EE2016 Experiment-9

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Generation of Sine Wave on Oscilloscope

The objective of this task is to generate a sine wave using the Digital-to-Analog Converter (DAC) on the LPC214x microcontroller and visualize it on an oscilloscope. The C code below configures the DAC on pin P0.25 and outputs pre-defined sine wave values in a continuous loop.

Code

```
#include <lpc214x.h>
#include <stdint.h>

void delay_ms(uint16_t j) {
    uint16_t x, i;
    for (i = 0; i < j; i++) {
        for (x = 0; x < 6000; x++);
    }
}

int main(void) {
    uint16_t value;
    uint8_t i = 0;
    PINSEL1 = 0x00080000; // P0.25 as DAC output

    uint16_t sin_wave[42] = {
        512, 591, 665, 742, 808, 873, 926, 968, 998, 1017, 1023,
        1017, 998, 968, 926, 873, 808, 742, 665, 591, 512,
        436, 359, 282, 216, 211, 151, 97, 55, 25, 6, 0, 6,
        25, 55, 97, 151, 211, 216, 282, 359, 436
    };

    while (1) {
        for (i = 0; i < 42; i++) {
            value = sin_wave[i];
            DACR = ((1 << 16) | (value << 6));
            delay_ms(1);
        }
    }
}
```

Listing 1: Sine Wave Generation Code

Explanation

- **DAC Initialization:** Configures P0.25 as DAC output by setting bits in PINSEL1.
- **Sine Wave Array:** Contains 42 values representing one cycle of a sine wave centered around 512 (midpoint).
- **Continuous Wave Output:** The while loop outputs each sine wave value to the DAC (DACR) with a delay, producing a continuous sine wave.

Output

The maximum amplitude was 2V.

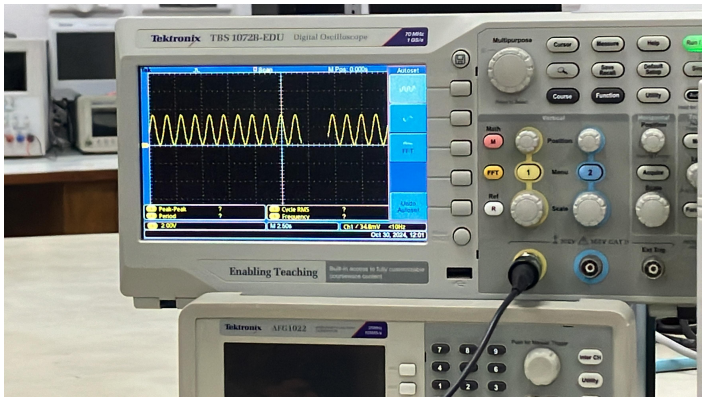

Figure 1: Sine Wave

DC Voltage of 1.25V on Oscilloscope

Code

```c
#include <lpc214x.h>
#include <stdint.h>

int main (void) {
    uint16_t value;
    PINSEL1 = 0x00080000;   /* P0.25 as DAC output */

    while (1) {
        value = 256;  // Corresponds to approximately 1.25V with 5V reference
        DACR = (1 << 16) | (value << 6);
    }
}
```

Listing 2: DC Voltage Generation Code

Explanation

This code configures the DAC on the LPC214x microcontroller to produce a stable analog voltage output. By setting P0.25 as the DAC output pin, a fixed value of 256 is continuously sent to the DAC register, resulting in an output of approximately 1.25V with a 5V reference.

Triangular Wave on Oscilloscope

Code

```c
#include <lpc214x.h>
#include <stdint.h>

void delay_ms(uint16_t j) {
    uint16_t x, i;
    for (i = 0; i < j; i++) {
        for (x = 0; x < 6000; x++);
    }
}

int main(void) {
    uint16_t value;
    PINSEL1 = 0x00080000;   /* P0.25 as DAC output */

    while (1) {
        value = 0;
        while (value != 1023) {
            DACR = ((1 << 16) | (value << 6));
            value++;
        }
        while (value != 0) {
            DACR = ((1 << 16) | (value << 6));
            value--;
        }
    }
}
```

Listing 3: Triangular Wave Generation Code

Explanation

- **DAC Initialization:** Configures P0.25 as the DAC output pin.
- **Waveform Generation:** The DAC output value is incremented from 0 to 1023 in a loop, creating a ramp-up to the DAC's maximum output, then decremented back to 0 to create a triangular waveform.
- **DAC Register Update:** The DACR register is updated with the current value shifted for DAC output.

