


K1G Series High-Accuracy Position Sensor User's Manual

for

EtherCAT Communication



Thank you for purchasing an Azbil Corporation product.



This manual contains information for ensuring the correct use of this product. It also provides necessary information for installation, maintenance, and troubleshooting.

This manual should be read by those who design and maintain equipment that uses this product. Be sure to keep this manual nearby for handy reference.

Azbil Corporation

NOTICE

Be sure that the user receives this manual before the product is used.

Copying or duplicating this user's manual in part or in whole is forbidden. The information and specifications in this manual are subject to change without notice.

Considerable effort has been made to ensure that this manual is free from inaccuracies and omissions. If you should find an error or omission, please contact the azbil Group.

In no event is Azbil Corporation liable to anyone for any indirect, special or consequential damages as a result of using this product.

© 2017 Azbil Corporation All Rights Reserved.

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Conventions Used in This Manual

■ In describing the product, this manual uses the icons and conventions listed below.

 **Handling Precautions:**

Handling Precautions indicate items that the user should pay attention to when handling the K1G Series High-Accuracy Position Sensor.

 **Note:**

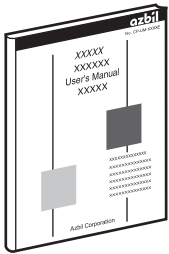
Notes indicate information that might benefit the user.



This indicates the item or page that the user is requested to refer to.

The Role of This Manual

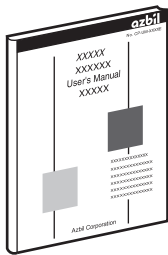
A total of six different manuals are available for the K1G Series High-Accuracy Position Sensor. Read them as necessary for your specific requirements. If a manual you require is not available, contact the azbil Group or its dealer.



K1G Series High-Accuracy Position Sensor User's Manual for EtherCAT Communication

Manual No. CP-SP-1419E

This manual. This manual describes K1G series EtherCAT communication specifications only. Before starting to use this product, please refer to K1G Series High-Accuracy Position Sensor User's Manual (CP-SP-1385E) or K1G Series High-Accuracy Position Sensor Global Model User's Manual (CP-SP-1397E), depending on the type of your controller.



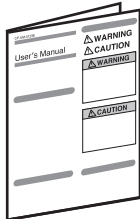
K1G Series High-Accuracy Position Sensor User's Manual

Manual No. CP-SP-1385E

K1G Series High-Accuracy Position Sensor Global Model User's Manual

Manual No. CP-SP-1397E

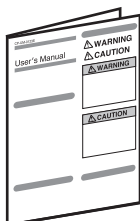
This manual describes the hardware and all functions of the K1G. Personnel in charge of the design, manufacture, operation, or maintenance of equipment that incorporates this device, or the design of communication software for your equipment that uses this device's serial communication function, should read this manual thoroughly.



K1G-C04E / K1G-C04EG High-Accuracy Position Sensor Controller User's Manual

Manual No. CP-UM-5910JE

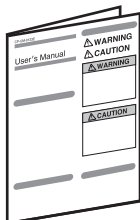
Personnel in charge of the design or configuration of equipment that incorporates this device should read this manual thoroughly. The manual covers safety precautions, installation, wiring, and primary specifications.



K1G Series High-Accuracy Position Sensor Head User's Manual

Manual No. CP-UM-5784JE

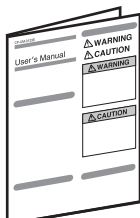
Personnel in charge of the design or manufacture of equipment that incorporates the sensor heads should read this manual thoroughly. The manual covers safety precautions, installation, wiring, and primary specifications.



Handling Precautions for the SZ-D01 Configuration Tool for K1G Series High-Accuracy Position Sensors

Manual No. CP-UM-5785JE

Personnel who use the configuration tool for K1G sensors should read this manual. The manual covers safety precautions, installation, and wiring.



Handling Precautions for K1G Series High-Accuracy Position Sensor Junction Cables

Manual No. CP-UM-5787JE

Personnel in charge of the design or manufacture of equipment that incorporates the cables should read this document thoroughly. The manual covers safety precautions.

Contents

Conventions Used in This Manual The Role of This Manual

Chapter 1. EtherCAT Communication	1-1
1-1 Overview	1-1
1-2 EtherCAT Communication Specifications	1-2
1-3 Appearance and Details	1-3
■ Communication connector pins	1-5
■ ECAT ID setting switches	1-5
■ LED indicators	1-6
1-4 Displays	1-7
■ EtherCAT communication status check display	1-7
■ EtherCAT status display	1-8
■ Link status display	1-8
Chapter 2. Object Dictionary	2-1
2-1 Default PDO mapping	2-2
2-2 Communication Area	2-3
2-3 Manufacturer Specific Area	2-5
■ Input Area (0x3000 to 0x30FF)	2-5
■ Output object (0x3100 to 0x31FF)	2-9
Chapter 3. ESI File	3-1
APPENDIX	App-1
APP-1 Specifications Compliance	App-1
APP-2 Terminology	App-2

Chapter 1. ETHERCAT COMMUNICATION

1 - 1 Overview

EtherCAT® is an Ethernet-based real-time fieldbus system proposed and developed by Beckhoff Automation GmbH, Germany. Since it is based on Ethernet, general-purpose Ethernet cables can be used to establish a network.

EtherCAT® is a registered trademark and the patented technology is licensed from Beckhoff Automation GmbH, Germany.

