SD-01/02
RS485 ICD specification

Edition 01/11/2021

1 Default Communication Parameters

Baud-Rate	115200 bits per second
Number of Data bits	8
Number of Stop bits	1
Parity	None
Frame Rate	50 Frames per Second
Max. Frame Rate	100 Frames per Second

Usable ID range:	0x01 … 0x1E
Broadcast ID (BID):	0x1F
Default ID:	0x01

Comment: Other communication parameters on request.

2 Command and Response Frames

Command Frame:

Byte #	Content
1	Command Code
2	Actuator ID
3	Argument 1 (high byte)
4	Argument 2 (low byte)
…	…
N-1	CRC High-Byte
N	CRC Low-Byte

Response Frame:

Byte #	Content
1	Command Code
2	Actuator ID
3	Argument 1 (high byte)
4	Argument 2 (low byte)
…	…
N-1	CRC High-Byte
N	CRC Low-Byte

3 Command Set

3.1 Set Point Command

Set point. ID: 0x01…0x1F	
Cmd. code	0x76
Arg. 1	FA F = Host Data Freshness Counter (4 bits, bit 15…12) A = set point position (4 bits, bit 11…8)
Arg. 2	BC B = set point position (4 bits, bit 7 … 4) C = set point position (4 bits, bit 3 … 0)
Resp. code	0x56
Arg. 1	FA F = Actuator Data Freshness Counter (4 bits, bit 15…12) A = actual position (4 bits, bit 11…8)
Arg. 2	BC B = actual position (4 bits, bit 7 … 4) C = actual position (4 bits, bit 3 … 0)

Com-Arg: FFFFAAAABBBBCCCC (bit 15...0)
F = host data freshness counter (4 bit counter, incremented by AP each transmission)
ABC = set point (or actual) position

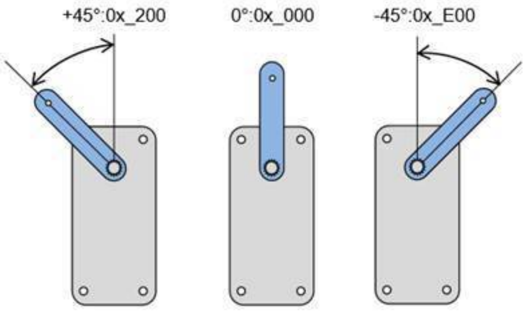
Resp-Arg: FFFFAAAABBBBCCCC (bit 15...0)
F = Actuator Data Freshness Counter (4 bit counter, decremented by servo for each reply)
ABC = actual position (position format: as command)

Data integrity: The actuator is deriving the integrity of the received set point position from correctness of the received freshness counter value. The host is expected to increment the 4-bit freshness counter for each transmission of a set point command. The actuator will accept that a configured number of frames are missing (e.g. due to interference on the RS485 bus). The number of permissible missing frames is defined in the “Freshness Counter Threshold” parameter of the configuration.
Freshness Counter Threshold = 0: no count of freshness counter may be skipped.
Freshness Counter Threshold = 1: one count of freshness counter may be skipped.
…
Freshness Counter Threshold ≥ 15: freshness counter check disabled

If the actuator detects a violation of the freshness counter check, then the following actions will be taken:
The servo will load its set point position from the configured “Fail-Safe Position”.

Position format: The position data is represented by a 12-bit two’s complements value. 0 = center, one digit is equal to 360/4096=0.088 degrees, positive set points = counter clockwise rotation, negative set points = clockwise rotation). See example for +45°, 0° and -45° positions below.

Response to BID: No



3.2 Read Actual Position Command

Readout actual position. ID: 0x01…0x1F	
Cmd. code	0x69
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x49
Arg. 1	0A 0 = 4 zero bits (4 bits, bit 15…12) A = actual position (4 bits, bit 11…8)
Arg. 2	BC B = actual position (4 bits, bit 7 … 4) C = actual position (4 bits, bit 3 … 0)

Resp-Arg: 0000AAAABBBBCCCC (bit 15...0)
ABC = actual position (position format: as command)

Response to BID: Yes

3.3 Set Velocity

Set velocity. ID: 0x01…0x1F	
Cmd. code	0x77
Arg. 1	Set velocity high byte[1]
Arg. 2	Set velocity low byte[1]
Resp. code	0x57
Arg. 1	Actual velocity high byte[1]
Arg. 2	Actual velocity low byte[1]

Cmd-Arg: Set velocity = velocity [Deg/sec] * 10

Resp-Arg: Actual velocity = (Arg. 1 * 256 + Arg. 2) * 0.1 [Deg/sec]

