULL;

    xmp_envp[0] =
        "NLSPATH=/QIBM/ProdData/OS400/Shell/MRI2924/%N";
    xmp_envp[1] = "QIBM_USE_DESCRIPTOR_STDIO=Y";
    xmp_envp[2] = NULL;

    if (pipe(stdoutFds) != 0) {
        printf("failure on pipe\n");
        return 1;
    }

    fd_map[0] = stdoutFds[1];
    fd_map[1] = stdoutFds[1];
    fd_map[2] = stdoutFds[1];

    if ((child_pid = spawn("/home/myuserid/myscript", 3,
                          fd_map, &xmp_inherit, xmp_argv,
                          xmp_envp)) == -1) {
        printf("failure on spawn\n");
        return 1;
    }

    if ((wait_rv = waitpid(child_pid,
                          &wait_stat_loc, 0)) == -1) {
        printf("failure on waitpid\n");
        return 1;
    }
    close(stdoutFds[1]);

    while ((rc = read(stdoutFds[0],
                     buffer, sizeof(buffer))) > 0) {
        buffer[rc] = '\0';
        printf("%s", buffer);
    }
    close(stdoutFds[0]);
    return 0;
}

```

where `"/home/myuserid/myscript"` could look like the following:

```

#!/usr/bin/qsh
print $1 $2

```

### Example Output:

