ETAS

ES4440.1 Compact Failure Simulation Module

User's Guide

Copyright

V1.1.0 R06 EN - 12.2012

Contents

1 Introduction

This User's Guide contains a description of the ES4440.1 Compact Failure Simulation Module.

It consists of the following chapters:

- Introduction

  This chapter
- "Hardware Features" on page 15

  This chapter contains a detailed description of the features of the ES4440.1 Compact Failure Simulation Module.
- "Pin Assignment" on page 25

  This chapter contains a description and assignment of all connectors on the front panel and on the rear of the housing.
- "Technical Data" on page 43

  This contains details of the technical data of the ES4440.1 Compact Failure Simulation Module.

1.1 Identification of safety information

The safety instructions contained in this manual are identified by the general danger symbol shown below:

The safety instructions shown below are used for this purpose. They provide notes about extremely important information. Please read this information very carefully.

DANGER!

Identifies an immediate danger with high risk, which could result in death or severe bodily injury if it is not avoided.

WARNING!

Identifies a possible danger with medium risk, which could result in death or (severe) bodily injury if it is not avoided.

CAUTION!

Identifies a danger with low risk that could result in slight or moderate bodily injuries or property damage if it is not avoided.

1.2 Basic safety instructions

Please observe the product safety advice ("Safety Advice for ETAS standard hardware products" and the "Safety advice for ETAS products for applications in high-voltage systems") and the subsequent safety instructions to avoid any impact on your health or damages to the device.

1.2.1 Safety advice for ETAS standard hardware products

WARNING!

It is critical that you read and follow this Security Advice, the technical data facilitated on ETAS website, www.etas.com (via Direct Product Access/select Product/Technical Data) and the instructions in the associated user manual. If information areas on the ETAS websites are password protected, please contact the ETAS hotline in your region www.etas.com/hotlines.

This ETAS product enables users to control systems which accomplish safety functions (e.g. in automobiles, automobile components and test facilities), to change security relevant data, or to allocate those for further processing. Hence, the application of this product can be hazardous. Improper use and unskilled application without adequate instruction and experience in handling of such products may cause threats to life and physical conditions as well as damages to property.

Our products have been developed and released exclusively for use in **automotive applications**.

Fitness and suitability of the products for any intended use beyond the utilization for which the products have been released (e.g. different stresses/strains or technical conditions) need to be verified by the user on own authority by taking appropriate actions and measures (e.g. by means of tests).

- Do not use this product if you do not have proper experience and training in using the product.
- To allow proper handling of ETAS products ETAS has released Known Issue Reports (KIR) on its website. Known Issue Reports provide information on known product problems of substantial relevance, including their technical impact, and give instructions on available solutions. Prior to the initial operation of the product you are required to verify whether a KIR is available for the current product version and adhere to available information in the KIR. Known Issue Reports (KIR) can be found on ETAS website www.etas.com/kir.
- **Program code and/or control actions of programs, which have been developed or modified as well as data of any kind, which have been identified by using ETAS products, will need to be verified with respect to reliability, quality and suitability prior to any use or dissemination.**
- **When using this product with systems which accomplish safety functions (e.g. in automobiles, automobile components and test facilities), that influence system behaviour and can affect the safe operation of the system, you must ensure that the system can be**

transitioned to a safe condition (e.g. emergency shutdown or emergency operation mode) if a malfunction or hazardous incident should occur.

- All applicable regulations and statutes regarding operation of motor vehicles and test facilities must be strictly followed when using this product.
- Use of this ETAS product or any program code, program control procedures in the public domain (e.g. on public roads) should not occur unless they have been tested and verified as being safe in advance. It is therefore recommended to use the products only in closed and designated test environment.

WARNING!

If you fail to follow these instructions, there might be a risk of death, serious injury or property damage.

The ETAS Group and their representatives shall not be liable for any damage or injury caused by improper use of the product. ETAS provides trainings regarding the proper and intended use of this product.

1.2.2 Safety advice for ETAS products for applications in high-voltage systems

Users of an ETAS product for applications in high-voltage systems must also observe the following "Safety advice for ETAS standard hardware products".

This safety advice applies to following ETAS products:

- ES4440.1 Compact Failure Simulation Module
- ES4440.2 Compact Failure Simulation Module

Before using the product, carefully read the following documents:

1. the "Safety advice for ETAS standard hardware products" (see chapter 1.2.1 on page 6),
2. the corresponding user's guide of the product
   - ES4440.1 Compact Failure Simulation Module - User's Guide
   - ES4440.2 Compact Failure Simulation Module - User's Guide

- Use the product only according to the specifications ion the corresponding user's guide. For any other use, the product safety is not ensured.
- Observe the regulations concerning electrical safety and the laws and regulations concerning occupational safety applicable at the application site!
- Observe the rules for working on equipment with dangerous voltages!
- Keep the cables short to minimize the risks of injuries from pinching, contracting, scoring or shearing.
- Do not use the product in a wet or humid environment.

- Keep the surfaces of the product clean and dry.

DANGER!

Risk of electric shock
with damaged housing of a ES4440 device!
Electric shock upon touching energized components of the ES4440 leads to injuries, heart failure or death.
A damaged Isolating Measurement Probe must be decommissioned ***immediately****!*
Ensure that the damaged ES4440 is not longer being used!
Attempts to repair are not permissible!

1.3 Applications

The ES4440.1 Compact Failure Simulation Module is used for real-time error simulation for ECUs. It is intended for use in a HiL system, but can also be used as a stand-alone system, e.g. for

- tests on engine test beds
- tests on roller dynamometers
- error simulation in a stationary vehicle.

WARNING!

The ES4440.1 Compact Failure Simulation Module is not intended for operation in a traveling vehicle!

The ES4440.1 Compact Failure Simulation Module is a 19" housing with 3 U which can be assembled in a rack using the corresponding mounts. Fig. 1-1 shows the front panel (with mounts for rack assembly) and the rear of the ES4440.1.

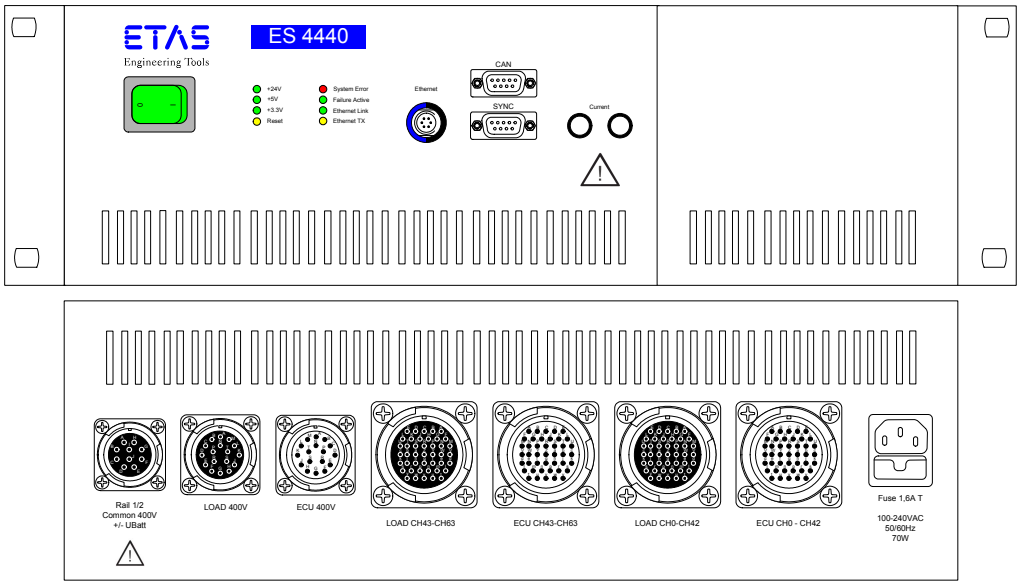


Fig. 1-1 Front View (Top) and Rear View (Bottom) of the ES4440.1 Compact Failure Simulation Module

The ES4440.1 Compact Failure Simulation Module is addressed via the Ethernet or CAN interface. The LABCAR-PINCONTROL V2.0 software provided offers simple and user-friendly interfaces for operating and configuring the ES4440.1 via Ethernet.

