8.3 SIMOLINK

8.3.1 General principles

Definition

SIMOLINK (**Si**emens **Mo**tion **Link**) is a digital, serial data transfer protocol with a fiber-optic cable as its transfer medium. The SIMOLINK drive link has been developed for extremely fast and strictly cyclical transfer of process data (control information, setpoints, actual values and status information) between individual MASTERDRIVES MC/VC units or between MASTERDRIVES MC/VC units and a higher-level control system with synchronization of all connected nodes to a common system clock.

Application

SIMOLINK enables highly dynamic and accurate synchronism of all connected MASTERDRIVES MC units to be realized on account of its extremely fast data transfer by transmitting a strictly time-equidistant and jitter-free SYNC telegram in each cycle. Typical areas of use are, for example, all applications requiring a high degree of synchronism (angular synchronism) of individual MASTERDRIVES MC units to each other. A typical area of application is, for example, the replacement of previously mechanically coupled moving axes by individual electric drives, e.g. for printing machines. SIMOLINK can further be used in highly dynamic coordination tasks of individual MASTERDRIVES MC/VC units, such as in the motion control of individual axes on packing machines.

Components

SIMOLINK consists of the following components:

- SIMOLINK master
  Interface for higher-level automation systems,
  e.g. SIMATIC FM458 or SIMADYN (see Chapter 8.3.8)
- SIMOLINK board (SLB)
  Interface for drives (see Chapter 8.3.4)
- SIMOLINK switch (see following section)
- Fiber-optic cable
  Connecting medium of nodes on the SIMOLINK ring (see Chapter 8.3.4)

The SIMOLINK master and the SIMOLINK board are active nodes on SIMOLINK. The SIMOLINK switch is a passive node.

- Active nodes can receive and send telegrams and can read or write the contained information.
- Passive nodes can only pass on received telegrams. It is not possible for them to process the information contained therein.

SIMOLINK switch

The SIMOLINK switch is a passive node which has a "switching" function between two SIMOLINK rings.

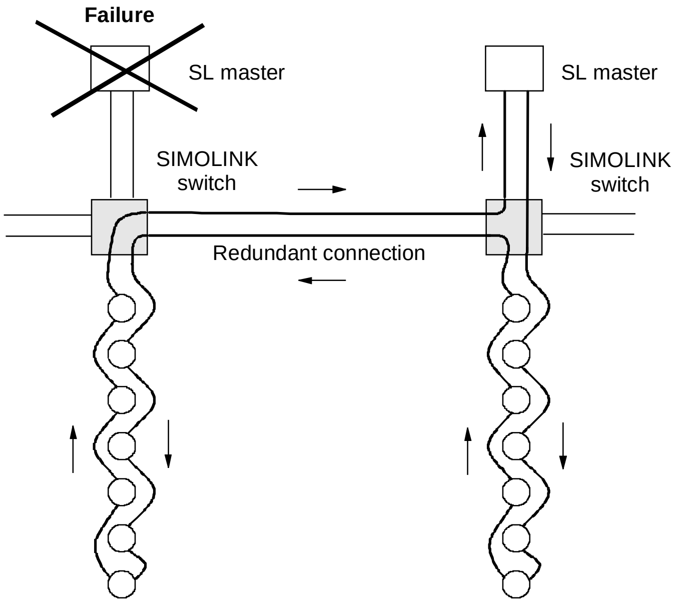

Fig. 8.3-1 Example of an application for the SIMOLINK switch

SIMOLINK features

- ♦ The transfer medium is a fiber-optic cable. Either glass or plastic fiber-optic cables can be used.
- ♦ SIMOLINK has the structure of a ring of fiber-optic cables where each node acts as a signal amplifier.
- ♦ Thus, the following distances can be realized, depending on the selected medium:
  - max. 40 m between each node on a plastic fiber-optic cable or
  - max. 300 m between each node on a glass-fiber-optic cable.
- ♦ Up to 201 active nodes [1] can be interlinked on SIMOLINK.

[1] From now on, the active nodes are only referred to in the text as nodes

- MASTERDRIVES MC only:
  Synchronization of the nodes is effected through a SYNC telegram which is generated by a node with a special function, the dispatcher function, and is received simultaneously by all other nodes. The SYNC telegram is generated absolutely time-equidistantly and jitter-free. The time between two SYNC telegrams is the bus cycle time of SIMOLINK and, at the same time, it corresponds to the common clock time for synchronization of all connected nodes.
- Data transfer between nodes is effected strictly cyclically in the bus cycle clock time. This means that all data written or read by the nodes is transferred between two SYNC telegrams. Upon receipt of the SYNC telegram, the previously received data in every MASTERDRIVES MC/VC unit is passed on to the control system of the converter as being the currently applicable data. This ensures that the latest applicable data is available to all nodes on the bus at the same time.

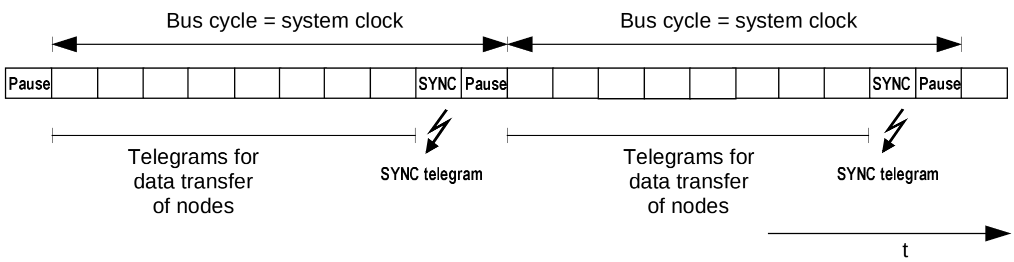

Fig. 8.3-2 SIMOLINK telegram traffic

- The transfer rate is a fixed 11 MBit/s
- A 32 bit word can be transferred in each telegram. The total length of each telegram is 70 bit, including the 32 bit net information. Thus, at a transfer rate of 11 Mbit/sec, a telegram has a transfer time of $6.\overline{36}\,\mu s$.
- SIMOLINK has a very high data throughput. This means that all the telegrams are sent without an interval directly one after the other. For example, with a selected bus cycle time of 1 ms, 155 telegrams with data contents (value of 32 bit per telegram) can be transferred via SIMOLINK.
- The functionality of the SIMOLINK application defines the assignment of telegrams to nodes. There are two possible applications:
  - the peer-to-peer functionality and
  - the master/slave functionality.