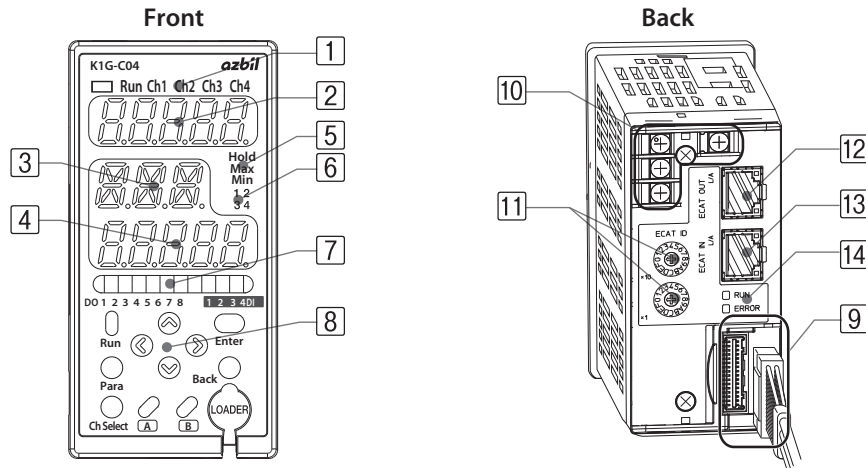
1 - 2 EtherCAT Communication Specifications

Item	Description
Communication standard	IEC 61158 Type12 (EtherCAT)
Physical layer	100BASE-TX, IEEE802.3
Connector	RJ-45 × 2 (IN, OUT)
Communication medium	STP cable with Cat. 5e or higher* ¹
Communication distance	20 meters between nodes
Process data communication	Process data objects (PDOs) can be configured.* ²
Process data communication cycle	250 μs min. (depends on the settings of the master device)
Mailbox communication	CoE
Synchronization method	Freerun only (distributed clocks is not supported.)
LED indicators	RUN, ERR, Link/Activity × 2
Node address	The address can be specified by using the configured station alias or explicit device identification.

*1. Use of a double-shielded STP cable is recommended in an environment with a large amount of electromagnetic noise (e.g., FA equipment).

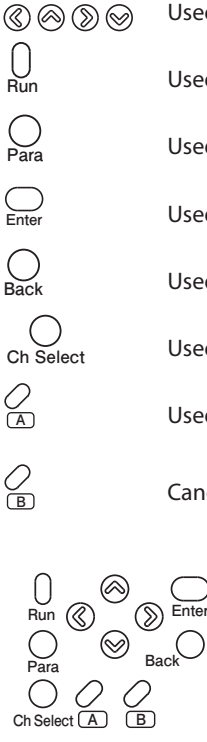
*2. PDOs to map can be selected by the master device. Accordingly, communication traffic can be reduced as needed.

1 - 3 Appearance and Details



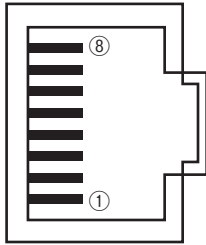
Number	Name	Description
1	Operation and channel indicators	<p><input type="checkbox"/> Run Ch1 Ch2 Ch3 Ch4</p> <p>— Lit to indicate which channel's measured value is displayed on display 1. — Lit while the state is "Run." — Lit while the controller is operating properly.</p>
2	Display 1*	Displays the measured value.
3	Auxiliary display*	Displays the setting that is being checked or changed.
4	Display 2*	Displays the measured value.
5	Status indicators	Indicate the operating status of the channel selected for display 1. Hold — Lit when the status of the measured value is "Hold." Max — Lit when the digital input (DI) max. value hold function is used. Min — Lit when the digital input (DI) min. value hold function is used.
6	Sensor connection indicators	Indicate channel(s) to which sensor heads are connected. 1 2 3 4
7	Digital input/output indicator	Indicates digital I/O status. The indicator is lit when digital I/O is on.

* The status of EtherCAT communication and the node address can be checked on these displays.

Number	Name	Description
8	Key functions	 <p>Used for changing a value, etc., during setting</p> <p>Used for switching between Run and Ready</p> <p>Used for switching to the display for changing settings</p> <p>Used for finalizing settings</p> <p>Used for cancellation</p> <p>Used for switching between channels</p> <p>Used for tuning</p> <p>Cancels EPS filtering.</p>
9	Sensor head cable connector	Connects the included sensor head cable and controller.
10	Terminals	Used for wiring of the power and input/output signal wires.
11	ECAT ID setting switches	Use these switches to specify an ECAT ID as a two-digit hexadecimal number.
12	RJ45 connector (ECAT OUT)	Connects to the network cable.
13	RJ45 connector (ECAT IN)	
14	EtherCAT RUN/ERROR LEDs	Displays the status of EtherCAT communication and errors.

■ Communication connector pins

The network ports of this device are used as follows.



Connector (jack) on this device

Pin No.	Signal	Description
1	TX +	Transmitted data (+)
2	TX -	Transmitted data (-)
3	RX +	Received data (+)
4	-	75 Ω terminating resistor connection
5	-	75 Ω terminating resistor connection
6	RX -	Received data (-)
7	-	75 Ω terminating resistor connection
8	-	75 Ω terminating resistor connection

Use STP (shielded twisted pair) cables, Cat. 5e or higher. Either a straight cable or a crossover cable can be used.

Connect the network cable from the master device to the IN port (RJ-45 connector) of this device. Additionally, if this device has a slave on the downstream side, connect the OUT port (RJ-45 connector) of this K1G to the IN port of the slave device with a network cable.

! Handling Precautions

- Do not use the EtherCAT communication network for other Ethernet communications.

■ ECAT ID setting switches



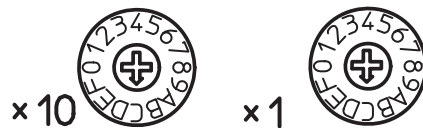
Use these switches to specify an ECAT ID as a two-digit hexadecimal value. The switches with ×10 and ×1 labels correspond to the 2nd and 1st digit of the hexadecimal number respectively. If no ECAT ID is used, set these rotary switches to the “00” position.

The settings for the ECAT ID are read only when the power is turned on. If the settings are changed during operation, the ECAT ID will not reflect the new settings. A new ID set by the switches will be valid only after the power of the device is turned off and back on.

Setting range: 00 to FF (decimal 0 to 255)

Factory default: 00

Example:



The above figure shows the following ECAT ID.

$$0x10 \times 0x0C + 0x0C = 0xCC \text{ (204 in decimal)}$$

LED indicators

LED indicators for EtherCAT are explained below.

