

The background image shows a man in a light blue shirt from the side, looking at a tablet. He is in a factory or industrial setting with various machines and equipment visible in the background. Overlaid on the image are several digital graphics: a large '24/7' with a circular arrow, a 'NEWS' section with a person icon, a 'Home' button, and a network diagram with three people icons. The overall theme is industrial digitalization and online support.

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SIMATIC S7-1500 (T): Drive Connection via PROFIdrive – Enables and General State Diagram

PROFIdrive / General State Diagram

<https://support.industry.siemens.com/cs/ww/en/view/109770665>

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1 Drive Connection via PROFIdrive

1.1 General

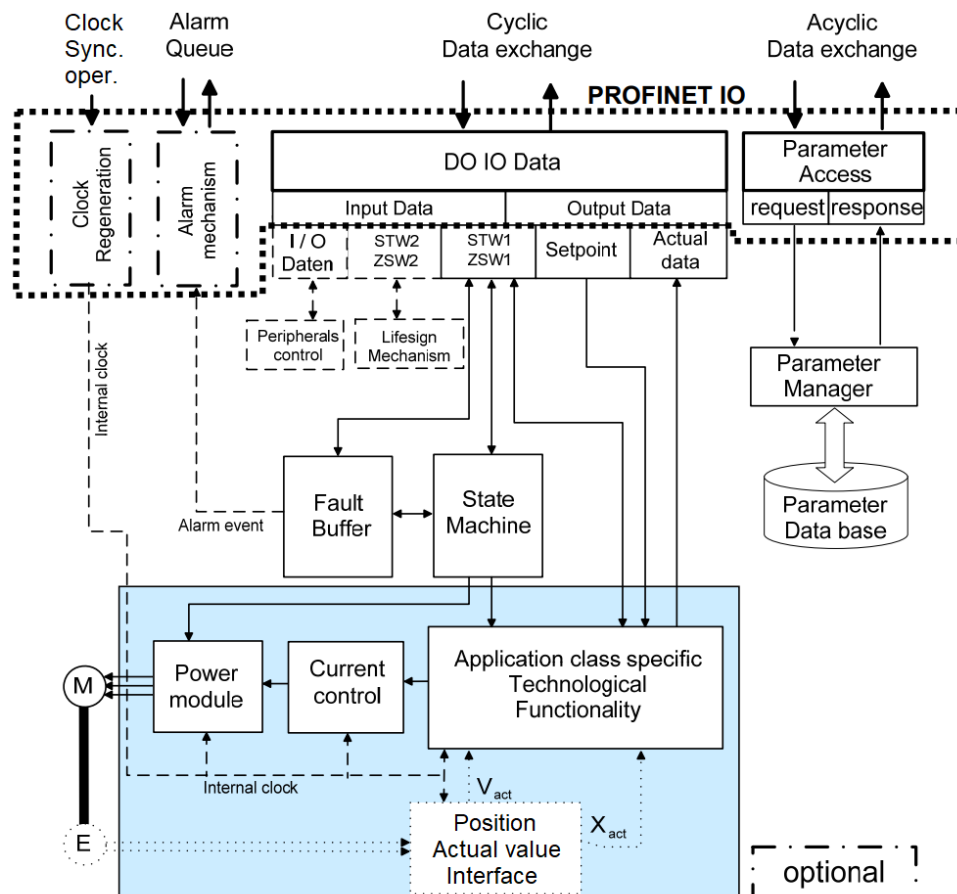
In TIA Portal, axes are represented by technology objects. The technology object is configured in the controller superimposed on the drive and connected to the drive. The technology object takes over control of the drive.

Communication with digital drives via PROFIBUS/PROFINET takes place in accordance with the PROFIdrive Profile V4 specification and application classes 1 to 4 (class 4 with and without DSC) via various PROFIdrive telegrams.