The individual functions are described in detail in the following section.

1.4 Functions and Features

This section provides a short overview of the functions and features of the ES4440.1 Compact Failure Simulation Module. A detailed description can be found in the chapter "Hardware Features" on page 15.

1.4.1 Error Simulation

The ES4440.1 Compact Failure Simulation Module makes it possible to simulate errors in real time for 80 ECU channels (per ES4440.1).

High-Current Channels

64 of these channels are for voltages up to 30 V and currents up to 20 A – the following errors can be simulated for these 64 channels:

- Open load
- Short to +UBatt_A, -UBatt_A, +UBatt_B, -UBatt_B with or without connected load
- Contacts between lines with and without resistance ("Pin-to-Pin") with or without connected load
- Line resistance ("In-Line")
- Pull-up resistance to +UBatt_A or +UBatt_B with or without connected load
- Pull-down resistance to -UBatt_A or -UBatt_B with or without connected load

High-Voltage Channels

A further 16 channels are for voltages up to 80 V RMS and currents up to 10 A – the following errors can be simulated for these 16 channels:

- Open load
- Short to +UBatt_C and -UBatt_C without connected load
- Contacts between lines (Pin-to-Pin Resistance) without connected load

Time Response

The difference between switching an error via a relay or via MOSFET is particularly seen in the time response. Whereas MOSFETs have negligible switch times (approx. 50 µs), relays have high switch times (the time it takes from activating the error in the software to switching: MOSFET 200 µs, relay 5 ms). The disadvantage when using MOSFETs is to do with the leakage currents which occur; these do not occur with relays.

If conventional relays are used for an error type, the delay between setting the error and closing the corresponding relay is measured on a reference relay and then sent to the application. This enables the precise measuring of the time the error actually occurs and also, for example, the duration of the error state.

Resistor Cascade

To simulate, for example, contact corrosion in a line and crosstalk between lines, there is a resistor cascade with which the corresponding resistances (line resistance and finite resistance between lines) can be simulated.

This is a 14-bit cascade with resistors from 2 Ω to 16384 Ω, with which resistances from 2 Ω to approx. 32 kΩ can be displayed in 2 Ω intervals. For more information on the resistor cascade, refer to the section "Resistor Cascade" on page 20.

1.4.2 Connectors, Displays and Fuses

Connectors on the Front Panel and Rear

The ES4440.1 Compact Failure Simulation Module has several connectors on the front and rear for connecting the ECU and loads, addressing the ES4440.1 and for master/slave operation.

The following connectors are on the front panel:

- Connector for synchronization signals when using several ES4440.1s in master/slave operation (""SYNC" Connector" on page 25)
- Connector for CAN bus (""CAN" Connector" on page 26)
- Connector for Ethernet (""Ethernet" Connector" on page 26)
- Connector for measuring currents between the two error rails with the error types "Pin-to-Pin Resistance", "Inline Resistance" and "Leakage Current" (""Current" Connector" on page 27)

The following connectors are on the rear:

- Connector for connecting the error rails when using several ES4440.1s in master/slave operation (""Rail 1/2" Connector" on page 27)
- Connector for the 16 high-voltage ECU signals (""ECU 400V" Connector" on page 28)
- Connector for the load to the channels above (""LOAD 400V" Connector" on page 29)
- Connector for the 64 high-current ECU signals (""ECU CH0-CH42" / "ECU CH43-CH63" Connector" on page 31)
- Connector for the load to the channels above (""LOAD CH0-CH42" / "LOAD CH43-CH63" Connector" on page 34)
- Mains connection with integrated fuse

Status Displays via LEDs on the Front Panel

There are several LEDs on the front panel of the ES4440.1 Compact Failure Simulation Module which provide information on operating states of the ES4440.1 and the communication interfaces. For more details on the LEDs, refer to the section "Status Displays via LEDs on the Front Panel" on page 20.

Fuses

The ES4440.1 Compact Failure Simulation Module is protected against overcurrents with fuses. When a reset[1] takes place, the fuse state is queried and transferred to the control software. The fuse monitor is designed so that there are no disturbing influences on the ECU signals.

For more details on the fuses used and how to change them, refer to the section "Safety Concept" on page 22.

1. When a reset takes place, all relays are set to a state in which no errors are switched any more.

1.4.3 Application Environment

Master/Slave Operation of Several ES4440.1 Systems

If greater demands are made of the number of channels than can be catered for with one ES4440.1 Compact Failure Simulation Module (64 + 16), you can use several ES4440.1s. A dedicated master synchronizes error simulation on the connected slave systems.

This takes place by connecting the error rails and the synchronization lines of the ES4440.1s involved and assigning corresponding IP addresses in the operating software LABCAR-PINCONTROL V2.0.

Communication Interfaces

The ES4440.1 Compact Failure Simulation Module has interfaces for communication via the Ethernet and CAN protocol. The relevant APIs are described in the LABCAR-PINCONTROL V2.0 User's Guide.

When using the LABCAR-PINCONTROL V2.0 software on a host system, communication takes place by Ethernet – otherwise the ES4440.1 can also be controlled using a CANbus.

In addition, it is also possible to realize complex hardware configurations in a HiL system with a real-time PC as simulation target and an ES600 Network Module (see the chapter "Accessories" on page 39).

Note

Using the LABCAR-PINCONTROL V2.0 software requires communication by Ethernet between the host and the ES4440.1.

LABCAR-PINCONTROL V2.0

LABCAR-PINCONTROL V2.0 (Version 2.0 and higher) provides an easy-to-use user interface in which all errors can be activated and reset.

LABCAR-PINCONTROL V2.0 has, in particular, the following features:

- Creating and managing failure sets. A failure set is a group of ECU signals (e.g. all signals of the oxygen sensor)
- Signal lists with all signals of a selected failure set. This is where the signal is selected for which an error is to be simulated.
- Display of all available errors for a selected signal in one window
- Errors are selected in this window by mouse click
- Settings of the desired error duration
- Triggering the error by mouse click
- Configuration of the Ethernet and CAN interface
- Configuration for master/slave operation
- Self-test and fuse test
- Automated control (with the LABCAR-PINCONTROL V2.0 controller)

1.5 Block Diagram

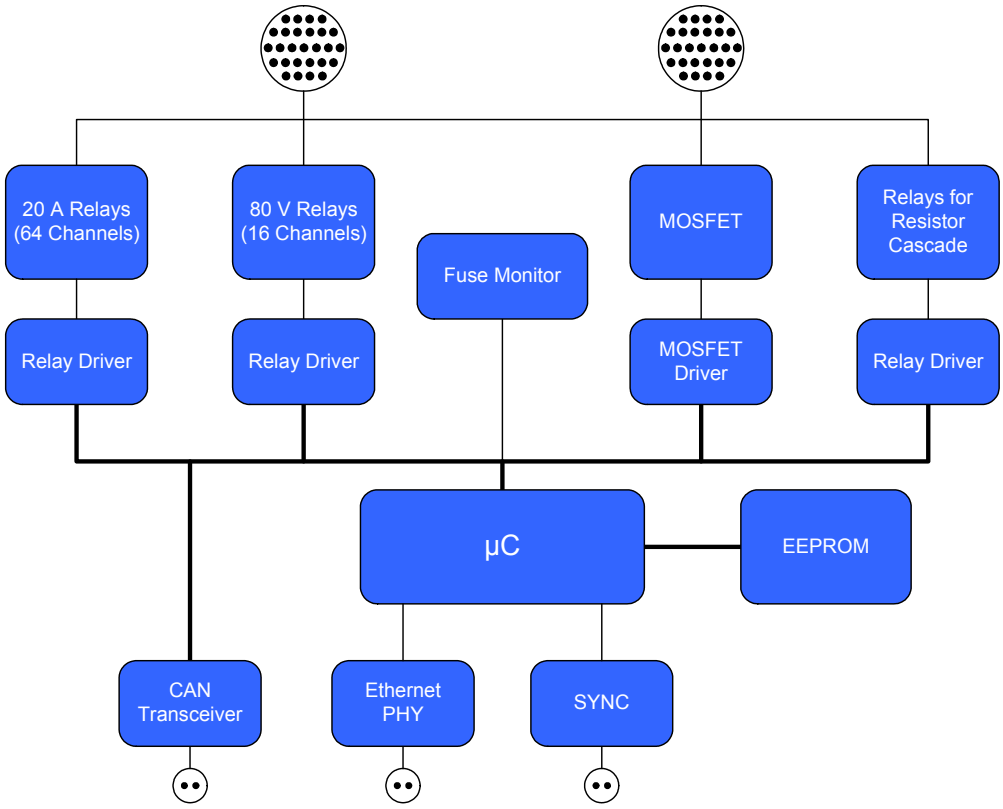


Fig. 1-2 Block Diagram of the ES4440.1 Compact Failure Simulation Module

The core of the ES4440.1 Compact Failure Simulation Module is a micro-controller (µC) with an integrated Ethernet controller – the µC is connected directly to Ethernet-PHY. A CAN transceiver acts as a second interface to control the ES4440.1.