● Link/Activity LED: Green

Indicates the status of physical link and data communication at the EtherCAT communication port.



LED state	Description
Off	Link is not established.
On	Link is established but no data is being communicated.
Blinking	Link is established and data is being communicated.

● EtherCAT RUN/ERROR LEDs

The RUN LED indicates the status of EtherCAT communication. The ERROR LED indicates EtherCAT errors.

- RUN
- ERROR

RUN LED: Green

LED state	Description	Remarks
Off	Init state	No communication is available.
Blinking	The device is in the Pre-Operational state.	Only mailbox communication is available.
Single flash	The device is in the Safe-Operational state.	Process (input) data communication and mailbox communication are available.
On	The device is in the Operational state.	Process (input and output) data communication and mailbox communication are available.

ERROR LED: Red


LED state	Description	Remarks
Off	No error	There is no EtherCAT error, or the device is not communicating.
Blinking	EtherCAT communication setting error	Invalid configuration for EtherCAT communication
Single flash	Device operation error	There is an application error in this device.
Double flash	Process data watchdog time-out EtherCAT watchdog time-out	Sync Manager Watchdog timeout or EtherCAT communication timeout has occurred.
On	PDI watchdog time-out	There is a critical error in communication or application.

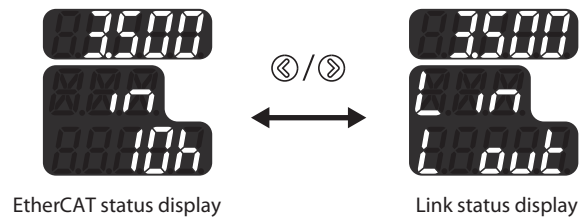
LED state	Definition
Blinking	200 ms ON, 200 ms OFF
Single flash	200 ms ON, 1000 ms OFF
Double flash	200 ms ON, 200 ms OFF, 200 ms ON, 1000 ms OFF

1 - 4 Displays

The status of EtherCAT communication and the node address can be shown on the displays of the controller. Set the controller's operation state to RUN and select the EtherCAT communication status check display

Note



-  4-2, "Changing the Display" in K1G Series High-Accuracy Position Sensor User's Manual (CP-SP-1385E), or K1G Series High-Accuracy Position Sensor Global Model User's Manual (CP-SP-1397E))



■ EtherCAT communication status check display

There are two modes for this display.

- EtherCAT status display
 - Display 1: Shows the measured process value from the selected channel.
 - Auxiliary display: Shows the status of EtherCAT communication.
 - Display 2: Shows the node address.
- Link status display
 - Display 1: Shows the measured process value from the selected channel.
 - Auxiliary display: Shows the link status of the RJ-45 IN connector.
 - Display 2: Shows the link status of the RJ-45 OUT connector.

To switch display modes, press  or .

■ EtherCAT status display



The auxiliary display shows the status of EtherCAT communication. The display corresponds to the behavior of the RUN LED.

Display	Description
<i>in</i>	The device is in the Init state.
<i>Po</i>	The device is in the Pre-Operational state.
<i>So</i>	The device is in the Safe-Operational state.
<i>oP</i>	The device is in the Operational state.
<i>Ein</i>	An error occurred in the Init state.
<i>EPo</i>	An error occurred in the Pre-Operational state.
<i>ESo</i>	An error occurred in the Safe-Operational state.
<i>EoP</i>	An error occurred in the Operational state.

Display 2 shows the node address as a four-digit hexadecimal number.

Value range: 0h to FFFFh (decimal 0 to 65535)

When not connected to EtherCAT:0h

! Handling Precautions

- The node address shown on this display is different from the ID specified by the ECAT ID setting switches. For management of the EtherCAT network node address, refer to the specifications of the master device.

■ Link status display



The auxiliary display shows whether the link to the RJ-45 connector for ECAT IN is established. The display corresponds to the behavior of the Link/Activity LED.

Display	Description
<i>- in</i>	Link is not established.
<i>Lin</i>	Link is established.

Display 2 shows whether the link to the RJ-45 connector for ECAT OUT is established. The display corresponds to the behavior of the Link/Activity LED.

Display	Description
<i>- out</i>	Link is not established.
<i>Lin</i>	Link is established.

Chapter 2. OBJECT DICTIONARY

The general structure of the CoE object dictionary is as follows

(all the index numbers in the following tables are in hexadecimal notation).

Index	Object dictionary area
0x0000 to 0x0FFF	Data type area
0x1000 to 0x1FFF	Communication area
0x2000 to 0x5FFF	Manufacturer specific area
0x6000 to 0xFFFF	Profile specific area

This device's objects, such as measured value, are mapped to the manufacturer specific area. The profile specific area is not used. Objects are mapped as follows in the manufacturer specific area.

Index	Manufacturer specific area
0x2000 to 0x2FFF	Not used
0x3000 to 0x30FF	Input area
0x3100 to 0x31FF	Output area
0x3300 to 0x5FFF	Not used

2 - 1 Default PDO mapping

The default TxPDO mapping is as follows. All objects in the input area (0x3000 to 0x30FF) are mapped by default. It is possible to change the mapping or delete the objects.

PDO index	PDO subindex	PDO entry index	PDO entry subindex	Bit length	Comment
0x1A00	0x01	0x3000	0x01	32	PV1
	0x02	0x3000	0x02	32	PV2
	0x03	0x3000	0x03	32	PV3
	0x04	0x3000	0x04	32	PV4
	0x05	0x3001	0x01	16	Event all
	0x06	0x3001	0x02	16	Event 1
	0x07	0x3001	0x03	16	Event 2
	0x08	0x3001	0x04	16	Event 3
	0x09	0x3001	0x05	16	Event 4
	0x0A	0x3002	0x01	16	Digital input
	0x0B	0x3002	0x02	16	Digital output
	0x0C	0x3003	0x01	16	Controller status
	0x0D	0x3003	0x02	16	Error status bit
	0x0E	0x3003	0x03	16	Sensor head status 1
	0x0F	0x3003	0x04	16	Sensor head status 2
	0x10	0x3003	0x05	16	Sensor head status 3
0x11	0x3003	0x06	16	Sensor head status 4	

The default RxPDO mapping is as follows. All objects in the output area (0x3100 to 0x31FF) are mapped by default. It is possible to delete the objects.

