

FS1 protocol

Serial and radio protocol for FS Scoreboards Version S11 - 11/11/2020

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1. INTRODUCTION

This document describes the FS1 protocol used to control FS-series and FC-series scoreboards via cable.

All data is sent through one serial cable which is then connected to the various scoreboards being used; each scoreboard picks up and displays the data relevant to it.

2. CHANGE LOG

Version S11, 11/11/2020

- from Console-700 firmware 2.51: modification on message 0x82, overtime is now 'O' (and not 'E') for basketball due to the new FIBA 2020 rules (on Console-700 the parameter "FIBA 2020" should be ON).

Version S10, 14/03/2019

- new message 0x96, high resolution chronometer.

Version S09, 22/10/2018

- message 0x81, better explanation of fields, no changes on protocol.

Version S08, 05/10/2017

- message 0x81, "red light" field becomes "yellow point / tenths"; "light-strip" becomes "red / yellow light-strip".

Version S07, 02/11/2015

- message 0xF0, added new sports from Console-700 firmware 2.00;
- message 0x83, team fouls with 2 figures.

Version S06, 04/11/2014

- messages 0xC0..0xDE, new data "foul number", to be displayed on scoreboards with fouls on one figure;
- viewable characters set;
- byte number indication on top of message diagrams;

Version S05, 27/08/2014

- on message 0x80, modification of chronometer status byte, to show chronometer type (game time, pause time, timeout time, other);
- implemented in Console-700 release 1.05 beta 2.

Version S04, 26/08/2014

- new protocol name FS1;
- clarification: on message 0x80 value 40hex for timeout means no timeouts;
- new light strip byte on message 0x80;
- new chronometer status flag on message 0x80;
- new shot-clock status byte on message 0x81;
- message 0x94: horn levels are 0 (min) to 3 (max) and not 0 to 2;
- message 0x82: extra time is 0x3E;
- messages now are ordered by message address;
- new document formatting;

3. PHYSICAL LAYER

The electrical characteristics are as specified by the EIA RS-485 (or RS-422) standard, with the following parameters:

Baud rate: 19200 bps
 No. of start bits: 1
 No. of data bits: 8
 Parity: Odd (1 bit)
 No. of stop bits: 1

Fig. 1 shows the electrical signals of the serial data output carried through the RJ-45 connectors on the control console; the serial data can be read or can directly control the scoreboards without the aid of the Console by connecting these signals to a PC equipped with an RS-485 adaptor. Communication takes place via a standard direct network cable (EIA/TIA-568A/B) or via a network cable with the connection of the individual wires as shown in Fig. 2; for distances less than 50m, an 8-wire flat telephone cable terminating in RJ-45 type jacks can be used.

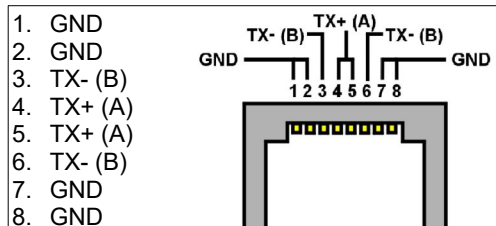


Fig. 1: Electrical signals

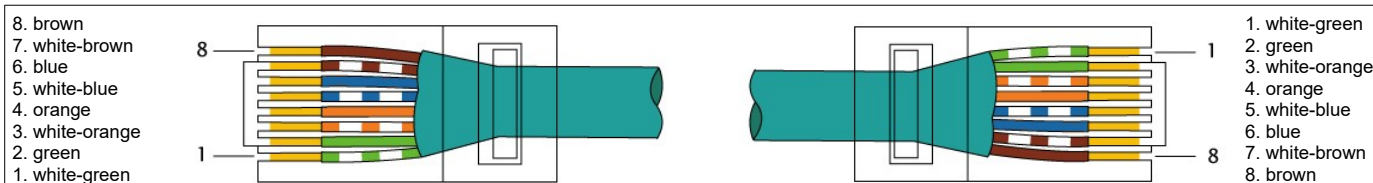


Fig. 2: Connections to the network connectors (RJ-45)

