## 16.3 DS101

### 16.3.1 General Information

The DS101 module is a programmable I/O module with 3 differential outputs, 3 differential inputs, 16 digital inputs and 32 digital outputs. The main area of application for this module is in the field of **Electronic Drum Sequencers.** The DS101 is basically the same as the DS100 but has 32 transistor outputs which the intelligent I/O processor handles without the support of the PCC CPU.

The drum sequencer gets its name from the mechanical drum sequencers which works by means of cam on a shaft. Every disc represents a certain output which during the rotation of the shaft is active in certain positions.
The electronic functionality of drum sequencer has the following advantages over the mechanical camshaft:

- Higher switching precision
- Switching cycle does not cause wear
- Easier disc adjustment
- Pre-stop times

The DS101 I/O processor in use as a drum sequencer can calculate the output states of up to 128 outputs according to the actual angular position. In addition, a time can be calculated to compensate for switching times. The output states are stored in the DPR (Dual Port RAM) and can be read cyclically by the PCC CPU and recopied to any digital output modules.

To read the actual angular position, the following encoders can be hooked up to the differential inputs or outputs of the DS101 module:

- Absolute encoder with synchronous serial interface (SSI)
- Absolute encoder with parallel interface
- Incremental encoder

The method of coding (gray or dual) as well as the encoder resolution can be defined by the user with software (function block).
The encoder supply comes from the module as well. It is electrically isolated from the PCC, short circuit protected and current limited and is available on the terminal block.

The electronic drum sequencer can be configured by the user using function blocks. The respective software can be obtained from B&R (including documentation).

### 16.3.2 Technical Data

| Module ID | DS101 | |
|---|---|---|
| Model Number | 2DS101.60-1 | |
| Description | 2010 Electronic Drum sequencer, absolute encoder, SSI/parallel, 16 Bit,<br>3 differential inputs, RS422 level, 100 kHz, 3 differential outputs, RS422 level, 100 kHz,<br>16 digital inputs 24 VDC, 5 µsec, Sink, 32 digital outputs 24 VDC, 0.5 A,<br>Order terminal blocks separately! | |
| C-UL-US Listed | in preparation | |
| B&R ID Code | $1B | |
| Module Type | B&R 2010 I/O module | |
| Base Plate Module | BP200, BP201, BP210 | |
| Communication | RISC processor | |
| Instruction Cycle Time | 0.8 µsec | |
| Dual Ported RAM (DPR) | 384 Byte SRAM (not buffered) | |
| System RAM | 256 KByte SRAM (not buffered) | |
| Encoder Supply (internal) | Electrical isolation, short circuit protection and current limitation | |
| Encoder Supply Voltage | 24 V ±10% | 4.6 V ±10% |
| Load | Max. 120 mA | Max. 120 mA |
| Encoders Used | | |
| Absolute Encoder (Single Turn)<br>Coding<br>Resolution | Synchronous serial Interface (SSI)<br>Gray or dual<br>Max. 16 Bit (range: 4096 steps) | Parallel interface<br>Gray or dual<br>Max. 12 Bit |