PDO index	PDO subindex	PDO entry index	PDO entry subindex	Bit length	Comment
0x1600	0x01	0x3100	0x01	16	Digital input

2 - 2 Communication Area

The objects in the communication area (0x1000 to 0x1FFF) are described below.

- Items in the tables

Index	SI	Data type	Access	Value	Comment
(Index_1)	Object code	Comment			
	(SI_1)	(Data type_1)	(Access_1)	(Value_1)	(Comment_1)
	(SI_2)	(Data type_2)	(Access_2)	(Value_2)	(Comment_2)
	⋮	⋮	⋮	⋮	⋮

Index: The object's index in a four-digit hexadecimal number

SI: The object's subindex in a two-digit hexadecimal number
For subindex 0x00, the object code is described instead.

Object code: The code of the object

Data type: The type of the object

Access: Read only (RO) or read and write (RW)

Value: Factory default setting

Comment: Object name or notes

Index	SI	Data type	Access	Value	Comment
0x1000	VAR	UDINT	RO	0x00000000	Device type
0x1001	VAR	USINT	RO	0	Error register
0x1008	VAR	V_STRING	RO	"K1G-C04E"	Device name
0x1009	VAR	V_STRING	RO	n.a.	Hardware version
0x100A	VAR	V_STRING	RO	n.a.	Software version
0x1018	RECORD	Identity object			
	0x01	UDINT	RO	0x00000629	Vender ID
	0x02	UDINT	RO	0x00000003	Product code
	0x03	UDINT	RO	0x00000100	Revision number
	0x04	UDINT	RO	0x00000000	Serial number *1
0x10F1	RECORD	Error settings (Not supported *2)			
	0x01	UDINT	RO	0x00000001	Local error reaction
	0x02	UINT	RO	0x0004	Sync error counter limit
0x1600	RECODE	RxPDO transmit PDO default mapping (1 max.)			
	0x01	UDINT	RW	0x31000110	RxPDO 1st parameter
0x1A00	RECODE	TxPDO transmit PDO default mapping (17 max.)			
	0x01	UDINT	RW	0x30000120	TxPDO 1st parameter
	0x02	UDINT	RW	0x30000220	TxPDO 2nd parameter
	0x03	UDINT	RW	0x30000320	TxPDO 3rd parameter
	0x04	UDINT	RW	0x30000420	TxPDO 4th parameter
	0x05	UDINT	RW	0x30010110	TxPDO 5th parameter
	0x06	UDINT	RW	0x30010210	TxPDO 6th parameter
	0x07	UDINT	RW	0x30010310	TxPDO 7th parameter
	0x08	UDINT	RW	0x30010410	TxPDO 8th parameter
	0x09	UDINT	RW	0x30010510	TxPDO 9th parameter
	0x0A	UDINT	RW	0x30020110	TxPDO 10th parameter
	0x0B	UDINT	RW	0x30020210	TxPDO 11th parameter
	0x0C	UDINT	RW	0x30030110	TxPDO 12th parameter
	0x0D	UDINT	RW	0x30030210	TxPDO 13th parameter
	0x0E	UDINT	RW	0x30030310	TxPDO 14th parameter
	0x0F	UDINT	RW	0x30030410	TxPDO 15th parameter
	0x10	UDINT	RW	0x30030510	TxPDO 16th parameter
0x11	UDINT	RW	0x30030610	TxPDO 17th parameter	
0x1C00	ARRAY	Sync manager type			
	0x01	USINT	RO	0x01	Mailbox out
	0x02	USINT	RO	0x02	Mailbox in
	0x03	USINT	RO	0x03	Process output data
	0x04	USINT	RO	0x04	Process input data

Index	SI	Data type	Access	Value	Comment
0x1C12	RECODE	Sync manager input PDO assignment (1 max.)			
	0x01	UINT	RO	0x1600	Input to K1G-C04E(G)
0x1C13	RECODE	Sync manager output PDO assignment (1 max.)			
	0x01	UINT	RO	0x1A00	Output from K1G-C04E(G)
0x1C32	RECODE	Sync manager parameter to sync ch2 (only Freerun is supported*3)			
	0x01	UINT	RO	0x0000	Synchronization type
	0x02	UDINT	RO	0x00000000	Cycle time *4
	0x04	UINT	RO	0x0001	Only Freerun is supported.
	0x05	UDINT	RO	0x0003D090	Minimum cycle time
	0x06	UDINT	RO	0x00000000	Calc and copy time
	0x08	UINT	RW	0x0000	Get cycle time
	0x09	UDINT	RO	0x00000000	Delay time
	0x0A	UDINT	RW	0x00000000	Sync0 cycle time
	0x0B	UINT	RO	0x0000	SM-Event missed
	0x0C	UINT	RO	0x0000	Cycle time too small
	0x20	BOOL	RO	FALSE	Sync error
0x1C33	RECODE	Sync manager parameter to sync ch3 (only Freerun is supported)			
	0x01	UINT	RO	0x0000	Synchronization type
	0x02	UDINT	RO	0x00000000	Cycle time *4
	0x04	UINT	RO	0x0001	Only Freerun is supported.
	0x05	UDINT	RO	0x0003D090	Minimum cycle time (250 μs)
	0x06	UDINT	RO	0x00000000	Calc and copy time
	0x08	UINT	RW	0x0000	Get cycle time
	0x09	UDINT	RO	0x00000000	Delay time
	0x0A	UDINT	RW	0x00000000	Sync0 cycle time
	0x0B	UINT	RO	0x0000	SM-Event missed
0x0C	UINT	RO	0x0000	Cycle time too small	
0x20	BOOL	RO	FALSE	Sync error	

*1. Serial numbers are not used, so this is always "0."