Peer-to-peer functionality

This field of application describes all applications for which there is no dedicated logical master for distributing information via SIMOLINK. A typical application example here today is the "Continuous material throughput" which is implemented with the peer-to-peer protocol, in which drives have equal rights in a logical sense (peer-to-peer) in their exchange of information with each other. In accordance with the definition of the term "peer-to-peer", (communication between equals), this function is described as the "Peer-to-peer" functionality on SIMOLINK. This functionality enables extremely fast, synchronized and absolutely freely selectable transfer of data (no restrictions imposed by the physical bus configuration as in the peer-to-peer protocol) between MASTERDRIVES MC/VC units. The system needs to be designed with a "timing generator" for generating the telegram traffic and which keeps the bus system fully functional. The SIMOLINK dispatcher provides the interface to this function in the converter. The term "Dispatcher" is used to describe the principle characteristic of this interface: independent, constant dispatching of telegrams. The interfaces in the other MASTERDRIVES MC/VC units on SIMOLINK operate as "Transceivers".

The term "Transceiver" is made up of the words "Transmitter" and "Receiver". It means that a transceiver can receive and then send telegrams, but it cannot initiate telegram traffic itself (main difference to the dispatcher).

Master/slave functionality

In this case, a central station (logical master) supplies all the other nodes (logical slaves) on the bus system with information (control bits, setpoints, etc.) This function is referred to hereafter as the "Master/slave" functionality. It refers to the logics of data transfer between the nodes on SIMOLINK. The system needs to be configured with a SIMOLINK interface in the central station (master) in this application field. This interface is both the logical master for data transfer and the initiator and monitor for telegram traffic on SIMOLINK (= dispatcher function). This interface, including its functions contained in an automation system, is referred to as the "SIMOLINK master".

The interfaces in the other nodes, e.g. in the converters, are "SIMOLINK transceivers".

NOTE

There is always only one node with a dispatcher function in the SIMOLINK ring. This is either a SIMOLINK board with dispatcher parameterization or a SIMOLINK master.

8.3.2 Peer-to-peer functionality

Each node on SIMOLINK has an active function either as a transceiver or as a dispatcher. There is always only one node with a dispatcher function in the SIMOLINK ring. All the other nodes are transceivers.

Bus topology

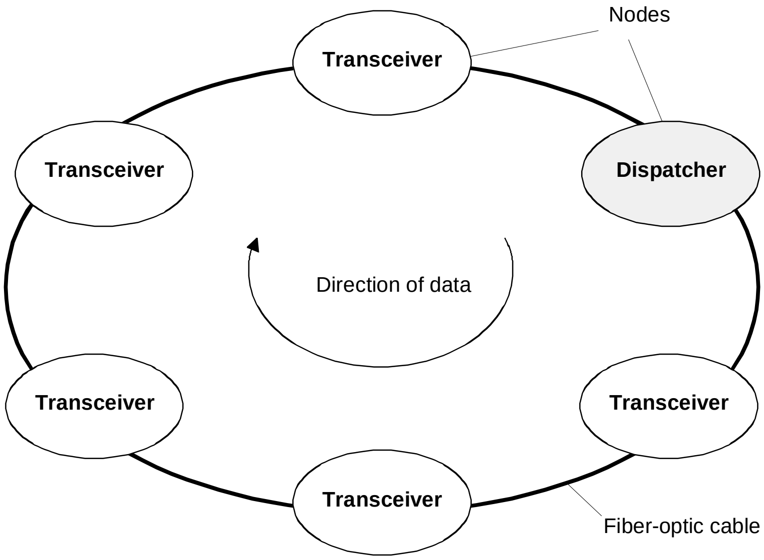

Fig. 8.3-3 SIMOLINK with dispatcher

Dispatcher

A table (= task table) is defined in the SIMOLINK dispatcher in which all telegrams are entered in the order in which they are sent. Each telegram has an address section (= node address) and a subaddress section (= channel number) in the telegram header. The telegrams are entered in the task table with ascending address and subaddress sections. The SIMOLINK dispatcher initiates telegram traffic by dispatching all the telegrams one after the other, beginning with the telegram with the lowest address and subaddress section according to the entry in the task table. As soon as the SIMOLINK dispatcher has dispatched all the telegrams, it sends a synchronization telegram (SYNC telegram) and a pause telegram. After this, it dispatches the first telegram from the task table again without any delay.

NOTE

The dispatcher can upread or overwrite the data contents of telegrams, as can every transceiver.

Transceiver

Each transceiver receives the telegrams (all of them) initiated by the dispatcher and can upread their data contents (value of 32 bit per telegram) or overwrite them with their own data, in accordance with a determined rule. The received telegrams are passed on to the next node in the ring, irrespective of whether the data contents have been read, overwritten or revised. Nodes with a transceiver function cannot maintain data traffic in the ring on their own.

8.3.3 Application with peer-to-peer functionality

Principle

The peer-to-peer functionality with SIMOLINK corresponds in principle to the peer-to-peer link with which you may already be familiar from MASTERDRIVES and SIMOREG, i.e. exchange of process data between MASTERDRIVES MC/VC units with the following additional advantages:

- Very fast (11 Mbit/s; one hundred and fify 32-bit data in 1 ms)
- Freely selectable, i.e. every MASTERDRIVES MC/VC can send process data to every other MASTERDRIVES MC/VC, or receive data from it.
- Maximum of sixteen 32-bit data per MASTERDRIVES MC/VC possible via SIMOLINK; i.e. every MASTERDRIVES MC/VC can receive up to 8 32-bit data via SIMOLINK, and send up to 8 32-bit data to other MASTERDRIVES MC/VC units.

Basic principle of addressing

The telegram address is not interpreted as a "destination address" (which determines to whom the information is to be sent), but is understood to be a "source address". This indicates where the information is coming from.

Dispatchers and transceivers write their information (= data) in the telegrams assigned to them (node address = address in telegram) on the bus. Dispatchers and transceivers can read every telegram on the bus. For this purpose, the nodes have separate storage areas for receive data and transmit data.

Addressing mechanism - writing

The dispatcher and transceiver nodes only transmit information (= write data) in the telegrams which are assigned to them via the address. A maximum of 8 x 32-bit data can be transferred in 8 telegrams (same address and channel number from 0 to 7). A channel number is assigned to each 32-bit value and thus clearly also a telegram on the bus.

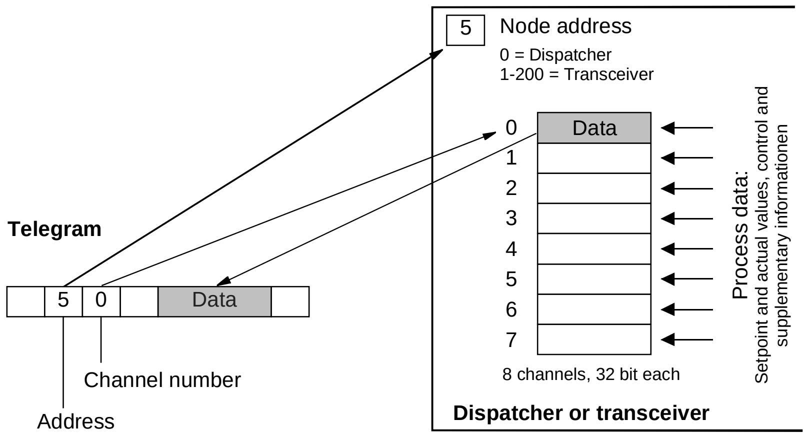

Fig. 8.3-4 Writing data

Addressing mechanism - reading

The active nodes (dispatcher and transceivers) can read the data of any telegram on the bus (also their own telegrams; separate storage areas for transmit data and receive data). A maximum of 8 different telegrams (8 x 32-bit data) can be read. For this purpose, **those** addresses and channel numbers whose data are to be read are parameterized as receive telegrams in the dispatcher or in the transceivers. This parameterization is carried out before data traffic is started up; in the case of MASTERDRIVES, for example, via the parameters of the converter.