```

Hello world!

```

---

## Header Files for UNIX-Type Functions

Programs using the UNIX<sup>®</sup>-type functions must include one or more header files that contain information needed by the functions, such as:

- Macro definitions
- Data type definitions
- Structure definitions
- Function prototypes

The header files are provided in the QSYSINC library, which is optionally installable. Make sure QSYSINC is on your system before compiling programs that use these header files. For information about installing the QSYSINC library, see [Include files](#) and the [QSYSINC library](#).

The table below shows the file and member name in the QSYSINC library for each header file used by the UNIX-type APIs in this publication.

Name of Header File	Name of File in QSYSINC	Name of Member
arpa/inet.h	ARPA	INET
arpa/nameser.h	ARPA	NAMESER
bse.h	H	BSE
bsdos.h	H	BSEDOS
bseerr.h	H	BSEERR
dirent.h	H	DIRENT
errno.h	H	ERRNO
fcntl.h	H	FCNTL
grp.h	H	GRP
inttypes.h	H	INTTYPES
limits.h	H	LIMITS
netdbh.h	H	NETDB
netinet/icmp6.h	NETINET	ICMP6
net/if.h	NET	IF
netinet/in.h	NETINET	IN
netinet/ip_icmp.h	NETINET	IP_ICMP
netinet/ip.h	NETINET	IP
netinet/ip6.h	NETINET	IP6
netinet/tcp.h	NETINET	TCP
netinet/udp.h	NETINET	UDP
netns/idp.h	NETNS	IDP
netns/ipx.h	NETNS	IPX
netns/ns.h	NETNS	NS
netns/sp.h	NETNS	SP
net/route.h	NET	ROUTE
nettel/tel.h	NETTEL	TEL
os2.h	H	OS2
os2def.h	H	OS2DEF

Name of Header File	Name of File in QSYSINC	Name of Member
pwd.h	H	PWD
Qlg.h	H	QLG
qp0lchsg.h	H	QP0LCHSG
qp0lflop.h	H	QP0LFLOP
qp0ljrnl.h	H	QP0LJRNL
qp0lrer.h	H	QP0LROR
qp0lrro.h	H	QP0LRRO
qp0lrtsg.h	H	QP0LRTSG
qp0lscan.h	H	QP0LSCAN
Qp0lstdi.h	H	QP0LSTDI
qp0wpid.h	H	QP0WPID
qp0zdipc.h	H	QP0ZDIPC
qp0zipc.h	H	QP0ZIPC
qp0zolip.h	H	QP0ZOLIP
qp0zolsm.h	H	QP0ZOLSM
qp0zrpic.h	H	QP0ZRIPC
qp0ztrc.h	H	QP0ZTRC
qp0ztrml.h	H	QP0ZTRML
qp0z1170.h	H	QP0Z1170
qsoasync.h	H	QSOASYNC
qtnxaapi.h	H	QTNXAAPI
qtnxadtp.h	H	QTNXADTP
qtomeapi.h	H	QTOMEAPI
qtossapi.h	H	QTOSSAPI
resolv.h	H	» RESOLV «
semaphore.h	H	SEMAPHORE
signal.h	H	SIGNAL
spawn.h	H	SPAWN
ssl.h	H	SSL
sys/errno.h	H	ERRNO
sys/ioctl.h	SYS	IOCTL
sys/ipc.h	SYS	IPC
sys/layout.h	» SYS «	LAYOUT
sys/limits.h	H	LIMITS
» sys/mman.h	SYS «	MMAN
sys/msg.h	SYS	MSG
sys/param.h	SYS	PARAM
sys/resource.h	SYS	RESOURCE
sys/sem.h	SYS	SEM
sys/setjmp.h	SYS	SETJMP
sys/shm.h	SYS	SHM

Name of Header File	Name of File in QSYSINC	Name of Member
sys/signal.h	SYS	SIGNAL
sys/socket.h	SYS	SOCKET
sys/stat.h	SYS	STAT
sys/statvfs.h	SYS	STATVFS
sys/time.h	SYS	TIME
sys/types.h	SYS	TYPES
sys/uio.h	SYS	UIO
sys/un.h	SYS	UN
sys/wait.h	SYS	WAIT
ulimit.h	H	ULIMIT
unistd.h	H	UNISTD
utime.h	H	UTIME

You can display a header file in QSYSINC by using one of the following methods:

- Using your editor. For example, to display the **unistd.h** header file using the Source Entry Utility editor, enter the following command:  
STRSEU SRCFILE(QSYSINC/H) SRCMBR(UNISTD) OPTION(5)
- Using the Display Physical File Member command. For example, to display the **sys/stat.h** header file, enter the following command:  
DSPPFM FILE(QSYSINC/SYS) MBR(STAT)

You can print a header file in QSYSINC by using one of the following methods:

- Using your editor. For example, to print the **unistd.h** header file using the Source Entry Utility editor, enter the following command:  
STRSEU SRCFILE(QSYSINC/H) SRCMBR(UNISTD) OPTION(6)
- Using the Copy File command. For example, to print the **sys/stat.h** header file, enter the following command:  
CPYF FROMFILE(QSYSINC/SYS) TOFILE(\*PRINT) FROMMBR(STAT)

Symbolic links to these header files are also provided in directory /QIBM/include.

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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## Errno Values for UNIX-Type Functions

Programs using the UNIX<sup>®</sup>-type functions may receive error information as *errno* values. The possible values returned are listed here in ascending *errno* value sequence.

Name	Value	Text	Details
EDOM	3001	A domain error occurred in a math function.	
ERANGE	3002	A range error occurred.	
ETRUNC	3003	Data was truncated on an input, output, or update operation.	

Name	Value	Text	Details
ENOTOPEN	3004	File is not open.	You attempted to do an operation that required the file to be open.
ENOTREAD	3005	File is not opened for read operations.	You tried to read a file that is not open for read operations.
EIO	3006	Input/output error.	A physical I/O error occurred or a referenced object was damaged.
ENODEV	3007	No such device.	
ERECIO	3008	Cannot get single character for files opened for record I/O.	The file that was specified is open for record I/O and you attempted to read it as a stream file.
ENOTWRITE	3009	File is not opened for write operations.	You tried to update a file that has not been opened for write operations.
ESTDIN	3010	The stdin stream cannot be opened.	
ESTDOUT	3011	The stdout stream cannot be opened.	
ESTDERR	3012	The stderr stream cannot be opened.	
EBADSEEK	3013	The positioning parameter in fseek is not correct.	
EBADNAME	3014	The object name specified is not correct.	
EBADMODE	3015	The type variable specified on the open function is not correct.	The mode that you attempted to open the file in is not correct.
EBADPOS	3017	The position specifier is not correct.	
