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Considerations for Use

of the SITOP DC UPS Module

6A without interface	**(6EP1931-2DC21)**
6A with serial interface	**(6EP1931-2DC31)**
6A with USB interface	**(6EP1931-2DC41)**
15A without interface	**(6EP1931-2EC21)**
15A with serial interface	**(6EP1931-2EC31)**
15A with USB interface	**(6EP1931-2EC41)**
40A without interface	**(6EP1931-2FC21)**
40A with USB interface	**(6EP1931-2FC41)**

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Contents

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0. Introduction

The user notices accompany the operating instructions belonging to the scope of supply of every SITOP DC UPS module. General information, protection notices, and warnings can be found in the operating instructions of the respective SITOP DC UPS module. In these user notices, the functions of the SITOP DC UPS module and its various application possibilities are described in detail.

1. Principle Functions

In case of a failure of the mains supply, the SITOP DC UPS module backs up critical consumers (Load 2 in Figure 1) with 24 VDC from the connected battery.

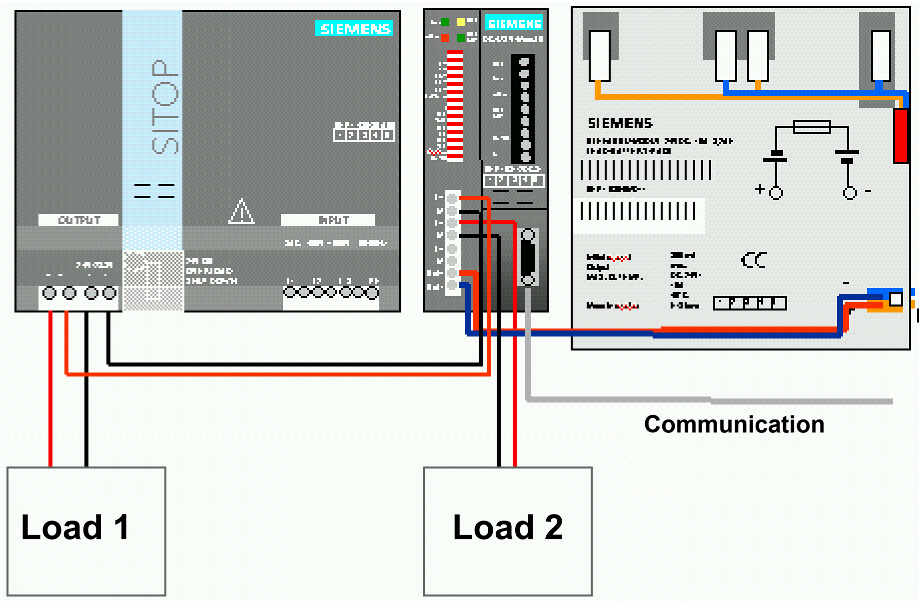


Figure 1: Principle connection and function of the SITOP DC UPS module

1.1 Normal Mode

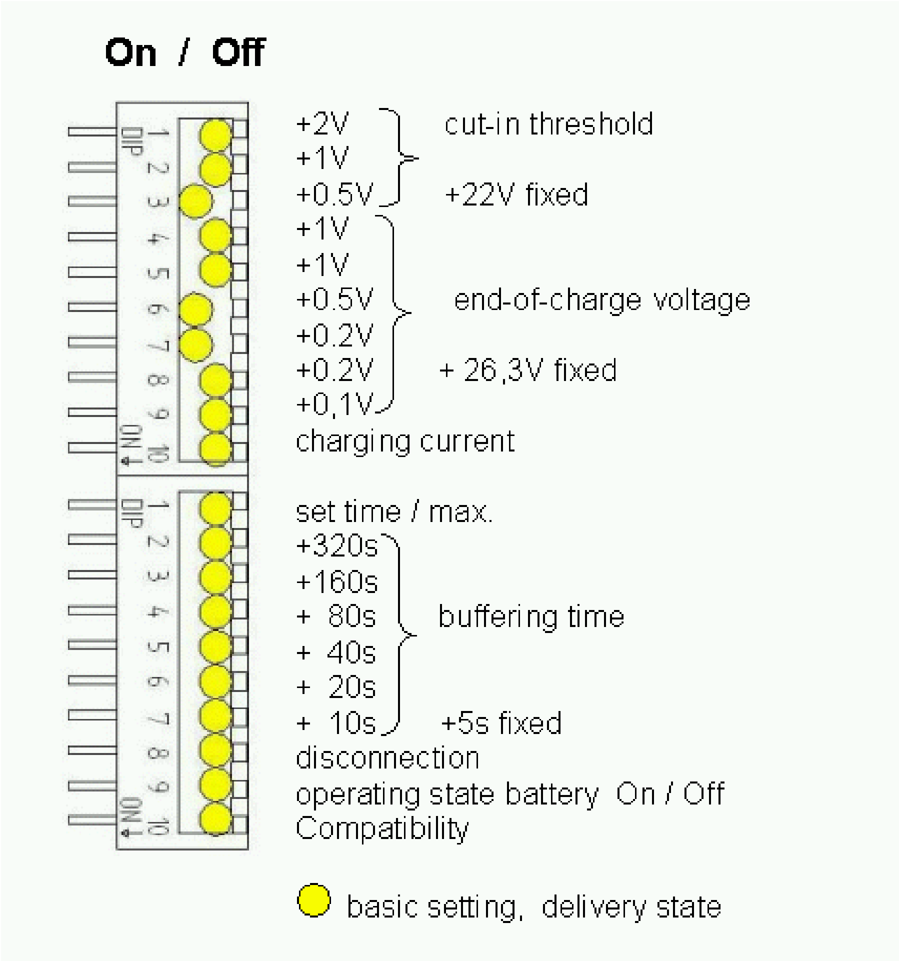
In the normal mode, the SITOP power supply provides 24VDC. This voltage is directly available at the consumers (Load 1 in Figure 1) and at the input of the SITOP DC UPS module. The SITOP DC UPS module loads the connected battery module and provides 24VDC for the critical consumer (Load 2 in Figure 1). The green "OK" LED lights up and the X2.2 – X2.3 "OK" relay contact is made. When the charge of the connected battery has reached a value of approximately 85%, the green "Bat >85%" lights up and the X2.7 – X2.8 "Bat >85%" relay contact is made.

