Chapter 10

PROFIBUS Communications

10.1 PROFIBUS Network Overview

PROFIBUS is an open, vendor-independent fieldbus standard for a wide range of applications in industrial automation, including motion control.

PROFIBUS is a dynamic technology that grows functionally while complying with the European Fieldbus Standard EN 50 170.

PROFIBUS Guidelines and Profiles provide the means for further technical development based on the ever-changing communication requirements of the networks, systems, and devices used in today's industrial automation applications.

PROFIBUS specifications reference three different protocols to cover a range of industrial requirements:

PROFIBUS – DP	High speed data communication. DP stands for *Decentralized Periphery*. In practice, the majority of slave applications are DP applications. The GE Fanuc S2K Motion Controller is a PROFIBUS-DP Slave device.
PROFIBUS – FMS	Object oriented general-purpose data communication. FMS stands for *Fieldbus Message Specification*. FMS protocol devices may exchange data on the same bus used for DP devices.
PROFIBUS – PA	Meets requirements for intrinsical safety and non-intrinsical safety areas and includes bus-powered field devices.

The PROFIBUS logo is a trademark of the PROFIBUS International Organization. Membership in the organization is open to all individuals, companies and organizations. More information about the organization and the protocol is available at http://www.profibus.com

10.1.1 Bus Communication

The PROFIBUS specification defines the technical characteristics of a serial field bus system that links distributed digital controllers on the network, from field level to cell level. PROFIBUS is a multi-master system that allows the joint operation of several automation, engineering or visualization systems with their distributed peripherals on one bus. PROFIBUS distinguishes between the following types of devices:

- **Master devices** determine the data communication on the bus. A master can send messages without an external request when it holds the bus access rights (the token). Masters are also called active stations.

- **Slave devices** include motion controllers, drives, I/O devices, valves, and transducers. Slaves do not have bus access rights and can only acknowledge received messages or send messages to the master when requested to do so. Slave devices are passive stations and require only small portions of the bus protocol.

The majority of PROFIBUS-DP applications are located at the field level. The field level typically includes slave devices (i.e. the S2K motion controller station) and host devices such as PLC or PC control systems for the PROFIBUS-DP master station. Operator interfaces and DCS type systems usually operate at the cell level.

Table 10-1. Data bandwidth demands on PROFIBUS communications systems

Level	Amount of Data	Transmission Duration	Transmission Frequency
Management level	Mbytes	Hours/Minutes	Day/Shift
Cell level	Kbytes	Seconds	Hours/Minutes
Field Level	Bytes	Several 100 µseconds to 100 milliseconds	10 to 100 milliseconds
Actuator sensor level	Bits	µsec to milliseconds	Milliseconds

10.1.2 Network Topology

A PROFIBUS-DP network may have up to 127 stations (address 0-126), however address 126 is reserved for commissioning purposes. The bus system must be sub-divided into individual segments to handle this many participants. These segments are linked by repeaters. The function of a repeater is to condition the serial signal to allow connection of segments. In practice, both regenerating and non-regenerating repeaters may be used. Regenerating repeaters actually condition the signal to allow increased range of the bus. *Up to 32 stations are allowed per segment and the repeater counts as a station address.*

A specialized “link” segment consisting only of optical fiber modem repeaters may be used to span long distances. Plastic fiber optic segments are typically 50 meters or less while glass fiber optic segments may extend several kilometers.

The user assigns a unique PROFIBUS station address to identify each master, slave, or repeater in the entire network. Each participant on the bus must have a unique station address.

Network addresses for the GE Fanuc S2K products are established using the DIP switches located on the bottom of the controller. *The GE Fanuc S2K controllers accommodate addresses 0 – 99.*

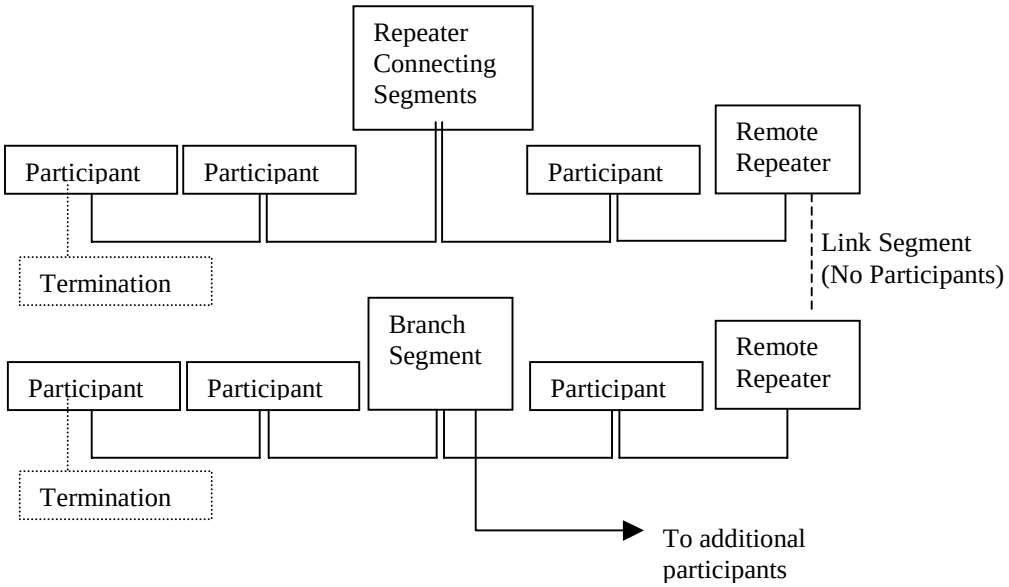

Figure 10-1. Repeaters and bus termination

10.1.3 Network Segment Length

PROFIBUS uses either fiber optic or RS-485 copper media. The copper bus line specified in EN 50 170 is "Line Type A" and is the recommended cable type. A more economical copper cable "Line Type B" is commonly used for smaller installations however is not specified in EN 50 170. It is extremely important to use cable rated to PROFIBUS specifications. The higher the baud rate selected and the longer the distances involved the more critical cable selection becomes. You will recognize the distinctive purple color of PROFIBUS cable.

Stub or "T" type branch connections are supported if the total stub (branch) lengths do not exceed 6.6 meters. Do not use stubs at all on 12 Mbaud networks.

The data rates for network communication with maximum segment trunk length per cable type are provided below. Multiple segments may be connected via repeater stations to extend the total bus length.

Table 10-2. Network Data Rates and segment distance limitations

Data Rates	9600 baud 19.2 Kbaud 93.75 Kbaud	187.5 Kbaud	500 Kbaud	1,500 Kbaud	3,000 Kbaud 6,000 Kbaud 12 Mbaud
Trunk distance: Line Type A RS-485 Copper	1.2 km (~3,937 ft)	1,000 m (~3,280 ft)	400 m (~1,312 ft)	200 m (~656 ft)	100 m (~328 ft)
Trunk distance: Line Type B RS-485 Copper	1.2 km (~3,937 ft)	600 m (~1,968 ft)	200 m (~656 ft)	N/A	N/A
Trunk Distance: (glass) Fiber	@ 6 km (~19,685 ft)				

10.1.4 Network connectors

PROFIBUS connections are created with a 9 pin sub-D connector. A minimum connection is to use a shielded pair of wires (Pins 1, 3 and 8) with terminating connections in the appropriate bus plugs. The pin to signal conventions are described below.

