ABSOLUTE ENCODER

PA035-017BM001

17 Bits/Multi-turn Specifications

SPECIFICATION

SANYO DENKI Co., Ltd.
1st Design Department, Servo System Division
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Approval	Examination	Person in charge
小 '09. 4. 13 野寺	石塚 '09. 4. 10 (上)	岡 '09. 4. 10 根

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1 OVERVIEW

This absolute encoder is a 33-bit modular electronic multi-turn absolute encoder that outputs 17-bit single turn absolute position data and 16-bit multi-turn position data obtained from the battery-backed counter, which counts magnetic incremental patterns with 1 pulse/turn. The encoder is primarily installed on the AC servo motor.

2 FEATURES

- This downsized encoder, which is comprised of a single substrate, measures 35 mm in diameter and 12mm height.
- The MR sensor is used for detection of multiple turns so that high-speed response can be available even during the back-up operation. There are virtually no restrictions on rotation angular acceleration.
- Writing and reading of data to and from the EEPROM mounted on the encoder are available.

3 BASIC SPECIFICATIONS

3.1 Resolution

	Single turn section (ST)	Multi-turn section (MT)
Resolution	At the address between 0 and +131,071 (2^{17})	65536 turns (2^{16})

3.2 Response Rotational Speed

(1) Normal operation : 7200min^{-1}

(2) Back-up operation : 10000min^{-1}

3.3 Classification of Operating State

There are three operational statuses depending on the states of power supply voltages as is in the bellow table. (For details, see "5.2 Electrical Characteristics")

State	Vcc power supply voltage	Vbat power supply voltage (typ)
Normal operating state	4.75 to 5.25 V	-
Back-up operating state	0 V	2.76 to 4.0 V
Non-operating state	0 V	Less than 2.76 V

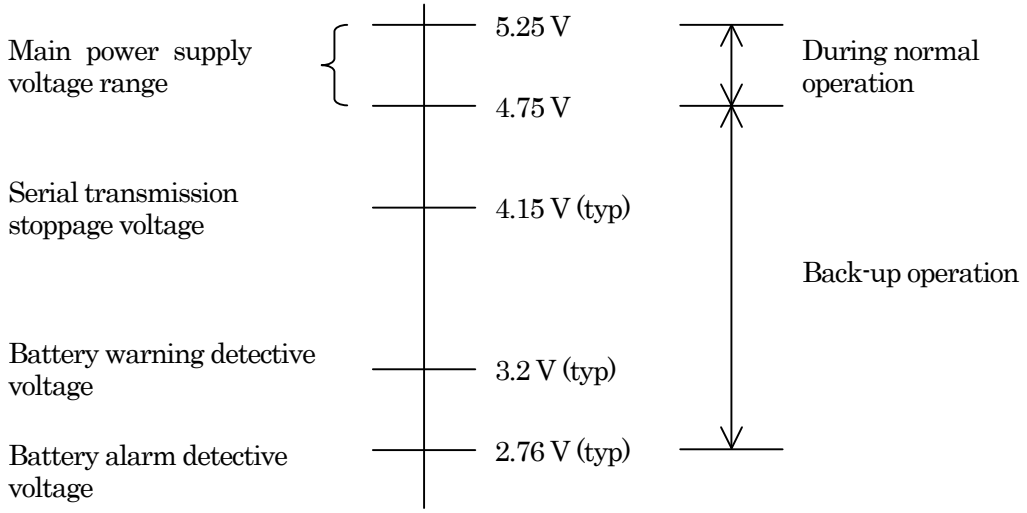


Figure 3-1 Classification of Operating State

3.3.1 Normal Operating State

Counting operation of single and multiple turns data and transmission/reception can be effected in this state. Data transmission starts in a maximum of 500 ms after turning on the main power supply. When the state is changed from backup to normal operation (on power-up), it must be carried out at a rotational speed of 250 min^{-1} or less. When the rotational speed of the encoder is 250min^{-1} or higher on power-up, normal scanning patterns of the absolute position may not take place. In such a case, the absolute position data cannot be determined and the BUSY flag is turned on.

When the rotational speed is reduced and normal scanning takes place, the BUSY flag is automatically turned off and absolute position data is determined. However, the BUSY flag is automatically turned off when normal scanning takes place regardless of a rotational speed of 250 min^{-1} or higher.

(Reference: Scannable rotational speed value is approximately 400min^{-1})

(For details, see "7 Status Flag Function Descriptions".)

3.3.2 Back-up Operating State

In this state, multi-turn counting operation is made possible by an external battery power supply. Data transmission is stopped in this state.

3.3.3 Non-operating State

All the operations of the encoder are stopped in this state. In this state, the battery alarm (BA) is latched within the encoder and externally transmitted after main power is turned on.

3.4 Multi-turn Counting Operation

The amount of multiple turns is maintained and multi-turn counting operation is performed during normal and back-up operations.

4 MECHANICAL SPECIFICATIONS

Mass	0.02kg
Axial moment of inertia (calculated value)	3.29×10^{-7} kg・m^2
Allowable rotation angular acceleration	1.0×10^{5} rad/sec^2

5 ELECTRICAL SPECIFICATIONS

5.1 Absolute Maximum Rate

(Temperature range of electrical substrate: -20 to +85℃)

Item	Symbol	Rated value	Unit
Main power supply voltage	Vcc	-0.3 - +6.0	V
External battery voltage	Vbat	-0.3 - +6.0	V

5.2 Electrical Characteristics

(Temperature range of electrical substrate other than specified: -20 to +85℃)

Item	Condition	Rated value			Unit
		MIN.	TYP.	MAX.	
Main power supply voltage	During normal operation (1% or less ripple) *Note1)	4.75	5.0	5.25	V
Battery power supply voltage	During back-up operation *Note1)	3.2	3.6	4.0	V
Normal operation ⇔ Back-up operation	Normal ⇒ Back-up *Note1)	4.05	4.15	4.25	V
	Back-up ⇒ Normal *Note1)	4.14	4.31	4.47	V
Battery alarm generation voltage	—	2.66	2.76	2.93	V
Battery warning generation voltage	*Note1)	3.13	3.2	3.27	V
Starting time of data transmission	After changing to the state of normal operation Power supply impedance = 0	-	-	0.5	Sec
Detection of temperature alarm	Temperature of electrical substrate	91	95	99	℃
Response rotational speed	Non-operation ⇒ Normal	-	-	250	min^{-1}
	Back-up ⇒ Normal				
	During normal operation	-	-	7200	min^{-1}
	During back-up operation	-	-	10000	min^{-1}
Current consumption during normal operation (when the transmission path has load)	During normal operation	-	130	170	mA
Battery current consumption during normal operation	-	-	1.0	3.4	uA
Battery current consumption during back-up operation	At 20℃ *Note2)	-	30	35	uA

*Note1) The voltage value at the power terminal on the encoder.

