12 Serial Communications

12.1 Introduction

Serial communications can be used by a host computer to perform the following:

Read and edit the values of parameters
Control the Drive

One host computer may control up to 99 Drives when line buffers are used, or 32 Drives without using line buffers.

The protocol is the following industry standard:

ANSI x 3.28 – 2.5 – A4

Connections

Warning

The RS485 serial communications connections in the Drive are not isolated from the other control circuits and are separated from the live parts by basic insulation; if the serial communications circuit is to be accessible to personnel, an isolation unit must be used. When multiple RS485 networks are to be used, each network will require its own isolation unit.

Note

It is not recommended that 2-wire serial communications are used. This would require the transmit and receive terminals in the Drive to be connected in parallel. Although the protocol would operate correctly, the maximum loading on the network may be exceeded; communications would then become unreliable.

If more than one Drive is to be connected to a serial link, make connections as shown in Figure 12–1. If only one Drive is to be connected, make the connections shown for the last Drive.

1. A termination resistor **must** be fitted between terminals B3 and B4 of the last (or only) Drive on the serial link. The value of this resistor should be 120Ω 0.25W.
2. The serial communications cable must be shielded. The shield(s) must be connected as shown in Figure 12–2.
3. Ensure the total cable length does not exceed 1200 metres (4,000 feet).
4. A unique address code must be given to each Drive that is connected to a port of the host computer.

