Timers on the Basis of a S7-1200 CPU in DTL Format

SIMATIC S7-1200

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1 Task

1.1 Overview

Introduction

Many fields of automation technology require accurate timing of processes. Accurate time switching of processes is also necessary in a large number of industrial applications in the field of automation technology.
For such applications the following instructions are available in the TIA Portal for the S7-1200:

- under “Basic instructions” > “Timer operation” e.g. on and off delays
- under “Extended instructions” > “Date and time-of -day“ e.g. “Add times“ and “Read time-of-day”

However, these instructions are not sufficient for all applications; e.g. if two times have to be added in DTL format of if a switch-on delay is to be programmed in DTL format.

Analogous to the time switching functions for S7-300/400 under entry ID 21669756, the respective time switching functions for S7-1200 are included in this application.

1.2 Requirements

Range of functions

To be able to design the above mentioned process sequences in terms of time, the S7-1200 requires time switching functions that, depending on the absolute time, set an output or which trigger a configured switching period based a specific event.

The absolute start and end times for these processes have to be configurable at the respective function block in the “DTL” format.
The switching distance between the start time and the end time has to be at least one second.

All time interfaces of these function blocks are to be configured in the “DTL” format.

The following time functions are included in this application:

- Day timer
- Week timer
- Month timer
- Year timer
- Relative timer
- Addition of two tags in DTL format
- Automatic summer time/winter time changeover
- Connecting a radio clock

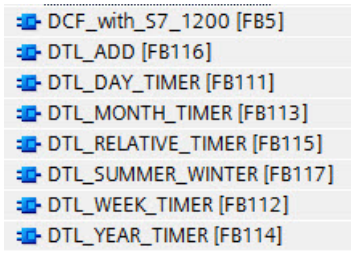
2 Solution

2.1 Overview

Function blocks

The figure below shows the most important components of the solution:

Figure 2-1



Advantages

This application offers you the following advantages:

- Expansion of the functionality of the system instructions by function blocks for which all time interfaces are programmed in “DTL” format.
- Tested function blocks that can be simply integrated into a user program.

Required knowledge

Basic knowledge of the S7-1200 and the TIA Portal is assumed.

2.2 Description of the core functionality

The application includes function blocks for absolute and relative time switching functions. Each function block has only one setting option (corresponds to one “cam”), i.e. one respective switch-on time and one switch-off time each can be entered at one function block. This property has several advantages:

- The design of the function blocks is very fine-grained. This allows optimum utilization of the memory requirement in the S7 CPU.
- The function blocks can be used flexibly.
- The function blocks can be easily configured.

The application furthermore includes a function block for the automatic summer time/ winter time changeover.
The changeover of the summer time/winter time can be optionally controlled by a radio clock with another function block. In this case, two digital inputs are required for the S7-1200 to which the radio clock is connected.

2.3 Hardware and software components

2.3.1 Validity

This application is valid for

- STEP 7 from V12
- S7-1200

2.3.2 Components used

The application was set up with the following components:

Hardware components

Table 2-1

Component	No.	Order number	Note
SIMATIC S7-1200	1	6ES7212-1AD30-0XB0	
SIPLUS DCF77 TIME RECEIVER	1	6AG1057-1AA03-0AA0	Alternatively SICLOCK DCF77 (2XV9450-1AR36) can also be used.

Software components

Table 2-2

Component	No.	Order number	Note
STEP 7 Basic V12 SP1	1	6ES78220A.02-..	or
STEP 7 PROF V12 SP1	1	6ES7822-1AA02-2YP4	

Sample files and projects

The following list includes all files and projects that are used in this example.

Table 2-3

Component	Note
78788733_S7-1200_DTL_Timer.zip	This zip file contains the STEP 7 project
78788733_S7-1200_DTL_Timer.zip	This document.

3 Basics on the “DTL” format

Detailed information on the “DTL” format can be found in STEP7 (TIA Portal) in the “help” menu under the search term “DTL (S7-1200)”.

4 Mode of Operation

4.1 General overview

The functions included in this application are divided into three groups.

Absolute time switching functions (chap. 4.3)

- Day timer
- Week timer
- Month timer
- Year timer

Relative time switching functions and addition (chap. 4.4)

- Relative timer
- Addition in DTL format

Additional functions (chapter 4.5)

- Automatic summer time/winter time changeover
- Connection of radio clock module with DCF77 signal

4.2 Program structure

In the user program only the required functions have to be programmed. Absolute and relative time switching functions can also be called several times.

In the user program the function blocks introduced here, do not necessarily have to be supplied via data blocks.

The following program structure corresponds to the program of this application.

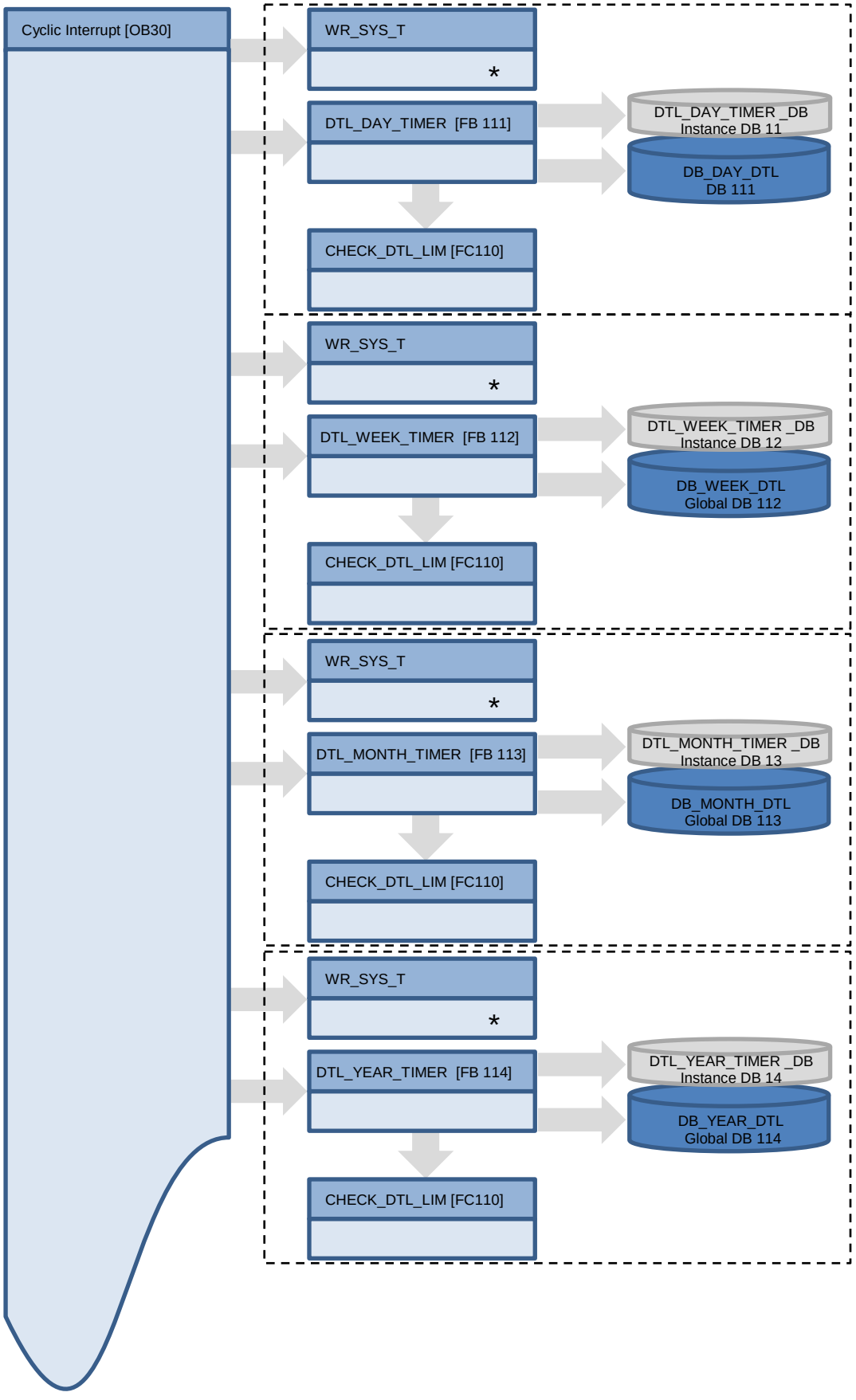
Two programs which both trigger a summer time / winter time changeover must not be used in one program. This is why the “DCF_with_S7_1200” block is disabled via the “EN” parameter in this application.