In addition to setpoints and actual values, control and status words are defined in PROFIdrive standard telegrams for controlling and evaluating the drives. A PROFIdrive axis according to IEC 61800-7 controls the drive in send direction with control word 1 (STW1) and receives its state in receive direction in status word 1 (ZSW1). A PROFIdrive axis always controls the drive via bits 0 to 6 of STW1. The status of the drive is mapped in five states according to the PROFIdrive state machine.

1.2 Block Diagram of a PROFIdrive Drive

Figure 1-1 Block diagram of a PROFIdrive axis in accordance with IEC 61800-7¹



¹ Profile Drive Technology PROFIdrive Profile - Technical Specification for PROFIBUS and PROFINET V4.2
Date: October 2015 - Order No.: 3,172

A PROFIdrive drive in accordance with IEC 61800-7 consists of the following elements:

- Fault buffer
- Position feedback interface
- Power stage
- Current closed loop control
- Life sign handling
- Periphery control
- PROFIdrive state machine
- Application classes and technology-specific functions

1.3 Control and Status Words

A PROFIdrive standard telegram consists of receive and send words.

From the perspective of the drive unit, the receive words represent the received process data and the send words represent the process data to be sent.

The receive and send words consist of the following elements:

- Receive words: Control words and setpoint values
- Send words: Status words and actual values

A PROFIdrive axis communicates with a drive via control words and status words. The PROFIdrive state machine of the drive is controlled via bits 0 to 6 of control word 1 (STW1). Each state of the drive is transferred in status word 1 (ZSW1). The states of an axis are defined in the PROFIdrive General State Diagram (see [Figure 1-4](#)).

With technology version 5.0 and higher, the bits in the control word not used by the technology object axis can be controlled via the user program with the Motion Control instruction "MC_SetAxisSTW" (see [3](#)).

An exact description of the bits is available in the "SINAMICS S120/S150" list manual (see [4](#)).

1.3.1 Control Word 1

Drive enables are set according to the PROFIdrive profile via control word STW1 bits 0 to 6.

Table 1-1 Control word 1 bits 0 to 6

Bit	Bit = 0	Bit = 1
0	OFF (OFF1)	0 → 1 = ON
1	Coasting down (OFF2)	No coasting down
2	Quick stop (OFF3)	No quick stop
3	Disable operation	Enable operation
4	Disable ramp-function generator	Enable ramp-function generator
5	Stop ramp-function generator	Resume ramp-function generator
6	Disable setpoint	Enable setpoint

The complete control word is given in section [2.1](#).

PROFIdrive Stop modes

- Ramp Stop (OFF1) - STW1 bit 0 = 0
 - The drive drops down to zero speed with the deceleration that you can set on the drive.
 - The stop procedure can be interrupted and the drive can be switched on again.
 - After stopping, the pulse is suppressed and the status changes to ready to switch on.
- Coast Stop (OFF2) - STW1 bit 1 = 0
 - The drive switches off immediately after pulse suppression and the status changes to switch-on inhibit.
 - The drive is deprived of voltage and coasts down.
- Quick Stop (OFF3) - STW1 bit 2 = 0
 - The drive drops down to zero speed with the torque limit that you can set on the drive.
 - The stop procedure cannot be interrupted.
 - After stopping, the pulse is suppressed and the status changes to switch-on inhibit.

1.3.2 Status word 1

The status word ZSW1 contains the drive status information corresponding to the PROFIdrive profile.

Table 1-2 Control word 1 bits 0 to 9

Bit	Bit = 0	Bit = 1
0	Not ready to switch on	Ready to switch on
1	Not ready for operation	Ready for operation
2	Operation disabled	Operation enabled
3	No fault present	Fault present
4	Coasting down active (OFF2) An OFF2 command is active.	No OFF2 is active
5	Quick stop active (OFF3) An OFF3 command is active.	No OFF3 is active
6	No switch-on inhibit Switch-on is possible	Switch-on inhibit Switching on again is only possible through OFF1 and subsequent ON.
7	No warning present	Warning present The drive is operating. No acknowledgment required. The warnings are in the warning buffer.
8	Setpoint/actual speed monitoring not in tolerance range	Setpoint/actual speed monitoring in tolerance range
9	Local operation	Control requested

The complete control word is given in section [2.2](#).