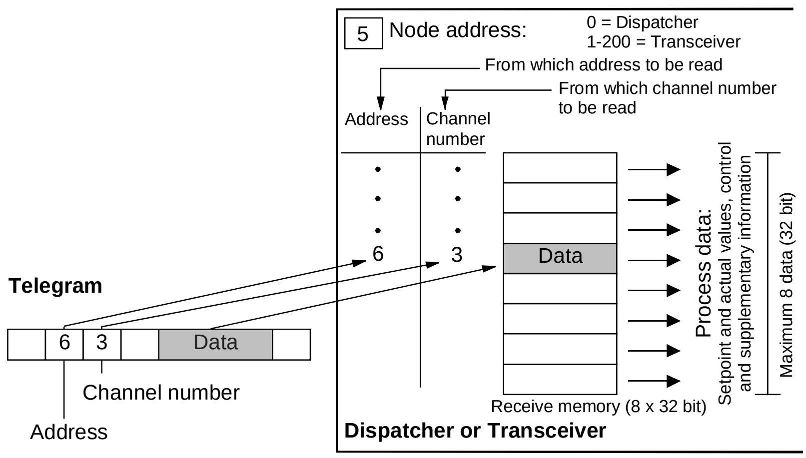

Fig. 8.3-5 Reading data

Example

The node with the address 5 (= transceiver interface) can "deposit" a maximum of 8 x 32 bit data on the bus. This means that the transceiver writes its data (32 bit in each case) in telegrams with address 5 and channel numbers 0 to 7. All the active nodes on SIMOLINK (the dispatcher as well as the transceivers) can decide whether they want to read this data. If, for example, a node wants to read the data of node 5 (= address 5) with channel number 2, this has to be configured accordingly. In this case, the address 5 and the channel number 2 have to be configured as the "Reading address".

Data transfer

In the "Peer-to-peer" application with the dispatcher, only process data (control and status words, setpoints and actual values) are transferred. When using a data area in the telegram, in the case of process data with word size (= 16 bit), two process data per telegram can also be transferred or read.

NOTE

All usable telegrams must be entered in the task table of the dispatcher.

Applications

Typical applications for SIMOLINK are the implementation of digital setpoint cascades in which one or more setpoints can be given to the slave drives by a MASTERDRIVES MC/VC unit acting as master drive.

8.3.4 Components of the peer-to-peer functionality

SLB optional board

The SLB optional board (*SIMOLINK board*) is used for linking drives to SIMOLINK.

Each SLB optional board is a node on SIMOLINK.

The optional board is provided with three LED displays which supply information on the current operating status.

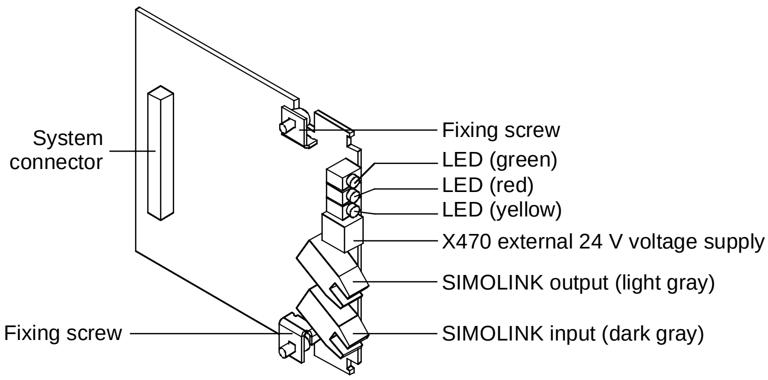

Fig. 8.3-6 SLB optional board (SIMOLINK board)

The SLB optional board links the converters/inverters to SIMOLINK. It can be used as the SIMOLINK dispatcher or as a SIMOLINK transceiver. The functionality is determined by parameterization.

Fiber-optic cable medium

A fiber-optic cable is used as the transfer medium in SIMOLINK. Plastic or glass-fiber optic cables can be used.

For cable lengths (the distance between two nodes) up to a maximum of 40 m, plastic cables are used.

NOTE

Recommendation:
Plastic fiber-optic cables from Siemens; CA-1V2YP980/1000,200A

For cable lengths (distance between two nodes) up to max. 300 m, fiber-optic cables with a glass core and a plastic sheath can be used.

NOTE

Recommendation:
Fiber-optic cables with glass core from Siemens; CLY-1V01S200/230,10A

The above-mentioned fiber-optic cables do not have an outer sheath. When using them for wiring outside switch cabinets, the cables must either be laid in cable ducts or conduits or suitable cables with an outer sheath must be used. On cables with an additional outer sheath, this must be removed before fixing the connector at the end of the cable as the connectors cannot accommodate the sheath. Therefore, when selecting the cable, one must make sure that the then remaining outer fiber diameter of 2.2 mm for attaching the connector is maintained.

24 V voltage supply

The SLB optional board has a 24 V voltage input for the external voltage supply of the board. This ensures that data transfer is maintained in SIMOLINK even with powered-down converter/inverter.

Changeover between internal voltage supply from the converter/inverter and external voltage supply is carried out automatically, with priority being given to the external voltage supply.

NOTICE

A changeover must not be performed during bus operation because it generates a reset signal on the option board as a result of which bus operation is interfered with.

8.3.5 Parameterization of the peer-to-peer functionality

The data traffic is determined by the parameterization of the dispatcher and the transceivers.

The configuration for enabling process data to be sent from a MASTERDRIVES MC/VC unit is determined by the BICO technique. The BICO technique is also used to determine the position in the control system at which the received process data are to act.

NOTE

Setting is carried out exclusively by means of the parameters of the MASTERDRIVES MC/VC unit. No additional configuration tool is required.

Parameterization of the SLB is carried out via the PMU, the OP1S or a PC with the SIMOVIS start-up tool.

