<https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/monitor-memory-usage?view=sql-server-ver16>

# Monitor memory usage

* Article
* 12/04/2023
* 7 contributors

Feedback

## In this article

1. [Configure SQL Server max memory](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/monitor-memory-usage?view=sql-server-ver16#configuring-include-ssnoversionincludesssnoversion-mdmd-max-memory)
2. [Monitor operating system memory](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/monitor-memory-usage?view=sql-server-ver16#monitor-operating-system-memory)
3. [Isolate memory used by SQL Server](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/monitor-memory-usage?view=sql-server-ver16#isolating-memory-used-by-include-ssnoversionincludesssnoversion-mdmd)
4. [Examples](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/monitor-memory-usage?view=sql-server-ver16#examples)
5. [Related content](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/monitor-memory-usage?view=sql-server-ver16#related-content)

**Applies to:**  [SQL Server](https://learn.microsoft.com/en-us/sql/sql-server/sql-docs-navigation-guide?view=sql-server-ver16#applies-to)

Monitor an instance of SQL Server periodically to confirm that memory usage is within typical ranges.

## Configure SQL Server max memory

By default, a SQL Server instance may over time consume most of the available Windows operating system memory in the server. Once the memory is acquired, it will not be released unless memory pressure is detected. This is by design and does not indicate a memory leak in the SQL Server process. Use [the **max server memory** option](https://learn.microsoft.com/en-us/sql/database-engine/configure-windows/server-memory-server-configuration-options?view=sql-server-ver16) to limit the amount of memory that SQL Server is allowed to acquire for most of its uses. For more information, see the [Memory Management Architecture Guide](https://learn.microsoft.com/en-us/sql/relational-databases/memory-management-architecture-guide?view=sql-server-ver16#changes-to-memory-management-starting-with-).

In SQL Server on Linux, [set the memory limit](https://learn.microsoft.com/en-us/sql/linux/sql-server-linux-performance-best-practices?view=sql-server-ver16#advanced-configuration) with the mssql-conf tool and the [memory.memorylimitmb setting](https://learn.microsoft.com/en-us/sql/linux/sql-server-linux-configure-mssql-conf?view=sql-server-ver16#memorylimit).

## Monitor operating system memory

To monitor for a low-memory condition, use the following Windows server counters. Many operating system memory counters can be queried via the dynamic management views [sys.dm\_os\_process\_memory](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-process-memory-transact-sql?view=sql-server-ver16) and [sys.dm\_os\_sys\_memory](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-sys-memory-transact-sql?view=sql-server-ver16).

* **Memory: Available Bytes**  
  This counter indicates how many bytes of memory are currently available for use by processes. Low values for the **Available Bytes** counter can indicate an overall shortage of operating system memory. This value can be queried via T-SQL using [sys.dm\_os\_sys\_memory](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-sys-memory-transact-sql?view=sql-server-ver16).available\_physical\_memory\_kb.
* **Memory: Pages/sec**  
  This counter indicates the number of pages that either were retrieved from disk due to hard page faults or written to disk to free space in the working set due to page faults. A high rate for the **Pages/sec** counter could indicate excessive paging.
* **Memory: Page Faults/sec** This counter indicates the rate of Page Faults for all processes including system processes. A low but non-zero rate of paging to disk (and hence page faults) is typical, even if the computer has plenty of available memory. The Microsoft Windows Virtual Memory Manager (VMM) takes pages from SQL Server and other processes as it trims the working-set sizes of those processes. This VMM activity tends to cause page faults.
* **Process: Page Faults/sec** This counter indicates the rate of Page Faults for a given user process. Monitor **Process: Page Faults/sec** to determine if disk activity is caused by paging by SQL Server. To determine whether SQL Server or another process is the cause of excessive paging, monitor the **Process: Page Faults/sec** counter for the SQL Server process instance.

For more information about resolving excessive paging, see the operating system documentation.