*Note2) The value when the axis is stopped and battery is 3.6[V].

5.3 Electrical Specifications for Single Turn

Item		Specification	Remarks
Resolution		2^{17} ST [16:0]	0 to 131071 address
Maximum rotational speed	During normal operation	$7200min^{-1}$	-
Maximum angular acceleration	During normal operation	1×10^{5} rad/s^2	Due to mechanical restrictions
Output code		Pure binary code	ES signal, serial data output
Direction of increase		CCW	Viewed from the axis end of encoder (see the Figure 5-1)

5.4 Electrical Specifications for Multi-turn Signal

Item		Specification	Remarks
Resolution		1 Count/Turn	-
Amount of maximum multi-turn counts		2^{16} ST [15:0]	65536 turns
Maximum rotational speed	During normal operation	$10000min^{-1}$	-
	During back-up operation		
Maximum angular acceleration	During normal operation	1×10^{5} rad/s^2	Due to mechanical restrictions
	During back-up operation		
Output code		Pure binary code	-
Direction of increase		CCW	Viewed from the axis end of encoder (see the Figure 5-1)

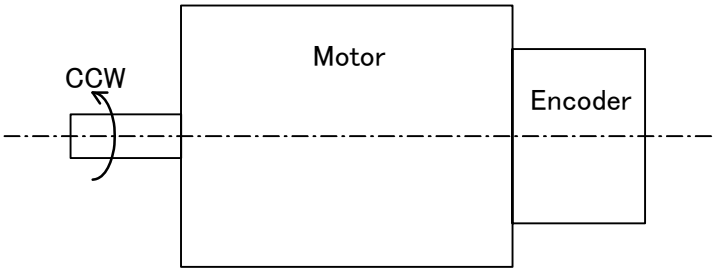


Figure 5-1 CCW direction

5.5 Back-up Section

5.5.1 External Back-up Power Supply (External battery)

Recommended battery	Lithium battery ER6 (3.6V)	Toshiba make with capacity of 2000mA･h
Life	About 6.5 years (For reference purpose)	2000mA･h / 35uA : Approx. 6.5 years

5.5.2 Switching Back-up Power Supply

Supplies in the order of voltage from the highest of main power supply (DC5V), external back-up power supply. However, power supply is not fully switched unless the voltage differential exceeds the forward voltage of the diode for switching in the switching circuit.

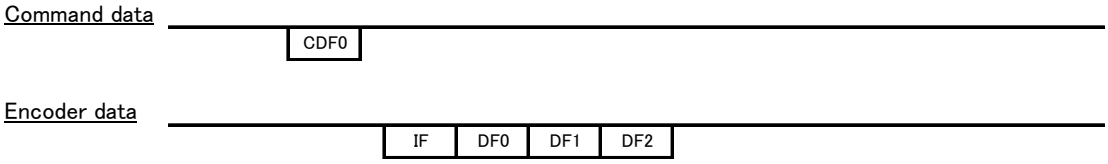
6 COMMUNICATION SPECIFICATIONS

6.1 Serial Communication Specifications

Item		Specification	Remarks
Transmission method		Half-duplex serial communication	Compliance with the EIA standard RS-485
Transmission code		NRZ code	-
Synchronous method		Asynchronous communication	-
Baud rate		2.5Mbps	-
Command data	Number of transfer frames	1 to 4 frames	-
	Frame configuration	18bits/frame	-
	Transmission error check	3-bit CRC code	$P(X) = X^3 + X + 1$
Encoder data	Number of transfer frames	1 frame	-
	Frame configuration	3-4 fields/frame	-
	Field configuration	18bits/field	-
	Transmission error check	8-bit CRC code	$P(X) = X^8+X^4+X^3+X^2+1$
	Position data format	Binary data 40 bits ABS [0:39]	ABS [0:16] = ST [0:16] ABS [17:32] = MT [0:15] ABS [33:39] = “0000000”

6.2 Frame Format

6.2.1 Position Data Request (application commands: CDF0 - CDF3)

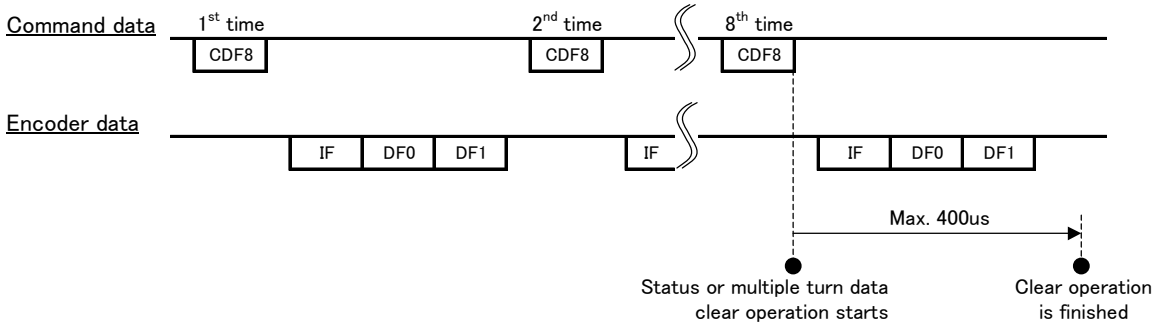


・ When any of “CDF0 to CDF3” is received as command data, the encoder is output designated data.