*2. An error settings object is defined, but functions related to it are not supported by this device.

*3. Only Freerun is supported as the synchronization mode.

*4. Cycle time is not supported.

2 - 3 Manufacturer Specific Area

■ Input Area (0x3000 to 0x30FF)

This area stores values measured by the K1G, and also operation results. Details on individual objects are given below.

- Items in the tables

Index	SI	Data type	Access	rx/tx	Comment
(Index_1)	Object code	Comment			
	(SI_1)	(Data type_1)	(Access_1)	(rx_tx_1)	(Comment_1)
	(SI_2)	(Data type_2)	(Access_2)	(rx_tx_2)	(Comment_2)
	:	:	:	:	:

Index: The object's index in a four-digit hexadecimal number

SI: The object's subindex in a two-digit hexadecimal number
For subindex 0x00, the object code is described instead.

Object code: The code of the object

Data type: The type of the object

Access: Read only (RO) or read and write (RW)

rx/tx: Indicates whether the object can be mapped to RxPDO (rx) or TxPDO (tx).

Comment: Object name or notes

Index	SI	Data type	Access	rx/tx	Comment
0x3000	RECORD	PV objects			
	0x01	DINT	RO	tx	PV1
	0x02	DINT	RO	tx	PV2
	0x03	DINT	RO	tx	PV3
	0x04	DINT	RO	tx	PV4
	◆ PV1 to PV4 Values measured by the sensor. A PV is a 32-bit integer in the ± 99.9999 mm range in units of 0.1 μm . Note that, for θ calculation, an integer for the angle in units of 0.0001 degrees is stored.				

Index	SI	Data type	Access	rx/tx	Comment																						
0x3001	RECORD	Event objects																									
	0x01	UINT	RO	tx	Event all																						
	0x02	UINT	RO	tx	Event 1																						
	0x03	UINT	RO	tx	Event 2																						
	0x04	UINT	RO	tx	Event 3																						
	0x05	UINT	RO	tx	Event 4																						
	<p>◆ Event 1 to Event 4 Event judgment results for sensor heads 1 to 4 and PV1 to PV4. Information shown below is stored. "Event all" stores the result of an OR calculation for Events 1 to 4.</p> <table border="1"> <thead> <tr> <th>Assignment</th> <th>Event occurrence status*</th> </tr> </thead> <tbody> <tr> <td>Bit 0</td> <td>Pass event occurrence</td> </tr> <tr> <td>Bit 1</td> <td>Out event occurrence</td> </tr> <tr> <td>Bit 2</td> <td>High event occurrence</td> </tr> <tr> <td>Bit 3</td> <td>Low event occurrence</td> </tr> <tr> <td>Bit 4</td> <td>EPS event occurrence</td> </tr> <tr> <td>Bit 5</td> <td>Hold event occurrence</td> </tr> <tr> <td>Bit 6</td> <td>Smudge detection event occurrence</td> </tr> <tr> <td>Bit 7</td> <td>Output update event occurrence</td> </tr> <tr> <td>Bit 8</td> <td>Normal operation event occurrence</td> </tr> <tr> <td>Bits 9–15</td> <td>No assignment (always 0)</td> </tr> </tbody> </table> <p>* Event occurred, 0: No event</p>					Assignment	Event occurrence status*	Bit 0	Pass event occurrence	Bit 1	Out event occurrence	Bit 2	High event occurrence	Bit 3	Low event occurrence	Bit 4	EPS event occurrence	Bit 5	Hold event occurrence	Bit 6	Smudge detection event occurrence	Bit 7	Output update event occurrence	Bit 8	Normal operation event occurrence	Bits 9–15	No assignment (always 0)
	Assignment	Event occurrence status*																									
	Bit 0	Pass event occurrence																									
	Bit 1	Out event occurrence																									
Bit 2	High event occurrence																										
Bit 3	Low event occurrence																										
Bit 4	EPS event occurrence																										
Bit 5	Hold event occurrence																										
Bit 6	Smudge detection event occurrence																										
Bit 7	Output update event occurrence																										
Bit 8	Normal operation event occurrence																										
Bits 9–15	No assignment (always 0)																										
<p>☞ 4-5, "Using Digital Input (DI) and Digital Output (DO)" in <i>K1G Series High-Accuracy Position Sensor User's Manual, No. CP-SP-1385E</i> and in <i>K1G Series High-Accuracy Position Sensor Global Model User's Manual, No. CP-SP-1397E</i> (for the conditions for event occurrence)</p>																											

