

Surname

Name Registration n°

1. Consider the following assembly ARM code and explain the evolution of the code and try to identify the general function developed if it exists.

```
main_fun:
    stmfd sp!, {r4, r6, lr}
    mov r6, r2
tailcall_entry:
    sub r7, r6, r1
    cmp r7, #1
    ldmlafd sp!, {r4, r6, pc}
    ldr r7, [r0, r1, asl #2]
    add r2, r1, #1
    mov r4, r6
partition_loop:
    ldr r3, [r0, r2, asl #2]
    cmp r3, r7
    addle r2, r2, #1
    ble partition_test
    sub r4, r4, #1
    ldr r5, [r0, r4, asl #2]
    str r5, [r0, r2, asl #2]
    str r3, [r0, r4, asl #2]
partition_test:
    cmp r2, r4
    blt partition_loop
partition_finish:
    sub r2, r2, #1
    ldr r3, [r0, r2, asl #2]
    str r3, [r0, r1, asl #2]
    str r7, [r0, r2, asl #2]
    bl main_fun
    mov r1, r4
    b tailcall_entry
```

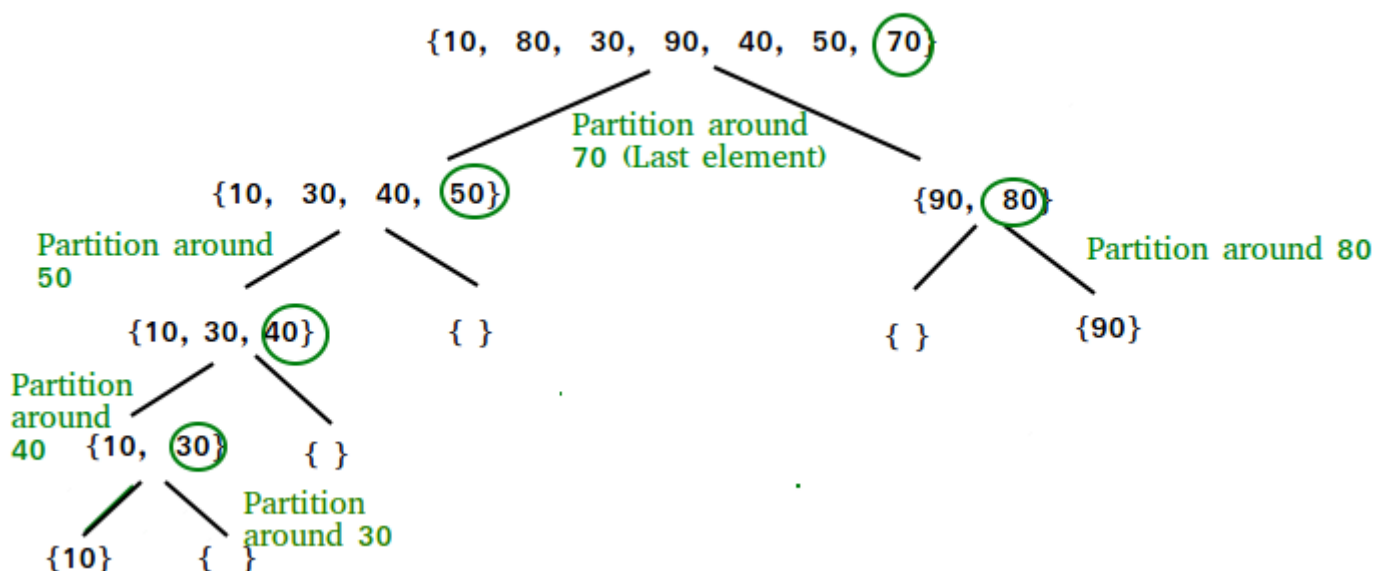
2. A 32 bit microprocessor with working frequency equal to 500 MHz must measure a pulse train frequency in the range [5 MHz -50 MHz] with +/- 5% precision. The processor drives a H-bridge motor with a Locked antiphase PWM generating a 50 Hz triangular wave signal and a 10 Hz ramp one. The more accurate technique that allows the best accuracy in the measurement must be identified considering the available resources. Neglect the interrupt latency.
3. Briefly answer to the following questions:
- Show how is the shape of the power supply of a step motor without the inductor in the chopper circuit
 - If a SCR is used to power supply a motor of a ship is it better to choke the power within a single period or to select the periods in to which the power is provided and those into which it is not provided?
 - What is the total time necessary for the data transferring if two devices that communicate at 0.1 Mb/s and are at a distance equal to 500m and with Can Bus protocol exchange their 32-bit identifiers in a half duplex way?
 - Why a three state buffer is necessary when a device makes access to a bus?
 - Why it is possible to say that an adaptor reduces the effect of the “disturbances” on the load of a motor?

