INTRINSIC DATA TYPES

What does “intrinsic data types” mean?

Intrinsic data types are the **built-in data sizes** that the assembler understands.

They answer three simple questions:

1. **How big is the data?** (8 bits, 16 bits, 32 bits, etc.)
2. **Is it signed or unsigned?** (can it be negative?)
3. **Is it an integer or a real (floating-point) number?**

That’s it. No magic.

What the assembler actually cares about

Here’s the key idea:

The assembler mainly cares about **size**.

It needs to know:

- how many bytes to reserve
- how many bytes an instruction will read or write

The assembler **does NOT strongly enforce**:

- signed vs unsigned

That distinction is mostly **for humans**.

Signed vs Unsigned (Important but subtle)

- DWORD → 32-bit **unsigned**
- SDWORD → 32-bit **signed**

Both:

- are **32 bits**
- take up **4 bytes**
- look identical in memory

The only difference is **how *you* interpret the bits**

That's why programmers often use SDWORD:

- not because the assembler demands it
- but because it makes intent clear

Why intrinsic data types matter

Intrinsic data types help you:

- choose the correct **operand size**
- avoid reading or writing the wrong number of bytes
- understand how values are stored in memory

If you get the size wrong, the CPU will still execute —
but your result may be **wrong or corrupted**.

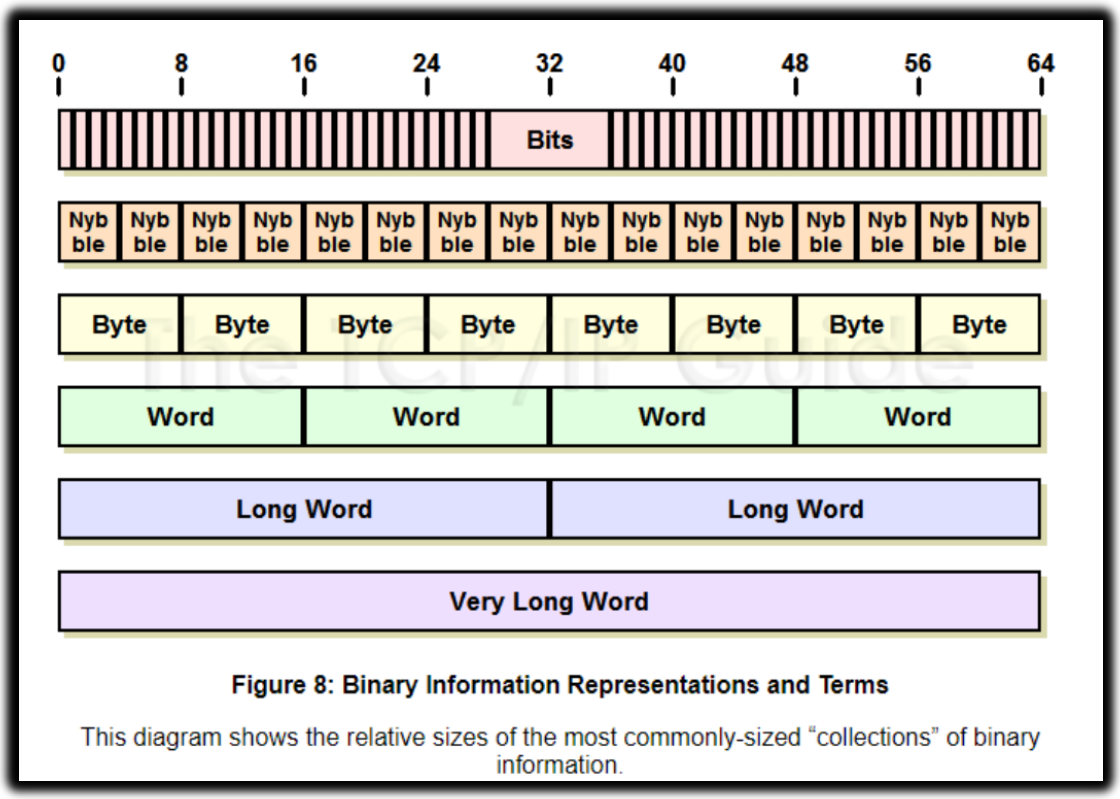


Figure 8: Binary Information Representations and Terms

This diagram shows the relative sizes of the most commonly-sized "collections" of binary information.