4. DATA LINK LAYER

The data is grouped into 12- or 14-byte packet lengths and sent cyclically; in order to display changes (in scores, times, fouls, etc.) on the scoreboards immediately, the cycle may be temporarily interrupted to send the packet with the changed data. When a scoreboard does not receive data for 5 seconds, it turns off. Each data packet defines the information displayed on a particular part of the scoreboard; the packet (Fig. 3) is made up of 12 or 14 bytes with the following fields:

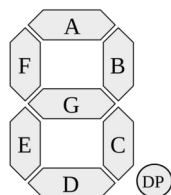
- Address: 1 byte, at the beginning of the packet, which identifies the part of the scoreboard that the packet is intended for. The most meaningful bit is always 1, so its value can range from 128 to 255 ($80_{\text{hex}} \div FF_{\text{hex}}$).
- Useful data: 10 or 14 bytes with printable ASCII characters, i.e., with codes from 32 to 127 ($20_{\text{hex}} \div 7F_{\text{hex}}$). The most meaningful bit is always 0. They take on different meanings depending on the Address value.
- LRC: 1 byte for error control, the sum of all the preceding bytes (Address+Useful data) and with the most meaningful bit set to zero. For example, summing the following packet of 11 bytes (Address + "PLAYERNAME"):
 $BA_{\text{hex}} + 50_{\text{hex}} + 4C_{\text{hex}} + 41_{\text{hex}} + 59_{\text{hex}} + 45_{\text{hex}} + 52_{\text{hex}} + 4E_{\text{hex}} + 41_{\text{hex}} + 4D_{\text{hex}} + 45_{\text{hex}}$
 we obtain $3A8_{\text{hex}}$; by only taking into consideration the last two numbers ($A8_{\text{hex}}$) and setting the most meaningful bit to zero, we obtain $LRC=28_{\text{hex}}$, which corresponds to the printable character '('.



Fig. 3: Packet format

5. VIEWABLE CHARACTER SET

La tabella qui sotto riporta i codici dei caratteri visualizzabili sui display a 7 segmenti per alcuni campi dati.