Index	SI	Data type	Access	rx/tx	Comment																															
0x3002	RECORD	Digital input / Digital output objects																																		
	0x01	UINT	RO	tx	Digital input																															
	0x02	UINT	RO	tx	Digital output																															
	<p>◆ Digital input A digital input command from the EtherCAT master device (0x3100.01 input value) that was recognized by the K1G. Details on individual objects are given below.</p> <table border="1"> <thead> <tr> <th>Assignment</th> <th>Event occurrence</th> </tr> </thead> <tbody> <tr> <td>Bit 0</td> <td>DI1: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 1</td> <td>DI2: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 2</td> <td>DI3: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 3</td> <td>DI4: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 4-15</td> <td>No assignment (always 0)</td> </tr> </tbody> </table> <p>◆ Digital output A digital output value. Details on individual objects are given below.</p> <table border="1"> <thead> <tr> <th>Assignment</th> <th>Event occurrence</th> </tr> </thead> <tbody> <tr> <td>Bit 0</td> <td>DO1: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 1</td> <td>DO2: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 2</td> <td>DO3: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 3</td> <td>DO4: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 4</td> <td>DO5: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 5</td> <td>DO6: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 6</td> <td>DO7: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 7</td> <td>DO8: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 8-15</td> <td>No assignment (always 0)</td> </tr> </tbody> </table>					Assignment	Event occurrence	Bit 0	DI1: ON =1, OFF = 0	Bit 1	DI2: ON =1, OFF = 0	Bit 2	DI3: ON =1, OFF = 0	Bit 3	DI4: ON =1, OFF = 0	Bit 4-15	No assignment (always 0)	Assignment	Event occurrence	Bit 0	DO1: ON =1, OFF = 0	Bit 1	DO2: ON =1, OFF = 0	Bit 2	DO3: ON =1, OFF = 0	Bit 3	DO4: ON =1, OFF = 0	Bit 4	DO5: ON =1, OFF = 0	Bit 5	DO6: ON =1, OFF = 0	Bit 6	DO7: ON =1, OFF = 0	Bit 7	DO8: ON =1, OFF = 0	Bit 8-15
Assignment	Event occurrence																																			
Bit 0	DI1: ON =1, OFF = 0																																			
Bit 1	DI2: ON =1, OFF = 0																																			
Bit 2	DI3: ON =1, OFF = 0																																			
Bit 3	DI4: ON =1, OFF = 0																																			
Bit 4-15	No assignment (always 0)																																			
Assignment	Event occurrence																																			
Bit 0	DO1: ON =1, OFF = 0																																			
Bit 1	DO2: ON =1, OFF = 0																																			
Bit 2	DO3: ON =1, OFF = 0																																			
Bit 3	DO4: ON =1, OFF = 0																																			
Bit 4	DO5: ON =1, OFF = 0																																			
Bit 5	DO6: ON =1, OFF = 0																																			
Bit 6	DO7: ON =1, OFF = 0																																			
Bit 7	DO8: ON =1, OFF = 0																																			
Bit 8-15	No assignment (always 0)																																			

Index	SI	Data type	Access	rx/tx	Comment																									
0x3003	RECORD	Device status																												
	0x01	UINT	RO	tx	Controller status																									
	0x02	UINT	RO	tx	Error status bit																									
	0x03	UINT	RO	tx	Sensor head status 1																									
	0x04	UINT	RO	tx	Sensor head status 2																									
	0x05	UINT	RO	tx	Sensor head status 3																									
	0x06	UINT	RO	tx	Sensor head status 4																									
	<p>◆ Controller status The status of the controller</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Controller status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No error</td> </tr> <tr> <td>1</td> <td>Partial sensor head disconnection</td> </tr> <tr> <td>2</td> <td>Device failure</td> </tr> <tr> <td>15*</td> <td>Starting up</td> </tr> </tbody> </table> <p>* "15" indicates that the slave device is not ready for measuring.</p>						Value	Controller status	0	No error	1	Partial sensor head disconnection	2	Device failure	15*	Starting up														
	Value	Controller status																												
	0	No error																												
	1	Partial sensor head disconnection																												
	2	Device failure																												
	15*	Starting up																												
	<p>◆ Error status bit The error status of the controller</p> <table border="1"> <thead> <tr> <th>Assignment</th> <th>Error status bit*</th> </tr> </thead> <tbody> <tr> <td>Bit 0</td> <td>CPU in infinite loop</td> </tr> <tr> <td>Bit 1</td> <td>FPGA malfunction</td> </tr> <tr> <td>Bit 2</td> <td>ROM error</td> </tr> <tr> <td>Bit 3</td> <td>EEPROM error</td> </tr> <tr> <td>Bit 4</td> <td>Ch1 sensor head disconnection</td> </tr> <tr> <td>Bit 5</td> <td>Ch2 sensor head disconnection</td> </tr> <tr> <td>Bit 6</td> <td>Ch3 sensor head disconnection</td> </tr> <tr> <td>Bit 7</td> <td>Ch4 sensor head disconnection</td> </tr> <tr> <td>Bit 8</td> <td>System error</td> </tr> <tr> <td>Bit 9</td> <td>EtherCAT communication error</td> </tr> <tr> <td>Bits 10–15</td> <td>No assignment (always 0)</td> </tr> </tbody> </table> <p>* Event occurred, 0: No event</p>						Assignment	Error status bit*	Bit 0	CPU in infinite loop	Bit 1	FPGA malfunction	Bit 2	ROM error	Bit 3	EEPROM error	Bit 4	Ch1 sensor head disconnection	Bit 5	Ch2 sensor head disconnection	Bit 6	Ch3 sensor head disconnection	Bit 7	Ch4 sensor head disconnection	Bit 8	System error	Bit 9	EtherCAT communication error	Bits 10–15	No assignment (always 0)
	Assignment	Error status bit*																												
Bit 0	CPU in infinite loop																													
Bit 1	FPGA malfunction																													
Bit 2	ROM error																													
Bit 3	EEPROM error																													
Bit 4	Ch1 sensor head disconnection																													
Bit 5	Ch2 sensor head disconnection																													
Bit 6	Ch3 sensor head disconnection																													
Bit 7	Ch4 sensor head disconnection																													
Bit 8	System error																													
Bit 9	EtherCAT communication error																													
Bits 10–15	No assignment (always 0)																													
<p>◆ Sensor head statuses 1 to 4 The status of sensor head connection and adjustment</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Sensor head status</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Not connected</td> </tr> <tr> <td>1</td> <td>Not adjusted</td> </tr> <tr> <td>2</td> <td>In use</td> </tr> <tr> <td>3</td> <td>Wrong connection</td> </tr> <tr> <td>4</td> <td>Disconnected</td> </tr> <tr> <td>5</td> <td>Prohibited</td> </tr> </tbody> </table>						Value	Sensor head status	0	Not connected	1	Not adjusted	2	In use	3	Wrong connection	4	Disconnected	5	Prohibited											
Value	Sensor head status																													
0	Not connected																													
1	Not adjusted																													
2	In use																													
3	Wrong connection																													
4	Disconnected																													
5	Prohibited																													

■ Output object (0x3100 to 0x31FF)

Command signals to the K1G are stored in this area. Details on individual objects are given below.

