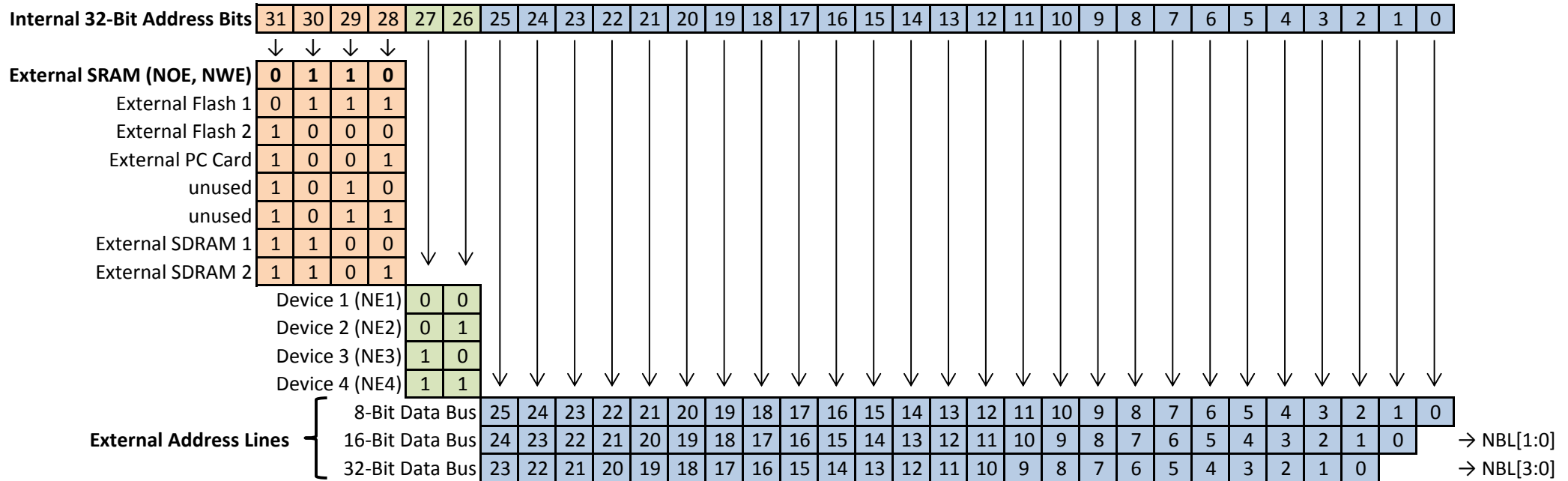


## STM32F429 Flexible Memory Controller (FMC) Decoding



A[31:28]	0x0 - 0x5	Non-FMC access to chip internal peripherals like flash, SRAM, control registers
	0x6 - 0xD	FMC access: Select one type of external memory
	0xE - 0xF	Non-FMC access to chip internal ARM peripherals like NVIC

For external SRAM	A[27:26]	0x0 - 0x3	Select one of 4 devices → controls NE1, NE2, NE3, NE4
-------------------	----------	-----------	---

For external SRAM	A[25:0]	8-Bit external data bus	Internal lines A[25:0] mapped to external A[25:0] No NBL signals required
-------------------	---------	-------------------------	--

16-Bit external data bus	Internal lines A[25:1] mapped to external A[24:0] Internal A[0] yields NBL[1:0]
--------------------------	--

32-Bit external data bus	Internal lines A[25:2] mapped to external A[23:0] Internal A[1:0] yields NBL[3:0]
--------------------------	--

## Datenblattauszug GPIO

Boundary address	Peripheral	Bus	Register map
0x4004 0000 - 0x4007 FFFF	USB OTG HS	AHB1	<a href="#">Section 35.12.6: OTG_HS register map on page 1445</a>
0x4002 B000 - 0x4002 BBFF	DMA2D		<a href="#">Section 11.5: DMA2D registers on page 349</a>
0x4002 9000 - 0x4002 93FF	ETHERNET MAC		<a href="#">Section 33.8.5: Ethernet register maps on page 1214</a>
0x4002 8C00 - 0x4002 8FFF			
0x4002 8800 - 0x4002 8BFF			
0x4002 8400 - 0x4002 87FF			
0x4002 8000 - 0x4002 83FF			
0x4002 6400 - 0x4002 67FF	DMA2		<a href="#">Section 10.5.11: DMA register map on page 332</a>
0x4002 6000 - 0x4002 63FF	DMA1		
0x4002 4000 - 0x4002 4FFF	BKPSRAM		
0x4002 3C00 - 0x4002 3FFF	Flash interface register		<a href="#">Section 3.9: Flash interface registers</a>
0x4002 3800 - 0x4002 3BFF	RCC		<a href="#">Section 7.3.25: RCC register map on page 263</a>
0x4002 3000 - 0x4002 33FF	CRC		<a href="#">Section 4.4.4: CRC register map on page 114</a>
0x4002 2800 - 0x4002 2BFF	GPIOK		<a href="#">Section 8.4.11: GPIO register map on page 284</a>
0x4002 2400 - 0x4002 27FF	GPIOJ		
0x4002 2000 - 0x4002 23FF	GPIOI		<a href="#">Section 8.4.11: GPIO register map on page 284</a>
0x4002 1C00 - 0x4002 1FFF	GPIOH		
0x4002 1800 - 0x4002 1BFF	GPIOG		
0x4002 1400 - 0x4002 17FF	GPIOF		
0x4002 1000 - 0x4002 13FF	GPIOE		
0x4002 0C00 - 0x4002 0FFF	GIOD		
0x4002 0800 - 0x4002 0BFF	GPIOC		
0x4002 0400 - 0x4002 07FF	GPIOB		
0x4002 0000 - 0x4002 03FF	GPIOA		
0x4001 6800 - 0x4001 6BFF	LCD-TFT	APB2	<a href="#">Section 16.7.26: LTDC register map on page 504</a>
0x4001 5800 - 0x4001 5BFF	SAI1		<a href="#">Section 29.17.9: SAI register map on page 944</a>
0x4001 5400 - 0x4001 57FF	SPI6	APB2	<a href="#">Section 28.5.10: SPI register map on page 906</a>
0x4001 5000 - 0x4001 53FF	SPI5		

