BiSS Interface

BP1: STANDARD ROTARY ENCODER

preliminary

FEATURES

- BiSS Standard Rotary Encoder
- Compatibility within a group
- Standardized data format
- Simple control configuration
- EDS definition for this profile
- Control Position Word (CPW)
- Combinable with BP3S

APPLICATIONS

- Fast and simple motion controller configuration
- Intelligent absolute rotary encoder

DESCRIPTION

This document describes the profile definition of the BiSS Standard Rotary Encoder Profile BP1 for absolute rotary encoder with BiSS C interface.

The profile defines the data channel parameters and device attributes. This information is placed in the electronic datasheet in a general way and can be implemented easily with the BP1 profile ID on the control side. With the definition of an application specific profile it is possible to define manufacturer independent standardized data communication format for identical devices.

The BiSS Standard Rotary Encoder Profile BP1 is identified with reading the 2 bytes in the register addresses 0x42 and 0x43 to provides the data length and the standardized format.

The BiSS Standard Rotary Encoder provides one position word. The position value transmitted over the BiSS interface is assembled from position value and additional information as are error and warning. The EDS of the BiSS Standard Rotary Encoder has one EDS common part and one EDS BiSS profile specific part: BP1 for position word. The BP1 profile ID can also be used without any additional EDS common part and EDS BiSS profile specific part.

Position
The data length of the position is 12 . . . 55 bit.

Error and Warning
Absolute rotary encoders do monitor internal system components and failures. The two feedback bits are transmitted low active: an error or a warning are indicated by a 0. The position value is valid with a warning and may be invalid with an error.

CRC
To increase the transmission reliability the data is extended by a CRC. The CRC is calculated with a standardized generator polynomial and a standardized start value. The CRC bits are transmitted inverted.

Figure 1: Data format BP1

DEFINITIONS

MT	**Multi turn data** 0, 12 or 24 bit, right aligned, unused bits are set to "0", data has binary format
ST	**Single turn data** 0, 12 or 24 bit . . . 31 bit, left-aligned, unused bits are set to "0", data has binary format
R_MT	**Multi turn resolution** 1 to 24 bit, available multiturn information (without fill bits)
R_ST	**Single turn resolution** 1 to 31 bit, available singleturn information (without fill bits)
DL_MT	**Multi turn data length** 0, 12 to 24 bit
DL_ST	**Single turn data length** 0, 12 to 24 . . . 31 bit
nE	**Error bit** 1 bit, inverted transmission position data is void on error
nW	**Warning bit** 1 bit, inverted transmission position data is valid on warning
DL	**Data length** DL_MT + DL_ST + 2 , total data length of the data channel
ID	**Identifier** BP1 identifier 0x20
VER	**Version** BP1 Version
CRC	**Cyclic redundancy check** CRC value for data defined by DL

Table 1: Definitions of data bits in BP1

DATA CHANNEL PARAMETER

The data channel parameter need to be set for the configuration of the BiSS master.

Transmission direction and type	SCDS (Single Cycle Data Sensor)
Number of bits	DL = DL_POS (position data bits) + 2 bit (feedback bits)
Stop bit	1
Data alignment	MT is right-justified with leading zero bits ST is left-justified with trailing zero bits
CRC polynomial	0x43 = $X^6 + X^1 + X^0$
CRC start value	0x00

Table 2: Data channel parameters for BP1

BiSS PROFILE IDENTIFICATION

To define a flexible standard with the "BiSS Standard Rotary Encoder Profile", this classification is applied with. For profile identification 2 bytes are provided on register address 0x42 and 0x43 as are **BiSS Profile Identification** .

The measurement data transferred with the BiSS interface is assembled with the number of complete revolutions (multi turn) and the angular information within a revolution (single turn) and additional information about error and warning. The name of the profile variant is defined by the portion of multi turn and single turn data length (e.g. 12-24).

Multiturn
The data length of multi turn is 24 bit or 12 bit (0 bit for single turn encoder). Does the encoder use a different bit count, the measurement value is placed right-aligned and filled with "0".

Singleturn
The data length of single turn is 24 bit or 12 bit. Does the encoder use a different bit count, the measurement value is placed left-aligned and filled with "0".

Resolutions exceeding 24 bit use the actual data length. This is the "24++" variant.

Error and warning
Modern encoder monitor the environmental changes and error. Typical examples are for instance: monitoring aging LED attributes or monitoring angular values to plausibility. Both bits are transmitted low active, error and warning are indicated with "0". The measurement is considered valid with warning and void with error.