1.2 Buffer Mode

If the supply voltage at the input of the SITOP DC UPS module sinks below the value set as the cut-in threshold, the module assumes the supply of the critical consumers (Load 2 in Figure 1) using the battery module. The yellow "Bat" LED lights up and the X2.2 – X2.1 "Bat" relay contact is made. They are accordingly supplied with backup power for the buffering time set via the DIP switches or until the maximum buffering time is up (deactivation after the exhaustive discharge threshold is reached).

2. Settings

All settings can be made using the DIP switch panel (Figure 2) on the front of the housing in a mechanically coded manner.



Note: DIP Switch 10 (compatibility) exists only on the SITOP 40A DC UPS module.

Figure 2: Setting the DIP switches

2.1 Setting the Cut-in Threshold

If the input voltage sinks below the set value of the cut-in threshold, the UPS module switches into buffer mode. The consumers are then supplied solely by the battery module. The setting of the cut-in threshold takes place using three DIP switches (for position, see Figure 2) according to Table 1.
Setting range: 22.0 to 25.5 VDC in 0.5V steps (delivery state: 22.5VDC ± 0.1V). Precision: ± 1.8%

	cut-in treshold [V]							
	22,0	22,5	23,0	23,5	24,0	24,5	25,0	25,5
On←1	0	0	0	0	1	1	1	1
2	0	0	1	1	0	0	1	1
3	0	1	0	1	0	1	0	1

Table 1: Settable cut-in threshold [V]

2.2 Setting the End-of-Charge Voltage

The end-of-charge voltage depends on the respective battery type, as well as on the temperature to which it is exposed. Table 2 contains the end-of-charge voltages for the given battery modules at various temperatures. It is possible to interpolate between the values. The end-of-charge voltage is set using six DIP switches (for position, see Figure 2) according to Table 3.

<u>Setting range:</u>

26.3 to 29.3 VDC in 0.1V steps (delivery state: 27.0 VDC ± 0.1V for +25°C lead-gel battery temperature). Precision: ± 0.7%

Battery module/battery: 6EP1935-6MC01, 6EP1935-6MD11, 6EP1935-6ME21, 6EP1935-6MF01:

-10°C	0°C	10°C	20°C	25°C	30°C	35°C	40°C
29.0V	28.4V	27.8V	27.3V	27.0V	26.8V	26.7V	26.6V

<u>Battery module/battery: 6EP1935-6MD31</u>

-10°C	0°C	10°C	20°C	25°C	30°C	35°C	40°C	45°C	50°C	60°C
29.0V	28.6V	28.3V	27.9V	27.7V	27.5V	27.4V	27.2V	27.0V	26.8V	26.4V

Table 2: End-of-charge voltages at other battery temperatures

end-of-charge voltage [V]

	26,3	26,4	26,5	26,6	26,7	26,8	26,9	27,0	27,1	27,2	27,3	27,4	27,5	27,6	27,7	27,8
On←4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
6	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1
7	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0
8	0	0	1	1	1	0	0	1	1	1	0	0	1	1	1	0
9	0	1	0	1	0	0	1	0	1	0	0	1	0	1	0	0

	27,9	28,0	28,1	28,2	28,3	28,4	28,5	28,6	28,7	28,8	28,9	29,0	29,1	29,2	29,3
On←4	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1
7	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1
8	0	1	1	1	0	0	1	1	1	0	0	1	1	1	1
9	1	0	1	0	0	1	0	1	0	0	1	0	1	0	1

Table 3: Setting the end-of-charge voltage at other battery temperatures [V]

2.3 Setting the Charging Current

The battery module is charged using constant current until the set end-of-charge voltage is reached. The charging procedure is then complete. During the setting of the charging current, the data for the battery module used must be observed when selecting the optimum setting. The charging current is set using a DIP switch (for position, see Figure 2).

<u>Setting ranges:</u>

SITOP DC UPS 6 (6EP1931-2DC21, -2DC31, and -2DC41):
0.2A DC ± 0.075A DC or 0.4A DC ± 0.075A DC (delivery state: 0.4A DC ± 0.075A DC)

SITOP DC-UPS 15 (6EP1931-2EC21, -2EC31, and -2EC41):
0.35A DC ± 0.1A DC or 0.7A DC ± 0.1A DC (delivery state: 0.7A DC ± 0.1A DC)

SITOP DC-UPS 40 (6EP1931-2FC21 and -2FC41):
1A DC ± 0.2A DC or 2A DC ± 0.2A DC (delivery state: 2A DC ± 0.2A DC)

On←10	Switch position: On = 1; Off = 0			
	For SITOP DC-UPS 6:	Switch 10 at Pos.	On: Charging current 0.2A DC	Off: Charging current 0.4A DC
	For SITOP DC-UPS 15:	Switch 10 at Pos.	On: Charging current 0.35A DC	Off: Charging current 0.7A DC
	For SITOP DC-UPS 40:	Switch 10 at Pos.	On: Charging current 1A DC	Off: Charging current 2A DC

Table 4: Setting the charging current

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2.4 Setting the Buffering Time

The buffering time is set using six DIP switches (for position, see Figure 2) from 5s to 635s in 10s steps according to Table 6.
DIP Switch 1 (set time/max.) can be used to select whether the buffering mode is ended after the set time or not until the exhaustive discharge threshold of the battery (= maximum buffering time) is reached. (Delivery state: Off pos. = maximum buffering time.) For devices with communication interfaces, the buffering time can be started using the remote signal (for the description, see the "Interface" chapter) to deactivate the UPS after the set buffering time. In this case, Switch 1 (set time/max.) must be at the Off position and Switch 8 ("Disconnection") must be at the On position. When deactivation has taken place, the buffer mode cannot be reactivated by changing the switch position. It cannot be reactivated until the input voltage returns.

