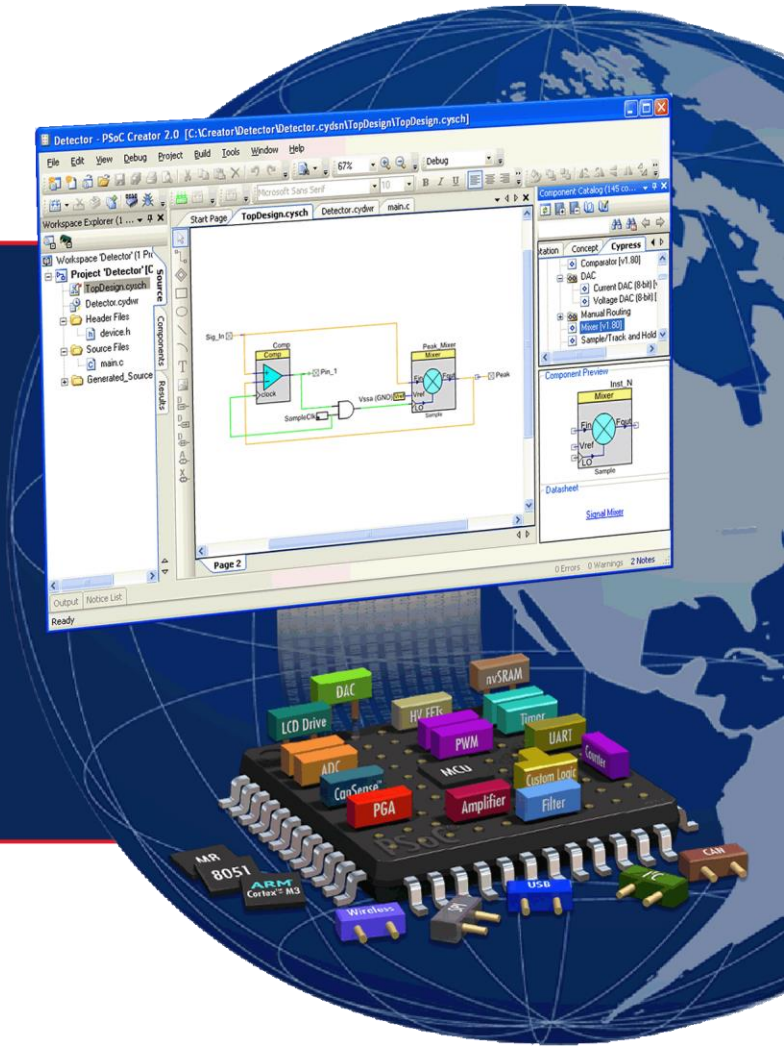
C Language Primer



What is C?

```
/*****************************************************
* Copyright 2014, YFS Corporation. All rights reserved.
*****************************************************/

#include <project.h>

#define MYCHANNEL (0)

/*
* Function Name: main
* Reads the ADC and displays the voltage on the LCD.
*/
int main()
{
  int16 output;

  /* Start the components */
  LCD_Start();
  ADC_Start();

  ADC_StartConvert();  // Start the ADC conversions

  /* Display the value of ADC output on LCD */
  LCD_Position( 0, 0 );
  LCD_PrintString( "ADC_Output" );

  while( 1 )
  {
    /* If ADC has data - read, convert to mV and print */
    if( ADC_IsEndConversion( ADC_RETURN_STATUS ) )
    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Language for controlling the ARM processor

Lets you run sequences of instructions from Flash

Manipulate data variables in SRAM

C code is written in text files (extension “.c”)

Comments

```
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  while( 1 )
  {
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    if( ADC_IsEndConversion( ADC_RETURN_STATUS ) )
    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Tell the reader what the code does