1) CDF0 : Absolute full 40bit data output
2) CDF1 : Absolute lower 24bit data output
3) CDF2 : Absolute upper 24bit data output
4) CDF3 : Encoder status output

(For details, see “6.4.3 Data Field”.)

6.2.2 Clear Request (application command: CDF8 - CDF10)



- Perform a clear request in the shaft halt condition(250min^{-1} or less).
- Transmit the "CDF8 - CDF10" commands to the encoder continuously 8 times. The encoder returns status data in response to the command.
  Note) If another command is received, or any of the commands is found abnormal due to noise and the like while transmitting the command continuously 8 times, the clear operation is not performed. Transmit the commands continuously 8 times again.
- The commands listed below enable to clear the statuses or multiple turn data described below.
  1) CDF8 : Status flag (over speed, battery alarm, memory access failure)
  2) CDF9 : Multiple turn data
  3) CDF10 : Status flag + multiple turn data
- It takes maximum 400 us to complete the clear operation after the 8th clear request command is received. During this processing time, the encoder data is still the data before the clear operation. Therefore, be sure to verify that the data has been cleared without fail, and then make another command request.

*Note) If you perform a clear request when a status failure occurs, and if you perform it without solving its cause, the status failure is solved temporarily, but it is detected again afterwards.
Encoder internal operations when a clear request command is received while a failure occurs in each status are described below:

■ When a battery warning occurs (BW)
- BW is non-latch status. This status is automatically cleared when battery line voltage repairs.

■ When over speed occurs (OVSPD)
- In the case that a clear request command is received at 7700min^{-1} or less
  It is cleared immediately after the 8th clear request command is received (ALM [3]: OVSPD bit of the encoder data corresponding to the 8th clear request command is turned to '0').
- In the case that a clear request command is received at 7700min^{-1} or more
  Although it is temporarily cleared immediately after the 8th clear request command is received (ALM [3]: OVSPD bit of the encoder data corresponding to the 8th clear request command is turned to '0'), over speed is detected again within maximum 60us.

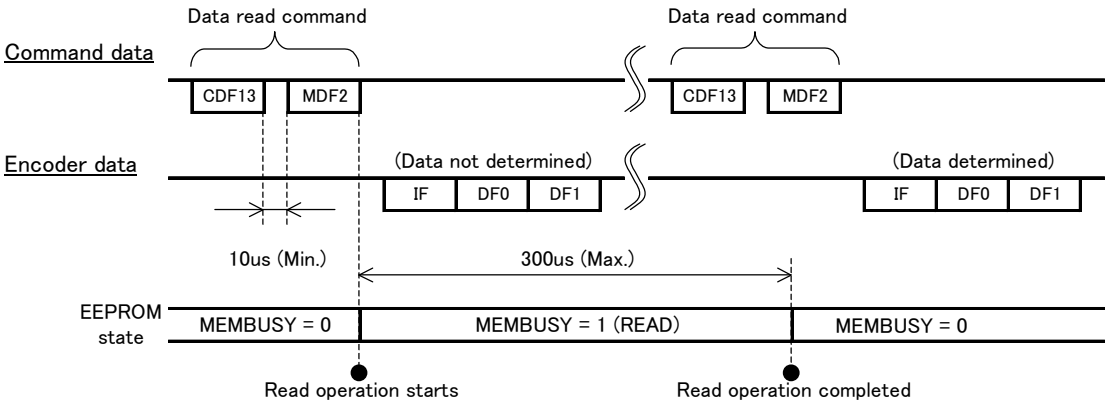
■ When a battery alarm occurs (BA)

A BA is solved within maximum 400us after the 8th clear request command is received. There is no chance that the BA recurs.

■ When a memory access failure occurs (MEMERR)

A memory access failure is solved immediately after the 8th clear request command is received. However, when a memory access error occurs, the encoder may be damaged, and therefore the error may occur again next time you access the memory.

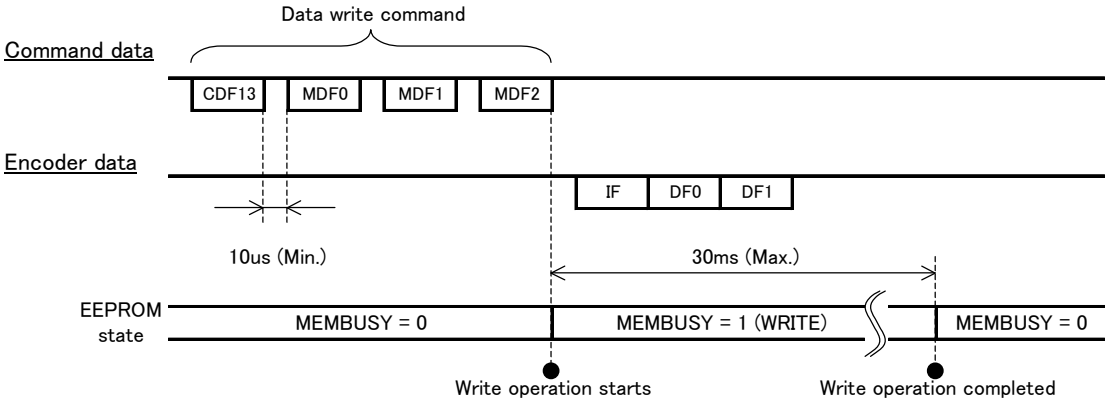
6.2.3 EEPROM Data Read (application command: CDF13)



- The data read command consists of two frames: a command data frame and a memory data frame.
- If the data read command (2 Frames) is not correctly detected, encoder data is not output. If any other command unrelated to the data read command is detected between the frames, the data read command becomes invalid.
- After the encoder correctly detects the data read command, it starts accessing the EEPROM in the encoder, and the MEMBUSY flag is turned on.
- If the same data read command is received after 300us, specified data is output.
- If data read is not done properly, the MEMERR flag is latched within the encoder.
- When the MEMBUSY or MEMERR flag is turned on, the encoder responds to the memory access request command, but data is not determined at that time. In the meantime, it returns designated data in response to the data request command and the operation request command.