The system functions marked by * in the following figures are used for testing the manual changing of the system time and are not required in the user program. Further notes on setting the system time can be found in the “STEP 7 Professional V12.0” system manual under the term “System Time”.

The function blocks have to be programmed according to their time critical processing:

- To be able to receive switching times of the timers which are as precise as possible, these function blocks have to be edited in the cyclic interrupt (OB 30). This includes the absolute time switching functions and the relative timer. The precision of the time switching function depends on a respectively short call interval of the cyclic interrupt.
- Non-time critical functions should be edited in the cyclic program (OB 1). This includes the addition in DTL format and the additional functions.

Figure 4-1: Program structure in cyclic interrupt



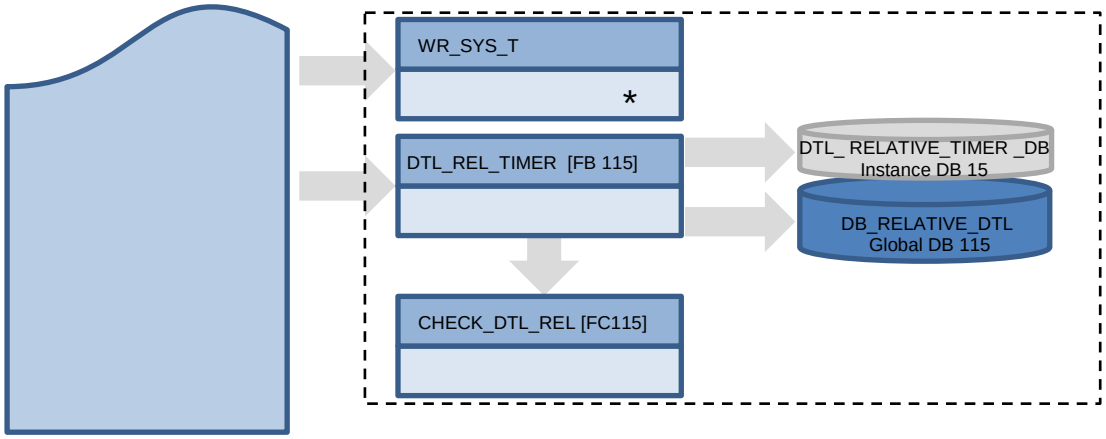
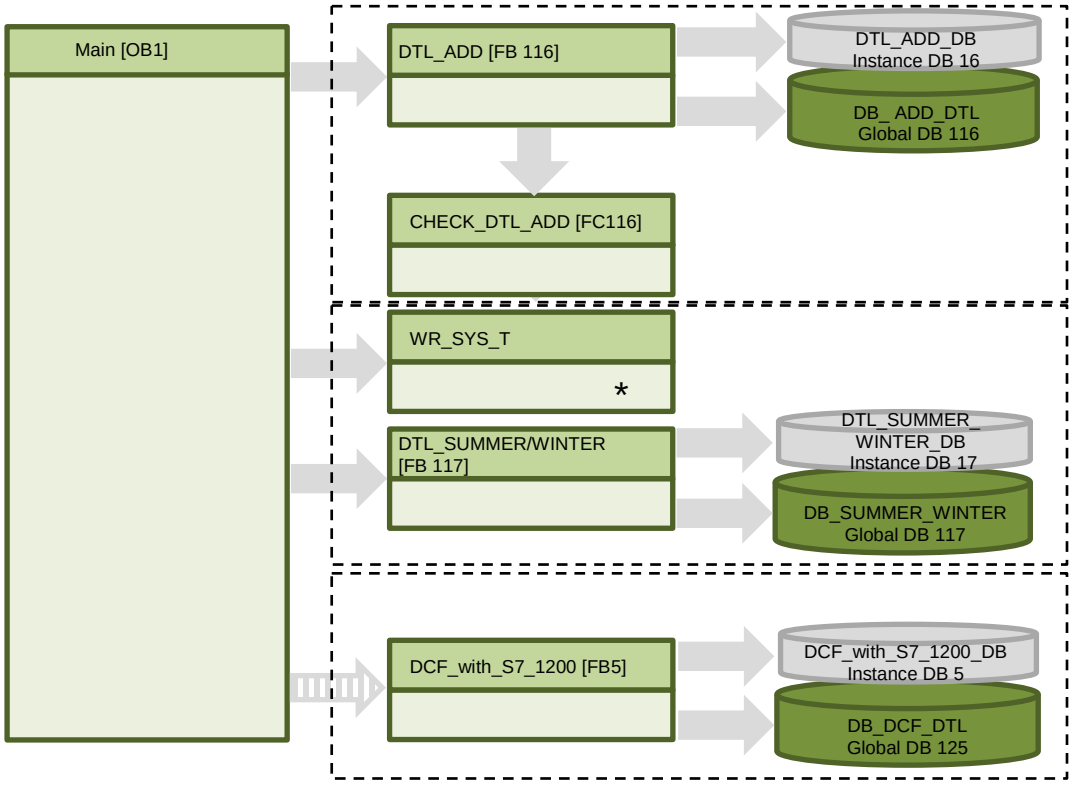


