SOFTWARE

KR C...

CREAD CWRITE

Release 4.1

PD Interleaf

Contents

1 General

"CREAD / CWRITE" describes the logical combination of symbolic interface names with predefined signal variables for serial interfaces as well as the declaration of signal names for input and output channels (CHANNEL), and how to open input and output channels (COPEN), read data from open channels (CREAD), write data to channels (CWRITE) and close channels (CCLOSE).

1.1 Areas of application

About 95% of CREAD/CWRITE applications are in the field of serial sensor systems. Examples include vision systems, barcode scanners and MeasureTech.

Command channel applications, e.g. automatic system start with CELL.SRC, account for the other 5%.

1.2 Operation

In order to be able to access a channel, it must be declared in the "CHANNEL" declaration. In the KR C2, the three serial interfaces COM1, COM2 and COM3 are declared by default as SER_1, SER_2 and SER_3 in the file "$CUSTOM.DAT".

Each channel must be opened by means of the "COPEN" statement before it can be used.

The "CREAD" statement can be used to read the channel, while the "CWRITE" statement is used to write to the channel.

The channel is closed with the "CCLOSE" statement.

1.3 Hardware prerequisites

Depending on the type of controller and the motherboard installed, the following COM ports are available for the serial communication of the robot (VxWorks):

	KR C1	**KR C2** with motherboard SuperMicro 370SBA	**KR C2** with motherboard Soyo SY-7VBA 133u
COM1	**X**	**–**	**–**
COM2	**X**	**(X)**	**–**
COM3	**–**	**X**	**X**

X	Port can be configured for robots.
–	Port cannot be configured for robots.
(X)	Port can be configured for robots if two ports are required simultaneously.

In the case of applications with the KR C2 controller, it may be necessary to deactivate the mouse drivers via the Windows Control Panel, as the serial data exchange may not run smoothly otherwise.

1.4 Application in SUB and SRC programs

The COPEN, CREAD, CWRITE and CCLOSE statements can be used in both SRC and SUB programs. If a channel has been opened in an SRC program, it must be closed again before it can be used in a SUB program.

The same applies inversely to channels that have been opened in a SUB program.

1.5 Overview of commands

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1.5.3 CREAD

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1.5.5 CCLOSE

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1.5.7 SWRITE

Writing of data to a variable.

1.6 Typographical conventions

Example	Explanation
DEFTP	Static syntax elements and keywords are printed as upper-case characters in bold type. They must be used without modification.
Name	Terms printed in italics must be replaced by user-specific information.
⟨ ⟩	Elements in angle brackets are optional.
|	The OR sign is used to separate mutually exclusive options.

2 Configuration

2.1 Configuration of the serial interface

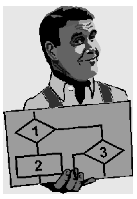
2.1.1 Assignment of a serial channel to the KR C2

By default, the serial interfaces are assigned to Windows. In order to be able to use them from the KR C2, they must be assigned to the KRC operating system VxWorks in the file "HW_INF.INI" (in the directory "C:\KRC\Roboter\INIT").

The required COMx port can be enabled using the Enum constants ENABLE and DISABLE:

ENABLE: the interface can be accessed by the KRC kernel system VxWorks

DISABLE: the interface can be accessed by Windows

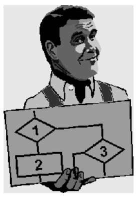


Example: COM3 is to be reserved for the KR C2:

```
[SERIAL]
;ENABLE: COM is accessible by vxWorks
;DISABLE: COM is accessible by Win95
COM1=DISABLE    ;[ENABLE, DISABLE]
COM2=DISABLE    ;[ENABLE, DISABLE]
COM3=ENABLE     ;[ENABLE, DISABLE] useable only for VxWorks
```

2.1.1.1 Interface definitions in the file SERIAL.INI

The serial interfaces are defined in the file "SERIAL.INI" (in the directory "C:\KRC\Roboter\INIT").



```
; SERIAL.INI
; Configuration of the serial ports and their procedures
;
; Lindemann 15.02.99  R12-S4: Protocol XON/XOFF implemented
; Lindemann 19.03.99  R12-T9: Receive buffer expanded to 2048
characters
; Lindemann 27.09.00  R12-T9: COM3/4 implemented

[COM1]

BAUD=9600
CHAR_LEN=8    ; 7,8
STOP_BIT=1    ; 1,2  at time not changeable
PARITY=2      ; EVEN=2, ODD=1, NONE=0

PROC=1        ; 3964R=1, SRVT=2, WTC=3, XONXOFF=4

[COM2]

BAUD=9600
CHAR_LEN=8    ; 7,8
STOP_BIT=1    ; 1,2  at time not changeable
PARITY=2      ; EVEN=2, ODD=1, NONE=0

PROC=1        ; 3964R=1, SRVT=2, WTC=3, XONXOFF=4

[COM3]

BAUD=9600
CHAR_LEN=8    ; 7,8
STOP_BIT=1    ; 1,2  at time not changeable
PARITY=2      ; EVEN=2, ODD=1, NONE=0
PROC=1        ; 3964R=1, SRVT=2, WTC=3, XONXOFF=4
```

```
[3964R]

CHAR_TIMEOUT=500   ; msec
QUITT_TIMEOUT=500  ; msec
TRANS_TIMEOUT=2000 ; msec

MAX_TX_BUFFER=2      ; 1..5
MAX_RX_BUFFER=10     ; 1..20
SIZE_RX_BUFFER=100   ; 1..2048
PROTOCOL_PRIOR=1     ; HIGH=1, LOW=0

[SRVT]
CHAR_TIMEOUT=200     ; msec

MAX_TX_BUFFER=2      ; 1..5
MAX_RX_BUFFER=2      ; 1..20
SIZE_RX_BUFFER=100   ; 1..2048

[WTC]
CHAR_TIMEOUT=200     ; msec

MAX_TX_BUFFER=2      ; 1..5
MAX_RX_BUFFER=2      ; 1..20
SIZE_RX_BUFFER=50    ; 1..2048

[XONXOFF]
CHAR_TIMEOUT=50      ; msec  Timeout after last received character
                     ; to recognize the end of telegram

MAX_TX_BUFFER=2      ; 1..5
MAX_RX_BUFFER=2      ; 1..20
SIZE_RX_BUFFER=100   ; 1..2048 longest expected telegram length
                     ;+ 15 characters

XON_VAL=17           ; 0..255  XON  character (decimal)
XOFF_VAL=19          ; 0..255  XOFF character (decimal)
                     ; if XON_VAL=0 and XOFF_VAL=0 then XON/XOFF
                     ; protocol
                     ; is disabled (pure communication)
[TEST]
;testprint (Rx/Tx-telegrams) on telnet if value > 0
TESTPRINT=0

[END SECTION]
```

The structure variables “$PSER_X” in the system file $CUSTOM.DAT are not evaluated.

Once modifications have been made in the files HW_INF.INI or SERIAL.INI, the controller must be rebooted by means of a cold start in order for the changes to take effect.

2.2 State and mode information

The state information is returned in a variable of the predefined structure type “STATE_T”. “STATE_T” has the following definition:

```
STRUC STATE_T CMD_STAT RET1, INT HITS, INT LENGTH
```

“CMD_STAT” is a predefined enumeration type of the following form:

```
ENUM CMD_STAT CMD_OK, CMD_TIMEOUT, DATA_OK, DATA_BLK, DATA_END,
CMD_ABORT, CMD_REJ, CMD_PART, CMD_SYN, FMT_ERR
```

The modes that can be used with the statements “CREAD” and “CWRITE” are made available as a predefined enumeration type:

```
ENUM MODUS_T SYNC, ASYNC, ABS, COND, SEQ
```

3 Commands

3.1 CHANNEL

Declaration of signal names for input and output channels.

3.1.1 Syntax

```
CHANNEL :Channel_Name:Interface_Name Structure_Variable
```

Argument	Type	Explanation
Channel_Name		Any symbolic name
Interface_Name		Predefined signal variable **SER_1** serial interface 1 **SER_2** serial interface 2 **SER_3** serial interface 3
Structure_Variable		System−dependent structure variable $PSER_1, $PSER_2 or $PSER_3 specifying the protocol. Evaluation is not carried out.