| Module ID | DS101 |
|---|---|
| Differential Outputs | |
| Number of Differential Outputs | 3 |
| Electrical Isolation<br>Output - PCC<br>Output - Output | <br>Yes (optocoupler)<br>No |
| Differential Outputs | |
| Output Level | RS422 |
| Output Frequency | Max. 100 kHz |
| Differential Inputs | |
| Number of Differential Inputs | 3 |
| Electrical Isolation<br>Input - PCC<br>Input - Input | <br>Yes (optocoupler)<br>No |
| Input Level | RS422 |
| Input Frequency | Max. 100 kHz |
| Digital Inputs | |
| Number of Inputs<br>Total<br>in Groups of | <br>16<br>4 |
| Connection | Sink connection require (COM connections are to be connected to GND) |
| Electrical Isolation<br>Input - PCC<br>Group - Group<br>Input - Input | <br>Yes (optocoupler)<br>Yes (optocoupler)<br>No |
| Input Voltage<br>Nominal<br>Maximum | <br>24 VDC<br>30 VDC |
| Input Resistance | 4.4 kΩ |
| Switching Threshold<br>LOW Range<br>Switching Range<br>HIGH Range | <br><5 V<br>5 to 15 V<br>>15 V |
| Switching Delay<br>log. 0 - log. 1<br>log. 1 - log. 0 | (max. and typ.)<br>5 µsec (pulse width≥ 20 µsec)<br>5 µsec (pulse width≥ 20 µsec) |
| Count Frequency | Max. 25 kHz (ratio 1:1) |
| Digital Outputs | |
| Number of Digital Outputs<br>Total 32<br>in Groups of | <br><br>8 |
| Type | Transistor (source connection required) |
| Electrical Isolation<br>Output - PCC<br>Group - Group<br>Output - Output | <br>Yes<br>Yes<br>No |
| Switching Voltage<br>Minimum<br>Nominal<br>Maximum | <br>18 VDC<br>24 VDC<br>30 VDC |
| Continuous Current<br>per Output<br>per Group<br>Module | <br>Max. 0.5 A<br>Max. 4 A<br>Max. 16 A |

| Module ID | DS101 |
|---|---|
| Switching Delay<br>log. 0 - log. 1<br>log. 1 - log. 0 | <br>Typ. 5 µsec / max. 110 µsec<br>Typ. 60 µsec / max. 100 µsec |
| Switching Frequency (resistive load) | Max. 500 Hz |
| Overload Protection | Yes |
| Starting after Overload Cutoff | Automatic after approx. 5 sec |
| Short Circuit Current | 0.75 to 1.5 A |
| Protective Circuit<br>Internal<br><br>External | <br>Against overvoltage peaks up to 55 V (VDE 160)<br>Against reverse polarity on the 24 V module supply<br>Only if required (Surge) |
| Reverse Voltage when Switching Off Inductive Loads | 45 to 55 V |
| Power Consumption<br>24 V Encoder Supply Voltage<br>4.6 V Encoder Supply Voltage | <br>13 W + 1.5 x encoder power<br>13 W + 2.5 x encoder power |
| Dimensions (H, W, D) [mm] | 285, 80, 185 |



### 16.3.3 Differential Outputs

If the DS101 module is used as an electronic drum sequencer, the differential outputs are to be used to connect an absolute encoder via a synchronous serial interface.
By installing the proper software, other functions (e.g. frequency inputs or pulse width modulation outputs) can also be can also be realized. If digital inputs 9 to 16 are used, differential output 3 is no longer available for use.

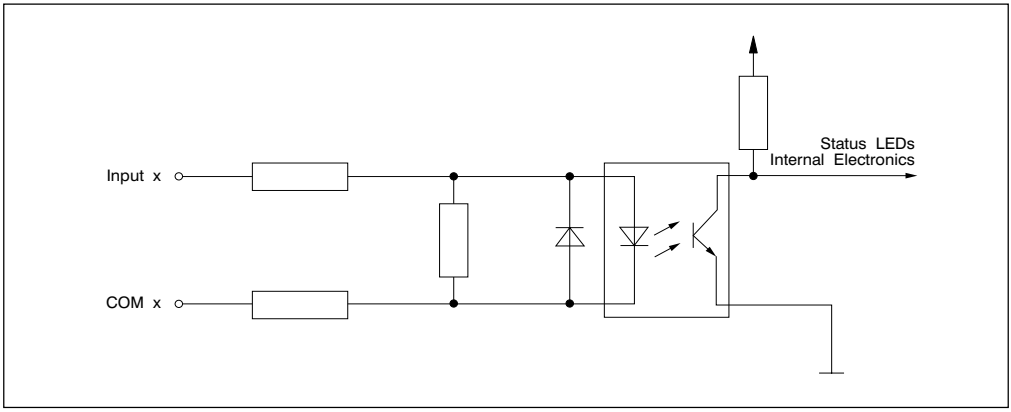
### 16.3.4 Differential Inputs

If the DS101 module is used as an electronic drum sequencer, the differential inputs are to be used to connect an absolute encoder via a synchronous serial interface.
By installing the proper software, the differential inputs can be used as impulse inputs or for gate time measurement for example.