Compiler ignores comments

Often have a company-standard copyright notice

/* block comment */

// end of line comment

Variables

```
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  while( 1 )
  {
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    if( ADC_IsEndConversion( ADC_RETURN_STATUS ) )
    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

SRAM-based data

int8 / int16 / int32

Simple numbers

int8: -128..127

int16: -32768..32767

uint8 / uint16 / uint32

Unsigned numbers

uint8: 0..255

uint16: 0..65535

Use memorable names

int8 ADCvalue; // good name

int8 myvar; // bad name

Operators

Assignment

=	x=2	Set x to 2

Arithmetic

+ - * /	x+2	Add up x and 2

Compound (shortcuts)

+= -= *= /=	x*=2	x = x * 2

Increment and Decrement

++ --	x++	x = x + 1

Comparison

== != < <= > >=	x==2	Compare x with 2

Functions

```
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  while( 1 )
  {
    /* If ADC has data - read, convert to mV and print */
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    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Bundles of instructions

Better than copy-paste of similar code

Run functions by typing the name and parentheses

```
function1();
```

Pass values inside the parentheses

```
function2( 5 );
```

Get data back in the “return value”

```
pos = getPos();
```

Logical Arithmetic – AND and OR

Compare true with false

Zero means false

Non-zero means true, operators yield 1

Logical AND (&&) is true if BOTH are true

```
0 && 1 yields 0
1 && 2 yields 1
```

Logical OR (||) is true if EITHER are true

```
0 || 1 yields 1
1 || 2 yields 1
0 || 0 yields 0
```

Often use multiple comparisons

```
( ( x > 7 ) && ( y < 10 ) )
```

Conditionals – “if”

```
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  while( 1 )
  {
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    if( ADC_IsEndConversion( ADC_RETURN_STATUS ) )
    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Execute instructions if a condition is true

Format:

```
if( condition )
{
   /* Execute block */
}
```

If the condition is not true, skip the block

Always use a block { … }

Conditionals – “if” and “else”

```
/*****************************************************
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  ADC_StartConvert();  // Start the ADC conversions

  /* Display the value of ADC output on LCD */
  LCD_Position( 0, 0 );
  LCD_PrintString( "ADC_Output" );

  while( 1 )
  {
    /* If ADC has data - read, convert to mV and print */
    if( ADC_IsEndConversion( ADC_RETURN_STATUS ) )
    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Alternative action

If the condition is not true, do something else

```
if( condition )
{
   /* Execute if true */
}
else
{
   /* Execute if false */
}
```

Note: Indenting (tabbing) the code is good style

Loops – “while”

```
/*****************************************************
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  {
    /* If ADC has data - read, convert to mV and print */
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    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Repeat instructions until the condition is not true

Format:

```
while( condition )
{
}
```

Condition typically the changes in the loop

```
while( x != 0)
{
   x = ADC_GetResult16();
   /* more code */
}
```

Loops – “for”

```
/*****************************************************
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*****************************************************/

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#define MYCHANNEL (0)

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    {
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      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Three expressions

Format:

```
for( init; cond; incr )
{
}
```

Bundle loop controls into one statement

```
int i;
for( i=0; i<100; i++ )
{
  /* Loop 100 times */
}
```

Infinite Loops

```
/*****************************************************
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#include <project.h>

#define MYCHANNEL (0)

/*
* Function Name: main
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    if( ADC_IsEndConversion( ADC_RETURN_STATUS ) )
    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Embedded systems never stop

Power on and run forever

Use never-false condition