Figure 4-2: Program structure in cyclic program



4.3 Absolute time switching functions

4.3.1 Day timer

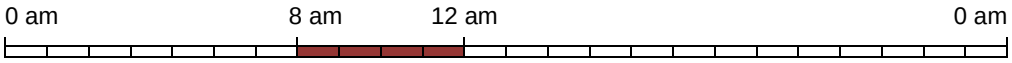
Block name

DTL_DAY_TIMER [FB111]

Description

This block acquires a period of 24 hours. The maximum switching period is 23 hours, 59 minutes and 59 seconds. The switching times are repeated daily. For example, 8 am to 12 am

Table 4-1: Period of the 24 hours DTL_DAY_TIMER function block



Function

This function block compares the current system time with the two inputs Start_Time and End_Time. YEAR, MONTH, DAY of Start_Time and End_Time are not relevant (in all the tables that follow, non-relevant parameters are marked gray).

Each comparator creates a pulse for setting/resetting the Q output. Accordingly, a Q is set when the system time is between Start_Time and End_Time.

RQ resets the “Q” output to “FALSE”.

When exceeding the input limits or if there are calculating errors caused by system blocks, the value “1” is output at the Error output.

A description of the error messages of the used system blocks can be found in their help.

The switching distance between Start_Time and End_Time is checked for a value >= 1 second. If this value is below this value the Error output = 2. Both cases are checked: Start_Time before End_Time; End_Time before Start_Time.

Interfaces

Table 4-2

Parameter	Declaration	Data type	Value range	Description
Start_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Start time
End_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	End time
RQ	Input	Bool	TRUE FALSE	Resets the “Q” output to “FALSE”.
Q	Output	Bool	TRUE FALSE	Timer active
Error	Output	Int	0000 0FFF	Error: 0001H: Configuration fault, Calculation error 0002H: Switching distance < 1 second
Int_Time	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	System time

Table 4-3

Subprograms	Description
CHECK_DTL_LIM [FC 110]	Checks the parameters Start_Time and End_Time for reliable values

4.3.2 Week timer

Block name

DTL_WEEK_TIMER [FB112]

Description

This function block has three modes:

- **Period 7 days**

Maximum acquired period 7 days. The switching period is a maximum of 6 days, 23 hours, 59 minutes and 59 seconds. These switching times are repeated on a weekly basis. For example, every Tuesday from 8 pm to Friday 6 am.

Table 4-4: Period of the 7 day DTL_WEEK_TIMER function block, WEEKDAY = 1 …7

Sunday		Tuesday			Friday	Saturday

- **Period Monday – Friday**

Maximum acquired period 7 days. The maximum switching period is 23 hours, 59 minutes and 59 seconds. These switching times are repeated daily between Monday and Friday. For example from 8 pm to 6 am.

Table 4-5: Period of the 7 day DTL_WEEK_TIMER function block, WEEKDAY = 8

	Monday	Tuesday			Friday	Saturday

- **Period Saturday and Sunday**

Maximum acquired period 7 days. The maximum switching period is 23 hours, 59 minutes and 59 seconds. These switching times are repeated daily Saturdays and Sundays. For example from 8 pm to 6 am.

Table 4-6: Period of the 7 day DTL_WEEK_TIMER function block, WEEKDAY = 9

Sunday	Monday					Saturday
■	■					
■	■					
■	■					
■	■					
■	■					
■						■
■						■
■						■

Function

This function block compares the current system time with the two inputs Start_Time and End_Time. YEAR, MONTH, DAY of Start_Time and End_Time are not relevant.

Each comparator creates a pulse for setting/resetting the Q output. Accordingly, a Q is set when the system time is between Start_Time and End_Time.

The mode of this function block is specified with the “WEEKDAY” DTL parameter included in Start_Time and End_Time:

WEEKDAY = 1 ... 7: Sunday … Saturday.
BOTH tags Start_Time and End_Time have to be located in a range of 1 ... 7. Start and end take place on the specified WEEKDAY.

For example, Start_Time.WEEKDAY = 7, Start_Time.HOUR = 11, MINUTE = 10
End_Time.WEEKDAY = 3, End_Time.HOUR = 7, MINUTE = 5
The timer starts on Saturday, 11:10:00;
the timer ends on Tuesday 07:05:00.

WEEKDAY = 8: all days between Mondays and Fridays
BOTH tags Start_Time and End_Time have to be “8”. The time switching function starts every day between Monday and Friday, the time switching function ends every day between Monday and Friday. In case that the end time is before the start time, the time switching function will also end on Saturday

For example, Start_Time.WEEKDAY = 8, Start_Time.HOUR = 3, MINUTE = 10
End_Time.WEEKDAY = 8, End_Time.HOUR = 16, MINUTE = 5
The timer starts each day between Monday and Friday at 3:10:00;
the timer ends each day between Monday and on Friday at 16:05:00.

For example, Start_Time.WEEKDAY = 8, Start_Time.HOUR = 22, MINUTE = 10
End_Time.WEEKDAY = 8, End_Time.HOUR = 4, MINUTE = 5
The timer starts each day between Monday and Friday at 22:10:00;
the timer ends each day between Tuesday and Saturday, 4:05:00.

WEEKDAY = 9: Saturday and Sunday

BOTH tags Start_Time and End_Time have to be 9. The time switching function starts Saturday and Sunday, the time switching function ends Saturday and Sunday,

In case that the end time is before the start time, the time switching function will also end on Monday

For example, Start_Time.WEEKDAY = 9, Start_Time.HOUR = 3, MINUTE = 10
End_Time.WEEKDAY = 9, End_Time.HOUR = 16, MINUTE = 5
The timer starts on Saturday and Sunday, 03:10:00;
the timer ends on Saturday and Sunday, 16:05:00.

For example, Start_Time.WEEKDAY = 9, Start_Time.HOUR = 22, MINUTE = 10
End_Time.WEEKDAY = 9, End_Time.HOUR = 4, MINUTE = 5
The timer starts on Saturday and Sunday at 22:10:00;
the timer ends on Sunday and Monday at 4:05:00.

General:

RQ resets the “Q” output to “FALSE”.

When exceeding the input limits or if there are calculating errors caused by system blocks, the value “1” is output at the Error output.

A description of the error messages of the system blocks used can be found in their help.

The switching distance between Start_Time and End_Time is checked for a value >= 1 second. If this value falls below, the Error output = 2. Both cases are checked: Start_Time before End_Time; End_Time before Start_Time.