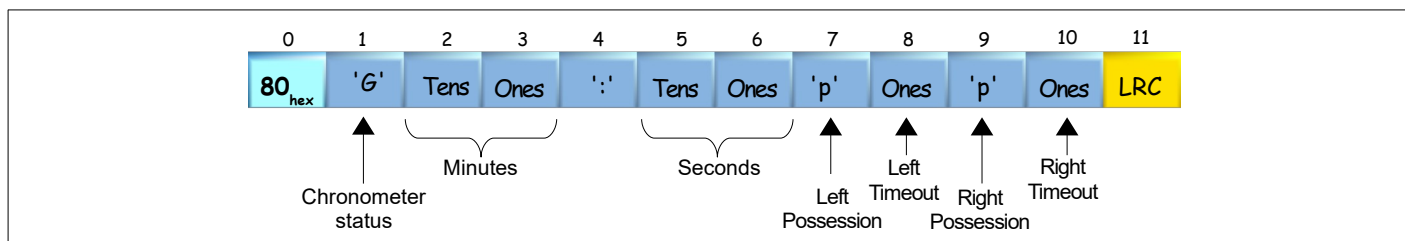


ASCII	Decimale	Esadecimale	Visualizzazione
' '	32	0x20	<empty>
'0'	48	0x30	0
'1'	49	0x31	1
'2'	50	0x32	2
'3'	51	0x33	3
'4'	52	0x34	4
'5'	53	0x35	5
'6'	54	0x36	6
'7'	55	0x37	7
'8'	56	0x38	8
'9'	57	0x39	9
':'	58	0x3A	A
','	59	0x3B	b
'<'	60	0x3C	C
'='	61	0x3D	d
'>'	62	0x3E	E
'?'	63	0x3F	F
'@'	64	0x40	<empty>
'A'	65	0x41	segment C
'B'	66	0x42	segments C+D
'C'	67	0x43	segments B+C+D
'D'	68	0x44	u (segments C+D+E)
'E'	69	0x45	- (segment G)
'F'	70	0x46	U
'G'	71	0x47	P
'H'	72	0x48	c
'I'	73	0x49	°
'J'	74	0x4A	H
'K'	75	0x4B	h
'L'	76	0x4C	L
'M'	77	0x4D	t
'N'	78	0x4E	y
'O'	79	0x4F	<empty>

6. DATA PACKETS

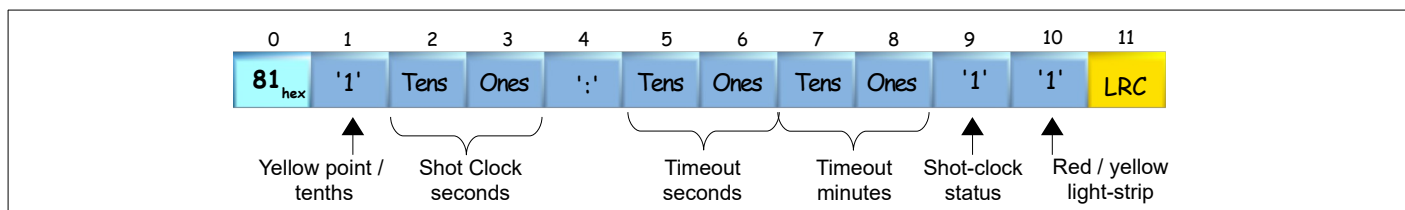
Listed below are the various types of packets and the meanings of their useful data. If the data is not relevant to the display, it takes on the value of ' ' (space = 32_{dec} = 20_{hex}). From here on in this document, "Left" and "Right" indicate information referring, respectively, to the team on the left and to the team on the right.

1.1. [0x80] Game clock + Possession + Timeout



- Address: 128 (80_{hex}).
- Game clock: 2 bytes with the ASCII digits entered to indicate the minutes (0÷99), 2 bytes for the digits showing the seconds (0÷59), and 1 byte for the 2 separation points. When tenths of a second are displayed, seconds take the place of the minutes, and tenths of a second take the place of the seconds.
The Console shows the timer count with the 2 points flashing; otherwise the scores stay lit without flashing.
 - ':' (3A_{hex}) → On,
 - ' ' (20_{hex}) → Off.
- Possession: 1 byte with the following ASCII values:
 - 'p' (70_{hex}) → On,
 - ' ' (20_{hex}) → Off.
- Timeout: 1 byte with the following ASCII values:
 - (40_{hex}) → nessuna segnalazione,
 - 'A' (41_{hex}) → 1 signal On,
 - 'B' (42_{hex}) → 2 signals On,
 - 'C' (43_{hex}) → 3 signals On.
- Chronometer status: 1 byte with the following ASCII values:
 - 'G' (47_{hex}) → Chronometer is counting, game time,
 - 'P' (50_{hex}) → Chronometer is counting, pause time,
 - 'T' (54_{hex}) → Chronometer is counting, timeout time,
 - 'O' (4F_{hex}) → Chronometer is counting, other,
 - ' ' (20_{hex}) → Chronometer is not counting.