Response to BID: No

3.4 Read Actual Velocity

Readout actual velocity. ID: 0x01…0x1F	
Cmd. code	0x68
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x48
Arg. 1	Actual velocity high byte[1]
Arg. 2	Actual velocity low byte[1]

Resp-Arg: Actual velocity = (Arg. 1 * 256 + Arg. 2) * 0.1 [Deg/sec]

Response to BID: Yes

3.5 Set Servo ID Command

Set servo ID. ID: 0x01…0x1F	
Cmd. code	0xAA
Arg. 1	New ID: 0x01 … 0x1E
Arg. 2	Same as argument 1
Resp. code	0x55
Arg. 1	New ID: 0x01 … 0x1E
Arg. 2	Same as argument 1

3.6 Read Servo ID Command

Read servo ID. ID: 0x01…0x1F	
Cmd. code	0xDA
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x6D
Arg. 1	ID: 0x01 … 0x1E
Arg. 2	Same as argument 1

3.7 Read Current Consumption

Read current consumption. ID: 0x01…0x1E	
Cmd. code	0xB0
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x30
Arg. 1	Current consumption = Arg. 1 * 0.02 [A]
Arg. 2	Same as argument 1

Comment: Maximum current value 5.1A

3.8 Read Bus Voltages

Read bus voltages. ID: 0x01…0x1E	
Cmd. code	0xB1
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x31
Arg. 1	Power Bus 1 (X1) Voltage = Arg. 1 * 0.2 [V]
Arg. 2	Power Bus 2 (X2) Voltage = Arg. 2 * 0.2 [V]

3.9 Read Extended Current Consumption

Read extended current consumption. ID: 0x01…0x1E	
Cmd. code	0xB2
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x32
Arg. 1	Current consumption high byte
Arg. 2	Current consumption low byte

Comment: The command is used if the current consumption exceeds 5.1A

Resp-Arg: Current consumption = (Arg. 1 * 256 + Arg. 2) * 0.02 [A]

3.10 Read Temperatures

Readout of temperature. ID: 0x01…0x1E	
Cmd. code	0xA0
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x20
Arg. 1	Motor temperature [°C] = Arg. 1 - 50
Arg. 2	PCB temperature [°C] = Arg. 2 - 50

Comment: Valid values for temperatures are from -49 to +204°C. A transmitted temperature of -50°C (0x00) indicates that there is no sensor available (or that the measured temperature is below -49°C) and a temperature of 205°C indicates that the sensor is defective.

3.11 Read Humidity

Readout of humidity. ID: 0x01…0x1E	
Cmd. code	0xA1
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x21
Arg. 1	0x00
Arg. 2	Same as argument 1

Comment: A valid value for the humidity reading is 1…100. A transmitted humidity of 0 indicates that there is no sensor available.

3.12 Read Skipped Frames Counter

Read skipped frames counter. ID: 0x01…0x1E	
Cmd. code	0x37
Arg. 1	0x00
Arg. 2	0x01
Resp. code	0x38
Arg. 1	Value of host freshness counter
Arg. 2	Number of dropped frames

3.13 Reset of the Dropped Frames Counter

Readout the role (master/slave). ID: 0x01…0x1E	
Cmd. code	0x37
Arg. 1	0x00
Arg. 2	0x02 - reset dropped frames counter
Resp. code	0x38
Arg. 1	Value of host freshness counter
Arg. 2	0x00

3.14 Read Actuator Status Word

Readout actuator status word. ID: 0x01…0x1E	
Cmd. code	0x40
Arg. 1	0xAA
Arg. 2	0x02
Resp. code	0x41
Arg. 1	See below
Arg. 2	See below

Resp. Arg1 Bits	Designation	Description
Bit7	0	
Bit6	Servo	0 = Memory ok (memory test passed)
Bit5	FRC	0 = COM1 freshness counter check ok
Bit4	TO	0 = COM1 time-out ok (1 = time-out) could be reset by command
Bit3	PWR	0 = Voltage of Power is ok (>20 VDC)
Bit2	Temp	0 = Dervo temperatures are ok (motor and PCB)
Bit1	IC	0 = internal communication bus:servo node ok
Bit0	APS	0 = All HALL-Sensor ok (all 3 Hall values are similar and int. communication also ok)

3.15 Reset Actuator Status Word

Reset of actuator status word. ID: 0x01…0x1E	
Cmd. code	0x40
Arg. 1	0xAA
Arg. 2	0x52
Resp. code	0x41
Arg. 1	See below
Arg. 2	See below

