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Real-time System Communication   
Library Documentation

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| **Library** | |
| Title | RTCommunication |
| Version | 1.0 |
| TwinCAT version | 2.11 |
| Name space | RtComm |
| Author | Daniel Sigg |
| Description | This library provides the basic encoding to send data between the EtherCAT system and the real-time system. The encoding uses 16 levels per line. Multiple lines can be ganged together. The library uses 1 bit internally for a keep-alive signal. The library also checks for multi-bit consistency. If the keep-alive is missing for 10 consecutive seconds, a communication lost error is raised. If multi-bit consistency could not be achieved with the last second, a communication reject error is raised. A configuration error is raise, if the number of input or output lines is not between 1 and 8.  The keep-alive bit is toggled every 100 ms. Up to 8 hardware lines are supported in each direction. At least one line must be provided in each direction. This yields a total of 32 bits, where up to 31 bits are available to the user. The input and output data words are filled starting with the LSB. |
| Error Code | 0x001 Configuration error  0x002 Communication lost  A communication lost error is generated when the link is not disabled and no keep alive signal was received from the other side of the link for more than 10 seconds.  0x004 Communication rejected  The receiver checks for multi-bit consistency by asking 3 consecutive read values to be the same. If for more than 250 ms, no consistent data was received, a communication reject error is generated. |

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| **Hardware Input Type**  TYPE ReceiveFromRtInStruct:  STRUCT  I: ARRAY[1..8] OF INT;  END\_STRUCT  END\_TYPE | |
|  | ReceiveFromRtInStruct |
| Description | Structure of the hardware input that are wired up for communication. Up to 8 individual hardware lines (ADCs) are supported. |
| Definition | STRUCT |
| Element | Name: I  Type: ARRAY [1..8] OF INT  Description: Analog inputs 1 through 8 |

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| **Hardware Output Type**  TYPE SendToRtOutStruct :  STRUCT  O: ARRAY[1..8] OF INT;  END\_STRUCT  END\_TYPE | |
|  | SendToRtOutStruct |
| Description | Structure of the hardware output that are wired up for communication. Up to 8 individual hardware lines (DACs) are supported. |
| Definition | STRUCT |
| Element | Name: O  Type: ARRAY [1..8] OF INT  Description: Analog outputs 1 through 8 |

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| **User Interface Type**  TYPE RtCommOperationModeEnum :  (RtCommEnable, RtCommDisable, RtCommTest, RtCommLoopback);  END\_TYPE | |
| Type name | RtCommOperationModeEnum |
| Description | Describes the mode of operation of the link to the real-time system. The possible modes are enable, disable, testing, and loopback. |
| Definition | ENUM |
| Enum Tag | Name: RtCommEnable  Description: The link is set to work normally |
| Enum Tag | Name: RtCommDisable  Description: The link is disabled. |
| Enum Tag | Name: RtCommTest  Description: The link is put into test mode. A random bit pattern is generated once a second and transmitted. It is expected that the other end of the link is in loopback mode and that the received data is identical to the sent one. |
| Enum Tag | Name: RtCommLoopback  Description: The data from the link is looped back. Every data received is reflected and transmitted back. |

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| **User Interface Type**  TYPE RtCommLoopbackStruct :  STRUCT  ResetStatistics: BOOL;  Errors: DINT;  Attempts: DINT;  Success: DINT;  Failed: DINT;  Wrong: DINT;  CommLost: LREAL;  CommReject: LREAL;  Latency: ARRAY[1..25] OF LREAL;  LatencyMax: LREAL;  LatencyMin: LREAL;  LatencyMean: LREAL;  END\_STRUCT  END\_TYPE | |
| Type name | RtCommLoopbackStruct |
| Description | Structure to keep statistics of the link. The number of errors and communication lost and rejected times are reported when the interface is working. The other statistics is only evaluated when in test mode. |
| Definition | STRUCT |
| Input Tag | Name: ResetStatistics  Type: BOOL  Description: Reset the statistics data back to zero |
| Output Tag | Name: Errors  Type: DINT  Description: Count the number of transmission errors encountered by the link |
| Output Tag | Name: Attempts  Type: DINT  Description: Number of attempts to send a test pattern |
| Output Tag | Name: Success  Type: DINT  Description: Number of successful test patterns returned by the link in loopback mode |
| Output Tag | Name: Failed  Type: DINT  Description: Number of failed attempts to loop back a test pattern |
| Output Tag | Name: Wrong  Type: DINT  Description: Number of incorrect data words received when testing the link with a loopback |
| Output Tag | Name: CommLost  Type: LREAL  Description: Time in seconds the link was lost, ie., the keep alive was not received. |
| Output Tag | Name: CommReject  Type: LREAL  Description: Time in seconds the link rejected the received data. The receiver checks for multi-bit consistency by asking 3 consecutive read values to be the same. If for more than 250ms, no consistent data was received, a communication reject error is generated. |
| Output Tag | Name: Latency  Type: ARRAY[1..25] OF LREAL  Description: Histogram of the latency when transmitting random data patterns during the loopback test. The first bin is at 10 ms, the second at 20 ms, etc. |
| Output Tag | Name: LatencyMax  Type: LREAL  Description: The maximum latency encountered in a loopback test |
| Output Tag | Name: LatencyMin  Type: LREAL  Description: The minimum latency encountered in a loopback test |
| Output Tag | Name: LatencyMean  Type: LREAL  Description: The mean latency encountered in a loopback test |