## 8.4.1 GPIO port mode register (GPIOx\_MODER) (x = A..I/J/K)

Address offset: 0x00

Reset values:

- 0xA800 0000 for port A
- 0x0000 0280 for port B
- 0x0000 0000 for other ports

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
MODER15[1:0]	MODER14[1:0]	MODER13[1:0]	MODER12[1:0]	MODER11[1:0]	MODER10[1:0]	MODER9[1:0]	MODER8[1:0]								
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MODER7[1:0]	MODER6[1:0]	MODER5[1:0]	MODER4[1:0]	MODER3[1:0]	MODER2[1:0]	MODER1[1:0]	MODER0[1:0]								
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

Bits 2y:2y+1 MODERy[1:0]: Port x configuration bits (y = 0..15)

These bits are written by software to configure the I/O direction mode.

00: Input (reset state)

01: General purpose output mode

10: Alternate function mode

11: Analog mode

### 8.4.2 GPIO port output type register (GPIOx\_OTYPER) (x = A..I/J/K)

Address offset: 0x04

Reset value: 0x0000 0000

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OT15	OT14	OT13	OT12	OT11	OT10	OT9	OT8	OT7	OT6	OT5	OT4	OT3	OT2	OT1	OT0
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Bits 31:16 Reserved, must be kept at reset value.

Bits 15:0 OTy: Port x configuration bits (y = 0..15)

These bits are written by software to configure the output type of the I/O port.

0: Output push-pull (reset state)

1: Output open-drain

### 8.4.3 GPIO port output speed register (GPIOx\_OSPEEDR) (x = A..I/J/K)

Address offset: 0x08

Reset values:

- 0x0000 00C0 for port B
- 0x0000 0000 for other ports

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
OSPEEDR15 [1:0]	OSPEEDR14 [1:0]	OSPEEDR13 [1:0]	OSPEEDR12 [1:0]	OSPEEDR11 [1:0]	OSPEEDR10 [1:0]	OSPEEDR9 [1:0]	OSPEEDR8 [1:0]	OSPEEDR7 [1:0]	OSPEEDR6 [1:0]	OSPEEDR5 [1:0]	OSPEEDR4 [1:0]	OSPEEDR3 [1:0]	OSPEEDR2 [1:0]	OSPEEDR1 [1:0]	OSPEEDR0 [1:0]
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
OSPEEDR15 [1:0]	OSPEEDR14 [1:0]	OSPEEDR13 [1:0]	OSPEEDR12 [1:0]	OSPEEDR11 [1:0]	OSPEEDR10 [1:0]	OSPEEDR9 [1:0]	OSPEEDR8 [1:0]	OSPEEDR7 [1:0]	OSPEEDR6 [1:0]	OSPEEDR5 [1:0]	OSPEEDR4 [1:0]	OSPEEDR3 [1:0]	OSPEEDR2 [1:0]	OSPEEDR1 [1:0]	OSPEEDR0 [1:0]
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Bits 2y:2y+1 OSPEEDRy[1:0]: Port x configuration bits (y = 0..15)

These bits are written by software to configure the I/O output speed.

00: Low speed

01: Medium speed

10: Fast speed

11: High speed

Note: Refer to the product datasheets for the values of OSPEEDRy bits versus V<sub>DD</sub> range and external load.