### 16.3.5 Digital Inputs

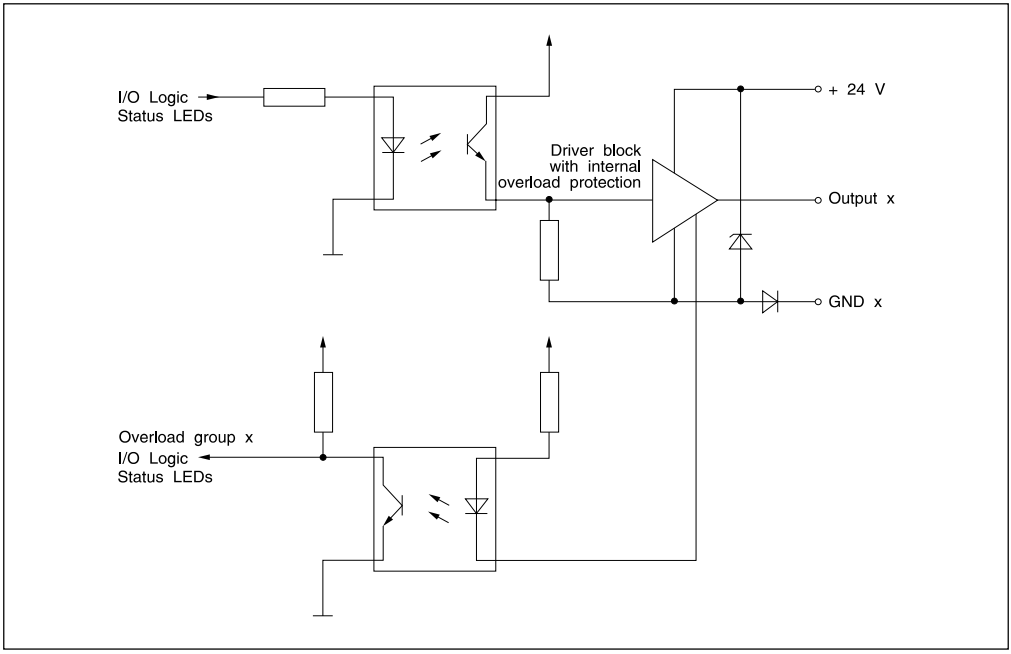
If the DS101 module is used as an electronic drum sequencer, the digital inputs are to be used to connect an absolute encoder via a parallel interface.
By installing the proper software, channels 1 to 8 can also be used as normal digital inputs, impulse inputs or for gate time measurement. Channels 9 to 16 are only used as normal digital inputs however.

**Digital Input Circuit**



### 16.3.6 Digital Outputs

**Output Circuit for the Digital Outputs**




**Overload Protection**

The overload protection circuit is activated in the following circumstances:

- ❍ The junction temperature of the transistor exceeds the allowed limitations (typical temperature limitation 150 °C, Min. 135 °C, Max. 175 °C). Cause: short circuit, overload or environmental temperature too high.
- ❍ The 24 V supply voltage (terminal block end) is lower than the normal 13 V (min. 10 V, max. 14.5 V)

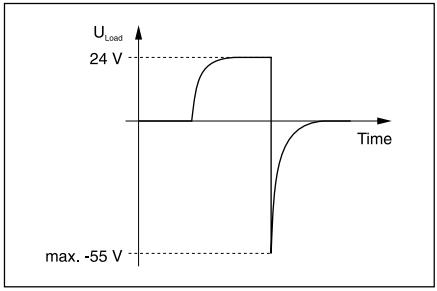
The affected output is switched off until ...

- ... the junction temperature sinks to within the allowed limits again (Hysteresis typ. 20 °C). Switch-on time is within seconds.
- ... the supply voltage is in the allowed range again (typ. > 14.5 V).
- ... the terminal block is properly connected.