The following parameterizations are necessary for configuring the SLB:

- **P740: SLB node address**
  0: simultaneous selection of dispatcher function
  1 - 200: simultaneous selection of transceiver function
- **P741: SLB telegram failure time** (dispatcher and transceiver)
  The telegram failure time is a parameterizable failure time which is stored in every node. The telegram failure time determines the maximum time between two HW interrupts. The HW interrupt is generated by the interface after receipt of a SYNC telegram.
  If a node does not receive a SYNC telegram within this time (→ no HW interrupt), the "TlgOFF" diagnostic bit is set in every node in which the telegram failure time is running.
  The telegram failure time is activated after receipt of the first SYNC telegram.
  The telegram failure time should be at least twice as long as the SIMOLINK cycle time.
  If you use the SIMOLINK, telegram failure monitoring should be activated! P741 = 4 x P746 (SLB bus cycle time) is recommended for the SLB telegram failure time. See also the function diagram [140].

♦ **P742: SLB transmit power** (dispatcher and transceiver)
The power of the fiber-optic transmit block for every node can be set by a parameter.
The transmit power can be set in the stages 3 = 40 m, 2 = 25 m and 1 = 15 m cable length. This scaling means, for example, that in stage "2" a transmit power is set for bridging a distance of up to 25 m plastic fiber-optic cable.

- Localization of fault sources in the medium upon start-up:
  Hidden fault sources on the transfer medium which may not be possible to detect with full power strength can be better localized by reducing the transmit power. Possible causes of the faults may, for example, be that the bending radii are too small or that the contacts of the fiber-optic cable fibers in the connector are poor.
- Ageing of the fiber-optic cable components:
  By reducing the transmit power, the ageing process of the fiber-optic cable components can be slowed down.

♦ **P743: Number of nodes** (dispatcher and transceivers)
With this function, each node can compensate for its individual time delay t_{delay} for compensation of runtime delays caused by the signal conversion in each node.
Formula for transceivers at the n-th position in the ring:

$t_{delay,n}$ = [number of nodes - n] x 3 bit times;

The "Number of nodes" value is specified to the nodes as a parameter.

NOTE The position n at which the node is situated in the ring is calculated automatically in the SIMOLINK starting cycle.

The SL master or dispatcher sends a special telegram with the address 253 "Count nodes" and the starting value 1. Each transceiver which receives this telegram remembers this number (= Count number) and then increments the data contents by the value 1. In this way, the node has the count number 1 directly after the SL master or dispatcher while the SL master or dispatcher has the maximum count number, which also corresponds to the number of node. The result of this procedure can be checked in parameters r748 Index 7 (position of the node in the ring) and r748 Index 8 (number of nodes in the ring).

NOTE The formula stated above neglects the throughput delay of the SIMOLINK switch. Generally, this is permissible as the switch, for example, is usually situated at the beginning of the ring and thus does not cause any delay between transceivers.

The transceiver n waits $t_{delay,n}$ before it can give an HW interrupt to the unit application after receipt of the SYNC telegram. This ensures that the interrupts to the unit applications of all nodes are effected as synchronously as possible.

Normally, this parameter does not have to be altered. The dispatcher passes on the determined number of nodes to the slaves automatically. The latter deduce the necessary delay time from this if the parameter has been set to 0 (= automatic calculation). Only in the case of high accuracy requirements and special influences (SIMOLINK switch, long leads) might it be necessary to manually alter this parameter.

The calculated delay time $t_{vz,n}$ (normalized to 3 bit times) can be checked in parameter r748 Index 6.

- **P744: SLB selection** (dispatcher and transceiver)
  Only MASTERDRIVE MC: Is for selecting source of synchronization and data when there are two SIMOLINK boards or CBPs in a MASTERDRIVES unit.
- **P745: SLB channel number** (dispatcher)
  This parameter is used to set the number of used channels (max. 8). The selected value is firmly applicable for all nodes on the bus.
- **P746: SLB cycle time** (dispatcher)
  This is used to set the bus cycle time. The bus cycle time can be set from 0.20 ms to 6.50 ms in a 10 µs grid.

NOTE

The dispatcher determines the task table from the SLB channel number and the SLB cycle time (consecutive numbering, starting with node address 0 and channel number 0, at first incrementing the channel number) in accordance with the following formula:

$$n = \left(\frac{P746 + 3.18\ \mu s}{6.36\ \mu s} - 2 \right) \times \frac{1}{P745}$$

n: Number of addressable nodes (checked at r748 Index 4)

Task table example:

P746 = 0.20 ms; P745 = 2; → n = 15

Address	0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8
Channel	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Address	9	9	10	10	11	11	12	12	13	13	14	14	255	255
Channel	0	1	0	1	0	1	0	1	0	1	0	1	0	0

Only those addresses and channels listed in the task table are processed.

- **P 749: SLB read address** (dispatcher and transceiver)
  Is for setting the channels to be read. Input is in the notation address.channel. Up to 8 channels can be defined by the 8 parameter indices. The data in these channels are transferred via connectors K7001 - K7016 or KK7031-KK7045.

♦ **P 751: Source SLB transmit data**
Used to select the connectors to be transmitted via SLB channels 1 to 8 (subdivided into low-word and high-word). Double connectors must be entered in two consecutive indices, so that they are transmitted with the full resolution.

♦ **P 755: SIMOLINK configuration (dispatcher)**
When data are transferred from one slave to another, the problem arises that the dead time on the bus depends on the node address of the transceiver. Specifically, this means that data transfer from slave 2 to slave 1 via the dispatcher takes one cycle time longer than data transfer between slave 1 and slave 2. The reason for this is that the data are collected by the dispatcher and are not transmitted onward until the next cycle. This problem can be eliminated by addressing each transceiver twice in one SLB cycle, a first time to obtain the current data of the transceiver which are then available in the dispatcher, and a second time to transmit that data onward, although the number of addressable nodes are thereby reduced by half.
Parameter values (only dispatcher):

- xxx0: No dead time compensation
- xxx1: Dead time compensation activated → Number of addressable nodes = n / 2

When 2 SIMOLINKs are operated in a converter, data adoption and synchronization can be changed over from one to the other (cf. P 744). If this changeover is also to be possible during operation (converter status °014), this is to be enabled by the user. This function is only provided in the case of MASTERDRIVE MC units.
Parameter values:

- xx0x: No changeover during operation (converter status °014)
- xx1x: Changeover of synchronization and data transfer allowed during operation

In the case of operation in a ring with a master which triggers the bus cycle externally (e.g. SIMADYN D), the MASTERDRIVE slaves are to be configured for exact adherence to the bus cycle time. Otherwise, it is assumed internally that the bus cycle time is determined by the particular number of telegrams. The actual bus cycle time does not then correspond exactly to the time which has been set. This function is only provided in the case of units which can be synchronized (MASTERDRIVE MC).
Parameter values:

- x0xx: Bus cycle time corresponding to the calculated number of telegrams (normal operation)
- x1xx: Exact adherence to the set bus cycle time

8.3.6 Diagnostics of the peer-to-peer functionality

The following diagnostics information is available to the user:

LED displays

Three LED displays are provided on the front section of the SLB optional board which supply information on the current operating status.