### 8.4.4 GPIO port pull-up/pull-down register (GPIOx\_PUPDR) (x = A..I/J/K)

Address offset: 0x0C

Reset values:

- 0x6400 0000 for port A
- 0x0000 0100 for port B
- 0x0000 0000 for other ports

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
PUPDR15[1:0]	PUPDR14[1:0]	PUPDR13[1:0]	PUPDR12[1:0]	PUPDR11[1:0]	PUPDR10[1:0]	PUPDR9[1:0]	PUPDR8[1:0]	PUPDR7[1:0]	PUPDR6[1:0]	PUPDR5[1:0]	PUPDR4[1:0]	PUPDR3[1:0]	PUPDR2[1:0]	PUPDR1[1:0]	PUPDR0[1:0]
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
PUPDR15[1:0]	PUPDR14[1:0]	PUPDR13[1:0]	PUPDR12[1:0]	PUPDR11[1:0]	PUPDR10[1:0]	PUPDR9[1:0]	PUPDR8[1:0]	PUPDR7[1:0]	PUPDR6[1:0]	PUPDR5[1:0]	PUPDR4[1:0]	PUPDR3[1:0]	PUPDR2[1:0]	PUPDR1[1:0]	PUPDR0[1:0]
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Bits 2y:2y+1 PUPDRy[1:0]: Port x configuration bits (y = 0..15)