Interfaces

Table 4-7

Parameter	Declaration	Data type	Value range	Description
Start_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Start time
Start_Time. WEEKDAY	Input	DTL	1 9	Weekday of start time
End_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	End time
End_Time. WEEKDAY	Input	DTL	1 9	Weekday of end time
RQ	Input	Bool	TRUE FALSE	Resets the “Q” output to “FALSE”.
Q	Output	Bool	TRUE FALSE	Timer active
Error	Output	Int	0000 H 0FFF H	Error: 0001 H: Configuration fault, Calculation error 0002 H: Switching distance < 1 second
Int_Time	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	System time

Table 4-8

Subprograms	Description
CHECK_DTL_LIM [FC 110]	Checks the parameters Start_Time and End_Time for reliable values

4.3.3 Month timer

Block name

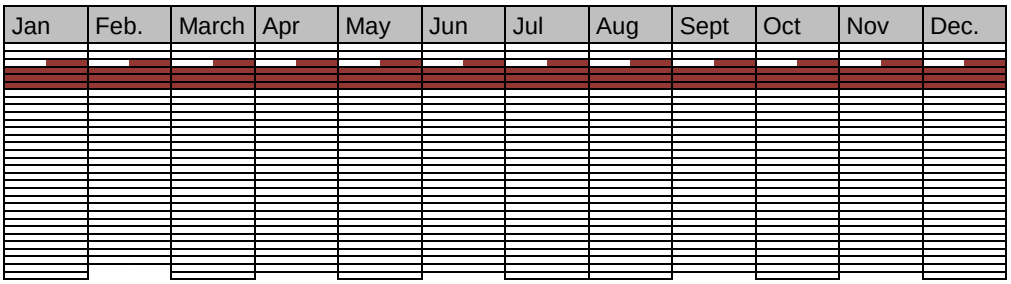
DTL_MONTH_TIMER [FB113]

Description

This block acquires a period of a maximum of 31 days. The switching period is a maximum of 30 days, 23 hours, 59 minutes and 59 seconds, e.g. each month from the 3rd, 12 am to the 7th, 0 am.

Considered are also special cases where the start date is on the last day of the month and the following month has fewer days. In this case and for a maximum switching period, the day of the end time is calculated for the last day of the following month. The calculation of the end time is the same as for all other start days.

Table 4-9: Period of the 1 month DTL_MONTH_TIMER function block



Function

This function block compares the current system time with the two inputs Start_Time and End_Time. YEAR, MONTH, DAY of Start_Time and End_Time are not relevant.

Each comparator creates a pulse for setting/resetting the Q output. Accordingly, a Q is set when the system time is between Start_Time and End_Time.

RQ resets the “Q” output to “FALSE”.

When exceeding the input limits or if there are calculating errors caused by system blocks, the value “1” is output at the output.

A description of the error messages of the system blocks used can be found in their help.

The switching distance between Start_Time and End_Time is checked for a value >= 1 second. If this value falls below, the Error output = 2. Both cases are checked: Start_Time before End_Time; End_Time before Start_Time.

Interfaces

Table 4-10

Parameter	Declaration	Data type	Value range	Description
Start_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Start time
End_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	End time
RQ	Input	Bool	TRUE FALSE	Resets the “Q” output to “FALSE”.
Q	Output	Bool	TRUE FALSE	Timer active
Error	Output	Int	0000 H 0FFF H	Error: 0001 H: Configuration fault, Calculation error 0002 H: Switching distance < 1 second
Int_Time	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	System time

Table 4-11

Subprograms	Description
CHECK_DTL_LIM [FC 110]	Checks the parameters Start_Time and End_Time for reliable values

4.3.4 Year timer

Block name

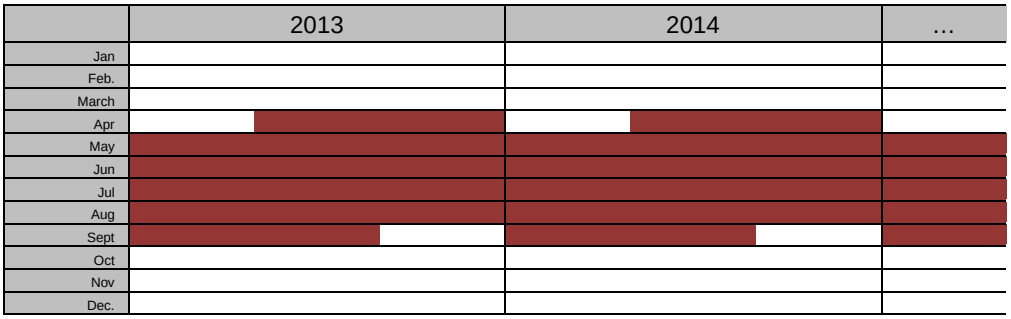
DTL_YEAR_TIMER [FB114]

Description

This block acquires a period of 365 / 366 days. The switching period is a maximum of 11 months, 30 days, 23 hours, 59 minutes and 59 seconds, e.g. from 11th April, 0 am to 21st September, 0 am.

Special cases where the start date is on the last day of the month and the following month has fewer days or where the start date falls on the 29th February of a leap year are also considered. In these cases and for a maximum switching period, the day of the end time is calculated for the last day of the following month. The calculation of the end time is the same as for all other start days.

Table 4-12: Period of the 1 year DTL_YEAR_TIMER function block



Function

This function block compares the current system time with the two inputs Start_Time and End_Time. YEAR of Start_Time and End_Time is not relevant.

Each comparator creates a pulse for setting/resetting the Q output. Accordingly, a Q is set when the system time is between Start_Time and End_Time.

RQ resets the “Q” output to “FALSE”.

When exceeding the input limits or if there are calculating errors caused by system blocks, the value “1” is output at the Error output.

A description of the error messages of the system blocks used can be found in their help.

The switching distance between Start_Time and End_Time is checked for a value >= 1 second. If this value falls below, the Error output = 2. Both cases are checked: Start_Time before End_Time; End_Time before Start_Time.

Interfaces

Table 4-13

Parameter	Declaration	Data type	Value range	Description
Start_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Start time
End_Time	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	End time
RQ	Input	Bool	TRUE FALSE	Resets the “Q” output to “FALSE”.
Q	Output	Bool	TRUE FALSE	Timer active
Error	Output	Int	0000 H 0FFF H	Error: 0001 H: Configuration fault, Calculation error 0002 H: Switching distance < 1 second
Int_Time	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	System time

Table 4-14

Subprograms	Description
CHECK_DTL_LIM [FC 110]	Checks the parameters Start_Time and End_Time for reliable values

4.4 Relative timer and time switching functions

4.4.1 Relative timer

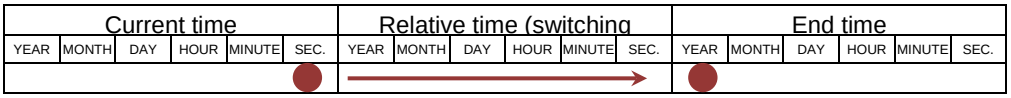
Block name

DTL_RELATIVE_TIMER [FB115]

Description

With a start pulse the timer is enabled and remains active until the configured switching period has lapsed.