Operating display

LED	Status	Diagnostic information
Green	Flashing	Fault-free net data transfer via SIMOLINK
Red	Flashing	SLB operating
Yellow	Flashing	Data exchange with basic unit is okay

Table 8.3-1 SLB operating display

Fault display

LED	Status	Diagnostic information
Green	off/on	No net data exchange possible via SIMOLINK; bus cable is not connected or is defective
Red	off/on	Voltage supply for SLB cut off; replace SLB or basic unit
Yellow	off/on	No data exchange with the basic unit; bus cable is not connected or is defective; replace SLB or basic unit

Table 8.3-2 SLB fault display

Binectors

- **B0041: Time out:**
  Bit = 1 indicates that an interruption has occurred in cyclic data transfer. This status remains active until cyclic data transfer has been resumed.

NOTE

The reaction time is permanently stored in the SLB and cannot be changed.

Every time "Time out" occurs, the SLB diagnostics parameter (r748, Index 3) is incremented by the value 1 (→ statistics).
At the same time, the address of the node that has first noticed the interruption in the ring can be upread in r748, Index 5.

- **B0040: SLB telegram failure**
  Bit = 1 indicates that the telegram failure time set in the "SLB TlgOFF" parameter (P741) has run out in this node, without a valid SYNC signal having been received.
- **B0042: Start alarm**
  Bit = 1 indicates that the SIMOLINK ring is physically open and that a start cannot be carried out. This status is also signaled by alarm A002.
  Bit = 0 indicates that the SIMOLINK ring is physically closed.
- **B0043: Drive synchr.** (only MC)
  Bit = 1 indicates whether the CU is synchronized to the SIMOLINK BUS. Corresponds to the inverse of alarm A003.

- **B0047: SLB2 timeout** (only MC)
  Bit = 1 indicates that a timeout has been detected on the passive SIMOLINK bus.
- **B0048: SLB2 start** (only MC)
  Bit = 1 indicates that the passive SIMOLINK ring is physically open and a start cannot be carried out. This binector corresponds to alarm A004.
- **r748: SLB diagnostics**

  The diagnostic parameter is used to retrieve various status data of the SIMOLINK bus. The following information can be read from the various indices:

  r748.1: Number of error-free SYNC telegrams (corresponds to the bus cycles that have elapsed without error).

  r748.2: Number of CRC errors (telegrams with errors).

  r748.3: Number of timeout errors (bus interrupt). Note: On bus initialization, data traffic is interrupted several times, causing some timeout errors.

  r748.4: (Dispatcher only) last addressable address; on initialization the last address addressable in the selected configuration is entered here.

  r748.5: Address of the station that has signaled timeout.

  r748.6: Here, the hardware interrupt delay is stored that was calculated from the number of stations set (P743), or from the number of stations transferred during initialization (with automatic parameterization P743 = 0), and the position of the station in the SLB ring.

  r748.7: Position of the station in the SLB ring (result of the count during initialization).

  r748.8: Number of stations in the SLB ring (result of the count during initialization).

  r748.9: (MASTERDRIVES MC) deviation from the synchronization point. Cannot be synchronized, the value is set to NO_SYNCHRONIZATION (= 65535). Should not fluctuate outside 65515 (-20) and 20.

  r748.10: Pulse period adapted to the bus cycle time in 100 ns (e.g. pulse frequency 5kHz ⇒ display value 2000). If no synchronization is possible, the value NO_SYNCHRONIZATION (= 65535) is entered.

  r748.11: Current state of the T0 counter. Should be 0 for active synchronization (MASTERDRIVE MC only).

  r748.14: Current state of the time slice counter.
  Should be 0 for active synchronization (MASTERDRIVES MC only).

  r748.15: Bus cycle time implemented in 10 µs.

  r748.16: Bus cycle time transmitted during initialization from the master/dispatcher in 10µs.

- **r750: SLB receive data**
  In indices 1 to 16, the received data word 1 to 16 are displayed.
- **r752: SLB transmit data**
  In indices 1 to 16, the received data word 1 to 16 (corresponds to channel 1 to 8) are displayed.

8.3.7 Synchronization of the control circuits by means of the bus cycle time (MC only)

The bus cycle time must be in a defined proportion to the time slots of the individual closed-loop control units in order to synchronize the decentralized lower-level control loops in the converters. The following applies to the time slots in the case of MASTERDRIVES MC:

- Current control in time slot T_0
- Speed control in time slot $T_1 = 2\ T_0$
- Position control in time slot $T_2 = 4\ T_0$
- Synchronism $T_3 = 8\ T_0$ or $T_4 = 16\ T_0$

Standard parameterization

- The time slot T_0 = 1/pulse frequency is set on the MASTERDRIVES MC by selecting the pulse frequency (P340).
  Thus the following applies to the selection of the bus cycle time:

Bus cycle time P746 = 1 / P340 * 2^n n = slowest time slot to be synchronized T_n; where $n \in N = \{2, 3, ...\}$ T_2 can be synchronized as a minimum. Individual synchronization of T_0 or T_1 cannot be implemented.

- Example:
  If the position control loops of the various converters have to be synchronized to each other, the selected bus cycle time has to be a 2^n-fold quantity of 4 T_0. At a pulse frequency of P340 = 5.0 kHz the resulting bus cycle time P746 is at least 0.80 ms (4 * 200 µs).

Synchronization of the slow time slots at a low bus cycle time

In a number of applications it is necessary to set a low bus cycle time and at the same time to synchronize the slower time slots. For this purpose, it is necessary to transfer additional time slot information from the dispatcher over the SIMOLINK to the transceivers. This information is generated in the dispatcher at connector K260. It must be transferred via the SIMOLINK and input to the transceivers at parameter P753. In parameter P754, the slowest time slot to be synchronized is set.

Example:

The bus cycle time should be as short as possible while at the same time the synchronization control is synchronized in T_4 for all drives. At a pulse frequency of 5 kHz (P340), the shortest bus cycle time is 0.80 ms (P746). The dispatcher sets connector K260 to SIMOLINK word 3 (P751 Index 3 = 260) for all transceivers (P753 = 7003). Parameter P754 is set to 4 (for T_4) at the dispatcher and at the transceivers.

Synchronization parameter assignment

Parameters:

- **P 746: SLB cycle time** (dispatcher)
  Serves for setting the bus cycle time. The bus cycle time can be set from 0.20 ms to 6.50 ms in increments of 10 µs. The bus cycle time of the dispatcher is transferred automatically to the slaves. The bus cycle time in effect can be upread from parameter r748 Index 15.
- **P753: Sync. time counter** (transceiver)
  Input parameter for additional time slot information from the dispatcher. This parameter must be connected to the SIMOLINK-connector (K7001 - K7016), which contains the time slot information.
- **P754: Max. sync. time slot** (dispatcher and transceiver)
  The slowest time slot n to be synchronized is entered here. This function will not work unless parameter P753 is connected correctly.