These bits are written by software to configure the I/O pull-up or pull-down

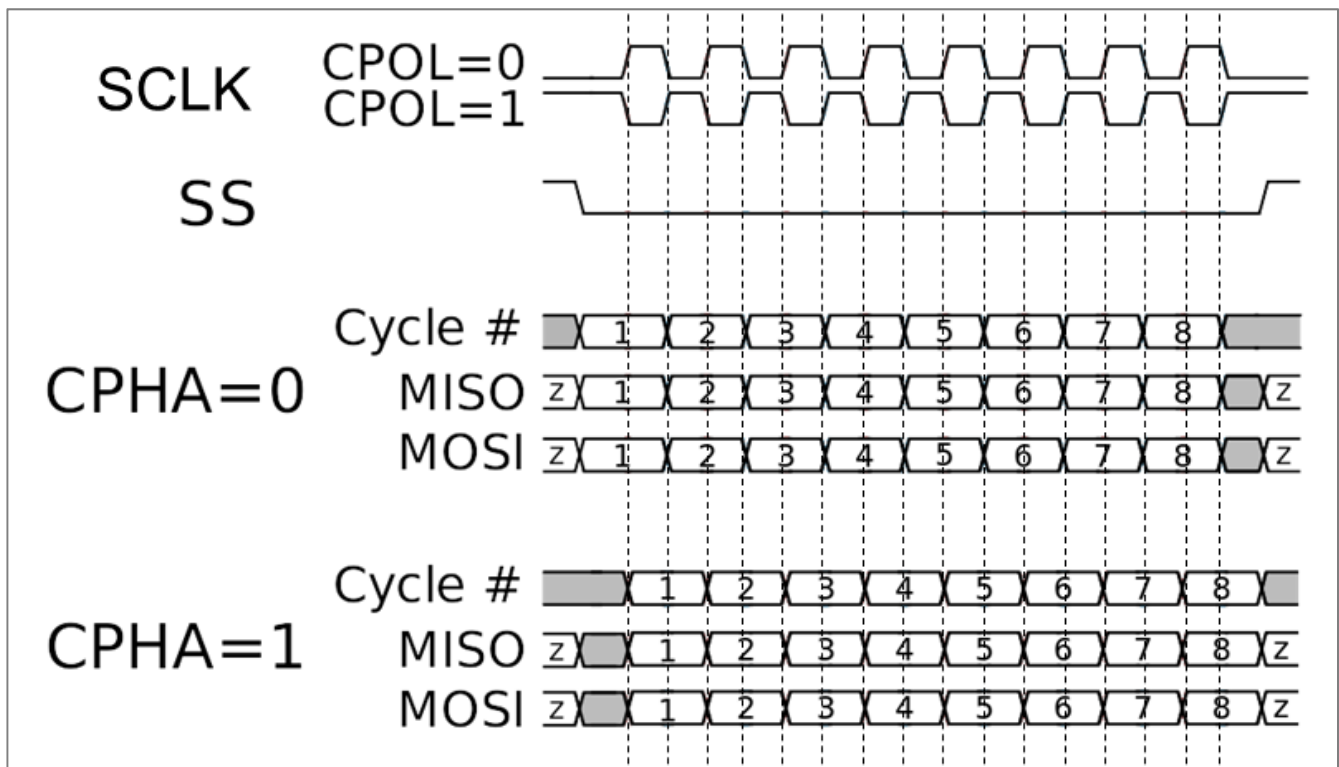
00: No pull-up, pull-down

01: Pull-up

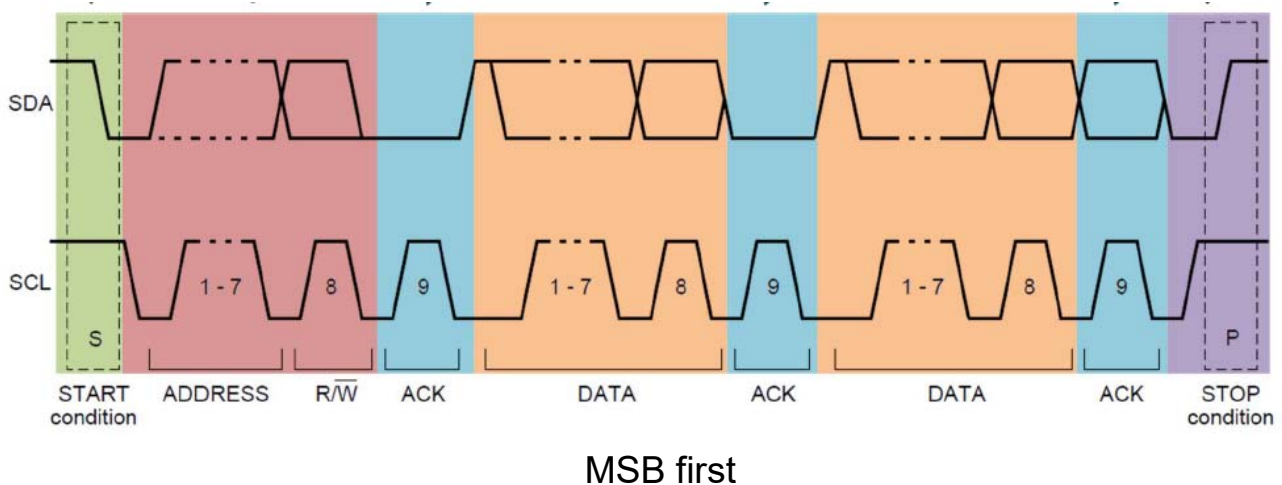
10: Pull-down

11: Reserved

## SPI



## I2C Timing



ACK = '0' → Übertragung erfolgreich

ACK = '1' → Übertragung nicht erfolgreich

### 13.13.14 ADC regular data register (ADC\_DR)

Address offset: 0x4C

Reset value: 0x0000 0000

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
DATA[15:0]															
r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

Bits 31:16 Reserved, must be kept at reset value.

Bits 15:0 **DATA[15:0]**: Regular data

These bits are read-only. They contain the conversion result from the regular channels. The data are left- or right-aligned as shown in [Figure 48](#) and [Figure 49](#).

### 13.13.1 ADC status register (ADC\_SR)

Address offset: 0x00

Reset value: 0x0000 0000

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Reserved															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved										OVR	STRT	JSTRT	JEOP	EOC	AWD
										rc_w0	rc_w0	rc_w0	rc_w0	rc_w0	rc_w0

Bits 31:6 Reserved, must be kept at reset value.

Bit 5 **OVR**: Overrun

This bit is set by hardware when data are lost (either in single mode or in dual/triple mode). It is cleared by software. Overrun detection is enabled only when DMA = 1 or EOCS = 1.

0: No overrun occurred  
1: Overrun has occurred

Bit 4 **STRT**: Regular channel start flag

This bit is set by hardware when regular channel conversion starts. It is cleared by software.

0: No regular channel conversion started  
1: Regular channel conversion has started

Bit 3 **JSTRT**: Injected channel start flag

This bit is set by hardware when injected group conversion starts. It is cleared by software.

0: No injected group conversion started  
1: Injected group conversion has started

Bit 2 **JEOP**: Injected channel end of conversion

This bit is set by hardware at the end of the conversion of all injected channels in the group. It is cleared by software.

0: Conversion is not complete  
1: Conversion complete

Bit 1 **EOC**: Regular channel end of conversion

This bit is set by hardware at the end of the conversion of a regular group of channels. It is cleared by software or by reading the ADC\_DR register.

0: Conversion not complete (EOCS=0), or sequence of conversions not complete (EOCS=1)  
1: Conversion complete (EOCS=0), or sequence of conversions complete (EOCS=1)

Bit 0 **AWD**: Analog watchdog flag

This bit is set by hardware when the converted voltage crosses the values programmed in the ADC\_LTR and ADC\_HTR registers. It is cleared by software.

0: No analog watchdog event occurred  
1: Analog watchdog event occurred

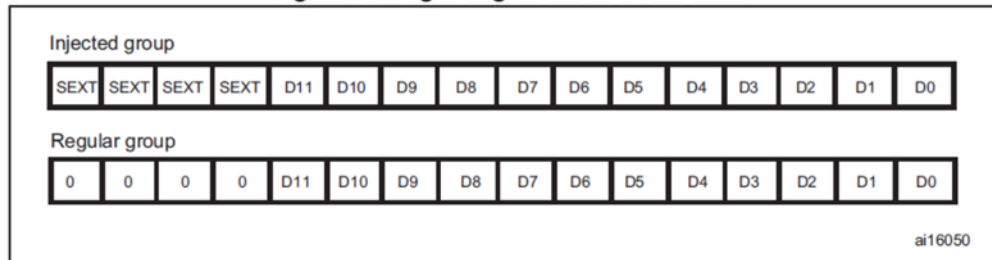
## 13.4 Data alignment

The ALIGN bit in the ADC\_CR2 register selects the alignment of the data stored after conversion. Data can be right- or left-aligned as shown in [Figure 48](#) and [Figure 49](#).