A serial, non-volatile EEPROM saves a range of specific parameters such as MAC address, IP address, CAN baud rate. Three PLDs with subsequent relay drivers address the relays and MOSFETs.

A further feature is the fuse monitoring by the µC.

1.6 General Instructions on Operating the ES4440.1

Please note the following when operating the device:

Connection to the Mains

Connect the device to a protective contact socket using only the power cable provided.

Ventilation

Never cover the ventilation slots of the device! When installing in a 19" rack, forced cooling may have to be carried out.

Cleaning the Device

Only clean the device with a dry cloth. Do not use any detergents or solvents.

Maintenance

The device requires no servicing by the user. If the device is faulty, switch it off, prevent it from being used again and send it to the manufacturer for repair.

2 Hardware Features

This chapter contains detailed information on the features of the ES4440.1 Compact Failure Simulation Module.

These are:

2.1 Error Simulation for 80 Channels

The ES4440.1 Compact Failure Simulation Module has 64 channels which are equipped for a continuous current of 20 A (at 30 V) and 16 channels for a voltage of 80 V RMS at 10 A current rating.

This number of ECU channels is sufficient if only outputs of engine ECUs (gasoline or diesel) have to be tested. If, however, inputs are to be tested simultaneously, two or more ES4440.1s are used in master/slave operation (see section 2.6 on page 21).

The text that follows describes which types of error can be simulated for which channels.

2.2 Error Types

In the following description of all available errors, the errors are shown separately according to the type of channel (high-voltage or high-current channels).

2.2.1 Errors for High-Voltage Channels

The following figure shows

- the errors which can be realized on the 16 high-voltage channels,
- whether these are switched by relay or MOSFET,
- whether several errors can be activated simultaneously,
- the settable duration of the error state and
- whether this error can also be realized in PWM control as a loose contact.

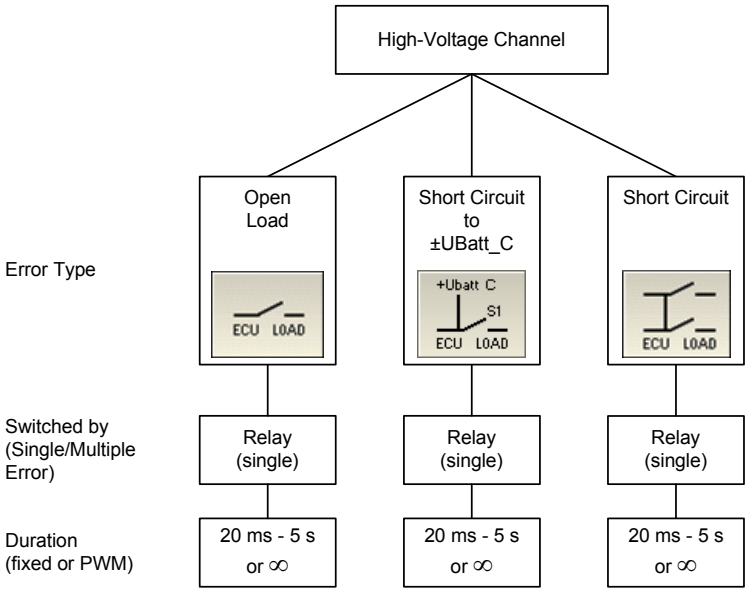


Fig. 2-1 Errors for High-Voltage Channels

2.2.2 Errors for High-Current Channels

The following figure shows

- the errors which can be realized on the 64 high-current channels,
- whether these are switched by relay or MOSFET,
- whether several errors can be activated simultaneously,
- the settable duration of the error state and
- whether this error can also be realized in PWM control as a loose contact.

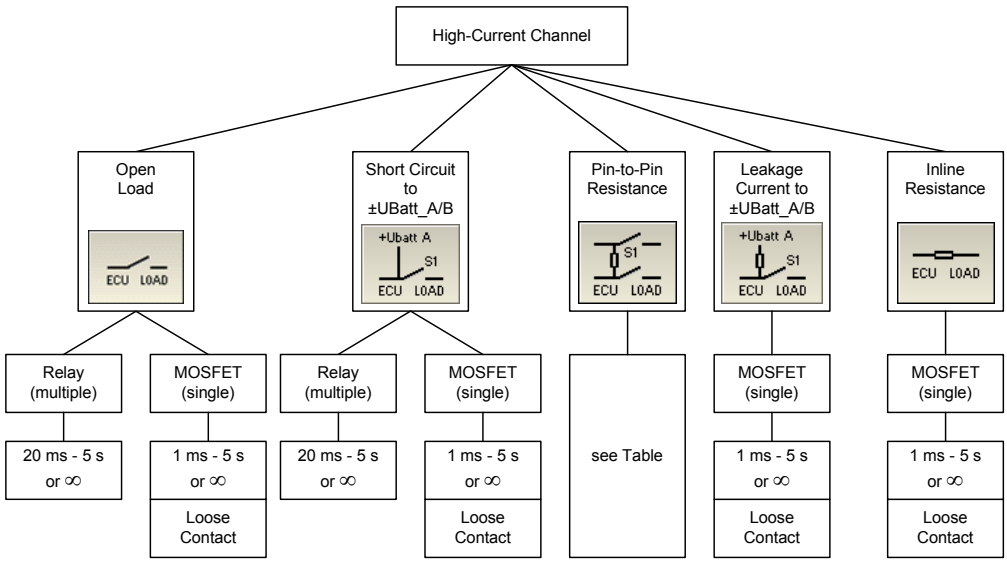


Fig. 2-2 Errors for High-Current Channels

The situation is slightly more complicated for the error type "Pin-to-Pin Resistance" – depending on whether the load is connected and whether there is finite resistance between the pins. Tab. 2-1 shows the underlying conditions for the possible configurations.

Resistance	Load Connected	Switched with	Loose Contact	Fuse
Finite	Yes	MOSFET	Possible	Yes
0 Ω	Yes	MOSFET	Possible	Yes
Finite	No	This configuration is not possible		
0 Ω	No	Relay	Not possible	No

Tab. 2-1 Possible Configurations with Pin-to-Pin Resistance

The first column shows whether there is a finite resistance for the contact between the lines or not; the second whether the load is connected during error simulation or not.

The fourth column tells you whether a loose contact can be simulated or not in each particular case. The last column lists whether the current path has a fuse for each particular case. In a non-protected case, make sure that the maximum permissible current of 20 A is not exceeded, e.g. by a current limitation in the power supply or by protecting the output stages accordingly.

2.2.3 Relay or MOSFET

Using MOSFETs has the advantage of disappearing switching times – minimal leakage currents are usually no problem for most types of error. If, however, they are, you can use relays to generate errors.

Please note, however, that error types which are switched via MOSFETs, can only be realized individually (see Fig. 2-1 on page 16 and Fig. 2-2 on page 17).

Relay Specifications

The relays and the conductors of the ES4440.1 are designed to simulate errors with ECUs – usually, the corresponding output stages are disabled only a few µs after an error has occurred.

Currents of 20 A (high-current channels) are possible in continuous operation – in addition, the current paths are protected with fuses (exception: see row 4 in Tab. 2-1).

2.2.4 Duration of the Error State

The period of time for which an error is active can be of interest for measuring latencies of the diagnostic system. For example, the ES4440.1 can simulate a specific error for 20 ms, but the ECU software requires at least 30 ms to generate an error memory entry.