1.3.3 Byte Ordering

Depending on the architecture of the processors, SIMATIC S7 controllers use the "big endian" format - and SINAMICS drive units use the "little endian" format. This influences the byte ordering (high byte and low byte).

The byte ordering must be observed when reading and writing the control and status words. Use the system PLC data types PD_STW1_611Umode and PD_ZSW1_611Umode to access the control and status words.

These data types are part of the data type PD_TEL10x of the SIEMENS telegrams.

Figure 1-2 Little endian STW1

	Name	Data type	Offset
1	Static		
2	STW1	PD_STW1_611Umode	0.0
3	Reserved_Bit08	Bool	0.0
4	EnableESRReaction	Bool	0.1
5	ControlByPlc	Bool	0.2
6	RampFunctionGeneratorActive	Bool	0.3
7	OpenHoldingBrake	Bool	0.4
8	Reserved_Bit13	Bool	0.5
9	ClosedLoopTorqueControl	Bool	0.6
10	Reserved_Bit15	Bool	0.7
11	On	Bool	1.0
12	NoCoastStop	Bool	1.1
13	NoQuickStop	Bool	1.2
14	EnableOperation	Bool	1.3
15	EnableRampGenerator	Bool	1.4
16	UnfreezeRampGenerator	Bool	1.5
17	EnableSetpoint	Bool	1.6
18	FaultAcknowledge	Bool	1.7

Figure 13 Little endian ZSW1

	Name	Data type	Offset
1	Static		
2	ZSW1	PD_ZSW1_611Umode	0.0
3	NoSpeedDeviation	Bool	0.0
4	ControlRequested	Bool	0.1
5	SpeedComparisonValueReachedExceeded	Bool	0.2
6	AlarmClassBit0	Bool	0.3
7	AlarmClassBit1	Bool	0.4
8	Reserved_Bit13	Bool	0.5
9	ClosedLoopTorqueControlActive	Bool	0.6
10	Reserved_Bit15	Bool	0.7
11	ReadyToSwitchOn	Bool	1.0
12	ReadyToOperate	Bool	1.1
13	OperationEnabled	Bool	1.2
14	FaultPresent	Bool	1.3
15	NoCoastStopActivated	Bool	1.4
16	NoQuickStopActivated	Bool	1.5
17	SwitchingOnInhibited	Bool	1.6
18	AlarmPresent	Bool	1.7

