

**IEC 60870-5-104
Configuration / Interoperability Guide for**

DinBox RTU M4

V1.0

Document History

Date	Version	Status	Author	Info
29-01-2018	0.1	Preliminair	Imre Leber	Initial version
25-09-2018	1.0	Final	Filip Lavaerts	Check contents with Imre

INTRODUCTION

The purpose of this document is to describe the specific implementation of the IEC 60870-5-104 Source Code Library within the **DinBox RTU M4**.

The IEC 60870-5-104 Slave Source Code Library Version 3 from the company Triangle MicroWorks, Inc. is used to implement IEC104 onto the **DinBox RTU M4** software/firmware design.

Interoperability

This document is adapted from the IEC60870-5-104 standard.

This companion standard presents sets of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of “structured” or “unstructured” fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike-through (corresponding check box is marked black).

Note:- In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows:

- Function or ASDU is not used
- Function or ASDU is used as standardized (default)
- Function or ASDU is used in reverse mode
- Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

System or device

(system-specific parameter, indicate the station's function by marking one of the following with 'X')

- System definition
- Controlling station definition (Master)
- Controlled station definition (Slave)

Network configuration

(network-specific parameter, all configurations that are used are to be marked 'X')

<input type="checkbox"/>	Point-to-point	<input type="checkbox"/>	Multipoint
<input type="checkbox"/>	Multiple point-to-point	<input type="checkbox"/>	Multipoint-star

Physical layer

(network-specific parameter, all interfaces and data rates that are used are to be marked 'X')

Transmission speed (control direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200bit/s	Balanced interchange Circuit X.24/X.27	
<input type="checkbox"/> 100 bit/s	<input type="checkbox"/> 2 400 bit/s	<input type="checkbox"/> 2 400 bit/s	<input type="checkbox"/> 56 000 bit/s
<input type="checkbox"/> 200 bit/s	<input type="checkbox"/> 4 800 bit/s	<input type="checkbox"/> 4 800 bit/s	<input type="checkbox"/> 64 000 bit/s
<input type="checkbox"/> 300 bit/s	<input type="checkbox"/> 9 600 bit/s	<input type="checkbox"/> 9 600 bit/s	
<input type="checkbox"/> 600 bit/s		<input type="checkbox"/> 19 200 bit/s	
<input type="checkbox"/> 1 200 bit/s		<input type="checkbox"/> 38 400 bit/s	

Transmission speed (monitor direction)

Unbalanced interchange Circuit V.24/V.28 Standard	Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200bit/s	Balanced interchange Circuit X.24/X.27	
<input type="checkbox"/> 100 bit/s	<input type="checkbox"/> 2 400 bit/s	<input type="checkbox"/> 2 400 bit/s	<input type="checkbox"/> 56 000 bit/s
<input type="checkbox"/> 200 bit/s	<input type="checkbox"/> 4 800 bit/s	<input type="checkbox"/> 4 800 bit/s	<input type="checkbox"/> 64 000 bit/s
<input type="checkbox"/> 300 bit/s	<input type="checkbox"/> 9 600 bit/s	<input type="checkbox"/> 9 600 bit/s	
<input type="checkbox"/> 600 bit/s		<input type="checkbox"/> 19 200 bit/s	
<input type="checkbox"/> 1 200 bit/s		<input type="checkbox"/> 38 400 bit/s	

Link layer

(network-specific parameter, all options that are used are to be marked 'X'. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.)

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.~~

Link transmission procedure

Balanced transmission

Unbalanced

Frame length

Maximum length L
(number of octets)

Address field of the link

not present (balanced transmission only)

One octet

Two octets

Structured

Unstructured

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

The standard assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission
9, 11, 13, 21	<1>

A special assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission

Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).

Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in clause 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked 'X')

One octet Two octets

Information object address

(system-specific parameter, all configurations that are used are to be marked 'X')

One octet Structured
 Two octets Unstructured
 Three octets

Cause of transmission

(system-specific parameter, all configurations that are used are to be marked 'X')

One octet Two octets (with originator address)
Originator address is set to zero if not used

Length of APDU

(system-specific parameter, specify the maximum length of the APDU per system)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

253 Maximum length of APDU per system in control direction
 253 Maximum length of APDU per system in monitor direction

Selection of standard ASDUs

Process information in monitor direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

<input checked="" type="checkbox"/>	<1> := Single-point information	M_SP_NA_1
<input type="checkbox"/>	<2> := Single-point information with time tag	M_SP_TA_1
<input type="checkbox"/>	<3> := Double-point information	M_DP_NA_1
<input type="checkbox"/>	<4> := Double-point information with time tag	M_DP_TA_1
<input type="checkbox"/>	<5> := Step position information	M_ST_NA_1
<input type="checkbox"/>	<6> := Step position information with time tag	M_ST_TA_1
<input checked="" type="checkbox"/>	<7> := Bitstring of 32 bit	M_BO_NA_1
<input type="checkbox"/>	<8> := Bitstring of 32 bit with time tag	M_BO_TA_1
<input checked="" type="checkbox"/>	<9> := Measured value, normalized value	M_ME_NA_1
<input type="checkbox"/>	<10> := Measured value, normalized value with time tag	M_ME_TA_1
<input checked="" type="checkbox"/>	<11> := Measured value, scaled value	M_ME_NB_1
<input type="checkbox"/>	<12> := Measured value, scaled value with time tag	M_ME_TB_1
<input checked="" type="checkbox"/>	<13> := Measured value, short floating point value	M_ME_NC_1
<input type="checkbox"/>	<14> := Measured value, short floating point value with time tag	M_ME_TC_1
<input type="checkbox"/>	<15> := Integrated totals	M_IT_NA_1
<input type="checkbox"/>	<16> := Integrated totals with time tag	M_IT_TA_1
<input type="checkbox"/>	<17> := Event of protection equipment with time tag	M_EP_TA_1
<input type="checkbox"/>	<18> := Packed start events of protection equipment with time tag	M_EP_TB_1
<input type="checkbox"/>	<19> := Packed output circuit information of protection equipment with time tag	M_EP_TC_1
<input type="checkbox"/>	<20> := Packed single-point information with status change detection	M_SP_NA_1
<input type="checkbox"/>	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
<input checked="" type="checkbox"/>	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
<input type="checkbox"/>	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
<input checked="" type="checkbox"/>	<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
<input type="checkbox"/>	<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
<input checked="" type="checkbox"/>	<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
<input type="checkbox"/>	<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
<input checked="" type="checkbox"/>	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
<input type="checkbox"/>	<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
<input checked="" type="checkbox"/>	<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
<input type="checkbox"/>	<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
<input type="checkbox"/>	<40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

<input checked="" type="checkbox"/>	<45> := Single command	C SC NA 1
<input checked="" type="checkbox"/>	<46> := Double command	C DC NA 1
<input type="checkbox"/>	<47> := Regulating step command	C_RC_NA_1
<input checked="" type="checkbox"/>	<48> := Set point command, normalized value	C_SF NA 1
<input checked="" type="checkbox"/>	<49> := Set point command, scaled value	C_SE NB 1
<input checked="" type="checkbox"/>	<50> := Set point command, short floating point value	C_SE_NC_1
<input type="checkbox"/>	<51> := Bitstring of 32 bit	C_BO_NA_1
<input checked="" type="checkbox"/>	<58> := Single command with time tag CP56Time 2a	C SC TA 1
<input type="checkbox"/>	<59> := Double command with time tag CP56Time 2a	C DC TA 1
<input type="checkbox"/>	<60> := Regulating step command with time tag CP56Time 2a	C_RC_TA_1
<input type="checkbox"/>	<61> := Set point command, normalized value with time tag CP56Time 2a	C_SE_TA_1
<input type="checkbox"/>	<62> := Set point command, scaled value with time tag CP56Time 2a	C_SE_TB 1
<input type="checkbox"/>	<63> := Set point command, short floating point value with time tag CP56Time 2a	C_SE_TC_1
<input type="checkbox"/>	<64> := Bitstring of 32 bit with time tag CP56Time 2a	C_BO_TA_1

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

(station-specific parameter, mark with an "X" if it is only used in the standard direction, "R" if only used in the reverse direction, and "B" if used in both directions).