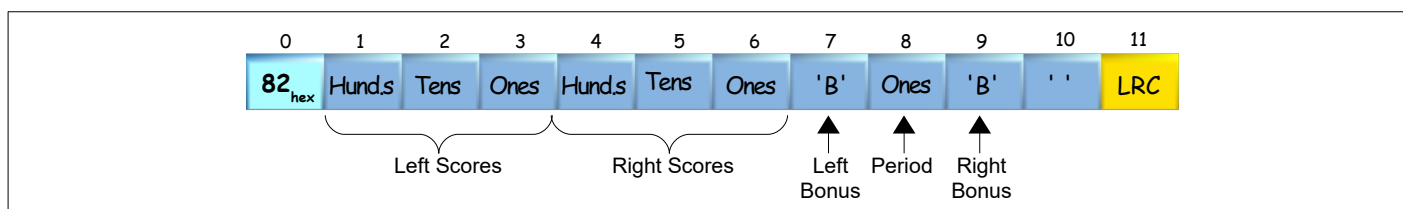
1.2. [0x81] Shot clock + Timeout



- Address: 129 (81_{hex}).
- Yellow point / tenths: 1 byte, command for the yellow point / tenths
 - ' ' (20_{hex}) → yellow point Off / tenths Off,
 - '1' (31_{hex}) → yellow point On,
 - '2' (32_{hex}) → tenths On
 - '3' (33_{hex}) → yellow point On / tenths On,
- Shot Clock: 2 bytes for the seconds
- Timeout status: The Console shows the timeout with the two scores flashing; otherwise they stay lit without flashing.
 - ':' (3A_{hex}) → On,
 - ' ' (20_{hex}) → Off.
- Timeout: 2 bytes for the minutes, and 2 bytes for the seconds.
- Shot-clock status: 1 byte with the following ASCII values:
 - '1' (31_{hex}) → Shot-clock is counting,
 - ' ' (20_{hex}) → Shot-clock is not counting.
- Light-strip red/yellow: 1 byte with the following ASCII values:

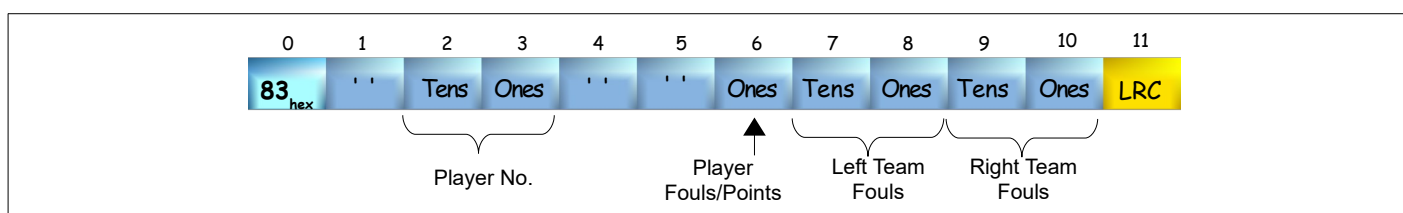
- ' ' (20_{hex}) → Red / yellow light-strips Off,
- '1' (31_{hex}) → Red light-strip On,
- '2' (32_{hex}) → Yellow light-strip On,
- '3' (33_{hex}) → Red / yellow light-strips On.

1.3. [0x82] Team scores + Period + Bonus



- Address: 130 (82_{hex}).
- Scores: 3 bytes with the ASCII digits corresponding to the score value (0÷199); for example, the score 52 is sequentially coded with the bytes ' ', '5', '2' (20_{hex}, 35_{hex}, 32_{hex}).
- Bonus: 1 byte, to indicate whether the bonus signal is activated or not.
 - 'B' (42_{hex}) → On,
 - ' ' (20_{hex}) → Off.
- Period: 1 byte with the ASCII digit corresponding to the value of the period.
 - ' ' (20_{hex}) → Off,
 - '0' (30_{hex}) ÷ '9' (39_{hex}) → numeric value,
 - 'O' (3E_{hex}) → overtime for Basketball (FIBA 2020 rules).
 - 'E' (3E_{hex}) → overtime for all other sports.