Table 10-2. Plug Connector Pin Allocation of the PROFIBUS Bus Plug Connector

Pin No.	Signal	Designation
1	Shield	Shield / Protective Ground
2	M24	Ground / Common of the 24 V output voltage
3	RxD/TxD-P	Receive data / transmission data plus
4	CNTR-P	Control signal for repeaters (direction control)
5	DGND	Data transmission potential (ground to 5V)
6	VP	Supply voltage of the terminating resistance (+ 5 V)
7	P24	Output voltage (+ 24 V)
8	RxD/TxD-N	Receive data / transmission data negative
9	CNTR-N	Control signal for repeaters (direction control)

10.1.5 Network Termination

The bus must be terminated at both ends of the trunk line. Commercially available plug connectors may have built in terminating resistors or you may build your own.

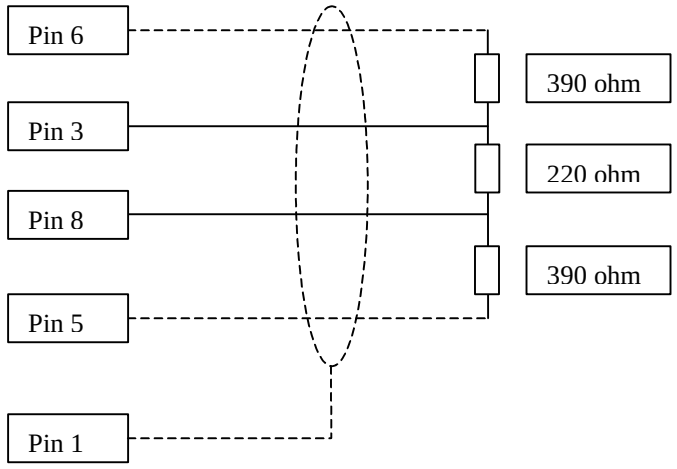

Figure 10-2. Bus Termination for Type A cable in accordance to PROFIBUS specifications

10.1.6 Network Baud Rate

The master configures the appropriate network baud for each station on the network. Allowed values for S2K network baud rates are: 9,600; 19,200; 45,450; 93,750; 187,500; 500,000; 1,500,000; 3,000,000; 6,000,000; or 12,000,000.

10.2 Getting Started

The following information is intended to outline the steps required to commission a S2K and incorporate it into a PROFIBUS network segment.

10.2.1 Connection Checklist

GE Fanuc-Supplied Components

1 S2K controller with PROFIBUS per axis

1 motor per axis

Cables

CIMPLICITY Motion Developer software

User-Supplied Components

DC power to digital I/O

16-gauge wire to jumper I/O connectors

PROFIBUS network hardware

10.2.2 Complete Basic Set-up Procedure

Before you connect and use your S2K controller on PROFIBUS, take a few minutes to complete the Process for Basic Set-up located in Chapter 4:

The set-up process takes you systematically through each of the following items:

- Install software
- Connect cables
- Jumper dedicated I/O (if applicable)
- Establish communication with the controller
- Complete basic equipment configuration
- Run the motor to verify correct set-up.

If you are using multiple S2K controllers, repeat the set-up for each controller. When you have completed the set-up, leave your connections and jumpers in place—you're ready to configure your PROFIBUS system.

To operate S2K Controllers for PROFIBUS, the S2K controller requires some simple network configuration before being used.

Step 1: Set the PROFIBUS Address

The PROFIBUS address provides a unique network address, from 0 through 99, for each S2K node. S2K controllers ship from the factory with the PROFIBUS address set to one.

Caution: Ensure that controller power is off before you handle DIP switches.

Use the DIP switches located on the bottom of the controller to set the PROFIBUS address to a network address indicated in figure 10-4.

Figure 10-3 shows the location of the controller switches and the proper orientation for left and right switch settings.

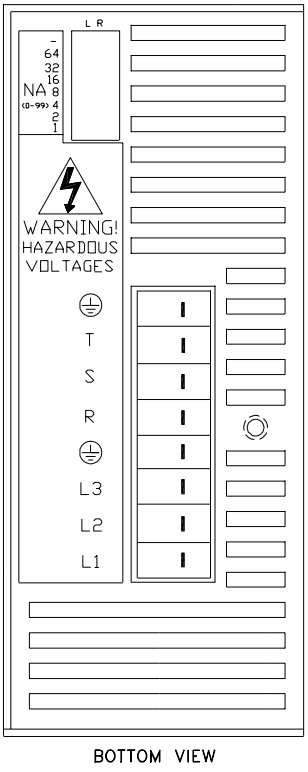

Figure 10-4. Location of DIP Switches on Bottom of S2K Controller

DIP Switch Positions (2)

Profibus Address		1	2	4	8	16	32
(NA) 0	64	R	R	R	R	R	R
1	65	L	R	R	R	R	R
2	66	R	L	R	R	R	R
3	67	L	L	R	R	R	R
4	68	R	R	L	R	R	R
5	69	L	R	L	R	R	R
6	70	R	L	L	R	R	R
7	71	L	L	L	R	R	R
8	72	R	R	R	L	R	R
9	73	L	R	R	L	R	R
10	74	R	L	R	L	R	R
11	75	L	L	R	L	R	R
12	76	R	R	L	L	R	R
13	77	L	R	L	L	R	R
14	78	R	L	L	L	R	R
15	79	L	L	L	L	R	R
16	80	R	R	R	R	L	R
17	81	L	R	R	R	L	R
18	82	R	L	R	R	L	R
19	83	L	L	R	R	L	R
20	84	R	R	L	R	L	R
21	85	L	R	L	R	L	R
22	86	R	L	L	R	L	R
23	87	L	L	L	R	L	R
24	88	R	R	R	L	L	R
25	89	L	R	R	L	L	R
26	90	R	L	R	L	L	R
27	91	L	L	R	L	L	R
28	92	R	R	L	L	L	R
29	93	L	R	L	L	L	R
30	94	R	L	L	L	L	R
31	95	L	L	L	L	L	R
32	96	R	R	R	R	R	L
33	97	L	R	R	R	R	L
34	98	R	L	R	R	R	L
35	99	L	L	R	R	R	L
36	–	R	R	L	R	R	L
37	–	L	R	L	R	R	L
38	–	R	L	L	R	R	L
39	–	L	L	L	R	R	L
40	–	R	R	R	L	R	L
41	–	L	R	R	L	R	L
42	–	R	L	R	L	R	L
43	–	L	L	R	L	R	L
44	–	R	R	L	L	R	L
45	–	L	R	L	L	R	L
46	–	R	L	L	L	R	L
47	–	L	L	L	L	R	L
48	–	R	R	R	R	L	L
49	–	L	R	R	R	L	L
50	–	R	L	R	R	L	L
51	–	L	L	R	R	L	L
52	–	R	R	L	R	L	L
53	–	L	R	L	R	L	L
54	–	R	L	L	R	L	L
55	–	L	L	L	R	L	L
56	–	R	R	R	L	L	L
57	–	L	R	R	L	L	L
58	–	R	L	R	L	L	L
59	–	L	L	R	L	L	L
60	–	R	R	L	L	L	L
61	–	L	R	L	L	L	L
62	–	R	L	L	L	L	L
63	–	L	L	L	L	L	L

Profibus address	64 –
0–63	R X
64–99	L X

Figure 10-3. S2K DIP Switch Profibus Address Settings

Step 2: Configure Master to Add Slave to the Network

PROFIBUS-DP systems accept S2K controllers as slaves to a network master. The network master automatically sets the network data rate for the S2K controllers that have been properly configured and connected to the network.

A device electronic data sheet or GSD file for the S2K Motion Controller is available from GE Fanuc to expedite the master configuration. A GSD file contains information to specify methods of communication and types of messaging available. Most PROFIBUS master configuration tools require the GSD file in order to operate.

