KL6051

Data transfer terminal with serial RS422 terminal
Configuration Instructions

Version 2.1
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BECKHOFF

Contents

Foreword

Notes on the documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards. It is essential that the following notes and explanations are followed when installing and commissioning these components.

Liability Conditions

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.
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In addition, the general delivery conditions of the company Beckhoff Automation GmbH apply.

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Safety Instructions

State at Delivery

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH.

Description of safety symbols

The following safety symbols are used in this documentation. They are intended to alert the reader to the associated safety instructions..

Danger

This symbol is intended to highlight risks for the life or health of personnel.

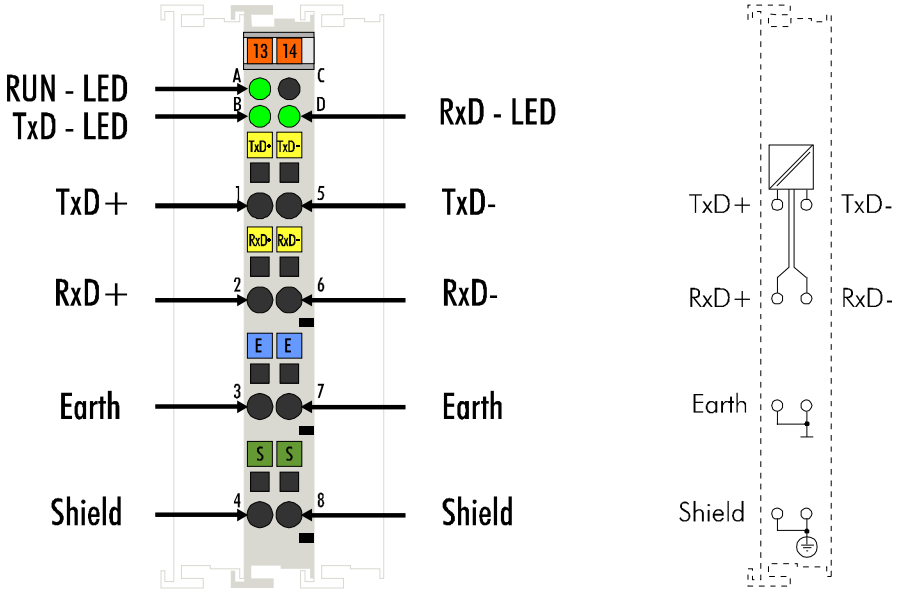
Attention

This symbol is intended to highlight risks for equipment, materials or the environment.

Note

This symbol indicates information that contributes to better understanding.

Technical data



Top view

Contact assignment

Technical data	KL6051
Data transfer channels	TxD and RxD, full duplex
Data transfer rate	62500 Baud (8N1)
Bit transfer	with differential signal
Line impedance	120 Ω
Data transfer link	approx. 1000 m twisted pair
Power supply	via the K-Bus
Current consumption from K-Bus	65 mA typ.
Electrical isolation	500 Vrms (K-Bus / signal voltage)
Bit width in the process image	I/O: 4 x 8 bits user data, 1 x 8 bits control/status (up to 5 x 8 bits user data possible)
Configuration	no address setting or configuration settings
Weight approx..	60 g
Operating temperature	0℃ ... +55℃
Storage temperature	-25℃ ... +85℃
Relative humidity	95%, no condensation
Vibration/shock resistance	conforms to IEC 68-2-6 / IEC 68-2-27
EMC resistance Burst / ESD	conforms to EN 50082 (ESD, Burst) / EN 50081
Installation position	any
Type of protection	IP20

Description of functions

The KL6051 serial interface terminal enables an exchange of data between different field bus systems. Regardless of the higher-level field bus system, data can be exchanged in full duplex mode. Up to 40 inputs and 40 outputs are transmitted between the field bus systems and, in addition, the status byte contains information about the quality and the status of data transfer. The terminal is supplied with a 200 ms RCV timeout, i.e. the inputs of the higher-level controller are set to zero if the terminal does not receive any valid data via the serial interface from the second station within 200 ms. In the default setting, 32 bits are bidirectionally available for data exchange.