## Isolate memory used by SQL Server

To monitor SQL Server memory usage, use the following [SQL Server object counters](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/use-sql-server-objects?view=sql-server-ver16). Many SQL Server object counters can be queried via the dynamic management views [sys.dm\_os\_performance\_counters](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-performance-counters-transact-sql?view=sql-server-ver16) or [sys.dm\_os\_process\_memory](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-process-memory-transact-sql?view=sql-server-ver16).

By default, SQL Server manages its memory requirements dynamically, based on available system resources. If SQL Server needs more memory, it queries the operating system to determine whether free physical memory is available and uses the available memory. If there is low free memory for the OS, SQL Server will release memory back to the operating system until the low memory condition is alleviated, or until SQL Server reaches the **min server memory** limit. However, you can override the option to dynamically use memory by using the **min server memory**, and **max server memory** server configuration options. For more information, see [Server Memory Options](https://learn.microsoft.com/en-us/sql/database-engine/configure-windows/server-memory-server-configuration-options?view=sql-server-ver16).

To monitor the amount of memory that SQL Server uses, examine the following performance counters:

* **SQL Server: Memory Manager: Total Server Memory (KB)**  
  This counter indicates the amount of the operating system's memory the SQL Server memory manager currently has committed to SQL Server. This number is expected to grow as required by actual activity, and will grow following SQL Server startup. Query this counter using the [sys.dm\_os\_sys\_info](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-sys-info-transact-sql?view=sql-server-ver16) dynamic management view, observing the **committed\_kb** column.
* **SQL Server: Memory Manager: Target Server Memory (KB)**  
  This counter indicates an ideal amount of memory SQL Server could consume, based on recent workload. Compare to **Total Server Memory** after a period of typical operation to determine whether SQL Server has a desired amount of memory allocated. After typical operation, **Total Server Memory** and **Target Server Memory** should be similar. If **Total Server Memory** is significantly lower than **Target Server Memory**, the SQL Server instance may be experiencing memory pressure. During a period after SQL Server is started, **Total Server Memory** is expected to be lower than **Target Server Memory**, as **Total Server Memory** grows. Query this counter using the [sys.dm\_os\_sys\_info](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-sys-info-transact-sql?view=sql-server-ver16) dynamic management view, observing the **committed\_target\_kb** column. For more information and best practices configuring memory, see the [Server memory configuration options](https://learn.microsoft.com/en-us/sql/database-engine/configure-windows/server-memory-server-configuration-options?view=sql-server-ver16#manually).
* **Process: Working Set**  
  This counter indicates the amount of physical memory that is in use by a process currently, according to the operating system. Observe the sqlservr.exe instance of this counter. Query this counter using the [sys.dm\_os\_process\_memory](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-process-memory-transact-sql?view=sql-server-ver16) dynamic management view, observing the physical\_memory\_in\_use\_kb column.
* **Process: Private Bytes**  
  This counter indicates the amount of memory that a process has requested for its own use to the operating system. Observe the sqlservr.exe instance of this counter. Because this counter includes all memory allocations requested by sqlservr.exe, including those not limited by [the max server memory option](https://learn.microsoft.com/en-us/sql/database-engine/configure-windows/server-memory-server-configuration-options?view=sql-server-ver16), this counter can report values larger than [the max server memory option](https://learn.microsoft.com/en-us/sql/database-engine/configure-windows/server-memory-server-configuration-options?view=sql-server-ver16).
* **SQL Server: Buffer Manager: Database Pages**  
  This counter indicates the number of pages in the buffer pool with database content. Does not include other nonbuffer pool memory within the SQL Server process. Query this counter using the [sys.dm\_os\_performance\_counters](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-performance-counters-transact-sql?view=sql-server-ver16) dynamic management view.
* **SQL Server: Buffer Manager: Buffer Cache Hit Ratio**  
  This counter is specific to SQL Server. A ratio of 90 or higher is desirable. A value greater than 90 indicates that more than 90 percent of all requests for data were satisfied from the data cache in memory without having to read from disk. Find more information on the SQL Server Buffer Manager, see the [SQL Server Buffer Manager Object](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/sql-server-buffer-manager-object?view=sql-server-ver16). Query this counter using the [sys.dm\_os\_performance\_counters](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-performance-counters-transact-sql?view=sql-server-ver16) dynamic management view.
* **SQL Server: Buffer Manager: Page life expectancy**  
  This counter measures amount of time in seconds that the oldest page stays in the buffer pool. For systems that use a NUMA architecture, this is the average across the all NUMA nodes. A higher, growing value is best. A sudden dip indicates a significant churn of data in and out of the buffer pool, indicating the workload could not fully benefit from data already in memory. Each NUMA node has its own node of the buffer pool. On servers with more than one NUMA node, view each buffer pool node's page life expectancy using **SQL Server: Buffer Node: Page life expectancy**. Query this counter using the [sys.dm\_os\_performance\_counters](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-performance-counters-transact-sql?view=sql-server-ver16) dynamic management view.