The required duration of the error state is set in the LABCAR-PINCONTROL V2.0 user interface. The selectable duration is between 20 ms and 5 s for relays and between 1 ms and 5 s for MOSFETs – it can be set in intervals of 20 ms for relays or 1 ms for MOSFETs.

2.2.5 Simulating Loose Contacts

Certain types of error on high-current channels can not only be realized as errors with a defined duration but also as loose contacts. These errors are controlled by a pulse-width modulation with a switching frequency of 3 Hz - 100 Hz and a duty cycle of 1% - 99% (2 Hz with a duty cycle of 50%).

2.2.6 Number of Possible Active Error States

With errors which are switched by relays, a maximum of ten errors can be activated simultaneously (e.g. open loads on ten channels). For the shorts to the battery voltages, it is also possible to simulate other errors at the same time – these cannot, however, be selected freely. If you are using LABCAR-PINCONTROL V2.0 for error simulation, errors which cannot be selected are excluded from the selection in the user interface.

If, however, you address the ES4440.1 automatically by Ethernet or CAN, you should ensure that the selected types of error are also possible simultaneously as otherwise an error message will be issued. Take a look at Fig. 2-3 to see which errors can be activated at the same time.

Errors which are switched by MOSFETS can only be activated individually.

Open Load	-	●	●	●	●
Short Circuit to +UBatt_A (Rail 1)	Load connected	●			
	Load disconnected	●			
Short Circuit to +UBatt_B (Rail 2)	Load connected		●		
	Load disconnected		●		
Short Circuit to -UBatt_A (Rail 1)	Load connected			●	
	Load disconnected			●	
Short Circuit to -UBatt_B (Rail 2)	Load connected				●
	Load disconnected				●

Fig. 2-3 Errors Which Can Be Simulated Simultaneously

2.2.7 Decoupling the Load before Error Activation

Normally the ES4440.1 is switched between the ECU and the LABCAR or between the ECU and the real vehicle. The following takes place to ensure that no channels of the LABCAR or components of the real vehicle are destroyed by shorts: if an error is switched *without a load*, the connection to the load is interrupted *before* the error is activated.

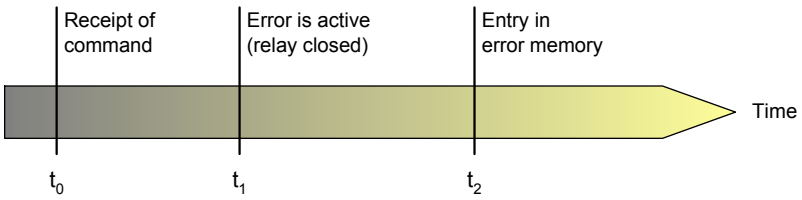
2.2.8 Measuring the Current

When errors are simulated in which both error rails are used (line resistance, short or resistance between two lines or leakage current), the current flowing via the rails can be measured. For this purpose, a current measuring device is connected to the "Current" connector on the front panel and measuring is activated with the command `CurrentMeasurement()` (see "LABCAR-PINCONTROL V2.0 – User's Guide").

2.3 Time Response

If you are using mechanical relays and have to determine how long an error has to be active ($(t_2 - t_1)$ in the figure) until an entry is made in the error memory, the finite activation time of the mechanical relays has to be taken into consideration.

In the following figure, this is the time ($t_1 - t_0$), i.e. the time between the receipt of the command and the actual closing of the relay.



Once the error is set, measuring this activation time is executed on a reference relay and transferred to the host in the command response.

For errors which are switched by MOSFETs, this kind of measuring is not necessary due to fast activation.

2.4 Resistor Cascade

To simulate contact corrosion and crosstalk between ECU channels, the ES4440.1 Compact Failure Simulation Module has a cascade of 14 resistors with which resistances of 2 Ω to approx. 32 kΩ can be generated (in 2 Ω intervals).

The individual resistors are activated (relay open) or bridged by 20 A relays. The cascade consists of the following resistance values: 2, 4, 6, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192 and 16384 Ω.

The maximum permissible current depends on the voltage drop over the cascade – it is 3 A with a voltage drop of 14 V and 1 A with a voltage drop of 30 V. As an error state is normally only ever active for a very short time, it is not a problem if these values are exceeded briefly.

If, however, overheating does occur, temperature sensors cause an error message to be issued, the occurrence of which results in a system reset (see "Resetting on Excess Temperature" on page 22).

2.5 Status Displays via LEDs on the Front Panel

There are several LEDs on the front panel of the ES4440.1 Compact Failure Simulation Module, the meaning of which is described in this section.

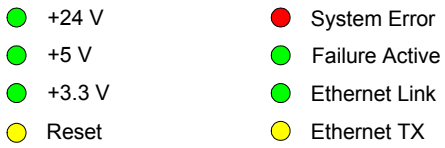


Fig. 2-4 LEDs on the Front Panel

Name	Color	Meaning
+24 V	Green	+24 V OK
+5 V	Green	+5 V OK
+3.3 V	Green	+3.3 V OK
Reset	Yellow	A reset takes place
System Error	Red	ES4440 system error
Failure Active	Green	An error state is active
Ethernet Link	Green	Ethernet connection to host available
Ethernet TX	Yellow	Transmit (data transfer is currently taking place)

Tab. 2-2 The Meaning of the LEDs on the Front Panel

2.6 Master/Slave Operation of Several ES4440.1 Systems

An ES4440.1 Compact Failure Simulation Module has 80 channels – this number is sufficient if, for example, errors are to be simulated for the outputs of an engine ECU.

If, however, inputs and outputs of an ECU are to be tested simultaneously, a second ES4440.1 Compact Failure Simulation Module is required.

In extreme cases, up to 15 slave systems can be connected to a master system. For this purpose, the following lines/signals of the master must be connected to the slave systems:

- The synchronization signals of the multiplexer relays ("SYNC" connector on the front panel, see Fig. 2-5 on the left)

  For details of the pin assignment of this connector, refer to section ""SYNC" Connector" on page 25.

- The lines of the error rails ("Rail 1/2" connector on the rear of the device (Fig. 2-5 on the right)

  For details of the pin assignment of this connector, refer to section ""Rail 1/2" Connector" on page 27.

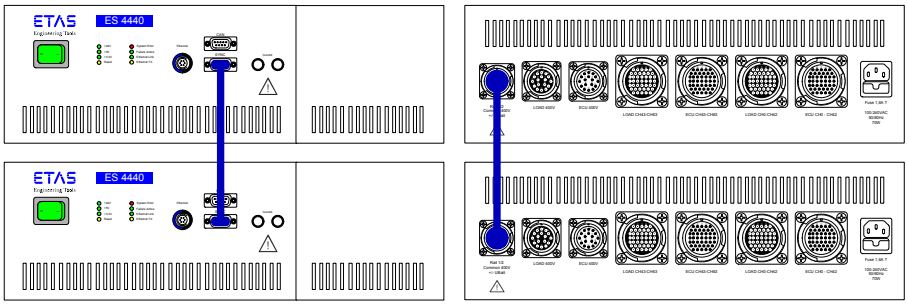


Fig. 2-5 Connecting the "SYNC" Lines and the Error Rails

Multiple errors in an ES4440.1 are always switched simultaneously – in addition, the synchronization of all systems used in master/slave operation also ensures the simultaneous switching of the errors on all systems.

2.6.1 IP Addresses and CAN Identifiers

If you are operating one or more ES4440.1 Compact Failure Simulation Modules with the operating software LABCAR-PINCONTROL V2.0 provided, you can assign (freely selectable) IP addresses for the individual modules there and assign CAN identifiers for read and write operations.

In addition, 120 Ω terminating resistors for CAN can be activated via LABCAR-PINCONTROL V2.0 in individual systems via relays.

2.7 Safety Concept

The ES4440.1 Compact Failure Simulation Module has protective mechanisms against excess temperature and overcurrents.

2.7.1 Resetting on Excess Temperature

When in operation, the temperature of the ES4440.1 Compact Failure Simulation Module is monitored at various points in the housing. If an excess temperature is detected at any one of these points, a reset is executed which is indicated via the yellow "Reset" LED on the front panel (see Fig. 2-4 on page 20).