On←1	Switch position: On = 1; Off = 0 Switch 1 at Pos. On: Setting for deactivation after the desired buffering time Switch 1 at Pos. Off: Deactivation takes place after the exhaustive discharge threshold of the battery is reached. For devices with interfaces, the voltage can be disconnected in remote mode after the set buffering time (DIP Switch 8, Disconnection – On).

Table 5: Selecting the buffering time

	buffering time [s]																															
	5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295	305	315
On←2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
5	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
7	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

	buffering time [s]																															
	325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475	485	495	505	515	525	535	545	555	565	575	585	595	605	615	625	635
On←2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
5	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
6	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
7	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Table 6: Setting the buffering time

2.5 Disconnection of the Output Voltage

DIP Switch 8 can be used to select whether or not the output voltage is disconnected for approximately 5 seconds after the set buffering time is up even in case the input voltage returns in the meantime (delivery state: no disconnection). In the case of the "Maximum Buffering Time" setting, the output voltage is disconnected using the remote signal of the interface (only in case of devices with interfaces).

On←8	Switch position: On = 1; Off = 0 Switch 8 at Pos. On: Disconnection of output voltage for approx. 5s Switch 8 at Pos. Off: None disconnection of the output voltage

Table 7: Disconnection of output voltage

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2.7 Setting the ON/OFF Operating State

To prevent an unintentional discharge of the battery (e.g. by deactivating the plant), the DC UPS module can be activated using DIP Switch 9 (or through a floating connection, wire jumper, or X2.9 and X2.10 terminals) in the OFF operating state (delivery state). DIP Switch 9 and the X2.9 and X2.10 terminals are switched electrically parallel. In the "ON" operating state, (DIP switch closed or Terminal X2.9 with X2.10 with floating make contact for Umax = 15 VDC, Imax. = 10mA connected or X2.9 grounded), the DC UPS module provides full functionality according to the specifications. In the "OFF" operating state, no switch to buffer mode takes place if the supply voltage is disconnected. All other functions are retained. If the UPS module is switched to OFF during the buffer mode, the buffer mode thus comes to an end as well. In normal mode, the ON/OFF setting is polled approximately every 20s.

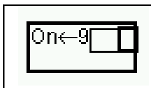	Switch position: On = 1; Off = 0 Switch 9 at Pos. On: Operating state ON Switch 9 at Pos. Off: Operating state OFF

Table 8: Selecting the operating mode

2.8 Compatibility

DIP Switch 10 "Compatibility" exists only on the SITOP 40A DC UPS module (6EP1931-2FC21 and 6EP1931–2FC41). In this way the "Analogous to new DC UPS family" or "Analogous to previous DC UPS module 40 6EP1931-2FC01" signaling can be selected.

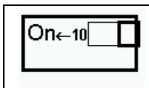	Switch position: On = 1; Off = 0 Switch 10 at Pos. On: Signaling analogous to previous DC UPS module 40 6EP1931-2FC01 Switch 10 at Pos. Off: Signaling analogous to new DC UPS family

Table 9: Selecting the compatibility

3. Signaling

3.1 Normal Mode

The input voltage on the DC UPS module is higher than the set cut-in threshold. The consumers are supplied by the upstream power supply. In case a battery module is connected, it is charged. In normal mode, the **green LED** (OK) lights up and the X2.2 – X2.3 (OK) relay contact is made.

3.2 Full Charge

The battery charge is greater than 85%. The second **green LED** (Bat>85%) lights up and the X2.7 – X2.8 relay contact is made.
If the second green LED is off and the X2.7 – X2.8 relay contact is made (idle position in case of deactivated device), this means "Bat<85%," i.e. the battery charge is under 85%.

3.3 Buffer Mode

The input voltage is lower than the set cut-in threshold. The consumers are supplied by the battery module. In buffer mode, the **yellow LED** (Bat) lights up and the X2.1 – X2.2 relay contact (Bat) is made (idle position in case of deactivated device).

3.4 Alarm Messages

3.4.1 Lack of Buffer Readiness

If the "Lack of Buffer Readiness" signal appears, the **red LED** (Alarm) lights up and the X2.4 – X2.5 relay contact (Alarm) is made (idle position in case of deactivated device). Causes for a lack of buffer readiness **in normal mode** could include the following:
Operating state OFF, no battery module connected, reversed or defective battery (battery voltage < 18.5V), or wire breakage between the battery and the UPS module.
The ON/OFF operating state, the battery status (reversed, defective, or non-existent), wire breakage, and the output of the signal are polled in normal mode every 20s. At the end of a malfunction, a reset takes place after the next poll.

In buffer mode, the "Alarm" signal means that the battery voltage has sunk to <20.4V and an automatic deactivation to protect the battery is pending. After the battery is shut down due to overload, short circuit, exhaustive discharge protection, or an expired buffering time, the red LED (Alarm) extinguishes, but the X2.4 – X2.5 relay contact remains made.

3.4.2 Battery Change Required

If the "Alarm" signal and the X2.4 – X2.5 relay contact (Alarm) are blinking in a 2s cycle, the battery is defective, but buffer mode can still take place. The set buffering times, however, can no longer be observed. An exchange of the battery module is required.

4. Communication with the PC (Only Devices with Serial or USB Interface)

SITOP DC UPS modules with serial or USB interfaces can also send operating state data to a connected PC or also receive remote signals. The signals (Table 10 and Diagram 1) can be integrated into their own applications according to their content or further processed on the PC using the "SITOP DC UPS Software" freeware tool. This tool is available for download under http://www.siemens.com/sitop.