<input checked="" type="checkbox"/>	<70> := End of initialization	M EI NA 1
-------------------------------------	-------------------------------	-----------

System information in control direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

<input checked="" type="checkbox"/>	<100>:= Interrogation command	C IC NA 1
<input type="checkbox"/>	<101>:= Counter interrogation command	C_CI_NA_1
<input type="checkbox"/>	<102>:= Read command	C_RD NA 1
<input checked="" type="checkbox"/>	<103>:= Clock synchronization command (option see 7.6)	C_CS_NA_1
<input type="checkbox"/>	<104>:= Test command	C_TS NA 1
<input type="checkbox"/>	<105>:= Reset process command	C_RP NA 1
<input type="checkbox"/>	<106>:= Delay acquisition command	C_CD NA 1
<input type="checkbox"/>	<107>:= Test command with time tag CP56time2a	C_TS TA 1

Parameter in control direction

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

■ <110>:=	Parameter of measured value, normalized value	P_ME_NA_1
■ <111>:=	Parameter of measured value, scaled value	P_ME_NB_1
■ <112>:=	Parameter of measured value, short floating point value	P_ME_NC_1
■ <113>:=	Parameter activation	P_AC_NA_1

File Transfer

(station-specific parameter, mark each Type ID 'X' if it is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

■ <120>:=	File ready	F_FR_NA_1
■ <121>:=	Section ready	F_SR_NA_1
■ <122>:=	Call directory, select file, call file, call section	F_SC_NA_1
■ <123>:=	Last section, last segment	F_LS_NA_1
■ <124>:=	Ack file, ack section	F_AF_NA_1
■ <125>:=	Segment	F_SG_NA_1
■ <126>:=	Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
■ <127>:=	Query Log – Request archive file	F_SC_NB_1

Type identifier and cause of transmission assignments (station-specific parameters)

Shaded boxes are not required.

Black boxes are not permitted in this companion standard

Blank: functions or ASDU not used.

Mark Type Identification/Cause of transmission combinations:

'X' if only used in the standard direction

'R' if only used in the reverse direction

'B' if used in both directions

Type identification		Cause of transmission																		
		periodic, cyclic	background scan	spontaneous	initialized	request or requested	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	return info caused by a remote cmd	return info caused by a local cmd	file transfer	interrogated by group <n>	request by group <n>	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X			X	X	X	X	X						X	X	X	X
<2>	M_SP_TA_1																			
<3>	M_DP_NA_1																			
<4>	M_DP_TA_1																			
<5>	M_ST_NA_1																			
<6>	M_ST_TA_1																			
<7>	M_BO_NA_1			X			X	X	X	X	X						X	X	X	X
<8>	M_BO_TA_1																			
<9>	M_ME_NA_1			X			X	X	X	X	X						X	X	X	X
<10>	M_ME_TA_1																			
<11>	M_ME_NB_1			X			X	X	X	X	X						X	X	X	X
<12>	M_ME_TB_1																			
<13>	M_ME_NC_1			X			X	X	X	X	X						X	X	X	X
<14>	M_ME_TC_1																			
<15>	M_IT_NA_1																			
<16>	M_IT_TA_1																			
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X			X	X	X	X	X						X	X	X	X
<31>	M_DP_TB_1																			
<32>	M_ST_TB_1			X			X	X	X	X	X						X	X	X	X
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1			X			X	X	X	X	X						X	X	X	X
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X			X	X	X	X	X						X	X	X	X
<37>	M_IT_TB_1																			
<38>	M_EP_TD_1			X			X	X	X	X	X						X	X	X	X
<39>	M_EP_TE_1																			

Type identification		Cause of transmission																		
		periodic, cyclic	background scan	spontaneous	initialized	request or requested	activation	activation confirmation	deactivation	deactivation confirmation	activation termination	return info caused by a remote cmd	return info caused by a local cmd	file transfer	interrogated by group <number>	request by group <n> counter request	unknown type identification	unknown cause of transmission	unknown common address of ASDU	unknown information object address
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X						X	X	X	X
<46>	C_DC_NA_1						X	X	X	X	X						X	X	X	X
<47>	G_RC_NA_1																			
<48>	C_SE_NA_1						X	X	X	X	X						X	X	X	X
<49>	C_SE_NB_1						X	X	X	X	X						X	X	X	X
<50>	C_SE_NC_1						X	X	X	X	X						X	X	X	X
<51>	G_BO_NA_1																			
<58>	C_SC_TA_1						X	X	X	X	X						X	X	X	X
<59>	G_DC_TA_1																			
<60>	G_RC_TA_1																			
<61>	G_SE_TA_1																			
<62>	C_SE_TB_1																			
<63>	G_SE_TC_1																			
<64>	G_BO_TA_1																			
<70>	M_EI_NA_1*																			
<100>	C_IC_NA_1						X	X	X	X	X						X	X	X	X
<101>	G_CI_NA_1																			
<102>	G_RD_NA_1																			
<103>	G_CS_NA_1																			
<104>	G_TS_NA_1																			
<105>	G_RP_NA_1																			
<106>	G_CD_NA_1																			
<107>	G_TS_TA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			
<127>	F_SC_NB_1*																			