All relays are reset during a reset, i.e. all errors set are canceled. Set errors are not executed and acknowledged with an error message as long as the excess temperature condition applies.

2.7.2 Protecting the Rails/Relays

To protect the relays and the entire circuit, the ES4440.1 Compact Failure Simulation Module has five fuses. These are standard blade fuses used commonly in the automotive environment.

Fuse*	Function	Specification
E1	Protects rail 2 against ±UBatt_B	20 A/32 V
E2	Protects the resistor cascade	3 A/32 V
E3	Protects rail 1 against ±UBatt_A	20 A/32 V
E4	Protects rail 1 against rail 2	20 A/32 V
E5	Protects the 80 V rail	10 A/80 V

* For details on the position of the fuses, please refer to the figure in the section "To change fuses" on page 24.

The 80 V channels are intended for injector or ignition signals. These signals are pulsed direct voltages with a pulse width of just a few milliseconds and with voltage peaks of up to 250 V. As the root mean square values of the voltages are under 80 V, a 10 A/80 V fuse can be used.

2.7.3 Automatic Monitoring of the Fuses

The state of the fuses can be monitored by an automatic application on the host system. The information is transferred via Ethernet or CAN (command: `test fuses()`)

This kind of automated monitoring takes place as follows:

1. Checking the state of the fuses
2. Applying an error
3. Resetting the error
4. Checking the state of the fuses

This procedure ensures that the fuses are intact during error simulation.

To ensure that checking the fuses does not have any effect on the signals between the ECU and the load, the test circuit is only activated when the ES4440.1 is in reset mode.

2.7.4 Changing Fuses

DANGER!

Dangerously high voltages can be pending at individual pins of the "ECU 400V" and "LOAD 400V" connectors. Only open the housing once you have disconnected the device from the mains and disconnected all other connections.

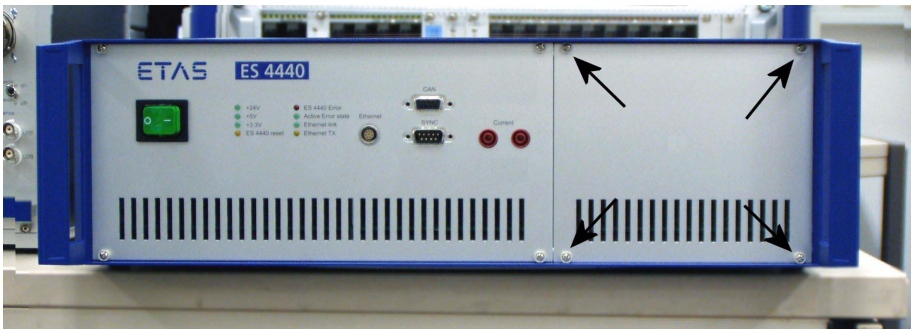
If you discover that one of the fuses is defective, proceed as follows:

Before opening the housing

- Switch off the device.
- Remove all connected lines.

To remove the right-hand front panel

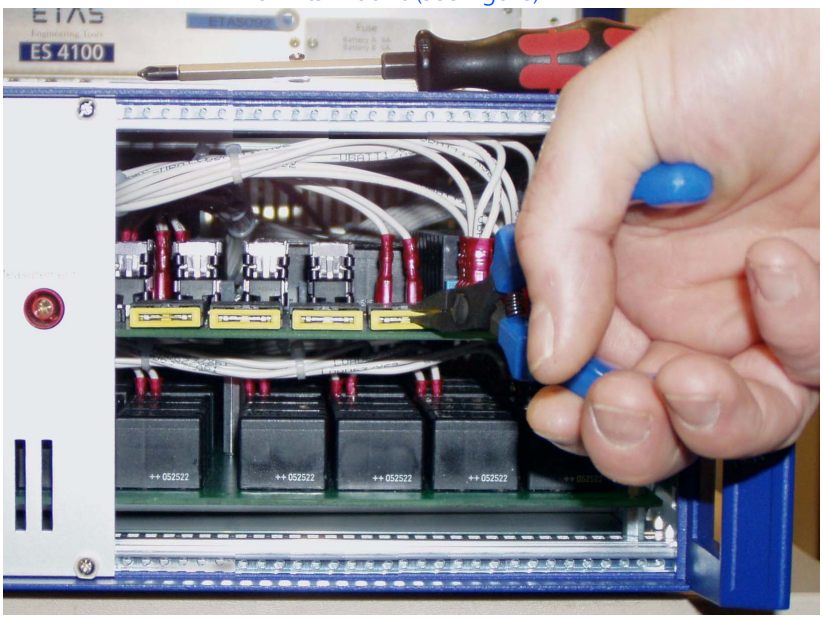
- Remove the four screws shown in the figure from the right-hand front panel with a Phillips screwdriver.
- Remove the front panel cover.



The five fuses of the error rails can now be easily accessed (see the following figure).

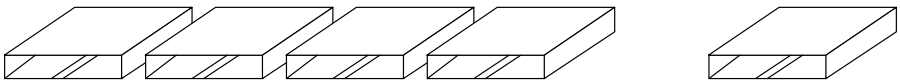
To change fuses

- Use flat-nose pliers to remove the defective fuse from its mount (see figure).



- Slide the new fuse into the holder.

  The mounting position of the fuse holders is shown in the following figure.



To replace the right-hand front panel

- Place the front panel cover in the position intended.
- Now tighten the screws you removed before.

3 Pin Assignment

This chapter contains the description of the pin assignment of the connectors of the ES4440.1 Compact Failure Simulation Module.

These are:

3.1 ”SYNC” Connector

The synchronization signals for the master/slave operation of several ES4440.1 Compact Failure Simulation Modules are pending at the ”SYNC” connector.

Type: DSub 9-pin (male)

Counterpart: DSub 9-pin (female)

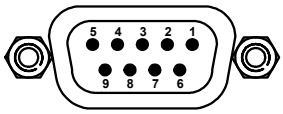


Fig. 3-1 ”SYNC” Pin Assignments (View from Front of Housing)

Pin	Assignment	Pin	Assignment
1	Reserved	6	n.c.
2	n.c.	7	n.c.
3	n.c.	8	Sync
4	n.c.	9	n.c.
5	GND	Housing	PE

Tab. 3-1 ”SYNC” Pin Assignment

3.2 "CAN" Connector

The signals for communication via the CANbus are pending at the "CAN" connector.

Type: DSub 9-pin (female)

Counterpart: DSub 9-pin (male)

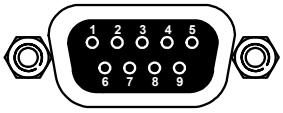


Fig. 3-2 "CAN" Pin Assignments (View from Front of Housing)

Pin	Assignment	Pin	Assignment
1	n.c.	6	GND
2	CAN Low	7	CAN High
3	GND	8	n.c.
4	n.c.	9	n.c.
5	n.c.	Housing	PE

Tab. 3-2 "CAN" Pin Assignment

3.3 "Ethernet" Connector

The "Ethernet" connector is used for the Ethernet connection to the host system or an Ethernet switch.

Type: Lemo EPD.1B.308.YLN

Counterpart: Lemo FGG.1B.308.CLAD62Z

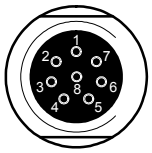


Fig. 3-3 "Ethernet" Pin Assignments (View from Front of Housing)

Pin	Assignment	Pin	Assignment
1	n.c.	5	TX-
2	n.c.	6	RX-
3	n.c.	7	n.c.
4	RX+	8	TX+

Tab. 3-3 "Ethernet" Pin Assignment

3.4 "Current" Connector

The current between the two error rails can be measured at the "Current" connector. The direction of the current is unimportant which is why the two jacks are not defined more precisely.

Type: Banana jacks

3.5 "Rail 1/2" Connector

The "Rail 1/2" connector is used to connect the two error rails of a master to those of the connected slave systems.