4.1 Design of Interface

4.1.1 Serial Connection
(6EP1931-2DC31 and 6EP1931-2EC31)

- Output of the signal states every 84ms ± 20%, 29ms ± 20% data output, 55ms ± 20% break
- Setting the interface: 9600 baud, 8 data bits; 1 stop bit, no parity bit
- Safe, electrical disconnection according to EN 60950

The connection to the PC takes place using a 1:1 connected 9-pole SUB-D extension cable (plug/socket), whereby only three poles are required:

Pin 2 (Pin 3 in case of 25-pole plug/socket): RxD (data line)
Pin 3 (Pin 2 in case of 25-pole plug/socket): TxD (negative supply for interface)
Pin 7 (Pin 4 in case of 25-pole plug/socket): RTS (positive supply for interface)

4.1.2 USB Connection
(6EP1931-2DC41; 6EP1931-2EC41 and 6EP1931-2FC41)

The prerequisite for communication via USB is a properly installed driver. Installation instructions can be found here: http://www.siemens.com/sitop.

- Output of the signal states every 75ms ± 20%, 29ms ± 20% data output, 46ms ± 20% break
- The USB interface corresponds to Specification 2.0, but communication takes place only at full speed, i.e. 12Mbps.
- The optional USB module is supplied with +5V from the DC USP ("self-powered").

It is connected to the PC by means of a four-wire, screened USB cable with a USB Series "A" plug on the PC side and a USB Series "B" plug on the SITOP DC UPS module side with a maximum length of 5m.

Pin 1: VBUS (+4.40V to +5.25V DC), transmit data to Pin2 (D-) and Pin 3 (D+), Pin 4: GND

4.2 Transmit Data of the SITOP DC UPS Module

The states of the SITOP DC UPS module are output to the interface of the SITOP DC UPS module as data words:

Signal	Plain text output	Comment
Buffer ready Alarm	BUFRD ALARM	 No buffer readiness
Battery charging	BA>85 BA<85	Battery charging >85% Battery charging <85%
Normal mode	DC_OK DC_LO	 No input voltage
 Buffer mode	***** *BAT*	No buffer mode

In case of a defective battery, the "Alarm/Buffer Ready" signal changes at a frequency of 0.25Hz and a keying ratio of 0.5.

Table 10: Transmit Data of SITOP DC UPS Module

4.3 Receive Data of the SITOP DC UPS Module

The SITOP DC UPS module can react to a remote signal transmitted by the PC. Prerequisite: DIP Switch 1 of the lower switch panel is at Off (right).

4.3.1 Serial Connection
(6EP1931-2DC31 and 6EP1931-2EC31)

A bit pattern is sent from the PC to Pin 7 (Pin 4 in case of a 25-pole plug/socket) according to Diagram 1. When this signal is received and the interface is closed by the operating system (last edge from high to low), the buffering time set using DIP Switches 2 through 7 of the lower switch panel is started and the output voltage is shut off when the buffering time is up.

Note: If DIP Switch 8 of the lower switch panel is set to On (right), the output voltage will be disconnected for approximately 5s according to the set buffering time even if the network returns in the meantime. (This enables an automatic restart of the industrial PC).

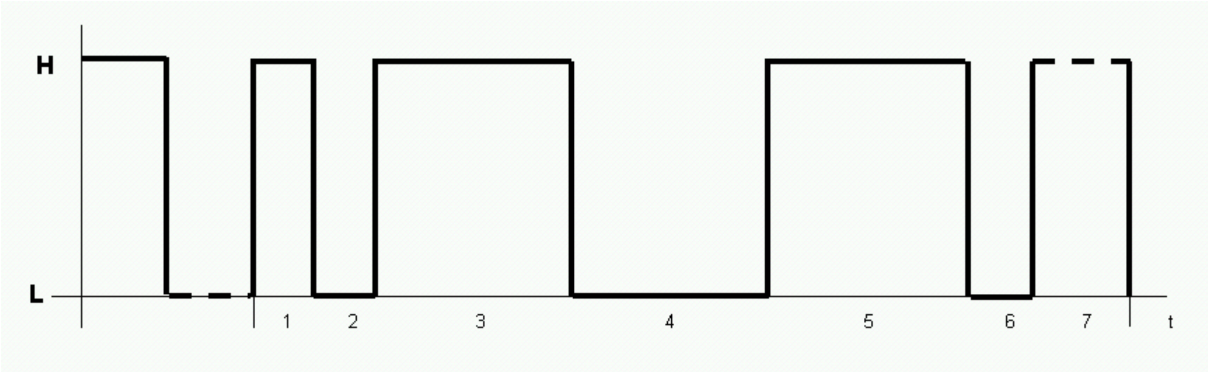

Diagram 1: Remote signal to Pin 7 (Pin 4 in case of 25-pole plug/socket) of the serial interface

A low signal of indeterminate length starts the remote signal.
1.) 30ms – 120ms high signal
2.) 30ms – 120ms low signal
3.) 200ms – 400ms high signal
4.) 200ms – 400ms low signal
5.) 200ms – 400ms high signal
6.) 30ms – 120ms low signal
7.) Max. 256s high signal
With the last high-low edge, the remote signal is evaluated and the timer is started.

4.3.2 USB Connection
(6EP1931-2DC41, 6EP1931-2EC41 and 6EP1931-2FC41)

From the PC, the "R" signal ("Remote Timer Start" signal) is sent to the input buffer of the USP module. When this signal is received and the subsequent polling of the USB devices by the IPC master during the shutdown process is completed, the buffering time set using DIP Switches 2 through 7 of the lower switch panel is started and, when this time is up, the output voltage is deactivated. If the SITOP DC UPS module is to be addressed from its own application, the following addressing can be used: Device=VID_0403&PID_E0E0; Converter=FTD2XX for the UPS module 6A (6EP1931-2DC41)
Device=VID_0403&PID_E0E1; Converter=FTD2XX for the UPS module 15A (6EP1931-2EC41),
Device=VID_0403&PID_E0E2; Converter=FTD2XX for the UPS module 40A (6EP1931-2FC41)
The drivers and documentation can be found on the manufacturer's homepage: http://www.ftdichip.com/

Note: If DIP Switch 8 of the lower switch panel is set to On (right), the output voltage will be disconnected for approximately 5 seconds according to the set buffering time even if the network returns in the meantime. (This enables an automatic restart of the industrial PC).