3.1.2 Definition, description

The robot controller contains two classes of interface:

- simple process interfaces − **signals.**
- logic interfaces − **channels.**

All of the interfaces are addressed using symbolic names. The specific interface names (symbolic names) are logically combined with the predefined signal variables for channels by means of the CHANNEL declaration.

The predefined signal variables for channels are

- **SER_1**
- **SER_2**
- **SER_3**

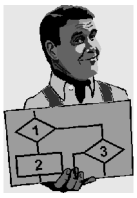
for the serial interfaces, and

- **$CMD (e.g. “RUN....”)**

for the command interpreter.

They are predefined in the file “$CUSTOM.DAT” in the directory “C:\KRC\ROBOTER\KRC\STEU\MADA”.

3.1.3 Example: **Assignment of a channel name to a physical channel**



With the “CHANNEL” statement:

Channel name SER_3

is assigned to

physical channel SER_3

```
CHANNEL :SER_3 :SER_3 $PSER_3
```

3.2 COPEN

Opening an input/output channel.

3.2.1 Syntax

COPEN (:*Channel_Name, Handle***)**

Argument	Type	Explanation
Channel_Name		Channel name declared in the “CHANNEL” statement.
Handle	INT	Open interface number feedback signal: 1, 2 or 3 (or 0 in the event of an error).

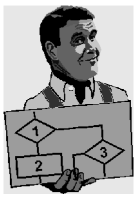
3.2.2 Definition, description

Input/output channels that have previously been declared with the CHANNEL statement can be opened using the “COPEN” statement – which may be included in programs at control or robot levels.

The “Handle” variable identifies the relevant channel for all of the following accesses. If the system refuses to open a channel, a 0 is returned.

The predefined system variable “$CMD” is available as a handle for execution of commands, which are generally open.

3.2.3 Example



Opening of a channel with the declared channel name “SER_3” and the handle “HANDLE”.

```
INT HANDLE
 ...
COPEN(:SER_3,HANDLE)
```

3.3 CREAD

Reading of data from channels.

3.3.1 Syntax

```
CREAD    (Handle, State, Mode, Timeout, Offset, Format,
⮱         Var1 〈, ..., VarN〉)
```

Argument	Type	Explanation
Handle	INT	The Handle variable transferred by “COPEN”. **Note:** the variable “$CMD” will be rejected!
State	STATE_T	“CMD_STAT” is an enumeration type which is the first component of the “State” variable of the structure type “STATE_T”. “CMD_STAT” can have the following values which are relevant for “CREAD”: **CMD_OK** Command successfully executed; no data available in #COND mode. **CMD_TIMEOUT** Reading aborted in “ABS” mode due to the defined time limit being exceeded. **DATA_OK** A data block has been received from the channel. All of the data have been assigned to the variables in accordance with the format description. However, it is not necessary for all the variables to have been described (see also the State variable “HITS” below). **DATA_BLK** Data have been read but further data which can be read using the mode “SEQ” are ready. **DATA_END** Data have been read. The data block has been completely read. **CMD_ABORT** Reading has been aborted, e.g. due to an error message from the channel or to a fatal error during read–out of the data. If the format specification and the variable type do not agree, reading is aborted not with CMD_ABORT but with DATA_BLK. **FMT_ERR** Incorrect format specification or non–corresponding variable. Other components of the State variable that are important for CREAD: **HITS** Number of correctly read formats. **LENGTH** Length of the “%s” or “%r” format that occurs first in the format. The lengths of all following “%s” or “%r” formats are not determined. If necessary, use several “CREAD” statements.

Argument	Type	Explanation
Mode	MODUS_T	"MODUS_T" is an enumeration type that can have the following values that are relevant for "CREAD": **ABS** Active reading of the channel. The function waits until the channel makes a data block available or until waiting is aborted by Timeout. **COND** Immediate reading when data are received. **SEQ** Completion of the reading of a data block from Bytes Offset onwards that has previously been requested using "ABS" or "COND" or returned to "CWRITE" as a reply and which has not yet been completely read out.
Timeout	REAL	The parameter "Timeout" can be used to specify a time in seconds, after which the wait for a data block is aborted. A Timeout with the value 0.0 corresponds to an endless wait. A value over 60 or negative values are rejected. A system–related inaccuracy is inherent in the wait time.
Offset	INT	The variable "Offset" is used to specify the number of bytes in the data that have been received after which the system is to start reading. If reading is to start from the beginning, Offset must be set to 0 (zero). After a "CREAD" statement that does not assign all of the data received to program variables, Offset specifies the number of characters that have been assigned so far.
Format	CHAR[ ]	The variable "Format" of the type "CHAR[ ]" (Textstring) contains the format of the text that is to be generated. The number of format specifications per call is limited to 10. The structure of the variable largely corresponds to the format string of the function "FPRINTF" of the "C" programming language.
VarX		The variables corresponding to "Format".

If a Handle that does not come from a "COPEN" statement of the process is transferred in the "CREAD" statement or if the channel has already been closed again, the acknowledgement message "INVALID HANDLE" is displayed.

3.3.2 Definition, description

The "CREAD" statement is used for reading data from open channels. Two cases are distinguished here:

- **Active reading**
  The program requests an input via a channel. The channel drivers set an input request and return the data that are received to the CREAD statement as a result.
- **Passive reading**
  Another partner has written data to a channel without being requested to and expects the data to be collected. A predefined variable is made available for each of the channels "SER_1", "SER_2" and "SER_3".

INT $DATA_SER1
INT $DATA_SER2 and
INT $DATA_SER3

There are also differences in the way that the system waits for the feedback signal of a read request. The “CREAD” statement can wait absolutely or conditionally.

- *Absolutely* means that the system waits until the channel provides the data of the type requested.
- In the case of *conditional* waiting, the system checks whether data are available.

By using the feedback signal, it can be determined whether the read statement was successful or not. The relevant procedure is defined by the parameter “Mode”.

The conversion specification for the Format variable has the following structure:

“% ⟨W⟩U”

For arrays and type r, the following applies:

“% ⟨W ⟨.Z⟩⟩U”

The following definitions apply here:

W Specification of the maximum number of characters to be read.

Z Only for arrays and type r: number of array elements to be written.

U Specification of the type to be written. The following are permissible: c, d, e, f, g, i, s, x and r in accordance with the table below.
The system cannot distinguish between upper and lower–case letters.

The format specification and data type are checked in accordance with the following table at run time:

Permissi-ble data type	Format specification											
	%d %i %x	**%f %e %g**	**%c**	**%s**	**%1r**	(3) **%1.⟨Z⟩r**	**%2r**	(3) **%2.⟨Z⟩r**	**%4r**	(3) **%4.⟨Z⟩r**	(4) **%r**	(3) **%.⟨Z⟩r**
(SIGNAL) INT	X	–	X	–	X	–	X	–	X	–	X	–
INT array	–	–	–	–	–	X	–	X	–	X	X	X
REAL	X	X	–	–	–	–	–	–	X	–	X	–
REAL array	–	–	–	–	–	–	–	–	–	X	X	X
(Signal) BOOL (1)	X	–	X	–	X	–	X	–	X	–	X	–
BOOL array	–	–	–	–	–	X	–	X	–	X	X	X
ENUM (2)	X	–	X	–	X	–	X	–	X	–	X	–
ENUM array	–	–	–	–	–	X	–	X	–	X	X	X
CHAR	X	–	X	–	X	–	–	–	–	–	X	–
CHAR array	–	–	–	X	–	X	–	–	–	–	X	X

Remarks

(1) Every value that is not equal to 0 (zero) is converted to TRUE

(2) The system checks whether the value is a permissible ENUM value. If it is not, reading is aborted. The value of the first Enum constant is 1.

(3) If there are not enough data available to satisfy the requirements of the format (e.g. %2.5r, but only 7 bytes are present), nothing is read for this format and the CREAD statement is aborted. The ignored data are, however, still ready for reading.

(4) Only as many bytes as can fit into the variable are read. The rest are still ready for reading. If the array is actually big enough but the number of available bytes is not a multiple of the size of an array element, the redundant bytes for the following format or for the next CREAD statement are left for reading.

A message that is not completely read can be read further by the following “CREAD” calls. The number of bytes of the “%s” or “%r” format specified first in the format string that have actually been read is returned in the State variable.

All of the other lengths are not determined. It is therefore advisable to use “%s” and “%r” formats only once in a format string and to repeat the “CREAD” call.