* For more information on MEMBUSY and MEMERR, see “7 Status Flag Function Descriptions”.

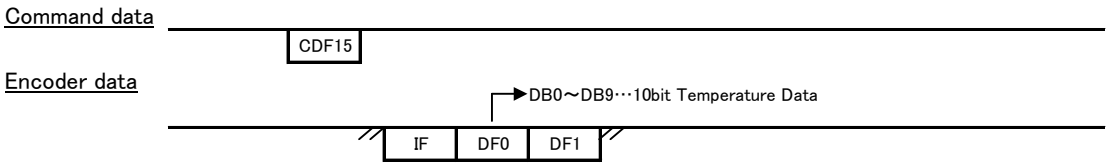
6.2.4 EEPROM Data Write (application command: CDF14)



- The data write command consists of total four frames: one command data frame and three memory data frames.
- If the data write command (4 frames) is not correctly detected, encoder data is not output. If any other command unrelated to the data write command is detected between the frames, the data write command becomes invalid.
- After the encoder correctly detects the data write command, it returns the same data (address and data for write) as specified by the data write command.
- After the write operation starts, the MEMBUSY flag is turned on for 30ms (MAX.).
- If data write is not done properly, the MEMERR flag is latched within the encoder.
- If the MEMBUSY or MEMERR flag is turned on, an access command to the memory is ignored.

* For more information on MEMBUSY and MEMERR, see "7 Status Flag Function Descriptions".

6.2.5 Temperature Data Read (application command: CDF15)



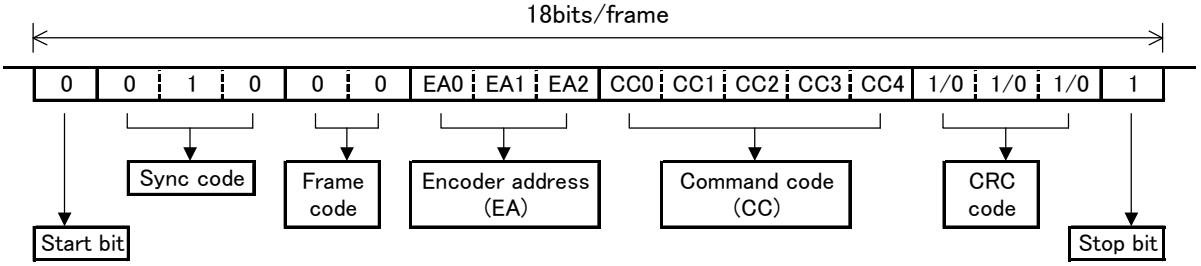
- When a specified encoder receives "CDF15" as command data, it outputs 10-bit information (DB[9:0]) on the temperature sensor installed on the encoder base plate.

Note) Temperature data read can be also done by specifying the address F9h and then transmitting the CDF13 command.

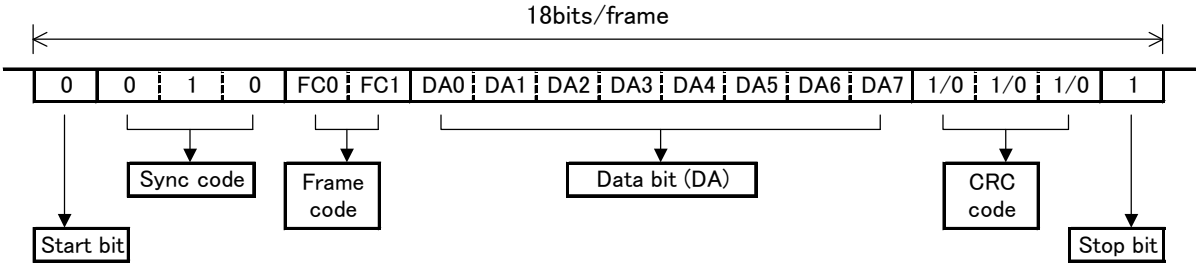
6.3 Command Data Specifications

6.3.1 Frame Configuration

(1) Command Data Frame (CDF)



(2) Memory Data frame (MDF)



6.3.2 Details of Frames

(1) Command Data Frame

Frame Name	Frame Code FC0	Frame Code FC1	Command Code CC[4:0]	Segment	Remarks
CDF0	0	0	0 0 0 0 0	Data request	Absolute full data request
CDF1			0 0 0 0 1		Absolute lower 24-bit data request
CDF2			0 0 0 1 0		Absolute upper 24-bit data request
CDF3			0 0 0 1 1		Encoder status request
CDF8	0	0	0 1 0 0 0	Operation request	Status flag clear request
CDF9			0 1 0 0 1		Multiple turn data clear request
CDF10			0 1 0 1 0		Status + multiple turn data clear request
CDF13	0	0	0 1 1 0 1	Memory access request	Memory read request
CDF14			0 1 1 1 0		Memory write request
CDF15	0	0	0 1 1 1 1	Data request	Temperature data (10-bit) request
CDF4 / CDF7 CDF11 / CDF12 CDF16 / CDF31	0	0	0 0 1 0 0 / 0 0 1 1 1 0 1 0 1 1 / 0 1 1 0 0 1 0 0 0 0 / 1 1 1 1 1	Not defined or prohibited to use	