5. Operating Modes

Abbreviations used:

Ue:	Input voltage at Terminals X1.1 – X1.2
Ua:	Output voltage at Terminals X1.3 – X1.4 and X1.5 - X1.6
ok:	Input voltage Ue is OK or above the set battery cut-in threshold
Bat:	Battery operation (batteries connected to the output, batteries supplying the load)
Remote:	Remote timer start signal with signal level = 0 at Pin 7 of the 9-pole serial interface (Pin 7 is usually the positive supply of the interface)
t1:	Input voltage Ue fails or falls under the set cut-in threshold
t2:	Buffering time set at the DIP switches is started with remote timer start (signal level = 0)
t3:	Input voltage Ue rises above the set cut-in threshold
t4:	End of the set buffering time (output is deactivated and/or battery is turned off)
t5:	Output is switched on again for 5 seconds after deactivation
tp	Buffering time set at the DIP switches (under Row 2 to 7)

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5.1 Long Power Failure in Devices without an Interface

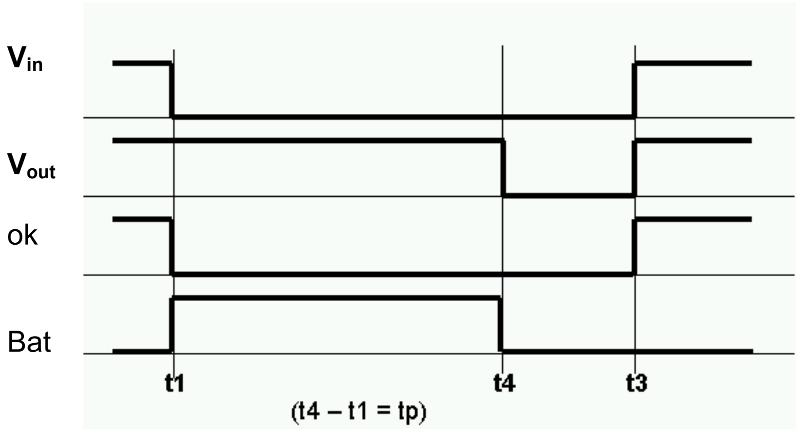

Diagram 2: Long power failure in devices without an interface

<u>Resumption of power supply when the buffering time tp is up (t3 is temporally **after** t4):</u>
In the input voltage of the DC UPS module drops (time t1), the "Bat" battery immediately assumes the direct voltage supply. In this way, the output voltage Ua remains absolutely uninterruptible. The floating changeover contact "OK/Bat" switches to its resting position "Bat." At the same time t1, the buffering time tp set on the DIP switches starts automatically. Whether or not the DIP switch is set to "Output Ua Interruption" does not have an effect in this case because the input voltage does not return to time t3 until the set buffering time (time t4) is up.

DIP switch settings: Buffering according to a set time using Switch 1 On (left)
Buffering time tp with Switch 2 through 7 from 5 to 635 sec.

5.2 Brief Power Failure in Devices without an Interface

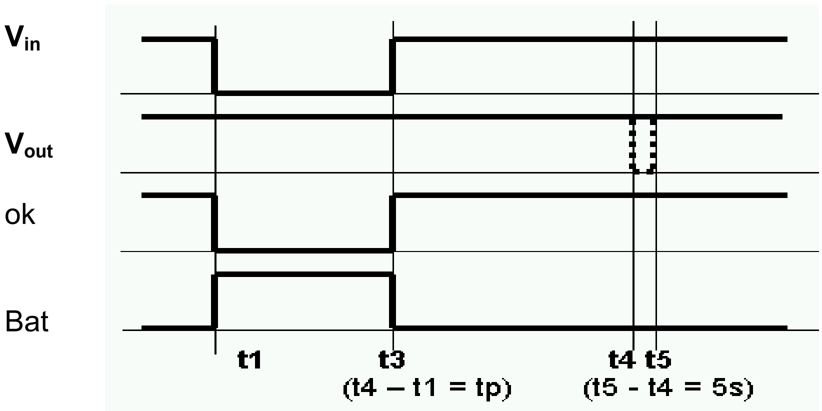

Diagram 3: Brief power failure in devices without an interface

⋮ = with setting of interruption Ua; DIP Switch 8 On (left)

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Resumption of power supply before the buffering time tp is up (t3 is temporally **before** t4):
In the input voltage of the DC UPS module drops (time t1), the "Bat" battery immediately assumes the direct voltage supply. In this way, the output voltage Ua remains absolutely uninterruptible. The floating changeover contact "OK/Bat" switches to its resting position "Bat." At the same time t1, the buffering time tp set on the DIP switches starts automatically. If the "Output Ua Interruption" DIP switch setting is selected, the output voltage Ua is automatically interrupted for 5 seconds after the buffering time tp (time t4) is up. The battery is already switched off because the input voltage has returned to time t3. f the DIP switch is not set to "Output Ua Interruption," there is no interruption in this example because the input voltage at time t3 has already returned before the set buffering time (time t4).