```
while( 1 )
{
}
```

Can also omit for-loop conditions

```
for( ; ; )
{
}
```

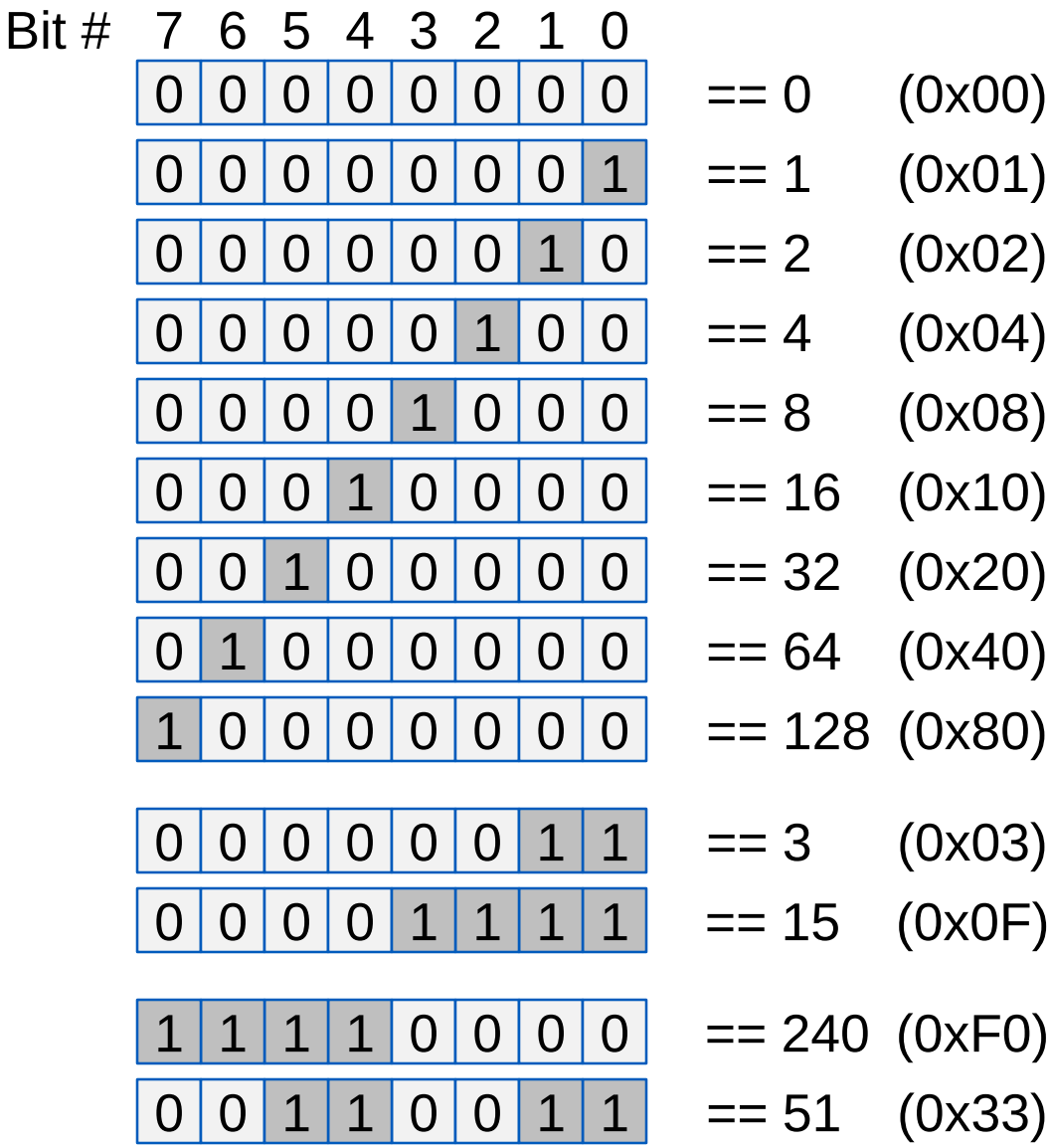
Understanding Numbers – uint8

Bit #	7	6	5	4	3	2	1	0		
	0	0	0	0	0	0	0	0	== 0	(0x00)
	0	0	0	0	0	0	0	1	== 1	(0x01)
	0	0	0	0	0	0	1	0	== 2	(0x02)
	0	0	0	0	0	1	0	0	== 4	(0x04)
	0	0	0	0	1	0	0	0	== 8	(0x08)
	0	0	0	1	0	0	0	0	== 16	(0x10)
	0	0	1	0	0	0	0	0	== 32	(0x20)
	0	1	0	0	0	0	0	0	== 64	(0x40)
	1	0	0	0	0	0	0	0	== 128	(0x80)

Understanding Numbers – uint8

Bit #	7	6	5	4	3	2	1	0		
	0	0	0	0	0	0	0	0	== 0	(0x00)
	0	0	0	0	0	0	0	1	== 1	(0x01)
	0	0	0	0	0	0	1	0	== 2	(0x02)
	0	0	0	0	0	1	0	0	== 4	(0x04)
	0	0	0	0	1	0	0	0	== 8	(0x08)
	0	0	0	1	0	0	0	0	== 16	(0x10)
	0	0	1	0	0	0	0	0	== 32	(0x20)
	0	1	0	0	0	0	0	0	== 64	(0x40)
	1	0	0	0	0	0	0	0	== 128	(0x80)
	0	0	0	0	0	0	1	1	== 3	(0x03)
	0	0	0	0	1	1	1	1	== 15	(0x0F)

Understanding Numbers – uint8



Bitwise Arithmetic – AND and OR