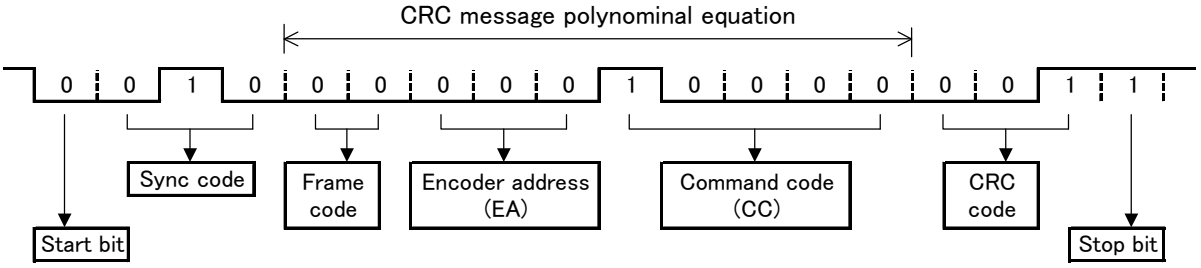
(2) Memory Data Frame

Frame Name	Frame Code FC0	Frame Code FC1	Assignment to Data Bit	Remarks
MDF0	1	0	DA [0:7] = MEMDAT [0:7]	Lower 8-bit data of EEPROM
MDF1	0	1	DA [0:7] = MEMDAT [8:15]	Upper 8-bit data of EEPROM
MDF1	1	1	DA [0:7] = MEMADR [0:7]	8-bit address of EEPROM

(3) CRC Code

- Generative polynomial equation for a CRC code is $P(x) = X^3 + X + 1$
- The CRC calculation range covers all the bits except the start bit, the stop bit, and sync codes.

  e.g.,) In the case of "CDF1" command

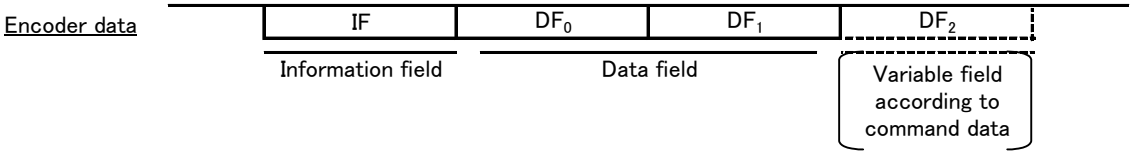


(4) Encoder Address (EA) – Specified Encoder Address

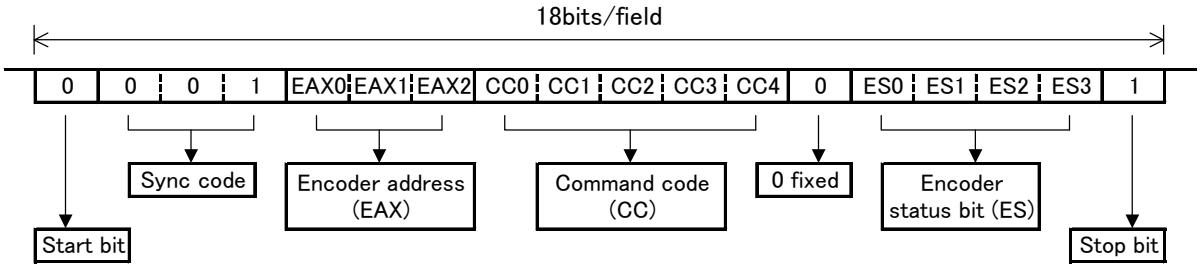
Specify a code of "000". {Encoder Address (EA) is used in optional bus connection mode.}

6.4 Encoder Data Specifications

6.4.1 Frame Configuration



6.4.2 Information Field (IF)



(1) The sync code is fixed to "001".

(2) The encoder address (EAX) is fixed to "000".

(This address is used in optional bus connection mode.)

(3) The command code is the same as the one specified by command data.

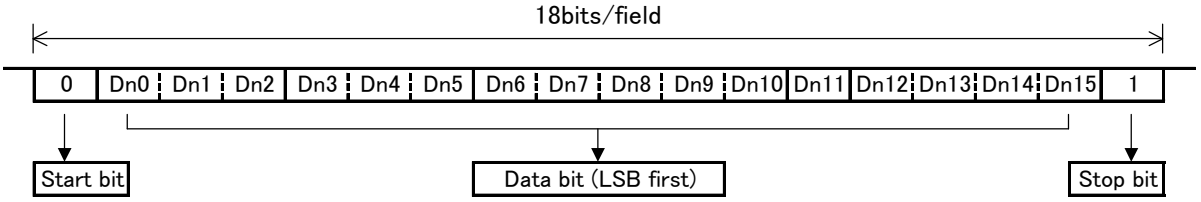
(See the table in (1) of section 6.3.2.)

(4) Encoder status bit

Bit	Status Flag	Remarks
ES0	BUSY + MEMBUSY	Logical sum output
ES1	BW	—
ES2	OVSPD + MEMERR + OVTEMP	Logical sum output
ES3	STERR + PSERR + BA	Logical sum output

Note) For more information on status flags, see "7 Status Flag Function Descriptions".

6.4.3 Data Field (DFn, n= 0 to 2)



(1) Data Assignment

Command Data	Encoder Data/Field Configuration			Data Transmission Time	Remarks
	DF_0	DF_1	DF_2		
CDF0	D0[0:15]=ABS[0:15]	D1[0:15]=ABS[16:31]	D2[0]=ABS[32] D2[1:7]="0000000" D2[8:15]=CRC[0:7]	28.8us	Absolute full data output
CDF1	D0[0:15]=ABS[0:15]	D1[0:7]=ABS[16:23] D1[8:15]=CRC[0:7]	-	21.6us	Absolute lower 24-bit data output
CDF2	D0[0:15]=ABS[16:31]	D1[0]=ABS[32] D1[1:7]="0000000" D1[8:15]=CRC[0:7]	-	21.6us	Absolute upper 24-bit data output
CDF3	D0[0:15]=ALM[0:15]	D1[0:7]="00000000" D1[8:15]=CRC[0:7]	-	21.6us	Encoder status Output
CDF8	D0[0:15]=ALM[0:15]	D1[0:7]="00000000" D1[8:15]=CRC[0:7]	-	21.6us	Status flag clear
CDF9					Multiple turn data clear
CDF10					Status + multiple turn data clear
CDF14	D0[0:15] =MEMDAT[0:15]	D1[0:7] =MEMADR[0:7] D1[8:15]=CRC[0:7]	-	21.6us	Memory read (2-Frames=CDF13+MDF2)
CDF13 (address≠F9h)					Memory write (4-Frames=CDF14+MDF0+MDF1+MDF2)
CDF13 (address=F9h)	D0[0:9]=DB[0:9] D0[10:15]="000000"	D1[0:7] =MEMADR[0:7] D1[8:15]=CRC[0:7]	-	21.6us	Temperature data output
CDF15	D0[0:9]=DB[0:9] D0[10:15]="000000"	D1[0:7]="00000000" D1[8:15]=CRC[0:7]	-	21.6us	Temperature data output