ENOPOS	3018	There is no record at the specified position.	You attempted to position to a record that does not exist in the file.
ENUMMBRS	3019	Attempted to use ftell on multiple members.	Remove all but one member from the file.
ENUMRECS	3020	The current record position is too long for ftell.	
EINVAL	3021	The value specified for the argument is not correct.	A function was passed incorrect argument values, or an operation was attempted on an object and the operation specified is not supported for that type of object.
EBADFUNC	3022	Function parameter in the signal function is not set.	
ENOENT	3025	No such path or directory.	The directory or a component of the path name specified does not exist.
ENOREC	3026	Record is not found.	
EPERM	3027	The operation is not permitted.	You must have appropriate privileges or be the owner of the object or other resource to do the requested operation.
EBADDATA	3028	Message data is not valid.	The message data that was specified for the error text is not correct.
EBUSY	3029	Resource busy.	An attempt was made to use a system resource that is not available at this time.
EBADOPT	3040	Option specified is not valid.	
ENOTUPD	3041	File is not opened for update operations.	

Name	Value	Text	Details
ENOTDLT	3042	File is not opened for delete operations.	
EPAD	3043	The number of characters written is shorter than the expected record length.	The length of the record is longer than the buffer size that was specified. The data written was padded to the length of the record.
EBADKEYLN	3044	A length that was not valid was specified for the key.	You attempted a record I/O against a keyed file. The key length that was specified is not correct.
EPUTANDGET	3080	» A write operation should not immediately follow a read operation. «	
EGETANDPUT	3081	» A read operation should not immediately follow a write operation. «	
EIOERROR	3101	A nonrecoverable I/O error occurred.	
EIORECERR	3102	A recoverable I/O error occurred.	
EACCES	3401	Permission denied.	An attempt was made to access an object in a way forbidden by its object access permissions.
ENOTDIR	3403	Not a directory.	A component of the specified path name existed, but it was not a directory when a directory was expected.
ENOSPC	3404	No space is available.	The requested operations required additional space on the device and there is no space left. This could also be caused by exceeding the user profile storage limit when creating or transferring ownership of an object.
EXDEV	3405	Improper link.	A link to a file on another file system was attempted.
EAGAIN	3406	Operation would have caused the process to be suspended.	
EWouldBLOCK	3406	Operation would have caused the process to be suspended.	
EINTR	3407	Interrupted function call.	
EFAULT	3408	The address used for an argument was not correct.	In attempting to use an argument in a call, the system detected an address that is not valid.
ETIME	3409	Operation timed out.	
ENXIO	3415	No such device or address.	
ECLOSED	3417	Socket closed.	
EAPAR	3418	Possible APAR condition or hardware failure.	
ERECURSE	3419	Recursive attempt rejected.	
EADDRINUSE	3420	Address already in use.	
EADDRNOTAVAIL	3421	Address is not available.	
EAFNOSUPPORT	3422	The type of socket is not supported in this protocol family.	

Name	Value	Text	Details
EALREADY	3423	Operation is already in progress.	
ECONNABORTED	3424	Connection ended abnormally.	
ECONNREFUSED	3425	A remote host refused an attempted connect operation.	
ECONNRESET	3426	A connection with a remote socket was reset by that socket.	
EDESTADDRREQ	3427	Operation requires destination address.	
EHOSTDOWN	3428	A remote host is not available.	
EHOSTUNREACH	3429	A route to the remote host is not available.	
EINPROGRESS	3430	Operation in progress.	
EISCONN	3431	A connection has already been established.	
EMSGSIZE	3432	Message size is out of range.	
ENETDOWN	3433	The network is currently not available.	
ENETRESET	3434	A socket is connected to a host that is no longer available.	
ENETUNREACH	3435	Cannot reach the destination network.	
ENOBUFS	3436	There is not enough buffer space for the requested operation.	
ENOPROTOPT	3437	The protocol does not support the specified option.	
ENOTCONN	3438	Requested operation requires a connection.	
ENOTSOCK	3439	The specified descriptor does not reference a socket.	
ENOTSUP	3440	Operation is not supported.	The operation, though supported in general, is not supported for the requested object or the requested arguments.
EOPNOTSUPP	3440	Operation is not supported.	The operation, though supported in general, is not supported for the requested object or the requested arguments.
EPFNOSUPPORT	3441	The socket protocol family is not supported.	
EPROTONOSUPPORT	3442	No protocol of the specified type and domain exists.	
EPROTOTYPE	3443	The socket type or protocols are not compatible.	
ERCVDERR	3444	An error indication was sent by the peer program.	
ESHUTDOWN	3445	Cannot send data after a shutdown.	
ESOCKTNOSUPPORT	3446	The specified socket type is not supported.	

Name	Value	Text	Details
ETIMEDOUT	3447	A remote host did not respond within the timeout period.	
EUNATCH	3448	The protocol required to support the specified address family is not available at this time.	