  Connectors:
  K260: Time counter (dispatcher only)
  This connector contains additional time slot information from the dispatcher.

8.3.8 Synchronization diagnostics (MC only)

The following diagnostics information is available to the user:

Binectors

- **B0043: Drive synchronism**
  Bit = 1 indicates that the drive is running is synchronism.
  Bit = 0 indicates that the drive is not yet running is synchronism or cannot be synchronized. This status is also signaled by alert A003.

Parameters

- **r748 Index 9: Synchronism deviation**
  The value should vary between -20 (= 65515) and 20, if synchronization is functioning. A stable value of 65535 indicates that synchronization is turned off because the pulse frequency (P340) and the SLB cycle time do not go together.
- **r748 Index 11: T0 counter**
  The value should always be 0 when synchronization is functioning.

8.3.9 Switchover of the synchronization source (MC only)

MASTERDRIVES MC devices provide the option of plugging in and parameterizing two SIMOLINK modules and two CBP2s. Because of the physical situation, synchronization on only one of the communication modules and data transfer from only one of the two SIMOLINK modules is possible. Connecting up a second SIMOLINK ring would not therefore enable transfer of more data. The only possible applications are installations in which different machine configurations with different SIMOLINK-ring nodes are desired or necessary or where redundancy of the SIMOLINK rings is desired or necessary.

Parameter

- **P744: SLB selection** (dispatcher and transceiver)
  BICO parameter, Index 1, is for selecting a source (binector) by means of which the active SIMOLINK (synchronization and data source) is defined when two SIMOLINK boards are present in a MASTERDRIVES unit.
  By means of Index 2, the Profibus can be selected as the synchronization source. A SIMOLINK, if present, can no longer be used to transfer data; it only works as a transmitter in order to maintain telegram traffic in the SLB ring.
  The synchronization source is selected according to the following scheme:

	744.1	744.2
SLB1 (lower slot) active	0	0
SLB2 (higher slot) active	1	0
CBP active	x	1

- **P755: SIMOLINK configuration**
  If a 1 is set at the second position of the configuration parameter, changeover between the two SIMOLINK boards can be enabled during operation. This is only possible if the bus cycle time is the same even if changeover is enabled during operation.
  - xx0x: No changeover during operation (converter status °014)
  - xx1x: Changeover of synchronization and data transfer allowed during operation

Description of functioning

When two SIMOLINK boards are being operated in one unit, the active board is used for data transfer (same as when only one board is present). The passive board is initialized (SIMOLINK ring starts) and sends the parameterized transmit data. Synchronization and data transfer by the passive board is not possible. Transmit and read data are the same for the active and passive SIMOLINK. Different parameterizations of the two SIMOLINK boards are only possible in the case of the following parameters:

- Node address (P740)
- Number of nodes (P743)
- Number of channels (P745)
- Bus cycle time (P746)

The 1st index is allocated to SLB1 (lower slot) and the 2nd index is allocated to SLB2 (higher slot). Which of the two SLBs is the active one is determined by the selection (P744).

The diagnostic parameter (P748) always indicates the data of the active SIMOLINK.

If it has not been ensured by a master (e.g. SYMADYN D) that the two SIMOLINK rings are working synchronously, it can be assumed that, when a changeover is made to the passive SIMOLINK, there is no synchronization at first. The drives are synchronous with the bus again only after the synchronization time (at 5 kHz pulse frequency and 3.2 ms bus cycle time, maximum 7 sec.). In the case of applications where synchronicity is an essential component of functioning, changeover during operation should not be carried out.

Changeover during operation must be explicitly enabled by the user (P755). In addition, changeover during operation is prevented if synchronization to the previously passive SIMOLINK is not possible because different bus cycle times (P746) have been selected.

8.3.10 Special data and application flags

For special functions, further options for data transmission are available via the SIMOLINK bus.

Application flags

With application flags it is possible to transmit an additional four binary items of information. These are not explicitly assigned to any station, i.e. every station can read and set the application flags. Resetting is only possible via the dispatcher/master.

Parameterization:
P747 Q.SLB Appl.Flags:
Used to specify the binectors to be used as application flags.
B7010 to B7013:
These binectors indicate the applications flags received.

Special data

In addition to the 8 telegrams per station, a total of four special telegrams with 32 bits of useful data are available for data transmission in the SIMOLINK bus. The special telegrams can be read by any station but only written by the dispatcher (currently only MASTERDRIVES MC) / master.

Parameterization:
P756 Q.SLB special data: (dispatcher only)
Used to specify the double connectors to be transmitted as special data.
KK7131 to KK7137:
These connectors indicate the special data received.

8.3.11 Configuration (example of peer-to-peer functionality)

Technology Angular synchronism with 3 MASTERDRIVES MC units.

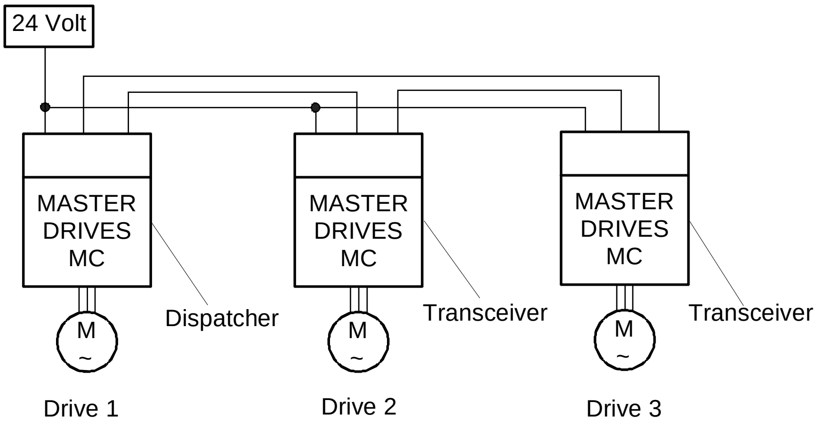

Fig. 8.3-7 Configuration example of peer-to-peer functionality

♦ Drive 1, master drive with integrated virtual master axis
The master speed setpoint for the drive group is specified via an analog input or via the PROFIBUS DP.