## Examples

### Determine current memory allocation

The following queries return information about currently allocated memory.

SQLCopy

SELECT

(total\_physical\_memory\_kb/1024) AS Total\_OS\_Memory\_MB,

(available\_physical\_memory\_kb/1024) AS Available\_OS\_Memory\_MB

FROM sys.dm\_os\_sys\_memory;

SELECT

(physical\_memory\_in\_use\_kb/1024) AS Memory\_used\_by\_Sqlserver\_MB,

(locked\_page\_allocations\_kb/1024) AS Locked\_pages\_used\_by\_Sqlserver\_MB,

(total\_virtual\_address\_space\_kb/1024) AS Total\_VAS\_in\_MB,

process\_physical\_memory\_low,

process\_virtual\_memory\_low

FROM sys.dm\_os\_process\_memory;

### Determine current SQL Server memory utilization

The following query returns information about current SQL Server memory utilization.

SQLCopy

SELECT

sqlserver\_start\_time,

(committed\_kb/1024) AS Total\_Server\_Memory\_MB,

(committed\_target\_kb/1024) AS Target\_Server\_Memory\_MB

FROM sys.dm\_os\_sys\_info;

### Determine page life expectancy

The following query uses sys.dm\_os\_performance\_counters to observe the SQL Server instance's current **page life expectancy** value at the overall buffer manager level, and at each NUMA node level.

SQLCopy

SELECT

CASE instance\_name WHEN '' THEN 'Overall' ELSE instance\_name END AS NUMA\_Node, cntr\_value AS PLE\_s

FROM sys.dm\_os\_performance\_counters

WHERE counter\_name = 'Page life expectancy';

## Related content

* [Monitor Resource Usage (Performance Monitor)](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/monitor-resource-usage-system-monitor?view=sql-server-ver16)
* [sys.dm\_os\_sys\_memory (Transact-SQL)](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-sys-memory-transact-sql?view=sql-server-ver16)
* [sys.dm\_os\_process\_memory (Transact-SQL)](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-process-memory-transact-sql?view=sql-server-ver16)
* [sys.dm\_os\_sys\_info (Transact-SQL)](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-sys-info-transact-sql?view=sql-server-ver16)
* [sys.dm\_os\_performance\_counters (Transact-SQL)](https://learn.microsoft.com/en-us/sql/relational-databases/system-dynamic-management-views/sys-dm-os-performance-counters-transact-sql?view=sql-server-ver16)
* [SQL Server, Memory Manager object](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/sql-server-memory-manager-object?view=sql-server-ver16)
* [SQL Server, Buffer Manager object](https://learn.microsoft.com/en-us/sql/relational-databases/performance-monitor/sql-server-buffer-manager-object?view=sql-server-ver16)
* [Server memory configuration options](https://learn.microsoft.com/en-us/sql/database-engine/configure-windows/server-memory-server-configuration-options?view=sql-server-ver16)
* [Memory management architecture guide](https://learn.microsoft.com/en-us/sql/relational-databases/memory-management-architecture-guide?view=sql-server-ver16)