* Blank or X only

Basic application functions

Station initialization

(station-specific parameter, mark 'X' if function is used)

Remote initialization

Cyclic data transmission

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

Cyclic data transmission

Read procedure

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

Read procedure

Spontaneous transmission

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter, mark each information type 'X' where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1

Double-point information ~~M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1~~

Step position information ~~M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1~~

Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)

Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1

Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1

Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

<input checked="" type="checkbox"/> global	<input type="checkbox"/> group-7	<input type="checkbox"/> group-13
<input type="checkbox"/> group-1	<input type="checkbox"/> group-8	<input type="checkbox"/> group-14
<input type="checkbox"/> group-2	<input type="checkbox"/> group-9	<input type="checkbox"/> group-15
<input type="checkbox"/> group-3	<input type="checkbox"/> group-10	<input type="checkbox"/> group-16
<input type="checkbox"/> group-4	<input type="checkbox"/> group-11	
<input type="checkbox"/> group-5	<input type="checkbox"/> group-12	
<input type="checkbox"/> group-6		

Information Object Addresses assigned to each group must be shown in a separate table

Clock synchronization

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Clock synchronization
- Day of week used
- RES1, GEN (time tag substituted/ not substituted) used
- SU-bit (summertime) used

optional, see 7.6

Command transmission

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Direct command transmission
- Direct set point command transmission
- Select and execute command
- Select and execute set point command
- C SE ACTTERM used
- No additional definition
- Short pulse duration (duration determined by a system parameter in the outstation)
- Long pulse duration (duration determined by a system parameter in the outstation)
- Persistent output

- Supervision of maximum delay in command direction of commands and set point commands

5 seconds

Maximum allowable delay of commands and set point commands

Transmission of integrated totals

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Mode A: Local freeze with spontaneous transmission
- Mode B: Local freeze with counter interrogation
- Mode C: Freeze and transmit by counter interrogation commands
- Mode D: Freeze by counter-interrogation command, frozen values reported spontaneously

- Counter read
- Counter freeze without reset
- Counter freeze with reset
- Counter reset

- General request counter
- Request counter group 1
- Request counter group 2
- Request counter group 3
- Request counter group 4

Parameter loading

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Threshold value
- Smoothing factor
- Low limit for transmission of measured values
- High limit for transmission of measured values

Parameter activation

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Test procedure

File transfer

(station-specific parameter, mark 'X' if function is used)

File transfer in monitor direction

- Transparent file
- Transmission of disturbance data of protection equipment
- Transmission of sequences of events
- Transmission of sequences of recorded analog values

File transfer in control direction

- Transparent file

Background scan

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Background scan

Acquisition of transmission delay

(station-specific parameter, mark 'X' if function is only used in the standard direction, 'R' if only used in the reverse direction, and 'B' if used in both directions)

- Acquisition of transmission delay

Definition of time outs

Parameter	Default value	Remarks	Selected value
t_0	30s	Time-out of connection establishment	Configurable
t_1	15s	Time-out of send or test APDUs	Configurable
t_2	10s	Time-out for acknowledges in case of no data messages $t_2 < t_1$	Configurable
t_3	20s	Time-out for sending test frames in case of a long idle state	Configurable

Maximum range of values for all time outs: 1 to 255 s, accuracy 1 s

Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w)

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	Configurable
w	8 APDUs	Latest acknowledge after receiving w I-format APDUs	Configurable

Maximum range of values k: 1 to 32767 ($2^{15}-1$) APDUs, accuracy 1 APDU

Maximum range of values w: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: w should not exceed two-thirds of k).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases