ME218b Smart Product Design

DrEd Reckoning System for ME 218b Project 2015

Rev 1 02/13/2015

Purpose:

The primary purpose of the DrEd Reckoning System (DRS) is to act as a gateway to the field infrastructure to allow your KART to request information about the position and orientation of each of the racers and the state of the race. Data on the positions, orientations and status of the race will be updated on the DRS from the field infrastructure at 10Hz.

Interface Connection

Connector:

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

Pinout:

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

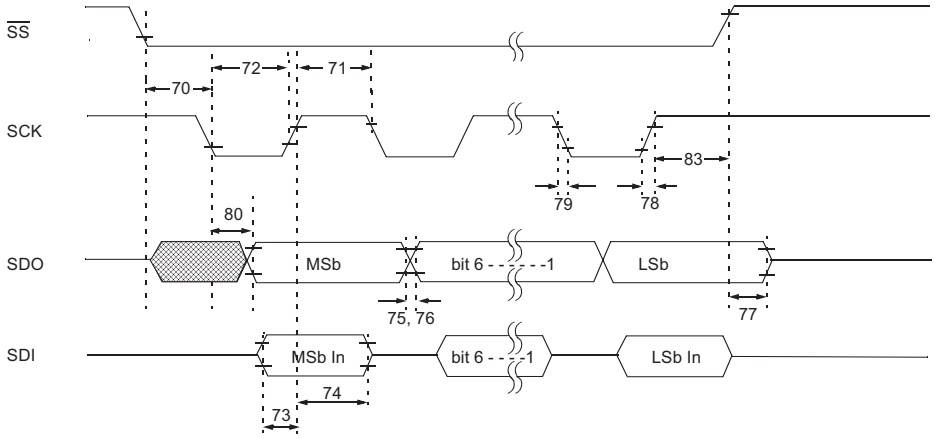
Electrical Specifications

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 DrEd Reckoning System uses a synchronous serial signaling method to transfer data into and out of the DRS. The signaling method is compatible with SPI communications, with the DRS operating as a slave device on an SPI network. The $\overline{SS}$ line must be lowered (asserted) to begin an 8-byte (64 bit) transfer and raised at the completion of the 8-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 DRS, while the SDI line represents serial data into the DRS.

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 DrEd Reckoning System (DRS) and your KART take place with eight successive bytes being exchanged. The first byte from the KART to the DRS is the actual command. The value returned from the DRS during this transfer will be 0x00, but has no meaning. The values sent to the DRS as the second through eighth bytes of the sequence should always be 0x00. The meanings of the values returned by the second through eighth byte transfers will be the results from the command byte.

KART to DrEd Reckoning System Bytes:

The meaningful values for the command bytes from the KART to the DrEd Reckoning System are shown in the following table:

Command	Meaning
0x3F	Return the status of the game.
0xC3	Return position and orientation for KART #1.
0x5A	Return position and orientation for KART #2.
0x7E	Return position and orientation for KART #3.

DrEd Reckoning System to KART Bytes:

The values and meanings of the response bytes returned by the DrEd Reckoning System are shown in the following table:

Command	Response Bytes	Description of meaning
0x3F	0xFF, 0x00, SS1, SS2, SS3, 0x00, 0x00	SS1 = match status for KART #1: Bits 0-2: number of laps remaining to be completed. Bits 3-4: 0x00 = waiting for start; 0x01 = Flag Dropped, 0x02 = Caution Flag (temporary stop), 0x03 = Race Over; Bit 7: Target status: set = Target successful; Bit 6: Obstacle status set = Obstacle completed. SS2 = match status for KART #2, SS3 = match status for KART #3
0xC3	0xFF, PXm, PXl, PYm, PYl, Om, Ol	For KART #1: PXm = X Position MSB, PXl = X Position LSB, PYm = Y Position MSB, PYl = Y Position LSB, Om = Orientation MSB, Ol = Orientation LSB
0x5A	0xFF, PXm, PXl, PYm, PYl, Om, Ol	For KART #2: PXm = X Position MSB, PXl = X Position LSB, PYm = Y Position MSB, PYl = Y Position LSB, Om = Orientation MSB, Ol = Orientation LSB

0x7E	0xFF, PXm, PXl, PYm, PYl, Om, Ol	For KART #3: PXm = X Position MSB, PXl = X Position LSB, PYm = Y Position MSB, PYl = Y Position LSB, Om = Orientation MSB, Ol = Orientation LSB

Query the Status of the Game:

To query the game status, send a byte of 0x3F to the DRS followed by 7 bytes of 0x00. The DRS will process the query and during the seven 0x00 bytes of the exchange will return 0xFF, followed by 0x00 followed by the game status bytes for each of the KARTs followed by 2 bytes of 0x00.

Query the Position of a KART:

To query the position of a KART, send a byte of 0xC3, 0x5A or 0x7E (for KARTs 1,2 & 3 respectively) to the DRS followed by 7 bytes of 0x00. The DRS will process the query and during the seven 0x00 bytes of the exchange will return 0xFF, followed by the X position (2 bytes, MSB first), Y position (2 bytes MSB first) and Orientation (2 bytes MSB first).

Power on and reset behavior:

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

Command Timing:

The interval between two successive transfers from KART to DrEd Reckoning System 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 DrEd Reckoning System 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 KART.

Sample Byte Sequences:

KART to DRS	0x3F	0x00	0x00	0x00	0x00	0x00	0x00	0x00
DRS to KART	0x00	0xFF	0x00	0x03	0x03	0x03	0x00	0x00

In this sequence, the KARTqueries the game state(0x3F), which will return 0xFF, then 0x00 followed by the status bytes for each of the KARTs. In this example it is telling us that there are 3 laps remaining for each of the KARTs, neither target nor obstacle has been accomplished for any of the KARTs, and the race has not started yet. This is a typical response before the start of a race.

KART to DRS	0xC3	0x00	0x00	0x00	0x00	0x00	0x00	0x00
DRS to KART	0x00	0xFF	0x00	0x20	0x00	0x20	0x00	0x00

In this sequence, the KART has queried the position and orientation of KART #1, which will return 0xFF, followed by the X, Y and Φ (16 bits each) for KART #1. In this example it is telling us that KART #1 is in the upper left corner of the field shown in Fig. 1 of the project description and facing towards the ultrasonic emitter.

Physical Specifications

Dimensions:

The DrEd Reckoning System dimensions are 2" x 3" x 1".