**Switching Inductive Loads**

The transistor enables the fast and safe switching of inductive loads. It is not necessary to use an inverse diode on the inductive load. Note however that the maximum switching frequency is inductively limited by the fixed reverse voltage of 45 to 55 V.

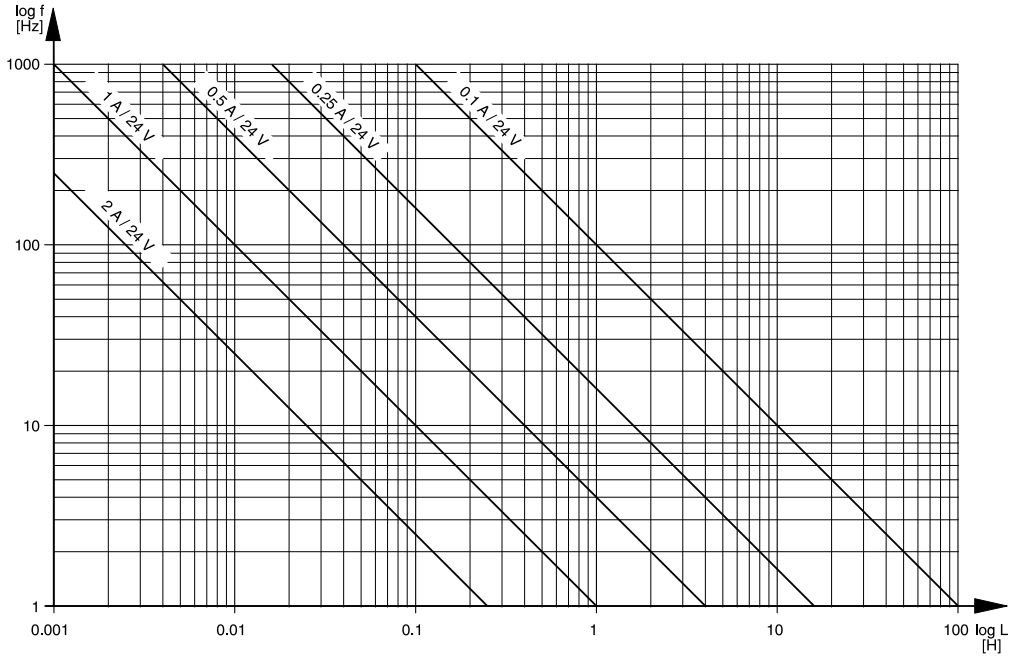
Reverse voltage: The reverse voltage is a negative voltage on the switching element (e.g. Valve). If the switching element does not allow operation with a negative voltage, an inverse diode must be installed externally in order to limit the voltage to approximately -0.6 V.




Reverse Voltage Diagram

The maximum switching frequency is reduced with increasing inductance. An inductance of 0.5 H can be switched without any problems with 0.5 Hz at 24 V / 0.5 A and 60 °C environmental temperature.

The maximum switching frequency for a given value for inductance can be calculated from the following graph:



### 16.3.7 Status LEDs

**Status LEDs on the Left Half of the Module:**

—< ●— Indicates the terminal block status, i.e. if this LED is lit, the terminal block behind the left module door is not connected properly or there isn't one.

**RUN** LED “RUN” light, if the intelligent I/O processor is in operation.

**FORCE** EEPROM is used or original TPU code overload

**SSI** This LED lights if an absolute encoder is connected with a synchronous serial interface (SSI) and delivers a signal.

**ERROR** Error or undefined state.

**APPL** The “APPL” LED lights if the application software is running.

**PGM** The LED is lit if data is being exchanged between the PCC CPU and the intelligent I/O processor program.

**INC** This LED has no function at this time (Reserved for incremental encoders).

**1 ... 16** LEDs 1 to 16 indicates the logical state of the respective digital input.

**Status LEDs on the Right Half of the Module:**

—< ●— Indicates the terminal block status, i.e. if this LED is lit, the terminal block behind the right module door is not connected properly or there isn't one.