DIP switch settings: Buffering according to a set time using Switch 1 On (left)
Buffering time tp with Switch 2 through 7 from 5 to 635 sec.
Possible interruption of Ua using Switch 8 On (left)

5.3 Long Power Failure in Devices with an Interface

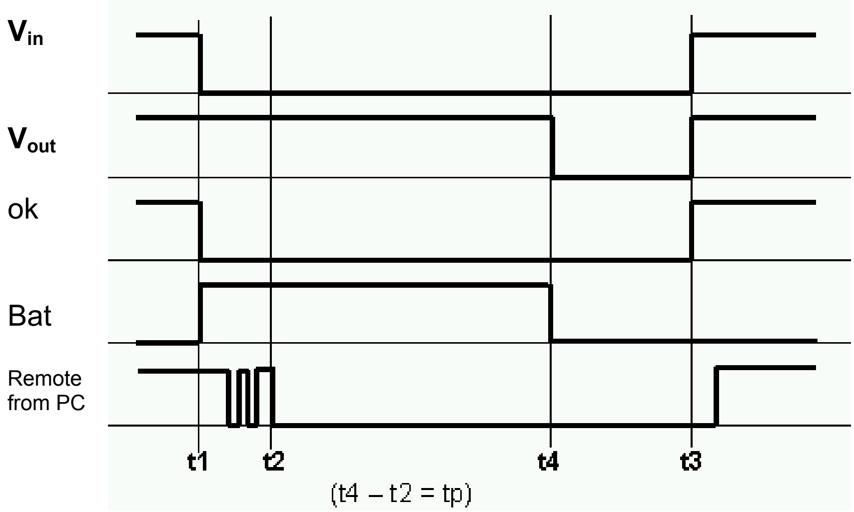

Diagram 4: Long power failure in devices with an interface

Resumption of power supply when the buffering time tp is up (t3 is temporally after t4):
In the input voltage of the DC UPS module drops (time t1), the "Bat" battery immediately assumes the direct voltage supply. In this way, the output voltage Ua remains absolutely uninterruptible.
The floating changeover contact "OK/Bat" switches to its resting position "Bat."
At time t2 selected by the user, the buffering time tp set at the DIP switches is started using the "Remote Timer Start" signal (signal level = 0 at Pin 7 of the 9-pole serial interface or the "R" signal in case of USB communication).
In the case of the selected "Output Ua Interruption" DIP switch setting, the output voltage Ua is automatically interrupted for approximately 5 seconds when the set buffering time is up (time t4) and, at the same time, the battery, which has not yet been disconnected due to a lack of input voltage, is deactivated from the output.

Note: Without the remote signal level=0 with the time period setting of t=max, the output voltage is not interrupted in this case because the set buffering time does not start (or, rather, it is interrupted only if the exhaustive discharge protection disconnects the battery and the input voltage has not yet returned up to that point).

DIP switch settings: Buffering at the maximum buffering time with Switch 1 Off (right)
Buffering time tp with Switch 2 through 7 from 5 to 635 sec.
Possible interruption of Ua using Switch 8 On (left)

5.4 Brief Power Failure in Devices with an Interface

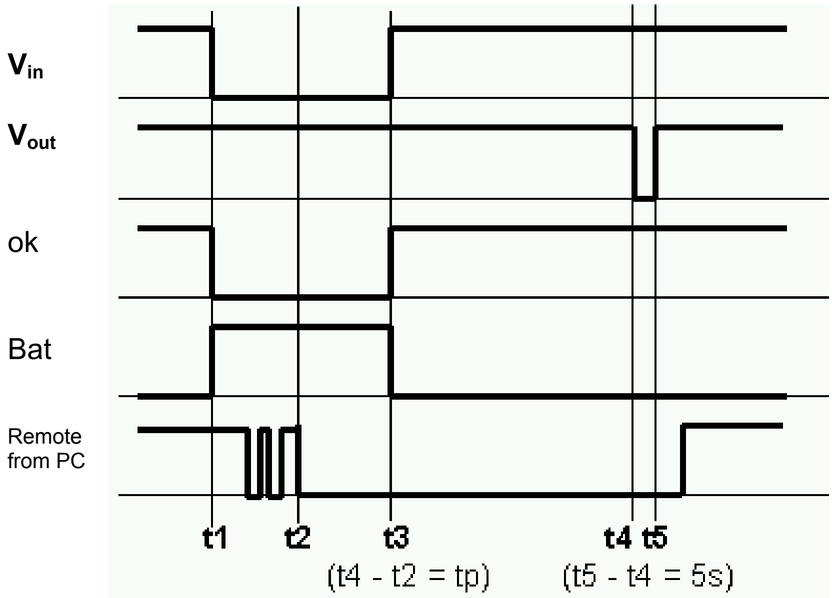

Diagram 5: Brief power failure in devices with an interface

<u>Resumption of power supply before the buffering time tp is up (t3 is temporally</u> before t4):
In the input voltage of the DC UPS module drops (time t1), the "Bat" battery immediately assumes the direct voltage supply. In this way, the output voltage Ua remains absolutely uninterruptible. The floating changeover contact "OK/Bat" switches to its resting position "Bat." At time t2 selected by the user, the buffering time tp set at the DIP switches is started using the "Remote Timer Start" signal (signal level = 0 at Pin 7 of the 9-pole serial interface). If the "Output Ua Interruption" DIP switch setting is selected, the output voltage Ua is automatically interrupted for approximately 5 seconds after the buffering time tp (time t4) is up. The battery is already switched off because the input voltage has returned to time t3. The interruption of the output voltage Ua for 5 seconds enables the automatic rebooting of industrial PCs even if the mains voltage (or the input voltage Ue on the DC UPS module) – as seen in this example – returns while the PC is being shut down.

<u>Note</u>: Without remote signal level=0 in case of a time period setting of t=max, the output voltage is not interrupted in this case because the set buffering time does not start.

DIP switch settings: Buffering at the maximum buffering time with Switch 1 Off (right)
Buffering time tp with Switch 2 through 7 from 5 to 635 sec.
Interruption of Ua using Switch 8 On (left)

6. Battery Modules

The maximum backup time cannot be calculated from the Ah capacity. The obvious forumula - "I x t = capacity in Ah" or "Backup time t = capacity in Ah : charging c current" generally leads to incorrect results.