Key Takeaways

Intrinsic data types describe the **size**, **signed/unsigned nature**, and whether the value is an **integer or real number**.

The assembler cares about **operand size**, but does **not enforce signed vs unsigned**.

Programmers often use SDWORD to indicate signedness, but it is **not required**.

Intrinsic data types help explain how data is stored and used in assembly.

About overlapping types (Very important concept)

Some types overlap in functionality.

Example:

- DWORD → 32-bit unsigned
- SDWORD → 32-bit signed

Same size. Same memory.
Different **meaning**.

The assembler sees "32 bits".
The programmer sees "signed" or "unsigned".

So when I say "intrinsic data types"...

Yes — you mean **the ones in that image**.

These are the **basic building blocks** of all data in a computer.

Let's walk through them naturally.

Bit-Level Building Blocks (From smallest to bigger)

- **Bit**
  A single 0 or 1. The smallest possible unit of data.
- **Nibble (4 bits)**
  Half a byte. One hexadecimal digit fits here.
- **Byte (8 bits)**
  Stores:
  - ✓ a character
  - ✓ a small number
    This is the most common basic unit.
- **Word (16 bits)**
  Twice a byte. Used for larger numbers.
- **Double Word (32 bits)**
  Four bytes. Very common in 32-bit programs.
- **Quad Word (64 bits)**
  Eight bytes. Used for very large numbers.

Everything else is built from these.

Intrinsic Data Types in Assembly

Integer types

- **BYTE**
  8-bit **unsigned** integer
  Range: 0 to 255
- **SBYTE**
  8-bit **signed** integer
  Range: –128 to 127
- **WORD**
  16-bit **unsigned** integer
  Range: 0 to 65,535
- **SWORD**
  16-bit **signed** integer
  Range: –32,768 to 32,767

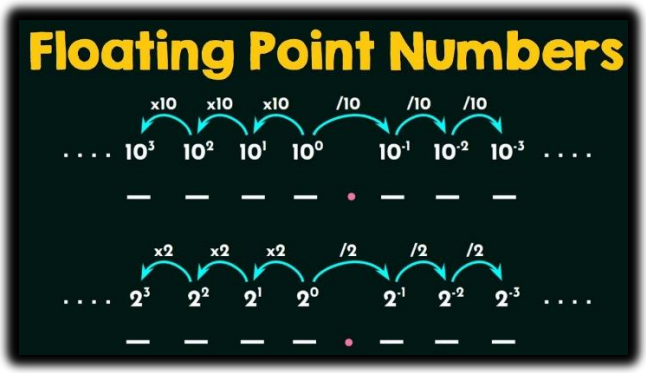
- **DWORD**
  32-bit **unsigned** integer
  Range: 0 to 4,294,967,295
- **SDWORD**
  32-bit **signed** integer
  Range: –2,147,483,648 to 2,147,483,647

Larger / special integer types

- **FWORD (48 bits)**
  Used mainly for **far pointers** (old protected-mode stuff)
- **QWORD (64 bits)**
  Very large integers
- **TBYTE (80 bits)**
  Rarely used
  Mostly related to the floating-point unit

Floating-point (real numbers)

- **REAL4**
  32-bit floating-point
  Common for basic decimal values
- **REAL8**
  64-bit floating-point
  Higher precision
- **REAL10**
  80-bit floating-point
  Very high precision, rarely used



Final idea

The assembler cares about **how many bytes**.
The programmer cares about **what those bytes mean**.

That's why intrinsic data types exist.

DATA DEFINITIONS (ASSEMBLY VARIABLES)

A **data definition** in assembly is how you create a variable.

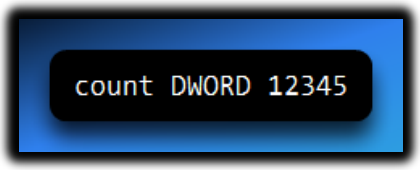
It answers two questions:

1. **How much memory do I need?**
2. **What value should it start with?**

General syntax

- **label** → the variable name (optional, but almost always used)
- **directive** → the data type / size
- **value** → the initial value

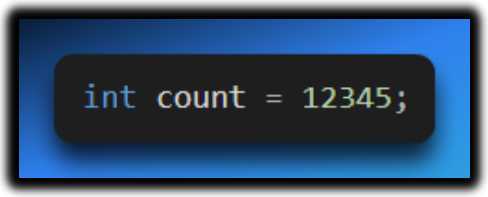
Example



This means:

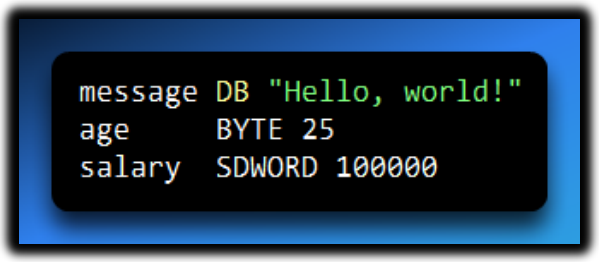
- create a variable named count
- reserve 4 bytes (32 bits)
- store the value 12345 in it

Equivalent C code:



Same idea, different language.

More examples



What's happening here:

- message
  - ✓ DB reserves **1 byte per character**
  - ✓ "Hello, world!" takes **13 bytes**
- age
  - ✓ BYTE reserves **1 byte**
  - ✓ stores the value 25
- salary
  - ✓ SDWORD reserves **4 bytes**
  - ✓ stores a signed integer value

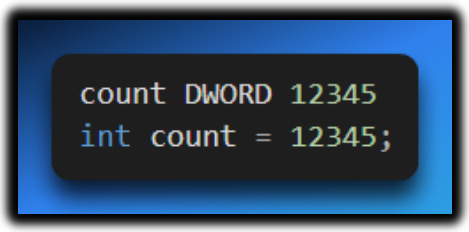
Why the data type matters

The assembler **must know the size** of the variable:

- how many bytes to reserve
- how many bytes instructions should read or write

If you don't specify the type, the assembler has no idea what to do.

Assembly vs C (Same concept)



Both:

- reserve memory
- assign an initial value
- give the memory a name

Assembly just makes the size explicit.

Short forms (Just aliases)

These are **short names**, not new types:

- BYTE → DB
- WORD → DW
- DWORD → DD
- QWORD → DQ
- TBYTE → DT

They all do the same job: **reserve memory**.

Legacy Data Directives (Still used in 2026?)

Yes — **absolutely still used**.

Directives like DB, DW, DD, DQ, and DT are:

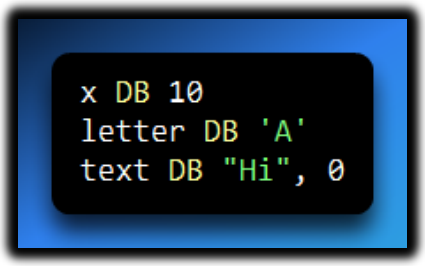
- still supported
- still common
- still the standard way to define data in MASM

They are called "legacy" only because they've been around forever — not because they're obsolete.

The Core Data Directives (Explained Clearly)

1. DB — Declare Byte (8 bits)

Reserves **1 byte** per value.



Common uses:

- characters
- small numbers
- strings (byte-by-byte)

2. DW — Declare Word (16 bits)

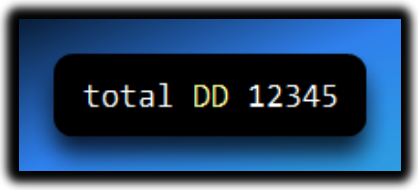
Reserves **2 bytes**.

Used for:

- 16-bit values
- older or compact data

3. DD — Declare Doubleword (32 bits)

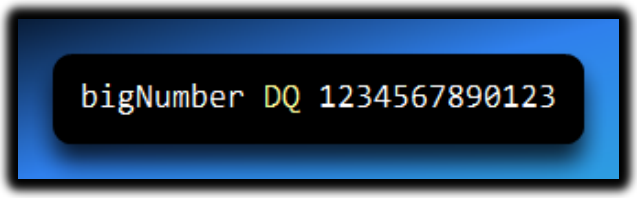
Reserves **4 bytes**.



This is one of the **most common** directives in 32-bit programs.

4. DQ — Declare Quadword (64 bits)

Reserves **8 bytes**.

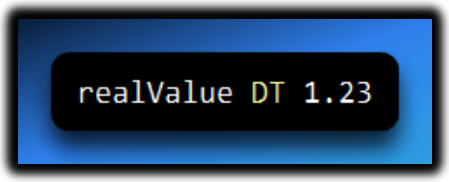


Used for:

- large integers
- 64-bit values

5. DT — Declare Ten Bytes (80 bits)

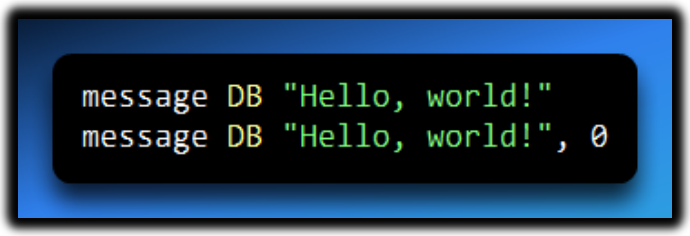
Reserves **10 bytes**.



Used for:

- extended precision floating-point (FPU)
- rare, but valid

About strings and null terminators



Both are valid.

The second one:

- adds a **null terminator**
- is better when interacting with C-style functions

MASM does **not** automatically add 0 for you.

Big Idea to Remember

Data definition directives:

- reserve memory
- define size
- optionally initialize values

The assembler:

- assigns addresses
- tracks them in the symbol table
- replaces variable names with real memory locations

You write **names**.
The assembler handles **addresses**.

Data definitions are how assembly creates variables — by explicitly stating how many bytes to reserve and what value to store in them.

Defining Data Types (Part 1 – Beginner Explanation)

Big Picture: What This Section Is About

This section explains:

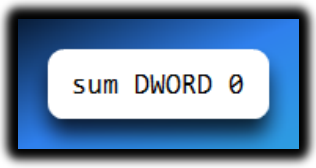
- How variables are **defined** in assembly
- How variables are **initialized**
- What happens if variables are **not initialized**
- How different **byte-sized data types** work

Main Rules for Data Definitions

1. At Least One Initializer Is Required

When you define a variable, the assembler expects **a value**.

Example:



- DWORD → data type (4 bytes)
- 0 → initializer

Even zero counts as a valid initializer.

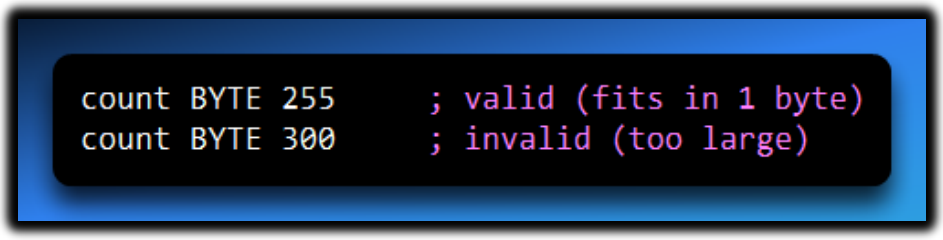
2. Multiple Initializers Use Commas

You can define **multiple values** at once by separating them with commas. Example:

This creates **four bytes** in memory.

3. Integer Initializers Must Match the Data Size

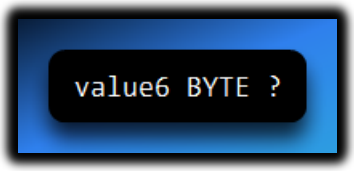
For integer data types, the value must **fit in the size** of the variable. Example:



4. Leaving a Variable Uninitialized (?)

If you want to reserve memory **without giving it a value**, use ?.

Example:



This means:

- Memory is reserved
- The value is unknown (garbage) at program start

⚠ **Important:** Uninitialized variables **must not be used** before assigning a value.

5. Everything Becomes Binary

No matter how you write an initializer:

- Decimal
- Hex
- Character literal

👉 The assembler converts it into **binary** before storing it in memory.

6. Worked Example: Adding Two Numbers

```
; AddTwo.asm
.386
.model flat, stdcall
.stack 4096

ExitProcess PROTO, dwExitCode:DWORD

.data
sum DWORD 0

.code
main PROC
    mov eax, 5
    add eax, 6
    mov sum, eax
    INVOKE ExitProcess, 0
main ENDP

END main
```

Defines a variable: **sum DWORD 0**

sum is a 4-byte integer initialized to 0; the program loads 5 into eax, adds 6 to it so eax becomes 11, and then stores the result: **mov sum, eax**

The program exits and final value is 11.