Index	SI	Data type	Access	rx/tx	Comment											
0x3100	RECORD	Digital input														
	0x01	UINT	RW	rx	Digital input											
	<p>◆ Digital input The EtherCAT master device can send digital input commands to the K1G. The result can be checked at 0x3002.01. Details on individual objects are given below.</p> <table border="1"> <thead> <tr> <th>Assignment</th> <th>Event occurrence</th> </tr> </thead> <tbody> <tr> <td>Bit 0</td> <td>DI1: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 1</td> <td>DI2: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 2</td> <td>DI3: ON =1, OFF = 0</td> </tr> <tr> <td>Bit 3</td> <td>DI4: ON =1, OFF = 0</td> </tr> <tr> <td>Bits 4–15</td> <td>No assignment (always 0)</td> </tr> </tbody> </table>					Assignment	Event occurrence	Bit 0	DI1: ON =1, OFF = 0	Bit 1	DI2: ON =1, OFF = 0	Bit 2	DI3: ON =1, OFF = 0	Bit 3	DI4: ON =1, OFF = 0	Bits 4–15
Assignment	Event occurrence															
Bit 0	DI1: ON =1, OFF = 0															
Bit 1	DI2: ON =1, OFF = 0															
Bit 2	DI3: ON =1, OFF = 0															
Bit 3	DI4: ON =1, OFF = 0															
Bits 4–15	No assignment (always 0)															

Memo

Chapter 3. ESI FILE

The ESI file for the K1G-C04E(G) can be downloaded from the website indicated below (search for K1G, “Download product documents,” and “EtherCAT ESI file”).

Compo Club URL: <http://www.compoclub.com/>

EtherCAT ESI file: Azbil_K1G_REV100.xml

Memo

APPENDIX

APP-1 Specifications Compliance

This device conforms to the following ETG specifications.

Number	Document	Type <STATE>	Version	Date
ETG.1000.2	EtherCAT Specification – Part 2 – Physical Layer Service Definition and Protocol Specification	S<R>	V1.0.3	2013/01/21
ETG.1000.3	EtherCAT Specification – Part 3 – Data Link Layer Service Definition	S<R>	V1.0.3	2013/01/21
ETG.1000.4	EtherCAT Specification – Part 4 – Data Link Layer Protocol Definition	S<R>	V1.0.3	2013/01/21
ETG.1000.5	EtherCAT Specification – Part 5 – Application Layer Service Definition	S<R>	V1.0.3	2013/01/21
ETG.1000.6	EtherCAT Specification – Part 6 – Application Layer Protocol Specification	S<R>	V1.0.3	2013/01/21
ETG.1020	EtherCAT Protocol Enhancements	S<R>	V1.2.0	2015/12/01
ETG.1300	EtherCAT Indicator and Labeling Specification	S<R>	V1.1.1	2015/07/03
ETG.2000	EtherCAT Slave Information Specification	S<R>	V1.0.7	2014/09/01
ETG.9001	EtherCAT Marking Rules	S<R>	V1.2.4	2016/3/04

APP-2 Terminology

Term	Description	Remarks
ESI	EtherCAT slave information	Slave device information
SII	Slave information interface	Slave device basic information
PDO	Process data objects	Cyclic data
TxPDO	Transmit PDO	Cyclic data that a master device reads out from a slave device
RxPDO	Receive PDO	Cyclic data that a master device writes to a slave device
CoE	CAN application protocol over EtherCAT	The CAN protocol over EtherCAT
SDO	Service data objects	Objects for data exchange between master and slave
ESC	EtherCAT slave controller	EtherCAT slave device
ENI	EtherCAT network information	EtherCAT network information

Term	Description
Master	Controls communication (data input and output) with connected slaves.
Slave	Receives data that is output from the master and transmits data to the master.
ECAT ID	An identifier for units connected to the EtherCAT network

Terms and Conditions

We would like to express our appreciation for your purchase and use of Azbil Corporation's products. You are required to acknowledge and agree upon the following terms and conditions for your purchase of Azbil Corporation's products (system products, field instruments, control valves, and control products), unless otherwise stated in any separate document, including, without limitation, estimation sheets, written agreements, catalogs, specifications and instruction manuals.

1. Warranty period and warranty scope

1.1 Warranty period

Azbil Corporation's products shall be warranted for one (1) year from the date of your purchase of the said products or the delivery of the said products to a place designated by you.

1.2 Warranty scope

In the event that Azbil Corporation's product has any failure attributable to azbil during the aforementioned warranty period, Azbil Corporation shall, without charge, deliver a replacement for the said product to the place where you purchased, or repair the said product and deliver it to the aforementioned place.

Notwithstanding the foregoing, any failure falling under one of the following shall not be covered under this warranty:

- (1) Failure caused by your improper use of azbil product (noncompliance with conditions, environment of use, precautions, etc. set forth in catalogs, specifications, instruction manuals, etc.);
- (2) Failure caused for other reasons than Azbil Corporation's product;
- (3) Failure caused by any modification or repair made by any person other than Azbil Corporation or Azbil Corporation's subcontractors;
- (4) Failure caused by your use of Azbil Corporation's product in a manner not conforming to the intended usage of that product;
- (5) Failure that the state-of-the-art at the time of Azbil Corporation's shipment did not allow Azbil Corporation to predict; or
- (6) Failure that arose from any reason not attributable to Azbil Corporation, including, without limitation, acts of God, disasters, and actions taken by a third party.

Please note that the term "warranty" as used herein refers to equipment-only-warranty, and Azbil Corporation shall not be liable for any damages, including direct, indirect, special, incidental or consequential damages in connection with or arising out of Azbil Corporation's products.

2. Ascertainment of suitability

You are required to ascertain the suitability of Azbil Corporation's product in case of your use of the same with your machinery, equipment, etc. (hereinafter referred to as "Equipment") on your own responsibility, taking the following matters into consideration:

- (1) Regulations and standards or laws that your Equipment is to comply with.
- (2) Examples of application described in any documents provided by Azbil Corporation are for your reference purpose only, and you are required to check the functions and safety of your Equipment prior to your use.
- (3) Measures to be taken to secure the required level of the reliability and safety of your Equipment in your use

Although azbil is constantly making efforts to improve the quality and reliability of Azbil Corporation's products, there exists a possibility that parts and machinery may break down.