1.4 PROFIdrive State Machine

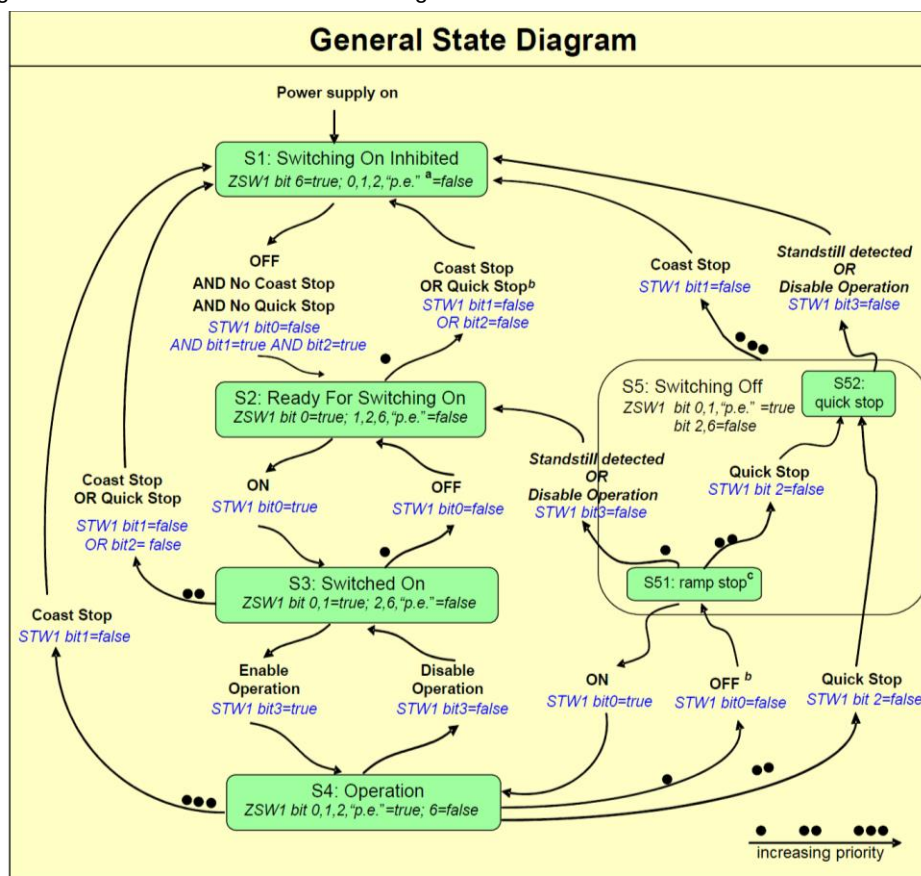
The PROFIdrive state machine specifies five states that are mapped by status word 1 (ZSW1) of a PROFIdrive telegram:

Table 1-3 States of the PROFIdrive state machine

State	Description
S1	Switch-on inhibit (drive switched off, brake closed where applicable)
S2	Ready to switch on
S3	Switched on (drive switched on, brake open where applicable)
S4	In operation (drive enabled, brake open where applicable)
S5	Switch off (brake with drive-defined ramp)

The transitions to the various states are shown in the PROFIdrive General State Diagram in [Figure 1-4](#).

Figure 1-4 PROFIdrive General State Diagram²



^a "p.e." = "Pulses Enabled" optional (refer to 6.3.2.7).

^b The internal condition "fault with ramp stop" also activates this transition.

^c Deceleration rate in ramp stop is switched to maximum if STW1 bit 4 = false in speed control mode.

NOTE 1 STW1 bit x,y =: These control word bits are set by the control.

NOTE 2 ZSW1 bit x,y = These status word bits indicate the current state.

NOTE 3 **Standstill detected** is an internal result of a stop operation.

² Profile Drive Technology PROFIdrive Profile - Technical Specification for PROFIBUS and PROFINET V4.2
Date: October 2015 - Order No.: 3,172

1.5 Interaction between Technology Object Axis and Drive

For the interaction of an axis technology object with the drive object, it is not necessary to completely map the PROFIdrive state machine in all states. You enable a technology object, and thus also the drive, by using the motion control instruction "MC_Power". When the axis is enabled with MC_Power, it is automatically switched through to state S4 "Operation".

In addition, for blocking the technology object you can specify a stop reaction at the input parameter "StopMode". The stop reaction is defined differently depending on the mode and is described in section [1.5.1](#).

If the drive stops automatically as a result of safety monitoring, it is automatically switched back to the S4 "Operation" state via the "MC_Power" motion control instruction after the safety function on the drive has been canceled and the technology alarm has been acknowledged with the "MC_Reset" motion control instruction.

1.5.1 Available Stop Reactions when Blocking the Axis

At the motion control instruction "MC_Power" the axis and the drive are switched off by resetting the input parameter "Enable". The following stop reactions are available at the input parameter "StopMode":

- 0 = Emergency Stop (Default value)
Axis is decelerated with the emergency stop ramp (<TO>.DynamicDefaults.EmergencyDeceleration) configured on the technology object without jerk limiting and the enable is withdrawn after standstill.
- 1 = Immediate Off
The setpoint 0 is output and the enable is withdrawn. The axis is brought to a standstill depending on the configuration in the drive.
- 2 = Stop with maximum dynamic values
The axis is brought to a standstill with the maximum deceleration (<TO>.DynamicLimits.MaxDeceleration) configured in the technology object and the enable is withdrawn. The configured maximum jerk (<TO>.DynamicLimits.MaxJerk) is taken into account.