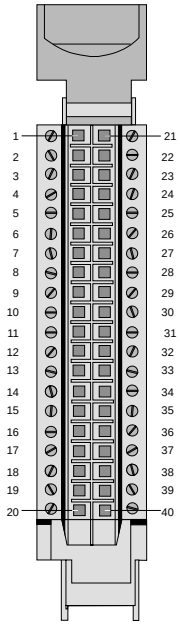
**TEMP** Indicates that all outputs will be switched off because of high temperature inside the housing.

**OL x-y** Overload: These LEDs indicate that the overload protection switch or the short circuit protection switch has been activated for the respective output group. E.g. if the LED OL 1-8 is lit, outputs 1 to 8 are switched off (more information in section "Overload Protection").

**1 ... 32** LEDs 1 to 32 indicate the logical status of the respective digital outputs. The LEDs light if the output is log. 1Y.

### 16.3.8 Terminal Assignments

**Connections for the terminal block are behind the left module door (encoder connections):**



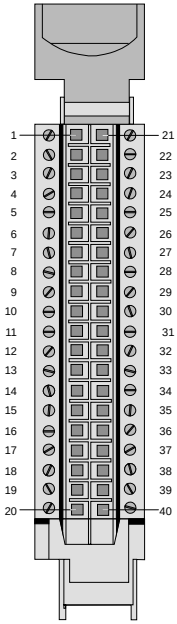
TB140

| Terminal | Description | Group | Terminal | Description | Group |
|---|---|---|---|---|---|
| 1 | RXD[1] | | 21 | TXD[1] | |
| 2 | Shield | | 22 | GND[1] | |
| 3 | 24V ENCODER | | 23 | GND ENCODER | |
| 4 | 4.6V ENCODER | | 24 | GND ENCODER | |
| 5 | Differential Output 1 + | | 25 | Differential Output 1 - | |
| 6 | Differential Output 2 + | | 26 | Differential Output 2 - | |
| 7 | Differential Output 3 + | | 27 | Differential Output 3 - | |
| 8 | Differential Input 1 + / A[2] | | 28 | Differential Input 1 - / $\overline{A}$[2] | |
| 9 | Differential Input 2 + / B[2] | | 29 | Differential Input 2 - / $\overline{B}$[2] | |
| 10 | Differential Input 3 + / R[2] | | 30 | Differential Input 3 - / $\overline{R}$[2] | |
| 11 | Digital Input 1 | | 31 | Digital Input 9 | |
| 12 | Digital Input 2 | | 32 | Digital Input 10 | |
| 13 | Digital Input 3 | 1 | 33 | Digital Input 11 | 3 |
| 14 | Digital Input 4 | | 34 | Digital Input 12 | |
| 15 | COM (1-4) | | 35 | COM (9-12) | |
| 16 | Digital Input 5 | | 36 | Digital Input 13 | |
| 17 | Digital Input 6 | | 37 | Digital Input 14 | |
| 18 | Digital Input 7 | 2 | 38 | Digital Input 15 | 4 |
| 19 | Digital Input 8 | | 39 | Digital Input 16 | |
| 20 | COM (5-8) | | 40 | COM (13-16) | |

[1] RS232 connection for VT100 terminal (in order to be able to work with IP Monitor). If terminals are not connected, connections 1 and 21 are to be jumped by the user.