(2) CRC[0:7]

- In the last field of the encoder data frame, a CRC code(8 bits) is included.
- Generative polynomial equation for a CRC code is $P(x) = X^8 + X^4 + X^3 + X^2 + 1$
- The CRC calculation range covers all the bits except the start bit and the stop bit of each field.

(3) ALM[0:15]

- Assignment of statuses to the status codes ALM[0:15] is done as shown in the table below.

Bit	ALM[0]	ALM[1]	ALM[2]	ALM[3]	ALM[4]	ALM[5]	ALM[6]	ALM[7]
Status	BW	BA	0 fixed	OVSPD	MEMERR	STERR	PSERR	BUSY
Bit	ALM[8]	ALM[9]	ALM[10]	ALM[11]	ALM[12]	ALM[13]	ALM[14]	ALM[15]
Status	MEMBUSY	OVTEMP	0 fixed	0 fixed	0 fixed	0 fixed	0 fixed	0 fixed

Note) For more information on status flags, see "7 Status Flag Function Descriptions".

(4) MEMADR[0:7], MEMDAT[0:15]

- MEMADR[0:7] : 8-bit EEPROM address (LSB first)
  Note) About the range of accessible addresses,
  see "8. ELECTRICAL SPECIFICATIONS FOR SERIAL EEPROM".
- MEMDAT[0:15] : In the case of data read, 16-bit EEPROM data (LSB first)
  In the case of data write, 16-bit user data (LSB first)

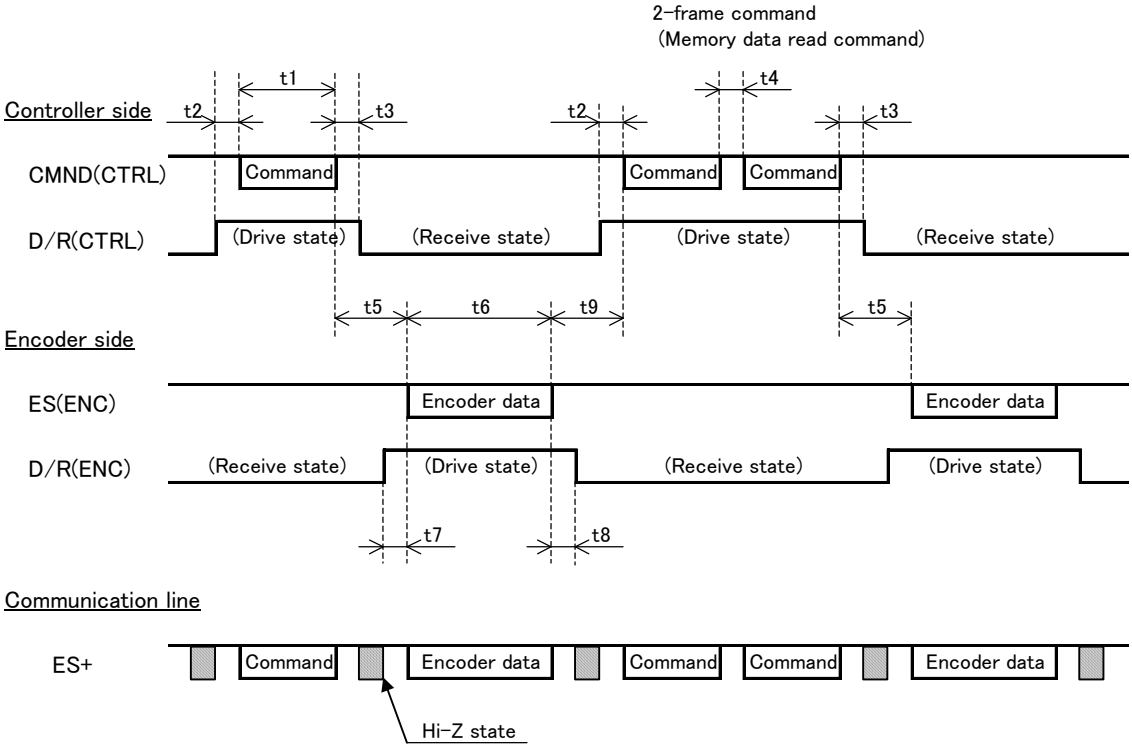
(5) DB[0:9]

Temperature data: A data of CDF15 or address F9H with command CDF13.
The format of 10Bit temperature data.

Temperature	DB[0:9]
-128℃	10 0000 0000
-50℃	11 0011 1000
-20℃	11 1011 0000
-0.25℃	11 1111 1111
0℃	00 0000 0000
+0.25℃	00 0000 0001
+10℃	00 0010 1000
+25℃	00 0110 0100
+50℃	00 1100 1000
+85℃	01 0101 0100
+127℃	01 1111 1100

6.5 Transmission/Reception Timings

6.5.1 Timing Chart



Time	Transmission Speed 2.5Mbps	Remarks	Time	Transmission Speed 2.5Mbps	Remarks
t1	7.2us	-	t6	28.8us	*Note2)
				21.6us	*Note3)
t2	1us(MIN.)	-	t7	200ns	-
t3	1.5us(MAX.)	-	t8	200ns	-
t4	10us(MIN.)	-	t9	5us(Min.)	-
t5	3us	-	-	-	-

*Note1) The specifications for timings comply with “10 Transmission/Reception Circuits”. It is assumed that the delay of the transmission path and the propagation delay of the transmission/reception circuits are “0”.