The integrated virtual master axis function generates a position, speed and acceleration setpoint for slave drives 2 and 3. In addition, the slave drives are powered up/down by the master drive (control word). This means that every slave drive is given its individual control word.
Vice versa the slave drives send their individual status word to the master drive. This results in the following table:

		Receive		
		Master drive 1	**Slave drive 2**	**Slave drive 3**
Transmit	Master drive 1		STW_2 s_{set} n_{set} a_{set}	STW_3 s_{set} n_{set} a_{set}
	Slave drive 2	ZW_2		
	Slave drive 3	ZW_3		

Table 8.3-3 Transmitting and receiving control/status words between master and slave drives

♦ Drive 2 and 3, slave drives with integrated position control

Communication

The 3 SIMOLINK interfaces must be parameterized as follows for transmitting the process data:

- SLB in master drive 1 (dispatcher)
  The following 5 process data have to be transferred (written):
  - STW_2 = control word for drive 2
  - STW_3 = control word for drive 3
  - s_{set} = position setpoint
  - n_{act} = speed setpoint
  - a_{act} = acceleration setpoint

    5 telegrams (= 5 channels) are required for this.
- SLB in slave drive 2 (transceiver)
  One item of process data is transferred in ZW_2 (written).
  For this, one telegram (= 1 channel) is required.
  ZW_2 = status word of drive 2
- SLB in slave drive 3 (transceiver)
  One item of process data is transferred in ZW_3 (written).
  For this, one telegram (= 1 channel) is required.
  ZW_3 = status word of drive 3

Parameterization of the dispatcher

The following parameter settings are of significance for the dispatcher as the master drive:

- **P740 = 0** (Dispatcher function)
- **P745 = 5** (SLB channel number)
  This means that each node is provided with five telegrams for writing.

NOTE

The setting always depends on the requirements of the node with the largest required number of channels. In this example, this is the dispatcher (master drive 1) with five telegrams.

- **P746 = 1 ms** (SLB cycle time)
  A sufficient number of additional telegrams are automatically added to non-addressed nodes as is required to achieve this cycle time.

  Synchronization of the control loops in the converter via the bus cycle time: The bus cycle time must be in a defined relation to the time slots of the individual controls for synchronization of the decentralized lower-level control loops in the converters. The following is applicable for the time slots on MASTERDRIVES units:
  - Current control in time slot T_0
  - Speed control in time slot 2 T_0
  - Position control in time slot 4 T_0

- The time slot T_0 = 1/pulse frequency is set on MASTERDRIVES units by selecting the pulse frequency (P340). Thus the following applies for the selection of the bus cycle time:

Bus cycle time = 2^n x slowest time slot to be synchronized; where $n \in N = \{2, 3, ...\}$

Example:
If the position control loops of the various converters have to be synchronized to each other, the selected bus cycle time has to be an n-fold quantity of 4 T_0.

Parameterization of the transceivers

Transceiver (slave drive 2) is given the node address 1 and transceiver (slave drive 3) is given the node address 2.

Parameterization of process data monitoring

The following diagrams show the assignment of the process data to be read or written using the example of master drive 1 and slave drive 2.

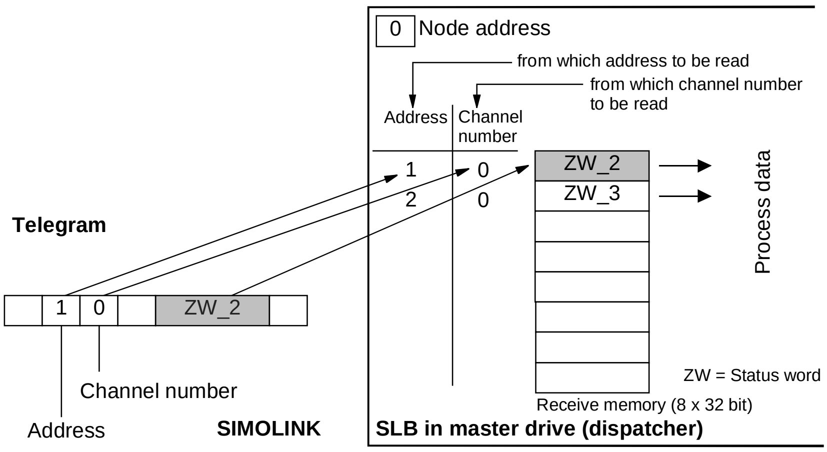

Fig. 8.3-8 Master drive 1, reading data

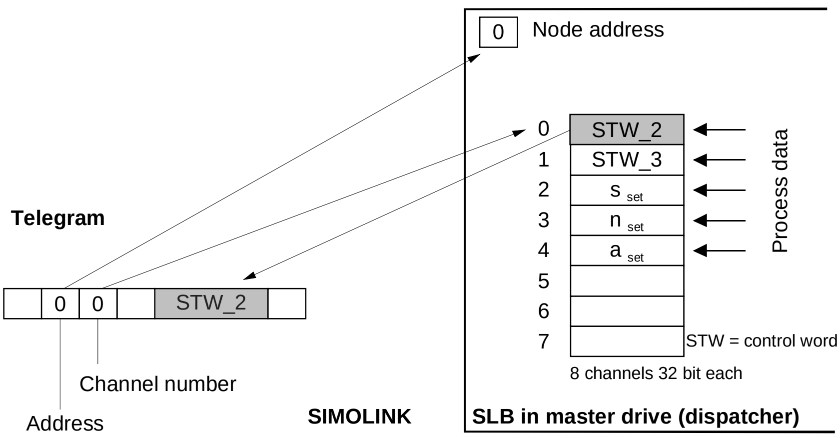

Fig. 8.3-9 Master drive 1, writing data

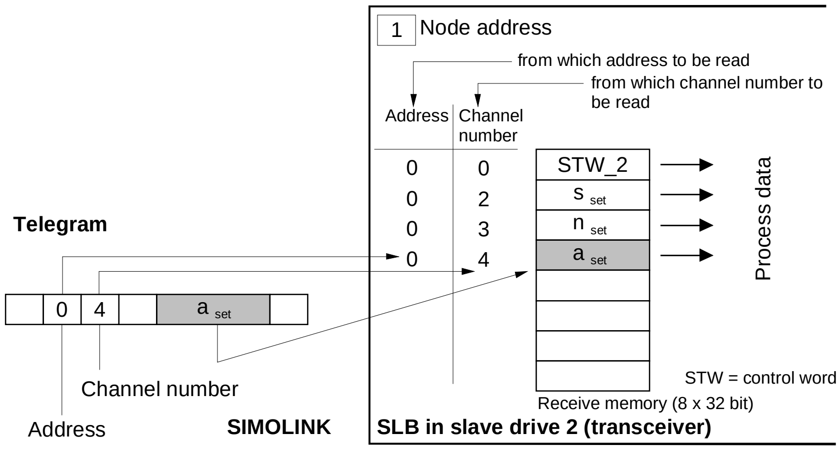

Fig. 8.3-10 Slave drive 2, reading data

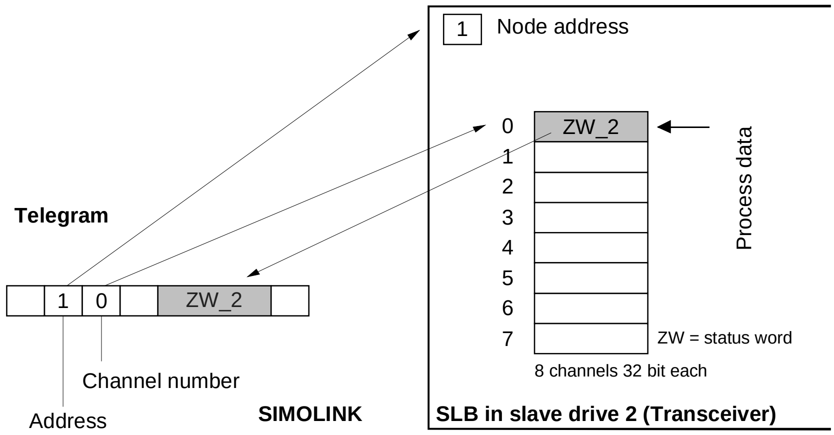

Fig. 8.3-11 Slave drive 2, writing data

8.3.12 Master/slave functionality

In the master-slave functionality, an SL master (SIMOLINK interface) operates in an automation system instead of the dispatcher (peer-to-peer).