Taking the set stop reaction into account, STW1 bit 2 is first reset (OFF3) by the system when the drive is switched off. STW1 Bit 0 is also reset (OFF1), but has lower priority.

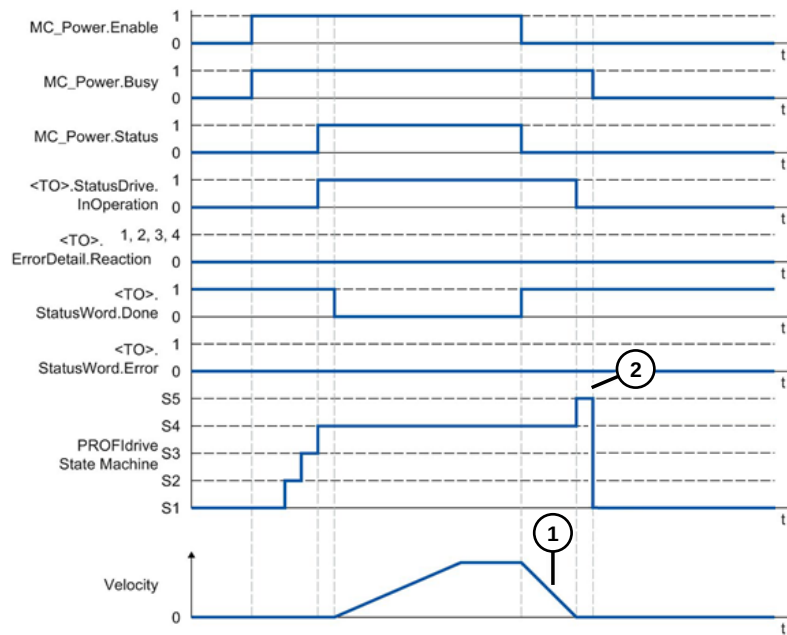
If the drive changes to state S1 "Switch-on inhibited" or S2 "Ready to switch on" and thus the power is switched off and, if present, the brake in the drive is implicitly closed, bits 0 to 6 are reset by the control system in STW1.

1.5.2 Meaning of the Stop Reactions

Stop reactions 0 and 2

For stop reactions 0 **"Emergency stop"** and 2 **"Stop with maximum dynamic values"** the axis is brought to a standstill with **the delay configured in the technology object**. The technology object has full control until standstill and is in state S4 "Operation". After the axis has come to a standstill, control is transferred to the drive by resetting bits 0 to 6, and thus S5 "Switch off", and changes to state S1 "Switch-on inhibit".