The formula applies only in case of very low discharge currents of a maximum of 0.05C (i.e. 0.16A for a 3.2Ah battery module, 0.35A for a 7Ah battery module, or 0.6A for a 12Ah battery module); in this case, the theoretical discharge time of 20 hours still results here. (See the characteristic field in Diagram 6. Discharge characteristic 0.05C does not fall to approximately 21.5 VDC until 20 hours have passed.)
At 0.1C, it is only 9 hours according to the characteristic (instead of the theoretical 10 hours); at 1C, it is only approximately 22 minutes according to the characteristic (instead of the theoretical one hour or 60 minutes); at 3C, for example, it is only 1 to 2 minutes (instead of the theoretical 1/3 hour or pprox.0 minutes). The cause for this is the charging current dependent voltage drop at the inner resistance of the battery (at the 10-fold charging current, for example, the approximately 10-fold voltage of the inner resistance of the battery drops) and the extremely "non-linear chemistry" of the battery at loads between 2C and 3C (see the characteristic field in Diagram 6). At charging currents between 0.05C and 2C, the battery voltage (already during the first second of the load) falls relatively linear to the charging current to 25.1V at 0.05C and to 23.7V at 2C. The difference between 1C (immediate fall to 24.3V) and 2C (immediate fall to 23.7V) amounts to only 0.6V. Between 2C (immediate drop to 23.7V) and 3C (immediate drop to 21.6V) the extreme non-linearity does not appear. The voltage does not drop by a further 0.6V (as in case of 1C to 2C), but rather by a whole 2.1V ! A further increase of the charging current from 3C to 5C does not lead to an extreme drop in the battery voltage (by at least several more volts), but rather just to and additional voltage drop of 0.2V (21.6V at 3C, 21.4V at of 5C.

The "battery chemistry" is thus extremely non-linear. For this reason, we recommend that the backup time be determined using the characteristic field (Diagram 6). The selection table (Table 11) can be used to make a rough determination of the battery module.

6.1 Battery Module Selection

Charging Current	**Battery module 1.2 Ah** (6EP1935-6MC01)	**Battery module 3.2 Ah** (6EP1935-6MD11)	**Battery module 7 Ah** (6EP1935-6ME21)	**Battery module 12 Ah** (6EP1935-6MF01)	**Battery module 2.5 Ah (high-temperature)** (6EP1935-6MD31)
1 A	30 min	2.5 h	6 h	10 h	2 h
2 A	11 min	45 min	2.5 h	4 h	45 min
4 A	2 min	20 min	45 min	2.5 h	20 min
6 A	1 min	10 min	30 min	1 h	13 min
8 A	-	4 min	20 min	40 min	9 min
10 A	-	1.5 min	15 min	30 min	7 min
12 A	-	1 min	10 min	25 min	5.5 min
14 A	-	50 s	8 min	20 min	4.5 min
16 A	-	40 s	6 min	15 min	4 min
20 A	-	-	2 min	11 min	-

- Not permitted

Table 11: Selection table for battery modules and mains failure backup times

Note:

During the determination of the mains failure back times, the discharge duration of completely discharged battery modules until the battery voltage drops was based on 21V and an ambient temperature of 25°C.

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6.2 Discharge Characteristics for Lead-Gel Battery Modules