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| **User Interface Type**  TYPE RtCommunicationStruct :  STRUCT  Error: ErrorStruct;  Link: RtCommOperationModeEnum;  KeepAliveDisable: BOOL;  Receive: DWORD;  Send: DWORD;  Transmit: DWORD;  ReceiveBits: INT;  SendBits: INT;  LoopbackTest: RtCommLoopbackStruct;  END\_STRUCT  END\_TYPE | |
| Type name | RtCommunicationStruct |
| Description | Structure to communicate with the real-time system. |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: For error handling |
| Input Tag | Name: Link  Type: RtCommOperationModeEnum  Description: Mode of operation for the link |
| Input Tag | Name: KeepAliveDisable  Type: BOOL  Description: Used to disable the keep alive signal sent out |
| Output Tag | Name: Receive  Type: DWORD  Description: Input word which is sent to the real-time system. The number of available bits is 4 \* number of analog input lines – 1. Bits are filled starting with the LSB. |
| Input Tag | Name: Send  Type: DWORD  Description: Output word which is received from the real-time system. The number of available bits is 4 \* number of analog output lines – 1. Bits are filled starting with the LSB. |
| Output Tag | Name: Transmit  Type: DWORD  Description: This is the actual transmitted data word. When the link is enabled, the transmit word reflects the Send word. When disabled, it is zero. When in test mode, a random bit pattern is generated and changed once a second. When in loopback mode, the transmit word reflects the Receive word. |
| Output Tag | Name: ReceiveBits  Type: INT  Description: The number of available bits for receiving. |
| Output Tag | Name: SendBits  Type: INT  Description: The number of available bits for sending. |
| In/Out Tag | Name: LoopbackTest  Type: RtCommLoopbackStruct  Description: Diagnostics of the link. It counts link errors and describes the statistics, when the link is in loopback test. |

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| **Function Block**  FUNCTION\_BLOCK RtCommunicationFB  VAR\_INPUT  Request: SaveRestoreEnum;  InputLines: INT := 1;  OutputLines: INT := 1;  ReceiveFromRt: ReceiveFromRtInStruct;  END\_VAR  VAR\_OUTPUT  SendToRt: SendToRtOutStruct;  LinkUp: BOOL;  END\_VAR  VAR\_IN\_OUT  RtCommunicationInit: RtCommunicationStruct;  RtCommunication: RtCommunicationStruct;  END\_VAR | |
| Name | RtCommunicationFB |
| Description | Controls communication with a real-time system. Upon initialization the receive word is set to 0, the keep-alive is enabled, and the link is set into the enable mode. |
| Input argument | Name: Request  Type: SaveRestoreEnum  Description: Save/restore command |
| Input argument | Name: InputLines  Type: INT  Description: Number of input lines dedicated for this communication channel. The value must between 1 and 8; default is 1. |
| Input argument | Name: OutputLines  Type: INT  Description: Number of input lines dedicated for this communication channel. The value must between 1 and 8; default is 1. |
| Input argument | Name: ReceiveFromRt  Type: ReceiveFromRtInStruct  Description: Receive structure which is mapped into hardware. |
| Output argument | Name: SendToRt  Type: SendToRtOutStruct  Description: Send structure which is mapped into hardware |
| Output argument | Name: LinkUp  Type: BOOL  Description: An up state is indicated, if a keep-alive signal has been received during the past 10 seconds. |
| In/out argument | Name: RtCommunicationInit  Type: RtCommunicationStruct  Description: Initialization structure |
| In/out argument | Name: RtCommunication  Type: RtCommunicationStruct  Description: User Interface structure |