Solution question n° 1

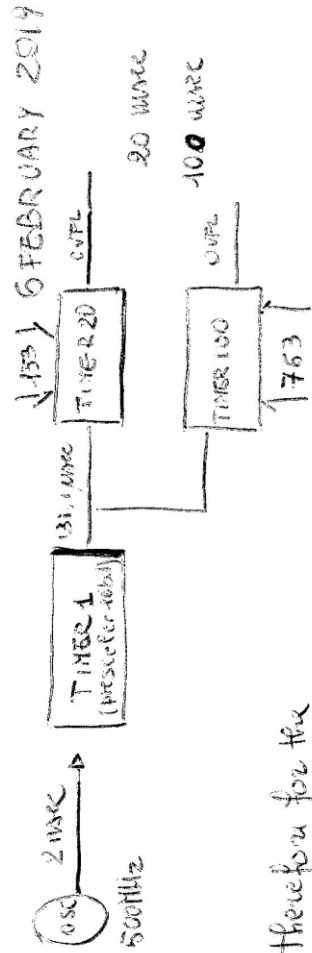
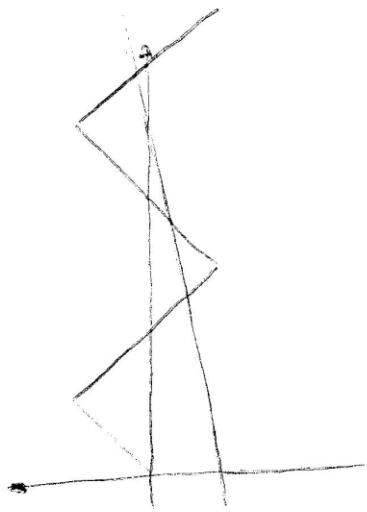
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qsort: @ Takes three parameters:
@ a:    Pointer to base of array a to be sorted (arrives in r0)
@ left: First of the range of indexes to sort (arrives in r1)
@ right: One past last of range of indexes to sort (arrives in r2)
@ This function destroys: r1, r2, r3, r5, r7
stmfd  sp!, {r4, r6, lr} @ Save r4 and r6 for caller
mov    r6, r2 @ r6 <- right
qsort_tailcall_entry:
sub    r7, r6, r1 @ If right - left <= 1 (already sorted),
cmp    r7, #1
ldmlefd sp!, {r4, r6, pc} @ Return, restoring r4 and r6
ldr    r7, [r0, r1, asl #2] @ r7 <- a[left], gets pivot element
add    r2, r1, #1 @ l <- left + 1
mov    r4, r6 @ r <- right
partition_loop:
ldr    r3, [r0, r2, asl #2] @ r3 <- a[l]
cmp    r3, r7 @ If a[l] <= pivot_element,
addle  r2, r2, #1 @ ... increment l, and
ble    partition_test @ ... continue to next iteration.
sub    r4, r4, #1 @ Otherwise, decrement r,
ldr    r5, [r0, r4, asl #2] @ ... and swap a[l] and a[r].
str    r5, [r0, r2, asl #2]
str    r3, [r0, r4, asl #2]
partition_test:
cmp    r2, r4 @ If l < r,
blt    partition_loop @ ... continue iterating.
partition_finish:
sub    r2, r2, #1 @ Decrement l
ldr    r3, [r0, r2, asl #2] @ Swap a[l] and pivot
str    r3, [r0, r1, asl #2]
str    r7, [r0, r2, asl #2]
bl     qsort @ Call self recursively on left part,
@ with args a (r0), left (r1), r (r2),
@ also preserves r4 and r6
mov    r1, r4
b     qsort_tailcall_entry @ Tail-call self on right part,
@ with args a (r0), l (r1), right (r6)