Type: ITT Cannon CA02COM-E18-1S-B-01 (female)

Counterpart: ITT Cannon CA06COM-E18-1P-B-01 (male)

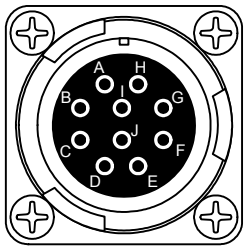


Fig. 3-4 "Rail 1/2" Pin Assignments

Pin	Assignment	Pin	Assignment
A	Rail 1	F	-UBatt_B
B	Rail 2	G	internal use
C	+UBatt_A	H	+UBatt_C
D	-UBatt_A	I	-UBatt_C
E	+UBatt_B	J	n.c.

Tab. 3-4 "Rail 1/2" Pin Assignment

3.6 "ECU 400V" Connector

DANGER!

Dangerously high voltages can be pending at individual pins of the "ECU 400V" and "LOAD 400V" connectors. Only open the housing once you have disconnected the device from the mains and disconnected all other connections.

The 16 high-voltage channels of the ECU are connected via these two connectors.

Type: ITT Cannon CA02COM-E20-29P-B (male)

Counterpart: ITT Cannon CA06COM-E20-29S-B (female)

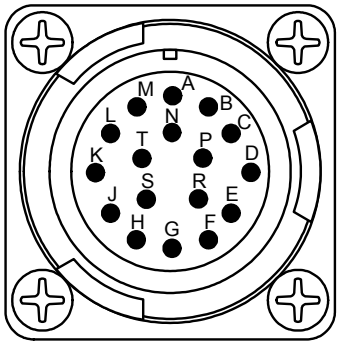


Fig. 3-5 "ECU 400V" Pin Assignments

Note

The lines of the signals "ECU0" and "ECU1" ... "ECU14" and "ECU15" are all "twisted pairs"!

Pin	Signal	Internally Connected to Connector "LOAD 400V" - Pin:
A	ECU0	LOAD0
B	ECU1	LOAD1
C	ECU2	LOAD2
D	ECU3	LOAD3
E	ECU4	LOAD4
F	ECU5	LOAD5
G	ECU6	LOAD6
H	ECU7	LOAD7
J	ECU8	LOAD8
K	ECU9	LOAD9
L	ECU10	LOAD10
M	ECU11	LOAD11
N	ECU12	LOAD12

Tab. 3-5 "ECU 400V" Pin Assignment

Pin	Signal	Internally Connected to Connector "LOAD 400V" - Pin:
P	ECU13	LOAD13
R	ECU14	LOAD14
S	ECU15	LOAD15
T	*	*
* The pins T of „ECU 400V“ and „LOAD 400V“ are directly connected with each other		

Tab. 3-5 "ECU 400V" Pin Assignment (Forts.)

3.7 "LOAD 400V" Connector

DANGER!

Dangerously high voltages can be pending at individual pins of the "ECU 400V" and "LOAD 400V" connectors. Only open the housing once you have disconnected the device from the mains and disconnected all other connections.

The 16 high-voltage channels of the ECU are connected to the loads via these two connectors.

Type: ITT Cannon CA02COM-E20-29S-B (female)

Counterpart: ITT Cannon CA06COM-E20-29P-B (male)

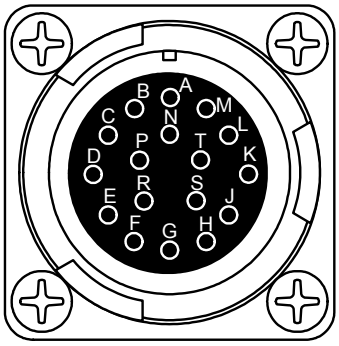


Fig. 3-6 "LOAD 400V" Pin Assignments

Note

The lines of the signals "LOAD0" and "LOAD1" ... "LOAD14" and "LOAD15" are all "twisted pairs" within the ES4440.1!

Pin	Signal	Internally Connected to Connector "ECU 400V" - Pin:
A	LOAD0	ECU0
B	LOAD1	ECU1
C	LOAD2	ECU2

Tab. 3-6 "LOAD 400V" Pin Assignment

Pin	Signal	Internally Connected to Connector "ECU 400V" - Pin:
D	LOAD3	ECU3
E	LOAD4	ECU4
F	LOAD5	ECU5
G	LOAD6	ECU6
H	LOAD7	ECU7
J	LOAD8	ECU8
K	LOAD9	ECU9
L	LOAD10	ECU10
M	LOAD11	ECU11
N	LOAD12	ECU12
P	LOAD13	ECU13
R	LOAD14	ECU14
S	LOAD15	ECU15
T	*	*
* The pins T of „LOAD 400V" and „ECU 400V" are directly connected with each other		

Tab. 3-6 "LOAD 400V" Pin Assignment (Forts.)

3.8 "ECU CH0-CH42" / "ECU CH43-CH63" Connector

The 64 high-current channels of the ECU are connected via these two connectors.

Type: ITT Cannon CA02COM-E28A51P-B-01 (male)

Counterpart: ITT Cannon CA06COM-E28A51S-B-01 (female)

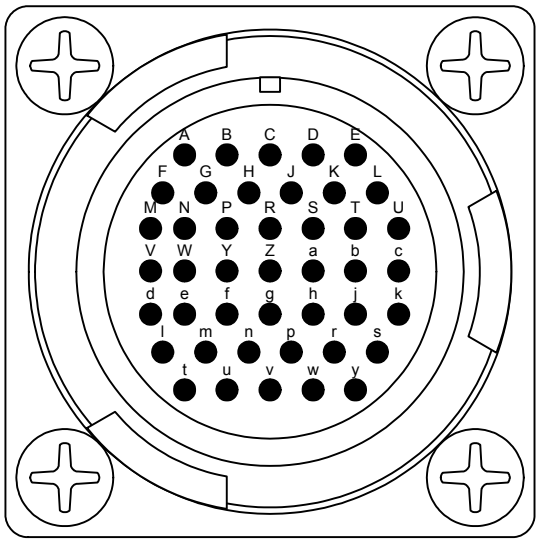


Fig. 3-7 "ECU CH0-CH42" and "ECU CH43-CH63" Pin Assignments

Pin	Signal	Internally Connected to Connector "LOAD CH0-CH42" - Pin:
A	ECU0	LOAD0
B	ECU1	LOAD1
C	ECU2	LOAD2
D	ECU3	LOAD3
E	ECU4	LOAD4
F	ECU5	LOAD5
G	ECU6	LOAD6
H	ECU7	LOAD7
J	ECU8	LOAD8
K	ECU9	LOAD9
L	ECU10	LOAD10
M	ECU11	LOAD11
N	ECU12	LOAD12
P	ECU13	LOAD13
R	ECU14	LOAD14
S	ECU15	LOAD15
T	ECU16	LOAD16

Tab. 3-7 "ECU CH0-CH42" Pin Assignment

Pin	Signal	Internally Connected to Connector "LOAD CH0-CH42" - Pin:
U	ECU17	LOAD17
V	ECU18	LOAD18
W	ECU19	LOAD19
Y	ECU20	LOAD20
Z	ECU21	LOAD21
a	ECU22	LOAD22
b	ECU23	LOAD23
c	ECU24	LOAD24
d	ECU25	LOAD25
e	ECU26	LOAD26
f	ECU27	LOAD27
g	ECU28	LOAD28
h	ECU29	LOAD29
j	ECU30	LOAD30
k	ECU31	LOAD31
l	ECU32	LOAD32
m	ECU33	LOAD33
n	ECU34	LOAD34
p	ECU35	LOAD35
r	ECU36	LOAD36
s	ECU37	LOAD37
t	ECU38	LOAD38
u	ECU39	LOAD39
v	ECU40	LOAD40
w	ECU41	LOAD41
y	ECU42	LOAD42

Tab. 3-7 "ECU CH0-CH42" Pin Assignment (Forts.)