CRC
To increase the transmission safety a CRC is extending the data. The CRC value is generated with the start value "0" and the generator polynomial $X^6 + X^1 + X^0$ and the bits are transferred inverted. The data length (containing data, error and warning bits) does not exceed a maximum length of 57 bit. The transferred data (measurement data + CRC) carry a hamming distance of 3 and permit a 2-bit-error detection and a 1-bit-error correction.

The sequence of the data is multi turn, single turn, error, warning and CRC and is transferred completely within a single cycle. Further measurement values e.g. revolution speed, acceleration or temperature are not covered with this profile. They can be transferred with separate data channels and individual profiles. This profile does also not cover incremental encoder.

DATA FORMAT

The following variants are standard applications with maximum single turn resolutions up to 24 bit. The multi turn resolution is defined by the bits 1 and 0 in address 0x42 and the bits 7 to 5 in address 0x43. The single turn resolution results from the bits 4 to 0 in address 0x43 (see examples).

Some variants do have limitations regarding the bit length for R_ST and R_MT:

1. Variant 24-12: R_MT minimum is 16 bit
2. For the ++ Variants: R_ST minimum is 25 bit:
   - Variant 24-24++: R_ST minimum is 25 bit
   - Variant 12-24++: R_ST minimum is 25 bit
   - Variant 0-24++: R_ST minimum is 25 bit

The following variants are used for special applications with single turn resolutions only.

Variant 0-12

	Addr. 0x42								Addr. 0x43								
Electrical Identifier	0	0	1	0	1	1	0	0	0	0	0	0	S	S	S	S	
Data Format	MT(0)		ST(12)						nE(1)		nW(1)		CRC(6)				

R_MT = 0, DL_MT = 0
R_ST = SSSS, DL_ST = 12
R_MT = 0, R_ST = 1...12

Variant 0-24

	Addr. 0x42								Addr. 0x43								
Electrical Identifier	0	0	1	0	1	0	0	0	0	0	0	S	S	S	S	S	
Data Format	MT(0)		ST(24)						nE(1)		nW(1)		CRC(6)				

R_MT = 0, DL_MT = 0
R_ST = SSSSS, DL_ST = 24
R_MT = 0, R_ST = 1...24

The following variants are used for standard applications with multi turn and single turn resolutions.

Variant 12-12

	Addr. 0x42								Addr. 0x43								
Electrical Identifier	0	0	1	0	1	0	0	M	M	M	M	0	S	S	S	S	
Data Format	MT(12)				ST(12)				nE(1)		nW(1)		CRC(6)				

R_MT = MMMM, DL_MT = 12
R_ST = SSSS, DL_ST = 12
R_MT = 1...12, R_ST = 1...12

Variant 12-24

	Addr. 0x42								Addr. 0x43								
Electrical Identifier	0	0	1	0	0	1	0	M	M	M	M	S	S	S	S	S	
Data Format	MT(12)				ST(24)				nE(1)		nW(1)		CRC(6)				

R_MT = MMMM, DL_MT = 12
R_ST = SSSSS, DL_ST = 24
R_MT = 1...12, R_ST = 1...24

Variant 24-12

	Addr. 0x42								Addr. 0x43								
Electrical Identifier	0	0	1	0	0	1	M	M	M	M	M	0	S	S	S	S	
Data Format	MT(24)								ST(12)				nE(1)		nW(1)		CRC(6)

R_MT = MMMMM, DL_MT = 24
R_ST = SSSS, DL_ST = 12
R_MT = 16...24, R_ST = 1...12

Variant 24-24

	Addr. 0x42								Addr. 0x43								
Electrical Identifier	0	0	1	0	0	0	M	M	M	M	M	S	S	S	S	S	
Data Format	MT(24)								ST(24)				nE(1)		nW(1)		CRC(6)

R_MT = MMMMM, DL_MT = 24
R_ST = SSSSS, DL_ST = 24
R_MT = 1...24, R_ST = 1...24

The following variants are used for special applications with multi turn resolutions only.

Variant 12-0

	Addr. 0x42								Addr. 0x43							
Electrical Identifier	0	0	1	0	1	1	0	M	M	M	M	0	0	0	0	0
Data Format	MT(12)				ST(0)				nE(1)		nW(1)		CRC(6)			

R_MT = MMMM, DL_MT = 12
R_ST = 0, DL_ST = 0
R_MT = 1...12, R_ST = 0

Variant 24-0

	Addr. 0x42								Addr. 0x43							
Electrical Identifier	0	0	1	0	1	0	M	M	M	M	M	0	0	0	0	0
Data Format	MT(24)				ST(0)				nE(1)		nW(1)		CRC(6)			

R_MT = MMMMM, DL_MT = 24
R_ST = 0, DL_ST = 0
R_MT = 1...24, R_ST = 0

The following variants are used for special applications with single turn resolutions beyond 24 bit. Differing to the first variants the data length results from the bits 3 and 2 in address 0x42 plus the bits 2 to 0 in address 0x43.