There is always only one SL master in the SIMOLINK ring. All the other nodes are transceivers.

Bus topology

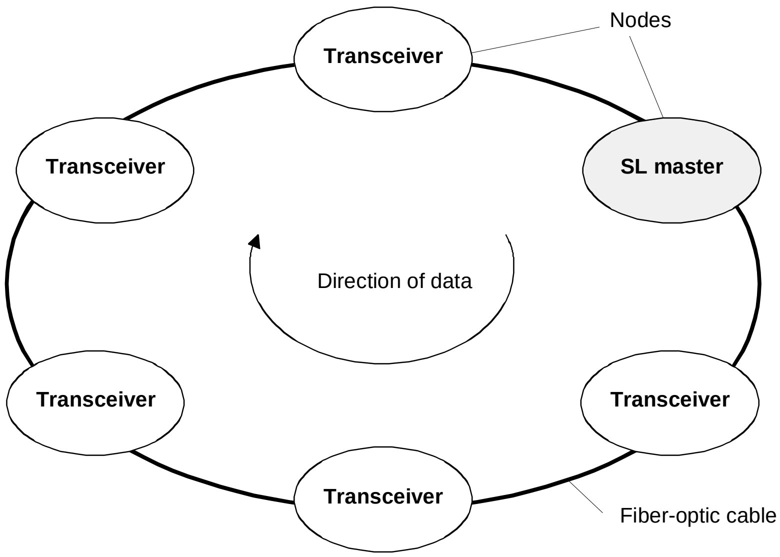

Fig. 8.3-12 SIMOLINK ring with SL master

SL master

The SL master is the SIMOLINK interface in "higher-level" open-loop and closed-loop control systems or industrial PCs. As far as the central control of telegram traffic is concerned, there is no difference between the dispatcher and the SL master. The task table also specifies in the case of the SL master which and how many telegrams the SL master shall send via the bus in one bus cycle.

Differences to the dispatcher:

- The applications of the "Master/slave" functionality require a different mechanism for data transfer than used in the "Peer-to-peer" functionality.
- Flexible address list (address gaps are possible), i.e. the task table can be configured a lot more freely.
- The number of channels used per transceiver can be individually determined and does not have to be identical. The maximum number of channels per transceiver is generally restricted to 8.
- The SL master itself has 8 channels for data transfer, just as in the case of the dispatcher or transceiver, however, at the same time it can use the telegrams with the address and channel number code of the transceivers for its data transfer.

NOTE

The SL master uses the "intelligence" and the possibilities offered by the open/closed-loop control system or the PC for configuring the task table. The following SL masters are currently available:

- SIMOLINK module in SIMATIC FM458
- Expansion board ITSL in SIMADYN D

Transceiver

In accordance with the peer-to-peer functionality

8.3.13 Application with master/slave functionality

Principle

This configuration is not based on the principle of freely selectable data transfer between MASTERDRIVES MC/VC units because control is effected from a higher-level automation system.

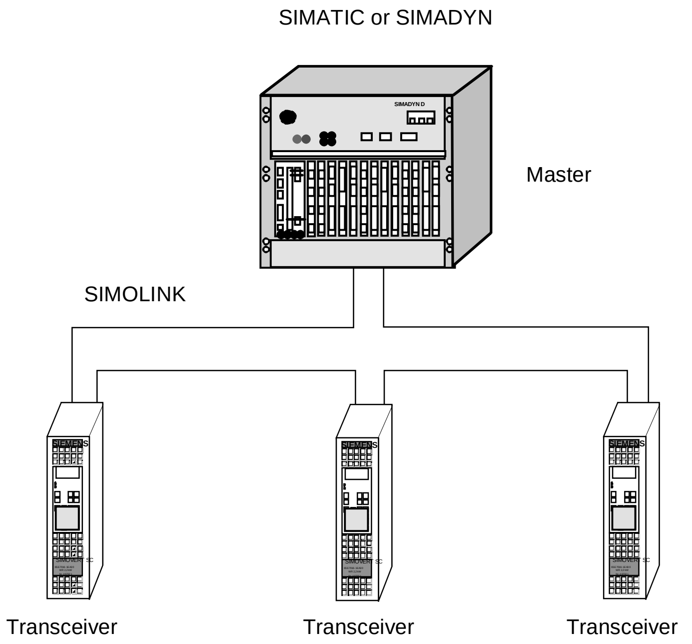

Fig. 8.3-13 Application example of master/slave functionality

There is a SIMOLINK interface in the automation system which also operates as a logical master in addition to the dispatcher function. This means that the automation system dispatches a maximum of eight 32 bit data back to the master by overwriting received telegrams with the dispatch information. This is the typical structure of data exchange according to the master/slave principle.

Rules for the exchange of data

- Each transceiver can read a maximum of 8 telegrams, however, the difference to the peer-to-peer functionality is that only telegrams which have an address corresponding to the address of the node or the master address 0 are read.
  Note: These telegrams must, of course, be entered in the task table of the master.
- As in the case of the peer-to-peer functionality, each transceiver can only write data on telegrams whose telegrams have the address of the transceiver.
- The master can read and write on all telegrams.

The master can implement data exchange between two transceivers by transferring the received data of one transceiver to the telegrams (= address) of the other.

NOTE

Every transceiver can also read the telegrams of any other node. However, whether the read data are receive or transmit data, depends on where the respective nodes are situated in the SIMOLINK ring (definite data traffic in the SIMOLINK ring).

NOTICE

The SIMADYN-D master can be operated in different SIMOLINK operating modes.
Modes 3 to 5 are suitable for error-free data traffic with MASTERDRIVES. Especially when using the asynchronous mode (= 1) problems can arise on the MASTERDRIVES MC/VC because the hardware interrupt generated by the bus cycle might not be equidistant and hardware interrupts triggered in too quick succession will cause a computation time overflow in the MASTERDRIVES MC/VC basic unit.