EBADF	3450	Descriptor is not valid.	A file descriptor argument was out of range, referred to a file that was not open, or a read or write request was made to a file that is not open for that operation.
EMFILE	3452	Too many open files for this process.	An attempt was made to open more files than allowed by the value of OPEN_MAX. The value of OPEN_MAX can be retrieved using the sysconf() function.
ENFILE	3453	Too many open files in the system.	A system limit has been reached for the number of files that are allowed to be concurrently open in the system.
EPIPE	3455	Broken pipe.	
ECANCEL	3456	Operation cancelled.	
EEXIST	3457	Object exists.	The object specified already exists and the specified operation requires that it not exist.
EDEADLK	3459	Resource deadlock avoided.	An attempt was made to lock a system resource that would have resulted in a deadlock situation. The lock was not obtained.
ENOMEM	3460	Storage allocation request failed.	A function needed to allocate storage, but no storage is available.
EOWNERTERM	3462	The synchronization object no longer exists because the owner is no longer running.	The process that had locked the mutex is no longer running, so the mutex was deleted.
EDESTROYED	3463	The synchronization object was destroyed, or the object no longer exists.	
ETERM	3464	Operation was terminated.	
ENOENT1	3465	No such file or directory.	A component of a specified path name did not exist, or the path name was an empty string.
ENOEQFLOG	3466	Object is already linked to a dead directory.	The link as a dead option was specified, but the object is already marked as dead. Only one dead link is allowed for an object.
EEMPTYDIR	3467	Directory is empty.	A directory with entries of only dot and dot-dot was supplied when a nonempty directory was expected.
EMLINK	3468	Maximum link count for a file was exceeded.	An attempt was made to have the link count of a single file exceed LINK_MAX. The value of LINK_MAX can be determined using the pathconf() or the fpathconf() function.

Name	Value	Text	Details
ESPIPE	3469	Seek request is not supported for object.	A seek request was specified for an object that does not support seeking.
ENOSYS	3470	Function not implemented.	An attempt was made to use a function that is not available in this implementation for any object or any arguments.
EISDIR	3471	Specified target is a directory.	The path specified named a directory where a file or object name was expected.
EROFS	3472	Read-only file system.	You have attempted an update operation in a file system that only supports read operations.
EC2	3473	C2 pointer validation error.	
EUNKNOWN	3474	Unknown system state.	The operation failed because of an unknown system state. See any messages in the job log and correct any errors that are indicated, then retry the operation.
EITERBAD	3475	Iterator is not valid.	
EITERSTE	3476	Iterator is in wrong state for operation.	
EHRICLSBAD	3477	HRI class is not valid.	
EHRICLBAD	3478	HRI subclass is not valid.	
EHRITYPBAD	3479	HRI type is not valid.	
ENOTAPPL	3480	Data requested is not applicable.	
EHRIREQTYP	3481	HRI request type is not valid.	
EHRINAMEBAD	3482	HRI resource name is not valid.	
EDAMAGE	3484	A damaged object was encountered.	
ELOOP	3485	A loop exists in the symbolic links.	This error is issued if the number of symbolic links encountered is more than POSIX_SYMLLOOP (defined in the limits.h header file). Symbolic links are encountered during resolution of the directory or path name.
ENAMETOOLONG	3486	A path name is too long.	A path name is longer than PATH_MAX characters or some component of the name is longer than NAME_MAX characters while _POSIX_NO_TRUNC is in effect. For symbolic links, the length of the name string substituted for a symbolic link exceeds PATH_MAX. The PATH_MAX and NAME_MAX values can be determined using the <b>pathconf()</b> function.
ENOLCK	3487	No locks are available.	A system-imposed limit on the number of simultaneous file and record locks was reached, and no more were available at that time.
ENOTEMPTY	3488	Directory is not empty.	You tried to remove a directory that is not empty. A directory cannot contain objects when it is being removed.

Name	Value	Text	Details
ENOSYSRSC	3489	System resources are not available.	
ECONVERT	3490	Conversion error.	One or more characters could not be converted from the source CCSID to the target CCSID.
E2BIG	3491	Argument list is too long.	
EILSEQ	3492	Conversion stopped due to input character that does not belong to the input codeset.	
ETYPE	3493	Object type mismatch.	The type of the object referenced by a descriptor does not match the type specified on the interface.
EBADDIR	3494	Attempted to reference a directory that was not found or was destroyed.	
EBADOBJ	3495	Attempted to reference an object that was not found, was destroyed, or was damaged.	
EIDXINVAL	3496	Data space index used as a directory is not valid.	
ESOFTDAMAGE	3497	Object has soft damage.	
ENOTENROLL	3498	User is not enrolled in system distribution directory.	You attempted to use a function that requires you to be enrolled in the system distribution directory and you are not.