Table 4-15: Switching period of the DTL_REL_TIMER function block maximum 200 years



Function

This function block adds the switching time (Rel_Time) to the current time (Int_Time). The calculated end time of the timer is output at the End_Time output when it has been calculated and the timer is running. The end time is set to zero whilst it is calculated or has lapsed.

The current system time is copied to the Int_Time output.

The format of Int_Time, Rel_Time and End_Time is DTL.

The Q output is set to “TRUE” straight away when the time switch is started by a pulse on the Start_Time input.

When the Check_Edge input is “TRUE”, the timer restarts at every pulse on the Start_Time input.

When the Check_Edge input is “FALSE” the timer can only be restarted when the End_time has been reached.

The RQ input always resets the timer; the timer can then be restarted.

When the input limits are exceeded the value “1” is output at the Error output.

A calculation error triggered by the system blocks used results in a value on the Error output = 2.

Descriptions on this matter can be found in the help of the system blocks used.

Note: The End_Time range is limited to the year 2262.

Interfaces

Table 4-16

Parameter	Declaration	Data type	Value range	Description
Check_Edge	Input	Bool	TRUE FALSE	If “TRUE”: Restart at Start_Time
Start_Time	Input	Bool	TRUE FALSE	Pulse for starting the timer and for calculating the end time
Rel_Time	Input	DTL	0-00-00-00:00:00.1 200-00-00-00:00:00.0	End time, maximum switching time 200 years, 11 months, 30 days, 23 hours, 59 minutes and 59 seconds
RQ	Input	Bool	TRUE FALSE	Resets the “Q” output to “FALSE”.
Q	Output	Bool	TRUE FALSE	Timer active
Error	Output	Int	0000 H 0FFF H	Error: 0001 H: Configuration error 0002 H: Calculation error
Int_Time	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	System time

Table 4-17

Subprograms	Description
CHECK_DTL_REL [FC 115]	Checks the Rel_Time parameter for reliable values

Signal diagrams

Table 4-18: Behavior for “Check_Edge” = “FALSE” signal

Signal	
Check_Edge	
Start_Time	
RQ	
Q	

Table 4-19: Behavior for “Check_Edge” = “TRUE” signal

Signal	
Check_Edge	
Start_Time	
RQ	
Q	

4.4.2 Addition in DTL format

Block name

DTL_ADD [FB116]

Description

The function block adds two summands in DTL format. This format is defined from 1970. This is why the summand 1 has to at least correspond to this value. The summand 2 has to be in a range of 1 second up to a recommended value of 200 years. The sum must not continue to go beyond the year 2262.

Table 4-20

Function

This function block calculates the sum of summand_1 and summand_2, if a change of edge from “TRUE” to Start_Calc is detected. The format of Summand_1, Summand_2 and the sum is DTL.

When the calculation of the sum has been completed the output Calculated becomes “TRUE”.

When the input limits are exceeded the value at the Error output = 1.

A calculation error triggered by the system blocks used results in a value on the Error output = 2. Descriptions on this matter can be found in the help of the system blocks used.

Interfaces

Table 4-21

Parameter	Declaration	Data type	Value range	Description
Start_Calc	Input	Bool	TRUE FALSE	Pulse for start calculating of Sum
Summand_1	Input	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Base time corresponds to a time
Summand_2	Input	DTL	0-00-00-00:00:00.1 200-00-00-00:00:00.0	Difference time corresponds to a period
Sum	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Calculated time corresponds a time
Calculated	Output	Bool	TRUE FALSE	Calculation of sum completed
Error	Output	Int	0000 H 0FFF H	Error: 0001 H: Configuration error 0002 H: Calculation error

Table 4-22

Subprograms	Description
check_DTL_LIM [FC 116]	Checks Summand_1 and Summand_2 for reliable values

4.5 Additional functions

4.5.1 Automatic summer time/winter time changeover

Block name

DTL_SUMMER_WINTER [FB117]

Description

The adjustment to the system time is automatic with the officially fixed times.

Function

This function block reads and writes the system time. Depending on the rules for the switchover between winter time and summer time, the system is automatically switched over.

Whilst the summer time is active the summer output is set to “TRUE”.

The Error output includes both RET_VALs of the system functions RD_SYS_T and WR_SYS_T.

RD_SYS_T is assigned to the #stat_ret_val.W0 word and WR_SYS_T to the #stat_ret_val.W1 word.

Descriptions on this matter can be found in the help of the system blocks used.

Interfaces

Table 4-23

Parameter	Declaration	Data type	Value range	Description
Time	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Current time
Summer	Output	Bool	TRUE FALSE	Summer time active
Error	Output	DInt	0000 0000 H 0FFF FFFF H	Error see help for “RD_SYS_T“ and “WR_SYS_T“

Table 4-24

Subprograms	Description
none	---

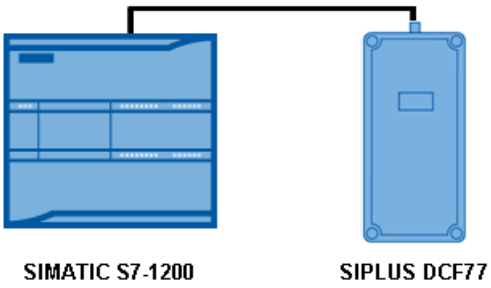
4.5.2 Connection of radio clock module with DCF77 signal

Block name

DCF_with_S7_1200 [FB5]

Description

Figure 4-3: Configuration S7-1200 with SIPLUS DCF77



The function block includes the following functions:

- Acquiring time signal of the radio clock module
- Decoding time signal
- Conversion of the data into the DTL format
- Adjusting module time of the S7-1200
- Error detection in the signal
- Supplying information on the current status

Function

The SIPLUS radio clock module DCF77 supplies coded information on the current time and date. The DCF_with_S7_1200 function block decodes this information and overwrites the system time of the S7-1200.