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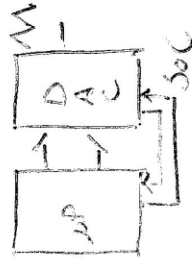


EX. 2)



therefor for the temporal basis we need 10 bits of the μP + 2 of overflow

For the generation of the triangular waveform we use a DAC with the same precision required in the measurement $\pm 5\% \Rightarrow \log_2 10 \Rightarrow 4$ bit plus SoC and EoC.



LET'S ASSUME THAT THE SAME DAC IS USED FOR THE GENERATION OF BOTH THE SIGNALS (RAMP AND TRIANGULAR WAVEFORM)

REMAINING BITS: $32 - 12 - 6 = 14$

SW SW $T_C = 20 \mu\text{s} \cdot 100 \text{ clock cycles} = 2000 \mu\text{s} \Rightarrow 5 \text{ MHz NOT FEASIBLE}$

4 W INT $f_{\text{max}} \cdot \Delta T = 2^N \quad \Delta T = \frac{2^{-14}}{50 \cdot 10^6} = 327.68 \mu\text{s}$ PRECISION

$\frac{1}{f_{\text{min}} \Delta T} = \frac{1}{5 \cdot 10^6 \cdot 2^{-14}} = 0.0006 \text{ V}$

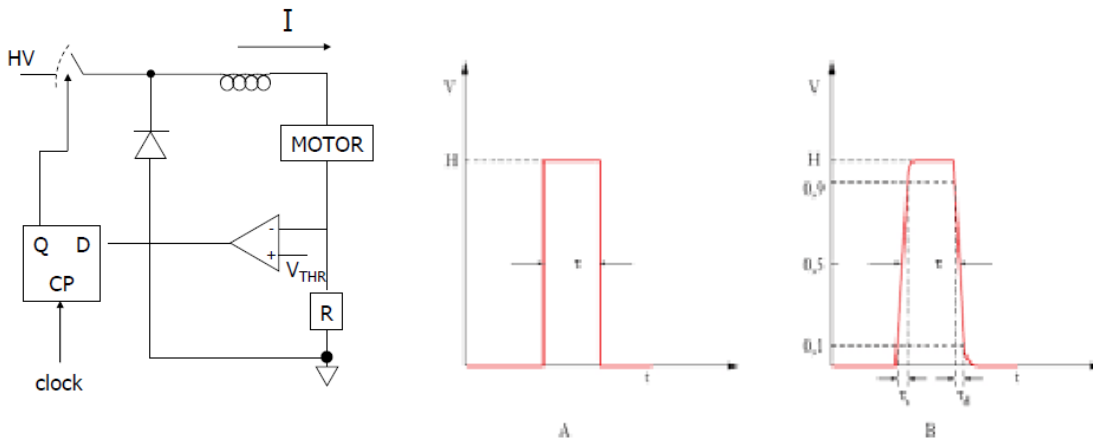
HW HW EVEN WORSE SINCE WE HAVE TWO BITS LESS

2 PULSES $T_{\text{clk}} \leq \frac{1}{f_{\text{max}}} = 20 \mu\text{s}$ $T_{\text{clk}} \geq \frac{2^N}{f_{\text{min}}} = 2^{-13} \cdot 200 \cdot 10^4 = \text{UNFEASIBLE}$