Compare the bit patterns

Bitwise AND (&) sets the bit if BOTH are 1

0x03 & 0x02

0	0	0	0	0	0	1	1
&	&	&	&	&	&	&	&
0	0	0	0	0	0	1	0
=	=	=	=	=	=	=	=
0	0	0	0	0	0	1	0

== 0x02

Bitwise Arithmetic

Compare the bit patterns

Bitwise AND (&) sets the bit if BOTH are 1

0x03 & 0x02

0	0	0	0	0	0	1	1
&	&	&	&	&	&	&	&
0	0	0	0	0	0	1	0
=	=	=	=	=	=	=	=
0	0	0	0	0	0	1	0

== 0x02

0x03 & 0x08

0	0	0	0	0	0	1	1	&	0	0	0	0	1	0	0	0

== 0x00

Bitwise Arithmetic

Compare the bit patterns

Bitwise AND (&) sets the bit if BOTH are 1

0x03 & 0x02

0	0	0	0	0	0	1	1
&	&	&	&	&	&	&	&
0	0	0	0	0	0	1	0
=	=	=	=	=	=	=	=
0	0	0	0	0	0	1	0

== 0x02

0x03 & 0x08

0	0	0	0	0	0	1	1	&	0	0	0	0	1	0	0	0

== 0x00

Bitwise OR (|) sets the bit if EITHER are 1

0x03 | 0x02

0	0	0	0	0	0	1	1	|	0	0	0	0	0	0	1	0

== 0x03

Bitwise Arithmetic

Compare the bit patterns

Bitwise AND (&) sets the bit if BOTH are 1

0x03 & 0x02