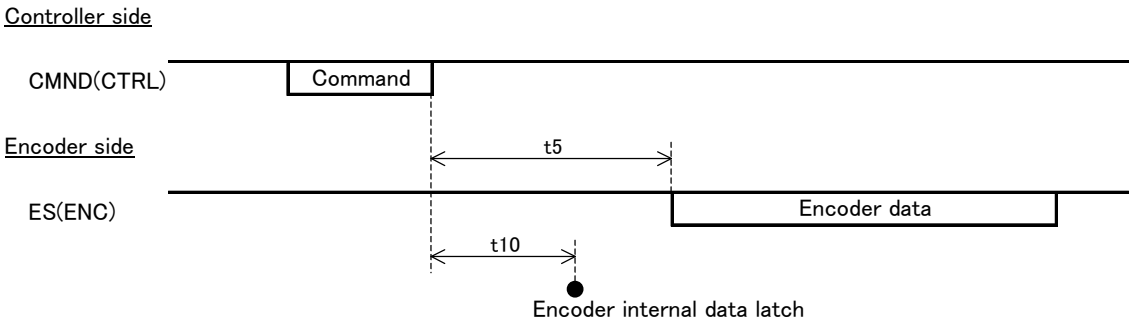
*Note2) In the case of CDF0 (4 field data)

*Note3) In the case of CDF1 - 3, CDF8 - 10, CDF13 - 15 (3 field data)

6.5.2 Encoder internal data latch timing (t10)

After a command is detected (i.e., after the frame is completed), internal data is latched within 2us ±0.5us.

In the case of the "CDF2" commands, internal data is not latched, and the previously latched data is output.



6.5.3 Specifications for command Data Detection

(1) Detection of Command Data Frame

(i) Verification of idle of 7.2us or more

↓ OK

(ii) Detection of the start bit

↓ OK

(iii) Verification of the sync code

↓ OK

(iv) Verification of the frame code … frame code "00"

↓ OK

(v) Verification of the CRC code and the stop bit

↓ OK

(vi) The command becomes valid

In accordance with the flow described above, a command is detected. If this flow is not satisfied, the command becomes invalid, and data transmission from the encoder is not made.

(2) Detection of Memory Data Frame

(i) Verification of idle of 7.2us or more

↓ OK

(ii) Detection of the start bit

↓ OK

(iii) Verification of the sync code

↓ OK

(iv) Verification of the frame code

The frame code is “11” in the case of data read

The frame code is changed from “01” to “10” to “11” in the case of data write

↓ OK

(v) Verification of the CRC code and the stop bit

↓ OK

(vi) The command becomes valid

In accordance with the flow described above, a command is detected. If this flow is not satisfied, the command becomes invalid, and data transmission from the encoder is not made.

7 STATUS FLAG FUNCTION DESCRIPTIONS

Name	Description	How to turn off
Busy flag (BUSY)	Function : This flag is turned on during the process to determine a single turn absolute value. To be more specific, if M-sequential scan data is logically incorrect, or if scan data which are detected three times do not match, "1" is output, and all the position data during that period becomes "0" fixed. After the determining process is completed, the flag returns to "0". Detection timing : During normal operation (when the main power is turned ON) Output : Non-latch	Automatically turned off (Set the turn speed at 250min^{-1} or less)
PS error (PSERR)	Function : To monitor the conformance between the "multiple turn calculation block" and the "single turn calculation block". To be more specific, (1) Multiple turn calculation value calculated by the magnetic encoder (2) Multiple turn calculation pseudo value calculated by carry/borrow of the single turn absolute value. When comparing (1) and (2), if (difference between (1) and (2)) ≧ (single turn), an alarm is turned on. Detection timing : During normal operation Output : Latch	The main power is turned ON again
ST error (STERR)	Function : To monitor the conformance between the "ABS block" and the "INC block". To be more specific, (1) Certain 1 bit of the absolute sensor (2) Certain 1 bit of the shift register in ASIC (generated by the M-sequential polynomial equation) When comparing (1) and (2), if the data do not match, an alarm is turned on. Detection timing : During normal operation Output : Latch	The main power is turned ON again
Over speed alarm (OVSPD)	Function : When the turn speed exceeds 7700min^{-1}, an alarm is turned on. Detection timing : During normal operation Output : Latch	A command (CDF8 or CDF10) is entered
Battery warning (BW)	Function : When the external battery voltage is 3.2V(TYP) or less, an alarm is turned on. Detection timing : During normal operation Output : Non-latch	Automatically turned off
Battery alarm (BA)	Function : When the encoder enters the non-operation state and it is unable to serve as an encoder, an alarm is turned on. To be more specific, the higher voltage between main power or the external battery becomes 2.76V(TYP) or less Detection timing : During back-up operation Output : Latch	A command (CDF10) is entered
MEMBUSY flag (MEMBUSY)	Function : This flag shows that access to the EEPROM in the encoder is under way. After the access is completed, the flag returns to "0". Detection timing : During normal operation (data read, data write) Output : Non-latch	Automatically turned off (Turned off after a certain period of time passes.)
MEM error (MEMERR)	Function : This flag is turned on when an error occurs while accessing the EEPROM in the encoder. To be more specific, an error occurs in cases described below: (1) Response failure in a data write completion signal during data write, or unmatched data (2) Check failure during data read Detection timing : During normal operation (data read, data write) Output : Latch	A command (CDF8 or CDF10) is entered; or the main power is turned ON again
Temperature alarm (OVTEMP)	Function : When the encoder temperature is 95℃±4℃ or more, an alarm is turned on. Detection timing : During normal operation Output : Non-latch	Automatically turned off