If the “%s” or “%r” format is not among the formats that have been successfully read (see “HITS” of the State variable), the value of “LENGTH” is not changed by the statement.

The specification of other modes or of non–initialized variables causes an error to be detected in the variable “State”. If reading with “ABS” oder “COND” is successful, the data of the data block that was previously received are overwritten, even if they have not yet been completely read out.

The text that is returned is segmented in accordance with the format specification. The values that are determined are assigned to the appropriate variables, with the system checking whether the value is valid for each variable. A conversion specification for the variable “Format” supports the formats described in Kernighan/Ritchie (The C Programming Language, Prentice Hall, 1978), with the exception of o, p, n, u and [list].

The length specifications “H” and “L” may not be used.

Only 10 format parameters may be specified in a CREAD statement.
If several variables are available for formatting, the read–in must be continued in #SEQ mode.

The system cannot distinguish between upper and lower–case letters. Read–in is aborted after the occurrence of the first error (unsuitable format or invalid value).

The conversion character “R”, which reads in either a byte sequence of the specified length (similar to with writing, e.g. “%2.5r”) or all bytes up to the end of the message, is also introduced.

Unlike the other formats, the reading of an individual byte must be explicitly stated using “%1r”.

There is no point specifying a width with the format “%c”; such a specification is therefore rejected. The byte sequence can be assigned to a sufficiently large variable of type INT, REAL, CHAR, BOOL, ENUM or to one–dimensional arrays of these types.

It is assumed that integer data appear in “little endian” format and are signed.

Data of type Real must be in 32–bit representation in IEEE 754 standard format

bit 31	sign,
bit 30– 23	exponent,
bit 22– 0	mantissa.

Particularly time–intensive input and output operations can have a considerable effect on program execution.

The following applies to all statements:

- A statement always waits until it is completely finished and then returns to the program. This is particularly important for the absolute CREAD statement for reading to text channels.
- Regardless of this, these statements can be interrupted by interrupt programs. Any attempts to access channels there can only be interrupted by other interrupt subprograms.

A complete example of a program can be found in Section 3.9.

3.4 CWRITE

Writing of data to channels.

3.4.1 Syntax

```
CWRITE (Handle, State, Mode, Format, Var1 〈, ..., VarN〉 )
```

Argument	Type	Explanation
Handle	INT	The Handle variable transferred by "COPEN" or the predefined variable "$CMD" for writing to the command channel.
State	STATE_T	"CMD_STAT" is an enumeration type which is the first component of the State variable of the structure type "STATE_T". "CMD_STAT" can have the following values which are relevant for CWRITE: **CMD_OK** Command successfully executed. **DATA_OK** The command has been successfully executed. Data are ready to be read as a reply. **CMD_ABORT** Command not successfully executed because "HANDLE" is not valid. **CMD_REJ** Only with Weltronic protocol: BCC error **CMD_SYN** Syntax error in the command. The syntax of the command is wrong and the command cannot therefore be executed. This also applies when an invalid Mode is specified. **FMT_ERR** Incorrect format specification or non–corresponding variable. Another component of the state variable that is important for "CWRITE": **HITS** Number of correctly written formats.
Mode	MODUS_T	Variable of type "MODUS_T" (structure type) defining how the channels are written to. It can have the following values: **SYNC** The statement is not executed until the data have been sent to the partner station and the transmit buffer is empty. **ASYNC** The statement is executed when the channel driver has confirmed that the data have been received. The system does not wait until the transmit buffer is empty again. It is thus possible for data to be lost.

Format	CHAR[ ]	The variable “Format” contains the format of the text that is to be generated. The number of format specifications per call is limited to 10. The structure of the variable largely corresponds to the format string of the function “FPRINTF” of the “C” programming language.
VarX		The variables or constants corresponding to “Format”. The variables “Var1”, ..., “VarN” may not be of a structure type or an array of a structure type (including structures such as “POS”).

The “CWRITE” statement triggers an advance run stop.

3.4.2 Definition, description

The statement “CWRITE” enables data to be written to an open channel, or commands to be written to a command channel.

The value of “Mode” is not relevant for writing to the command channel. If “Mode” is a non–initialized variable in the other cases, the statement is aborted and an error flag is set in the variable “State”.

If “Mode” has a value other than SYNC or ASYNC, data are written to the channel in the SYNC mode.

The conversion specification for the Format variable has the following structure:

“%⟨FW.G⟩U”

The following definitions apply here:

F Formatting character +, –, # etc., (optional).

▪	+	Converted positive arguments are indicated with a sign in the same way as negative ones.
▪	–	The converted argument is left–aligned.
▪	#	In format x, every value that is not equal to zero is preceded by 0X. In formats e, f and g, a decimal point is always inserted.
▪	0	The converted argument is preceded by zeros to make up the specified minimum number of digits.
▪	Space	In format d, e, f, g or i, the converted argument is preceded by a space.

W Width, specifies the minimum number of bytes that are to be output (optional).

The value is extended by adding zero bytes at the end (little endian format).

If the width is not specified, the internal representation is output: 4 bytes for INTEGER, REAL and ENUM, one byte for BOOL and CHAR.

G Accuracy specification:

(a) For arrays: Number of array elements to be represented.

(b) In all other cases:

- Number of characters to be represented; if the source value contains more characters, it is either abbreviated or rounded.
- Number of decimal places to the right of the decimal point in the case of e and f.

- Number of significant figures in the case of format g.
- The maximum number of represented characters in the case of format s.

The following are permitted:

- .* The width specification is positioned in front of the actual argument, e.g. "%*.*d", 10, 20, 300 corresponds to "%10.20d", 300
- *.Integer*

υ Permissible conversion characters: c, d, e, f, g, i, s, x and %.
The system cannot distinguish between upper and lower–case letters. In addition to the conversion characters given above (corresponding to "FPRINTF" in "C"), the character "r" is also available.

- c A single–character argument is expected; this is then processed as an ASCII character.
- s represents a character string.
- d Integer number represented as a decimal.
- i Integer number represented as a decimal.
- e Exponential notation; the argument is converted into the format [–]m.nnnnnnE[+–]xx. The second character string in Format specifies the number of digits to the right of the decimal point.
- f Decimal point representation
  An argument is represented in the format [–]mm.nnnnnn. The second character string in Format specifies the number of digits to the right of the decimal point.
- g Formatting is carried out using %e or %f, depending on which format allows the shorter representation.
- x Hexadecimal notation; represents the argument in base 16.
- r converts the value of its variable not into ASCII, but into binary notation. With the format "%r", the system does not check whether the variable or the array element is initialized.
- % represents the percent sign.

Boolean values are output as 0 or 1, ENUM constants as numbers.

The format specification and data type are checked in accordance with the following table at run time:

Permissible data type	**Format specification**											
	%d %i %x	%f %e %g	%c	%s	%1r	%1.⟨Z⟩r	%2r	%2.⟨Z⟩r	%4r	%4.⟨Z⟩r	%r	%.⟨Z⟩r
(SIGNAL) INT	X	X	–	–	X	–	X	–	X	–	X	–
INT array	–	–	–	–	–	X	–	X	–	X	X	X
REAL	–	X	–	–	–	–	–	–	X	–	X	–
REAL array	–	–	–	–	–	–	–	–	–	X	X	X
(signal) BOOL	X	–	–	–	X	–	X	–	X	–	X	–
BOOL array	–	–	–	–	–	X	–	X	–	X	X	X
ENUM	X	–	–	–	X	–	X	–	X	–	X	–
ENUM array	–	–	–	–	–	X	–	X	–	X	X	X
CHAR	X	–	X	–	X	–	–	–	–	–	X	–
CHAR array	–	–	–	X	–	X	–	–	–	–	X	X

In the case of arrays, the optional format specification Z can be used to define the number of array elements to be represented.

Conversion is aborted if types are incompatible or when the system encounters the first value that has not been initialized, except in the case of "%r". An error message is not output.

Particularly time–intensive input and output operations can have a considerable effect on program execution.

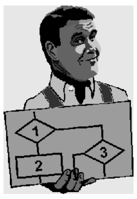
The following applies to all statements: A statement always waits until it is completely finished and then returns to the program. This is particularly important for the absolute CWRITE statements for command channels.

Regardless of this, these statements can be interrupted by interrupt routines. Any attempts to access channels there can themselves be interrupted again only by other interrupt subprograms.