Features

Coupling of two field bus systems
Exchange of up to 40 bits bidirectionally
Status byte for data channel status message
Safeguarded data transfer by longitudinal parity, vertical parity, log
Transmission medium: RS422 full duplex
Maximum transmission distance: 1000 m
Simple software interface for control by the emulation of up to 40 bits Parallel I/O
Data transfer time exchange time < 5 ms

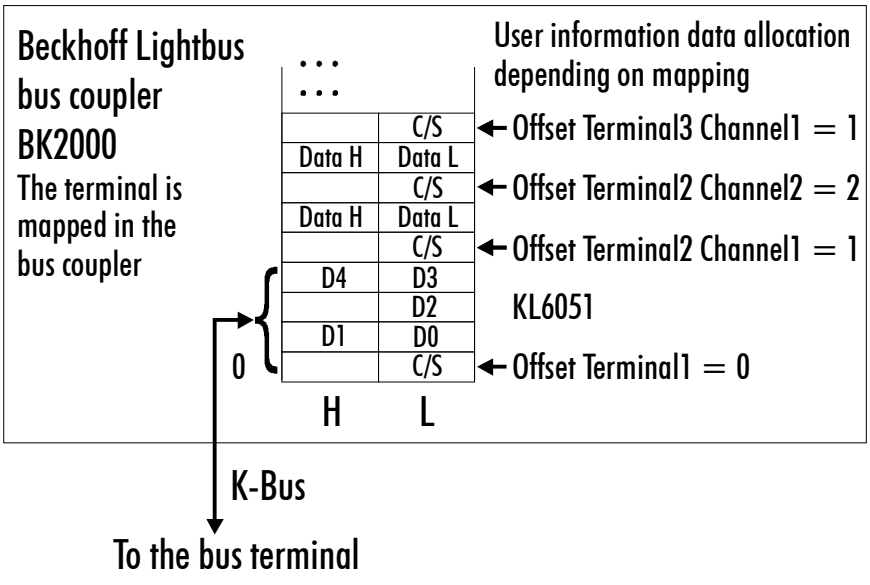
Terminal configuration

The terminal can be configured and parametrized via the internal register structure.

Each terminal channel is mapped in the bus coupler. The data of the terminal is mapped differently in the memory of the bus coupler depending on the type of the bus coupler and on the set mapping configuration (eg Motorola / Intel format, word alignment.
For parametrization of a terminal, the control / status byte must also be mapped.

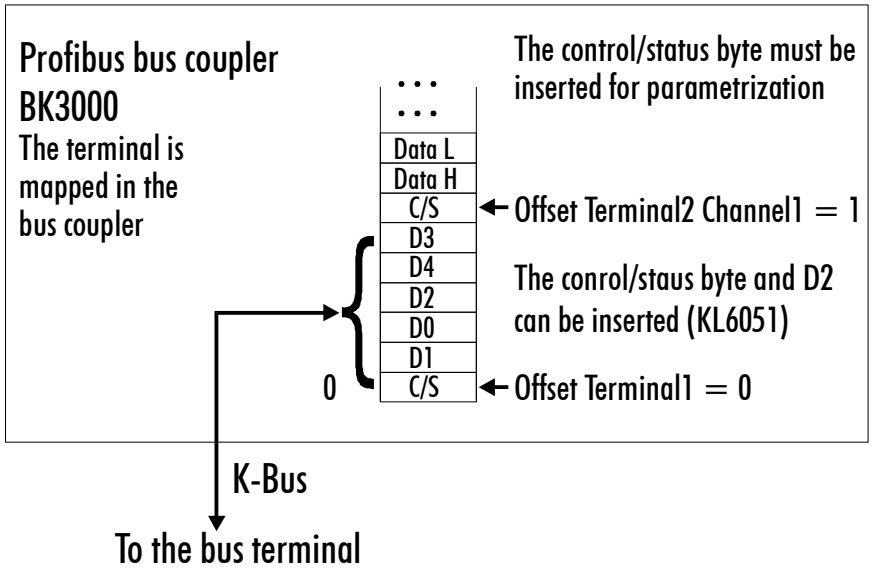
Beckhoff Lightbus coupler BK2000

When using the Beckhoff Lightbus coupler BK2000, the control / status byte is always mapped in additon to the data bytes. It is always in the low byte at the offset address of the terminal channel. In the case of the KL6051 there will be 6 bytes data (5 bytes user data and 1 byte control/status) exchanged with the control system.