RS485 Multidrop link

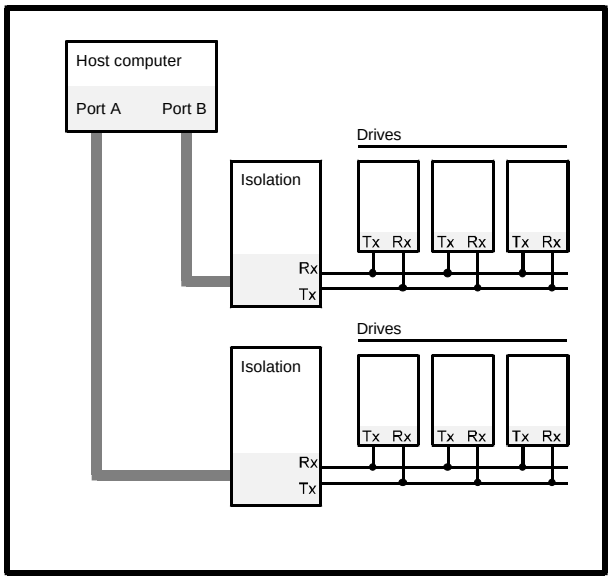

Figure 12–1 Basic RS485 Serial Communications

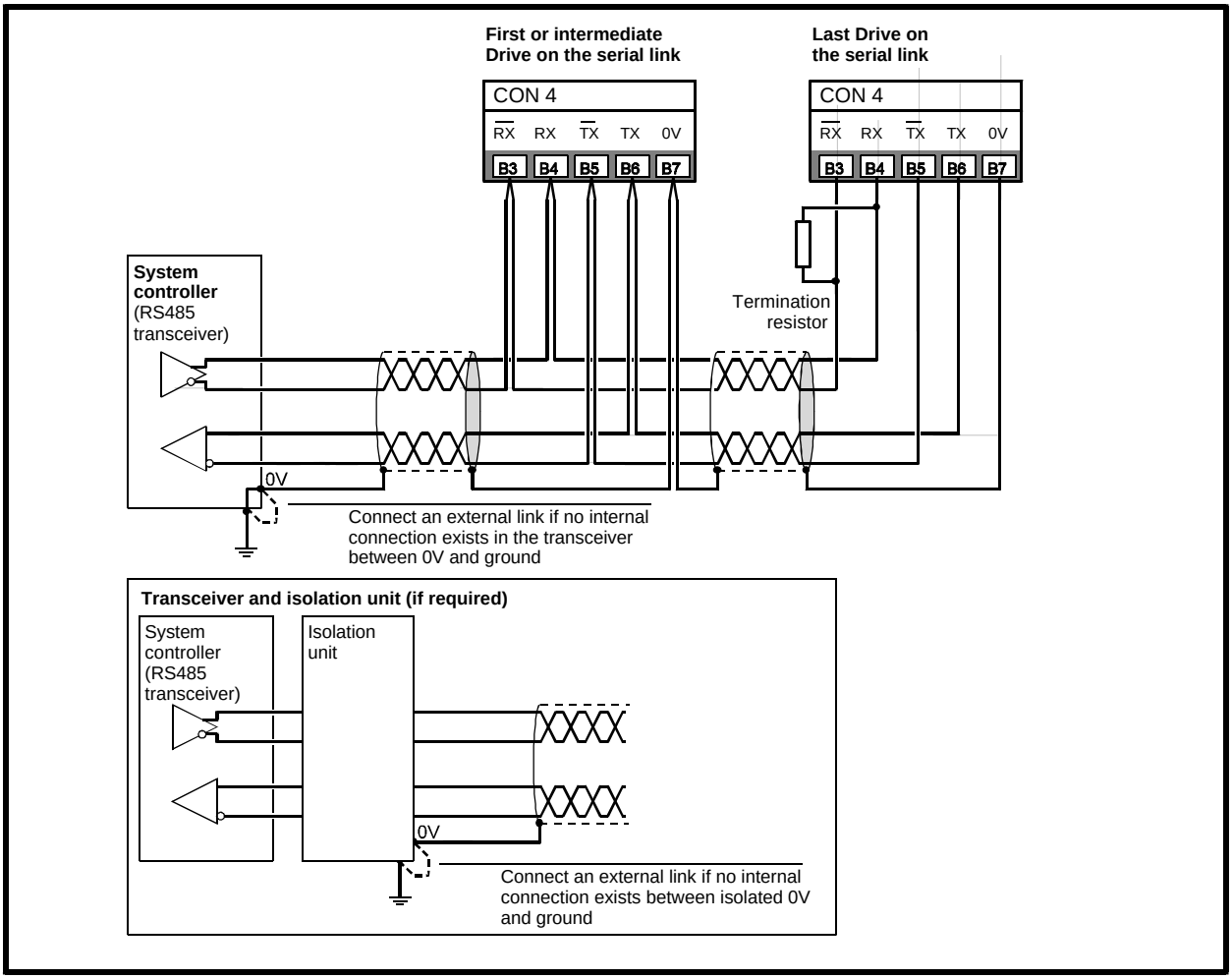

Figure 12–2 RS485 or RS422 Serial Communications connections with isolation

12.2 List of mnemonics

The following list shows the sequence in which the mnemonics (and their corresponding parameter values) appear in response to repeated <ACK> messages from the host to the Drive.