0	0	0	0	0	0	1	1
&	&	&	&	&	&	&	&
0	0	0	0	0	0	1	0
=	=	=	=	=	=	=	=
0	0	0	0	0	0	1	0

== 0x02

0x03 & 0x08

0	0	0	0	0	0	1	1	&	0	0	0	0	1	0	0	0

== 0x00

Bitwise OR (|) sets the bit if EITHER are 1

0x03 | 0x02

0	0	0	0	0	0	1	1	|	0	0	0	0	0	0	1	0

== 0x03

0x03 | 0x08

0	0	0	0	0	0	1	1	|	0	0	0	0	1	0	0	0

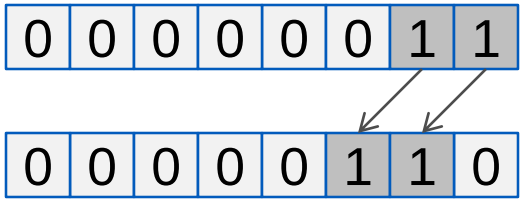
== 0x0B (11)

Bit Shift

<< move all the bits left (up)

>> move all the bits right (down)

0x03 << 1



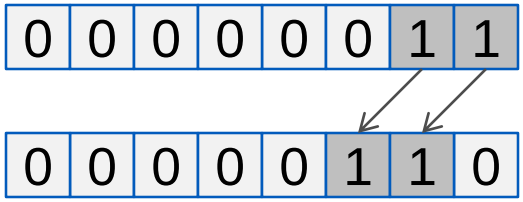
== 0x06

Bit Shift

<< move all the bits left (up)

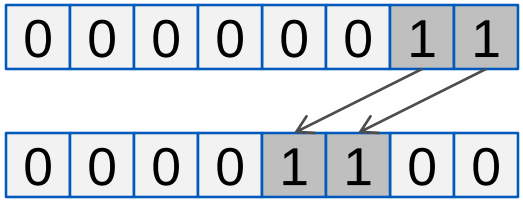
>> move all the bits right (down)

0x03 << 1



== 0x06

0x03 << 2

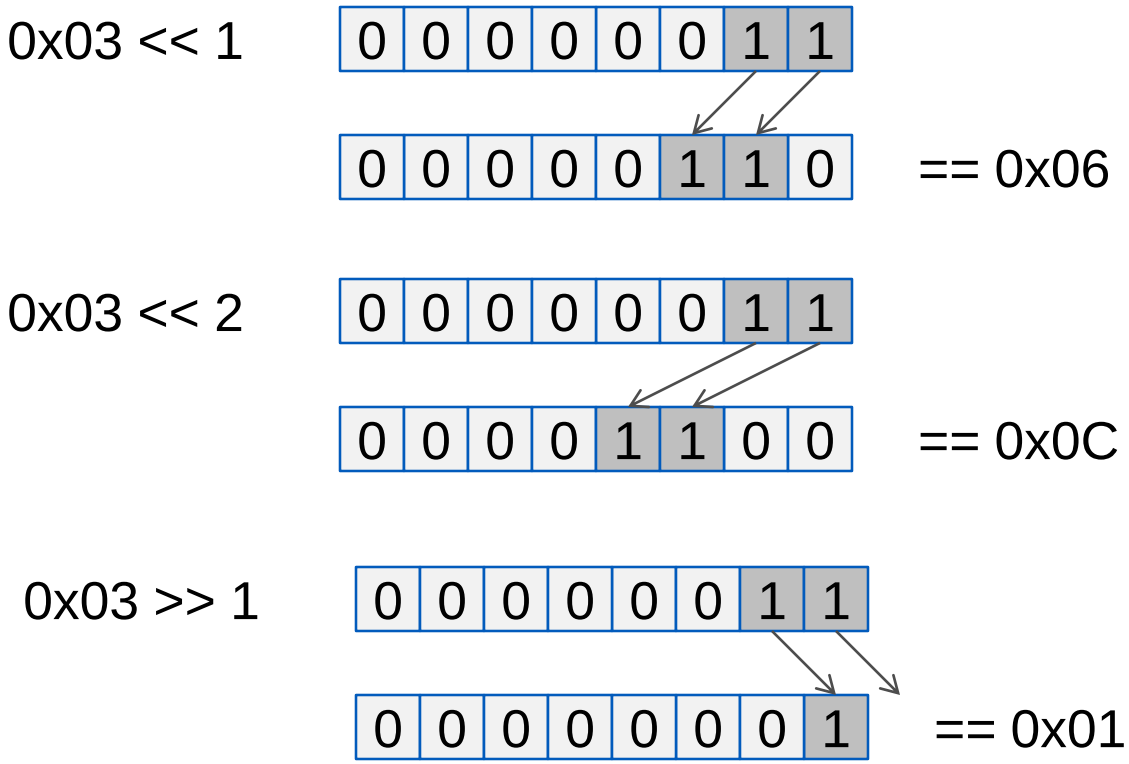


== 0x0C

Bit Shift

<< move all the bits left (up)

>> move all the bits right (down)



Arrays and Strings

Consecutive group of variables

e.g. lookup tables

Use square brackets to create and use arrays