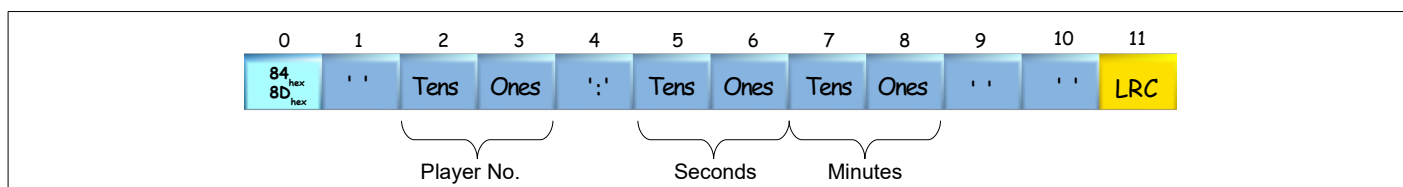
1.4. [0x83] Team Fouls + Player No. + Player Fouls



The number of the player and the player fouls/points is normally turned off (byte with ' ', 20_{hex}); the Console activates the flashing light for about 6 seconds when a new foul is assigned to a player.

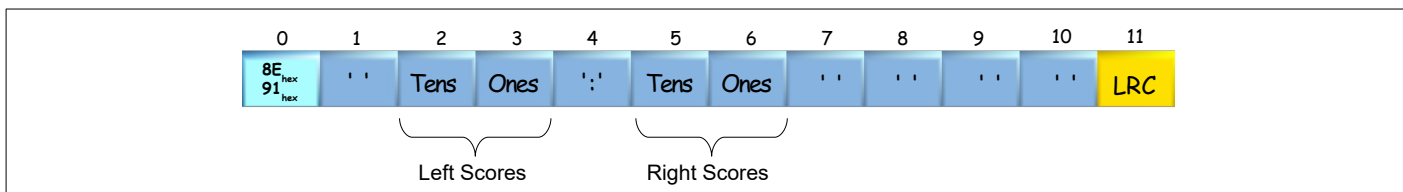
- Address: 131 (83_{hex}).
- Player No.: 2 bytes with the corresponding ASCII digits (0÷99).
- Player fouls: 1 byte with the corresponding ASCII digit (0÷9).
- Team fouls: 1 byte with the corresponding ASCII digit (0÷9).

1.5. [0x84..0x8D] Player No. + Penalty Time



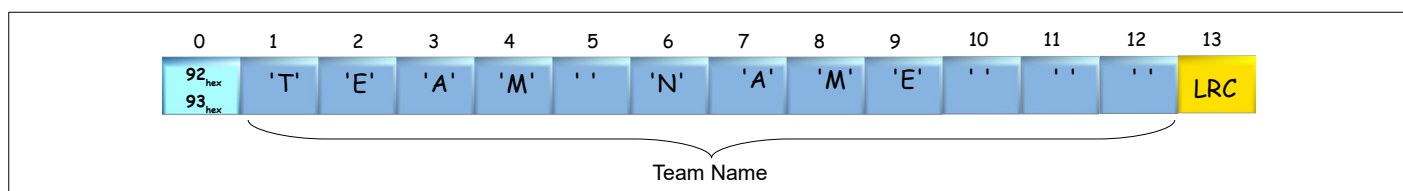
- Addresses: 5 Left Penalties: 132 ÷ 136 (84_{hex} ÷ 88_{hex}).
5 Right Penalties: 137 ÷ 141 (89_{hex} ÷ 8D_{hex}).
- Player No.: 2 bytes with the corresponding ASCII digits (0÷99).
- Penalty time: 2 bytes for the minutes, 2 bytes for the seconds. The Console shows the penalty time count with the two scores flashing; otherwise they stay lit without flashing.
 - ':' (3A_{hex}) → On,
 - ' ' (20_{hex}) → Off.