Mnemonic	Parameter number and name		Type	Notes
SV	p61	Drive software version number	RO	
ER		Error code	RO	
SP		Set speed	R–W	Enter the required value in Hz.
TP		Set torque	R–W	Enter % FLC
AC		Actual speed	RO	
LD		Actual torque	RO	
MN	p0	Minimum frequency	R–W	Enter value in Hz
MX	p1	Maximum frequency	R–W	Enter value in Hz
AL	p2	Acceleration time	R–W	Enter number of seconds from 0Hz to ULF
DL	p3	Deceleration time	R–W	Enter number of seconds from ULF to 0Hz
TR	p4	Timed current limit	R–W	Enter % FLC > value of p5
TH	p5	Maximum continuous current	R–W	Enter % FLC
BO	p6	Torque (Voltage) boost	R–W	Select require voltage boost
SL	p7	Slip compensation	R–W	Enter number of Hz
BR	p8	DC injection brake current	R–W	Enter value for maximum DC injection current as % FLC
SE	p9	Serial address	R–W	Enter the required Drive address.
SC	pb	Security code	R–W	Enter value: 0 to 255 (100 to 255 using keypad)
SW		Status word	RO	
DS–	b0 ~ b12	Drive configuration	R–W	b6, b9, b10, b12 cannot be changed
FQ	b14	Switching frequency and frequency range selector	R–W	Select from a range of values
BS	pc	Maximum voltage frequency	R–W	Enter the minimum required frequency for the motor voltage to be at maximum
CW		Command word	R–W	Enter the required code.
S1 ~ S3	p10	Skip frequencies 1, 2, 3	R–W	Enter Hz to avoid mechanical resonances
B1 ~ B3	p13 ~ p15	Skip bands 1, 2, 3	R–W	Enter required width in Hz
P1 ~ P7	p20 ~ p26	Preset speeds	R–W	Enter required speeds in Hz Select preset speeds using terminals or by programming
PJ	p27	Jog Speed	R–W	Set b20 at 0 to select three preset speeds and jog
A1 ~ A7	p30 ~ p36	Preset accelerations	R–W	Enter number of seconds from 0Hz to ULF Use b21 and b23 to select standard or preset acceleration
AJ	p37	Jog acceleration	R–W	Set b20 at 0 to select three preset speeds and jog
D1 ~ D7	p40 ~ p46	Preset decelerations	R–W	Use b21 and b23 to select standard or preset acceleration
DJ	p47	Jog deceleration	R–W	Set b20 at 0 to select three preset speeds and jog
C1–	b20 ~ b27 b50 ~ b56	Drive configuration	R–W	Enter the required code.
PI	b28	PI control selector	R–W	When b28 = 1, p25 and p26 control the PI loop
PS		Select preset speed	R–W	Select three preset speeds and jog, or seven preset speeds
RN	p50	Number of reset attempts	R–W	Enter the number of attempts required.
RD	p51	Reset delay	R–W	Enter the value of the required delay.
RC		Reset counter	RO	
HR		High resolution speed control	R–W	Enter the required number in Hz.
DR	p60	Power rating of the Drive	RO	
RL	p63	Duration of Drive running time	RO	
RH	p63	Duration of Drive running time	RO	Combine the values for total running time
T0 ~ T9	pA ~ p9	Trip logs	RO	T0 is most recent trip
BL	p64	DC bus braking level	R–W	Enter required DC bus threshold voltage for braking

12.3 Additional connections

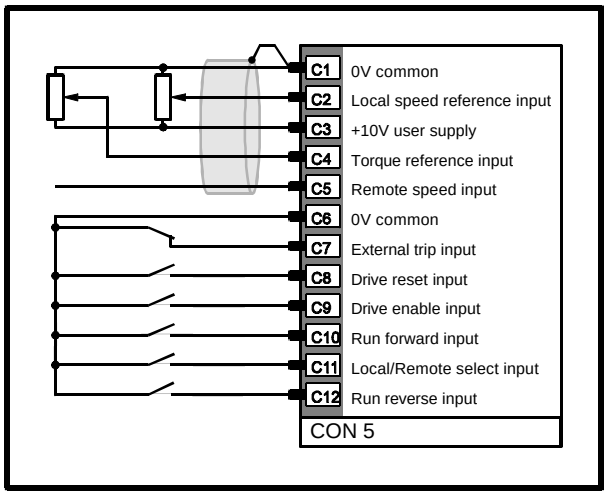

Figure 12–3 Basic connections for serial communications control (parameter b6 must be set at 1)

Make the connections as shown in Figure 12–3.

The Drive runs when Command Word bits 0, 1, 2 and 4 are all set at 1 (ie. the hexadecimal number sent to mnemonic CW must be >17 (see the *List of Mnemonics*).

The Drive stops when Command Word bits 0 and 1 are both set at 0 (ie. the hexadecimal number sent to mnemonic CW must be >14).

Note that the Drive can be tripped by an open-circuit at terminal C9. Restoring the connection does not re-start the Drive. The Drive can be re-started only by using the mnemonic CW.

12.4 Switching between local and remote control

If the Drive is running in local control, it is possible to switch to remote control by closing the contact at terminal C11. The motor continues running at the speed immediately before the change-over, and in the same direction.

When the contact at terminal C11 is opened in order to return to local control, full control is resumed at the terminals.

Warning

The Drive will start immediately on return to local mode if the contacts at terminal C9 and at either C10 or C12 are closed

12.5 ANSI communications protocol

Host-to-Drive message types

Sending data

The message always contains 16 bytes.

<EOT>	a1	a2	a3	a4	<STX>	m1	m2	...

...	d1	d2	d3	d4	d5	d6	<ETX>	bcc

Example: <EOT> 1144 <STX> SP –047.6 <ETX> &

Sending a *high-resolution speed* setting

The message always contains 16 bytes.