7. Debugging Tip

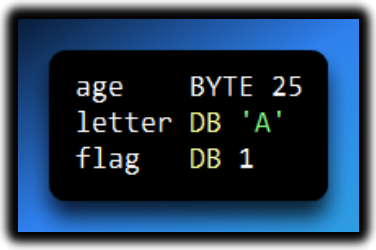
To observe the variable, set a breakpoint after mov sum, eax, step through the instructions, and watch sum in the debugger to see the memory value change in real time.

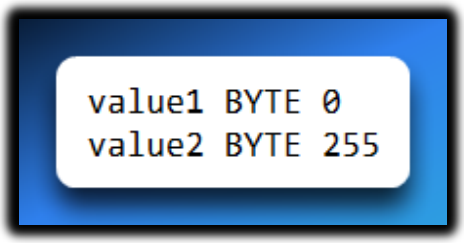
BYTE-SIZED DATA TYPES (Very Important)

BYTE / DB (Unsigned, 8 bits)

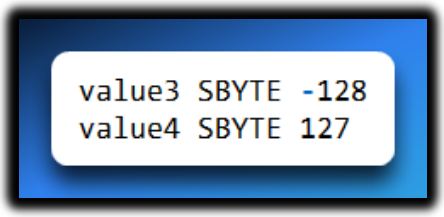
- Size: **1 byte (8 bits)**
- Range: **0 to 255**
- Used for: small numbers, characters, raw data

Examples:





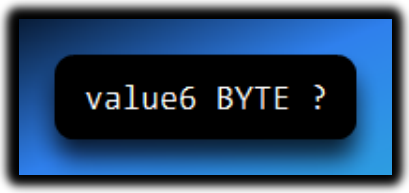
SBYTE is a signed 8-bit data type that occupies 1 byte of memory, can store values from −128 to +127, and is commonly used for small numbers that may be negative (for example: temp SBYTE -10 or change SBYTE 5).



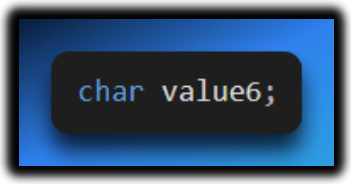
Signed vs Unsigned

- **Unsigned** → only positive values (and zero)
- **Signed** → positive **and** negative values

Uninitialized Variables (Important Warning)



Reserves 1 byte of memory but does not initialize it, so the value stored is random garbage just like



...in C language, which is why you must always initialize variables before using them.

Data Definition Directives

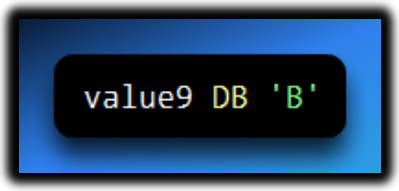
DIRECTIVE	MEANING	CAPACITY
DB	**Define Byte** (Legacy MASM style)	8-bit
BYTE	**Unsigned Byte** (Modern MASM style)	8-bit (0 to 255)
SBYTE	**Signed Byte**	8-bit (-128 to +127)

```
; These are functionally identical
value9 DB 'B' ; Allocated 1 byte
value9 BYTE 'B' ; Same allocation

; Range difference
val1 BYTE 255 ; Valid
val2 SBYTE -1 ; Valid (same bit pattern as 255)
```

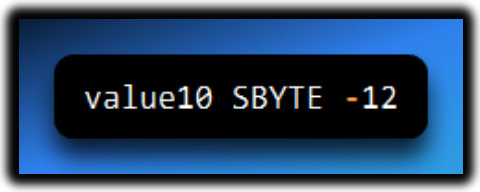
> **Pro Tip:** Use SBYTE when the value represents a temperature, coordinate, or any number that can be negative. Use BYTE for raw data or characters.

Character Initialization Example



- 'B' is a character
- ASCII value of 'B' = **66**
- Stored as **one byte**

Signed Byte Example



- Stores -12
- Uses signed representation
- Can hold negative values

Key Takeaways (Exam-Ready)

- Variables must have an initializer (or ?)
- ? means uninitialized (garbage value)
- BYTE / DB = unsigned 8-bit
- SBYTE = signed 8-bit
- Character literals are stored as ASCII values
- All data becomes binary in memory

💡 **Defining a variable means reserving memory and deciding how the bits should be interpreted.**