1.6. [0x8E..0x91] Set scores



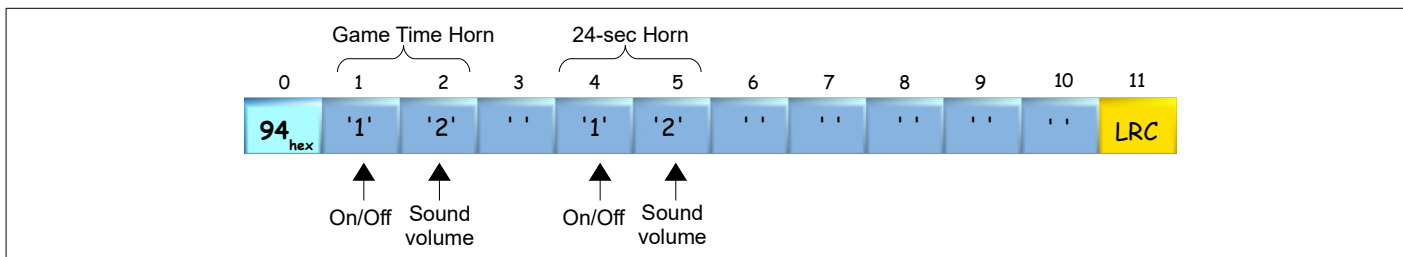
- Addresses:
 - Set 1 → 142 (8E_{hex})
 - Set 2 → 143 (8F_{hex})
 - Set 3 → 144 (90_{hex})
 - Set 4 → 154 (91_{hex})
- Scores: 2 bytes for each score, with the corresponding ASCII digits (0+99). Two separation points are inserted between the Left and Right scores (3A_{hex}).

1.7. [0x92-0x93] Team Names (14 bytes)



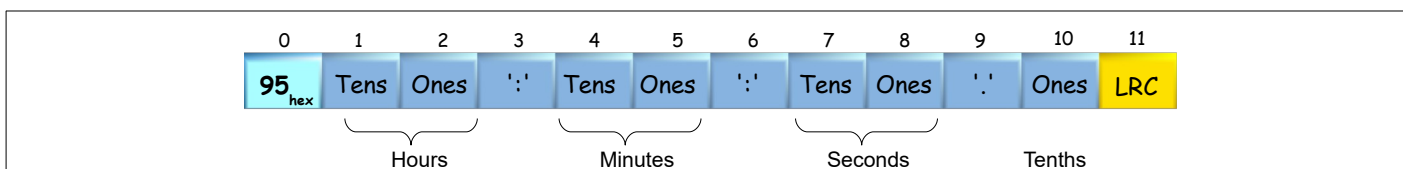
- Addresses:
 - 2. Left team → 146 (92_{hex}).
 - 3. Right team → 147 (93_{hex}).
- Name:
 - 4. 12 bytes with the ASCII characters of the team name.

4.1. [0x94] Horns



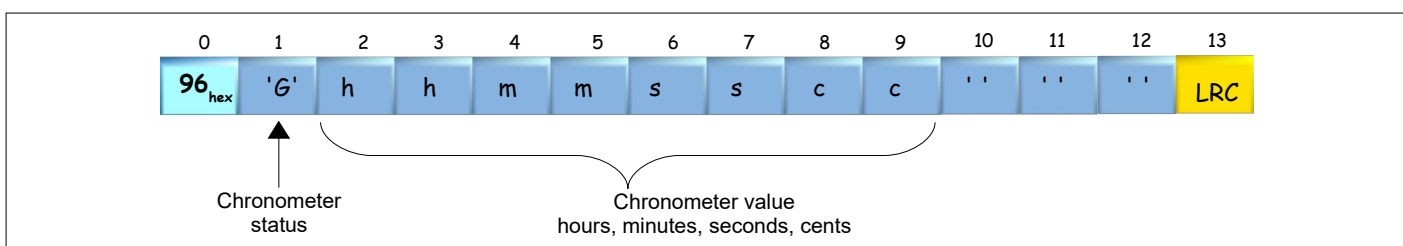
- Address: 148 (94_{hex}).
- Game time horn: 1 byte to activate the sound of the horn:
 - '1' (31_{hex}) → On,
 - ' ' (20_{hex}) → Off.
 1 byte to show the sound volume:
 - '0' (30_{hex}) → minimum,
 - '1' (31_{hex}) → medium,
 - '2' (32_{hex}) → medium,
 - '3' (33_{hex}) → maximum.
- Shot Clock Horn: 1 byte to activate the sound of the horn:
 - '1' (31_{hex}) → On,
 - ' ' (20_{hex}) → Off.
 1 byte to show the sound volume:
 - '0' (30_{hex}) → minimum,
 - '1' (31_{hex}) → medium,
 - '2' (32_{hex}) → medium,
 - '3' (33_{hex}) → maximum.