10.2.3 The GSD File Data for the S2K Motion Controller

```
;=======================================================
; GSD File   Standalone Motion Controller
;
; Version:  V1.0
;=======================================================
#Profibus_DP
GSD_Revision        = 1

;General parameters
Vendor_Name         = "Whedco, Inc."
Model_Name          = "Standalone Motion Controller"
Revision            = "V1.0"
Ident_Number        = 0x05E9
Protocol_Ident      = 0
Station_Type        = 0
FMS_supp            = 0
Hardware_Release    = "D"
Software_Release    = "V1.0"
9.6_supp            = 1
19.2_supp           = 1
45.45_supp          = 1
93.75_supp          = 1
187.5_supp          = 1
500_supp            = 1
1.5M_supp           = 1
3M_supp             = 1
6M_supp             = 1
12M_supp            = 1
MaxTsdr_9.6         = 60
MaxTsdr_19.2        = 60
MaxTsdr_45.45       = 250
MaxTsdr_93.75       = 60
MaxTsdr_187.5       = 60
MaxTsdr_500         = 100
MaxTsdr_1.5M        = 150
MaxTsdr_3M          = 250
MaxTsdr_6M          = 450
MaxTsdr_12M         = 800
Redundancy          = 0
```

```
Repeater_Ctrl_Sig    = 2
24V_Pins             = 0
Implementation_Type  = "DPC31"

; Slave-Specification:
Freeze_Mode_supp     = 1
Sync_Mode_supp       = 1
Auto_Baud_supp       = 1
Set_Slave_Add_Supp   = 0
User_Prm_Data_Len    = 3             ; 3 bytes for DPV1
User_Prm_Data        = 0x00,0x00,0x00
Fail_Safe            = 1
Min_Slave_Intervall  = 1
Max_Diag_Data_Len    = 6
Modul_Offset         = 0
Slave_Family         = 1      ; Drive Family
Modular_Station      = 1
Max_Module           = 1     ; Only one module at a time
Max_Input_Len        = 20  ; 20 bytes input data
Max_Output_Len       = 20; + 20 bytes output data
Max_Data_Len         = 40  ; = 40 bytes I/O data

; Module Definition List
;
; PPO Type 1 (PKW 4 words, PZD 2 words)
;
Module = "PPO-Type 1" 0xF3, 0xF1
EndModule
;
; PPO Type 2 (PKW 4 words, PZD 6 words)
;
Module = "PPO-Type 2" 0xF3, 0xF5
EndModule
;
; PPO Type 3 (PZD 2 words)
;
Module = "PPO-Type 3" 0xF1
EndModule
;
; PPO Type 4 (PZD 6 words)
;
Module = "PPO-Type 4" 0xF5
EndModule
```

10.3 Overview of Master/Slave Station Types

The PROFIBUS-DP protocol defines two station types: Masters and Slaves. Masters form the logical token ring and may access the medium while holding the token. Masters initiate message cycles to other stations. There are two classes of master devices. The class 1 master handles the data exchange with slaves assigned to it. The class 2 master is provided for configuration purposes and may briefly take over control of a given slave device. Commonly only a class 1 master (mono master) is used for configuration and data messaging.

During startup, the master sets up the communication connections to the configured slave list and begins the cyclic polling process. A monitoring time is established and if communication is not possible, an error in communications is reported. This monitoring time is reset on each successful message transfer. Slave stations are configured and added to the messaging sequence from lowest address to highest address.

Slaves act neutrally with respect to medium access and respond to requests from master stations only within a message cycle. All slaves have the same priority for bus access. When a slave detects a loss of communication, it sets outputs to a known state and waits for a configuration message from a master station.

S2K motion controllers serve as slaves on a PROFIBUS-DP network.

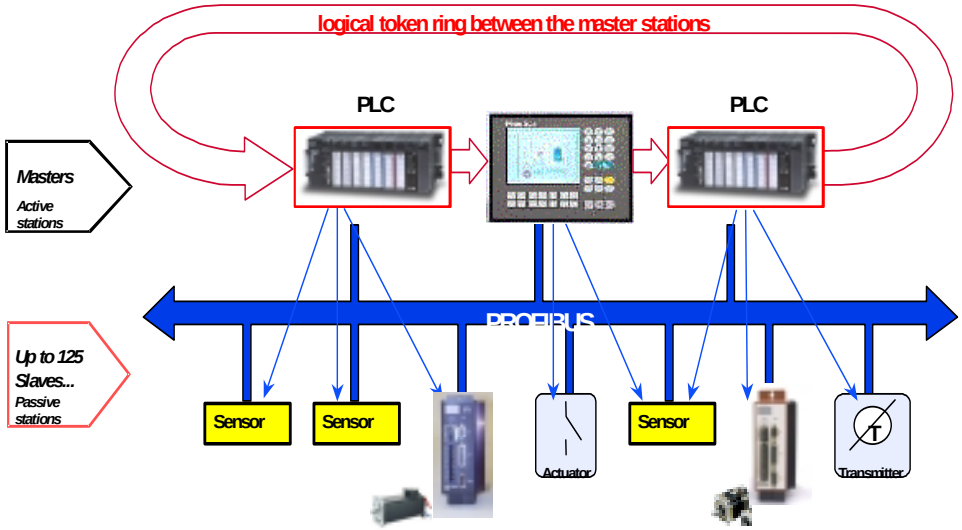

Figure 10-5. PROFIBUS Master/Slave Network Architecture

10.3.1 PROFIBUS Communication

S2K's communicate via cyclic data transfer, the process by which process data (PZD) and parameters (PKW) are transferred from master to slave and from slave to master. GE Fanuc S2K motion controllers use the PROFIBUS profile's Type 2 Octet-String 20 -- the 20-byte data string.

When writing data, the master transfers process data (control word and setpoints) and tasks for parameter processing to the slave. When the data are read, the master retrieves process data (status word and actual values) and responses from parameter processing.

10.3.2 Global Control for PROFIBUS-DP

The PROFIBUS-DP "global control" mechanism can be used when slave coordination requirements are high. For example, when setpoints must be switched or specified simultaneously.

In addition to the node-related user data communication, the masters can send control commands simultaneously to one slave, a group of slaves (Multicast) or all slaves (Broadcast). These global control commands can be used for event-controlled synchronization of the slaves. The master establishes the global commands to use and assigns the global group number to the slaves during the configuration message.

Typical global commands are “clear data” to establish a known output state on fault, the “freeze” message to coordinate the reading of the inputs and the “sync” message to coordinate switching of outputs. There is additionally an unfreeze and unsync command to restore the station to normal messaging.

The S2K Motion Controller supports global messages: *clear data*, *auto baud*, *freeze/unfreeze* and *sync/unsync*. The global message *change address* is not supported. The S2K station address is set via DIP switches.

10.3.3 Output Data Words

The format for the 20 bytes of data the PROFIBUS-DP master will write to the S2K motion controller is described in the following table. This format conforms to the user profile group PROFIDrive 0302hex (indicates Version 2, Application Class 3). User profile groups promote operability between products created by different vendors and allow users to interchange products.

The *Parameter Channel* (PKW), composed of the first four data words (eight bytes), is used with the appropriate *Task ID* and *Parameter Number* (PNU) to access variable and register data in the S2K on an as needed basis.

The *Process Data Channel* (PZD), composed of two to six words, is used to operate the axis and is always active.

The message (telegram) actually transmitted to the S2K will take one of the following supported message forms depending on the settings in the Task ID and Control Word (STW):

- PPO-Type 1 message consisting of 4 PKW words and 2 PZD words (PZD – words 5 and 6).
- PPO-Type 2 message consisting of 4 PKW words and 6 PZD words.
- PPO-Type 3 message consisting of 0 PKW words and 2 PZD words (PZD – words 5 and 6).
- PPO-Type 4 message consisting of 0 PKW words and 6 PZD words.