Interfaces

Table 4-25

Parameter	Declaration	Data type	Value range	Description
Timezone	Input	INT	+12 -12	Specifying time zone in which the S7- 1200 is located, depending on the UTC/GMT. For example, in Germany = +1, since there is an hour time difference
DCF77_data	Input	BOOL	FALSE TRUE	This is where the input is created which is wired with the DCF data signal of the radio clock module.
DCF77_tact	Input	BOOL	FALSE TRUE	This is where the input is created which is wired with the sec cycle of the radio clock module.
Time	Output	DTL	1970-01-01-00:00:00.0 2262-01-01-00:00:00.0	Entry of the time received by the DCF77 with which the CPU is synchronized.
Sync	Output	BOOL	FALSE TRUE	If this value is “TRUE”, the CPU time is the time of the DCF77 – time signal. The CPU is synchronous. This is only the case if there are no errors.
Summer time	Output	BOOL	FALSE TRUE	Gives information on summer time “TRUE“ = summer time “FALSE“ = winter time
Error_Code	Output	WORD	0FFF H 0000 H	The error code gives information on several signal errors.

Table 4-26

Subprograms	Description
none	---

A further documentation on this function block can be found under the following link: http://support.automation.siemens.com/WW/view/en/63628396

5 Installation

In this chapter you can find the necessary steps in order to operate the code from the download and the hardware from the above list.

5.1 Hardware installation

A hardware installation is only required for the setup with the connection of the radio clock module with DCF77 signal. The description can be found under the following link: http://support.automation.siemens.com/WW/view/en/63628396

5.2 Installation of the software (download)

This chapter describes the steps for the installation of the example code.

Table 5-1

No.	Action	Comments
1.	Load the download 78788733_S7-1200_DTL_Timer.zip into a respective directory	
2.	Unzip the files into a respective directory	
3.	Start the TIA Portal	
4.	Open the global “78788733_S7-1200_DTL_Timer” library via the menu: Tools > Global library > Open library… > 78788733_S7-1200_DTL_Timer > 78788733_S7-1200_DTL_Timer.al12	
5.	Create a new project	
6.	Add a new device	From the group of the SIMATIC S7-1200 CPU
7.	Copy all blocks from the master copy of the global “78788733_S7-1200_DTL_Timer” library, for example via drag and drop into the program block folder of the project	
8.	Copy the tag tables accordingly into the watch and force tables	

5.3 Commissioning

Table 5-2

No.	Action	Comments
1.	Create a connection to the S7-1200.	See S7-1200 automation system manual

6 Operating the Application

This application provides tag tables as an operating option for the time and special functions.

Note The individual input and output parameters of the functions have already been described in chapter 5 Describing the time switching functions.

6.1 Absolute time switching functions

For operating and monitoring, e.g. for test purposes each absolute time switching function is assigned to a VAT tag table. These are:

- “VAT_DAY_Timer_DTL” for the day timer
- “VAT_WEEK_Timer_DTL” for the week timer
- “VAT_MONTH_Timer_DTL” for the month timer
- “VAT_YEAR_Timer_DTL” for the year timer

Month timer

The figure below shows the “VAT_MONTH_Timer_DTL” tag table of FB113 “DTL_MONTH_TIMER” as an example for the operation of the absolute timers. The tag table is divided into 5 blocks:

Figure 6-1: VAT_MONTH_Timer_DTL

	Name	Anz...	Beobachtu...	Steuerwert	Kommentar
1	"DB_MONTH_DTL".start_time.YEAR	DEZ	0	0	start time timer
2	"DB_MONTH_DTL".start_time.MONTH	DEZ	0	0	
3	"DB_MONTH_DTL".start_time.DAY	DEZ	12	12	
4	"DB_MONTH_DTL".start_time.WEEKDAY	DEZ	0		
5	"DB_MONTH_DTL".start_time.HOUR	DEZ	11	11	
6	"DB_MONTH_DTL".start_time.MINUTE	DEZ	8	8	
7	"DB_MONTH_DTL".start_time.SECOND	DEZ	45	45	
8	"DB_MONTH_DTL".start_time.NANOSECOND	DEZ	0	0	
9	"DB_MONTH_DTL".end_time.YEAR	DEZ	0	0	end time timer
10	"DB_MONTH_DTL".end_time.MONTH	DEZ	0	0	
11	"DB_MONTH_DTL".end_time.DAY	DEZ	31	31	
12	"DB_MONTH_DTL".end_time.WEEKDAY	DEZ	0	0	
13	"DB_MONTH_DTL".end_time.HOUR	DEZ	0	0	
14	"DB_MONTH_DTL".end_time.MINUTE	DEZ	0	0	
15	"DB_MONTH_DTL".end_time.SECOND	...	15	15	
16	"DB_MONTH_DTL".end_time.NANOSECOND	DEZ	0	0	
17	"DB_MONTH_DTL".RQ	BOOL	FALSE		
18	"DB_MONTH_DTL".Q	BOOL	TRUE		timer between start time and end time
19	"DB_MONTH_DTL".Error	DEZ...	0		collective fault timer
20	"DB_MONTH_DTL".int_time.YEAR	DEZ	2013		internal time timer
21	"DB_MONTH_DTL".int_time.MONTH	DEZ	8		
22	"DB_MONTH_DTL".int_time.DAY	DEZ	12		
23	"DB_MONTH_DTL".int_time.HOUR	DEZ	11		
24	"DB_MONTH_DTL".int_time.MINUTE	DEZ	8		
25	"DB_MONTH_DTL".int_time.SECOND	DEZ	54		
26	"DB_MONTH_DTL".int_time.NANOSECOND	DEZ	249000		
27	"DB_MONTH_DTL".set_time.YEAR	DEZ	2013	2013	set system clock values
28	"DB_MONTH_DTL".set_time.MONTH	DEZ	8	8	
29	"DB_MONTH_DTL".set_time.DAY	DEZ	12	12	
30	"DB_MONTH_DTL".set_time.HOUR	DEZ	11	11	
31	"DB_MONTH_DTL".set_time.MINUTE	DEZ	6	6	
32	"DB_MONTH_DTL".set_time.SECOND	DEZ	0	0	
33	"DB_MONTH_DTL".set_time.NANOSECOND	DEZ	0	0	
34	"Tag_13"	Hex	16#0000		
35	"DB_MONTH_DTL".set_pulse	BOOL	TRUE	TRUE	set timer by pulse (put it to zero after setting)

- 1st and 2nd block: setting of start and end times of the timer
- 3rd block: resetting of timer, output of timer, error information
- 4th block: System time
- 5th block: setting of system time. The transfer takes place during the change of edge to “TRUE” on the DB_MONTH_DTL.set_pulse bit.

Table 6-1

No.	Action	Comments
1.	Call the respective watch table under “watch and force tables”	
2.	Set the system time via block 5 and execute a change of edge to “TRUE” at “DB_MONTH_DTL.set_pulse” so that the value is accepted. Use the tag button “modify now“ 	The “WEEKDAY” parameters are only relevant for the week timer
3.	Monitor the changed system time in block 4	
4.	Set the start and end time on block 1 and 2.	
5.	Monitor the error information when invalid values are entered	
6.	Monitor the output of the timer when • the start time is reached • the end time is reached	
7.	Repeat steps 1 – 5 if required.	