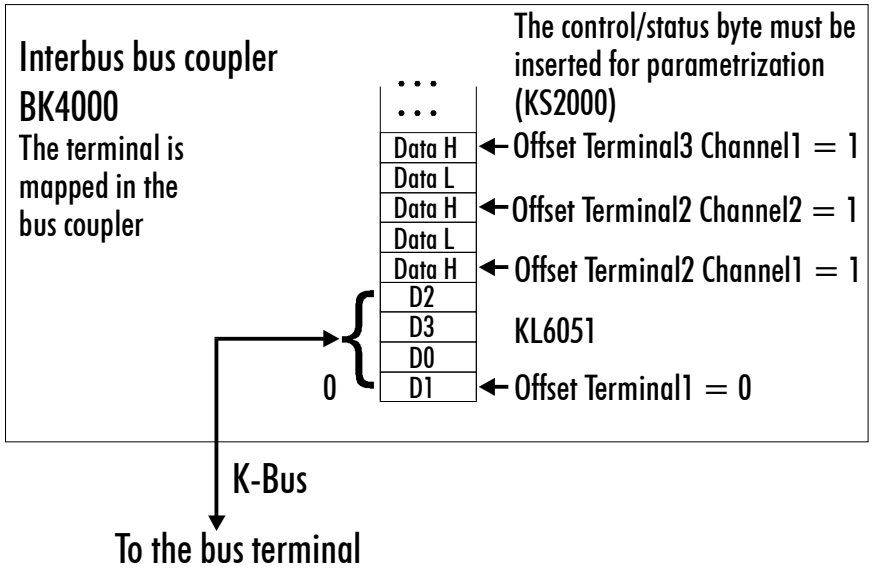
Profibus coupler BK3000

When using the Profibus coupler BK3000, how the KL6051 is to map itself in the bus coupler is set in the master configuration software. The figure shows the mapping for 6 bytes of input data and 6 bytes of output data.



Interbus coupler BK4000

By default, the Interbus coupler BK4000 maps the KL6051 with 4 bytes of input data and 4 bytes of output data. Parametrization via the field bus is not possible. The KS2000 software is needed to redefine the terminal's parameters.



Other bus couplers and further information

You will find further information of the mapping configuration of bus couplers in the annex of the respective bus coupler manual under the heading of "Configuration of Masters".

Note

The annex contains an overview of possible mapping configurations depending on the parameters that can be set.

Parametrization with the KS2000 software

Parametrization operations can be carried out independently of the field bus system using the Beckhoff KS2000 configuration software via the serial configuration interface in the bus coupler.

Register description

The complex terminals can be adjusted to different operating modes or functionalities. The " general description of register " describes the contents of the registers, which are identical for all complex terminals.

The terminal-specific registers are explained in the section following to it.

The access to the internal registers of the terminal is described in the section " register communication ".

General register description

Complex terminals that possess a processor are capable of bidirectionally ex-changing data with the higher-level control system. Below, these terminals are referred to as intelligent bus terminals. They include the analog inputs (0-10V, -10-10V, 0-20mA, 4-20mA), the analog outputs (0-10V, -10-10V, 0-20mA, 4-20mA), serial interface terminals (RS485, RS232, TTY, data transfer terminals), counter terminals, encoder interfaces, SSI interfaces, PWM terminals and all other parametrizable terminals.

Internally, all intelligent terminals possess a data structure that is identical in terms of it's essential characteristics. This data area is organized in words and embraces 64 memory locations. The essential data and parameters of the terminal can be read and adjusted by way of the structure. Function calls with corresponding parameters are also possible. Each logical channel of an intelligent terminal has such a structure (therefore, 4-channel analog terminals have 4 register sets.

This structure is broken down into the following areas:
(You will find a list of all registers at the end of this documentation).