<EOT>	a1	a2	a3	a4	<STX>	H	R	...

...	d1	d2	d3	d4	d5	d6	d7	d8	<ETX>	bcc

Example: <EOT> 1144 <STX> HR –047.001 <ETX> 8

Requesting data

The message always contains 8 bytes.

<EOT>	a1	a2	a3	a4	m1	m2	<ENQ>

Example: <EOT> 1122 <SP> <ENQ>

Repeat request for the same mnemonic

The message always contains 1 byte.

<NAK>

Repeat request for the next mnemonic in the sequence

The message always contains 1 byte.

<ACK>

Drive-to-host message types

Response when the received message is accepted

The message always contains 1 byte.

<ACK>

Response when the received message, the format of the data bytes or the block checksum is invalid

The message always contains 1 byte.

<NAK>

Response to valid requests for data

The message always contains 11 bytes.

<STX>	m1	m2	d1	d2	d3	d4	d5	d6	...

... | <ETX> | bcc |
|---|---|

Example: <STX> SP +011.2 <ETX>

Response to valid requests for a *high-resolution speed* setting

The message always contains 11 bytes.

<STX>	H	R	d1	d2	d3	d4	...

... | d5 | d6 | d7 | d8 | <ETX> | bcc |
|---|---|---|---|---|---|

Example: <STX> HR -047.001 <ETX> 8

Response to messages with unrecognised mnemonics

The message always contains 4 bytes.

<STX>	m1	m2	<EOT>

The data bytes are as follows:

a1	First digit (group) of address of Drive as an ASCII digit 1 to 9
a2	Same as **a1**
a3	Second digit (unit) of address of Drive as an ASCII digit 1 to 9
a4	Same as **a3**
m1	First character of mnemonic (ASCII letter)
m2	Second character of mnemonic (ASCII letter or digit)
d1 ~ d2	Value of data in ASCII decimal or hexadecimal (see below)
bcc	Block checksum as a single ASCII character calculated below

Calculating the block checksum

Use the following procedure to calculate the bcc.

1. Start with the first byte after the <STX> code.
2. Convert the bytes into binary
   eg. digit 0 = 30 (hex) = 00110000 (binary).
3. Arrange the binary codes vertically, as follows:

S	0	1	0	1	0	0	1	1
P	0	1	0	1	0	0	0	0
–	0	0	1	0	1	1	0	1
0	0	0	1	1	0	0	0	0
4	0	0	1	1	0	1	0	0
7	0	0	1	1	0	1	1	1
.	0	0	1	0	1	1	1	0
6	0	0	1	1	0	1	1	0
<ETX>	0	0	0	0	0	0	1	1

4. Count the occurences of the number **1** in each column (eg. the second column has two occurrences of the number **1**, the third column has six occurrences.

   When the number is even, the bcc is 0 for that column. When the number is odd, the bcc is 1 for that column . (This is not binary addition so do not *carry* to the next column).

   For the example shown above, the bcc is 00000110.

5. If the total is less than 20 (hex), add 20 (hex).

   For the example shown above, 06 (hex) is less than 20 (hex), so add 20 (hex) to give 26 (hex). This is sent to the host as the ASCII **&** character.

12.6 Data formats

Decimal

The values of most parameters that represent a quantity are represented in decimal notation having six characters, as follows:

Character	Information
1	Sign (+ or –)
2 3 4	Integer
5	Decimal point
6	Decimal value (often zero)

Example

d1	d2	d3	d4	d5	d6
+	0	9	5	.	0

The *high-resolution speed* setting uses eight characters, as in the following example:

d1	d2	d3	d4	d5	d6	d7	d8
–	0	4	7	.	0	0	1

12.7 Accessing the mnemonics

Some mnemonics require to be accessed by a two-digit hexadecimal number; other mnemonics require a four-digit hexadecimal number.