Table 10-4. PROFIBUS-DP Output Data Words for S2K Motion Controllers

	Output Word	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PKW	1	Task ID				Res	Parameter Number (PNU)										
	2	Index								Reserved							
	3	Parameter Value MSW															
	4	Parameter Value LSW															
PZD	5	Control Word (STW)															
	6	Digital Outputs								Motion Block to Execute							
		Res	Res	14	13	12	11	10	9								
	7	Velocity Setpoint MSW															
	8	Velocity Setpoint LSW															
	9	Position Setpoint MSW															
	10	Position Setpoint LSW															

Res = Reserved

10.3.3.1 Parameter Channel Task ID

The Task ID defines the functions available in the parameter channel (PKW) and sets behavior for the PKW messaging. Setting Task ID equal to zero effectively shuts down the parameter channel and causes the remainder of the channel to be void.

Table 10-3. Available Output Word Task ID's

Task ID	Function
0	No task
1	Request parameter value
2	Change parameter value (word)
3	Change parameter value (double word)
4	Reserved
5	Reserved
6	Request parameter value (array)
7	Change parameter value (array word)
8	Change parameter value (array double word)
9	Request number of array elements
10 – 15	Reserved

10.3.3.2 Parameter Number (PNU):

The Parameter Number (PNU) allows you to read and write specific registers and variables of the S2K controller. PROFIBUS-DP parameters fit into two data classes: cyclic and acyclic.

Cyclic data communicate set points and actual values for parameters that frequently change, such as speed, and position. Cyclic data is contained in the process data channel (PZD). Cyclic parameters use low quantities of data (from 16 to 32 bits) and require a short cycle time of a few milliseconds. Cyclic data exchange is efficient and has the following characteristics:

- Devices produce data at a user-configured rate
- Devices that need more bandwidth can get it
- Data are sampled at precise intervals for better determinism

Acyclic data are those parameters that seldom change, like minimum and maximum speed limits. Acyclic data is transferred over the parameter channel (PKW). Parameters that require higher quantities of data use *acyclic* data exchange.

Table 10-4. PROFIBUS Parameter Number (PNU) List for S2K

PNU	Parameter	S2K Equivalent Register	Valid Access Modes	Data Type	Description
1	Command Position	PSC	RO	integer32	Command position of the axis.
2	Actual Position	PSA	RW	integer32	Real position in pulses. Set to redefine actual position.
3	Actual Velocity	VLA	RO	integer32	Actual velocity in pulses/sec.
4	Following Error	FE	RO	integer16	Axis following error is the difference between the axis position (PSA) and the command position (PSC).
5	Current Command	CMD	RO	integer16	Position controller command output, used to control the position of the axis (where 1000 = full continuous current setting).
6 – 19	Reserved				
20	Position Setpoint	MPA/MPI	RW	integer32	Profile move position defined in pulses.
21	Velocity Setpoint	MVL	RW	integer32	Defines motion velocity of the axis. Signed quantity in speed control mode automatically determines the direction of the move.
22	Acceleration	MAC	RW	unsigned32	Profile acceleration rate defined in pulses/second^2.
23	Deceleration	MDC	RW	unsigned32	Profile deceleration rate defined in pulses/second^2.
24	Jerk	MJK	RW	unsigned16	Percentage of acceleration/deceleration time that the axis will jerk limit.
25	Jog Velocity One	MVL	RW	integer32	Defines motion velocity of the axis while jogging one. Signed quantity automatically determines the direction of the jog.
26	Jog Acceleration/Deceleration One	MAC, MDC	RW	unsigned32	Defines acceleration/deceleration rate in pulses/second^2 while jogging one.
27	Jog Velocity Two	MVL	RW	integer32	Defines motion velocity of the axis while jogging two. Signed quantity automatically determines the direction of the jog.
28	Jog Acceleration/Deceleration Two	MAC, MDC	RW	unsigned32	Defines acceleration/deceleration rate in pulses/second^2 while jogging two.
29	Reference Position		RW	integer32	Set actual position (PSA) to this value when Referencing finishes.
30	Reference Velocity		RW	integer32	Set velocity (MVL) to this value during Referencing while in position control mode. Signed quantity automatically determines the direction of the move.
31	Marker Velocity		RW	integer16	Defines the motion velocity (MVM) of the axis when running to a marker input (RMF or RMR). Signed quantity automatically determines the direction of the move. Maximum value 4096 pulses/sec.
32	Reference Acceleration/Deceleration		RW	unsigned32	Defines acceleration/deceleration rate in pulses/sec^2 while referencing.
33	Reference Position Type	*RMF*, *RMR*, *RHF*, *RHR*, *ROF*, *ROR*	RW	unsigned16	Establishes the type of homing move to execute. Home to: 0=Home input, 1=Marker input, 2=OT input
34	Torque Limit	TLC	RW	unsigned16	Output torque limit; set value to limit torque when torque limit is enabled. 1000 = 100% full continuous current setting.
35	Torque Limit Enable	TLE	RW	Boolean	Set to FFhex to enable torque limit; set to 0 to disable torque limit.
36 - 49	Reserved				
50	Motor Direction for Forward moves	DIR	RW	unsigned16	Defines direction: 0=CW forward direction, 1=CCW forward direction, as viewed from the load end of the motor shaft.
51	Position Length	PLA	RW	unsigned32	Defines axis position length (value is half the axis position register length).

PNU	Parameter	S2K Equivalent Register	Valid Access Modes	Data Type	Description
52	Position Wrap Enable	PWE	RW	Boolean	Determines whether position register wrap is enabled: FFhex = enabled; 0 = disabled.
53	Overtravel Input Enable	OTE	RW	Boolean	Determines whether hardware overtravel inputs are enabled: FFhex = enabled; 0 = disable.
54	Forward Software Overtravel	OTF	RW	integer32	Defines forward software overtravel limit for the axis in pulses.
55	Reverse Software Overtravel	OTR	RW	integer32	Defines reverse software overtravel limit for the axis in pulses.
56	Following Error Bound	FEB	RW	unsigned16	Limit set on the following error in pulses. System faults when limit is exceeded.
57	In-position Band	IPB	RW	unsigned16	Defines maximum amount of position error in pulses that the axis can have and still be in position.
58	Motor Feedback Resolution	FR	RW	unsigned32	Number of actual position feedback pulses in one revolution of the motor. Set value to a positive number only.
59	Commutation Ratio	CMR	RW	unsigned16	Motor poles to resolver poles commutation ratio. One of the motor constants needed to operate a resolver feedback servo motor. This value, along with the value of CMO, can be set automatically by the MOTORSET command.
60	Commutation Offset	CMO	RW	integer16	Commutation angle offset. Set by the motor manufacturer. This value, along with the value of CMR, can be set automatically by the MOTORSET command.
61	Continuous Current	CURC	RW	unsigned16	Continuous current limits the current that the drive will continuously supply to the motor. It is a percentage of the maximum continuous current rating of the drive times ten.
62	Peak Current	CURP	RW	unsigned16	Limits the peak value of the current that the drive will supply to the motor. It is a percentage of the maximum peak current rating of the drive times ten. Servo motor controllers only.
63	Power Save Current	CURS	RW	unsigned16	The power save current is used to reduce motor heating when the axis is stopped. While the axis is in position, the continuous current value, CURC, is reduced to the percentage loaded into CURS. The percentage is times ten. Stepping motor controllers only.
64	Proportional Gain	KP	RW	unsigned16	The position loop proportional control gain is used to multiply the following error to control the position of the axis. Set automatically by the AUTOTUNE command.
65	Integral Gain	KI	RW	unsigned16	The position loop integral control gain is used to multiply the time integral of the following error to control the position of the axis. Set automatically by the AUTOTUNE command.
66	Derivative Gain	KD	RW	unsigned16	The position loop derivative control gain is used to multiply the time derivative of the following error to control the position of the axis. Set automatically by the AUTOTUNE command.
67	Acceleration Feed Forward	KA	RW	unsigned16	The acceleration feedforward constant is used to reduce following error during acceleration or deceleration. Set automatically by the AUTOTUNE command.
68	Filter Time Constant	KT	RW	unsigned16	Filter time constant is used to eliminate dither. Set automatically by the AUTOTUNE command.
69	Motor Inductance	KL	RW	unsigned16	Tunes the digital current controller to the attached

