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Real-time System Communication Library Documentation

Daniel Sigg

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California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project – NW22-295
185 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory
P.O. Box 159
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

http://www.ligo.caltech.edu/

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. |

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

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

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.

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

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.

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