6.2 Relative time switching functions

Relative timer

The “VAT_REL_timer_DTL” tag table is available for operating and monitoring, e.g. to test the relative time switching function. The tag table is divided into 6 blocks:

Figure 6-2: VAT_REL_Timer_DTL

	Name	Adresse	Anzeige..	Beobachtu...	Steuerwert		Kommentar
1	"DB_RELATIVE_DTL".check_edge		BOOL	FALSE	FALSE		1
2	"DB_RELATIVE_DTL".start_time		BOOL	TRUE	TRUE		1
3	"DB_RELATIVE_DTL".rel_time.YEAR		DEZ	1	1		rel time timer
4	"DB_RELATIVE_DTL".rel_time.MONTH		DEZ	2	2		
5	"DB_RELATIVE_DTL".rel_time.DAY		DEZ	3	3		
6	"DB_RELATIVE_DTL".rel_time.HOUR		DEZ	4	4		
7	"DB_RELATIVE_DTL".rel_time.MINUTE		DEZ	5	5		
8	"DB_RELATIVE_DTL".rel_time.SECOND		DEZ	6	6		
9	"DB_RELATIVE_DTL".end_time.YEAR		DEZ	2014			end time timer
10	"DB_RELATIVE_DTL".end_time.MONTH		DEZ	10			
11	"DB_RELATIVE_DTL".end_time.DAY		DEZ	15			
12	"DB_RELATIVE_DTL".end_time.WEEKDAY		DEZ	4			
13	"DB_RELATIVE_DTL".end_time.HOUR		DEZ	18			
14	"DB_RELATIVE_DTL".end_time.MINUTE		DEZ	7			
15	"DB_RELATIVE_DTL".end_time.SECOND		DEZ	0			
16	"DB_RELATIVE_DTL".end_time.NANOSECOND		DEZ	6189000			
17	"DB_RELATIVE_DTL".RQ		BOOL	FALSE	FALSE		
18	"DB_RELATIVE_DTL".Q		BOOL	TRUE			timer between start time and end time
19	"DB_RELATIVE_DTL".Error		DEZ+/-	0			collective fault timer
20	"DB_RELATIVE_DTL".int_time.YEAR		DEZ	2013			internal time timer
21	"DB_RELATIVE_DTL".int_time.MONTH		DEZ	8			
22	"DB_RELATIVE_DTL".int_time.DAY		DEZ	12			
23	"DB_RELATIVE_DTL".int_time.HOUR		DEZ	14			
24	"DB_RELATIVE_DTL".int_time.MINUTE		DEZ	9			
25	"DB_RELATIVE_DTL".int_time.SECOND		DEZ	44			
26	"DB_RELATIVE_DTL".int_time.NANOSECOND		DEZ	6167000			
27	"DB_RELATIVE_DTL".set_time.YEAR		DEZ	2013	2013		set system clock values
28	"DB_RELATIVE_DTL".set_time.MONTH		DEZ	8	8		
29	"DB_RELATIVE_DTL".set_time.DAY		DEZ	12	12		
30	"DB_RELATIVE_DTL".set_time.HOUR		DEZ	14	14		
31	"DB_RELATIVE_DTL".set_time.MINUTE		DEZ	0	0		
32	"DB_RELATIVE_DTL".set_time.SECOND		DEZ	0	0		
33	"DB_RELATIVE_DTL".set_time.NANOSECOND		DEZ	0	0		
34	"DB_RELATIVE_DTL".set_pulse		BOOL	TRUE	TRUE		set timer by pulse (put it to zero after setting)

- 1st block: Start the time switching function via “DB_RELATIVE_DTL.check_Edge” and “DB_RELATIVE_DTL.start_time”, see 4.4.1
- 2nd und 3rd block: setting of relative and end time of the timer
- 4th block: resetting of timer, output of timer, error information
- 5th block: system time
- 6th block: setting of system time. The transfer takes place during the change of edge to “TRUE” on the DB_MONTH_DTL.set_pulse bit.

Table 6-2

No.	Action	Comments
1.	Call the respective watch table under “watch and force tables”	
2.	Set the system time via block 6 and execute a change of edge to “TRUE” at “DB_MONTH_DTL.set_pulse” so that the value is accepted. Use the tag button “modify now“ 	
3.	Monitor the changed system time in block 5	
4.	Set the relative time on block 2.	
5.	Monitor the error information when invalid values are entered	

No.	Action	Comments
6.	Monitor the “DB_RELATIVE_DTL.Q“ output of the timer when • the start time is set • the end time is reached	In this period the end time is calculated. In order to have only a low load on the cycle time, the calculation of, e.g. years can take some minutes, which in practice is not relevant.
7.	Repeat steps 1 – 6 if required.	

Addition in DTL format

The “VAT_ADD_DTL” tag table is available for operating and monitoring, e.g. to test the addition in DTL format. The tag table is divided into 6 blocks:

Figure 6-3: VAT_ADD_DTL

	Name	Adresse	Anzeige...	Beobachtungswert	Steuerwert	Kommentar
1	"DB_ADD_DTL".Start_Calc		BOOL	TRUE	TRUE	start calc. pulse
2	"DB_ADD_DTL".Summand_1.YEAR		DEZ	2000	2000	summand_1
3	"DB_ADD_DTL".Summand_1.MONTH		DEZ	1	1	
4	"DB_ADD_DTL".Summand_1.DAY		DEZ	1	1	
5	"DB_ADD_DTL".Summand_1.HOUR		DEZ	0		
6	"DB_ADD_DTL".Summand_1.MINUTE		DEZ	0		
7	"DB_ADD_DTL".Summand_1.SECOND		DEZ	0		
8	"DB_ADD_DTL".Summand_2.YEAR		DEZ	0	0	summand_2
9	"DB_ADD_DTL".Summand_2.MONTH		DEZ	0	0	
10	"DB_ADD_DTL".Summand_2.DAY		DEZ	0	0	
11	"DB_ADD_DTL".Summand_2.HOUR		DEZ	9	9	
12	"DB_ADD_DTL".Summand_2.MINUTE		DEZ	0		
13	"DB_ADD_DTL".Summand_2.SECOND		DEZ	0	0	
14	"DB_ADD_DTL".Calculated		BOOL	TRUE		sum is calculated
15	"DB_ADD_DTL".Sum.YEAR		DEZ	2000		sum
16	"DB_ADD_DTL".Sum.MONTH		DEZ	1		
17	"DB_ADD_DTL".Sum.DAY		DEZ	1		
18	"DB_ADD_DTL".Sum.HOUR		DEZ	9		
19	"DB_ADD_DTL".Sum.MINUTE		DEZ	0		
20	"DB_ADD_DTL".Sum.SECOND		DEZ	0		
21	"DB_ADD_DTL".Error		Hex	16#0000		calculation error