Pin	Signal	Internally Connected to Connector "LOAD CH43-CH63" - Pin:
A	ECU43	LOAD43
B	ECU44	LOAD44
C	ECU45	LOAD45
D	ECU46	LOAD46
E	ECU47	LOAD47
F	ECU48	LOAD48

Tab. 3-8 "ECU CH43-CH63" Pin Assignment

Pin	Signal	Internally Connected to Connector "LOAD CH43-CH63" - Pin:
G	ECU49	LOAD49
H	ECU50	LOAD50
J	ECU51	LOAD51
K	ECU52	LOAD52
L	ECU53	LOAD53
M	ECU54	LOAD54
N	ECU55	LOAD55
P	ECU56	LOAD56
R	ECU57	LOAD57
S	ECU58	LOAD58
T	ECU59	LOAD59
U	ECU60 *	LOAD60
V	ECU61 *	LOAD61
W	ECU62 *	LOAD62
Y	ECU63 *	LOAD63
Z	Shield 1 (shielding for ECU60/ECU61) *	Shield 1
a	Shield 2 (shielding for ECU62/ECU63) *	Shield 2
b	n.c.	n.c.
c	n.c.	n.c.
d	n.c.	n.c.
e	n.c.	n.c.
f	n.c.	n.c.
g	n.c.	n.c.
h	n.c.	n.c.
j	n.c.	n.c.
k	n.c.	n.c.
l	n.c.	n.c.
m	n.c.	n.c.
n	n.c.	n.c.
p	n.c.	n.c.
r	n.c.	n.c.
s	n.c.	n.c.
t	n.c.	n.c.

Tab. 3-8 "ECU CH43-CH63" Pin Assignment (Forts.)

Pin	Signal	Internally Connected to Connector "LOAD CH43-CH63" - Pin:
u	n.c.	n.c.
v	n.c.	n.c.
w	n.c.	n.c.
y	n.c.	n.c.
* The lines of the signals "ECU60", "ECU61" (pins U,V) and "ECU62", "ECU63" (pins W,Y) are routed to "LOAD CH43-CH63" as "twisted pairs". Together with the two "Shield" lines (pins Z and a), these are thus suitable to be used as CAN lines, but can also be used as normal channels.		

Tab. 3-8 "ECU CH43-CH63" Pin Assignment (Forts.)

3.9 "LOAD CH0-CH42" / "LOAD CH43-CH63" Connector

The 64 high-current channels of the ECU are connected to the loads via these two connectors.

Type: ITT Cannon CA02COM-E28A51S-B-01 (female)

Counterpart: ITT Cannon CA06COM-E28A51P-B-01 (male)

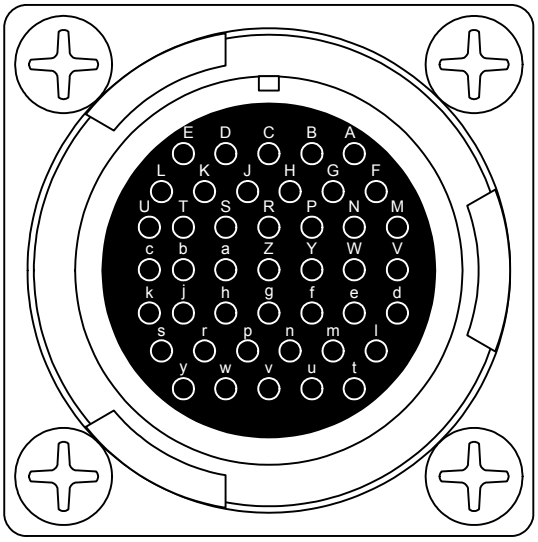


Fig. 3-8 "LOAD CH0-CH42" and "LOAD CH43-CH63" Pin Assignments

Pin	Signal	Internally Connected to Connector "ECU CH0-CH42" - Pin:
A	LOAD0	ECU0
B	LOAD1	ECU1
C	LOAD2	ECU2
D	LOAD3	ECU3
E	LOAD4	ECU4
F	LOAD5	ECU5

Tab. 3-9 "LOAD CH0-CH42" Pin Assignment

Pin	Signal	Internally Connected to Connector "ECU CH0-CH42" - Pin:
G	LOAD6	ECU6
H	LOAD7	ECU7
J	LOAD8	ECU8
K	LOAD9	ECU9
L	LOAD10	ECU10
M	LOAD11	ECU11
N	LOAD12	ECU12
P	LOAD13	ECU13
R	LOAD14	ECU14
S	LOAD15	ECU15
T	LOAD16	ECU16
U	LOAD17	ECU17
V	LOAD18	ECU18
W	LOAD19	ECU19
Y	LOAD20	ECU20
Z	LOAD21	ECU21
a	LOAD22	ECU22
b	LOAD23	ECU23
c	LOAD24	ECU24
d	LOAD25	ECU25
e	LOAD26	ECU26
f	LOAD27	ECU27
g	LOAD28	ECU28
h	LOAD29	ECU29
j	LOAD30	ECU30
k	LOAD31	ECU31
l	LOAD32	ECU32
m	LOAD33	ECU33
n	LOAD34	ECU34
p	LOAD35	ECU35
r	LOAD36	ECU36
s	LOAD37	ECU37
t	LOAD38	ECU38
u	LOAD39	ECU39

Tab. 3-9 "LOAD CH0-CH42" Pin Assignment (Forts.)

Pin	Signal	Internally Connected to Connector "ECU CH0-CH42" - Pin:
v	LOAD40	ECU40
w	LOAD41	ECU41
y	LOAD42	ECU42

Tab. 3-9 "LOAD CH0-CH42" Pin Assignment (Forts.)

Pin	Signal	Internally Connected to Connector "ECU CH43-CH63" - Pin:
A	LOAD43	ECU43
B	LOAD44	ECU44
C	LOAD45	ECU45
D	LOAD46	ECU46
E	LOAD47	ECU47
F	LOAD48	ECU48
G	LOAD49	ECU49
H	LOAD50	ECU50
J	LOAD51	ECU51
K	LOAD52	ECU52
L	LOAD53	ECU53
M	LOAD54	ECU54
N	LOAD55	ECU55
P	LOAD56	ECU56
R	LOAD57	ECU57
S	LOAD58	ECU58
T	LOAD59	ECU59
U	LOAD60 *	ECU60
V	LOAD61 *	ECU61
W	LOAD62 *	ECU62
Y	LOAD63 *	ECU63
Z	Shield 1 (shielding for LOAD60/LOAD61) *	Shield 1
a	Shield 2 (shielding for LOAD62/LOAD63) *	Shield 2
b	n.c.	n.c.
c	n.c.	n.c.
d	n.c.	n.c.

Tab. 3-10 "LOAD CH43-CH63" Pin Assignment

Pin	Signal	Internally Connected to Connector "ECU CH43-CH63" - Pin:
e	n.c.	n.c.
f	n.c.	n.c.
g	n.c.	n.c.
h	n.c.	n.c.
j	n.c.	n.c.
k	n.c.	n.c.
l	n.c.	n.c.
m	n.c.	n.c.
n	n.c.	n.c.
p	n.c.	n.c.
r	n.c.	n.c.
s	n.c.	n.c.
t	n.c.	n.c.
u	n.c.	n.c.
v	n.c.	n.c.
w	n.c.	n.c.
y	n.c.	n.c.
* The lines of the signals "LOAD60", "LOAD61" (pins U,V) and "LOAD62", "LOAD63" (pins W,Y) are routed to "ECU CH43-CH63" as "twisted pairs". Together with the two "Shield" lines (pins Z and a), these are thus suitable to be used as CAN lines, but can also be used as normal channels.		

Tab. 3-10 "LOAD CH43-CH63" Pin Assignment (Forts.)

4 Accessories

This chapter contains information on important accessories for the ES4440.1 Compact Failure Simulation Module.

4.1 ES600 Network Module

The ES600 Network Module is used as an Ethernet switch for connecting the simulation target and possibly several ES4440.1s to an Ethernet board of the user PC.