Variant 24-24++

	Addr. 0x42								Addr. 0x43							
Electrical Identifier	0	0	1	0	0	0	M	M	M	M	M	S	S	S	S	S
Data Format	MT(24)				ST(24++)				nE(1)		nW(1)		CRC(6)			

R_MT = MMMMM, DL_MT = 24
R_ST = SSSSS,
DL_ST = 25...31
R_MT = 1...24, R_ST = 25...31

Variant 12-24++

	Addr. 0x42								Addr. 0x43							
Electrical Identifier	0	0	1	0	0	1	0	M	M	M	M	S	S	S	S	S
Data Format	MT(12)				ST(24++)				nE(1)		nW(1)		CRC(6)			

R_MT = MMMM, DL_MT = 12
R_ST = SSSSS,
DL_ST = 25...31
R_MT = 1...12, R_ST = 25...31

Variant 0-24++

	Addr. 0x42								Addr. 0x43							
Electrical Identifier	0	0	1	0	1	0	0	0	0	0	0	S	S	S	S	S
Data Format	MT(0)				ST(24++)				nE(1)		nW(1)		CRC(6)			

R_MT = 0, DL_MT = 0
R_ST = SSSSS,
DL_ST = 25...31
R_MT = 0, R_ST = 25...31

CALCULATION OF DATA LENGTHS

Calculation of DL (DataLength)

```
if ((REG[0x42] & 0xF0) == 0x20) {
  DL = 12 * (4 - ((REG[0x42] & 0x0C) >> 2)) + 2;
  if ((REG[0x43] & 0x1F) >= 0x018) {
    DL += (REG[0x43] & 0x07);
  }
}
```

Calculation of R_ST and R_MT (single turn and multi turn resolutions)

```
if ((REG[0x42] & 0xF0) == 0x20) {
  R_ST = REG[0x43] & 0x1F;
  R_MT = ((REG[0x42] & 0x03) << 3) +
         ((REG[0x43] & 0xE0) >> 5);
}
```

ELECTRONIC DATA SHEET DEFINITION BP1

The profile EDS contains, depending on the BiSS profile, required information about data transmission, product and process relevant information for the motion control system. Hereto belong mechanical data, accuracy, structure of position words and product attributes. The specification of the first part of the EDS, the BiSS EDS (common) part, is located in the applied BiSS EDS (common part) document.

Addr.	Symbol	Description	Group	Format	Unit	Values
0x00	BP_VER	Version	Orga	U8	-	0x02 ... 0x0E
0x01	BP_LEN	Length of this profile	Orga	U8	Banks	1
0x02 0x03	BP_ID	Profile ID BP1 (same content in addresses 0x42 and 0x43)	Orga	U8 U8	- -	0x20 ... 0x2D 0x00 ... 0xFF
0x04	FB1	Feedback bit 1 = error = 1	Orga	U8	Table B	1
0x05	FB2	Feedback bit 2 = warning = 2	Orga	U8	Table B	2
0x06	PON_PDL	Maximum power on delay until process data available	Timing	U8	ms	1 ... 254
0x07		Reserved	Prot	U8	-	0
0x08	EN_TYP	Encoder type = rotary = 0	Orga	U8	Table T	0
0x09	POS_NUM	Position value = position value not defined/required = 0	Safety	U8	Table N	0 ... 2
0x0A	MT_LEN	Data length MULTITURN (0, 12, 24 bit)	Orga	U8	bit	0 ... 24
0x0B	MT_FMT	Data format MULTITURN = right aligned = 0	Meas	U8	Table F	0
0x0C	CO_LEN	Data length COARSE (0, 12, 24, ... 31 bit)	Orga	U8	bit	0 ... 31
0x0D	CO_FMT	Data format COARSE = left aligned = 1	Meas	U8	Table F	1
0x0E	FI_LEN	Data length FINE = not used = 0	Orga	U8	bit	0 ... 31
0x0F	FI_FMT	Data format FINE = not used = 1	Meas	U8	Table F	1
0x10 0x11 0x12 0x13	MT_CNT	Number of distinguishable revolutions / multi turn	Meas	U32[1]	-	1 ... 2^{32}-2
0x14 0x15 0x16 0x17	SIP_CNT	Number of signal periods per revolution / length of a signal period	Meas	U32[1]	PPR (rotary) nm (linear)	1 ... 2^{32}-2
0x18 0x19 0x1A 0x1B	SIP_RES	Resolution per signal period (LSB of interpolation)	Meas	U32[1]	LSB	1 ... 2^{32}-2
0x1C 0x1D 0x1E 0x1F	CPOLY	CRC polynomial (32:1) [3] = $X^6 + X^1 + X^0$ = 0x43(32:1) = 0x21 [3]	Orga	U32[1]	-	0x00 0x00 0x00 0x21
0x20 0x21 0x22 0x23	CSTART	CRC start value = 0	Orga	U32[1]	-	0x00 0x00 0x00 0x00