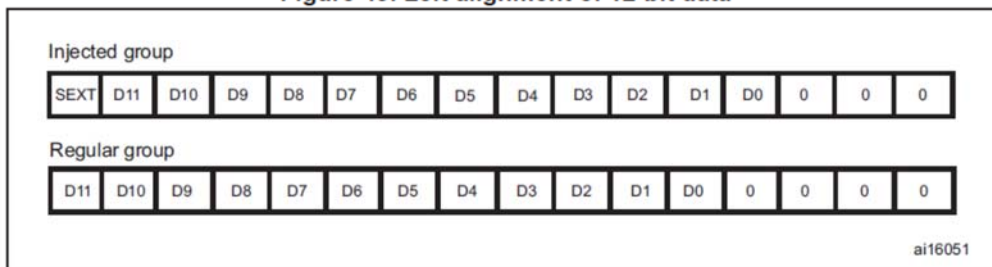
The converted data value from the injected group of channels is decreased by the user-defined offset written in the ADC\_JOFRx registers so the result can be a negative value. The SEXT bit represents the extended sign value.

For channels in a regular group, no offset is subtracted so only twelve bits are significant.

**Figure 48. Right alignment of 12-bit data**



**Figure 49. Left alignment of 12-bit data**



Special case: when left-aligned, the data are aligned on a half-word basis except when the resolution is set to 6-bit. In that case, the data are aligned on a byte basis as shown in [Figure 50](#).

ADC Base Address			Address of Register
0x4001 2000	ADC1	Specific registers	0x4001 2000 + 0x000 + register offset
	ADC2	Specific registers	0x4001 2000 + 0x100 + register offset
	ADC3	Specific registers	0x4001 2000 + 0x200 + register offset
	Common	Common registers	0x4001 2000 + 0x300 + register offset



# C Reference Card (ANSI)

## Program Structure/Functions

<i>type fnc</i> ( <i>type</i> <sub>1</sub> , ...);	function prototype
<i>type name</i> ;	variable declaration
int main(void) {	main routine
<i>declarations</i>	local variable declarations
<i>statements</i>	
}	
<i>type fnc</i> ( <i>arg</i> <sub>1</sub> , ...) {	function definition
<i>declarations</i>	local variable declarations
<i>statements</i>	
return <i>value</i> ;	
}	
/* */	comments
int main(int argc, char *argv[])	main with args
exit( <i>arg</i> );	terminate execution

## C Preprocessor

include library file	#include <filename>
include user file	#include "filename"
replacement text	#define <i>name text</i>
replacement macro	#define <i>name</i> ( <i>var</i> ) <i>text</i>
Example. #define max(A,B) ((A)>(B) ? (A) : (B))	
undefine	#undef <i>name</i>
quoted string in replace	#
Example. #define msg(A) printf("%s = %d", #A, (A))	
concatenate args and rescan	##
conditional execution	#if, #else, #elif, #endif
is <i>name</i> defined, not defined?	#ifdef, #ifndef
<i>name</i> defined?	defined( <i>name</i> )
line continuation char	\

## Data Types/Declarations

character (1 byte)	char
integer	int
real number (single, double precision)	float, double
short (16 bit integer)	short
long (32 bit integer)	long
double long (64 bit integer)	long long
positive or negative	signed
non-negative modulo 2 <sup>m</sup>	unsigned
pointer to int, float,...	int*, float*,...
enumeration constant	enum <i>tag</i> { <i>name</i> <sub>1</sub> = <i>value</i> <sub>1</sub> ,...};
constant (read-only) value	<i>type</i> const <i>name</i> ;
declare external variable	extern
internal to source file	static
local persistent between calls	static
no value	void
structure	struct <i>tag</i> {...};
create new name for data type	typedef <i>type</i> <i>name</i> ;
size of an object (type is <i>size_t</i> )	sizeof <i>object</i>
size of a data type (type is <i>size_t</i> )	sizeof( <i>type</i> )

## Initialization

initialize variable	<i>type</i> <i>name</i> = <i>value</i> ;
initialize array	<i>type</i> <i>name</i> []={ <i>value</i> <sub>1</sub> ,...};
initialize char string	char <i>name</i> []="string";

## Constants

suffix: long, unsigned, float	65536L, -1U, 3.0F
exponential form	4.2e1
prefix: octal, hexadecimal	0, 0x or 0X
Example. 031 is 25, 0x31 is 49 decimal	
character constant (char, octal, hex)	'a', '\ooo', '\xhh'
newline, cr, tab, backspace	\n, \r, \t, \b
special characters	\\, \?, \', \"
string constant (ends with '\0')	"abc...de"

## Pointers, Arrays & Structures

declare pointer to <i>type</i>	<i>type</i> * <i>name</i> ;
declare function returning pointer to <i>type</i>	<i>type</i> *f();
declare pointer to function returning <i>type</i>	<i>type</i> (*pf)();
generic pointer type	void *
null pointer constant	NULL
object pointed to by <i>pointer</i>	* <i>pointer</i>
address of object <i>name</i>	& <i>name</i>
array	<i>name</i> [ <i>dim</i> ]
multi-dim array	<i>name</i> [ <i>dim</i> <sub>1</sub> ][ <i>dim</i> <sub>2</sub> ]...