PNU	Parameter	S2K Equivalent Register	Valid Access Modes	Data Type	Description
					motor.
70	Stepping Motor Number	KM	RW	unsigned16	Tunes the controller to provide optimum performance for the attached stepper motor.
71	Output Control		RW	v2	0 = output is not under Profibus control; 1 = output is under Profibus control. Bit-wise control for each of outputs 9 – 14.
72 – 89	Reserved				
90	Integer variables (1-100)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1 through 100.
91	Integer variables (101-200)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 101 through 200.
92	Integer variables (201-300)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 201 through 300.
93	Integer variables (301-400)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 301 through 400.
94	Integer variables (401-500)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 401 through 500.
95	Integer variables (501-600)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 501 through 600.
96	Integer variables (601-700)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 601 through 700.
97	Integer variables (701-800)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 701 through 800.
98	Integer variables (801-900)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 801 through 900.
99	Integer variables (901-1000)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 901 through 1000.
100	Integer variables (1001-1100)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1001 through 1100.
101	Integer variables (1101-1200)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1101 through 1200.
102	Integer variables (1201-1300)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1200 through 1300.
103	Integer variables (1301-1400)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1301 through 1400.
104	Integer variables (1401-1500)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1401 through 1500.
105	Integer variables (1501-1600)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1601 through 1700.
106	Integer variables (1601-1700)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1601 through 1700.
107	Integer variables (1701-1800)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1701 through 1800.
108	Integer variables (1801-1900)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1801 through 1900.
109	Integer variables (1901-2000)	VI	RW	array [100] integer32	Value from –2,147,483,648 to +2,147,483,647 for integer variables 1901 through 200.
110	Floating point variables (1-100)	VF	RW	array [100] floating point	Absolute value from 1.5×10^{-39} to 1.7×10^{38} for floating point variables 1 through 100.
111	Floating point variables (101-200)	VF	RW	array [100] floating point	Absolute value from 1.5×10^{-39} to 1.7×10^{38} for floating point variables 101 through 200.
112	Floating point variables (201-300)	VF	RW	array [100] floating	Absolute value from 1.5×10^{-39} to 1.7×10^{38} for floating point variables 201 through 300.

PNU	Parameter	S2K Equivalent Register	Valid Access Modes	Data Type	Description
				point	
113	Floating point variables (301-400)	VF	RW	array [100] floating point	Absolute value from 1.5 x 10^{-39} to 1.7 x 10^{38} for floating point variables 301 through 400.
114	Floating point variables (401-500)	VF	RW	array [100] floating point	Absolute value from 1.5 x 10^{-39} to 1.7 x 10^{38} for floating point variables 401 through 500.
115	Floating point variables (501-600)	VF	RW	array [100] floating point	Absolute value from 1.5 x 10^{-39} to 1.7 x 10^{38} for floating point variables 501 through 600.
116	Floating point variables (601-700)	VF	RW	array [100] floating point	Absolute value from 1.5 x 10^{-39} to 1.7 x 10^{38} for floating point variables 601 through 700.
117	Floating point variables (701-800)	VF	RW	array [100] floating point	Absolute value from 1.5 x 10^{-39} to 1.7 x 10^{38} for floating point variables 701 through 800.
118	Floating point variables (801-900)	VF	RW	array [100] floating point	Absolute value from 1.5 x 10^{-39} to 1.7 x 10^{38} for floating point variables 801 through 900.
119	Floating point variables (901-1000)	VF	RW	array [100] floating point	Absolute value from 1.5 x 10^{-39} to 1.7 x 10^{38} for floating point variables 901 through 1000.
120	Boolean variables (1-100)	VB	RW	array [100] Boolean	Value 0 or FFhex for Boolean variables 1 through 100
904	Current PPO-Write		RO	unsigned16	PPO data word type 1 through 4.
911	Current PPO-Read		RO	unsigned16	PPO data word type 1 through 4.
918	Node address		RO	unsigned16	Network address for the motion controller.
930	Operating mode		RW	unsigned16	1=Speed control, 2=Position control
947	Fault Number	FC	RO	array[64] unsigned16	Identifies up to 64 types of system faults that have taken place. Stores the numerical equivalent of each FC register bit that would be set + 1.
952	Number of Faults		RW	unsigned16	Identifies the number of faults (up to 65,535) that have occurred since the last power cycle. Set to zero to clear.
953	Alarm Parameter		RO	v2	Bit 0 = forward hardware overtravel; bit 1 = reverse hardware overtravel; bit 2 = forward software overtravel (OTF); bit 3 = reverse software overtravel (OTR).
963	Current baud rate	BAUDN	RO	unsigned16	Rate at which bit transfer takes place to and from the PROFIBUS port.
965	Profile Number		RO	octet-string2	0302hex indicates Application Class 3, version 2.
967	Control word		RO	v2	Bits 0 through 15 control the drive. See figure 3.8.
968	Status word		RO	v2	Displays information about the status and signals of the motion controller. See figure 3.9.

Note: RW= Read/Write, RO=Read Only

10.3.3.4 Index:

Index into the data array for PNU 90 through 120 (variables) and PNU 947 (fault array).

10.3.3.5 Parameter Value

The data to be sent to the slave station.

MSW: Parameter value, most significant word.

LSW: Parameter value, least significant word.

10.3.3.6 Process Data Channel Control Word (STW):

The bits set in this word control the axis operation. The Control Word (STW) is always active to the motion controller and the status of the bits must be constantly maintained in the host PLC or PC control application logic.

Speed Control Mode or *Position Control Mode* is selected via the parameter channel PNU 930. The default is for Position mode. See PNU 967 in a previous table for an alternate way to acquire this data.

Table10-7. Allocation of Control Word Bits (STW)

Bit	Meaning	
	Speed Control Mode	**Position Control Mode**
0	ON/OFF 1	
1	Operating condition/OFF 2	
2	Operating condition/OFF 3	
3	Enable operation/Inhibit operation	
4	Operating condition/Inhibit ramp	Operating condition /Reject traversing
5	Enable ramp/Stop ramp	Operating condition/Intermediate stop
6	Enable setpoint/Inhibit setpoint	Activate traversing task (edge)
7	Acknowledge/No meaning	
8	Jogging 1 ON/Jogging 1 OFF	
9	Jogging 2 ON/Jogging 2 OFF	
10	Control by automation/No control	
11	Reserved	Start Referencing/Terminate Referencing
12	Reserved	Relative/Absolute
13	Reserved	
14	Reserved	
15	Reserved	

10.3.3.6.1 Speed Control Mode – Descriptions of Control Word (STW) Bits.

The following table describes the operation of the STW Control Word when the mode selected is Speed. PNU 930 in the parameter channel sets the mode of operation.

Table 10-8. Detailed allocation of control word (STW) bits for speed control mode.