3.16 Reset Default Role and Reset Error Flags

Access to special actuator features. ID: 0x01…0x1E	
Cmd. code	0xB4
Arg. 1	0x41
Arg. 2	0x53
Resp. code	0x5A
Arg. 1	0x41
Arg. 2	0x53

3.17 Set Current Position As Zero

Set current position as zero. ID: 0x01…0x1E	
Cmd. code	0x99
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x4C
Arg. 1	0A 0 = 4 zero bits (4 bits, bit 15…12) A = offset relative to the real zero of the encoder (4 bits, bit 11…8)
Arg. 2	BC B = offset relative to the real zero of the encoder (4 bits, bit 7 … 4) C = offset relative to the real zero of the encoder (4 bits, bit 3 … 0)

Resp-Arg: 0000AAAABBBBCCCC (bit 15...0)
ABC = offset relative to the real zero of the encoder (format: 12-bit two’s complements value)

3.18 Read Current Zero Offset

Report of zero position. ID: 0x01…0x1E	
Cmd. code	0x95
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x65
Arg. 1	0A 0 = 4 zero bits (4 bits, bit 15…12) A = offset relative to the real zero of the encoder (4 bits, bit 11…8)
Arg. 2	BC B = offset relative to the real zero of the encoder (4 bits, bit 7 … 4) C = offset relative to the real zero of the encoder (4 bits, bit 3 … 0)

Resp-Arg: 0000AAAABBBBCCCC (bit 15...0)
ABC = offset relative to the real zero of the encoder (format: 12-bit two’s complements value)

3.19 Reset Zero Offset

Reset zero offset. ID: 0x01…0x1E	
Cmd. code	0x98
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x64
Arg. 1	0x00
Arg. 2	0x00

3.20 Readout of Electronic Serial Number

Readout of electronic serial number. ID: 0x01…0x1E	
Cmd. code	0xF0
Arg. 1	0x00
Arg. 2	Number of byte (0x00…0x1F)
Resp. code	0x10
Arg. 1	Character of serial number string
Arg. 2	Length of the string (0x00…0x20)

3.21 Readout of Product Description

Readout of product description. ID: 0x01…0x1E	
Cmd. code	0xF1
Arg. 1	0x00
Arg. 2	Number of byte (0x00…0x1F)
Resp. code	0x11
Arg. 1	Character of product description string
Arg. 2	Length of the string (0x00…0x20)

3.22 Readout of Software Revision Number

Readout of software revision number. ID: 0x01…0x1E	
Cmd. code	0xF2
Arg. 1	0x00
Arg. 2	Number of byte (0x00…0x1F)
Resp. code	0x12
Arg. 1	Character of software revision number string
Arg. 2	Length of the string (0x00…0x20)

3.23 Readout of Hardware Revision Number

Readout of hardware revision number. ID: 0x01…0x1E	
Cmd. code	0xF3
Arg. 1	0x00
Arg. 2	Number of byte (0x00…0x1F)
Resp. code	0x13
Arg. 1	Character of hardware revision number string
Arg. 2	Length of the string (0x00…0x20)

3.24 Readout Total Run-time Counter

Readout total run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA2
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x22
Arg. 1	Total run-time counter high byte [hours]
Arg. 2	Total run-time counter low byte [hours]

Readout total run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA2
Arg. 1	0x00
Arg. 2	0x01
Resp. code	0x22
Arg. 1	Total run-time counter [min.] (0x00-0x3B)
Arg. 2	Total run-time counter [sec.] (0x00-0x3B)

3.25 Readout 0%...24% Load Run-time Counter

Readout 0%...24% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA3
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x23
Arg. 1	0%...24% load run-time counter high byte [hours]
Arg. 2	0%...24% load run-time counter low byte [hours]

Readout 0%...24% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA3
Arg. 1	0x00
Arg. 2	0x01
Resp. code	0x23
Arg. 1	0%...24% load run-time counter [min.] (0x00-0x3B)
Arg. 2	0%...24% load run-time counter [sec.] (0x00-0x3B)

3.26 Reset 0%...24% Load Run-time Counter

Reset 0%...24% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA3
Arg. 1	0xAA
Arg. 2	0x55
Resp. code	0x23
Arg. 1	0%...24% load run-time counter high byte [h] (before reset)
Arg. 2	0%...24% load run-time counter low byte [h] (before reset)

3.27 Readout 25%...49% Load Run-time Counter

Readout 25%...49% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA4
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x24
Arg. 1	25%...49% load run-time counter high byte [hours]
Arg. 2	25%...49% load run-time counter low byte [hours]