### Structures

struct <i>tag</i> {	structure template
<i>declarations</i>	declaration of members
};	

create structure	struct <i>tag</i> <i>name</i>
member of structure from template	<i>name</i> . <i>member</i>
member of pointed-to structure	<i>pointer</i> -> <i>member</i>
Example. (*p).x and p->x are the same	
single object, multiple possible types	union
bit field with <i>b</i> bits	unsigned <i>member</i> : <i>b</i> ;

## Operators (grouped by precedence)

struct member operator	<i>name</i> . <i>member</i>
struct member through pointer	<i>pointer</i> -> <i>member</i>
increment, decrement	++, --
plus, minus, logical not, bitwise not	+, -, !, ~
indirection via pointer, address of object	* <i>pointer</i> , & <i>name</i>
cast expression to type	( <i>type</i> ) <i>expr</i>
size of an object	sizeof
multiply, divide, modulus (remainder)	*, /, %
add, subtract	+, -
left, right shift [bit ops]	<<, >>
relational comparisons	>, >=, <, <=
equality comparisons	==, !=
and [bit op]	&
exclusive or [bit op]	^
or (inclusive) [bit op]	
logical and	&&
logical or	
conditional expression	<i>expr</i> <sub>1</sub> ? <i>expr</i> <sub>2</sub> : <i>expr</i> <sub>3</sub>
assignment operators	+=, -=, *=, ...
expression evaluation separator	,

Unary operators, conditional expression and assignment operators group right to left; all others group left to right.

## Flow of Control

statement terminator	;
block delimiters	{ }
exit from switch, while, do, for	break;
next iteration of while, do, for	continue;
go to	goto <i>label</i> ;
label	<i>label</i> : <i>statement</i>
return value from function	return <i>expr</i>

### Flow Constructions

if statement	if ( <i>expr</i> <sub>1</sub> ) <i>statement</i> <sub>1</sub> else if ( <i>expr</i> <sub>2</sub> ) <i>statement</i> <sub>2</sub> else <i>statement</i> <sub>3</sub>
while statement	while ( <i>expr</i> ) <i>statement</i>
for statement	for ( <i>expr</i> <sub>1</sub> ; <i>expr</i> <sub>2</sub> ; <i>expr</i> <sub>3</sub> ) <i>statement</i>
do statement	do <i>statement</i> while( <i>expr</i> );
switch statement	switch ( <i>expr</i> ) { case <i>const</i> <sub>1</sub> : <i>statement</i> <sub>1</sub> break; case <i>const</i> <sub>2</sub> : <i>statement</i> <sub>2</sub> break; default: <i>statement</i> }

## ANSI Standard Libraries

<assert.h>	<ctype.h>	<errno.h>	<float.h>	<limits.h>
<locale.h>	<math.h>	<setjmp.h>	<signal.h>	<stdarg.h>
<stddef.h>	<stdio.h>	<stdlib.h>	<string.h>	<time.h>

## Character Class Tests <ctype.h>

alphanumeric?	isalnum(c)
alphabetic?	isalpha(c)
control character?	isctrl(c)
decimal digit?	isdigit(c)
printing character (not incl space)?	isgraph(c)
lower case letter?	islower(c)
printing character (incl space)?	isprint(c)
printing char except space, letter, digit?	ispunct(c)
space, formfeed, newline, cr, tab, vtab?	isspace(c)
upper case letter?	isupper(c)
hexadecimal digit?	isxdigit(c)
convert to lower case	tolower(c)
convert to upper case	toupper(c)

## String Operations <string.h>

s is a string; cs, ct are constant strings

length of s	strlen(s)
copy ct to s	strcpy(s,ct)
concatenate ct after s	strcat(s,ct)
compare cs to ct	strcmp(cs,ct)
only first n chars	strncmp(cs,ct,n)
pointer to first c in cs	strchr(cs,c)
pointer to last c in cs	strrchr(cs,c)
copy n chars from ct to s	memcpy(s,ct,n)
copy n chars from ct to s (may overlap)	memmove(s,ct,n)
compare n chars of cs with ct	memcmp(cs,ct,n)
pointer to first c in first n chars of cs	memchr(cs,c,n)
put c into first n chars of s	memset(s,c,n)

# C Reference Card (ANSI)

## Input/Output <stdio.h>

### Standard I/O

standard input stream	<code>stdin</code>
standard output stream	<code>stdout</code>
standard error stream	<code>stderr</code>
end of file (type is <code>int</code> )	<code>EOF</code>
get a character	<code>getchar()</code>
print a character	<code>putchar(<i>chr</i>)</code>
print formatted data	<code>printf("format",<i>arg</i><sub>1</sub>,...)</code>
print to string <i>s</i>	<code>sprintf(<i>s</i>, "format",<i>arg</i><sub>1</sub>,...)</code>
read formatted data	<code>scanf("format",&amp;<i>name</i><sub>1</sub>,...)</code>
read from string <i>s</i>	<code>sscanf(<i>s</i>, "format",&amp;<i>name</i><sub>1</sub>,...)</code>
print string <i>s</i>	<code>puts(<i>s</i>)</code>