You are required to provide your Equipment with safety design such as fool-proof design, *1 and fail-safe design*2 (anti-flame propagation design, etc.), whereby preventing any occurrence of physical injuries, fires, significant damage, and so forth. Furthermore, fault avoidance,*3 fault tolerance,*4 or the like should be incorporated so that the said Equipment can satisfy the level of reliability and safety required for your use.

*1. A design that is safe even if the user makes an error.

*2. A design that is safe even if the device fails.

*3. Avoidance of device failure by using highly reliable components, etc.

*4. The use of redundancy.

3. Precautions and restrictions on application

Azbil Corporation's products other than those explicitly specified as applicable (e.g. azbil Limit Switch For Nuclear Energy) shall not be used in a nuclear energy controlled area (radiation controlled area).

Any Azbil Corporation's products shall not be used for/with medical equipment.

The products are for industrial use. Do not allow general consumers to install or use any Azbil Corporation's product.

However, azbil products can be incorporated into products used by general consumers. If you intend to use a product for that purpose, please contact one of our sales representatives.

In addition,

you are required to conduct a consultation with our sales representative and understand detail specifications, cautions for operation, and so forth by reference to catalogs, specifications, instruction manual, etc. in case that you intend to use azbil product for any purposes specified in (1) through (6) below.

Moreover, you are required to provide your Equipment with fool-proof design, fail-safe design, anti-flame propagation design, fault avoidance, fault tolerance, and other kinds of protection/safety circuit design on your own responsibility to ensure reliability and safety, whereby preventing problems caused by failure or nonconformity.

- (1) For use under such conditions or in such environments as not stated in technical documents, including catalogs, specification, and instruction manuals
- (2) For use of specific purposes, such as:
 - * Nuclear energy/radiation related facilities
[For use outside nuclear energy controlled areas] [For use of Azbil Corporation's Limit Switch For Nuclear Energy]
 - * Machinery or equipment for space/sea bottom
 - * Transportation equipment
[Railway, aircraft, vessels, vehicle equipment, etc.]
 - * Antidisaster/crime-prevention equipment

- * Burning appliances
 - * Electrothermal equipment
 - * Amusement facilities
 - * Facilities/applications associated directly with billing
- (3) Supply systems such as electricity/gas/water supply systems, large-scale communication systems, and traffic/air traffic control systems requiring high reliability
 - (4) Facilities that are to comply with regulations of governmental/public agencies or specific industries
 - (5) Machinery or equipment that may affect human lives, human bodies or properties
 - (6) Other machinery or equipment equivalent to those set forth in items (1) to (5) above which require high reliability and safety
4. Precautions against long-term use

Use of Azbil Corporation's products, including switches, which contain electronic components, over a prolonged period may degrade insulation or increase contact-resistance and may result in heat generation or any other similar problem causing such product or switch to develop safety hazards such as smoking, ignition, and electrification. Although acceleration of the above situation varies depending on the conditions or environment of use of the products, you are required not to use any Azbil Corporation's products for a period exceeding ten (10) years unless otherwise stated in specifications or instruction manuals.
 5. Recommendation for renewal

Mechanical components, such as relays and switches, used for Azbil Corporation's products will reach the end of their life due to wear by repetitious open/close operations. In addition, electronic components such as electrolytic capacitors will reach the end of their life due to aged deterioration based on the conditions or environment in which such electronic components are used. Although acceleration of the above situation varies depending on the conditions or environment of use, the number of open/close operations of relays, etc. as prescribed in specifications or instruction manuals, or depending on the design margin of your machine or equipment, you are required to renew any Azbil Corporation's products every 5 to 10 years unless otherwise specified in specifications or instruction manuals. System products, field instruments (sensors such as pressure/flow/level sensors, regulating valves, etc.) will reach the end of their life due to aged deterioration of parts. For those parts that will reach the end of their life due to aged deterioration, recommended replacement cycles are prescribed. You are required to replace parts based on such recommended replacement cycles.
 6. Other precautions

Prior to your use of Azbil Corporation's products, you are required to understand and comply with specifications (e.g., conditions and environment of use), precautions, warnings/cautions/notices as set forth in the technical documents prepared for individual Azbil Corporation's products, such as catalogs, specifications, and instruction manuals to ensure the quality, reliability, and safety of those products.
 7. Changes to specifications

Please note that the descriptions contained in any documents provided by azbil are subject to change without notice for improvement or for any other reason. For inquires or information on specifications as you may need to check, please contact our branch offices or sales offices, or your local sales agents.
 8. Discontinuance of the supply of products/parts

Please note that the production of any Azbil Corporation's product may be discontinued without notice. For repairable products, we will, in principle, undertake repairs for five (5) years after the discontinuance of those products. In some cases, however, we cannot undertake such repairs for reasons, such as the absence of repair parts. For system products, field instruments, we may not be able to undertake parts replacement for similar reasons.
 9. Scope of services

Prices of Azbil Corporation's products do not include any charges for services such as engineer dispatch service. Accordingly, a separate fee will be charged in any of the following cases:

 - (1) Installation, adjustment, guidance, and attendance at a test run
 - (2) Maintenance, inspection, adjustment, and repair
 - (3) Technical guidance and technical education
 - (4) Special test or special inspection of a product under the conditions specified by you

Please note that we cannot provide any services as set forth above in a nuclear energy controlled area (radiation controlled area) or at a place where the level of exposure to radiation is equivalent to that in a nuclear energy controlled area.



Specifications are subject to change without notice. (09)

Azbil Corporation
Advanced Automation Company

1-12-2 Kawana, Fujisawa
Kanagawa 251-8522 Japan

URL: <http://www.azbil.com>

1st edition: June 2017 (V)