```
/* Array of four 8-bit signed integers */
int8 buffer[4];
/* set the specific element to 99 */
buffer[2] = 99;
```

Arrays always start at zero

buffer[0] is the first element in the array

buffer[3] is the last element in the array

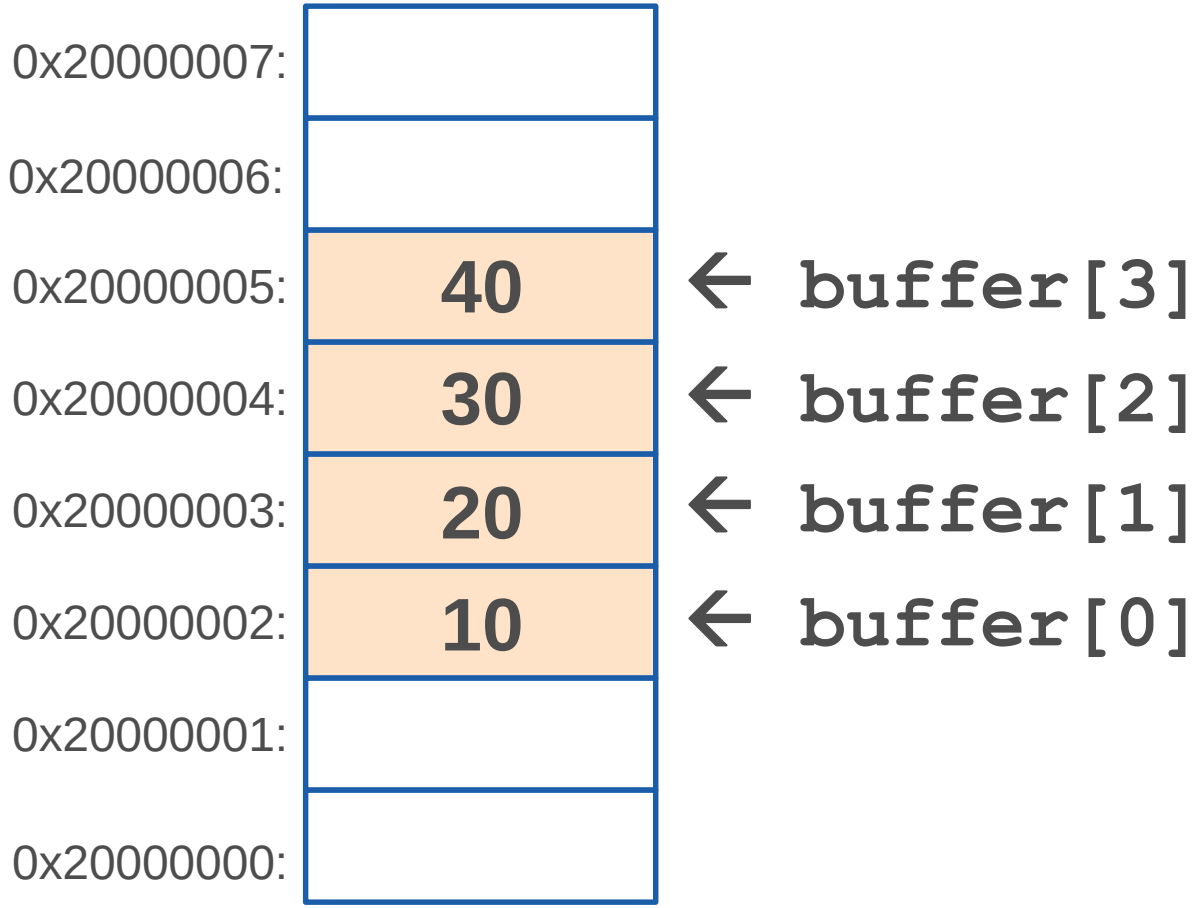
Strings are arrays of chars

Use double quotes “Print me”

Array Example

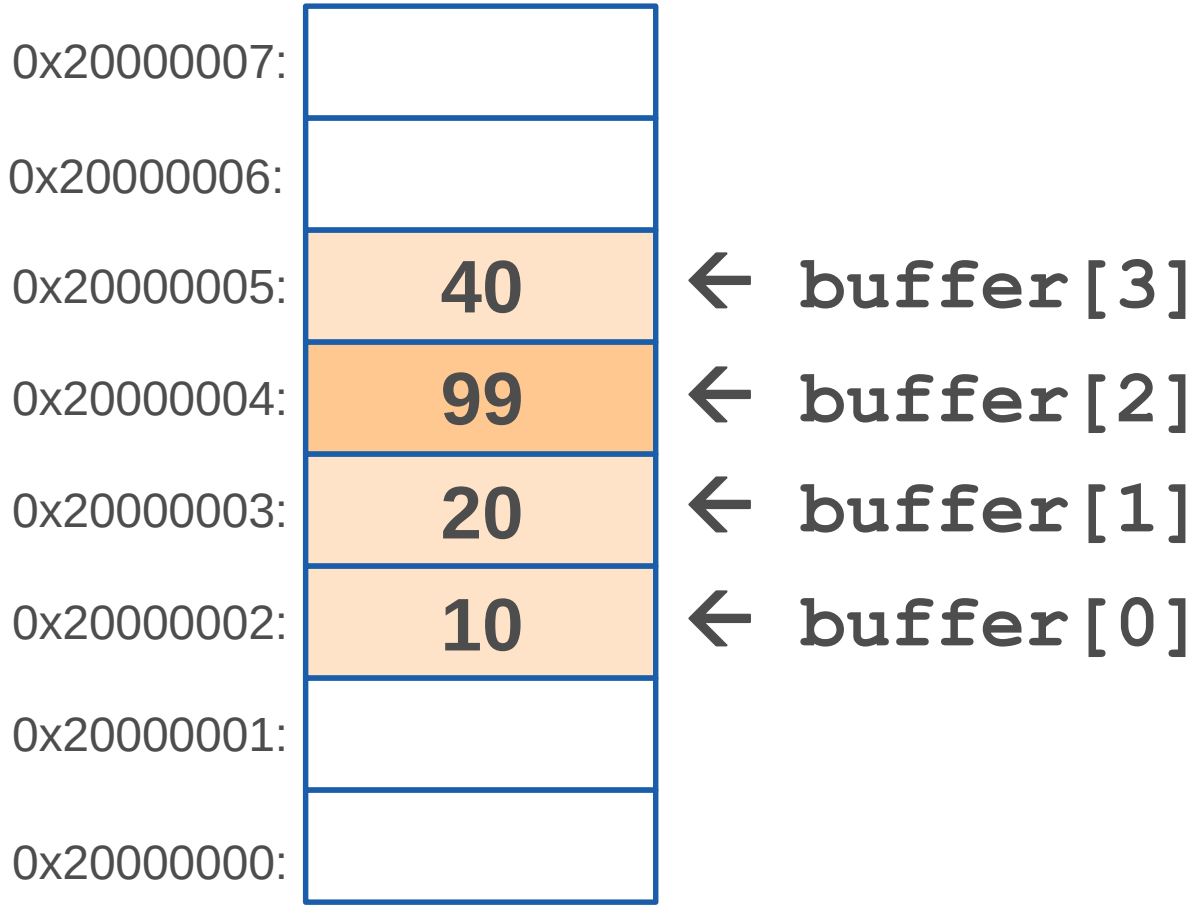
Initialize arrays with { comma-separated list }