Two-digit hexadecimal mnemonics

The mnemonics listed in this section must be accessed in the two-digit hexadecimal format shown below:

d1	d2	d3	d4	d5	d6
space	space	space	>	h1	h2

where **h1** and **h2** are hexadecimal digits

When individual bits are stored, they are allocated as follows:

h1 contains bits 4 to 7
h2 contains bits 0 to 3

SE

Serial address accessed as hex
(eg. address 22 would be read as >16)

SC

Security code accessed as hex
(eg. **pb** set at 100 would be read as >64)

FQ

There are 12 valid codes which may be stored in **FQ** to determine the PWM switching frequency and the ULF, as follows:

FQ	Nominal PWM frequency	ULF
	kHz	Hz
>**00**	2.9	120
>**01**	2.9	240
>**10**	5.9	120
>**11**	5.9	240
>**12**	5.9	480
>**20**	8.8	120
>**21**	8.8	240
>**22**	8.8	480
>**30**	11.7	120
>**31**	11.7	240
>**32**	11.7	480
>**33**	11.7	960

CW

Except for bits 2 and 3 which are read-only (labelled **RO** in the following table), the six least-significant bits of **h2** can be used to read the state of terminals C7 to C12 and to over-ride these terminals for controlling the Drive in remote control (in this case, parameter **b6** must be set at 1).

Note that these bits have a latching action which is different from the wire-proof action of the terminals they over-ride.

Bit	When set at 0...	When set at 1...
0	No effect	Drive starts (subject to the state of bits 1, 2, 4, 5)
1	Forces the Drive to stop	Allows the Drive to start
2 (RO)	Indicates the Drive is in local control (C11 contact is open)	Indicates the Drive is in remote control (C11 contact is closed)
3 (RO)	Indicates forward direction	Indicates reverse direction
4	Causes an external trip	No effect
5	No effect	Resets the Drive

Bits 6 and 7 are unused and should both be set at 0.

Note that with software version 1.02.07 onward, the contacts at terminals C7 EXTERNAL TRIP and C9 ENABLE must be closed so that the Drive can be run under serial communications control.

Opening the contact at terminal C7 EXTERNAL TRIP will trip the Drive.

Opening the contact at C9 will stop the Drive. Re-closing the contact at C9 will not re-start the Drive until bits 0 and 1 are subsequently set at 1.

PI

>20 indicates that PI control is disabled

>A0 indicates that PI control is enabled

PS

The three least-significant bits of **h2** can be used to read the state of terminals B8, B9, B10 and to over-ride these terminals for control of the Drive. In this case parameter **b6** must be set at 1).

Bits 3 to 7 are unused and should be all set at 0.

Bit	When set at 0...	When set at 1...
0	B8 contact open	B8 contact closed
1	B9 contact open	B9 contact closed
2	B10 contact open	B10 contact closed

RN

This is a decimal number that corresponds with parameter **p50** which is indicated as a hexadecimal number (eg. five attempts would be indicated as >05).

RC

This is a decimal number that corresponds with the number of remaining attempts that will be displayed at the next attempt. This is indicated as a hexadecimal number (eg. 4 remaining attempts would be indicated as >04).

Four-digit hexadecimal mnemonics

The mnemonics listed in this section must be accessed in the four-digit hexadecimal format shown below:

d1	d2	d3	d4	d5	d6
space	>	h1	h2	h3	h4

where **h1** to **h4** are hexadecimal digits

When individual bits are stored, they are allocated as follows:

h1 contains bits 12 to 14
h2 contains bits 8 to 11
h3 contains bits 4 to 7
h4 contains bits 0 to 3

SW

This is the Status Word which contains 14 read-only bits. They are used to indicate the following:

- Trip status
- Local or remote control selected by terminal C11
- Run and ready states

Bit	When set at 0...	When set at 1...
1		**Oh** trip
2		**th** trip
3		**It** trip
4	**OI** trip	
5	**PS** trip	
6	**UV** trip	
7	**OV** trip	
8		**Ph** trip
9		**cL** trip
10		**Err** condition
11		Drive tripped
12	**RUN** flag is reset (0)	**RUN** flag is set (1)
13	**READY** flag is reset (0)	**READY** flag is set (1)
14	Local operation	Remote operation

Bits 0 and 15 are unused and indicate zero.

The following table shows the states of the flags for the basic conditions of the Drive.

Condition	READY flag	RUN flag
Display shows **rdY**	1	0
Drive running	0	1
Drive is stopping	0	0
Drive tripped	1	1

T0 ~ T9

These correspond to parameters **pA0** to **pA9** and have the same data format as mnemonic **SW**.