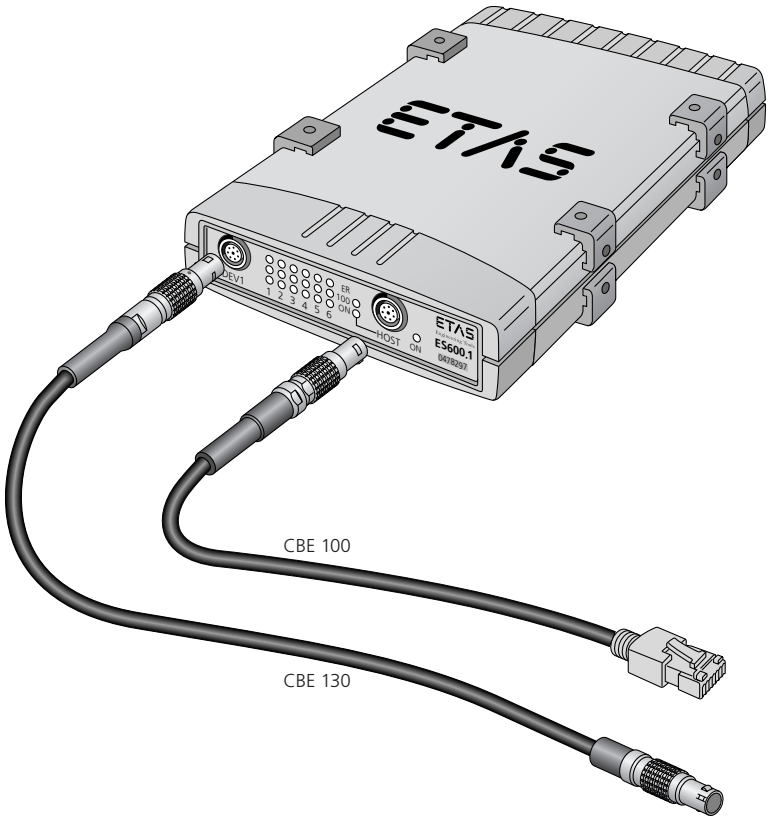


Fig. 4-1 ES600 Network Module

The following is an overview of the most important features of the ES600 Network Module:

- Ethernet switch with 10/100 MBit/s data rate
- Six Ethernet ports (1 x front, 5 x rear)
- One host port
- Cascadable to eight levels
- Status display for every port
- Stable and functional metal housing

Ordering Information

Order Name	Short Name	Order Number
ES600 Module, Cable CBP120-2, 4 T-Brackets for ES600 Housing, User's Guide (German and English)	ES600	F 00K 102 712

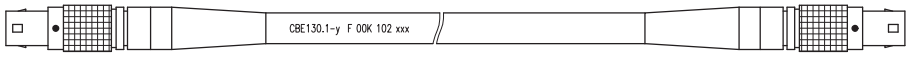
4.2 Cables

Note

Only ETAS cables can be used at the ES600 interfaces. The maximum permissible cable lengths must be adhered to.

4.2.1 Ethernet Cable (Straight, Lemo Connector – Lemo Connector)

This cable is used to connect an ES4440.1 to the ES600 Network Module.



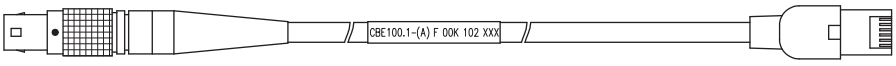
Side A Side B

Fig. 4-2 CBE130-x Cable

Connectors	Length	Short Name	Order Number
Lemo connector – Lemo connector	0.45 m	CBE130-0m45	F-00K-102-748
	1 m	CBE130-1	F-00K-102-588
	3 m	CBE130-3	F-00K-102-587
	8 m	CBE130-8	F-00K-102-586

4.2.2 Ethernet Cable (RJ-45 Connector – Lemo Connector)

This cable is used to connect an ES600 Network Module to the host.



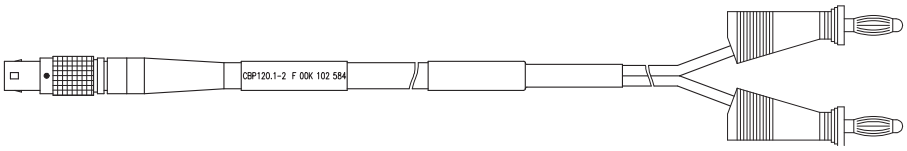
Side A Side B

Fig. 4-3 CBE100-x Cable

Connectors	Length	Short Name	Order Number
RJ-45 connector – Lemo connector	3 m	CBE100-3	F-00K-102-559
	8 m	CBE100-8	F-00K-102-571
	20 m	CBE100-20	F-00K-102-570

4.2.3 Power Cable

This cable is required for the power supply of an ES600 Network Module.



Side A Side B

Fig. 4-4 CBE120-2 Cable

Connectors	Length	Short Name	Order Number
Banana connector – Lemo connector	2 m	CBP120-2	F-00K-102-584

5 Technical Data

This chapter contains the technical data of the ES4440.1 Compact Failure Simulation Module.

High-Current Channels

Number	64
Maximum permissible voltage	30 V
Maximum permissible current	20 A
Total resistance between in- and outputs (after "clean-up" of the relays)	25 mΩ

High-Voltage Channels

Number	16
Maximum permissible voltage	80 V RMS
Maximum permissible current	10 A
Total resistance between in- and outputs (after "clean-up" of the relays)	25 mΩ

Resistor Cascade

Number of resistors	14
Smallest resistance	2 Ω
Largest resistance	16384 Ω
Accuracy	0.5 Ω ±3%
Max. total resistance	Approx. 32 kΩ
Maximum permissible current through the cascade	3 A with 14 V voltage drop 1 A with 30 V voltage drop

Relays

	High-Current Channels	**High-Voltage Channels**
Number	205	20
Maximum permissible voltage	30 VDC	80 V RMS, max. 250V pulse voltage
Maximum permissible current	30 A	16 A
Contact resistance	Approx. 1.5 mΩ	Approx. 3 mΩ

MOSFETs

Max. permissible voltage	30 VDC
Max. permissible current	70 A
Resistance	Approx. 14 mΩ

Time Response

	Relay	**MOSFET**
Duration from receipt of switch command at the ES4440.1 to conclusion of the switch procedure	5 ms	200 µs
Error duration	20 ms - 5 s or ∞	1 ms - 5 s or ∞
Accuracy of error duration	±10 ms	±10 ms

Simulation of Loose Contacts

Duty cycle	1% - 99% at 3 Hz to 100 Hz 50% at 2 Hz
Accuracy of duty cycle	±0,1%

Communication Interfaces

Ethernet	10 MBaud
CAN	High Speed CAN (CAN2.0B) to 1 MBaud Transceiver: MCP2515

Fuses

E1, E2, E3*	20 A, 32 V in acc. with ISO 8820-3 (e.g. Pudenz, FKS series)
E4*	3 A, 32 V in acc. with ISO 8820-3 (e.g. Pudenz, FKS series)
E5*	10 A, 80 V in acc. with ISO 8820-3 (e.g. Pudenz, FKS series)
24 V supply	3.15 A delay-action, glass fuse 5x20
Mains circuit breaker	2 A delay-action, glass fuse 5x20 (IEC60127-2/3)
* For information on the position of the fuses see "To change fuses" on page 24	

The hardware revisions 1.10 and 1.11 have different fuse specifications from those described above. The table below contains the correct specification for these revisions:

E1, E3, E4	20 A, 32 V in acc. with ISO 8820-3 (e.g. Pudenz, FKS series)
E2	3 A, 32 V in acc. with ISO 8820-3 (e.g. Pudenz, FKS series)
E5	10 A, 80 V in acc. with ISO 8820-3 (e.g. Pudenz, FKS series)

Note

The HW revision number is on the back of the ES4440.1.

Electrical Data

Input voltage (mains frequency)	100 - 240 VAC (50 Hz - 60 Hz)
Power input	70 W

Mechanical Data

Height of the front panel	3 U
Width of the front panel	19”
Depth (incl. connectors)	455 mm

Environmental Conditions

Operating temperature	5 °C to 35 °C (41 °F to 95 °F)
Relative humidity	0 to 95% (non-condensing)

6 ETAS Contact Addresses

ETAS HQ

ETAS GmbH

Borsigstraße 14 Phone: +49 711 89661-0

70469 Stuttgart Fax: +49 711 89661-106

Germany WWW: www.etas.com

ETAS Subsidiaries and Technical Support

For details of your local sales office as well as your local technical support team and product hotlines, take a look at the ETAS website:

ETAS subsidiaries	WWW:	www.etas.com/en/contact.php
ETAS technical support	WWW:	www.etas.com/en/hotlines.php

Index