8 ELECTRICAL SPECIFICATIONS FOR SERIAL EEPROM

Item	Specification	Remarks
Memory size	8K bit	512 × 16 bits
Accessible addresses	0 to 239 address (0H to FEH address)	Data configuration for one word : MEMDAT [15:0]
Allowable write times	10^6 times	-
Data retention period	10 years	-

9 ENVIRONMENT CONDITIONS

9.1 Temperature

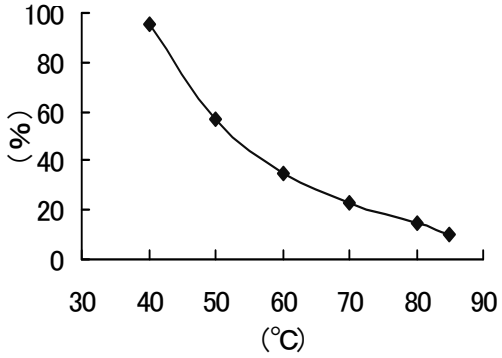
- In operation : Base plate temperature -20℃ to 85℃
- In non-operation : Base plate temperature -20℃ to 85℃

9.2 Humidity (no dew condensation)

- 95%RH or less (+40℃)
- 57%RH or less (+50℃)
- 35%RH or less (+60℃)
- 23%RH or less (+70℃)
- 15%RH or less (+80℃)
- 10%RH or less (+85℃)

*For more information, see the right chart.

Correlation between temperature and humidity



9.3 Vibration

3000Hz or less at 98m/sec^2

9.4 Impact

980m/sec^2, 6msec or less

9.5 Noise Resistance

In the following tests, there must be no displacement.

(1) Power supply noise

Common mode (between the frame and the power supply)

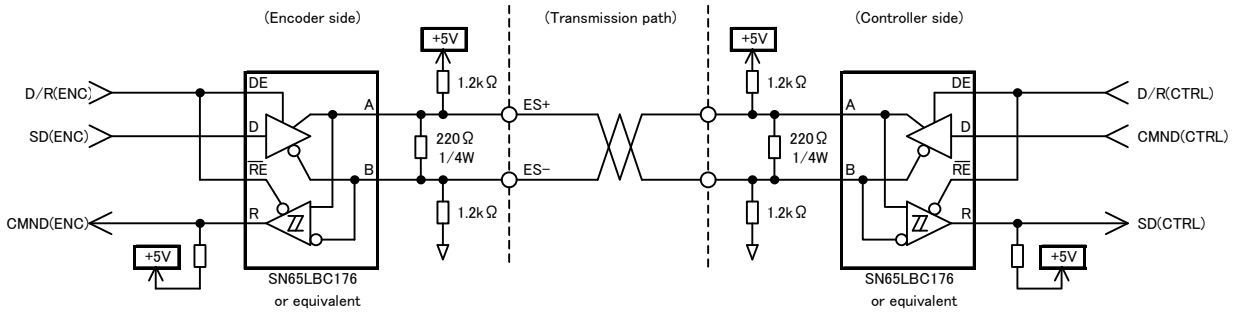
Normal mode (between 0V and 5V)

±100V for the both nodes (pulse width 50nsec and 1usec ; polarity ±)

(2) Magnetic noise

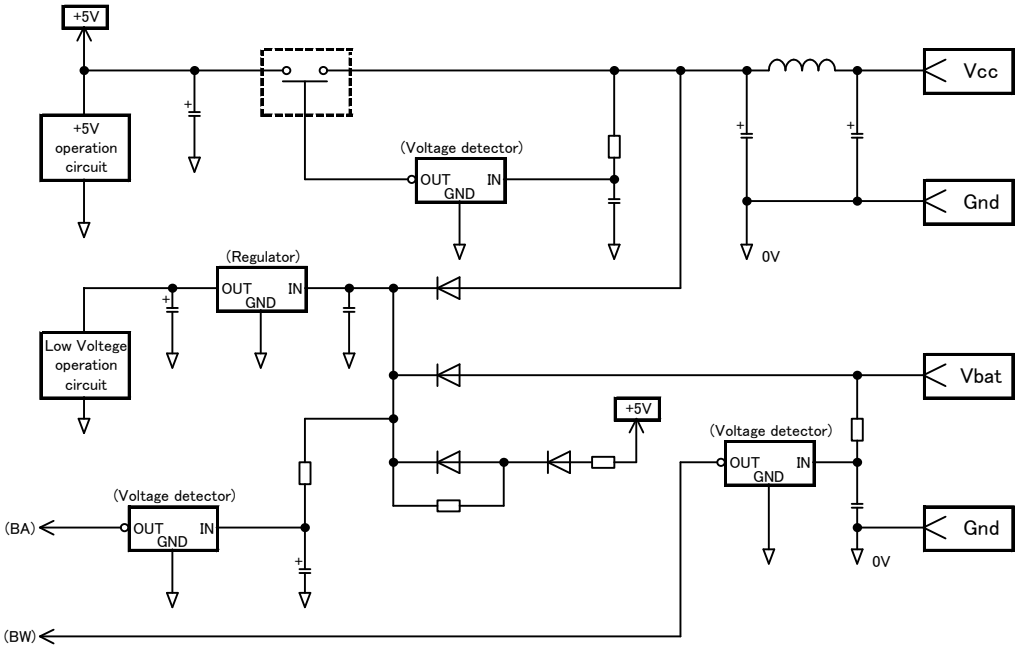
0.01tesla

10 TRANSMISSION/RECEPTION CIRCUIT (for Reference)



*Note) Constant numbers and wiring in the referential reception circuit from given above may differ according to an actual environment. Make adjustments according to the situation.

11 POWER SUPPLY CIRCUIT (for Reference)



12 SAFETY INSTRUCTIONS

Our encoder is intended for use as general industrial equipment.

Therefore, make sure to note the following points:

- Do not use this device on the medical equipment that influence human life.
- Do not use this device on the equipment that may have a significant social and public impact.
- Do not modify or tamper the device.

Before using the encoder (installation, wiring, operation, maintenance, inspection, etc.), be sure to this specification thoroughly in order to familiarize yourself with proper operation.