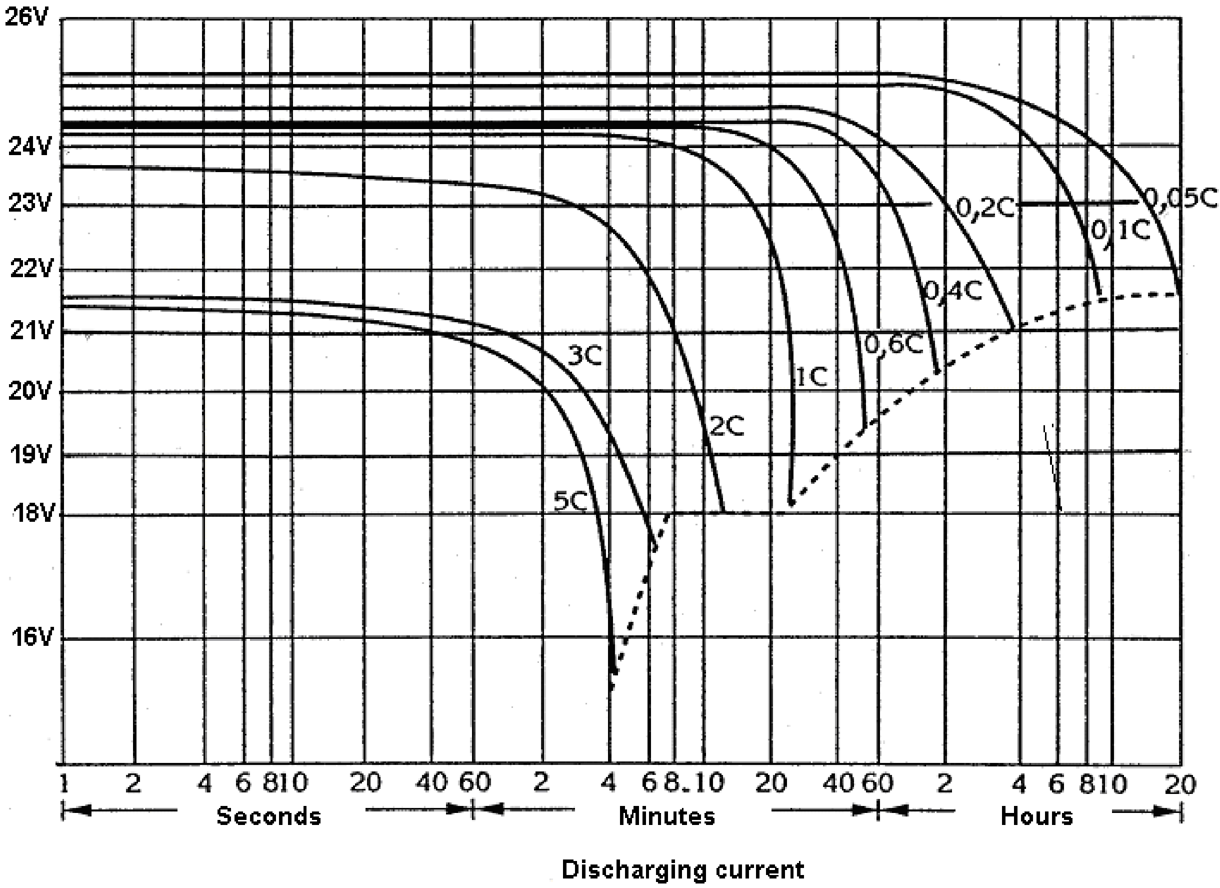

Diagram 6: Discharge characteristics for lead-gel battery modules

<u>Definitions</u>: DISCHARGING CURRENT = Output or charging current of SITOP DC UPS module
Ordinate = Battery voltage in V, abscissa = discharging time in seconds/minutes/hours

- **5C** means: Charging current = **5 x** battery capacity x 1/h
  (i.e., in case of a 3.2Ah battery module, 5C is a charging current of 5 x 3.2Ah x 1/h = 16A)
- **3C** means: Charging current = **3 x** battery capacity x 1/h
  (i.e., in case of a 3.2Ah battery module, 3C is a charging current of 3 x 3.2Ah x 1/h = 9.6A, while, in case of a 7Ah battery module, 3C is a charging current of 3 x 7Ah x 1/h = 21A)
- **1C** is particularly easy: 3.2A charging current for a 3.2Ah battery module, 7A charging current for a 7Ah battery module, or 12A charging current for a 12Ah battery module).
- **0.2C** means: **charging current =** 0.2 x battery capacity x 1/h
  (i.e., in case of a 12Ah battery module, 0.2C is a charging current of 0.2 x 12Ah x 1/h = 2.4A)

  and so on

6.3 Instructions for the Characteristic Field/Selection of the Battery Capacity

1. **Determine the minimum permissible consumer voltage** (e.g. 18 VDC or 20.4 VDC, according to the consumer).

2. **Determine the minimum required battery voltage as follows:** An approximately 0.5V voltage drop in the DC UPS module and the voltage drop in the lines to the consumers (e.g. 0.1V) must be added to the minimum permissible consumer voltage (e.g. 20.4 VDC) (results in a sum of 21V in this example).

3. On the ordinate (axis upwards, voltage axis), the minimum required battery voltage according to Item 2 is entered and a horizontal line is drawn parallel to the abscissa (horizontal time axis) at this height (i.e., a horizontal line is drawing here in this example).

4. Vertical to the points of intersection of this horizontal line according to Item 3 with the discharge characteristics 5C, 3C, 2C, 1C, etc., the backup time can be read from the time axis in regard to a non-aged battery (in the example with 21V, the following results: 40sec at 5C; approx. 80sec at 3C; approx. 8 min. at 2C; approx. 25 min. at 1C; approx. 50min. at 0.6C; approx. 100min. at 0.4C; approx. 4 h at 0.2C; approx 10 h at 0.1C).

5. The maximum backup time (duration until the battery voltage determined in Item 3 is reached) depends on the "charging current in A **:** battery capacity in Ah = ... C in 1/h" ratio, in addition to the minimum required battery voltage. For this reason, the times lying under the points of intersection for the various "...C" for a non-aged battery are calculated. In order for the aging of the battery (reduction of the available maximum backup time at the end of the battery service life to half of the maximum backup time of the unaged battery) is also taken into consideration, <u>the backup time required for the plant </u>(e.g. 3.5 min) **doubles** (= 7 min), and this value (here: 7 min) is entered on the abscissa (horizontal time axis) of the characteristic field.

6. The next point of intersection lying to the right above this value (here: 7 min) between the horizontal line parallel to the abscissa (according to item 3) and the respective discharging characteristic yields the value sought **"...C"** (in the example here, the point of intersection of the horizontal line lies at 21V with a discharge characteristic of 2C to the right above the value 7 min. at 8 min.; that is, at 2C, the backup time amounts to 8 min at the beginning and still 4 min. at the end of the battery service life, which means that it is slightly more than the necessary backup time of, for example, 3.5 min in the example).

7. "...C in 1/1 h" is the ratio "Charging current in A **:** battery capacity in Ah"; using the value "...C" determined according to Item 5 ("2C" in the example above) and <u>the charging current I to be buffered known for the plant</u>, the required battery capacity is determined as follows:
   Required battery capacity in Ah = charging Current in A : C in 1/h

   Examples: 14A charging current, e.g. 2C, results in the required battery capacity = 14AA: 2CCx 1/h = 7Ah battery module
   6.4A charging current, e.g. 2C, results in the required battery capacity = 6.4A : 2C x 1/h = 3.2Ah battery module

8. In case of high charging currents for long backup times, a required battery capacity may result that lies above the 12Ah battery module; in this case, battery modules must be switched parallel and conducted to the +Bat connection of the DC UPS module using a common Type FKS fuse (due to the overload protection of the DC UPS module during battery operation.

9. Example: 12a charging current for 2 h at the minimum required battery voltage of 21v: according to Item 5, the time doubles to 4 hours. The point of intersection of the 21V horizontal lies above the time of 4 hours with "discharge characteristic 0.2C."

   Required battery capacity = 12A : 0.2 x 1/h = 60Ah; five 12Ah battery modules must thus be switched parallel.

Note: The information contained in these considerations for use are only general descriptions or features that do not always apply in the concrete case of application or which may change due to the further development of the products. Subject to change. Errors and omissions excepted.

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