

## Redundant coupling via PROFIBUS DP

### I.S. 1 remote I/O system Redundant coupling via PROFIBUS DP

#### 1. Functions

An I. S. 1 fieldstation can be equipped with a primary and a redundant central unit (CPM), whereby each CPM has its own independent PROFIBUS DP interface.

From the point of view of the automation system, each fieldstation has 2 separate DP slaves, and both are involved in the cyclical data exchange with the DP master. Thus, there are two independent transmission paths between the DP master and the fieldstation.

These two transmission paths are monitored for proper and error-free operation by using the automation system user software. In addition, one of the transmission paths is selected to transmit the useful data. The CPM linked to the transmission path selected by the AS is made 'active' by transmitting a control register from the AS to the CPM.

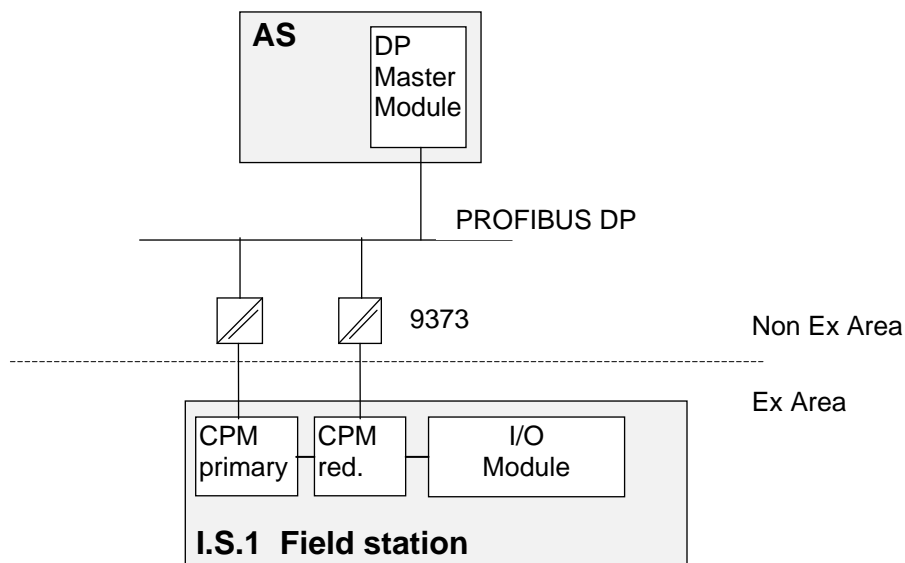
Of course, data can also be transmitted through the other (inactive) transmission path. However, it only helps to monitor the connection. Data transmitted here is not used.

Only the active CPM handles the data traffic to the fieldstation I/O modules. The active CPM monitors the inactive CPM and likewise provides it with the current input data.

#### 2. Redundancy structures

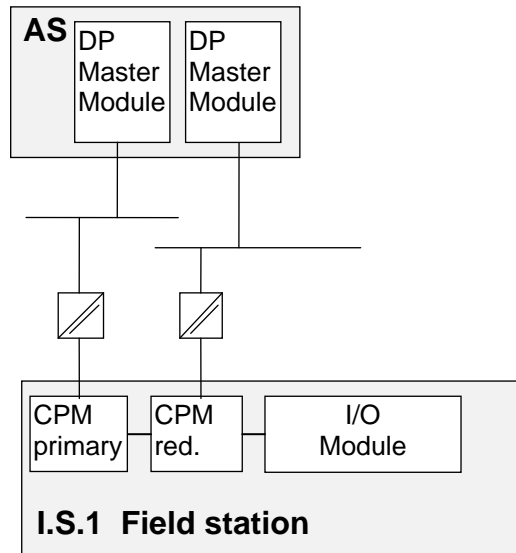
The following redundant PROFIBUS network structures are supported:

##### 2.1 Cable redundancy in the Ex Area redundant transmission units (CPM) in the I.S.1 field station, non-redundant DP master.

