

UNIVERSITÀ DEGLI STUDI DI PADOVA
DIPARTIMENTO DI TECNICA E GESTIONE DEI SISTEMI INDUSTRIALI

**CORSO DI LAUREA TRIENNALE IN INGEGNERIA
MECCANICA E MECCATRONICA
CURRICULUM MECCATRONICO**



**USO DI MICROCONTROLLORE PER LO
SVILUPPO DI UN SISTEMA DI
COMUNICAZIONE E GESTIONE ALLARMI IN
UN ROBOT PER LA RIABILITAZIONE**

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laureando: ENRICO REGINATO
anno accademico: 2013/2014

ROBOT PER RIABILITAZIONE



..la Riabilitazione

..e i Robot

..ok, quindi..

..COSA SONO?

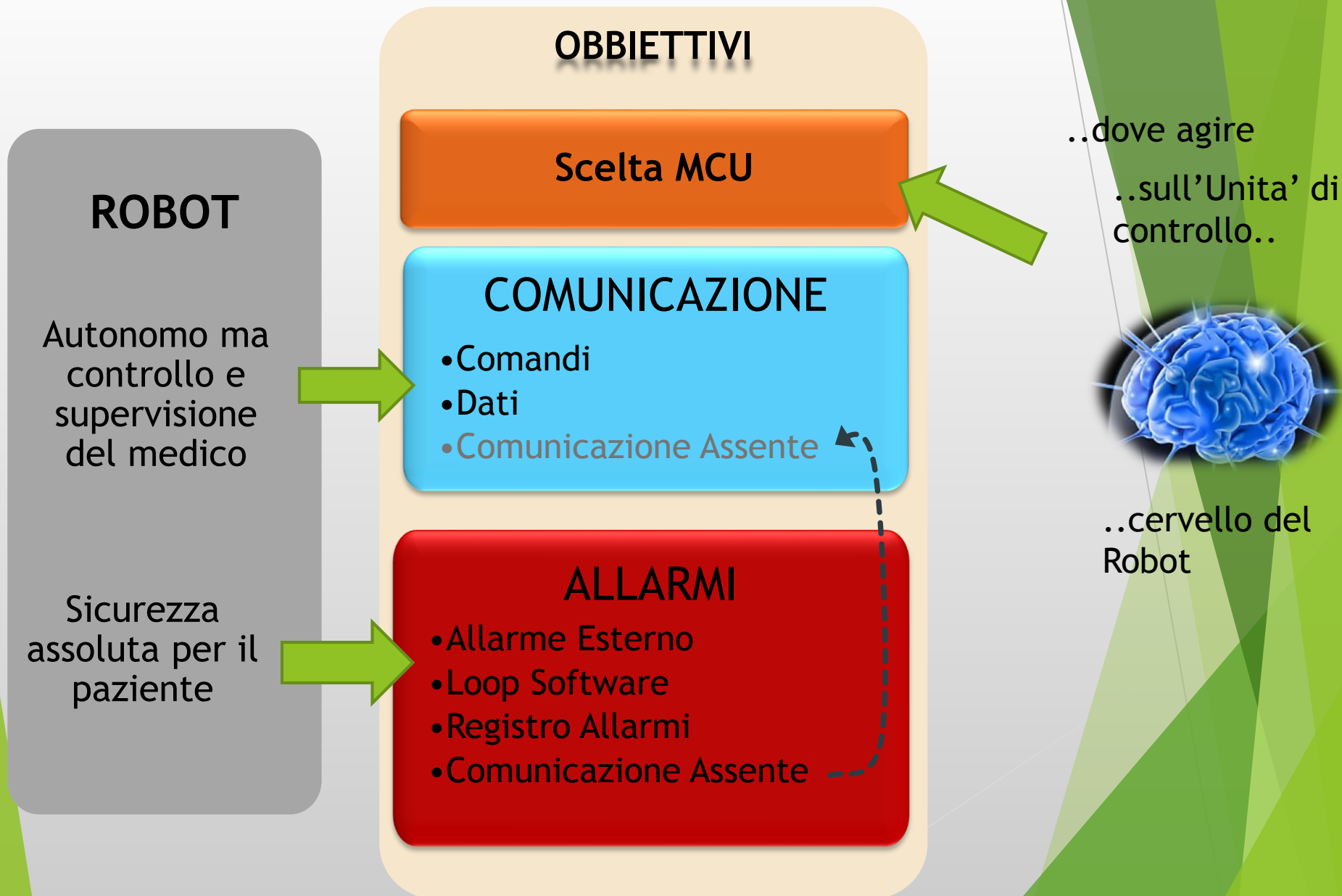
La mano del fisioterapista

..COME SONO FATTI?