0x24 0x25	ABS_ACU	Absolute accuracy	Meas	U16[1]	LSB/2	1 . . . 2^{16}-2
0x26 0x27	REL_ACU	Relative accuracy	Meas	U16[1]	LSB/2	1 . . . 2^{16}-2
0x28 0x29	SPD_ACU	Accuracy depending on rotational speed	Meas	U16[1]	LSB/2	1 . . . 2^{16}-2
0x2A 0x2B	HYST	Hysteresis	Meas	U16[1]	LSB/2	1 . . . 2^{16}-2
0x2C 0x2D	SPD_MAX	Maximum rotational speed / maximum speed	Mech	U16[1]	1/min m/min	1 . . . 2^{16}-2
0x2E 0x2F	ACC_MAX	Maximum angular acceleration / maximum acceleration	Mech	U16[1]	$1/min^2$ m/min^2	1 . . . 2^{16}-2
0x30 0x31	TMP_MIN	Minimum operating temperature	Mech	U16[1]	K	1 . . . 2^{16}-2
0x32 0x33	TMP_MAX	Maximum operating temperature	Mech	U16[1]	K	1 . . . 2^{16}-2
0x34 0x35	VLT_MIN	Minimum supply voltage	Elec	U16[1]	mV	1 . . . 2^{16}-2
0x36 0x37	VLT_MAX	Maximum supply voltage	Elec	U16[1]	mV	1 . . . 2^{16}-2
0x38 0x39	CUR_MAX	Maximum supply current	Elec	U16[1]	mA	1 . . . 2^{16}-2
0x3A		Reserved	Prot	U8	-	0
0x3B		Reserved	Prot	U8	-	0
0x3C		Reserved	Prot	U8	-	0
0x3D		Reserved	Prot	U8	-	0
0x3E		Reserved	Prot	U8	-	0
0x3F	CHKSUM	Check sum (sum of bytes in 0x00 . . . 0x3E)	Orga	U8	-	0 . . . 255

Table 3: EDS address mapping for BP1

[1)] The U16 and U32 values are saved as a Big Endian, i.e. with the highest-value byte at the lowest-value address.
[3)] The CRC polynomial is stored as a bit pattern (32:1). The ”least significant” bit of the CRC polynomial is -on active CRC verification- always 1 and is not stored. So that a CRC check sum with a maximum length of 32 bit is possible. On a deactivated CRC verification the CRC polynomial 0x00000000 is used.

Table B	Addr. . . . ; bit . . .	R
Code	Function	
0x00	No function	
0x01	Error bit	
0x02	Warning bit	

Table 4: Bit Function Of Feedback Bits

Table F	Addr. . . . ; bit . . .	R
Code	Function	
0x00	Right aligned	
0x01	Left aligned	

Table 5: Data Format

Table T	Addr. . . . ; bit . . .	R
Code	Function	
0x00	Angular encoder	

Table 6: Encoder Type

Table N	Addr. . . . ; bit . . .	R
Code	Function	
0x00	Position value number not defined	
0x01	Position value 1	
0x02	Position value 2	

Table 7: Position Value Number

BP1 in BiSS SAFETY ENCODERS

A BiSS Safety Encoder provides two position words: Control Position Word (CPW) and Safety Position Word (SPW). The CPW of the BiSS Safety Encoders can be described with the BiSS profiles BP1 or BP3. The EDS of the BiSS Safety Encoders has one EDS common part and two EDS BiSS profile specific parts: BP3S for SPW and BP1 or BP3 for CPW.

REVISION HISTORY

Rel.	Rel. Date*	Chapter	Modification	Page
A1	2007-09-20		Initial release	

Rel.	Rel. Date*	Chapter	Modification	Page
A2	2008-12-03		Minor text updates	all

Rel.	Rel. Date*	Chapter	Modification	Page
A3	2010-04-09		Minor text updates	all

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A4	2012-08-13		Minor text updates	all

Rel.	Rel. Date*	Chapter	Modification	Page
A5	2019-03-06	All	Minor text updates	all
		IDENTIFIER SCHEME: BiSS PROFILE BP1	Prior CLASSIFICATION renamed	3
		DEFINITIONS	At multiturn data and singleturn data: Data has binary format added	5
		DATA FORMAT	The variant 12-24 and 24-12 are now distinguishable by bit 1 of address 0x42	6
		Examples	Removed, subject for application notes	12 . . . 20
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