Commands which can return segmented or several feedback signals are rejected by the command channel.

A complete example of a program can be found in Section 3.9.

3.4.3 Examples



Several examples of the "CWRITE" statement are given below.

3.4.3.1 Conversion of an integer value into decimal and hexadecimal notation

Conversion of the value of **"I"** into decimal and hexadecimal ASCII notation:

```
INT I
I=123

CWRITE(HANDLE,SW_T,MW_T,"%D",I)   ;123

CWRITE(HANDLE,SW_T,MW_T,"%X",I)   ;7B
```

3.4.3.2 Writing an integer value in binary notation

```
INT I
I=123
CWRITE(HANDLE,SW_T,MW_T,"%R",I)
```

3.4.3.3 Writing of the first 5 array elements of an array

Random values are generated for array elements that have not been initialized.

```
REAL R[10]

CWRITE(HANDLE,SW_T,MW_T,"%.5R",R[])   ; transmission data 20
                                      bytes in binary
                                      notation
```

3.4.3.4 Output of values of all array elements of an array

```
REAL R[10]

CWRITE(HANDLE,SW_T,MW_T,"%R",R[])
```

3.4.3.5 Output of the first initialized array elements

Output of the array elements of "S", ending with the first non–initialized element:

```
CHAR S[100]

CWRITE(HANDLE,SW_T,MW_T,"%S",S[])
```

3.4.3.6 Writing of the first 50 elements of a character string

Writing of the first 50 array elements of "S", disregarding the initialization information:

```
CHAR S[100]

CWRITE(HANDLE,SW_T,MW_T,"%.50R",S[])
```

3.4.3.7 Conversion of the ENUM constants into ASCII format

Conversion of the internal value of the “ENUM” constants into ASCII. The corresponding number is output.

```
DECL ENUM_TYP E

CWRITE(HANDLE,SW_T,MW_T,“%D“,E)
```

3.4.3.8 Writing of two real values with text

```
REAL W1,W2

W1=3.97

W2=-27.3

CWRITE(...,...,...,”Value1=%+#07.3F Value2=+#06.2F”,W1, W2)
                   ;transmission data: Value1=+03.970
                   Value2=-27.30
```

3.4.3.9 Writing to the command channel

The program A6.SRC is to be started, stopped and deselected via the command channel; the following program lines in a Submit program are used for this.

```
DECL STATE_T STAT
DECL MODUS_T MODE
MODE=#SYNC
...
;select program A6( )
;to start the program the “START” button or
;an external start–signal is needed
IF $FLAG[1]==TRUE THEN
CWRITE($CMD,STAT,MODE,”RUN /R1/A6()”)
$FLAG[1]=FALSE
ENDIF

;stop program A6( )
IF $FLAG[2]==TRUE THEN
CWRITE($CMD,STAT,MODE,”STOP /R1/A6()”)
$FLAG[2]=FALSE
ENDIF

;cancel program A6( )
IF $FLAG[3]==TRUE THEN
CWRITE($CMD,STAT,MODE,“CANCEL /R1/A6()”)
$FLAG[3]=FALSE
ENDIF
```

3.5 CCLOSE

Closing of channels.

3.5.1 Syntax

`CCLOSE` `(`*`Handle, State`*`)`

Argument	Type	Explanation
Handle	INT	The integer variable transferred by “COPEN”.
State	STATE_T	“CMD_STAT” is an enumeration type which is the first component of the State variable of the structure type “STATE_T”. Values of the component “CMD_STAT” that are relevant for “CCLOSE” are: **CMD_OK** Command successfully executed. **CMD_ABORT** Command not successfully executed.

3.5.2 Definition, description

Input/output channels that have previously been declared with the “CHANNEL” statement can be closed using the “CCLOSE” statement. “CCLOSE” deletes all of the data that are waiting to be read.

Similarly, when deselecting and resetting a program, all of the channels that are open there are closed.

Possible causes of “CMD_ABORT” are:

The channel

– is already closed.

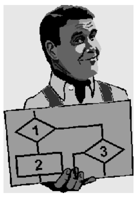
– HANDLE not valid.

– has been opened by another process.

The “HANDLE” can no longer be used for channel statements once this function has been called successfully. The value of the variable is not changed, however.

“CCLOSE” deletes all of the data that are waiting to be read. When deselecting and resetting a program, all of the channels that are open there are implicitly closed.

3.5.3 Example



Closing of a channel with the handle “HANDLE”. The state variable “SC_T” returns information about the state.

```
DECL STATE_T SC_T
...
CCLOSE(HANDLE,SC_T)
```

3.6 SREAD

Reading of character strings from a variable.

3.6.1 Syntax

SREAD (*String1, State, Offset, Format, Var1* 〈 **, ...,** *VarN* 〉**)**

Argument	Type	Explanation	
String1	CHAR[ ]	This character array is read, formatted and written to VarX.	
State	STATE_T	This structure returns information about the state from the kernel system, which the user can evaluate.	
		STATE.MSG_NO	If an error occurs during execution of a command, this variable contains the error number.
		CMD_OK	Command successfully executed.
		CMD_ABORT	Command not successfully executed.
		FMT_ERR	Incorrect format specification or non-corresponding variable.
		State variable:	
		HITS	Number of correctly written formats.
		LENGTH	Length of the “%s” format that occurs first in the format.
Offset	INT	Specifies the position from which String1 is used for the formatting.	
Format	CHAR[ ]	The variable “Format” contains the format of the data to be generated. The number of format specifications per call is limited to 10.	
Var1 ... ***VarN***	CHAR[ ] INT REAL	The variables or constants corresponding to “Format” to which the formatted String1 is written.	

3.6.2 Definition, description

The “SREAD” statement breaks character strings down into their constituent parts.

Unlike with “CREAD”, data are not read from an open channel but from a variable.

The conversion specification “Format” has the following structure:

```
“% ⟨W⟩U”
```

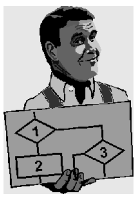
The following definitions apply here:

W Specification of the maximum number of characters to be read.

U Specification of the target type. The following are permissible: c, d, e, f, g, i and s. The system cannot distinguish between upper and lower–case letters.

▪ c	Character string
▪ s	Single character
▪ d	Integer
▪ i	Integer
▪ e	Floating–point number
▪ f	Floating–point number
▪ g	Floating–point number

3.6.3 Example



An example of the “SREAD” statement is given below

Reading the content of the variable HUGO using formatting characters

```
INT OFFSET
DECL STATE_T STATE
DECL CHAR HUGO[20]
DECL INT VAR1, VAR2


OFFSET=0
HUGO[]=”1234567890”
SREAD(HUGO[],STATE,OFFSET,”%01d%02d”,VAR1,VAR2)
                                   ;Result: VAR1=1; VAR2=23
```

Format specifications:	%01d ⇒	Number of characters to be read, here one, therefore in VAR1 the first number in HUGO, i.e. 1.
	%02d ⇒	Number of characters to be read, here two, therefore in VAR2 the second and third numbers in HUGO, i.e. 2 and 3.

3.7 SWRITE

Writing of data to a variable.

3.7.1 Syntax

SWRITE (*String1, State, OFFSET, Format, Var1* 〈 *, ..., VarN* 〉**)**

Argument	Type	Explanation
String1	CHAR[ ]	The formatted contents of VarX are written to this character array.
State	STATE_T	This structure returns information about the state from the kernel system, which the user can evaluate. **STATE.MSG_NO** If an error occurs during execution of a command, this variable contains the error number. **CMD_OK** Command successfully executed. **CMD_ABORT** Command not successfully executed. State variable: **HITS** Number of correctly written formats.
OFFSET	INT	Specifies the position from which VarX is copied into String1.
Format	CHAR[ ]	The variable "Format" contains the format of the text that is to be generated. The number of format specifications per call is limited to 10.
Var1 ... ***VarN***	INT REAL CHAR[ ] BOOL	The content of this variable is pasted into String1 in the format specified. Boolean values are output as 0 or 1, ENUM constants as numbers.

3.7.2 Definition, description

The "SWRITE" statement makes it possible to combine several data to form a character string.

Unlike with "CWRITE", data is not written to an open channel but to a variable.

The conversion specification for the Format variable has the following structure:

"%〈 FWG 〉 U"

The following definitions apply here:

F Formatting character +, –, # etc., (optional).

- + Converted positive arguments are indicated with a sign in the same way as negative ones.
- – The converted argument is left–aligned.
- # In format x, every value that is not equal to zero is preceded by 0X. In formats e, f and g, a decimal point is always inserted.
- 0 The converted argument is preceded by zeros to make up the specified minimum number of digits.

- Space In format d, e, f, g or i, the converted argument is preceded by a space.

W Width, specifies the minimum number of bytes that are to be output (optional).

The value is extended by adding zero bytes at the end (little endian format).

If the width is not specified, the internal representation is output: 4 bytes for INTEGER, REAL and ENUM, one byte for BOOL and CHAR.

G Accuracy specification:

- Number of characters to be represented; if the source value contains more characters, it is either abbreviated or rounded.
- Number of decimal places to the right of the decimal point in the case of e and f.
- Number of significant figures in the case of format g.
- The maximum number of represented characters in the case of format s.

'.*' or *.integer* can be used.

- .* The width specification is positioned in front of the actual argument, e.g. "%*.*d", 10, 20, 300 corresponds to "%10.20d", 300
- *.Integer*

U Permissible conversion characters: c, d, e, f, g, i, s, x and %.
The system cannot distinguish between upper and lower-case letters. In addition to the conversion characters given above (corresponding to "FPRINTF" in "C"), the character "r" is also available.

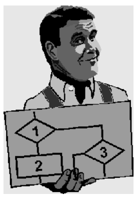
- c A single-character argument is expected; this is then processed as an ASCII character.
- s represents a character string.
- d Integer number represented as a decimal.
- i Integer number represented as a decimal.
- e Exponential notation; the argument is converted into the format [-]m.nnnnnnE[+-]xx. The second character string in Format specifies the number of digits to the right of the decimal point.
- f Decimal point representation
  An argument is represented in the format [-]mm.nnnnnn. The second character string in Format specifies the number of digits to the right of the decimal point.
- g Formatting is carried out using %e or %f, depending on which format allows the shorter representation.
- x Hexadecimal notation; represents the argument in base 16.
- % represents the percent sign.

Boolean values are output as 0 or 1, ENUM constants as numbers.

Conversion is aborted if types are incompatible or when the system encounters the first value that has not been initialized, except in the case of “%r”. An error message is not output.

The “SWRITE” statement triggers an advance run stop.

3.7.3 Examples



Two examples of the “SWRITE” statement are given below

3.7.3.1 Copy the content of the variable HUGO into the variable BERTA

```
INT OFFSET
DECL STATE_T STATE
DECL CHAR HUGO[20]
DECL CHAR BERTA[20]

OFFSET=0
HUGO[]= “TEST”
BERTA[]= “              ”
SWRITE(BERTA[],STATE,OFFSET,HUGO[])    ;Result: BERTA[]=”TEST”
                                        as “OFFSET” called by
                                        reference, this variable now has
                                        the value 4
                                        ;repeat the same command

SWRITE(BERTA[],STATE,OFFSET,HUGO[])    ;Result:
                                        BERTA[]=”TESTTEST”

OFFSET=OFFSET+1
SWRITE(BERTA[],STATE,OFFSET,HUGO[],0)  ;Result:
                                         BERTA[]=”TESTTEST TEST”
```

3.7.3.2 Use of formatting characters

```
INT OFFSET
INT NO
DECL STATE_T STAT
DECL CHAR HUGO[20]
DECL CHAR BERTA[20]

NO=1
OFFSET=0
HUGO[]=”TEST%d”
BERTA[]=”      “
SWRITE(BERTA[],STATE,OFFSET,HUGO[],NO)
                                        ;Result: BERTA[]=”TEST1“
OFFSET=OFFSET+1
NO=22
SWRITE(BERTA[];STATE,OFFSET,HUGO[],NO)
                                   ;Result: BERTA[]=”TEST1TEST22”
```

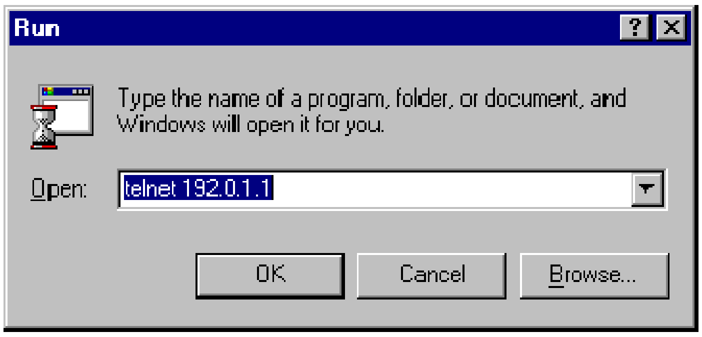
3.8 Diagnosis

Telnet makes it possible to display data that have been transmitted and received. For this, the following setting must be made in the file “SERIAL.INI” in the directory “C:\KRC\Roboter\INIT”:

[TEST]

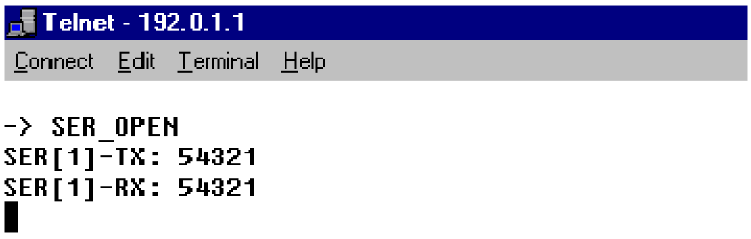
TESTPRINT = 1

Telnet itself is called by pressing the Windows Start button and calling the command “Run”. Enter the string “telnet 192.0.1.1” in the selection box “Open” and press OK:


Run
?
Type the name of a program, folder, or document, and Windows will open it for you.
Open:
OK
Cancel
Browse...

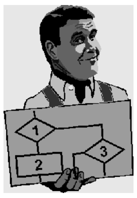
Open: telnet 192.0.1.1

Once CREAD/CWRITE has transmitted the integer value 54321 and it has been mirrored by the receiver, the following Telnet window is opened:



```
-> SER_OPEN
SER[1]-TX: 54321
SER[1]-RX: 54321
```

3.9 Example program for using COPEN, CWRITE, CREAD and CCLOSE



```
DEFDAT CHANNEL
  ; ---- Declaration section ----
    INT HANDLE, OFFSET
    REAL TIMEOUT
    INT IS_VALUE, IR_VALUE
    REAL R_VALUE
    BOOL B_VALUE
    DECL STATE_T SR_T, SW_T, SC_T
    DECL MODUS_T MR_T, MW_T
ENDDAT

DEF CHANNEL ()

; ---- Initialization ----
   MW_T=#SYNC  ; initialize synchronous transmission
   MR_T=#ABS   ; initialize active reading
   TIMEOUT=3.0; initialize timeout after 3 seconds
   IS_VALUE=54321


; ---- Main program ----
   OPEN_P( 3 )
   SENDEN()
   CLOSE_P( 3 )
END

DEF SEND()           ; subprogram for reading and writing a value
  ; writing the IS_VALUE;
   CWRITE(HANDLE,SW_T,MW_T,”%d”,IS_VALUE)
 ; the status component SW_T.RET1 checks whether the transmission was successful
   IF (SW_T.RET1<>#CMD_OK) THEN
      HALT ;         transmission error
   ENDIF

   OFFSET=0          ;read from 1st character

  ; read IR_VALUE;
   CREAD(HANDLE,SR_T,MR_T,TIMEOUT,OFFSET,”%d”,IR_VALUE)

  ; the status component SR_T.RET1 checks whether the reading was successful
   IF (SR_T.RET1<>#DATA_END) THEN
      HALT           ; transmission error
   ENDIF

   IF IR_VALUE<>IS_VALUE THEN
      HALT
   ENDIF
END
; --- SP to open the interface channel
DEF OPEN_P (C_NUMBER :OUT )  ;transmit desired channel number
   INT C_NUMBER
   SWITCH C_NUMBER
   CASE 2
      COPEN(:SER_2, HANDLE)
   CASE 3
      COPEN(:SER_3, HANDLE)
   DEFAULT
      HALT
   ENDSWITCH
   IF (HANDLE==0) THEN          ; channel could not be opened
```

```
      HALT
   ENDIF
END
```

; --- SP to close the channel

```
DEF CLOSE_P (C_NUMBER :OUT )
   INT C_NUMBER
   CCLOSE(HANDLE,SC_T)
```

; evaluation of the channel status:

```
   IF (SC_T.RET1==#CMD_ABORT) THEN
```

; channel operation canceled

```
   HALT
   ENDIF
END
```

4 Procedure 3964R and Xon/Xoff protocol

4.1 Procedure 3964R

Procedure 3964R – an asynchronous, bit–serial transmission procedure – controls the data flow between a device – in this case a KR C2 controller – and a partner device, for example a second KR C2 controller, a higher–level process computer or an intelligent sensor system. The interpreter transfers the transmission data to the procedure in so–called output buffers (TX–BUFFER).

4.1.1 Procedure data

The procedure sends data with the transmission protocol 3964R to the partner device, repeats the transmission if necessary and signals to the interpreter any errors that cannot be eliminated.

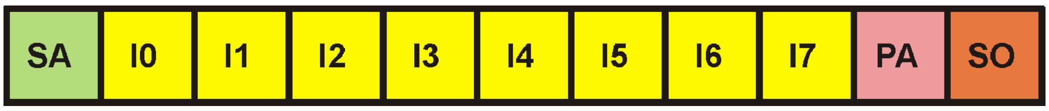
Incoming data from the connected partner device are stored in input buffers (RX_BUFFER) and, if correctly received, transferred to the interpreter for further processing.

As procedure 3964R is an asynchronous, bit–serial transmission procedure, the transmitter and receiver clock rates (baud rate) must be the same for both connected devices.

Control information and user data are sent via the connecting cable. In order to ensure that every character is recognized by the receiver and to be able to check that the transmission is error–free, other bits are added before and after the transmitted characters.

4.1.1.1 Bit sequence

The sequence of the bits is:



Definitions:	**SA**	Start bit
	I0...I7	Information bits
	PA	Parity bit
	SO	Stop bit

The control characters for procedure 3964R are taken from the DIN 66003 standard for 7–bit code. The transmission itself, however, uses an 8–bit unit interval with bit 7=0. For the purposes of data protection, a block check character (BCC) is sent at the end of each data block.

The block check character, BCC, is the even block parity of the information bits of all data bytes in a transmitted or received block (EXCLUSIVE OR operation). It begins with the first user data byte after the connection has been made and ends after the “DLE ETX” character on termination of the connection. No code is stipulated for the information signals, giving code transparency.

4.1.1.2 Procedure parameters

The procedure parameters described below are set in the file “SERIAL.INI”. This file is located in the directory “C:\KRC\Roboter\INIT”.

Transmission speed

The transmission speed is given in bits per second (Baud). The preset value in the KR C1 controller is 9600 Baud. Since the Baud rate for both connected devices must be the same, this is determined by the device with the lower Baud rate.

Possible values are: 115200, 57600, 38400, 19200, 9600, 4800, 2400, 1200, 600, 300, 150 and 110 Baud.

Setting the transmission speed in the file “SERIAL.INI”:

```
[COM1]

BAUD=9600
...

[COM2]

BAUD=9600
...
```

Priority

In order to avoid initialization conflicts – should both devices attempt simultaneously to execute an active transmission – the priority can be set.

The opposite priority must always be set for the partner device. The following options are available:

– higher priority	(high)
– low priority	(low)

If, for example, the KR C2 controller has the higher priority, the lower priority is assigned to the partner device and vice versa.

Setting the priority in the file SERIAL.INI

```
[3964R]
...
PROTOCOL_PRIOR=1       ; HIGH=1, LOW=0
```

The value “1” signifies higher priority, the value “0” low priority.

4.1.1.3 Variable specifications for procedure 3964R

For procedure 3964R, the number of data bits and the parity must be specified:

Data bits:	8, 7
Parity:	even, odd, none

4.1.1.4 Fixed specifications for procedure 3964R

The following is permanently defined for procedure 3964R:

Stop bits	1

4.1.1.5 Procedure 3964R settings in the file SERIAL.INI

```
[3964R]

CHAR_TIMEOUT=500   ; msec              Character delay time
QUITT_TIMEOUT=500  ; msec              Acknowledgement delay time
TRANS_TIMEOUT=2000 ; msec              Wait time

MAX_TX_BUFFER=2      ; 1..5            Max. no. of transmit buffers
MAX_RX_BUFFER=10     ; 1..20           Max. no. of receive buffers
SIZE_RX_BUFFER=100   ; 1..2048         Size of receive buffers
PROTOCOL_PRIOR=1     ; HIGH=1, LOW=0   Priority
```

4.1.2 Transmission with procedure 3964R

4.1.2.1 Establishing the connection

In order to make a connection, procedure 3964R sends out the control character “STX”. If the partner device responds within the acknowledgement delay time “QUITT_TIMEOUT” (default: 500 ms) with the character “DLE”, the procedure switches to transmission mode.

If the partner device responds with “NAK”, or any character or string other than “DLE”, or the acknowledgement delay time (QUITT_TIMEOUT) elapses without a response, the connection has failed.

After a total of six failed attempts to make a connection, the procedure cancels the process, signals the error to the interpreter and sends the character “NAK” to the partner device.

4.1.2.2 Sending information

If the connection is successfully established, the user data contained in the current output buffer is sent to the partner device at the selected transmission speed. The partner device monitors the time interval between incoming characters. The interval between two characters may not exceed the character delay time “CHAR_TIMEOUT” (default: 500 ms).

Every “DLE” character contained in the buffer is transmitted as two “DLE” characters, i.e. a datum (10H) is sent twice (DLE duplication). See also Section 4.1.3.2.

Once the contents of the buffer have been sent, the procedure adds the characters “DLE”, “ETX” and “BCC” as an end label and waits for an acknowledgement character. If the partner device sends the character “DLE” within the acknowledgement delay time (QUITT_TIMEOUT), the data block has been correctly received.

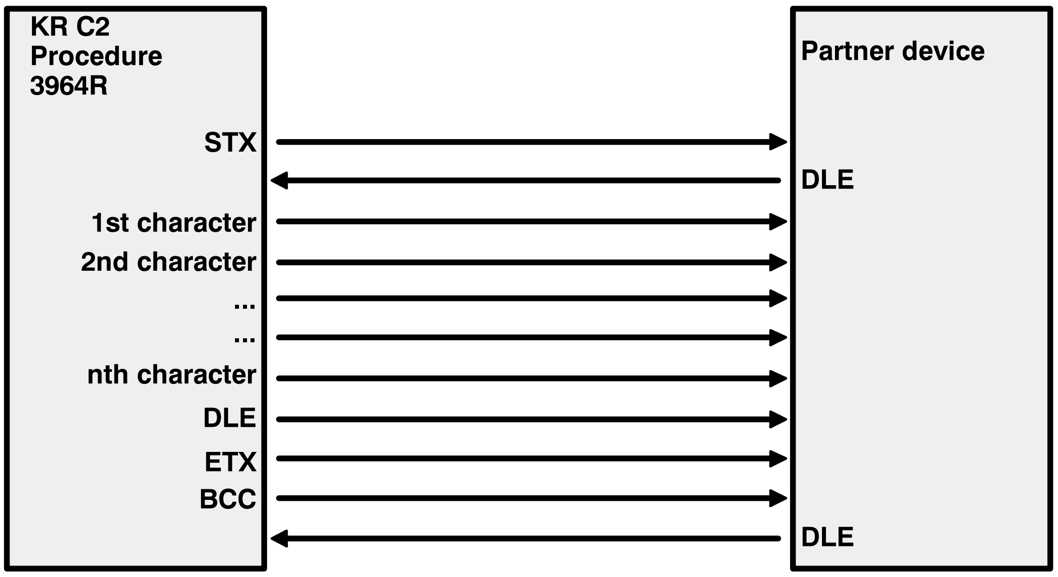
If the partner device responds with “NAK” or with any character or string other than “DLE”, or if the acknowledgement delay time elapses with no reaction, the procedure begins the transmission again with the connection set-up “STX”.

After a total of six failed attempts to send the data block, the procedure cancels the process, signals the error to the interpreter and sends the character “NAK” to the partner device.

If the partner device sends the character “NAK” while a transmission is in progress, the procedure terminates the block and repeats the transmission as described above. In the event of a different character, the procedure first waits for the character delay time (CHAR_TIMEOUT) to elapse and then transmits “NAK” to bring the partner device back to the rest condition. The procedure then begins the transmission again with the connection set-up “STX”.

4.1.2.3 KR C2 sends data

The following is an example of error–free data traffic. The KR C2 sends data to the partner device.



4.1.3 Receiving with procedure 3964R

4.1.3.1 Rest condition

In the rest condition, i.e. when there is no transmission request to process, procedure 3964R waits for a connection to be established by the partner device.

If the procedure in the rest condition receives any character (except STX), it waits for the character delay time “CHAR_TIMEOUT” to elapse and then sends the character “NAK”. This error is signaled to the interpreter.

4.1.3.2 Receiving information

If the procedure receives the character “STX”, and if it has an empty input buffer, it answers with “DLE”. Incoming characters are now stored in the input buffer.

If two consecutive “DLE” characters are received, only one “DLE” character is placed in the input buffer. See also Section 4.1.2.2.

If the input buffer is already full when the partner device commences the connection set–up, the full buffer is transferred to the interpreter and further incoming characters are placed in a second input buffer.

After each character is received, the procedure waits the character delay time (CHAR_TIMEOUT) for the next character. If the character delay time elapses without any further characters being received, the “NAK” character is sent to the partner device and the error is signaled to the interpreter.

If the procedure identifies the character string “DLE”, “ETX” and “BCC”, the reception is terminated. The received block check character “BCC” is compared with the internally generated block parity.

If the block check character is correct and no other receiving errors have occurred, the procedure sends the character “DLE”. The procedure transfers the contents of the input buffer to the interpreter and returns to the rest condition.

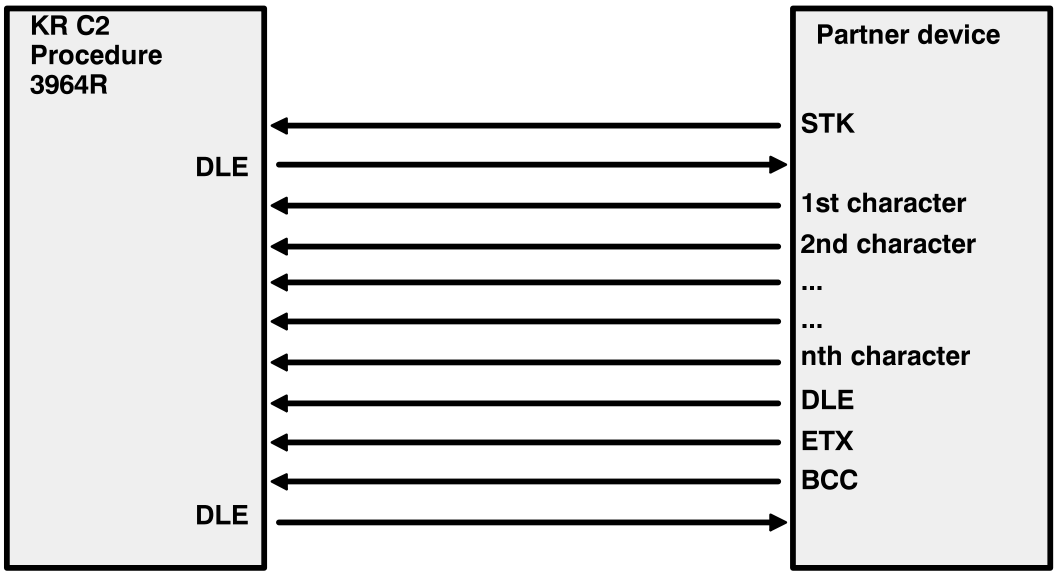
If the “BCC” is incorrect, an “NAK” character is sent to the partner device. The procedure then waits for the transmission to be repeated.

If the block has still not been received without errors after six attempts, or if the partner device does not repeat the transmission within the wait time “TRANS_TIMEOUT” (2000 ms by default), procedure 3964R cancels the reception and signals the error to the interpreter.

If transmission errors occur during reception (e.g. lost characters, frame errors, parity errors), reception continues until the connection is terminated, at which time “NAK” is sent to the partner device. The procedure then waits for the transmission to be repeated as described above.

4.1.3.3 KR C2 receives data

The following is an example of error–free data traffic. The KR C2 receives data from the partner device.



4.1.4 Initialization conflicts

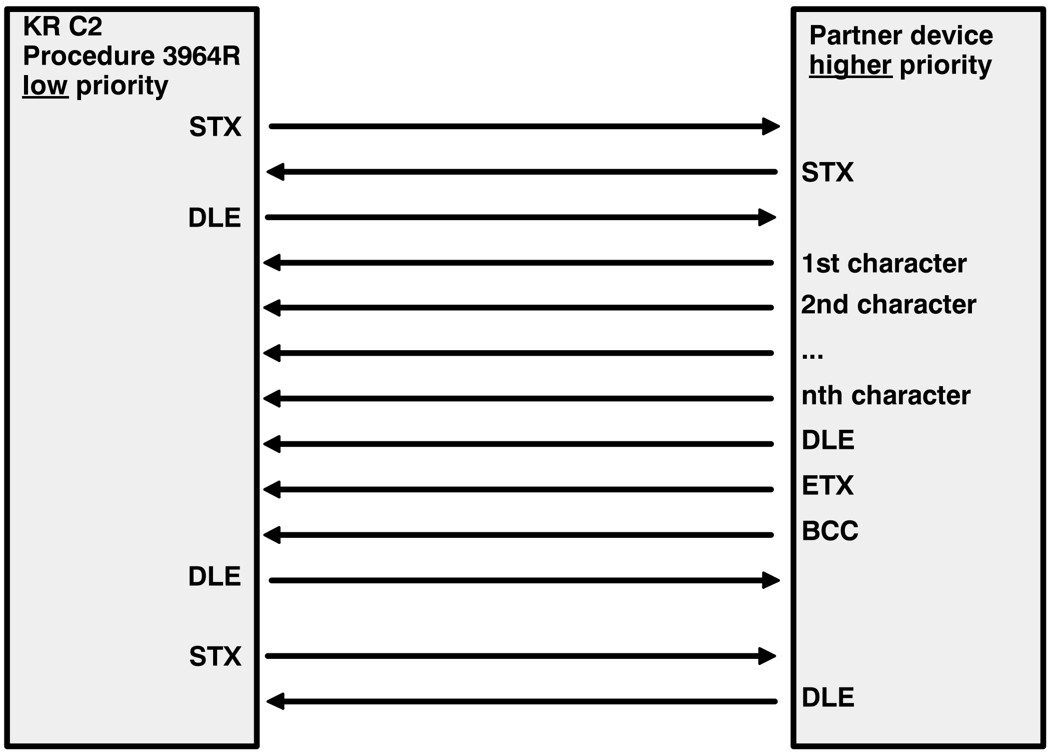
If the receiving device responds to the “STX” character, not with the acknowledgement “DLE” or “NAK” within the acknowledgement delay time (QUITT_TIMEOUT), but instead also with the character “STX”, an initialization conflict has occurred.

Should both devices attempt simultaneously to execute an active transmission request, the order is determined by the priority settings that have been made.

The device with the lower priority withdraws its transmission request and answers with the character “DLE”. In this way, the device with the higher priority can send its data.

Once the connection has been terminated, the device with the lower priority can carry out its transmission.

Example of error–free data traffic



4.2 Xon/Xoff protocol

Handshake procedures, also known as low–level protocols, are used to stop the partner station's transmitter when the input buffer is in danger of overflowing.

Along with "RTS/CTS", the "Xon/Xoff" protocol is a common handshake procedure that is easy to implement. Every incoming character is monitored to see if it is a protocol character.

A software handshake using the "Xon/Xoff" procedure presupposes that neither of the protocol characters "Xon" or "Xoff" are present in the transmission data of the application programs communicating with one another.

"Xon/Xoff" settings in the file SERIAL.INI

In the KR C2, the "Xon/Xoff" settings are made in the file "SERIAL.INI". This file is located in the directory "C:\KRC\Roboter\INIT".