4.2. [0x95] Time of the day



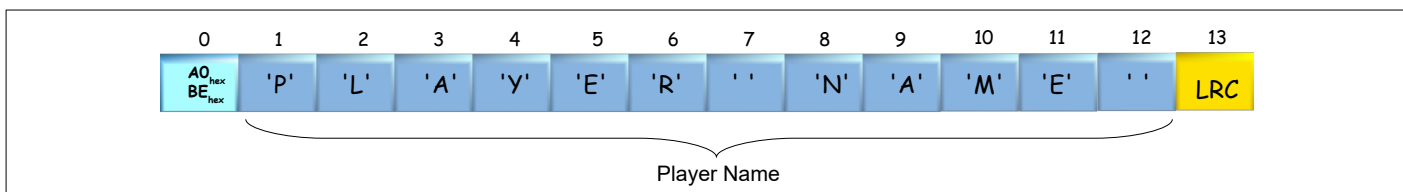
- Addresses: 149 (95_{hex}).
- Time of the day: 2 bytes with the ASCII digits entered to indicate the hours (0÷99), 2 bytes for the digits showing the minutes (0÷59), 2 bytes for the digits showing the seconds (0÷59), and 1 byte for the 2 separation points. When tenths of a second are displayed, seconds take the place of the minutes, and tenths of a second take the place of the seconds.
The Console shows the timer count with the 2 points flashing; otherwise the scores stay lit without flashing.
 - ':' (3A_{hex}) → On,
 - ':' (2E_{hex}) → On,
 - ' ' (20_{hex}) → Off.

4.3. [0x96] High resolution chronometer (14 bytes)



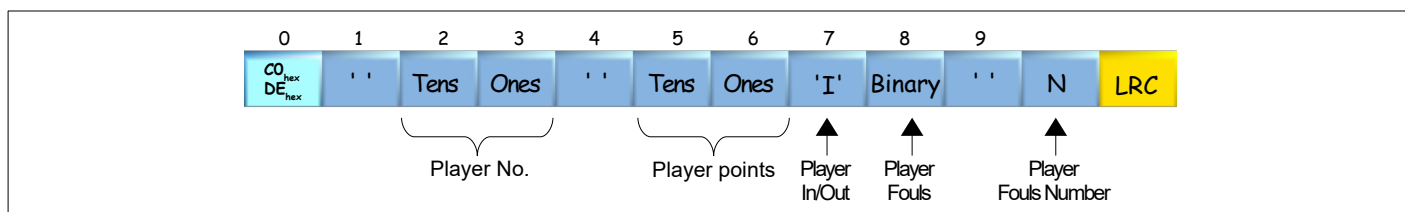
- Address: 150 (96_{hex}).
- Chronometer status: 1 byte with the following ASCII values:
 - 'G' (47_{hex}) → Chronometer is counting, game time,
 - 'P' (50_{hex}) → Chronometer is counting, pause time,
 - ' ' (20_{hex}) → Chronometer is not counting.
- Chronometer value: High resolution chronometer value: hours, minutes, seconds, cents

4.4. [0xA0..0xBE] Player Names (14 bytes)



- Addresses: 14 Left Players → 160 ÷ 174 (A0_{hex} ÷ AE_{hex}).
14 Right Players → 176 ÷ 190 (B0_{hex} ÷ BE_{hex}).
- Name: 12 bytes with the ASCII characters of the player name.

