ME218b Smart Product Design

Radio Equipped Facilitator for ME 218b Project 2018

Rev 1 02/07/2018

Purpose:

The primary purpose of the Radio Equipped Facilitator (REF) is to act as a gateway to the field infrastructure to allow your ATHLETE to request information about the state of the game.

Interface Connection

Connector:

The connector of the REF is a 6-pin keyed Molex connector.

Pinout:

Pin	Name/Function
1	+3.3V (@ 100mA) / Power to the REF (V_{dd})
2	SDI / Serial Data Into the REF
3	SDO / Serial Data Out of the REF
4	SCK / Serial Clock
5	SS / active low select line for the REF with on-board pull-up to +3.3V
6	GND / Ground reference for the REF

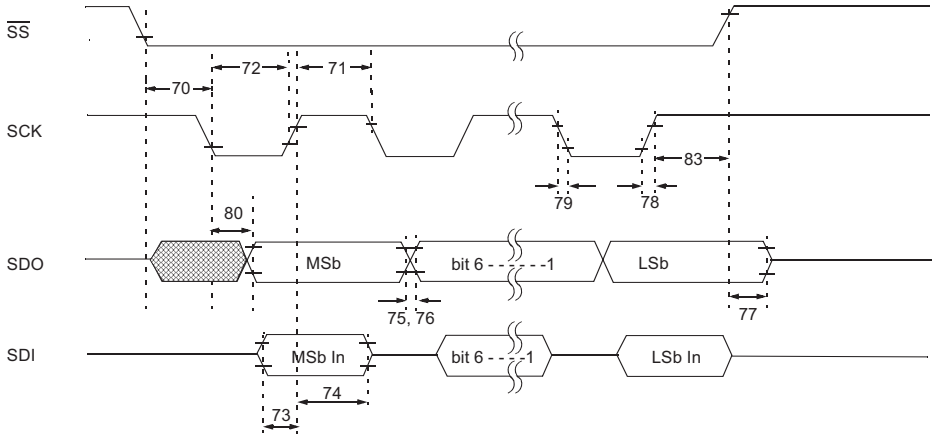
Electrical Specifications

Parameter	Min.	Max	Units
V_{iH}	V_{dd}*0.65		V
V_{oH}	V_{dd}-0.4		V
V_{iL}		V_{dd}*0.35	V
V_{oL}		0.4	V
$I_{iH,}$ I_{iL}		±1	µA
I_{oH}	-20		µA
I_{OL}	20		µA
All Specifications at V_{dd} = 3.3V			

Byte Transfer Specification

The Radio Equipped Facilitator uses a synchronous serial signaling method to transfer data into and out of the REF. The signaling method is compatible with SPI communications, with the REF operating as a slave device on an SPI network. The $\overline{SS}$ line must be lowered (asserted) to begin a 4-byte (40 bit) transfer and raised at the completion of the 4-byte transfer. The $\overline{SS}$ line must remain de-asserted for a minimum of 2ms between transfers. The SDO line represents the serial data out of the REF, while the SDI line represents serial data into the REF.

The relationships between the four lines involved in the transfer of a byte are shown in the figure & table below:



Param No.	Symbol	Characteristic		Min	Typ	Max	Units	Conditions
70*	TssL2scH, TssL2scL	$\overline{SS}\downarrow$ to SCK$\downarrow$ or SCK$\uparrow$ input		Tcy[a]	—	—	ns	
71*	TscH	SCK input high time (Slave mode)		Tcy + 20	—	—	ns	
72*	TscL	SCK input low time (Slave mode)		Tcy + 20	—	—	ns	
73*	TdiV2scH, TdiV2scL	Setup time of SDI data input to SCK edge		100	—	—	ns	
74*	TscH2diL, TscL2diL	Hold time of SDI data input to SCK edge		100	—	—	ns	
75*	TdoR	SDO data output rise time	3.0-5.5V	—	10	25	ns	
			2.0-5.5V	—	25	50	ns	
76*	TdoF	SDO data output fall time		—	10	25	ns	
77*	TssH2doZ	$\overline{SS}\uparrow$ to SDO output high-impedance		10	—	50	ns	
78*	TscR	SCK output rise time (Master mode)	3.0-5.5V	—	10	25	ns	
			2.0-5.5V	—	25	50	ns	
79*	TscF	SCK output fall time (Master mode)		—	10	25	ns	
80*	TscH2doV, TscL2doV	SDO data output valid after SCK edge	3.0-5.5V	—	—	50	ns	
			2.0-5.5V	—	—	145	ns	
83*	TscH2ssH, TscL2ssH	$\overline{SS}\uparrow$ after SCK edge		1.5Tcy + 40	—	—	ns	