Area	Address
Process variables	0-7
Type registers	8-15
Manufacturer parameters	16-30
User parameters	31-47
Extended user area	48-63

Process variables

R0 - R7: Registers in the terminal's internal RAM:
The process variables can be used in additional to the actual process image and their functions are specific to the terminal.

R0 - R5: These registers have a function that depends on the terminal type.

R6: Diagnostic register
The diagnostic register may contain additional diagnostic information. In the case of serial interface terminals, for example, parity errors that have occurred during data transfer are indicated.

R7: Command register
High-Byte_Write = function parameter
Low-Byte _Write = function number
High-Byte _Read = function result
Low-Byte_ Read = function number

Type registers

R8 - R15 Registers in the terminal's internal ROM der Klemme

The type and system parameters are programmed permanently by the manufacturer and can only be read by the user but cannot be modified.

R8: Terminal type:

The terminal type in register R8 is needed to identify the terminal.

R9: Software version X.y

The software version can be read as an ASCII character string.

R10: Data length

R10 contains the number of multiplexed shift registers and their length in bits.
The bus coupler sees this structure.

R11: Signal channels

In comparison with R10, the number of logically existing channels is located here. For example, one physically existing shift register may consist of several signal channels.

R12: Minimum data length

The respective byte contains the minimum data length of a channel to be transferred. If the MSB is set, then the control/status byte is not necessarily needed for the function of the terminal and, with appropriate configuration of the coupler, is not transferred to the control system.

R13: Data type register

Data type register	
0x00	Terminal without valid data type
0x01	Byte array
0x02	1 byte n bytes structure
0x03	Word array
0x04	1 byte n words structure
0x05	Double word array
0x06	1 byte n double words structure
0x07	1 byte 1 double word structure
0x08	1 byte 1 double word structure
0x11	Byte-array with a variable logical channel length
0x12	1 byte n bytes structure with a variable logical channel length (eg 60xx)
0x13	Word-array with a variable logical channel length
0x14	1 byte n words structure with a variable logical channel length
0x15	Double word array with a variable logical channel length
0x16	1 byte n double words structure with a variable logical channel length

R14: not used

R15: Alignment bits (RAM)

The analog terminal is set to a byte limit in the terminal bus with the alignment bits.

Manufacturer parameters

R16 - R30 is the area of the "Manufacturer parameters" (SEEROM)

The manufacturer parameters are specific to each terminal type. They are programmed by the manufacturer but can also be modified from the control system. The manufacturer parameters are stored permanently in a serial EEPROM and are therefore not destroyed by power failures.
These registers can only be modified after setting a code word in R31.

User parameters

R31 - R47 "Application parameters" area (SEEROM)
The application parameters are specific to each terminal type. They can be modified by the programmer. The application parameters are stored permanently in a serial EEPROM in the terminal and cannot be destroyed by power failures. The user area is write protected over a Codeword.


Note

R31: Code word-register in the RAM
The code word **0x1235** must be entered here to enable modification of parameters in the user area. Write-protection is set if a different value is entered in this register. When write protection is inactive, the code word is returned during reading of the register. The register contains the value zero when write protection is active.

R32: Feature-register
This register defines the operating modes of the terminal. For example, a user-specific scaling can be activated for the analog I/O's.

R33 - R47
Registers that depend on the terminal type

Extended application area

R47 - R63
These registers have not yet been implemented.

Terminal-specific register description

Process variables

R1-R5: no function

R6: diagnostic register [R/W]
HB HB Status of station 2 (partner terminal)
LB LB Status of station 1

R7: no function

Type registers

R8: terminal type [0x17A3] [R]
The terminal type in register R8 is identical with the general terminal designation.
HB,LB = 6051
HB = 0x17
LB = 0xA3

R9: software version X.y [R]
HB = main number X of X.y
LB = sub-number y of X.y

R10: data length [R]
R10 contains the number of multiplexed shift registers in the terminal bus and their length in bits. The bus coupler sees this structure.
HB = 2 - multiplexed channels
LB = 24-bit shift registers