Output

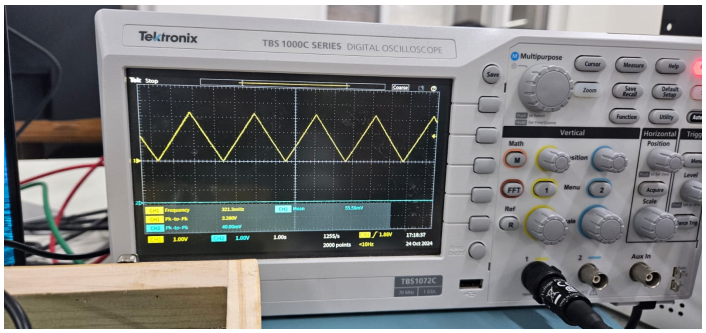

Figure 2: Triangular Wave

Staircase Waveform on the Oscilloscope with Maximum Amplitude of 2.38V

Code

```
#include <lpc214x.h>
#include <stdint.h>

void delay_ms(uint16_t j) {
    uint16_t x, i;
    for (i = 0; i < j; i++) {
        for (x = 0; x < 6000; x++);
    }
}

int main() {
    PINSEL1 = (1 << 19);  // Configure P0.25 as DAC output

    int value = 0;  // Starting DAC value
    int step = 10;  // Step size for each increment

    while (1) {
        // Upward staircase: Increase from 0 to ~2.38V
        for (value = 0; value <= 487; value += step) {
            DACR = (1 << 16) | (value << 6);  // Set DAC value with BIAS bit
            delay_ms(50);  // Adjust this to control frequency
        }

        // Downward staircase: Decrease back to 0
        for (value = 487; value >= 0; value -= step) {
            DACR = (1 << 16) | (value << 6);  // Set DAC value with BIAS bit
            delay_ms(50);  // Adjust this to control frequency
        }
    }

    return 0;
}
```

Listing 4: Staircase Waveform Generation Code

Explanation

- **DAC Configuration:** Configures P0.25 as the DAC output pin.
- **Value Initialization:** The ‘value‘ variable starts at 0, and ‘step‘ is set to 10, which determines the increment size for the DAC output.
- **Upward Staircase:** The code increments the value from 0 to 487, updating the DAC output in steps of 10, creating a ramping effect towards approximately 2.38V.
- **Downward Staircase:** The value is decremented back to 0, completing the staircase waveform.
- **Continuous Loop:** This process repeats indefinitely, generating a continuous staircase waveform oscillating between 0 and approximately 2.38V.

Output

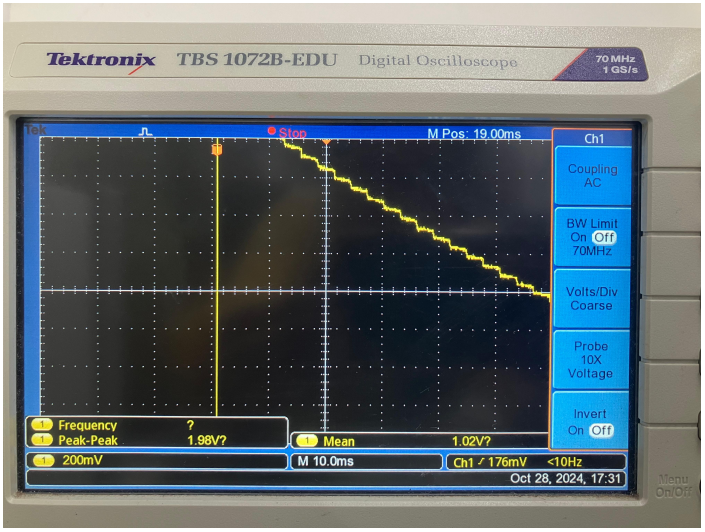

Figure 3: Staircase Wave