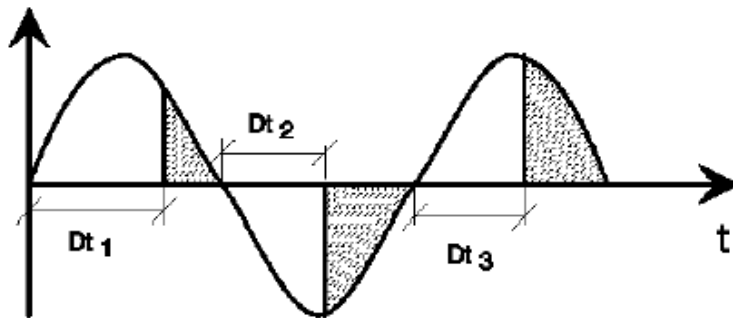
$E_{\text{inf}} = \frac{f_{\text{max}} (T_{\text{clk}})}{1 + f_{\text{max}} T_{\text{clk}}}$ $E_{\text{VSO}} = \frac{f_{\text{min}} T_{\text{clk}}}{f_{\text{max}} T_{\text{clk}}}$

Solution questions n° 3:

- 3.1) Show how is the shape of the power supply of a step motor without the inductor in the chopper circuit

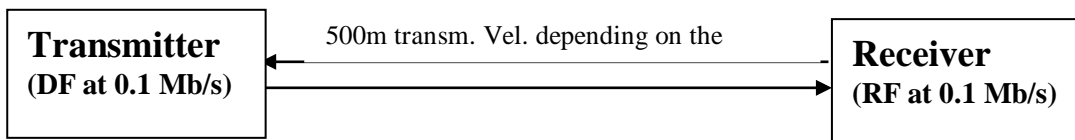


- 3.2) SCR is used to power supply a motor of a ship is it better to choke the power within a single period or to select the periods in to which the power is provided and those into which it is not provided?

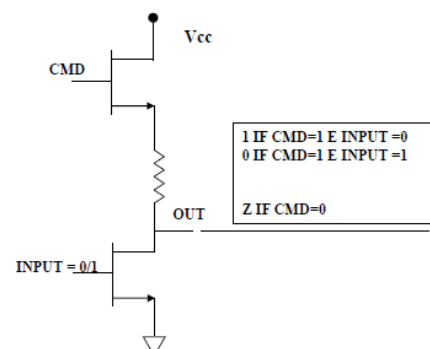
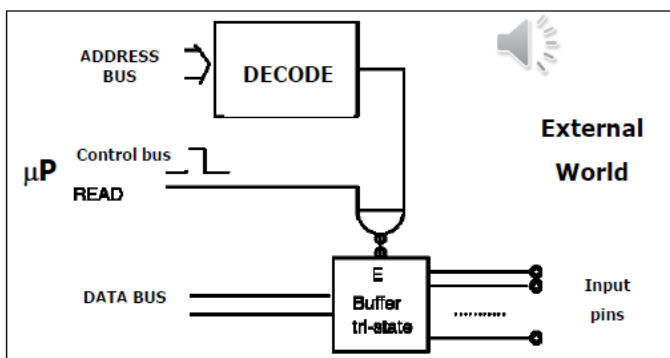


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- 3.3) What is the total time necessary for the data transferring if two devices t that communicate at 0.1 Mb/s and are at a distance equal to 500m and with Can Bus protocol exchange their 32-bit identifiers in a half duplex way?



- 3.4) Why a three state buffer is necessary when a device makes access to a bus?



- 3.5) Why it is possible to say that an adaptor reduces the effect of the “disturbances” on the load of a motor?

$$\tau_c = J_c \cdot \frac{\ddot{\theta}_m}{n^2 \cdot \xi} + B_c \cdot \frac{\dot{\theta}_m}{n^2 \cdot \xi} + \frac{d'}{n \cdot \xi}$$

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