### File I/O

declare file pointer	<code>FILE *<i>fp</i>;</code>
pointer to named file	<code>fopen("name", "mode")</code> modes: <i>r</i> (read), <i>w</i> (write), <i>a</i> (append), <i>b</i> (binary)
get a character	<code>getc(<i>fp</i>)</code>
write a character	<code>putc(<i>chr</i>, <i>fp</i>)</code>
write to file	<code>fprintf(<i>fp</i>, "format",<i>arg</i><sub>1</sub>,...)</code>
read from file	<code>fscanf(<i>fp</i>, "format",<i>arg</i><sub>1</sub>,...)</code>
read and store <i>n</i> elts to * <i>ptr</i>	<code>fread(*<i>ptr</i>,<i>eltsize</i>,<i>n</i>,<i>fp</i>)</code>
write <i>n</i> elts from * <i>ptr</i> to file	<code>fwrite(*<i>ptr</i>,<i>eltsize</i>,<i>n</i>,<i>fp</i>)</code>
close file	<code>fclose(<i>fp</i>)</code>
non-zero if error	<code>ferror(<i>fp</i>)</code>
non-zero if already reached EOF	<code>feof(<i>fp</i>)</code>
read line to string <i>s</i> (< <code>max</code> chars)	<code>fgets(<i>s</i>,<i>max</i>,<i>fp</i>)</code>
write string <i>s</i>	<code>fputs(<i>s</i>,<i>fp</i>)</code>

### Codes for Formatted I/O: "%-+ 0w.pmc"

-	left justify
+	print with sign
<i>space</i>	print space if no sign
0	pad with leading zeros
<i>w</i>	min field width
<i>p</i>	precision
<i>m</i>	conversion character:
	<i>h</i> short, <i>l</i> long, <i>L</i> long double
<i>c</i>	conversion character:
<i>d,i</i>	integer <i>u</i> unsigned
<i>c</i>	single char <i>s</i> char string
<i>f</i>	double (printf) <i>e,E</i> exponential
<i>f</i>	float (scanf) <i>lf</i> double (scanf)
<i>o</i>	octal <i>x,X</i> hexadecimal
<i>p</i>	pointer <i>n</i> number of chars written
<i>G,g</i>	same as <i>f</i> or <i>e,E</i> depending on exponent

## Variable Argument Lists <stdarg.h>

declaration of pointer to arguments	<code>va_list <i>ap</i>;</code>
initialization of argument pointer	<code>va_start(<i>ap</i>,<i>lastarg</i>);</code> <i>lastarg</i> is last named parameter of the function
access next unnamed arg, update pointer	<code>va_arg(<i>ap</i>,<i>type</i>)</code>
call before exiting function	<code>va_end(<i>ap</i>);</code>

## Standard Utility Functions <stdlib.h>

absolute value of <code>int</code> <i>n</i>	<code>abs(<i>n</i>)</code>
absolute value of <code>long</code> <i>n</i>	<code>labs(<i>n</i>)</code>
quotient and remainder of <code>ints</code> <i>n,d</i>	<code>div(<i>n</i>,<i>d</i>)</code> returns structure with <code>div_t.quot</code> and <code>div_t.rem</code>
quotient and remainder of <code>longs</code> <i>n,d</i>	<code>ldiv(<i>n</i>,<i>d</i>)</code> returns structure with <code>ldiv_t.quot</code> and <code>ldiv_t.rem</code>
pseudo-random integer [0,RAND_MAX]	<code>rand()</code>
set random seed to <i>n</i>	<code>srand(<i>n</i>)</code>
terminate program execution	<code>exit(<i>status</i>)</code>
pass string <i>s</i> to system for execution	<code>system(<i>s</i>)</code>

### Conversions

convert string <i>s</i> to double	<code>atof(<i>s</i>)</code>
convert string <i>s</i> to integer	<code>atoi(<i>s</i>)</code>
convert string <i>s</i> to long	<code>atol(<i>s</i>)</code>
convert prefix of <i>s</i> to double	<code>strtod(<i>s</i>,&amp;<i>endp</i>)</code>
convert prefix of <i>s</i> (base <i>b</i> ) to long	<code>strtoul(<i>s</i>,&amp;<i>endp</i>,<i>b</i>)</code>
same, but unsigned long	<code>strtoul(<i>s</i>,&amp;<i>endp</i>,<i>b</i>)</code>

### Storage Allocation

allocate storage	<code>malloc(<i>size</i>), calloc(<i>nobj</i>,<i>size</i>)</code>
change size of storage	<code>newptr = realloc(<i>ptr</i>,<i>size</i>);</code>
deallocate storage	<code>free(<i>ptr</i>);</code>

### Array Functions

search array for key	<code>bsearch(<i>key</i>,<i>array</i>,<i>n</i>,<i>size</i>,<i>cmpf</i>)</code>
sort array ascending order	<code>qsort(<i>array</i>,<i>n</i>,<i>size</i>,<i>cmpf</i>)</code>