R11: signal channels [R]
In comparison with R10, this register contains the number of logically existing channels. Thus, for example, one physically existing shift register may consist of several signal channels or vice versa.
HB = 1
LB = 48

R12: minimum data length (auto configuration) [R]
The respective byte contains the minimum data length to be transferred of a signal channel. The status byte is omitted if the MSB is set.
HB = 48 ; HB is the number of outputs in the case of auto configuration
LB = 48 ; LB is the number of inputs in the case of auto configuration

R15: alignment bits (RAM)
With the alignment bits, the analog terminal is set to a byte limit in the terminal bus.
HB = LB converted (contains zero in the event of input)
LB = number of bit doublets 0,1,2,3

Manufacturer parameter

R16: hardware version [R/W]
HB = main number X of X.y
LB = sub-number y of X.y

User parameters

R32 Feature register
[0x0007]

Feature bit nr.		
bit 0	1	RCV-timeout enable (R334) [1]
bit 1	1	TRS-timeout enable (R35) [1]
bit 2	0/1	0: terminal bus communiction via interrupt 1: terminal bus: poll state [1]
bit 3	0/1	0: data is transferred word-consistently 1: data is transferred completely consistently
bit 15-4	-	not used

R33: Baud rate
[0x0003] (62.5kHz)
HB = DC
LB = Baud rate = 4MHz / (16 * (LB + 1))

R34: RCV timeout
[0x00014] (200ms)
HB, LB = unsigned integer, 1 digit corresponds to 10ms
When the RCV timeout enable bit is set in R32, this value is valid. If the terminal does not receive any valid data via the serial interface for X-ms, the controller's inputs are set to the value ZERO.

R35: TRS timeout
[0x0014] (200ms)
HB, LB = unsigned integer,1 digit corresponds to 10ms
When the TRS timeout enable bit is set in R32, this value is valid. If the terminal does not receive any valid data via the serial interface for X-ms, no data is sent via the serial interface. Accordingly, the RCV timeout of the 2rd terminal would take effect.

Register communication KL6051

Register access via process data transfer Bit 7=1: register mode

When bit 7 of the control byte is set, the first two bytes of the user data are not used for process data transfer, but are written into or read out of the terminal's register.

Bit 6=0: read
Bit 6=1: write

In bit 6 of the control byte, you define whether a register is to be read or written. When bit 6 is not set, a register is read without modification. The value can be taken from the input process image.

When bit 6 is set, the user data is written into a register. The operation is concluded as soon as the status byte in the input process image has supplied an acknowledgement (see examples).

Bits 0 to 5: address

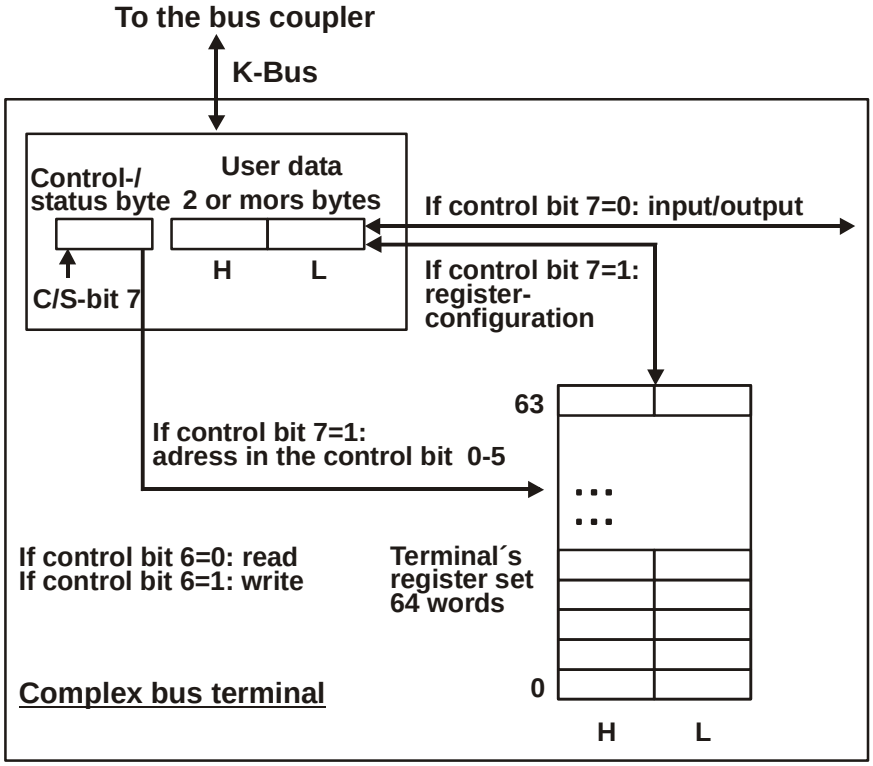
The address of the register to be addressed is entered in bits 0 to 5 of the control byte.