- 1st block: Start the addition with the change of edge to “TRUE” via “DB_ADD_DTL.Start_Calc”
- 2nd and 3rd block: setting of Summand_1 and Summand_2
- 4th block: calculation status bit sum completed
- 5th block: total
- 6th block: error information

Table 6-3

No.	Action	Comments
1.	Call the respective watch table under “watch and force tables”	
2.	Enter Summand_1	as time
3.	Enter Summand_2	as period (configuration see 4.4.2)
4.	Execute a change of edge to “TRUE” to “DB_ADD_DTL.Start_Calc” so that the values can be accepted. Use the tag button “modify now“ 	
5.	Monitor the outputs “DB_ADD_DTL.Q” and “DB_ADD_DTL.Sum”	The calculation of longer periods, e.g. of years can take

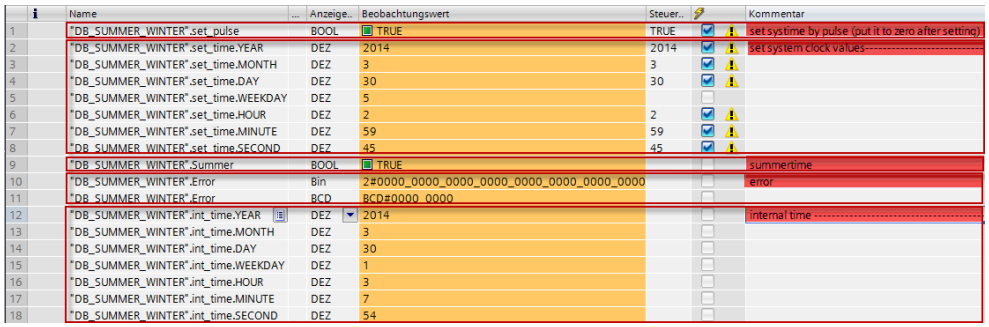
No.	Action	Comments
		some minutes
6.	Monitor the error information when invalid values are entered	

6.3 Additional functions (chapter 4.5)

Automatic summer time/winter time changeover

The “VAT_SUMMER_WINTER” tag table is available for operating and monitoring, e.g. to test the automatic summer time/winter time changeover. The tag table is divided into 5 blocks:

Figure 6-4: VAT_SUMMER_WINTER



	Name	Anzeige..	Beobachtungswert	Steuer..	Kommentar
1	"DB_SUMMER_WINTER".set_pulse	BOOL	TRUE	TRUE	set systime by pulse (put it to zero after setting)
2	"DB_SUMMER_WINTER".set_time.YEAR	DEZ	2014	2014	set system clock values
3	"DB_SUMMER_WINTER".set_time.MONTH	DEZ	3	3	
4	"DB_SUMMER_WINTER".set_time.DAY	DEZ	30	30	
5	"DB_SUMMER_WINTER".set_time.WEEKDAY	DEZ	5		
6	"DB_SUMMER_WINTER".set_time.HOUR	DEZ	2	2	
7	"DB_SUMMER_WINTER".set_time.MINUTE	DEZ	59	59	
8	"DB_SUMMER_WINTER".set_time.SECOND	DEZ	45	45	
9	"DB_SUMMER_WINTER".Summer	BOOL	TRUE		summertime
10	"DB_SUMMER_WINTER".Error	Bin	2#0000_0000_0000_0000_0000_0000_0000_0000		error
11	"DB_SUMMER_WINTER".Error	BCD	BCD#0000_0000		
12	"DB_SUMMER_WINTER".int_time.YEAR	DEZ	2014		internal time
13	"DB_SUMMER_WINTER".int_time.MONTH	DEZ	3		
14	"DB_SUMMER_WINTER".int_time.DAY	DEZ	30		
15	"DB_SUMMER_WINTER".int_time.WEEKDAY	DEZ	1		
16	"DB_SUMMER_WINTER".int_time.HOUR	DEZ	3		
17	"DB_SUMMER_WINTER".int_time.MINUTE	DEZ	7		
18	"DB_SUMMER_WINTER".int_time.SECOND	DEZ	54		

- 1st setting of system time. The transfer takes place during the change of edge to “TRUE” on the DB_SUMMER_WINTER.set_pulse bit.
- 2nd block: setting of values of the system time
- 3rd block: summer time status bit
- 4th block: error information
- 5th block: system time

Table 6-4

No.	Action	Comments
1.	Set the system time directly before the changeover to summer time	Further details can be found, e.g. in wikipedia.org
2.	Observe how the time “jumps” from 02:00 to 03:00 when switching the DB_SUMMER_WINTER.Summer bit	
3.	Set the system time directly before the changeover to winter time	
4.	Observe how the time “jumps” from 03:00 to 02:00 when switching the DB_SUMMER_WINTER.Summer bit	This behavior does not occur a 2nd time when 03:00 is reached again

Connection of radio clock module with DCF77 signal

This function is the subject of an independent entry. Further information on this function block is available at the following link:
http://support.automation.siemens.com/WW/view/en/63628396

7 Further Notes, Tips & Tricks, etc.

How can you program several switch-on/switch-off times of the same type?

Table 7-1

No.	Action	Comments
1	Create a global data block for the desired function block, e.g. by copying when its interfaces are to be provided via DB.	Alternatively the global data block can be expanded according to its function block.
2	Search for the type of function block in the example program that you require a second time.	
3	Add a new network under it.	
4	Call the respective function block there and supply it, if required, with the respective data blocks.	The function block can also be called with another structure. It is important that it is called, as shown here, via the cyclic interrupt or via cyclic editing.
5	Integrate the interfaces into your user program.	
6	Compile the project.	
7	Transfer the program into your S7-1200	

8 Related Literature

Table 8-1:

	Topic	Title
\1\	Siemens Industry Online Support	http://support.automation.siemens.com
\2\	Download page of the entry	http://support.automation.siemens.com/WW/view/en/78788733
\3\	S7-300/400 CPUs: Time switches on the basis of S7-300/400 CPUs, optional radio clock connection	http://support.automation.siemens.com/WW/view/en/21669756
\4\	Connection of radio clock module with DCF77 signal	http://support.automation.siemens.com/WW/view/en/63628396
\5\	S7-1200 System Manual	http://support.automation.siemens.com/WW/view/en/36932465
\6\	STEP 7 Professional V12.0 (TIA Portal)	http://support.automation.siemens.com/WW/view/en/68113685

9 History

Table 9-1:

Version	Date	Modifications
V1.0	08/2013	First version