Bit	Value	Meaning	Remarks
0	1	ON	Drive ready. Must be set for operation.
	0	OFF 1	Drive disabled. Returns to status "ready to switch-on."
1	1	Operating Condition	All "OFF2" commands are withdrawn. Must be set for operation.
	0	OFF2	Drive disabled. Drive at "switch-on inhibit" status.
2	1	Operating Condition	All "OFF3" commands are withdrawn. Must be set for operation.
	0	OFF3	Drive disabled. Drive at "switch-on inhibit" status (Fast Stop).
3	1	Enable Operation	Enable drive. Then acceleration to the entered setpoint.
	0	Inhibit Operation	Drive disabled. Motor coasts down and into the "ready" status (refer to control word, bit 0).
4	1	Operating Condition	--
	0	Inhibit Ramp	Speed set to zero. Drive remains enabled. Same functionality as the S2K "HT" command.
5	1	Enable Ramp	--
	0	Stop Ramp	Speed ramps down to zero. Same functionality as the S2K "ST" command.
6	1	Enable Setpoint	Velocity setpoint input is switched on
	0	Inhibit Setpoint	Speed ramps to zero. Velocity setpoint set to zero. Same functionality as the S2K "ST" command.
7	1	Acknowledge	Group signal is acknowledged at a positive edge; converter is in the "fault' status until the fault has been removed and then goes into "switch-on inhibit".
	0	No Meaning	--
8	1	Jogging 1 ON	Prerequisite: Operation is enabled and setpoint inhibited. Drive accelerates to jogging 1 velocity (See PNU's 25 and 26).
	0	Jogging 1 OFF	Drive stops if jogging 1 was previously on.
9	1	Jogging 2 ON	Prerequisite: Operation is enabled and setpoint inhibited. Drive accelerates to jogging 2 velocity (See PNU's 27 and 28).
	0	Jogging 2 OFF	Drive stops if jogging 2 was previously on.

Bit	Value	Meaning	Remarks
10	1	Control by Automation	Control via interface, process data valid.
	0	No Control	Process data invalid.
11-15	--	Reserved	--

10.3.3.6.2 Position Control Mode -- Descriptions of Control Word (STW) Bits

The following table describes the operation of the STW (Control Word) bits when the operating mode selected is position. PNU 930 in the parameter channel sets the mode of operation.

Table 10-9. Detailed allocation of control word (STW) bits for position control mode

Bit	Value	Meaning	Remarks
0	1	ON	Drive ready. Must be set to operate.
	0	OFF1	Drive disabled. Returns to status “ready to switch-on.”
1	1	Operating Condition	All “OFF2” commands are withdrawn. Must be set to operate.
	0	OFF2	Drive disabled. Drive at “switch-on inhibit” status.
2	1	Operating Condition	All “OFF3” commands are withdrawn. Must be set to operate.
	0	OFF3	Drive disabled. Drive at “switch-on inhibit” status (Fast Stop).
3	1	Enable Operation	Enable drive. Then acceleration to the entered set point.
	0	Inhibit Operation	Drive disabled. Motor coasts down and into the “ready” status (refer to control word, bit 0).
4	1	Operating Condition	--
	0	Reject Traversing	Speed set to zero. Drive remains enabled. Same functionality as the S2K “HT” command.
5	1	Operating Condition	Must be continuously available for execution of a drive task.
	0	Intermediate Stop	Speed ramps down to zero. Same functionality as the S2K “ST” command. The drive task is not cancelled. The drive task continues when a change to bit 5=1 occurs.

Bit	Value	Meaning	Remarks
6	edge	Activate Traversing Task	Each edge transition enables a drive task (toggle bit). A change in edge may occur only when the following conditions exist: 1) Drive must be enabled. 2) Reference point has been set by status bit 11. 3) Bit 12 has acknowledged the previous change in edge.
7	1	Acknowledge	Group signal is acknowledged at a positive edge; converter is in the "fault' status until the fault has been removed and then goes into "switch-on inhibit".
	0	No Meaning	--
8	1	Jogging1 ON	Prerequisite: Operation is enabled and setpoint inhibited. Drive accelerates to jogging 1 velocity (See PNU's 25 and 26).
	0	Jogging1 OFF	Drive stops if "Jogging1" was previously on.
9	1	Jogging2 ON	Prerequisite: Operation is enabled and set point inhibited. Drive accelerates to "Jogging2" velocity (See PNU's 27 and 28).
	0	Jogging2 OFF	Drive stops if "Jogging2" was previously on.
10	1	Control by Automation	Control via interface, process data valid.
	0	No Control	Process data invalid.
11	1	Start Referencing	Referencing is started with a change from 0 to 1. Bit 11 of the status word is set to 0. Prerequisite: Operation is enabled and no positioning procedure is active.
	0	Terminate Referencing	A running reference procedure is terminated. Drive ramps to a stop.
12	1	Relative	Position set point is relative to drives current position.
	0	Absolute	Position set point is absolute to drives reference position.
13-15	--	Reserved	

10.3.3.7 Digital Outputs 9 through 14:

Digital outputs 9 through 14 (DO09-DO14) are available on the S2Kcontroller. These 24V DC outputs may be operated by the motion program operating in the S2K or may be controlled by the PROFIBUS master station. Use PNU 71, output control, to determine which digital outputs are under PROFIBUS control (0=not under PROFIBUS control; 1=under PROFIBUS control). Bit-wise control for each of outputs 9 – 14.

10.3.3.8 Velocity Setpoint

MSW: Velocity setpoint value, most significant word. See PNU 21.

LSW: Velocity setpoint value, least significant word. See PNU 21.

10.3.3.9 Position Setpoint

MSW: Position setpoint value, most significant word. See PNU 20.

LSW: Position setpoint value, least significant word. See PNU 20.

10.3.3.10 Motion Block to Execute

The "Motion Block to Execute" portion of the command words allow the master device to initiate operation of any of the stored motion blocks in the S2K. Stored S2K motion blocks 0-99 are available to be executed however they must be created and stored in the S2K memory. The commanded value of the "Motion Block to Execute" references the S2K internal motion blocks with block numbers 1-100. For example to execute S2K, motion block 0 set "Motion Block to Execute" equal to one. Setting "Motion Block to Execute" = 0 is a command to execute no internal S2K motion blocks. Other portions of this manual detail operation of S2K motion blocks and provide example programs. Commanding a motion block to execute will immediately terminate any previously operating motion block.

10.3.4 Input Data Words

The PROFIBUS master reads this reply data from the S2K slave each time the slave is accessed.

The parameter channel (PKW) returns data because of the active command words Task ID and specified PNU. This data will vary as the command word task changes.

The Process Data channel (PZD) reflects cyclic status information. The actual position and velocity values are always represented in feedback pulses (encoder counts) and feedback pulses per second respectively.

Table 10-10. PROFIBUS-DP Input Data Words for S2K Motion Controllers

	Input Word	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PKW	1	Response ID				Res	Parameter Number (PNU)										
	2	Index								Reserved							
	3	Parameter Value MSW															
	4	Parameter Value LSW															
PZD	5	Status Word (ZSW)															
	6	Digital Inputs								Motion Block Executing							
		8	7	6	5	4	3	2	1								
	7	Actual Velocity MSW															
	8	Actual Velocity LSW															
	9	Actual Position MSW															
	10	Actual Position LSW															

Res = Reserved

10.3.4.1 Response ID:

Defines the responses available.

Table 10-11. Available Input Word Response ID's

Response ID	Function
0	No response
1	Transfer parameter value (word)
2	Transfer parameter value (double word)
3	Reserved
4	Transfer parameter value (array word)
5	Transfer parameter value (array double word)
6	Transfer number of array elements
7	Task cannot be executed (with error number in PKW4 see table below)
8 – 15	Reserved

10.3.4.1.1 PKW4 Word Error Numbers

Possible error numbers reported in the PKW4 word are listed below when the task response ID =7.

Displays information about the status and signals of the position controller. See PNU 968 in a previous table.

Table 10-12. Reply message ID 7, Error Numbers (PKW4)

Error	Explanation
0	Illegal parameter number (PNU)
1	Parameter value cannot be changed
2	Lower or upper limit violated
3	Erroneous array index
4	No array
5	Incorrect data type
6	Reserved
7	Descriptive element cannot be changed
8	Reserved
9	Descriptive data not available
10 – 16	Reserved
17	Task cannot be executed due to operating status
18	Reserved
19	Data cannot be read in cyclic data transfer

Process Data Channel Status Word (ZSW)

The bits in this word report status of the drive. Speed Control mode or Position Control Mode is selected via command word PNU 930. See PNU 967 in a previous table for alternate ways to acquire this data..

Table 10-13. Allocation of Status Word Bits (ZSW)

Bit	Meaning	
	Speed Control Mode	**Position Control Mode**
0	Ready for switch-on/Not ready for switch-on	
1	Ready for operation/Not ready for operation	
2	Operation enabled/Operation inhibited	
3	Fault/No fault	
4	No OFF 2/Off 2	
5	No OFF 3/Off 3	
6	Switch-on inhibit/No switch-on inhibit	
7	Alarm/No alarm	
8	Setpoint in range/Setpoint out of range	No contouring error/Contouring error
9	Control requested/Operation on site	
10	Setpoint reached/Setpoint not reached	Setpoint in range/Setpoint out of range
11	Reserved	Reference point set/No reference point set
12	Reserved	Setpoint acknowledge (edge)
13	Reserved	Drive stationary/Drive moving
14	Torque limit/No torque limit	
15	Heartbeat (edge) (100ms)	

10.3.4.2.1 Speed Control Mode -- Descriptions of Status Word (ZSW) Bits

Table10-14. Detailed allocation of status word (ZSW) bits for speed control mode

Bit	Value	Meaning	Remarks
0	1	Ready for switch-on	Drive ready to be enabled
	0	Not ready for switch-on	Drive disabled.
1	1	Ready for operation	Refer to control word, bit 0.
	0	Not ready for operation	Drive disabled
2	1	Operation enabled	Refer to control word, bit 3.
	0	Operation inhibited	Drive disabled
3	1	Fault	Drive faulted, and thus not operational. Goes into the switch-on inhibit status after acknowledgement if the fault has been removed. Fault numbers are returned in the fault parameters.
	0	No-Fault	No unacknowledged faults exist.
4	1	No OFF 2	See control word, bit 1.
	0	OFF 2	“OFF 2” command present.
5	1	No OFF 3	See control word, bit 2
	0	OFF 3	“OFF 3” command present.
6	1	Switch-on Inhibit	Re-close only with “OFF 1” and then “ON”
	0	No switch-on Inhibit	Drive ready to be enabled
7	1	Alarm	Drive still operational. Alarm in service parameter: No acknowledge. See PNU 953.
	0	No Alarm	Alarm not present or alarm has disappeared again. See PNU 953.
8	1	Setpoint in range	Drive running at velocity setpoint.
	0	Setpoint out of range	Drive not running at velocity setpoint. Equivalent to S2K “FE” fault.

Bit	Value	Meaning	Remarks
9	1	Control requested	The automation system is requested to accept control (always true).
	0	Operation on site	Control only possible on the device itself.
10	1	Setpoint reached	Actual value = comparison value (velocity setpoint), set via PNU 21.
	0	Setpoint not reached	Drive has not yet reached the setpoint.
11-13	--	Reserved	--
14	1	Torque Limit	Drive at torque limit specified by PNU 34. Torque limit must be enabled via PNU 35.
	0	No torque limit	Drive not at torque limit specified by PNU 34.
15		Heartbeat edge	Bit turns on and off every 100 milliseconds to validate that the drive remains functional

10.3.4.2.2 Position Control Mode -- Descriptions of Status Word Bits

Table10-15. Detailed allocation of status word (ZSW) bits for position control mode

Bit	Value	Meaning	Remarks
0	1	Ready for switch-on	Drive ready to be enabled
	0	Not ready for switch-on	Drive disabled.
1	1	Ready for operation	Refer to control word, bit 0.
	0	Not ready for operation	Drive disabled
2	1	Operation enabled	Refer to control word, bit 3.
	0	Operation inhibited	Drive disabled
3	1	Fault	Drive faulted, and thus not operational. Goes into the switch-on inhibit status after acknowledgement if the fault has been removed. Fault numbers are returned in the fault parameters.
	0	No-Fault	No unacknowledged faults exist.

Bit	Value	Meaning	Remarks
4	1	No OFF2	See control word, bit 1.
	0	OFF2	“OFF2” command present.
5	1	No OFF3	See control word, bit 2
	0	OFF3	“OFF3” command present.
6	1	Switch-on Inhibit	Re-close only with “OFF1” and then “ON”
	0	No switch-on Inhibit	Drive ready to be enabled
7	1	Alarm	Drive still operational. Alarm in service parameter: No acknowledge. See PNU 953.
	0	No Alarm	Alarm not present or alarm has disappeared again. See PNU 953.
8	1	No Contouring error	No following error faults.
	0	Contouring error	Following error faults exist.
9	1	Control requested	The automation system is requested to accept control (always true).
	0	Operation on site	Control only possible on the device itself.
10	1	Set point in range	The actual position value is located at the end of a drive task in the positioning window.
	0	Set point out of range	Drive task active or actual position outside positioning window.
11	1	Reference Point Set	Referencing was preformed and is valid.
	0	No reference point set	No valid reference present.
12	edge	Set point acknowledge	An edge was used to acknowledge that a new drive task was accepted. Same level as bit 6 of the control word.
13	1	Drive stationary	Signals the conclusion of a drive task or stand still during intermediate stop and stop.
	0	Drive moving	Drive task is being executed.

Bit	Value	Meaning	Remarks
14	1	Torque Limit	Drive at torque limit specified by PNU 34. Torque limit must be enabled via PNU 35.
	0	No torque limit	Drive not at torque limit specified by PNU 34. Torque limit must be enabled via PNU 35.
15	edge	Heartbeat	Bit turns on and off every 100 milliseconds to validate that the drive remains functional

10.3.4.3 Digital Inputs 1 through 8:

Status (level) of the S2K digital inputs (DI01- DI08) available on the controller.

10.3.4.4 Actual Velocity

MSW: Actual velocity value, most significant word. See PNU 3.

LSW: Actual velocity value, least significant word. See PNU 3.

10.3.4.5 Actual Position

MSW: Actual position value, most significant word. See PNU 2.

LSW: Actual position value, least significant word. See PNU 2.

10.3.5 Fault History and Fault Cause Codes

Parameter (PNU) 952, *number of faults*, stores fault conditions (a maximum of 65,535) that have occurred since the last power cycle or since the last time the *number of faults* parameter (PNU 952) was reset by writing a zero.

The *fault number* parameter (PNU 947) can return up to eight fault causes for each of the eight fault conditions the S2K can store.

> *Fault condition* – Any of the various severe faults that may occur to cause the S2K Motion Controller to immediately stop motion and internally execute motion program four. The S2K maintains a specific 32-bit register “FC” of which the transition to “on” state of one or multiple bits is considered a fault condition.

Fault cause – In S2K terms this is any one of the possible thirty-two fatal errors constantly monitored and listed in the "FC" register. This is represented by a specific bit in the "FC" register.

Parameter (PNU) 947, *fault number*, identifies a single fault cause of a fault condition by returning a PROFIBUS fault number code. The PROFIBUS fault number codes are derived from the Fault Code (FC) register in the S2K controller and are represented by the FC register bit position plus one. For example, the S2K fault code register bit FC03 (bit 3) "lost enable" fault would be represented as PROFIBUS fault number code 04. FC21 (bit21) "excessive following error" would be PROFIBUS fault number code 22.