- Struttura meccanica
- Interfaccia aptica (feedback)
- Unità di controllo (autonomo)



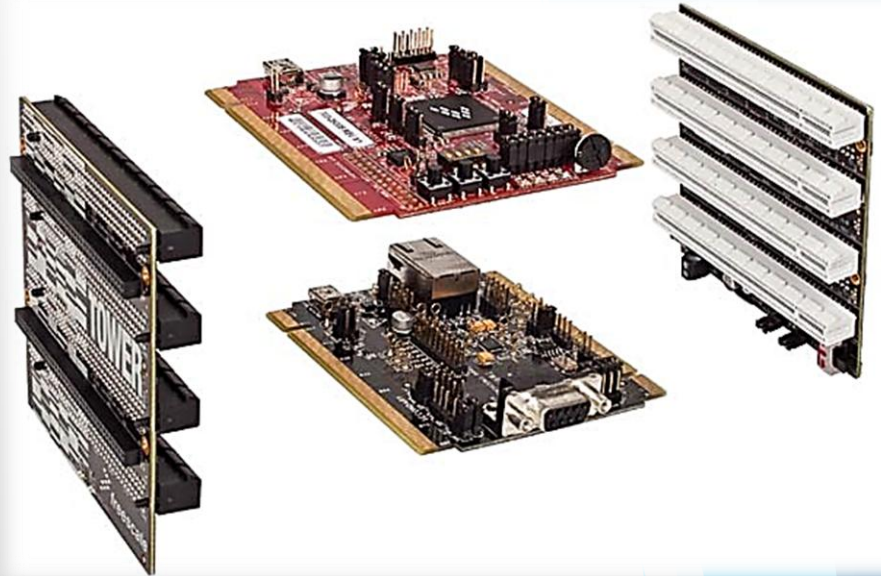
Sistema di COMUNICAZIONE e gestione ALLARMI



SCELTA MCU

Tower system:

- MCU (no PC)
- per sviluppo
- Modulare (50+ moduli)