[2] Incremental encoder

**Connections for the terminal block are behind the left module door:**



TB140

| Terminal | Description | Group | Terminal | Description | Group |
|---|---|---|---|---|---|
| 1 | Digital Output 1 | 1 | 21 | Digital Output 17 | 3 |
| 2 | Digital Output 2 | | 22 | Digital Output 18 | |
| 3 | Digital Output 3 | | 23 | Digital Output 19 | |
| 4 | Digital Output 4 | | 24 | Digital Output 20 | |
| 5 | +24 V (1-8) | | 25 | +24 V (17-24) | |
| 6 | Digital Output 5 | | 26 | Digital Output 21 | |
| 7 | Digital Output 6 | | 27 | Digital Output 22 | |
| 8 | Digital Output 7 | | 28 | Digital Output 23 | |
| 9 | Digital Output 8 | | 29 | Digital Output 24 | |
| 10 | GND (1-8) | | 30 | GND (17-24) | |
| 11 | Digital Output 9 | 2 | 31 | Digital Output 25 | 4 |
| 12 | Digital Output 10 | | 32 | Digital Output 26 | |
| 13 | Digital Output 11 | | 33 | Digital Output 27 | |
| 14 | Digital Output 12 | | 34 | Digital Output 28 | |
| 15 | +24 V (9-16) | | 35 | +24 V (25-32) | |
| 16 | Digital Output 13 | | 36 | Digital Output 29 | |
| 17 | Digital Output 14 | | 37 | Digital Output 30 | |
| 18 | Digital Output 15 | | 38 | Digital Output 31 | |
| 19 | Digital Output 16 | | 39 | Digital Output 32 | |
| 20 | GND (9-16) | | 40 | GND (25-32) | |

### 16.3.9 Encoder Connection

The following encoders can be connected to the DS101 module:

- ❍ Absolute encoder with synchronous serial interface (SSI)
- ❍ Absolute encoder with parallel interface
- ❍ Incremental encoder

| | Absolute encoder with syn. serial interface | | Absolute encoder with parallel interface | | Incremental encoder | | Encoder supply | |
|---|---|---|---|---|---|---|---|---|
| Terminal | Desc. | Definition | Desc. | Definition | Desc. | Definition | Desc. | Definition |
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | 24V | +24 V enc. supply |
| 4 | | | | | | | 4.6V | +4.6 V enc. supply |
| 5 | T | Clock output | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | D | Data input | | | A | Channel A | | |
| 9 | | | | | B | Channel B | | |
| 10 | | | | | R | Reference pulse | | |
| 11 | | | D1 | Data input bit 0 | | | | |
| 12 | | | D2 | Data input bit 1 | | | | |
| 13 | | | D3 | Data input bit 2 | | | | |
| 14 | | | D4 | Data input bit 3 | | | | |
| 15 | | | | | | | | |
| 16 | | | D5 | Data input bit 4 | | | | |
| 17 | | | D6 | Data input bit 5 | | | | |
| 18 | | | D7 | Data input bit 6 | | | | |
| 19 | | | D8 | Data input bit 7 | | | | |
| 20 | | | | | | | | |
| 21 | | | | | | | | |
| 22 | | | | | | | | |
| 23 | | | | | | | GND | GND enc. supply |
| 24 | | | | | | | GND | GND enc. supply |
| 25 | $\overline{T}$ | T inverted | | | | | | |
| 26 | | | | | | | | |
| 27 | | | | | | | | |
| 28 | $\overline{D}$ | D inverted | | | $\overline{A}$ | A inverted | | |
| 29 | | | | | $\overline{B}$ | B inverted | | |
| 30 | | | | | $\overline{R}$ | R inverted | | |
| 31 | | | D9 | Data input bit 8 | | | | |
| 32 | | | D10 | Data input bit 9 | | | | |
| 33 | | | D11 | Data input bit 10 | | | | |
| 34 | | | D12 | Data input bit 11 | | | | |
| 35 | | | | | | | | |
| 36 | | | | | | | | |
| 37 | | | | | | | | |
| 38 | | | | | | | | |
| 39 | | | | | | | | |
| 40 | | | | | | | | |

**Signal Cable Shielding**

Twisted pair cable must be used for the connections for absolute encoders with synchronous serial interfaces. The shielding is done through the specially built shield connection on the terminal block. The shield connections are linked directly to ground (⏚,i.e.: with the mounting rail).

Shielded connection cables are also recommended for absolute encoders with parallel interfaces.

### 16.3.10 Variable Declaration

The variable declaration for intelligent I/O processors is described in chapter “PG2000 Programming System” of the “B&R 2000 Software User's Manual”.