EOffline	3499	Object is suspended.	You have attempted to use an object that has had its data saved and the storage associated with it freed. An attempt to retrieve the object's data failed. The object's data cannot be used until it is successfully restored. The object's data was saved and freed either by saving the object with the STG(*FREE) parameter, or by calling an API.
EROOBJ	3500	Object is read-only.	You have attempted to update an object that can be read only.
EEAHDDSI	3501	Hard damage on extended attribute data space index.	
EEASDDSI	3502	Soft damage on extended attribute data space index.	
EEAHDDS	3503	Hard damage on extended attribute data space.	
EEASDDS	3504	Soft damage on extended attribute data space.	
EEADUPRC	3505	Duplicate extended attribute record.	
ELOCKED	3506	Area being read from or written to is locked.	The read or write of an area conflicts with a lock held by another process.
EFBIG	3507	Object too large.	The size of the object would exceed the system allowed maximum size.
EIDRM	3509	The semaphore, shared memory, or message queue identifier is removed from the system.	

Name	Value	Text	Details
ENOMSG	3510	The queue does not contain a message of the desired type and (msgflg logically ANDed with IPC_NOWAIT).	
EFILECVT	3511	File ID conversion of a directory failed.	To recover from this error, run the Reclaim Storage (RCLSTG) command as soon as possible.
EBADFID	3512	A file ID could not be assigned when linking an object to a directory.	The file ID table is missing or damaged. To recover from this error, run the Reclaim Storage (RCLSTG) command as soon as possible.
ESTALE	3513	File or object handle rejected by server.	
ESRCH	3515	No such process.	
ENOTSIGINIT	3516	Process is not enabled for signals.	An attempt was made to call a signal function under one of the following conditions: <ul style="list-style-type: none"> <li>• The signal function is being called for a process that is not enabled for asynchronous signals.</li> <li>• The signal function is being called when the system signal controls have not been initialized.</li> </ul>
ECHILD	3517	No child process.	
EBADH	3520	Handle is not valid.	
ETOOMANYREFS	3523	The operation would have exceeded the maximum number of references allowed for a descriptor.	
ENOTSAFE	3524	Function is not allowed.	Function is not allowed in a job that is running with multiple threads.
E_OVERFLOW	3525	Object is too large to process.	The object's data size exceeds the limit allowed by this function.
EJRNDDAMAGE	3526	Journal is damaged.	A journal or all of the journal's attached journal receivers are damaged, or the journal sequence number has exceeded the maximum value allowed. This error occurs during operations that were attempting to send an entry to the journal.
EJRNINACTIVE	3527	Journal is inactive.	The journaling state for the journal is *INACTIVE. This error occurs during operations that were attempting to send an entry to the journal.
EJRNRCVSPC	3528	Journal space or system storage error.	The attached journal receiver does not have space for the entry because the storage limit has been exceeded for the system, the object, the user profile, or the group profile. This error occurs during operations that were attempting to send an entry to the journal.

Name	Value	Text	Details
EJRNRMT	3529	Journal is remote.	The journal is a remote journal. Journal entries cannot be sent to a remote journal. This error occurs during operations that were attempting to send an entry to the journal.
ENEWJRRCV	3530	New journal receiver is needed.	A new journal receiver must be attached to the journal before entries can be journaled. This error occurs during operations that were attempting to send an entry to the journal.
ENEWJRN	3531	New journal is needed.	The journal was not completely created, or an attempt to delete it did not complete successfully. This error occurs during operations that were attempting to start or end journaling, or were attempting to send an entry to the journal.
EJOURNALED	3532	Object already journaled.	A start journaling operation was attempted on an object that is already being journaled.
EJRMENTTOOLONG	3533	Entry is too large to send.	The journal entry generated by this operation is too large to send to the journal.
EDATALINK	3534	Object is a datalink object.	
ENOTAVAIL	3535	Independent Auxiliary Storage Pool (ASP) is not available.	The independent ASP is in Vary Configuration (VRYCFG) or Reclaim Storage (RCLSTG) processing. To recover from this error, wait until processing has completed for the independent ASP.
ENOTTY	3536	I/O control operation is not appropriate.	
EFBIG2	3540	Attempt to write or truncate file past its sort file size limit.	
ETXTBSY	3543	Text file busy.	An attempt was made to execute an i5/OS® PASE program that is currently open for writing, or an attempt has been made to open for writing an i5/OS PASE program that is being executed.
EASPRPNOTSET	3544	ASP group not set for thread.	
ERESTART	3545	A system call was interrupted and may be restarted.	
ESCANFAILURE	3546	Object had scan failure.	An object has been marked as a scan failure due to processing by an exit program associated with the scan-related integrated file system exit points.

[Top](#) | [UNIX-Type APIs](#) | [APIs by category](#)

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