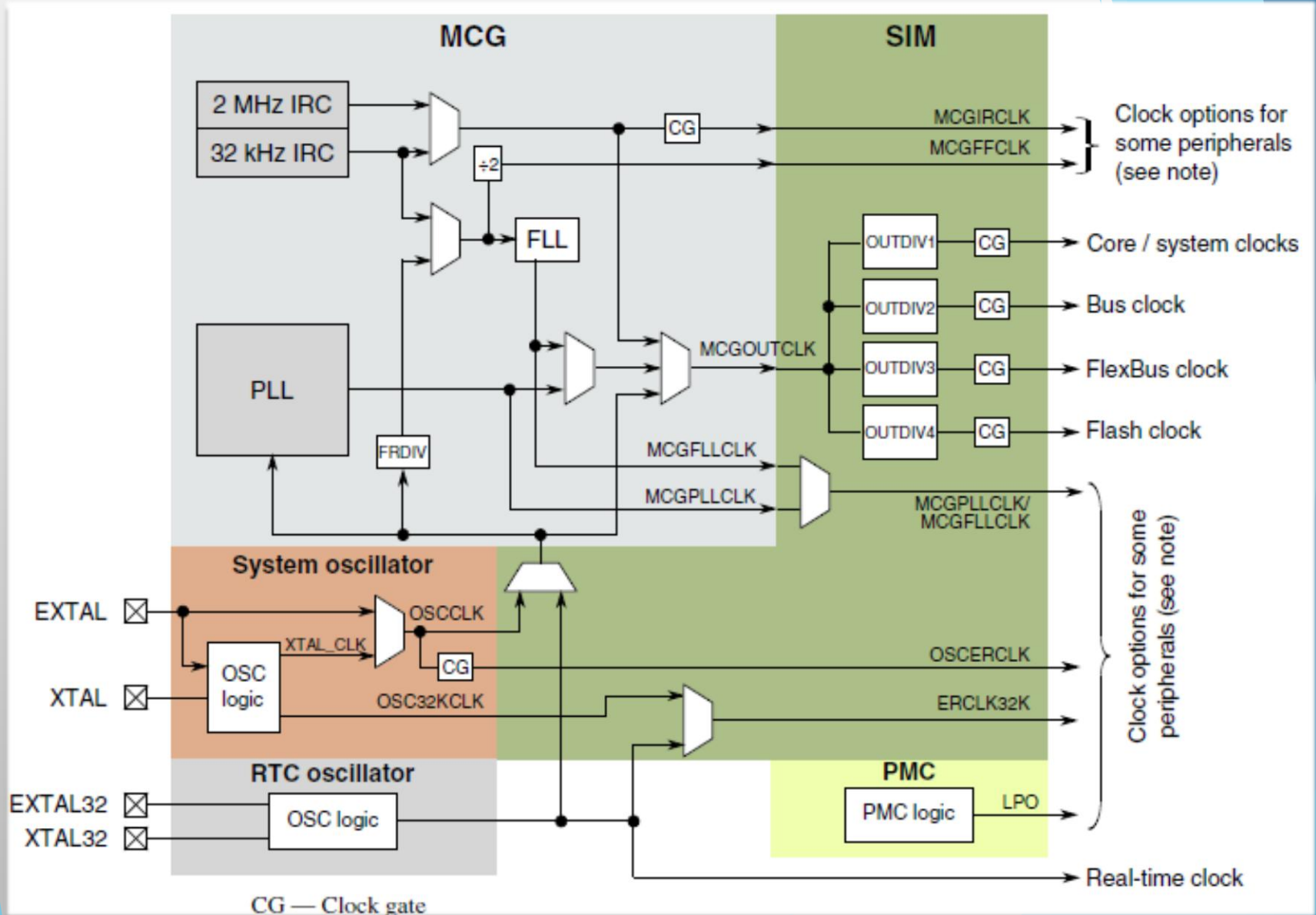


Caratteristiche	PSX30	MPC5643L	K60_120
analogiche	pwm	pwm	DAC/pwm
comunicazione	Seriale+ Eth	seriale	Seriale + Eth
sicurezza	SI (sor)	SI (sor)	SI
IDE e supporto	NO (legacy)	NO	SI

K60_120 + CodeWarrior + PE

K60_120 + CodeWarrior + PE

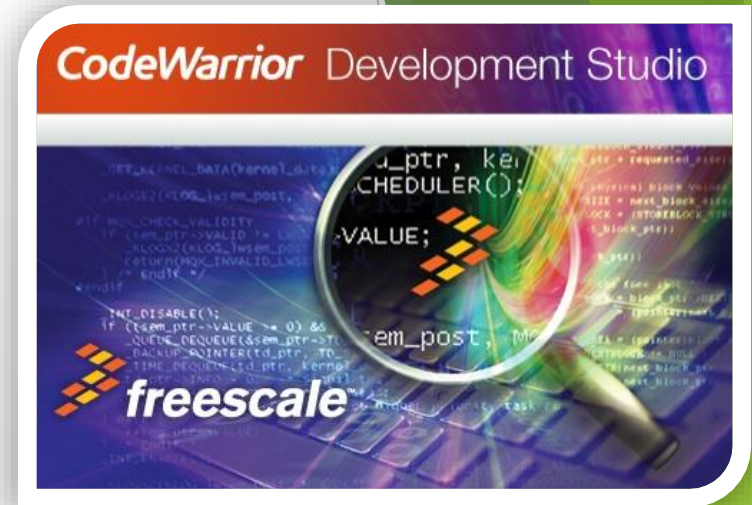
Esempio configurazione moduli in una MCU ..i clock



K60_120 + CodeWarrior + PE

Cos'è CodeWarrior?..

IDE , C/C++, Win/Linux + plug-in MCU



Cos'è PE?..

Processor Expert

librerie componenti

Impostazioni e Codice (funzionalità)

..esempio:

The image shows a screenshot of the CodeWarrior Components Library. The "Components Library" window is open, showing a list of components. The "IntFLASH" component is selected, and a red arrow points to it. A green plus sign icon is next to the "Add to project" button. The "Component Inspector" window is also open, showing the properties of the selected component. A green checkmark icon is next to the "Component Inspector" window.