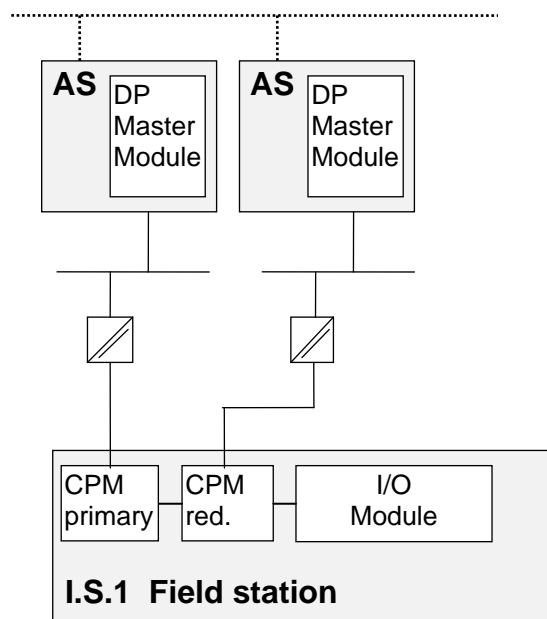


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**2.2 Redundant PROFIBUS networks (redundant DP master modules in the AS)  
non-redundant AS,  
redundant transmission units (CPM) in the I.S.1 field station,**



**2.3 Redundant AS, redundant PROFIBUS networks  
redundant transmission units (CPM) in the I.S.1 field station,**



## Redundant coupling via PROFIBUS DP

### 3. Behaviour of DP slaves

#### 3.1 Addressing

Both the I.S.1 fieldstation CPMs are configured for the same address by using the keys and LCD display on the CPM.

The 'CPM primary' and 'CPM redundant' allocation is done through slot coding.

Both CPMs can be addressed at one address via the service bus. The distinction, whether the primary or the redundant CPM must be addressed, is made through a separate label in the protocol.

The primary CPM uses the configured address as the slave address for the PROFIBUS DP.

The redundant CPM increments the configured address by 1 for the PROFIBUS DP interface.

This increment is indicated in the redundant CPM display by '+1' next to the address.

With the redundant CPM increment, the two CPMs have different PROFIBUS addresses, whereby even redundancy solutions are possible with a non-redundant DP master (see 2.1).

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### 3.2 Behaviour of CPM

Parallel cyclical data traffic can be defined via PROFIBUS DP for both CPMs (both CPMs are in data exchange).

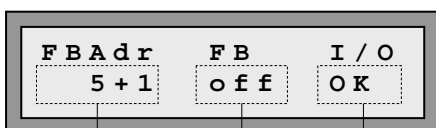
Both CPMs in an I.S.1 fieldstation are connected with the non-redundant installed I/O modules. The two CPMs in an I.S.1 fieldstation are not allowed simultaneous access to the I/O modules. For this reason, only one CPM is switched to active status by a control register from the AS software. The active CPM takes over the access to the I/O modules (read and write).

The other CPM is in the 'inactive' status. The active CPM updates the input data in the inactive CPM in a cycle and monitors it for correct operation.

As a result, input data can be read cyclically by both CPMs, in error free standard operation mode. The data between the active CPM and the inactive CPM can be different in case of error ! Therefore the data of the inactive CPM should not be used for the application software.

Although the automation system does receive output data in 'inactive' status via the PROFIBUS and this data is stored in the CPM RAM, it is, however, not forwarded to the output modules.

CPM display:



#### Collective errors IOM

OK : No signal or module alarms of IOM's  
 err : One or more signal- or module alarms are present in IOM's  
 ----: CPM inactive. No access to the IO modules

#### Field bus status

off : No activity in field bus.  
 baud : Found baud rate, but no data exchange

Operation without redundancy:

OK: Data exchange on field bus

Operation with redundancy:

OK-A: Data exchange on field bus, CPM active  
 OK-I: Data exchange on field bus, CPM inactive

#### Field bus address:

--- : No valid address available  
 0 ... 127 : Configured address (0 ... 127)

Display on redundant CPM:

xxx+1 : Non-incremented address on service bus (xxx).  
 Address on PROFIBUS (xxx +1) incremented by 1.

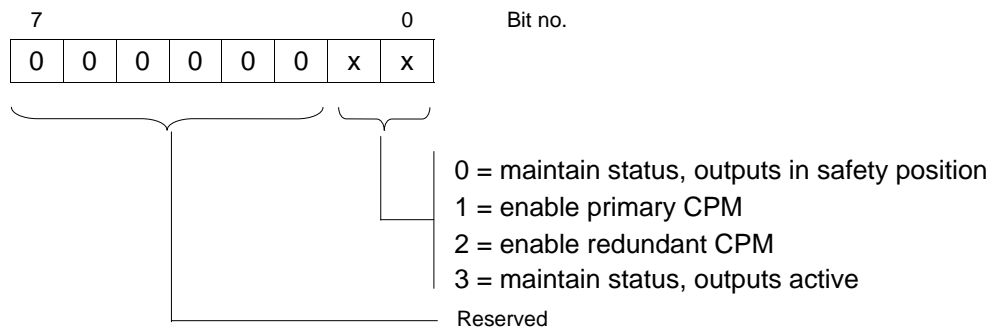
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### 3.3 Control register - CPM

The CPM to be activated is selected by a logic in the AS (see 4.2.1).

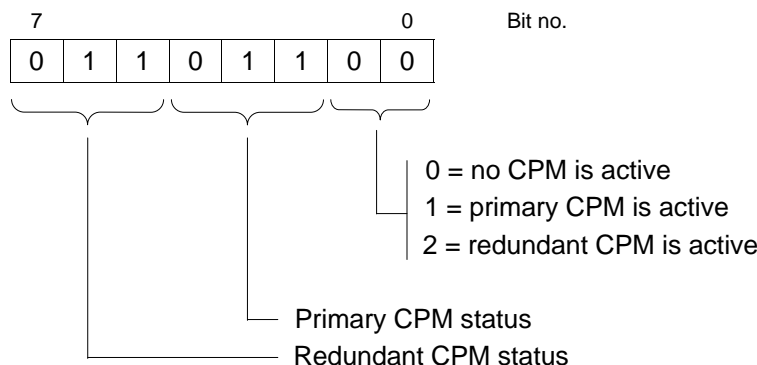
Either CPM in a redundant I.S.1 fieldstation can be enabled by writing a control register from the automation system for both CPMs.

The selected (active) CPM is permanently (cyclically) controlled with the respective control code. This facilitates automatic restart after malfunctions. The control register for switching to redundancy is updated with identical content for both CPMs (prim. and red.).



### 3.4 Status register - CPM:

The AS can read the current status of both CPMs through the status register for monitoring purposes.



#### CPM status:

Value 1 (001)	CPM hardware error
Value 2 (010)	<b>Data exchange with AS</b> <b>Diagnostic data available ! --&gt; Generate group alarm FS</b>
Value 3 (011)	No data exchange (after power on)
Value 4 (100)	Configuration or parameter error
Value 5 (101)	Quit data exchange with AS
Value 6 (110)	<b>Data exchange with AS</b> <b>without diagnostic data --&gt; all IOMs and CPMs are non-errored</b>
Value 7 (111)	no response from inactive CPM

The status register contains information about both CPMs. During regular operation, this status information is cross-coupled between both CPMs and can thus be read by both CPMs. However, in case of malfunction, the status information in the inactive CPM may be lost. Therefore, the AS always analyses just the status register of the active CPM.

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### 3.5 Timeout time for Output modules

If an active transmission route fails, the cyclical updating of the output module stops. There are Watchdog circuits on the output modules that monitor the cyclical data transmission between the CPM and the output modules.

If no valid data is transmitted to the output module beyond the time  $T_{Mod}$ , the module places its outputs in safety position. This should not be done for error-free redundancy switching.

This produces the following requirement for error-free switching:

#### Parameterising rule for the timeout for output modules ( $T_{Mod}$ ):

$T_{Mod}$  must be parameterised **greater** than the maximum total time between the occurrence of a transmission error and the activation of the hitherto inactive CPM (switching time).

The maximum switching time is defined by the parameterised DP master bus cycle, the PROFIBUS baud rate, the monitoring software cycle time in the automation system and the startup delay of the CPM (< 500 ms).

The I.S.1 timeout time for output modules ( $T_{MOD}$ ) can be parameterised in the DP master in the range of 100 ms to 25.5 sec. (default value: 100 ms).

#### Startup delay of the CPM:

When the status of a CPM is changed from inactive to active via the control register, there is a delay of 500ms (maximum) before the CPM will report its status as active.

If the (previously active) CPM contains valid input data, then this information is transferred to the AS within this time. The AS can then use this input data immediately after switch over.

If the now active CPM receives new configuration data, so that the input data of the previously active CPM cannot be used, all the IOM must be initialized by the now active CPM. In this case, new input data is not available before the CPM reports its status as active in the status register.

The AS therefore cannot use any data that was transmitted before the CPM reported its status as active.

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### 4. Behaviour of the DP Master (AS)

#### 4.1 Configuration and parameterisation of the I.S.1 fieldstation in the DP Master

The superordinate automation system provides two DP slave devices on the PROFIBUS with address n (primary) and address n+1 (redundant).

Both slave devices must be configured separately in the DP master configurator with identical I/O arrangements and parameterised with identical slave parameters.

(Recommendation: first configure and parameterise the primary slave and then copy the complete slave to slave address n+1).

Consequently, there is a separate memory area with the respective associated I/O data for each of the CPMs (primary and redundant).

For the CPM parameters, set the parameter 'CPM redundant = Yes' in the DP master configurator.

When configuring a field station with CPM redundancy, the CPM with the additional '**Red.**' from the module list of the GSD file must be configured as the first module in both slaves (Module No. / Slot = 0) (for example, '9440/1.-.-.-. CPM Zone 1 Red.')

The CPM module for redundancy has 1 byte input data (status register) and 1 byte output data (control register), which is transmitted in the cyclical data area from PROFIBUS DP. These registers help to control and monitor the redundancy by means of the AS.

Even if redundant CPMs are used, you must configure **only one CPM in slot 0 per field station**, as from the point of view of the master, there are two slaves with one CPM each respectively.

As described in Chapter 3.6, the output module stop time to be parameterised depends on the project.

#### Prepared Redundancy:

With the parameter 'CPM redundant = Yes / No' and the different CPM Modul descriptors the following configuration possibilities are possible: (available with CPM firmware V01-20 or higher)

Operation:	not Redundant Operation		not allowed	Redundant Operation
Parameter 'CPM redundant':	No	No	Yes	Yes
DP Modul-descriptor CPM:	9440/1.-.-.-. CPM Zone. not redundant (without status- and controlreg.)	9440/1.-.-.-. CPM Zone. Red. redundant (with status- and controlreg.)	9440/1.-.-.-. CPM Zone. not redundant (without status and controlreg.)	9440/1.-.-.-. CPM Zone. Red. redundant (with status- and controlreg.)
behaviour:	<p>The CPM can be located on all slots of the rail !</p> <p><b>To prepare a later redundancy (prepared Redundancy)</b> the CPM has to be located on redundant slots (1 red, 3 red). The Slave address of the CPM will be incremented (+1) by using the CPM in these slots. The left slot beside the CPM remains empty for later extension with the redundant CPM. The right slot beside the CPM is the slot 1 for IOM modules.</p>		<p>Configuration error on PROFIBUS DP, no Data Exchange, Diagnosis message 'Redundant CPM descriptor required' in device specific diagnosis.</p>	<p>control of the redundancy via the control register from the AS required.</p>
	<p>The content of the control register is not considered.. The Statusregister is updated.</p>			

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## 4.2 Software functions in the AS

The following software functions are required in the automation system (AS):

- Functionality to update the I/O data to the user program.
- Switching logic and redundancy control

Software parts required in the automation system for redundancy support are almost identical for all the described redundancy structures.

### 4.2.1 Switching logic and redundancy control in the AS

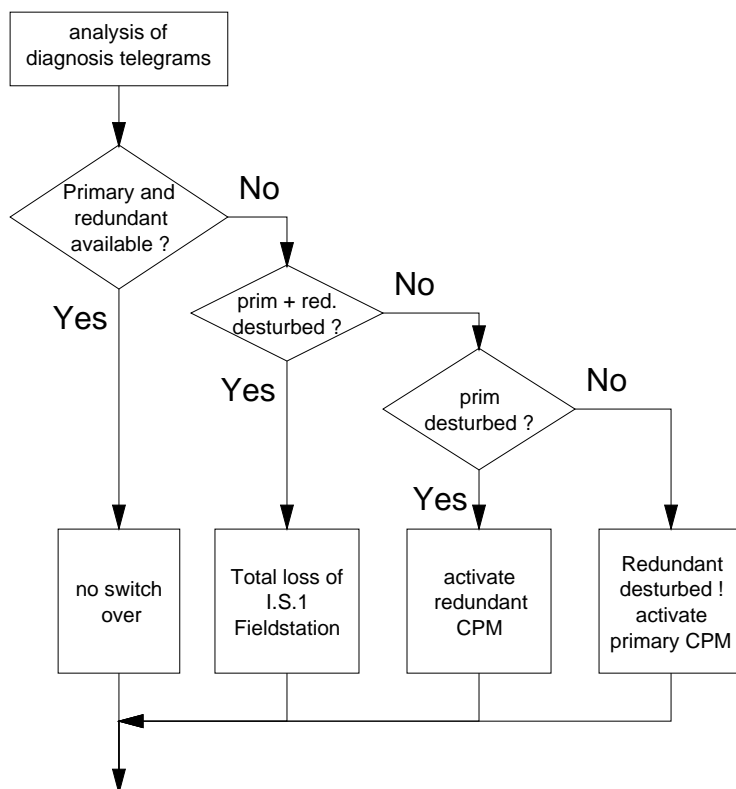
Check the availability of both transmission paths in the automation system by using an application program and make one of the transmission paths active. Data can be exchanged between the application software and the I.S.1 fieldstation I/O modules only via the active transmission path.

The automation system monitors the redundant transmission paths by implementation and analysis of the PROFIBUS service 'Read Slave Diagnosis'.

In the first byte of the received diagnosis telegram, Bit No. 0 returns and indicates whether the addressed PROFIBUS slave is involved in the cyclical data exchange or not.

After using this service for both CPMs, a logic in the AS helps to select one of the transmission paths (from either CPM) to be activated. By transmitting the control register from the AS to the CPMs, the result of this decision is notified to the CPMs, which react accordingly.

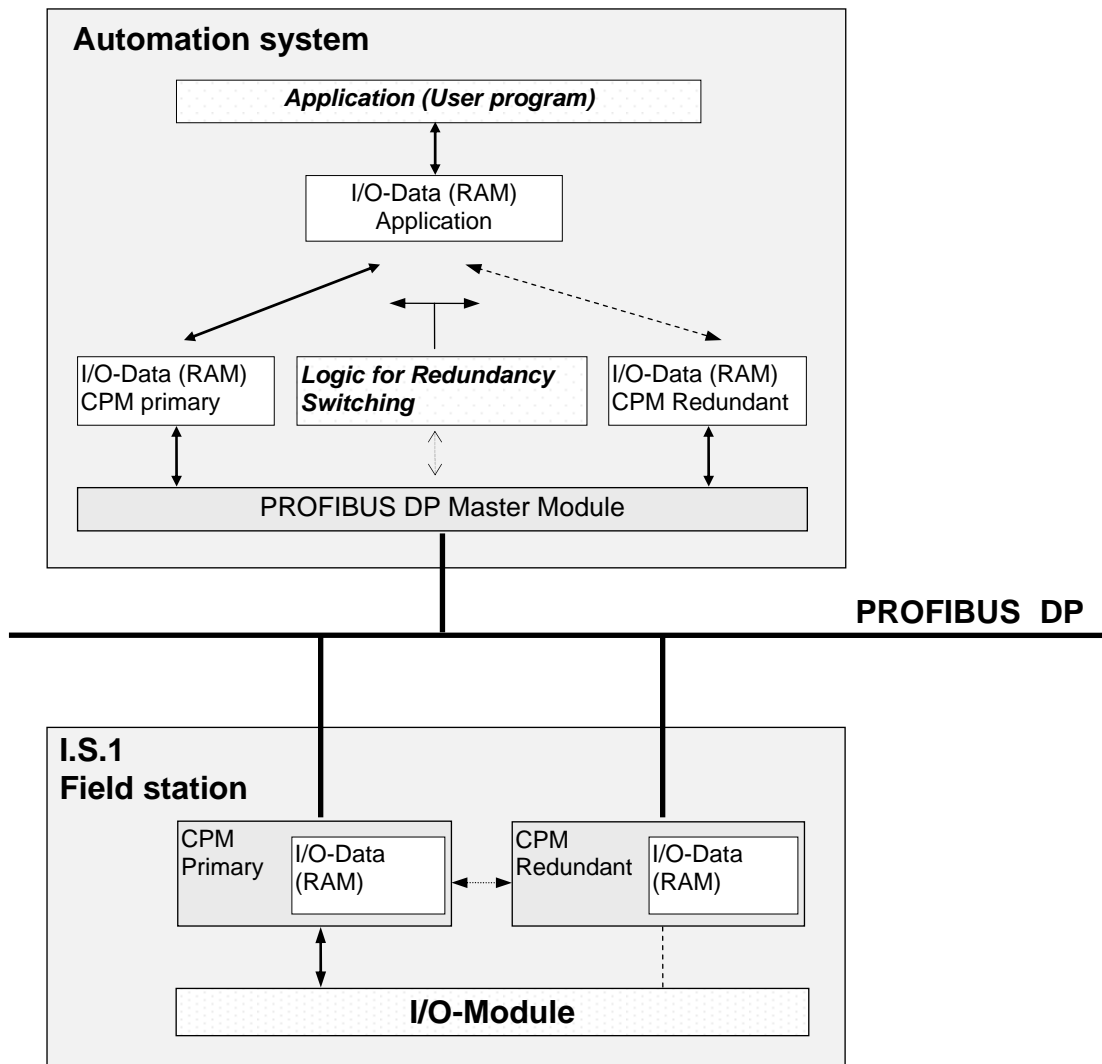
#### Switching logic in the AS for controlling the redundancy switching:



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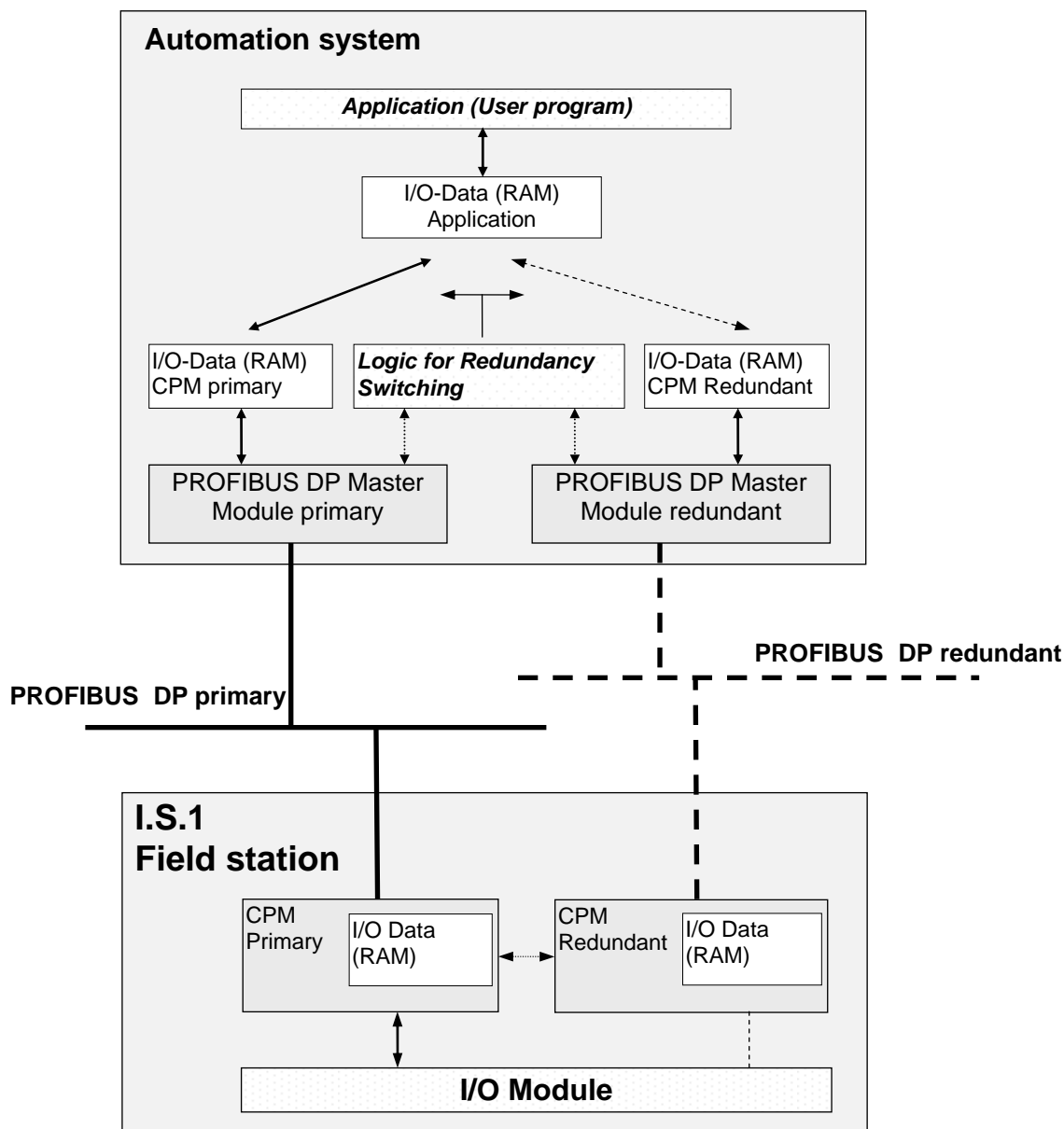
### 4.2.2 Updating the I/O data to the user program

In the AS, there is a third memory area for the application I/O data. This application memory area must be updated cyclically with the memory area of the active CPM by using the user program. The memory area for the inactive CPM output data must not be updated cyclically. However, note that during a redundancy switching, the control command for activation and the current output data in the same DP cycle of the hitherto inactive CPM must be transmitted.



**Example 1:** Non-redundant automation system with redundant I.S.1 field station

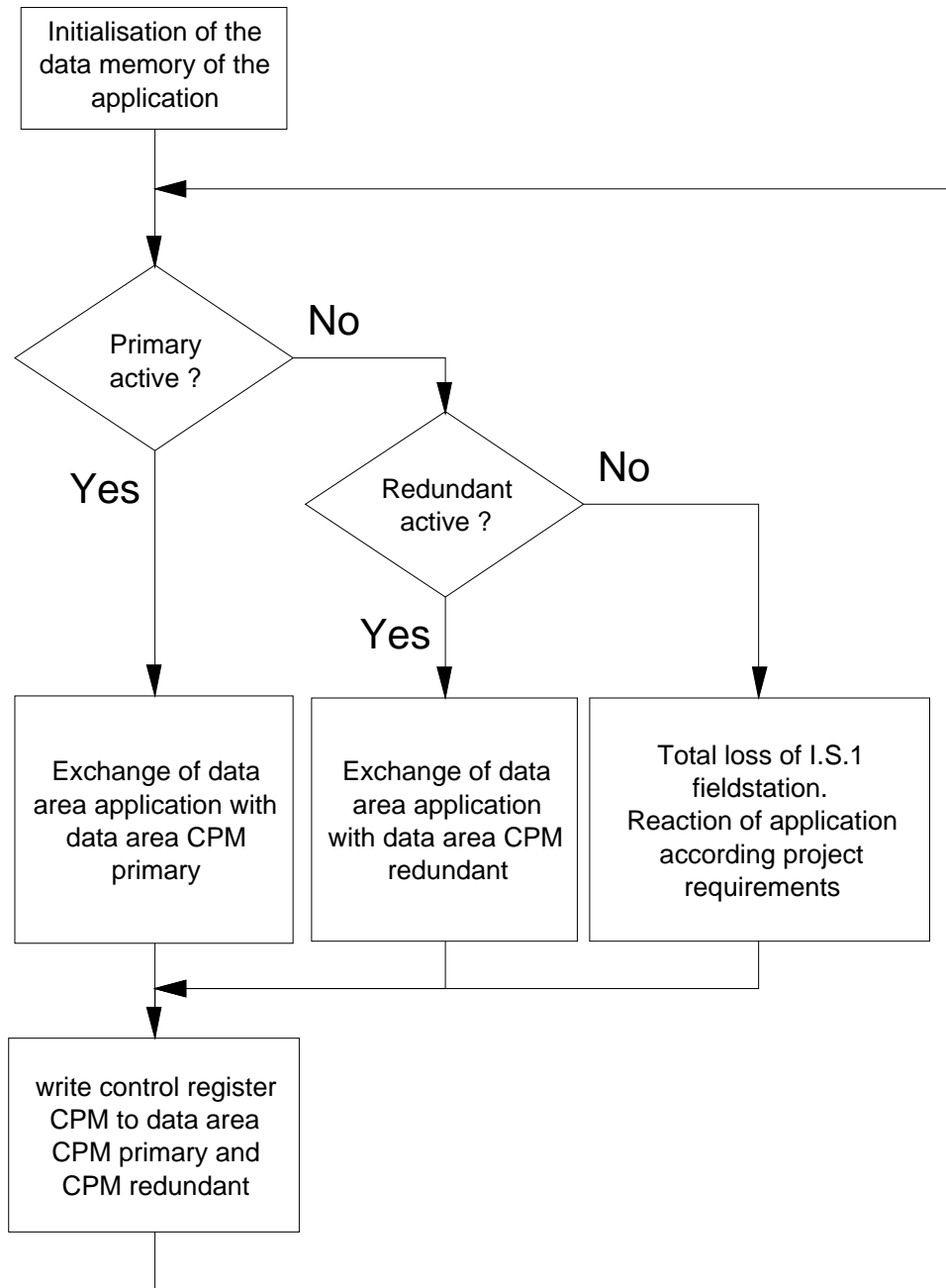
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**Example 2:** Automation system with redundant PROFIBUS interface

## Redundant coupling via PROFIBUS DP

Logic for controlling data update in the AS:





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### Release Notes:

<b>Revision</b> (Description of redundant PROFIBUS DP interface for I.S.1)	<b>Version</b> GSD file	<b>Extensions / Changes</b>
1.2	1.02	<b>new CPM PROFIBUS firmware rev. 01-22:</b> <ul style="list-style-type: none"><li>- support of CPM redundancy</li><li>- support of prepared redundancy (see chapter 4)</li></ul>
1.4	1.05	<b>new CPM PROFIBUS firmware rev. 01-22:</b> <ul style="list-style-type: none"><li>- PNO conformity test</li><li>- input signal update in inactive CPM</li><li>- CPM display: signal- and diagnosis information supported.</li><li>- 2 wire calibration for TIM R 9480/.. supported (9480 firmware rev. V 01-00).</li><li>- <b>startup delay (inactive -&gt; active) of CPM optimized from 800 to &lt; 500 ms</b></li></ul>
1.5	1.05	Description in chapter 3.2 extended. No functional changes.
1.6	-	Fieldstation group alarm in Status Byte added. (available as of CPM firmware rev. 01-30 or 02-30)