* These parameters are characterized but not tested. [a]Tcy = 33µS

Byte Level Protocol Specification

Common Byte Format:

Exchanges between the Radio Equipped Facilitator (REF) and your ATHLETE take place with four successive bytes being exchanged. The first byte from the ATHLETE to the REF is the actual command. The value returned from the REF during this transfer will be 0x00, but has no meaning. The values sent to the REF as the second through fourth bytes of the sequence should always be 0x00. The meanings of the values returned by the second through fourth byte transfers will be the results from the command byte.

ATHLETE to Radio Equipped Facilitator Bytes:

The meaningful values for the command bytes from the ATHLETE to the Radio Equipped Facilitator are shown in the following table:

Command	Meaning
0x3F	Request the status of the game.
0xC3	Request the current score in the game.

Radio Equipped Facilitator to ATHLETE Bytes:

The values and meanings of the response bytes returned by the Radio Equipped Facilitator are shown in the following table:

Command	Response Bytes	Description of meaning
0x3F	0xFF, **SC**, **SS**	**SC** = shot clock time remaining: 0.1sec/count; **SS** = game status: Bits 0-2: 000 = Waiting for Start; 001 = Face-off, 010 = Playing, 011 = Tie-break; 1xx = Game Over; Bits 4-5: 00 = No one in possession, 01 = RED in possession, 10 = BLUE in possession.
0xC3	0xFF, **RR**,**BB**	Score in the match: **RR** = score for RED team, **BB** = Score for BLUE team

Query the Status of the Game:

To query the game status, send a byte of 0x3F to the REF followed by 3 bytes of 0x00. The REF will process the query and during the three 0x00 bytes of the exchange will return 0xFF, followed by the two status/info bytes as described above.

Query the Score:

To query the game score, send a byte of 0xC3 to the REF followed by 3 bytes of 0x00. The REF will process the query and during the three 0x00 bytes of the exchange will return 0xFF, followed by the RED team's score followed by the BLUE team's score.

Power on and reset behavior:

Initially, after power on or a reset, the Radio Equipped Facilitator will return 0xFF from any query until such time as the Radio Equipped Facilitator is internally initialized.

Command Timing:

The interval between two successive transfers from ATHLETE to Radio Equipped Facilitator should be at least 2ms. The $\overline{SS}$ line must remain high for a minimum of 2ms between successive transfers.

Invalid Command Bytes:

If the Radio Equipped Facilitator receives a command byte not listed in the table, it will respond to the invalid command byte by queuing a series of 0xFF bytes to be returned to the ATHLETE.

Sample Byte Sequences:

ATHLETE to REF	0x3F	0x00	0x00	0x00
REF to ATHLETE	0x00	0xFF	0x00	0x00

In this sequence, the ATHLETE queries the game state (0x3F), which will return 0xFF, then 0x00 followed by 0x00 if the game has not started yet and therefore no one has possession.

ATHLETE to REF	0x3F	0x00	0x00	0x00
REF to ATHLETE	0x00	0xFF	0x65	0x12

The next query (0x3F) shows the result from a status request during active play when RED is in possession and 10.1 seconds remain on the shot clock.

ATHLETE to REF	0xC3	0x00	0x00	0x00
REF to ATHLETE	0x00	0xFF	0x0A	0x0B

The next query (0xC3) demonstrates requesting the score. The returned result indicates a score of RED = 10, BLUE = 11.

Physical Specifications

Dimensions:

The Radio Equipped Facilitator dimensions are 2" x 3" x 1".

Revision History:

Rev 0: First draft, out for review.

Rev 1: Included comments on wording and layout changes