Name	Value
SetBlockFlash	generate code
GetBlockFlash	generate code
RestoreToFlash	generate code
<	don't generate code

COMUNICAZIONE MCU-PC_REMOTO

..cosa scambio?

COMANDI
(fixed length)

+

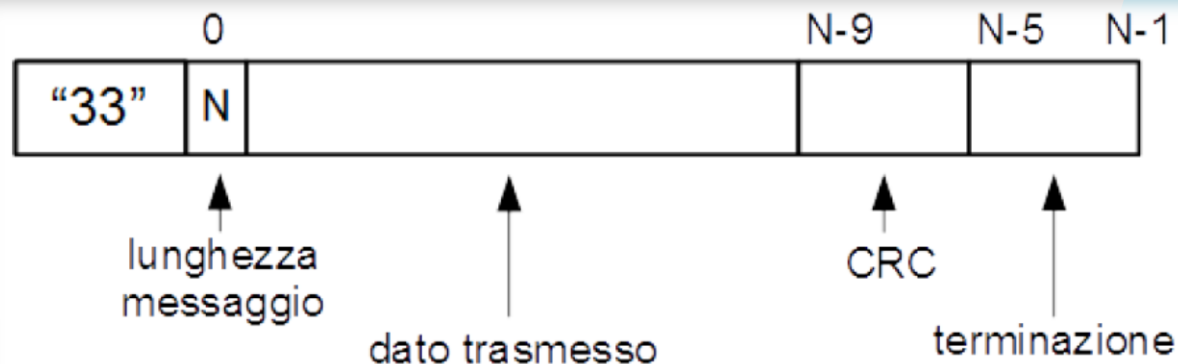
DATI
(variable length)



COMANDI



DATI



COMUNICAZIONE MCU-PC_REMOTO

- ..sicurezza,
- ..il PC (supervisore) c'è ancora?

mySerialParse_waitForPcResponse() + flag (global_serialCom_msgReceived)

..e i messaggi corrotti?

CRC (Cyclic Redundancy Check)

```
11010011101100 000 <--input right padded by 3 zero bits
1011 <--divisor
01100011101100 000 <--result (the firsts four bits are the XOR with the..
01011 ..divisor, the rest of the bits are unchanged)
00111011101100 000
001011 <--divisor..
000111011101100 000
0001011
00000011101100 000 <--the divisor moves to align with the next 1 in
0000001011 ..divider (..can move more than one byte at time)
0000000110100 000
00000001011
0000000011000 000
000000001011
0000000001110 000
0000000001011
0000000000101 000
0000000000101 1
000000000000 100 <--remainder(3bits) division algorithm
<--stops here as quotient is equal to zero
```

```

11010011101100 000
1011
01100011101100 000
01011
00111011101100 000
001011
000111011101100 000
0001011
0000001101100 000
0000001011
0000000110100 000
00000001011
0000000011000 000
000000001011
0000000001110 000
0000000001011
0000000000101 000
0000000000101 1
0000000000000 100

```

<--input right padded by 3 zero bits

<--divisor

**<--result (the firsts four bits are the XOR with the..
..divisor, the rest of the bits are unchanged)**

<--divisor..

**<--the divisor moves to align with the next 1 in
..divider (..can move more than one byte at time)**

<--remainder(3bits) division algorithm

..stops here as quotient is equal to zero

COMUNICAZIONE MCU-PC_REMOTO

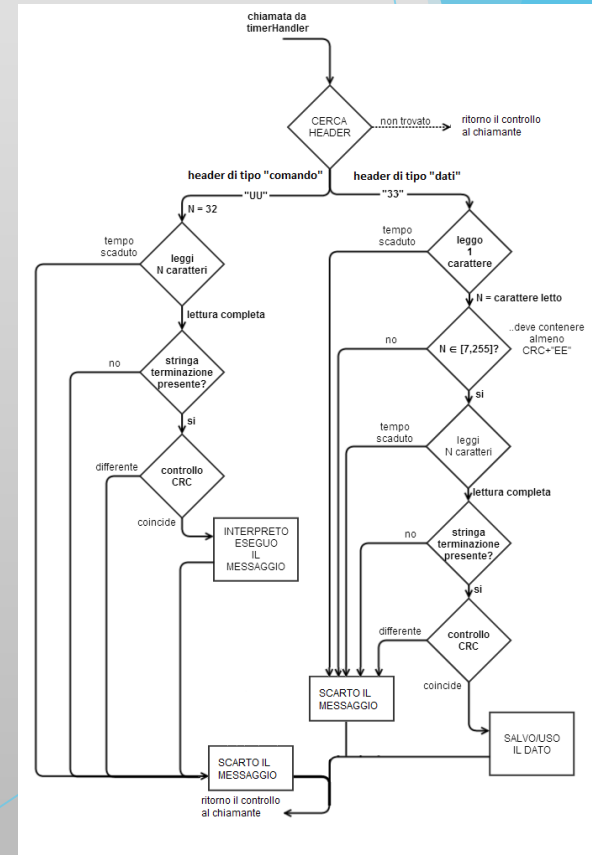
..con la seriale (ma universale)