Control byte in the register mode

MSB

REG=1	W/R	A5	A4	A3	A2	A1	A0

REG = 0 : Process data transfer
REG = 1 : Access to register structure
W/R = 0 : Read register
W/R = 1 : Write register
A5..A0 = Register address
A total of 64 registers can be addressed with the addresses A5....A0.



The control or status byte occupies the lowest address of a logical channel. The corresponding register values are located in the following 2 data bytes (the BK2000 is an exception to the rule: here, an unused data byte is inserted after the control or status byte, thus setting the register value to a word limit).

Example

Reading register 8 in the BK2000 with a Kl3022 and the end terminal.

If the following bytes are transferred from the controller to the terminal,

Byte0 Control	Byte1 Not used	Byte2 Data OUT, high byte	Byte3 Data OUT, low byte
0x88	0xXX	0xXX	0xXX

the terminal returns the following type designation (0x0BCE corresponds to the unsigned integer 3022).

Byte0 Status	Byte1 Not used	Byte2 Data IN, high byte	Byte3 Data IN, low byte
0x88	0x00	0x0B	0xCE

A further example

Writing register 31 in the BK2000 with an intelligent terminal and the end terminal.

If the following bytes (user code word) are transferred from the controller to the terminal,

Byte0 Control	Byte1 Not used	Byte2 Data OUT, high byte	Byte3 Data OUT, low byte
0xDF	0xXX	0x12	0x35

the user code word is set and the terminal returns the register address with the bit 7 for register access and the acknowledgement.

Byte0 Status	Byte1 Not used	Byte2 Data IN, high byte	Byte3 Data IN, low byte
0x9F	0x00	0x00	0x00

Data transfer, function

8 data bits, 1 start bit, 1 stop bit, even parity

Data containing errors is not transferred to the controller. The processed data is still valid when the CHK, OVR or PAR date is set. These bits merely represent the quality of data transfer.

Status byte in the process data mode

MSB

REG=0			**RCVT1**	**RCVT2**	**CHK**	**OVR**	**PAR**

PAR: parity error or invalid data frame

OVR: buffer overflow

CHK: invalid checksum

RCVT2: the partner terminal has an RCD timeout

RCVT1: the terminal is not receiving any data from the partner. The terminal has set the controller inputs to zero.

For use without status information, the data transfer link can be monitored from the other respective side of the link by means of a bit set by the controller. Data transfer of the KL6051 is checked by a watchdog. Thus, failures of the field buses or of data transfer between the KLK6051 units are easily recognizable.

Annex

As already described in the chapter terminal configuration, each bus terminal is mapped in the bus coupler. In the standard case, this mapping is done with the default setting in the bus coupler / bus terminal. This default setting can be modified with the Beckhoff KS2000 configuration software or using master configuration software (e.g. ComProfibus or TwinCAT System Manager). The following tables provide information on how the KL6051 maps itself in the bus coupler depending on the set parameters.

Mapping in the bus coupler

Mapping in the bus coupler

The KL is mapped in the bus coupler depending on the set parameters. The terminal occupies memory space in the process image of the inputs and outputs.