Readout 25%...49% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA4
Arg. 1	0x00
Arg. 2	0x01
Resp. code	0x24
Arg. 1	25%...49% load run-time counter [min.] (0x00-0x3B)
Arg. 2	25%...49% load run-time counter [sec.] (0x00-0x3B)

3.28 Readout 25%...49% Load Run-time Counter

Reset 25%...49% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA4
Arg. 1	0xAA
Arg. 2	0x55
Resp. code	0x24
Arg. 1	25%...49% load run-time counter high byte [h] (before reset)
Arg. 2	25%...49% load run-time counter low byte [h] (before reset)

3.29 Readout 50%...74% Load Run-time Counter

Readout 50%...74% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA5
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x25
Arg. 1	50%...74% load run-time counter high byte [hours]
Arg. 2	50%...74% load run-time counter low byte [hours]

Readout 50%...74% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA5
Arg. 1	0x00
Arg. 2	0x01
Resp. code	0x25
Arg. 1	50%...74% load run-time counter [min.] (0x00-0x3B)
Arg. 2	50%...74% load run-time counter [sec.] (0x00-0x3B)

3.30 Reset 50%...74% Load Run-time Counter

Reset 50%...74% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA5
Arg. 1	0xAA
Arg. 2	0x55
Resp. code	0x25
Arg. 1	50%...74% load run-time counter high byte [h] (before reset)
Arg. 2	50%...74% load run-time counter low byte [h] (before reset)

3.31 Readout 75%...99% Load Run-time Counter

Readout 75%...99% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA6
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x26
Arg. 1	75%...99% load run-time counter high byte [hours]
Arg. 2	75%...99% load run-time counter low byte [hours]

Readout 75%...99% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA6
Arg. 1	0x00
Arg. 2	0x01
Resp. code	0x26
Arg. 1	75%...99% load run-time counter [min.] (0x00-0x3B)
Arg. 2	75%...99% load run-time counter [sec.] (0x00-0x3B)

3.32 Reset 75%...99% Load Run-time Counter

Reset 75%...99% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA6
Arg. 1	0xAA
Arg. 2	0x55
Resp. code	0x26
Arg. 1	75%...99% load run-time counter high byte [h] (before reset)
Arg. 2	75%...99% load run-time counter low byte [h] (before reset)

3.33 Readout of 100% Load Run-time Counter

Readout of 100% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA7
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x27
Arg. 1	100% load run-time counter high byte [hours]
Arg. 2	100% load run-time counter low byte [hours]

Readout of 100% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA7
Arg. 1	0x00
Arg. 2	0x01
Resp. code	0x27
Arg. 1	100% load run-time counter [min.] (0x00-0x3B)
Arg. 2	100% load run-time counter [sec.] (0x00-0x3B)

3.34 Reset of 100% Load Run-time Counter

Reset of 100% load run-time counter. ID: 0x01…0x1E	
Cmd. code	0xA7
Arg. 1	0xAA
Arg. 2	0x55
Resp. code	0x27
Arg. 1	100% load run-time counter high byte [h] (before reset)
Arg. 2	100% load run-time counter low byte [h] (before reset)

3.35 Readout Stall Event Counter

Readout stall event counter. ID: 0x01…0x1E	
Cmd. code	0xA8
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x28
Arg. 1	Stall event counter high byte
Arg. 2	Stall event counter low byte

3.36 Reset Stall Event Counter

Reset stall event counter. ID: 0x01…0x1E	
Cmd. code	0xA8
Arg. 1	0xAA
Arg. 2	0x55
Resp. code	0x28
Arg. 1	Stall event counter high byte (before reset)
Arg. 2	Stall event counter low byte (before reset)

3.37 Readout of Number of Power Up Cycles

Readout of number of power up cycles. ID: 0x01…0x1E	
Cmd. code	0xA9
Arg. 1	0x00
Arg. 2	0x00
Resp. code	0x29
Arg. 1	Number of power up cycles high byte
Arg. 2	Number of power up cycles low byte

[1] The data is represented by a 16-bit two’s complements value.

4 CRC checksum generation (in C)

Below a C code sample for the CRC16 checksum calculation is shown:

```
uint16_t crc(const uint8_t* data, uint16_t size)
{
  uint16_t crc = 0xFFFF;

  for (uint16_t i = 0u; i < size; i++) {
    crc = (uint16_t) ((data[ i ] << 8u) ^ crc);
    for (uint8_t k = 0u; k < 8u; k++) {
      if (crc & 0x8000u)
        crc = (uint16_t) ((crc << 1u) ^ 0x8005u);
      else
        crc = (uint16_t) (crc << 1u);
    }
  }
  return crc;
}
```