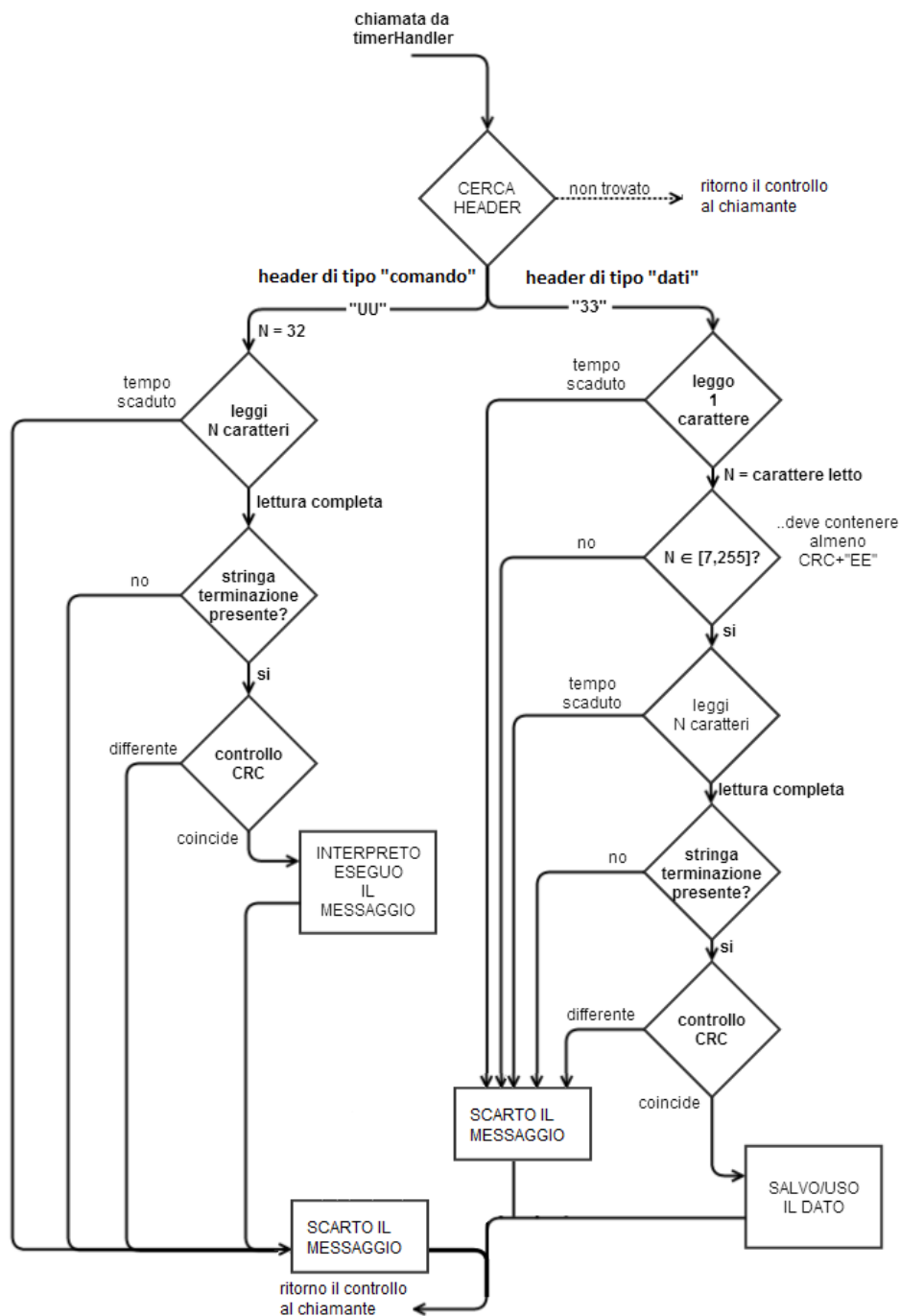
Inhr1_RecvChar() & Inhr1_SendChar()

..ma nella pratica?