Default: CANCAL, CANopen, RS232, RS485, ControlNet, DeviceNet

		I/O Offset	High Byte	Low Byte
Complete evaluation	= 0	3		
MOTOROLA format	= 0	2		
Word alignment	= X	1	D3	D2
		0	D1	D0

Default: Interbus, Profibus

		I/O Offset	High Byte	Low Byte
Complete evaluation	= 0	3		
MOTOROLA format	= 1	2		
Word alignment	= X	1	D2	D3
		0	D0	D1

		I/O Offset	High Byte	Low Byte
Complete evaluation	= 1	3		
MOTOROLA format	= 0	2	D4	D3
Word alignment	= 0	1	D2	D1
		0	D0	CT/ST

		I/O Offset	High Byte	Low Byte
Complete evaluation	= 1	3		
MOTOROLA format	= 1	2	D3	D4
Word alignment	= 0	1	D2	D0
		0	D1	CT/ST

Default: Lightbus, Bus Terminal Controller (BCxxxx)

		I/O Offset	High Byte	Low Byte
Complete evaluation	= 1	3	D4	D3
MOTOROLA format	= 0	2		D2
Word alignment	= 1	1	D1	D0
		0		CT/ST

		I/O Offset	High Byte	Low Byte
Complete evaluation	= 1	3	D3	D4
MOTOROLA format	= 1	2		D2
Word alignment	= 1	1	D0	D1
		0		CT/ST

Legend

Complete evaluation: the terminal is mapped with control / status byte.
Motorola format: the Motorola or Intel format can be set.
Word alignment: the terminal is at a word limit in the bus coupler.
CT: Control- Byte (appears in the PI of the outputs).
ST: Status- Byte (appears in the PI of the inputs).
D0 – D4: Data bytes 0 - 4

Table of the register

Register set

Address	Designation	Default	R/W	Storage medium
R0	Not used	0x0000	R	
R1	Not used	0x0000	R	
R2	Not used	0x0000	R	
R3	Not used	0x0000	R	
R4	Not used	0x0000	R	
R5	Not used	0x0000	R	
R6	Diagnostic register	0x0000	R	RAM
R7	Command register not used	0x0000	R	
R8	Terminal type	6051	R	ROM
R9	Software version number	0x????	R	ROM
R10	Multiplexed shift register	0x0218	R	ROM
R11	Signal channels	0x0130	R	ROM
R12	Minimum data length	0x3030	R	ROM
R13	Data structure	0x0000	R	ROM
R14	Not used	0x0000	R	
R15	Alignment register	variable	R/W	RAM
R16	Hardware version number	specific	R/W	SEEROM
R17	Not used	0x0000	R/W	SEEROM
R18	Not used	0x0000	R/W	SEEROM
R19	Not used	0x0000	R/W	SEEROM
R20	Not used	0x0000	R/W	SEEROM
R21	Not used	0x0000	R/W	SEEROM
R22	Not used	0x0000	R/W	SEEROM
R23	Not used	0x0000	R/W	SEEROM
R24	Not used	0x0000	R/W	SEEROM
R25	Not used	0x0000	R/W	SEEROM
R26	Not used	0x0000	R/W	SEEROM
R27	Not used	0x0000	R/W	SEEROM
R28	Not used	0x0000	R/W	SEEROM
R29	Not used	0x0000	R/W	SEEROM
R30	Not used	0x0000	R/W	SEEROM
R31	Code word register	variable	R/W	RAM
R32	Feature register	0x0007	R/W	SEEROM
R33	Baud rate	0x0003	R/W	SEEROM
R34	RCV timeout	0x0014	R/W	SEEROM
R35	TRS timeout	0x0014	R/W	SEEROM
R36	Not used	0x0000	R/W	SEEROM
R37	Not used	0x0000	R/W	SEEROM
R38	Not used	0x0000	R/W	SEEROM
R39	Not used	0x0000	R/W	SEEROM
R40	Not used	0x0000	R/W	SEEROM
R41	Not used	0x0000	R/W	SEEROM
R42	Not used	0x0000	R/W	SEEROM
R43	Not used	0x0000	R/W	SEEROM
R44	Not used	0x0000	R/W	SEEROM
R45	Not used	0x0000	R/W	SEEROM
R46	Not used	0x0000	R/W	SEEROM
R47	Not used	0x0000	R/W	SEEROM

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