```
int8 buffer[] = { 10, 20, 30, 40 };
```



Array Example

```
int8 buffer[] = { 10, 20, 30, 40 };
buffer[2] = 99;
```



Macros - #define

```
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  ADC_Start();

  ADC_StartConvert();  // Start the ADC conversions

  /* Display the value of ADC output on LCD */
  LCD_Position( 0, 0 );
  LCD_PrintString( "ADC_Output" );

  while( 1 )
  {
    /* If ADC has data - read, convert to mV and print */
    if( ADC_IsEndConversion( ADC_RETURN_STATUS ) )
    {
      output = ADC_GetResult16( MYCHANNEL );
      output = ADC_CountsTo_mVolts( MYCHANNEL, output );

      LCD_Position( 1, 0 );
      LCD_PrintInt16( output );
    }
  }
}
```

Simple text substitution

```
#define MYCHANNEL 0
#define MSG "Hello!"
```

Improve readability

Magic numbers

Improve quality

Need to change the ADC channel?

- Just one edit and rebuild

Cannot forget to change every use

Q & A


Detector - PSoC Creator 2.0 [C:\Creator\Detector\Detector.cydsn\TopDesign\TopDesign.cysch]
DAC
LCD Drive
PWM
UART
ADC
MCU
PGA
Amplifier
Filter
8051
ARM
Cortex-M3
USB
Wireless