..si fa cosi..

..Algoritmo per l'interpretazione dei pacchetti..





..ALGORITMO PER INTERPRETAZIONE DEI PACCHETTI..

ALLARMI

timeout comunication
(lettura troppo lenta)



timerMaxLettura
myTimerLettura_Counter (flag)

&

lost comunication
(comunicazione persa)



timerLostCom
global_serialCom_flag (flag)

..esempio attivazione timer (PIT)

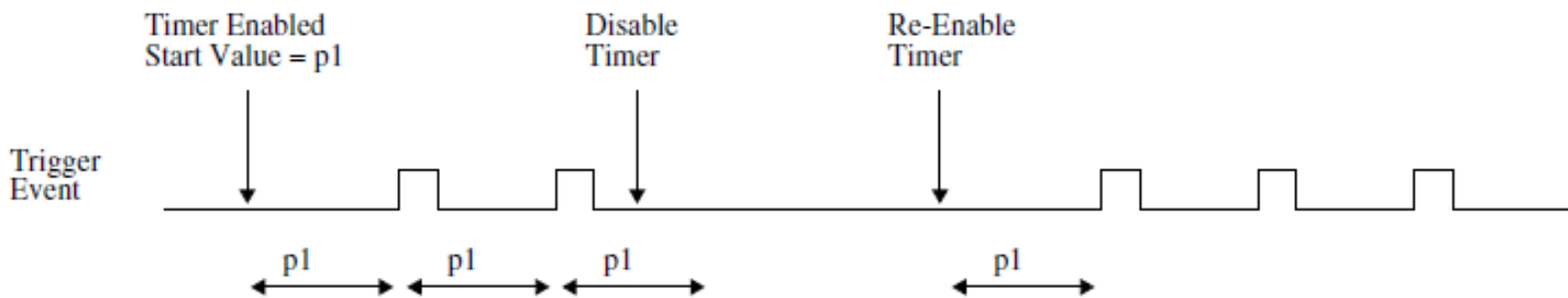


Figure 40-23. Stopping and Starting a Timer

..USO DEL **WDOG**:

- Continous WDOG servicing
- down counter (timer)
- Timeout : salva allarme & reset MCU

ALLARMI

..il REGISTRO ALLARMI

Allarmi

- Hard fault
- Bus usage fault
- Allarme Ext.
- WDOG timeout
- Lost communication



Salva..

tipo allarme
+
data/ora

..in memoria



0	last alarm
1	
2	
...	
38	
39	



..ALLARME ESTERNO:

GPIO + IRQ =



asincrono

Aspetta riarmo
bordo macchina
(SW_1)



Aspetta riarmo
software
(messaggio da PC)

RISULTATI OTTENUTI

COMUNICAZIONE

TIPO DATO
comando

..controllo remoto
uscita

Terminal v1.91b - 20140110B - by Br@y++

Connect ReScan Help About.. Quit

COM Port: COM4

Baud rate: 600, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 56000, 57600, 115200, 128000, 256000, custom

Data bits: 5, 6, 7, 8

Parity: none, odd, even, mark, space

Stop bits: 1, 1.5, 2


Handshaking: none, RTS/CTS, XON/XOFF, RTS/CTS+XON/XOFF, RTS on TX, invert

Settings

Receive

CLEAR AutoScroll Reset Cnt 13 Cnt = 252 HEX ASCII LogDateStamp StartLog StopLog Req/Resp Dec Bin Hex

```
robot_time is : 5:43:17 of 1/1/2014
robot_time is : 5:43:19 of 1/1/2014
robot_comando ricevuto: CMD_out_high
inside handler CMD_out_high 1
robot_time is : 5:43:22 of 1/1/2014
robot_comando ricevuto: CMD_out_low
inside handler CMD_out_low 2
robot_time is : 5:43:24 of 1/1/2014
robot_time is : 5:43:26 of 1/1/2014
robot_comando ricevuto: CMD_out_high
inside handler CMD_out_high 3
robot_time is : 5:43:28 of 1/1/2014
robot_time is : 5:43:30 of 1/1/2014
```



Transmit

Macros

Set Macros	47	48	49	51	53	55	57	59	61	63	M11	M12
	PCok	allCmd	machine	motor	avanti	indietro	log	time	outH	outL	faseN	cmd??