The S2K PROFIBUS controller internally maintains a 64-place data table (1-64) to store a series of PROFIBUS fault number codes. The S2K fault code data is organized in an 8x8 array table where each of the possible eight fault conditions (each time the S2K sensed a fault) may contain up to eight fault causes (fault code descriptions). This data is volatile and will be lost or reset to zero if the S2K is power cycled. Each element of the fault history array will contain one of the fault number codes in the following table or the value zero. A maximum of eight fault codes are stored when a fault condition occurs. A maximum of eight fault conditions, representing the most recent faults are saved.

The PROFIBUS acknowledge/reset fault sequence described in the next section or other methods may be used to place the S2K back into operation. This does not clear the fault history data in the S2K. Only a power cycle clears the table.

When a new fault condition occurs, the number of faults (PNU 952) parameter is increased by one. The previous fault condition data (if present) is relocated eight places lower in the S2K fault history table. The new fault number data is placed in the first eight locations

The PNU 947 command will use the *Index* field of the PKW command (parameter channel) to select which element (1-64) of the fault data history to read. The command field *Task ID* should be set to one when the message is executed. This will return the value of the index selected PROFIBUS fault code parameter. Subsequent messages may increment the Index value to get the next fault code value stored in the S2K. A returned value of zero indicates the end of the fault code list for that fault condition. The fault codes for the most recent fault condition will always be in index one through eight.

Table 10-16. PROFIBUS S2K Fault Number Codes

Fault Code	Message	Fault Code	Message
1	Power Failure	20	Network Power Failure
2	Reserved	21	Duplicate Network Address
3	Software Fault	22	Excessive Following Error
4	Lost Enable	23	Excessive Command Increment
5	Digital Output Fault	24	Position Register Overflow
6	Invalid Command in String	25	*(IMJ)* Position Feedback Lost
7	Transmit Buffer Overflow		
8	Resource Not Available	26	Motor Power Over-Voltage
9	Invalid Variable Pointer	27	*(3 – 4.3 Amp)* Motor Power Clamp Excessive Duty Cycle
10	Mathematical Overflow		*(7.2 Amp)* Motor Power Clamp Excessive Duty Cycle—Under-Voltage
11	Mathematical Data Error		*(12–28 Amp)* Motor Power Under-Voltage
12	Value Out of Range	28	*(3 – 4.3 Amp)* Reserved
13	String Too Long		*(7.2 Amp)* Motor Power Clamp Over-Current Fault
14	Nonexistent Label		*(12–28 Amp)* Motor Power Clamp Excessive Duty Cycle
15	Gosub Stack Underflow	29	Motor Over-Current Fault
16	Gosub Stack Overflow	30	Motor Over-Temperature
17	Invalid Motion	31	Controller Over-Temperature
18	Reserved	32	Network Communication Error
19	Reserved		

Table 10-17. Example Fault Number Parameters

Number of faults (n = PNU 952)	Index	Fault Number (cause) (PNU 947)	Fault Code Register Message
n (The is the most recent fault condition)	1	22	Excessive following error
	2	29	Motor Over-current Fault
	3	0	Indicates no more fault causes exist for this fault condition. Query until you reach zero to ensure you have reviewed all faults.
	. . .	. . .	. . .
n - 1	9 . . . 16	Up to 8 fault causes	…
. . .	. . .	. . .	…
n - 7	57 . . . 64	Up to 8 fault causes	…

10.3.5.1 Acknowledging and Resetting Faults

Faults disable the drive. When a fault condition occurs, examine the fault numbers (see the previous section) and determine the fault cause. Once the condition that triggered the fault is removed, you are ready to reset the fault. The fault must be acknowledged and cleared before the drive can be enabled. Use the following procedure to reset faults and re-enable the axis. The bits referenced are in the PKZ channel, within the ZSW input and STW output words.

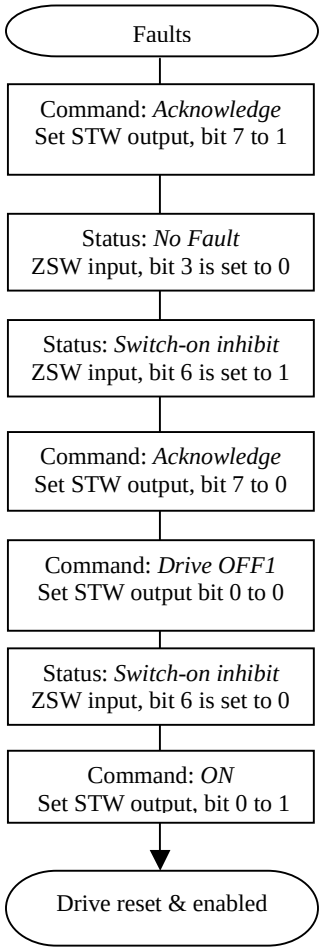

Figure 10-6. Acknowledging and Resetting Faults

10.3.6 Enabling

To drop the enable on the drive, set bit 3 of the control word to zero. Disabling the drive does not set the fault bit (bit 3) of the status word. When bit 3 is set to 1, the drive goes to the enable state.

Bit 2 of the status word indicates the state of the drive enable: 1 = enabled; 0 = inhibited (i.e., disabled)

> *Note that control word bits 0 through 3 must be true in order to keep the controller in the enabled state.*

10.3.7 Referencing

Prior to activating a drive task in position mode, the drive must have a reference point set. The PNU's 29 – 33 are used for the reference task. The signed value in the *reference velocity* parameter, PNU 30, determines the direction of referencing for reference position types 0 (home input), and 2 (OT input). The signed value in the *marker velocity* parameter, PNU 31, determines the direction of referencing for reference position type 1 (marker input).

The value in the *reference position type* parameter, PNU 33, determines the reference type.:

0 = Home input = DI1
1 = Marker input = Resolver position zero or encoder index
2 = OT input (DI2 = forward; DI3 = reverse)

Table 10-18. Excerpt from Data Word Parameters (PNU) Table

PNU	Parameter *(Generation D RTOS Equivalent)*	Data Type	Description
29	Reference position	integer32	Set actual position (PSA) to this value when Referencing finishes.
30	Reference velocity	integer32	Set velocity (MVL) to this value during Referencing while in position control mode. Signed quantity automatically determines the direction of the move.
31	Marker velocity	integer16	Defines the motion velocity (MVL) of the axis when running to a marker input (RMF or RMR). Signed quantity automatically determines the direction of the move.
32	Reference acceleration/deceleration	unsigned32	Defines acceleration/deceleration rate in pulses/sec^2 while referencing.
33	Reference position type *(RMF, RMR, RHF, RHR, ROF, ROR)*	unsigned16	0=Home input, 1=Marker input, 2=OT input

10.3.8 Performing a Drive Task

The user may perform a drive task by either running at a velocity setpoint, to a position setpoint or by executing a motion block. To run to a position setpoint, set the byte *Motion Block to Execute* to zero. To execute a motion block, set the byte *Motion Block to Execute* to the number of the motion block, from 1 to 100. The status byte *Motion Block Executing* indicates whether a motion block is executing.

10.3.9 Relative Positioning in Motion Blocks

Do not use incremental commands such as MPI for relative positioning within a motion block executed via a PROFIBUS drive task. Instead, use offset commands (e.g., MPO) for relative positioning. To allow the offset commands to be used for relative positioning, set PSO=0 at the beginning of a motion block.

10.4 Diagnostics

S2K controllers provide a Network Status LED on the front of the unit to indicate three possible network states:

- OFF = no connection
- RED = baud rate found – not in data exchange
- GREEN = Data exchange.

Figure 10-7. Location of Network Status LED on the S2K