4.5. [0xC0..0xDE] Player No. + Fouls+ Points + On-field status



These packets are sent to the side panels to display the player fouls and points.

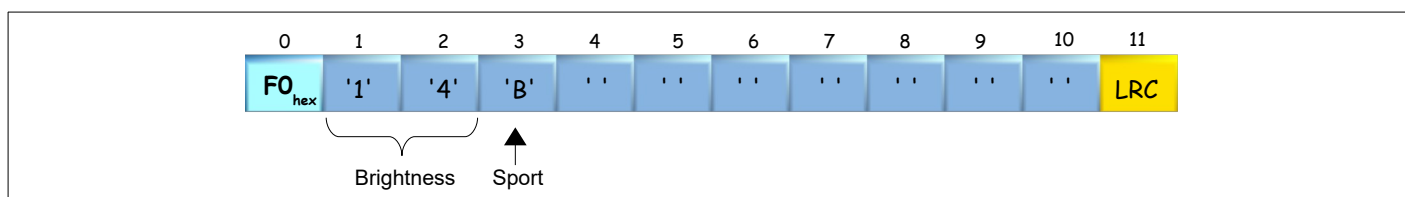
- Addresses: 14 Left Players → 192 ÷ 206 (C0_{hex} ÷ CE_{hex}).
14 Right Players → 208 ÷ 222 (D0_{hex} ÷ DE_{hex}).
- Player No.: 2 bytes with the corresponding ASCII digits (0÷99).
- Player Points: 2 bytes with the corresponding ASCII digits (0÷99).
- Player Fouls: 1 byte, with a minimum value of 80 (50_{hex}), to which each of the 5 least meaningful bits is assigned a foul; when the bit is at 1, the foul indicator light is activated; otherwise it remains turned off.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	5th foul	4th foul	3th foul	2th foul	1th foul

For example, the binary value of '00010100' (14_{hex}) corresponds to activation of the 3rd and 5th fouls; the minimum value of 80 must be added to obtain 100 (64_{hex}).

- Player Fouls Number: 1 byte, number to be displayed on scoreboards with fouls on one figure.
- Player In/Out: 1 byte.
 - ▶ 'I' (49_{hex}) → On,
 - ▶ ' ' (20_{hex}) → Off.

4.6. [0xF0] Scoreboard brightness and sport



- Address: 240 (F0_{hex}).
- Brightness: 2 bytes with the ASCII digits corresponding to the brightness level (0 ÷ 255).
- Sport: 1 byte to indicate the sport:
 - ▶ '3' (33_{hex}) → Basket 3x3,
 - ▶ 'A' (41_{hex}) → Futsal (AMF rules),
 - ▶ 'B' (42_{hex}) → Basketball,
 - ▶ 'D' (44_{hex}) → Badminton,
 - ▶ 'E' (45_{hex}) → Wrestling,
 - ▶ 'F' (46_{hex}) → Futsal (FIFA rules),
 - ▶ 'H' (48_{hex}) → Handball,
 - ▶ 'K' (4B_{hex}) → Ice Hockey,
 - ▶ 'M' (4D_{hex}) → Minibasket,
 - ▶ 'N' (4E_{hex}) → Netball,
 - ▶ 'P' (50_{hex}) → Table tennis,
 - ▶ 'R' (52_{hex}) → Rink hockey,
 - ▶ 'S' (53_{hex}) → Football/soccer,
 - ▶ 'T' (54_{hex}) → Tennis,
 - ▶ 'V' (56_{hex}) → Volley,
 - ▶ 'W' (57_{hex}) → Waterpolo,
 - ▶ 'X' (58_{hex}) → Boxing,
 - ▶ 'Y' (59_{hex}) → Rugby,

Note 1: Brightness, in the example above '1' is the LSB and '4' is the MSB.