Disconnected Rx: 7107 Tx: 674 Rx OK 395

RISULTATI OTTENUTI

COMUNICAZIONE

TIPO DATO
comando

..PC 'sono pronto'

The image shows a terminal window with a toolbar at the top containing buttons for CLEAR, AutoScroll, Reset Lnt, Lnt = 860, ASCII, StartLog, StopLog, Req/Hesp, and a Help icon. The terminal output displays the following text:

```
inizio
time is : 11:15:30 of 21/1/2014
 size of log is:692
 size of packageMsg is:22
number start-up:0
Wdog log: not WDOG error
*****
*****
*****
Ok60F120UniPd<0><0><0><0><0><0><0><0>
*****
*****
**PC*HA*RISPOSTO*****
*****
```

Overlaid on the terminal is a dialog box titled "Request/Response (experimental)". It has an "Enable" checkbox checked and a close button (X). The text inside the dialog reads: "Terminal will wait for string and will respond. As a response you could also use macro commands." Below this is a table with two columns: "REQUEST" and "RESPONSE". The first row contains the request "Ok60F120UniPd<0><0><0><0><0><0><0><0>" and the response "Sono Pronto".

REQUEST	RESPONSE
Ok60F120UniPd<0><0><0><0><0><0><0><0>	Sono Pronto

At the bottom left of the terminal window, there is a "Transmit" button.

RISULTATI OTTENUTI

COMUNICAZIONE

TIPO DATO

dato

(variable length)

..CRC corrotto

```
Terminal v1.91b - 20140110B - by Br@y++
Connect ReScan Help About.. Quit
COM Port: COM4
Baud rate: 600 14400 57600 1200 19200 115200 2400 28800 128000 4800 38400 256000 9600 56000 custom
Data bits: 5 6 7 8
Parity: none odd even mark space
Stop bits: 1 1.5 2

Settings
Receive
12:58:12.025> -----startUp routine--START-----
12:58:12.025>
12:58:12.025> number start-up:9
12:58:12.025>
12:58:12.046> -----startUp routine---END-----
12:58:12.046>
12:58:12.046> inizio
12:58:12.046> time is : 12:58:56 of 31/1/2014
12:58:12.046> size of log is:692
12:58:12.046> size of packageMsg is:32
12:58:12.046> primaDiinit
12:58:13.038> dopoWhileheader
12:58:13.038>
12:58:14.045> HEADER1 non trovatodopoWhileheader
12:58:14.045> HEADER1_2 trovato..
12:58:14.045>
12:58:14.045> lunghezza da leggere 16 byte..msg ok controllo crc..
12:58:14.045>
12:58:14.045> CRC calcolato = 1349279715
12:58:14.045> CRC ricevuto = 2793719750CRC non coincide msg corrotto..
12:58:15.027> dopoWhileheader
12:58:15.027>
12:58:16.026> HEADER1 non trovatodopoWhileheader

Transmit
CLEAR Send File 0 12345A789$c6$ DTR RTS
Macros
Set Macros 47 48 49 51 53 55 57 59 61
PCok allCmd machine motor avanti indietro log time outH
55#016012345A789$c6$7$84$a6EE +CR -> Send
Disconnected Rx: 24850 Tx: 890 Rx OK 1509
```


CONCLUSIONI

..COMUNICAZIONE:

- Affidabile
- Comandi base efficaci



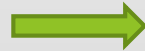
CRC
comunica allarmi
uscita controllo remoto
imposta data e ora

..ALLARMI:

- efficaci (test comunicazione persa, lenta, IRQ Ext.)
- ricostruzione temporale situazione di allarme (registro allarmi)

..orientato a sviluppi futuri:

- Comunicazione universale
- Scalabile



leggo/scrivo carattere per carattere
sistema a pacchetti

..MCU e IDE:

- supporto community
- CodeWarrior+PE binomio perfetto per sviluppo