## Time and Date Functions <time.h>

processor time used by program	<code>clock()</code>
<i>Example.</i> <code>clock()/CLOCKS_PER_SEC</code> is time in seconds	
current calendar time	<code>time()</code>
<i>time</i> <sub>2</sub> - <i>time</i> <sub>1</sub> in seconds (double)	<code>difftime(<i>time</i><sub>2</sub>,<i>time</i><sub>1</sub>)</code>
arithmetic types representing times	<code>clock_t</code> , <code>time_t</code>
structure type for calendar time comps	<code>struct tm</code>
<code>tm_sec</code>	seconds after minute
<code>tm_min</code>	minutes after hour
<code>tm_hour</code>	hours since midnight
<code>tm_mday</code>	day of month
<code>tm_mon</code>	months since January
<code>tm_year</code>	years since 1900
<code>tm_wday</code>	days since Sunday
<code>tm_yday</code>	days since January 1
<code>tm_isdst</code>	Daylight Savings Time flag

convert local time to calendar time	<code>mktime(<i>tp</i>)</code>
convert time in <i>tp</i> to string	<code>asctime(<i>tp</i>)</code>
convert calendar time in <i>tp</i> to local time	<code>ctime(<i>tp</i>)</code>
convert calendar time to GMT	<code>gmtime(<i>tp</i>)</code>
convert calendar time to local time	<code>localtime(<i>tp</i>)</code>
format date and time info	<code>strftime(<i>s</i>,<i>smax</i>, "format",<i>tp</i>)</code> <i>tp</i> is a pointer to a structure of type <code>tm</code>

## Mathematical Functions <math.h>

Arguments and returned values are double

trig functions	<code>sin(x), cos(x), tan(x)</code>
inverse trig functions	<code>asin(x), acos(x), atan(x)</code>
<code>arctan(<i>y/x</i>)</code>	<code>atan2(<i>y</i>,<i>x</i>)</code>
hyperbolic trig functions	<code>sinh(x), cosh(x), tanh(x)</code>
exponentials & logs	<code>exp(x), log(x), log10(x)</code>
exponentials & logs (2 power)	<code>ldexp(x,<i>n</i>), frexp(x,&amp;<i>e</i>)</code>
division & remainder	<code>modf(x,<i>ip</i>), fmod(x,<i>y</i>)</code>
powers	<code>pow(x,<i>y</i>), sqrt(x)</code>
rounding	<code>ceil(x), floor(x), fabs(x)</code>

## Integer Type Limits <limits.h>

The numbers given in parentheses are typical values for the constants on a 32-bit Unix system, followed by minimum required values (if significantly different).

<code>CHAR_BIT</code>	bits in char	(8)
<code>CHAR_MAX</code>	max value of char	( <code>SCHAR_MAX</code> or <code>UCHAR_MAX</code> )
<code>CHAR_MIN</code>	min value of char	( <code>SCHAR_MIN</code> or 0)
<code>SCHAR_MAX</code>	max signed char	(+127)
<code>SCHAR_MIN</code>	min signed char	(-128)
<code>SHRT_MAX</code>	max value of short	(+32,767)
<code>SHRT_MIN</code>	min value of short	(-32,768)
<code>INT_MAX</code>	max value of int	(+2,147,483,647) (+32,767)
<code>INT_MIN</code>	min value of int	(-2,147,483,648) (-32,767)
<code>LONG_MAX</code>	max value of long	(+2,147,483,647)
<code>LONG_MIN</code>	min value of long	(-2,147,483,648)
<code>UCHAR_MAX</code>	max unsigned char	(255)
<code>USHRT_MAX</code>	max unsigned short	(65,535)
<code>UINT_MAX</code>	max unsigned int	(4,294,967,295) (65,535)
<code>ULONG_MAX</code>	max unsigned long	(4,294,967,295)

## Float Type Limits <float.h>

The numbers given in parentheses are typical values for the constants on a 32-bit Unix system.

<code>FLT_RADIX</code>	radix of exponent rep	(2)
<code>FLT_ROUNDS</code>	floating point rounding mode	
<code>FLT_DIG</code>	decimal digits of precision	(6)
<code>FLT_EPSILON</code>	smallest <i>x</i> so $1.0f + x \neq 1.0f$	( $1.1E - 7$ )
<code>FLT_MANT_DIG</code>	number of digits in mantissa	
<code>FLT_MAX</code>	maximum float number	(3.4E38)
<code>FLT_MAX_EXP</code>	maximum exponent	
<code>FLT_MIN</code>	minimum float number	( $1.2E - 38$ )
<code>FLT_MIN_EXP</code>	minimum exponent	
<code>DBL_DIG</code>	decimal digits of precision	(15)
<code>DBL_EPSILON</code>	smallest <i>x</i> so $1.0 + x \neq 1.0$	( $2.2E - 16$ )
<code>DBL_MANT_DIG</code>	number of digits in mantissa	
<code>DBL_MAX</code>	max double number	(1.8E308)
<code>DBL_MAX_EXP</code>	maximum exponent	
<code>DBL_MIN</code>	min double number	( $2.2E - 308$ )
<code>DBL_MIN_EXP</code>	minimum exponent	

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