Figure 1-5 Flow chart of stop reactions 0 and 2

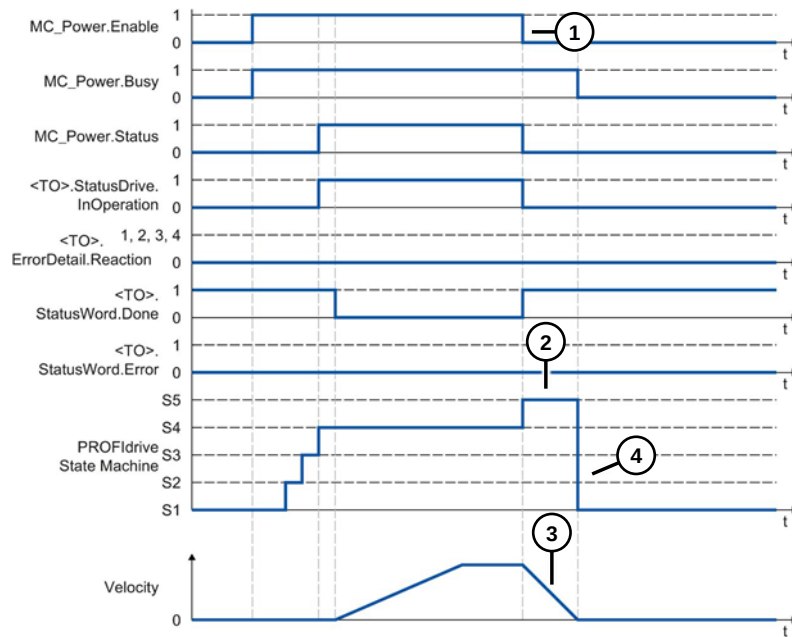


1. The technology object brakes autonomously with the configured delay (depending on the stop reaction).
2. After shutdown, bits 0 to 6 are reset and thus changed to state S1 "Switch-on inhibit" via state S5 "Switch off".

Stop reaction 1

With stop reaction 1 **"Immediate Off"**, bit 2 (OFF3) in STW1 is reset and the enable is withdrawn. The technology object changes to state S5 "Switch off" and the axis is brought to a standstill with the **delay defined in the drive**. After the axis has come to a standstill, the status changes to S1 "Switch-on inhibit" by resetting bits 0 to 6.

Figure 1-6 Flow chart of stop reactions 0 and 2



1. Reset control word 1, bit 2 "OFF3".
2. Immediate transition to state S5 "Switch off".
3. The technology object is braked with the configured deceleration of the drive. After shutdown, bits 0 to 6 are reset.
4. Transition to state S1 "Switch-on inhibit".

2 Annex

2.1 Control Word 1 (STW1)

Table 2-1 Control word 1 of the SIEMENS telegram 10x

Bit	Bit = 0	Bit = 1
0	OFF (OFF1)	0 → 1 = ON
1	Coasting down (OFF2)	No coasting down
2	Quick stop (OFF3)	No quick stop
3	Disable operation	Enable operation
4	Disable ramp-function generator	Enable ramp-function generator
5	Stop ramp-function generator	Resume ramp-function generator
6	Disable setpoint	Enable setpoint
7	-	0 → 1 = Acknowledge fault
8	Reserved	
9	Extended shutdown and retraction (ESR) not enabled	Release ESR reaction
10	No control via PLC	Control via PLC
11	Ramp-function generator disabled	Ramp-function generator enabled
12	Close holding brake	Holding brake must be opened
13	Reserved	
14	Speed control enabled	Torque control enabled
15	Reserved	

2.2 Status Word 1 (ZSW1)

Table 2-2 Status word 1 of the SIEMENS telegram 10x

Bit	Bit = 0	Bit = 1
0	Not ready to switch on	Ready to switch on
1	Not ready for operation	Ready for operation
2	Operation disabled	Operation enabled
3	No fault present	Fault present
4	Coasting down active (OFF2) An OFF2 command is active.	No OFF2 is active
5	Quick stop active (OFF3) An OFF3 command is active.	No OFF3 is active
6	No switch-on inhibit Switch-on is possible	Switch-on inhibit Switching on again is only possible through OFF1 and subsequent ON.
7	No warning present	Warning present The drive is operating. No acknowledgment required. The warnings are in the warning buffer.
8	Setpoint/actual speed monitoring not in tolerance range	Setpoint/actual speed monitoring in tolerance range
9	Local operation	Control requested
10	Maximum speed not reached	f or n comparison value reached/exceeded
11	Warning class bit 0	
12	Warning class bit 1	
13	Reserved	
14	Speed control enabled	Torque control enabled
15	Reserved	

2.3 Links and Literature

Table 2-3 Links and literature

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the entry page of the application example https://support.industry.siemens.com/cs/ww/en/view/109770665
\3\	MC_SetAxisSTW: Control the bits of control words 1 and 2 https://support.industry.siemens.com/cs/ww/en/view/109773506/128236441611
\4\	SINAMICS S120/S150 list manual https://support.industry.siemens.com/cs/ww/en/view/109763271