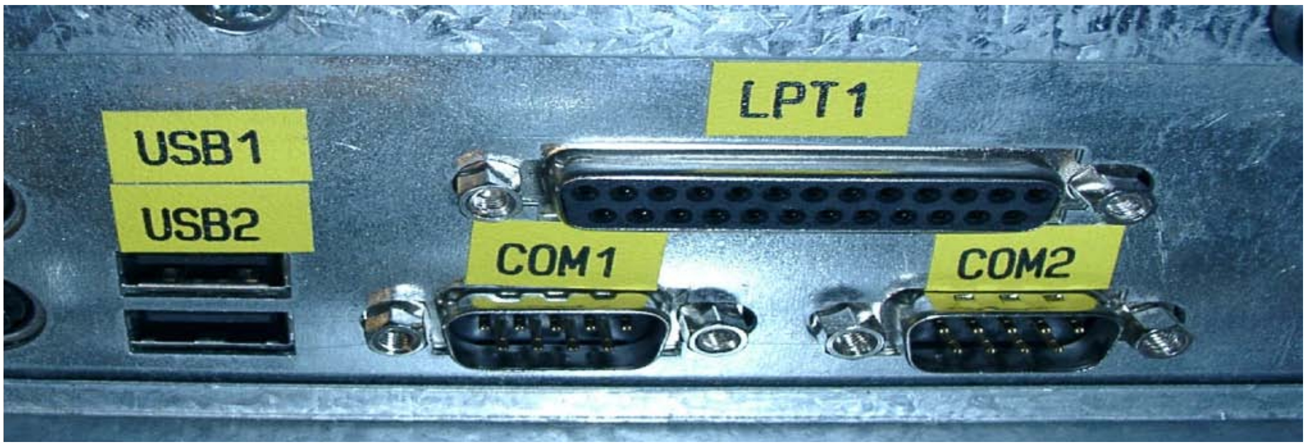
```
[XONXOFF]
CHAR_TIMEOUT=50      ; msec Timeout after last received character
                     ; to recognize the end of telegram
MAX_TX_BUFFER=2      ; 1..5
MAX_RX_BUFFER=2      ; 1..20
SIZE_RX_BUFFER=100   ; 1..2048 longest expected telegram length +
                     ; 15 characters

XON_VAL=17           ; 0..255  XON  character (decimal)
XOFF_VAL=19          ; 0..255  XOFF character (decimal)
                     ; if XON_VAL=0 and XOFF_VAL=0 then XON/XOFF-
                     ; protocol is disabled (pure communication)
DSR_LINE=0          ;  0  =  DSR  line  not  connected,  1  =  DSR  line
                       must be high
```

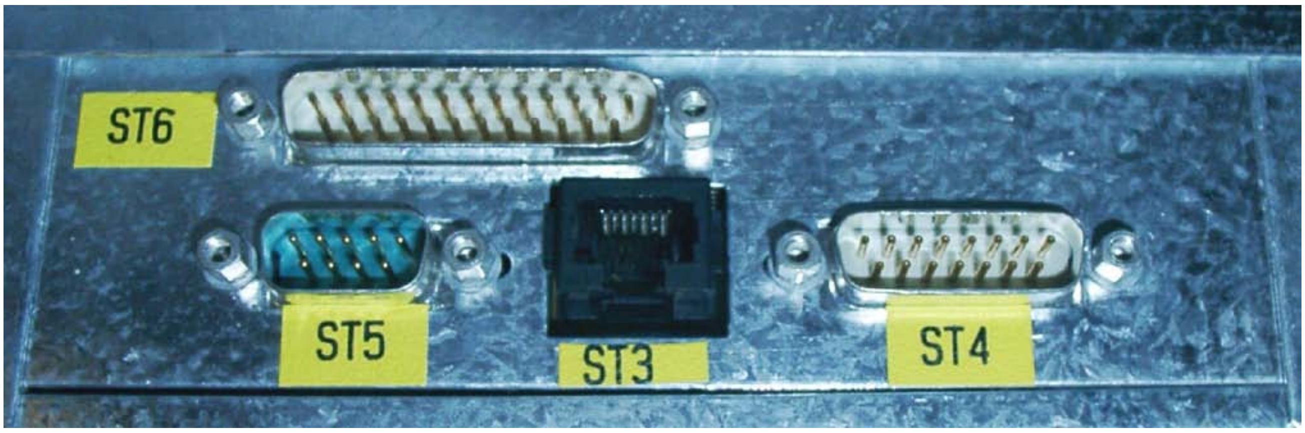
5 Serial interfaces

The KR C2 controller has three serial interfaces:

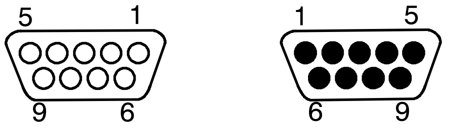
COM1, COM2 and COM3, all 3 designed as 9–pole Sub–D connectors.



COM3 is labeled as ST5 on the connector panel:



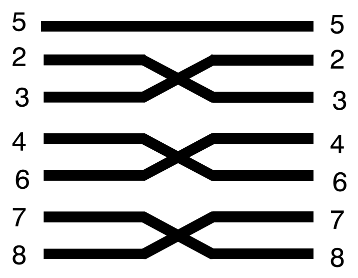
5.1 Sub–D connector, 9 pins



(Female) (Male)

5.2 Connector pin allocation for Sub–D, 9 pins

PIN	Direction	Name	Description
1	←	CD	Carrier Detect (Telephone answered)
2	←	RXD	Receive Data (Data line – receive)
3	→	TXD	Transmit Data (Data line – transmit)
4	→	DTR	Data Terminal Ready (Handshake – output for DSR)
5	—	GND	System Ground (Ground)
6	←	DSR	Data Set Ready (Handshake – input for DTR)
7	→	RTS	Request to Send (Handshake – request to send)
8	←	CTS	Clear to Send (Handshake – input for RTS from partner)
9	←	RI	Ring indicator (Telephone bell)



6 Appendix

6.1 ASCII character map

Number	Character	Number	Character	Number	Character	Number	Character
32	(space)	33	!	34	"	35	#
36	$	37	%	38	&	39	'
40	(	41	)	42	*	43	+
44	,	45	-	46	.	47	/
48	0	49	1	50	2	51	3
52	4	53	5	54	6	55	7
56	8	57	9	58	:	59	;
60	<	61	=	62	>	63	?
64	@	65	A	66	B	67	C
68	D	69	E	70	F	71	G
72	H	73	I	74	J	75	K
76	L	77	M	78	N	79	O
80	P	81	Q	82	R	83	S
84	T	85	U	86	V	87	W
88	X	89	Y	90	Z	91	[
92	\	93	]	94	^	95	_
96	`	97	a	98	b	99	c
100	d	101	e	102	f	103	g
104	h	105	i	106	j	107	k
108	l	109	m	110	n	111	o
112	p	113	q	114	r	110	s
116	t	117	u	118	v	119	w
120	x	121	y	122	z	123	{
124	|	125	}	126	~	127	
128	□	129	□	130	‚	131	ƒ
132	„	133	…	134	†	135	‡
136	ˆ	137	‰	138	Š	139	‹
140	Œ	141	□	142	□	143	□
144	□	145	‘	146	’	147	“
148	”	149	•	150	–	151	—
152	˜	153	™	154	š	155	›
156	œ	157	□	158	□	159	Ÿ
160		161	¡	162	¢	163	£
164	¤	165	¥	166	¦	167	§
168	¨	169	©	170	ª	171	«
172	¬	173	-	174	®	175	¯
176	°	177	±	178	²	179	³
180	´	181	µ	182	¶	183	·
184	¸	185	¹	186	º	187	»
188	¼	189	½	190	¾	191	¿
192	À	193	Á	194	Â	195	Ã

Number	Character	Number	Character	Number	Character	Number	Character
196	Ä	197	Å	198	Æ	199	Ç
200	È	201	É	202	Ê	203	Ë
204	Ì	205	Í	206	Î	207	Ï
208	Đ	209	Ñ	210	Ò	211	Ó
212	Ô	213	Õ	214	Ö	215	×
216	Ø	217	Ù	218	Ú	219	Û
220	Ü	221	Ý	222	Þ	223	ß
224	à	225	á	226	â	227	ã
228	ä	229	å	230	æ	231	ç
232	è	233	é	234	ê	235	ë
236	ì	237	í	238	î	239	ï
240	ð	241	ñ	242	ò	243	ó
244	ô	245	õ	246	ö	247	÷
248	ø	249	ù	250	ú	251	û
252	ü	253	ý	254	þ	255	ÿ